Pioneer in ultrafast
high energy lasers

laser solutions for scientific applications

LATEST DEVELOPMENT IN HIGH ENERGY LASER SYSTEMS

MEDEA Kick off meeting, MBI - Berlin

nothing but ultrafast

Amplitude TECHNOLOGIES

Amplitude group

Amplitude TECHNOLOGIES

Amplitude SYSTEMES

Continuum

AMPLITUDE TECHNOLOGIES

Amplitude Technologies in figures…

- Created in 2001
- 80 co-workers (150 for the whole Amplitude group)
- 3 x 1 Petawatt on-going project (10^{15} W – 30 J – 25 fs)
- 25 x 100 TW-class laser system installed
- > 50 femtosecond Ti:Sa lasers installed
- > 200 nanosecond Nd:YAG lasers installed

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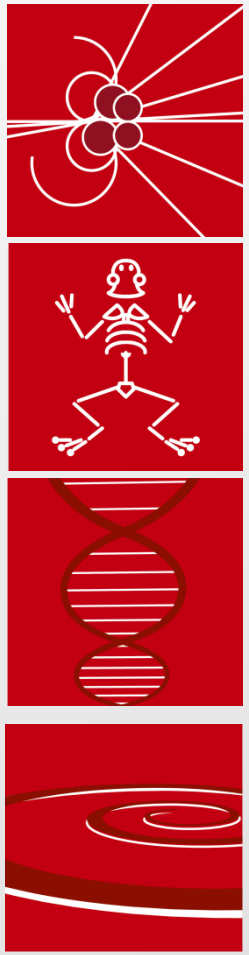
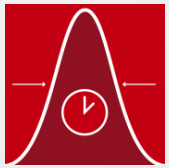
Multi-100's TW and PW lasers applications

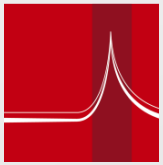
- **Proton acceleration** (European project Saphir)
- **Electron acceleration** (*Easarey et al 2009*)
- **Ion acceleration** (*Borghesi et al 2006*)



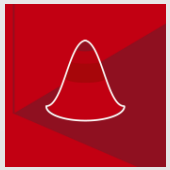
High pulse energy on the target



Ultra-short pulse duration



High temporal contrast



High quality wavefront

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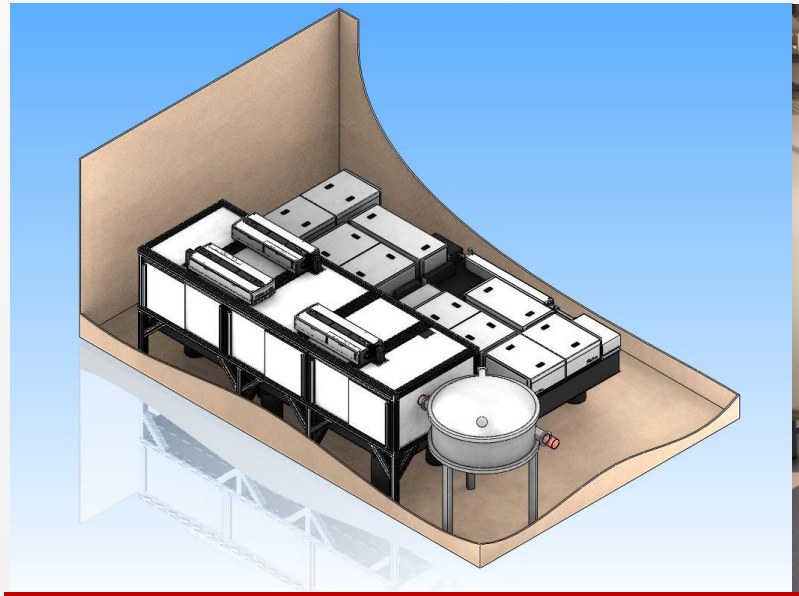
JETI100

