

EUROPEAN
PLASMA
RESEARCH
ACCELERATOR
WITH
EXCELLENCE IN
APPLICATIONS



WP12 – Laser Technology and Liaison to Industry

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September 24th, 2024



This project has received funding from the European Union's
Horizon Europe research and innovation programme under grant
agreement
No. 101079773

18:00	Status of WP12 <i>Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy</i>	<i>Dr Leonida Antonio Gizzi</i> 18:00 - 18:10
	FBH Contribution <i>Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy</i>	<i>Neysha Lobo Ploch</i> 18:10 - 18:20
	STCF Contribution <i>Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy</i>	<i>Mariastefania De Vido</i> 18:20 - 18:30
	DESY Contribution <i>Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy</i>	<i>Andreas Maier</i> 18:30 - 18:40
	Key technologies for compact accelerators <i>Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy</i>	<i>Antoine Courjaud</i>  18:40 - 18:50

Technical WP's Main Goals

Update of CDR concepts and parameters, towards technical design (full technical design requires more funding)

Specify in detail Excellence Centers and their required funding: TDR related R&D, prototyping, contributions to construction

Help in defining funding applications for various agencies

- **Amplitude (F) – New partner (Contact A. Curjaud)**
- **Université Côte d'Azur, Nice (F) – New observer (Contact G. Cheriaux)**

Main Objective of WP12 / duration 48m :

This is the Laser Technology R&D WP, dealing with all aspects required to target and address laser needs for EuPRAXIA



As one of the TECHNICAL WPs of PP, WP12 should:

- **Make progress towards the technical design** of the laser-driver for the 2nd laser-driven site;
- **strengthen the role of industry** to enable the delivery of a robust laser-driver to enable reliable and affordable operation;



Effort

Work package number	12			Lead beneficiary	CNR			
Work package title	Laser Technology and Liaison to Industry							
Participant number	1	2	9	10	11	16	20	23
Short name of part.	INFN	CNR	THAL	DESY	FBH	USZ	STFC	ELIBL
Person months per part.:	0 (+12)	18 (+30)	0 (+4)	6 (+6)	6 (+2)	0 (+6)	0 (+12)	18 (+6)
Participant number	27	32	34					
Short name of part.	CLPU	ILT	EMPA					
Person months per part.:	0 (+2)	0 (+1)	0 (+56)					
Start month	1			End month	48			

Deliverables

Del no.	Deliverable Name	WP no.	Beneficiary	Type	Diss. level	Due month
D12.1 	Report on structures to be funded from national/bilateral/european level for laser technology	WP12	2 - CNR	R — Document, report	PU - Public	12
D12.2 	Report on technical results achieved in the field of Lasers	WP12	2 - CNR	R — Document, report	PU - Public	24
D12.3	TRL Report and maturity assessment on the development of Lasers	WP12	2 - CNR	R — Document, report	PU - Public	42

