Studies of simulation of the SPD Straw Tracker simulation efficiency in p–p collisions & last updates on «simulation of the SPD Straw Tracker performance in p-p and ion-ion collisions» study

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TS full hit rate and straw occupancy in p-p collisions

Fig. 1 - TS full hit rate (barrel и end-caps parts) in p-p collisions

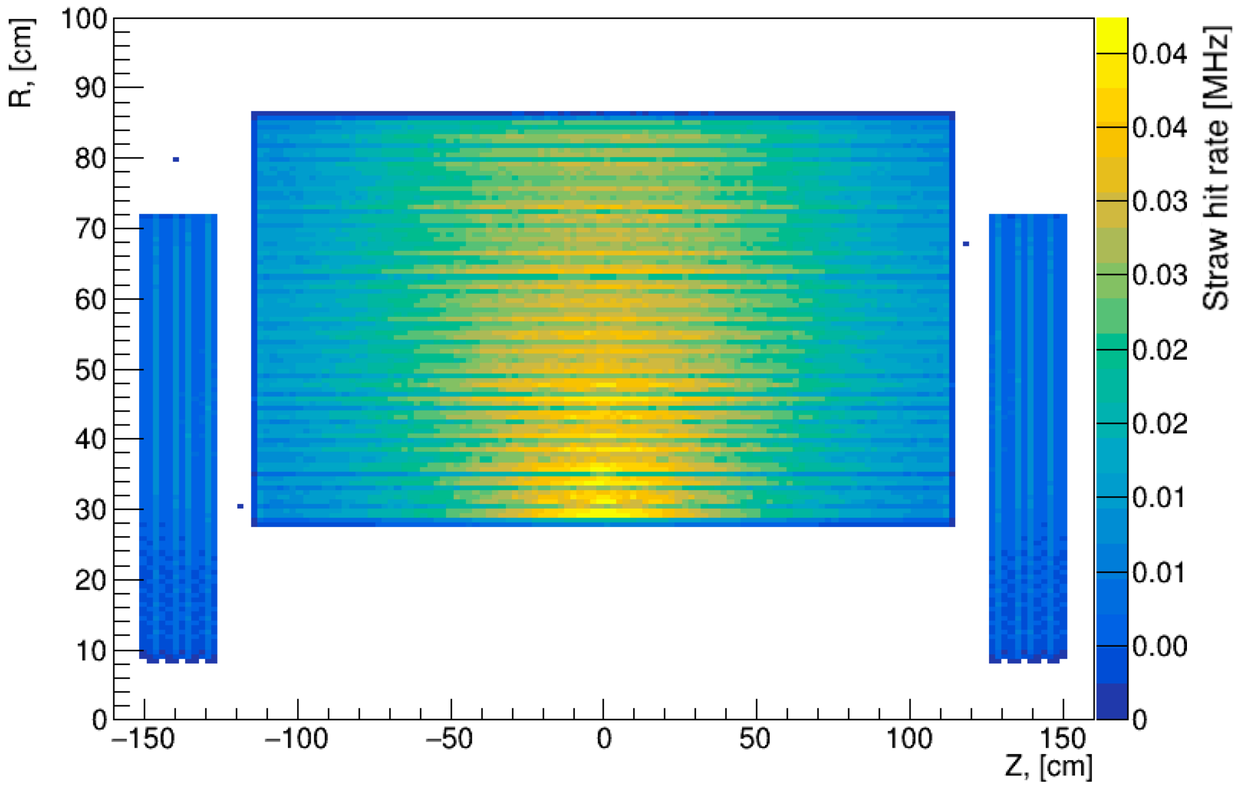
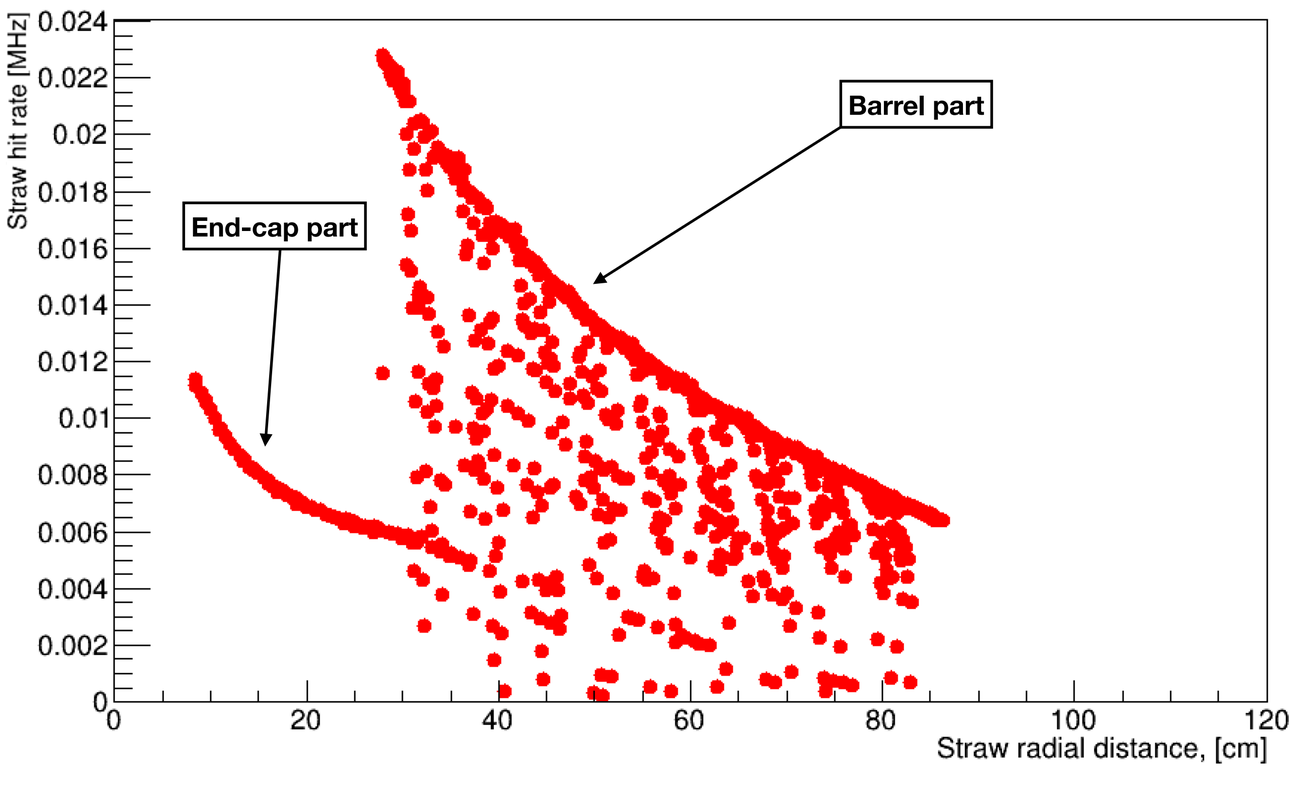


Fig. 2 - Average number of hits per straw in the TS in p-p collisions



Simulation parameters:

- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 100 000 p-p collisions
- Minimum bias
- Interaction rate (for colored Z-axis) = 0.4 MHz

The relative fraction of active straws (straws with at least 1 hit): 1.8%

Interaction rates are obtained from SPD TDR: https://arxiv.org/pdf/2404.08317

Compared relative fraction of active straws in the TS

Fig. 3 shows the relative fraction of active straws in the TS, compared between p-p, O-O, Kr-Kr and Xe-Xe collisions

Simulation parameters:

- Event Generator: URQMD
- $\sqrt{s} = 10\ GeV$
- 100 000 p-p and 10 000 ion-ion collisions
- Minimum bias

