

# **Computer simulations of the MPD-FXT experiment with thin Au wire target installed inside the beam pipe**

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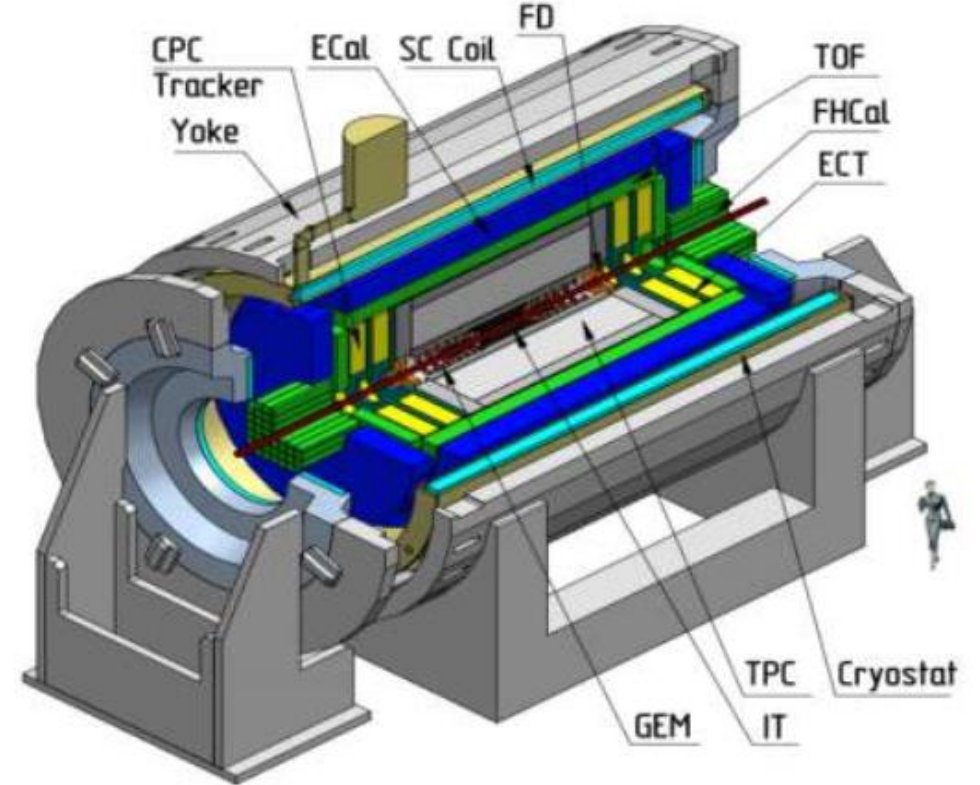
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- introduction
- goals and objectives of simulations
- experiment characteristics
- simulation:
  - source code updates
  - results
- conclusions

## MPD experiment:

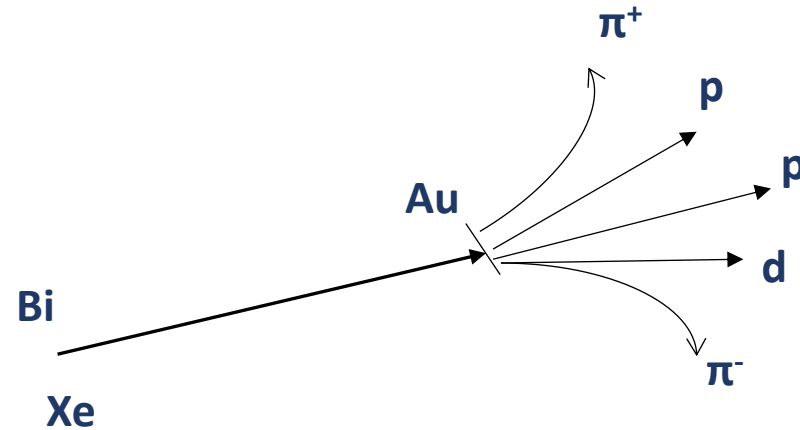
- the main tracking detector in the central rapidity region is TPC,
- for reliable identification of short-lived hadrons ( $\Lambda$ , D) and to extend the particles' momentum range towards small values TPC will be supplemented with vertex tracker ITS,
- the NICA collider is expected to begin operation at the **end of 2025**.  
At the first stage it is planned to run MPD in FXT mode with thin gold wire target installed inside the beam pipe with TPC only as the tracking system.



**IT** – inner tracker  
**TPC** – time-projection chamber  
**TOF** - time-of-flight detector  
**ECal** - electromagnetic calorimeter  
**SC Coll** – superconducting solenoid

## Goals:

- to simulate MPD “1<sup>st</sup> day” experiment (fixed target mode with thin wire target installed inside the beam pipe, TPC only is involved into the tracking system);
- to reconstruct primary vertices and based on interaction points of projectile-target plot the wire-target image;
- to analyze modelling results for two types of beam pipes (Be, Ti) for reactions: Bi + Au, Xe + Au;
- as a result to provide recommendations for NICA beam control systems.



- target parameters:

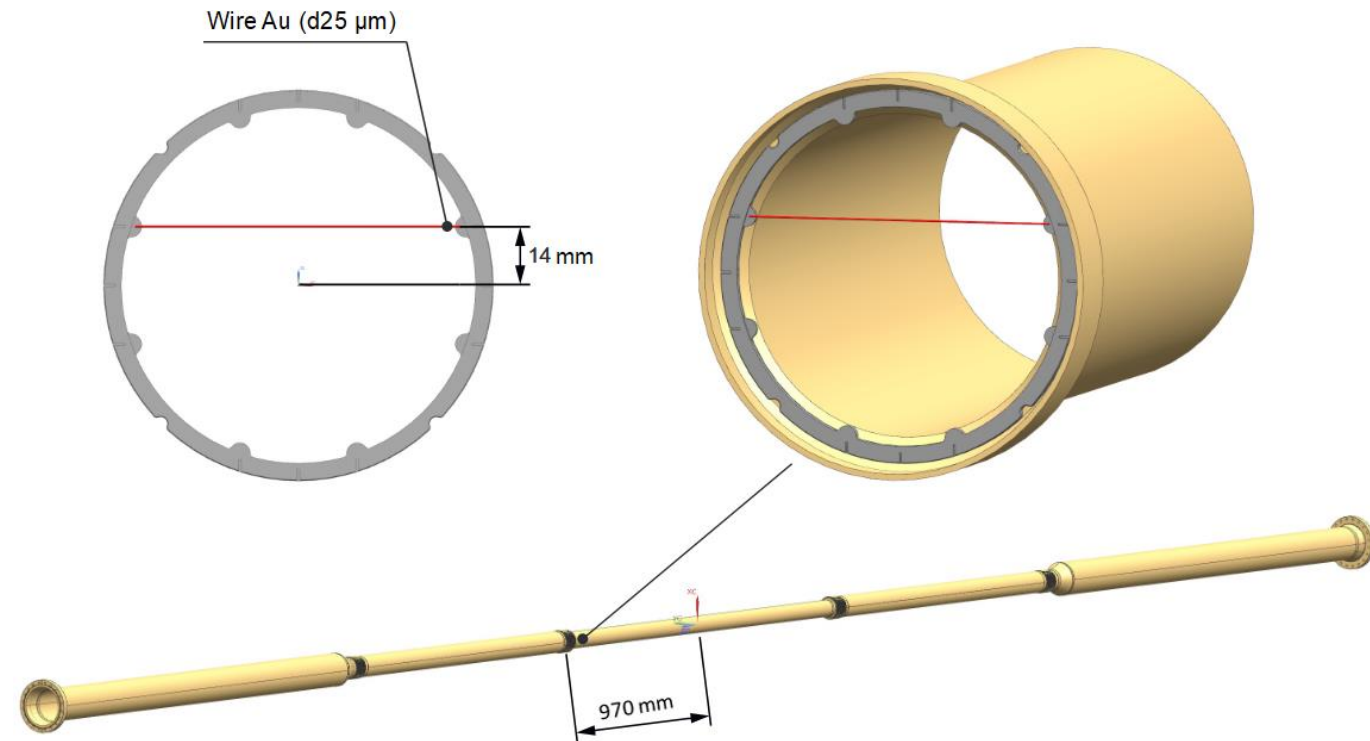
Material	Diameter, mm	Length, mm
Au(99.90 %)	0.025	10

- target parameters:

X, mm	Y, mm	Z, mm
0	14	906

- beam pipe parameters:

Beam pipe	Material	Outer diameter, mm	Width, mm
#1	Ti	83.0	1.5
#2	Be	58.0	1.0



- reactions / data:

- Bi + Au, 2.5 A GeV
- Xe + Au, 2.5 A GeV
- DCMSMM minbias 50K events for each reaction

## General stages of simulation:

1. MC transport of particles by event generator through TPC
2. generation of detectors' hits for primary and secondary particles passing through TPC
3. reconstruction of tracks of charged particles based on the generated hits
4. reconstruction of the primary vertex of nucleus-nucleus interactions
5. analysis of results obtained

## Source code updated for MPDROOT:

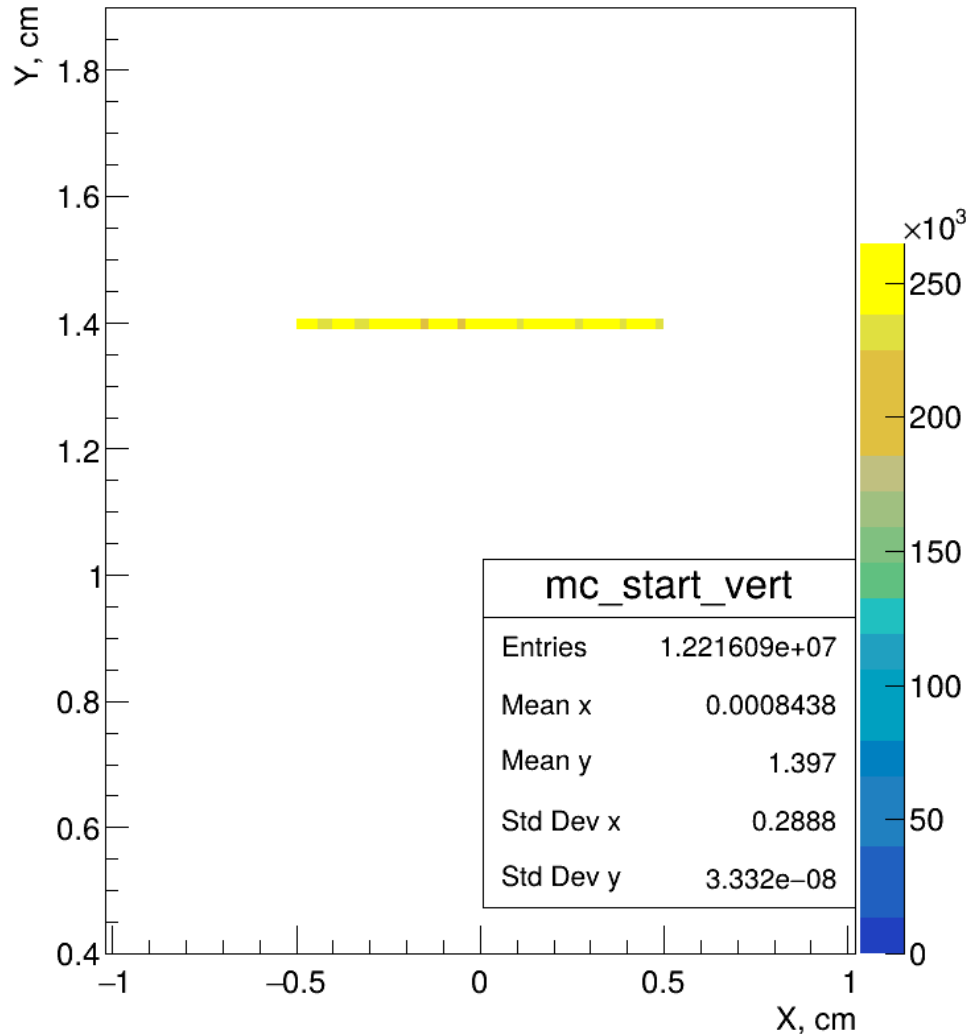
- updates by A. Zinchenko to take into account wire target position in primary vertex reconstruction by Kalman filter:
  - *MpdKfPrimaryVertexFinder.cxx*
- updates for the DCMSMM event generator class - interaction vertex for each event was randomly placed along the wire target:
  - *MpdDCMSMMGeneratorET.cxx*

- MC StartXY primary particles tracks distributions (left),
- RECO PrimaryVertexXY tracks distributions (right) for Bi + Au, Be beam pipe, no cuts

