

LhARA: Capture Meeting

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Laser Source and Simulation Parameters (2D)

Laser wavelength	0.8 μm
Laser energy	2.5 J
Laser power	100 TW
Focal spot FWHM	3 μm
Pulse width FWHM	25 fs
Laser angle of incidence	45 $^\circ$

Table: Laser Parameters

Laser intensity	9.18 $\times 10^{20}$ W/cm 2
Laser a_0	20.75

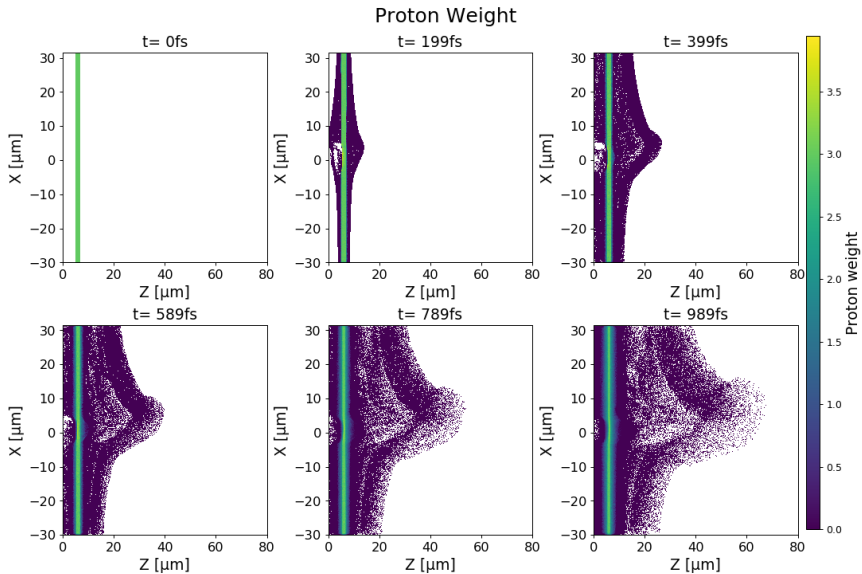
Table: Calculated quantities from laser parameters.

Grid Horizontal Size (x)	80 μm
Grid Vertical Size (y)	60 μm

Table: Simulation grid size.

- Thin target is modelled with a hydrocarbon (2 μm)

Proton Timesteps



2D to 3D Distribution

- Only able to run a highly resolved simulation in 2D, so distribution at last timestep is sampled to get a 3D beam
- Underlying assumption that angle of incidence is 45° for both transverse axes

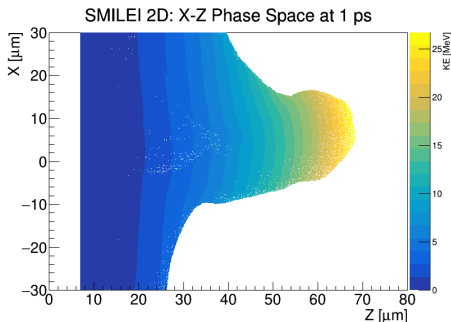


Figure: Proton distribution coming off the rear of target. Colour represents the kinetic energy of protons.

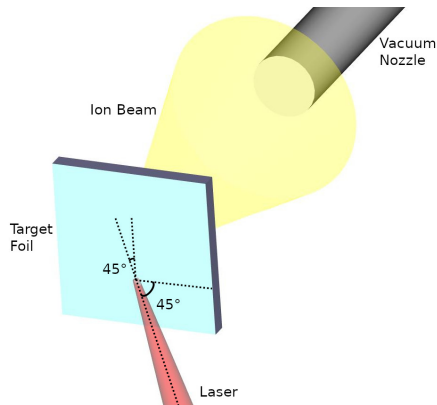
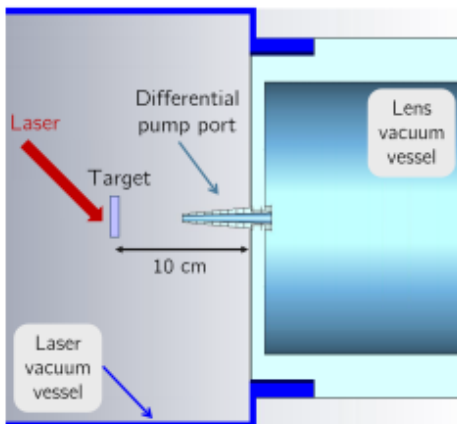


Figure: Assumed setup geometry in 3D.

