Phase 1- Upgrade Injector Model for KLF

Sunil Pokharel

July 27, 2021

Outline

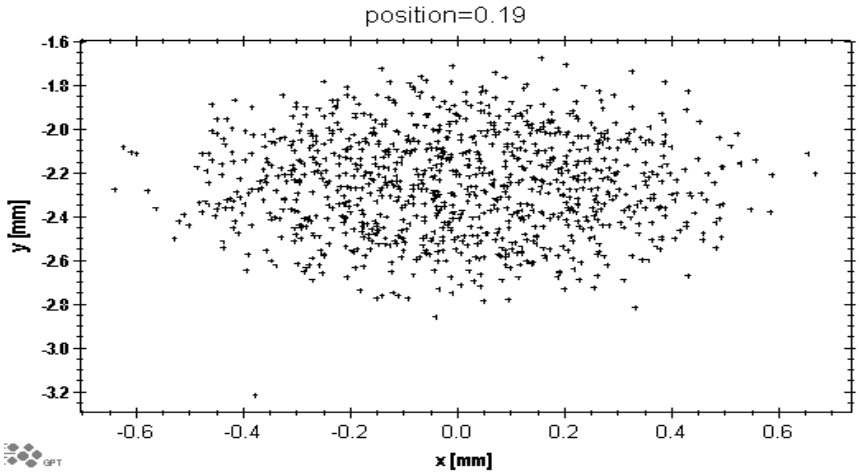
- Used the optimized parameter Phase 1 Upgrade Injector GPT Model (Courtesy- Alicia Hofler, 06/16/2021)
- Positions for elements from the gun through MFA0I03 are based on beamlinelayoutapril152020-gun-chopper.pdf and is noted as beamlinelayoutapril15.pdf in the GPT files.
- Downstream of MFA0I03, the positions are based on measurements Y. Wang and A. Hofler made in 2011, information from mechanical drawings, and even extracted from the old CEBAF PARMELA deck.
- Reference the quick reference drawing injector-quick-reference-rev6-20210607.pdf
- Initial distributions
- Energy gain
- Beam Envelope
- End distribution

Initial distribution

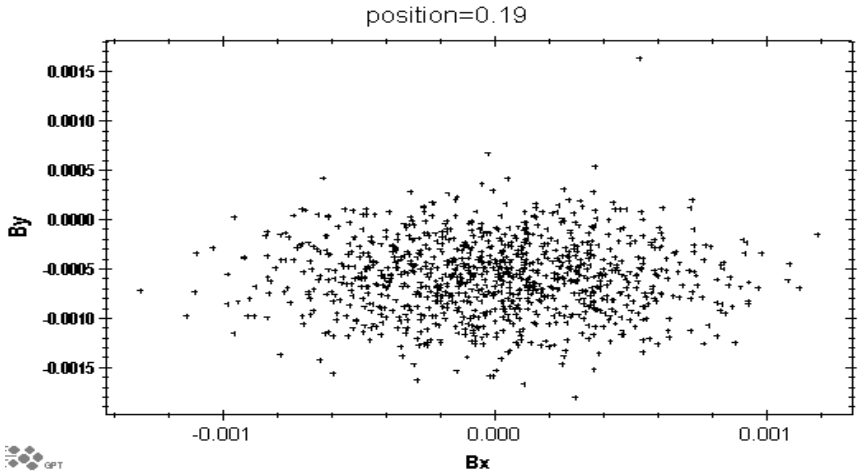
- 130 kV D.C. gun
- 1 Prebuncher, 1Buncher, 5 Captures, Old 5-5 1/4 Cryomodule Booster
- 100 μA beam current at laser rf frequency=499 MHz (with space charge3Dmesh, q=$-2.0040080160321 \times 10^{-13}$ C = 0.20 pC)
- Equivalent to 5 μA, 25 MHz repetition rate, 40 ns bunch spacing
- GaAsMTE = 0.030691;
- Thermal emittance 0.061 mm-mrad, FWHM=45 ps; 19.10 ps bunch length, 0.25 mm beam size, Gaussian Beam
- 1000 macro-particles

