



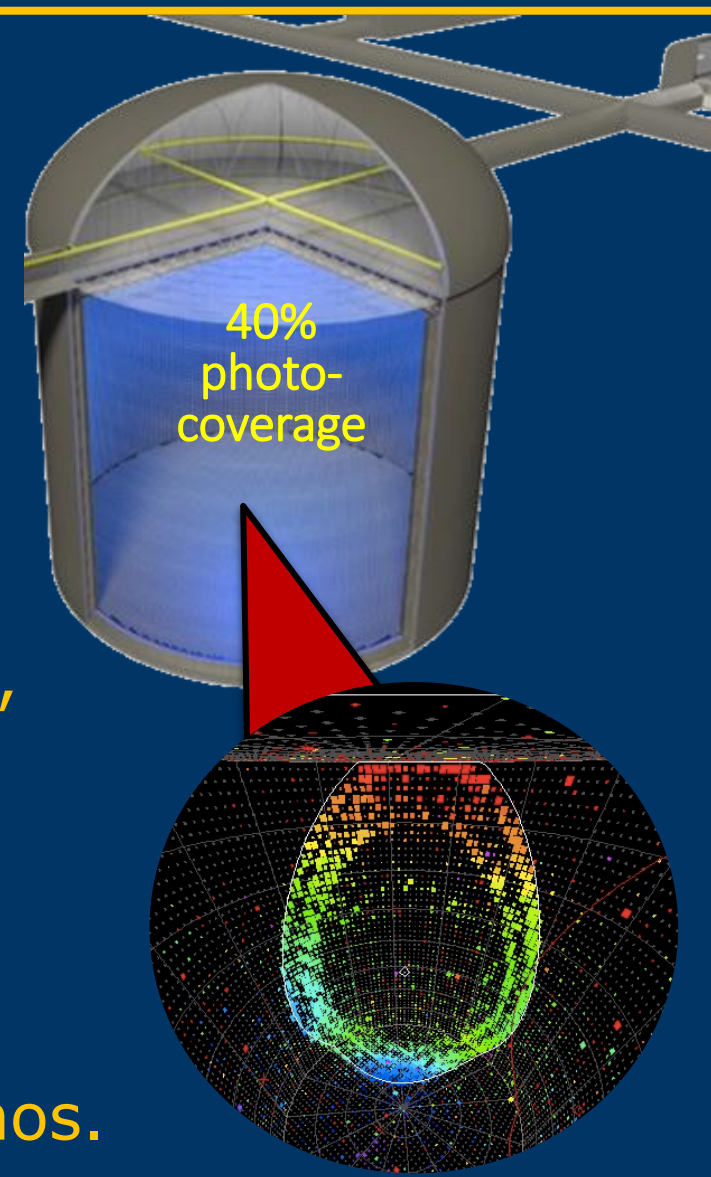
# Preparation for mass production and quality assurance of the mPMT module for Hyper-Kamiokande

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## The Experiment

Hyper-Kamiokande (HK) is the next generation Water-Cherenkov detector with multi-purpose scientific goals:

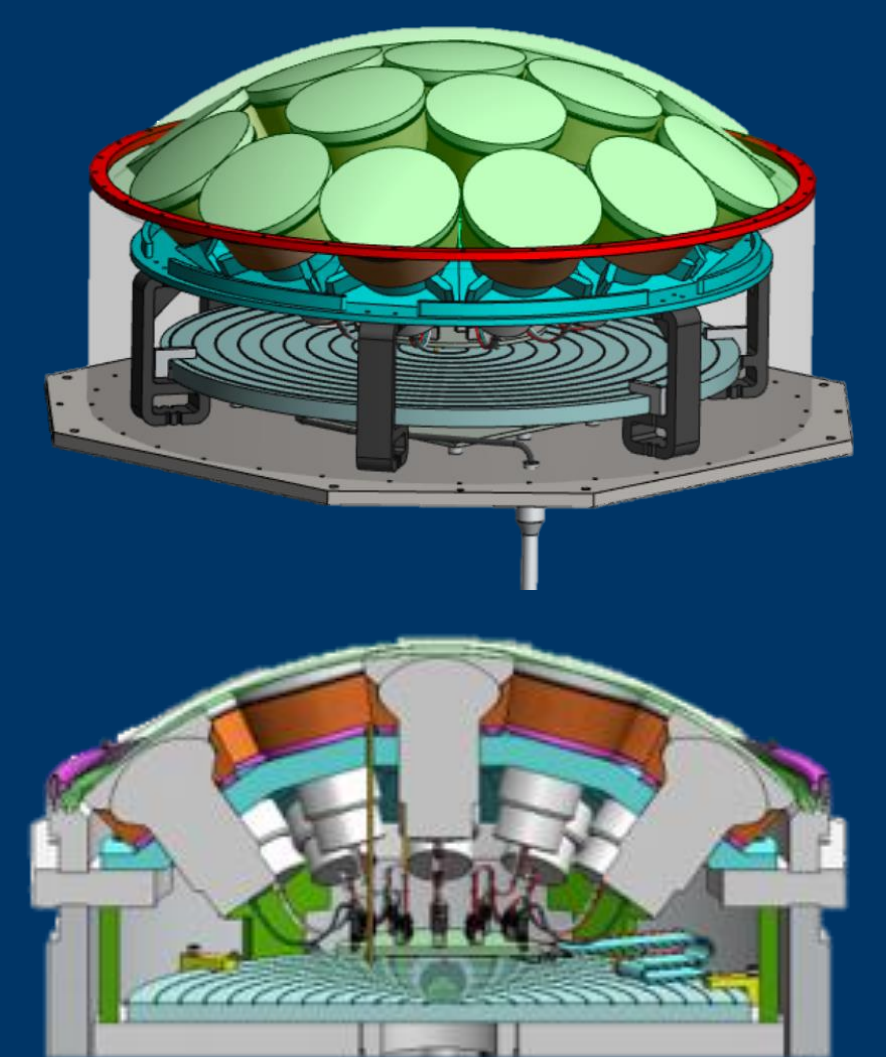
- Investigation on **CP-violation** in leptonic sector;
- Neutrino **oscillations** (atmospheric, accelerator and solar);
- Determination of the neutrino mass ordering;
- **Proton Decay**;
- Observation of astrophysical neutrinos.



