Study of water Cherenkov detector designs for the SWGO experiment

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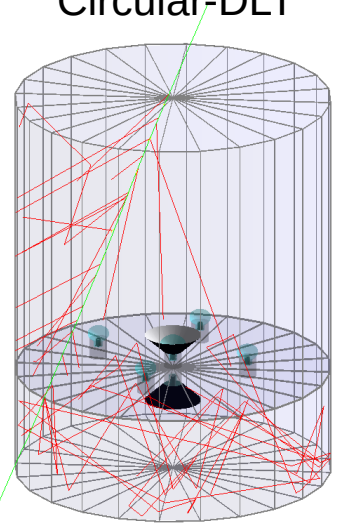
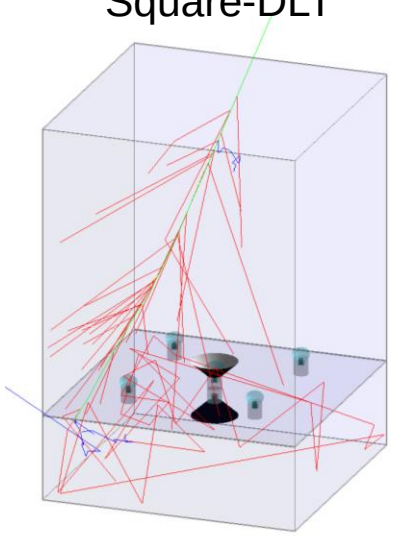
Simulation Setup

Circular-DLT



Square-DLT



Coming soon:

Hexagonal-DLT

Tank	Width (m)	Height up.l. Cir. (m)	Height up.l. Sqr. (m)	Height low.l. (m)
T1	3.0	2.7	3.4	0.5, 0.75, 1.0
T2	3.5	3.0	3.8	0.5, 0.75, 1.0
T3	4.0	3.3	4.2	0.5, 0.75, 1.0
T4	4.5	3.6	4.6	0.5, 0.75, 1.0
T5	5.0	3.9	5.0	0.5, 0.75, 1.0
T6	5.5	4.2	5.4	0.5, 0.75, 1.0

Size of the tanks. “Width” is the diameter of Circular-DLT and the side of the Square-DLT; “Height up.l. Cir.” is the height of the upper layer of Circular-DLT; “Height up.l. Sqr.” is the height of the upper layer of the Square-DLT; “Height low.l.” is the height of the lower layer.

- **Simulation of single particles through single water Cherenkov detectors**, considering the option of an array of tanks for the SWGO experiment
- **Comparison of Circular (Circular-DLT) and Square (Square-DLT) Double-Layer Tanks** with **different sizes**
- **Different PMT configurations**:
  - Upper layer:
    1 central 10’’ PMT, 4 peripheral 5’’ PMTs
  - Lower layer:
    1 central 10’’ PMT, 1 central 5’’ PMT
- **Inner walls**:
  - Upper layer:
    Polypropylene (non-reflective), Tyvek (reflective)
  - Lower layer:
    Tyvek (reflective)
- **Injected particles**:
  - Electrons and gammas (10 MeV, 100 MeV, 1 GeV)
  - Muons (1 GeV, 10 GeV)

