DREMTubes

A Geant4 simulation of the DR tubes prototype 2021 beam tests

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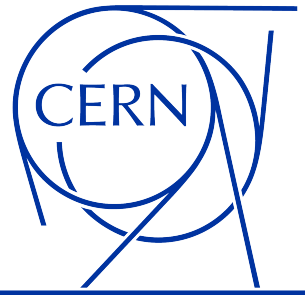
Dual-Readout Calorimetry bi-weekly Meeting
21/7/2021



Program to validate Geant4 on test beam data

- The Geant4 Collaboration started a new validation program using test beam data. Mostly focused on the hadronic sector. Work started in May 2021.
- Five test beam selected:

1. ATLAS Hadronic Endcap Calorimeter (HEC) (beam test 2000/2001).
2. ATLAS Hadronic Tile Calorimeter (TileCAL).
3. Calice iron/scintillator hadronic technological prototype.
4. Dual-readout em-sized tubes prototype (beam test Desy&CERN 2021).
5. Dual-readout hadronic-sized prototype (based on RD52-lead calo or new ones).

Dual-Readout calorimeters beam tests now recognized as a priority by the Geant4 Collaboration.

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- **Five test beam selected:**

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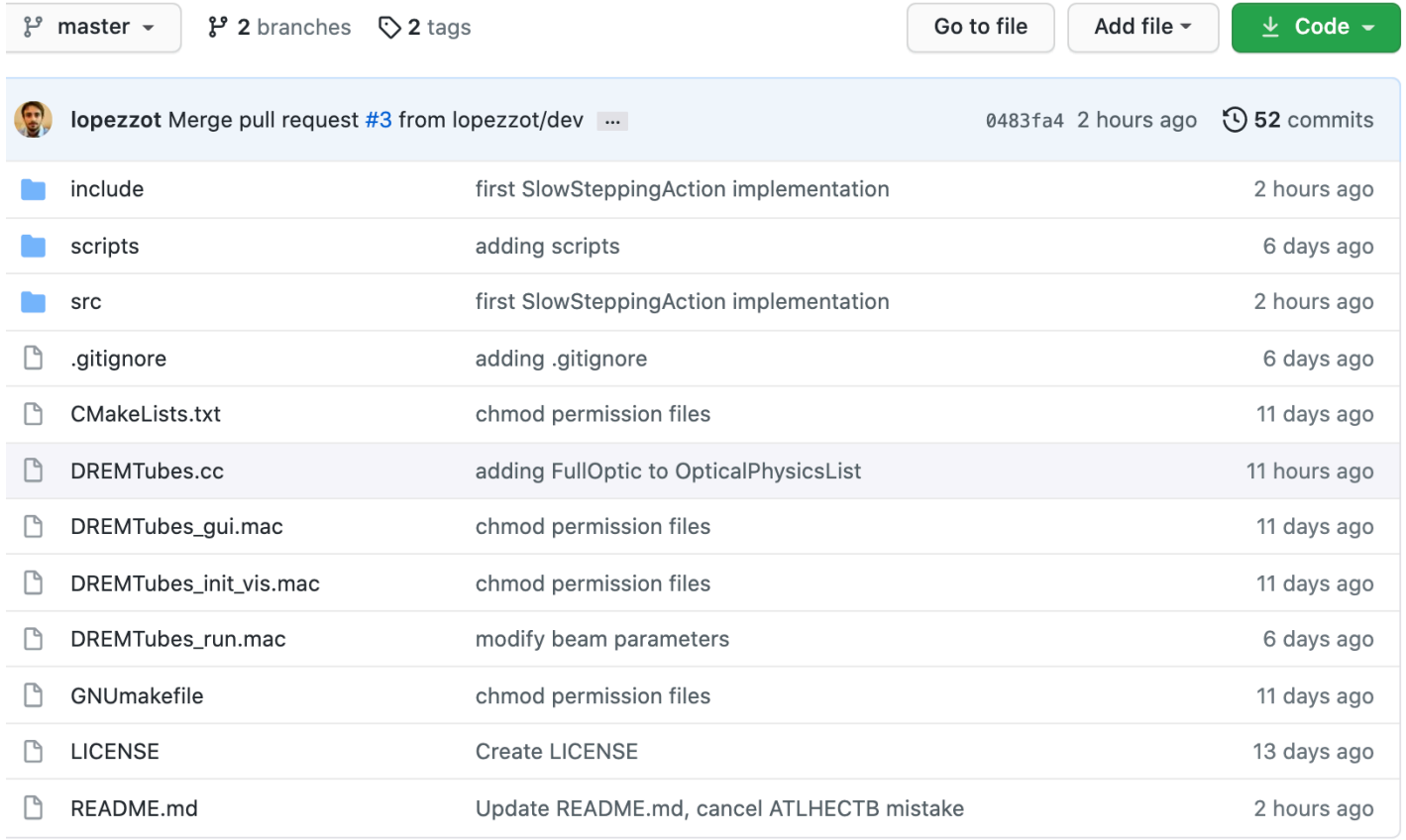
2. **ATLAS Hadronic Tile Calorimeter (TileCAL).**
3. **Calice iron/scintillator hadronic technological prototype.**
4. **Dual-readout em-sized tubes prototype (beam test Desy&CERN 2021).** → Today's topic! See Romulado's talk for a first test-beam report [link]
5. **Dual-readout hadronic-sized prototype (based on RD52-lead calo or new ones).**

