**Minutes of the FNAL G4 core team/users meeting**

Friday Nov. 19th 2010

People attending: S. Banerjee, Ph. Canal, D. Elvira, M. Fischler, K. Genser, Ch. Green, A. Hahn, Th. Junk, J. Kowalkowski, R. Kutschke, R. Lipton, A. Para, B. Rebel, P. Spenzouris, R. Tschirhart, H. Wenzel, J. Yarba. (K. Lynch intended to attend but had technical problems connecting to the meeting.)

**The Geant4 Team at Fermilab (Daniel Elvira)**

Daniel explained the strategy of the FNAL detector simulation group so far: develop expertise at the level of tool kit development (core group), as well as application development (users).

Activities are centered on the areas underlined by G4 external reviews: hadronic physics, performance. Man-power at FNAL for the core G4 development activities is ~< 2 FTE but Sunanda Banerjee is leaving the lab in December. FNAL has responsibility in the areas of G4 computing performance and hadronic physics.

The “extended” detector simulation team provides support to FNAL experiments and projects: CMS, mu2e, detector research, muon collider.

Daniel consulted the FNAL G4 user experts (before the meeting) on what they thought the G4 critical issues to resolve were given the needs of the Fermilab scientific program. A summary is in the talk and a longer description in a document attached to the agenda.

**Physics in Geant4 (Sunanda Banerjee)**

Sunanda divided the users concerns in: usability of the code (particle production cuts and physics lists), availability of the right physics models, correctness and reliability. He gave an introduction on how the physics is implemented in G4 (models). He described the different models used for hadronic showers in the high (QGS), intermediate (FTF/Bertini), and low energy ranges (Bertini). He showed excellent agreement between the FTF model predictions and HARP-CPD data.

The Bertini-style cascade model is used by the LHC experiments to handle inelastic collisions in the 0-10 GeV range. The physics of these models was greatly improved in recent years: most energy non-conservation removed, pi-nucleon and nucleon-nucleon cross sections and angular distributions improved. Performance (CPU and memory use) was improved significantly.

The Geant4 pre-compound model is used to handle nuclear de-excitation and Fermi breakups in many models. It was significantly improved during the last 2 years.

Hadronic cross sections (Barashenkov, Axen-Wellisch, Gheisha) have generally a good performance in the 1-90 GeV range. Alternate parameterizations describe well the high energy rise (100-5000 GeV).

No model describes all physics processes in all energy ranges. The G4 strategy is to compose “physics lists”, a set of physics processes valid over a finite energy domain.

During the past two years much effort has been devoted to improve Geant4 hadronic validation. This includes a large set of validation packages or suites.

**Proposed items for discussion:**

• How the FNAL G4 core team could better serve the FNAL community and how the community (project/experiment application developers) could be better integrated to G4.

• How could application developers communicate with G4, ask for features, contribute code?

• What core development activities should the FNAL team be involved to advance the needs of the local community.

A.Para: How does the G4 Collaboration see the future?

D.Elvira: Effort dedicated to support running experiments, improve physics, re-engineering based on architecture review document.

R.Kutschke: Is the support for multi-thread included in the architecture review document?

S.Banerjee/D.Elvira: G4 has a project with the goal of producing a multi-thread safe version but this is not part of the architecture review document.

S. Banerjee: The neutrino-nucleus process is not available in G4. It would have to be added as an external generator.

Question: If something is developed outside G4, how is it integrated?

S.Banerjee: thinks it is a delicate issue. Typically, the development team is invited to collaborate with the associated G4 group, studies and validation takes place and, if the code is accepted the contributing group has to take responsibility for the maintenance.

D. Elvira: In G4 you cannot submit code to a repository for an integration team to review, test and include. The later would be best but the Collaboration argues there is no man-power.

A. Para: In principle cross sections have everything; no need of parameters.

S. Banerjee: You still have to define the particles that compose the final state, the kinematics. All models have internal cross sections in addition to the total cross section.

S. Banerjee: energy conservation in Bertini was always good, unlike the case of other models.

A. Para: disagrees. There are problems at high energy.

A. Para: are users expected to put together their own physics lists?

S. Banerjee: it was the case in the past. Now there are example physics lists to choose from.

D. Elvira: there many examples and then the user needs to consult/interact with the experts.

R.Kutschke: then even if an experiment had an expert to be trained, it would take many months or years for him/her to get meaningful results.

B. Rebel/A. Hahn: the documentation is not clear. How do I tune a parameter in a physics list? How do I turn on/off multiple scattering for example.

D. Elvira: we need to separate two things. The need to introduce switches or handles to turn on/off processes and the process for an experiment of converging to a suitable physics list. Right now, the way to go on the second item is to consult with the experts and test different options until the physics is acceptable. Improvements on the underlying physics models would happen over time through validation (both within the experiment and G4) and fixing. The experiment expert may choose to work within the G4 group and contribute to the fix and/or validation.

A.Para: why can’t we have just one physics list with all the good physics?

P. Spentzouris: big experiments tweak knobs and declare it is good for them. Other experiments may disagree on what’s good enough. Lists then proliferate. You can tag versions but there will be never a single list with complete physics.

P. Spentzouris: how is feedback provided to G4? How is the process?

B. Rebel: would like post code or a request for a feature in something such as red mine and get something in the next few days from G4. Should the FNAL G4 team do the communication or should the user talk directly with the experts?

D. Elvira/M. Fischler: The former option would be good but resources would be needed.

A. Para: the ROOT team provides fast response to a large number of users with little resources. The FNAL framework team also does.

R.Kutschke/P. Spentzouris: G4 is a more complex operation. It is not the same to provide support on physics lists, involving physics judgement, tests, validation than to answer questions on what a framework does or how to use it. Same with ROOT, most features required by all experiments are similar.

B.Rebel: suggests that the FNAL team develops and maintain a set of examples relevant to our applications.

M.Fischler/D.Elvira/P.Spentzouris: this is a good idea but it needs resources that may come from the lab but also the projects/experiments.

M.Fischler: automation may be part of the solution.

D. Elvira: there are two clear proposals from the FNAL users today. 1- We could develop and maintain examples. 2- We could dedicate resources of the core group to fix local issues fast and take them through the G4 review.

**Action Item:**

The FNAL detector simulation group will elaborate a strategy based on the input received today, iterate with the community (for feedback) and with the lab management for resources. A follow-up meeting will be held once we’ve made progress.