Summer School Program - CERN

Studies of the particle production in the K12 beam line

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Outline

Introduction

Where am I from

- Physics student at Simón Bolívar University (USB).
- Caracas, Venezuela.

Project degree

Study of the interaction between massive vector fields and massive scalar fields in the classical field theory framework.

What do we want?

Studies of the particle production at K12 beamline for different physics lists.

Why do we want it?

To quantify the differences between the Geant4 physics lists and compare with measurements.

How we will do it?

- Performed in G4beamline (Geant4).
- Analyzed in the ROOT framework.

Theoretical Basis

Fixed-target experiment at CERN SPS dedicated to measurements of **rare kaon decays.**

Physics motivation

1. CP violation
2. Quark mixing

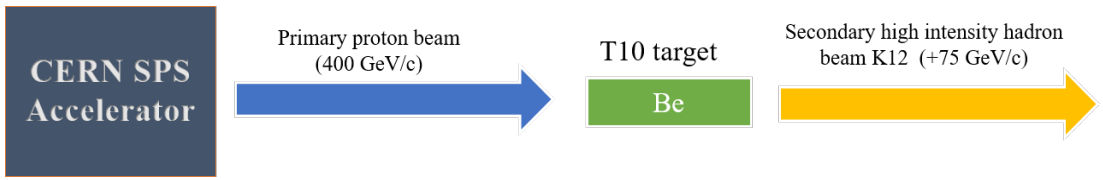
$$K^+ \to \pi^+ \nu\bar{\nu}. \tag{1}$$

CP symmetry The same laws of physics if a particle is interchanged with its antiparticle and its spatial coordinates inverted.

Charge conjugation C: if p denote a particle, $C\,|p\rangle = \pm\,|p\rangle = |\bar{p}\rangle$.
Parity P: if $\vec{v}$ denote a polar vector, $P(\vec{v}) = -\vec{v}$.

Fixed-target experiment.

Production of a variety of different particles and energies through interaction of a proton beam with a solid fixed target.



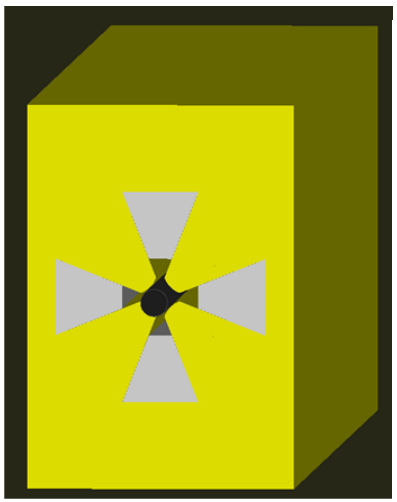
Sign and magnitude chosen to **maximize the fraction of kaons** and amount of decays of kaons with respect to the flux of incident protons and other hadrons in the beam.

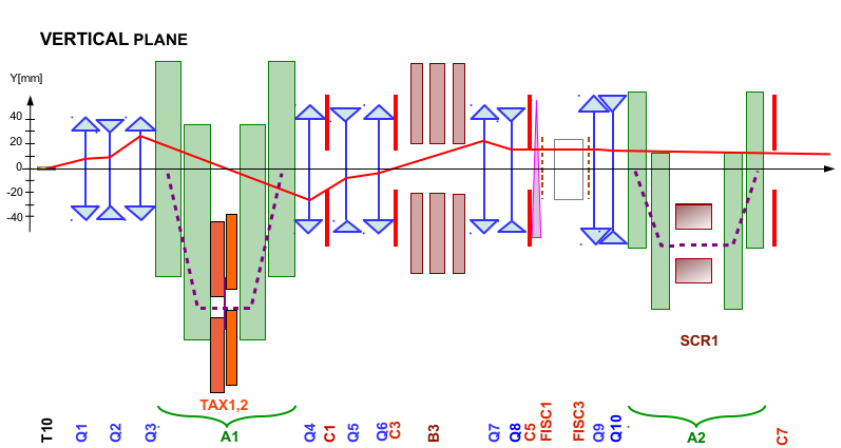
Beam line design

1. Collect produced particles
2. Select momentum
3. Select particle type
4. Transport beam to experiment

Active elements

- Quadrupole magnets to focus the beam and tune the magnification
- Achromat A1: 4 dipole magnets with 2 TAX between them.
- TAX (Target attenuator) to define the momentum and remove the primary protons of the beam.
- Collimators to reduce the background and define the beam.
- Bending magnets to transport and select the momentum.





