

Hadron Phase Space Prediction ML

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Project Ideas: Neutrino flux predictions from the muon signals

Main idea: Mapping the muon monitor signal images to the pions phase space can be used to predict the neutrino flux at the near detector

» Data preparation:

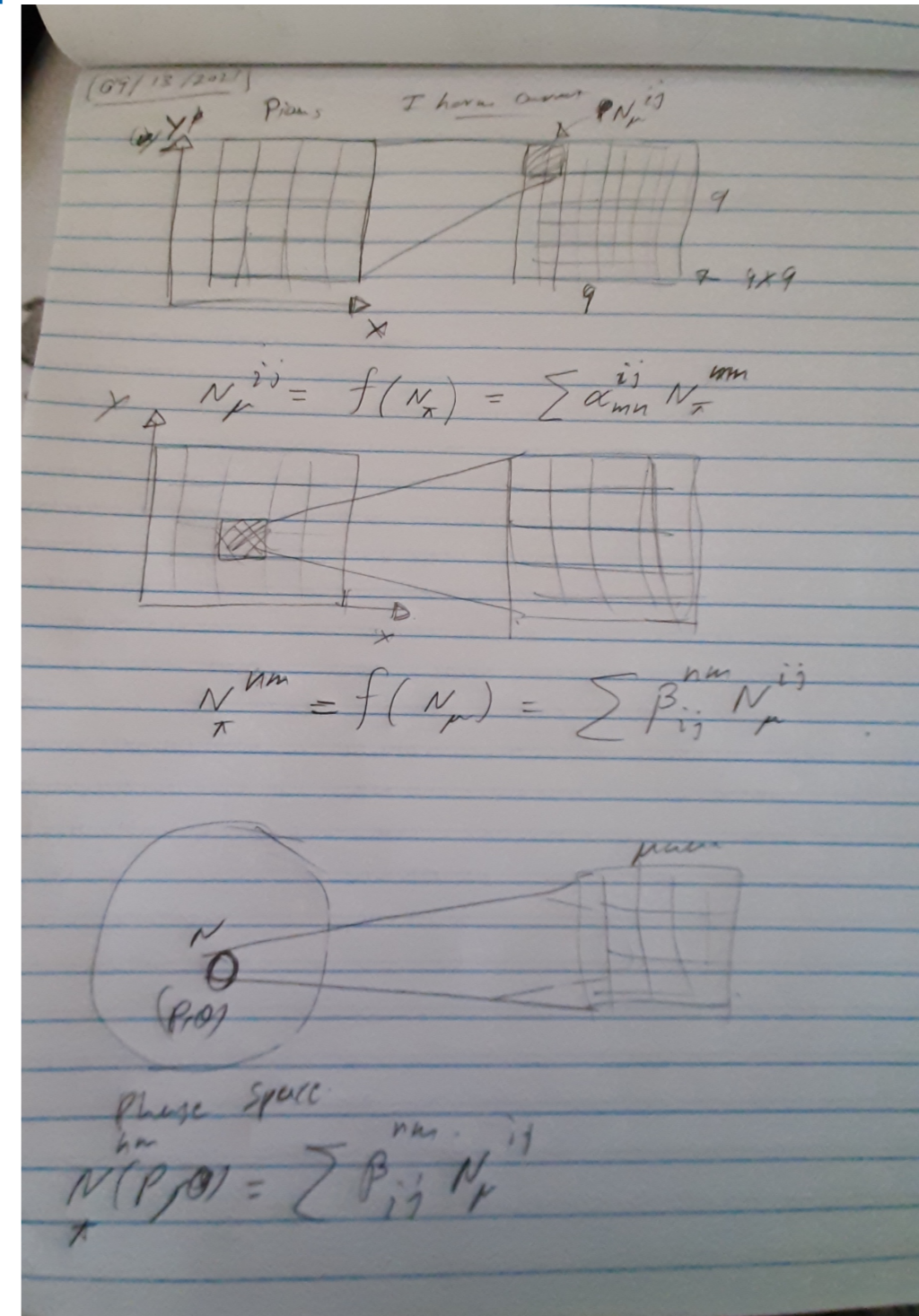
- **INPUTS:** MM images taking account only 7x7 pixels to eliminate data/MC disagreements
- **OUTPUTS:** hadron momentum mapping
- Have to prepare significant amount of MC samples for different beam and horn current correlations