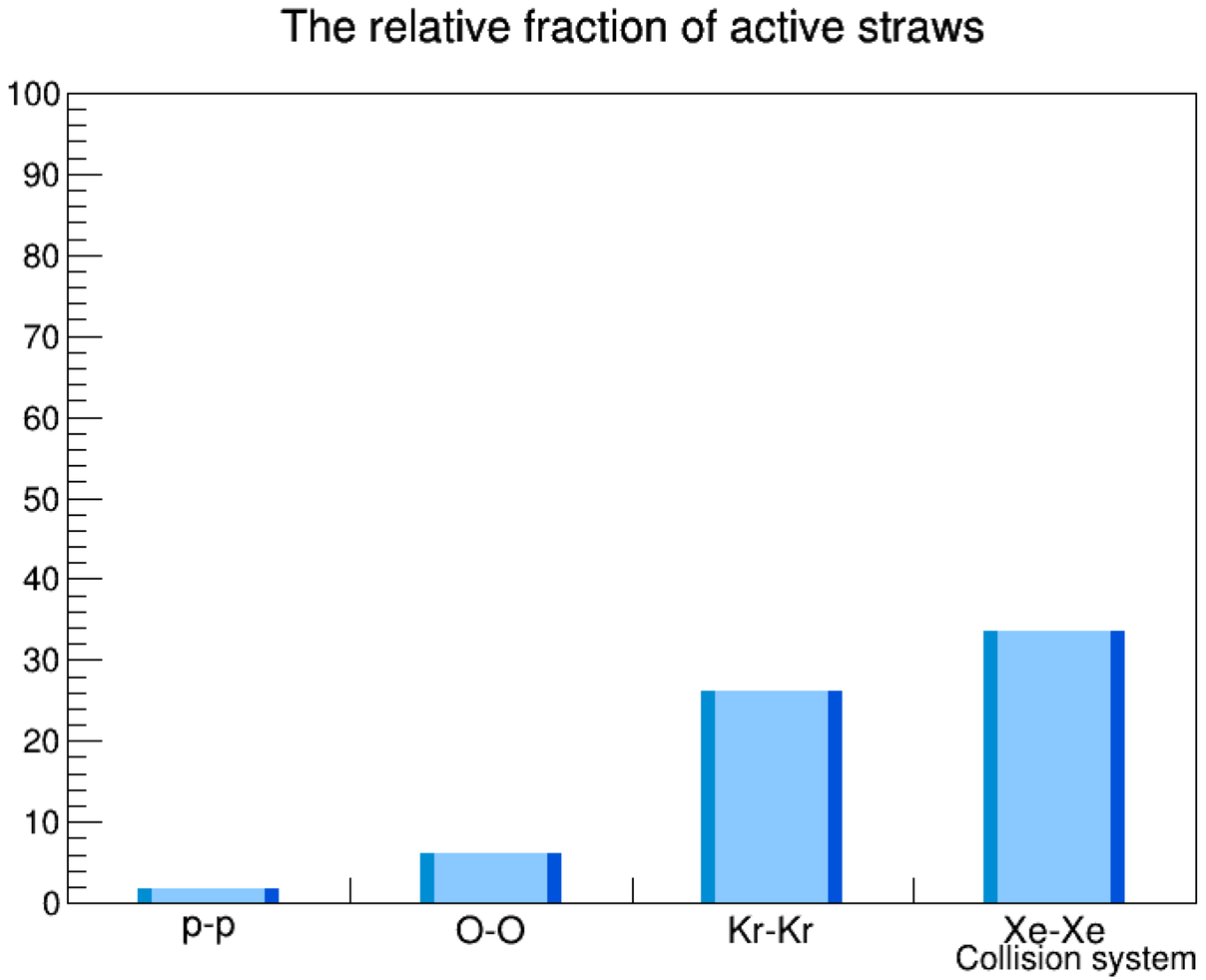


Fig. 3 - Compared relative fraction of active straws in the TS

Comparison of momentum resolution in the Straw Tracker in p-p and ion-ion collisions

By comparing the momentum resolution distributions between proton-proton and various ion-ion collision systems, a combined distribution was obtained.

<u>Simulation parameters:</u>

- Event Generator: URQMD
- $\sqrt{s} = 10\ GeV$
- 10 000 p-p and 1000 ion-ion collisions
- Minimum bias

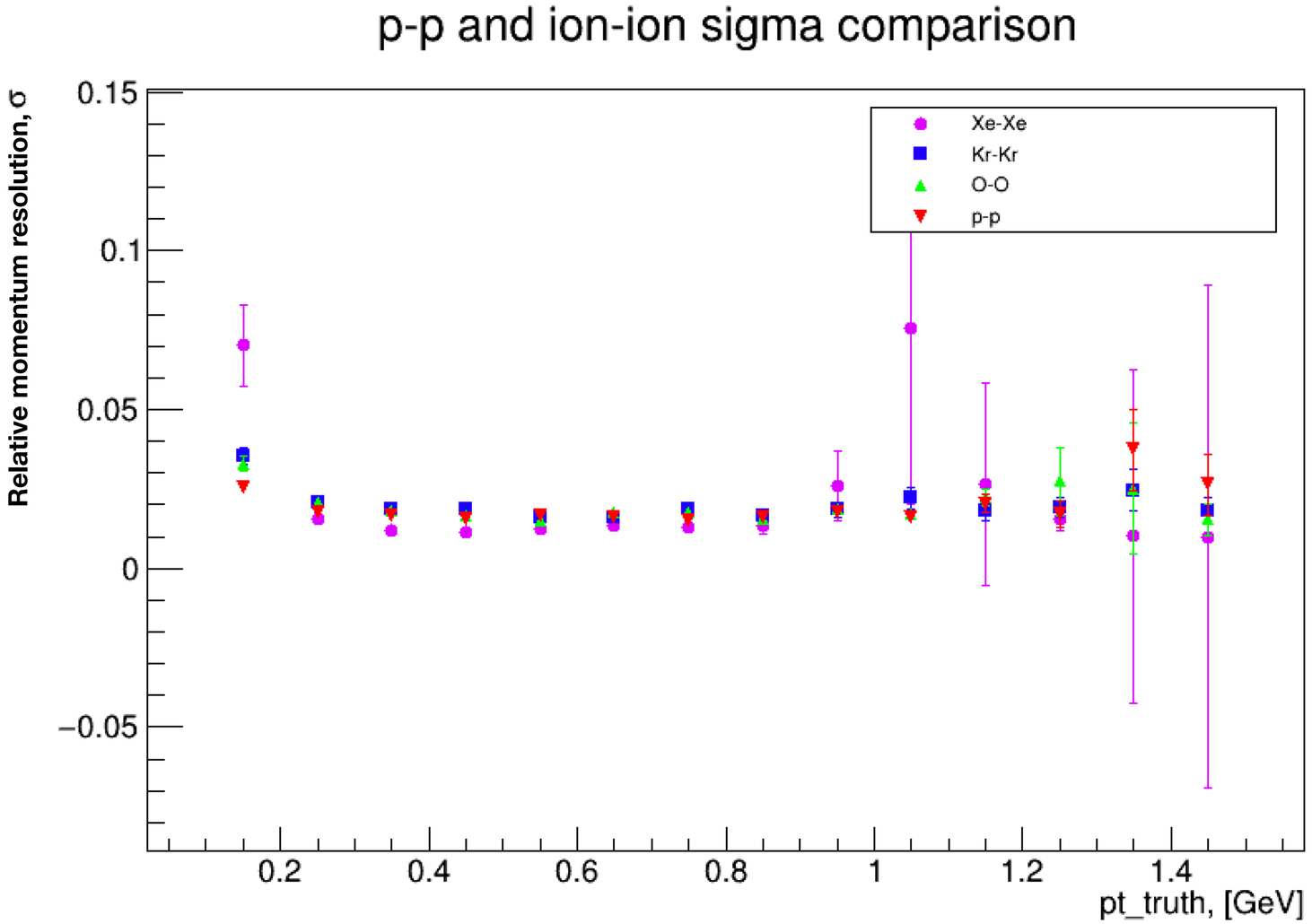


Fig. 4 - Comparison of momentum resolution in the Straw Tracker in p-p and ion-ion collisions

Straw Tracker (TS) & purpose of the study

- **Purpose:**
  To reconstruct charged particle tracks, measure their momenta based on trajectory curvature in a magnetic field, and perform particle identification via energy loss (dE/dx)

- **Design:**
  The detector consists of a barrel section (for tracking) and two end-caps (primarily for tracking and for identification)

1. **Barrel:** Comprises 8 modules, each containing approximately 3,300 straw tubes (both straight and inclined), totaling around 26,000 tubes
2. **End-caps:** Each contains 8 coordinate planes (disks) utilizing straw tubes with various orientations and lengths

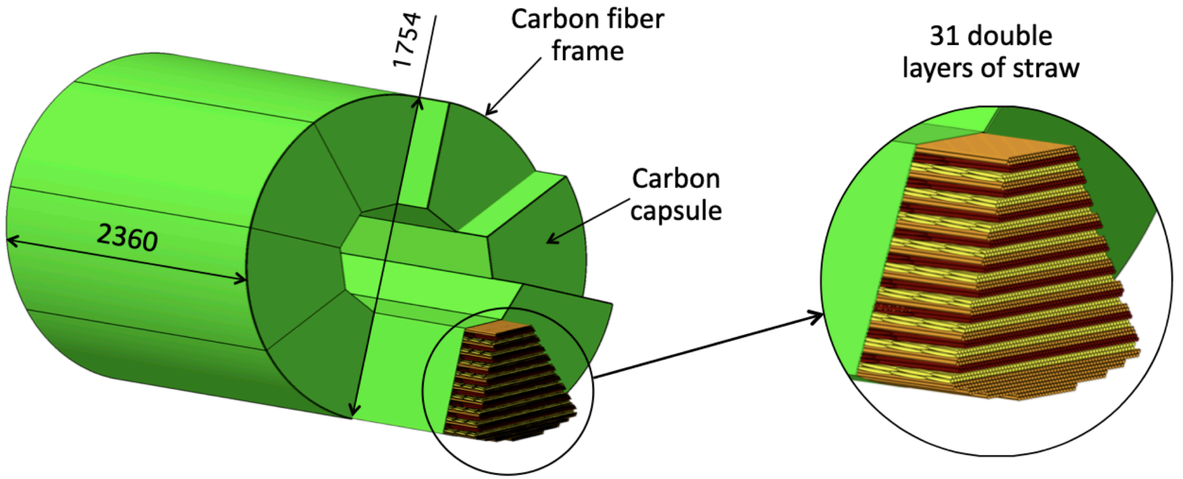


Fig. 5 - Straw Tracker (barrel)

