T2K

closed session FJPPL08 Workshop, F.Pierre

Outline

-General
-Accelerator and Beam Line
-near detector

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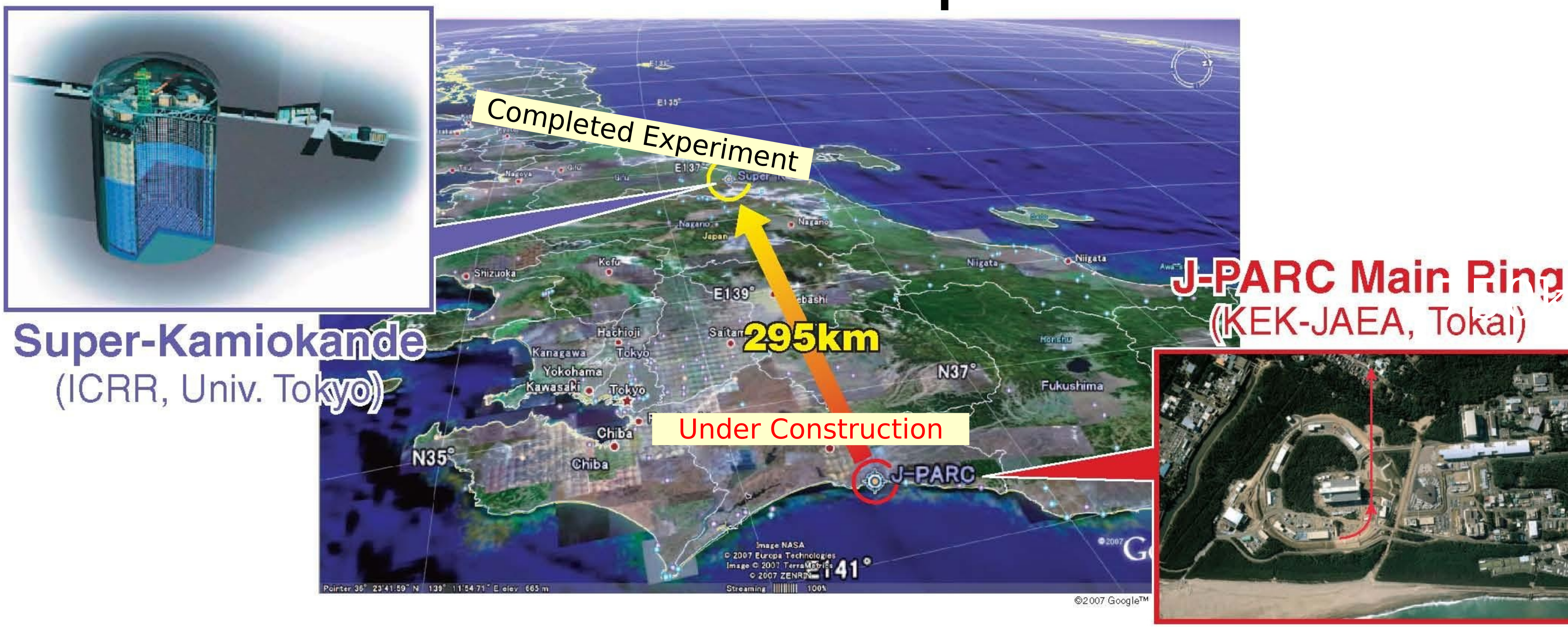
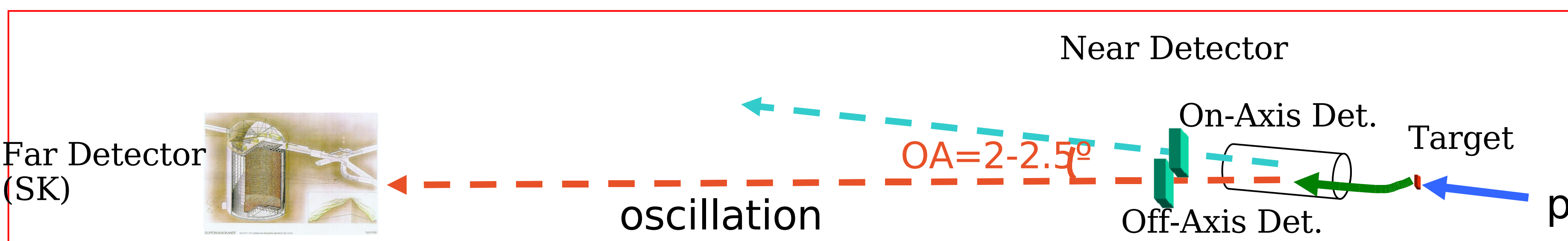
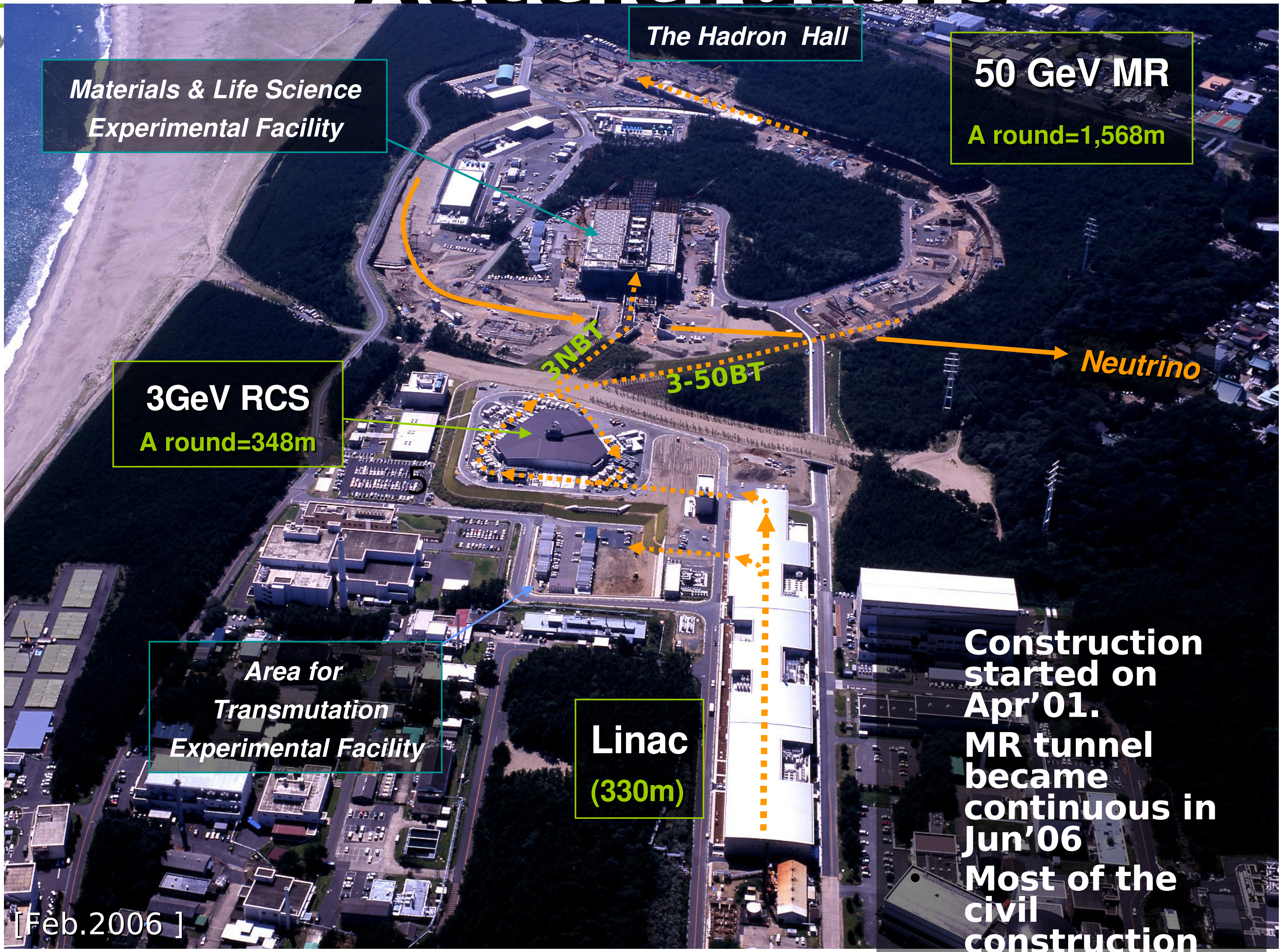
T2K : Tokai to Kamioka long base line neutrino experiment





295 km **280m** **0m**

J-PARC Accelerators

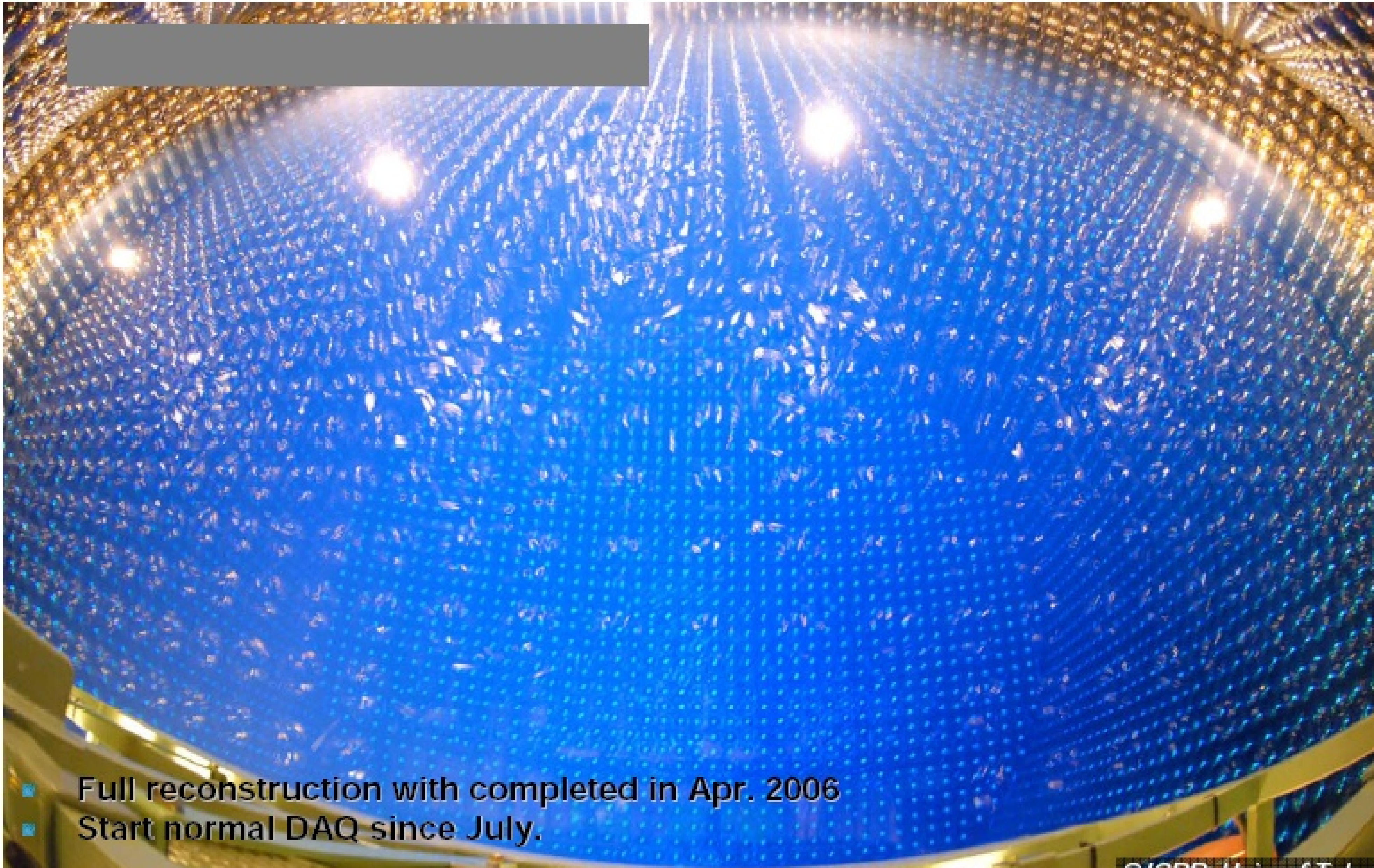


- Construction started on Apr'01.
- MR tunnel became continuous in Jun'06
- Most of the civil construction have been completed

Neutrino Facility at J-PARC

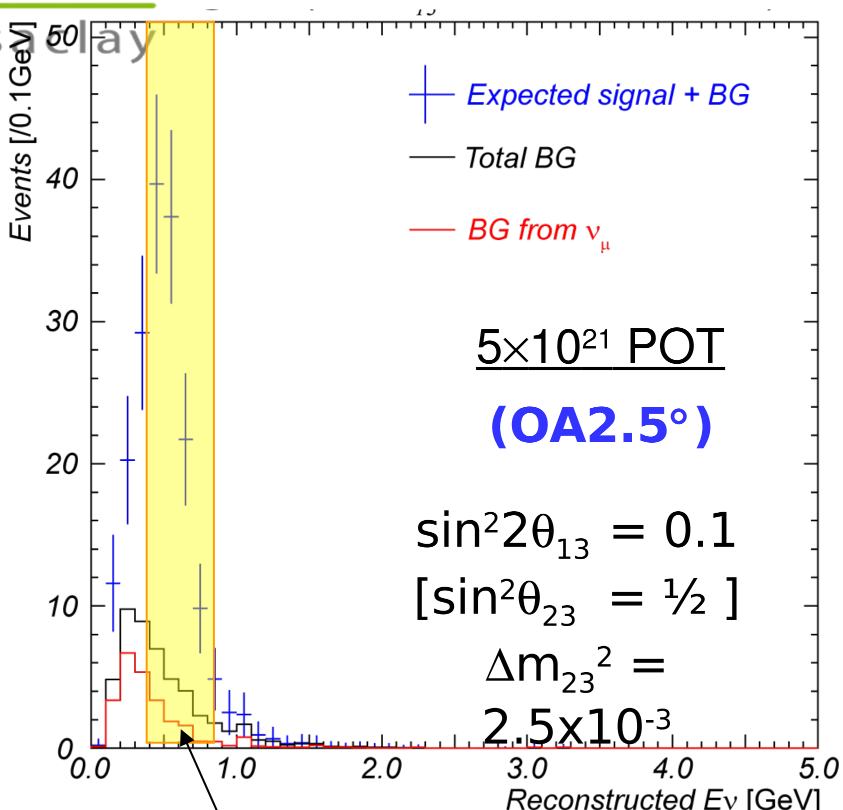
The Far Detector: SK-III

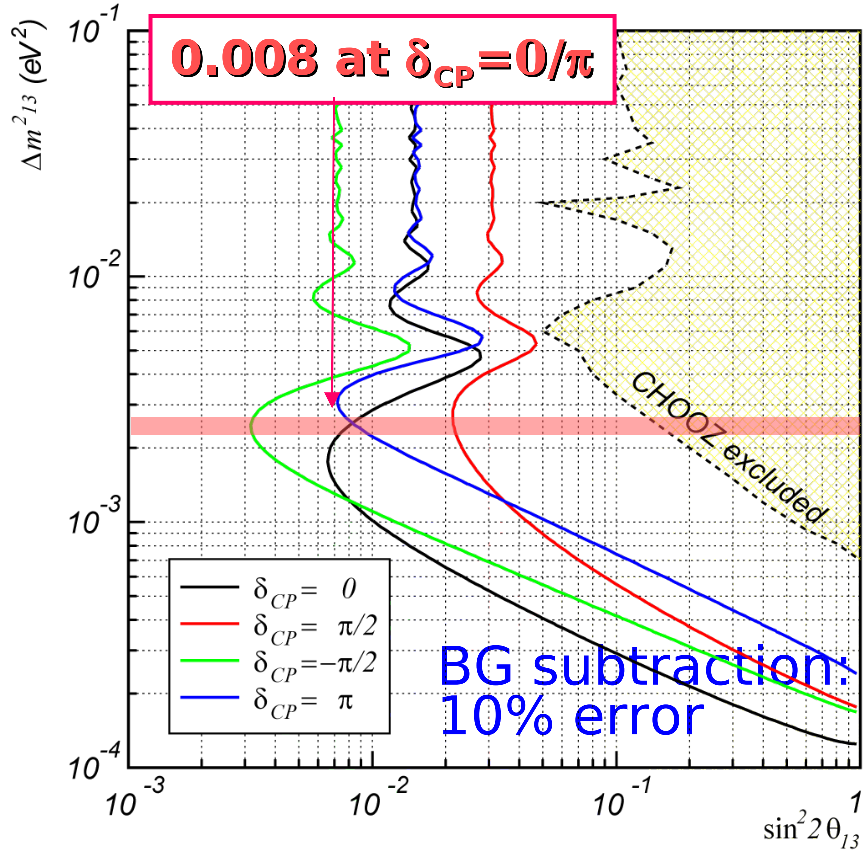
T.Ishida
(IPNS, KEK)



- Full reconstruction with completed in Apr. 2006
- Start normal DAQ since July.