Initial distribution

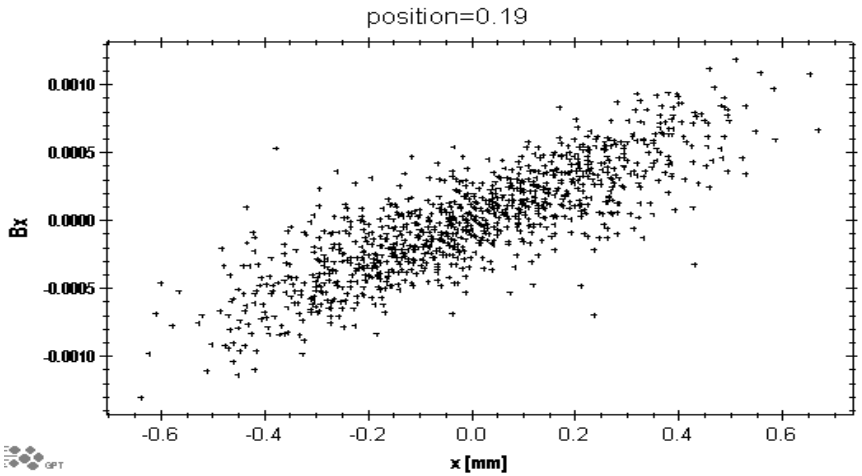
spatial distribution



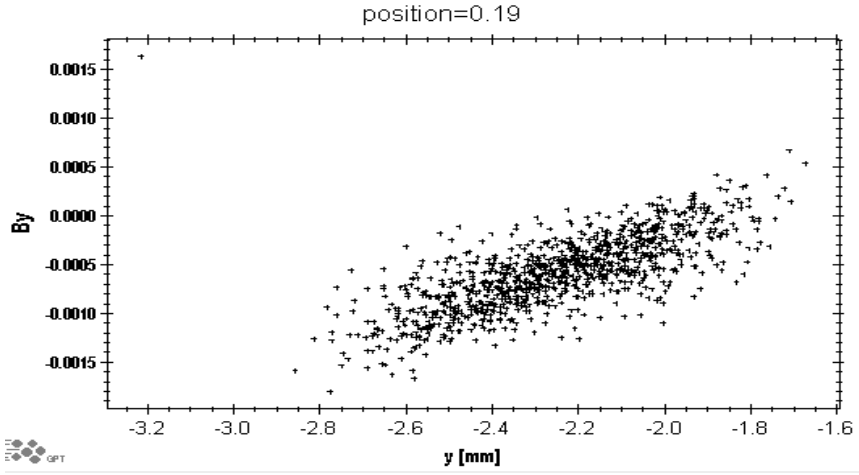
momentum distribution



horizontal phase space

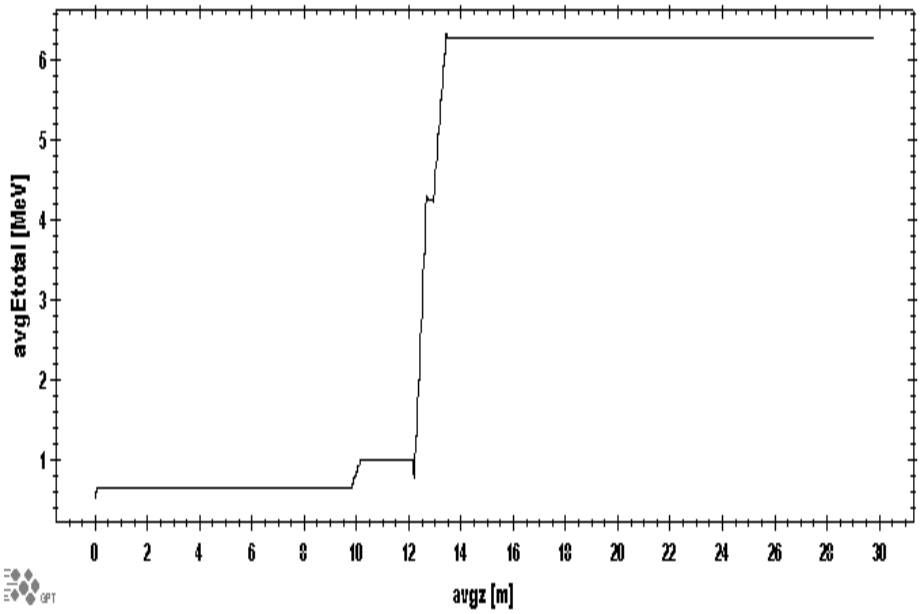


