PWG-COM

Activities & Production Overview

Frédéric Julian Linz

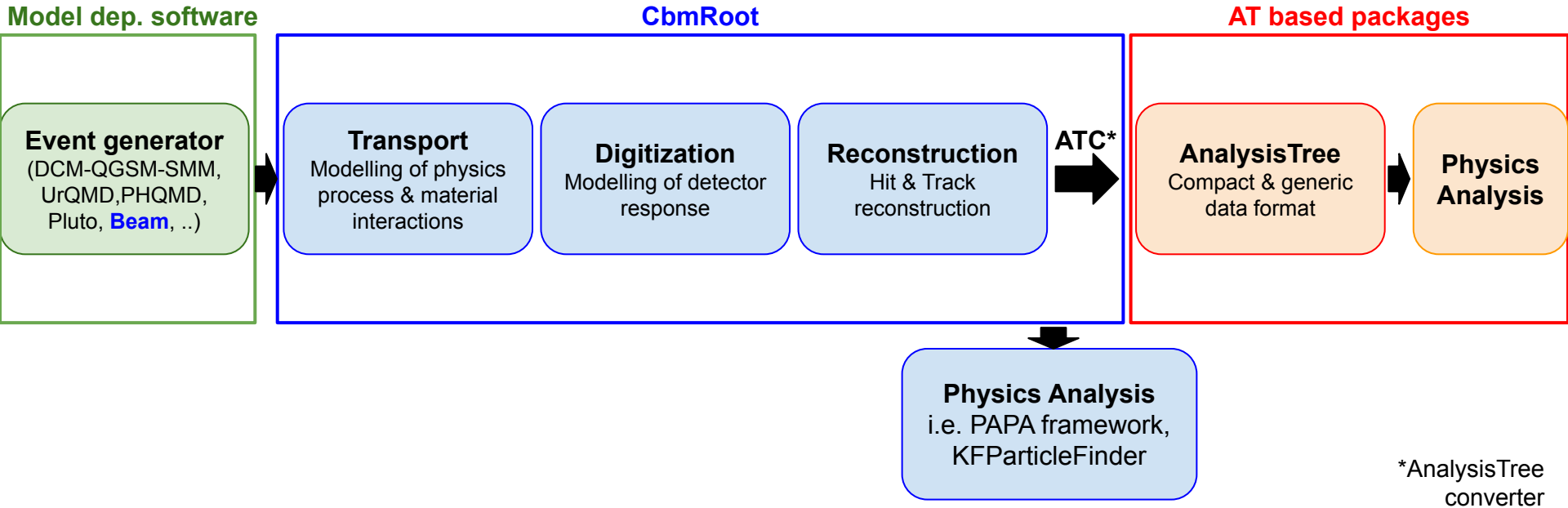
46th CBM collaboration meeting

20th October 2025

Outline

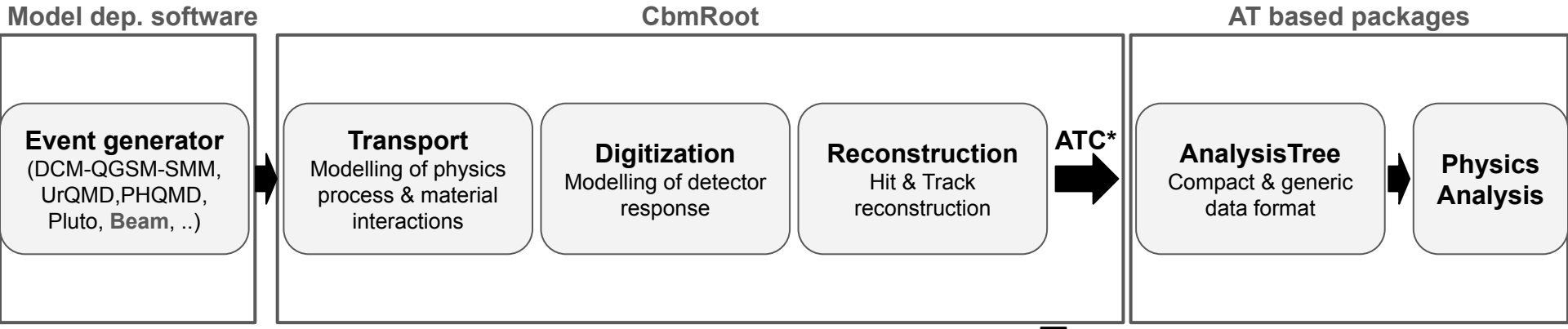
- **Introduction**
  - Simulation data flow & PWG-COM activities
- **Common Productions**
  - Status of existing productions, purpose and future strategy
- **Analysis Tools**
  - PID & centrality framework

Software & data flow (sim)



*AnalysisTree converter

Software & data flow (sim)



