



Modification and Simulation of H6 Secondary Beamline

Luke Weaver

Supervisors: Dr. Laurie Nevay & ~Dr. Fabian Metzger

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Overview and Recap

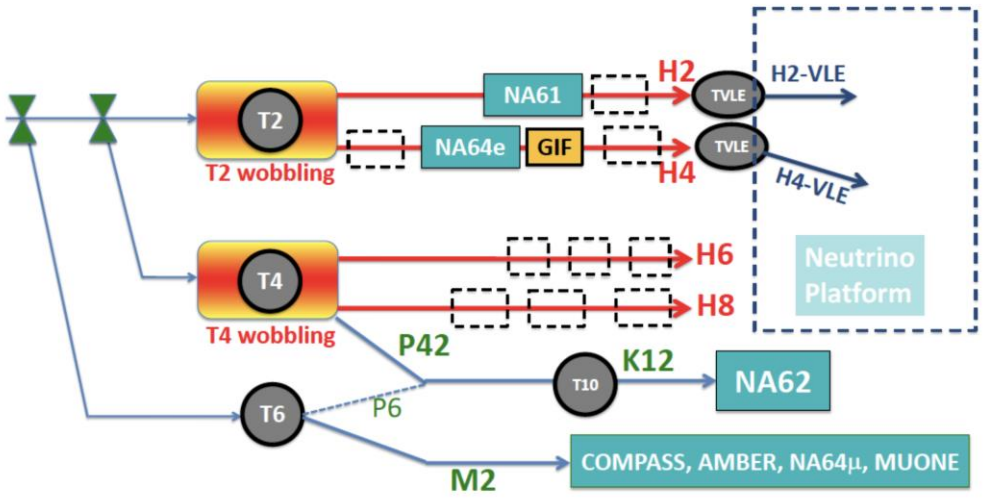
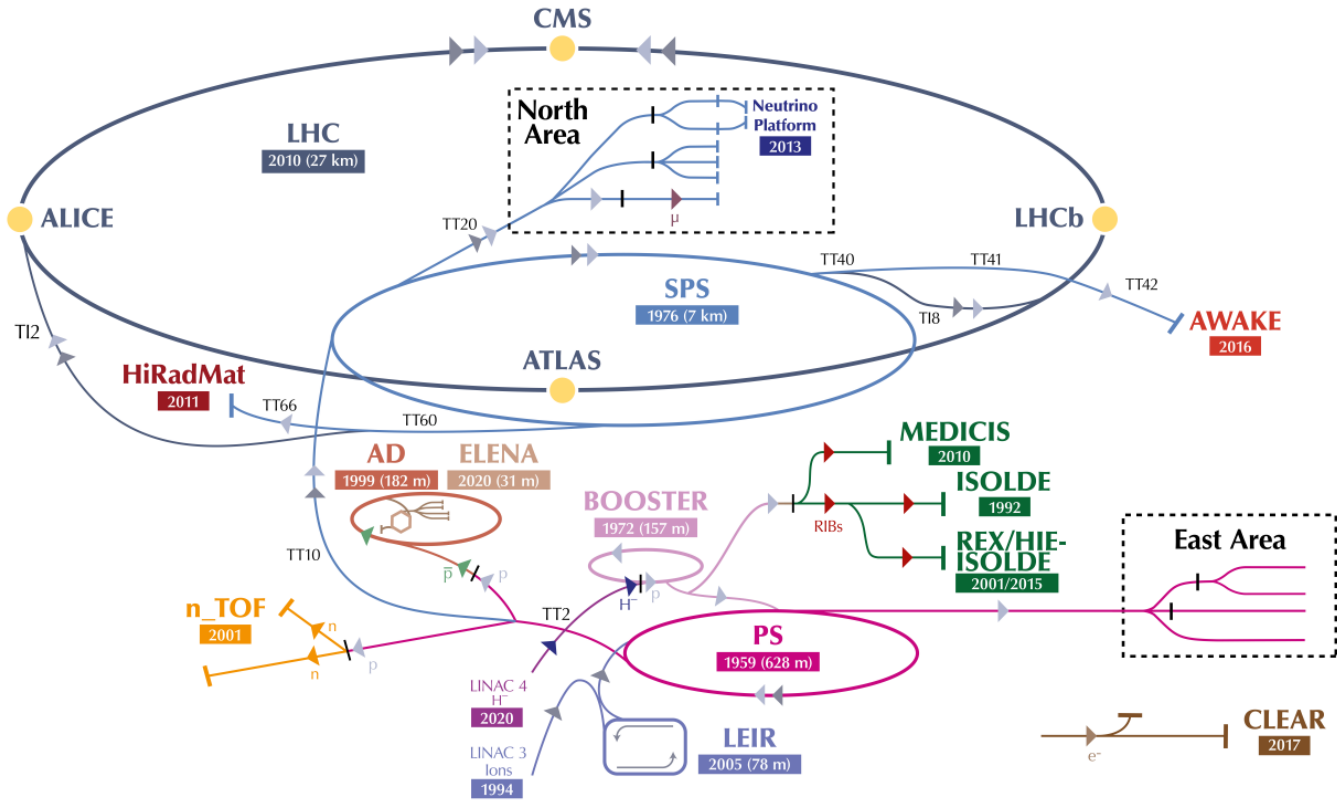


