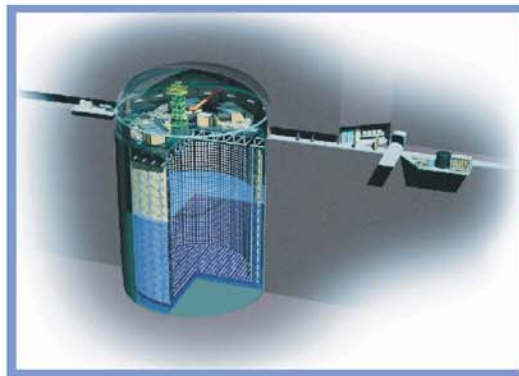


# T2K Overview

Taku Ishida (IPNS, KEK)  
For the J-PARC  $\nu$  construction group

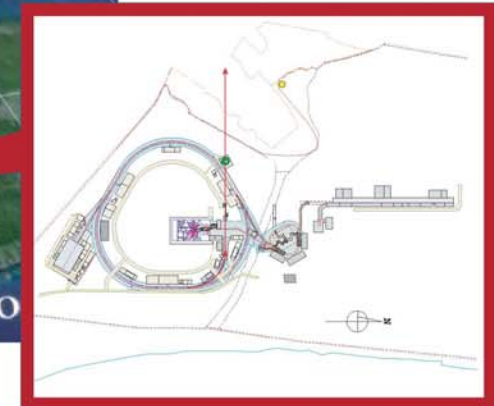
- Status of the Accelerators
- The Beam-line Construction, Apparatus Development, and Production



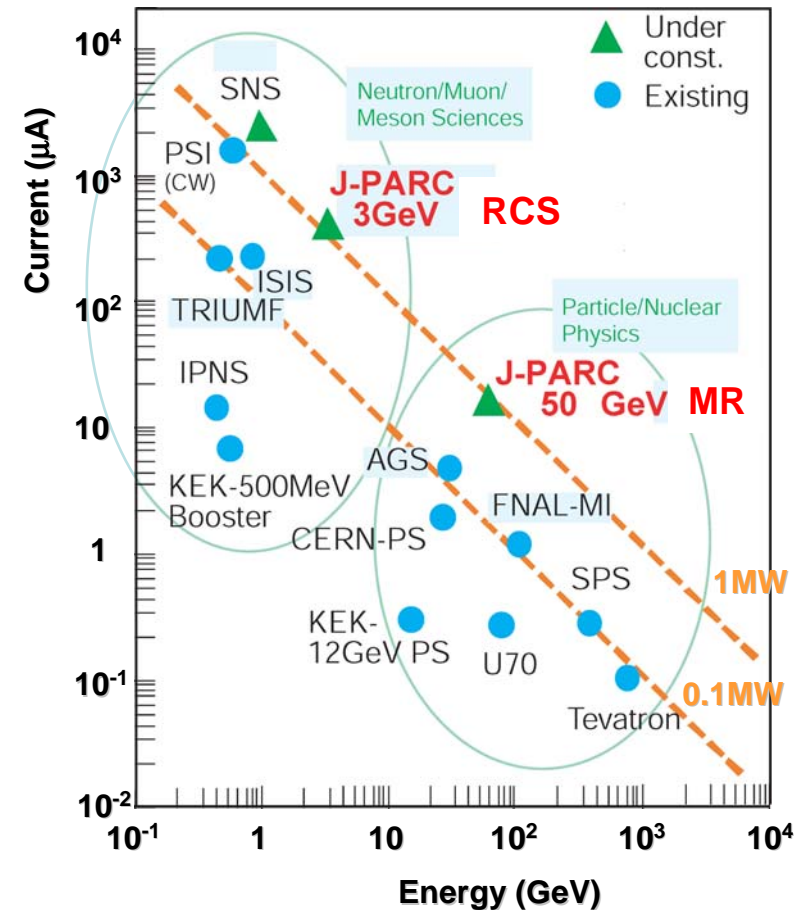
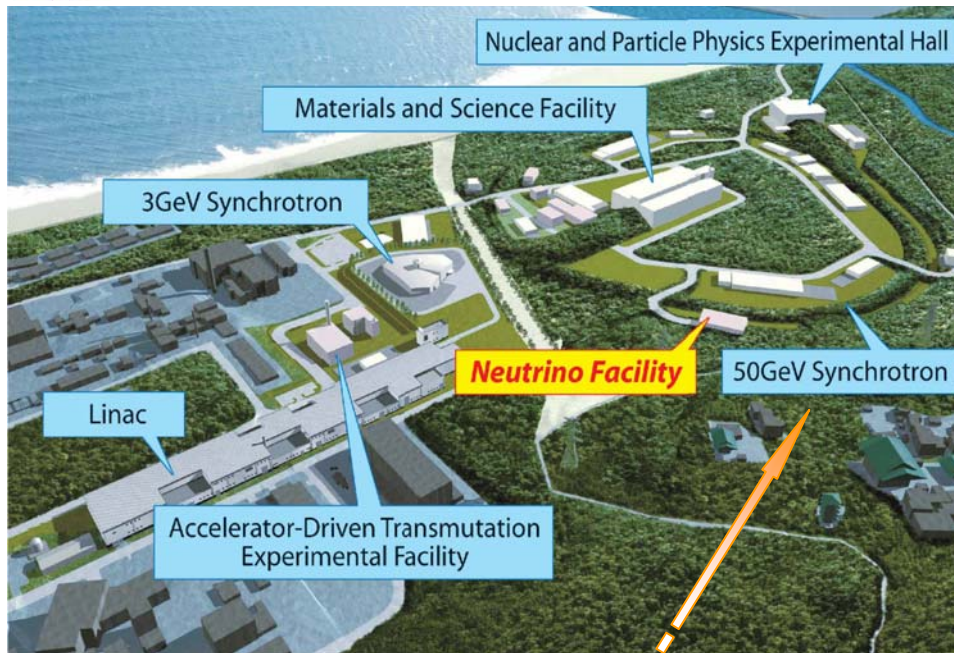
Super-Kamiokande  
(ICRR, Univ. Tokyo)



J-PARC 50GeV PS  
(KEK-JAEA, Tokai)



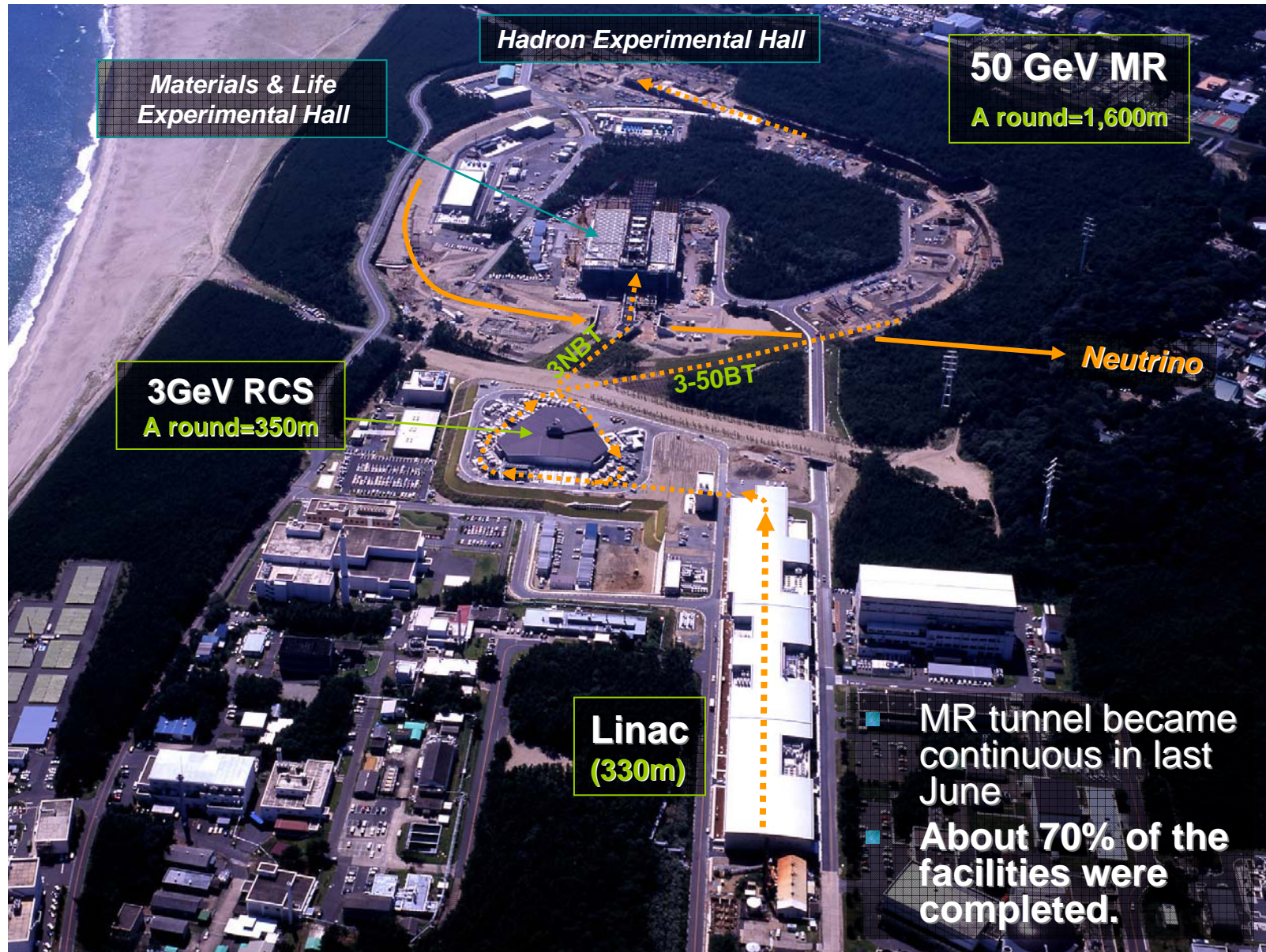
- A next-generation long-baseline neutrino oscillation experiment, designed to observe the first signal of  $\nu_e$  appearance
  - ◆ Pseudo-monochromatic, low-energy off-axis beam, tunable by changing the off-axis angle between  $2^\circ$  and  $2.5^\circ$  ( $E_n=0.8\text{GeV} \sim 0.65\text{GeV}$ )
  - ◆ Quasi-Elastic interactions are dominant, suitable to minimize the electromagnetic shower background caused by inelastically-produced  $\pi^0$

