Facility Design & Stage 2

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WPB Meeting

29th October 2024

ROYAL HOLLOWAY UNIVERSITY OF LONDON

LhARA Laser-hybrid Accelerator for Radiobiological Applications

JAI John Adams Institute for Accelerator Science

WPB.6: Tentative Goals

- Design review FFA - examine issues - 1-day meeting Jan 25?
  - List critical issues

- Revise FFA physics design (protons and ions) - Oct 25
  - Assess ion (C6+) design - Oct 25
  - Space charge assessment - July 25
  - Revision FFA magnet design - Dec 25
  - **Deliverable**: revised optics and magnet design that addresses critical issues raised in design review

- Engineering assessment and FFA revision April 26
  - **Deliverable**: revised engineering layouts compatible with new FFA design

- FFA Instrumentation
  - Definition of RF cavity concept Jun 25
  - Definition of Injection/Extraction magnets Jun 25
  - Beam modelling of injection/extraction Oct 25
  - Definition of diagnostic instrumentation May 26

- FFA Concept Reporting
  - Costing and engineering assessment April 26 - July 26
  - (including power requirements, building requirements)
  - Review meeting and report write-up July-Sep 26 - make definition of contents

- **Key Decision** meeting July 26; decide on feasibility of FFA

Integration Challenges

- Injection line redesign
  - Spatial constraints (FFA spiral angle, septum magnets)
  - FFA field leakage
- Proton source description
  - Parameterised distribution - unmodelled features (e.g. pre-plasma)
  - Ion distributions & spectra (simulation)
- Electron spectrum
  - Co-propagating beams – space charge neutralisation
  - Simulation program to establish electron beam sensitivity (GPT / RF-Track)
- PMQs for improved capture efficiency
  - Engineering challenges - optimal target configuration
  - Demagnetisation, shielded / unshielded?
  - Charge neutralisation / beam dynamics
- Gabor lens field description
  - Monte Carlo transport modelling (BDSIM)
  - Confinement EM fields for low energy protons & electrons.
    - Geometry dependant