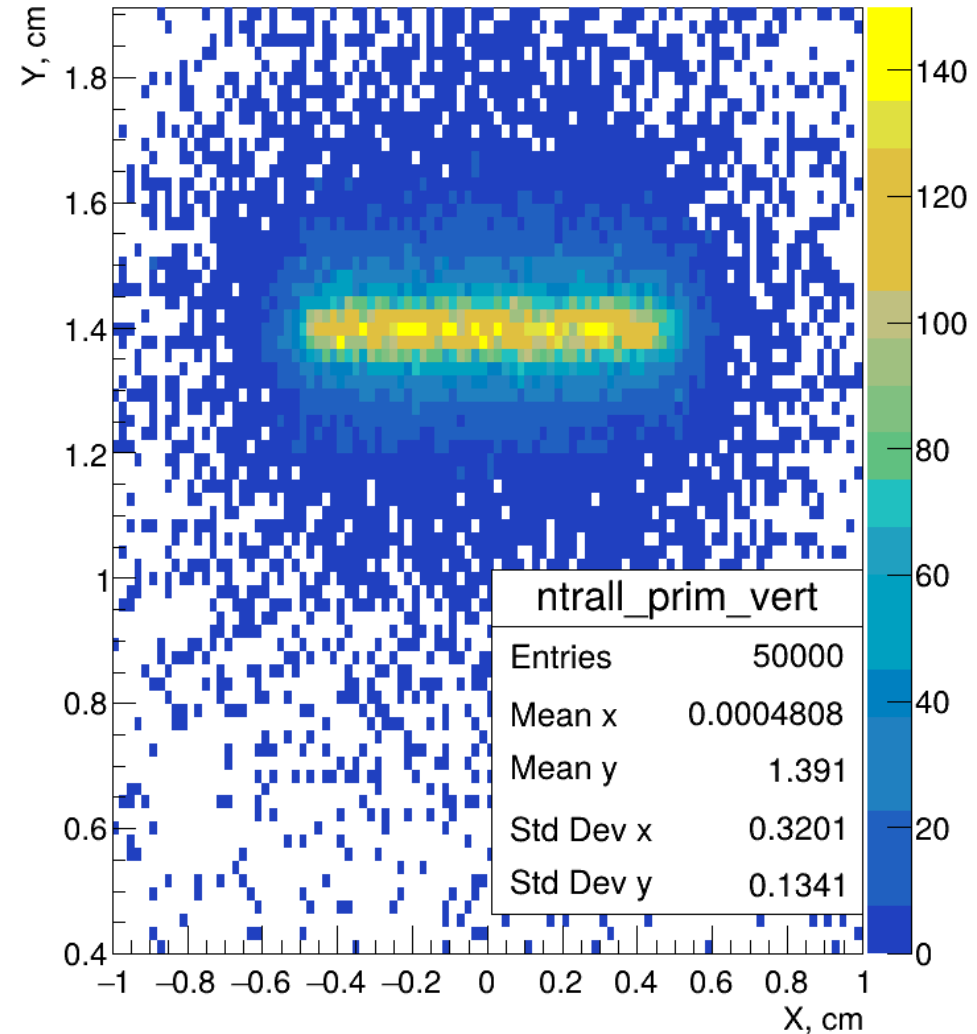


blurred image is caused by large XY Std Dev which appears due to low multiplicity events

MC primary vertex

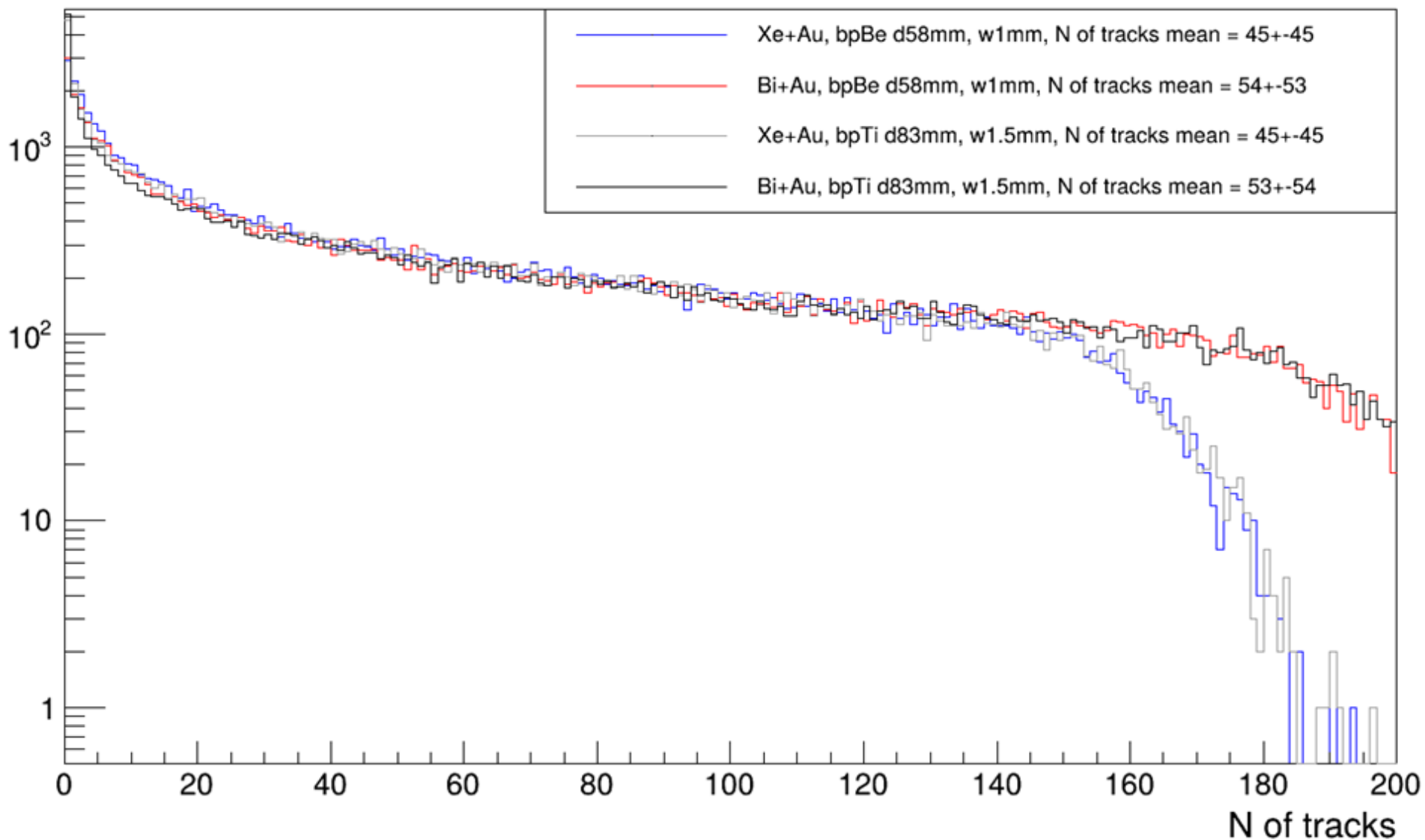


RECO Primary vertex



Number of tracks used to reconstruct primary vertices in reactions: Bi+Au и Xe+Au, 2.5 A GeV

