Report from the ν-TAC Committee

Ewart Blackmore – TRIUMF

Neutrino Facility Technical Advisory Committee met twice

November 12-13, 2003 and April 26-28, 2005

(also NBI'06 Workshop – CERN September 2006)

"Report from Neutrino Beamline Construction Group on Responses to Recommendations and Recent Developments" – November 2006

- Charge to the committee
- Committee members
- Describe main components of the facility
- Summarize important recommendations from the committee, the responses and present project status
- Conclusions

Charge to the Committee

Advise on Technical/Engineering Issues on Components of the Neutrino Beam Line

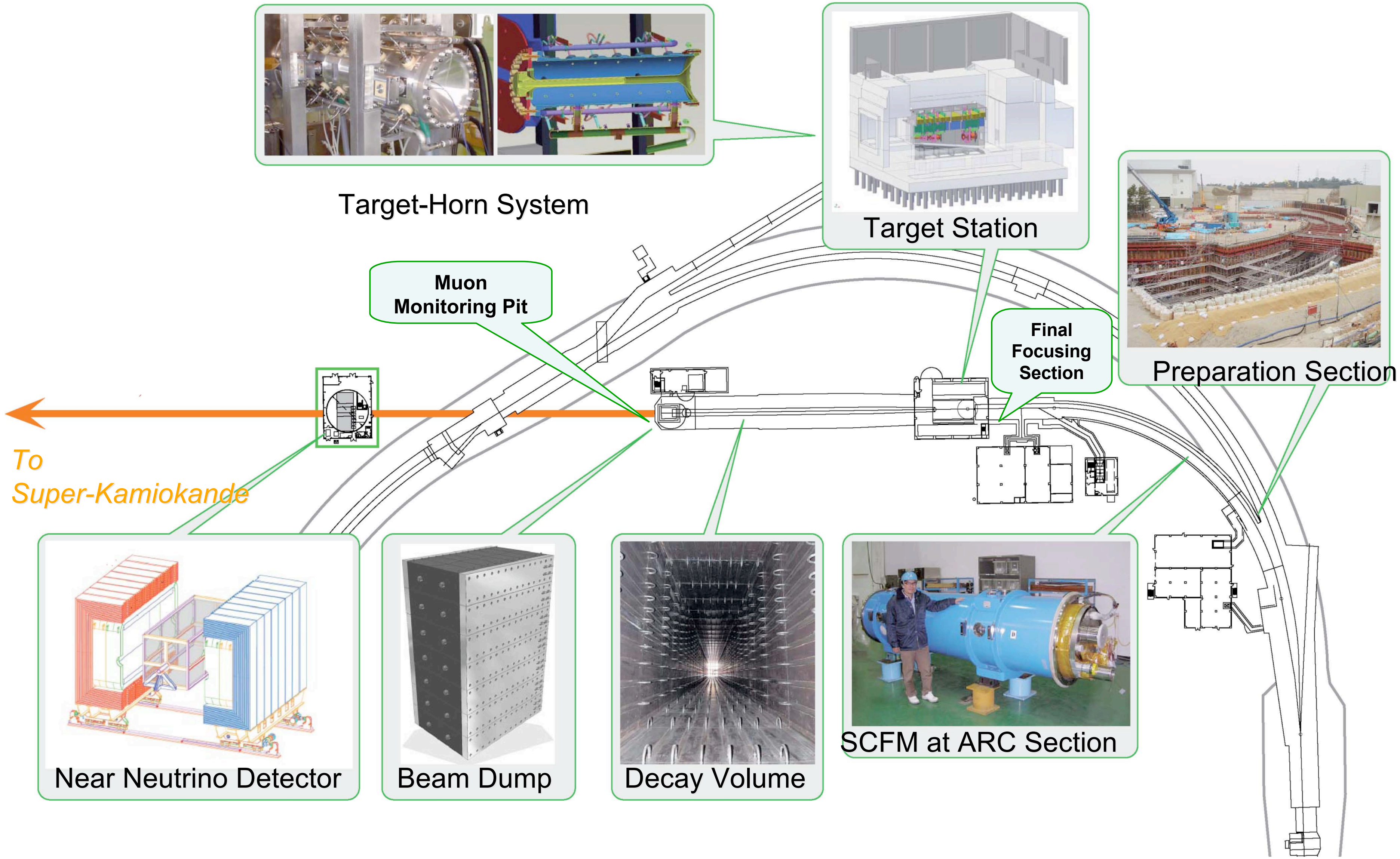
- Proton beam line
  - Beam simulation
  - Normal conducting magnets
  - Superconducting magnets
  - Cryogenics
  - Beam monitors
  - Vacuum, beam plug
  - Maintenance scheme
- Production target
- Focusing horns
- Beam window
- Target station (including remote handling)
- Decay volume
- Beam dump
- Muon monitors
- Control/monitor system
- Survey and alignment
- Radiation safety

