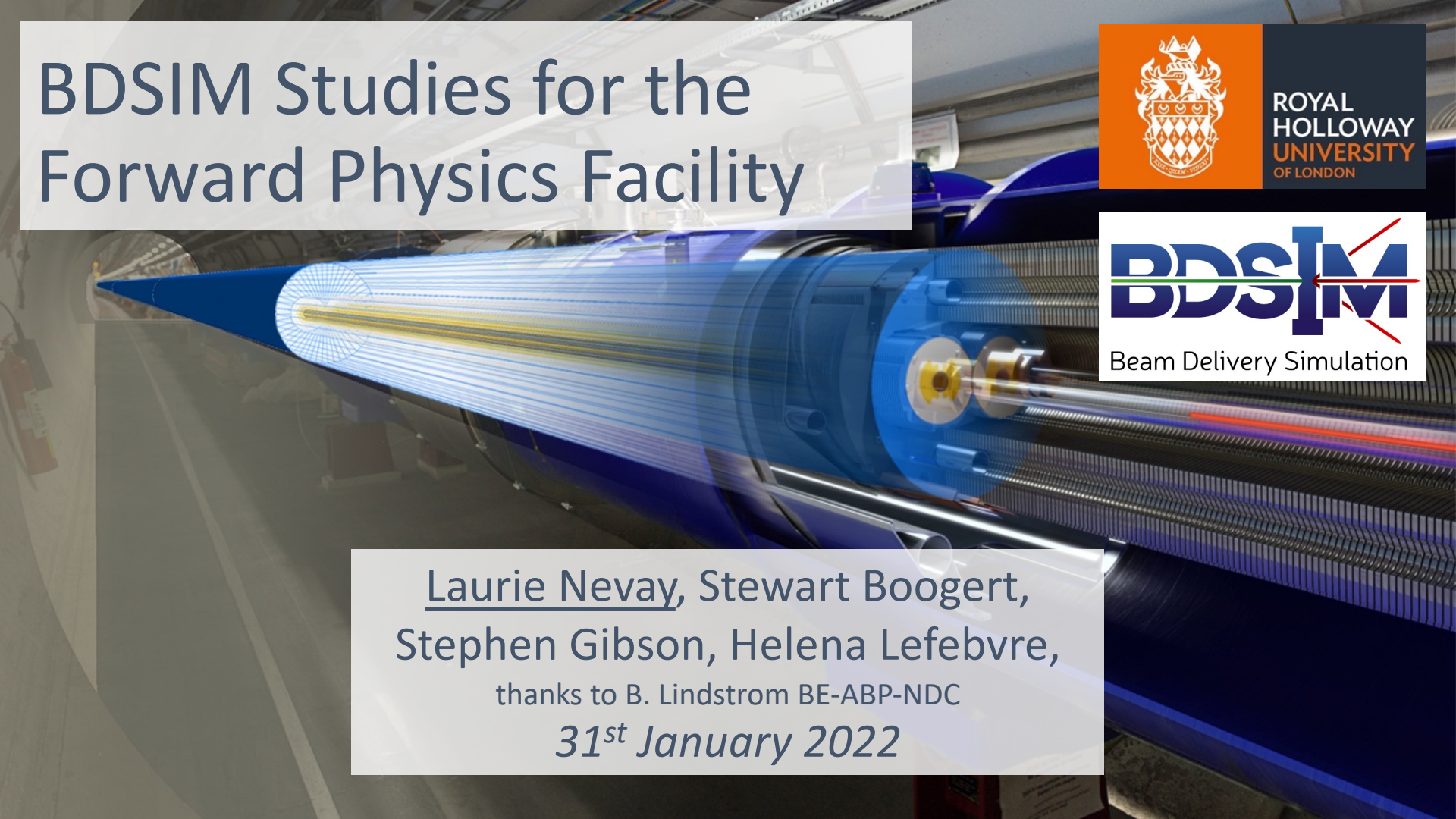
BDSIM Studies for the Forward Physics Facility



Laurie Nevay, Stewart Boogert,
Stephen Gibson, Helena Lefebvre,
thanks to B. Lindstrom BE-ABP-NDC