Tuesday 21st

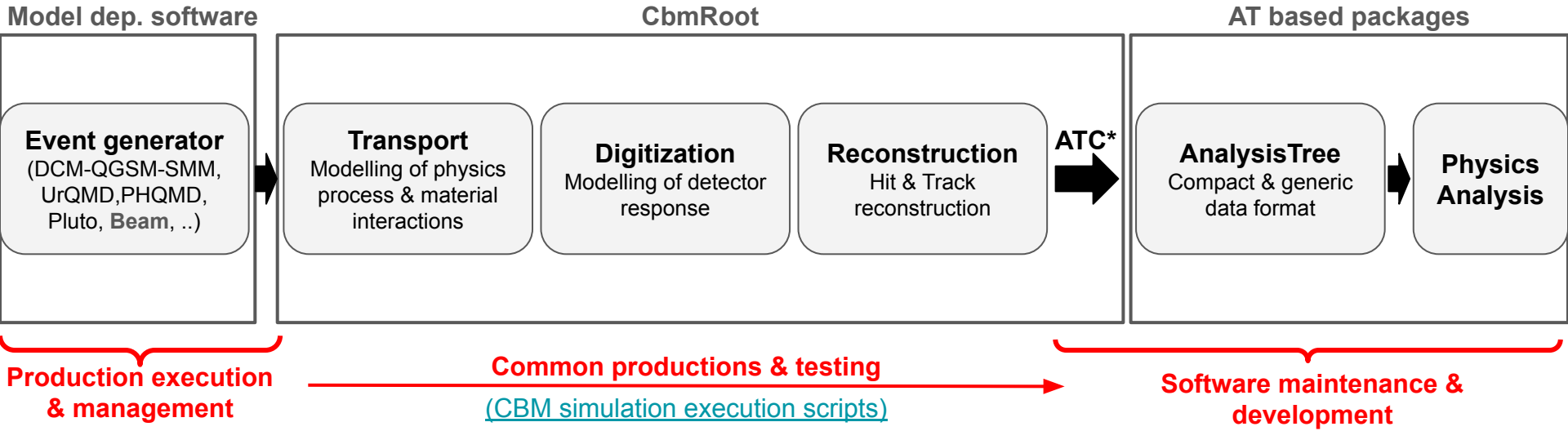
Hypernuclei signal extraction and mixed-event background using KFParticle with AnalysisTree *Yingjie Zhou*

Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences 11:50 - 12:10

Physics Analysis
i.e. PAPA framework,
KFParticleFinder

*AnalysisTree converter

PWG-COM activities



*AnalysisTree converter

Common Productions

(Updated) PHQMD productions

- JUL25 productions available (detailed production and geometry documentation)
  - **5M events with Day-1 setup**
    /lustre/cbm/prod/mc/phqmd52_winn/jul25p1_v18.8.2_jan24p5/geant3/auau/pbeam12agev/mbias/small_clusters/day-1
  - **5M events with CFV setup**
    /lustre/cbm/prod/mc/phqmd52_winn/jul25p1_v18.8.2_jan24p5/geant3/auau/pbeam12agev/mbias/small_clusters/cfv
  - **1M events with Day-1 setup and GEANT4**
    /lustre/cbm/prod/mc/phqmd52_winn/jul25p1_v18.8.2_jan24p5/geant4/auau/pbeam12agev/mbias/small_clusters/day-1

Exactly same input as JUL24 productions

- **Purpose:** comparison (https://redmine.cbm.gsi.de/boards/8/topics/42) …
  - … with JUL24 production: will be abandoned soon if everything is ok
  - **… between setups: day-1 vs. cfv**
  - … between transport engines: geant3 vs. geant4

Monday 20th

CBM Performance for Λ Yield Analysis for CVF and Day1 Setup	*Axel Puntke*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences	15:15 - 15:35
Strangeness and Hypernuclei reconstruction with Day-1 and CFV setup	*Iouri Vassiliev*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences	15:35 - 15:55

Tuesday 21st

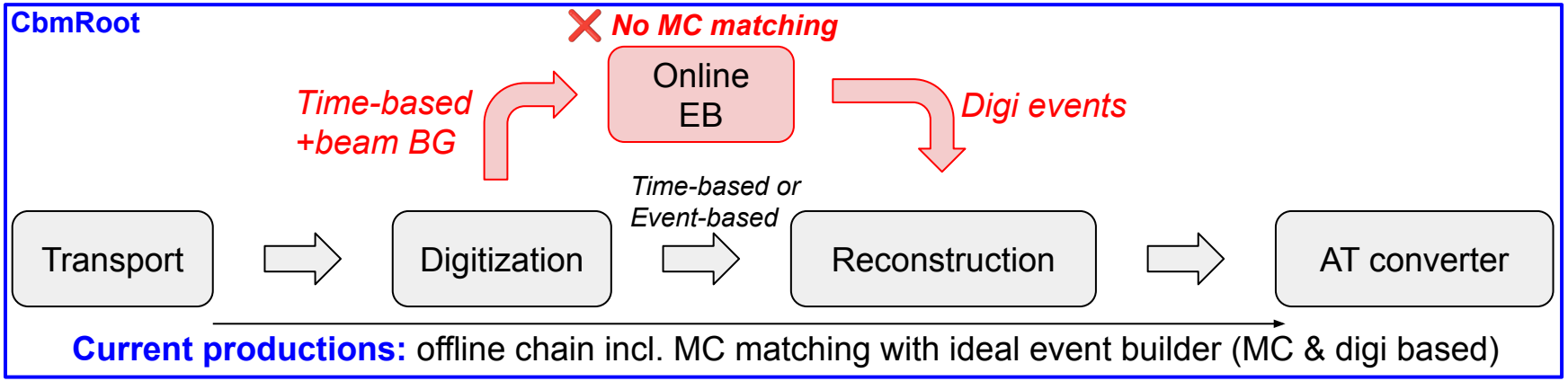
(Femtoscopy)	*Dr Daniel Wielanek*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences	14:25 - 14:45

Next steps / upcoming productions

Tuesday 21st

Vertical test: Status and first experiences — *Frederic Julian Linz et al.*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences 14:00 - 14:25

- **Vertical Test based on UrQMD v4.0 (GEANT3)**
  - 100M UrQMD event ready for CBM simulations



