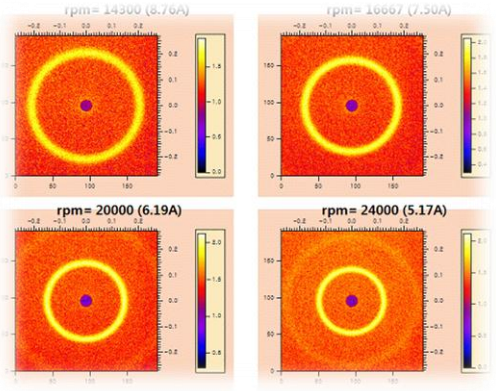
Cold Neutron Research Facility and its Utilization
at HANARO, 2003~2011



Chang-Hee Lee

(leech@kaeri.re.kr)

On behalf of CNRF project team,

Korea Atomic Energy Research Institute

IAEA Int'l Conf. on RRs: Safe Management & Effective Utilization , 14~18 November, 2011, Rabat, Morocco

Outline

- **RR History & HANARO,** the neutron source
- **Cold Neutron Research Facility** Project
- **Korean Neutron Users & Int'l network**

Outline

- **RR History & HANARO,** the neutron source
- **Cold Neutron Research Facility Project**
- **Korean Neutron Users**

RR history & Users program

1960 1970 1980 1990 2000 2010 2020

- 1962 TRIGA MARK II (200 kW)

- 1972 TRIGA MARK III (2 MW)

- Radiation Isotope
- Nuclear Fuel Test
- Materials Irradiation
- Neutron Beam Science

- 1985 HANARO (30 MW) Project launched
- 1995 HANARO 1st Criticality
- 2003 HANARO Cold Neutron Project launched

- 1998 Informal User Program
- 1999 Formal User Program (MOST)
- 2000 HANARO Users Association
- 2003 Korean Neutron Beam Users Association

Capability build-up

Users facility

- Rx construction
- Criticality &
- Initial operation

1985~1995

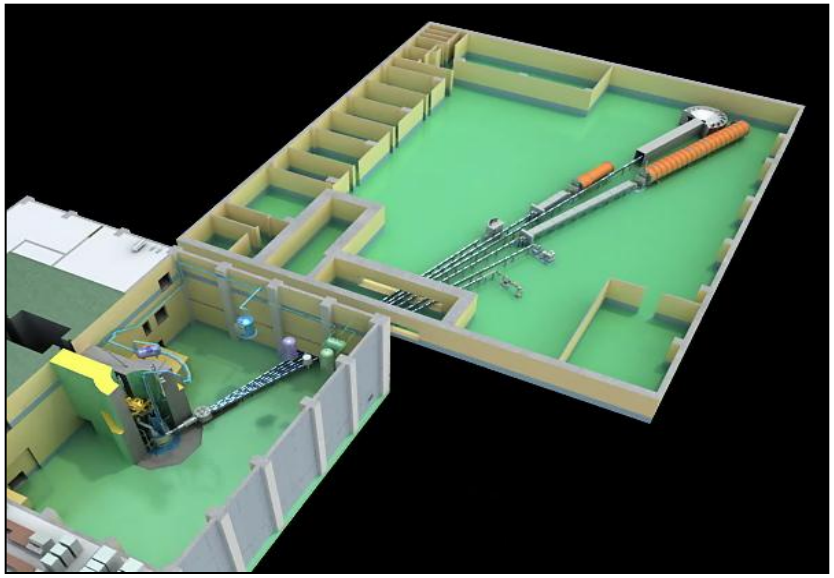
- Thermal instruments
- Users facility
- Neutron scattering R&D

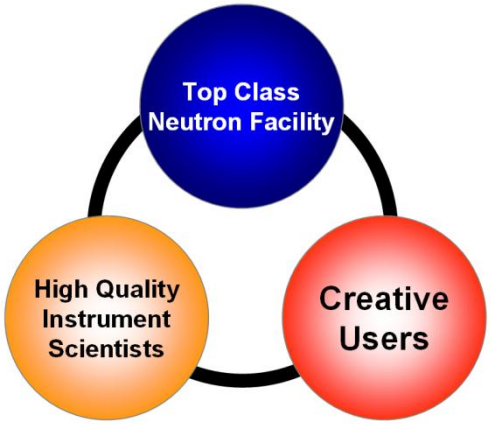
1995~2005

- CNRF project

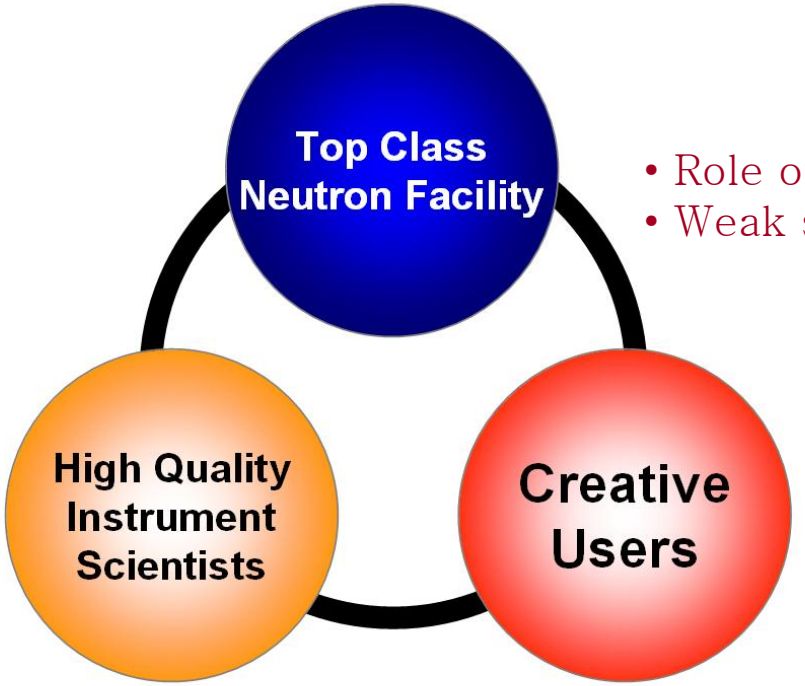
(2003~2010)

2010 ~ …





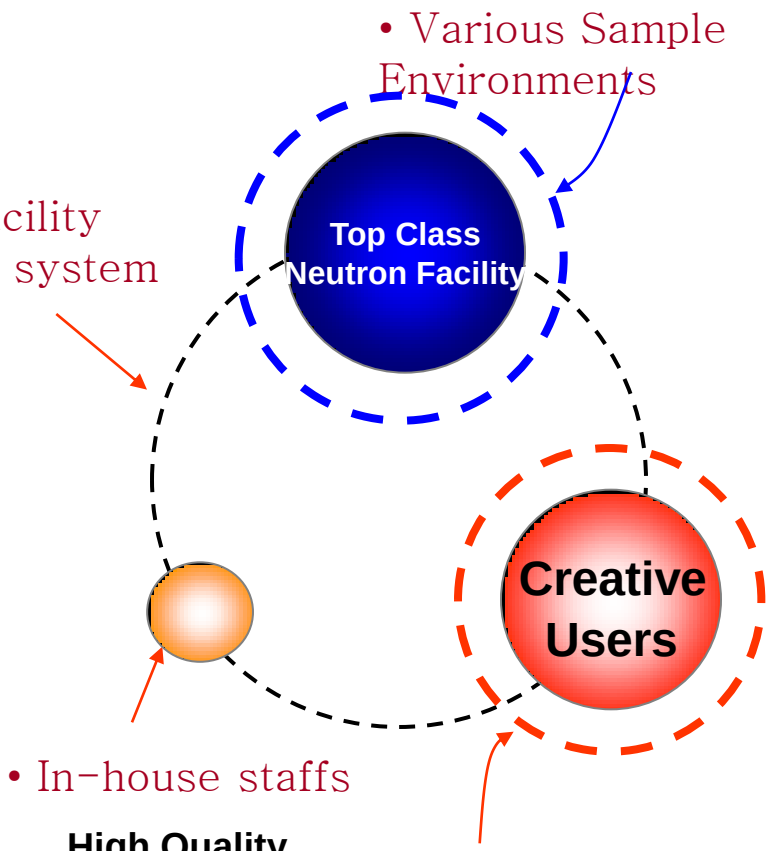
Objectives



- Role of Users Facility
- Weak supporting system

Competitive National User Facility & Users Program
instrument scientists **engineers & technicians** **sample environments**

Present Situation



Outline

- History & HANARO, the neutron source
- **Cold Neutron Research Facility Project**
- Korean Neutron Users

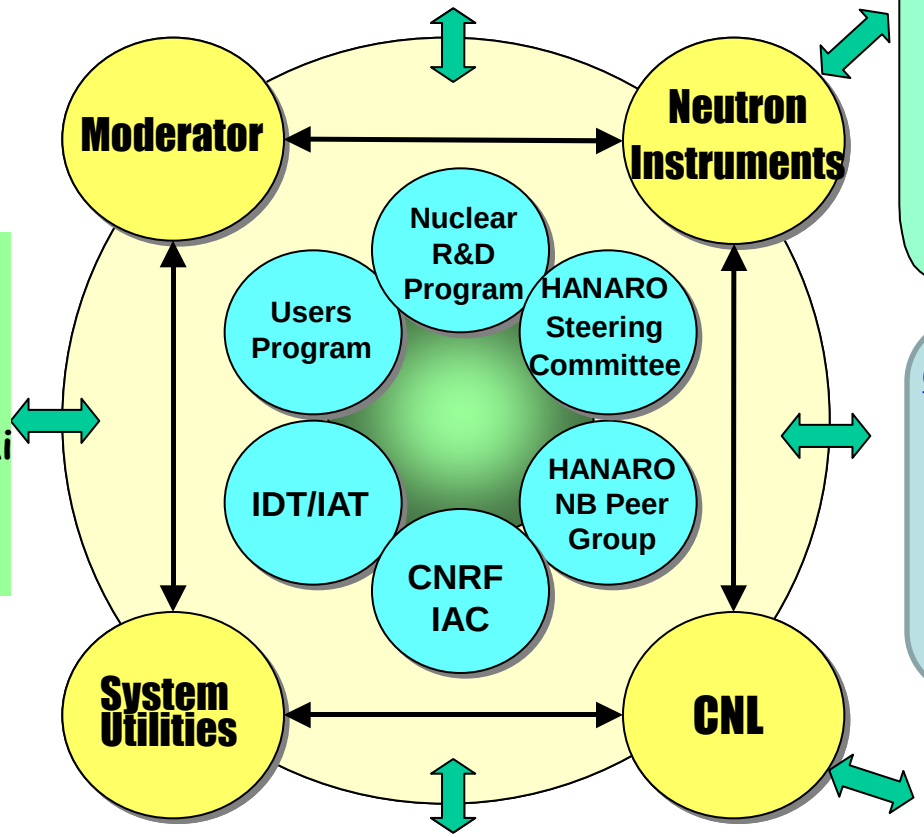
Project Structure

Collaborating institute:
NIST, JAEA, ORNL, ILL
FRM-II, ANSTO, HMI

New:
40M-SANS KAIST
Cold-TAS KAERI
DC-TOF SNU

Relocated:
12M-SANS KAERI
REF-Vertical KAERI
Bio-REF SGU

Companies:
Design: HEC
IPA: Moojin
Construction: Hyundai
Compressor: Linde



Guide: ,
SwissNeutronics
HANARO

Plug/PS:
Design: MTF
Construction: Suryuck

Licensing:
MEST/KINS

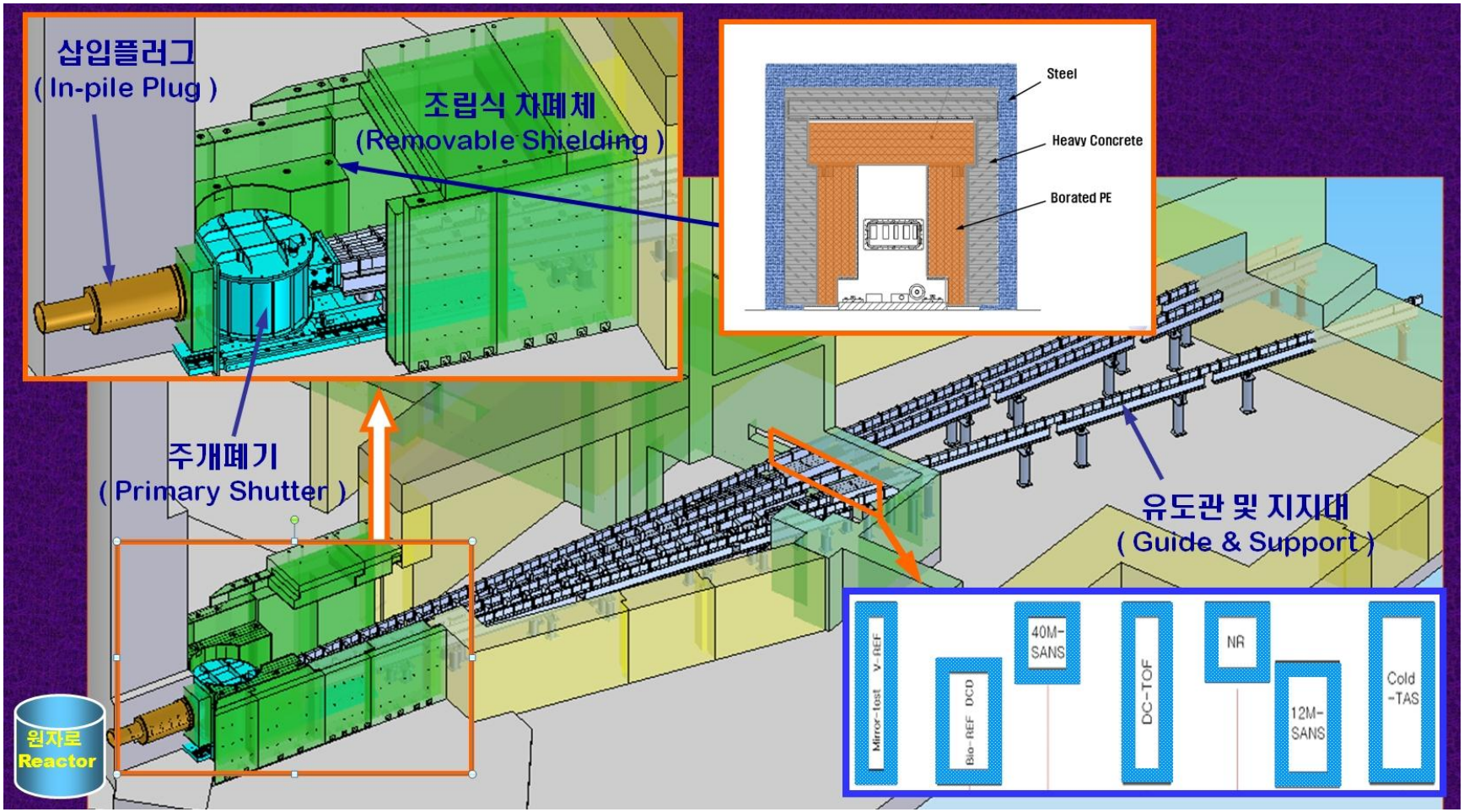
Design: HEC
Construction: HJH

CNRF outline

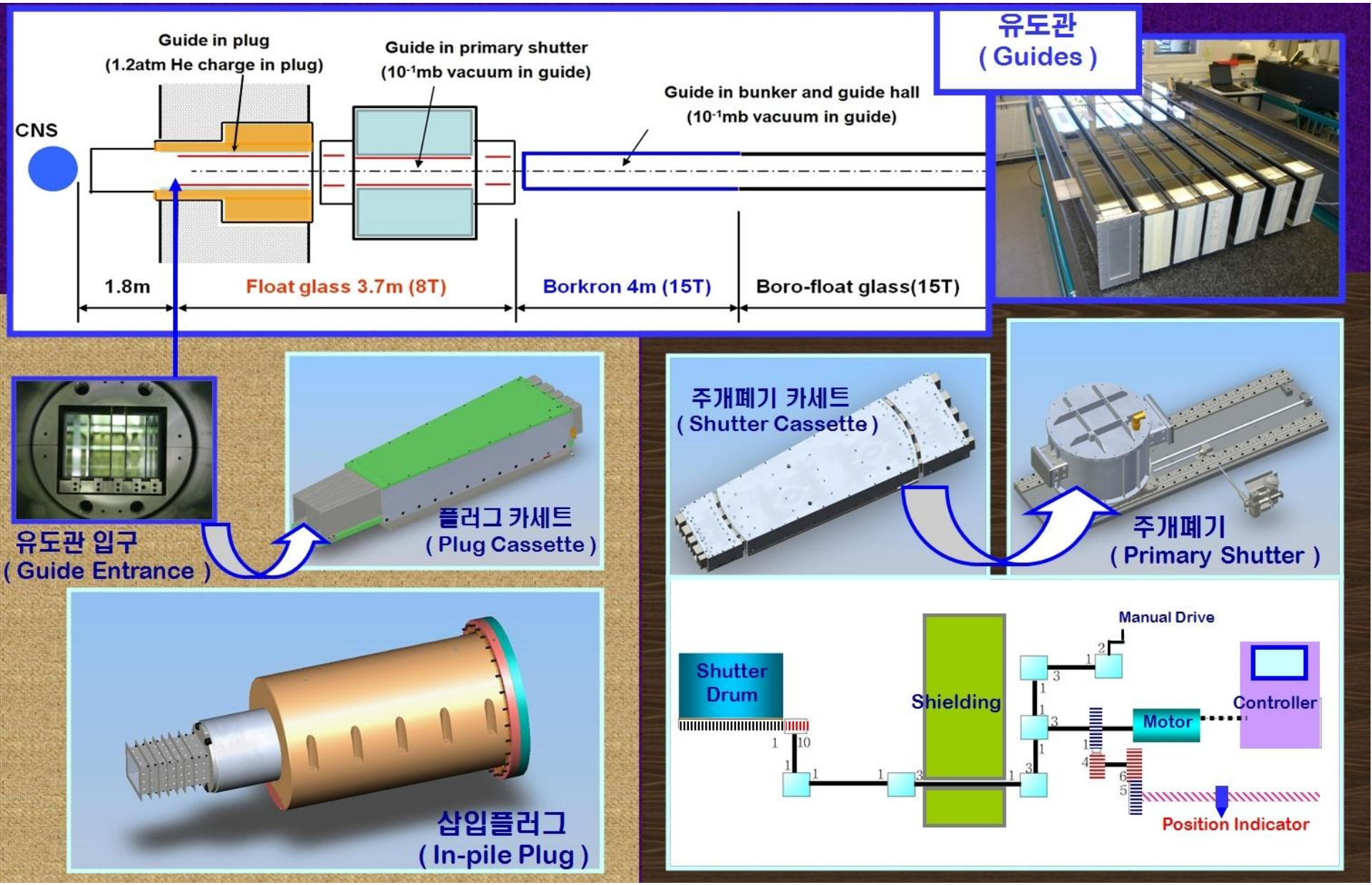
- Cold neutron guide
- Cold neutron instruments
- Technical development

- **Cold neutron guide**
- **Cold neutron instruments**
- **Technical development**

