Optical Photons In Geant4

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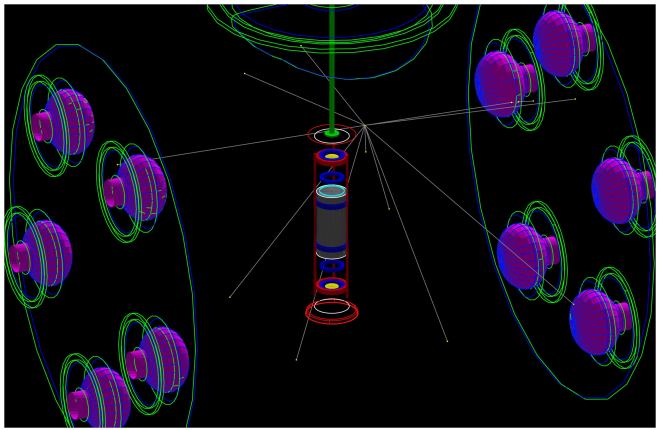
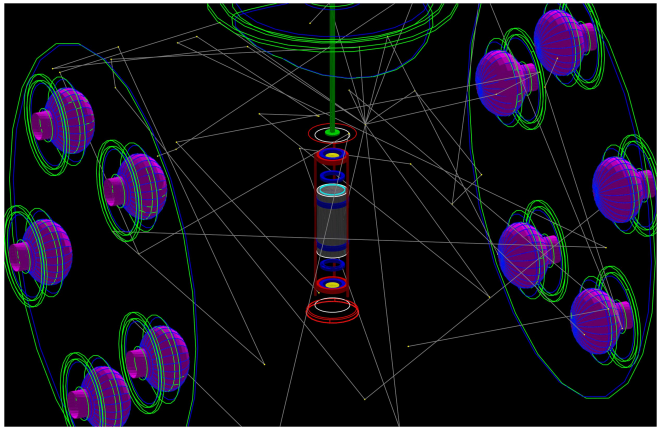
- SABREPhysicsList: enable optical photon physics.
  - Absorption, scintillation, Cherenkov, WLS, reflection/refraction.
- SABREDetectorMaterial: Set material optical properties and optical surfaces.
  - Optical processes aren't enabled without setting material properties.
- Limitations:
  - Only veto scintillator, PMT glass, and veto vessel/CIS surfaces have optical parameters.