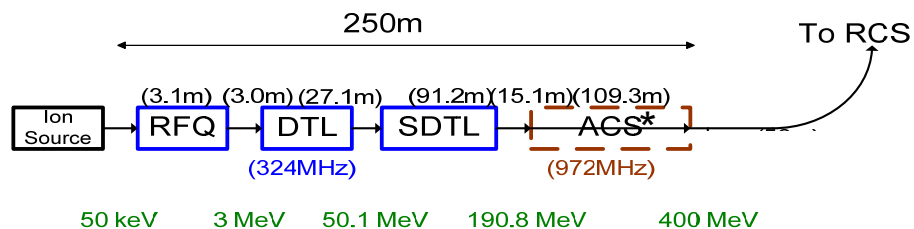


<b>Proton beam kinetic energy</b>	<b>50GeV (30GeV@T=0)</b>
<b># of protons / pulse</b>	<b><math>3.3 \times 10^{14}</math> ppp</b>
<b>Beam power</b>	<b>750kW</b>
<b>Bunch structure</b>	<b>8 bunches</b>
<b>Bunch length / spacing</b>	<b>58 ns / 598ns</b>
<b>Spill width</b>	<b>4.2μs</b>
<b>Beam Emittance</b>	<b><math>6\pi</math> mm.mr (<math>10\pi</math>@30GeV)</b>
<b>Cycle</b>	<b>3.64 sec (2.1sec@30GeV)</b>

- **$1 \times 10^{21}$  protons per year**  
[130 days operation per year, 50GeV]

# Bird's-Eye View (Feb. 2006)





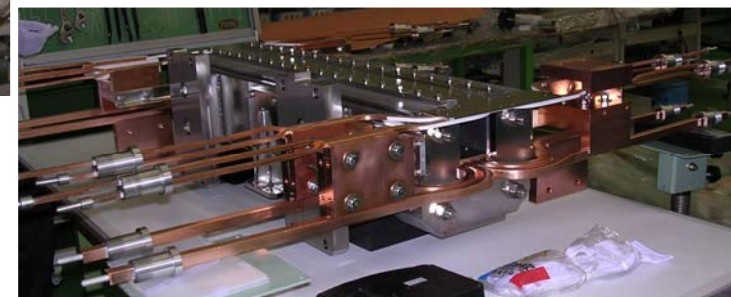
\*ACS: Annular ring Coupled Structure, to be constructed in FY2008~2011

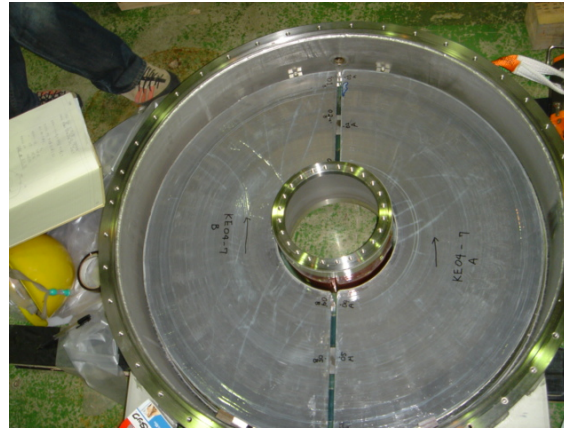


- 180MeV Linac at t=0
- Installation almost fin.
- Klystron test: done
- Beam comissioning in this December
- ACS high power test for 400MeV upgrade: done

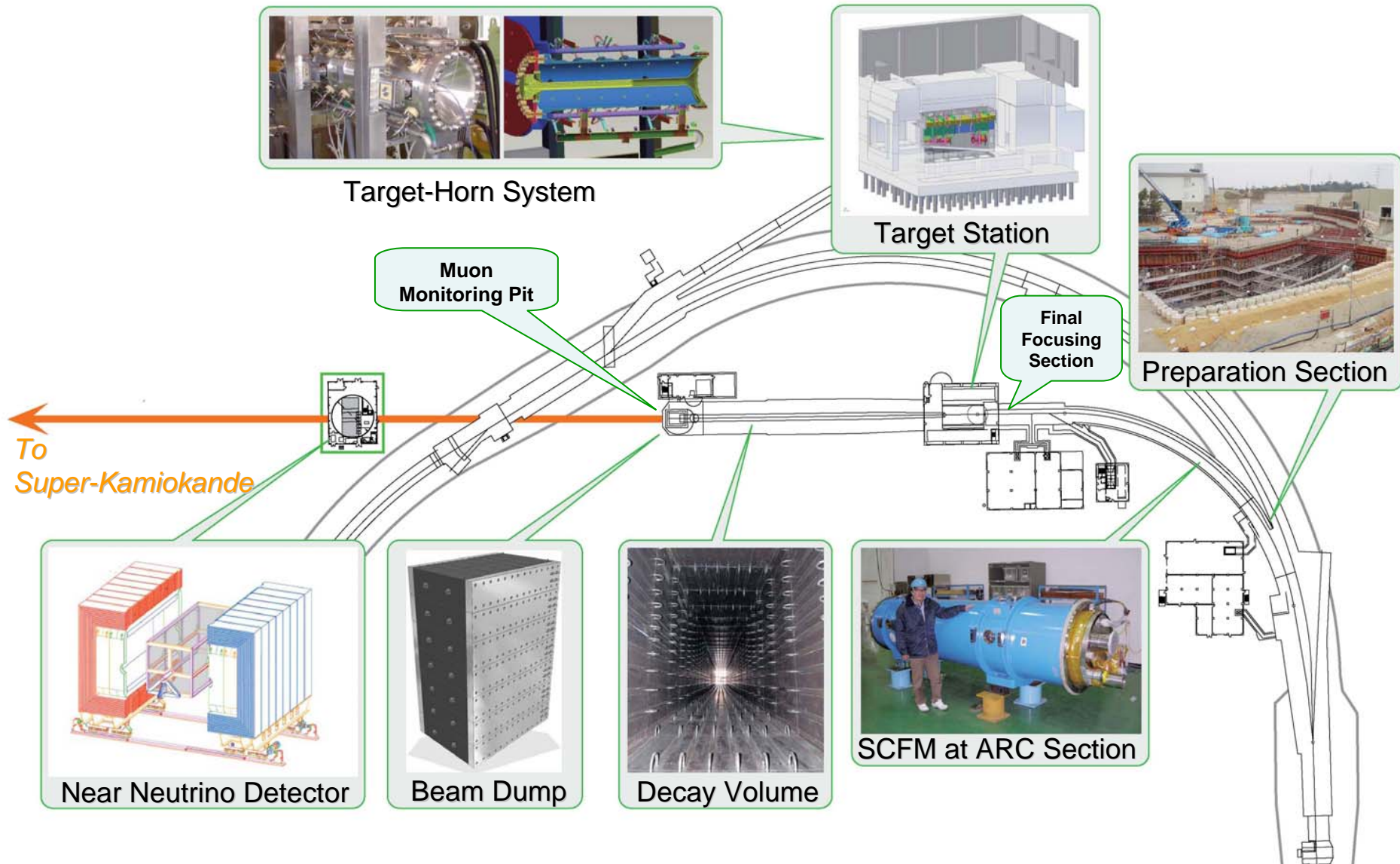


Kicker &  
Septum  
Magnets  
for fast  
extraction





- In order to achieve the high field acceleration as designed (25kV/m), improvement is needed for the magnetic alloy core of the RCS/MR RF.
- Commissioning will start for the linac in December 2006, for RCS in 2007, and for MR in 2008 with current RF system.
- T2K: Up to 100 kW within FY 2009.
- Need continuing upgrade
  - ◆ For RF (until 2010) and for Linac (until 2011).
- MR power recovery scenario is being discussed
  - ◆ Increasing repetition rate (cycle=3.64 to 2.04sec)
  - ◆ Reduce harmonic number of RCS from 2 to 1 (1x8 injections instead of 2x4).





