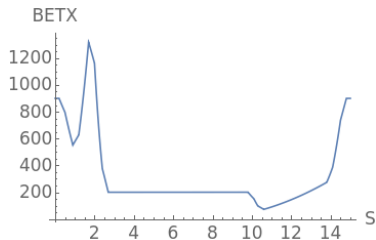


LhARA: Invivo Lattice in GPT

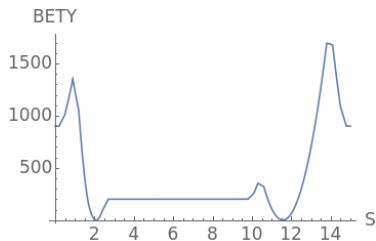
Hin Tung Lau

February 28, 2020

Beta Twiss Parameters



Minima: (10.6, 72.1307)

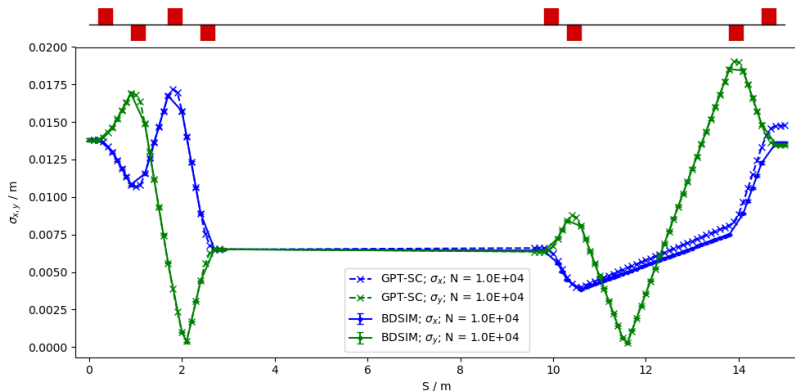


1st Minima: (2.075, 0.00137)

2nd Minima: (12, 0.00294)

BDSIM Comparison – 127 MeV – Space Charge

127 MeV beam, BDSIM and GPT comparison with space charge:
(BETX = BETY = 900, emittance = 0.021×10^{-5})

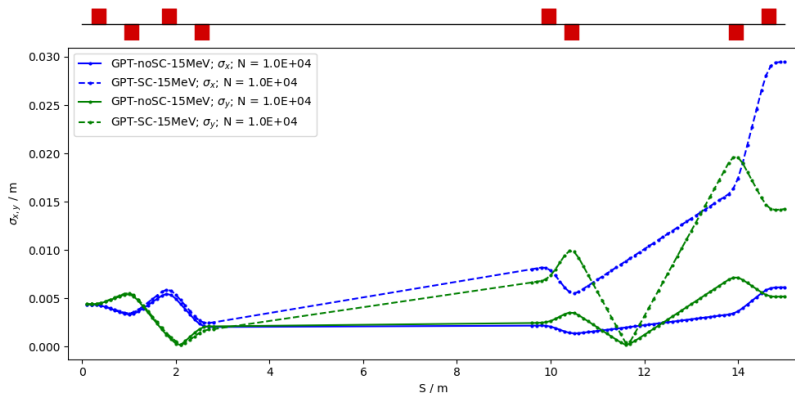


Space charge not a major issue, but appears need to tune last several quadrupoles to get a more circular beam.

GPT Comparison – 15 MeV – $B\rho$ Scaling

Comparison of no space charge and space charge from GPT with beam changed to 15 MeV:

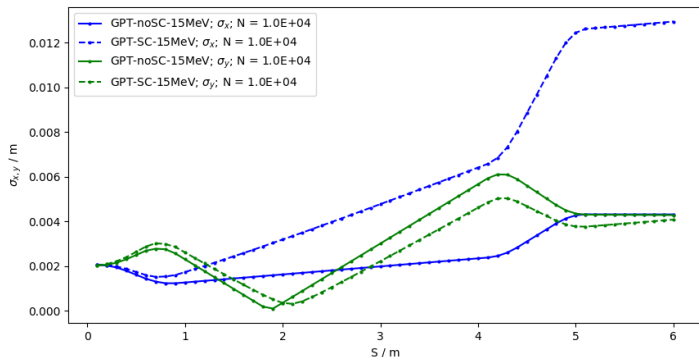
(BETX = BETY = 900, emittance = 0.021×10^{-6})



Beam small, and space charge appears to cause major deviations.

