

LhARA Meeting

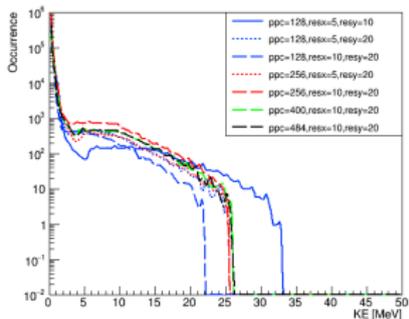
Hin Tung Lau

September 24, 2020

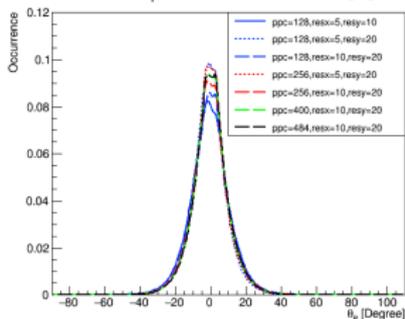
Convergence Update

- Most notable discrepancy is the KE spectrum coming from PZ.
- Trend suggests lower ppc can be used, but finer resolution scales required.

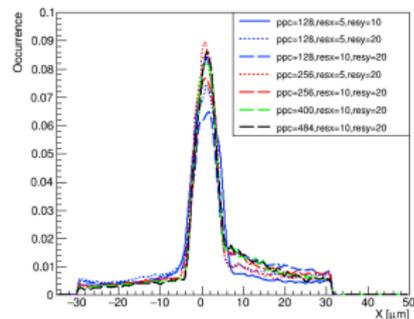
Proton KE Histogram: Time = 998 ± 10 [fs]



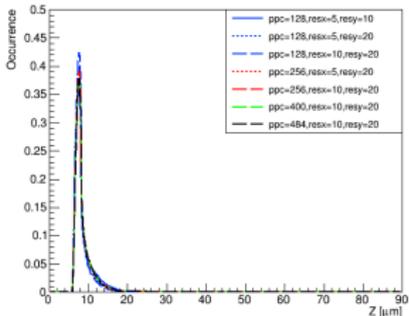
Proton θ_p -PDF: Time = 998 ± 10 [fs]



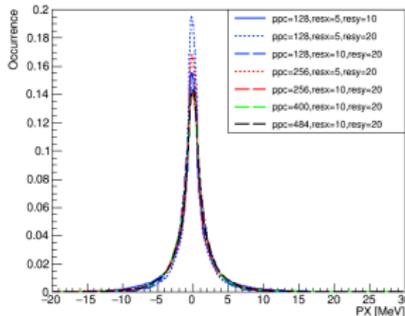
Proton X-PDF: Time = 998 ± 10 [fs]



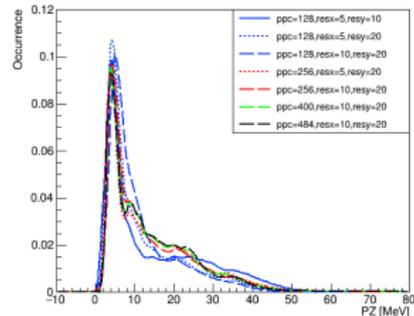
Proton Z-PDF: Time = 998 ± 10 [fs]



Proton PX-PDF: Time = 998 ± 10 [fs]



Proton PZ-PDF: Time = 998 ± 10 [fs]



1 Near-100 MeV protons via a laser-driven transparency-enhanced hybrid acceleration scheme by Higginson et al.

- Achieved > 94 MeV protons with Vulcan laser ($E_L = (210 \pm 40)$ J, $\tau_L = (0.9 \pm 0.1)$ ps, $\lambda_L = 1.053 \mu\text{m}$) on foil thickness = 90 nm.
- Trend of simulations match experiments, though absolute values higher due to 2D dimensionality.
- Used a shorter pulse duration for simulations.

2 Effect of rear surface fields on hot, refluxing and escaping electron populations via numerical simulations by Rusby et al.

- Extra cooling in rear sheath seen in simulations compared to formulae:
 - Lost electrons due to grid size
 - Energy going into creation/driving of sheath field.
- Simulations show 95% of initial hot electrons are refluxing electrons and 5% escape (1% are ballistic electrons)
- Experimentally 15% of initial hot electrons escape
 - Vast number of sheath electrons which consist of a large number of low energy electrons.

