O2 simulation: Status and News

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Link to WP12 meetings

Outline

- **Detector contributions for Run3**
  - Global Status Update
  - DPL Integration Status
  - Remaining Tasks
- **Updates on simulation resource estimation**: from Run2 to Run3
- **Strongly track-reproducible simulation as a tool for parameter tunings**

Status of detector implementation in AliceO2

Coarse-grained picture

	Start	Planning	Geometry	Hits	Digits	Ready
Passive*			✅	na	na	
ITS			✅	✅	✅	
TPC			✅	✅	✅	
MFT			✅	✅	✅	
EMCAL			✅	✅	✅	
TOF			✅	✅	✅	
FIT(T0+)			✅	✅	✅	
FIT(V0+)			✅	✅		Q2/'19
TRD			✅	✅	✅	Q2/'19
PHOS			✅	✅	✅	Q2/'19
MUON			✅	✅	✅	Q2/'19
HMPID			✅	✅	✅	
ZDC			✅	✅		Q2/'19

- Steady development since last offline week (Dec 2019); arrows indicate which detector had significant changes since last meeting
- Important progress for TRD and MUON (both MCH and MID) in digitization phase; close to ready
- V0+ part of FIT now active; geometry integrated and first version of hits
- HMPID polished digitization and moved to done status
- PHOS agreed to finish developments during the next weeks
- ZDC has code sprint scheduled in May to finish developments

details in session on Wednesday

DPL digitization: Picture

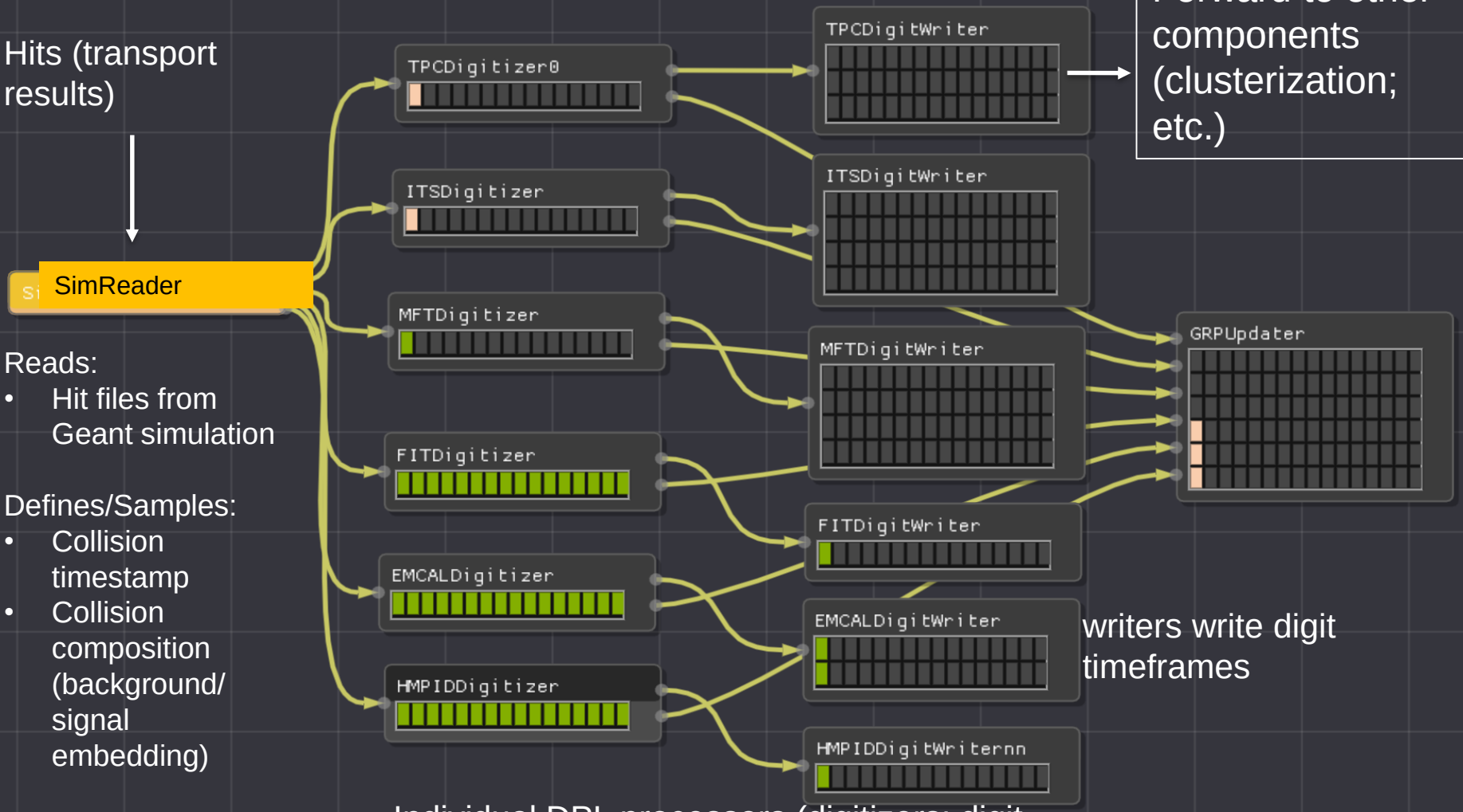
Hits (transport results)

SimReader

Reads:
- Hit files from Geant simulation

Defines/Samples:
- Collision timestamp
- Collision composition (background/ signal embedding)

Invokes digitization processing



Forward to other components (clusterization; etc.)

