G4beamline Simulations for the H8 Beamline at the North Area

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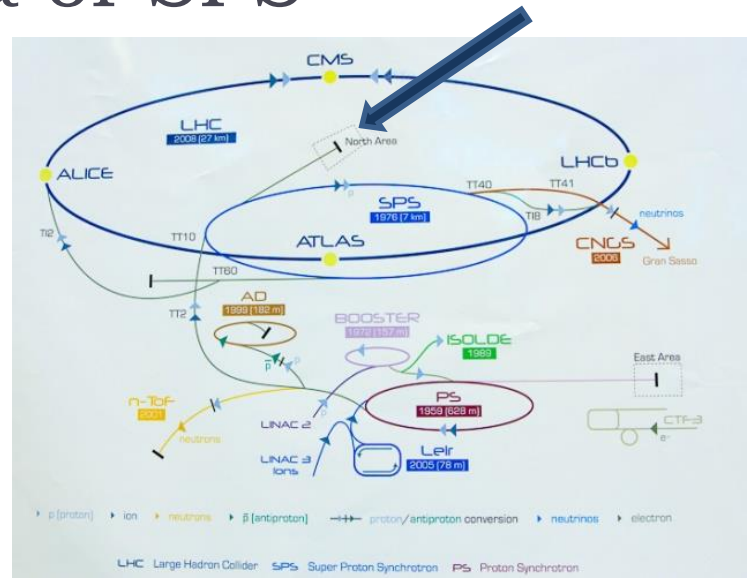
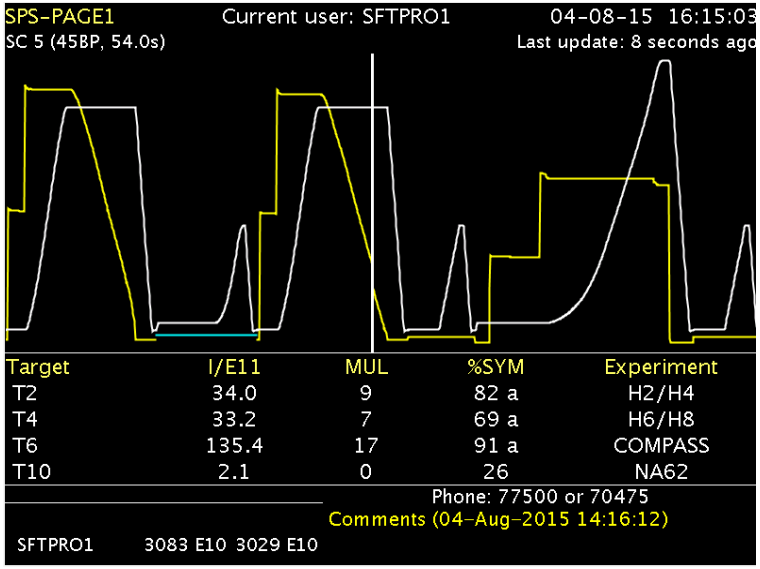
Outline of Presentation

- Introduction
  - The EHN1 area of SPS
- H8 beamline
  - Simulation of H8 with G4BL
- Results