K12 beamline simulation

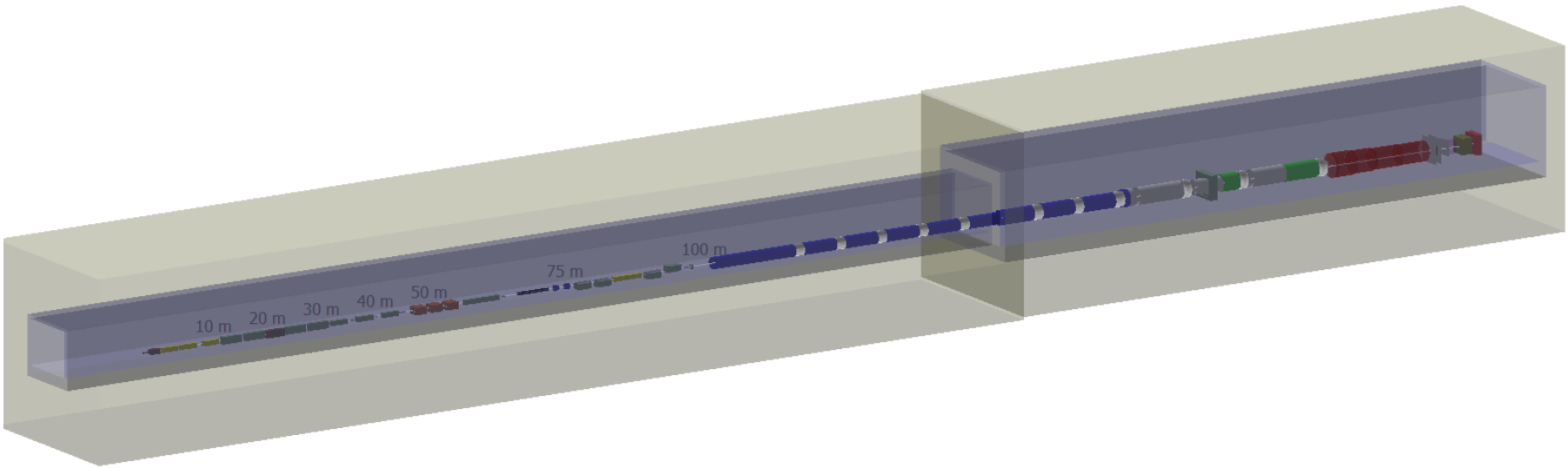
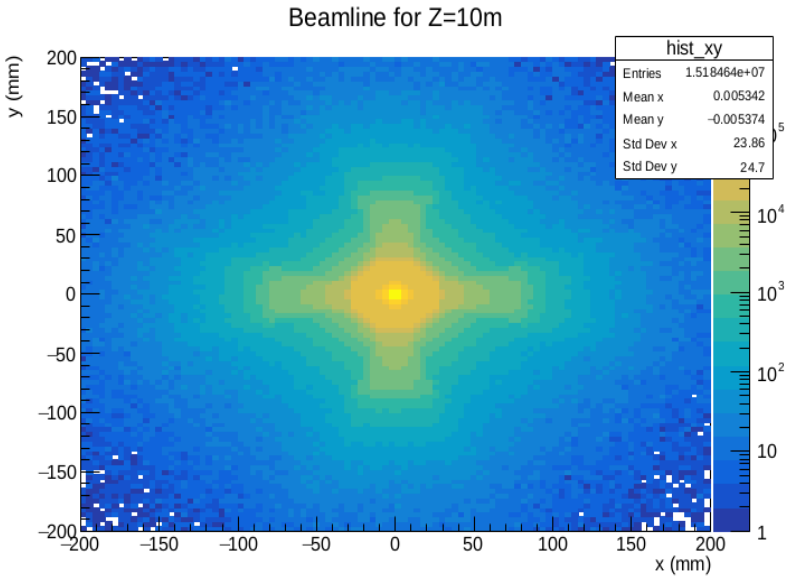
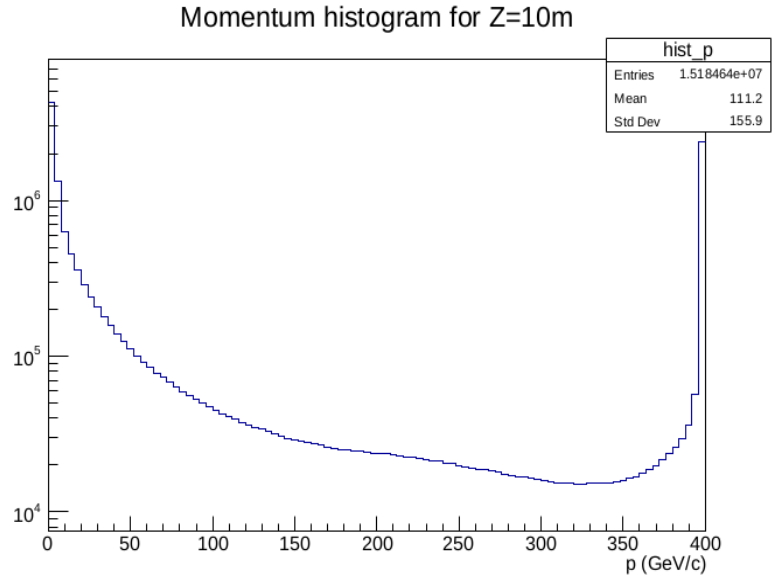


