The Commissioning Workshop of ESS-J-PARC collaboration

Example J-PARC Commissioning:
BL01 4SEASONS

Ryoichi KAJIMOTO

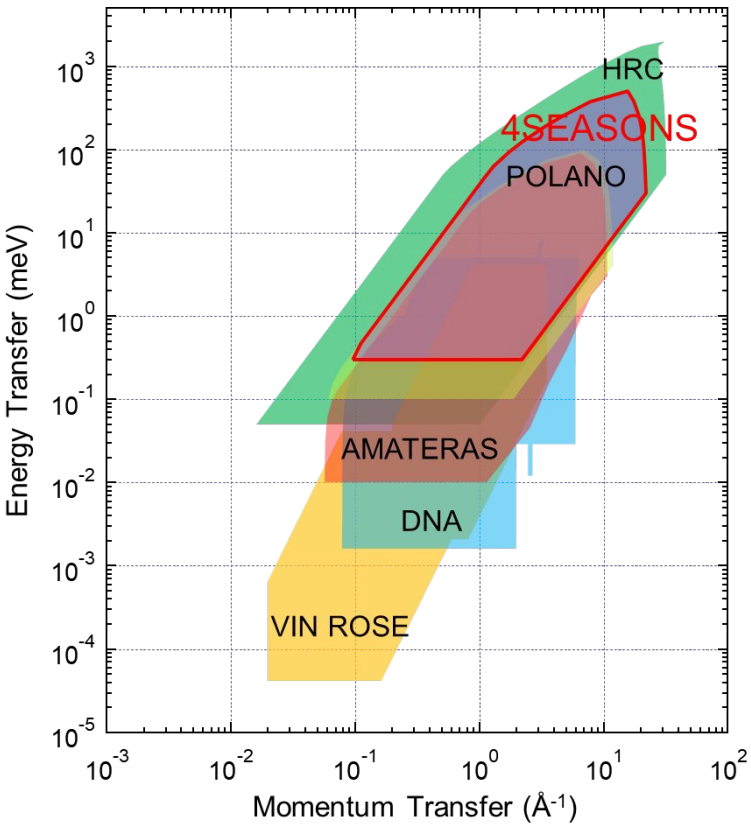
Neutron Science Section
Materials and Life Science Division
J-PARC Center
Japan Atomic Energy Agency

BL01 4SEASONS
4D-Space Access Neutron Spectrometer

- **Features**
  - A high-efficient measurements of 10^0-10^2 meV dynamics
  - Map out over 4-dimensional ***Q***-*E* space with the multi-E_i (RRM) capability

- **Specifications**
  - Coupled moderator
  - E_i = 10–300 meV
  - $\Delta E/E_i$ > 5% @ E = 0
  - L_1 = 18 m , L_2 = 2.5 m, L_3 = 1.7 m
  - Detector coverage
    - ✔ −35–+127 deg. (horizontal)
    - ✔ −25–+27 deg. (vertical)
  - Sample environments
    - ✔ Closed-cycle refrigerator (4–600 K)
    - ✔ Other MLF-shared SEs

Inelastic/Quasielastic Spectrometers in MLF

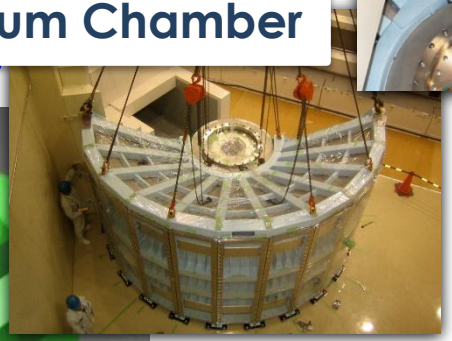


4SEASONS

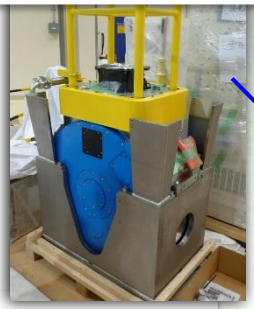
Disk Choppers

Sample & Cryostat

Vacuum Chamber

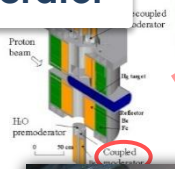


T0 Chopper



Shielding Blocks

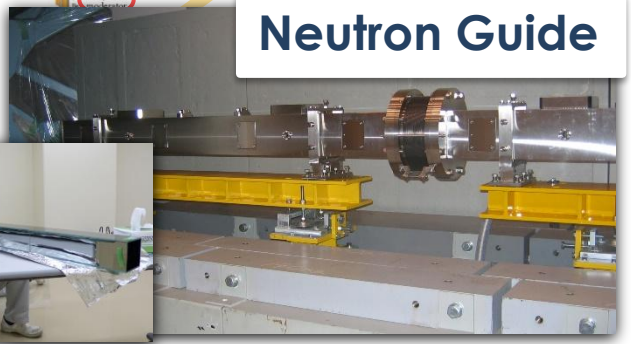
Coupled Moderator



Fermi Chopper

Detectors

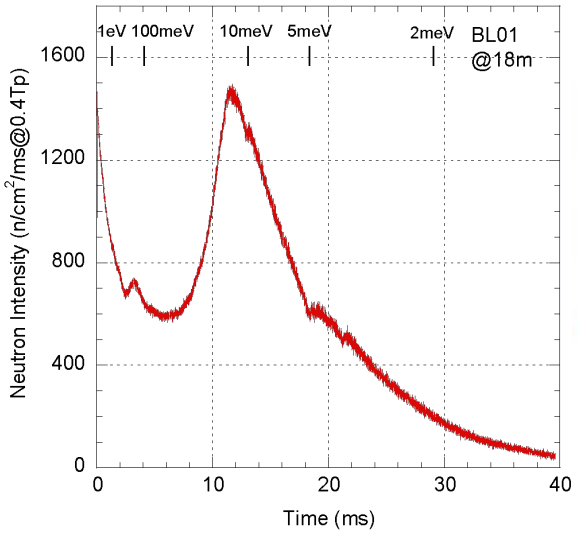
Neutron Guide

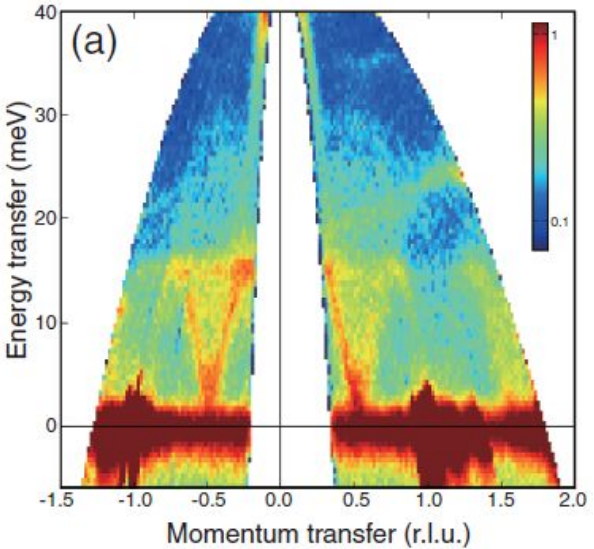


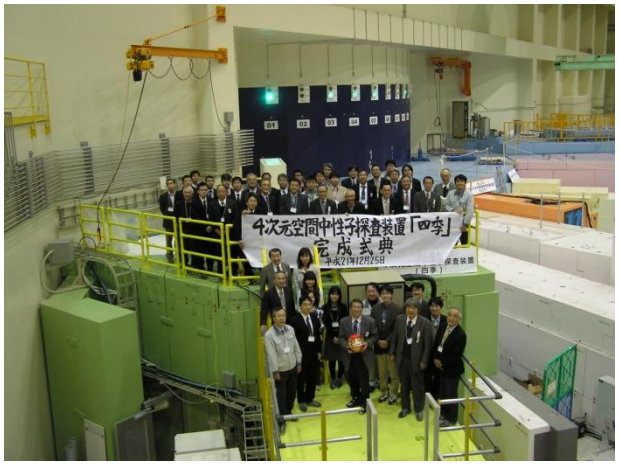
History

- FY2005: Start of the construction as a part of a KAKENHI research project of high-T_c superconductors by JAEA, KEK, and Tohoku Univ. (FY2005-2010, PI: M. Arai)
- FY2007: Installation of the vacuum scattering chamber, the shielding blocks, etc.
- FY2008: Installation of the neutron guide, the detectors, etc.
  The first neutron beam (Sep.)
- FY2009: Installation of the choppers, the vacuum system, etc.
  The first inelastic experiment (Jun.)
  —Demonstration of the multi-E_i measurement of a single crystal for the first time on a Fermi chopper spectrometer.
  Construction Completion ceremony (Dec.)
- FY2011: The instrument became one of the **public beamlines**.