Figure 3: Schematic layout of experiment and test beam zones on the various North Area beam lines (not to scale)

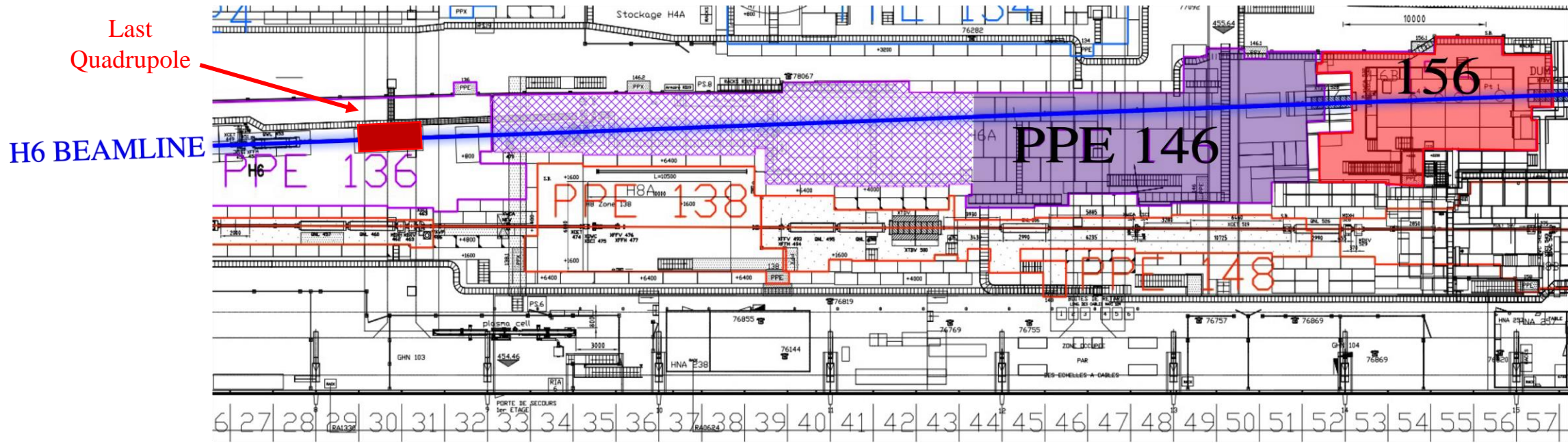


Overview and Recap (cont')