31st January 2022

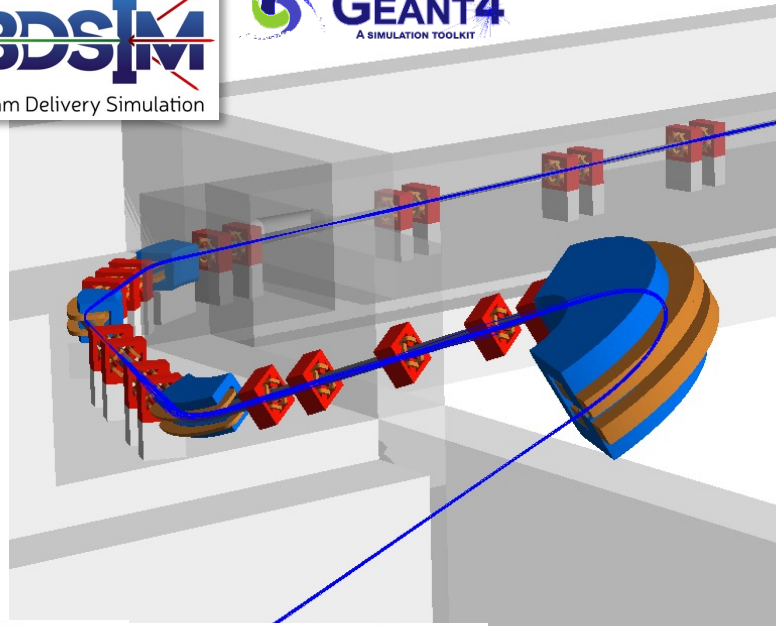
Beam Delivery Simulation (BDSIM)

L. Nevay, W. Shields, S. Boogert

- Started at Royal Holloway for Linear Collider muon backgrounds
  - redeveloped and modernised since 2014 by L. Nevay, S. Boogert, W. Shields and RHUL group
- Automatic Geant4 models of accelerators
- Applied to many experiments and machines
  - ***ILC / CLIC***, ***AWAKE, XFEL*** *undulators,* ***LHC*** *collimation,* ***Laserwires, ATLAS*** *non-collision backgrounds,* ***MAGIX*** *at* ***MESA,*** *and recently* ***FASER, KLEVER, NA62 (PBC)***
- Also for **medical therapy systems**
  - including radiobiological research facilities - e.g. LhARA

