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Update on spectrum monitoring

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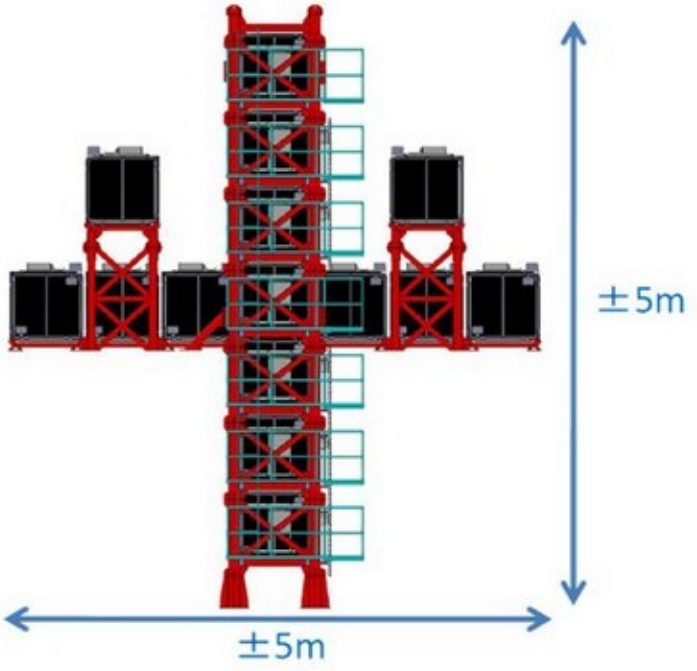
Rate and spectrometer comparison

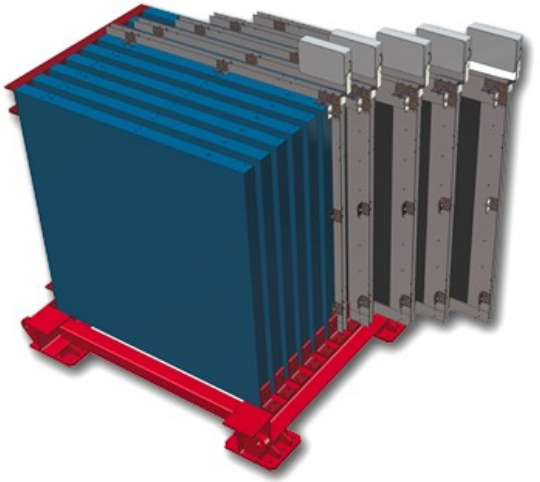
- Rate : INGRID-like, range out a list of modules along X, each one has 7 tons mass.
- Spectrometer: MUON ONLY FOR NOW! 8.7 ton 3DST with smearing of muon P x 4% (we know it is likely to be 4% at 1 GeV)

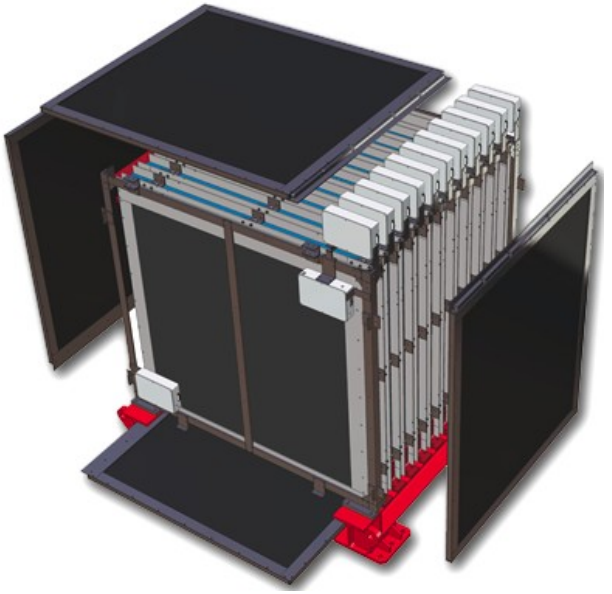
- Important facts:
  - Binning for the flux variation is 0.25 GeV.
  - For spectrometer, evaluate averaged performance from multiple samples.

INGRID-like → rate only

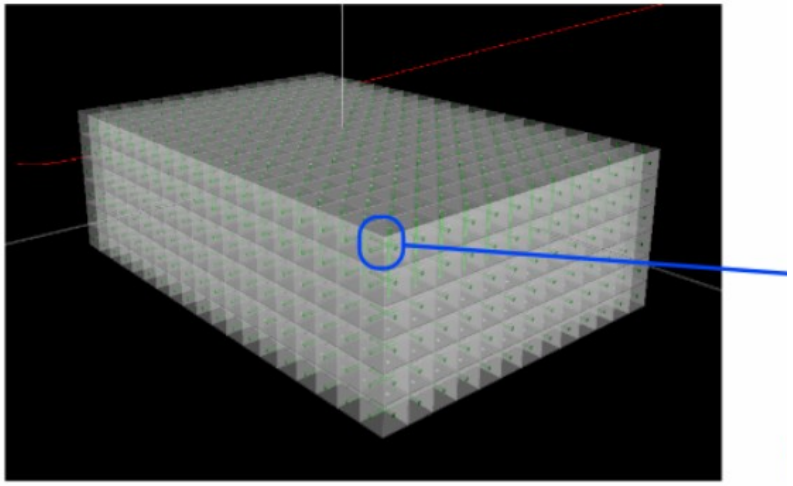
- ~7 tons per module array along X and/or Y.
- Target: scintillator and iron
- Ranged over few meters

