

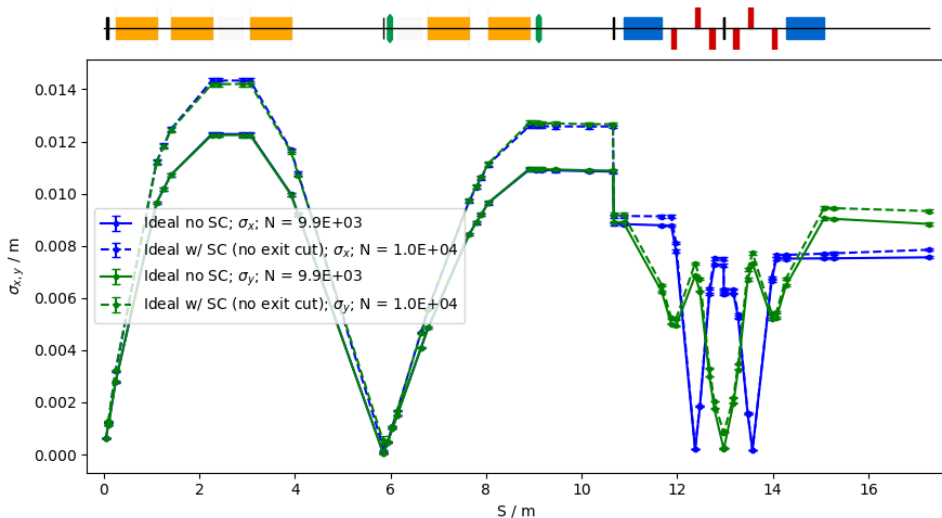
LhARA: Capture Meeting

Hin Tung Lau

February 4, 2021

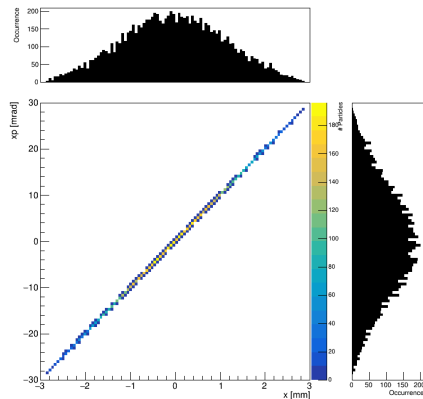
- To investigate lack of growth of beam emittance:
- Ideal beam used for comparison in previous cases was simulated by Will previously in GPT
- Verified result by running ideal beam simulation starting from the source
- Also included collimation due to the nozzle which was missing in Will's simulations
- The lack of emittance growth in sampled beam is not because of an issue in the procedure

Reran Ideal Beam Starting from Target (no nozzle collimation)



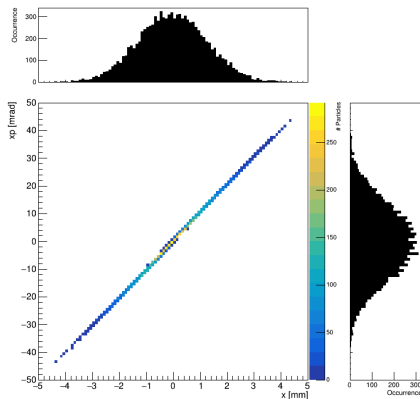
Reran Ideal Beam Starting from Target (no nozzle collimation)

Ideal Beam: Nozzle End (no SC)



β_x [m]	66.3 ± 0.6
α_x	-663.3 ± 6.5
ϵ_x [m rad]	$1.9 \times 10^{-8} \pm (1.8 \times 10^{-10})$
β_y [m]	65.6 ± 0.6
α_y	-655.4 ± 6.3
ϵ_y [m rad]	$1.9 \times 10^{-8} \pm (1.8 \times 10^{-10})$