## KEK

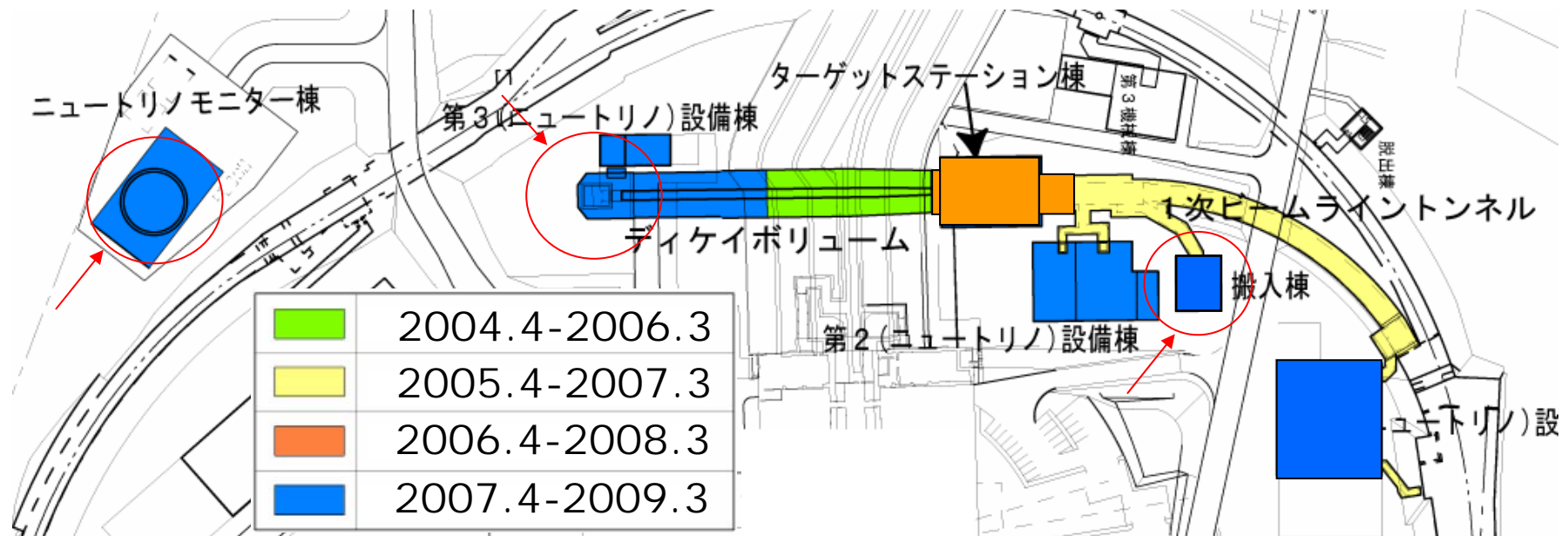
- Neutrino group, IPNS (Core)
  - ◆ Every beam line components (except S.C.magnets / cryo.)
  - ◆ *New members for engineering works / DAQ control / ND*
- Hadron group, IPNS
  - ◆ Monitor / N.C.magnets / Power supply
- Cryogenics group, IPNS
  - ◆ Cryogenics / Target Helium circulation system
- Cryogenics 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



*K.Nishikawa moving to KEK  
as leader of our division (IPNS)*



- Further optimization of the civil construction design
  - ◆ DV length -20m
  - ◆ OA angle range 2~3deg → 2~2.5deg
    - ▶ ND hole depth -2.5m / Shorten vertical vending magnet
    - ▶ ND hole diameter 19m → 17.5m
    - ▶ Eliminate carry-in building, but only shaft and crane.
    - ▶ Reduce part of cooling system in TS/DV/BD in the earliest stage
    - ▶ ...
- Impact on physics sensitivity is minimum

# Decay Volume (Under 3NBT)

T. Ishida  
(IPNS, KEK)

Oct., 2005



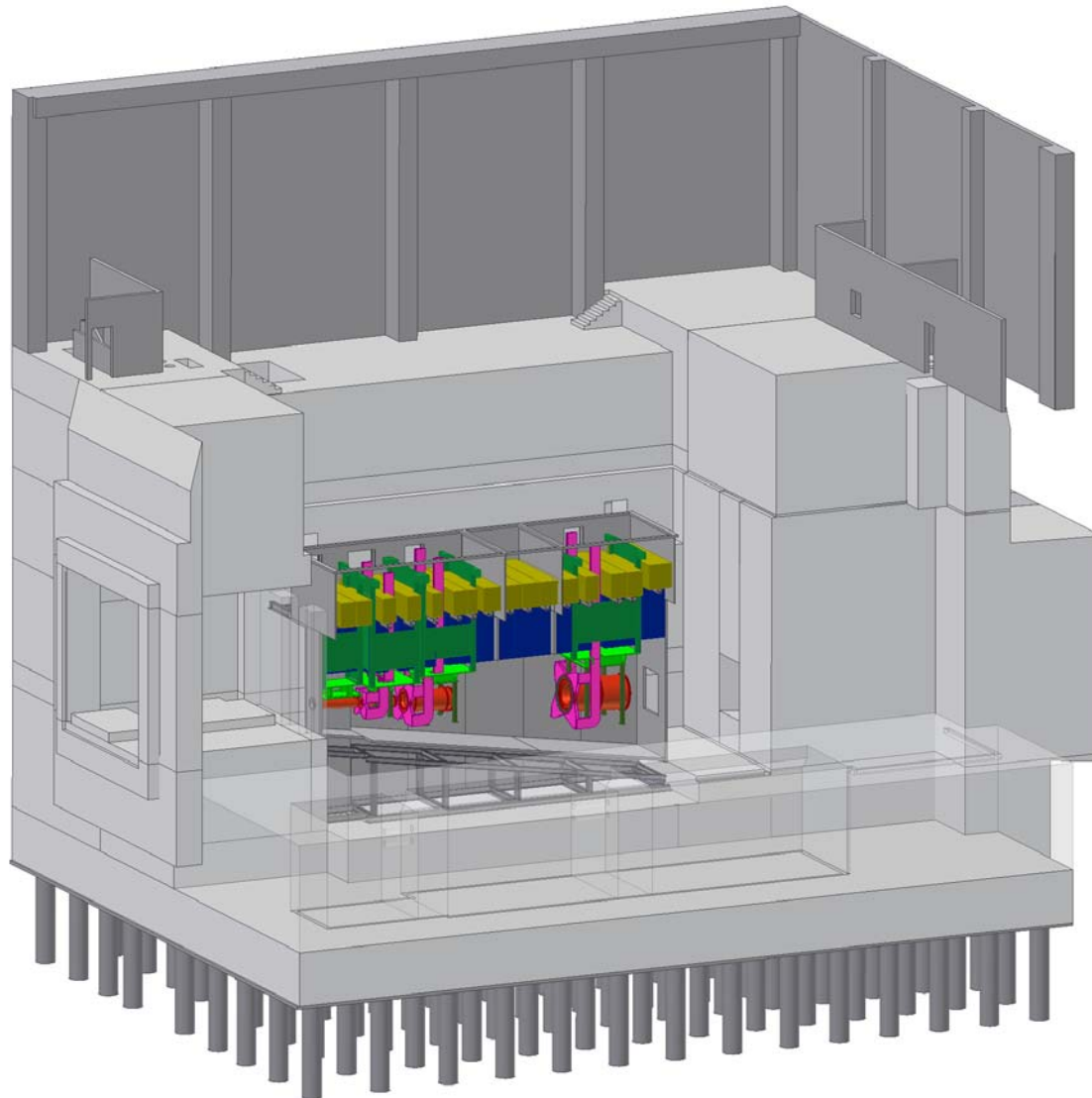
All cooling channels connected  
by 1,080 U-shape pipes.



March, 2006

July, 2006





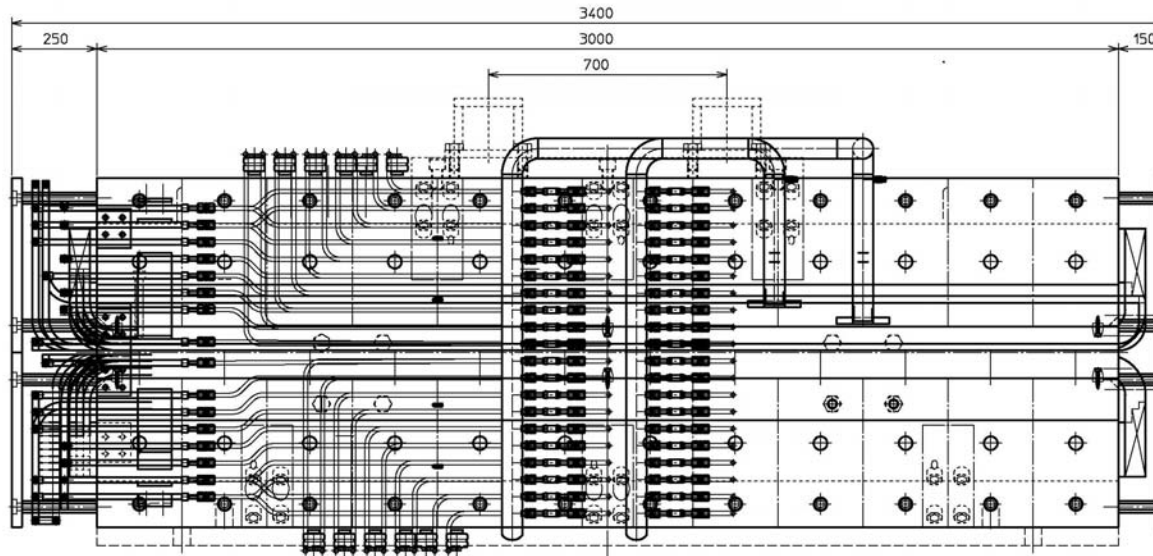
- Civil Construction
  - ◆ Underground part will be started very soon.
  - ◆ Surface part in spring 2008
- He vessel and support structure
  - ◆ Successful bid for three years of contract.
  - ◆ Parts construction in 2006
  - ◆ Assembly in 2007 and plumbing in summer 2008

