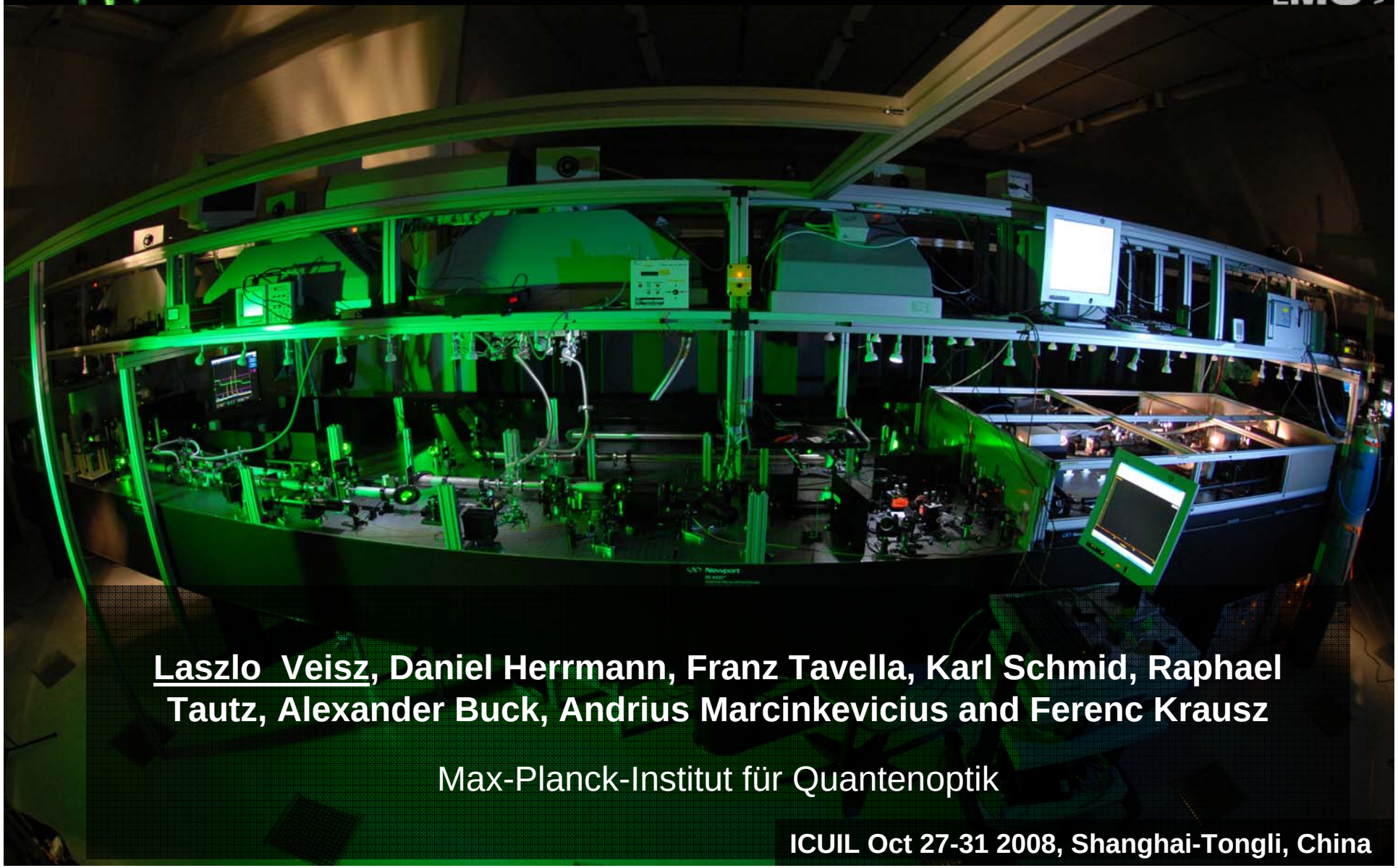
Light Wave Synthesizer 20 (LWS-20) : Development of a 8 fs, 20 TW Optical Parametric Chirped Pulse Amplifier



