



Muon Production from Backscattered Photons on Targets at the EIC

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U.S. DEPARTMENT OF
ENERGY | Office of
Science

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Outline

- Prior work on muon generation from gammas
- Geant4 simulation
 - Setup
 - Physics List study
- Kinematics distributions
- Next steps

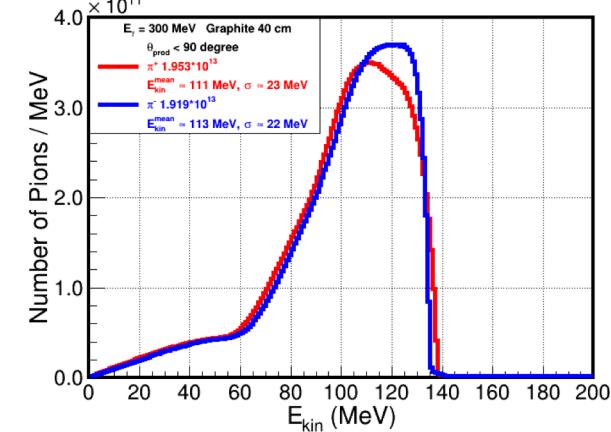
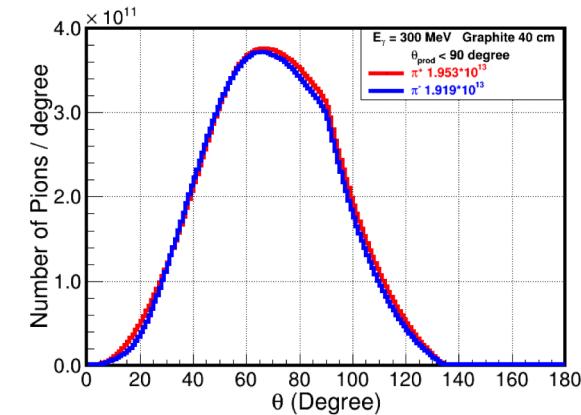
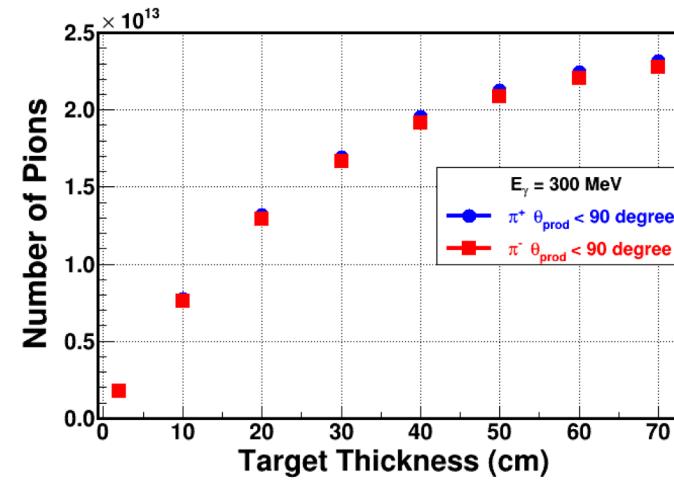
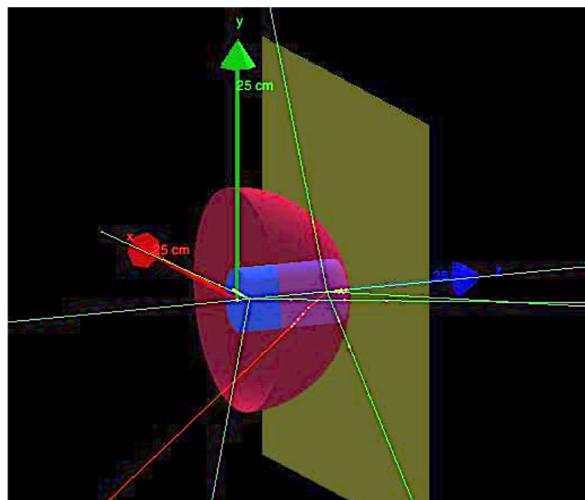


