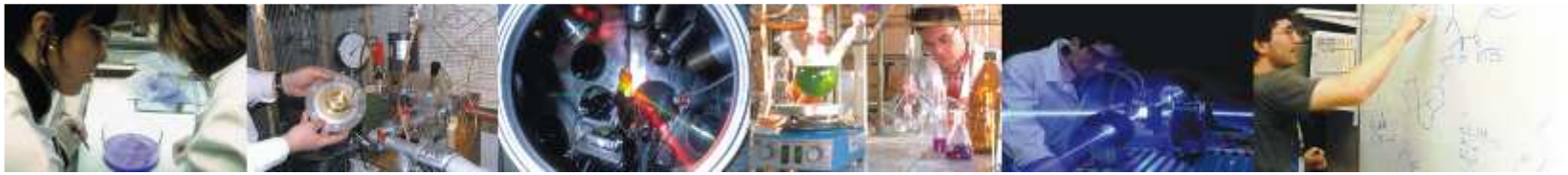
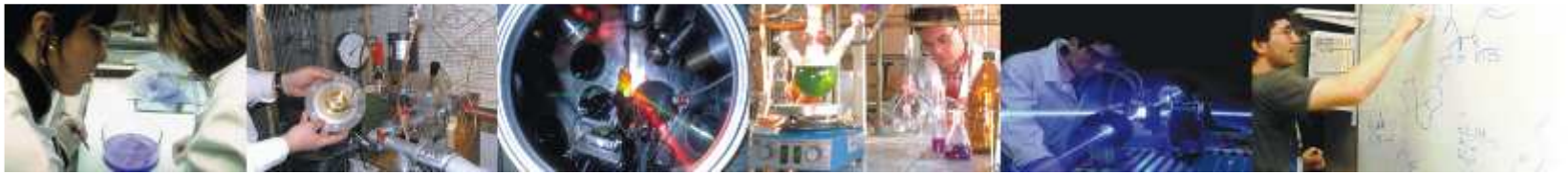


Fiber-based laser

for wakefield applications to high energy physics

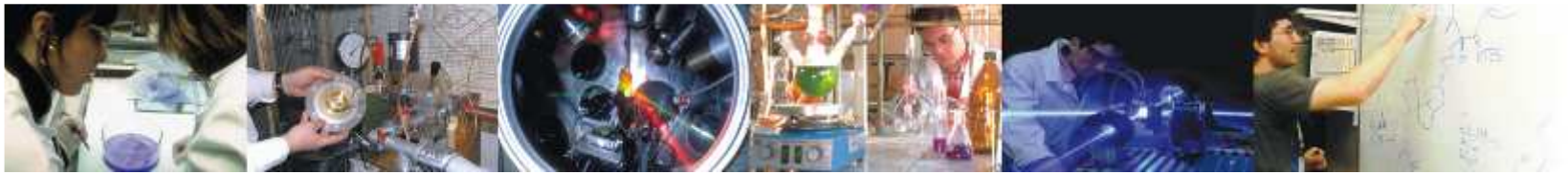
Gérard Mourou, Toshi Tajima, David Payne, Johan Nilsson, Bill Brocklesby, Andres Tünnermann, Thomas Schreiber, Jens Limpert, Patrick Georges, Marc Hanna, L. Daniault, Matthieu Somekh



Context and motivations

- Requirement of the future applications in High Energy physics

- Low laser efficiency (especially true for high peak power laser systems)