Neutron guides



Design & Fabrication



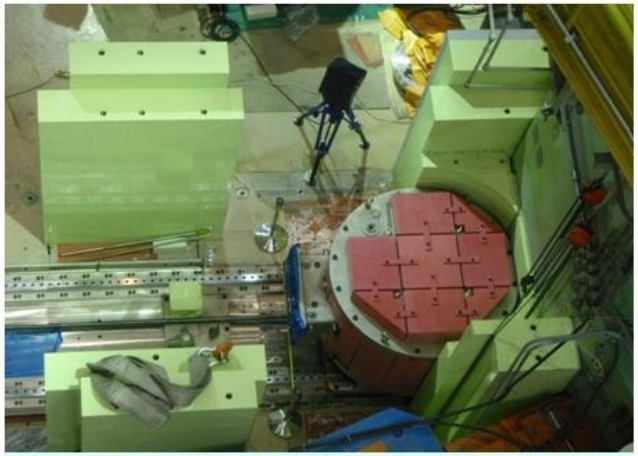
Plug & PS

기존 SANS 08. 4. 8

SANS 제거 2008. 8. 7

기존 플러그 제거 08. 8. 28

삽입플러그 설치 08.9.9



주개폐기 설치 08.9.30

조립식 차폐체 설치 08.10. 5

Installation & alignment

2009. 4

2009. 6

2009. 7

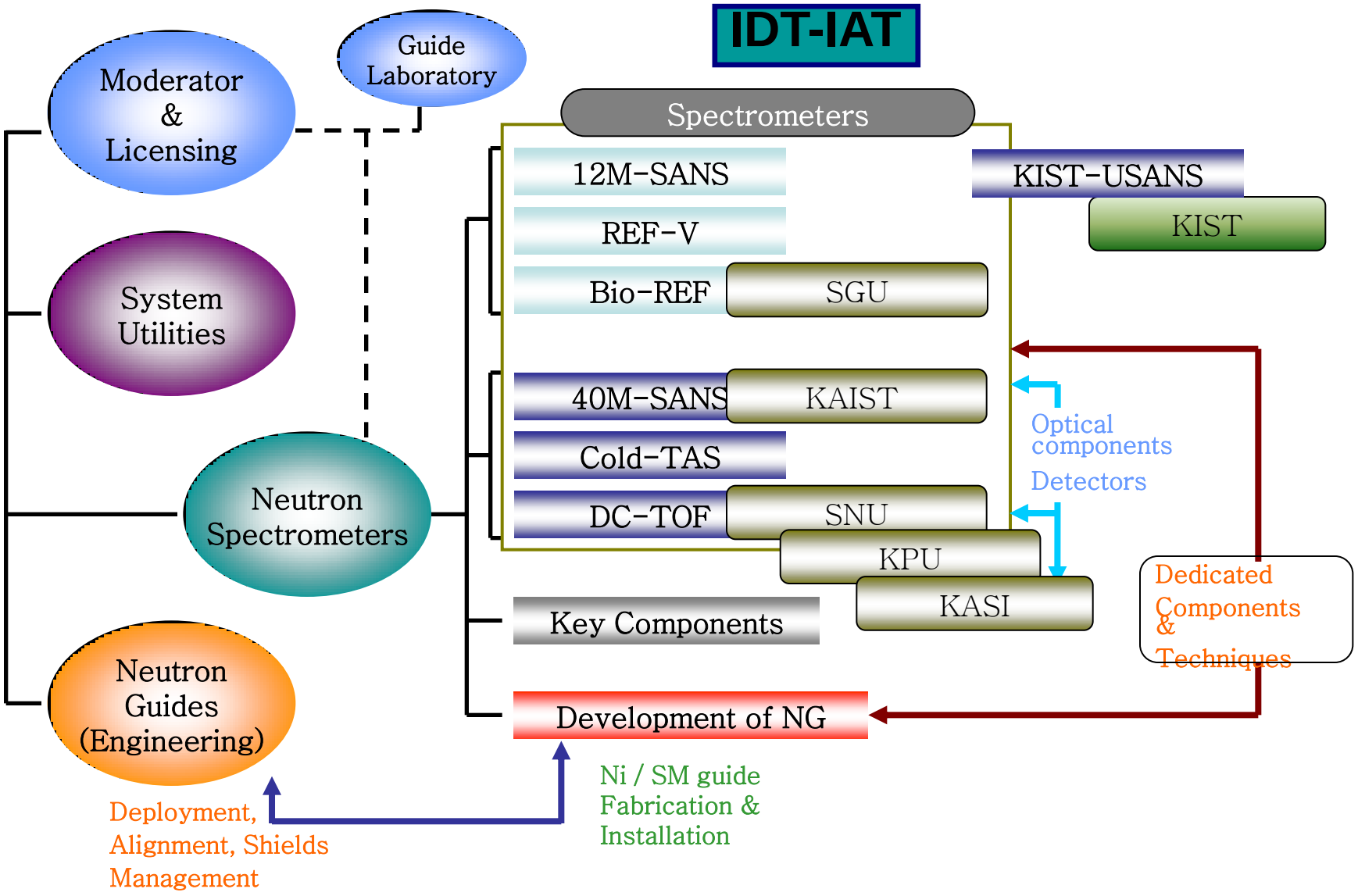
2009. 9

2009. 9

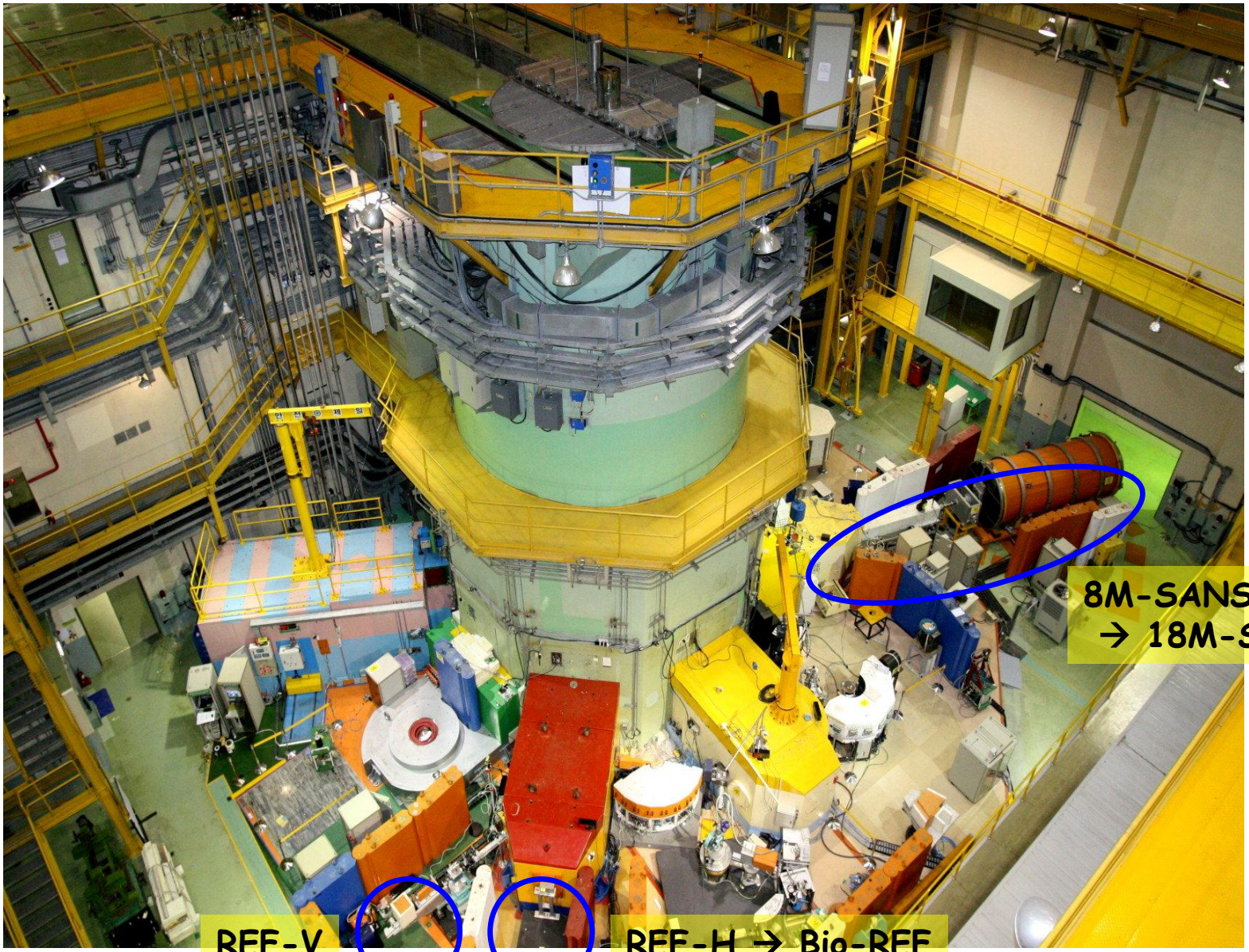
2009.10

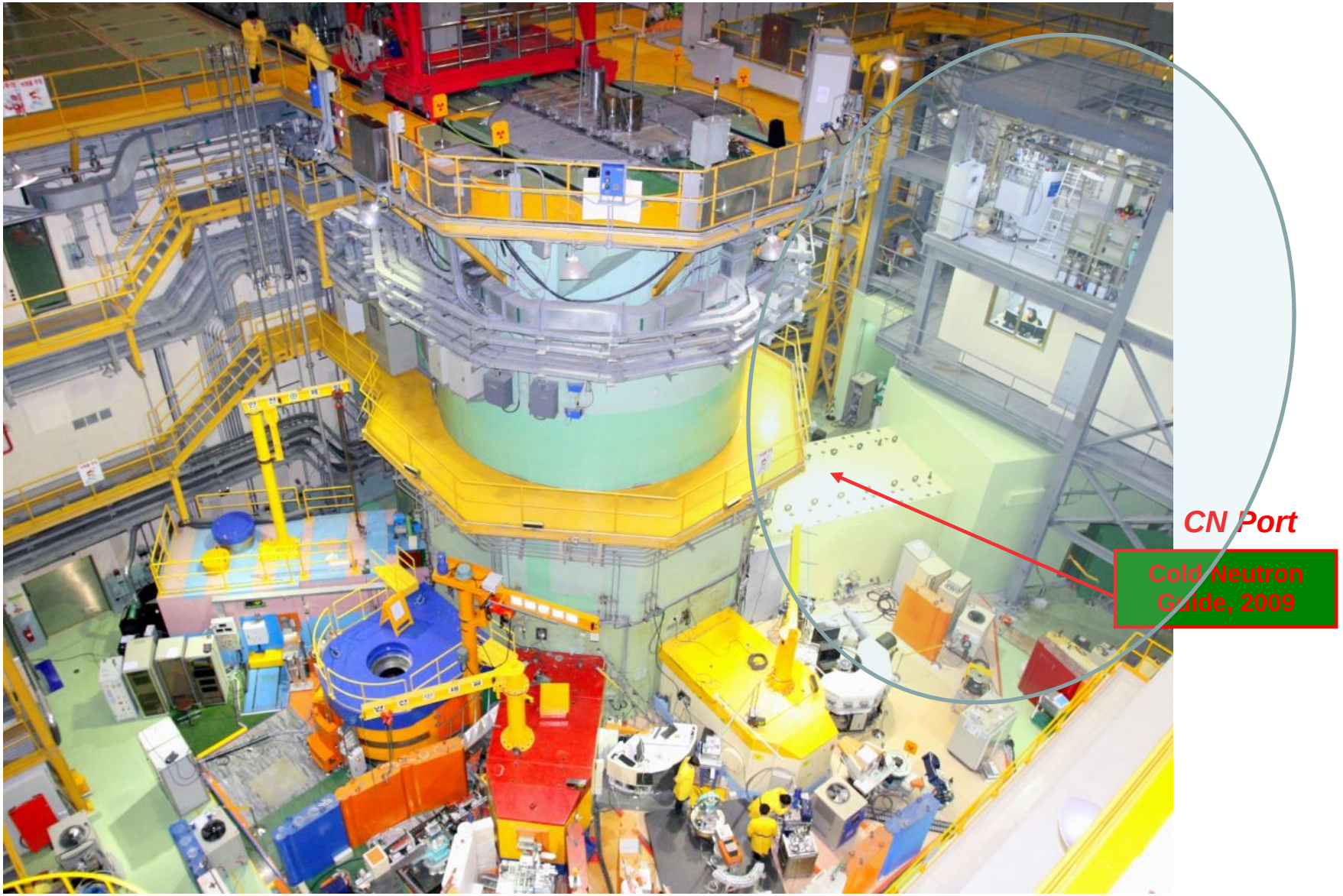
- HANARO & Thermal Sources
- **Cold neutron instruments**
- Technical development

Project Structure - NI



Instruments - before relocation

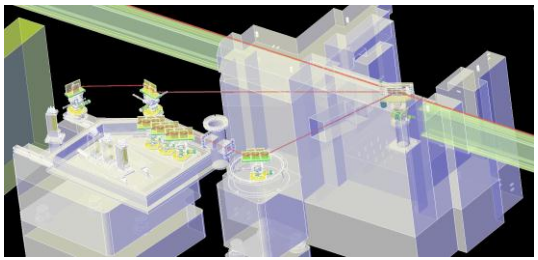



CN Port
Cold Neutron Guide, 2009

Instruments – new

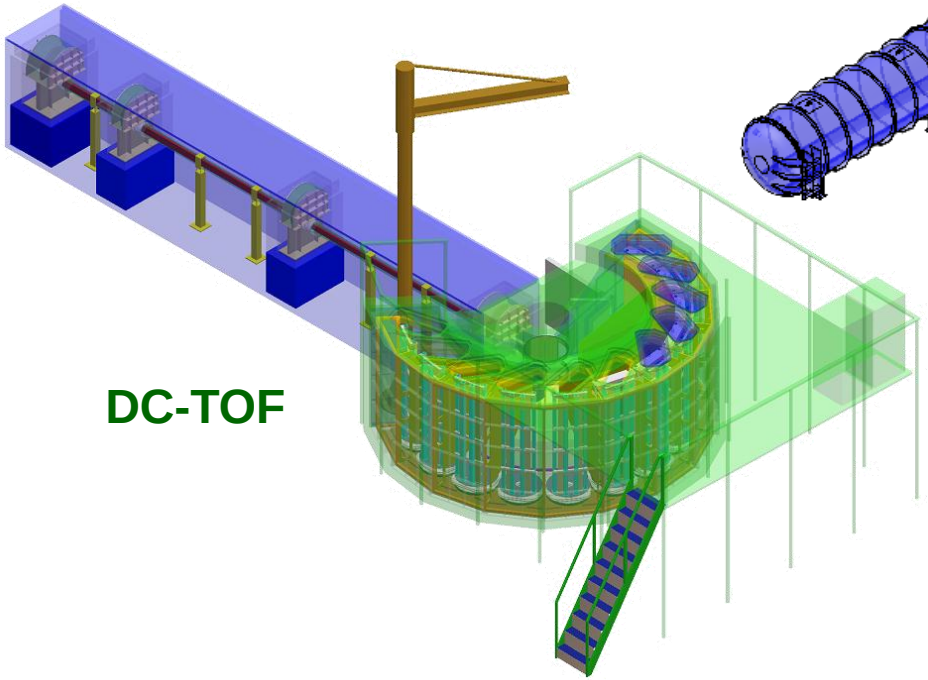
- ✓40M-SANS
- ✓Cold-TAS
- ✓DC-TOF

- ✓KIST-USANS

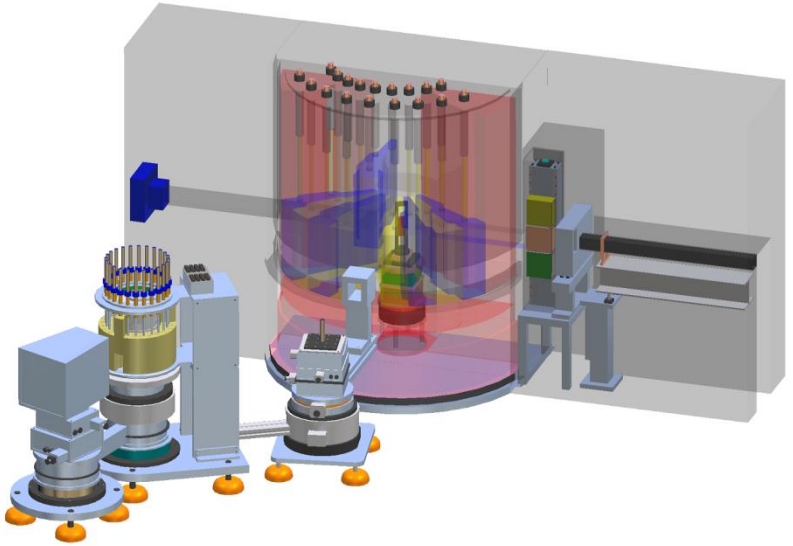


KIST-USANS

40M-SANS

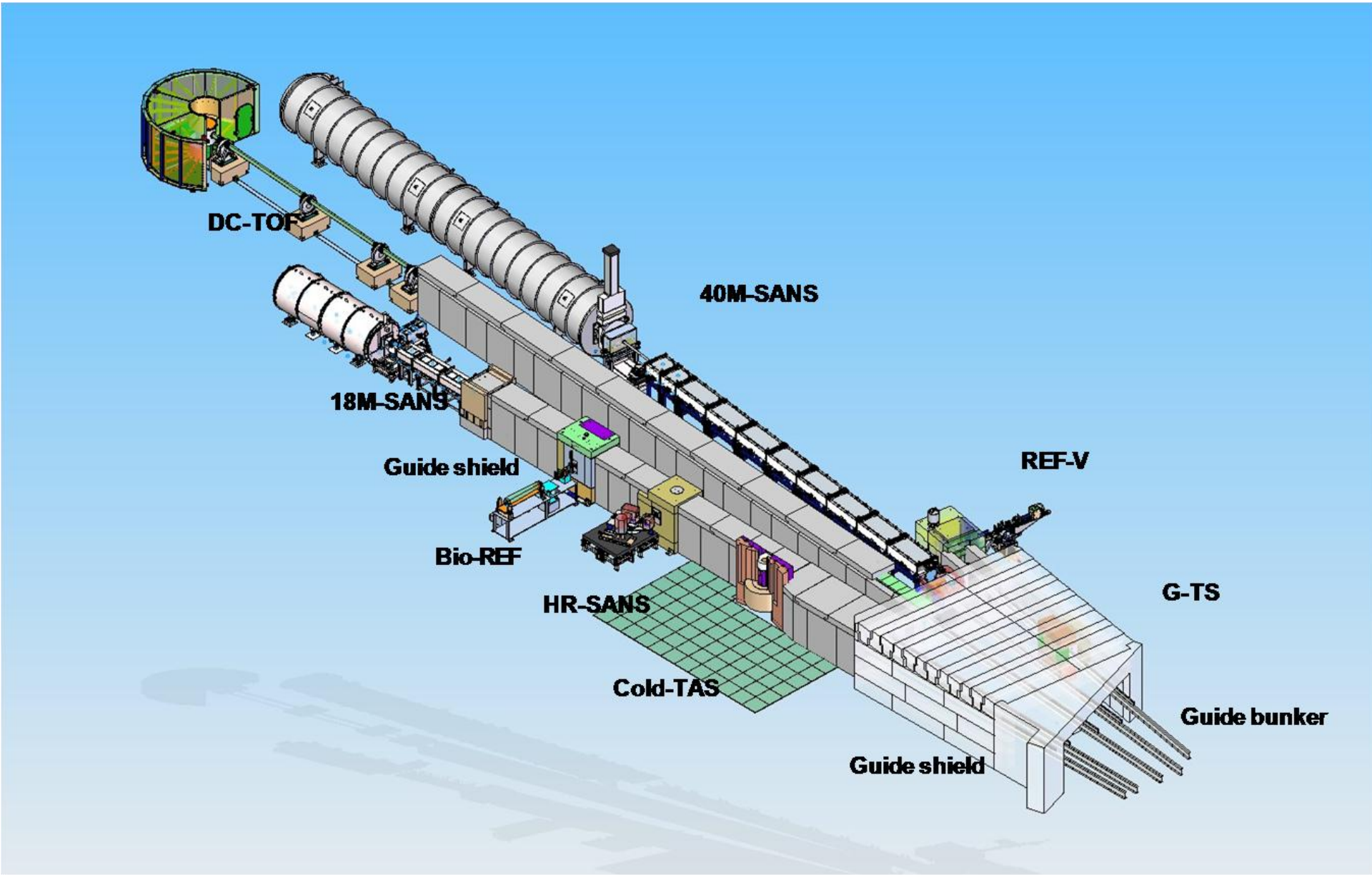


DC-TOF



Cold-TAS

Layout of the Cold Instruments




2008. 11. 6.


