US00RE44042E

(19) United States
(12) Reissued Patent
Yun et al.

(10) Patent Number: US RE44,042 E
(45) Date of Reissued Patent: Mar. 5, 2013

(54) **SYSTEM AND METHOD FOR OPTICAL COHERENCE IMAGING**

(75) Inventors: **Seok-Hyun Yun**, Cambridge, MA (US); **Brett Eugene Bouma**, Quincy, MA (US); **Guillermo J. Tearney**, Cambridge, MA (US); **Johannes F. De Boer**, Amstelveen (NL)

(73) Assignee: **The General Hospital Corporation**, Boston, MA (US)

(21) Appl. No.: **12/277,178**

(22) Filed: **Nov. 24, 2008**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **7,365,859**
Issued: **Apr. 29, 2008**
Appl. No.: **11/225,840**
Filed: **Sep. 12, 2005**

U.S. Applications:
(60) Provisional application No. 60/608,800, filed on Sep. 10, 2004.

(51) **Int. Cl.**
G01B 11/02 (2006.01)
(52) **U.S. Cl.** **356/497**; 356/479
(58) **Field of Classification Search** 356/450–521; 600/476–480
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,339,754	A	1/1944	Brace
3,090,753	A	5/1963	Matuszak et al.
3,872,407	A	3/1975	Hughes
4,030,831	A	6/1977	Gowrinathan
4,140,364	A	2/1979	Yamashita et al.
4,224,929	A	9/1980	Furihata
4,295,738	A	10/1981	Meltz et al.
4,300,816	A	11/1981	Snitzer et al.
4,585,349	A	4/1986	Gross et al.
4,601,036	A	7/1986	Faxvog et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN	1550203	12/2004
DE	4309056	9/1994

(Continued)

OTHER PUBLICATIONS

International Search Report and Written Opinion mailed Jun. 9, 2006 for PCT/US2005/032422.

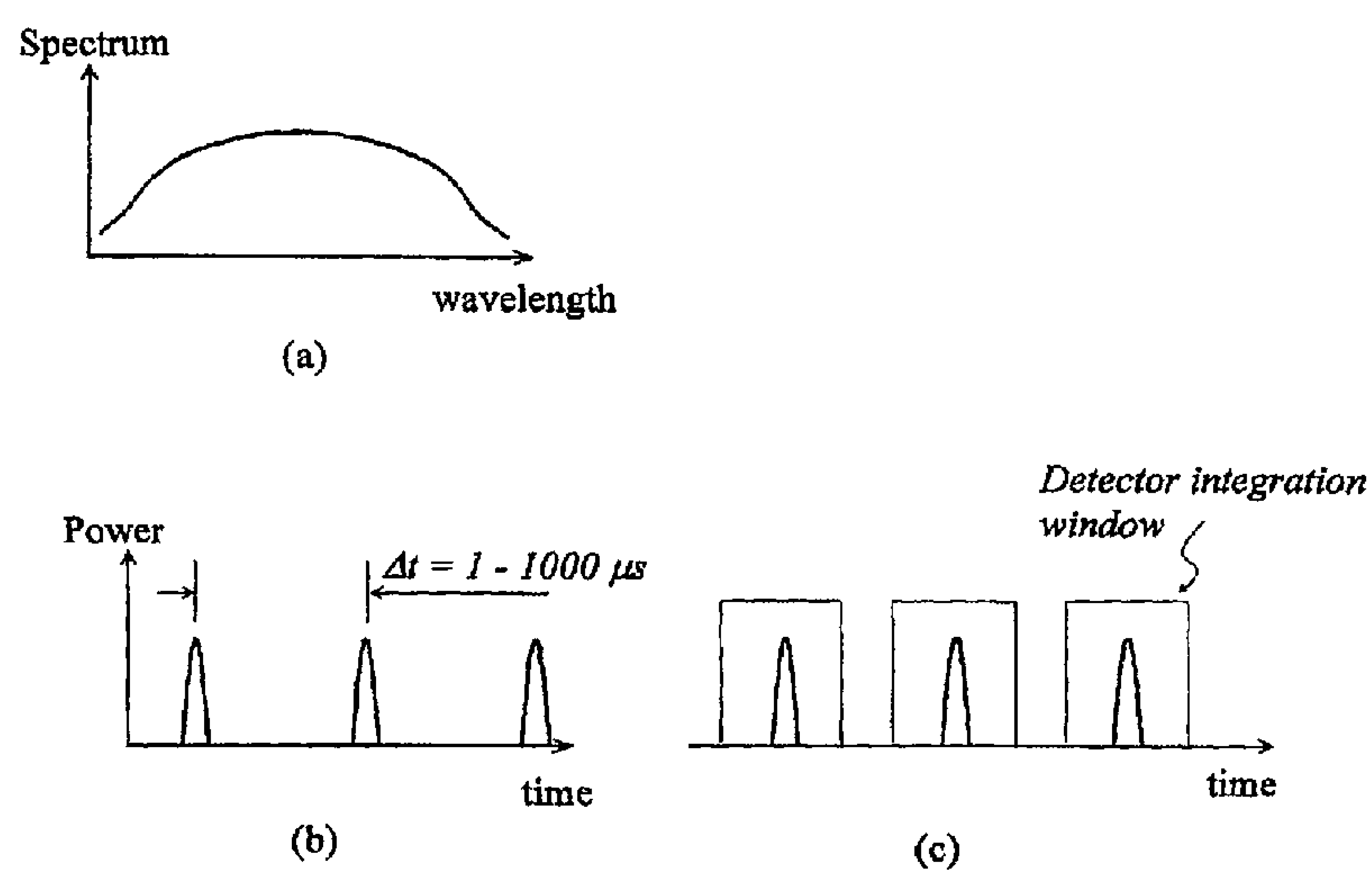
(Continued)

Primary Examiner — Tarifur Chowdhury
Assistant Examiner — Jonathon Cook
(74) *Attorney, Agent, or Firm* — Dorsey & Whitney LLP

(57) **ABSTRACT**

A system and method for imaging of a sample, e.g., biological sample, are provided. In particular, at least one source electro-magnetic radiation forwarded to the sample and a reference may be generated. A plurality of detectors may be used, at least one of the detectors capable of detecting a signal associated with a combination of at least one first electro-magnetic radiation received from the sample and at least one second electro-magnetic radiation received from the reference. At least one particular detector may have a particular electrical integration time, and can receive at least a portion of the signal for a time duration which has a first portion with a first power level greater than a predetermined threshold and a second portion immediately preceding or following the first portion. The second portion may have a second power level that is less than the predetermined threshold, and extends for a time period which may be, e.g., approximately more than 10% of the particular electrical integration time.

56 Claims, 15 Drawing Sheets



U.S. PATENT DOCUMENTS

4,631,498 A 12/1986 Cutler
4,639,999 A 2/1987 Daniele
4,650,327 A 3/1987 Ogi
4,734,578 A 3/1988 Horikawa
4,744,656 A 5/1988 Moran et al.
4,751,706 A 6/1988 Rohde et al.
4,763,977 A 8/1988 Kawasaki et al.
4,770,492 A 9/1988 Levin et al.
4,827,907 A 5/1989 Tashiro et al.
4,834,111 A 5/1989 Khanna et al.
4,868,834 A 9/1989 Fox et al.
4,890,901 A 1/1990 Cross, Jr.
4,905,169 A 2/1990 Buican et al.
4,909,631 A 3/1990 Tan et al.
4,925,302 A 5/1990 Cutler
4,928,005 A 5/1990 Lefevre et al.
4,940,328 A 7/1990 Hartman
4,965,441 A 10/1990 Picard
4,966,589 A 10/1990 Kaufman
4,984,888 A 1/1991 Tobias et al.
4,993,834 A 2/1991 Carlhoff et al.
4,998,972 A 3/1991 Chin et al.
5,039,193 A 8/1991 Snow et al.
5,040,889 A 8/1991 Keane
5,045,936 A 9/1991 Lobb et al.
5,046,501 A 9/1991 Crilly
5,065,331 A 11/1991 Vachon et al.
5,085,496 A 2/1992 Yoshida et al.
5,120,953 A 6/1992 Harris
5,121,983 A 6/1992 Lee
5,127,730 A 7/1992 Brelje et al.
5,197,470 A 3/1993 Helfer et al.
5,202,745 A 4/1993 Sorin et al.
5,202,931 A 4/1993 Bacus et al.
5,208,651 A 5/1993 Buican
5,212,667 A 5/1993 Tomlinson et al.
5,214,538 A 5/1993 Lobb
5,217,456 A 6/1993 Narciso, Jr.
5,241,364 A 8/1993 Kimura et al.
5,248,876 A 9/1993 Kerstens et al.
5,250,186 A * 10/1993 Dollinger et al. 210/656
5,251,009 A 10/1993 Bruno
5,262,644 A 11/1993 Maguire
5,275,594 A 1/1994 Baker
5,281,811 A 1/1994 Lewis
5,283,795 A 2/1994 Fink
5,291,885 A 3/1994 Taniji et al.
5,293,872 A 3/1994 Alfano et al.
5,293,873 A 3/1994 Fang
5,302,025 A 4/1994 Kleinerman
5,304,173 A 4/1994 Kittrell et al.
5,304,810 A 4/1994 Amos
5,305,759 A 4/1994 Kaneko et al.
5,317,389 A 5/1994 Hochberg et al.
5,318,024 A 6/1994 Kittrell et al.
5,321,501 A 6/1994 Swanson et al.
5,348,003 A * 9/1994 Caro 600/310
5,353,790 A 10/1994 Jacques et al.
5,383,467 A 1/1995 Auer et al.
5,394,235 A * 2/1995 Takeuchi et al. 356/73.1
5,404,415 A 4/1995 Mori et al.
5,419,323 A 5/1995 Kittrell et al.
5,424,827 A 6/1995 Horwitz et al.
5,439,000 A 8/1995 Gunderson et al.
5,441,053 A 8/1995 Lodder et al.
5,450,203 A 9/1995 Penkethman
5,454,807 A 10/1995 Lennox et al.
5,459,325 A 10/1995 Hueton et al.
5,459,570 A 10/1995 Swanson et al.
5,465,147 A 11/1995 Swanson
5,486,701 A 1/1996 Norton et al.
5,491,524 A 2/1996 Hellmuth et al.
5,491,552 A 2/1996 Knuttel
5,522,004 A 5/1996 Djupsjobacka et al.
5,526,338 A 6/1996 Hasman et al.
5,555,087 A 9/1996 Miyagawa et al.
5,562,100 A 10/1996 Kittrell et al.
5,565,983 A 10/1996 Barnard et al.
5,565,986 A 10/1996 Knuttel
5,566,267 A 10/1996 Neuberger
5,583,342 A 12/1996 Ichie
5,590,660 A 1/1997 MacAulay et al.
5,600,486 A 2/1997 Gal et al.
5,601,087 A 2/1997 Gunderson et al.
5,623,336 A 4/1997 Raab et al.
5,635,830 A 6/1997 Itoh
5,649,924 A 7/1997 Everett et al.
5,697,373 A 12/1997 Richards-Kortum et al.
5,698,397 A 12/1997 Zarling et al.
5,710,630 A 1/1998 Essenpreis et al.
5,719,399 A 2/1998 Alfano et al.
5,730,731 A 3/1998 Mollenauer et al.
5,735,276 A 4/1998 Lemelson
5,748,318 A 5/1998 Maris et al.
5,748,598 A 5/1998 Swanson et al.
5,752,518 A 5/1998 McGee et al.
5,784,352 A 7/1998 Swanson et al.
5,785,651 A 7/1998 Baker et al.
5,795,295 A 8/1998 Hellmuth et al.
5,801,826 A 9/1998 Williams
5,801,831 A 9/1998 Sargoytchev et al.
5,803,082 A 9/1998 Stapleton et al.
5,807,261 A 9/1998 Benaron et al.
5,810,719 A 9/1998 Toida
5,817,144 A 10/1998 Gregory et al.
5,836,877 A 11/1998 Zavislan et al.
5,840,023 A 11/1998 Oraevsky et al.
5,842,995 A 12/1998 Mahadevan-Jansen et al.
5,843,000 A 12/1998 Nishioka et al.
5,843,052 A 12/1998 Benja-Athon
5,847,827 A 12/1998 Fercher
5,865,754 A 2/1999 Sevick-Muraca et al.
5,867,268 A 2/1999 Gelikonov et al.
5,871,449 A 2/1999 Brown
5,877,856 A 3/1999 Fercher
5,887,009 A 3/1999 Mandella et al.
5,892,583 A 4/1999 Li
5,910,839 A 6/1999 Erskine et al.
5,912,764 A 6/1999 Togino
5,920,373 A 7/1999 Bille
5,920,390 A 7/1999 Farahi et al.
5,921,926 A 7/1999 Rolland et al.
5,926,592 A 7/1999 Harris et al.
5,949,929 A 9/1999 Hamm
5,951,482 A 9/1999 Winston et al.
5,955,737 A 9/1999 Hallidy et al.
5,956,355 A 9/1999 Swanson et al.
5,968,064 A 10/1999 Selmon et al.
5,975,697 A 11/1999 Podoleanu et al.
5,983,125 A 11/1999 Alfano et al.
5,987,346 A 11/1999 Benaron et al.
5,991,697 A 11/1999 Nelson et al.
5,994,690 A 11/1999 Kulkarni et al.
5,995,223 A 11/1999 Power
6,002,480 A 12/1999 Izatt et al.
6,004,314 A 12/1999 Wei et al.
6,006,128 A 12/1999 Izatt et al.
6,007,996 A 12/1999 McNamara et al.
6,010,449 A 1/2000 Selmon et al.
6,016,197 A 1/2000 Krivoshlykov
6,020,963 A 2/2000 Dimarzio et al.
6,025,956 A 2/2000 Nagano et al.
6,033,721 A 3/2000 Nassuphis
6,037,579 A 3/2000 Chan et al.
6,044,288 A 3/2000 Wake et al.
6,045,511 A 4/2000 Ott et al.
6,048,742 A 4/2000 Weyburne et al.
6,053,613 A 4/2000 Wei et al.
6,069,698 A 5/2000 Ozawa et al.
6,078,047 A 6/2000 Mittleman et al.
6,091,496 A 7/2000 Hill
6,091,984 A 7/2000 Perelman et al.
6,094,274 A 7/2000 Yokoi
6,107,048 A 8/2000 Goldenring et al.
6,111,645 A 8/2000 Tearney et al.
6,117,128 A 9/2000 Gregory
6,120,516 A 9/2000 Selmon et al.

6,134,003	A	10/2000	Tearney et al.
6,134,010	A	10/2000	Zavislan
6,134,033	A	10/2000	Bergano et al.
6,141,577	A	10/2000	Rolland et al.
6,151,522	A	11/2000	Alfano et al.
6,159,445	A	12/2000	Klaveness et al.
6,160,826	A	12/2000	Swanson et al.
6,161,031	A	12/2000	Hochmann et al.
6,166,373	A	12/2000	Mao
6,174,291	B1	1/2001	McMahon et al.
6,175,669	B1	1/2001	Colston et al.
6,185,271	B1	2/2001	Kinsinger
6,191,862	B1	2/2001	Swanson et al.
6,193,676	B1	2/2001	Winston et al.
6,198,956	B1	3/2001	Dunne
6,201,989	B1	3/2001	Whitehead et al.
6,208,415	B1	3/2001	De Boer et al.
6,208,887	B1	3/2001	Clarke
6,245,026	B1	6/2001	Campbell et al.
6,249,349	B1	6/2001	Lauer
6,249,381	B1	6/2001	Suganuma
6,249,630	B1	6/2001	Stock et al.
6,263,234	B1	7/2001	Engelhardt et al.
6,272,376	B1	8/2001	Marcu et al.
6,282,011	B1	8/2001	Tearney et al.
6,297,018	B1	10/2001	French et al.
6,301,048	B1	10/2001	Cao et al.
6,308,092	B1	10/2001	Hoyns
6,324,419	B1	11/2001	Guzelsu et al.
6,341,036	B1	1/2002	Tearney et al.
6,353,693	B1	3/2002	Kano et al.
6,374,128	B1	4/2002	Toida et al.
6,377,349	B1	4/2002	Fercher
6,384,915	B1	5/2002	Everett et al.
6,393,312	B1	5/2002	Hoyns
6,394,964	B1	5/2002	Sievert, Jr. et al.
6,396,941	B1	5/2002	Bacus et al.
6,421,164	B2	7/2002	Tearney et al.
6,437,867	B2	8/2002	Zeylikovich et al.
6,441,892	B2	8/2002	Xiao et al.
6,441,959	B1	8/2002	Yang et al.
6,445,485	B1	9/2002	Frigo et al.
6,445,939	B1	9/2002	Swanson et al.
6,445,944	B1	9/2002	Ostrovsky
6,463,313	B1	10/2002	Winston et al.
6,469,846	B2	10/2002	Ebizuka et al.
6,475,159	B1	11/2002	Casscells et al.
6,475,210	B1	11/2002	Phelps et al.
6,477,403	B1	11/2002	Eguchi et al.
6,485,413	B1	11/2002	Boppart et al.
6,485,482	B1	11/2002	Belef
6,501,551	B1	12/2002	Tearney et al.
6,516,014	B1	2/2003	Sellin et al.
6,517,532	B1	2/2003	Altshuler et al.
6,538,817	B1	3/2003	Farmer et al.
6,540,391	B2	4/2003	Lanzetta et al.
6,549,801	B1	4/2003	Chen et al.
6,552,796	B2	4/2003	Magnin et al.
6,556,305	B1 *	4/2003	Aziz et al. 356/512
6,556,853	B1	4/2003	Cabib et al.
6,558,324	B1	5/2003	Von Behren et al.
6,564,087	B1	5/2003	Pitris et al.
6,564,089	B2	5/2003	Izatt et al.
6,567,585	B2	5/2003	Harris
6,593,101	B2	7/2003	Richards-Kortum et al.
6,611,833	B1	8/2003	Johnson et al.
6,615,071	B1	9/2003	Casscells, III et al.
6,622,732	B2	9/2003	Constantz
6,654,127	B2	11/2003	Everett et al.
6,657,730	B2	12/2003	Pfau et al.
6,658,278	B2	12/2003	Gruhl
6,680,780	B1	1/2004	Fee
6,685,885	B2	2/2004	Nolte et al.
6,687,007	B1	2/2004	Meigs
6,687,010	B1	2/2004	Horii et al.
6,692,430	B2	2/2004	Adler
6,701,181	B2	3/2004	Tang et al.
6,721,094	B1	4/2004	Sinclair et al.
6,738,144	B1	5/2004	Dogariu et al.
6,757,467	B1	6/2004	Rogers
6,806,963	B1	10/2004	Wälti et al.
6,816,743	B2	11/2004	Moreno et al.
6,831,781	B2	12/2004	Tearney et al.
6,839,496	B1	1/2005	Mills et al.
6,882,432	B2	4/2005	Deck
6,900,899	B2	5/2005	Nevis
6,909,105	B1	6/2005	Heintzmann et al.
6,949,072	B2	9/2005	Furnish et al.
6,961,123	B1	11/2005	Wang et al.
6,980,299	B1	12/2005	de Boer
6,996,549	B2	2/2006	Zhang et al.
7,006,231	B2	2/2006	Ostrovsky et al.
7,006,232	B2	2/2006	Rollins et al.
7,019,838	B2	3/2006	Izatt et al.
7,027,633	B2	4/2006	Foran et al.
7,061,622	B2	6/2006	Rollins et al.
7,072,047	B2	7/2006	Westphal et al.
7,075,658	B2	7/2006	Izatt et al.
7,099,358	B1	8/2006	Chong et al.
7,113,288	B2	9/2006	Fercher
7,113,625	B2	9/2006	Watson et al.
7,130,320	B2	10/2006	Tobiason et al.
7,139,598	B2	11/2006	Hull et al.
7,142,835	B2	11/2006	Paulus
7,148,970	B2	12/2006	De Boer
7,177,027	B2	2/2007	Hirasawa et al.
7,190,464	B2	3/2007	Alphonse
7,230,708	B2	6/2007	Lapotko et al.
7,236,637	B2	6/2007	Sirohey et al.
7,242,480	B2	7/2007	Alphonse
7,267,494	B2	9/2007	Deng et al.
7,272,252	B2	9/2007	De La Torre-Bueno et al.
7,304,798	B2	12/2007	Izumi et al.
7,330,270	B2	2/2008	O'Hara et al.
7,336,366	B2	2/2008	Choma et al.
7,342,659	B2	3/2008	Horn et al.
7,355,716	B2	4/2008	De Boer et al.
7,355,721	B2	4/2008	Quadling et al.
7,359,062	B2	4/2008	Chen et al.
7,366,376	B2	4/2008	Shishkov et al.
7,382,809	B2	6/2008	Chong et al.
7,391,520	B2	6/2008	Zhou et al.
7,458,683	B2	12/2008	Chernyak et al.
7,530,948	B2	5/2009	Seibel et al.
7,539,530	B2	5/2009	Caplan et al.
7,609,391	B2	10/2009	Betzig
7,630,083	B2	12/2009	de Boer et al.
7,643,152	B2	1/2010	de Boer et al.
7,643,153	B2	1/2010	de Boer et al.
7,646,905	B2	1/2010	Guittet et al.
7,649,160	B2	1/2010	Colomb et al.
7,664,300	B2	2/2010	Lange et al.
7,733,497	B2	6/2010	Yun et al.
7,782,464	B2	8/2010	Mujat et al.
7,805,034	B2	9/2010	Kato et al.
2001/0036002	A1	11/2001	Tearney et al.
2001/0047137	A1	11/2001	Moreno et al.
2002/0016533	A1	2/2002	Marchitto et al.
2002/0024015	A1	2/2002	Hoffmann et al.
2002/0048025	A1	4/2002	Takaoka
2002/0048026	A1	4/2002	Isshiki et al.
2002/0052547	A1	5/2002	Toida
2002/0057431	A1	5/2002	Fateley et al.
2002/0085209	A1	7/2002	Mittleman et al.
2002/0086347	A1	7/2002	Johnson et al.
2002/0091322	A1	7/2002	Chaiken et al.
2002/0109851	A1	8/2002	Deck
2002/0122182	A1	9/2002	Everett et al.
2002/0122246	A1	9/2002	Tearney et al.
2002/0140942	A1	10/2002	Fee et al.
2002/0158211	A1	10/2002	Gillispie
2002/0161357	A1	10/2002	Rox et al.
2002/0163622	A1	11/2002	Magnin et al.
2002/0168158	A1	11/2002	Furusawa et al.
2002/0183623	A1	12/2002	Tang et al.
2002/0196446	A1	12/2002	Roth et al.
2002/0198457	A1	12/2002	Tearney et al.
2003/0001071	A1	1/2003	Mandella et al.

2003/0013973	A1	1/2003	Georgakoudi et al.
2003/0023153	A1	1/2003	Izatt et al.
2003/0026735	A1	2/2003	Nolte et al.
2003/0028114	A1	2/2003	Casscells, III et al.
2003/0030816	A1	2/2003	Eom et al.
2003/0043381	A1	3/2003	Fercher
2003/0053673	A1	3/2003	Dewaele et al.
2003/0067607	A1	4/2003	Wolleschensky et al.
2003/0082105	A1	5/2003	Fischman et al.
2003/0097048	A1	5/2003	Ryan et al.
2003/0108911	A1	6/2003	Klimant et al.
2003/0120137	A1	6/2003	Pawluczyk
2003/0135101	A1	7/2003	Webler
2003/0137669	A1	7/2003	Rollins et al.
2003/0165263	A1	9/2003	Hamer et al.
2003/0171691	A1	9/2003	Casscells, III et al.
2003/0174339	A1	9/2003	Feldchtein et al.
2003/0220749	A1	11/2003	Chen et al.
2003/0236443	A1	12/2003	Cespedes et al.
2004/0002650	A1	1/2004	Mandrusov et al.
2004/0039298	A1	2/2004	Abreu
2004/0054268	A1	3/2004	Esenaliev et al.
2004/0072200	A1	4/2004	Rigler et al.
2004/0075841	A1	4/2004	Van Neste et al.
2004/0076940	A1	4/2004	Alexander et al.
2004/0077949	A1	4/2004	Blofgett et al.
2004/0085540	A1	5/2004	Lapotko et al.
2004/0110206	A1	6/2004	Wong et al.
2004/0126048	A1	7/2004	Dave et al.
2004/0126120	A1	7/2004	Cohen et al.
2004/0150829	A1	8/2004	Koch et al.
2004/0150830	A1	8/2004	Chan
2004/0152989	A1	8/2004	Puttappa et al.
2004/0165184	A1	8/2004	Mizuno
2004/0166593	A1	8/2004	Nolte et al.
2004/0189999	A1	9/2004	De Groot et al.
2004/0239938	A1	12/2004	Izatt et al.
2004/0246490	A1	12/2004	Wang
2004/0246583	A1	12/2004	Mueller et al.
2004/0254474	A1	12/2004	Seibel et al.
2004/0263843	A1	12/2004	Knopp et al.
2005/0018133	A1	1/2005	Huang et al.
2005/0018201	A1	1/2005	de Boer et al.
2005/0035295	A1	2/2005	Bouma et al.
2005/0036150	A1	2/2005	Izatt et al.
2005/0046837	A1	3/2005	Izumi et al.
2005/0057680	A1 *	3/2005	Agan 348/362
2005/0057756	A1	3/2005	Fang-Yen et al.
2005/0059894	A1	3/2005	Zeng et al.
2005/0065421	A1	3/2005	Burckhardt et al.
2005/0119567	A1	6/2005	Choi et al.
2005/0128488	A1	6/2005	Yelin et al.
2005/0165303	A1	7/2005	Kleen et al.
2005/0171438	A1	8/2005	Chen et al.
2005/0190372	A1	9/2005	Dogariu et al.
2005/0254061	A1	11/2005	Alphonse et al.
2006/0033923	A1	2/2006	Hirasawa et al.
2006/0093276	A1	5/2006	Bouma et al.
2006/0103850	A1	5/2006	Alphonse et al.
2006/0146339	A1	7/2006	Fujita
2006/0164639	A1	7/2006	Horn et al.
2006/0171503	A1	8/2006	O'Hara et al.
2006/0184048	A1	8/2006	Saadat et al.
2006/0193352	A1	8/2006	Chong et al.
2006/0244973	A1	11/2006	Yun et al.
2007/0019208	A1	1/2007	Toida et al.
2007/0038040	A1	2/2007	Cense et al.
2007/0070496	A1	3/2007	Gweon et al.
2007/0076217	A1	4/2007	Baker et al.
2007/0086013	A1	4/2007	De Lega et al.
2007/0086017	A1	4/2007	Buckland et al.
2007/0091317	A1	4/2007	Freischlad et al.
2007/0133002	A1	6/2007	Wax et al.
2007/0188855	A1	8/2007	Shishkov et al.
2007/0223006	A1	9/2007	Tearney et al.
2007/0236700	A1	10/2007	Yun et al.
2007/0258094	A1	11/2007	Izatt et al.
2007/0291277	A1	12/2007	Everett et al.
2008/0002197	A1	1/2008	Sun et al.
2008/0007734	A1	1/2008	Park et al.
2008/0049220	A1	2/2008	Izzia et al.
2008/0094613	A1	4/2008	de Boer et al.
2008/0094637	A1	4/2008	de Boer et al.
2008/0097225	A1	4/2008	Tearney et al.
2008/0097709	A1	4/2008	de Boer et al.
2008/0100837	A1	5/2008	de Boer et al.
2008/0152353	A1	6/2008	de Boer et al.
2008/0154090	A1	6/2008	Hashimshony
2008/0204762	A1	8/2008	Izatt et al.
2008/0265130	A1	10/2008	Colomb et al.
2008/0308730	A1	12/2008	Vizi et al.
2009/0011948	A1	1/2009	Uniu et al.
2009/0196477	A1	8/2009	Cense et al.
2009/0273777	A1	11/2009	Yun et al.
2009/0290156	A1	11/2009	Popescu et al.
2010/0086251	A1	4/2010	Xu et al.
2010/0094576	A1	4/2010	de Boer et al.
2010/0150467	A1	6/2010	Zhao et al.

FOREIGN PATENT DOCUMENTS

DE	19542955	5/1997
DE	10351319	6/2005
EP	0110201	6/1984
EP	0617286	2/1994
EP	0728440	8/1996
EP	0251062	1/1998
EP	1324051	7/2003
EP	1426799	6/2004
FR	2738343	8/1995
GB	2209221	5/1989
GB	2298054	8/1996
JP	6073405	4/1985
JP	20040056907	2/1992
JP	4135550	5/1992
JP	4135551	5/1992
JP	5509417	11/1993
JP	02214127	7/2002
JP	20030035659	2/2003
JP	2004037165	2/2004
JP	2007271761	10/2007
WO	7900841	10/1979
WO	9201966	2/1992
WO	9216865	10/1992
WO	WO 9219930	11/1992
WO	WO 9303672	3/1993
WO	9216865	10/1993
WO	WO 9533971	12/1995
WO	2298054	8/1996
WO	WO 9732182	9/1997
WO	9800057	1/1998
WO	WO 9814132	4/1998
WO	WO 9835203	8/1998
WO	9848846	11/1998
WO	WO 9848838	11/1998
WO	9944089	2/1999
WO	WO 9944089	9/1999
WO	WO 9957507	11/1999
WO	WO 0058766	10/2000
WO	0101111	1/2001
WO	0127679	4/2001
WO	WO 0138820	5/2001
WO	WO 0142735	6/2001
WO	0237075	5/2002
WO	WO 0236015	5/2002
WO	WO 0238040	5/2002
WO	02053050	7/2002
WO	WO 02054027	7/2002
WO	02084263	10/2002
WO	WO 03020119	3/2003
WO	03046495	6/2003
WO	03046636	6/2003
WO	03062802	7/2003
WO	WO 03062802	7/2003
WO	03105678	12/2003
WO	2004057266	7/2004
WO	WO 2004105598	12/2004
WO	2005047813	5/2005
WO	2005082225	9/2005

WO	2006004743	1/2006
WO	2006039091	3/2006
WO	2006038876	4/2006
WO	2006059109	6/2006
WO	2006124860	11/2006
WO	2007028531	3/2007
WO	2007083138	7/2007
WO	2007084995	7/2007

OTHER PUBLICATIONS

Notification of Transmittal of the International Preliminary Report of Patentability mailed Dec. 21, 2006 for PCT/US2005/032422.
Amendment under Article 34 and reply to PCT Written Opinion mailed Sep. 7, 2006 for PCT/US2005/032422.
Liptak David C. et al., (2007) "On the Development of a Confocal Rayleigh-Brillouin Microscope" *American Institute of Physics* vol. 78, 016106.
Office Action mailed Oct. 1, 2008 for U.S. Appl. No. 11/955,986.
Invitation of Pay Additional Fees mailed Aug. 7, 2008 for International Application No. PCT/US2008/062354.
Invitation of Pay Additional Fees mailed Jul. 20, 2008 for International Application No. PCT/US2007/081982.
International Search Report and Written Opinion mailed Mar. 7, 2006 for PCT/US2005/035711.
International Search Report and Written Opinion mailed Jul. 18, 2008 for PCT/US2008/057533.
Aizu, Y et al. (1991) "Bio-Speckle Phenomena and Their Application to the Evaluation of Blood Flow" Optics and Laser Technology, vol. 23, No. 4, Aug. 1, 1991.
Richards G.J. et al. (1997) "Laser Speckle Contrast Analysis (LASCA): A Technique for Measuring Capillary Blood Flow Using the First Order Statistics of Laser Speckle Patterns" Apr. 2, 1997.
Gonick, Maria M., et al (2002) "Visualization of Blood Microcirculation Parameters in Human Tissues by Time Integrated Dynamic Speckles Analysis" vol. 972, No. 1, Oct. 1, 2002.
International Search Report and Written Opinion mailed Jul. 4, 2008 for PCT/US2008/051432.
Jonathan, Enock (2005) "Dual Reference Arm Low-Coherence Interferometer-Based Reflectometer For Optical Coherence Tomography (OCT) Application" *Optics Communications* vol. 252.
Motaghian Nezam, S.M.R. (2007) "increased Ranging Depth in optical Frequency Domain Imaging by Frequency Encoding" *Optics Letters*, vol. 32, No. 19, Oct. 1, 2007.
Office Action dated Jun. 30, 2008 for U.S. Appl. No. 11/670,058.
Office Action dated Jul. 7, 2008 for U.S. Appl. No. 10/551,735.
Australian Examiner's Report mailed May 27, 2008 for Australian patent application No. 2003210669.
Notice of Allowance mailed Jun. 4, 2008 for U.S. Appl. No. 11/174,425.
European communication dated May 15, 2008 for European patent application No. 05819917.5.
International Search Report and Written Opinion mailed Jun. 10, 2008 for PCT/US2008/051335.
Oh. W.Y. et al (2006) "Ultrahigh-Speed Optical Frequency Domain Imaging and Application to laser Ablation Monitoring" *Applied Physics Letters*, vol. 88.
Office Action dated Aug. 21, 2008 for U.S. Appl. No. 11/505,700.
Sticker, Markus (2002) En Face Imaging of Single Cell layers by Differential Phase-Contrast Optical Coherence Microscopy) *Optics Letters*, col. 27, No. 13, Jul. 1, 2002.
International Search Report and Written Opinion dated Jul. 17, 2008 for International Application No. PCT/US2008/057450.
International Search Report and Written Opinion dated Aug. 11, 2008 for International Application No. PCT/US2008/058703.
US National Library of Medicine (NLM), Bethesda, MD, US; Oct. 2007 (Oct. 2007), "Abstracts of the 19th Annual Symposium of Transcatheter Cardiovascular Therapeutics, Oct. 20-25, 2007, Washington, DC, USA."
International Search Report and Written Opinion dated May 26, 2008 for International Application No. PCT/US2008/051404.
Office Action dated Aug. 25, 2008 for U.S. Appl. No. 11/264,655.
Office Action dated Sep. 11, 2008 for U.S. Appl. No. 11/624,334.
Office Action dated Aug. 21, 2008 for U.S. Appl. No. 11/956,079.
Gelikono, V. M. et al. Oct. 1, 2004 "Two-Wavelength Optical Coherence Tomography" Radio physics and Quantum Electronics, Kluwer Academic Publishers-Consultants. vol. 47, No. 10-1.
International Search Report and Written Opinion for PCT/US2007/081982 dated Oct. 19, 2007.
Database Compendex Engineering Information, Inc., New York, NY, US; Mar. 5, 2007, Yelin, Dvir et al: "Spectral-Domain Spectrally-Encoded Endoscopy".
Database Biosis Biosciences Information Service, Philadelphia, PA, US; Oct. 2006, Yelin D. et al: "Three-Dimensional Miniature Endoscopy".
International Search Report and Written Opinion mailed Mar. 14, 2005 for PCT/US2004/018045.
Notification of the international Preliminary Report on Patentability mailed Oct. 21, 2005.
Shim M.G. et al., "Study of Fiber-Optic Probes For In vivo Medical Raman Spectroscopy" Applied Spectroscopy. vol. 53, No. 6, Jun. 1999.
Bingid U. et al., "Fibre-Optic Laser-Assisted Infrared Tumour Diagnostics (FLAIR); Infrared Tomour Diagnostics" Journal of Physics D. Applied Physics, vol. 38, No. 15, Aug. 7, 2005.
Jun Zhang et al. "Full Range Polarization-Sensitive Fourier Domain Optical Coherence Tomography" Optics Express, vol. 12, No. 24. Nov. 29, 2004.
Yonghua et al., "Real-Time Phase-Resolved Functional Optical Hilbert Transformation" Optics Letters, vol. 27, No. 2, Jan. 15, 2002.
Siavash et al., "Self-Referenced Doppler Optical Coherence Tomography" Optics Letters, vol. 27, No. 23, Dec. 1, 2002.
International Search Report and Written Opinion dated Dec. 20, 2004 for PCT/US04/10152.
Notification Concerning Transmittal of International Preliminary Report on Patentability dated Oct. 13, 2005 for PCT/US04/10152.
International Search Report and Written Opinion dated Mar. 23, 2006 for PCT/US2005/042408.
International Preliminary Report on Patentability dated Jun. 7, 2007 for PCT/US2005/042408.
International Search Report and Written Opinion dated Feb. 28, 2007 for International Application No. PCT/US2006/038277.
International Search Report and Written Opinion dated Jan. 30, 2009 for International Application No. PCT/US2008/081834.
Fox, J.A. et al; "A New Galvanometric Scanner for Rapid tuning of C02 Lasers" New York, IEEE, US vol. Apr. 7, 1991.
Motaghian Nezam, S.M. et al: "High-speed Wavelength-Swept Semiconductor laser using a Diffrection Grating and a Polygon Scanner in Littro Configuration" *Optical Fiber Communication and the National Fiber Optic Engineers Conference* Mar. 29, 2007.
International Search Report and Written Opinion dated Feb. 2, 2009 for International Application No. PCT/US2008/071786.
Bilenca A et al: "The Role of Amplitude and phase in Fluorescence Coherence Imaging: From Wide Filed to Nanometer Depth Profiling", *Optics IEEE*, May 5, 2007.
Inoue, Yusuke et al: "Varible Phase-Contrast Fluorescence Spectrometry for Fluorescently Strained Cells", *Applied Physics Letters*, Sep. 18, 2006.
Bernet, S et al: "Quantitative Imaging of Complex Samples by Spiral Phase Contrast Microscopy", *Optics Express*, May 9, 2006.
International Search Report and Written Opinion dated Jan. 15, 2009 for International Application No. PCT/US2008/074863.
Office Action dated Feb. 17, 2009 for U.S. Appl. No. 11/211,483.
Notice of Reasons for Rejection mailed Dec. 2, 2008 for Japanese patent application No. 2000-533782.
International Search Report and Written Opinion dated Feb. 24, 2009 for PCT/US2008/076447.
European Official Action dated Dec. 2, 2008 for EP 07718117.0.
Barfuss et al (1989) "Modified Optical Frequency Domain Reflectometry with High spatial Resolution for Components of integrated optic Systems", Journal of Lightwave Technology, IEEE vol. 7., No. 1.
Yun et al., (2004) "Removing the Depth-Degeneracy in Optical Frequency Domain Imaging with Frequency Shifting", Optics Express, vol. 12, No. 20.
International Search Report and Written Opinion dated Jun. 10, 2009 for PCT/US08/075456.