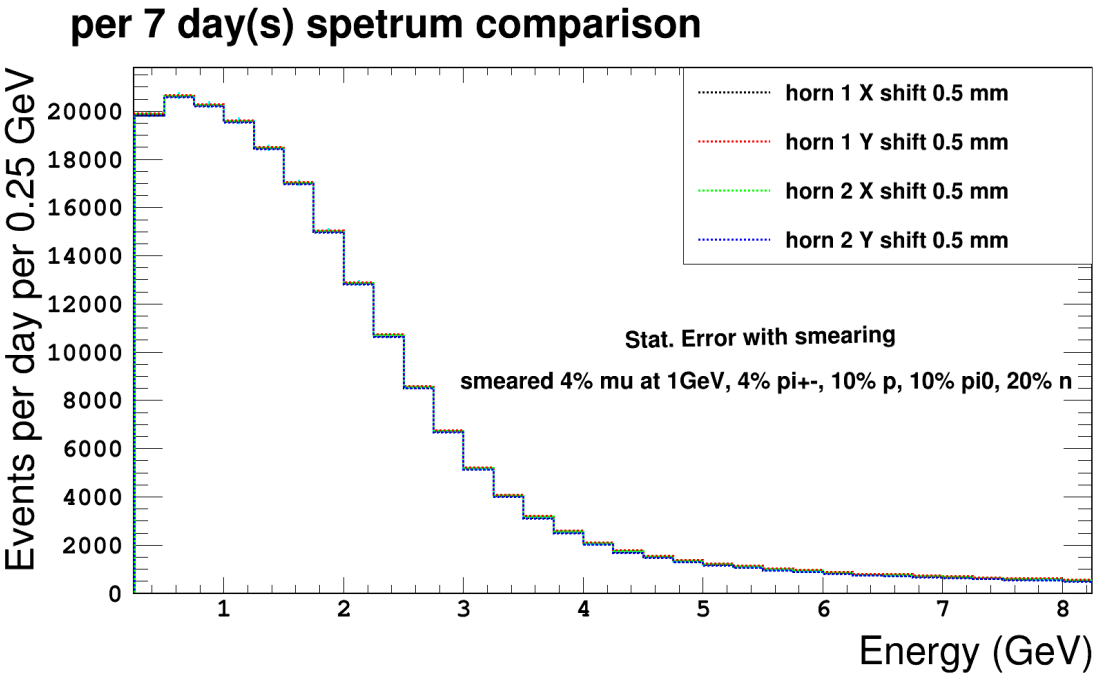


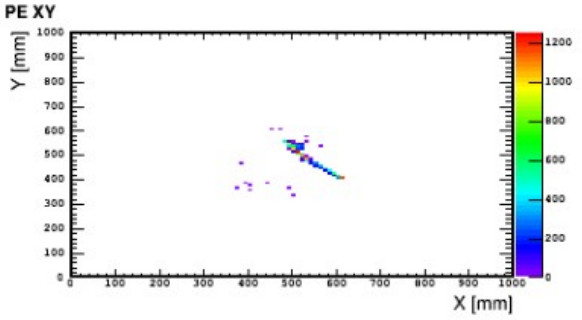


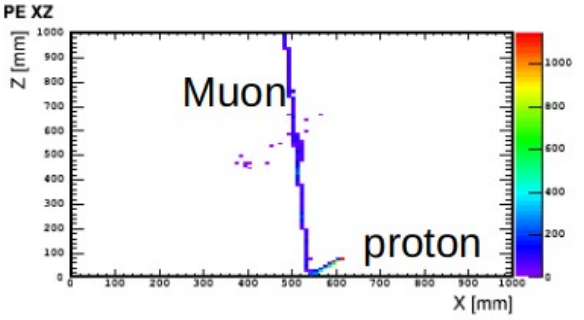


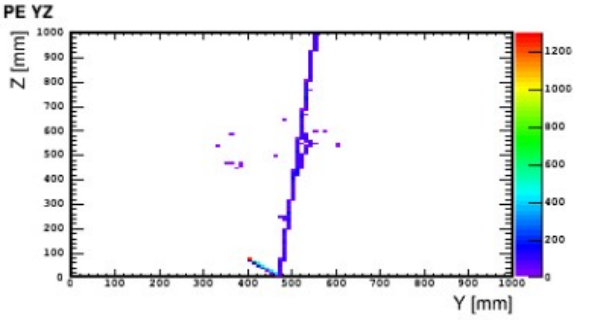
3DST-like → shape available











Variations considered

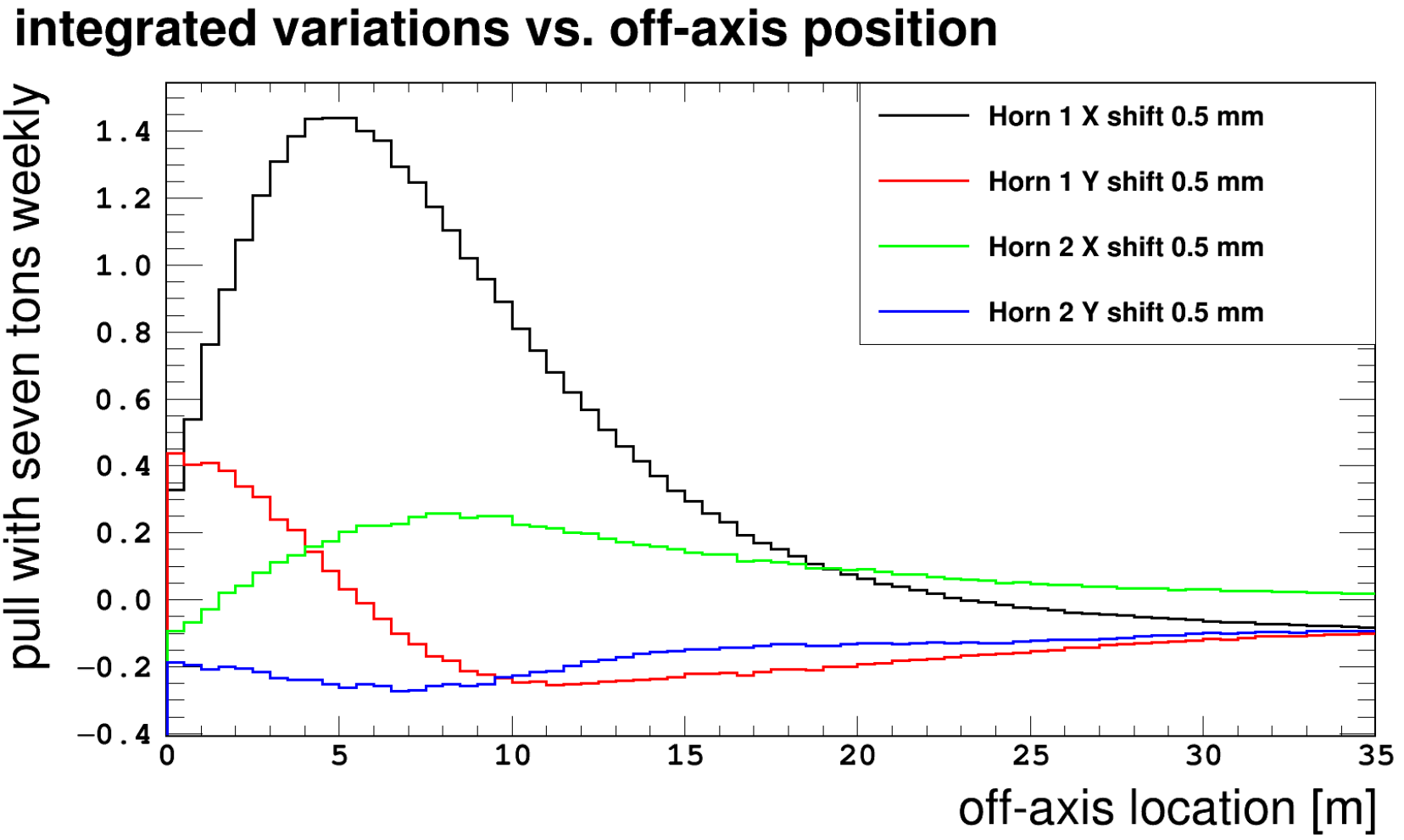
12 available shifts:

- Proton Target Density: 1.71 → 1.74 g/cm3
- Proton Beam Offset X: -0.45 mm
- Proton Beam width: 2.7 → 2.8 mm
- Proton Beam theta: beamtheta 0.07 mrad
- Proton Beam theta phi: beamtheta 0.07 mrad beamPhi 1.5707 rad
- Decay Pipe radius: 2.0 m → 2.1 m
- Horn current: -293 → -290 kA
- Water Layer thickness: 1 → 1.5 mm
- Horn 1 or 2 along x or y : shift 0.5 mm

The way to compare

- Rate-only: At a location, for a given mass scenario (one on-axis plus few off-axis modules) and a time period, if we vary one parameter above, what is the sqrt(chi2) ((shift – nominal)/stat.) we will get. Shift and nominal are one single rate numbers. A Sum in quadrature is calculated if considering multiple modules at different locations.
- Spectrometer: On-axis; For a given mass scenario (one on-axis spectrometer) and a time period, if we vary one parameter as above, what is the sqrt(chi2) ((shift – nominal)/stat.) we will get with the spectral information.
- We call the quantity of sqrt(chi2) a pull.

