A Large Ion Collider Experiment

Opportunities for simulation optimizations (in Run3)

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Introduction

"Simulate what we need for our physics goals, not more (and not less)"

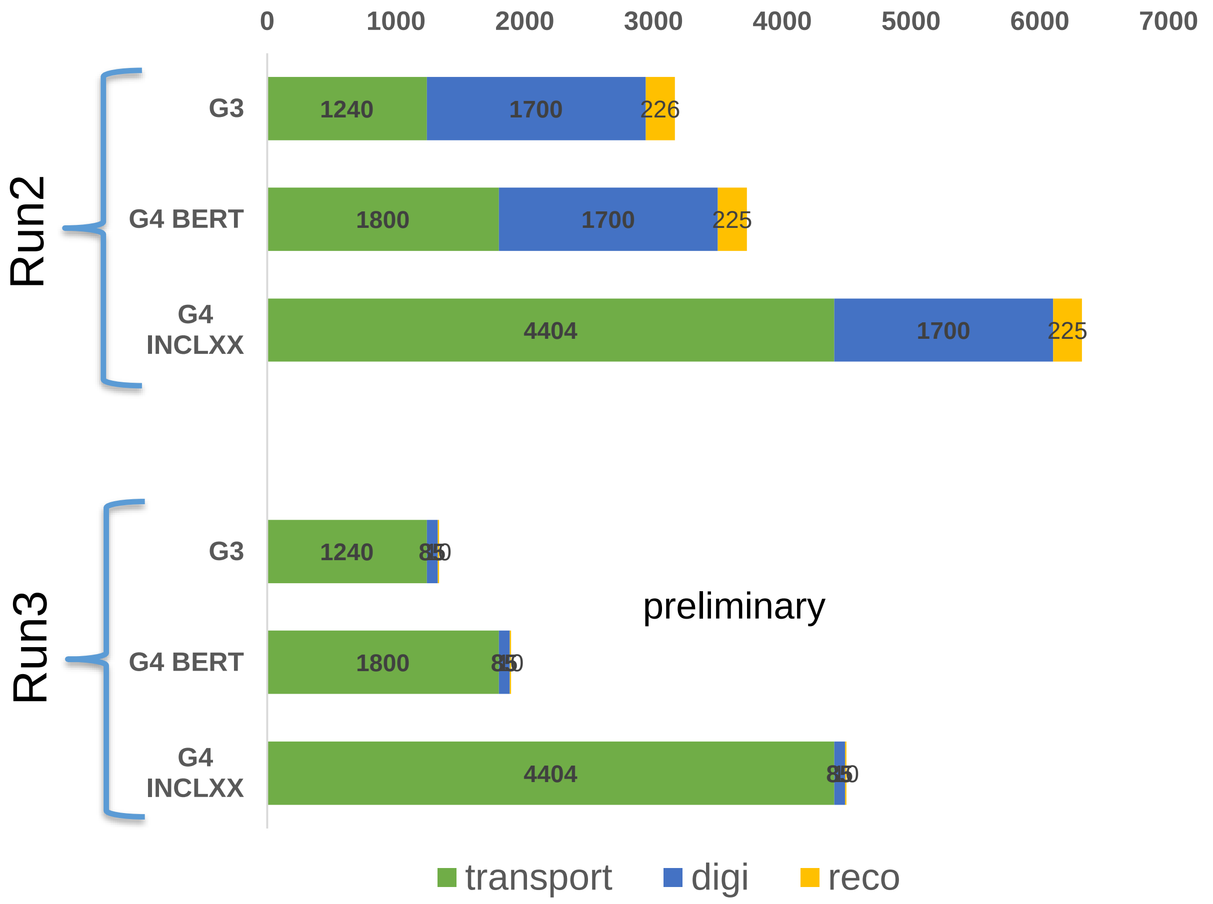
"Achieve this need within the resource budget (no-gap scenario)"