European Search Report issued May 5, 2009 for European Application No. 01991471.2.
Motz, J.T. et al: "Spectral-and Frequency-Encoded Fluorescence Imaging" Optics Letters, OSA, Optical Society of America, Washington, DC, US, vol. 30, No. 20, Oct. 15, 2005, pp. 2760-2762.
Japanese Notice of Reasons for Rejection dated Jul. 14, 2009 for Japanese Patent application No. 2006-503161.
Office Action dated Aug. 18, 2009 for U.S. Appl. No. 12/277,178.
Office Action dated Aug. 13, 2009 for U.S. Appl. No. 10/136,813.
Office Action dated Aug. 6, 2009 for U.S. Appl. No. 11/624,455.
Office Action dated May 15, 2009 for U.S. Appl. No. 11/537,123.
Office Action dated Apr. 17, 2009 for U.S. Appl. No. 11/537,343.
Office Action dated Apr. 15, 2009 for U.S. Appl. No. 12/205,775.
Office Action dated Dec. 9, 2008 for U.S. Appl. No. 09/709,162.
Office Action dated Dec. 23, 2008 for U.S. Appl. No. 11/780,261.
Office Action dated Jan. 9, 2010 for U.S. Appl. No. 11/624,455.
Office Action dated Feb. 18, 2009 for U.S. Appl. No. 11/285,301.
Beddow et al, (May 2002) "Improved Performance Interferomater Designs for Optical Coherence Tomography", IEEE Optical Fiber Sensors Conference, pp. 527-530.
Yaqoob et al., (Jun. 2002) "High-Speed Wavelength-Multiplexed Fiber-Optic Sensors for Biomedicine," Sensors Proceedings of the IEEE, pp. 325-330.
Office Action dated Feb. 18, 2009 for U.S. Appl. No. 11/697,012.
Zhang et al, (Sep. 2004), "Fourier Domain Functional Optical Coherence Tomography", Saratov Fall Meeting 2004, pp. 8-14.
Office Action dated Feb. 23, 2009 for U.S. Appl. No. 11/956,129.
Office Action dated Mar. 16, 2009 for U.S. Appl. No. 11/621,694.
Office Action dated Oct. 1, 2009 for U.S. Appl. No. 11/677,278.
Office Action dated Oct. 6, 2009 for U.S. Appl. No. 12/015,642.
Lin, Stollen et al.,(1977) " A AW Tunable Near-infrared (1.085-1.175-um) Raman Oscillator," Optics Letters, vol. 1, 96.
Summons to attend Oral Proceedings dated Oct. 9, 2009 for European patent application No. 06813365.1.
Office Action dated Dec. 15, 2009 for U.S. Appl. No. 11/549,397.
R. Haggitt et al., "Barrett's Esophagus Correlation Between Mucin Histochemistry, Flow Cytometry, and Histological Diagnosis for Predicting Increased Cancer Risk," Apr. 1988, American Journal of Pathology, vol. 131, No. 1, pp. 53-61.
R.H. Hardwick et al., (1995) "c-erbB-2 Overexpression in the Dysplasia/Carcinoma Sequence of Barrett's Oesophagus," Journal of Clinical Pathology, vol. 48, No. 2, pp. 129-132.
W. Polkowski et al, (1998) "Clinical Decision making in Barrett's Oesophagus can be supported by Computerized Immunoquantitation and Morphometry of Features Associated with Proliferation and Differentiation," Journal of pathology, vol. 184, pp. 161-168.
J.R. Turner et al., MN Antigen Expression in Normal Preneoplastic, and Neoplastic Esophagus: A Clinicopathological Study of a New Cancer-Associated Biomarker,: Jun. 1997, Human Pathology, vol. 28, No. 6, pp. 740-744.
D.J. Bowery et al., (1999) "Patterns of Gastritis in Patients with Gastro-Oesophageal Reflux Disease,", Gut, vol, 45, pp. 798-803.
O'Reich et al., (2000) "Expression of Oestrogen and Progesterone Receptors in Low-Grade Endometrial Stromal Sarcomas,", British Journal of Cancer, vol. 82, No. 5, pp. 1030-1034.
M.I. Canto et al., (1999) "Vital Staining and Barrett's Esophagus," Gastrointestinal Endoscopy, vol. 49, No. 3, Part 2, pp. S12-S16.
S. Jackle et al., (2000) "In Vivo Endoscopic Optical Coherence Tomography of the Human Gastrointestinal Tract—Toward Optical Biopsy," Encoscopy, vol. 32, No. 10, pp. 743-749.
E. Montgomery, et al., "Reproducibility of the Diagnosis of Dysplasia in Barrett Esophagus: A Reaffirmation," Apr. 2001, Human Pathology, vol. 32, No. 4, pp. 368-378.
H. Geddert et al., "Expression of Cyclin B1 in the Metaplasia-Dysphasia-Carcinoma Sequence of Barrett Esophagus," Jan. 2002, Cancer, vol. 94, No. 1, pp. 212-2180.
P. Pfau et al., (2003) "Criteria for the Diagnosis of Dysphasia by Endoscopic Optical Coherence Tomography," Gastrointestinal Endoscopy, vol. 58, No. 2, pp. 196-2002.
R. Kiesslich et al., (2004) "Confocal Laser Endoscopy for Diagnosing Intraepithelial Neoplasias and Colorectal Cancer in Vivo," Gastroenterology, vol. 127, No. 3, pp. 706-713.
X. Qi et al., (2004) "Computer Aided Diagnosis of Dysphasia in Barrett's Esophagus Using Endoscopic Optical Coherence Tomography," SPIE, Coherence Domain Optical Methods and Optical Coherence Tomography in Biomedicine VIII. Proc. of Conference on., vol. 5316, pp. 33-40.
Seltzer et al., (1991) "160 nm Continuous Tuning of a MQW Laser in an External Cavity Across the Entire 1.3 μm Communications Window," Electronics Letters, vol. 27, pp. 95-96.
Office Action dated Jan. 25, 2010 for U.S. Appl. No. 11/537,048.
International Search Report dated Jan. 27, 2010 for PCT/US2009/050553.
International Search Report dated Jan. 27, 2010 for PCT/US2009/047988.
International Search Report dated Feb. 23, 2010 for U.S. Appl. No. 11/445,131.
Office Action dated Mar. 18, 2010 of U.S. Appl. No. 11/844,454.
Office Action dated Apr. 8, 2010 of U.S. Appl. No. 11/414,564.
Japanese Office Action dated Apr. 13, 2010 for Japanese Patent application No. 2007-515029.
International Search Report dated May 27, 2010 for PCT/US2009/063420.
Office Action dated May 28, 2010 for U.S. Appl. No. 12/015,642.
Office Action dated Jun. 2, 2010 for U.S. Appl. No. 12/112,205.
Office Action dated Jul. 7, 2010 for U.S. Appl. No. 11/624,277.
Montag Ethan D., "Parts of the Eye" online textbook for JIMG 774: Vision & Psycophysics, download on Jun. 23, 2010 from http://www.cis.rit.edu/people/faculty/montag/vandplite/pp./chap.8/ch8p3.html.
Office Action dated Jul. 16, 2010 for U.S. Appl. No. 11/445,990.
Office Action dated Jul. 20, 2010 for U.S. Appl. No. 11/625,135.
Office Action dated Aug. 5, 2010 for U.S. Appl. No. 11/623,852.
Chinese office action dated Aug. 4, 2010 for CN 200780005949.9.
Chinese office action dated Aug. 4, 2010 for CN 200780016266.3.
Zhang et al., "Full Range Polarization-Sensitive Fourier Domain Optical Coherence Tomography" Optics Express, Nov. 29, 2004, vol. 12, No. 24.
Office Action dated Aug. 27, 2010 for U.S. Appl. No. 11/569,790.
Office Action dated Aug. 31, 2010 for U.S. Appl. No. 11/677,278.
Office Action dated Sep. 3, 2010 for U.S. Appl. No. 12/139,314.
Yong Zhao et al: "Virtual Data Grid Middleware Services for Data-Intensive Science", Concurrency and Computation: Practice and Experience, Wiley, London, GB, Jan. 1, 2000, pp. 1-7, pp. 1532-0626.
Swan et al., "Toward Nanometer-Scale Resolution in Fluorescence Microscopy using Spectral Self-Inteference" IEEE Journal. Selected Topics in Quantum Electronics 9 (2) 2003, pp. 294-300.
Moiseev et al., "Spectral Self-Interfence Fluorescence Microscopy", J. Appl. Phys. 96 (9) 2004, pp. 5311-5315.
Hendrik Verschueren, "Interference Reflection Microscopy in Cell Biology", J. Cell Sci. 75, 1985, pp. 289-301.
Park et al., "Diffraction Phase and Fluorescence Microscopy", Opt. Expr. 14 (18) 2006, pp. 8263-8268.
Swan et al. "High Resolution Spectral Self-Interference Fluorescence Microscopy", Proc. SPIE 4621, 2002, pp. 77-85.
Sanchez et al., "Near-Field Fluorscence Microscopy Based on Two-Photon Excvitation with Metal Tips", Phys. Rev. Lett. 82 (20) 1999, pp. 4014-4017.
Wojtkowski, Maciej, Ph.D. "Three-Dimensional Retinal Imaging with High-Speed Ultrahigh-Resolution Optical Coherence Tomography" Ophthalmology, Oct. 2005 112(10): 1734-1746.
Vaughan, J.M. et al., "Brillouin Scattering, Density and Elastic Properties of the Lens and Cornea of the Eye", Nature, vol. 284, Apr. 3, 1980, pp. 489-491.
Hess, S.T. et al. "Ultra-high Resolution Imaging by Fluorescence Photoactivation Localization Microscopy" Biophysical Journal vol. 91, Dec. 2006, 4258-4272.
Fernandez-Suarez, M. et al., "Fluorescent Probes for Super-Resolution Imaging in Living Cells" Nature Reviews Molecular Cell Biology vol. 9, Dec. 2008.
"In vivo imaging of blood flow in human retinal vessels using color Doppler optical coherence tomography" Yazdanfar et al, Part of the SPIE Conference on Coherence Domain Methods in Biomedical Science and Clinical Applications III * San Jose, California * Jan. 1999 177 SPIE vol. 3598 * 0277-786X199/$ 10.00.*

Fujimoto et al., "High Resolution in Vivo Intra-Arterial Imaging with Optical Coherence Tomography", *Official Journal of the British Cardiac Society*, vol. 82, pp. 128-133 Heart, 1999.
D. Huang et al., "Optical Coherence Tomography", *Science*, vol. 254, pp. 1178-1181, Nov. 1991.
Tearney et al., "High-Speed Phase -and Group Delay Scanning with a Grating Based Phase Control Line", *Optics Letters*, vol. 22, pp. 1811-1813, Dec. 1997.
Rollins, et al., "In Vivo Video Rate Optical Coherence Tomography", *Optics Express*, vol. 3, pp. 219-229, Sep. 1998.
Saxer, et al., High Speed Fiber-Based Polarization-Sensitive Optical Coherence Tomography of in Vivo Human Skin, *Optical Society of America*, vol. 25, pp. 1355-1357, Sep. 2000.
Oscar Eduardo Martinez, "3000 Times Grating Compress or Positive Group Velocity Dispersion", *IEEE*, vol. QE-23, pp. 59-64, Jan. 1987.
Kulkarni, et al., "Image Enhancement in Optical Coherence Tomography Using Deconvolution", *Electronics Letters*, vol. 33, pp. 1365-1367, Jul. 1997.
Bashkansky, et al., "Signal Processing for Improving Field Cross-Correlation Function in Optical Coherence Tomography", *Optics & Photonics News*, vol. 9, pp. 8137-8138, May 1998.
Yung et al., "Phase-Domain Processing of Optical Coherence Tomography Images", *Journal of Biomedical Optics*, vol. 4, pp. 125-136, Jan. 1999.
Tearney, et al., "In Vivo Endoscopic Optical Biopsy with Optical Coherence Tomography", *Science*, vol. 276, Jun. 1997.
W. Drexler et al. "In Vivo Ultrahigh-Resolution Optical Coherence Tomography", Opt. Lett. vol. 24, pp. 1221-1223, Sep. 1999.
Nicusor V. Iftimia et al., "A Portable, Low Coherence Interferometry Based Instrument for Fine Needle Aspiration Biopsy Guidance" Accepted to Review to Scientific Instruments, 2005.
Abbas, G.L., V.W.S. Chan et al., "Local-Oscillator Excess-Noise Suppression for Homodyne and Heterodyne-Detection", *Optics Letters*, vol. 8, pp. 419-421, Aug. 1982 issue.
Agrawall, G.P., "Population Pulsation and Nondegenerate 4-Wave Mixing in Semiconductor-Lasers and Amplifiers", *Journal Of The Optical Society Of America B-Optical Physics*, vol. 5, pp. 147-159, Jan. 1998.
Andretzky, P. et al., "Optical Coherence Tomography by Spectral Radar: Improvement of Signal-to-Noise Ration", *The International Society for Optical Engueering*, USA, vol. 3915, 2000.
Ballif, J. et al., "Rapid and Scalable Scans at 21 m/s in optical Low-Coherence Reflectometry", *Optics Letters*, vol. 22, pp. 757-759, Jun. 1997.
Barfuss H. et al., "Modified Optical Frequency-Domain Reflectometry with High Spatial-Resolution for Components of Integrated Optics Systems", *Journal Of Lightwave technology*vol. 7, pp. 3-10, Jan. 1989.
Beaud, P. et al., "Optical Reflectometry with Micrometer Resolution for the Investigation of Integrated Optical-Devices", *Leee Journal of Quantum Electronics*, vol. 25, pp. 755-759, Apr. 1989.
Bauma, Brett et al., "Power-Efficient Nonreciprocal Interferometer and Linear-Scanning Fiber-Optic Catheter for Optical Coherence Tomography", *Optics Letters*, vol. 24, pp. 531-533, Apr. 1999.
Brinkmeyer, E., et al., "Efficient Algorithm for Non-Equidistant Interopolation of Sampled Data", *Electronics Letters*, vol. 28, p. 693, Mar. 1992.
Brinkmeyer, E. et al., "High-Resolution OCDR in Dispersive Wave-Guides", *Electronics Letters*, vol. 26, pp. 413-414, Mar. 1990.
Chinn, S.R. et al., "Optical Coherence Tomography Using a Frequency-Tunable Optical Source", *Optical Letters*, vol. 22, pp. 340-342, Mar. 1997.
Danielson, B.L. et al., "Absolute Optical Ranging Using Low Coherence Interferometry", *Applied Optics*, vol. 30, p. 2975, Jul. 1991.
Dorrer, C. et al., "Spectral Resolution and Sampling Issues in Fourier-Transform Spectral Interferometry", *Journal of the Optical Society of America B-Optical Physics*, vol. 17, pp. 1795-1802, Oct. 2000.
Dudley, J. M. et al., "Cross-Correlation Frequency Resolved Optical Gating Analysis of Broadband Continuum Generation in Photonic Crystal Fiber: Simulations and Experiments", *Optics Express*, vol. 10, p. 125, Oct. 2002.
Fercher, Adolf "Optical Coherence Tomography", *Journal of Biomedical Optics*, vol. 1, pp. 157-173, Apr. 1996.
Ferreira, L.A. et al., "Polarization-Intensive Fiberoptic White-Light Interferometry", *Optics Communications*, vol. 114, pp. 386-392, Feb. 1995.
Fujii, Yohji, "High-Isolation Polarization-Independent Optical Circulator", *Journal of Lightware Technology*, vol. 9, pp. 1239-1243, Oct. 1991.
Glance, B., "polarization Independent Coherent Optical Receiver", *Journal of Light wave Technology*, vol. LT-5, p. 274, Feb. 1987.
Glombitza, U., "Coherent Frequency-Domain Reflectometry for Characterization of Single-Mode Integrated-Optical Wave Guides", *Journal of Lightwave Technology*, vol. 11, 1377-1384, Aug. 1993.
Golubovic, B. et al., "Optical Frequency-Domain Reflectometry Using Rapid Wavelength Tuning of a Cr4+:Forsterite Laser", *Optics Letters*, vol. pp. 1704-1706, Nov. 1997.
Haberland, U. H. P. et al., "Chirp Optical Coherence Tomography of Layered Scattering Media", *Journal of Biomedical Optics*, vol. 3, pp. 259-266, Jul. 1998.
Hammer, Daniel X. et al., "Spectrally Resolved White-Light Interferometry for Measurement of Ocular Dispersion", *Journal of the Optical Society of America A-Optics Image Science and Vision*, vol. 16, pp. 2092-2102, Sep. 1999.
Harvey, K.C. et al., "External-Cavity Diode-Laser Using a Grazing-Incidence Diffraction Grating", *Optics Letters*, vol. 16, pp. 910-912, Jun. 1991.
Hausler, Gerd et al., "'Coherence Radar' and 'Spectral Radar' New Tools for Dermatological Diagnosis", *Journal of Biomedical Optics*, vol. 3, pp. 21-31, Jan. 1998.
Hee , Michael R. et al., "Polarization-Sensitive Low-Coherence Reflectometer for Birefringence Characterization and Ranging", *Journal of the Optical Society of America B* (*Optical Physics*), vol. 9, p. 903-908, Jun. 1992.
Hotate Kazuo et al., "Optical Coherence Domain Reflectometry by Synthesis of Coherence Function", *Journal of Lightwave Technology*, vol. 11, pp. 1701-1710, Oct. 1993.
Inoue, Kyo et al., "Nearly Degenerate 4-Wave-Mixing in a Traveling-Wave Semiconductor-Laser Amplifier", *Applied Physics Letters*, vol. 51, pp. 1051-1053, 1987.
Ivanov, A. P. et al., "New Method for High-Range Resolution Measurements of Light Scattering in Optically Dense Inhomogeneous Media", *Optics Letters*, vol. 1, pp. 226-228, Dec. 1977.
Ivanov, A. P. et al., "Interferometric Study of the Spatial Structure of Light-Scattering Medium", *Journal of Applied Spectroscopy*, vol. 28, pp. 518-525, 1978.
Kazovsky, L. G. et al., "Heterodyne Detection Through Rain, Snow, and Turbid Media: Effective Receiver Size at Optical Through Millimeter Wavelengths", *Applied Optics*, vol. 22, pp. 706-710, Mar. 1983.
Kersey, A. D. et al., "Adaptive Polarization Diversity Receiver Configuration for Coherent Optical Fiber Communications", *Electronics Letters*, vol. 25, pp. 275-277, Feb. 1989.
Kohlhaas, Andreas et al., "High-Resolution OCDR for Testing Integrated-Optical Waveguides: Dispersion-Corrupted Experimental Data Corrected by a Numerical Algorithm", *Journal of Lightwave Technology*, vol. 9, pp. 1493-1502, Nov. 1991.
Larkin, Kieran G., "Efficient Nonlinear Algorithm for Envelope Detection in White Light Interofeometry", *Journal of Optical Society of America A-Optics Image Science and Vision*, vol. 13, pp. 832-843, Apr. 1996.
Leitgeb, R. et al., "Spectral measurement of Absorption by Spectroscopic Frequency-Domain Optical Coherence Tomography", *Optics Letters*, vol. 25, pp. 820-822, Jun. 2000.
Lexer, F. et al., "Wavelength-Turning Interferometry of Introacular Distances", *Applied Optics*, vol. 36, pp. 6548-6553, Sep. 1997.
Mitsui, Takahisa, "Dynamic Range of Optical Reflectometry with Spectral Interferometry", *Japanese Journal of Applied Physics Part I—Regular Papers Short Notes & Review Papers*, vol. 38, pp. 6133-6137, 1999.
Naganuma, Kazunori et al., "Group-Delay Measurement Using the Fourier-Transform of an Interferometric Cross-Correlation Generated by White Light", *Optics Letters*, vol. 15, pp. 393-395, Apr. 1990.

Okoshi,Takanori, "Polarization-State Control Schemes for Heterodyne or Homodyne Optical Fiber Communications", *Journal of Lightwave Technology*, vol. LT-3, pp. 1232-1237, Dec. 1995.
Passy, R. et al., "Experimental and Theoretical Investigations of Coherent OFDR with Semiconductor-Laser Sources", *Journal of Lightwave Technology*, vol. 12, pp. 1622-1630, Sep. 1994.
Pololeanu, Adrian G., "Unbalanced Versus Balanced Operation in an Optical Coherence Tomography System", *Applied Optics*, vol. 39, pp. 173-182, Jan. 2000.
Price, J. H. V. et al., "Tunable, Femtosecond Pulse Source Operating in the Range 1.06-1.33 mu m Based on an Yb3+-doped Holey Fiber Amplifier", *Journal of the Optical Society of America B-Optical Physics*, vol. 19, pp. 1286-1294, Jun. 2002.
Schmitt, J. M. et al., "Measurement of Optical-Properties O Biological Tissues By Low-Coherence Reflectometry" *Applied Optics*, vol. 32, pp. 6032-6042, Oct. 1993.
Silverberg, Y. et al., "Passive-Mode Locking of a Semiconductor Diode-Laser", *Optics Letters*, vol. 9, pp. 507-509, Nov. 1984.
Smith, L. Montgomery et al., "Absolute Displacement Measurements Using Modulation of the Spectrum of White-Light in a Michelson Interferometer", *Applied Optics*, vol. 28, pp. 3339-3342, Aug. 1989.
Sonnenschein, C. M. et al. , "Signal-To-Noise Relationships for Coaxial Systems that Heterodyne Backscatter from Atmosphere", *Applied Optics*, vol. 10, pp. 1600-1604, Jul. 1971.
Sorin, W. V. et al., "Measurement of Rayleigh Backscattering at 1.55 mu m with 32 mu m Spatial Resolution", *IEEE Photonics Technology Letters*, vol. 4, pp. 374-376, Apr. 1992.
Sorin, W. V. et al., "A Simple Intensity Noise-Reduction Technique for Optical Low-Coherence Reflectometry", *IEEE Photonics Technology Letters*, vol. 4, pp. 1404-1406, Dec. 1992.
Swanson, E. A. et al., "High-Speed Optical Coherence Domair Reflectometry", *Optics Letters*, vol. 17, pp. 151-153, Jan. 1992.
Takada, K. et al., "High-Resolution OFDR with Incorporated Fiberoptic Frequency Encoder", *IEEE Photonics Technology Letters*, vol. 4, pp. 1069-1072, Sep. 1992.
Takada, Kazumasa et al., "Narrow-Band light Source with Acoustic Tunable Filter for Optical Low-Coherence Reflectometry", *IEEE Photonics Technology Letters*, vol. 8, pp. 658-660, May 1996.
Takada, Kazumasa et al., "New Measurement System for Fault Location in Optical Wave-Guide Devices Based on an Interometric-Technique", *Applied Optics*, vol. 26, pp. 1603-1606, May 1987.
Tateda, Mitsuhiro et al., "Interferometric Method for Chromatic Dispersion Measurement in a Single-Mode Optical Fiber", *IEEE Journal of Quantum Electronics*, vol. 17, pp. 404-407, Mar. 1981.
Toide, M. et al., "Two-Dimensional Coherent Detection Imaging in Multiple Scattering Media Based the Directional Resolution Capability of the Optical Heterodyne Method", *Applied Physics B* (*Photophysics and laser Chemistry*), vol. B52, pp. 391-394, 1991.
Trutna, W. R. et al., "Continuously Tuned External-Cavity Semiconductor-Laser", *Journal of Lightwave Technology*, vol. 11, pp. 1279-1286, Aug. 1993.
Uttam, Deepak et al., "Precision Time Domain Reflectometry in Optical Fiber Systems Using a Frequency Modulated Continuous Wave Ranging Technique", Journal of *Lightwave Technology*, vol. 3, pp. 971-977, Oct. 1985.
Von Der Weid, J. P. et al., "On the Characterization of Optical Fiber Network Components with Optical Frequency Domain Reflectometry", Journal of *Lightwave Technology*, vol. 15, pp. 1131-1141, Jul. 1997.
Wysocki, P.F. et al., "Broad-Spectrum, Wavelength-Swept, Erbium-Doped Fiber Laser at 1.55-Mu-M", *Optics Letters*, vol. 15, pp. 879-881, Aug. 1990.
Youngquist, Robert C. et al., "Optical Coherence-Domain Reflectometry—A New Optical Evaluation Technique", *Optics Letters*, vol. 12, pp. 158-160, Mar. 1987.
Yun, S. H. et al., "Wavelength-Swept Fiber Laser with Frequency Shifted Feedback and Resonantly Swept Intra-Cavity Acoustioopic Tunable Filter", *IEEE Journal of Selected Topics in Quantium Electronics*, vol. 3, pp. 1087-1096, Aug. 1997.
Yun, S. H. et al., "Interrogation of Fiber Grating Sensor Arrays with a Wavelength-Swept Fiber Laser", *Optics Letters,* vol. 23, pp. 843-845, Jun. 1998.
Yung, K. M., "Phase-Domain Processing of Optical Coherence Tomography Images", *Journal of Biomedical Optics*, vol. 4, pp. 125-136, Jan. 1999.
Zhou, Xiao-Qun et al., "Extended-Range FMCW Reflectometry Using an optical Loop with a Frequency Shifter", *IEEE Photonics Technology Letters*, vol. 8, pp. 248-250, Feb. 1996.
Zorabedian, Paul et al., "Tuning Fidelity of Acoustooptically Controlled External Cavity Semiconductor-Lasers", *Journal of Lightwave Technology*, vol. 13, pp. 62-66, Jan. 1995.
Victor S. Y. Lin. et al., "A Porous Silicon-Based Optical Interferometric Biosensor", *Science Magazine*, vol. 278, pp. 840-843, Oct. 31, 1997.
De Boer, Johannes F. et al., "Review of Polarization Sensitive Optical Coherence Tomography and Stokes Vector Determination," *Journal of Biomedical Optics*, vol. 7, No. 3, Jul. 2002, pp. 359-371.
Jiao, Shuliang et al., "Depth-Resolved Two-Dimensional Stokes Vectors of Backscattered Light and Mueller Matrices of Biological Tissue Measured with Optical Coherence Tomography," *Applied Optics*, vol. 39, No. 34, Dec. 1, 2000, pp. 6318-6324.
Park, B. Hyde et al., "In Vivo Burn Depth Determination by High-Speed Fiber-Based Polarization Sensitive Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 6 No. 4, Oct. 2001, pp. 474-479.
Roth, Jonathan E. et al., "Simplified Methods for Polarization-Sensitive Optical Coherence Tomography," *Optics Letters*, vol. 26, No. 14, Jul. 25, 2001, pp. 1069-1071.
Hitzenberger, Christopher K. et al., "Measurement and Imaging of Birefringence and Optic Axis Orientation by Phase Resolved Polarization Sensitive Optical Coherence Tomography," *Optics Express*, vol. 9, No. 13, Dec. 17, 2001, pp. 780-790.
Wong, Brian J.F. et al., "Optical Coherence Tomography of the Rat Cochlea," Journal of *Biomedical Optics*, vol. 5, No. 4, Oct. 2000, pp. 367-370.
Yao, Gang et al., "Propagation of Polarized Light in Turbid Media: Simulated Animation Sequences," *Optics Express*, vol. 7, No. 5, Aug. 28, 2000, pp. 198-203.
Wang, Xiao-Jun et al., "Characterization of Dentin and Enamel by Use of Optical Coherence Tomography," *Applied Optics*, vol. 38, No. 10, Apr. 1, 1999, pp. 2092-2096.
De Boer, Johannes F. et al., "Determination of the Depth-Resolved Stokes Parameterss of Light Backscattered from Turbid Media by use of Polarization-Sensitive Optical Coherence Tomography," *Optics Letters*, vol. 24, No. 5, Mar. 1, 1999, pp. 300-302.
Ducros, Mathieu G. et al., "Polarization Sensitive Optical Coherence Tomography of the Rabbit Eye," *Journal of Selected Topics in Quantum Electronics*, vol. 5, No. 4, Jul./Aug. 1999, pp. 1159-1167.
Groner, Warren et al., "Orthogonal Polarization Spectral Imaging: A New Method of Study of the Microcirculation," *Nature Medicine Inc.*, vol. 5, No. 10, Oct. 1999, pp. 1209-1213.
De Boer, Johannes F. et al., "Polarization Effects in Optical Coherence Tomography of Various Biological Tissues," *IEEE Journal of Selected Topics in Quantum Electronics*, vol. 5, No. 4, Jul./Aug. 1999, pp. 1200-1204.
Yao, Gang et al., "Two-Dimensional Depth-Resolved Mueller Matrix Characterization of Biological Tissue by Optical Coherence Tomography," *Optics Letter*, Apr. 15, 1999, vol. 24, No. 8, pp. 537-539.
Lu, Shih-Yau et al., "Homogeneous and Inhomogeneous Jones Matrices," *J. Opt. Soc. Am. A.*, vol. 11, No. 2, Feb. 1994, pp. 766-773.
Brickel, S. William et al., "Stokes Vectors, Mueller Matrices, and Polarized Scattered Light," *Am. J. Phys.*, vol. 53, No. 5, May 1985 pp. 468-478.
Bréhonnet, F. Le Roy et al., "Optical Media and Target Characterization by Mueller Matrix Decomposition," *J. Phys. D: Appl. Phys.* 29, 1996, pp. 34-38.
Cameron, Brent D. et al., "Measurement and Calculation of the Two-Dimensional Backscattering Mueller Matrix of a Turbid Medium," *Optics Letters*, vol. 23, No. 7, Apr. 1, 1998, pp. 485-487.
De Boer, Johannes F. et al., "Two-Dimensional Birefringence Imaging in Biological Tissue by Polarization-Sensitive Optical Coherence Tomography," *Optics Letters*, vol. 22, No. 12, Jun. 15, 1997, pp. 934-936.

De Boer, Johannes F. et al., "Imaging Thermally Damage Tissue by Polarization Sensitive Optical Coherence Tomography," *Optics Express*, vol. 3, No. 6, Sep. 14, 1998, pp. 212-218.
Everett, M.J. et al., "Birefringence Characterization of Biological Tissue by Use of Optical Coherence Tomography," *Optics Letters*, vol. 23, No. 3, Feb. 1, 1998, pp. 228-230.
Hee, Michael R. et al., "Polarization-Sensitive Low-Coherence Reflectometer for Birefringence Characterization and Ranging," *J. Opt. Soc. Am. B.,* vol. 4, No. 6, Jun. 1992, pp. 903-908.
Barakat, Richard, "Statistics of the Stokes Parameters," *J. Opt. Soc. Am. B.,* vol. 4, No. 7, Jul. 1987, pp. 1256-1263.
Schmitt, J. M. et al., "Cross-Polarization Backscatter in Optical Coherence Tomography of Biological Tissue," *Optics Letters*, vol. 23, No. 13, Jul. 1, 1998, pp. 1060-1062.
Schoenberger, Klaus et al., "Mapping of Birefringence and Thermal Damage in Tissue by use of Polarization-Sensitive Optical Coherence Tomography," *Applied Optics*, vol. 37, No. 25, Sep. 1, 1998, pp. 6026-6036.
Piecer, Mark C., et al., "Simultaneous Intensity, Birefringence, and Flow Measurements with High-Speed Fiber-Based Optical Coherence Tomography," *Optics Letters*, vol. 27, No. 17, Sep. 1, 2002, pp. 1534-1536.
De Boer, Johannes F. et al., "Review of Polarization Sensitive Optical Coherence Tomography and Stokes Vector Determination," *Journal of Biomedical Optics*, Jul. 2002, vol. 7, No. 3, pp. 359-371.
Fried, Daniel et al., "Imaging Caries Lesions and Lesion Progression with Polarization Sensitive Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 7, No. 4, Oct. 2002, pp. 618-627.
Jiao, Shuliang et al., "Two-Dimensional Depth-Resolved Mueller Matrix of Biological Tissue Measured with Double-Beam Polarization-Sensitive Optical Coherence Tomography," *Optics Letters*, vol. 27, No. 2, Jan. 15, 2002, pp. 101-103.
Jiao, Shuliang et al., "Jones-Matrix Imaging of Biological Tissues with Quadruple-Channel Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 7, No. 3, Jul. 2002, pp. 350-358.
Kuranov, R.V. et al., "Complementary Use of Cross Polarization and Standard OCT for Differential Diagnosis of Pathological Tissues," *Optics Express*, vol. 10, No. 15, Jul. 29, 2002, pp. 707-713.
Cense, Barry et al., "In Vivo Depth-Resolved Birefringence Measurements of the Human Retinal Nerve Fiber Layer by Polarization-Sensitive Optical Coherence Tomography," *Optics Letters*, vol. 27, No. 18, Sep. 15, 2002, pp. 1610-1612.
Ren, Hongwu et al., "Phase-Resolved Functional Optical Coherence Tomography: Simultaneous Imaging of In Situ Tissue Structure, Blood Flow Velocity, Standard Deviation, Birefringence, and Stokes Vectors in Human Skin," *Optics Letters*, vol. 27, No. 19, Oct. 1, 2002, pp. 1702-1704.
Tripathi, Renu et al., "Spectral Shaping for Non-Gaussian Source Spectra in Optical Coherence Tomography," *Optics Letters*, vol. 27, No. 6, Mar. 15, 2002, pp. 406-408.
Yasuno, Y. et al., "Birefringence Imaging of Human Skin by Polarization-Sensitive Spectral Interferometric Optical Coherence Tomography," *Optics Letters*, vol. 27, No. 20, Oct. 15, 2002, pp. 1803-1805.
White, Brian R. et al., "In Vivo Dynamic Human Retinal Blood Flow Imaging Using Ultra-High-Speed Spectral Domain Optical Doppler Tomography," *Optics Express*, vol. 11, No. 25, Dec. 15, 2003, pp. 3490-3497.
De Boer, Johannes F. et al., "Improved Signal-to-Noise Ratio in Spectral-Domain Compared with Time-Domain Optical Coherence Tomography," *Optics Letters*, vol. 28, No. 21, Nov. 1, 2003, pp. 2067-2069.
Jiao, Shuling, et al., "Optical-Fiber-Based Mueller Optical Coherence Tomography," *Optics Letters*, vol. 28, No. 14, Jul. 15, 2003, pp. 1206-1208.
Jiao, Shuliang et al., "Contrast Mechanisms in Polarization-Sensitive Muller-Matrix Optical Coherence Tomography and Application in Burn Imaging," *Applied Optics*, vol. 42, No. 25, Sep. 1, 2003, pp. 5191-5197.
Moreau, Julien et al., "Fuel-Field Birefringence Imaging by Thermal-Light Polarization-Sensitive Optical Coherence Tomography. I. Theory," *Applied Optics*, vol. 42, No. 19, Jul. 1, 2003, pp. 3800-3810.
Moreau, Julien et al., "Fuel-Field Birefringence Imaging by Thermal-Light Polarization-Sensitive Optical Coherence Tomography. II. Instrument and Results," *Applied Optics*, vol. 42, No. 19, Jul. 1, 2003, pp. 3811-3818.
Morgan, Stephen P. et al., "Surface-Reflection Elimination in Polarization Imaging of Superficial Tissue," *Optics Letters*, vol. 28, No. 2, Jan. 15, 2003, pp. 114-116.
Oh, Jung-Taek et al., "Polarization-Sensitive Optical Coherence Tomography for Photoelasticity Testing of Glass/Epoxy Composites," *Optics Express*, vol. 11, No. 14, Jul. 14, 2003, pp. 1669-1676.
Park, B. Hyle et al., "Real-Time Multi-Functional Optical Coherence Tomography," *Optics Express*, vol. 11, No. 7, Apr. 7, 2003, pp. 782-793.
Shribak, Michael et al., "Techniques for Fast and Sensitive Measurements of Two-Dimensional Birefingence Distributions," *Applied Optics*, vol. 42, No. 16, Jun. 1, 2003, pp. 3009-3017.
Somervell, A.R.D. et al., "Direct Measurement of Fringe Amplitude and Phase Using a Heterodyne Interferometer Operating in Broadband Light," *Elsevier, Optics Communications*, Oct. 2003.
Stifter, D. et al., "Polarisation-Sensitive Optical Coherence Tomography for Medical Characterisation and Strain-Field Mapping," Applied Physics A 76, Materials Science & Processing, Jan. 2003, pp. 947-951.
Davé, Digant P. et al., "Polarization-Maintaining Fiber-Based Optical Low-Coherence Reflectometer for Characterization and Ranging of Birefingence," *Optics Letters*, vol. 28, No. 19, Oct. 1, 2003, pp. 1775-1777.
Yang, Ying et al., "Observations of Birefringence in Tissues from Optic-Fibre-Based Optical Coherence Tomography," *Measurement Science and Technology*, Nov. 2002, pp. 41-46.
Yun. S.H. et al., "High-Speed Optical Frequency-Domain Imaging," *Optics Express*, vol. 11, No. 22, Nov. 3, 2003, pp. 2953-5963.
Yun, S.H. et al., "High-Speed Spectral-Domain Optical Coherence Tomography at 1.3 μm Wavelength," *Optics Express*, vol. 11, No. 26, Dec. 29, 2003, pp. 3598-3604.
Zhang, Jun et al., "Determination of Birefringence and Absolute Optic Axis Orientation Using Polarization-Sensitive Optical Coherence Tomography with PM Fibers," *Optics Express*, vol. 11, No. 24, Dec. 1, 2003, pp. 3262-3270.
Pircher, Michael et al., "Three Dimensional Polarization Sensitive OCT of Human Skin In Vivo," 2004, *Optical Society of America*.
Götzinger, Erich et al., "Measurement and Imaging of Birefringencement Properties of the Human Cornea with Phase-Resolved, Polarization-Sensitive Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 9, No. 1, Jan./Feb. 2004, pp. 94-102.
Guo, Shuguang et al., "Depth-Resolved Birefringence and Differential Optical Axis Orientation Measurements with Fiber-based Polarization-Sensitive Optical Coherence Tomography," *Optics Letters*, vol. 29, No. 17, Sep. 1, 2004, pp. 2025-2027.
Huang, Xiang-Run et al., "Variation of Peripapillary Retinal Nerve Fiber Layer Birefringence in Normal Human Subjects," *Investigative Opthalmology & Visual Science*, vol. 45, No. 9, Sep. 2004, pp. 3073-3080.
Matcher, Stephen J. et al., "The Collagen Structure of Bovine Intervertebral Disc Studied Using Polarization-Sensitive Optical Coherence Tomography," *Physics in Medicine and Biology*, 2004, pp. 1295-1306.
Nassif, Nader et al., "In Vivo Human Retinal Imaging by Ultrahigh-Speed Spectral Domain Optical Coherence Tomography," *Optics Letters*, vol. 29, No. 5, Mar. 1, 2004, pp. 480-482.
Nassif, N.A. et al., "In Vivo High-Resolution Video-Rate Spectral-Domain Optical Coherence Tomography of the Human Retina and Optic Nerve," *Optics Express*, vol. 12, No. 3, Feb. 9, 2004, pp. 367-376.
Park, B. Hyle et al., Comment on "Optical Fiber-Based Mueller Optical Coherence Tomography," *Optics Letters*, vol. 29, No. 24, Dec. 15, 2004, pp. 2873-2874.
Park, B. Hyle et al., "Jone Matrix Analysis for a Polarization-Sensitive Optical Coherence Tomography System Using Fiber-Optic Components," *Optics Letters*, vol. 29, No. 21, Nov. 1, 2004, pp. 2512-2514.