writers write digit timeframes

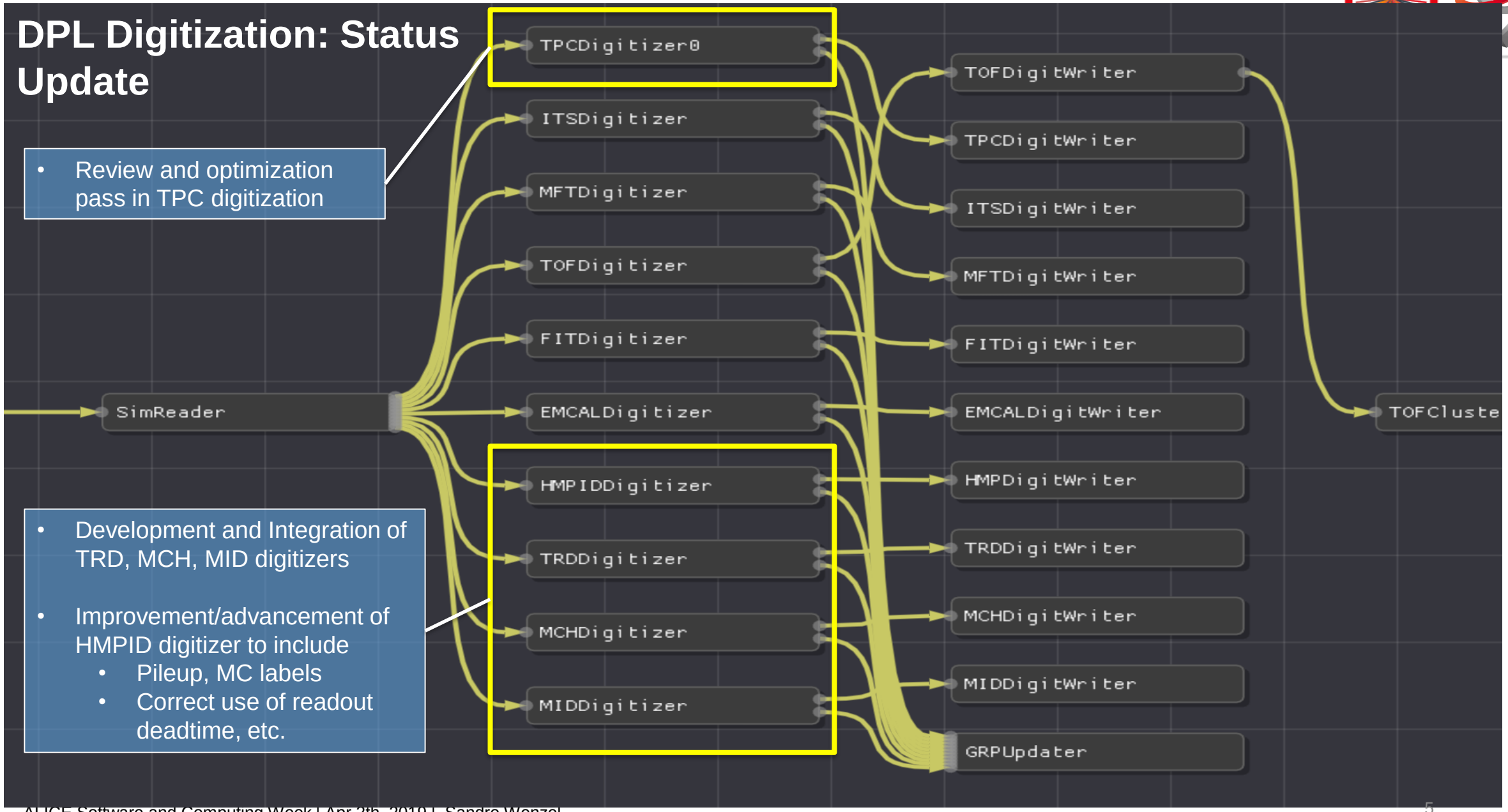
Individual DPL processors (digitizers; digit-consumers) run in parallel

cmd: digitizer-workflow

DPL Digitization: Status Update

- Review and optimization pass in TPC digitization

- Development and Integration of TRD, MCH, MID digitizers
- Improvement/advancement of HMPID digitizer to include
  - Pileup, MC labels
  - Correct use of readout deadtime, etc.



What is missing towards simulation challenge?

- Completed the major part towards simulation data challenge …

Roadmap to September 2019 includes:

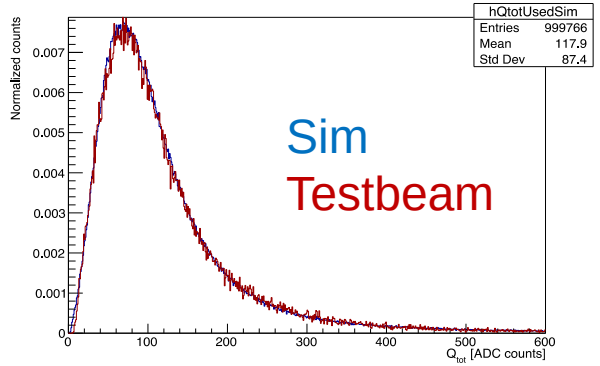
- Few missing pieces in detector code
  - See table in first slide
  - AD, (ACORDE) ?? – not in the loop so far
- CCDB access
- More stress tests with many large events
  - Detectors should should first undertake this individually
- Prepare/test workflow on GRID
- MC digits to raw data format
  - For “horizontal slice / integration” tests
- Work on fast simulation (see later; and tomorrow)
- Fix geometry overlap problems O2-547
- Anything else?

Preliminary !

TPC digitization update

- Dedicated code sprint in Jan 2019 to review O2 TPC digitization code
  - A. Mathis, J. Wiechula, SW
- Achieved very substantial improvement in CPU performance while keeping constant physics quality
  - largely simplified GEM Amplification scheme
    - good agreement with test-beam data (see tomorrow)
  - algorithmic, memory layout and C++ code optimizations
  - see detailed report

Setup	AliRoot	AliceO2 (single core)	Speedup
ppbench : 50 pp (Pythia6)	840s	36s	**23.3 !**
ppbench: 1 PbPb (central Hijing)	1471s	206s	**7.1**
AliDPG : 1 PbPb (Hijing) run 282367	1211s	126s	9.6*
AliDPG : 100 pp (Pythia8_Monash) run 296196	1811s	66s	27*



*includes static distortion in AliRoot; not in O2 – no ion tail treatment at all

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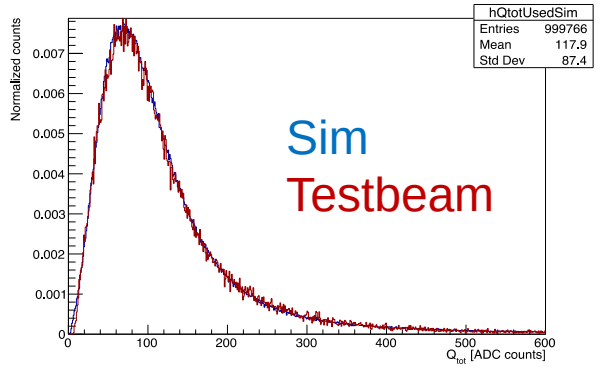

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- **Potentially very positive and significant impact on Run3 CPU resource planning** (see later)
- **Raises** usefulness and **potential impact of fast sim approaches** in (Geant) transport since less bounded by digitization.