Problem: Smaller beam spot for smaller sensors

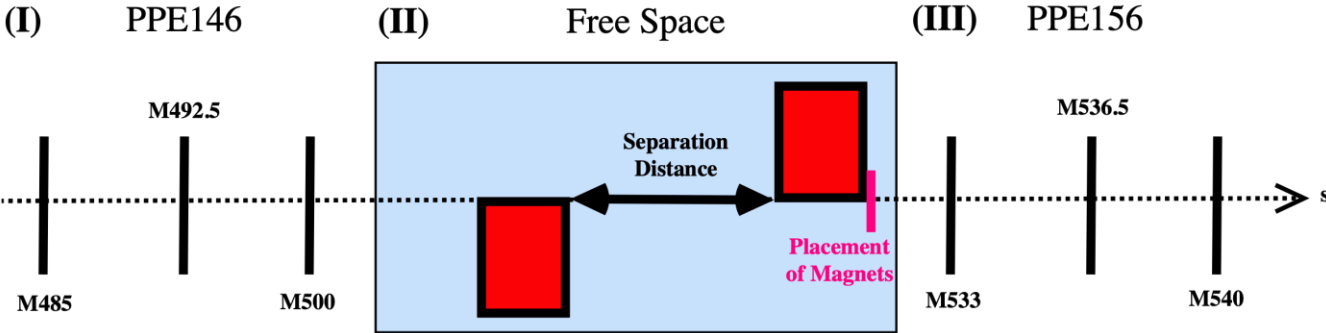
Solutions:

- 1. Increase intensity – already at RP limit **X**
(~5e6 particles / spill)
- 2. Decrease beam size – add new quadrupoles **✓**

