JUNO-Italia Meeting

14-15 March 2018 *Laboratori Nazionali di Frascati*

Status of electronics and activities in Padova

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Outline

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- ✓ 1F3 scheme
- ✓ The Global control unit
  - GCU block diagram
  - GCU PCB layout
  - Status of GCU
- ✓ Electronic integration test facility
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JUNO electronics: 1F3 Scheme

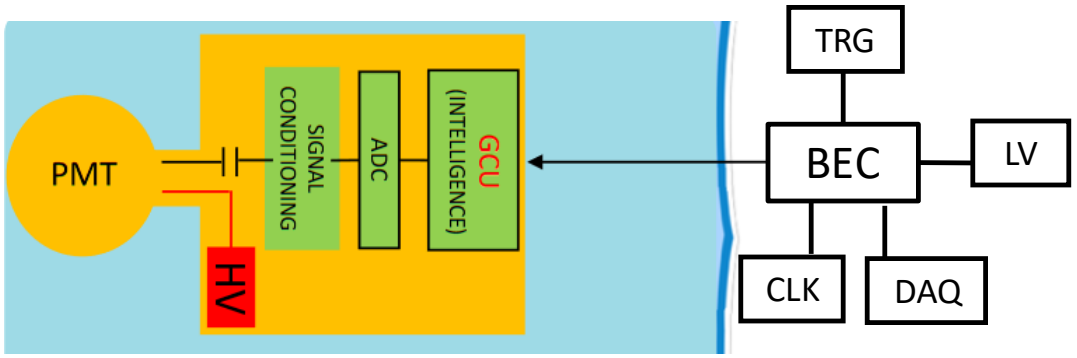
The readout architecture of JUNO PMT signal is designed to be placed in a watertight box : the 1F3 scheme was chosen (July 2017).

Only the base will be potted with the PMT and the electronics will be placed in the box at around 1 m from PMT.

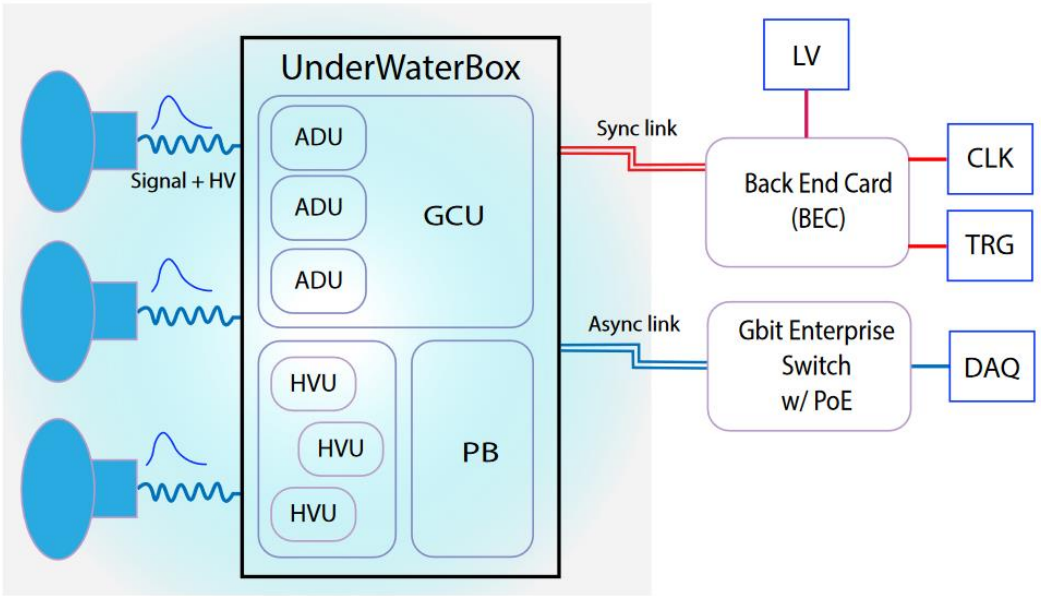
Constraints:

- Inaccessibility after installation.
- Minimize the power consumption and cost per channel.
- Minimize the number of cables and waterproof connectors.
- Maximize the reliability of the electronics

