Some MC checks on track reconstruction efficiency

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Introduction

- In order to start to fix some preliminary numbers on reconstruction efficiency, a study about tracking efficiency, without magnetic field, has been performed in the ideal situation of MC simulated data
- For this purpose, the GSI2021_MC campaign has been used, where both VTX, MSD and TW are included
- We have considered both Straight Line Tracking and Kalman (GenFit) global tracks

Method

- We select particles produced in target, emitted in a fiducial cone (within 10 degrees)
- We count the number of particles (MC truth) arriving at TW, and define the efficiency as ε = No. of reconstructed tracks/No. of selected particles *(reconstruction is achieved by using DecodeGlb -mc)*
- Separately, we also define, at the level of "Local Reconstruction", the VTX tracking efficiency, and the MSD tracking efficiency, by selecting particles crossing all planes of those detectors: straight line tracking at present is using VTX tracks as initial seed
- The GSI2021_MC run 400 case is studied at first, since the run 200 is the particular case where beam, TG, VTX and MSD are shifted horizontally by 1.2 cm. A statistics of 10^5 primaries has been used.
- *We anticipate that the simple case of primary particles not interacting in target, gives local and global tracking efficiency close to 1, and will not be considered in the following discussion*

GSI2021_MC Run 400 Straight line reconstruction

No. of processed events: 100000
No. of TW points found: 99763
No. of MSD tracks found: 122337

No. of VTX tracks (incl. primary) Theta<10 deg: 107377
No. of VTX multi tracks Theta<10 deg: 11233
No of VTX tracks in the 4th sensor acceptance: 13176
No. of VTX tracks pointing to TW: 8798 8601 197

No. of MSD tracks Theta<10 deg: 122304
No of MSD tracks with 3 layers: 23040

Local reco:
VTX tracking efficiency = 11233/11290 = 99.5%
MSD??? : 23040/11290

No. of MC tracks Theta<10 deg: 104174 of which the No. of uninteracted primary MC tracks is 92884 and the No. of secondary MC tracks from target is 21122
No. of secondary MC tracks Theta<10 deg: 11290
No. of MC tracks at the end of VTX: 106421 (including primary)
No. of MC sec. tracks at the end of VTX (E > Ecut && z_fin > z_VTX3): 13537
No. of MC tracks at the end of TW: 103712 (including primary)
No. of MSD tracks corr. to charged MC sec: 23040
No. of MSD tracks corr. to charged MC sec. with Theta<10 deg: 23040
No. of MC ch. sec. tracks arriving at end of VTX tracks (cross, E>Ecut, z_fin>z_VT3): 13659
No. of MC ch. sec. crossing MSD with 4 points: 358
No. of MC ch. sec. crossing MSD with 5 points: 96
No. of MC ch. sec. crossing MSD with 6 points: 8523
No. of MC ch. sec. tracks arriving at TW (cross, E > Ecut, z_cross > z_TW): **8907**
No. of MC ch. sec. tracks arriving at TW (cross, E > Ecut, z_cross > z_TW) with 4 VTX points: 8882; with 3 VTX points: 25
==== Global tracking ====
No. of Global Tracks: 111997
No. of Global Tracks with a TW point found: 95651
No. of Global Tracks with Theta<10 deg: 106988; No. of Global Tracks with a TW point with Theta<10 deg: 95651
No. of MC Global Tracks corr. to secondaries (E > Ecut): 13907; No. of MC Global Tracks corr. to secondaries with Theta<10 deg (E > Ecut): 9596
No. of MC Global Tracks with a TW point corr. to secondaries (E > Ecut): **6693**; No. of MC Global Tracks with a TW point corr. to secondaries with Theta<10 deg (E > Ecut): 6693

Eff of Global Tracking = 6693/8907 = 0.75

GSI2021_MC Run 400 GenFit reconstruction (9 pts)

No. of processed events: 100000
No. of TW points found: 99763
No. of MSD tracks found: 122337

No. of VTX tracks (incl. primary) Theta<10 deg: 107377
No. of VTX multi tracks Theta<10 deg: 11233
No of VTX tracks in the 4th sensor acceptance: 13176
No. of VTX tracks pointing to TW: 8798 8601 197

