Nu_2: R&D of detectors for future high statistics, high precision experiment

INGRID & TPC in T2K-ND280

Workshop FJPPL'08
for the ND280 group of the T2K collaboration

- J-PARC
- T2K
- T2K-ND280
  - Facility & magnet
  - INGRID
  - TPC

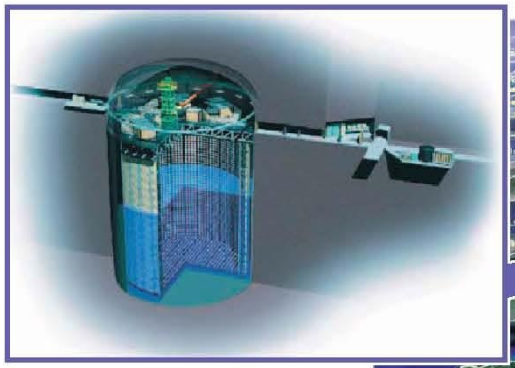
J-PARC Accelerators

Construction started on Apr'01.

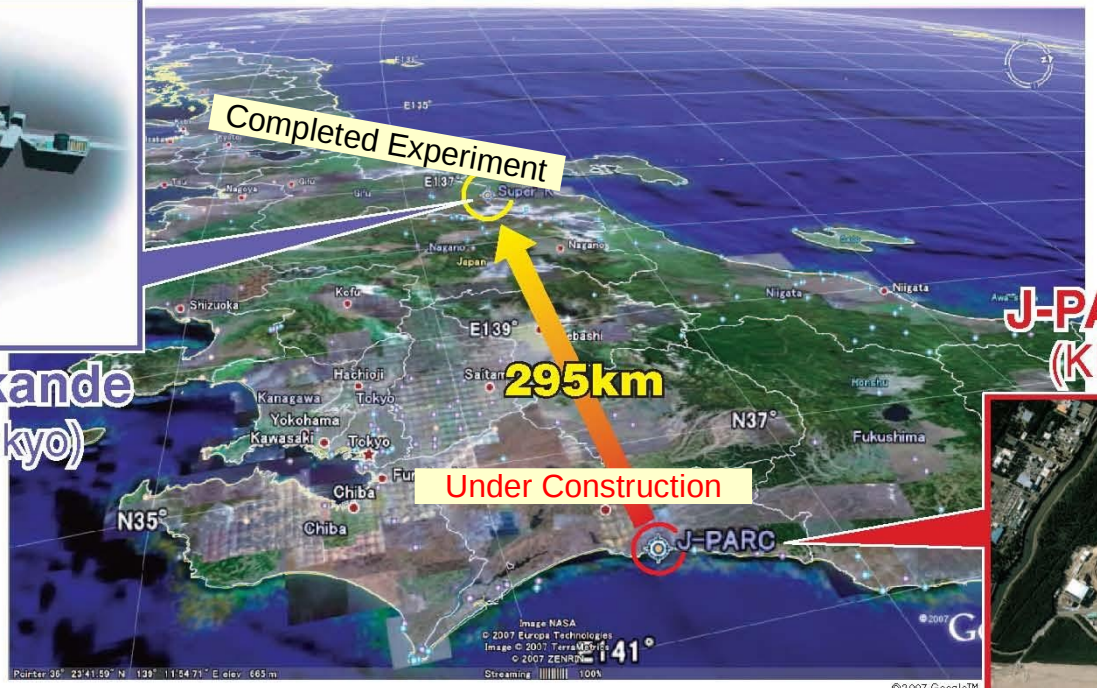
MR tunnel became continuous in Jun'06

Most of the civil construction have been completed except for ν-line

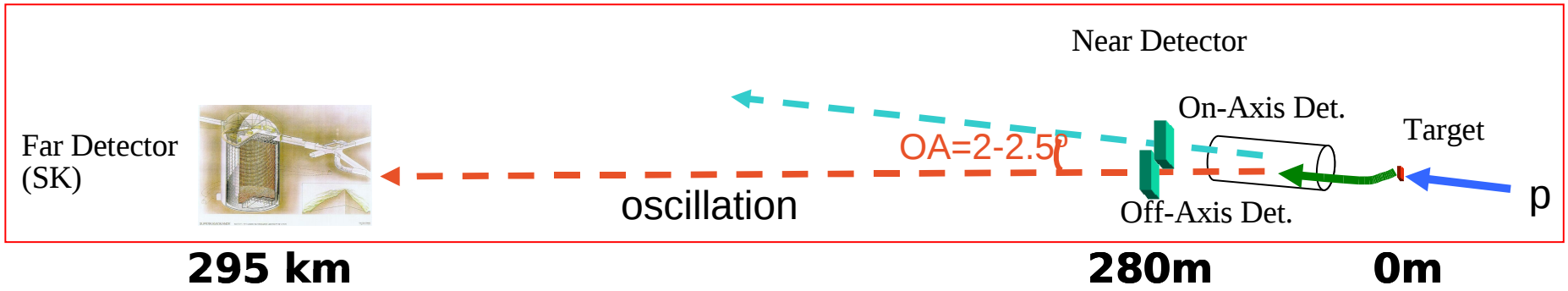
T2K : Tokai to Kamioka long base line neutrino experiment



Super-Kamiokande
(ICRR, Univ. Tokyo)

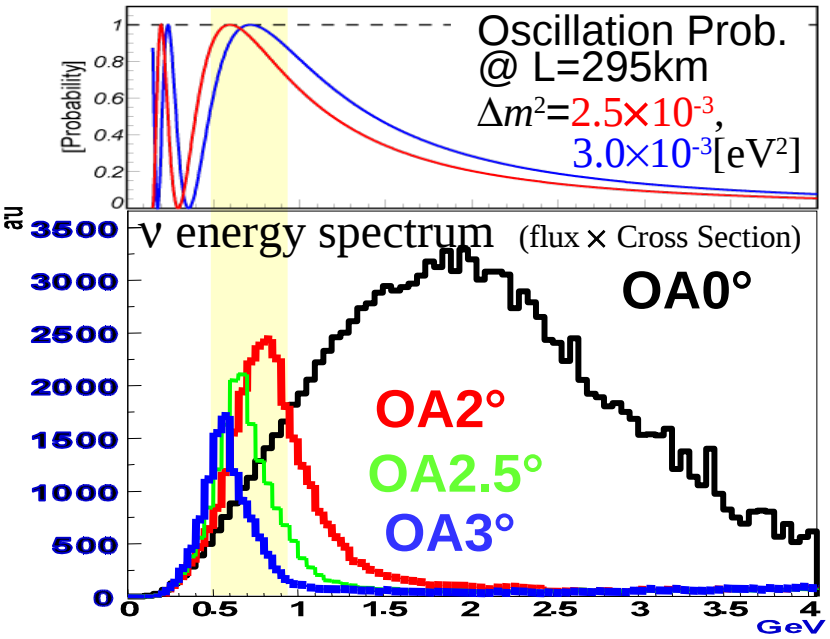


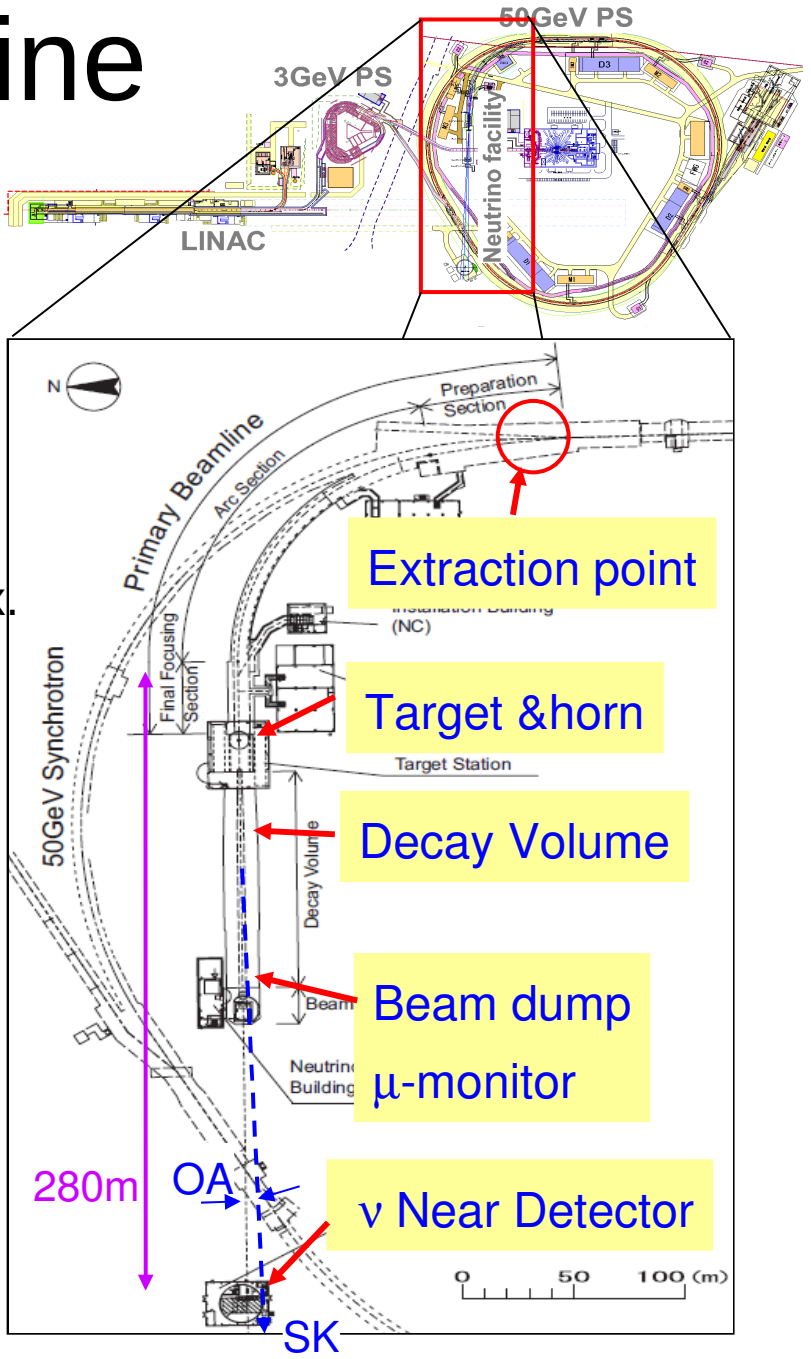
J-PARC Main Ring
(KEK-JAEA, Tokai)