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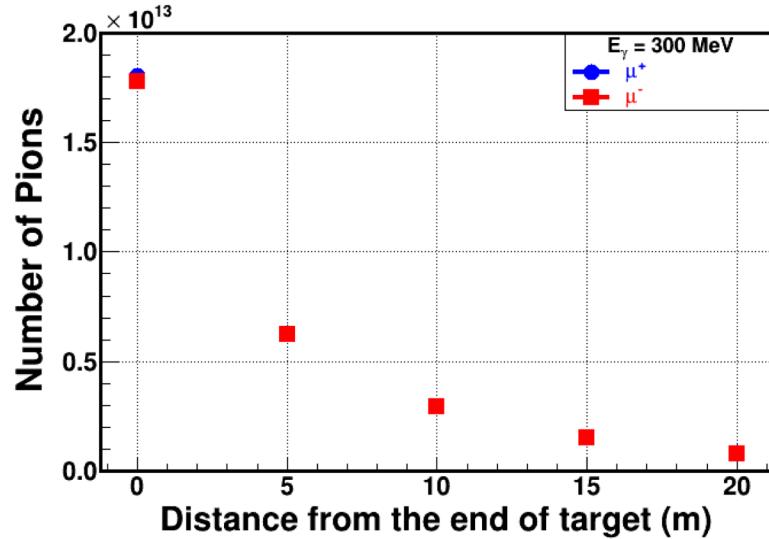
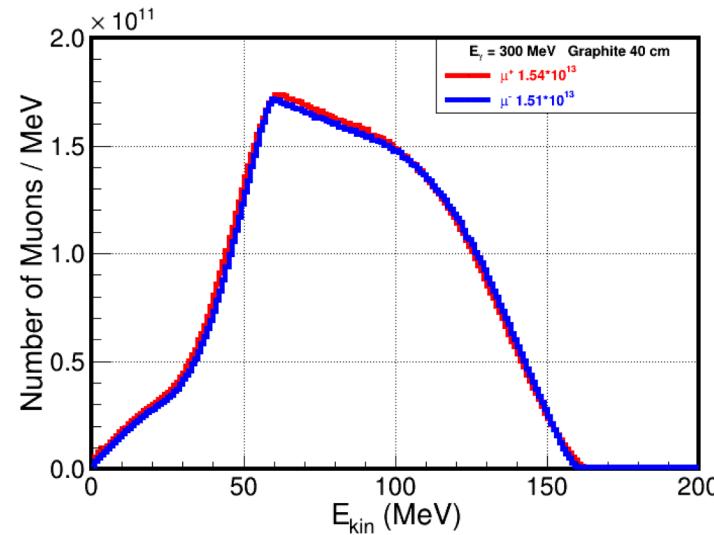
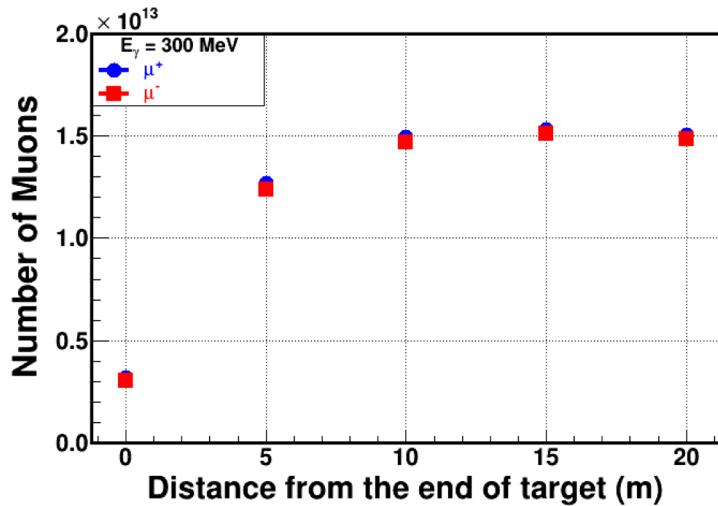
Prior Work – Apyan & Krasny [1]

▪ Armen Apyan & Witold Krasny

- Physics Opportunities with the Gamma Factory, MITP, Mainz (2020)
- $\gamma + \text{Target} \rightarrow \pi^\pm \rightarrow \mu^\pm$
- Target study
 - » Be, Cu, W ...: best one is C
 - » Thickness: 40 cm
 - » Gamma beam energy: 300 MeV, 1MW ($2 \times 10^{16} \gamma/\text{s}$)



