Brookhaven National Laboratory

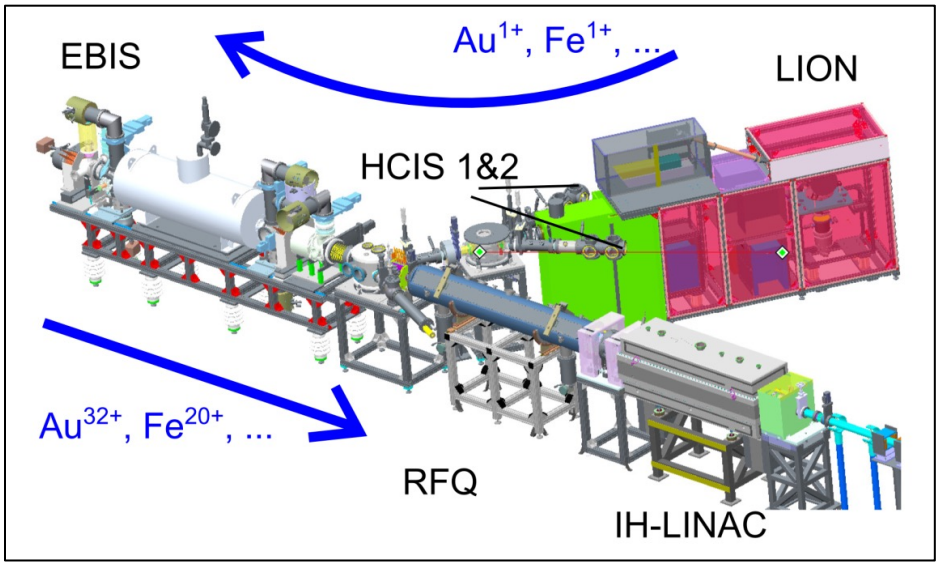
U.S. DEPARTMENT OF ENERGY

Development of Laser Ion Source

Shunsuke Ikeda

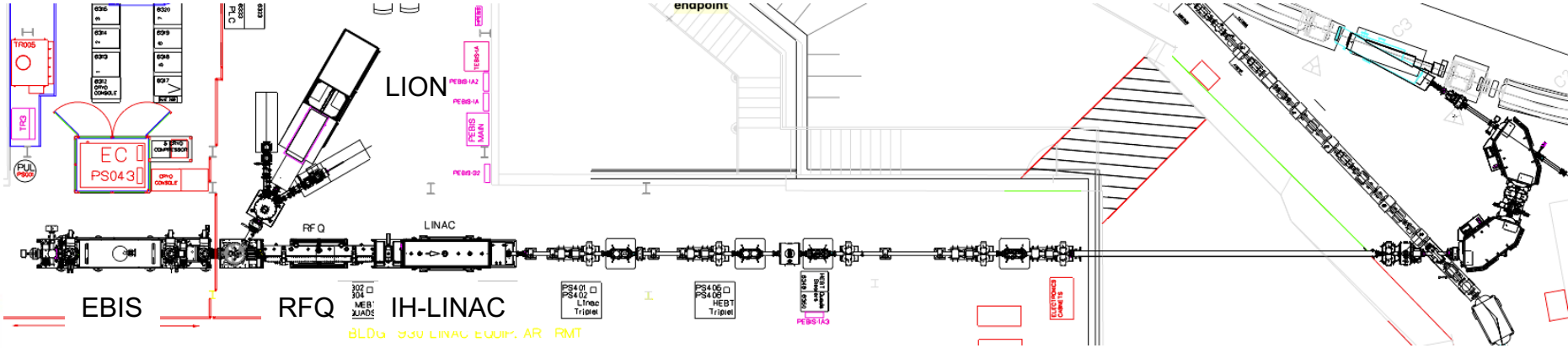
