Ion Source and Injector
VNL Status and future opportunities

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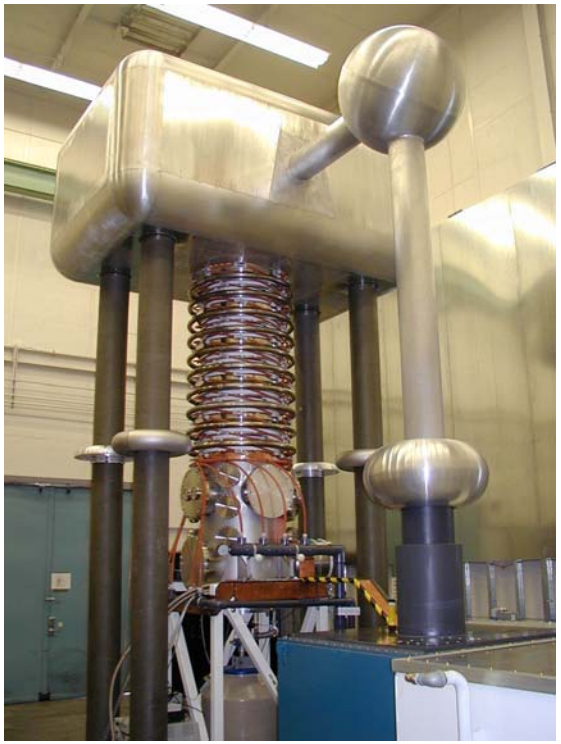
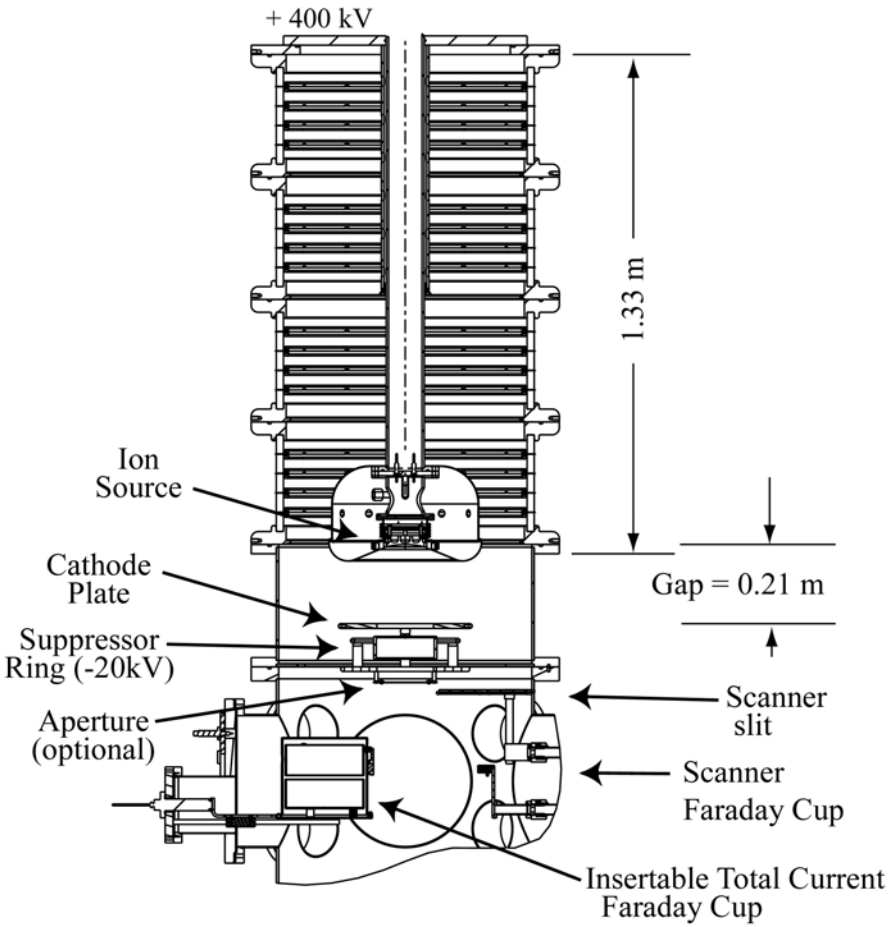
Experiments on STS-500 to study beam optics

