



Physics and Detector Simulation Projects in the Scientific Computing Division

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The Detector Simulation Group

“Detector Simulation” name is misleading; we also do “Physics Simulation” (generators), and ROOT development

- Physics Simulation:
 - PYTHIA (generates particle collision events)
 - GENIE (neutrino generator that includes first interaction)
- Detector Simulation:
 - GEANT4 (models particle passage through matter and EM fields)

Projects: GEANT4, PYTHIA, GENIE (objects of this talk!)

Support: simulation applications, consulting for intensity frontier experiments, future colliders, detector R&D (not reporting today!)



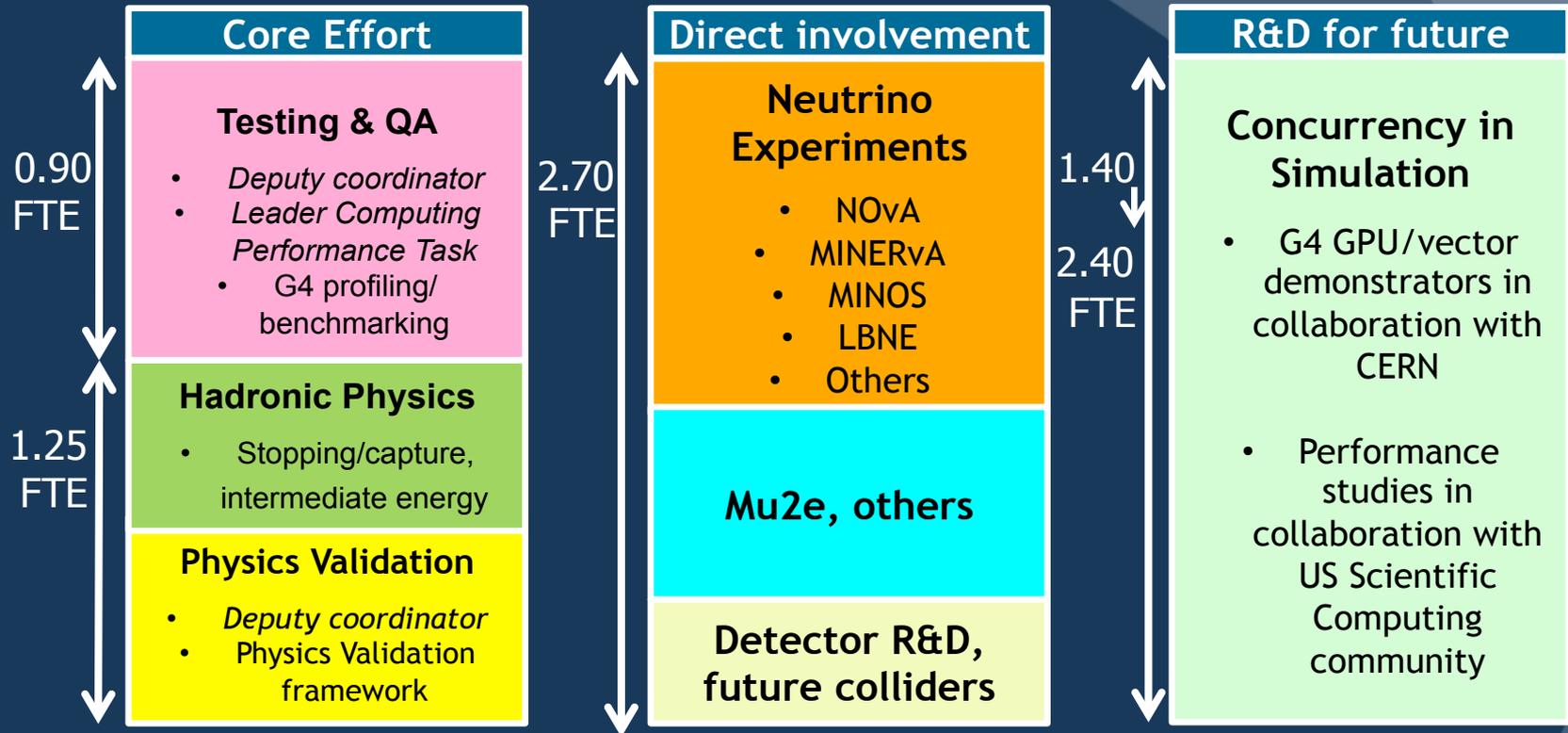
GEANT4 Project

GEANT4 is the prime detector simulation tool used in HEP and other areas of research (medical, space, ...)