9/9/2022

Pre-injector: LION and EBIS



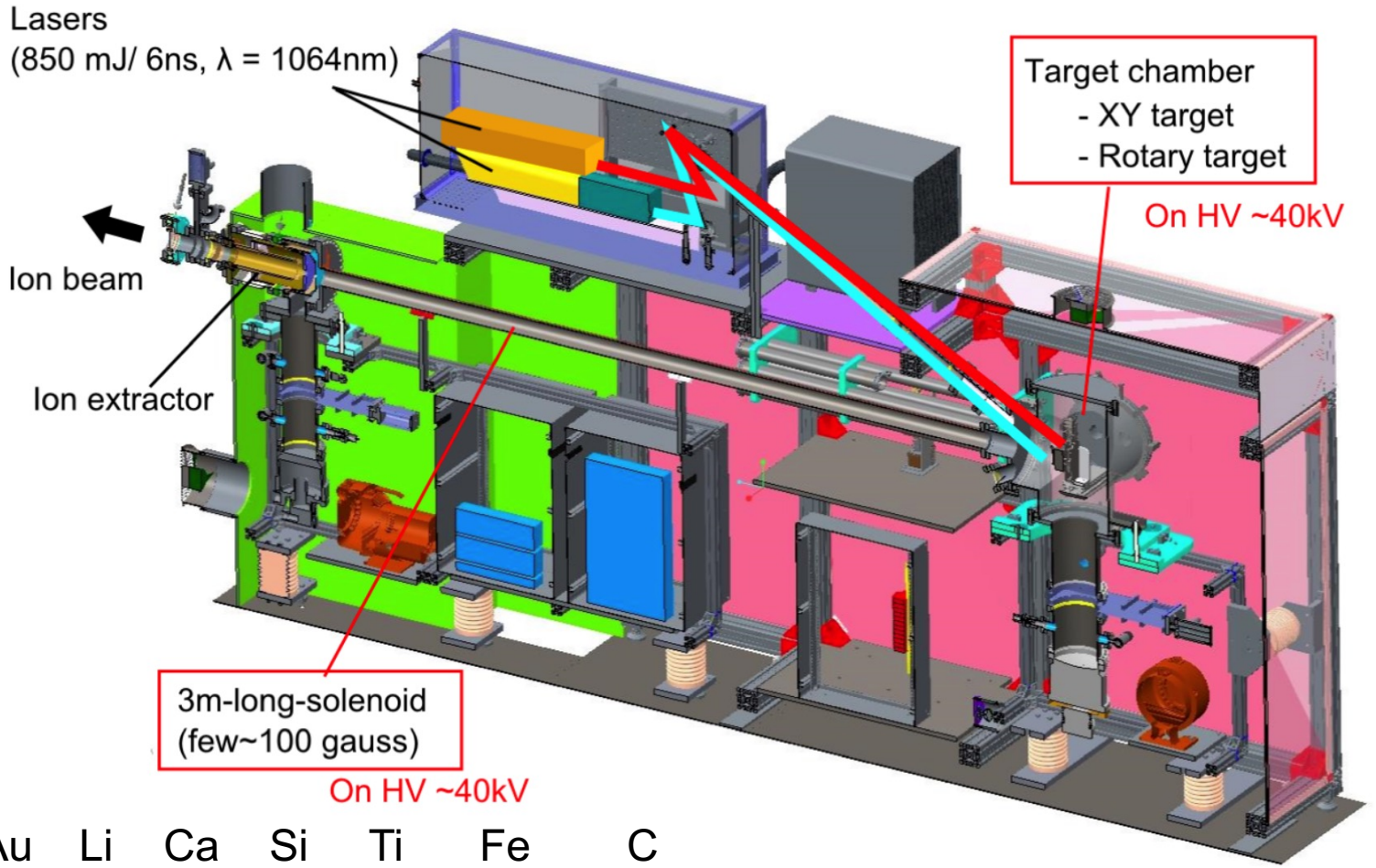
Laser ion source and electron beam ion source provide many types of ions to RHIC and NSRL from Li to Bi.