Pierce, Mark C. et al., "Collagen Denaturation can be Quantified in Burned Human Skin Using Polarization-Sensitive Optical Coherence Tomography," *Elsevier, Burns*, 2004, pp. 511-517.
Pierce, Mark C. et al., "Advances in Optical Coherence Tomography Imaging for Dermatology," *The Society for Investigative Dermatology, Inc.* 2004, pp. 458-463.
Pierce, Mark C. et al., "Birefringence Measurements in Human Skin Using Polarization-Sensitive Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 9, No. 2, Mar./Apr. 2004, pp. 287-291.
Cense, Barry et al., "In Vivo Birefringence and Thickness Measurements of the Human Retinal Nerve Fiber Layer Using Polarization-Sensitive Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 9, No. 1, Jan./Feb. 2004, pp. 121-125.
Pircher, Michael et al., "Imaging Of Polarization Properties of Human Retina in Vivo with Phase Resolved Transversal PS-OCT," *Optics Express*, vol. 12, No. 24, Nov. 29, 2004 pp. 5940-5951.
Pitcher, Michael et al., "Transversal Phase Resolved Polarization Sensitive Optical Coherence Tomography," *Physics in Medicine & Biology*, 2004, pp. 1257-1263.
Srinivas, Shyam M. et al., "Determination of Burn Depth by Polarization-Sensitive Optical Coherence Tomography," *Journal of Biomedical Optics*, vol. 9, No. 1, Jan./Feb. 2004, pp. 207-212.
Strasswimmer, John et al., "Polarization-Sensitive Optical Coherence Tomography of Invasive Basal Cell Circonoma," *Journal of Biomedical Optics*, vol. 9, No. 2, Mar./Apr. 2004, pp. 292-298.
Todorovič, Miloš et al., "Determination of Local Polarization Properties of Biological Samples in the Presence of Diattenuation by use of Mueller Optical Coherence Tomography," *Optical Letters*, vol. 29, No. 20, Oct. 15, 2004, pp. 2402-2404.
Yasuno, Yoshiaki et al., "Polarization-Sensitive Complex Fourier Domain Optical Coherence Tomography for Jones Matrix Imaging of Biological Samples," Applied Physics Letters, vol. 85, No. 15, Oct. 11, 2004, pp. 3023-3025.
Acioli, L. H., M. Ulman, et al. (1991). "Femtosecond Temporal Encoding in Barium-Titante." *Optics Letters* 16(24): 1984-1986.
Aigouy, L., A. Lahrech, et al., (1999). "Polarization effects in apertectureless scanning near-filed optical microscopy: an experimental study." *Optics Letters* 24(4): 187-189.
Akiba, M., K. P. Chan, et al. (2003). "Full-filed optical coherence tomography by two-dimensional heterodyne detection with a pair of CCD cameras." *Optics Letters* 28(10): 816-818.
Akkin, T., D. P. Dave, et al., (2004). "Detection of neural activity using phase-sensitive optical low-coherence reflectometry." *Optics Express* 12(11): 2377-2386.
Akkin, T., D. P. Dave, et al. (2003). "Surface analysis using phase sensitive optical low coherence reflectometry." *Lasers in Surgery and Medicine*: 4-4.
Akkin, T., D. P. Dave, et al. (2003). "Imaging tissue response to electrical and photothermal stimulation with nanometer sensivity." *Lasers in Surgery and Medicine* 33(4): 219-225.
Akkin, T., T. E. Milner, et al. (2002). "Phase-sensitive measurement of birefringence change as an indication of neural functionality and diseases." *Lasers in Surgery and Medicine*: 6-6.
Andretzky, P., Lindner, M.W., Herrmann, J.M., Schultz, A., Konzog, M., Kiesewetter, F., Haeusler, G. (1999). "Optical coherence tomography by 'spectral radar': Dynamic range estimation and in vivo measurements of skin." *Proceedings of SPIE—The International Society for Optical Engineering* 3567: pp. 78-87.
Antcliff, R. J., T. J. ffytche, et al., (2000). "Optical coherence tomography of melanocytoma." *American Journal of Ophthalmology* 130(6): 845-7.
Antcliff, R. J., M. R. Standford, et al. (2000). "Comparison between optical coherence tomography and fundus fluorescein angiography for the detection of cystoid mascular edema in patients with uveitis." *Ophthalmology* 107(3): 593-9.
Anvari, B., T. E. Milner, et al. (1995). "Selective Cooling of Biological Tissues—Application for Thermally Mediated Therapeutic Procedures." *Physics in Medicine and Biology* 40(2): 241-252.
Anvari, B., B. S. Tanenbaum, et al. (1995). "A Theoretical-Study of the Thermal Response of Skin of Cryogen Spray Cooling and Pulsed-Laser Irradiation—Implications for Treatment of Port-Wine Stain Birthmarks." *Physics in Medicine and Biology* 40(9): 1451-1465.
Arend, O., M. Ruffer, et al. (2000). "Macular circulation in patients with diabetes mellitus with and without arterial hypertension." *British Journal of Ophthalmology* 84(12): 1392-1396.
Arimoto, H. and Y. Ohtsuka (1997). "Measurements of the complex degree of spectral coherence by use of a wave-front-folded interferometer." *Optics Letters* 22(13):958-960.
Azzolini, C., F. Patelli, et al. (2001). "Correlation between optical coherence tomography data and biomicroscopic interpretation of idiopathic macular hole." *American Journal of Ophthalmology* 132(3): 348-55.
Baba, T., K. Ohno-Matsui, et al. (2002). "Optical coherence tomography of choroidal neovascularization in high myopia." *Acta Ophthalmoloqica Scandinavica* 80(1):82-7.
Bail, M. A. H., Gerd; Herrmann, Jurgen M.; Lindner, Michael W.; Ringer, R. (1996). "Optical coherence tomography with the "spectral radar": fast optical analysis in volume scatters by short-coherence interferometry." *Proc. SPIE*, 2925: p. 298-303.
Baney, D. M. and W. V. Sorin (1993). "Extended-Range Optical Low-Coherence Reflectometry Using a Recirculating Delay Technique." *Ieee Photonics Technology Letters* 5(9): 1109-1112.
Baney, D. M., B. Szafraniec, et al. (2002). "Coherent optical spectrum analyzer." *Ieee Photonics Technology Letters* 14(3): 355-357.
Barakat, R. (1981). "Bilinear Constraints between Elements of the 4by4 Mueller-Jones Transfer-Matrix of Polarization Theory." *Optics Communications* 38(3): 159-161.
Barakat, R. (1993). "Analytic Proofs of the Arago-Fresnel Laws for the Interference of Polarized-Light." *Journal of the Optical Society of America a-Optics Image Science and Vision* 10(1): 180-185.
Barbastathis, G. and D. J. Brady (1999). "Multidimensional tomographic imaging using volume halography." *Proceedings of the Ieee* 87(12) 2098-2120.
Bardal, S., A. Kamal, et al. (1992). "Photoinduced Birefringence in Optical Fibers—a Comparative-Study of Low-Birefringence and High-Birefringence Fibers." *Optics Letters* 17(6): 411-413.
Barsky, S. H., S. Rosen, et al. (1980). "Nature and Evolution of Port Wine Stains—Computer-Assisted Study." *Journal of Investigative Dermatology* 74(3): 154-157.
Barton, J. K., J. A. Izatt, et al. (1999). "Three-dimensional reconstruction of blood vessels from in vivo color Doppler optical coherence tomography images." *Dermatology* 198(4): 355-361.
Barton, J. K., A. Rollins, et al. (2001). "Photothermal coagulation of blood vessels: a comparison of high-sped optical coherence tomography and numerical modelling." *Physics in Medicine and Biology* 46.
Barton, J. K., A. J. Welch, et al. (1988. "Investigating pulsed dye laser-blood vessel interaction with color Doppler optical coherence tomography," *Optics Express* 3.
Bashkansky, M., M. D. Duncan, et al. (1997). "Subsurface defect detection in ceramics by high-speed resolution optical coherent tomography." *Optics Letters* 22 (1): 61-63.
Bashkansky, M. and J. Reintjes (2000). "Statistics and reduction of speckle in optical coherence tomography." *Optics Letters* 25(8): 545-547.
Baumgartner, A., S. Dichtl, et al. (2000). "Polarization-sensitive optical coherence tomography of dental structures." *Caries Research* 34(1): 59-69.
Baumgartner, A., C. K. Hitzenberger, et al. (2000). "Resolution-improved dual-beam and standard optical coherence tomography: a comparison." *Graefes Archive for Clinical and Experimental Ophthalmology* 238(5): 385-392.
Baumgartner, A., C. K. Hitzenberger, et al. (1998). "Signal and resolution enhancements in dual beam optical coherence tomography of the human eye." *Journal of Biomedical Optics* 3(1): 45-54.
Beaurepaire, E., P. Gleyzes, et al. (1998) *Optical coherence microscopy for the in-depth study of biological structures: System based on a parallel detection scheme*, Proceedings os SPIE—The International Study for Optical Engineering.
Beaurepaire, E., L. Moreaux, et al. (1999). "Combined scanning optical coherence and two-photon-excited fluorescence microscopy." *Optical Letters* 24(14): 969-971.
Bechara, F. G., T. Gambichler, et al. (2004). "Histomorphologic correlation with routine histology and optical coherence tomography." *Skin Research and Technology* 10 (3): 169-173.

Bechmann, M., M. J. Thiel, et al. (2000). "Central corneal thickness determined with optical coherence tomography in various types of glaucoma. [see comments]." *British Journal of Ophthalmology* 84(11): 1233-7.
Bek, T. and M. Kandi (2000). "Quantitative anomaloscopy and optical coherence tomography scanning in central serous chorioretinopathy." *Acta Ophthalmologica Scandinavica* 78(6): 632-7.
Benoit, A. M., K. Naoun, et al. (2001)."Linear dichroism of the retinal nerve fiber layer expressed with Mueller matrices." *Applied Optics* 40(4): 565-569.
Bicout, D., C. Brosseau, et al. (1994). "Depolarization of Multiply Scattered Waves by Spherical Diffusers—Influence of the Size Parameter." *Physical Review* E 49(2): 1767-1770.
Blanchot, L., M. Lebec, et al. (1997). *Low-coherence in depth microscopy for biological tissues imaging. Design of a real time control system*. Proceedings of SPIE—The International Society for Optical Engineering.
Blumenthal, E. Z. and R. N. Weinreb (2001). "Assessment of the retinal nerve fiber layer in clinical trials of glaucoma neuroprotection. [Review] [36 refs]." *Survey of Ophthalmology* 45(Suppl 3): S305-12; discussion S332-4.
Blumenthal, E. Z., J. M. Williams, et al. (2000). "Reproducibility of nerve fiber layer thickness measurement by use of optical coherence tomography." *Ophthalmology* 107(120: 2278-82.
Boppart, S. A., B. E. Bauma, et al. (1996). "Imaging developing neural morphology using optical coherence tomography." *Journal of Neuroscience Methods* 70.
Boppart, S. A., B. E. Bauma, et al. (1997). "Forward-imaging instruments for optical coherence tomography." *Optics Letters* 22.
Boppart, S. A., B. E. Bauma, et al. (1998). "Intraoperative assessment of microsurgery with three-dimensional optical coherence tomography." *Radiology* 208: 81-86.
Boppart, S. A., J. Herrmann, et al. (1999). "High-resolution optical coherence tomography-guided laser ablation of surgical tissue." *Journal of Surgical Research* 82(2): 275-84.
Bouma, B. E. and J. G. Fujimoto (1996). "Compact Kerr-lens mode-locked resonators." *Optics Letters* 21.
Bouma, B. E., L. E. Nelson, et al. (1998). "Optical coherence tomographic imaging of human tissue at 1.55 mu m and 1.81 mu m using Er and Tm-doped fiber sources." *Journal of Biomedical Optics* 3.
Bouma, B. E., M. Ramaswamy-Paye, et al. (1997). "Compact resonator designs for mode-locked solid-state lasers." *Applied Physics B* (*Lasers and Optics*) B65.
Bouma, B. E. and G. J. Tearney (2002). "Clinical imaging with optical coherence tomography." *Academic Radiology* 9(8): 942-953.
Bouma, B. E., G. J. Tearney, et al. (1996). "Self-phase-modulated Kerr-lens mode-locked Cr:forsterite laser source for optical coherence tomography." *Optics Letters* 21(22): 1839.
Bouma, B. E. G. J. Tearney, et al. (2000). "High-Resolution imaging of the human esophagus and stomach in vivo using optical coherence tomography." *Gastrointestinal Endoscopy* 51(4): 467-474.
Bouma, B. E., G. J. Tearney, et al. (2003). "Evaluation of intracoronary stenting by intravascular optical coherence tomography." *Heart* 89(3): 317-320.
Bourquin, S., V. Monterosso, et al. (2000). "Video-rate optical low-coherence reflectometry based on a linear smart detector array." *Optics Letters* 25(2): 102-104.
Bourquin, S., P. Seitz, et al. (2001). "Optical coherence topography based on a two-dimensional smart detector array." *Optics Letters* 26(8): 512-514.
Bouzid, A., M. A. G. Abushagur, et al. (1995). "Fiber-optic four-detector polarimeter." *Optics Communications* 118(3-4): 329-334.
Bowd, C., R. N. Weinreb, et al. (2000). "The retinal nerve fiber layer thickness in ocular hypertensive, normal, and glaucomatous eyes with optical coherence tomography." *Archives of Ophthalmology* 118(1): 22-6.
Bowd, C., L. M. Zangwill, et al. (2001). "Detecting early glaucoma by assessment of retinal nerve fiber layer thickness and visual function." *Investigative ophthalmology & Visual Science*42(9): 1993-2003.
Bowd, C., L. M. Zangwill, et al. (2002). "Imaging of the optic disc and the retinal nerve fiber layer: the effects of age, optic disc area, refractive error, and gender." *Journal of the Optical Society of America, A, Optics, Image Science & Vision* 19(1): 197-207.
Brand, S., J. M. Poneros, et al. (2000). "Optical coherence tomography in the gastrointestinal tract." *Endoscopy* 32(10): 796-803.
Brezinski, M. E. and J. G. Fujimoto (1999). "Optical coherence tomography: high-resolution imaging in nontransparent tissue." *IEEE Journal of Selected Topics in Quantum Electronics* 5(4): 1185-1192.
Brezinski, M. E., G. J. Terney, et al. (1996). "Imaging of coronary artery microstructure (in vitro) with optical coherence tomography." *American Journal of Cardiology* 77(1): 92-93.
Brezinski, M. E., G. J. Tearney, et al. (1996). "Optical coherence tomography for optical biopsy—Properties and demonstration of vascular pathology." *Circulation* 96(6): 1206-1213.
Brezinski, M. E., G. J. Tearney, et al. (1997). "Assessing atherosclerotic plaque morphology: Comparison of optical coherence tomography and high frequency intravascular ultrasound." *Heart* 77(5): 397-403.
Brink, H. B. K. and G. J. Vanblokland (1988). "Birefringence of the Human Foveal Area Assessed Invivo with Mueller-Matrix Ellipsometry." *Journal of the Optical Society of America a-Optics Image Science and Vision* 5(1): 49-57.
Brosseau, C. and D. Biscout (1994). "Entropy Production in Multiple-Scattering of Light by a Spatially Random Medium." *Physical Review* E 50(6): 4997-5005.
Burgoyne, C. F., D. E. Mercante, et al. (2002). "Change detection in regional and volumetric disc parameters using longitudinal confocal scanning laser tomography." *Ophthalmology* 109(3): 455-66.
Candido, R. and T. J. Allen (2002). "Haemodynamics in microvascular complications in type 1 diabetes." *Diabetes-Metabolism Research and Reviews* 18(4): 286-304.
Cense, B., T. C. Chen, et al. (2004). "Thickness and birefringence of healthy retinal nerve fiber layer tissue measured with polarization-sensitive optical coherence tomography." *Investigative Ophthalmology & Visual Science* 45(8): 2606-2612.
Cense, B., N. Nassif, et al. (2004). "Ultrahigh-Resolution High-Speed retinal Imaging Using Spectral-Domain Optical Coherence Tomography." *Optics Express* 12(11): 2435-24473.
Chance, B., J. S. Leigh, et al. (1988). "Comparison of Time-Resolved and Time-Unresolved Measurements of Deoxyhemoglobin in Brain." *Proceedings of the National Academy of Sciences of the United States of America* 85(14): 4971-4975.
Chang, E. P., D. A. Keedy, et al. (1974). "Ultrastructures of Rabbit Corneal Stroma—Mapping of Optical and Morphological Anisotropies." *Biochemica Et Biophysica Acta* 343(3): 615-626.
Chartier, T., A. Hideur, et al. (2001). "Measurement of the elliptical birefringence of single-mode optical fibers." *Applied Optics* 40(30): 5343-5353.
Chauhan, B. C., J. w. Blanchard, et al. (2000). "Technique for Detecting Serial Topographic Changes in the Optic Disc and Peripapillary Retina Using Scanning Laser Tomograph." *Invest Ophthalmol Vis Sci* 41:775-782.
Chen, Z. P., T. E. Milner, et al. (1997). "Optical Doppler tomographic imaging of fluid flow velocity in highly scattering media." *Optics Letters* 22(1): 64-66.
Chen, Z. P., T. E. Milner, et al., (1997). "Noninvasive imaging of in vivo blood flow velocity using optical Doppler tomography." *Optics Letters* 22(14): 1119-1121.
Chen, Z. P., Y. H. Zhao, et al. (1999). "Optical Doppler tomography." *Ieee Journal of Selected Topics in Quantum Electronics* 5(4): 1134-1142.
Cheong, W. F., S. A. Prahl, et al. (1990). "A Review of the Optical-Properties of biological Tissues." *Ieee Journal of Quantum Electronics* 26(12): 2166-2185.
Chernikov, S. V., Y. Zhu, et al. (1997). "Supercontinuum self-Q-switched ytterbium fiber laser." *Optics Letters* 22(5): 298-300.
Cho. S. H., B. E. Bouma, et al. (1999). "Low-repetition-rate high-peak-power Kerr-lens mode-locked Ti:AI/sub 2/0/sub 3/ laser with a multiple-pass cavity." *Optics Letters* 24(6): 417-419.

Choma, M. A., M. V. Sarunic, et al. (2003). "Sensitivity advantage of swept source and Fourier domain optical coherence tomography ." *Optics Express* 11(18): 2183-2189.
Choma, M. A., C. H. Yang et al. (2003). "Instantaneous quadrature low-coherence interferometry with 3×3 fiber-optic couplers." *Optics Letters* 28(22): 2162-2164.
Choplin, N. T. and D. C. Lundy (2001). "The sensitivity and specificity of scanning laser polarimetry in the detection of glaucoma in a clinical setting." *Ophthalmology* 107 (5): 899-904.
Christens Barry, W. A., W. J. Green, et al. (1996). "Spatial mapping of polarized light transmission in the central rabbit cornea." *Experimental Eye Research* 62(6): 651-662.
Chvapil, M., D. P. Speer, et al. (1984). "Identification of the depth of burn injury by collagen stainability." *Plastic & Reconstructive Surgery* 73(3): 438-41.
Cioffi, G. A. (2001). "Three common assumptions about ocular blood flow and glaucoma." *Surgery of Ophthalmology* 45: S325-S331.
Coleman, A. L. (1999). "Glaucoma." *Lancet* 354(9192): 1803-10.
Collaborative Normal-Tension Glaucoma Study Group (1998). "Comparision of Glaucomatous Progression Between Untreated Patients With Normal Tension Glaucoma and Patients with Therapeutically Reduced Intraocular Pressures." *Am J Ophthalmol* 126: 487-97.
Collaborative Normal-Tension Glaucoma Study Group (1998). "The effectiveness of intraocular pressure reduction in the treatment of normal-tension glaucoma." *Am J Ophthalmol* 126: 498-505.
Collaborative Normal-Tension Glaucoma Study Group (2001). "Natural History of Normal-Tension Glaucoma." *Opthalmology* 108: 247-253.
Colston, B. W., M. J. Everett, et al. (1998). "Imaging of hard- and soft tissue structure in the oral cavity by optical coherence tomography." *Applied Optics* 37(16): 3582-3585.
Colston, B. W., U. S. Sathyam, et al. (1998). "Dental OCT." *Optics Express* 3(6): 230-238.
Congdon, N. G., D. S. Friedman, et al. (2003). "Important causes of visual impairment in the world today." *Jama—Journal of the American Medical Association* 290(15): 2057-2060.
Cregan, R. F., B. J. Mangan, et al. (1999). "Single-mode photonic band gap guidance of light in air." *Science* 285(5433): 1537-1539.
DalMolin, M., A. Galtrarossa, et al. (1997). "Experimental investigation of linear polarization in high-birefringence single-mode fibers." *Applied Optics* 36(12); 2526-2528.
Danielson, B. L. and C. D. Whittenbrg (1987). "Guided-Wave Reflectometry with Micrometer Resolution." *Applied Optics* 26(14): 2836-2842.
Dave, D. P. and T. E. Milner (2000). "Doppler-angle measurement in highly scattering media." *Optics Letters* 25(20): 1523-1525.
de Boer, J. F., T. E. Milner, et al. (1998). *Two dimensional birefringence imaging in biological tissue using phase and polarization sensitive optical coherence tomography.* Trends in Optics and Photonics (TOPS): Advances in Optical Imaging and Photon Migration, Orlando, USA, Optical Society of America, Washington, DC 1998.
de Boer, J. F., C. E. Saxer, et al. (2001). "Stable carrier generation and phase-resolved digital data processing in optical coherence tomography." *Applied Optics* 40(31): 5787-5790.
Degroot, P. and L. Deck (1993). "3-Dimensional Imaging by Sub-Nyquist Sampling of White-Light Interferograms." *Optics Letters* 18(17): 1462-1464.
Denk, W., J. H. Strickler, et al. (1990). "2-Photon Laser Scanning Fluorescence Microscopy." *Science* 248(4951): 73-76.
Descour, M. R., A. G. H. O. Karkkainen, et al. (2002). "Toward the development of miniaturized Imaging systems for detection of pre-cancer." *Ieee Journal of Quantum Electronics* 38(2): 122-130.
Dettwiller, L. (1997). "Polarization state interference: A general investigation." *Pure and Applied Optics* 6(1): 41-53.
DiCarlo, C. D., W. P. Roach, et al. (1999). "Comparison of optical coherence tomography imaging of cataracts with histopathology." *Journal of Biomedical Optics* 4.
Ding, Z., Y. Zhao, et al. (2002). "Real-time phase-resolved optical coherence tomography and optical Doppler tomography." *Optics Express* 10(5): 236-245.
Dobrin, P. B. (1996). "Effect of histologic preparation of the cross-sectional area of arterial rings." *Journal of Surgical Research* 61(2): 413-5.
Donohue, D. J., B. J. Stoyanov, et al. (1995). "Numerical Modeling of the Corneas Lamellar Structure and Birefringence Properties." *Journal of the Optical Society of America a-Optics Image Science and Vision* 12(7): 1425-1438.
Doornbos, R. M. P., R. Lang, et al. (1999). "The determination of in vivo human tissue optical properties and absolute chromophore concentrations using spatially resolved steady-state diffuse reflectance spectroscopy." *Physics in Medicine and Biology* 44(4): 967-981.
Drexler, W., A. Baumgartner, et al. (1997). "Biometric investigation of changes in the anterior eye segment during accomodation." *Vision Research* 37(19): 2789-2800.
Drexler, W., A. Baumgartner, et al. (1997). "Submicrometer precision biometry of the anterior segment of the human eye." *Investigative Ophthalmology & Visual Science* 38(7): 1304-1313.
Drexler, W., A. Baumgartner, et al. (1998). "Dual beam optical coherence tomography: signal identification for ophthalmologic diagnosis." *Journal of Biomedical Optics* 3 (1): 55-65.
Drexler, W., O. Findl, et al. (1998). "Partial coherence interferometry: A novel approach to biometry in cataract surgery." *American Journal of Ophthalmology* 126(4): 524-534.
Drexler, W., O. Findl, et al. (1997). "Clinical feasibility of dual beam optical coherence topography and tomography for ophthalmologic diagnosis." *Investigative Ophthalmology & Visual Science* 38(4): 1038-1038.
Drexler, W., C. K. Hitzenberger, et al. (1998). "Investigation of dispersion effects in ocular media by multiple wavelength partial coherence interferometry." *Experimental Eye Research* 66(1): 25-33.
Drexler, W., C. K. Hitzenberger, et al. (1996). "(Sub)micrometer precision biometry of the human eye by optical coherence tomography and topography." *Investigative Ophthalmology & Visual Science* 37(3): 4374-4374.
Drexler, W., C. K. Hitzenberger, et al. (1995). "Measurement of the Thickness of Fundus Layers by Partial Coherence Tomography." *Optical Engineering* 34(3): 701-710.
Drexler, W., U. Morgner, et al. (2001). "Ultrahigh-resolution ophthalmic optical coherence tomography." *Nature Medicine* 7 (4): 502-507.
Drexler, W., U. Morgner, et al. (2001). "Ultra-high resolution ophthalmic optical coherence tomography. [erratum appears in Nat Med 2001 May;7(5):636.]." *Nature Medicine* 7 (4): 502-7.
Drexler, W., H. Sattmann, et al. (2003). "Enhanced visualization of macular pathology with the use of ultrahigh-resolution optical coherence tomography." *Archives of Ophthalmology* 121(5): 695-706.
Drexler, W., D. Stamper, et al. (2001). "Correlation of collagen organization with polarization sensitive imaging of in vitro cartilage: implications for osteoarthritis." *Journal of Rheumatology* 28(6): 1311-8.
Droog, E. J., W. Steenbergen, et al. (2001). "Measurement of depth of burns by laser Doppler perfusion imaging." *Burns* 27(6): 561-8.
Dubois, A., K. Grieve, et al. (2004). "Ultrahigh-resolution full-field optical coherence tomography." *Applied Optics* 43(14): 2874-2883.
Dubois, A., L. Vabre, et al. (2002). "High-resolution full-field optical coherence tomography with a Linnik microscope." *Applied Optics* 41(4): 805-812.
Ducros, M., M. Laubscher, et al. (2002). "Parallel optical coherence tomography in scattering samples using a two-dimensional smart-pixel detector array." *Optics Communications* 202(1-3): 29-35.
Ducros, M. G., J. D. Marsack, et al. (2001). "Primate retina imaging with polarization-sensitive optical coherence tomography." *Journal of the Optical Society of America a-Optics Image Science and Vision* 18(12): 2945-2956.
Duncan, A., J. H. Meek, et al. (1995). "Optical Pathlength Measurements on Adult Head, Calf and Forearm and the Head of the New-born-Infant Using Phase-Resolved Optical Spectroscopy." *Physics in Medicine and Biology* 40(2): 295-304.
Eigensee, A., G. Haeusler, et al. (1996). "New method of short-coherence interferometry in human skin (in vivo) and in solid volume scaterers." *Proceedings of the SPIE—The International Society for Optical Engineering* 2925: 169-178.

Eisnebeiss, W., J. Marotz, et al. (1999). "Reflection-optical multispectral imaging method for objective determination of burn depth." *Burns* 25(8): 697-704.
Elbaum, M., M. King, et al. (1972). "Wavelength-Diversity Technique for Reduction of Speckle Size." *Journal of the Optical Society of America* 62(5): 732-&.
Ervin, J. C., H. G. Lemij, et al. (2002). "Clinician change detection viewing longitudinal stereophotographs compared to confocal scanning laser tomography in the LSU Experimental Glaucoma (LEG) Study." *Ophthalmology* 109(3): 467-81.
Essenprises, M., C. E. Elwell, et al. (1993). "Special Dependence of Temporal Point Spread Functions in Human Tissues." *Applied Optics* 32(4): 418-425.
Eun, H. C. (1995). "Evaluation of skin blood flow by laser Doppler flowmetry. [Review] [151 refs]." *Clinics in Dermatology* 13(4): 337-47.
Evans, J. A., J. M. Poneros, et al. (2004). "Application of a histopathologic scoring system to optical coherence tomography (OCT) images to identify high-grade dysplasia in Barrett's esophagus." *Gastroenterology* 126(4): A51-A51.
Feldchtein, F. I., G. V. Gelikonov, et al. (1998). "In vivo OCT imaging of hard and soft tissue of the oral cavity." *Optics Express* 3(6): 239-250.
Feldchtein, F. I., G. V. Gelikonov, et al. (1998). "Endoscopic applications of optical coherence tomography." *Optics Express* 3(6): 257-270.
Fercher, A. F., W. Drexler, et al. (1997). "Optical ocular tomography." *Neuro- Ophthalmology* 18(2): 39-49.
Fercher, A. F., W. Drexler, et al. (1994). *Measurement of optical distances by optical spectrum modulation*. Proceedings of the SPIE—The International Society for Optical Engineering.
Fercher, A. F., W. Drexler, et al. (2003). "Optical coherence tomography—principles and applications." *Reports on Progress in Physics* 66(2): 239-303.
Fercher, A. F., C. Hitzenberger, et al. (1991). "Measurement of Intraocular Optical Distances Using Partially Coherent Laser-Light." *Journal of Modern Optics* 38(7): 1327-1333.
Fercher, A. F., K. Hitzenberger, et al. (1996). *Ocular partial coherence interferometry*. Proceedings of the SPIE—The International Society for Optical Engineering.
Fercher, A. F., C. K. Hitzenberger, et al. (1993). "In-Vivo Optical Coherence Tomography." *American Journal of Ophthalmology* 116(1): 113-115.
Fercher, A. F., C. K. Hitzenberger, et al. (1994). *In-vivo dual-beam optical coherence tomography*. Proceedings of SPIE—The International Society for Optical Engineering.
Fercher, A. F., C. K. Hitzenberger, et al. (1995). "Measurement of Intraocular Distances by Backscattering Spectral Interferometry." *Optics Communications* 117(1-2): 43-48.
Fercher, A. F., C. K. Hitzenberger, et al. (2000). "A thermal light source technique for optical coherence tomography." *Optics Communications* 185(1-3): 57-64.
Fercher, A. F., C. K. Hitzenberger, et al. (2001). "Numerical dispersion compensation for Partial Coherence Interferometry and Optical Coherence Tomography." *Optics Express* 9(12): 610-615.
Fercher, A. F., C. K. Hitzenberger, et al. (2002). "Dispersion compensation for optical coherence tomography depth- scan signals by a numerical technique." *Optics Communications* 204(1-6): 67-67.
Fercher, A. F., H. C. Li, et al. (1993). "Slit Lamp Laser-Doppler Interferometer." *Lasers in Surgery and Medicine* 13(4): 447-452.
Fercher, A. F., K. Mengedoht, et al. (1988). "Eye-Length Measurement by Interferometry with Partially Coherent-Light." *Optics Letters* 13(3): 186-188.
Ferro, P., M. Haelterman, et al. (1991). "All-Optical Polarization Switch with Long Low-Birefringence Fiber." *Electronics Letters* 27(16): 1407-1408.
Fetterman, M. R., D. Goswami, et al. (1998). "Ultrafast pulse shaping: amplification and characterization." *Optics Express* 3(10): 366-375.
Findl, O., W. Drexler, et al. (2001). "Improved prediction of intraocular lens power using partial coherence interferometry." *Journal of Cataract and Refractive Surgery* 27 (6): 861-867.
Fork, R. L., C. H. B. Cruz, et al. (1987). "Compression of Optical Pulse to 6 Femtoseconds by Using Cubic Phase Compensation." *Optics Letters* 12(7): 483-485.
Foshini, G. J. and C. D. Poole (1991). "Statistical-Theory of Polarization Dispersion in Single Mode Fibers." *Journal of Lightwave Technology* 9(11): 1439-1456.
Francia, C., F. Bruyere, et al. (1998). "PMP second-order effects on pulse propagation in single-mode optical fibers." *Ieee Photonics Technology Letters* 10(12): 1739-1741.
Fried, D., R. E. Glena, et al. (1995). "Nature of Light-Scattering in Dental Enamel and Dentin at Visible and near-Infrared Wavelengths." *Applied Optics* 34(7): 1278-1285.
Fujimoto. J. G., M. E. Brezinski, et al. et al. (1995). "Optical Biopsy and Imaging Using Optical Coherence Tomography." *Nature Medicine* 1(9): 970-972.
Fukasawa, A. and H. Iijima (2002). "Optical coherence tomography of choroidal osteoma." *American Journal of Ophthalmology* 133(3): 419-21.
Fymat, A. L. (1981). "High-Resolution Interferometric Spectrophotopolarimetry." *Optical Engineering* 20(1): 25-30.
Galtarossa, A., L. Palmieri, et al. (2000). "Statistical characterization of fiber random birefringence." *Optics Letters* 25(18): 1322-1324.
Galtarossa, A., L. Palmieri, et al. (2000). "Measurements of beat length and perturbation length in long single-mode fibers." *Optics Letters* 25(6): 384-386.
Gandjbakhche, A. H., P. Mills, et al. (1994). "Light-Scattering Technique for the Study of Orientation and Deformation of Red-Blood-Cells in a Concentrated Suspension." *Applied Optics* 33(6): 1070-1078.
Garcia, N. and M. Nieto-Vesperinas (2002). "Left-handed materials do not make a perfect lens." *Physical Review Letters* 88(20).
Gelikpnov, V. M., G. V. Gelikonov, et al. (1995). "Coherent Optical Tomography of Microscopic Inhomogheneities in Biological Tissue." *Jept Letters* 61(2): 158-162.
George, N. and A. Jain (1973). "Speckle Reduction Using Multiple Tones of Illumination." *Applied Optics* 12(6): 1202-1212.
Gibson, G. N., R. Klank, et al. (1996). "Electro-optically cavity-dumped ultrashort-pulse Ti:sapphire oscillatro." *Optics Letters* 21(4): 1055.
Gil, J. J. (2000). "Characteristic properties of Mueller matrices." *Journal of the Optical Society of America a-Optics Image Science and Vision* 17(2): 328-334.
Gil, J. J. and E. Bernabeu (1987). "Obtainment of the Polarizing and Retardation Parameters of Nondepolarizing Optical-System from the Polar Decomposition of Its Mueller Matrix." *Optik* 76(2): 67-71.
Gladkova, N. D., G. A. Petrova, et al. (2000). "In vivo optical coherence tomography imaging of human skin: norm and pathology." *Skin Research and Technology* 6 (1): 6-16.
Glaessl, A., A. G. Schreyer, et al. (2001). "Laser surgical planning with magnetic resonance imaging-based 3-dimensional reconstructions for intralesional Nd: YAG laser therapy of a venous malformation of the neck." *Archives of Dermatology* 137(10): 1331-1335.
Gloesmann, M., B. Hermann, et al. (2003). "Histologic correlation of pig retina radial stratisification with ultrahigh-resolution optical coherence tomography." *Investigative Ophthalmology & Visual Science* 44(4): 1696-1703.
Goldberg, L. and D. Mehuys (1994). "High-Power Superluminenscent Diode Source." *Electronics Letter* 30(20): 1682-1684.
Goldsmith, J. A., Y. Li, et al. (2005). "Anterior chamber width measurement by high speed optical coherence tomography." *Ophthalmology* 112(2): 238-244.
Goldstein, L. E., J. A. Muffat, et al. (2003). "Cytosolic beta-amyloid deposition and supranuclear cataracts in lenses from people with Alzheimer's disease." *Lancet* 361(9365): 1258-1265.
Golubovic, B., B. E. Bouma, et al. (1996). "Thin crystal, room-temperature Cr/sup 4 +/:forstefite laser near-infrared pumping."0 *Optics Letters* 21(24): 1993-1995.
Gonzalez, S. and Z. Tannous (2002). "Real-time, in vivo confocal reflectance microscopy of basal cell carcinoma." *Journal of the American Academy of Dermatology* 47(6): 869-874.

