

Upgrade of Hokkaido University Neutron Source (HUNS)



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Hokkaido University neutron source (HUNS) original one

Stopped operation
in Oct. 2017



"Pulsed" "Cold" Neutron Source

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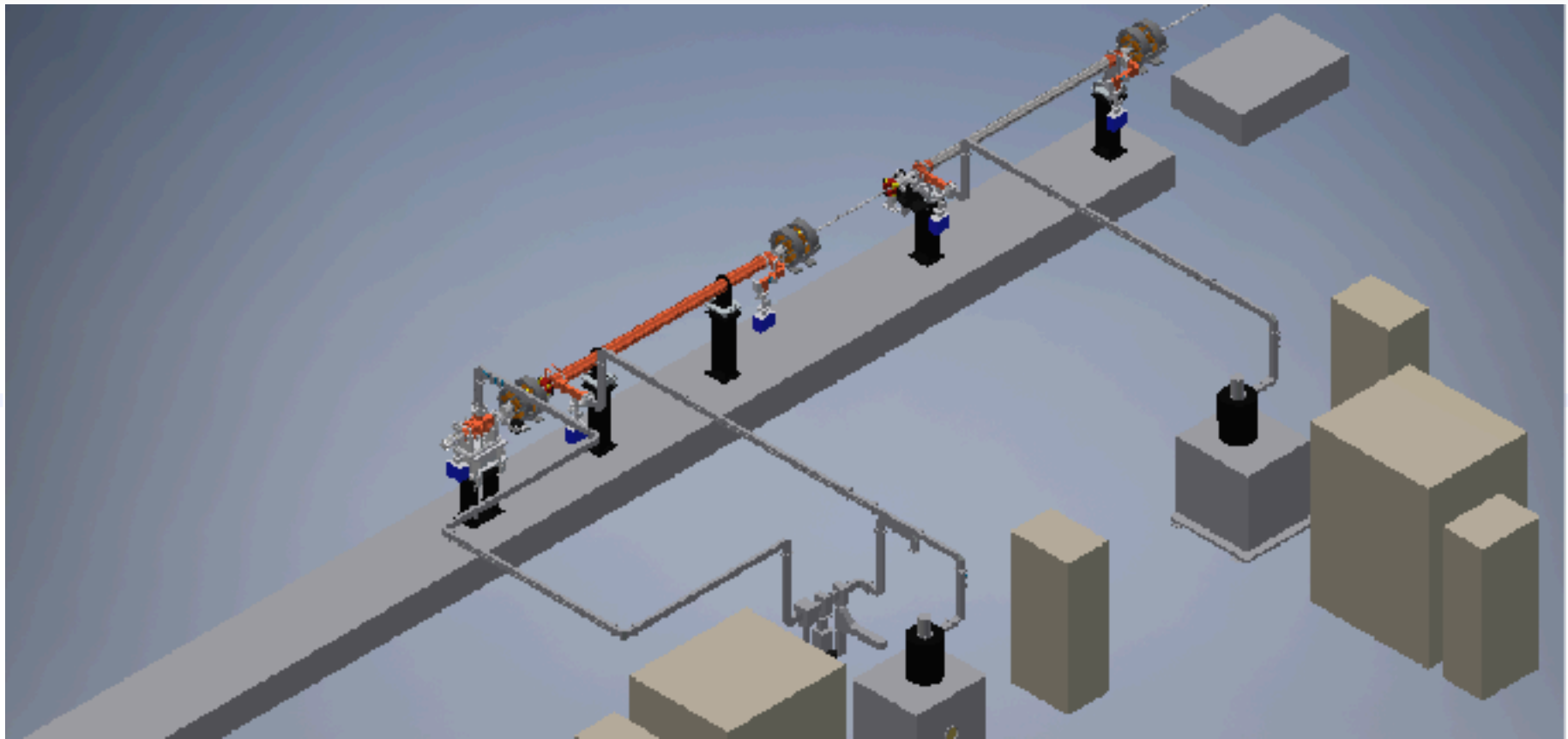
- **Electron Linac**
 - 34 MeV, 35 μ A, **1.2 kW**
 - Since 1974
- **Pulsed & Time of flight**
 - **50 PPS, 3 μ sec electron pulse**