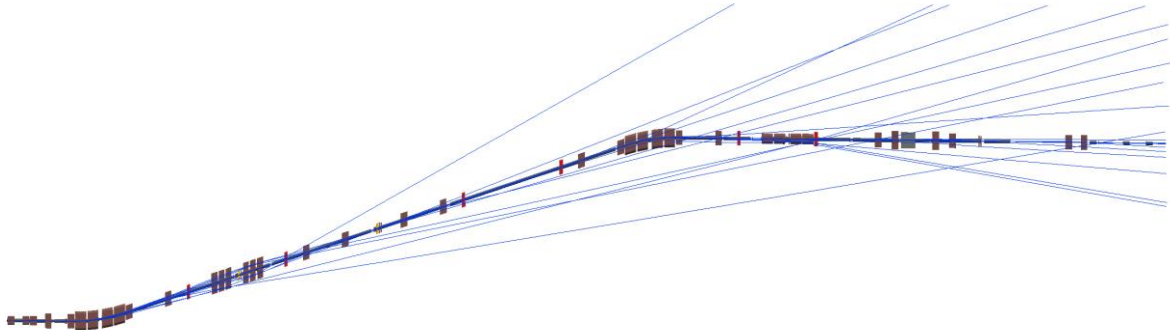


Steps

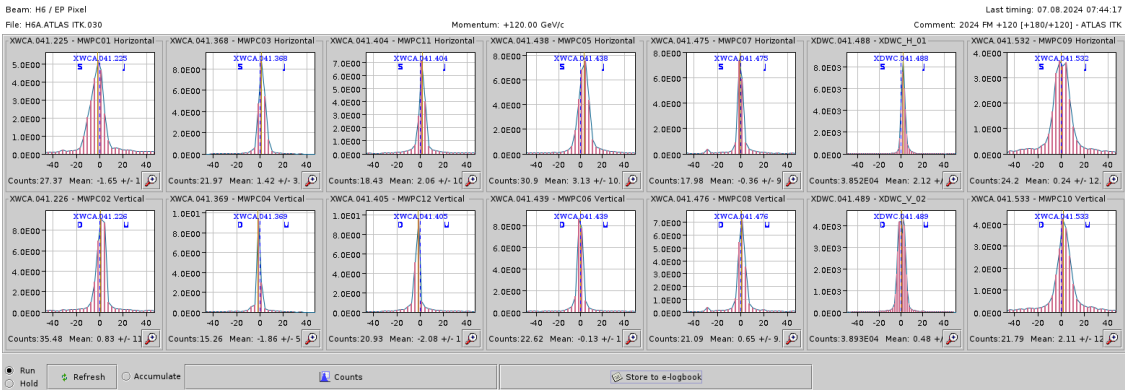
1. Determine optimal configuration



2. BDSIM/GEANT4 3D Simulation and Analysis



