

LhARA WP2 – Work Package Management Meeting #2 – 15/11/2022

----- Technical Talks -----

1. [10 minutes] Reminder of LhARA & WP2 Programme

2. [5 Minutes] WPM Meeting Admin & Slack Team

----- WP2 Administration -----

3. [5 Minutes] Update on Experimental Scheduling/Progress
[ND, RG]

4. [5 minutes] Report on Consumables & Travel Spend [ND, RG]


5. [5 Minutes] Report on Simulations [EB]

6. [5 Minutes] ITRF Reporting: Milestones, Spend & Risks [ND]

7. AOB



Monthly



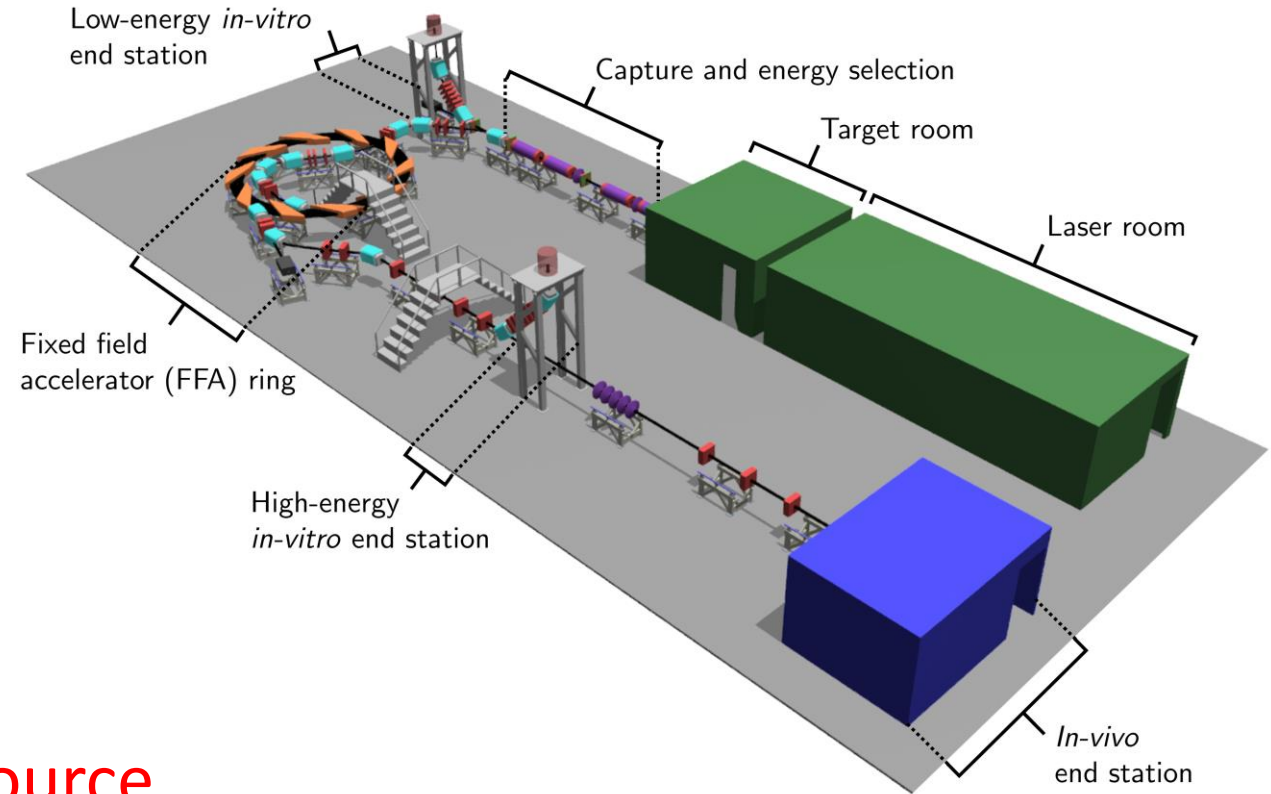
Every two weeks (next meeting 29th
November)

LhARA WP2 Introduction/Reminder....



