WP2: Assessment of risk in delivery of laser driven ion source

LhARA Advisory Board Meeting
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The inherent risks for WP2

LhARA source parameters never been shown *simultaneously*

- Relatively high energy (e.g. 15 MeV for protons, 4 MeV/u C^{6+})
- High flux (e.g. ~10^9 ions per shot in energy band)
- High repetition rate (10 Hz), long term operation
- Multi-ion species (protons, carbon, others…)

The key goals of WP2 are:

- Demonstrate the concept and de-risk the source
- Specify the drive laser, targetry and instrumentation for CDR

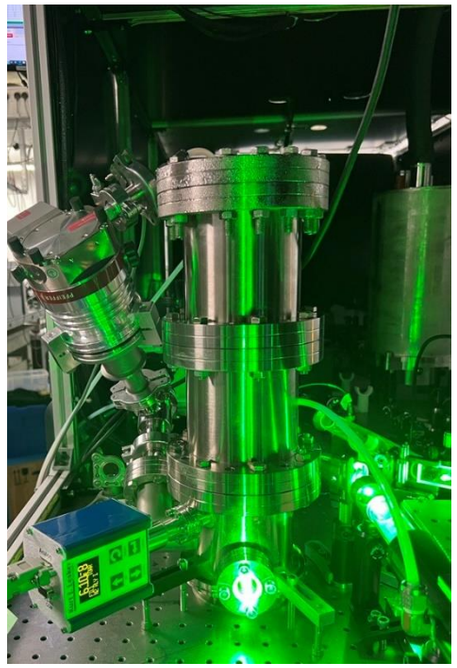
The risks in achieving the goals can be grouped:

- Insufficient resources and beamtime
- Insufficient beam parameters from the ion source
- Challenges related to high repetition rate & long term operation

Insufficient resources and beamtime

What are the risks?

- Not enough beamtime paid for on the SCAPA or Zhi facilities
- Technical issues during the beamtimes
- Insufficient computing resources for simulation
- Insufficient staff/student effort to execute R&D



Zhi laser cryo-amplifier (ICL)

What is the mitigation?

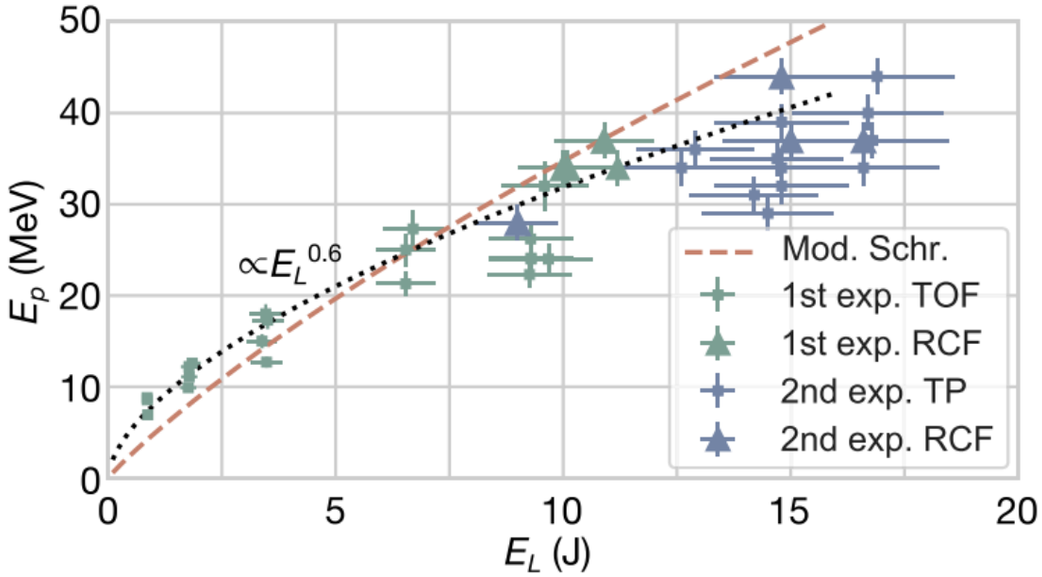
- Collaborate with other facilities to secure beamtime, piggy-back on other experiments
- Competitively apply (or pay) for additional resources e.g. computational time, beamtime
- Build links with outside groups with similar goals

SCAPA interaction chambers (Strathclyde)

Insufficient beam parameters from the ion source

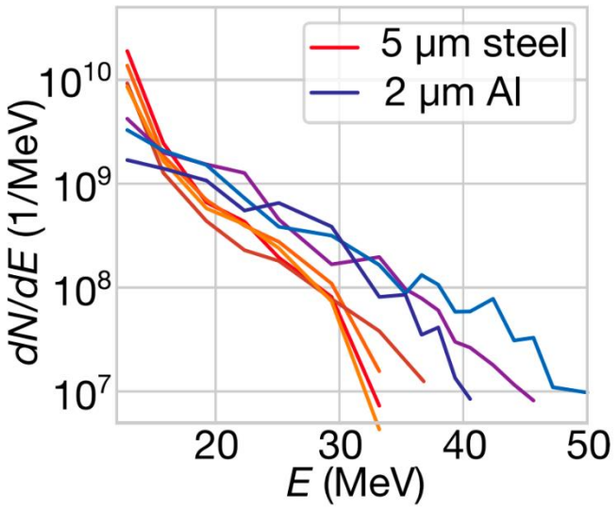
What are the risks?

- Not able to reach required energy
- Not enough beam flux
- Difficulty with different ions (C, etc)



What is the mitigation?

- Additional resources for source optimisation experiments and simulations
- Investigate techniques for spectral shaping
- CDR specification of larger laser system (more cost, space, shielding!)
- Trade-off between particle flux, energy and/or repetition rate

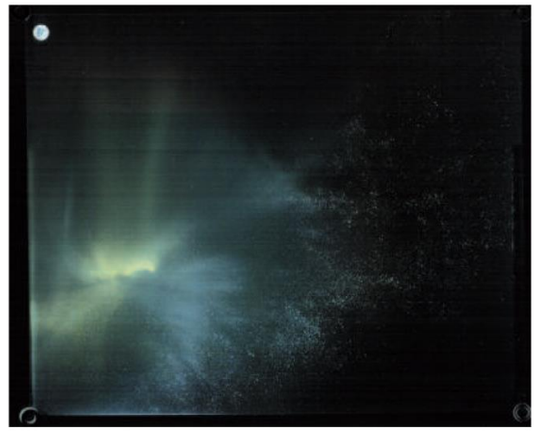


From Dover et al. HEDP 37, 100847 (2020)

Challenges related to high repetition rate & long term operation

What are the risks?

- Targetry replenishment and stability not sufficient
- Large shot-to-shot variation of beam parameters
- Target debris causes degradation of key optics
- Activation and radiation safety issues of apparatus and surrounding area



Debris on a glass plate following PW irradiation of Au targets (Andrew et al. CLF Reports 2007/2008)

What is the mitigation?

- Allocate more resources and form collaborations on other innovative target types (see next talk)
- Dedicate further resources to laser and target diagnostic suite to allow fast-feedback stabilisation
- More effort on testing debris reduction and capture