Rate-only sensitivity with 7 ton mass for a week



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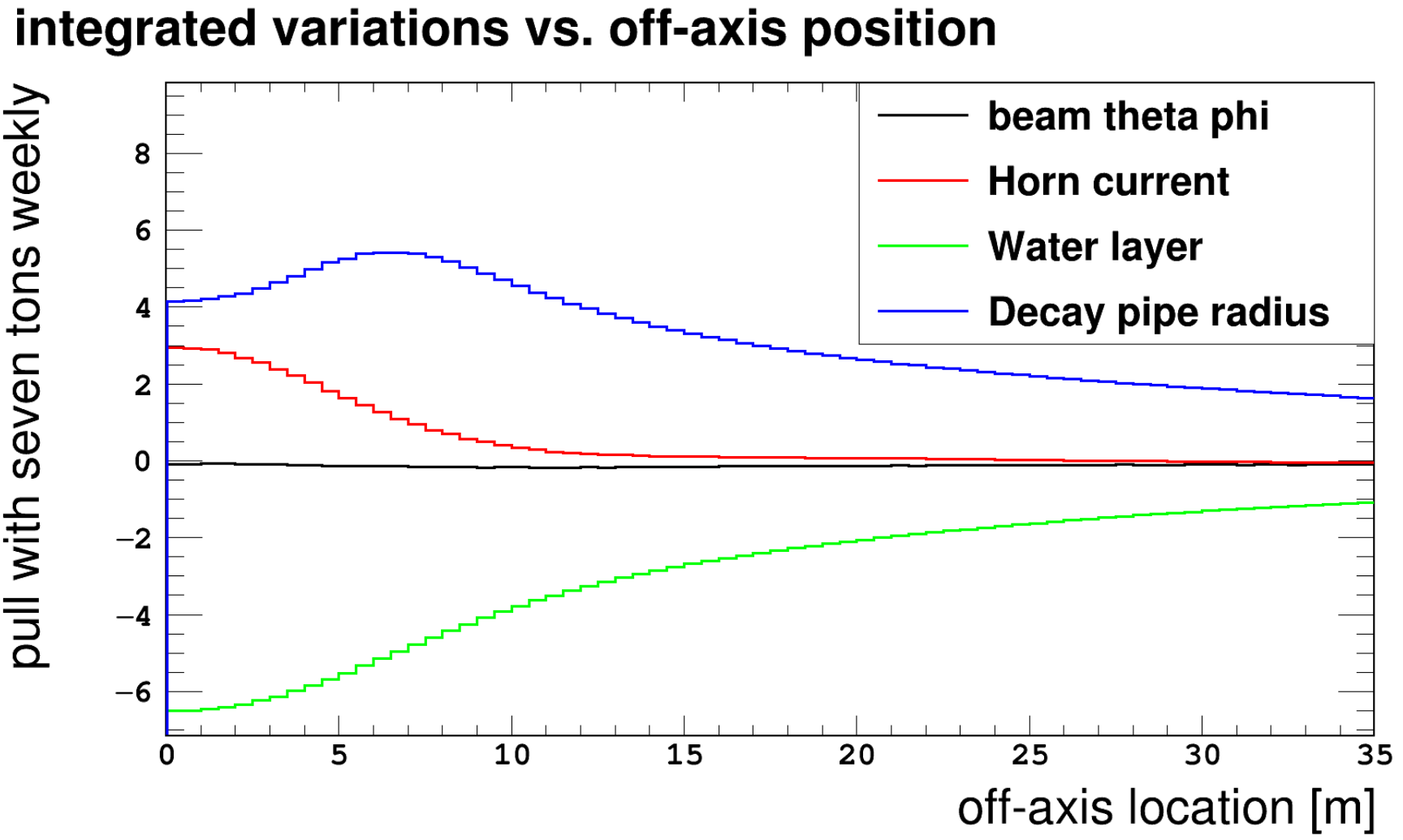