# Status for each components

	Conceptual Design	Engineering Design	Real Production	Installation	Operation test
Proton Beam monitor				2007~	2008
Superconducting magnets	Done	Done	~10%	2008	2008
Cryogenics				2008	2008
Normal Conducting magnets			~25%	2007~	2008
Vacuum system				2007~	2008
Target				2008	2008
Horn				2008	2008
Target Station				2007~	2008
Beam Window				2008	2008
Decay Volume				~60%	2008
Beam Dump				2008	2008
Muon monitor				2008	2008

- Working design in hand for most of the components
- Shifting to prototyping, final engineering design, and production

# Normal conducting magnets



Q360MIC

	Dipole	Quad.	Steer.	Total	(MIC)
Prep.	2(H)	5	3(H)+2(V)	12	(5)
FF	2(V)	4	2(H)+2(V)	10	(0)
<b>Total</b>	<b>4</b>	<b>9</b>	<b>9</b>	<b>22</b>	<b>(5)</b>

- Almost on schedule
- Magnets in the preparation section and iron yokes for final-focusing section magnets are under fabrication

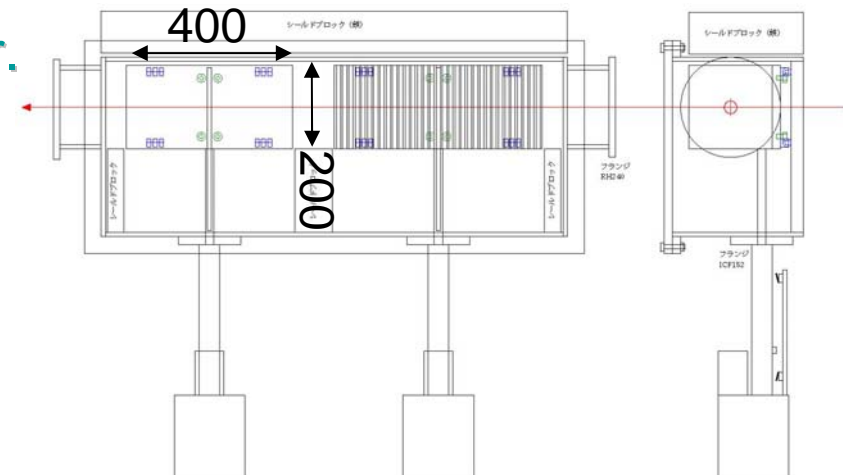
- Layout of the preparation section almost finalized
- Vacuum Chamber:
  - ◆ Ti and Al-alloy ducts for D
  - ◆ “Cross-shaped” aluminum ducts for Q
  - ◆ Semi-remote flange mover and hands-on clamp
- Gate valves, emergency-closing valves, ion pumps..
  - ◆ Preparing for tenders



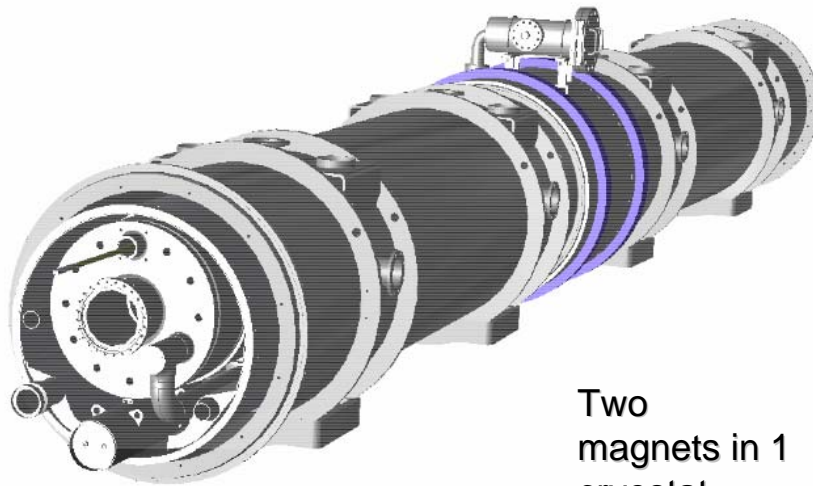
Flange Mover, developed for MR

## Beam Plug & Collimator

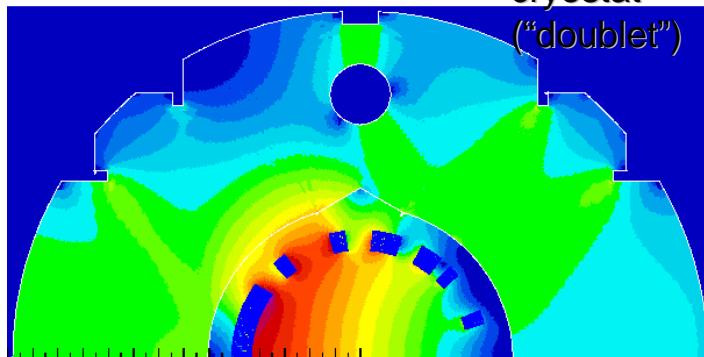
- A diffuser and a stopper made of invar.
  - ◆ 110MPa with a single pulse
    - ▶ Cf. normal iron: 2.7GPa
- Collimator in a conceptual design stage
- Barely in time to make them within this FY.







Two  
magnets in 1  
cryostat  
("doublet")



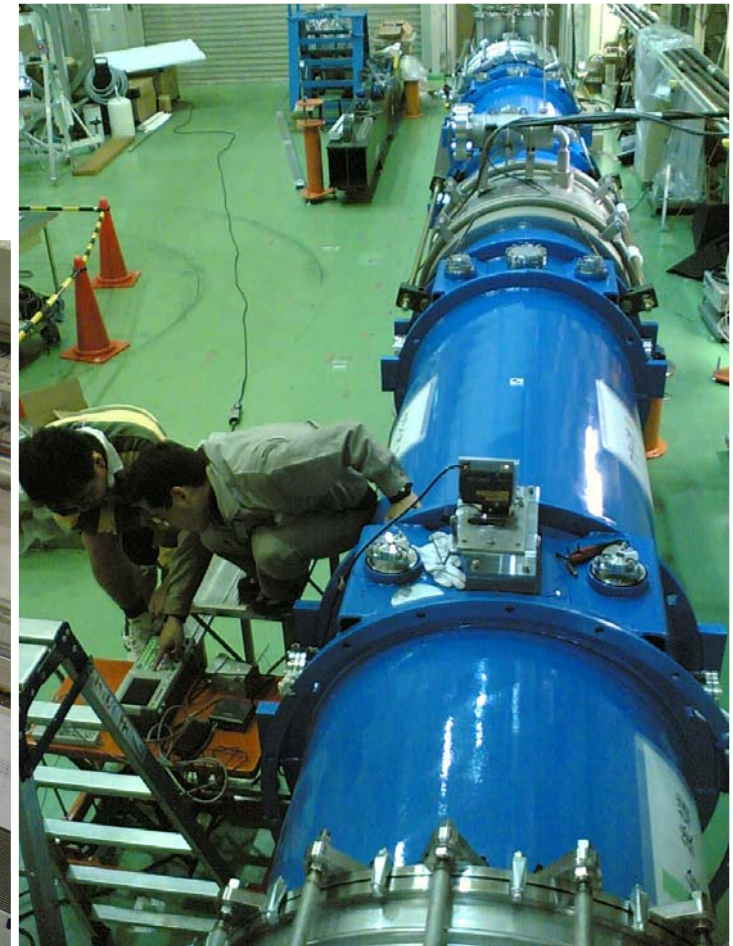
Superconducting Combined Function Magnet  
28 SCFMs in total, D: 2.6 T, Q: 18.6  
T/m  
Length: 3.3m  
Current: 7,345A @ 50GeV

- Pre-production magnet successfully assembled and excited.
  - ◆ No spontaneous quenches to 105% of 50 GeV, with satisfactory field quality
- Mass production started
  - ◆ Three production magnets in hand
  - ◆ **First doublet assembled** and tested for cryogenic performance / alignment / quench protection
- Interconnect Corrector
  - ◆ Prototyping in collaboration with BNL
- Plan
  - ◆ 6 doublets each in FY'06/'07 + 2 in '08
  - ◆ Refrigerator construction: '06~'08
  - ◆ Transport line construction: '07~'08
  - ◆ **Installation/system testing in CY'08**

# Doublet Cryostat Test

T. Ishida  
(IPNS, KEK)

- Optical window to observe cold mass alignment directly from outside
- Use laser distance meter to measure cold mass displacement during cool down



