Session 1B: Computing Performance

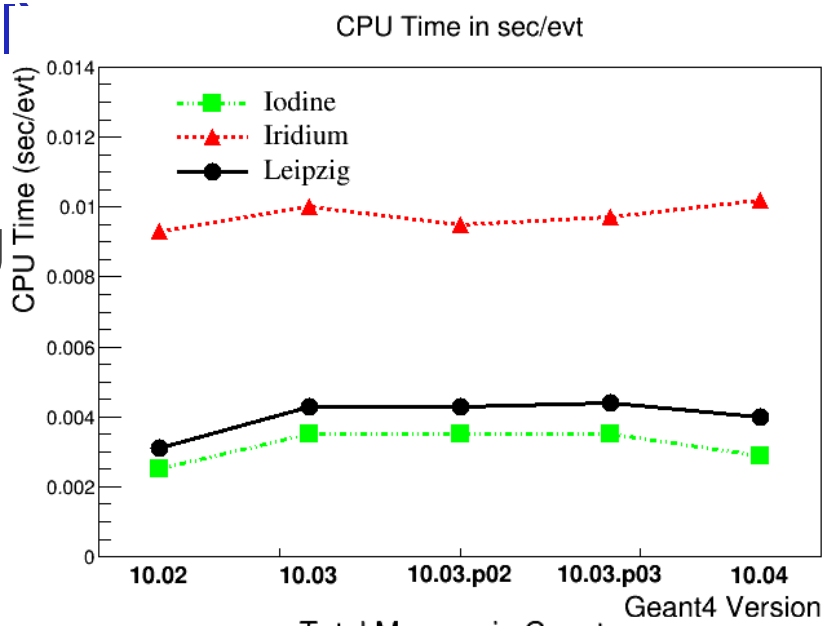
(co-chaired by Gunter Folger and Soon Yung Jun)

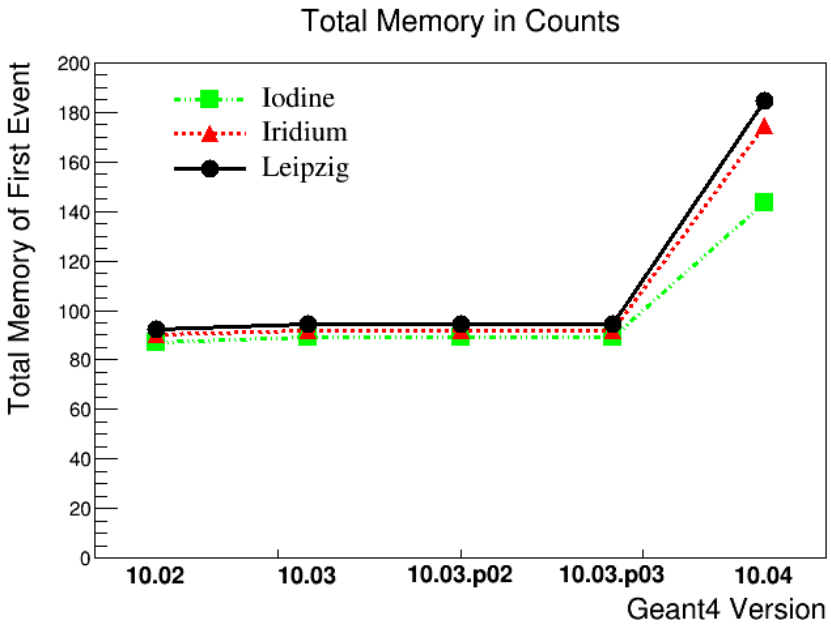
Profiling for low energy physics	*Kihyeon Cho*	14:00 - 14:15
Medcial Domain	*Susanna Guatelli*	14:15 - 14:30
ALICE	*Ivana Hrivnacova*	14:30 - 14:45
ATLAS	*John Apostolakis*	14:45 - 15:00
CMS	*Victor Daniel Elvira*	15:00 - 15:15
Intensity Frontier	*Krzysztof Genser et al.*	15:15 - 15:30