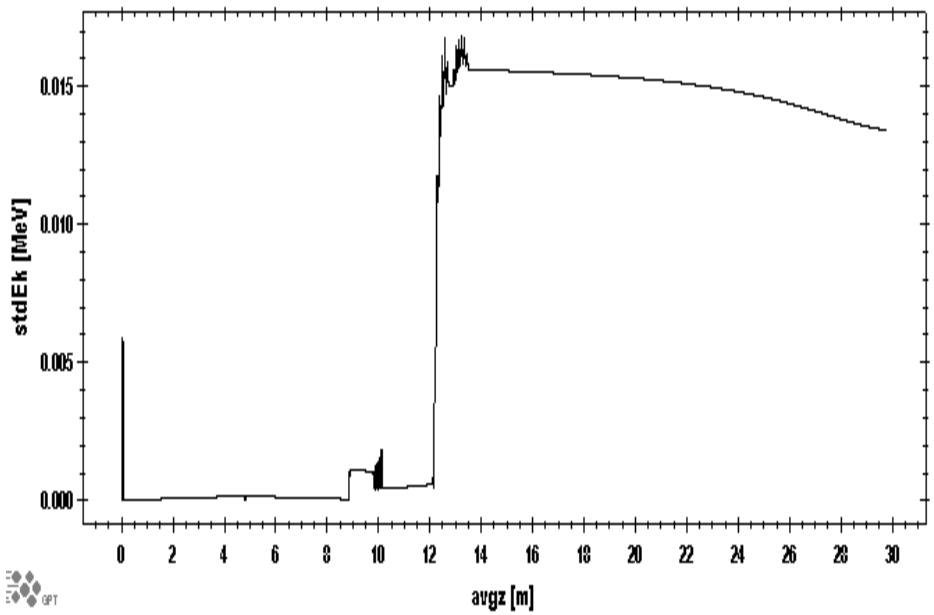
vertical phase space



Total energy at 30 m downstream beamline

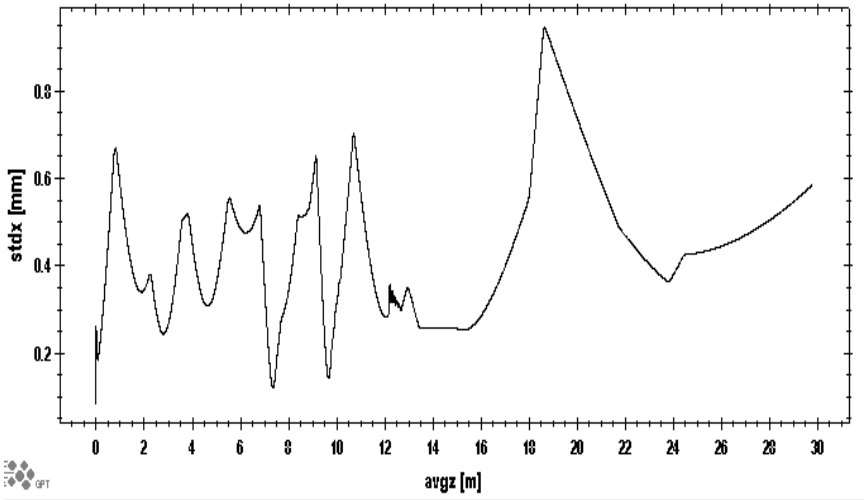
E_{total}=6.284 MeV, Ek_{avg}=5.7732 MeV, stdE_k=0.0134 MeV