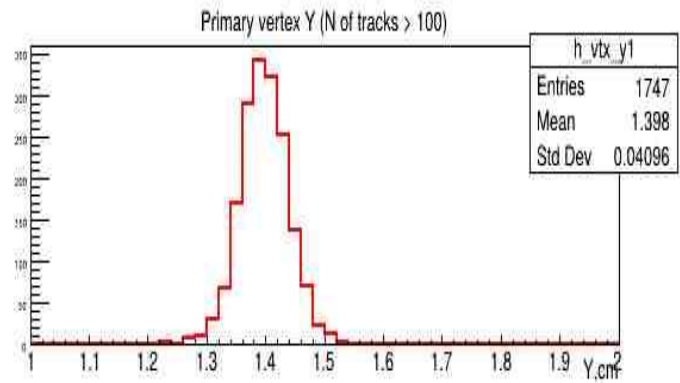
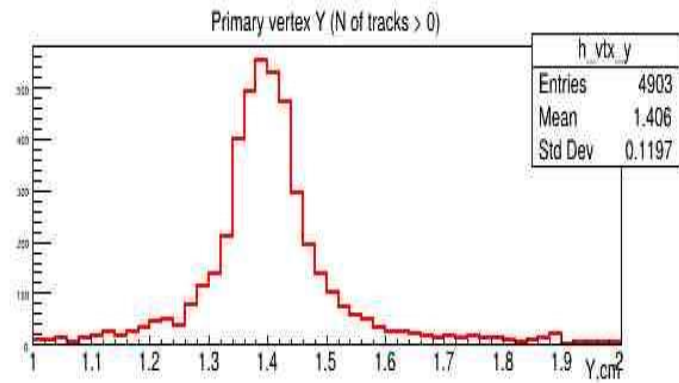
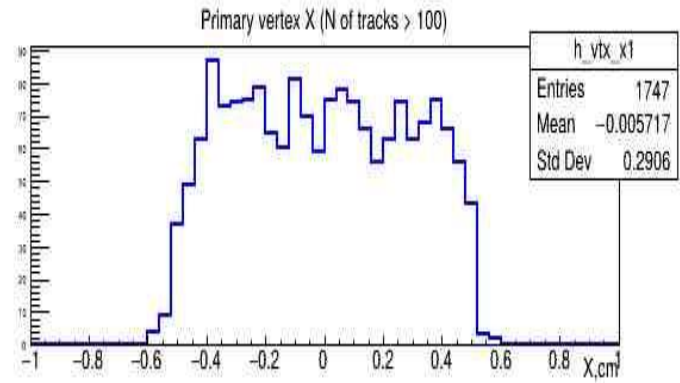
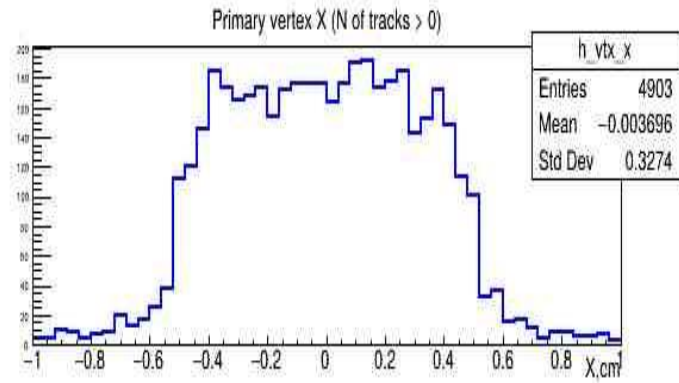
N of tracks to reconstruct vertex



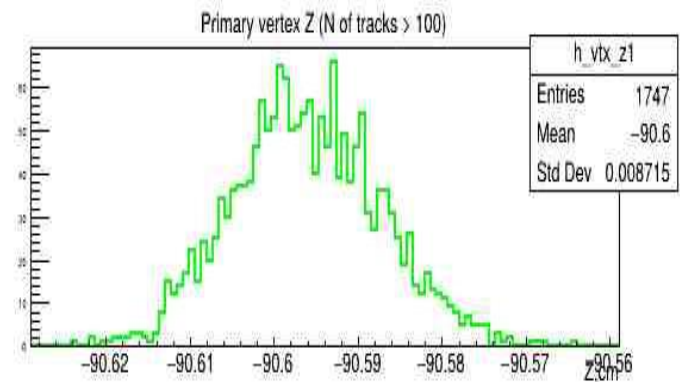
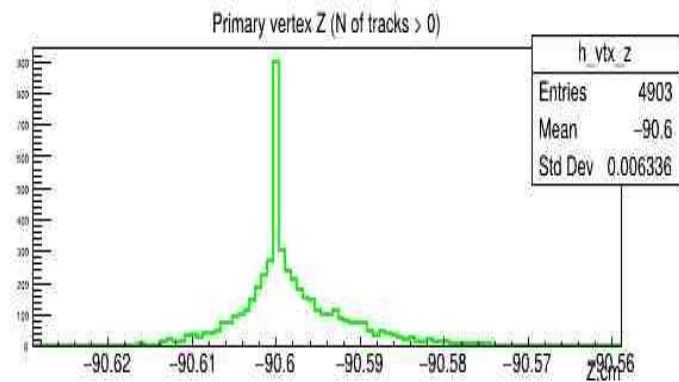


X, Y, Z coordinates' distributions of reconstructed primary vertices, 5K events, Bi + Au with

- N of tracks > 0 (left)
- N of tracks > 100 (right)