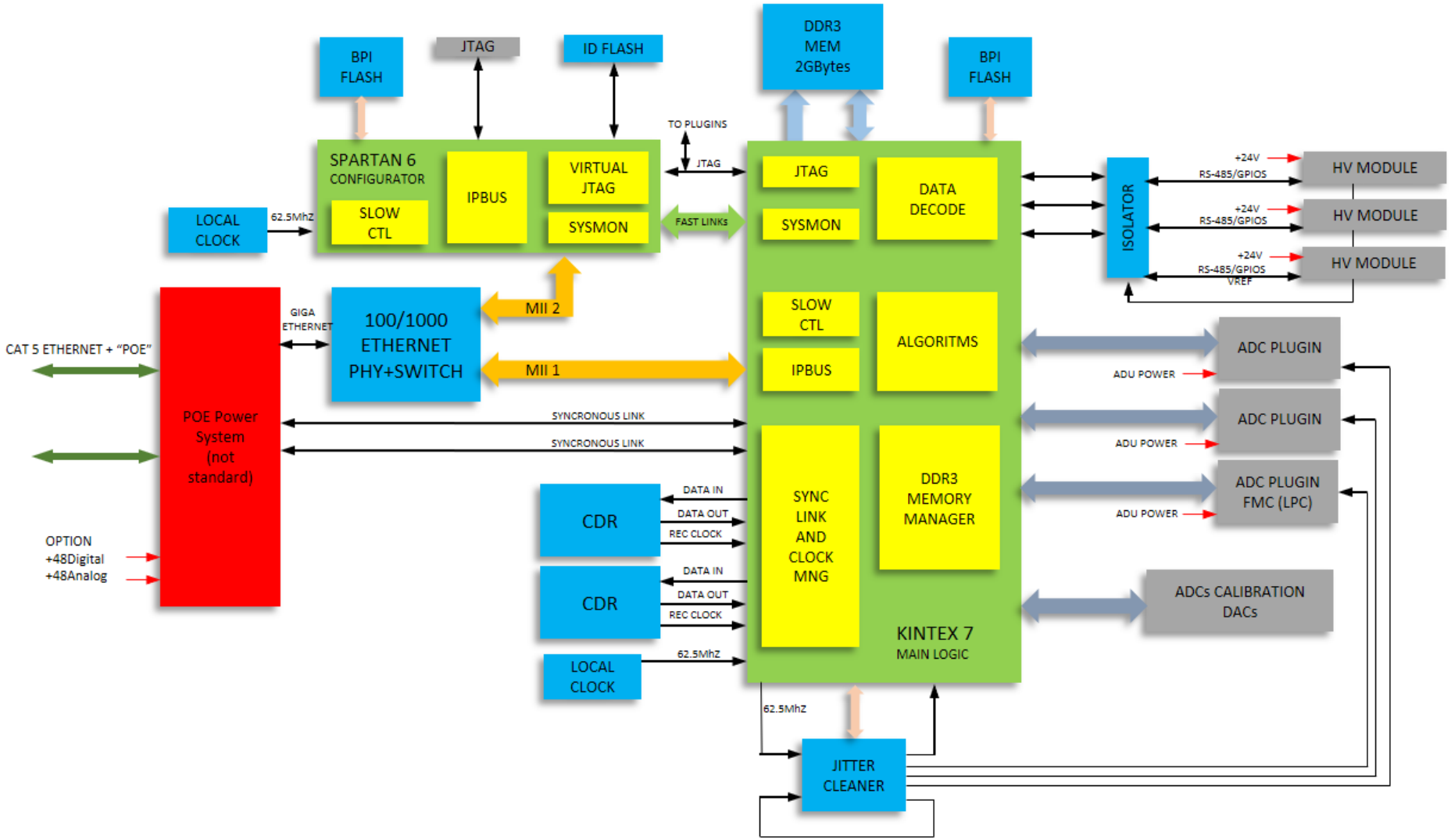
BX scheme



1F3 scheme



GCU: global control unit

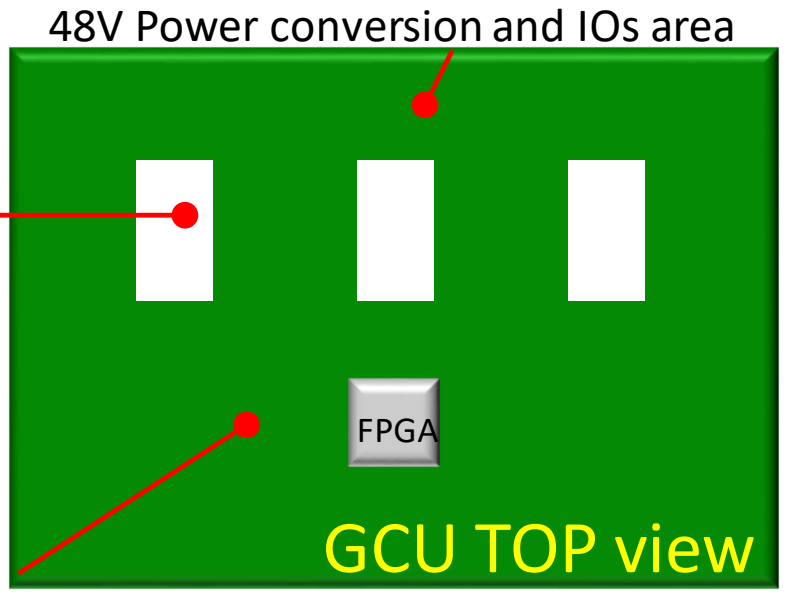


GCU PCB layout

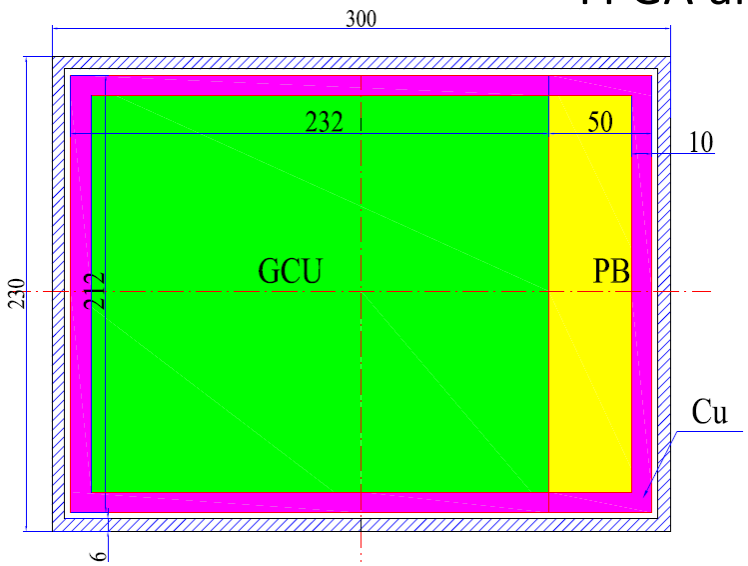
The power board is integrated in the new 1F3 