**Stopped operation
in Oct. 2017**

Upgrade in the final stage.
First beam in May

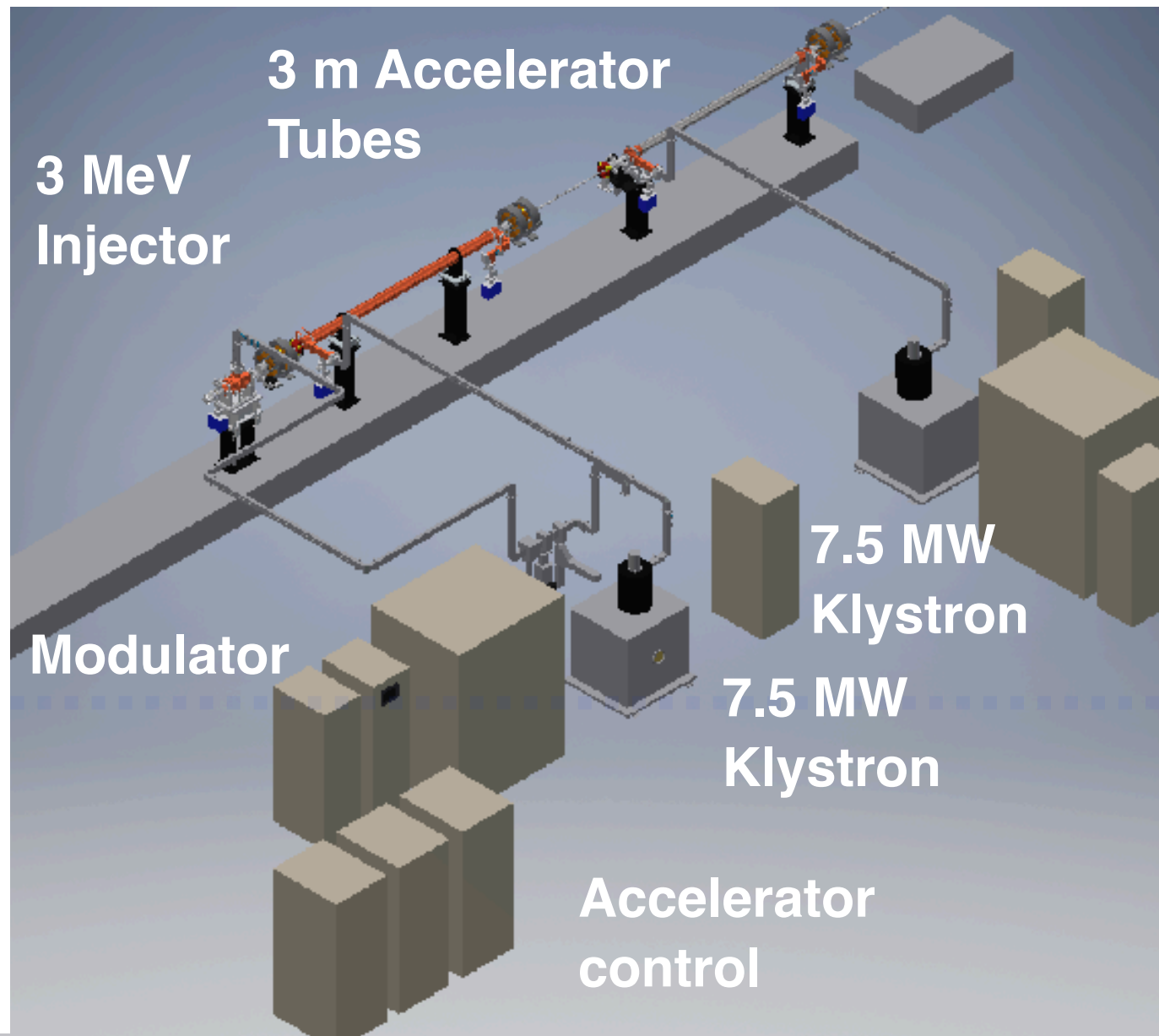
HUNS upgrade: 1.2 kW to 3 kW



New electron accelerator

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- Same ≈ 34 MeV (full loading)
 $1.2 \text{ kW} \rightarrow 3 \text{ kW}$
- $50 \text{ pps} \rightarrow 100 \text{ pps}$
- pulse duration:
 $3 \mu\text{sec} \rightarrow 4 \mu\text{sec}$



Electron injector

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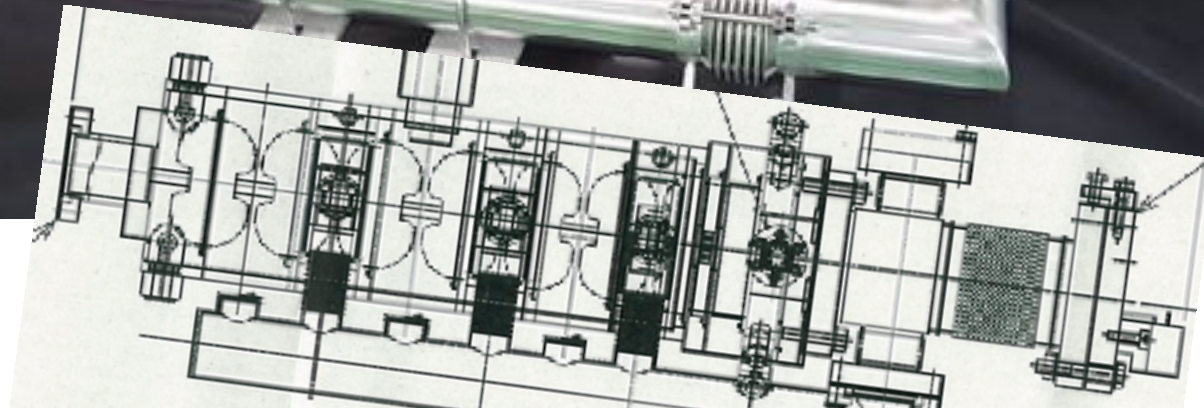
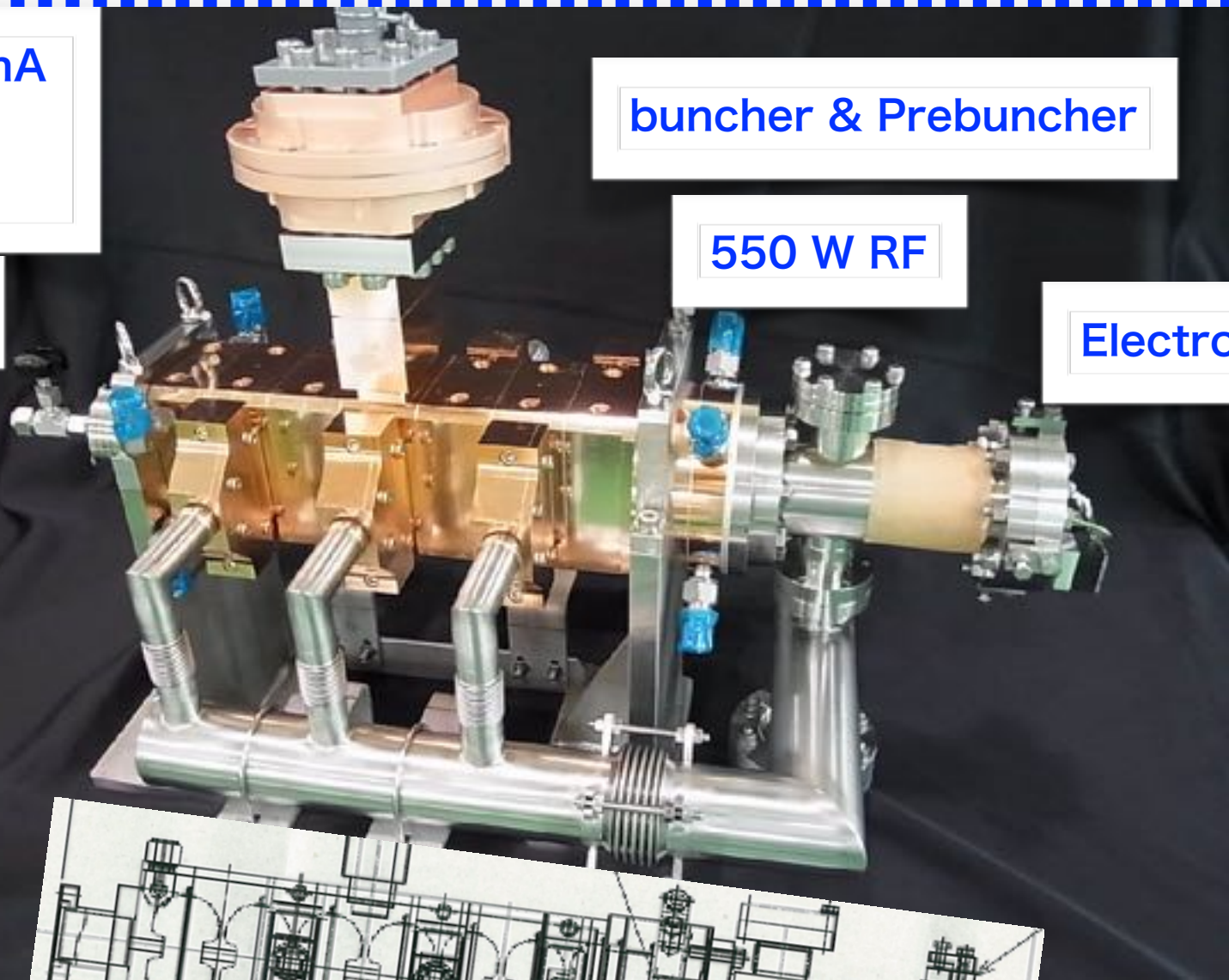
3MeV-250mA
Accelerator
8 μ sec

