LhARA Stage 1 Optimization

William Shields

(william.shields@rhul.ac.uk)

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ROYAL HOLLOWAY UNIVERSITY OF LONDON

BDSIM

LhARA Laser-hybrid Accelerator for Radiobiological Applications

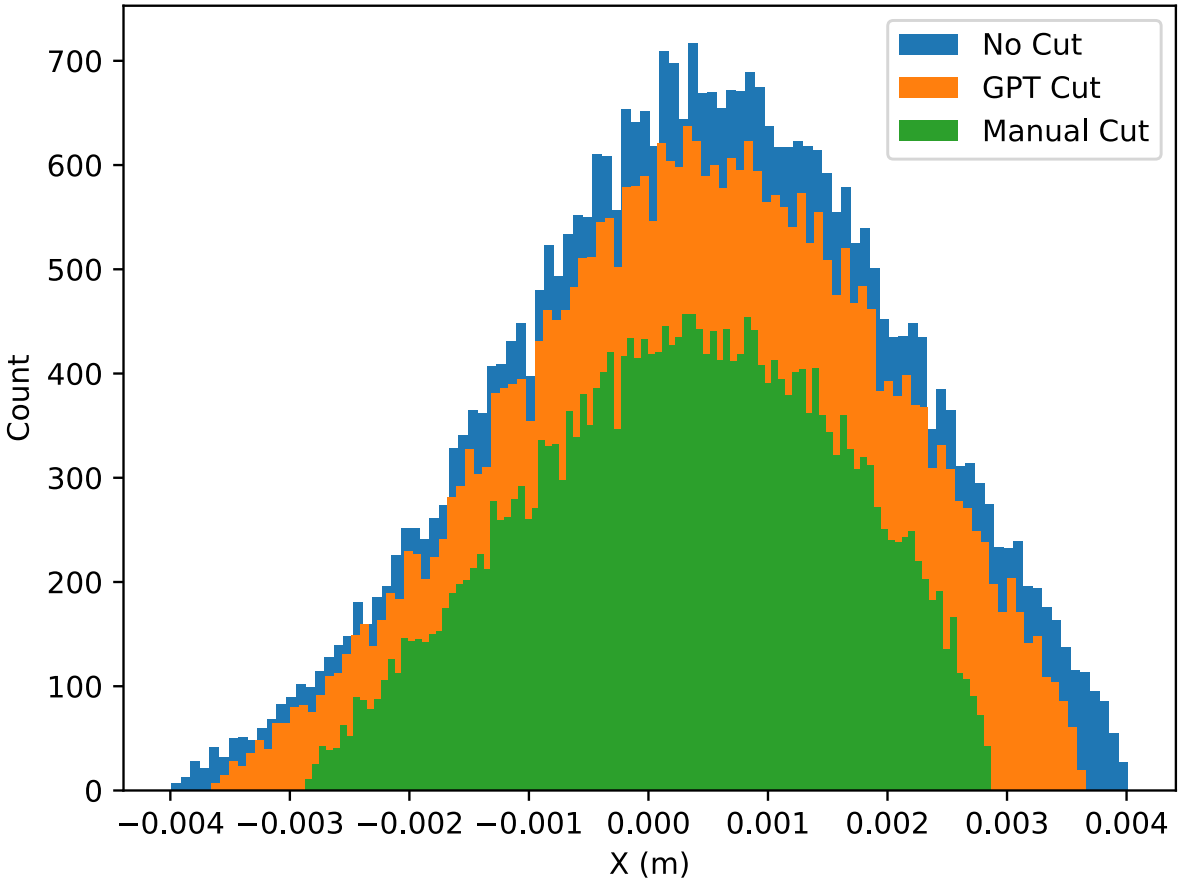
JAI John Adams Institute for Accelerator Science