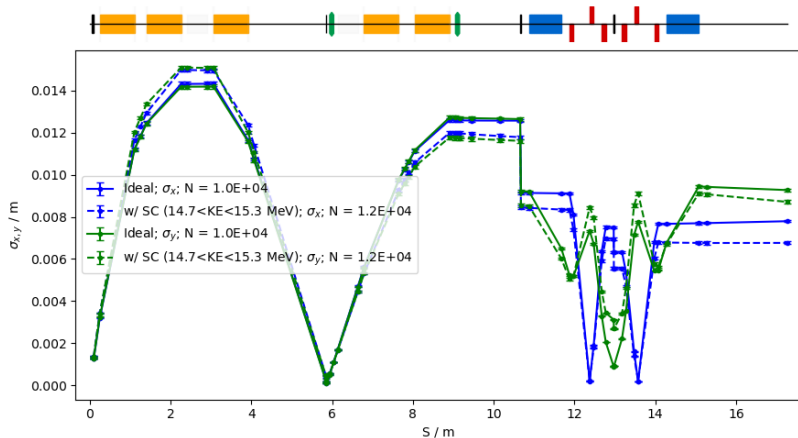
Vacuum Nozzle Interface

- Between the target and entrance to Gabor lens element is about 10 cm
- 5 cm will be drift space, the other half is the vacuum nozzle
- Vacuum nozzle modelled as a cone has entrance radius of 2 mm, and exit radius of 2.87 mm



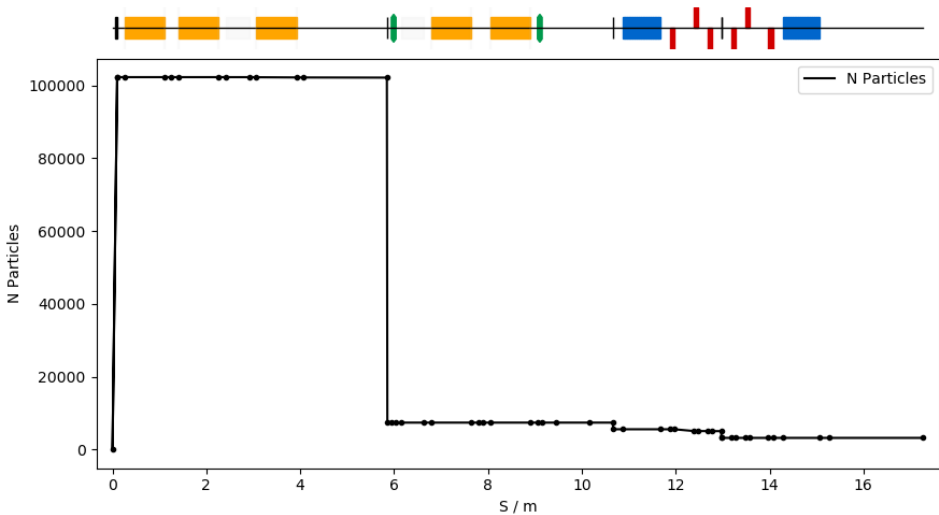
Beam Size Evolution

- Bug fix affecting all simulations (collimator + userdist token)
- Ran simulation with slightly higher number of particles (about 12000 particles out of nozzle have energies between $14.7 < KE < 15.3$ MeV)



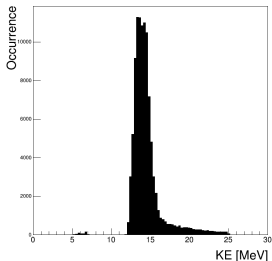
Beam Losses

- For KE > 5 MeV beam

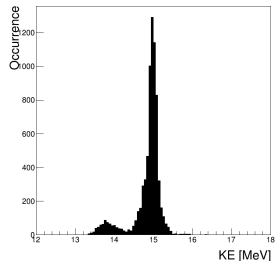


Beam Losses

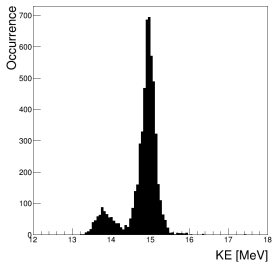
Cartesian Sampled Proton Beam: At Nozzle End (w/ SC)