Gordon, M. O. and M. A. Kass (1999). "The Ocular Hypertension Treatment Study: design and baseline description of the participants." *Archives of Ophthalmology* 117(5): 573-83.
Grayson, T. P., J. R. Torgerson, et al. (1994). "Observation of the Nonlocal Pancharatnam Phase-Shift in the Process of Induced Coherence without Induced Emission." *Physical Review* A 49(1): 626-628.
Greaney, M. J., D. C. Hoffman, et al. (2002). "Comparison of optic nerve imaging methods to distinguish normal eyes from those with glaucoma." *Investigative Ophthalmology & Visual Science* 43(1): 140-5.
Greenfield, D. S., H. Bagga, et al. (2002). "Macular thickness changes in glaucomatous optic neuropathy detected using optical coherence tomography." *Archives of Ophthalmology* 121(1): 41-46.
Greenfield, D. S., R. W. Knighton, et al. (2000). "Effect of corneal polarization axis on assessment of retinal nerve fiber layer thickness by scanning laser polarimetry." *America Journal of Ophthalmology* 129(6): 715-722.
Griffin, R. A., D. D. Sampson, et al. (1995). "Coherence Coding for Photonic Code-Division Multiple Networks." *Journal of Lightwave Technology* 13(9): 1826-1837.
Guedes, V., J. S. Schuman, et al. (2003). "Optical coherence tomography measurement of macular and nerve fiber layer thickness in normal and glaucomatous human eyes." *Ophthalmology* 110(1): 177-189.
Gueugniaud, P. Y., H. Carsin, et al. (2000). "Current advances in the initial management of major thermal burns. [Reviews] [76 refs]." *Intensive Care Medicine* 26(7): 848-56.
Guido, S. and R. T. Tranquillo (1993). "A Methology for the Systematic and Quantitiative Study of Cell Contact Guidance in Oriented Collagen Gels—Correlation of Fibroblast Orientation and Gel Birefringence." *Journal of Cell Science* 106: 317-331.
Gurses-Ozden, R., H. Ishikawa, et al. (1999). "Increasing sampling improves reprodicbility of optical coherence tomography measurements." *Journal of Glaucoma* 8(4): 238-41.
Guzzi, R. (1998). "Scattering Theory from Homogeneous and Coated Spheres." 1-11.
Haberland, U. B., Vladimir; Schmitt, Hans J. (1996). "Optical coherent tomography of scattering media using electrically tunable near-infrared semiconductor laser." *Applied Optics* Draft Copy.
Haberland, U. R., Walter; Blazek, Vladimir Schmitt, Hans J. (1995). "Investigation of highly scattering media using near-infrared continuous wave tunable semiconductor laser." *Proc. SPIE* , 2389: 503-512.
Hale, G. M. and M. R. Querry (1973). "Optical-Constants of Water in 200-Nm to 200-Mum Wavelength Region." *Applied Optics* 12(3): 555-563.
Hammer, D. X., R. D. Ferguson, et al. (2002). "Image stabilization for scanning laser ophthalmoscopy." *Optics Express* 10(26): 1542.
Hara, T., Y. Ooi, et al. (1989). "Transfer Characteristics of the Microchannel Spatial Light-Modulator." *Applied Optics* 28(22): 4781-4786.
Harland, C. C., S. G. Kale, et al. (2000). "Differentiation of common benign pigmented skin lesions from melanoma by high-resolution ultrasound." *British Journal of Dermatology* 143(2): 281-289.
Hartl, I. X. D. Li, et al. (2001). "Ultrahigh-resolution optical coherence tomography using continuum generation in air-silica microstructure optical fiber." *Optical Letters* 26(9): 608-610.
Hassenstein, A., A. A. Bialasiewicz, et al. (2000). "Optical coherence tomography in uveitis patients." *America Journal of Ophthalmology* 130(5): 669-70.
Hattenhauer, M. G., D. H. Johnson, et al. (1998). "The probability of blindness from open-angle glaucoma. [see comments]." *Ophthalmology* 105(1-1): 2099-104.
Hausler, G., J. M. Herrmann, et al. (1996). "Observation of light propagation in volume scatters with 10(11)-fold slow motion." *Optics Letters* 21(14): 1087-1089.
Hazebroek, H. F. and A. A. Holscher (1973). "Interferometric Ellipsometry." *Journal of Physics E-Scientific Instruments* 6(9): 822-826.
Hazebroek, H. F. and W. M. Visser (1983). "Automated Laser Interfeometric Ellipsometry and Precision Reflectometry." *Journal of Physics E-Scientific Instruments* 16(7): 654-661.
He, Z. Y., N. Mukohzaka, et al. (1997). "Selective image extraction by synthesis of the coherence function using two-dimensional optical lock-in amplifier with microchannel spatial light modulator." *Ieee Photonics Technology Letters* 9(4): 514-516.
Hee, M. R., J. A. Izatt, et al. (1993). "Femtosecond Transillumination Optical Coherence Tomography." *Optics Letters* 18(12): 950-952.
Hee, M. R., J. A. Izatt, et al. (1995). "Optical coherence tomography of the human retina." *Archives of Ophthalmology* 113(3): 325-32.
Hee, M. R., C. A. Puliafito, et al. (1998). "Tomography of diabetic macular edema with optical coherence tomogrpahy." *Ophthalmology* 105(2): 360-70.
Hee, M. R., C. A. Puliafito, et al. (1995). "Quantitative assessment of macular edema with optical coherence tomography." *Archives of Ophthalmology* 113(8): 1019-29.
Hellmuth, T. and M. Well (1998). "Simultaneous measurement of dispersion, spectrum, and distance with a fourier transform spectrometer." *Journal of Biomedical Optics* 3(1): 7-11.
Hemenger, R. P. (1989). "Birefringence of a medium of tenuous parallel cylinders." *Applied Optics* 28(18): 4030-4034.
Henry, M. (1981). "Fresnel-Arago Laws for Interference in Polarized-Light—Demonstration Experiment." *American Journal of Physics* 49(7): 690-691.
Herz, P. R., Y. Chen, et al. (2004). "Micromotor endoscope catheter for in vico, ultrahigh-resolution optical coherence tomography." *Optics Letters* 29(19): 2261-2263.
Hirakawa, H., H. Iijima, et al. (1999). "Optical coherence tomography of cystoid masular edema associated with retinitis pigmentosa." *American Journal of Ophthalmology* 128(2): 185-91.
Hitzenberger, C. K., A. Baumgartner, et al. (1994). "Interferometric Measurement of Corneal Thickness with Micrometer Precision." *American Journal of Ophthalmology* 118(4): 468-476.
Hitzenberger, C. K., A. Baumgartner, et al. (1990). "Dispersion effects in partial coherence inferometry: Implications for intraocular ranging." *Journal of Biomedical Optics* 4(1): 144-151.
Hitzenberger, C. K., A. Baumgartner, et al. (1998). "Dispersion induced multiple signal peak splitting in partial coherence interferometry." *Optics Communications* 154 (4): 179-185.
Hitzenberger, C. K., M. Danner, et al. (1999). "Measurement of the spatial coherence of superluminescent diodes." *Journal of Modern Optics* 46(12): 1763-1774.
Hitzenberger, C. K. and A. F. Fercher (1999). "Differential phase contrast in optical coherence tomography." *Optics Letters* 24(9): 622-624.
Hitzenberger, C. K., M. Sticker, et al. (2001). "Differential phase measurements in low-coherence interferometry without 2 pi ambiguity." *Optics Letters* 26(23): 1864-1866.
Hoeling, B. M., A. D. Fernandez, et al. (2000). "An optical coherence microscope for 3-dimensional imaging in developmental biology." *Optics Express* 6(7): 136-146.
Hoerauf, H., C. Scholz, et al. (2002). "Transscleral optical coherence tomography: a new imaging method for the anterior segment of the eye." *Archives of Ophthalmology* 120(6): 816-9.
Hoffmann, K., M. Happe, et al. (1998). "Optical coherence tomography (OCT) in dermatology." *Journal of Investigative Dermatology* 110(4): 583-583.
Hoh, S. T., D. S. Greenfield, et al. (2000). "Optical coherence tomography and scanning laser polarimetry in normal, ocular hypertensive, and glaucomatous eyes." *American Journal of Ophthalmology* 129(2): 129-35.
Hohenleutner, U., M. Hilbet, et al. (1995). "Epidermal Damage and Limited Coagulation Depth with the Flashlamp-Pumped Pulsed Dye-Laser—a Histochemical-Study." *Journal of Investigative Dermatology* 104(5): 798-802.
Holland, A. J. A., H. C. O. Martin, et al. (2002). "Laser Doppler imaging prediction of burn wound outcome in children." *Burns* 28(1): 11-17.
Hotake, K, and T. Okugawa (1994). "Optical Information-Processing by Synthesis of the Coherence Function." *Journal of Lightwave Technology* 12(7): 1247-1255.
Hourdakis, C. J. and A. Perris (1995). "Monte-Carlo Estimation of Tissue Optical-Properties for Use in Laser Dosimetry." *Physics in Medicine and Biology* 40(3): 351-364.

Hu, Z., F. Li, et al. (2000). "Wavelength-tunable narrow-linewidth semiconductor fiber-ring laser." *IEEE Photonics Technology Letters* 12(8): 977-979.
Huang, F., W. Yang, et al. (2001). "Quadrature spectral interferometric detection and pulse shaping." *Optics Letters* 26(6): 382-384.
Huang, X. R. and R. W. Knighton (2002). "Linear birefringence of the retinal fiber layer measured in vitro with a multispectral imaging micropolarimeter." *Journal of Biomedical Optics* 7(2): 199-204.
Huber, R., M. Wojtkowski, et al. (2005). "Amplified, frequency swept lasers for frequency domain reflectometry and OCT imaging: design and scaling principles." *Optics Express* 13(9): 3513-3528.
Hunter, D. G., J. C. Sandruck, et al. (1999). "Mathematical modeling of retinal birefringence scanning." *Journal of the Optical Society of America a-Optics Image Science and Vision* 16(9): 2103-2111.
Hurwitz, H. H. and R. C. Jones (1941). "A new calculus for the treatment of optical systems II. Proof of the general equivalence theorems." *Journal of the Optical Society of America* 31(7): 493-499.
Huttner, B., C. De Barros, et al. (1999). "Polarization-induced pulse spreading in birefringent optical fibers with zero differential group delay." *Optics Letters* 24(6): 370-372.
Huttner, B., B. Gisin, et al. (1999). "Distributed PMD measurement with a polarization-OTDR in optical fibers." *Journal of Lightwave Technology* 17(10): 1843-1848.
Huttner, B., J. Reecht, et al. (1998). "Local birefringence measurements in single-mode fibers with coherent optical frequency-domain reflectometry." *Ieee Photonics Technology Letters* 10(10): 1458-1460.
Hyde, S. C. W., N. P. Barry, et al. (1995). "Sub-100-Mu-M Depth-Resolved Holographic Imaging through Scattering Media in the near-Infrared." *Optics Letters* 20(22): 2330-2332.
Hyde, S. C. W., N. P. Barry, et al. (1995). "Depth-Resolved Holographic Imaging through Scattering Media by Photorefraction." *Optics Letters* 20(11): 1331-1333.
Iftimia, N. V., B. E. Bouma, et al. (2004). "Adaptive ranging for optical coherence tomography." *Optics Express* 12(17): 4025-4034.
Iida, T., N. Hagimura, et al. (2000). "Evaluation of central serous chorioretinopathy with optical coherence tomography." *American Journal of Ophthalmology* 129(1): 16-20.
Imai, M., H. Iijima, et al. (2001). "Optical coherence tomography of tractional macular elevations in eyes with proliferative diabetic retinopathy, [republished in Am J Opthalmol. Sep. 2001; 132(3):458-61 ; 11530091.]." *American Journal of Ophthalmology* 132(1): 81-4.
Indebetouw, G. and P. Klysubun (2000). "Imaging through scattering media with depth resolution by use of low-coherence gating in spatiotemporal digital halography." *Optics Letters* 25(4): 212-214.
Ip, M. S., B. J. Baker, et al. (2002). "Anatomical outcomes of surgery for idiopathic macular hole as determined by optical coherence tomography." *Archives of Ophthalmology* 120(1): 29-35.
Ismail, R., V. Tanner, et al. (2002). "Optical coherence tomography imaging of severe commotio retinae and associated macular hole." *British Journal of Ophthalmology* 86(4): 473-4.
Izatt, J. A., M. R. Hee, et al. (1994). "Optical Coherence Microscopy in Scattering Media." *Optics Letters* 19(8): 590-592.
Izatt, J. A., M. R. Hee, et al. (1994). "Micrometer-scale resolution imaging of the anterior eye in vivo with optical coherence tomography." *Archives of Ophthalmology* 112 (12): 1584-9.
Izatt, J. A., M. D. Kulkami, et al. (1997). "In vivo bidirectional color Doppler flow imaging of picoliter blood volumes using optical coherence tomography." *Optics Letters* 22(18): 1439-1441.
Izatt, J. A., M. D. Kulkarni, et al. (1996). "Optical coherence tomography and microscopy in gastrointestinal tissues." *IEEE Journal of Selected Topics in Quantum Electronics* 2(4): 1017.
Jacques, S. L., J. S. Nelson, et al. (1993). "Pulsed Photothermal Radiometry of Port-Wine-Stain Lesions." *Applied Optics* 32(13): 2439-2446.
Jacques, S. L., J. R. Roman, et al. (2000). "Imaging superficial tissues with polarizedlight." *Lasers in Surgery and Medicine* 26(2): 119-129.
Jang, I. K., B. E. Bouma, et al. (2002). "Visualization of coronary atherosclerotic plaques in patients using optical coherence tomography: Comparison with intravascular ultrasound." *Journal of the American College of Cardiology* 39(4): 604-609.
Jang, I. K., B. D. MacNeill, et al. (2002). "In-vivo characterization of coronary plaques in patients with ST elevation acute myocardial infarction using optical coherence tomography (OCT)." *Circulation* 106(19): 698-698 3440 Suppl. S,.
Jang, I. K., G. J. Tearney, et al. (2000). "Comparison of optical coherence tomography and intravascular ultrasound for detection of coronary plaques with large lipid-core in living patients." *Circulation* 102(18): 509-509.
Jeng, J. C., A. Bridgeman, et al. (2003). "Laser Doppler imaging determines need for excision and grafting in advance of clinical judgment: a prospective blinded trail." *Burns* 29(7): 665-670.
Jesser, C. A., S. A. Boppart, et al. (1999). "High resolution imaging of transitional cell carcinoma with optical coherence tomography: feasibility for the evaluation of bladder pathology." *British Journal of Radiology* 72: 1170-1176.
Johnson, C. A., J. L. Keltner, et al. (2002). "Baseline visual field characteristics in the ocular hypertension treatment study." *Ophthalmology* 109(3): 432-7.
Jones, R. C. (1941). "A new calculus for the treatment of the optical systems III. The Sohncke theory of optical activity." *Journal of the Optical Society of America* 31 (7): 500-503.
Jones, R. C. (1941). "A new calculus for the treatment of optical systems I. Description and discussion of the calculus." *Journal of the Optical Society of America* 31(7): 488-493.
Jones, R. C. (1942). "A new calculus for the treatment of optical systems. IV." *Journal of the Optical Society of America* 32(8): 486-493.
Jones, R. C. (1947). "A New Calculus for the Treatment of Optical Systems .6. Experimental Determination of the Matrix." *Journal of the Optical Society of America* 37(2): 110-112.
Jones, R. C. (1947). "A New Calculus for the Treatment of Optical Systems .5. A More General Formulation, and Description of Another Calculus." *Journal of the Optical Society of America* 37(2): 107-110.
Jones, R. C. (1948). "A New Calculus for the Treatment of Optical Systems .7. Properties of the N-Matrices." *Journal of the Optical Society of America* 38(8): 671-685.
Jones, R. C. (1956). "New Calculus for the Treatment of Optical Systems .8. Electromagnetic Theory." *Journal of the Optical Society of America* 46(2): 126-131.
Jopson, R. M., L. E. Nelson, et al. (1999). "Measurement of second-order polarization-mode dispersion vectors in optical fibers." *Ieee Photonics Technology Letters* 11 (9): 1153-1155.
Jost, B. M., A. V. Sergienko, et al. (1998). "Spatial correlations of spontaneous down-converted photon pairs detected with a single-photon-sensitive CCD camera." *Optics Express* 3(2): 81-88.
Kaplan, B., E. Compain, et al. (2000). "Phase-modulated Mueller ellipsometry characterization of scattering of latex sphere suspensions." *Applied Optics* 39 (4): 629-636.
Kass, M. A., D. K. Heuer, et al. (2002). "The Ocular Hypertension Treatment Study: a randomized trial determines that topical ocular hypotensive medication delays or prevents the onset of primary open-angle glaucoma." *Archives of Ophthalmology* 120(6): 701-13; discussion 829-30.
Kasuga, Y. Y. Arai, et al. (2000). "Optical coherence tomography to confirm early closure of macular holes." *American Journal of Ophthalmology* 130(5): 675-6.
Kaufman, T., S. N. Lusthaus, et al. (1990). "Deep Partial Skin Thickness Burns—a Reproducible Animal-Model to Study Burn Wound-Healing." *Burns* 16(1): 13-16.
Kemp, N. J., J. Park, et al. (2005). "High-sensitivity determination of birefringence in turbid media with enhanced polarization-sensitive optical coherence tomography." *Journal of the Optical Society of America a-Optics Image Science and Vision* 22(3): 552-560.
Kerrigan-Baumrind, L. A. H. A. Quigley, et al. (2000). "Number of ganglion cells in glaucoma eyes compared with threshold visual field tests in the same persons." *Investigative Ophthalmology & Visual Science* 41(3): 741-8.
Kesen, M. R., G. L. Spaeth, et al. (2002). "The Heidelberg Retina Tomograph vs clinical impression in the diagnosis of glaucoma." *American Journal of Ophthalmology* 133(5): 613-6.

Kienle, A., and R. Hibst (1995). "A New Optimal Wavelength for Treatment of Port-Wine Stains." *Physics in Medicine and Biology* 40(10): 1559-1576.
Kienle, A., L. Lilge, et al. (1996). "Spatially resolved absolute diffuse reflectance measurements for noninvasive determination of the optical scattering and absorption coefficients of biological tissue." *Applied Optics* 35(13): 2304-2314.
Kim, B. Y. and S. S. Choi (1981). "Analysis and Measurement of Birefringence in Single-Mode Fibers Using the Backscattering Method." *Optics Letters* 6(11): 578-580.
Kimel, S., L. O. Svaasand et al. (1994). "Differential Vascular-Response to Laser Photothermolysis." *Journal of Investigative Dermatology* 103(5): 693-700.
Kloppemberg, F. W. H., G. Beerthuizen, et al. (2001). "Perfusion of burn wounds assessed by Laser Doppler Imaging is related to burn depth an healing time." *Burns* 27(4): 359-363.
Knighton, R. W. and X. R. Huang (2002). "Analytical methods for scanning laser polarimetry." *Optics Express* 10(21): 1179-1189.
Knighton, R. W., X. R. Huang, et al. (2002). "Analytical mode of scanning laser polarimetry for retinal nerve fiber layer assessment." *Investigative Ophthalmology & Visual Science* 43(2): 383-392.
Knuettel, A. R. S., Joseph M.: Shay, M.; Knutson, Jay R. (1994). "Stationary low-coherence light imaging and spectroscopy using a CCD camera." *Proc. SPIE*, vol. 2135: p. 239-250.
Knuttel, A. and M. Boehlau-Godau (2000). "Spatially confined and temporally resolved refractive index and scattering evaluation in human skin performed with optical coherence tomography." *Journal of Biomedical Optics* 5(1): 83-92.
Knuttel, A. and J. M. Schmitt (1993). "Stationary Depth-Profiling Reflectometer Based on Low-Coherence Interferometry." *Optics Communications* 102(3-4): 193-198.
Knuttel, A., J. M. Schmitt, et al. (1994). "Low-Coherence Reflectometry for Stationary Lateral and Depth Profiling with Acoustoopic Deflectors and a Ccd Camera." *Optics Letters* 19(4): 302-304.
Kobayashi, M., H. Hanafusa, et al. (1991). "Polarization-Independent Interferometric Optical-Time-Domain Reflectometer." *Journal of Lightwave Technology* 9(5): 623-628.
Kolios, M. C., M. D. Sherar, et al. (1995). "Large Blood-Vessel Cooling in Heated Tissues—a Numerical Study." *Physics in Medicine and Biology* 40(4): 477-494.
Koozekanani, D., K. Boyer, et al. (2001). "Retinal thickness measurements from optical coherence tomography using a Markov boundary model." *Ieee Transactions on Medical Imaging* 20(9): 900-916.
Kop, R. H. J. and R. Sprik (1995). "Phase-sensitive Interferometry with ultrashort optical pulses." *Review of Scientific Instruments* 66(12): 5459-5463.
Kramer, R. Z., J. Bella, et al. (1999). "Sequence dependent conformational variations of collagen triple-helical structure." *Nature Structural Biology* 6(5): 454-7.
Kulkarni, M. D., T. G. van Leeuwen, et al. (1998). "Velocity-estimation accuracy and frame-rate limitations in color Doppler optical coherence tomography." *Optics Letters* 23(13): 1057-1059.
Kwon, Y. H., C. S. Kim, et al. (2001). "Rate of visual field loss and long-term visual outcome in primary open-angle glaucoma." *American Journal of Ophthalmology* 132(1): 47-56.
Kwong, K. F., D. Yankelevich, et al. (1993). "400-Hz Mechanical Scanning Optical Delay-Line." *Optics Letters* 18(7): 558-560.
Landers, J., I. Goldberg, et al. (2002). "Analysis of risk factors that may be associated with progression from ocular hypertension to primary open angle glaucoma." *Clin Experiment Ophthalmology* 30(4): 242-7.
Laszlo, A. and A. Venetianer (1998). Heat resistance in mammalian cells: Lessons and challenges. *Stress of Life*. 851: 169-178.
Laszlo, A. and Venetianer (1998). "Heat resistance in mammalian cells: lesson and challenges. [Review] [52 refs]." *Annals of the New York Academy of Sciences* 851: 169-78.
Laufer, J., R. Simpson, et al. (1998). "Effect of temperature on the optical properties of ex vivo human dermis and subdermis." *Physics in Medicine and Biology* 43(9): 2479-2489.
Lederer, D. E., J. S. Shuman, et al. (2003). "Analysis of macular volume in normal and glaucomatous eyes using optical coherence tomography." *American Journal of Ophthalmology* 135(6): 838-843.
Lee, P. P., Z. W. Feldman, et al. (2003). "Longitudinal prevalence of major eye diseases." *Archives of Ophthalmology* 121(9): 1303-1310.
Lehrer, M. S., T. T. Sun, et al. (1998)."Strategies of opithelial repair: modulation of stem cell and transit amplifying cell proliferation." *Journal of Cell Science* 111(Pt 19): 2867-75.
Leibowitz, H. M., D. E. Krueger, et al. (1980). "The Framingham Eye Study monograph: An ophthalmological and epidemiological study of cataract, glaucoma, diabetic retinopathy, macular degeneration, and visual acuity in a general population of 2631 adults, 1973-1975." *Survey of Ophthalmology* 24(Suppl): 335-610.
Leitgeb, R., C. K. Hitzenberger, et al. (2003). "Performance of fourier domain vs. time domain optical coherence tomography." *Optics Express* 11(8): 889-894.
Leitgeb, R., L. F. Schmetterer, et al. (2002). "Flow velocity measurements by frequency domain short coherence interferometry." *Proc. SPIE* 4619: 16-21.
Leitgeb, R. A., W. Drexler, et al. (2004). "Ultrahigh resolution Fourier domain optical coherence tomography." *Optics Express* 12(10): 2156-2165.
Leitgeb, R. A., C. K. Hitzenberger, et al. (2003). "Phase-shifting algorithm to achieve high-speed long-depth-range probing by frequency-domain optical coherence tomography." *Optics Letters* 28(22): 2201-2203.
Leitgeb, R. A., L. Schmetterer, et al. (2003). "Real-time assessment of retinal blood flow with ultrafast acquisition by color Doppler Fourier domain optical coherence tomography." *Optics Express* 11(23): 3116-3121.
Leitgeb, R. A., L. Schmetterer, et al. (2004). "Real-time measurement of in vitro flow by Fourier-domain color Doppler optical coherence tomography." *Optics Letters* 29 (2): 171-173.
LeRoyBrehonnet, F. and B. LeJeune (1997). "Utilization of Mueller matrix formalism to obtain optical targets depolarization and polarization properties." *Progress in Quantum Electronics* 21(2): 109-151.
Leske, M. C., A. M. Connell, et al. (1995). "Risk factors for open-angle glaucoma. The Barbados Eye Study. [see comments]." *Archives of Ophthalmology* 113(7): 918-24.
Leske, M. C., A. M. Connell, et al. (2001). "Incidence of open-angle glaucoma: the Barbados Eye Studies. The Barbados Eye Studies Group. [see comments]." *Archives Ophthalmology* 119(1): 89-95.
Leske, M. C., A. Heijl, et al. (1999). "Early Manifest Glaucoma Trial. Design and Baseline Data." *Ophthalmology* 106(11): 2144-2153.
Lewis, S. E., J. R. DeBoer, et al. (2005). "Sensitive, selective, and analytical improvements to a porous silicon gas sensor." *Sensors and Actuators B: Chemical* 110(1): 54-65.
Lexer, F., C. K. Hitzenberger, et al. (1999). "Dynamic coherent focus OCT with depth-independent transversal resolution." *Journal of Modern Optics* 46(3): 541-553.
Li, X., C. Chudoba, et al. (2000). "Imaging needle for optical coherence tomography." *Optics Letters* 25: 1520-1522.
Li, X., T. H. Ko, et al. (2001). "Intraluminal fiber-optic Doppler imaging catheter for structural and functional optical coherence tomography." *Optics Letters* 26: 1906-1908.
Liddington, M. I. and P. G. Shakespeare (1996). "Timing of the thermographic assessment of burns." *Burns* 22(1): 26-8.
Lindmo, T., D. J. Smithies, et al. (1998). "Accuracy and noise in optical Doppler tomography studied by Monte Carlo simulation." *Physics in Medicine and Biology* 43(10): 3045-3064.
Liu, J., X. Chen, et al. (1999). "New thermal wave aspects on burn evaluation of skin subjected to instantaneous heating." *IEEE Transactions on Biomedical Engineering* 46(4): 420-8.
Luke, D. G., R. McBride, et al. (1995). "Polarization mode dispersion minimization in fiber-wound piezoeletric cylinders." *Optics Letters* 20(24): 2550-2552.
MacNiell, B. D., I. K. Jang, et al. (2004). "Focal and multi-focal plaque distributions in patients with macrophage acute and stable presentations of coronary artery disease." *Journal of the American College of Cardiology* 44(5): 972-979.

Mahgerefteh, D. and C. R. Menyuk (1999). "Effect of first-order PMD compensation on the statistics of pulse broadening in a fiber with randomly varying birefringence." *Ieee Photonics Technology Letters* 11(3): 340-342.
Maitland, D. J. and J. T. Walsh, Jr. (1997). "Quantitative measurements of linear birefringence during heating of native collagen." *Lasers in Surgery & Medicine* 20 (3): 310-8.
Majaron, B., S. M. Srinivas, et al. (2000). "Deep coagulation of dermal collagen with repetitive Er: YAG laser irradation." *Lasers in Surgery and Medicine* 26(2): 215-222.
Mansuripur, M. (1991). "Effects of High-Numerical-Aperture Focusing on the State of Polarization in Optical and Magnetoopic Data Storage Systems." *Applied Optics* 30(22): 3154-3162.
Marshall, G. W., S. J. Marshall, et al. (1997). "The dentin substrate: structure and properties related to bonding." *Journal of Dentistry* 25(6): 441-458.
Martin, P. (1997). "Wound healing—Aiming for perfect skin regeneration." *Science* 276 (5309): 75-81.
Martinez, O. E. (1987). "3000 Times Grating Compressor with Positive Group-Velocity Dispersion—Application to Fiber Compensation in 1.3-1.6 Mu-M region." *Ieee Journal of Quantum Electronics* 23(1): 59-64.
Martinez, O. E., J. P. Gordon, et al. (1984). "Negative Group-Velocity Dispersion Using Refraction." *Journal of the Optical Society of America a-Optics Image Science and Vision* 1(10): 1003-1006.
McKinney, J. D., M. A. Webster, et al. (2000). "Characterization and imaging in optically scattering media by use of laser speckle and a variable-coherence source." *Optics Letters* 25(1): 4-6.
Miglior, A., M. Casula, et al. (2001). "Clinical ability of Heidelberg retinal tomograph examination to detect glaucomatous visual field changes." *Ophthalmology* 108 (9): 1621-7.
Milner, T. E., D. M. Goodman, et al. (1996). "Imaging laser heated subsurface chromophores in biological materials: Determination of lateral physical dimensions." *Physics in Medicine in Biology* 41(1): 31-44.
Milner, T. E., D. M. Goodman, et al. (1995). "Depth Profiling of Laser-Heated Chromophores in Biological Tissues by Pulsed Photothermal Radiometry." *Journal of the Optical Society of America a-Optics Image Science and Vision* 12 (7): 1479-1488.
Milner, T. E., D. J. Smithies, et al. (1996). "Depth determination of chromophores in human skin by pulsed photothermal radiometry." *Applied Optics* 35(19): 3379-3385.
Mishchenko. M. I. and J. W. Hovenier (1995). "Depolarization of Light Backscattered by Randomly Oriented Nonspherical Particles." *Optics Letters* 20(12): 1356-&.
Mistlberger, A., J. M. Liebermann, et al. (1999). "Heidelberg retinal tomography and optical coherence tomography in normal, ocular-hypertensive, and glaucomatous eyes." *Ophthalmology* 106(10): 2027-32.
Mitsui, T. (1999). "High-speed detection of ballistic photons propatating through suspensions using spectral interferometry." *Japanese Journal of Applied Physics* Part 1—Regular Papers Short Notes & review Papers 38(5A): 2978-2982.
Molteno, A. C., N. J. Bosma, et al. (1999). "Otago glaucoma surgery outcome study: long-term results of trabeculectomy—1976 to 1995." *Ophthalmology* 106(9): 1742-50.
Morgener, U., W. Drexler, et al. (2000). "Spectroscopic optical coherence tomography." *Optics Letters* 25(2): 111-113.
Morgener, U., F. X. Kartner, et al. (1999) . "Sub-two-cycle pulses from a Kerr-lens mode-locked Ti : sapphire laser (vol. 24, p. 411, 1999)." *Optics Letters* 24(13): 920-920.
Mourant, J. R., A. H. Hielscher, et al. (1998). "Evidence of intrinsic differences in the light scattering properties of tumorigenic and nontumorigenic cells." *Cancer Cytopathology* 84(6): 366-374.
Muller, M., J. Squier, et al. (1998). "Dispersion pre-compensation of 15 femtosecond optical pulses for high-numerical-aperture objectives." *Journal of Microscopy-Oxford* 191: 141-150.
Muscat, S., N. McKay, et al. (2002). "Repeatability and reproducibility of corneal thickness measurements by optical coherence tomography." *Investigative Ophthalmology & Visual Science* 43(6): 1971-5.
Musch, D. C., P. R. Lichter, et al. (1999). "The Collaborative Initial Glaucoma Treatment Study. Study Design, Methods, and Baseline Characteristics of Enrolled Patients." *Ophthalmology* 106: 653-662.
Neerken, S., Lucassen, G. W., Bisschop, M.A., Lenderink, E., Nuijs, T.A.M. (2004). "Characterization of age-related effects in human skin: A comparative study that applies confocal laser scanning microscopy and optical coherence tomography." *Journal of Biomedical Optics* 9(2): 274-281.
Nelson, J. S., K. M. Kelly, et al. (2001). "Imaging blood flow in human port-wine stain in situ and in real time using optical Doppler tomography." *Archives in Dermatology* 137(6): 741-744.
Newson T. P., F. Farashi, et al. (1988). "Combined Interferometric and Polarimetric Fiber Optic Temperature Sensor with a Short Coherence Length Source." *Optics Communications* 68(3): 161-165.
November, L. J. (1993). "Recovery of the Matrix Operators in the Similarity and Congruency Transformations—Applications in Polarimetry." *Journal of the Optical Society of America a-Optics Image Science and Vision* 10(4): 719-739.
Oh, W. Y., S. H. Yun, et al. (2005). "Wide tuning range wavelength-swept laser with two semiconductor optical amplifiers." *Ieee Photonics Technology Letters* 17(3): 678-680.
Oka, K. and T. Kato (1999). "Spectroscopic polarimetry with a channeled spectrum." *Optics Letters* 24(21): 1475-1477.
Okugawa, T. and K. Rotate (1996). "Real-time optical image processing by synthesis of the coherence function using real-time holography." *Ieee Photonics Technology Letters* 8(2): 257-259.
Oshima, M., R. Torii, et al. (2001). "Finite element simulation of blood flow in the cerebral artery." *Computer Methods in Applied Mechanics and Engineering* 191 (6-7): 661-671.
Pan, Y. T., H. K. Xie, et al. (2001). "Endoscopic optical coherence tomography based on a microelectromechanical mirror." *Optics Letters* 26(24): 1966-1968.
Parisi, V., G. Manni, et al. (2001). "Correlation between optical coherence tomography, pattern electroretinogram, and visual evoked potentials in open-angle glaucoma patients." *Ophthalmology* 108(5): 905-12.
Park, B. H., M. C. Pierce, et al. (2005). "Real-time fiber-based multi-functional spectral-domain optical coherence tomography at 1.3 mu m." *Optics Express* 13(11): 3931-3944.
Park, D. H., J. W. Hwang, et al. (1998). "Use of laser Doppler flowmetry for estimation of the depth of burn." *Plastic and Reconstructive Surgery* 101(6): 1516-1523.
Pendry, J. B., A. J. Holden, et al. (1999). "Magnetism from conductors and enhanced nonlinear phenomena." *Ieee Transactions on Microwave Theory and Techniques* 47(11): 2075-2084.
Penninckx, D. and V. Morenas (1999). "Jones matrix of polarization mode dispersion." *Optics Letters* 24(13): 875-877.
Pierce, M. C., M. Shishkov, et al. (2005). "Effects of sample arm motion in endoscopic polarization-sensitive optical coherence tomography." *Optics Express* 13(15): 5739-5749.
Pircher, M., E. Gotzinger, et al. (2003). "Measurement and imaging of water concentration in human cornea with differential absorption optical coherence tomography." *Optics Express* 11(18): 2190-2197.
Pircher, M., E. Gotzinger, et al. (2003). "Speckle reduction in optical coherence tomography by frequency compounding." *Journal of Biomedical Optics* 8(3): 565-569.
Podoleanu, A. G., G. M. Dobre, et al. (1998). "En-face coherence imaging using galvanometer scanner modulation." *Optics Letters* 23(3): 147-149.
Podoleanu, A. G. and D. A. Jackson (1999). "Noise analysis of a combined optical coherence tomograph and confocal scanning ophthalmoscope." *Applied Optics* 38(10): 2116-2127.
Podoleanu, A. G., J. A. Rogers, et al. (2000). "Three dimensional OCT images from retina and skin." *Optics Express* 7(9): 292-298.
Podoleanu, A. G., M. Seeger, et al. (1998). "Transversal and longitudinal images from the retina of the living eye using low coherence reflectomtry."*Journal of Biomedical Optics* 3(1): 12-20.
Poole, C. D. (1988). "Statistical Treatment of Polarization Dispersion in Single-Mode Fiber." *Optics Letters* 13(8): 687-689.
Povazay, B., K. Bizheva, et al. (2002). "Submicrometer axial resolution optical coherence tomography." *Optics Letters* 27(20): 1800-1802.

