Physics and Detector Simulation Projects
in the Scientific Computing Division

V. Daniel Elvira for the DS-ADSS group

Fermi National Accelerator Laboratory

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!)
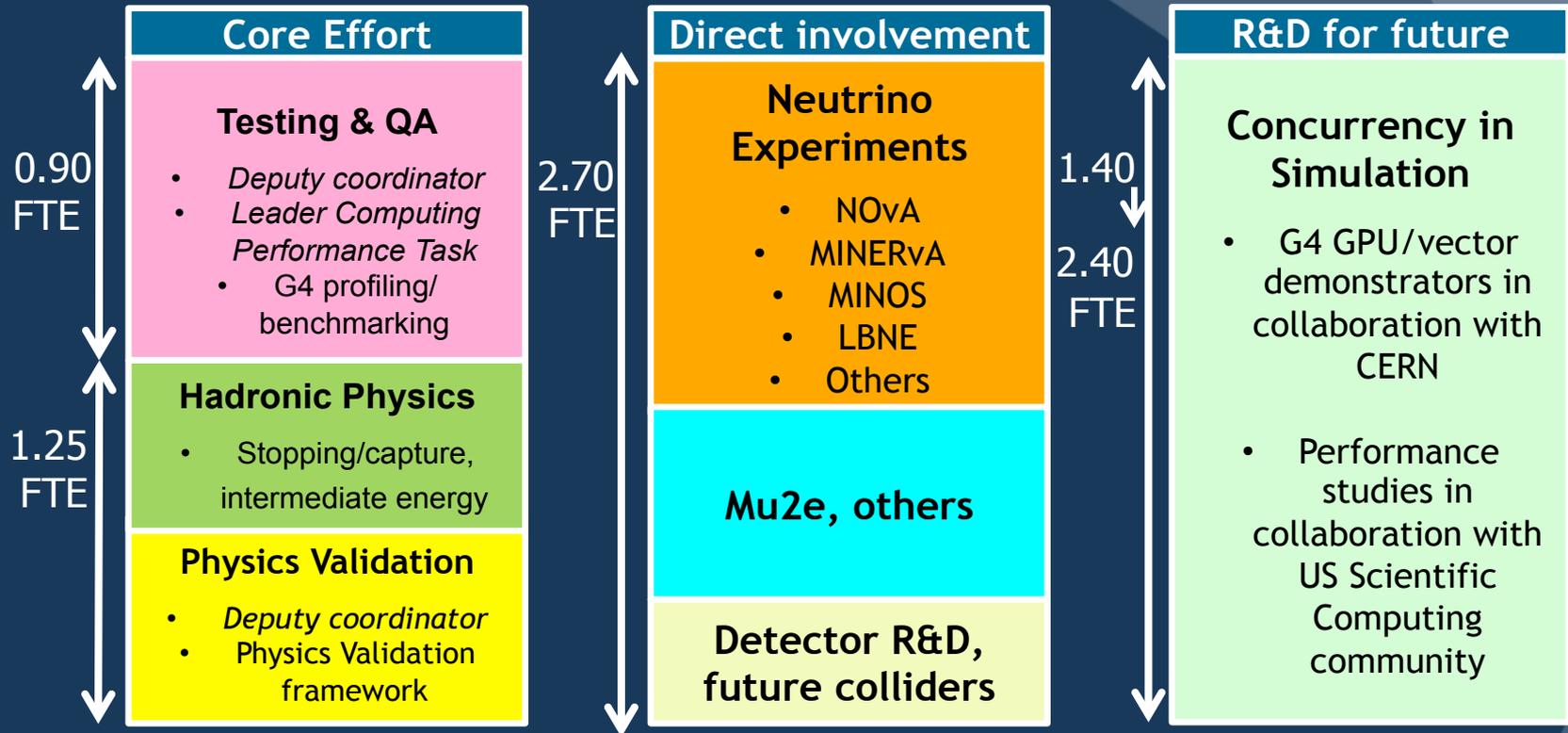
V. Daniel Elvira