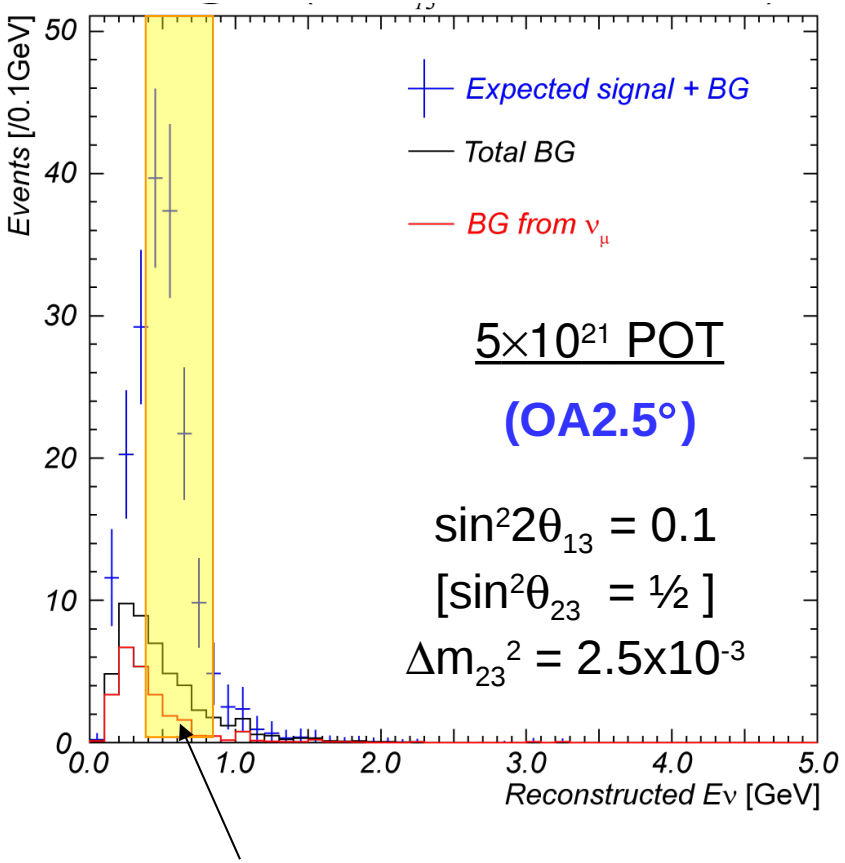
J-PARC ν-beam line

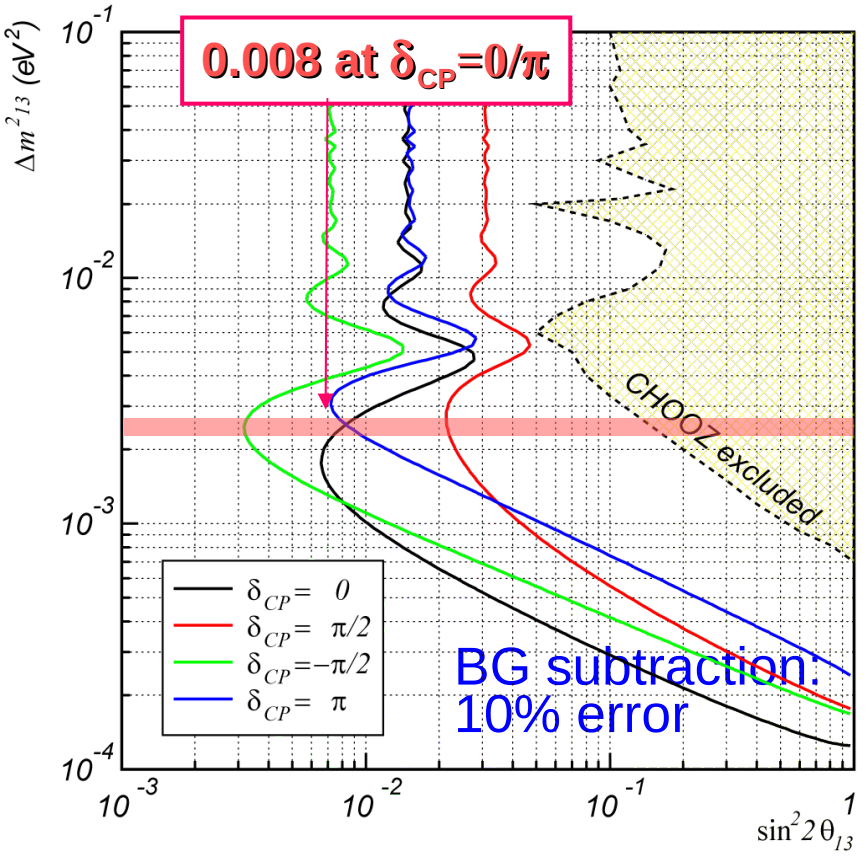
- Conventional ν_μ beam:
  - protons + Graphite target $\rightarrow$ pions
  - Pions are focused by 3 horns
  - ν_μ from pion decays
- Pseudo-Monochromatic beam by Off-Axis method: (OA = 2° ~ 2.5°)
  - Set peak of (flux × σ_{CC}) @ oscillation max.
  - Small fraction of high energy neutrino.





Sensitivity to θ_{13}



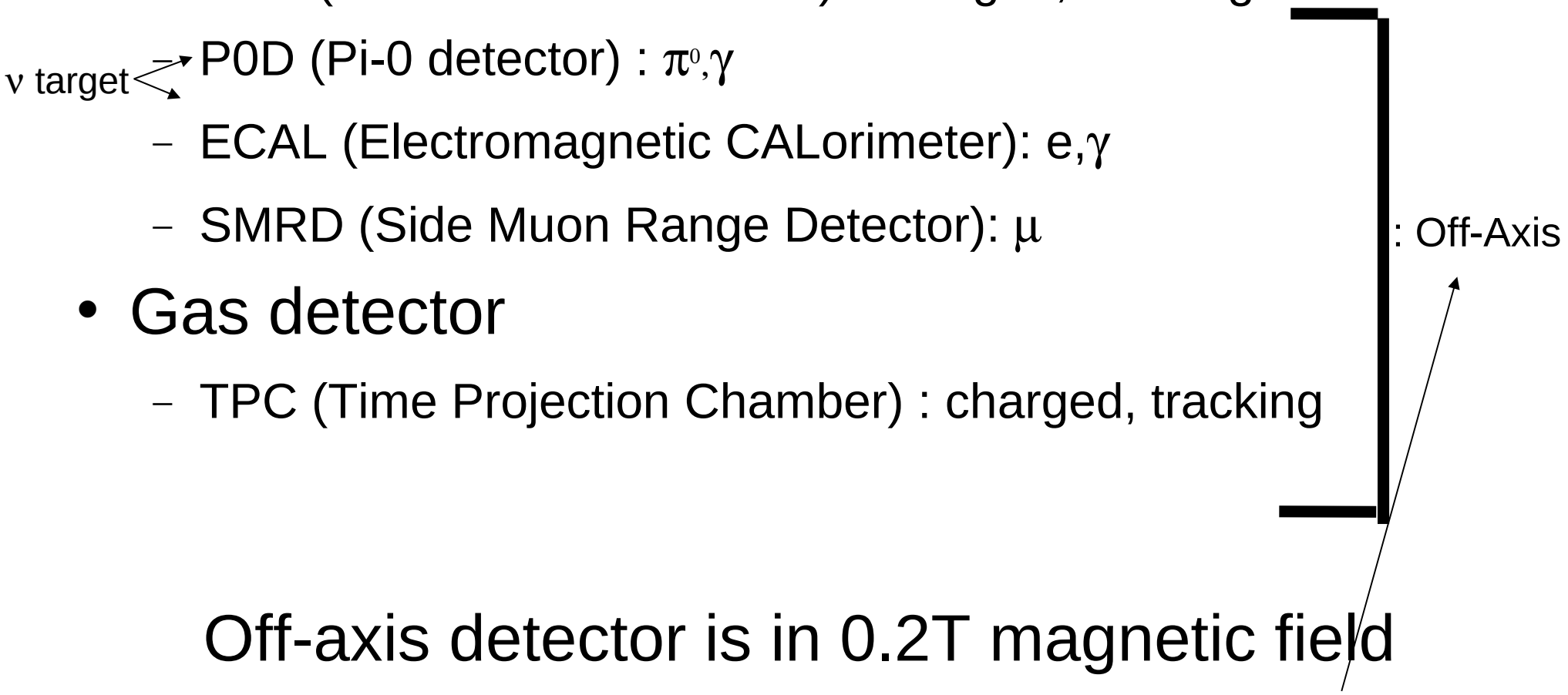


# of events in Evrec=0.35~0.85 [GeV]

$\sin^2 2\theta_{13}$	Background in Super-K			Signal [~40% eff]	Signal + BG
	ν_μ	ν_e	total		
0.1	10	13	23	103	126
0.01				10	33

T2K-ND280

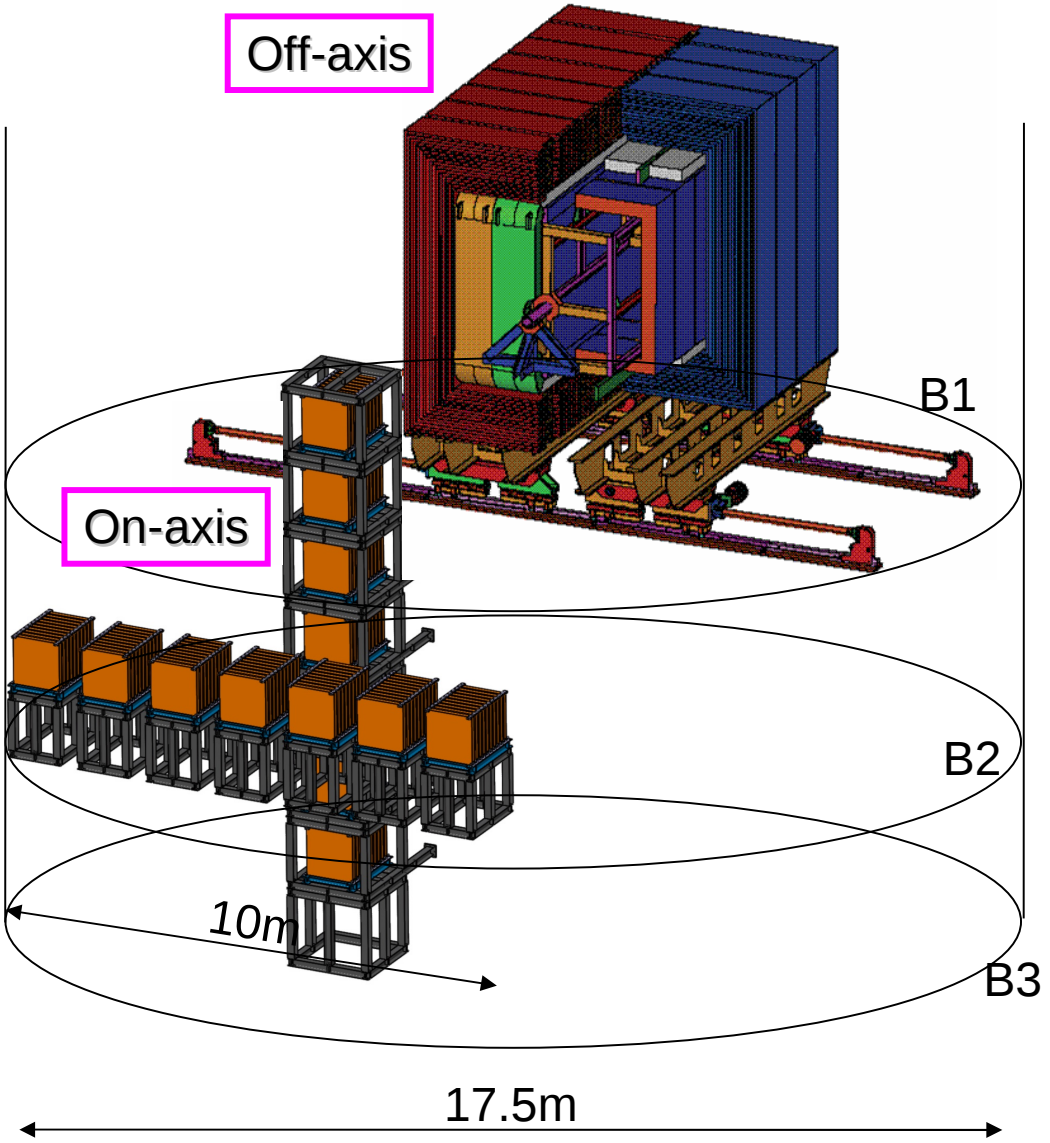
- Scintillator + WLS optical fiber + photo sensor
  - INGRID (Interactive Neutrino GRID detector) : On-Axis
  - FGD (Fine Grained Detector) : charged, tracking
  - P0D (Pi-0 detector) : π^0,γ
  - ECAL (Electromagnetic CALorimeter): e,γ
  - SMRD (Side Muon Range Detector): μ
- Gas detector
  - TPC (Time Projection Chamber) : charged, tracking