SCAPA Beam Collimation

- Applied manual radial cut of 2.87mm
  - Vacuum nozzle exit aperture

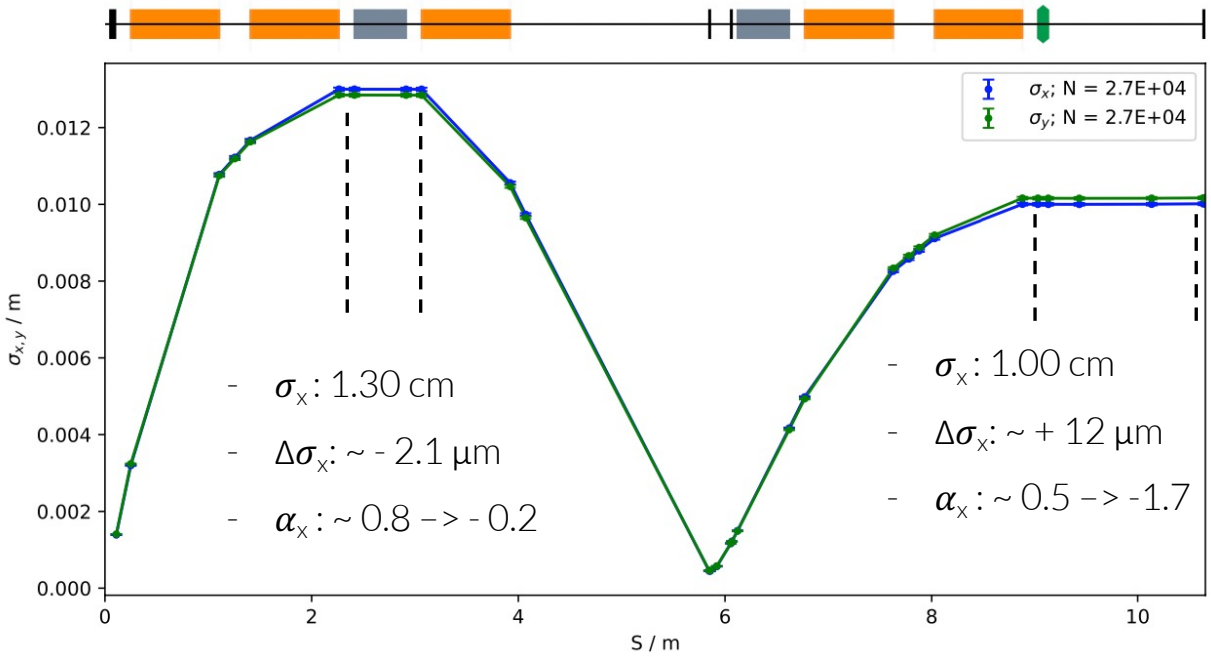
- GPT cut not behaving as anticipated
  - RMAX
  - Avoid.

- ~ 77% transmission efficiency



Version 4.4 Model

- Solutions found for parallel beam with nozzle-collimated beam
  - Large beam sizes only (β ~ 793)