3. Compare with Experimental Results



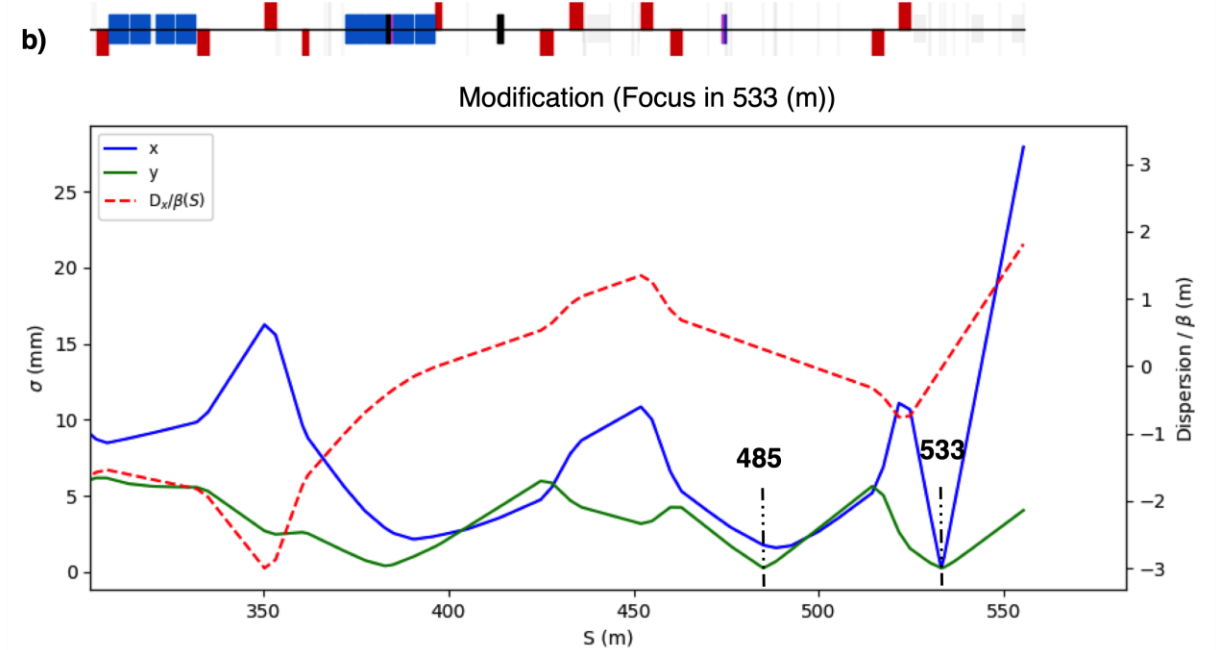
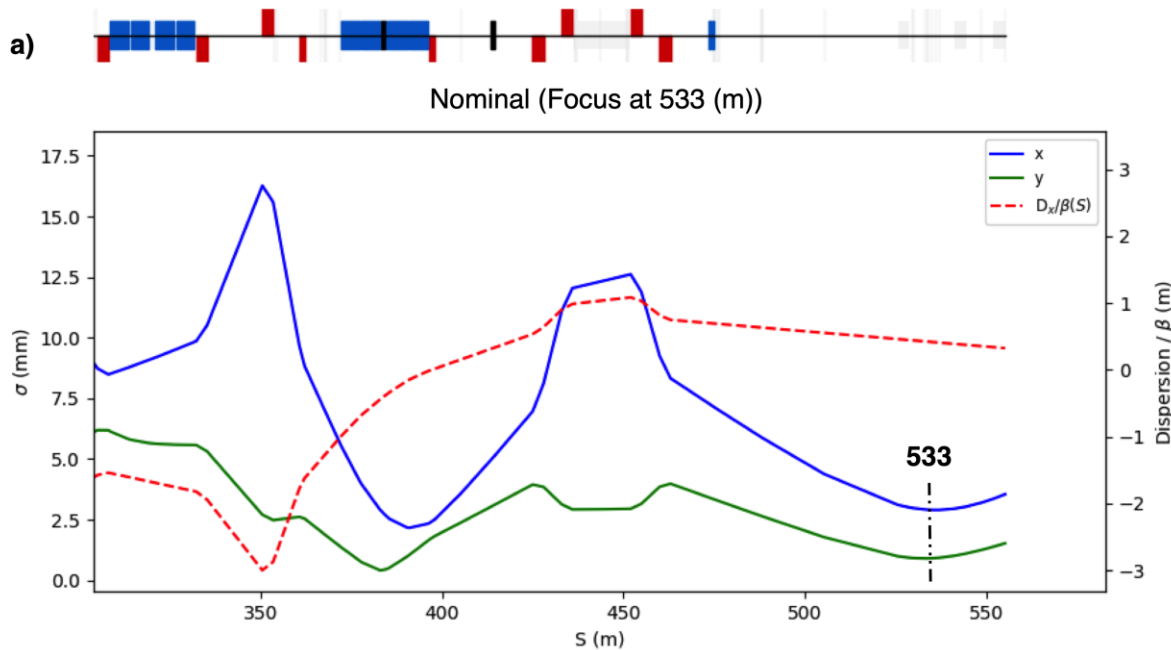
Determine Optimal Configuration