Qi, B., A. P. Himmer, et al. (2004). "Dynamic focus control in high-speed optical coherence tomography based on a microelectromechanical mirror." *Optics Communications* 232(1-6): 123-128.
Radhakrishnan, S., A. M. Rollins, et al. (2001). "Real-time optical coherence tomography of the anterior segment at 1310 nm." *Archives of Ophthalmology* 119(8): 1179-1185.
Rogers, A. J. (1981). "Polarization-Optical Time Domain Reflectometry—a Technique for the Measurement of Field Distributions." Applied Optics 20(6): 1060-1074.
Rollins, A. M. and J. A. Izatt (1999). "Optimal interferometer designs for optical coherence tomography." *Optics Letters* 24(21): 1484-1486.
Rollins, A. M., R. Ung-arunyawee, et al. (1999). "Real-time in vivo imaging in human gastrointestinal ultrastructure by use of endoscopic optical coherence tomography with a novel efficient interferometer design." *Optics Letters* 24(19): 1358-1360.
Rollins, A. M., S. Yazdanfar, et al. (2002). "Real-time in vivo colors Doppler optical coherence tomography." *Journal of Biomedical Optics* 7(1): 123-129.
Rolllins, A. M., S. Yazdanfar, et al. (2000). "Imaging of human retinal hemodynamics using color Doppler optical coherence tomography." *Investigative Ophthalmology & Visual Science* 41(4): S548-S548.
Sandoz, P. (1997). "Wavelet transform as a processing tool in white-light interferometry." *Optics Letters* 22(14): 1065-1067.
Sankaran, V., M. J. Everett, et al. (1999). "Comparison of polarized-light propagation in biological tissue and phantoms." *Optics Letters* 24(15): 1044-1046.
Sankaran, V., J. T. Walsh, et al. (2000). "Polarized light propagation through tissue phantom, ehms containing densely packed scatterers." *Optics Letters* 25(4): 239-241.
Sarunic, M. V., M. A. Choma, et al. (2005). "Instantaneous complex conjugate resolved spectral domain and swept-source OCT using 3×3 couplers." *Optics Express* 13(3): 957-967.
Sathyam, U. S., B. W. Colston, et al. (1999). "Evaluation of optical coherence tomography quantitation of analytes in turbid media by use of two wavelengths." *Applied Optics* 38(10): 2097-2104.
Schmitt, J. M. (1997). "Array detection for speckle reduction in optical coherence microscopy." *Physics in Medicine and Biology* 42(7): 1427-1439.
Schmitt, J. M. (1999). "Optical coherence tomography (OCT): A review." *Ieee Journal of Selected Topics in Quantum Electronics* 5(4): 1205-1215.
Schmitt, J. M. and A. Knuttel (1997). "Model of optical coherence tomography of heterogeneous tissue." *Journal of the Optical Society of America a-Optics Image Science and Vision* 14(6): 1231-1242.
Schmitt, J. M., S. L. Lee, et al. (1997). "An optical coherence microscope with enhanced resolving power in thick tissue." *Optics Communications* 142(4-6): 203-207.
Schmitt, J. M., S. H. Xiang, et al. (1998). "Differential absorption with optical coherence tomography." *Journal of the Optical Society of America a-Optics Image Science and Vision* 15(9): 2288-2296.
Schmitt, J. M., S. H. Xiang, et al. (1999). "Speckle in optical coherence tomography." *Journal of Biomedical Optics* 4(1): 95-105.
Schmitt, J. M., M. J. Yadlowsky, et al. (1995). "Subsurface Imaging of Living Skin with Optical Coherence Microscopy." *Dermatology* 191(2): 93-98.
Shi, H., J. Finlay, et al. (1997). "Multiwavelength 10-GHz picosecond pulse generation from a single-stripe semiconductor diode laser." *Ieee Photonics Technology Letters* 9(11): 1439-1441.
Shi. H., I. Nitta, et al. (1999). "Demonstration of phase correlation in multiwavelength mode-locked semiconductor diode lasers." *Optics Letters* 24(4): 238-240.
Simon, R. (1982). "The Connection between Mueller and Jones Matrices of Polarization Optics." *Optics Communications* 42(5): 293-297.
Smithies, D. J., T. Lindmo, et al. (1998). "Signal attenuation and localization in optical coherence tomography studied by Monte Carlo simulation." *Physics in Medicine and Biology* 43(10): 3025-3044.
Sorin, W. V., and D. F. Gray (1992). "Simultaneous Thickness and Group Index Measurement Using Optical Low-Coherence Reflectometry." *Ieee Photonics Technology Letters* 4(1): 105-107.
Sticker, M., C. K. Hitzenberger, et al. (2001). "Quantitative differential phase measurement and imaging in transparent and turbid media by optical coherence tomography." *Optics Letters* 26(8): 518-520.
Sticker, M., M. Pircher, et al. (2002). "En face imaging of single cell layers by differential phase-contrast optical coherence microscopy." *Optics Letters* 27(13): 1126-1128.
Stoller, P., B. B. M. Kim, et al. (2002). "Polarization-dependent optical second-harmonic imaging of a rat-tail tendon." *Journal of Biomedical Optics* 7(2): 205-214.
Sun, C. S. (2003). "Multiplexing of fiber-optic acoustic sensors in Michelson interferometer configuration." *Optics Letters* 28(12): 1001-1003.
Swanson, E. A., J. A. Izatt, et al. (1993). "In-Vivo Retinal Imaging by Optical Coherence Tomography." *Optics Letters* 18(21): 1864-1866.
Takada, K., A. Himeno, et al. (1991). "Phase-Noise and Shot-Noise Limited Operations of Low Coherence Optical-Time Domain Reflectometry." *Applied Physics Letters* 59(20): 2483-2485.
Takenaka, H. (1973). "Unified Formalism for Polarization Optics by Using Group-Theory I (Theory)," *Japanese Journal of Applied Physics* 12(2): 266-231.
Tanno, N., T. Ichimura, et al. (1994). "Optical Multimode Frequency-Domain Reflectometer." *Optics Letters* 19(8): 587-589.
Tan-no, T. Ichumura, et al. (1994). "Optical Multitude Frequency-Domain Reflectometer." *Optics Letters* 19(8): 587-589.
Targowski, P., M. Wojtkowski, et al. (2004). "Complex spectral OCT in human eye imaging in vivo." *Optics Communications* 229(1-6): 79-84.
Tearney, G. J., S. A. Boppart, et al. (1996). "Scanning single-mode fiber optic catheter- endoscope for optical coherence tomography (vol. 21, p. 543, 1996)." *Optics Letters* 21(12): 912-912.
Tearney, G. J., B. E. Bouma, et al. (1996). "Rapid acquisition of in vivo biological images by use of optical coherence tomography." *Optics Letters* 21(17): 1408-1410.
Tearney, G. J., B. E. Bouma, et al. (1997). "In vivo endoscopic optical biopsy with optical coherence tomography." *Science* 276(5321): 2037-2039.
Tearney, G. J., M. E. Brezinski, et al. (1996). "Catheter-based optical imaging of a human coronary artery." *Circulation* 94(11): 3013-3013.
Tearney, G. J., M. E. Brezinski, et al. (1997). "In vivo endoscopic optical biopsy with optical coherence tomography." *Science* 276(5321): 2037-9.
Tearney, G. J., M. E. Brezinski, et al. (1997). "Optical biopsy in human gastrointestinal tissue using optical coherence tomography." *American Journal of Gastroenterology* 92(10): 1800-1804.
Tearney, G. J., M. E. Brezinski, et al. (1995). "Determination of the refractive index of highly scattering human tissue by optical coherence tomography." *Optics Letters* 20(21): 2258-2260.
Tearney, G. J., I. K. Jang, et al. (2000). "Porcine coronary imaging in vivo by optical coherence tomography." *Acta Cardiologica* 55(4): 233-237.
Tearney, G. J., R. H. Webb, et al. (1998). "Spectrally encoded confocal microscopy." *Optics Letters* 23(15): 1152-1154.
Tearney, G. J., H. Yabushita, et al. (2003). "Quantification of macrophage content in atherosclerotic plaques by optical coherence tomography." *Circulation* 107(1): 113-119.
Tower, T. T. and R. T. Tranquillo (2001). "Alignment maps of tissues: I. Microscopic elliptical polarimetry." *Biophysical Journal* 81(5): 2954-2963.
Tower, T. T. and R. T. Tranquillo (2001). "Alignment maps of tissues: II. Fast harmonic analysis for imaging." *Biophysical Journal* 81(5): 2964-2971.
Troy, T. L. and S. N. Thennadil (2001). "Optical properties of human skin in the near infrared wavelength range of 1000 to 2200 nm." *Journal of Biomedical Optics* 6 (2): 167-176.
Vabre, L., A. Dubois, et al. (2002). "Thermal-light full-field optical coherence tomography." *Optics Letters* 27(7): 530-532.
Vakhtin, A. B., D. J. Kane, et al. (2003). "Common-path interferometer for frequency-domain optical coherence tomography." *Applied Optics* 42(34): 6953-6958.
Vakhtin, A. B., K. A. Peterson, et al. (2003. "Differential spectral interferometry: an imaging technique for biomedical applications," *Optics Letters* 28(15): 1332-1334.

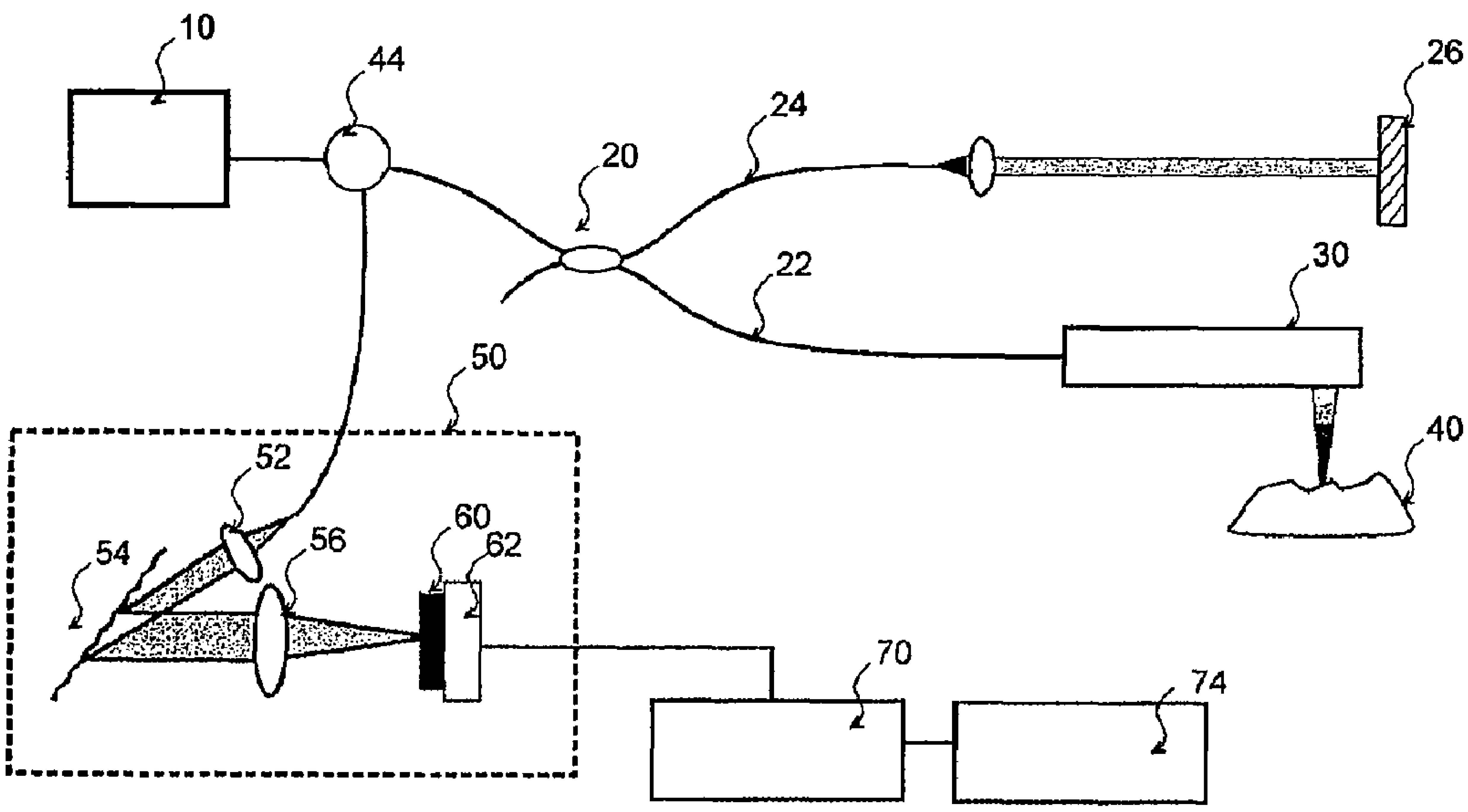
Vakoc, B. J., S. H. Yun, et al. (2005). "Phase-resolved optical frequency domain imaging." *Optics Express* 13(14): 5483-5493.
van Leeuwen, T. G., M. D. Kulkami, et al. (1999). "High-flow-velocity and shear-rate imaging by use of color Doppler optical coherence tomography." *Optics Letters* 24(22): 1584-1586.
Vansteenkiste, N., P. Vignolo, et al. (1993). "Optical Reversibility Theorems for Polarization—Application to Remote-Control of Polarization," *Journal of the Optical Society of America a-Optics Image Science and Vision* 10(10): 2240-2245.
Vargas, O., E. K. Chan, et al. (1999). "Use of an agent scattering in skin." *Lasers in Surgery and Medicine* 24(2): 133-141.
Wang, R. K. (1999). "Resolution improved optical coherence-gated tomography for imaging through biological tissues." *Journal of Modern Optics* 46(13): 1905-1912.
Wang, X. J., T. E. Milner, et al. (1997). "Measurement of fluid-flow-velocity profile in turbid media by use of optical Doppler tomography." *Applied Optics* 36(1): 144-149.
Wang, X. J., T. E. Milner, et al. (1995). "Characterization of Fluid-flow Velocity by Optical Doppler Tomography." *Optics Letters* 20(11): 1337-1339.
Wang, Y. M., J. S. Nelson, et al. (2003). "Optimal wavelength for ultrahigh-resolution optical coherence tomography." *Optics Express* 11(12): 1411-1417.
Wang, Y. M., Y. M. Zhao, et al. (2003). "Ultrahigh-resolution optical coherence tomography by broadband continuum generation from a photonic crystal fiber." *Optics Letters* 28(3): 182-184.
Watkins, L. R., S. M. Tan, et al. (1999). "Determination of interfererometer phase distributions by use of wavelets." *Optics Letters* 24(13): 905-907.
Wetzel, J. (2001). "Optical coherence tomography in dermatology: a review." *Skin Research and Technology* 7(1): 1-9.
Wentworth, R. H. (1989). "Theoretical Noise Performance of Coherence-Multiplexed Interferometric Sensors." *Journal of Lightwave Technology* 7(6): 941-956.
Westphal, V., A. M. Rollins, et al. (2002). "Correction of geometric and refractive image distortions in optical coherence tomography applying Fermat's principle." *Optics Express* 10(9): 397-404.
Westphal, V., S. Yazdanfar, et al. (2002). "Real-time, high velocity-resolution color Doppler optical coherence tomography." *Optics Letters* 27(1): 34-36.
Williams, P. A. (1999). "Rotating-wave-plate Stokes polarimeter for differential group delay measurements of polarization-mode dispersion." *Applied Optics* 38(31): 6508-6515
Wojtkowski, M., T. Bajrazewski, et al. (2003). "Real-time in vivo imaging by high-speed spectral optical coherence tomography." *Optics Letters* 28(19): 1745-1747.
Wojtkowski, M., A. Kowalczyk, et al. (2002). "Full range complex spectral optical coherence tomography technique in eye imaging." *Optics Letters* 27(16): 1415-1417.
Wojtkowski, M., R. Leitgeb, et al. (2002). "In vivo human retinal imaging by Fourier domain optical coherence tomography." *Journal of Biomedical Optics* 7(3): 457-463.
Wojtkowski, M., R. Leitgeb, et al. (2002). "Fourier domain OCT imaging of the human eye in vivo." *Proc. SPIE* 4619: 230-236.
Wojtkowski, M., V. J. Srinivasan, et al. (2004). "Ultrahigh-resolution, high-speed, Fourier domain optical coherence tomography and methods for dispersion compensation." *Optics Express* 12(11): 2404-2422.
Wong, B. J. F., Y. H. Zhao, et al. (2004). "Imaging the internal structure of the rat cochlea using optical coherence tomography at 0.827 mu m and 1.3 mu m." *Otolaryngology—Head and Neck Surgery* 130(3): 334-338.
Yang, C., A. Wax, et al. (2001). "Phase-dispersion optical tomography."*Optic Letters* 26(10): 686-688.
Yang, C., Wax, et al. (2001). "Phase-referenced interferometer with subwavelength and subhertz sensitivity applied to the study of cell membrane dynamics." *Optics Letters* 26(16): 1271-1273.
Yang, C. H., A. Wax, et al. (2001). "Phase-dispersion optical tomography." *Optics Letters* 26(10): 686-688.
Yang, C. H., A. Wax, et al. (2000). "Interferometric phase-dispersion microscopy." *Optics Letters* 25(20): 1526-1528.
Yang, V. X. D., M. L. Gordon, et al. (2002). "Improved phase-resolved optical Doppler tomography using the Kasai velocity estimator and histogram segmentation." Optics Communications 208(4-6): 209-214.
Yang, V. X. D., M. L. Gordon, et al. (2003). "High speed, wide velocity dynamic range Doppler optical coherence tomography (Part I): System design, signal processing, and performance." *Optics Express* 11(7): 794-809.
Yang, V. X. D., M. L. Gordon, et al. (2003). "High speed, wide velocity dynamic range Doppler optical coherence tomography (Part II): Imaging in vivo cardiac dynamics of *Xenopus laevis*." *Optics Express* 11(14): 1650-1658.
Yang, V. X. D., M. L. Gordon, et al. (2003). "High speed, wide velocity dynamic range Doppler optical coherence tomography (Part III): in vivo endoscopic imaging of blood flow in the rates and human gastrointestinal tracts." *Optics Express* 11(19): 2416-2424.
Yang, V. X. D., B. Qi, et al. (2003). "In vivo feasibility of endoscopic catheter-based Doppler optical coherence tomography." *Gastroenterology* 124(4): A49-A50.
Yao, G. and L. H. V. Wang (2000). "Theoretical and experimental studies of ultrasound-modulated optical tomography in biological tissue." *Applied Optics* 39(4): 659-664.
Yazdanfar, S. and J. A. Izatt (2002). "Self-reference Doppler optical coherence tomography." *Optics Letters* 27(23): 2085-2087.
Yazdanfar, S., M. D. Kulkarni, et al. (1997). "High resolution imaging of in vivo cardiac dynamics using color Doppler optical coherence tomography." *Optics Express* 1 (13): 424-431.
Yazdanfar, S., A. M. Rollins, et al. (2000). "Imaging and velocimetry of the human retinal circulation with color Doppler optical coherence tomography." *Optics Letters* 25(19): 1448-1450.
Yazdanfar, S., A. M. Rollins, et al. (2000). "Noninvasive imaging and velocimetry of human retinal blood flow using color Doppler optical coherence tomography" *Investigative Ophthalmology & Visual Sciences* 41(4): S548-S548.
Yazdanfar, S., A. M. Rollins, et al. (2003). "In vivo imaging of human retinal flow dynamics in color Doppler optical coherence tomography." *Archives of Ophthalmology* 121(2): 235-239.
Yazdanfar, S., C. H. Yang, et al. (2005). "Frequency estimation precision in Doppler optical coherence tomography using the Cramer-Rao lower bound." *Optics Express* 13(2): 410-416.
Yun, S. H., C. Boudoux, et al. (2004). "Extended-cavity semiconductor wavelength- swept laser for biomedical imaging." *Ieee Photonics Technology Letters* 16(1): 293-295.
Yun, S. H., C. Boudoux, et al. (2003). "High-speed wavelength-swept semiconductor laser with polygon-scanner-based wavelength filter." *Optics Letters* 28(20): 1981-1983.
Yun, S. H., G. J. Tearney, et al. (2004). "Pulsed-source and swept-source spectral-domain optical coherence tomography with reduced motion artifacts." *Optics Express* 12(23): 5414-5624.
Yun, S. H., G. J. Tearney, et al. (2004). "Removing the depth-degeneracy in optical frequency domain imaging with frequency shifting." *Optics Express* 12(20): 4822-4828.
Yun, S. H., G. J. Tearney, et al. (2004). "Motion artifacts in optical coherence tomography with frequency-domain ranging." *Optics Express* 12(13): 2977-2998.
Zhang, J., J. S. Nelson, et al. (2005). "Removal of a mirror image and enhancement of the signal-to-noise ratio in Fourier-domain optical coherence tomography using an elctro-optic phase modulator."*Optics Letters* 30(2): 147-149.
Zhang, Y., M. Sato, et al. (2001). "Numerical investigations of optimal synthesis of several low coherence sources for resolution improvements." *Optics Communications* 192(3-6): 183-192.
Zhang, Y., M. Sato, et al. (2001). "Resolution improvement in optical coherence tomography by optical synthesis of light-emitting diodes." *Optics Letters* 26(4): 205-207.
Zhao, Y., Z. Chen, et al. (2002). "Real-time phase-resolved functional optical coherence tomography by use of optical Hilbert transformation." *Optics Letters* 27(2): 98-100.
Zhao, Y. H., Z. P. Chen, et al. (2000). "Doppler standard deviation imaging for clinical monitoring of in vivo human skin blood flow." *Optics Letters* 25(18): 1358-1360.
Zhao, Y. H., Z. P. Chen, et al. (2000). "Phase-resolved optical coherence tomography and optical Doppler tomography for imaging blood flow in human skin with fast scanning speed and high velocity sensitivity." *Optics Letters* 25(2): 114-116.

Zhou, D., P. R. Prucnal, et al. (1998). "A widely narrow linewidth semiconductor fiber laser." *IEEE Photonics Technology Letters* 10(6): 781-783.
Zuluaga, A. F. and R. Richards-Kortum (1999). "Spatially resolved spectral interferometry for determination of subsurface structure ." *Optics Letters* 24(8): 519-521.
Zvyagin, A. V., J. B. FitzGerald, et al. (2000). "Real-time detection technique for Doppler optical coherence tomography." *Optics Letters* 25(22): 1645-1647.
Marc Nikles et al., "Brillouin gain spectrum characterization in single-mode optical fibers", *Journal of Lightwave Technology* 1997, 15 (10): 1842-1851.
Tsuyoshi Sonehara et al., "Forced Brillouin Spectroscopy Using Frequency-Tunable Continuous-Wave Lasers", *Physical Review Letters* 1995, 75 (23): 4234-42373.
Hajime Tanaka et al., "New Method of Superheterodyne Light Beating Spectroscopy for Brillouin-Scattering Using Frequency-Tunable Lasers", *Physical Review Letters* 1995, 74 (9): 1609-1612.
Webb RH et al. "Confocal Scanning Laser Ophthalmoscope", *Applied Optics* 1987, 26 (8): 1492-1499.
Andreas Zumbusch et al. "Three-dimensional vibrational imaging by coherent anti-Stokes Raman scattering", *Physical Review Letters* 1999, 82 (20): 4142-4145.
Katrin Kneipp et al., "Single molecule detection using surface-enhanced Raman scattering (SERS)", *Physical Review Letters* 1997, 78 (9): 1667-1670.
K.J. Koski et al., "Brillouin imaging" *Applied Physics Letters* 87, 2005.
Boas, et al., "Diffusing temporal light correlation for burn diagnosis", *SPIE*, 1999, 2979:468-477.
David J. Briers, "Speckle fluctuations and biomedical optics: implications and applications", *Optical Engineering*, 1993, 32 (2):277-283.
Clark, et al., "Tracking Speckle Patterns with Optical Correlation", *SPIE*, 1992 1772:77-87.
Facchini et al., "An endoscopic system for DSPI", *Optik*, 1993, 95(1):27-30.
Hrabovsky, M., "Theory of speckle displacement and decorrelation: application in mechanics", *SPIE*, 1998, 3479:345-354.
Sean J. Kirkpatrick et al., "Micromechanical behavior of cortical bone and inferred from laser speckle data", *Journal of Biomedical Materials Research*, 1998, 39(3):373-379.
Sean J. Kirkpatrick et al., "Laser speckle microstain measurements in vascular tissue", *SPIE*, 1999, 3598:121-129.
Loree et al., "Mechanical Properties of Model Atherosclerotic Lesion Lipid Pools", *Ateriosclerosis and Thrombosis*, 1994, 14(2):230-234.
Podbielska, H. "Interferometric Methods and Biomedical Research", *SPIE*, 1999, 2732:134-141.
Richards-Kortum et al., "Spectral diagnosis of atherosclerosis using an optical fiber laser catheter", *American Heart Journal*, 1989, 118(2):381-391.
Ruth, B. "blood flow determination by the laser speckle method", *Int J Microcirc: Clin Exp*, 1990, 9:21-45.
Shapo et al., "Intravascular strain imaging: Experiments on an Inhomogeneous Phantom", *IEEE Ultrasonics Symposium* 1996, 2:1177-1180.
Shapo et al., "Ultrasonic displacement and strain imaging of coronary arteries with a catheter array", *IEEE Ultrasonics Symposium* 1995, 2:1511-1514.
Thompson et al., "Imaging in scattering media by use of laser speckle", *Opt. Soc. Am. A.*, 1997, 14(9):2269-2277.
Thompson et al., "Diffusive media characterization with laser speckle", *Applied Optics*, 1997, 36(16):3726-3734.
Tuchin, Valery V., "Coherent Optical Techniques for the Analysis of Tissue Structure and Dynamics," *Journal of Biomedical Optics* 1999, 4(1): 106-124.
M. Wussling et al., "Laser diffraction and speckling studies in skeletal and heart musle", *Biomed, Biochim, Acta*, 1986, 45(1/2): S 23-S 27.
T. Yoshimura et al., "Statistical properties of dynamic speckles", *J. Opt. Soc. Am A.* 196, 3(7):1032-1054.
Zimnyakov et al., "Spatial speckle correlometry in applications to tissue structure monitoring", *Applied Optics* 1997, 36(22): 5594-5607.
Zimnyakov et al., "A study of statistical properties of partially developed speckle fields as applied to the diagnosis of structural changes in human skin", *Optics and Spectroscopy*, 1994, 76(5): 747-753.
Zimnyakov et al., "Speckle patterns polarization analysis as an approach to turbid tissue structure monitoring", *SPIE* 1999, 2981:172-180.
Ramasamy Manoharan et al., "Biochemical analysis and mapping of atherosclerotic human artery using FT-IR microspectroscopy", *Atherosclerosis*, May 1993, 181-1930.
N. V. Salunke et al., "Biomechanics of Atherosclerotic Plaque" *Critical Reviews™ in Biomedical Engineering* 1997, 25(3):243-285.
D. Fu et al., "Non-invasive quantitative reconstruction of tissue elasticity using an iterative forward approach", Phys. Med. Biol. 2000 (45): 1495-1509.
S.B. Adams Jr. et al., "The use of polarization sensitive optical coherence tomography and elastography to assess connective tissue", Optical Soc. of American Washington 2002, p. 3.
Erdelyi et al. "Generation of diffraction-free beams for applications in optical microlithography", J. Vac. Sci Technol. B 15 (12), Mar./Apr. 1997, pp. 287-292.
Tearney, et al., "Spectrally encoded miniature endoscopy" Optical Society of America; Optical Letters vol. 27, No. 6, Mar. 15, 2002; pp. 412-414.
Yelin et al., "Double-clad Fiber for Endoscopy" Optical Society of America; Optical Letters vol. 29, No. 20, Oct. 16, 2005; pp. 2408-2410.
PCT International Preliminary Report on Patentability for International Application No. PCT/US2004/038404 dated Jun. 2, 2006.
Office Action dated Aug. 24, 2006 for U.S. Appl. No. 10/137,749.
Barry Cense et al., "Spectral-domain polarization-sensitive optical coherence tomography at 850nm", Coherence Domain Optical Methods and Optical Coherence Tomography in Biomedicine IX, 2005, pp. 159-162.
A. Ymeti et al., "Integration of microfluidics with a four-channel integrated optical Young interferometer immunosensor", Biosensors and Bioelectronics, Elsevier Science Publishers, 2005, pp. 1417-1421.
PCT International Search Report for Application No. PCT/US2006/018865 filed May 5, 2006.
International Written Opinion for International Patent application No. PCT/US2006/018865 filed May 5, 2006.
John M. Poneros, "Diagnosis of Barrett's esophagus using optical coherence tomography", Gastrointestinal Endoscopy clinics of North America, 14 (2004) pp. 573-588.
P.F. Escobar et al., "Diagnostic efficacy of optical coherence tomography in the management of preinvasive and invasive cancer of uterine cervix and vulva", Int. Journal of Gynecological Cancer 2004, 14, pp. 470-474.
Ko T et al., "Ultrahigh resolution in vivo versus ex vivo OCT imaging and tissue preservation", Conference on Lasers and electroptics, 2001, pp. 252-253.
Paul M. Ripley et al., "A comparison of Artificial Intelligence techniques for spectral classification in the diagnosis of human pathologies based upon optical biopsy", Journal of Optical Society of America, 2000, pp. 217-219.
Wolfgang Drexler et al., "Ultrahigh-resolution optical coherence tomography", Journal of Biomedical Optics Spie USA, 2004, pp. 47-74.
PCT International Search Report for Application No. PCT/US2006/016677 filed Apr. 28, 2006.
International Written Opinion for International Patent application No. PCT/US2006/016677 filed Apr. 28, 2006.
Office Action dated Nov. 13, 2006 for U.S. Appl. No. 10/501,268.
Office Action dated Nov. 20, 2006 for U.S. Appl. No. 09/709,162.
PCT International Search Report and Written Opinion for Application No. PCT/US2004/023585 filed Jul. 23, 2004.
Office Action dated Dec. 6, 2006 for U.S. Appl. No. 10/997,789.
Elliot, K. H. "The use of commercial CCD cameras as linear detectors in the physics undergraduate teaching laboratory", European Journal of Physics 19, 1998, pp. 107-117.

Lauer, V. "New approach to optical diffraction tomography yielding a vector equation of diffraction tomography and a novel tomographic microscope", Journal of Microscopy vol. 205, Issue 2, 2002, pp. 165-176.
Office Action dated Dec. 18, 2006 for U.S. Appl. No. 10/501,276.
Devesa, Susan S. et al. (1998) "Changing Pattern in the Incidence of Esophegeal and Gastric Carcinoma in the United States." *American Cancer Society* vol. 83, No. 10, pp. 2049-2053.
Barr, H et al. (2005) "Endoscopic Therapy for Barrett's Oesophaugs" *Gut* vol. 54:875-884.
Johnston, Mark H.(2005) "Technology Insight: Ablative Techniques for Barrett's Esophagus—Current and Emerging Trends" , www.Nature.com/clinicalpratice/gasthep.
Falk, Gary W. et al. (1997) "Surveillance of Patients with Barrett's Esophagus for Dysplasia and Cancer with Balloon Cytology" *Gastroenterology* vol. 112, pp. 1787-1797.
Sepchler, Stuart Jon. (1997) "Barrett's Esophagus: Should We Brush off this Ballooning Problem?" *Gastroenterology* vol. 112, pp. 2138-2152.
Froehly, J. et al. (2003) "Multiplexed 3D Imaging Using Wavelength Encoded Spectral Interferometry: A Proof of Principle" *Optics Communications* vol. 22, pp. 127-136.
Kubba A.K. et al. (1999) "Role of p53 Assessment in Management of Barrett's Esophagus" *Digestive Disease and Sciences* vol. 44, No. 4. pp. 659-667.
Reid, Brian J. (2001) "p53 and Neoplastic Progression in Barrett's Esophagus" *The American Journal of Gastroenterology* vol. 96, No. 5, pp. 1321-1323.
Sharma, P. et al.(2003) "Magnification Chromoendoscopy for the Detection of Intestinal Metaplasia and Dysplasia in Barrett's Oesophagus" *Gut* vol. 52, pp. 24-27.
Kuipers E.J. et al. (2005) "Diagnostic and Therapeutic Endoscopy" *Journal of Surgical Oncology* vol. 92, pp. 203-209.
Georgakoudi, Irene et al. (2001) "Fluorescence, Reflectance, and Light-Scattering Spectroscopy for Evaluating Dysplasia in Patients With Barrett's Esophagus" *Gastroenterology* vol. 120, pp. 1620-1629.
Adrian, Alyn L. et al. (1997) "High-Resolution Endoluminal Sonography is a Sensitive Modality for the Identification of Barrett's Meaplasia" *Gastrointestinal Endoscopy* vol. 46, No. 2, pp. 147-151.
Canot, Marcia Irene et al (1999) "Vital Staining and Barrett's Esophagus" *Gastrointestinal Endoscopy* vol. 49, No. 3, part 2, pp. 12-16.
Evans, John A.. et al. (2006) "Optical Coherence Tomography to Identify Intramucosal Carcinoma and High-Grade Dysplasia in Barrett'Esophagus" *Clinical Gastroenterology and Hepatology* vol. 4, pp. 38-43.
Poneros, John M. et al. (2001) "Diagnosis of Specialized Intestinal Metaplasia by Optical Coherence Tomography" *Gastroenterology* vol. 120, pp. 7-12.
Ho. W. Y. et al. (2005) "115 KHz Tuning Repetition Rate Ultrahigh-Speed Wavelength-Swept Semiconductor Laser"*Optics Letters* col. 30, No. 23, pp. 3159-3161.
Brown, Stanley B. et al. (2004) "The Present and Future Role of Photodynamic Therapy in Cancer Treatment" *The Lancet Oncology* vol. 5, pp. 497-508.
Boogert, Jolanda Van Den et al. (1999) "Endoscopic Ablation Therapy for Barret's Esophagua with High-Grade Dysplasia: A Review" *The American Journal of Gastroenterology* vol. 94, No. 5, pp. 1153-1160.
Sampliner, Richard E. et al. (1996) "Reversal of Barrett's Esophagus with Acid Suppression and Multipolar Electrocoagulation: Preliminary Results" *Gastrointestinal Endoscopy* vol. 44, No. 5, pp. 532-535.
Sampliner, Richard E. (2002) "Endoscopic Ablative Therapy for Barrett's Esophagus: Current Status" *Gastrointestinal Endoscopy* vol. 59, No. 1, pp. 66-69.
Soetikno, Roy M. et al. (2003) "Endoscopic Mucosal resection" *Gastrointestinal Endoscopy* vol. 57, No. 4, pp. 567-579.
Ganz, Robert A. et al. (2004) "Complete Ablation of Esophageal Epithelium with a Balloon-based Bipolar Electrode: A Phased Evaluation in the Porcine and in the Human Esophagus" *Gastrointestinal Endoscopy* vol. 60, No. 6, pp. 1002-1010.
Pfefer, Jorje et al. (2006) "Performance of the Aer-O-Scope, A Pneumatic, Self Propelling, Self Navigating Colonoscopy in Animal Experiments" *Gastrointestinal Endoscopy* vol. 63, No. 5, pp. AB223.
Overholt, Bergein F. et al. (1999) "Photodynamic Therapy for Barrett'Esophagus: Follow-Up in 100 Patients" *Gastrointestinal Endoscopy* vol. 49, No. 1, pp. 1-7.
Vogel, Alfred et al. (2003) "Mechanism of Pulsed Laser Ablation of Biological Tissues" *American Chemical Society* vol. 103, pp. 577-644.
McKenzie, A. L. (1990) "Physics of Thermal Processes in Laser-Tissue Interaction" *Phys. Med. Biol* vol. 35, No. 9, pp. 1175-1209.
Anderson, R. Rox et al. (1983) "Selective Photothermolysis Precise Microsurgery by Selective Absorption of Pulsed Radiation" *Science* vol. 220, No. 4596, pp. 524-527.
Jacques, Stevens L. (1993) "Role of Tissue Optics and Pulsed Duration on Tissue Effects During High-Power Laser Irradiation" *Applied Optics* vol. 32, No. 13, pp. 2447-2454.
Nahen, Kester et al. (1999) "Investigations on Acoustic On-Line Monitoring of IR Laser Ablation of burned Skin" *Lasers in Surgery and Medicine* vol. 25, pp. 69-78.
Jerath, Maya R. et al. (1993) "Calibrated Real-Time Control of Lesion Size Based on Reflectance Images" *Applied Optics* vol. 32, No. 7, pp. 1200-1209.
Jerath, Maya R. et al (1992) "Dynamic Optical Property Changes: Implications for Reflectance Feedback Control of Photocoagulation" *Journal of Photochemical,.Photobiology, B: Biol* vol. 16, pp. 113-126.
Deckelbaum, Lawrence I. (1994) "Coronary Laser Angioplasty" *Lasers in Surgery and Medicine* vol. 14, pp. 101-110.
Kim, B.M. et al. (1998) "Optical Feedback Signal for Ultrashort Laser Pulse Ablation of Tissue" *Applied Surface Science* vol. 127-129, pp. 857-862.
Brinkman, Ralf et al. (1996) "Analysis of Cavitation Dynamics During Pulsed Laser Tissue Ablation by Optical On-Line Monitoring" *IEEE Journal of Selected Topics in Quantum Electronics* vol. 2, No. 4, pp. 826-835.
Whelan, W.M. et al. (2005) "A novel Strategy for Monitoring Laser Thermal Therapy Based on Changes in Optothermal Properties of Heated Tissues" *International Journal of Thermophyics* vol. 26, No. 1, pp. 233-241.
Thomsen, Sharon et al. (1990) "Microscopic Correlates of Macroscopic Optical Property Changes During Thermal Coagulation of Myocardium" *SPIE* vol. 1202, pp. 2-11.
Khan, Misban Huzaira et al. (2005) "Intradermally Focused Infrared Laser Pulses: Thermal Effects at Defined Tissue Depths" *Lasers in Surgery and Medicine* vol. 36, pp. 270-280.
Neumann, R.A. et al. (1991) "Enzyme Histochemical Analysis of Cell Viability After Argon Laser-Induced Coagulation Necrosis of the Skin" *Journal of the American Academy of Dermatology* vol. 25, No. 6, pp. 991-998.
Nadkarni, Seemantini K. et al. (2005) "Characterization of Atherosclerotic Plaques by Laser Speckle Imaging" *Circulation* vol. 112, pp. 885-892.
Zimnyakov, Dmitry A. et al. (2002) "Speckle-Contrast Monitoring of Tissue Thermal Modification" *Applied Optics* vol. 41, No. 28, pp. 5989-5996.
Morelli, J. G., et al (1986) "Tunable Dye Laser (577 nm) Treatment of Port Wine Stains" *Lasers in Surgery and Medicine* vol. 6, pp. 94-99.
French, P.M.W. et al. (1993) "Continuous-wave Mode-Locked Cr^{4+}: YAG Laser" *Optics Letters* vol. 18, No. 1, pp. 39-41.
Sennaroglu, Alphan at al. (1995) "Efficient Continuous-Wave Chromium-Doped YAG Laser" *Journal of Optical Society of America* vol. 12, No. 5, pp. 930-937.
Bouma, B et al. (1994) "Hybrid Mode Locking of a Flash-Lamp-Pumped Ti: Al_2O_3 Laser" *Optics Letters* vol. 19, No. 22, pp. 1858-1860.
Bouma, B et al. (1995) "High Resolution Optical Coherence Tomography Imaging Using a Mode-Locked Ti: Al_2O_3 Laser Source" *Optics Letters* vol. 20, No. 13, pp. 1486-1488.
Fernández, Cabrear Delia et al. "Automated detection of retinal layer structures on optical coherence tomography images" *Optics Express* vol. 13, No. 25, Oct. 4, 2005, pp. 10200-10216.
Ishikawa, Hiroshi et al. "Macular Segmentation with optical coherence tomography", Investigative Ophthalmology & Visual Science, vol. 46, No. 6, Jun. 2005, pp. 2012-2017.

