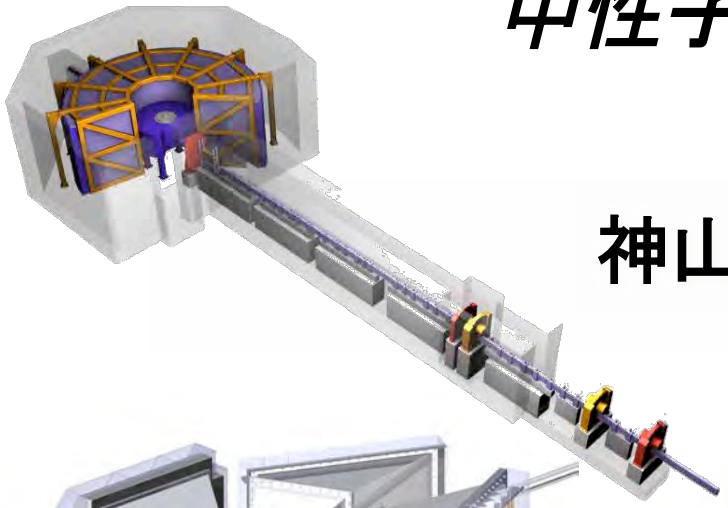
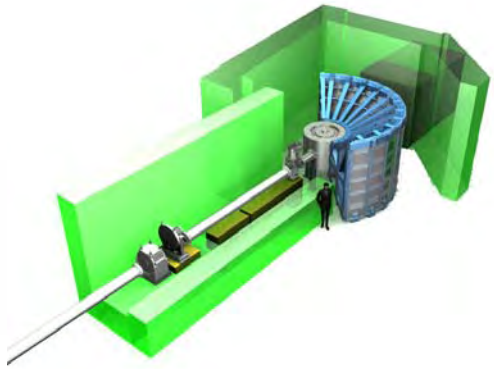
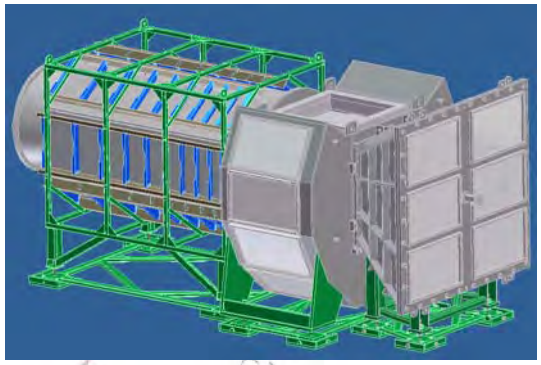
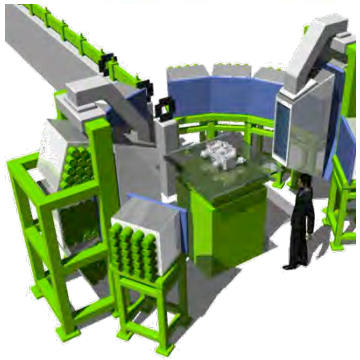
中性子利用セクション

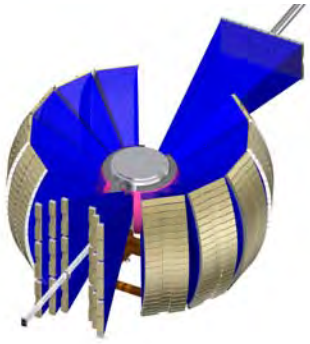
神山　崇、相澤一也

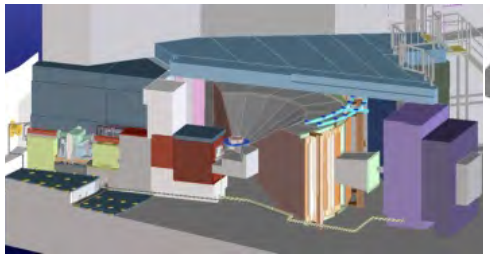


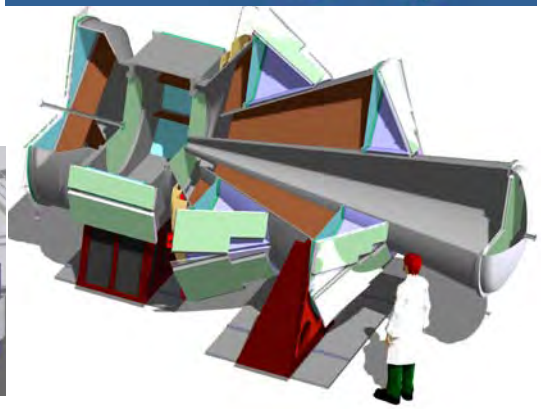






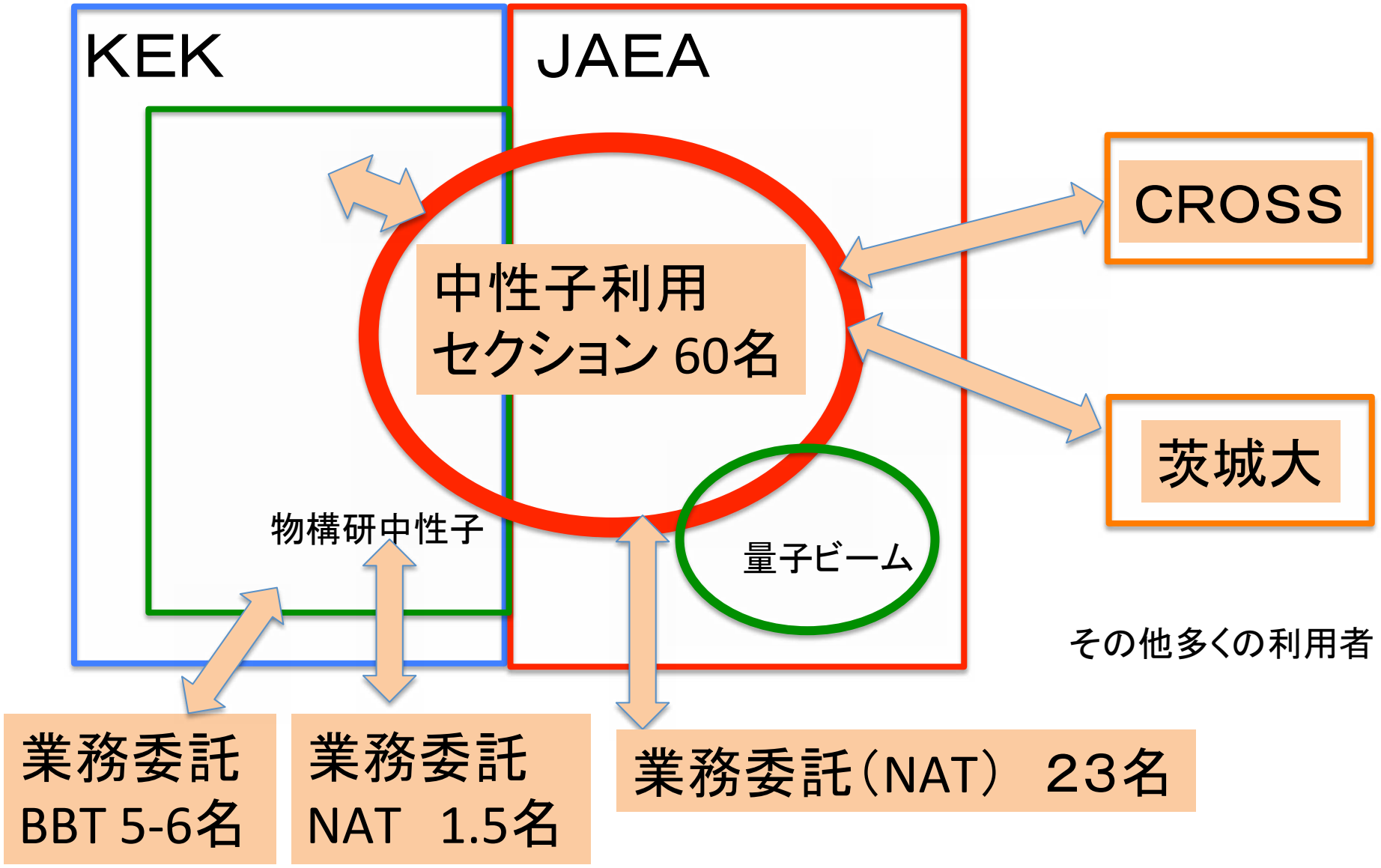






中性子利用セクション（JAEAとKEK） ミッション
・実験装置・周辺環境・デバイスの開発・建設
・工事、維持・管理、安全等
・利用者支援
・先導的研究

これらのミッションは、中性子利用セクションメンバー
だけできるものではなく、業務委託・派遣、茨城大、茨城県、
CROSS-Tokai、物構研のメンバー他、多くの利用者らとの
共同作業である


KEK
JAEA
中性子利用
セクション 60名
CROSS
茨城大
物構研中性子
量子ビーム
その他多くの利用者
業務委託
BBT 5-6名
業務委託
NAT　1.5名
業務委託（NAT）　23名

中性子利用セクション

人員

（1）セクション員 54

JAEA（39）

職員12、技開協力員4、特定課題推進1、任期付職員2、兼3　22

任期付研究員3、PD5、学生5(特4、連1）、事務4　17

KEK（兼務15）

（2）物構研メンバーで、セクション員でない人24

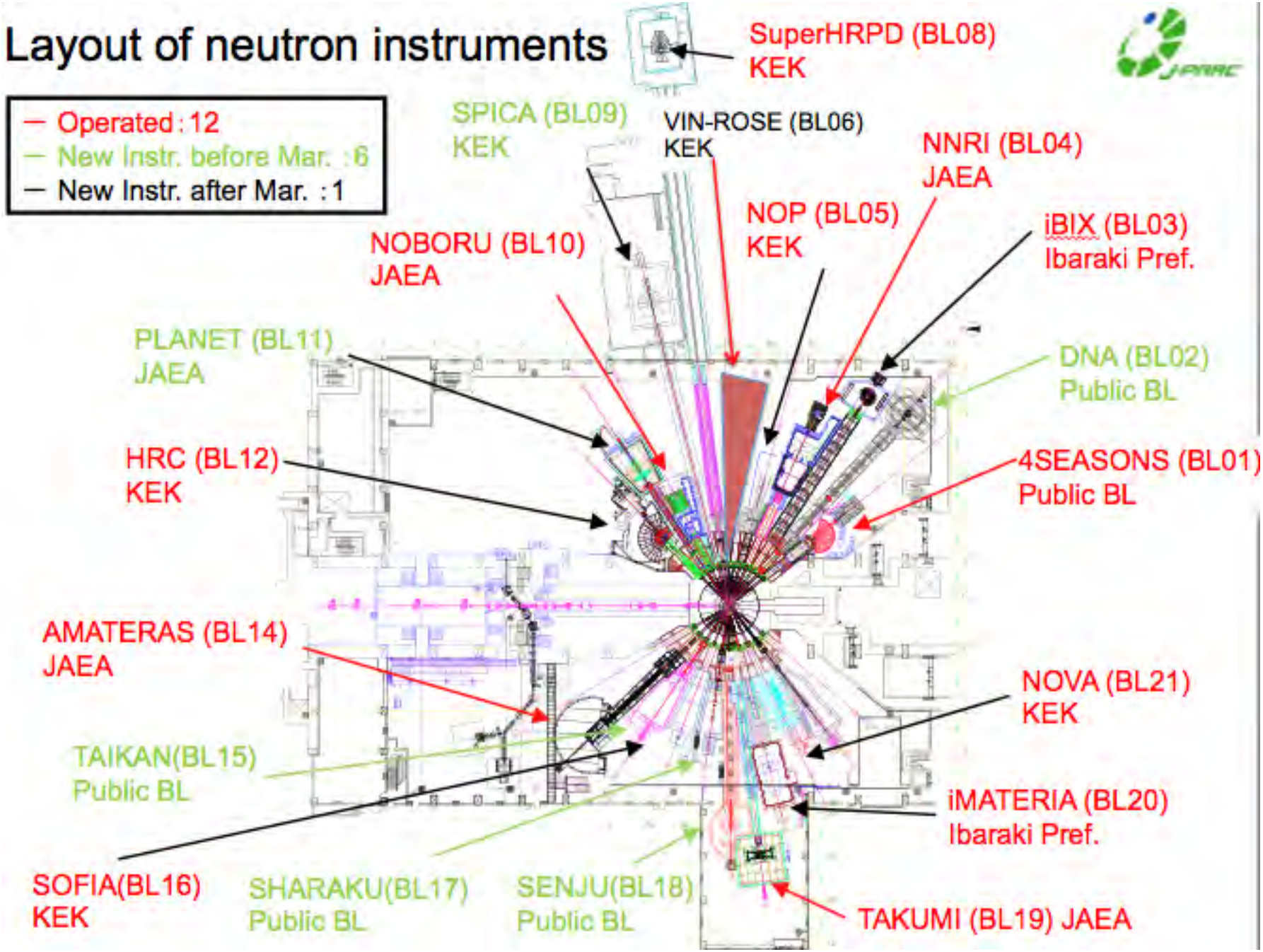
特任、研究支援員、ポスドク、総研大生、事務等

#　東海・水戸地区に住んでいる人：約20人

（3）業務委託

3社契約（セクション） NAT 23,

KEK業務委託： NAT1.5 + BBT 5-6


Layout of neutron instruments
— Operated : 12
— New Instr. before Mar. : 6
— New Instr. after Mar. : 1
SuperHRPD (BL08)
KEK
SPICA (BL09)
KEK
VIN-ROSE (BL06)
KEK
NNRI (BL04)
JAEA
NOP (BL05)
KEK
iBIX (BL03)
Ibaraki Pref.
NOBORU (BL10)
JAEA
PLANET (BL11)
JAEA
DNA (BL02)
Public BL
HRC (BL12)
KEK
4SEASONS (BL01)
Public BL
AMATERAS (BL14)
JAEA
NOVA (BL21)
KEK
TAIKAN(BL15)
Public BL
iMATERIA (BL20)
Ibaraki Pref.
SOFIA(BL16)
KEK
SHARAKU(BL17)
Public BL
SENJU(BL18)
Public BL
TAKUMI (BL19) JAEA