*includes static distortion in AliRoot; not in O2 – no ion tail treatment at all

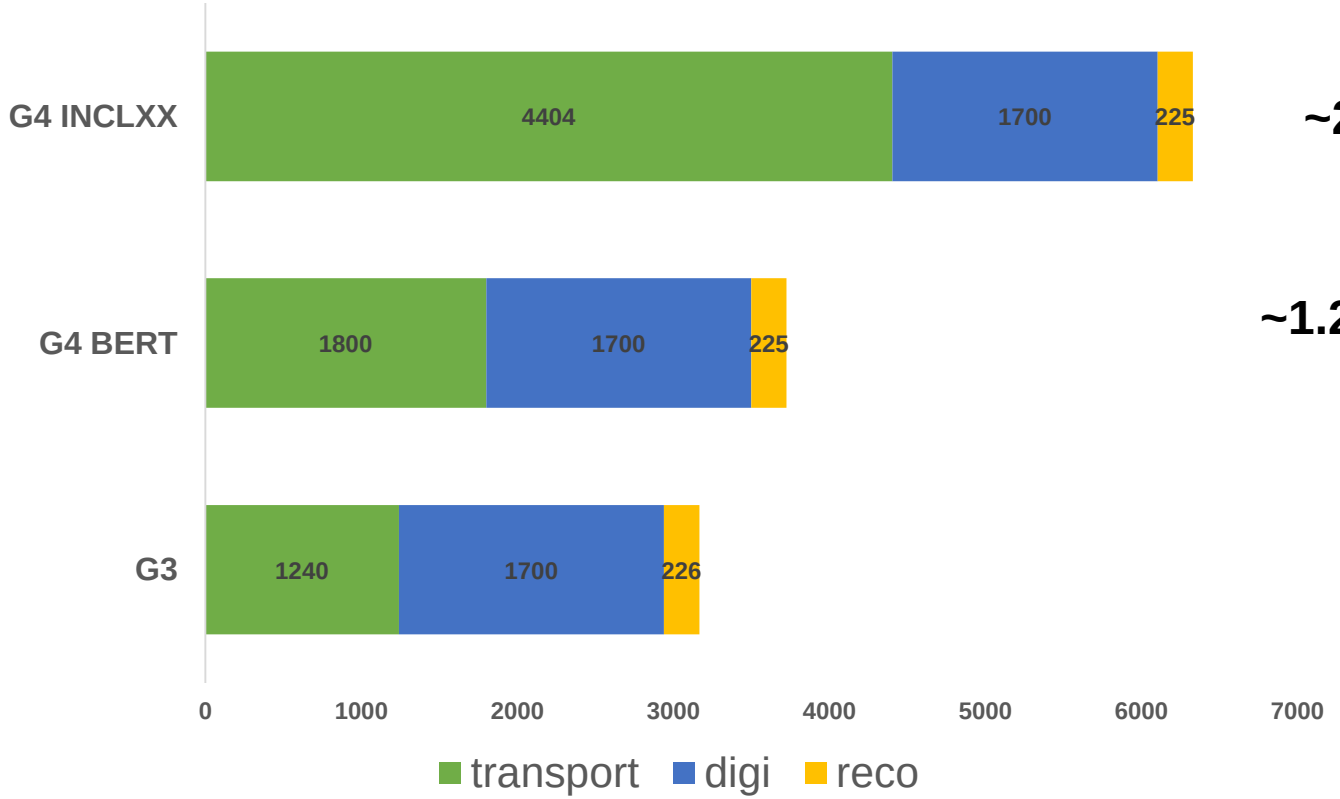
Update on simulation resource planning

- Lately, new effort on getting update on simulation resource usage:
  - Know about G4 vs G3 performance within G4 validation effort
  - Get projection of possible Run3 performance for resource pledges and production planning
  - Be aware of things to improve
  - Identify areas of fast-simulation

- Collected numbers based on a recent general purpose production setup as undertaken for G3/G4 validation (pp)
  - Official AliDPG scripts (e2be46fdc);
  - `dpgsim.sh --run 282367 --mode sim --uid 10 --generator Pythia8_Monash2013 --nevents 100`
  - AliRoot master (b291a1108306); alidist (d3f8bb25c)
  - Dedicated benchmark server Intel(R) Xeon(R) CPU E5-2660 v4 @ 2.00GHz; Ubuntu 18.04; Linux aliendb10 4.4.0-128-generic #154-Ubuntu SMP Fri May 25 14:15:18 UTC 2018 x86_64 x86_64 x86_64 GNU/Linux

Global view on current Run2 performance

- Run2 pp production (100 events; benchmark server); PbPb in progress …
- Separate timings for transport, digi, reco



