Deliverable 3.4: 200-W, ~500-fs laser 1MHz at 1030nm for seeding an Yb:YAG amplifier

Dissemination Level: Public

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Context

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Task:	T3.2 200-W, 500-fs laser > 1MHz at 1030nm

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Declaration: Any work or result described therein is genuinely a result of the Hiperdias project. Any other source will be properly referenced where and when relevant

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1. Version History

Version	Summary of Change	Written By	Approver	Date
0.01	First version	Martin DELAIGUE	CHO	13/04/18
1.0	Making suitable for public disclosure	Marwan Abdou-Ahmed	same	05/07/18

2. Scope

Thanks to the combined use of chirped pulse amplification and high power amplifier media combination, the Tangor amplifier platform is able to deliver short pulse duration (<500fs) high average power (up to 100W) and high energy (>500µJ) within a small footprint.

Figure 1: TANGOR

In this work package, Amplitude Systemes had to scale up the laser design in order to produce up to 200W before compression for seeding an YbYAG amplifier. Amplitude has to confirm the possibility to compress the pulse under 500fs too.

3. Average power before compression

The main challenge of this work package was to increase the performances of the TANGOR in term of average power without degrading the other performances of the laser in term of beam profile, pulse duration and stability. Intensive work on the improvement of the thermal management in the laser allowed the increasing of the pump and output power.

Figure 2, e.g., shows the result of this improvement in term of average power.

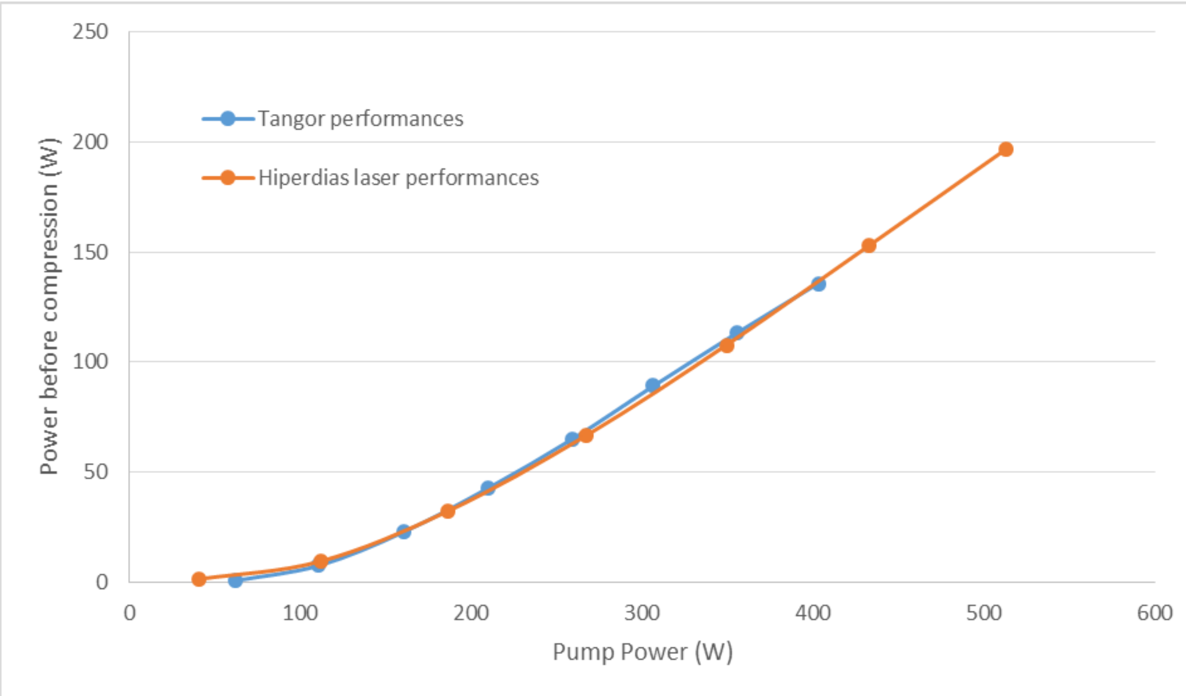

Figure 2: Power before compression vs Pump power measurement

We didn't observe any saturation of the produced average power which confirms that the new design allows an increase of the pump power and thus an increase of the power produced by the laser.