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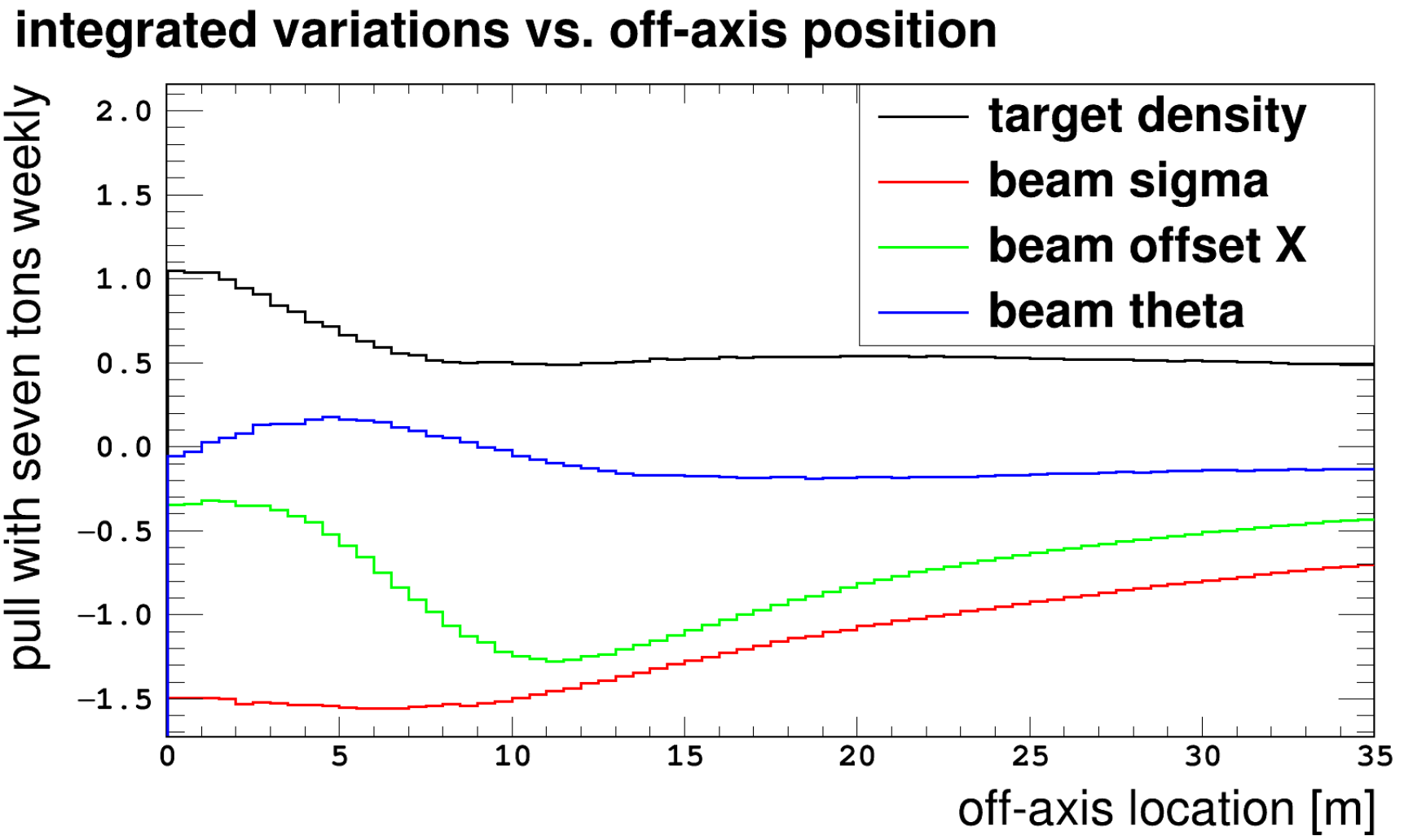
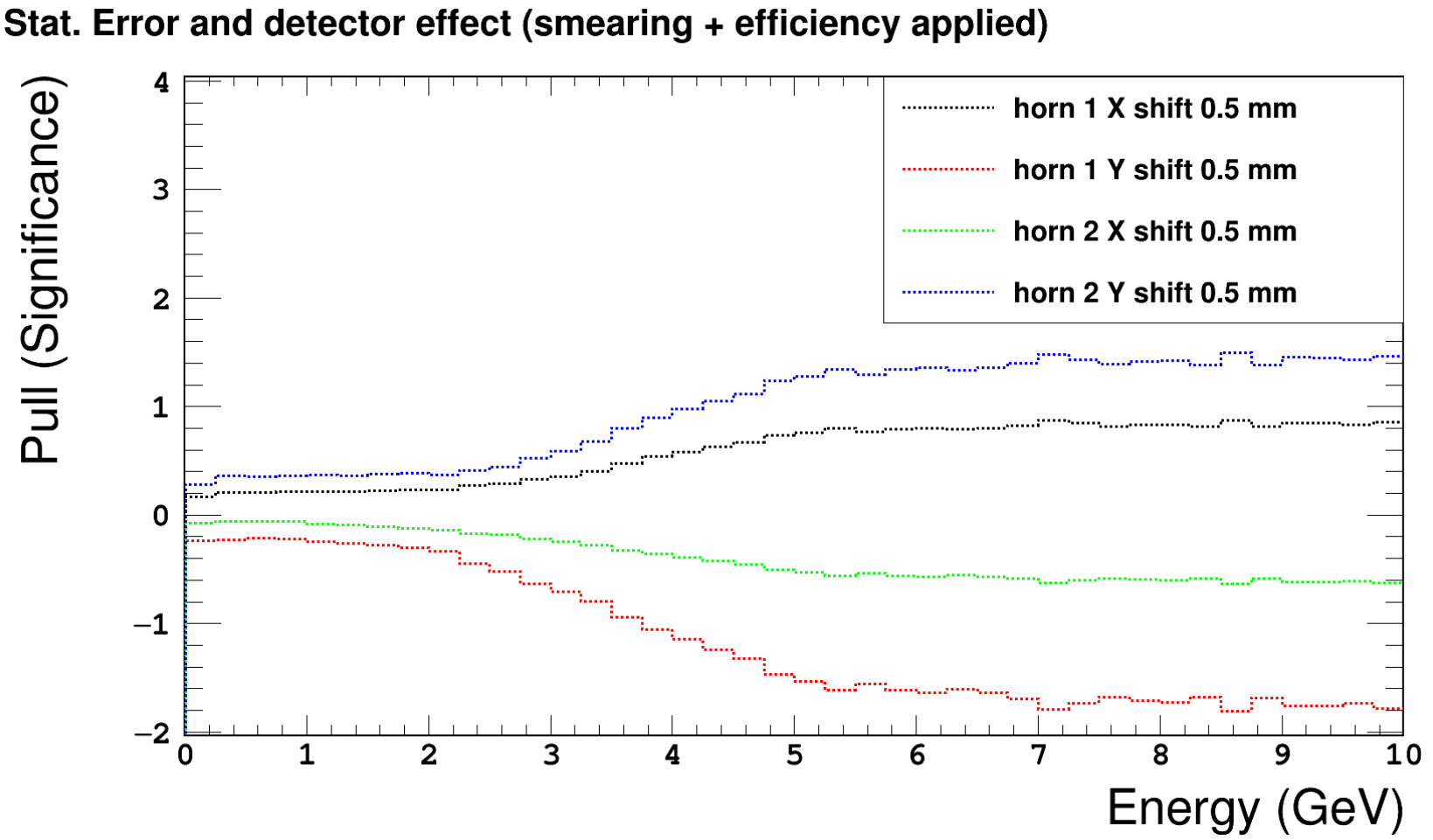