1.4MW RF

buncher & Prebuncher

550 W RF

Electron Gun



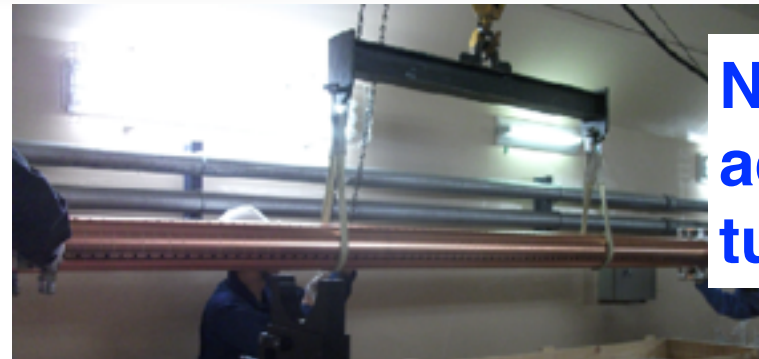
Construction progress

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Accelerator removed



New
accelerator
tube



Installed

supports

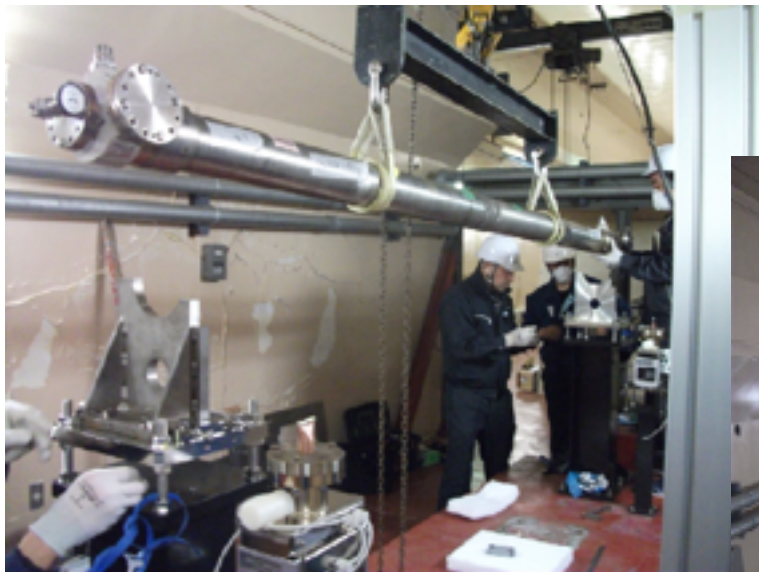


Alignment



Construction progress

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**Secondhand
Accelerator tube
from AIST**

