Low intensity noise ultrafast Yb-doped fiber amplifier

***Francesco Canella*[1,2,*]*, Lisa Marta Molteni*[1,3]*, Simone Cialdi*[4,2]*, Paolo Laporta*[1,3]*, Nicola Coluccelli*[1,3]*
and Gianluca Galzerano*[3,1]***

1 Dipartimento di Fisica, Politecnico di Milano, Piazza L. Da Vinci 32, IT-20133, Milano, Italy
2 INFN- Sezione di Milano, Via Caloria 16, IT-20133 Milano, Italy
3 Istituto di Fotonica e Nanotecnologie-CNR, Piazza L. Da Vinci 32, IT-20133, Milano, Italy
4 Dipartimento di Fisica "Aldo Pontremoli", Università degli Studi di Milano, Milano, Italy
**francesco.canella@polimi.it*

Low noise and low cost Yb-doped fiber amplifier is presented. Average output power levels in excess of 2W in the near-infrared spectral region without significant noise intensity degradation are demonstrated using ~2mW input average power.
Keywords: fiber amplifier, ultrafast pulses

High-peak power and low intensity noise optical pulses in the near infrared spectral region are interesting for many applications in several fields of physics and science in general, such as in astrophysics, high precision spectroscopy, environmental monitoring and supercontinuum generation.
Low intensity noise pulses can be generally obtained using low-power oscillators with high-repetition pulse rate. To increase the average output power without intensity degradation, low intensity noise ultrafast optical amplifiers have to be developed.
We will present a compact, low cost cladding-pumped Yb-doped fiber amplifier operating at room temperature. The seed pulse is made by an Yb:CaGdAlO$_4$ [1] SESAM mode-locked source emitting 70-fs pulses at 160MHz of repetition rate with 50mW average power. Before the amplification the pulses are stretched using a Volume-Bragg-Grating reaching a time duration of ~100ps, in order to avoid nonlinear effects and make dispersion compensation easy (Chirped Pulse Amplification [2]). In this way, we obtain an incoming pulse of about 100ps, with central wavelength of 1030nm with a spectrum FWHM of 7nm and a maximum power of 2.3mW.
As active fiber we choose a two-meter long polarization-maintaining double-clad Liekki Yb1200-10/125, pumped by a commercially available laser diode at 976nm with 6W of power in forward configuration. The seed signal is coupled with the 10µm-diameter fiber core, while the pump is sent to the internal cladding, which diameter is 125µm. Our amplifier operates in saturation regime, as visible in Fig.1 where the output power is almost independent (>2W) from the seed power above 1.5mW (with a 30dB optical gain).
This condition allows us to reach the maximum in Yb population inversion that leads to a reduction of amplitude noise.
We measured Relative Intensity Noise (RIN) spectra that are reported in Fig.2. The RIN of the amplified radiation in saturation regime has values lower the one of the seeder source even if the pump radiation is more noisy than the signal of about 20dB over all the measured bandwidth. This happens evidently for frequencies up to 1kHz, as well as in the fluorescence spectrum.
Moreover, pump noise over 1kHz is suppressed by Yb typical decay time of about 0.8ms.

In addition, the output radiation maintains temporal structure and spectral properties.
More details of the experimental setup and of the obtained results will be exposed during the ICOP2020, where a complete characterization of the system will be provided (pulse measurements after recompression, amplifier performances without pulse temporal stretching).

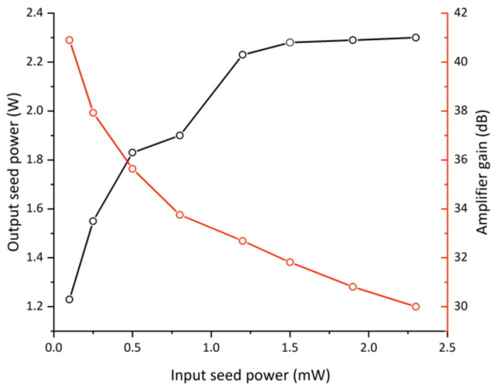

Fig. 1 Measured amplified signal as a function of the power of the incoming seed (in black). In red the amplifier gain curve is shown.

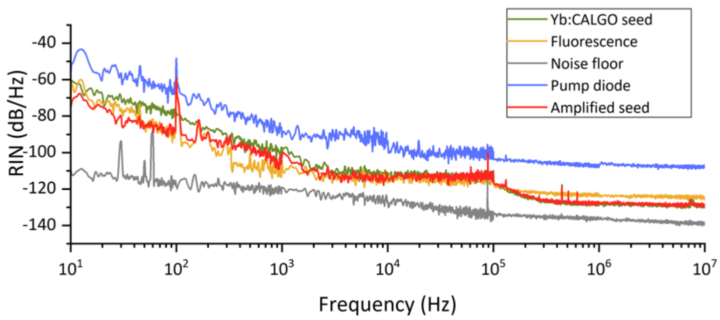

Fig. 2 Power spectral density of the RIN versus Fourier frequency of the Yb:CALGO seed laser, of the pump diode, of fluorescence and of the amplified signal.

References

1. F. Pirzio, M. Kemnitzer, A. Guandalini, et al. and A. Agnesi, *Opt. Express.* **24**, 11782–11792 (2016).
2. Donna Strickland and Gerard Mourou, *Optics Communications*, **55(6),** 447 – 449 (1985).