- Use MAD-X to match Twiss parameters by varying upstream magnets to create a focus which
 1. Minimizes dispersion
 2. Decreases beam size

Optimal Solution:

1. Doublet Solution
2. 4.2 (m) separation
3. Placed as far downstream as possible

Total reduction in σ of 41.52.



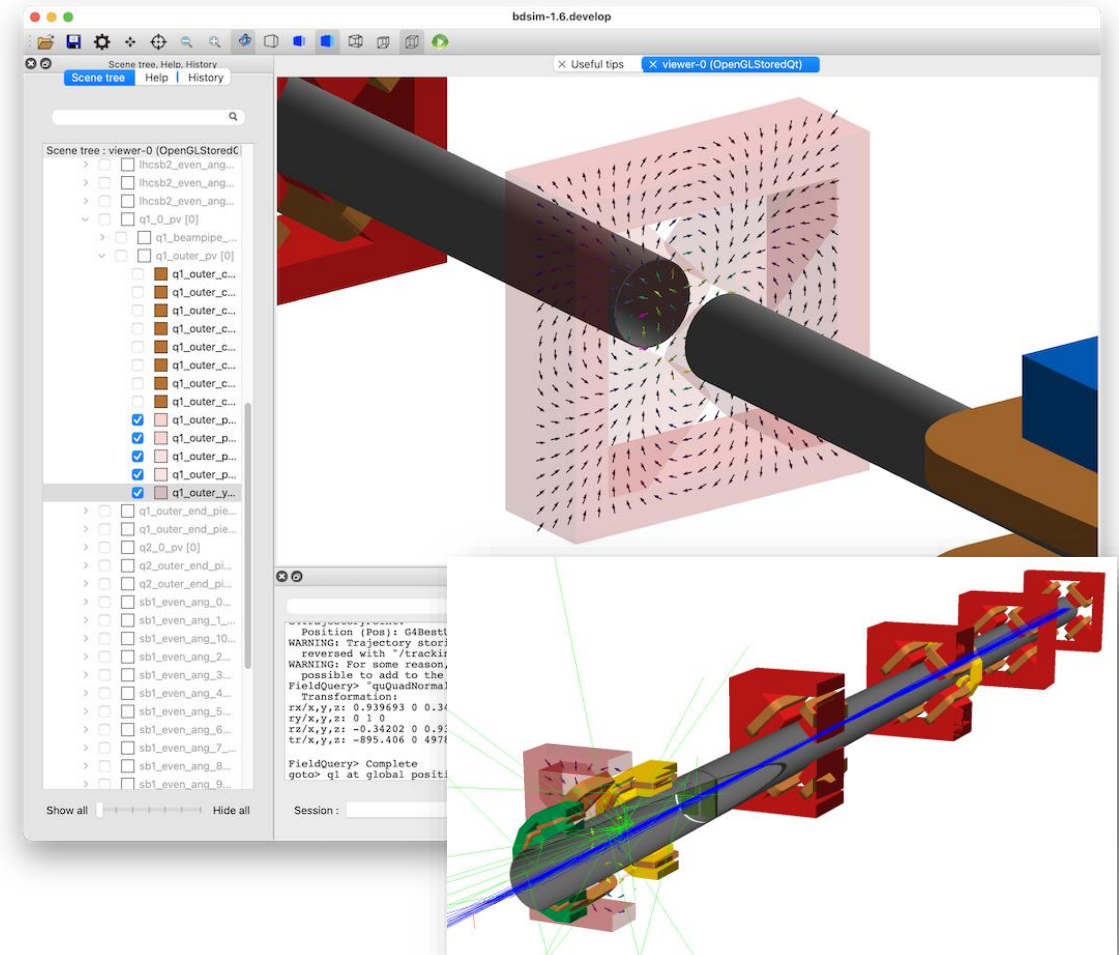
BDSIM / GEANT4



[Comp. Phys. Comm. \(252\), July 2020, 107200](#)

<http://geant4.web.cern.ch>

- Beam Delivery Simulation (BDSIM) builds GEANT4 models of accelerators and simulate beam losses and experimental backgrounds
- Use group's Python package to build model from library of geometry following MAD-X sequence
- Start with 400 GeV/c protons on Be target and simulate all particles and physics processes
- Look at distributions in a plane after each element – a “sampler”