Members of J-PARC ν-TAC

Ewart Blackmore	Head of Accelerator Technology Division, TRIUMF	General (incl. proton beam monitor, remote handling)
Konrad Elsener	Project leader of CNGS at CERN	Target station, Decay pipe, Beam dump
Kenji Hosoyama	Professor, Accelerator Laboratory, KEK-B	Cryogenics
James Hylen	Leader of Neutrino Beam Devices group in NuMI, FNAL	Target, horn, target station
Takahiko Kondo	Head of Phys. Div. II, Institute for Particle and Nuclear Studies	Neutrino beam
Clive Mark	Leader of Remote Handling Group, TRIUMF	Remote handling
Katsunobu Oide	Head of Acc. Div. II, Accelerator Laboratory, KEK-B	Proton beam optics
Peter Sievers	Accelerator Technology Department, CERN	Target, Horn
James Strait	Head of Particle Physics Division, FNAL	Superconducting magnets

The Neutrino Facility

(Slides from Talk by Taku Ishida at NBI06)



Collaboration (Local & International)

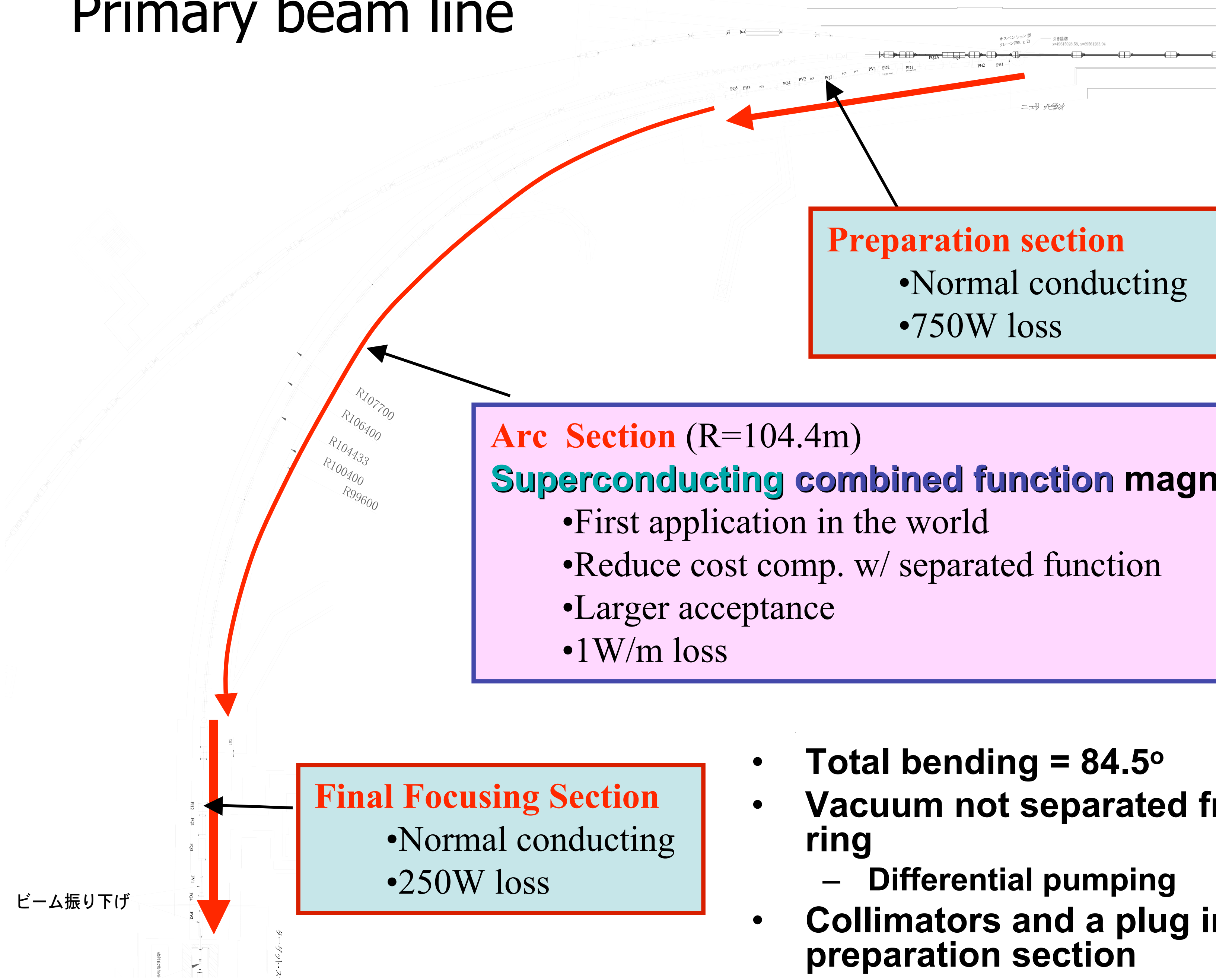
KEK

- Neutrino group, IPNS (Core)
  - 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

Primary beam line



Preparation section
- Normal conducting
- 750W loss

Arc Section (R=104.4m)

Superconducting combined function magnets
- First application in the world
- Reduce cost comp. w/ separated function
- Larger acceptance
- 1W/m loss

Final Focusing Section
- Normal conducting
- 250W loss

- **Total bending = 84.5°**
- **Vacuum not separated from 50-GeV ring**
  - **Differential pumping**
- **Collimators and a plug in preparation section**

Primary Beam Line – Overview

Concerns

Lack of knowledge of the extraction beam parameters eg. emittances, halos, beam stabilities, kicker errors, etc and impact on collimation scheme and optimum beam monitor and corrector location. Recommended working with 50 GeV MR group on beam simulations.