3 **Energy absorption and coupling to electrons in the transition from surface- to volume-dominant intense laser-plasma interaction regimes by Williamson et al.**

- Experiments and simulations show significant direct laser acceleration of electrons in volumetric-dominated regime (ultra thin foils).
- An optimum thickness of about 380 nm is where target does not become relativistically transparent.
- Total absorption varies weakly with target thickness, but dynamics of electrons varies greatly.

4 **Role of magnetic field evolution on filamentary structure formation in intense laser-foil interactions by King et al.**

- Filamentary structures in magnetic field appear for ultra thin targets (tens of nm) during RPA.
- Investigated using two laser pulses.
- For this structure to influence protons, it has to form early enough before protons expand.

5 **Enhanced laser-energy coupling to dense plasmas driven by recirculating electron currents by Gray et al.**

- Laser absorption scales differently with intensity depending on whether pulse energy or focal spot size is varied.
- Larger spot sizes can give higher total energy of electrons compared to small spots sizes for the same peak intensity.
- Target thickness has greatest effect on electron spectra for large focal sizes due to recirculation of electrons.

Generating Distribution (for M.King)

From 2D TNSA simulations using SMILEI on a $2\ \mu\text{m}$ plastic foil, sample and smear a third dimension to obtain a 3D distribution to send into the beamline.

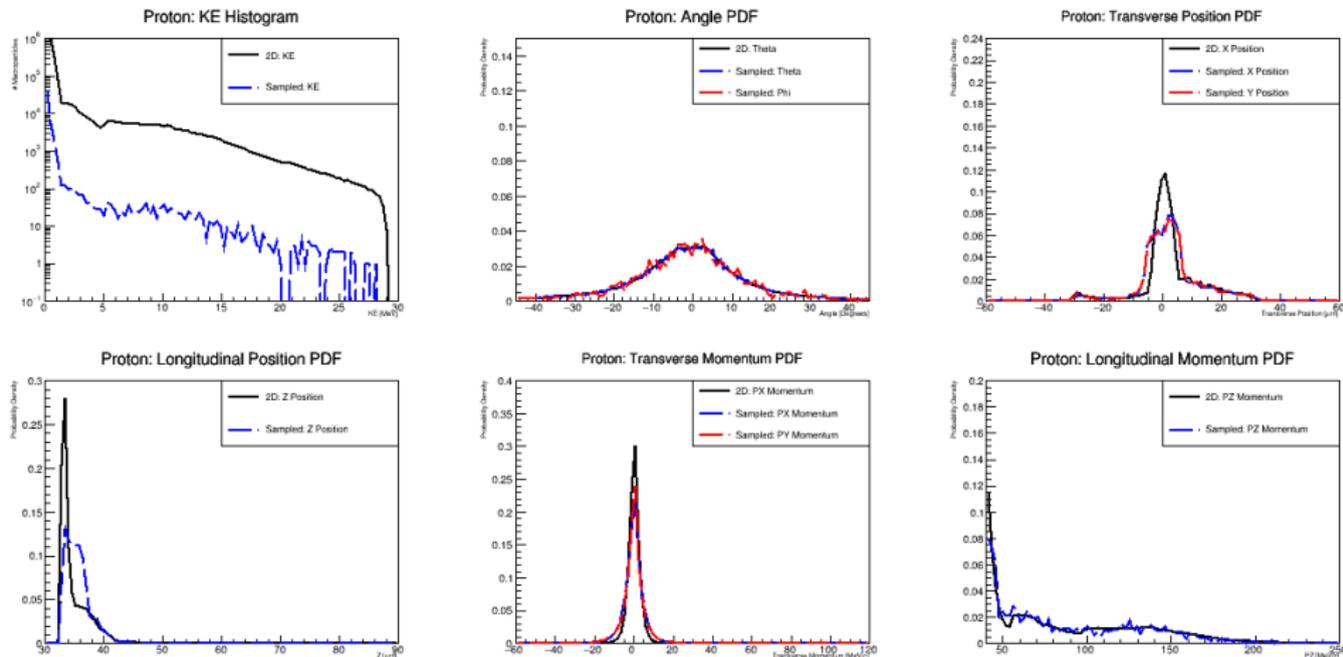


Figure: Comparison of sampled proton beam distribution against the simulations from SMILEI.

- 1 Methods on dealing with enhanced 2D simulation energies compared to 3D simulations and experiments?
 - Reasoning of adjusting pulse duration?
(<https://www.nature.com/articles/s41467-018-03063-9>)
- 2 Are there particular benchmark experiments used to test simulation parameter convergence?