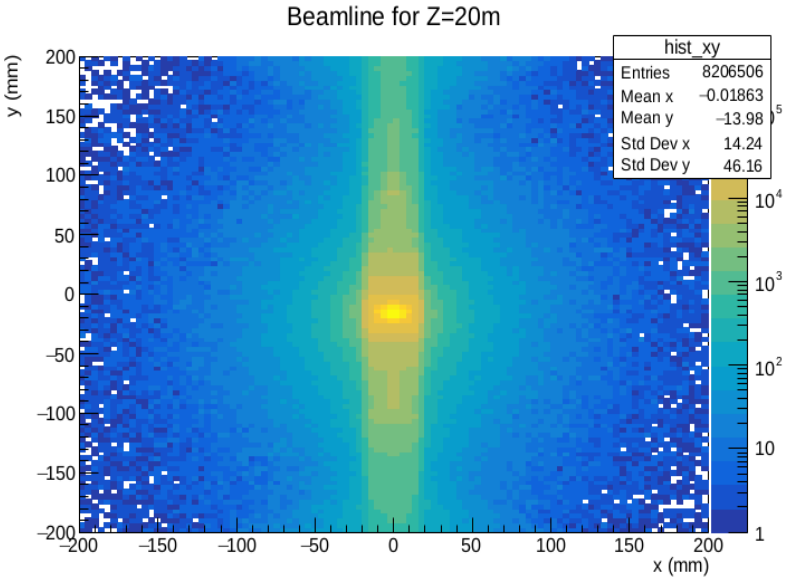
Figure: K12 beamline simulation performed in G4beamline, M. Rosenthal.