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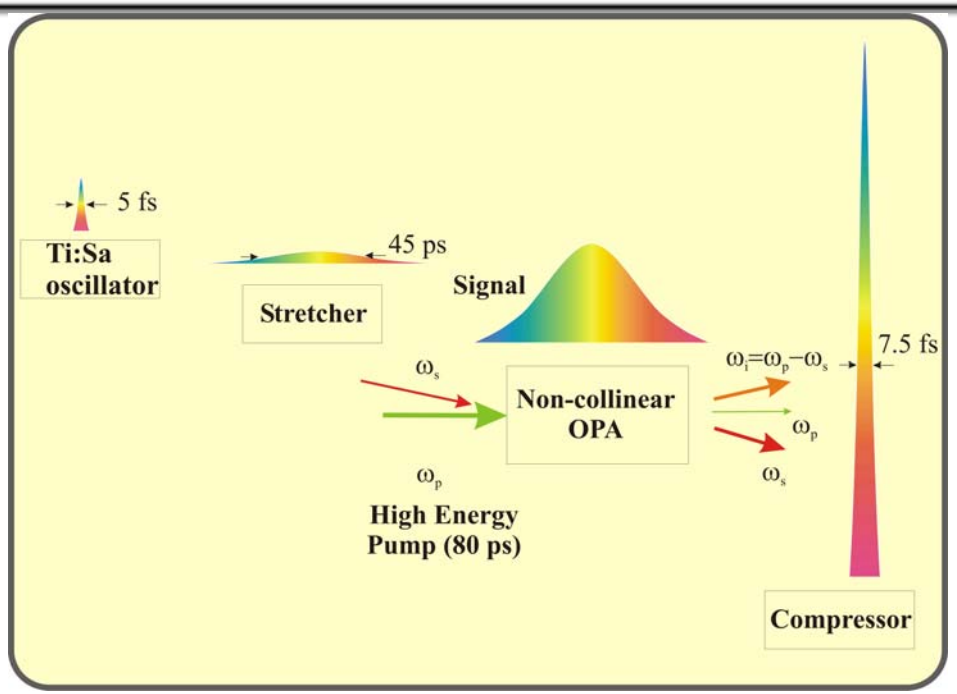
Motivation for few-cycle OPCPA



