

The Laser Induced Fusion program

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ELI-ERIC LIF kick-off meeting

28-29 November 2023

ELI ERIC Seat/Beamlines, Dolní Břežany





A new world landscape

- The **world landscape has changed** in the recent years and “fusion” could be a realistic possibility as an “abundant, safe and sustainable energy”.
- **ELI has been solicited** by several key actors of fusion community, ELI can offer technical capability and expertise of interest.
- **A new potential user demand** in technical developments and scientific topics related to laser fusion



How the European landscape has changed

- Europe is facing an energy crisis
- NIF breakthrough demonstrated that **Laser-fusion is possible** and imply **renewed interest** in laser plasma physics and applications
- Exponential increase of start-up** companies dedicated to laser fusion energy
- Recent **reports on positions and initiatives**: (BRN USA, UK Roadmap, German Memorandum and HiPER+ Roadmap)
- EUROfusion** keep in touch activities (two projects funded: Magnetised Plasma, low density Foams)
- EURATOM** is preparing a call for advanced fusion schemes including ICF
- LASERLAB** establish an Expert group on ICF



ELI is being solicited for input by a number of key actors

- **ELI facilities** are already involved in collaborations in the fusion domain
 - **ELI beamlines** is commissioning LPI diagnostics with the L4n system with Focus Energy
 - **ELI NP collaborates** with Thales, Marvel Fusion and Siemens Energy
 - **ELI collaborates** with several EU actors within IMPULSE project for laser-plasma diagnostics and targetry at HRR
- **ELI is mentioned** as a potential player for USA collaboration in the **FESAC** document (Report on International Collaboration Opportunities)
- **ELI is involved** in the **THRILL** project on high-energy high-repetition-rate lasers.
- The **German Government** and **ELI launched an initiative on Laser Induced Fusion**



ELI ERIC German LIF project goals

- **Bring together** key actors - in particular among the German industry and academia (Kick-off meeting Nov 28-29)
- **Explore** the role ELI could play in the wider LIF landscape
- **Plan and prepare a dedicated mission-oriented** programme at ELI ERIC laser facilities in the domain of laser fusion energy
- **Help industrial actors** to achieve higher levels of solution readiness level (SRL)
- **Prepare EU position** in laser fusion energy

A vertical poster with a dark blue background and a bright blue laser beam effect on the left side. The ELI logo is at the top right. The text is in white and orange. A QR code is at the bottom right.

 **eli**

**ELI Laser-Induced Fusion
Kick-off Meeting**

28-29 November 2023,
**The Extreme Light Infrastructure ERIC
Za Radnicí 835, Dolní Břežany, CZ**

The Extreme Light Infrastructure ERIC (ELI) launched an initiative in Laser-Induced Fusion (LIF) supported by the German Ministry of Education and Research.

A dedicated workshop bringing together relevant stakeholders from academia and industry will facilitate discussion on recent developments, identify common strategies, and explore the role ELI could play in enabling the development of methods or technologies in the field. This initiative is a first step to ultimately contributing to practical ways to generate laser-based clean energy.

The workshop will be divided in two sessions:

Day 1 Overview of the worldwide laser-fusion landscape.

Day 2 The role of ELI in contributing to methods and technology relevant to LIF in collaboration with key German actors and other potential partners.

More information:
<https://indico.eli-laser.eu/e/LIF2023>

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What are the challenges and needs of the laser fusion community?

Challenges in laser fusion:

1. Demonstration of direct drive high gain ignition
2. Study alternative schemes
3. Demonstrating science at target and diagnostic high repetition rate operation
4. Assessing material resistance to fast pulsed neutrons

Some example of scientific needs in laser fusion:

- laser plasma Instabilities for direct drive
 - Target injection at High Repetition Rate
 - Fast pulsed neutron physics
 - Laser plasma diagnostics
 - Laser conversion efficiency (diode pumped lasers)



Potential areas of relevant technical strength and expertise at ELI

- **Low density foams** target laboratory for HRR and laser plasma instabilities mitigation (i.e. foams) experience at ELI-NP; needs for ELI Beamlines for increasing the number of experiments focused on laser fusion
- **Laser plasma diagnostics** (example ELI Beamlines/Focus Energy) diagnostic tools are extremely important and can be developed in parallel at ELI.
- **Laser broad band** development to mitigate laser plasma instabilities (CHINA and USA are already working on this)
- **Laser-driven beams** (protons, electrons, X-rays) for diagnostics, fast neutron generation and fast ignition.
- **Ultra-fast extreme state of matter** to study high energy density, warm dense matter, Ion stopping power and fast X-ray absorption spectroscopy.