Movement when cooled well  
under control:

$$\Delta X = 0.03 \pm 0.06$$

$$\Delta Y = 0.95 \pm 0.09$$

$$\Delta Z = 5.8 \pm 0.4$$

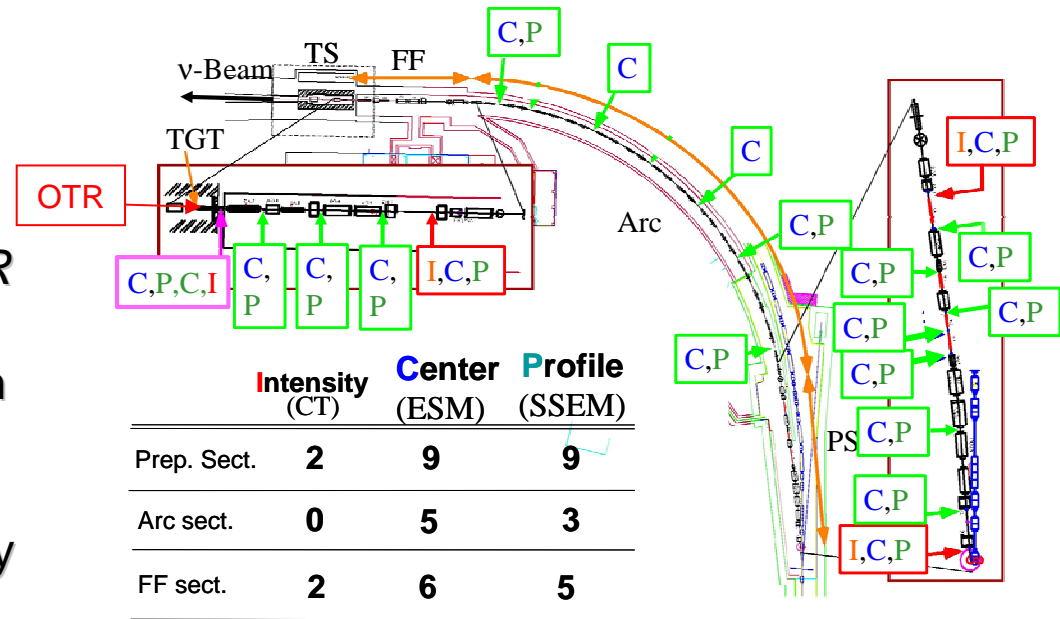
## Configuration

- ◆ Position : Electro-static monitor (ESM)
- ◆ Profile : Segmented Secondary Emission Monitor (SSEM), OTR
- ◆ Intensity : CT
- ◆ Loss monitors (BLM): Ionization chamber

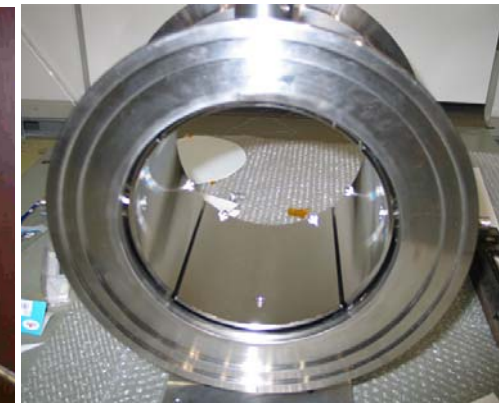
## Status

- ◆ ESM: Wave form reproduced by simulation, 0.3mm position resolution demonstrated for the T2K beam.
- ◆ SSEM: ~0.25mm for position, ~0.23mm for width (beamtest at KEK NML)
- ◆ Cryogenic / irradiation test for SSEM remote handler

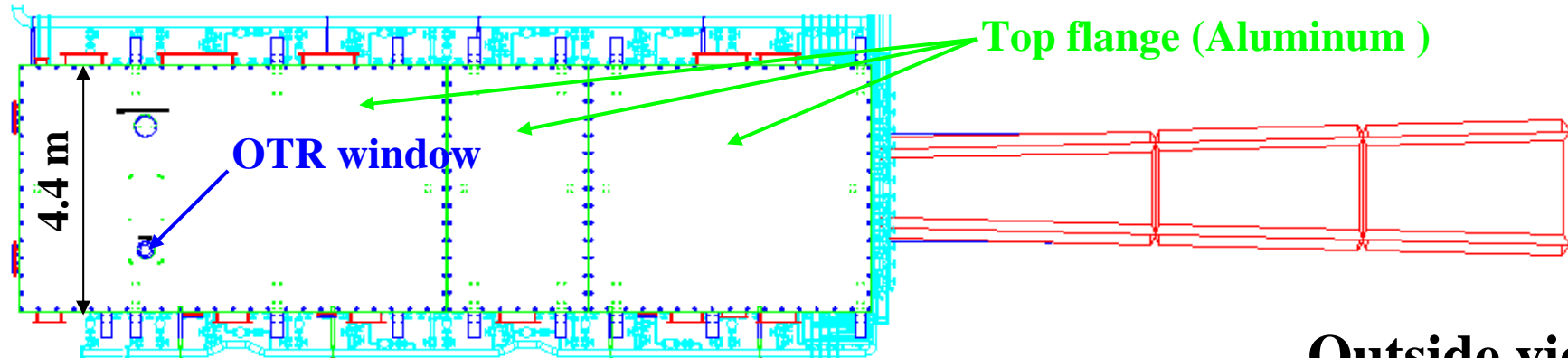
- Going to establish the engineering design by the middle of this FY



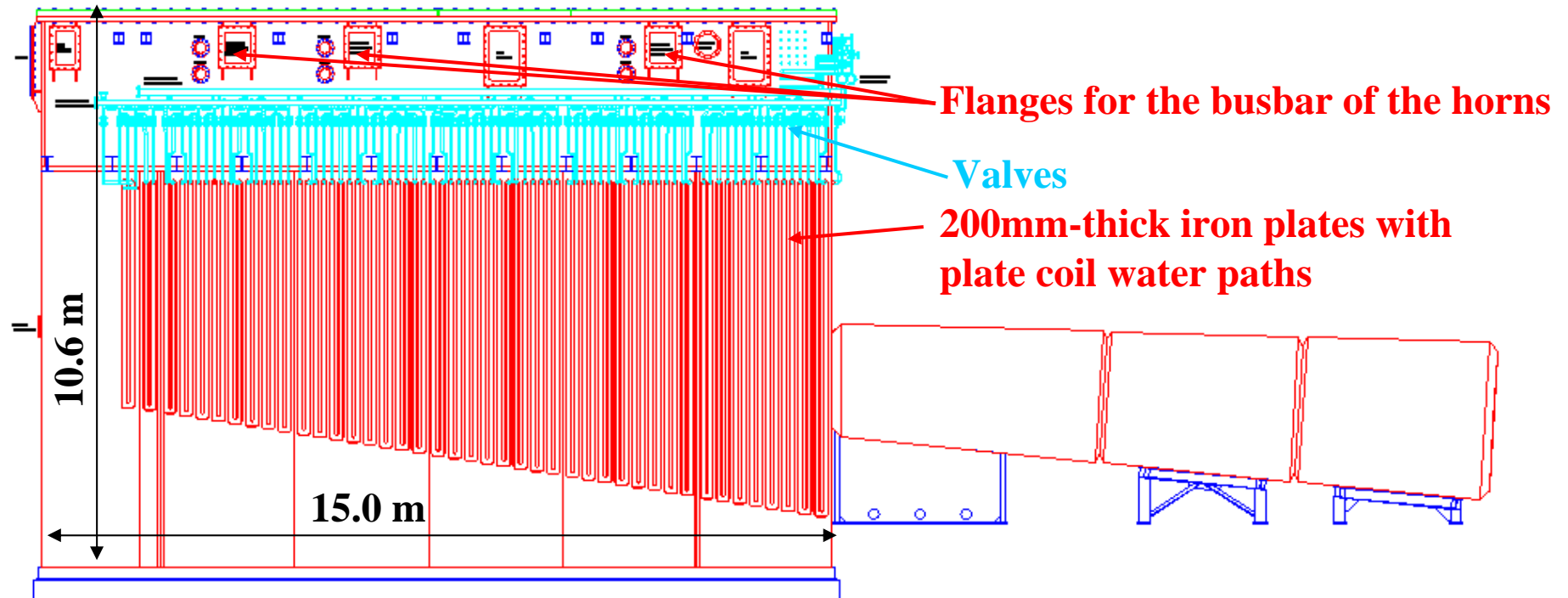
Beam loss monitor will be placed along the beam line.

