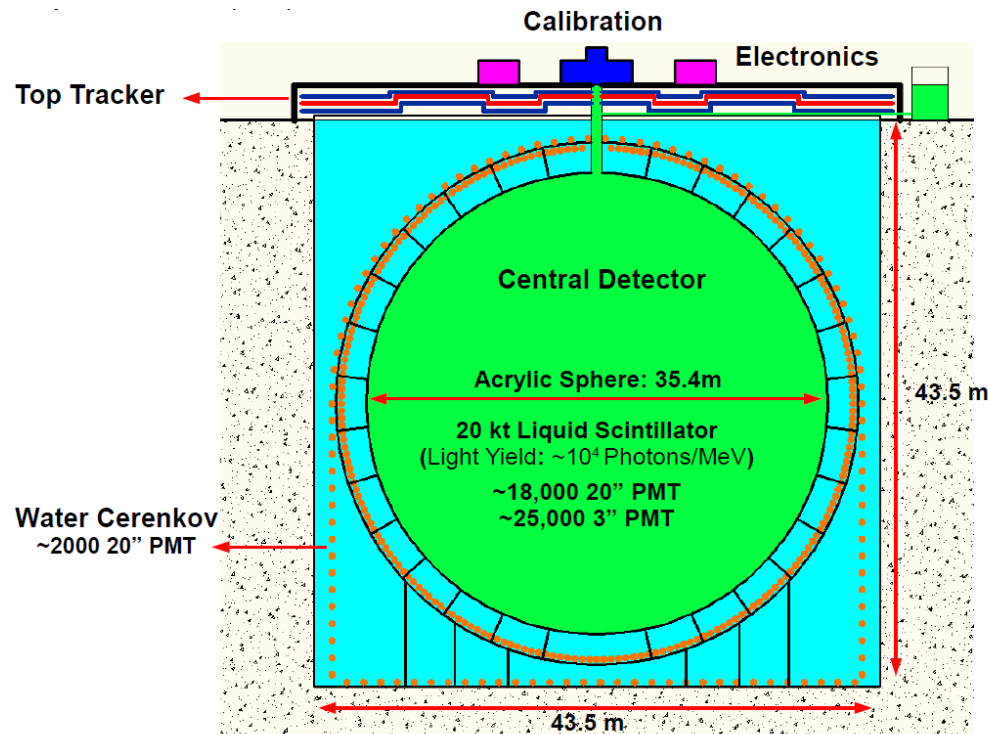# Parallelized JUNO simulation software based on SNiPER

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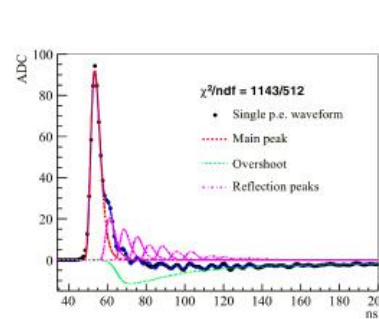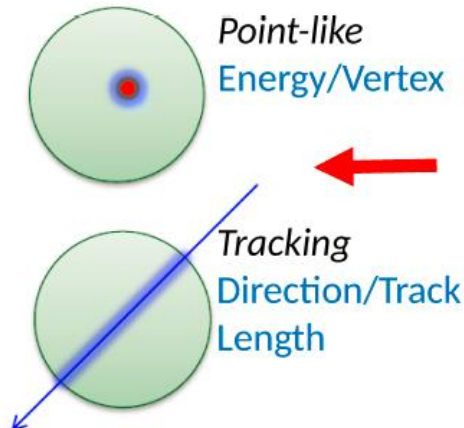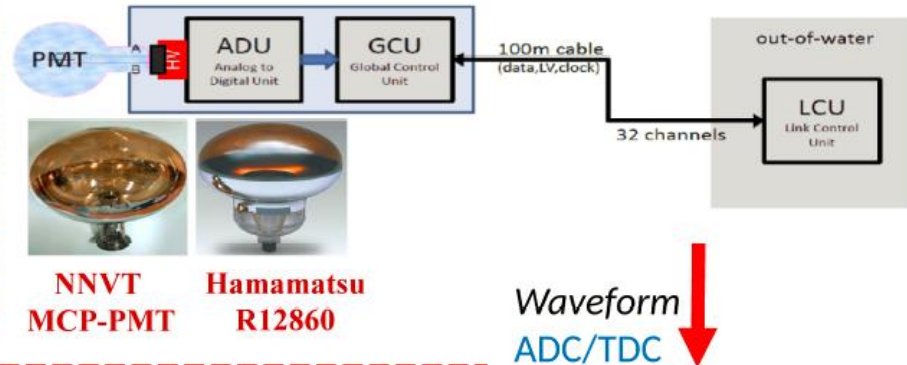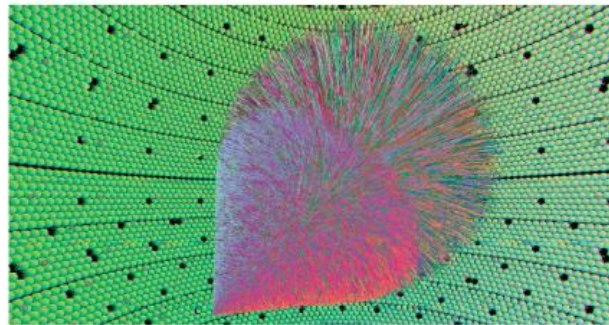
ACAT 2017, Seattle

