Research activities in our

Ultrafast Optical Logic Laboratory

2007-2008

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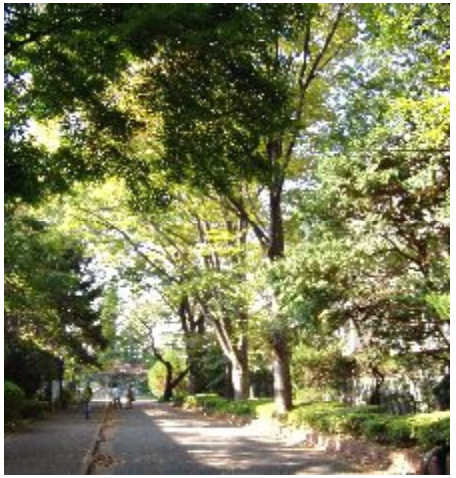
Chofu city, Tokyo, Japan



This bi-annual report can be downloaded from
http://www.ultrafast.ee.uec.ac.jp/annual.pdf

The University of Electro-Communications UEC

The 21st century COE Program
Innovation in Coherent Optical Science

On-going Research Project lineup

On-going Projects that we want to run in our lab.
(depending upon the quantity and quality of grad students every two-three years!!)

(1) 200 Gb/s DISC gate experiment

high speed limit, low-energy-dissipation limit
quantum-electronical, optical-acceleration mechanism

(2) New scheme of mode-locking pulse generation

sub-picosecond high-quality pulse generation,
precise frequency-comb generation,
wide-gap materials

(3) Materials nonlinear-response characterization

dilute quantum-dot versus bulk semiconductors, taking into account the Krammers-Kronig relation,
size reduction with pc/qd waveguides

(4) Newly exploring the 200-to-500 GHz speed region

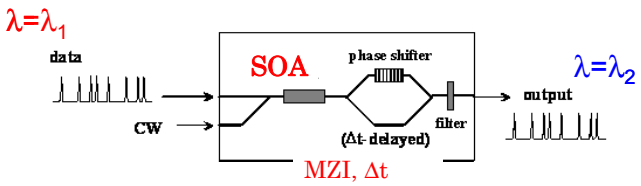
optical-spectrum-synthesis design and characterization which we have proposed (Nakamoto et al., OE 2007)
attention to: effective efficiency, i.e., dc energy consumption

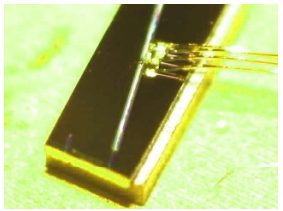
COE-research: DISC-type all-optical semiconductor gate

200-Gb/s, data-driven, optically gated waveform

Sakaguchi, et al., submitted to Opt. Comm., Elsevier.
UEC---Tech. Univ. Denmark collaboration, 2004-2005.

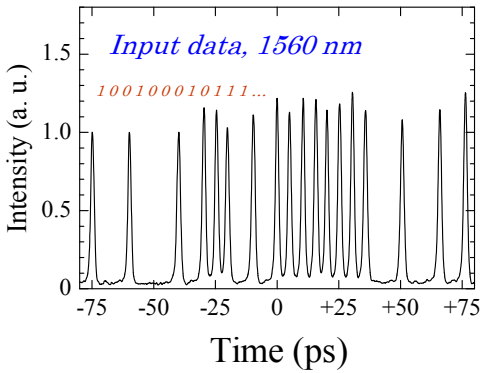
SMZ-DISC-type gate structure (1998)

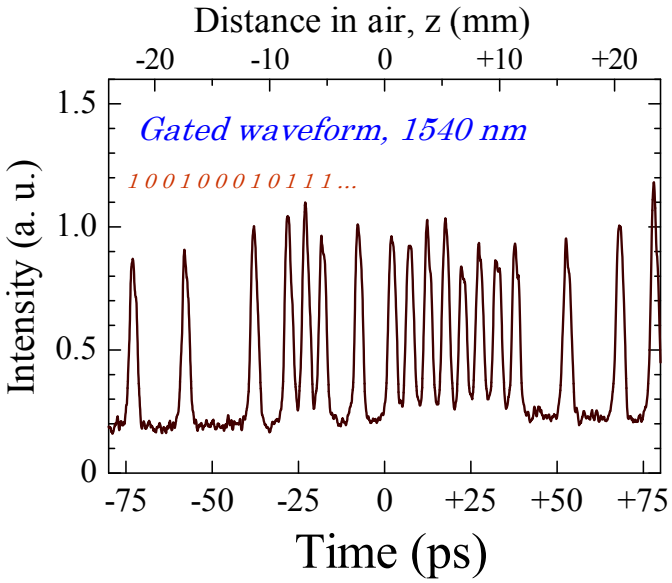




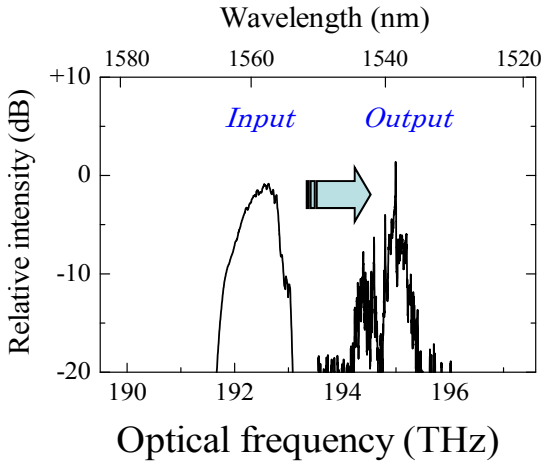
Custom-designed
InGaAsP semiconductor optical amp.

200-Gb/s, 5,000-bit-long, gated waveform, May 2008,
measured with a home-made, precisely synchronized 40-MHz monitoring system.





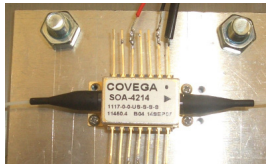
Spectra before and after the DISC gate.



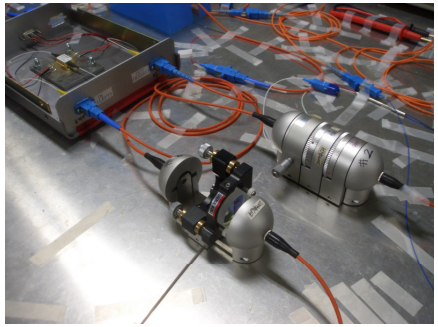
SOA's dc-electric-power consumption= 0.59 Watt= 3.0 pJ/bit.