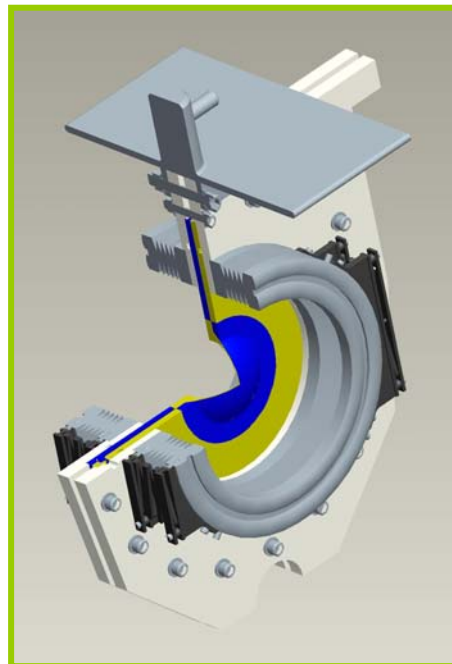


# TS Helium Vessel

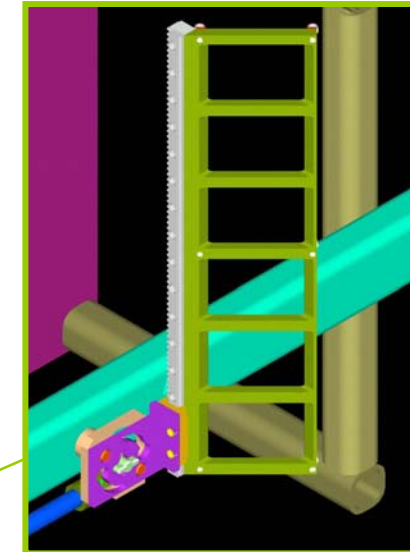
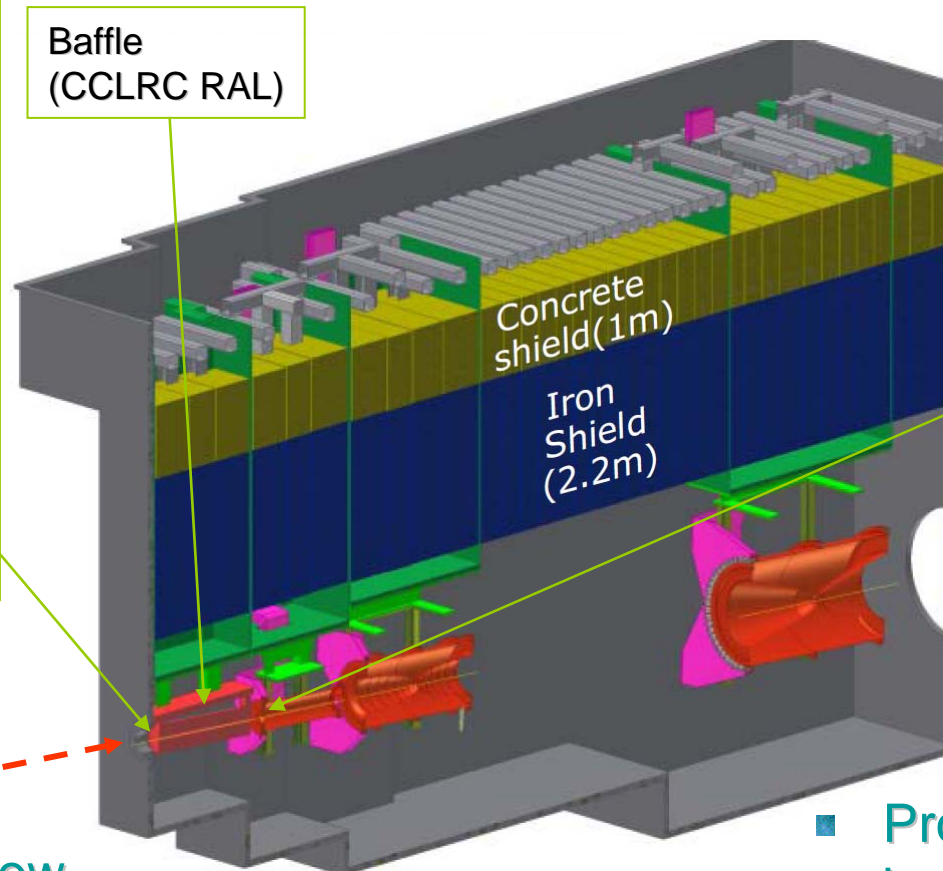


Outside view





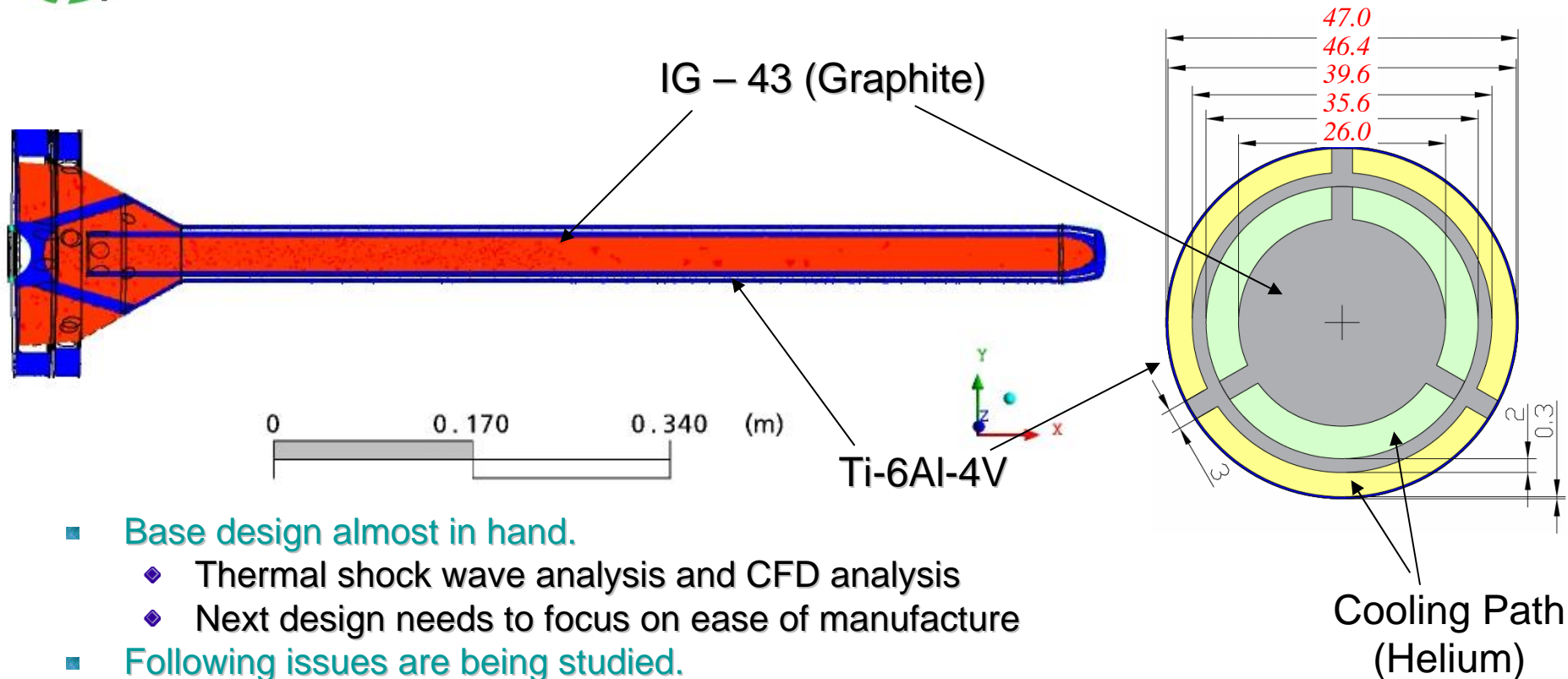
Ti-alloy Beam Window  
with pillow-seal  
(CCLRC RAL)



OTR Ladder  
In front of the target  
(TRIUMF)

- Complete window design in 2006
- Prototyping in 2007

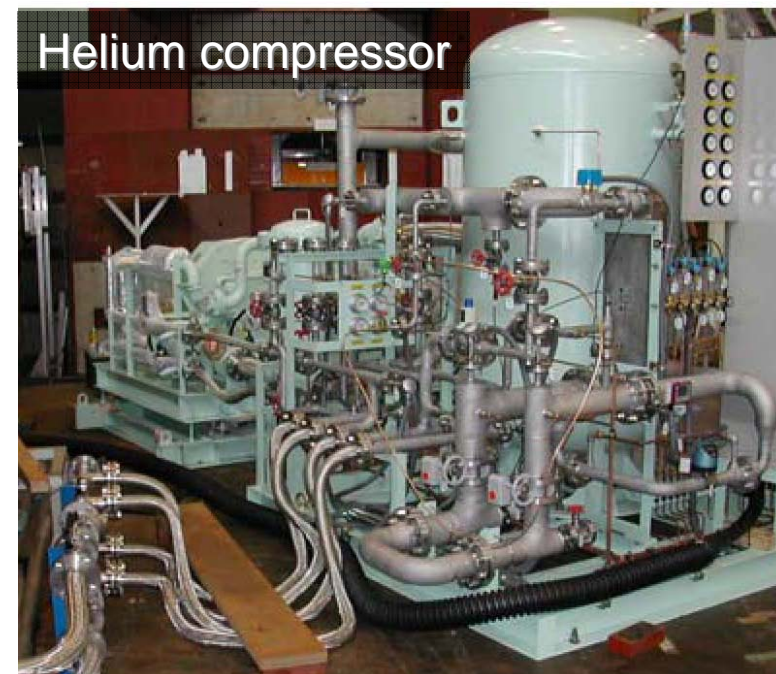
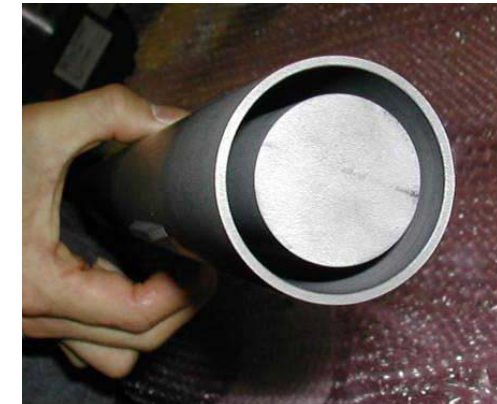
- Prototype test has been done.
- Irradiation test / support structure