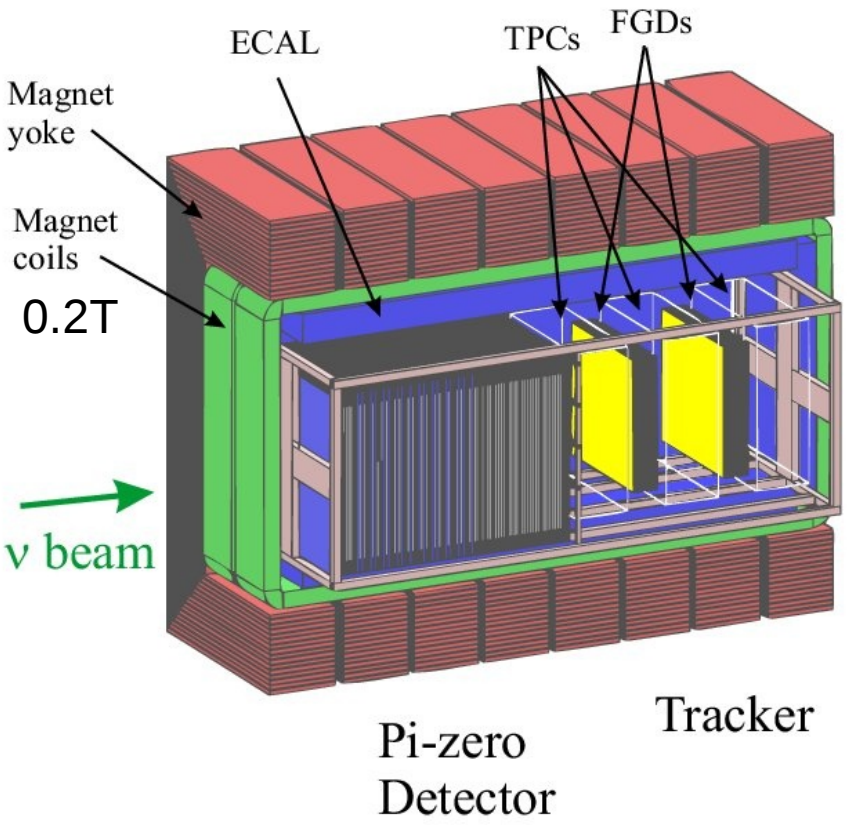


Off-axis detector is in 0.2T magnetic field

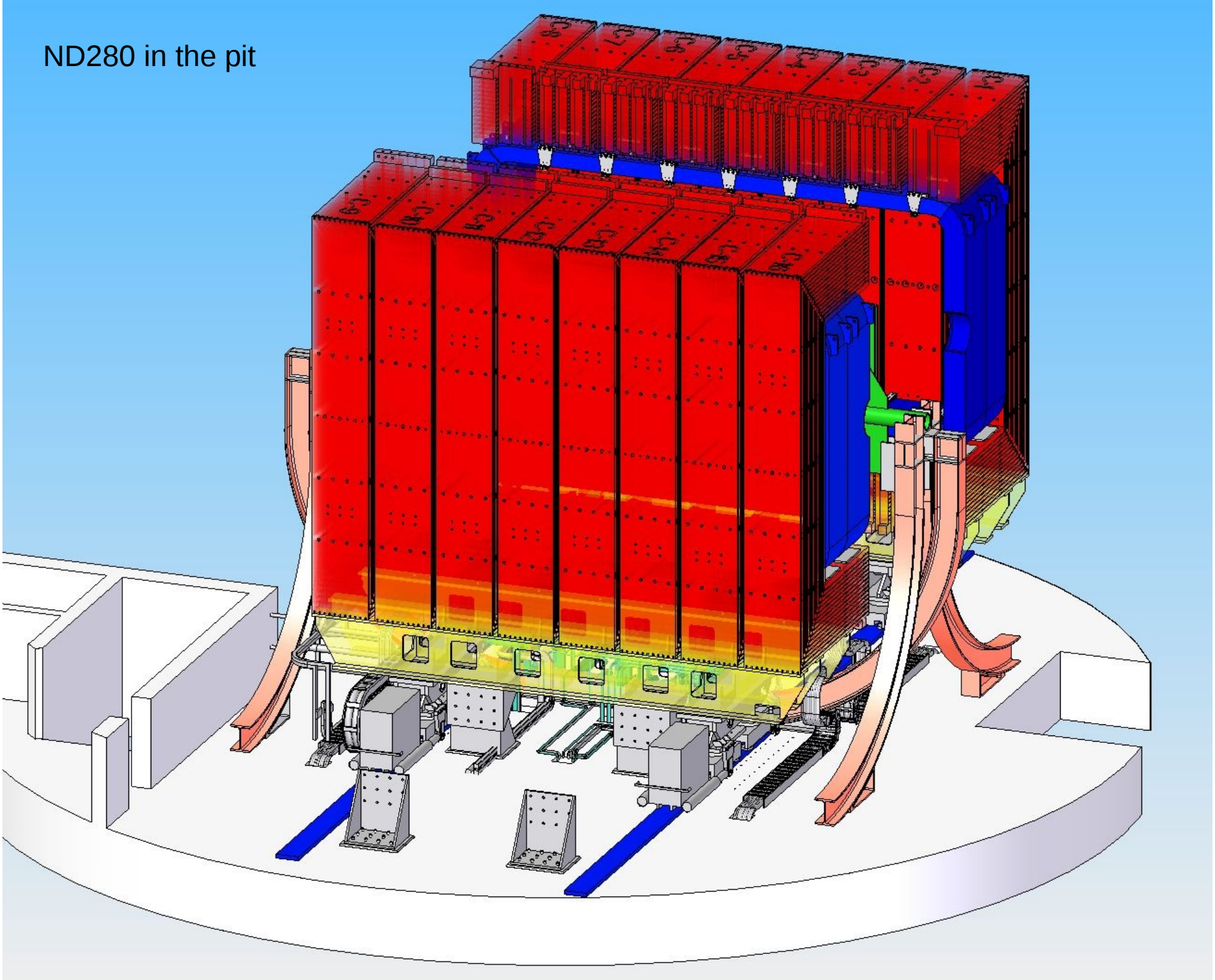
Facility & magnet

ND280 sub-detectors





ND280 in the pit



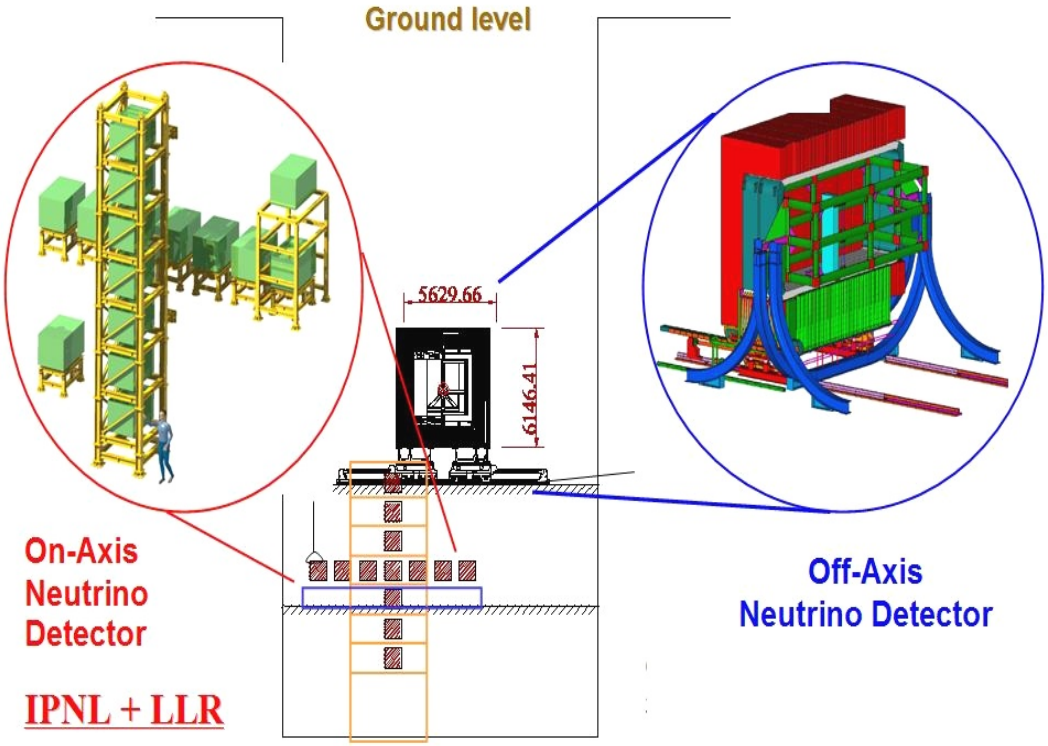
- Pit/facility construction and magnet installation
  - The floor is ready by Mar. ,2008 for installation of magnet.
  - Magnet installation will be done before construction of the surface building
  - Magnet has been shipped from CERN
    - Yokes and carriages are in J-PARC
    - Coils will arrive at the port in Japan by the middle of May
  - Carriages are installed in the pit
  - Yoke assembling is going on.
  - Yoke installation will be done in the end of May, then coils will be installed by the middle of June.
  - Surface building and facility will be constructed by the end of Jan., 2009.

Carriage installation and yoke pieces

INGRID

INGRID

イングリッド

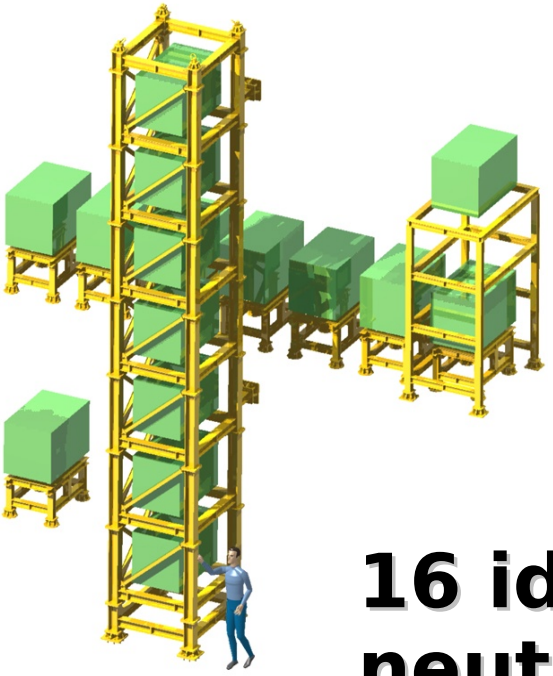


On-Axis neutrino detector

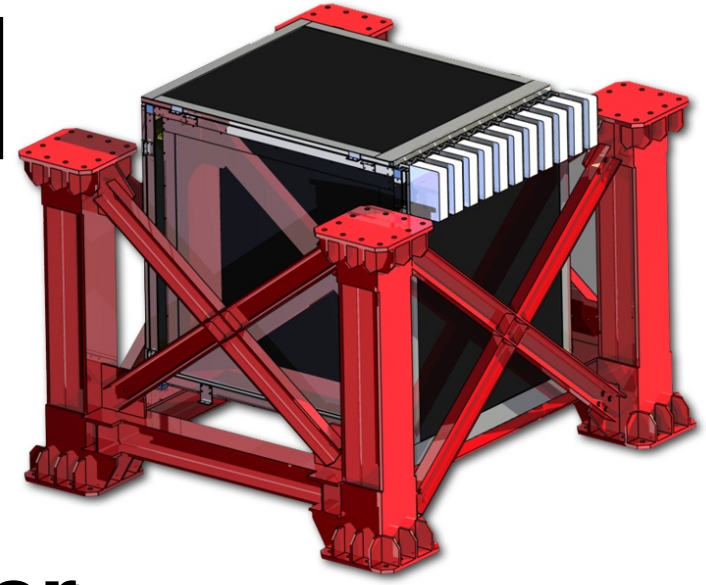
IPNL / LYON

LLR / Ecole Polytechnique

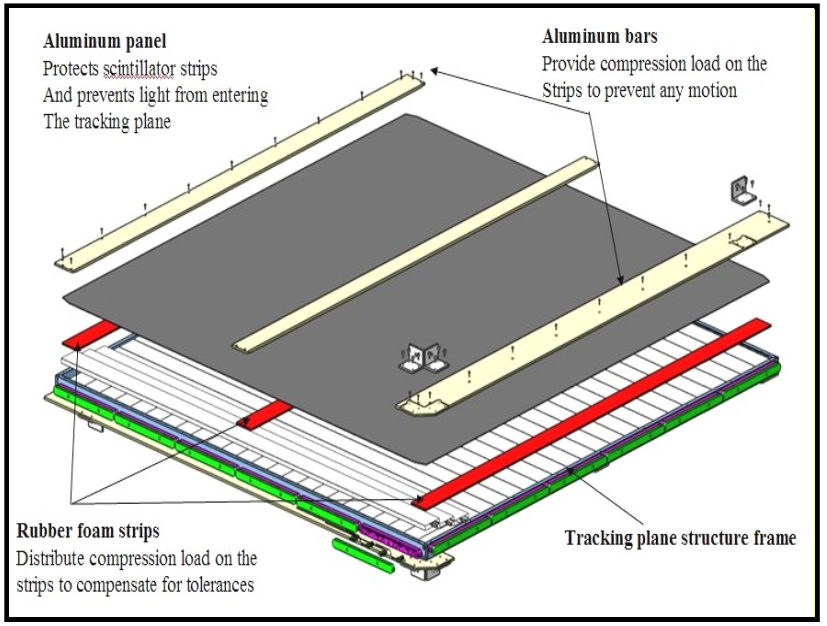
The commissioning of INGRID will (and has to) start in April 2009

