MultiPMT Status

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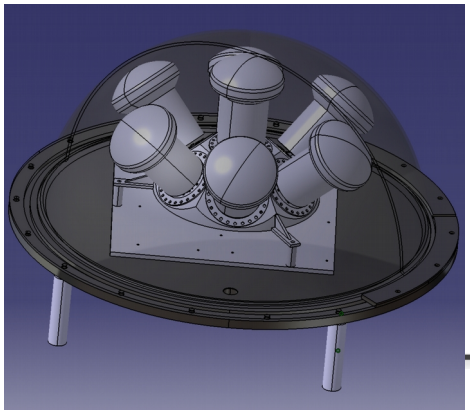
Description

- *What it is*
  - The multiPMT module combines several 3-inch PMTs, power supply and read-out electronics inside a waterproof vessel. This solution is very flexible (e.g. number of PMTs and orientation can be optimized), provides intrinsic directional sensitivity and extended dynamics range, at a competitive cost.
  - Electronics is fully hosted inside the vessel. Only 2 cables exit from the module, network & low voltage



- *Compatibility*
  - Works with all local electronics options
  - Works with both single and dual layer WCDs

Advantages / Performance

- *Why is this a good idea and what advantages does it have with respect to other options?*
  - instrinsic directionality – modularity – higher dynamic range – lower TTS
  - could help gamma/hadron discrimination in the outer array
  - Hamamatsu has an excellent large scale production capability for the 3’’ pmts (~2500 pmts per month). High PMTs reliability and production uniformity based on Km3 experience
  - Fully assembled in lab and easily deployed (only low voltage and network connections are needed)
  - Electronics inside the vessel operated in a stable environment, no cooling required. May help to prevent local freezing in the WCD (near the MultiPMT)

- *Comment on its performance*
  - all performances requirements are met, and improved with respect to larger pmts → look at HAP-23-022

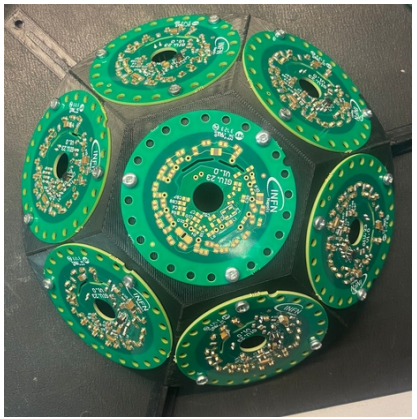
The first multiPMT prototype

PMT holder, HV boards, 3’’ pmts

Particular of the PMT holder

Each PMT is soldered on its circular active board

The central PMT not yet mounted to better show the board



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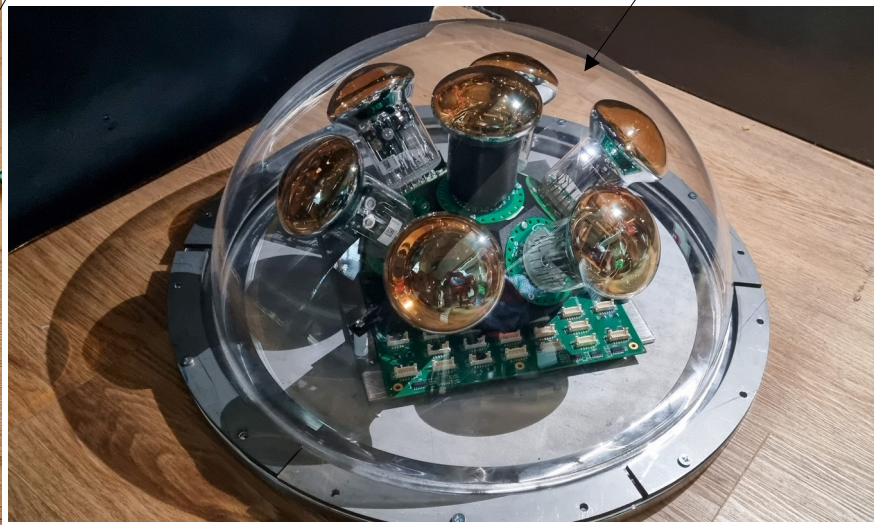


Technological Readiness

1) initial design definition
2) interface validation
3) first prototype
4) performance verification
5) interface verification
6) reliability testing
7) small batch production, lab verification & testing
8) small batch operation in realistic conditions

- *Where on the scale 1-8 are you?*
  - → We are at level 3

- *Prototyping status*
  - → First protoype is being assembled : mechanics design complete and parts already available. Custom SWGO HV and FEB electronics developed : HV boards mounted, FEB expected to arrive in a few days. HyperK main board used for prototype.
  - → INFN already funded for 3 more gen2-prototypes with full SWGO electronics gen2-prototypes to be defined depending on the results in simulation and test
  - → Expect to level 7 in a few months

