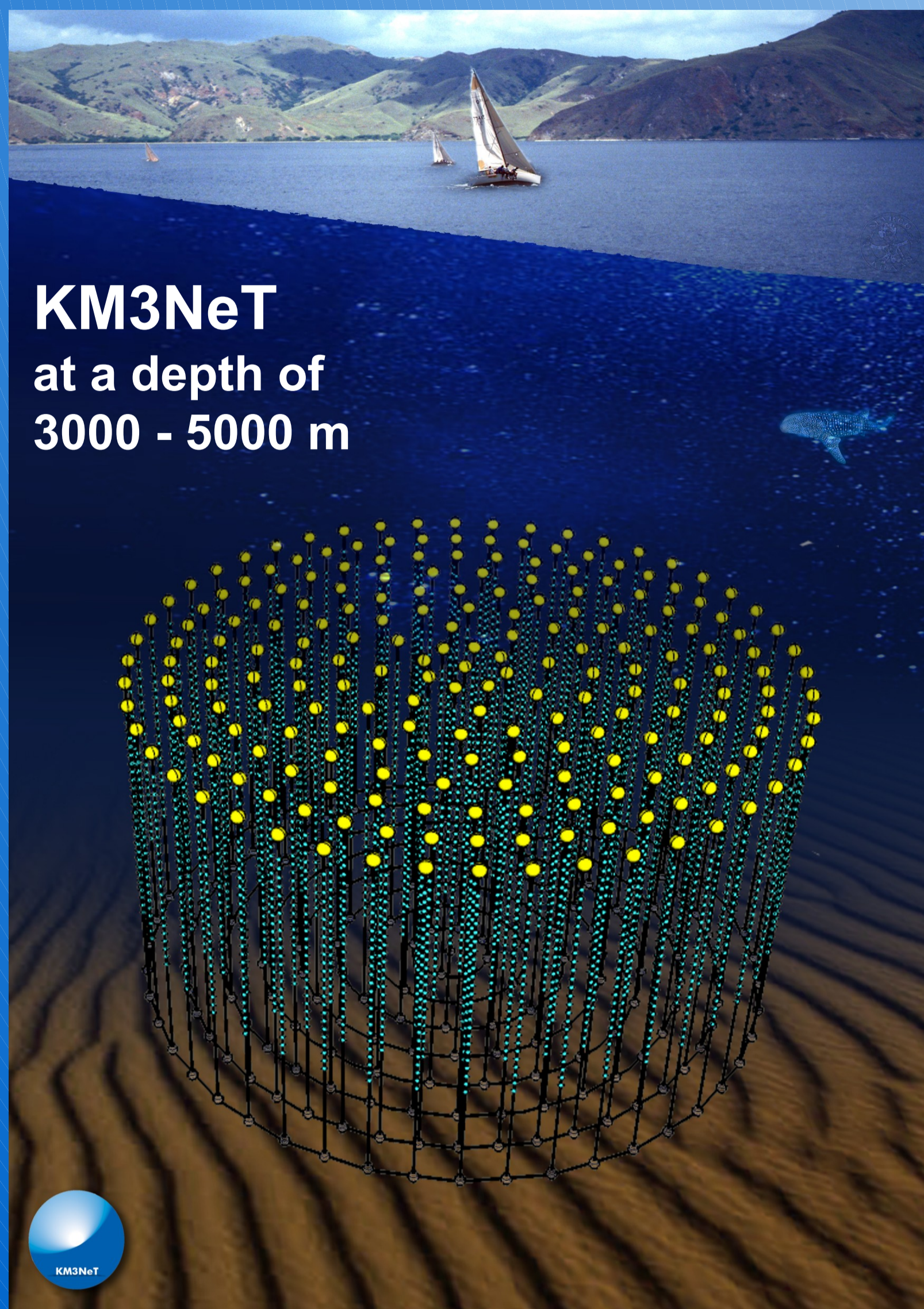


The multi-PMT Optical Module for KM3NeT

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KM3NeT at a depth of 3000 - 5000 m