~2x w.r.t. G3

physics list currently best suiting our needs

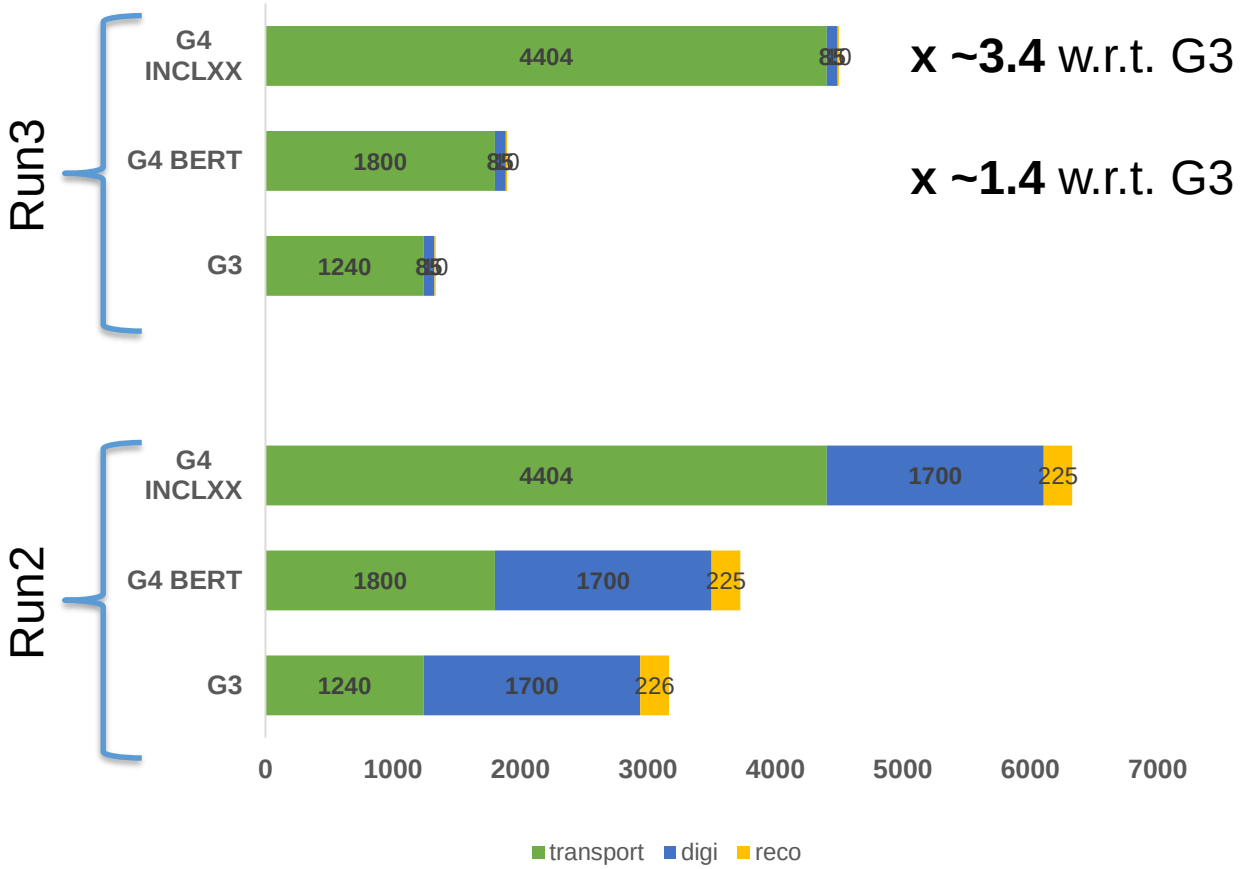
~1.2x w.r.t. G3

standard G4 physics list

digitization time essentially exclusively due to TPC

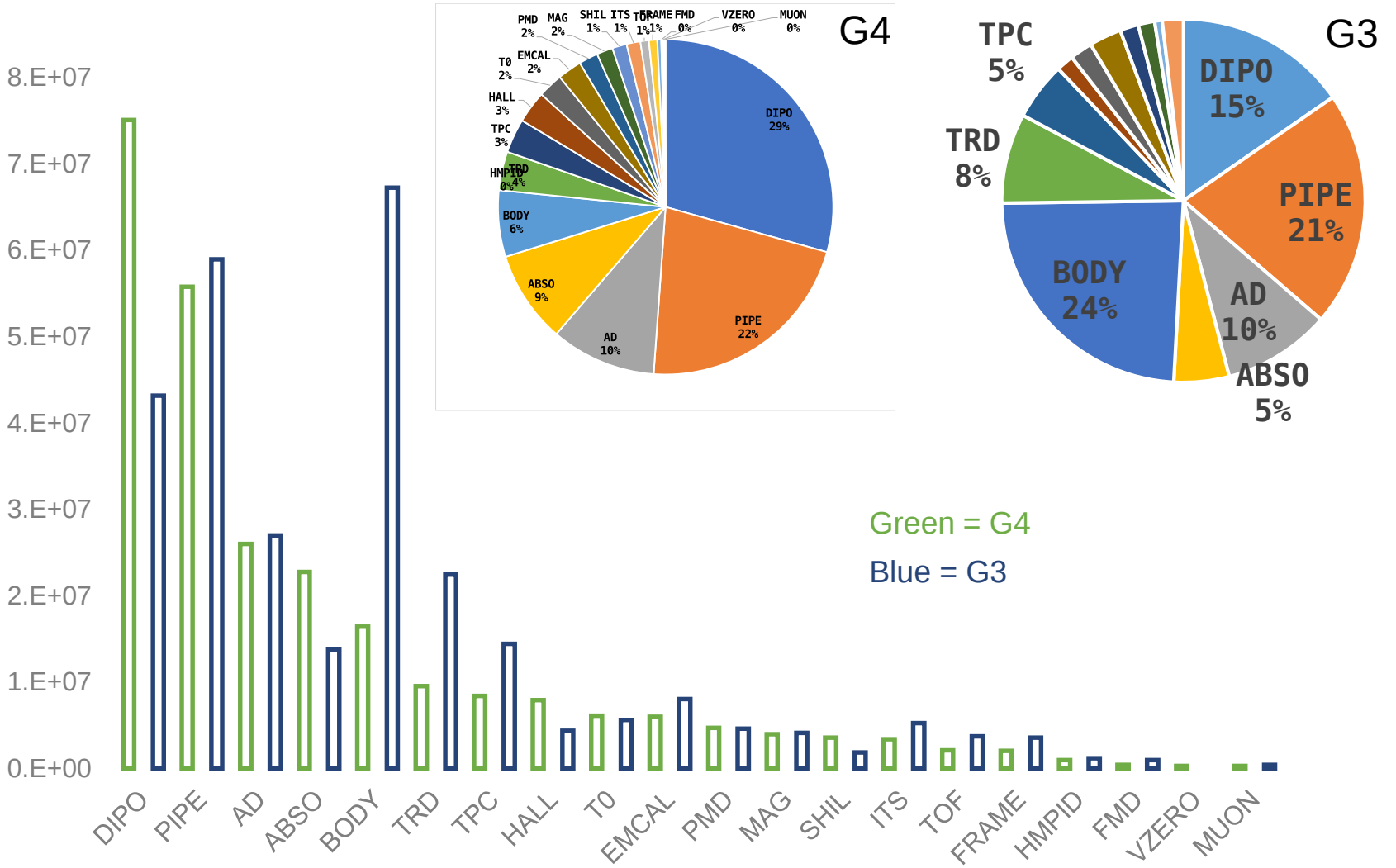
Preliminary !

Extrapolated Performance Part I



- Transport time is approx same in AliceO2
- Reco time and digitization time much smaller
- **For G3 pp productions, a speedup ~2.3 possible**
- Overall impact of G4 will be larger than in Run2
- Increased weight of transport part leads to
  - Call for optimization effort focusing on transport (cuts, parameters)
  - Better applicability of traditional fast-sim methods

Where are MC steps done (Run2 setup)?