LhARA - Project organisation

- WP1 – Project management
- **WP2 – Laser Driven proton and ion source**
- WP3 – Proton and Ion Capture
- WP4 – Real-time dose-deposition profiling
- WP5 – End station development & Instrumentation
- WP6 – Facility design and integration



<https://ccap.hep.ph.ic.ac.uk/trac/wiki/Research/LhARA/LaserDrivenSource>

Update on LhARA... partners

Imperial College London

ICR The Institute of Cancer Research

Medical Research Council
UKRI
Oxford Institute for Radiation Oncology

UNIVERSITY OF OXFORD

JAI
John Adams Institute for Accelerator Science

CCAP
Centre for the Clinical Application of Particles

Imperial College Academic Health Science Centre

CANCER RESEARCH UK

IMPERIAL CENTRE

Imperial College Healthcare
NHS Trust



Partners

University

Clinical

Laboratory

Accelerator

Industry

MANCHESTER 1824
The University of Manchester

UNIVERSITY OF BIRMINGHAM

UNIVERSITY OF LIVERPOOL

NHS University Hospitals Birmingham
NHS Foundation Trust

NHS The Clatterbridge Cancer Centre
NHS Foundation Trust

NHS The Christie
NHS Foundation Trust

institut Curie

QUEEN'S UNIVERSITY BELFAST

Swansea University
Prifysgol Abertawe

UCL
MEDICAL PHYSICS & BIOMEDICAL ENGINEERING

NETHERLANDS CANCER INSTITUTE
ANTONI VAN LEEUWENHOEK

HAMPTON UNIVERSITY
PROTON THERAPY INSTITUTE
FIGHTING CANCER. SAVING LIVES.

University of Strathclyde Glasgow
DEPARTMENT OF PHYSICS

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Lancaster University

UKRI
Science and Technology Facilities Council

central laser facility

UNIVERSITY OF BIRMINGHAM

CYCLOTRON FACILITY

POSITRON IMAGING CENTRE

ASTeC
Daresbury Laboratory
Particle Physics Department
ISIS Neutron and Muon Source

INFN CATANIA

The Cockcroft Institute
of Accelerator Science and Technology

CERN

Corerain
鯤云科技

LEO
Cancer Care

MAXELLER
Technologies
Maximum Performance Computing

The Rosalind Franklin Institute

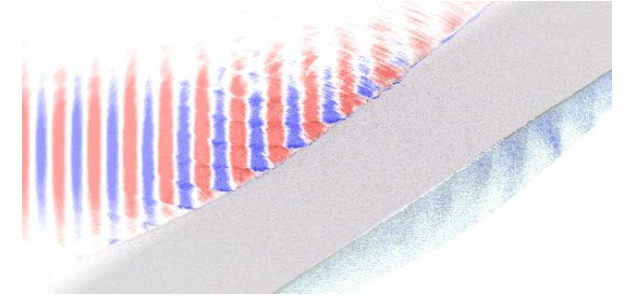
NPL
National Physical Laboratory

Planned objectives for WP2 activity (Oct 2022 – Oct 2024)

Years 1-2: preliminary activity

Baseline simulation campaign to optimise source

- Hydrodynamics simulations of low intensity “prepulse”
- Full-scale 3D particle-in-cell simulations of ion generation