- Used by most Fermilab experiments and projects
- DS-ADSS team participates in “GEANT4 Collaboration” (tool kit development, R&D on future platforms, user support)
- **Physics Model Development & Validation:**
 - Validation framework, hadronic physics and muon stopping/capture models, validation packages
 - ART based G4 validation package for intensity frontier to improve models, customize “physics lists”
- **R&D toward track level parallelization of G4**
 - DOE FWP in collaboration with ASCR, partnership with CERN SFT
- **G4 Computing Performance Task**
 - FNAL leads the G4CPT within the G4 Collaboration



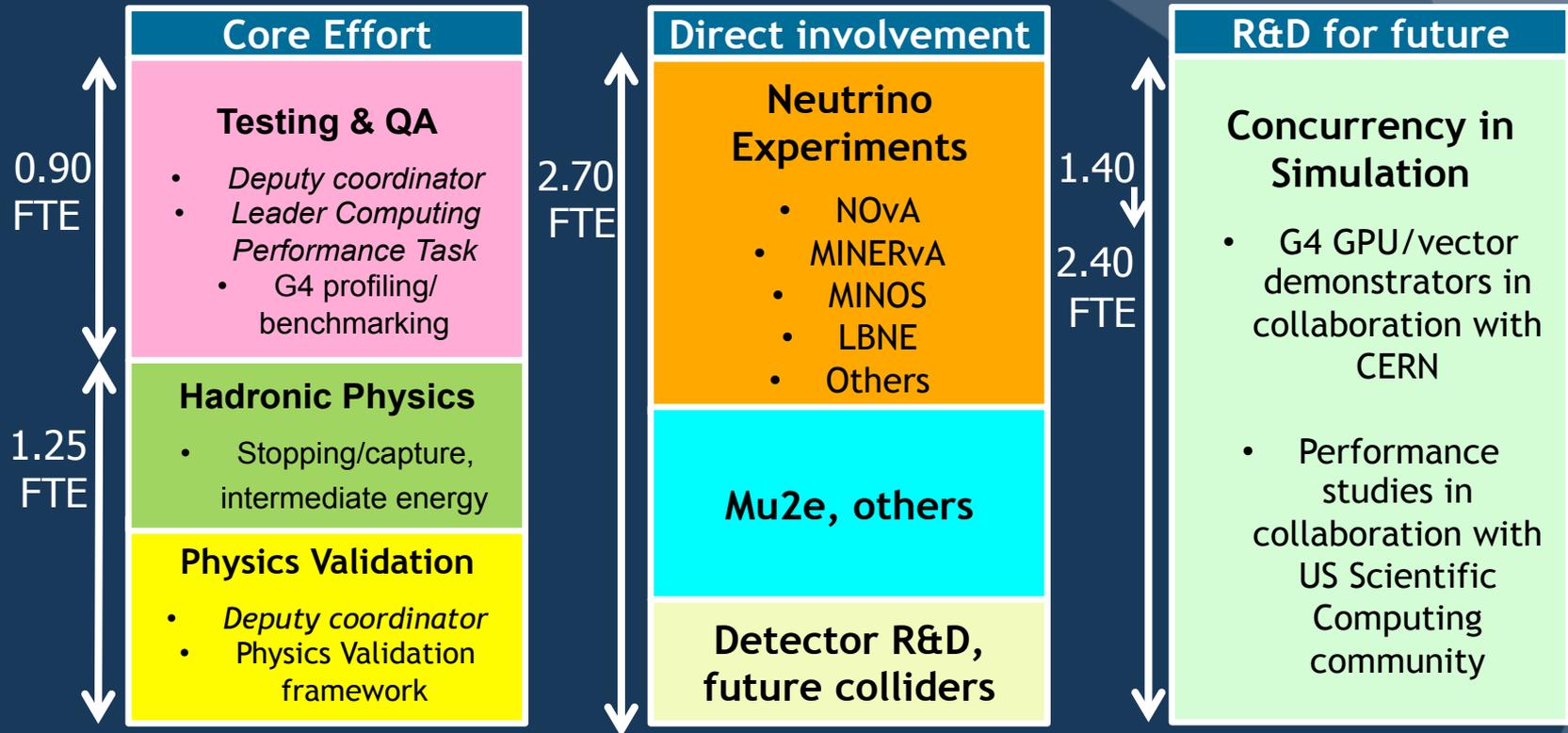
Geant4 Effort at FNAL



- Fermilab contributes to the Geant4 core effort (SCD base funding – detector operations),
- G4 application development & support of the FNAL scientific program (experiment/project funding),
- R&D for the future (US Department of Energy project funding FWP)



Geant4 Effort at FNAL



Contributing members: Ph. Canal, D. Elvira, K. Genser, R. Hatcher, J. Kowalkowski, S. Jun, M. Paterno, H. Wenzel, J. Yarba



Physics Generators at FNAL

Essential tool used by every HEP experiment

Used by most Fermilab experiments and projects (CMS, MINOS, Minerva, ArgoNeut, NOvA, μ BooNE, LBNE, ...)