JUNO (Jiangmen Underground Neutrino Observatory)

- Physics goals: determine neutrino mass hierarchy and precisely measure oscillation parameters.

- It's located in southern China about 53 km away from Yangjiang and Taishan nuclear power plants.

Calibration

Electronics

Top Tracker ←

Central Detector

Acrylic Sphere: 35.4m

20 kt Liquid Scintillator
(Light Yield: ~10^4 Photons/MeV)

~18,000 20" PMT
~25,000 3" PMT
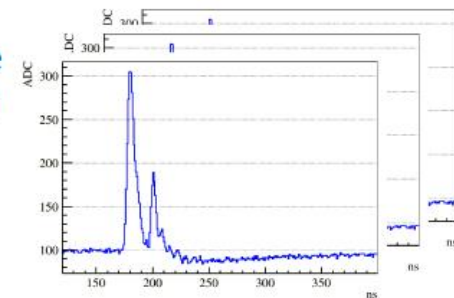
43.5 m

Water Cerenkov
~2000 20" PMT →

43.5 m

Offline Software

- JUNO offline software is developed based on the SNiPER framework.
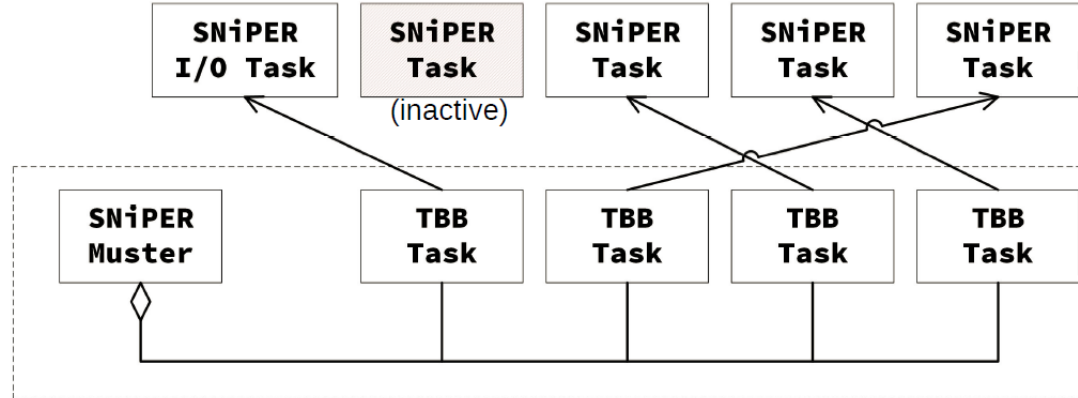
SNiPER Muster (Talk is given by Jiaheng, Track 1 on Thursday)

- SNiPER <u>Mu</u>ster (<u>Mul</u>tiple <u>S</u>NiPER <u>T</u>ask Schedul<u>er</u>) is a task based scheduler.
 - To process one event, a TBB task gets a SNiPER task first and runs SNiPER task once.

Events could be dispatched dynamically.

Notes:
- TBB: Intel Threading Building Blocks.
- SNiPER task is configured by user and could be run in sequential mode.
- TBB Task is underlying worker.

