Simulation Update

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WP6 Meeting

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End Station Dose

- BDSIM end station model matches pre-CDR description:

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!+++++   End Station   +++++

ES_01: drift, l=0.01*m, beampipeRadius = 0.05*m;
vacuumWindow: rcol, l=75e-6*m, material = "G4_MYLAR", outerDiameter = 0.1;
scintFibre: rcol, l=250e-6*m, material = "G4_POLYSTYRENE", outerDiameter = 0.1;
gap1: gap, l=5.0e-3*m, material = "air"; ! Tried as air or water
container: rcol, l=1.15*mm, material = "G4_POLYSTYRENE", outerDiameter = 0.1;
cells: rcol, l=30e-6*m, material="G4_WATER", outerDiameter = 0.1; ! water will need to be u
skincells: rcol, l=30e-6*m, material="G4_SKIN_ICRP", outerDiameter = 0.1;
water: rcol, l=0.024*m, material="G4_WATER", outerDiameter = 0.1;

endStationSkin: line=(ES_01, vacuumWindow, scintFibre, gap1, container, skincells, water);
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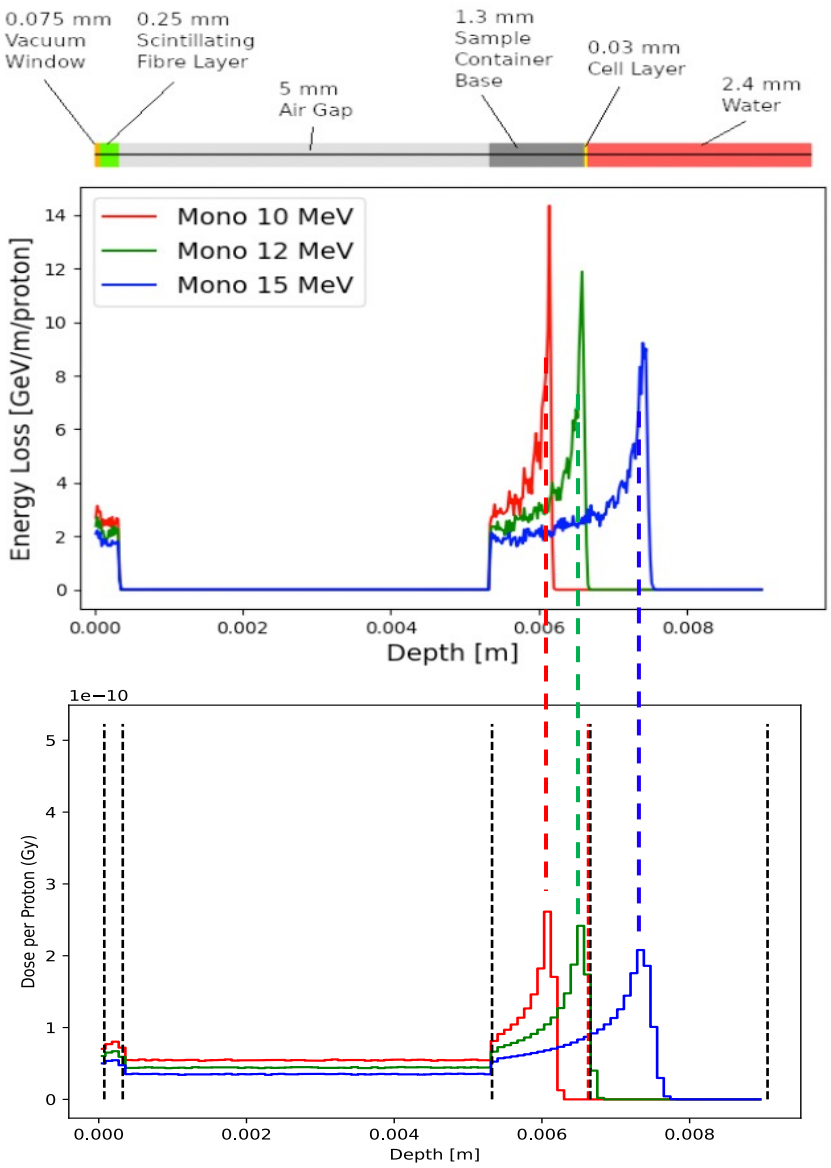
- Modelled idealised beam to match pre-CDR
- Unsure if HT dose calculations are start-to-end simulations?
- Nparticles entering cell layer disagrees
  - Will: 10000
  - HT: 7247
    - Approximate stage 1 transmission - tbc
- BDSIM scoring mesh added (unavailable at time of preCDR studies
  - Dose in GeV & dose in Gy.
- NOT Markus ion chamber simulations