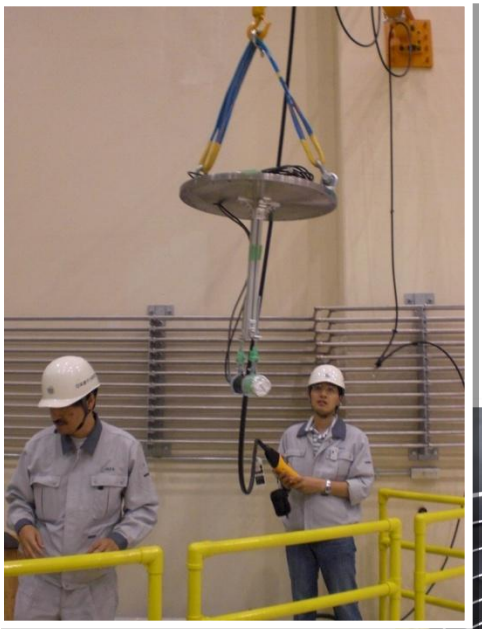
User program is more widely open to users

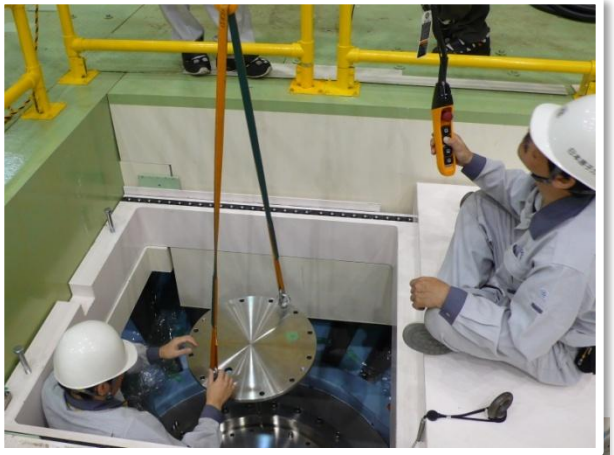






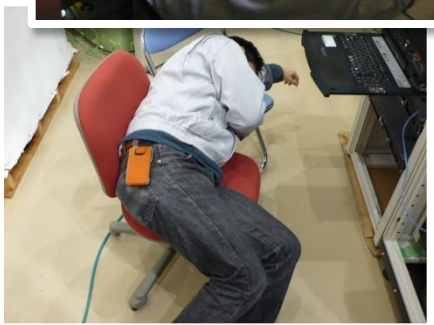
Commissioning











Collaborators

J-PARC staffs:

Instrumental scientist of 4SEASONS

- M. Nakamura, Y. Inamura

Instrumental scientists of AMATERAS

- K. Nakajima, S. Ohira-Kawamura

Data acquisition and analysis

- Y. Inamura, T. Nakatani, S. Sato

Support for the construction and commissioning

- F. Mizuno, T. Yokoo, N. Takahashi, R. Maruyama, K. Soyama, K. Shibata, K. Suzuya, K. Aizawa, S. Wakimoto, M. Arai

Technicians

- Y. Ito, T. Iwahashi, W. Kambara, H. Tanaka, N. Yoshida, A. Katabira and technicians from *Nippon Advanced Technology*

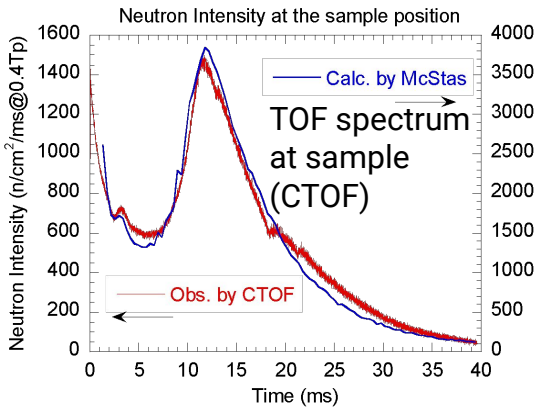
Support from outside J-PARC:

- S. Shamoto — *QuBS, JAEA*
- M. Fujita, H. Hiraka, K. Ohoyama — *IMR, Tohoku Univ.*
- K. Yamada — *WPI, Tohoku Univ.*

Copied from a presentation in Feb. 2011

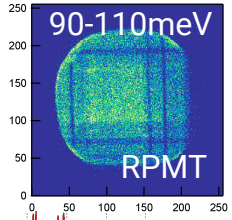
Beam Characterization

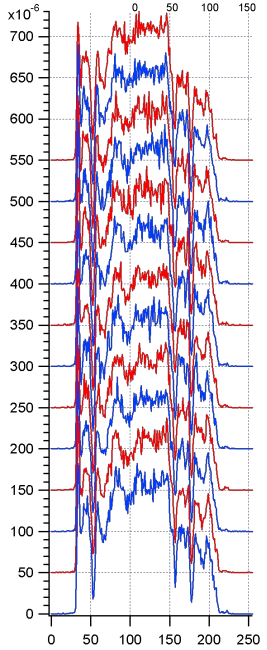
First beam (Sep. 2008)



Official inspection of radiation safety

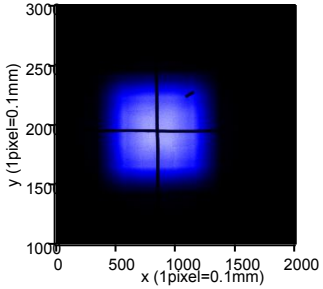
Repeatability of the shutter



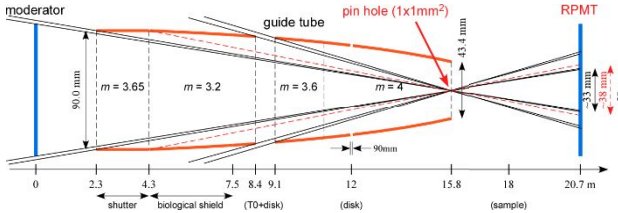


12 times

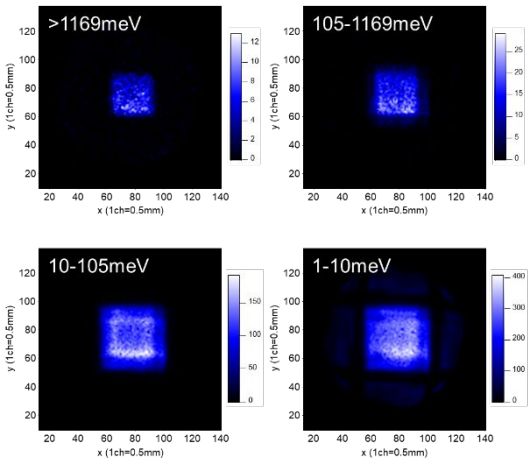
Spatial distribution at sample & moderator

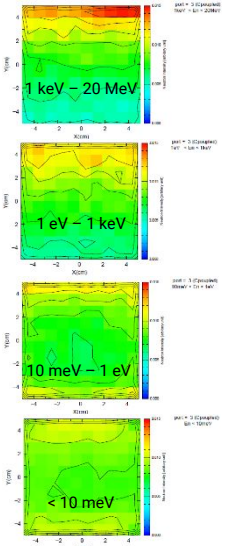


Spatial distribution at sample (IP)



Calculation

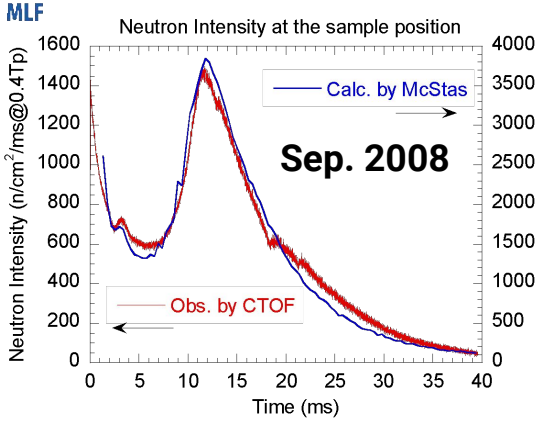


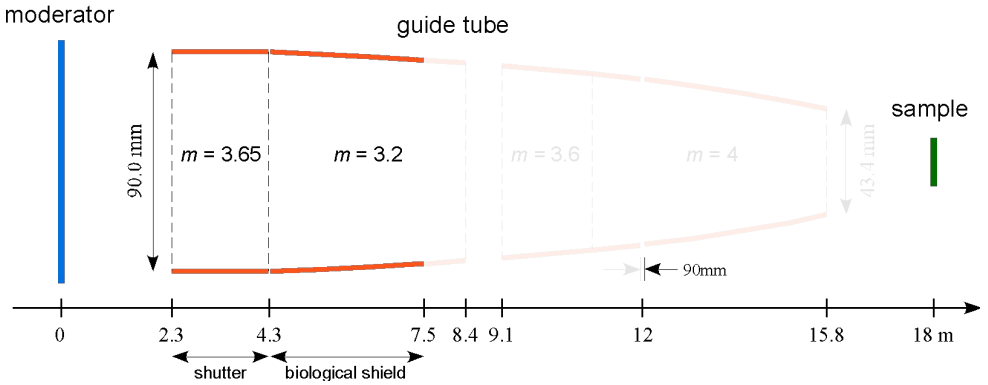


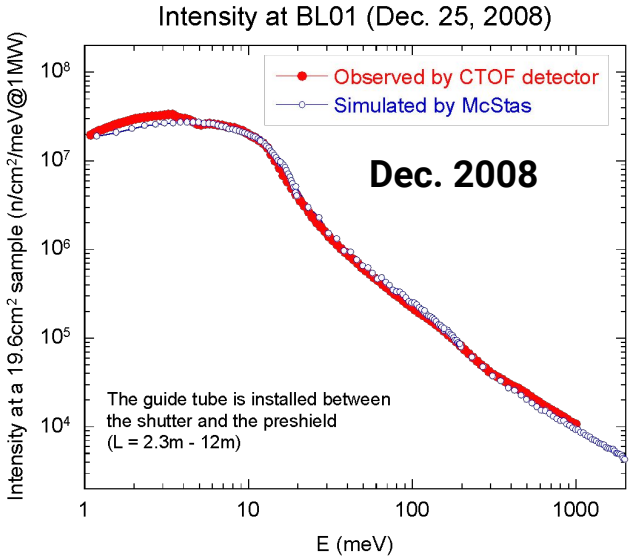
Luminance distribution of the moderator (RPMT)

Beam Characterization (cont.)