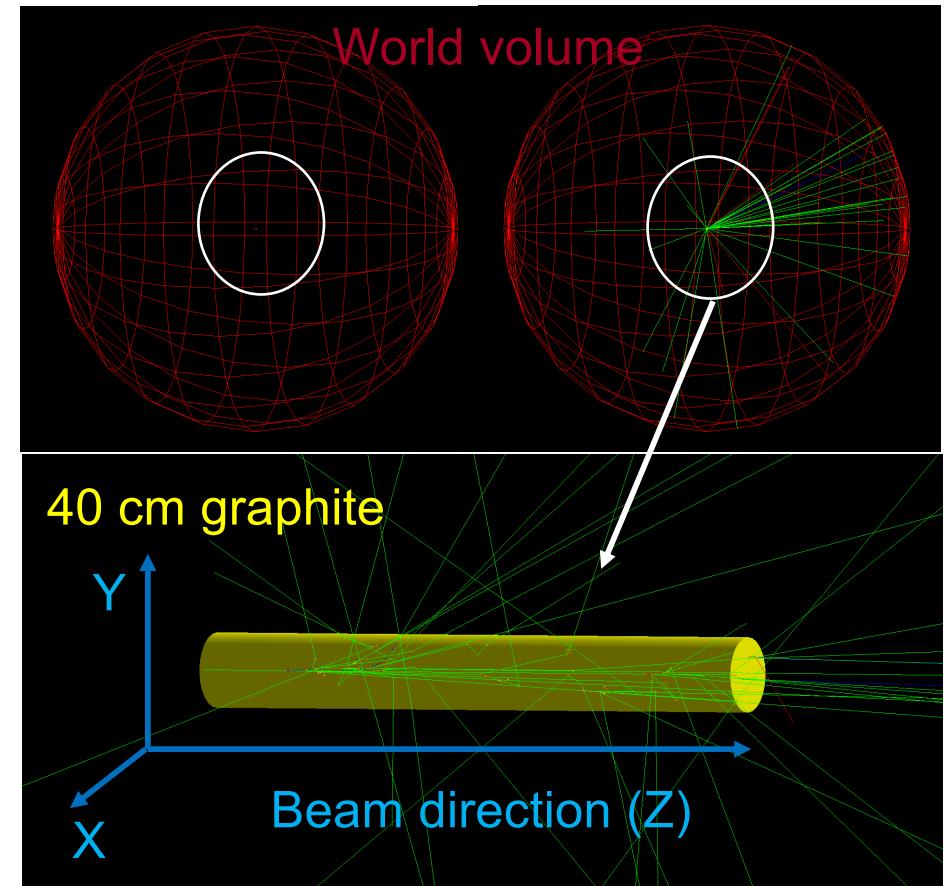
Prior Work Work – Apyan & Krasny [2]



Dist. (m)	$\pi^+ \times 10^{13}$	$\mu^+ \times 10^{13}$
0	1.81	0.32
5	0.63	1.27
10	0.30	1.49
15	0.15	1.54
20	0.08	1.51