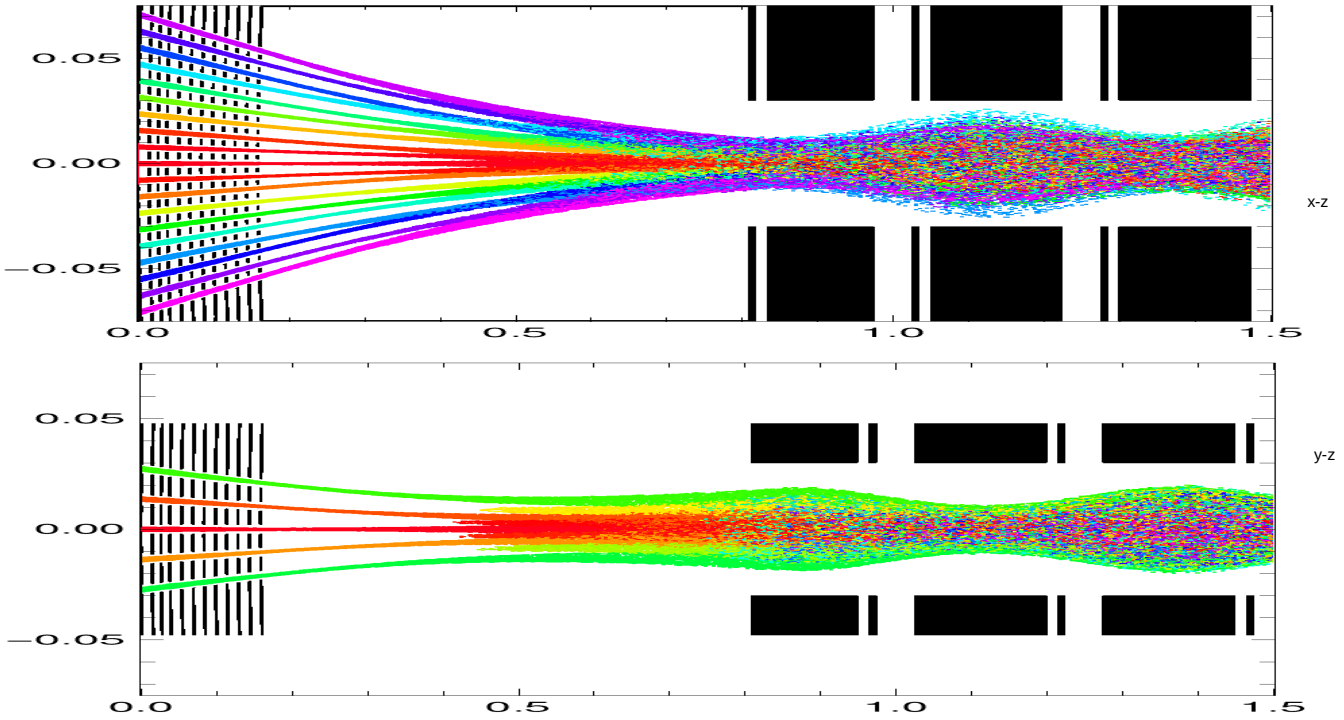


500 kV, 17 μs pulse, 1.0 μs time

10-cm diameter K+ Al-Si source with Pierce electrode



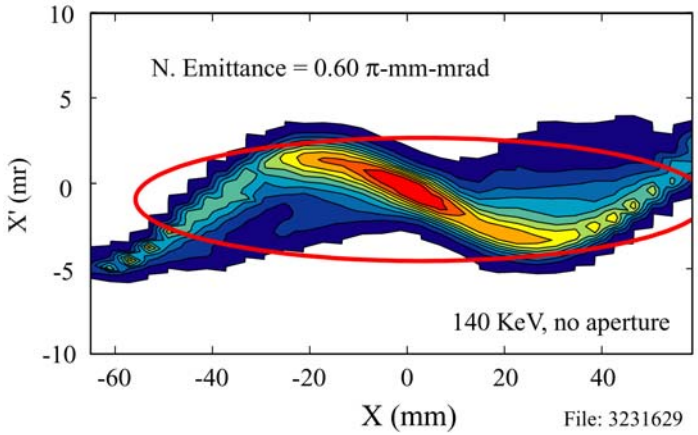
Merging high density beamlets for HIF injector is more compact and is today's preferred option