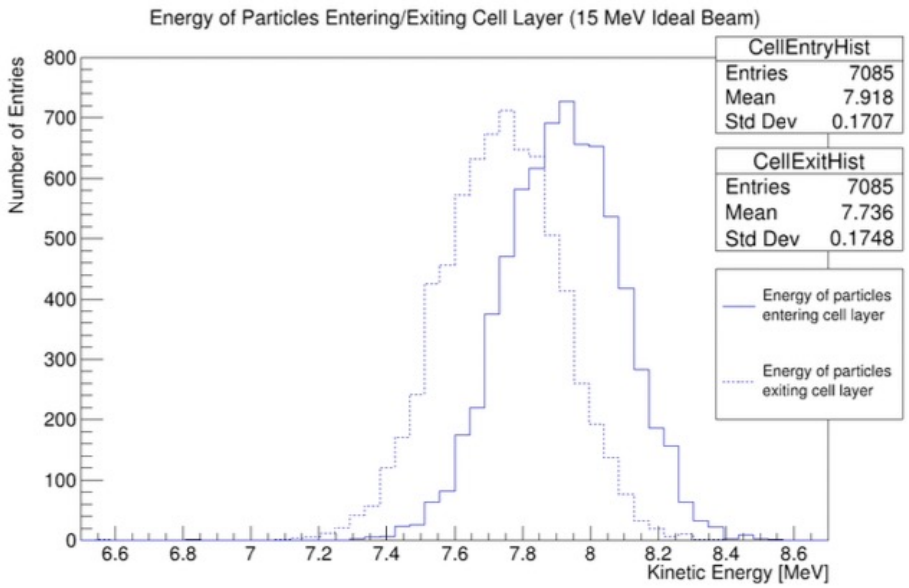
Bragg Peak Depth

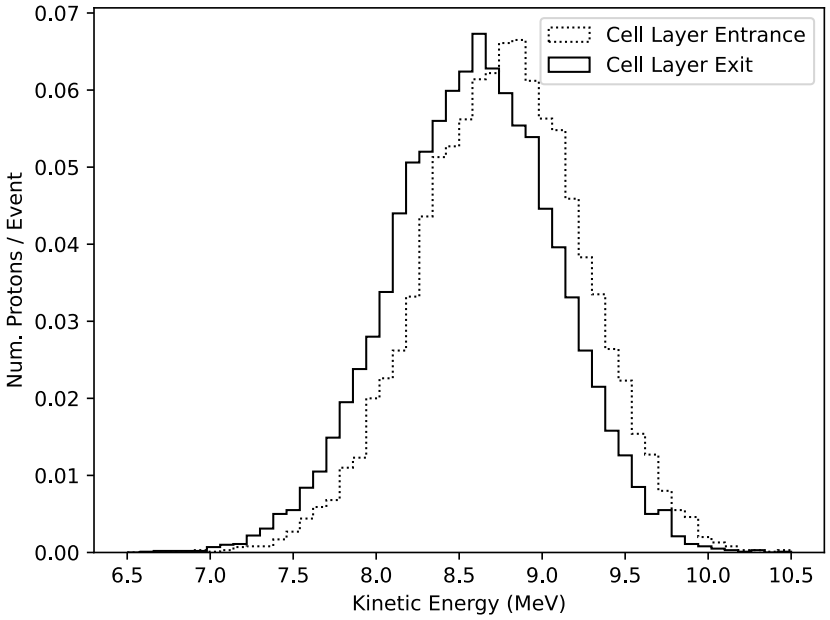


- Good agreement between pre-CDR & recent simulations on BP depth
  - 10, 12, 15 MeV proton beams
  - Validated BDSIM model.

- Model differences:
  - ± 2% energy spread in BDSIM – broader peak
  - Water volume thickness

Cell Layer Spectra





- Differences in spectrum pre & post cell layer.
- Mean KE (HT):
  - Entrance : 7.92 MeV
  - Exit: 7.73 MeV (calculated)
- Mean KE (Will):
  - Entrance: 8.758 +/- 0.488 MeV
  - Exit: 8.590 +/- 0.496 MeV
- Possible source of differences:
  - Geant4 version
  - Model materials
    - Cell Layer
  - Model element lengths
    - Sample container

Dose Comparison (15 MeV)

- Energy deposited:
  - HT: 1.32 GeV – 7247 particles
  - Will: 1.68 GeV – 10000 particles
    - Scaling: 1.22 GeV - 7247 particles

- Unknown how HT calculated dose in Gy
  - Energy deposited & volume known, cell layer density to be looked up

- Scaled dose per pulse (HT conversion ratio GeV -> Gy):
  - HT: 1.33 Gy
  - Will: 1.1639 Gy (KE method)
  - Will: 1.1644 Gy (Scoring method)