Intensity at sample

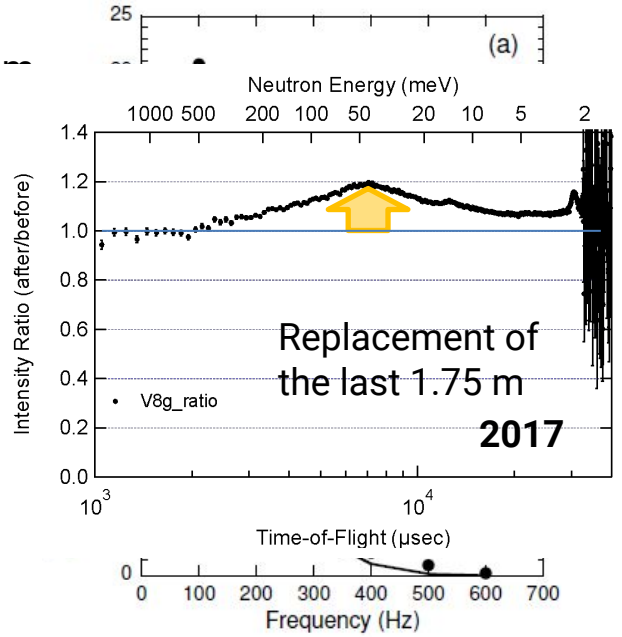






Monochromatic beam with a vanadium sample

Oct. 2010



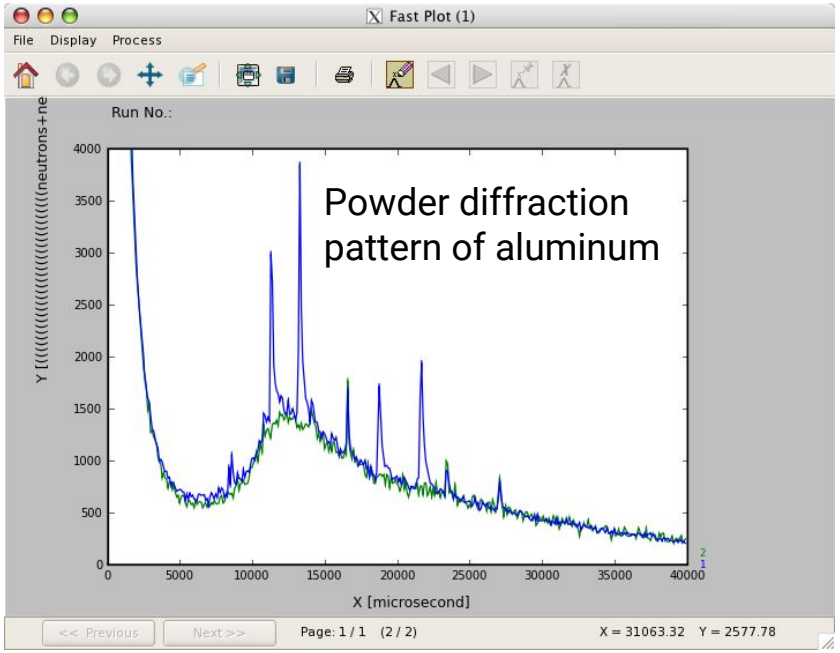
R. Kajimoto et al.,
J. Phys. Soc. Jpn. **80**, SB025 (2011)

With gold foil

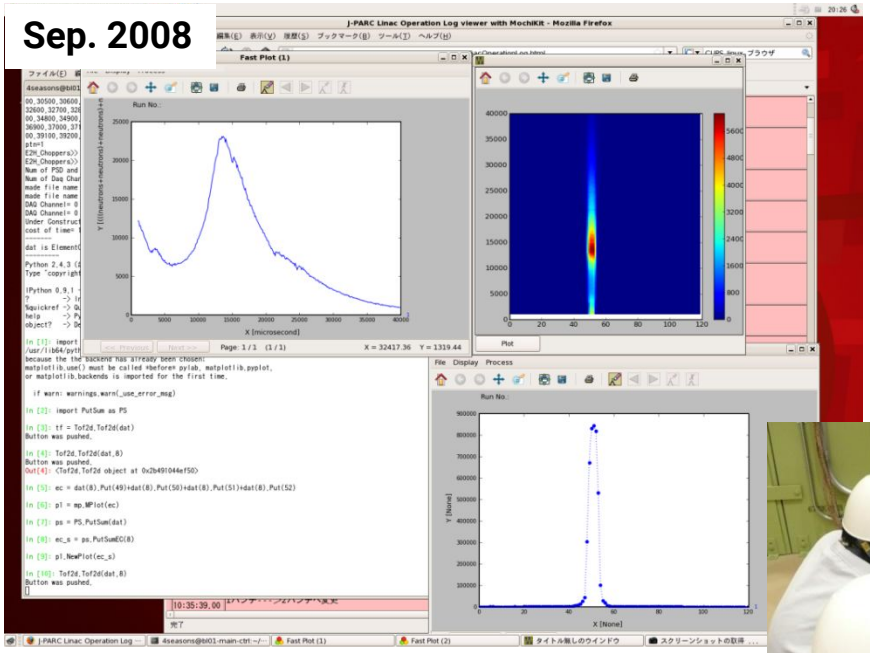
Guide tube	Obs. [n/s/cm²]	Calc. [n/s/cm²]	Obs./Calc.
Only *L* < 12m installed (Dec. 14, 2008)	**3.0×10⁸**	**3.3×10⁸**	**0.92**

Data Acquisition and Analysis with Our Own System

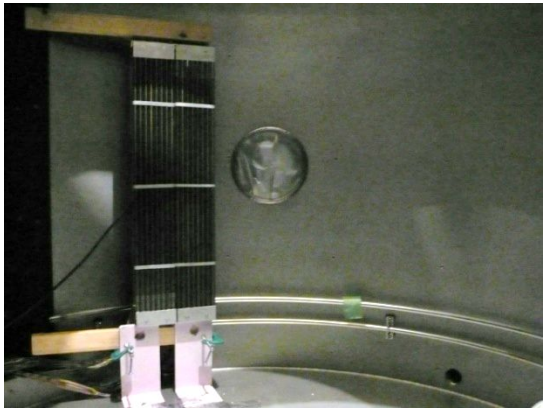
Signal from a Sample



Sep. 2008



Displays of **position and time** of the direct beam **using the new data analysis software**.



60 cm ^{3}He PSDs borrowed from KEK

Commissioning of (Our Own) Detectors

Nov. 2008

Oct. 2008

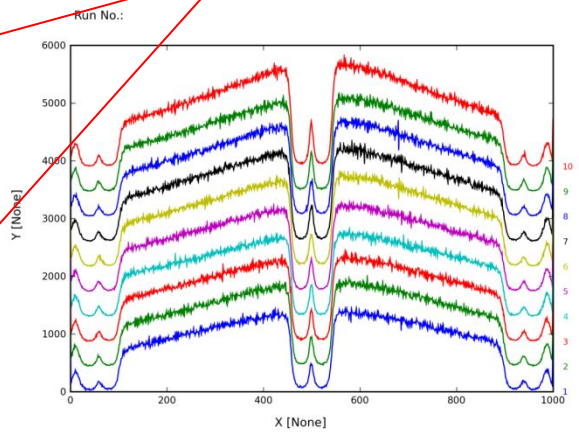
Powder (Al_2O_3)

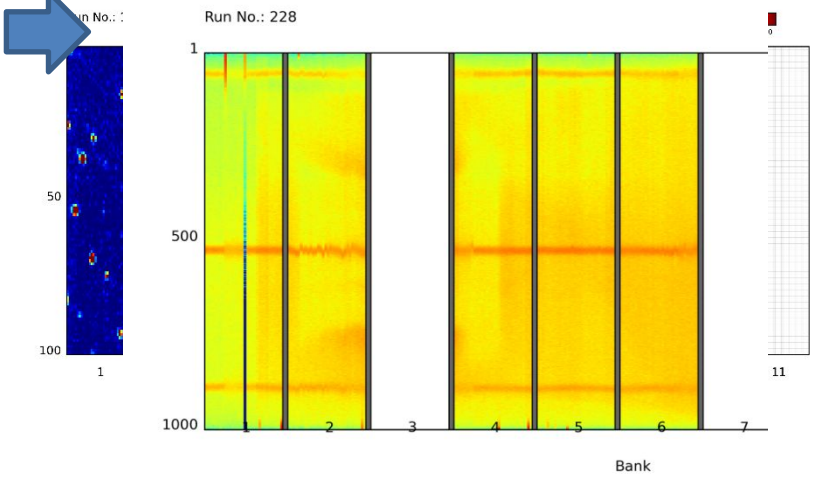
Jun. 2009 ~
Jan. 2009

New detector calibration device
(similar to the one at MERLIN, ISIS)

Single crystal ($Pr_{0.82}LaCe_{0.18}CuO_4$)

