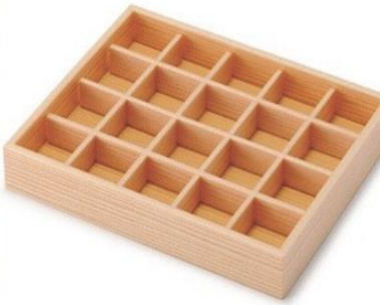
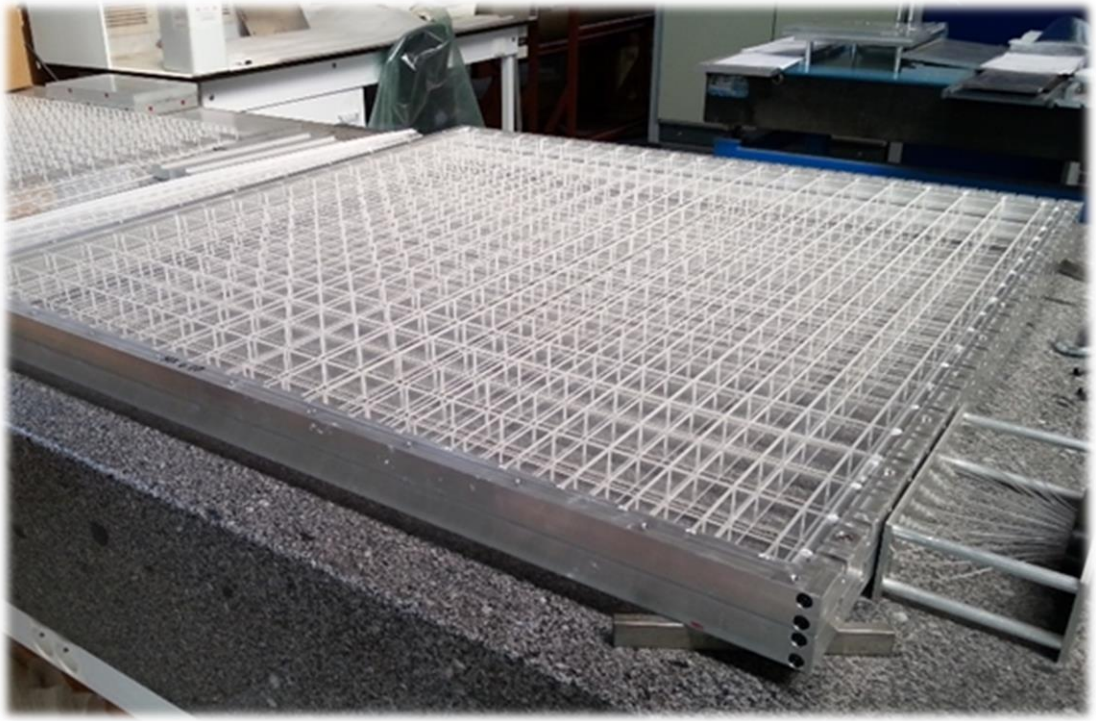
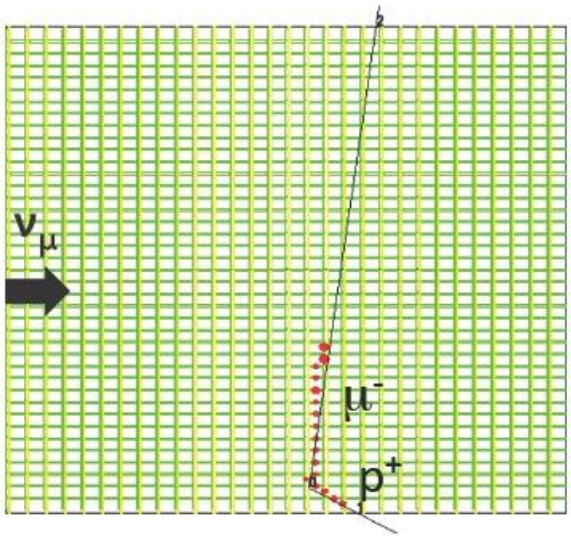
The WAGASCI detector

Japanese sweets (Wagashi)







Michel GONIN
LLR ECOLE POLYTECHNIQUE
HK-EU Meeting at CERN , April 2015

The WAGASCI detector

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Geneva

Purpose of the WAGASCI detector

H_2O to CH cross section ratios with 3% accuracy

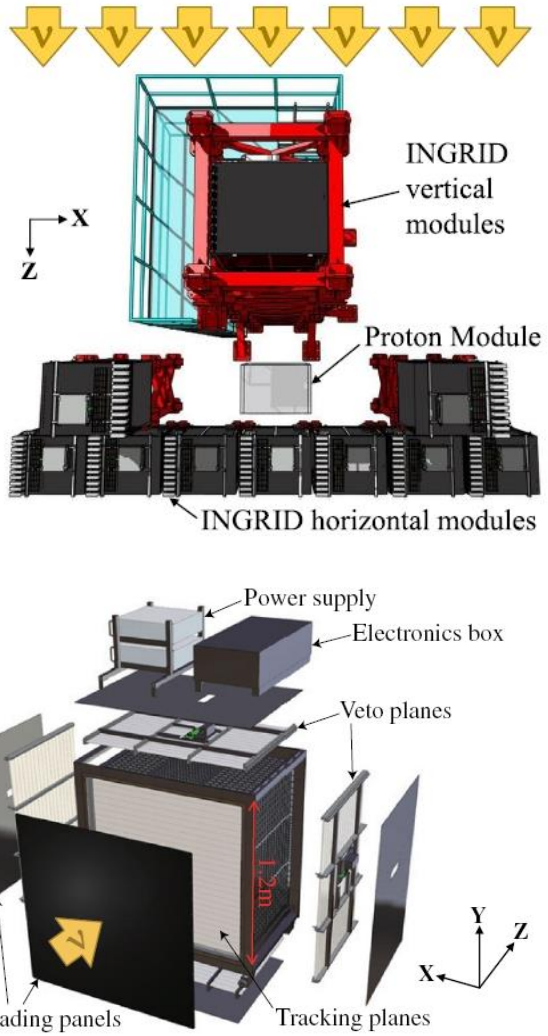
- Neutrino interaction models predict that the target dependence between H_2O and CH is small, but no high precision measurement so far.
- Test the correctness of the target dependence in the models. Then, constrain the target-dependent neutrino cross section errors by the ND280 measurement.
- The analysis technique is established in the INGRID measurement.
- CC-inclusive channel. Then, exclusive channels.

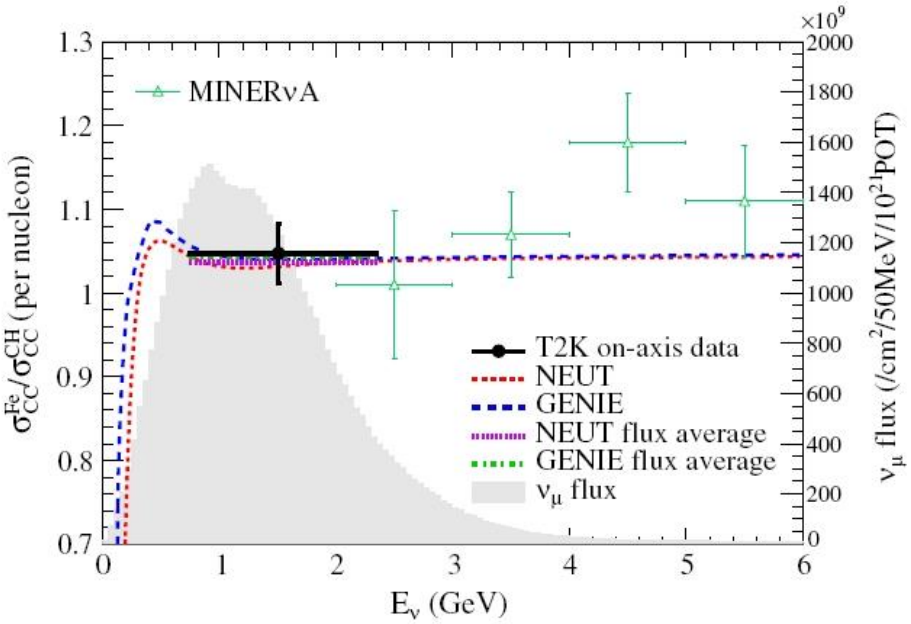
Cross sections on H_2O and CH with 10% accuracy.

- Neutrino flux uncertainties are dominant errors.
- Double differential cross sections for (T_μ, $\cos\theta_\mu$)
- CC-inclusive channel. Then, exclusive channels.