- BDSIM scoring Gy:
  - Will: 0.2318 Gy

Dose: Summary & Next Steps

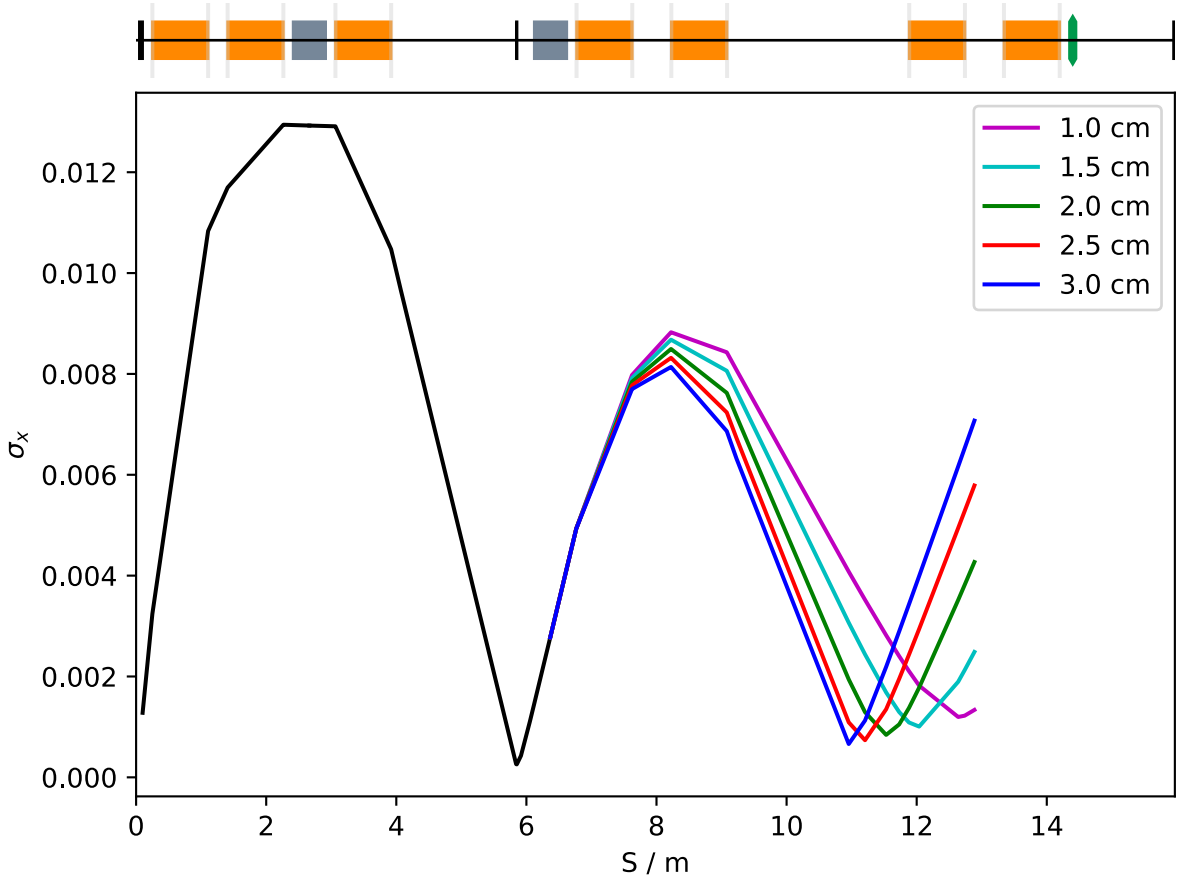
- Repeated some of HTs procedures – disagreement
  - Dose calculation in Gy unknown
  - Agreement between BDSIM calculation methodologies in GeV
  - BDSIM scoring in Gy factor ~5 off.

- Next steps (Lilli & myself):
  - Cross-check dose calculations
  - Markus Ion chamber volume at Bragg peak
    - 2.65mm radius, 2mm depth
    - Minimum specified beam diameter of 10mm.
    - Model changes (preCDR pg 31):

> was simulated into the chamber. The thickness of the sample container was reduced so the Bragg peak could be positioned within the chamber volume leading to a total energy deposited of 3.1×10^{-4} J, corresponding

    - Thickness change NOT specified
  - Investigate possible discrepancy sources (slide 4)
  - Standardised set of doses at various energies:
    - Scale to transmission.

