

Requirements of LHC and other HEP energy frontier experiments

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Outline

- ATLAS
- CMS
- LHCb
- ALICE
- CALICE
- FCC
- Reminder of HEP-related Open Requirements

ATLAS

- Hadronic physics processes for **c**-mesons and **b**-mesons
 - Work of this started this year in Geant4, for both cross sections and final states
- Being able to deal with particles with pre-defined zero life-times
 - On-going discussion with Makoto, but the assumption that there is a minimum (non-zero) lifetime or propagation distance seems to be deeply embedded into Geant4
- Ability to set up physics processes without needing to create a G4RunManger
 - In order to be able to use hadronic physics in FATRAS
- Moving away from storing G4 physics data tables on **afs** to either CVMFS/eos or a database?
 - Already available in `/cvmfs/geant4.cern.ch/share/data`

CMS

- CMS plans to use the coming Geant4 release, **10.6**, as its 2021 production version for Run3

See CMS-related talks by Sunanda Banerjee and Vladimir Ivanchenko for more details about Geant4 physics and computing performance in CMS

LHCb

- Hadronic physics processes for **c**-mesons and **b**-mesons in Geant4
 - Same request as ATLAS
- Ability to set up physics processes without needing to create a G4RunManager
 - Same request as ATLAS
 - For LHCb, it would allow to plug in their fast simulation (but at the moment is a lower priority)
- Ability to set a parametrised description of volumes
 - This would allow the VELO RF foil description obtained from data to be used
- Review of hadronic cross sections for protons and anti-protons

ALICE

Same requirements as presented one year ago in Lund:

- Already open requirement #4703
 - On FTFP_INCLXX ... see last slide
- Support for "sub-event" parallelism across G4 threads
 - Since ALICE has very big events it would be very valuable to get one event done quicker
- Benefit from VecGeom developments
 - In particular, Geant4 interface with VecGeom navigation, the same way possible for TGeo
- Interest in tests with monopole physics
 - As the monopole physics is provided only in a Geant4 example, ALICE has to duplicate the classes (G4*) from the Geant4 example in Geant VMC. This duplication could be avoided if these classes are provided with Geant4 source

CALICE (1/2)

- Timing in hadronic showers is very important for CALICE
- How valuable are CALICE 'pointlike' events ?
 - i.e. events in which basically the primary particle is only scattered but which create spikes in the energy deposition
 - The advantage of these events is that they are far less complicated and thus maybe interesting
- CALICE supports and would like to see the continuation of the G4 effort of implementing CALICE prototypes into the G4 validation chain
 - SiW ECAL test-beam is nearly completed but not yet integrated in geant-val
- There is a deficit to describe data in gaseous sensitive media
 - e.g. transverse shower profile and number of hits in CALICE SDHCAL

CALICE (2/2)

- Very helpful to have the ability to track changes w.r.t. to reference versions by easy switching between older and recent physics lists by e.g. a plug-in mechanism for physics lists

Note: there will be a CALICE Meeting at CERN next week, so we will meet and discuss with them

FCC

- Important to model very high-energy physics effects for FCC-hh
 - The main issue is the lack of gluon-jet emissions in the current Geant4 string models (FTF and QGS)
 - On-going activity to compare very energetic jets between FTFP_BERT and “CRMC_FTFP_BERT” (where EPOS is used)

Reminder of HEP-related Open Requirements

4701 : More realistic matrix element for decays $\tau \rightarrow \nu + \text{hadrons}$

- Originator
 - CMS, at the 47th Technical Forum
- Scope
 - The current implementation of tau decays to hadrons uses phase space decay. More realistic matrix elements are requested
- Responsible
 - Vladimir Ivanchenko
- Status
 - Open
 - Similar requirement expressed by ATLAS earlier – with suggestion to use external decayer. But in view of HL-LHC it would be useful to extend Geant4 decays of heavy particles and in some cases use more accurate final state

4702 : Inclusion of gamma polarization effects in the high-energy EM models

- **Originator**
 - CMS, at the 47th Technical Forum
- **Scope**
 - Include Linear Polarization into high-energy gamma models
 - This has a potential usage in the analysis of $H \rightarrow \gamma \gamma$
- **Responsible**
 - Vladimir Ivanchenko
- **Status**
 - Open
 - Difficult requirement; development to be included in coming years plans

4703 : Improve light nucleon production in FTFP_BERT

- **Originator**
 - ALICE, at the 2018 Collaboration meeting in Lund
- **Scope**
 - ALICE switched to FTFP_INCLXX physics lists (to cope with a deficit of light ions in FTFP_BERT), but this costs extra CPU
 - Request to improve light ion production in FTFP_BERT (while keeping support to FTFP_INCLXX)
- **Responsible**
 - Alberto Ribon, Dennis Wright
- **Status**
 - Open
 - Solution (based on “Generic Biasing”) to use INCLXX only in the Tracker region (while using BERT elsewhere) under testing