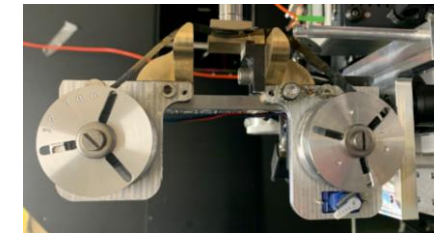
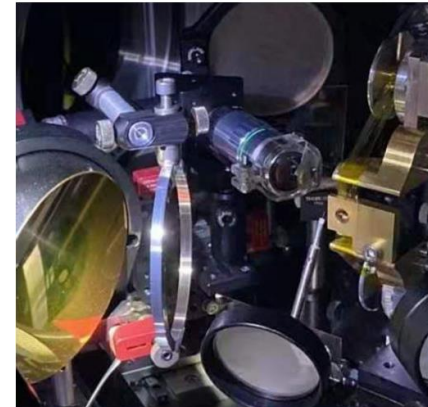
Single-shot LhARA spec. proton generation (SCAPA, Strath)

- Proton generation on SCAPA, matched to LhARA laser
- Parametric optimisation



Ion generation at 10 Hz (Zhi/Cerberus lasers, ICL)

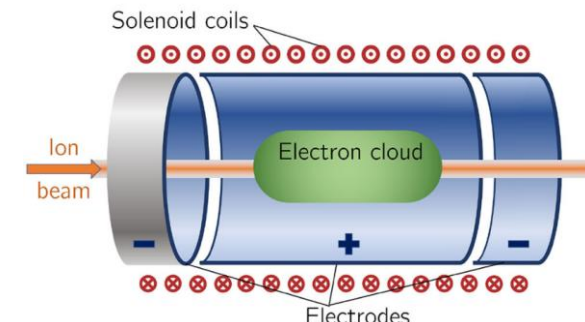
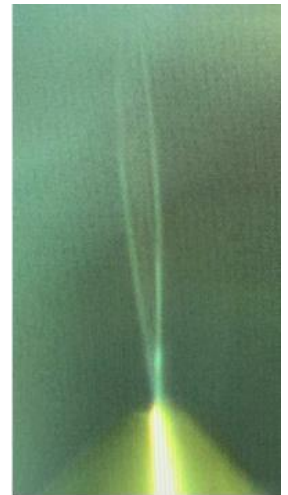
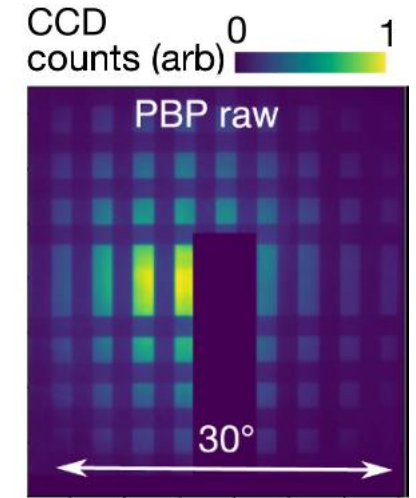
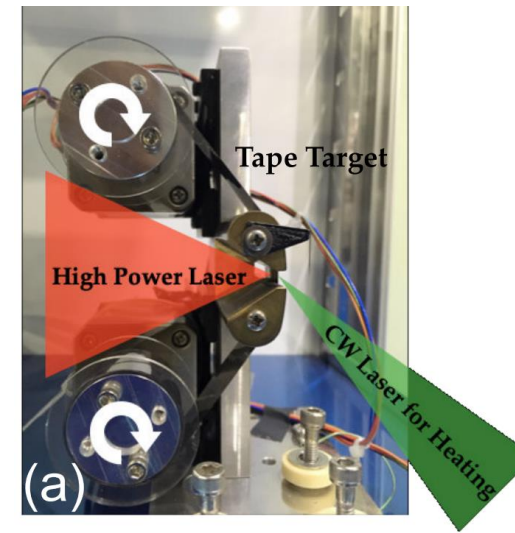
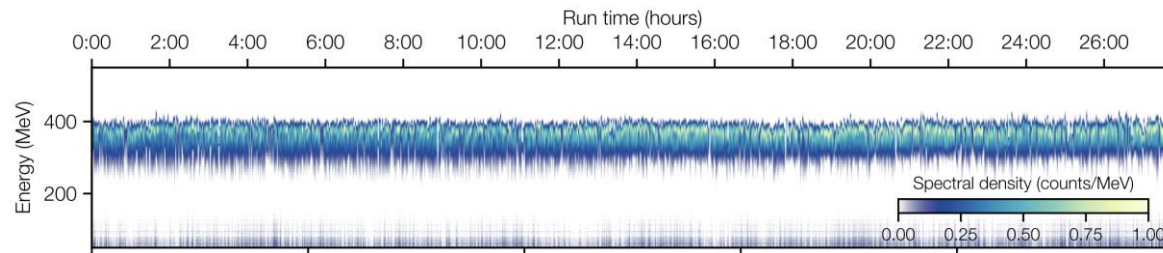
- Targetry requirements at 10 Hz
- Source monitoring and stabilisation