Detector Simulation Framework

- Detector simulation framework is implemented to integrate SNiPER and Geant4.
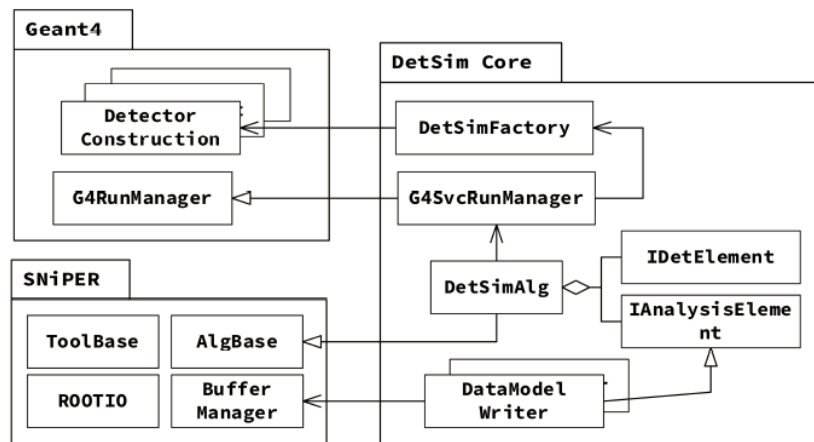

Features:
- Lightweight simulation framework.
- Easy to migrate from standalone application.
- Support both batch and interactive modes.
- Support Geant4's macro files/commands in Python.
- Modular design of User Action.

- Starting from Geant4 10.x, multi-threaded Geant4 applications enable event-level parallelism.
  - With the evolution of Geant4, it makes possible to run simulation with Intel TBB, MPI and so on.

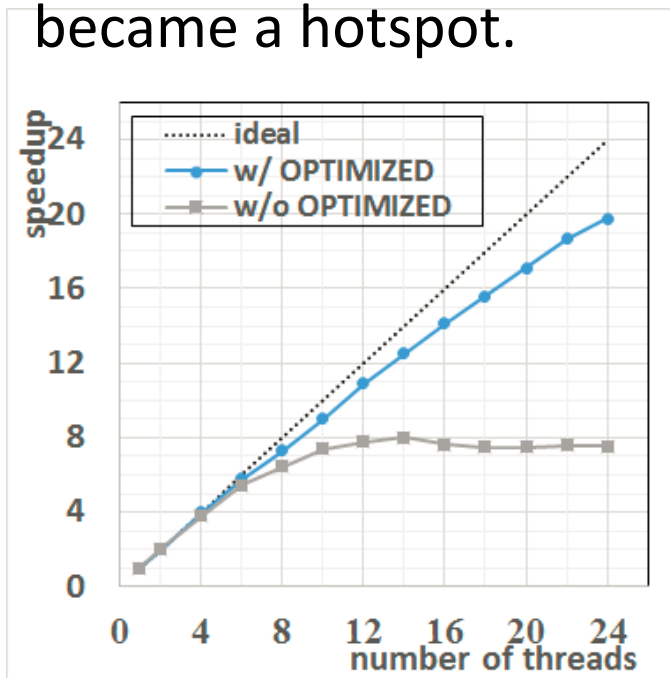A. Dotti *et al.*, arXiv:1605.01792

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SNiPER Muster based Simulation Framework