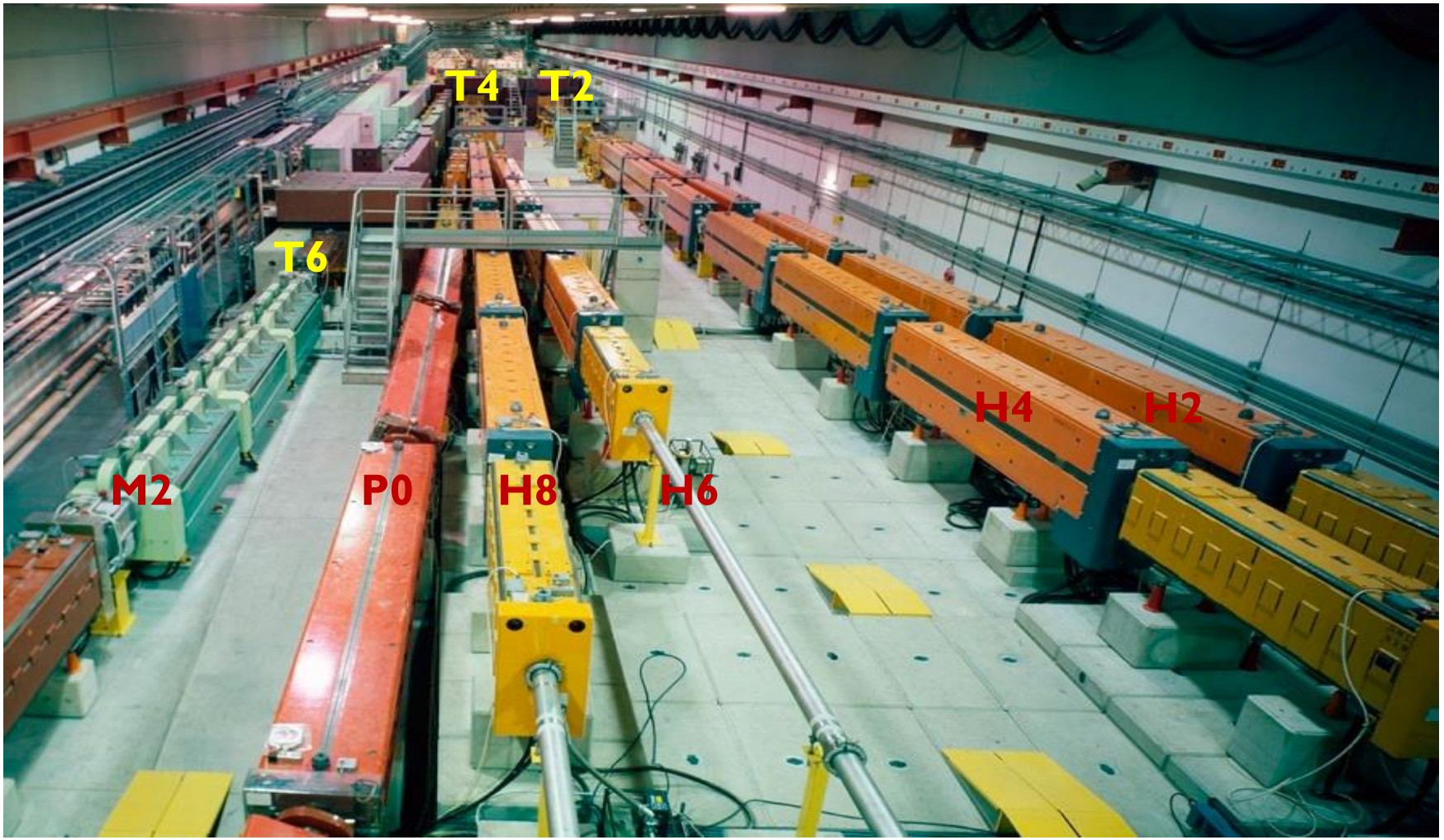
The EHN1 area of SPS

- Controlled *secondary* beam area for experiments
  - 4 beam lines (“H2”, “H4”, “H6”, “H8”)
- Beam (400 GeV/c) extracted on a Be-Target and produces the secondary beam
- Beam is extracted approx. every 54 s