HELMHOLTZ ASSOCIATION
Helmholtz Institute Jena

Amplitude TECHNOLOGIES

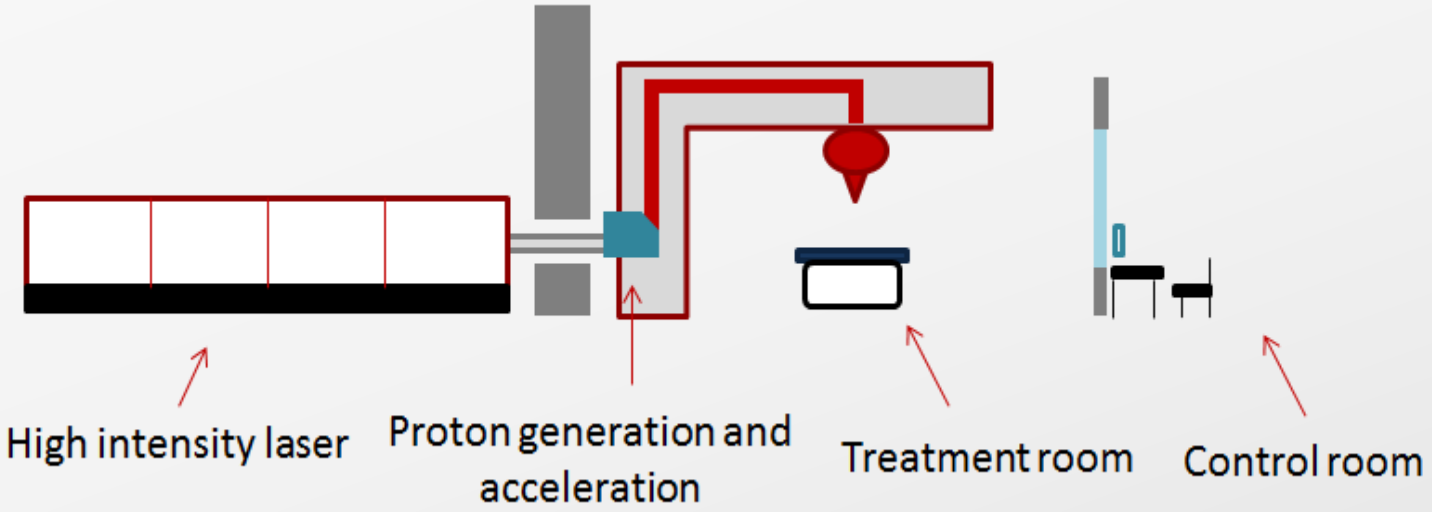
Prof. Dr. Gerhard Paulus / ultra-compact high peak power laser system



Ultra-short high peak power laser
16 fs as temporal duration at 250 TW (4 J)
5 Hz - Temporal contrast 10^{12}

