Muon and pion production from electron on target

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Motivation

·Muon and pion has a lot of **applications** in both basic fundemental science research and practical application;

·Based on high energy electron accelerator in Shanghai, such as **SHINE** [1] (8GeV), electron on target can produce high brightness **muon beam** and ultrahigh brightness **pion beam**;

·By using the Geant4 **simulation**, the momentum spectrum, angle distribution of muon and pion are studied, and the effect of target parameters on muon's and pion's yield are analyzed **in the process of photon-nuclear reaction**.

Muon and Pion Production Channel

$$e^- + N \rightarrow e^{-*} + N + \gamma$$ (In bremsstrahlung process)

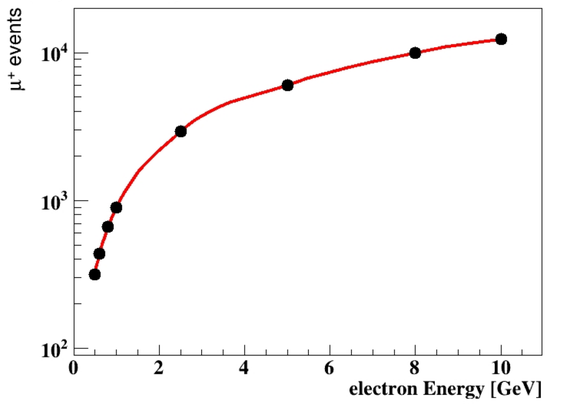
(In photon-nuclear reaction process)

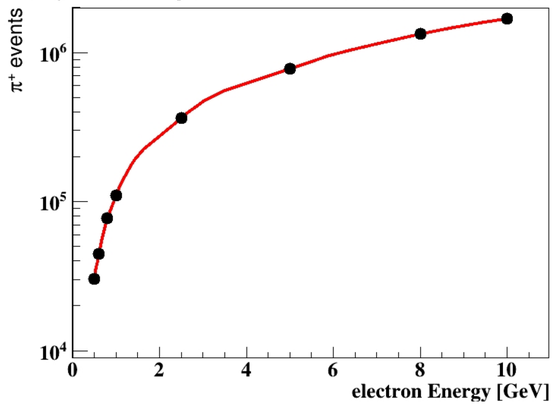
$$\gamma + N \rightarrow N^* \rightarrow \pi^+/\mathrm{K}^+ + X$$

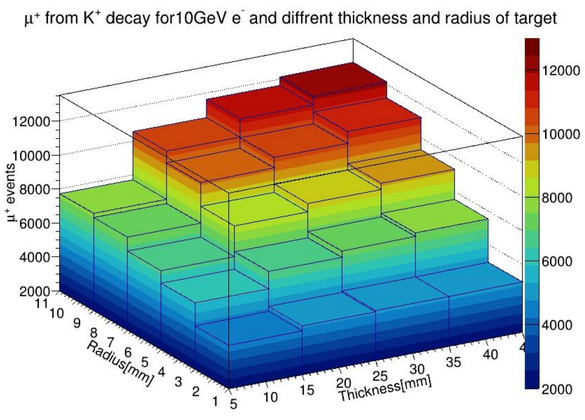
$$\pi^+ \rightarrow \mu^+ + \upsilon_\mu$$

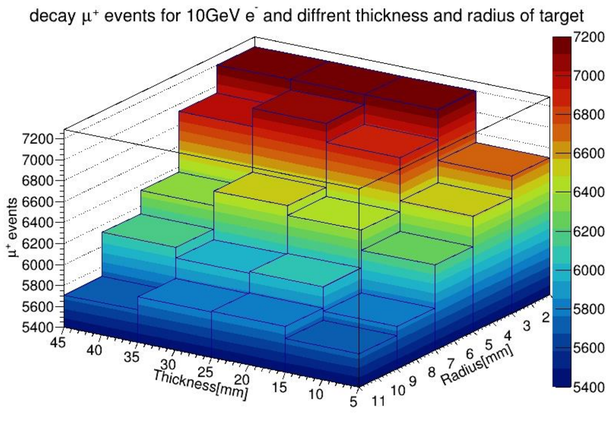
$$\mathrm{K}^+ \rightarrow \mu^+ + \upsilon_\mu$$

