



ENGINEERING  
DEPARTMENT

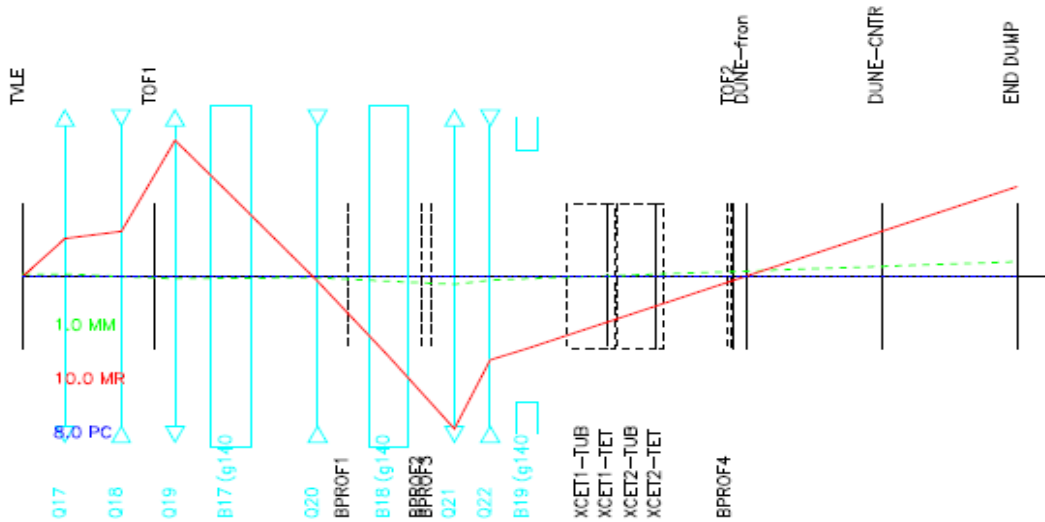
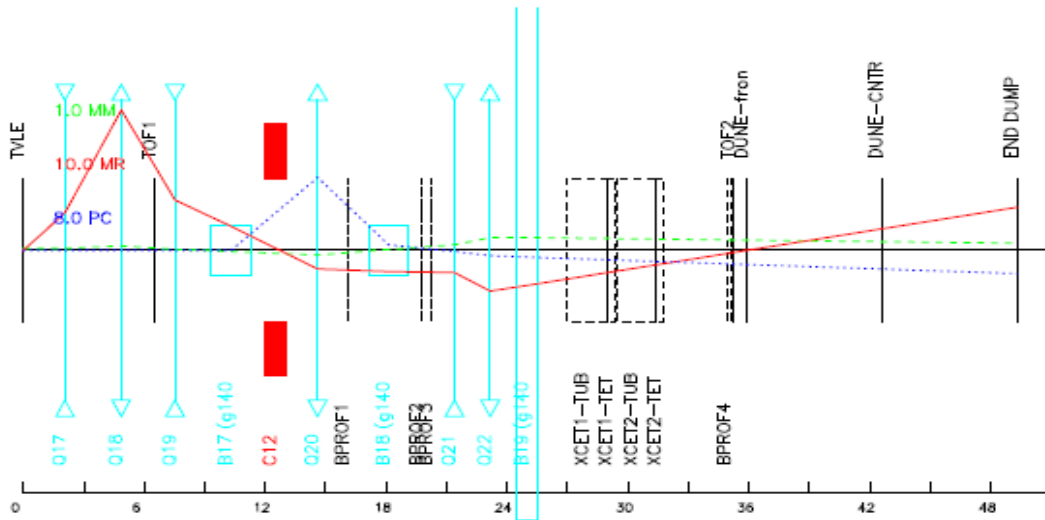
# Beam Calculations Status Report

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29/06/2016

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# H4: Layout



## Design Characteristics (27/06/2016)

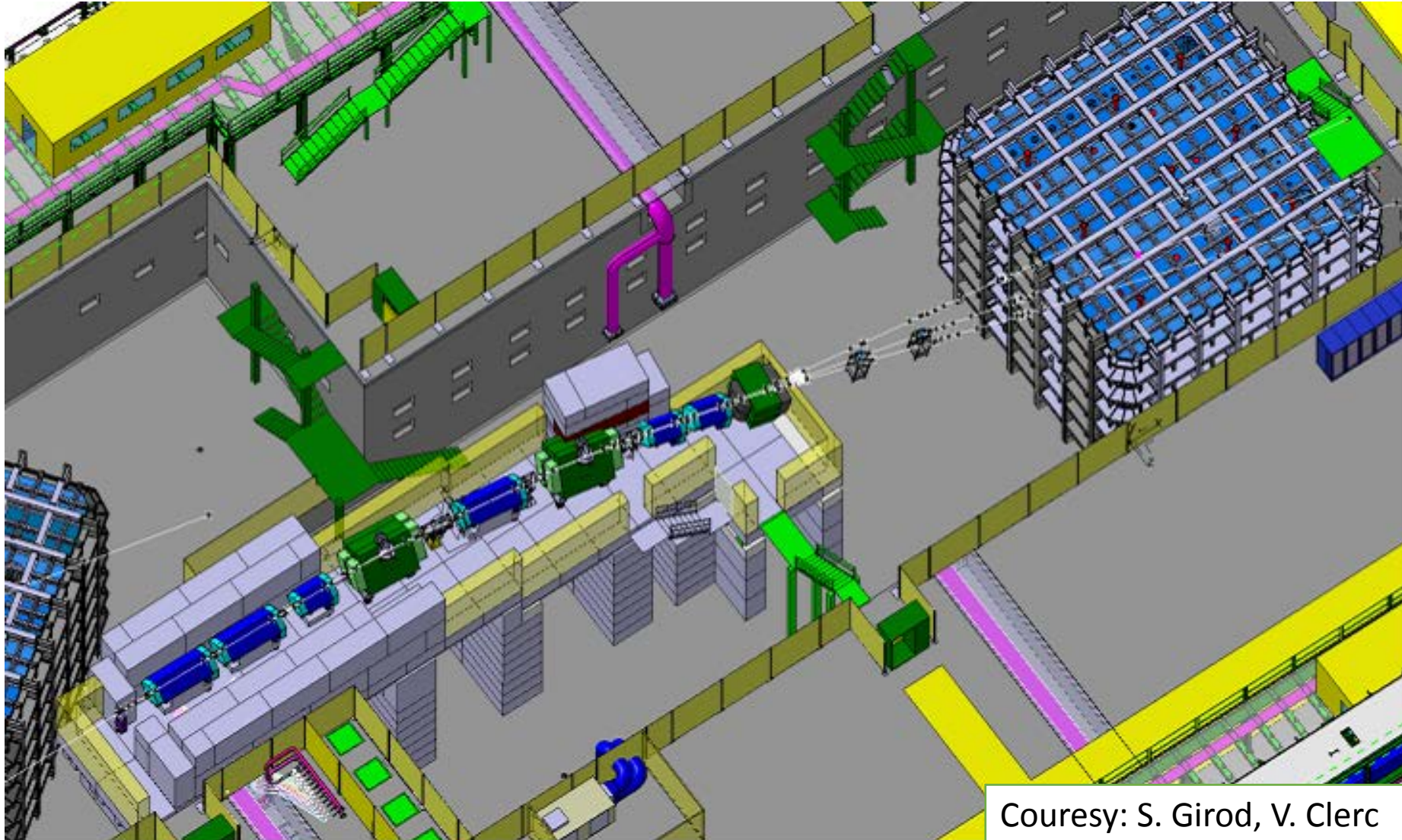
→ Total length from target up to DUNE-SP : 35.261 m

