Institute of Physics ASCR, v. v. i., Na Slovance 2, 182 21 Praha 8
info@eli-beams.eu | www.eli-beams.eu

CALL FOR PROPOSALS

USER-ASSISTED COMMISSIONING of the ELIMAIA Ion Beam Transport section at high repetition-rate

The ELI Beamlines user facility invites the scientific community to submit proposals for commissioning the ELIMAIA (ELI Multidisciplinary Applications of laser-Ion Acceleration) Ion Beam Transport section in its E4 Experimental Hall that will offer future open-access experiments on laser-plasma ion acceleration and applications in radiobiology, chemistry, material science, archaeology, nuclear physics, etc.
We invite specially qualified users to perform early experiments aimed at enhancing the performances of the accelerated proton beam for an efficient injection into the Ion Beam Transport section at high repetition-rate.
The commissioning experiment are expected to place between November 2022 and February 2023. Beam-time allocation and timing will be at the discretion of ELI-Beamlines.

The aim of the call is to

1) Perform user-assisted commissioning experiments, using the capabilities already in operation at the Ion Accelerator section of the ELIMAIA beamline in the E4 experimental hall.
2) Carry out the basic commissioning the Ion Beam Transport (ELIMED) section of the ELIMAIA facility with enhanced performances of the accelerated proton beam at high repetition-rate.
3) Increase the future value of experimental capabilities of the ELIMAIA-ELIMED beamline for the user community by ensuring that the final development and commissioning steps are completed in collaboration with leading international experts.
4) Train ELI Beamlines scientific staff, user office personnel, and support teams together with expert users in the interactions necessary for efficient user operations.

Instruments available for user-assisted commissioning experiments at ELIMAIA

1) L3-HAPLS laser beam: 12J/30fs/0.5Hz (and single shot capability) focused down to 2-3μm (FWHM), including shot-to-shot, full-energy, full-size laser beam characterization at the ELIMAIA beamline (local laser diagnostics station)
2) Large vacuum chamber for laser-target interaction (bread board surface 3.7mx2m, ~8m^3 volume, min pressure ~1x10^{-6} mbar).
3) Target tower for foil-target positioning (5-20 μm) and operation up to 1Hz (900 consecutive shots).
4) Ion (TP, TOF, RCF, CR39) and plasma (XUV, gamma-ray, electron) diagnostics.
5) Online data acquisition and analysis tools operating at high repetition-rate (up to 1 Hz).
6) Ion beam transport section (ELIMED) equipped with magnets for beam handling and selection

A street-view style overview of the hall and inside of the chamber can accessed here: https://my.matterport.com/show/?m=fyEZSuFtWVW
Applicants must be aware that ELI Beamlines will be in a "ramp-up mode" during the time of the commissioning experiments and this may affect the performance and availability of the individual instruments.
An overview of the ELIMAIA beamline technical equipment is available here [1, 2] and recent results from the ELIMAIA Ion Accelerator technical commissioning are available here [3].

