MultiPMTs in WCSim

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fiTQun! Workshop
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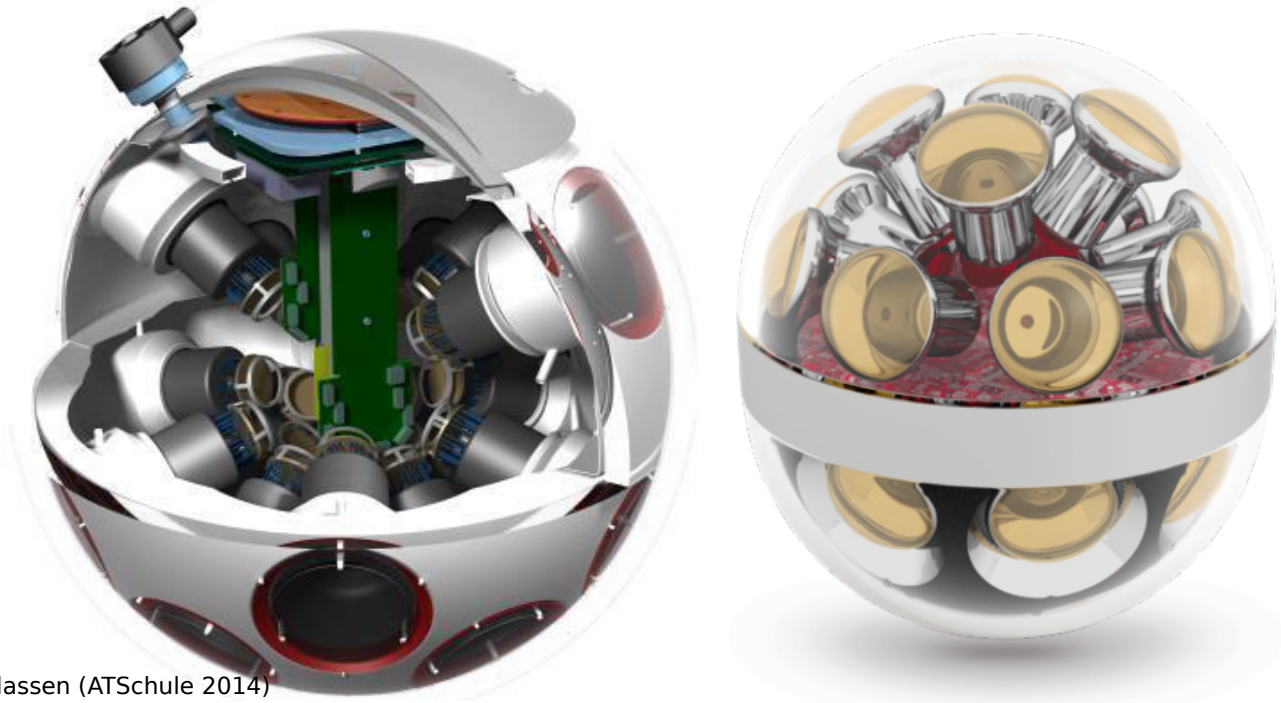
Why MultiPMTs?

- Developed by the KM3Net collaboration for a Mediterranean neutrino telescope.
- Under investigation by the PINGU collaboration for neutrino telescope in ice.
- 20" PMTs not very pressure resistant. mPMTs are encased in pressure vessel.
- Natural solution for in-water electronics.
- Small PMTs so no magnetic field shielding necessary.
- Directionality as each single PMT sees a different part of the tank.
- Improved granularity should help reconstruction and enlarging fiducial volume.
- Price per photocathode area cheaper then/comparable to 20" PMTs.
- Electronics could be simplified.