Position Calibration using **Cd-slits** (width:10mm)



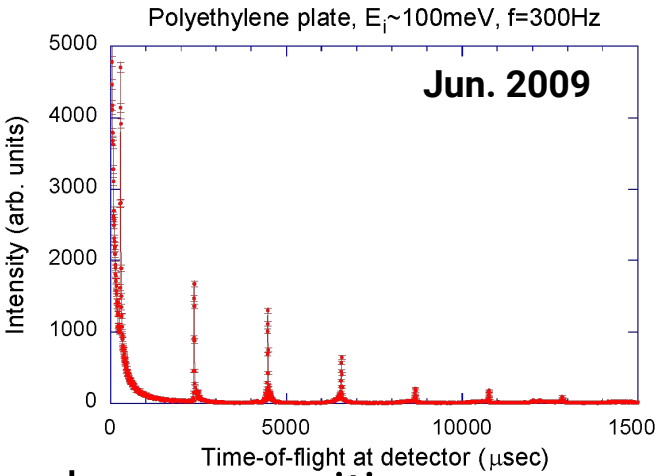


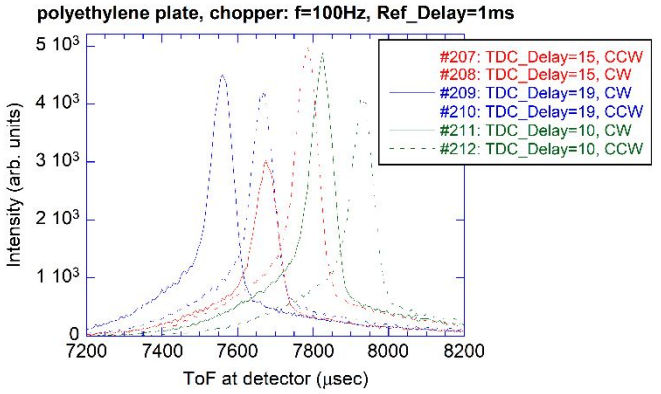
Performed regularly after a long shutdown

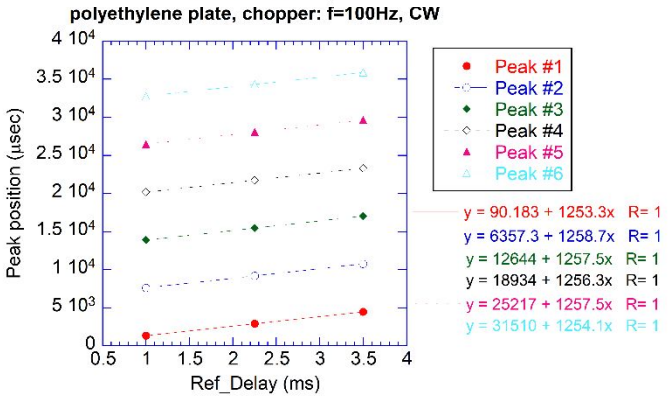
Femi Chopper

—4SEASONS became a *chopper spectrometer*—

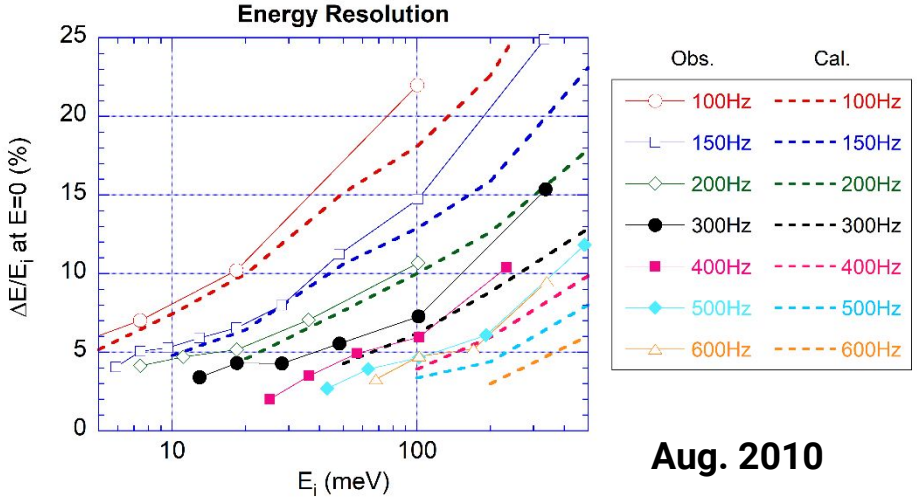
May 2009





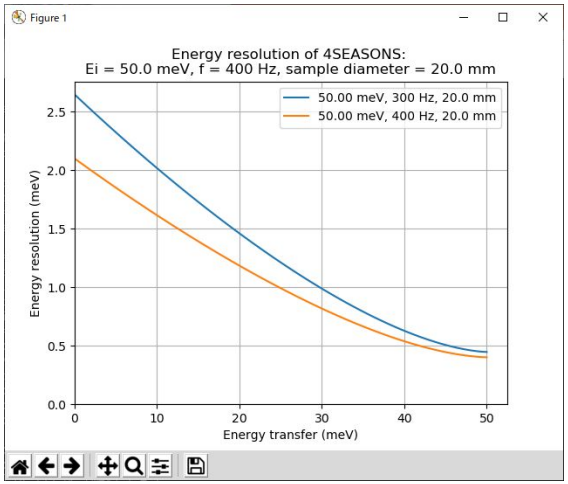


- Determination of the chopper position
- CW vs CCW rotations
- Phase delay dependence
  - Conversion from E_i to phase delay
- **Resolution and flux**



Aug. 2010

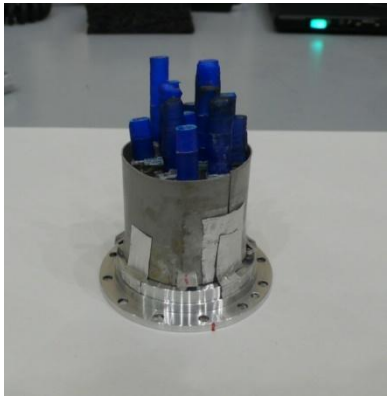
Now,...

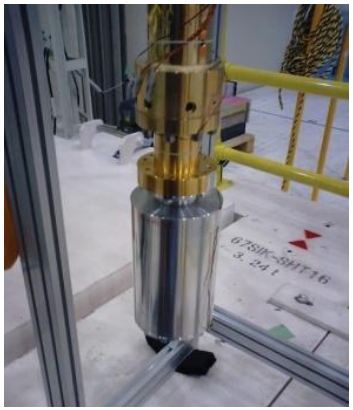


Inelastic Scattering

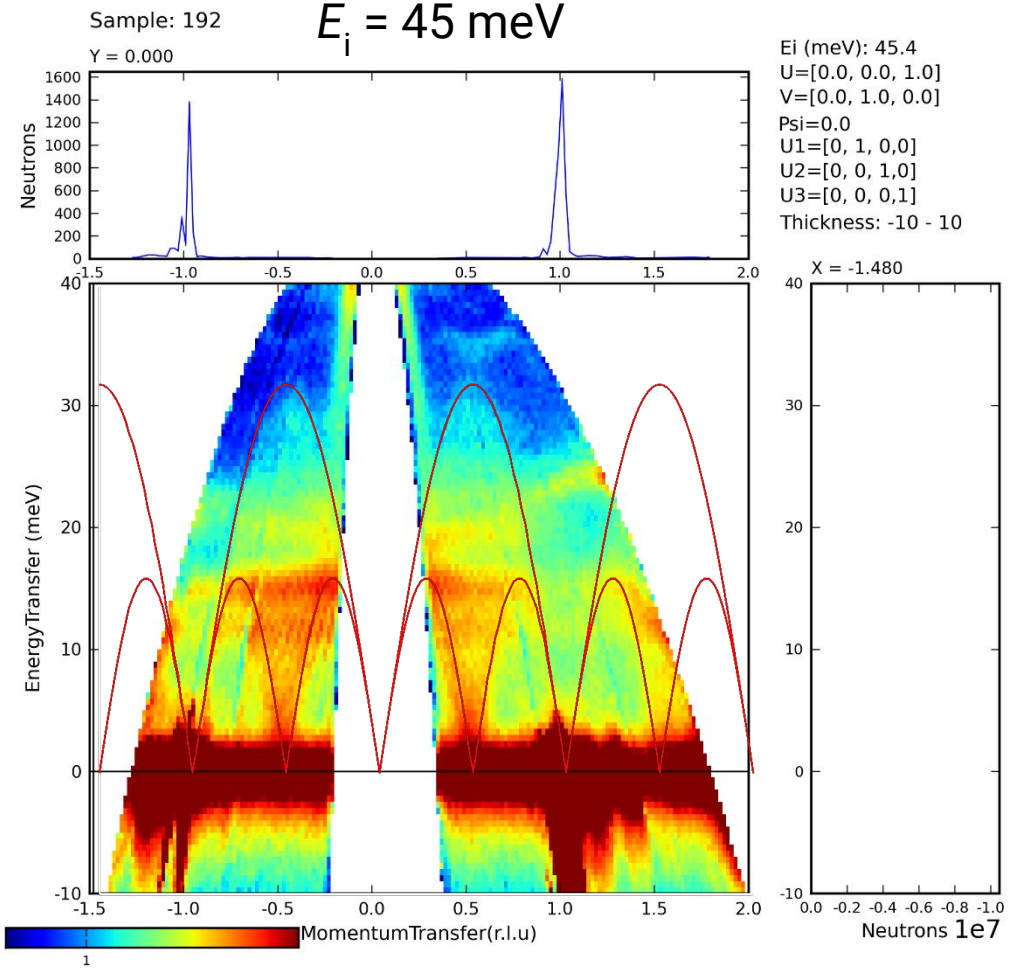
$CuGeO_3$
Single crystal
1D S=1/2 AF

- ~~4SEASONS's cryostat~~
- AMATERAS's cryostat





T = 12.5-28.5 K
E_i = 45 meV



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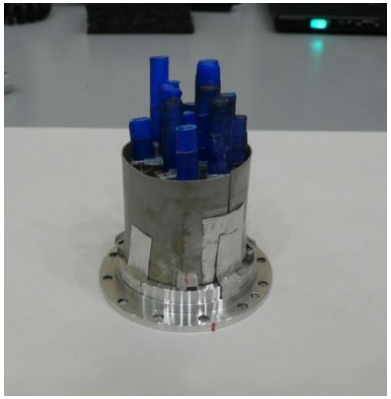