GCU design. The power section is developed by IHEP.

Holes to accommodate the ADU castellated edge cards on bottom layer.

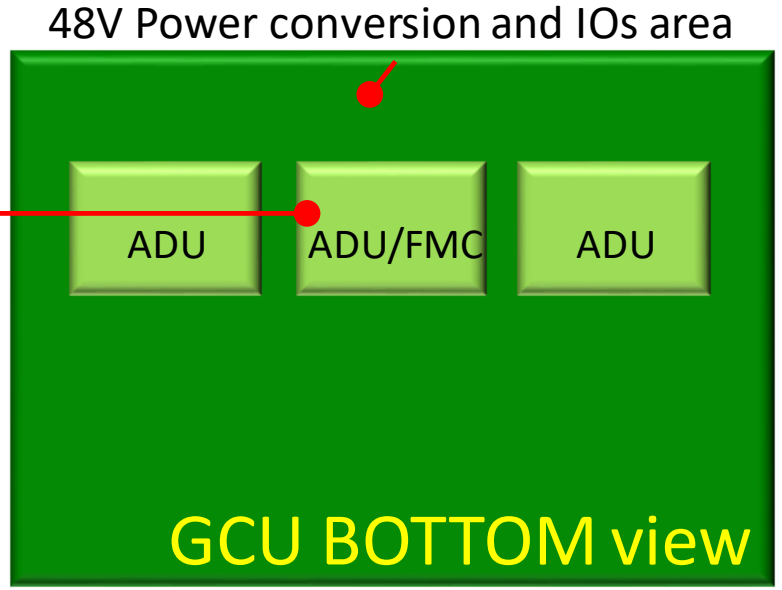
The GCU has holes in order to fit those ADU components that face the GCU.



