Letter of intent:

LasEr-driven Neutron source for Applications (LENA)

Please specify an acronym, a project title and the name(s) of the project leader(s)

Project leaders:

- **Vincent Bagnoud (GSI)**
- **Johannes Hornung (GSI)**
- **Antoine Maitrallain (Subatech)**

1. Research objectives

The primary objective of this initiative is to expand the user community at GSI/PHELIX, through the implementation of a laser-driven neutron source and performing first user-friendly experiments. This will involve generating neutrons either from high-charge electron beams or from deuterons accelerated within gas jets to ensure scaling these sources to higher repetition rate laser systems. Both sources could operate in a moderated and unmoderated fashion to tailor the resulting neutron spectrum. GSI has extended experience in the generation of secondary radiation (proton, electrons). The project will focus on neutron production and source characterization from those secondary sources. To realize this, we plan to apply for beamtimes at PHELIX in order to perform commissioning and development experiments aiming at the characterization and optimizing the neutron source. Within the funding period, 2 to 3 beamtimes will take place for source optimization and proof-of-principle applications.

A second objective is the enhancement of user accessibility at the facility by providing a neutron source that can be operated without requiring users to have in-depth knowledge of the underlying generation mechanisms, similar to experiments at accelerator facilities. The source supports a broad range of applications, including hadron physics, neutron imaging, the production of radioisotopes for medical and interdisciplinary research, with potential links to industrial use cases. In parallel, we aim to develop neutron detectors to ensure a well-characterized and benchmarked neutron source, facilitating comparisons with other facilities.

A third objective is to progress in data standardization for laser-driven particle facilities. Data collected during beamtime experiments will be stored and structured according to a metadata standard developed within the Helmholtz Metadata Collaboration project HELPMI. This standard connects laser parameters and experimental data within a structured container format, incorporating a pre-defined vocabulary, in order to aligned with the F.A.I.R. data principles. This approach is expected to enhance data accessibility, interoperability, and comparability across research infrastructures.

2. Relevance to the INFRA-SERV call

The proposal is relevant to hardon physics and it is interdisciplinary. Laser-driven neutron sources is an emerging field, which is still in its infancy and not a standard instrument for hardon physics. However, in the long run, it is relevant to applications in hadron physics like the measurement of neutron-neutron and neutron-proton scattering processes. Compared to other

sources, the particle bunches are created at once on ps time scales, which already yields peak production rates of 10^{21} n/sr/sec [1].

The proposal is inherently interdisciplinary: it is an instrumentation project that brings together plasma physics and nuclear physics. The proposed demonstration of laser-driven radio-isotope production for medical application, such as ^{99}Mo or ^{177}Lu, completes the picture.

The proposed work on data management builds on existing work done by GSI and HZDR and answers one of the central aspects in the call.

The task will be conducted jointly by three institutes of two European members states, with significant complementary contributions from all partners.

3. Connection to Transnational Access infrastructures (TAs) and / or Virtual Access projects (VAs)

- TA:
  - The experimental program will be centered around PHELIX one of GSI's user facilities
  - Technical and scientific user support or training for the operation of the neutron source
  - Participation in infrastructure networks such as Laserlab (https://laserlab-europe.eu/)

- VA:
  - Partial VA thanks to the provision of the neutron source in combination to the data distribution via the HELPMI standard, containing all laser and source information. This allows for a VA for the majority of the experiment crew.

4. Estimated budget request

position	beneficiary	cost	overhead	total
Post-doc 1 (2 years)	GSI	180.000 €	45.000 €	225.000 €
Detector development	GSI	100.000 €	25.000 €	125.000 €
PhD	Subatech	140.000 €	35.000 €	175.000 €
scientist (1 year)	HZDR	90.000 €	22.500 €	112.500 €
Travel to beamtime*	Subatech	18.000 €	4.500 €	22.500 €
Travel to beamtime*	HZDR	9.000 €	2.250 €	11.250 €
Total		**537.000 €**	**134.250 €**	**671.250 €**

*Travel on the base of 3 external participants for 3 weeks for 3 beamtimes

5. Participating and partner institutions

Institute	short name	city/country
GSI Hemholtzzentrum für Schwerionenforschung GmbH	GSI	Darmstadt, Germany
Laboratoire de physique subatomique et des technologies associées	Subatech	Nantes, France
Helmholtz Zentrum Dresden-Rossendorf e.V.	HZDR	Dresden, Germany

[1] A. Yogo et al., Phys. Rev. X **13**, 011011 (2023)