Sensitivity to θ_{13}





# of events in Eνrec=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

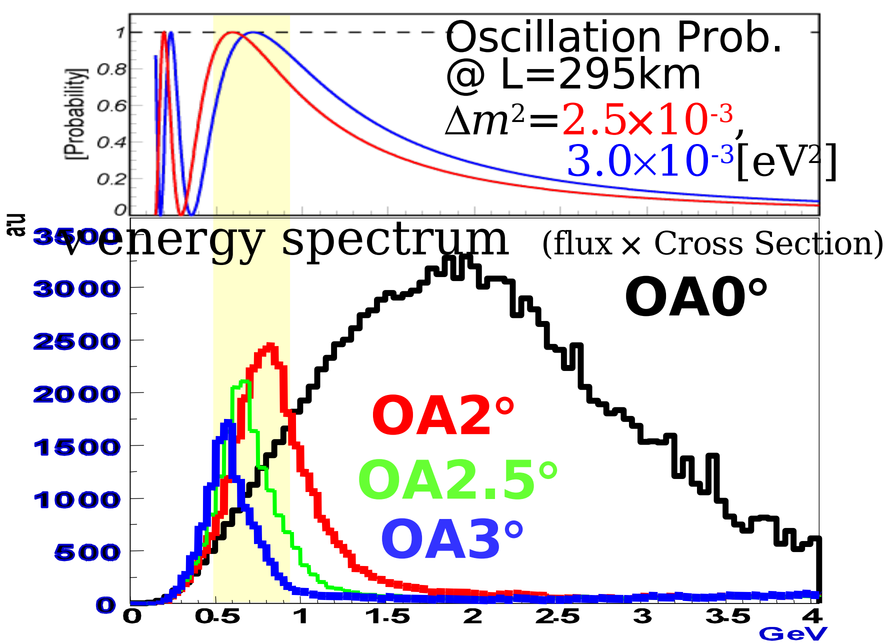
-General

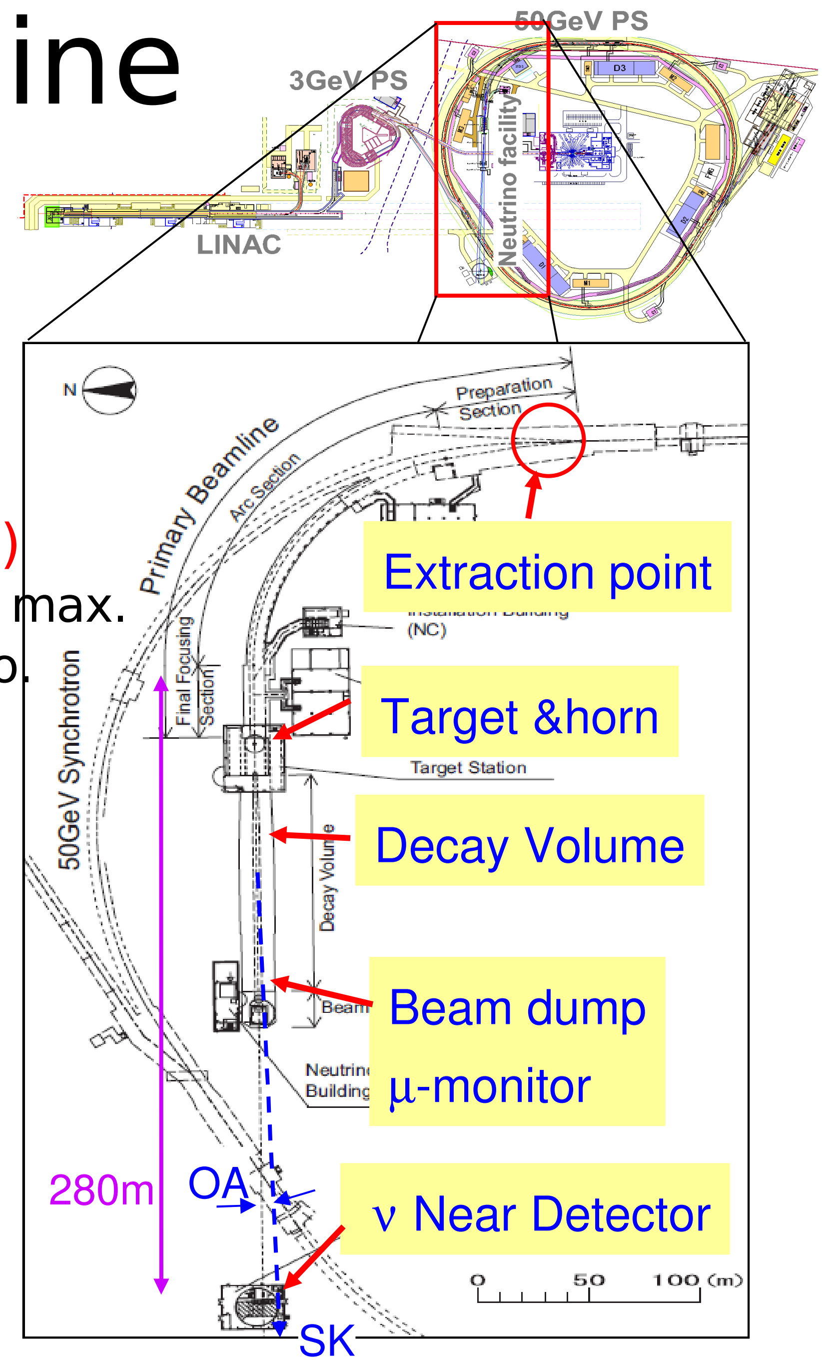
-Accelerator and Beam Line

-near detector

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.





Saclay is in charge of superconducting magnet safety system(F.P. talk, this workshop)

Future Prospects in a Few-year Scale

T.Ishida (IPNS, KEK)

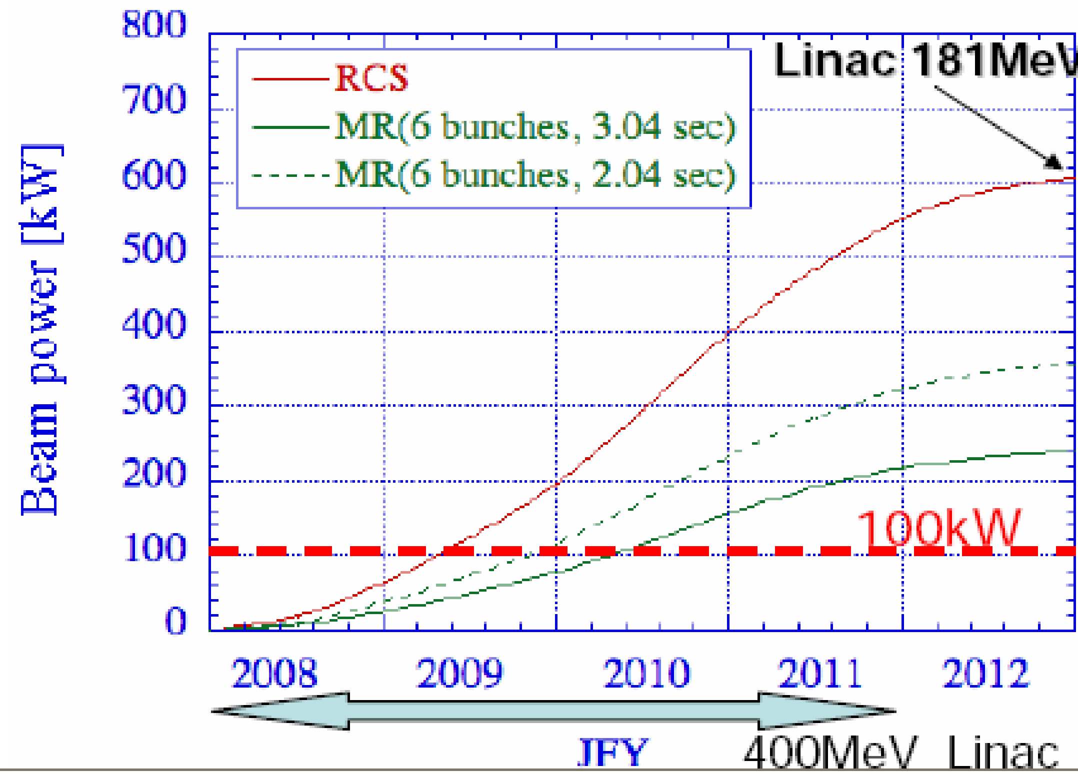
- We are requesting 100kW operation of MR for more than 10^7s(several months) to the accelerator group.
  - This is vitally important, in order to get the 1st result with enough impact.
  - Nominal beam power: 30GeV-9uA (270kW), to be achieved in JFY2012
  - However, # of bunches should be reduced from 8 to 6 due to the Fx kicker-rise time problem.

To achieve the request, to inclease rep. rate is a preferable solution, without significant hardware upgrades:

Cycle: 3.04→2.04sec, 30GeV
- Acc1.9 →1.1sec
- Reset 0.87 →0.67sec

[J-PARC Director's order: "Nagamiya Chart"]