Planned objectives for WP2 activity

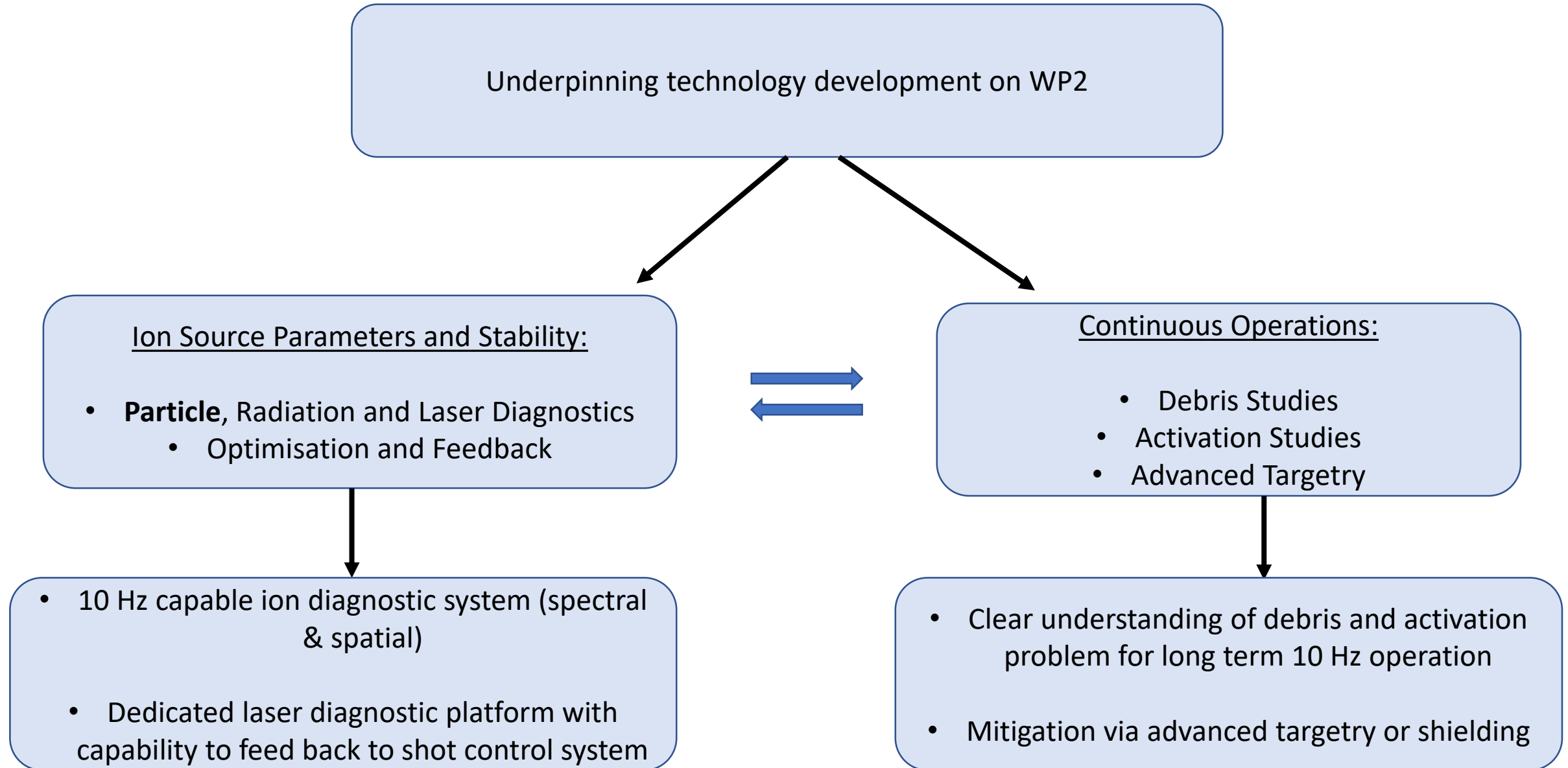
Years 3-5: preconstruction programme

- **Construction of bespoke diagnostic suite**
 - Laser spatial and temporal measurement
 - Ion spectral and spatial measurement
- **Optimisation of heavy ion acceleration**
 - Contaminant control at high repetition
- **Development of advanced 10 Hz target platform**
 - Water jet target
 - Active target stabilisation and debris control
- **Integration of developed laser ion source technologies**
 - Demonstrate integrated source and diagnostic system and compatibility with capture
- **LhARA specification beam generation at 5 Hz**