2. The effect of electron energy and target shape on μ+/π+ yield

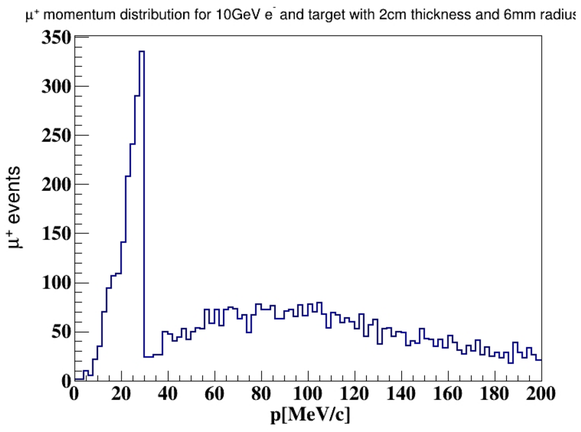


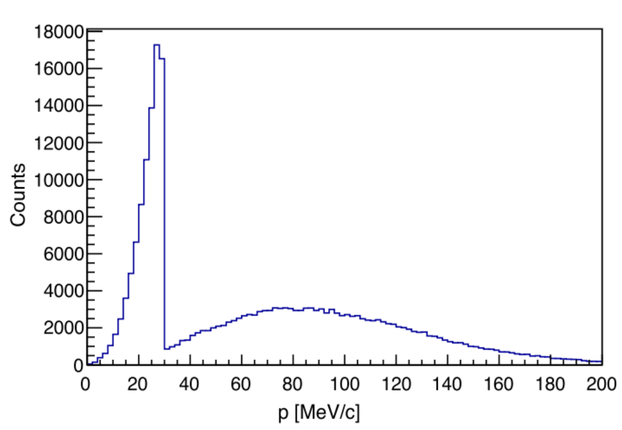






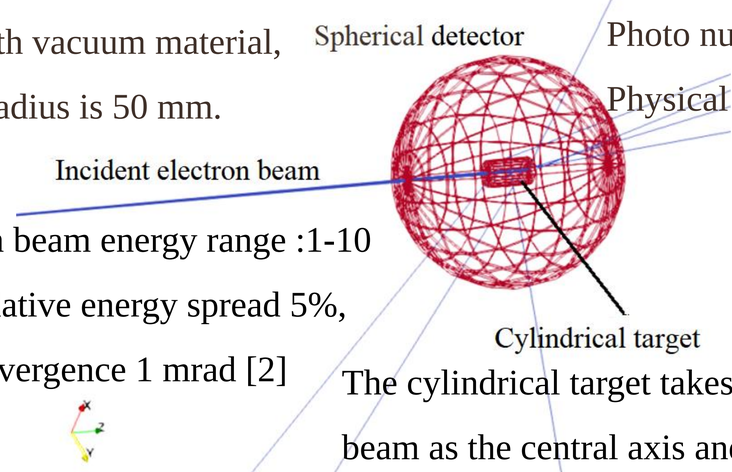
3. The muon momentum spectrum from pion decay Vs Reference [3]





Simulation and Parameters in Photon-Nuclear Process

The spherical detector is 1 cm thick with vacuum material, and its radius is 50 mm.



Electron beam energy range :1-10 GeV, relative energy spread 5%, angle divergence 1 mrad [2]