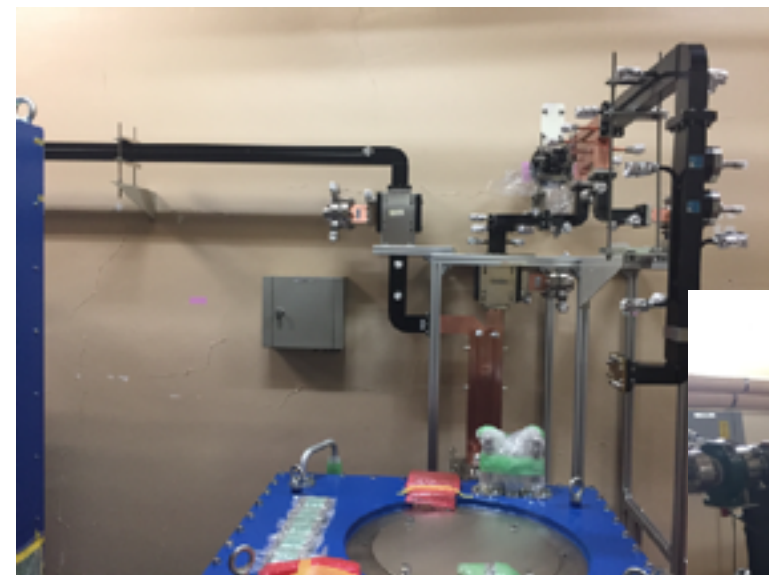


**Injector and
Two Accelerator
tubes Installed**

National Institute of
Advanced Industrial Science and Technology

Construction progress

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Wave guides,
Phase shifter



Old and new
Control systems

Construction progress

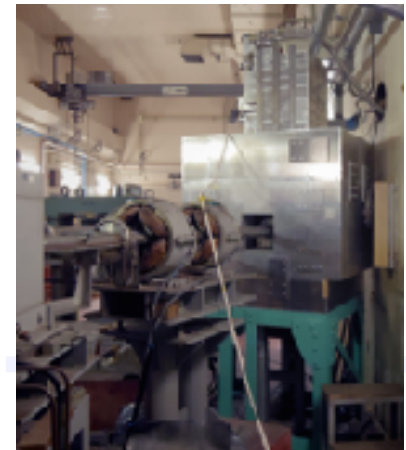
10



Same as
before

Neutron target stations

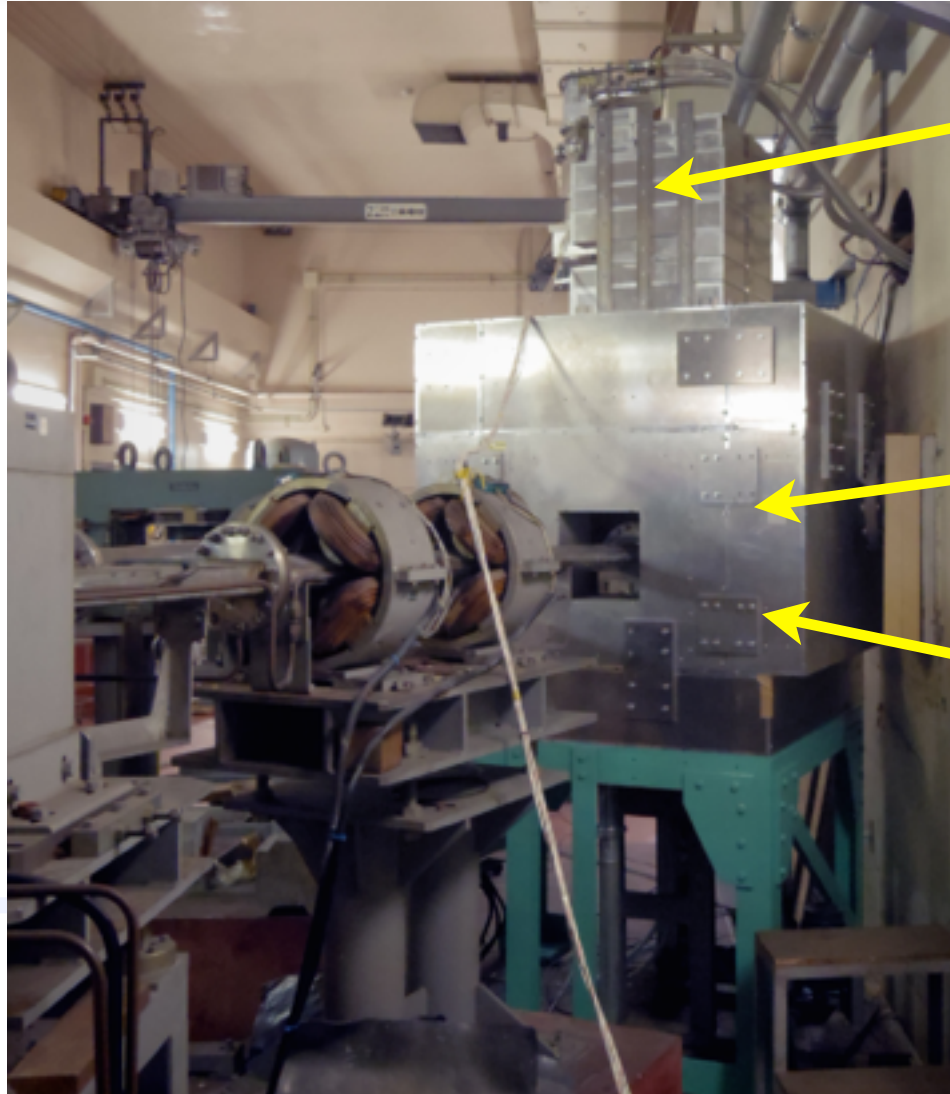
11



Coupled **Cold** neutron source

Shielding improved

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cold neutron source
currently **Mesitylene**
to be **Methane**

10 cm Pb inside

20 cm Borated Polyethylene

We will use it as it is.

Thermal & Fast Neutron/X-ray Imaging

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Fast neutrons for
single event effects