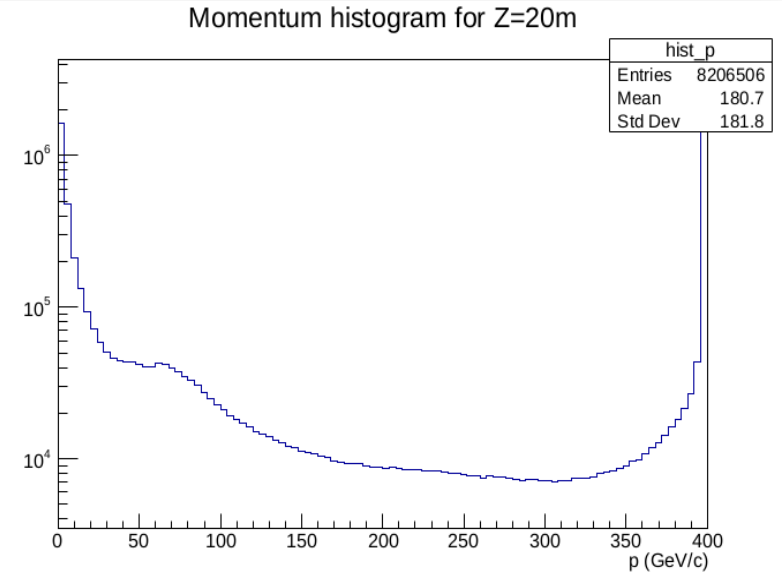
Results and analysis

Distribution of particles at the beam line









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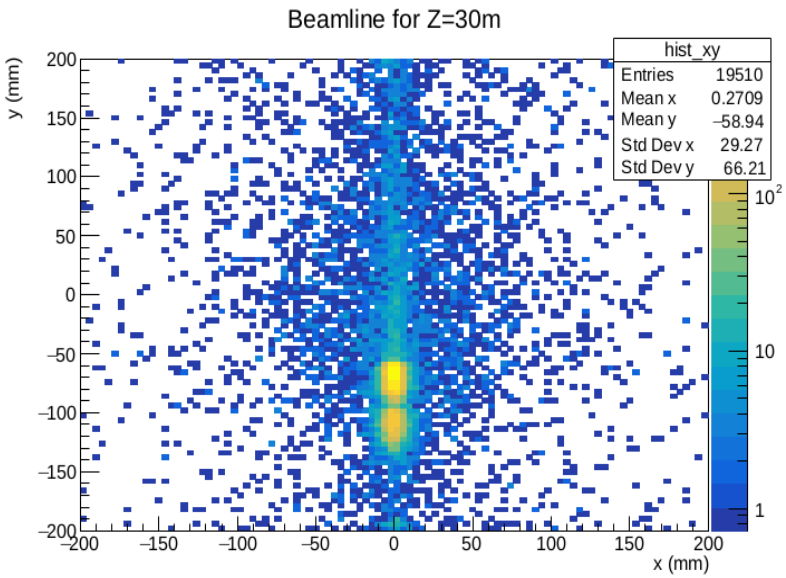