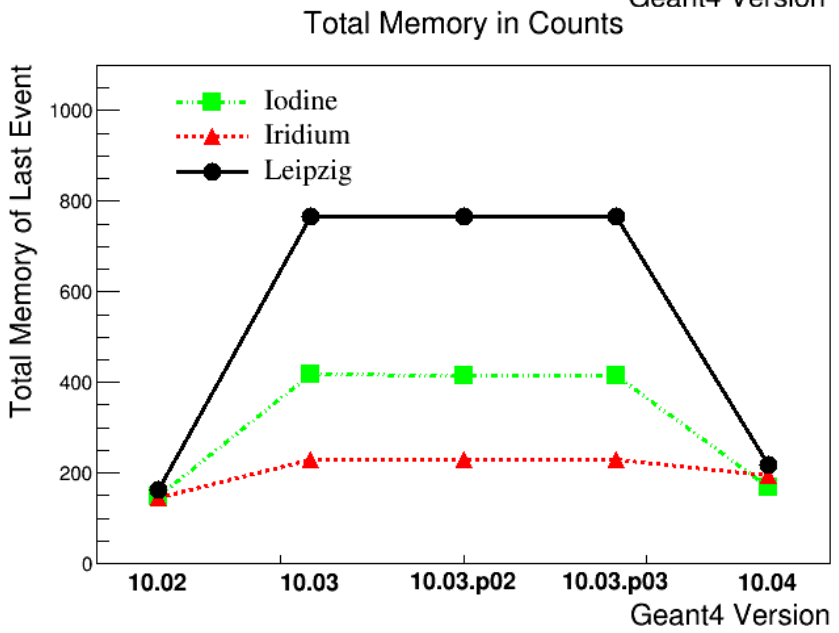
Geant4 Profiling for Low Energy Physics

Kihyeon Cho, Insung Yeo (KIST

- Brachytherapy
  - Source: Iodine, Iridium, Leipzig
  - QGSP_BIC_EMY/EMZ/LIV
  - Dependency on the mesh size
  - Scaling studies on HPC







- Detail profiling results will be cross-linked to the G4CPT webpage

Geant4 Performance for Medical Physics Applications

Susanna Guatelli (Univ. of Wollongong)

- Still MC is too slow for a clinical use ← MT is very useful

Ideally O(min) !!!	1 CPU (~ 3GHz)	Local cluster (200 CPUs)
Brachytherapy Geant4 TPS	~60 days	~ 7 hours
ProtonCT	~90 days	~ 11 hours
Microbeam Radiation Therapy	~ 1.4 years	~2.5 days
Study of novel nanoparticles to enhance radiotherapy clinical outcome (Geant4-DNA)	~1.6 years	~ 3 days
Neutron dosimetry in external X-ray	~3 years	~ 5 days

- How to improve
  - Software: Variance reduction, Phase space Files, Reverse MC
  - Hardware: GPU, use of HPC systems (ex. Supercomputer)
- Propose to profile a light-weighted "Neutron dosimetry in external X-ray radiotherapy (only Geant4 part)

ALICE Experiment

Ivana Hrivnacova(PNO IN2P3/CNRS), Sandro Wenzel (CERN)

- Run2-AliRoot Geant4 Productions on Grid
  - Last big: 5.5M (took 18y 168d), 10.1.p03, FTFP_BERT_EMV
  - Latest configuration: switched to
    - FTFP_BERT_EMV → FTFP_INCLXX_EMV (~20% slower, but results are much closer to G3 and data)
    - Default stepper → Nystrom (~9% speed up)
  - The physics analysis has not yet moved to Geant4 due to remaining issues (q/pT, $\delta\phi$,θ) in the General Purpose productions
- Run2-AliRoot → Run3-ALICE-O2 (many cores, HPC ready)
  - Run2-AliRoot: O(GBs) of memory/event, O(h) CPU/event
  - Multi-processing parallelism based on FairMQ: sub-event level parallelism and collaborative simulation (copy-on-write late fork)
  - Multi-threading parallelism based FairRoot: event level parallelism with Geant4MT

ATLAS Computer performance: a brief update

J. Apostolakis (CERN, contribution by J. Chapman, H. Gray)

- Geometry improvements: G4Box, G4Trap, complex Polycone)

