

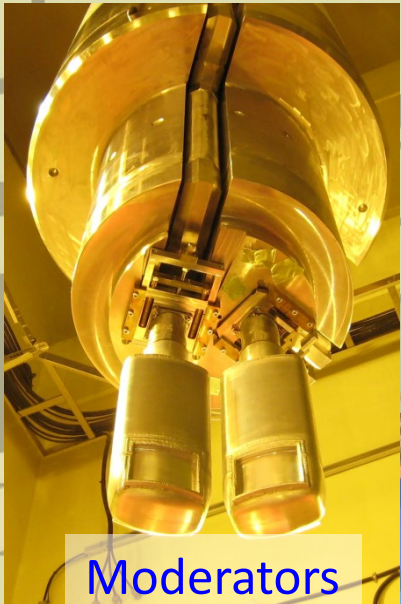
# Neutron Source Commissioning Overview

Katsuhiko Haga

Neutron source section

J-PARC

# 1-MW spallation neutron source at J-PARC



3NBT

Proton beam  
3 GeV, 1MW, 25 Hz

5m

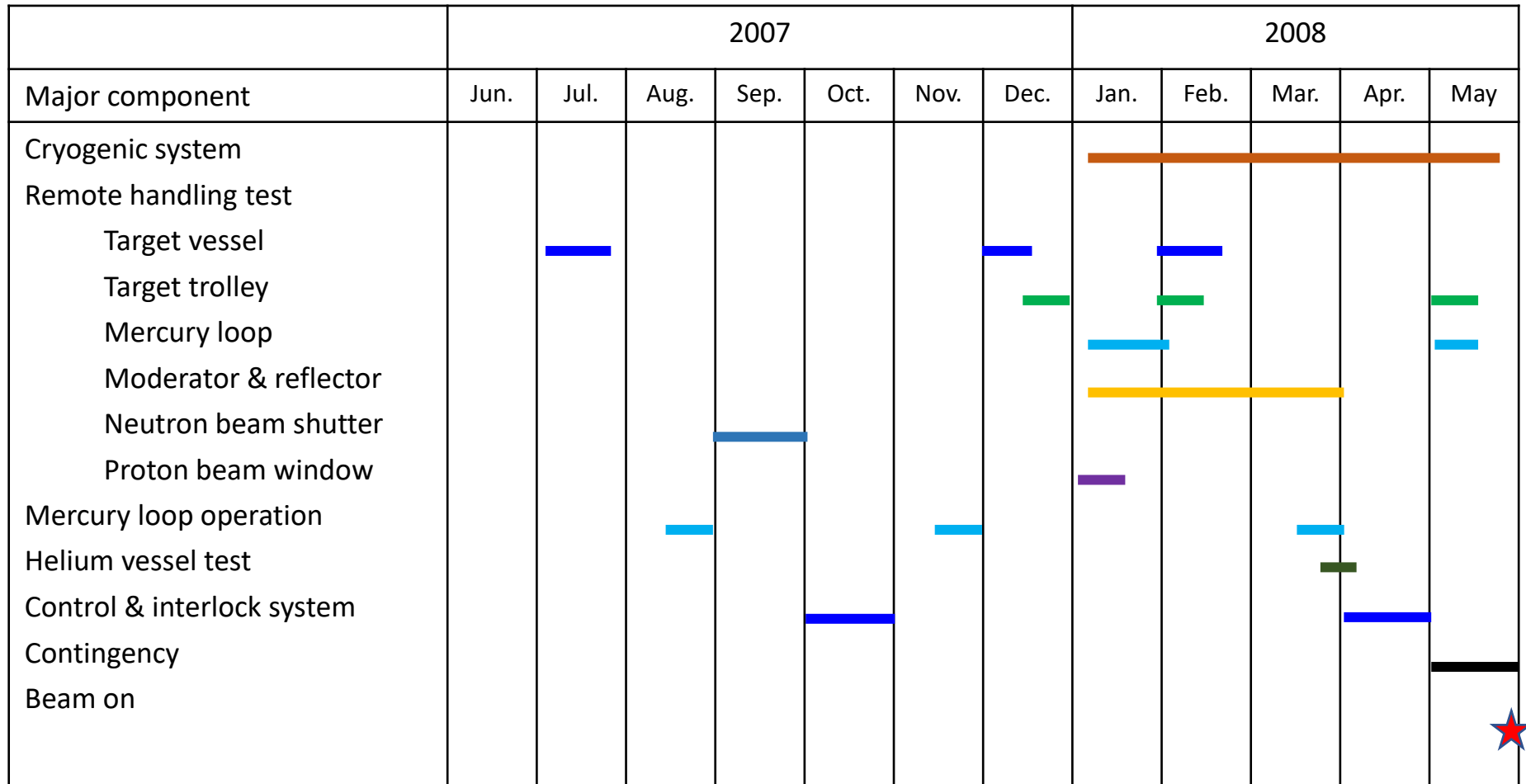
- ◆ Remote-handling system
- ◆ Ancillary system
- ◆ Control system