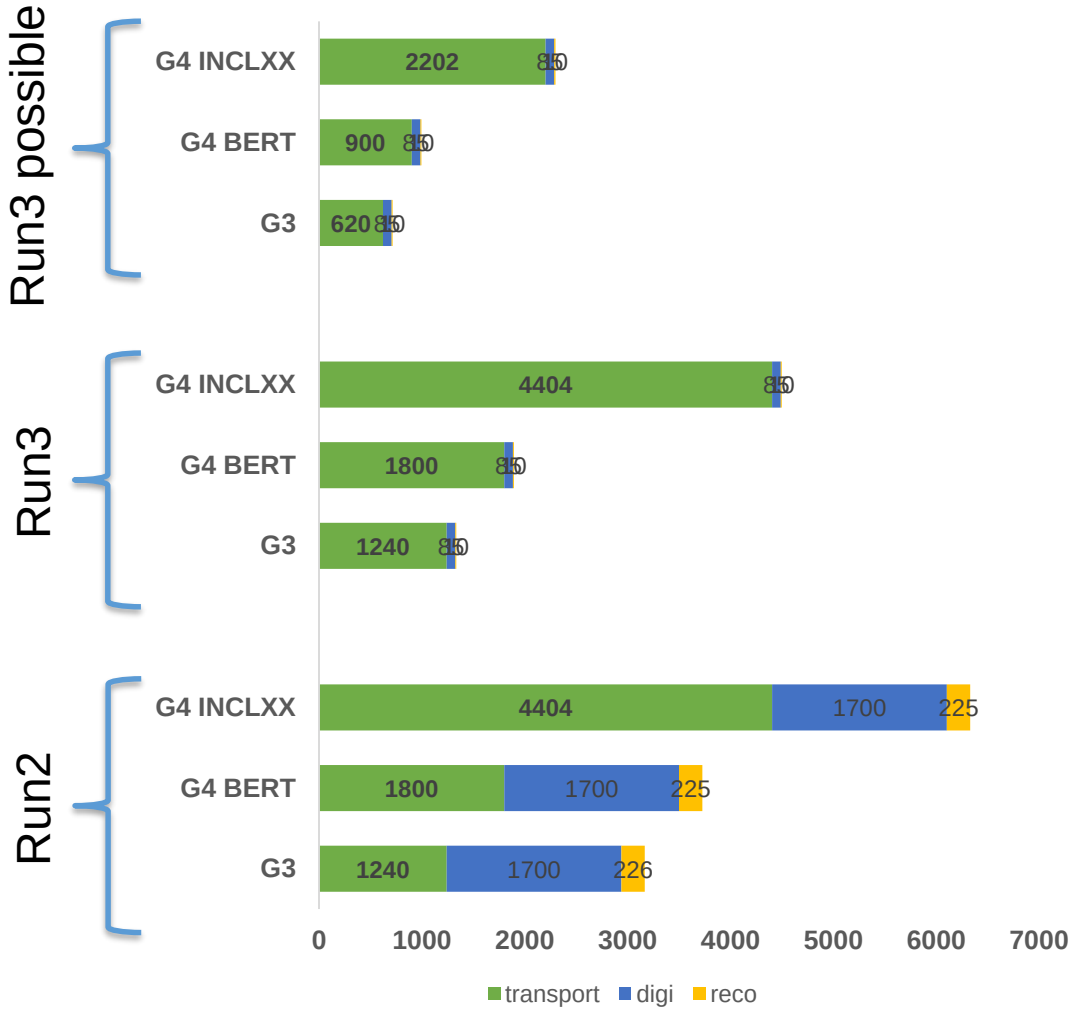
Green = G4

Blue = G3

- (Suprisingly) most MC steps are done in non-sensitive detector areas
  - DIPO, PIPE, BODY
- AD most important sensitive part (ZDC not included)
- DIPO actually dominated by a single volume “voMagnetYoke” (iron) on the A-side
- **In summary, certainly lot’s of tuning potential !**

Preliminary !

Extrapolated Performance Part II

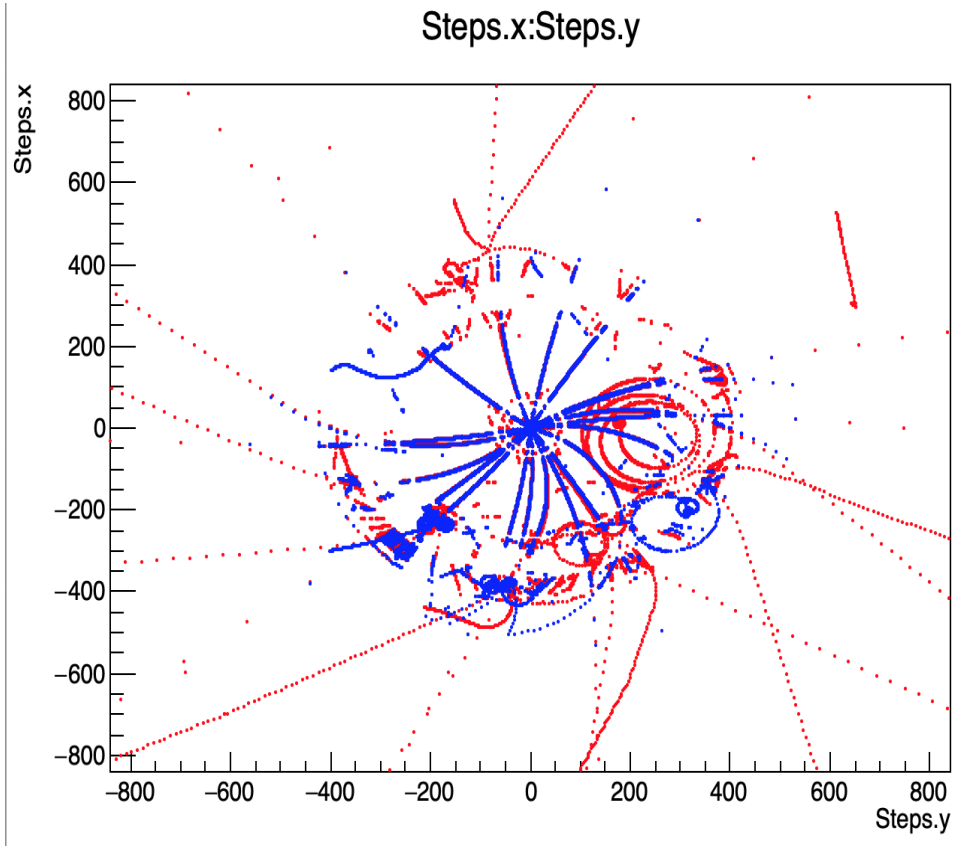


- **Reasonable assumption:**
  - Manage to gain factor of 2+ in transport based on monitoring data
    - Stronger (geometry) cuts
    - Review of parameters
    - Possible fast sim modules for DIPO, PIPE, etc.
    - VecGeom instead of TGeo
- G3 productions could be an estimated ~4.2 faster than today
- Together with embedding technique, this should be a good step forward
- Ideas to use G4-INCLXX only in inner tracker and G4-BERT elsewhere to close gap