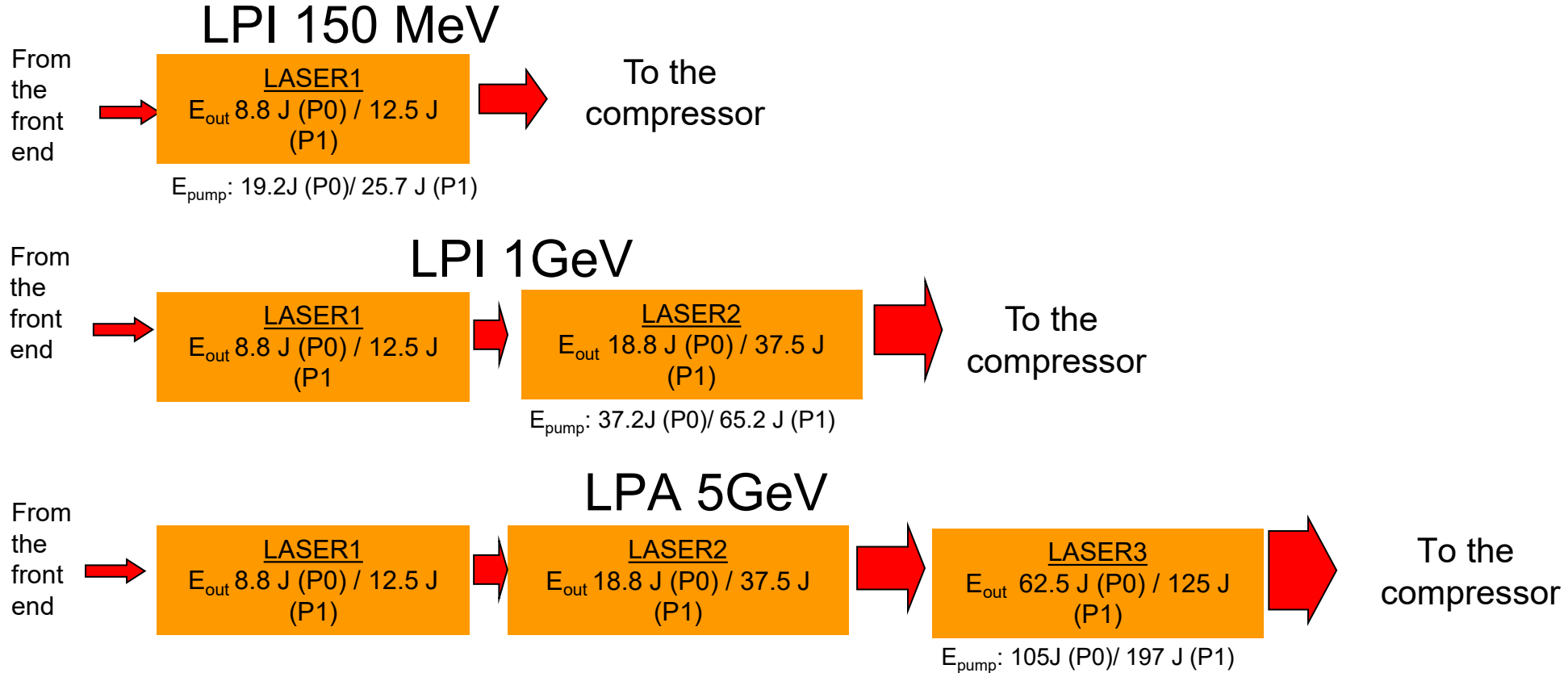
Milestones

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
25 	Definition of criteria for down-selection of core industrial tech for the laser design	WP12	2-CNR	Report	12
26 	Update of concepts for EuPRAXIA, systems status report (WP12)	WP12	2-CNR	Report	24
27	Design and project of transport beamlines focusing on the preservation of beam parameters	WP12	2-CNR	Report	30

- **Baseline: proven technology based on Ti:Sa technology, pumped by diode-pumped lasers**
 - Strong R&D effort in place (e.g HAPLS@ELI now entering into USER operation)
 - \approx 3-5 years to go to first industrial LWFA demonstrator [1]
- **Fully diode pumped with Direct Chirped Pulse Amplification** with lasing media pumped directly by diodes is ideal for higher efficiency and higher rep-rate;
 - several materials under consideration, Yb:CaF₂, Tm:YLF, Tm:Lu₂O₃ (Pisa) ...
 - Available ps kW thin disk lasers using plasma modulation (Oxford [2]) spectral broadening & post compression [3]
- **OPCPA** optical parametric amplification within large-aperture (LBO) crystals;
 - ELI-Beamlines facility, L2 DUHA (100 TW, 2 to 5 J between 20, 50, 100 Hz)

1. L.A Gizzi, F. Mathieu, P. Mason, P P Rajeev, *Laser drivers for Plasma Accelerators*, in Félicie Albert et al, *2020 roadmap on plasma accelerators*, 2021 New J. Phys. 23 031101, <https://doi.org/10.1088/1367-2630/abcc62>;
2. O. Jakobsson, S. M. Hooker and R. Walczak, PRL, 2021
3. A.L. Viotti et al., Optica 9, 197-216 (2022).