Purpose of the study:

- Compare two different tracking algorithms:

1. Default SPDRoot realisation
2. New tracking algorithms by Vladimir Andreev

- Test new tracking algorithms by Vladimir Andreev in an ongoing study
- Make a decision on what tracking algorithms to use in what studies

Pt truth (old reconstruction scripts, WITH ITS)

Simulation parameters:

- Old reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

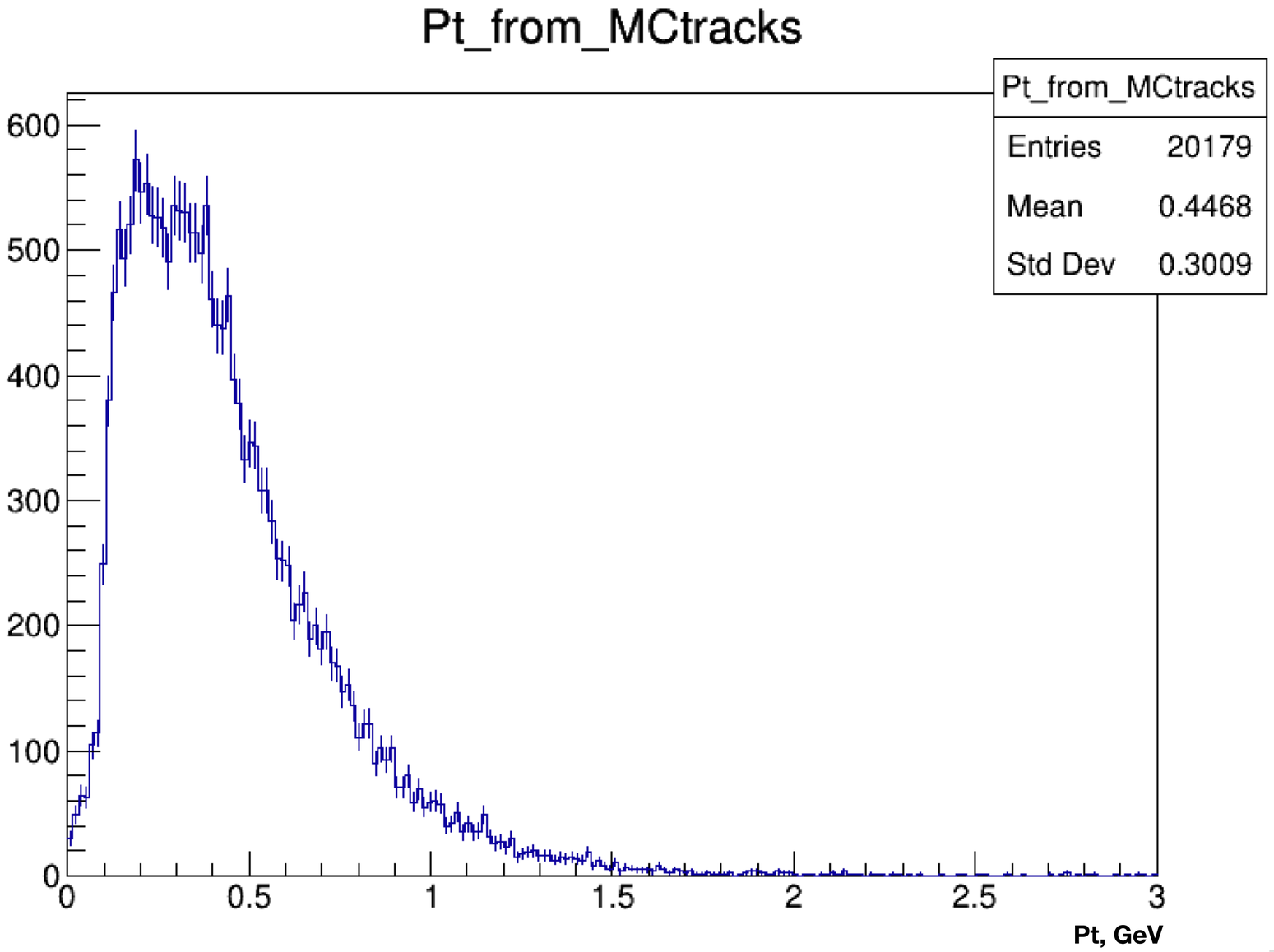


Fig. 6 - Pt truth

Pt MC (old reconstruction scripts, WITH ITS)

Simulation parameters:

- Old reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

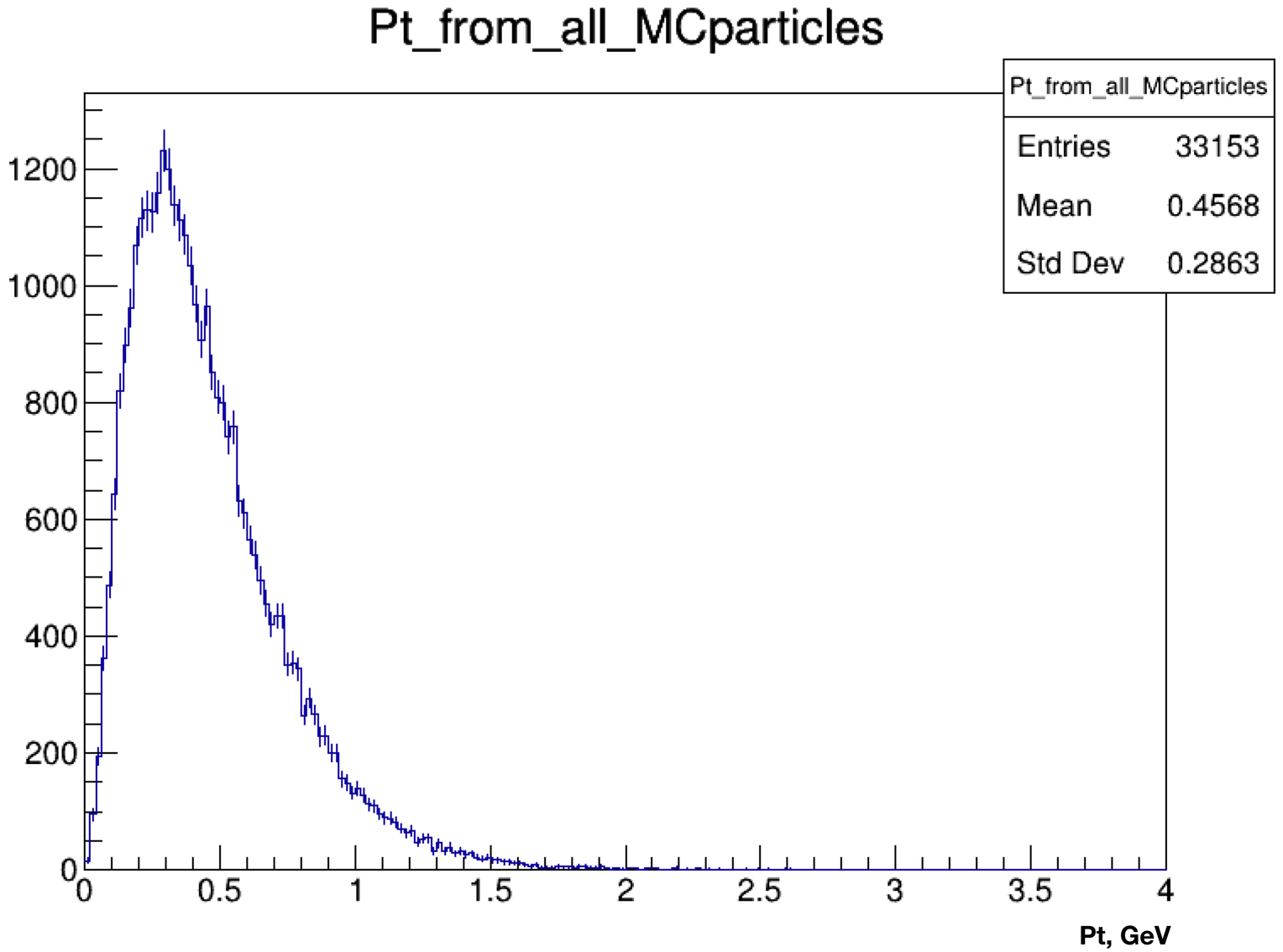


Fig. 7 - Pt MC

Pt truth / Pt mc (old reconstruction scripts, WITH ITS)