* cited by examiner

Figure 1



Prior Art

Figure 2A

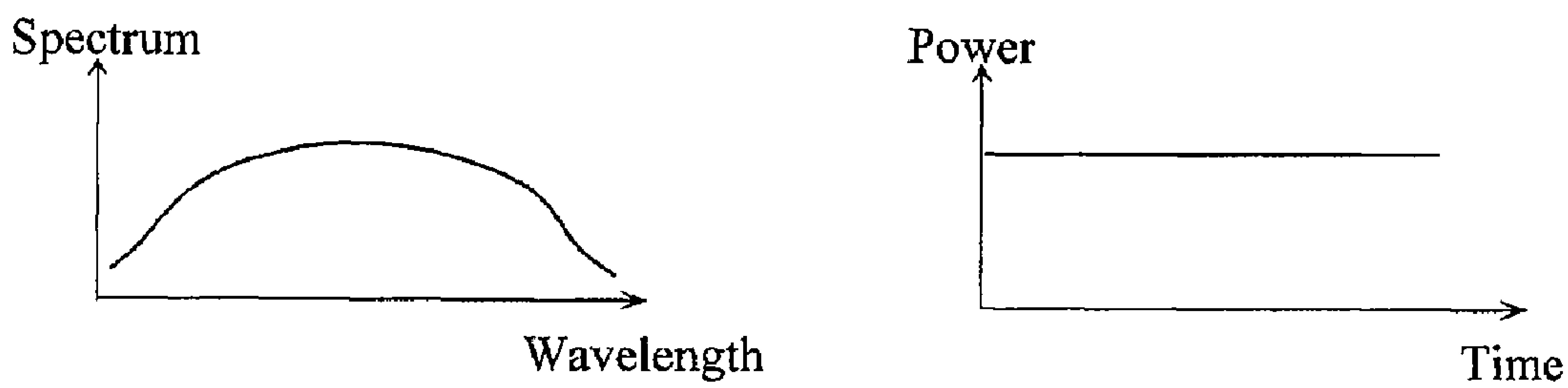
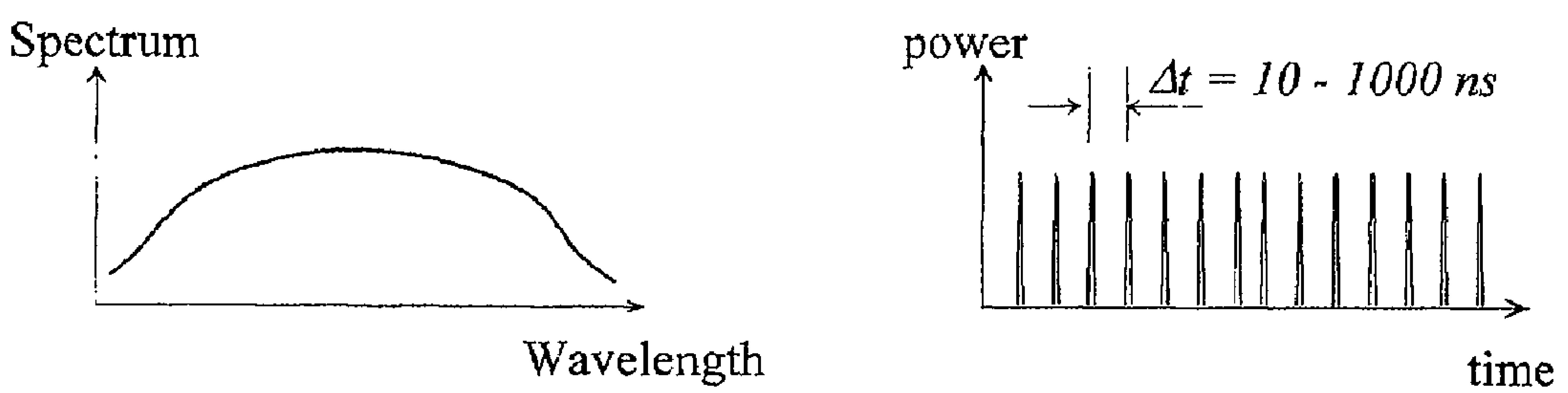


Figure 2B



Prior Art

Figure 3

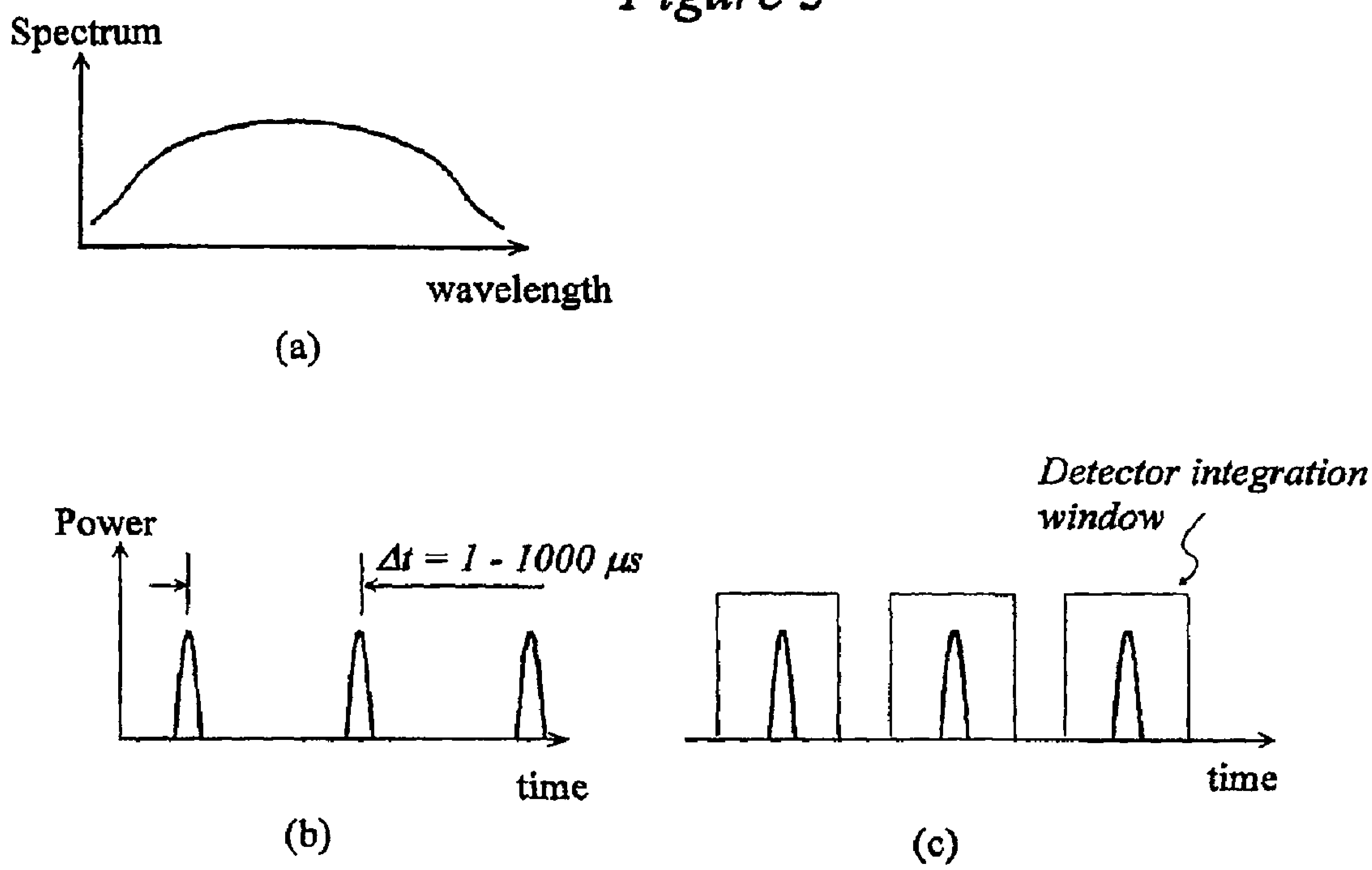

Spectrum
wavelength
(a)
Power
Δt = 1 - 1000 μs
time
(b)
Detector integration window
time
(c)

Figure 4

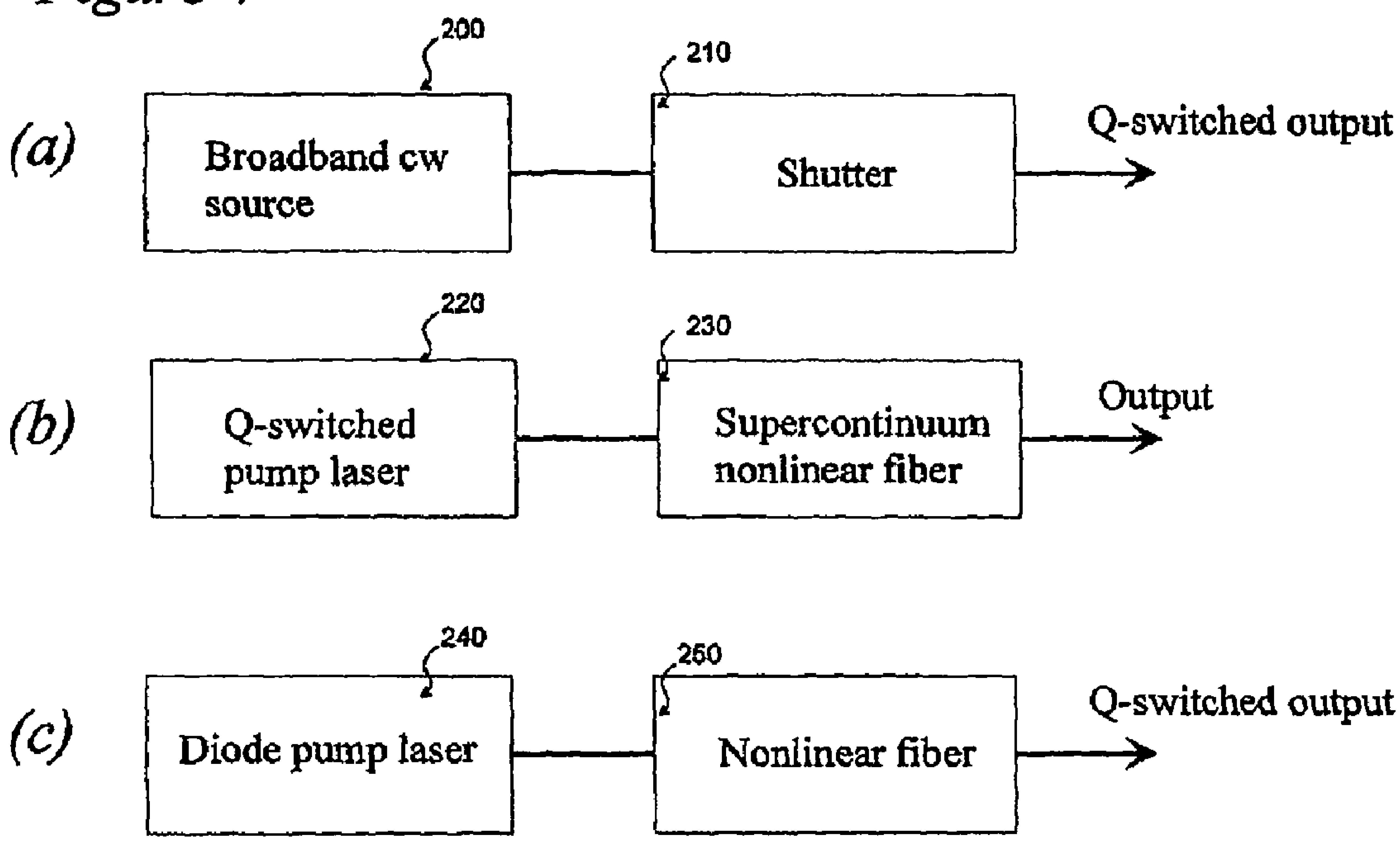

(a)
200
Broadband cw source
210
Shutter
Q-switched output
(b)
220
Q-switched pump laser
230
Supercontinuum nonlinear fiber
Output
(c)
240
Diode pump laser
250
Nonlinear fiber
Q-switched output

Figure 5

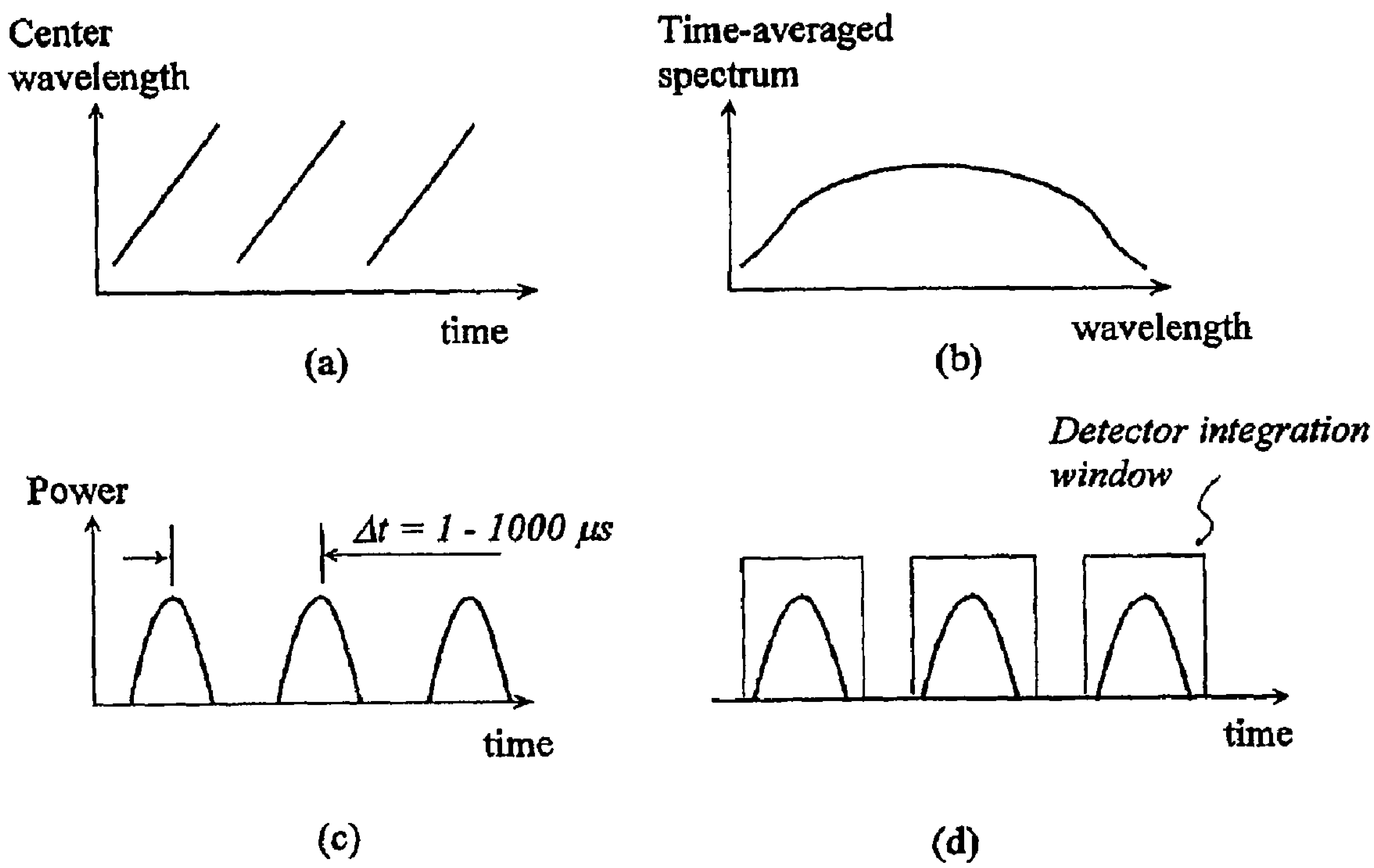

Center
wavelength
time
(a)
Time-averaged
spectrum
wavelength
(b)
Power
Δt = 1 - 1000 μs
time
(c)
Detector integration
window
time
(d)

Figure 6

(a)

(b)

(c)

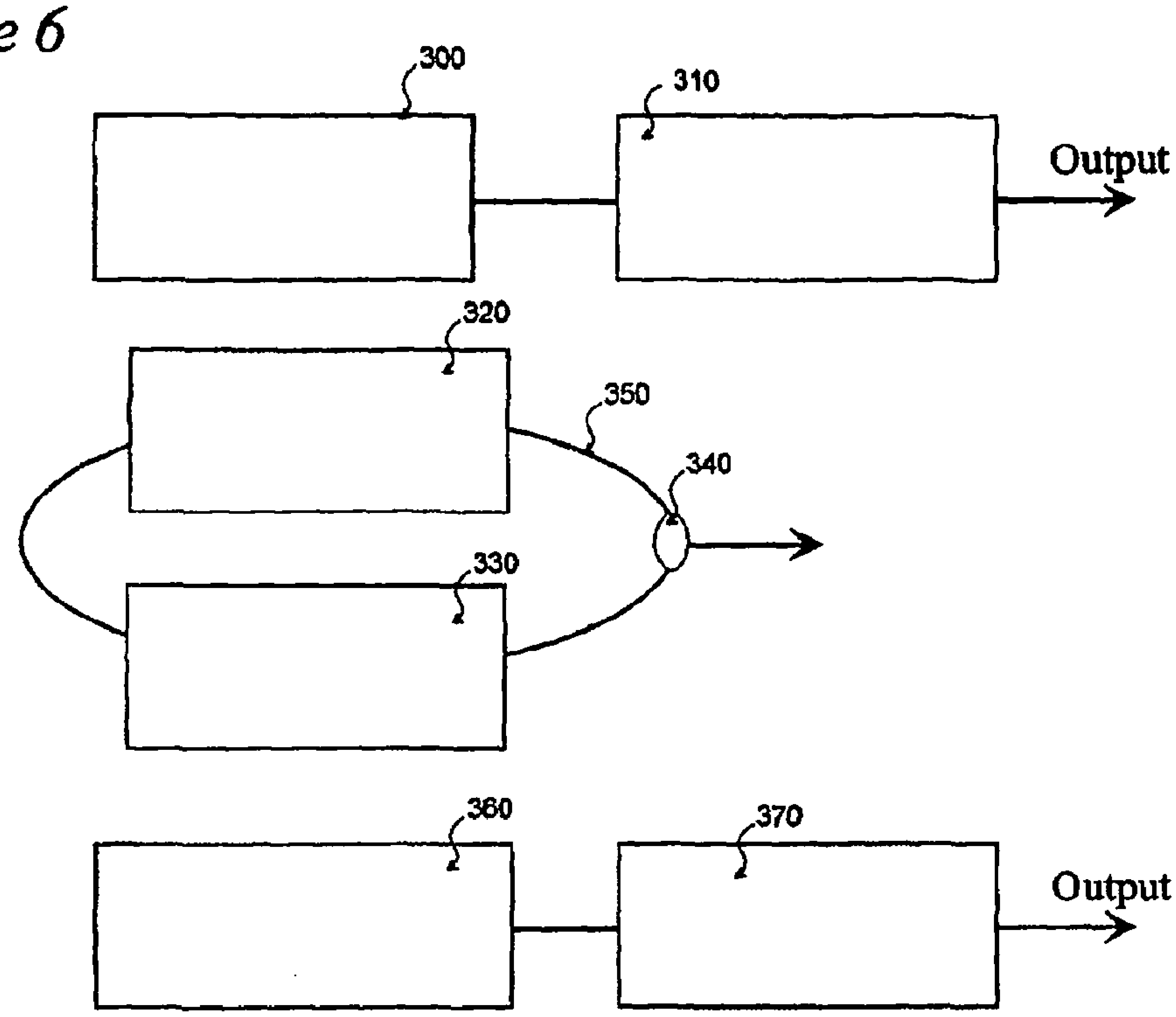


Figure 7

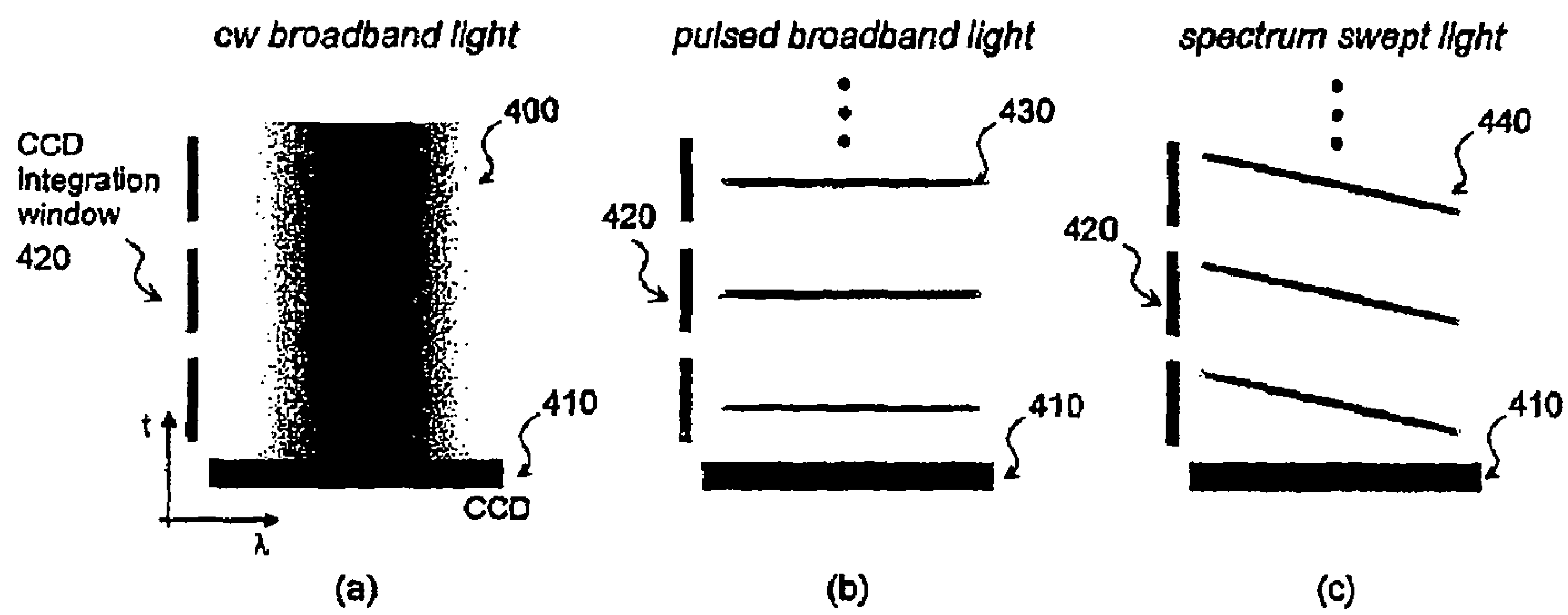
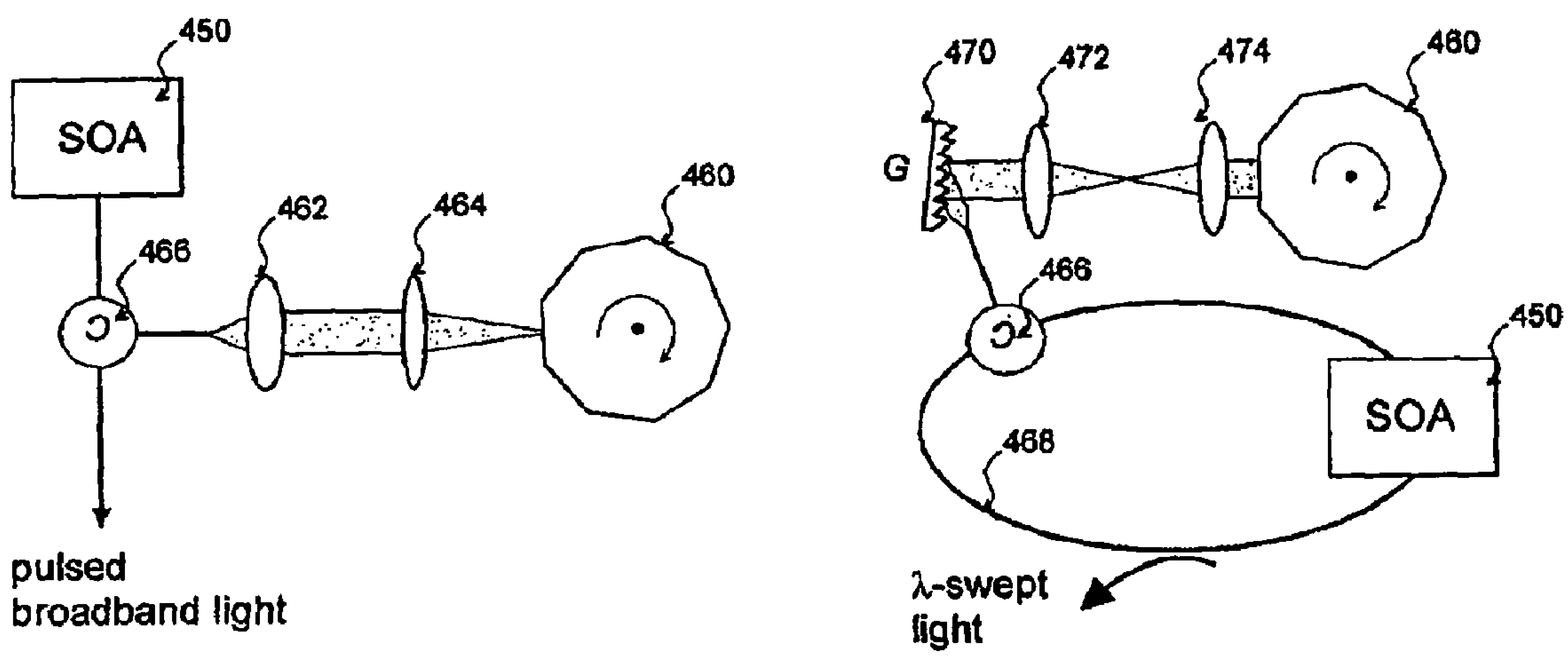

cw broadband light
pulsed broadband light
spectrum swept light
CCD
Integration
window
420
400
410
CCD
t
λ
430
420
410
440
420
410
(a)
(b)
(c)

Figure 8


450
SOA
466
462
464
460
pulsed
broadband light
470
472
474
460
G
466
450
SOA
468
λ-swept
light

(a) (b)

Figure 9

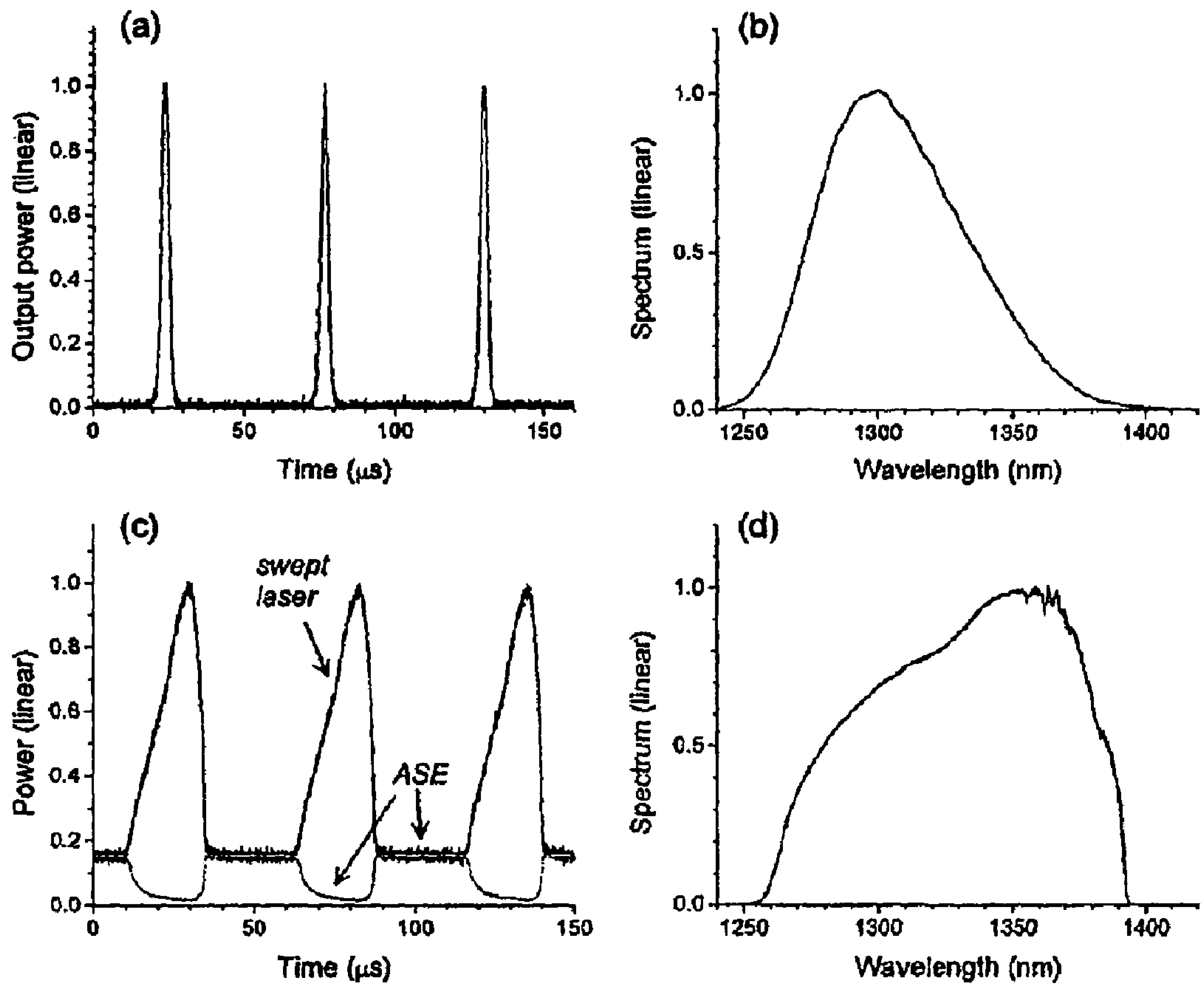

(a)
Output power (linear)
Time (μs)
(b)
Spectrum (linear)
Wavelength (nm)
(c)
swept laser
ASE
Power (linear)
Time (μs)
(d)
Spectrum (linear)
Wavelength (nm)

Figure 10

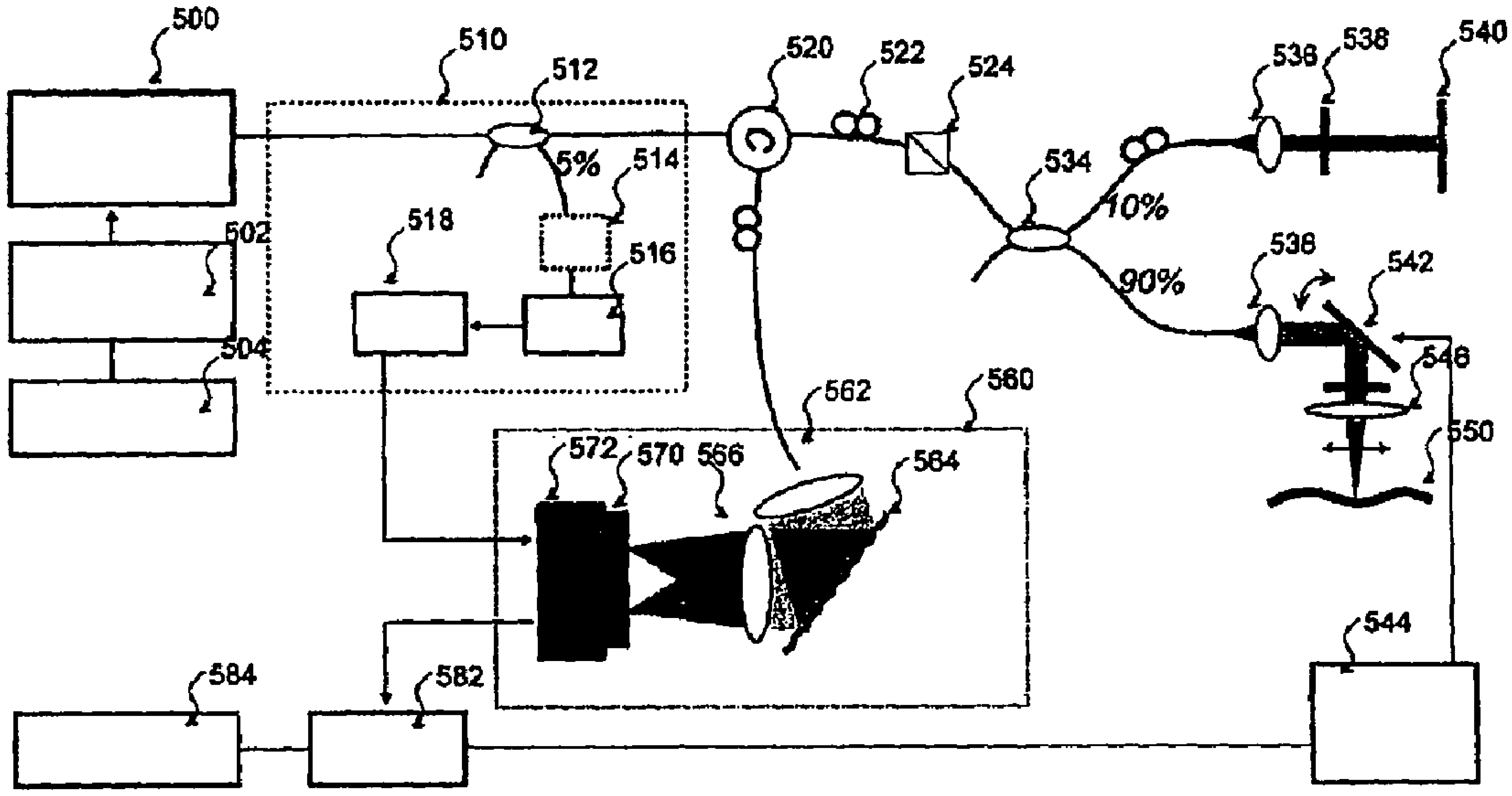

500
510
512
5%
514
518
516
502
504
520
522
524
534
10%
90%
536
538
540
536
542
546
550
562
560
572
570
566
564
544
584
582