2010.04.13.

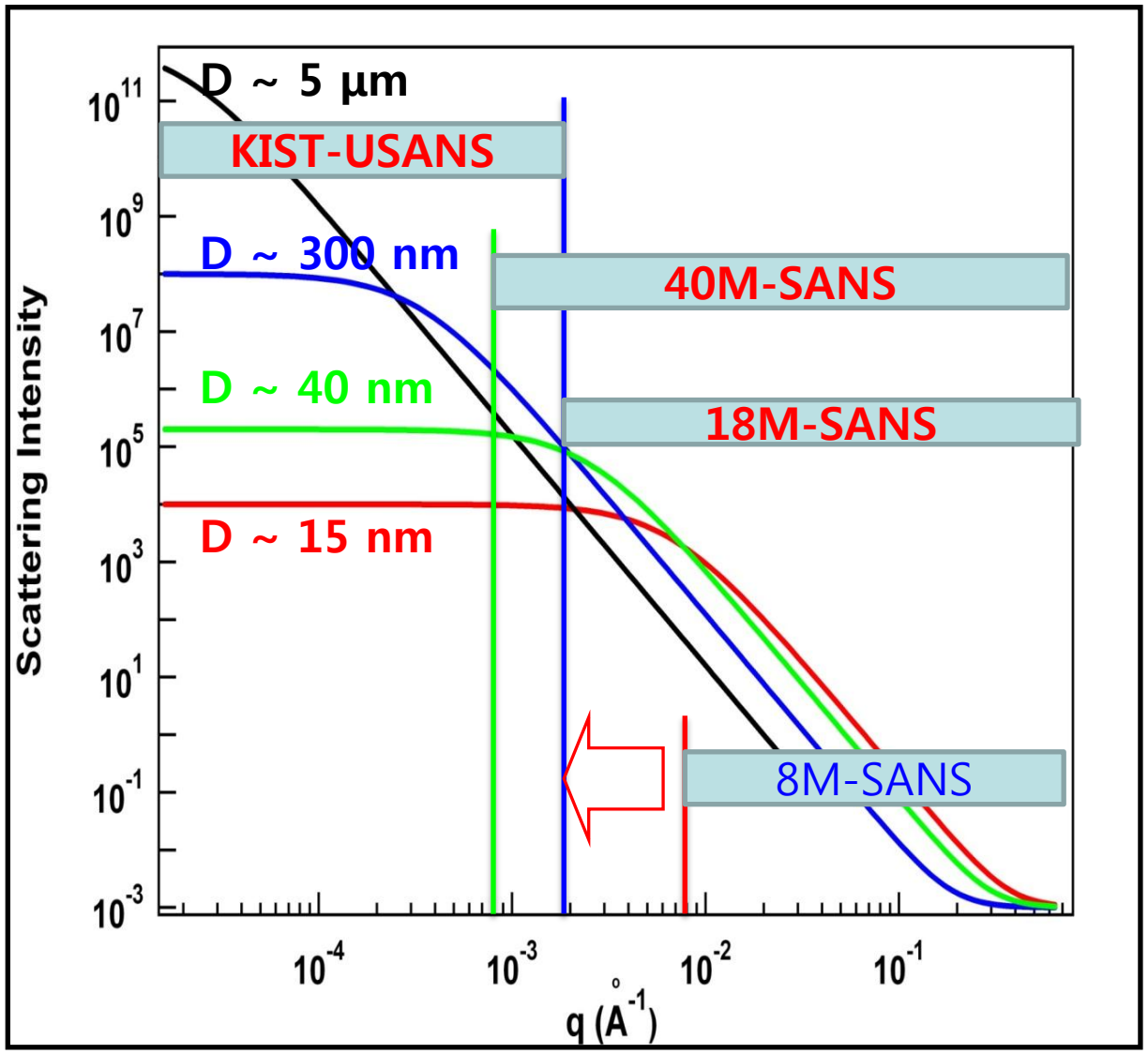

2010.10.13.

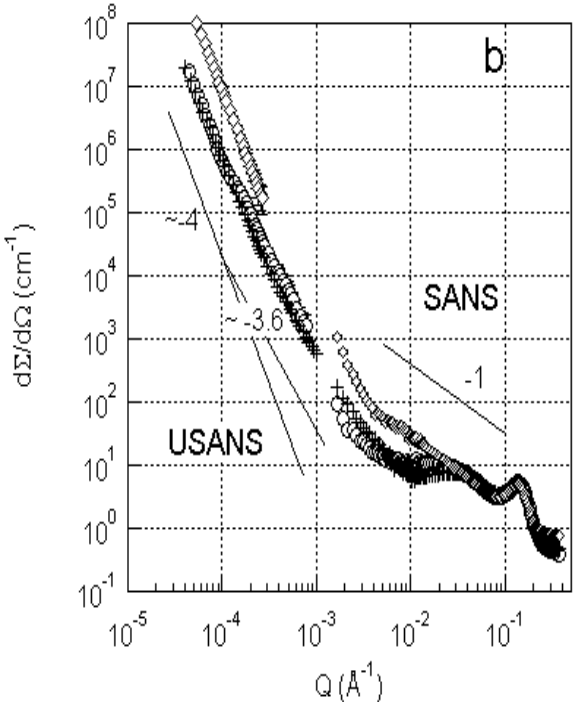
Current status as of 2011

- 40M-SANS fully Operational
- 18M-SANS fully Operational
- KIST-USANS Commissioning, final
- REF-V Commissioning, final
- Bio-REF Commissioning, final
- Cold-TAS Commissioning, initial
- DC-TOF under Construction
- G-TS fully Operational

HANARO SANS Q-range

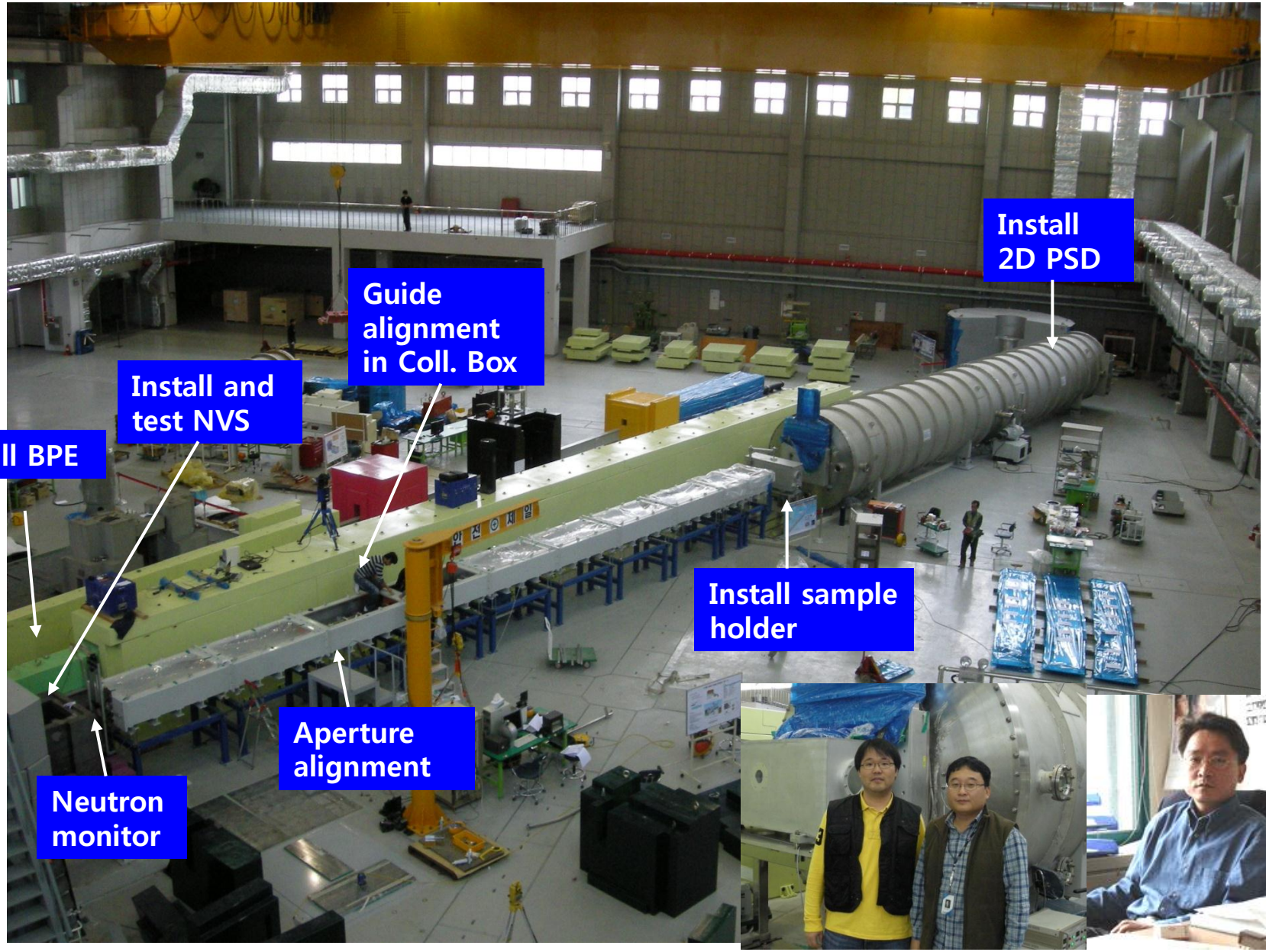
40M/18M-SANS/KIST-USANS





With the thickness of Nafion Membrane
NIST, Macromolecules (2006), 39, 4775

40M-SANS


Install
2D PSD
Guide
alignment
in Coll. Box
Install and
test NVS
Install BPE
Install sample
holder
Aperture
alignment
Neutron
monitor

Main Instrument Parameters

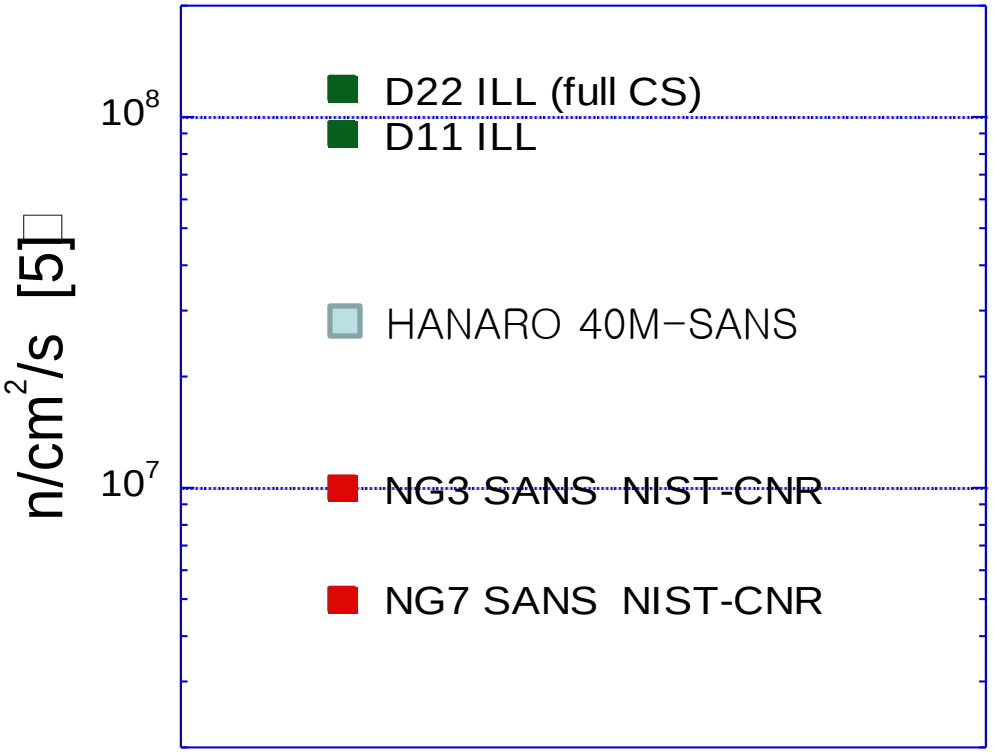
Parameter	Value
Total Instrument Length (m)	40
Detector Dimensions (cm^2)	100 x 100
Detector Resolution (cm^2)	0.5 x 0.5
Detector supplier	ODELRA, 21000N
Velocity selector supplier	ASTRIUM
Max. Selector Transmission (%)	10%
Wavelength range (Å)	4 – 20
Wavelength spread (FWHM, %)	10 – 20 (or wider)
Removable guide cross section (cm x cm)	5 x 5
Guide coating	Ni
Source to sample distance (m)	2 - 20 (steps : 2m)
Sample to detector distance (m)	1 – 20 continuously (Actually 1.1 – 19.8)
Max. detector offset (cm)	50
Sample diameter (mm)	5 – 25
Q-range ($Å^{-1}$) (with lenses)	0.001 – 1.0 (>0.0007)
Neutron polarizer	YES(to be installed)
Refractive Focusing Optics	YES(to be installed)

Calibration

- Standard sample, AgBe
- NVS rpm speed
- NVS tilting
- Spatial resolution by Pin-hole measurements
- Deadtime measurements
- Comparison with old data using same sample and other instruments