Included in the design :

- 4 spectrometer chambers (“BPROF<sub>x</sub>”)
  - Distances from the (center of the )bend : 1.883 m, 1.652 m, 2.111 m
- 2 TOF counters of total envelope 10 cm (“TOF<sub>x</sub>”)
  - Total distance between them : 28.159 m
- 2 Cherenkov counters, with total length ~ 2m (“XCET-x”)
  - Able for pressures up to 15 b

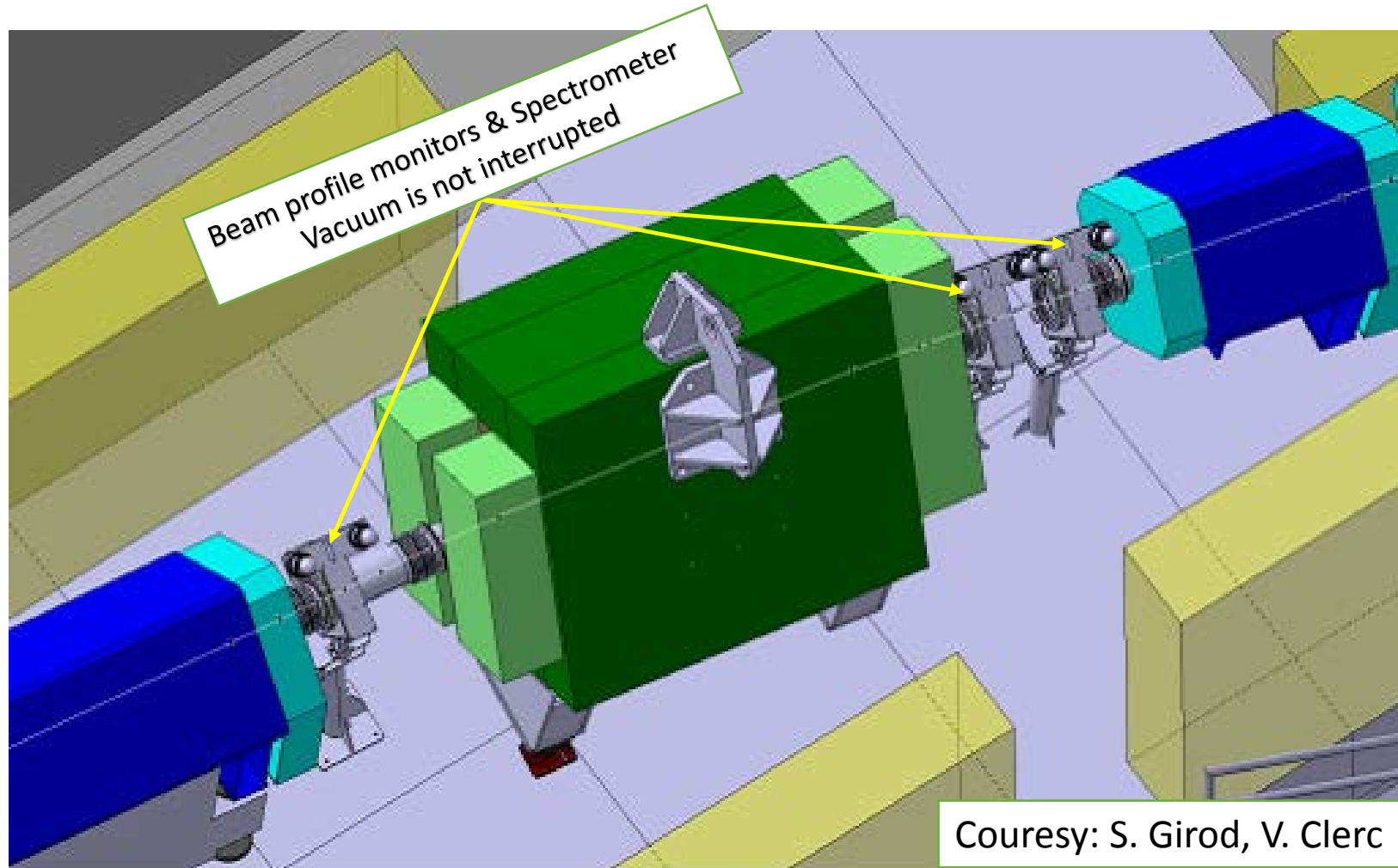
# H4 : Integration

Dipoles tilted : 60.15 degrees