Response

Working with accelerator experts to improve simulations of extracted beam.

Developing a beam tuning strategy.

Determined location of corrector magnets in arc section and working on optimizing the monitor and steering magnet location in the other sections.

Primary Beam Line - Magnets

Achievement: Successful production of combined function SC magnet – 2.6T dipole with 18.6 T/m quadrupole and assembly of 2 magnets in 1 cryostat.

<u>Concerns</u>

Normal MIC Magnets – activation radiation levels and servicing procedures (although KEK has excellent experience in this).

SC Magnets – increase spares, failure mode analysis on beam upset conditions, field measurements

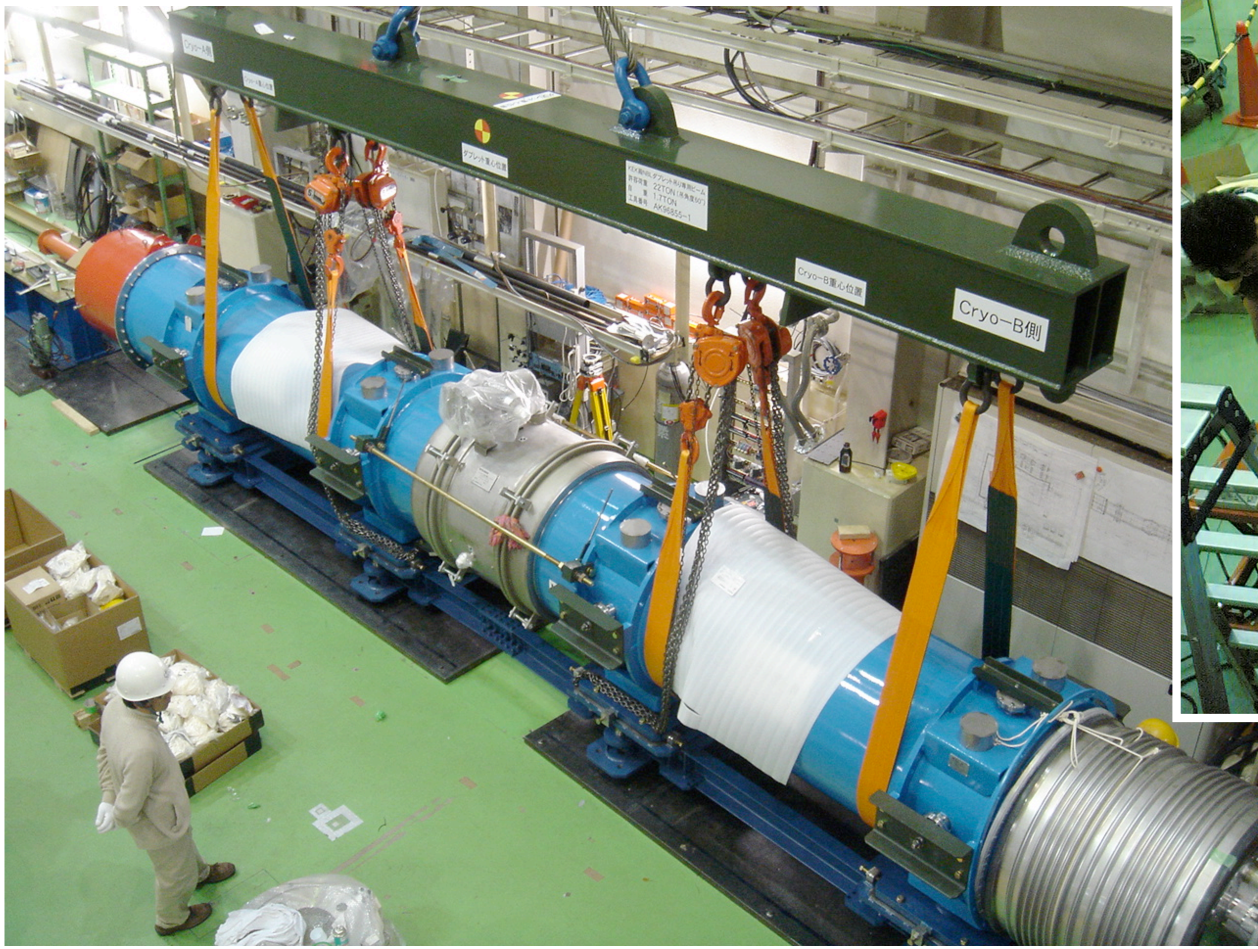
<u>Response</u>

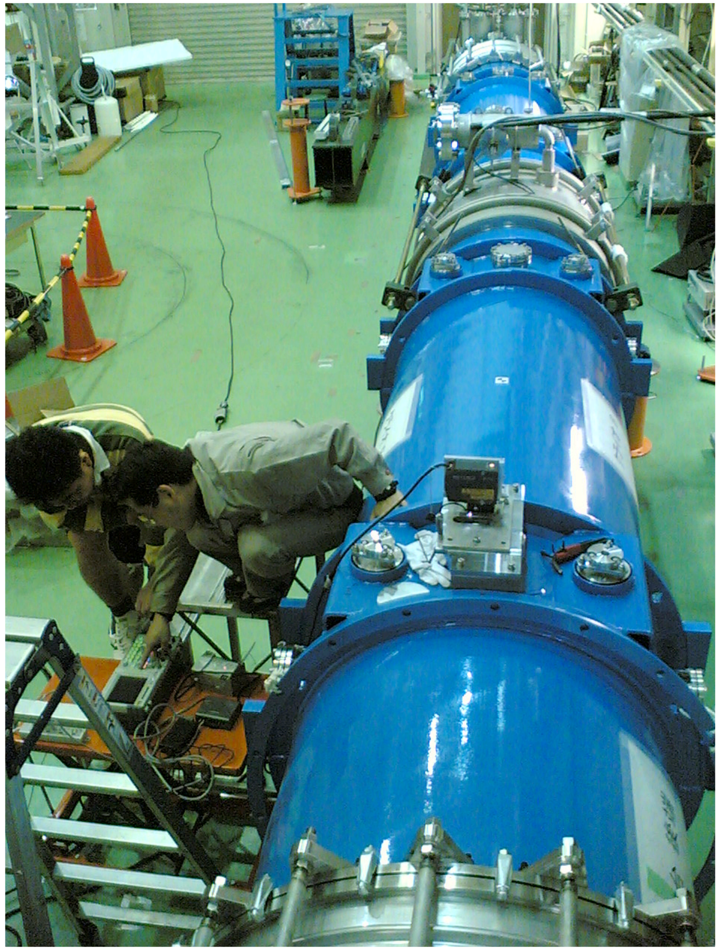