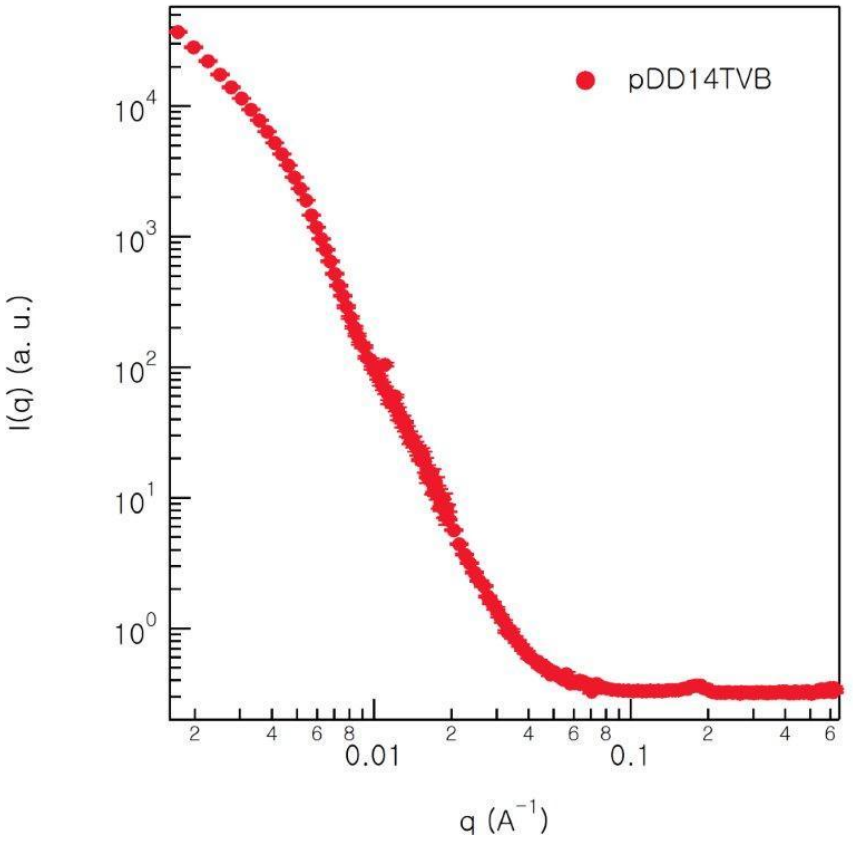
Neutron Flux at Sample Position

Neutron flux at sample position



Wavelength of 5Å
Collimation length of1.7 m

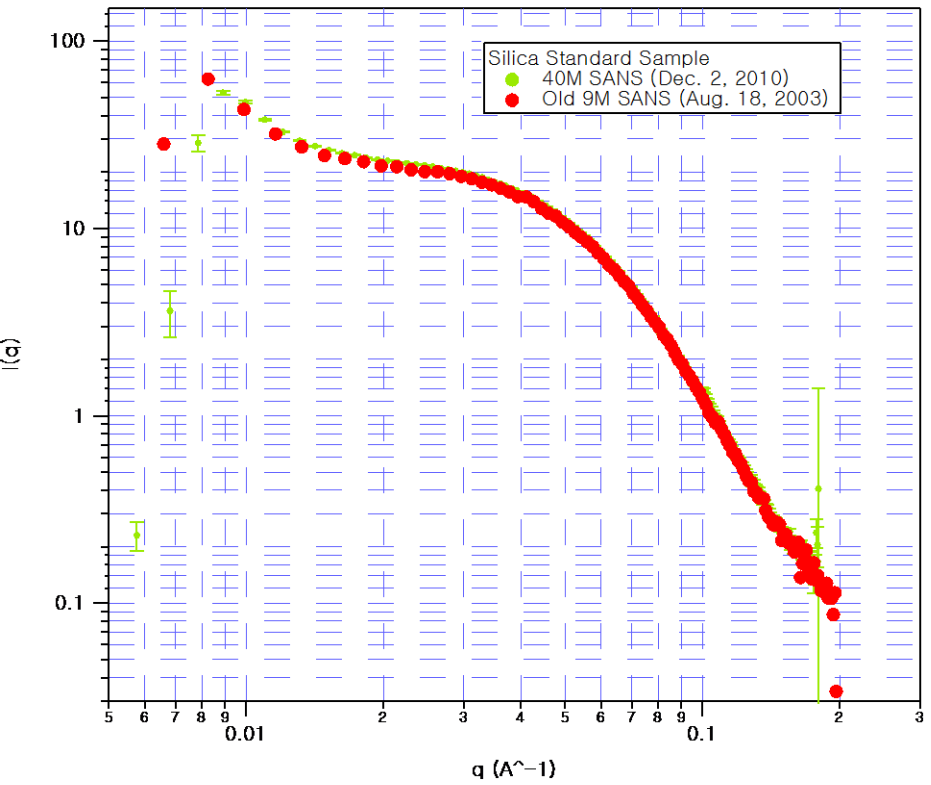
SANS data of micelle



Wavelength of 6Å
SDD = 19.85m, 5m, 1.16m
Q range = 0.0017 – 0.7 Å^{-1}

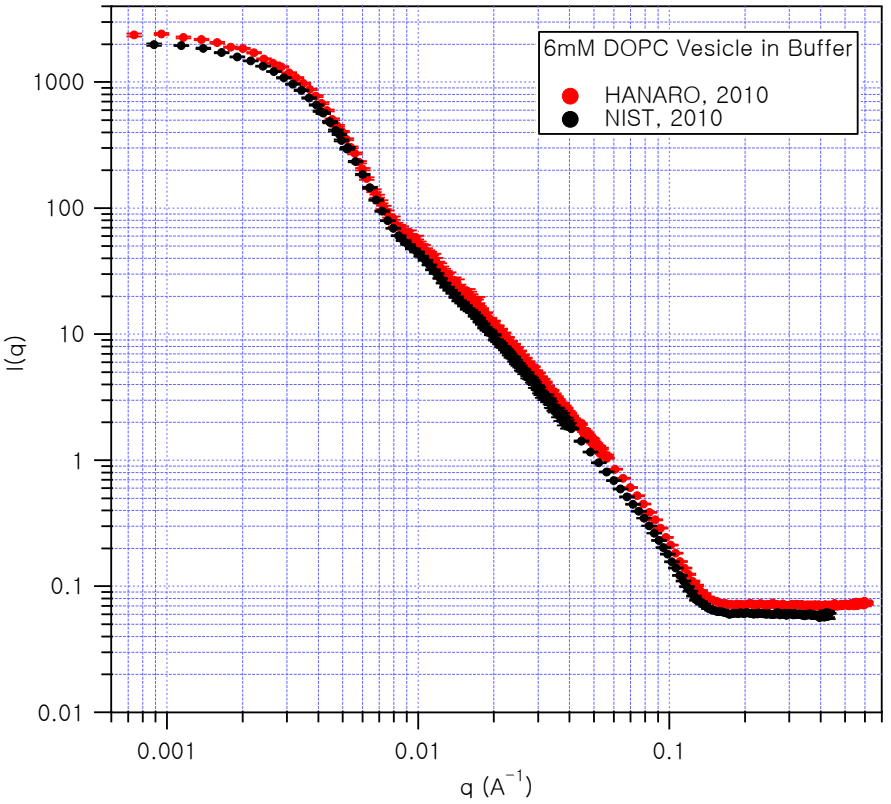
Comparison of SANS Data

Old & New HANARO SANS Instruments



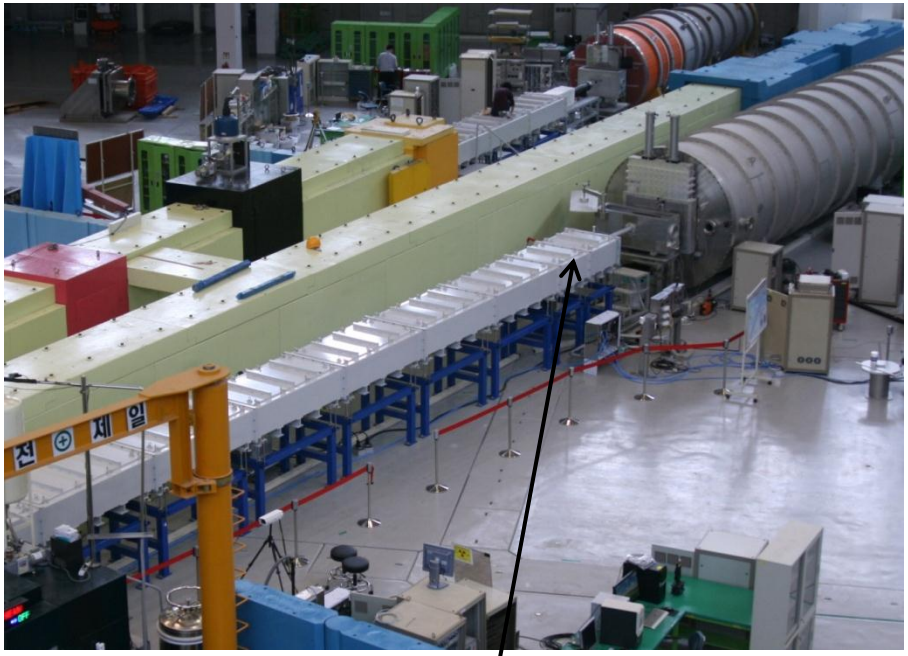
- Both are absolutely calibrated with Silica Standard

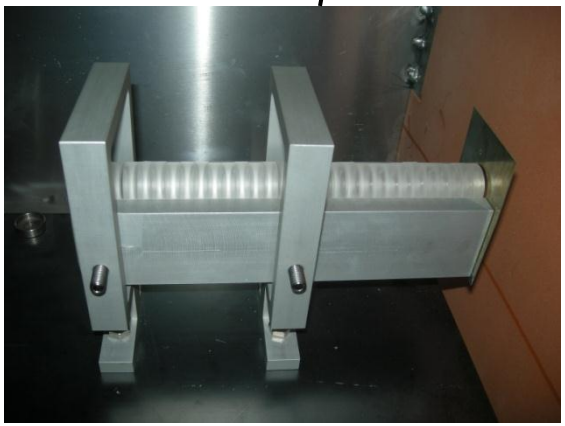
HANARO & NIST NG-7 SANS Instruments

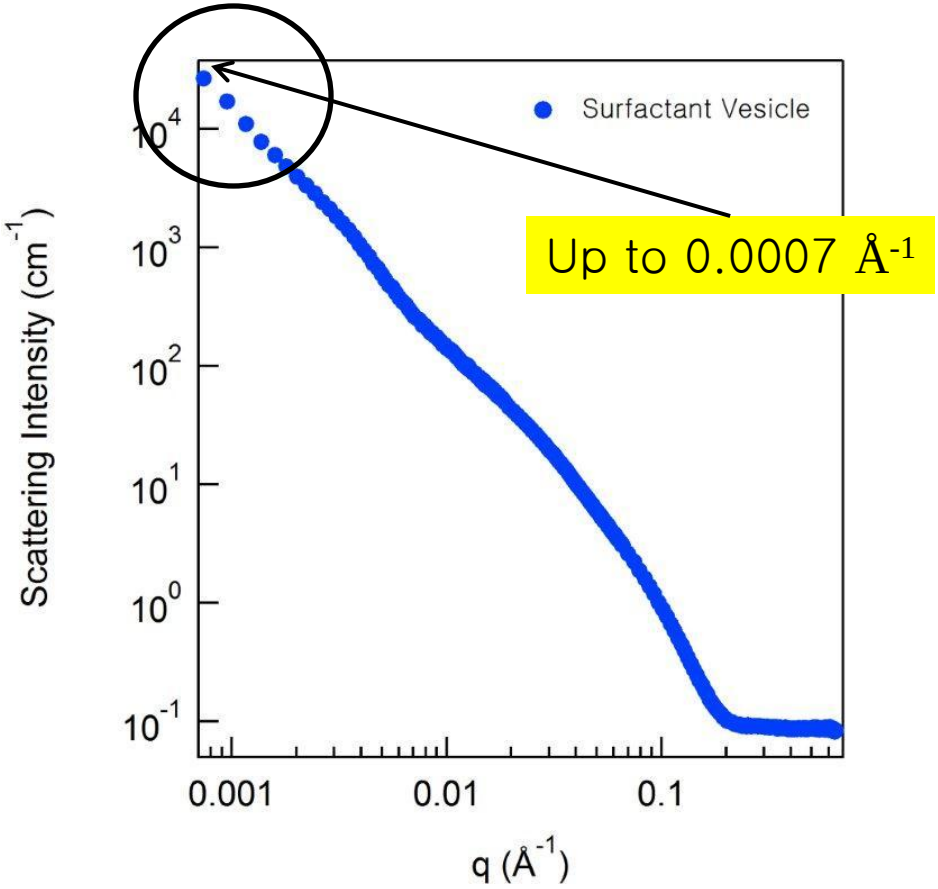


- NIST data are absolutely calibrated with using direct beam method

MgF2 Focusing Lenses



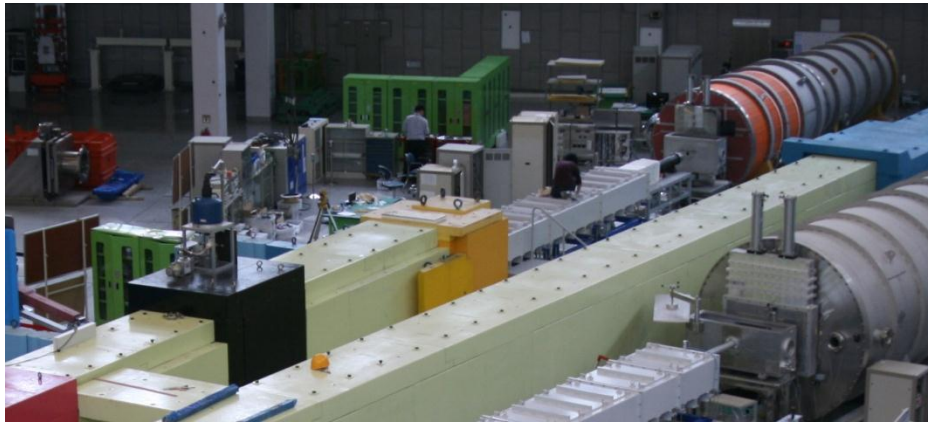




Wavelength of 7.49 Å for lense, 6Å
SDD = 19.85m(lense), 5m, 1.16m
Q range = 0.0007 – 0.7 Å^{-1}

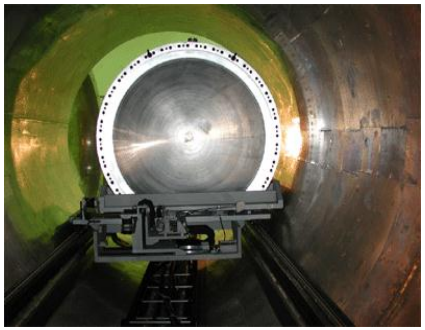
18M-SANS

8M-SANS at Rx Hall(2001)

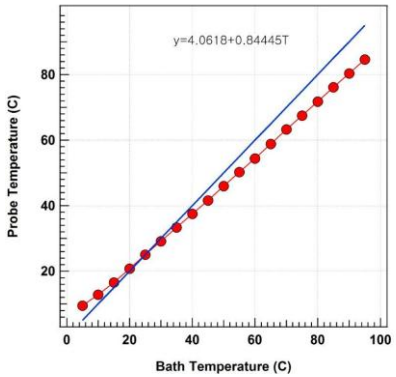


18M-SANS at guide hall (2011)

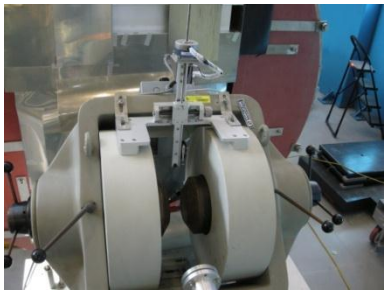
- Location : CG4B guide
- Total length : 18M
- Monochromator : mechanical velocity selector (DORNIER)
  . Transmission : ~ 90%, FWHM: ~ 12 %(normal)
- Wavelength : 4 - 11 Å
- Collimation : Ni –coated mirror
  . Length: 9m (three steps), beam size : 5cm x 5cm
- Measureable Q_range : 0.002 – 0.7 $Å^{-1}$
  . size : 1 ~ 100nm
- SDD: 1.3 ~ 9 m (variable)
- Detector : 2D-PSD (ORDELA 2600N)
  . Active area : 64 cm x 64 cm, resolution : 0.5 cm x 0.5 cm
- Neutron polarizer)/lens system



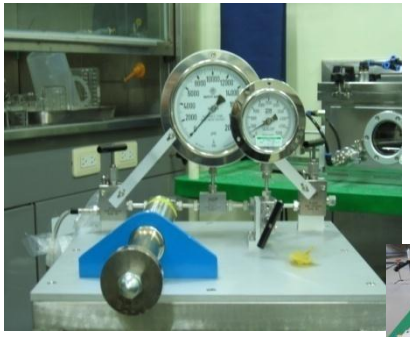
Sample environments



- Circulation Bath
  - Bath volume : 30L
  - Tem. Range : -10˚C ~ 90˚C
  - Control : PID control with Pt-100Ω
  - Cooling capacity : 550kcal/Hr

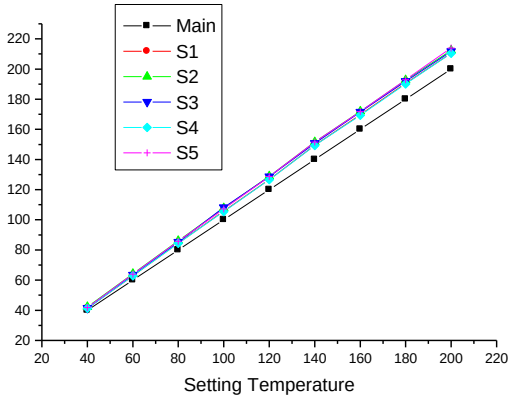


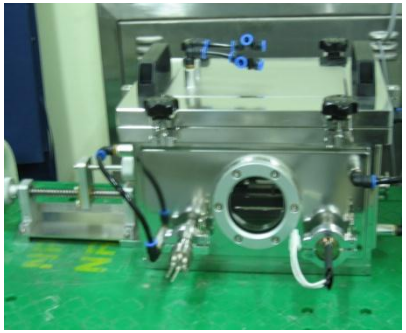
- Electromagnet
  - Gap : 0.165-18.42 cm
  - Field : max 1.5T
  - Type : Horizontal



- Pressure/temperature
  - Pressure : 30,000PSI (measured < 20,000 PSI)
  - Tem. Range : RT ~ 250 C
  - Window : Sappire

- Heating block
  - Tem. Range : RT ~ 250˚C
  - Control : PID control with Pt-100Ω



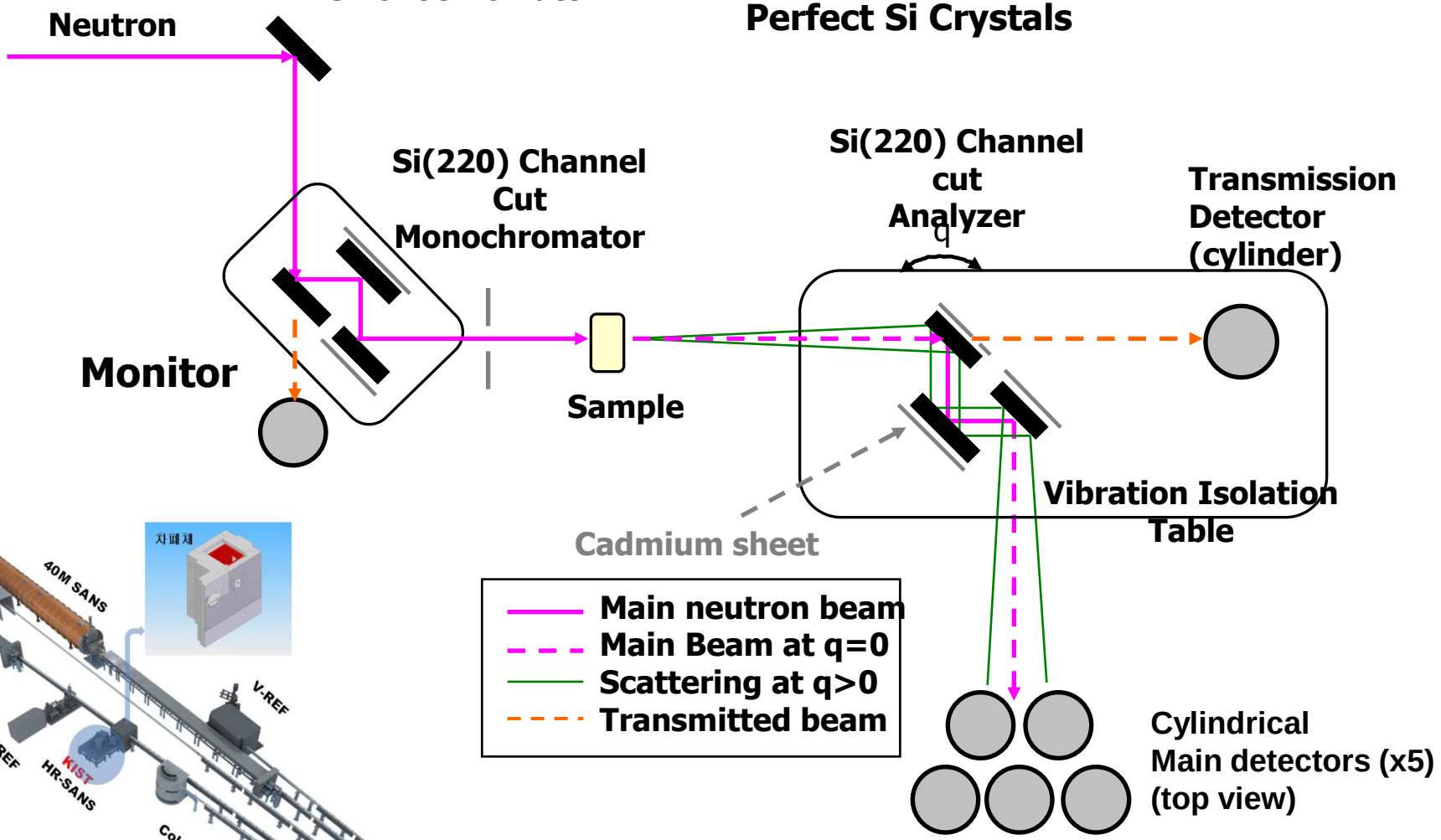


- Furnace
  - Tem. : RT ~ 600 C
  - Window : Sappire
  - Heater : Halogen

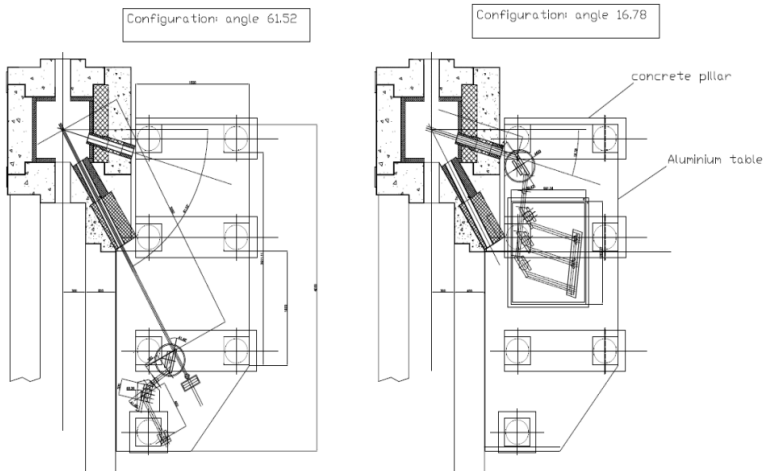



KIST-USANS

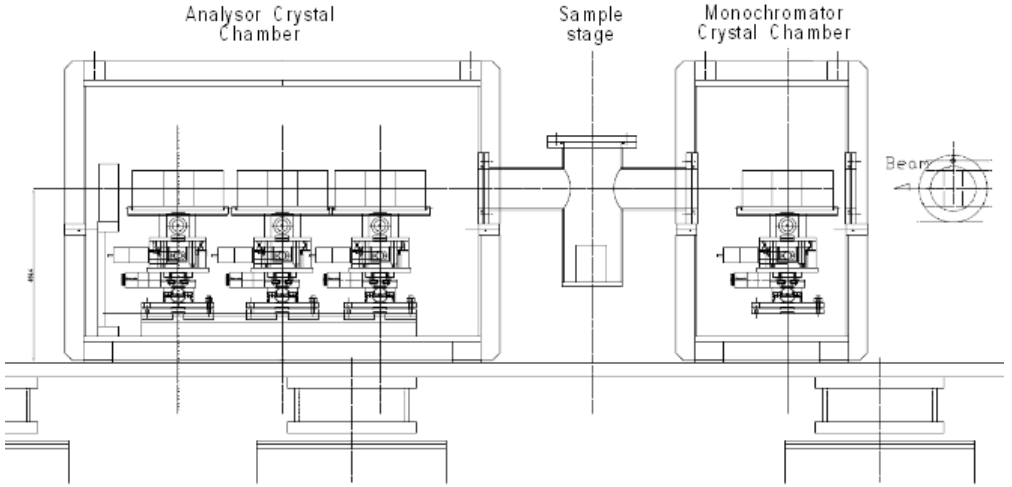
Bonse-Hart-Type Ultra Small Angle Neutron Spectrometer (USANS) Using Triple-Bounce Channel-Cut Perfect Si Crystals