From Koseki-san's Nufact07 talk



-General
-Accelerator and Beam Line
-near detector

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

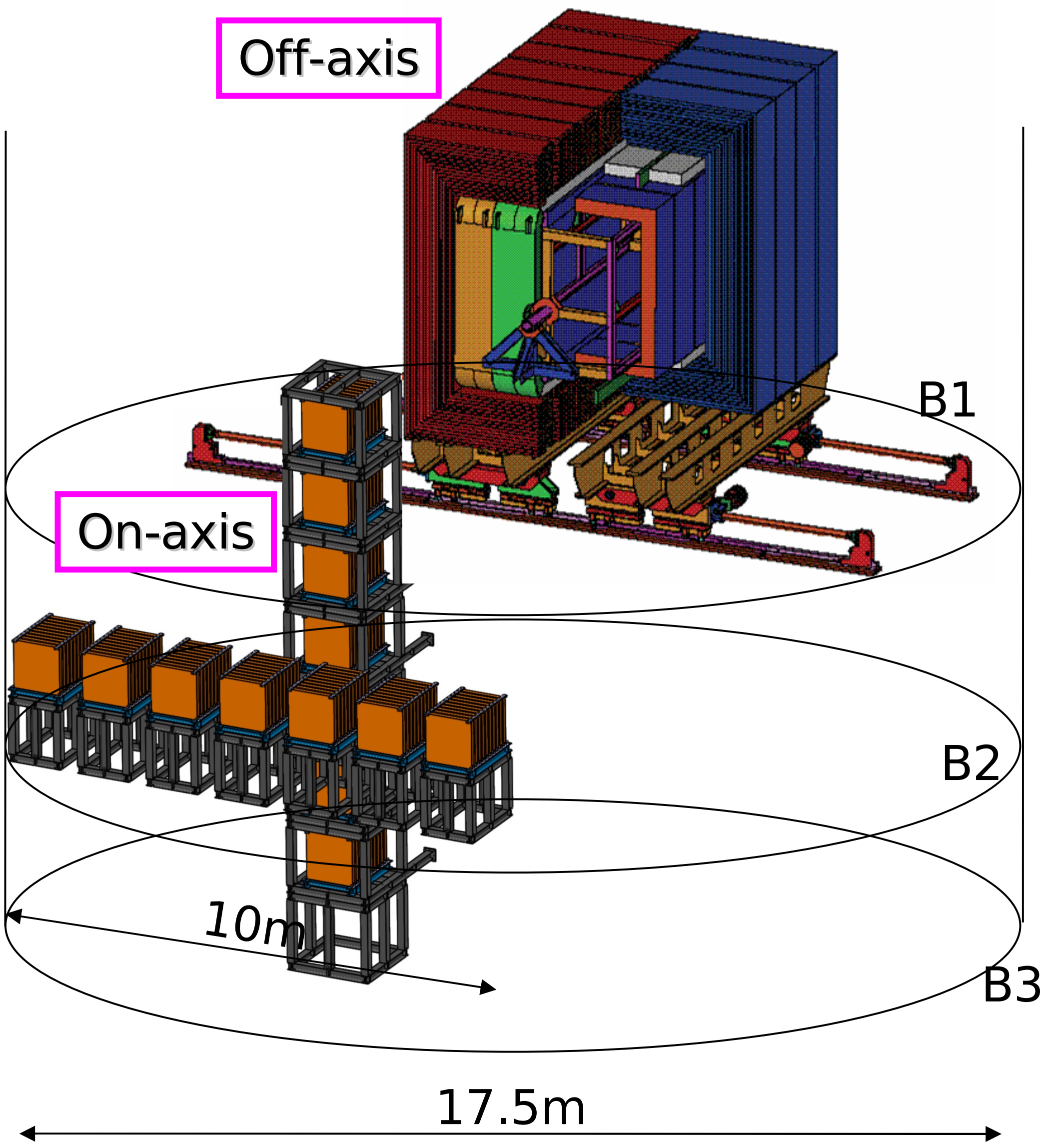
ν target

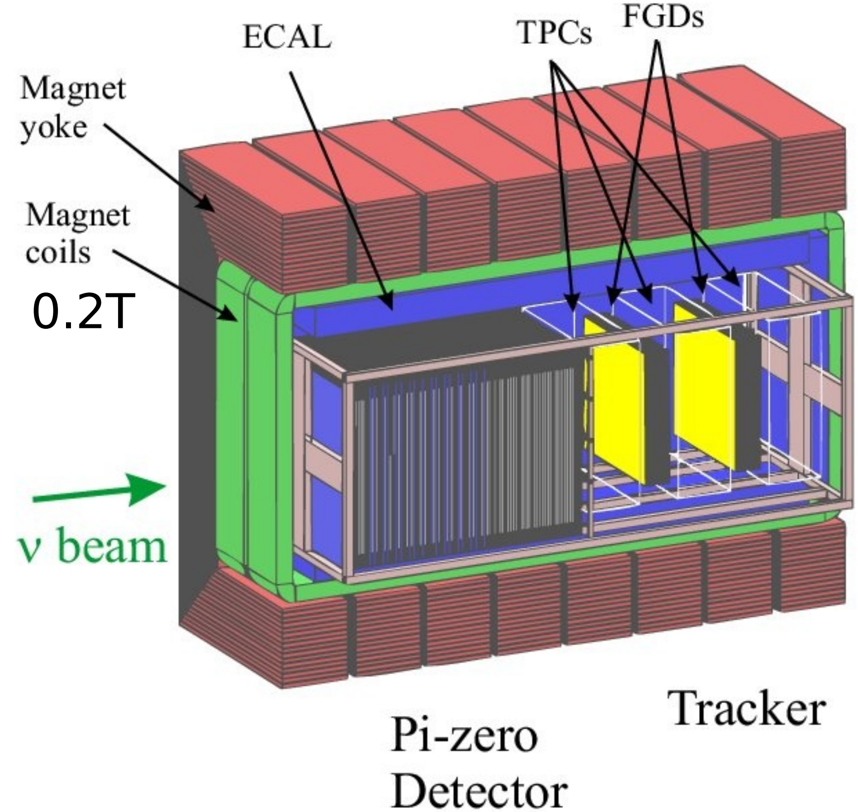
: Off-Axis

Off-axis detector is in 0.2T magnetic field

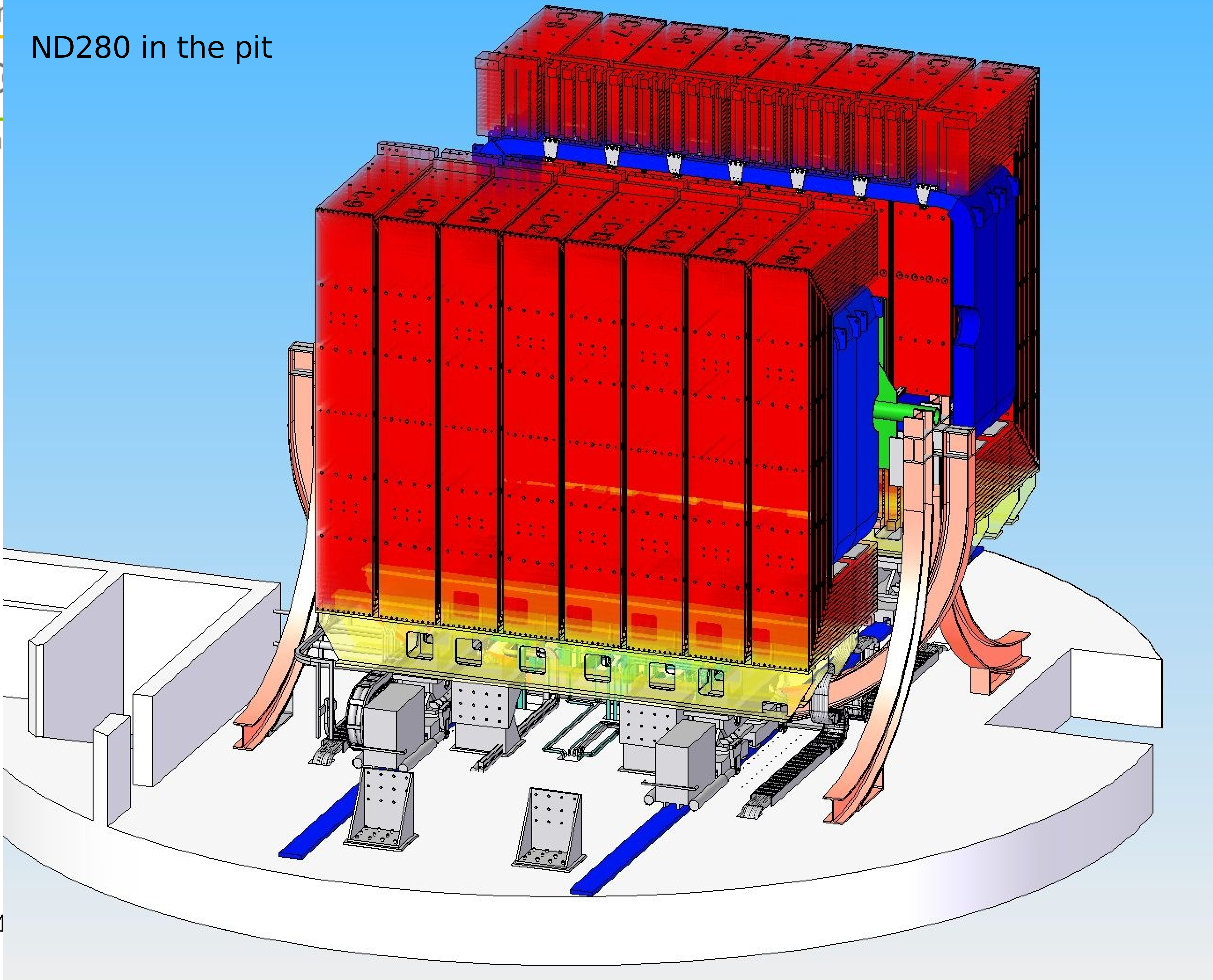
Facility & magnet

ND280 sub-detectors





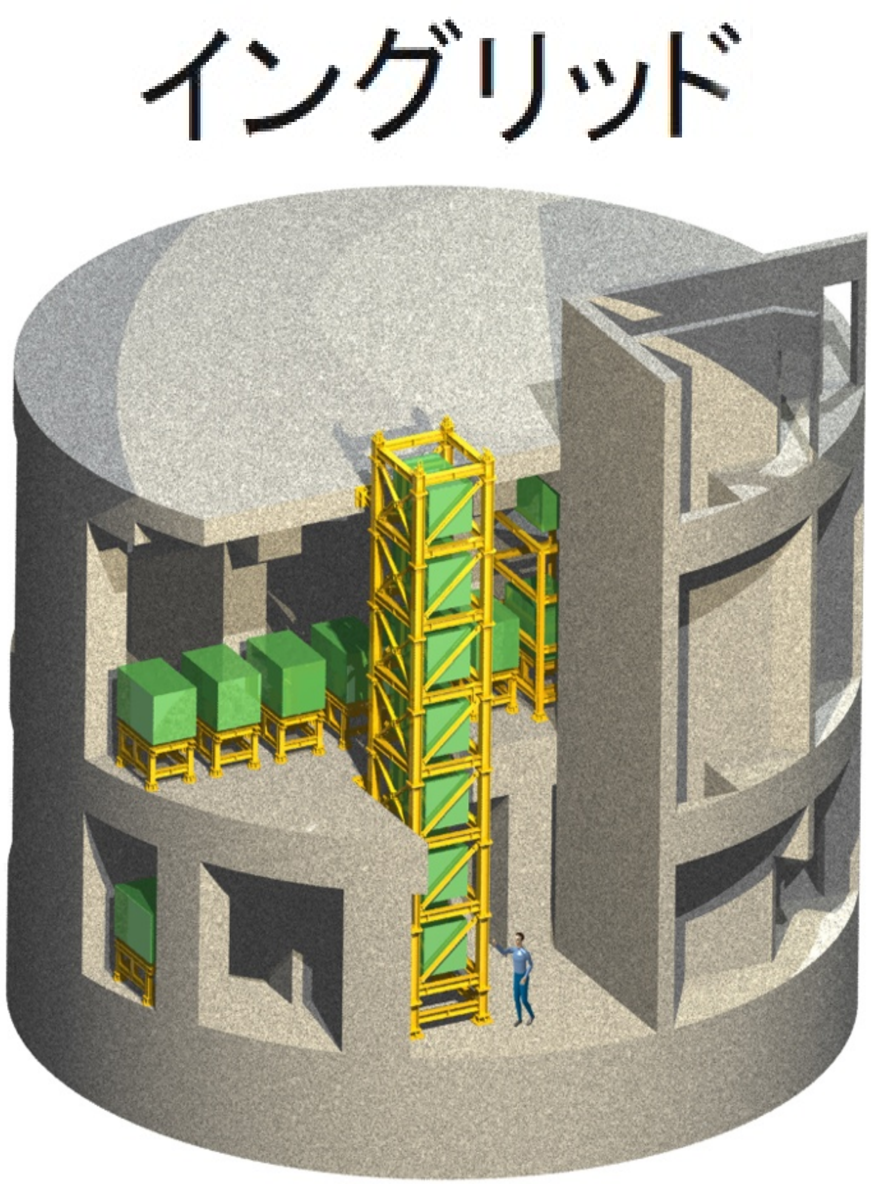
ND280 in the pit

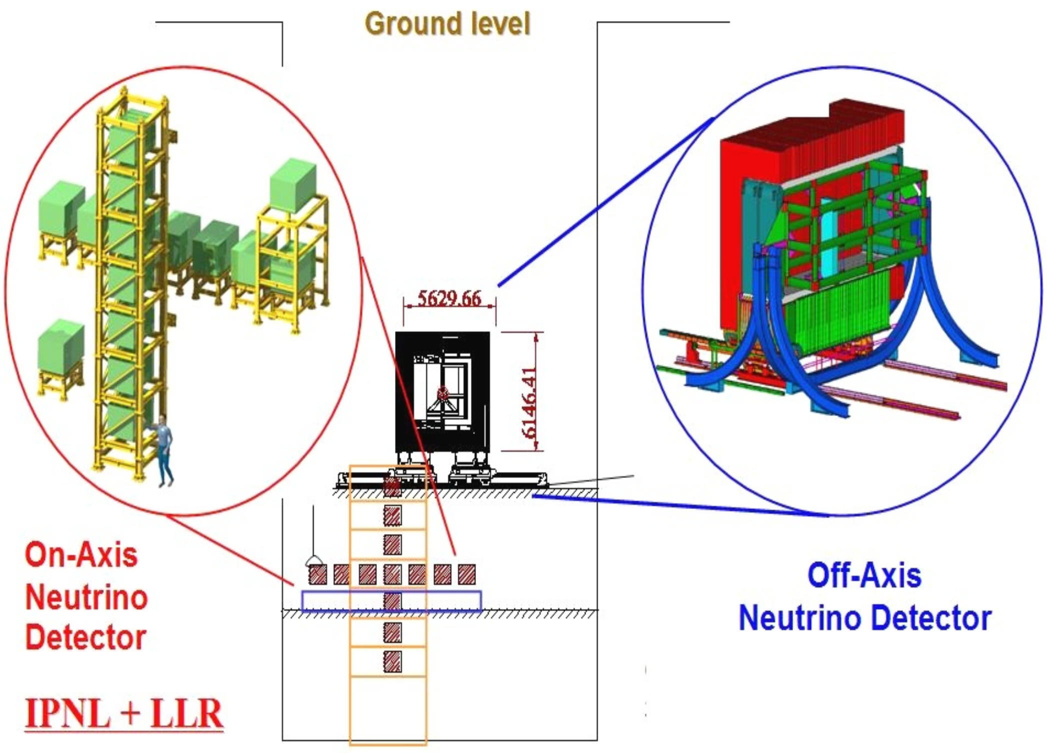


Carriage installation and yoke pieces

INGRID

INGRID



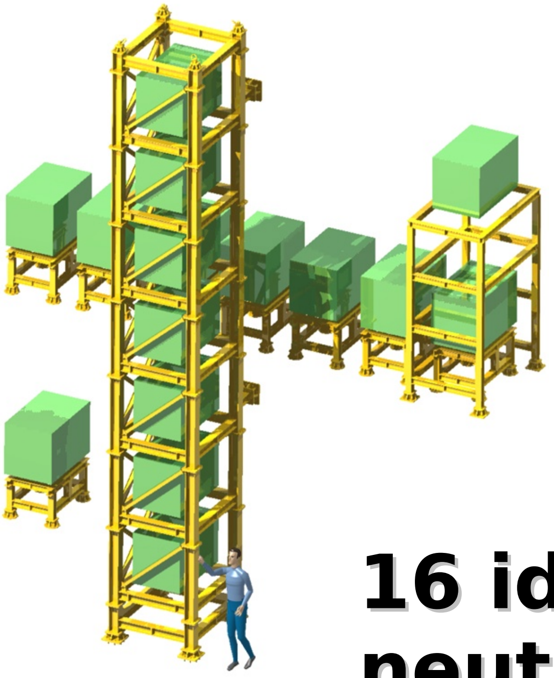


On-Axis neutrino detector

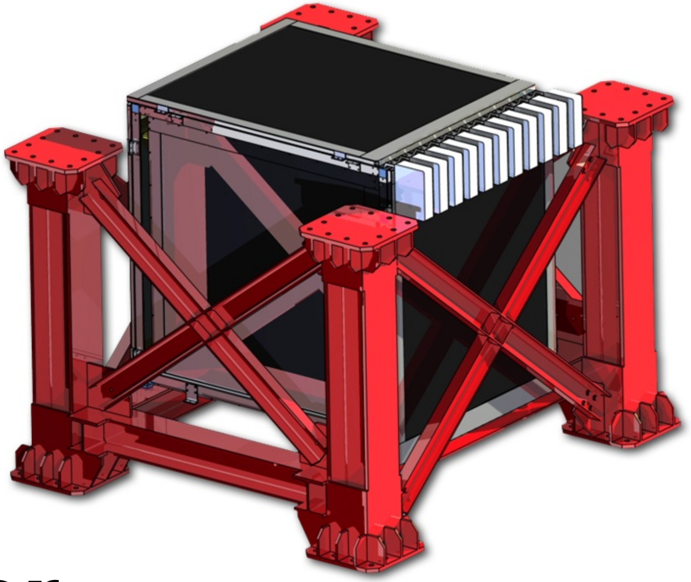
IPNL / LYON

LLR / Ecole Polytechnique

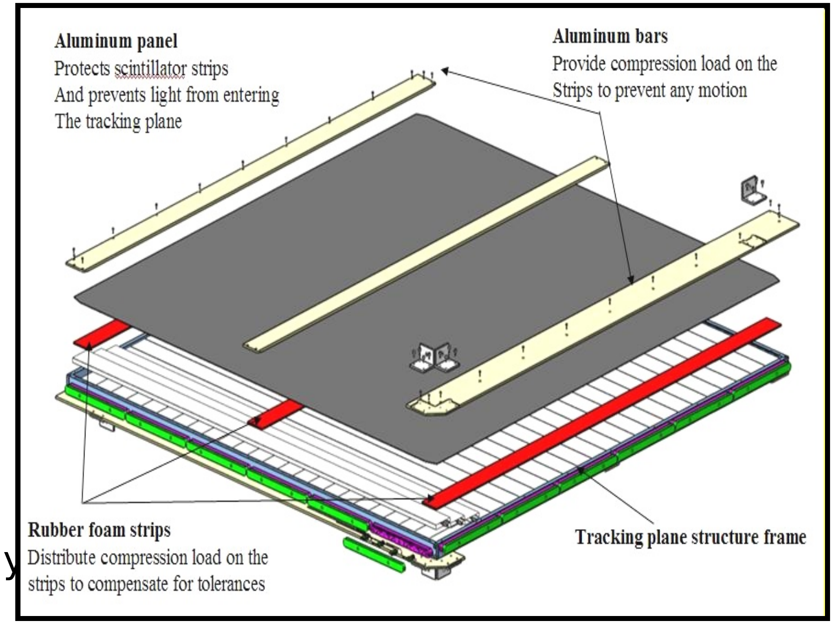
The commissioning of INGRID will (and has to) start in <u>April 2009</u>