4. Beam parameters

One of the challenges in scaling up the hybrid TANGOR amplifier platform is to maintain high spatial beam quality at higher pump power without degradation of the spatial beam quality. In this study we have considerably put off the appearance of beam quality degradations as shown by the following measurements.

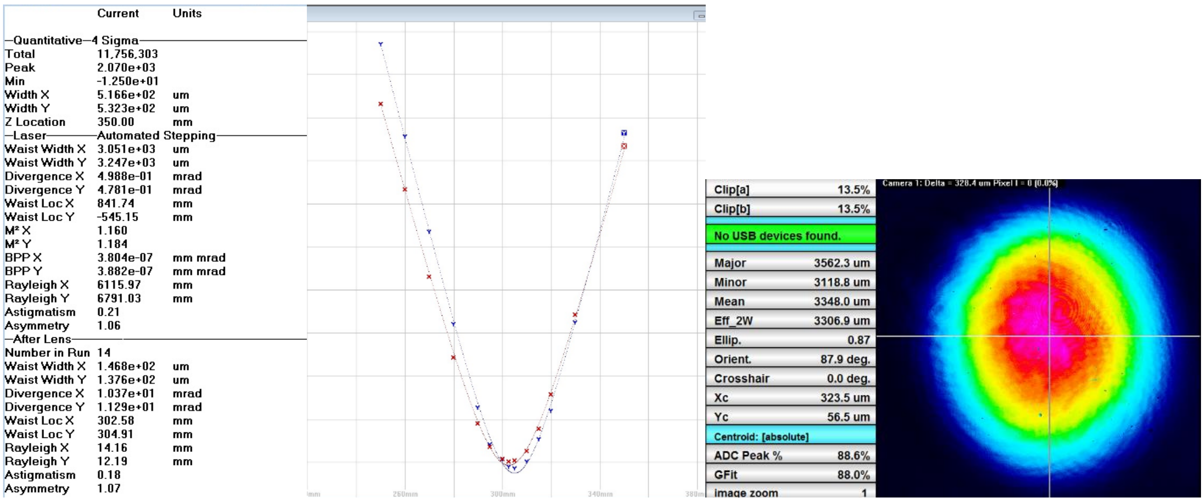

Figure 3: Beam parameters at 160W before compression

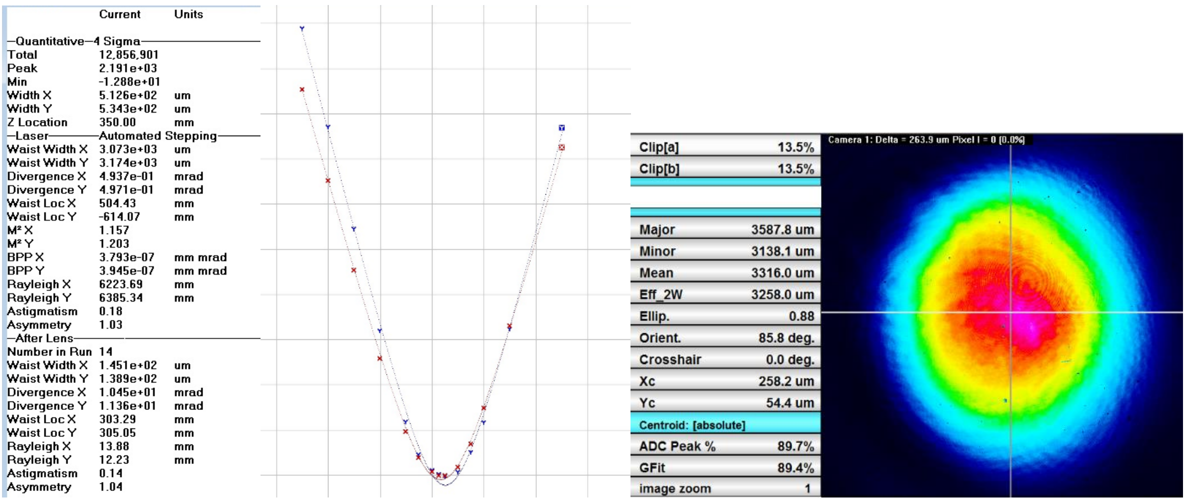

Figure 4: Beam parameters at 175W before compression

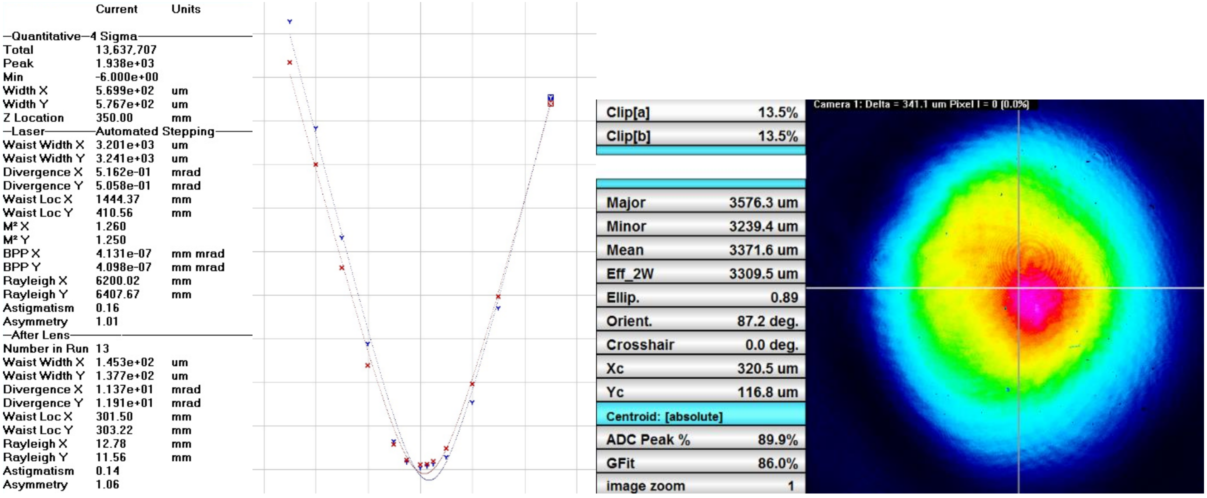

Figure 5: Beam parameters at 187W before compression

The modifications performed on the Hiperdias laser allow to maintain a beam quality within our standard specifications (M^2<1.3, Astigmatism <50% and waist ellipticity <13%) up to ~200W amplifier power (before compression).

5. Spectrum and pulse compression

In this work package, Amplitude had to confirm that the produced laser spectrum matches the gain spectrum of the Yb:YAG thin disk multipass amplifier of partner USTUTT. This aspect was not a huge challenge as the Hiperdias laser is based on the same gain material and only the slight differences in center wavelength are expected due to slight differences in the inversion level between the two amplifier architectures. We measure a spectral bandwidth of about 2.5nm with a center wavelength close to 1030nm at full power and for ~200µJ pulse energy.