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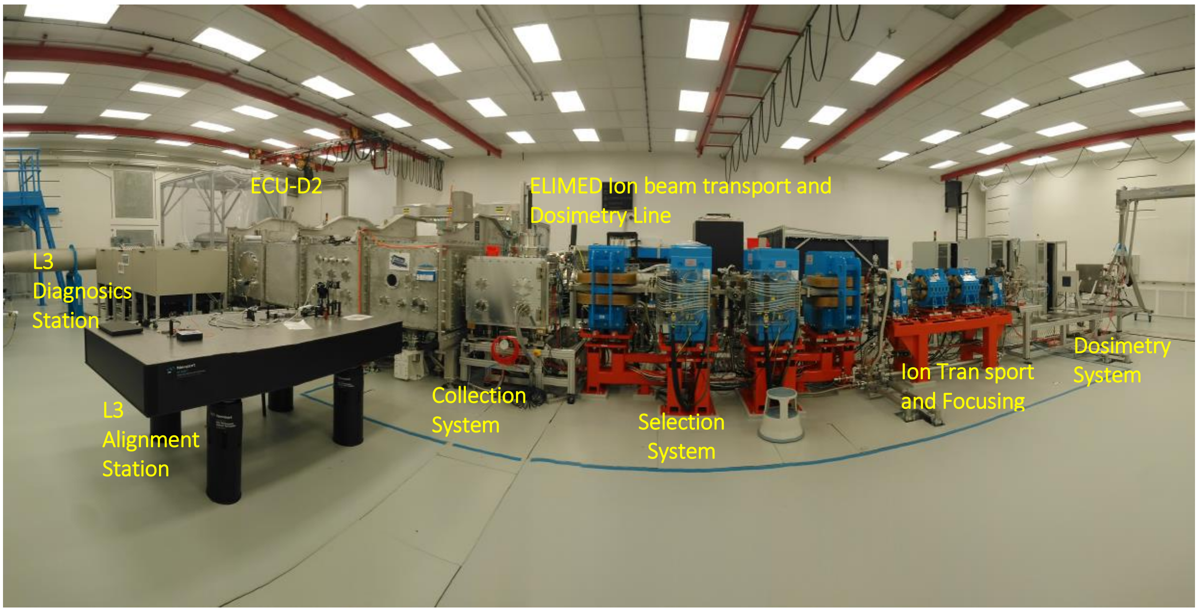

Photo of the ELIMAIA beamline in E4. The main sections of the ELIMAIA beamline (Ion Accelerator and ELIMED) consist of different subsystems: (i) acceleration, collection and diagnostics; (ii) selection, transport and diagnostics; (iii) dosimetry and sample irradiation.

Deadline for applications

The deadline for submission of the proposal is 5.11.2022. Expected time from submission to decision is up to 3 weeks.

Application procedure and admittance

On-line application forms are generated from the instrument pages. The user will be asked to structure the proposal according to the basic section below:

i. detailed scientific description of the project
ii. technical requirements (laser, diagnostics, etc.)
iii. information about the applicant team expertise in the field

The proposal should be around 3 pages long.

All applications will be processed by the user administration at ELI Beamlines user.office@eli-beams.eu. Submitted proposals will go through a feasibility assessment headed by the lead scientist of the ELIMAIA beamline and be selected or rejected based on an evaluation against the aims of the call stated above and the feasibility of the proposed experiments. Experiments will be scheduled or rejected on the basis of scientific merit in relation to the aims of the call, technical feasibility, and safety assessment. Results will be communicated to the applicants by the user office of ELI Beamlines.

The lead scientist of the ELIMAIA beamline will assign one suitable researcher of the ELI Beamlines' team to be the local Person Of Contact (PoC) for the experiment. The ELI PoC will automatically become a co-proposer (local PI) of the commissioning experiment. The PoC will be responsible for communications with the users before, during, and after the experiment, including aspects related to bringing user equipment to ELI Beamlines. Beam time of about 4 weeks will be allocated (see below for more details) with approximately 8 hours of user beamtime per day.

Before gaining access to the premises of ELI Beamlines, users must complete relevant trainings (e.g. general safety, laser safety training). This will be provided by the ELI Beamlines safety team either as on-line training or on-site training as appropriate. A list all relevant safety trainings can be found here.

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Useful general information about the ELI Beamlines facility can be found in the ELI Beamlines User-guide.

Relevant information for Applicants

The applicants are encouraged to be familiar with the Data Policy and the User Publication Policy.

User-owned equipment can be included in the experimental. The user shall be familiar and follow the Instructions for bringing user equipment.

Other relevant information can be found in the document Application procedure and admittance.