定常的な業務が確立されていくなかで、建設と研究が同時進行していた、その中で地震が起きた

運用・管理業務体制

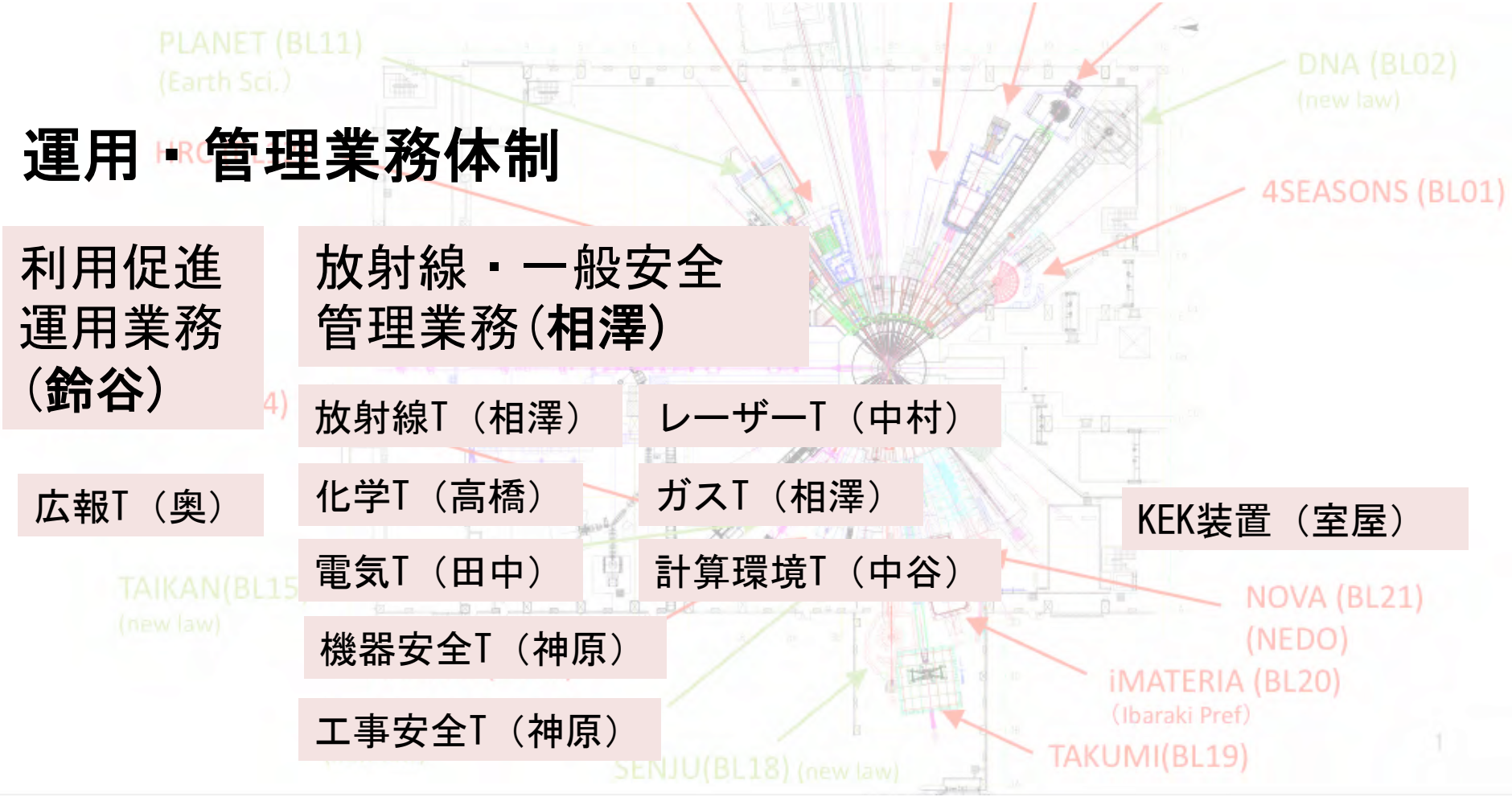
利用促進運用業務（鈴谷）

広報T（奥）

放射線・一般安全管理業務（相澤）

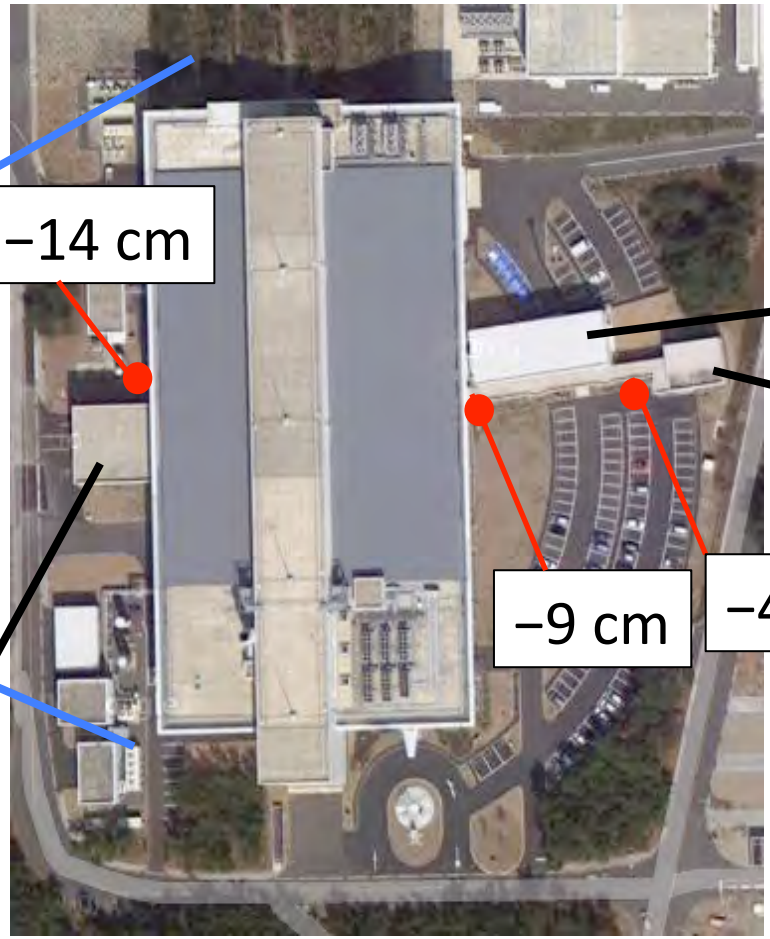
- 放射線T（相澤）
- レーザーT（中村）
- 化学T（高橋）
- ガスT（相澤）
- 電気T（田中）
- 計算環境T（中谷）
- 機器安全T（神原）
- 工事安全T（神原）

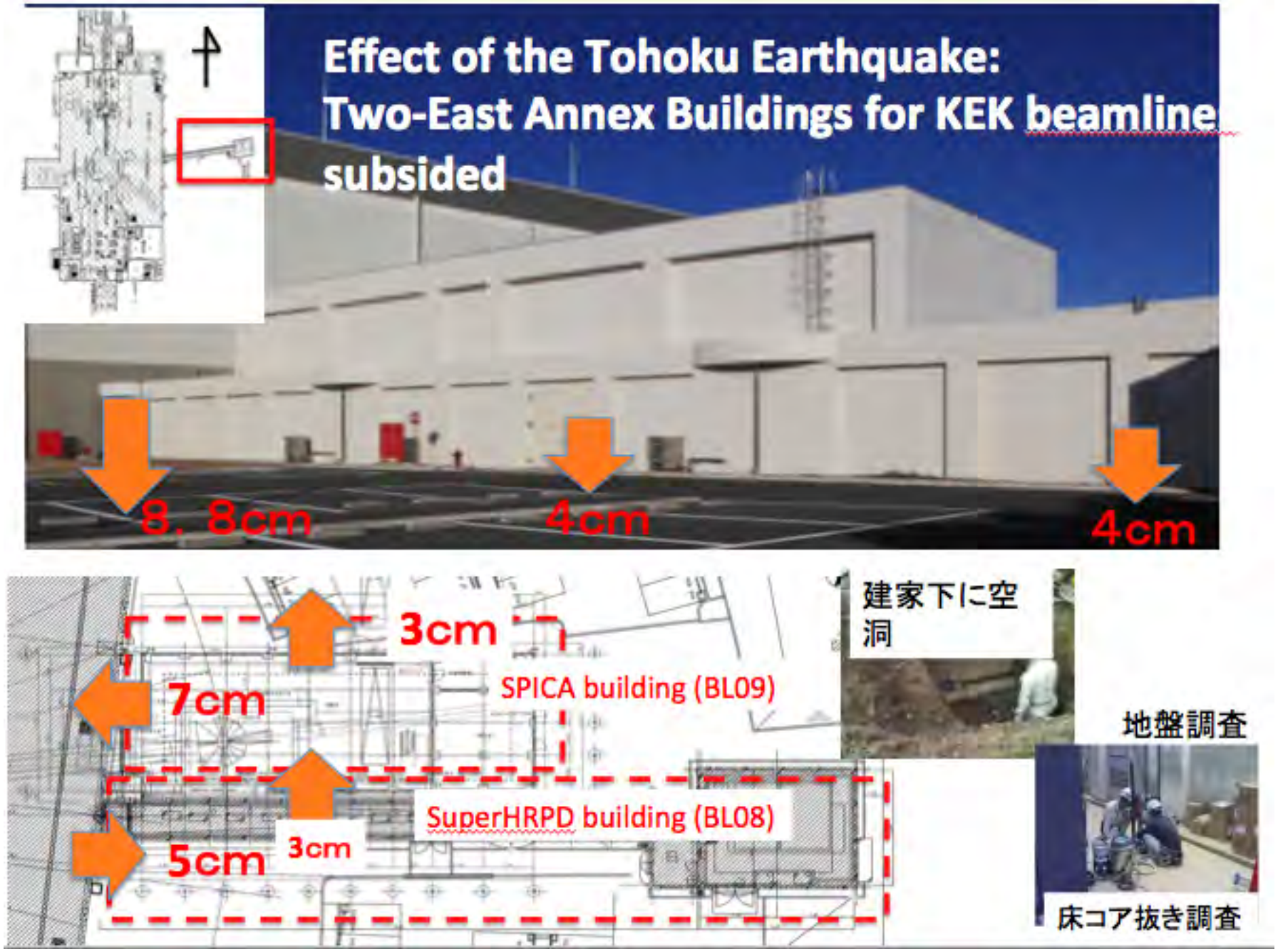
KEK装置（室屋）



J-PARC

MLF (物質・生命科学実験施設)の周辺が軒並み沈下




Effect of the Tohoku Earthquake:
Two-East Annex Buildings for KEK beamline subsided
8．8cm
4cm
4cm
3cm
7cm
SPICA building (BL09)
SuperHRPD building (BL08)
3cm
5cm
建家下に空洞
地盤調査
床コア抜き調査

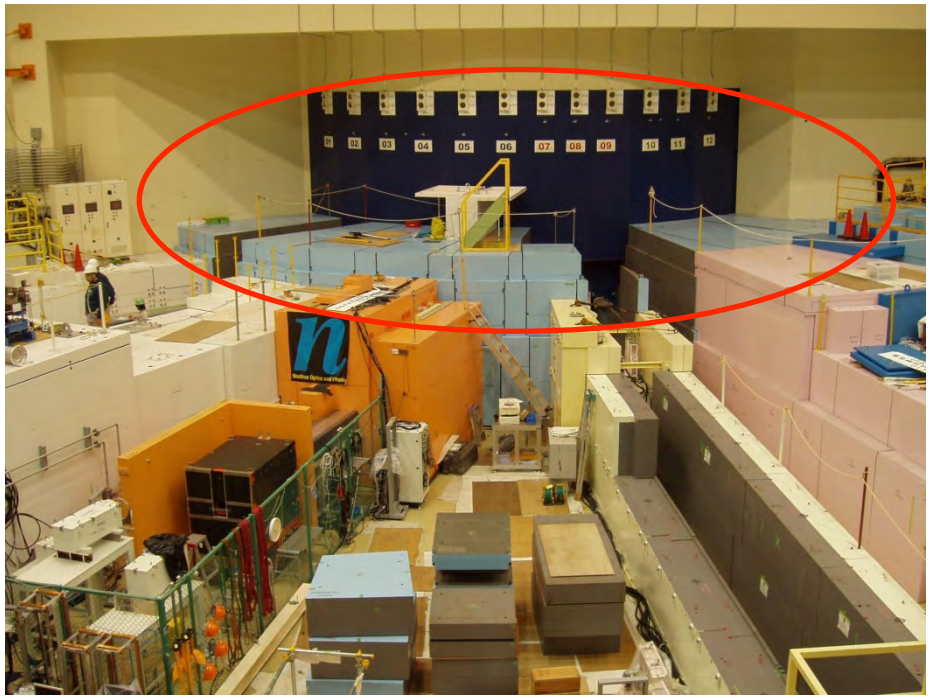
前置き遮蔽体（青）がずれて、
部分的に沈み込んでいた
ー＞下部の遮蔽体が片持ち状態。

前置き遮蔽体の再設置（神原チーム）

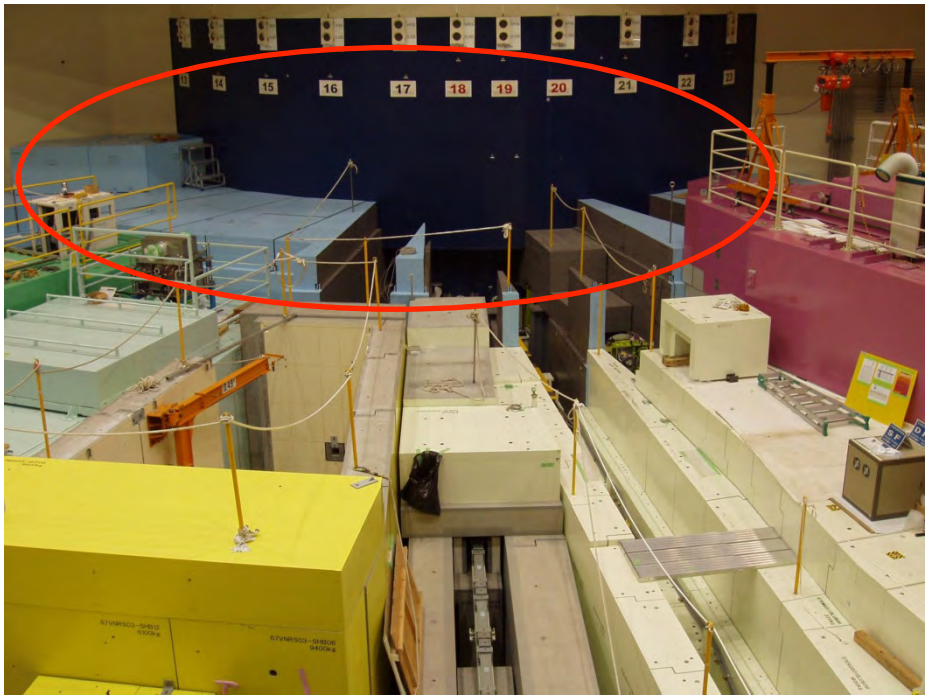
膨大な数のブロックの一つ一つを再組み立てし、留め金で固定

前置き遮蔽体修正に数ヶ月かかった

No.1 experimental hall　　September 12



No.2 experimental hall　　September 9



JAEA No.1 experimental hall after Tohoku earthquake on March 11

Falling and shearing of components of each instrument occurred.
But, there were not big damages.
Front shieldings were strongly sheared.