Simulation parameters:

- Old reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

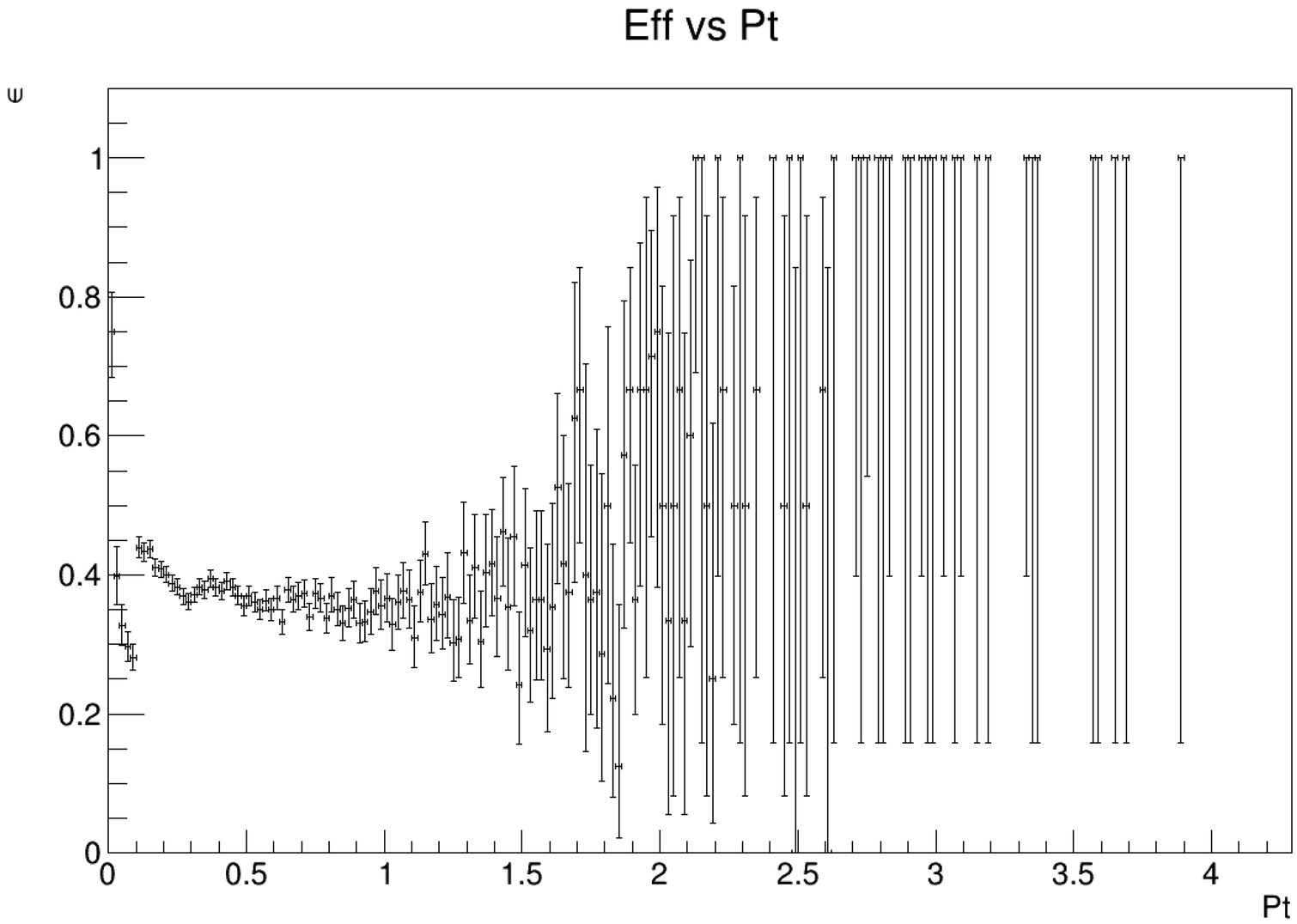


Fig. 8 - Pt truth / Pt mc (efficiency)

Pt truth (new reconstruction scripts, WITH ITS)

Simulation parameters:

- New reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

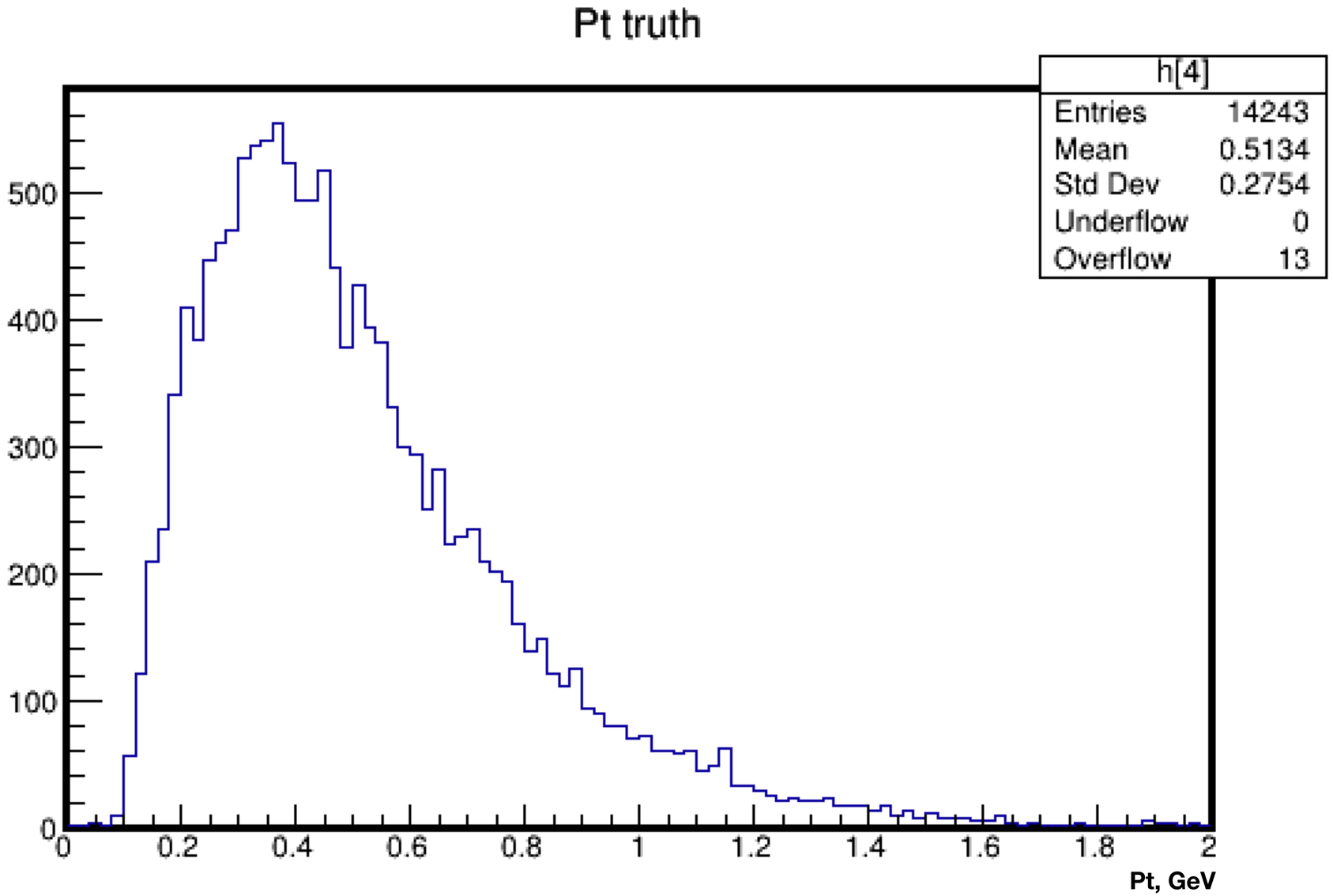


Fig. 9 - Pt truth

Pt MC (new reconstruction scripts, WITH ITS)

Simulation parameters:

- New reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

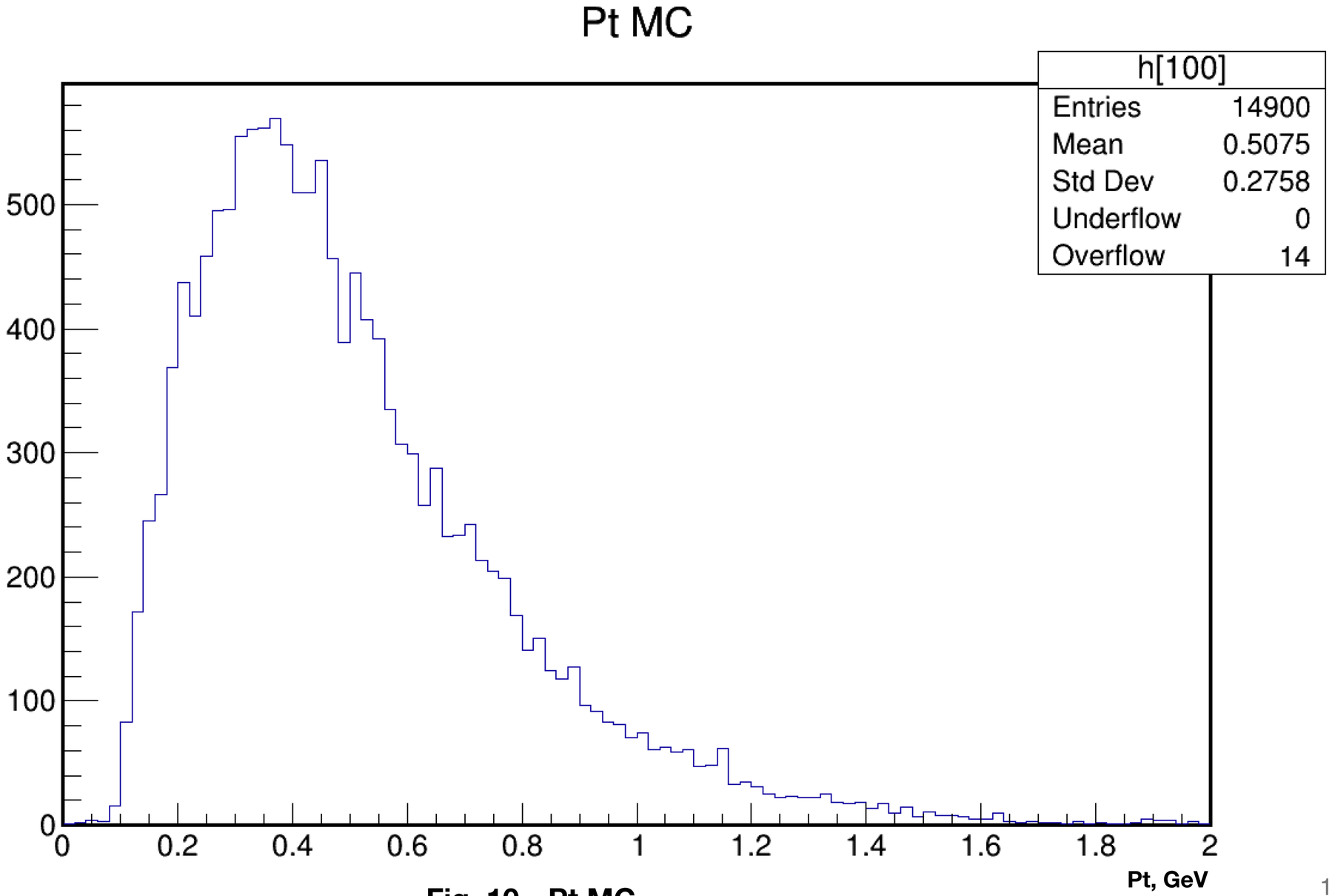


Fig. 10 - Pt MC

Pt truth/mc efficiency (new reconstruction scripts, WITH ITS)

Simulation parameters:

- New reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

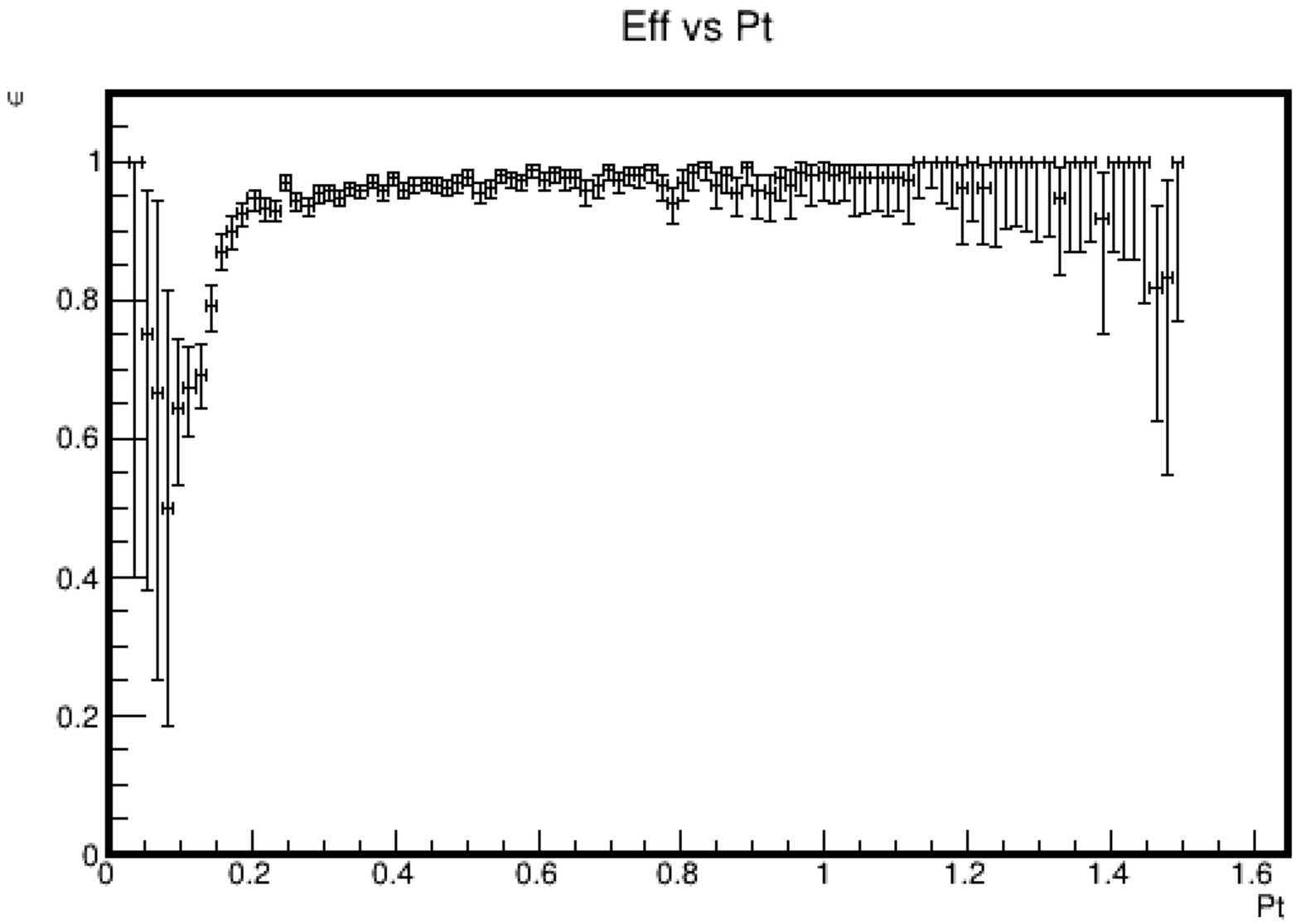


Fig. 11 - Pt truth/mc (efficiency)

Pt truth (new reconstruction scripts, NO ITS)

Simulation parameters:

- New reconstruction scripts
- No vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 1 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