References

[1] D. Margarone et al., “ELIMAIA: A Laser-Driven Ion Accelerator for Multidisciplinary Applications”, Quantum Beam Science 2 (2018) 8

[2] G.A.P. Cirrone et al., “ELIMED-ELIMAIA: The First Open User Irradiation Beamline for Laser-Plasma-Accelerated Ion Beams”, Frontiers in Physics 8 (2020) 564907

[3] F. Schillaci et al., “The ELIMAIA Laser-Plasma Ion Accelerator: Technological Commissioning and Perspectives”, Quantum Beam Science (accepted)

Basic commissioning of the Ion Beam Transport section of the ELIMAIA beamline

For the ELIMAIA user programme on ion acceleration and its multidisciplinary applications, we are presently seeking users to work with us during the basic commissioning of the Ion Beam Transport section with the main goal of demonstrating the ELIMAIA beamline performances for a broader user community. The goal of the basic commissioning of the Ion Beam Transport Section consists in the stable generation of high energy protons (20-30 MeV) at relatively high repetition rate (1 Hz) and to optimize their beam transport efficiency according to the following steps:

i. Proton source characterization and optimization
Time frame: 1 week (lead by the users)

ii. Proton beam collimation and injection into the energy selection system
Time frame: 1 week (lead by the ELI team)

iii. Proton beam energy selection (controllable energy spread) and quality demonstration (final beam handling) in vacuum (commissioning of the beamline in-Air Dosimetry section is not envisioned)
Time frame: 1 week (lead by the ELI team)

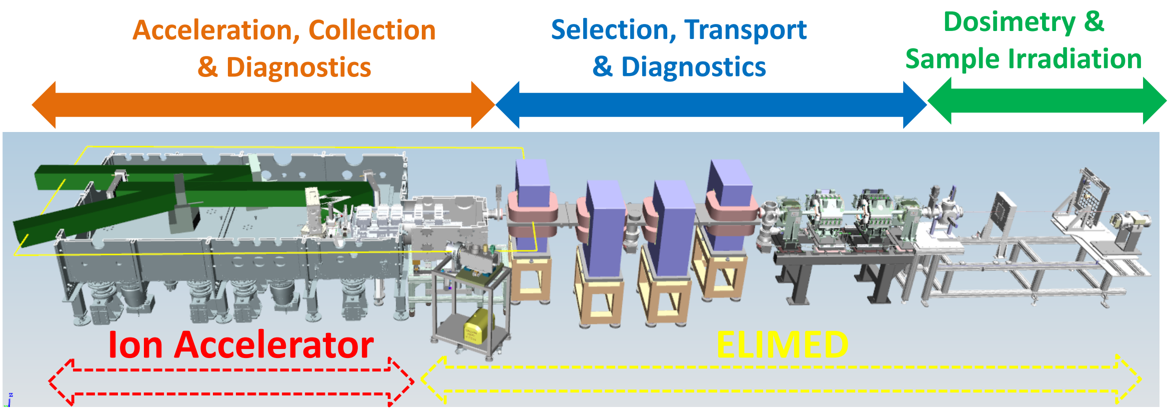
iv. High repetition-rate (0.5 Hz) test of the Ion Beam Transport section using innovative target delivery systems
Time frame: 1 week (lead by the users)

Contact persons: Lorenzo Giuffrida, email: *lorenzo.giuffrida@eli-beams.eu*
Francesco Schillaci, email: *francesco.schillaci@eli-beams.eu*

In case you are interested in working with us through the ELIMAIA Ion Beam Transport basic commissioning in the E4 experimental hall of ELI Beamlines, please fill in the user contact form following the link below:
Application form

Brief description of the available ELIMAIA set up

The ELIMAIA (*ELI Multidisciplinary Applications of laser-Ion Acceleration*) beamline is a modular experimental platform (L3 laser shot-to-shot diagnosis; laser-plasma interaction and monitoring; ion source generation, characterization, and optimization; ion beam transport and treatment; online dosimetry and in-air sample irradiation end-station) available for users to apply laser-driven ion beams in multidisciplinary fields. The ELIMAIA expert user community aims at taking advantage from innovative features offered by high-power laser driven ion beams, such as ultrashort bunch duration (0.1-10 ns) and ultrahigh dose rate (10^7-10^9 Gy/s) at the user sample. ELIMAIA is a fully open-access user beamline aiming at providing reliable and well-characterized (shot-to-shot) ion bunches for systematic studies in various disciplines (Physics, Biology, Medicine, Chemistry, Archaeology, etc.)