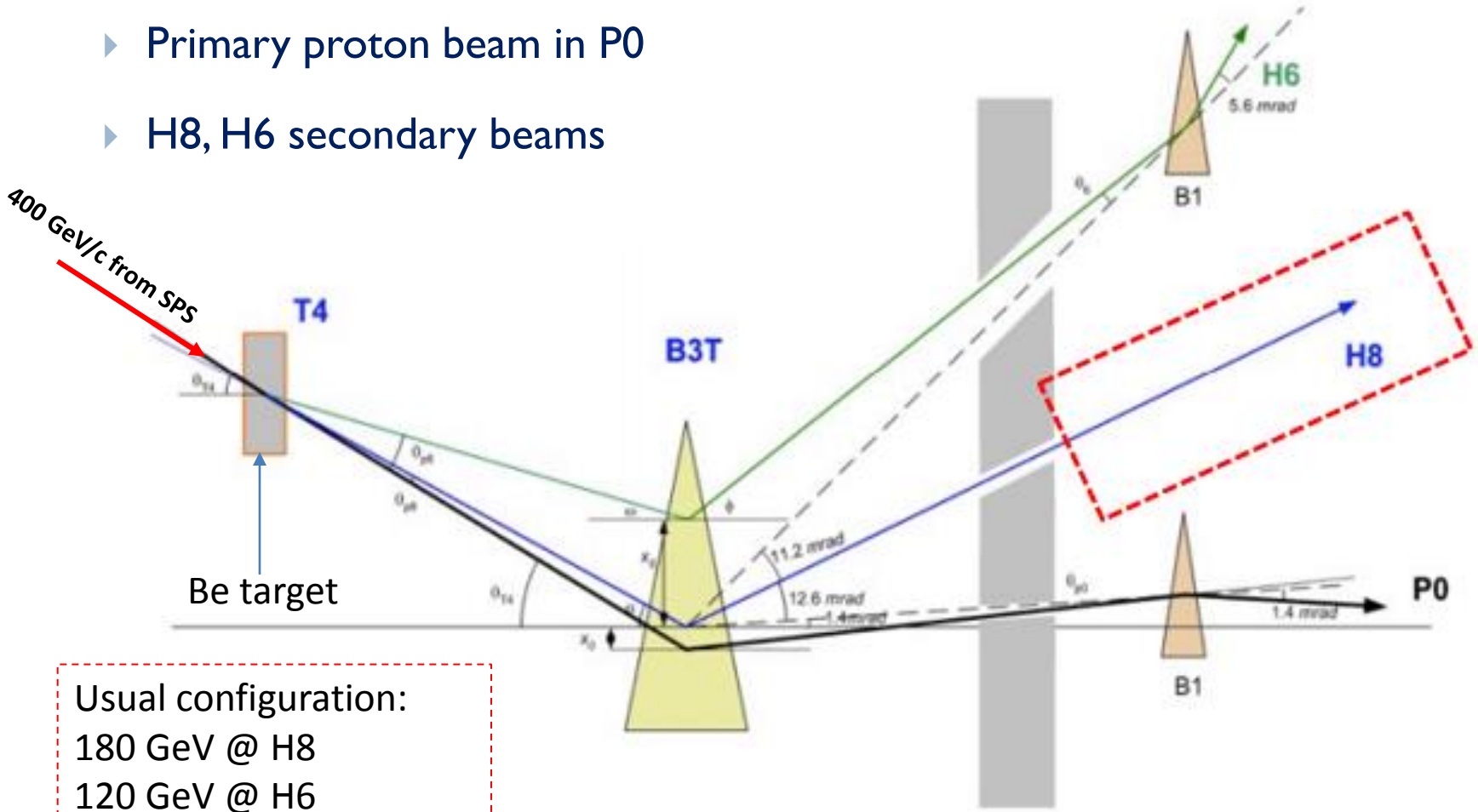


Target Station



Beamlines from T4

- Primary proton beam in P0
- H8, H6 secondary beams



Usual configuration:
180 GeV @ H8
120 GeV @ H6
400 GeV @ P0

Motivation

- But in a real beam line…
  - Misalignments, power supplies not perfect, …
  - Particle losses and creation of secondaries
  - "Changes" in the beam purity, not Gaussian shapes, …
- Better understanding of the beam line behavior is necessary!
  - Many elements (~ 600 m beam line length)
  - Many different particle types interacting with the elements
  - Understand the conventions ("left" ,"right")

My task:

a) Detailed modelling of the line including magnets, beam instrumentation and detectors in a specialized program based on GEANT4, G4BeamLine!