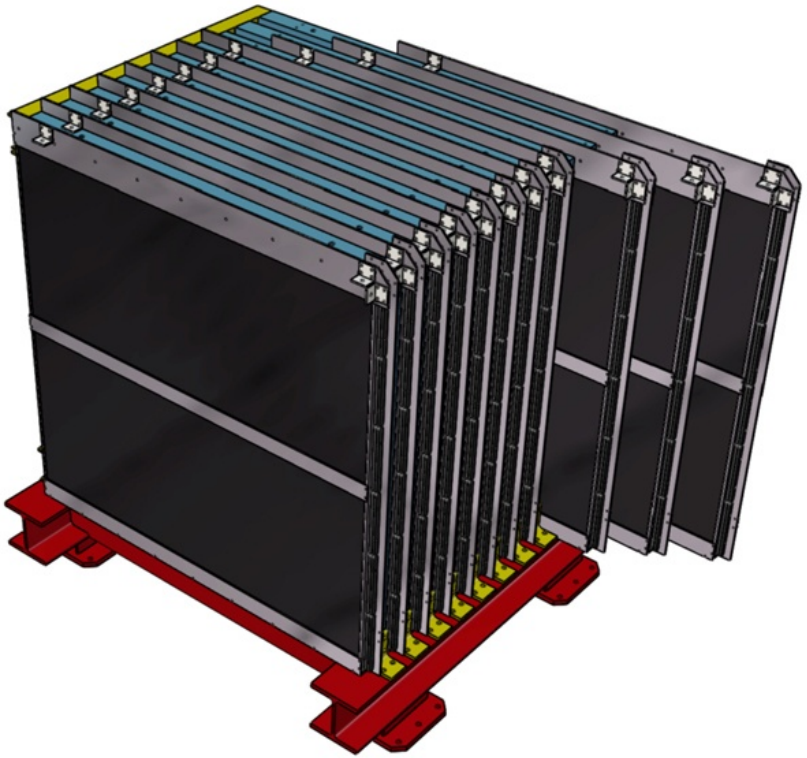


Laboratoire
Leprince-Ringuet



16 identical modules for neutrino beam profile detection





may

Laboratoire Leprince-Ringuet

MPPC Test bench

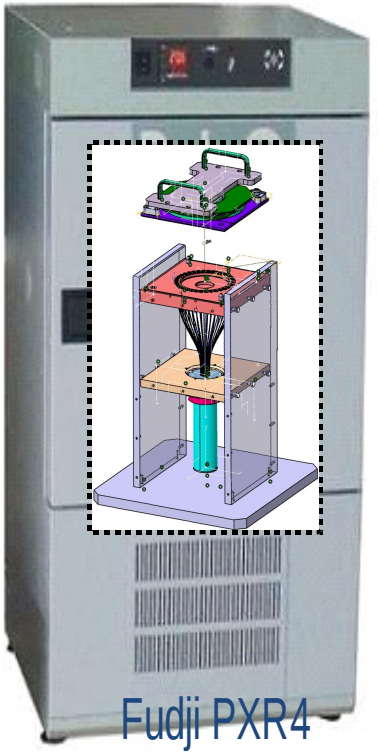
Agilent 33250

Keithley 2700

Keithley 2612

GPIB

RS485



Fudji PXR4

Eth. 1

Lecroy 104MXi

RS232

FPGA Eval. board

Test Bench Application

PyMySQL

Eth. 2

INGRID DB

Web Browser

GUI

Device LOG

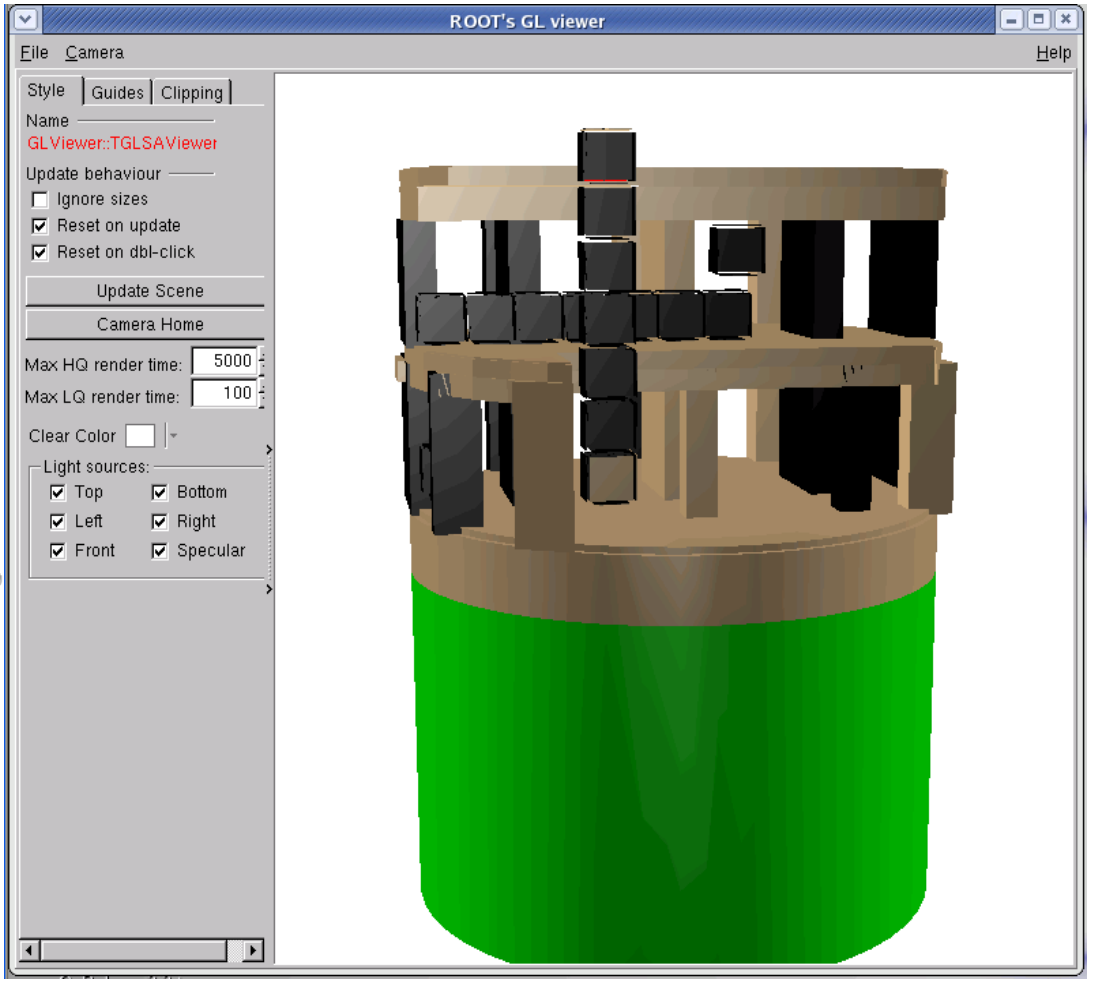
Institut de Physique Nucléaire de Lyon
IN2P3-CNRS / Université Lyon I

Offline software for INGRID

Make use of OPERA scintillator/software/simulation expertise for INGRID simulation in the ND280 framework

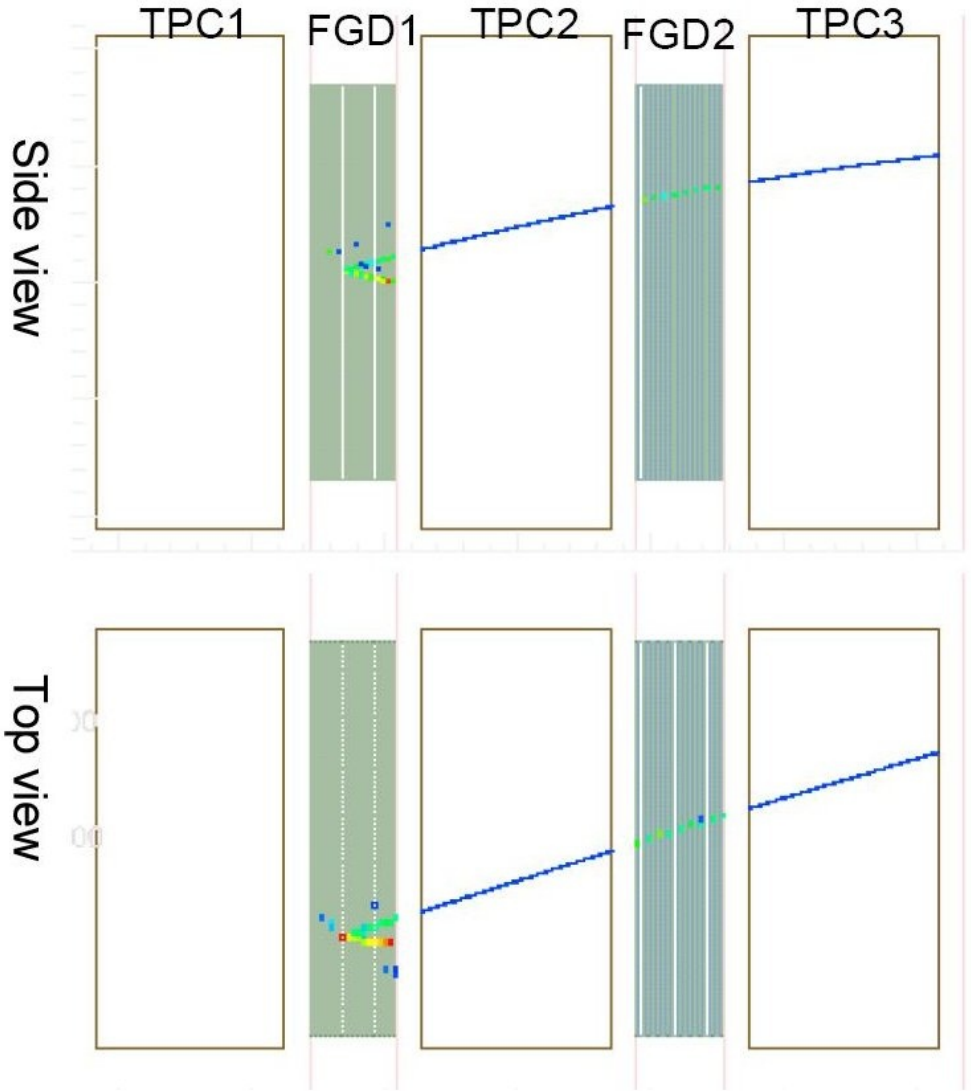
- **Direct usage of ROOT TGeoManager description** instead of starting first with a GEANT4 description which is then converted into ROOT.

- **Usage of the ROOT VMC** (Virtual Monte Carlo) which allows to switch between GEANT3, GEANT4, FLUKA



TPC

MC ν_μ CCQE (Charged Current Quasi-Elastic) event



Event No.: 24 Reaction code: 1 Position in File: 24

Primary Vertex [mm]: (-423, 53, 808)