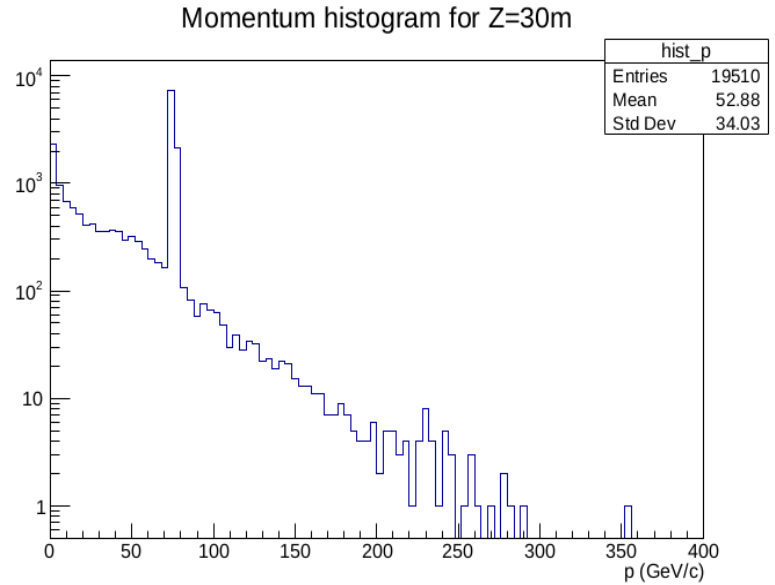

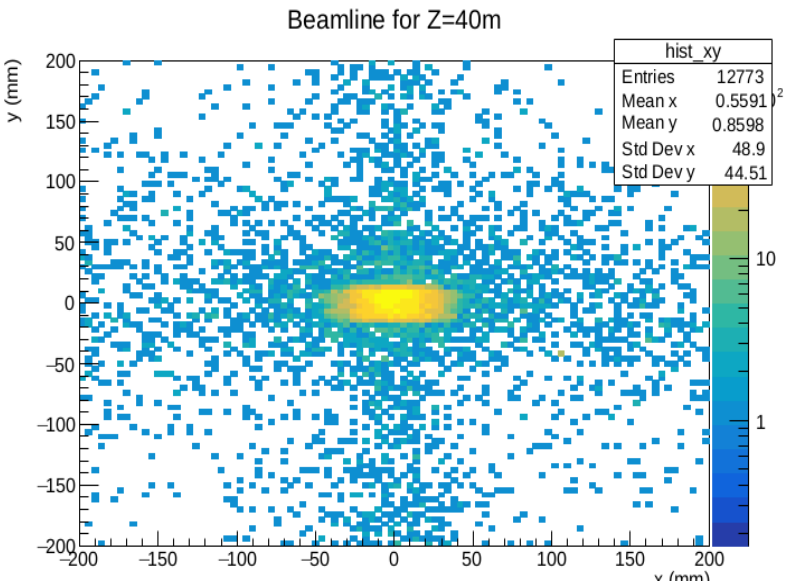

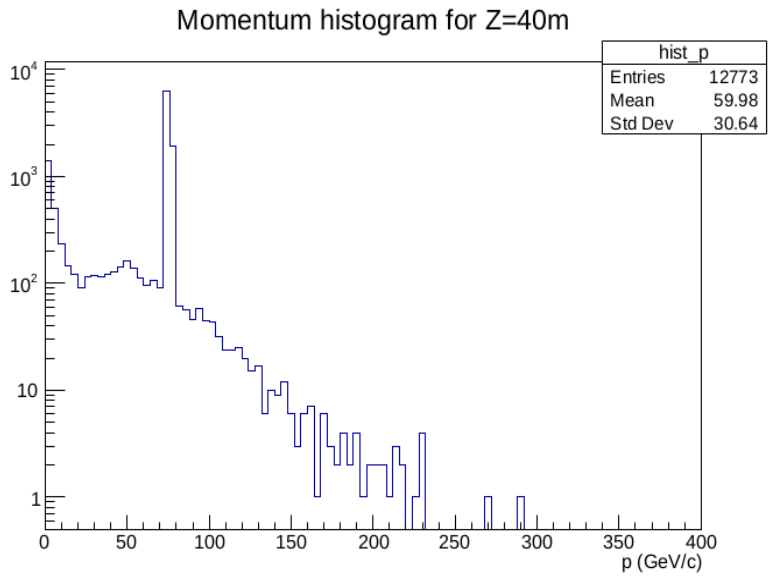

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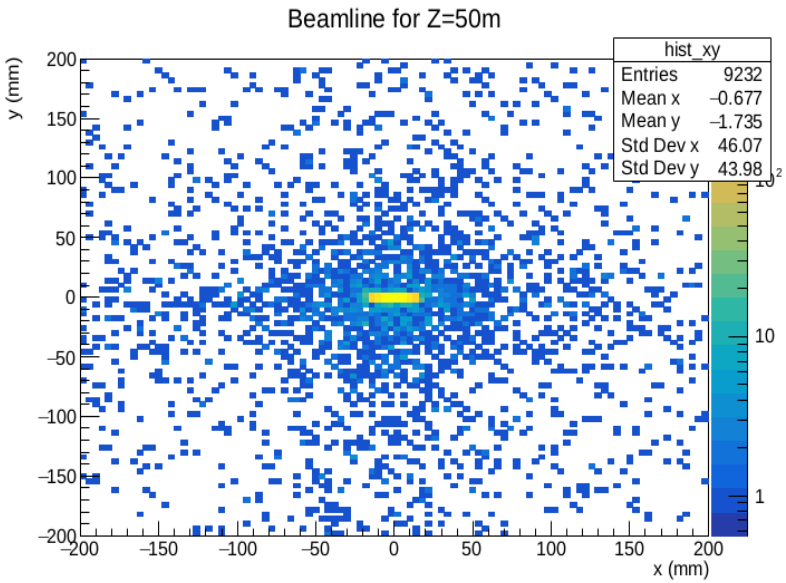