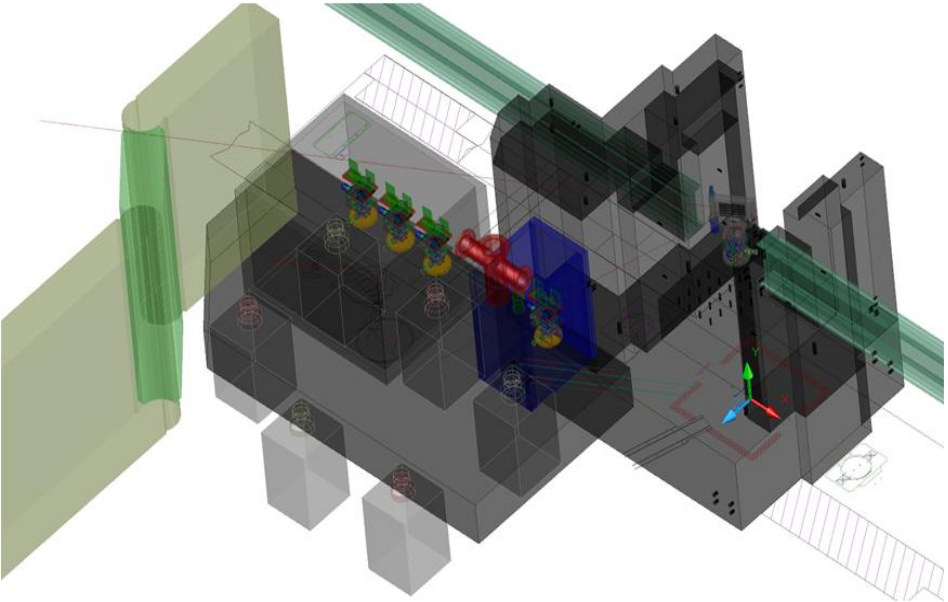
KIST-USANS

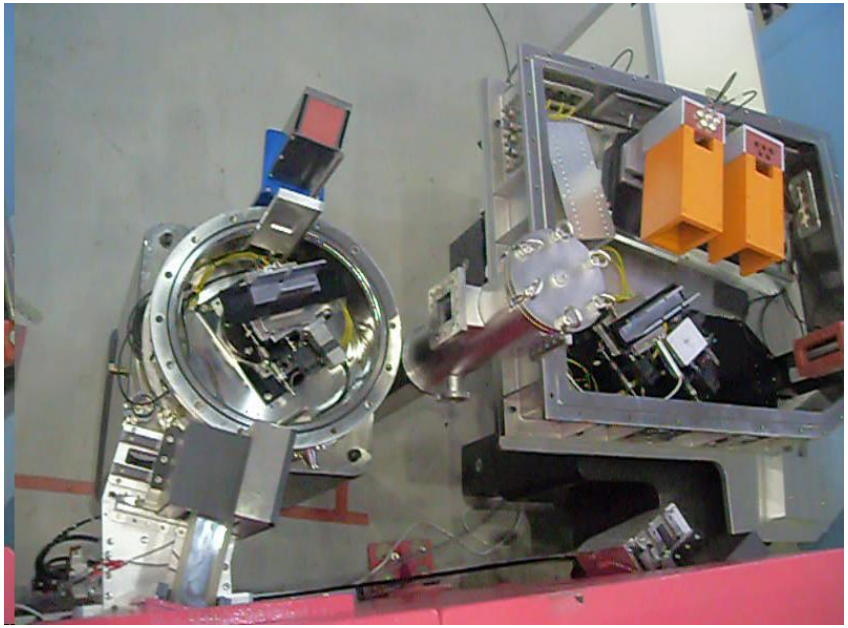


Beam Ports for 4 A and 2 A



Monochromator and multiple Analyzers



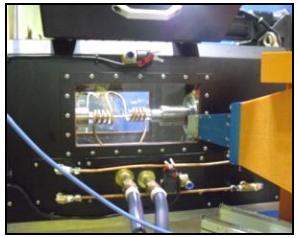


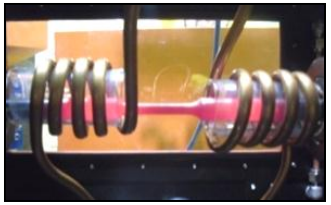
Neutron techniques & sample environments on steel research

In-situ measurements

High temperature furnace (~1,600℃)

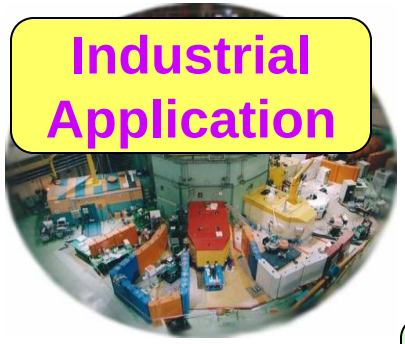
Loading device for Four Circle Diffractometer





Loading device under high temperature (20KN + 800C)

Industrial Application



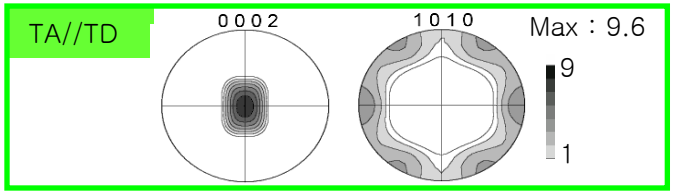
Residual Stress

Residual Stress Instrument

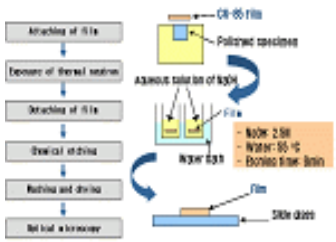
Measureable sample depth

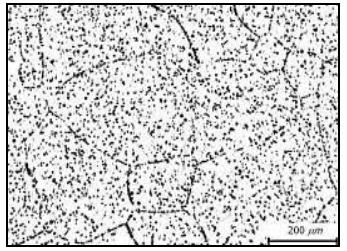
1) **Steel: 55 mm**
2) **Stainless steel: 50 mm**
3) **Aluminum: 100 mm**

Texture & simulation



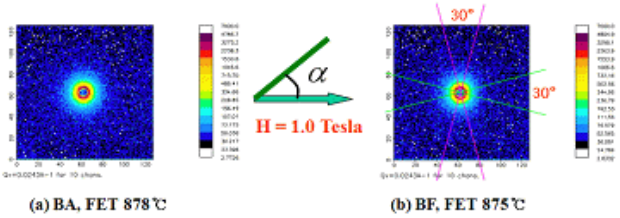
Texture measurement and simulation





Measurement of Boron distribution by Particle Tracking Autoradiography(PTA)

Chracterization of nano-sized precipitates by SANS

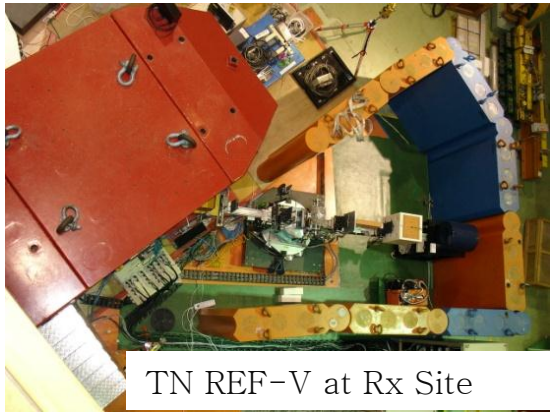


SANS spectra in steel samples

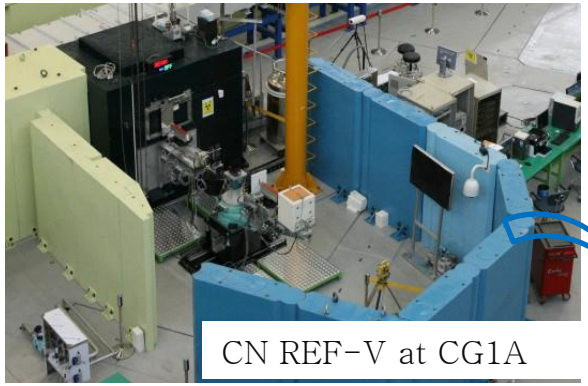
REF-V

REF-V current status

Compleation of Instrument Relocation & Performance Test

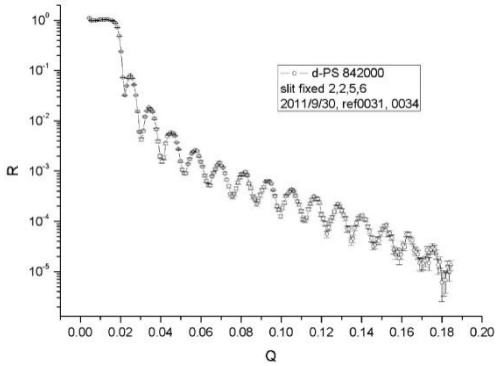


TN REF-V at Rx Site



CN REF-V at CG1A

D-PS Reflectivity Pattern



Main Application Field

- **Solid Thin Film**

  Polymer Films, Dielectric Thin Film, Multilayer Mirror, Metal Thin Film, Hard Carbon Film,

- **Surface Magnetism**

  Ferromagnetic Film, Magnetic Multilayer, Spin Valve Structure

Sample Environment Facility

High Temp Chamber : ~650 K
Magnetic Field : 0.3 T, EM
Low Temp. CCR : > 10 K(plan)
Other : Cryo-Furnace (plan)

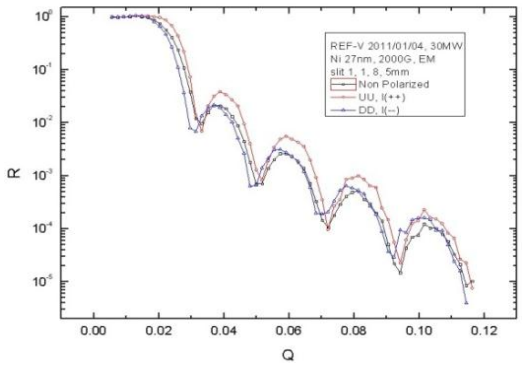
Instrument Characteristic & Performance

Item	Characteristics
Monochromator Wavelength Resolution Filter system Flux(sample)	Vertical focused PG(002) 4.75 Å, $2\Theta_M$=90° $\Delta\lambda/\lambda$ < 1.0% LN_2 Cooled Be ~6.0 x 10^5 n/cm^2 /sec
Single detector 1-D PSD (plan)	He3.6 atm. 8x12cm^2, efficiency 90% at 4 Å
Polarizer, Analyzer Spin flipper Polarization	Fe/Si SM(m=3) Mezei type, FR > 95% P = > 95%
Q Region Min. reflectivity	0.003 ~ 0.3 $Å^{-1}$ 10^{-7}

REF-V current status

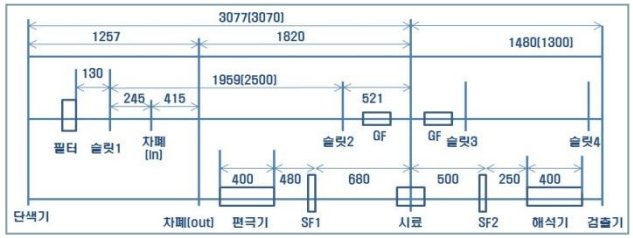
The Performance Test of PNR Tool

PNR Measurement with CN REF-V



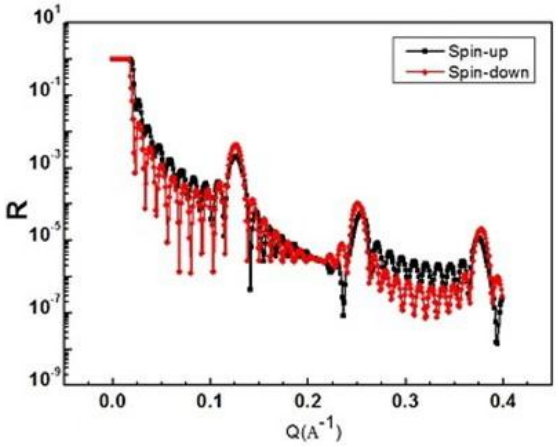
PNR Pattern of Ni Thin Film

Instrument Polarization Ratio : P>95%
Minimum Sample Size : >10x10mm^2
Maximum B Field : 0.3T
ICP : GUI mode, Labview

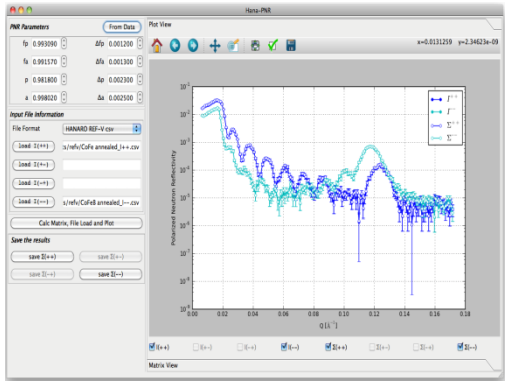


Instrument Beam Geometry

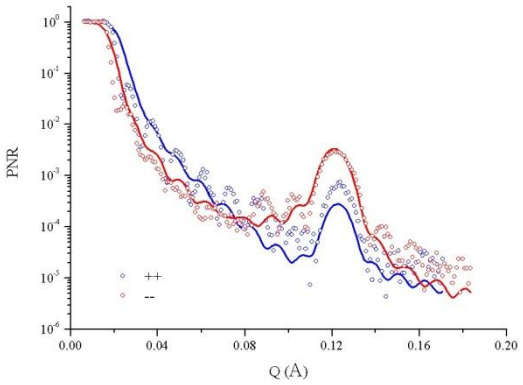
- PNR Measurement of $(CoFeB/MgO)_{10}$ & $(CoFe/MgO)_{10}$ Thin Film
  Under Analysing of Measurement PNR Pattern : Magnetic Structure of Thin Film



PNR Simulation of CoFeB Thin Film

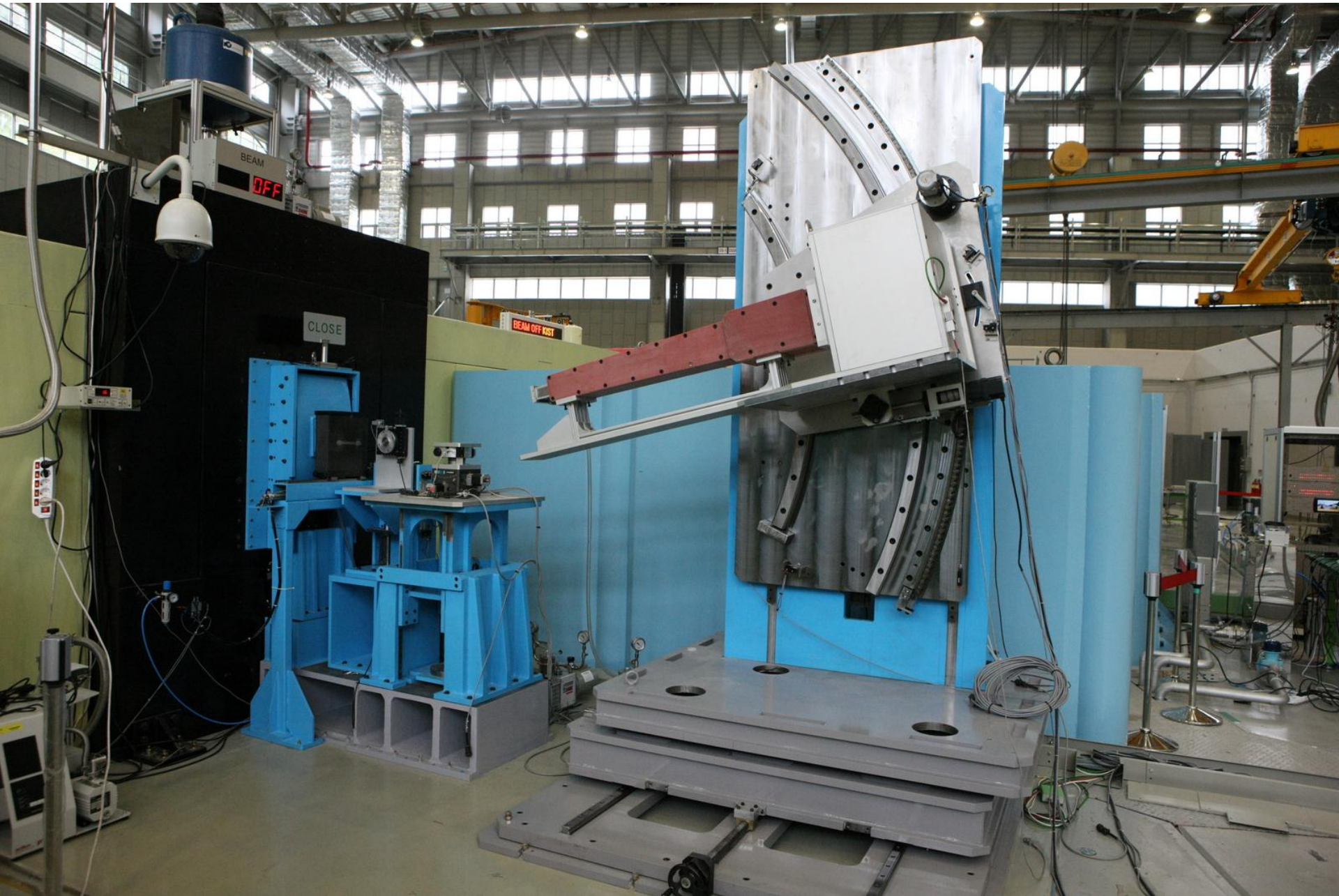


PNR Pattern Reduction



CoFe/MgO Thin Film : PNR Pattern
Annealed State, B=400G, I(++), I(--)