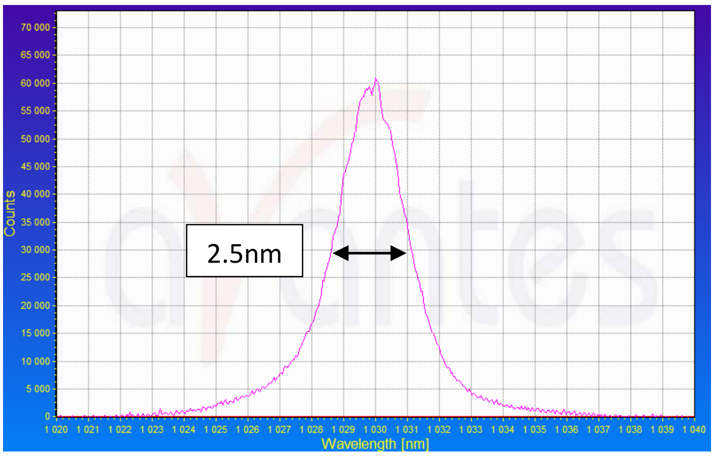

Figure 6: Laser spectrum at 187W before compression

Amplitude also showed the capability to compress the pulse to <500fs. We used a compressor with a standard transmission efficiency of about 80%. The following figure shows an autocorrelation obtained at 1MHz, with 160W and corresponding to a 436fs pulse duration assuming a sech² pulse profile.

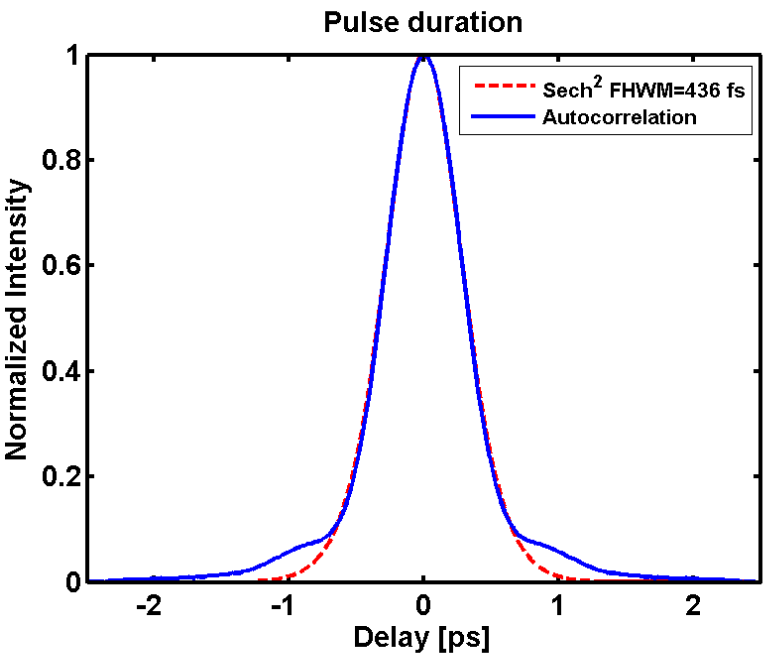

Figure 7: Pulse duration at ~160W after compression (corresponding to 200W before compression taking into account a compressor transmission of 80%) and 1MHz repetition rate

6. Long term stability

Good power stability was observed as well. We validated the different laser components at high power and high energy.

The following figure shows the power stability of the Hiperdias laser amplifier at ~200W average power (before compression).