DREMTubes

A Geant4 simulation of the 2020 Dual-Readout em-sized tubes prototype beam tests.

- Github [link]
- v1.1 released on 20/7/2021
- Tested with no crashes and no warnings for multi-threaded data production on Mac, lxplus and lxplus+HTCondor.
- Documentation available in README.md
- Need to start collaborating on test-beam data analysis and data simulation.



How to use

- **Build and compile just by sourcing the Geant4 env, as explained [here].**
- **Execute with no GUI:**

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created with CMake

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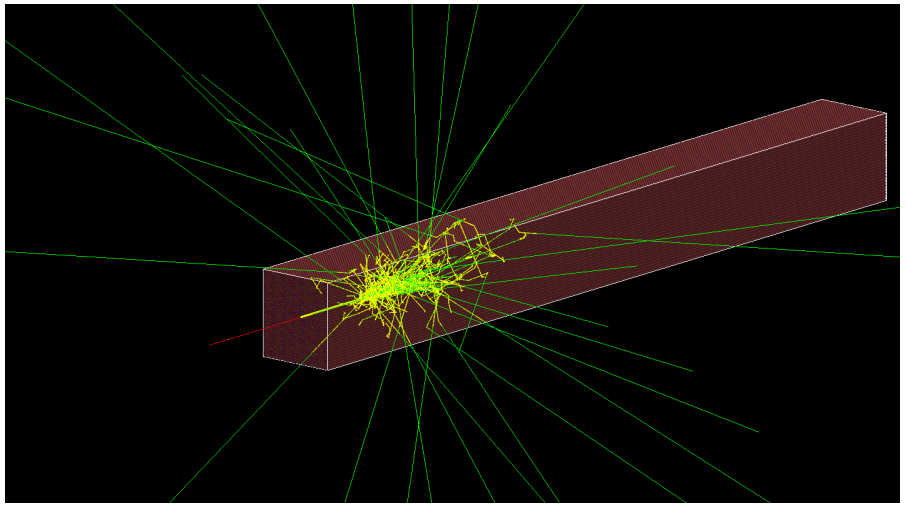
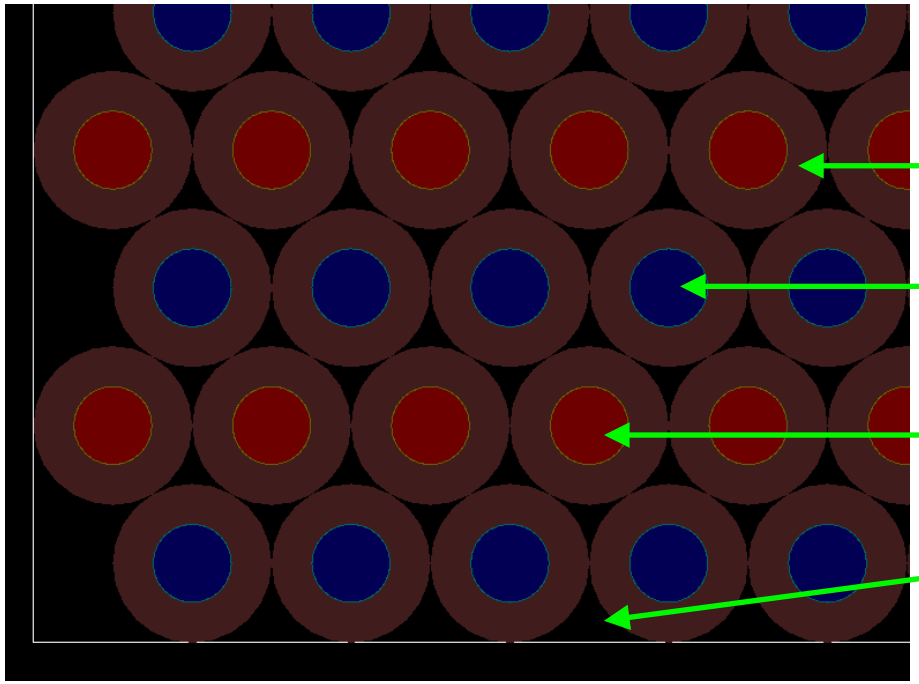
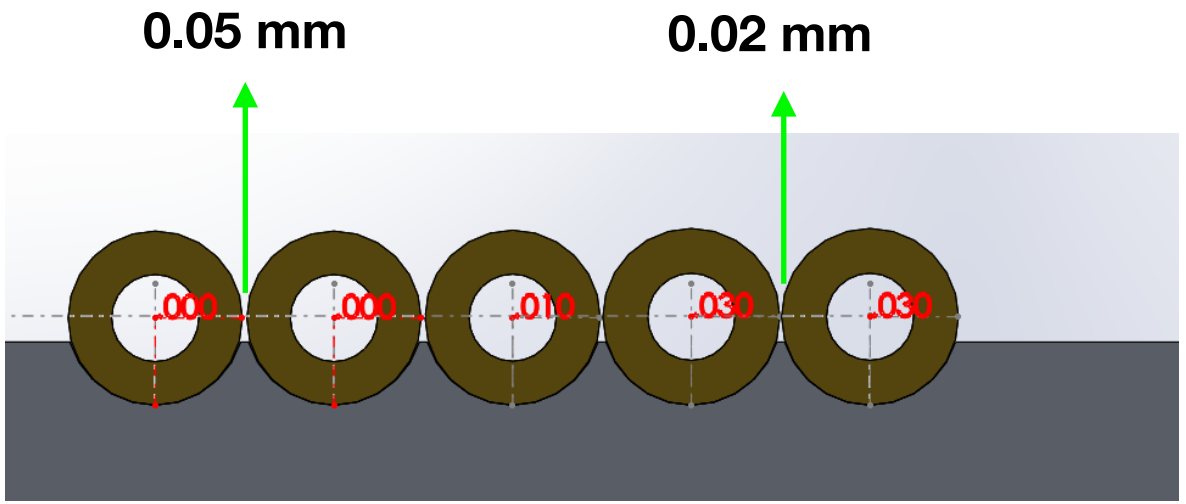
- If true optical photons are propagated inside fibers.
- Otherwise a fast signal computation is performed.
- Default *false*.