Effect of G4Solid patches on ATLAS Computing Performance

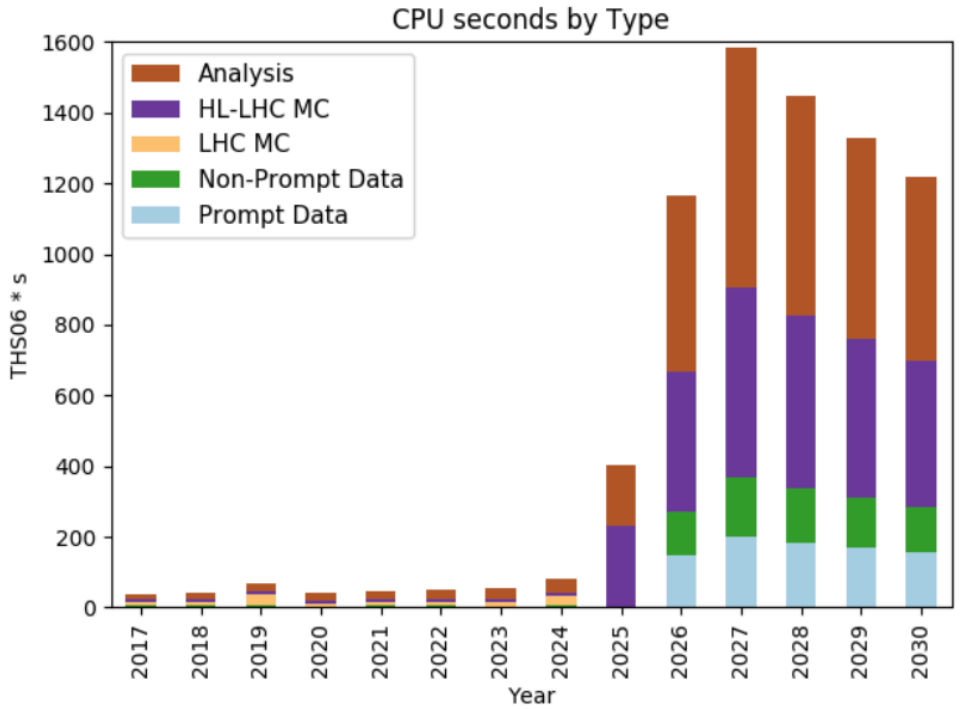
Patch	G4 10.1.patch03.atlas02 (MC16 Production version)	G4 10.1.patch03.atlas07 (latest G4Solid patches)
Standard Simulation <CPU/event> (relative)	1.0	0.97
G4Exception instances during standard simulation of 500 events	63 - Track stuck or not moving. 8 - Proposed step is zero; hstep = 0 ! 1 - Expected normal-global-frame to be valid	None
Fast Simulation (ATLFASTII) <CPU/event> (relative)	1.0	0.95

- Other performance improvements in the work for ATLAS
  - A. Dotti combined all ATLAS code with a G4 dependency into a single library (linked to static G4 build) → Ben Morgan
  - Athena + 10.5.beta + VecGeom (also Ben)
  - Profile guided optimization and bias option for further speedup

CMS Experiment

Daniel Elvira (Fermilab)

- Past improvements
  - ~3-5x speedup mainly by shower library and Russian roulette
- 2018 improvements:
  - ~7-10% VecGeom (scalar mode)
  - ~8-10% G4ClassicalRK4 → DormanPrince745 + smart tracking
- Challenges of HL-LHC era
  - Geometry (21M elements)
  - Need more simulation events
  - Better physics accuracy
- Efforts in different avenues
  - Early testing with GeantV
  - Efficient use of HPC system
  - ML techniques for FastSim



Intensity Frontier

Soon Yung Jun, Krzysztof Genser, Robert Hatcher (Fermilab)

- Muon experiments (Mu2e, Muon g-2): no critical Geant4 computing issues are identified (with 10.3.patch) → 10.4 MT
- Liquid Argon TPC simulation: LArSoft + DUNE (Far detector)
  - LArSoft/DUNE-Far Detector workflow
  - Geant4 fraction of simulation chain: CPU 3%, Memory 35%
- Summary of Profiling
  - CPU: (Fast) Optical photon simulation
  - Large memory footprint: hit scoring in finely-voxelized stepping, lookup-table for (Fast) optical photons
  - Flops/Momory ops: Geant4/detsim/reco = 7.20e-04/0.35/0.24
  - Neither simulation and reconstruction are fast, but it seems there are no critical bottles from Geant4 itself
- Intensity frontier experiments are actively adopting recent versions of Geant4 (10.3.p01+) and moving to Geant4MT