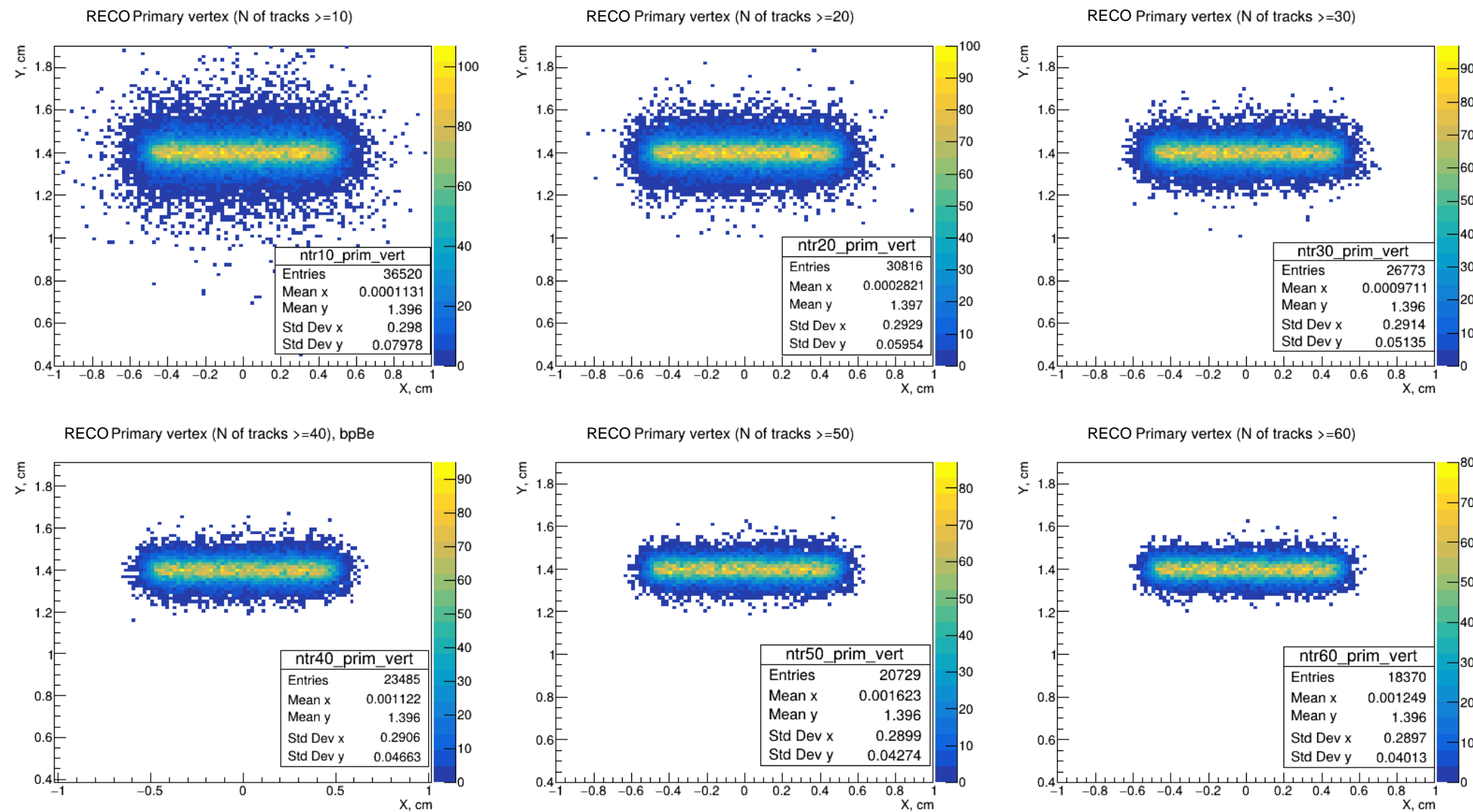


→  $\sigma_y(N > 100)$  is 3 times less



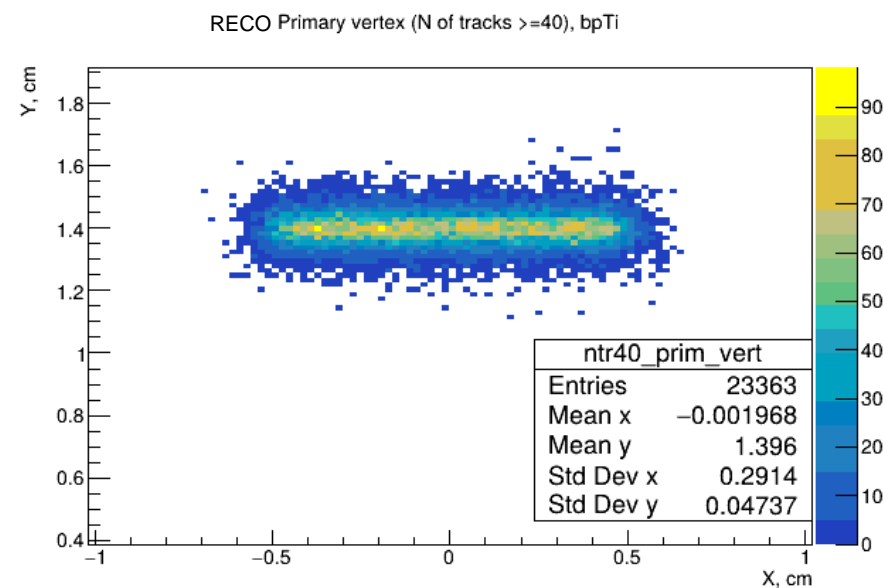
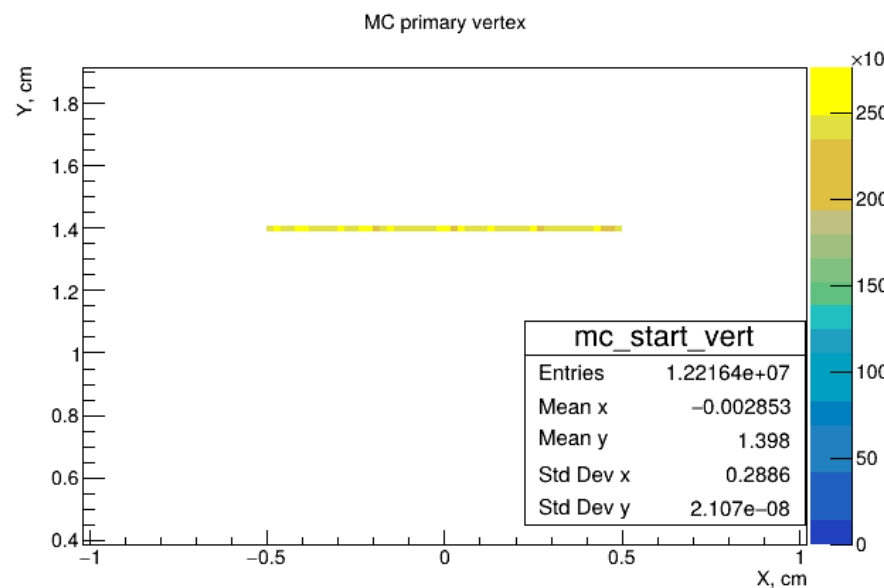
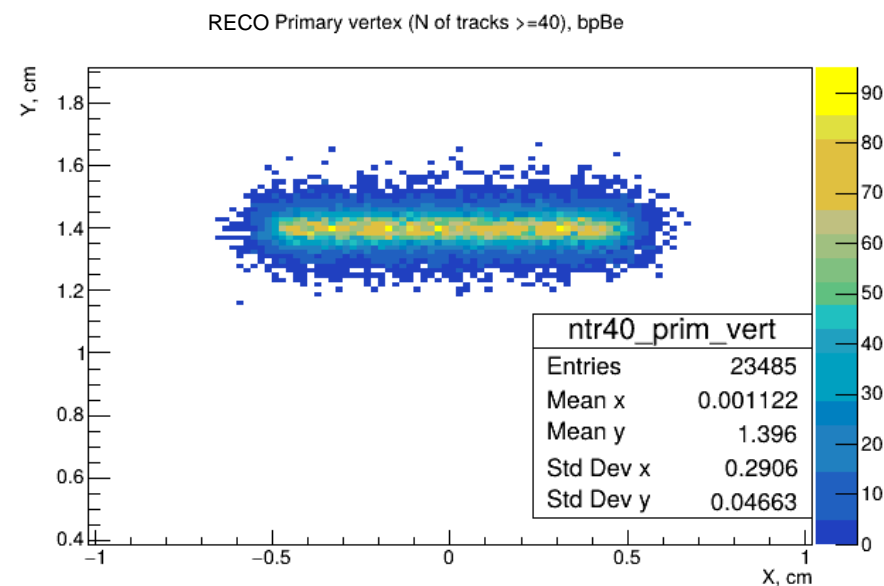
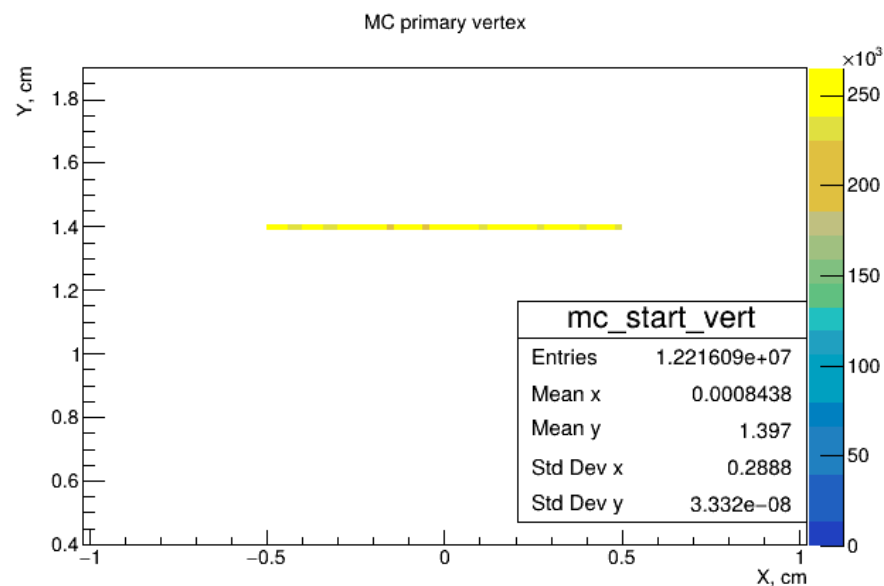
2-dimensional XY-distributions of reconstructed primary vertices in Bi+Au in events with