Strongly reproducible simulation on track level

We would like to perform tuning of sim parameters …

- Unfortunately using the canonical way of random number seeding will (almost always) **alter the global evolution of an event**
  - Under identical initial conditions (event + seed) the tracks will evolve differently when we apply a outer geometry cut (blue) vs not cut (red)
- Causes **large fluctuations in physical properties** which makes quantifying effect of parameter change hard
- Recently implemented a “strongly track reproducible simulation” mode
  - Re-seed RNG at **start of each track**
  - Calculate seed deterministically as function of track-properties (without history)
  - Related to ideas investigated during a Google-Summer-of-Code project (D. Savin, J. Apostolakis, SW) and ideas to have reproducible sim in multi-threaded environments (GeantV R&D)

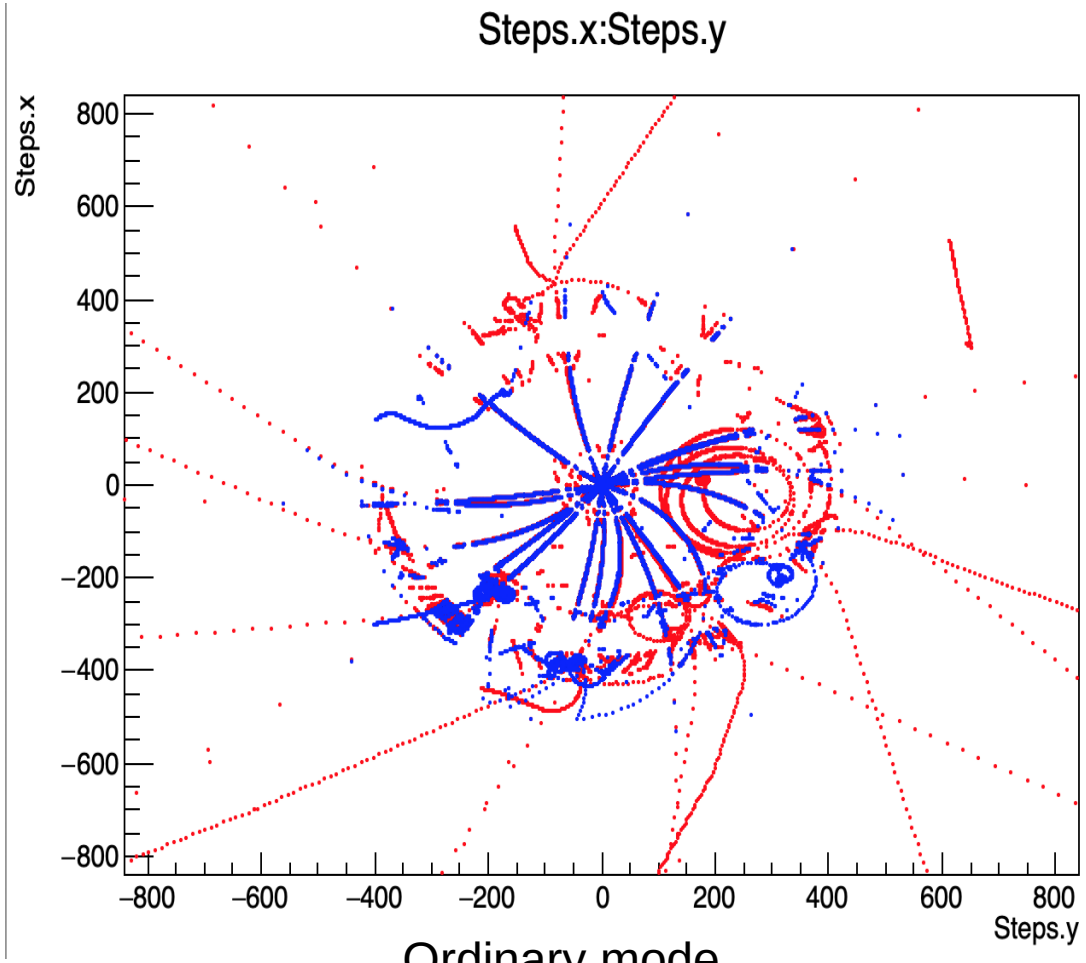


- AliceO2/pull/1722

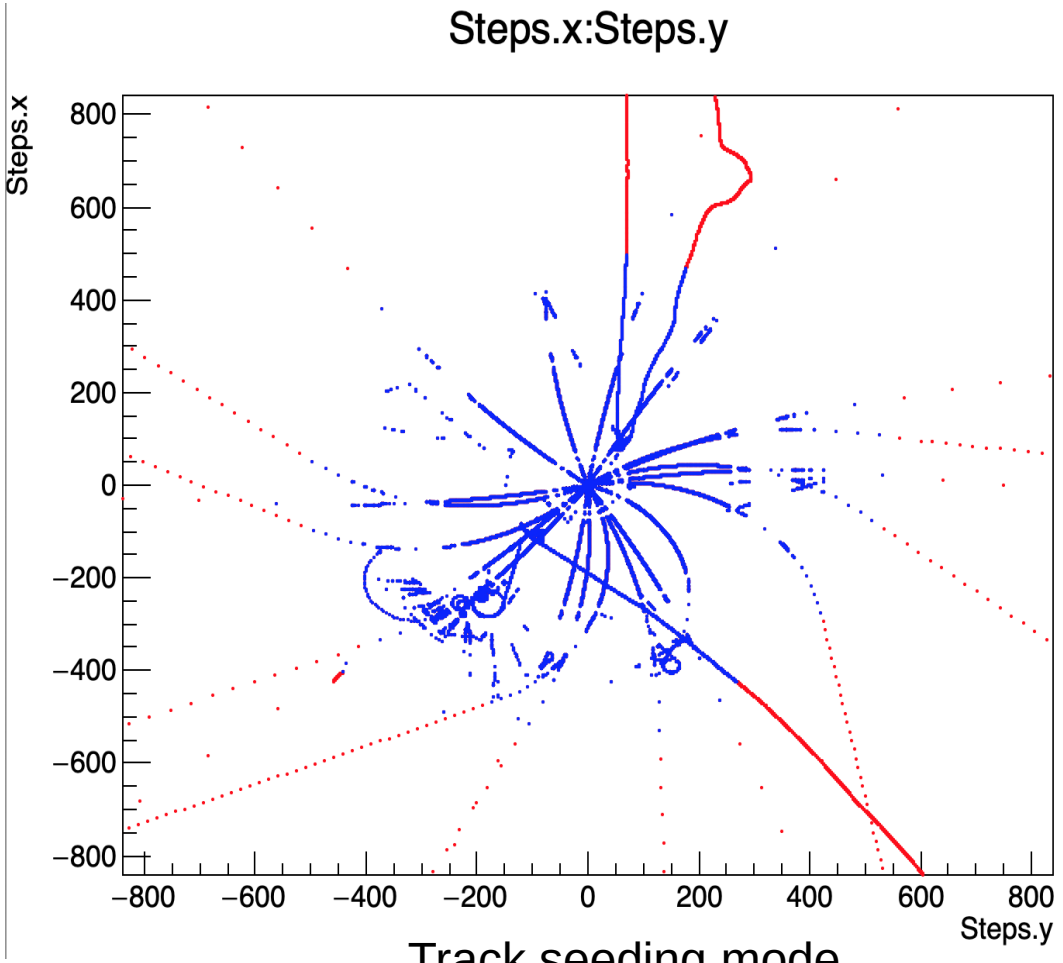
```
o2sim -n 1 -m PIPE ITS TPC TOF --seed 2 [--configKeyValues="SimCutParams.trackSeed=1”]
```


