Demonstration of a Uniform Beam Simulation Technique

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Bob Zwaska's simulation suggestion

Prepare a single high-statistics simulation sample for each variable by simulating a uniform distribution, then use post-processing to generate the data points.

» Prepare a high stat simulation sample by setting up a uniform distribution for any study variables

» Calculate the gaussian weights according to the settings of the studying variable

» Apply corresponding weights for all observations / measurements

» In this method we are able to generate many gaussian distributions similar to the actual scan studies

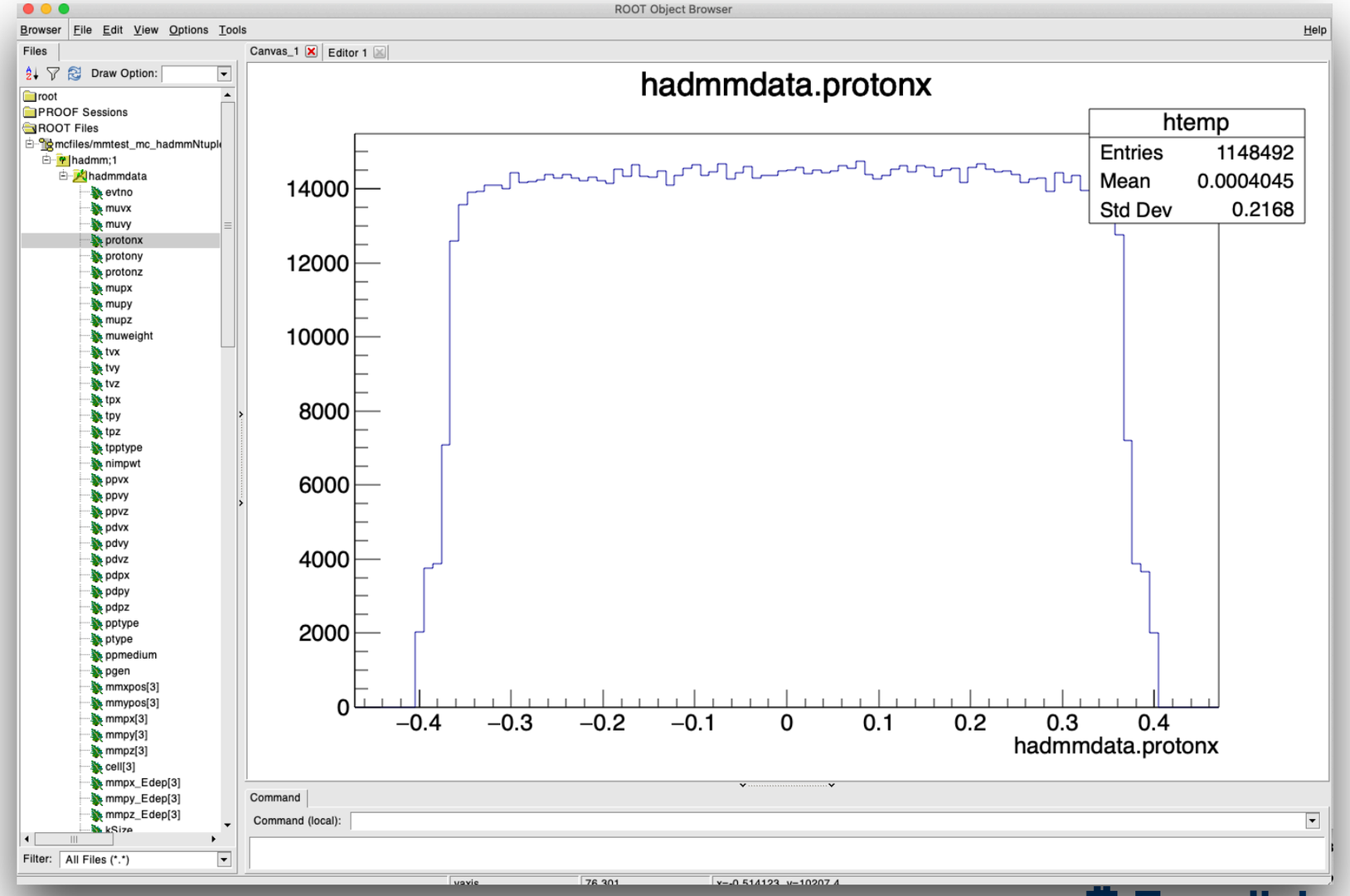
Muon Monitor Simulation Updates

Sudeshna and Yiding has updated following items in the g4numi+muon monitor simulations

- **The *NumiPrimaryGeneratorAction.cc* in the g4numi simulation has been updated to generate any uniform distributions on horizontal proton beams**
- **The muon monitor simulation has been updated to store the proton beam information**

Future updates:

- **Need to update g4numi for uniform distributions on the vertical position**
- **Good to add the horn current as a output in the muon monitor simulation**



