WP4 – Laser Design and Optimization.

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Objectives

Laser Design and Optimization (LDO)

4.1 Overview Industrially Available Lasers

Design study will be based upon an industrial laser system

4.1 Error and Stability Analysis for Lasers

Identification of critical issues for reliable operation

4.2 Feedbacks and Correction Methods

Design of techniques for self-optimization

4.4 Prototype Laser Feedbacks and Tests

Use existing facilities to demonstrate self-optimization

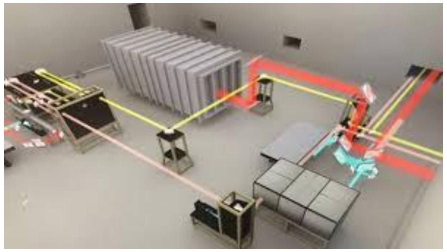
4.5 Two plasma-module laser acceleration

Identify and test scheme for two (multiple) stage acceleration

Deliverables 1/2

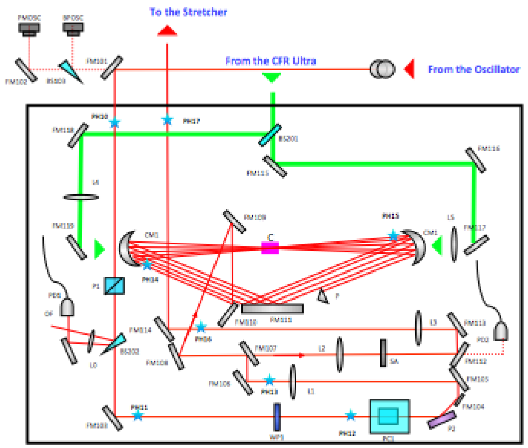
D4.1 (M12) Benchmarking of existing technologies and comparison with EuPraxia requirements

ELI multi PW lasers, Apollon, J-Karen …



D4.2 (M24) Preliminary laser design

To be developed with an eye to perspective industrial development



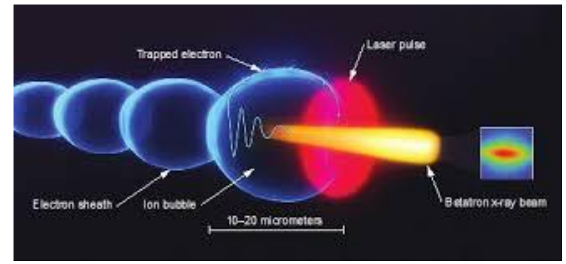
D4.3 (M24) Preliminary design of transverse functions

To account for final use of EuPRAXIA (user facility?)

Deliverables 1/2

D4.4 (M36) Finale requirements of laser system

To comfortably accommodate LWFA design



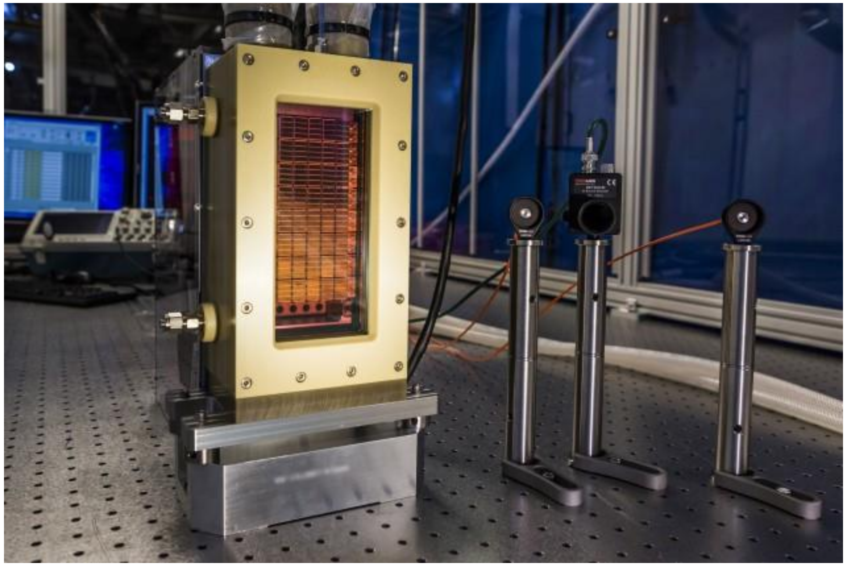
D4.5 (M36) Control command design system

To enable turn-key-like operation of the laser system

Kick-off considerations 1/3

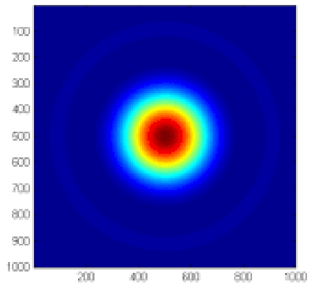
- Baseline parameters
  - **Repetition rate**
    - Above 10 Hz switch from flashlamp to DPSSL/fibers?
    - **100 Hz/1KHz could be beneficial for close loop stabilization**