# Commissioning of MLF

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- Off-beam commissioning
  - Confirmation and demonstration without beam irradiation.
  - Started from around April 2007.
  - Results were reflected on the improvement of work procedures and device designs.
- On-beam commissioning
  - Confirmation of designed performance with beam irradiation.

# Schedule of off-beam commissioning



- Almost all of installation works were finished in Oct 2007.
- Cryogenic system experienced the significant delay by the trouble of LH2 pump.
- Remote handling and operation tests of each devices were carried out at the end of the installation works with vendors as the completion inspections.
- Full-rehearsal operations were carried out by ourselves as commissioning works.

## Objectives to check readiness

- to list all necessary conditions which are needed to be completed before the beam acceptance, and
- to share the checklists among those who are in charge of JSNS construction and operation for mutual confirmation.

## This procedure is effective

- to avoid forgetting to do something important before the beam acceptance, and to make acceptance criteria clear.

## Schedule

- October 2007 : Started to prepare readiness checklist.
  - ✓ 3NBT line
  - ✓ Hg-target system
  - ✓ Moderator / reflector assembly & He-vessel
  - ✓ Cryogenic hydrogen circulation system
  - ✓ Neutron beam shutter & vessel window
  - ✓ Control system
  - ✓ Building & ancillary facilities
  - ✓ Alignment
  - ✓ Licensing
- December 2007 : The 1st summary
- February 2008 : Reviewed by technical advisory committee
- May 2008 : Final summary

General item	Detailed item	Acceptance Criteria	Confirmation methods (Name of document)	Necessity A: Indispensable by Day-1 B: Preferable by Day-1	Status A: Completed B: Conditionally Completed C: Not yet Completed
1.1 Functions	Moderators have been installed at the right positions. Pressure proof and leak tests have been passed after connecting to the hydrogen circulation system.	Hydrogen region Pressure proof test: 1.5 MPa Leak rate: not detectable by He-leak test Vacuum region Leak rate: not detectable by He-leak test He-blanket region Leak rate: not detectable by He-leak test Cooling water region	Off-beam commissioning report	A	C
	Stable operations of hydrogen, vacuum, He-blanket and cooling water systems at the nominal conditions have been confirmed.	Hydrogen system: OK Vacuum system: OK He-blanket system: OK Cooling water system: OK	Off-beam commissioning report	A	C
	Integrity of cryogenic temperature region has been confirmed.	Unexpected contact between cold and room temperature regions: No	Off-beam commissioning report	A	C
	Arrangement with the process control system has been completed.	NA	NETH transmission list Console display pages	A	C
	Levels for PPS, TPS, MPS, alarm and warning have been determined.	Hydrogen Temperature: Pressure: Flow rate: Vacuum Degree of vacuum: He-blanket Pressure: Cooling water region Pressure: Flow rate:	NETH transmission list Operation parameter list	A	C