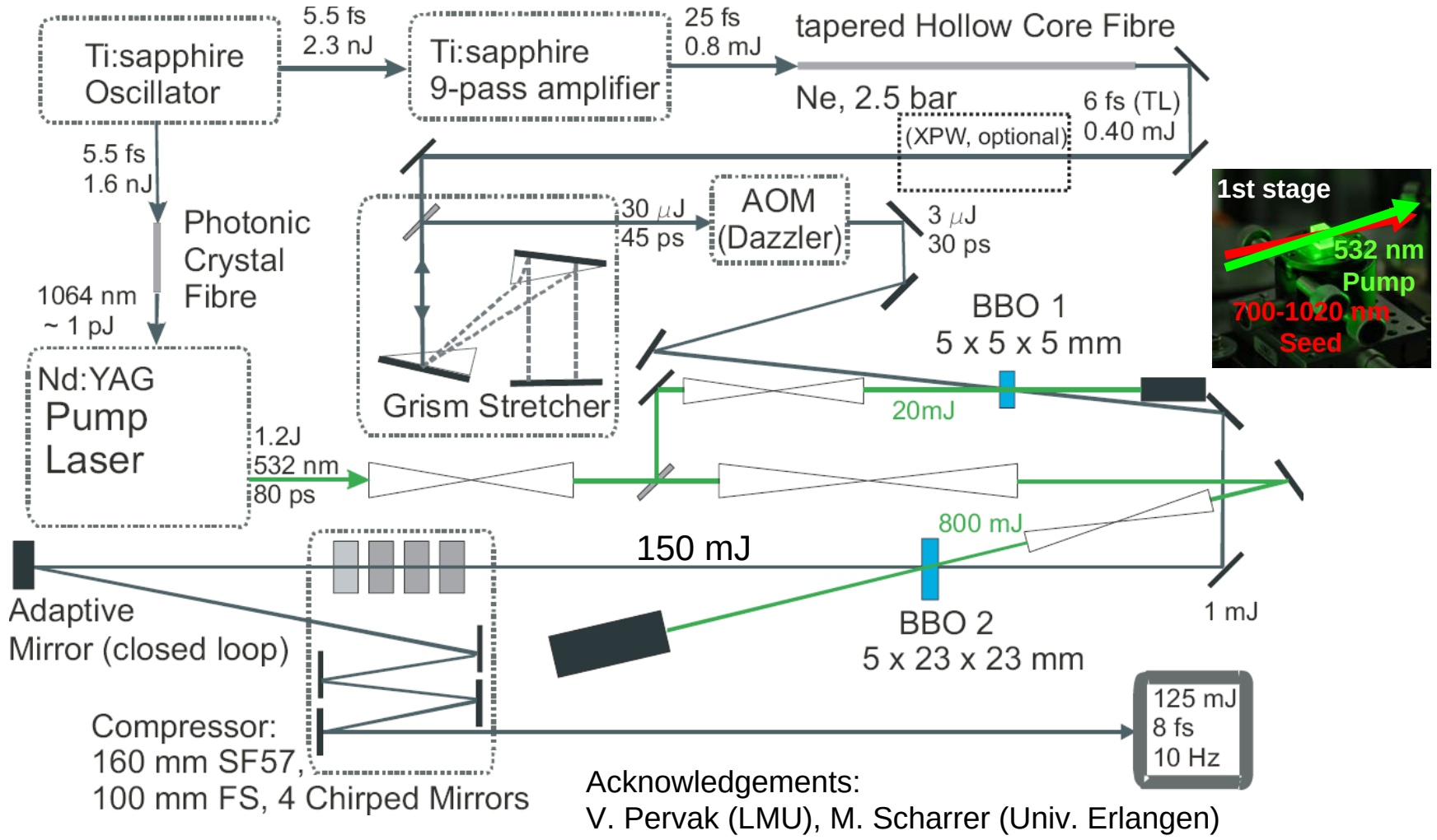
Advantages

- Broad gain bandwidth, supporting few-cycle pulses
- Huge single pass gain (~10^6)
- No thermal load in the amplifier crystals
- Good contrast achievable

Challenges

- Stretching and compression of huge spectral bandwidth
- Synchronization of pump and seed pulses
- Amplification of the optical parametric fluorescence (superfluorescence)
- Carrier envelope phase stabilization