Located in

Basket_0/TRK_0/Active_1/ScintX1_136/bar_37278

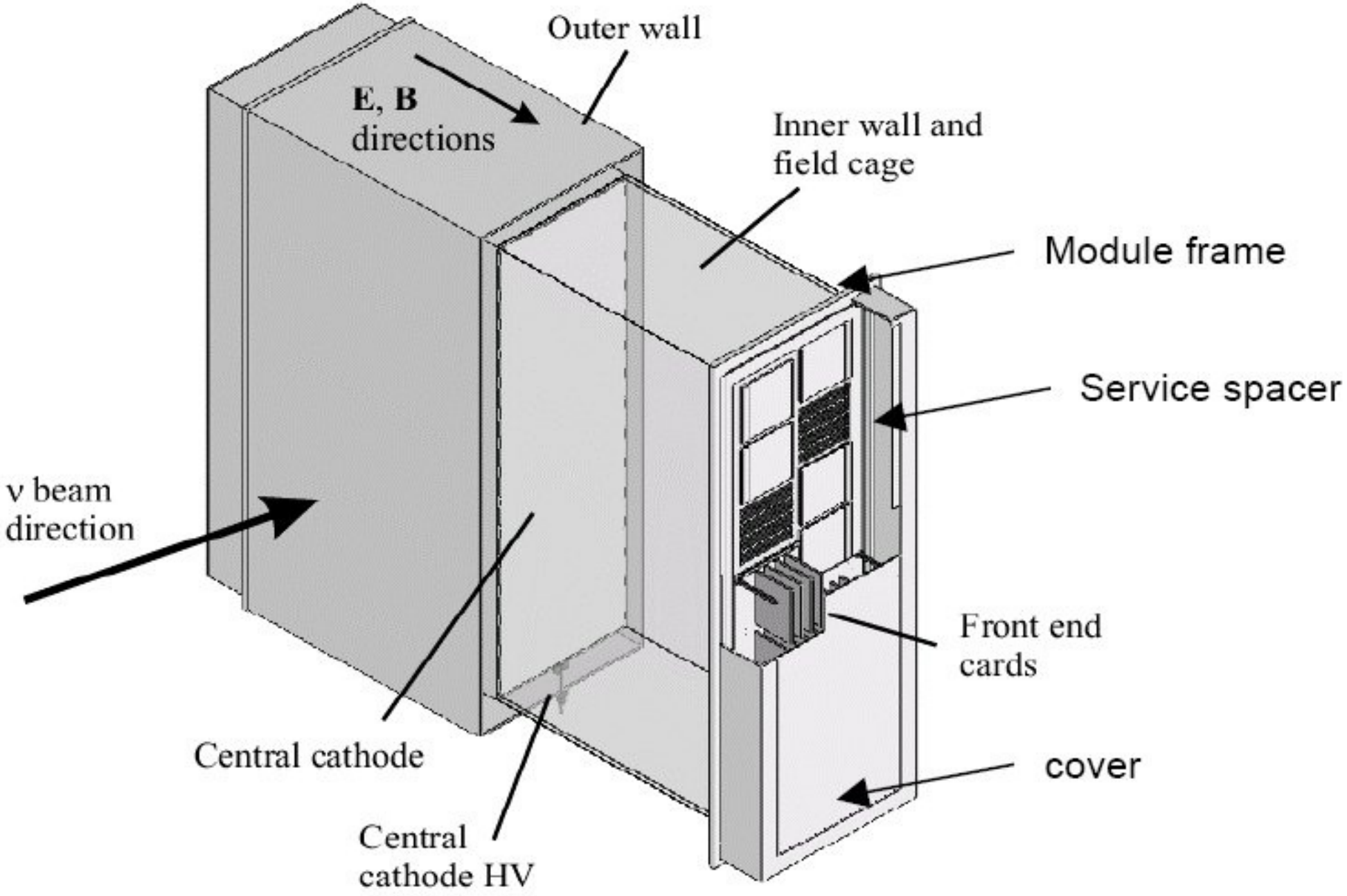
Informational particles

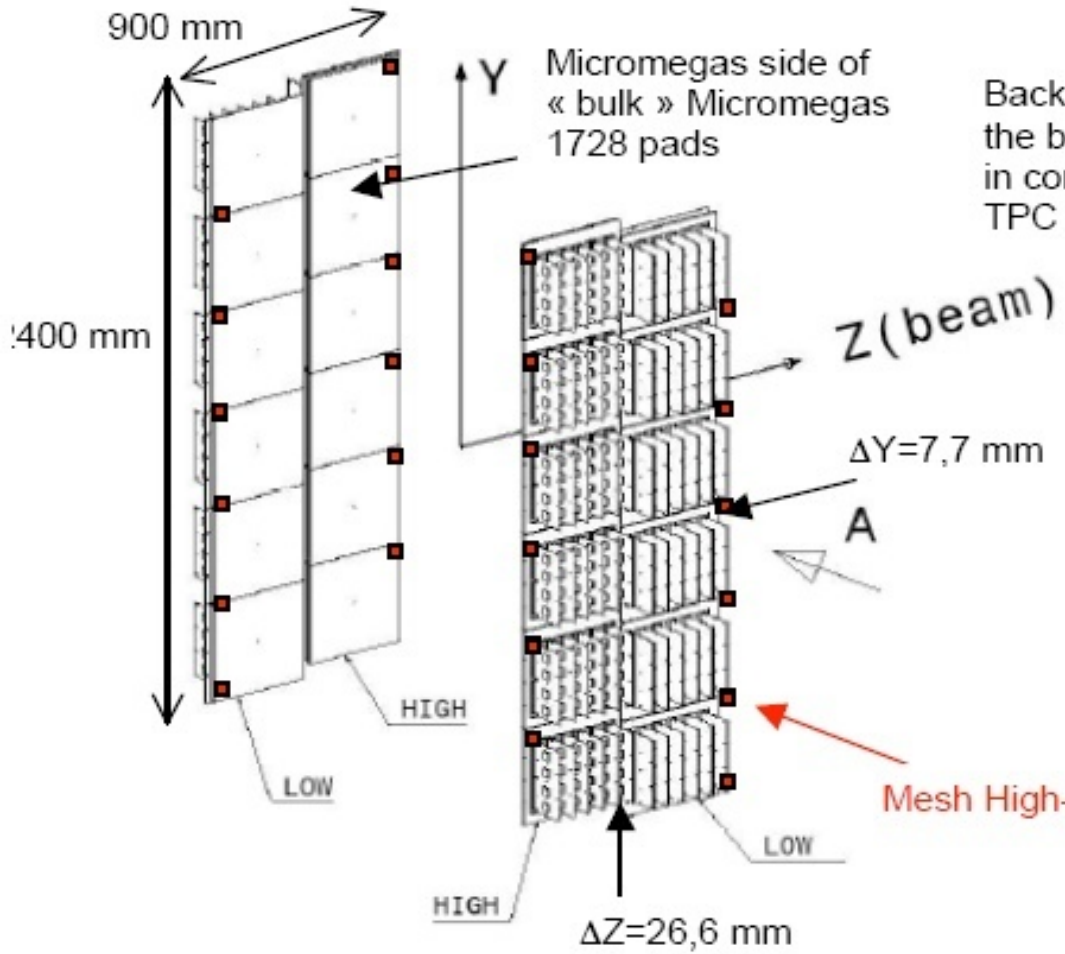
ν_μ (14)	Trk -1,	KE= 1340 MeV
n (2112)	Trk -1,	KE= 0 MeV

Primary particles

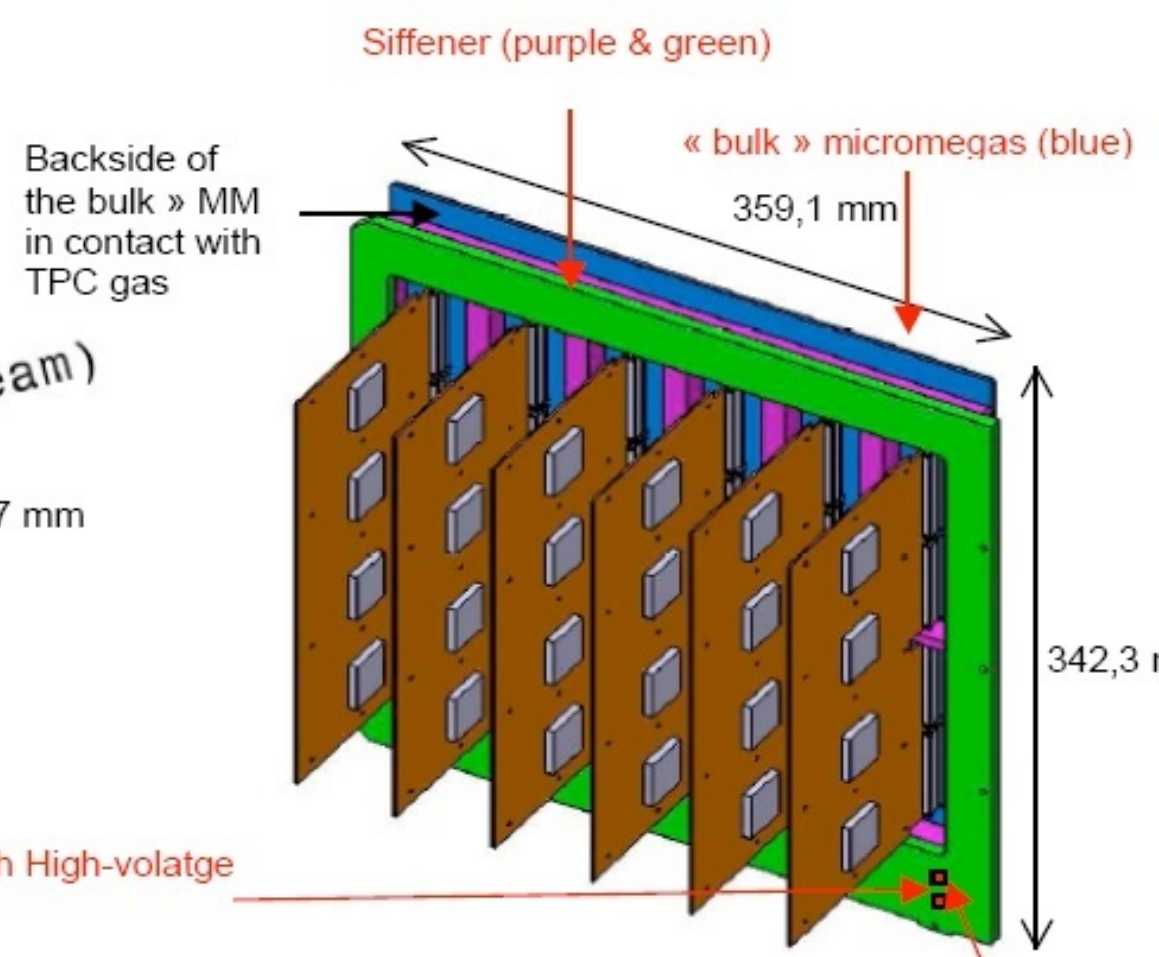
μ^- (13)	Trk 1,	KE= 938 MeV
p (2212)	Trk 2,	KE= 170 MeV
n (2112)	Trk 3,	KE= 72 MeV
p (2212)	Trk 4,	KE= 12 MeV
p (2212)	Trk 5,	KE= 3 MeV
p (2212)	Trk 6,	KE= 3 MeV
γ (22)	Trk 7,	KE= 6 MeV

Collaboration Canada-Germany-France-Spain-Switzerland.

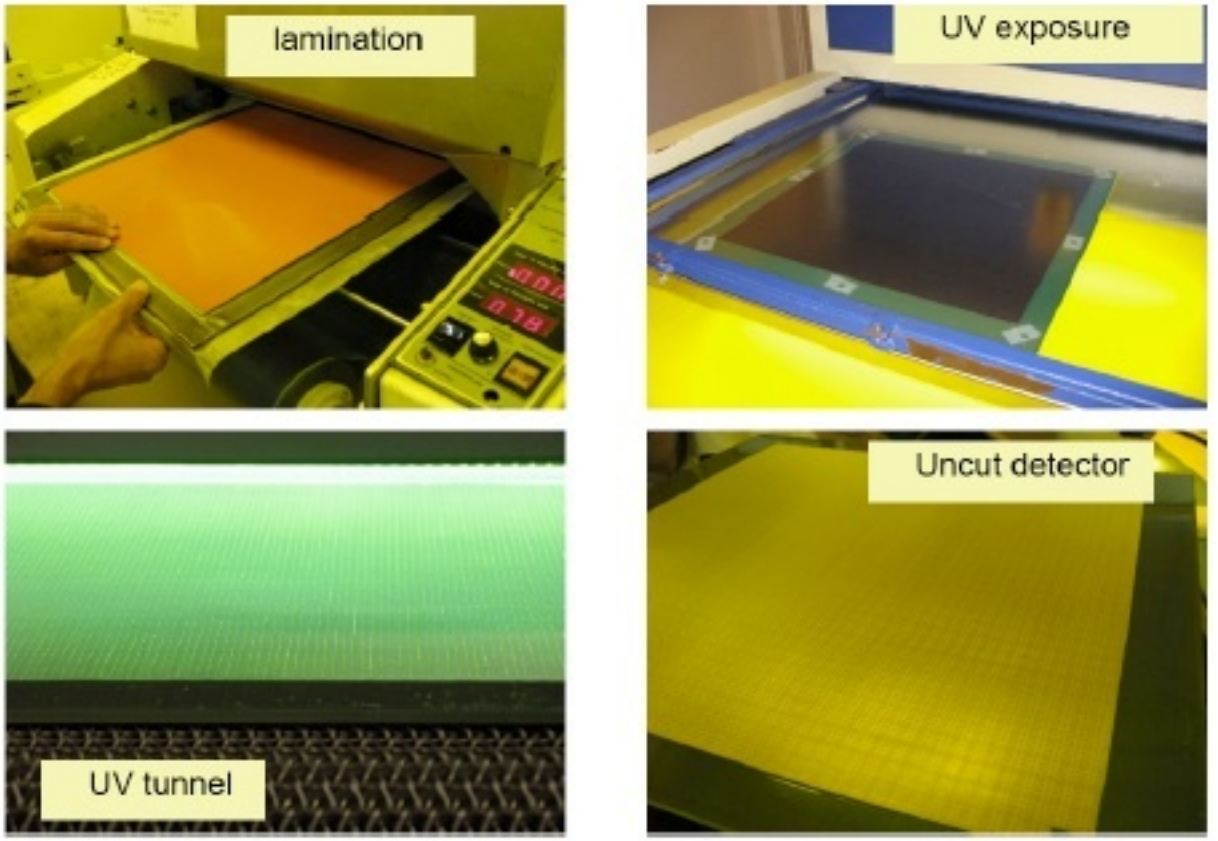




The 2 readout planes of a TPC



A MM module with 6 Front End cards
The « bulk » Micromegas is in blue



Picture 4.11 : *Mesh integration of the MM0-007 « bulk » micromegas (UV tunnel is used after step (6) for final polymerization and baking of pyralux)*

At step (4) of the integration, the last 64 μm pyralux layer is laminated on top of the woven micromesh, with the mechanical Frame on which it was stretched (***figure 4.12***).