FPGA and logic Area



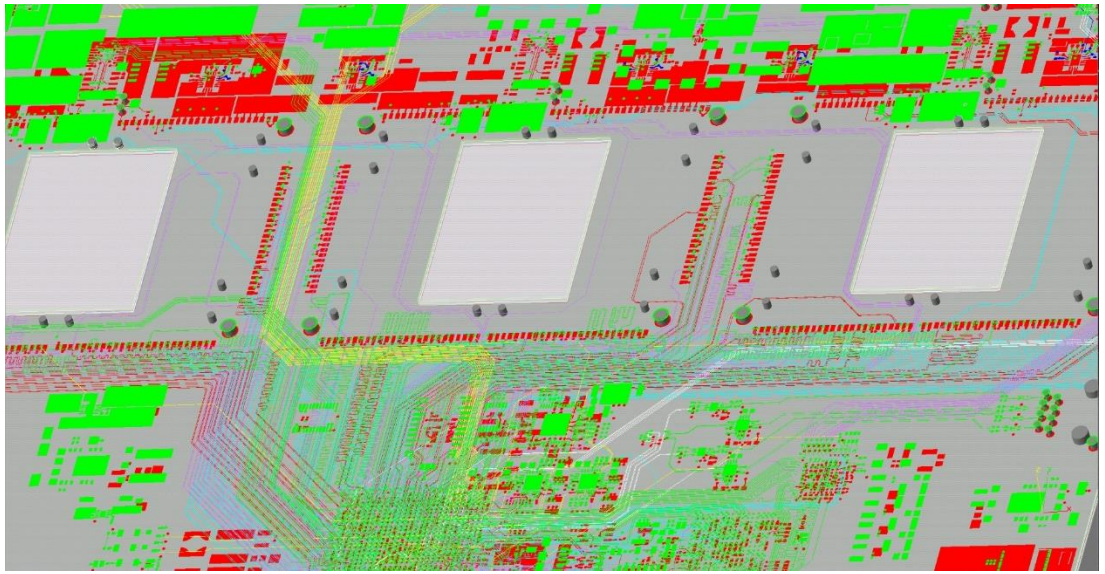
ADUs/user modules castellated edge cards on bottom layer.

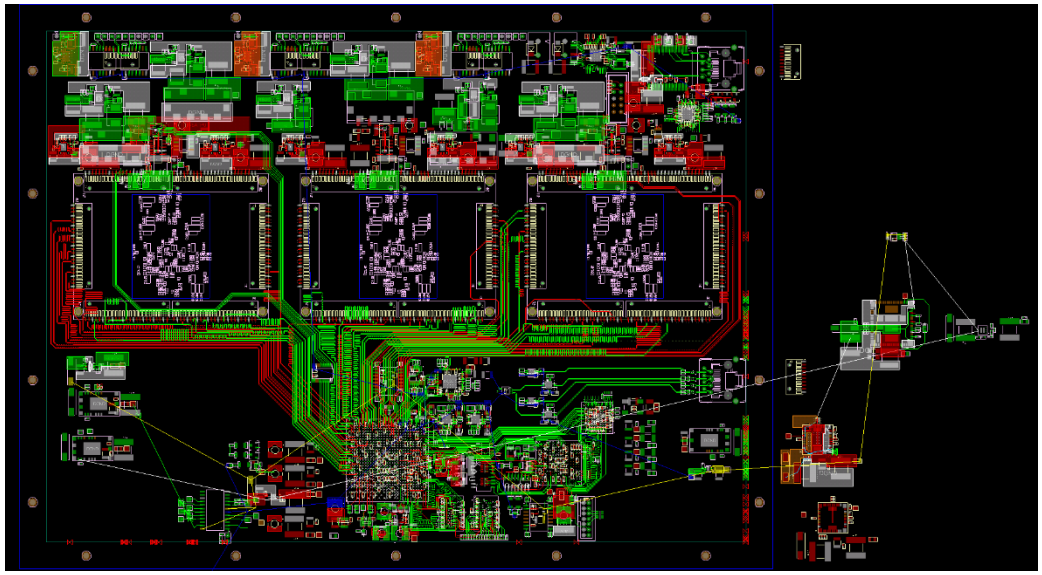


Status of GCU

Actual status:

- The design of the new GCU has been complete
- The routing of the whole board (GCU + PB) is ongoing at CERN (end of March)





Plans:

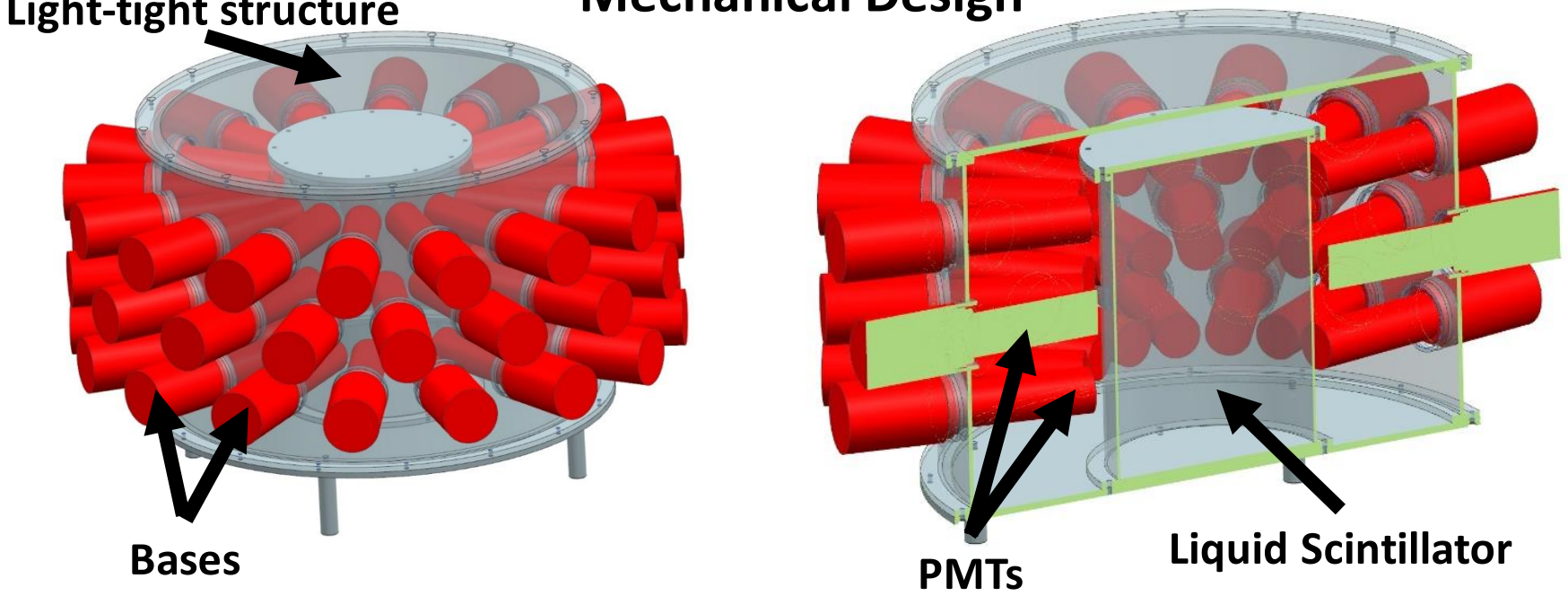
- ✓ 16 prototype boards (48 channels) will be produce
- ✓ after the electrical verification of the first boards, an integration test is foreseen with the rest of the electronics

Electronic integration test facility

A test system for JUNO electronics is under construction at Legnaro National Laboratories (Italy). It will be composed by:

- ✓ ~ 17 l of LAB liquid scintillator;
- ✓ 48 Philips XP2020 (diameter of 2'') PMTs with their bases;
- ✓ Two plastic scintillator to have a trigger on cosmic rays (one on the top of the and one on the bottom);
- ✓ Black plastic structure to avoid the light inside the system;

Mechanical Design



PMT characteristics

photomultiplier tubes **XP2020**

product specification

Standard very fast, 12-stage, 51 mm (2") round tube

Applications :	High and medium energy physics where the number of photons to be detected is very low and where utmost time characteristics are required. This tube features a good linearity, a very low background noise and extremely good time characteristics and good single electron spectrum		
Description :	Window :	Material :	borosilicate glass
		Photocathode :	bi-alkali
		Refr. index at 420 nm :	1.48
	Multiplier :	Structure :	linear focused
		Nb of stages :	12
	Mass :	240 g	

Photocathode characteristics

Spectral range :					290-650	nm
	Maximum sensitivity at :				420	nm
Sensitivity ① :	Luminous :				70	µA/lm
†	Blue :	min :	7.5	typ :	10	µA/lmF
	Radiant, at 420 nm :			typ :	80	mA/W