Foreseen I/O energy and pump requirements



Three main modules: LASER1, LASER2, LASER3

LASER1: stand-alone for LPI 150 MeV

LASER2: output stage for LPI 1 GeV, second stage for LPA 5 GeV

LASER3: high energy stage for LPA 5 GeV

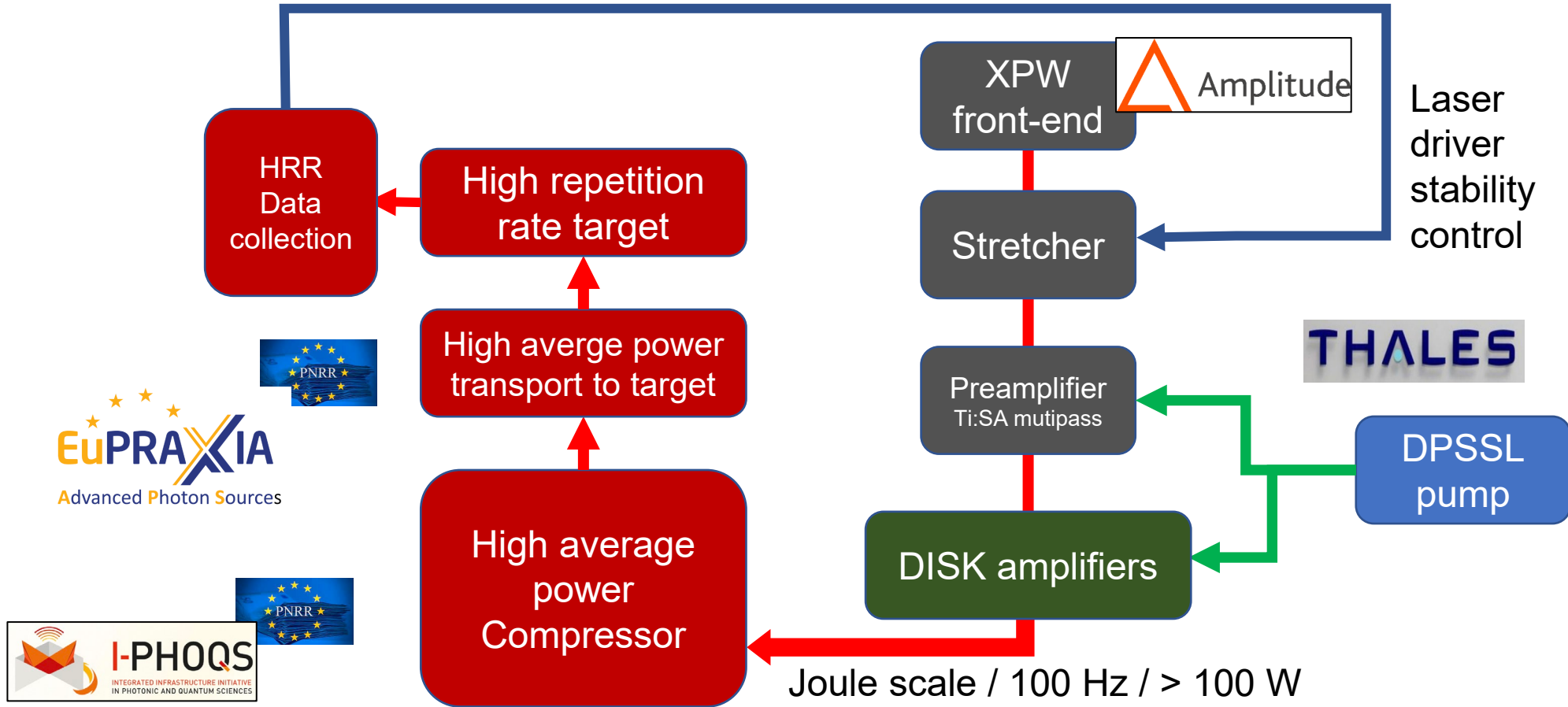
Two levels of performance : P0 and P1

Key development areas identified for the baseline EuPRAXIA laser driver configuration