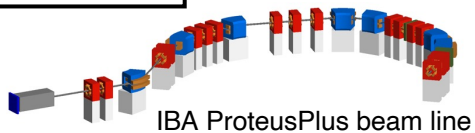
BDSIM Beam Delivery Simulation

GEANT4 A SIMULATION TOOLKIT

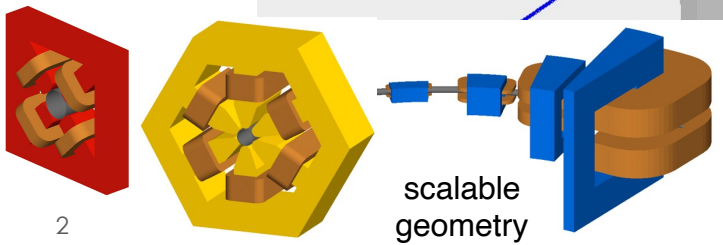


PSI Gantry 2 model

Computer Physics Communications (252), July 2020, 107200



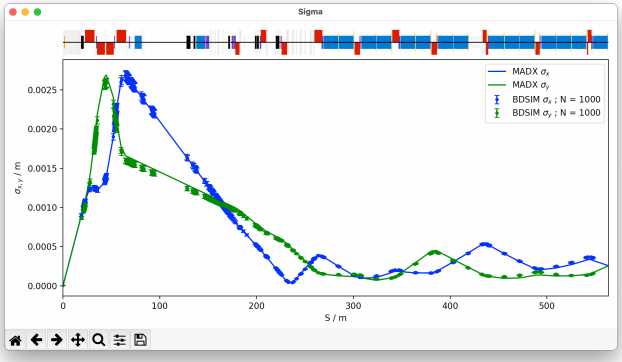
IBA ProteusPlus beam line



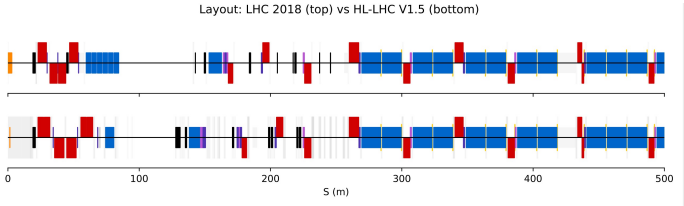
scalable geometry

HL-LHC Model

- New model for HL-LHC
- HL-LHC Optics V1.5
- Updated aperture model