SAPHIR PROJECT: LASER-BASED PROTONTHERAPY R&D

Idea of laser-based protontherapy installation



PULSAR PW laser system / DRACO

Power supplies and cooling units

TITAN pump lasers

SUPERBOOSTER front-end

PW compressor

TWIN amplifier

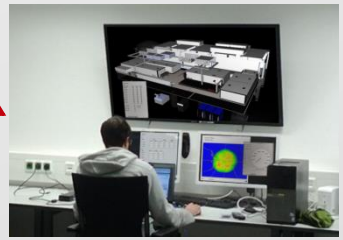
2.5 J amplifier

800 mJ amplifier

PULSAR 200 TW

Metrology and diagnostics

CONTROL / COMMAND



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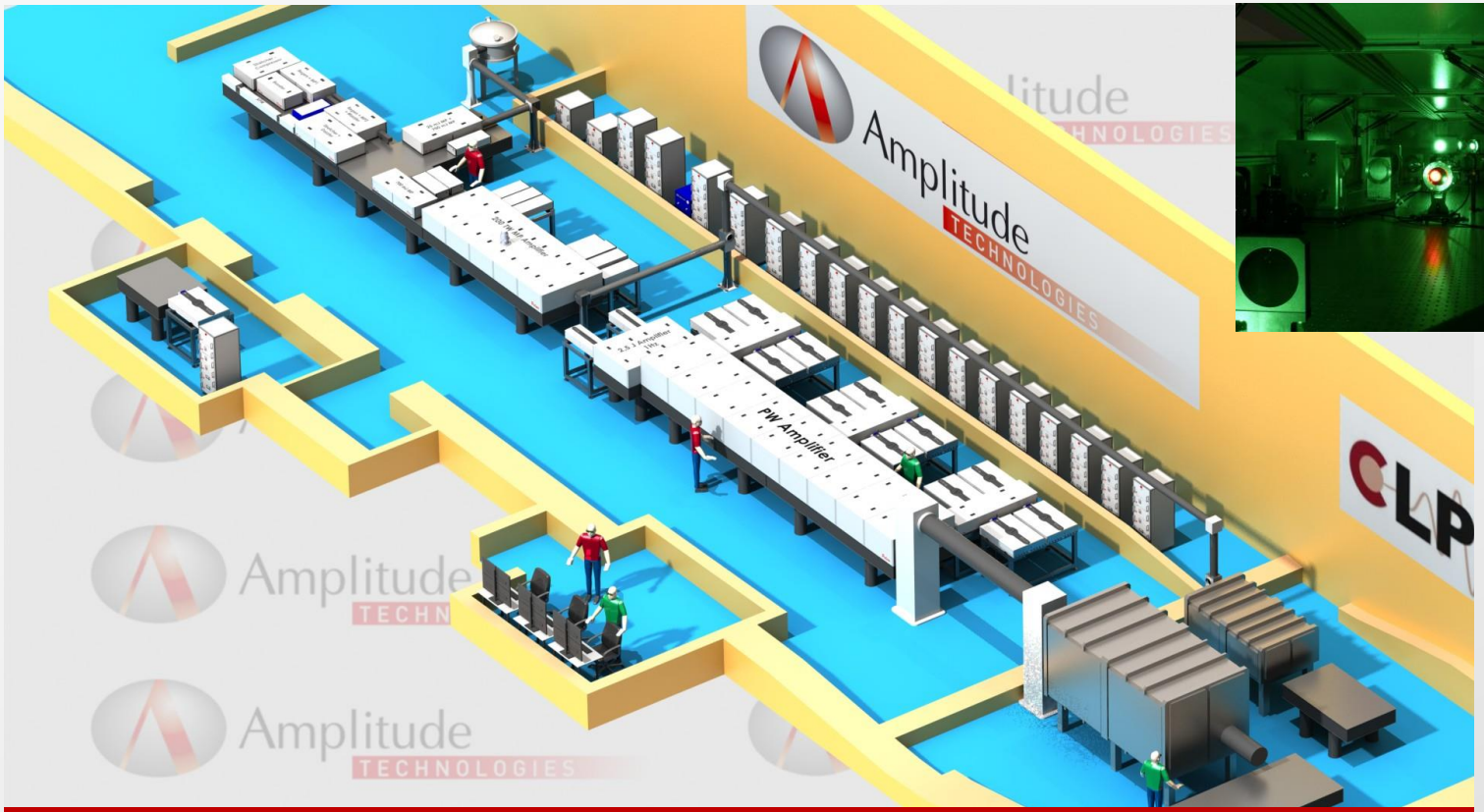
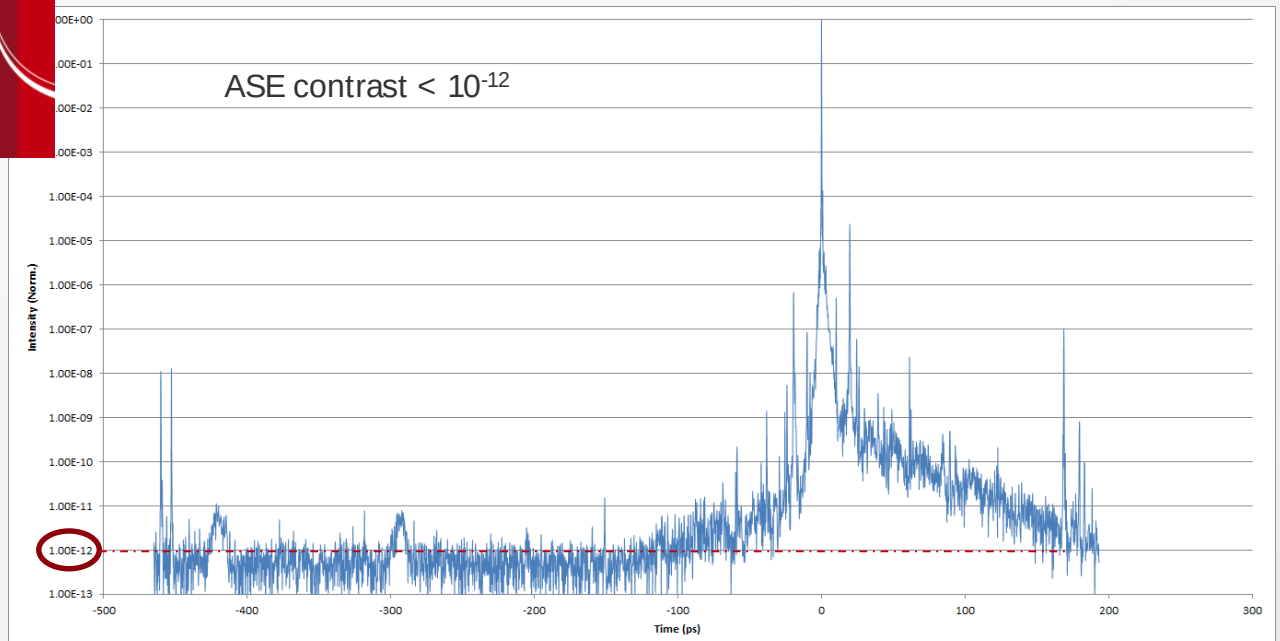
VEGA LASER SOURCE

Centro de Laseros Pulsados / Prof. Dr. Luis Roso



PULSAR PW – 1 Hz – < 25 fs – Temporal contrast 10^{12}
Multiple high peak power laser outputs