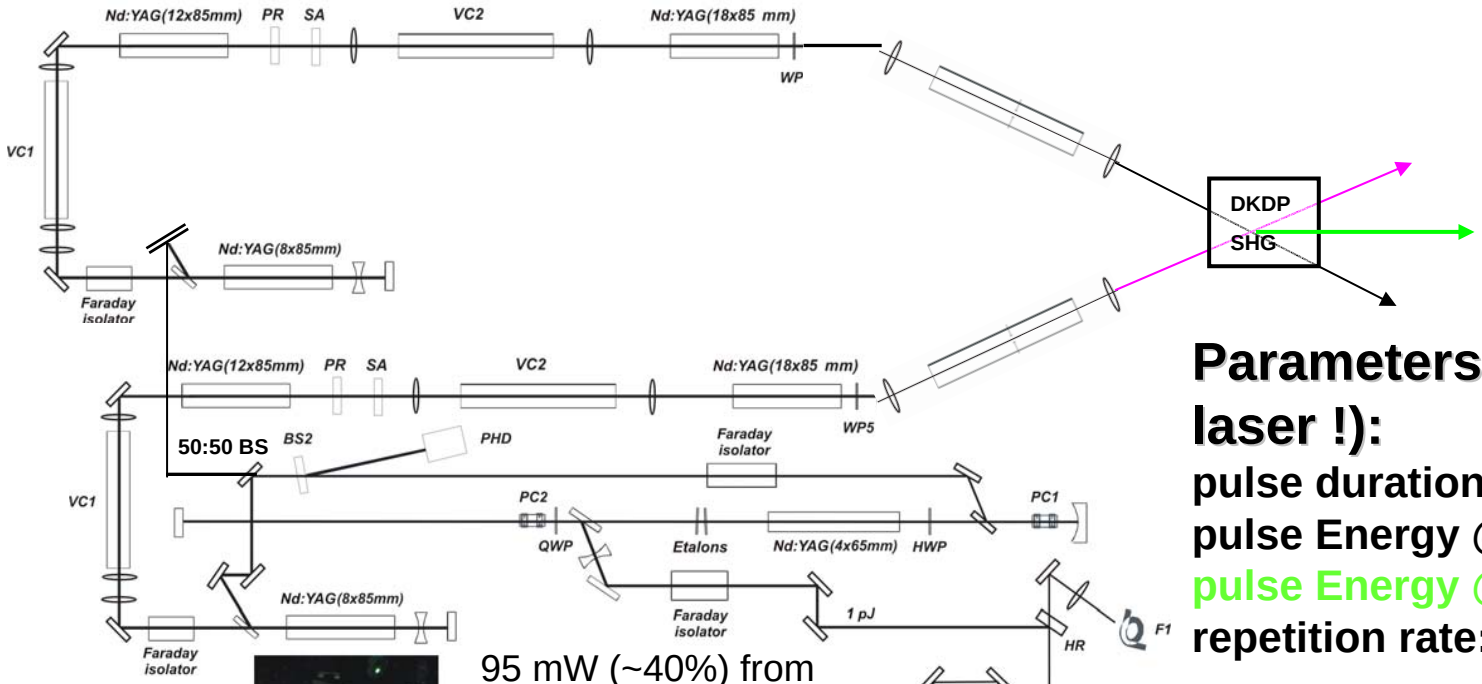
LWS-20 OPCPA Setup

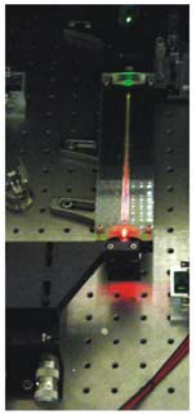


Acknowledgements:
V. Pervak (LMU), M. Scharrer (Univ. Erlangen)

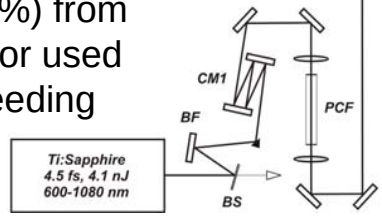
XPW: Cross-polarized wave generation, A. Jullien *et al.* Opt. Lett. 30, p. 920 (2005).

LWS-20: Pump Laser

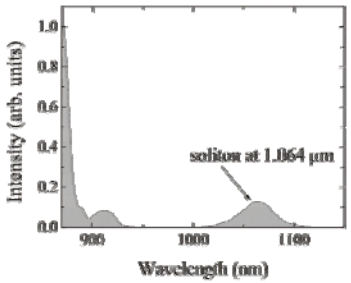




95 mW (~40%) from Ti:sa oscillator used for optical seeding



soliton-based optical pump-seed synchronization*



Parameters (Not a CPA laser !):

pulse duration: 80 ps

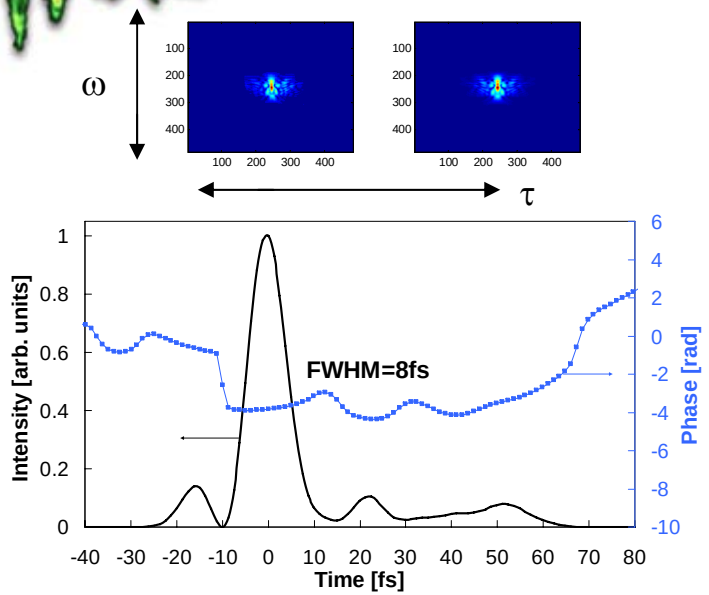
pulse Energy @1064 nm: 2 x 1.2 J

pulse Energy @532 nm: 1-1.2 J

repetition rate: 10 Hz

*C.Y. Teisset *et al.* Opt. Express **13**, 6550 (2005)

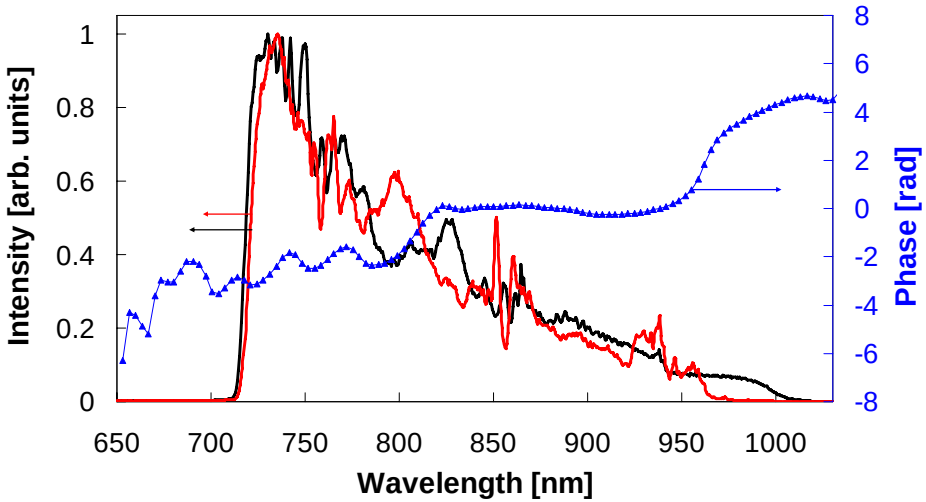
Pulse Compression



SHG-FROG results:

- nearly flat spectral phase over compressed bandwidth of 700 nm-980 nm
- Duration (FWHM)=8 fs, compressed within 6% of the Fourier limit
- 80% of the total energy is contained in the main pulse

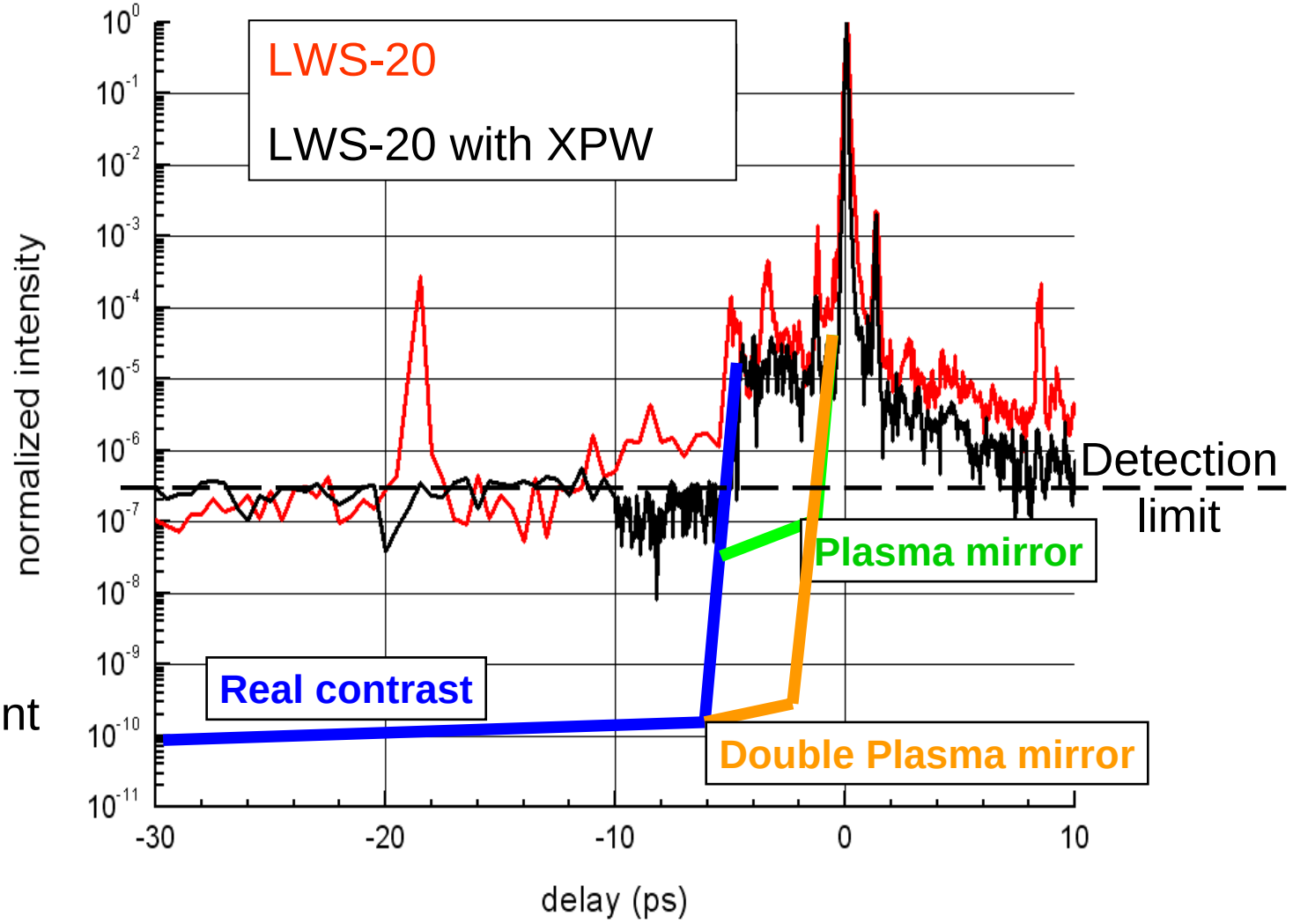
- potential compressed bandwidth (700-**1020 nm**) (TL=7-7.5 fs) is *reduced* by phase-load of Dazzler