 - SCAPA experiments for near-full scale LhARA beam generation over ~ 1 hr duration



Aymar et al. Front Phys. (2020)

WP2 Technology Development Programme:



Experiments & Technology Development in 2-year Programme: Characterising Source and Benchmarking Simulations

Established Diagnostics...

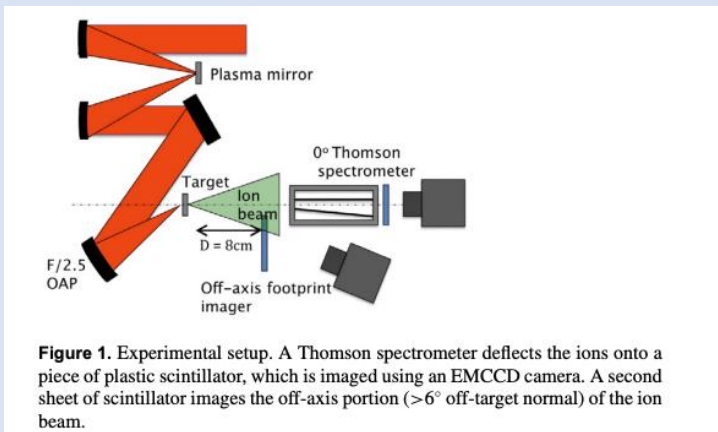
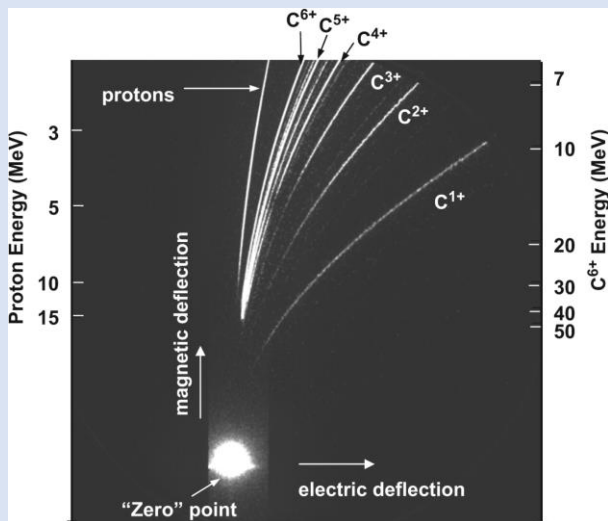


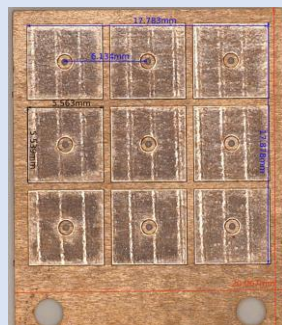
Figure 1. Experimental setup. A Thomson spectrometer deflects the ions onto a piece of plastic scintillator, which is imaged using an EMCCD camera. A second sheet of scintillator images the off-axis portion ($>6^\circ$ off-target normal) of the ion beam.

