Delay-Coupled Diode Lasers for Photonic Applications

DeCoDicA

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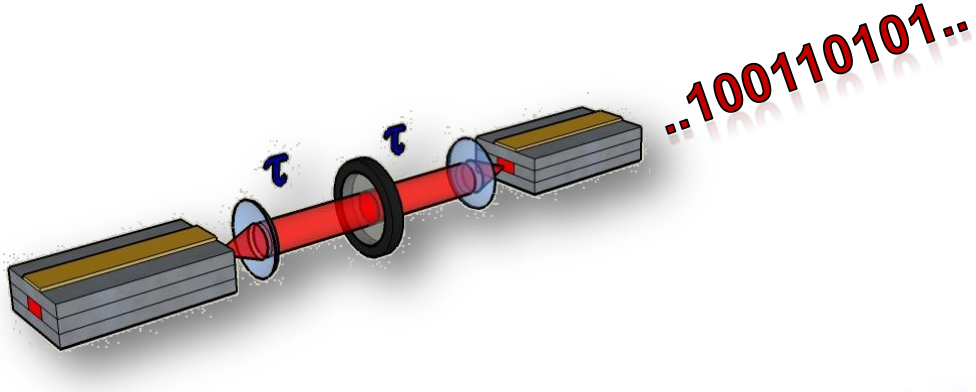


IFISC

- MINISTERIO DE CIENCIA E INNOVACIÓN

  Plan Nacional de I + D + I (2008-2011)

- en el programa : Investigación Fundamental
- en el subprograma: Proyecto de Investigación Fundamental no orientada
- Area Temática Gestión: Tecnologías Electrónicas (MIC) y de Comunicaciones (TEC)
- TEC2009-14101: Delay-Coupled Diode Lasers for Photonic Applications
- 3 year project: 1.1.2010-31.12.2012

- **exploration of the potential of delay-coupled semiconductor lasers for high-bit-rate random number generation and secure key distribution**

1. realization and characterization of delay-coupled semiconductor laser configurations based on optical fiber setups
2. characterization and tailoring of dynamical and synchronization properties of coupled laser configurations
3. realization of a random number generator based on coupled lasers
4. implementation of a secure key exchange protocol based on chaotic lasers

1. realization and characterization of delay-coupled semiconductor laser configurations based on optical fiber setups

2. characterization and tailoring of dynamical and synchronization properties of coupled laser configurations

- 4-channel 16 GHz real-time acquisition
- 30 GHz spectral and 14GHz real-time spectral characterization
- highly resolved optical spectra characterization

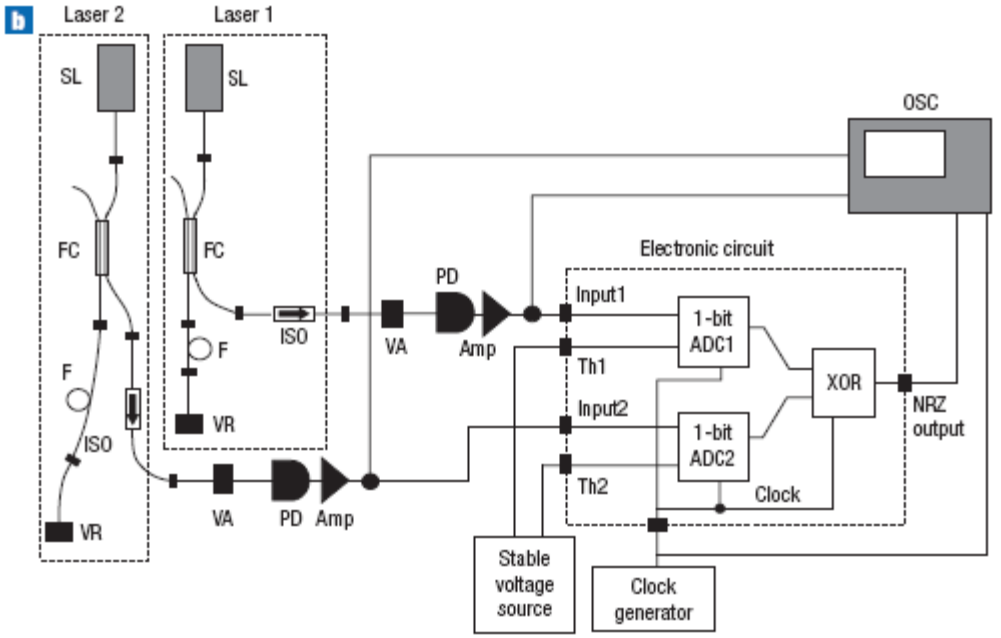
3. realization of a random number generator based on coupled lasers

- analog (optical) chaos as generator of randomness
- no recurrences
- suitable / optimal properties of complex dynamics for Random Number Generation?
  - short correlations
  - high entropy
  - ..?