March 17

BL01
Falling of rack

BL02
Shearing of Beamstop

BL10
Falling of devices

BL04
Break of Ge detector shielding

BL11
Shearing of shieldings

JAEA No.2 experimental hall and west extension after Tohoku earthquake on March 11

March 17

Falling and shear of components of each instrument occurred.
West side extension was sunk approximately 15cm at whole place.

BL14
Dropping out of shielding surface

BL15
Damage of upper shielding clasp

BL17
Shearing of upper shieldings

BL18
Shearing and falling of shieldings

Sinkage of building

BL19
Shearing of upper shieldings

KEK

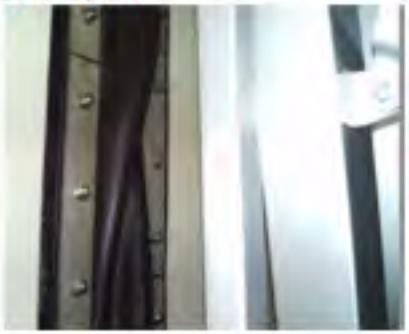
Effect of the Tohoku Earthquake:
1st Experimental Hall and East Annex Building

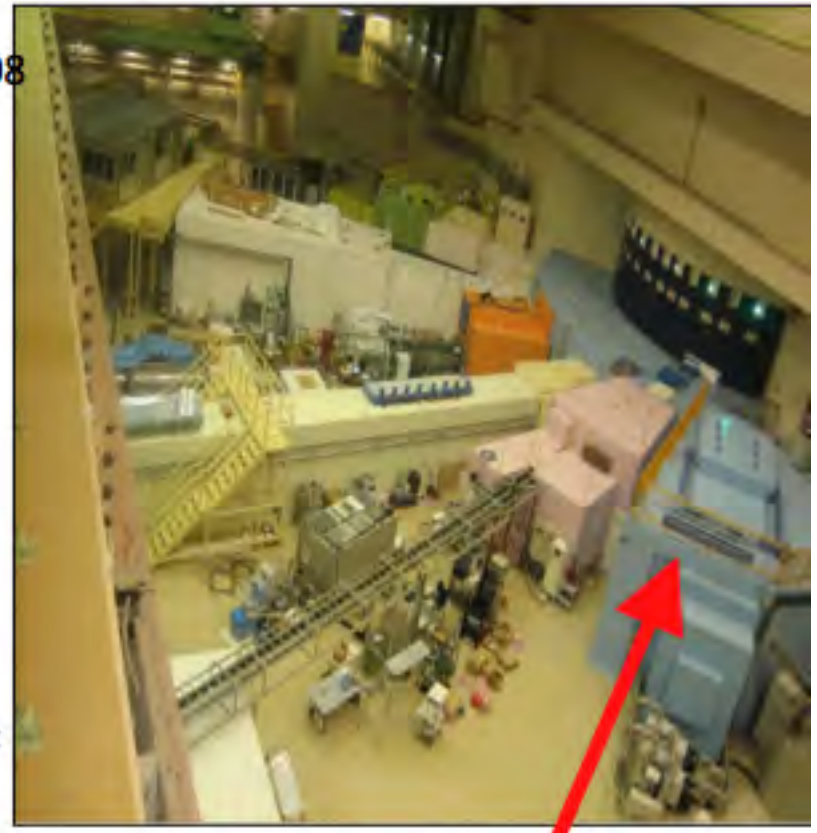
BL08 floor level subsided

Expansion joint labor distorted between BL08 &BL09 :

BL09 floor level subsided

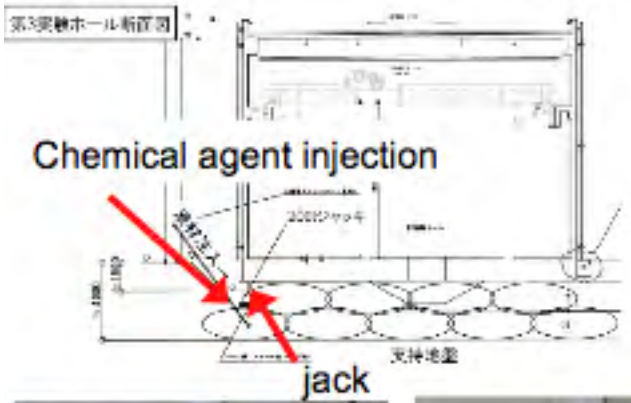
Expansion joint labor distorted between MLF & BL08 :

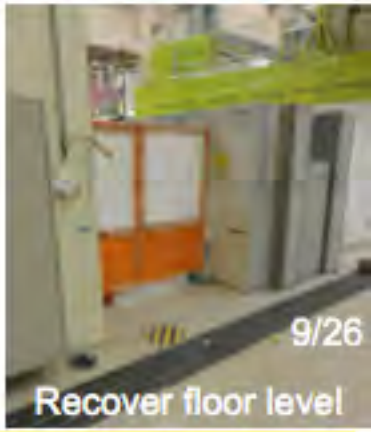




BL12 KEK HRC
Nine of 3m-long He3 tube was broken. (2kV HV was ON when Earthquake)

JAEA 西側増築建屋（BL19 +BL18, BL20）





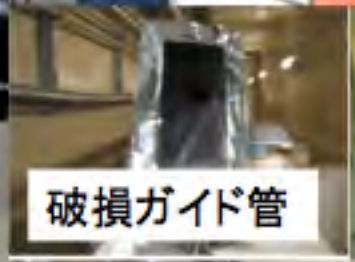
BL18 & 19撤去、建屋全体ジャッキアップ、グラウト注入、機器再設置

BL19 shieldings rebuild
10/21-24, continued

KEK BL08修復

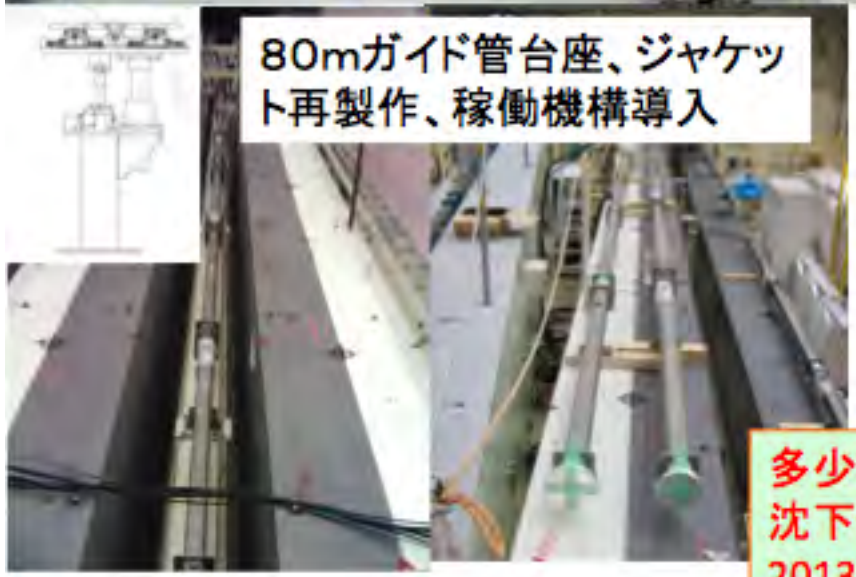
壁際遮蔽体撤去・修復

補助遮蔽体解体・修復



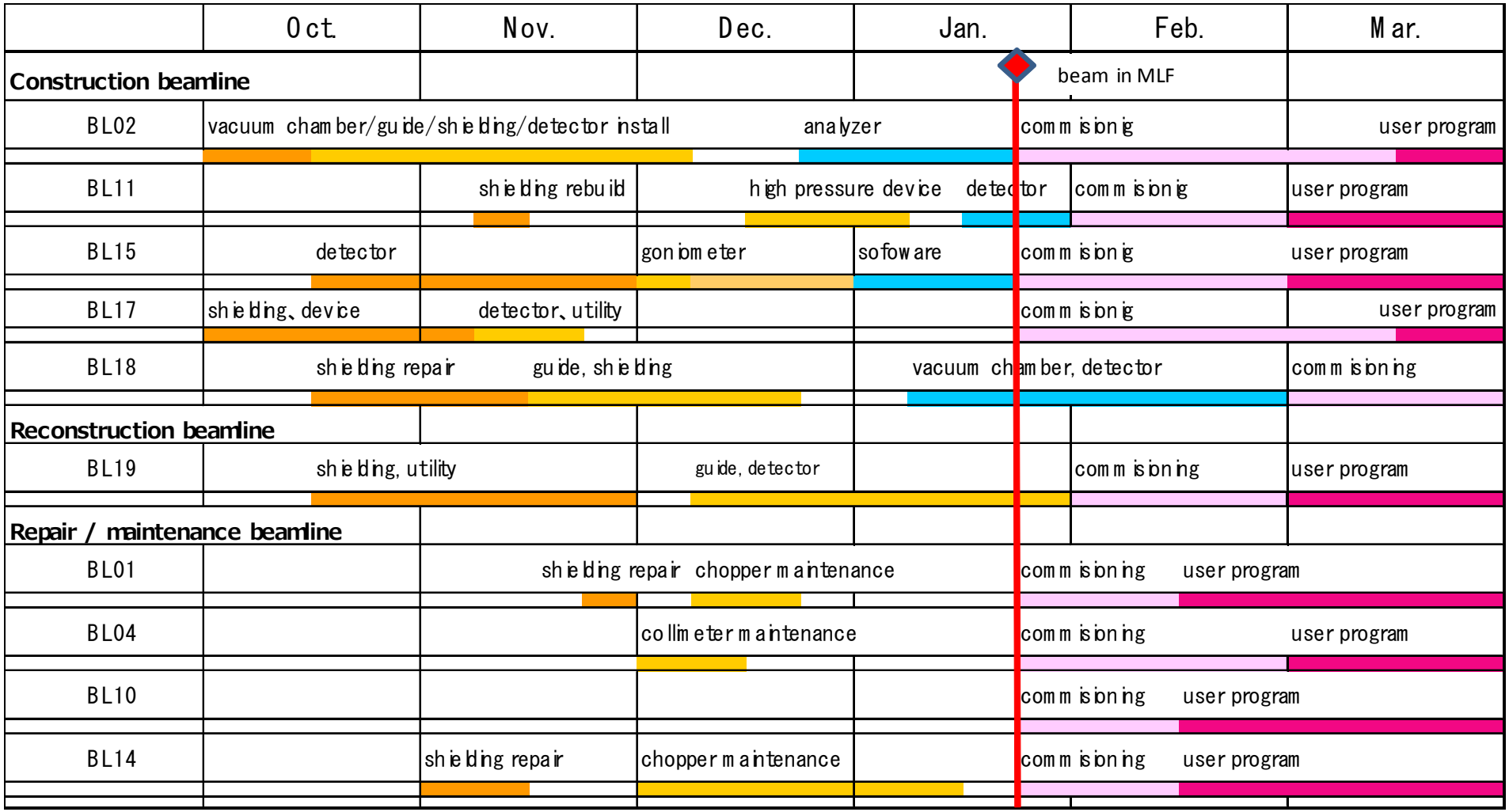
壁際遮蔽体解体

下流ガイド管撤去・清掃・修理等作業



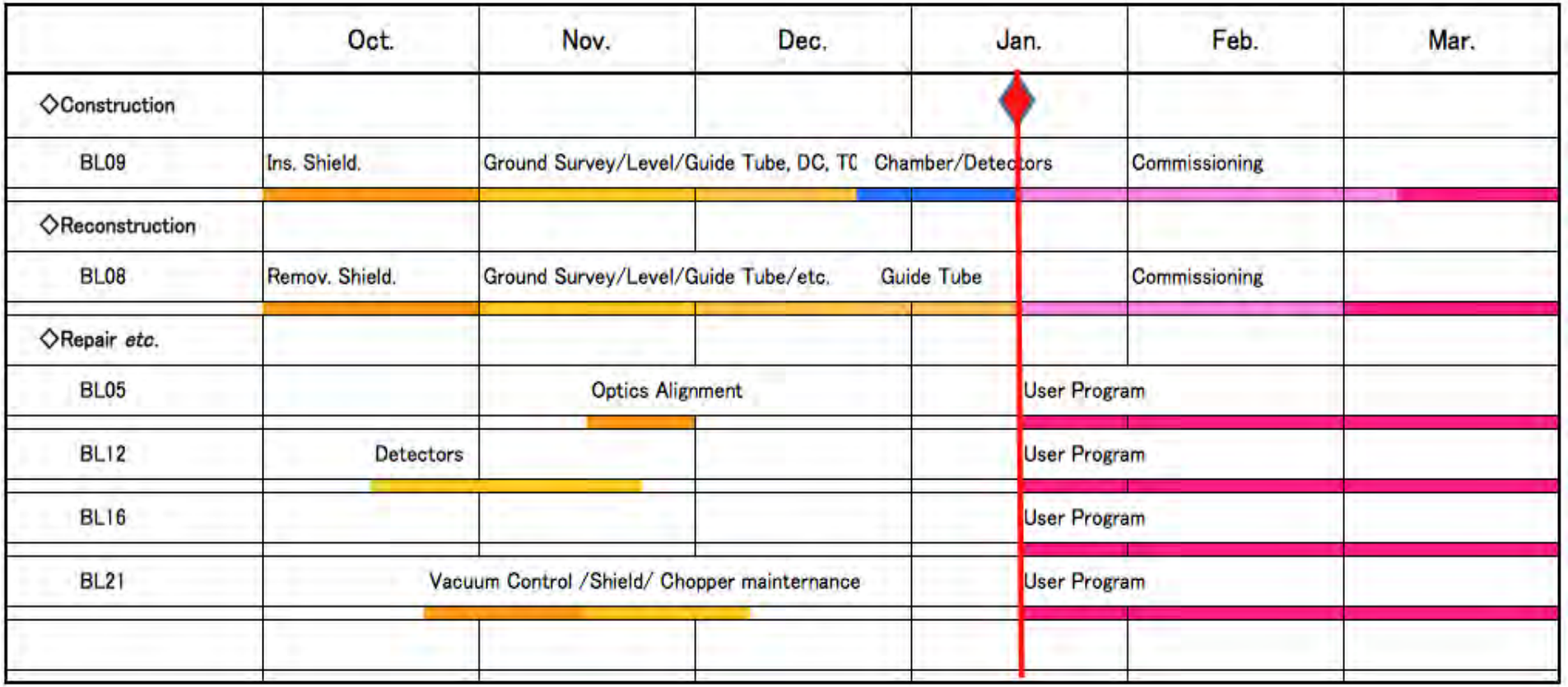
多少ひびが入ったガイド管は用いる
沈下分と今後の沈下・移動に対処する機構導入。
2013夏、鉄ジャケット補強。