SUPERBOOSTER / PERFORMANCES



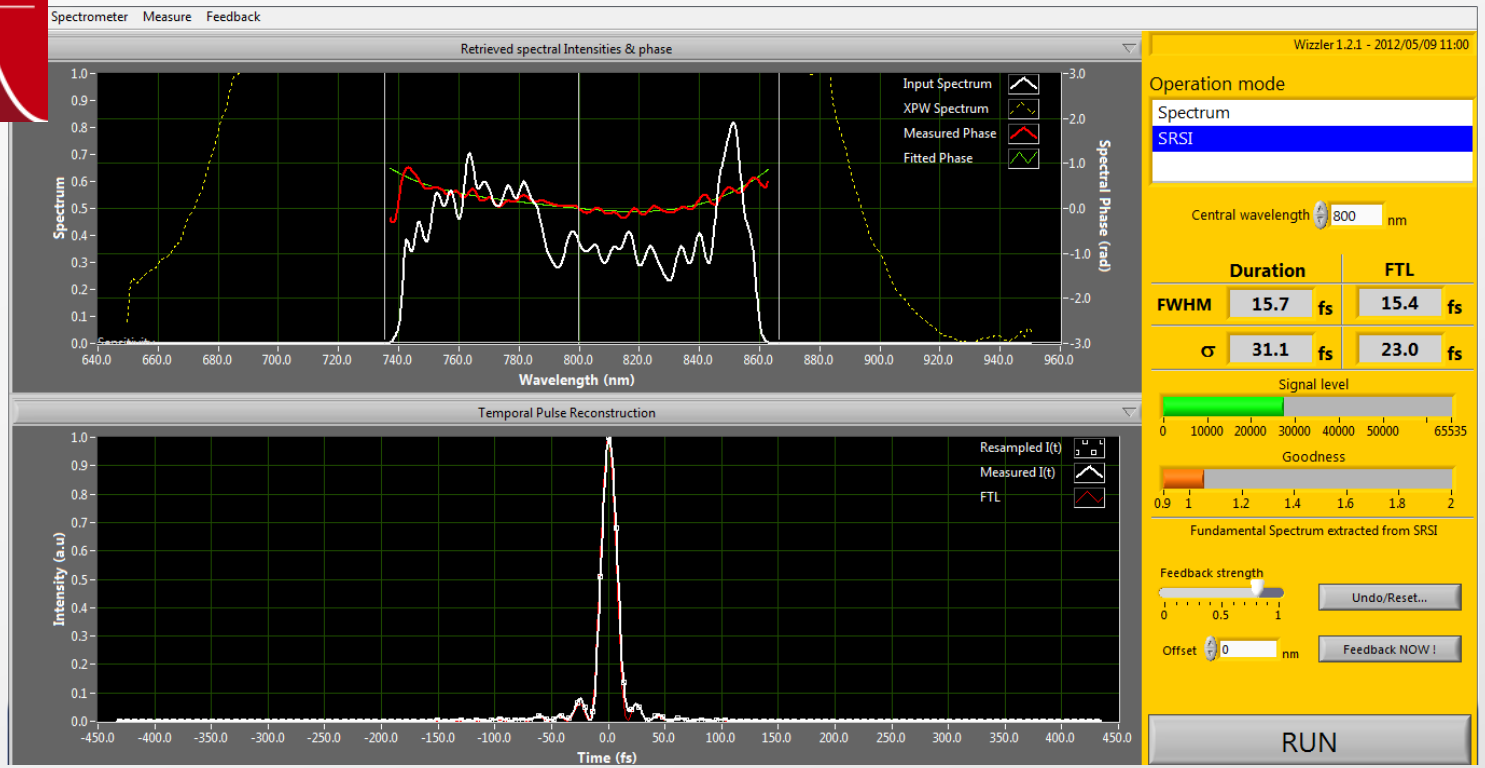
PULSAR 250 TW, 5 Hz
JETI100

Typical SEQUOIA HD for PULSAR multi-TW-class laser system with SUPERBOOSTER front-end

•	ns	guaranteed	< 10^{-8}
•	1 ps	guaranteed	< 10^{-3}
•	2 ps	guaranteed	< 10^{-4}
•	5 ps	guaranteed	< 10^{-6}
•	30 ps	guaranteed	< 10^{-11}
•	> 50 ps	guaranteed	< 5.10^{-12}

•	ns	measured at FAT	< 10^{-8}
•	1 ps	measured at FAT	< 10^{-5}
•	2 ps	measured at FAT	< 10^{-5}
•	5 ps	measured at FAT	< 10^{-7}
•	30 ps	measured at FAT	< 10^{-11}
•	> 50 ps	measured at FAT	10^{-12}

JETI100



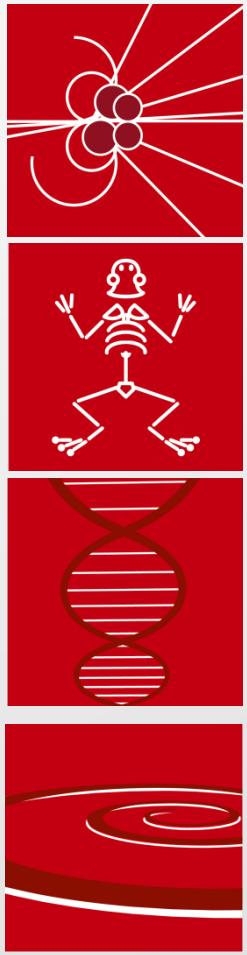
Ultra-short high peak power laser

16 fs as temporal duration at 250 TW (4 J)

5 Hz - Temporal contrast 10^{12}

kHz systems with CEP stabilization

- **High Harmonic Generation**
- **Generation of attosecond pulses**



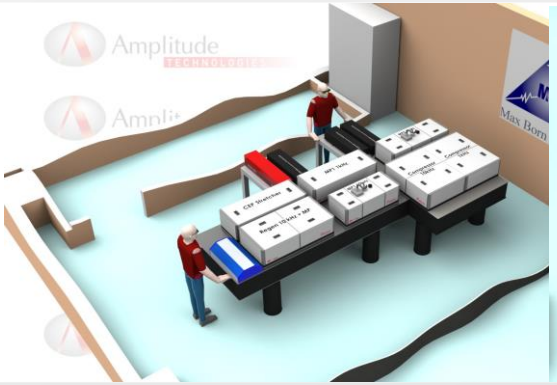
CEP, high repetition rate, high power, ultrafast lasers: Objectives