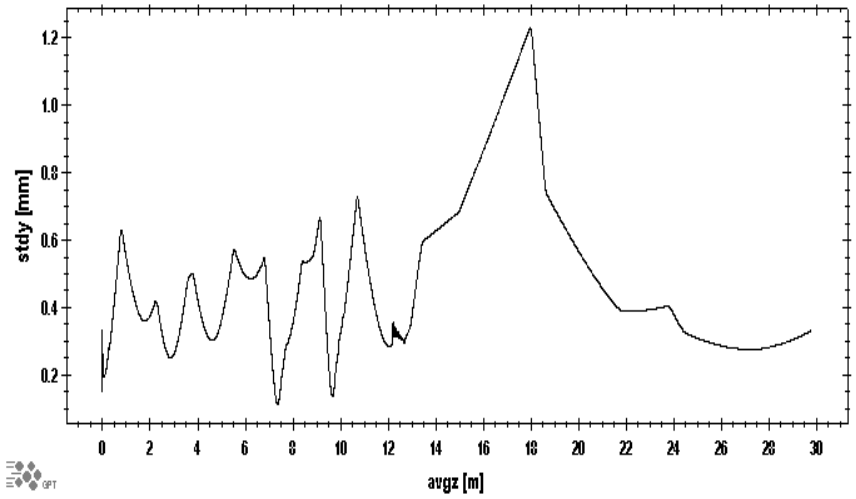


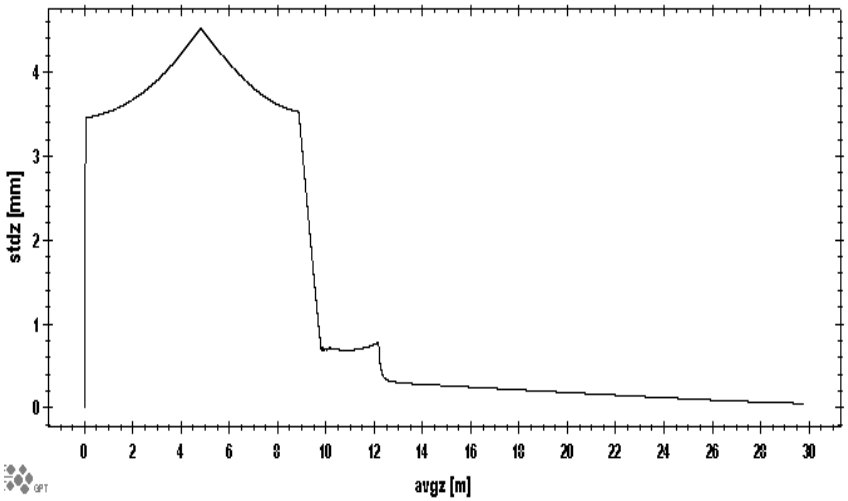


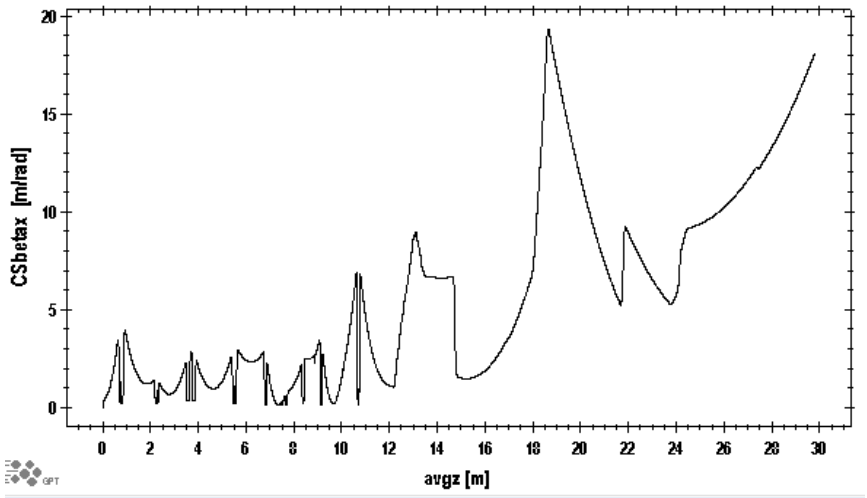
The average beam energy is 6.284 MeV and the energy spread (stde) of the beam is about 0.0134 MeV.