Bio-REF

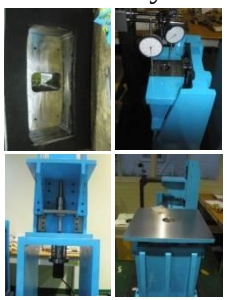


Bio-REF

Prof. K.W. Shin (Sogang Univ)

Monochromator System

Beryllium Filter Cooling System



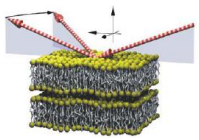
Beam Flight Path & Sample Stage

SPECIFICATIONS

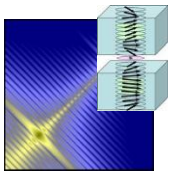
Monochromator-to-sample distance	2 m
Sample-to-detector distance	2 m
Sample Area	500 mm^2
# of monochromators	1 Set (4 ea)
Filter	Beryllium(Cooled)
Q_z range (Liquid) (Solid)	0.002 - 0.6 Å^{-1} 0.002 - 0.25 Å^{-1}
Wavelength	4.75 Å
Measurements	Solid/Liquid Air/Liquid Air/Solid
Minimum reflectivity	1 X 10^{-8}
Flux	8.0 X 10^{6}n/cm^2/sec
Detector (Liquid) (Solid)	2D PSD Point type
Sample environments	Temp, Press Cell Liquid Cell, LB
Strategies	Under construction

** Applications in Nanotechnology & Biotechnology*

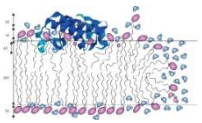
- *Nano-structured polymer thin films*
- *Polymer/metal nanostructures*
- *Nano-porous materials characterization*
- *Thin Films at high pressure*
- *Bio mimetic materials*
- *Bio mimetic materials*
- *Langmuir monolayer characterization.*
- *Poly-electrolytes at the air/water interface*
- *Wetting transition on water surface*
- *Protein (DNA) adsorption in solution.*



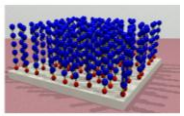
Bio-membranes



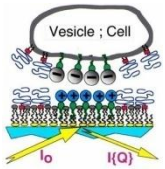
Magnetic multilayer



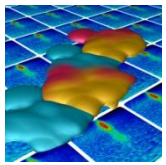
Enzyme, proteins



Polymer Brush



Adhesion



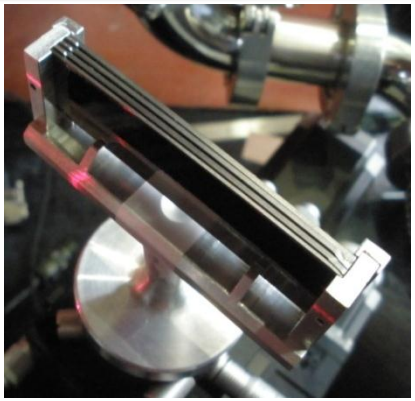
Wetting/de-wetting

Bio-REF Current Status

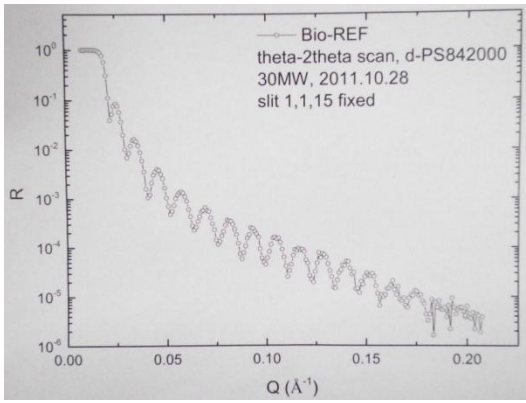
Compleation of Instrument Installation

Bio-REF at CNLB site

Inner Side of Bio-REF

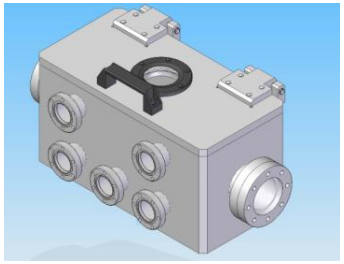


Monochromator

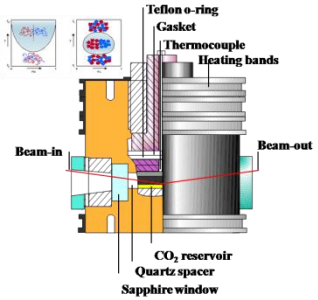


D-PS reflectivity Pattern

Sample Environments

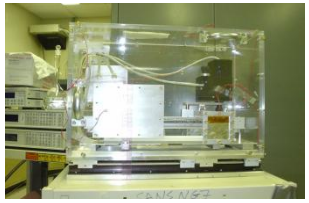


Temp. Chamber



Pressure Chamber

Neutron Cell



LB-Trough

Instrument Characteristic & Performance

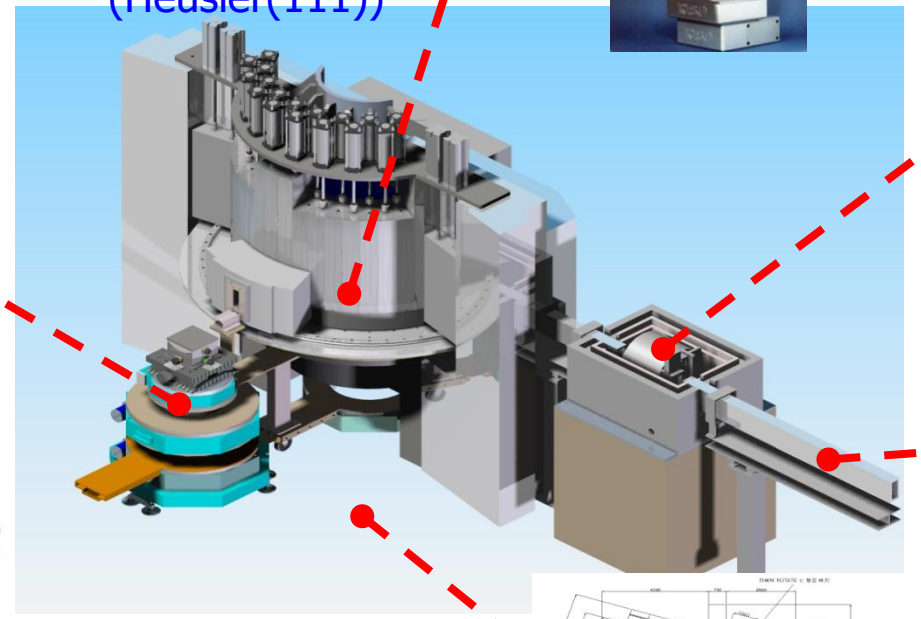
Item	Characteristics
Monochromator Wavelength Resolution Filter system	Pyrolytic graphite (002); 0.4° mosaic 4.75 Å $\Delta\lambda/\lambda$ < 2.0% LN_2 Cooled Be
Single detector Count rate	^{3}He-detector < 3MHz
SDD(Sample-to-detector distance)	2 m
Q-range	0.005 to 0.23 $Å^{-1}$ (Liquid surface) 0.005 to 0.6 $Å^{-1}$ (Solid surface)

Cold-TAS

Cold-TAS

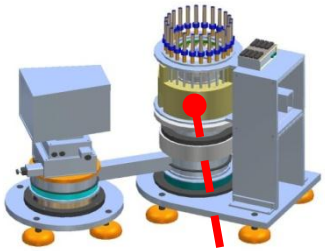
C&DAQ SPICE

M_Shield
HOPG Monochromator
(Heusler(111))



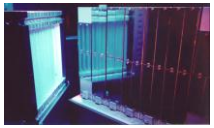
Beam Filter
(NVS)

Sample
Table

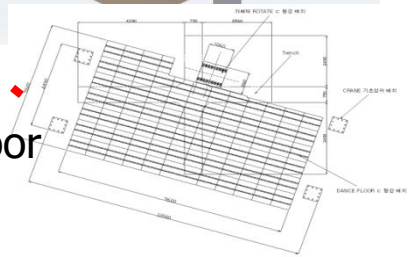


NG, CG5
Super-
mirror ,m=2
5cm W x 15cm H
R= 1500m

Analyser/Detector
(Heusler Analyser, PSD)



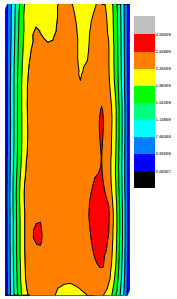
Dance Floor

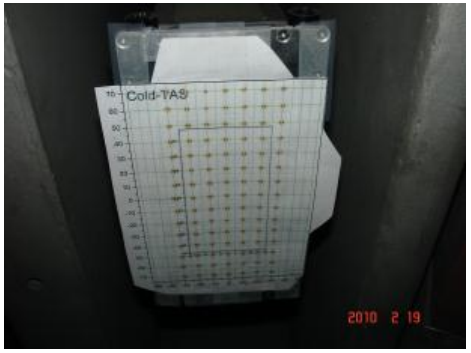


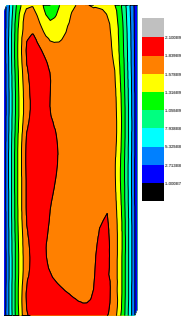
Cold-TAS

Guide, CG5	Super-mirror m = 2, In-pile Straight Section, ~ 5 m Curved Guide, ~ 26 m w/ R = 1500 m Straight Guide before the Instrument, ~ 16 m
Filters	Neutron Velocity Selector before Monochromator Be, BeO before Analyzer (Future, if needed.)
Monochromators	Vertically Focusing Monochromators PG(002) and Heusler(111) Doubly Focusing Monochromators (Future, if needed.)
Monochromator-Sample Distance	Up to 2 m
Collimation C1	Soller Collimators, 20′, 40′, 80′
Beam Height at the Sample Table	Up to 1.5 m
Sample-Analyzer Distance	Up to 1.0 m
Collimation C2	Soller Collimators, 20′, 40′, 80′ & Radial Collimator
Analyzers	Horizontally Focusing Analyzers w/ Fixed Vertical Focusing PG(002) and Heusler(111)
Analyzer-Detector Distance	Up to 0.5 m
Detectors	5 cm Tube Detector 25 cm wide Position Sensitive Detector

Cold-TAS: flux







	Simulated Flux	Center of Mass	Measured Thermal Flux	Converted Flux
After the Primary Shutter	5.57×10^{9}	3.82		
Front of the 2nd Shutter	2.84×10^{9}	4.89	8.16×10^{9}	3.00×10^{9}
Front of the Higher-Order-Filter	2.58×10^{9}	4.83	5.37×10^{9}	2.00×10^{9}
Front of the Monochromator Chamber	2.30×10^{9}	4.70	**3.58×10^{9}**	**1.37×10^{9}**

DC-TOF

DC-TOF


Park J-G


So JY


Moon MK


Choi YH

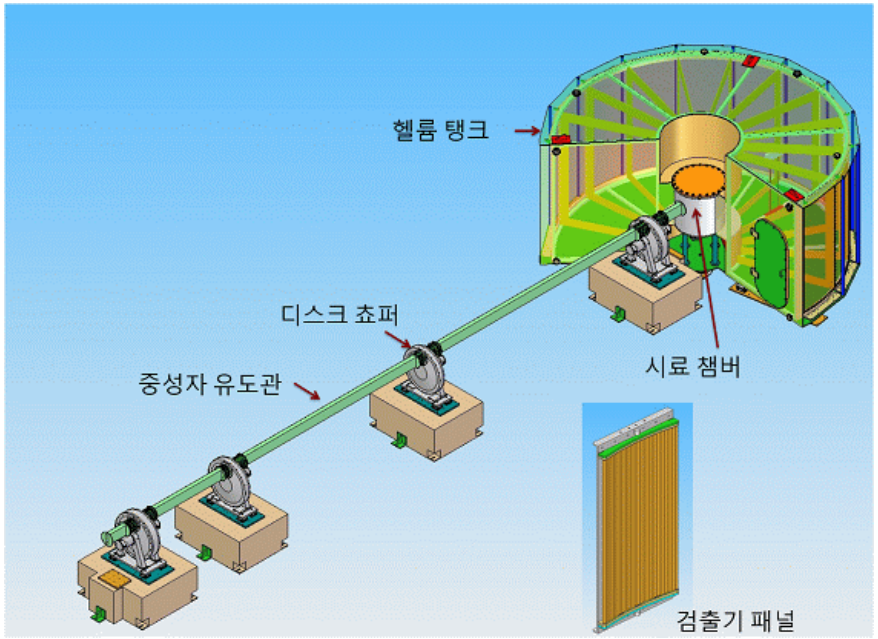

Nam UW


Kim HJ,


Kim HO

Korea Astronomy and Space Science Institute

KYUNGPOOK NATIONAL UNIVERSITY



- Vacuum in sample chamber & detector chamber → He-gas for detector chamber
- Detector panel in the chamber
  - 352 detectors in 11 panels
  - Detector electronics in the chamber

  → panel outside of chmaber
- 6 combined choppers
- Elliptic focusing guide

  → in-house fabrication
- Shielding structure of HC, Pb, PE+B-rubber around choppers, and detector chamber

  → intensive enforcement

Instrument Characteristics

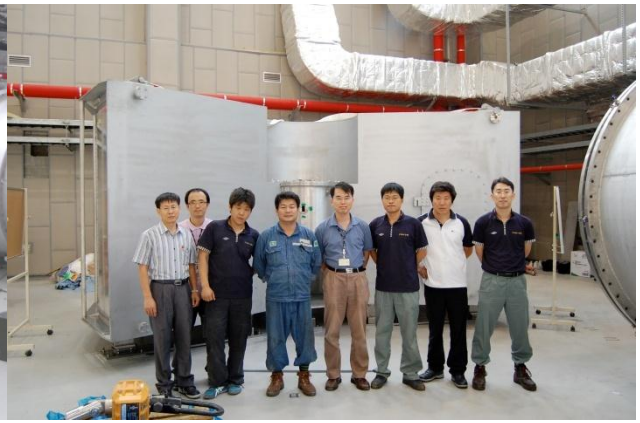
Cold Neutron Source	Neutron Flux (MCNP calc.) [neutrons/cm^2/sec]	7.7x10^{12} (26.3 K) + 6.4x10^{13}(125.14 K)
Upcomming Guide	Super-mirror guide Curved Guide Total Length	M = 2.0 R = 2500 m, Length = 24.4 m 74.7 m
Focusing Guide	Elliptical shape High M super-mirror guide	Total Length = 1250.0 cm 3.0 cm(W)x14.5 cm(H) → 2.2 cm(W) x 6.1 cm(H) Mmax ~ 2.3
Disk Chopper System	Number of Chopper	6 [2 counter rotating pairs, 2 single]
	Disk Diameter	68.0 cm ~ 60.0 cm
	Rotation Speed	1,000 - 20,000 rpm
	Chopper Distance	12 m
Secondary Spectrometer	Angular coverage	$-90^0 < 2q < 140^0$, $-22^0 < 2\Phi < 22^0$,
	Position Sensitive Detector	Height=2 m, diameter=25 mm
	Sample-Detector Distance	2.5 m
Instrument Characteristics	Neutron Flux @ 5 A (10% Resolution)	4x10^4 neutrons/sec/cm^2
	Minimum Resolution	2% of Neutron Incident Energy
	Detector Coverage	Maximum 352 PSDs, 2.8 sr.

DC-TOF - Performance Comparison

Instrument	Neutron Flux On Sample @ 10% Resolution	Detector-sample distance (m)	Total area [m^2 or sr]	Flux × Detecting Area
DC-TOF (HANARO)	**4.0×10^4**	**2.5 m**	**10.47 m^2 (1.7 sr)**	**1.7**
DCS (NIST)	**1.0×10^4**	**4.0 m**	**~0.65 sr**	**0.33**
NEAT (HMI)	**1.0×10^4**	**2.5 m**	**~1.0 sr**	**0.5**
IN5 (ILL)	**6.8×10^5**	**4.0 m**	**1.7 sr**	**5.4 11.56**

Development activities, ~ 2009

2009.04 Electronics Development

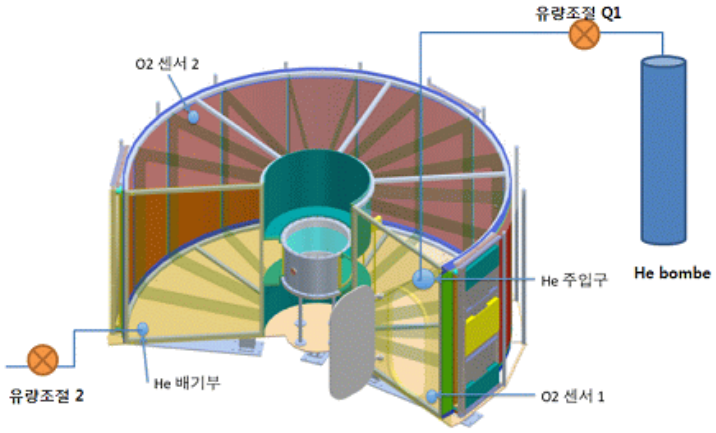


2009.08 Detector Tank Install.

2009.11 Guide Install.

DC-TOF – detector chamber

2009.08.25



- He gas injection and leak rate
  - 93.5 % He gas in the volume
  - > 4 weeks pressure maintained

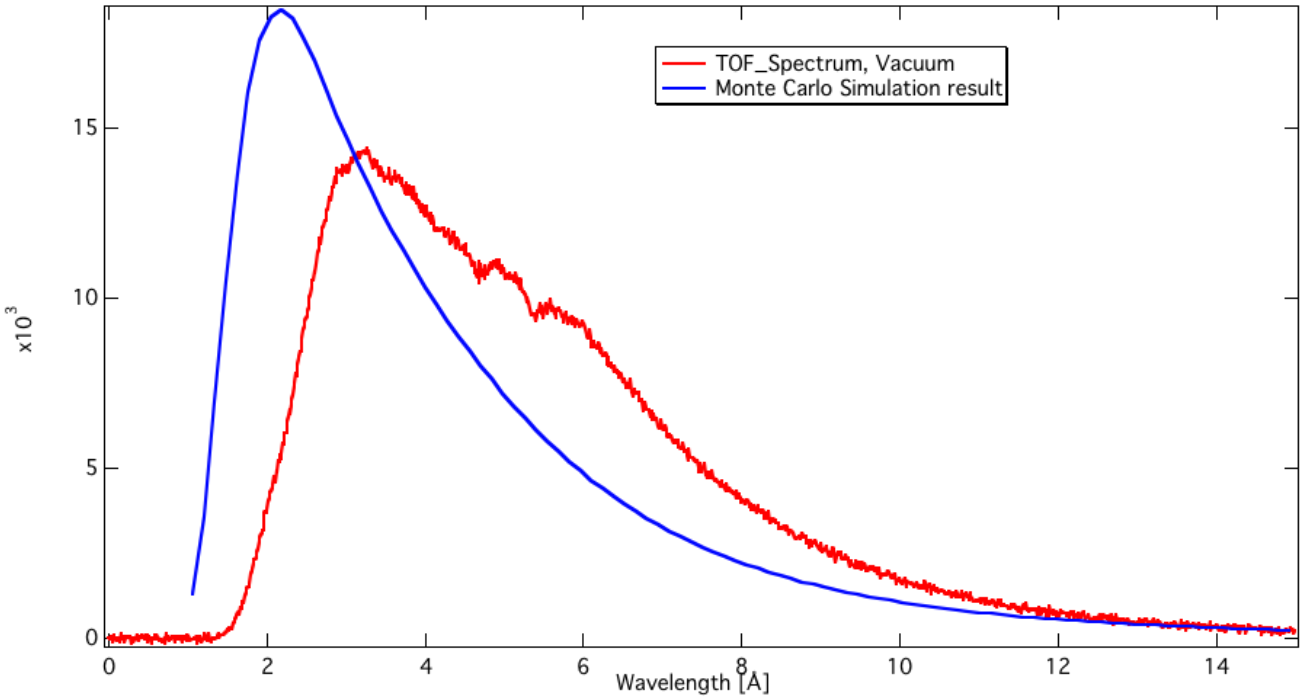
Development activities in 2010

2010.02 Chopper Shielding Install.

2010.04 Detector Tank Shielding.

2010.04 Guide Shielding

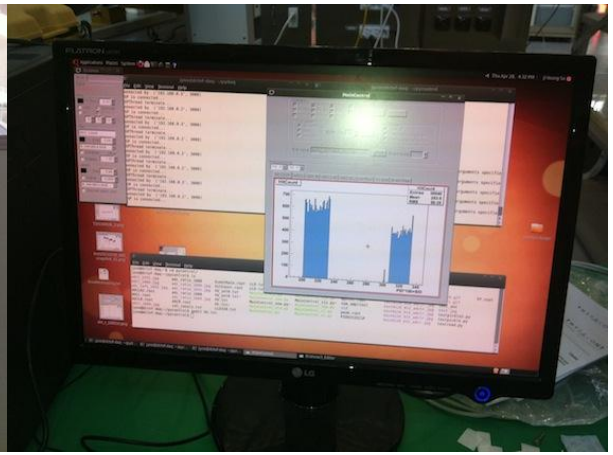
Incident neutron beam flux



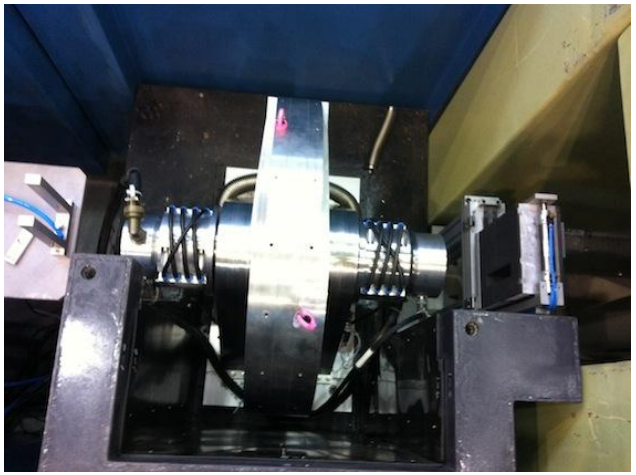
- Spectrum is measured by TOF experiment.
- Measured @ first chopper site
- Normalized by total simulation flux.