Example

General item	Detailed item	Acceptance Criteria	Confirmation methods (Name of document)	Necessity A: Indispensable by Day-1 B: Preferable by Day-1	Status A: Completed B: Conditionally Completed C: Not yet Completed
1.2 Process operation	Nominal values and ranges for operation parameters have been determined.	Hydrogen Temperature: 20K Pressure: 1.5 MPa Flow rate: Vacuum Degree of vacuum: < 1e-4 Pa He-blanket Pressure: Cooling water region Pressure:	Operation parameter list	A	C
	Operation manuals have been prepared.	NA	Operation manual	A	C
1.3 Maintainability	Criteria when the moderators are to be replaced have been established.	6 MW*years	Technical report	B	C
	A procedure to replace the moderators has been established.	NA	Maintenance manual	A	C
	Smooth remote-handling replacement of the moderators has been demonstrated.	NA	Off-beam commissioning report	A	C
	Working time, manpower and necessary tools have been estimated, and prepared.	NA	Off-beam commissioning report	A	C
	Templates to manufacture spare moderators have been prepared.	NA	Off-beam commissioning report	B	C
	A disposal method (cooling, drying, cutting and retaining) has been established.	NA	Technical report	B	C
1.4 Measures for off-normal events	Kinds, detection methods and counter-measures against off-normal events have been arranged.	NA	Off-normal event list	B	C
	A scenario for preparing a spare moderator in case of unexpected failure has been established.	NA	Technical report	B	C

# Details of Checklist

- **1st column:** General items
  - functions, process operation, maintainability, measures for off-normal events, *etc.*
- **2nd column:** Detailed items
- **3rd column:** Acceptance criteria for each detailed item.
  - Only major acceptance criteria are described in this checklist while detailed and many other acceptance criteria are dropped for simplification.
  - Other documents such as documents prepared by manufacturer and technical reports can be referred in the checklist if needed.
- **4th column:** Confirmation method to satisfy the acceptance criteria
  - The confirmation should rely on **documents** as much as possible that are accessible by any interested persons of JSNS in order to be checked by third persons from an objective point of view.
  - Examples of the documents
    - documents prepared by manufacturer
    - technical reports
    - presentation files for N-TAC meeting
    - papers
    - lists on file servers
    - operation manual
    - *etc.*