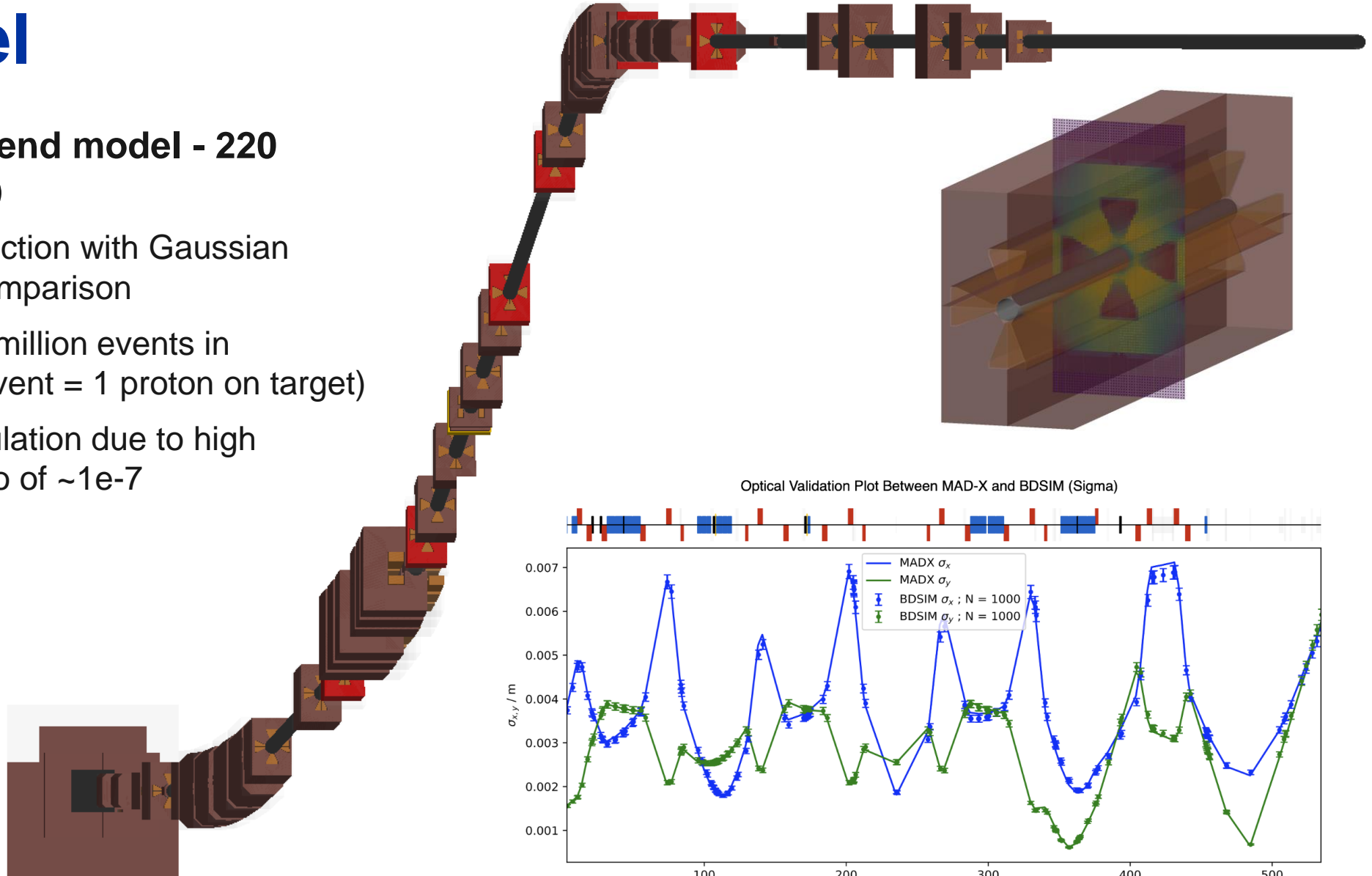


BDSIM Model

1. **Built full start to end model - 220 elements (585 m)**
 1. Verified construction with Gaussian beam optics comparison
 2. Simulated 100 million events in HTCondor (1 event = 1 proton on target)
 3. Two stage simulation due to high attenuation ratio of $\sim 1e-7$