- N of tracks  $\geq 10, 20, 30$  (up row)
- N of tracks  $\geq 40, 50, 60$  (down row)



→ with  $N \geq 40$   
XY reconstruction  
quality is  
noticeably better

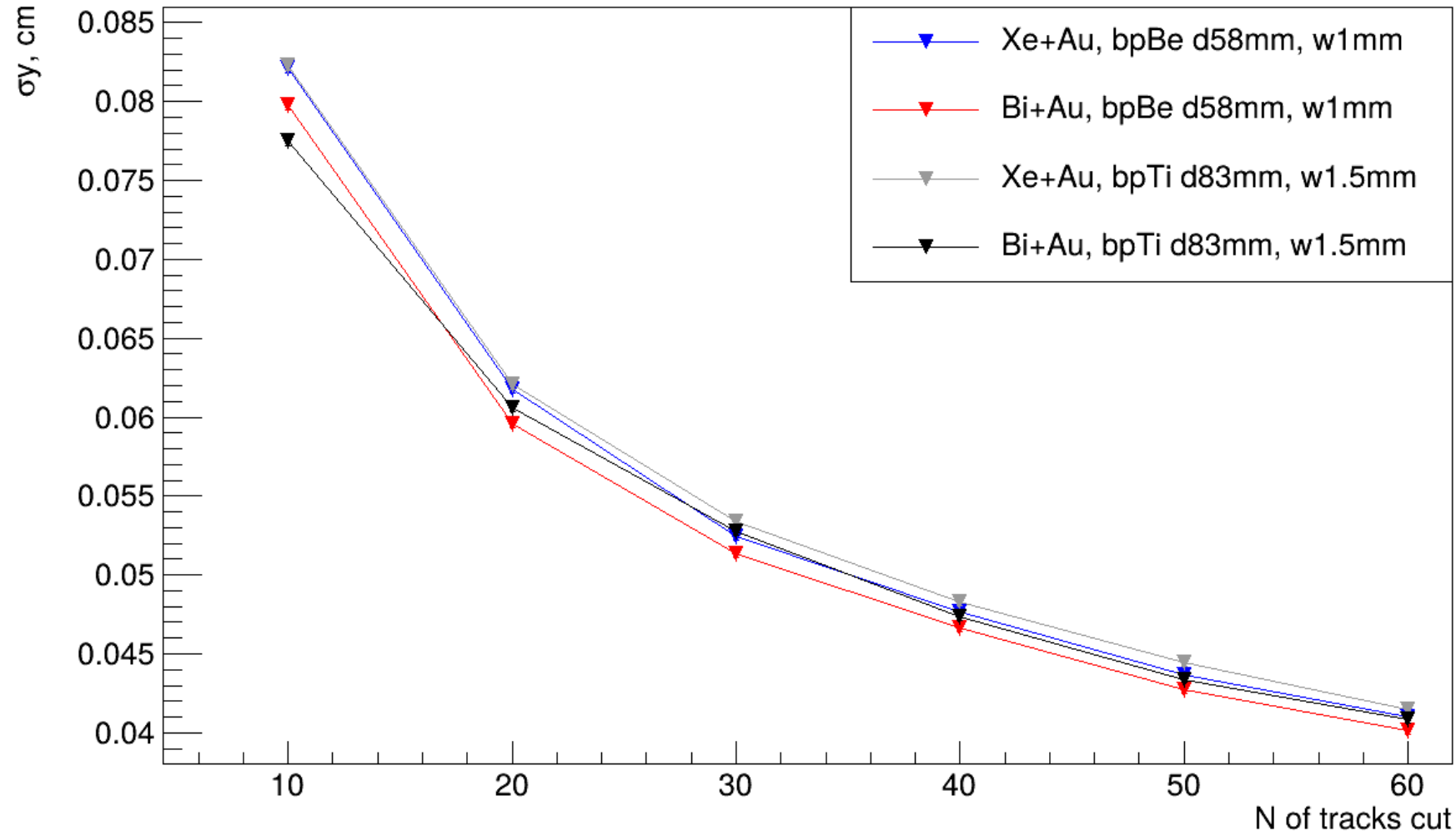
- MC StartXY primary particles tracks distributions (left) Bi + Au, Be beam pipe (up), Ti beam pipe (down)
- RECO PrimaryVertexXY tracks distributions,  $N \geq 40$  (right) for Bi + Au, Be beam pipe (up), Ti beam pipe (down)