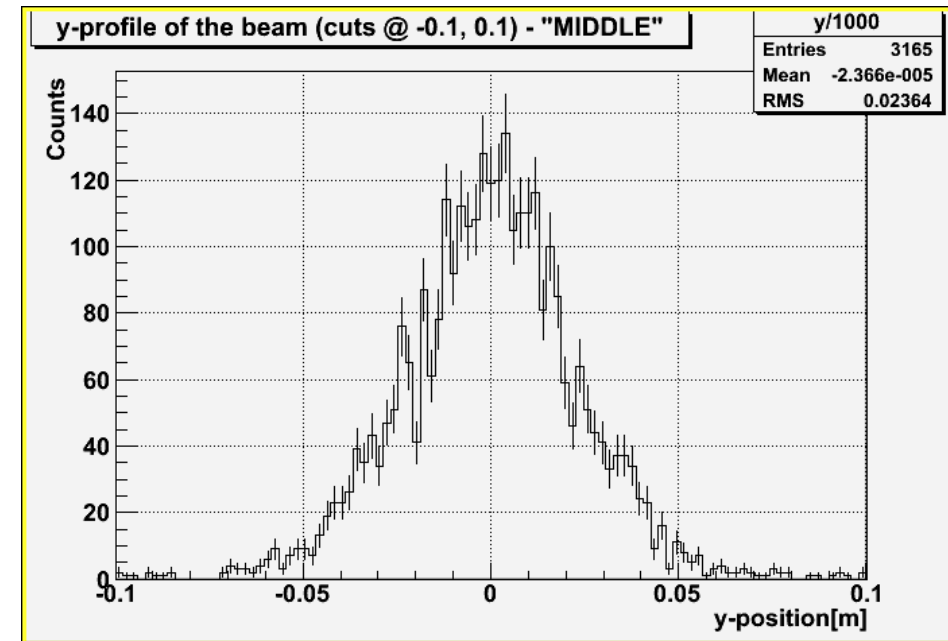
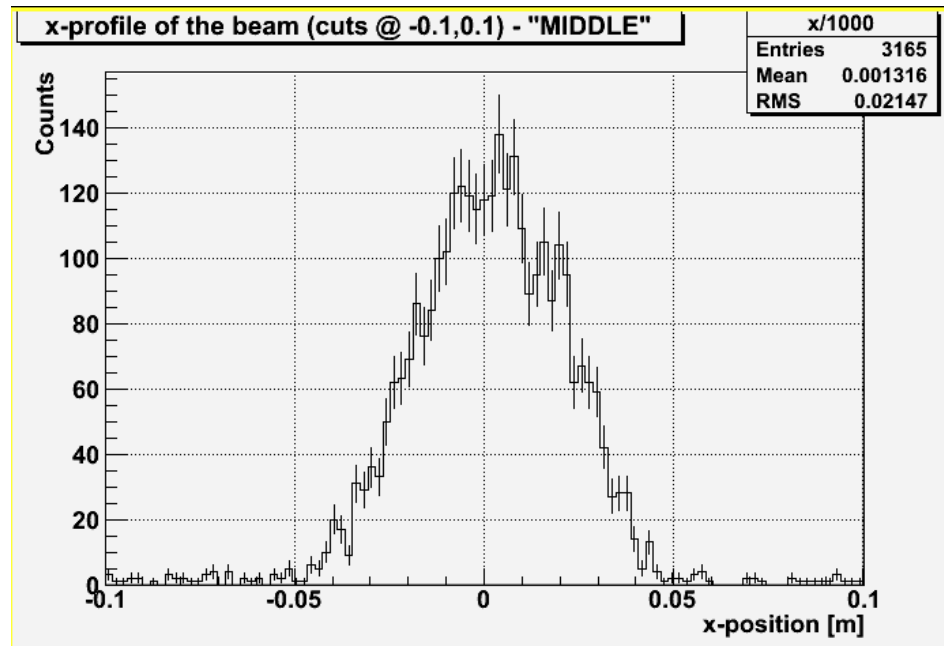


Courtesy: S. Girod, V. Clerc

# H4: Integration of vacuum / instrumentation elements



# Spot size for H2 @ Middle of WA105



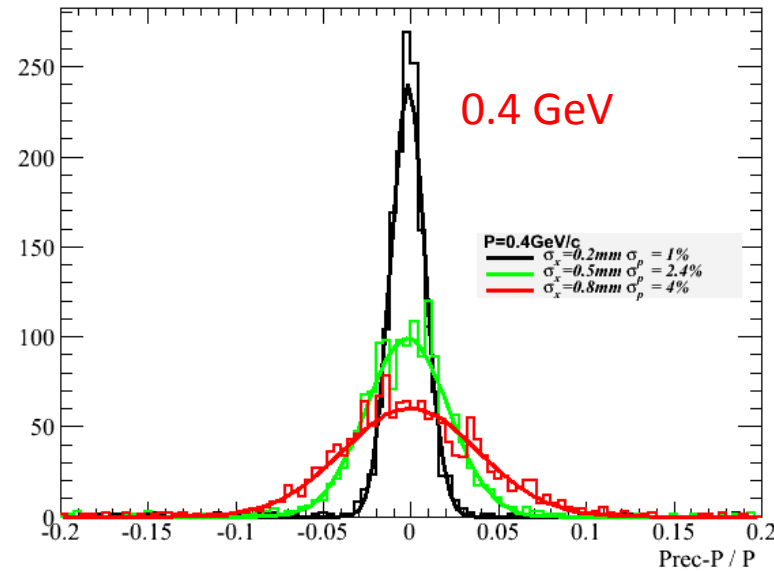
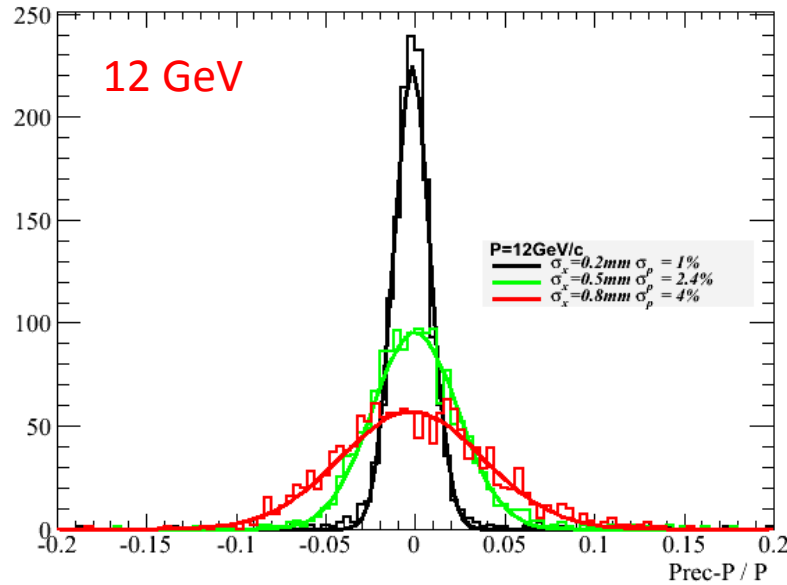
Similar spot size expected for H4

→ Will increase when the last bend is “on” (dispersion) – studies to follow.