Fibre laser technology

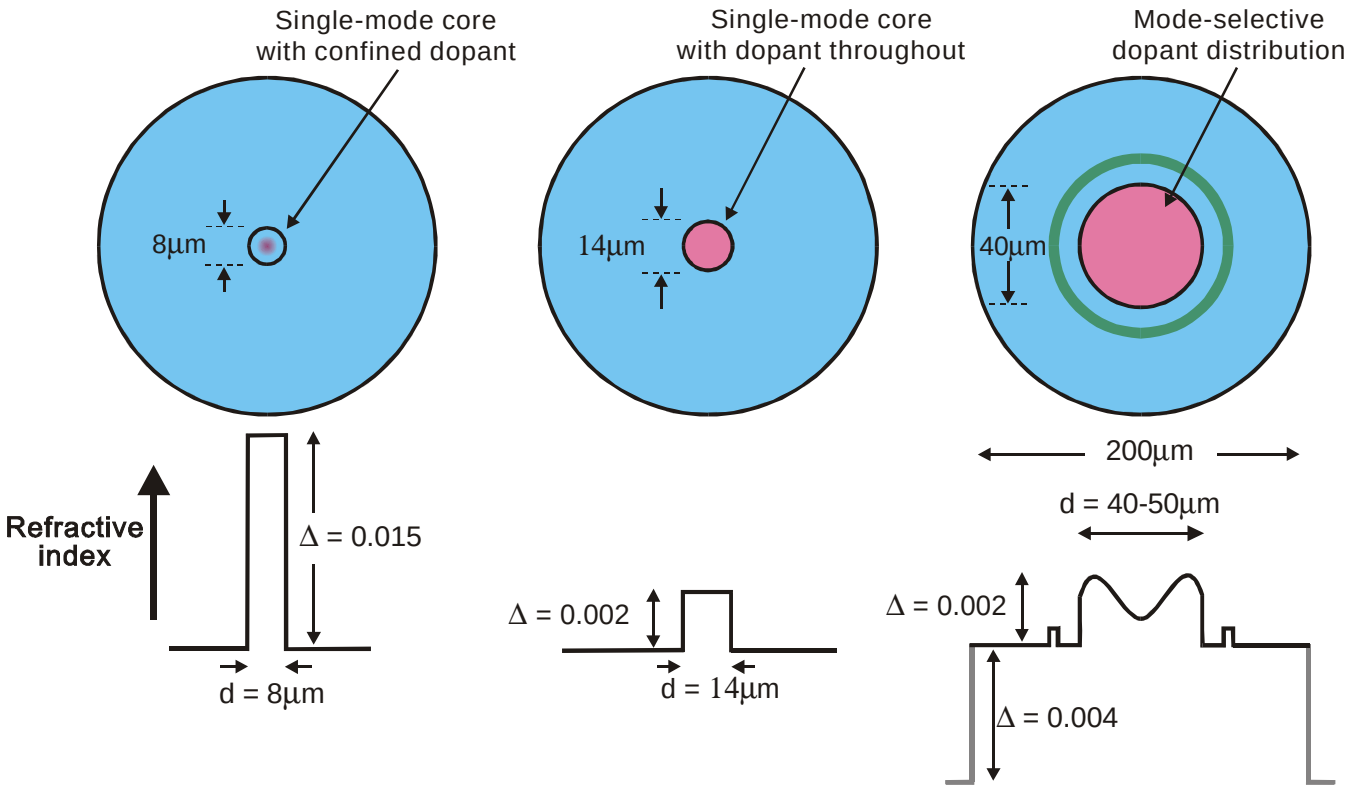
Key concepts for high power fiber laser operation

- Cladding Pumping to allow the launch of high power pump radiation
- Large mode area core designs to facilitate:
  - power handling
  - minimisation of nonlinear effects
  - high energy storage for pulsed application
  - efficient pump absorption/reduced device lengths

Fibre laser technology

Advanced amplifier designs for high power applications

Conventional amplifier	Single-mode large mode area fibre	Multi-mode large mode area fibre