MIC magnets are designed for quick servicing – limited manpower to perform activation studies now.

SC magnet spare increased, failure mode analysis underway and horizontal field measurement developed for warm measurements and cold test by March 2007. Quench protection is robust.

Doublet Cryostat Test

- 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:

$\Delta X=0.03\pm0.06$

$\Delta Y=0.95\pm0.09$

$\Delta Z=5.8\pm0.4$

Primary Beam Line – Monitors

Position – ESM, Profile – SSEM, Beam loss, OTR @ target

Concerns

Reliability and serviceability, choice of position monitor LPM vs ESM, profile monitors in cryogenic section, beam loss monitors, OTR for target protection (backup).

Response

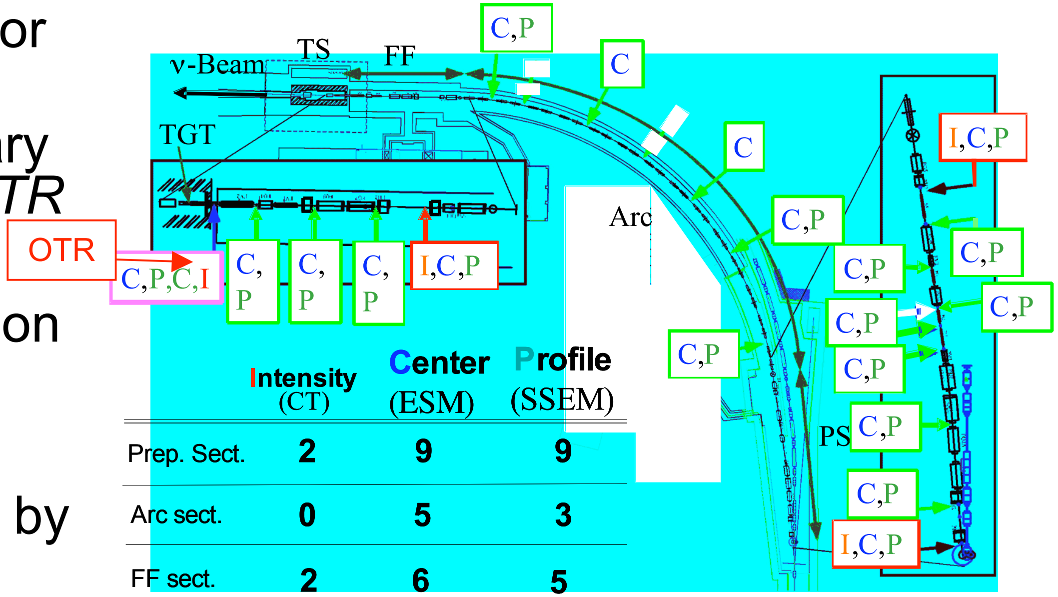
ESM has been selected for position monitor. Tests in KEK-PS beam show resolution of 0.3 mm.