# Spectrometer reconstruction Results

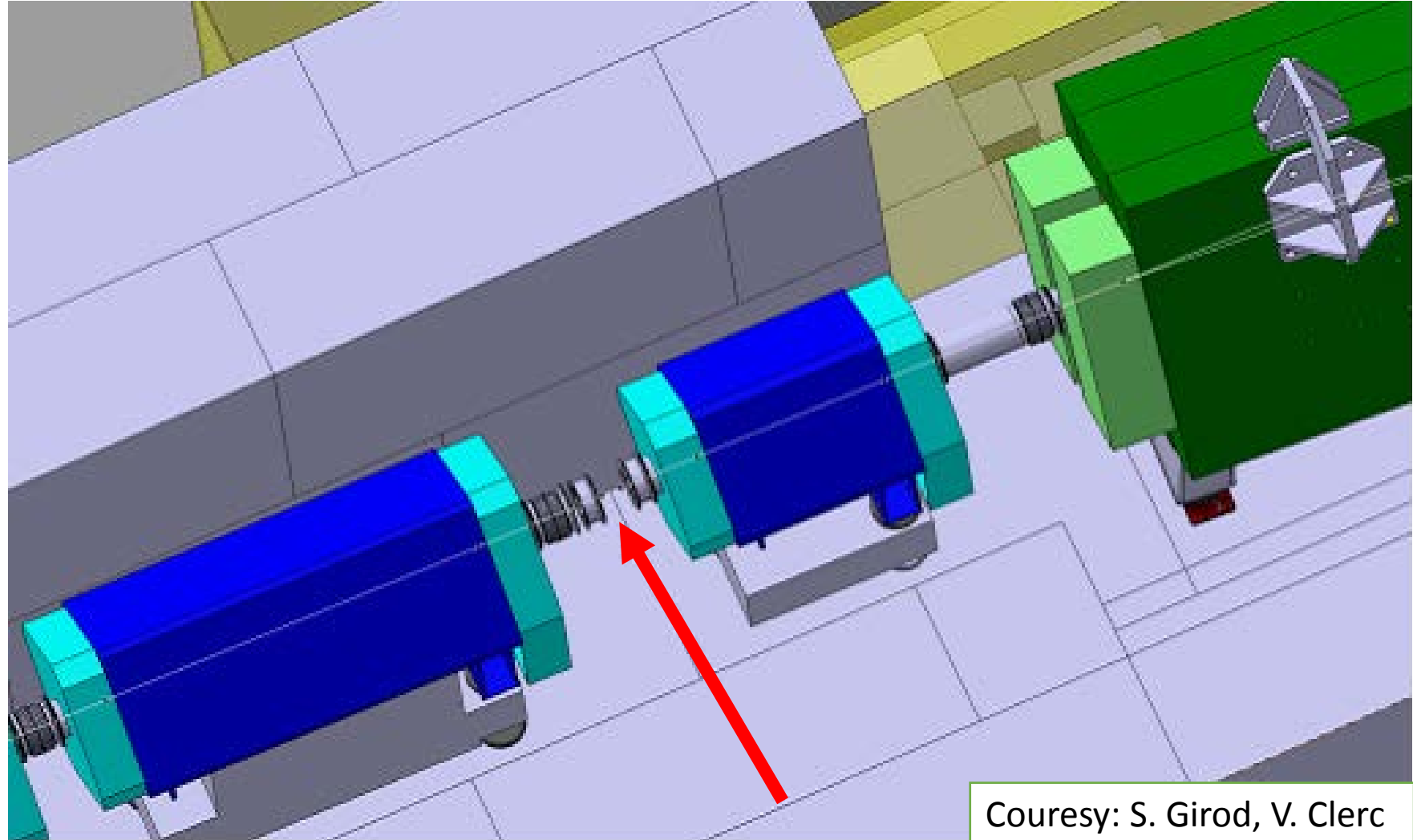
Full Simulation from GEANT4. Extracted x1, x3 and x4 used in the reconstruction.



No difference between the different energies since no windows etc are implemented in the simulation  
→ Ongoing work

# TOF Counters

- Space reserved between 2<sup>nd</sup> and 3<sup>rd</sup> quadrupole for a 10 cm TOF counter *in air*
- ..and for another one in front of the experiment
- → *Material budget to be considered carefully*