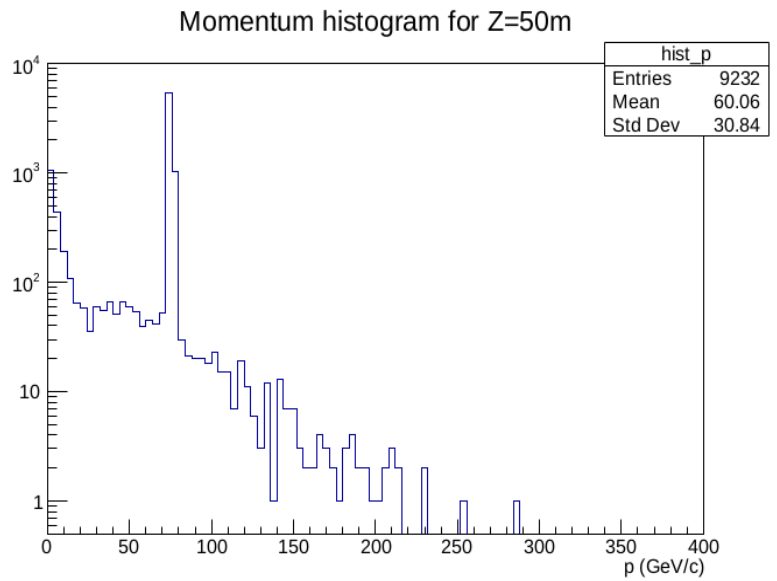

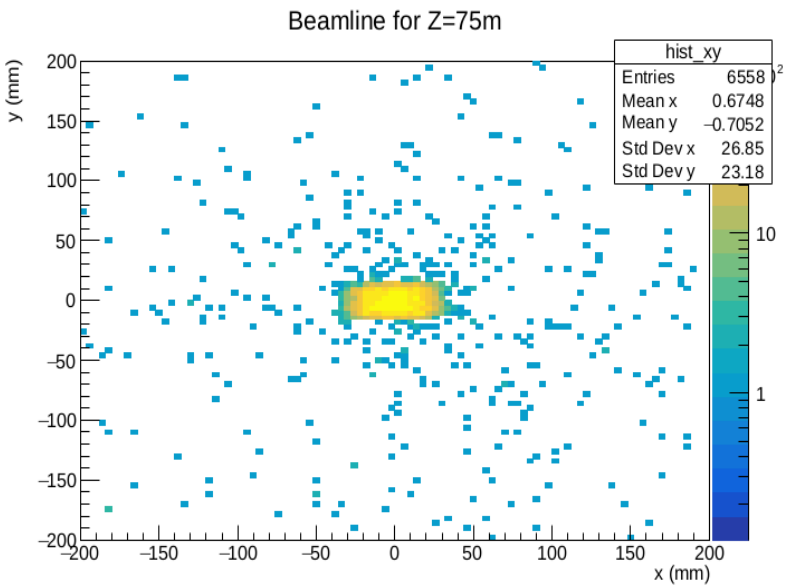

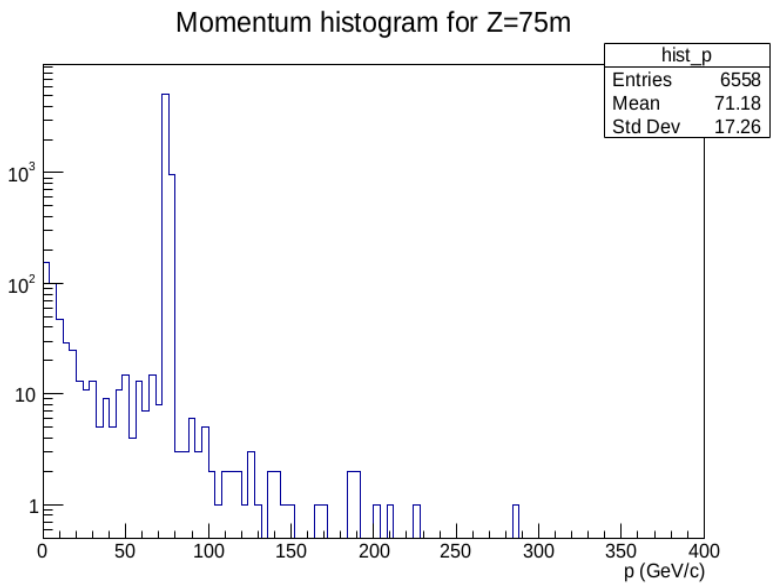

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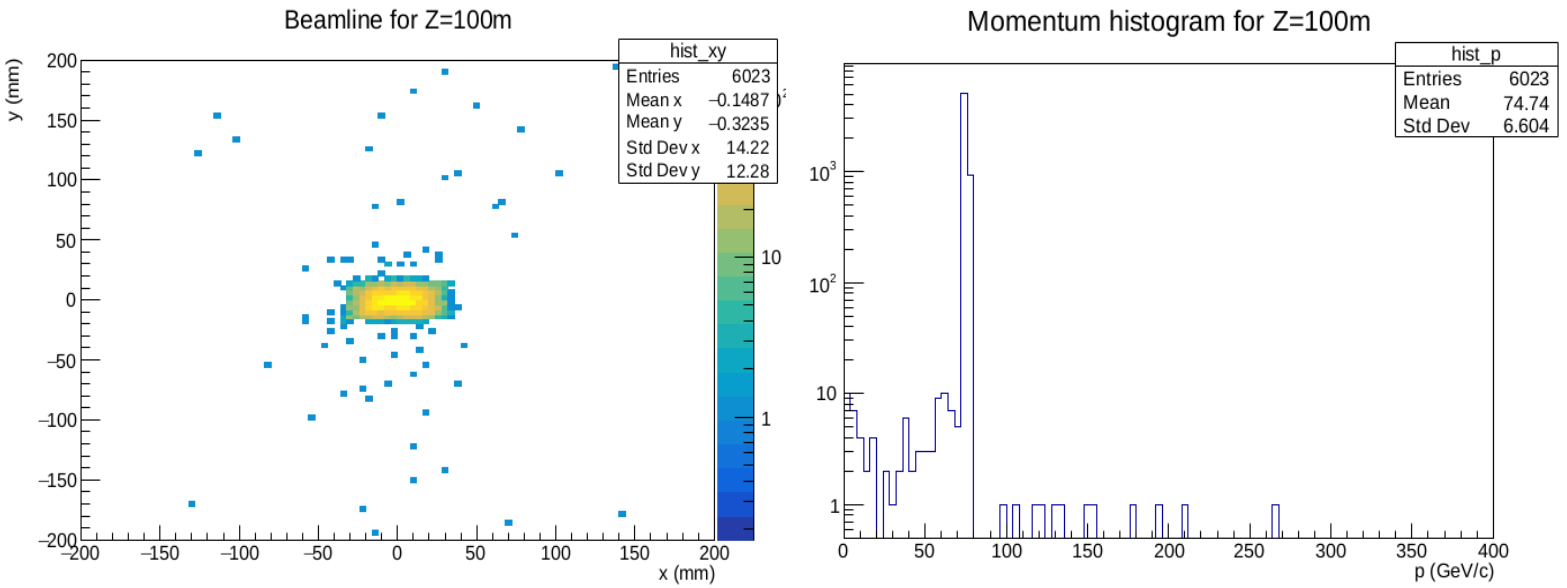