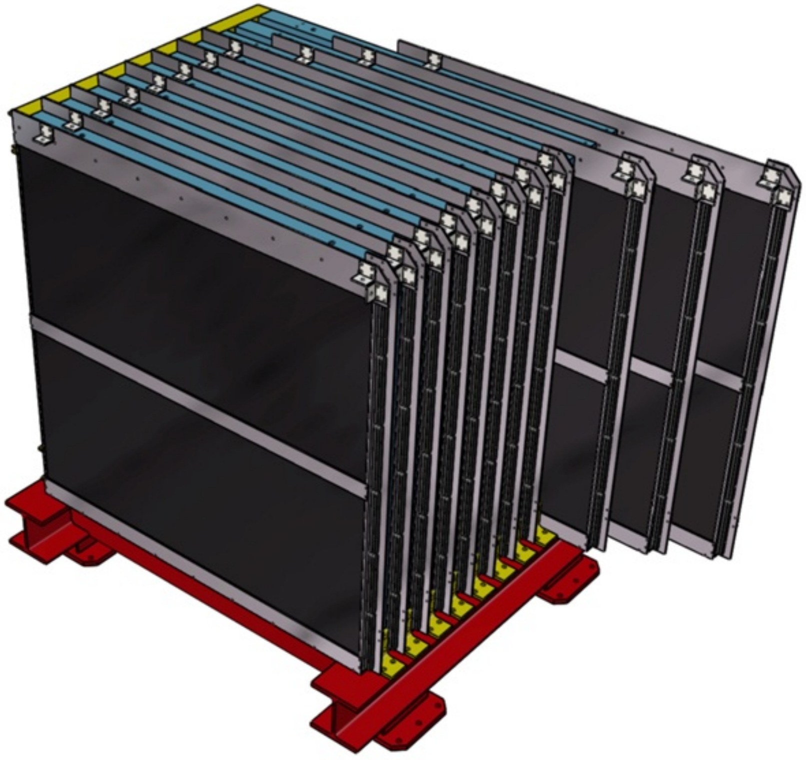


Laboratoire
Leprince-Ringuet



16 identical modules for neutrino beam profile detection

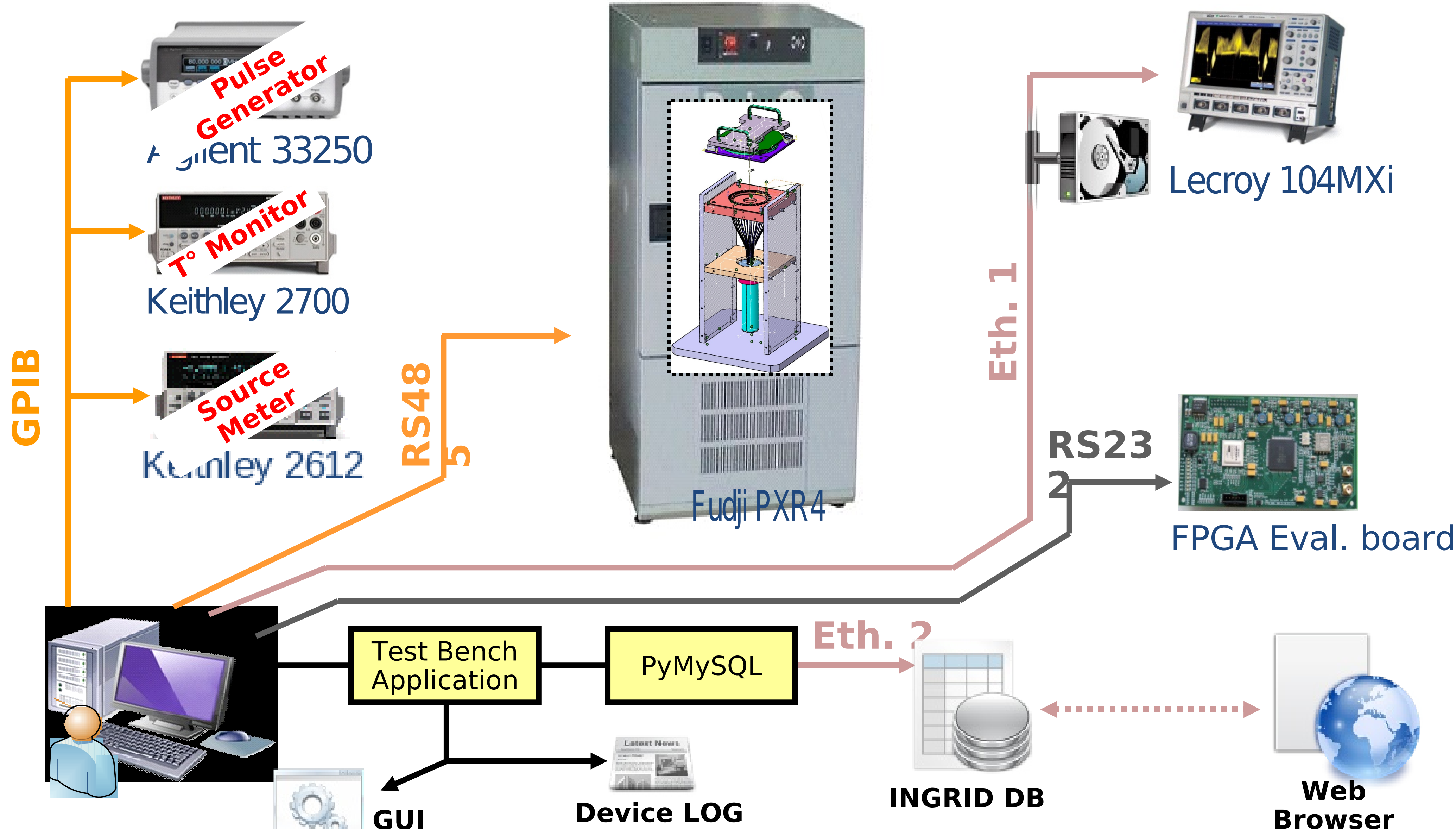




Laboratoire Leprince-Ringuet

saclay

MPPC Test bench



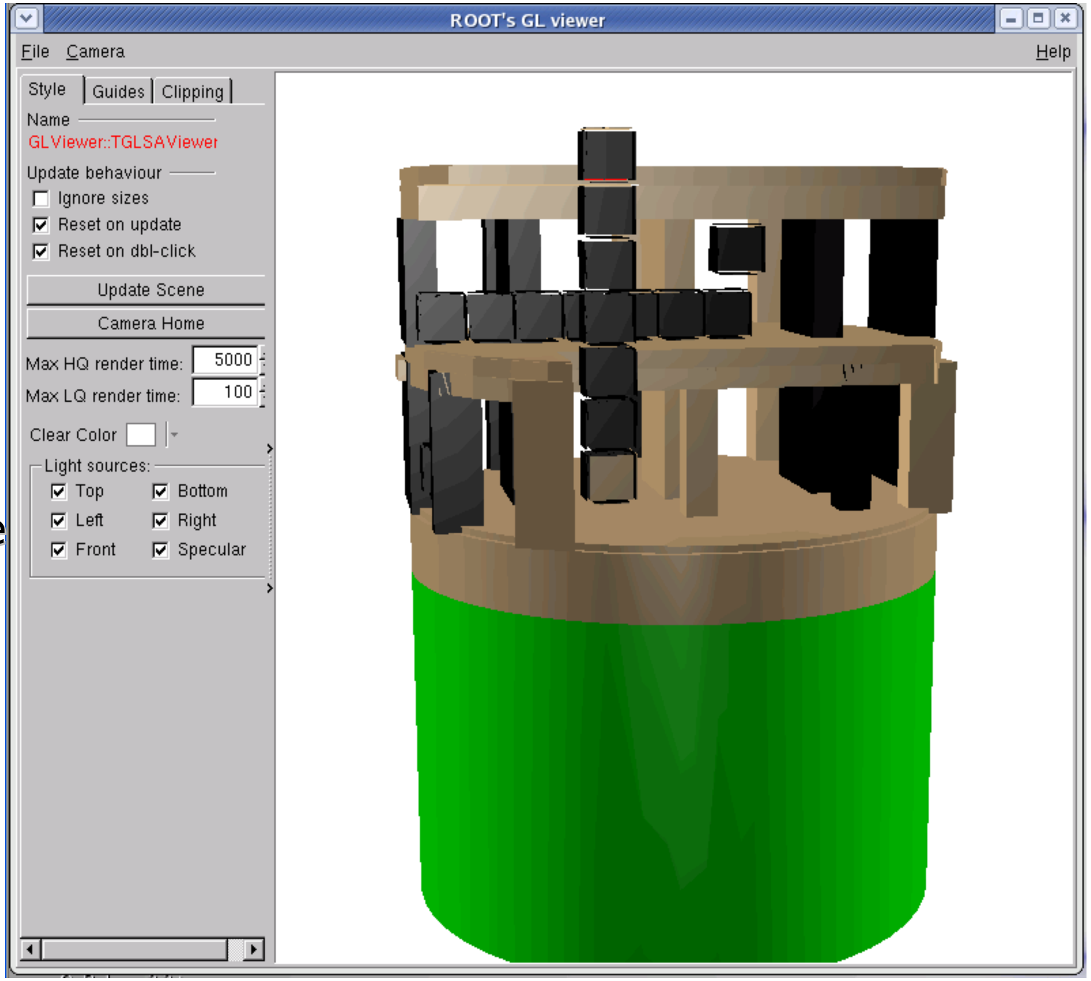
stitut de Physique Nucléaire de Lyon
2P3-CNRS / Université Lyon I

Offline software for INGRID

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

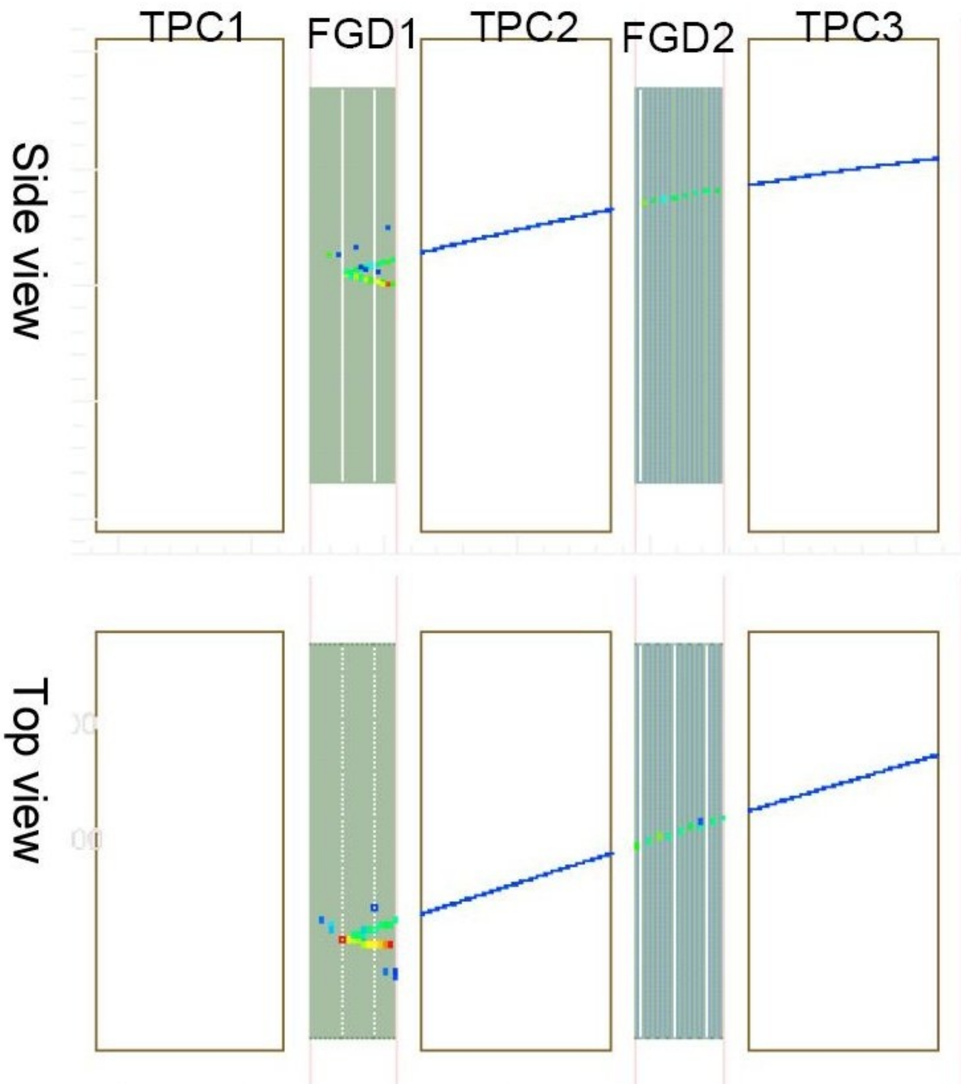
- **Direct usage of ROOT TGeoManager description** instead of starting first with a GEANT4 description which is then converted into ROOT.