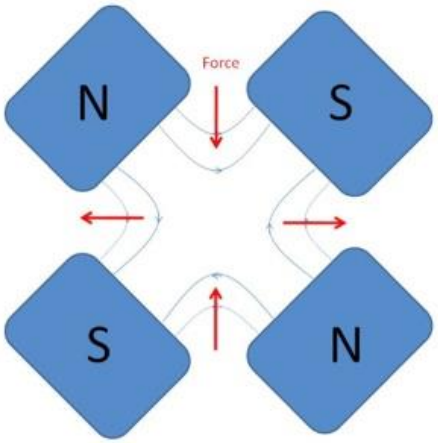
b) Comparison of simulations and measurements

H8 Beam Line

Other Elements

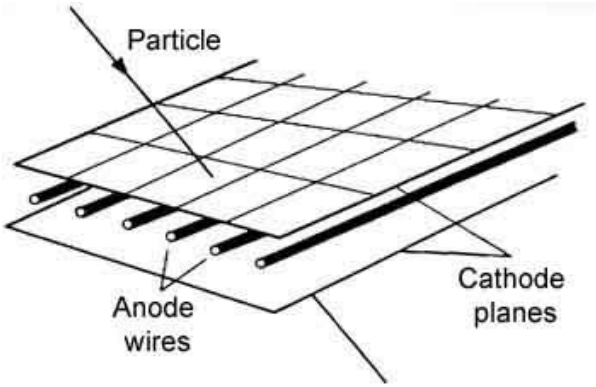
- Detectors
  - Scintillators/Triggers
  - FISC (FIlament SCanners)