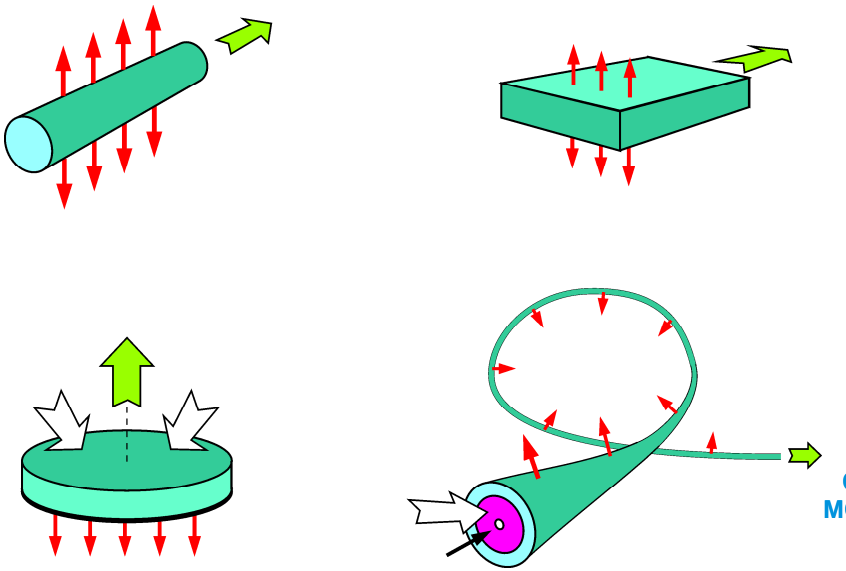
Fibre laser technology

HPFL: Some record results

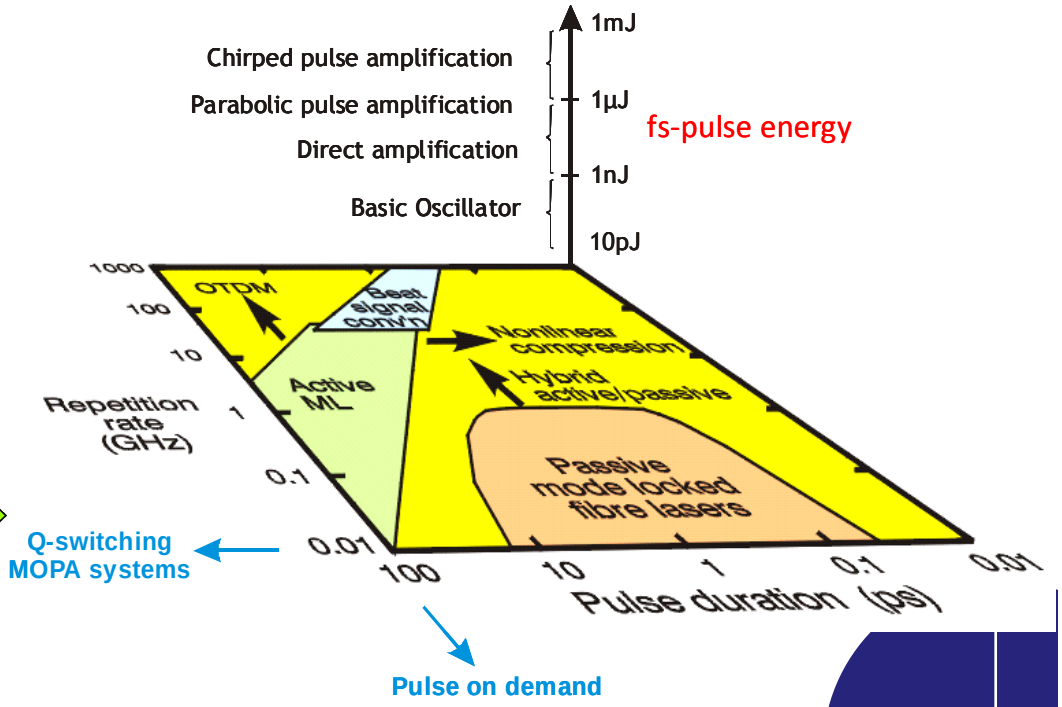
What	Characteristics	Who	Comments
Highest-power fiber laser (MM)	50 – 100 kW	IPG	Yb-doped, 10xx nm, cw. Large number of (SM) fiber lasers bundled together so no inherent limitation.
Highest-power SM fiber laser	5 – 10 kW	IPG	Yb-doped, 10xx nm, cw, tandem-pumped with 1018 nm YDFLs
Highest-power diode-pumped SM fiber laser	2 – 3 kW	IPG, Jena, **ORC**	Yb-doped, 10xx nm, cw
Highest-power Tm-doped	1 kW	Q-Peak / Nufern	2000 nm, SM, cw
Highest-power Er-doped	0.3 kW	**ORC**	1570 nm, cw, M^2 = 3.9
Highest-power 980 nm	0.1 kW	Jena, Bordeaux	Cw, nearly diffraction-limited, air:silica micro-structured fiber
Highest-power 9xx Nd-doped fiber laser	10 W	Lightwave Electronics	SM, pulsed (ns). Shortest-wavelength band demonstrated for cladding-pumped fiber lasers.
Highest-power Bi-doped laser	~ 20 W (?)	GPI	~ 1150 nm, cw, SM, core-pumped by 10xx nm YDFL