Booster

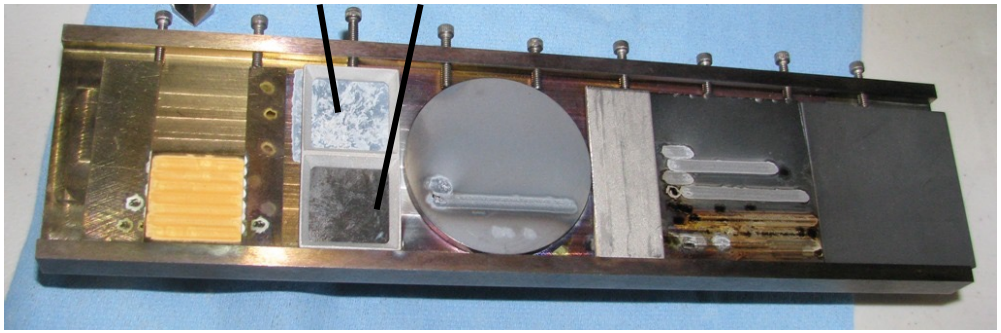


Brookhaven National Laboratory

Laser ion source



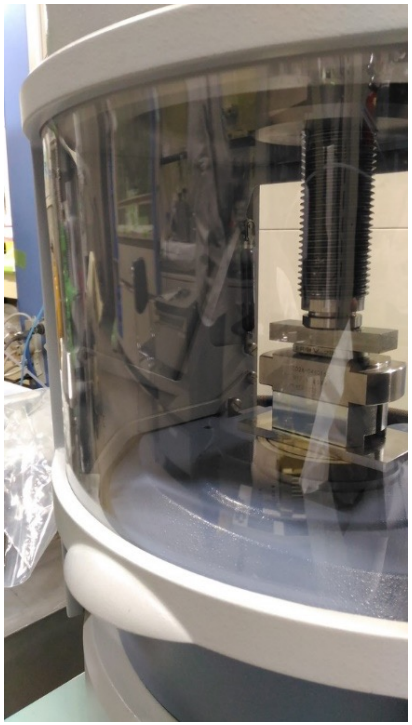
Al Au Li Ca Si Ti Fe C

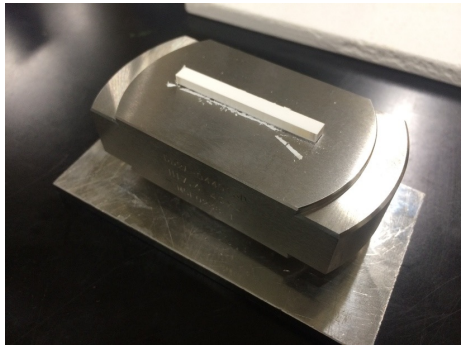


Advantage of laser ion source :

- Any types of ions can be produced from solid material
- Fast species switch (within seconds, 130 switches/day)

Target development 1: Sintering oxide

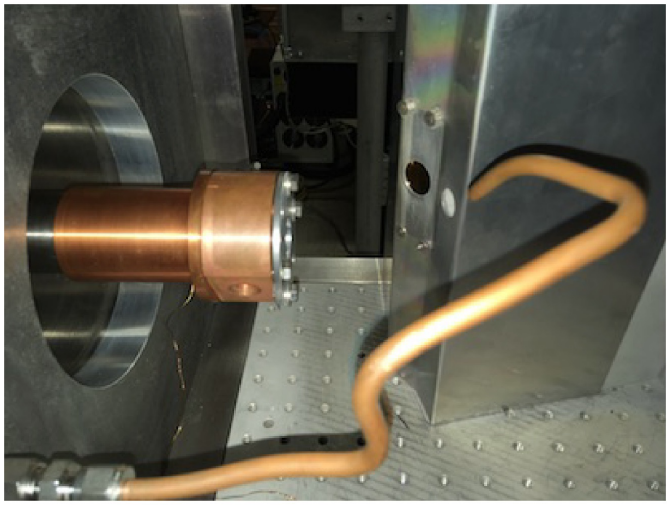




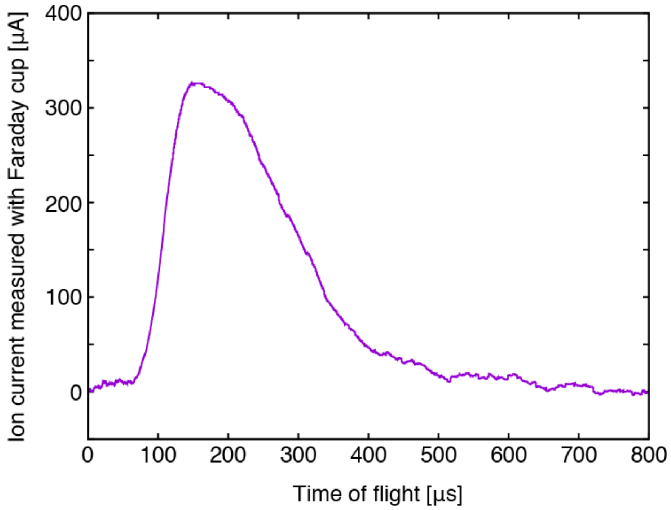
Developed to use powder of oxide of enriched Zr as a laser target