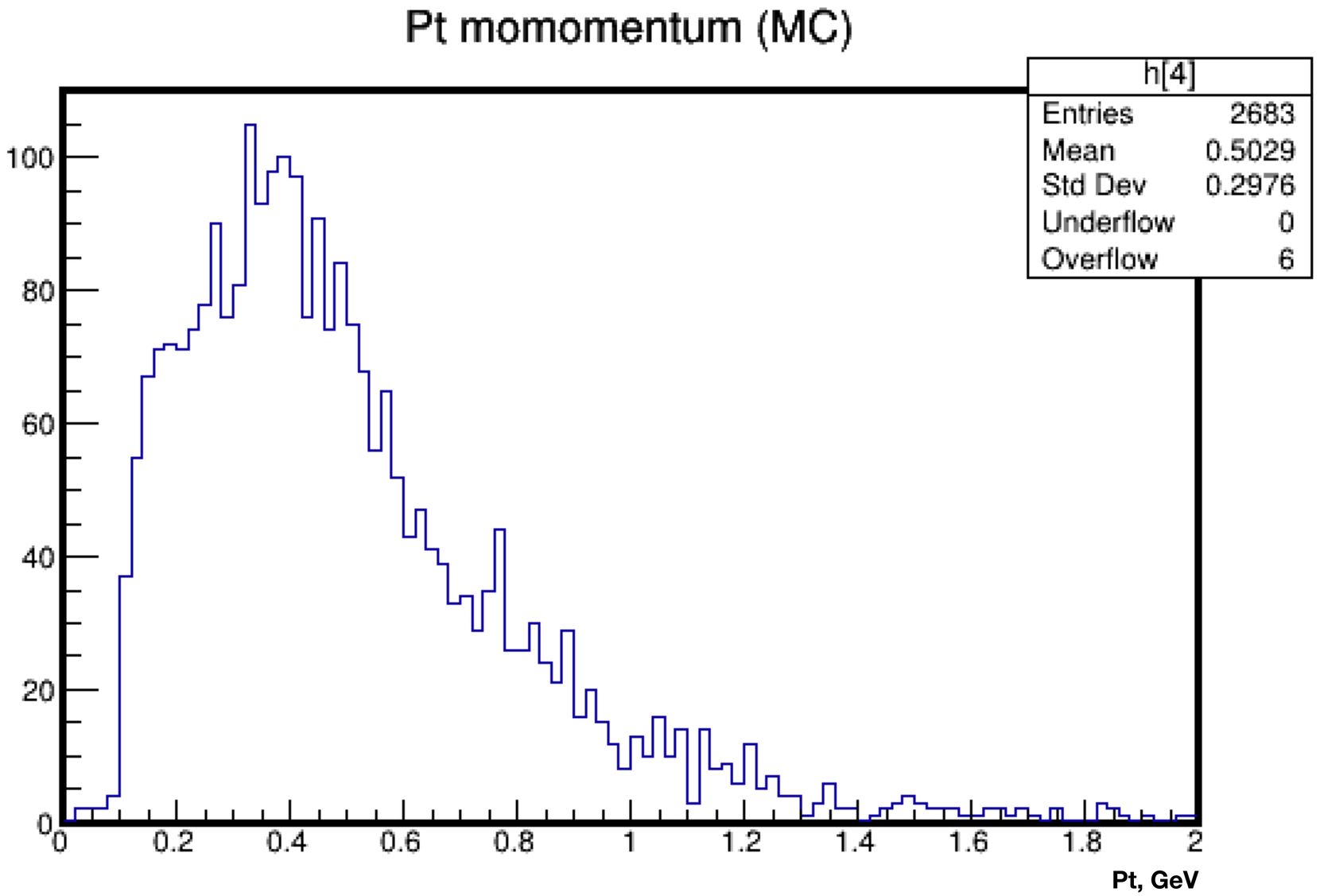


Fig. 12 - Pt truth

Pt MC (new reconstruction scripts, NO ITS)

Simulation parameters:

- New reconstruction scripts
- No vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 1 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

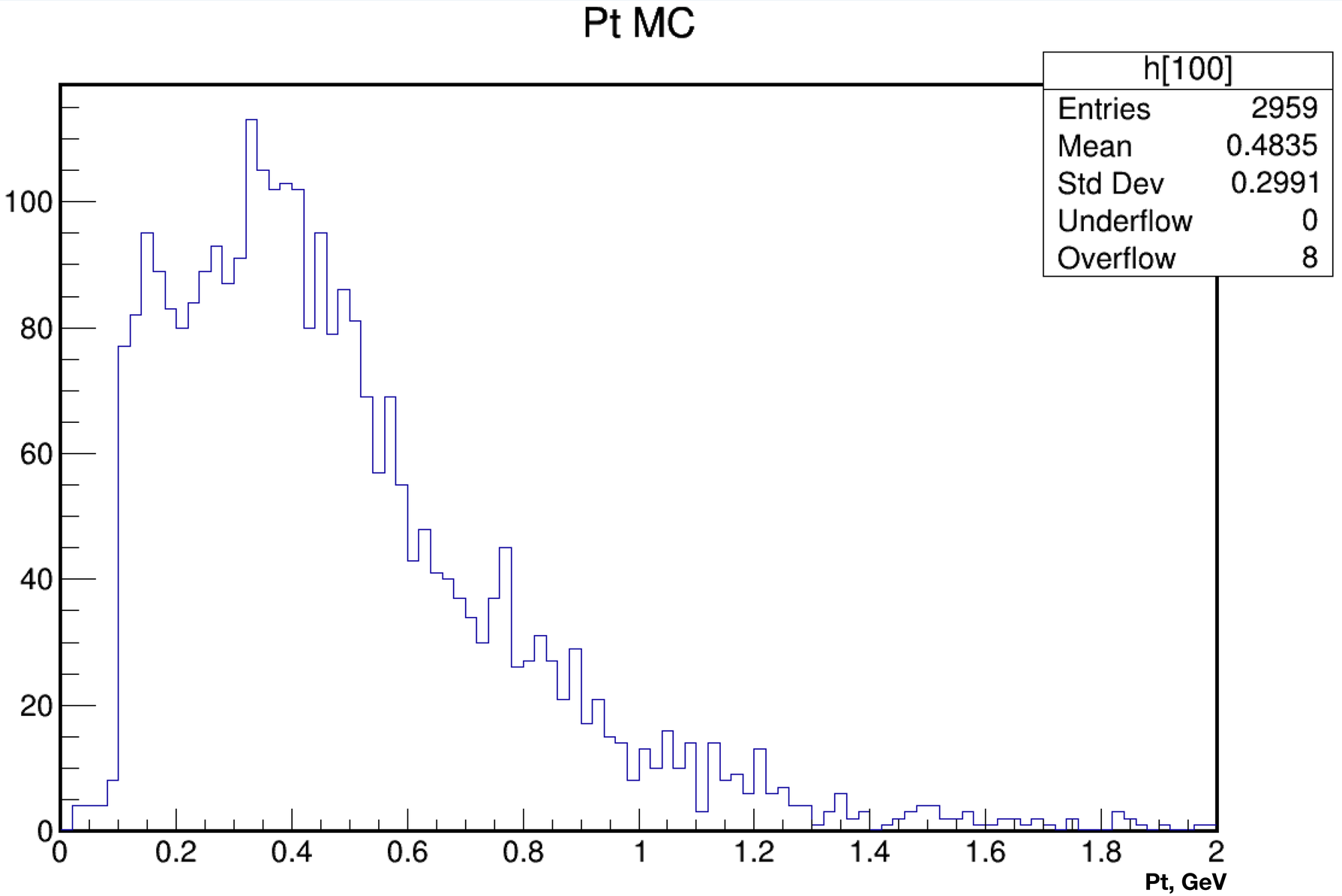


Fig. 13 - Pt MC

Pt truth/mc eff (new reconstruction scripts, NO ITS)

Simulation parameters:

- New reconstruction scripts
- No vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 1 000 p-p collisions
- Minimum bias
- Only 1st generation
- $-2 < \eta < 2$ pseudorapidity region

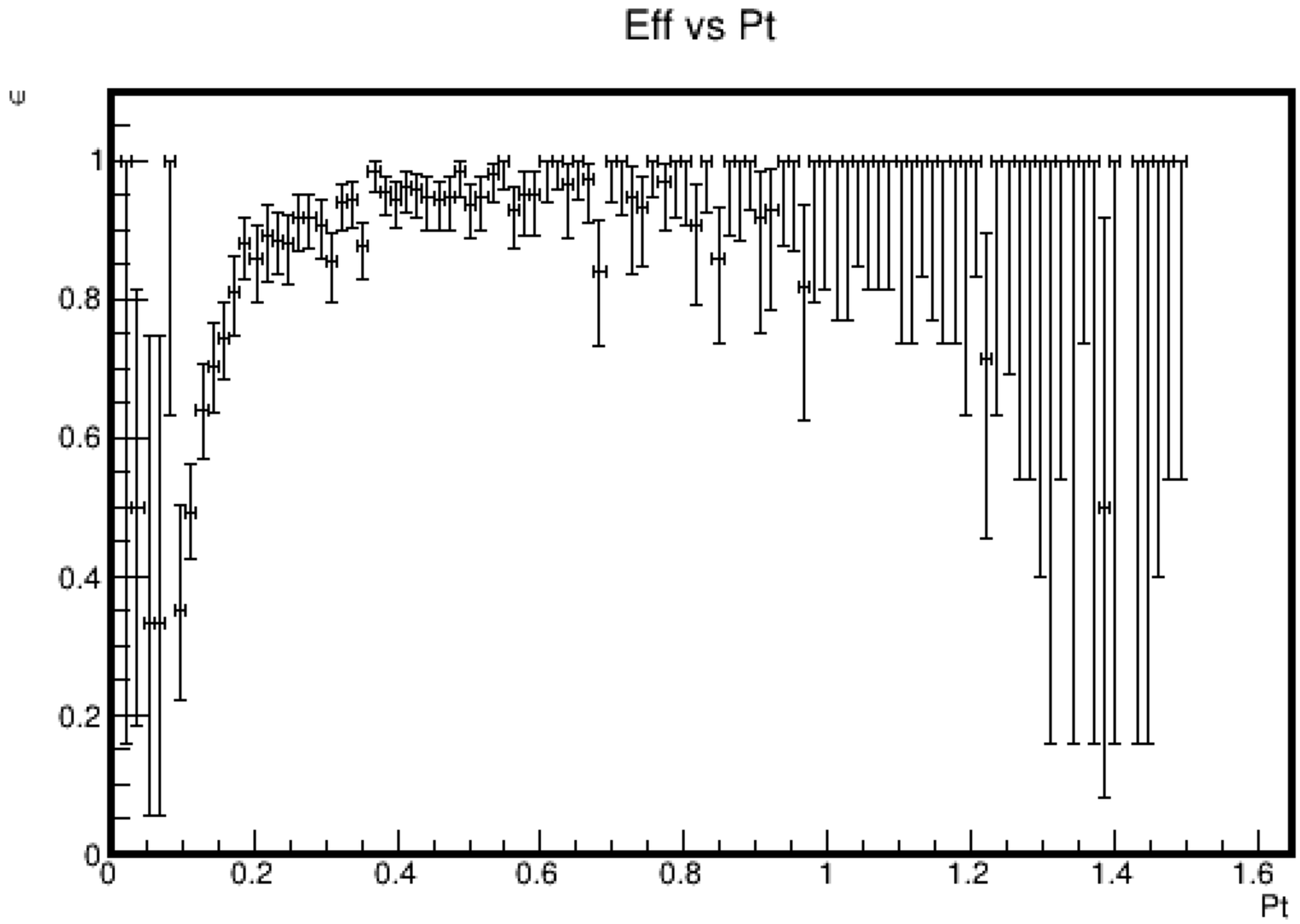


Fig. 14 - Pt truth/mc (efficiency)