Courtesy: S. Girod, V. Clerc



# H4 : Material Budget to be considered

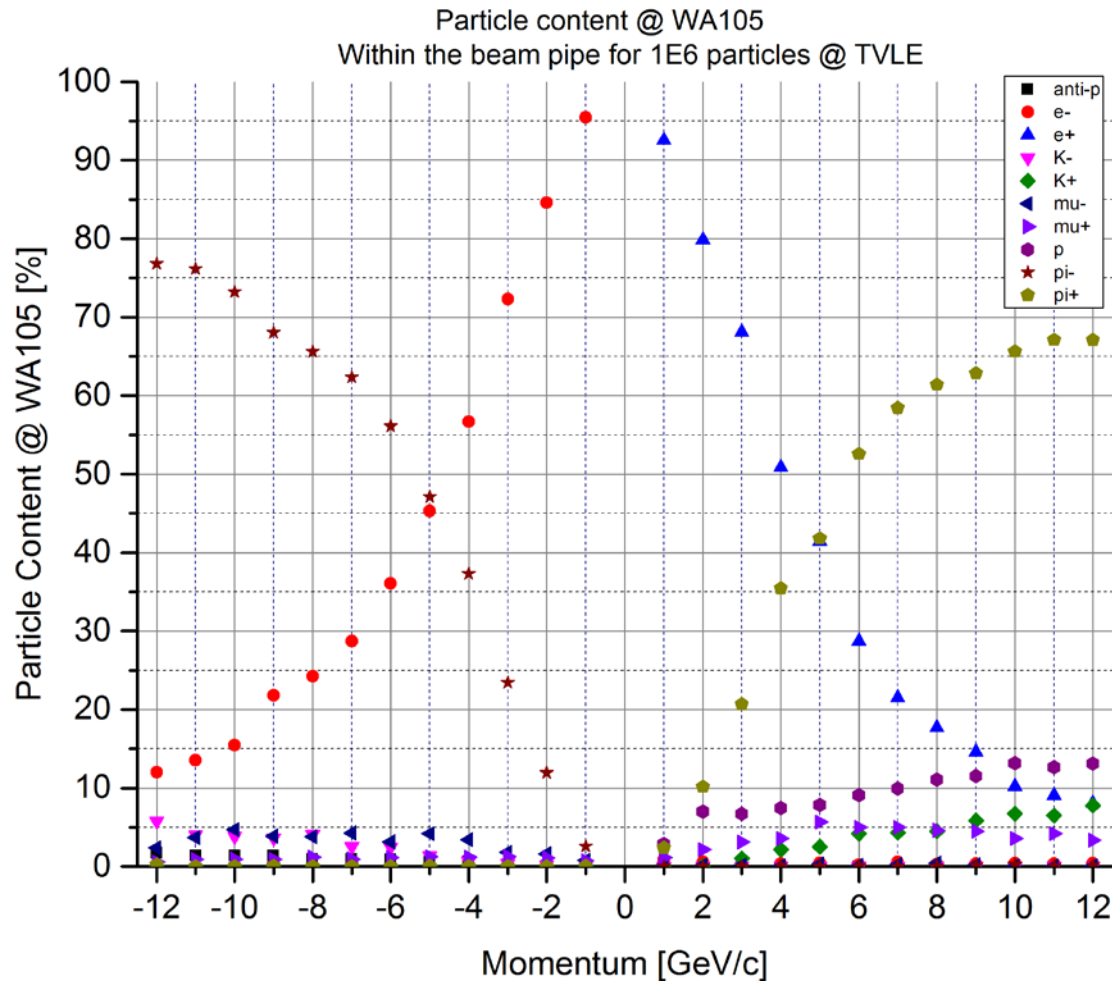
Beam Element	Nature	Size(cm)	Nb	Total Thickness (cm)	$\lambda$ (%)	X0 (%)
After T22	Air	110	1	110	0,15%	0,36%
BPROF1	Fibers	0,05	2	0,1	0,13%	0,23%
BPROF1	Scintillator	0,2	2	0,4	0,51%	0,94%
BPROF2	Fibers	0,05	2	0,1	0,13%	0,23%
BPROF2	Scintillator	0,2	2	0,4	0,51%	0,94%
BPROF3	Fibers	0,05	2	0,1	0,13%	0,23%
BPROF3	Scintillator	0,2	2	0,4	0,51%	0,94%
Before XCET1	Air	3	1	3	0,00%	0,01%
XCET1	Al	0,085	2	0,17	0,43%	1,91%
XCET1	Freon12	200	1	200	1,19%	5,32%
Before XCET2	Air	3	1	3	0,00%	0,01%
XCET2	Al	0,085	2	0,17	0,43%	1,91%
XCET2	Freon12	200	1	200	1,19%	5,32%
Before BPROF4	Air	3	1	3	0,00%	0,01%
BPROF4	Fibers	0,05	4	0,2	0,25%	0,47%
BPROF4	Scintillator	0,2	4	0,8	1,01%	1,88%
<b>Total</b>					<b>6,41%</b>	<b>20,35%</b>

@ 1 bar

@ 1 bar

Studies to investigate the exact effect of this material on the beam rate/shape and the momentum reconstruction are ongoing.

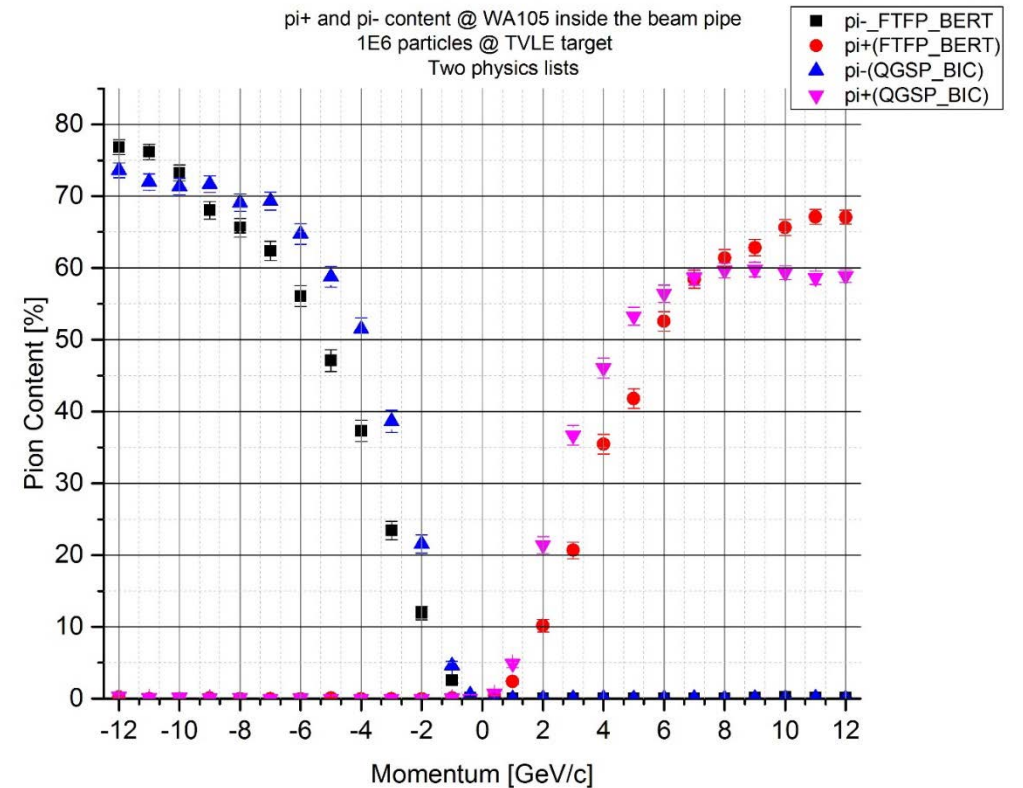
# Particle Composition (for H2 – Similar Results expected in H4)



Both **positive** and **negative** polarities have been simulated

→ Target: Cu-300 mm (under optimisation)

→ Physics List : **FTFP\_BERT** (cited as better for energies < 10 GeV )