NTT, Fujitsu,
Hitachi, NEC

Elevator
neutron/X-ray
target change

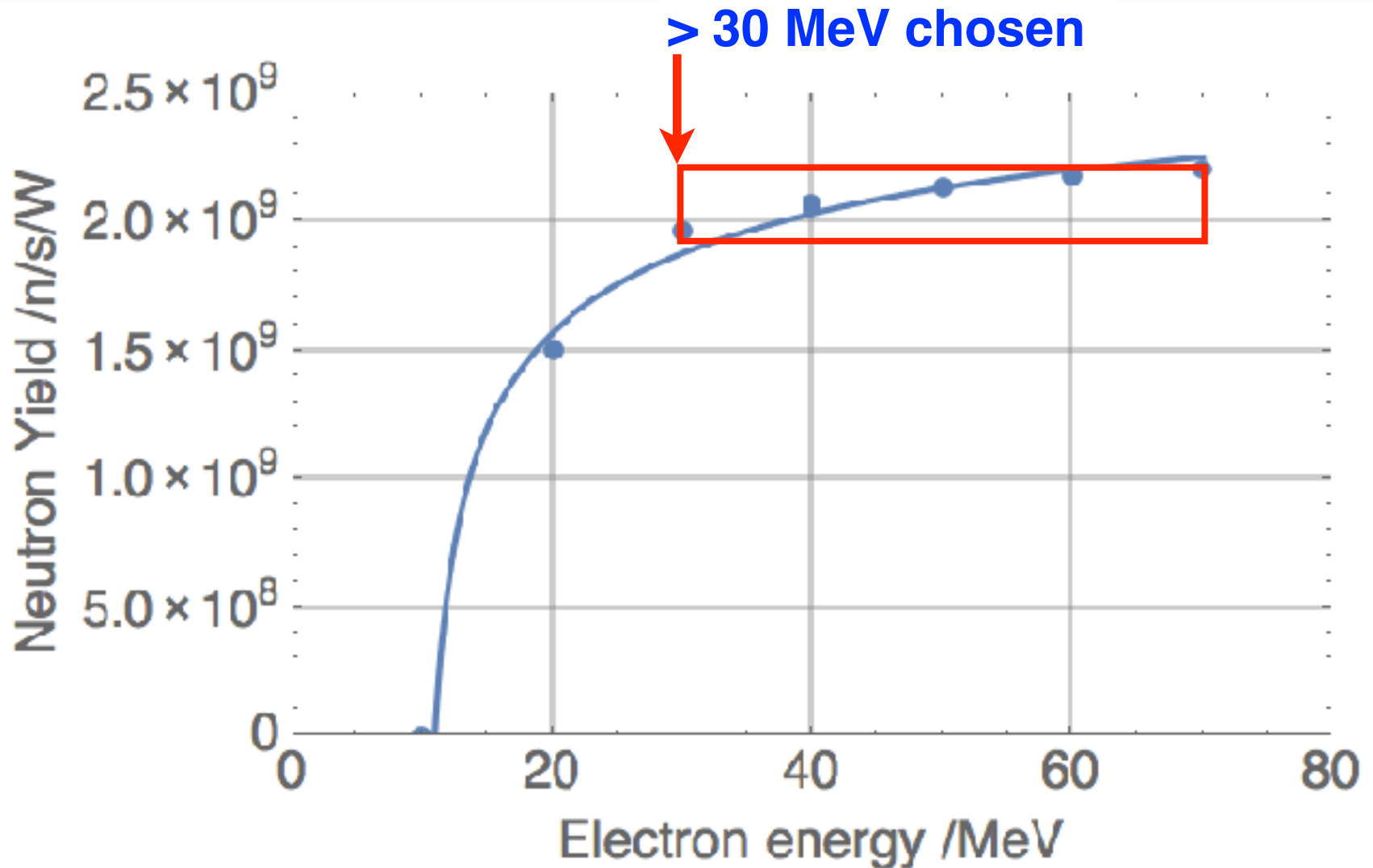


We will use it
as it is.

Accelerator parameter choice

Neutron yield

15



Klystron choice

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- S band
- 7.5 MW peak power
 - 9.5 kW average
 - 160 kV-116 A
- RF pulse width: 5.0 μ s
- Repetition rate: 250 pps

- Toshiba
- **E3772A**



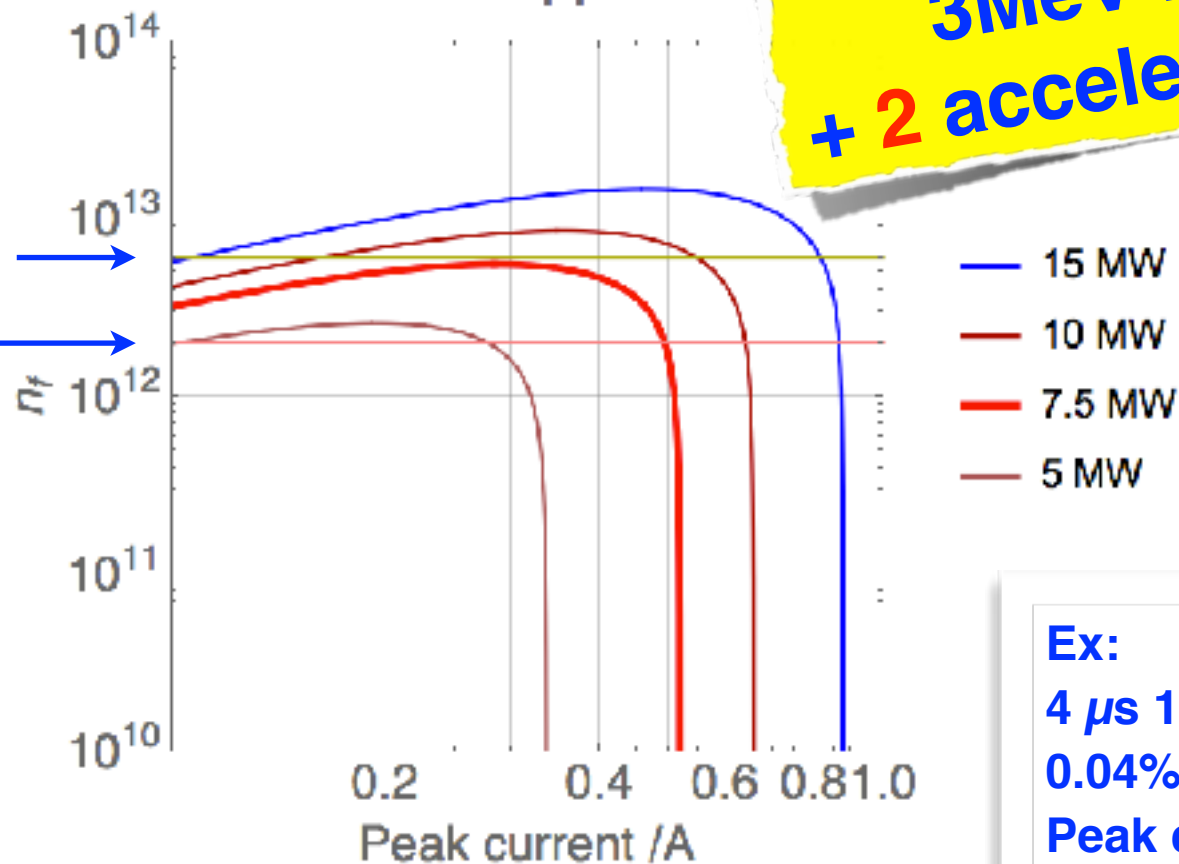
2 accelerator tubes for HUNS upgrade

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2 × 3m accelerator tube,
100 pps