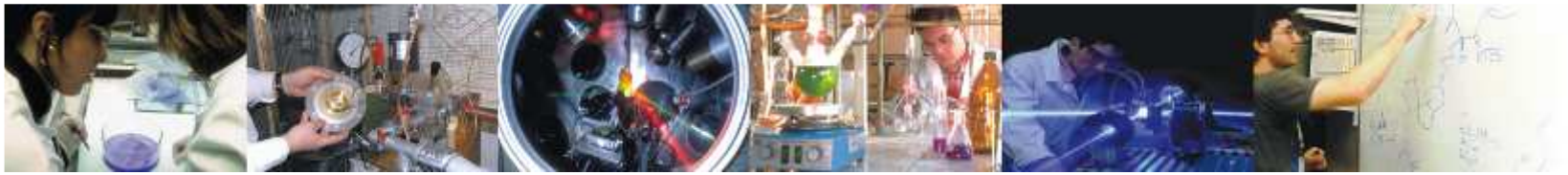
Fibre laser technology

Thermal Management



Operating regimes of fibre based ultrashort pulse sources





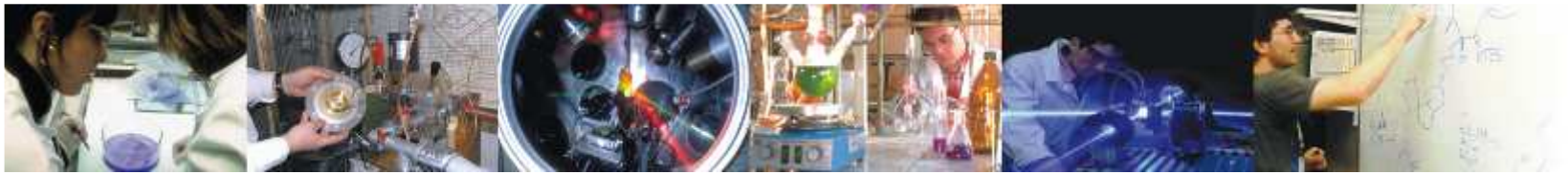
Fibre laser strengths & limitations

☺

- Initial & running cost
- Reliability / Robustness
- Maintenance
- Footprint
- Frequency
- Beam Quality

☹

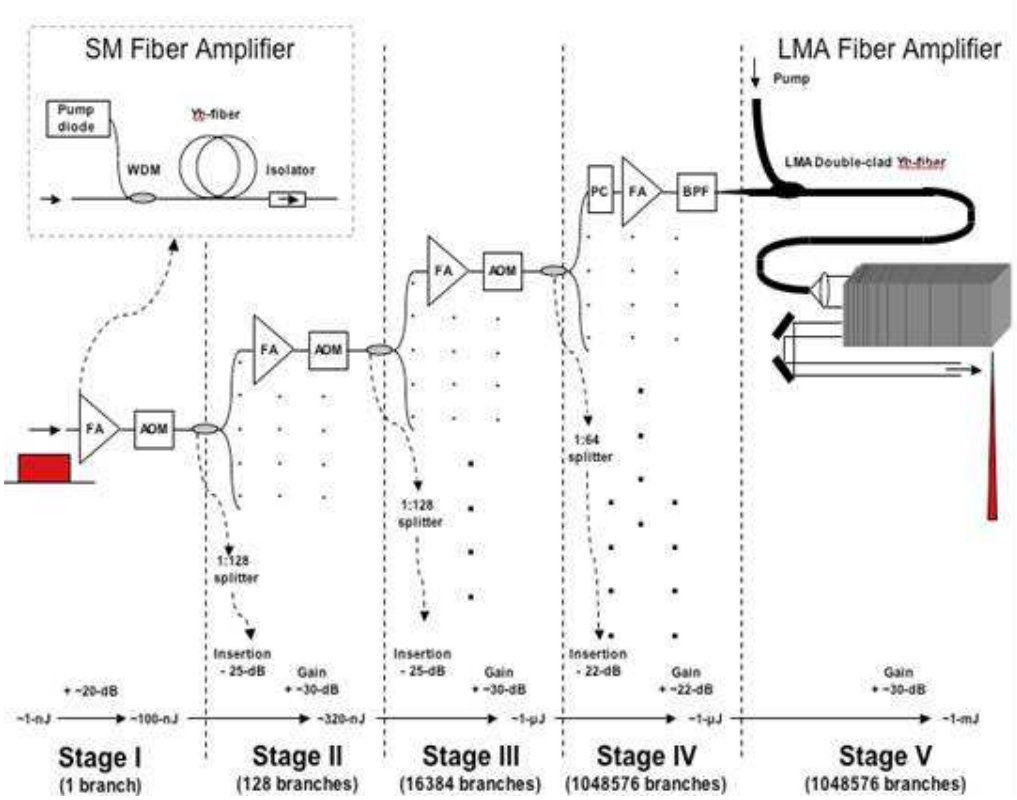
- Scalability of the energy in a single fibre in short pulse laser operation