KM3NeT in the Mediterranean Sea

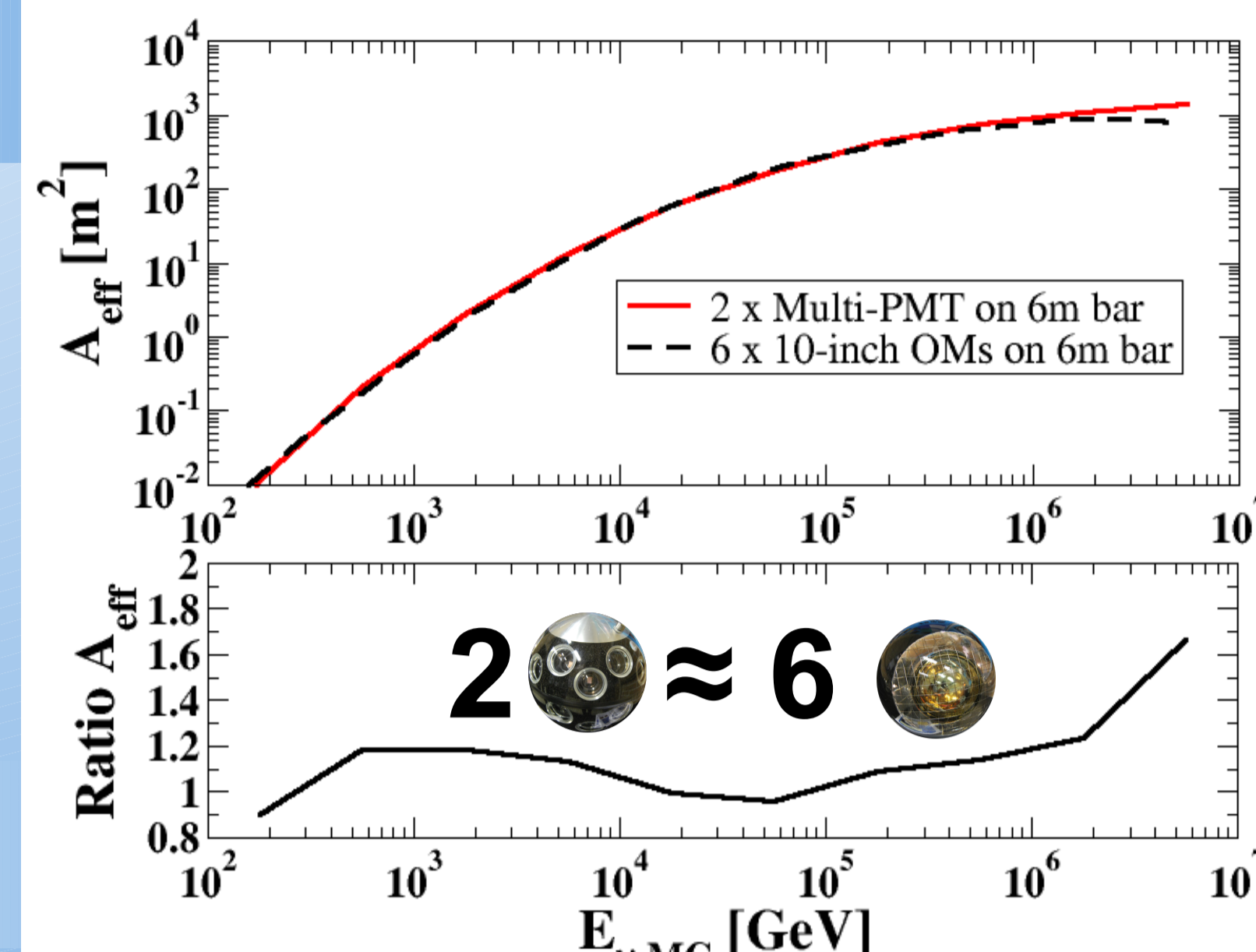
KM3NeT, the future European deep-sea research facility; a **neutrino telescope** of multi-cubic-kilometer scale: array of Optical Modules (OMs) detects **Cherenkov light** from neutrino-induced charged particles; Optical Modules are pressure resistant glass spheres containing photomultiplier tubes.

Detection unit (DU)

A flexible tower of 900 m height with 20 storeys (floors) at 40 m distance.

