

# FY27 NPP LDRD Type B Pre-Proposal



## A Laser Ion Source Using a Porous-Supported Liquid Lithium Target for Repetitive Operation Toward Compact Pulsed Neutron Applications

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Proposal title: A Laser Ion Source Using a Porous-Supported Liquid Lithium Target for Repetitive Operation Toward Compact Pulsed Neutron Applications

Primary Investigator: Shunsuke Ikeda

Other Investigators: Antonino Cannavo, Takeshi Kanetsue, Masahiro Okamura, Sergey Kondrashev, Yoichi Momozaki, Takuji Kanemura, Ryoto Iwai

Indicate if this is a cross-directorate proposal: Yes  No

If yes, identify other directorates/organizations: ANL, FRIB

Proposal Term: From: 2026/10 To: 2028/9

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Title and brief abstract: A Laser Ion Source Using a Porous-Supported Liquid Lithium Target for Repetitive Operation Toward Compact Pulsed Neutron Applications

We aim for a new laser ion source with liquid lithium target under the collaboration with the developers of the liquid lithium charge stripper at FRIB. A first lithium circulating system dedicated to the laser ion source for repetitive and long-term operation will be developed.

- Technical concept: Porous steel (sponge) for capillary action
- Application: Compact neutron source with high directionality

Program: NP

Return on Investment:

- A validated repetitive laser ion source with liquid lithium target.
- Experience of collaboration on this topic.
- Early Career Award Proposal, FOA

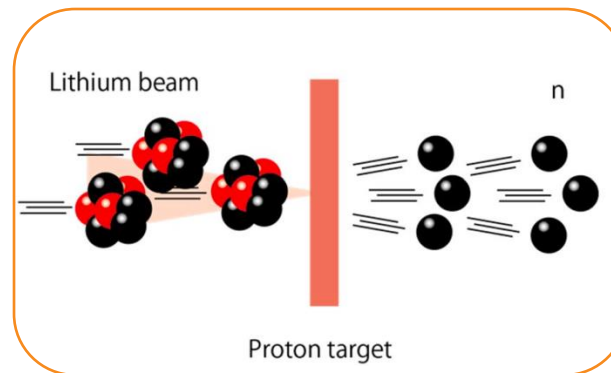
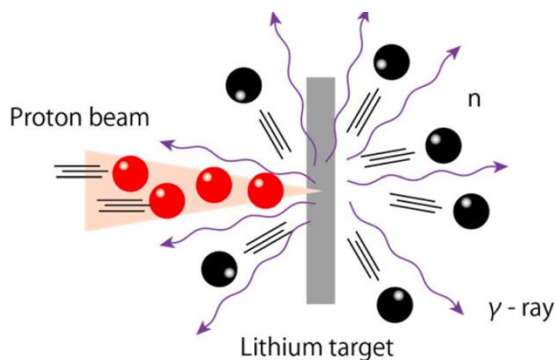
Broader impact on the activities at the laboratory:

- Aligns with the mission of developing state-of-the-art accelerators, enhancing the lab's uniqueness and leadership.
- Basics for repetitive laser ion sources for the other types of elements.

Total planned funding per year in FY27 and FY28: \$250k / year

# Description of the LDRD: Motivation

- Motivation for new lithium-ion source development
  - Enabling technology for a new compact neutron source with high directionality and pulse capability.