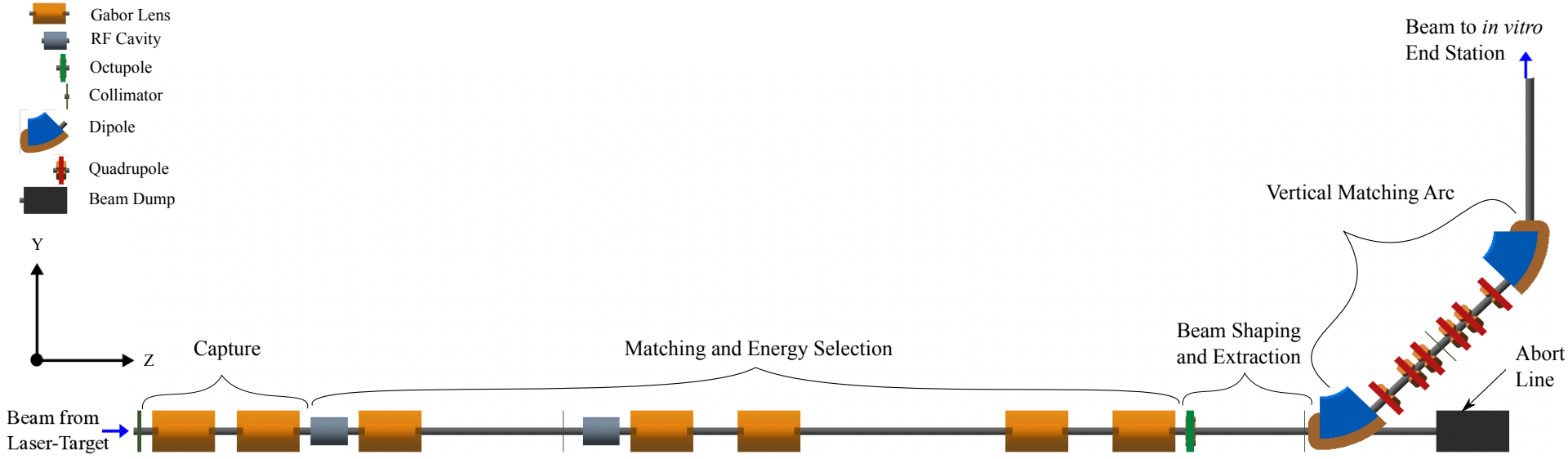


- <u>Cannot generate β=50m beam with 5 Gabor Lens / solenoid model</u>

Model Version 4.5

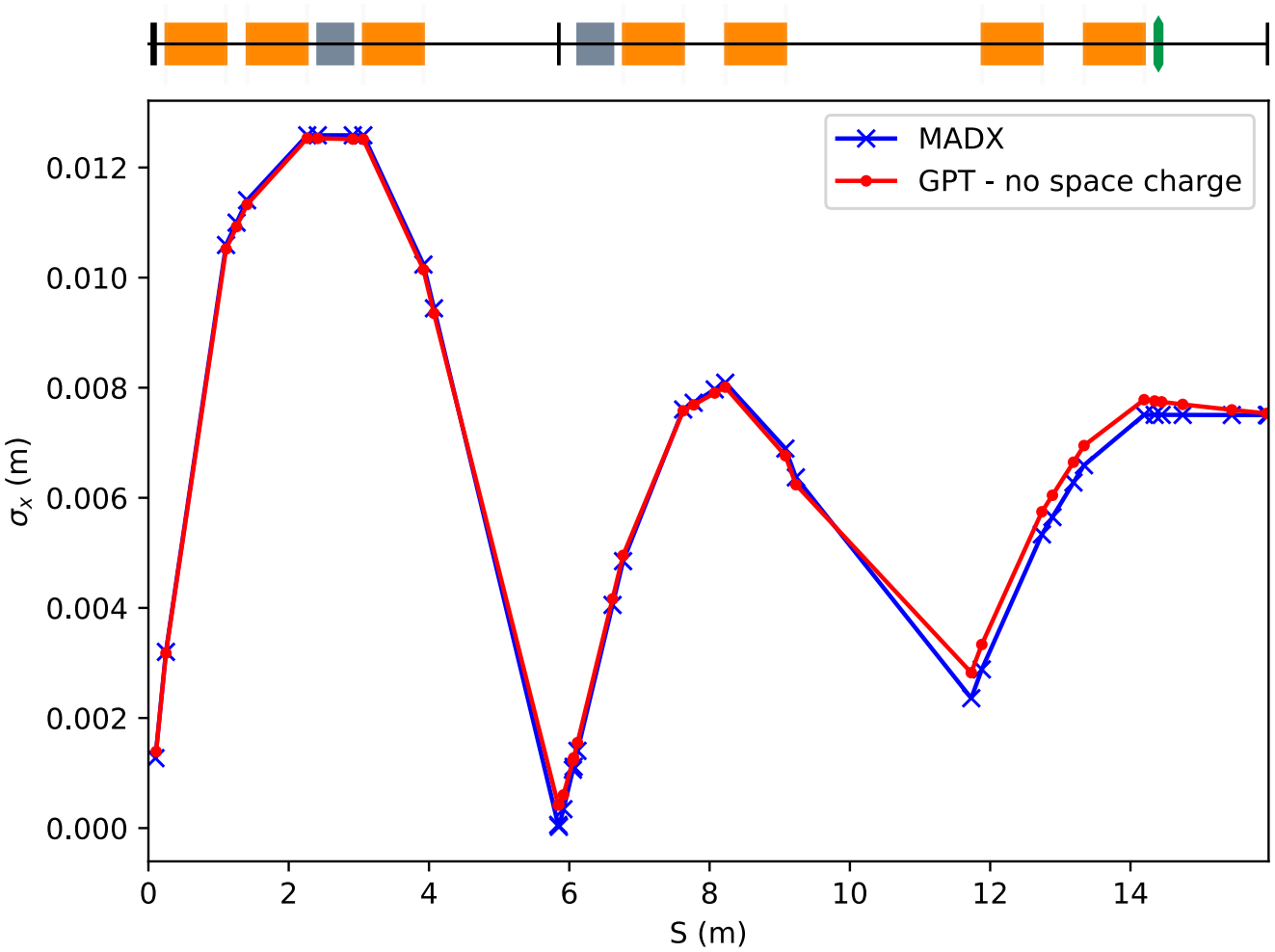
- New version based on 7 Gabor lens / solenoid solution
  - Stage 1 MADX, BDSIM, GPT models created
  - To do: GPT injection line model
  - Schematic diagrams updated