- Offline Event builder (EB) is not up-to-date & some bugs (SM talk by H.Dvorakova)
- Online EB most developed code, clear separation between triggering and event building
  - **Online MC matching needs to be implemented for PWG studies !!!**

Next steps / upcoming productions

- **Switch to GEANT4 as default transport engine**
  - Common effort with software & detector groups
  - *Timescale: within 2025 (ideally)*

Thursday 23rd

Di-muon simulations with GEANT4: preliminary results *Sanchari Thakur*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences 09:15 - 09:30

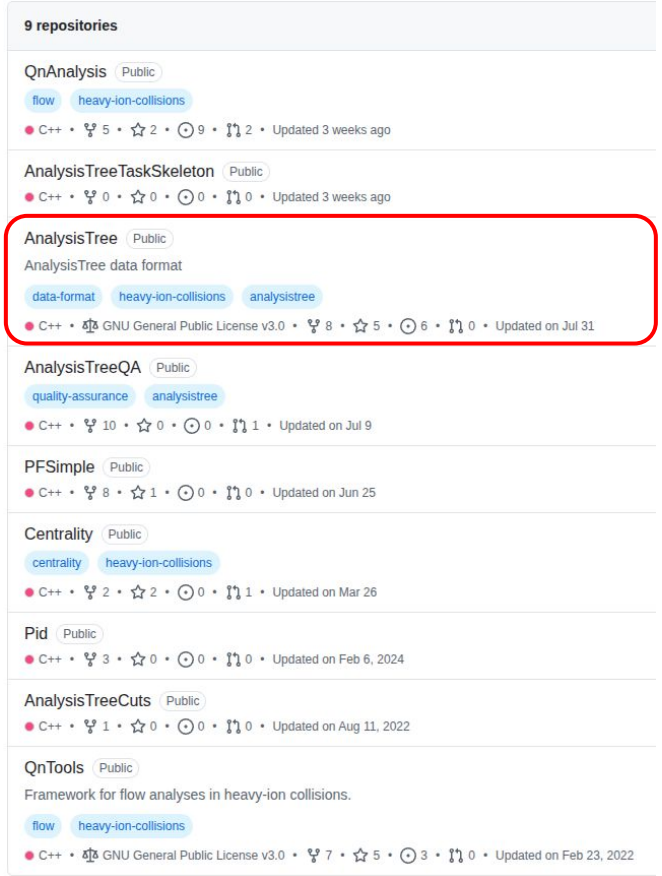
- One technical issue #3664
  - GEANT3: within CBM transport, η and ϕ decays and special channels for hypernuclei are user-defined (CbmTransport::PiAndEtaDecay function, by default skipped if GEANT4 is used)
  - Implementation with GEANT4 functions already prepared: tests show that is only working technically, but user-defined decays for η, ϕ and hypernuclei are NOT set correctl

- **Move to time-based digitization incl. background (online EB with MC matching)**

Analysis Tools

AnalysisTree & packages

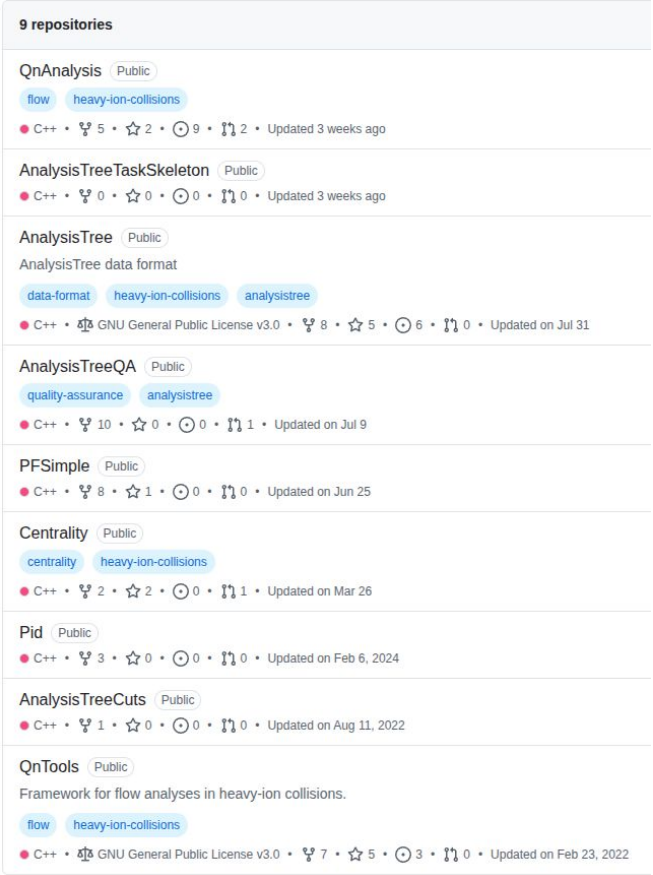
- Source code: https://github.com/HeavyIonAnalysis



AnalysisTree & packages

- Source code: https://github.com/HeavyIonAnalysis
- Modularized analysis software

- Helper packages, i.e. AnalysisTreeCuts



AnalysisTree & packages

- Source code: https://github.com/HeavyIonAnalysis
- PID framework:

Thursday 23rd

Global Electron Identification Based on Machine Learning	*Pavish Subramani*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences	11:20 - 11:35

+Hadron identification scheme (Physics Forum October 10th)

9 repositories

QnAnalysis Public
flow heavy-ion-collisions
C++ • 5 • 2 • 9 • 2 • Updated 3 weeks ago