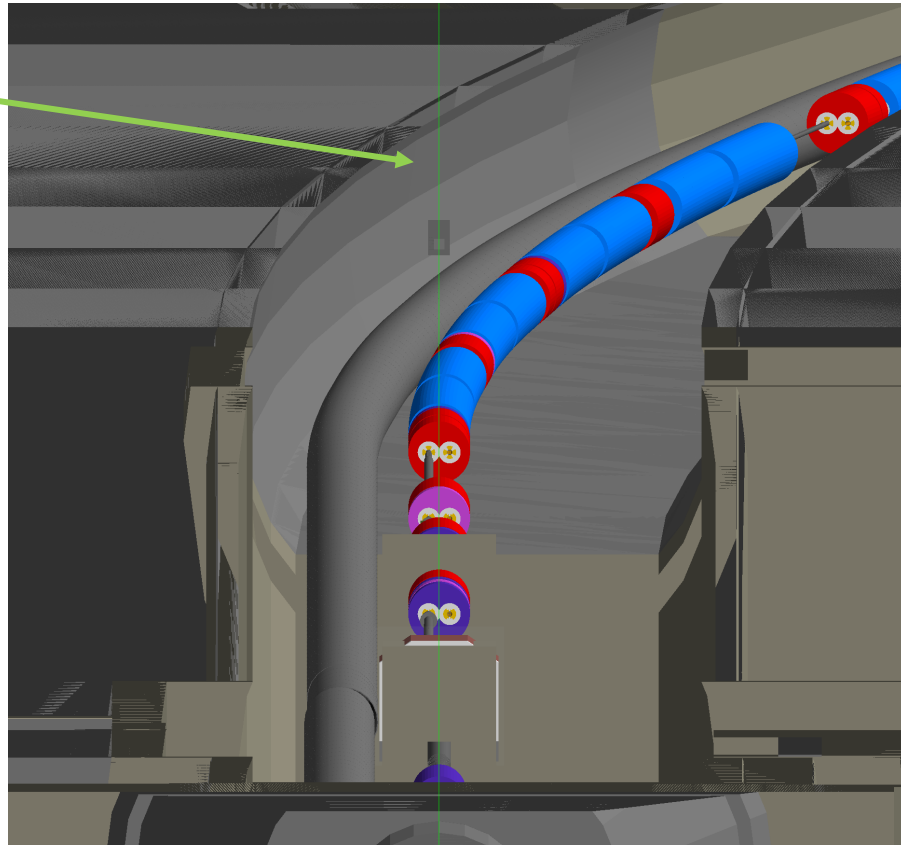


optical comparison



LHC vs HL-LHC machine layout along S

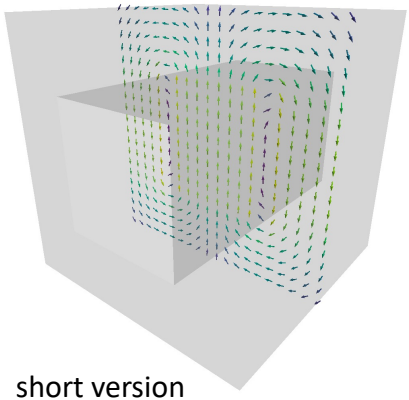
line of sight



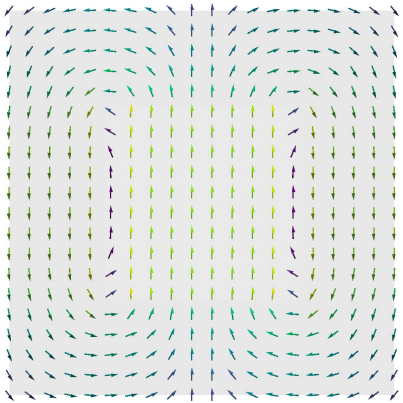
beam line view from IP1 towards FPF

Sweeper Magnet Model

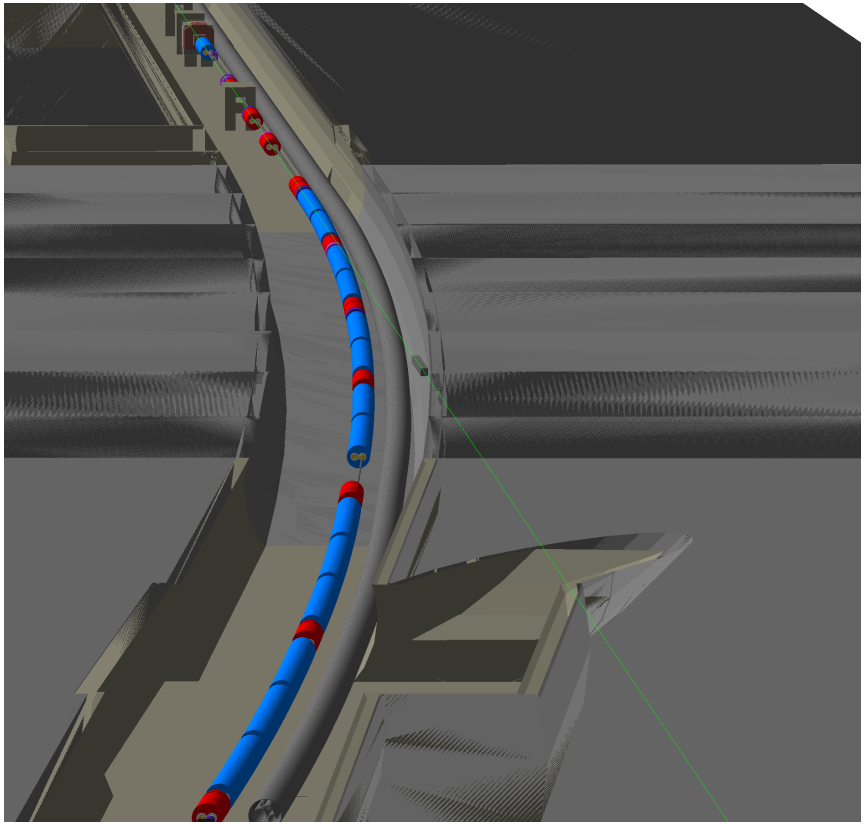
- Sweeper magnet model included
- Based on field map from FLUKA group via Jamie
- Peak field of 1.4T
  - but can be scaled in future
- Can be rotated and moved