Conclusion:
8 fs, 125 mJ, 16 TW
@805 nm

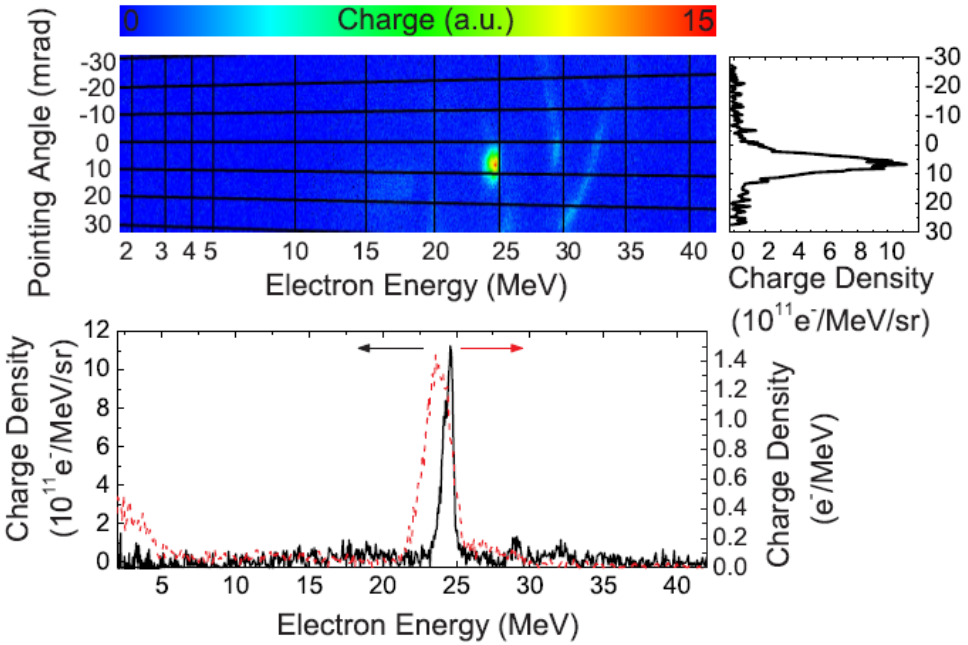
Contrast Measurements

- LWS-20 contrast: 10^{-7}– 10^{-8}
- LWS-20 contrast with XPW: 10^{-10} beyond 5 ps
- Single / double plasma mirror is under development to remove 5 ps pedestal

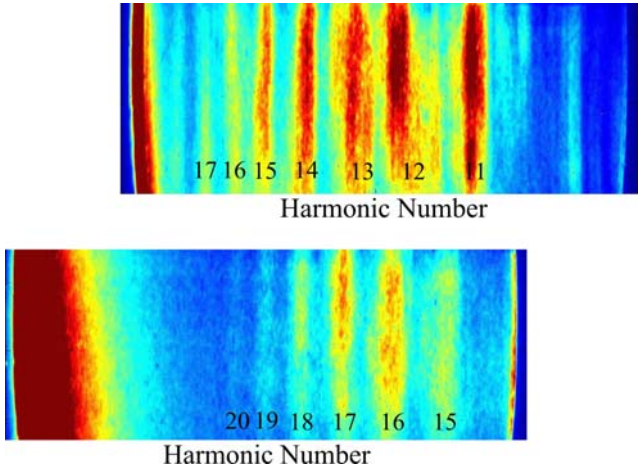


Applications

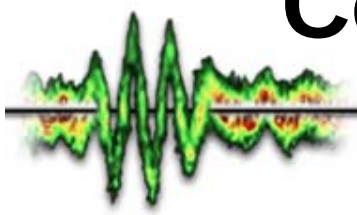
- **<u>Electron acceleration</u> in He gas jet**