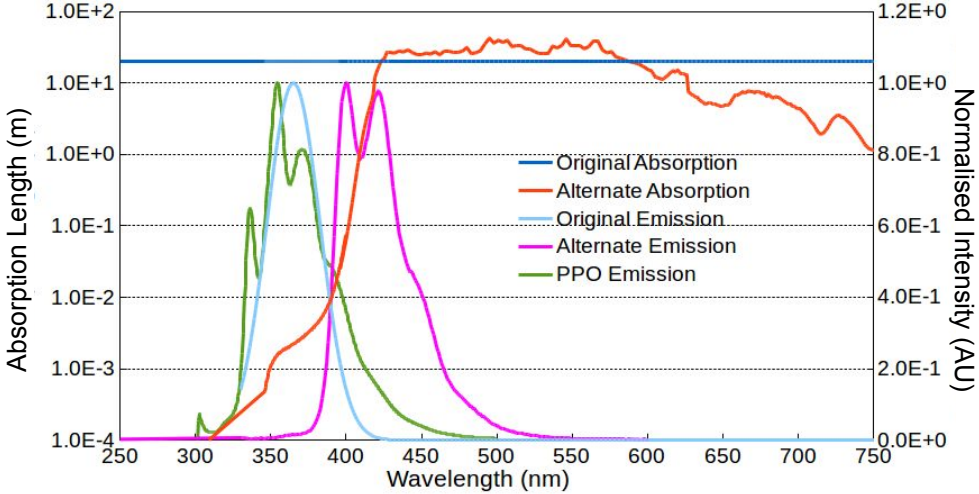
10 keV electron, no reflections



10 keV electron, with reflections

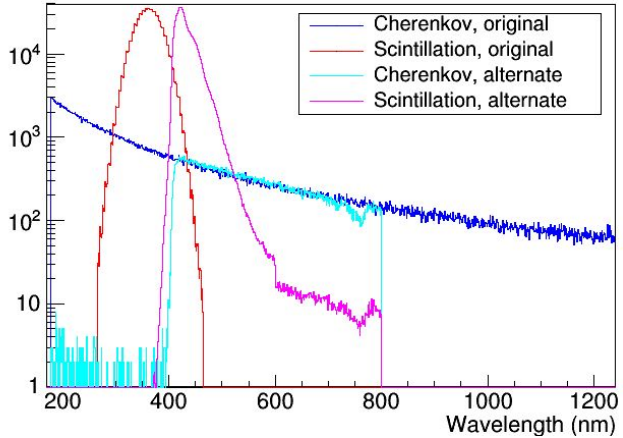
Optical Photons in Geant4

- LAB data largely cribbed from BNL.
  - Spectrally averaged QE: 22.8%
  - Light yield: 11522 ph/MeV
  - Decay times:
    - Fast = 7 ns
    - Slow = 31 ns



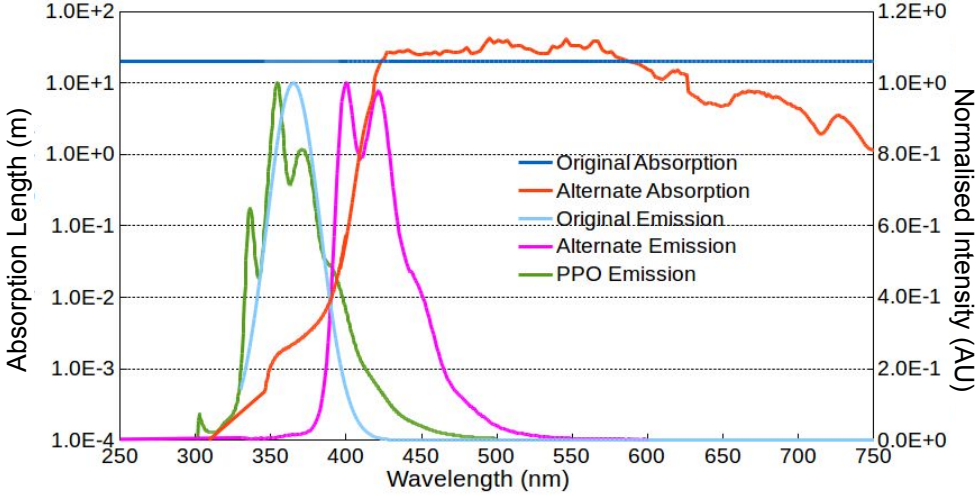
Mean # photons on all PMTs, no cuts.

Data	*Reflections*	*<# Ckov>*	*<# Scint>*
Original	No	4.5	22
Original	Yes	49	245
Alternate	No	0.11	14
Alternate	Yes	11	134



Optical Photons in Geant4

- *Results are very sensitive to optical data (particularly absorption length).*
- *90% of optical photons are reflected: the properties of the lumirror are important to determine!*