Monitors are one of the collaboration areas. Good progress has been made with prototype testing. Cryogenic profile monitor may be useful so development will continue. Readout electronics being developed.

OTR design and testing underway (Canada). Backup is not needed at 1% design intensity as SSEM can be used.

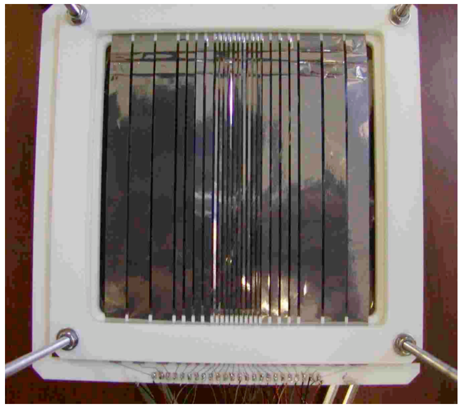
Beam Monitors

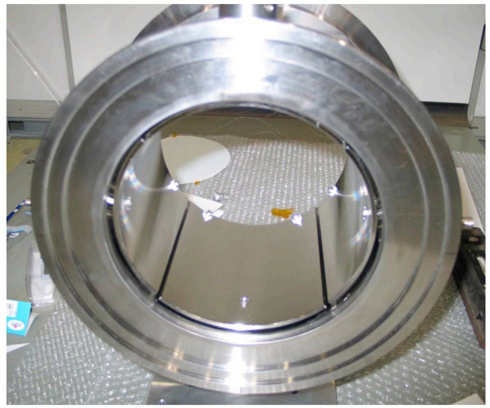
- Configuration
  - Position : Electro-static monitor (ESM)
  - Profile : Segmented Secondary Emission Monitor (SSEM), *OTR*
  - Intensity : CT
  - Loss monitors (BLM): Ionization chamber
- Status
  - ESM: Wave form reproduced by simulation, 0.3mm position resolution demonstrated for the T2K beam.
  - SSEM: ~0.25mm for position, ~0.23mm for width (beamtest at KEK NML)
  - Cryogenic / irradiation test for SSEM remote handler
- Engineering design to be finished by the end of this FY.



	Intensity (CT)	Center (ESM)	Profile (SSEM)
Prep. Sect.	2	9	9
Arc sect.	0	5	3
FF sect.	2	6	5

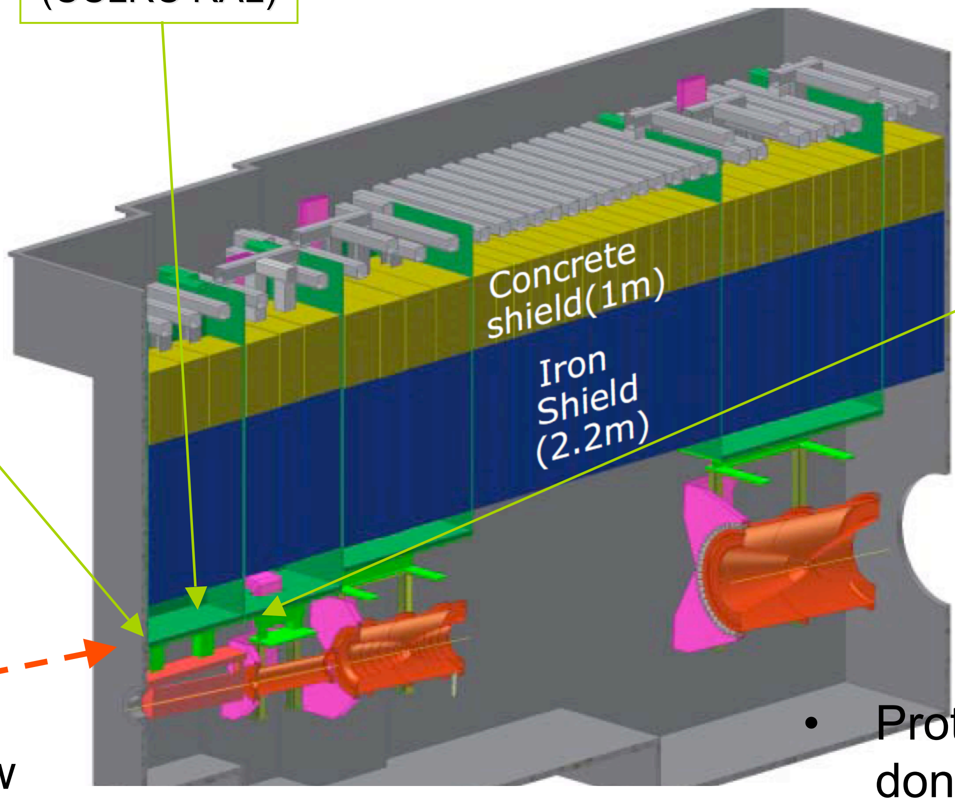
Beam loss monitor will be placed along the beam line.