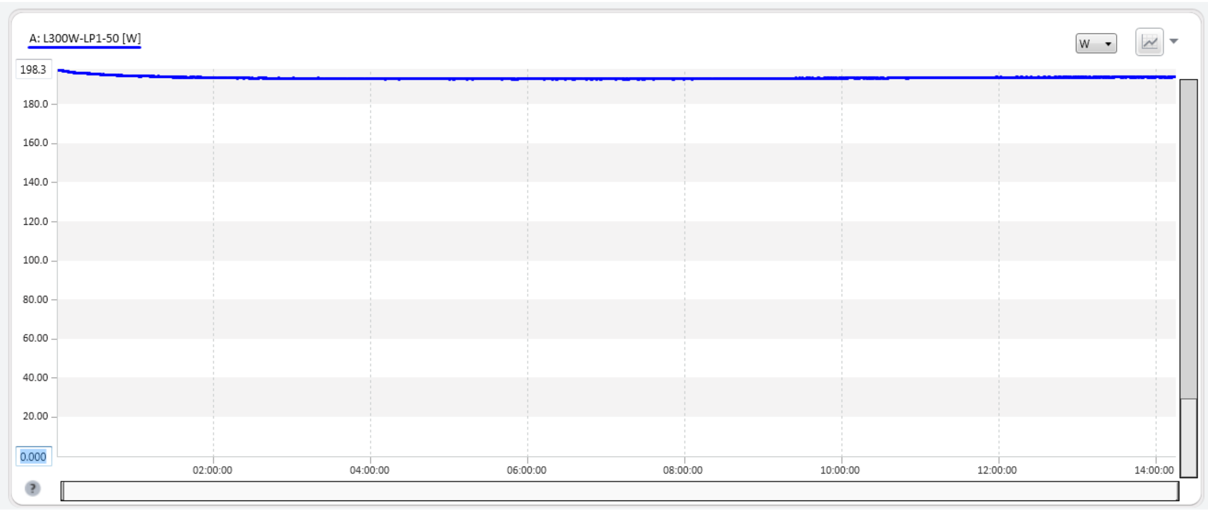

Figure 7: Amplifier long term stability before pulse compression (Power vs time (h))

Figure 8 shows the power stability of the complete laser system including compressor and modulator at high energy (430µJ). The power stability is excellent with an RMS noise of less than 0.25% over the test period of more than 14hours.

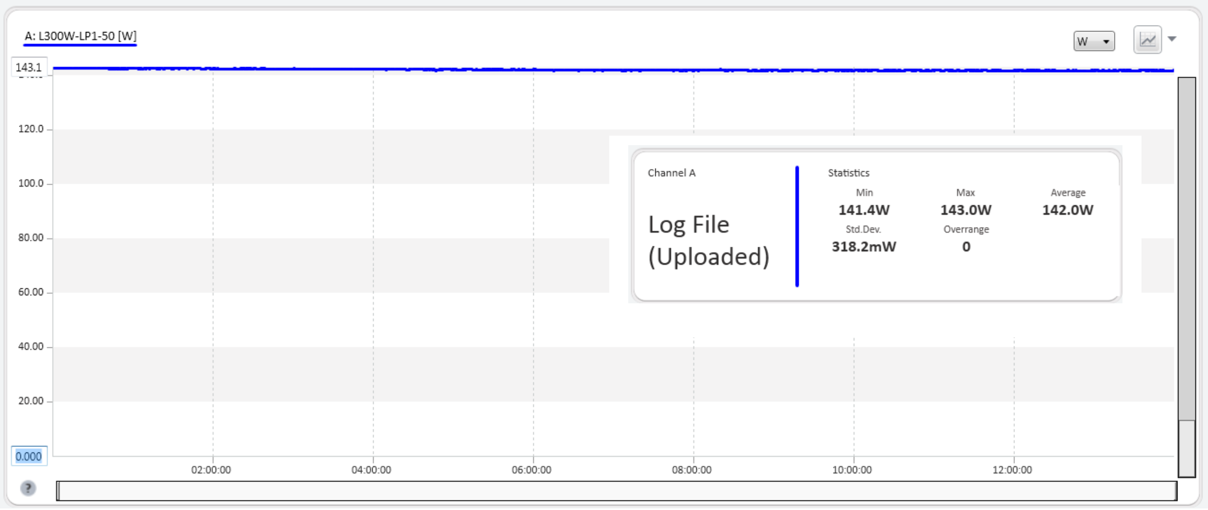

Figure 8: Laser long term stability at high energy (330kHz, 430µJ) (Power vs time (h))