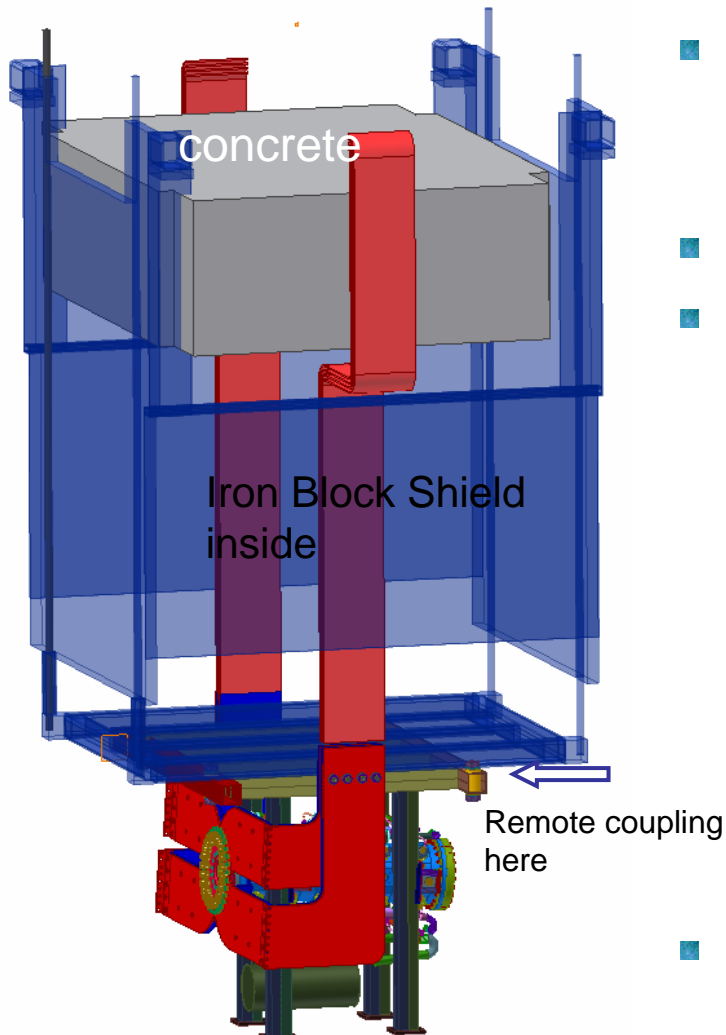


- **Base design almost in hand.**
  - ◆ Thermal shock wave analysis and CFD analysis
  - ◆ Next design needs to focus on ease of manufacture
- **Following issues are being studied.**
  - ◆ Outer Titanium tube has been made. R&D for sealing ceramic underway.
  - ◆ Brazing between graphite and Ti-alloy is promising.
- **Helium cooling system is purchased and ready for full scale cooling test.**
- **FY06: Establish the actual equipment design and make full-set prototype.**
  - ◆ Full scale cooling test using actual He circulation system.
  - ◆ Fixation and alignment mechanism should be developed.

# Target Prototypes / Compressor

T. Ishida  
(IPNS, KEK)





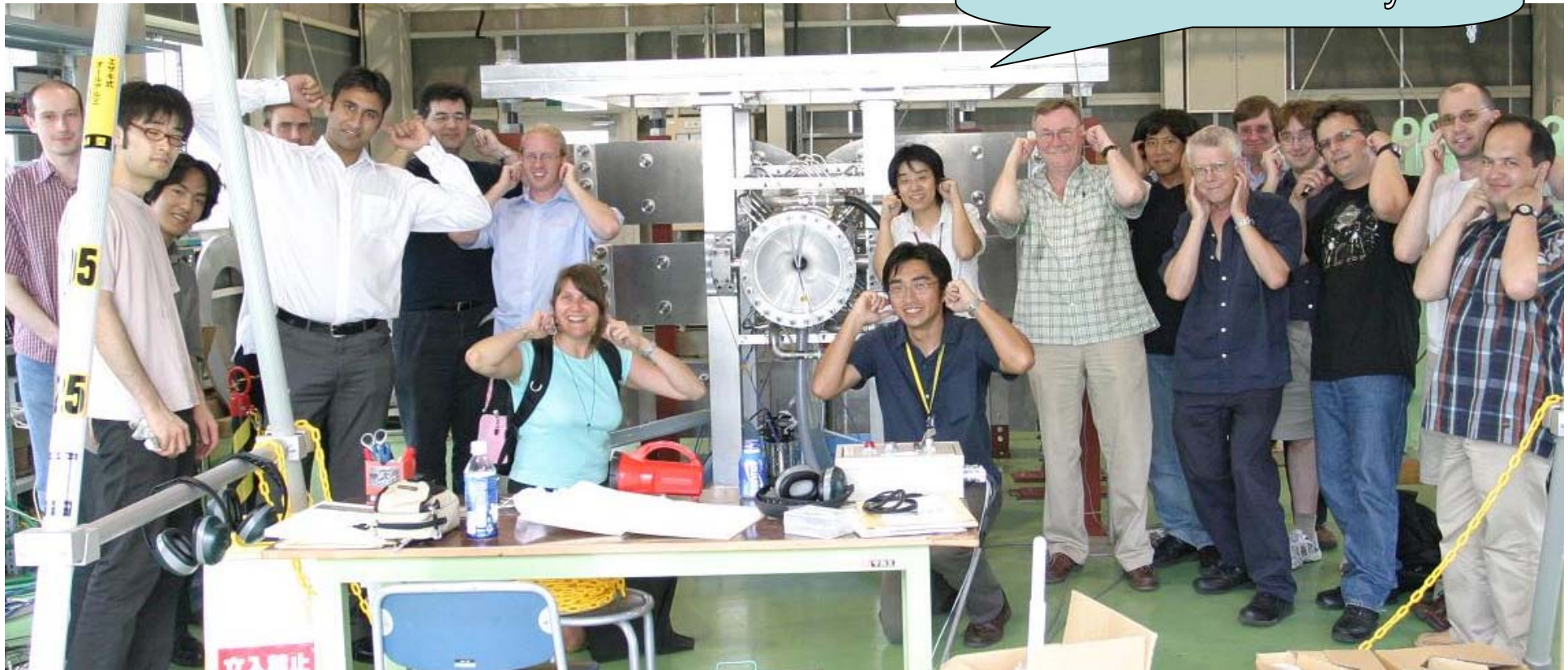
- 1<sup>st</sup> horn
  - ◆ Successful operation at 320kA
  - ◆ Long-term current operation test
- 2<sup>nd</sup> horn design / 3<sup>rd</sup> horn prototype in FY06
- Support module
  - ◆ Conceptual design done on
    - ▶ Remote coupling of horns and water / He pipes.
    - ▶ Kinematic alignment system
  - ◆ R&D
    - ▶ Remote coupling of strip-lines
    - ▶ Water circulation system (7m pumping up)
    - ▶ Support module itself
- Produce everything in FY2007