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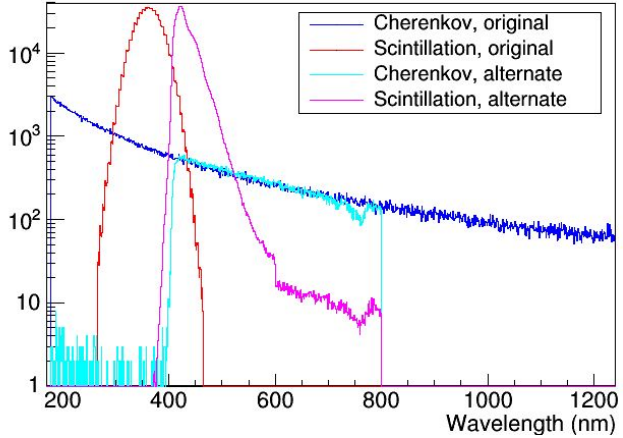
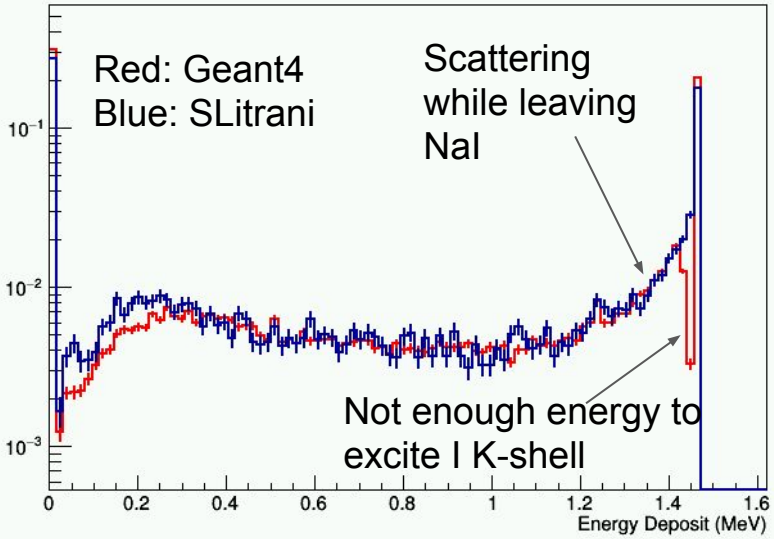


SLitrani Comparison

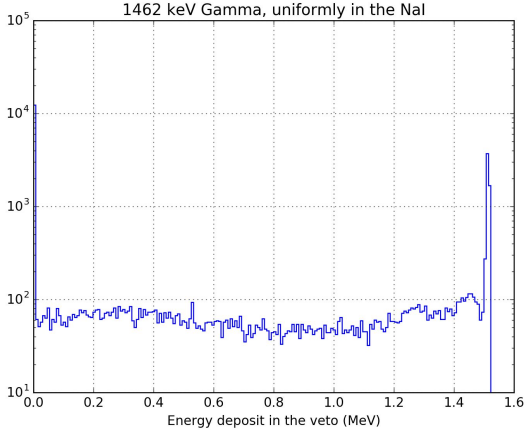
1462 keV gamma (K-40) in crystal.

- The energy deposit in the scintillator Is different!
- The ~1.45 MeV feature:
  - ‘Dip’ in G4 data until ~30 keV below peak.
  - Small energy Compton transfers suppressed due to atomic effects (not included in SLitrani).
- Low energy discrepancy??

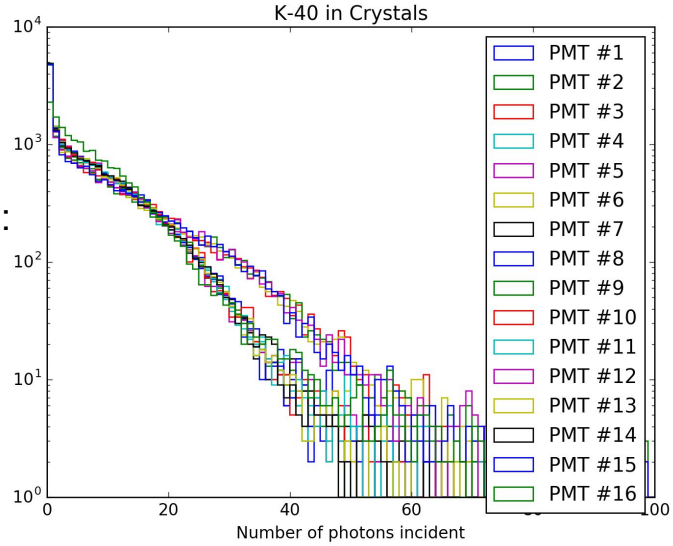


SABRE South Geometry

- SABRE south geometry has recently been added to SABREMC as part of a code restructure (thanks Francesco!)
- Geometry:
  - 16 veto PMTs, 7 crystal enclosures.
  - Wet CIS, Cu surface.
- Source:
  - K-40 1462 keV gamma rays in the crystal.