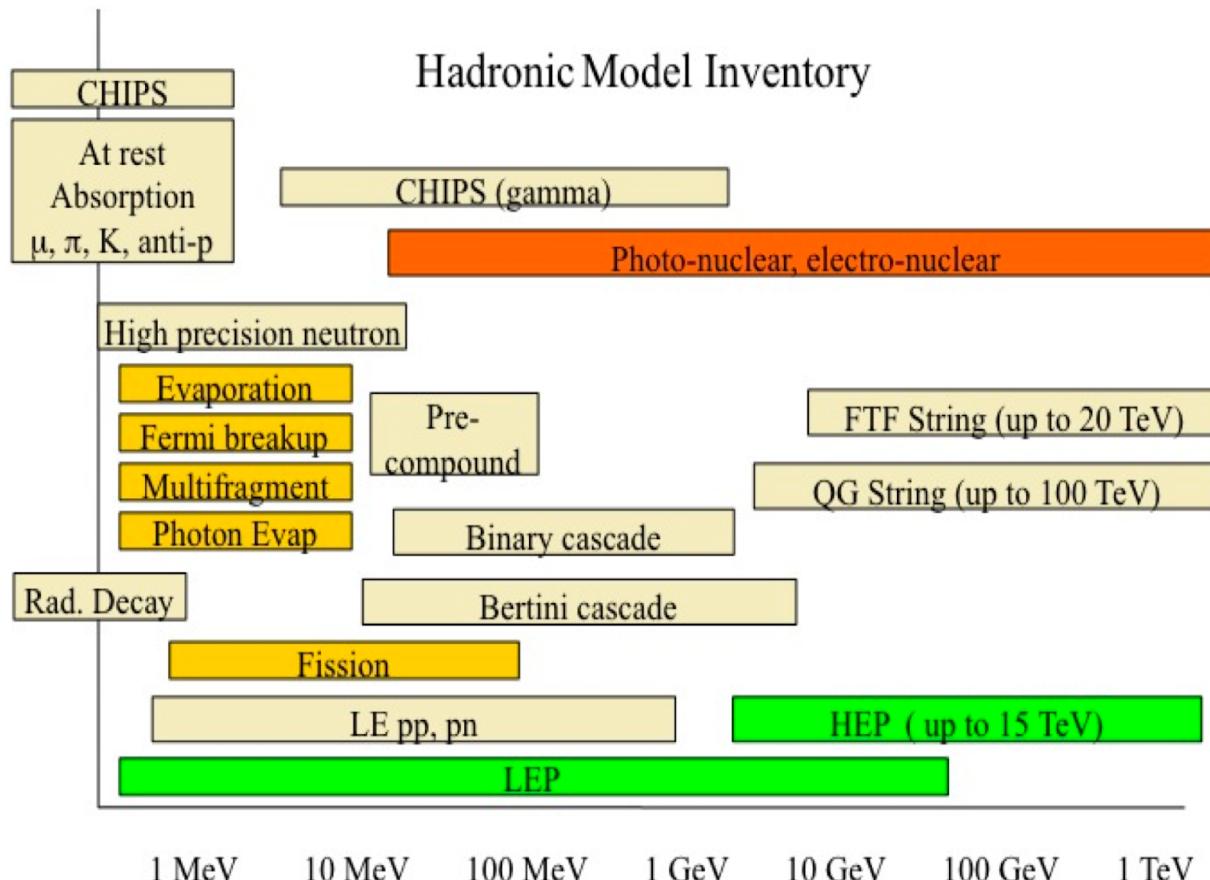
Geant4 Simulation: Setup

- Target
 - 40 cm graphite
 - 50 m world volume
 - » 4π sphere
- Beam
 - Beam: $10^{10} \gamma$
 - Kinetic energy: 300 MeV
- $\Theta_X = \text{atan}(\vec{P}_X/\vec{P}_Z)$