JAEA-CROSS ビームラインのSchedule in late FY2011



- BL19 building: BL18 & BL19 遮蔽体撤去、BL18検出器撤去、BL19全ての機器撤去後、ジャッキアップ、グラウト注入、すべての機器を再設置
- 前置き遮蔽体再設置
- シャッター内真空シール破損修理 （及川・ハルヨ チーム）

KEK 各ビームラインのSchedule in late FY2011



BL08 & 09 buildings: 地盤調査に基づきBL09地下の一部にグラウト注入
BL08 beamline: 高さはガイド管台座に調整機構を設けた
BL12: 壊れた検出器の代わりに新規購入

・シャッター内真空シール破損修理（及川・ハルヨ　チーム）

利用セクション
復旧デイリーミーティング

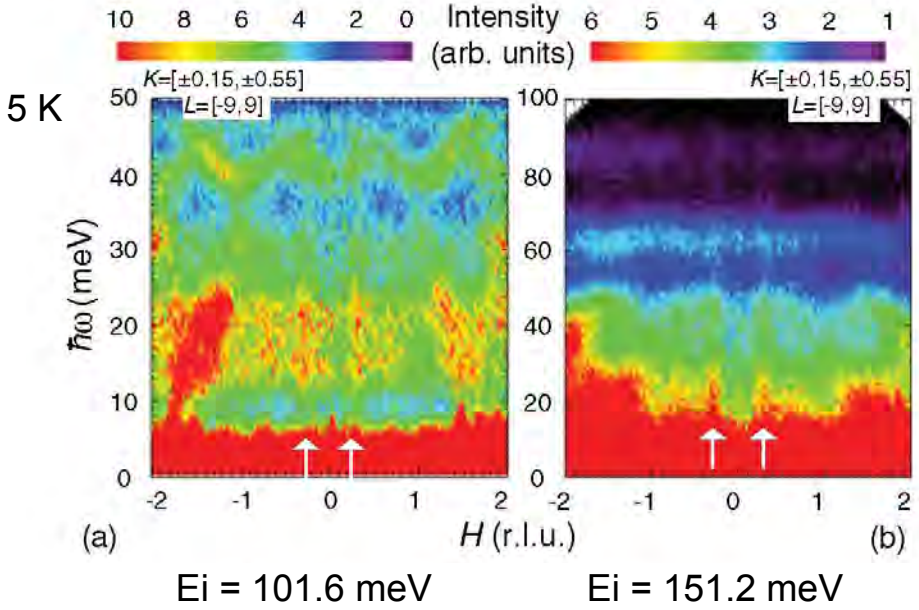
議事メモ、作業報告書

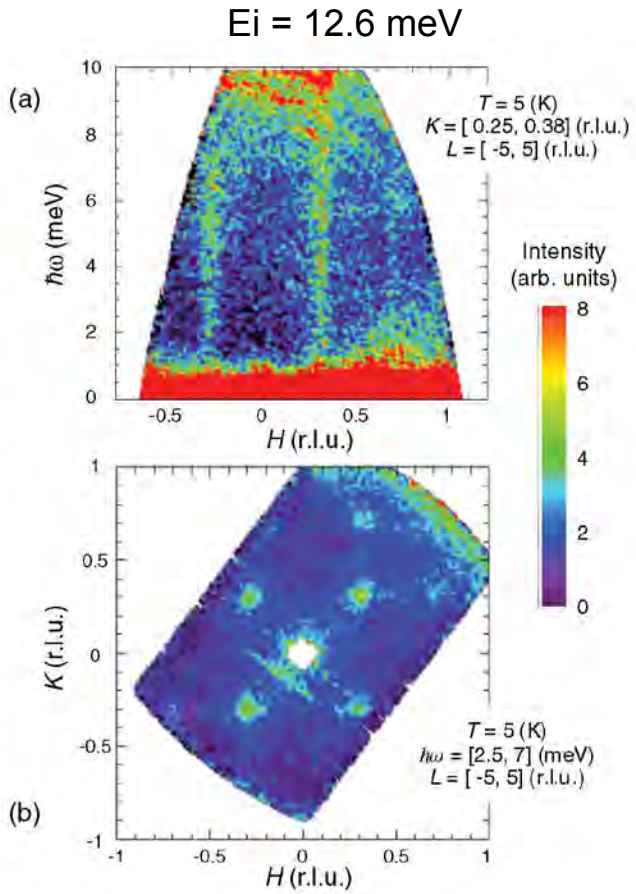
BL01 Inelastic neutron scattering study of the magnetic fluctuations in Sr_2RuO_4

K. Iida, M. Kofu, N. Katayama, J. Lee, R. Kajimoto, Y. Inamura, M. Nakamura, M. Arai,
Y. Yoshida, M. Fujita, K. Yamada, and S.-H. Lee
PHYSICAL REVIEW B, 84, (2011), 060402(R)

セッション1（ハイライト）

Magnetic fluctuations in wide (q, ω) space, using Multi Ei method





There are strong spin fluctuations at the incommensurate positions centered at **Qc** = (0.*3,0.3)* that exist up to ħω of at least 80 meV, which are consistent with a previous polarized inelastic neutron scattering experiment that reported the incommensurate peaks up to 40 meV

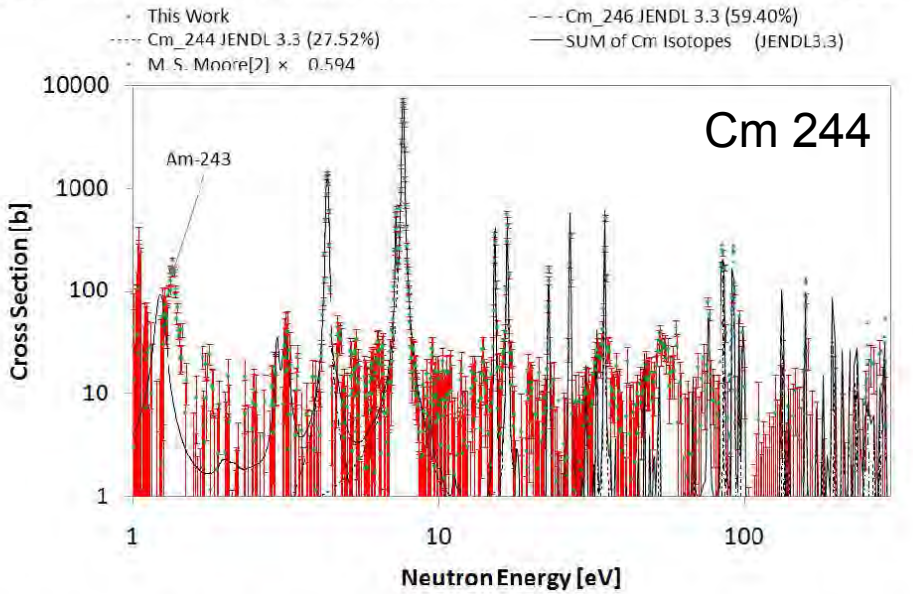
The data show strong magnetic fluctuations that exist on the ridges connecting the incommensurate peaks around the (π,π) point.
The results are consistent with the semi-mean-field random phase approximation calculation for a two-dimensional Fermi liquid with a characteristic energy of 5.0 meV.

BL04 Measurements of Neutron-capture Cross Sections of 244Cm and 246Cm at J-PARC/MLF/ANNRI

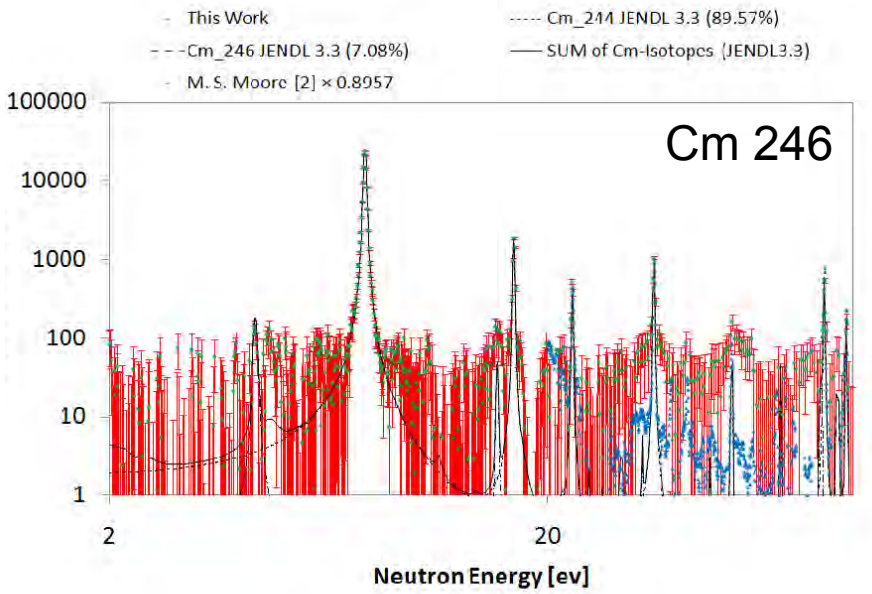
A. Kimura, K. Furutaka, S. Goko,y H. Harada, T. Kin, F. Kitatani, M. Koizumi, S. Nakamura, M. Ohta, M. Oshima, Y. Toh, T. Fujii, S. Fukutani, J. Hori, K. Takamiya, M. Igashira, T. Katabuchi , M. Mizumoto T. Kamiyama, K. Kino and Y. Kuyanagi

Journal of the Korean Physical Society, 59, (2011), 828－1831

セッション2 （ターゲット及び装置開発）



New data



New data

ANNRI(BL04)

It is a powerful instrument to measure neutron-capture cross sections of minor actinides in following conditions.

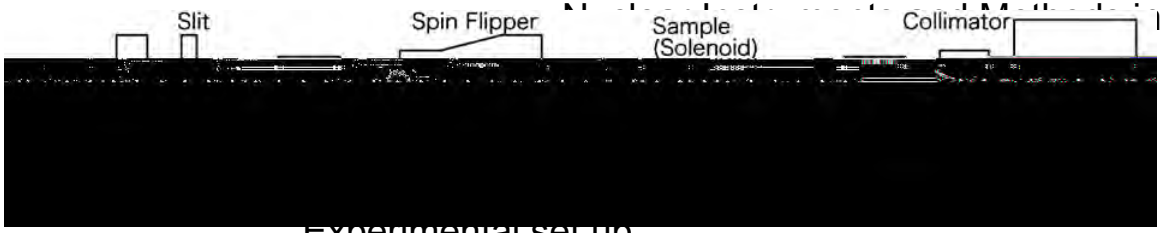
- Smaple amount < 1mg
- Activity < 1GB
- Half life < 30 years

BL10

セッション2
（ターゲット及び装置開発）

Quantitative magnetic field imaging by polarized pulsed neutrons at J-PARC

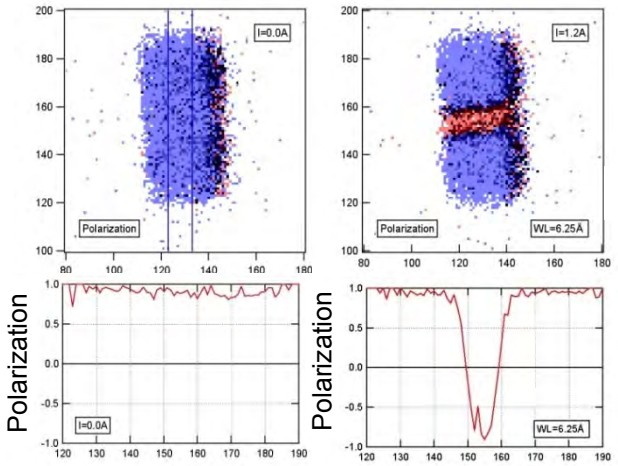
T. Shinohara, K. Sakai, M. Ohi, T. Kai, M. Harada, K. Oikawa, F. Maekawa, J. Suzuki, T. Oku, S. Takata, K. Aizawa, M. Arai, Y. Kiyanagi



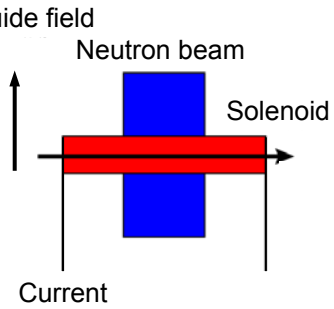
Experimental set up

Current **OFF**
I=0.0A

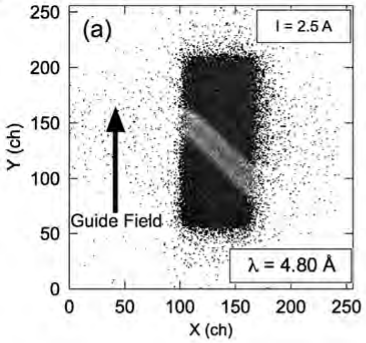
Current **ON**
I=1.2A



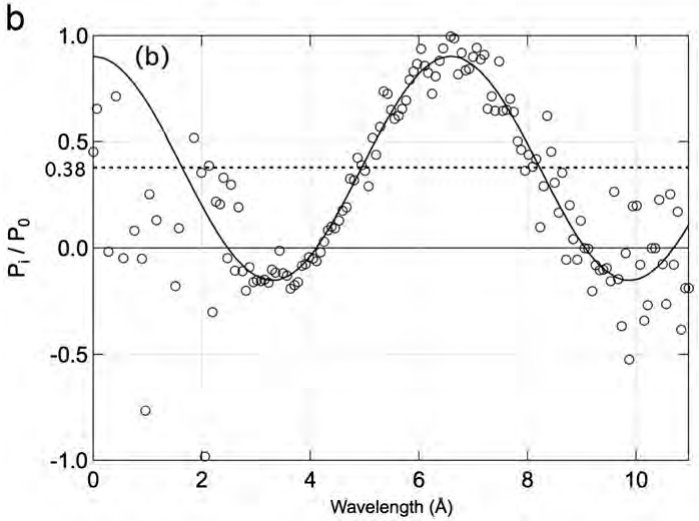
λ=6.25A



a



b



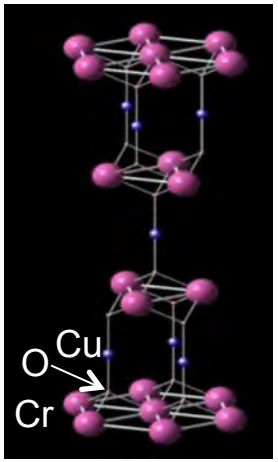
The magnetic field inside a solenoid coil have been successfully observed and quantification of the strength of the magnetic field by analyzing the wavelength dependence of polarization are performed.

It is possible to quantitatively evaluate both the strength and the direction of the magnetic field with spatial resolution by analyzing the wavelength dependence of polarization.