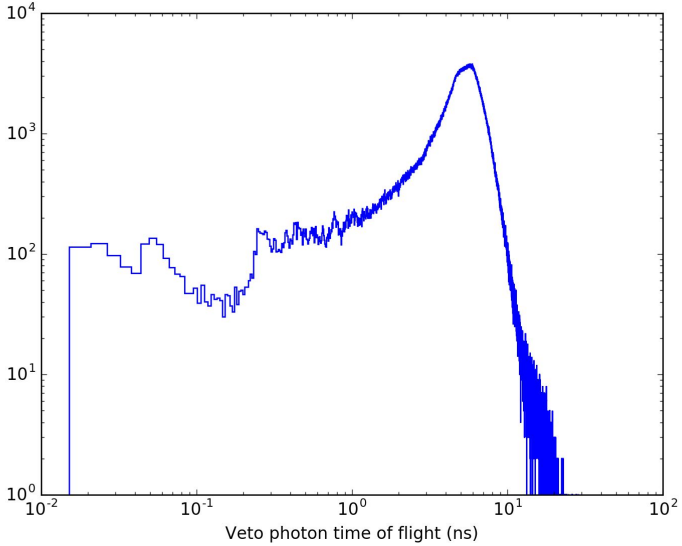


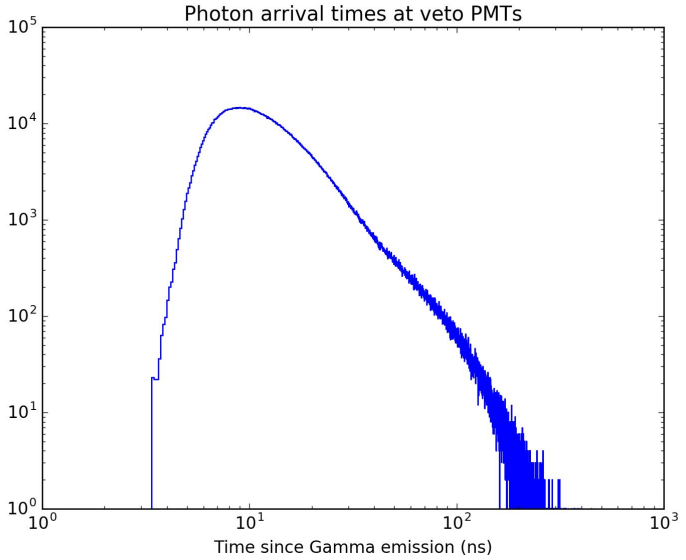
Differing PMT light collection:
Can optimise placement?