Quadrupole



$$\frac{1}{f_{total}} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$

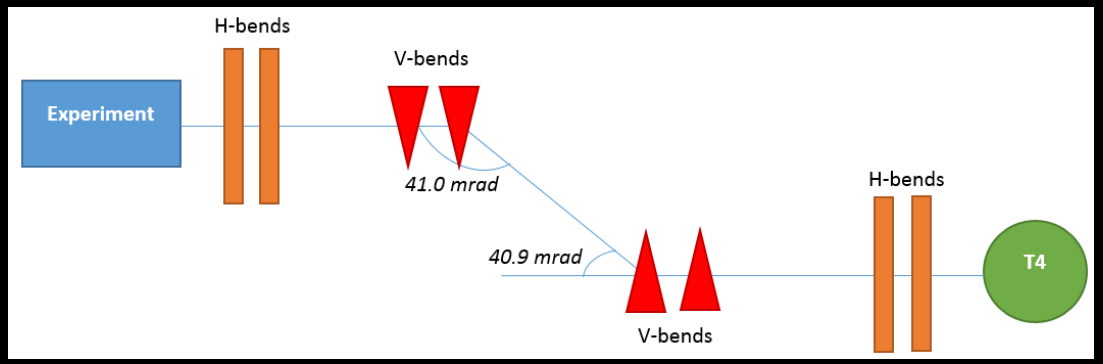
Wire Chamber



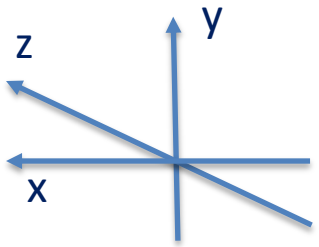
Collimator

Simulation of H8

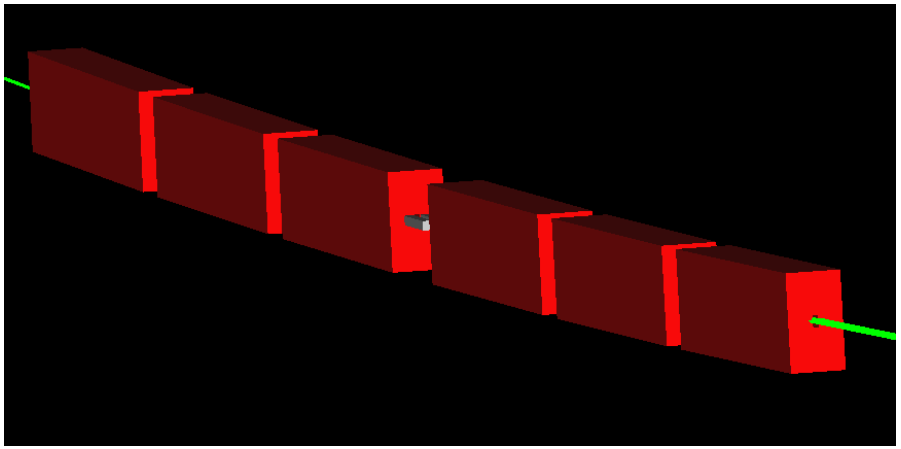
Beam goes right, up, down and right



B1, B2
Modelling of the Vertical Bends



- Parameters for modelling a bend in G4BL
  - Magnetic field (defines beam rotation)
  - Geometry rotation (independent!)
  - Shift of bend (for correct positioning!)