- **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

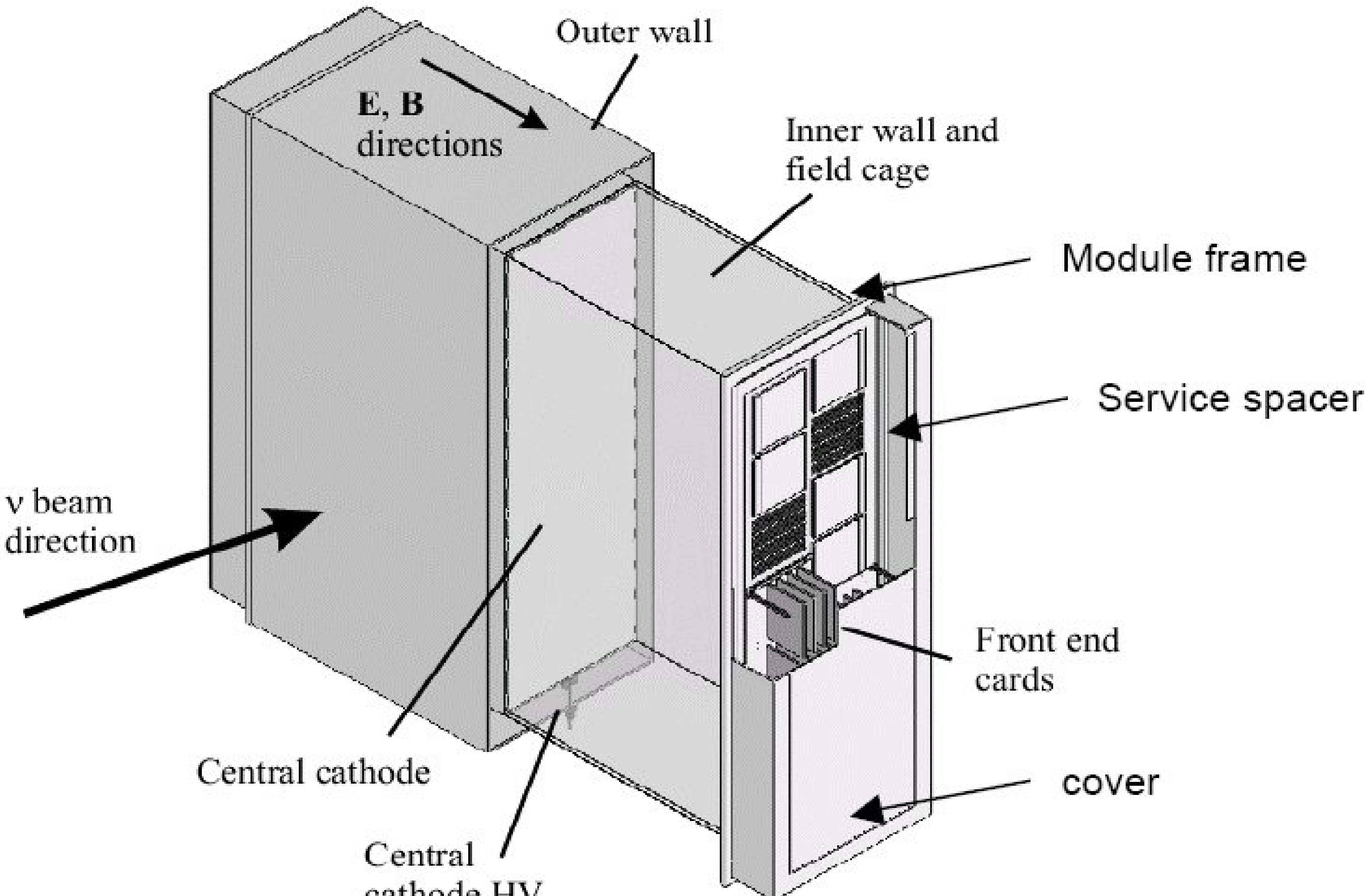
Informational particles

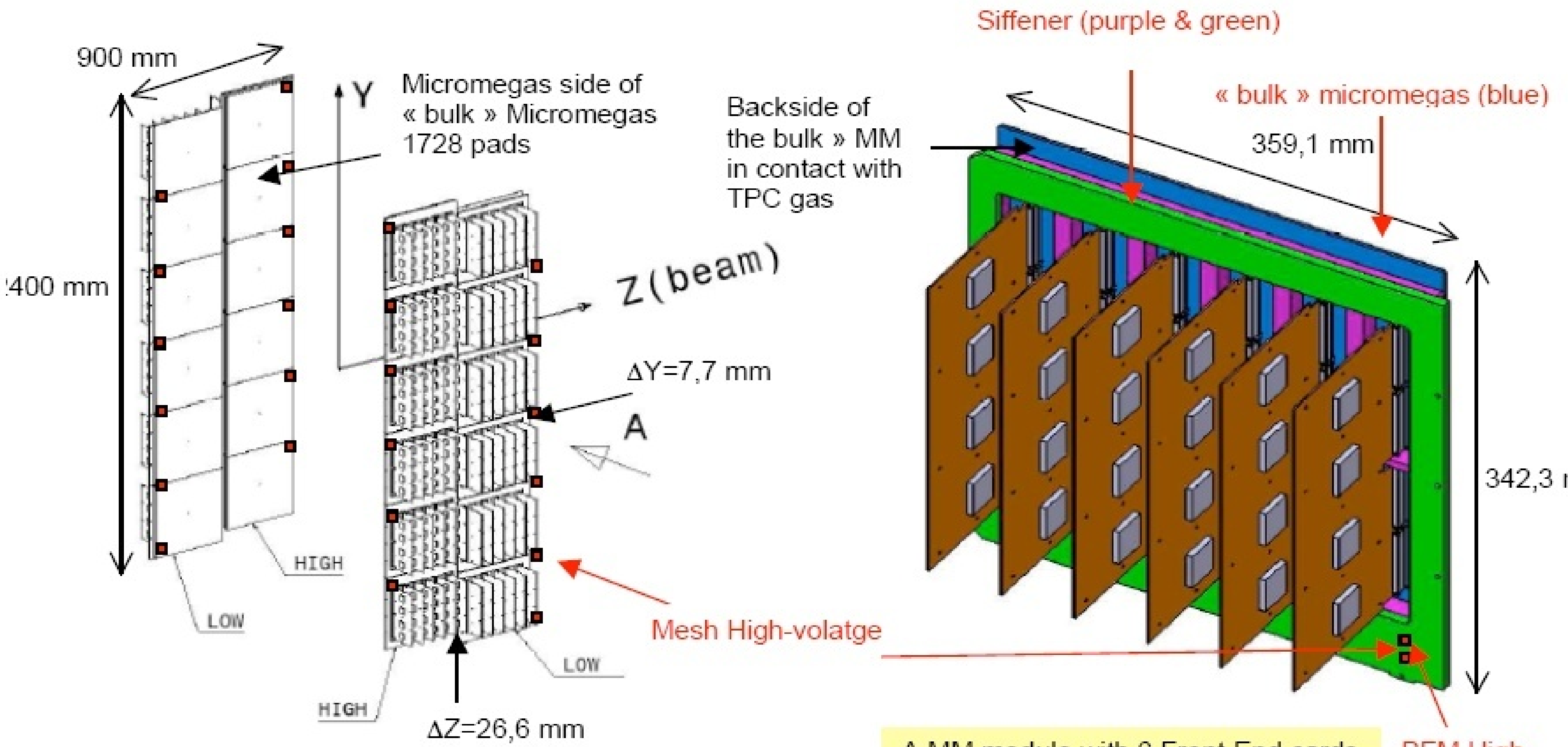
ν_μ (14)	Trk -1,	KE= 1340 MeV
n (2112)	Trk -1,	KE= 0 MeV

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

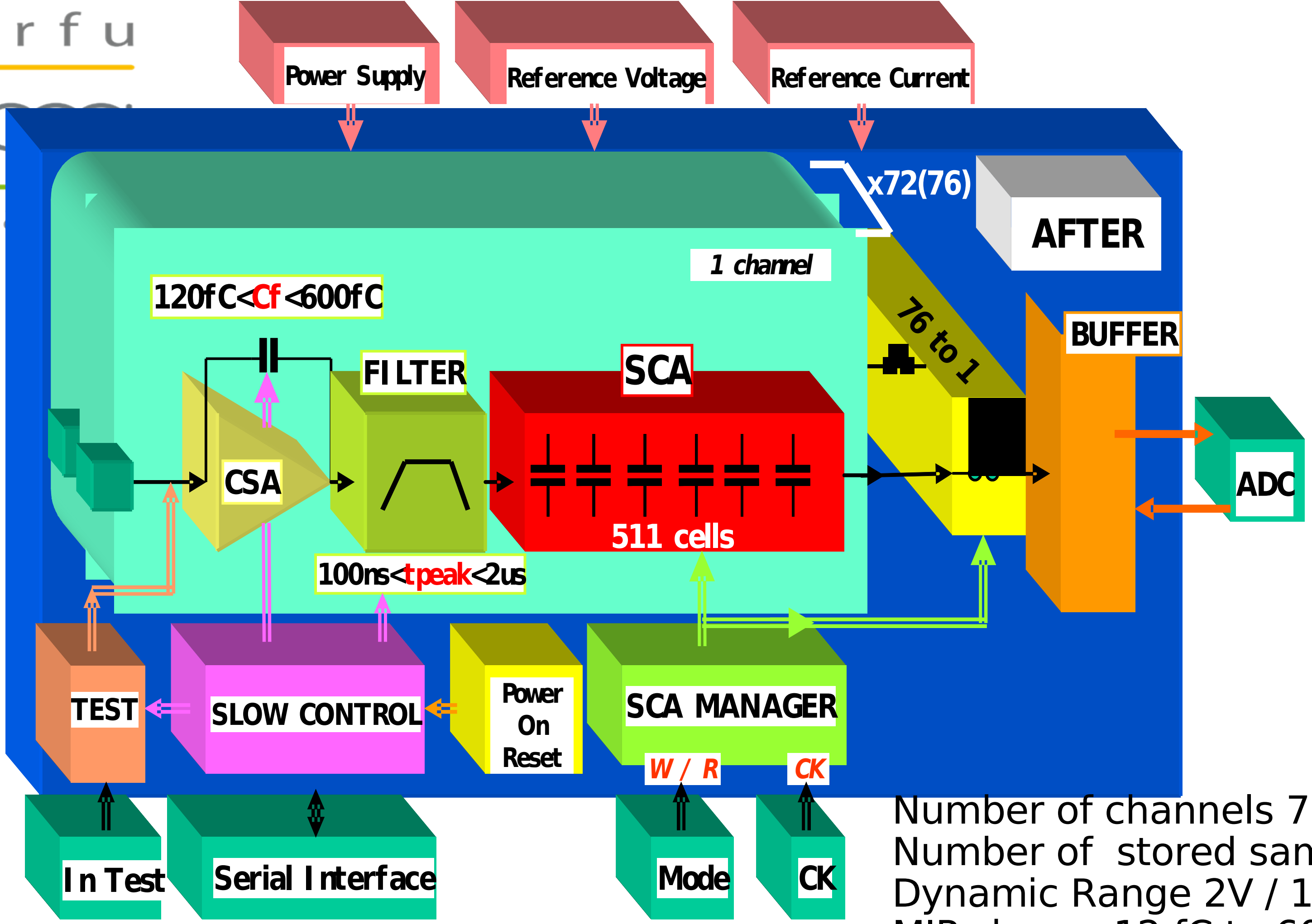
Collaboration Canada-Germany-France(**LPNHE, Saclay**)-Spain-Switzerland.