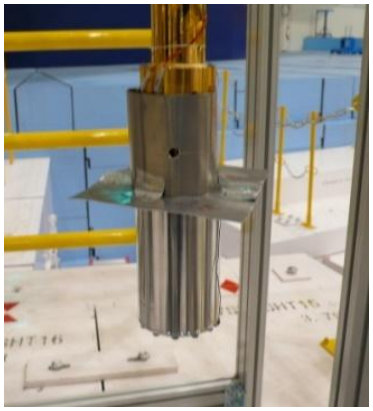

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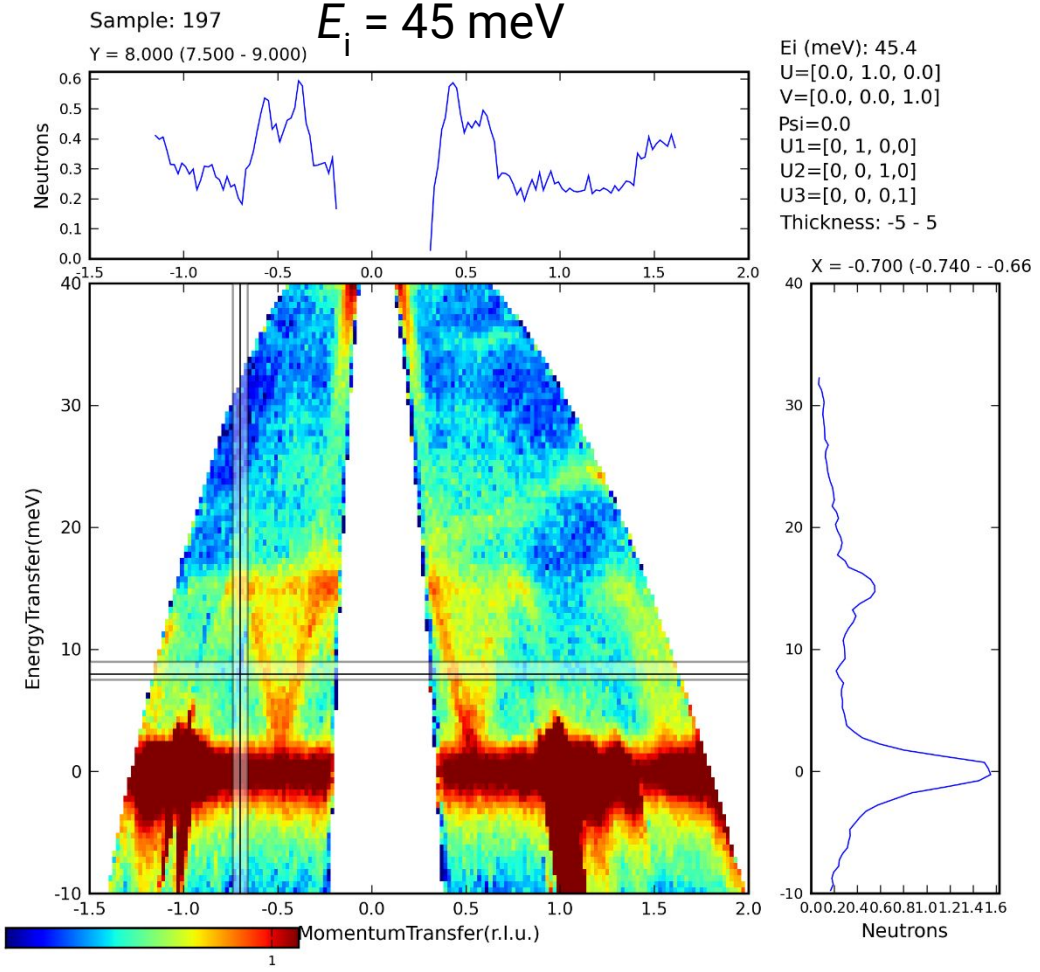

Inelastic Scattering

$CuGeO_3$
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1D S=1/2 AF

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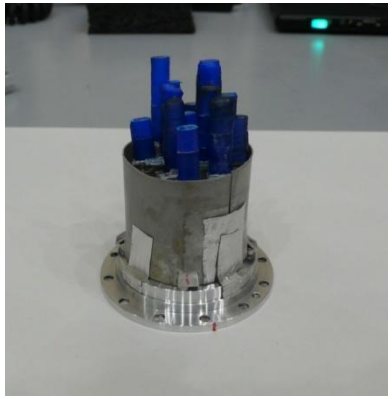
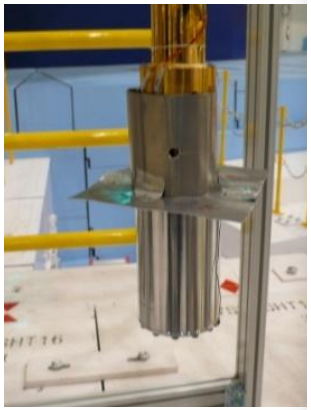
- AMATERAS's cryost