- $\Theta_Y = \text{atan}(\vec{P}_Y/\vec{P}_Z)$



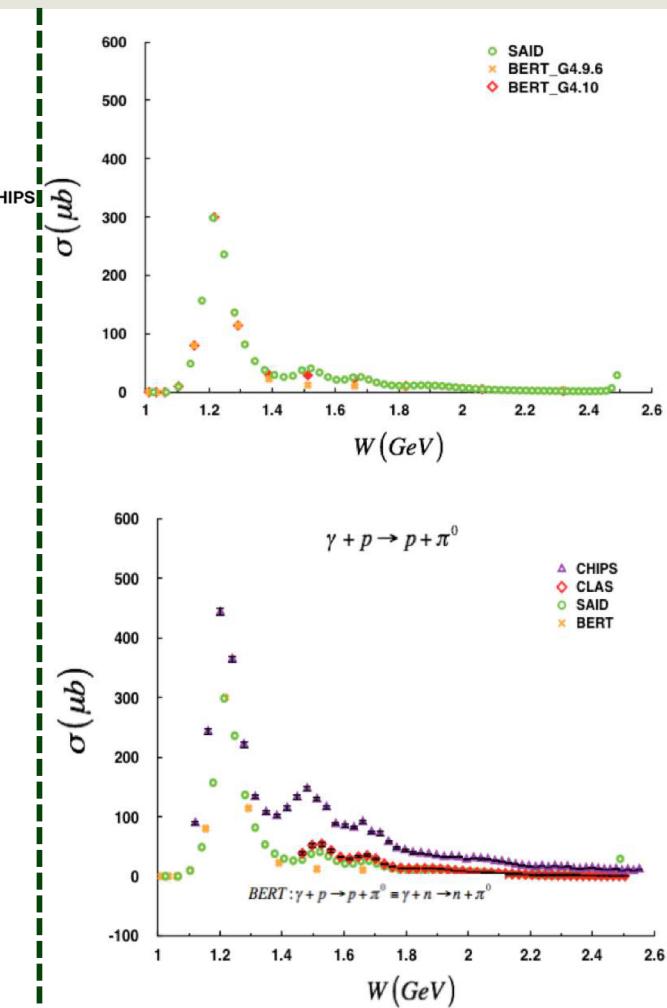
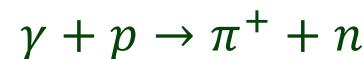
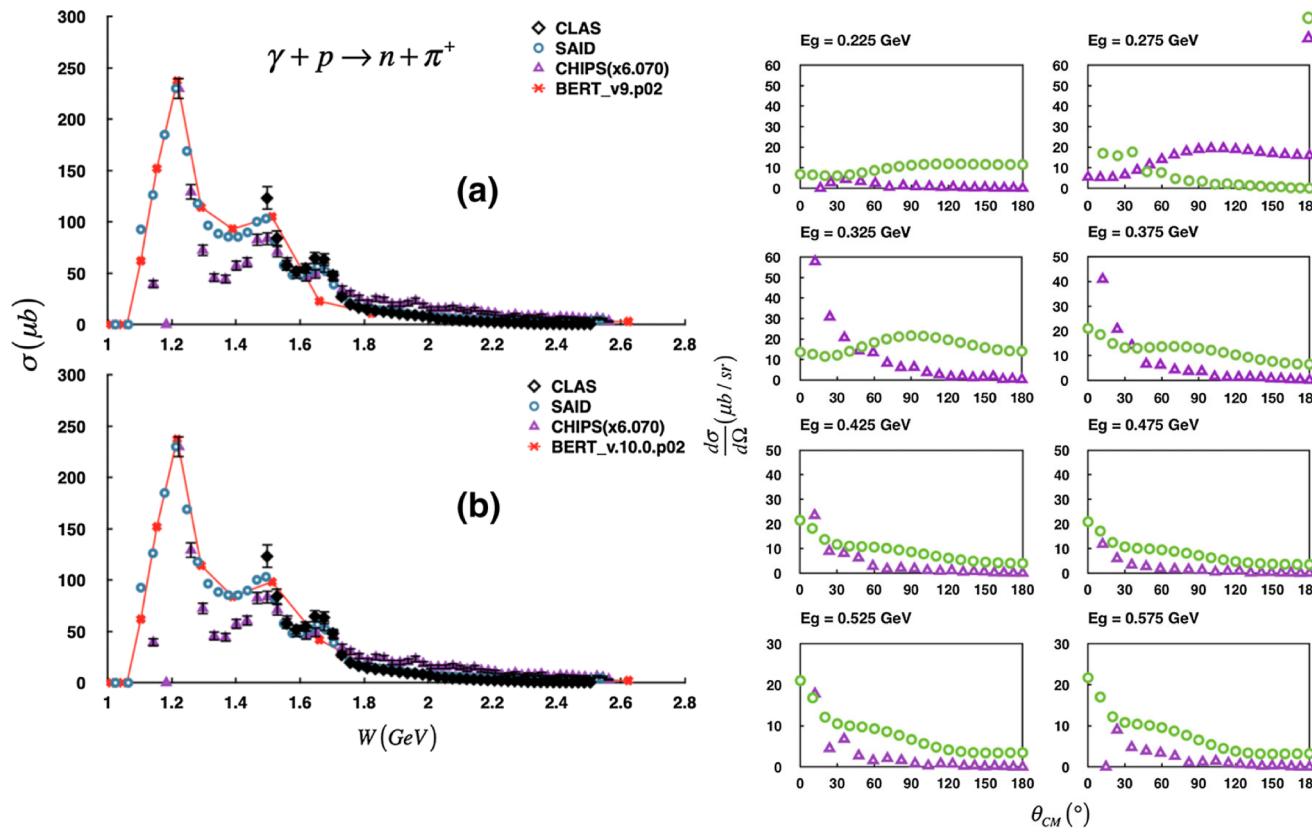
Geant4 Physics List