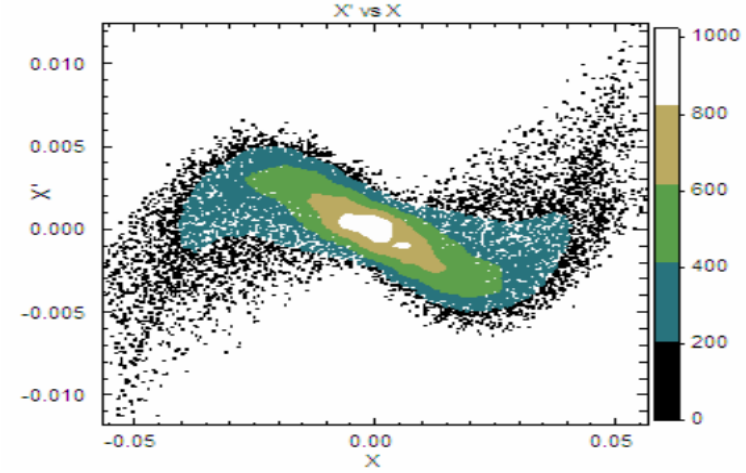
- need current density > 100 mA/cm^2 (Ar^+)
- need merged total current > 0.5 A
- 20 μs, steady current, low emittance

