EURONNAC Special Topics 18–24 Sep 2022, Hotel Hermitage, La Biodola Bay, Isola d'Elba, Ital

Special Topic S-ST3: Laser Technology and LPA Results (e-, p+, ion)

Conveners: Leonida Antonio GIZZI (CNR-INO also at INFN, Pisa) Stefan KARSCH (LMU, München)

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

IFAST

About I.FAST - Horizon 2020 (Research Innovation Action)

WP6: Novel particle accelerators concepts and technologies

Objectives

- Define a roadmap towards low-energy and high-energy physics applications
- Organise the biannual European Advanced Accelerator Concepts workshop (EAAC)
- Develop innovative targets for laser-plasma acceleration
- Demonstrate improved beam features with the new targets
- Develop a new passive system to improve beam-pointing stability
- Define solutions to stabilize beam profile in the focal spot and ensure a shot-to-shot stability of the Strehl ratio

Tasks

Task	Name	Task Leader
6.1	Novel Particle Accelerators Concepts and Technologies (NPACT)	R. Assmann (DESY)
6.2	Lasers for Plasma Acceleration (LASPLA)	L. Gizzi (CNR)
6.3	Multi-scale Innovative targets for laser-plasma accelerators	C. Thaury (CNRS)
6.4	Laser focal Spot Stabilization Systems (L3S)	F. Mathieu (CNRS)



https://ifast-project.eu/

Task 6.2 LASers for Plasma Acceleration

- CNR, CERN, INFN, CNRS, DESY,
- THALES and AMPLITUDE Technologies





Task 6.2: Objectives

- Establish a roadmap to foster delivery of advanced industrial laser drivers with high-repetition rate and higher efficiency, for the first user laser-plasma based accelerators.
- Establish a coordination activity with networking and training of main laser labs, focused on laser-driver R&D.
- MS22 LASPLA Workshop/School [M30] Report
- D6.2 : LASPLA Strategy [M46] Strategy for laser drivers for plasma accelerators



Scenario on intense lasers

- Current laser technology development mainly driven by extreme intensity applications;
- Laser-Plasma acceleration has developed along with progress in laser performance;
- Recent LWFA-FEL demonstration [*] highlights the role of laser stability and control;
- LASPLA will focus on the technology required to achieve high-repetition rate at multi-joule (≈100 TW) scale [**], with high quality and enhanced control and stability;
- Key role of industry to establish turn-key, high average/peak power ultrashort pulse technology;

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*W. Wang, K.Feng et al., Free-electron lasing at 27 nanometres based on a laser wakefield accelerator, <u>Nature</u> **595**, 516–520 (2021) **L.A. Gizzi et al., A viable laser driver for a user plasma accelerator, NIM **A 909**, 58 (2018); <u>https://doi.org/10.1063/1.4984906</u>

Currently explored R&D paths for future LPA



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I.FAST WORKSHOP 2022 LASER DRIVERS FOR PLASMA ACCELERATORS



Ècole Polytechnique, Palaiseau, Paris (FR), 20-22 April 2022

PARTICIPANT LIST REGISTRATION HOMEPAGE

LASER DRIVERS FOR PLASMA ACCELERATORS

IFAST (ifast-project.eu), funded through the EU's Horizon Europe 2020 Research & Innovation Programme is pursuing innovation in all accelerator technology through a comprehensive science programme and a large network of leading institutions. The IFAST project features a workpackage on Novel Particle Accelerators Concepts and Technologies (led by R. Assmann) including coordinated action towards the development of LASER DRIVERS and innovative TARGETS for plasma accelerators to drive the development of novel accelerators with specifications driven by user application and meeting industry standards.

The iFAST meeting on "LASER DRIVERS FOR PLASMA ACCELERATORS" will be held on April 20-23, 2022 in Palaiseau, Paris (FR). The workshop follows the the technical meetings of the LASer drivers for PLasma Acceleration (LASPLA) task of the iFAST (Innovation Fostering in Accelerator Science and Technology) held recently and providing a unique platform for discussion in this rapidly evolving area of research and development. Here the idea is to to drive the development of lasers with specifications driven by USER applications of high power and intense lasers for laser-plasma accelerators and other relevant user areas. This will require the development of systems which operate at very high repetition rates (100 Hz, kHz and beyond).