## The mPMT

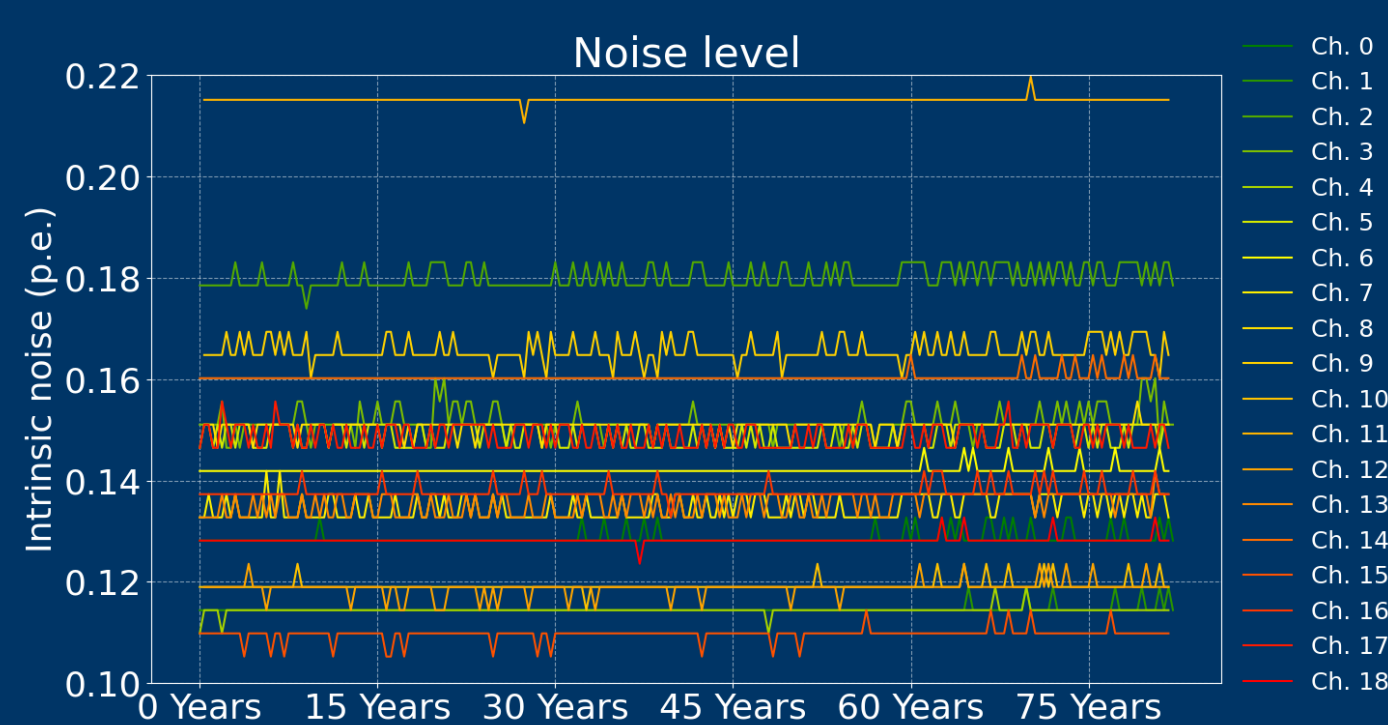
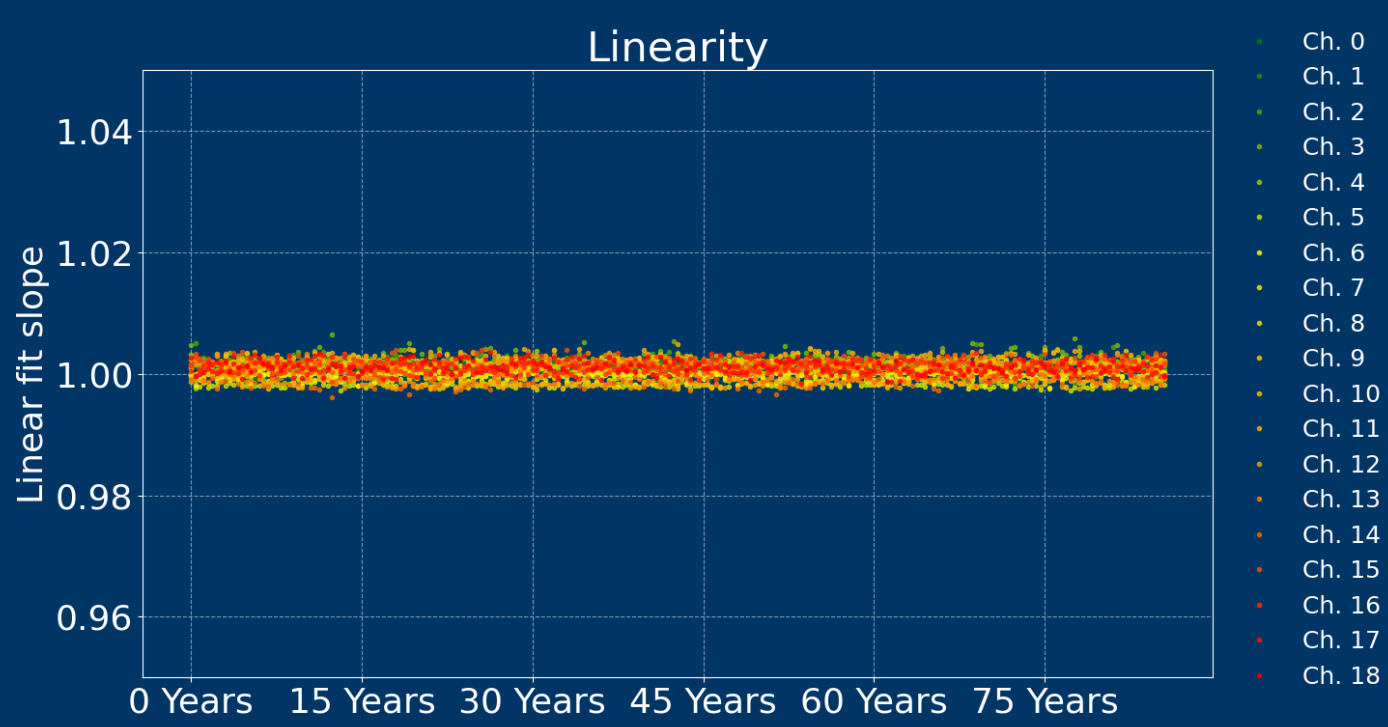
HK will be instrumented with 20,000 20-inch PMTs and **800 mPMTs**. The mPMT is a new detector inspired by KM3NeT, consisting of 19 single 3-inch smaller PMTs.