GPT Comparison – 15 MeV – $B\rho$ Scaling – Second Half

Comparison of no space charge and space charge from GPT for 15 MeV for second half of lattice assuming we can match in first half:
($BETX = BETY = 200$, emittance = 0.021×10^{-6})

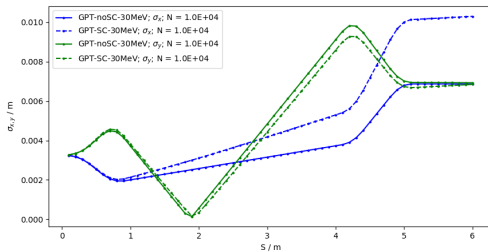


Issues persist.

- 1 Find minimum energy where space charge isn't such a big issue
- 2 Modify quad strengths to get larger beam size
- 3 Find better lattice
 - Not enough time...

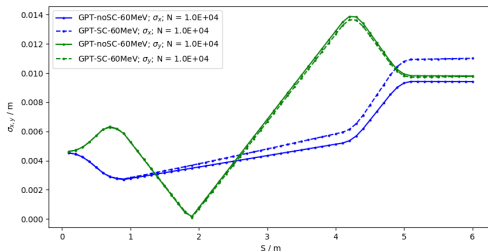
1) Minimum Energy with just $B\rho$ Scaling

Looking at part 2 of lattice:



30 MeV

- Deviation quite apparent

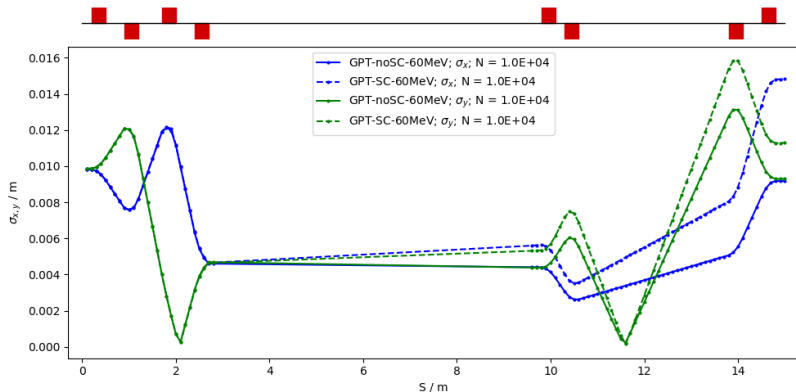


60 MeV

- Deviation not as apparent, need to optimize to get circular beam

1) Minimum Energy with just $B\rho$ Scaling

Looking at full lattice for 60 MeV:

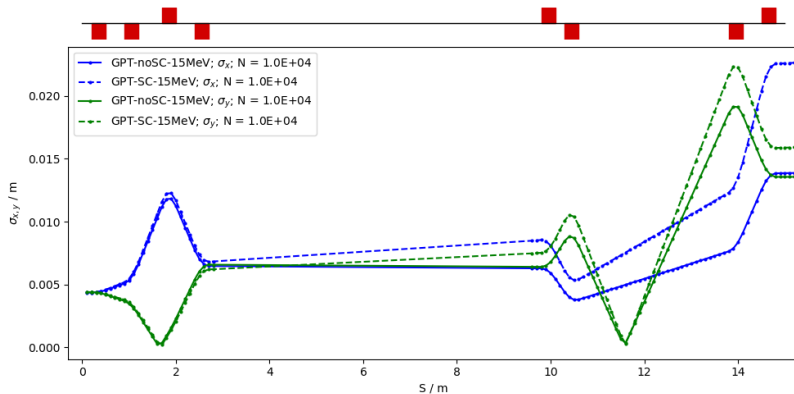


Assuming you can match to RF cavity, then 60 MeV should be okay based on previous slide.

2) Tuning Quad Strengths to Match Higher Beta

For lower energies beam size small due to smaller emittance, so try matching to higher β to compensate:

Assuming the same starting conditions of $\beta = 900$:

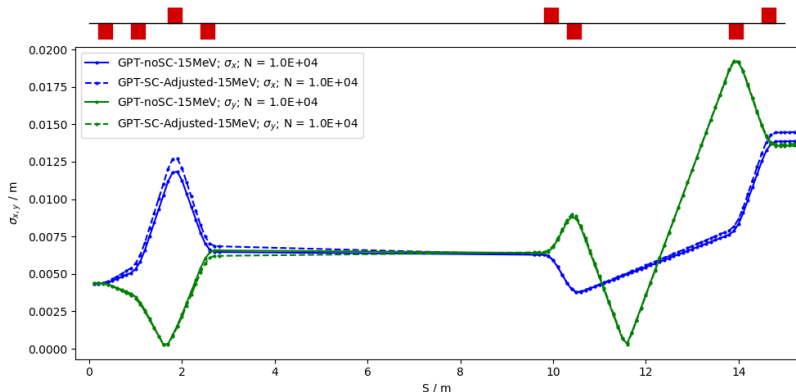


Still a bit problematic.