- Derived from Geant4's run managers.
  - Event loop is controlled by SNiPER Muster.
- Global task initializes Master RunMgr before Slave RunMgrs start.
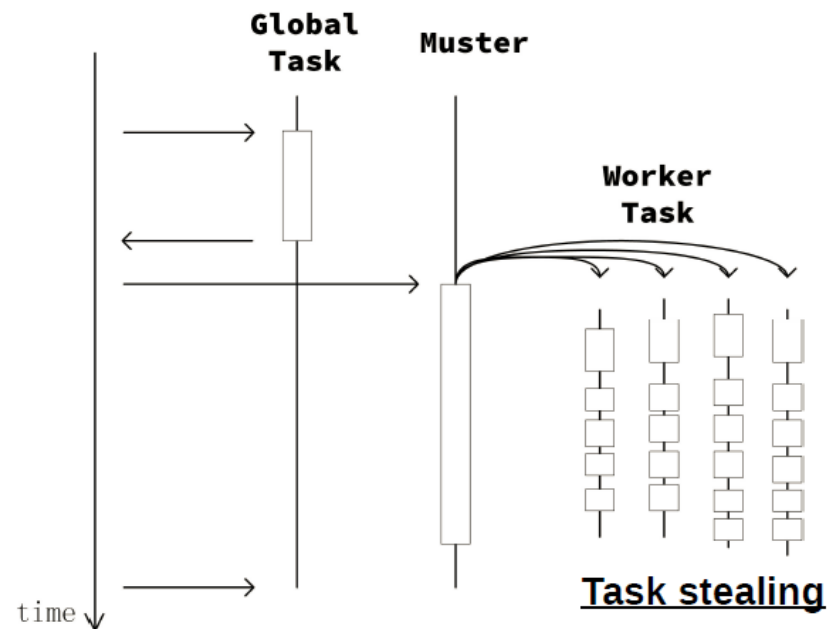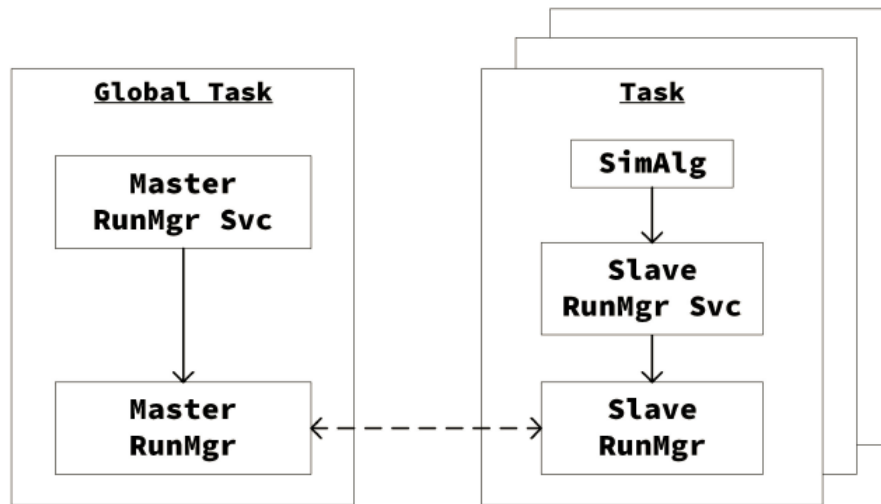
Performance optimization

- Hotspot:
  - Due to a lot of optical photons accessing refractive index, mutex used in Geant4's material properties table became a hotspot.
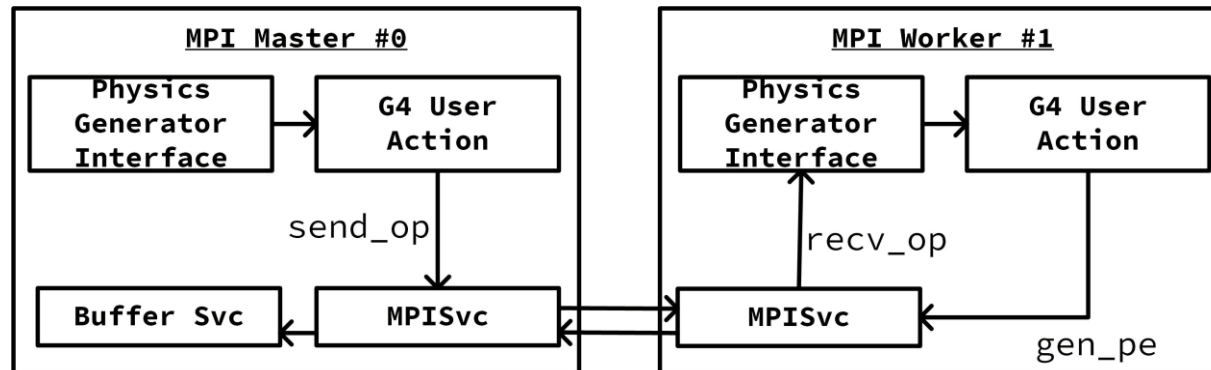

- CPU: Intel(R) Xeon(R) CPU E5-2680 v3 @ 2.50GHz (2 sockets, 12 cores per socket).
- Memory: 64 GB
- OS: Scientific Linux 6.5; GCC: 4.9.4
- TBB: tbb2017_20160916oss
- Geant4: 10.03.p01
  - G4EmStandardPhysics + G4OpticalPhysics
- Particle: 2.2 MeV gamma at center.

After optimization, we can get a better performance.

Summary and Plans

- An event-level parallelism simulation framework is developed based on Geant4 10.x and SNiPER Muster.
  - Benefit from the multi-threading support and thread safe of Geant4 10.x.
- Plan: using MPI to speedup events such as cosmic ray muons.

Thank you!