The detector is divided into an upper side, where the PMTs, immersed in an optical gel, look through an acrylic dome. On the lower side there is the main electronic board and the cooling steel backplate.



## HALT

HK will operate for 20 years, underwater and without any maintenance. So it is fundamental to have electronic components capable to last many years. To test this a HALT (Highly Accelerated Life Test) has been performed.



During the test, the ability of the boards to provide a required voltage and the intrinsic noise were tested.

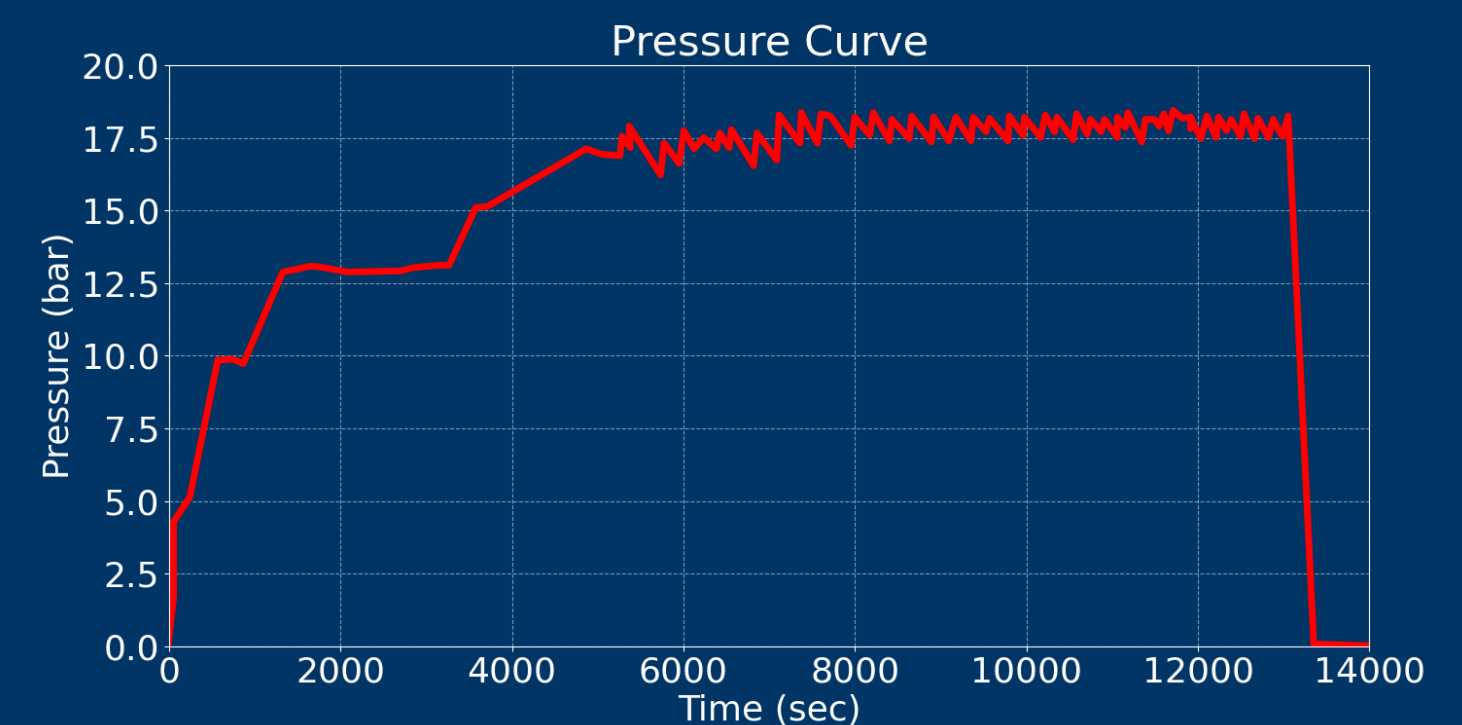
After more than one month at 70°C, all 19 channels still work and can supply the correct voltage for the PMTs.