Beam Envelope

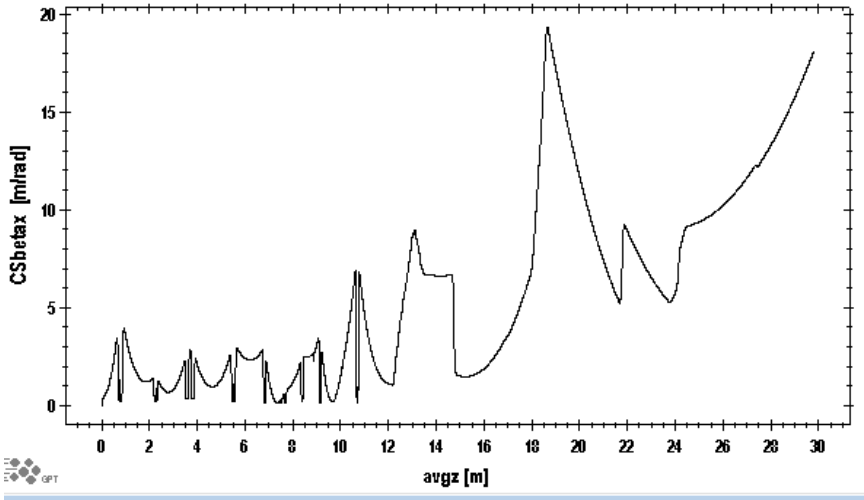


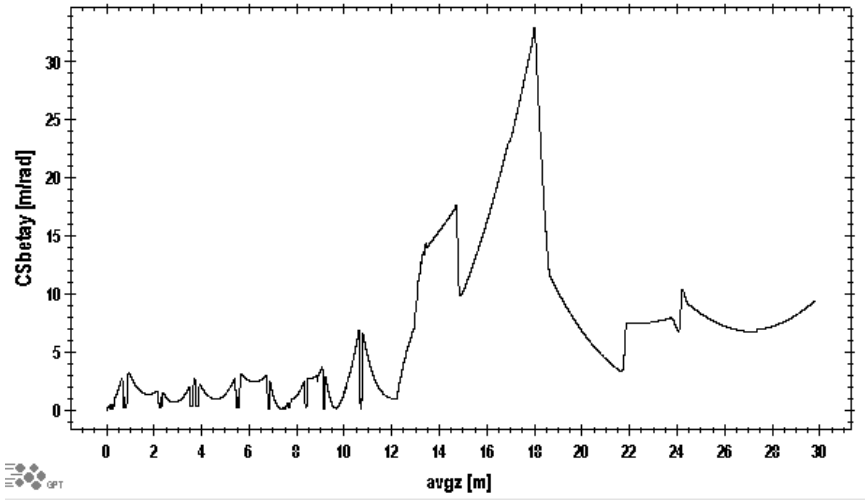


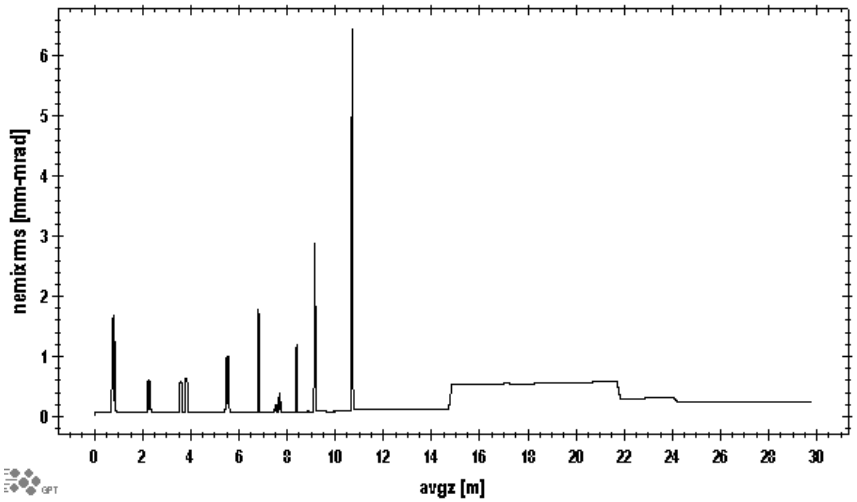


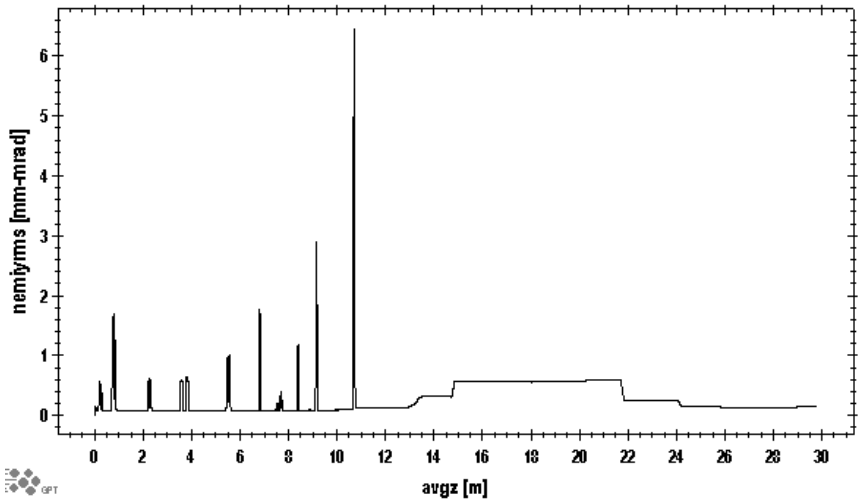


Beam Envelope



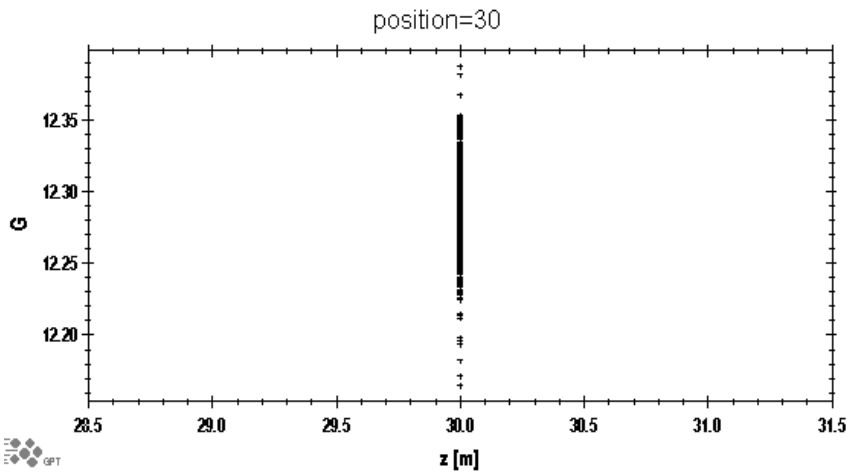




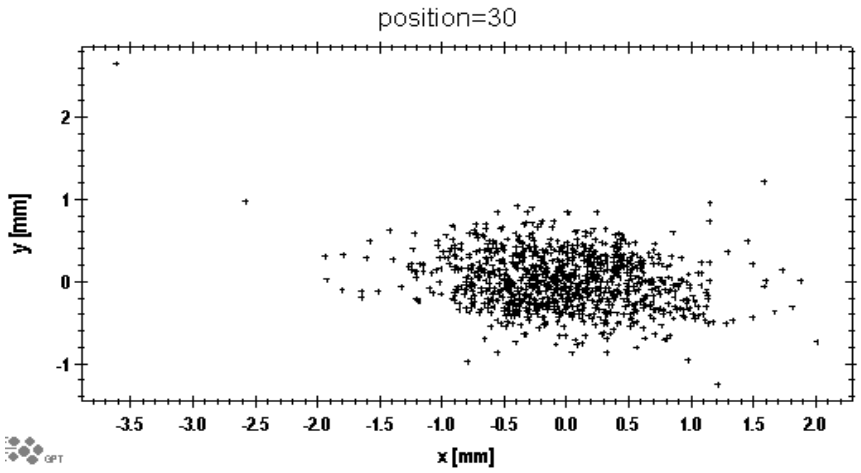


Final distribution

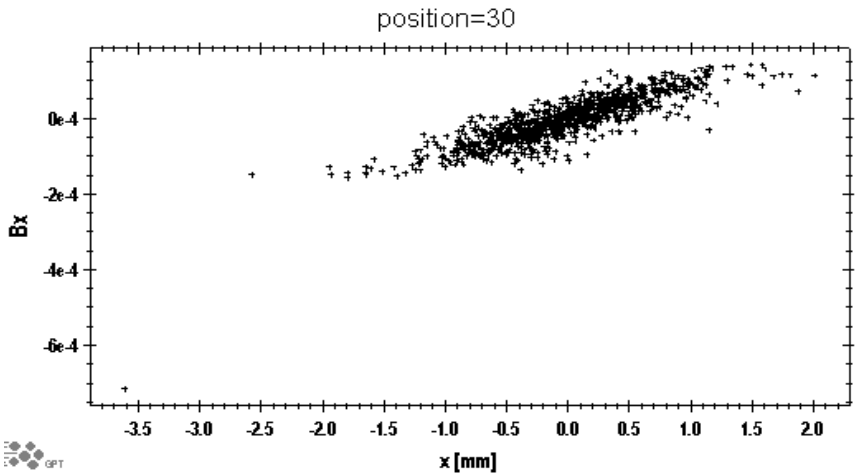