- Single energy collimator
  - Replace old stage 2 collimator with drift



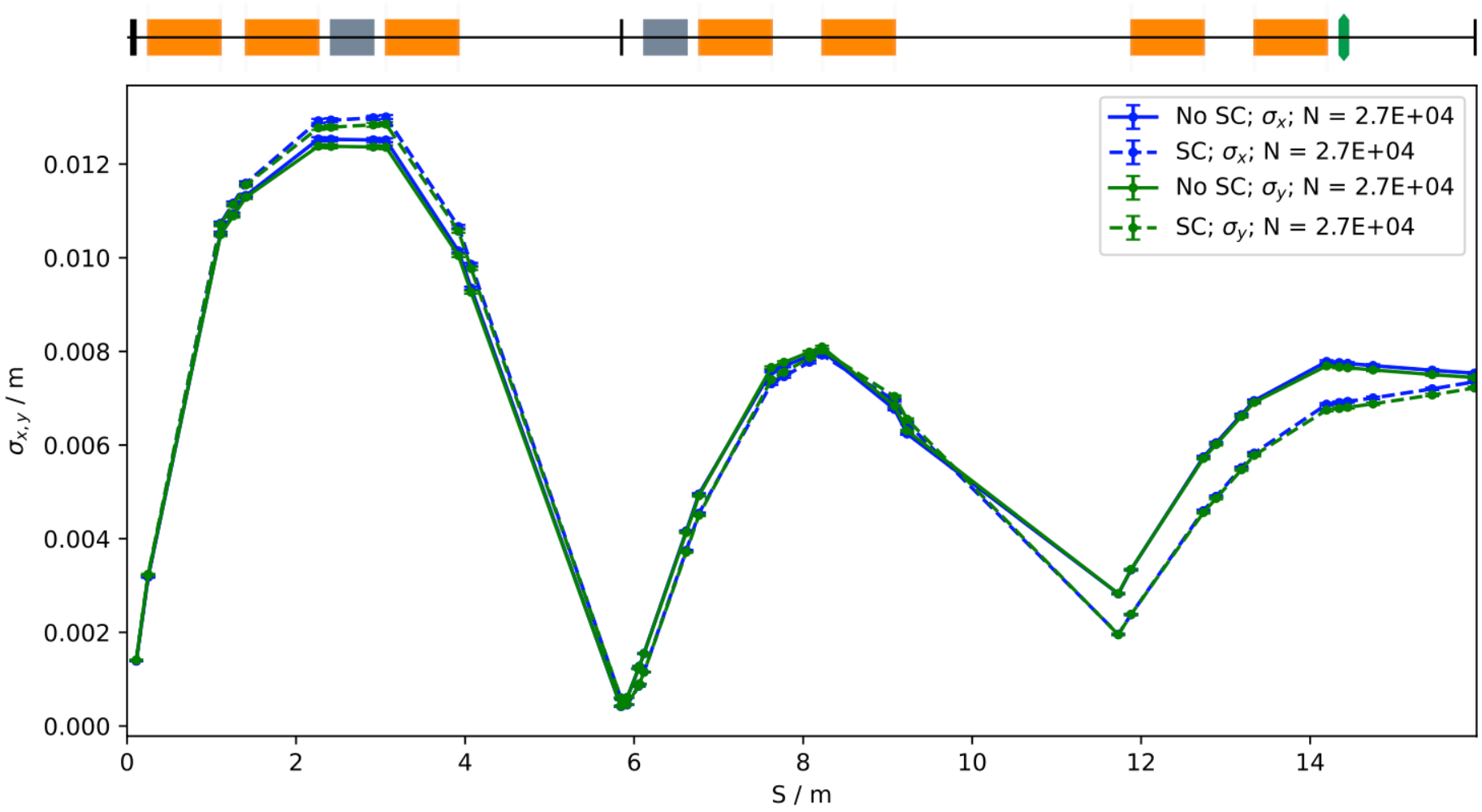
GPT MADX Comparison

- Minor differences in model optics performance
  - Imperfect beam
- Identical lattices (lengths & strengths)
- Optimisation to modify Gabor Lens strengths regardless