This session is meant to

- Get an updated picture of MC requirements needed for Run3 (feedback from PWGs)
- Give latest numbers on G3/G4 (pp) performance as baseline
- Give some pointers about simulation hotspots and areas where
  - Optimization / parameter tuning will be most effective
  - Fast-simulation modules could make impact
- Trigger general discussions about approaches for simulation/workflow optimizations

This talk … with overlap + extra info in [yesterday's session]

Starting point: MC resources for pp (Run2 vs Run3)



Time in [s] for 100 pp events using production scripts on a benchmark machine; see [ALIROOT-7121]

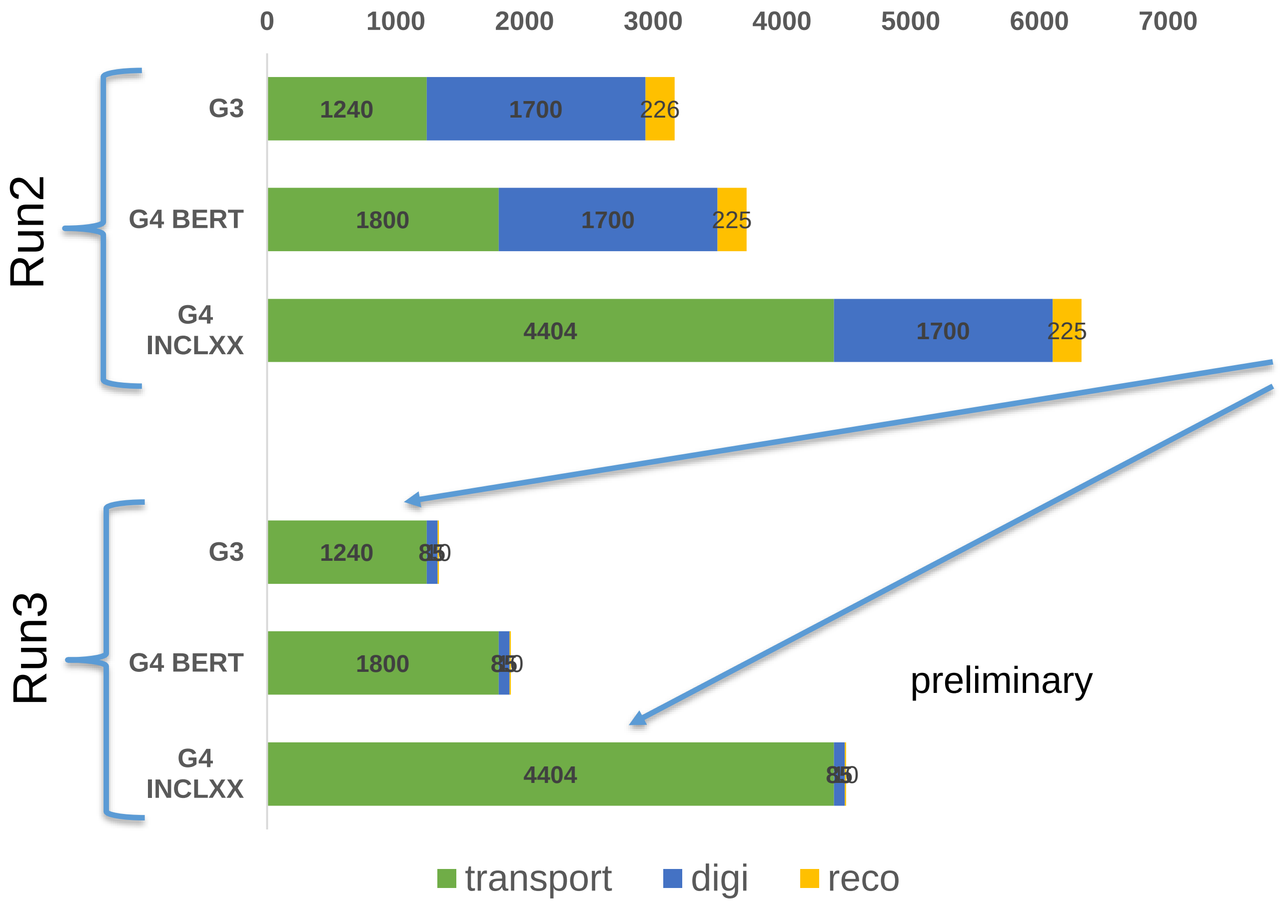
Run2:

- **Transport and digitization** major time consumers
- Overall G4/G3 ratio: **2.0x (INCLXX); 1.2x (BERT);**

Run3: (current status)

- Transport time same as Run2 for the moment
- Much improved time for digitization and reco
- Leads to increased effect of G4 globally
  - **Potentially ~3.4x (INCLXX), ~1.4x (BERT)**
  - **Target to use INCLXX only in ITS**
- Makes **transport the real hotspot**
  - Calls for optimization effort focusing on transport (cuts, parameters)
  - Better applicability of traditional fast-sim methods (shower libraries)

Starting point: MC resources for pp (Run2 vs Run3)



- **Understand where we spend time in transport**
  - Per detector categories (modules)
  - Per particle categories (etc)
- **Work out few suggestion to follow-up**
- Use MCStepLogger to collect step info
  - Works for both AliRoot and O2
  - Produces ROOT files which can be analyzed using any sort of query and cuts

See also previous CWG8 report (2013) with similar focus and conclusions

General overview

	transp. time	steps (1E6)	Tracks (1E6)	steps/track	functional hotspots (Intel VTUNE)	dominating PDG	remarks
G3	1240s	**291**	25	11.64	geometry calculations (TGeo safety)	gamma: 36% e-: 42% e+: 7.2% neutron: 5.6% proton: 1.8%	VecGeom would be beneficial
G4-BERT	1800s	256	**42**	6.09	geometry calculations (TGeo + TGeo/G4 conversions lookups)	gamma: 34.6% e-: 51% e+: 4.4% neutron: 1.8% proton: 1.6%	VecGeom would be beneficial
G4-INCLXX	4404s	256	**42**	6.09	G4 physics processes	gamma: 33.6% e-: 50.4% e+: 4.2% neutron: 3.2% proton: 2.8%	

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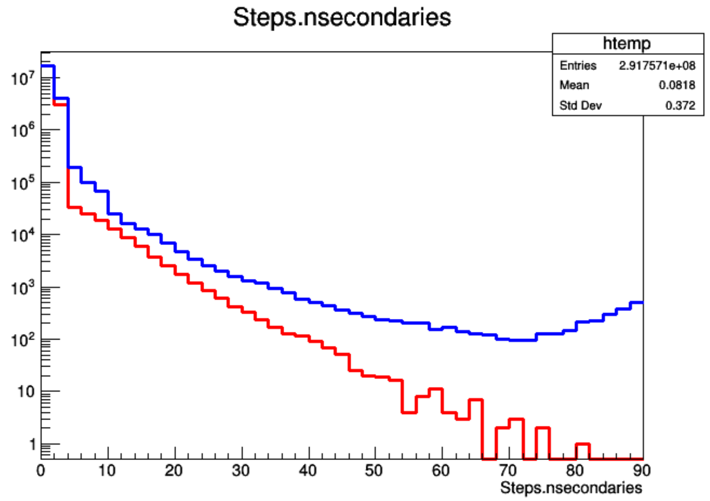
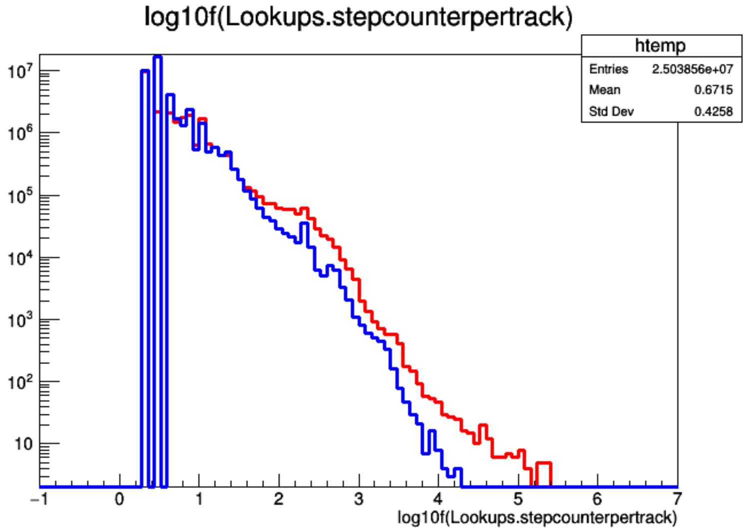
Blue G4 (INCLXX) Red G3

