A R&D on a triggerless acquisition for next generation neutrino experiments

The next generation of megaton scale water tanks implies very large surfaces of photodetection and a large volume of data. PMm² is a funded R&D project to implement a solution. The main features are:

- Replace large 20" PMTs by 12" (cheaper)
- Modular design (assembly by 16 PMTs)
- Underwater front-end electronics (less cables)
- Triggerless data acquisition

Principle of a Megaton scale Cerenkov water tank experiment

- The Cerenkov light impinges on a few PMTs (among 80,000)
- The PMT signal charge and time stamp are digitized underwater
- All the PMT data are transferred continuously to the surface controller
- The Cerenkov light impinges on a few PMTs (among 80,000)
- The PMT signal charge and time stamp are digitized underwater
- All the PMT data are transferred continuously to the surface controller
- The coincidence and data analysis are performed offline

200 to 300,000 12 inch PMTs at up to 7 bars

- New glass envelope design for 10 bar resistance
- New multiplier (adapted to the new envelope)
- Potted base
- Production and cost driven design

Constraint calculations on a PMT showed the weaknesses of the existing tubes. The new PMT, base and electronics enclosure will be tested in a vessel at up to 10 bars.

Modular design by groups of 16 PMTs

- Single high voltage power supply
- Gain compensation on the front-end electronics
- Local front-end

- PMTs sorted according to the gain (validated by simulations).
- Cost reduction by using the same cable for signal and high voltage and by reducing the number of connectors.

Prototype test:

Tests with cosmic muons and LEDs. Schedule to begin by the end of 2009 at IPN Orsay.

A 16 PMT module + surface controller

Test in a Cerenkov water tank of:

- 16 independent channels
- Analog processing + digitization
- Charge: 1 to 300 photoelectrons
- Time: 1 ns resolution FWHM

Front-End ASIC (PARISROC)

- 16 independent channels
- Analog processing + digitization
- Charge: 1 to 300 photoelectrons
- Time: 1 ns resolution FWHM

Surface controller

- GPS (for clock synchronization)
- Dedicated serial protocol
- Readout: Ethernet

Underwater front-end (principle)

- Network Controller
- FPGA
- HV
- Monitoring
- FE-ASIC