AnalysisTreeTaskSkeleton Public
C++ • 0 • 0 • 0 • 0 • Updated 3 weeks ago

AnalysisTree Public
AnalysisTree data format
data-format heavy-ion-collisions analysistree
C++ • GNU General Public License v3.0 • 8 • 5 • 6 • 0 • Updated on Jul 31

AnalysisTreeQA Public
quality-assurance analysistree
C++ • 10 • 0 • 0 • 1 • Updated on Jul 9

PFSimple Public
C++ • 8 • 1 • 0 • 0 • Updated on Jun 25

Centrality Public
centrality heavy-ion-collisions
C++ • 2 • 2 • 0 • 1 • Updated on Mar 26

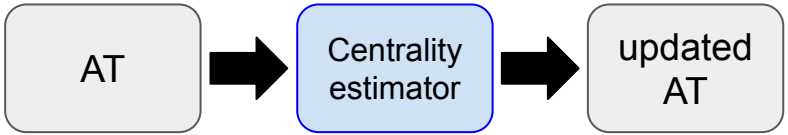
Pid Public
C++ • 3 • 0 • 0 • 0 • Updated on Feb 6, 2024

AnalysisTreeCuts Public
C++ • 1 • 0 • 0 • 0 • Updated on Aug 11, 2022

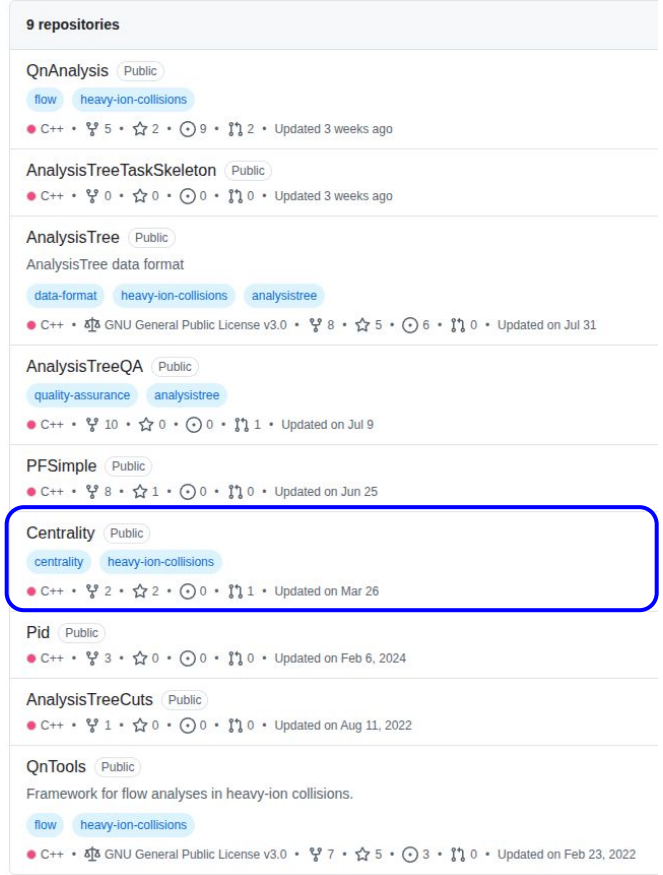
QnTools Public
Framework for flow analyses in heavy-ion collisions.
flow heavy-ion-collisions
C++ • GNU General Public License v3.0 • 7 • 5 • 3 • 0 • Updated on Feb 23, 2022

Centrality package

- Centrality estimator updating AnalysisTree



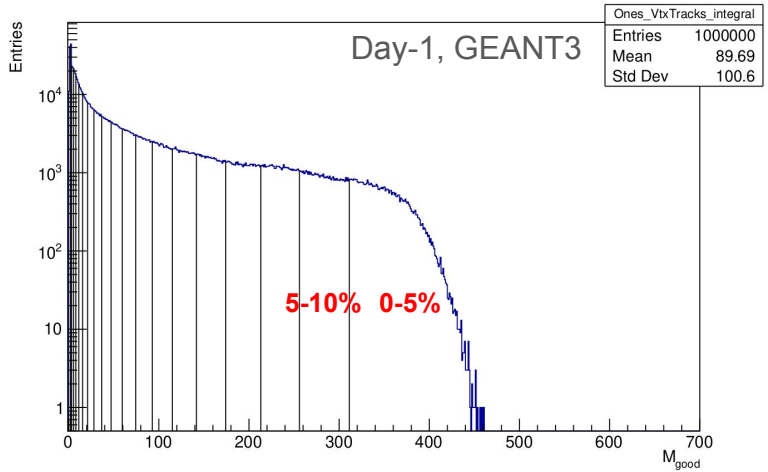
1. **Define centrality classes**
   a. Slicing from histogram
      i. 1D ✅
      ii. 2D ✗
   b. Including Glauber fit ✅*
2. **Apply centrality hypothesis and update AT**



*Working, but more work required to prepare Glauber input files etc.

Centrality integration to AnalysisTree

- Centrality estimator based on selected track multiplicity (simple 1D slicing)



***Minimum track quality selection:**

- $\chi^2_{Vertex} < 3$
- $N_{MVD+STS} > 4$
- χ^2 /ndf < 3
- $0.2 < \eta < 6$

first iteration: to be improved!