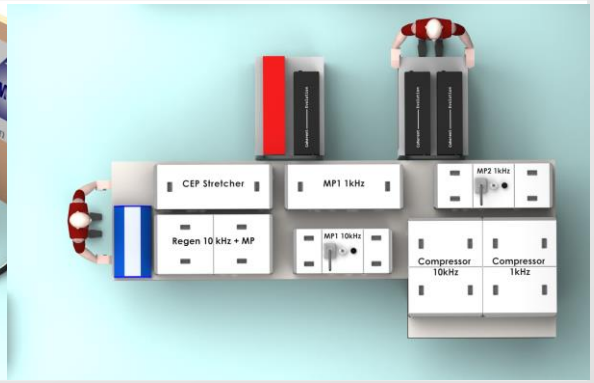
- Quantitative:

- Repetition rate: **10 kHz**
- Energy (Power): **1 mJ (10 W), > 2 mJ (20 W) or 3 mJ (30 W)**
- Pulse Duration **< 20 fs, down to 15 fs**
- CEP Stabilization: **< 250 mrad RMS**

- Qualitative:

- User friendly/simple
- Compactness
- Mode Quality
- Reliability





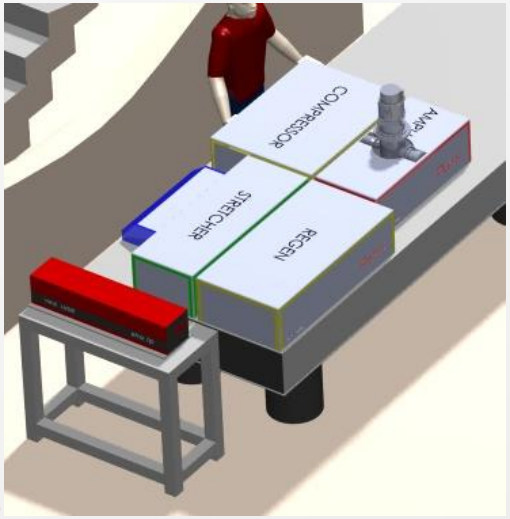
AURORA 10 kHz and DUAL

Politecnico Milano, Italy
20 W, 10 kHz, 20 fs CEP
Prof. Giuseppe SANSONE
Giuseppe.sansone@polimi.it

MBI Berlin, Germany
20 W, 10 kHz, 20 fs CEP
20 W (20 mJ), 1 kHz, 20 fs CEP
Prof. Marc VRAKKING / Prof. Noack
vrakking@mbi-berlin.de

Attolab Platform, France
20 W, 10 kHz, 16 fs CEP
20 W (20 mJ), 1 kHz, 16 fs CEP
Dr. Pascal D'OLIVEIRA
pascal.doliveira@cea.fr

POLITECNICO DI MILANO



Complete analog control of the carrier-envelope-phase of a high-power laser amplifier

C. Feng[1], J.-F. Hergott[2], P.-M. Paul[3], X. Chen[3], O. Tcherbakoff[2], M. Comte[2], O. Gobert[2],M. Reduzzi[1], F. Calegari[1], C. Manzoni[1], M. Nisoli[1], and G. Sansone[1]

(1) CNR-IFN Dipartimento di Fisica Politecnico, Piazza Leonardo da Vinci 32 20133 Milano Italy

(2) CEA-Saclay, IRAMIS, Service des Photons, Atomes et Molécules, 91191 Gif-sur-Yvette, France

(3) Amplitude Technologies, 2-4 rue du Bois Chaland CE 2926, 91029 Evry, France

jean-francois.hergott@cea.fr

giuseppe.sansone@polimi.it

Abstract: In this work we demonstrate the development of a complete analog feedback loop for the control of the carrier-envelope phase (CEP) of a high-average power (20 W) laser operating at 10 kHz repetition rate. The proposed method combines a detection scheme working on a single-shot basis at the full-repetition-rate of the laser system with a fast actuator based either on an acousto-optic or on an electro-optic crystal. The feedback loop is used to correct the CEP fluctuations introduced by the amplification process demonstrating a CEP residual noise of 320 mrad measured on a single-shot basis. The comparison with a feedback loop operating at a lower update rate indicates an improvement up to 45% in the residual noise. The measurement of the CEP drift for different integration times clearly evidences the importance of the single-shot characterization of the residual CEP drift. The demonstrated scheme could be efficiently applied for systems approaching the 100 kHz repetition rate regime.

OCIS codes: (320.7080) Ultrafast devices; (320.7090) Ultrafast lasers

20 W, 10 kHz, 20 fs CEP

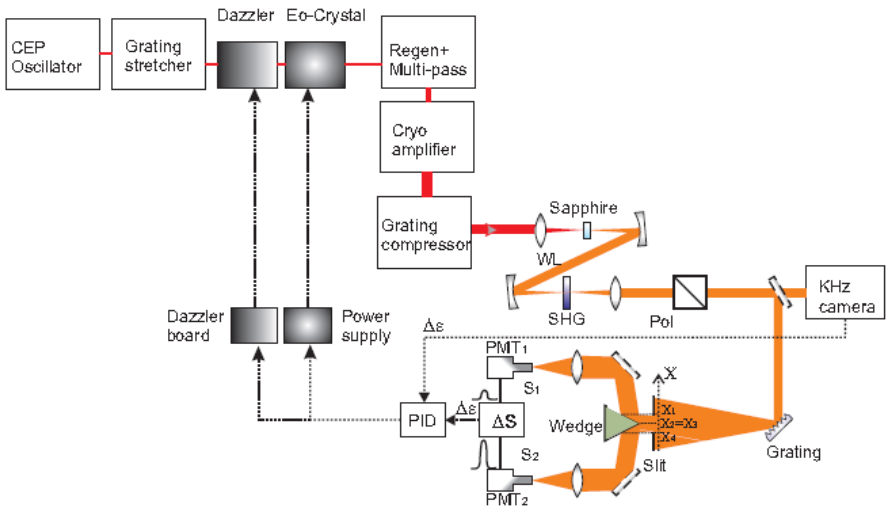


Fig. 1. Experimental setup. WL: white light; SHG : second harmonic generation crystal; Pol: polarizer; PMT: photomultiplier; PID: proportional-integrative-derivative.