Storey

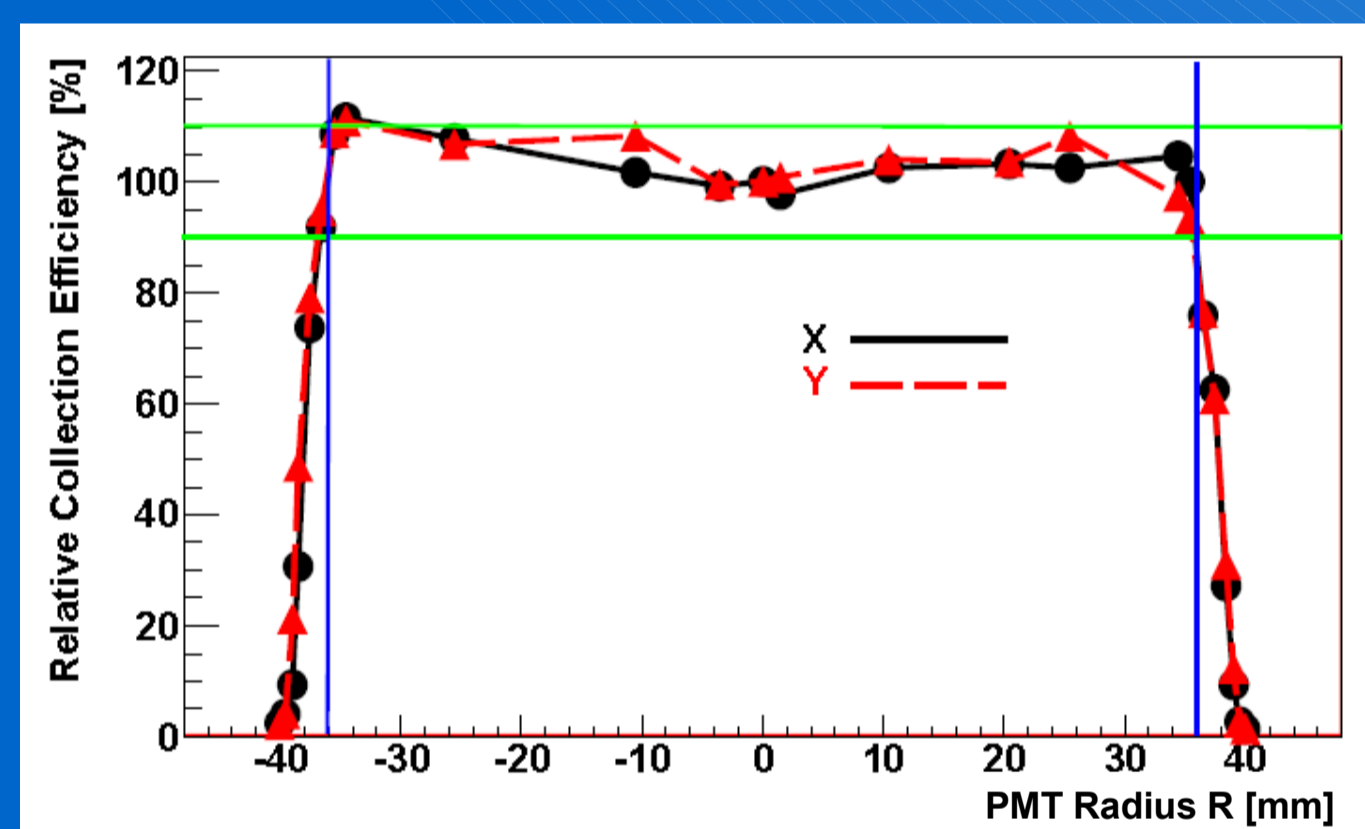
A 6m long bar equipped with 2 multi-PMT OMs : pressure sphere containing 31 3-inch PMTs.