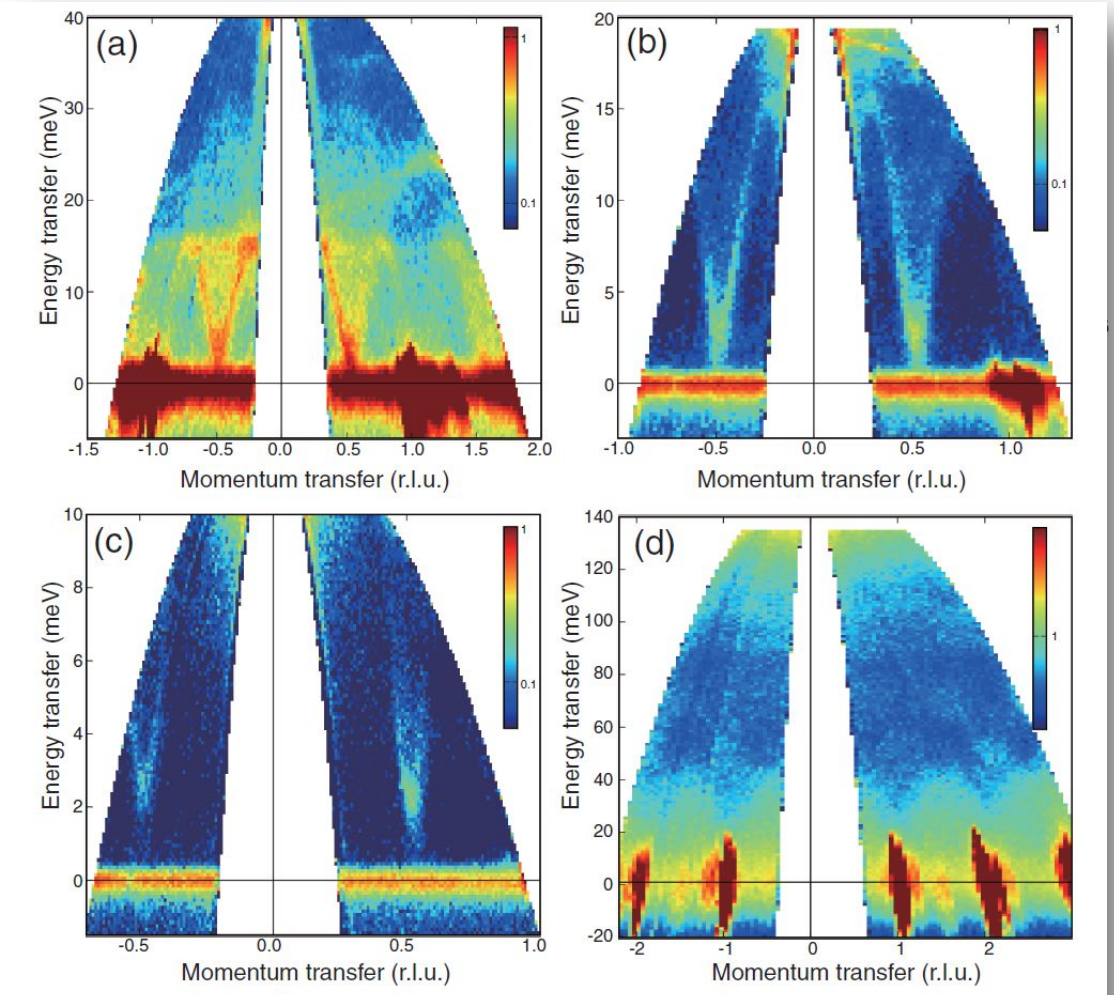


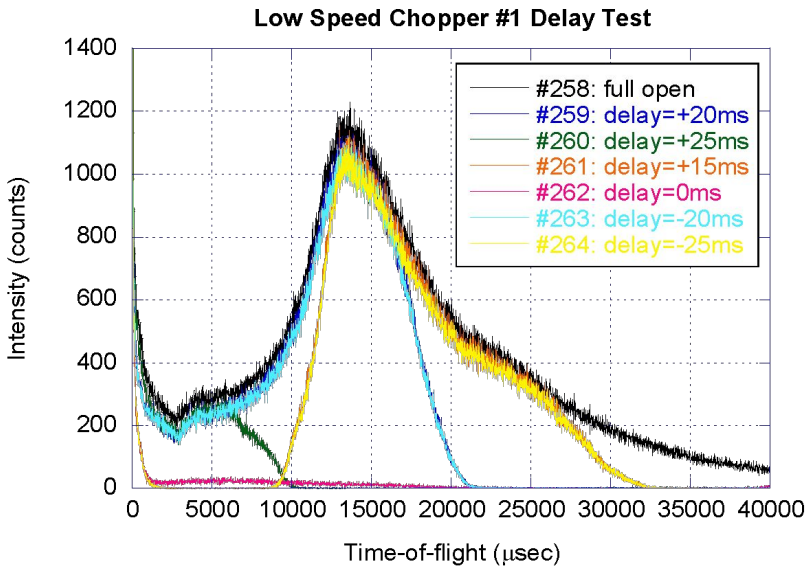
Fig. 3. Simultaneous observation of multiple two-dimensional maps of dynamical structure factor of $CuGeO_3$ by one measurement. The horizontal axis shows the c component of the momentum transfer in the reciprocal lattice unit and the vertical axis shows the energy transfer. The incident energies are (a) 45.4, (b) 21.5, (c) 12.6, and (d) 150.7 meV. In (b) and (c), the data from several PSDs around the direct beam ($Q_c = 0$) were eliminated from the analysis due to the overlap of the intense background.

M. Nakamura et al., J. Phys. Soc. Jpn. **78**, 093002 (2009)

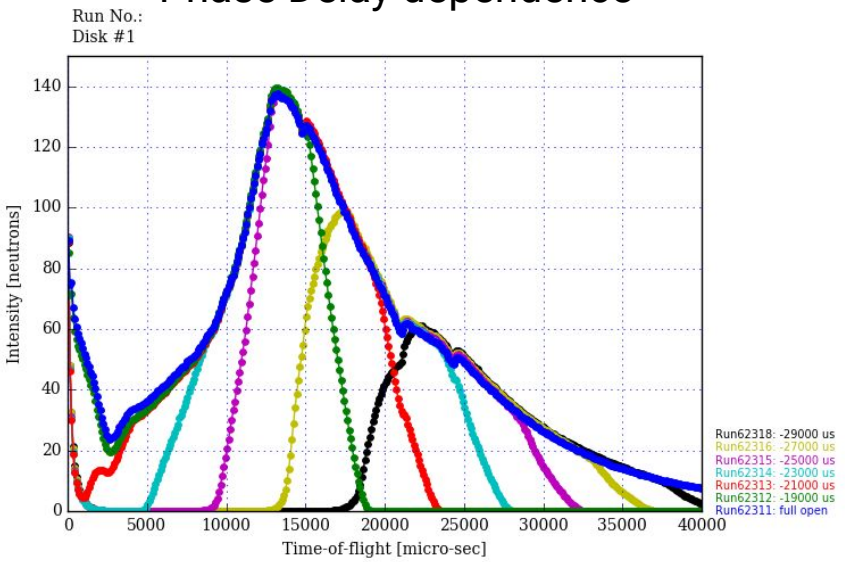
Disk Choppers

Oct. 2019

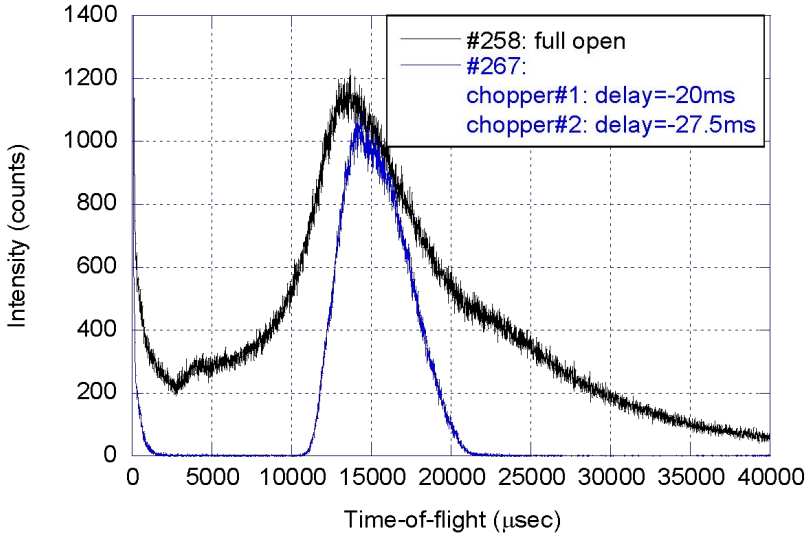
Disk Chopper #1



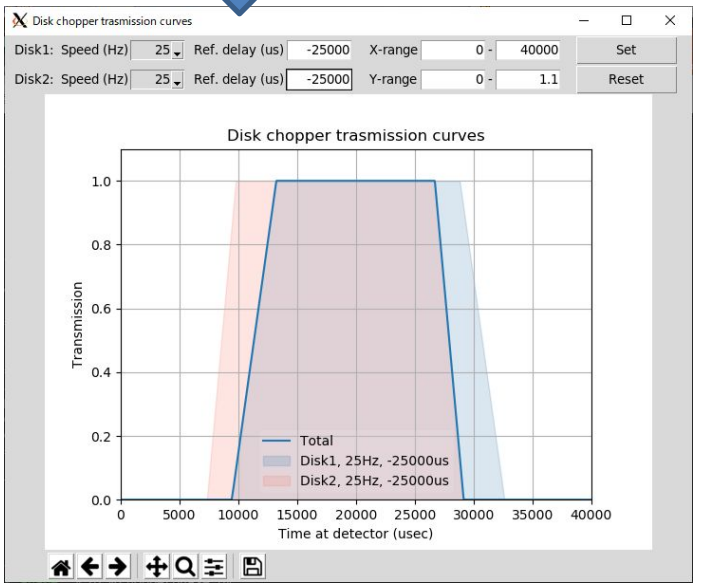
Phase Delay dependence



Disk Choppers #1&#2

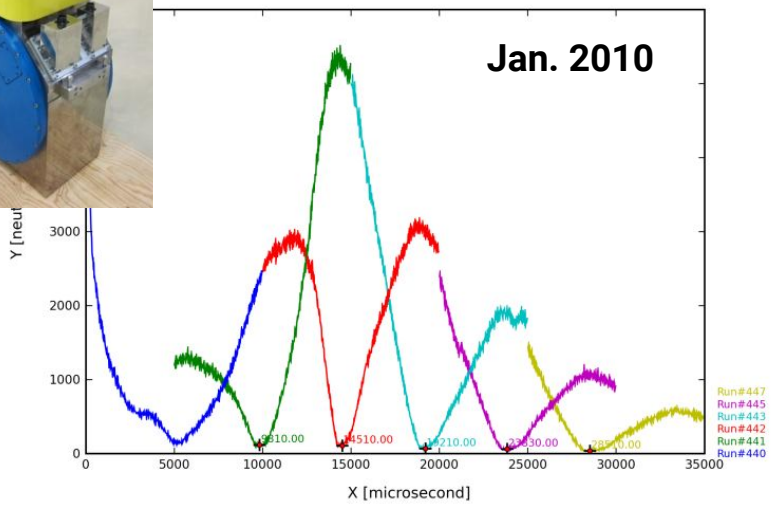


Now,...