- **<u>Surface high harmonic generation</u>** *(see talk of R. Hörlein)*



Conclusions and Future Work



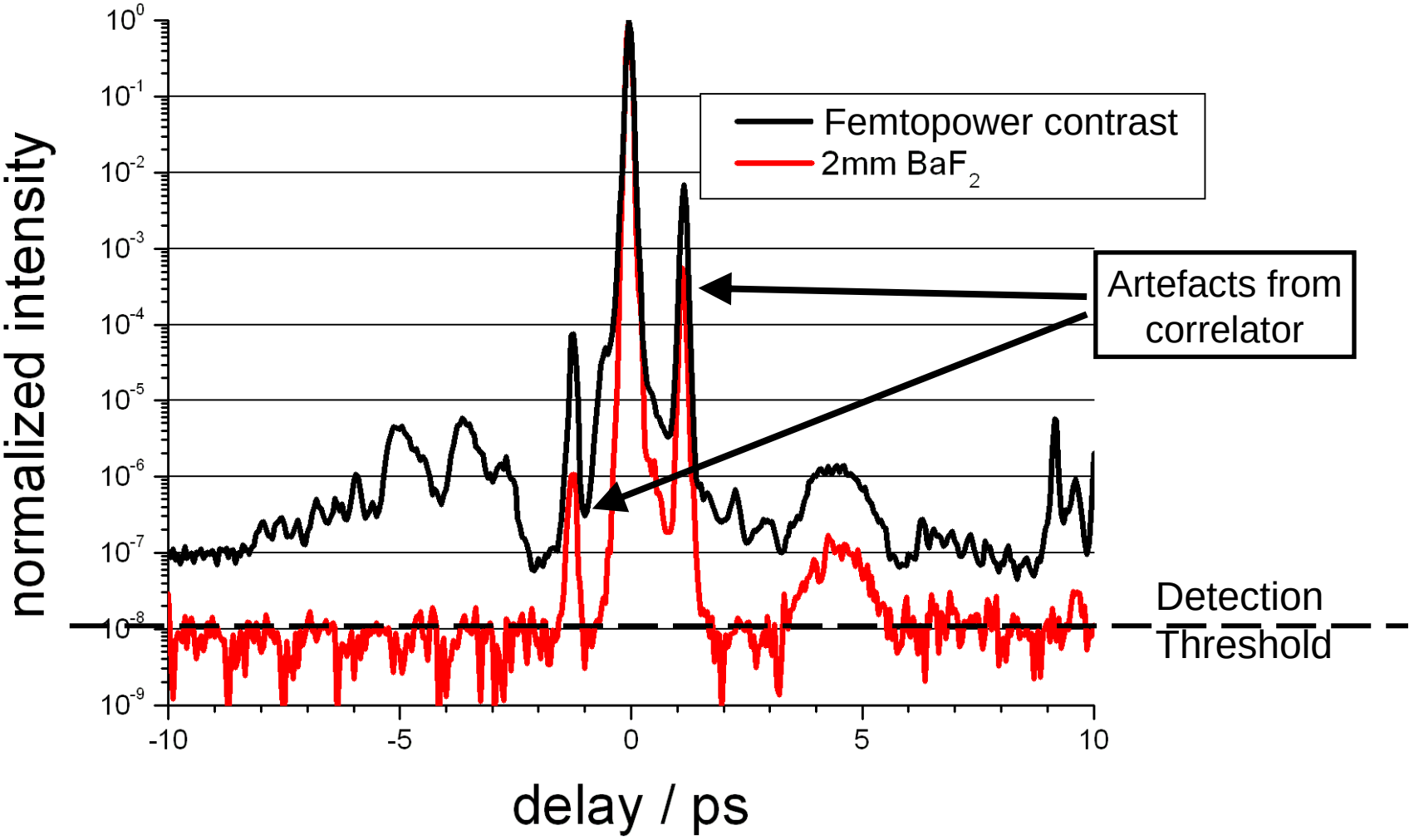
MPQ LMU www.attoworld.de

- **LWS-20 is the most intense few-cycle system worldwide**
- **Optimization of stretcher and compressor**
  - **to achieve 7-7.5 fs in duration**
  - **increase the pulse energy (150-200 mJ)**
  - **increase the pulse contrast - 5 ps pedestal -**
- **CEP-Stabilization of the OPCPA system**
- **Next upgrade: aiming for ~600 mJ, ~6 fs (~100 TW)**

Thank you for your attention !