PHYSICAL REVIEW D **90,** 052010 (2014)

Measurement of the inclusive ν_μ charged current cross section on iron and hydrocarbon in the T2K on-axis neutrino beam

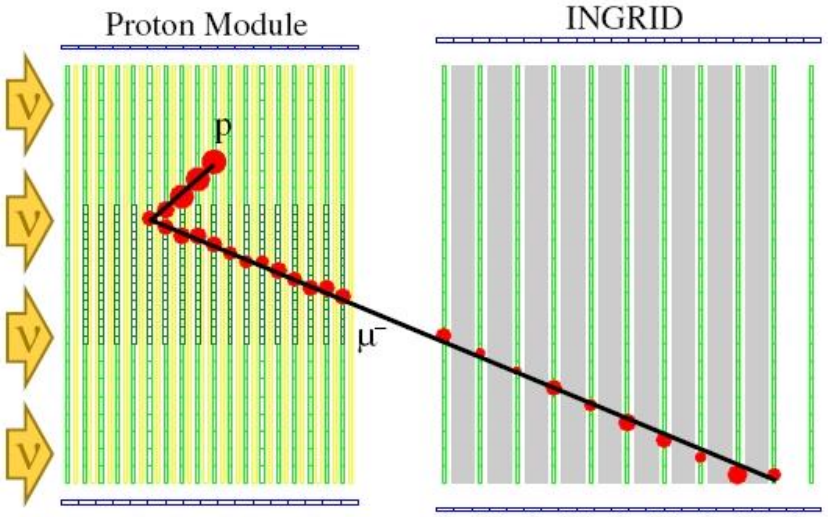




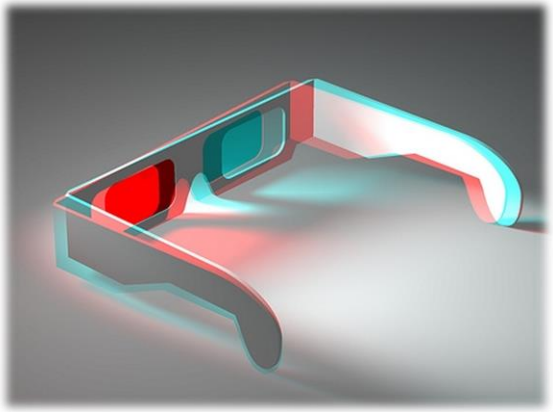
$$\frac{\sigma^{Fe}_{CC}}{\sigma^{CH}_{CC}} = 1.047 \pm 0.007(\text{stat}) \pm 0.035(\text{syst})$$

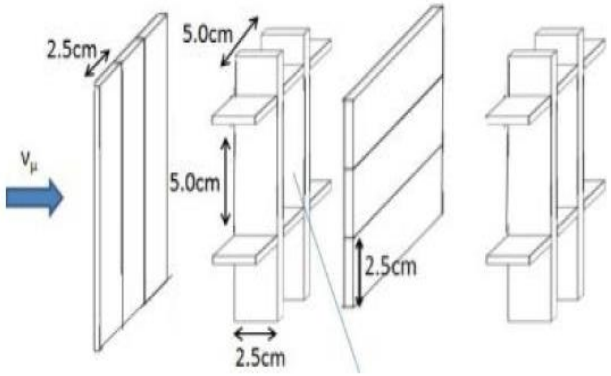
FIG. 4 (color online). Exploded view of the proton module.

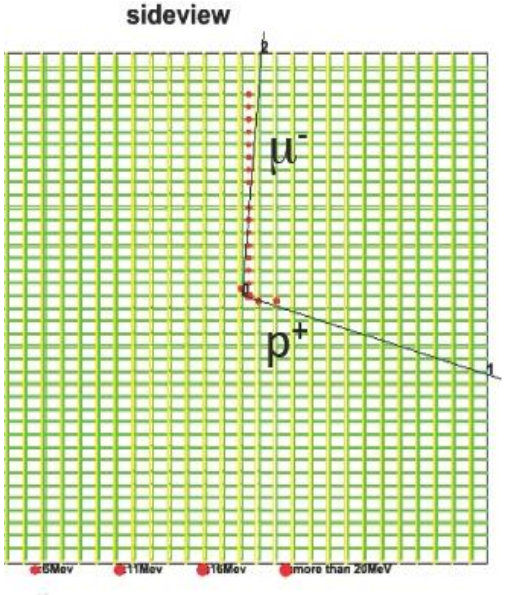
INGRID & Proton Module (2D)

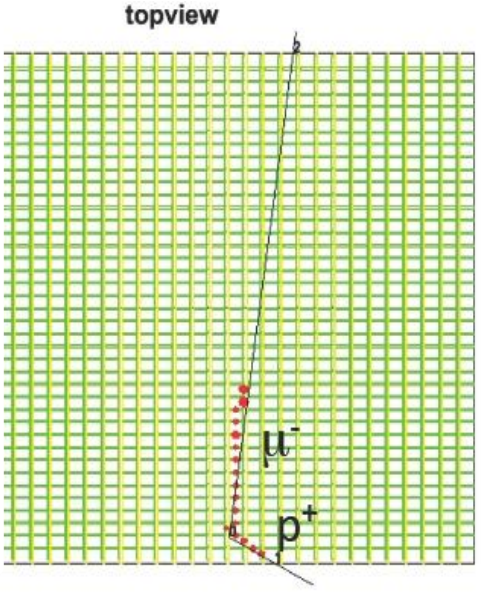


WAGASCI (3D)



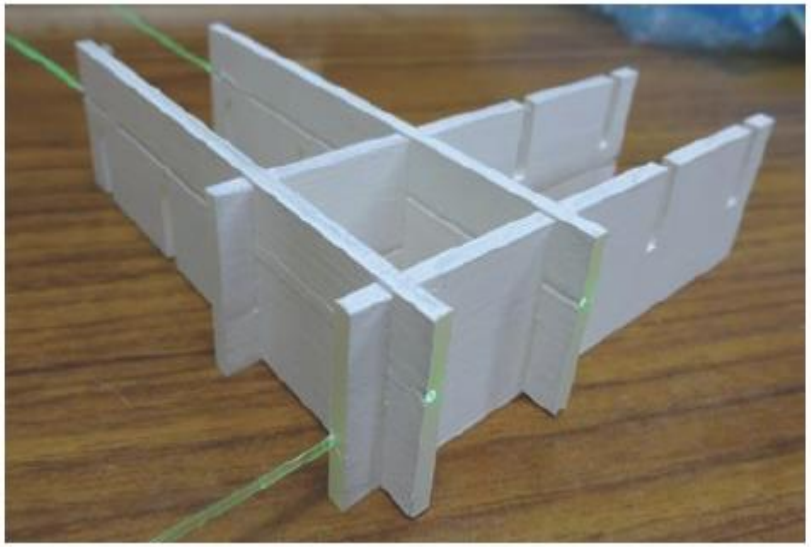






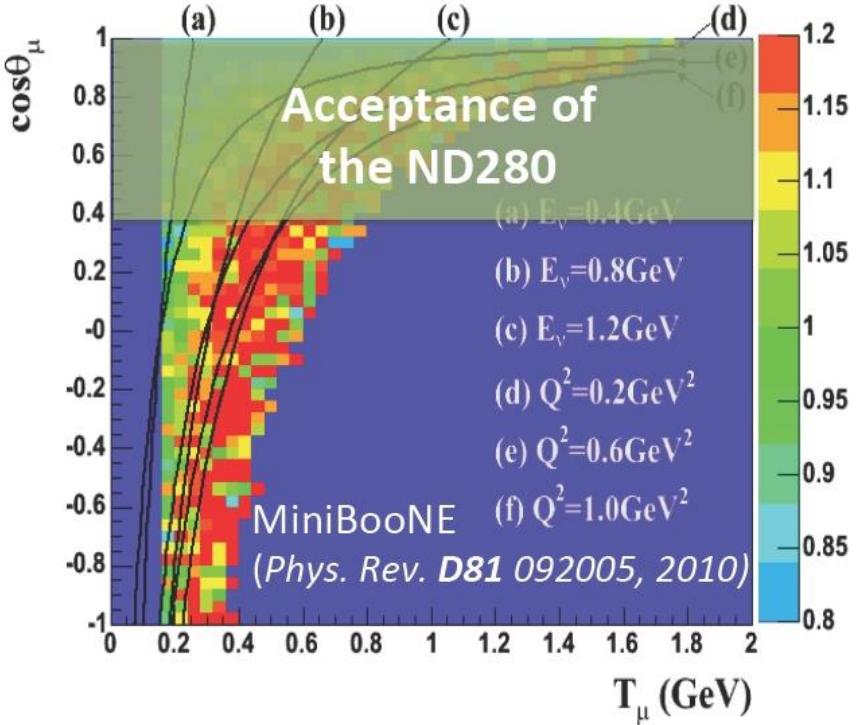
3D grid-like structure (x, y, grid layers + WLS fibers + MPPCs)

- 4π angular acceptance for charged particles
- 5cm grid spacing enables us to reconstruct short tracks originated from protons and charged pions with high efficiency.
- Thin plastic scintillator bars (thickness ~ 0.3cm) will be used for the detector to increase the mass ratio of H_2O (signal) to CH (background).
- The WAGASCI detector can be made possible if we have high light yield from the thin scintillator bars in water with the MPPC readout.