- Physics chosen by users
 - Must check various physics lists to identify best suitable one



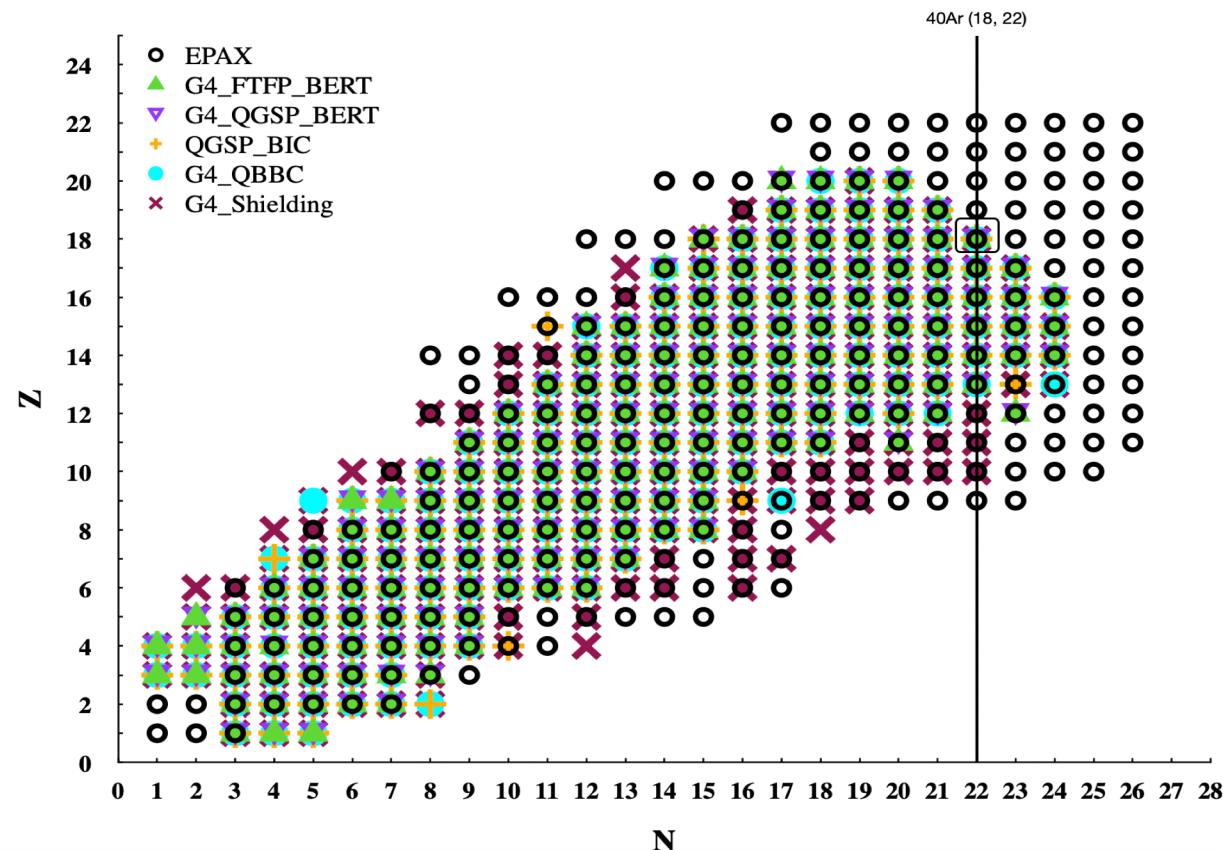
Pion Photo-Production Production

S. B. L. Amar et al., Eur. Phys. J. **A55**: 6 (2019)
 S. B. L. Amar et al., Eur. Phys. J. **A57**:340 (2021)

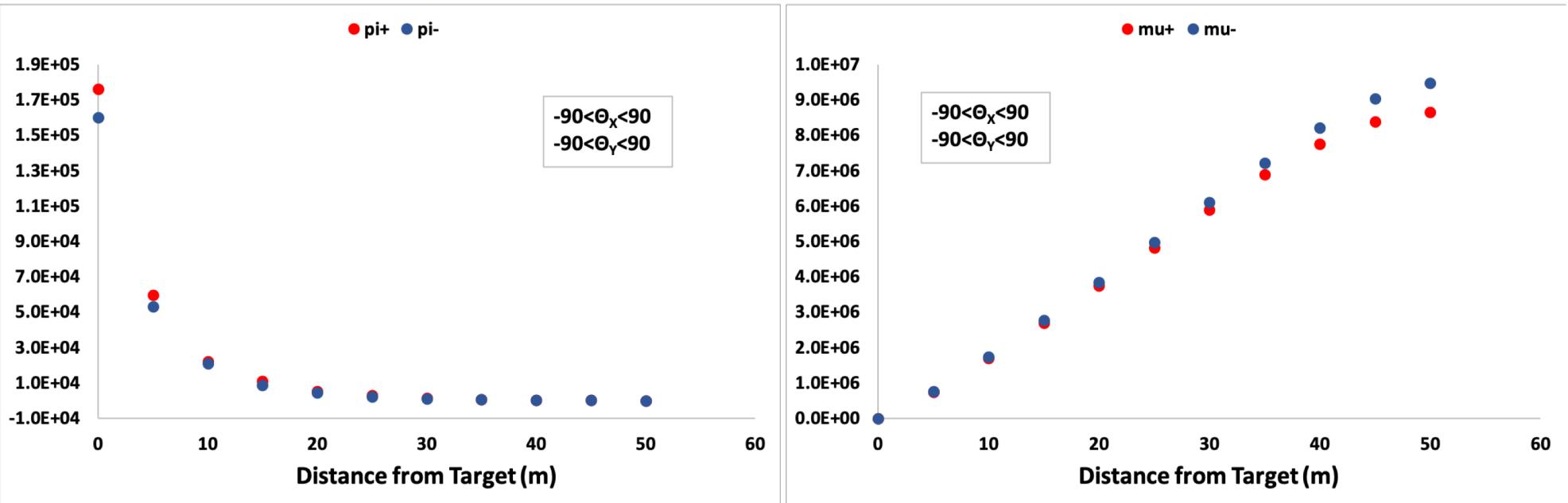


More Hadronic Physics Study

- Recent study (B. Amar Lo, FRIB, private communication, 2023)
 - For ion fragmentation in 100s MeV/u ions: **Shielding** physics list is best



