

Laser-hybrid Accelerator for Radiobiological Applications

Imperial College London

LhARA Laser-Driven Proton & Ion Source WP1.2

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LhARA 6 month review, 21st February 2023



Laser driven ion sources



- High intensity laser driven ion sources have unique features:
 - Naturally extremely high peak current (< ps generation time)
 - Triggerable and on-demand
 - High energy from source (up to ~100 MeV)
- Attractive for delivering ions at high instantaneous dose rate

Progress towards ITRF milestones is on schedule

- M2.1: Prediction of optimised proton source for 100+ TW laser systems based on hydrodynamic and kinetic simulations
 - Due September 2023
 - Initial 3D simulations of LhARA-like source completed -E. Boella (Lancaster)
- M2.2: First SCAPA ion source simulations and experiment completed
 - Due March 2024
 - First experimental beam time booked July 2023
 - Experimental area commissioning completed







Progress on full 3D PIC simulations

Simulations and analysis performed by E. Boella (Lancaster)



- 3D simulations predict generation of ion beam parameters similar to LhARA baseline
- Optimal density profile will boost ion energies
- Currently developing workflow for modelling of effect of laser temporal pulse structure



Progress towards SCAPA experiments Led by R. Wilson & R. Gray (Strathclyde)

SCAPA: 8 J, 25 fs at 5 Hz repetition rate up to $\sim 10^{20}$ W/cm²



- Initial ion acceleration experiments performed at SCAPA using tape drive
- LhARA dedicated beamline planned for July 2023 for parametric source optimisation
- Diagnostic & hardware development ongoing

Online beam spatial & spectral profile monitor



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Data collection system capable of working at 10 Hz





Other activities are also ongoing

- Development of high repetition ion acceleration facility at ICL
 - Driven by in-house 10-100 Hz ~100 mJ laser system, to address issues related to high repetition rate
 - High repetition ion source commissioning experiments have now begun
- Other LhARA relevant experiments
 - Strathcylde experiments at the Central Laser Facility investigating parametric optimisation of laser plasma interaction
- Ongoing discussions with WP3/WP6 on beamline interface
- New collaboration on debris with CLF, overlap with development of STFC funded EPAC facility
 - Sharing of diagnostics, equipment and experimental access for measurements



Summary

- WP2 team making excellent progress towards fulfilling the ITRF milestones to schedule
- Many complementary and collaborative activities underway at Imperial, SCAPA, Lancaster, QUB and CLF
- Provided funding has given much needed impetus to LhARA related R&D and collaborative activity
- Full exploitation of the ion source will require further R&D and investment at later stages of the project