BL14 Temperature and Ag Doping Effect on Magnetic Excitations in the Quasi-Two-Dimensional Triangular Lattice Antiferromagnet $CuCrO_2$ Studied by Inelastic Neutron Scattering

R. KAJIMOTO, K. NAKAJIMA, S. OHIRA-KAWAMURA, Y. INAMURA, K. KAKURAI, M. ARAI, T. HOKAZONO, S.OOZONO, and T. OKUDA

Journal of the Physical Society of Japan, 79, (2010), 123705



$CuCrO_2$: 2D Triangular lattice of Cr spins

- A novel spin dynamics is expected due to the geometrical frustration.
- But, Finite three-dimensionality suppresses such a novel state.

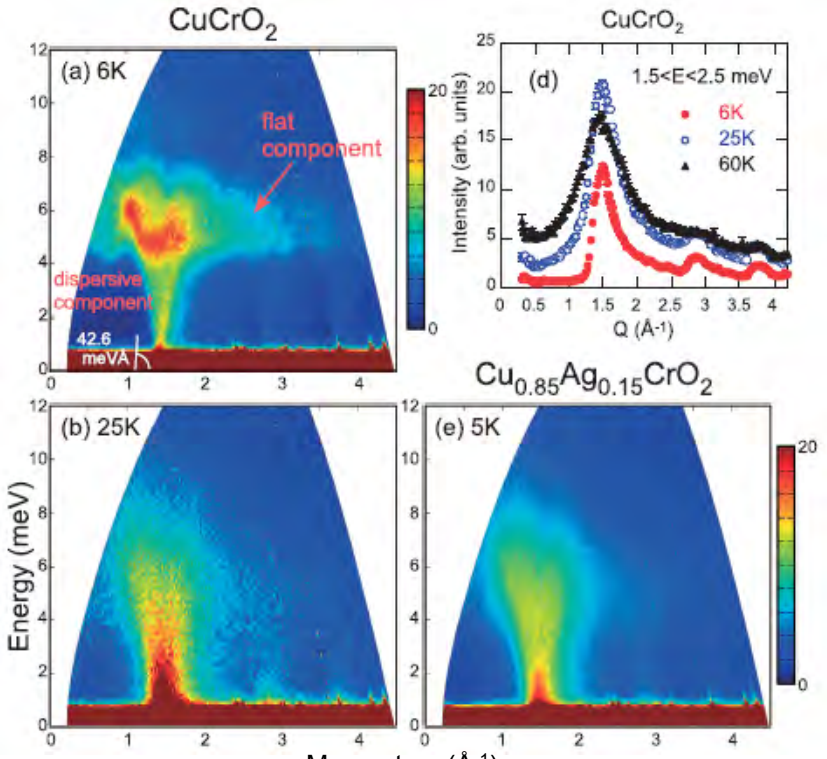
$(Cu,Ag)CrO_2$: substitution of Cu between Cr triangular planes by Ag

- intentional increase in two-dimensionality by disturbing interplanar exchange interactions
- *How does spin dynamics change by Ag doping?*

Inelastic neutron scattering study of $CuCrO_2$ and $Cu_{0.85}Ag_{0.15}CrO_2$ reveals *a large impact of Ag doping on the spin dynamics*:

- Disappearance of "flat component"
- Appearance of "diffuse component"

⇒ expectation of realization of a novel spin dynamics



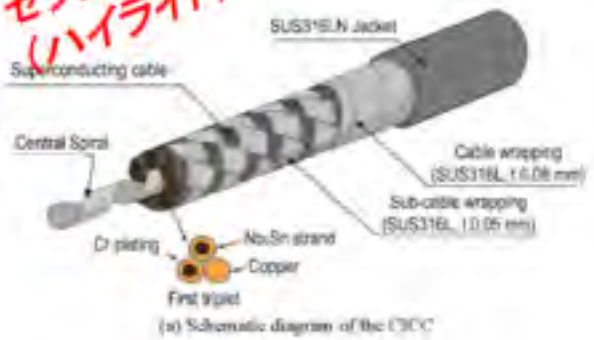
Excitation spectra of $CuCrO_2$ and $Cu_{0.85}Ag_{0.15}CrO_2$ represented as momentum-energy maps

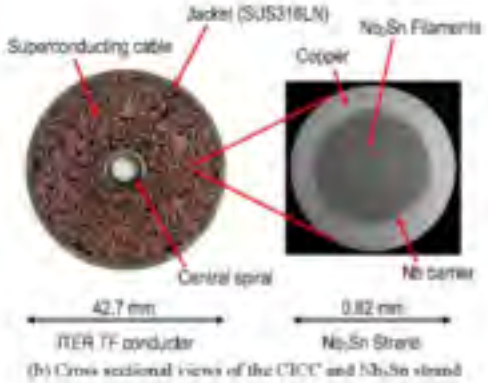
BL19 Neutron Diffraction Measurements of Internal Strain in Nb_3Sn Cable-In-Conduit Conductors

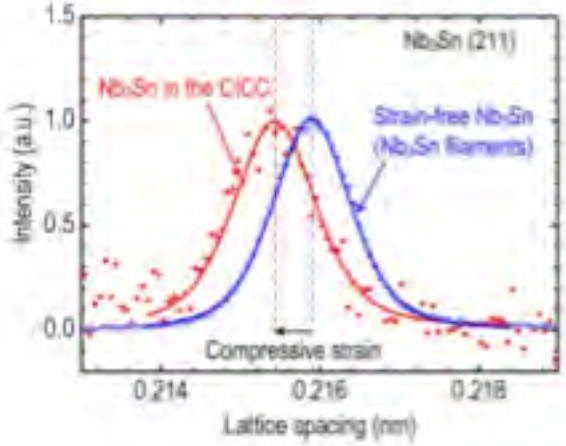
T. Hemmi, S. Hario, T. Ito, K. Matsui, Y. Nunoya, N. Koizumi, Y. Takahashi, H. Nakajima, K. Aizawa, H. Suzuki, S. Machiya, H. Oguro, Y. Tsuchiya, K. Osamura

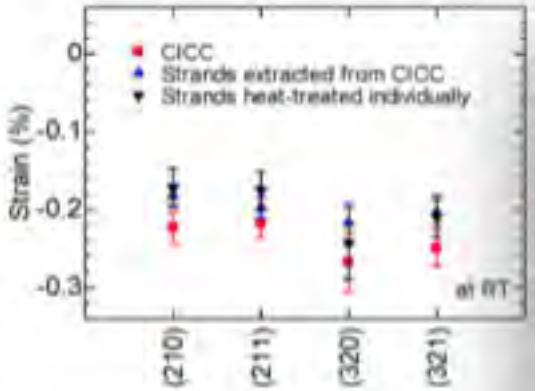
IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY, 21, (2011), 2028－2031

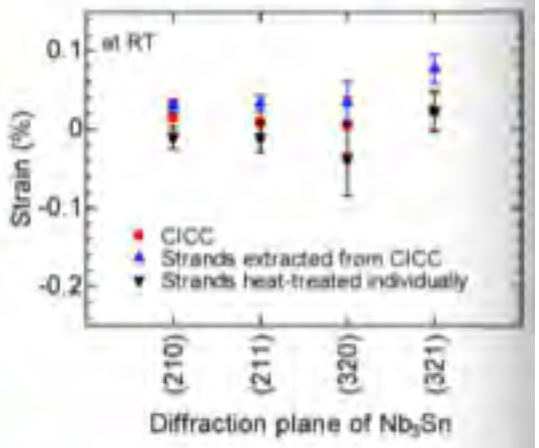
セッション1（ハイライト）











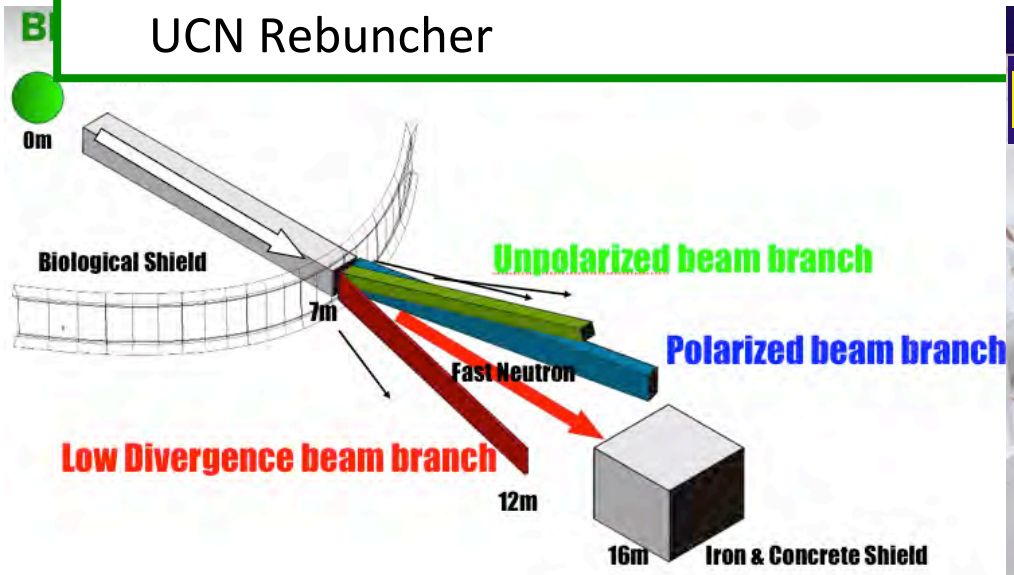
TAKUMI(BL19)

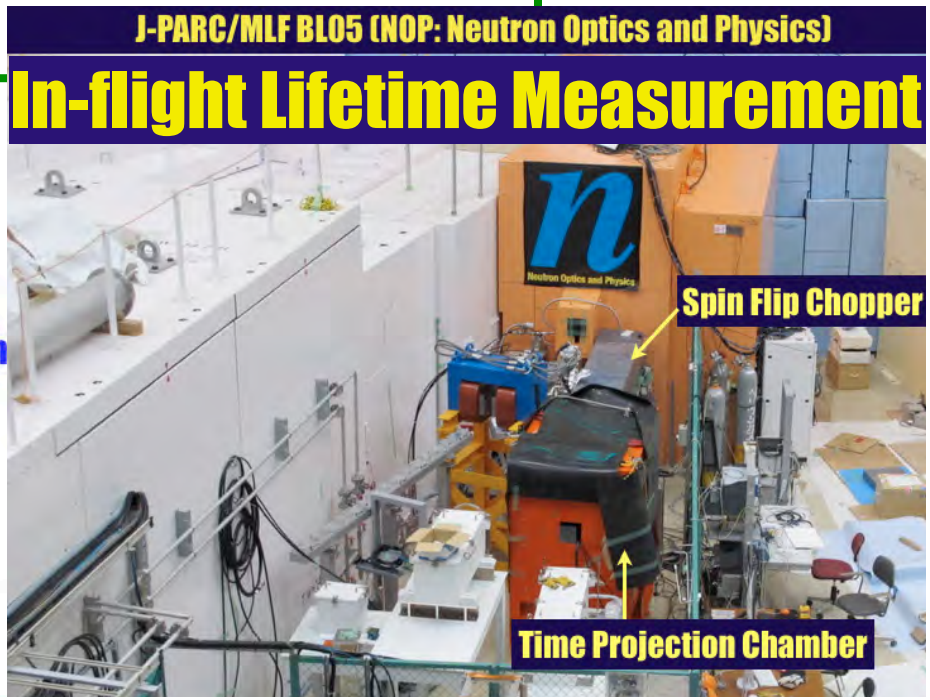
It is a powerful tool for evaluating directly the internal strain of big composite materials.

BL05: Neutron Optics and Physics (NOP) beamline
S-type Project Title: Fundamental Physics with Pulsed Cold Neutrons

In-flight Measurement of the Lifetime of Cold Neutrons
Search of Medium-range Force in Differential Cross Section
Neutron Interference

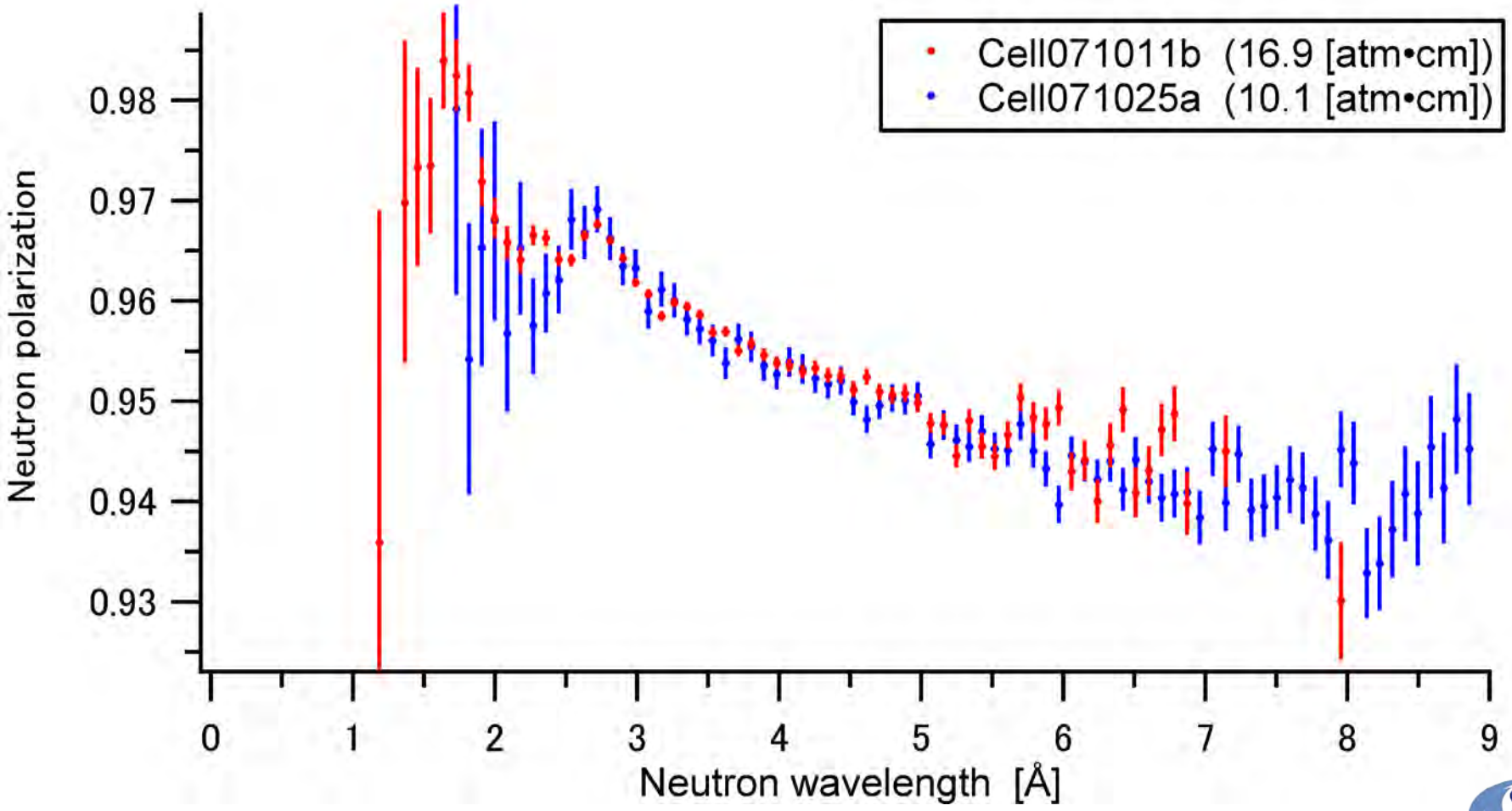
Slow Neutron Optics R&D
- Spin Flip Chopper for CN
- Reflective Optics for CN, VCN, UCN
- Doppler Shifter (VCN→UCN)
- UCN Rebuncher





Neutron beam polarization

$$P_N = 0.9562 \pm 0.0003 \quad (0.1\,\text{nm} < \lambda < 0.7\,\text{nm})$$



Goal is much precise measurement (<10^{-3}) for the neutron Lifetime

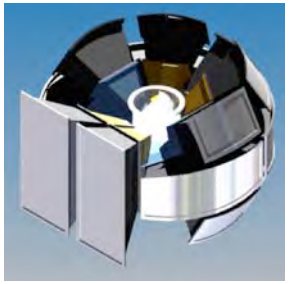
Three KEK Diffractometers

BL08 *SuperHRPD*

Very High Resolution

Main Target:
Sol. State Physics, Large Crystal Structures, Hybrid Str. *etc*.