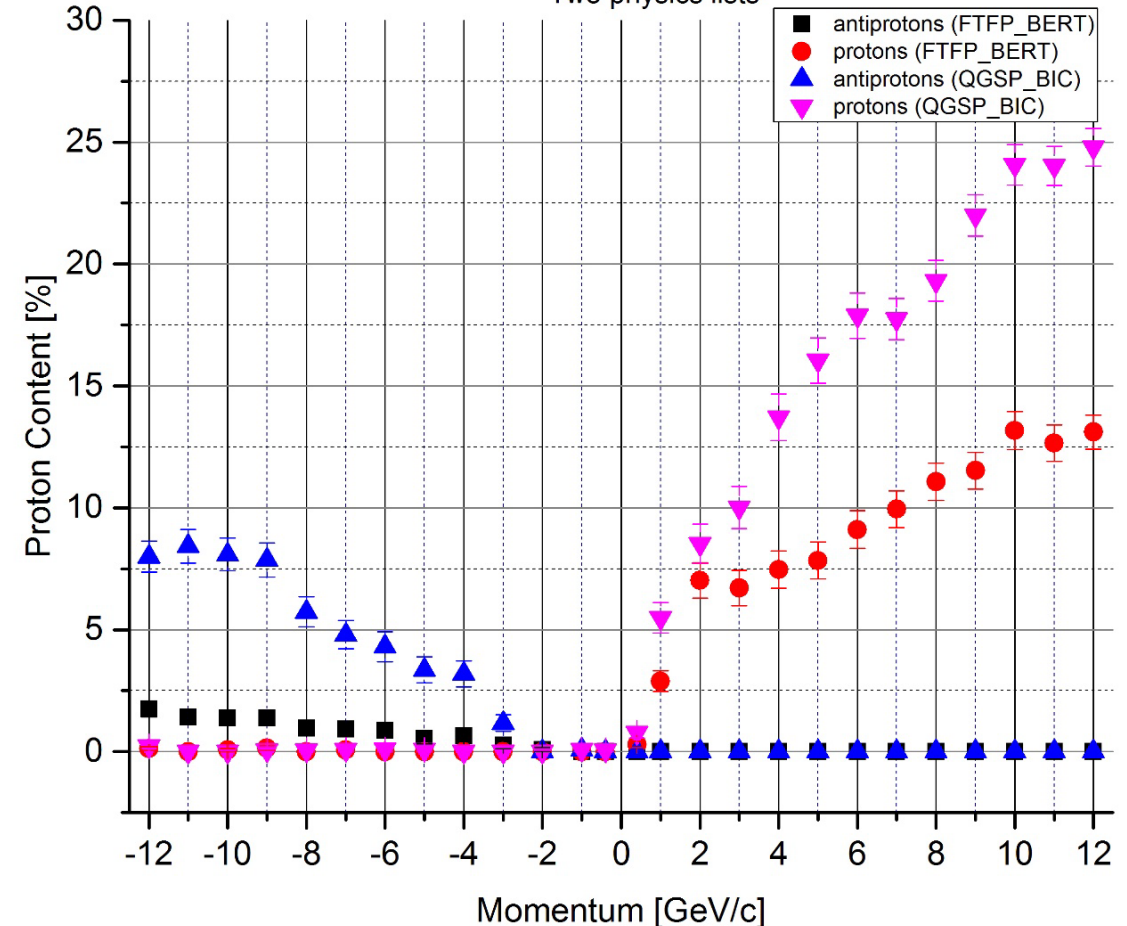


# Proton / Antiproton Content @ WA105

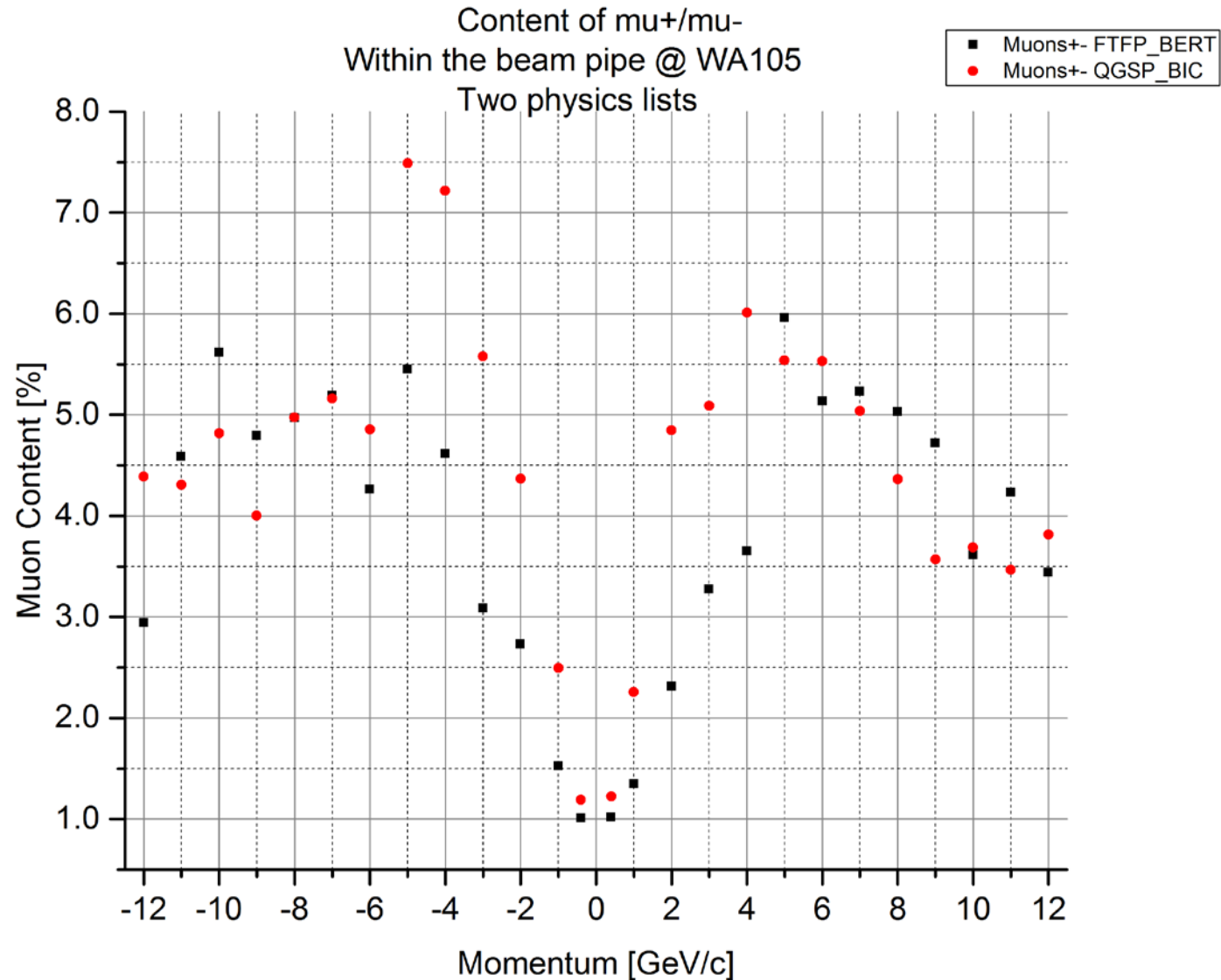
→ Similar expected for ProtoDune - SP

- Anti proton production is suppressed for (FTFP\_BERT) in low energies
- Difference for positive protons ~ factor 2 for positive high energies between the lists

proton and antiproton content @ WA105 inside the beam pipe  
1E6 particles @ TVLE target  
Two physics lists