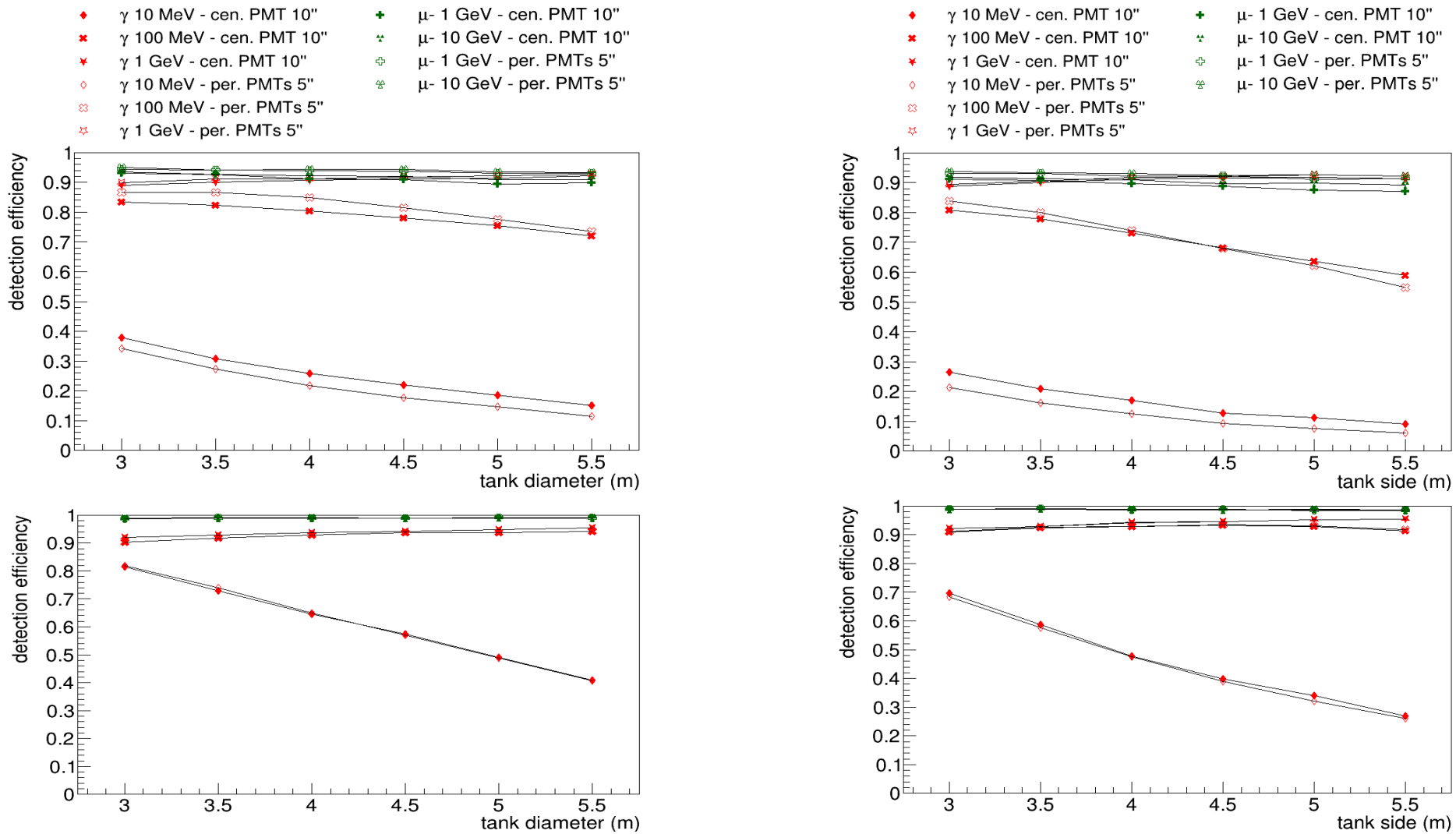
Detection Efficiency of the Upper Layer

Circular-DLT – 1 PE threshold

Square-DLT – 1 PE threshold

non-reflecting walls

reflecting walls



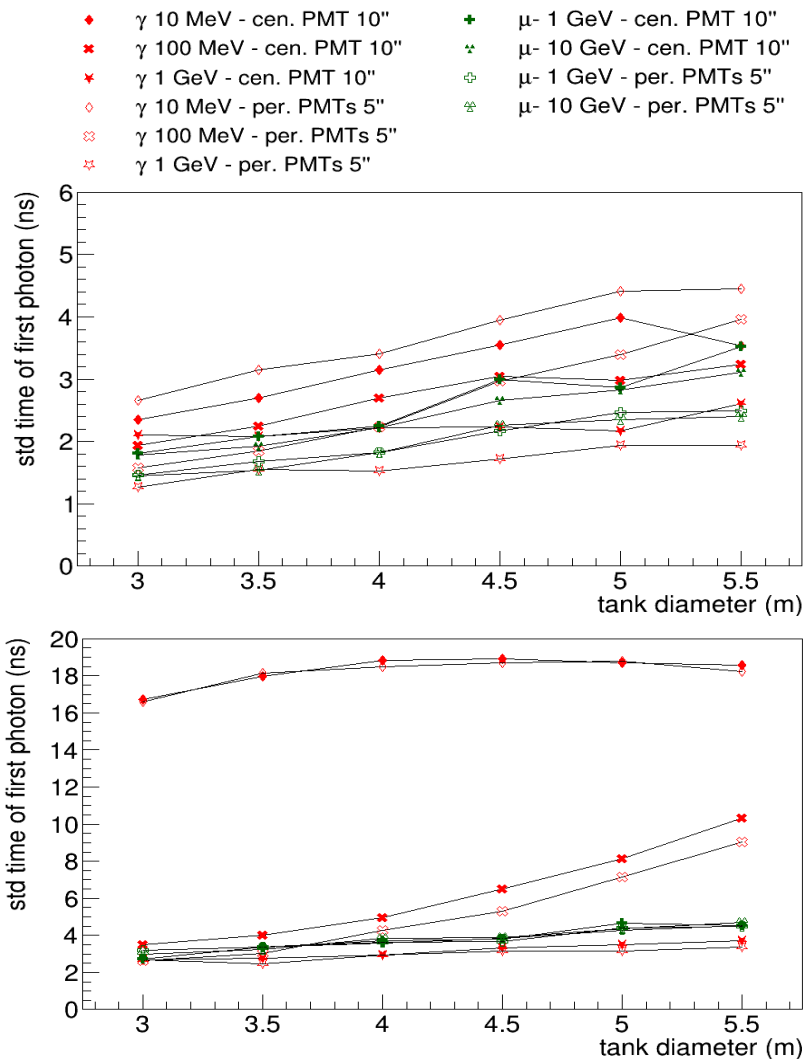
Time Resolution of the Measurement of the First Photon in the Upper Layer