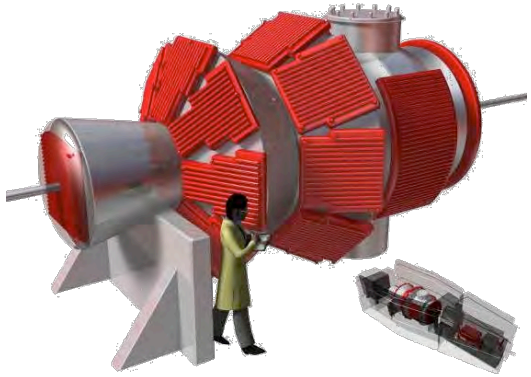
BL09 *SPICA*



High Resolution & High Intensity

Main Target:
Li-ion Battery Research, Crystal, Disordered Mater.

BL21 *NOVA*



High Intensity S(Q) machine

Wide *Q*: 0.01 ~ 100 Å^{-1}

Main Target:
Hydrogen Storage Mechanism, Crystal, Amorphous, Glass, Liquid, *etc*.

BL08: SuperHRPD

S-type Project Title: Development of SuperHRPD and Structural study of functional materials

Topics 1）Detect small distortion not observed previously to study structural science with weak interactions (weaker in 4d systems than 3d), or interplay of 'more than two' interactions,

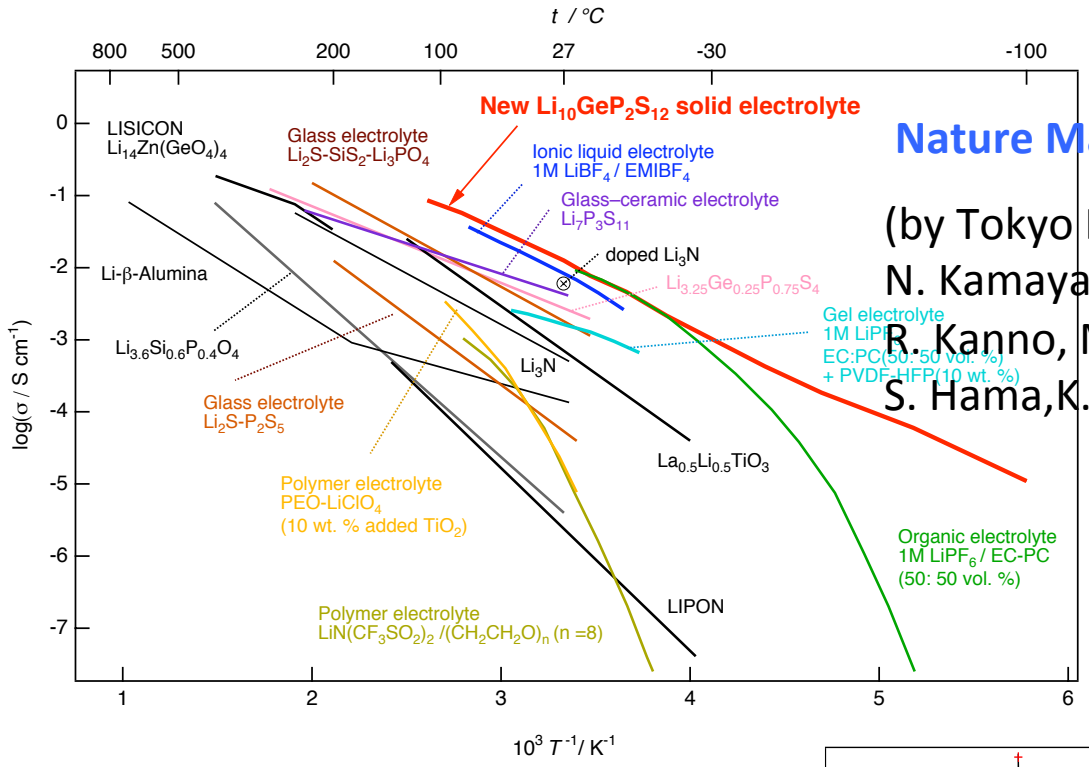
ex.) lattice - spin (0.001Å) < lattice – charge (0.01Å) < lattice – orbital (0.1Å) (by Prof. Arima)

Topics 2) Structural sciece in large structures, organic-inorganic hybrid structure, super-molecules, pharmaceuticals, *etc*.

Topics 3) Ionic conductivity and battery systems,

Crystal Structure of the Highest Li superionic conductor $Li_{10}GeP_2S_{12}$

セッション3
(環境エネルギー)

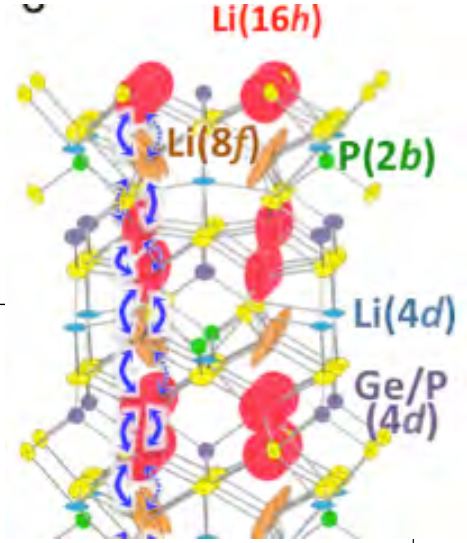


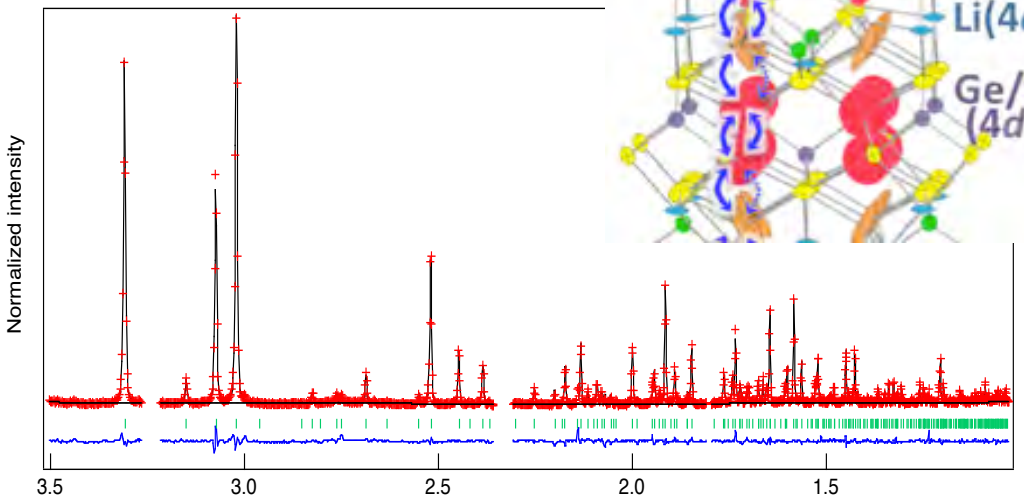
Li-ion conductivity with 12 mS cm^{-1} at 27°C is the highest ever synthesized, and better than liquid electrolyte used in commercial secondary batteries.

It is revealed a three dimensional framework of (Ge,P)S_4, LiS_4 and LiS_6, with a one-dimensional lithium conduction pathway along the c axis.

Nature Materials 10, 682-686 (2011)

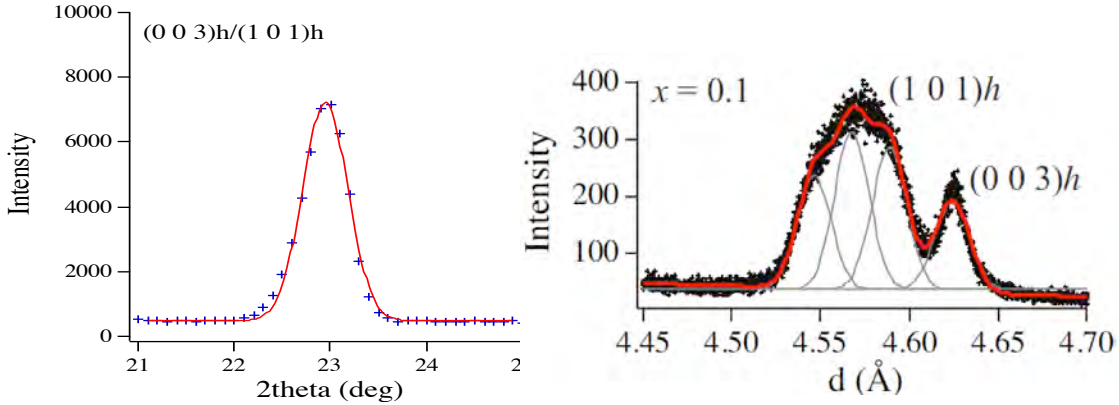
(by Tokyo Inst. Tech., KEK & Toyota Motor Co.)
N. Kamaya, K. Homma,Y. Yamakawa,M. Hirayama,
R. Kanno, M. Yonemura,T. Kamiyama,Y. Kato,
S. Hama,K. Kawamoto, A. Mitsui





$P4_2/nmc$ (137); a = 8.69407(18) Å, c = 12.5994(4) Å

Magnetic peaks of multiferoic 0.9 $BiFeO_3$ - 0.1 $BaTiO_3$



R. Kiyanagi, Y. Noda *et al*.

(left) conventional 0.3 % resolution diffractometer, (right)S-HRPD

BL08 General User Programs

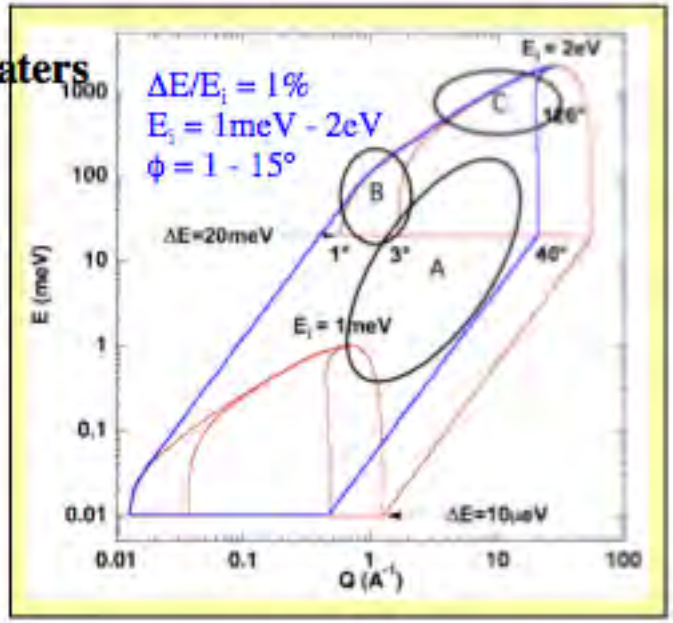
	2008	2009A	2009B	2010A	2010B
No. Application	14	13	5	12	12
No. Approved	5	10	5	12	12

Two Original Science Papers and 4 Submitted science papers

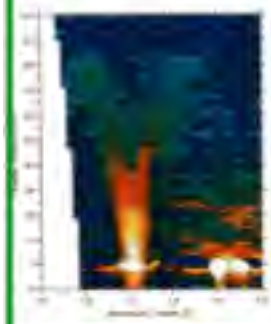
- Kamaya *et al*., A lithium superionic conductor, Nature Materials 10, 682-686 (2011)
- H. Matsuo *et al*., Structural and piezoelectric properties of high-density $(Bi_{0.5}K_{0.5})TiO_3$–$BiFeO_3$ ceramics, J. Appl. Phys. 108, 104103 (2010).