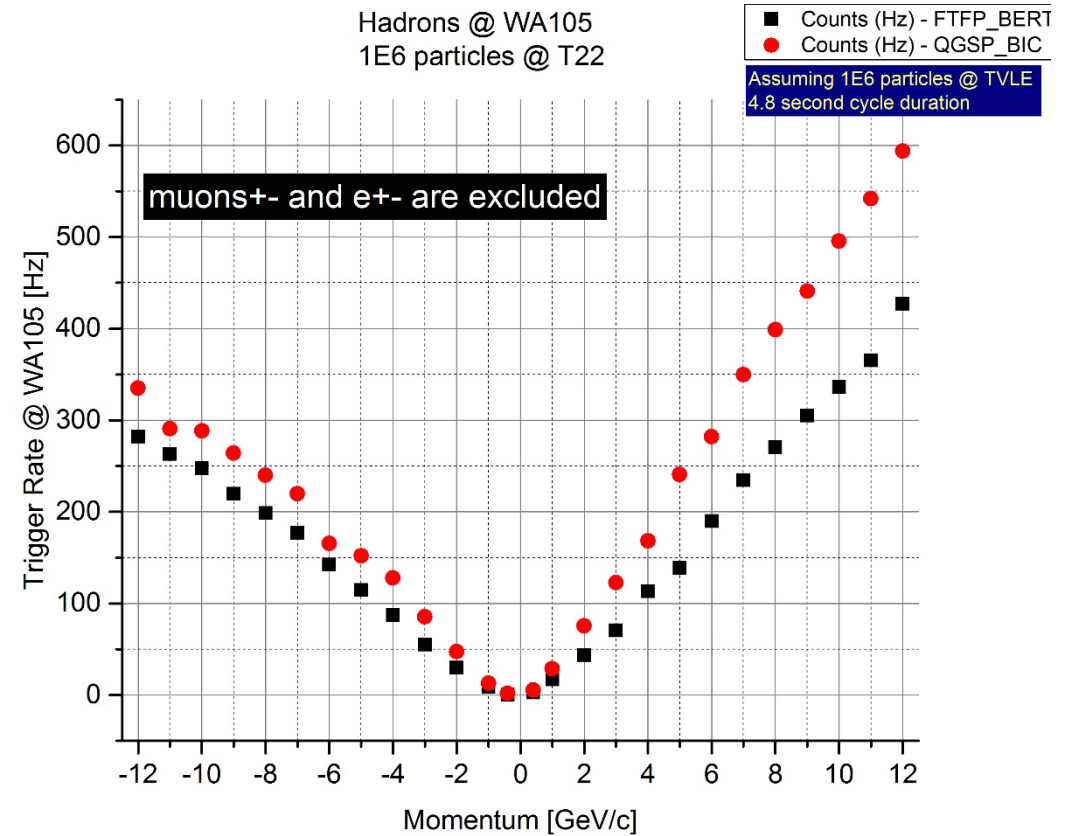
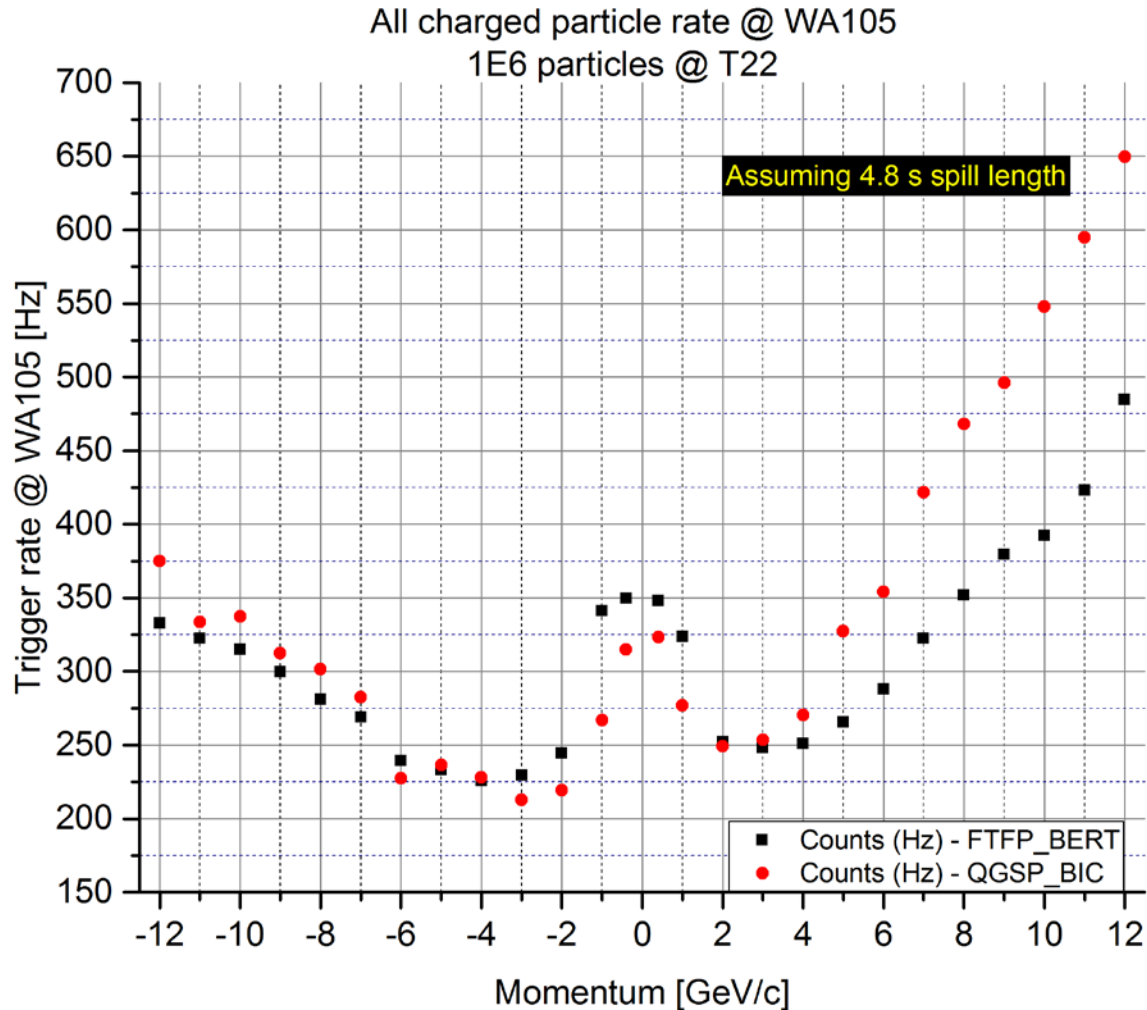