short version



20x20cm x7m x 1.4T

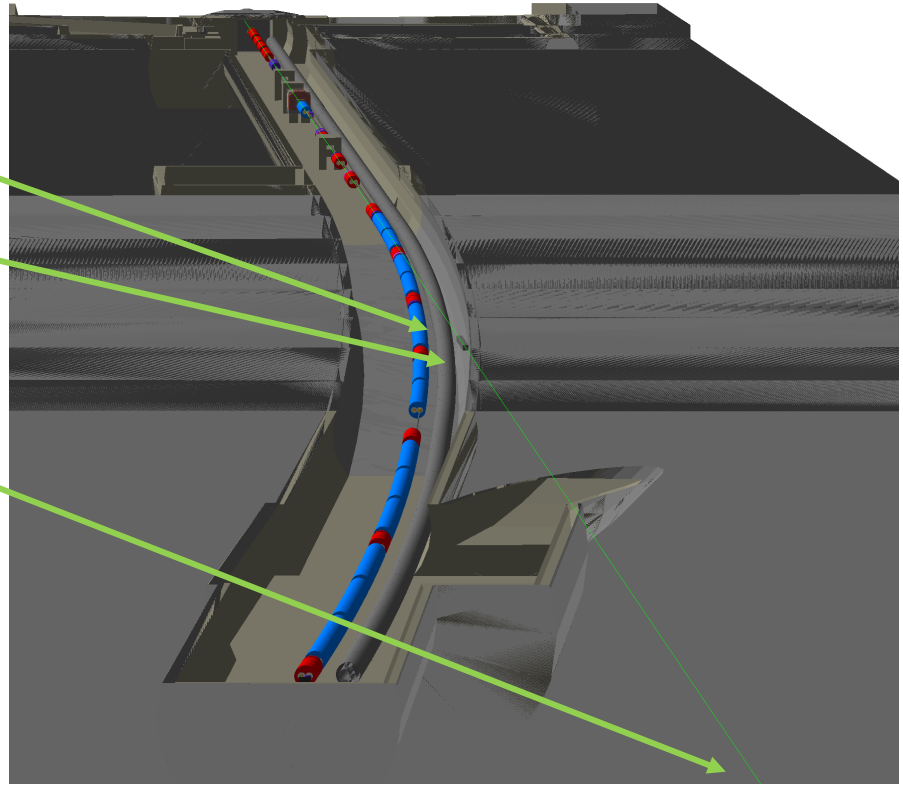


geometry composited using [pyg4ometry]

Sample Plane Location for Study

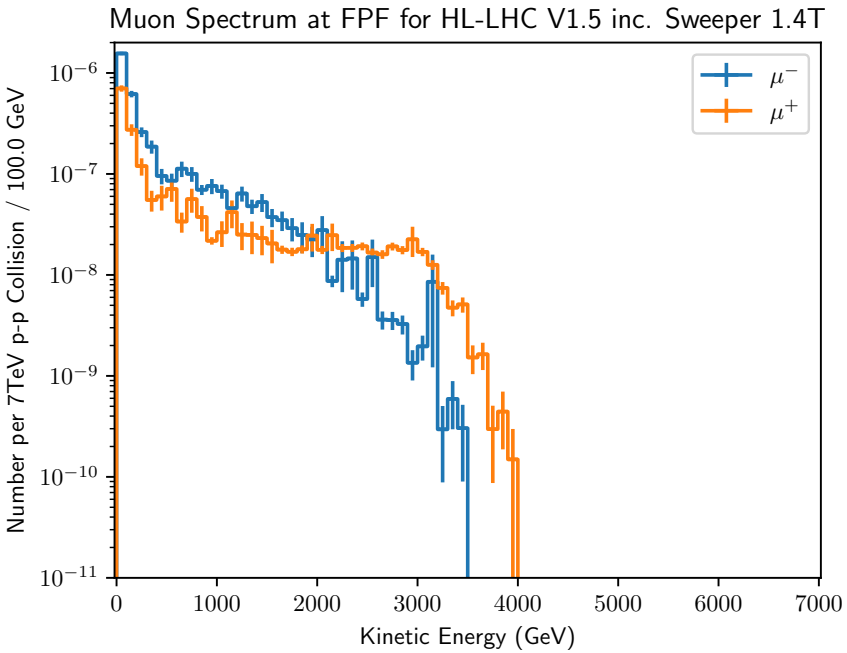
- 3 Sample planes to record distribution for simulation
- 1x start of sweeper (40 x 40cm)
- 1x end of sweeper (40 x 40cm)
- 1x at FPF Z = 617m

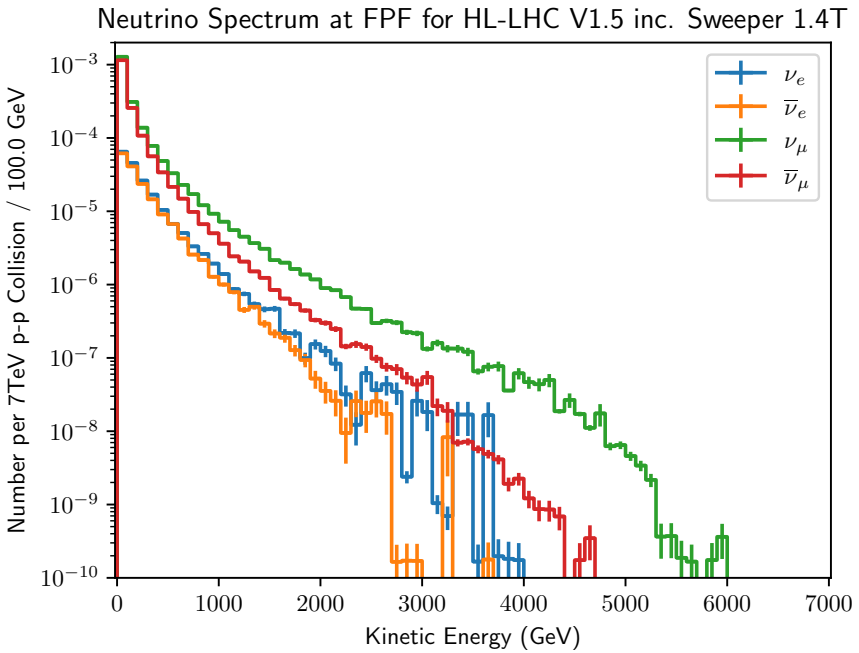
- Sample of 130M events
  - Geant4 V10.7.p03
- CRMC using SIBYLL
- Decay cross-section biasing for pions and kaons throughout