Effect of track seeding

Demonstrate effect with 1 (same) event (ITS, TPC, PIPE, TOF only); red = no geometry cut; blue = cut at R=5m



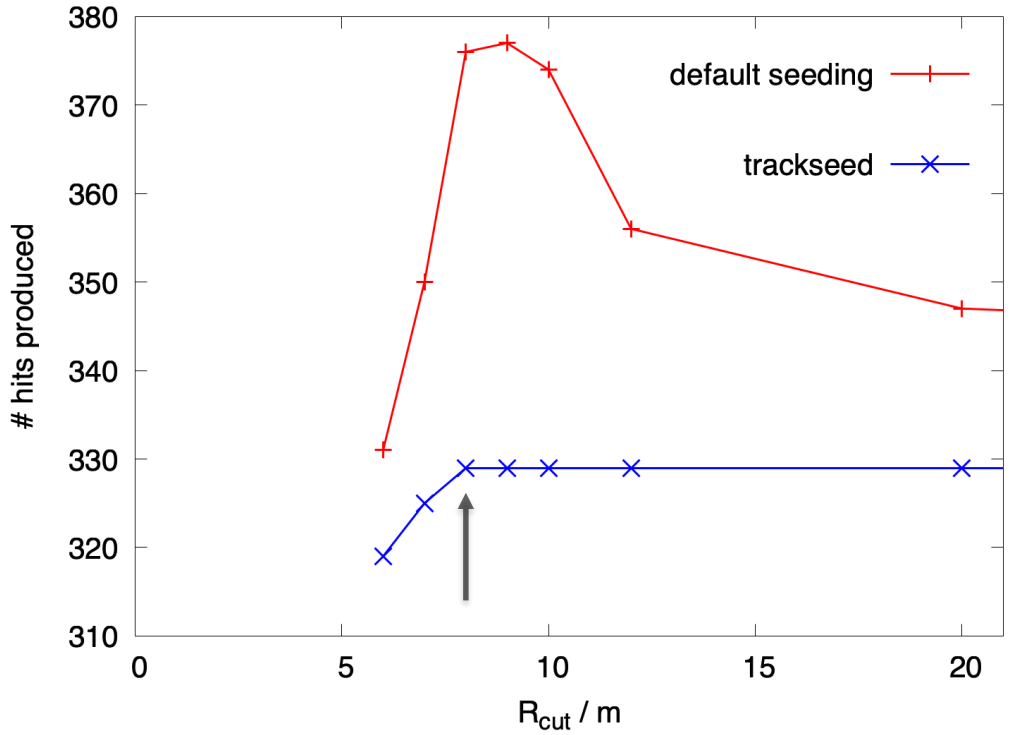
Ordinary mode

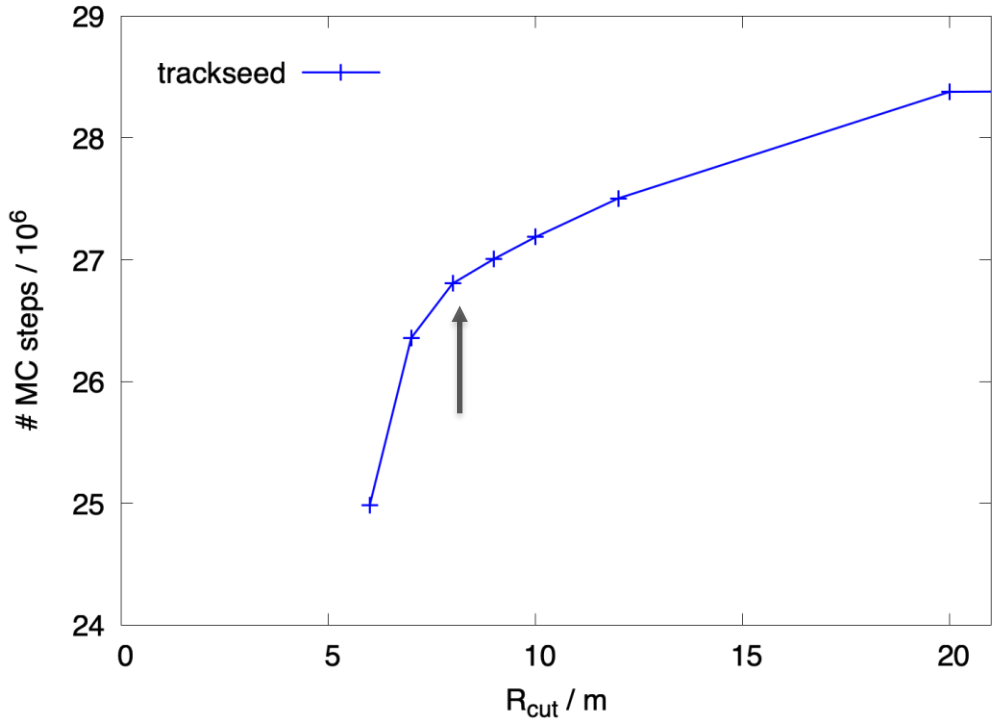


Track seeding mode

Example use: Geometry cut optimization in central barrel simulation

- Study influence of geometry R cut (say R=20m to 6m)
- With track seeding we can easily identify R=~8m as having **no influence** on TOF.
  - Below that probably less backscattering particles from magnet.
- R=8m already reduces MC steps by 10% compared to no cut !