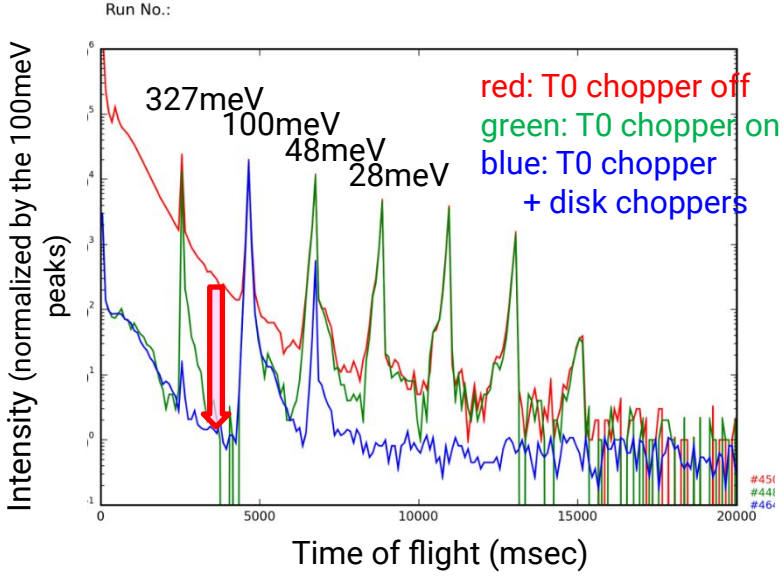


T0 Chopper

Phase Delay dependence

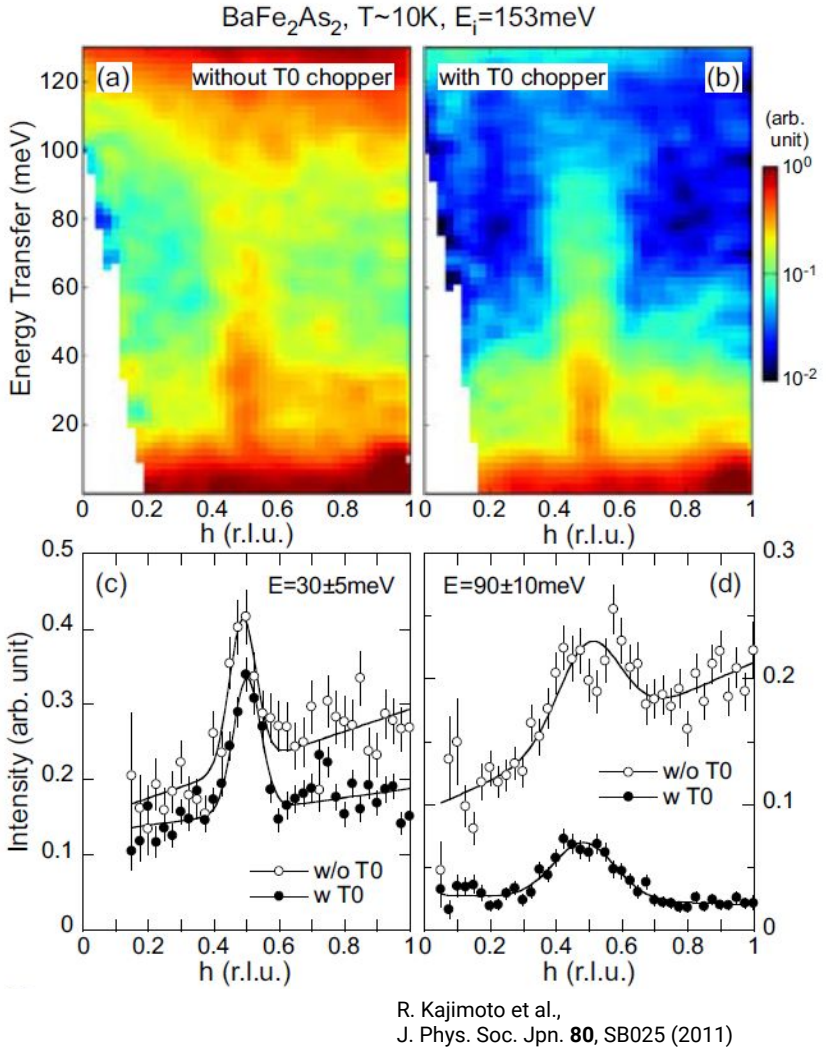


Comparison with/without the T0 chopper



R. Kajimoto et al., Proc. ICANS-XIX

Inelastic scattering experiment

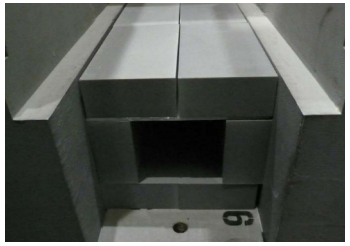


R. Kajimoto et al.,
J. Phys. Soc. Jpn. **80**, SB025 (2011)

Reduce Background!

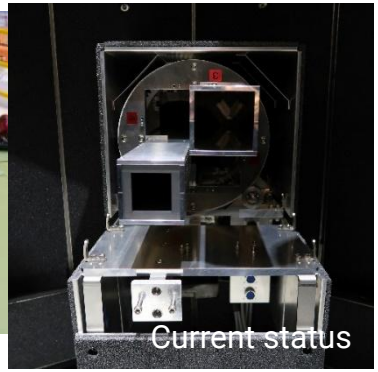
- Jun. 2009 □ Oct. 2009

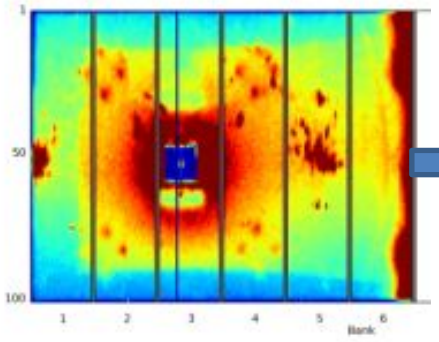
  Addition of shielding materials to reduce background