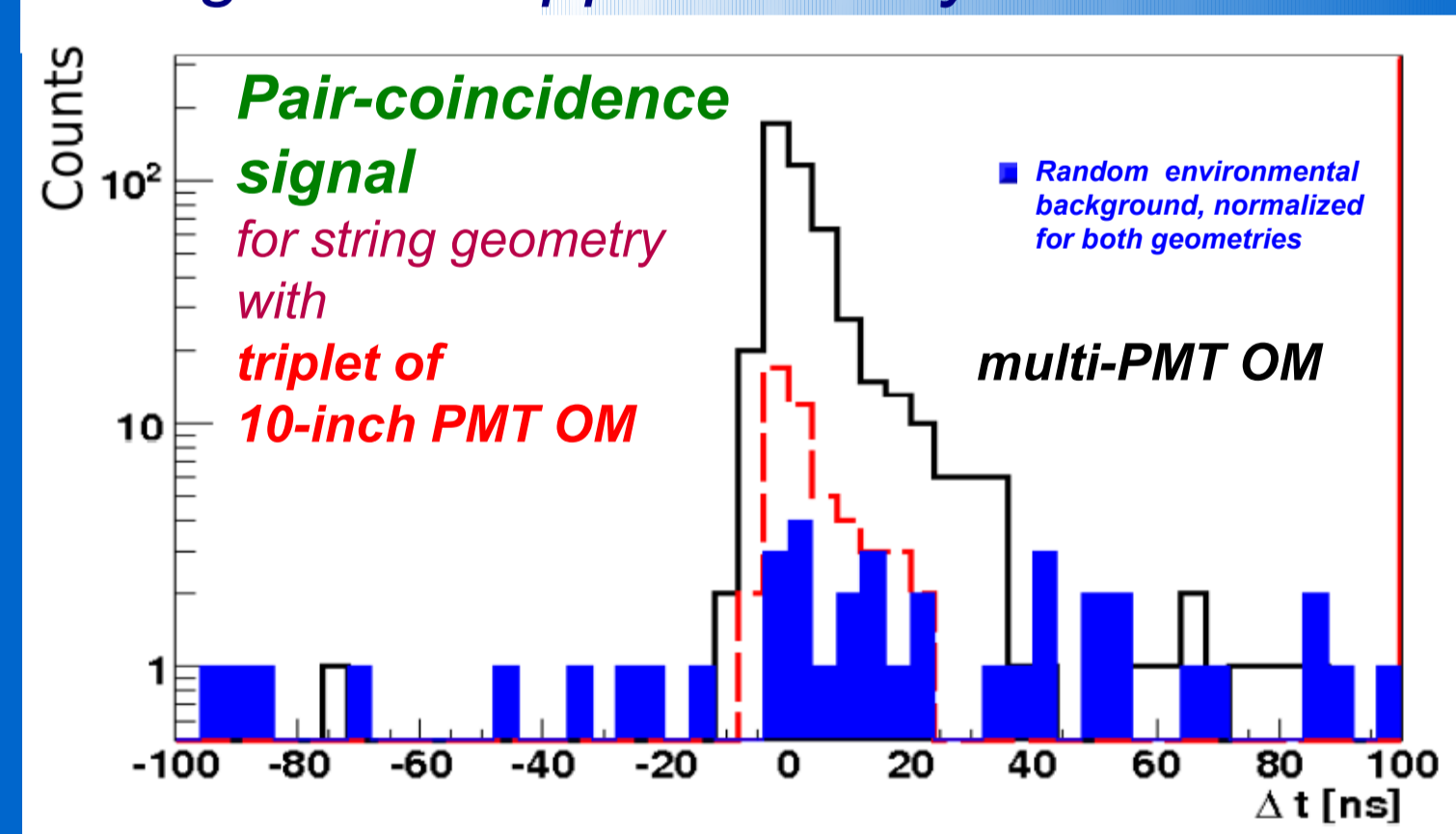
Effective area for neutrino detection from Monte Carlo simulations as function of the neutrino energy, after full reconstruction for the KM3NeT design options with **multi-PMT OMs** or with **conventional OMs (10-inch PMT)**. The ratio is shown in the bottom panel.