This workshop will contribute to the main objectives in this area, including:

Establish a roadmap to foster delivery of advanced industrial laser drivers with high-repetition rate and higher efficiency;
Highlight laser requirements for user plasma-based accelerators and other key high power, high intensity laser applications;
Promote a coordination activity with networking and training of main laser labs and industry, focused on laser-driver R&D.

The meeting will be chaired by **Gerard MOUROU** and co-chaired by **Leonida A. GIZZI** and **Francois MATHIEU** and will be jointly organised by CNR, CNRS, Amplitude, Thales and Trumpf.

The workshop will deliver an overview on novel architectures, concepts and materials for ultra-short pulse laser amplification that are likely to become drivers for the first generation of user laser plasma accelerators like the EuPRAXIA Research Infrastructure that was recently included in the Roadmap 2021 of the European Strategy Forum of Research Infrastructures <u>EuPRAXIA</u>. Participation is foreseen by representative from key laser and laser-plasma research Institutions and leading industries in the field. INVITED SPEAKERS will report on the latest progress at their respective laboratories and companies in all relevant areas including:

Chair

Gérard MOUROU

Co-chairs

- s
- Leonida A. GIZZI (CNR)
- François MATHIEU (CNRS)

Organizing Committee

- Franck FALCOZ (Amplitude)
- Leonida A. GIZZI (CNR)
- Luca LABATE (CNR)
- François MATHIEU (CNRS)
- Daniele PALLA (CNR)
- Christophe SIMON-BOISSON (Thales)

Scientific Secretariat

- Leonida A. GIZZI (CNR)
- François MATHIEU (CNRS)

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This week: Laser Technology and LPA

	Sept. Monday 19	Sept. Tuesday 20	Sept. Wednesday 21	Sept. Thursday 22	Sept. Friday 23	Sept. Saturday 24
Morning I 9:00 – 10:30	S-IN (RA&MF) News from field - 1 short talk per ST	S-ST1-b (EG&PM) Beam driven Plasma Accelerators with focus on proton- driven	S-ST3-b (LG&SK) Laser Technology and LWFA Results	S-ST4-b (EC&RP) Distributed Plasma Accelerator Landscape in Europe and Technical Progress towards Applications	S-ST5 (PM&CG&MH&MK &WL) International Landscape: Facilities, projects, initiatives	NPACT / EuroNNAc Yearly Meeting (RA&MF)
Coffee Break (20')						
Morning II 10:50 –12:30	S-IN (RA&MF) News from field - 1 short talk per ST	S-ST2 (MT&JV) Simulation tools and roadmap,	S-ST3-b (LG&SK) Laser Technology and LWFA Results	S-ST4-b (EC&RP) Special sub-session (JO&al) Particle physics plasma test facility	S-ST5 (PM&CG&MH&MK &WL) International Landscape: Facilities, projects, initiatives	NPACT / EuroNNAc Yearly Meeting (RA&MF)
Lunch Break (3h30')						
Afternoon I 16:00 –17:30	S-ST1-a (EG&PM) Beam driven Plasma Accelerators with focus on proton-driven	S-ST3-a (LG&SK) Laser Technology and LWFA Results	S-ST4-a (EC&RP) Distributed Plasma Acc. Landscape in Europe and Technical Progress towards Appl.	S-SP (BH&RW) Student Talks - Prize Award Session	S-ST6 (RI&al) Structure-based accelerators and advanced radiation generation schemes	
Coffee Break (20')						
Afternoon II 17:50– 19:15	S-ST1-a: (EG&PM) Beam driven Plasma Accelerators with focus on proton-driven	S-ST3-a (LG&SK) Laser Technology and LWFA Results	Special sub-session (AI&al) Talks and discussion on plasma-based FEL exp.	S-SP: (BH&RW) Student Talks - Prize Award Session	S-SU (RA&MF) Summary Report from discussions - input to IFAST/NPACT MS21	
Posters	Participants and	Participants and	Participants and			
19:15 - 20:15 Dinner 20:20	student grantees	student grantees	student grantees	RANOUET		
Dinner 20:30				BANQUET		

Main topics for Laser Technology and LPA

Novel results and repetitive operation of LPA with quality and stability

- Demonstration of multiple hours of continuous, stable operation
- Novel LPA concepts for exploitation of industrial grade existing lasers
- Controlled injection
- Plasma targets

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- High spatial and temporal resolution Wakefield diagnostics
- Few cycle proton acceleration

Major cases towards industrial and medical applications

- Preclinical in vivo tumor studies with laser-driven protons
- VHEE towards FLASH radiotherapy
- Applications with X-rays and neutron for industry, energy and medicine