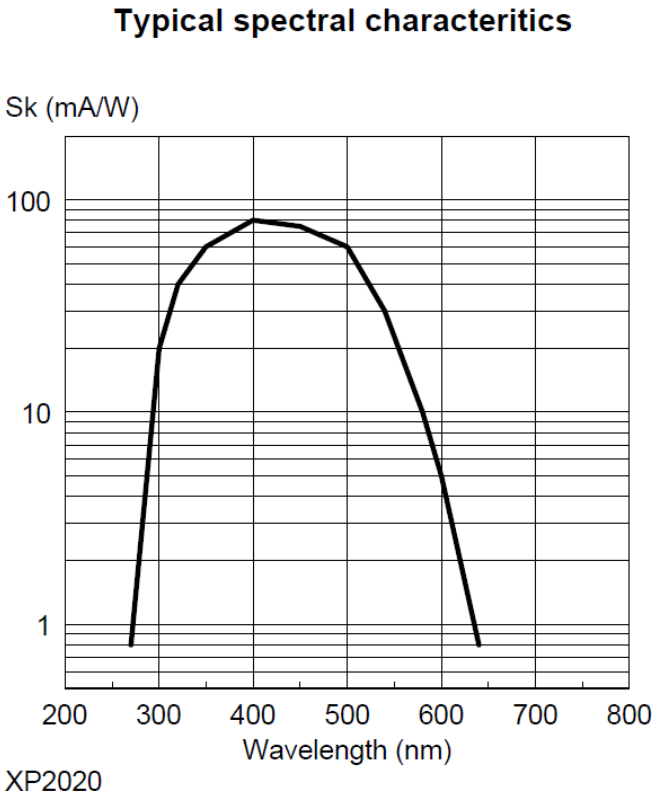
The LAB scintillator

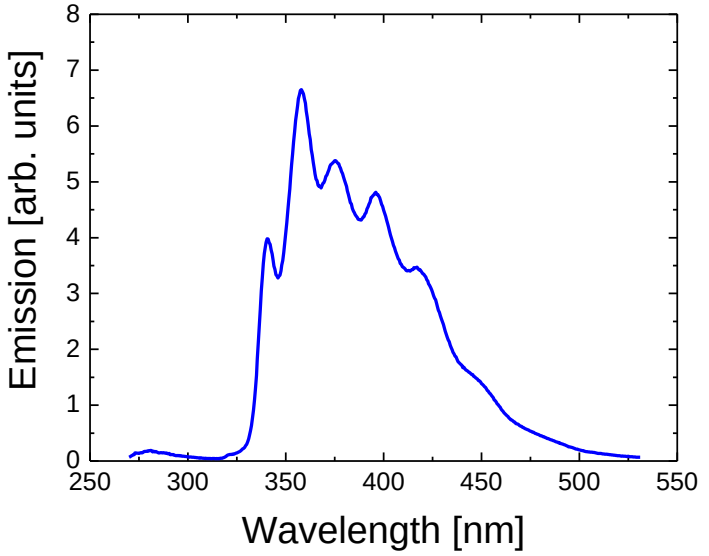
Thank to F. Ortica

The same concentration of Daya Bay was used:

LAB + PPO 3g/l + bisMSB 15 mg/l

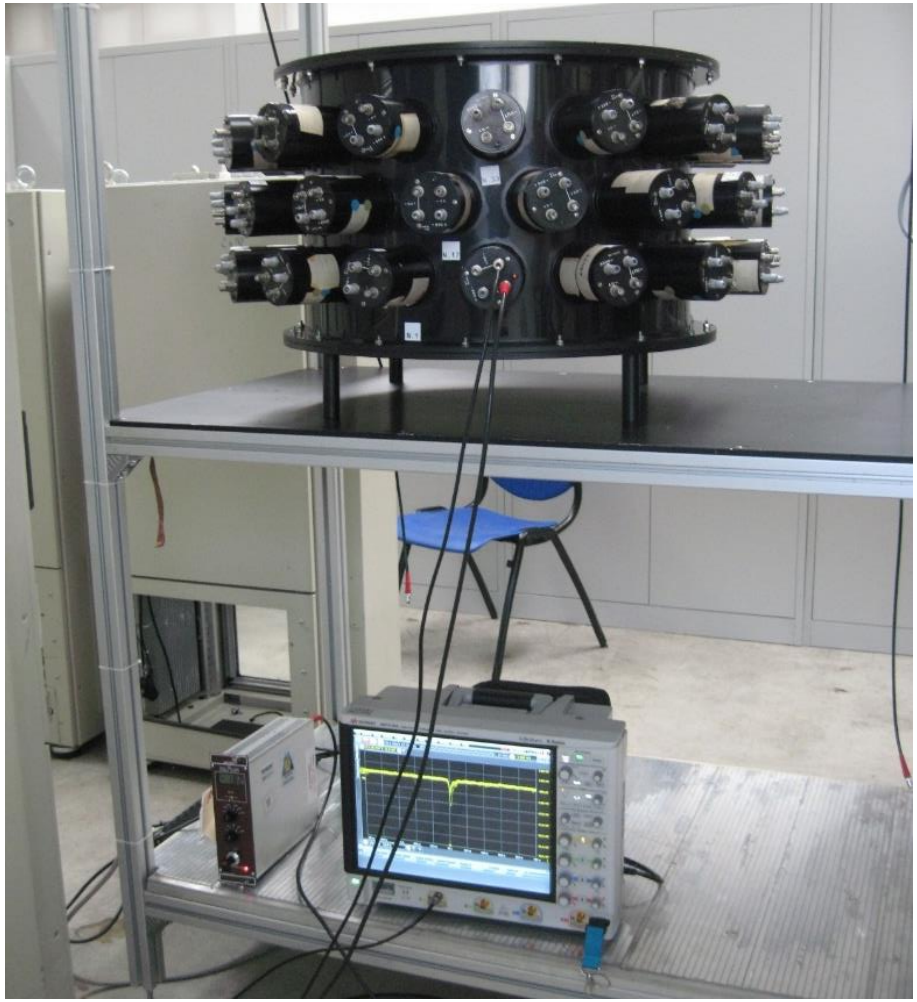
in order to match the PMT response.