Development activities in 2011

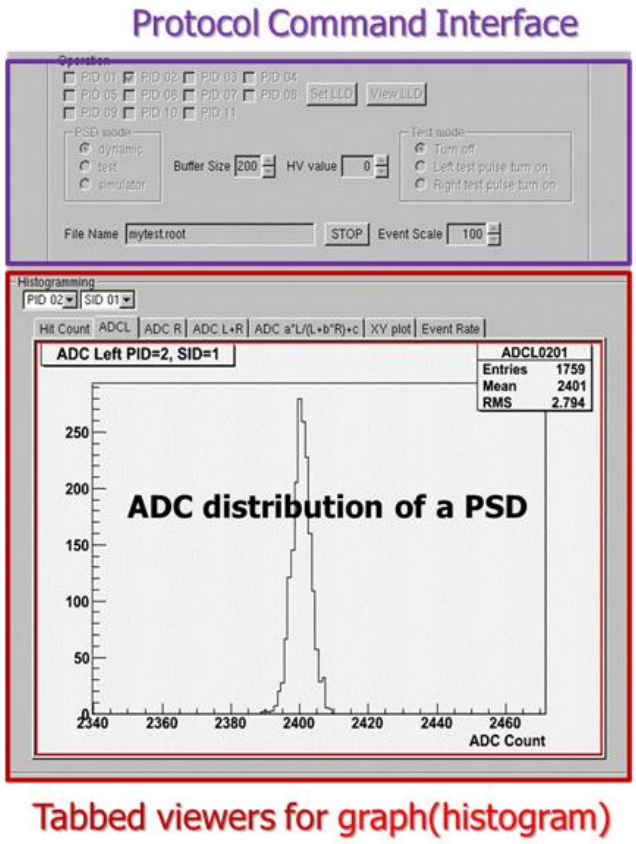
2011.04 Background
Measurement test



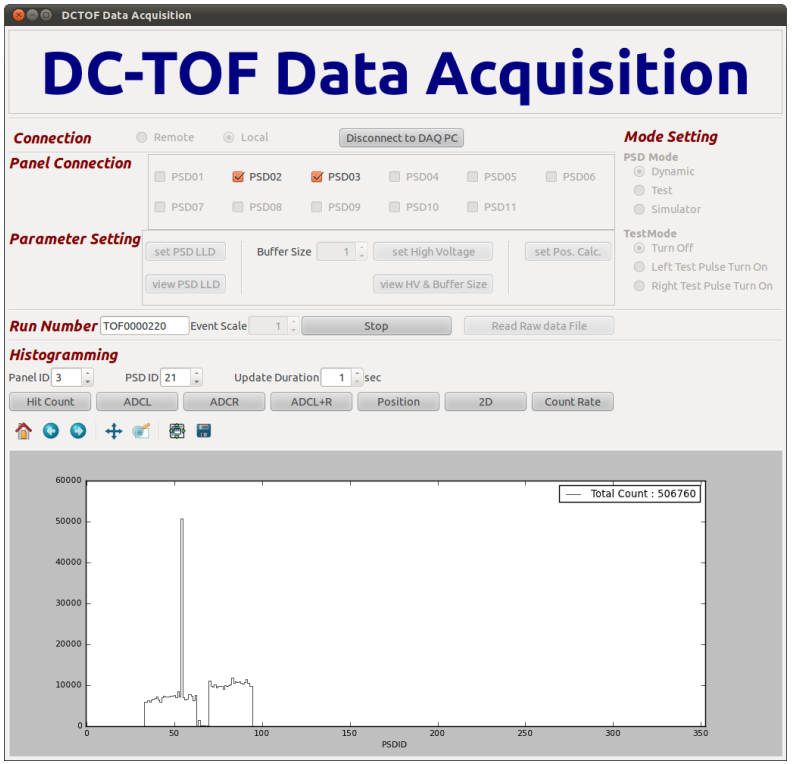
2011.07 Chopper Install.



Software Development

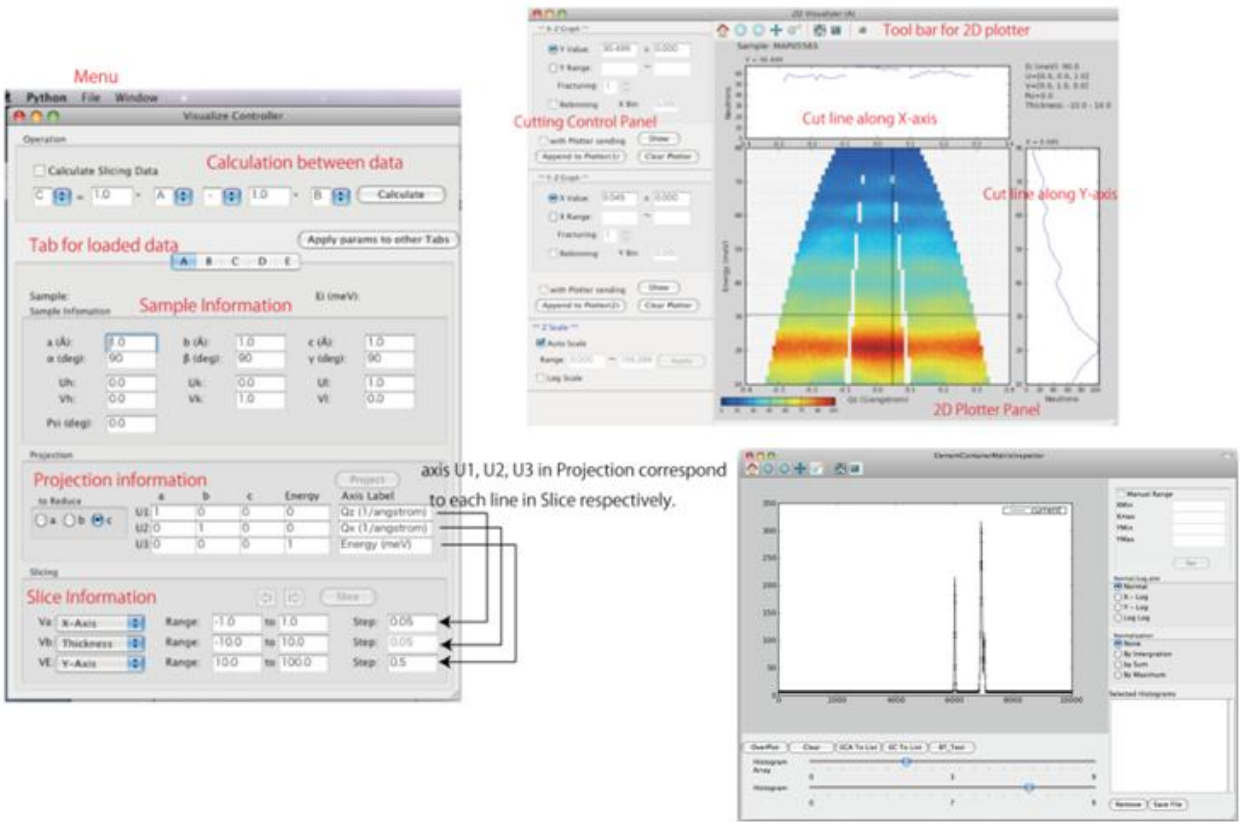


Old Data Acquisition Software
- Developed by KNU group.
- Developed in Python.
- Based on ROOT(by CERN)



New Data Acquisition Software
- Upgraded from Old one
- Developed by KAERI
- No ROOT Dependency.

K-J Collaboration for Analysis SW



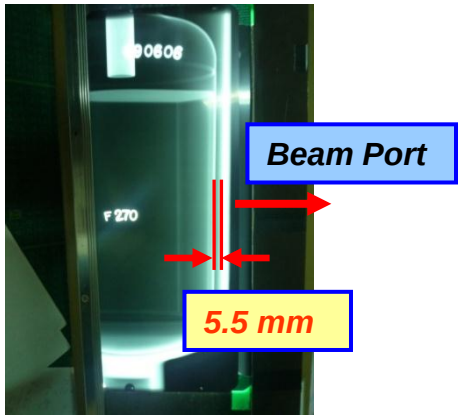
- Since 2007, Korea DC-TOF team and J-PARC MLF group have developed data reduction software.
- Based on Manyo-Lib developed in KEK/J-PARC & developed in Python programming language, Now used in J-PARC instruments and HANARO DC-TOF

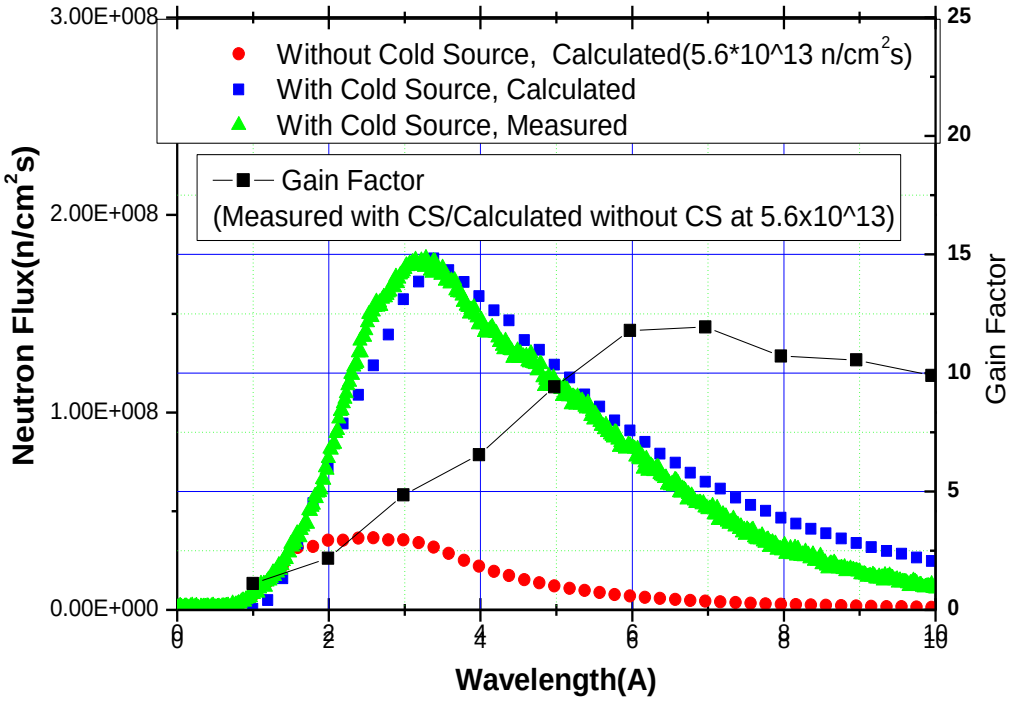
Current Status

Component	Status	Description
Focusing Guide	completed	In-house developed, & future upgrade with with higher m
Disk Chopper (EADS Astrium)	being repaired	Fast counter rotating double choppers and all controllers are now being repaired.
Chopper Shielding	completed	Heavy concrete for neutron & gamma radiation
Guide Shielding	completed	Pb shielding , B-rubber & heavy concrete
Detector Tank	completed	He-filling type.
Detector (Toshiba)	57 PSD	Full capacity : 352 PSDs
Detector Electronics	for 64 PSD	
Tank Shielding	completed	Cd sheet inside of tank & B-rubber and PE out of tank
He control system for tank	completed	He pressure and flow control.
Monitor, Slit, Shutter	completed	
Sample Environment	-	Not yet available.
DAQ Software	completed	Developed by collaboration with KNU, upgraded by KAERI
Control Software	95%	Each part of components control is now working and ICP(Integrated Instrument Control Program) is under test.

- HANARO & Thermal Sources
- Cold Neutron Project
- **Technical development**

1st operation of the CNS



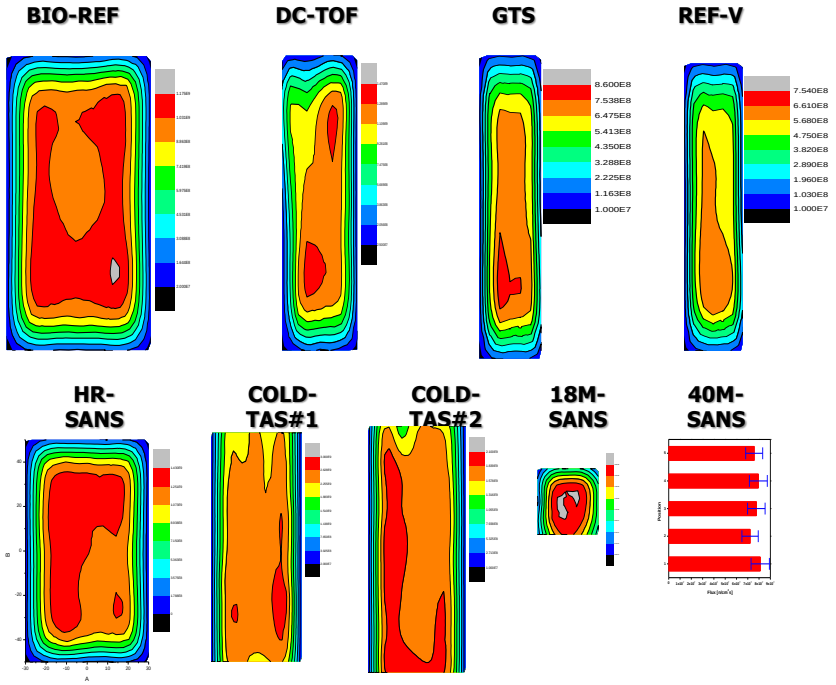


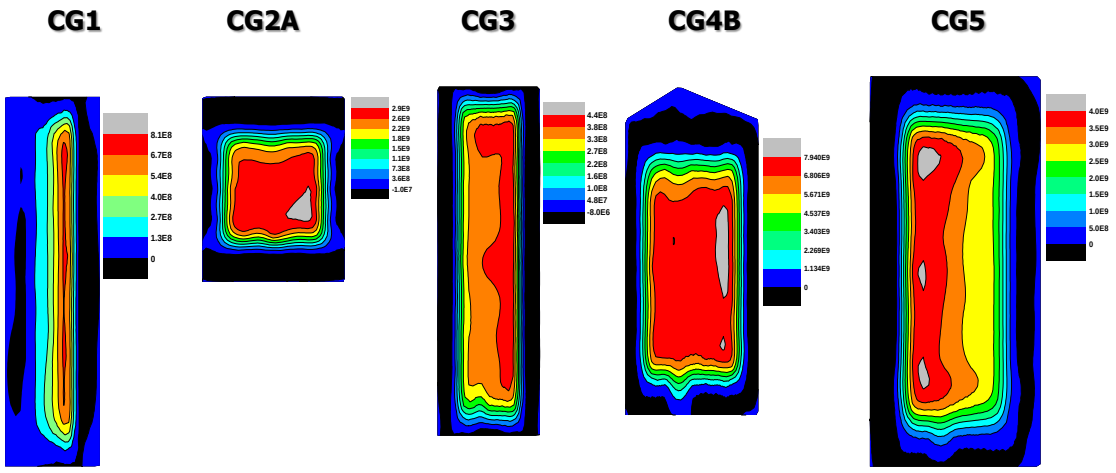
The HANARO reactor started with operation of the cold neutron source on **September 3rd 2009**, and the reactor reached the full power of **30 MW with a steady operation of the cold neutron source at 11:30 PM**.

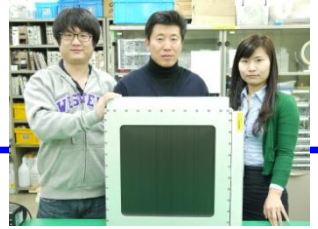
The Time-of Flight measurements of neutron flux was performed at CG2A guide position in the guide hall and **the cold neutron was successfully measured at 01:30 AM September 4th 2009**.