The CAN concept, opening to the scalability

→ Laser concept based on a diode-pumped fiber network

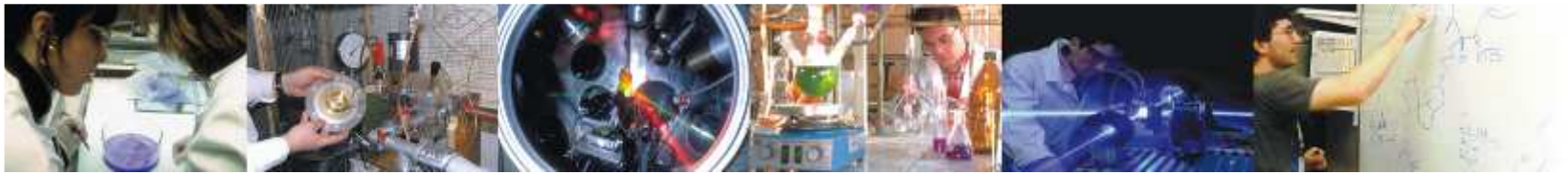
→ Device possibly based on standard, cheap and reliable telecom components



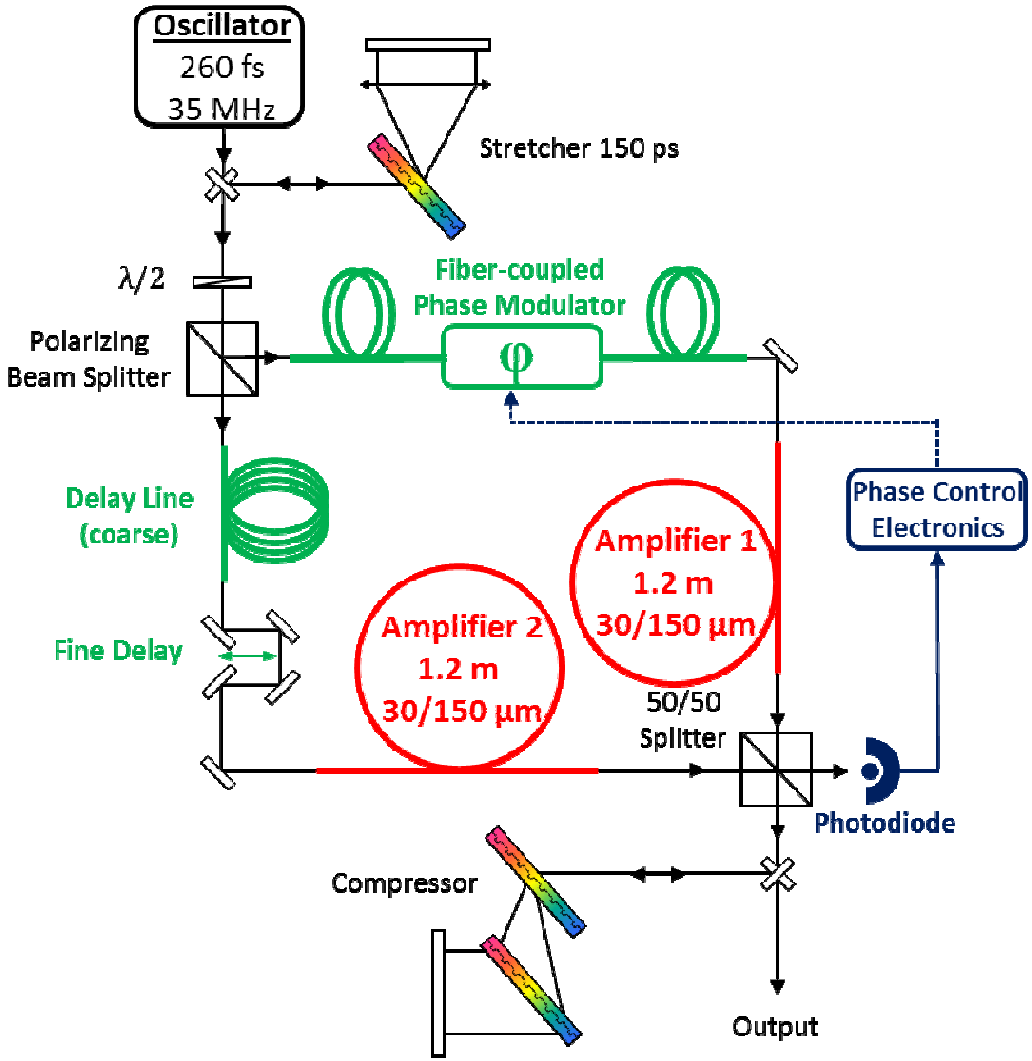
- Laser architecture allowing high peak / high average powers are desired for future societal application