3MeV injector
+ 2 accelerator tubes

HUNS upgrade
HUNS



Ex:

4 μ s 100 pps

0.04% duty

Peak current: 0.25A,

Averaged current: 100 μ A

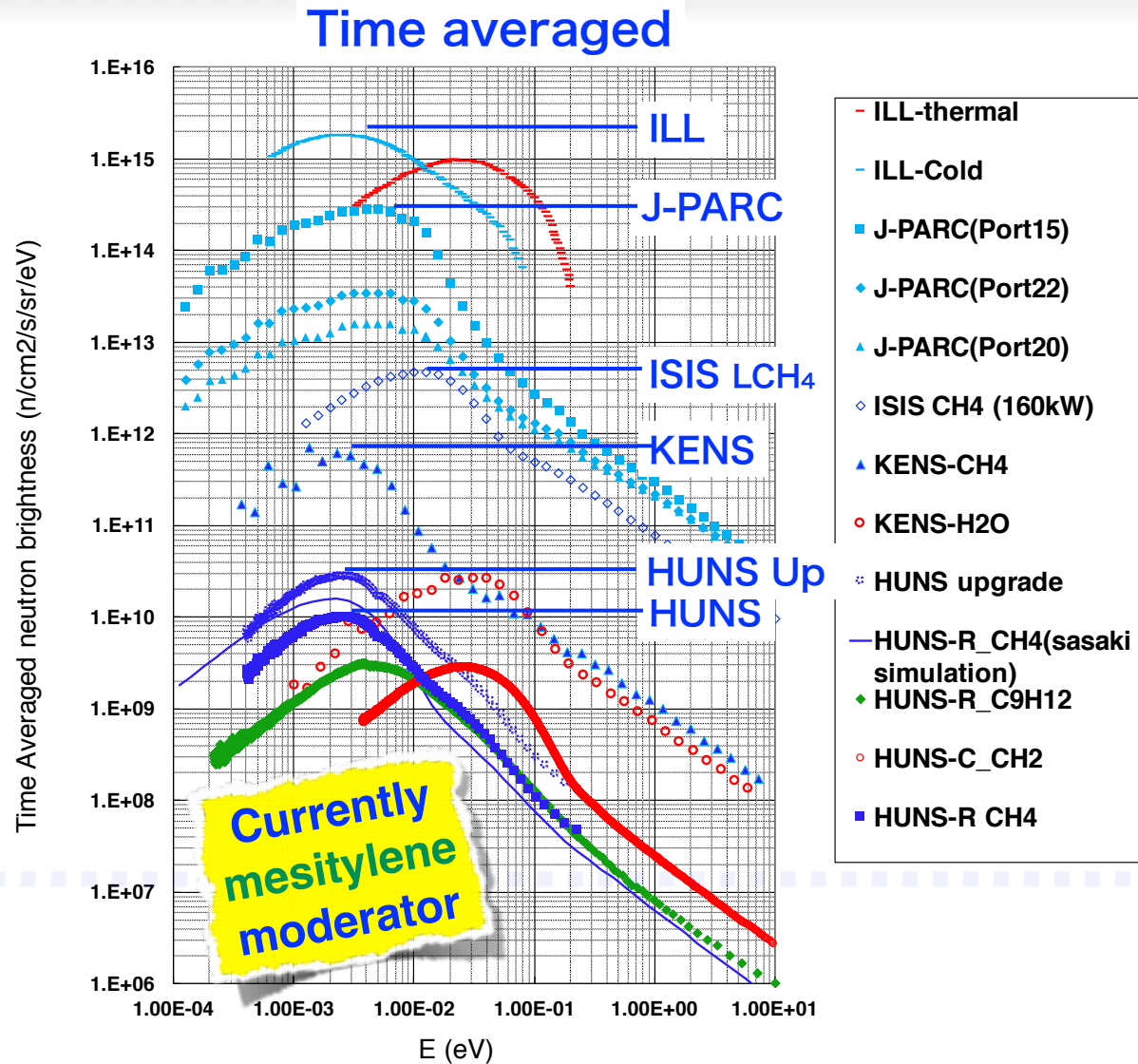
≈ 30 MeV, 3 kW

Intensity compared

R. Ishida

Time averaged intensity comparison

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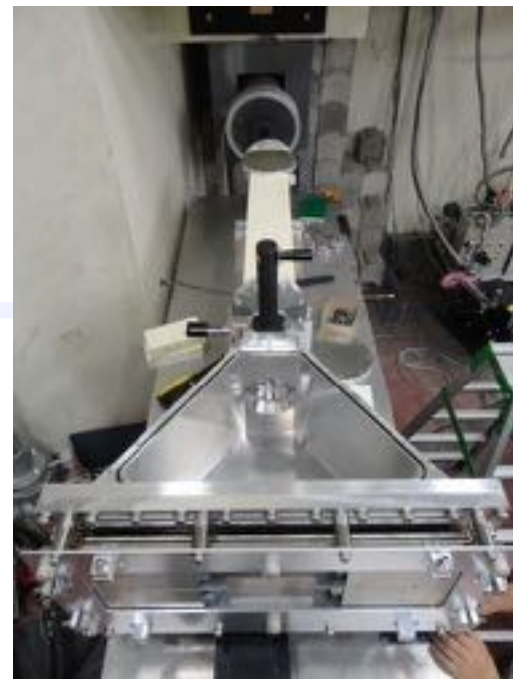
intermediate-Angle
Neutron Scattering