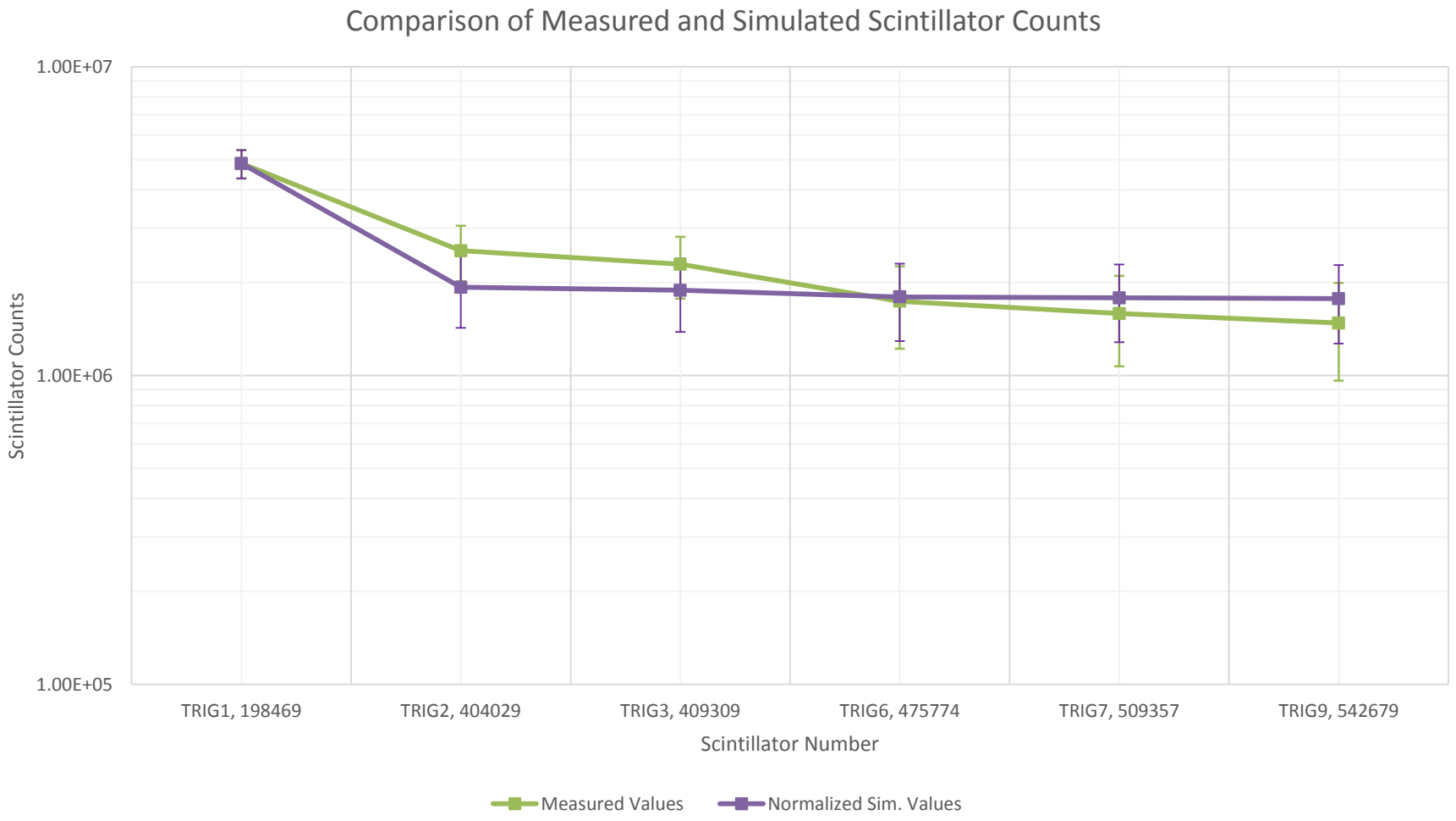
From Lorentz force law,

$$\mathbf{F} = m\frac{d\boldsymbol{v}}{dt} = e[\cancel{\boldsymbol{E}} + (\boldsymbol{v} \times \boldsymbol{B})]$$

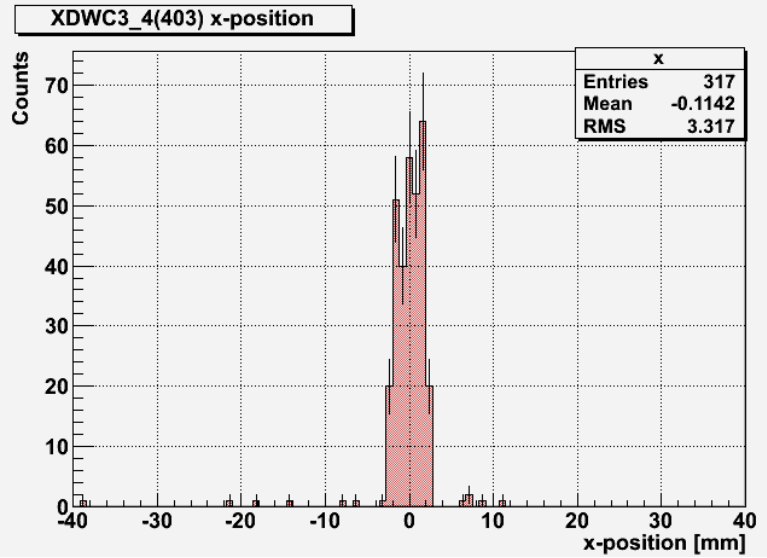
A equation can be derived for a magnetic bend,

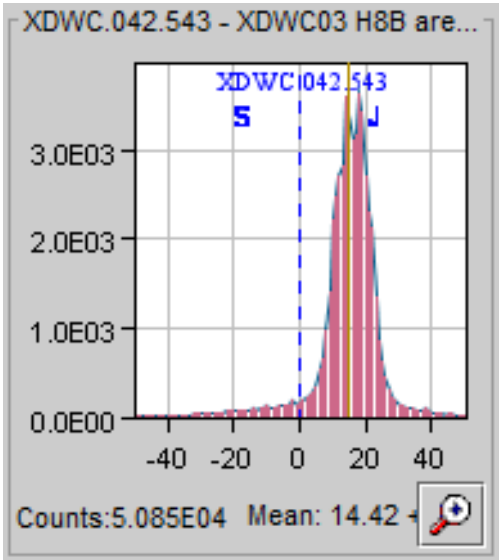
$$\theta[mrad] = \frac{299.79 \cdot B[T] \cdot L[m]}{p[GeV/c]}$$