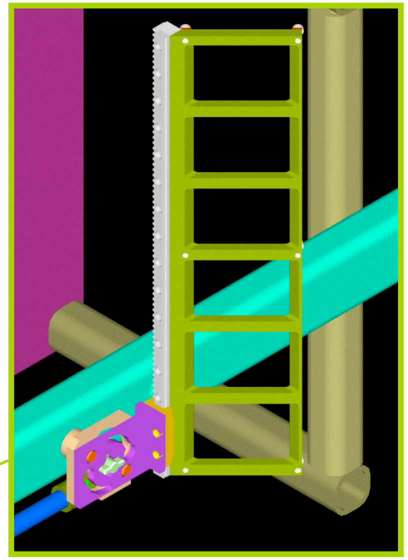


Beam Window / Target OTR

Baffle
(CCLRC RAL)



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

Final Monitor Station

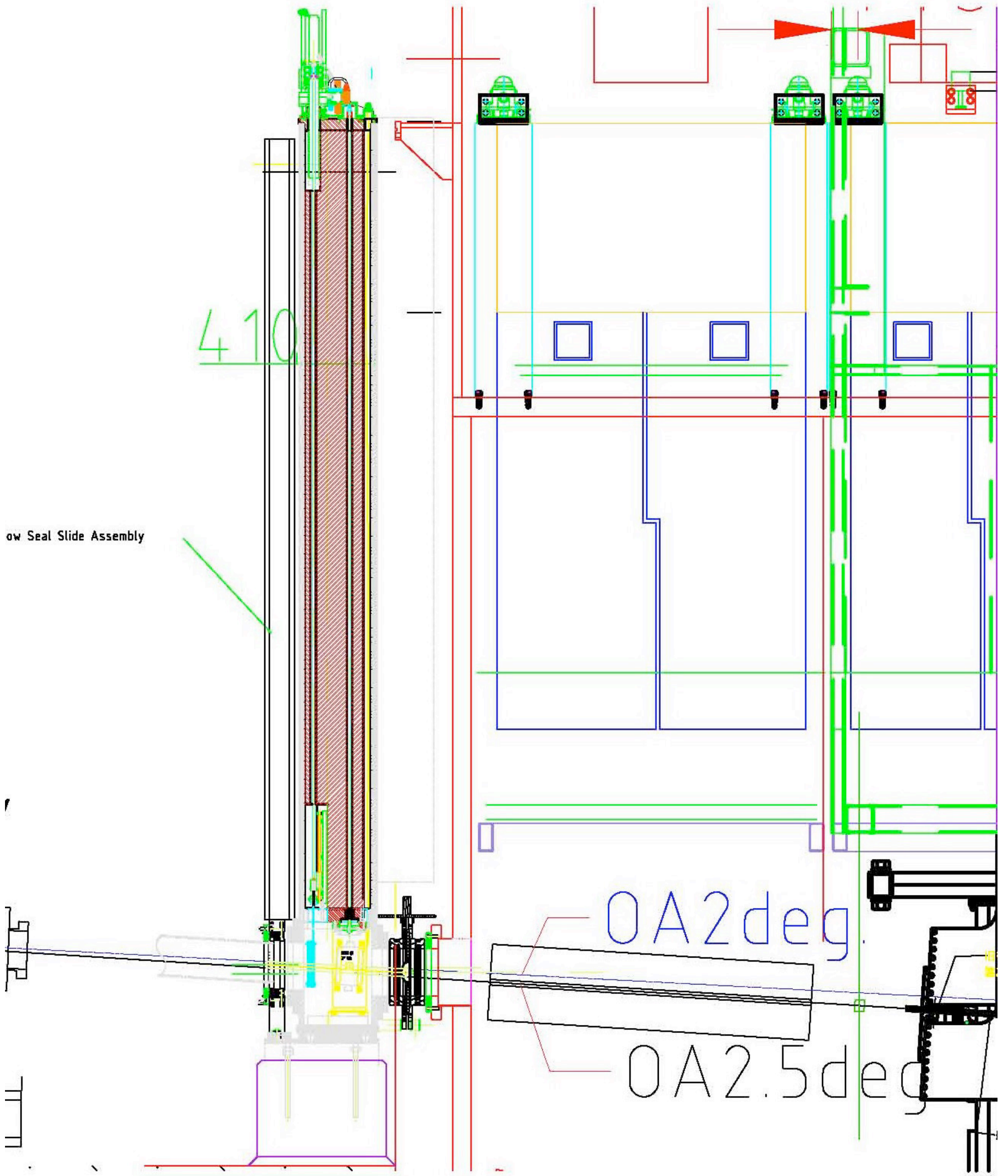
KEK-RAL-TRIUMF

Insertable profile monitor
Fixed ESM monitor

Beam window – Ti alloy separates the beamline vacuum from Target Vessel helium.