The 2 readout planes of a TPC

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



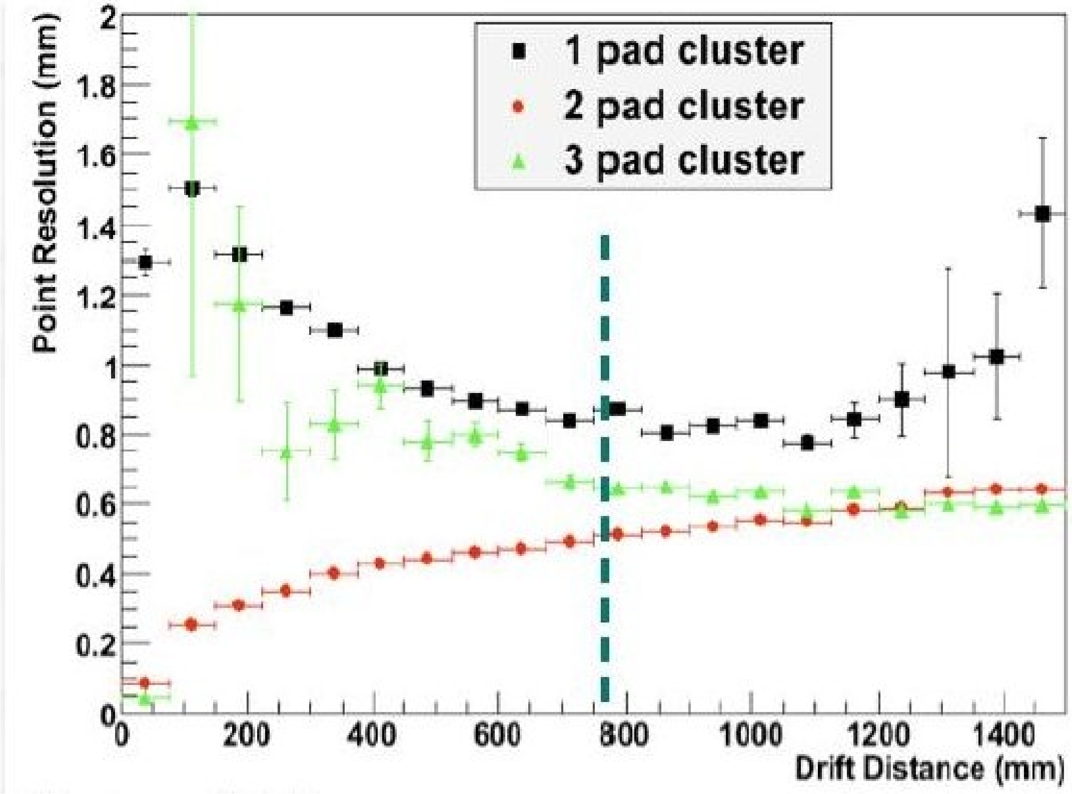
ASIC AFTER

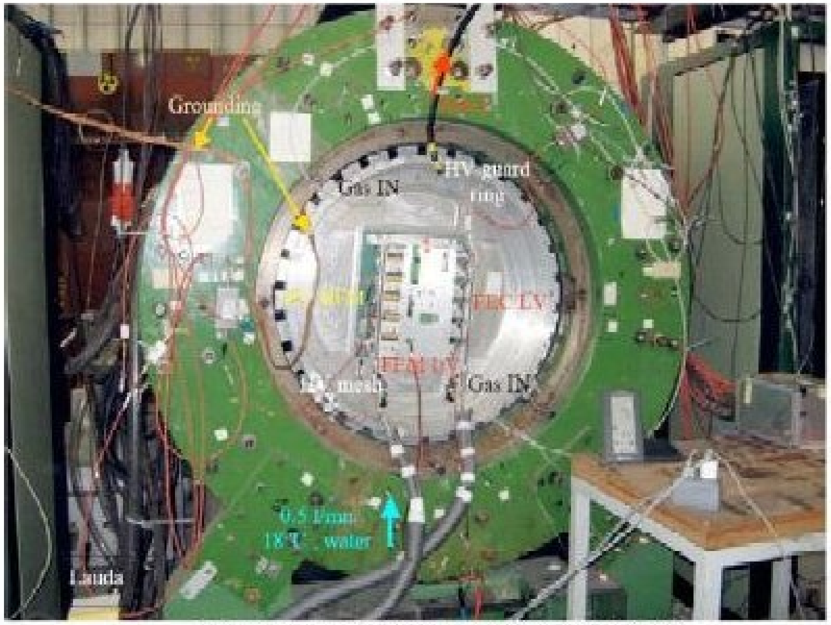
Versatile

- 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

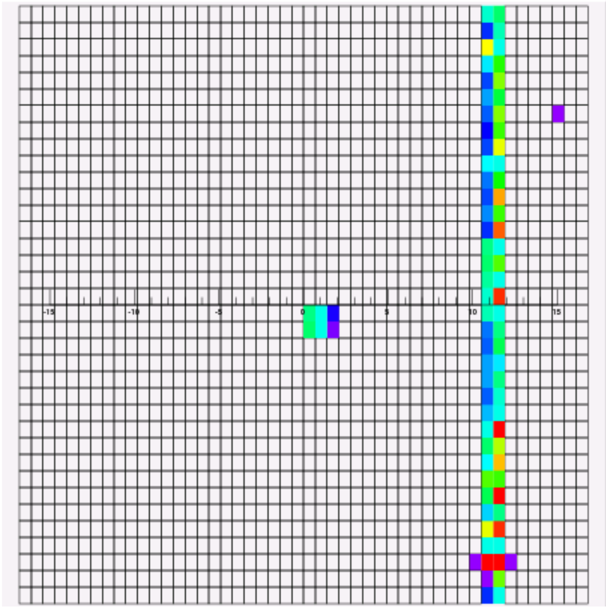
HARP test november 2007

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





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



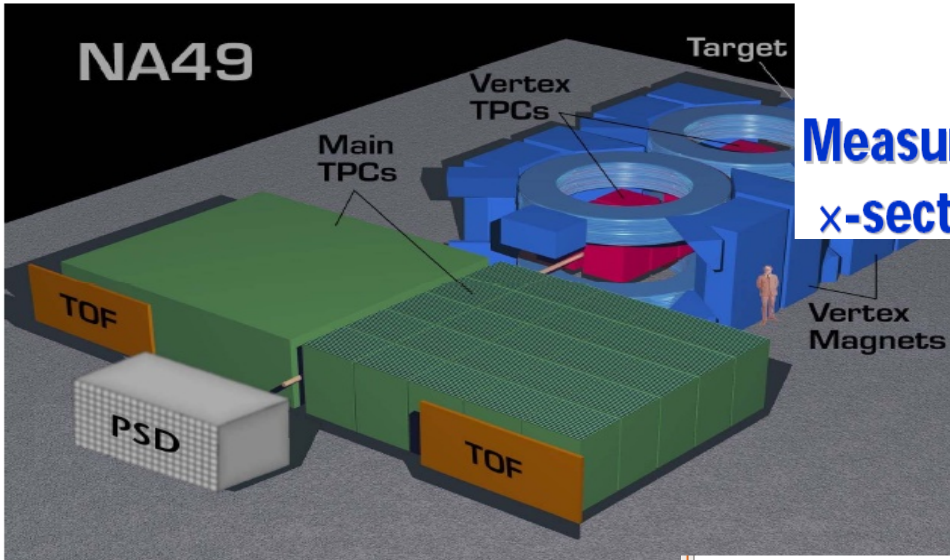
FRENCH CONTRIBUTIONS TO TPC :

-Micromegas modules : Irfu/Saclay
-Front End Card, includind ASIC AFTER : Irfu/Saclay
-Mezzanine Card : Irfu/Saclay
-digital Concentration Card : LPNHE/Paris
-software

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).**

NA61 setup



Detector as used by NA49 collaboration:
some upgrades required for NA61 physics (inc

NA61 @ CERN

Measurement of $\pi^{+/-}$, $K^{+/-}$ hadro-production $\times$-sections to characterize the T2K n beam

LPNHE contributes,
see talk of B.Andrieu at this workshop,

How to Use NA61 Data in T2K Analysis ?

strategy A (beam montecarlo tuning):

- measure $d^2\sigma/dpd\theta$ for $p + C$ with a thin target over a broad kinematical range and for different particles (π / K / p)
- use the measured $\times$-sections as input to the beam MC for generating the primary interaction (table, parameterization, …);
- secondary interactions described by hadronization model, e.g. FLUKA
- compare the MC predictions to the π / K yields measured off C targets of different lengths (e.g. T2K replica target) and adjust the model accordingly

strategy B (direct input to beam transport):

- measure π/K yields off the T2K replica target
- use the measured π/K yields as input to the beam MC (no simulation of secondary interactions required)

Summary

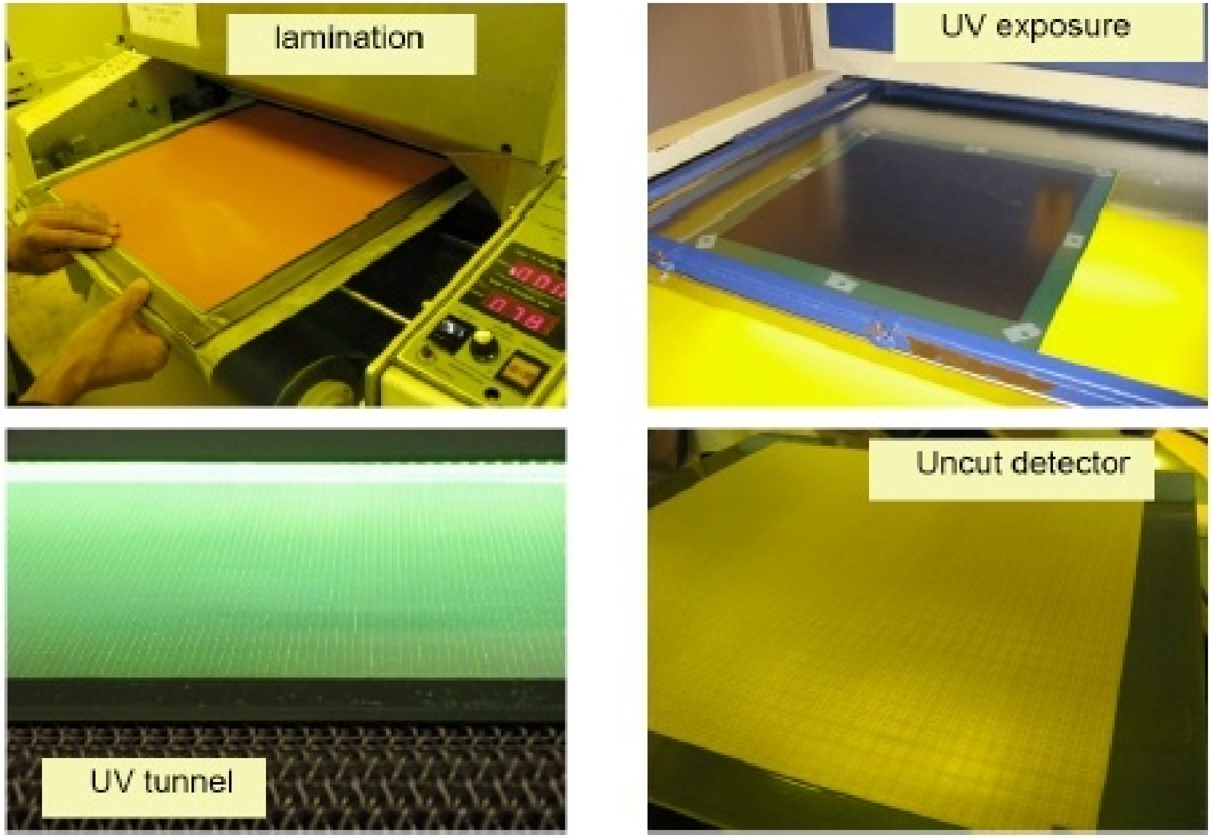
Intense activity in T2K

French contributions to collaboration :

-neutrino beam, starting april 2009
***protection system of Superconducting magnets**
-near detector starting april 2009
***0° INGRID**
-near detector starting november 2009
***off axis, including TPC**
-NA61 for understanding of beam

RESERVE

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



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*).