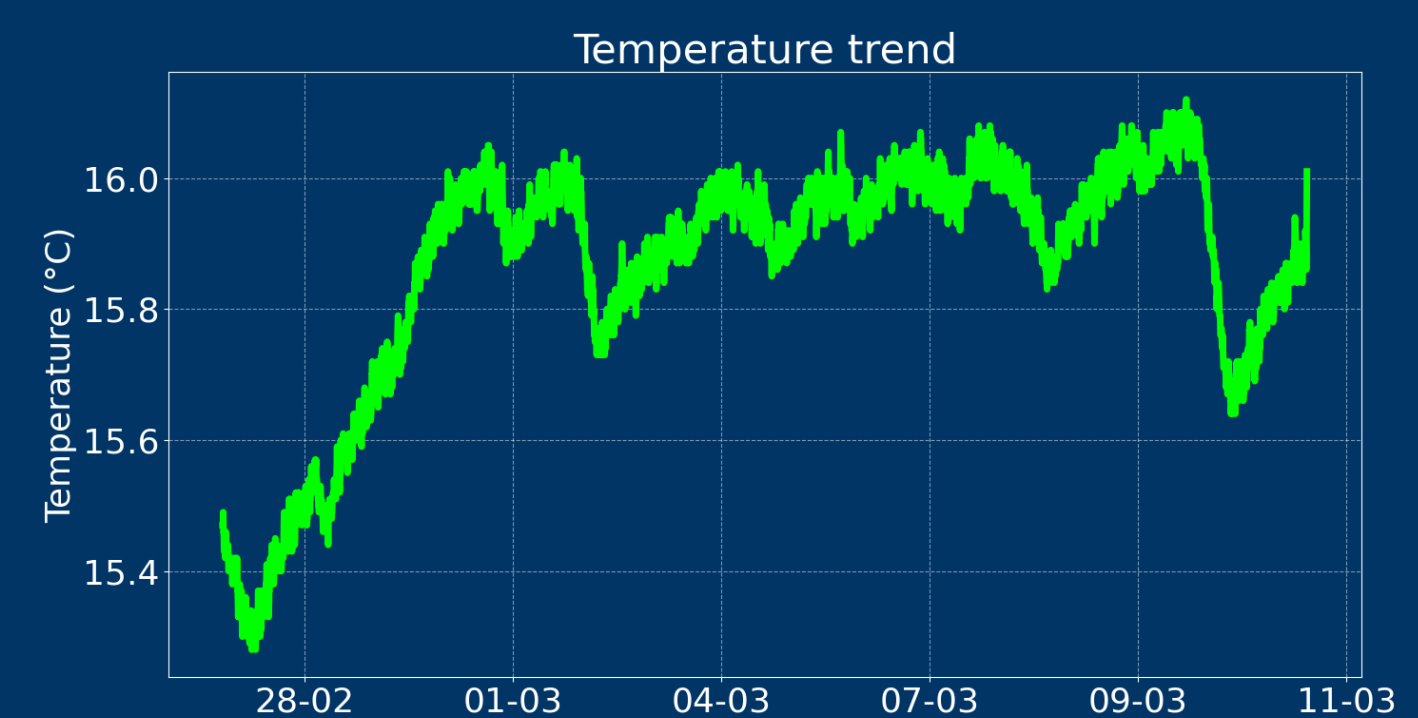
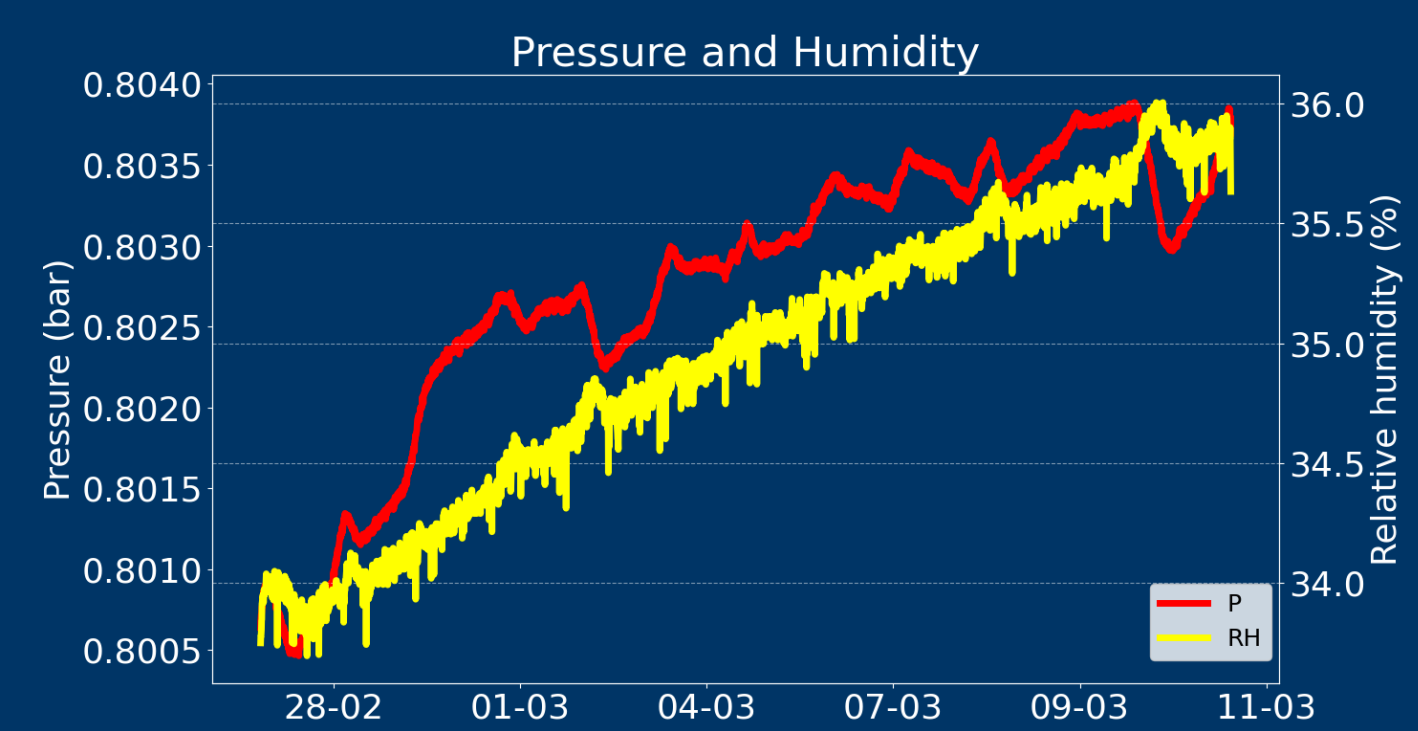
Single channel boards tested in the HALT

## Pressure test

One of the first prototypes was tested in Italy in a hyperbaric chamber, to test the pressure resistance of the entire vessel. The mPMT passed the test without any problem, also at bigger pressure than the one expected in the HK tank.



## Immersion test



To measure the tightness and the internal parameters underwater a prototype was kept in a dark water tank for 2 weeks.

## Conclusions

- The mPMT has passed every test it was subjected to, for all its components, from the electronic ones to the mechanical ones.
- The design is almost finalized and mass production is scheduled for the end of the year.

## Acknowledgments

Work is being carried out within INFN and the Hyper-Kamiokande international collaboration.