Available 3-inch PMT prototypes

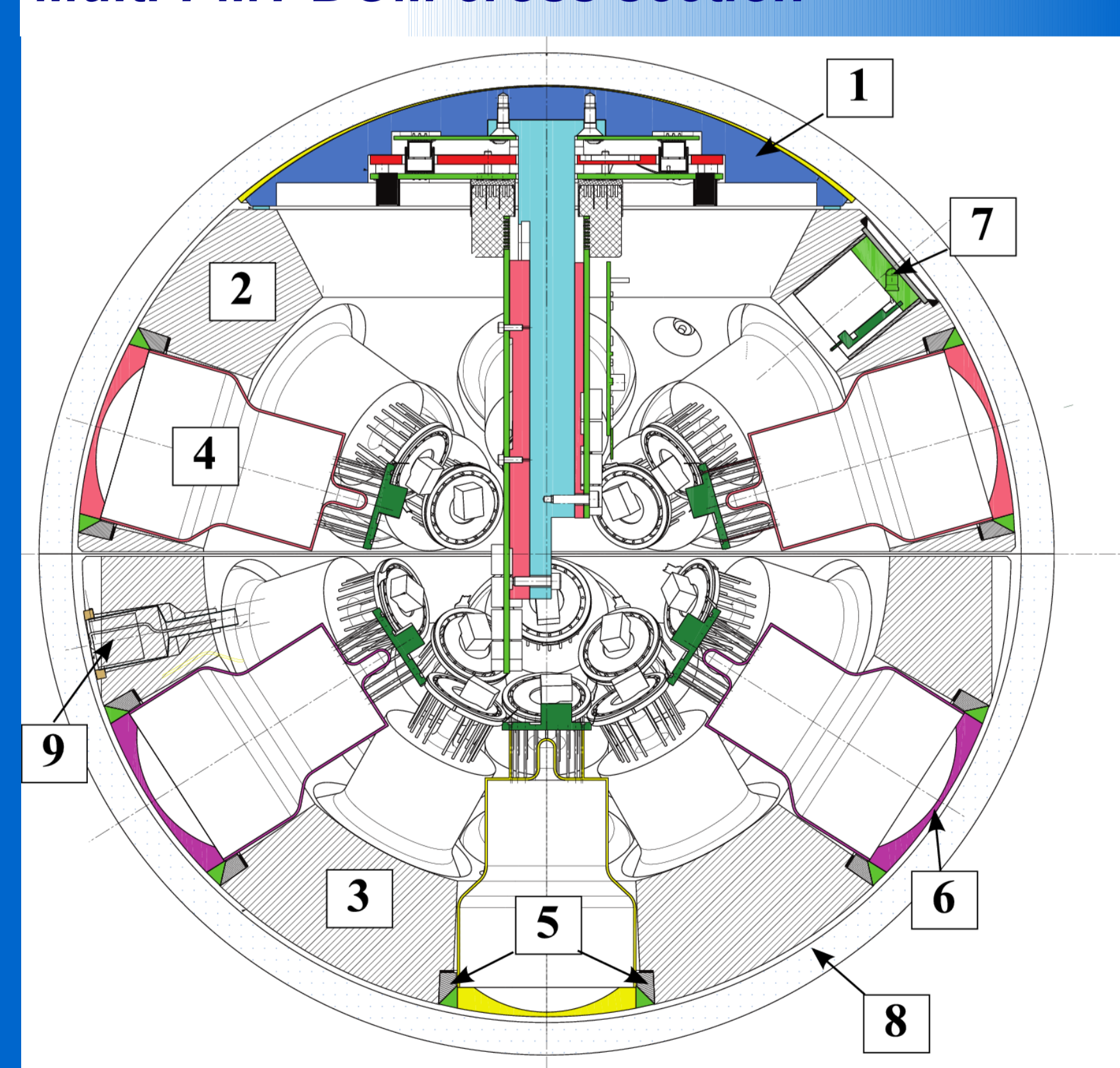
quantum efficiency	>32% at 404 nm >20% at 470 nm
Transit time spread	< 2 ns (σ)
Dark count rate	< 3 kHz at 15°C