Note first quad changes polarity.

2) Tuning Quad Strengths to Match Higher Beta – Compensating for Space Charge

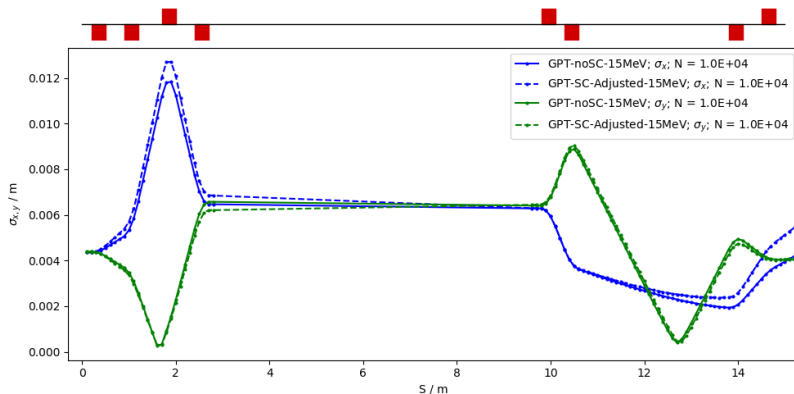
If starting conditions is $\beta = 900$:



Matched to get a converging beam at entrance of RF to counteract space charge.

2) Tuning Quad Strengths to Match Higher Beta – Compensating for Space Charge

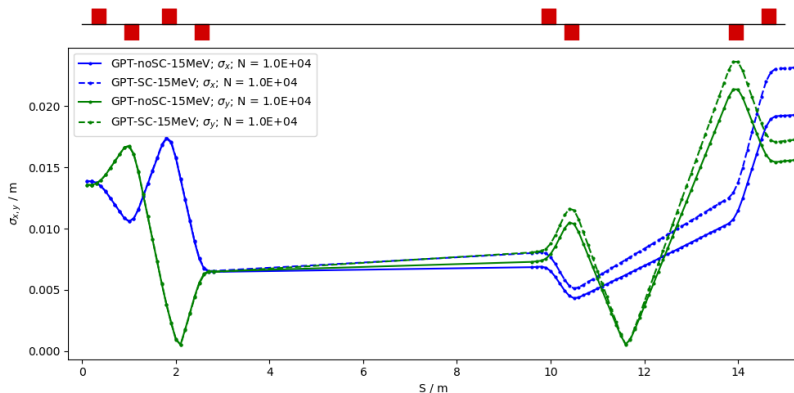
Trying to get 1 cm beam: (Used same quad settings as previous slide for match to RF, while retaining the same last 4 quad settings as no space charge.)



May be possible to try to compensate to get round beam, though smaller beam likely not possible.

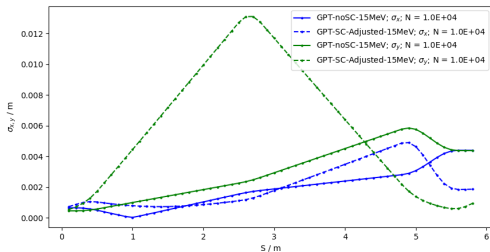
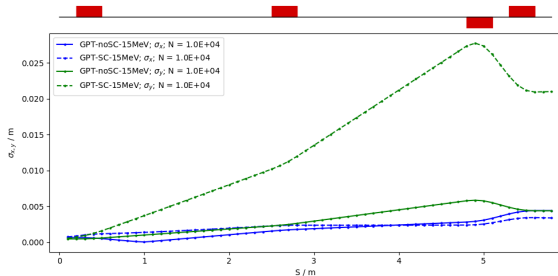
2) Tuning Quad Strengths to Match Higher Beta – Changing Initial Condition

If the starting conditions was larger $\beta = 9000$:



From Last Dipole to Entrance of Invivo Beamline

For 15 MeV, assuming initial: $\beta_x = 20.64, \beta_y = 10$



First attempt at compensating for space charge.