3D model of the ELIMAIA beamline

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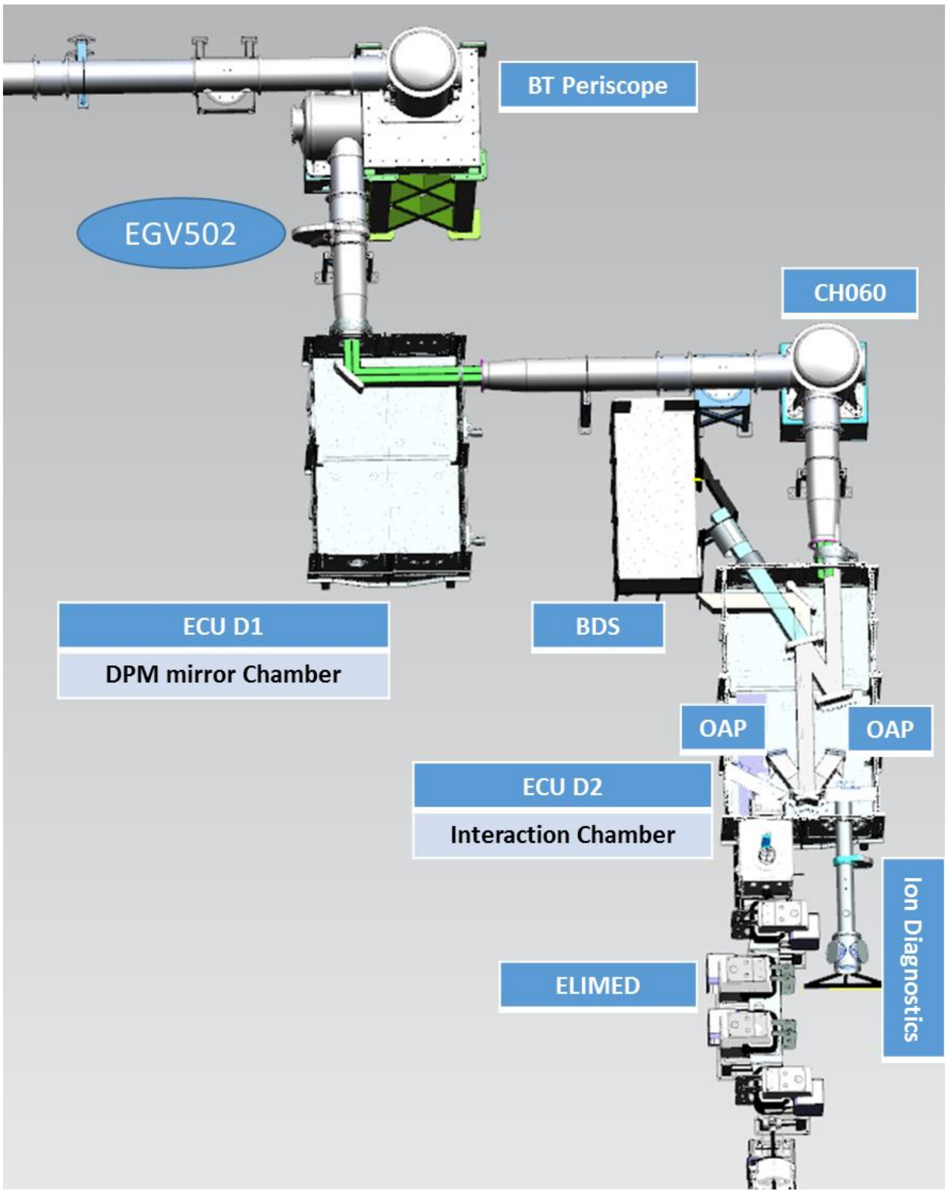