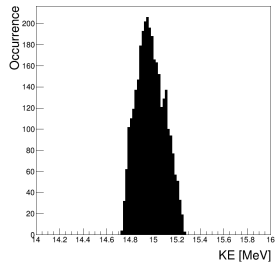
Cartesian Sampled Proton Beam: After First Collimator (w/ SC)



Cartesian Sampled Proton Beam: After Second Collimator (w/ SC)

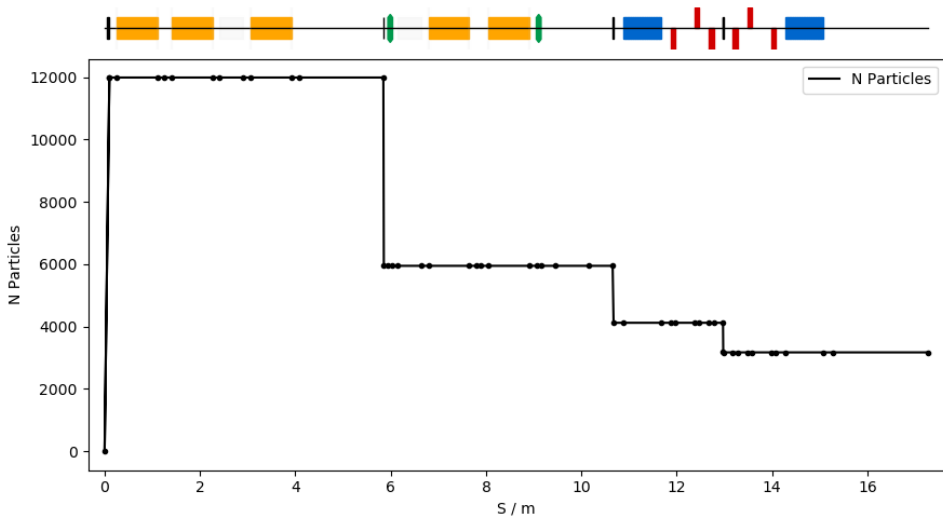


Cartesian Sampled Proton Beam: After Collimator in Arc (w/ SC)



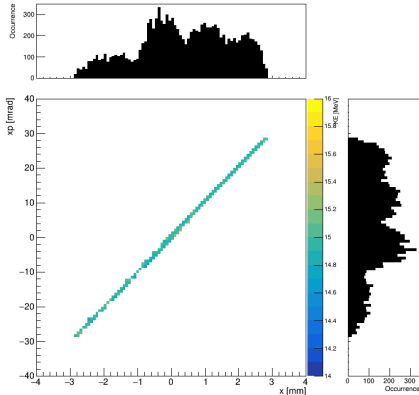
Beam Losses

- For the $14.7 < KE < 15.3$ MeV beam

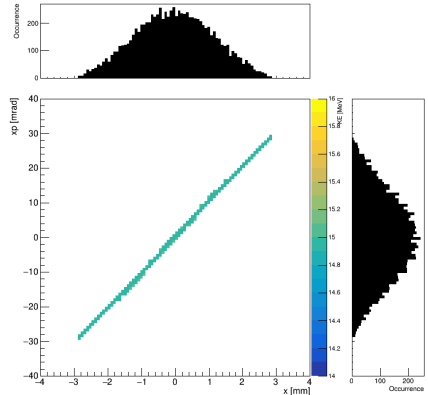


Fitted Twiss coming out of Nozzle ($14.7 < KE < 15.3$ MeV)

Cartesian Sampled Proton Beam: Nozzle End (w/ SC)



