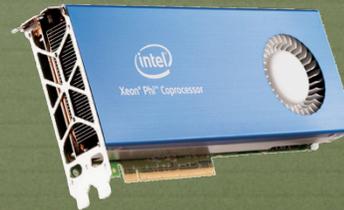
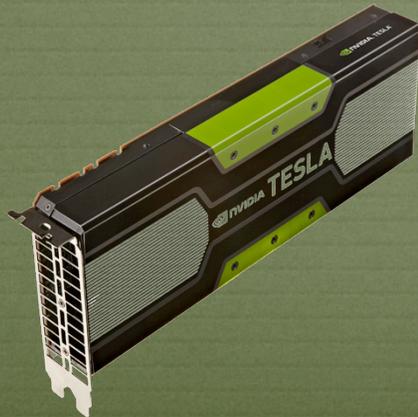


# Geant4 R&D Projects

Philippe Canal



# Participants

## Local

- ❖ Philippe Canal
- ❖ Daniel Elvira
- ❖ Soon Yung Jun
- ❖ Jim Kowalkowski
- ❖ Marc Paterno
- ❖ FTE to be named later

## Institutions

- ❖ FNAL
- ❖ ASCR
- ❖ RENCIS
- ❖ ISI
- ❖ ANL
- ❖ CERN
- ❖ SLAC

# Geant4

- ❖ Performance studies shows no ‘hot spot’ but overall non optimal use of current hardware
  - ❖ Relatively low instruction count per cycles
- ❖ New generation of hardware exacerbate the issues
  - ❖ GPU, Intel Xeon Phi
  - ❖ Deeper vector unit,
  - ❖ more (‘small’) cores
- ❖ Requires shift in implementation style



# G4CPT

- ❖ Geant4 Computing Performance Task
- ❖ Monitor performance of each
  - ❖ Development (reference) releases
  - ❖ Candidate releases
  - ❖ Public releases
- ❖ Results provided to Geant4 collaboration and posted to a publicly available web-site
- ❖ Commissioning of Geant4.10 (aka Geant4MT)
  - ❖ Compare to Geant4.9 and to single thread version
  - ❖ Test scalability
  - ❖ Evaluating HPCToolkits, Open | Speedshop and TAU.



# GPU Prototype

- ❖ Focus on Nvidia and CUDA
  - ❖ Testing cutting edge to understand potential
- ❖ Many parts from Geant4
  - ❖ *Particle Transportation*
  - ❖ *Electromagnetic Physics*
  - ❖ *Random Number Generator*
  - ❖ *Geometry Navigator on the GPU*
  - ❖ *Stepping Manager*
  - ❖ *Validation Framework*
  - ❖ *Kernel scheduling and CPU/GPU communication*



# Collaborations



- ❖ Geant4, CERN, SLAC, ISI, RENCI, ANL
- ❖ Joint effort for vectorized prototypes (CERN)
  - ❖ Insert GPU Prototype in a full(er) fledged prototype.
- ❖ Performance analysis and redesign efforts (ISI, RENCI)
  - ❖ Leverage external input/knowledge, alternative point of view, tools.

# ASCR (ISI, RENC I, ANL)

- ❖ Geant4 Performance Studies
  - ❖ Performance evaluation based on realistic Geant4 application
    - ❖ CMSexp a simplified version of CMS simulation
  - ❖ Alternative track stacker
  - ❖ Performance evaluation of a Geant4 prototype running on GPU
- ❖ Review of the Geant4 electromagnetic physics packages
- ❖ Migration of geometry classes

# Milestones

- ❖ Feb, 2013: Concurrency Annual Meeting @ FNAL
- ❖ Mar, 2013: Ramp-up collaboration with ASCR
- ❖ Summer
  - ❖ EM Physics code review
  - ❖ Working GPU/Vector prototype chain
- ❖ Early 2014:
  - ❖ semi-realistic benchmarks of Vector and GPU prototypes using simple geometry and small sets of physics processes.

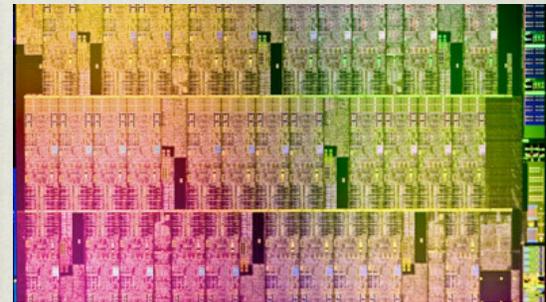


# Outlook

- ❖ Early benchmarks shows GPU is half the cost of a single CPU to purchase *and* to operate for the same workload.
- ❖ Many collaborative projects started.
  - ❖ Regular bi-weekly meetings, progress reports.

## ❖ Future

- ❖ Try out Intel Xeon Phi.
- ❖ Apply lessons from prototypes, reviews and performance analysis to recommend and implement (significant) improvements in Geant4.



# Backup Slides

# ROOT

- ❖ 2013 User Workshop

- ❖ <http://www.cern.ch/root-2013>

- ❖ Current Status and Plan for ROOT 6

- ❖ <https://indico.cern.ch/getFile.py/access?contribId=2&resId=2&materialId=slides&confId=2175>  
[1](#)