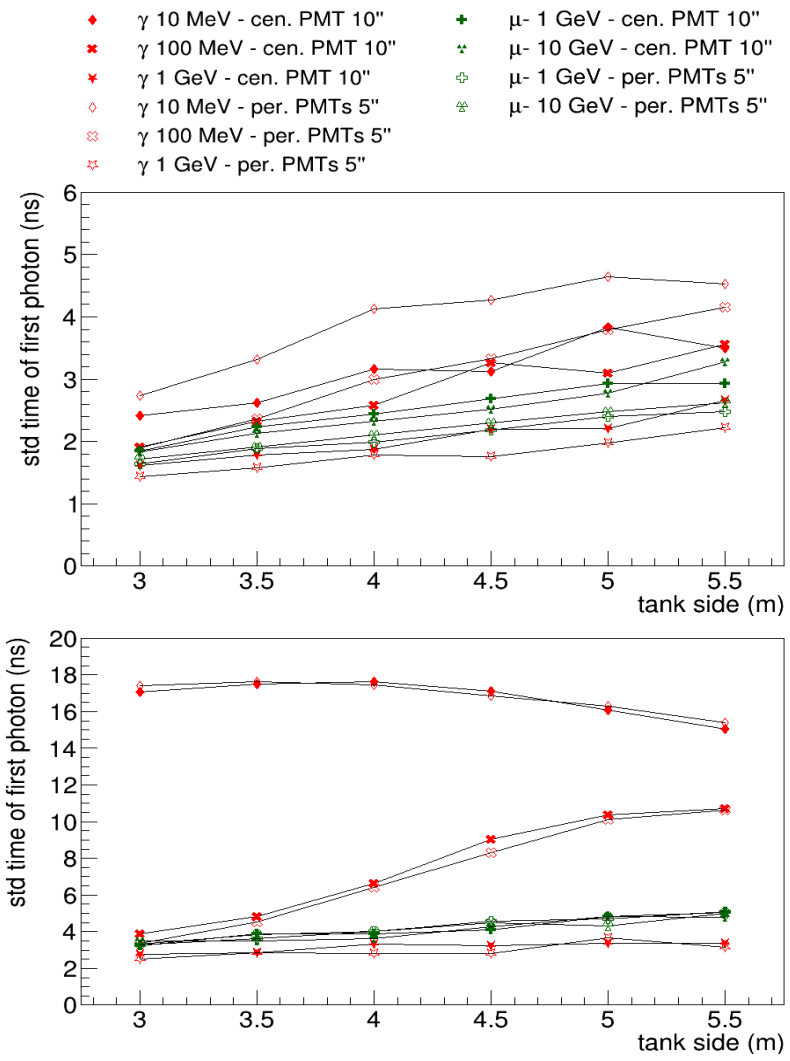
Circular-DLT – 1 PE threshold

Square-DLT – 1 PE threshold

non-reflecting walls

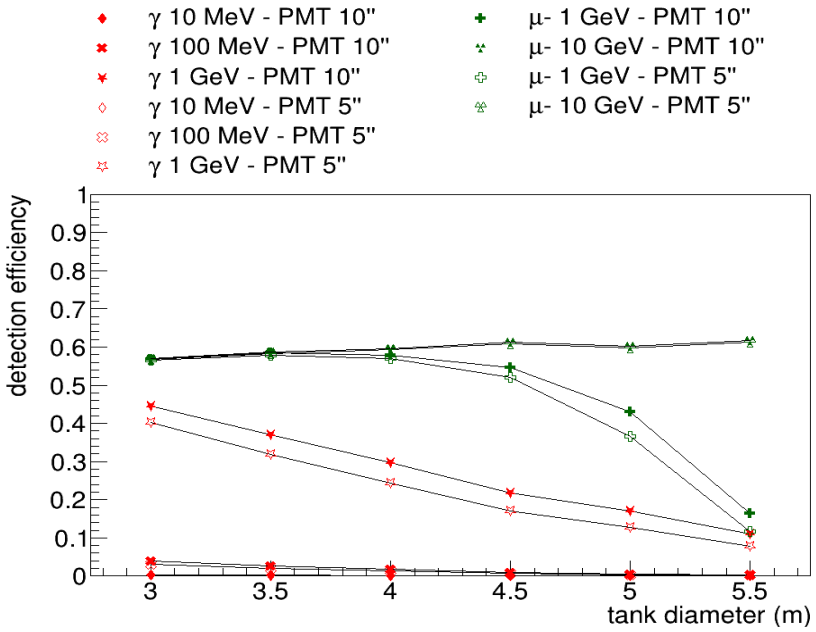
reflecting walls



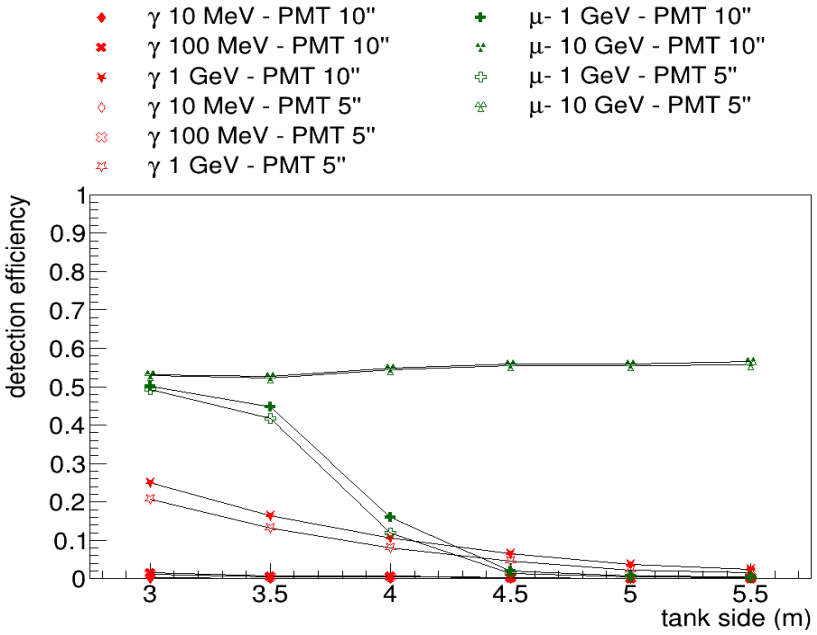


Detection Efficiency of the Lower Layer

Circular-DLT – 1 PE threshold



Square-DLT – 1 PE threshold



Results

- The performance worsen increasing the size of the tank, because the area covered by the PMTs decreases with respect to the area of the base of the tank.
- Circular-DLTs have slightly better performance with respect to Square-DLTs. Nevertheless, for the final design of the SWGO array we should take into account that with Square-DLTs a higher fill factor is achievable.
- By using reflective walls instead of non-reflective walls in the upper layers, the detection efficiency increases, but the time resolution of the measurement of the first photon widen, in particular for particle with low energy.
- The two configurations of PMTs in both levels allow similar performance.
- We plan to complete the study performing simulations of double-layer tanks with hexagonal base.