- PYTHIA

- Fortran version is frozen, most effort on PYTHIA8 (C++)
- Steve Mrenna is co-developer and author (0.15 FTE - a lot more if we count his time on CMS support)

- GENIE

- International Collaboration, Robert Hatcher is a member and local developer and expert (~0.5 FTE)
- Effort needed in the area of evaluating and implementing ν -nucleus cross-sections (first interaction)

The community is requesting more help from SCD in both areas.
Need to add more manpower at the level of at least 1 FTE



New Directions

The DS group has phased out CMS simulation development & support (still doing CMS generators) and steered onto:

- Software infrastructure and physics modeling (detector simulation & generators) needed by the intensity frontier, detector R&D

Fermilab Neutrino Program and Geant4 Simulation

chaired by Julia Yarba (FNAL)

Monday, March 4, 2013 from 15:00 to 16:05 (US/Central)
at Fermilab, Wilson Hall (WH_1North)

Description Esnet-ReadyTalk Phone Conference Information

<http://esnet.readytalk.com>

or

Dial-in number 866-740-1260

Access code 6148087

Monday, March 4, 2013

15:00 - 15:05	Introduction 5' Speaker: Dr. V. Daniel Elvira (Fermilab) Material: Slides
15:05 - 15:15	Simulation Tools in the Neutrino Experiments 10' Speaker: Dr. Robert Hatcher (FNAL/CD) Material: Slides
15:15 - 15:25	Application of Geant4 Hadronic Physics Models in Simulation for Neutrino Experiments 10' Speaker: Dr. Julia Yarba (FNAL) Material: Slides
15:25 - 16:00	Round Table Discussion 35' Material: Minutes

Held meeting with neutrino community about their needs on simulation & G4 physics →
Action items & work plan

Plan to do the same for generators



New Directions

The DS group has phased out CMS simulation development & support (still doing CMS generators) and steered onto:

- R&D efforts to re-engineer software tools to run on HPC systems, generated funding opportunities

Annual Concurrency Forum Meeting

4-6 February 2013 *Fermilab*
US/Central timezone

Overview

Scientific Programme
Timetable
Contribution List
Author index
Registration
Registration Form
List of registrants

The **Concurrency Forum** is an outcome of the "Workshop on Concurrency in the many-Cores Era" held at Fermilab in November 2011 to explore the possibility that interested High Energy Physics (HEP) institutions and projects collaborate on concurrent frameworks and applications R&D. The function of the Forum is to communicate and exchange information and results.

The goals for the February 2013 annual meeting are the following:

- We would like to discuss progress made with each demonstrator, drawing conclusions for those that have completed their work programme and identifying topics that still need to be investigated.
- It would be nice if each collaboration (experiments, Geant4 etc.) could report on its current views on parallelism issues, such as choice of concurrency model and software technologies. This will be an opportunity for us all to discuss and see if we can converge on a common overall strategy.
- One outcome of the meeting is the possibility of launching development projects with specific deliverables that can be of benefit to the whole community. The extra day can be used by interested groups to get together and to start to discuss a programme of work.

“Concurrency Forum Annual Meeting”
co-organized with CERN at FNAL

FWP with Scientific Computing

OHEP-ASCR R&D Effort Towards Geant4 Re-engineering

May 20th, 2013

Report Period: October 2012-May 2013

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1 Introduction

Precise modeling of particle interactions with matter in systems with complex geometries is essential in experimental high-energy physics (HEP) and certain accelerator and astrophysics applications. Because of the impact of this type of simulation, it is imperative that the HEP community has access to computational tools that provide state-of-the-art physical and numerical algorithms and run efficiently on modern computing hardware. Geant4 [1] is a toolkit for the simulation of particle-matter interactions that has been developed for almost twenty years by an international collaboration of physicists and computer scientists. The most commonly used simulation tool in experimental HEP, Geant4 incorporates physics knowledge from modern HEP and nuclear physics experiments and theory.

In 2012, the Fermilab group took interest in the opportunities offered by new computing technology and started to explore the possibility to parallelize Geant4 at the level of tracks and run many-threads in multi-core CPU and GPU systems. Towards the end of 2012, FNAL, UNC, USC, ANL joined forces and made a proposal to build on the powerful physics capabilities of Geant4 by evolving the software infrastructure and numerical algorithms of the toolkit to utilize on these emerging new technologies. The two years plan that resulted from the proposal utilizes the combined strengths of the ASCR and OHEP investigators to:

- Pursue the low hanging fruit, gathering performance gains based on knowledge and tools that already exist and just need to be appropriately applied.
- Perform a set of experiments to understand what the ultimate performance gain could possibly be in a highly parallelized environment.

The outcome of these experiments could then be a plan that serves as the foundation of a larger, multi-year effort to restructure Geant4, in coordination with the broader Geant4 collaboration and the users community.



What you will see today

Members of the team will go through the projects: description and scope, milestones, status, future

- Geant4 Physics (K. Genser)
- Geant4 R&D (Ph. Canal)
- Generators: PYTHIA, GENIE (S. Mrenna)