- *Comment on Reliability and Maintainability*
  - → multiPMTs are largely and successfully operated in maintainance free experiments (Km3Net). Modularity offers intrinsic redundancy and prevents from critical failures. Replacing units is possible and fixing can be made in lab

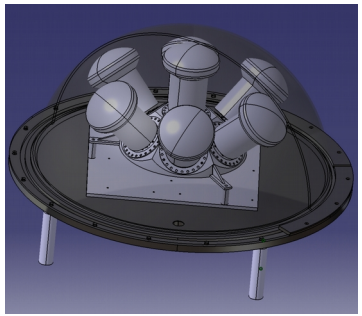
Cost

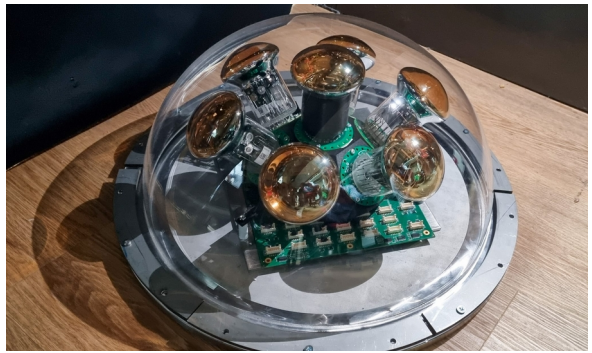
- *Summary of costs for component production, assembly, deployment and operations (power, in-field maintenance, …)*
  - → Mechanics : final quotations with details for 1000 / 5000 modules (VAT excluded) :
    - 200€ inox backplate
    - 60€ / 50€ UV transparent acrylic dome
    - 20€ 3D printed PMTs holder
    - 180€ 3'' pmts R14374 (Yen/€ exchange rate 0.0064 as of July 2023) tot. 1260€
    - 100€ assembly (not yet the final quotation!)
    - ***Total for mechanics & pmts for one module → 1540€ + 100€ assembly***
  - → Electronics ~1400€ (quotation for 100 boards, will be sensibly lower for mass production)
    - Power consumption (~2.3 W) - Only 2 cables, network and low voltage (48 V)
    - ***Total cost for one multiPMT module → 2940€ + 100€ assembly***
- All quotations for mechanics mass production (1000 and 5000) already available, except for assembly. Quotations for electronics to be updated (expect to be lower).

Development Plan
towards large scale production

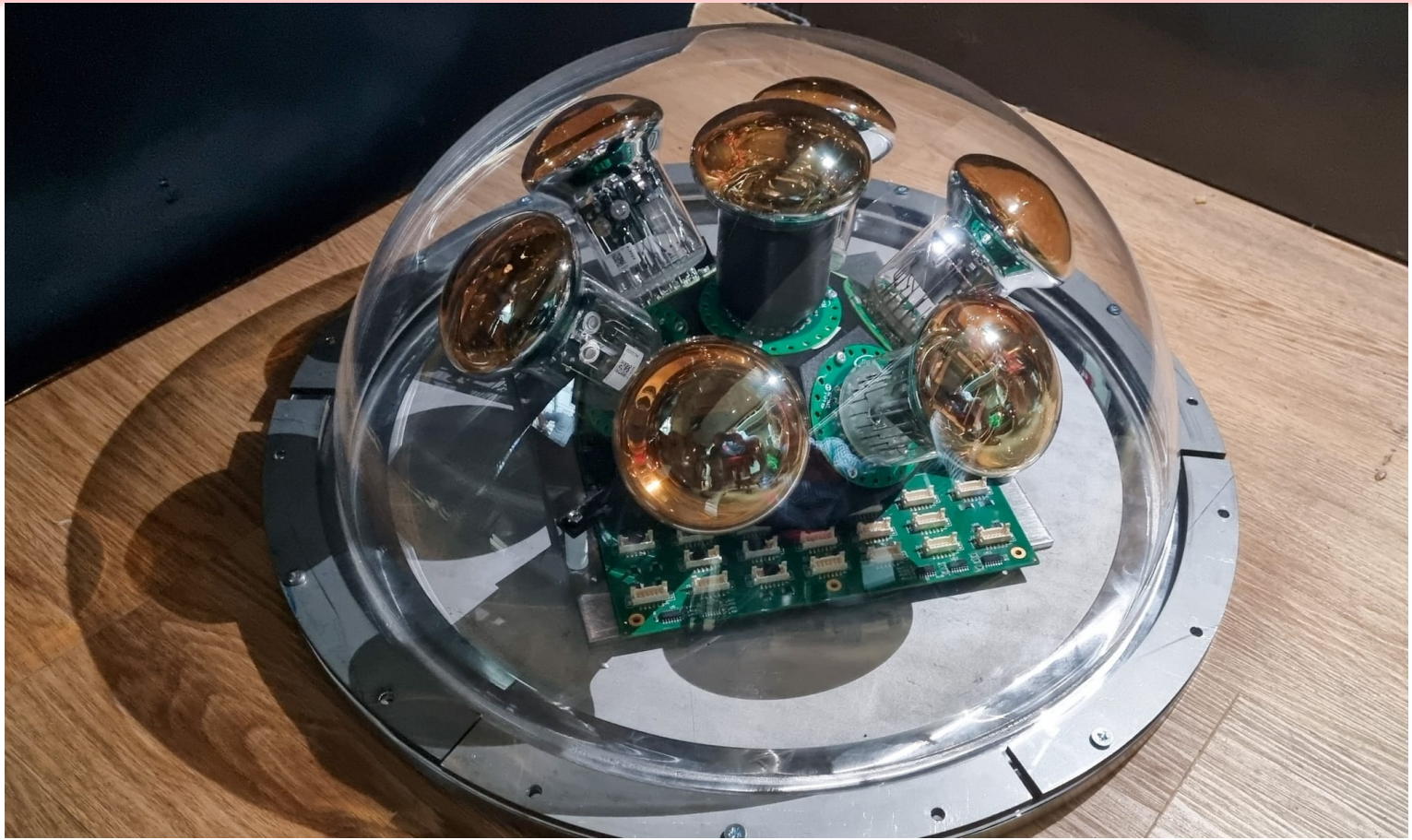
- *Next steps are*
  - → Full test and characterization of first prototype (in lab and in WCD tanks available within the collaboration)
  - → The small batch of gen2-prototypes to be operated on proposed sites