<p>THERMAL MANAGEMENT OF POWER AMPLIFIERS</p>	<p>AMPLIFIER GEOMETRY TRANSMISSION VS. REFLECTION</p> <p><u>Multipass transmission</u></p>	<p>DPSSL PUMP SOURCES TECHNOLOGY</p>	<p>DIODE LASERS EFFICIENCY, BRIGHTNESS AND LIFETIME</p>	<p>COMPRESSOR AND TRANSPORT: THERMAL AND MECHANICAL</p> <p>Gold -> MD, MLD, MMLD</p> <p>reduction of the thermal load cooling of residual heat control of thermal effects</p>
<p>WATER/GAS COOLING</p> <p>Prototyping needed</p>	<p><u>Multipass reflection</u></p> <p>Prototyping needed</p>	<p>P-60 technology (Amplitude)</p> <p>Currently no solution for full system specs (P1): development</p>	<p>Needs development</p>	<p>Diode: Major Influences</p> <p>Pump removed, covers in place, drivers switched off Added heatsource covers Removed Amp300 cells</p> <p>Recording mode: ROI</p> <p>Main challenges: large optics, mechanical stability, beam quality control, pointing stability</p>

Partially funded by ongoing (EUAPS, IPHOQS) and new (PACRI) projects.

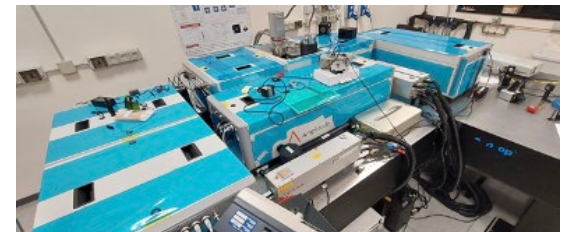
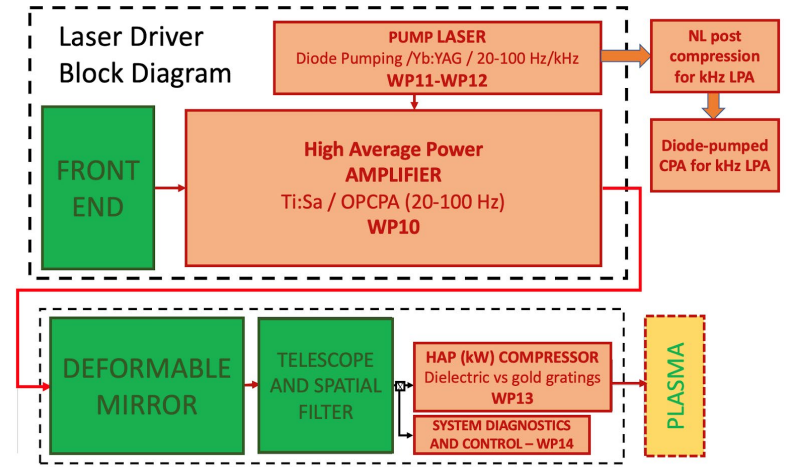
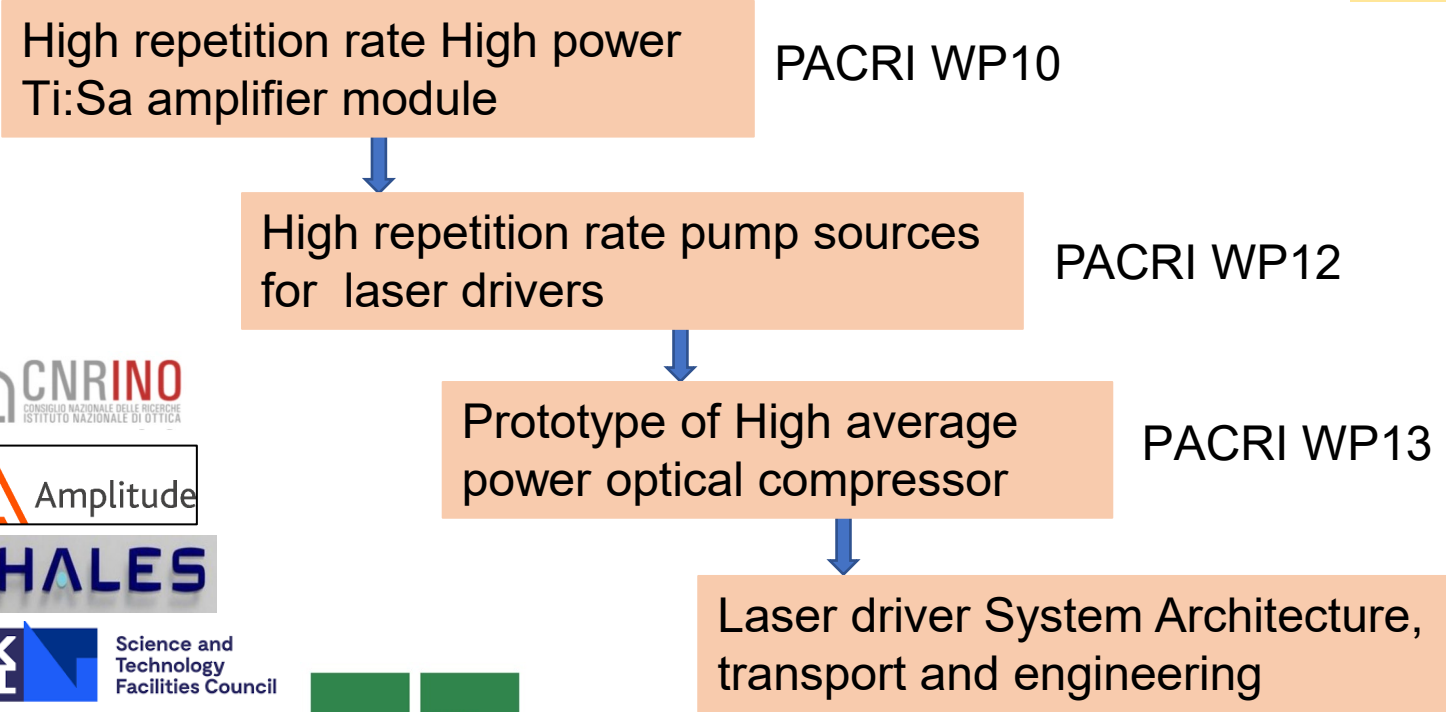
100 Hz operation at Joule level pulse energy is outstanding and a unique opportunity to address HAP issues



Procurement and preparation in progress

Scaleup of collaborative TDR development of EuPRAXIA Laser

EuPRAXIA laser driver (100 Hz) and longer term options (1 kHz)



PACRI WP11 Efficient kHz laser driver modules for plasma acceleration

Project PACRI to start on March 1st, 2025 PACRI Overview tomorrow by Gerardo D'Auria



Central Laser Facility



- **D12.1 Report on structures to be funded from national/bilateral/european level for laser technology (M12)** ✓
- **D12.2 Report on technical results achieved in the field of Lasers (M24)**
 - PACRI/EUAPS/IPHOQS preparation serving as knowledge base for this report
- **D12.3 TRL Report and maturity assessment on the development of Lasers (M42)**
 - Based on technical development -> PACRI + other initiatives

- **M25 Definition of criteria for down-selection of core industrial tech for the laser design (M12)** ✓
- **M26 Update of concepts for EuPRAXIA, systems status report (M24)**
 - Included in PACRI – cooperation with 2nd Site candidates and dedicated technical work
- **M27 Design and project of transport beamlines focusing on the preservation of beam parameters (M30)**
 - Included in PACRI – cooperation with 2nd Site candidates and dedicated technical work