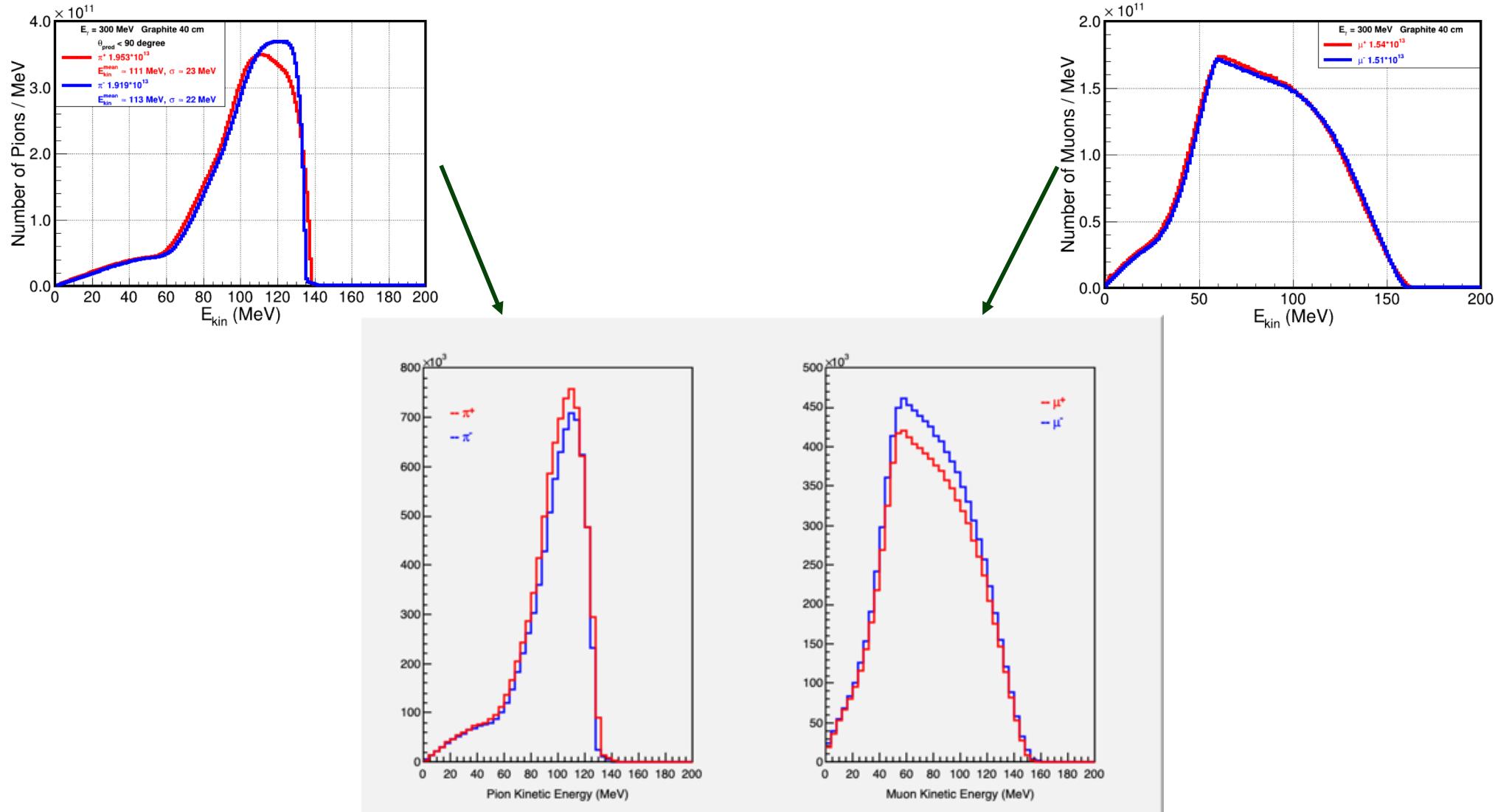
Pion/Muon Production



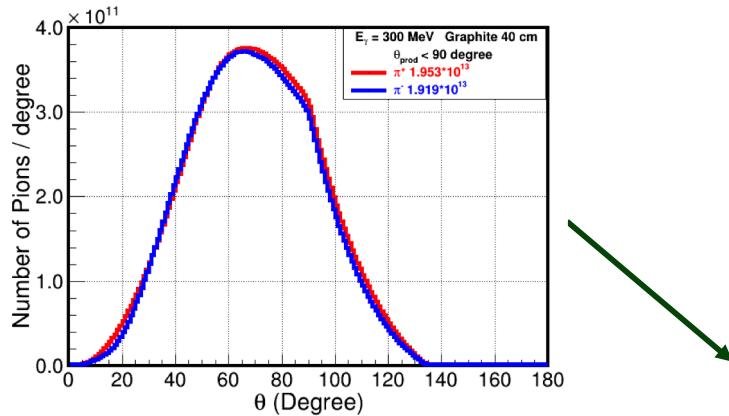
Muon production higher than expected?