Laser developments addressing high repetition rate and high efficiency

- High average power development taking place at industrial partners
- New development platforms for DPSSL
- Fiber lasers with coherent combination
- Thin disk amplifiers and NL Pulse Compression
- Perspective of OPCPA developments
- New high-repetition rate facilities for LPA

Speakers - Laser Technology and LPA – Tue 20/09

16:00	Stability of ionization-injection-based laser-plasma accelerators	Simon Bohlen			
	Sala Maria Luisa - Hotel Hermitage	16:00 - 16:20			
	High-Resolution Diagnostics for Laser Wakefield Accelerators – a Tool for Detailed Insights into the Interaction Malte Kaluza				
	GeV-scale accelerators driven by plasma-modulated pulses from kilohertz lasers.	Roman Walczak			
	Sala Maria Luisa - Hotel Hermitage	16:40 - 17:00			
17:00	Carrier-envelope phase control of a kilohertz laser-wakefield accelerator	Lucas Rovige 🥝			
	Sala Maria Luisa - Hotel Hermitage	17:00 - 17:20			
	Laser-plasma acceleration for tomography and radiotherapy	Olle Lundh			
	Sala Maria Luisa - Hotel Hermitage	17:20 - 17:40			
	Coffee Break				
	Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy	17:40 - 18:00			
18:00	Establishing Laser Accelerated Proton Beam Performance for Dose Controlled Irradiation Studies and Beyond Ulrich Schramm				
	Enhancing the proton cutoff energy in Target Normal Sheath Acceleration via an improved laser-to-electron coupling in Elisabetta Boella				
	Beam driven wakefield characteristics probed by femtosecond-scale shadowgraphy	Susanne Schoebel			
	Sala Maria Luisa - Hotel Hermitage	18:40 - 19:00			
19:00	Development and characterization of Plasma Targets for LWFA experiments at SPARC_LAB	Gemma Costa			
	Sala Maria Luisa - Hotel Hermitage	19:00 - 19:20			



Speakers - Laser Technology and LPA – Wed 21/09

09:00	External injections of electrons into a laser-driven plasma wakefield at CLARA	Dr Laura Corner
	Sala Maria Luisa - Hotel Hermitage	09:00 - 09:20
	Coherent combination of fiber lasers towards drivers for future wakefield accelerators	Prof. Jens Limpert
	Sala Maria Luisa - Hotel Hermitage	09:20 - 09:40
	Thin-Disk Amplifiers and Nonlinear Pulse Compression	Dr Tom Metzger
	Sala Maria Luisa - Hotel Hermitage	09:40 - 10:00
10:00	Proton and deuteron acceleration with few-cycle, relativistic intensity laser pulses	Karoly Osvay
	Sala Maria Luisa - Hotel Hermitage	10:00 - 10:20
	Roadmap at Amplitude for high average power PW system	Franck Falcoz
	Sala Maria Luisa - Hotel Hermitage	10:20 - 10:40
	Coffee Break	
	Hotel Hermitage, La Biodola Bay, Isola d'Elba, Italy	10:40 - 11:00
11:00	Latest developments of high repetition rate TiSa lasers for laser plasma accelerators	Mr Christophe SIMON-BOISSON
	Sala Maria Luisa - Hotel Hermitage	11:00 - 11:20
	Khz rep-rate, kW average power class laser development with Tm-based ceramics	Dr Luca Labate
	Sala Maria Luisa - Hotel Hermitage	11:20 - 11:40
	OPCPA as an amplifier technology for high repetition rate 100 TW-class lasers	Tyler Green
	Sala Maria Luisa - Hotel Hermitage	11:40 - 12:00
12:00	KALDERA	Andreas Maier
	Sala Maria Luisa - Hotel Hermitage	12:00 - 12:20
	Discussion	
	Sala Maria Luisa - Hotel Hermitage	12:20 - 12:30



WORD CLOUD of CONTRIBUTION TITLES

accelerators advanced applications awake beams bunch cern codes compact control current demonstrated density development drive driven driver **electron** energy experiment facility fields generation gev intense aSer laserplasma Ipa Iwfa model particle physics plasma plasma-based power present proton pulses pwfa rate recent repetition required simulations sources stability stage study technology wakefield



Laser Technology and LPA Results

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Leonida (Leo) A. GIZZI, la.gizzi@ino.cnr.it Stefan KARSCH, stefan.karsch@physik.uni-muenchen.de