WARP-3D simulation is benchmarked as reliable design tool

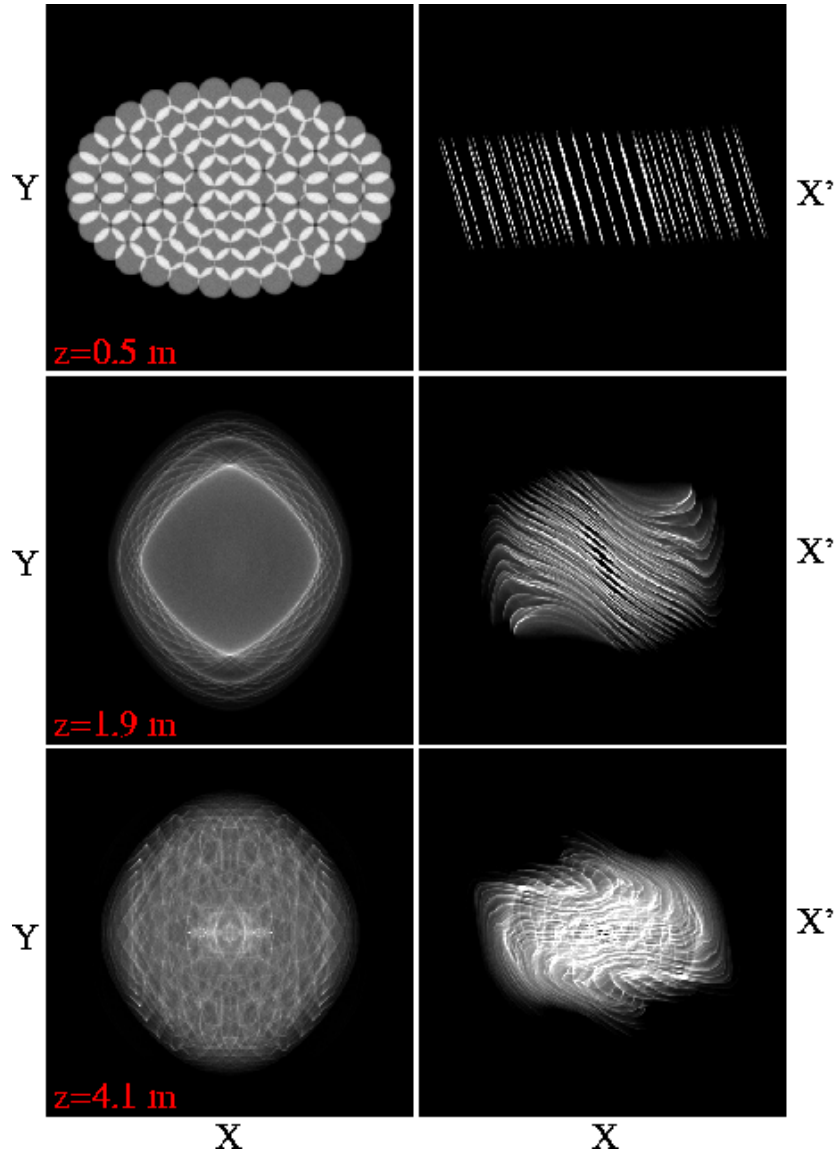
Experimental results



Warp simulations

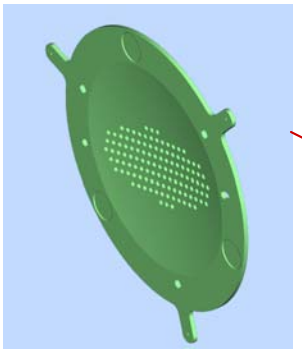


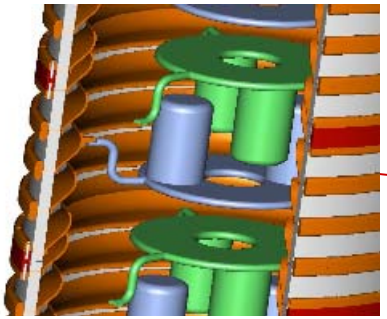
Configuration Phase

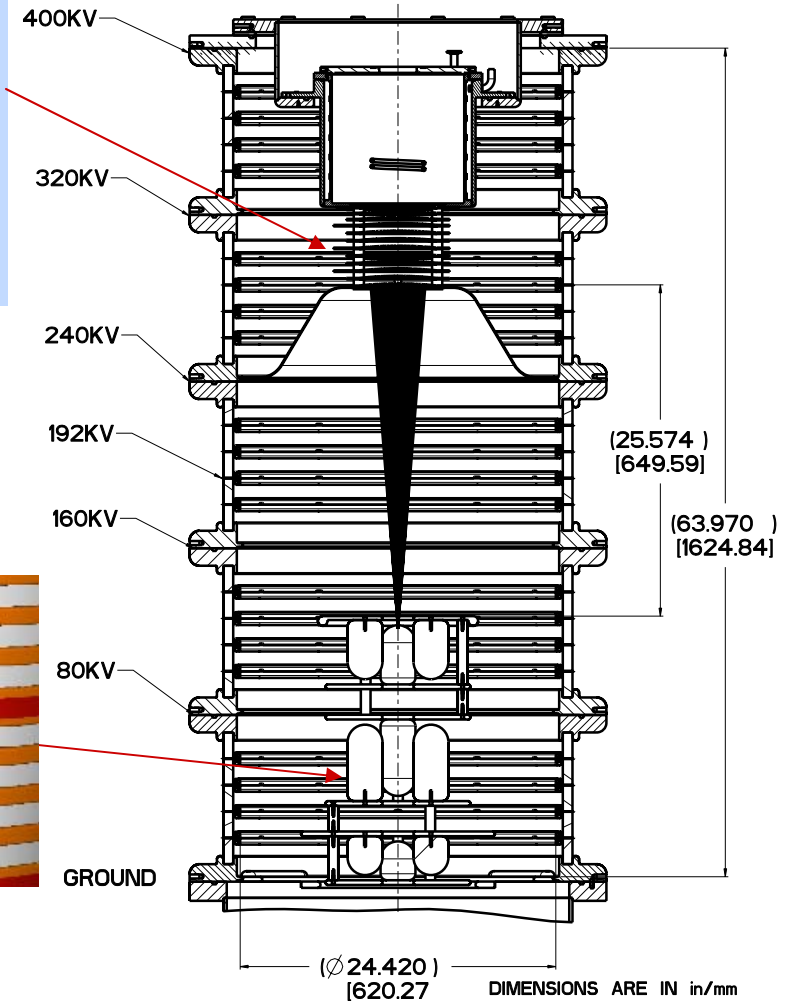


Merging Beamlets test will begin in September

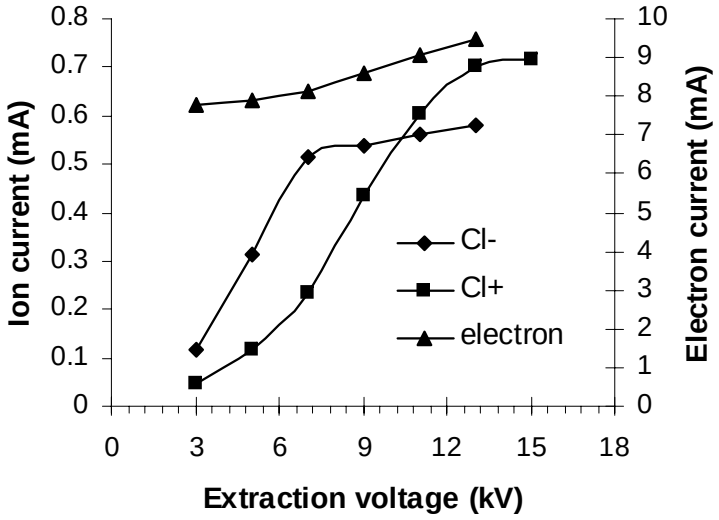
- **Apparatus is full scale in dimension, but 1/4 scale in voltage, so 1/8 in current.**
- **The experiment will study emittance growth physics, beam matching parameters, and beam halos.**
- **Success in this experiment will establish the basis for building a (future) driver-scale injector.**

