

# 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



Núcleo de Computação Científica - UNESP



Intel Parallel Computing Centers

# Previous event

- this meeting is a follow up of [community meeting](#) in October 2016

## HEP software community meeting on GeantV R&D

25-27 October 2016  
CERN  
Europe/Zurich timezone


- Overview
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The **HEP Software Foundation** (HSF) has organized this open meeting at the request of the GeantV project. A group of community experts has been empanelled and provided with a charge to guide an assessment of the project. The panel is asked to produce a report that summarizes the meeting and make observations and recommendations constituting advice to the GeantV team to help it improve its work and set the future direction. See the information page for meeting background and details.


Speakers have been asked to allow for discussion in their allotted time, and to post slides in time for panel members to read them on the plane. The agenda is provisional and subject to adjustment as required to accommodate discussion and topics arising during the meeting.


[Standard format timetable](#)

[Final report](#)

 **Starts** 25 Oct 2016, 09:00  
**Ends** 27 Oct 2016, 19:00  
Europe/Zurich

 CERN  
32/1-A24

 [Pere Mato Vila](#)  
[Torre Wenaus](#)

 [Final report](#)  
[Meeting information](#)  
[Report summary talk](#)

# Simulation R&D motivations

- future accelerators (HL-LHC, FCC) experiments will benefit (require) with large speed-up in detector simulation (one of dominant CPU-time 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
- 1<sup>st</sup> HSF Community meeting on GeantV - October 2016
  - Final [report](#) 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>
  
- 1<sup>st</sup> 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

CERN: 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

FNAL: 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


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


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





# Agenda







## GeantV HSF meeting and discussion

 Tuesday 15 Oct 2019, 14:00 → 18:00 Europe/Zurich

 32/1-A24 (CERN)

 Witold Pokorski (CERN)

**Videoconference Rooms**  GEANTV\_Weekly\_meetings [Join](#)   32/1-A24 

- 14:00** → 14:10 **Introduction**  10m   
Speaker: Witold Pokorski (CERN)
- 14:10** → 15:10 **Design, implementation and performance results of the GeantV prototype.**  1h   
Speaker: Andrei Gheata (CERN)
- 15:10** → 16:00 **Conclusion and discussion**  50m   
Speaker: Pere Mato Vila (CERN)