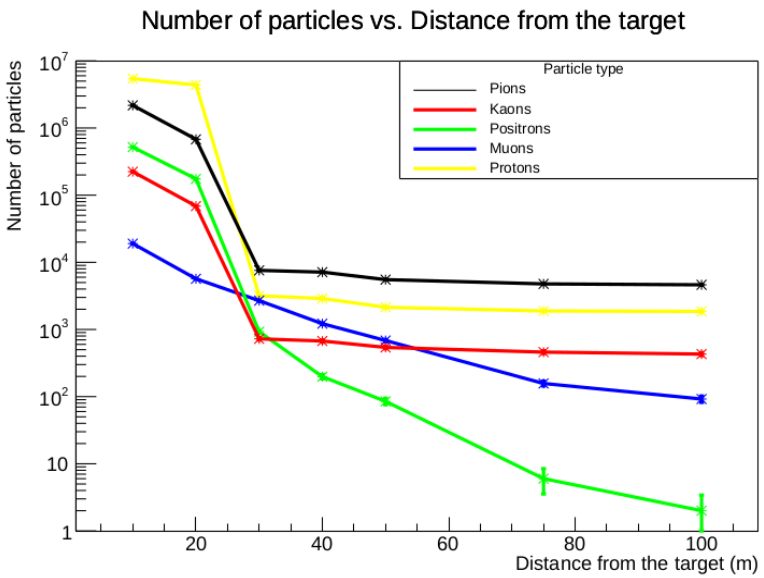
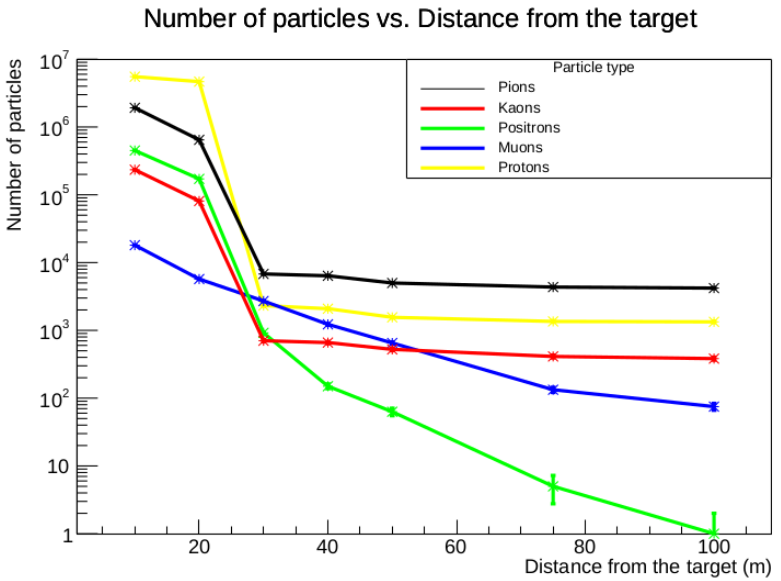


Figure: Final beamline distribution at 100 m behind the production target.



Rates of particles using QGSP BERT physics list



Rates of particles using FTFP BERT physics list

NEXT STEPS

1. Calculate the ratios of the particles.
2. Compare the rates of each particle for different physics list.

Acknowledgement

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