Light Collection Time Measurement in $PbWO_4$

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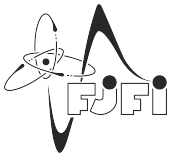
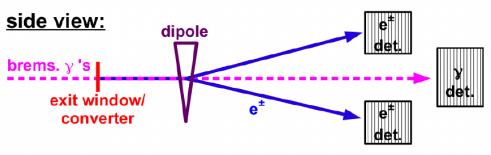


Outline

1. Luminosity monitor for EIC
2. Geometry model of PWO
3. Simulation overview
4. Results
   - Different cases
5. Conclusion

Luminosity monitor for EIC



Two methods for detecting bremsstrahlung photons from $ep \to e\gamma p$ and $eAu \to e\gamma Au$

1. Direct γ
2. $e^{\pm}$ pair conversion

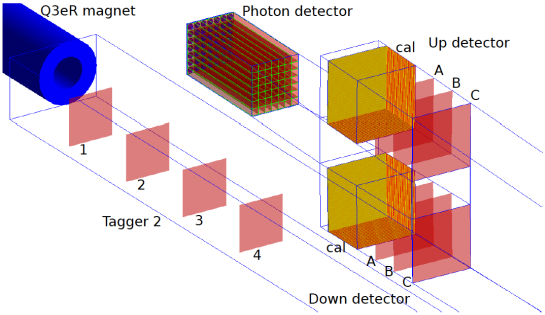


Figure: Detector section in Geant4

Geometry model of PWO

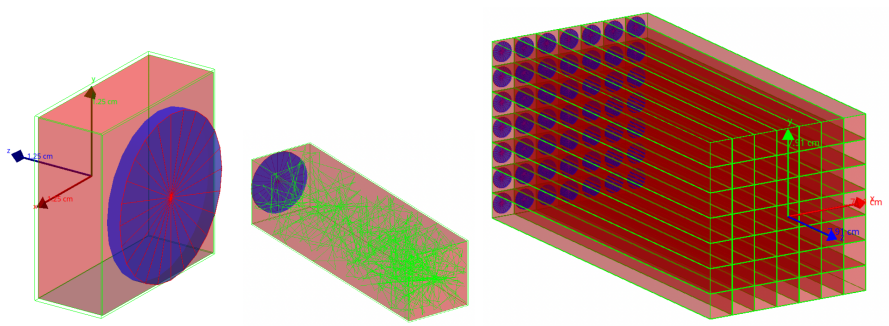


Figure: Single cell light collection and 7 $\times$ 7 towers of $PbWO_4$ crystals

- Implementation as homogeneous or fused silica spaghetti calorimeter
- Direct counts of bremsstrahlung photons $\rightarrow$ provides fast machine performances
- More γ are incident in every bunch crossing because of large cross section (and luminosity)

Geant4 implementation

1. Detector construction
   - PWO crystal (Red with green wrapping)
     - Single cell: $22 \times 22 \times 350$ mm^3
     - 7×7 module
   - 2 mm thick BK7 glass (Blue)
   - Photocathode (Red circles)
2. General particle source
   - Number of particles: 2
   - particle type: e^-
   - Distance: 1 mm
   - Angular distribution: iso
   - Energy distribution: Gauss
   - Position distribution: Point
   - Time difference: 20 ns
3. Simulation of light collection

```
#detector
#/lmon/construct/geometry geom_pwo_cell.in
/lmon/construct/geometry geom_pwo_module.in

#input by general particle source
/lmon/input/type gps

/gps/verbose 0

/lmon/input/type gps
/gps/particle e-
/gps/number 1
/gps/ene/type Gauss
/gps/ene/mono 10 MeV
#/gps/ene/mono 511 keV
/gps/ene/sigma 0.0 GeV
/gps/pos/type Point
/gps/pos/centre 0 0 1 mm
/gps/ang/type iso
/gps/ang/rot1 0 0 1
/gps/ang/rot2  0 0 1

/gps/source/add 1
/gps/particle e-
/gps/number 1
/gps/ene/type Gauss
/gps/ene/mono 10 MeV
#/gps/ene/mono 511 keV
/gps/ene/sigma 0.0 GeV
/gps/pos/type Point
#/gps/pos/centre -44 22 1 mm
/gps/pos/centre 0 0 1 mm
/gps/time 20 ns
/gps/ang/type iso
/gps/ang/rot1 0 0 1
/gps/ang/rot2  0 0 1

/gps/source/multiplevertex true

/gps/source/list
```