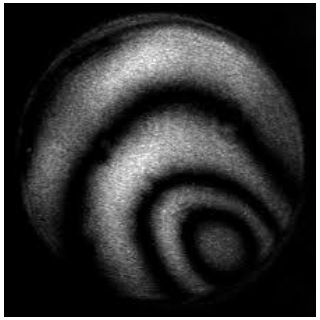
HALPS laser system
LLNL for ELI Beamlines
1PW/10 Hz

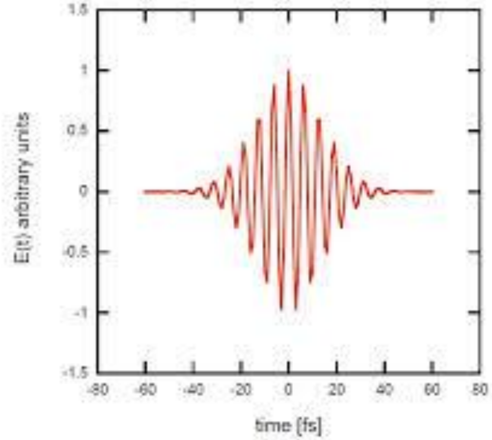


Kick-off considerations 2/3

- Interface with other WPs
  – Input interface from WP2 (Phys&simulation)
  – Output interface at
    - laser output?
      – Define near field temporal and transverse phase (correction)
    - laser focus?
      – Define focused pulse performances (after OAP)
  – Negotiate with WP3 (high gradient acc)







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Kick-off considerations 3/3

- Industial involvement
  - Start involvement after definition of baseline parameters
  - Drive/stimulate industrial development in the Eupraxia direction
  - Key partners include Amplitude and Thales
  - Additional alternative partners overseas (LLNL, NE) …
  - Wait for ELI experience

Amplitude TECHNOLOGIES
Nothing but ultrafast.

THALES

proton laser

…

Conclusions

- WP4 is up and running!
- Laser WP4 task: make EuPRAXIA laser technology appealing for future (2020) industrial development!

WP4 - personnel

Manpower (Name / Position)	Email	Institute	WPs	Fraction available	Start Date	End Date	Funded with EU Money*	Not funded with EU Money*
Petra Koester / Term position/ Researcher	petra.koester@ino.it	INO-CNR	4	100%	01/04/16	31/03/18	90000	
Fernando Brandi /Term Position/researcher	fernando.brandi@ino.it	INO-CNR	4	100%	01/07/16	31/03/18	45000	45000
Luca Labate/Permanent staff/Researcher	luca.labate@ino.it	INO-CNR	4	20%				9119
Leonida A. Gizzi/Permanent Staff/Senior Researcher	la.gizzi@ino.it	INO-CNR	4	30%				22102
To be determined		CNRS-LULI	4	100%	24	48	105360	
François MATHIEU	francois.mathieu@polytechnique.edu	CNRS-LULI	4	10%	0	24		23623
François MATHIEU	francois.mathieu@polytechnique.edu	CNRS-LULI	4	20%	24	48		47246
Dimitrios PAPADOPOULOS	Dimitrios.papadopoulous@polytechnique.edu	CNRS-LULI	4	15%	24	48		13140
Audrey BELUZE	audrey.beluze@polytechnique.edu	CNRS-LULI	4	30%	36	48		10512
Jean Luc PAILLARD	jean-luc.paillard@polytechnique.edu	CNRS-LULI	4	15%	24	48		12264

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1° Steering committe meeting

CNR, CNRS, STFC-RAL,

discussions with Amplitude, Thales ...

Discussion on key laser parameters

- Laser configuration will be defined according to the plasma acceleration configuration;
- A preliminary set of possible laser configurations can be identified taking into account established laser schemes and technologies;
- Laser configurations should include schemes currently under development/prototyping, which are likely to mature by the tyme of implementation.

Key parameters

- Number of main beams: 1 to 4
- Number of Aux beams: 1 to 2
- Pulse duration, 15fs – 1ps – **100 fs**
- Wavelength, 800 nm, 1µm, both, 2ω?
- Pulse energy (main beams): 50J-250J (?) **100 J**
- Pointing stability?
- Peak intensity?
- Contrast Ratio?
- Rep rate: 10 Hz – 1kHz – **100 Hz**?

N° of main beams

- Multiple main beams from same oscillator to drive multiple accelerator stages;
- Specs of each main beam tunable in energy and optimized pulse duration (chirping?)
- Possibility to have beams at different wavelengths: 0.8µm and 1.0 µm.
- Cost roughly scales with number of beams and energy.
- Multiple beams address redundancy issue.

Pulse duration

- Pulse duration sets choice on front-end and amplification technology:
- Sub-20 fs: Apollon is the reference system (OPCPA+ TiSa)
- 20-100 fs: Full TiSa with bandwidth and long phase control (standard commercial systems)
- 100 fs-1ps: Nd based (glass, crystal, ceramics) Advantage of direct diode pumping (e.g Polaris)

Main beam pulse energy and rep rate

- Energy per pulse in the 100J range, up to 250J?
- Critically dependent on pumping technology
- Rep-Rate of 10Hz or more needs DPSSL
- Reference system here is ELI (Cz, Hu, Ro)