TODO

1) More thorough study of the same *Efficiency* method for old tracking & compare with the new tracking

2) Repeat comparisons for ion-ion collisions

Thank you for your attention!

BACK-UP SLIDES

Pt truth / Pt mc (*incorrect*, old script, NO ITS)

Simulation parameters:

- Old reconstruction scripts
- No vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 1 000 p-p collisions
- Minimum bias
- All generations
- Whole pseudorapidity region

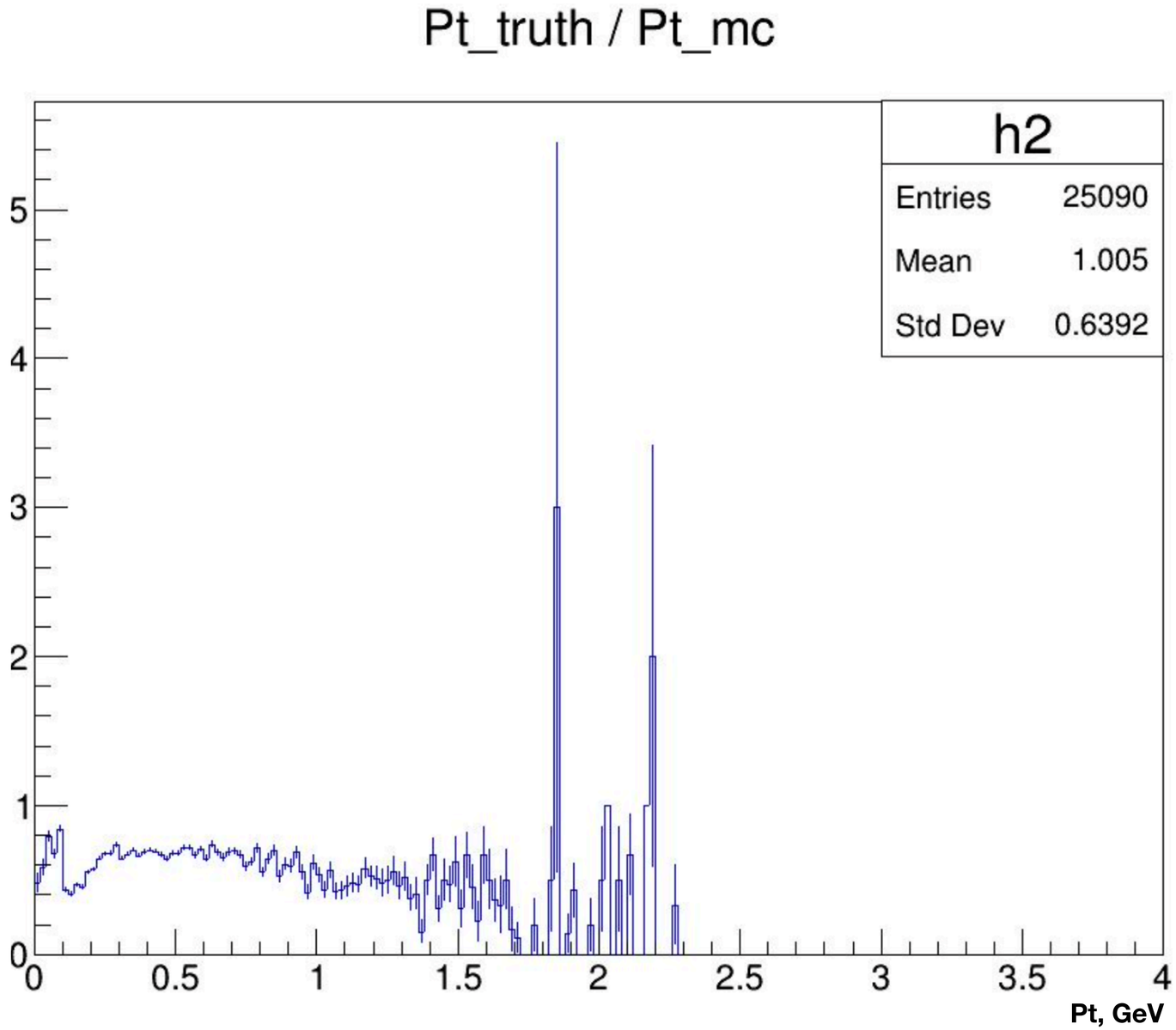


Fig. 15 - Pt truth / Pt mc (efficiency)

Pt reco (new reconstruction scripts, WITH ITS)

Simulation parameters:

- New reconstruction scripts
- With vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 5 000 p-p collisions
- Minimum bias
- All generations
- Whole pseudorapidity region

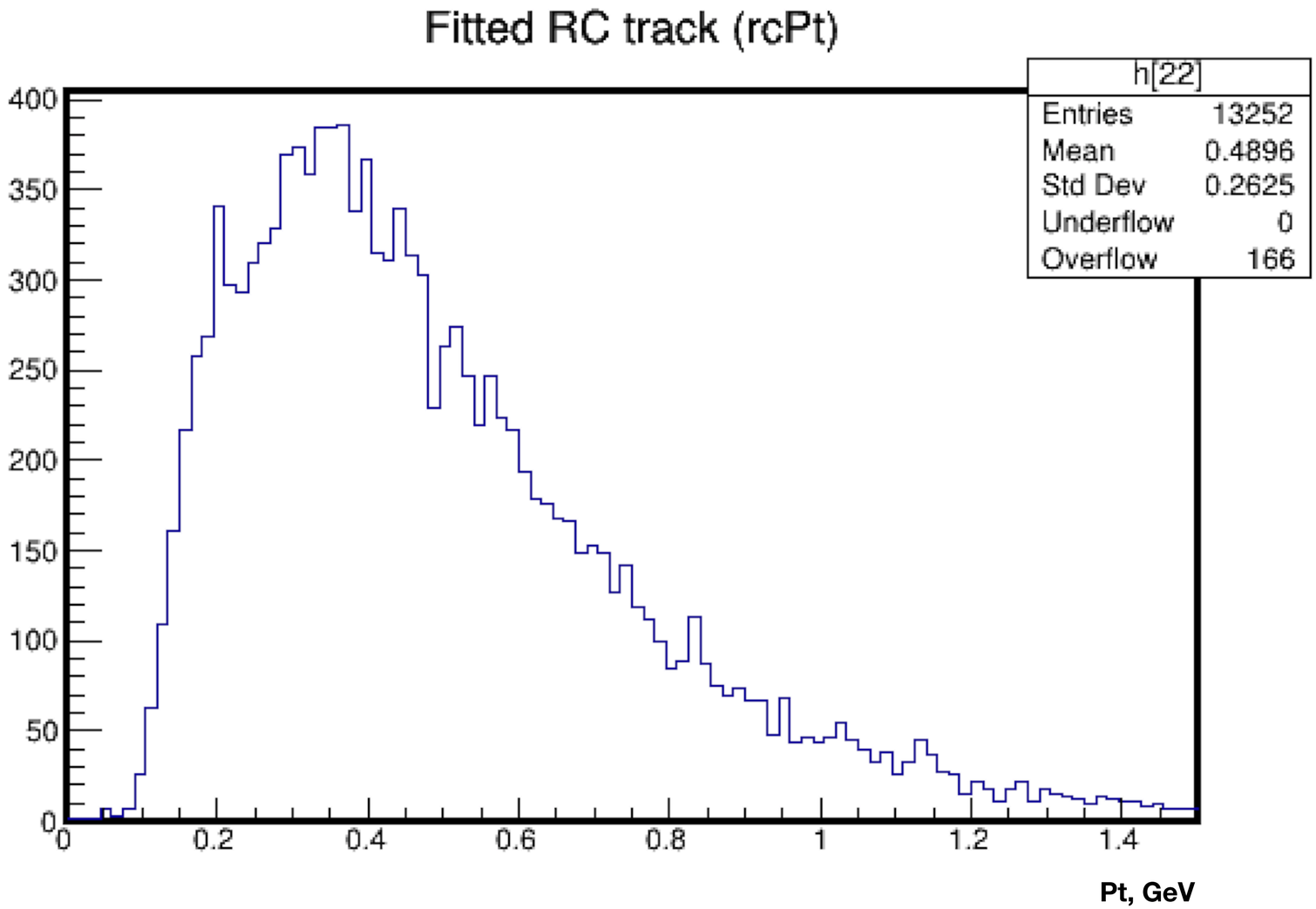


Fig. 16 - Pt reco

Pt reco (new reconstruction scripts, NO ITS)