3D simplified model of the main ELIMAIA Beamline sub-systems

The local vacuum system of the ELIMAIA accelerator consists of two large vacuum chambers: ECU (Experimental Chamber Unit) D1 and D2. The ECUs technical design allows for an extensive flexibility towards future upgrades requiring an increase of the vacuum volume (modular solution), ultrahigh stability of the optical setup (de-coupled breadboards) and, at the same time, easy access and use of the entire space inside the chamber (the aluminium panels are fully demountable). The interaction chamber has a volume of ~8 m^3 and can reach a pressure level of ~10^{-5} mbar in ~40 min. The Ion Beam Transport section consists of a small vacuum chamber in the middle of the ion energy selection electromagnetic system and a long vacuum tube, thus the small vacuum volume can be pumped in/out in few minutes.

The first sub-system of the ELIMAIA beamline is the “Ion Accelerator”, which consists of the following devices:

1) *Laser Beam Diagnostics Station (BDS)*
The L3 propagates through the long (~80 m) laser beam transport line up to the local ELIMAIA vacuum system by entering the ECU-D1 chamber and then continues its propagation through a small turning chamber to be finally delivered into the Interaction Chamber (ECU-D2). A laser leak from one of the

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mirrors in ECU-D2 is extracted in air and sent into the laser diagnostic station (BDS), for shot-to-shot characterization of the L3 laser at full power (far/near field and laser ASE/pre-pulses).

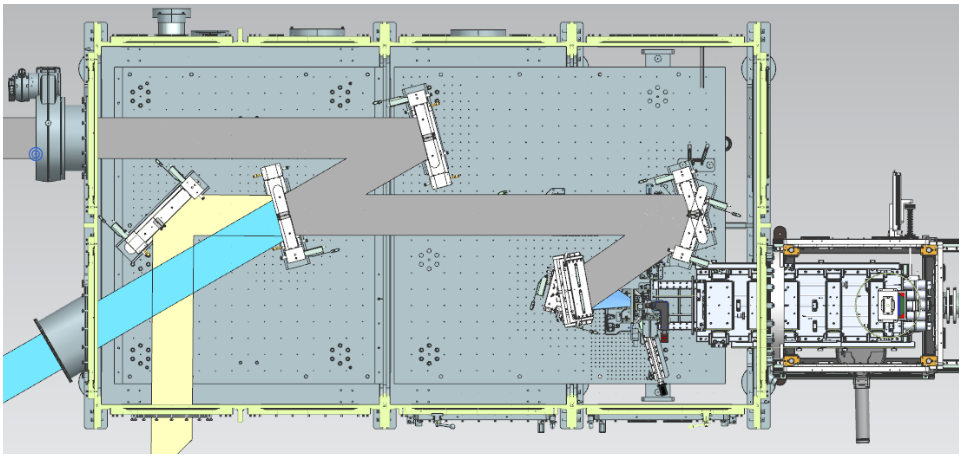
2) *Interaction Chamber (ECU-D2) setup*
In the interaction chamber, a set of flat mirrors and an off-axis-parabola (OAP) are available to transport and focus the L3 laser beam down to a few micrometres on target; a target delivery system (fully automated target tower) along with its alignment/monitoring system is used for accommodating foil targets of various thickness and geometry depending on the user requirements. The target tower allows for up to 900 consecutive shots, on 9 different target materials/thicknesses, with a max repetition rate of 1 Hz. The main proton/ion beam produced at the laser-target interaction point propagates downstream (see scheme below) towards the Ion Diagnostic systems, which consists of a Thomson Parabola Spectrometer (TPS), Time-Of-Flight (TOF) diagnostics based on SiC, Diamond, and Faraday Cup detectors for an on-line provided to the users at high repetition-rate (1 Hz), including the data acquisition and analysis. Passive detectors (radio-chromic films and CR39 solid state detectors) are also available. A scheme of the ECU-D2 interaction chamber is shown below.