COE-research: DISC-loop-type mode-locked pulse source
Single-mode, 2-ps, 10-GHz pulse and comb generation

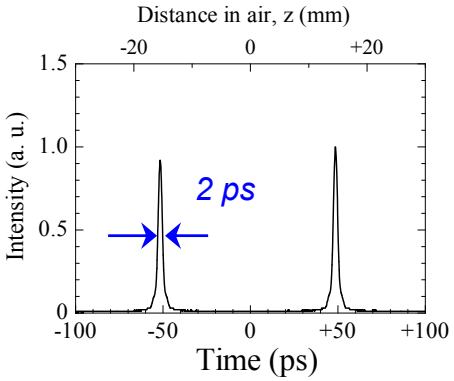
2-ps, 10-GHz pulse's optical waveform, and comb spectrum

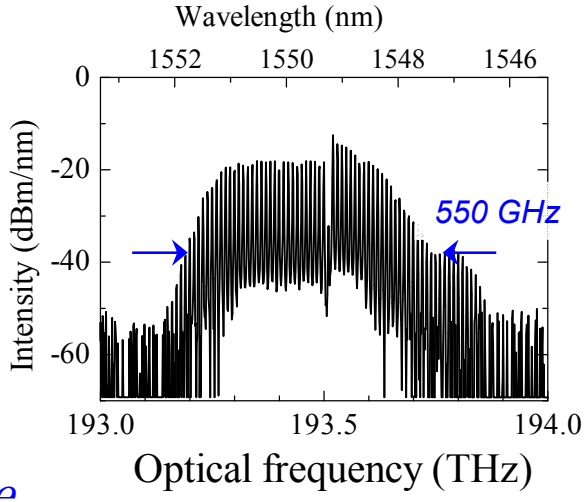


commercially-available InGaAsP SOA module.
SOA's dc-electric-power consumption
= 0.56 Watt

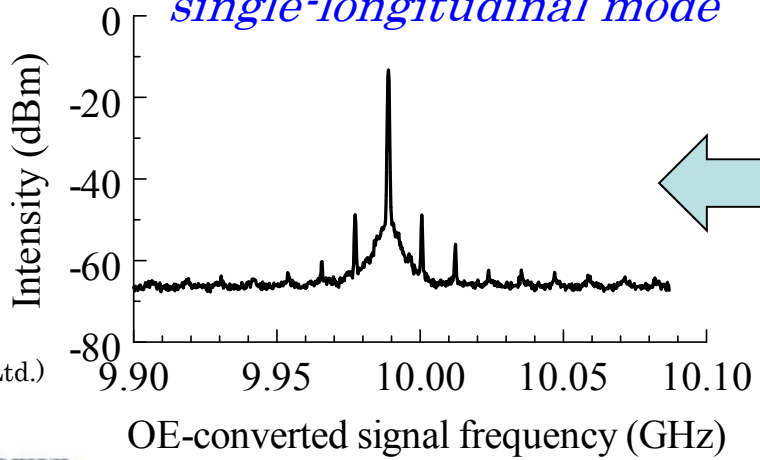


high-Finesse solid etalon
(FSR= 10 GHz, Δf_{3dB}= 180 MHz,
Japan Aviation Electronics Industries, Ltd.)

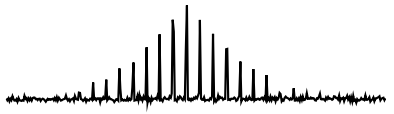




single-longitudinal mode



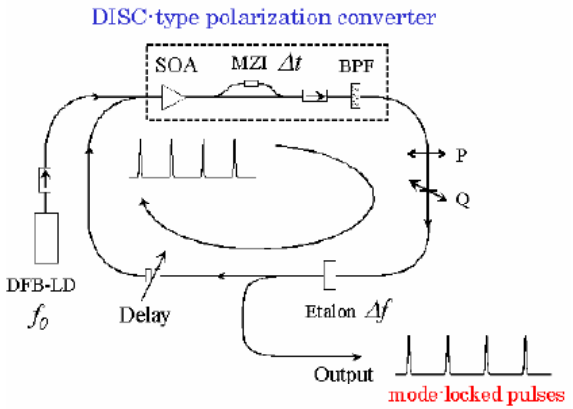
multi-mode
(previous result)



COE-research: DISC-loop-type mode-locked pulse source

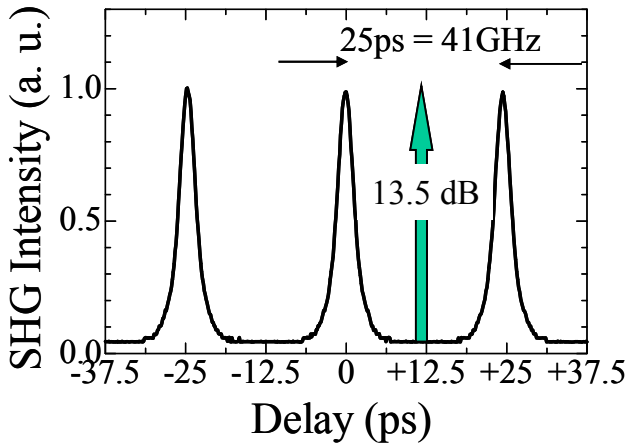
2-ps, 40-GHz pulse and comb generation, 2005-2006

R. Suzuki, et al., CLEO, Long Beach, USA, May 2006.

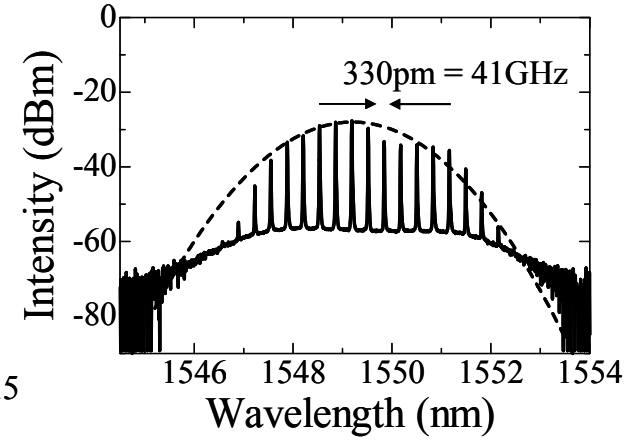


Original scheme from,
Y. Ueno, et al., Appl. Phys. Lett. Oct. 2001

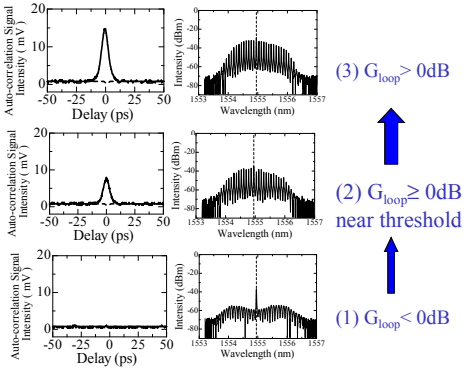
Auto-correlation trace



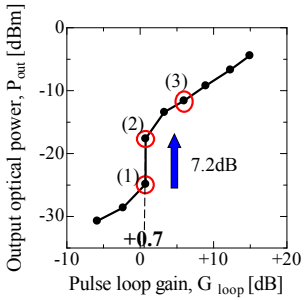
Optical-frequency-comb spectrum



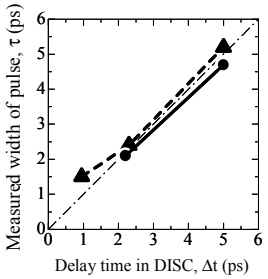
measured t-f product, Δt·Δf= 0.53
(1.2 times that of a Gaussian pulse)