J.S Green *et al.*, NJP. 12 (2010) 085012

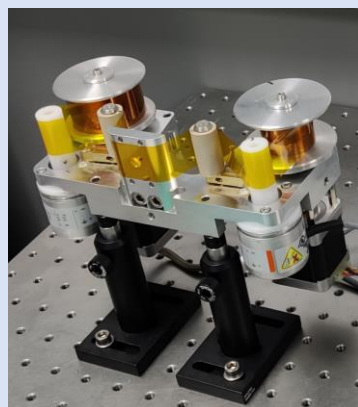


R. Prasad *et al.*, Nucl. Instrum. Methods. 623.2 (2010): 712-715.

Established Targetry...moving toward Hz-level targetry



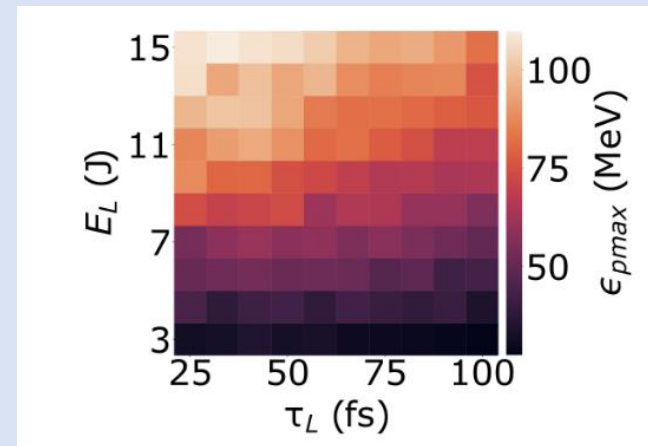
Typical 9-target array



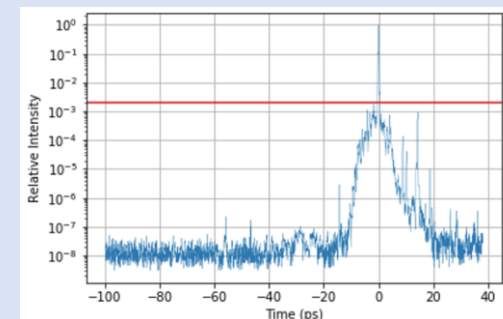
Tape targetry system (online in SCAPA 2022)

...to build a systematic parameter space map of the source performance

- Energy, Flux, Divergence across multiple ion species

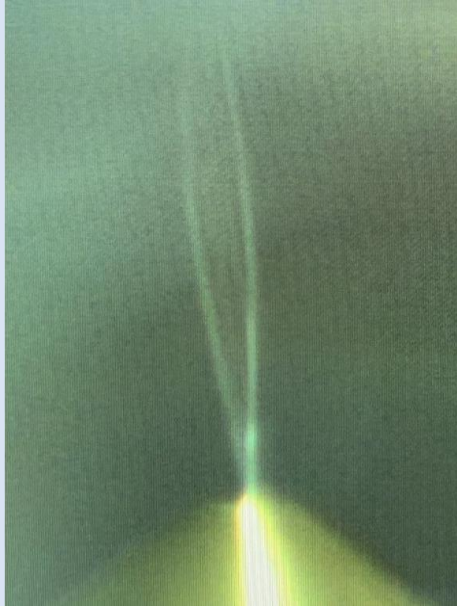


..but also need to consider some other experimental contributions like temporal contrast