ν_μ QQCE double differential cross section

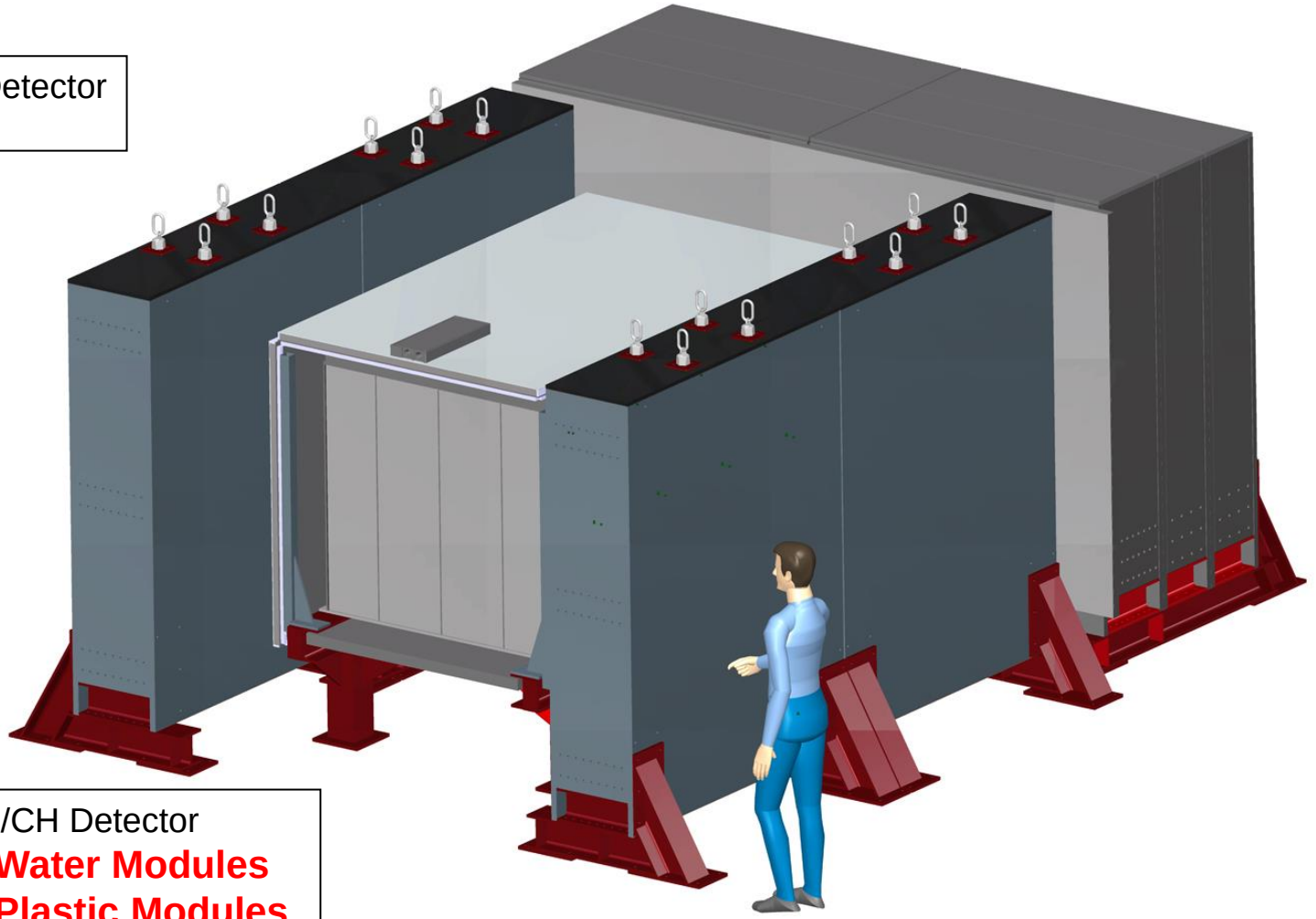
discrepancies between DATA and Model



WAGASCI detector configuration

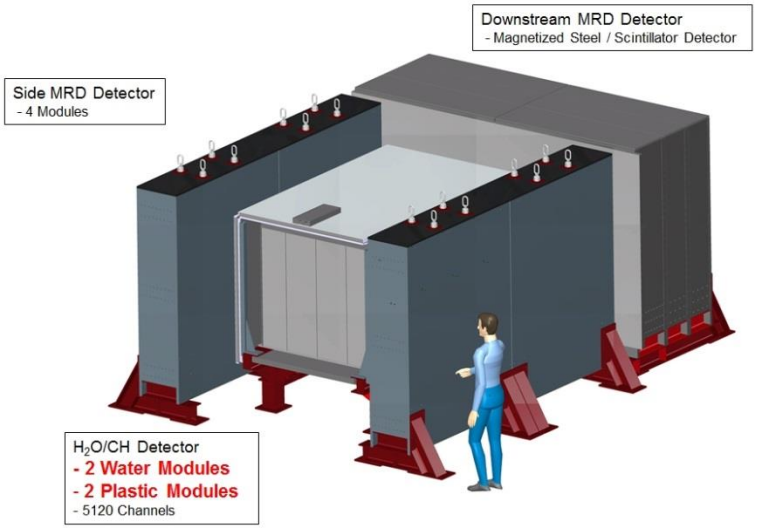
Downstream MRD Detector
- Magnetized Steel / Scintillator Detector

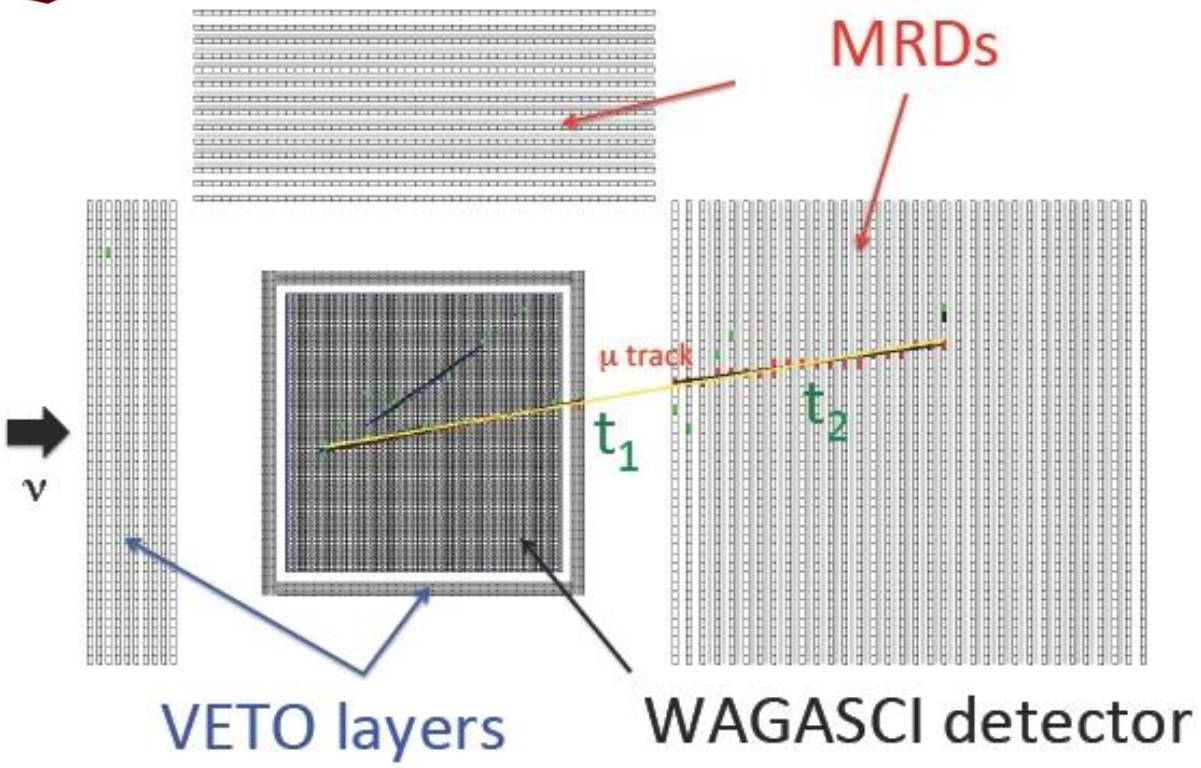
Side MRD Detector
- 4 Modules



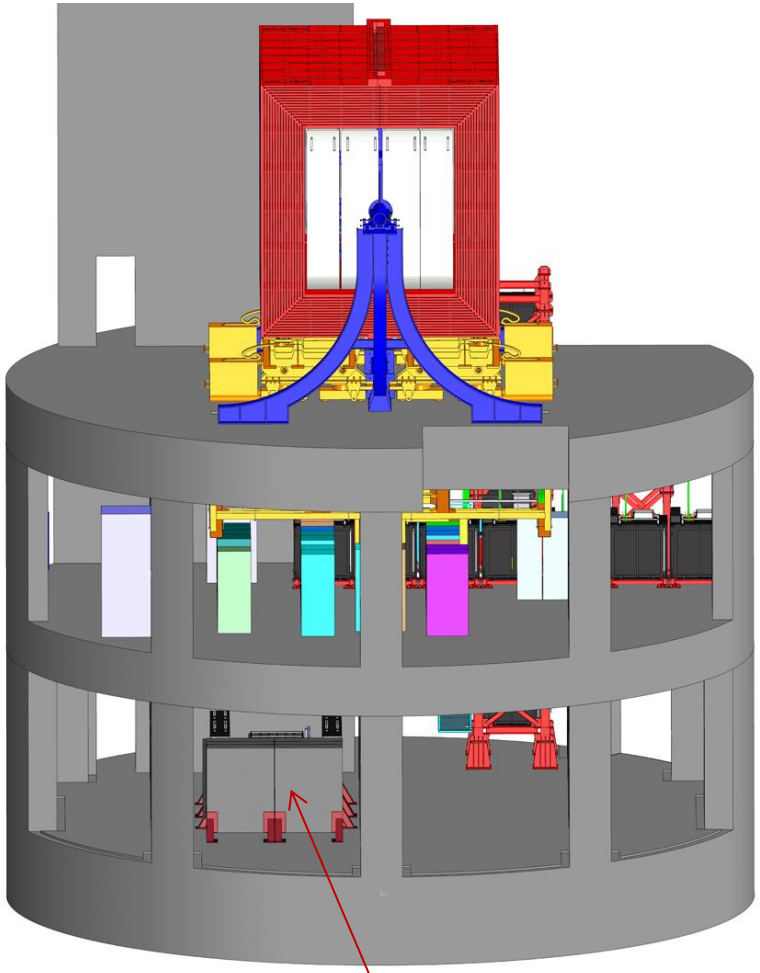
H_2O/CH Detector
- 2 Water Modules
- 2 Plastic Modules
- 5120 Channels