Proof of principle (1), threshold behavior



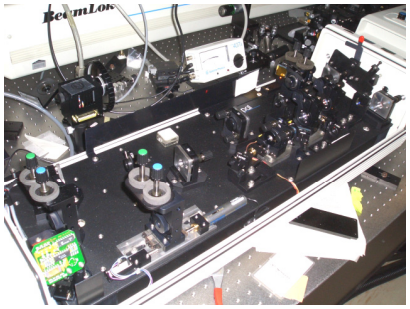
Proof of principle (2), linearly controlled pulse widths

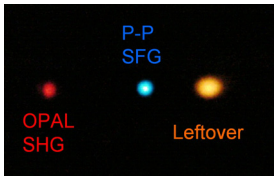


solid curve: 10 GHz
dashed curve: 40 GHz

COE-research: Ultrafast optical phase/intensity-response characterization research of PC/QD waveguides

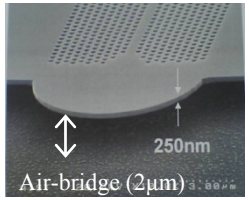
Collaboration project between U. Tsukuba-AIST-UEC-NEC, 2005-2007.

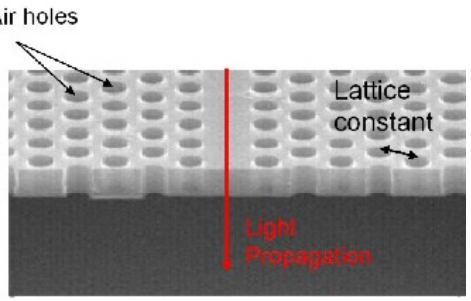


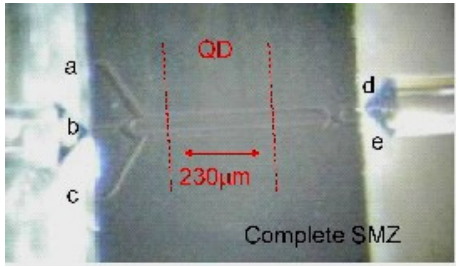


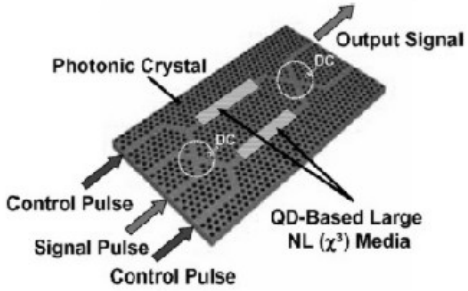
(by Salleras and Honma)

home-made pump-and-probe, AOM-heterodyne, system, combined with commercial Green -- Ti:S -- Parametric Osc. System (Spectra Phys.) in our lab.









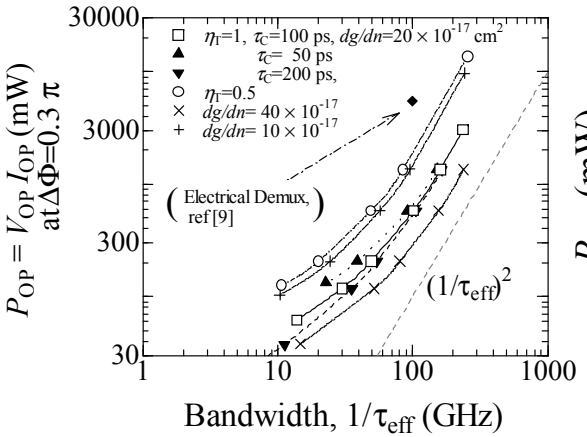
air-bridged GaAs-photonic-crystal (PC)/ InAs quantum-dot (QD) integrated waveguides, fabricated by U. Tsukuba and AIST.

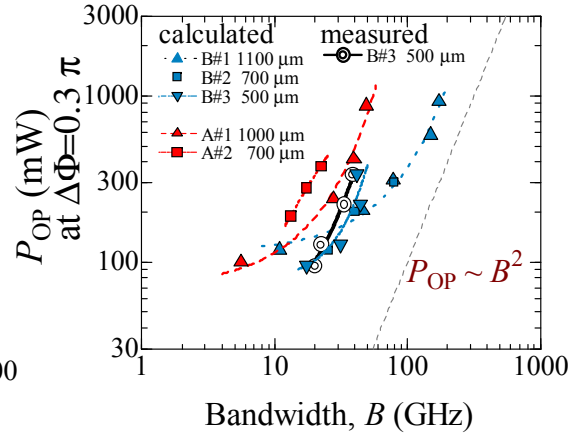
ref.: K. Asakawa, et al., New J. Phys. 8 (2006) 208.

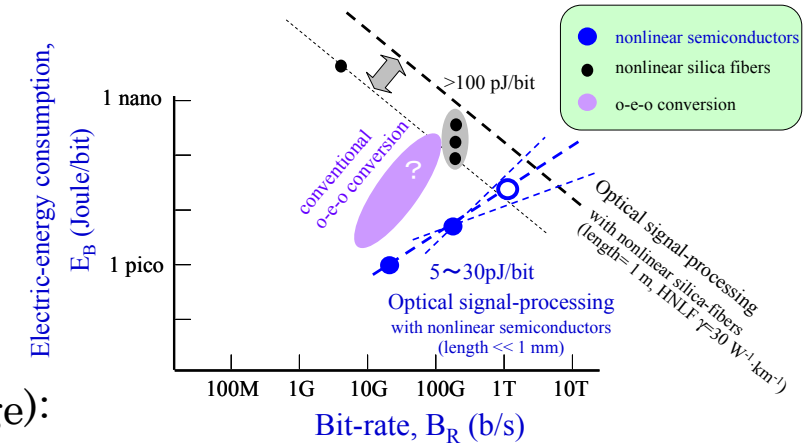
COE research, for making-up Future Vision:

dc-electric-energy consumption model (DISC gate)

J. Sakaguchi et al., Opt. Express, Oct. 2007.
Y. Ueno et al., IEICE PN-society mtg, Dec. 2007, Tokyo.
UEC--KDDI collaboration project, 2005-2006.







numbers from this work (very first report, to our knowledge):

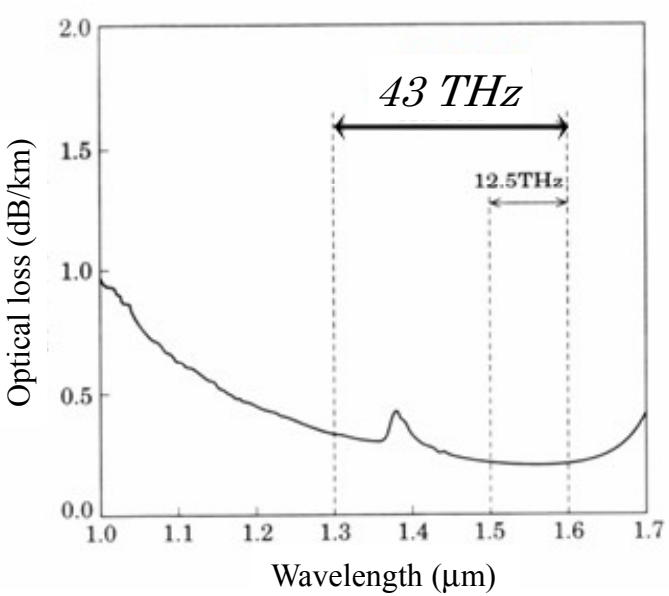
- 10-20 pJ of dc energy, per one-bit all-optical signal-process
- 7×10^7 electrons, per one-bit all-optical signal-process