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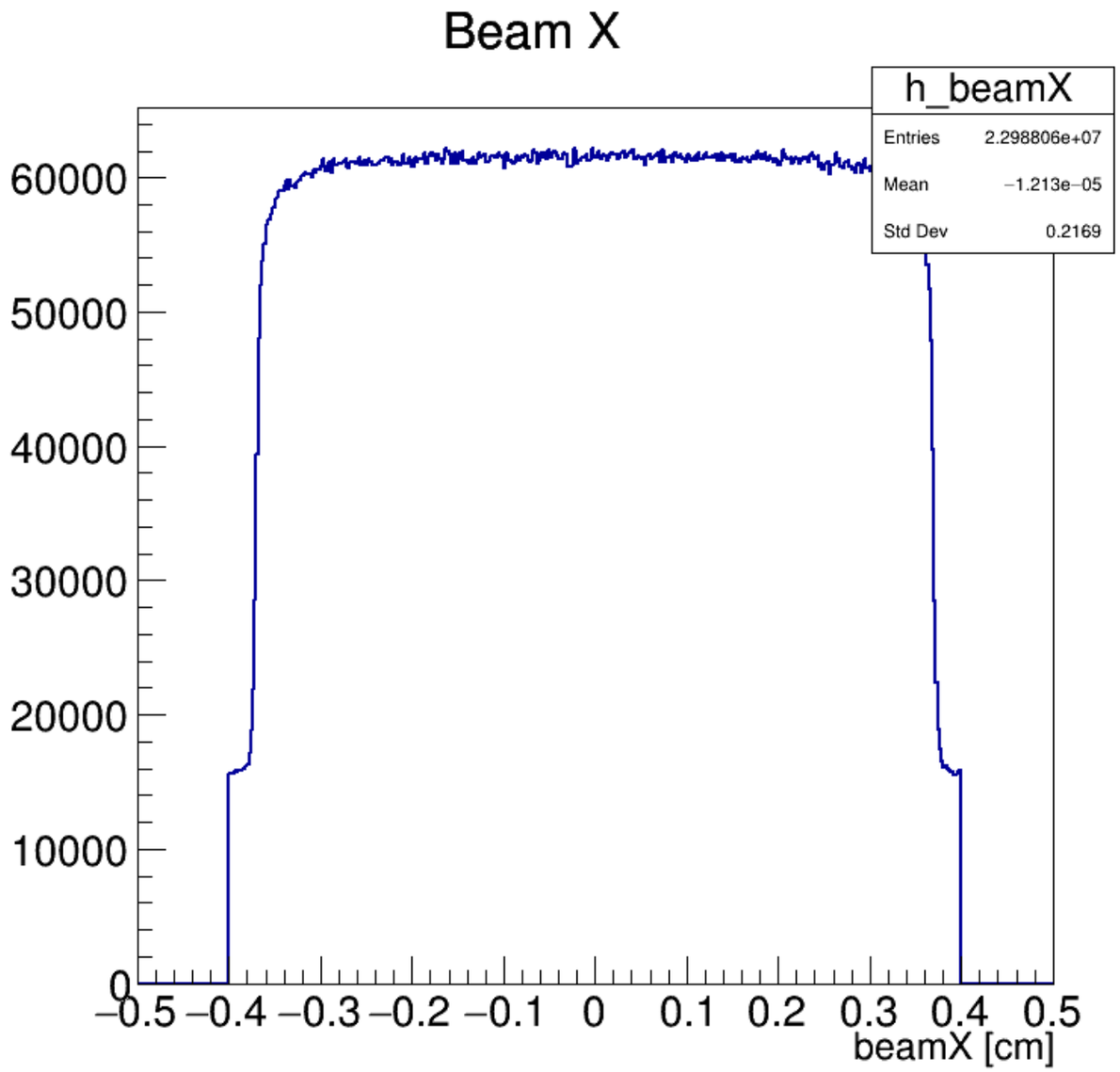