Energy distribution, Mean KE=5.7732 MeV



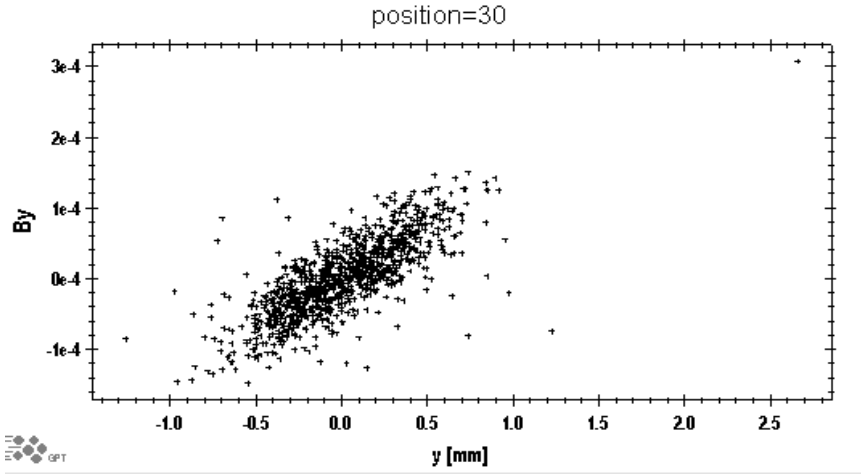
spatial distribution



horizontal phase space



vertical phase space



Summary

1. Phase 1- Upgrade Injector Model for KLF is simulated using GPT
2. For 130 keV beam, the sample results were reproduced using GPTwin.
3. The average electron beam kinetic energy is 5.7774 MeV with sigma energy spread around 13.4 keV. The average beam energy is 6.284 MeV downstream at 30 m.
4. The $\sigma_x < 0.6$ mm, $\sigma_y < 0.4$ mm and $\sigma_z = 0.172$ ps.
5. The normalized emittances are $\epsilon_x = 0.2332$ mm-mrad and $\epsilon_y = 0.1436$ mm-mrad respectively.

Thank You !