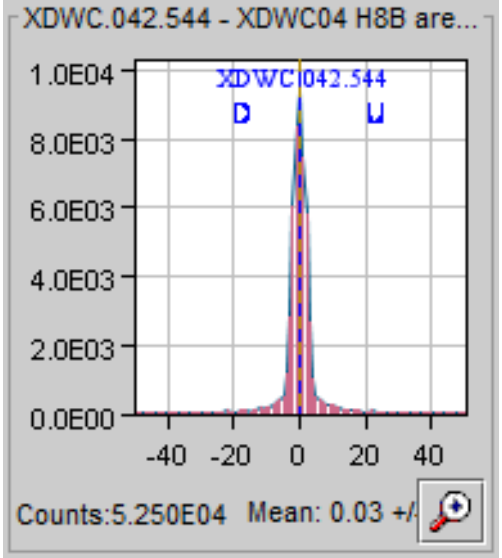
Results (analysis still ongoing ….)



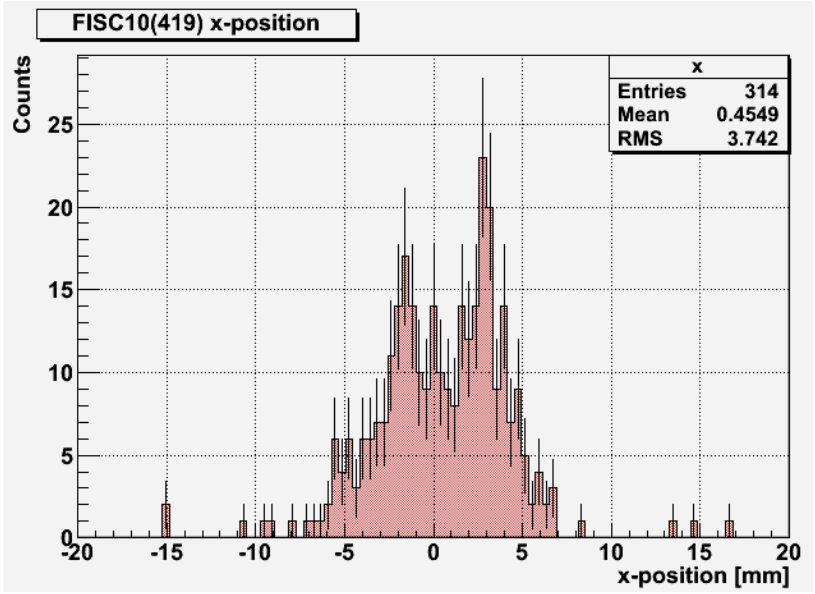
XDWC3_4 (403)