Our research backgrounds:

Broad bandwidth of optically wired systems

(for the Industrial Systems Market)

100 THz



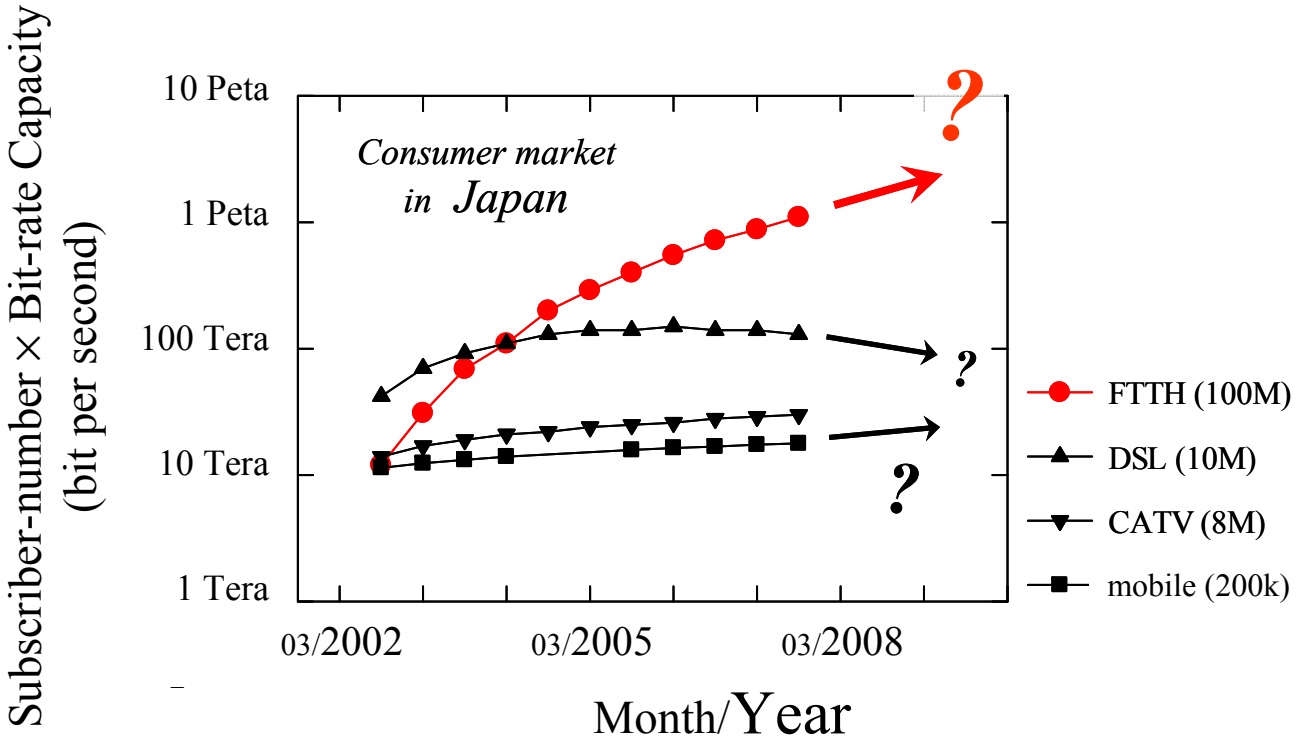
100-THz transmittance bandwidth

of a standard, high-quality, silica-based single-mode-fiber cable.

Our research background:

Increasing FTTH capacity in Japan, Year 2002-2008

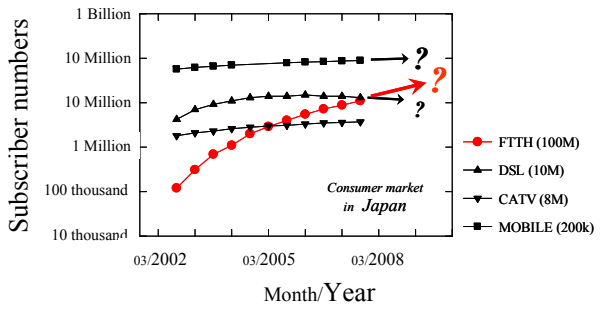
(in the Consumers Market)



FTTH: optically wired.

DSL&CATV: electrically wired.

mobile: electrically wireless.

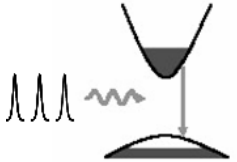


統計作成者：総務省、2008年公式発表

図作成者：大平高志・坂口淳(2005) ⇒ Nguyen Tuan Anh(2008)

examples of

Experimental resources, --2008 present



http://www1.ttcn.ne.jp/gagnon/resources-e.html

Laboratory Resources - Microsoft Internet Explorer

ファイル(F) 編集(E) 表示(V) お気に入り(A) ツール(T) ヘルプ(H)

戻る 検索 お気に入り

アドレス(D) http://www1.ttcn.ne.jp/gagnon/resources-e.html 移動

Laboratory Resources

Resources for Experimental Research

- All-optical gates and circuits
  - Delayed-interference signal-wavelength convertors (DISC), 40Gb/s, 100-200 Gb/s, keep updating
  - DISC-loop pulse generator, repetition frequency= 10-40 GHz, output pulse width= 1-5 ps (i.e., 40-160 Gb/s after optical Mux), keep updating
  - Ultrafast, nonlinear, monolithically integrated photonic-crystal/Quantum-dot waveguides (nation-wide collaboration research with Univ. Tsukuba, AIST, NEC R&D, etc., FY2005-2007).
- Signal sources
  - Actively-mode-locked fiber-ring laser, tunable frequency 4-12.5 GHz, pulse width= 2 ps, tunable wavelength 1535-1560 nm, from Pritel, Inc., Chicago, USA.
  - Passively-mode-locked fiber-ring laser, nominal pulse width= 250 fs, 40 MHz, 1555 nm, from Calmar Optcom Inc., Sunnyvale, California, USA.
  - Adiabatic soliton pulse compressors #1 and #2, to less than 500 fs.
  - Optical time-division multiplexers, #1, low loss, low dispersion, high precision, high stability, from Pritel, Inc.
  - Handmade optical multiplexers, #1, low loss, low dispersion, high precision, high stability.
  - Optical fiber amplifiers, #1-#4, high power and low dispersion, from Pritel, Inc.
  - Handmade optical fiber amplifier, #1, high power and low dispersion.
  - Diode-pumped mode-locked Ti:S lasers and ultrabroadband optical parametric oscillator systems (nominal 130 fs, 80MHz, 1.1-2.2 um, Spectra Physics, California).
  - High-speed electrical digital-data-pattern generator, up to 12.5 GHz, from Anritsu, Japan.
  - High-precision microwave signal synthesizer (on loan), up to 20 GHz, from Hewlett-Packerd, California, USA.
- Characterization equipments
  - Auto-correlator and cross-correlator, resolution of less than 100 fs, from Femtochrome, Inc., California.