SABRE South Geometry

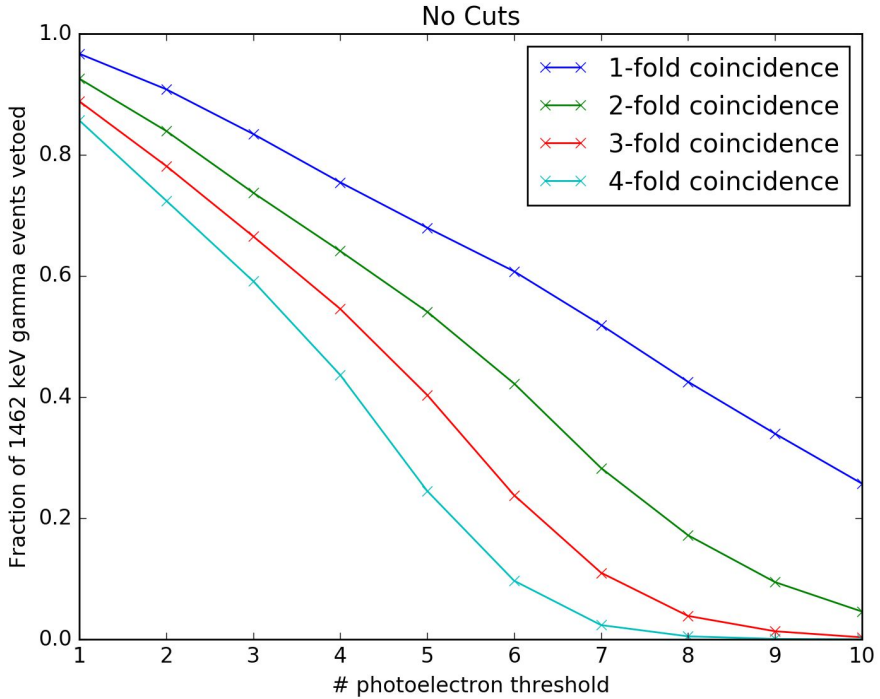
Timing:





SABRE South Geometry

- Veto efficiency vs trigger conditions (applied spectrally average QE):



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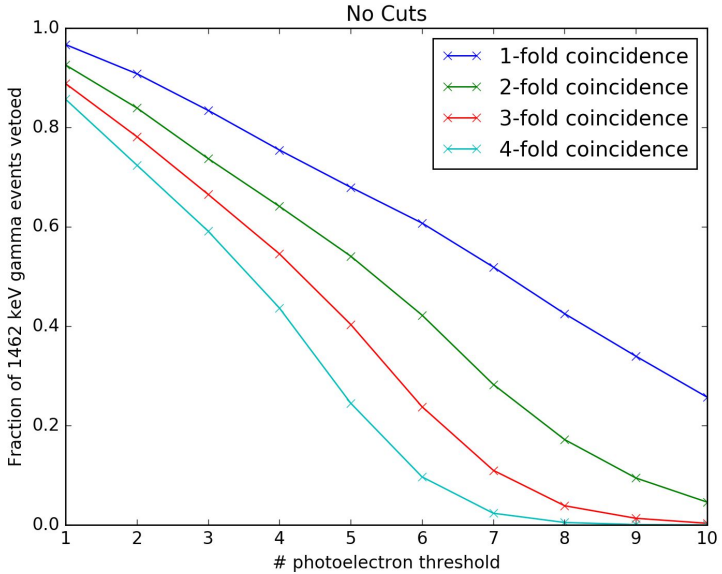
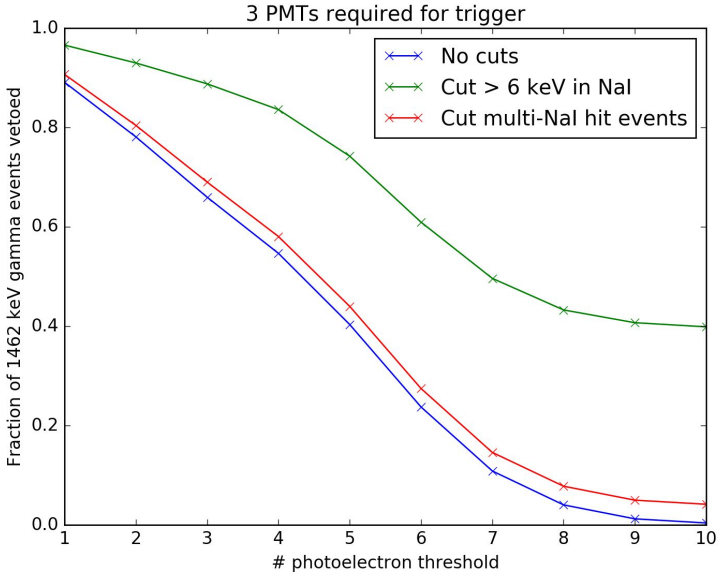
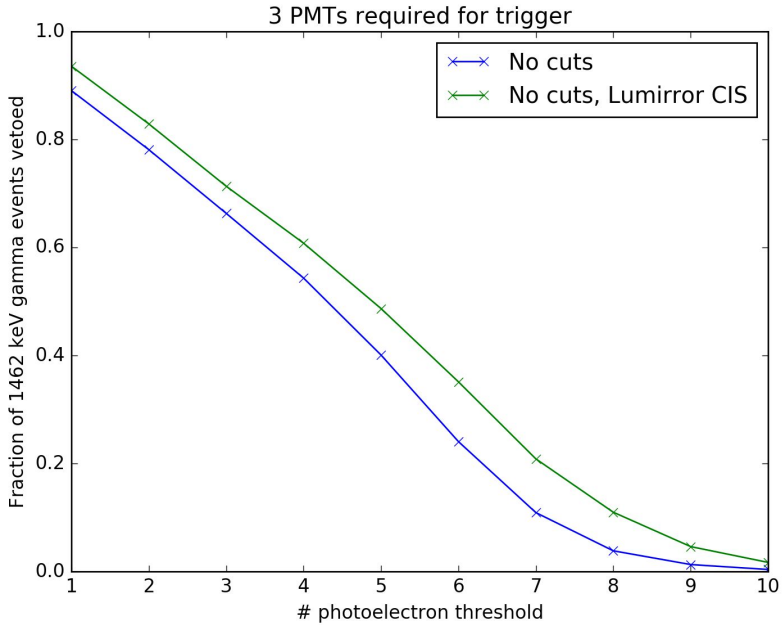