2. Compare

1. Rate
2. Spectra
3. Beam Size



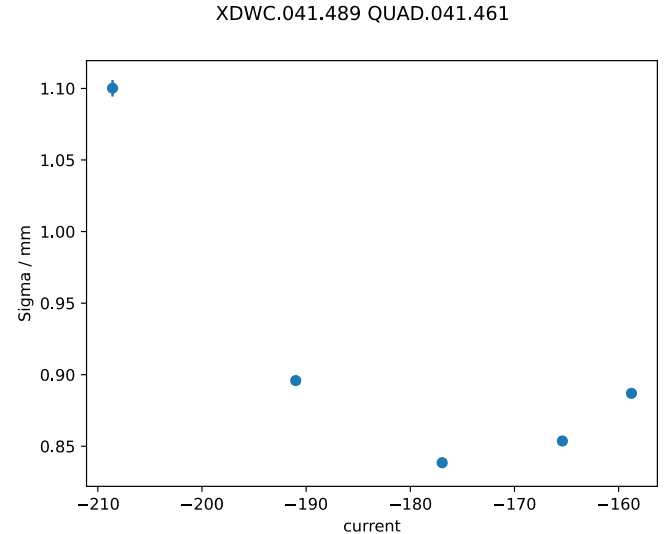
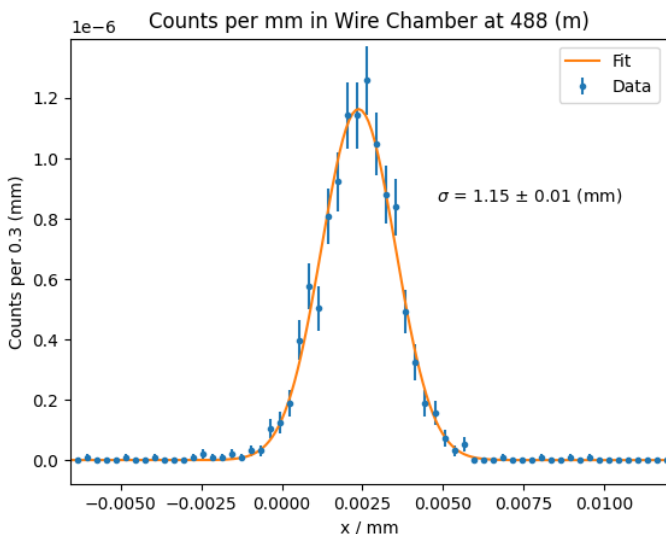
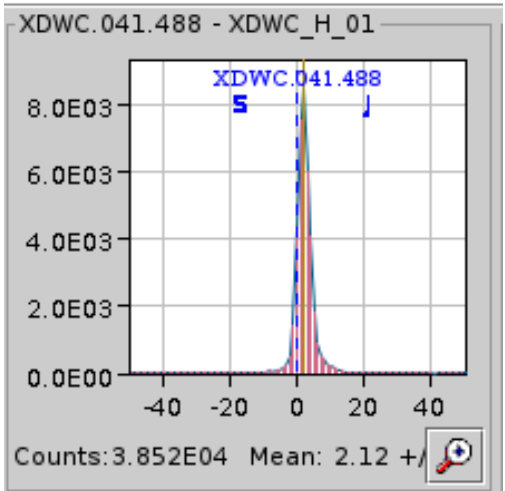
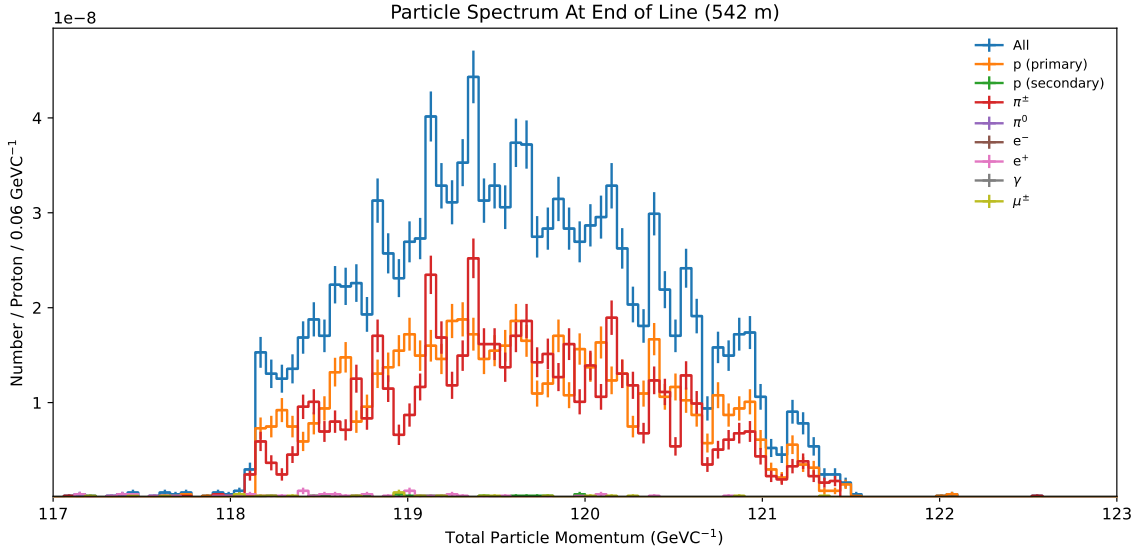
Measurement & Simulation Comparison

1. Rate Rate/Spill: 7e5

Rate/Proton on Target: 1.75e-7

2. Beam Size

3. Spectra



Summary and Outlook

- 1. Investigated optics to determine the optimal focusing in PPE156**
- 2. Built a 3D BDSIM / Geant4 model simulated it from start to finish**
 1. BDSIM shows positive preliminary results
- 3. Measured beam sizes with calculated optics in H6**
 1. Performed quadrupole scans to determine beam phase space (emittance)
 2. Performed 7 quadrupole scans for scan of optimal focus with no dispersion
 3. Scans performed yesterday and today due to machine and user availability – analysis ongoing
- 4. Made comparisons of simulated distributions and measured profiles**