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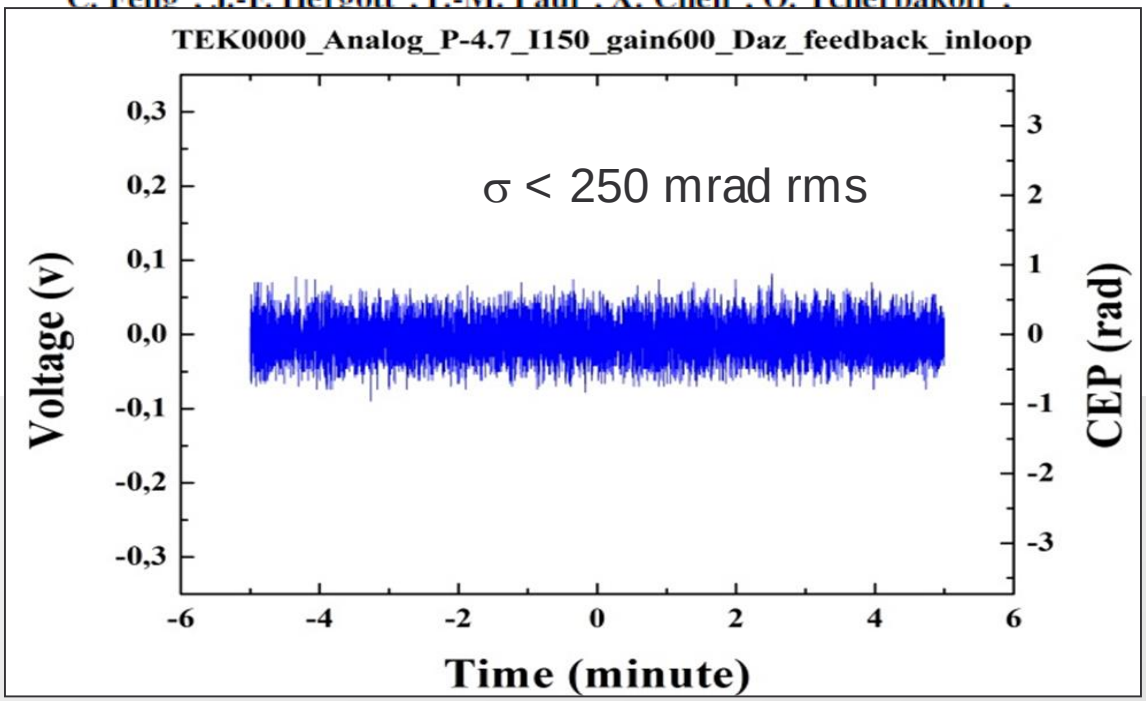

AURORA 10

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Fast f-to-$2f$ interferometer for a direct measurement of the carrier-envelope phase drift of ultrashort amplified laser pulses

Sebastian Koke, Christian Grebing, Bastian Manschwetus, and Günter Steinmeyer*

Max Born Institute, Max-Born-Straße 2A, D-12489 Berlin, Germany
**Corresponding author: steinmey@mbi-berlin.de*