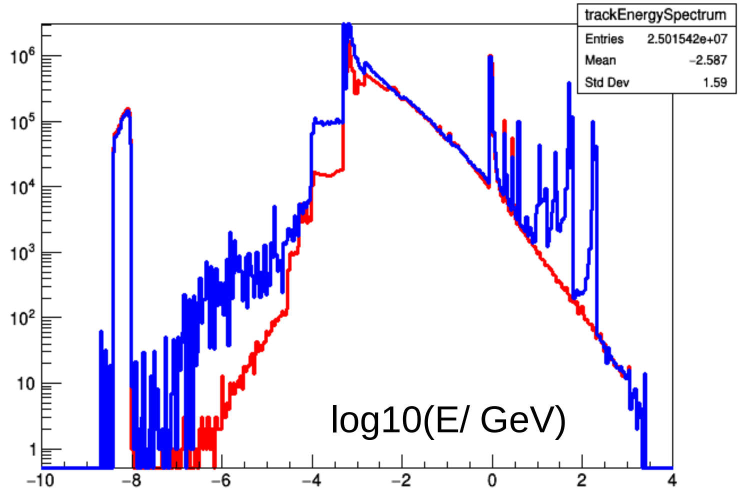
MC transport analysis dashboard



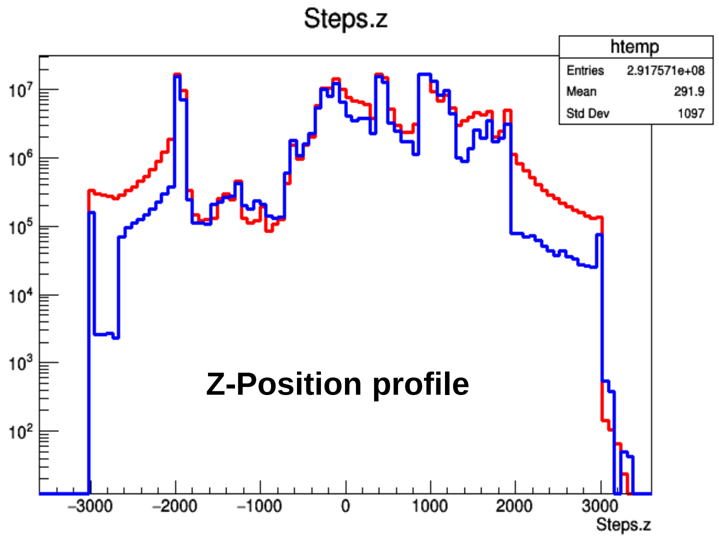
#Secondaries per step



Steps per track

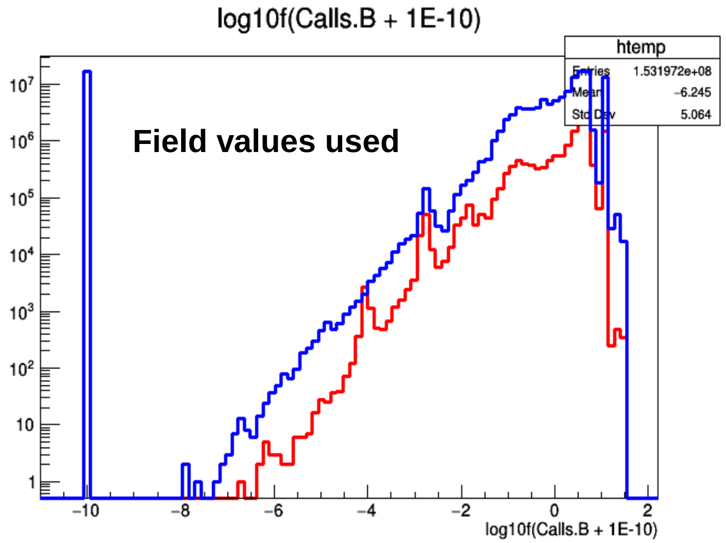