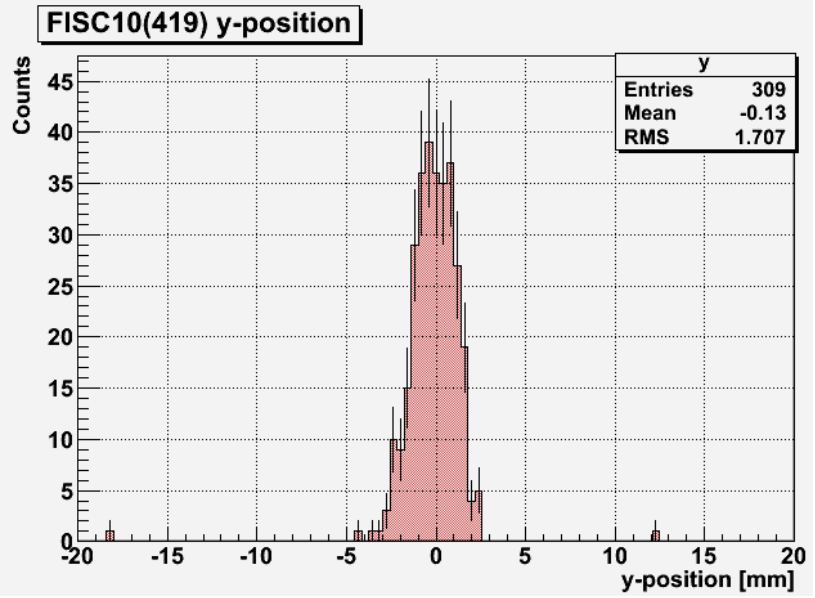

XDWC3_4(403) x-position
x
Entries 317
Mean -0.1142
RMS 3.317
Counts
x-position [mm]
XDWC3_4(403) y-position
y
Entries 314
Mean -0.4148
RMS 3.443
Counts
y-position [mm]

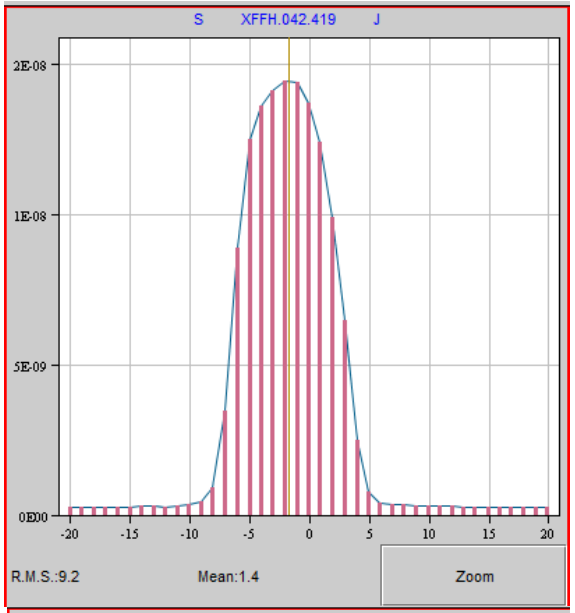

XDWC.042.543 - XDWC03 H8B are...
XDWC042.543
Counts:5.085E04 Mean: 14.42

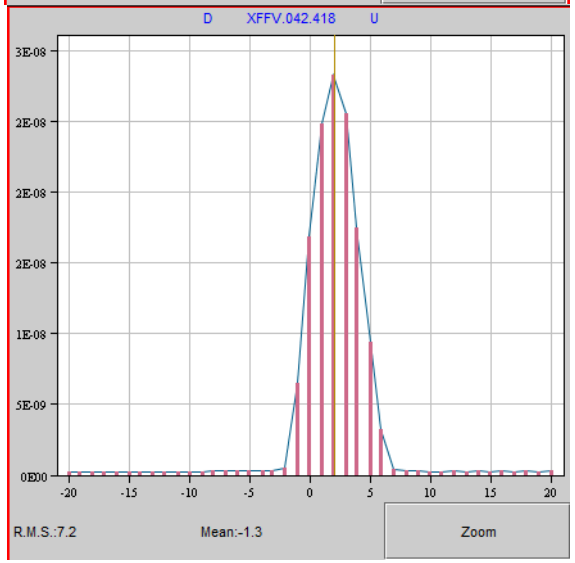

XDWC.042.544 - XDWC04 H8B are...
XDWC042.544
Counts:5.250E04 Mean: 0.03

FISC10 (419)


FISC10(419) x-position
Counts
x
Entries 314
Mean 0.4549
RMS 3.742
x-position [mm]


FISC10(419) y-position
Counts
y
Entries 309
Mean -0.13
RMS 1.707
y-position [mm]


S XFFH.042.419 J
R.M.S.:9.2
Mean:1.4
Zoom


D XFFV.042.418 U
R.M.S.:7.2
Mean:-1.3
Zoom

Conclusion

- Simulation of H8 beamline in G4BeamLine
  - Detailed simulation (detectors, magnets…)
  - Up to now very good agreement between measurements and simulations!
- Future steps
  - Simulate the correct beam composition (mixed beam of protons and pions)
  - Simulating the target
  - Obtain more statistics and understand the causes of some differences with the measurements

Questions?