- Coherent combining demonstrated for CW regime, few experiments in ns regime, no results yet in fs regime

- Coherent combining required for some application not for all of them



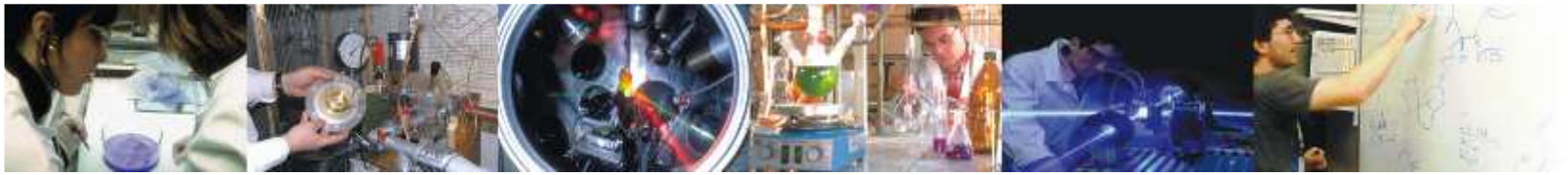
CAN recent results / phase locking technique *(1)*



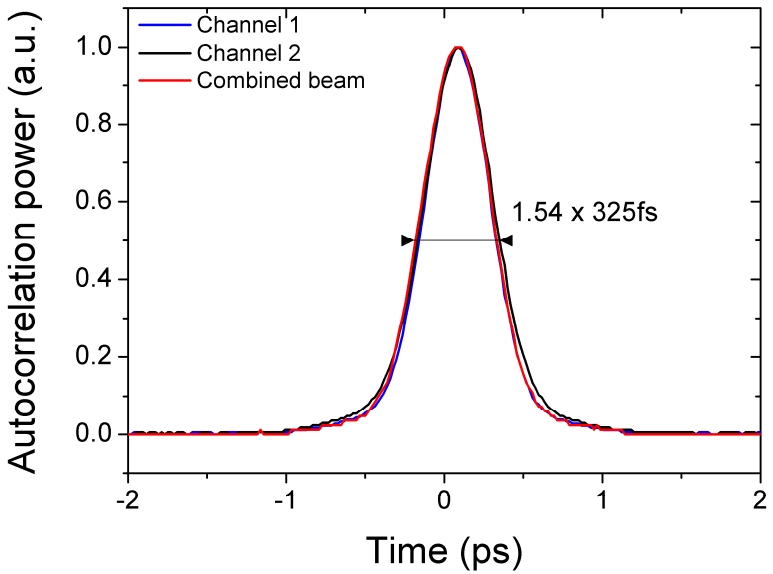
Combining efficiency > 90%

L. Daniault, M. Hanna, L. Lombard, D. Goular, P. Bourdon, F. Druon, P. Georges