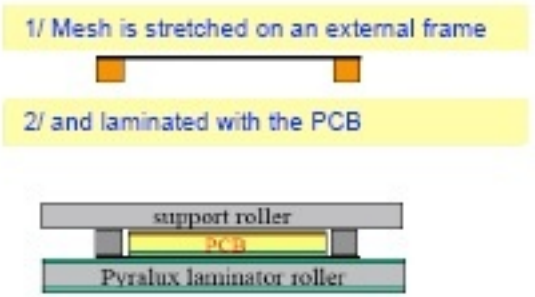


Figure 4.12 : *« Stretched mesh » procedure for mesh integration.*

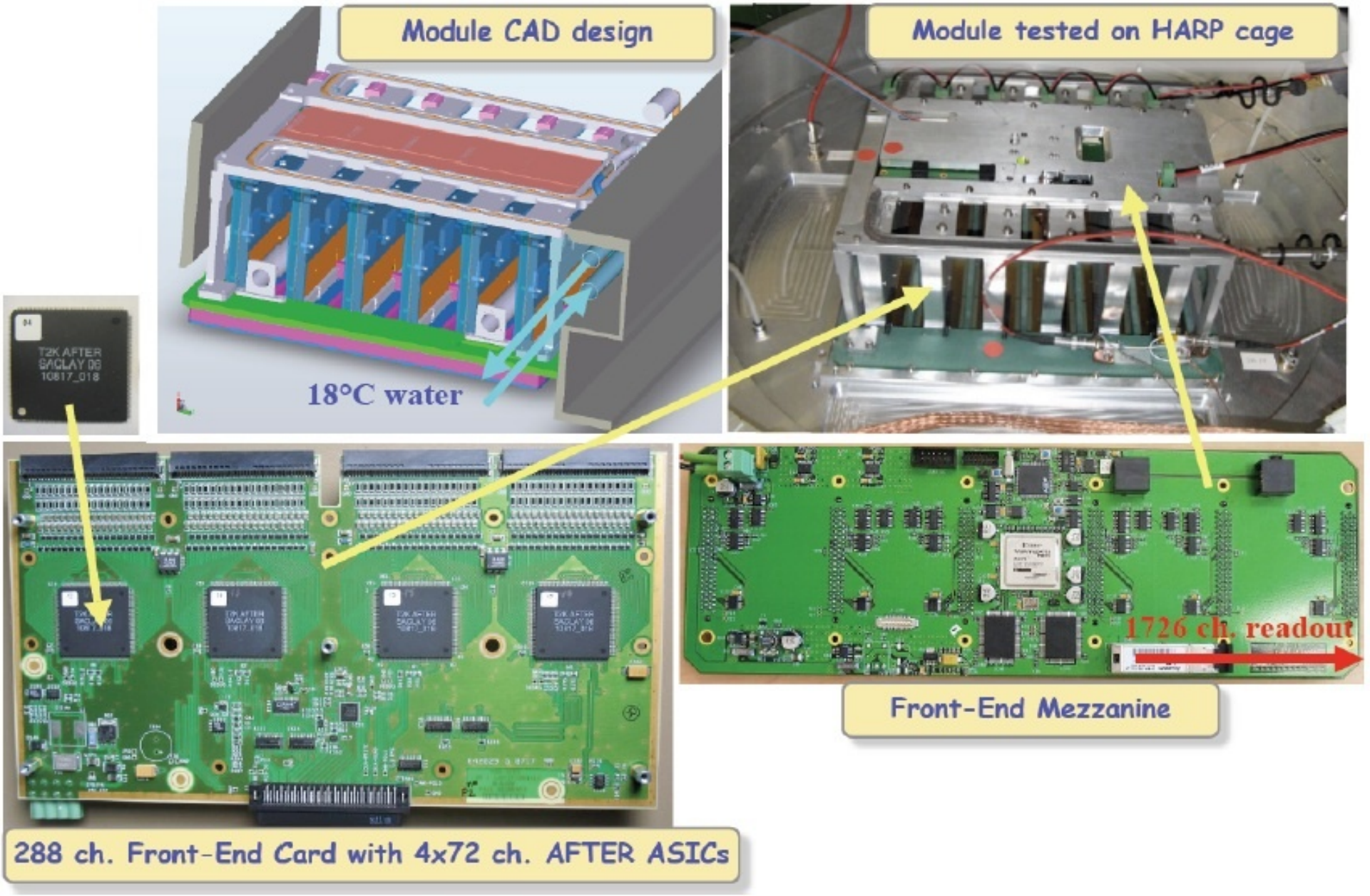
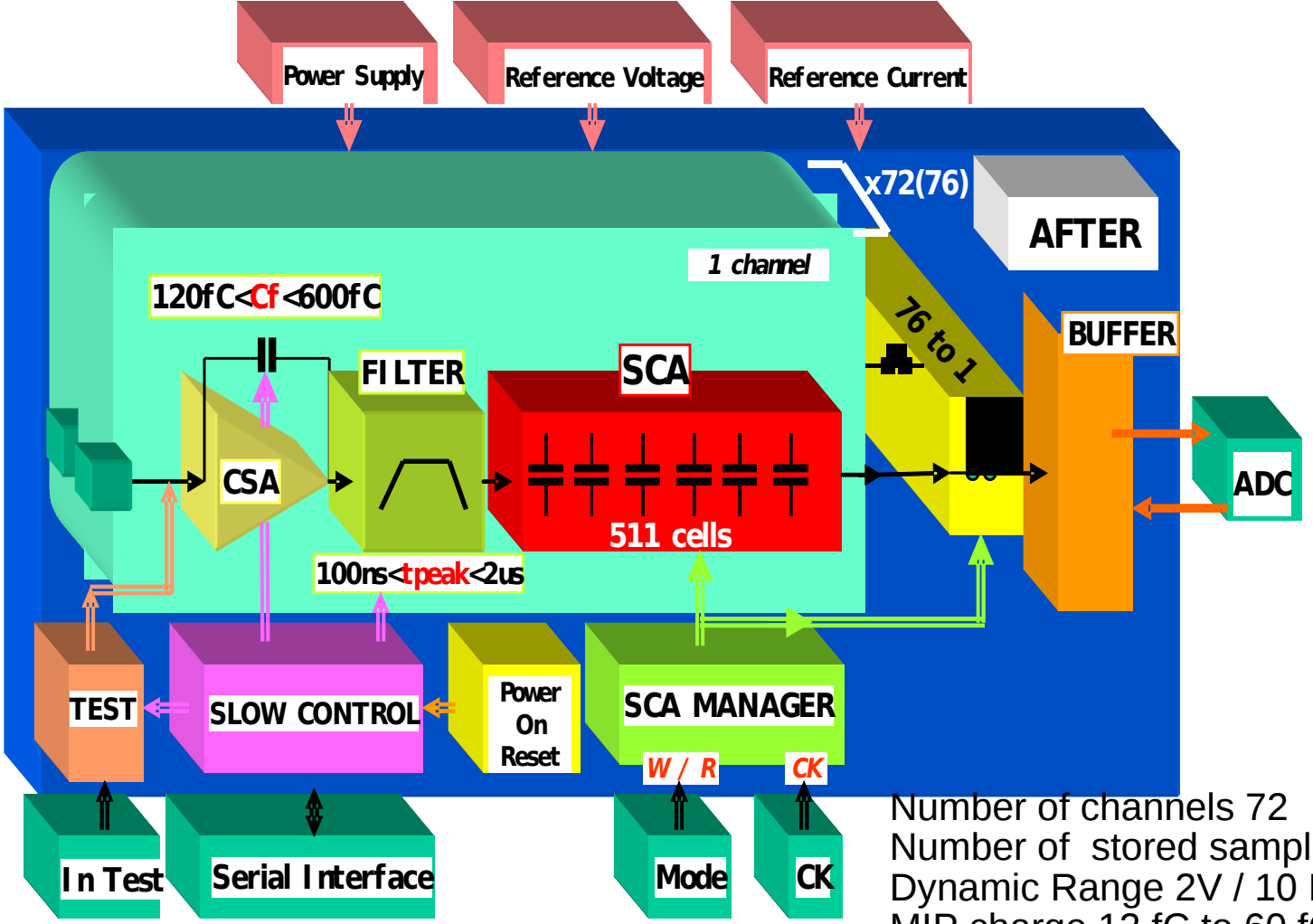


Figure 1.10 : *Pictures of a MM Module equipped with water cooled AFTER Front-End Electronics*



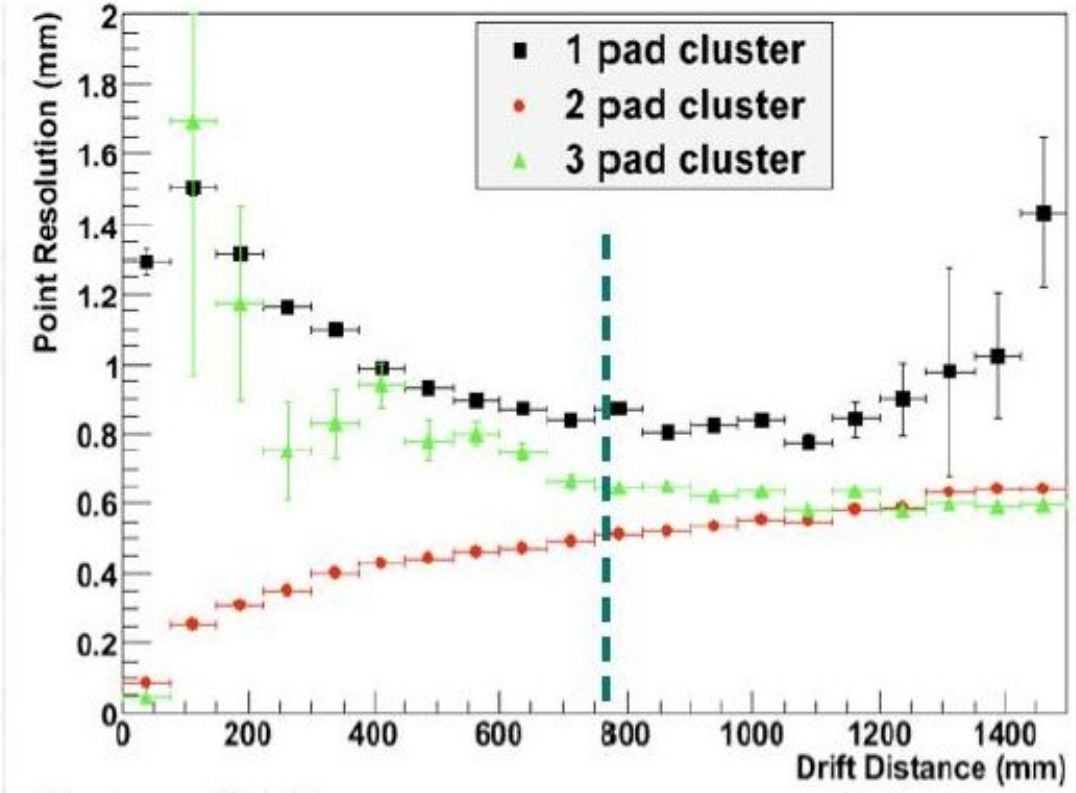
ASIC AFTER

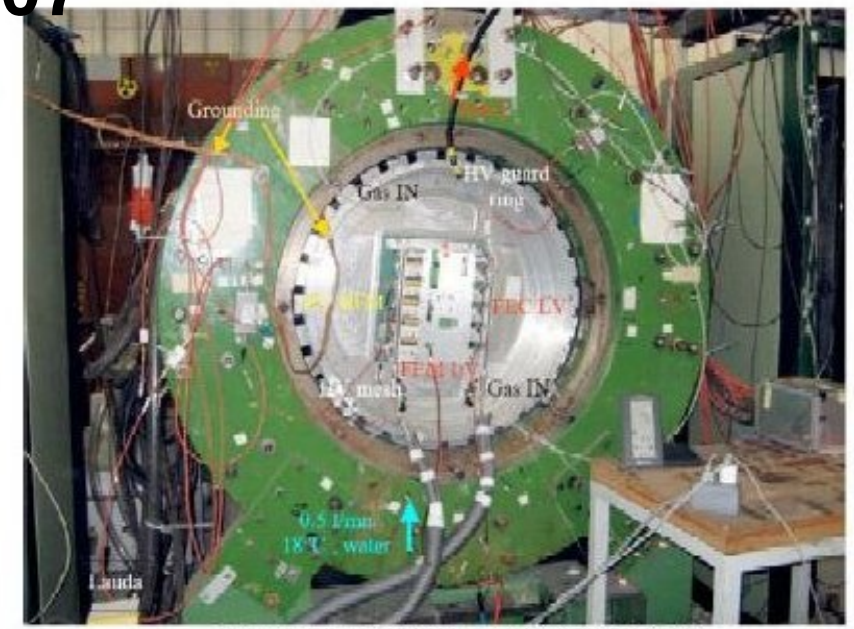
Versatile

Number of channels 72
Number of stored samples for each channel 511
Dynamic Range 2V / 10 MIPs on 12bits
MIP charge 12 fC to 60 fC
MIP/Noise ratio 100
Gain Adjustable (4 values)
“Detector” capacitor range 20-30pF
Peaking Time 100ns to 2µs (16 values)
I.N.L 1% 0-3 MIPs; 5% 3-10MIPs
Sampling frequency 1 MHz to 50 MHz
Readout frequency 20 to 25 MHz
Polarity of detector signal Negative(T2K) or Positive
Test 1 among72 channels or all