» ML algorithm development

» Model validation and testing

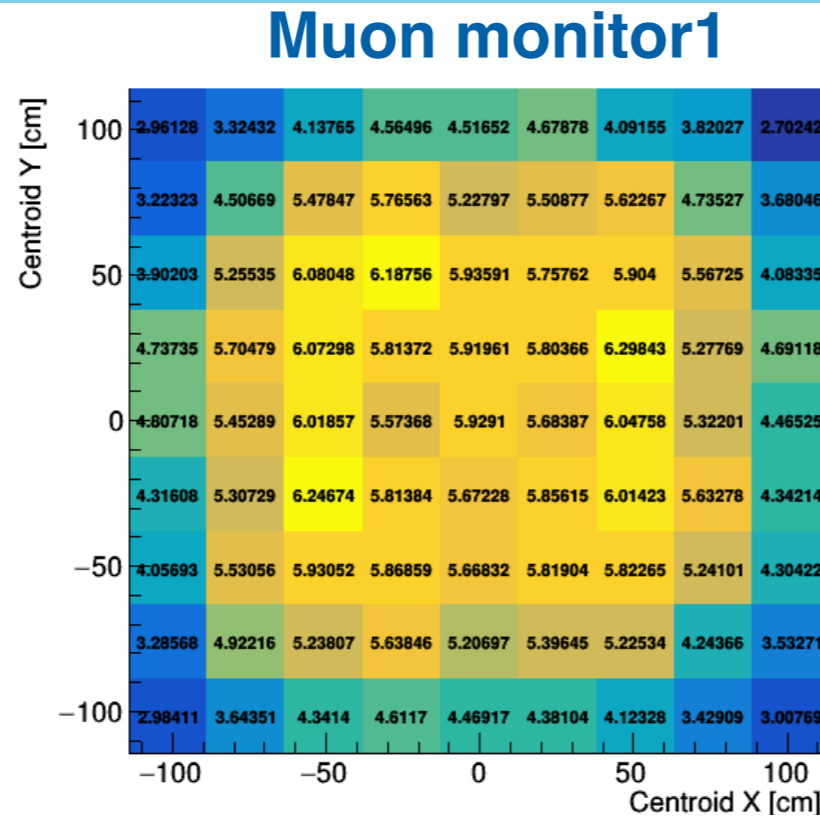
» Model deployment with spill-by-spill data