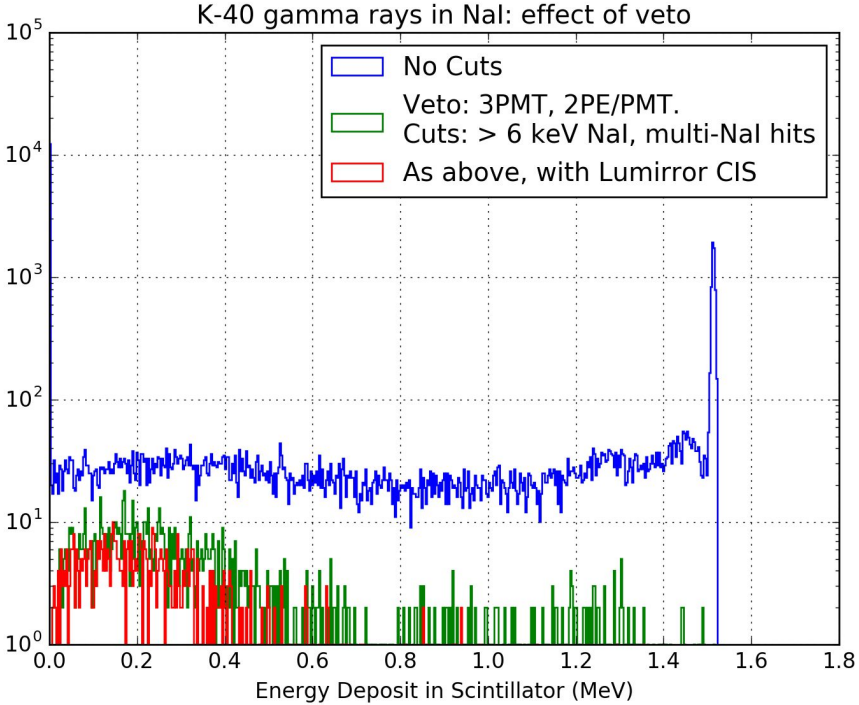
SABRE South Geometry

- What if we coat the crystal enclosures in lumirror?



SABRE South Geometry

- Effect of veto on scintillator spectrum:



To Do

- Complete SLitrani comparison
- More studies in SABRE South vessel
- NaI optical properties
- Geant4 quenching model