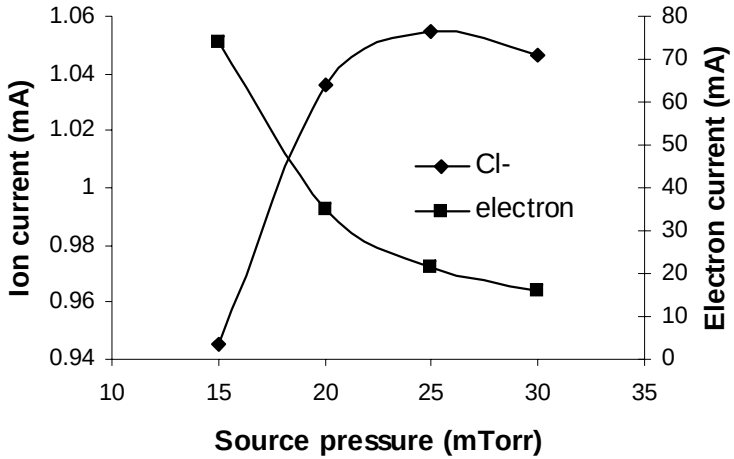






Negative ion sources for HIF Drivers

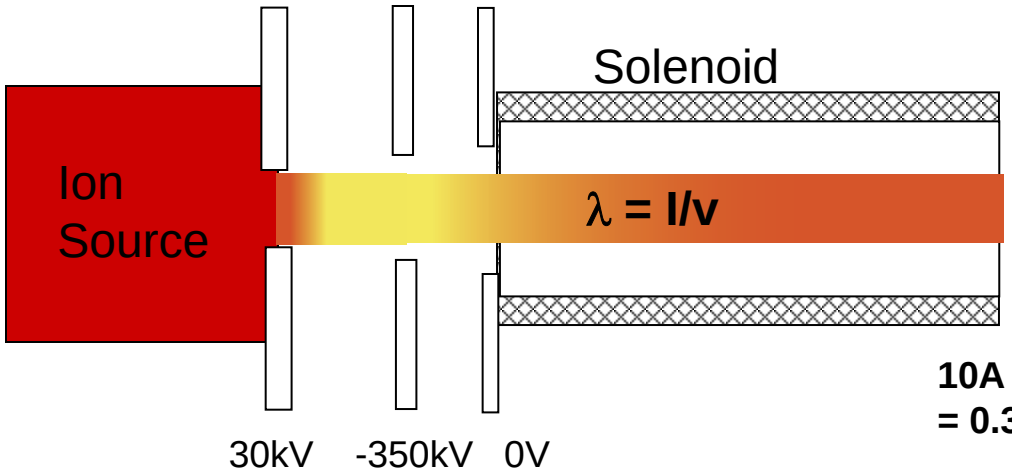




- **We have already demonstrated 45 mA/cm^2 of pure Cl$^-$ ions with relatively low co-extracted electrons (7:1) from a single aperture.**
- **Current density scaled almost linearly with RF power (12.56 MHz).**
- **Current density of Cl$^+$ ~ 1.3 x Cl$^-$.**
- **A new experiment will run on STS-100 this summer to examine the negative ion production from a large source, measure emittance, and form an array of beamlets.**

The accel-decel injector is an innovation to meet our HEDP challenge: build a low energy high current driver to hit target

- **In an accel-decel injector, a long pulse is compressed when decelerates into a solenoid, the Super-High λ (line charge density) bunch is then accelerated without expansion.**