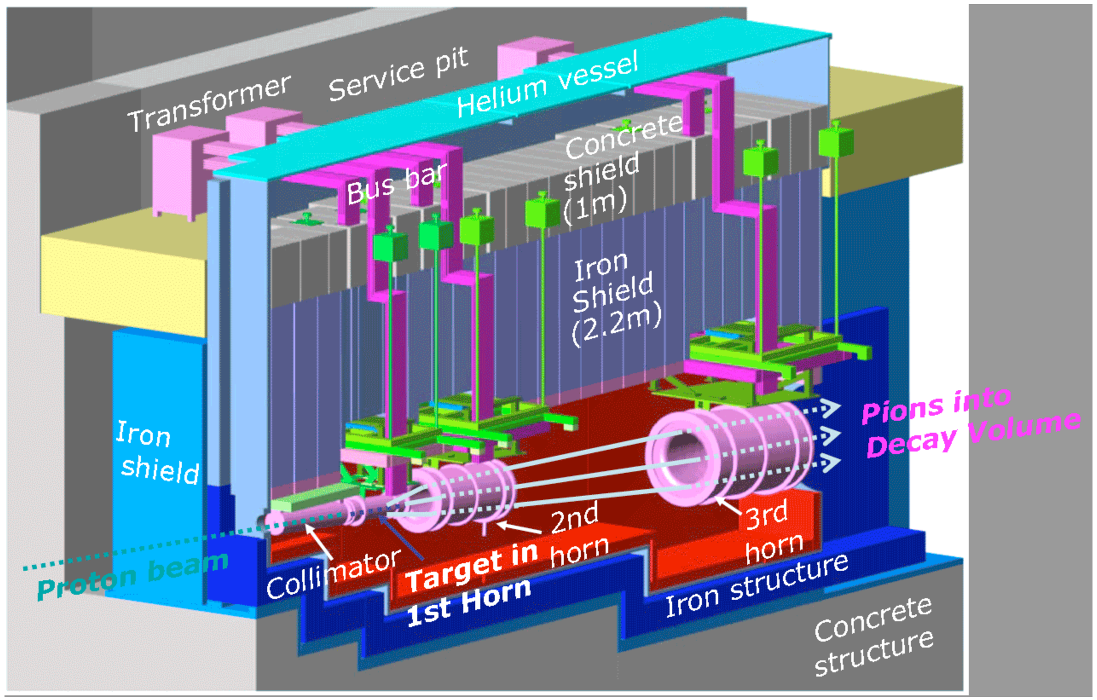
Pillow seal vacuum connections

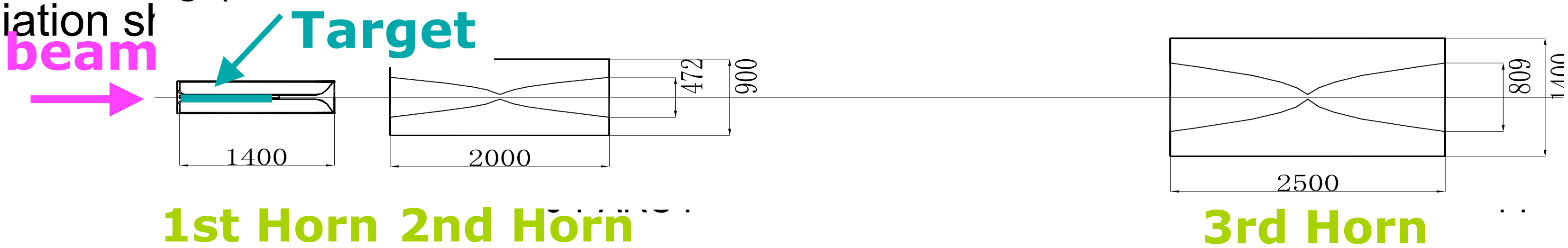
Remotely handleable.



Neutrino Target Station

- Target:
  - Graphite 2.6cmϕ x 90cm
  - 58kJ/spill (~20kW) load
  - Helium gas cooling
  - Baffle (Graphite, 1.7m long) in front of target
- Horns:
  - 3 horns operated at 320kA
  - Water cooled
- Area filled with Helium gas
  - reduce Tritium, NOx production
- Highly radio-activated
  - ~1Sv/h,
  - Need remote-controlled maintenance system
- Need cooling (Helium vessel, radiation sh





Target and Horns

Achievement: 320 kA operation of 1st horn prototype achieved July 2006 and now undergoing lifetime tests.