No. of MSD tracks Theta<10 deg: 122304
No of MSD tracks with 3 layers: 23040

No. of MC tracks Theta<10 deg: 104174 of which the No. of uninteracted primary MC tracks is 92884 and the No. of secondary MC tracks from target is 21122
No. of secondary MC tracks Theta<10 deg: 11290
No. of MC tracks at the end of VTX: 106421 (including primary)
No. of MC sec. tracks at the end of VTX (E > Ecut && z_fin > z_VTX3): 13537
No. of MC tracks at the end of TW: 103712 (including primary)
No. of MSD tracks corr. to charged MC sec: 23040
No. of MSD tracks corr. to charged MC sec. with Theta<10 deg: 23040
No. of MC ch. sec. tracks arriving at end of VTX tracks (cross, E>Ecut, z_fin>z_VT3): 13659
No. of MC ch. sec. crossing MSD with 4 points: 358
No. of MC ch. sec. crossing MSD with 5 points: 96
No. of MC ch. sec. crossing MSD with 6 points: 8523
No. of MC ch. sec. tracks arriving at TW (cross, E > Ecut, z_cross > z_TW): **8907**
No. of MC ch. sec. tracks arriving at TW (cross, E > Ecut, z_cross > z_TW) with 4 VTX points: 8882; with 3 VTX points: 25
==== Global tracking ====
No. of Global Tracks: 104119
No. of Global Tracks with a TW point found: 95442
No. of Global Tracks with Theta<10 deg: 104119; No. of Global Tracks with a TW point with Theta<10 deg: 95442
No. of MC Global Tracks corr. to secondaries (E > Ecut): 8630; No. of MC Global Tracks corr. to secondaries with Theta<10 deg (E > Ecut): 8630
No. of MC Global Tracks with a TW point corr. to secondaries (E > Ecut): **7891**; No. of MC Global Tracks with a TW point corr. to secondaries with Theta<10 deg (E > Ecut): 7891

Eff of Global Tracking = 7891/8907 = 0.886

A first comment

- Local tracking efficiency for VTX is quite high (confirming studies performed years ago)
- There remain a problem in MSD track reconstruction *(already mentioned one or two meetings ago):* there are duplicated tracks. The correction of some bugs (found by C. Finck) was not sufficient to cure this. We also repeat the info that such a duplication does not exist for single track events
- This fact may impair the reconstruction efficiency of global tracking. We tried to use GenFit excluding MSD (thanks to R. Zarrella for advices and checks). Technical issue: tracking has to be performed with only 5 points, a bit at the limit.

GSI2021_MC Run 400 GenFit rec. (No MSD, 5 pts)

No. of processed events: 100000
No. of TW points found: 99763
No. of MSD tracks found: 0

No. of VTX tracks (incl. primary) Theta<10 deg: 107377
No. of VTX multi tracks Theta<10 deg: 11233
No of VTX tracks in the 4th sensor acceptance: 13176
No. of VTX tracks pointing to TW: 8798 8601 197

No. of MSD tracks Theta<10 deg: 0
No of MSD tracks with 3 layers: 0

No. of MC tracks Theta<10 deg: 104174 of which the No. of uninteracted primary MC tracks is 92884 and the No. of secondary MC tracks from target is 21122
No. of secondary MC tracks Theta<10 deg: 11290
No. of MC tracks at the end of VTX: 106421 (including primary)
No. of MC sec. tracks at the end of VTX (E > Ecut && z_fin > z_VTX3): 13537
No. of MC tracks at the end of TW: 103712 (including primary)
No. of MSD tracks corr. to charged MC sec: 0
No. of MSD tracks corr. to charged MC sec. with Theta<10 deg: 0
No. of MC ch. sec. tracks arriving at end of VTX tracks (cross, E>Ecut, z_fin>z_VT3): 13659
No. of MC ch. sec. crossing MSD with 4 points: 358
No. of MC ch. sec. crossing MSD with 5 points: 96
No. of MC ch. sec. crossing MSD with 6 points: 8523
No. of MC ch. sec. tracks arriving at TW (cross, E > Ecut, z_cross > z_TW): **8907**
No. of MC ch. sec. tracks arriving at TW (cross, E > Ecut, z_cross > z_TW) with 4 VTX points: 8882; with 3 VTX points: 25
==== Global tracking ====
No. of Global Tracks: 96163
No. of Global Tracks with a TW point found: 95536;
No. of Global Tracks with Theta<10 deg: 95765; No. of Global Tracks with a TW point with Theta<10 deg: 95535
No. of MC Global Tracks corr. to secondaries (E > Ecut): 8736; No. of MC Global Tracks corr. to secondaries with Theta<10 deg (E > Ecut): 8358
No. of MC Global Tracks with a TW point corr. to secondaries (E > Ecut): **8146**; No. of MC Global Tracks with a TW point corr. to secondaries with Theta<10 deg (E > Ecut): 8146

Eff of Global Tracking = 8146/8907 = 0.915

Tracking efficiency seems to improve

The analysis is now performed for Run 200

- Warning: the following numbers may be not the final ones. To be checked again to assure that the geometrical shift on the horizontal plan has been correctly taken into account
- Local tracking:
  - **VTX tracking efficiency = 9302/9346= 99.5%**
  - **MSD: same problem (14335/9346)**
- Global tracking:
  - **Straight Tracking Efficiency = 5960/6957 = 0.857**
  - **Genfit Tracking (9 pts) Eff. = 5534/6957 = 0.795**
  - **Genfit Tracking (no MSD 5 pts) Eff. = 5960/6957 = 0.845**

Some preliminary conclusions

- Local tracking efficiency for VTX turns out to be as expected *(at least at MC level… the issue of cluster size reproduction can be dominant)*
- In the case of no-magnet-setup the global tracking efficiency can probably be improved. At present we see 2 important issues:
  - The failure to assign of a good TW point for the track seems to be the main source of inefficiency (already discussed in the past)
  - MSD tracking is not yet ready and maybe, at present, can be a source of problems.
- It is fundamental to improve the MSD track reconstruction. This can be essential for the analysis of both HIT2022 and next CNAO2022 campaigns. We suggest to concentrate some efforts in this direction.