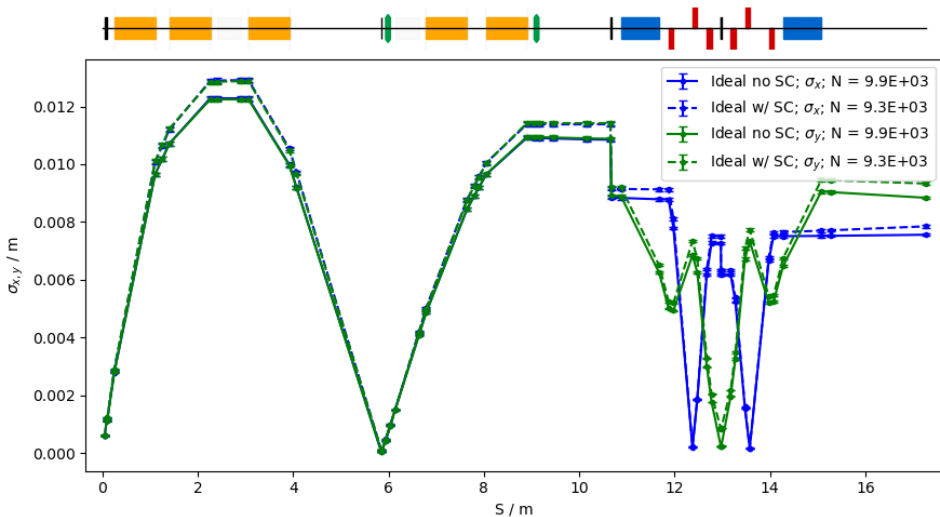
Ideal Beam: Nozzle End (w/ SC, no exit nozzle cut)



β_x [m]	5.2 ± 0.04
α_x	-53.4 ± 0.4
ϵ_x [m rad]	$3.0 \times 10^{-7} \pm (4.3 \times 10^{-9})$
β_y [m]	5.4 ± 0.04
α_y	-55.0 ± 0.4
ϵ_y [m rad]	$3.0 \times 10^{-7} \pm (4.4 \times 10^{-9})$

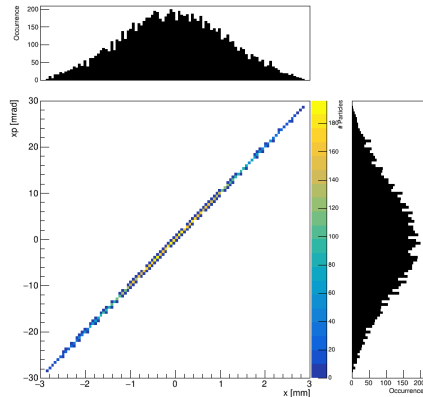
Ideal Beam Starting from Target (with nozzle cuts)

- Exit radius brings beam evolution to be more similar to no space charge evolution



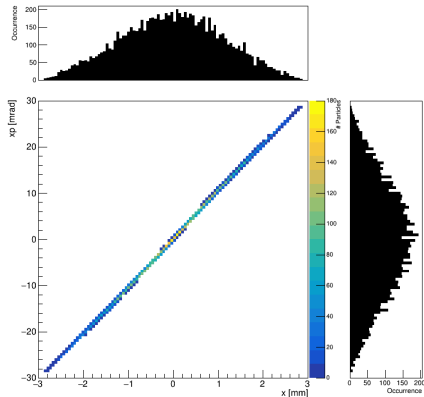
Ideal Beam Starting from Target (with nozzle cuts)

Ideal Beam: Nozzle End (no SC)



β_x [m]	66.3 ± 0.6
α_x	-663.3 ± 6.5
ϵ_x [m rad]	$1.9 \times 10^{-8} \pm (1.8 \times 10^{-10})$
β_y [m]	65.6 ± 0.6
α_y	-655.4 ± 6.3
ϵ_y [m rad]	$1.9 \times 10^{-8} \pm (1.8 \times 10^{-10})$

Ideal Beam: Nozzle End (w/ SC)

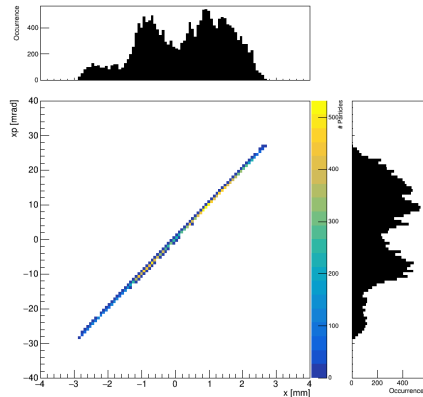


β_x [m]	5.9 ± 0.04
α_x	-60.7 ± 0.4
ϵ_x [m rad]	$2.2 \times 10^{-7} \pm (2.6 \times 10^{-9})$
β_y [m]	6.2 ± 0.4
α_y	-63.9 ± 0.4
ϵ_y [m rad]	$2.1 \times 10^{-7} \pm (2.4 \times 10^{-9})$