BL12: HRC

S-type Project Title: Study on dynamics in condensed maters on HRC −toward sub-eV neutron spectroscopy−



A. High resolution experiments in conventional QE space



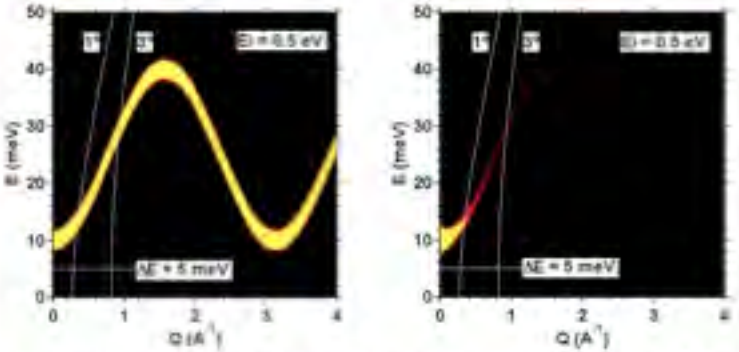
$\Delta E/E_i$=1%: ΔE=1meV, ΔQ=0.03A^{-1}@E_i=100meV

Determination of dispersion relation as well as discussion on S(q,w) in detail

- quantum phase transition in random system
- hole doped Haldane system
- detection of orbital waves
- excitations in multi-pole system
- metal ferromagnets

B. Access to 1st Brillouin zone

$\Delta E/E_i$=1%: ΔE=5meV, ΔQ=0.07A^{-1}@E_i=0.5eV

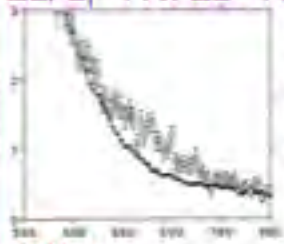


observation ferromagnetic spin waves in polycrystalline sample

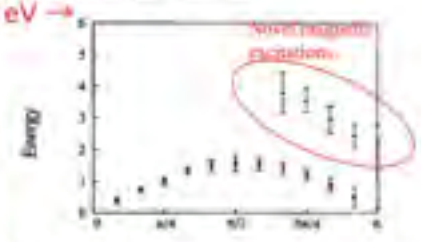
- multi degree of freedom in correlated electron systems
- origin of magnetism in ferromagnetic semiconductors

C. Possibility of eV neutron spectroscopy

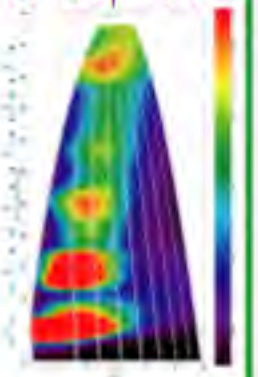
$\Delta E/E_i$=1%: ΔE=10meV, ΔQ=0.1A^{-1}@E_i=1eV



High energy excitations in Cr



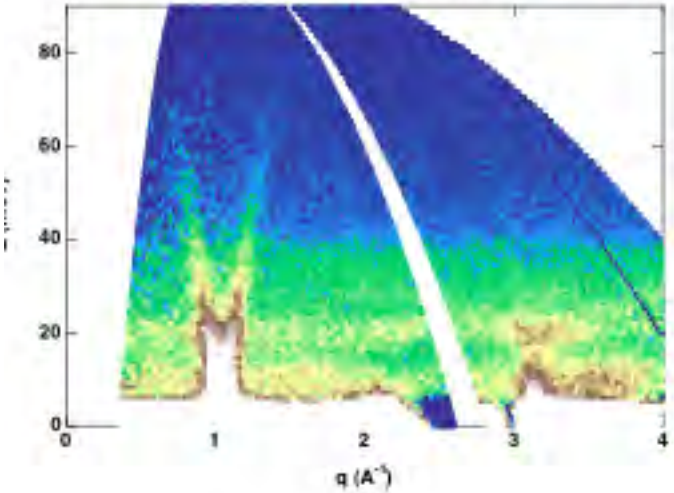
Electronic excitations

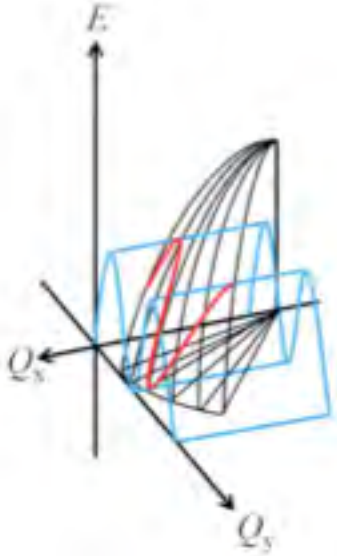


vibration modes in hydrogen

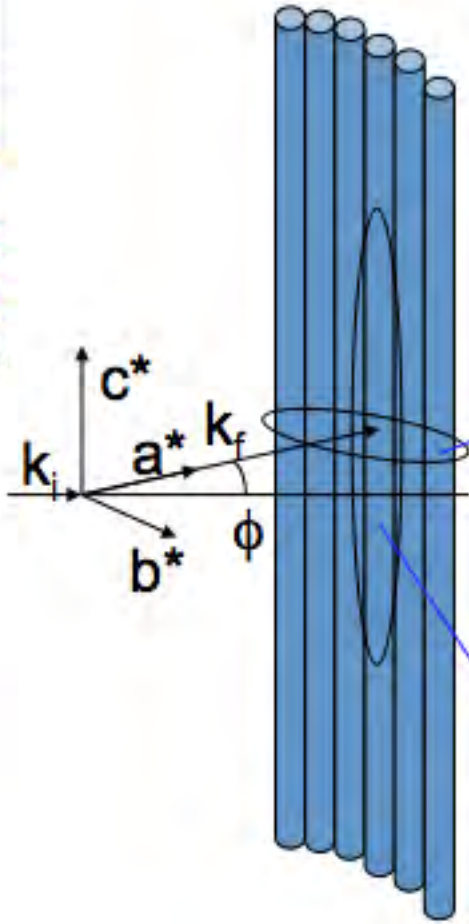
Experiments on HRC

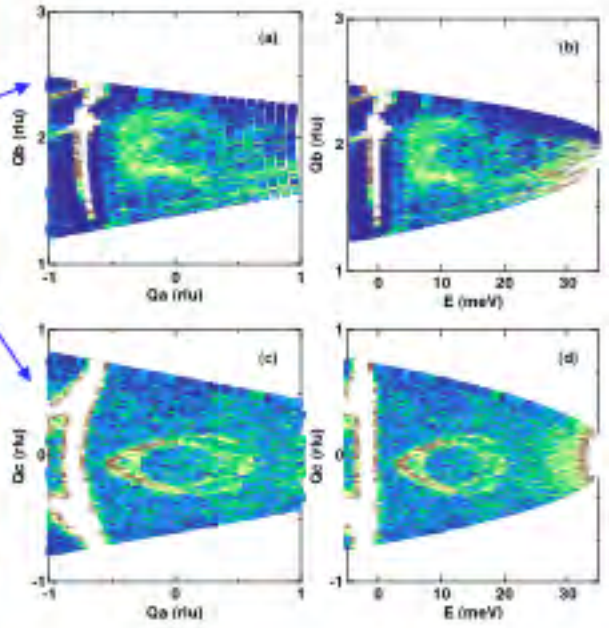
$CsVCl_3$ 20K (1D AF)





MnP 60K (3Dferro)





BL16: Soft Interface Analyzer SOFIA
(Reflectometer with a Horizontal Sample Geometry)
S-type Project Title: Analysis of Dynamics at Nano Interface of Functional Soft Matter

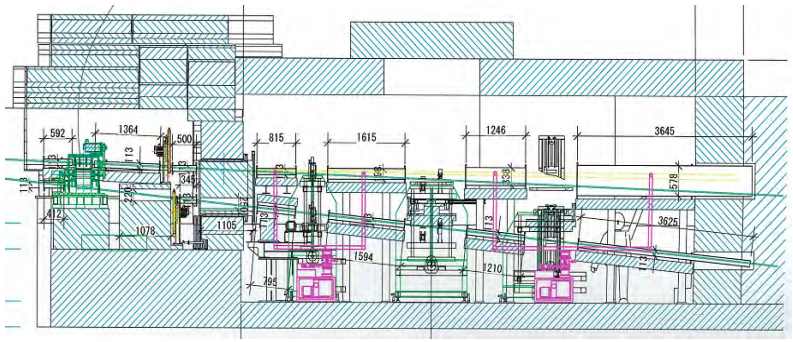
Funded by the ERATO project of JST

Topics 1) Time-dependent studies on the kinetics of the interfacial structure formation

Topics 2) 3D structural analyses of interfaces by simultaneous reflectivity/GISANS measurements

Topics 3) Time-dependent studies on the response of interface under external fields

Topics 4) Direct observation of interfacial dynamical fluctuation by the Spin echo method



2010

-A. Horinouchi *et al.*, *Chem. Lett.* **39**, 810-811 (2010).

-2011

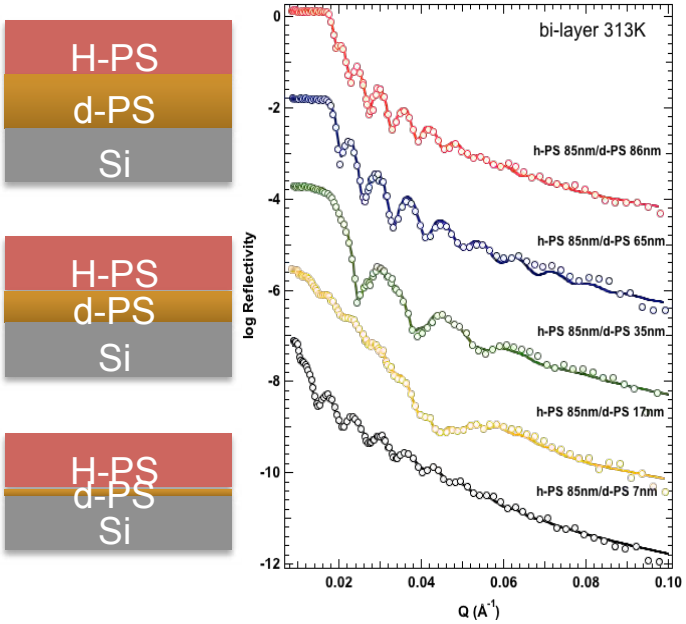
- R. Inoue *et al.*, *Phys. Rev. E*, accepted.
- H.-J. Liu *et al.*, *Softmatter*, accepted.
- N. Torikai *et al.*, *J. Phys.: Conf. Ser.*, accepted.
- N. Torikai *et al.*, *J. Phys.: Conf. Ser.* **272**, 012027 (2011)
- M. Kobayashi *et al.*, *J. Phys.: Conf. Ser.* **272**, 012019 (2011).
- K. Mitamura *et al.*, *J. Phys.: Conf. Ser.* **272**, 012017

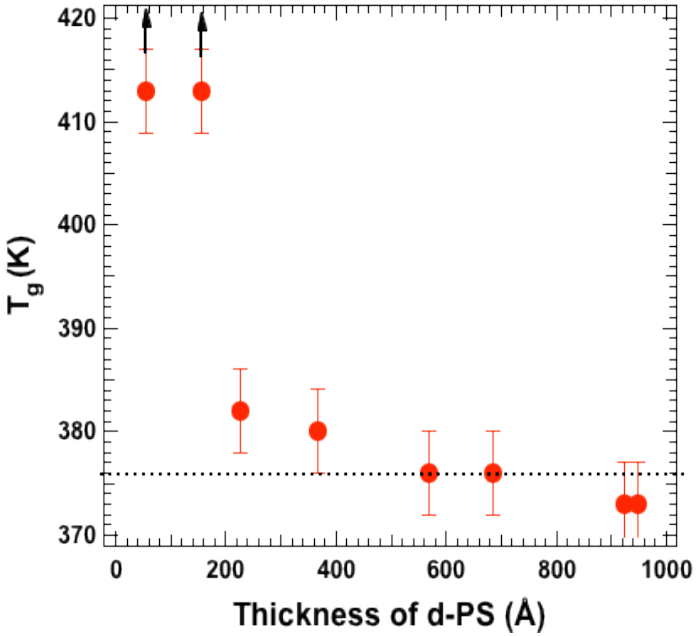
BL16 Anomalous glass transition of polymer thin film

セッション5
(ソフトマター)

R. Inoue and T. Kanaya *et al.*

NR technique can distinguish depth dependence by deuteration labeling.





Strange interfacial effect onset at round 500Å from substrate.

BL21: NOVA

S-type Project Title: Fundamental research of hydrogen storage mechanism with high-intensity total diffractometer

- NOVA is funded by a NEDO project, HydroStar, Advanced Fundamental Research Project on Hydrogen Storage Materials (2007-2011)
- Commissioning of NOVA started in 2009 and the hardware are almost ready including in-situ environments.
- 10 % beamtime is supplied to the J-PARC general users program on hydrogen related topics

JAEA / Kyoto Univ. / Yamagata Univ. / Fukuoka Univ. / Kyushu Univ. / Niigata Univ. / LANL

BL21 Surface structure of AlD_3

セッション3 (環境エネルギー)

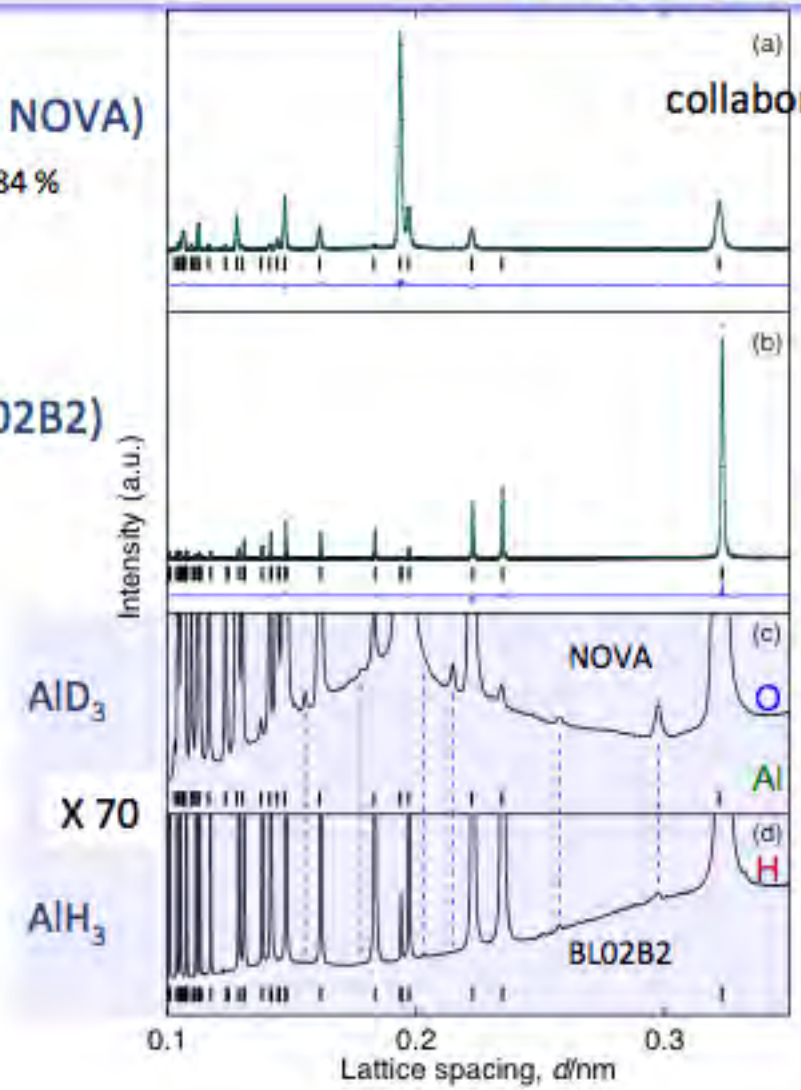
The first Science Paper

Ikeda, K. et al., *Materials Transactions*, **2011**, *52*, 598

AlD_3
(J-PARC MLF NOVA)

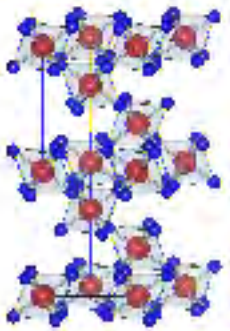
R_B 2.42 %, R_F 2.84 %
(Z-Rietveld)

AlH_3
(SPring-8 BL02B2)

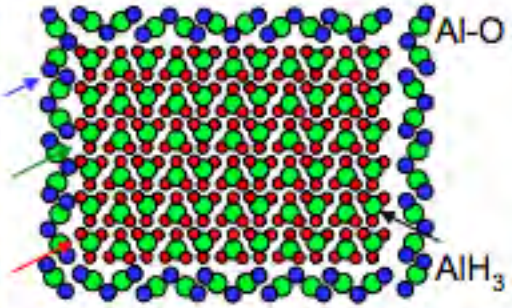


collaboration with S. Orimo (Tohoku Univ.)