LETTERS

Fast physical random bit generation with chaotic semiconductor lasers

ATSUSHI UCHIDA[1,2*], KAZUYA AMANO[1], MASAKI INOUE[1], KUNIHITO HIRANO[1], SUNAO NAITO[1], HIROYUKI SOMEYA[1], ISAO OOWADA[1], TAKAYUKI KURASHIGE[1], MASARU SHIKI[1], SHIGERU YOSHIMORI[1], KAZUYUKI YOSHIMURA[3] AND PETER DAVIS[3]



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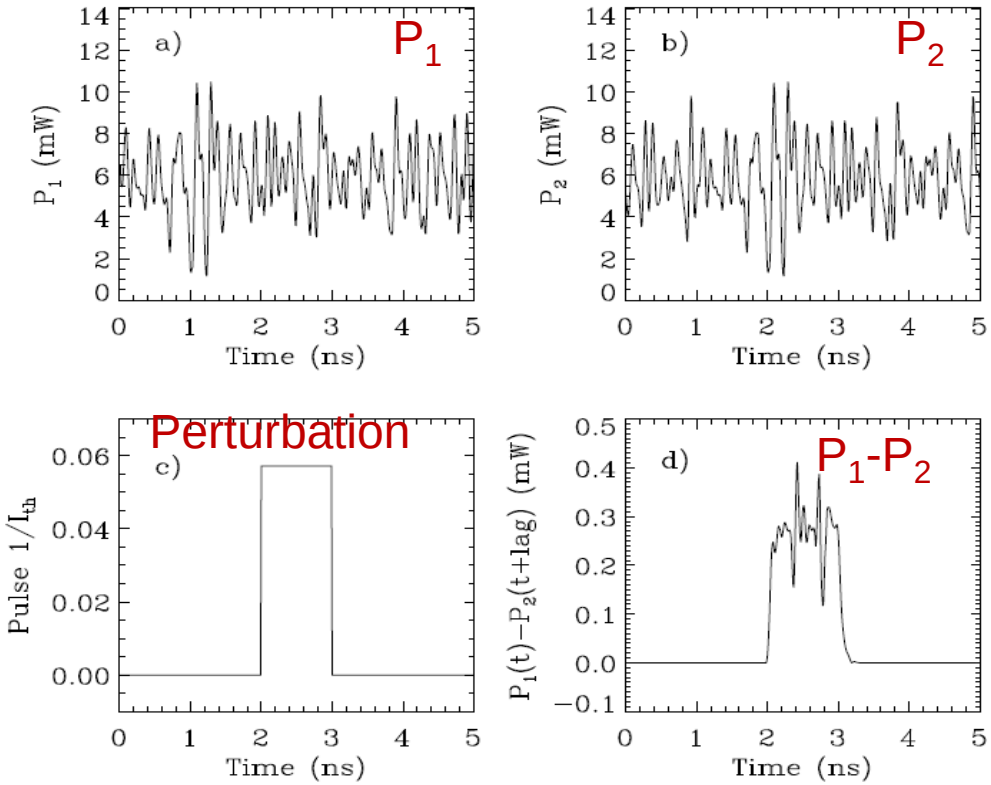
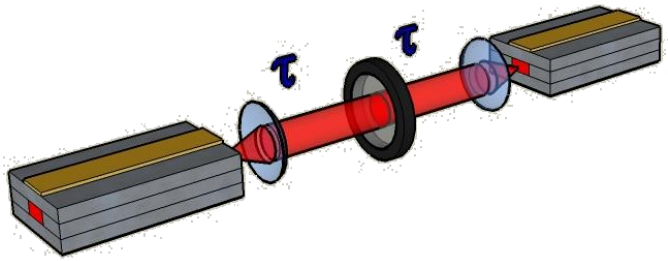
- Comparison between a quantum and chaos approach
- ULB and VUB: Thesis Stephane Vanderminnen and Antoine Boyer (2007)