» Extend the project plan to predict the neutrino flux

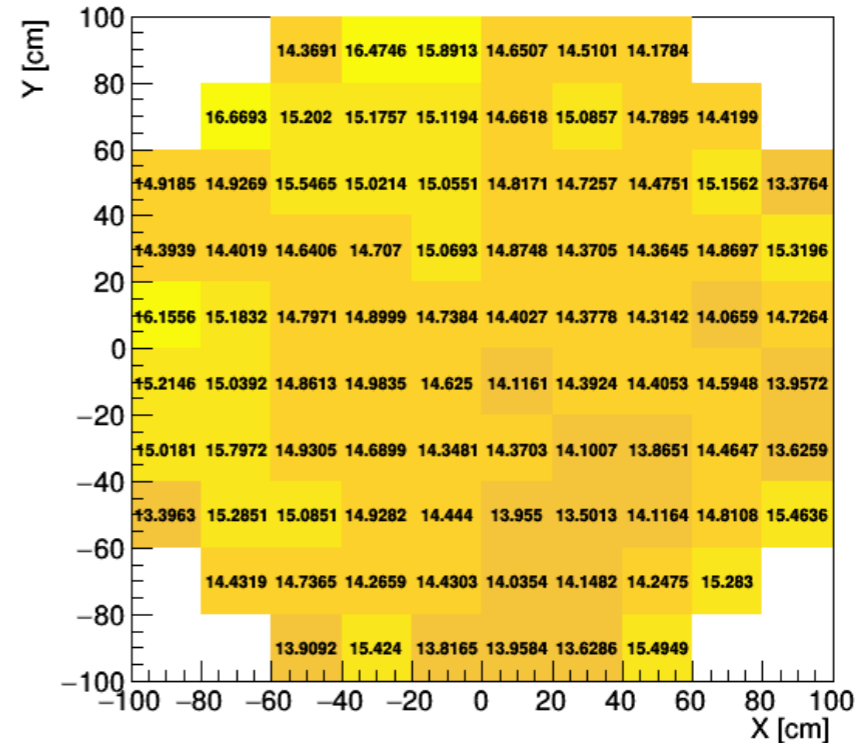


Example of Mapping Averaged Momenta

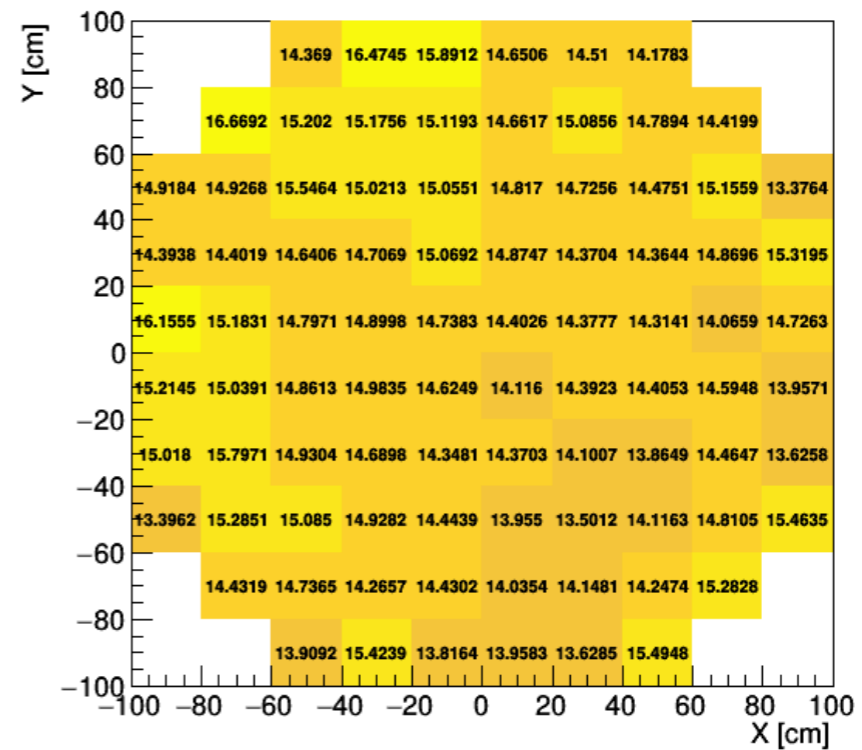
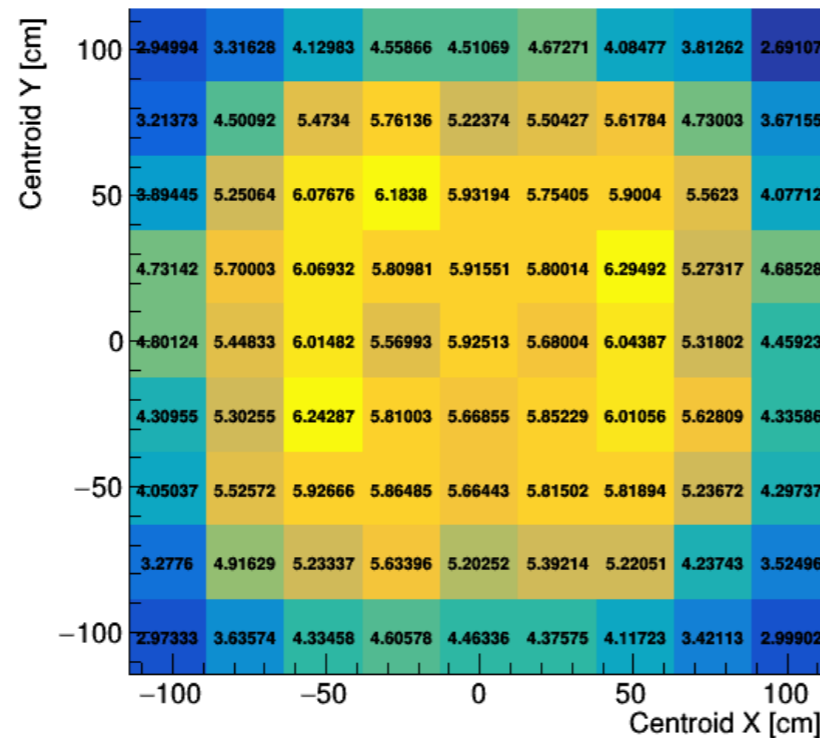
Total Momentum