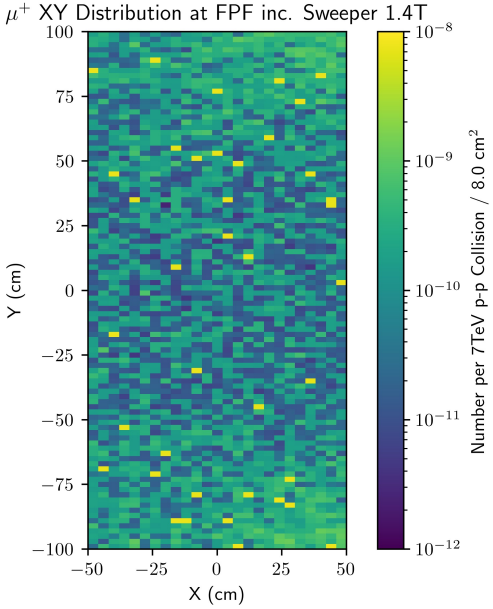
Spectra

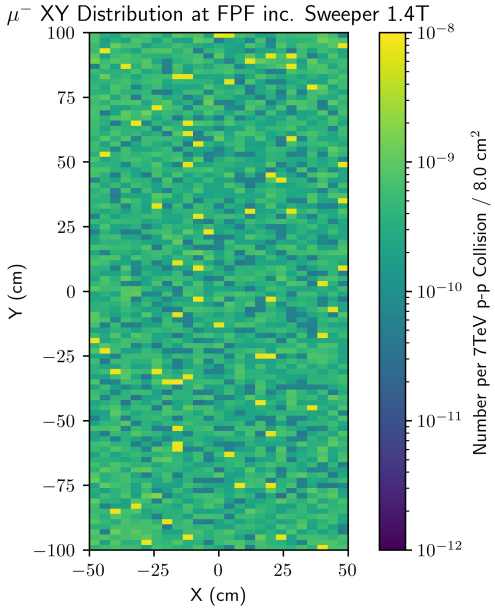
- Spectra at FPF per p-p collision integrated over 2 x 2m^2