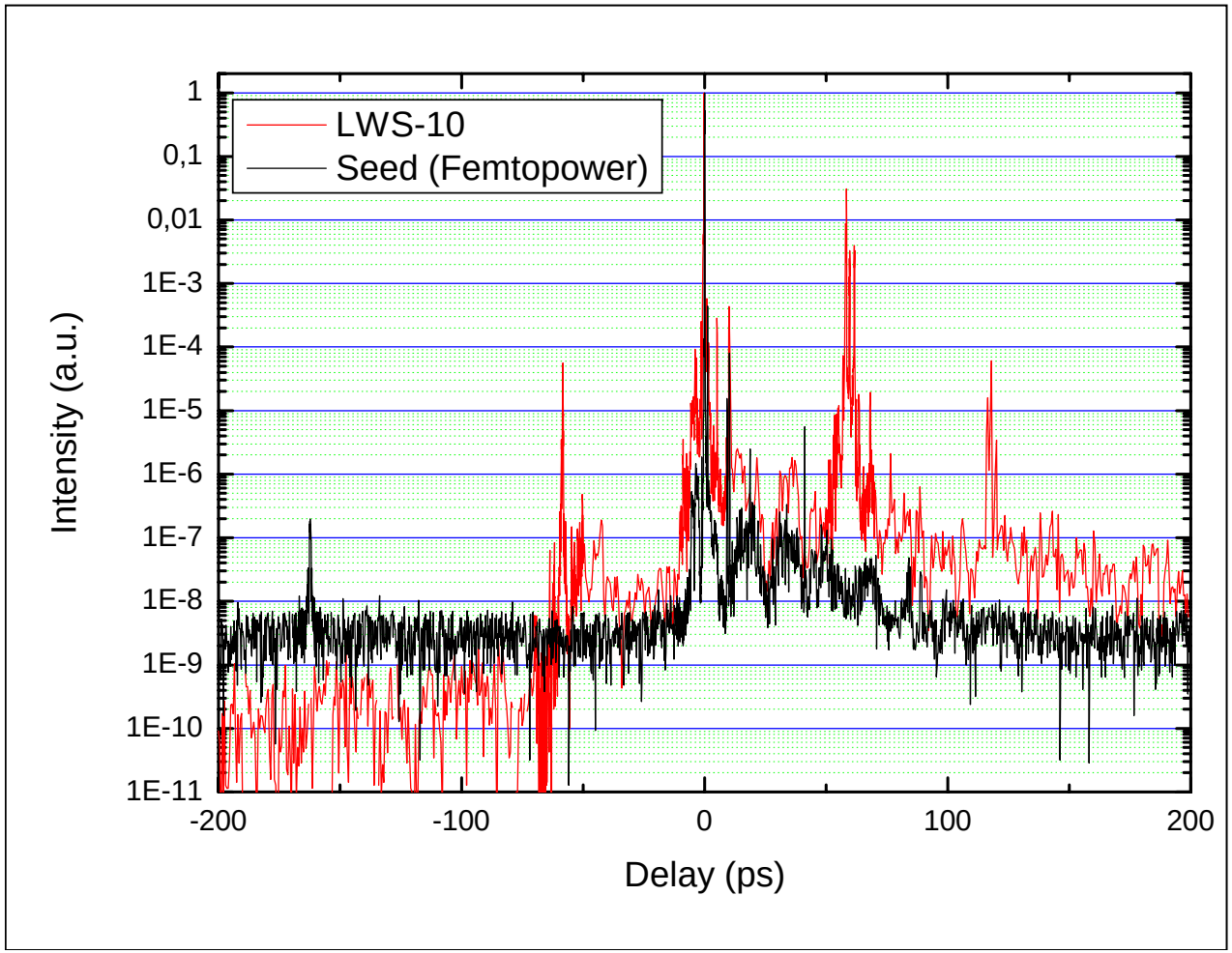
XPW Test after front end

Incoming pulse energy: 800uJ
XPW signal with 1x 2mm BaF2: 75uJ → 9%
XPW signal with 2x 2mm BaF2: 130uJ →16%

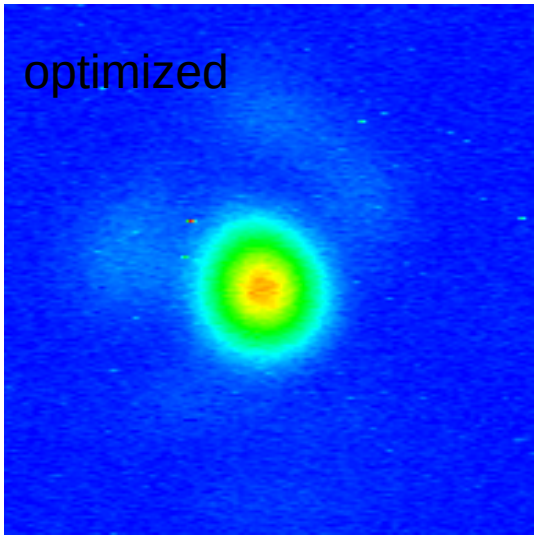


LWS-10 properties

Contrast



Focus



FWHM: 3.6 µm x 3.8 µm
focused with
f = 150mm (F# 3)