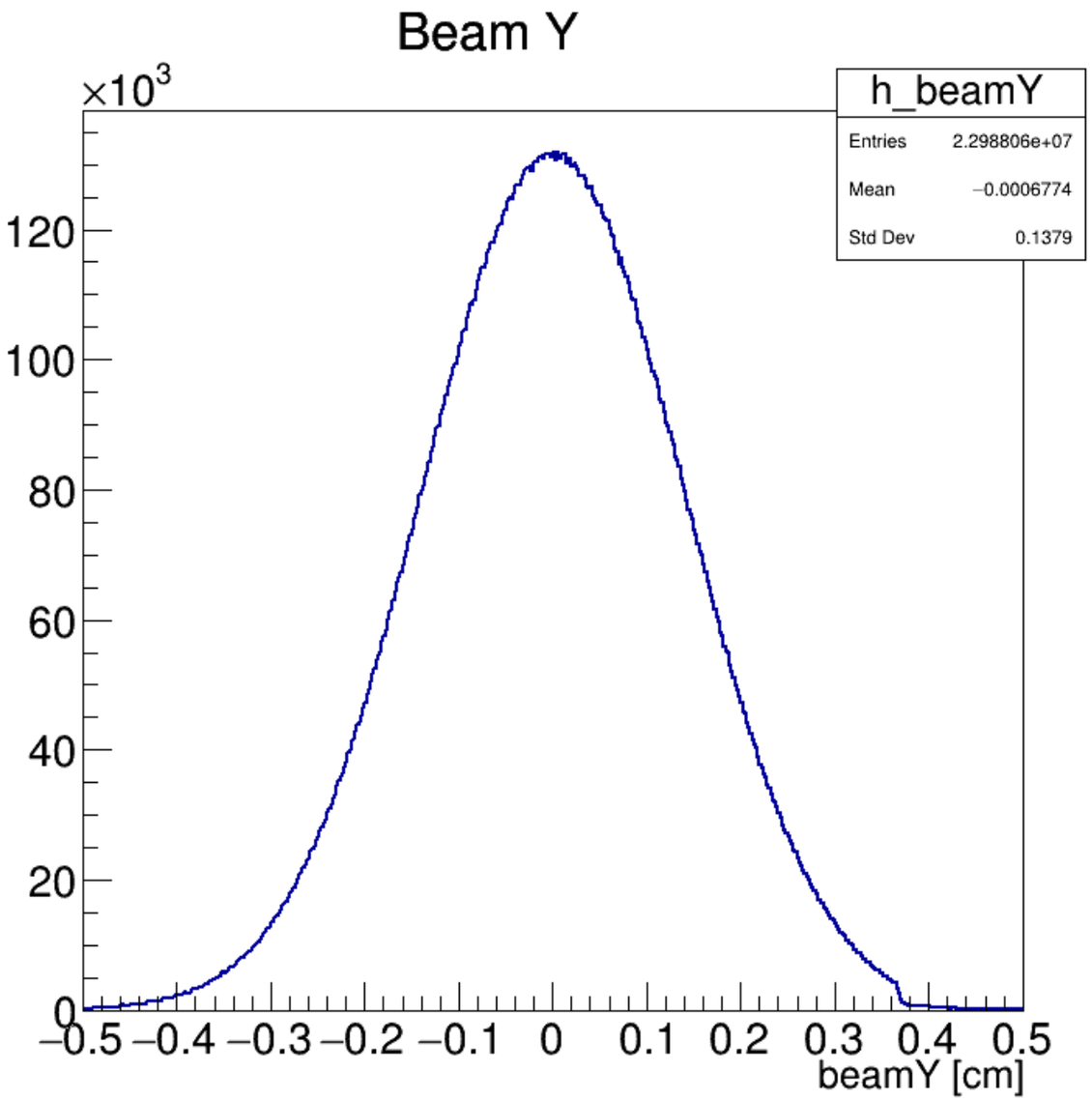
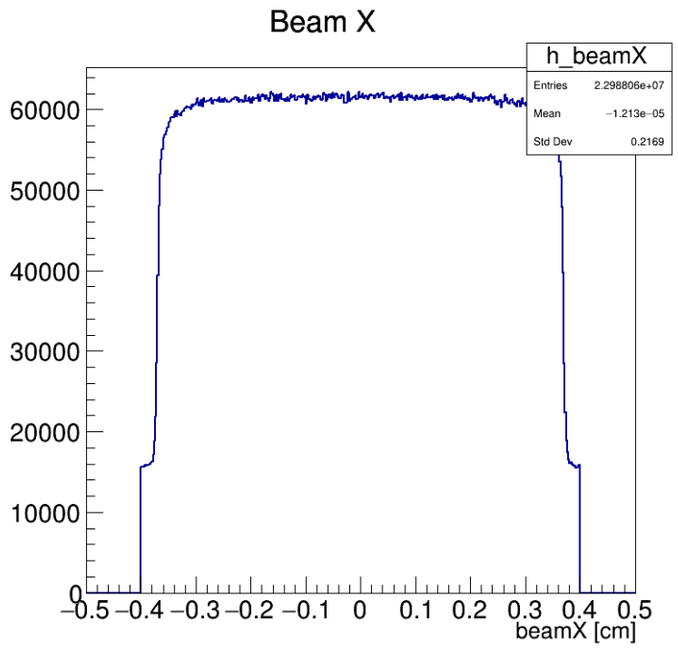
Simulated Beam X and Y