# Details of Checklist

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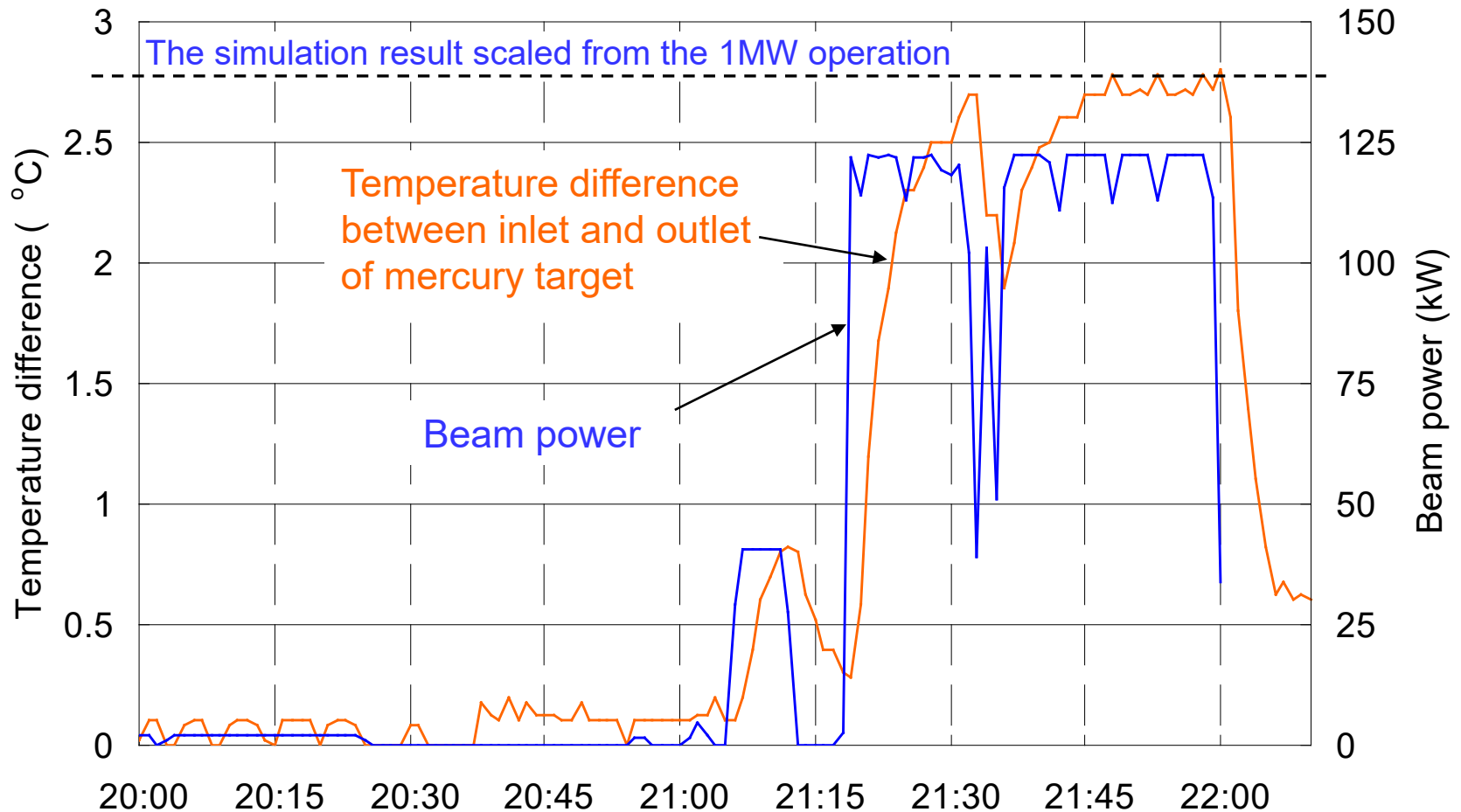
- 5th column: **Necessity** to satisfy the acceptance criteria
  - A: Items that are **indispensable** to be completed by the Day-one
  - B: Items that are **preferable** to be completed by the Day-one
- 6th column: **Current status**
  - A: completed
  - B: conditionally completed
  - C: not yet completed
- For all the items for which the necessity A is given, status must be A or B on the Day-one.

# **On-Beam Commissioning**

## **-- Examples --**

# Temperature change in 120 kW beam operation

--- Mercury temperature ---



Mercury temperature increased 2.8 °C in 120 kW beam operation.