インターネット

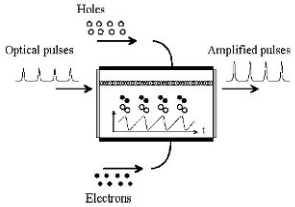
examples of

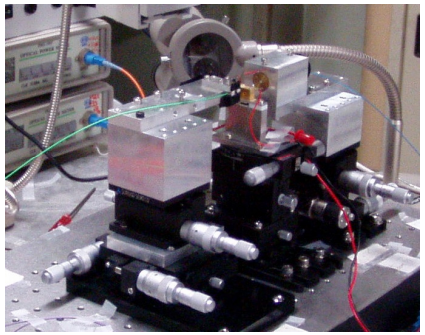
Experimental resources, --2008 present

http://www1.ttcn.ne.jp/gagnon/resources-e.html

200-Gb/s data-signal source, and,
high-resolution monitor system (2008)

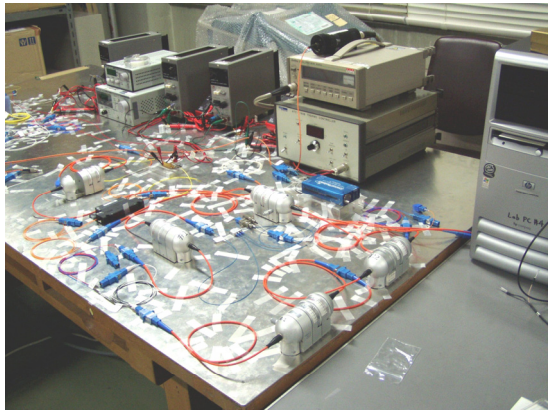
(commercial mode-locked pulse sources,
data-pattern modulators,
homemade optical MUX's, optical amps, e tc.,)



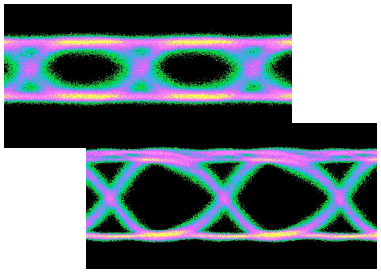


Custom SOA chips

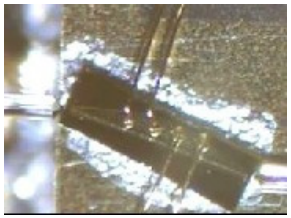
reliably coupled to
lensed-optical-fiber cables
for studying their physical high-speed limits!

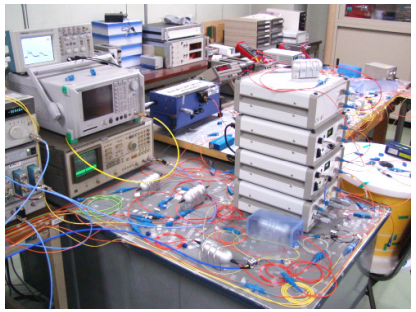


Proto-type disc-loop
mode-locked pulse laser (G1, 2005)



Eye patterns of
12.5-Gb/s NRZ signals
(by Sakaguchi and Nishida)





Commercial optical MUX's, optical amps,
optical cross-correlator,
high-precision electronic spectrum analyzer

Collaboration research activities

http://www1.ttcn.ne.jp/gagnon/lab-j.html

Our lab – NEC R&D Center (Dr. Tajima), 2003

Our lab – MIC/NICT project members, 2003-2005

Our lab – UEC-COE-program members, 2003-2007

Our lab – Technical Univ. Denmark (Dr. Nielsen, Prof. Mork), 2004-2005

Our lab – KDDI R&D Center (Dr. Nishimura), 2004-2005

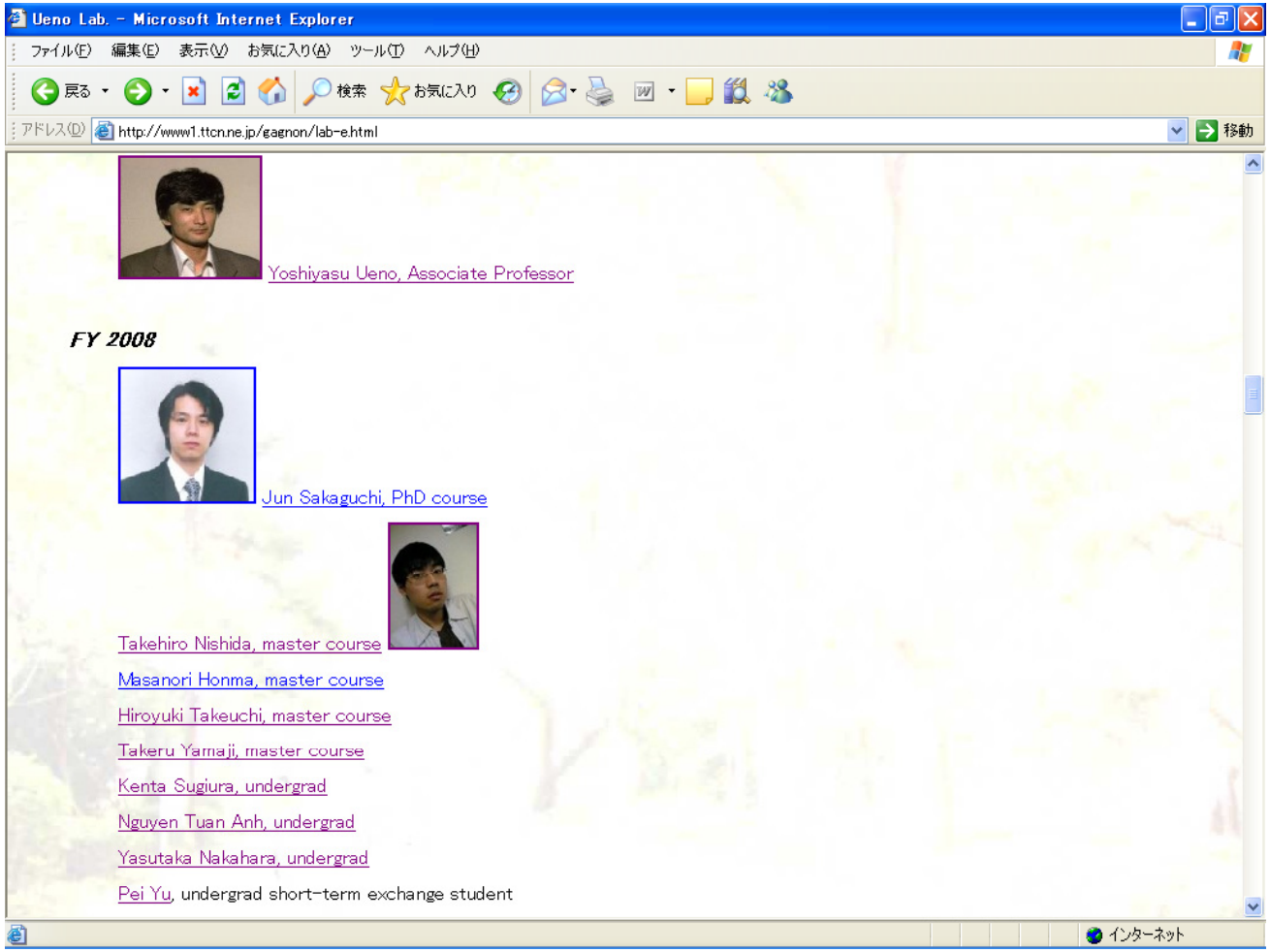
Our lab – Univ. Tsukuba and AIST (METI/NEDO project), 2005-2007

