Secondary Pion Production using the LINAC Beam on Graphite and Tungsten Targets

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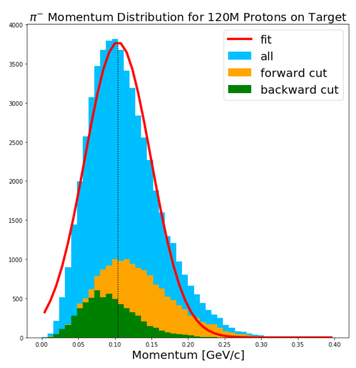
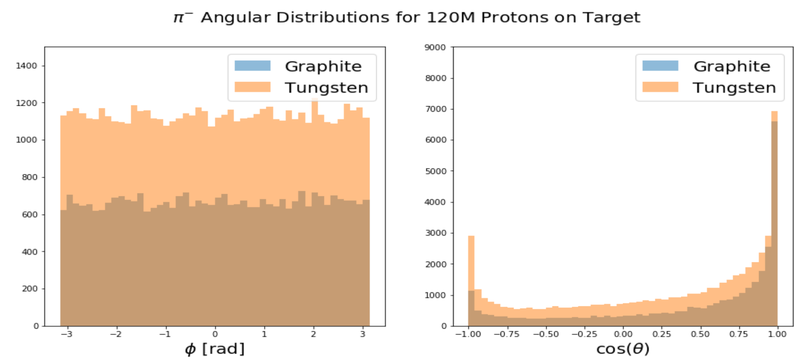
Introduction

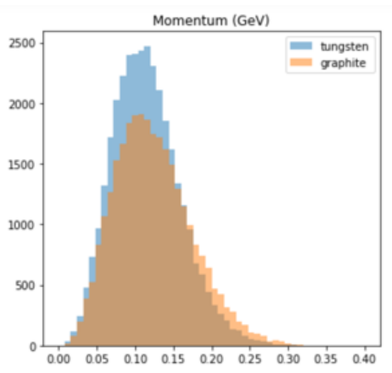
- The FermiLab 400 MeV LINAC primary proton beam can produce precision, single-species secondary beams using a production target in the MeV Test Area experimental hall; specifically, pions from 4 up to 80 MeV kinetic energy.
- Higher mass targets such as tungsten can increase low energy mu+ and mu- rates by factors of 3 and 8.
- Initial production studies have confirmed higher muon yield from heavy targets (tungsten vs. carbon) and show significant differences in pion production between modern hadronic models and between GEANT and MCNP.

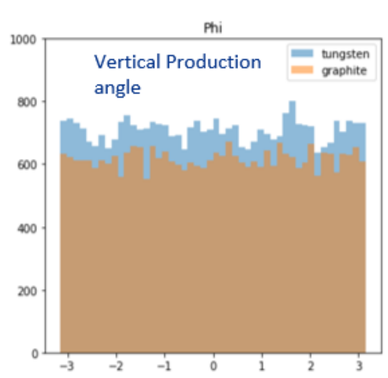
Project Purpose

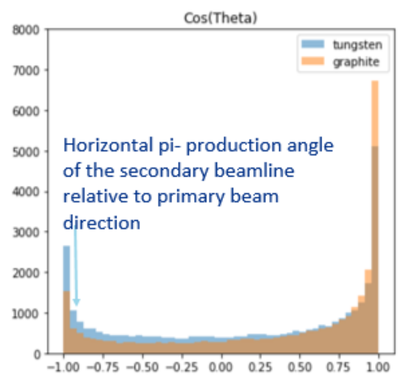
Project further investigates production discrepancies between the two target materials and between different physics models with high-statistic runs using GEANT-based code and G4Beamline to better quantify the results and compare with production data which will be obtained using the MTA secondary beamline.