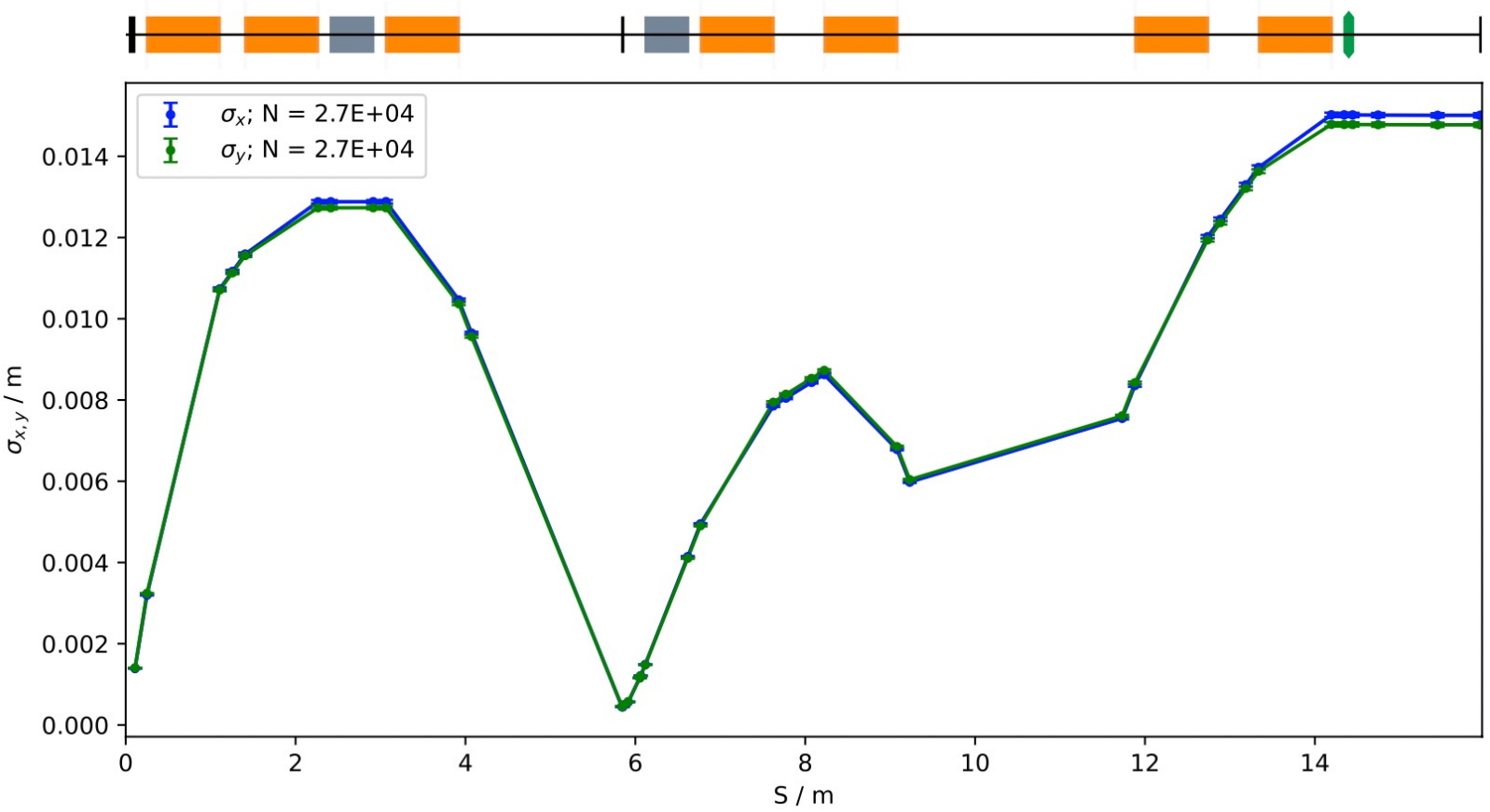


Space Charge Effects

- Space charge impacting performance:



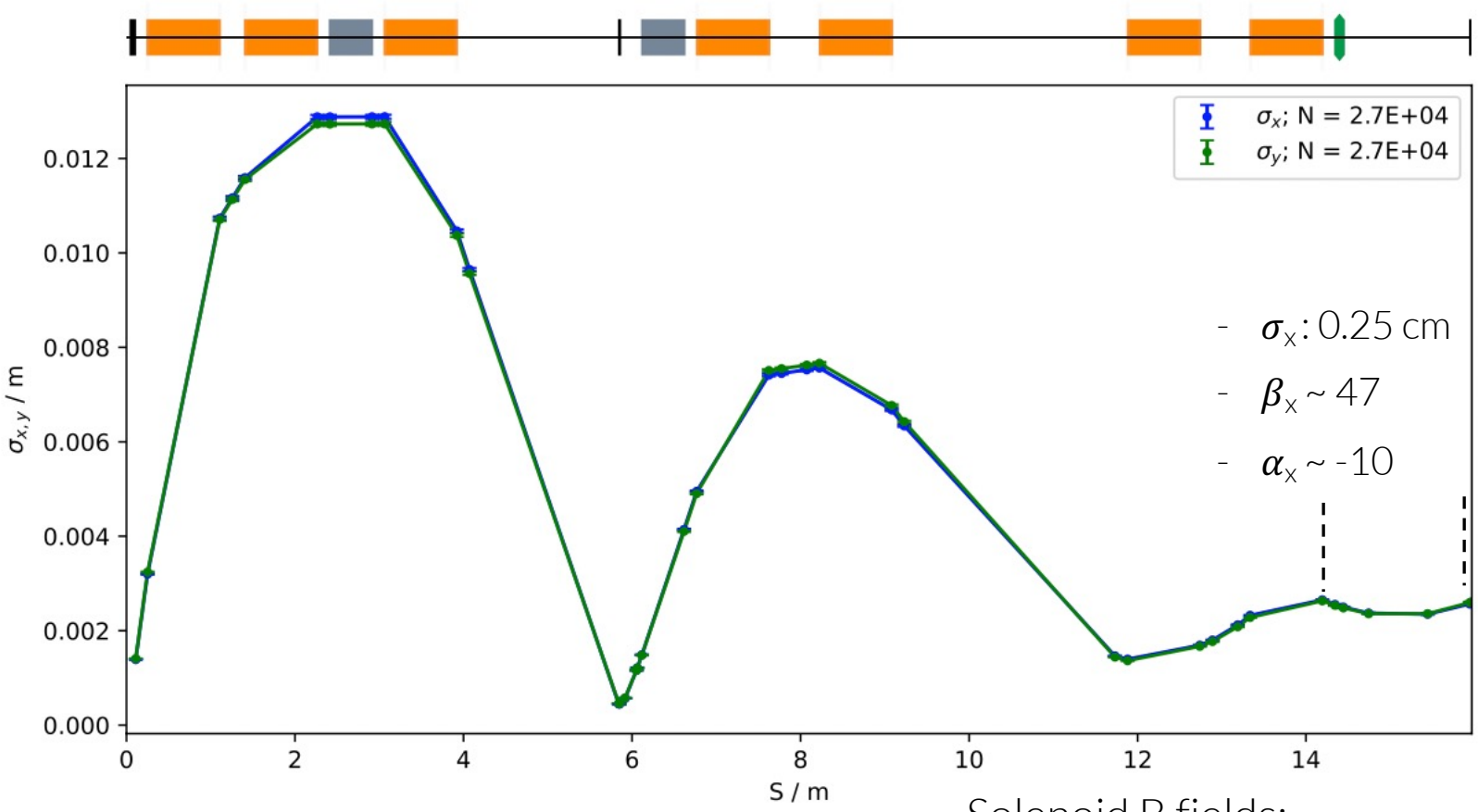
Optimisation – 1.5cm beam



- All 7 solenoid strengths optimised including space charge
- Parallel beam in straight section
- GL3 focus at collimator exit
- Near parallel beam after GL7
- Will split 2.5m drift to highlight focal point

- Solenoid B fields:
  - GL1 : 1.400000 T
  - GL2 : 0.582830 T
  - GL3 : 0.817489 T
  - GL4 : 0.948313 T
  - GL5 : 1.095205 T
  - GL6 : 0.606182 T
  - GL7 : 0.538273 T