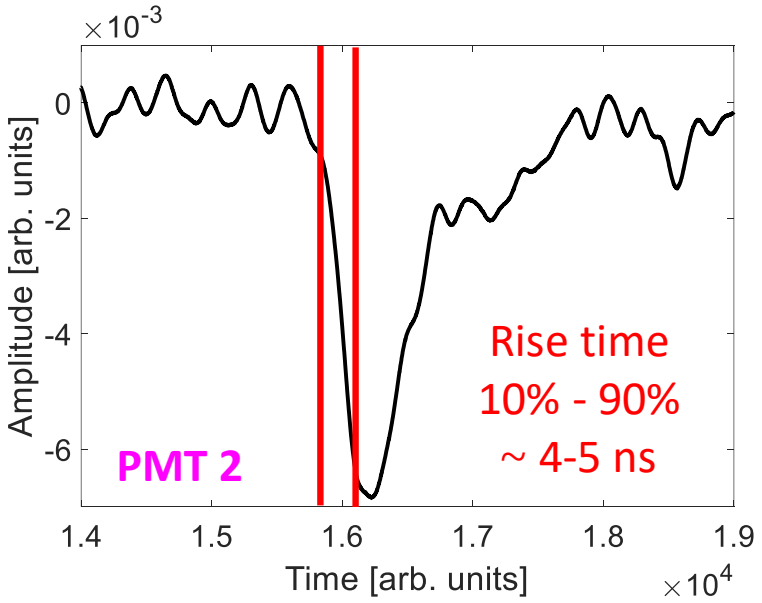
PMT first test: dark current noise

The PMTs were tested using the dark current noise. They were supplied at the nominal voltage. The signal was checked with an oscilloscope.



All PMTs provieds a signal.
Work has to be done to reduce the noise.

Bandwidth 1 GHz



Current Status

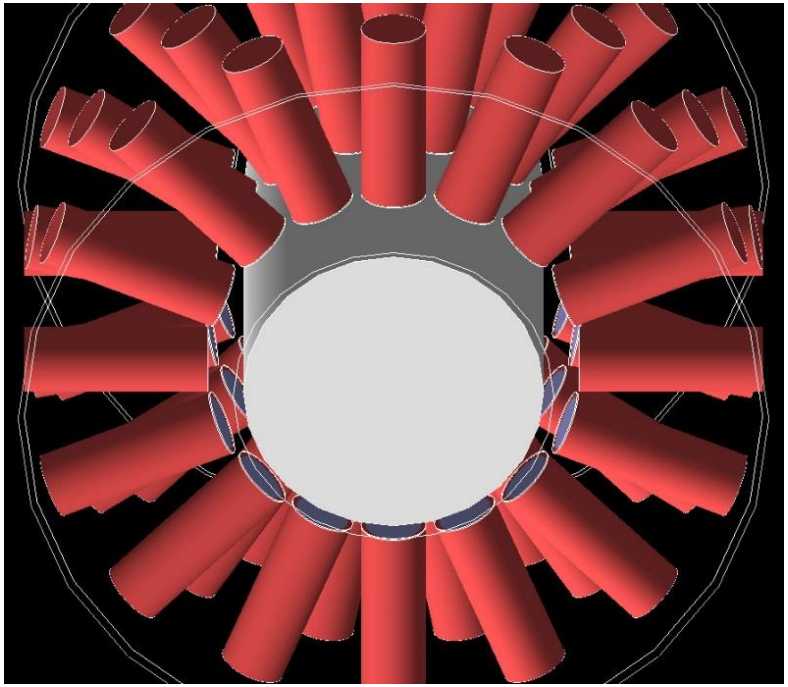
- ✓ The mechanical structure is ready and the PMT are mounted;
- ✓ The liquid scintillator was doped with PPO and bisMSB;
- ✓ We are testing the PMT, all of them work, we plan to test them with a LED and the scintillator;
- ✓ The standard electronics (V1730 CAEN digitizer) is ready to be used for the facility test