In this demonstration, we used ~23M POTs

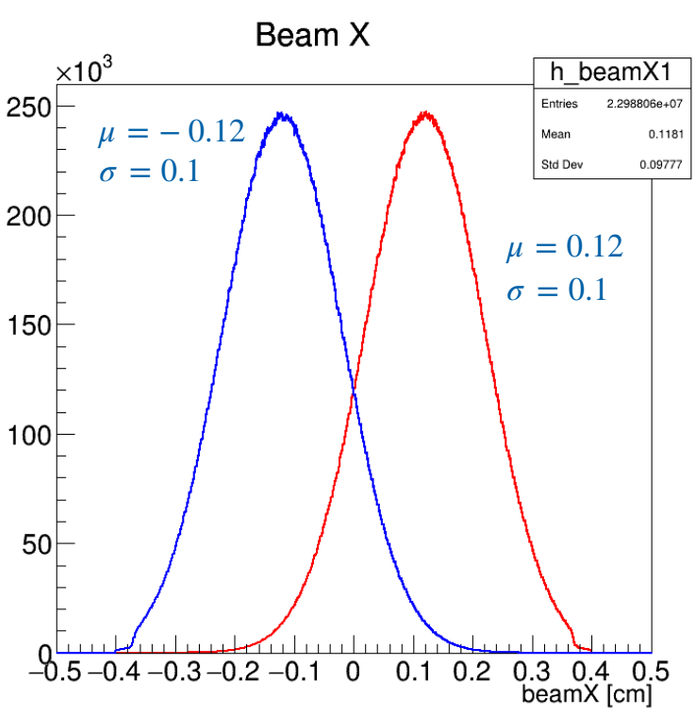
Technique1: Area Normalized Distributions



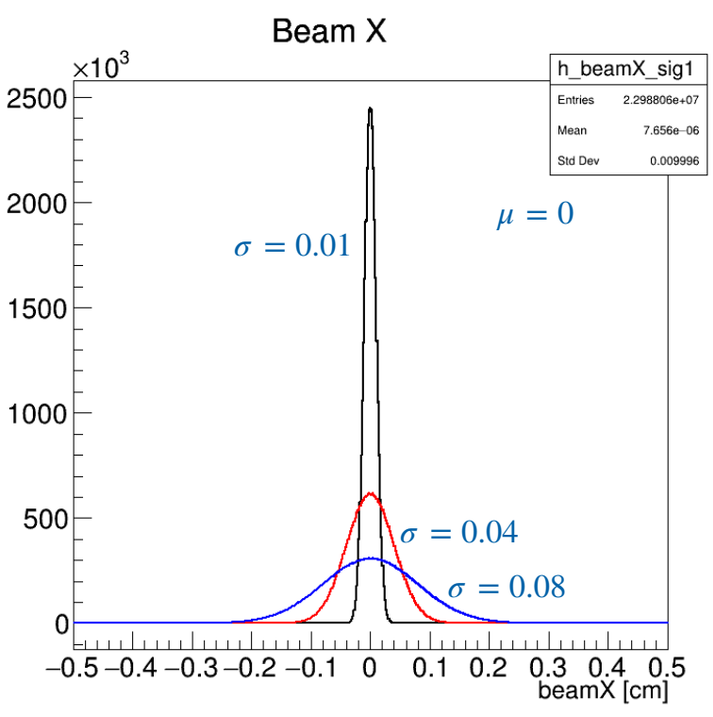
- We calculate the gaussian weight for each proton beam events
- Next, we apply that weights on every measurement in the analysis

$$w_i = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x_i-\mu)^2}{2\sigma^2}}$$