α-AlD_3/AlH_3
R-3*c*



Suggesting Al-oxide layer



AlH_3	0.98
Al_2O_3	0.02

TEM suggests 5 nm thickness shell

BL20 Rietveld Analysis (LNCC+AB+PVdF, Al, After a Charge)

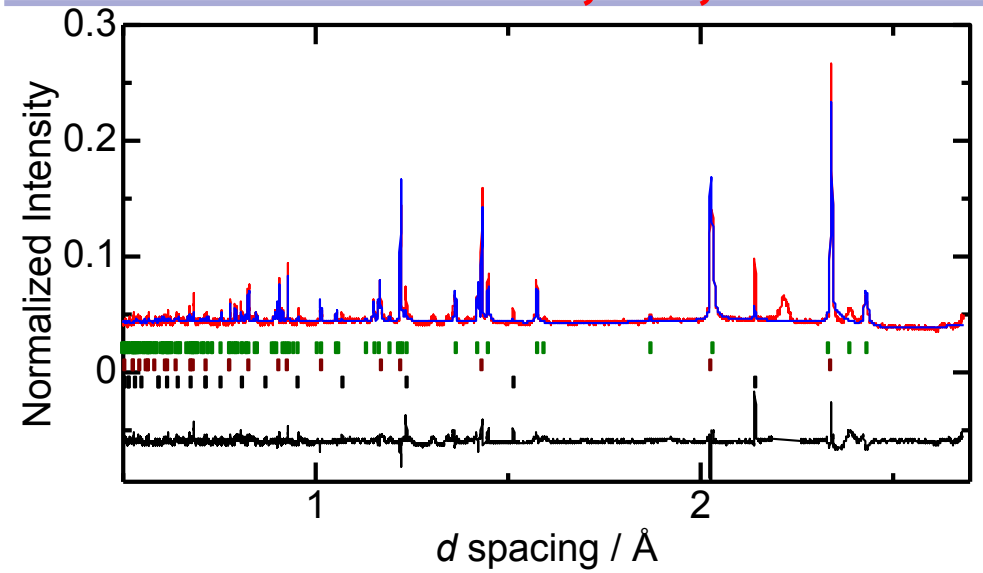


Fig. 15 Rietveld refinement patterns.

Idemoto *et al.*

活物質　ca.
8.5mg
（全体 ca. 32mg）
10 mm
Al foil含む
6時間23分

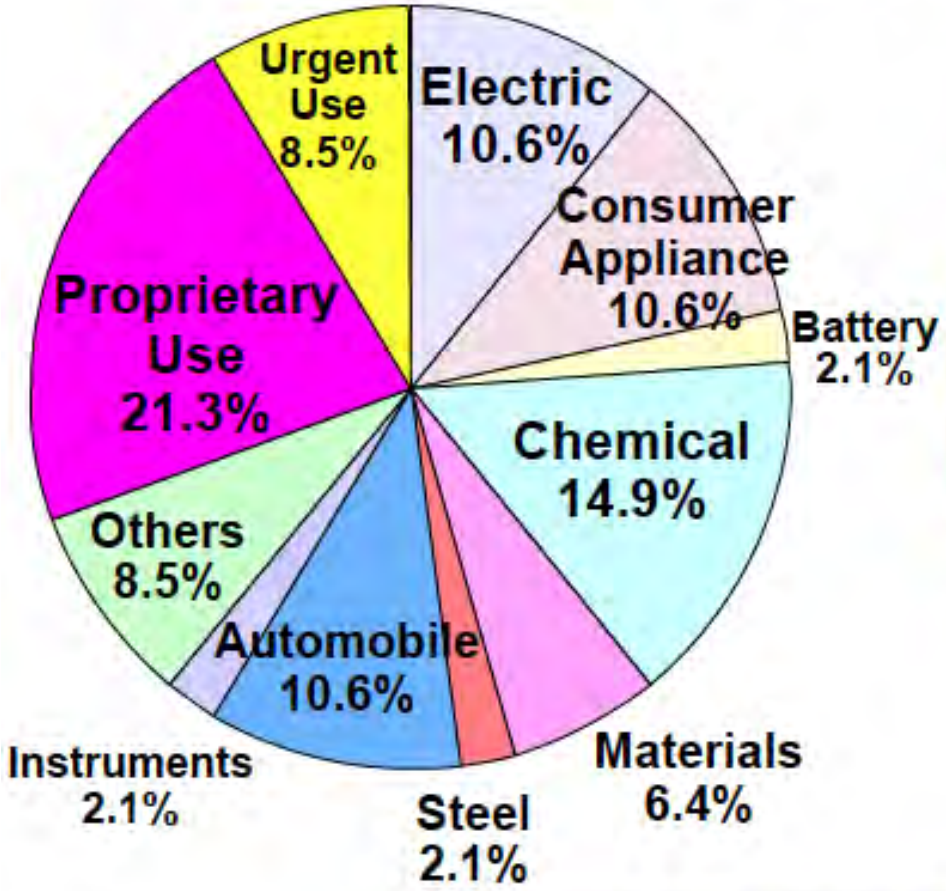
R-factors: R_{wp} = 5.00%, R_P = 3.36 %, S=2.90
Space group:*R-3m*
Lattice parameter:*a* =0.2844910(1)nm
c =1.43309(2)nm

Table 4 Refined structure parameters.

Atom	Site	*x*	*y*	*z*	$10^2 \times B$(nm^2)	Site occupancy
Li1	3a	0	0	0	1.6	0.650
Ni1	3a	=Li1(*x*)	=Li1(*y*)	=Li1(*z*)	=Li1(*B*)	0.050(3)
Ni2	3b	0	0	1/2	0.19	0.770(3)
Li2	3b	=Ni2(*x*)	=Ni2(*y*)	=Ni2(*z*)	=Ni2(*B*)	0.031
Co	3b	=Ni2(*x*)	=Ni2(*y*)	=Ni2(*z*)	=Ni2(*B*)	0.189
Cu	3b	=Ni2(*x*)	=Ni2(*y*)	=Ni2(*z*)	=Ni2(*B*)	0.01
O	6c	0	0	0.23679(9)	0.7	1

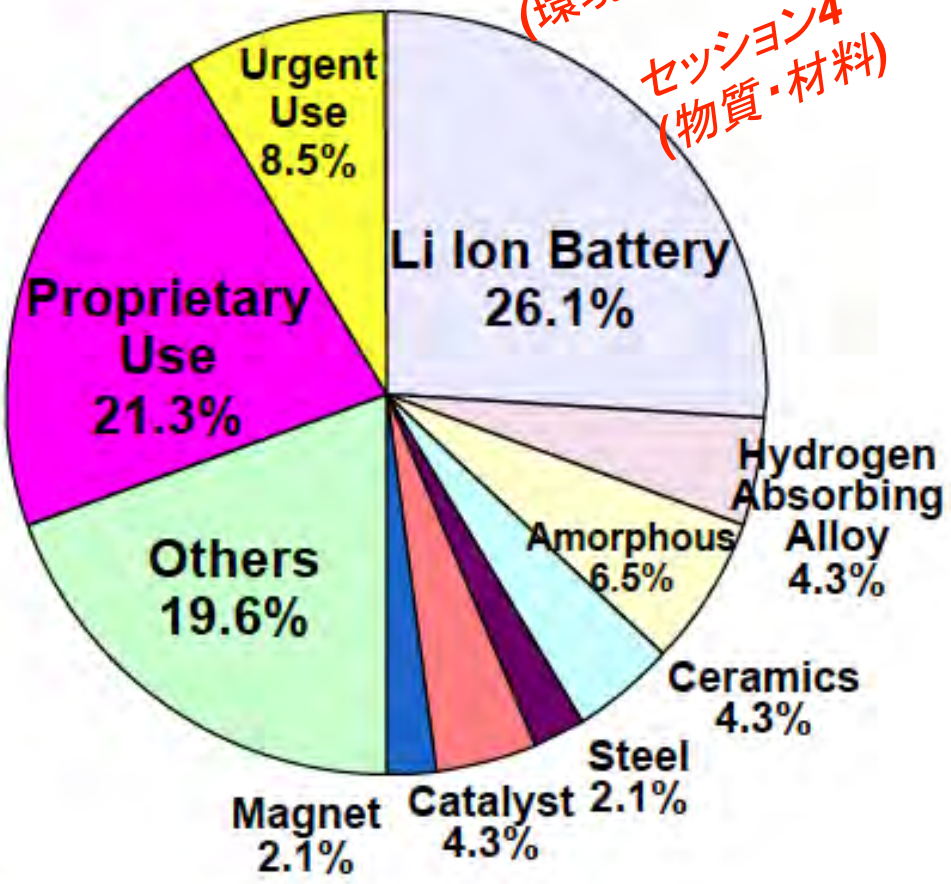
Classification of Usage in 2010FY

Number of Tasks:46



セッション3
(環境エネルギー)

セッション4
(物質・材料)



- Every industrial fields use
- Proprietary occupies about 30%
- Li ion battery occupies about 25%

Summary of Samples at iBIX in 2010

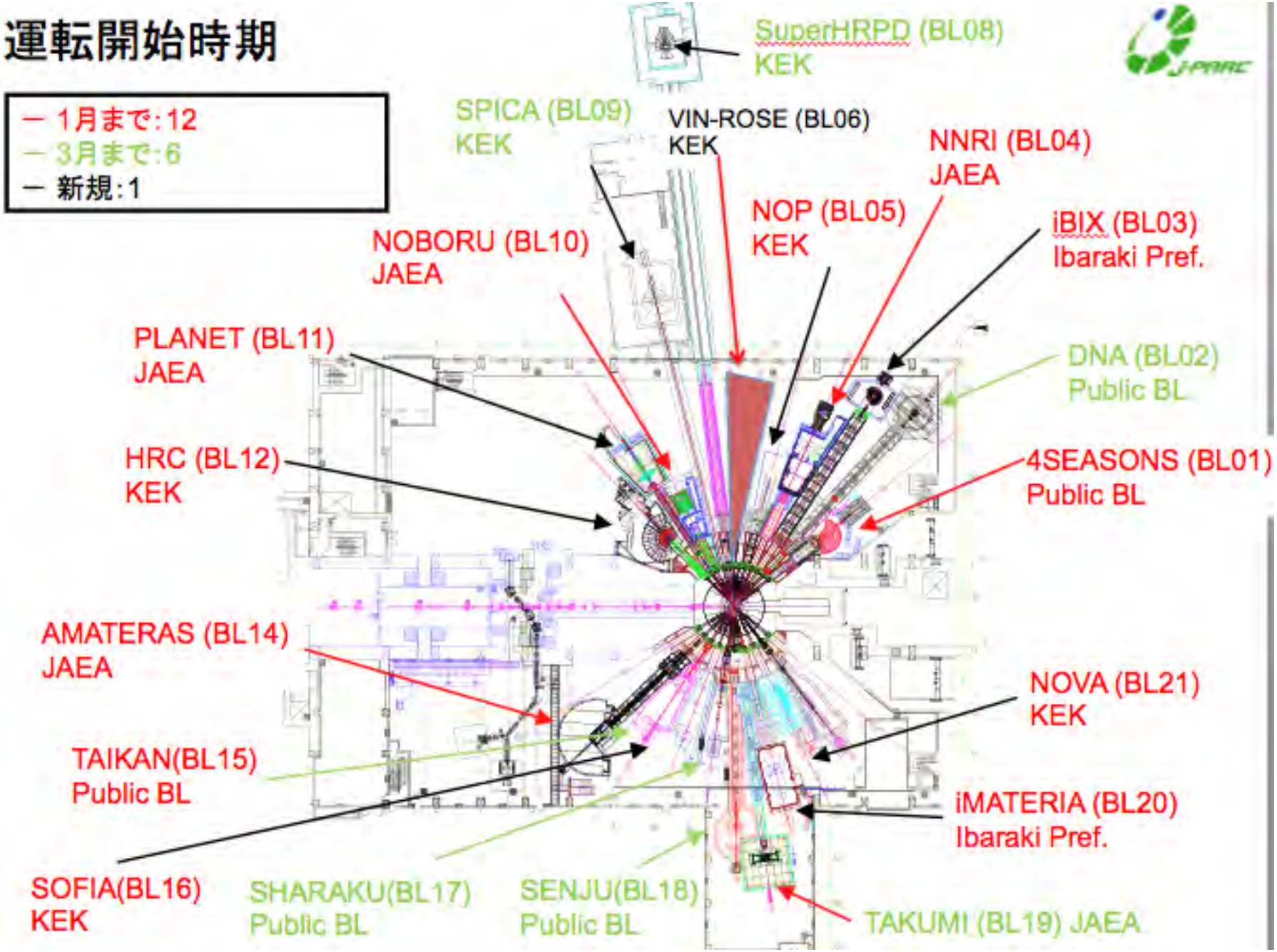
セッション1 (トピックス)　セッション4 (物質・材料)

Sample (red: protein)	Lattice Dimension / Å	Meas. Period /day	Cryst. Vol. /mm^3	Reso-lution / Å	Acc. Power /kW	Meas. Temp. /K	Status/ Information
RNaseA	a=30.4, b=38.6, c=53.4	15.5	4.7	1.7	120	RT	Initial stage of analysis (Kusaka *et al.*)
Anti-Freeze Protein (AFP)	a=71.7, b=108.3, c=38.0	13.8	9.4	2.5	120	120	Initial stage of analysis (Ohhara *et al.*)
Transthyretin (TTR)	a=44.3, b=86.3, c=66.7	27	2.5	2.0	120-220	RT	Yokoyama *et al.*, To be submitted
CO-Hemoglobin	a=b=54.2, c=196.4	11	6	2.4	220	RT	Initial stage of analysis (Chatake *et al.*)
Lead compound	a=9.677, b=7.922, c=14.983, γ=102.867°	4	7.2	0.6	120	120	Initial stage of analysis (Takahashi *et al.*)
Pt compound	a=13.374, b=14.594, c=8.090, β=103.44°	3	13.5	0.6	120	120	Initial stage of analysis (Nakamura *et al.*)
MOMA Cellobiose	-	3 hrs	50	-	120	RT	Trial measurement (Kimura *et al.*)

Industrial & Project use　J-PARC use

運転開始時期

- 1月まで:12
- 3月まで:6
- 新規:1



おわりに

- 建設、復旧
- 海外の研究の進展
- さて我々の研究は？