$\sigma_y$  dependency from N of tracks in Bi+Au, Xe+Au events, registered by MPD-TPC with

- Be beam pipe
- Ti beam pipe

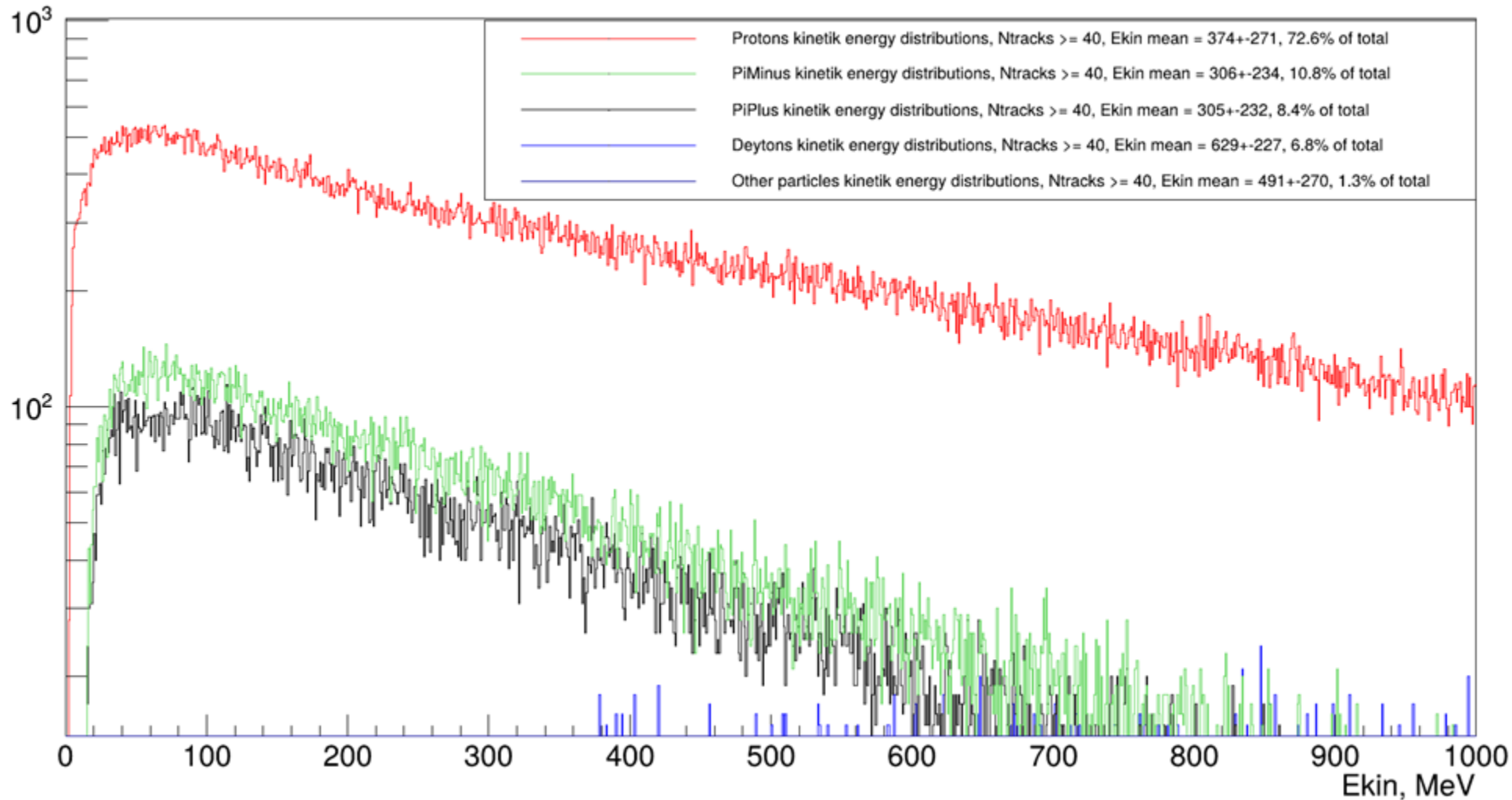
$\sigma_y$  from N of tracks cut



→ changing beam pipe parameters (width, material) does not have significant impact on track reconstruction quality for the given parameters