***Renaming convention:**

- rTee, RecEventHeader → aTree, AnaEventHeader
- Additional field: AnaEventHeader.centrality_tracks (centrality %)

- **AT files including centrality estimator for all JUL25 PHQMD productions can be found here:**

/lustre/cbm/users/fkornas/mc/data/release/jul25_patches/phqmd52_winn/geant3/auau/pbeam12agev/mbias/small_clusters/day-1
/lustre/cbm/users/fkornas/mc/data/release/jul25_patches/phqmd52_winn/geant3/auau/pbeam12agev/mbias/small_clusters/cfv
/lustre/cbm/users/fkornas/mc/data/release/jul25_patches/phqmd52_winn/geant4/auau/pbeam12agev/mbias/small_clusters/day-1

Centrality study

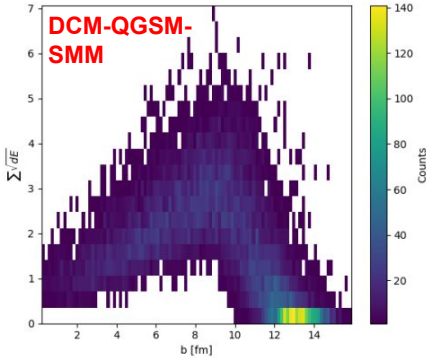
- Ongoing activities in the FSD group:

Monday 20th

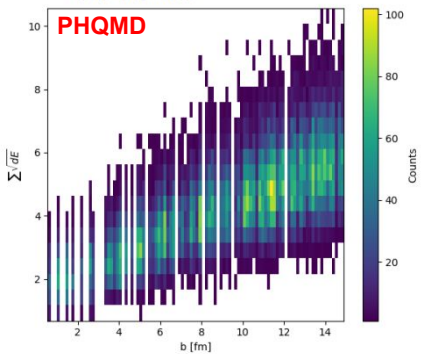
Centrality determination: comparing SMASH and PHQMD results	*Beatriz Artur*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences	*11:20 - 11:40*
FSD - status	*Petr Chaloupka*
Conference Hall, 3rd floor, No. 6 Building, IMP, Institute of Modern Physics, Chinese Academy of Sciences	*11:40 - 12:10*

[Study by R.Dvorak]

$\sum_{dE>3MeV} \sqrt{dE}$



$\sum_{dE>7.5MeV} \sqrt{dE}$



- Focus on **forward** region: most realistic model?
- *PHQMD* is mostly validated with STAR data (no coverage in the forward spectator region)
- *DCM-QGSM-SMM* has been validated by/tuned to data from ALADIN, HADES (low energy) & NA61 (Pb+Pb @ p_{Beam}=13AGeV & 30AGeV) to fit the forward spectator energy distribution
- In this forward region, *PHQMD* has about 2 orders of magnitudes less heavy fragments

Conclusions & Outlook

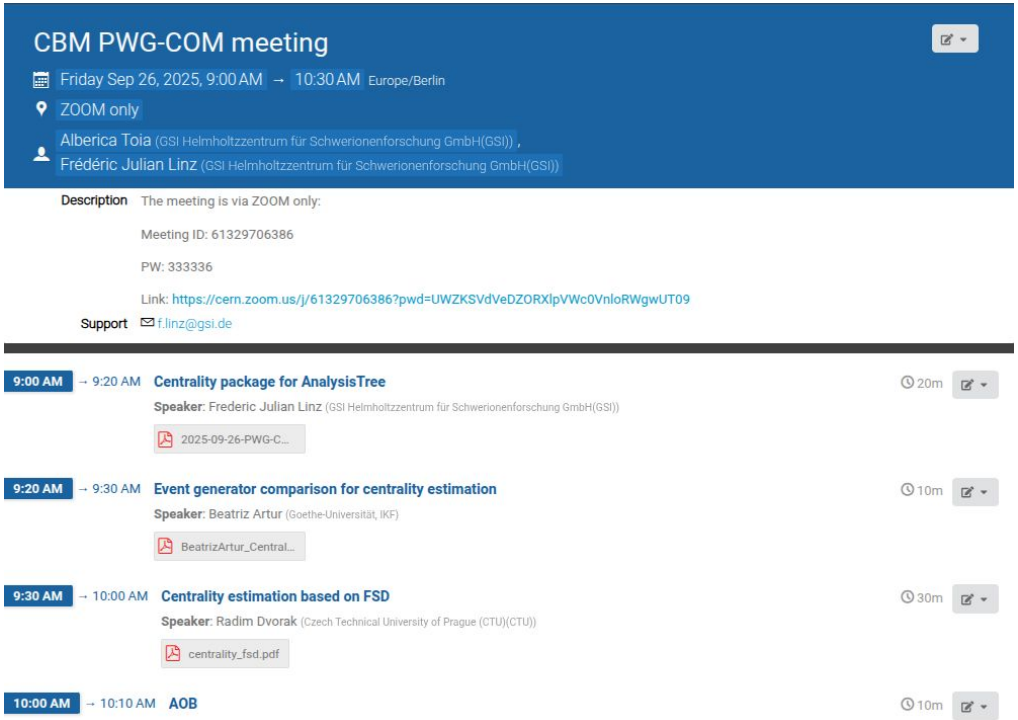
Conclusions & outlook

- Common productions and software key for efficient workflow
  - Development - production - feedback from a large variety of physics analysis’
- Requirements for upcoming productions: Hadron setup? Embedding? “Offline” UrQMD reference?
- Strategy: development of central analysis tools **based on AnalysisTree**
  - Framework for PID hypothesis
  - Framework for centrality estimation
- **Dedicated manpower required for further development and optimization!**
  - Possible project: centrality based on Glauber + online centrality selection tool
- **Goal asap:** step-by-step to full fletched CBM simulations (time-based incl. background, i.e. beam & realistic (hadronic) particle production using GEANT4, triggering, real eventbuilder, MC matching)