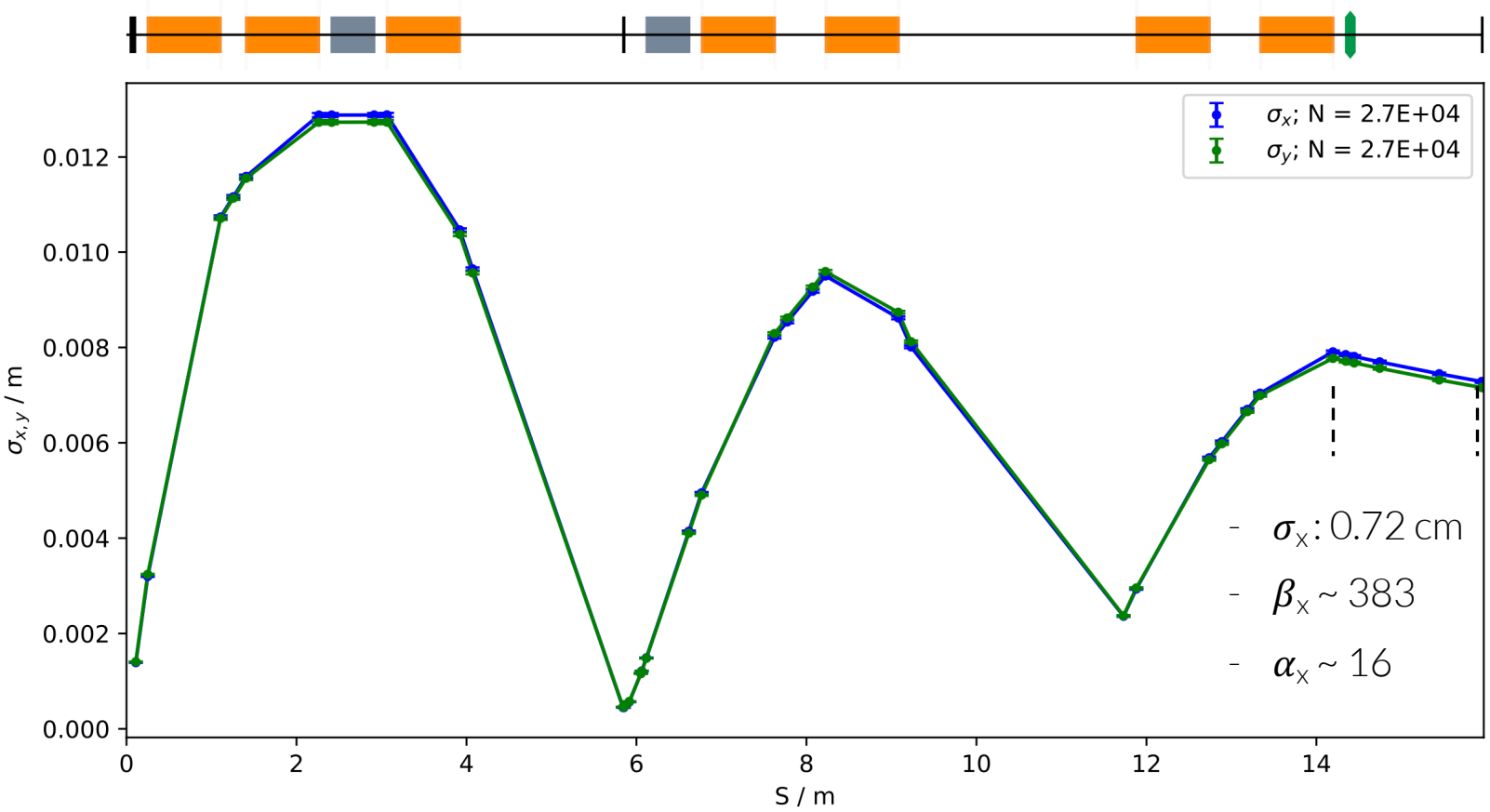
Optimisation



- Same strength GL1 to GL3
- GL4 to GL7 “solutions” but further optimisation required
- Tendency to focus after GL7

- Solenoid B fields:
  - GL4 : 1.073328 T
  - GL5 : 0.718683 T
  - GL6 : 1.360444 T
  - GL7 : 1.201434 T

1.3T Limit Solution



- Straight section beam size comparable to uncollimated beam
- Smaller parallel beams after GL7 likely difficult to achieve
- Revisit MADX with 1.3T constraints

- Solenoid B fields:
  - GL1 : 1.300000 T
  - GL2 : 0.668277 T
  - GL3 : 0.815088 T
  - GL4 : 0.836526 T
  - GL5 : 0.981281 T
  - GL6 : 0.779916 T
  - GL7 : 0.720556 T

Summary

- Done:
  - Found optimised solutions for stage 1 & collimated SCAPA beam with space charge
    - Large beam sizes so far

- Ongoing:
  - Optimisation with collimated SCAPA beam for smaller beam sizes
    - Stage 2 operation
  - Evaluation with 1.3 T field limit
  - New version of alternative baseline design (v5.5)

- Todo:
  - Model beams with full energy spread (missing file)
    - Limited to 15 MeV +/- 2 %
  - Quads only model (v6.0)
  - Update models with JP modifications
  - Develop OPAL model of FFA – need JP input.