Beam scan studies



Beam spot size studies



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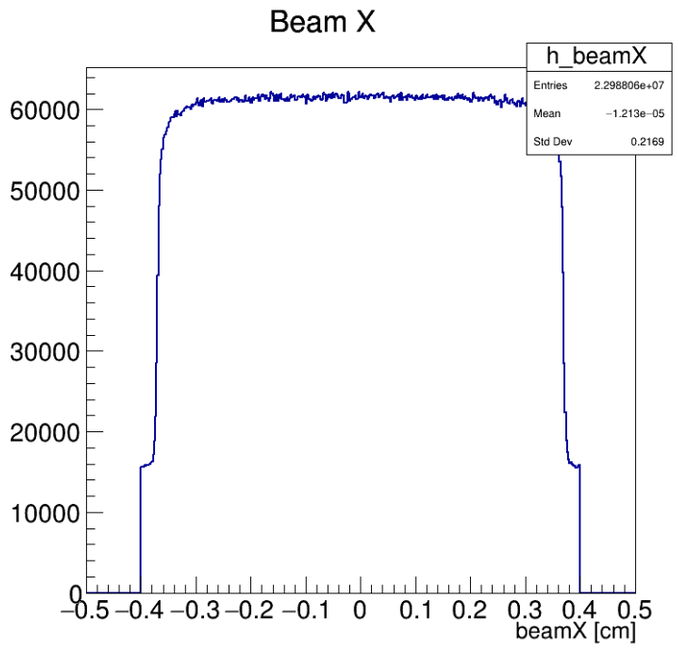
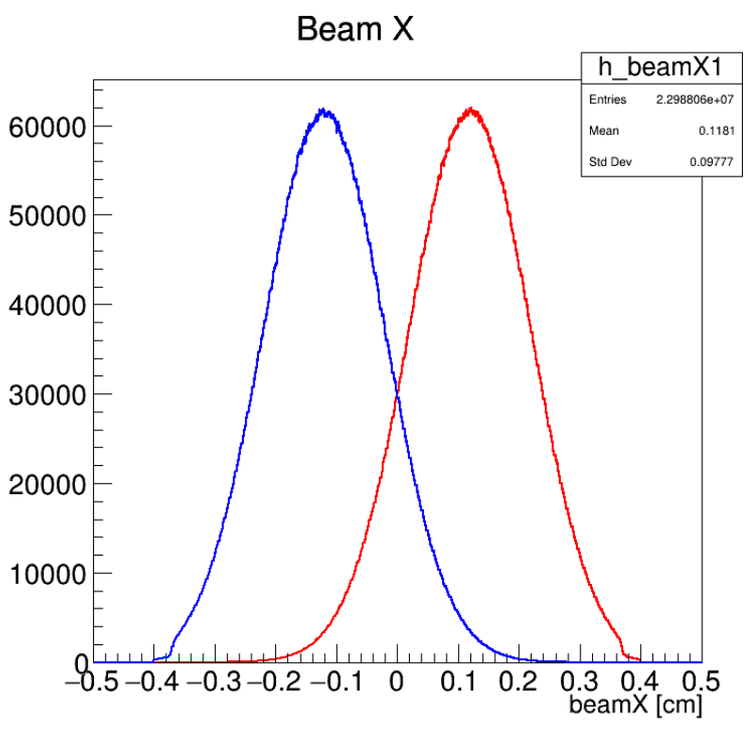
Technique2: Peak Normalized Distributions



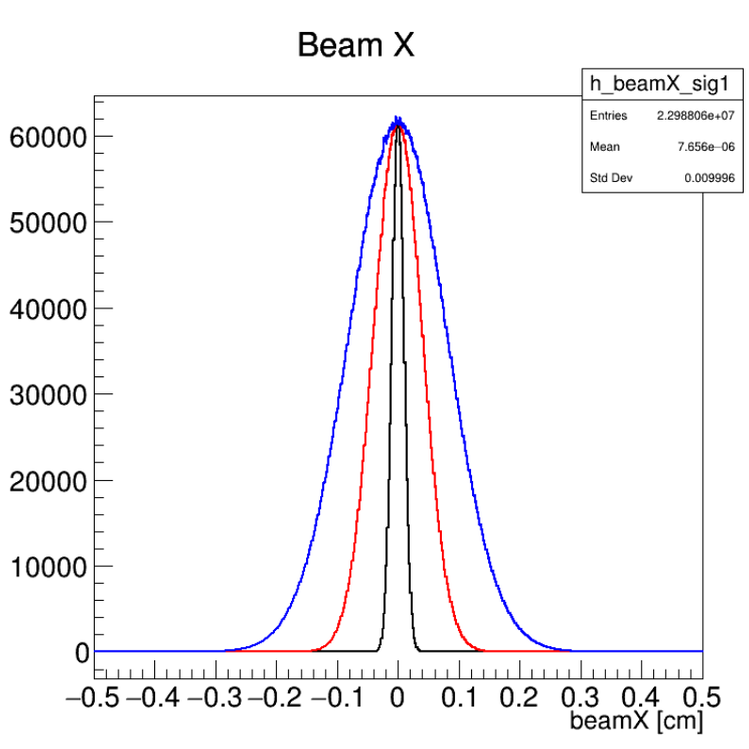
- We calculate the gaussian weight for each proton beam events
- Next, we apply that weights on every measurement in the analysis