Background suppression by coincidences



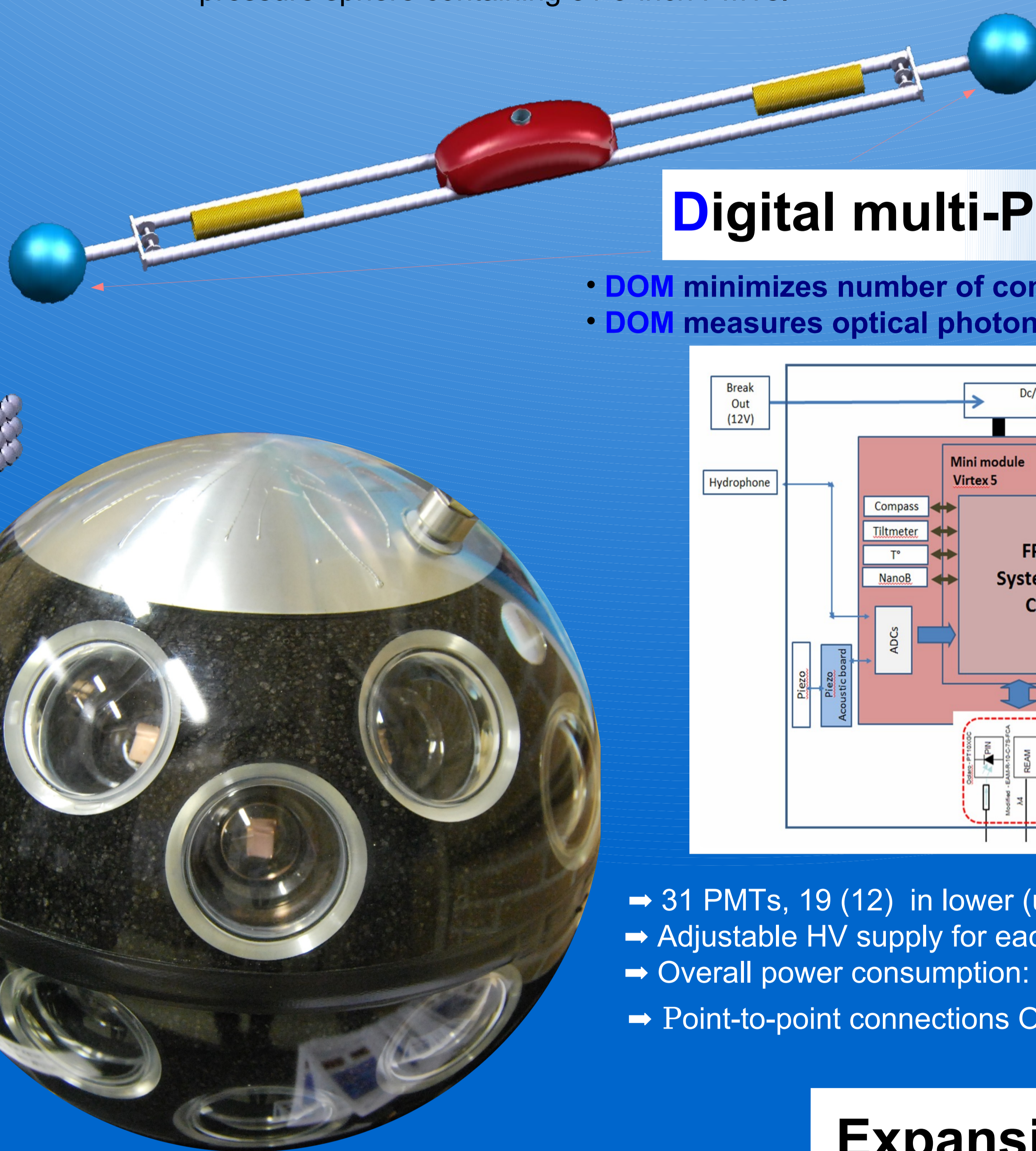
Multi-PMT DOM cross section



1-Heat conductor, 2,3- Foam cores, 4-PMT with base, 5-Expansion cone, 6-Optical coupler, 7-Nanobeacon, 8-Glass sphere, 9-Piezo element.