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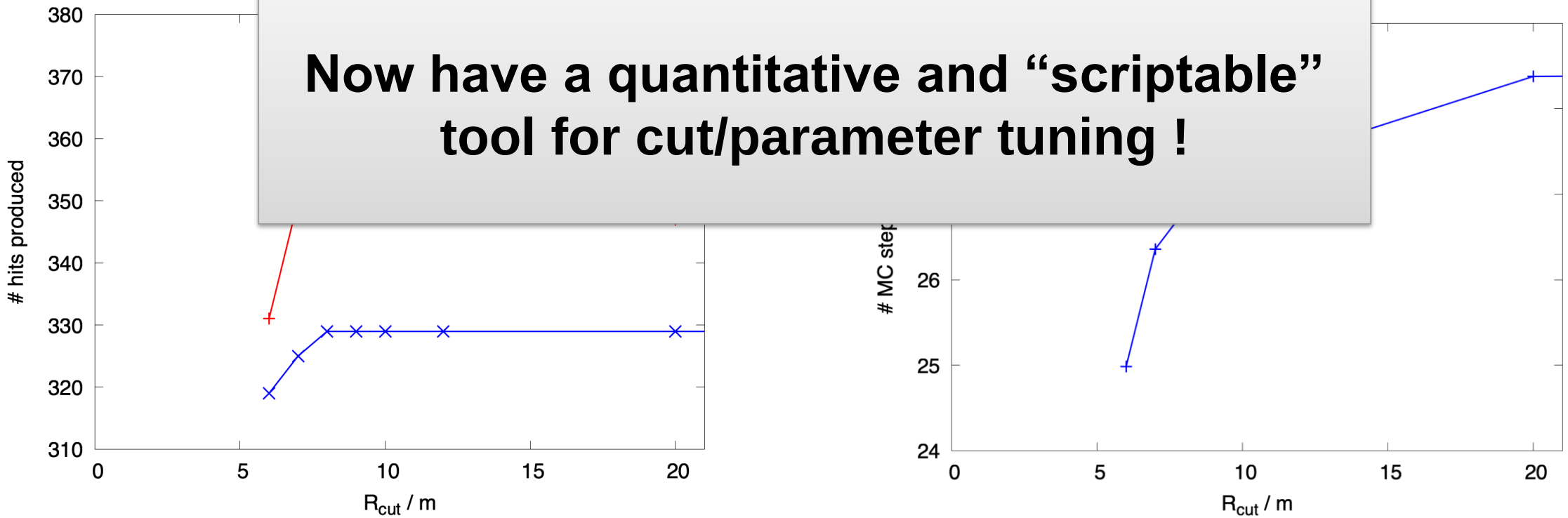


Now have a quantitative and "scriptable" tool for cut/parameter tuning !

Thanks for your attention !

Backup section

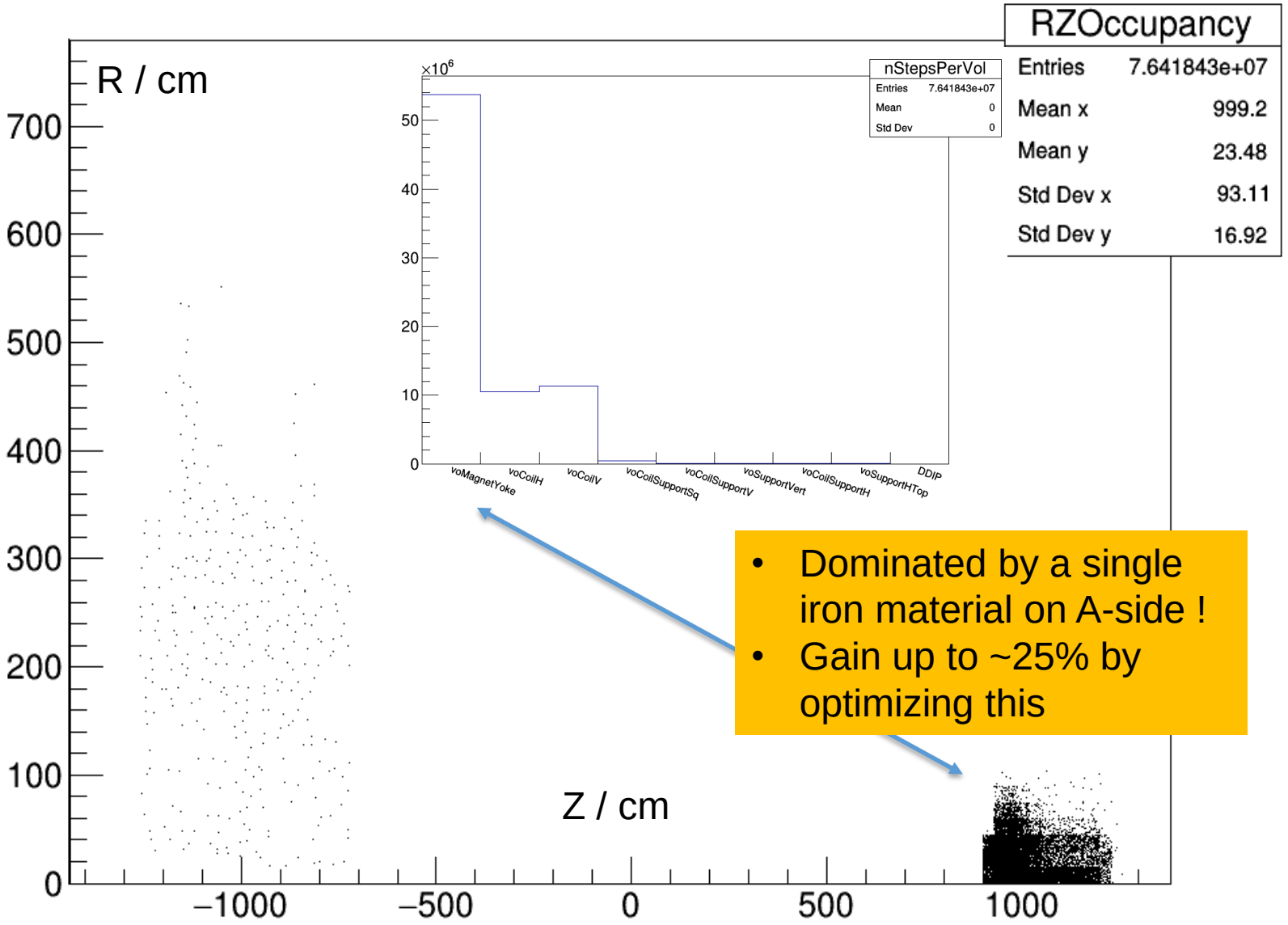
DPL digitization: Status table

- Detector with first DPL integration:
  - TPC, ITS, MFT, EMC, TOF, FIT(T0), HMPID, TRD, MUON
- Rough feature status for available code (red when change w.r.t. Dec. 2018)

	Basic DPL version	MC labels	Digit embedding / pileup
TPC, ITS, MFT, HMPID	done	done	done
TOF, EMC	done	done	?
FIT(T0), TRD, MUON	done	-	-

- Detectors yet to do DPL workflow integration
  - PHOS, ZDC, V0+

DIPO: Most evident optimization target for G4



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