HARP test november 2007

- Uses AFTER front end electronics; B = 0.2T
- Real ND280 software





Hardware setup in T9A experimental zone (09/19/2007)

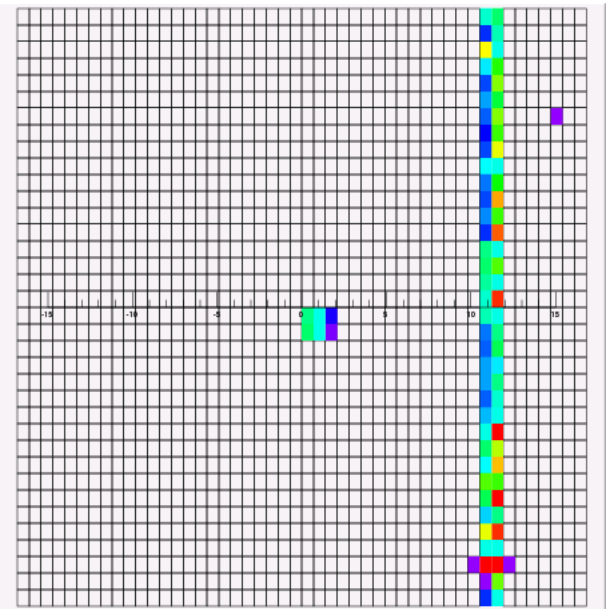


Figure 4.18 : Test bench for fianl calibration of the MM Modules

MOST RECENT NEWS FOR T2K TPC :

-Micromegas module production has started, 3% gain uniformity achieved.
-AFTER Asic in production, delivery this month.
-first real TPC being tested this summer in Canada(TRIUMF).

Summary

Intense activity in T2K

-neutrino beam, starting april 2009
***Superconducting magnets**
***MSS**
-near detector starting april 2009
***0° INGRID**
-near detector starting november 2009
***off axis, including TPC**

Thanks to Tsukamoto-san, M.Gonin and TPC collaborators.

RESERVE

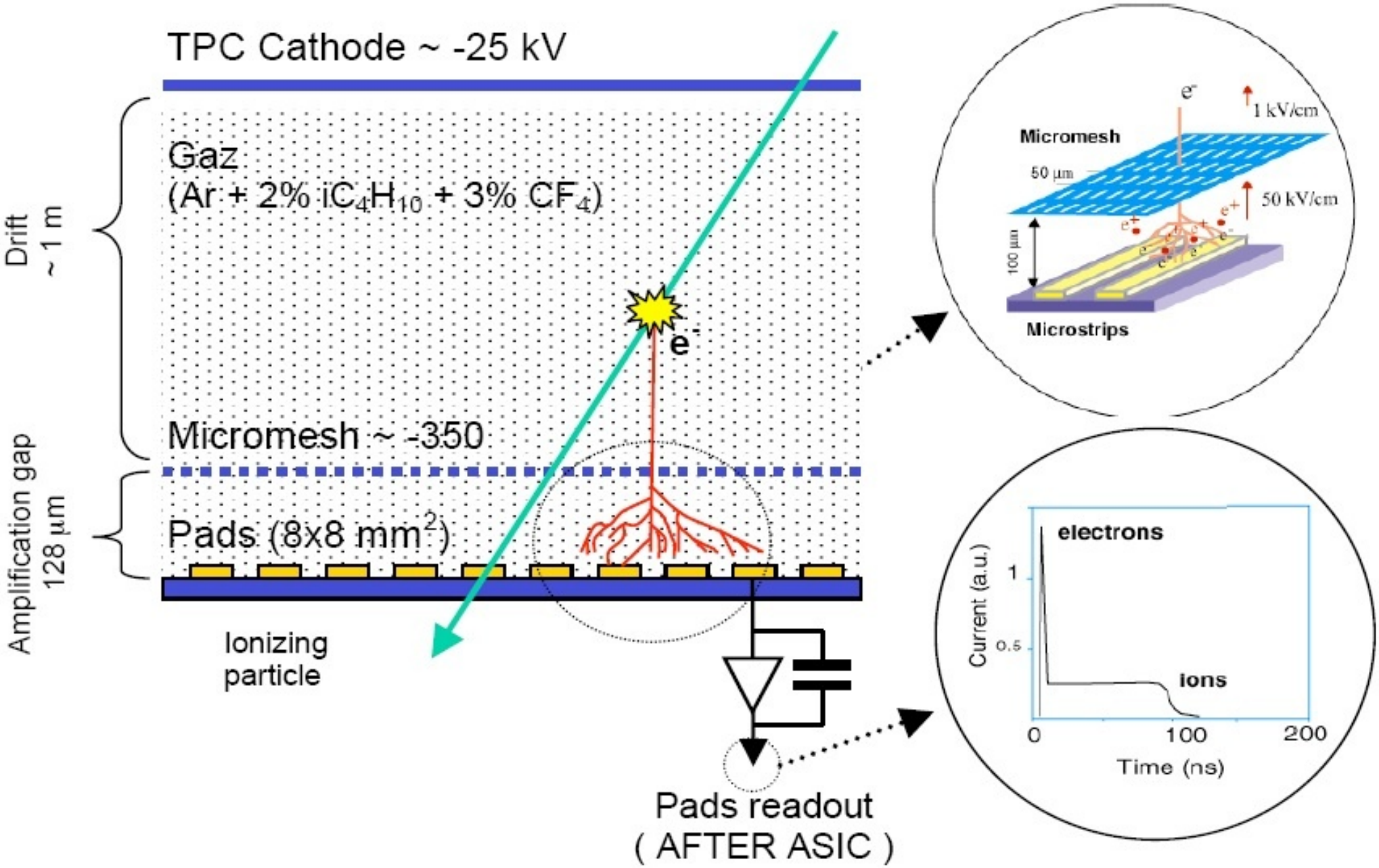


Figure 3.1: *T2K/TPC micromegas principle.*

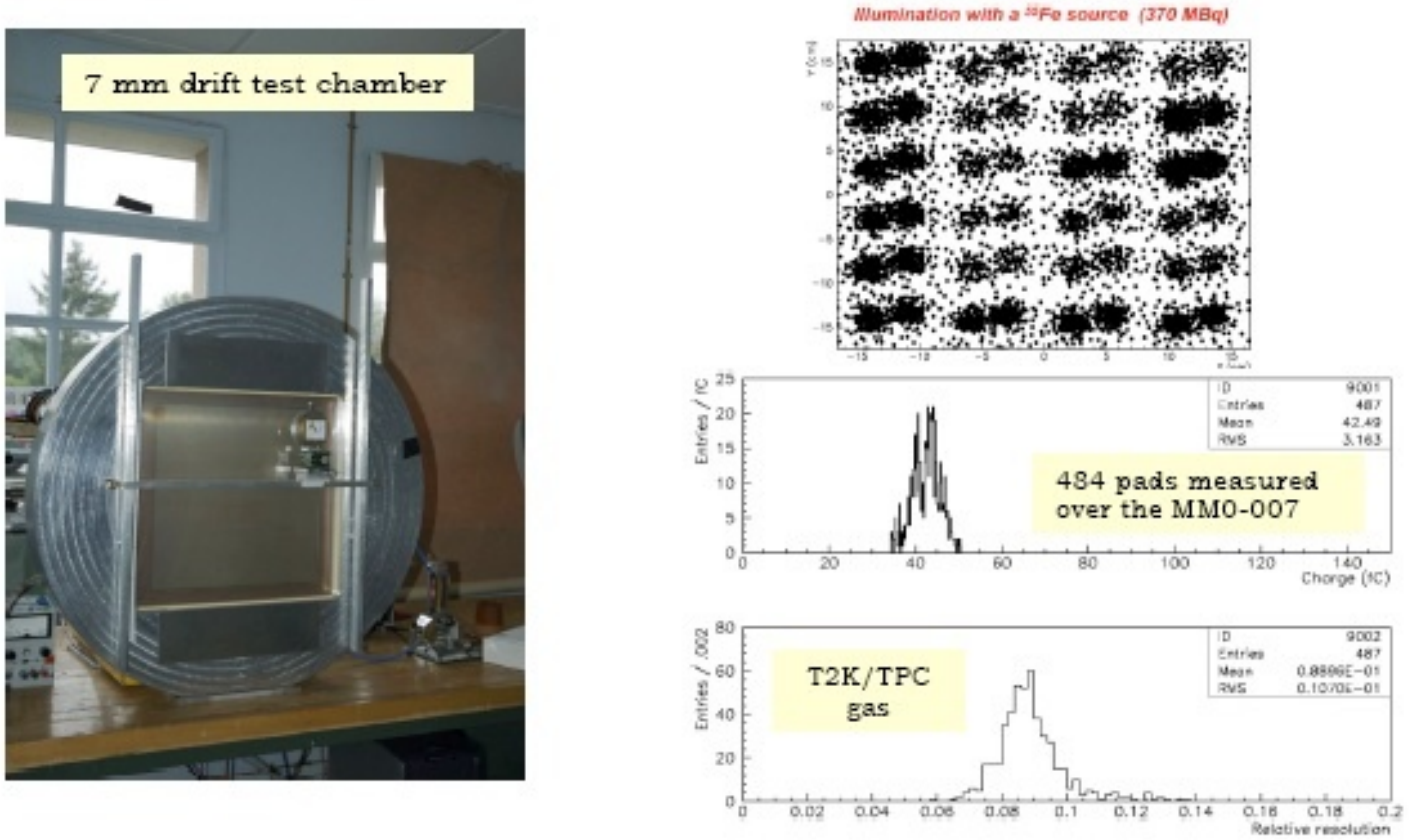


Figure 3.14 : Gain uniformity and 55Fe 5,9 keV resolution of the MM0-007 « bulk » micromegas.