Energy spectrum of transported tracks

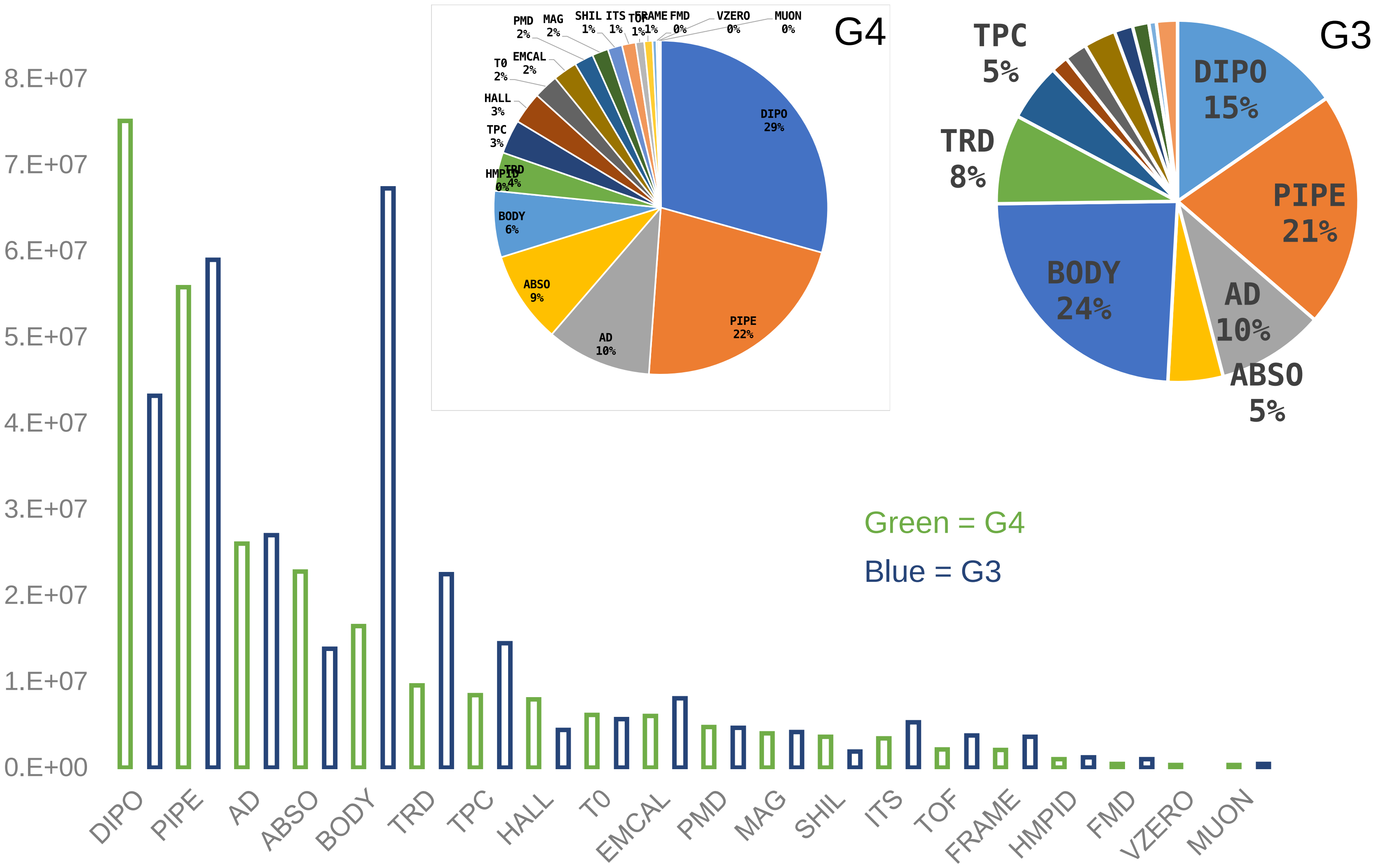


Advertisement that we can get access to insightful (big) data and we should use it!