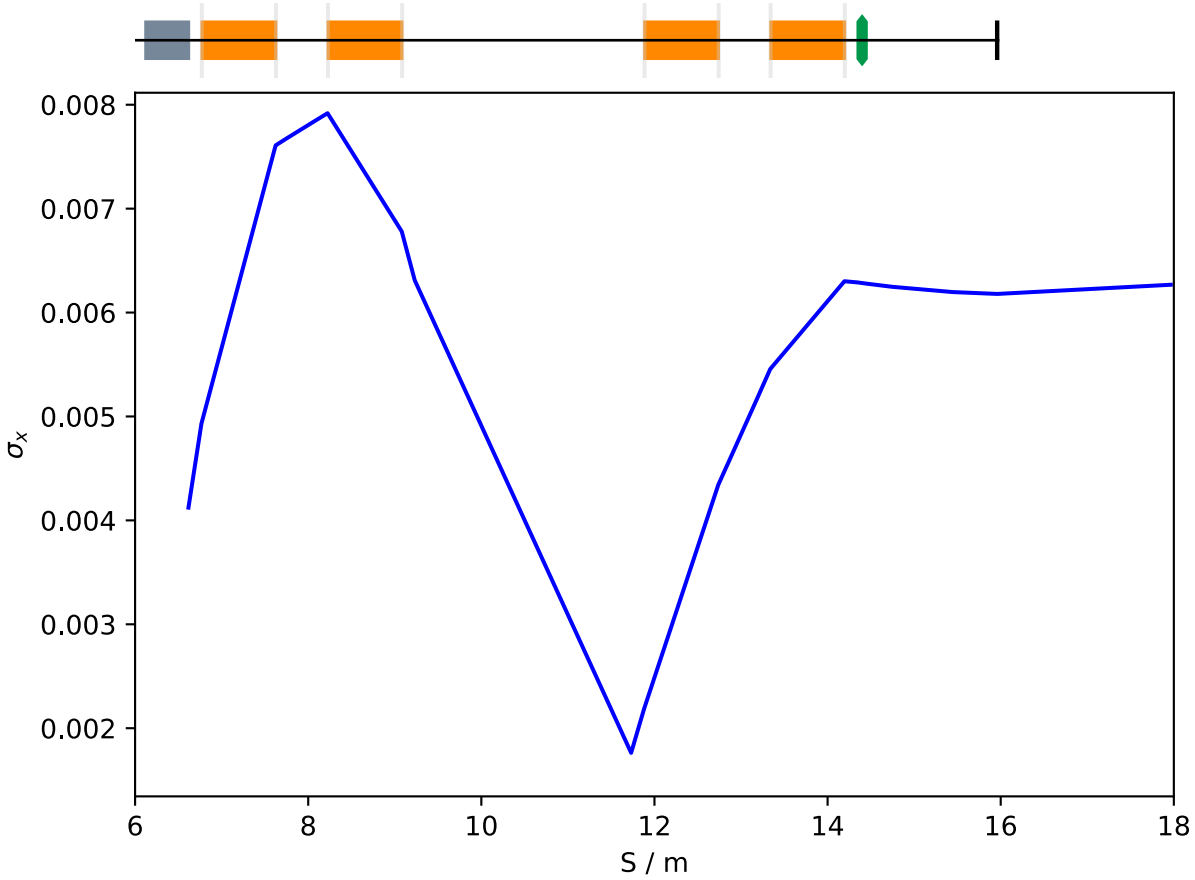
Spot Size Optimisation



- 2 optimisation methods (GL 1, 2, & 3 done):
  - 1) GL 4 – 7 altogether
  - 2) GL 4 & 5, then GL 6 & 7.
    - Focus in GL6
- Aim: spot sizes (2 sigma diameter) of 3.0, 2.5, 2.0, 1.5, and 1.0 cm.

- Status:
  - 1) 3.0 & 2.5 cm achieved, smaller beams needing large fitting tolerances
  - 2) GL 4 & 5 optimised for all spot sizes, GL 6 & 7 achieved, tolerance issues for smaller.

Spot Size Optimisation



- Typically seeing beam waist after the final Gabor lens
  - All beam sizes
- Attempting madx optimisation with updated beam after GL3.
  - Possibly vary drift length between GL5 & GL6.

Next Week

- At CERN for multiple meetings/discussions including Andrea Latina (RF-track)

- Topics of discussion:
  - RF-track access
  - Validating GPT LhARA simulations
  - Co-propagating beams & validation of
  - Interfacing potential (BDSIM / xsuite)
  - Electrostatic focusing (Gabor lens approximation)
  - FFA modelling feasibility

  Any other suggestions ???

Summary

- Done:
  - IOP PAB Talk
  - Start dose comparison study

- Ongoing:
  - Re-run optimisation routines

- Todo:
  - Comparison to baseline design
  - Test IMPACT-T & model LhARA beam.
  - Update models of alternative baseline design (v5.5)
  - Develop OPAL model of FFA – need JP input.