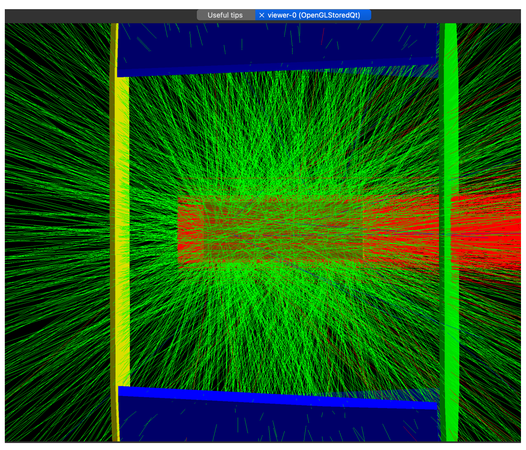


High-Statistics on the Fermi Grid

In G4Beamline, 1e6 or 1e7 events are used for efficient computation. However, results need to be confirmed with a high-statistics run of up to 2e13 events. G4Beamline only allows up to 2e9 events to be executed in 1 process. In order to get 2e13, we would have to run the program 10000 times (2e13/2e9=10000). One process of running 2e9 takes a couple of days and then to repeat the process, you would have to run it again. Because of this, we run high-statistics on the Fermi Grid. Running it by hand would take us months. When 120,000,000 events was tested for Tungsten, it took 3 days. This means 2e13 would take almost 50 days to complete. The Fermi Grid gives us access to run it on multiple computers simultaneously, in order to get through the process quicker.

```
#!/bin/bash
file="test_script.g4bl"

line_number="124"

text_to_insert="file_num_a"


i_start=1
i_end=15
if [ -r "$file" ] && [ -r "$file" ]; then
    # For every i (standing for submission order)
    for (( i = i_start; i <= i_end; i++ )); do

        # on line number #, change file_num_. to file_num_i
        sed -i '' "${line_number}s/file_num_[a-zA-Z0-9]*/file_num_$i/g" $file

        # print the number on that line for confirmation
        sed -n "${line_number}p" "$file"


        # Add your submission
    done

    # sed -i '' '${line_number}s/.*/${text_to_insert}/g' $file
else
    echo "The file '$file' is either not readable or not writable, or both."
fi
```

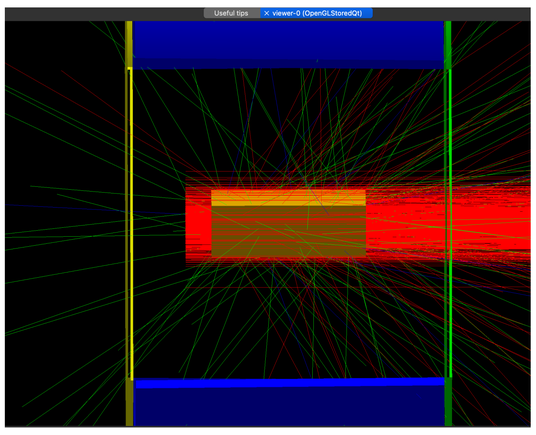
To run scripts by hand in G4 Beamline, we need to parametrize the file name where the data is written to avoid overwriting the data from a previous run. However, running it on the Fermi Grid, we are unable to feed it via the command line with g4blplot. To avoid this, a bash script is written to do it for us. The bash script and G4 Beamline script file have been submitted to the Fermi Grid by Kevin Lynch who is a collaborator and has a grid account. Results are pending.



Tungsten Running 1000 Events (10.5 mm x 10.5 mm x 30 mm) Protons – Red, Pi – Green, Mu - Blue

G4 Beamline

- Code Incorporates secondary particle production models and predictions.
- Allows us to study the performance based on those predictions/simulations
- Usually tested in tracking mode but sometimes would switch to visualizing mode to see if target was in the right place or was being properly tracked.
- “viewer=none” command allows us to track specified number of events in the code, while ”viewer=best” allows us to go event by event.



Graphite Running 1000 Events (10.5 mm x 10.5 mm x 30 mm Target) Protons – Red, Pi – Green, Mu - Blue

Acknowledgments

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