Our lab – Japan Aviation Electronics Industries, Ltd., 2006-2007

Our lab – MIC/NICT (Dr. Wada), 2007--

Grad- and undergrad-student members, FY2008

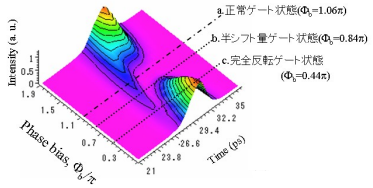
http://www1.ttcn.ne.jp/gagnon/lab-e.html#members



Grad- and undergrad-student members

http://www1.ttcn.ne.jp/gagnon/lab-e.html#members

opening our laboratory
to anybody inside and outside campus



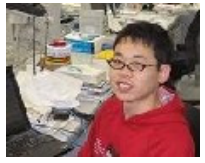
Optical phase-bias condition
by Nagasue, 2003

we're walking step-by-step towards

our future life …

Graduated students
from our master- and doctor-courses

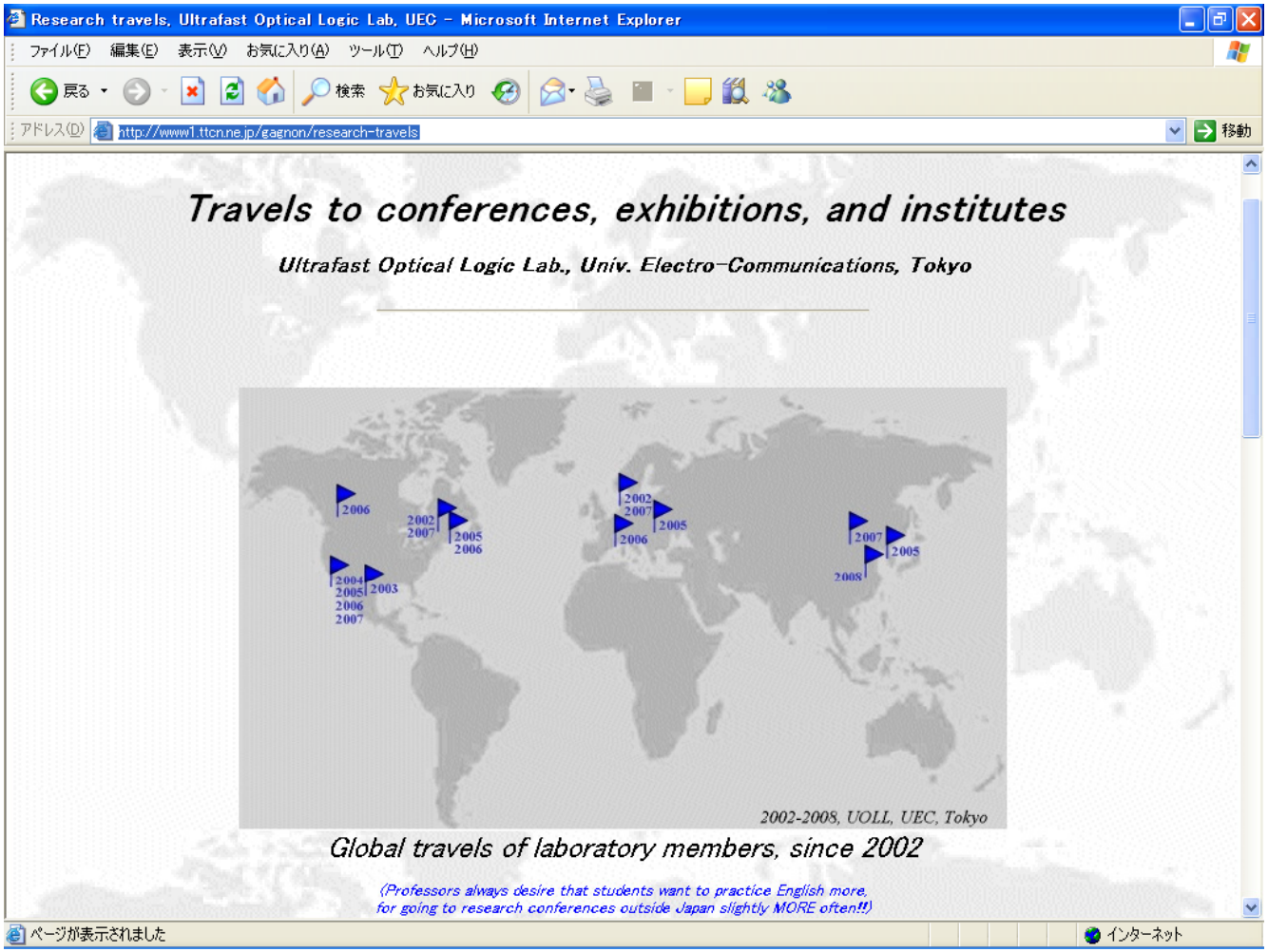


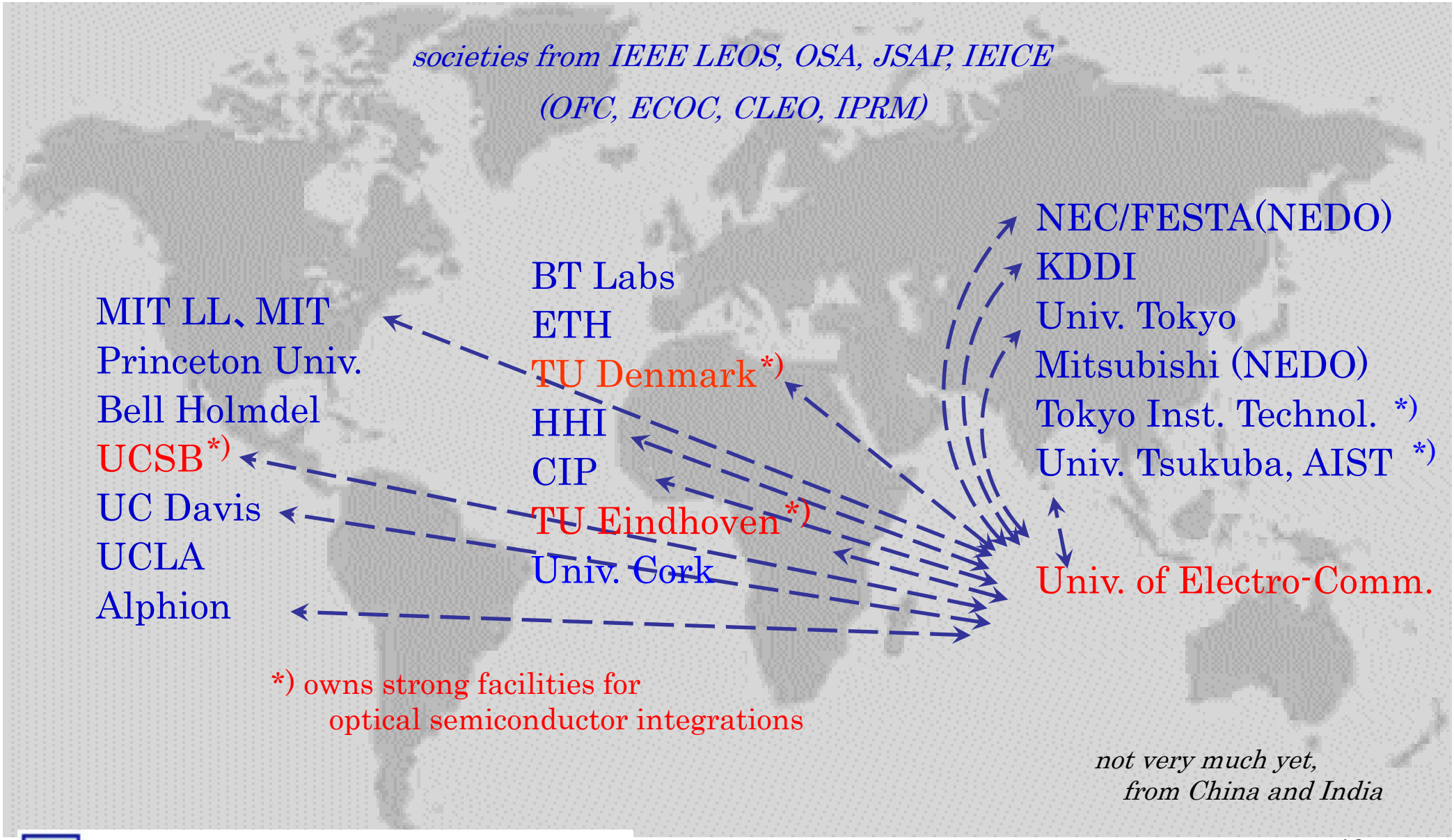

open laboratory

Travels to conferences

http://www1.ttcn.ne.jp/gagnon/research-travels.html



Global spreads and collaborations (SMZ-DISC-related gate research)



Selected publications, 2005-present

Journal Papers

http://www1.ttcn.ne.jp/gagnon/publications.html

- J. Sakaguchi, M.L. Nielsen, T. Ohira, R. Suzuki, and Y. Ueno, 'Observation of small sub-pulses out of the delayed-interference signal-wavelength converter,' Jpn. J. Appl. Phys vol. 44, no. 44, pp. L1358-1360, Oct. 2005.
- M.L. Nielsen, J. Mørk, R. Suzuki, J. Sakaguchi, and Y. Ueno, 'Theoretical and experimental study of fundamental differences in the noise suppression of high-speed SOA-based all-optical switches,' Optics Express vol. 13, no. 13, pp. 5080-5086, June 2005.
- M.L. Nielsen, J. Mørk, R. Suzuki, J. Sakaguchi, and Y. Ueno, 'Experimental and theoretical investigation of the impact of ultra-fast carrier dynamics on high-speed SOA-based all-optical switches,' Optics Express, vol. 14, no. 1, pp. 331-347, Jan. 2006.
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- Jun Sakaguchi, Mads L. Nielsen, Takashi Ohira, Rei Suzuki, and Yoshiyasu Ueno, "Analysis of sub-pulse generation from the delayed-interference signal-wavelength converter for a wide carrier recovery rate range," Jpn. J. Appl. Phys. vol. 47, no. 9, pp. 7182-7189, Sept. 2008.
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Selected publications, 2005-present

http://www1.ttcn.ne.jp/gagnon/publications.html

Conferences Talks (except invited)

- M.L. Nielsen, J. Mørk, J. Sakaguchi, R. Suzuki, and Y. Ueno, 'Reduction of nonlinear patterning effects in SOA-based all-optical switches using optical filtering', Optical Fiber Communication Conference (OFC 2005), Los Angeles, USA, March 6-11, 2005, paper OThE7.