$$w_i = e^{-\frac{(x_i-\mu)^2}{2\sigma^2}}$$

Beam scan studies



Beam spot size studies



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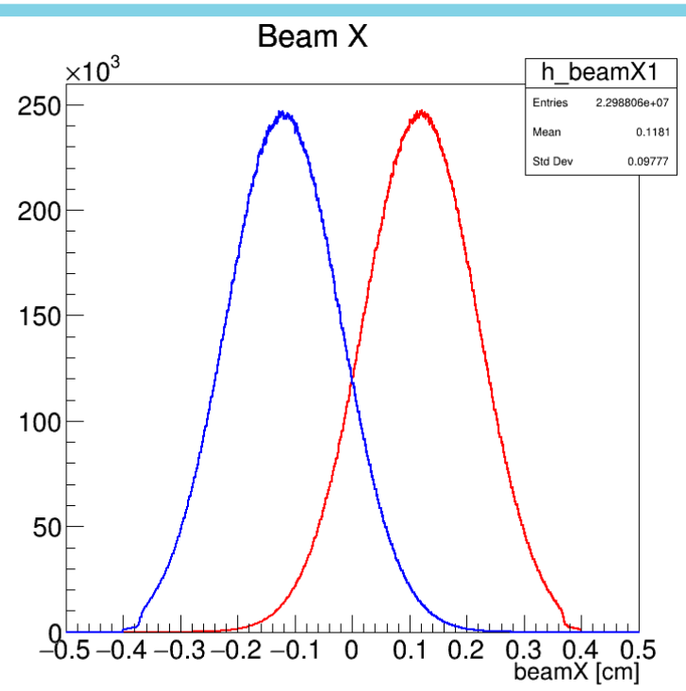