WAGASCI detector configuration



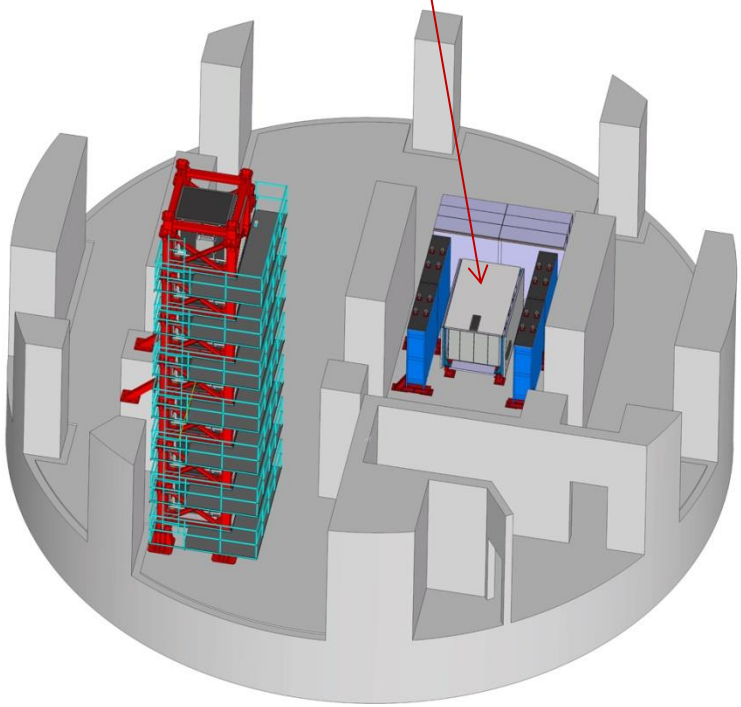


WAGASCI location in the pit



Detector Position in the Pit

Detector Position on B2 Floor



WAGASCI Schedule

April 2014 Proposal submitted to the J-PARC PAC as an independent experiment from T2K

June 2014 Test of the candidate site for Wagasci with existing INGRID module

October 2014 Beam tests at Tohoku for performances of scintillator bars, new MPCC and WLS fibers.

Mai 2015 Completion of the mechanical design

Summer 2015 Delivery of the MPPC, Scintillators. Test.

October-November 2015 Assembly of the first module

November 2015 Completion of the electronic and DAQ design

December 2015 Installation of the first module in the ND280 pit

February – July 2016 Production and tests of the electronic boards

Spring-Summer 2016 Assembly of the MRD

Mai - September 2016 Assembly of Wagasci

October 2016 Installation of Wagasci and MRD on B2 floor

Responsibilities (construction)

WAGASCI components
scintillators, MPCC, WLS, …

WAGASCI mechanical design

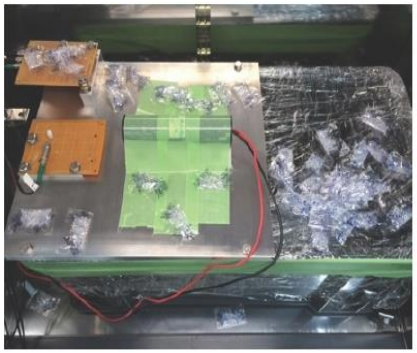
WAGASCI electronics and DAQ

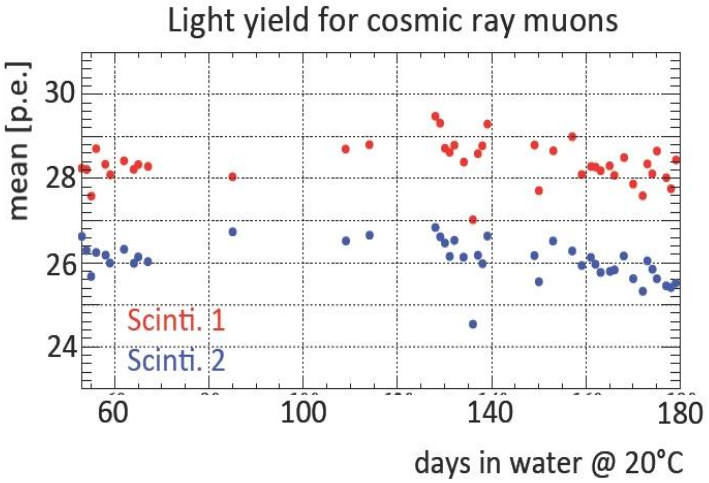

MRD


Baby MIND

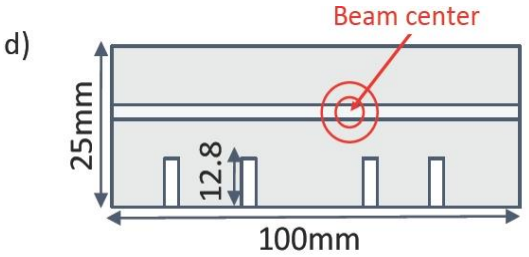

Test of detector components

Long-term durability test of scintillator bars & WLS fibers in water





3mm-thick scintillator bars

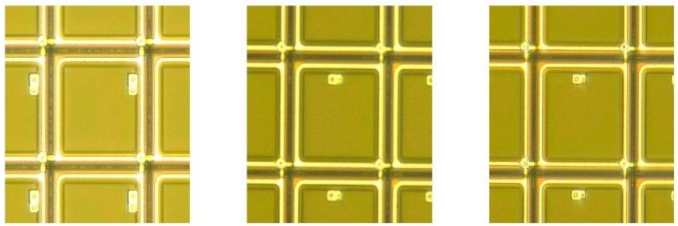


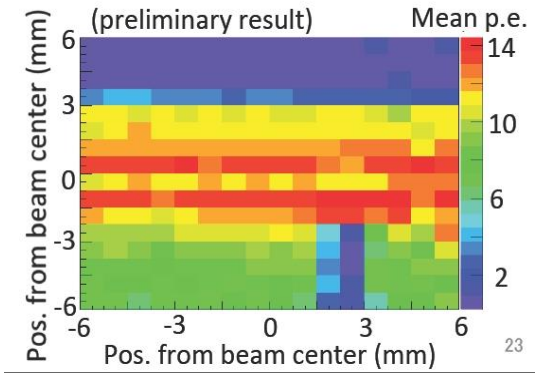
Performance of new MPPCs developed by Hamamatsu

- Low noise (~1/10 compared to T2K version)
- Much less after pulse
- Wider operation voltage
- Low cross-talk (optional)

New MPPC S13081-050CS(X1)

• Pre production • June 2014	• S13081-050CS(X) • Dec. 2014 • Smaller contacts	• S13081-050CS(X1) • Feb. 2015 • Larger active area?