On-axis shape sensitivity with 8.7 ton for a week



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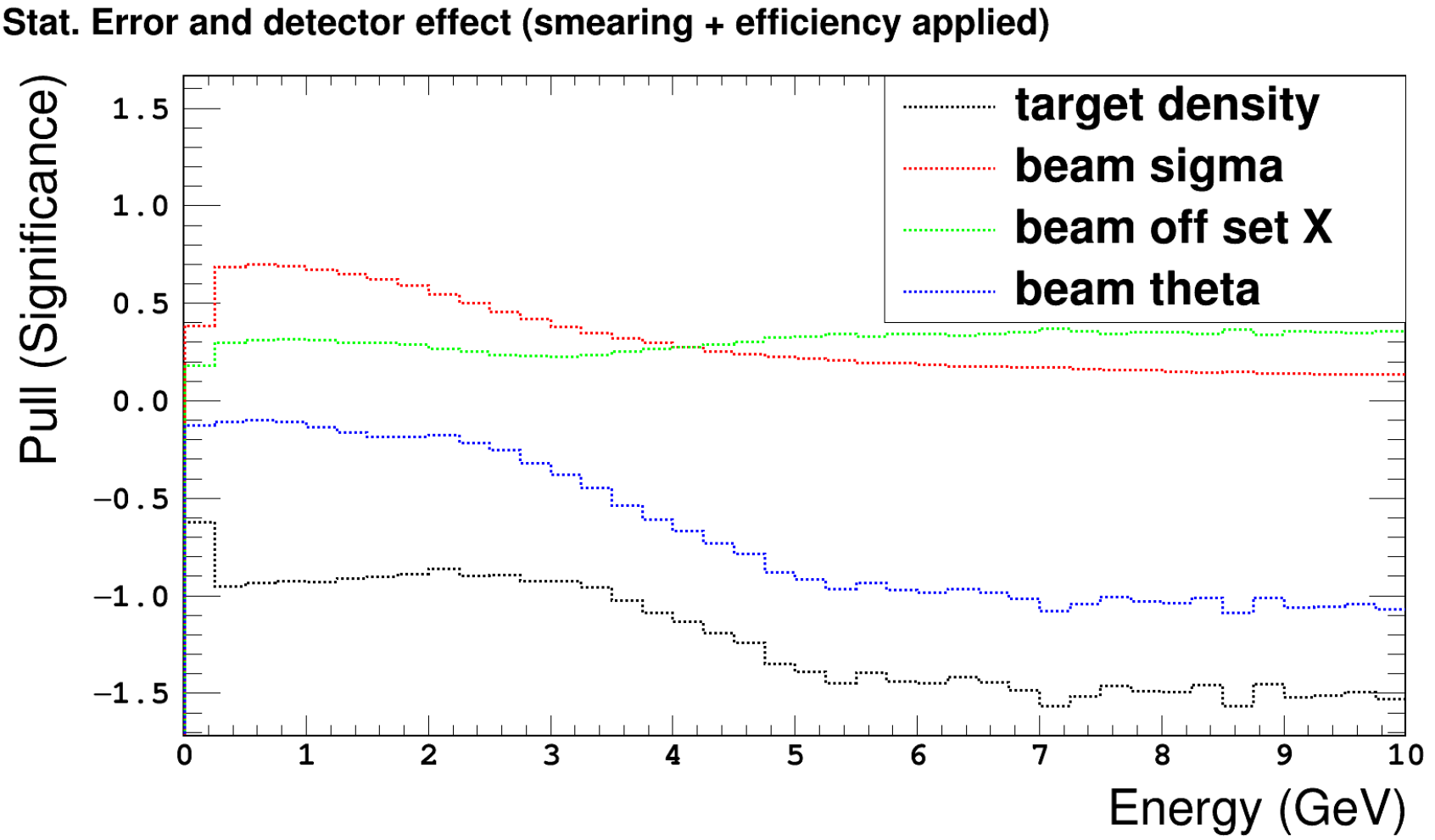