MultiPMTs: Two example designs

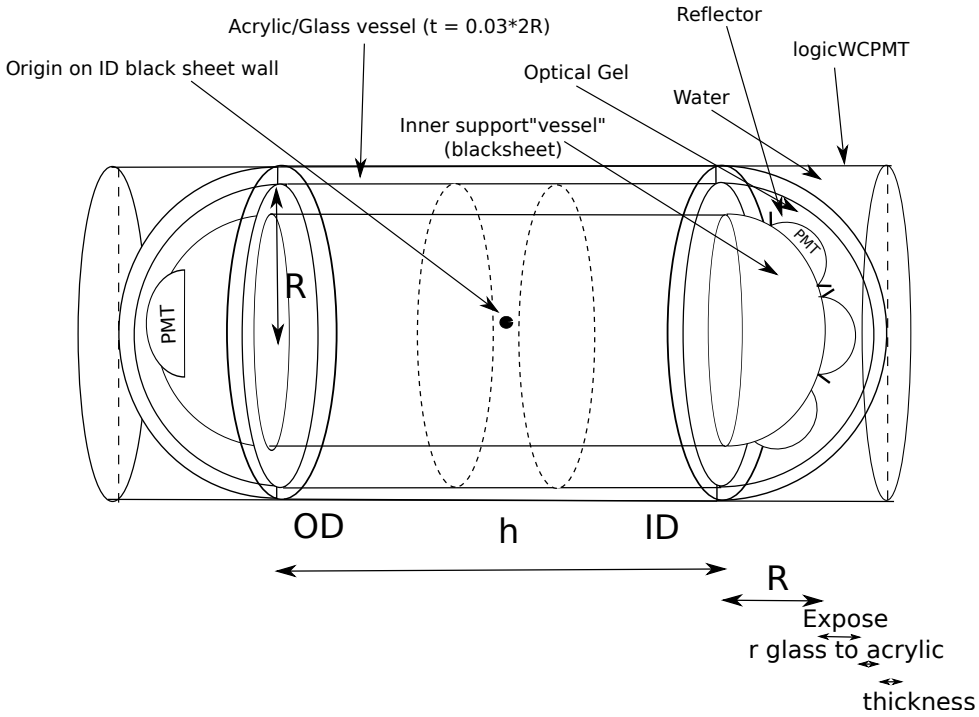


L.Classen (ATSchule 2014)

- KM3Net: 17" sphere with 31 3" PMTs (Top: 12, Bottom: 19). Maximum possible for 17" glass pressure sphere. Being deployed now.
- PINGU and beyond: 14" sphere with 24 3" PMTs (2 x 12). Currently in R&D phase.
- HyperK: in standard perifery geometry need different ID and OD. More flexibility for vessel size, hence filling. Initially replace 20" photocathode area.

$\Rightarrow$ Flexible implementation in WCSim for first performance studies with possibility for optimization.

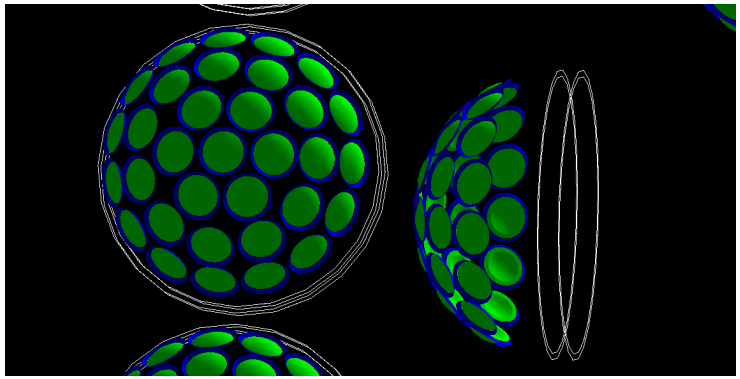
Implementation in WCSim

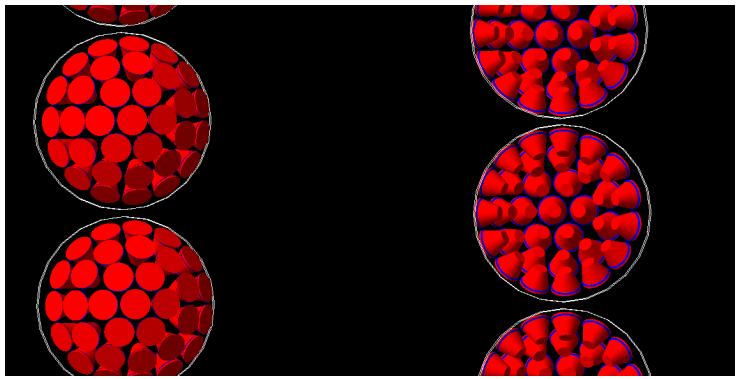


- User options in macro file for simulation:
  - Cylinder height and radius.
  - Orientation of cylinder wrt wall: vertical, horizontal, perpendicular.
  - Material for outer container (glass/acrylic/wavelength shifter/...), material for inner container (black sheet?)
  - ID and OD PMT type: Same vessel with different ID/OD configuration (needs some WCSim reorganization).
  - Reflector properties.
  - Free parameters for number of PMTs in mPMT with algorithm giving their optimal orientation.

Implementation in WCSim

- 20" PMT = 33×3" PMT in 18mm thick sphere of R=305mm.
- Implemented 3" R12199-02, except detailed charge properties.
- Implemented reflectors, acrylic, silicon gel.
- Made sure PMTs view above neighbouring mPMT and bases do not touch.





Reconstruction with fiTQun: thoughts

- Starting fiTQun tuning (charge, time pdf, angular acceptance): for each 3inch PMT and for full mPMT.
- Potential issues? Reconstruction time scales with number of PMTs? Factor of 30 slower?
- Does fiTQun need changes to use directionality from 3inch PMTs?
- Directionality from 3inch PMTs should make fit converge faster and give sharper minimum. Seeding more crucial?
- More information and directionality should benefit fit and fiducial volume: how to prove?
- KM3Net electronics based on photon counting from Time-over-Threshold. Is it possible to have a fiTQun based on discrete number of photons and their times?

Summary

- Flexible implementation of multiPMTs in WCSim ready for performance studies.
- Particle gun studies starting.
- FiTQun tuning for single 3" PMTs and full mPMTs necessary.
- FiTQun reconstruction studies crucial to understand potential advantage of mPMTs.