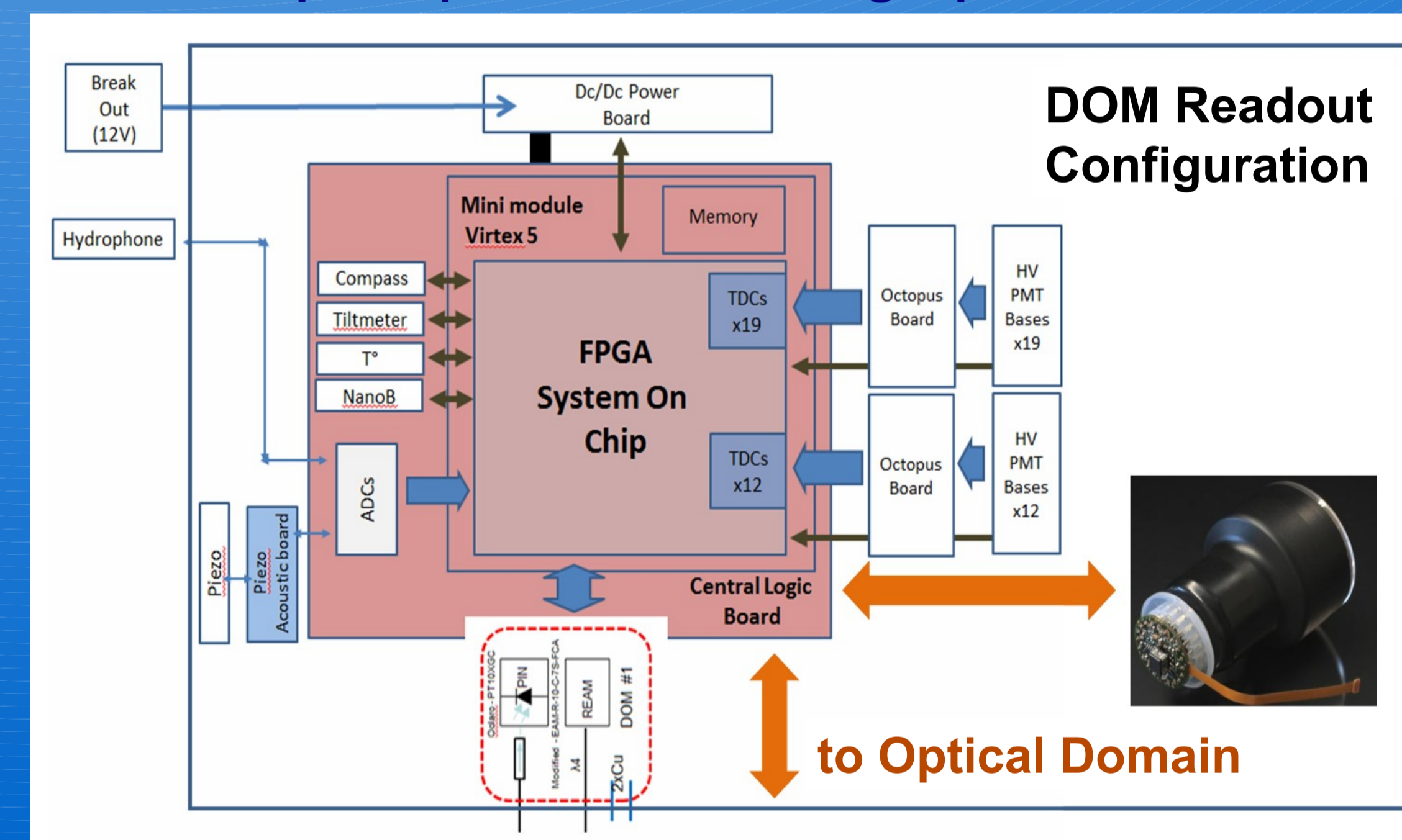
Acknowledgements

This work is supported through the EU, FP6 Contract no. 011937, FP7 grant agreement no. 212252, and the Dutch Ministry of Education, Culture and Science.