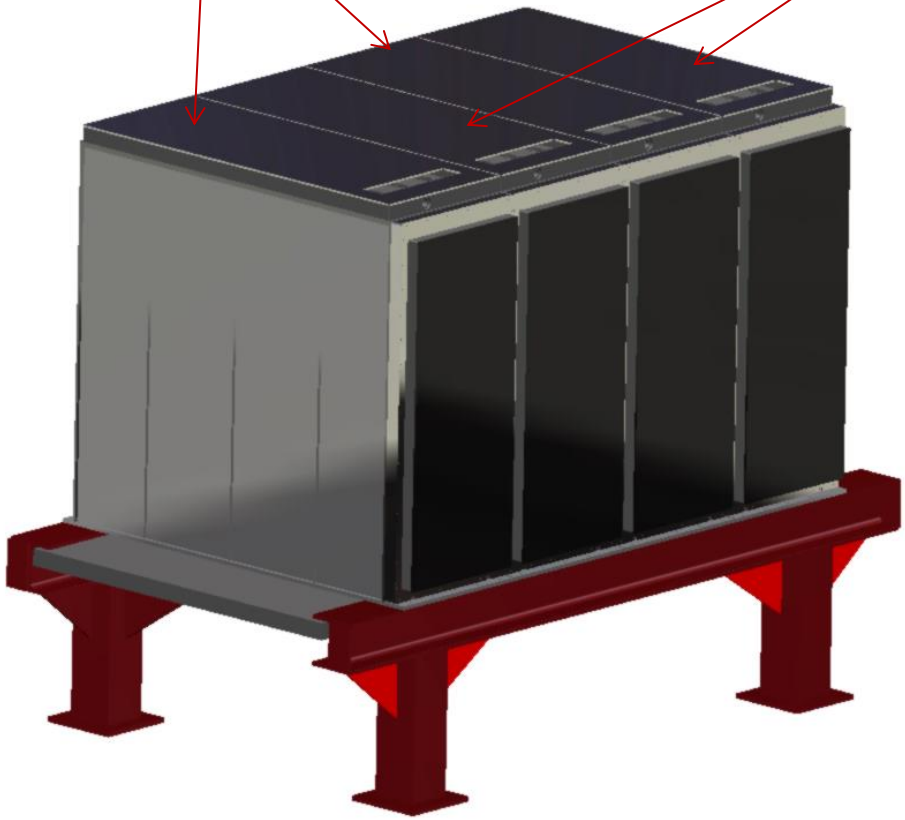




H20 and CH detector design

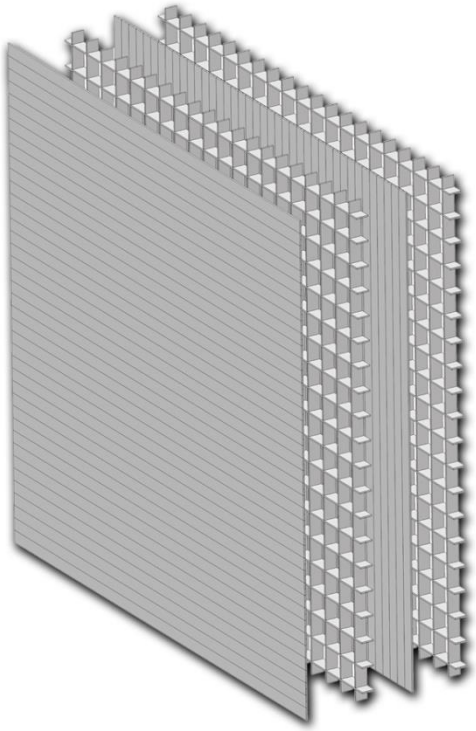
2 Water Modules
Scintillator Grids and planes in Water

2 Plastic Modules
Scintillator Grids and planes in with plastic cubes filling



VETO Scintillator Planes on the 4 sides

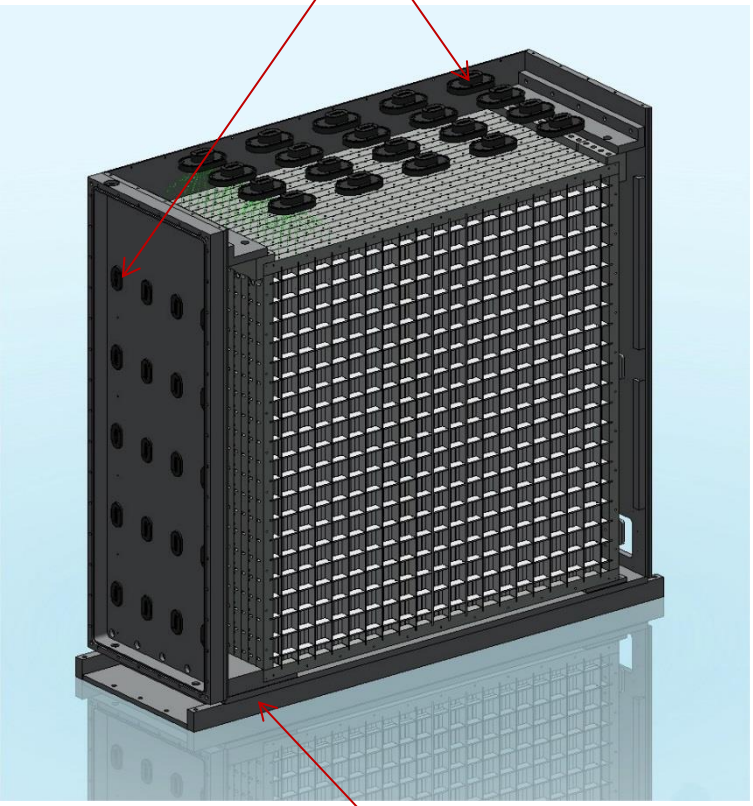
Configuration of the scintillators
of each WAGASCI Plane: X/Grid/YGrid



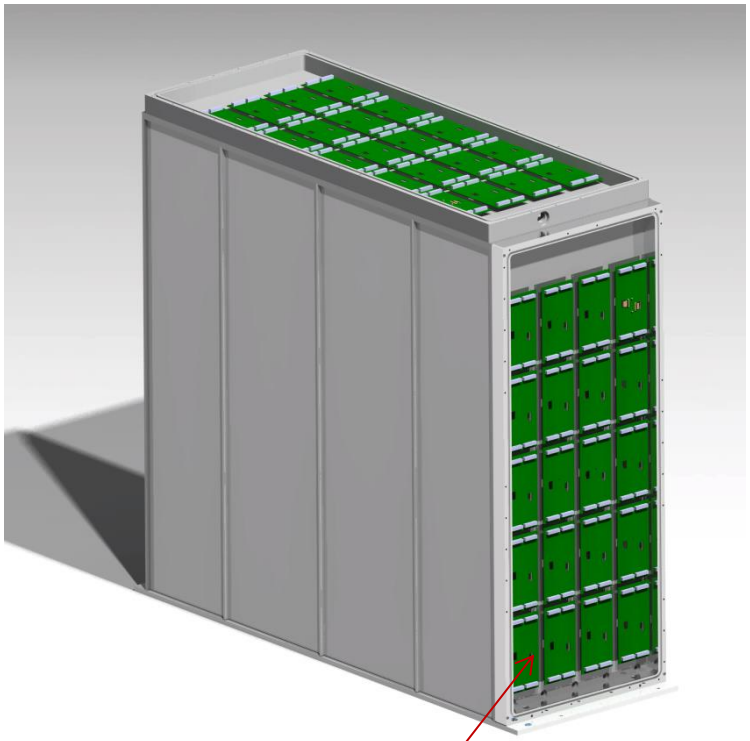
Scintillator bars: 25x3x1020 mm^3

H20 and CH detector design

Bundles of 32 WLS fibers read by 32 channel MPPC arrays



Stainless Steel Tank
- With water / Without water



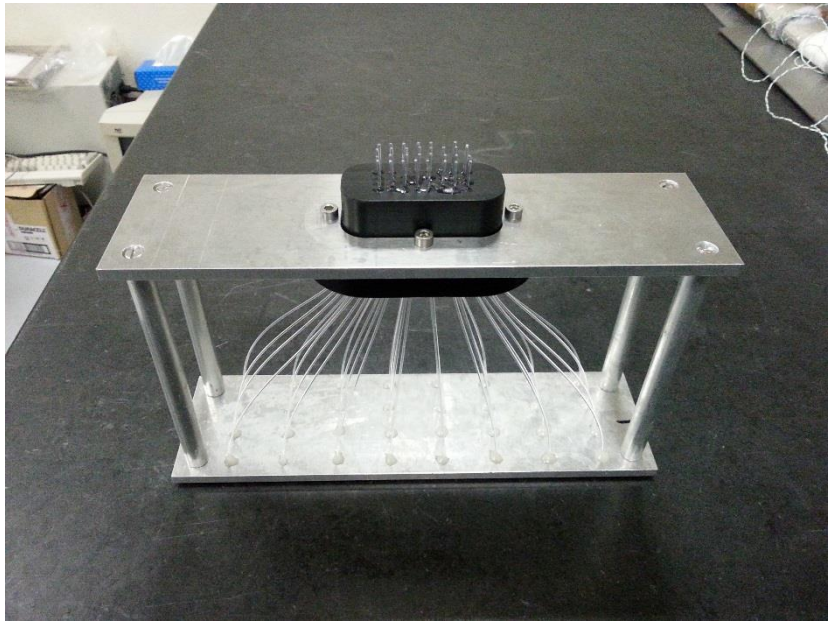
40 Electronic Readout boards
- 1 Board per MPPC array with 1 SPIROC Asic
- 1280 Channels

Detector prototypes

Wagasci Plane Prototype build with Plexiglas strip validates:
- Mechanical design
- Assembly and scintillator gluing procedures
- Mechanical strength