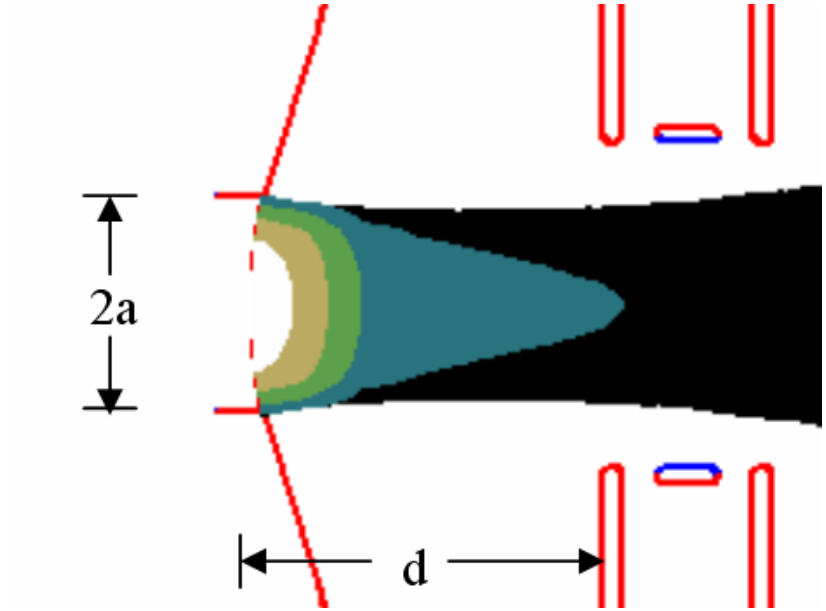
The situation is similar to loading passengers into a roller coaster train.

10A x 100ns
= 0.3m x 3.3 μC/m

- **At 3.3 μC/m, the HEDP λ is > 10x the present HCX experiment.**
- **Longitudinal emittance can coupling to transverse emittance**
- **Possible compression limit when the bunch's forward kinetic energy becomes comparable to the beam potential.**

HEDP requires a 100 ns/ 10A ion source & injector

$$J = \chi \frac{V^{3/2}}{d^2}$$



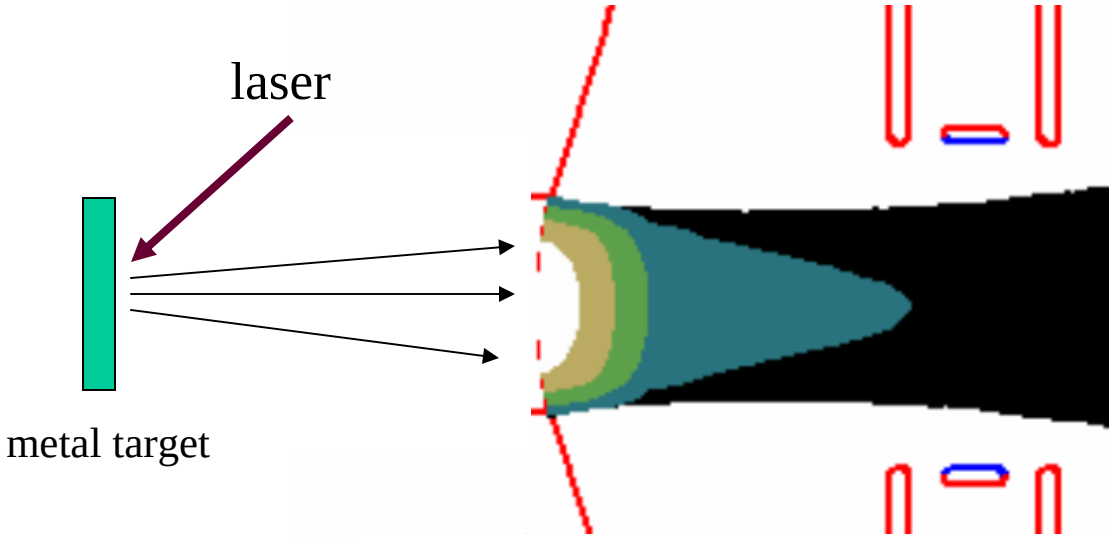
To do this we need:

- An ion source
  with J > 100 mA/cm^2.
- Boost the space charge CL limit by using high gradient
- A low energy beam transport system after the ion diode.

What kind of short pulse high current source to use?

One possibility is to use a laser source, if:

- It can produce a single charge state
- With high enough current (I) and current density (J)
- Low enough transverse and longitudinal emittance.



Since HEDP only requires short pulse and a single beam, it may be possible to select the right window of charge state and velocity spread by adjusting the drift geometry (even possible to add a magnetic bent.

A noval laser ion source approach

Combine the Alumino-silicate source with a laser trigger

- The alumino-silicate will be heated to about 900 degree C
- Flash heat the alumino-silicate with a laser beam, high enough intensity to release K+ but low enough not to ablate