Selections/cuts/joins can be applied to study very specific questions

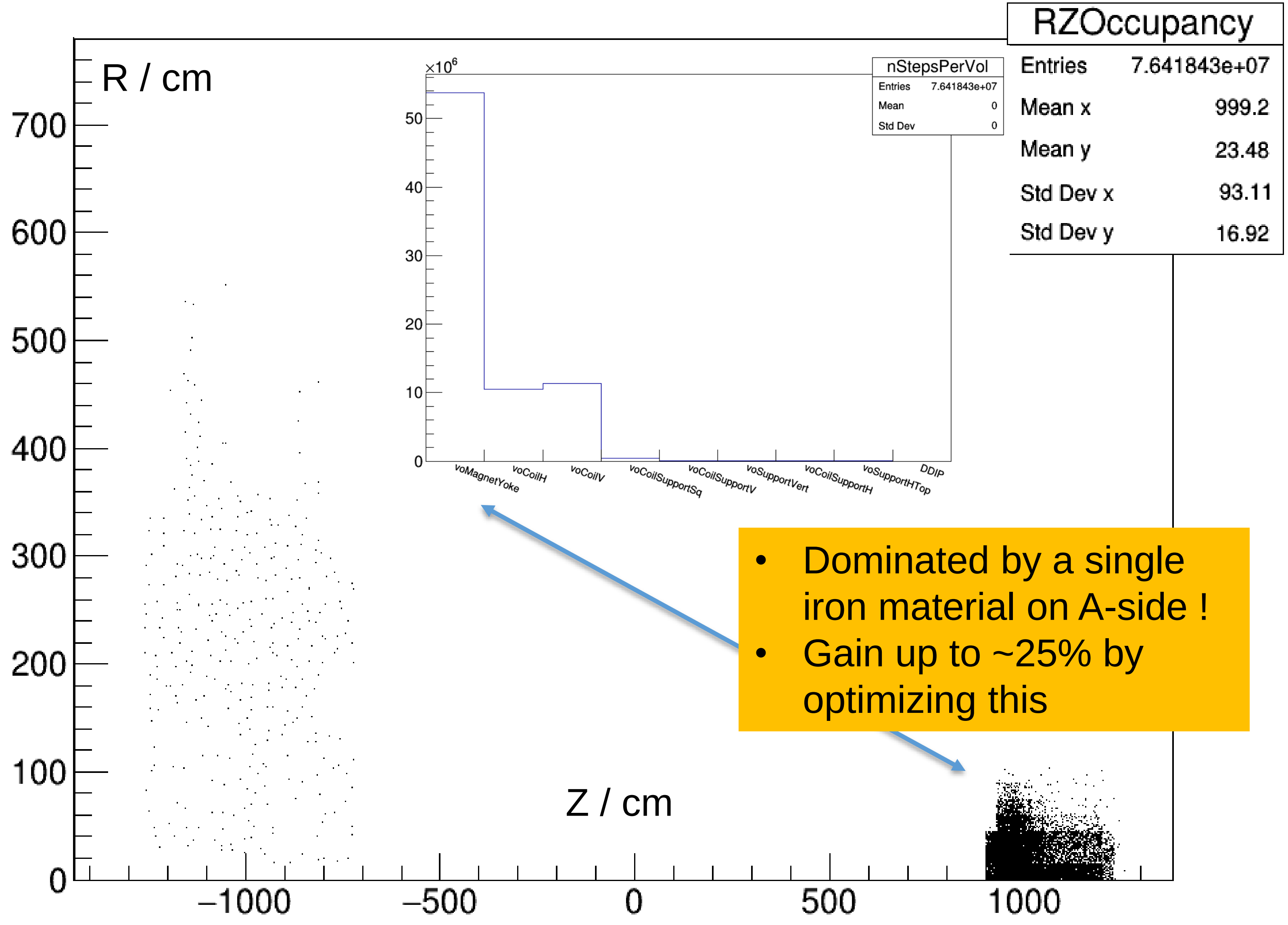


Where are MC steps done (Run2 pp setup)?