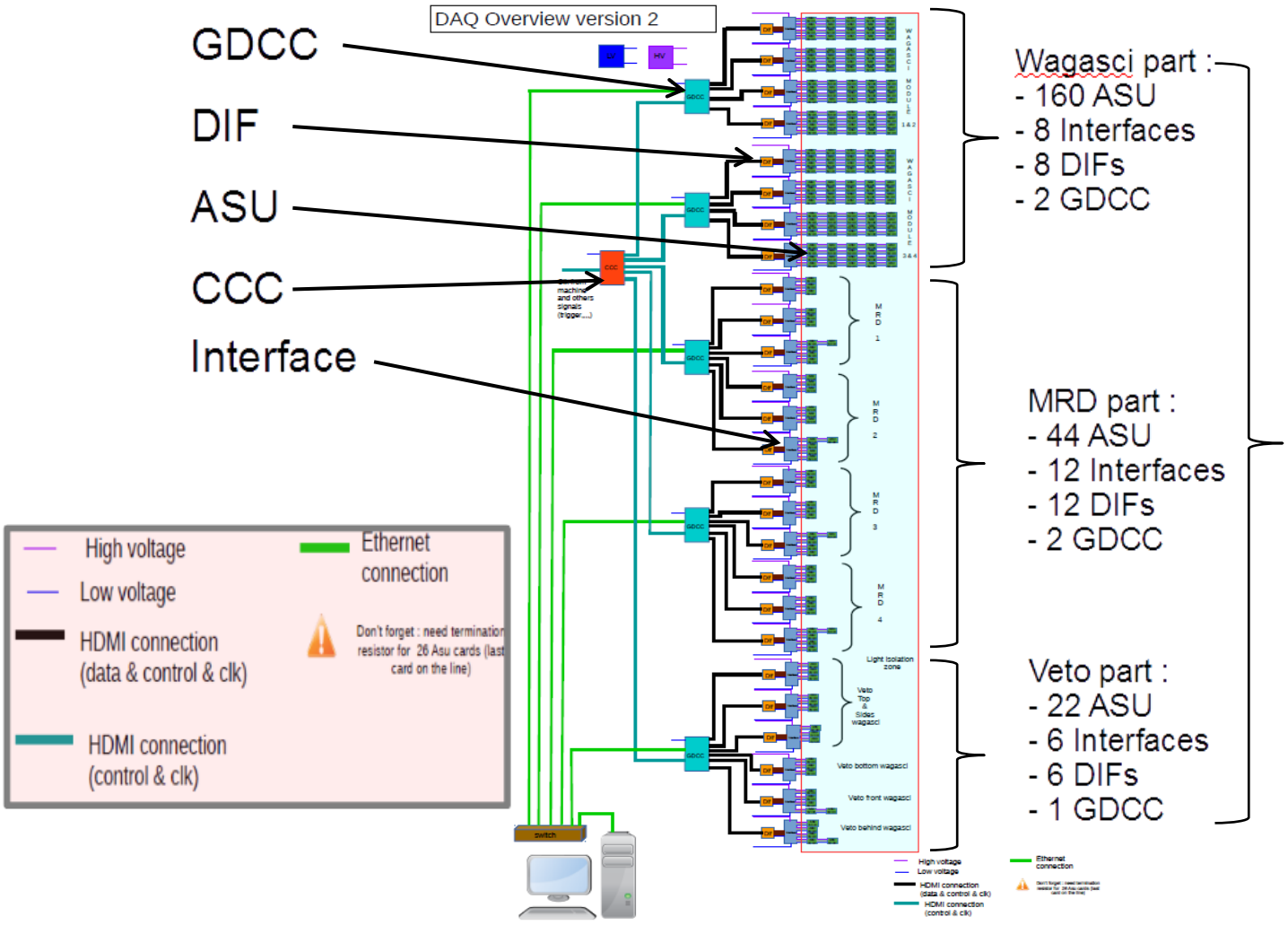
Detector prototypes

Prototyping of fiber bundles to test:
- Bundle preparation
- Bonding procedure
- Quality of optical surface with diamond head machining



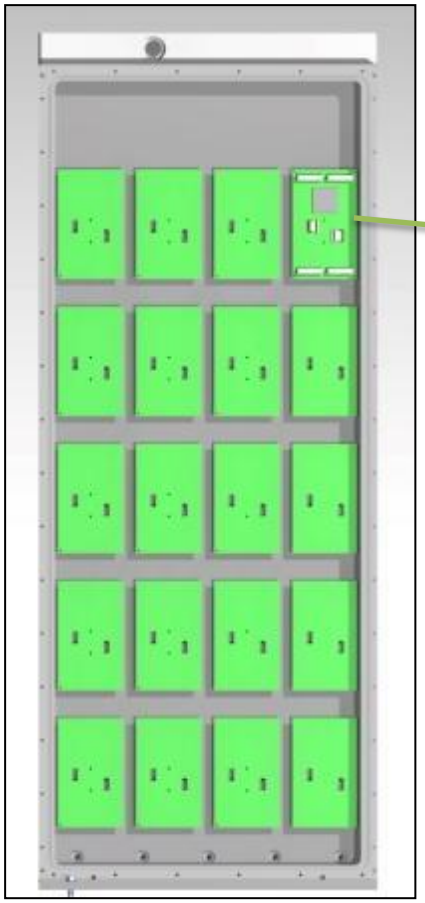
Diamond cutter machining

Overview of electronics and DAQ



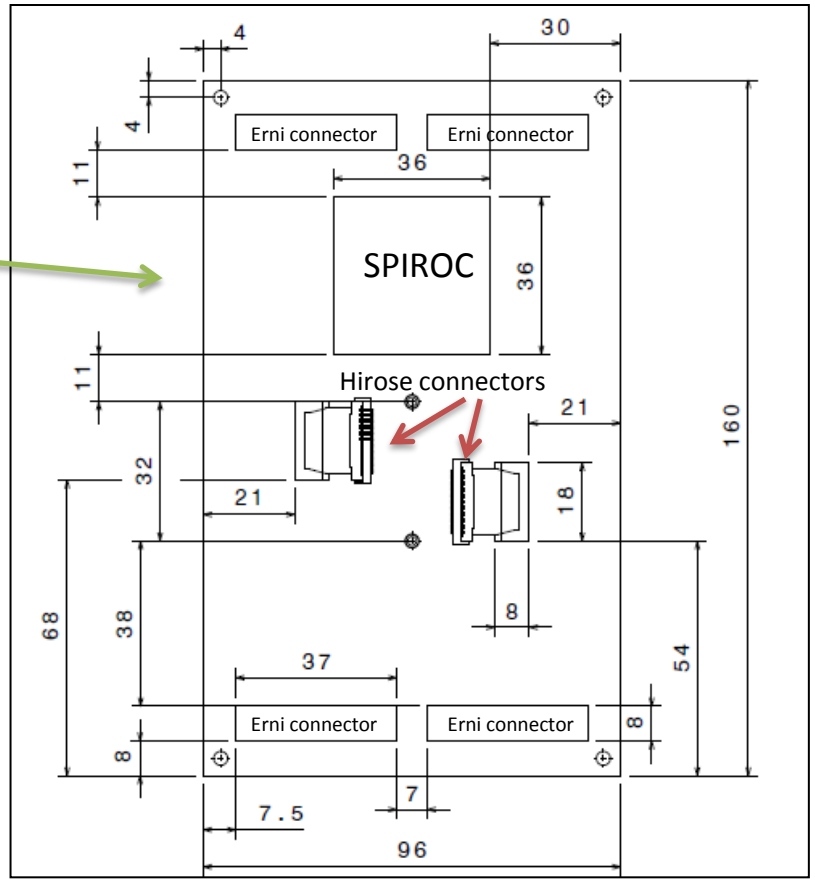
Based on CALICE SiWEcal DAQ at Ecole Polytechnique

MPPC – SPIROC BOARD



View of a part Wagasci module

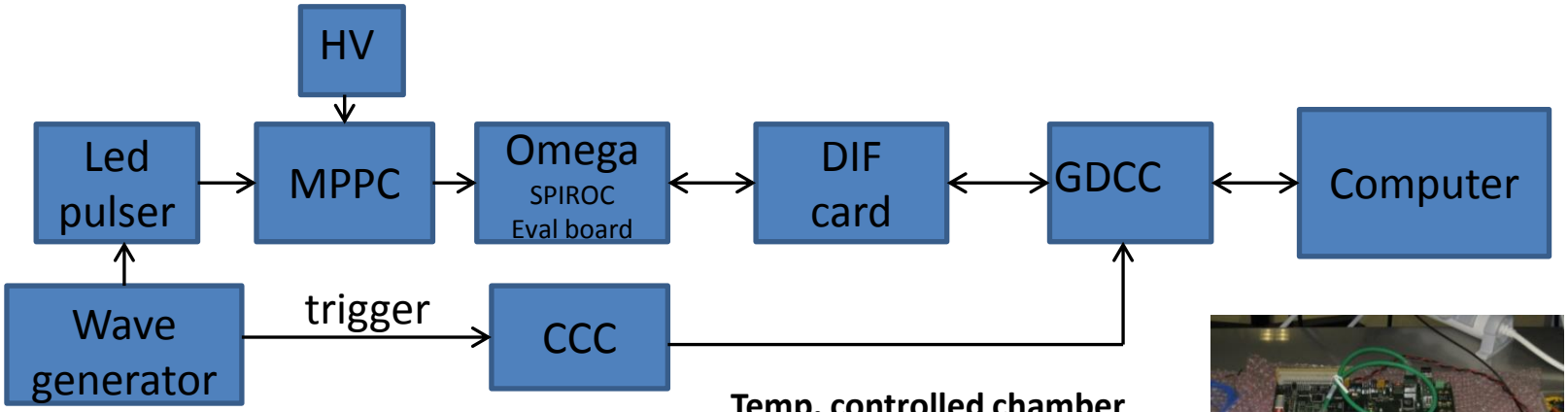
MPPC is fixed on other side of the board

