



Fermilab



U.S. DEPARTMENT OF
ENERGY

Office of
Science



Integration of Opticks¹ and Geant4

[Hans Wenzel](#)

Krzysztof Genser

Soon Yung Jun

Fermilab



¹developed by Simon Blyth



CaTS:

Highly configurable (at runtime) Geant4 Application that allows to simulate Detector setups ranging from a single Detector (e.g. single crystal) to complex setups (e.g. test beam experiment consisting of many detector elements). It is used to demonstrate the G4Opticks hybrid workflow, works with Code: <https://github.com/hanswenzel/CaTS>. Use CaTS tag v_01_10_7_p01 when using geant4. 10.7.p01. The opticks commit point we are using is: commit c74e0670d232fe371eab056bc2c85fa33d33f69e (would be nice to have tags)

Features are:

- Make use of Geant4 API, if something is missing add to Geant4 even if that means losing backward compatibility.
- Uses gdml with extensions for flexible Detector construction and to provide optical properties at runtime. The gdml extensions include:
 - Assigning sensitive detectors to logical Volumes. Available:
 - RadiatorSD, IArTPCSD, TrackerSD, PhotonSD, TrackerSD, CalorimeterSD, DRCalorimeterSD,....
 - Assigning step-limits to logical Volume
 - Assigning visualization attributes.
 - Uses G4PhysListFactoryAlt to define and configure physics at runtime via command line option.
`./G4OpticksTest -gdml G4Opticks_50000.gdml -pl 'FTFP_BERT+OPTICAL+STEPLIMIT+NEUTRONLIMIT' -macro time.mac`
 - Uses Root IO to provide persistency for Hits.
 - With G4opticks:
 - Uses Geant4 to collect Scintillation and Cerenkov Gensteps. The Genstep harvesting is done in sensitive Detectors(SD) (RadiatorSD/IArTPCSD) the collection of the Photon Hits is done in PhotonSD.
 - At runtime allows to select Opticks/Geant4 optical physics to generate and propagate optical photons, returns Photon-Hits.

New CaTS workflow (with opticks) Geant4 (Host) G4Opticks(Device)

gdml
.mac

- event loop:
- Begin of event:

RadiatorSD::ProcessHits:
collect gensteps (C/S),
Nr. Photons > NMAX:

Step:

Gensteps (C/S)

PhotonSD::AddOpticksHits

PhotonHits

g4ok->propagateOpticalPhotons

Generate and propagate
Cerenkov and Scintillation
photons

- End of event:

EventAction::EndOfEventAction

Gensteps (C/S)

g4ok->propagateOpticalPhotons

Generate and propagate
Cerenkov and Scintillation
photons

PhotonSD::AddOpticksHits

PhotonHits

g4ok Hit

input
output

Root file

TTree:

Event 1: IArTPCHits. PhotonHits

Event 2: IArTPCHits. PhotonHits

Event 3: IArTPCHits. PhotonHits





Plans

- Short term:
 - Continue working on 10.7.ref03/ref04 → goal to be ready for Geant4.11.
 - Make it an advanced Geant4 example.
 - Integrate with the Fermilab liquid Argon experiments software stacks (LArSoft) → should be straightforward since the LArSoft Geant4 module is based on CaTS.
 - Provide more realistic geometry examples
- medium term:
 - Update Opticks so it corresponds to the current Geant4 optical processes and uses the same properties.
 - Implement wavelength shifting (WLS) process on GPU needed for LArTPCs.
 - Enable Event based multithreading for the Geant4 process.
 - Use G4Tasking (by J. Madsen) (available since Geant4 10.7).
 - Keep up with Opticks development.