Target development 2: Cryotarget

Cold head (20K) Nozzle for Xe gas

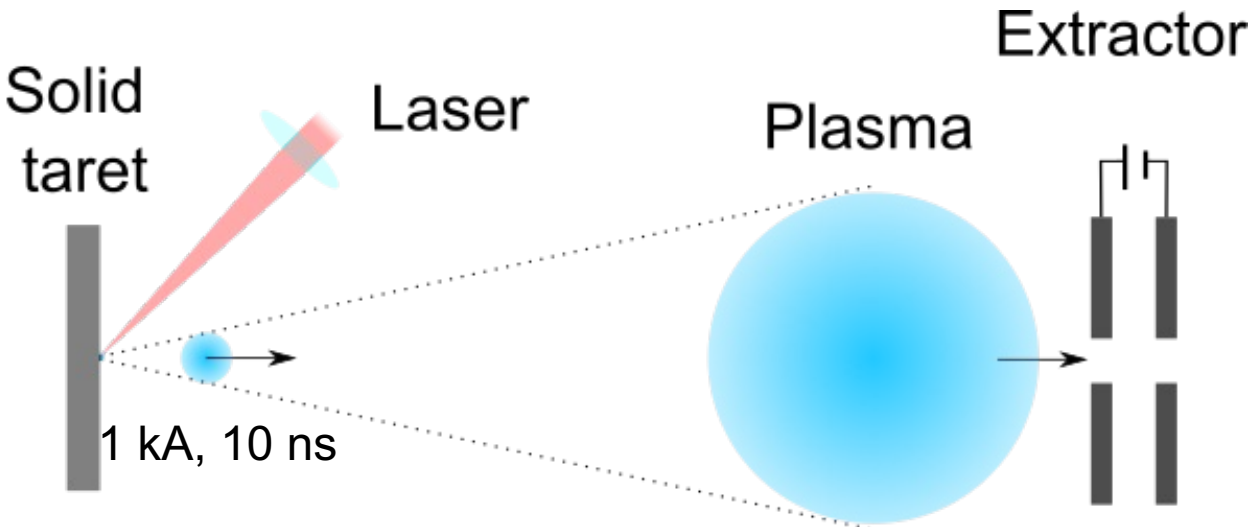


Enough beam current was produced



Under development to produce ions of gases

Intense pulsed beam of highly charged ions with focused laser pulse



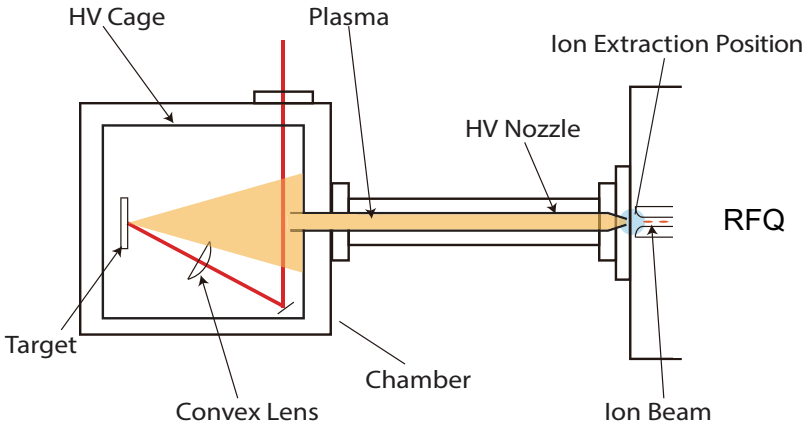
Plasma expanded for desired current and pulse width

- Large number of ions (10^{14} – 10^{15}) are produced within laser pulse (<10 ns)
- Ions are emitted from point source -> low emittance