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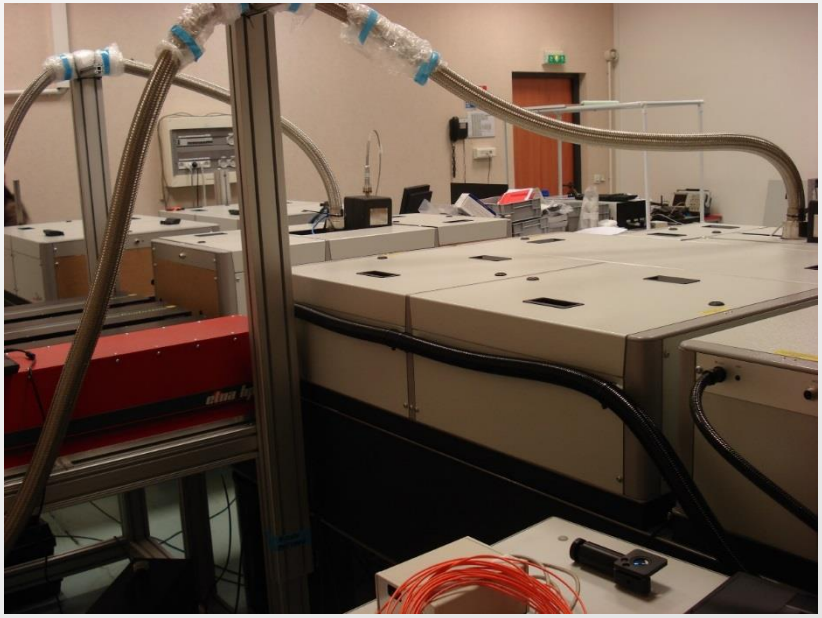
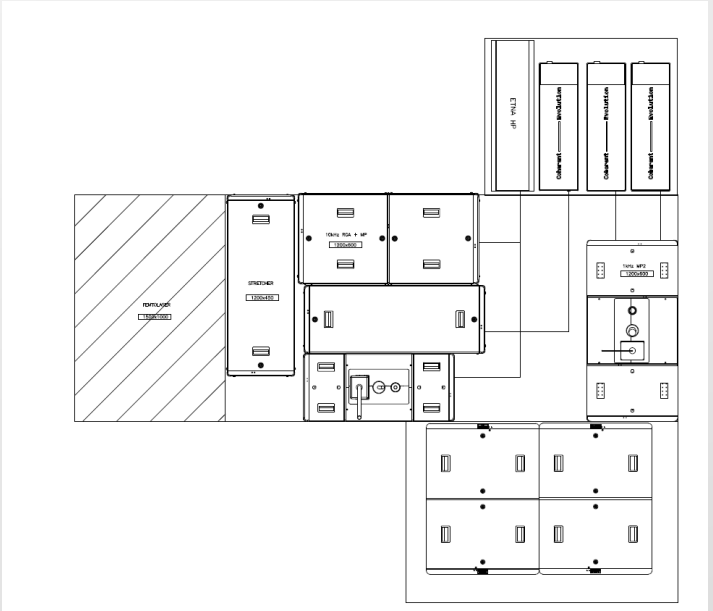
We propose a novel method to directly extract the phase from spectral interferograms, without the need for digital signal processing. This method is demonstrated with single-shot measurement and stabilization of the carrier-envelope phase of a 3 kHz amplifier system. Our scheme allows for real-time monitoring of the carrier-envelope drift and an increased loop width for stabilization. We find that in our amplifier laser system fast carrier-envelope phase jitter is mainly inherited from the oscillator stabilization loop but we also find previously unreported indications for a rapid pulse-to-pulse jitter from the amplifier pump laser.

OCIS codes: 140.7090, 140.3280, 320.7160, 320.7090.

20 W, 10 kHz, 20 fs CEP
20 W (20 mJ), 1 kHz, 20 fs CEP





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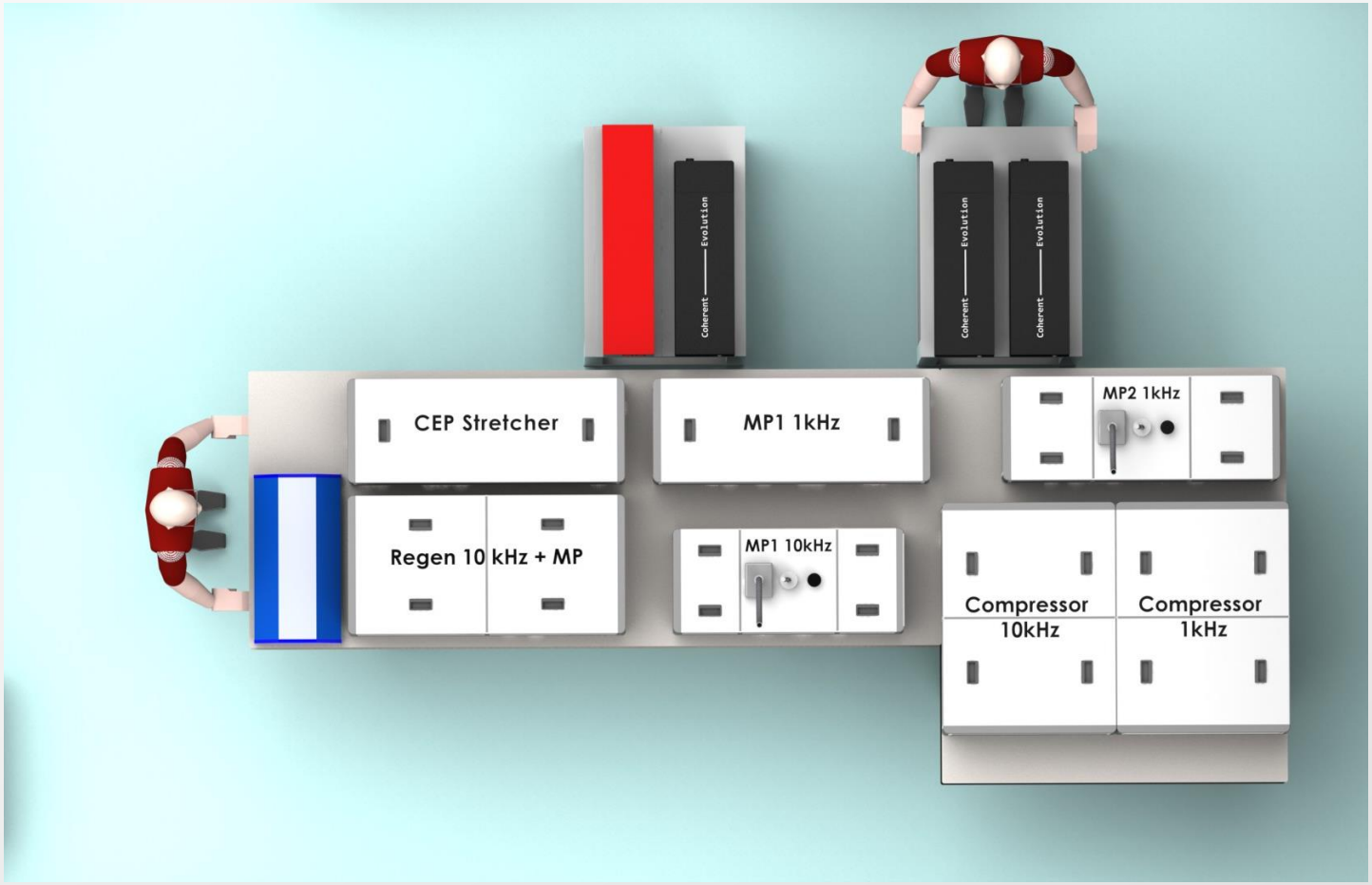