Simulation parameters:

- New reconstruction scripts
- No vertex detector
- Event Generator: Pythia8
- $\sqrt{s} = 10\ GeV$
- 1 000 p-p collisions
- Minimum bias
- All generations
- Whole pseudorapidity region

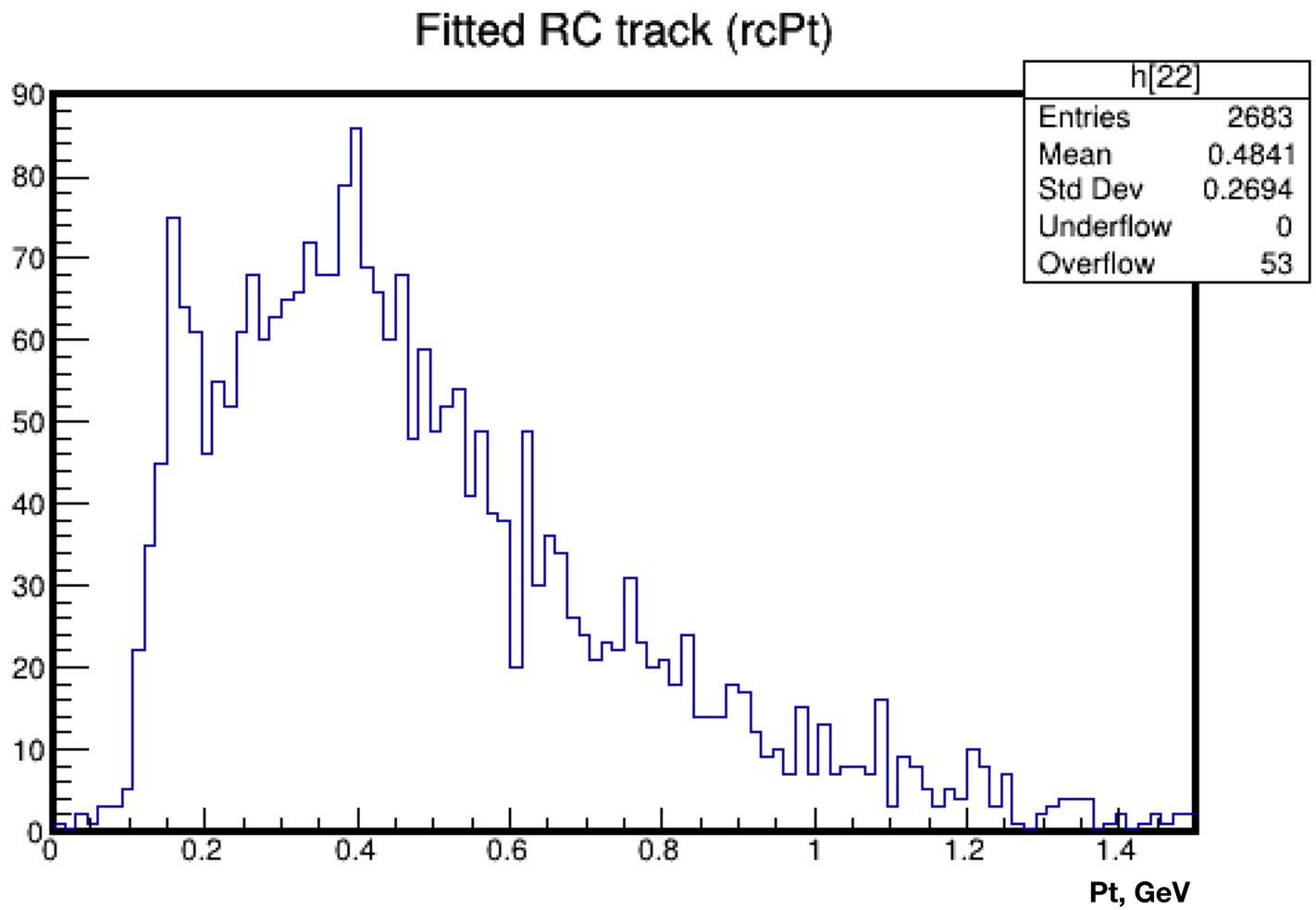


Fig. 17 - Pt reco

SPD Experiment

- **Spin Physics Detector (SPD)** is an experiment at the NICA facility designed to study the spin structure of the proton and deuteron using polarized beams, as well as other spin-related phenomena. It is being developed as a universal 4π detector equipped with tracking, particle identification systems, and high luminosity (up to $10^{32} cm^{-2} s^{-1}$)
- Expected energies for **Phase 1 is** $\sqrt{s} = 10\ GeV$ and for **Phase 2 is** $\sqrt{s} = 27\ GeV$
- **Straw Tracker (ST)** is a subsystem responsible for charged track reconstruction and their momentum determination. It plays a critical role in ion-ion collisions with high particle multiplicity, where signal overlap is likely. It is susceptible to occupancy issues, as the front-end electronics require time to process events, which may reduce accuracy under high load conditions. The Straw Tracker is planned to be used throughout all stages of the SPD experiment

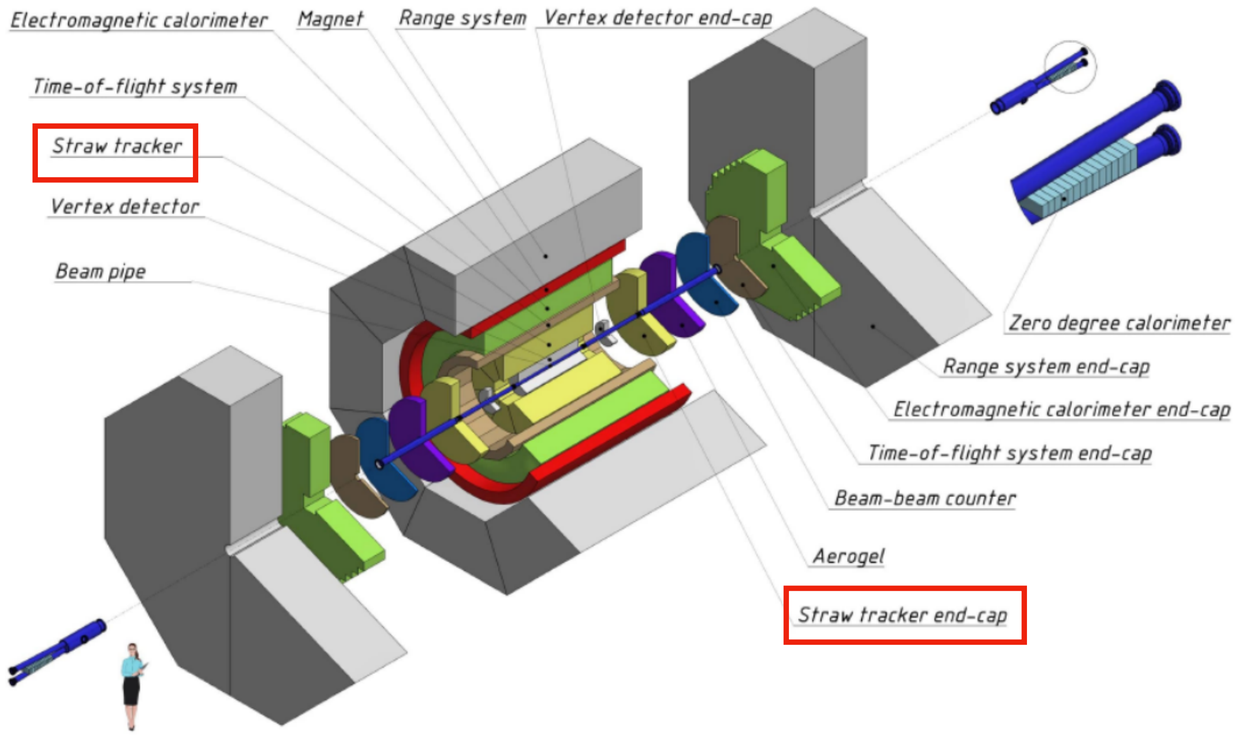


Fig. 18 - SPD Experiment