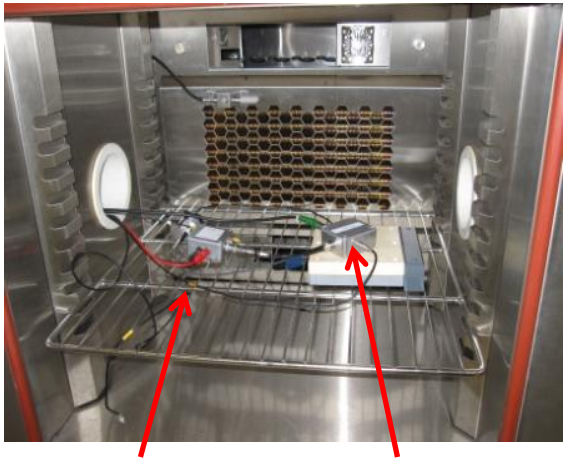


Drawing of ASU PCB

Test bench (single MPPC)

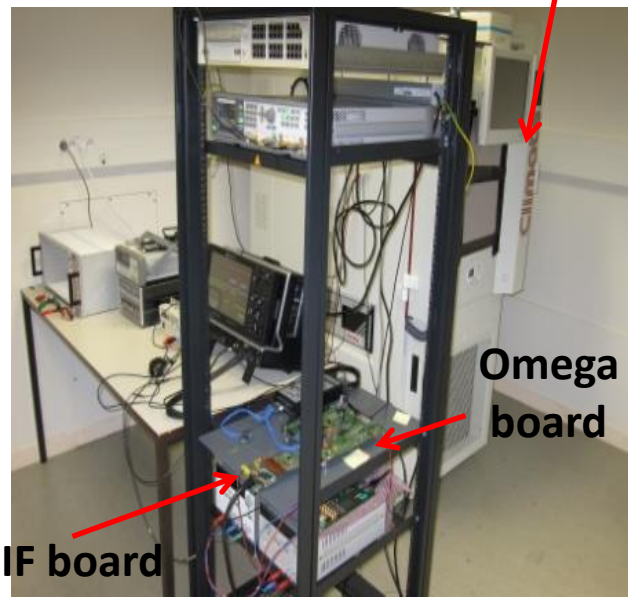
Based on CALICE SiWEcal DAQ at Ecole Polytechnique

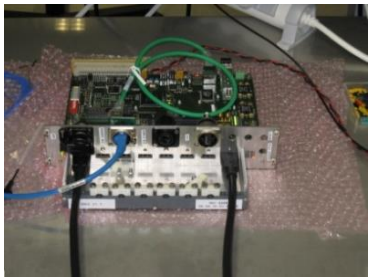




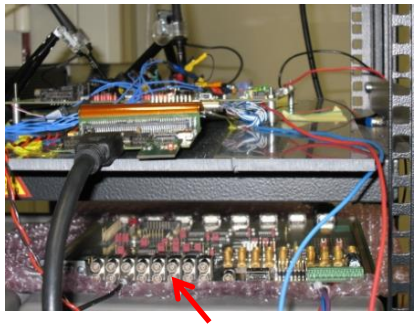
Pulser box MPPC box

Temp. controlled chamber



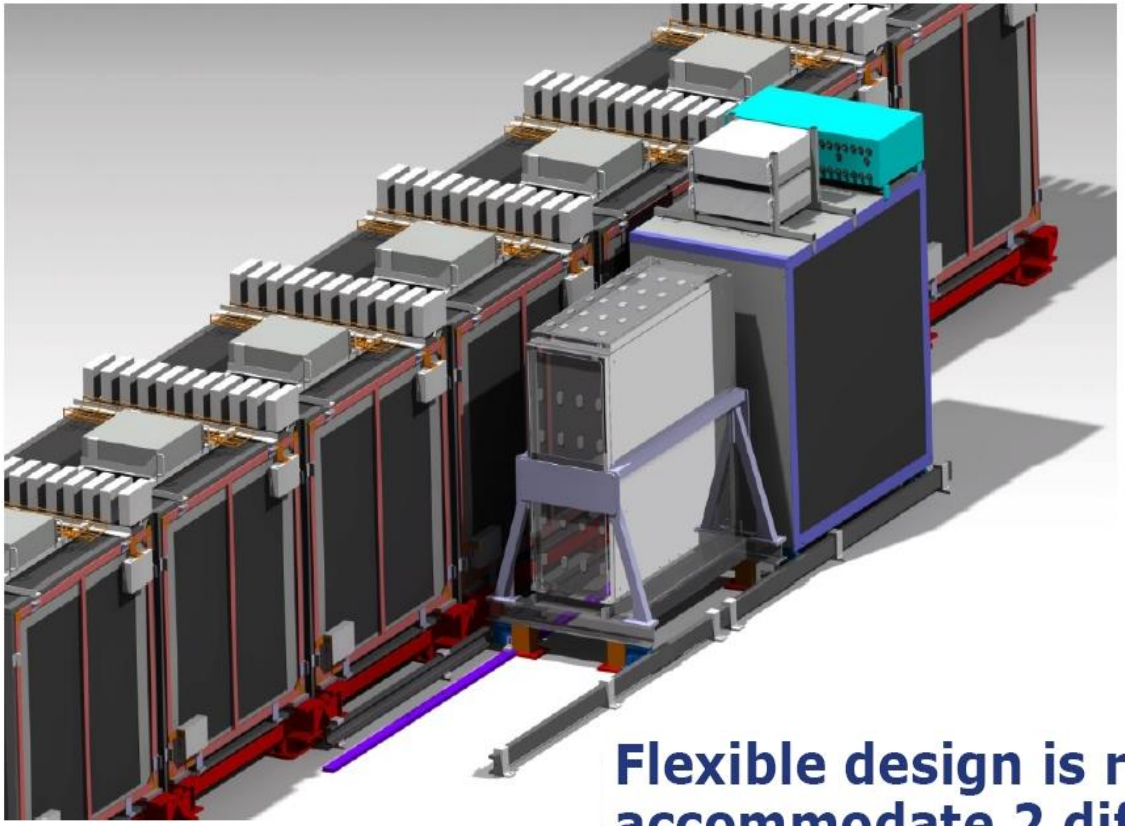


GDCC board



CCC board

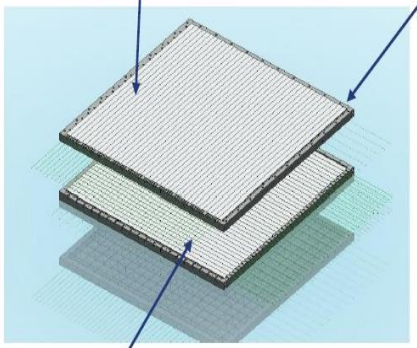
Installation of Module 1 in December

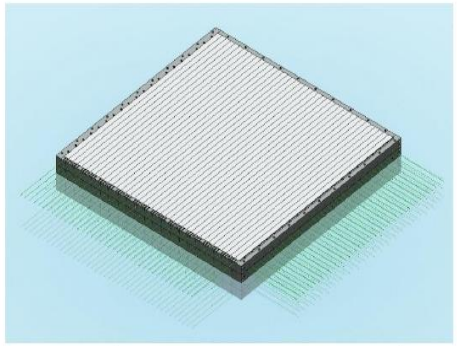


Flexible design is required to probably accommodate 2 different types of electronics

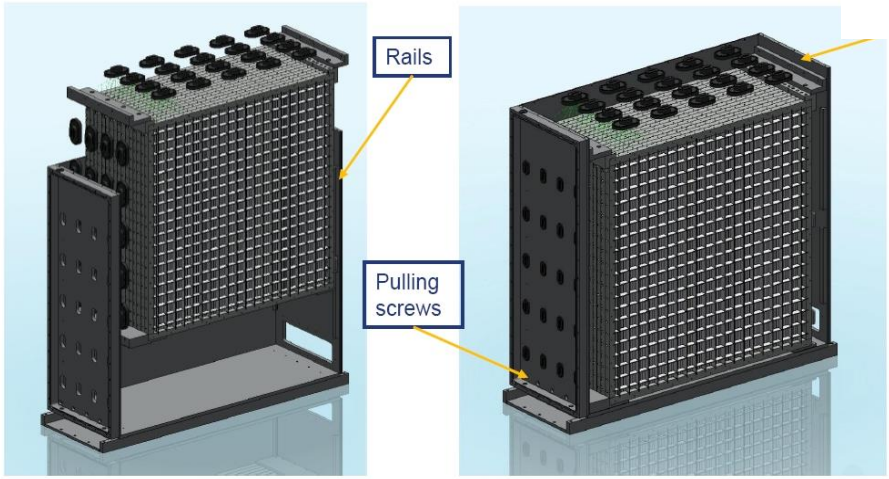
- Spiroc based electronics currently designed at LLR
  - Designed to receive MPPC arrays with connection to Kapton flexible circuit
- INGRID Trip-T boards
  - Designed to receive mini coax cables with HIROSE connectors

Installation of Module 1 in December

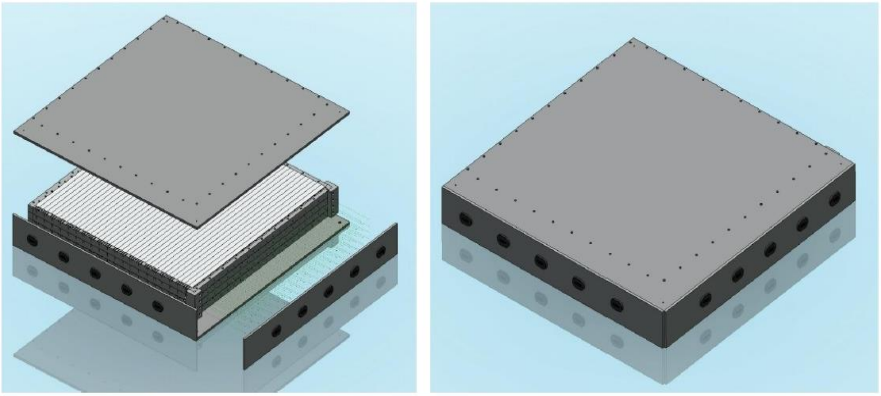




Double layer assembly (32Kg)