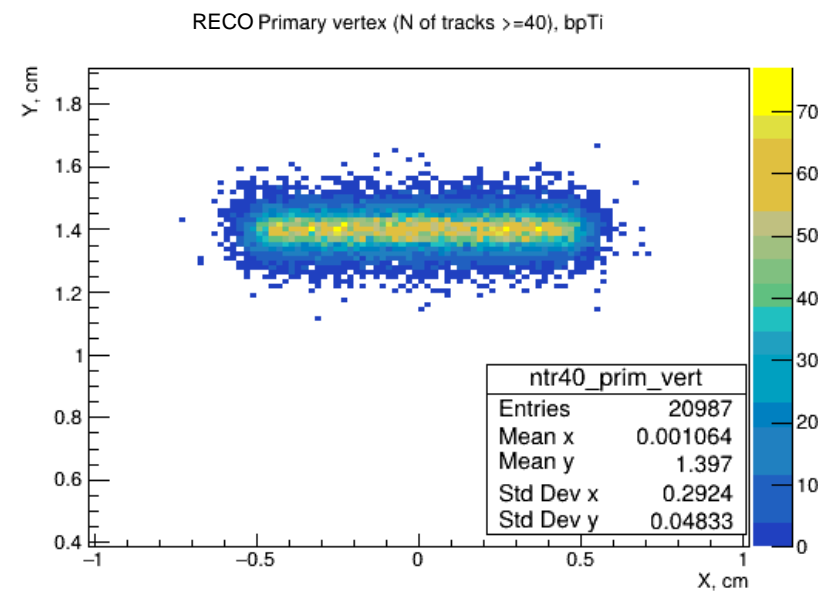
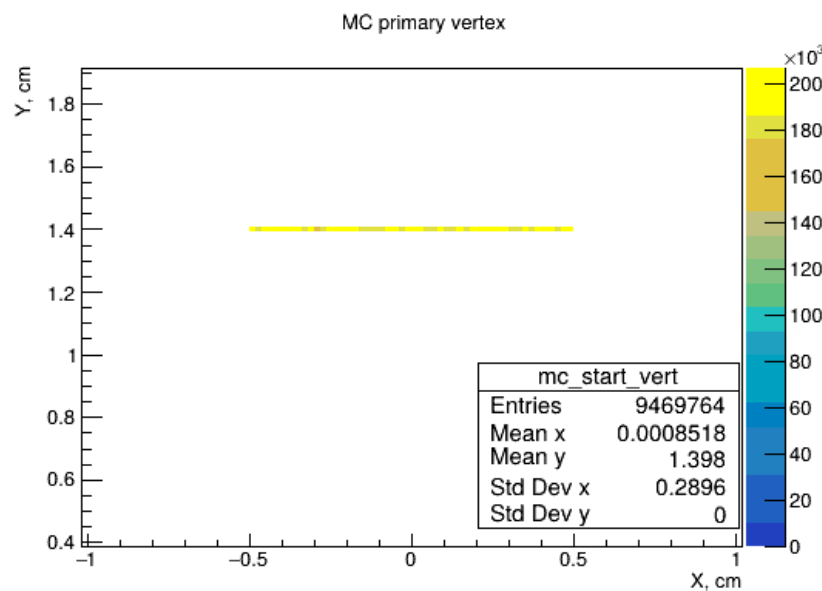
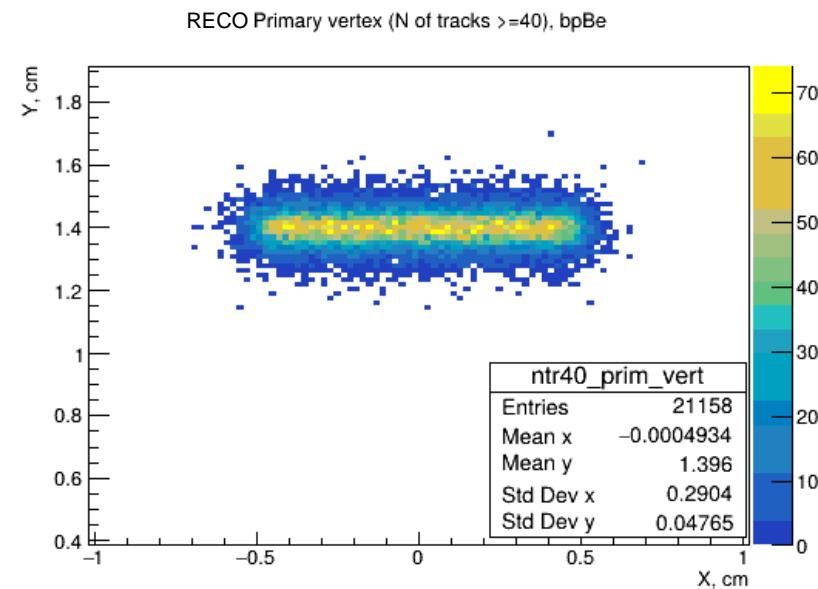
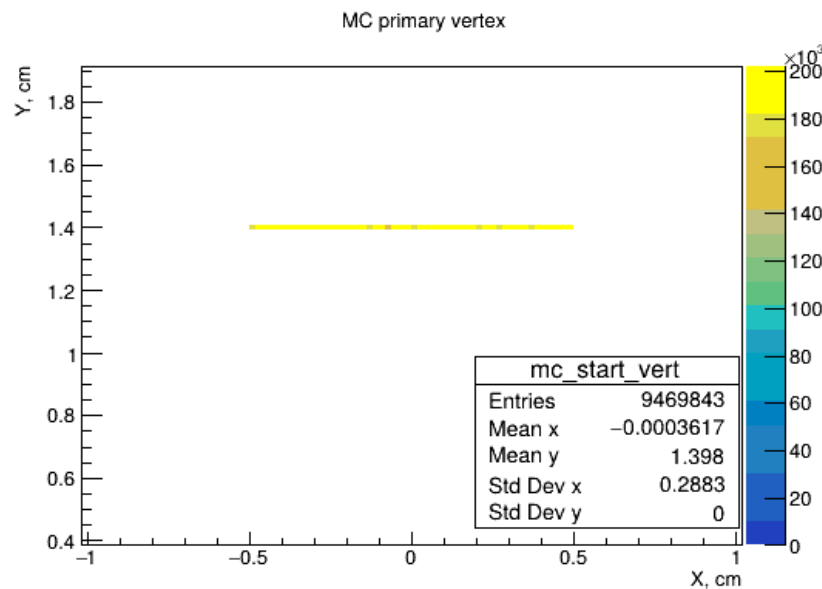
Kinetic energy distributions of charged reaction products Bi+Au, 2.5 A GeV,  
N of tracks  $\geq 40$

### Kinetic energy distributions (N of tracks $\geq 40$ )



→ Average  $E_{kin}$  ( $p, \pi$ ) = 300 MeV, thus particle trajectories are slightly distorted by multiple Coulomb scattering while passing through the beam pipe

- MC StartXY primary particles tracks distributions (left) Xe + Au, Be beam pipe (up), Ti beam pipe (down)
- RECO PrimaryVertexXY tracks distributions,  $N \geq 40$  (right) for Xe + Au, Be beam pipe (up), Ti beam pipe (down)



- the first stage experiment - MPD in FXT mode with thin gold wire target installed inside the beam pipe with TPC only as the tracking system was simulated;
- reconstruction accuracy of primary vertices was studied for Bi + Au and Xe + Au, 2.5 A GeV, using the tracks of the charged reaction products reconstructed in the TPC was studied:
  - for 50 K events, a clear two-dimensional image of the wire can be obtained when reconstructing the primary vertex in high-multiplicity events ( $N \geq 40$ );
- material (Be, Ti) and thickness (1mm, 1.5 mm) of the beam pipe do not have a significant effect on the quality of the reconstructed image of the wire target.

Thank you for your attention!