Results - I

Energy: 100 MeV

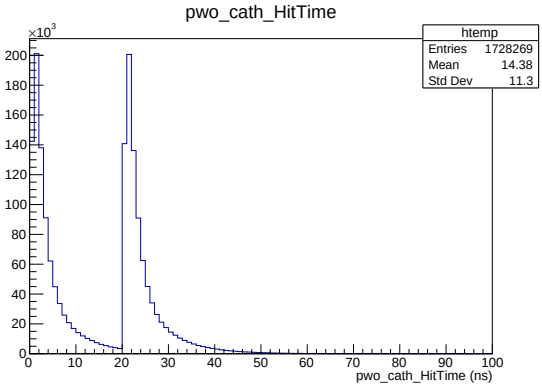


Figure: Statistics for 1000 events

Results - II

Energy: 500 MeV

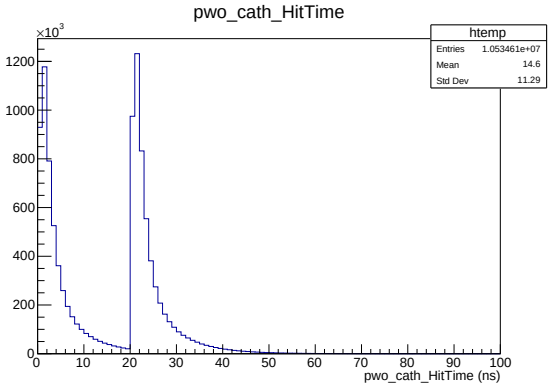


Figure: Statistics for 1000 events

Results - III

Energy: 1 GeV

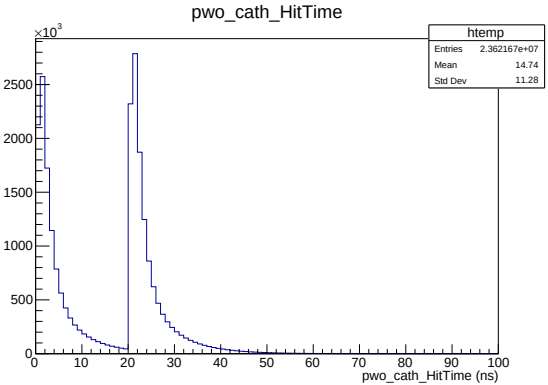


Figure: Statistics for 1000 events

Results - IV

Energy: 5 GeV

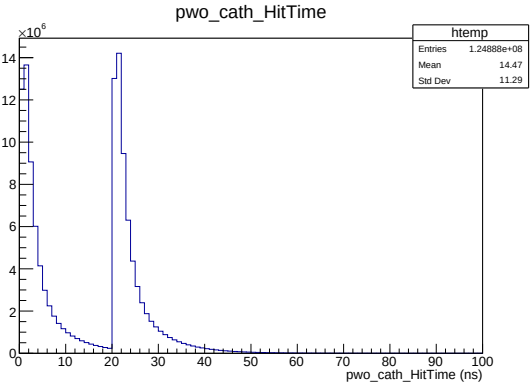


Figure: Statistics for 1000 events

Results - V

Energy: 10 GeV

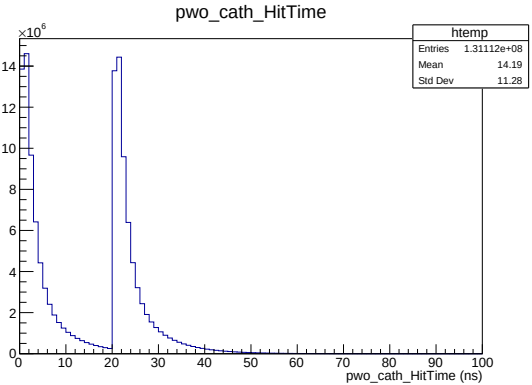


Figure: Statistics for 500 events

Results - VI

Energy: 15 GeV

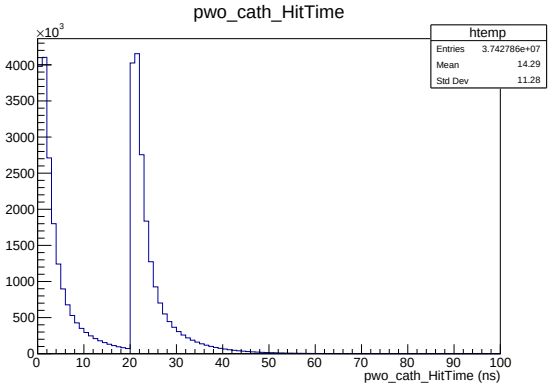


Figure: Statistics for 100 events

Results - VII

Energy: 18 GeV

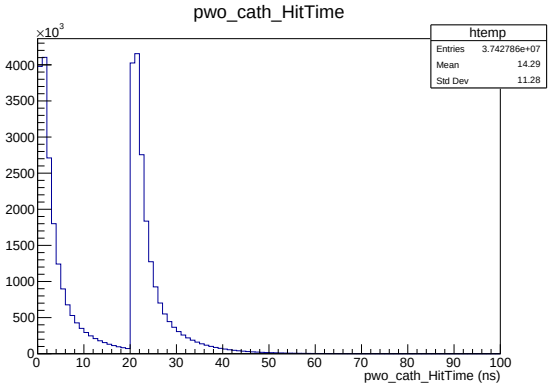


Figure: Statistics for 100 events

Conclusion

- Time distribution of optical photons absorbed on photocathode is obtained from the simulation
- Scintillation decay time – fast component at 1.67 ns (55% total light yield), and 6.6 ns for slow component
- Observation of expected pulse shape for our calorimeter at different energies
- **Next step:** test for time response and rate capabilities with SiPM readout and 60 ps laser pulses
- **Reference:** JINST 16 (2021) 08, P08040

Thank You