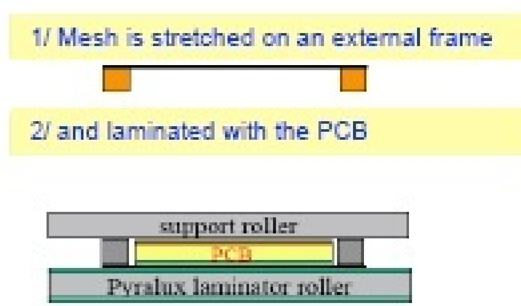


Figure 4.12 : *« Stretched mesh » procedure for mesh integration.*

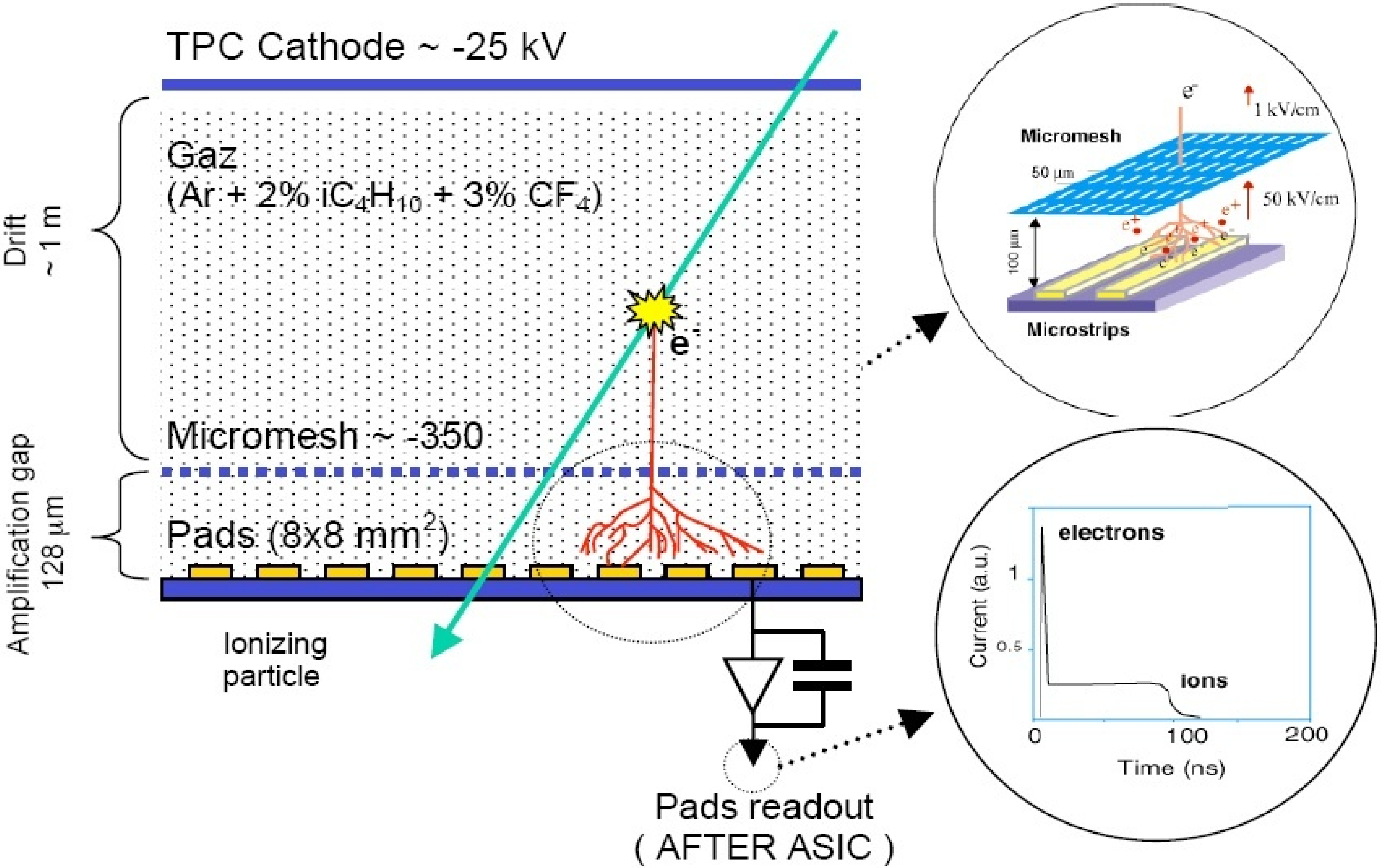


Figure 3.1: *T2K/TPC micromegas principle.*

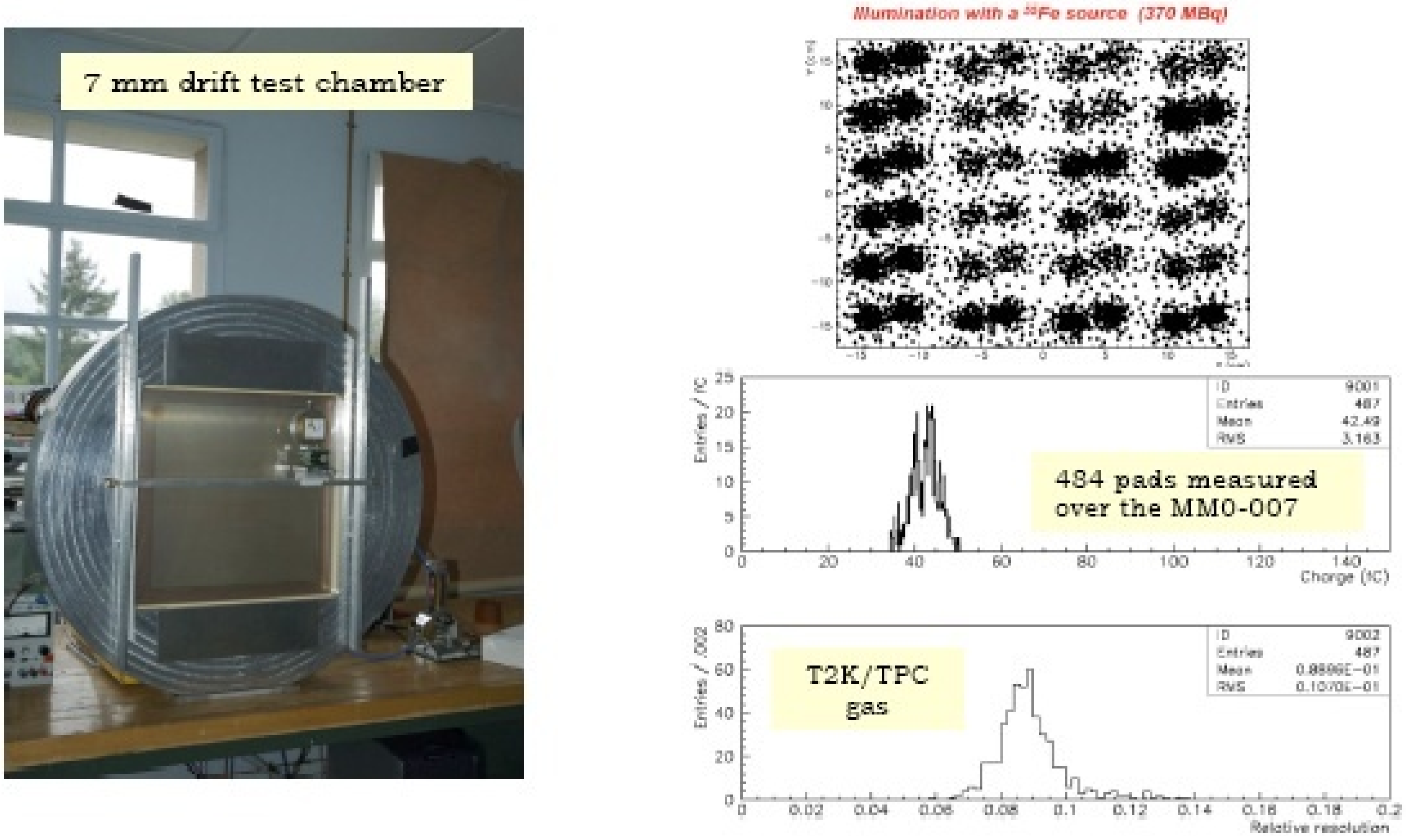


__Figure 3.14 :__ Gain uniformity and 55Fe 5,9 keV resolution of the MM0-007 « bulk » micromegas.

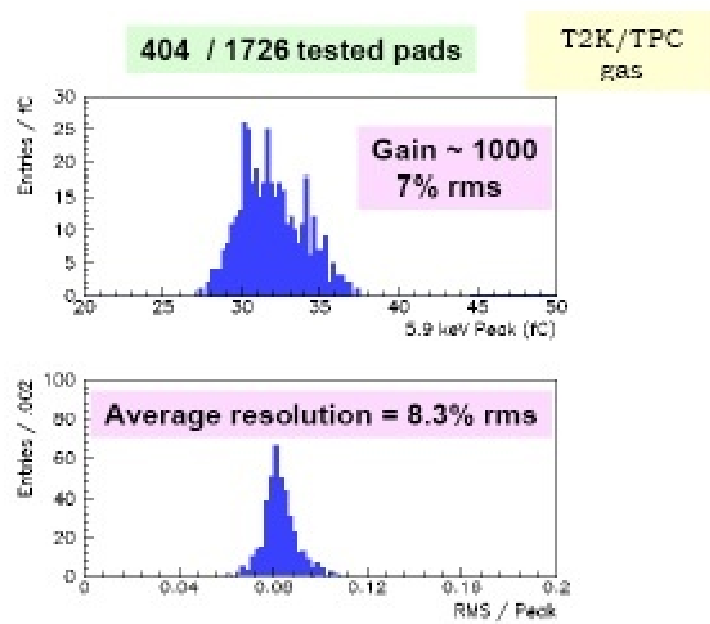
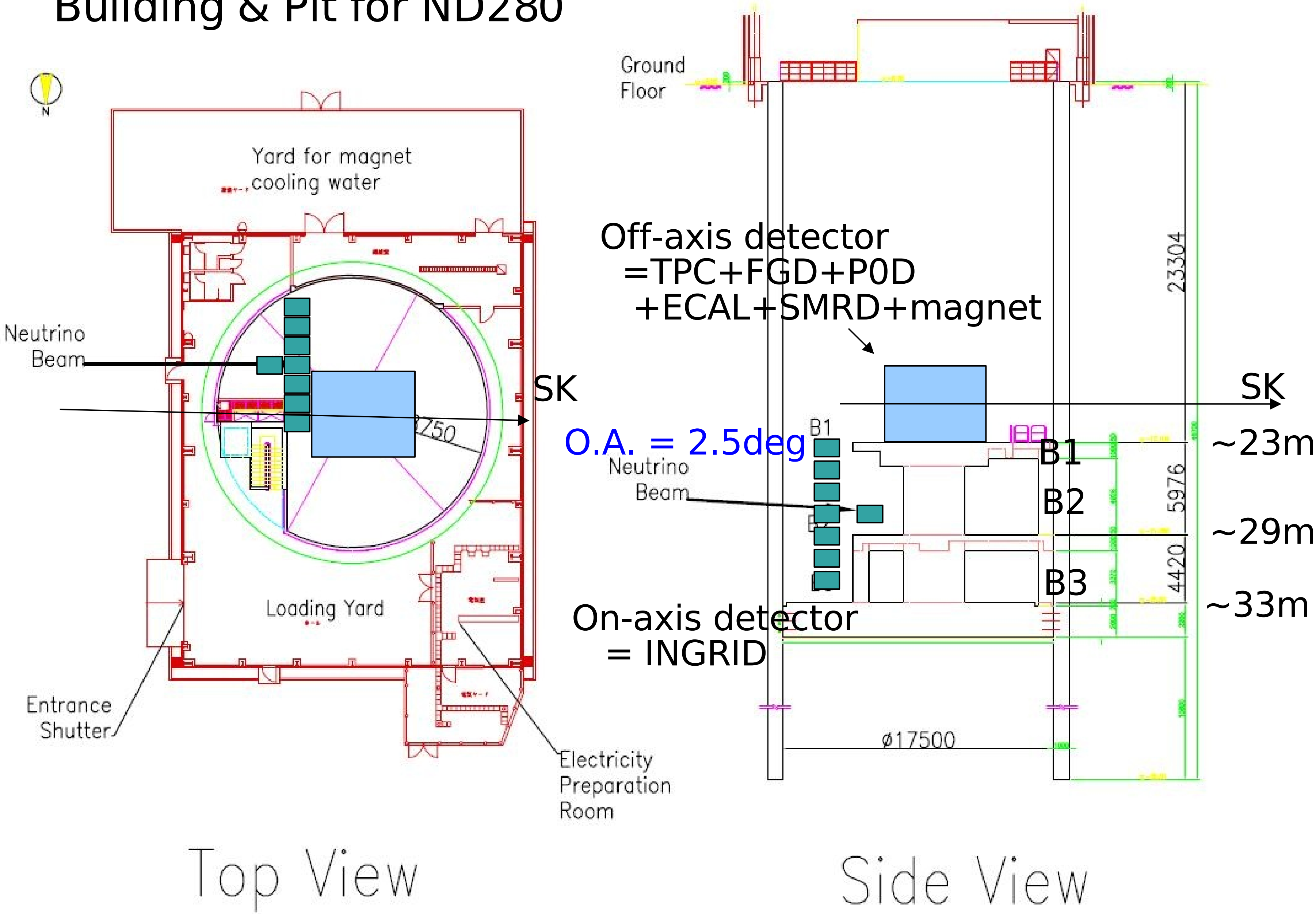
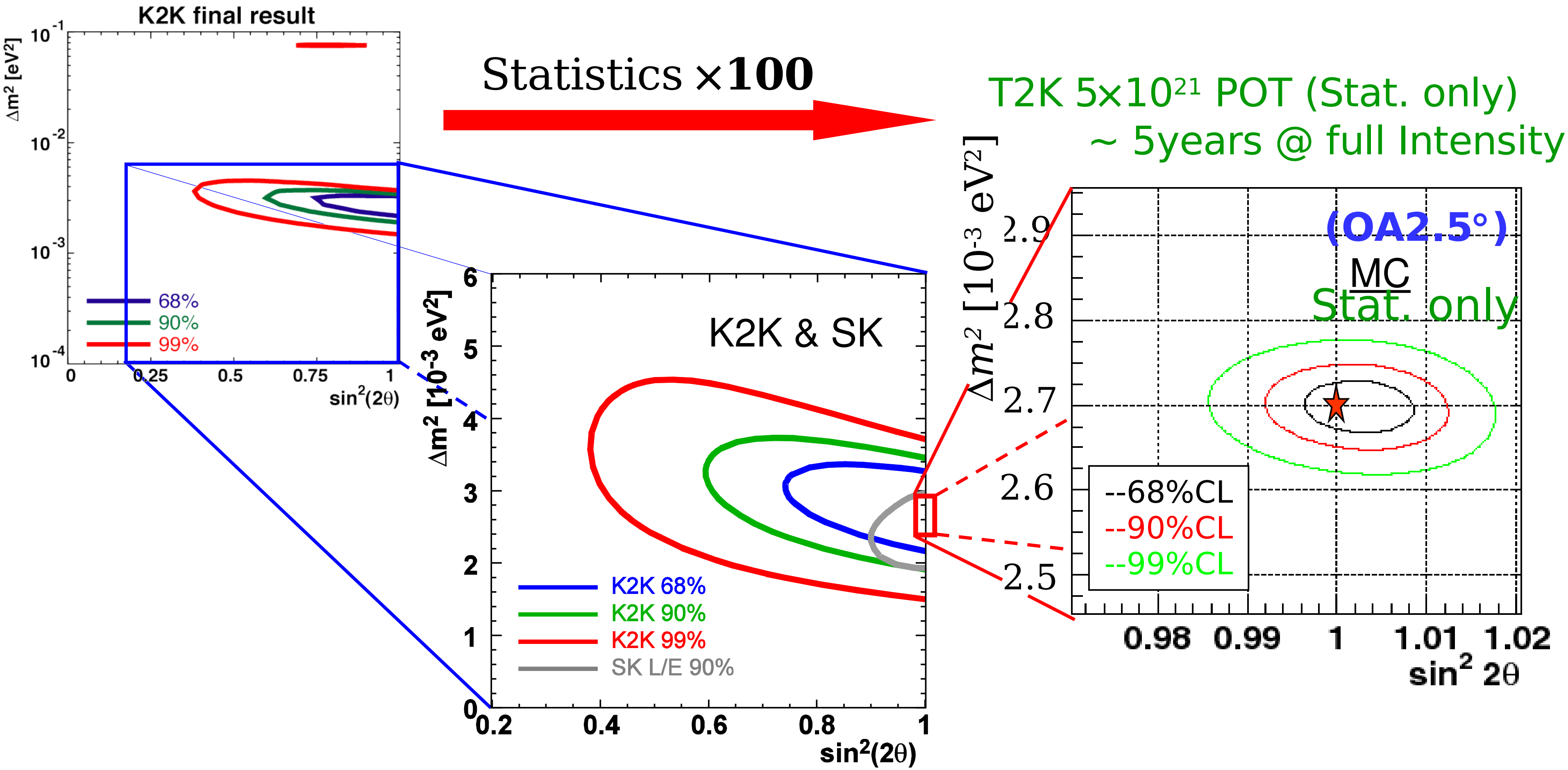


Figure 3.15 : Gain uniformity and 55Fe 5,9 keV resolution of the MM1-001 « bulk » micromegas

Building & Pit for ND280



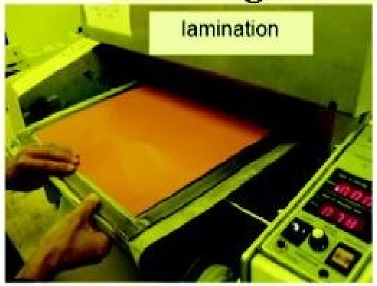
Sensitivity: ν_μ disappearance

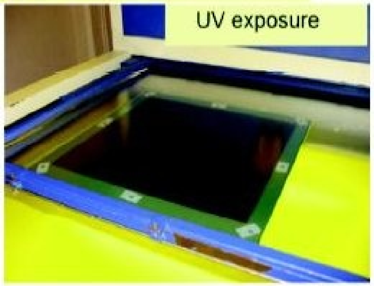


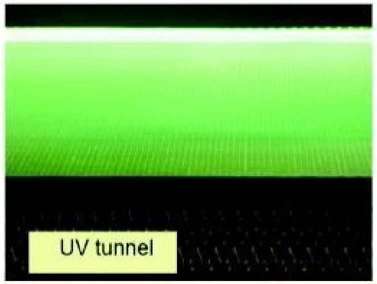
Goal : $\delta(\sin^2 2\theta_{23})\sim 0.01$, $\delta(\Delta m^2_{23}) < 1\times10^{-4}$ [eV^2]

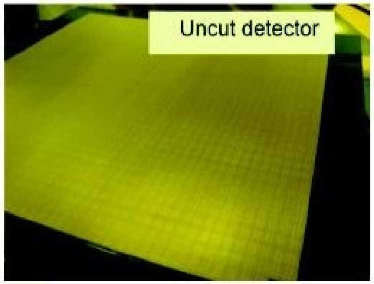
T2K/TPC WP4 « bulk » Micromegas status report