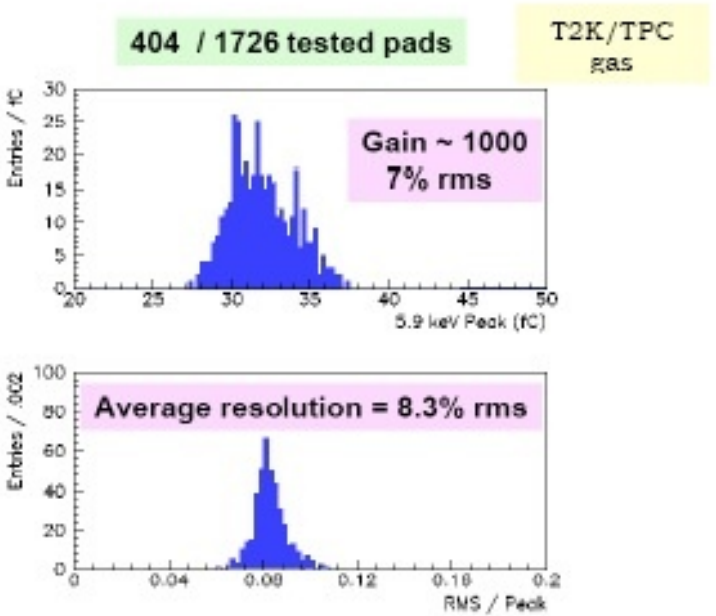
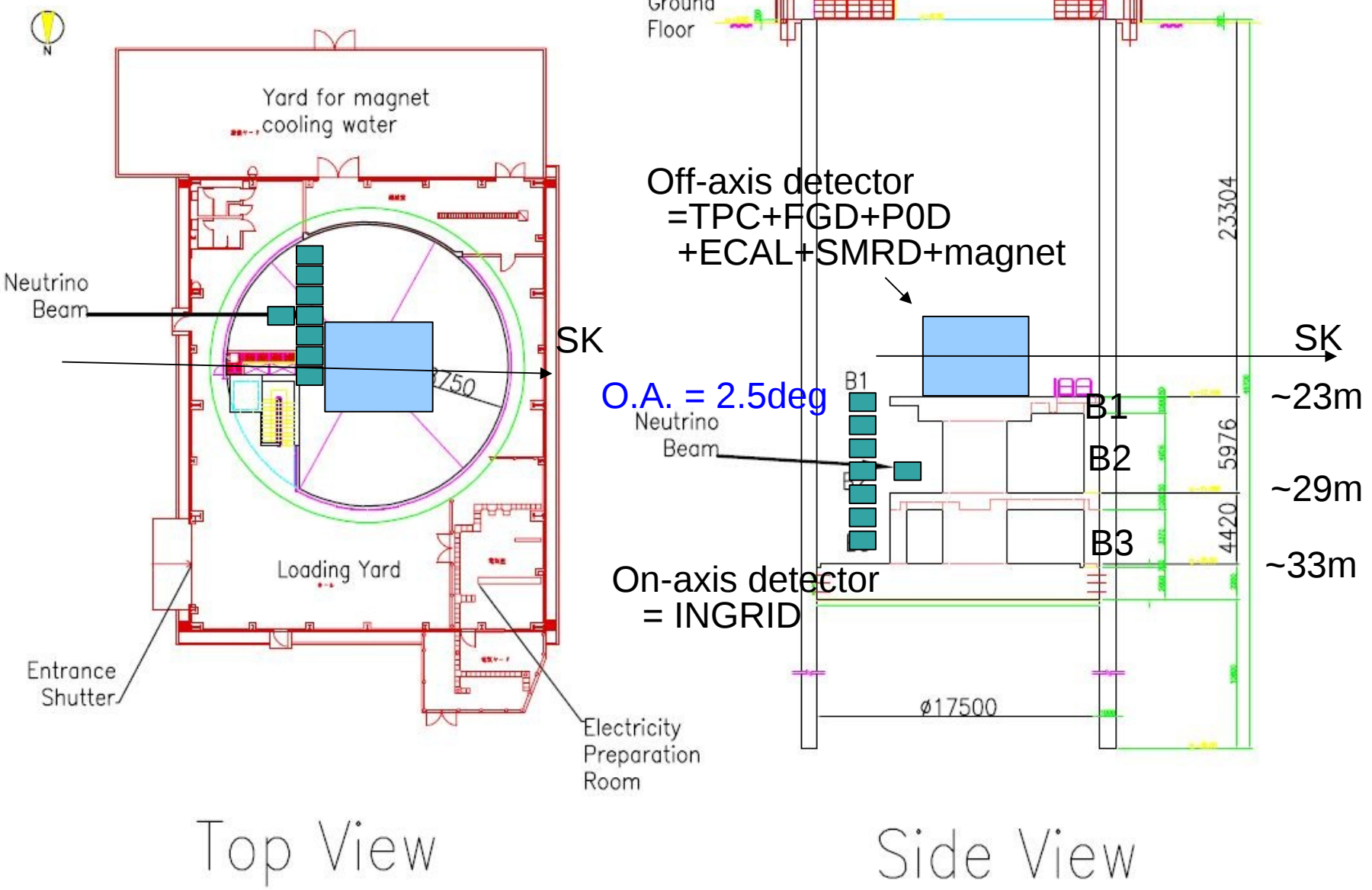
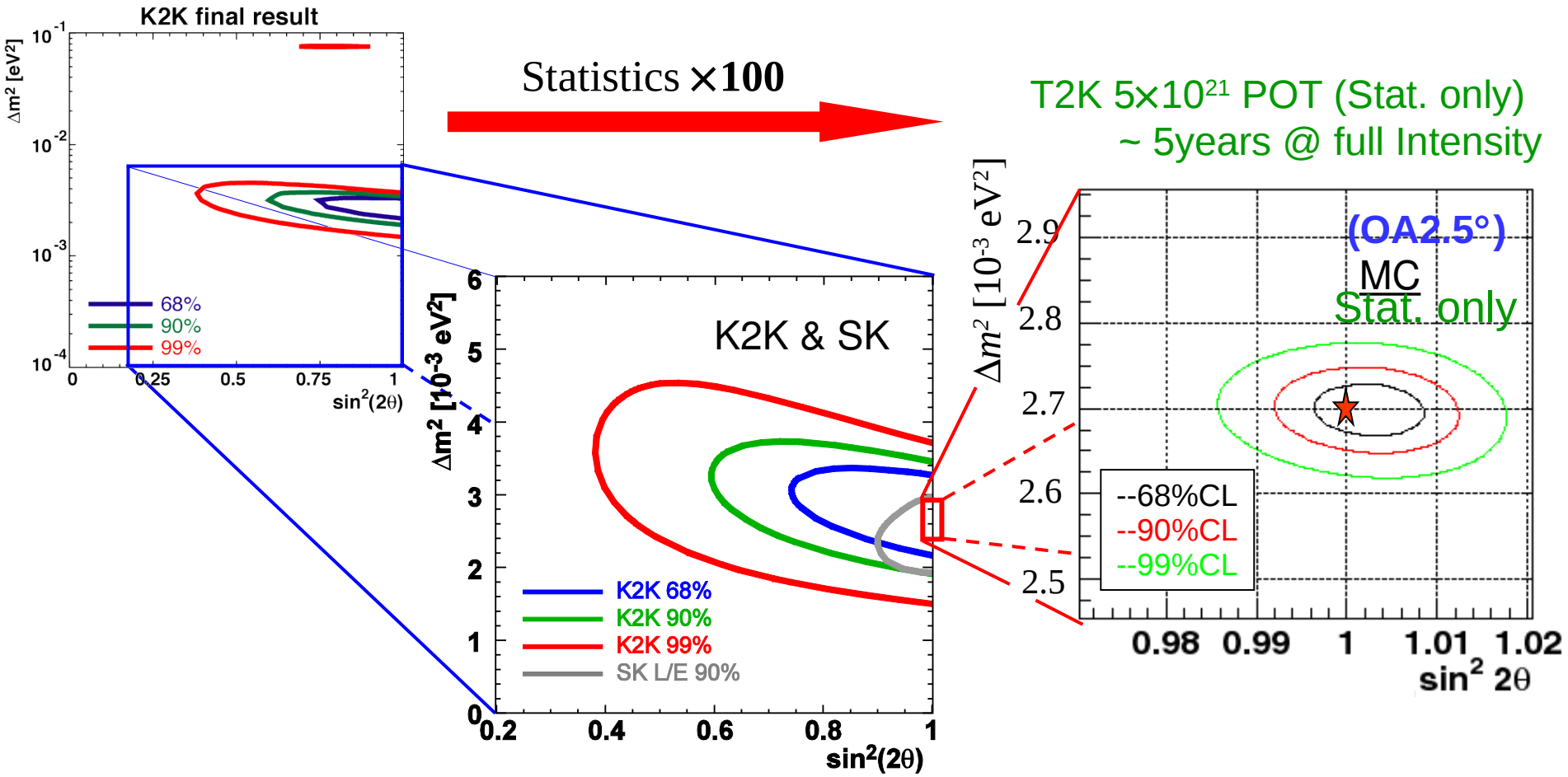


Figure 3.15 : Gain uniformity and 55Fe 5,9 keV resolution of the MM1-001 « bulk » micromegas

Building & Pit for ND280



Sensitivity: ν_μ disappearance

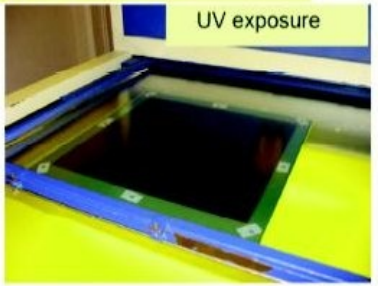


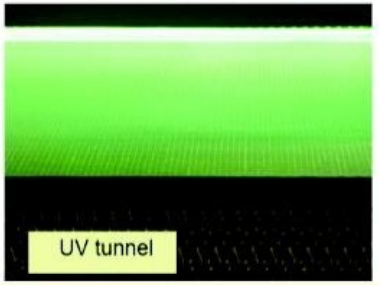
Goal : $\delta(\sin^2 2\theta_{23}) \sim 0.01$, $\delta(\Delta m^2_{23}) < 1\times10^{-4}$ [eV²]

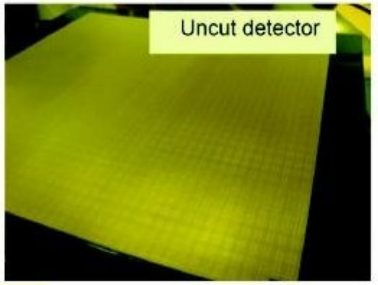
T2K/TPC WP4 « bulk » Micromegas status report

dapnia
cea
saclay

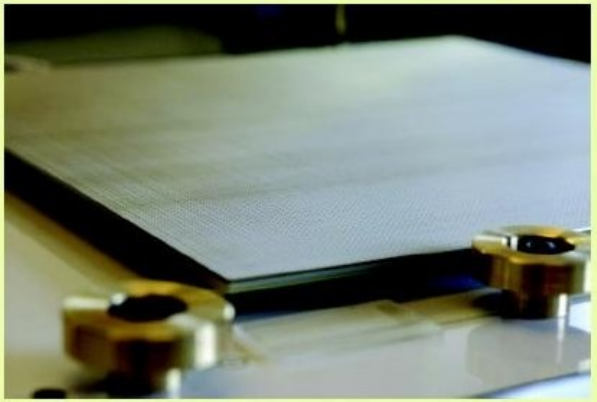
« bulk » Micromegas mesh integration
@ CERN/TS-DEM-PMT





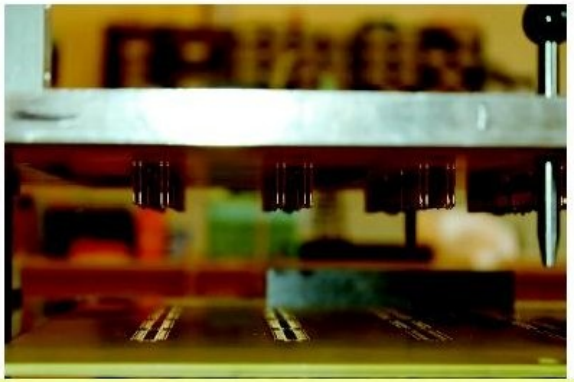


« bulk » Micromegas

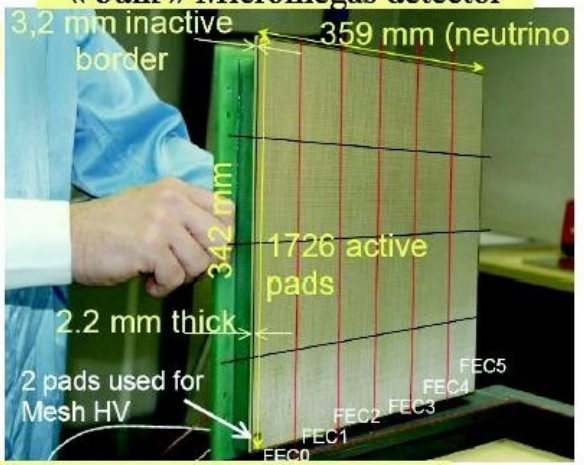


MM1_001 calibration on test bench @ CERN

« Fakir » Quality control test bench



« bulk » Micromegas detector



A. Delbart for T2K/TPC WP4 group: CEA-Saclay, CERN/TS-DEM-PMT, IFAE, UNIGE

Yoke reassembling