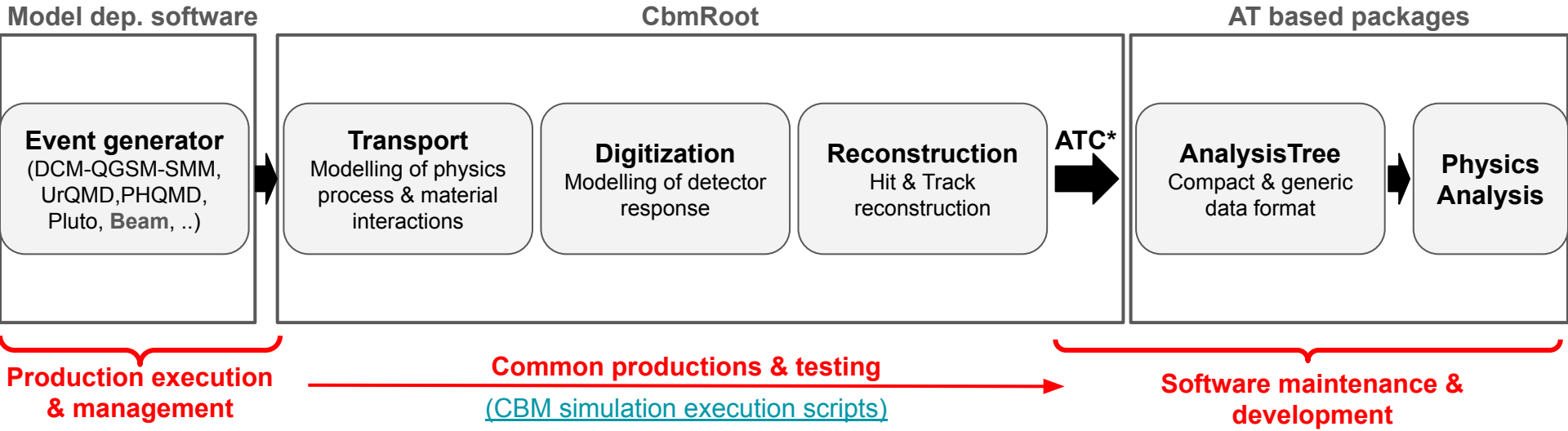
PWG-COM meetings restarted

- Meeting 26th September, topic: centrality estimation
  https://indico.gsi.de/event/23185/
- Current time slot:
  Friday, 9 - 10:30 am
- Slowly pick up the pace (topics) …
- 1 meeting per month alternating with Physics Board & Forum
- Next PWG-COM meeting:
  7th November 2025

  will be announced…



PWG-COM activities



*AnalysisTree converter

If you wish to discuss something related to PWG-COM activities, please contact:

PWG-COM coordination team

Frederic Linz

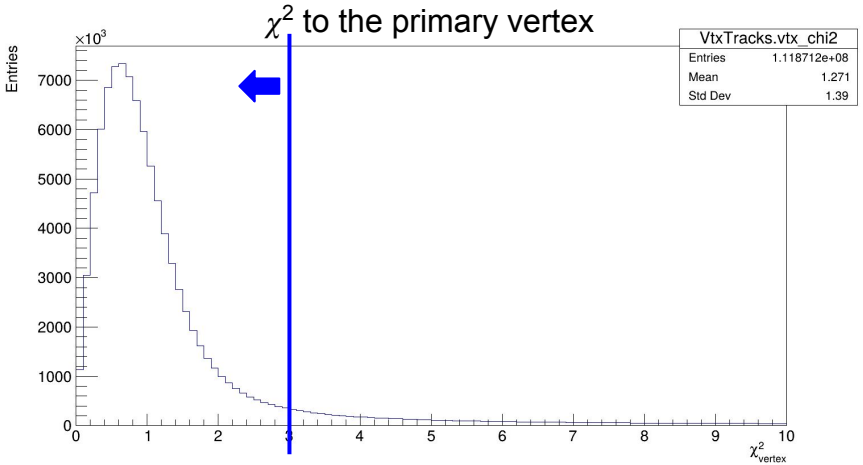
Alberica Toia

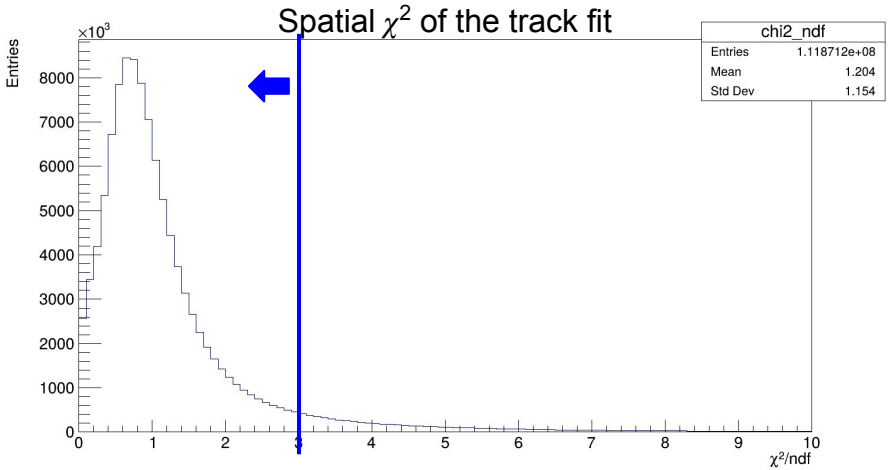
Thank you for your attention!