"Coherent combining of two femtosecond fiber chirped pulse amplifiers"
Oral : Advanced Solid State Photonics, ASSP 2011, Istanbul, Turkey (February 13-16 2011)

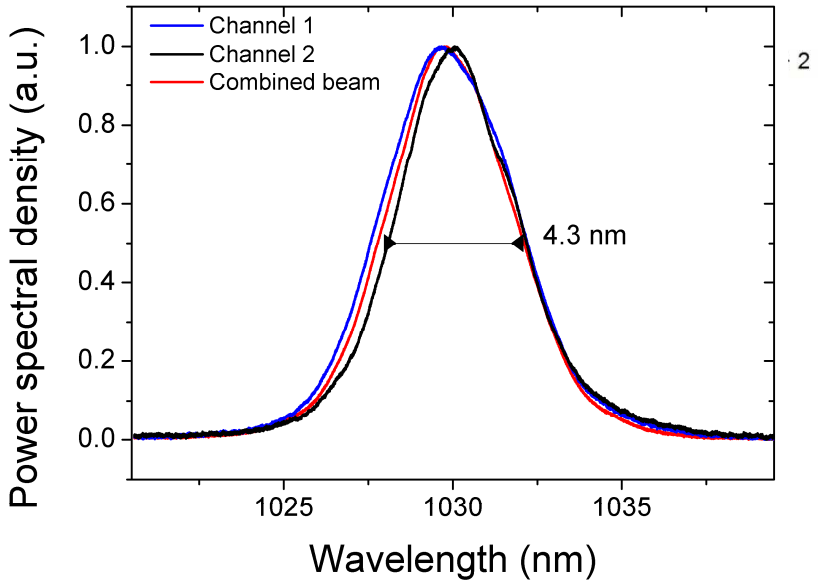
Accepted: Optics Letters, L. Daniault et al, « Coherent beam combining of two femtosecond fiber chirped pulse amplifiers »



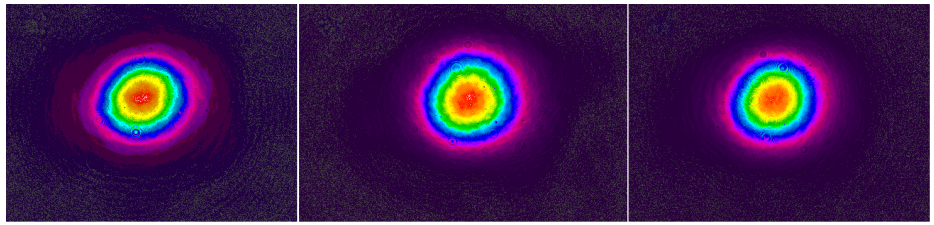
CAN recent results / phase locking technique *(2)*