- *Large scale production plan/sketch*
  - → multiPMT large scale assembly most probably to be performed by third part company. This could be shared with other institutions on a common design.





The first multiPMT prototype



Updates wrt Prague meeting

PROCUREMENTS :

Mechanics : 5 backplates with some modification + 5 acrylic domes
INFN Padova funds trasferred to Napoli allowes to anticipate these orders!

Electronics : 15 FEB + HV modules (7+7 to complete two prototypes + 1 spare module)
expect to order 21 FEB + HV modules January 2024 (to complete remaining 3)

New entries in the Naples group : master thesis students (Vincenzo, Matteo and Fabio)

Vincenzo/Waqas → multiPMT simulation (see presentation tomorrow)
Matteo → full characterization of the multiPMT prototype and automation of DAQ for massive tests

Updates wrt Prague meeting

FULL TEST OF PROTOTYPE 1 IN PROGRESS :

Spectroscopic analysis of the acrylic used to produce the dome (comparison with HyperK)

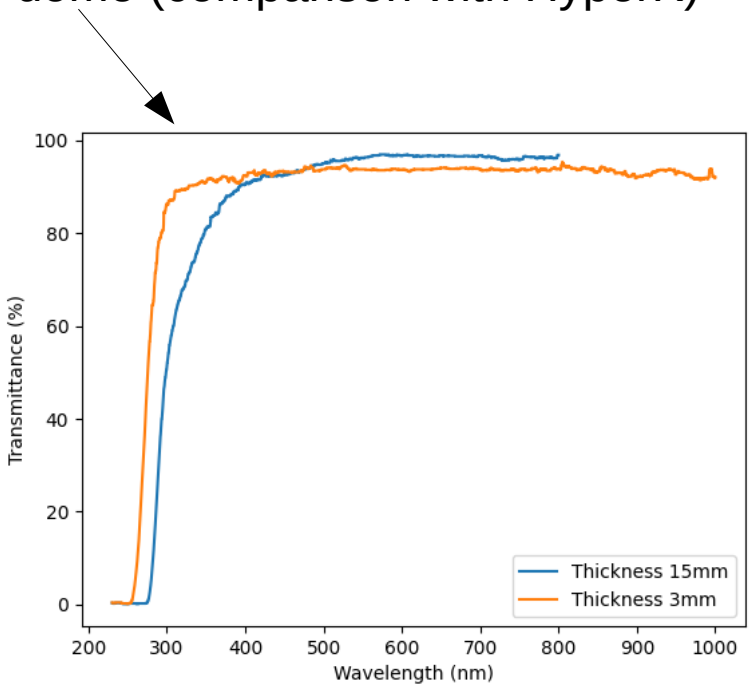
Expected watertight seal test within 1 month

MORE WORK IN PROGRESS

Design and realization of the main board

MultiPMT simulations in progress
(see presentation tomorrow)

Python scripts to automatize detector characterization



BACKUP

Under investigation : use of optical gel

The use of optical gel between the acrylic dome and the pmts cathode is under investigation.

Might be useful to reduce the change of refractive index between acrylic dome and photocatodes

SOLUTION TO BE TESTED :

Optical Gel Pads → one for each pmt. To be injected in a mold to perfectly fit the space between photocatode and dome. During assembly it can be glued directly to the PMTs.

This solution will be tested → we already have contacts with a company that produces the gel.