Back Up

Minimum track quality selection criteria

- Input files: */lustre/cbm/prod/mc/phqmd52_winn/jul25p1_v18.8.2_jan24p5/geant3/auau/pbeam12agev/mbias/small_clusters/day-1*





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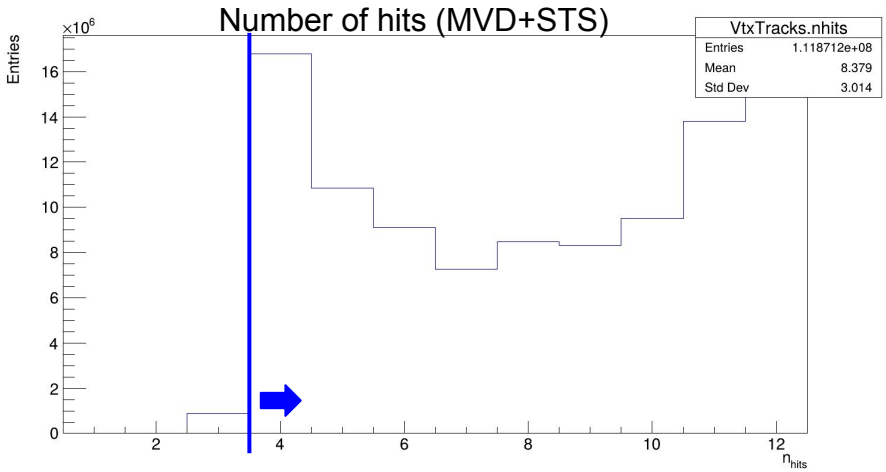
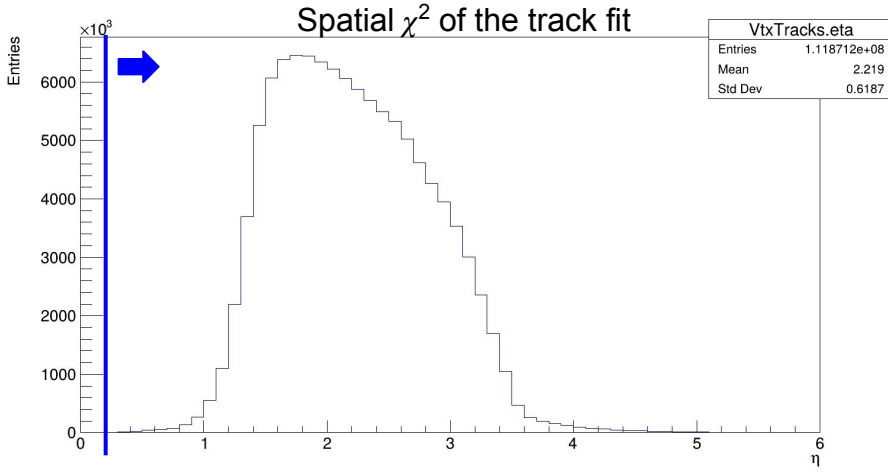
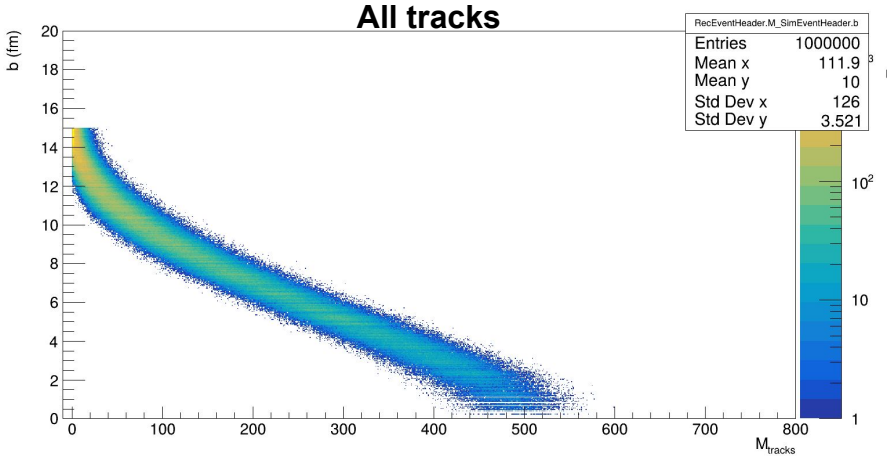
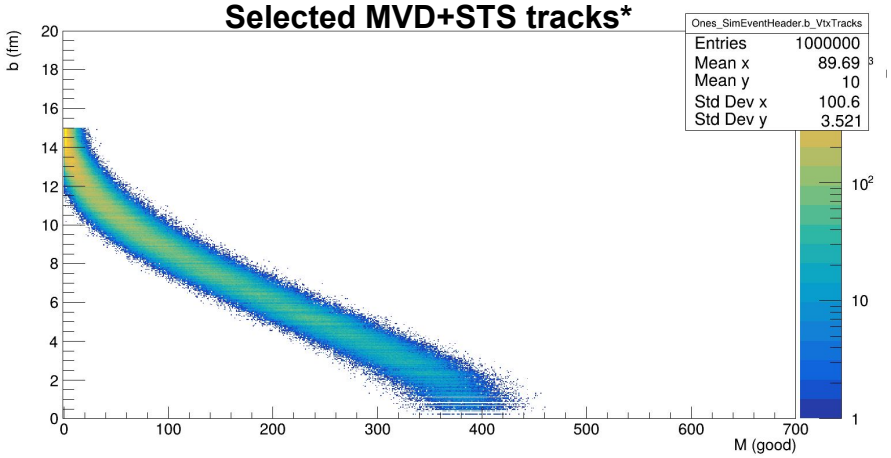