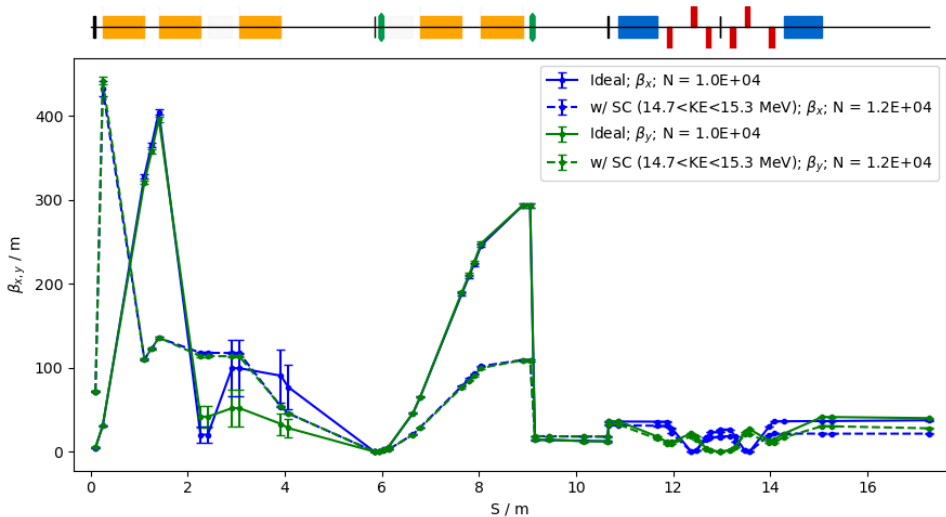
Ideal Beam: Nozzle End (w/ SC)



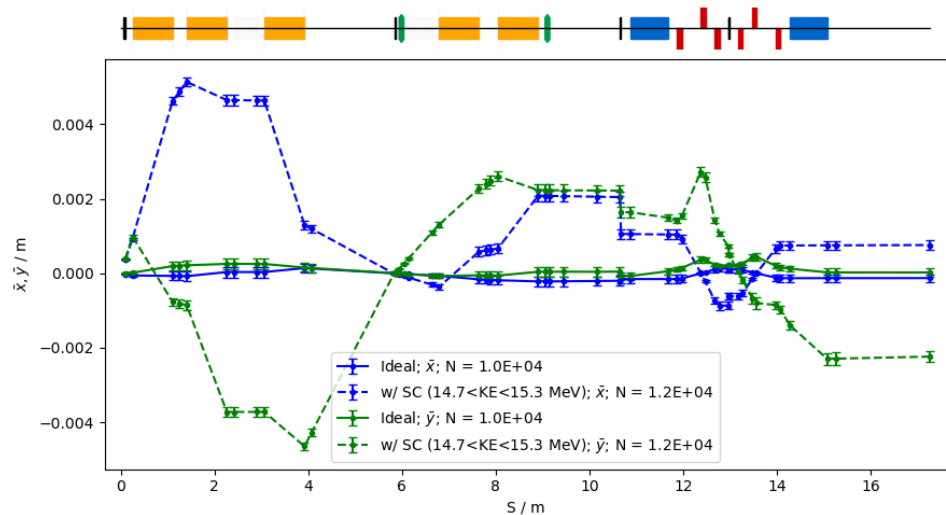
β_x [m]	71.69 ± 0.62
α_x	-718.60 ± 6.25
ϵ_x [π m rad]	$2.62 \times 10^{-8} \pm (2.61 \times 10^{-10})$
β_y [m]	71.49 ± 0.72
α_y	-716.41 ± 7.21
ϵ_y [π m rad]	$2.61 \times 10^{-8} \pm (2.85 \times 10^{-10})$

β_x [m]	4.81 ± 0.03
α_x	-49.43 ± 0.35
ϵ_x [π m rad]	$3.28 \times 10^{-7} \pm (4.3 \times 10^{-9})$
β_y [m]	5.00 ± 0.35
α_y	-51.00 ± 0.35
ϵ_y [π m rad]	$3.26 \times 10^{-7} \pm (4.4 \times 10^{-9})$

Beta Evolution of Beam ($14.7 < KE < 15.3$)



Mean of Beam ($14.7 < KE < 15.3$)



Positional Plots

Cartesian Sampled Proton Beam: Nozzle End (14.7-KE<15.3 MeV w/ SC)

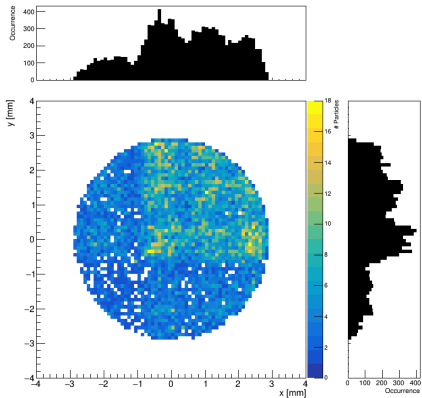


Figure: Colour represents binning population.