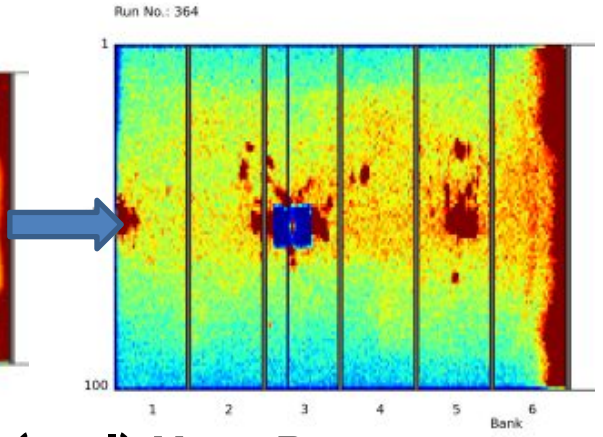


- Nov. 2009

  Temporary beam collimator made of Cd

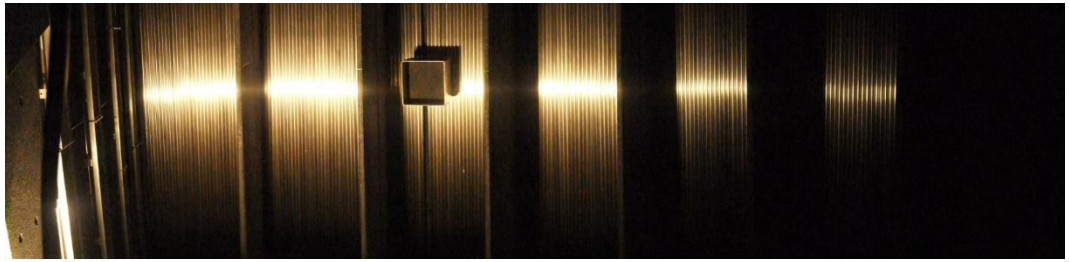


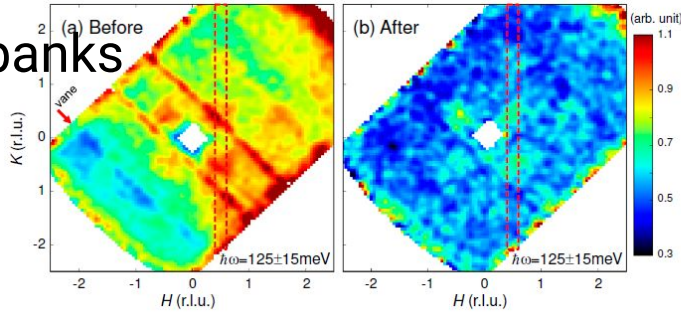




Start of (real) User Program

- Jan. 2010 : T0 chopper
- Mar. 2011 : Shielding vanes between detector banks



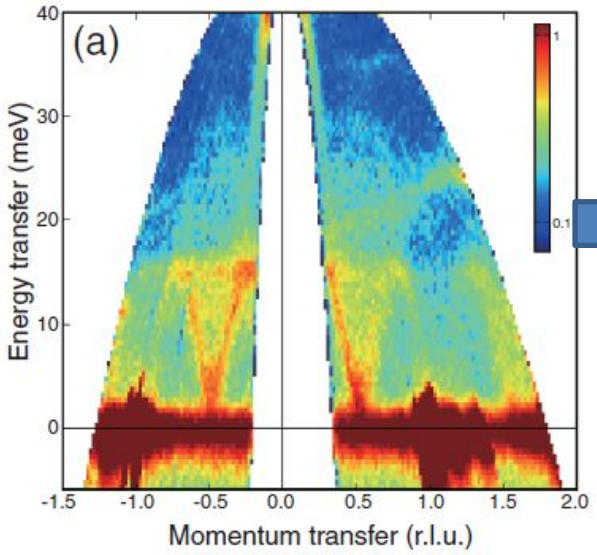


R. Kajimoto et al., J. Phys. Soc. Jpn. 82, SA032 (2013)

- Other measures inside the vacuum chamber and around sample

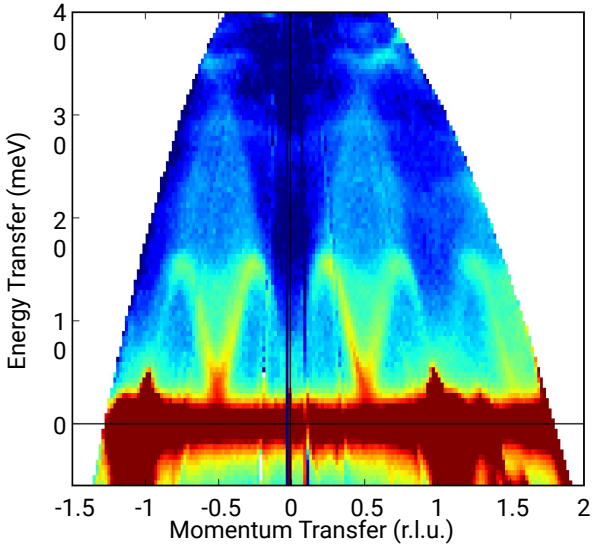
Improvement of S/N Ratio

2009.6



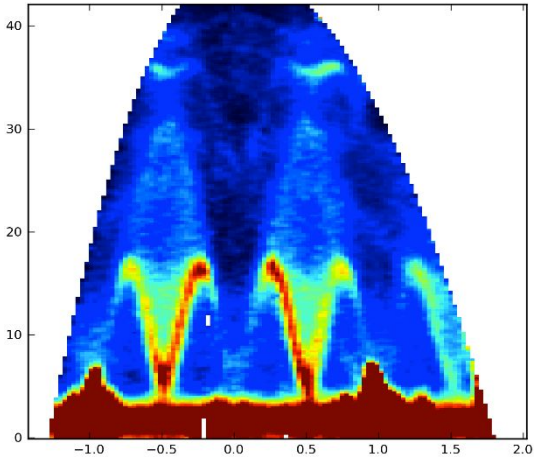
- First measurement
- ~20kW

2009.11



- Addition of several shielding materials
- Addition of detectors around the beam center
- ~100kW

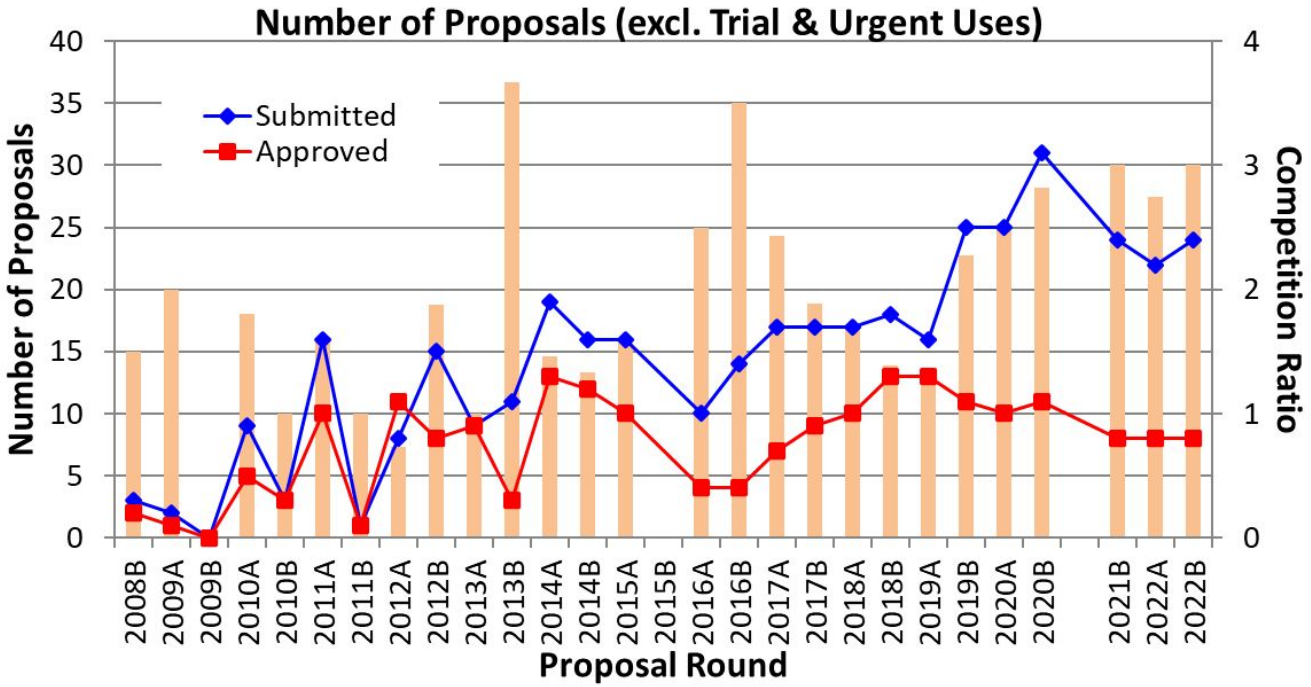
2011.03



- Installation of the T0 chopper
- ~200kW

But we are still struggling with background…

Summary



nature COMMUNICATIONS

ARTICLE

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High-energy spin and charge excitations in electron-doped copper oxide superconductors

K. Ishii[1], M. Fujita[2], T. Sasaki[2], M. Minola[3], G. Dellea[3], C. Mazzoli[3], K. Kummer[4], G. Ghiringhelli[3], L. Braicovich[3], T. Tohyama[5,†], K. Tsutsumi[2], K. Sato[2], R. Kajimoto[6], K. Ikeuchi[7], K. Yamada[8]

PHYSICAL REVIEW LETTERS **122,** 017001 (2019)

Preferred Magnetic Excitations in the Iron-Based $Sr_{1-x}Na_xFe_2As_2$ Superconductor

Jianqing Guo,[1,*] Li Yue,[1,*] Kazuki Iida,[2] Kazuya Kamazawa,[2] Lei Chen,[1] Tingting Han,[1] Yan Zhang,[1,3] and Yuan Li[1,3,†]

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PHYSICAL REVIEW X **12,** 011022 (2022)

Neutron Spectroscopy Evidence on the Dual Nature of Magnetic Excitations in a van der Waals Metallic Ferromagnet $Fe_{2.72}GeTe_2$

Song Bao,[1,*] Wei Wang,[2,*] Yanyan Shangguan,[1,*] Zhengwei Cai,[1,*] Zhao-Yang Dong,[3] Zhentao Huang,[1] Wenda Si,[1] Zhen Ma,[4] Ryoichi Kajimoto,[5] Kazuhiko Ikeuchi,[6] Shin-ichiro Yano,[7] Shun-Li Yu,[1,8,†] Xiangang Wan,[1,8] Jian-Xin Li,[1,8,‡] and Jinsheng Wen[1,8,§]

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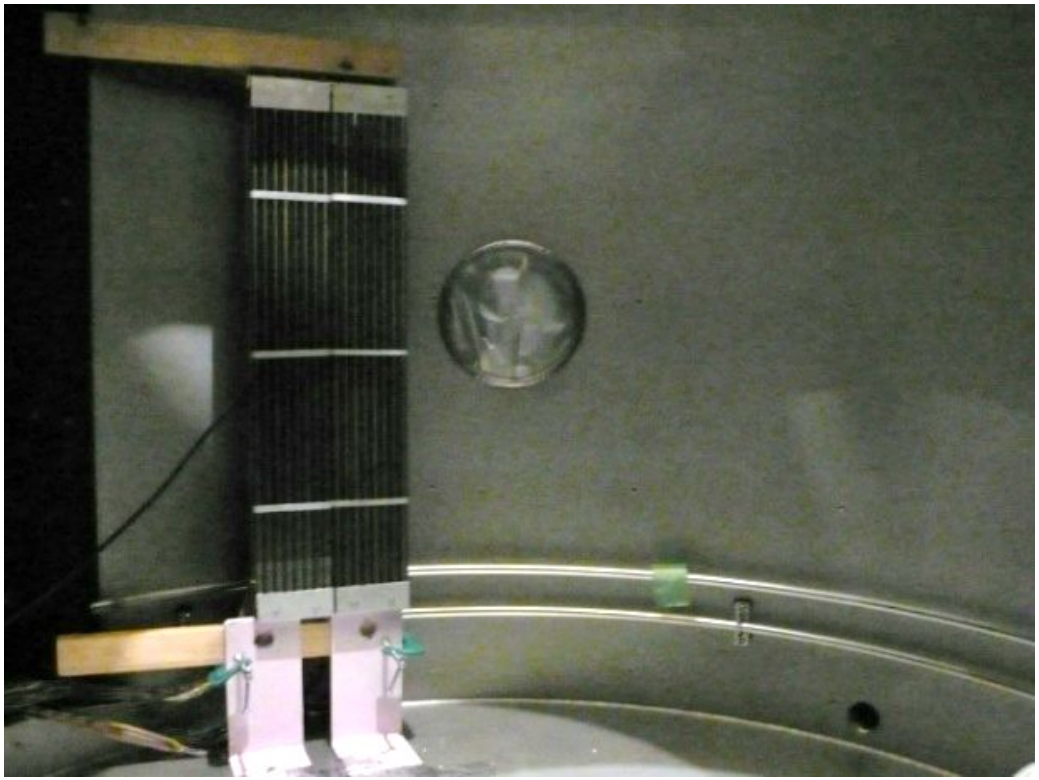
LETTERS

https://doi.org/10.1038/s41567-018-0213-x

Topological spin excitations in a three-dimensional antiferromagnet

Weiliang Yao[1,9], Chenyuan Li[1,9], Lichen Wang[1,9], Shangjie Xue[1], Yang Dan[1,7], Kazuki Iida[2], Kazuya Kamazawa[2], Kangkang Li[3,4,8], Chen Fang[3,5*] and Yuan Li[1,6*]

Summary



- There will be many issues during the commissioning, but you can solve them.
- Even if something is not ideal, it will work.
- Enjoy the commissioning!