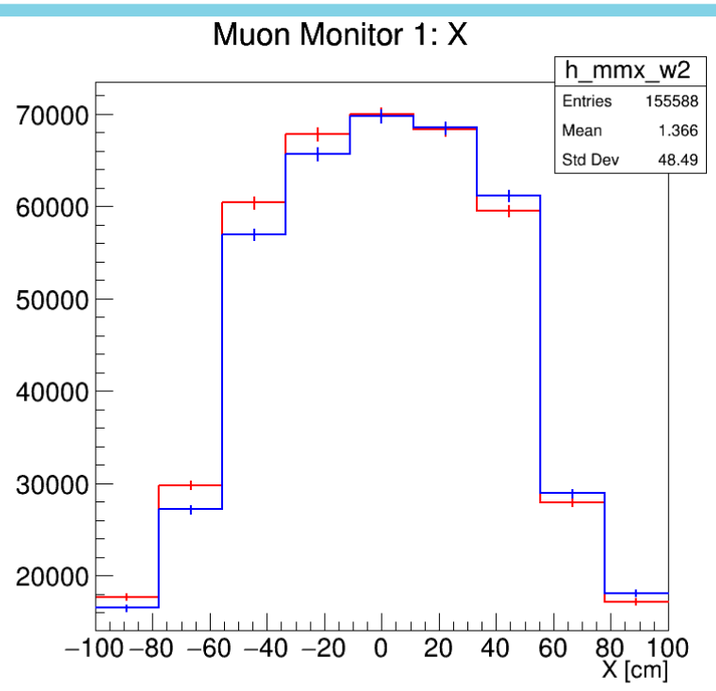
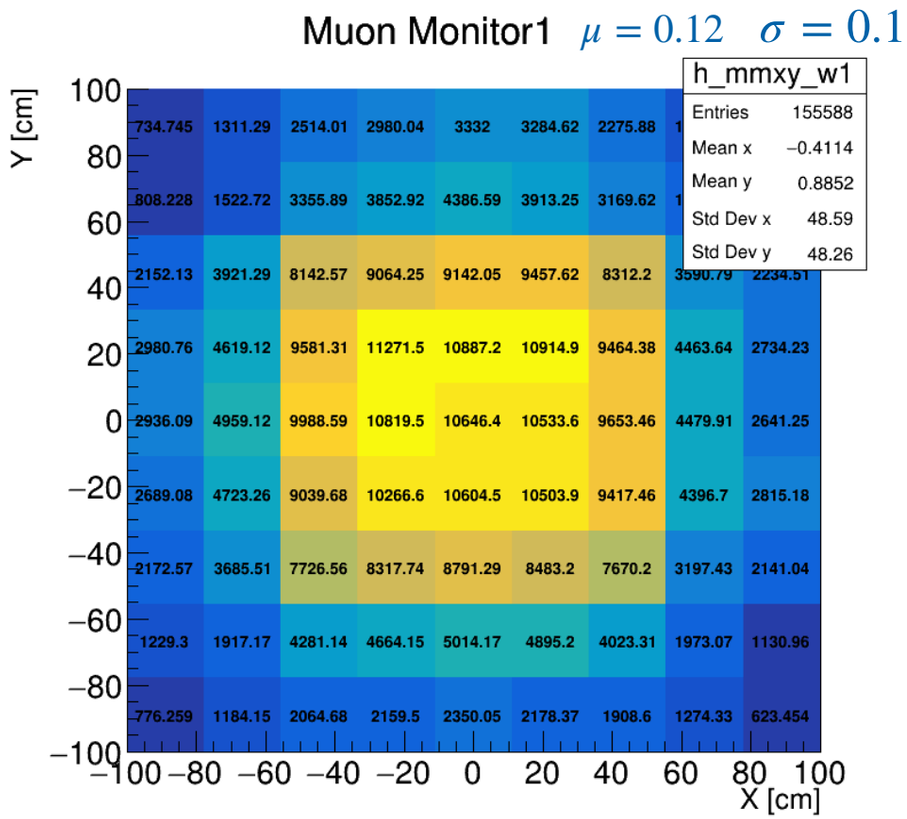
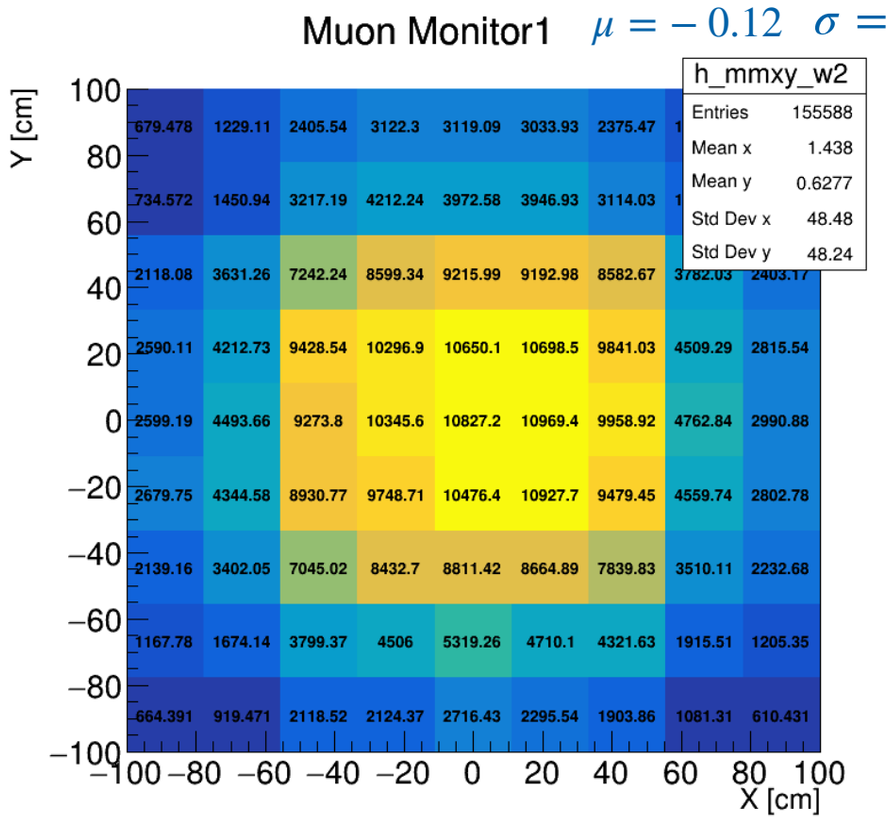
Weighted Observables