Cartesian Sampled Proton Beam: Nozzle End (KE>5 MeV w/ SC)

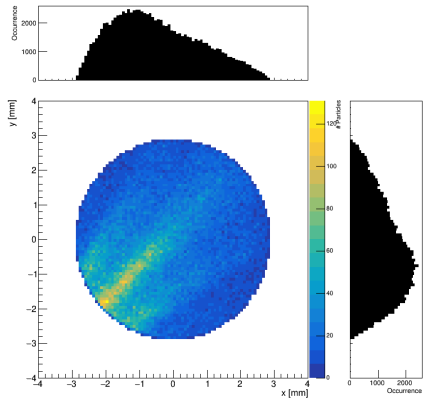
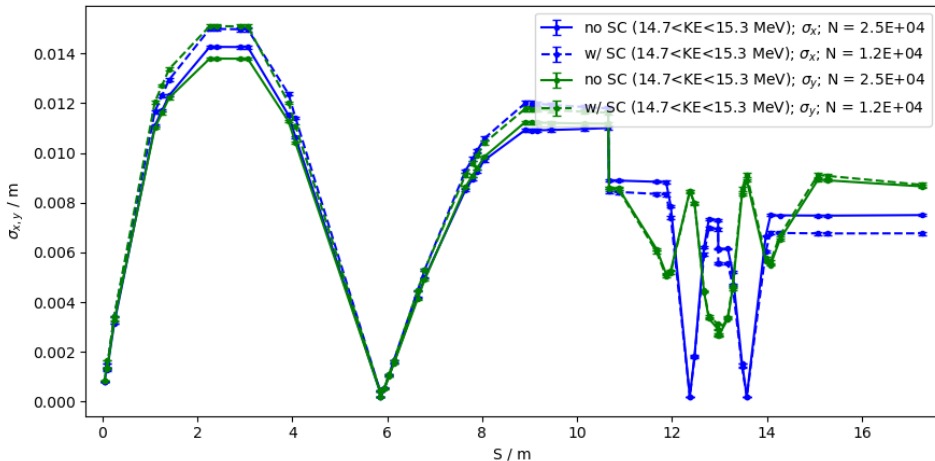


Figure: Colour represents binning population.

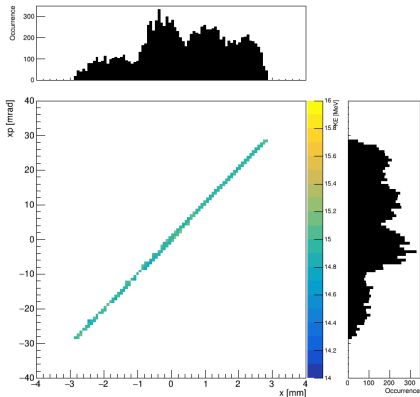
No SC vs SC for Sampled Beam ($14.7 < KE < 15.3$ MeV)

• No SC vs SC beam size evolution

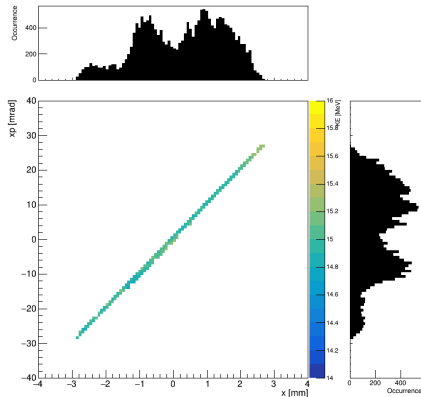


No SC vs SC for Sampled Beam ($14.7 < KE < 15.3$ MeV)

Cartesian Sampled Proton Beam: Nozzle End (w/ SC)



Cartesian Sampled Proton Beam: Nozzle End (no SC)



β_x [m]	71.69 ± 0.62
α_x	-718.60 ± 6.25
ϵ_x [π m rad]	$2.62 \times 10^{-8} \pm (2.61 \times 10^{-10})$
β_y [m]	71.49 ± 0.72
α_y	-716.41 ± 7.21
ϵ_y [π m rad]	$2.61 \times 10^{-8} \pm (2.85 \times 10^{-10})$

β_x [m]	85.57 ± 0.64
α_x	-855.47 ± 6.39
ϵ_x [π m rad]	$1.82 \times 10^{-8} \pm (1.4 \times 10^{-10})$
β_y [m]	87.69 ± 0.98
α_y	-876.60 ± 0.98
ϵ_y [π m rad]	$1.91 \times 10^{-8} \pm (2.1 \times 10^{-10})$