The instrument **iANS** using very short flight-paths

Pronounced like “**Irons**”

20

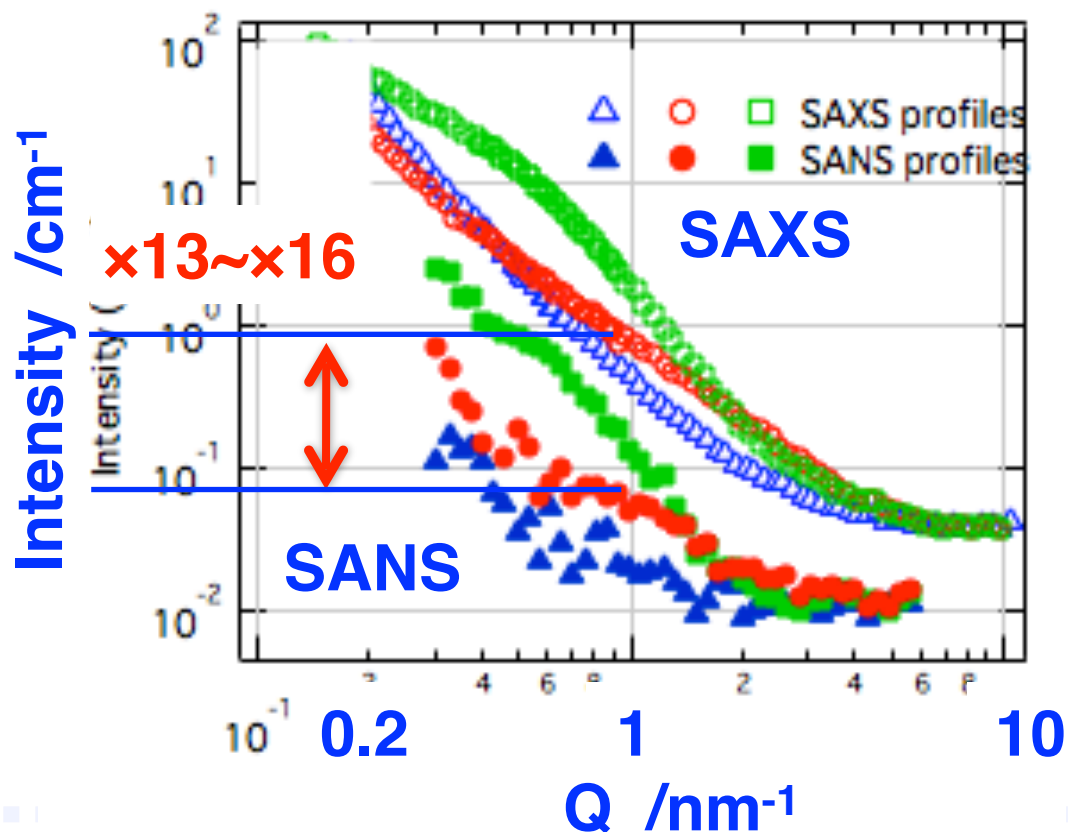
Optimized to a
nanoscopic region



Production measurements

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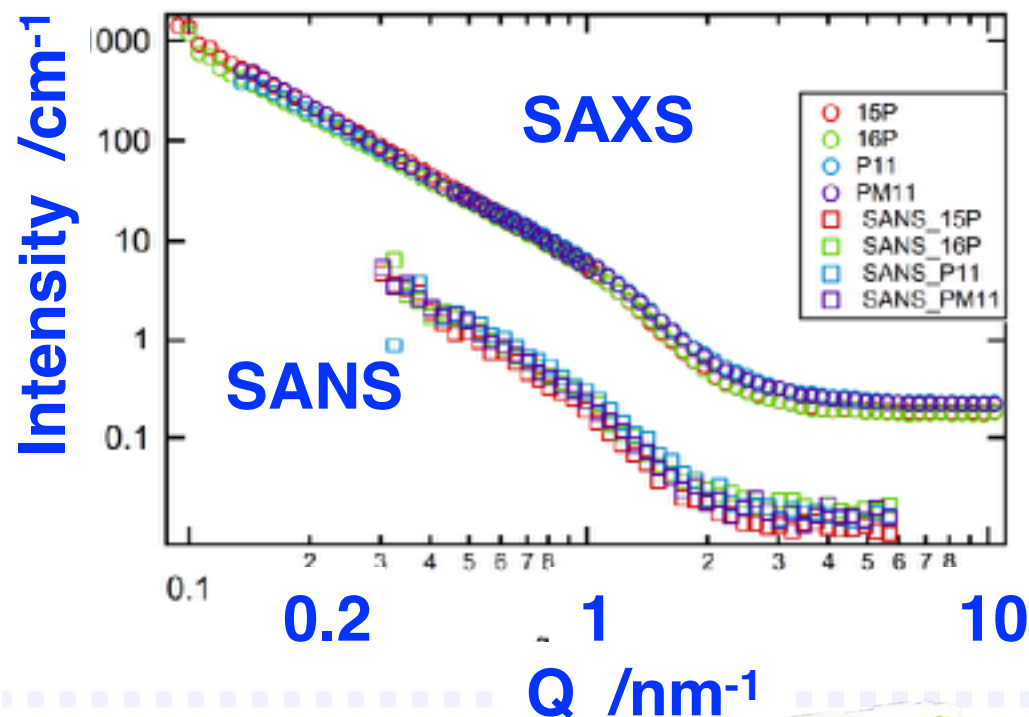
TiC precipitates in steels (2015.10)



Precipitates are **TiC**: $\times 14$

Several hours

ODS steels (2015.11)