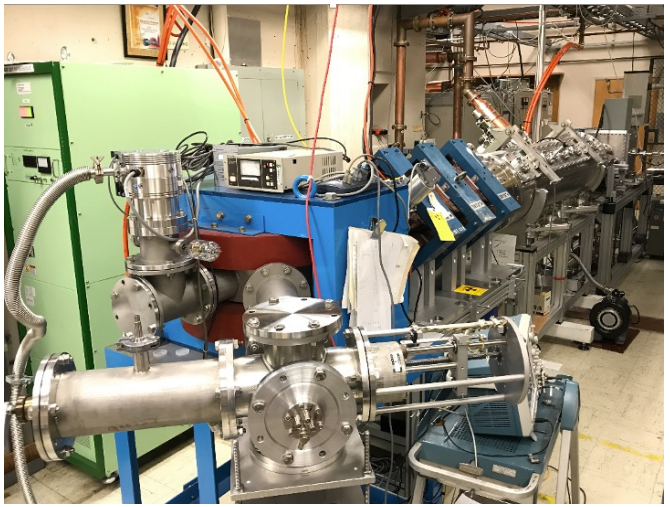
Brookhaven National Laboratory

High potential for intense pulsed beam machine

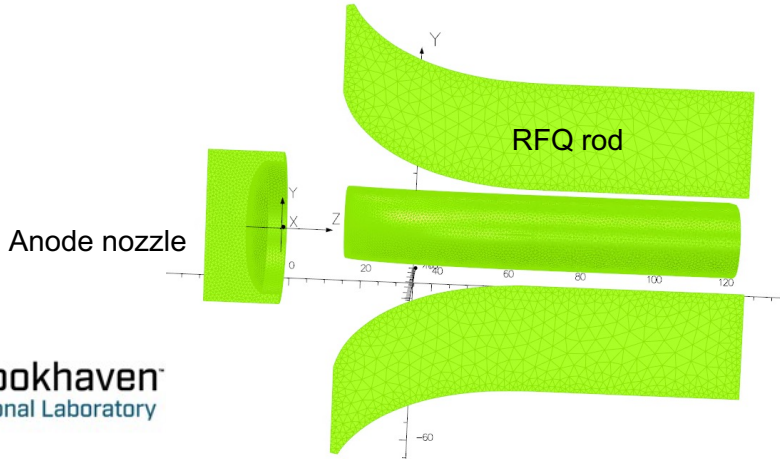
Intense pulsed beam production



Direct Plasma Injection Scheme



35 mA of $^{7}Li^{3+}$ was accelerated



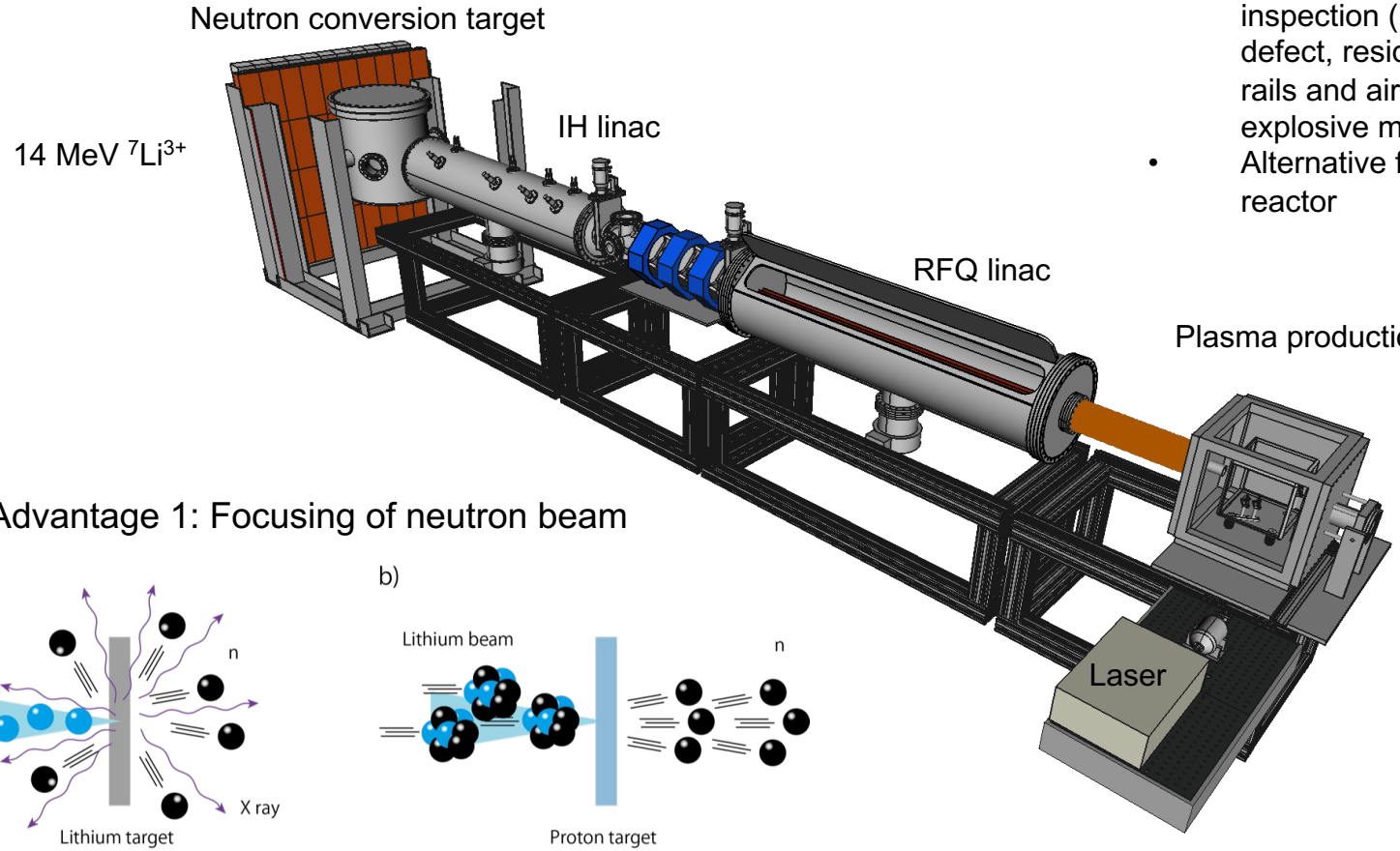
Simulation work is being performed to pursue large current. (300 mA acceleration suggested)