Incident electron events: 1e6

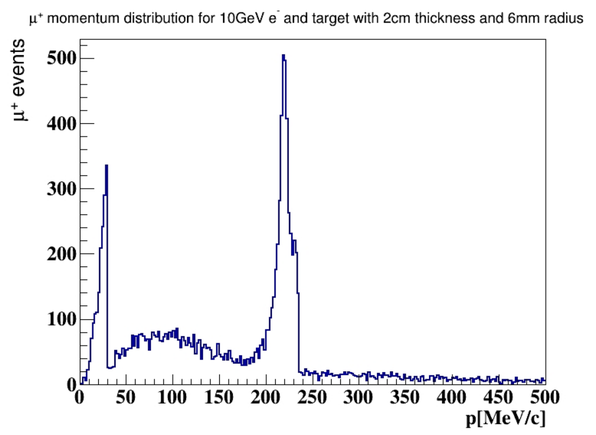
Photo nuclear cross section factor:1e6

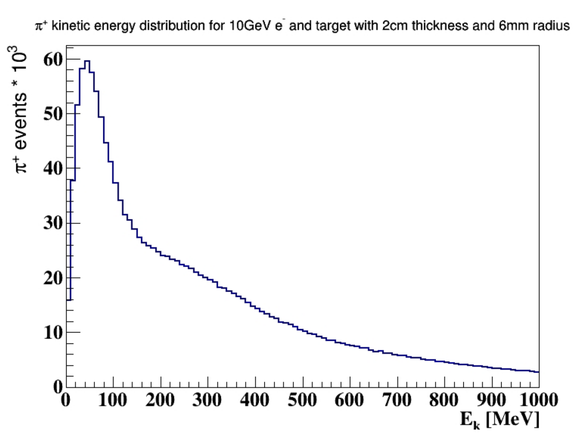
Physical list: FTFP-BECT

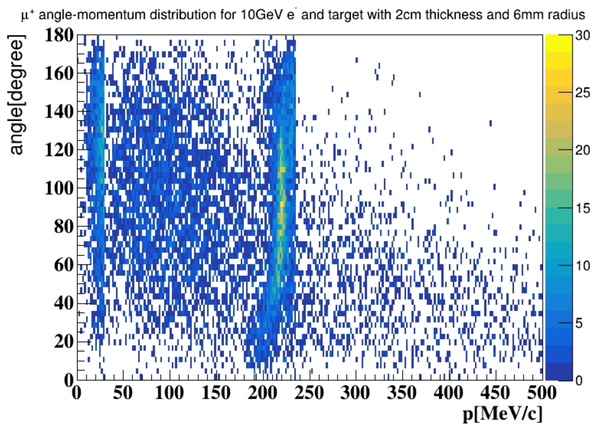
The cylindrical target takes the incident electron beam as the central axis and the material is **tungsten**

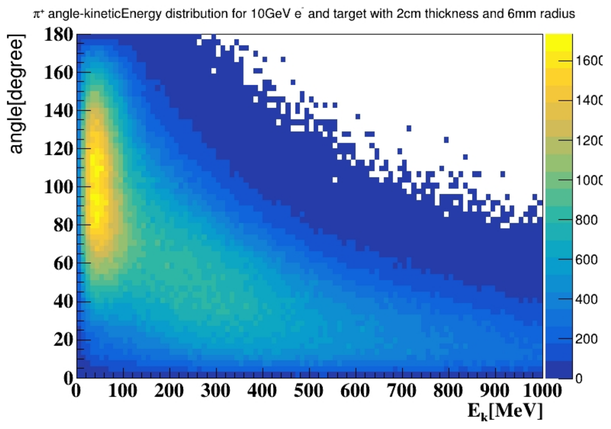
Result in Photo-Nuclear Process

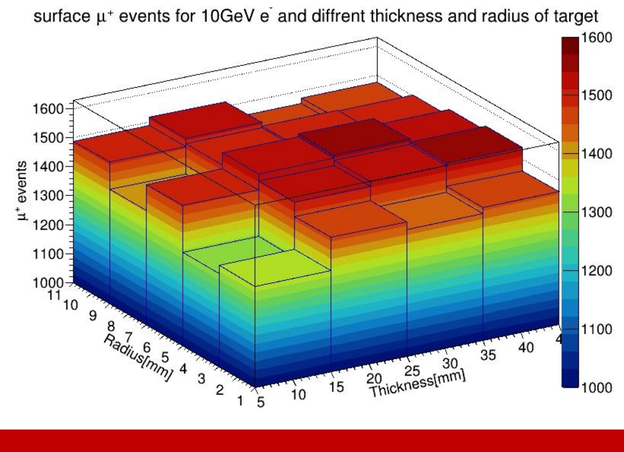
1. The momentum and angle distribution of μ+/π+

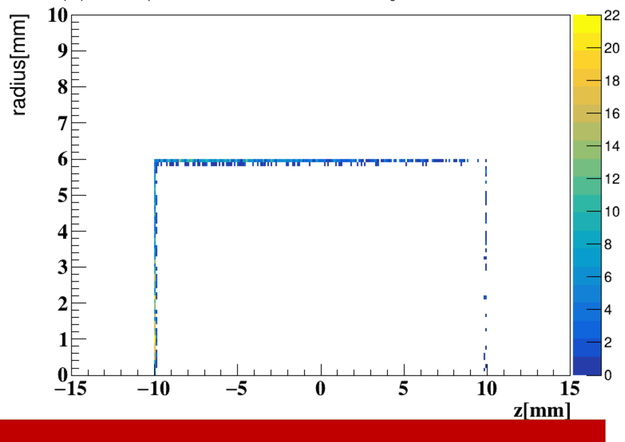












Conclusion

·Three peaks in muon momentum spectrum. (surface muon:30 MeV/c, decay muon:90 MeV/c and from K+ decay:210 MeV/c). Pion's peak kinetic Energy is about 40 MeV.

·The surface muon production position is mainly located on the side surface and back surface of the target.

·The yield of muon and pion increases linearly with the increase of electron energy.

·When the incident electron energy is 10 GeV and the target is tungsten, the thickness is 3 cm, and the radius is 6 mm, the number of surface muon is the highest.

·The muon momentum spectrum from pion decay is similar to the result of reference [3].

Reference **[1]** 辐射防护, 2020, 40(6):6. **[2]** Phys. Rev. Accel. Beams 19, 024701 (2016) . **[3]** Plasma physics and controlled fusion, 2018(9).