Outcome of the GeantV prototype – HSF meeting

15.10.2019

Witek Pokorski for the GeantV team

GeantV R&D Project

- has been carrying an extensive R&D program to investigate new approaches that aim to exploit modern computing architectures which could improve the performance of the simulation applications in the experiments
- international collaboration with CERN, FNAL, BARC, IPN, UNESP
 - with the support of DOE, CERN openlab, Intel









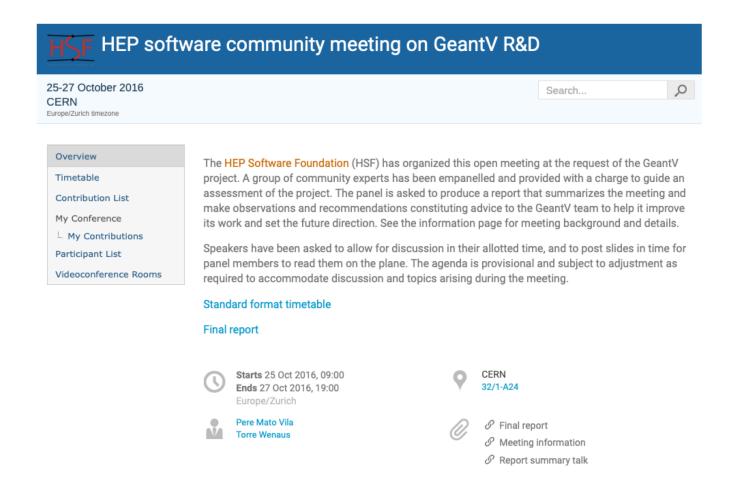






Previous event

• this meeting is a follow up of community meeting in October 2016



Simulation R&D motivations

- future accelerators (HL-LHC, FCC) experiments will benefit (require) with large speed-up in detector simulation (one of dominant CPUtime consumers)
 - some say they require an order of magnitude speed-up in simulation
- GeantV R&D explores vectorized particle transport for next generation simulation toolkit
 - aiming at demonstrating the speed up of simulation using a novel approach to concurrent processing and data handling
 - allows to exploit vector operations on modern CPU

Project timeline

- First ideas proposed by Rene Brun end of 2010
- R&D work on parallel transport started ~2012
 - First prototypes available in ~2013
- 1st HSF Community meeting on GeantV October 2016
 - Final <u>report</u> available
- Alpha release of the GeantV demonstrator March 2018
 - no vectorized physics
- Beta (final) release of the GeantV demonstrator August 2019
 - full EM shower vectorized demonstrator

GeantV goals (as presented at the previous meeting)

- Develop a detector simulation framework with a multithreaded transport engine that exploits data locality and explicit SIMD vectorization.
- Design the code from the ground up for maximum performance on modern computing architectures. The code will be portable to different CPUs and accelerators such as (but not limited to) GPGPUs and Xeon Phi machines.
- Start either from Geant4 physics models and improve them in performance and accuracy or develop entirely new models, whatever is the most appropriate.
- Achieve computing time speedup factor of 3-5 on complex (LHC-size) HEP detectors for improved physics performance with respect to Geant4. Investigate and understand the limitations to reach a factor of 10.
- Integrate full and fast simulation capabilities in a single detector simulation framework.

Development since the previous HSF meeting

- implemented demonstrator to assess the achievable speed-up in realistic (LHC geometries, full EM physics) conditions
 - vectorization of full EM shower transport
 - vectorized EM physics models, magnetic field propagation and geometry
 - performance tuning for the core scheduler
 - performance tuning for magnetic field

 performed a set of validations and benchmarks with respect to Geant4 in identical (physics) setup

Goals for this meeting

 Discuss the prototype implementation to understand the technical solutions that have been tested

Discuss the performance obtained

Discuss possible implications on Geant4

Discuss future R&D directions

Some resources

- GeantV goals
- webpage: http://geant.cern.ch
- gitlab repository: https://gitlab.cern.ch/GeantV/geant/tree/master
- some publications: http://geant.cern.ch/content/publications

- 1st GeantV HSF meeting: https://indico.cern.ch/event/570876/overview
 - report: https://hepsoftwarefoundation.org/assets/GeantVPanelReport20161107.pdf
 - report summary talk: https://indico.cern.ch/event/581258/contributions/2357212/attachments/1378380/2208103/GeantVReportTalk20161128.pdf

GeantV team

<u>CERN</u>: G. Amadio, Ananya, J. Apostolakis, M. Bandieramonte, R. Brun, F. Carminati, G. Cosmo, A. Gheata, M. Gheata, I. Goulas, F. Hariri, V. Ivantchenko, G. Khattak, D. Konstantinov, P. Karpinski, P. Mendez Lorenzo, K. Nikolics, M. Novak, E. Orlova, W. Pokorski, A. Ribon, O. Shadura, S. Sharan, S. Vallecorsa, S. Wenzel

<u>FNAL</u>: S. Banerjee, Ph. Canal, D. Elvira, K.L. Genser, S.Y. Jun, J.G. Lima, K. Pedro

BARC: A. Bhattacharyya, S. Behera, H. Kumawat, R. Sehgal

<u>IPN</u>: J. Martínez Castro, A. Miranda, A. Maldonado-Romo, Oscar R. Chaparro Amaro

<u>UNESP</u>: G. Amadio (now CERN), C. De Paula Bianchini, R. Iope, S. Novaes

Agenda