- J. Sakaguchi, M.L. Nielsen, T. Ohira, R. Suzuki, and Y. Ueno, 'Observation of small sub-pulses generated in the DISC-type wavelength converter,' 10th Optoelectronics and Communications Conference (OECC 2005), Seoul, Korea, July 5-8, 2005, paper 8F1-4.
- R. Suzuki, S. Kobayashi, J. Sakaguchi, and Y. Ueno, 'Threshold condition for pulse generation from a DISC-loop-type pulse generator,' IQEC/CLEO-PR, July 11-15, 2005, Tokyo, paper CMF1-4, pp. 1522-1523.
- J. Sakaguchi, Y. Ueno, K. Nishimura, and T. Yazaki, 'New method for characterizing the injected-carrier-to-photon conversion efficiencies inside the ultrafast all-optical semiconductor gates,' 9th International Symposium on Contemporary Photonics Technology (CPT 2006), Tokyo, Jan. 11-13, 2006, paper no. P-26, pp. 130-131.
- R. Suzuki, T. Ohira, J. Sakaguchi, and Y. Ueno, '40-GHz mode-locked pulse generation with a new scheme of SOA-based pulse generation,' CLEO/QELS 2006, May 21-26, 2006, Long beach, USA, paper no. CMG5.
- J. Sakaguchi, Y. Ueno, K. Nishimura, and T. Yazaki, 'New method for characterizing the injected-carrier-to-photon conversion efficiencies inside the ultrafast all-optical semiconductor gates,' Optical Amplifiers and their Applications (OAA 2006), June 25-28, 2006, Whisler, Canada, paper no. OTuC4.
- Jun Sakaguchi, Ferran Salleras, and Yoshiyasu Ueno, "Frequency-dependent electric dc power consumption in ultrafast all-optical semiconductor gates," 12th Optoelectronics and Communications Conference (OECC 2007), July 9-13, 2007, Yokohama, Japan, paper no. 10D2-3.
- Ferran Salleras, Masanori Honma, Jun Sakaguchi, Yoshiyasu Ueno, Nobuhiko Ozaki, Yoshinori Kitagawa, Kiyoshi Asakawa, Naoki Ikeda, Yoshimasa Sugimoto, "Criterion for removing a delayed peak from the ultrafast nonlinear response of photonic crystal/quantum dot waveguides," 1st Nonlinear Photonics Topical Meeting (NP 2007), Optical Society of America, Quebec city, Canada, Sept. 2-6, 2007, paper no. NTuC6.
- Ryoichi Nakamoto, Hiroyuki Takeuchi, Jun Sakaguchi, and Yoshiyasu Ueno, "1.55-um, mode-locked, single-longitudinal-mode, 10-GHz, 2-ps, ultra-short optical pulse train from our original semiconductor-based pulse-source scheme," Topical Conference on Nanophotonics (NANO), Optical Society of America, May 26-29, 2008, Southeast Univ., Nanjing, P.R. China, paper no. Nano-08-191.