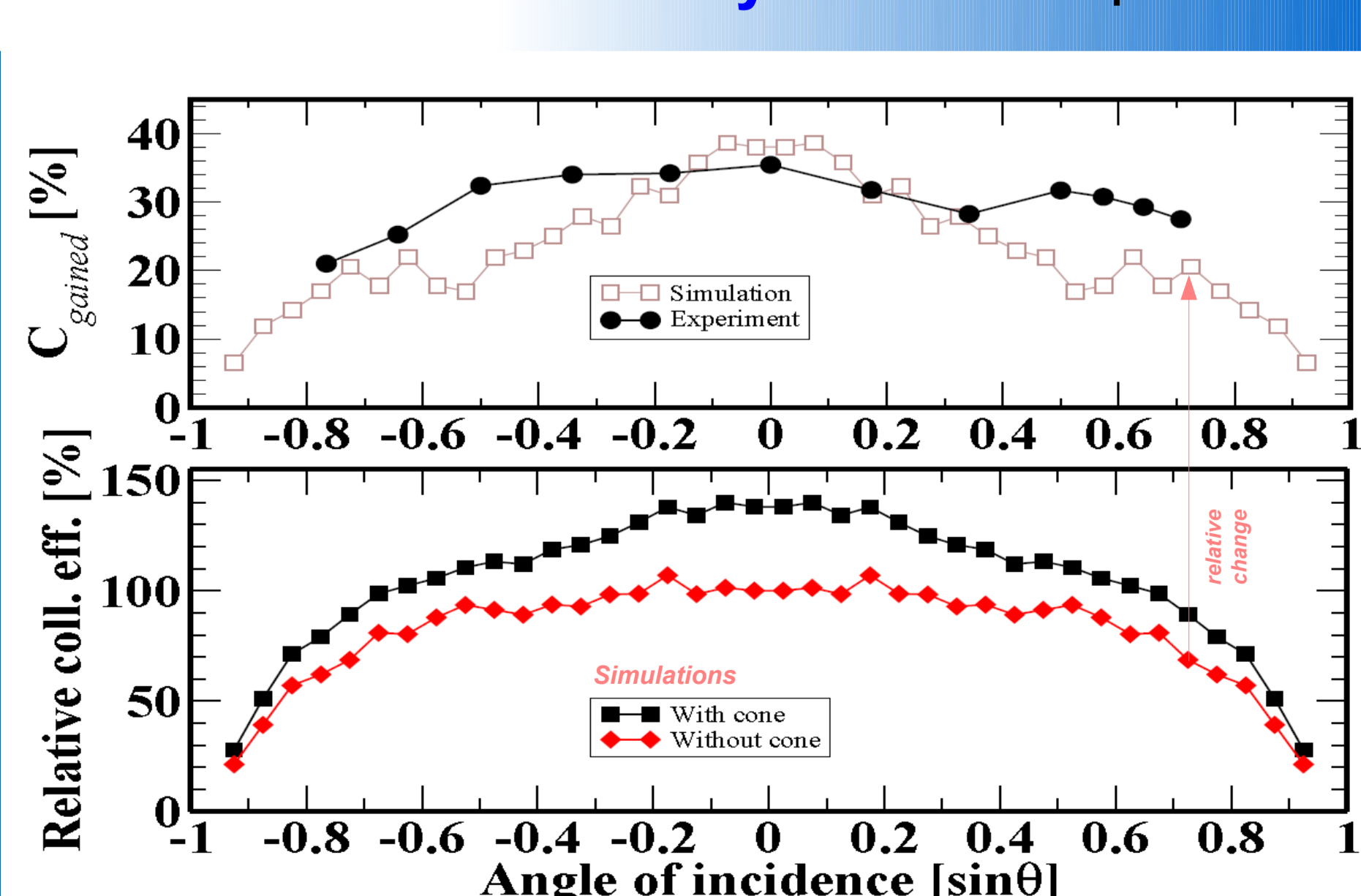
Digital multi-PMT Optical Module

- DOM minimizes number of connectors in the detection system;
- DOM measures optical photons at the single-photon level



- 31 PMTs, 19 (12) in lower (upper) hemisphere, foam supported
- Adjustable HV supply for each PMT
- Overall power consumption: 7 W / OM
- Point-to-point connections OM ↔ shore station

PMT Collection efficiency without /with expansion cone



Expansion Cone



- Bevelled reflective aluminum collar (filled with silicon gel) extends photon collection
- 30 % average increase in collection efficiency for angles of incidence from -50° to $+45^\circ$, 35 % for perpendicular incidence
- Simulations with SLitrani (NIM A 486, 2002, 35) of reflected light propagation reveal an overall increase of photon acceptance by 27 %

Summary

Digital multi-PMT Optical Module outperforms single large-PMT OM: local coincidences reduce optical background; expansion cone gains photon collection efficiency; low-power consumption OM logic board / signal collection board: optical data transmission.