3) *Laser and plasma diagnostics*
The IC ECU-D2 is also equipped with Plasma Imaging and Plasma Spectroscopy systems, along with scintillator-based detectors for X-ray and gamma-ray characterization.

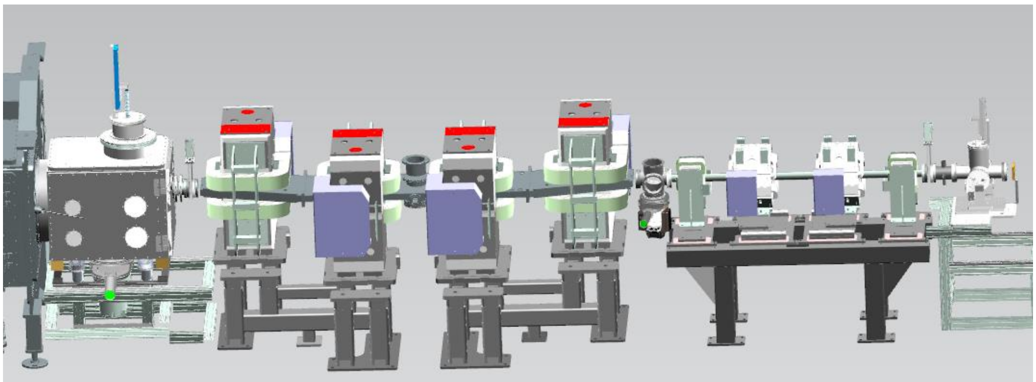
4) *Ion Beam Collimation*
The first part of the ELIMED Ion Beam Transport section is an ion collimation system consisting of five Permanent Magnet Quadrupoles (PMQ) with 100 T/m field gradient over a 36 mm bore. The PMQs have 3 different length (160mm, 120mm and 80mm). The optics can be tuned either varying the relative distances of the magnets using the fully automated mechanical system or changing the number of magnets and their polarity.

5) *Energy Selection System (ESS)*
This device is a chicane with four electromagnetic dipoles having a magnetic field ranging from 0.06 to 1.22 T. The ion beam reference orbit is fixed and a slit based on an automated blades system for cutting the unwanted energies is available. The slit aperture size allows for regulating the energy spread in a linear way (from an energy spread of 1 mm corresponding to ±1%, up to 30 mm corresponding to ±30%.

6) *Conventional particle beam optics*
The final section is based on two electromagnetic quadrupoles (gradient up to 10 T/m over the 80 mm bore) and two X-Y steerers. This sections allows to tune the final beam focusing and pointing features before its delivery into the in-Air Station (out of the scope of this user-assisted call).



The ELIMAIA interaction chamber (ECU-D2) optical setup (the ion collimation system is also visible)



The ELIMAIA Ion Beam Transport section (in-vacuum)

L3 laser HAPLS: brief description & expected parameters

The L3 (HAPLS) laser system is designed and developed to provide 30 fs, 30 J laser pulses at a repetition rate of 10 Hz. In the early ramp-up stages, the L3 laser beam will be operating at a maximum of 3.3-Hz repetition-rate (single shot mode is also available) with 10-12 J energy on target. The L3 laser beam is delivered to the ELIMAIA interaction chamber and focused down to 2-3 μm (FWHM) by a short focal length off-axis-parabola (f/1.5), thus providing ultra-relativistic laser intensities exceeding 10^{21} W/cm^2.

The L3 laser system and its compressor

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