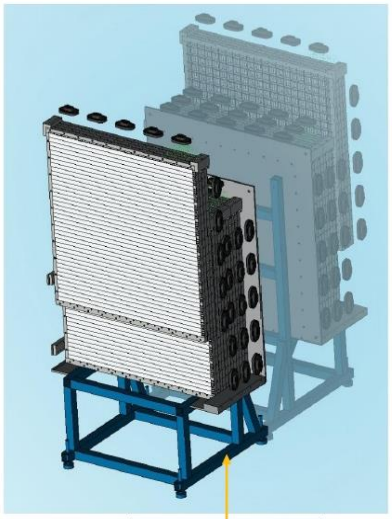


Tank (500kg) (side plate not shown)

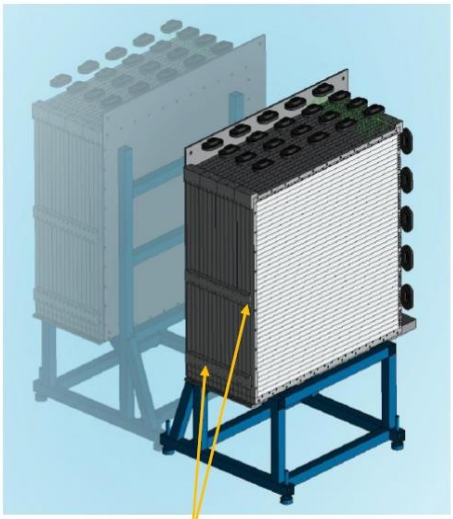


2 Double layers

1 Sub-module assembly (150 Kg)

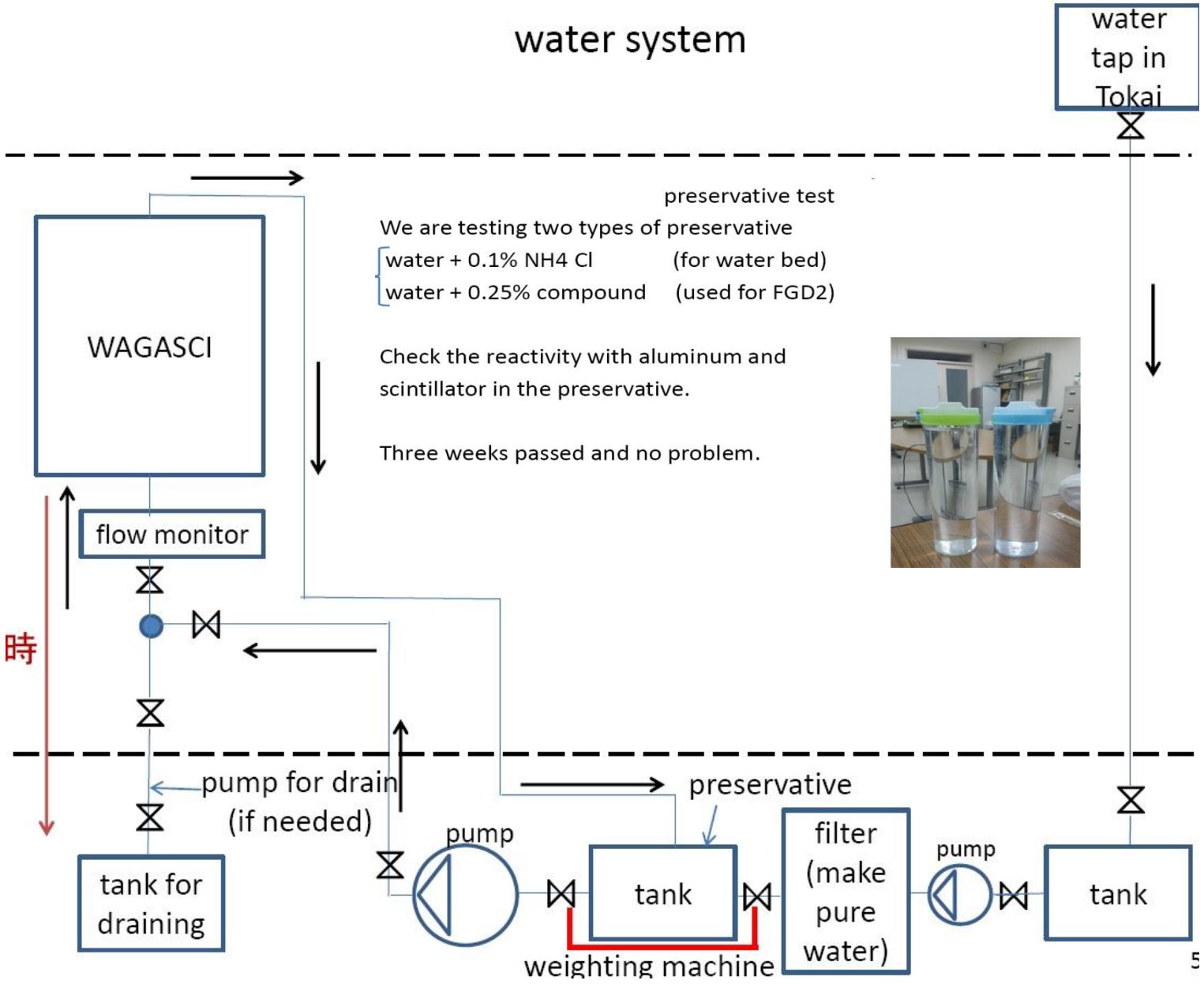


Assembly tooling

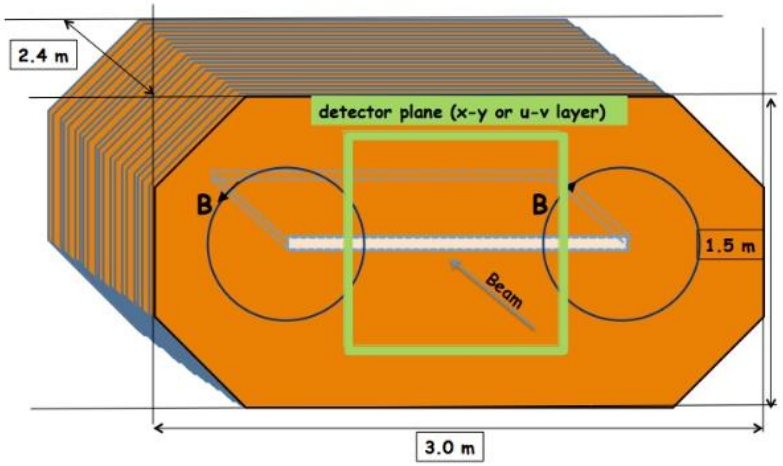


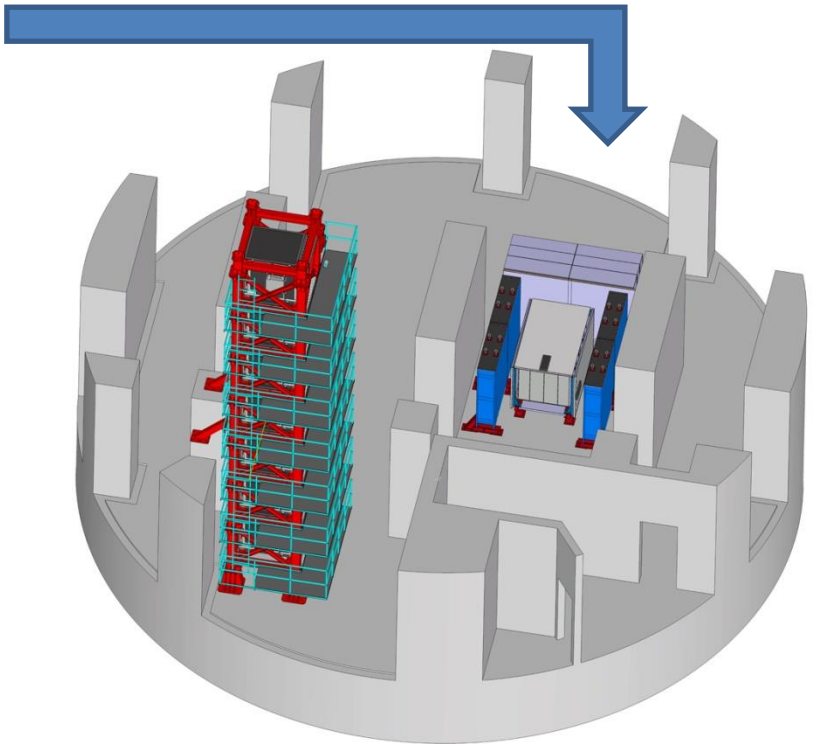
Connection plates

Installation of Module 1 end of the year



WAGASCI location in the pit





Installation of the Baby MIND (CERN) detector downstream of WAGASCI ??

Open questions remain