Secondary processes: $\gamma_{prim.} + C \rightarrow \gamma_{sec.} \rightarrow \pi^\pm \rightarrow \mu^\pm$

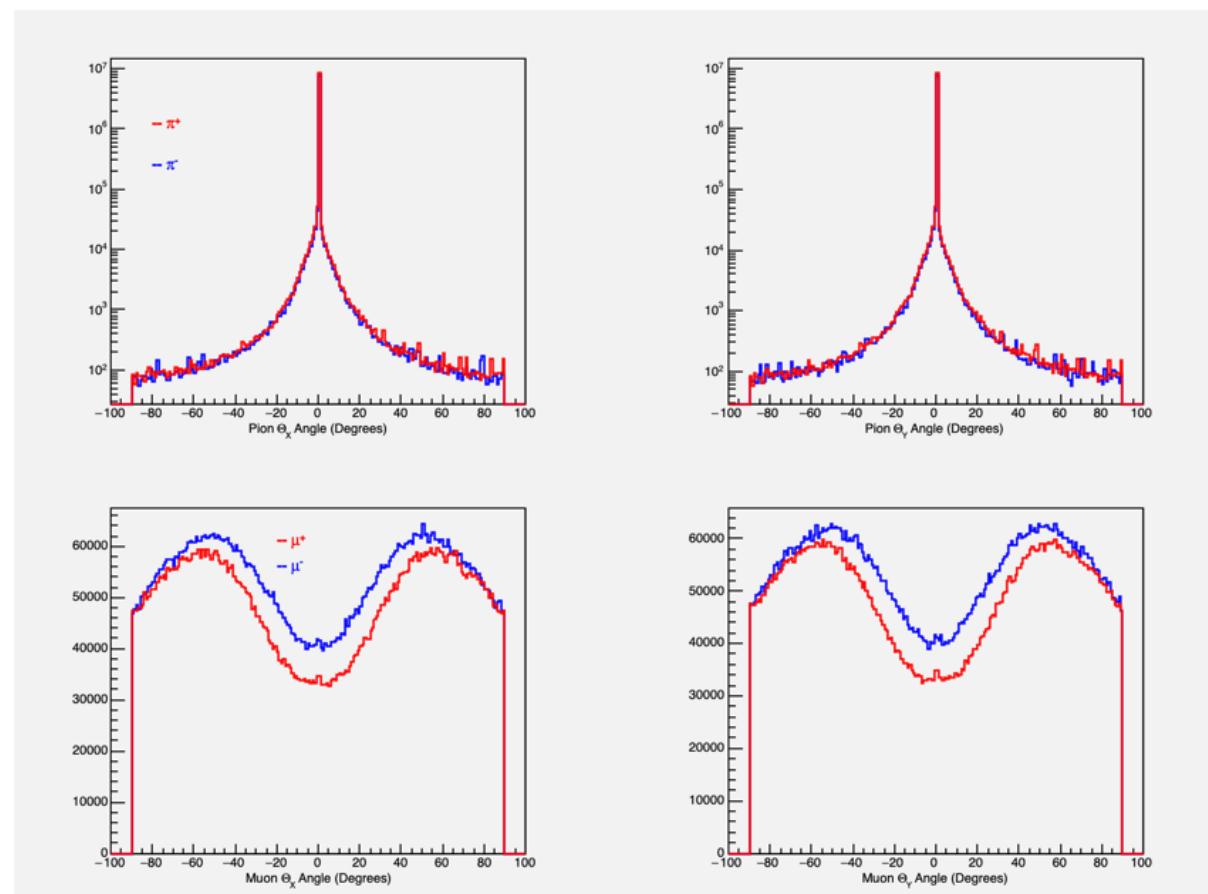
Pion/Muon Kinematics [1]



Pion/Muon Kinematics [2]



- Angular distribution
 - Do we need to measure both forward & backward muons?



Next Steps

- Physics list

- Need more comprehensive study
- Understand primary vs. secondary processes

- Physics

- Forward and backward distributions?

- Beam parameters vs. physics output

- Background
- Resolution needed?
- ...

Thank You!

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Paul Gueye - Muons Backscattering Gamma - CFNS - 04/05/23 13