Brookhaven National Laboratory

One application : Compact neutron source

Application:

- Nondestructive inspection (building defect, residual stress in rails and aircraft parts, explosive material, etc..)
- Alternative for small reactor



Advantage 1: Focusing of neutron beam

Advantage 2: Short beam pulse
Background can be separated by TOF method

Brookhaven National Laboratory

Summary

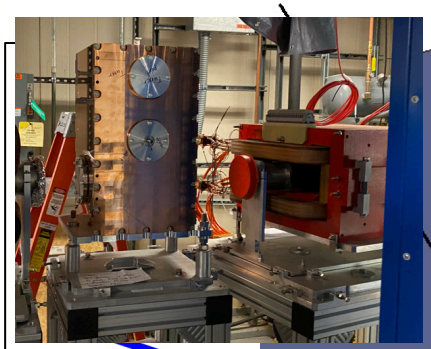
Laser ion sources have several features.

- All most all types of the ions can be produced from solid material.
- The species can be switched in short time.
- Intense pulsed beam can be produced.

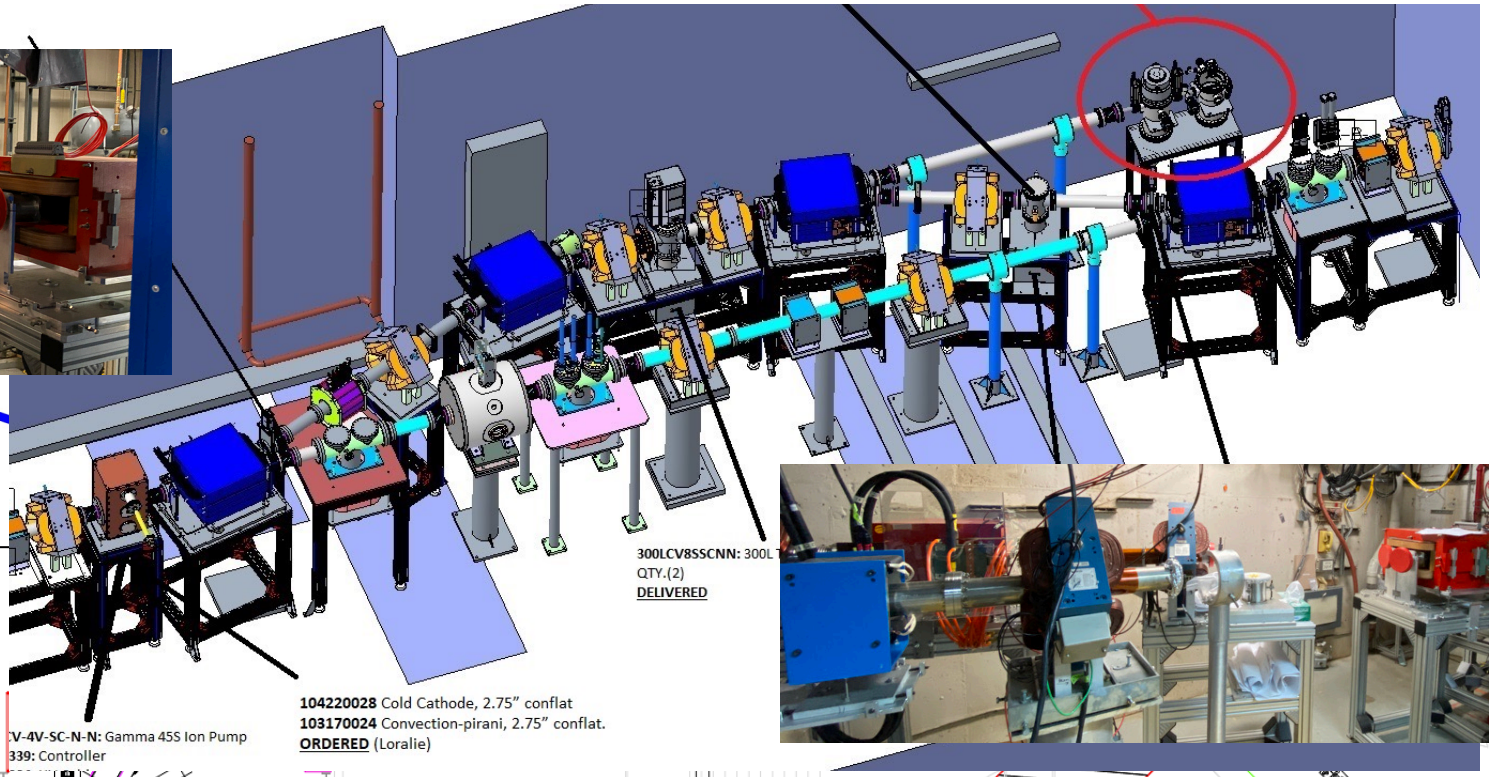
Development continues to expand the ability and the application of laser ion sources.