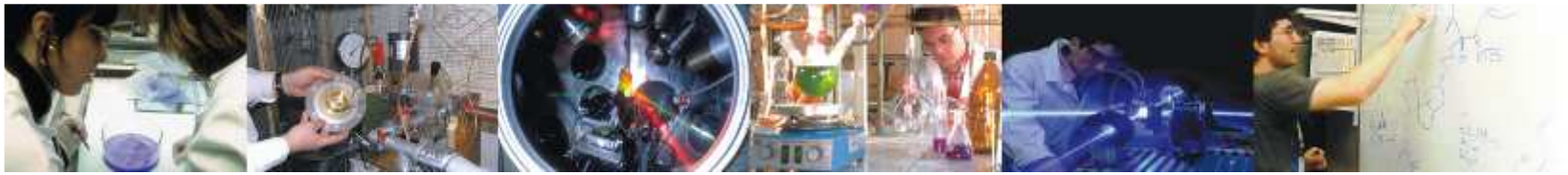


Autocorrelations
325 fs pulsewidth



Spectra
4.3 nm FWHM



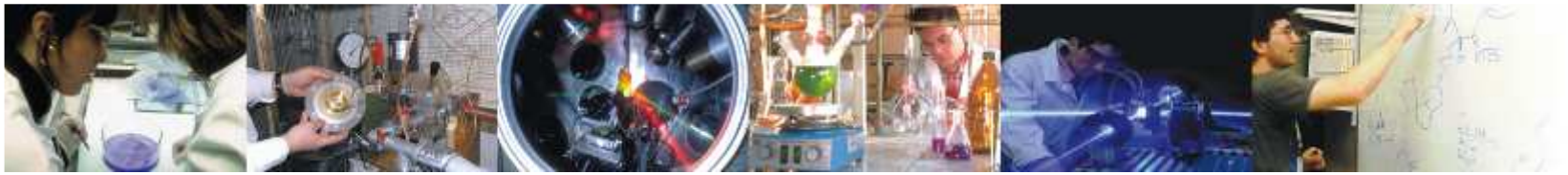


The ICAN initiative

Different communities joining their efforts towards the collaborative evaluation of the fiber CAN concept as one of the possible solutions for the next laser-based driver generation:

- Laser & fibre communities
- High energy physics community

→ <u>Final goal</u> : definition, conception, design and realisation of such a laser

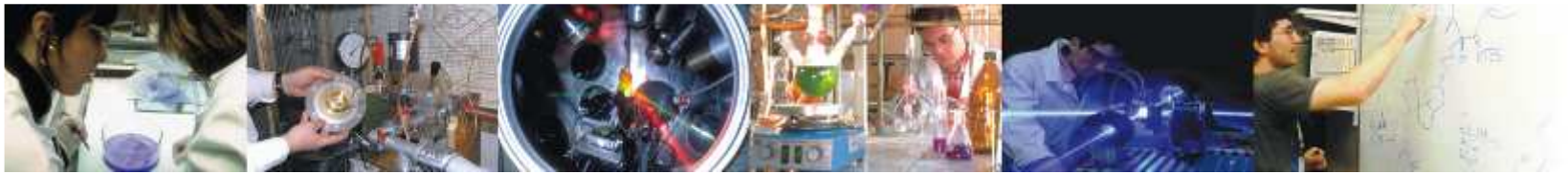


A first targeted step of 2 years

- 1 proposal submitted to Brussels (*Type of funding scheme: Coordination and support actions (Supporting)*)

- 18 participants from laser, fibre and high energy physics communities already behind the ICAN project

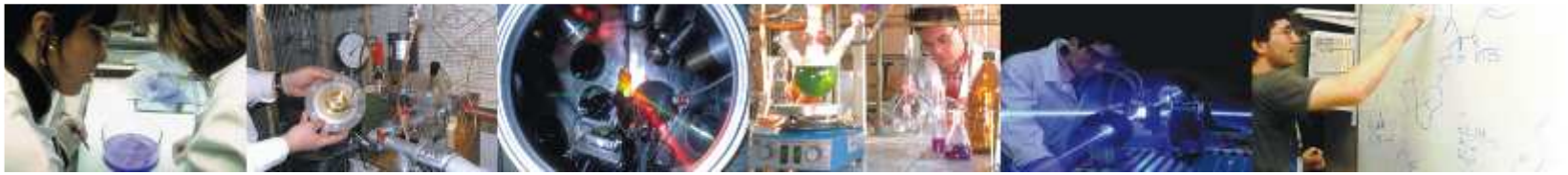
- To be organized in 2012-2013 :
  - Conferences
  - Workshops



To go further all together…

- **ICFA and ICUIL** communities started to join their efforts to imagine the next laser driver required by the future applications in High Energy Physics.
- The **fiber laser technology** offers strong advantages, including high efficiency, and is only limited in energy in pulsed operation.
- The **CAN concept** makes possible the scalability by keeping all the other advantages.

→ The **ICAN initiative** proposes to join the efforts of laser and high energy physics communities to define, conceive, design and realize such a laser…



Contact us to get more info about ICAN and join the team…

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ILE, coordinator of ICAN