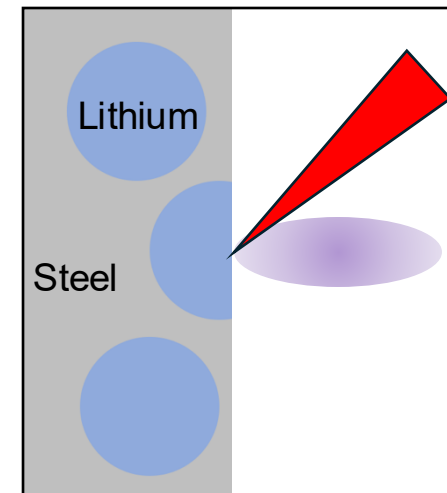
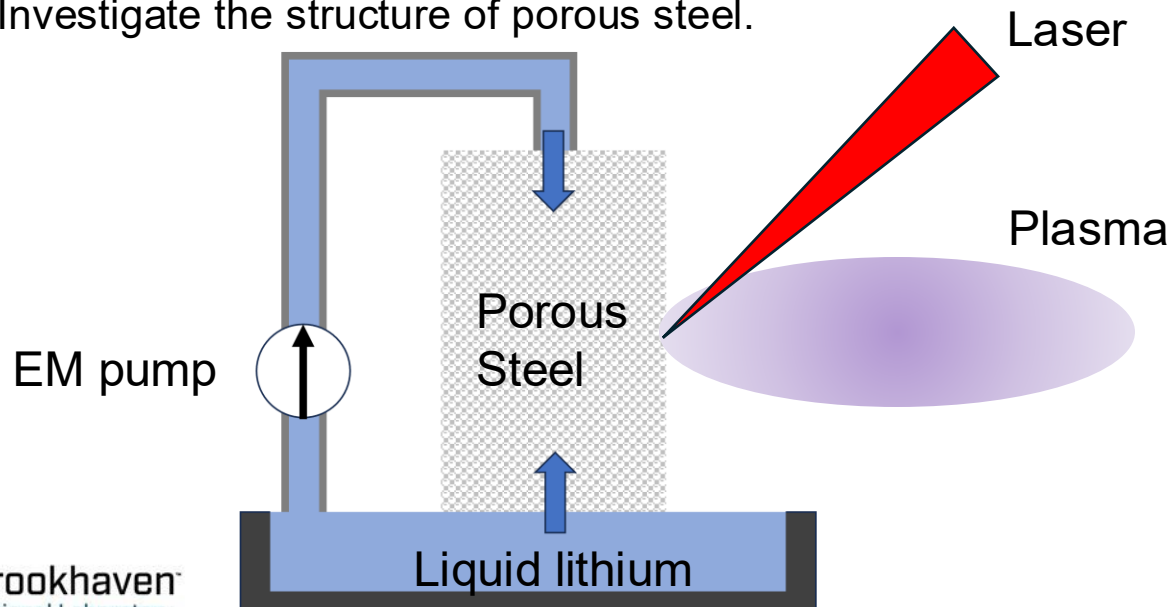


High directionality  
->  
High efficiency,  
low background

- Limitation of conventional lithium accelerator
  - Insufficient ion current for practical use such as imaging (100nA vs 1  $\mu$ A)
- Approach
  - A laser ion source with high peak current (100 mA) of  $\text{Li}^{3+}$  over us pulse.
- Challenge
  - Laser ion sources are currently single-shot-oriented, and repetitive, long-term stable operation remains unestablished

# Target Concept for Repetitive Operation

- Limitations in repetitive operation with solid targets
  - Solid lithium targets suffer surface degradation under repetitive high-power laser irradiation.
- Proposed solution: porous-supported liquid lithium target
  - Continuous lithium supply via capillary action in porous steel (or sponge).
  - Small, stabilized liquid surface (robust against laser impulse).
  - Horizontal beam extraction geometry.
- Research goals
  - Aim for 10 Hz production of  $\text{Li}^{3+}$ .
  - Investigate the structure of porous steel.



Enlarged view

# Outcome, Impact & Extensibility

- Primary outcome
  - Repetitive (10 Hz), long-duration laser ion source operation.
- Immediate impact
  - New compact neutron source with pulsed, forward-directed output.
- Additional outcome
  - R&D knowledge gained on laser–plasma generation from liquid lithium through cross-disciplinary collaboration, enabling future ultra-high-repetition-rate operation (over kHz).
- Personnel involved: Ion source specialists at BNL (5) and liquid lithium specialists at ANL (1) and FRIB (2).
- Procurement for experiments: lithium, steel sponge or substrate to form, power supply and magnet for lithium pump, heater, temperature sensor and controller, vacuum and optical components.

# Summary Slide

We aim for a repetitive laser ion source enabled by a porous-supported liquid lithium target through cross-disciplinary collaboration with lithium stripper developers.

- Goal: Repetitive (10 Hz), long-duration laser ion source operation
- Method: Porous-supported liquid lithium target
- Result: Sustained ion output → pulsed neutron capability
- Outlook: Insight toward higher repetition-rate operation