Light collection in $PbWO_4$

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August 25, 2022

Far-backward meeting

Geometry model

- Aim to reproduce JINST 16 (2021) 08, P08040
- Time constants were measured and light collection was simulated for various $PbWO_4$ samples in the above paper
- Fast time constant was observed as 2 ns (55% total light yield), 6 ns slow component (some variations among samples and temperature)
- Geant4 in this work followed from geometry in JINST paper (right plot), crystal of $25 \times 25 \times 10$ mm^3, 2 mm thick BK7 glass, photocathode
- Response to gamma at 511 keV (the paper deals with positron tomography)

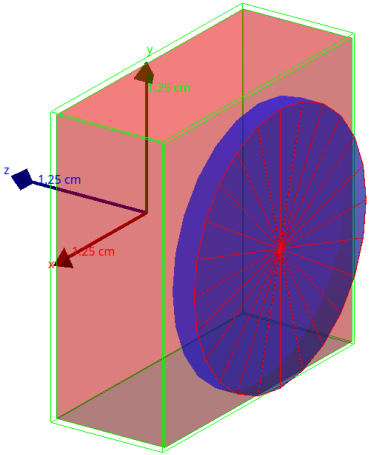


Figure: $PbWO_4$ crystal (red), wrapping (green), glass (blue), photocathode (red circle)

Collection time for instantaneous light production

- The gamma is incident on the front surface
- Time distribution of optical photons absorbed on photocathode is obtained from the simulation
- Instantaneous light production in the crystal is achieved by setting 1 ps as scintillation decay time
- The distribution here has similar features as in the paper, overall time is shorter
- Likely because of more detailed treatment of the surface in the paper

Figure: This work

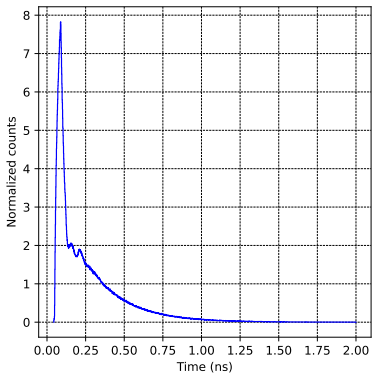
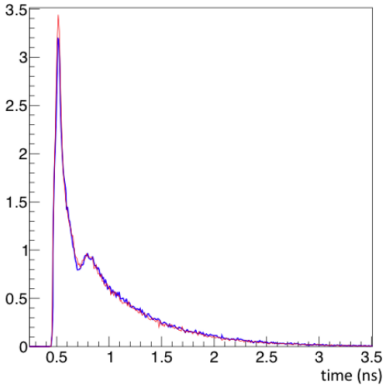


Figure: JINST, Fig. 7



Simulated pulse shape

- Scintillation decay time is set as 1.67 ns (fast) and 6.6 ns (slow), equal yield ratio
- Compatible pulse length is seen here and is in the JINST paper
- The paper applies convolution with PMT and amplifier response for direct comparison with measured pulses

Figure: This work

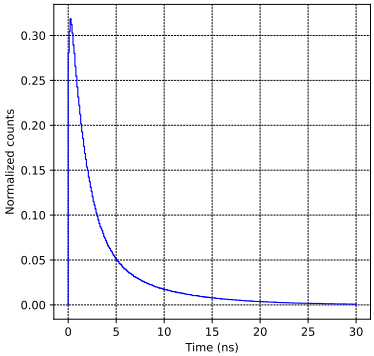
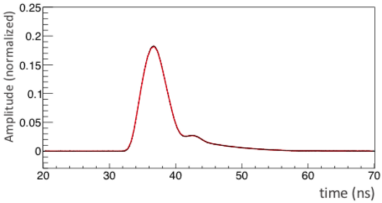


Figure: JINST, Fig. 9



- Model used here is: github.com/adamjaro/lmon/blob/master/calo/src/CalPWO.cxx
- Geometry: github.com/adamjaro/lmon/blob/master/calo/macro/PWO/geom_pwo_cell.in

Next steps

- Get expected pulse shape for a calorimeter at our energies and SiPM readout
- E.g. crystals of $22 \times 22 \times 350$ mm^3 (right plot) or similar

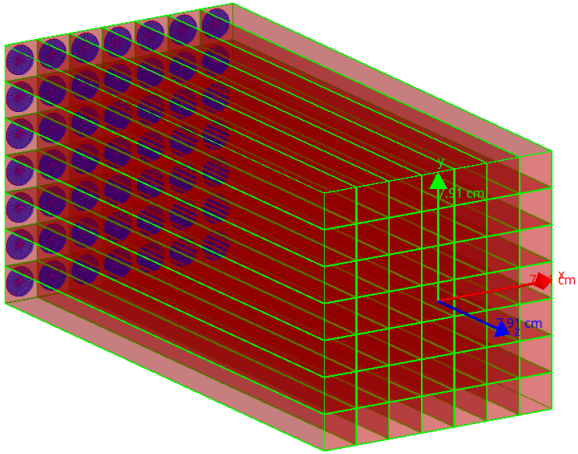


Figure: 7×7 towers of $PbWO_4$ crystals

Geometry for the example:
github.com/adamjaro/lmon/blob/master/calo/macro/PWO/geom_pwo_module.in