Invited Talks (international), 2001-present

http://www1.ttcn.ne.jp/gagnon/publications.html

Y. Ueno, S. Nakamura, and K. Tajima, "Ultrahigh-speed data regeneration and wavelength conversion for OTDM systems," ECOC 2001, Amsterdam, the Netherlands.

Y. Ueno, S. Nakamura, and K. Tajima, "Ultrafast SOA-based SMZ-type all-optical regenerators and wavelength converters," ssdm 2002, Nagoya, Japan

S. Nakamura, T. Tamanuki, Y. Ueno, and K. Tajima, "Ultrafast optical demultiplexing, regeneration, and wavelength conversion with symmetric-Mach-Zehnder all-optical switches," OFC 2003, Atlanta, USA.

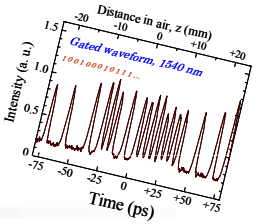
Y. Ueno, 'All-optical signal processing for over-100-Gb/s optical TDM networks,' IEEE LEOS Annual Meeting (LEOS 2003), Tucson, USA.

G. Theophilopoulos, Y. Ueno, and S.A. Hamilton, panel discussion 'Outlook in 10-20 years,' OFC workshop 'All-optical wavelength conversion and signal processing for next generation network,' OFC 2005, Los Angeles, USA.

Y. Ueno, M. Toyoda, and R. Suzuki, 'Theoretical models of the SOA-based SMZ-type optical-3R gates,' OSA-OAA 2005, Budapest, Hungary.

Yoshiyasu Ueno, Jun Sakaguchi, Ryoichi Nakamoto, and Takehiro Nishida, "Ultrafast, low-energy-consumption, semiconductor-based, all-optical gate devices (Invited Talk)," 4th Asia-Pacific Microwave Photonics Conference (APMP 2009), April 22-24, 2009, Beijing, P.R. China.

Our alumni members who joined global industry and academy



http://www1.ttcn.ne.jp/gagnon/professionals-e.html

- *NEC Communication Systems, Ltd.*
- *Hitachi Cable, Ltd.*
- *OAS Co., Ltd.*
- *Tokyo Institute of Technology (Titech)*
- *Mie Bank., Ltd.*
- *Electric Power Development Co., Ltd. (J-Power)*
- *eAccess, Ltd.*
- *Hitachi Communication Technologies, Ltd.*
- *Innotech Corporation*
- *NEC Corporation (System device research laboratories, Ohtsu city)*
- *Hitachi Kokusai Electric, Inc.*
- *Fujitsu Access, Limited*
- *NEC Corporation (computer division, Fuchu city)*
- *Sumitomo Electric Industries, Ltd. (Yokohama city)*
- *Nara Institute of Science and Technology, Research Associate*
- *Bookham, Inc. (Zurich plant, Switzerland)*

statistics of:

our National University of Electro-Communications

http://www.uec.ac.jp/eng/index.html

Location: Chofu city, Tokyo (border between metropolitan and suburb areas), Japan

Number of faculty members: 350

Number of bachelor students: 4,400 (120 from outside japan)

Number of grad students: 1,400 (180 from outside japan)

number of foreign students: 300 (more than half from China)

Number of affiliated international universities: about 20 (China, Australia, Thai, Estonia, etc.)

Center-of-Excellence (COE) Program (physics category of MEXT):

program's title: Innovation in Coherent Optical Sciences, 2003-2007

CEP-locked frequency-comb, bose-einstein-condensation, atomic optics, etc.

http://www.ils.uec.ac.jp/COEcoherent/eng/index.html

number of original member professors: 22

more biased to PhD students than bachelor students.

Yoshiyasu Ueno, Prof. Dr.

Members of IEEE, OSA, and JSAP.

1961: born in Osaka, Japan.
1987: received Master's degree of Physics, Univ. of Tokyo.
1987-1994: AlGaInP crystal growth and 680-nm red lasers, Opto-Electronics Research Labs. , NEC Corp.
1995-1996: visiting researcher in CREOL/UCF, USA.
1998: received PhD degree of Applied Physics, Univ. of Tokyo.
1996-2002: Ultrafast all-optical semiconductor gates, Opto-Electronics Research Labs. , NEC Corp.
2002-present: National University of Electro-Communications, Tokyo.

Times of Citations (Thomson-Reuters database):

Total times cited= 900

- 400 from authored and 500 from co-authored SCI-indexed journal papers in 1987-2009.
- average times cited= 900 / 50 journal papers = **18 times per paper** (as of March 2010).

Invited Talks:

- Y. Ueno, S. Nakamura, H. Hatakeyama, T. Tamanuki, T. Sasaki, and K. Tajima, "168-Gb/s OTDM wavelength conversion using SMZ-type all-optical switch," 26th European Conference on Optical Communication (ECOC 2000), Sept. 4-7, 2000, Munich, Germany.
- Y. Ueno, 'All-optical signal processing for over-100-Gb/s optical TDM networks (Invited Talk),' IEEE LEOS Annual Meeting (LEOS 2003), Oct. 26-30, 2003, Tucson, USA.
- G. Theophilopoulos, Y. Ueno, and S.A. Hamilton, panel discussion 'Outlook in 10-20 years (invited),' OFC workshop 'All-optical wavelength conversion and signal processing for next generation network,' Optical Fiber Communication Conference (OFC 2005), Los Angeles, March 6-11, 2005.
- Y. Ueno, M. Toyoda, and R. Suzuki, 'Theoretical models of the SOA-based SMZ-type optical-3R gates (Invited talk),' Optical Amplifiers and their Applications (OAA 2005), Budapest, Hungary, August 7-10, 2005.
- Yoshiyasu Ueno, Jun Sakaguchi, Ryoichi Nakamoto, and Takehiro Nishida, "Ultrafast, low-energy-consumption, semiconductor-based, all-optical gate devices (Invited Talk)," 4th Asia-Pacific Microwave Photonics Conference (APMP 2009), April 22-24, 2009, Beijing, P.R. China. digest.
- Yoshiyasu Ueno, "Roadmap of ultrafast energy-saving optical semiconductor devices to Year 2025 (Invited Talk)," 42nd International Conference on Solid Sate Devices and Materials (ssdm2010), Sept. 22-24, 2010, Univ. of Tokyo, Tokyo, Japan.

Memorandum