JUNO test system simulations

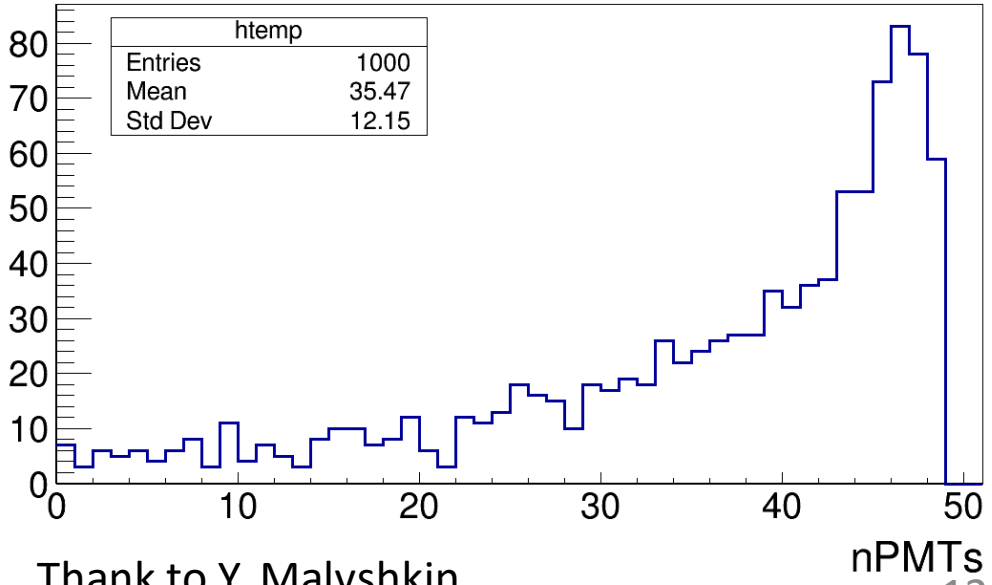
- ✓ The simulation of the geometry in the Geant4 are ready;
- ✓ PMTs are approximated by fully absorbing cylinders with a photocathode (radius of 44 mm → from datasheet) covered by 1 mm of glass;
- ✓ The QE curves are to be tuned.

The response to the calibration sources ^{137}Cs and ^{60}Co was simulated.

Simulation Output: geometrical view of the setup



Simulation Output: number of PMTs that collects photon in case of ^{137}Cs events



Thank to Y. Malyshkin

Summary

- ✓ JUNO Electronics scheme was changed from BX to 1F3
- ✓ The signals of 3 PMT are read from one GCU
- ✓ The Global control unit block diagram and PCB layout were shown
- ✓ The routing of the whole board (GCU + PB) is ongoing at CERN. The and is foreseen for the and of March.
- ✓ Electronic integration test facility is under construction at Laboratori Nazionali di Leganro.
- ✓ The PMT were mounted and the first tests were performed.
- ✓ The LAB scintillator was prepared with the same “recipe” of Daya Bay.
- ✓ Preliminary simulation of the set up were shown.

Perspectives

GCU

- ✓ Production of 16 prototype boards (48 channels)
- ✓ Electrical verification of the boards
- ✓ Test bench of the boards

Electronic integration test facility

- ✓ Test with a LED to obtain the peak to valley plot for each PMT (before summer);
- ✓ Test of the signal shape and timing test (before summer);
- ✓ Test different sources, such as ^{137}Cs and ^{60}Co and cosmic ray (before summer);

Standard electronics to be use characterize the PMT (before first prototypes of electronics):

- Caen V1730 digitizer (16 channels) 500 MHz – 14 bit
- Caen SY5527 power supply (48 channels)

- ✓ Integration test with JUNO electronics and first 1F3 GCU prototypes (~ October 2018)