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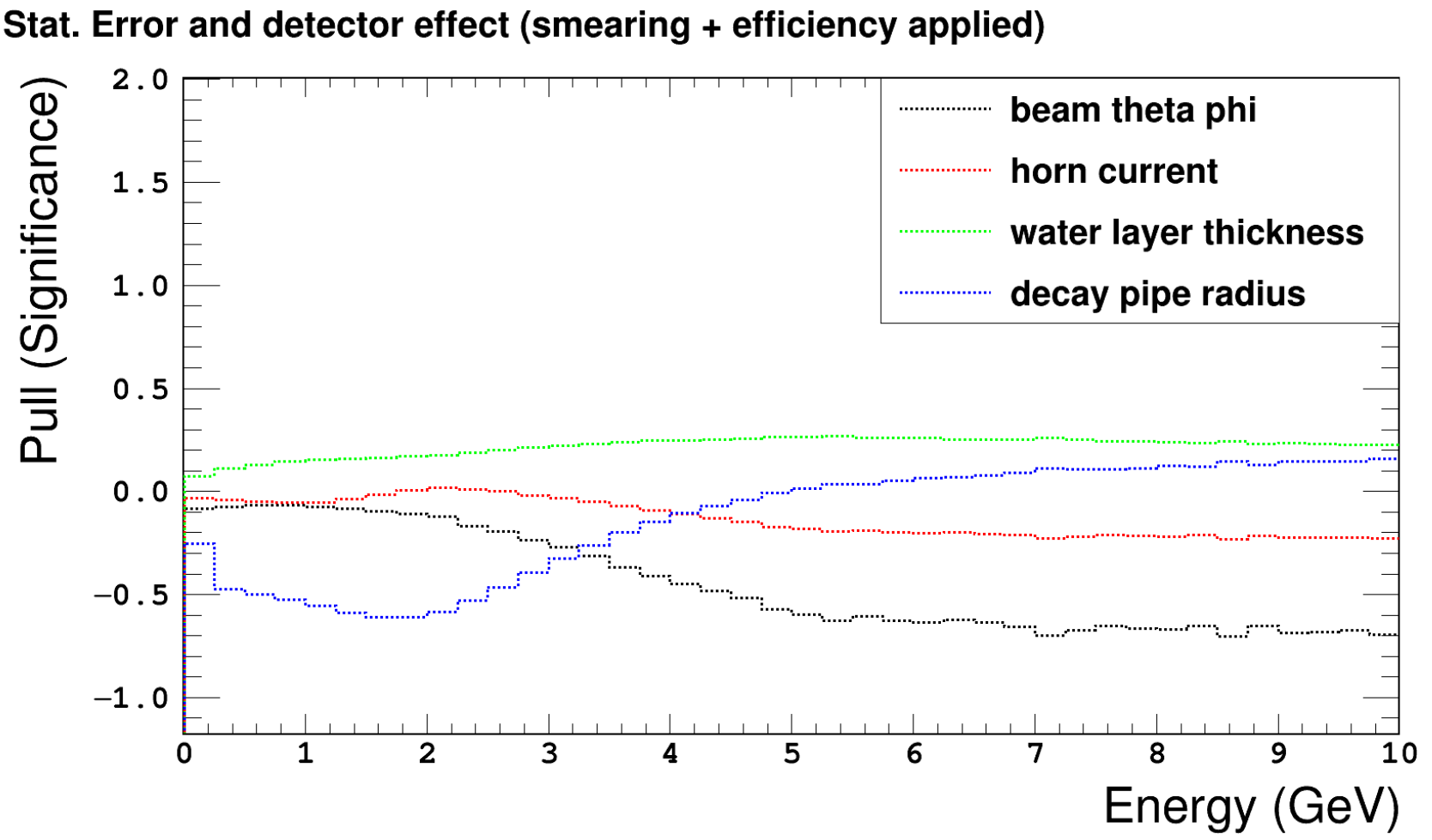
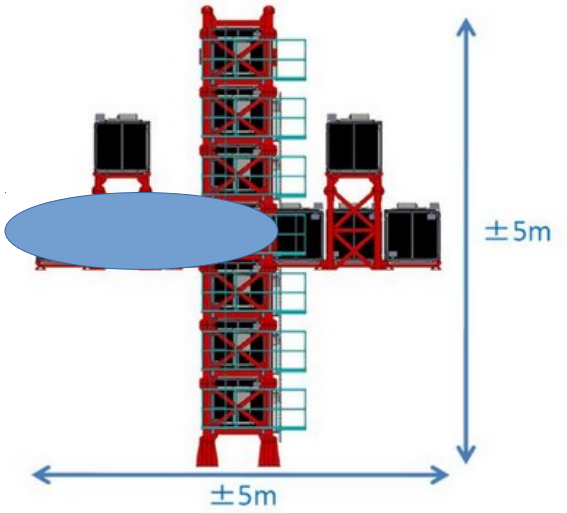
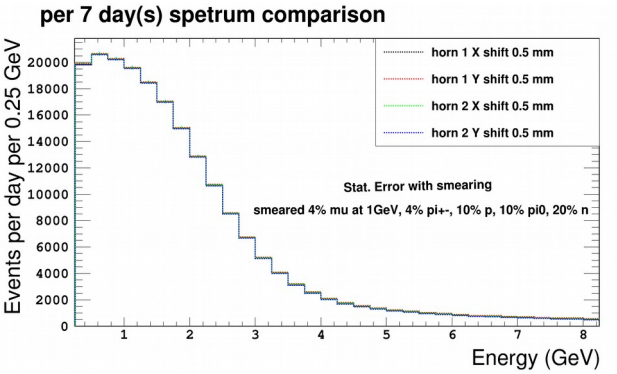
On-axis shape sensitivity with 8.7 ton for a week