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

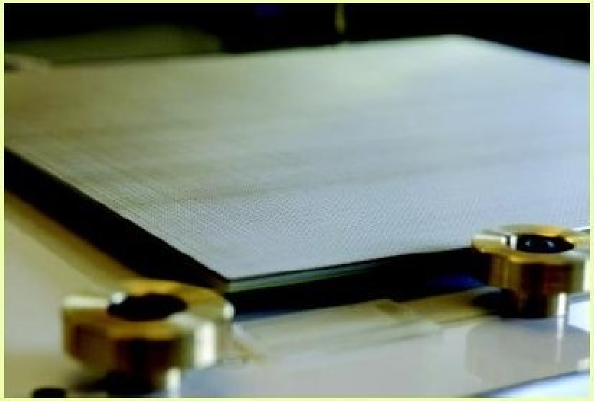






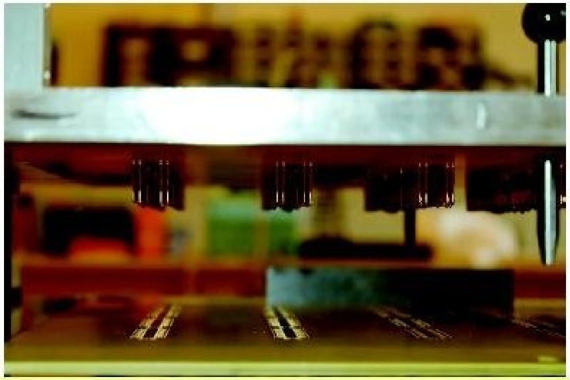


« bulk » Micromegas

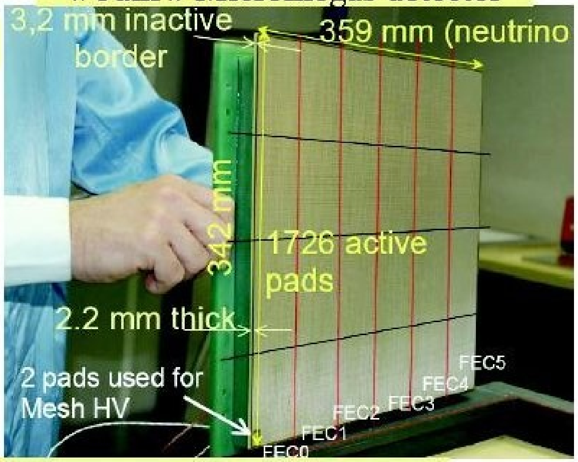


MM1_001 calibration on test bench @ CERN

« Fakir » Quality control test bench

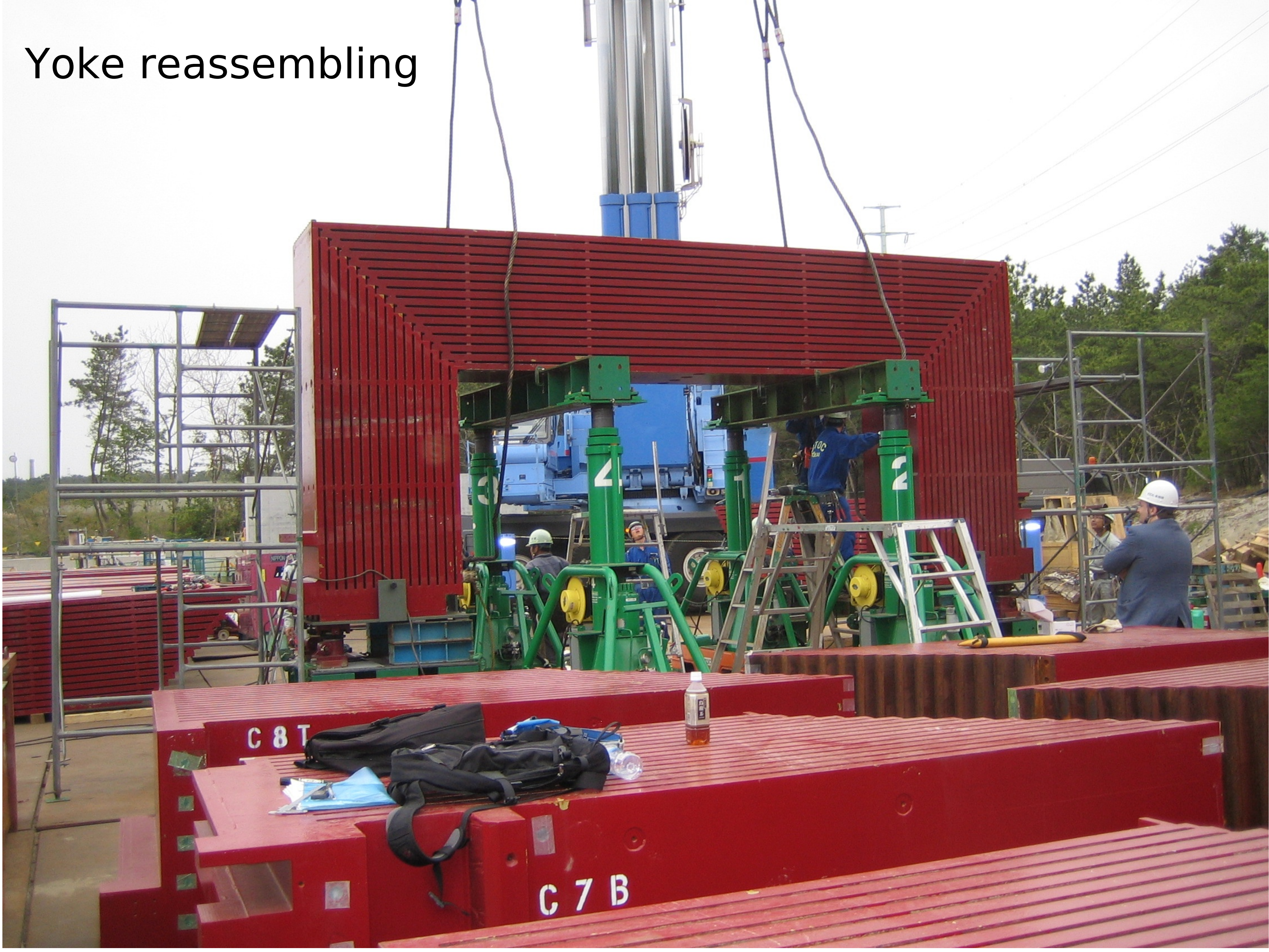


« bulk » Micromegas detector



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

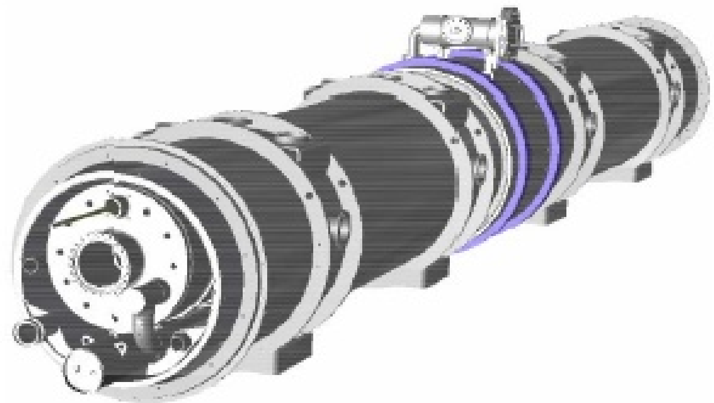
Yoke reassembling



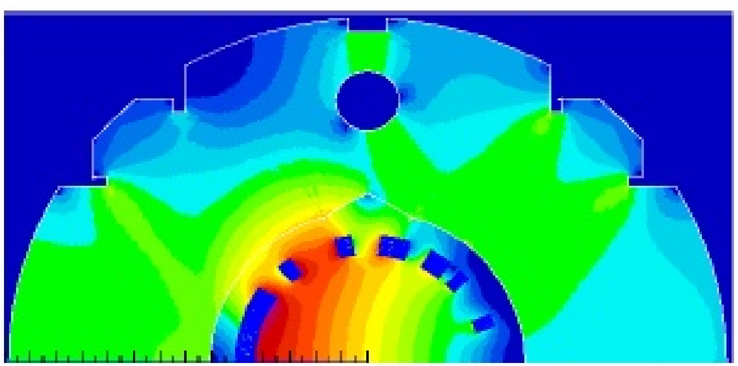
NEUTRINO FACILITY AT J-PARC

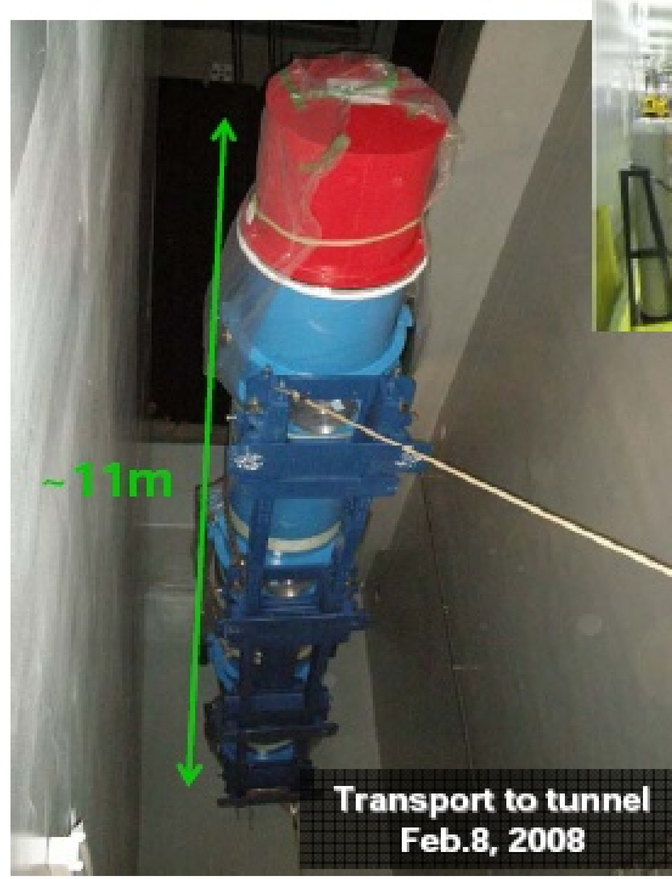
T.Ishida
(IPNS, KEK)

Superconducting Magnets



Two magnets in cryostat "doublet"
14 doublets + 2 spare doublets
+ 4 corrector magnets by BNL





SCFM : Superconducting Combined Function Magnet
D: 2.6 T, Q: 18.6 T/m, Length: 3.3m, Current: 7,345A@ 50GeV

- 11 doublets in beam-line, Cryogenics installation on time.
- *Entire system will be completed by December 2008*

NEUTRINO FACILITY AT J-PARC

Beam-line Collaboration

T.Ishida (IPNS, KEK)

KEK

- Neutrino group, IPNS (Core)
  - Every beam line components (except S.C.magnets / cryo.)
- Hadron group, IPNS
  - Monitor / N.C.magnets / Power supply
- Cryogenics group, IPNS
  - Cryogenics / Target Helium circulation system
- Cryogenics science center
  - Superconducting magnet / Cryogenics
- Mechanical Engineering Center
- Radiation Science Center

In collaboration with

- U. Tokyo: Primary beam monitor
- Kyoto U: Primary beam monitor, Muon monitor
- UK: Target, Target remote handling, Beam window, Baffle, Dump
- Canada : Remote chamber for the most downstream monitors, OTR, Remote maintenance
- US: Horn, Beam monitor, S.C. corrector magnets, GPS, Monitor electronics
- France: Quench detection system
- Korea: Proton monitor electronics

Intensity Recovery to 750kW & Upgrade for T2K-Phase II

T.Ishida
(IPNS, KEK)

Neutrino Facility at J-PARC

- Need continuing upgrades for accelerator components for the recovery.
  - For Linac : 181MeV → 400MeV with ACS Installation
    - Just after completion of J-PARC Phase-I: Apr.'09
  - For RCS/MR RF: Improvement for the magnetic alloy cut core to achieve the high field acceleration as designed (25kV/m)
    - To improve procution process / Water → Oil (paraffin) cooling
  - For MR Fx kicker: To improve slow rise time 1.6us→1.1us (#b 6→8)
    - Without causing discharge
  - 30GeV →40(50)GeV energy boot-up
- MR intensity upgrade scenario:
  - Increasing repetition rate (cycle=3.04 to 2.04sec)
  - Reduce harmonic number of RCS from 2 to 1 (1x8 injections instead of 2x4: Almost twice of beam injected to MR !).
- Many of neutrino beam-line apparatus should be upgraded for >1MW beam
  - Need to develop MW target which can fit into the horn.
  - Horn / Beam Window only allow 750kW.
  - It is preferable more materials (such as beam plug) inside of TS, to keep safety margin for DV/BD.
  - Severer beam control than 1st phase, to reduce irradiation along beam-line.
- We should learn a lot more by the successful operation for the 1st phase !

Irfu cea saclay

- 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.

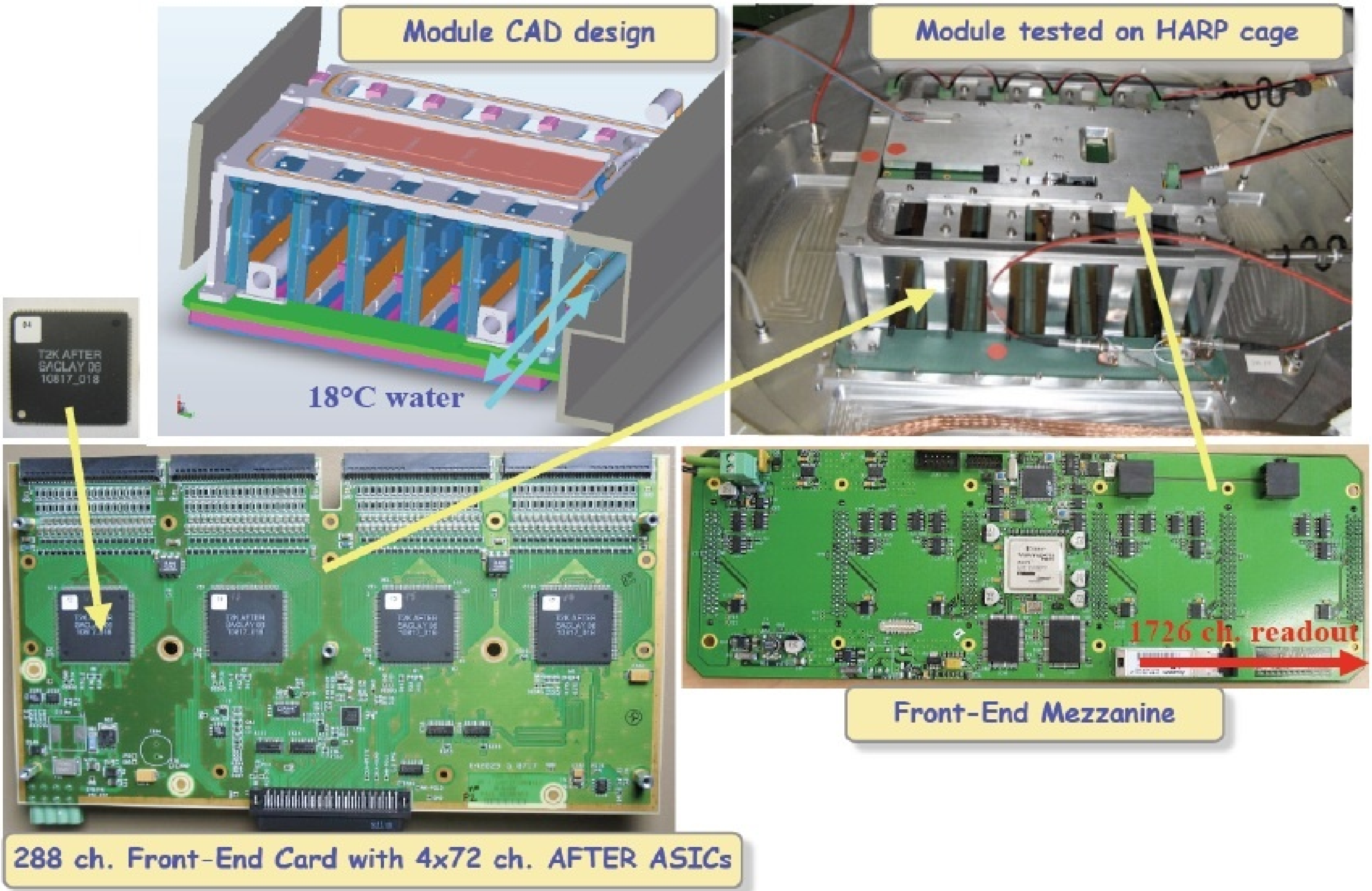


Figure 1.10 : *Pictures of a MM Module equipped with water cooled AFTER Front-End Electronics*