2

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
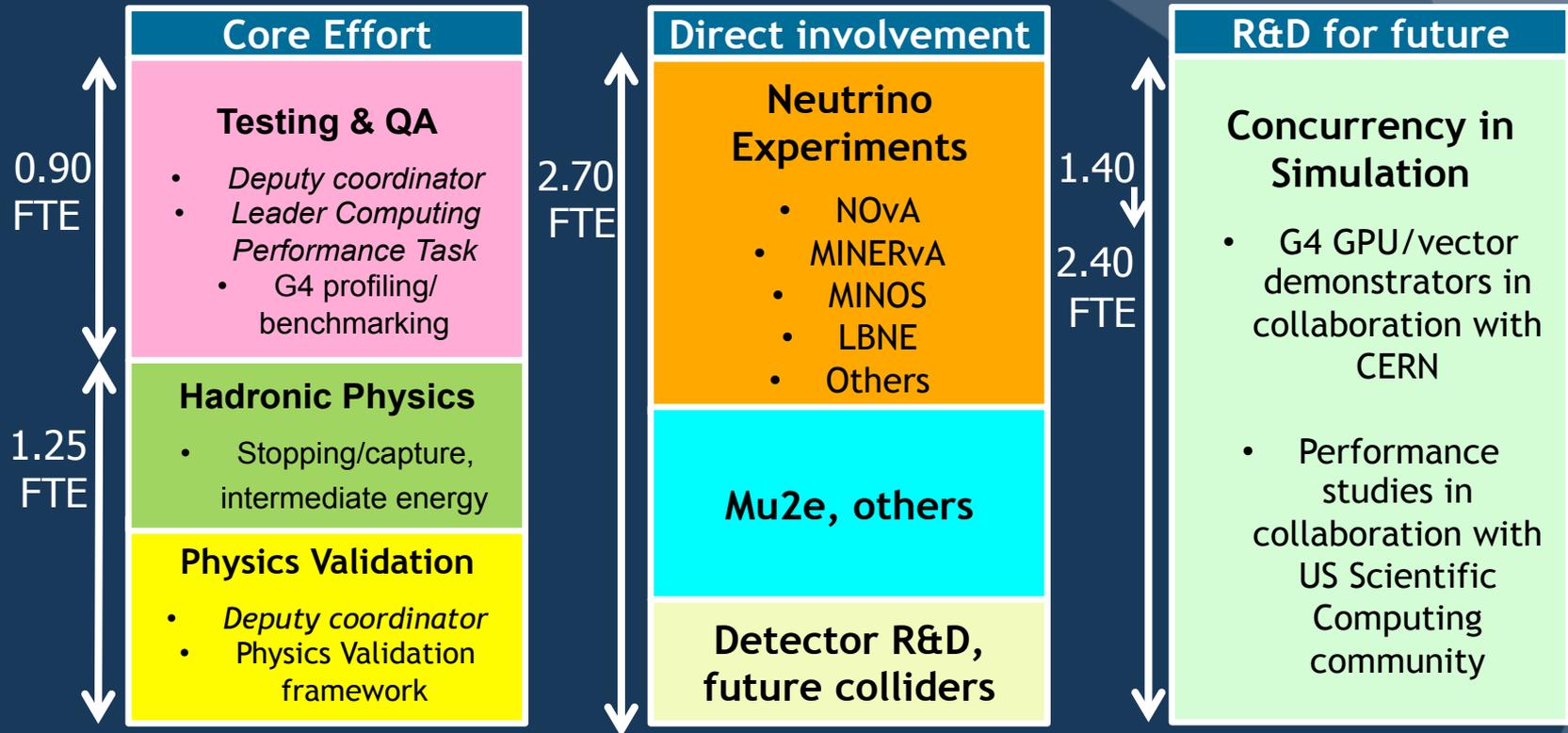 - ➢ FNAL leads the G4CPT within the G4 Collaboration

Geant4 Effort at FNAL

Core Effort

0.90 FTE

Testing & QA
- *Deputy coordinator*
- *Leader Computing Performance Task*
- G4 profiling/ benchmarking

1.25 FTE

Hadronic Physics
- Stopping/capture, intermediate energy

Physics Validation
- *Deputy coordinator*
- Physics Validation framework

Direct involvement

2.70 FTE

Neutrino Experiments
- NOvA
- MINERvA
- MINOS
- LBNE
- Others

Mu2e, others

Detector R&D, future colliders

R&D for future

1.40 FTE

2.40 FTE

Concurrency in Simulation
- G4 GPU/vector demonstrators in collaboration with CERN

- Performance studies in collaboration with US Scientific Computing community

- 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)

V. Daniel Elvira

4

Geant4 Effort at FNAL

Core Effort

Testing & QA
- *Deputy coordinator*
- *Leader Computing Performance Task*
- G4 profiling/ benchmarking

Hadronic Physics
- Stopping/capture, intermediate energy

Physics Validation
- *Deputy coordinator*
- Physics Validation framework

0.90 FTE

1.25 FTE

Direct involvement

Neutrino Experiments
- NOvA
- MINERvA
- MINOS
- LBNE
- Others

Mu2e, others

Detector R&D, future colliders

2.70 FTE

R&D for future

Concurrency in Simulation
- G4 GPU/vector demonstrators in collaboration with CERN

- Performance studies in collaboration with US Scientific Computing community

1.40 FTE

2.40 FTE

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, μBooNE, 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

FWP with Scientific Computing

"Concurrency Forum Annual Meeting" co-organized with CERN at FNAL

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)