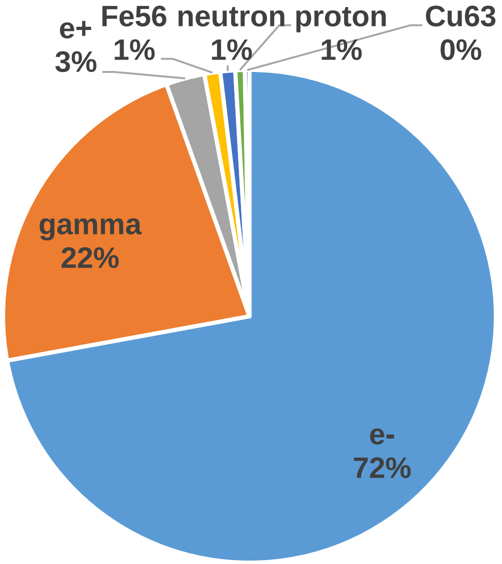


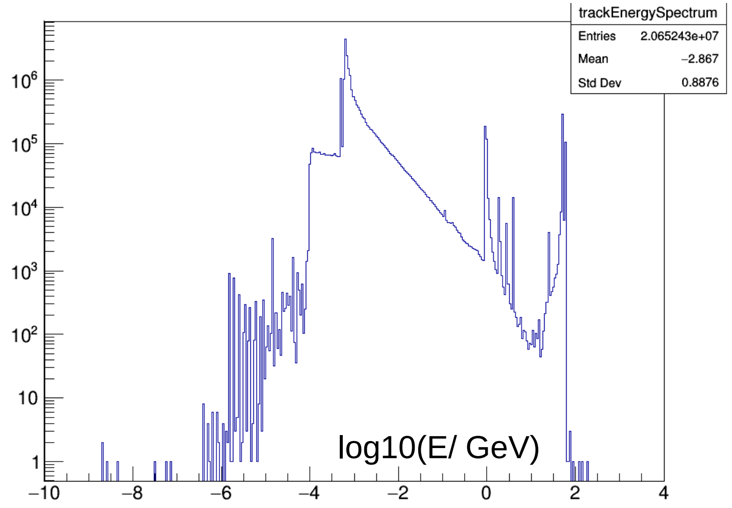
- (Suprisingly) most MC steps are done in non-sensitive detector areas
  - DIPO, PIPE, BODY/ALIC standing out
- AD most important sensitive part (ZDC not included)
- G3/G4 differ somewhat (DIPO, BODY)
- Details for DIPO on next slide

DIPO: Most evident optimization target for G4



- Dominated by a single iron material on A-side !
- Gain up to ~25% by optimizing this





Summary : Finding about sim performance

- Few very dominating materials (voMagnetYoke, PIPE)
  - Should be priority target of optimization
    - Cut optimizations
    - Parametrized/fast simulation
- Too large geometry cuts in general; Too many steps (G3) far away from any detector in mother volume
  - Example: taking out ACORDE reduces mother volume and instantly gives 10% gain for G3
  - In general should try to apply geometry tracking cuts as tight as possible
    - Set Rmax, ZmaxA, ZmaxC, implement “black body” absorber with custom voxels
    - Might need systematic studies
  - Crude / fast transport in ALIC
- AD (apart from ZDC) most resource taking sensitive module
- Tailored productions (taking out certain modules or secondaries) if possible will save resources

How to continue

- Believe we have some evident items to work on!
  - Geometry cuts !
  - Physics parameter tuning
  - Parametrized fast sim for few candidates
- How to organize the work ?
  - Some dedicated task force / discussion forum would be appropriate / essential
  - Where to attach such task force ?
  - Participation and input from PWG and detector experts
- Continuous performance monitoring
  - Wishful to have MC reports (such as included here) generated automatically and visible to collaboration