# Muons inside the beam pipe < 6%



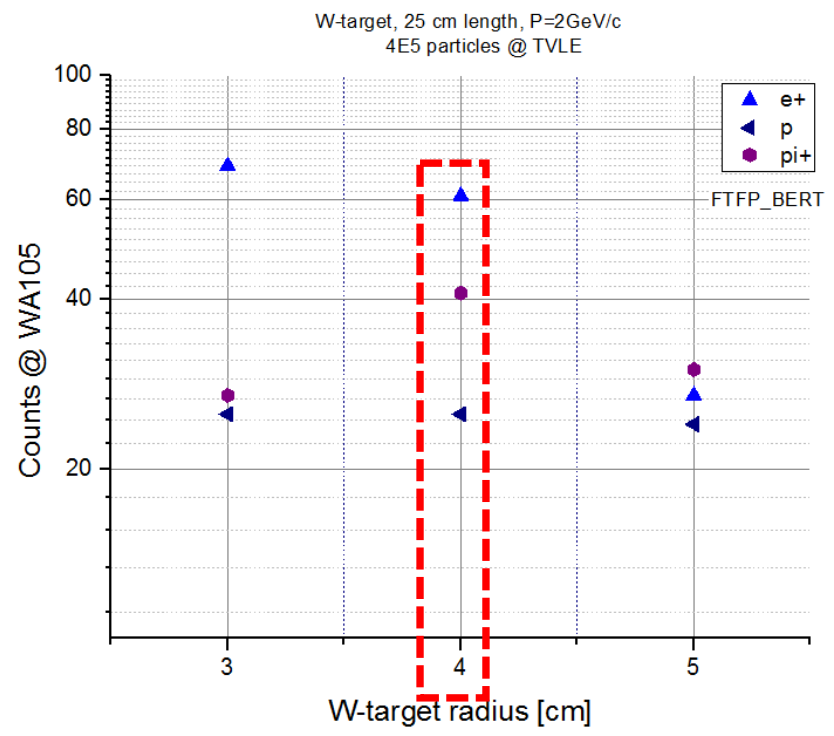
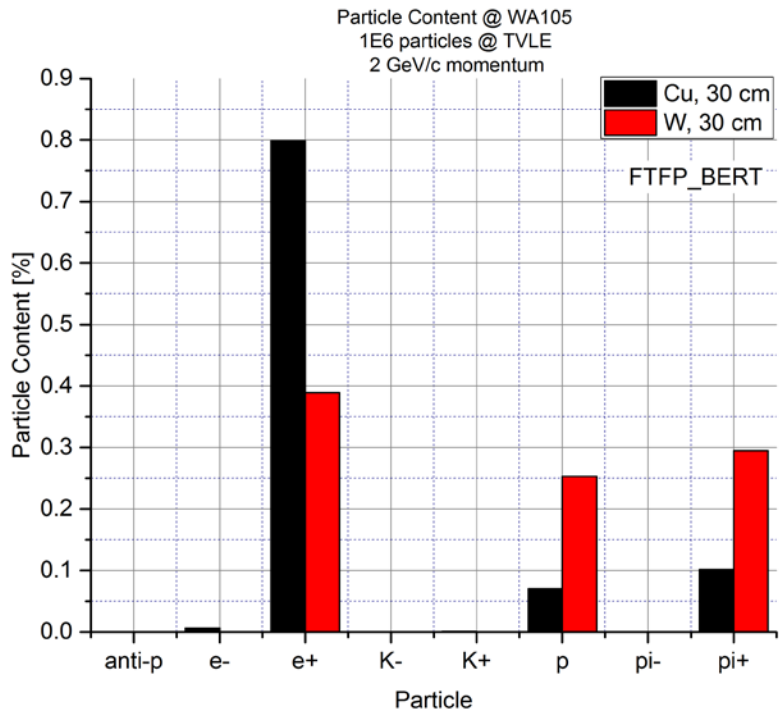
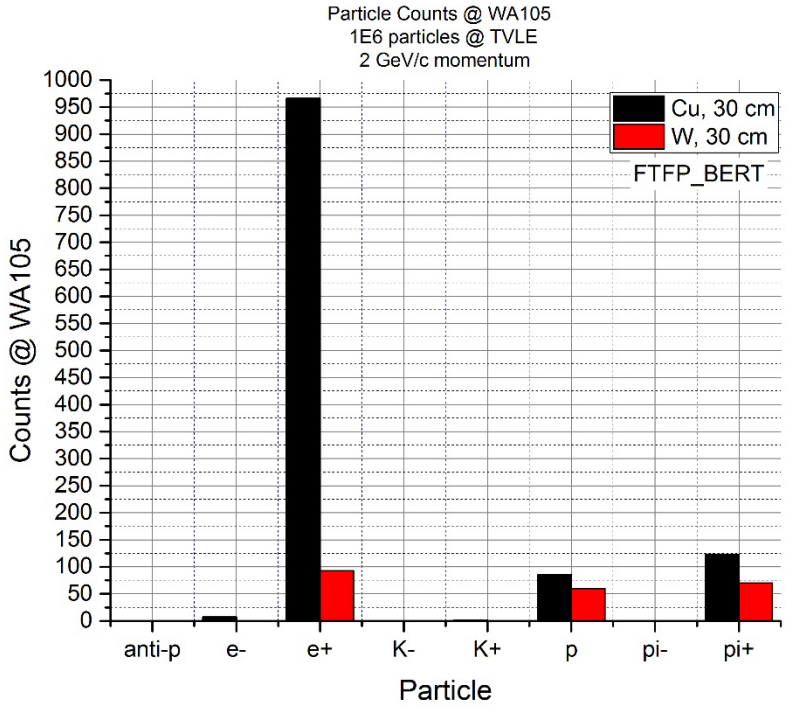
# Absolute Rates

The rate is adjustable by modifying the secondary beam intensity and / or collimating the beam



100 Hz trigger rate is easily achievable

# Target optimization – W 30 cm, 4 cm radius looks favorable in terms of efficiency for the low energies



# The end.

- Thank you !