STS track multiplicity

- 2D multiplicity histogram vs. impact parameter





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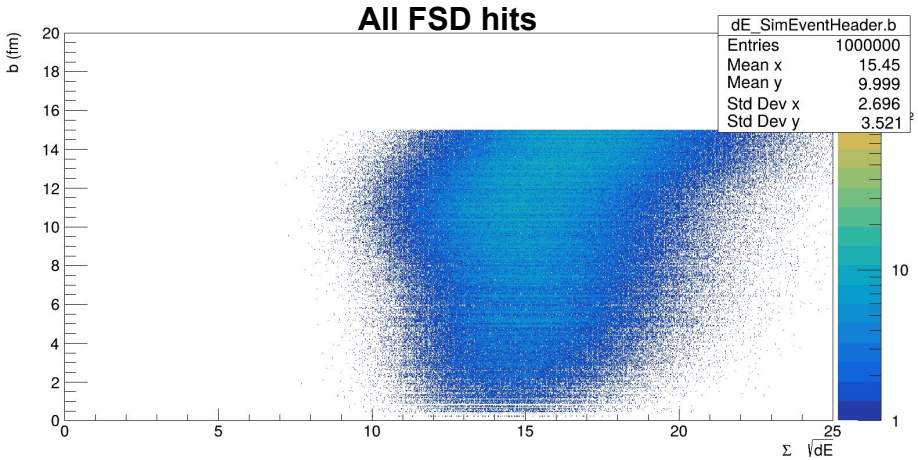
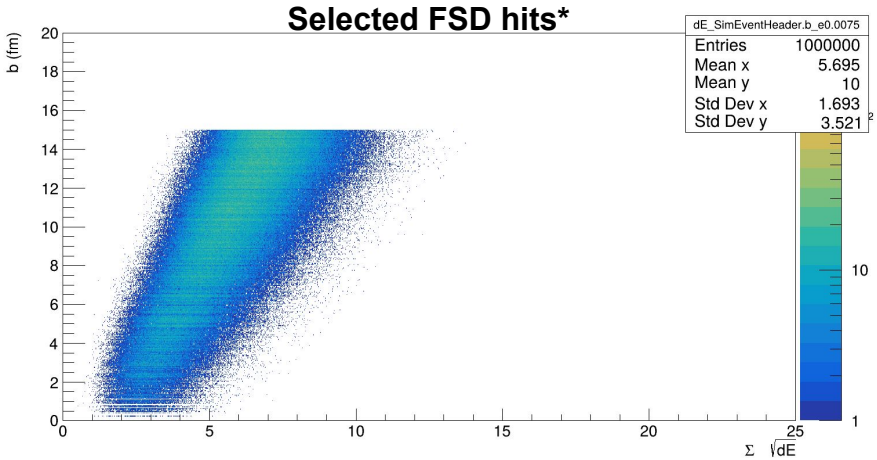
- Input files: */lustre/cbm/prod/mc/phqmd52_winn/jul25p1_v18.8.2_jan24p5/geant3/auau/pbeam12agev/mbias/small_clusters/day-1*

Energy deposit in FSD

- 2D impact parameter vs. FSD energy deposit Σ√(dE/dx)





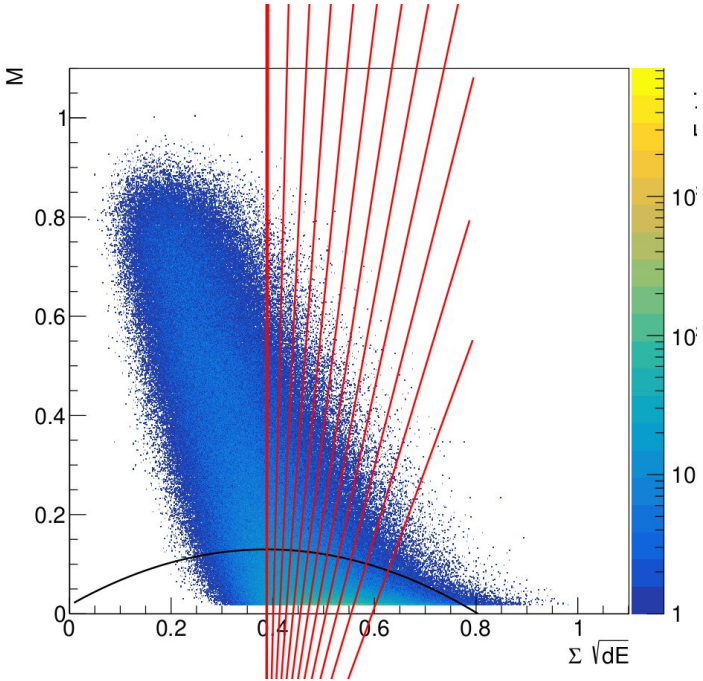
***Hit selection:**

- dE/dx > 0.0075 GeV (remove electrons)
- r < 40cm around (40cm, 0) (spectator selection)

- Input files: */lustre/cbm/prod/mc/phqmd52_winn/jul25p1_v18.8.2_jan24p5/geant3/auau/pbeam12agev/mbias/small_clusters/day-1*

Centrality estimator

- 2D slicing based on selected track multiplicity and FSD energy deposit:



- 2D slicing does not work properly (not adapted to the 2D correlation)
- Source code needs to be developed
- Only a single flag to define (anti-)correlation w.r.t. the impact parameter but
  - Multiplicity anti-correlated
  - FSD energy deposit correlated