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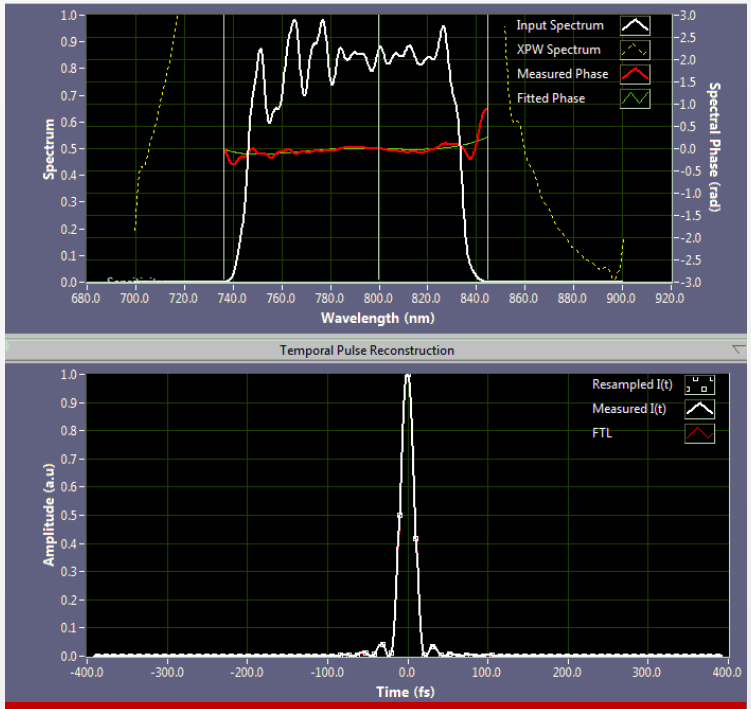
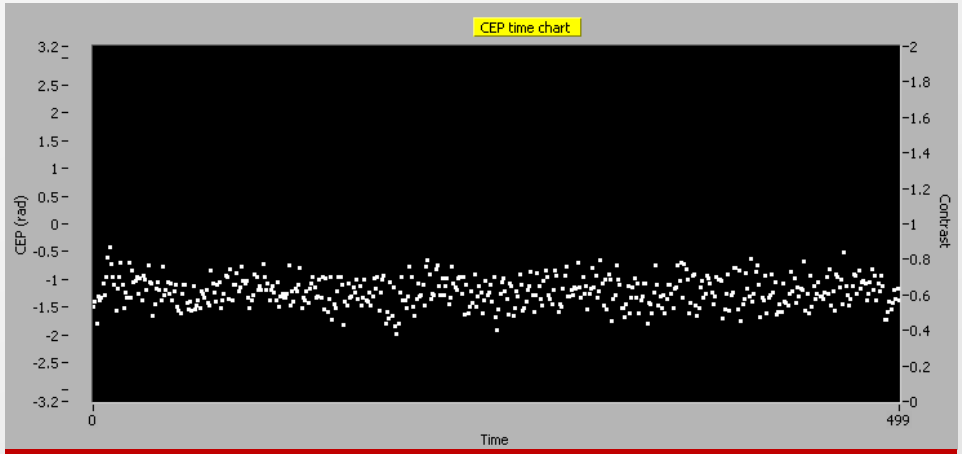


Pulse duration measurements using a wizzler **τ = 19.8 fs**



CEPmeasurements using a Fastlite software and Menlo APS **σ² < 260 mrad RMS**

Amplitude TECHNOLOGIES

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Julie Siv
Area sales engineer
jsiv@amplitude-technologies.com
+33 (0)789 85 86 91

AMPLITUDE TECHNOLOGIES
2-4 rue du Bois Chaland,
CE 2926 Lisses
91029 Evry - France

AMPLITUDE LASER
One broadway, floor 14
Cambridge, MA 02142
USA

AMPLITUDE TECHNOLOGIES
Pythagore Optical Business Center
323 Guo Ging rd, bld 3, 9th floor,
Yangpu district
200 433 Shanghai - China

AMPLITUDE SYSTEMES
11, avenue de Canteranne
Cité de la Photonique
33600 Pessac - France