- Centring beam is a free parameter
- The fitted emittance after space charge can change depending on initial centring

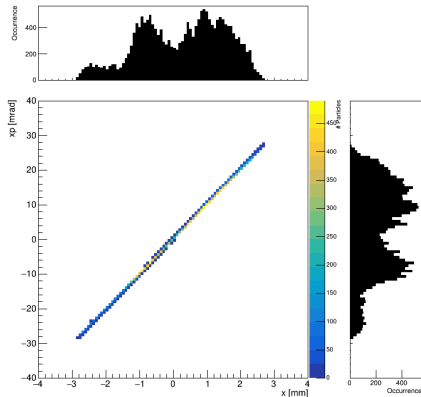
No SC vs SC for Sampled Beam (14.7 < KE < 15.3 MeV) – 1

Cartesian Sampled Proton Beam: Nozzle End (14.7 < KE < 15.3 MeV, no SC)



β_x [m]	85.57 ± 0.64
α_x	-855.47 ± 6.39
ϵ_x [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 [m rad]	$1.91 \times 10^{-8} \pm (2.1 \times 10^{-10})$

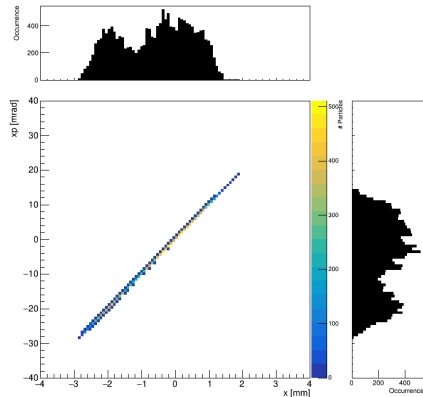
Cartesian Sampled Proton Beam: Nozzle End (14.7 < KE < 15.3 MeV w/ SC)



β_x [m]	53.2 ± 0.3
α_x	-534.5 ± 2.7
ϵ_x [m rad]	$2.94 \times 10^{-8} \pm (2.41 \times 10^{-10})$
β_y [m]	52.8 ± 0.3
α_y	-530.11 ± 2.9
ϵ_y [m rad]	$3.2 \times 10^{-8} \pm (2.6 \times 10^{-10})$

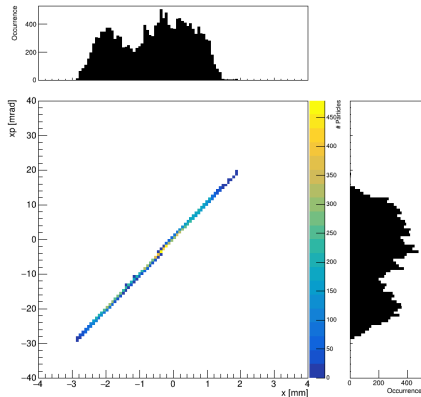
No SC vs SC for Sampled Beam ($14.7 < KE < 15.3$ MeV) – 2

Cartesian Sampled Proton Beam: Nozzle End ($14.7 < KE < 15.3$ MeV, no SC)



β_x [m]	80.9 ± 0.5
α_x	-809.1 ± 5.1
ϵ_x [m rad]	$1.4 \times 10^{-8} \pm (1.1 \times 10^{-10})$
β_y [m]	80.2 ± 1.0
α_y	-802.2 ± 10.0
ϵ_y [m rad]	$1.5 \times 10^{-8} \pm (1.9 \times 10^{-10})$

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



β_x [m]	10.1 ± 0.1
α_x	-103.0 ± 0.6
ϵ_x [m rad]	$1.1 \times 10^{-7} \pm (7.8 \times 10^{-10})$
β_y [m]	10.5 ± 0.1
α_y	-107.2 ± 0.7
ϵ_y [m rad]	$1.1 \times 10^{-7} \pm (7.9 \times 10^{-10})$