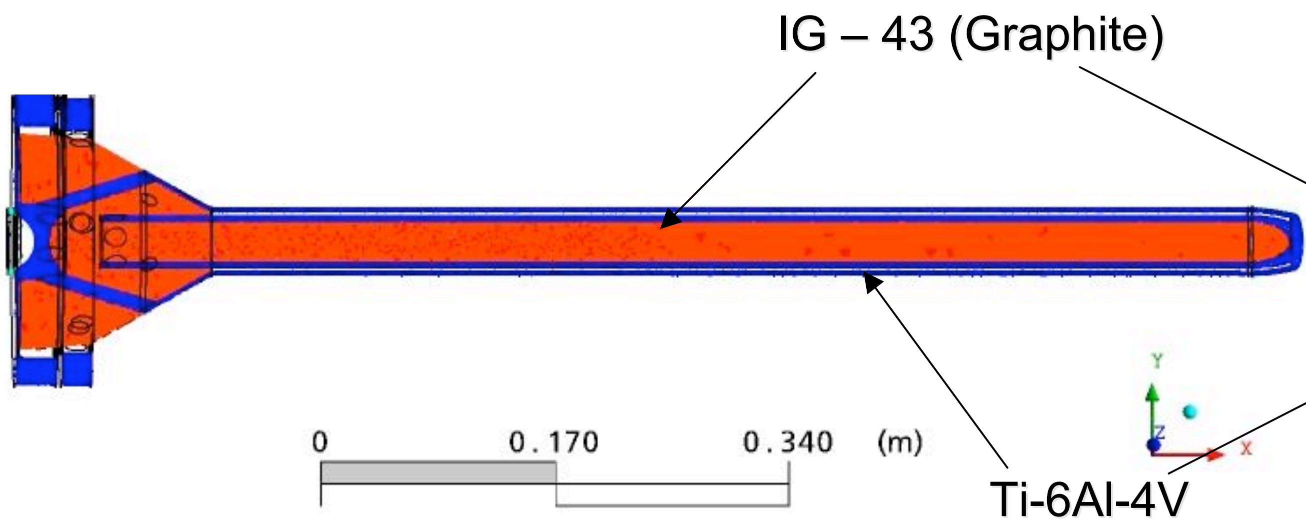
Concerns

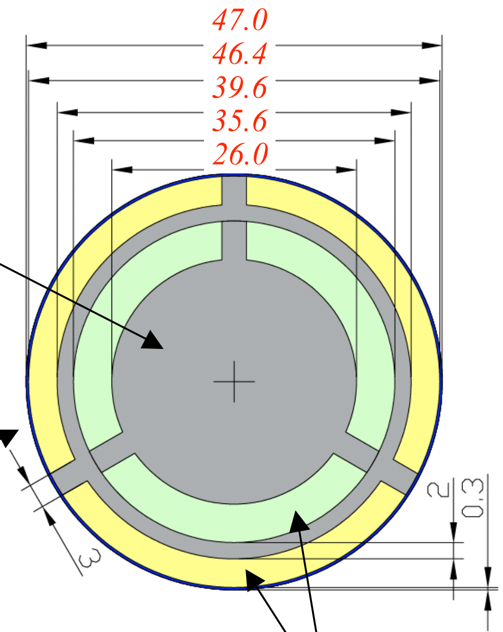
Details of horn exchange procedure, 320kA connections, installation and alignment/realignment.
Target helium cooling optimization and dynamic stress studies**.**

Response

Working on the development of the remote couplings of the horn and installation/alignment procedures.
Target is being designed in collaboration with RAL and various prototypes and tests are underway. Installation of a target in 1st horn in summer 2008.

Target





- 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 Station

Concerns

Floor space adequate for services infrastructure, shielding removal and component storage.

Specifications for the remote crane

Evacuation of the Target Station and decay volume for helium backfill.

Response

Shielding block removal has been studied and space OK for most situations.

Remote crane specifications are being discussed with manufacturer.

High purity helium requires evacuation and successful vacuum test of decay volume gives confidence.

Assembly of Helium vessel in Target Station by summer 2007, surface building and crane July 2008, horns and inner shielding by September 2008 (Critical Path)

Decay Volume, Collimator and Beam Dump

Concerns

Quality control on welds, material selection of collimator, instantaneous pressure and temperature rise from beam pulse, plate coil coupling method to reduce stresses, cooling water pipe arrangement, water leak detection.

Response

First 50 m completed before review – some leaks but repaired – successfully evacuated. Remaining decay tunnel and target vessel will be tested by dye penetrant and ultrasound.

Collimator material - iron cooled by plate coil method like DV.

Plate coil connection changed to U-shaped pipe, cooling issues being addressed, humidity sensors installed.

General – Controls, Radiation, Alignment & Project Management

Concerns

Activation of ion exchange resins in cooling systems, shielding issues. Control of neutrino beamline from central control room. Responsibility for maintenance of components.

Independent reviews of major design decisions and contract specifications. Questions on regulatory issues and safety requirements.

Response

Controls and radiation issues have been satisfied.

Procedure for review of specifications for contracts exceeding 5 MYen

Expert Committee on the safety of the J-PARC neutrino facility formed and review process underway.

Conclusions

- Response to ν-TAC recommendations have been addressed to the satisfaction of the committee members.
- No fundamental design concerns remain, although there are still many details that remain to be worked out and implemented.
- FY2007 and FY2008 are critical years for remaining prototyping, series production and installation.
- International collaborations have been a learning experience for both sides but are progressing nicely.
- Target Hall schedule is most critical as many components have to come together in sequence for this to be successful.
- Extremely important that components in the high radiation areas are well commissioned prior to running beam and getting activated.
- Goal of startup of neutrino beams in April 2009 is still OK.