Figure 11

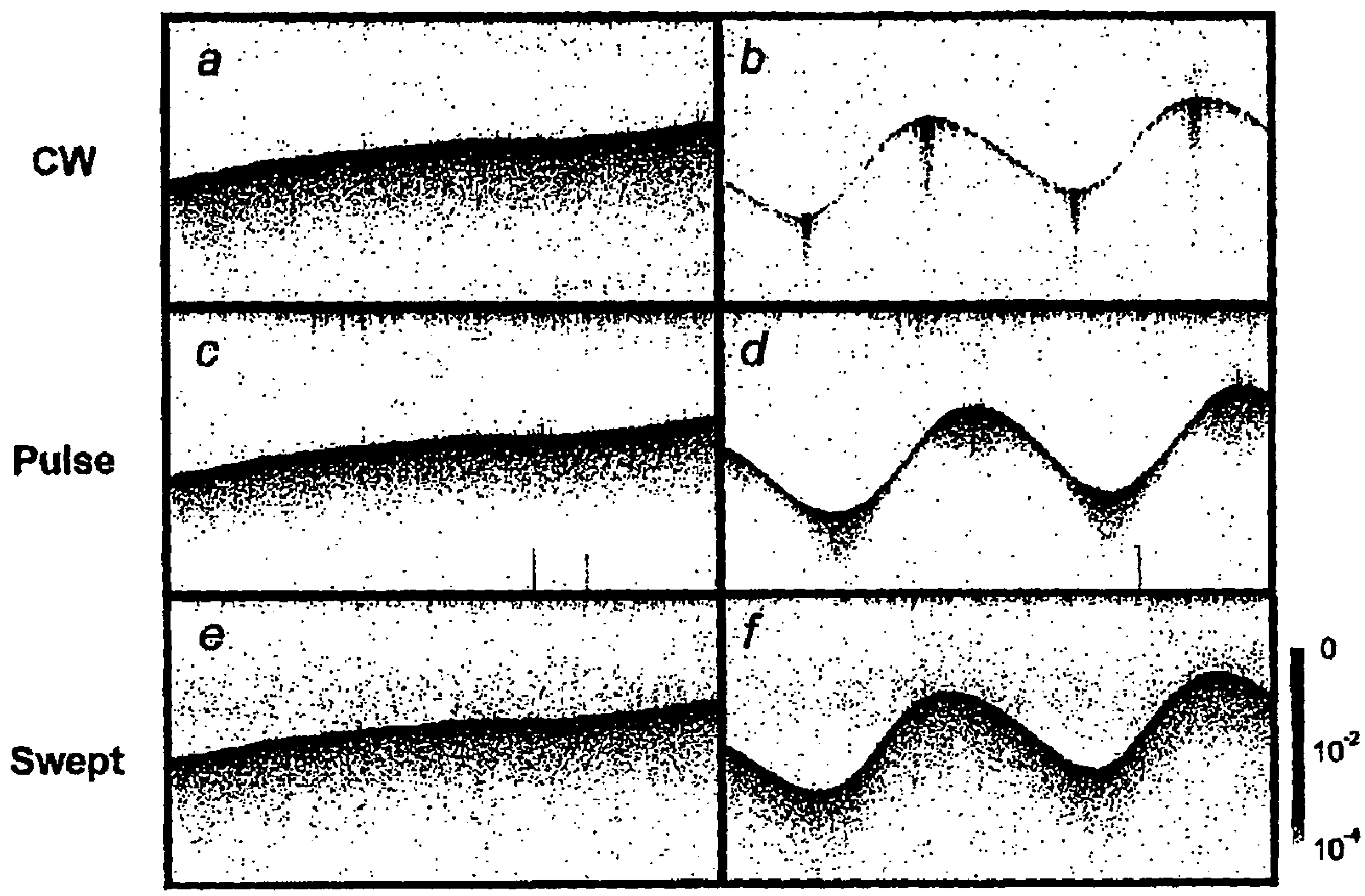


Figure 12

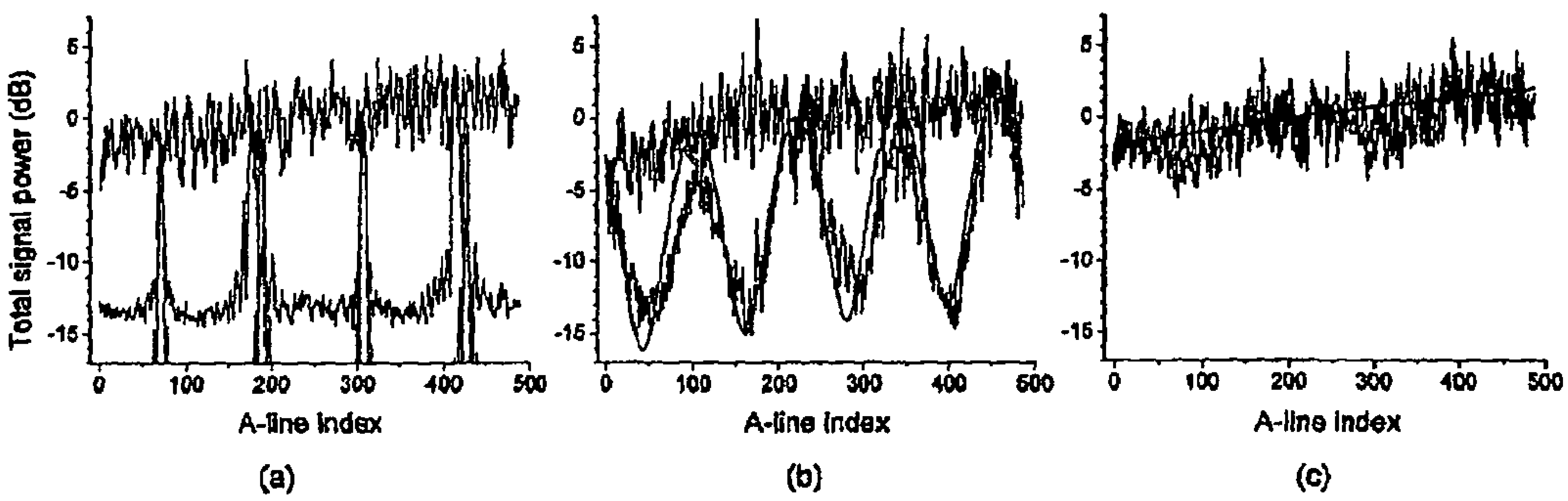

Total signal power (dB)
5
0
-5
-10
-15
0
100
200
300
400
500
A-line index
(a)
(b)
(c)

Figure 13

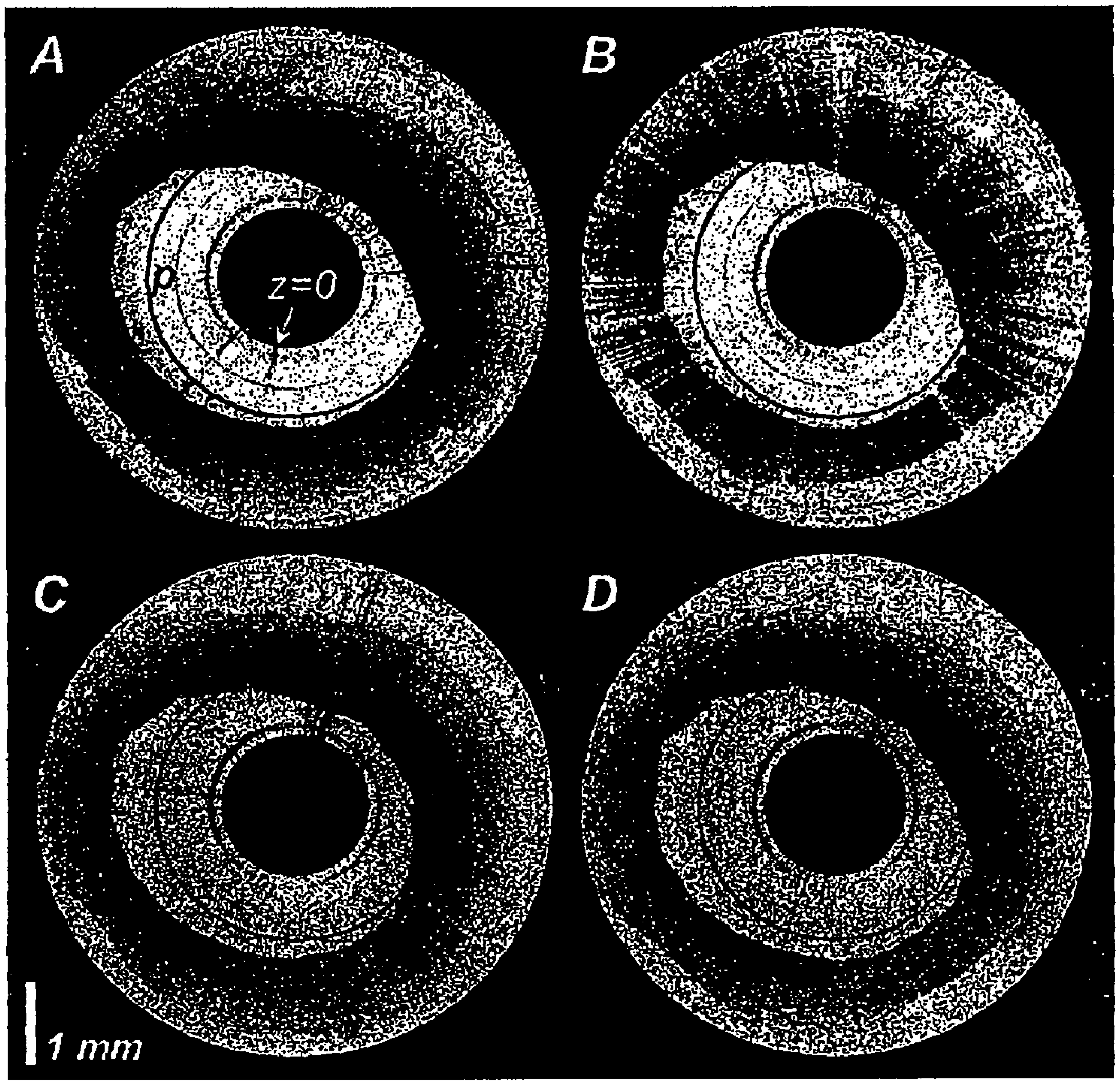


Figure 14

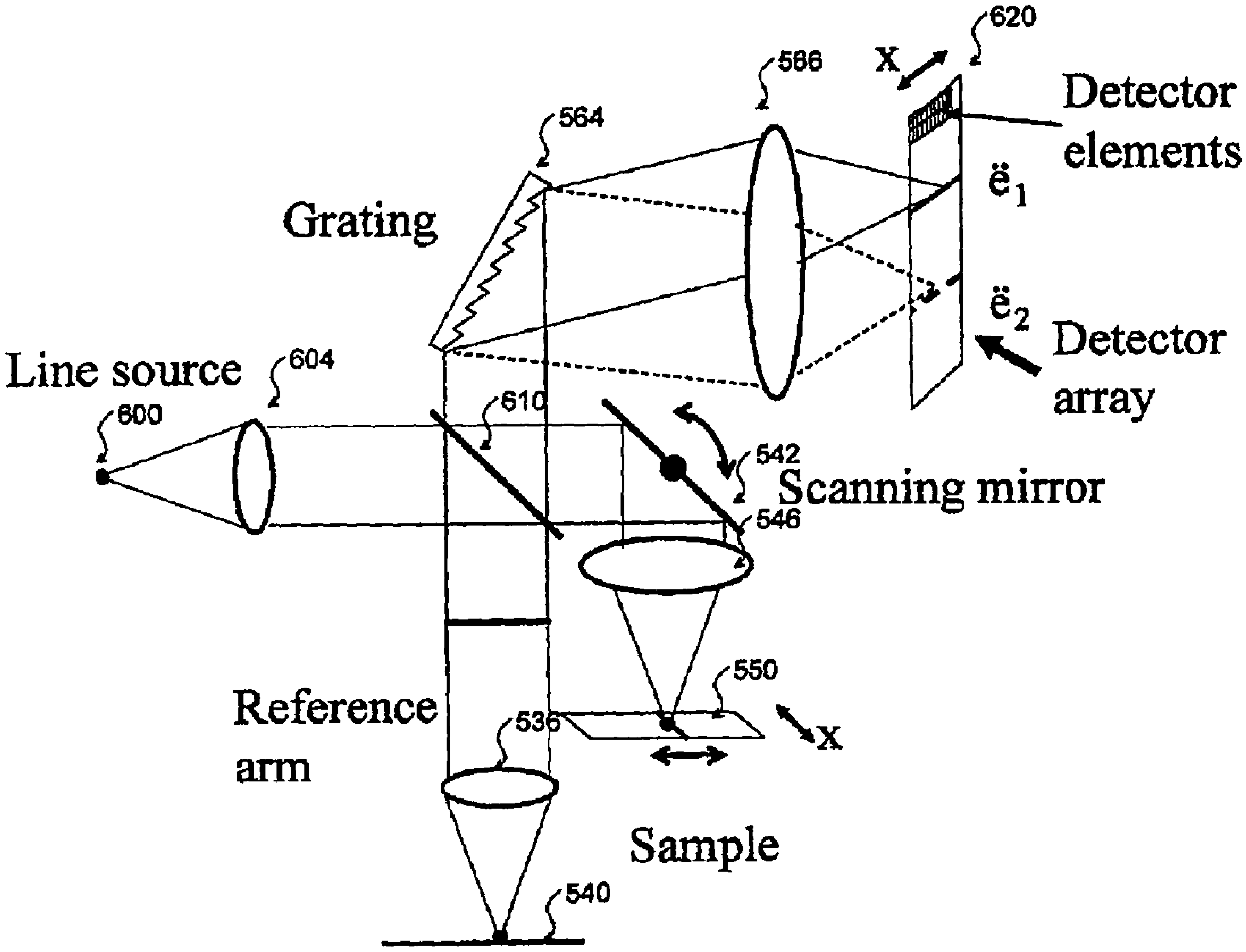
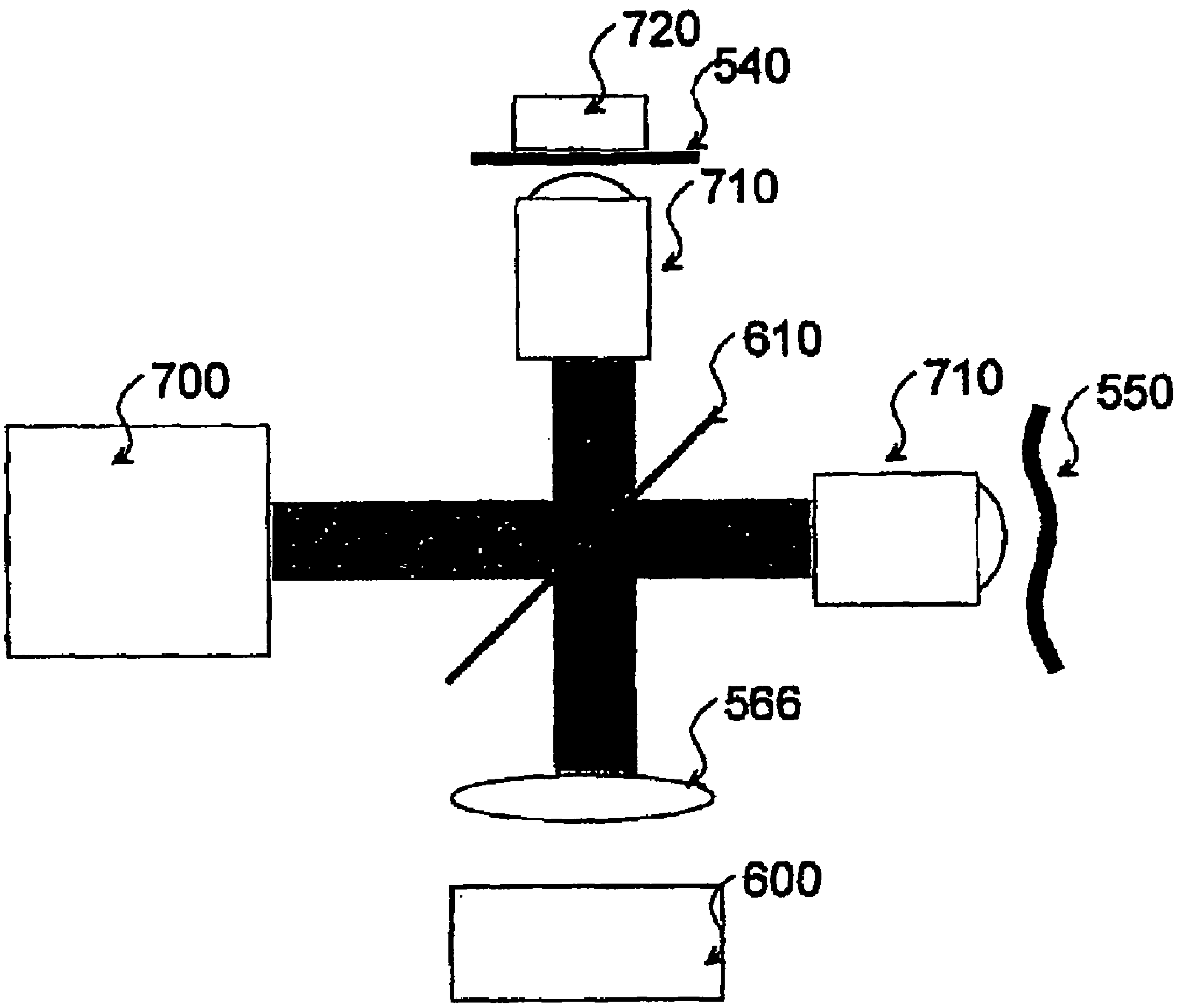

620
566
X
Detector
elements
564
Grating
ë1
ë2
Detector
array
Line source
604
600
610
542
Scanning mirror
546
550
Reference
arm
536
X
Sample
540

Figure 15



SYSTEM AND METHOD FOR OPTICAL COHERENCE IMAGING

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present invention claims priority from U.S. Patent Application Ser. No. 60/608,800 filed on Sep. 10, 2004, the entire disclosure of which incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates generally to optical coherence tomography imaging, and more particularly, to a system and method that uses optical coherence tomography that permits imaging of biological samples with high sensitivity and reduced artifacts, e.g., due to sample and probe motion.

BACKGROUND OF THE INVENTION

Image artifacts resulting from motion have been important issues of research in many medical imaging modalities because they may degrade the image quality and cause inaccurate clinical interpretation of images. Artifacts can arise when an object being imaged (sample) is moved during data acquisition but is assumed stationary in the image reconstruction process. In each imaging modality, motion artifacts can be present in different forms and with different magnitudes. Understanding basic motion effects in a particular imaging method is an essential step toward the development of techniques to avoid or compensate resulting artifacts. Optical interferometric imaging methods using frequency domain ranging have recently received considerable interest due to their high image acquisition speed and sensitivity.

Two frequency domain techniques have been demonstrated: spectral-domain optical coherence tomography (SD-OCT) as described in A. F. Fercher et al., "Measurements of intraocular distances by backscattering spectral interferometry," Opt. Comm. 117, 43-48 (1995), G. Hausler et al., "Coherence radar and spectral radar—new tools for dermatological diagnosis," J. Biomed. Opt. 3, 21-31 (1998), M. Wojtkowski et al., "Real time in vivo imaging by high-speed spectral optical coherence tomography," Opt. Lett. 28, 1745-1747 (2003), N. Nassif et al., "In-vivo human retinal imaging by ultra high-speed spectral domain optical coherence tomography," Opt. Lett. 29, 480-482 (2004), S. H. Yun et al., "High-speed spectral domain optical coherence tomography at 1.3 μm wavelength," Opt. Express 11, 3598-3604 (2003), and optical frequency domain imaging ("OFDI") S. R. Chinn, E. Swanson, and J. G. Fujimoto, "Optical coherence tomography using a frequency-tunable optical source," Opt. Lett. 22, 340-342 (1997), B. Golubovic et al., "Optical frequency-domain reflectometry using rapid wavelength tuning of a Cr^{4+}:forsterite laser," Opt. Lett. 22, 1704-1706 (1997), F. Lexer et al., "Wavelength-tuning interferometry of intraocular distances," Appl. Opt. 36, 6548-6553 (1997), S. H. Yun et al, "High-speed optical frequency-domain imaging," Opt. Express 11, 2953-2963 (2003), the entire disclosures of all of which are incorporated herein by reference. Using the SD-OCT technique, the spectral interference fringe can be measured in the spatial domain by means of a diffraction grating and a charge-coupled device ("CCD") array. In exemplary OFDI techniques, the spectral fringe is mapped to the time domain by use of a frequency-swept light source and measured with a photodetector as a function of time. In both methods; axial reflectance profile (A-line) is obtained by performing a discrete Fourier transform of the acquired data. Since the Fourier transform process involves integration of the entire data set obtained in single A-line period, the signal-to-noise ratio ("SNR") is enhanced relative to time domain ranging, as described in S. H. Yun et al., "High-speed optical frequency-domain imaging," Opt. Express 11, 2953-2963 (2003), R. Leitgeb, et al. "Performance of Fourier domain vs. time domain optical coherence tomography," Opt. Express 11, 889-894 (2003), J. F. de Boer et al., "Improved signal-to-noise ratio in spectral-domain compared with time-domain optical coherence tomography," Opt. Lett. 28, 2067-2069 (2003), and M. A. Choma et al., "Sensitivity advantage of swept source and Fourier domain optical coherence tomography," Opt. Express 11, 2183-2189 (2003), the entire disclosures of all of which are incorporated herein by reference This improvement in SNR is particularly advantageous for applications requiring high image acquisition rates such as screening for disease and surveillance of large tissue volumes. It is, however, possible that the integration effect enhances the sensitivity to sample motion because the motion-induced change in signal is also integrated over the entire A-line acquisition period.

Spectral-domain optical coherence tomography ("SD-OCT") makes use of low-coherence spectral interferometry to obtain cross-sectional images of a biological sample. Interference fringes as a function of wavelength are measured using a broadband light source and a spectrometer based on a charge-coupled-device ("CCD") camera. The axial reflectivity profile of a sample, or an A-line, can be obtained by a discrete Fourier transform of the camera readout data. This imaging technique has recently gone through rapid technical development to demonstrate high quality imaging of biological samples with fast image acquisition time, an order of magnitude faster than state-of-the-art time-domain OCT systems. The recent advancement in imaging speed may lead to the utilization of SD-OCT in a number of clinical applications in the near future.

The SD-OCT systems that have been used to date utilized either a continuous-wave ("cw") broad-spectrum light source, such as super luminescent diodes ("SLD"), or ultrashort mode-locked pulses with a high repetition rate in the range of 10-100 MHz. In both cases, the CCD array is generally illuminated constantly, and therefore the exposure time of the CCD camera determines the signal acquisition time for a single A-line. In this case, a path length change in the interferometer during image acquisition results in phase drift in the interference fringe. If the phase drifts over more than μ during a single A-line acquisition, the interference fringe can be completely erased, resulting in a degradation of SNR. This motion artifact can be caused by axial motion of a sample relative to the probe beam. By comparison, transverse sample motion or transverse beam scanning does not result in fringe washout. However, the transverse motion can result in degradation in transverse resolution and SNR. In medical imaging in vivo, the motion effects can arise from various sources. The main causes include patient motion, physiological phenomena such as cardiac motion, blood flow, pulsation, and catheter movement associated with beam scanning or uncontrolled movement of operator's hand. Furthermore, environmental changes such as mechanical vibration, sound waves, and temperature drift can alter the path length difference in the interferometer, resulting in SNR degradation through fringe washout. Considering that cameras appropriate for SD-OCT typically provide exposures times longer than 10 μs, a solution to the fringe washout problem will be required for biomedical applications where sample and probe motion is common.

Therefore, one of the objects of the present invention is to reduce or eliminate the motion artifacts.

SUMMARY OF THE INVENTION

According to the present invention, an imaging apparatus/system is provided which includes an optical source and at least one detector array. In one exemplary embodiment of the present invention, an optical source can emit a broadband spectrum in a pulsed mode, for example, by Q-switching or mode locking, with a pulse repetition rate preferably being equal to a readout rate of a detector array. The pulsed source can produce enough average optical power to provide sufficient signal to noise ratio required for imaging, while the relatively short duration of the output pulses results in an effective signal integration time substantially shorter than the detector's integration time, leading to high-sensitivity motion-artifact-free imaging. This pulsed-source approach may pertain to full-field optical coherence tomography and/or spectral-domain optical coherence tomography. In another exemplary embodiment of the present invention, the optical source is a wavelength-swept source emitting relatively narrowband spectrum swept over a wide range with a repetition rate preferably being equal to the readout rate of the detector array or A-line rate. This exemplary embodiment of the present invention allows the interference signal associated with each spectral component to be measured with an effective integration time substantially shorter than an A-line acquisition time. This exemplary scheme may also eliminate the fringe washout problem as in the prior art using continuous-wave broadband source or high-repetition mode-locked pulses. The above-described exemplary embodiments of the present invention may employ two or more detector arrays for dual-balanced detection and/or polarization diversity and further employ fiber-optic probes, allowing for medical imaging in vivo with high sensitivity, high speed, and the immunity from motion artifacts.

Accordingly, an exemplary embodiment of a system and method for imaging at least a portion of a sample are provided. In particular, at least one source electro-magnetic radiation can be generated and forwarded to the sample and a reference. A signal associated with a combination of at least one first electro-magnetic radiation received from the sample and at least one second electro-magnetic radiation received from the reference can be detected using at least one of a plurality of detectors. At least one particular detector can have a particular electrical integration time. Such detector may received at least a portion of the signal for a time duration which has at least one first portion with at least one first power level that is greater than a predetermined threshold and at least one second portion immediately preceding or following the at least one first portion. The second portion can have at least one second power level which is less than the predetermined threshold, and may be extended for a time period which is approximately at least 10% of the particular electrical integration time.

In addition, the signal may be at least one of frequency components of the combination, and the particular detector can receive such frequency component. The source electro-magnetic radiation can be generated by a source arrangement which may be a pulsed broadband source. The source electro-magnetic radiation generated by the pulsed source may be a single pulse per the particular electrical integration time. The pulsed source may be a Q-switched laser, a cavity-dumped mode-lock laser, and/or a gain-switched laser. The source electro-magnetic radiation generated by the source arrangement may be a burst of radiation that extends for at most approximately 90% of the particular electrical integration time. The burst of radiation may include multiple pulses. The source electro-magnetic radiation generated by the pulsed broadband source can have a spectrum with (i) a center wavelength between approximately 700 nanometers and 2000 nanometers, and/or (ii) a spectral width of approximately greater than 1% of the center wavelength. The source electro-magnetic radiation generated by the pulsed broadband source may have a pulse width approximately shorter than 1 μsec. A duration of the burst of radiation can be approximately shorter than 1 μsec.

According to another exemplary embodiment of the present invention, the source arrangement generating the source electro-magnetic radiation may include an optical gating switch. A frequency of the source electro-magnetic radiation can vary over time. A mean frequency of the source electro-magnetic radiation may change (i) substantially continuously over time at a tuning speed that is greater than 100 terahertz per millisecond, and/or (ii) with a repetition period that is less than approximately 90% of the particular electrical integration time. The source electro-magnetic radiation can have a tuning range (i) with a center wavelength between approximately 700 nanometers and 2000 nanometers, and/or (ii) of approximately greater than 1% of the center wavelength. The source electro-magnetic radiation may have an instantaneous line width and a tuning range, with the instantaneous line width being less than approximately 10% of the tuning range. The source arrangement may include (i)a tunable laser, (ii) a tunable filter, and/or (iii) a medium, and can generate the source electro-magnetic radiation based on a non-linearity associated with the medium. The frequency may vary substantially (i) linearly with time, and/or (ii) sinusoidally with time.

A detector arrangement which includes the detectors can be provided, that includes an electrical shutter that is adapted to gate a transmission of photoelectrons associated with the combination of the first and second electro-magnetic radiation, wherein a time period for the gating to allow the transmission of the photoelectrons is less than approximately 90% of the particular electrical integration time. The sample can be a biological sample. The detection arrangement may include at least one charged-coupled device. The source arrangement may be a pulsed broadband source. At least one spectral separating unit can be provided which separates spectrum of the first electro-magnetic radiation, the second electro-magnetic radiation and/or the combination into the at least one of the frequency components.

These and other objects, features and advantages of the present invention will become apparent upon reading the following detailed description of embodiments of the invention, when taken in conjunction with the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects, features and advantages of the invention will become apparent from the following detailed description taken in conjunction with the accompanying figures showing illustrative embodiments of the invention, in which:

FIG. **1** is an exemplary schematic diagram of a conventional SD OCT system;

FIG. 2A is a set of exemplary graphs of spectral and temporal characteristics obtained from a conventional continuous-wave optical source;

FIG. 2B is a set of exemplary graphs of spectral and temporal characteristics obtained from a high-repetition rate mode locked laser source;

FIG. 3 is a set of exemplary graphs of spectrum and temporal characteristics obtained from a low-repetition rate broadband source;

FIGS. 4(a)-(c) are block diagrams of exemplary embodiments of low-repetition broadband source arrangements according to the present invention;

FIGS. 5(a)-(d) are exemplary graphs of spectrum and temporal characteristics obtained from an exemplary wavelength-swept source;

FIGS. 6(a)-(c) are block diagrams of exemplary embodiments of an exemplary wavelength-swept source arrangements according to the present invention;

FIG. 7(a) is an exemplary illustration of a detection signal of a cw light with a CCD array in a spectrometer;

FIG. 7(b) is an exemplary illustration of a detection signal of a pulsed light with a CCD array in a spectrometer;

FIG. 7(c) is an exemplary illustration of a detection signal of a swept light with a CCD array in a spectrometer;

FIG. 8(a) is a schematic of an exemplary pulsed ASE source;

FIG. 8(b) is a schematic of an exemplary wavelength-swept source;

FIGS. 9(a) and (b) are illustrations of signals of exemplary temporal and spectral output characteristics obtained from the exemplary pulsed ASE source;

FIGS. 9(c) and (d) are illustrations of signals of exemplary temporal and spectral output characteristics obtained from the exemplary swept source;

FIG. 10 is an exemplary block diagram of an exemplary embodiment of an SD OCT system according to the present invention;

FIG. 11 is an exemplary illustration of SD-OCT images of a paper, acquired when a sample is static (in sections a, c and e) and moving at 80 Hz over 0.8 mm (in sections b, d and f) with three different light sources;

FIG. 12(a) is an illustration of a variation of a total signal power, a sum of reflectivity of 256 depth points in each A-line, as a function of A-line index or time, obtained from images a and b shown in FIG. 11;

FIG. 12(b) is an illustration of a variation of a total signal power, a sum of reflectivity of 256 depth points in each A-line, as a function of A-line index or time, obtained from images c and d shown in FIG. 11;

FIG. 12(c) is an illustration of a variation of a total signal power, a sum of reflectivity of 256 depth points in each A-line, as a function of A-line index or time, obtained from images e and f shown in FIG. 11;

FIG. 13 is a set of illustrations of exemplary SD-OCT images of a human. coronary artery in vitro, obtained using an exemplary embodiment of the system according to the present invention, with a rotation speed of a catheter and the light source (Section A—4.5 rps, cw ASE source, Section B—37.9 rps, cw ASE source, Section C—4.5 rps, swept source, and Section C—37.9 rps, swept source);

FIG. 14 is a block diagram of another exemplary SD-OCT system that uses a line pulsed or swept source and a two-dimensional CCD array; and

FIG. 15 is a block diagram of an exemplary full-field OCT system that uses a pulsed source and a two-dimensional CCD array.

DETAILED DESCRIPTION

FIG. 1 depicts an exemplary basic configuration of a spectral-domain optical coherence tomography ("SD-OCT") system. Broadband light **10** is split by a coupler **20** into a sample arm **22** and a reference arm **24** that is terminated by a mirror **26** at its distal end. A probe **30** at the end of the sample arm delivers light to a sample **40**, and receives the light backscattered from within the sample. The light returned from the two interferometer arms is recombined and directed via a circulator **44** to a spectrometer **50** consisting of a collimator **52**, a diffraction grating **54**, and a lens **56**, a CCD array **60**, and camera **62**. Individual pixels of the CCD array **60** measure the optical power as a function of wave number, $k=2\pi/\lambda$ where λ is the optical wavelength. The CCD output is digitized using a digitizer **70** and processed in a computer **74**. A discrete Fourier transform ("DFT") of the CCD scan output produces an axial reflectance profile of the sample (A-line). A 2-D tomographic image can be obtained by acquiring multiple A-lines as the probe beam is scanned over the sample along a transverse direction. This exemplary architecture and the operating principle described above are well known in the art.

The broadband optical source used in prior art can be categorized into two types: continuous wave ("cw") as shown in FIG. 2A, and mode-locked pulsed source as shown in FIG. 2B. The cw source emits constant spectrum and constant output power. In this case, the integration time of OCT signals is equal to the exposure time of the detector array. Examples of such cw sources include super luminescent diodes, amplified spontaneous emission ("ASE") source, and supercontinuum source. On the other hand, the mode-locked source emits very short optical pulses with a duration ranging from sub nanoseconds to several femtoseconds and a relatively high repetition rate from 10 MHz to 1 GHz. The exposure time of CCD is typically in the order of 10 microseconds to 10 milliseconds. As a result, the mode-locked pulses essentially behave like continuous wave, illuminating the CCD array constantly over its entire exposure time. The use of the cw and mode-locked source in OCT has two shortcomings: (a) significant motion artifacts due to relatively long signal integration time and (b) SNR degradation in case <100% duty cycle of signal integration in the detector array. The exemplary embodiments according to the present inventions provide sample solutions to such problems.

One exemplary embodiment of the present invention relates to a system for imaging of a sample, e.g., biological sample, which may include a source arrangement that generates at least one source electro-magnetic radiation forwarded to the sample and a reference. Such exemplary system may include at least one detection arrangement that has a plurality of detectors, at least one of the detectors capable of detecting a signal associated with a combination of at least one first electro-magnetic radiation received from the sample and at least one second electro-magnetic radiation received from the reference. At least one particular detector may have a particular electrical integration time, and can receive at least a portion of the signal for a time duration which has a first portion with a first power level greater than a predetermined threshold and a second portion immediately preceding or following the first portion. The second portion may have a second power level that is less than the predetermined threshold, and extends for a time period which is approximately more than 10% of the particular electrical integration time.

The electro-magnetic radiation is preferably light with a center wavelength in the range of 700 to 2000 nm. The detector array is preferably charge-coupled devices ("CCD"). Using the exemplary SD-OCT system, the signal detected in the detector array is frequency components of the combination, or the spectrum. Typically the spectrum is obtained using a spectrally separating device such as a diffraction grating. A number of methods to obtain the spectrum with detector arrays are well known in the art. For full-field OCT, the signal is the optical power of the combination, which is linked to specific transverse locations in the sample.

In another exemplary embodiment of the present invention, the source arrangement can be a pulsed broadband source generating a single pulse per the particular electrical integration time or producing a burst of radiation that extends for at most approximately 90% of the particular electrical integration time. Each burst may include multiple ultrashort optical pulses in it. Examples of the pulsed sources include a Q-switched laser, a cavity-dumped mode-lock laser, and a gain-switched laser. Preferably, the spectrum of the pulsed source may have a spectral width of approximately greater than 1% of the center wavelength and a pulse width or a duration of the burst of radiation approximately shorter than 1 microseconds. The source arrangement may comprise a broadband cw source and an optical gating switch or electrical shutter integrated in the CCD array. The time window where the optical power is less than the threshold can be considered as OFF state, and the window where the power is greater than the threshold as ON state. The threshold is preferably less than 50% of the power level during ON state, however a typical pulsed source may provide much larger power extinction between the ON and OFF state. During a single detector integration time, one or multiple ON states may exist, however the total illumination span, or the duration from the start of the first ON state to the end of the last ON state is preferably shorter than 90% of the detector integration time. For example, the shorter the illumination span, the more suppression of motion artifacts can be obtained.

In yet another exemplary embodiment of the present invention, the source arrangement can be a wavelength swept source where a mean frequency of the output spectrum varies over time. The mean frequency of the source electro-magnetic radiation may change substantially continuously over time at a tuning speed that is greater than 100 terahertz per millisecond and repeatedly with a repetition period that is less than approximately 90% of the particular electrical integration time. The tuning range of the source electro-magnetic radiation may have a tuning range with a center wavelength between approximately 700 nanometers and 2000 nm, a tuning width of approximately greater than 1% of the center wavelength, and an instantaneous line width of less than approximately 10% of the tuning range. Such a source arrangement includes a tunable laser, soliton laser in conjunction with Raman self frequency shift, or cw broadband source in conjunction with a tunable filter. The mean frequency may vary substantially linearly or sinusoidally with time. As for the pulsed source, the time window where the optical power received by a specific pixel is less than the threshold can be considered as OFF state for the particular pixel, and the window where the power is greater than the threshold as ON state. The threshold is preferably less than 50% of the power level during ON state, however a typical pulsed source may provide much larger power extinction between the ON and OFF state. During the detector integration time of the pixel, one or multiple ON states may exist, however the total illumination span, or the duration from the start of the first ON state to the end of the last ON state is preferably shorter than 90% of the pixel integration time. The shorter the illumination span is, the more suppression of motion artifacts can be obtained.