The detector (v1.1)

- Including 2 mm-diameter tubes, 1 mm-diameter fibers, 60 rows x 48 fibers per row.
- Possible to smear the geometry according to the tubes diameter tolerance.
  Change the tolerance with the hardcoded parameter [here].







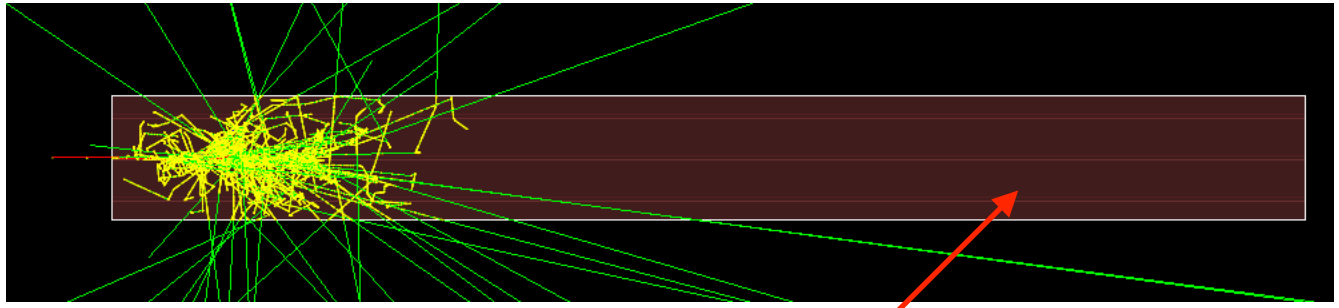
Optical photons

-opt false

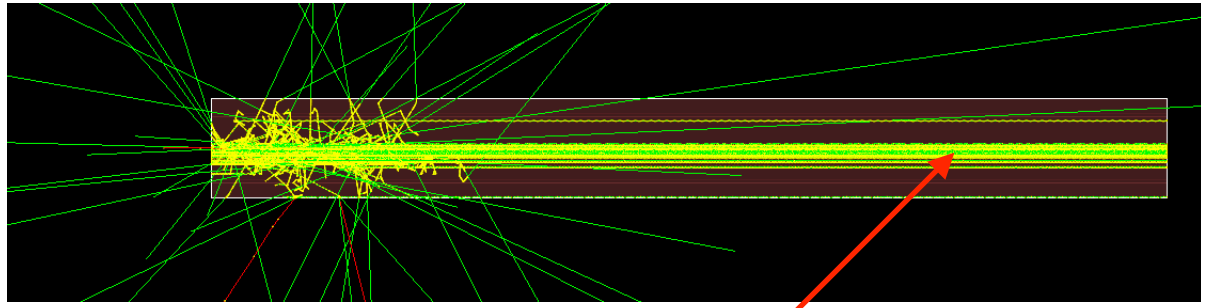
- Scintillation signal is parameterized starting from the ionizing energy deposited in S fibers.
  Photo-statistical fluctuations included.
- Cherenkov signal is taken from the Chrenkov photons trapped (and KILLED!) in C fibers.
  Photo-statistical fluctuations included.
- Approx time per 10 events with 1 thread, 1 GeV electron: 2.2 s

-opt true

- Optical photons are killed at their first step with a Poissonian probability tuned on the experimental light yields.
- Signals come from the SURVIVED optical photons, propagated within fibers and detected at the SiPMs surface.
- Suitable for studies on light absorption, light cross talk, optical fibers properties, …
- Approx time per 10 events with 1 thread, 1 GeV electron: 53.4 s



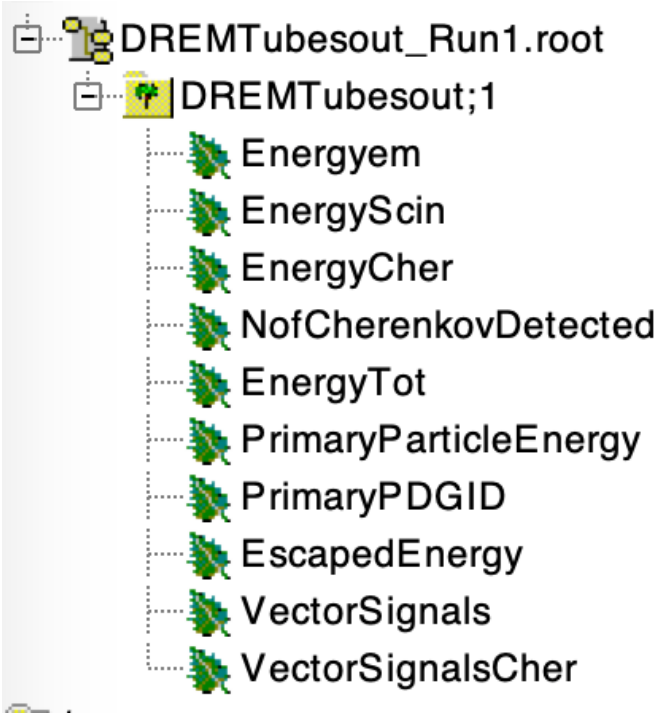
No optical photons tracked inside fibers



Optical photons tracked inside fibers

What do I get?

- Each run produces a dedicated ROOT output file.
- If executed in multi-threaded mode, thread-allocated ntuples are automatically merged at the end of each run.
- If a macro card contains more runs, output files are named according to the Run numbers: example DREMTubesout_Run1.root



Energy deposited in calo by e^-, e^+
Energy deposited in S fibers
Energy deposited in C fibers
Total number of Cherenkov p.e.
Total energy deposited in calo
Primary Particle vertex energy
Primary Particle PDGID
Energy carried by leaking particles
std::vector, p.e. in S fiber, one entry per fiber
std::vector, p.e. in C fiber, one entry per fiber

What can I do?

The 2021 beam tests give the possibility to validate this code and include it in the geant-val framework. ⇨ Key test-beam to reproduce for the Geant4 Collaboration.

However, help is needed to:

1. Implement a 9-towers-based geometry and EDM (Work ongoing in Pavia with Jinky, PhD Student).
2. Check the simulated optical properties of fibers and SiPMs and tune them on the very new test-beam data.
3. Have fun spotting my bugs.
4. Start the simulated-data analysis and compare results with preliminary plots from Desy beam test.