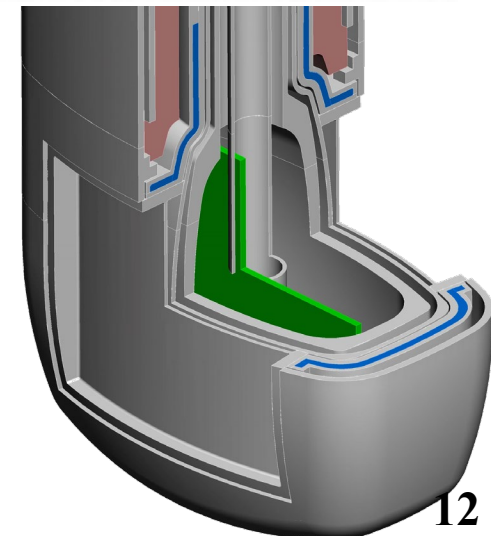
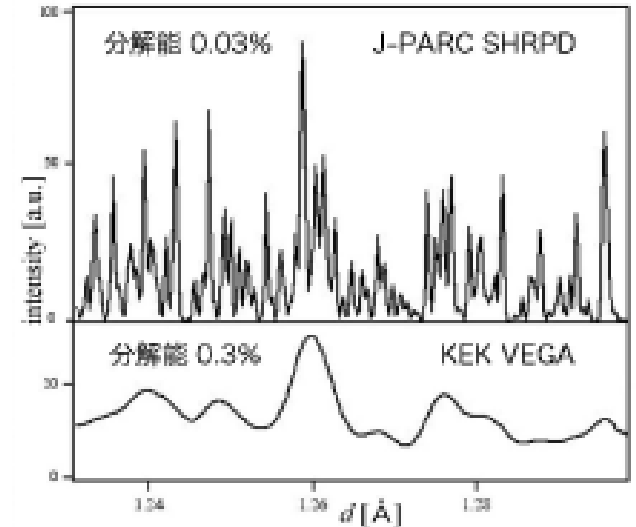
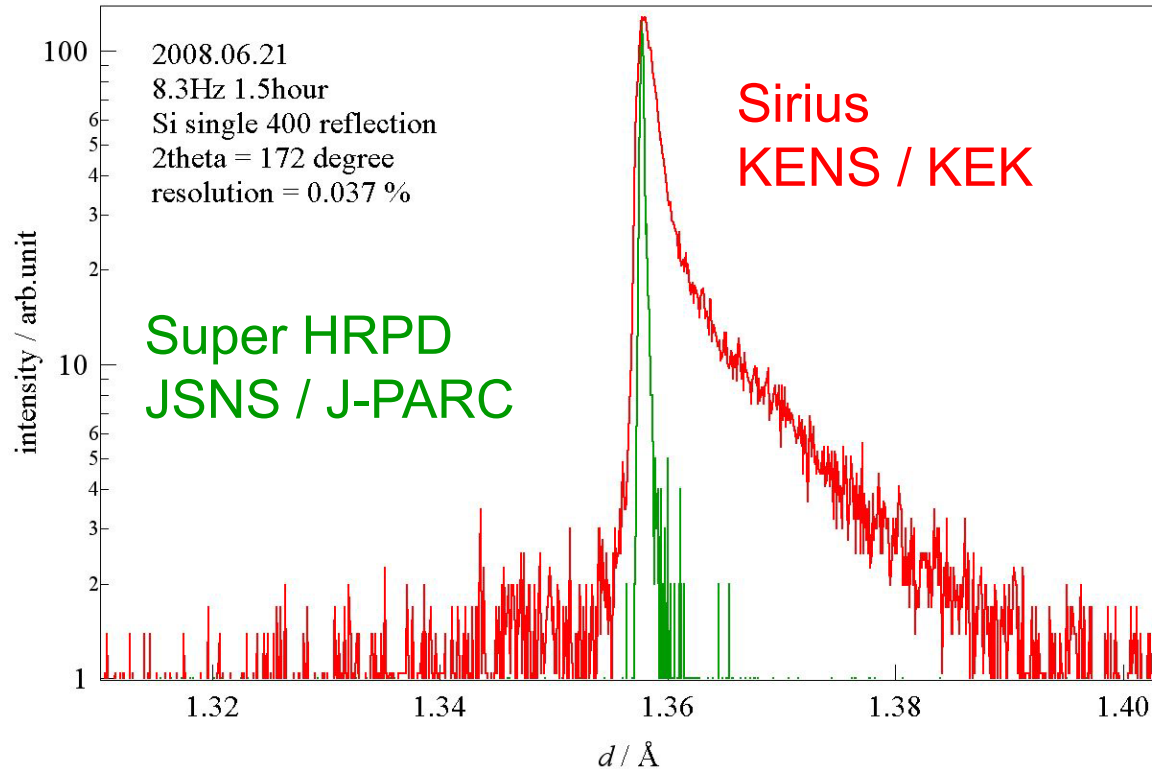
That agreed with the simulation result which was scaled from 1 MW beam operation.

