Spectral Pulse Synthesis in ICAN

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Regional and national funding
Coherent combining at LCF / AS

2011  Active coherent combining with femtosecond CPAs [1]

2012  Analysis of spectral phase effects [2], passive coherent combining [3], Spatial and temporal combining (DPA) [4]

2013  Chirped and divided pulse amplification [5], Spectral pulse synthesis [6]

Down to 50 fs pulsewidth, up to 0.6 mJ energy

Contributed to establish feasibility for ICAN

Laser specs required for a CAN system are application-dependent

Ultrashort pulses (<100 fs) sometimes required, or relax energy spec

Fs fiber amplifier designs limited to 300 fs by gain narrowing

Take advantage of coherent combining architecture to generate shorter pulsewidths
Instead of amplifying in parallel the exact same pulses, **distribute spectral content** over coherently combined amplifiers.

Need for a **proof of principle** in the context of **high power fiber amplifiers**
Experimental setup

Nonlinear broadening

Dichroic Mirror (DM)

Stretcher 400 ps

Fiber-coupled Phase modulator

Amplifier #1 40/200 2 m

Amplifier #2 40/200 2 m

Compressor

DM

Sortie

Electronic feedback $B = 1$ kHz

Photodiode

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ParisTech
Recombined spectra

Spectral gain-narrowing

Single amplifier $\Delta \lambda = 12$ nm
2 channels $\Delta \lambda = 19$ nm

Broader spectrum $\Rightarrow$ Shorter pulses
Pulse synthesis – time domain

Pulse-width: 127 fs

$\Delta \tau \cdot \Delta \nu = 0.7$

$\Delta \tau_{TF} = 115$ fs

Pulse synthesis – movie
Conclusion – outlook

- Principle of pulse synthesis experimentally demonstrated
- Towards sub-100 fs pulses from high energy fiber amplifiers – work in progress with four channels
- Integration in a large scale ICAN system is natural as a coherent combining step
- Built-in pulse shaping capabilities
Back-up slides
Active stabilization

![Graph showing photodiode signal vs time with 'Free run' and 'Locked regime' plotted.](Graph.png)
Combining efficiency

(a) Output power vs. Total pump power

(b) Spectral FWHM vs. Gain

- Single amplifier
- 2 channels pulse synthesis