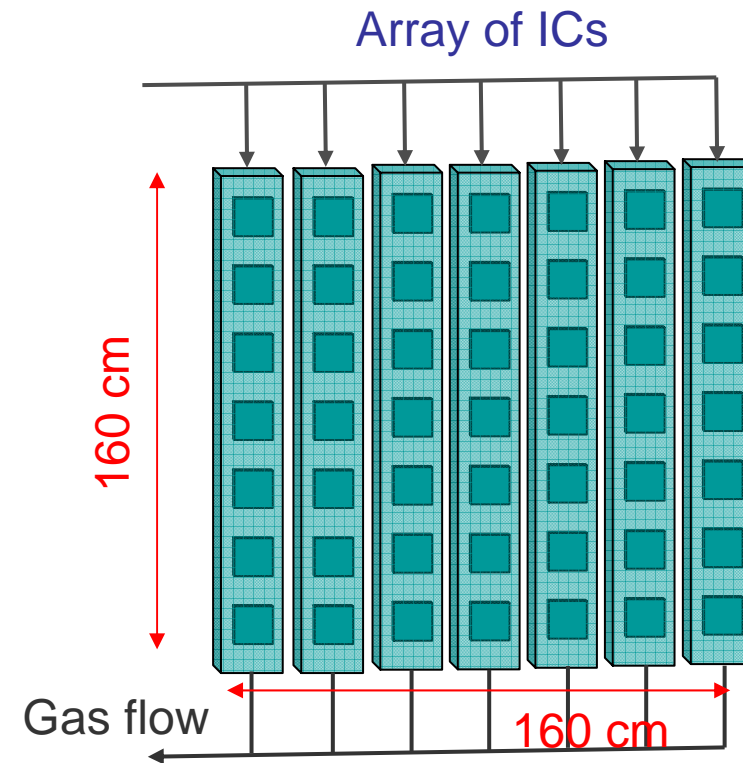


# 1<sup>st</sup> Horn with 320 kA

T. Ishida  
(IPNS, KEK)

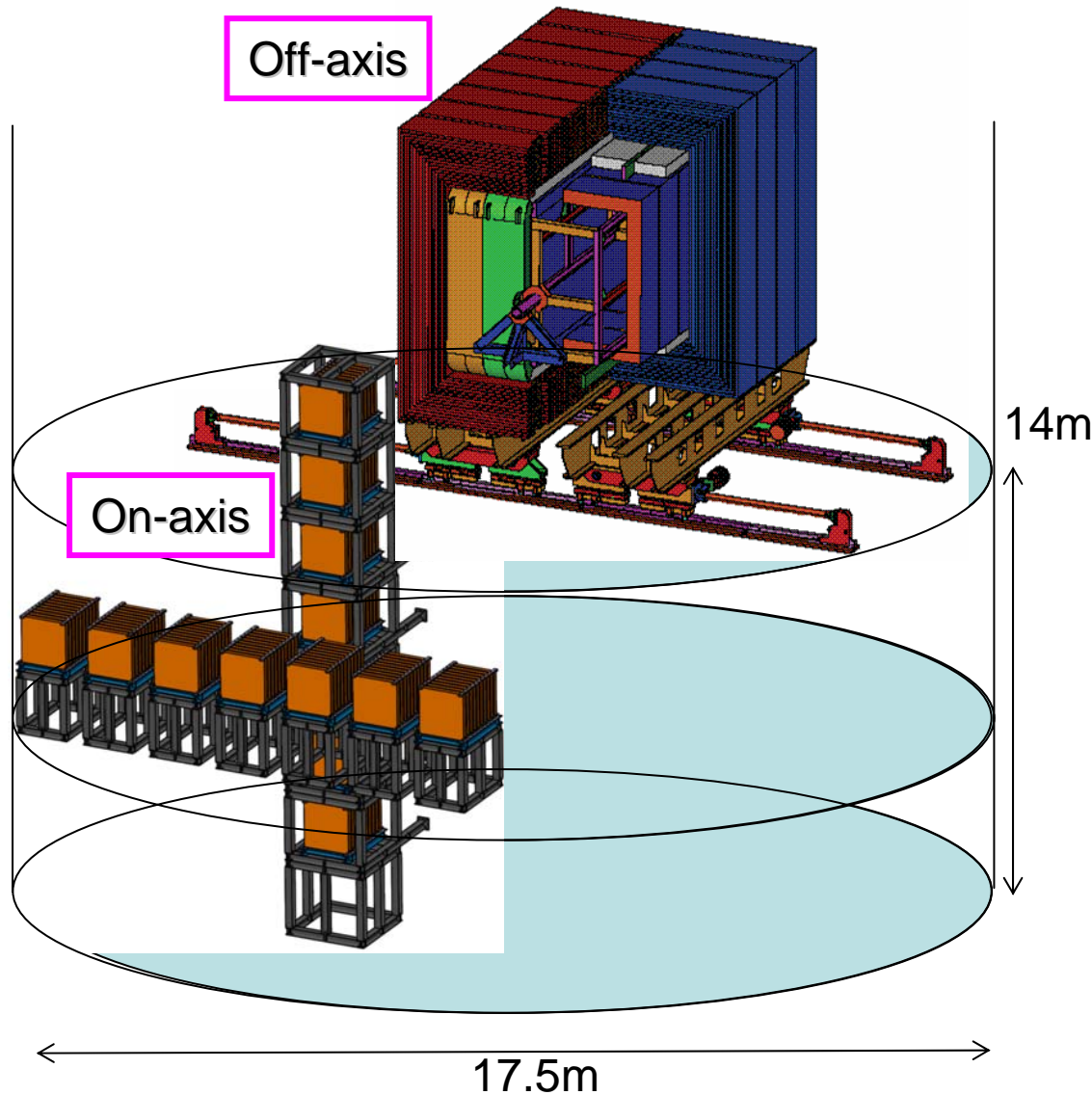
Haa ?  
We cannot hear you !





- Graphite production started
- Detailed design in FY06
- Machining: FY07
- Assemble/installation: FY08

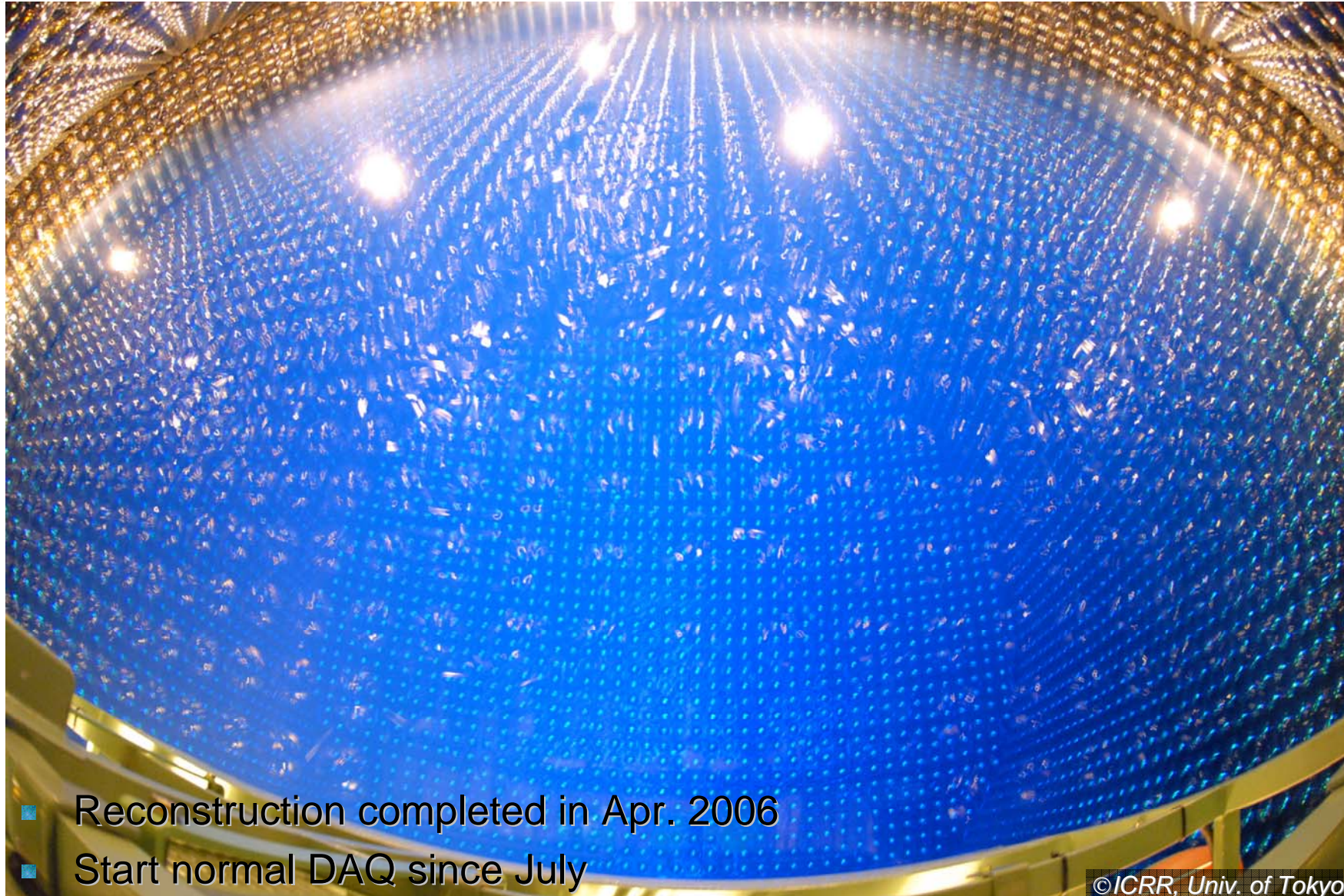
- Two Independent System
  - ◆ Semiconductor detector array
  - ◆ Ionization chamber array
- Spill –by-spill monitor for the muon profile center



- Off-axis detector
  - ◆ Spectrum
  - ◆ Cross section
  - ◆  $\nu_e$  contamination
  - ◆ UA1 magnet, FGD, TPC, Ecal,...
- On axis detector
  - ◆ Monitor beam dir.
  - ◆ Grid layout
- Scintillator+WLS fiber with
  - ◆ MRS APD (Russia)
  - ◆ MPPC (Hamamatsu)

# Far Detector: SK-III

T. Ishida  
(IPNS, KEK)



- Reconstruction completed in Apr. 2006
- Start normal DAQ since July

©ICRR, Univ. of Tokyo

- Facility construction is going well:
  - ◆ Decay volume (50m finished), primary beam line, target station
- Beam line equipment:
  - ◆ Shifting from design phase to prototyping and actual production
  - ◆ International contributions for crucial parts of the beam line components.
- Passing some of critical milestones:
  - ◆ Production of the 1<sup>st</sup> doublet of SCFM magnets
  - ◆ 1<sup>st</sup> Horn operation with 320 kA
- We should work harder to start experiment as scheduled !

Our acknowledge goes on to CNGS colleagues for organizing this workshop,  
in the midst of the busiest time.