Experiments & Technology Development in 3-year Programme: Producing a stable, high-rep source

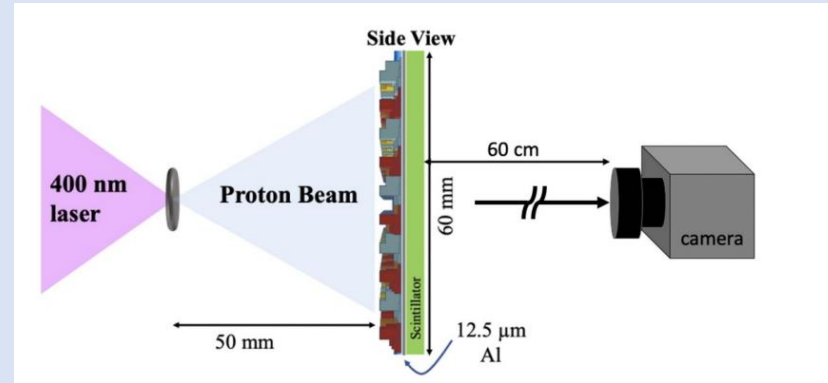
Novel Liquid Targetry



Courtesy of C. Palmer

- Reduces production of debris
- Increases operational time and possible rep rate

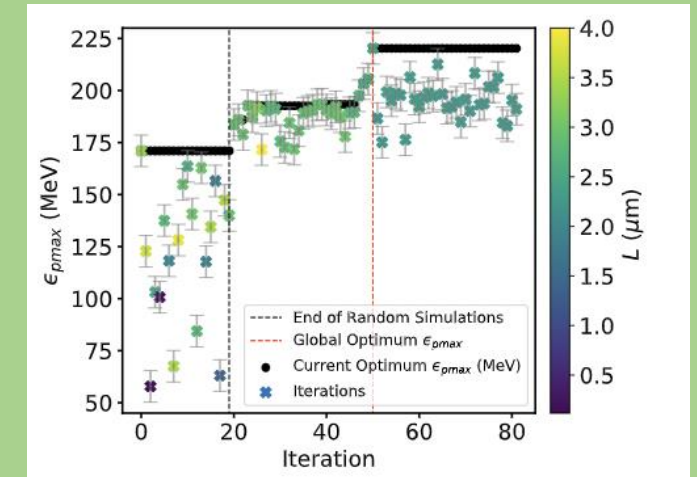
Advanced Particle & Laser Diagnostics



D. Marsical *et al.*, Plasma Phys. Control. Fusion 63 (2021) 114003

- Implementation of advanced (existing) particle diagnostics, taking account of long term operation.
- Implementation of full laser diagnostic suite to support automation, stabilisation.

ML/AI Control & Optimisation



- Application of ML techniques (e.g Bayesian Optimisation) for parameter space
- Application of AI techniques (DNNs, CNNs) for system control and virtual diagnostics

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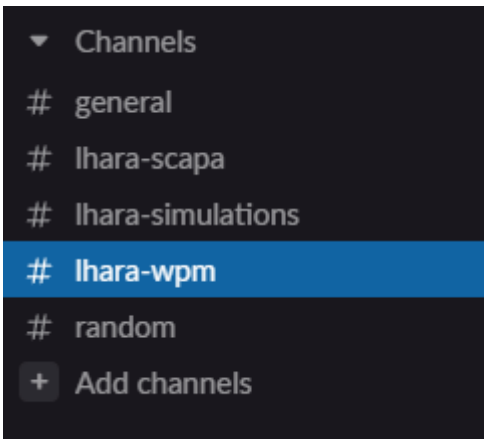
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slack

lhara-source.slack.com

Invite link: https://join.slack.com/t/lhara-source/shared_invite/zt-1jawhl1k0-du69ITEEEy4RvryAx_81Pg