Structure of the kick-off meeting

1. State of the art (day 1)
2. ELI presentations (day 2)
3. Round table discussion (day 2)



Structure of the meeting

State of the Art (day 1)

13:00 – 16:00	Section II. / The laser-fusion landscape: Fusion Energy projects Worldwide	
<p>A section dedicated to a first introduction to the status of the European countries and institutions that can be relevant for the future of the LIF in the EU. Moderator: Luca Volpe</p>		
13:00	The German Roadmap on IFE state of the art and prospective	Constantin Häfner Fraunhofer ILT
13:25	Fusion-related laser plasma expertise and interests in the German Helmholtz Association	Ulrich Schramm Helmholtz Zentrum Dresden-Rossendorf
13:50	US program on laser-driven fusion (including indirect and direct drive schemes) after the NIF ignition shots (what next?)	Riccardo Betti University of Rochester
14:15	The recommendations of the US FESAC report	Tammy Ma Lawrence Livermore National Laboratory
14:40 – 15:00	Coffee Break	
15:00	Update on European Fusion Program by EURATOM (online)	Fabio Belloni Fusion European Commission Directorate-General for Research & Innovation (online)
15:25	80 beams, 270 kJ ICF implosions on LMJ-PETAL	Alexis Casner CEA DAM
15:50	The European laser fusion community	Dimitri Batani University of Bordeaux, CELIA



Structure of the meeting

ELI-presentations (day 1)

16:45 - 18:30	Section III. / Possible LIF-related Research, Experiments, and Technological Developments at the ELI Facilities and Industrial Commitment	
<p>A section dedicated to clarifying the role of Industries in a future power plan for the construction of a laser-fusion reactor. Special focus on the German industries. Moderator: Federico Canova</p>		
16:45 – 17:15	Introduction to ELI commitment to technological development	Federico Canova ELI ERIC
17:15 – 17:40	Introduction to ELI Nuclear Physics Facility	Daniel Ursescu ELI NP
17:40 – 18:05	Introduction to ELI Beamlines Facility	Daniele Margarone ELI Beamlines
18:05 – 18:30	Introduction to ELI ALPS Facility	Subhendu Kahaly ELI ALPS
19:00	Bus to Prague city centre	
20:00	For Invited Participants Dinner	



Structure of the meeting

Round tables (day 2)

Time	Agenda Item	Speaker
8:45– 09:00	Welcome and Introduction to the Round Table Programme Luca Volpe	
9:00 – 10:30	Parallel Section I Laser-plasma Physics Inertial Fusion and Applications	
	Round table 1 Laser-driven particles and Inertial Confinement Fusion (Conference Hall) Round table 2 ICF related physics such as Extreme state of matter (Dark Room)	
10:30 – 11:00	Coffee Break	
11:00 – 12:30	Parallel Section II Laser Technology and Targetry	
	Round table 3 Laser technology development for laser fusion (Conference Hall) Round table 4 Targetry technology for laser matter interaction optimization (Dark Room)	
12:30 – 13:30	Buffet Lunch	
13:30 - 14:30	Final joint section with open discussion and concluding remarks	
14:30 – 15:30/16:00	ELI Beamlines Facility Tours (GROUP B)	



Goals for the Round tables

- Discuss the main scientific and technical challenges within the laser fusion community.
- highlight the possible role of ELI in meeting such challenges by considering the needs and the implication of the German scientific community and industries in such activities as well as identifying in which areas they can be engaged in.
- Four round tables these are:
 1. Laser-driven particles and Inertial Confinement Fusion
 2. ICF related physics, including extreme states of matter.
 3. Laser technology development for laser fusion
 4. Targetry technology for laser matter interaction optimization



RT key participants, include:

- specialists from Germany,
- Specialist from ELI,
- Specialists form relevant EU institutions
- Representatives of the industrial sector.

These subject areas can provide a focus to explore the ***intersection between laser fusion needs, ELI capability and German activities***, particularly where it is strong or has the potential to be strong.



- The round tables will be organised in **two parallel sessions** and followed by a final join section, allowing this wide range of subjects to be discussed in some depth.
- Each section will be coordinated by two selected chairs supported by one rapporteur which main task is to collect conclusions of each round table and then reporting in the final join session.
- The final join section will be formed by the 8 chairs (2 for each of the round table) plus the 4 reporters to form the primary basis of a report.
- The report should address the following questions for each of the key scientific and technical areas discussed, in general and in relation to the areas of greatest activity and strength in Germany:
 - What are the specific scientific and technical challenges in this area?
 - What are ELIs particular strengths in helping to address such challenges?
 - What actions could ELI take to best exploit or develop such strengths and be a more effective actor in this area?
 - How can ELI facilitate the co-development between academy, laboratories and industry to face key technical challenges.



Round Table 1

Laser-driven particles and Inertial Confinement Fusion

Chairs: Matt Zepf, Daniele Margarone and Florian Condamine

Reporters: Lorenzo Giuffrida and Domenico Doria

Participants: Vladimir Tikhonchuk, Robbie Scott

Round Table 2

ICF related physics, including extreme states of matter

Chairs: Thomas Kuehl and Subhendu Kahaly

Reporters: Daniel Papp

Participants: Joao Santos, Garret Williams, Dominik Kraus, Jean Claude Kieffer, Christos Kamperidis.



Round Table 3

Laser technology development for laser fusion

Chairs: Vincent Bagnoud, Bedrich Rus and Federico Canova

Reporters: Pavel Bakule

Contributors: Leo Gizzi

Round Table 4

Laser-driven particles and Inertial Confinement Fusion

Chairs: Rüdiger Quay and Victor Leca

Reporters: Florian Condamine

Contributors: J. Joao Santos, Cristina Gheorghiu, Fabrizio Consoli, Mario Manuel, Lorenzo Giuffrida

Thanks for the attention

It is by seeking the impossible that man has always achieved the possible.

Those who have wisely limited themselves to what appeared to them as possible have never advanced a single step.

(Michael Bakunin 1814-1876)



1818 Caspar David Friedrich - Wanderer above the sea of fog