Seed Vertex Finder

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18 April 2023

introduction

- relevant issue: #1778
- pull request: #2038

- idea is to provide an estimation of the vertex position, that can be used for filtering of the track seeds
- will (hopefully) reduce amount of seeds to consider
- assuming there is only 1 high-multiplicity vertex in an event
- so far using particle gun

procedure

- sort spacepoints according their distance from Z-axis:
  - near, middle, far
- make all possible combinations
- discard a combination if:
  - the spacepoints are not from nearby phi-slices
  - the angle in X-Y or in 3D between near-middle and middle-far spacepoint pairs is too large
  - the fitted line doesn't come close to Z-axis
  - the fitted line has its closest approach to Z-axis at high $|z|$
  - (no cuts on η)

procedure

- filling histograms based on the Z coordinate turned out to be very dependent on the distance of truth vertex from the Z-axis

- instead define:
  1. a plane, using the 3 spacepoint; OR
  2. a straight line (=ray) fitted through the 3 spacepoints

- find a point closest to all planes or rays
  - doesn't depend on truth vertex position
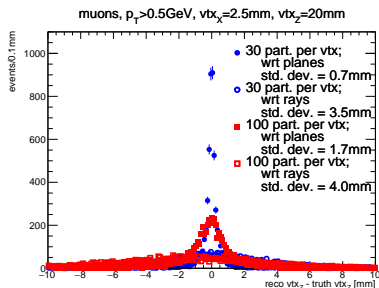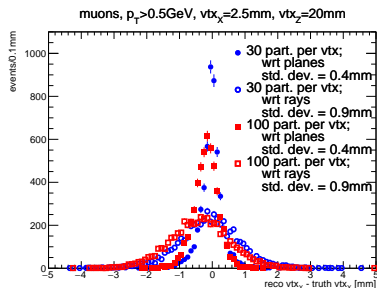 - $\sum distance^2$ is $O(N_{combinations})$
  - minimalization is $O(1)$
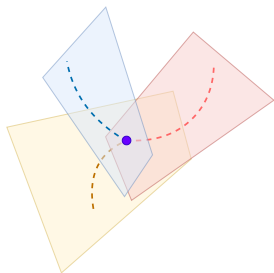
performance – distance from Z-axis
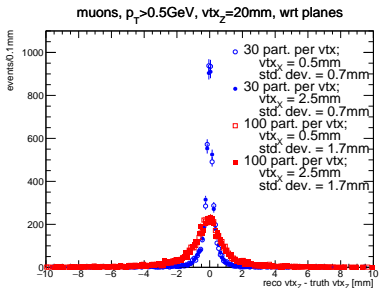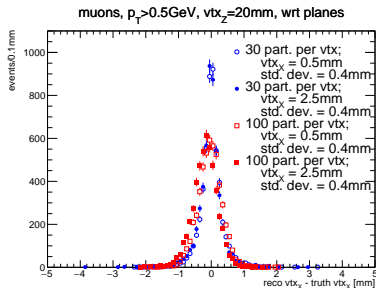
- all vertices at $vtx_Y = 0.0$mm and $vtx_Z = 20.0$mm
- very small dependence on vtx_X
  - for histograms showed last time, the resolution deteriorated quickly with increasing vtx_X
- higher multiplicity has worse resolution

performance – minimalization method

- minimalization with respect to rays has worse resolution
- still much better than using histograms
- also doesn't depend on vtx_X

summary & outlook

- minimalization with respect to planes/rays defined by the spacepoints is much better than filling histograms with Z positions
- takes about $\sim$1ms for 30 particles, $\sim$10ms for 100 particles, $\sim$100ms for 300 particles
  - comparable to histograming

- add an option for iterations?
  - wouldn't take much longer as most of the time is spent on fitting spacepoints with a stright line (even for minimalization w.r.t. planes as it's used to reject some spacepoints combination)
- problems with writing to a file when having more tracks
  - no crash, no error, just the output file is empty...
- test on Pythia/Hijing sample