According to still another exemplary embodiment of the present invention, a method may be provided for imaging of a sample, typically biological sample. For example, at least one source electro-magnetic radiation may be generated to be forwarded to the sample and a reference. At least a portion of a signal associated may be detected with a combination of at least one first electro-magnetic radiation received from the sample and at least one second electro-magnetic radiation received from the reference using at least one detector of a plurality of detectors of a detection arrangement. At least one particular detector may have a particular electrical integration time, and can receive at least a portion of the signal for a time duration which has a first portion with a first power level greater than a predetermined threshold and a second portion immediately preceding or following the first portion. The second portion may have a second power level less than the predetermined threshold, and can extend for a time period which is approximately more than 10% of the particular electrical integration time.

FIG. **3** illustrates sample outputs of one exemplary embodiment of a system and method according to the present invention that is based on a broadband pulsed source. Such source emits a single burst of optical energy, or simply "pulse", per each integration window of the detector array with timing synchronization between the pulses and integration window of the detector array, as illustrated in FIG. **3**. Examples of such sources may include time-gated cw or mode-locked broadband source **200** using an external intensity modulator **210** (as shown in FIG. **4**(a)), supercontinuum source based on a Q-switched pump laser **220** and supercontinuum generation medium **230** (as shown in FIG. **4**(b)), self-Q-switched supercontinuum source or Raman source based on pump laser **240** and nonlinear medium **250** (as shown in FIG. **4**(c)). The use of such source results in an effective signal integration time equal to the duration of the pulse, which may range from sub microseconds to sub nanoseconds, substantially shorter than the integration time of the detector array itself. Although a single pulse operation is described, other optical sources emitting multiple pulses per each integration time may be used if the pulses are generated within duration substantially shorter than the detector integration time. In exemplary clinical applications such as ophthalmology, the maximum optical energy or intensity level that can be illuminated to the retina is limited by potential damage to the tissue. Using the exemplary arrangement shown in FIG. **4**(a), it is possible to use a broadband source emitting a high output power, such as SLD and Ti:Sapphire mode-locked laser, and time-gate the output to decrease the duty cycle and therefore an effective exposure energy level to the sample.

FIGS. **5**(a)-(d) illustrate graphs to explain the principle of another exemplary embodiment of the present invention based on a wavelength-swept source which emits substantially narrowband spectrum that is swept over a wide spectral range, repeatedly in time. FIG. **5**(c) show exemplary signals generated using a swept source with the output wavelength swept in a saw-tooth fashion. The tuning cycle is synchronized with the integration window of the detector array. In this exemplary case, each detector element can receive the light with corresponding wavelength during only a short period of time which determines the effective signal integration time. As a numerical example, when the total tuning range is 150 nm, centered at 1300 nm, and the instantaneous linewidth is 1 nm, the effective signal integration time can be only one hundredth of the detector integration time.

As shown in FIGS. **6**(a)-(c), a wavelength-swept source may be implemented by using a conventional broadband source **300** followed by a wavelength scanning filter **310**. According to an exemplary variant of the present invention, a wavelength-swept laser may be used using a gain medium **320**, tunable filter **330** and output coupler **340** in a laser cavity **350**. A wavelength-swept laser may be configured to yield a linewidth that is narrower than the resolution of the spectrometer; in this case the complexity and tolerance in spectrometer design may be relaxed. The combination of wavelength-swept source and detector array described above may be analogized with optical frequency domain imaging and exhibits motion artifacts such as Doppler distortion. To further reduce the motion artifacts, the wavelength-swept source may be operated in a low-duty-cycle or Q-switched regime, with an advantage of further reduction of effective signal integration time. Another possible source can includes a broadly tunable source based on soliton self frequency shift using a soliton source **360** and Raman medium **370**.

Exemplary conventional SD-OCT systems utilize either a continuous-wave (cw) broad-spectrum light source, such as super luminescent diodes (SLD), or ultrashort mode-locked pulses with a high repetition rate in the range of 10-100 MHz. Full field OCT systems have typically employed cw thermal light source. For such conventional systems, the CCD array is illuminated constantly, and therefore the exposure time of the CCD camera determines the signal acquisition time for a single A-line. However, sample or probe motion during the A-line acquisition time can result in various undesirable artifacts such as signal fading and spatial resolution degradation. In particular, due to axial sample motion, the visibility of detected spectral fringes can diminish significantly resulting in significant image fading. Considering that cameras appropriate for SD-OCT typically provide exposures times longer than 10 μs, a solution to the fringe washout problem is preferable for biomedical applications where sample and probe motion is common.

FIGS. **7**(a)-(c) illustrates exemplary illustration of a detection signal with a CCD array in a spectrometer how the signal detection in the exemplary SD-OCT system for three different light sources: broadband cw source (see FIG. **7**(a)), broadband pulsed source (see FIG. **7**(a)), and narrowband wavelength-swept source (see FIG. **7**(a)). In this figure, spectrally dispersed, broad-spectrum light **400** is incident on a CCD array **410** so that each CCD pixel receives a narrowband portion of the source light. The vertical bars **420** represent the time window during which the camera integrates photon-generated electrons. FIG. **7**(a) shows the signals obtained using a common implementation of the SD-OCT system. The operational principles of the systems generating signals shown in FIGS. **7**(b) and (c) are described below.

In particular, FIG. **7**(b) depicts a train of short broadband pulses **430** with a repetition rate equal to the CCD readout rate. The integration time of this exemplary system is given by the pulse duration rather than the camera readout time. As a result, snap-shot A-line profiles can be obtained with freedom from sample or probe motion. This exemplary technique is conceptually similar to the use of stroboscopic illumination in photography. Although for most biomedical applications nanosecond pulses are sufficiently short to avoid motion artifacts, it is interesting to note that in principle, this approach could provide femtosecond temporal resolution A-line acquisition through the use of low-repetition mode locked lasers. The following analysis, however, pertains to an arbitrary pulsed source delivering either single bursts of short-duration broadband light or bursts comprising a brief train of mode locked pulses.

To understand the imaging characteristics of a pulsed-source SD-OCT system, the signal-to-noise ratio (SNR) for pulsed and cw operation in the presence of axial motion may be reviewed. For example, let T_s and T_e denote the duration of the pulse and the electrical integration time of the camera, respectively. For a sample moving axially in parallel to an optical probe beam with a speed v_z, the signal power S, normalized to the signal at $v_z=0$, is given by

$$S \approx |\int_o^{T_e} P(t) e^{j2k_o v_z 2} dt|^2 / \int_o^{T_e} P(t) dt^2, \quad (1)$$

where P(t) represents time-varying optical power of the pulse, and $k_o=2\pi/\lambda_o$ denotes the wave number corresponding to the center wavelength λ_o. Equation 1 yields $S \approx \sin^2 (k_o \Delta z)/(k_o \Delta z)^2$ for a square pulse and $S \approx \exp[-k_o^2 \Delta z^2 /(2 \ln 2)]0$ for a Gaussian pulse with T_s as the full-width-at-half-maximum ("FWHM") pulse duration, where $\Delta z = v_z T_s$ represents the total sample movement during pulse duration T_s. These expressions imply that significant signal fading occurs if the sample movement is greater than a half optical wavelength during the pulse duration. Therefore, the short pulsed technique ($T_s \ll T_e$) offers a significant advantage over the conventional cw operation in terms of motion-induced signal fading. Similarly, one can see that pulsed operation can also suppress other motion artifacts, such as spatial resolution degradation due to sample motion and transverse beam scanning.

The fundamental noise characteristics of pulsed operation are likely approximately identical to those of cw operation, because the detection bandwidth is solely determined by the integration time of the camera. If both a pulsed and cw sources produce the same average optical power and relative intensity noise ("RIN"), both would yield the same SNR in the limit of a stationary sample.

FIG. **7**(c) shows signals generated using another exemplary techniques that uses another exemplary pulsed-source SD-OCT approach that is based on a narrowband, wavelength-swept source. Since the optical spectrum **440** incident to the CCD array **420** is continuously changed in time, each of the CCD pixels receives its corresponding spectral component only for a short time interval. As with pulsed broad bandwidth illumination, rapidly sweeping the wavelength allows the SD-OCT signal to be free from signal fading due to fringe washout. However, unlike pulsed operation, individual "spectrum pulses" do not arrive at the CCD pixels at the same time.

For a linear sweep shown in FIG. **7**(c), the swept operation is approximately analogous to optical frequency domain imaging ("OFDI") as described in U.S. patent application No. 60/514,769 filed Oct. 27, 2003, the entire disclosure of which is incorporated herein by reference. In this exemplary swept operation, spectral fringes are measured as a function of time using a swept source and a standard photodiode. Therefore, both imaging techniques can exhibit similar motion artifacts. The generation of motion artifacts in produced by the exemplary OFDI system is known. The swept-source operation in the exemplary SD-OCT system, however, differs from the operations of the OFDI system in that it does not require a linear tuning slope or narrow instantaneous linewidth of the source because these specifications are governed by the detection spectrometer. Such distinctions are significant considering that tuning speed and power in wavelength swept lasers are often limited by constraints on linearity and instantaneous linewidth.

For example, pulsed and wavelength-swept sources may be constructed according to an exemplary embodiment of the present invention. A block diagram of the exemplary system of the present invention which includes a gating device is shown in FIG. **8**(a). The pulsed broadband source can be provided by an external time-gating of cw broadband amplified spontaneous emission ("ASE") from a semiconductor optical amplifier **450** (e.g., SOA, Philips CQF 882/e). The output of the SOA, prior to the time gating, can be characterized as cw un-polarized ASE centered 1.3 μm, with 7-mW total power at an injection current of 450 mA. The cw ASE can be coupled to an external optical gating device which includes a polygonal mirror scanner **460** and lenses **462**, **464**, in conjunction with a circulator **466**. The polygonal mirror had 40 facets with a facet-to-facet angle of 9 degrees. The focal lengths of the collimating **462** and focusing **464** lenses can be 11 and 100 mm, respectively, to obtain a duty cycle of approximately 5% in the output. FIG. **9**(a) shows an output pulse train measured with an InGaAs photodetector and oscilloscope (detection bandwidth=100 MHz) as the polygon scanner may be rotated at 474 revolutions per second to produce a pulse repetition rate of 18.94 kHz. The measured pulse width and corresponding duty cycle were 2.85 μs (FWHM) and 5.4%, respectively. The average output power measured with a power meter can be 300 μW. FIG. **9**(b) shows the output spectrum measured with an optical spectrum analyzer. The spectrum may be approximately identical to that of the input ASE, with a center wavelength at 1300 nm and a FWHM of 66 nm.

FIG. **8**(b) shows a block diagram of another exemplary embodiment of a system according to the present invention which includes the wavelength-swept laser. The laser employed the same SOA **450** and a scanning wavelength filter based on a polygonal mirror scanner **460** in a fiber-optic ring laser cavity **468**. The scanning filter consisted of a diffraction grating **470** (830 lines per mm), two lenses in 4f configuration (**472**; f=60 mm, **474**; f=63.5 mm), and the same 40-facet polygonal mirror scanner **460** as used for the pulsed source. The scanning filter can be configured to have a free spectral range of 275 nm centered at 1320 nm wavelength, which may result in a duty cycle of the laser output closely matched to that of the CCD camera (46%). When the pass band of the filter scans outside the gain bandwidth of the SOA, the source likely does not reach the lasing threshold and simply produces ASE. FIG. **9**(c) shows the temporal characteristics of the laser output at a sweep repetition rate of 18.94 kHz. The region where the output power varies with a Gaussian-like profile corresponds to when the source was operated above the lasing threshold. Outside this region, the output is ASE with a constant power. To determine how much the ASE level contributed to the detected light during swept laser operation, the backward-propagating ASE power was measured by inserting a 5% tap coupler in the cavity between the filter and SOA (lower trace in FIG. **9**(c), gray line). The ASE level dropped significantly during laser operation because ASE was suppressed due to gain saturation in the SOA. The laser-to-ASE ratio reached as high as 16 dB in the middle of the lasing tuning range. Horizontal bars (green) represent the integration window of the camera, which was synchronized with laser tuning. The average output power measured with a power meter was 18 mW.

FIG. **9**(d) shows an exemplary output spectrum measured with the optical spectrum analyzer in a peak-hold mode. In a peak-hold mode, the contribution of ASE to the measurement would be negligible owing to its much lower spectral density than laser light at a given time. Therefore, the measured spectrum represents the tuning envelope of the swept laser. The tuning range was approximately 135 nm, centered at 1325 nm. An exemplary instantaneous linewidth of the swept output was approximately 0.4 nm, as determined by measuring the coherence length with a variable-delay interferometer.

FIG. **10** shows a block diagram of yet another exemplary embodiment of the system according to the present invention. This exemplary system includes an interferometer, a probe, and a detection spectrometer which have been described in detail in elsewhere in detail S. H. Yun et al., “High-speed spectral domain optical coherence tomography at 1.3 μm wavelength,” Opt. Express 11, 3598-3604 (2003). In summary, this exemplary system included a light source **500**, scanner driver **502**, scanner clock generator **504**, optical trigger generator **510** comprising a 5% tap **512**, an (optional) optical narrowband filter **514**, photodetector **516**, and a TTL generating circuit **518**. The narrowband filter **514** is used for a swept source operation, but is not needed for the pulsed broadband source operation. The interferometer can include a circulator **520**, polarization controllers **522**, polarizer **524**, 10/90 coupler **534**, collimator **536**, neutral density filter **538**, reference mirror **540**, galvanometer-mounted mirror **542**, galvanometer driver **544**, imaging lens **546**, sample **550**. The detection arm may include a spectrometer **560** that has a collimator **562**, grating **564**, imaging lens **566**, CCD linear array **570**, camera **572**. A galvanometer can be used in the probe to provide transverse beam scanning across a sample with a FWHM beam diameter and confocal length of 18 μm and 1.1 mm, respectively. The detection spectrometer **560**, shown in the dash-dot box, consisted of a ruled diffraction grating **564** with 1,200 lines per mm, focusing lens **566** (f=150 mm), and a line scan camera (LSC) with a 512-element InGaAs CCD array (Sensors Unlimited Inc., SU512LX). Polarization controllers were adjusted to maximize the fringe visibility in the CCD. A total wavelength span of 106 nm centered at 1320 nm was projected to the 512-element CCD array with a spectral resolution of 0.1 nm.

The camera readout can be triggered by an external TTL signal generated from the source output. In the case of the pulsed light source, the electrical trigger pulses were generated directly from the optical pulses, as illustrated in the dotted box in FIG. **10**. In the swept source case, the laser output may be transmitted through a combination of a circulator and a fiber Bragg grating reflector with 0.2 nm bandwidth and 90% reflectivity (the narrowband filter arrangement being presented by a small dotted box **510**). The photodetector can then detect a train of short pulses generated when the output spectrum of the laser swept through the reflection band of the Bragg grating. From the photodetector output, TTL trigger pulses were generated with adjustable phase delay.

As described above, both lasers may be operated at a repetition rate of 18.939 kHz. This rate corresponded to the maximum readout rate of the camera. Upon receiving the trigger, the camera integrates photo-generated electrons for 24.4 μs; in the subsequent 28.4 μs period, the integrated voltage can be read out. By adjusting the phase delay in a PPL pulse generator, the integration time window of the camera was aligned to the output of the light sources, as shown in FIGS. **7**(a) and (c). The camera output can be digitized with a 4-ch, 12-bit data acquisition board **582** (National Instruments, NI PCI-6115) and processed in a personal computer **584**. The data processing may involve zero padding, interpolation and mapping to linear k-space, prior to a fast Fourier transform to create an image.

SD-OCT imaging can be performed using three different light sources: (a) the cw ASE obtained directly from the SOA, (b) the intensity-gated ASE pulses (as shown in FIG. **8**(a)), and (c) the wavelength swept laser (as shown in FIG. **8**(b)). In order to investigate motion artifacts, a sample can be constructed by mounting paper on an acoustic speaker. FIG. **11** shows exemplary images obtained with three different sources for comparison purposes. Shown on the left portion of FIG. **11** are exemplary OCT images acquired using cw, pulsed, and swept light, respectively, when the paper sample was kept stationary. Each image includes 256 axial and 500 transverse pixels, spans a depth of 2.1 mm and a width of 5 mm, and was acquired over a total time period of 26.4 ms. The images are generated using a logarithmic inverse grayscale over a dynamic range of 40 dB in reflectivity (as shown as a grayscale map in FIG. **11**). For each of the light sources, the optical power illuminating the sample was adjusted approximately to the same level by using neutral density filters in the probe. The offset of the gray-scale map for each light source can be finely adjusted so that the three static images (See FIG. **11**, sections a, c, and e) exhibited nearly the same contrast. Images of the axially moving sample (see FIG. **11**, sections b, d, and f) may be acquired when the speaker was driven with a sinusoidal waveform at 80 Hz with peak-to-peak amplitude of 0.8 mm. Signal fading due to fringe washout is distinct for the case of the cw ASE source (see FIG. **11**, section b). Except near the peaks and valleys of the oscillation when the axial velocity is zero, the image contrast and penetration depth may be noticeably degraded. In contrast, the image d can be obtained with the pulsed source and exhibits considerably reduced image fading. Signal fading may not be observed while using the wavelength swept source (see FIG. **11**, section f).

To quantify the amount of signal fading, a sum of the pixel values in the unit of linear power along each A-line may be obtained from the exemplary images shown in FIG. **11**, representing a total signal power in the particular A-line. A total of 200 pixels, from the 31^{st} to 230^{th} elements, were considered in the summation. The results thereof are shown in FIGS. **12**(a)-(c), such that the results in FIG. **12**(a) corresponds to the signals obtained using to the cw source (see FIG. **11**, sections a and b), the results in FIG. **12**(b) corresponds to the signals obtained using the pulsed source (see FIG. **11**, sections c and d), and the results in FIG. **12**(c) corresponds to the signals obtained using the swept source (see FIG. **11**, section e and **1**).

In each graph, the integrated signal power is plotted as a function of A-line index for the stationary-sample image (a lighter line) and the moving-sample image (a darker line). As depicted by the lighter lines, the signal power for the stationary sample exhibits random fluctuation due to speckle as the probe beam is scanned across the sample with standard deviation of approximately 2 dB. The speckle-averaged mean value varies linearly over transverse locations of the sample, a variation that was attributed to the finite confocal parameter and resulting depth-dependent light collection efficiency. The signal power traces obtained from FIG. **11**, section b, d, and f (darker lines) clearly demonstrate the benefit of the pulsed and swept source in terms of reducing motion-induced signal fading.

The time gated pulses may provide a factor 8.6 reduction in signal integration time, from 24.4 μs to 2.85 μs. For the swept source with an instantaneous linewidth of 0.4 nm, individual CCD pixels may be illuminated for only 75 ns per each A-line acquisition representing a 325-fold reduction in signal integration time. Theoretical curves based on Eq. (1) show good correspondence with the experimental results with the following exceptions. The experimental noise floor can prohibit detection of signal loss greater than −14 dB; the small discrepancy between the blue and black curves in FIG. **12**(c), by up to 3 dB, is attributed to the uneven probe collection efficiency at different depths of the two samples.

An exemplary SNR analysis indicates that the pulsed ASE source produced essentially the same noise characteristics as cw ASE of the same average optical power. However, images which may be acquired using the wavelength swept laser exhibited a noise floor that can be 10-20 dB higher, depending on depth, than that observed when using the ASE source of the same average power. We attribute this increased noise floor to the RIN of the swept laser in the frequency band from DC to 41 kHz corresponding to a reciprocal of the CCD integration time. The best sensitivity obtained with the swept source may be approximately −95 dB at a reference-arm power of 1-2 μW.

Exemplary SD-OCT imaging of a human coronary artery in vitro may be conducted by use of a fiber-optic catheter. The fiber-optic catheter comprised a graded-index lens and a 90-degree prism at its distal end and was connected to the interferometer through a high-speed rotational joint which could provide a rotational speed of up 100 revolutions per second (rps). FIG. **13** shows exemplary images obtained with the cw ASE source (see images A and B of FIG. **13**) and the swept source (see images C and D of FIG. **13**) at the same A-line acquisition rate of 18.94 kHz. The difference between images of images A and B and images C and D is the rotational speed of the catheter, which was 9.5 rps for images A and C, corresponding to 2000 A-lines per image, and 37.9 rps for images B and D, corresponding to 500 A-lines per image. Zero delay of the interferometer was positioned between the sample and the outer prism surface, resulting in a circular artifact superimposed on the image of the tissue (marked asp).

Image A may represent a typical OCT image of a vessel. In contrast, Image B can exhibit distinct radial streaks due to loss of signal This image fading may be attributed mainly to catheter-induced modulation in path length, increasing with the rotational speed. The path length modulation can result from three mechanisms: (a) rotational beam scanning of an off-center object inevitably results in axial path length variation of the probe beam, as if the probe was retracting or approaching to the sample; (b) the tip of a rotating catheter can wobble in a protection sheath to modulate the distance between the probe and the sample; (c) mechanical vibration from a rotation joint can modulate the length of the optical fiber inside the catheter by twist or strain. Such third mechanism was thought to a dominant cause in this particular experiment, since the circle (p) corresponding to the prism surface also suffers from significant loss of contrast at the same radial locations. Images C and D of FIG. **13** are exemplary SD-OCT images obtained with the swept source. The signal fading is not noticeable in image D, demonstrating clearly the benefit of the pulsed-source approach.

Thus, multiple strategies can be applied to realize the benefit of pulsed or gated illumination. Traditional light sources include cw SLD's, supercontinuum sources, or mode-locked lasers. Each of these sources can be converted into a pulsed source by use of an external intensity modulation scheme. As an intensity modulator or switch, one may consider electro-optic or acousto-optic modulators or injection current modulation. Alternatively, CCD cameras with built-in electrical shutters may be used. This external gating approach, however, has a main drawback in that it results in a loss of optical power and therefore may degrade the detection sensitivity. However, in situations where motion causes significant signal fading through fringe washout, external gating can lead to a better sensitivity despite the loss of optical power. In other applications, however, the usable optical power in the system is often limited by the maximum permissible exposure of the sample. In this case, external gating would be an effective way to attenuate the power level entering the system from a powerful source. For example, ophthalmologic retinal imaging has been performed with SD-OCT at a wavelength of 800-nm. At this wavelength, the maximum permissible cw exposure to the eyes is limited to approximately 600-700 μW according to American National Standards Institute (ANSI). For this application, one could gate the output from a commercially available mode-locked Ti:Sapphire laser and, while still providing sufficient power to the system, reduce sensitivity to motion by more than an order of magnitude.

Instead of external gating, various power-efficient internal modulation techniques may be employed. For example, Q-switching and cavity dumping are well known techniques applicable to ultrashort pulsed lasers. Q-switched supercontinuum sources with repetition rates of a few to tens of kHz have been reported and may be suitable for use in the exemplary SD-OCT systems. Beside the benefit of reducing motion artifacts, the reduced fringe washout of the pulsed source approach may also facilitate quadrature fringe detection based on sequential phase dithering.

The use of a wavelength swept source as described in this manuscript is essentially a hybrid between the OFDI and SD-OCT techniques that may permit otherwise less-flexible OFDI source requirements including narrow instantaneous linewidth and tuning linearity to be relaxed. In this case, the high resolution and linearity of the spectrometer can accommodate a swept laser with a nonlinear tuning element such as a resonantly scanned Fabry-Perot filter or a tunable source based on soliton self-frequency shifting in nonlinear fibers. Furthermore, the relaxed requirement on the instantaneous linewidth of a swept laser may facilitate the generation of higher output powers.

In another exemplary embodiment of the system according to the present invention, each of the CCD arrays can be a 2-dimensional array. Two dimensional simultaneous scanning can be performed by using the 2-dimensional array, where along one axis of the array spectral information is encoded, while across the second dimension spatial information is encoded. FIG. **14** shows a block diagram of such exemplary system which may include a line source **600**, lens **604**, beam splitter **610**, and a two-dimensional CCD array **620**. The tissue is preferably illuminated by a line beam, and the illuminated portion in the sample is imaged on one dimension of the array, while the light is spectrally dispersed in the other direction of the array. As previously discussed, long integration times with a continuous source lead to motion artifacts and fringe washout. Also, read-out times of 2-dimensional arrays are larger that of 1-dimensional arrays. By using a pulsed source, motion artifacts and fringe wash-out can be avoided, where the exposure time of the array is significantly shorter than the frame transfer rate. Since the light intensity is distributed over a line, more power is allowed to be incident on the tissue. When using a pulsed source with pulse durations longer than 100 femtoseconds, the source can be treated as semi-continuous in ophthalmic applications. Thus, high peak power can be used over short periods of time, while the average power is in compliance with ANSI standards for light exposure of tissue. In addition, a swept source can be used in combination with line illumination, where the detector can be a 1 or 2 dimensional array. In case of a one dimensional array, the tissue information over a full line is acquired for each wavelength consecutively by a 1-dimensional array. By using a 2-dimensional array, the wavelength is encoded along the second dimension of the array.

As yet another exemplary embodiment of the present invention, a pulsed source can be employed in full-field optical coherence tomography, as depicted in FIG. **15** as a block diagram. The detector array is typically a 2-dimensional CCD array. The operating principle and generic system architecture for full-field OCT is well known in the art. Full-field OCT typically produces en face images. As with the earlier description of SD-OCT, the pulsed-source approach effectively reduces the effective signal acquisition time in a CCD array which is typically two dimensional. The repetition rate is matched to the frame readout rate of the CCD array. Since a typical full-field OCT technique is not based on spectral-domain interferometry, the swept source approach does not provide an advantage in full-field OCT in terms of motion artifacts. Nevertheless, a swept source whose sweep repetition rate is matched to the CCD readout rate may be still usable for full-field OCT as an alternative source to conventional broadband source. This is because of the fact that a swept spectrum seen by the CCD in a time-integrated manner is identical to a broadband spectrum of a same spectral envelope. The light source **700** is preferably spatially incoherent source, such as Halogen or Tungsten lamp in Kohler configuration, but operated in a pulsed regime to reduce the motion artifacts in full-field imaging. The source beam is divided into a reference and a sample by a beam splitter. High-NA objective lenses **710** are typically used. The reference mirror **540** may be attached to a mechanical actuator such as PZT for phase dithering to realize heterodyne detection.

The invention disclosed here may be used in various imaging applications, ranging from coronary artery imaging, GI tract, ophthalmologic imaging, to monitoring of dynamic biological or chemical process, moving materials and components, where high-sensitivity, high-speed, motion-artifact-free imaging is preferred.

The foregoing merely illustrates the principles of the invention. Various modifications and alterations to the described embodiments will be apparent to those skilled in the art in view of the teachings herein. For example, the invention described herein is usable with the exemplary methods, systems and apparatus described in U.S. Provisional Patent Application No. 60/514,769 filed Oct. 27, 2003, and International Patent Application No. PCT/US03/02349 filed on Jan. 24, 2003, the disclosures of which are incorporated by reference herein in their entireties. It will thus be appreciated that those skilled in the art will be able to devise numerous systems, arrangements and methods which, although not explicitly shown or described herein, embody the principles of the invention and are thus within the spirit and scope of the present invention. In addition, all publications, patents and patent applications referenced above are incorporated herein by reference in their entireties.

What is claimed is:

1. A system for imaging at least a portion of a sample, comprising:

a source arrangement generating at least one source electro-magnetic radiation forwarded to the sample and a reference; **[**and**]**

at least one detection arrangement including a plurality of detectors, at least one of the detectors capable of detecting a signal associated with a combination of at least one first electro-magnetic radiation received from the sample and at least one second electro-magnetic radiation received from the reference, *wherein the signal is at least one of frequency components of the combination;*

at least one spectral separating unit which separates spectrum of at least one of the first electro-magnetic radiation, the second electro-magnetic radiation or the combination into the at least one of the frequency components,

wherein at least one particular detector of the detectors has a particular electrical integration time, wherein the at least one particular detector receives at least a portion of the signal for a time duration which has at least one first portion with at least one first power level greater than a predetermined threshold and at least one second portion immediately preceding or following the at least one first portion, the at least one second portion having at least one second power level less than the predetermined threshold, and wherein the at least one second portion is extended for a time period which is approximately at least 10% of the particular electrical integration time*; and*

at least one processing arrangement which is configured to generate at least one image associated with the sample based on the detected signal which is provided for the particular electrical integration time, the at least one image including at least one portion associated with the sample below a surface thereof, and the at least one portion of the at least one image illustrates the sample at multiple depths thereof immediately below a surface location at which the forwarded radiation impacts the sample.

[**2**. The system according to claim **1**, wherein the signal has frequency components of the combination.]

3. The system according to claim **1**, wherein the source arrangement is a pulsed broadband source.

4. The system according to claim **1**, wherein the detection arrangement includes at least one charged-coupled device.

5. The system according to claim [**2**] *1*, wherein the at least one particular detector receives the at least one of the frequency components.

6. The system according to claim **5**, wherein the source arrangement is a pulsed broadband source.

7. The system according to claim **5**, wherein the source arrangement includes an optical gating switch.

8. The system according to claim **5**, wherein a frequency of the at least one source electro-magnetic radiation varies over time.

9. The system according to claim **5**, wherein the detector arrangement further includes an electrical shutter that is adapted to gate a transmission of photoelectrons associated with the combination of the first and second electro-magnetic radiation, wherein a time period for the gating to allow the transmission of the photoelectrons is less than approximately 90% of the particular electrical integration time.

10. The system according to claim **5**, wherein the sample is a biological sample.

11. The system according to claim **5**, wherein the detection arrangement includes at least one charged-coupled device.

[**12**. The system according to claim **5**, further comprising at least one spectral separating unit which separates spectrum of at least one of the first electro-magnetic radiation, the second electro-magnetic radiation and the combination into the at least one of the frequency components.]

13. The system according to claim **6**, wherein the at least one source electro-magnetic radiation generated by the pulsed source is a single pulse per the particular electrical integration time.

14. The system according to claim **6**, wherein the at least one source electro-magnetic radiation generated by the source arrangement is a burst of radiation that extends for at most approximately 90% of the particular electrical integration time.

15. The system according to claim **6**, wherein the at least one source electro-magnetic radiation generated by the pulsed broadband source has a spectrum with a center wavelength between approximately 700 nanometers and 2000 nanometers.

16. The system according to claim **6**, wherein a duration of the burst of radiation is approximately shorter than 1 μsec.

17. The system according to claim **8**, wherein a mean frequency of the at least one source electro-magnetic radiation changes substantially continuously over time at a tuning speed that is greater than 100 terahertz per millisecond.

18. The system according to claim **8**, wherein the mean frequency changes repeatedly with a repetition period that is less than approximately 90% of the particular electrical integration time.

19. The system according to claim **8**, wherein the at least one source electro-magnetic radiation generated by the source arrangement has a tuning range with a center wavelength between approximately 700 nanometers and 2000 nanometers.

20. The system according to claim **8**, wherein the at least one source electro-magnetic radiation generated by the source arrangement has a timing range of approximately greater than 1% of the center wavelength.

21. The system according to claim **8**, wherein the at least one source electro-magnetic radiation generated by the source arrangement has an instantaneous line width and a tuning range, the instantaneous line width being less than approximately 10% of the tuning range.

22. The system according to claim **8**, wherein the source arrangement includes a tunable laser.

23. The system according to claim **8**, wherein the source arrangement includes a tunable filter.

24. The system according to claim **8**, wherein the source arrangement includes a medium, and wherein the source arrangement generates the at least one source electro-magnetic radiation based on a non-linearity associated with the medium.

25. The system according to claim **8**, wherein the frequency varies substantially linearly with time.

26. The system according to claim **8**, wherein the frequency varies substantially sinusoidally with time.

27. The system according to claim **13**, wherein the pulsed source includes at least one of a Q-switched laser, a cavity-dumped mode-lock laser, and a gain-switched laser.

28. The system according to claim **13**, wherein the at least one source electro-magnetic radiation generated by the pulsed broadband source has a pulse width approximately shorter than 1 μsec.

29. The system according to claim **14**, wherein the burst of radiation includes multiple pulses.

30. The system according to claim **15**, wherein the at least one source electro-magnetic radiation generated by the pulsed broadband source has a spectrum with a spectral width of approximately greater than 1% of the center wavelength.

31. A method for imaging at least a portion of a sample, comprising:

generating at least one source electro-magnetic radiation forwarded to the sample and a reference; [and]

detecting at least a portion of a signal associated with a combination of at least one first electro-magnetic radiation received from the sample and at least one second electro-magnetic radiation received from the reference using at least one detector of a plurality of detectors of a detection arrangement, *wherein the signal is at least one of frequency components of the combination;*

separating spectrum of at least one of the first electro-magnetic radiation, the second electro-magnetic radiation or the combination into the at least one of the frequency components,

wherein at least one particular detector of the detectors has a particular electrical integration time, and wherein the at least one particular detector receives at least a portion of the signal for a time duration which has a first portion with a first power level greater than a predetermined threshold and a second portion immediately preceding or following the first portion, the second portion having a second power level less than the predetermined threshold, and extending for a time period which is approximately more than 10% of the particular electrical integration time*; and*

generating at least one image associated with the sample based on the detected signal which is provided for the particular electrical integration time, the at least one image including at least one portion associated with the sample below a surface thereof, and the at least one portion of the at least one image illustrates the sample at multiple depths thereof immediately below a surface location at which the forwarded radiation impacts the sample.

[**32**. The method according to claim **31**, wherein the signal has frequency components of the combination.]

33. The method according to claim **31**, wherein the generating step is performed by a source arrangement which is a pulsed broadband source.

34. The method according to claim **31**, wherein the detection step is performed by a detection arrangement which includes at least one charged-coupled device.

35. The method according to claim [32] *31*, wherein the at least one particular detector receives the at least one of the frequency components.

36. The method according to claim **35**, wherein the generating step is performed by a source arrangement which is a pulsed broadband source.

37. The method according to claim **35**, wherein the source arrangement includes an optical gating switch.

38. The method according to claim **35**, wherein a frequency of the at least one source electro-magnetic radiation varies over time.

39. The method according to claim **35**, wherein the detector arrangement further includes an electrical shutter that is adapted to gate a transmission of photoelectrons associated with the combination of the first and second electro-magnetic radiation, wherein a time period for the gating to allow the transmission of the photoelectrons is less than approximately 90% of the particular electrical integration time.

40. The method according to claim **35**, wherein the sample is a biological sample.

41. The method according to claim **35**, wherein the detecting step is performed by a detection arrangement which includes at least one charged-coupled device.

[**42**. The method according to claim **35**, further comprising the step of separating spectrum of at least one of the first electro-magnetic radiation, the second electro-magnetic radiation and the combination into the at least one of the frequency components.]

43. The method according to claim **36**, wherein the at least one source electro-magnetic radiation generated by the pulsed source is a single pulse per the particular electrical integration time.

44. The method according to claim **36**, wherein the at least one source electro-magnetic radiation generated by the source arrangement is a burst of radiation that extends for at most approximately 90% of the particular electrical integration time.

45. The method according to claim **36**, wherein the at least one source electro-magnetic radiation generated by the pulsed broadband source has a spectrum with a center wavelength between approximately 700 nanometers and 2000 nanometers.

46. The method according to claim **36**, wherein a duration of the burst of radiation is approximately shorter than 1 μsec.

47. The method according to claim **38**, wherein a mean frequency of the at least one source electro-magnetic radiation changes substantially continuously over time at a tuning speed that is greater than 100 terahertz per millisecond.

48. The method according to claim **38**, wherein the mean frequency changes repeatedly with a repetition period that is less than approximately 90% of the particular electrical integration time.

49. The method according to claim **38**, wherein the at least one source electro-magnetic radiation generated by the source arrangement has a tuning range with a center wavelength between approximately 700 nanometers and 2000 nanometers.

50. The method according to claim **38**, wherein the at least one source electro-magnetic radiation generated by the source arrangement has a timing range of approximately greater than 1% of the center wavelength.

51. The method according to claim **38**, wherein the at least one source electro-magnetic radiation generated by the source arrangement has an instantaneous line width and a tuning range, the instantaneous line width being less than approximately 10% of the tuning range.

52. The method according to claim **38**, wherein the source arrangement includes a tunable laser.

53. The method according to claim **38**, wherein the source arrangement includes a tunable filter.

54. The method according to claim **38**, wherein the source arrangement includes a medium, and wherein the source arrangement generates the at least one source electro-magnetic radiation based on a non-linearity associated with the medium.

55. The method according to claim **38**, wherein the frequency varies substantially linearly with time.

56. The method according to claim **38**, wherein the frequency varies substantially sinusoidally with time.

57. The method according to claim **43**, wherein the pulsed source includes at least one of a Q-switched laser, a cavity-dumped mode-lock laser, and a gain-switched laser.

58. The method according to claim **43**, wherein the at least one source electro-magnetic radiation generated by the pulsed broadband source has a pulse width approximately shorter than 1 μsec.

59. The method according to claim **44**, wherein the burst of radiation includes multiple pulses.

60. The method according to claim **45**, wherein the at least one source electro-magnetic radiation generated by the pulsed broadband source has a spectrum width a spectral width of approximately greater than 1% of the center wavelength.

* * * * *