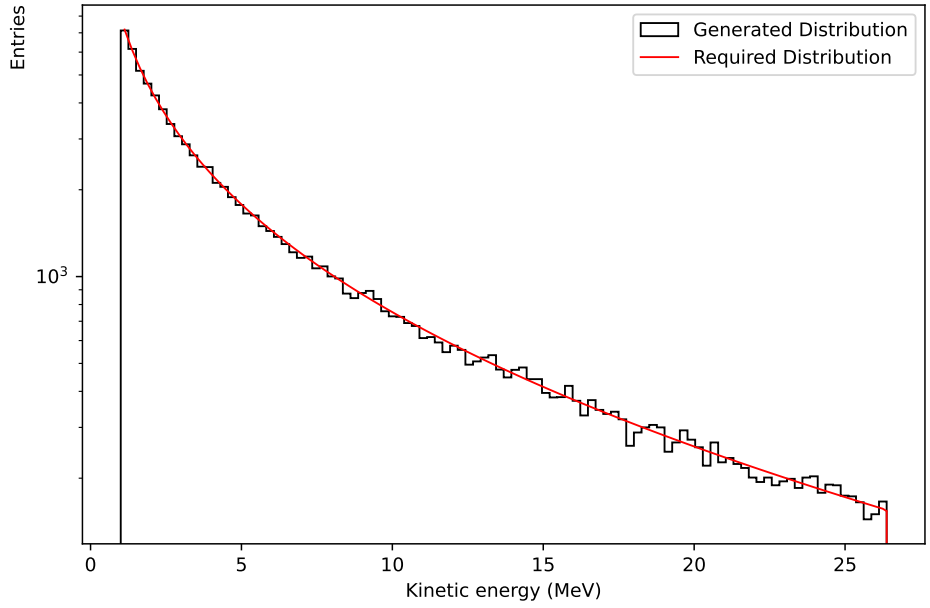
Source Description

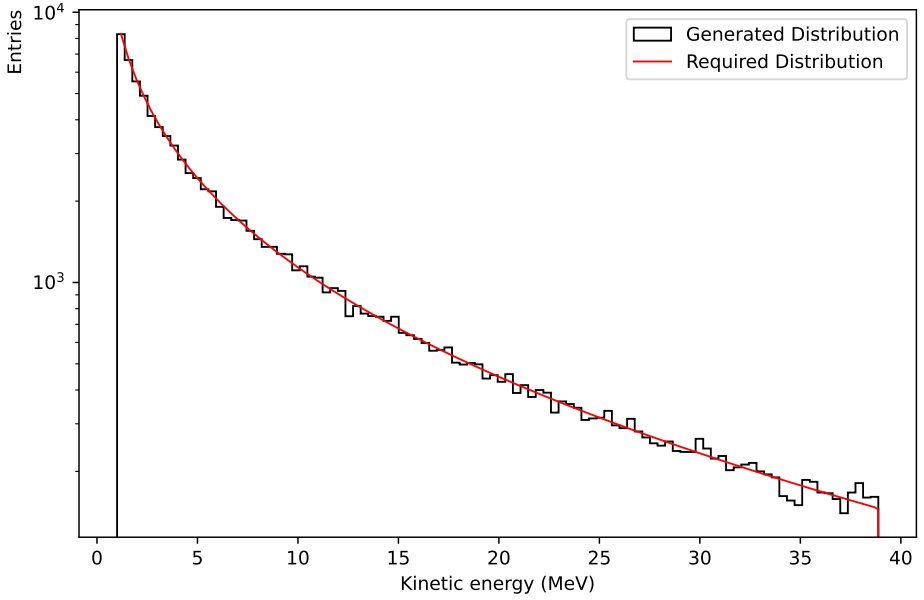
Previous laser parameters (LION)

Parameter	Value	Unit
σ_x	4e-06	μm
σ_y	4e-06	μm
$\cos\theta_S\|_{\min}$	0.998	
$\varepsilon_{\min}$	1.0	MeV
$\varepsilon_{\max}$	25.0	MeV
Laser power	2.5e+15	W
Laser energy	70.0	J
Laser wavelength	0.8	μm
Laser pulse duration	2.8e-14	s
Laser spot size	4e-07	m
Laser intensity	4e+20	J/m^2
Electron divergence angle	25.0	degrees
Intercept of σ_{θ_S}	20.0	degrees
Scaled slope of σ_{θ_S}	15.0	degrees

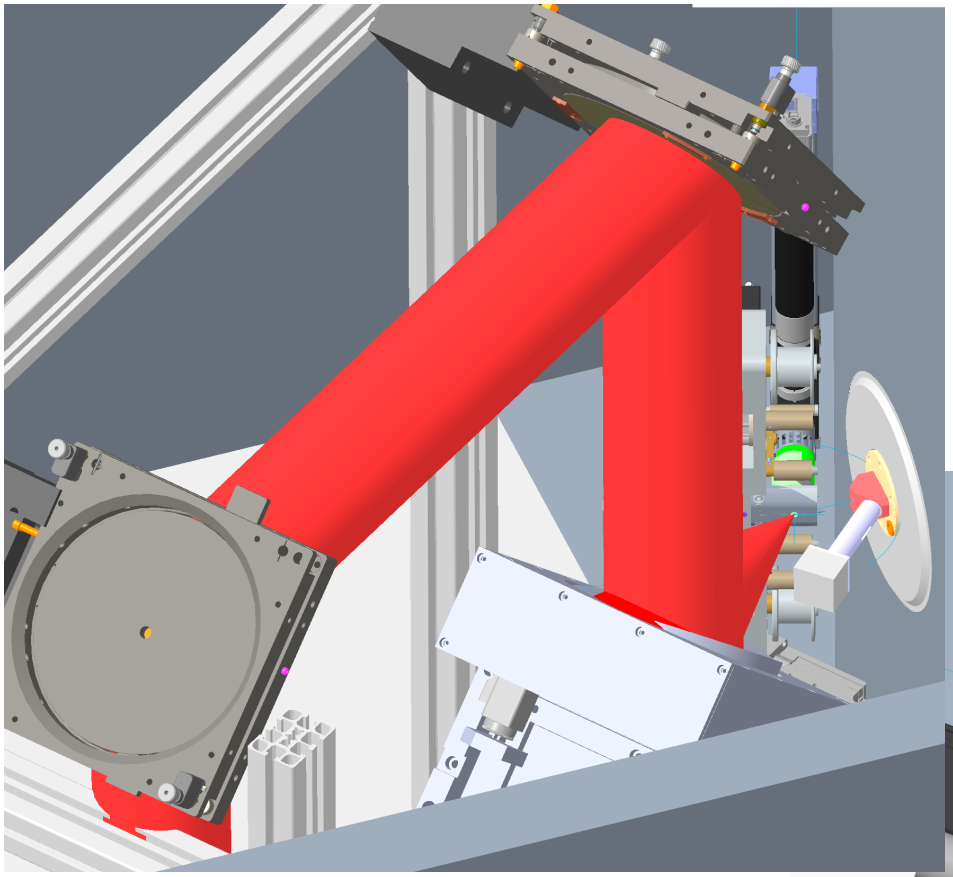
Updated laser parameters (LhARA)