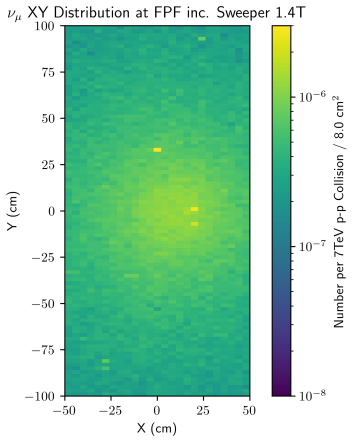


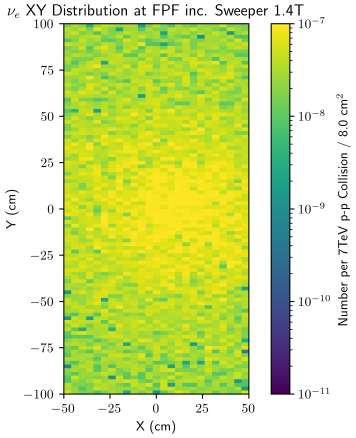


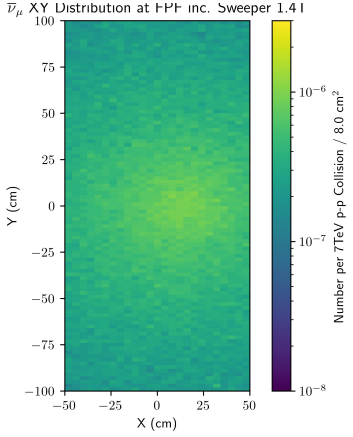
XY Distribution at FPF

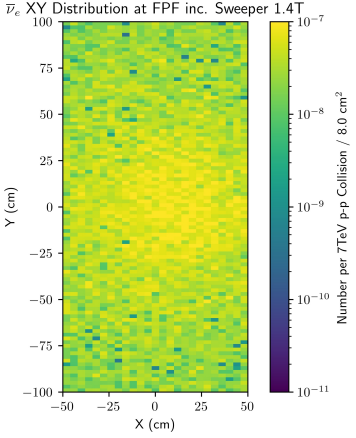






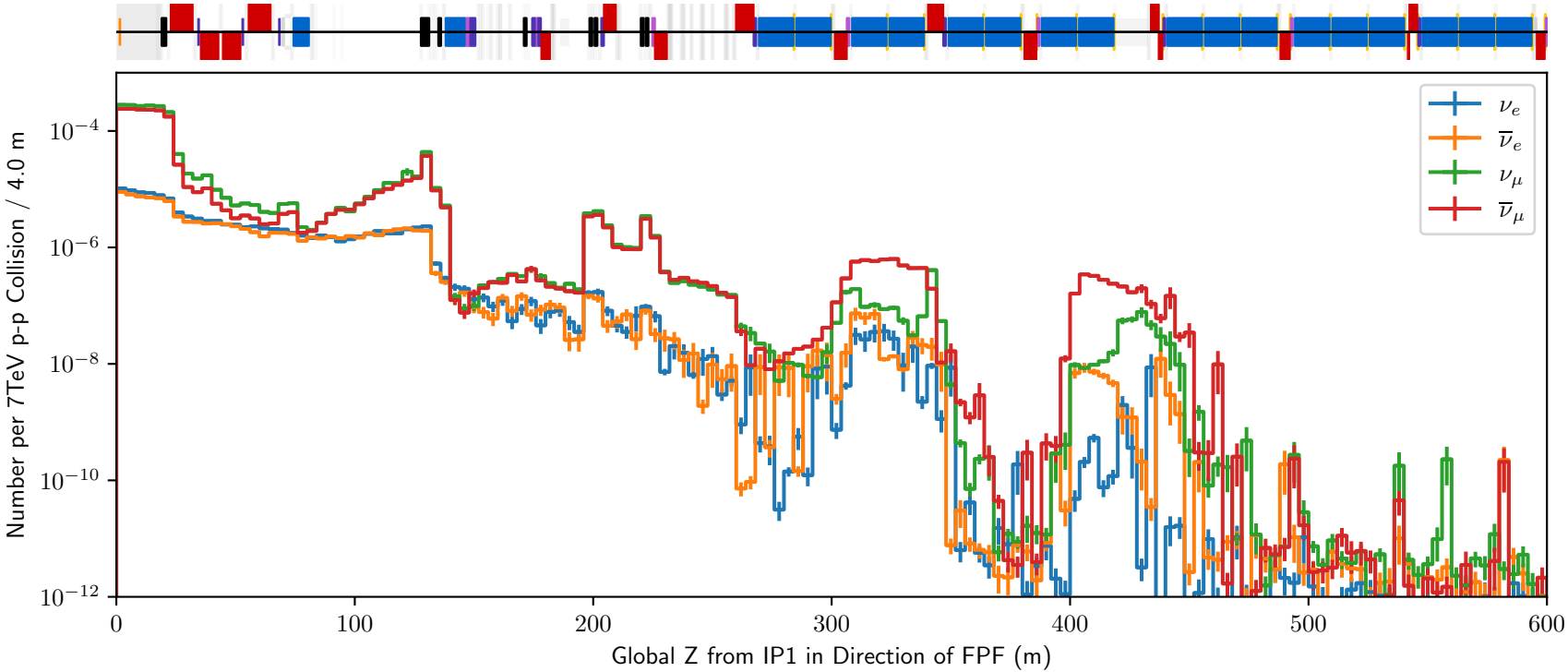






*accident with histogram binning

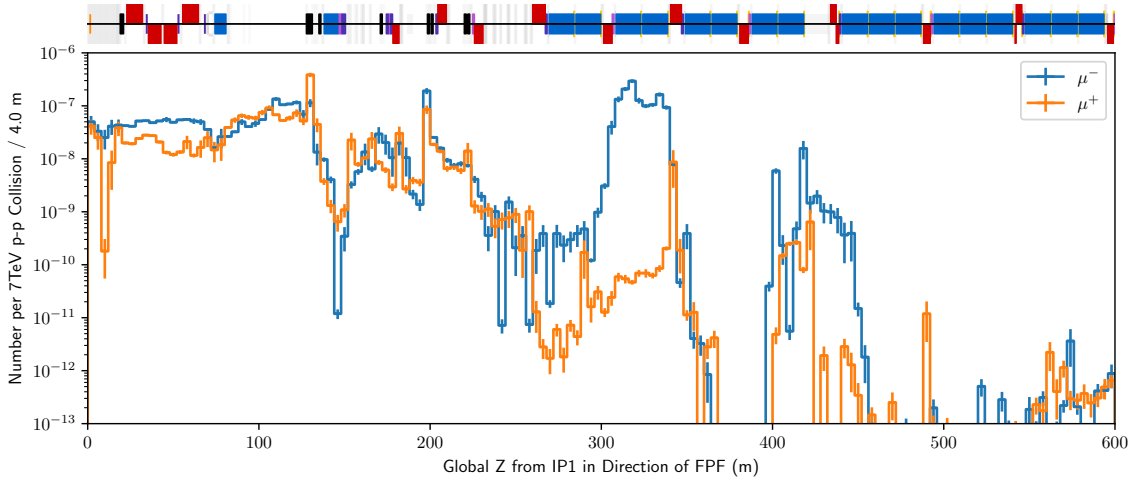
Origins of Neutrinos Reaching the FPF

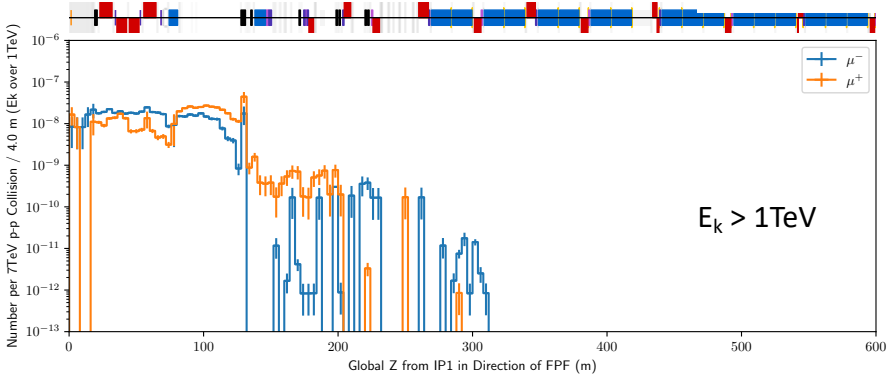


Note, not flux at that position - number originating from that location that reach FPF

Origin of Muons Reaching the FPF

- Muons from throughout
- Some peaks related to dispersion in the accelerator
- More asymmetry than previous studies
  - suspect effect of sweeper
- Some high energy muons still originate from close to IP





Muons that make it to FPF

Outlook

- HL-LHC BDSIM model prepared
- Initial MC sample generated
  - available in ROOT files for analysis
  - 130M events in ~60k cpu hours (~0.6s / event)
- Muon splitting being introduced to improve efficiency
  - improved efficiency will enable more studies
- Analysis on effect of sweeper ongoing
  - initially seems to have more effect on mu+
- Analysis will reveal optimal length, strength and area of magnet for best way to reduce the muon flux
  - although not too much variability here
- Geometry improvements ongoing
  - some minor aperture constrictions from LHC model
- Usual normalisations to Hz/cm^2 ongoing