Measured Flux at Guide Hall

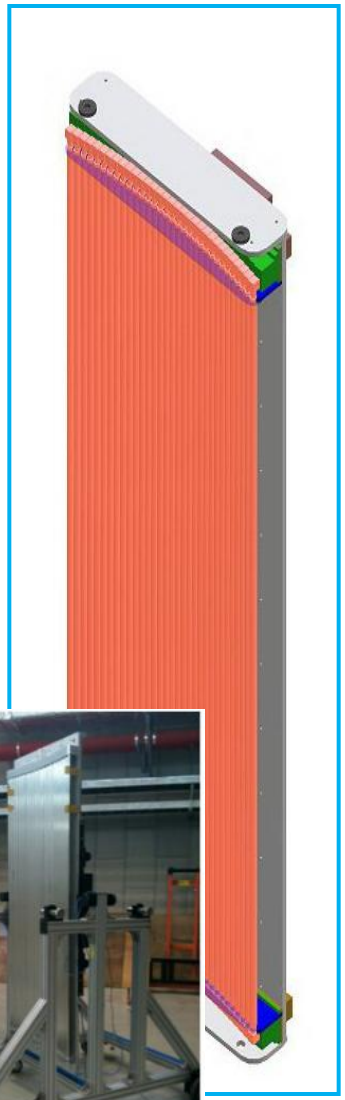
Position		Thermal flux	Real flux	Real flux(max)
CG1	4.48*	2.01E+09	8.08E+08	1.37E+09
CG2A	4.54 *	5.82E+09	2.31E+09	2.94E+09
CG3	3.87 *	6.74E+09	3.14E+09	3.56E+09
CG4B	4.83 *	7.71E+09	2.87E+09	2.92E+09
CG5	4.21 *	8.16E+09	3.49E+09	4.02E+09
BIO-REF	4.90[1]	2.79E+09	1.02E+09	1.17E+09
DC-TOF	4.16*	2.58E+09	1.12E+09	1.47E+09
GTS	4.57*	1.83E+09	7.21E+08	8.93E+08
REF-V	4.57*	1.49E+09	5.87E+08	7.81E+08
HR-SANS	4.90[1]	3.57E+09	1.31E+09	1.43E+09
Cold-TAS(#1)	4.03+	5.37E+09	2.40E+09	3.00E+09
Cold-TAS(#2)	4.03+	3.58E+09	1.60E+09	2.10E+09
18M-SANS	4.90[1]	4.96E+08	1.82E+08	1.82E+08
40M-SANS	4.97[2]	7.76E+07	2.81E+07	2.94E+07

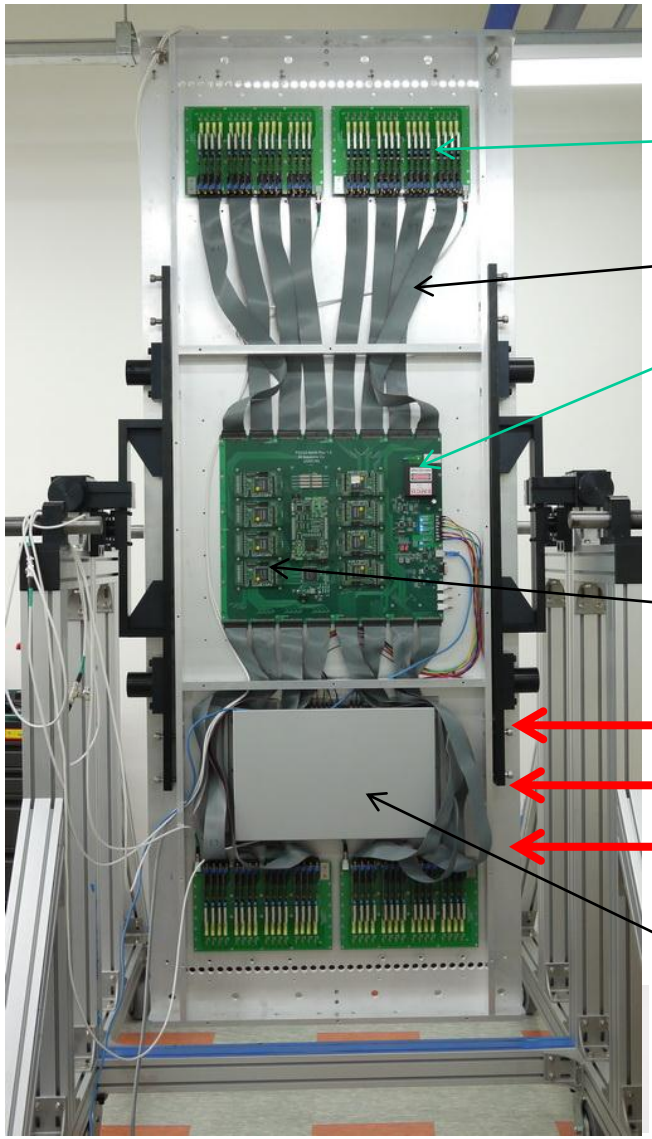






Detector Electronics





PAM32-A

Flat Cables

HV module

Main Acquisition Board
- PLM
- DSP

AC POWER

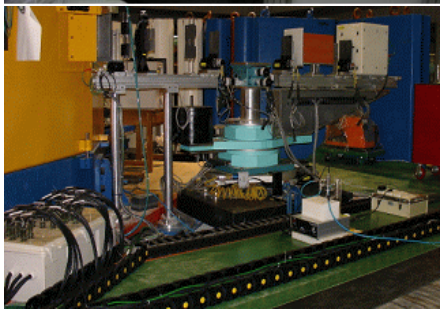
Ethernet Cable

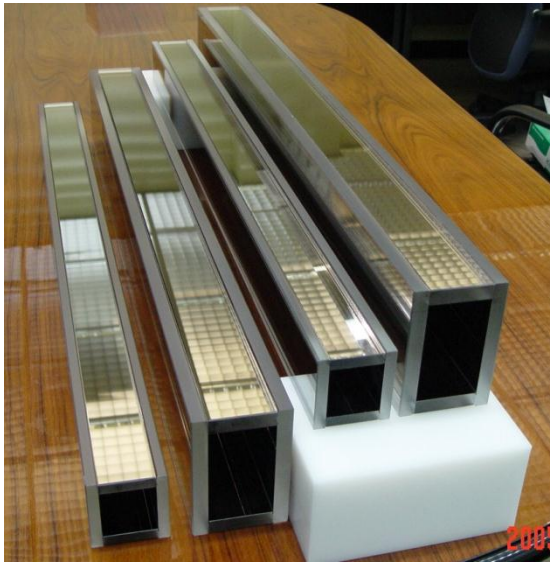
Test Input

Power Box

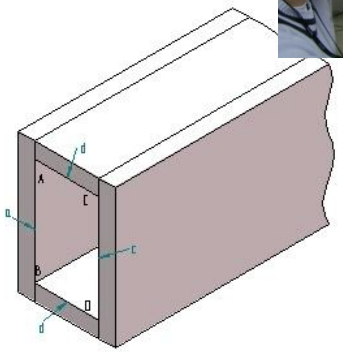
Ni & Ni/Ti super-mirrors

Large sputtering chamber for mirror coating of 1.2m length



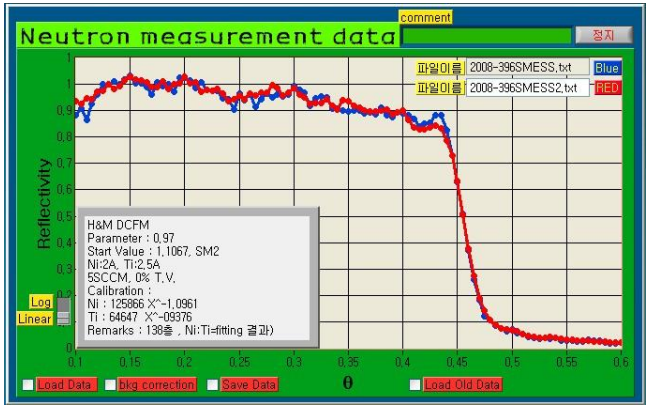


Neutron guide tubes fabricated



Distance	Entrance/mm	Exit /mm
A - B	100.004	99.993
B - C	60.002	60.007
B - D	60.001	59.999
C - D	100.006	100.002

Measurement result for a guide with a cross section 100x60mm



- HANARO & Thermal Sources
- Cold Neutron Research Project
- **Korean Neutron Users & International network**

Current Stage of NS at HANARO

8 Operating	3 Improving	7 Developing	2 new projects
HRPD	18M-SANS	40M-SANS	CNAS
HIPD	RSI	Cold-TAS	CNIF
FCD	FCD	DC-TOF	
REF-V		Bio-REF	
REF-H		KIST-USANS	
NR, ENF		Th-TAS	
PGAA		Bio-D	

Planning

Thermal Guide & Instruments

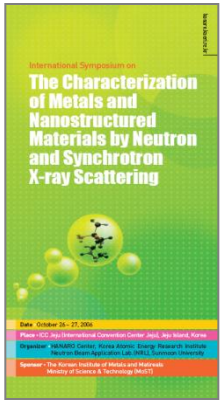
Korean Neutron Beam Users' Association

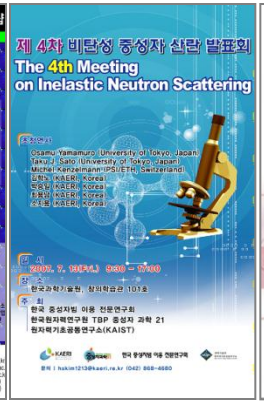
KNBUA
The Korean Neutron Beam Users Association

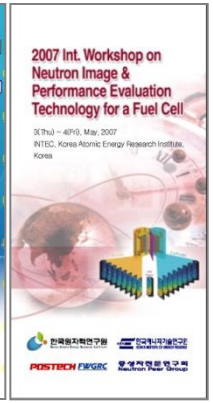
President: Ki-Bong Lee (POSTECH)
Secretary: Je-Geun Park (SNU)

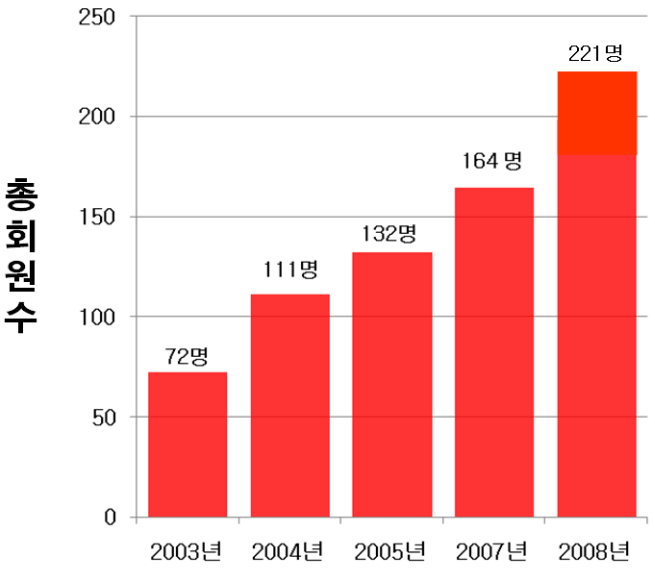
- HANARO Representative: KH Lee
- News Letter Editor: SK Park (PU)

Elastic group | **Low-Q group** | **Inelastic group** | **Radiography group**









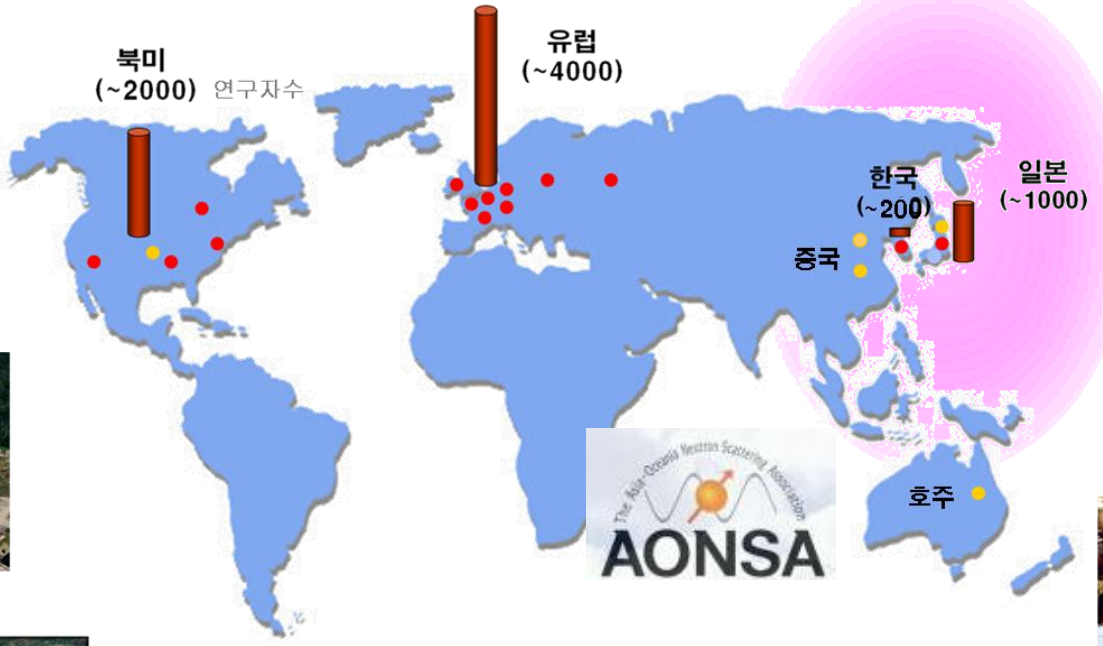
World of Neutron Scattering

- ***Pulsed*** **Source:** ISIS, SNS, J-PARC
- ***Continuous*** **Source:** **HANARO**, JRR-3M, OPAL, NCNR, ILL, FRM-II,…

NIST, US

ORNL, US

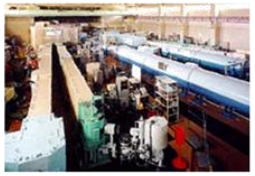
SNS, US



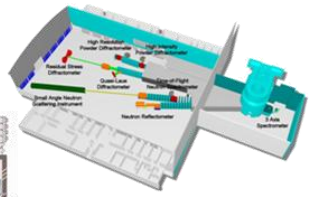
HANARO

J-PARC, Japan

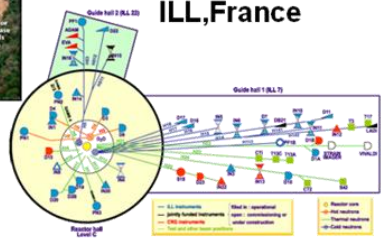
JAERI, Japan



ANSTO, Australia

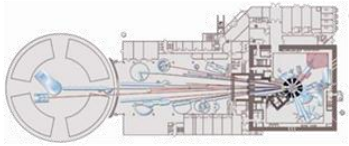


ILL,France



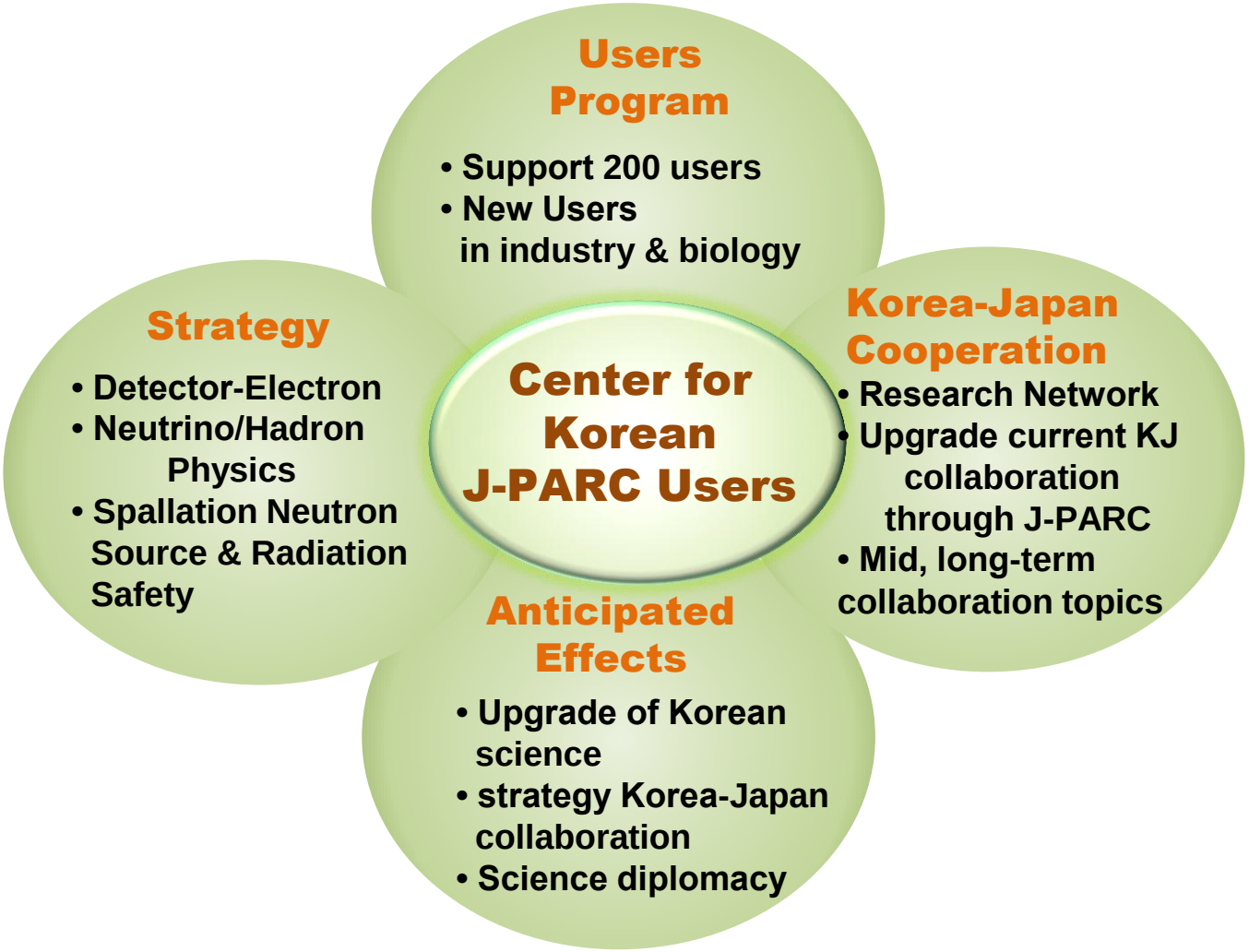
ISIS, UK

FRM-II, Germany



Center for Korean J-PARC Users (CKorJPARC)

2010 → 2013



Conclusions

- CNRF project successfully finished
- Neutron spectrometers
  - 40M-SANS, 18M-SANS, G-TS fully Operational
  - KIST-USANS, REF-V, Bio-REF Commissioning, final
  - Cold-TAS Commissioning, initial
  - DC-TOF under Construction
- KNBUA, AOCNS, K-J NSM, CKorJPARC, …
  - User office, secretarial service, technical supports,..
- Facility operations, In-house R&D & Technical developments, Strategic planning for next decade

- CNRF project leaders; Young-Ki Kim, Kye-Hong Lee, Young-Gap Cho, Sang-Ik Wu, Chang-Hee Lee / Young-Jin Kim, Hark-Rho Kim

- 18M-SANS; Baek-Seok Seong, Eun-Joo Shin
- REF-V; Jeong-Soo Lee, Ki-Yeon Kim
- Bio-REF; Kwan-Woo Shin, Dong Jin Choi, Ja-Sung Koo
- 40M-SANS; Sung-Min Choi, Young Soo Han, Tae-Hwan Kim
- Cold-TAS; Sungil Park
- DC-TOF; Je-Geun Park, Ji-Yong So, Myungkook Moon, Young-Hyun Choi, Uk-Won Nam, Hong-Ju Kim, Hyun-Ok Kim
- Guides & Shielding; Sang-Jin Cho
- Detector & Electronics; Myungkook Moon, Uk-Won Nam

Thank you for your attention!