Parameter	Value	Unit
σ_x	4e-06	m
σ_y	4e-06	m
$\cos\theta_S\|_{\min}$	0.998	
$\varepsilon_{\min}$	1.0	MeV
$\varepsilon_{\max}$	25.0	MeV
nPnts	1000	
Laser power	1.0e14	W
Laser energy	10.0	J
Laser wavelength	0.8	μm
Laser pulse duration	2.8e-14	s
Laser spot size	2e-06	m
Laser intensity	9e+20	W/cm^2
Electron divergence angle	25.0	degrees
Intercept of σ_{θ_S}	20.0	degrees
Scaled slope of σ_{θ_S}	15.0	degrees

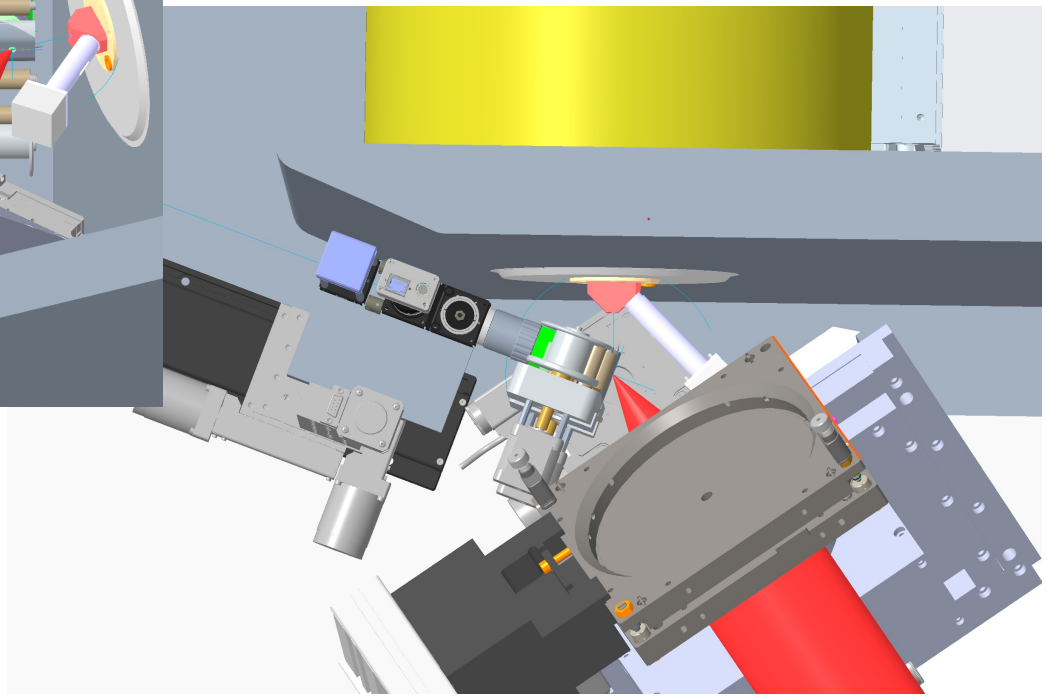




Source Housing: Engineering



- Target &/or incident laser angle
- PMQ dimensions
  - Proximity to target, fringe field extent
  - Capture may alleviate spatial challenges



- Proximity of Gabor lens plasma field to physical device boundary.
  - Assumed 15cm space