	Generator based on QM	Generator based on chaotic SLs
Principle	White shot noise from photodetection	Chaotic dynamics of intensity time series
Advantages	"True" randomness Simple setup High bit rate	Optical and analog signal Flexible system Very high bit rate
Shortcomings	Presence of classical noise Necessity of a bandpass filter	Precision required
Bit rate	0.2 Gbit/s	1 Gbit/s
Setup	- Laser diode - Attenuator - Photodiode - Amplifier - Filter - Comparator	- Semiconductor laser - Semi-transparent mirror - Photodiode - Comparator or A/D converter
Results of tests	All tests passed	All tests passed

4. implementation of a secure key exchange protocol based on chaotic lasers

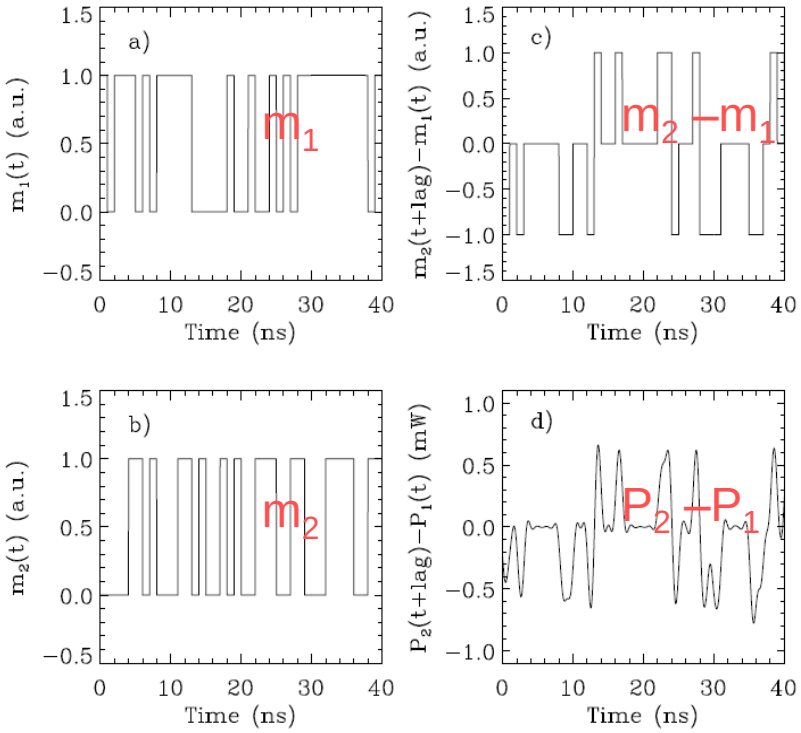


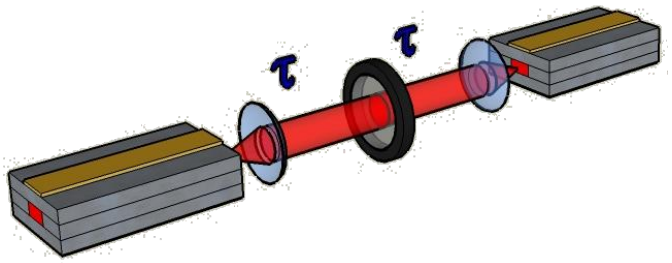


• R.Vicente, C.R. Mirasso, I.F., Optics Letters, **32**, 403, (2007)

- onset of synchronization ~ delay time
- very fast resynchronization (<< delay times)
- offers the possibility to implement a key exchange system

- key exchange protocol scheme





- partners get
  - synchronization for equal choice of 0 or 1
  - no synchronization for unequal choice
- rule: just keep the bits from synchronized case

challenge in experiments: phase-sensitive setup → fiber setup

- **Principal Investigator** : Ingo Fischer
- **Involved Investigators**:
  - Pere Colet
  - Claudio Mirasso
  - Miguel Cornelles
  - Damià Gomila
  - Alessandro Scirè
  - Gianluca Giorgi
  - Adrian Jacobo

  - *Xavier Porte*
  - *Neus Oliver*
  - *Konstantin Hicke*
  - *Daniel Conti*