Parent Hadrons at the decay

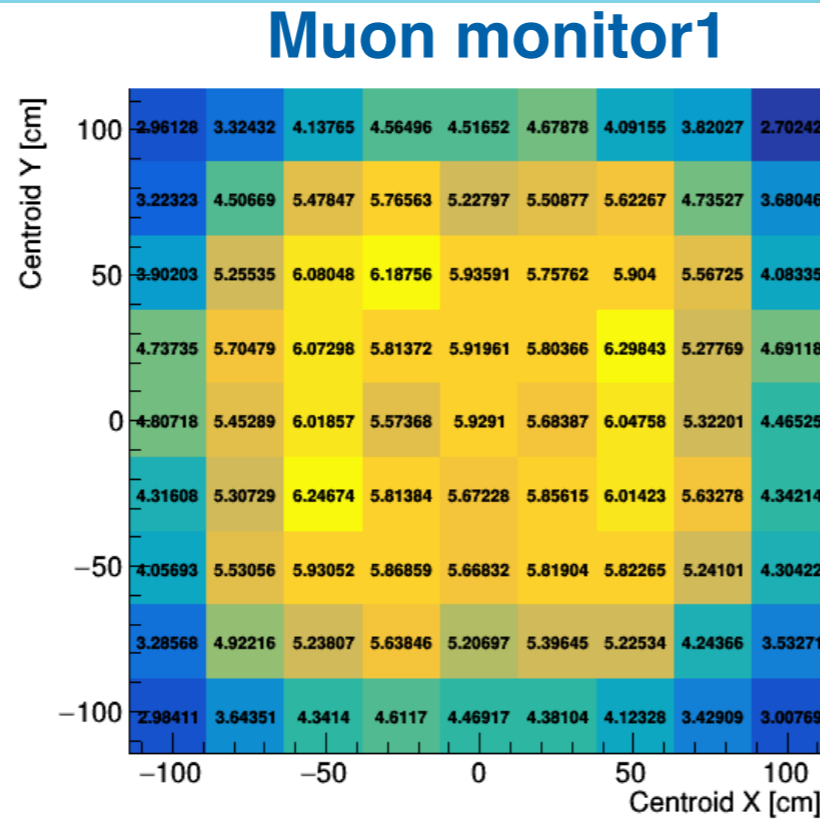


Longitudinal Momentum

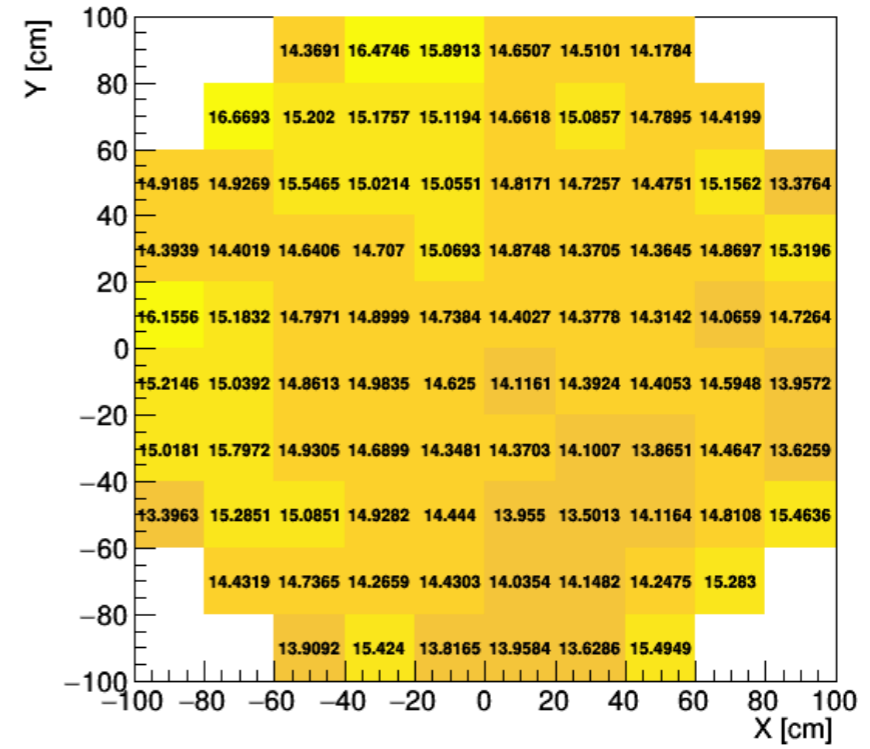


Example of Mapping Averaged Momenta

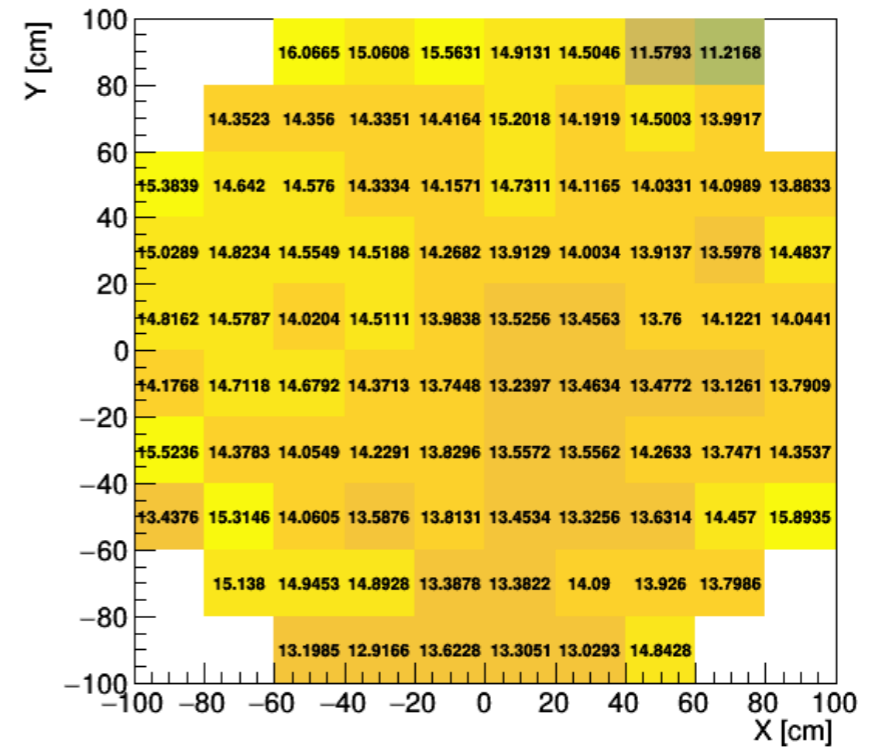
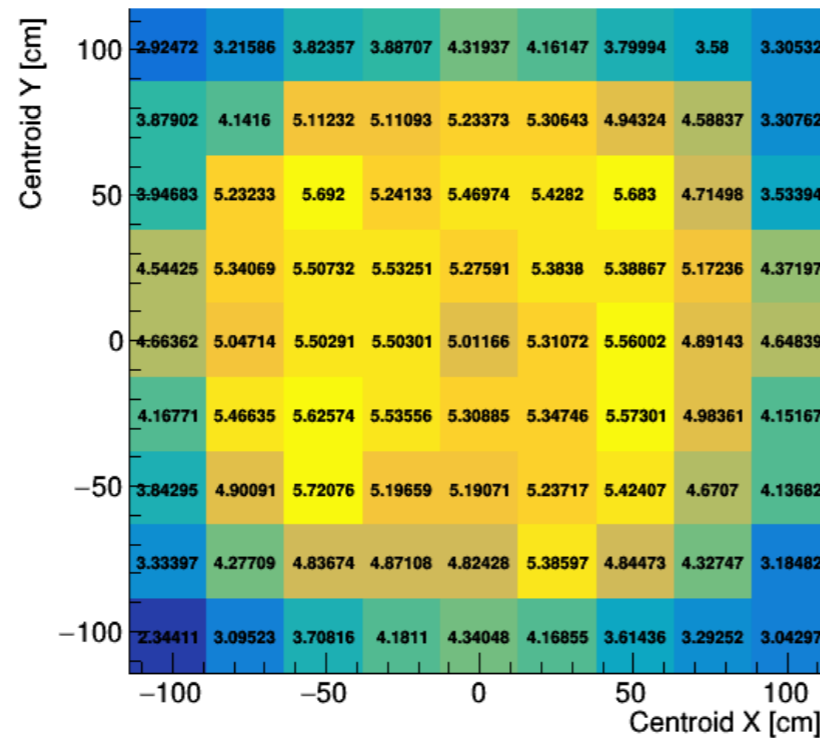
120 kA



Parent Hadrons at the decay



180 kA



Simulation Data

1. **Generate uniform beam data files according to the g4numi + muon monitor + multiple decay simulation techniques**
2. **Prepare new data files with randomly selected gaussians**
3. **Prepare final format of ML training files**

Suggestions for the initial steps:

Step 1: Generate uniform beam (-1.0 cm, +1.0 cm) sim data sets for -170 kA, -180 kA, 185 kA, -190 kA, -195 kA, -200kA

(Yiding and Sudeshna can help on this)

Step 2: Generate MM distributions from randomly selected 500 gaussian beams within (-0.1 cm , +0.1 cm) on both X and Y directions for each horn configurations

Step3: Prepare ML input data files for each beam configurations

Let's proceed to the demonstration!

Folder on numix: /nashome/a/athula/G4numi/SimML