Rate monitor → 7 ton each module
Spectrometer → 8.7 FV in total

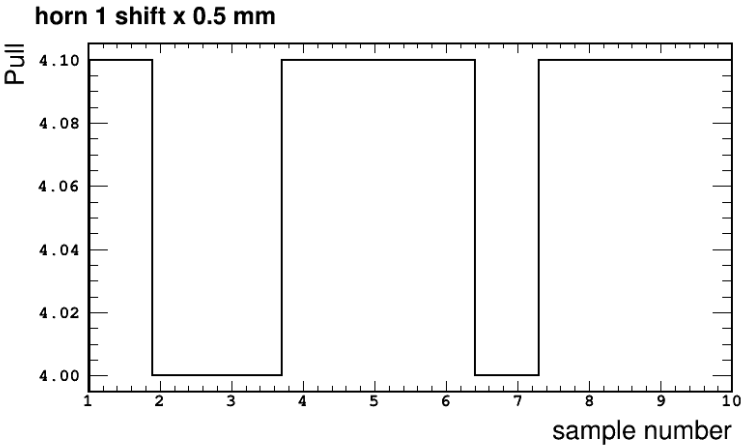
sqrt(chi2)	4 modules One-side rate	Muon spectrometer
Beam targ. dens.	1.9	7.9
Beam offset x	0.7	2.0
Beam theta	0.2	4.9
Beam theta phi	0.2	8.5
Horn 1 X 0.5 mm	1.9	4.1
Horn 1 Y 0.5 mm	0.7	8.3
Horn 2 X 0.5 mm	0.2	2.9
Horn 2 Y 0.5 mm	0.4	6.9

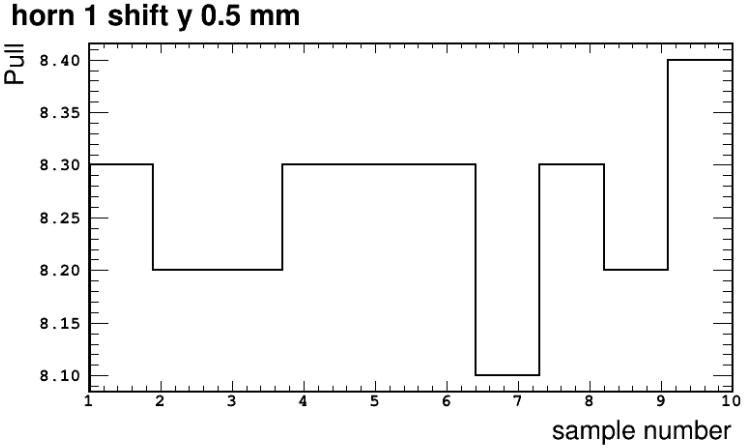


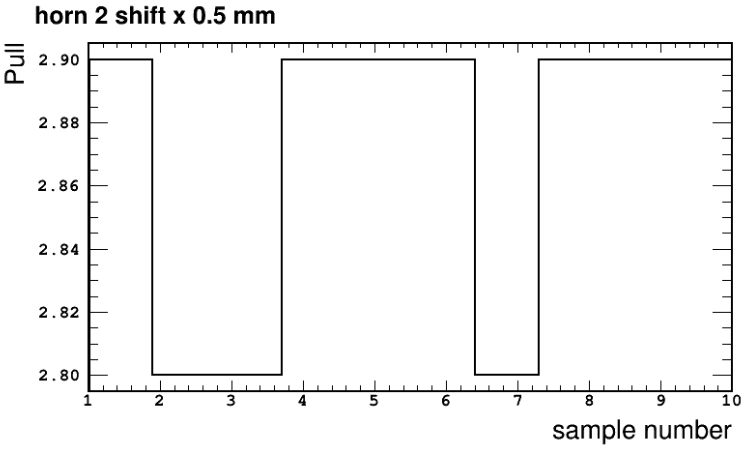


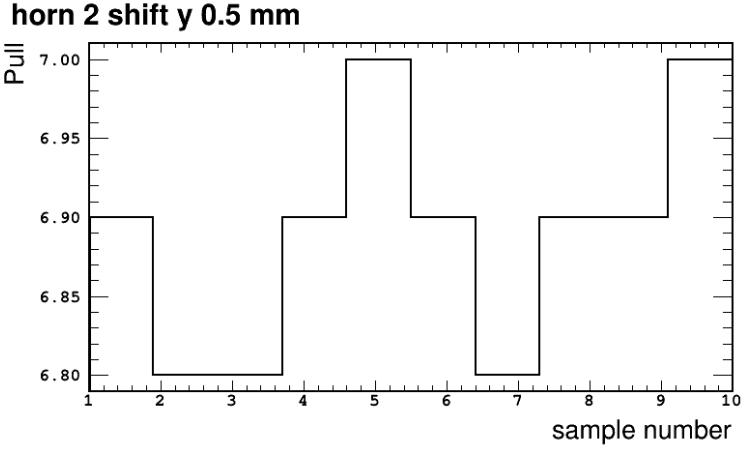
Are the results “sample sensitive”?

- A number of 7-day samples are generated and compared.









Summary and comments

- Spectrometer is much more sensitive to the beam variation than the rate monitor.
- We need more statistics from the flux simulation, and with further finer binning of the variations, we may see even better sensitivity.
- Trying to work closely with the beam group (attending beam meeting regularly) and additional beam variations are suggested by the beam group.