# The World's Highest Performance - Resolution

## Poisoned moderator

Achieved:  $\Delta d/d = 0.037\%$  (to be  $0.030\%$  after tuning)

Previous:  $\Delta d/d = 0.05\%$  (ISIS facility / UK)



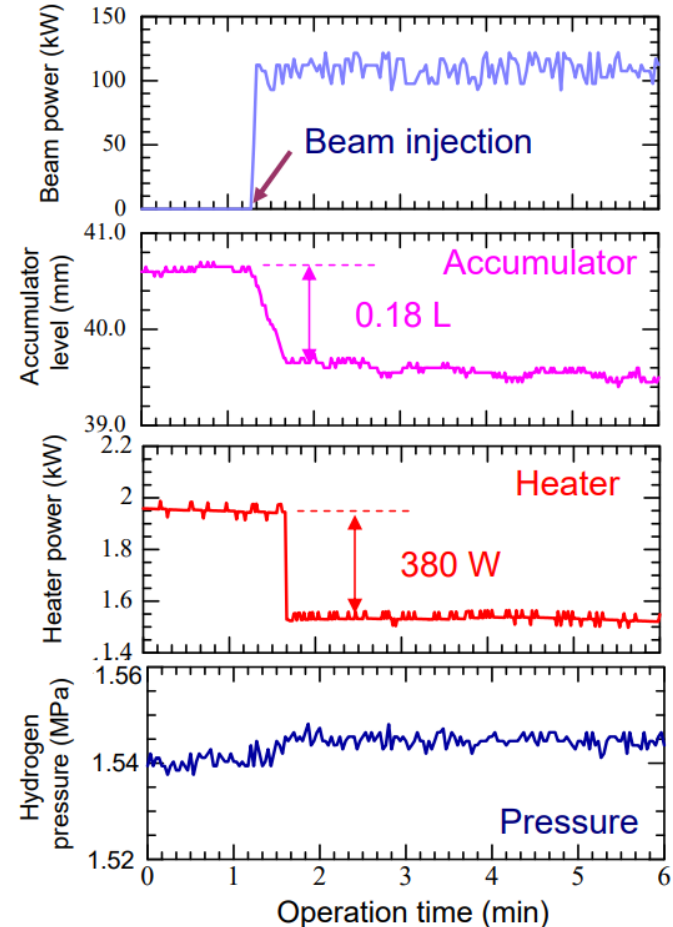
- Achievement due to excellent moderator & instrument designs
- Enable us to analyze more complicate material structures

# Cryogenic system

## 4. On-Beam Commissioning Results (100 kW beam operation)

In December 2008, 100 kW proton beam has been injected for an hour.

- As soon as the beam is injected, the accumulator starts to be contracted.
- Heater control for the heat compensation can be activated. (380 W for 100 kW beam)
- Hydrogen pressure rise is reduced to 6 kPa.
  - if we do not use the pressure control system, the pressure would increase to 1.73 MPa.



The pressure fluctuation can be absorbed by the pressure control system, which combines use of the accumulator and the heater.

The effectiveness of the pressure control system has been confirmed.

# Beam profile measurement at the target for 1<sup>st</sup> beam

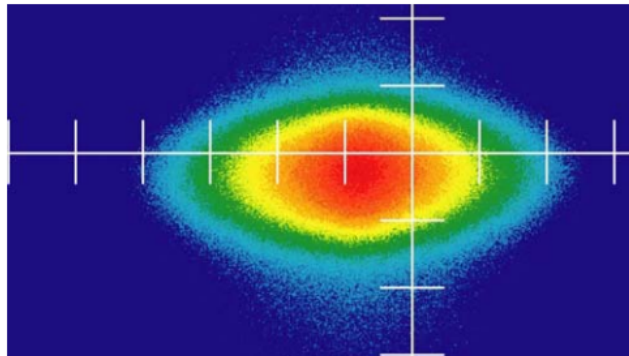
To obtain 2-D beam profile on the target, activation technique is applied.  
- Performed May-30 (without muon target)



Al : 0.3mm-t

-Foil removed by human hands (Shot number <2000 shots)  
-Placed Imaging plate

Result of profile



Confirmed  
No skew and simple shape!

# Summary

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- Off-beam commissioning was carried out for over 1 year.
- Readiness check was carried out to complete the commissioning activities.
- Readiness checklists for all MLF components were prepared and total 700 items were included.
- On-beam commissioning was carried out successfully.
- The improvements of the devices were continued reflecting the commissioning results.