Muon monitor response for two beam X settings







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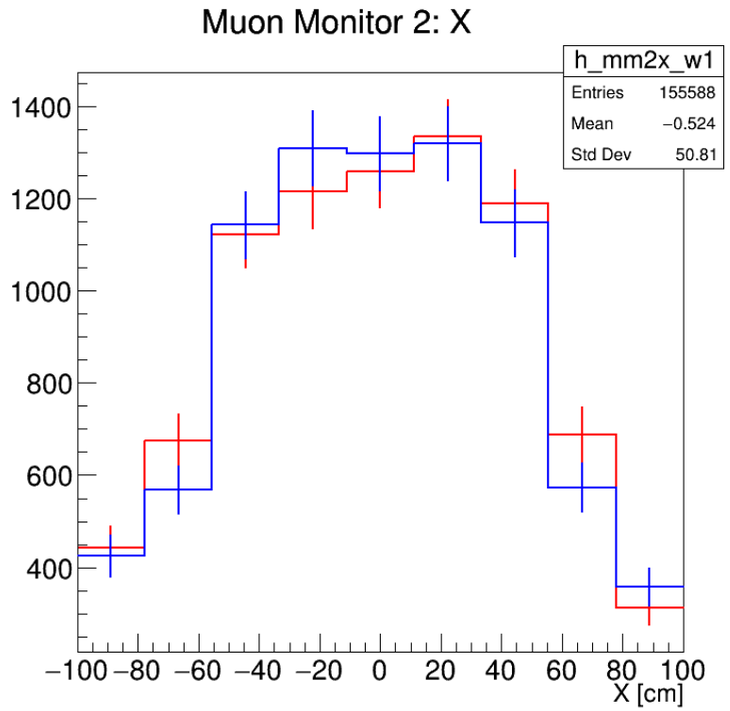
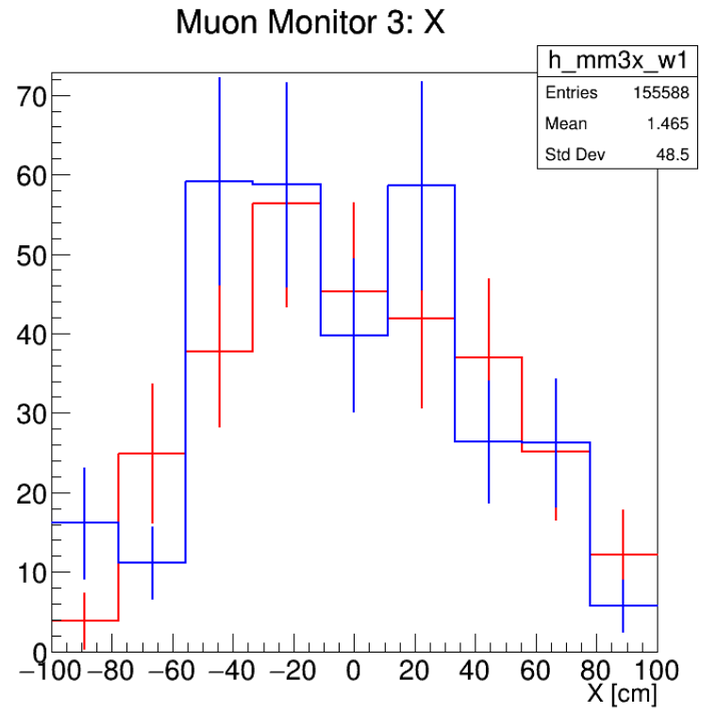
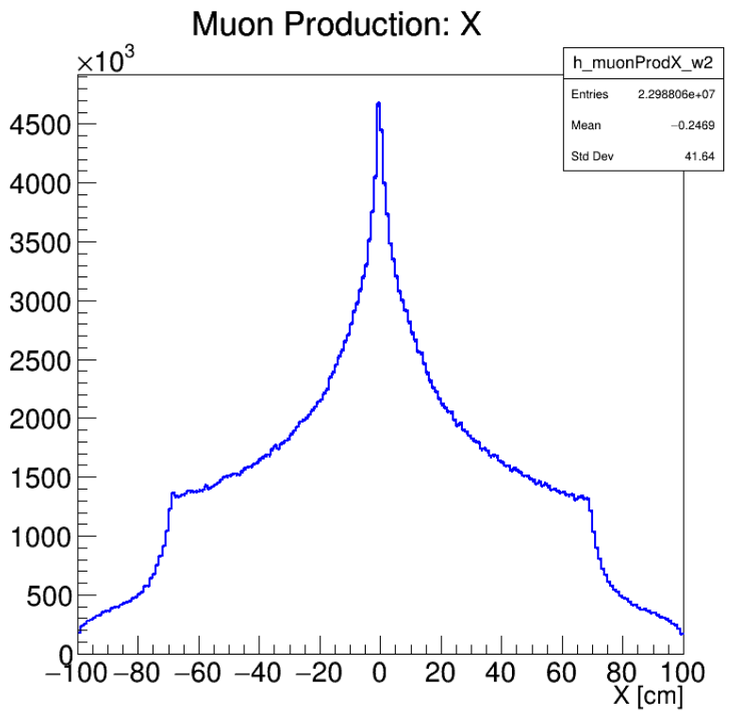
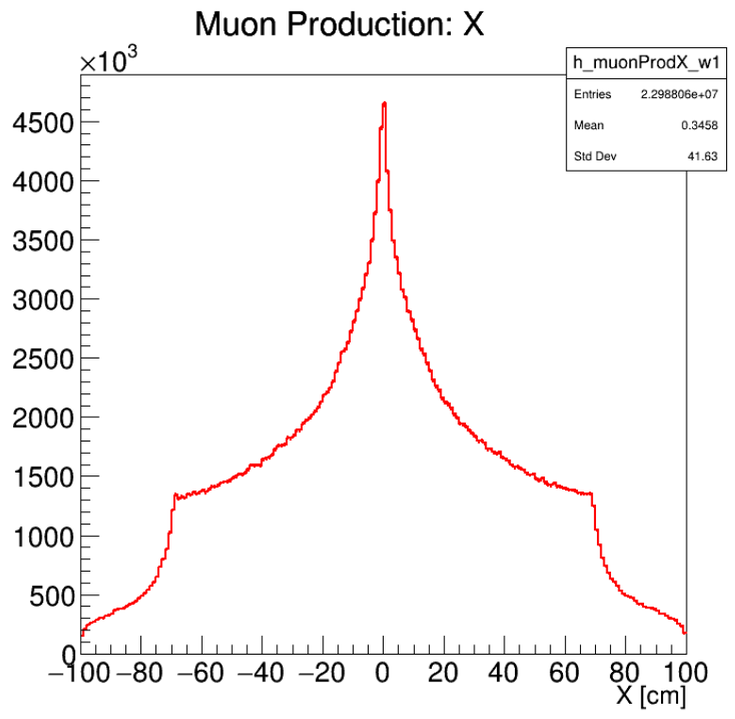
Weighted Observables









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Remarks

- This technique is easy and effective to do multiple scan studies by generating many possibilities without running the MC generator
- We can save the waiting time for generating MC samples
- We will be able to do the beam spot size studies and horn current studies by following the same technique
- This techniques is helpful to prepare MC data samples for future ML studies