Thank you

Pre-injector: LION and EBIS



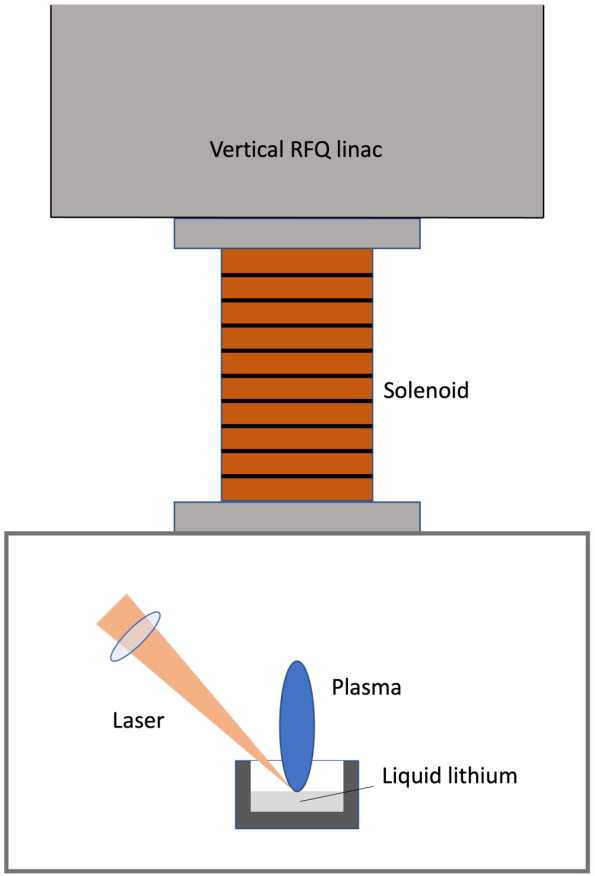
Au^{32+}, Fe^{20+}, ...



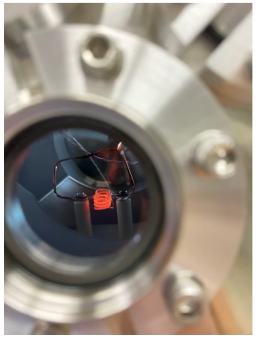
$^3He^{2+}$

Brookhaven National Laboratory

Liquid target development to increase repetition rate



- Solid target should be moved every shot to provide a fresh surface -> large surface area is needed for high repetition rate.
- It is expected that the same spot can be used for liquid target.



Heating test