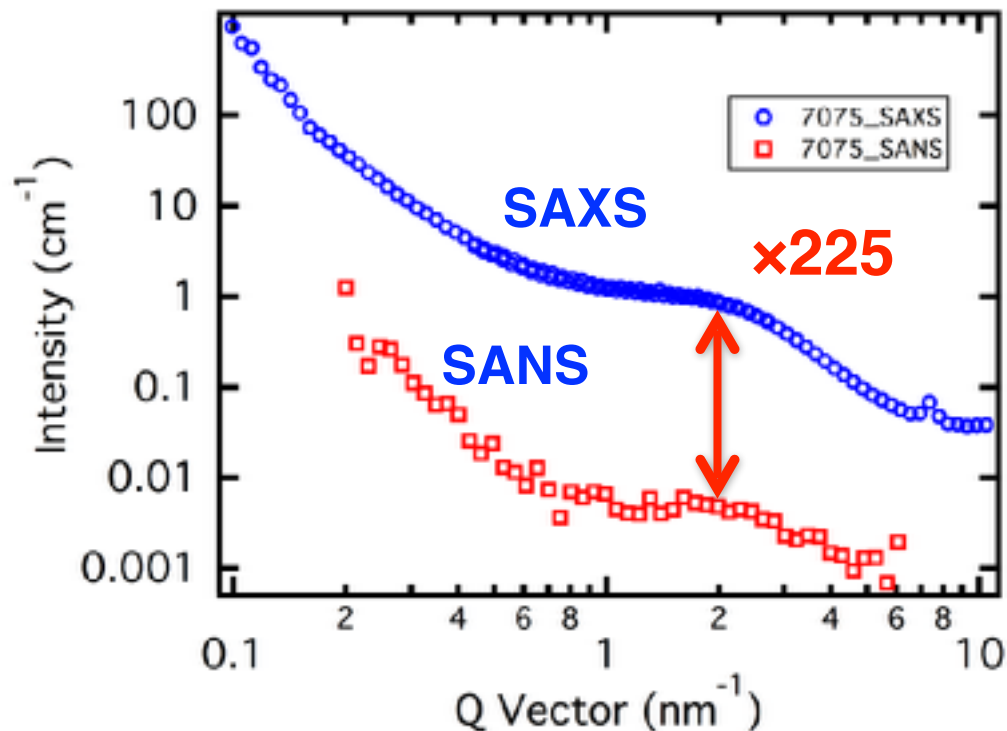


Collaboration with
3+ major **steel making**
companies.

Production measurements

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Al alloys : 7000 series (2015.12)



Many others

Precipitates are TiCMgZn_2 : 230

Collaboration with
3+ major steel making
companies.

Focusing mirror SANS

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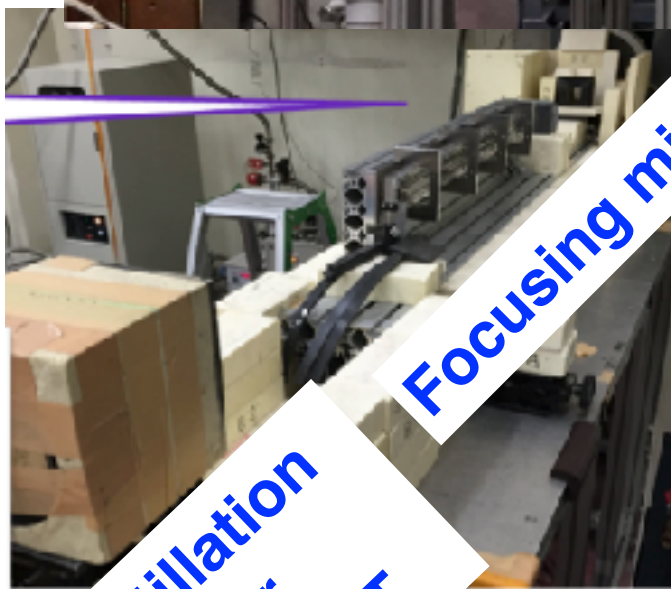
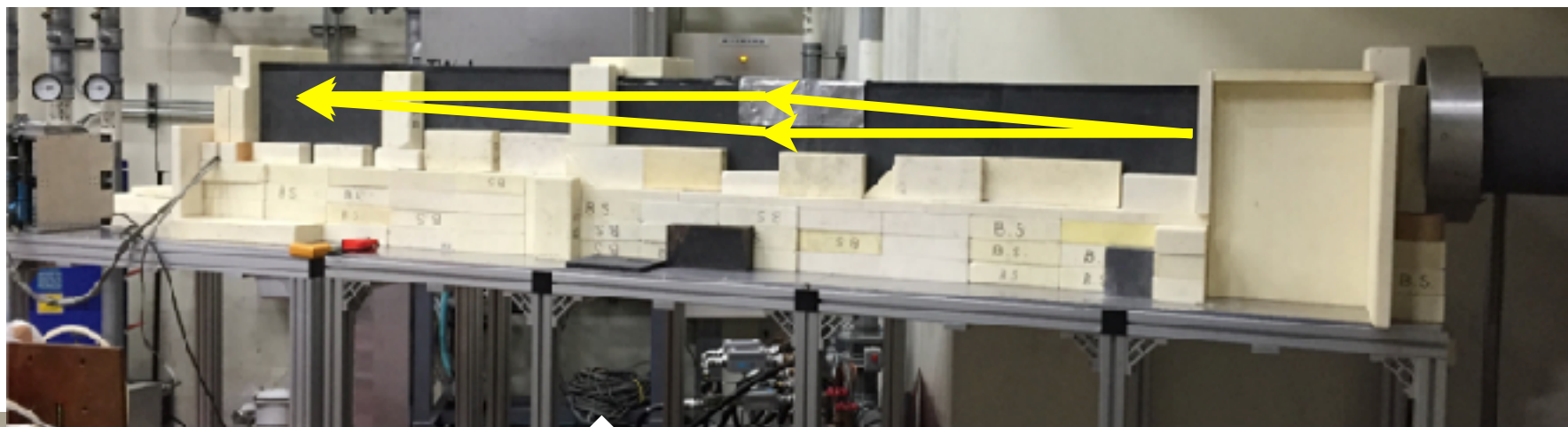
S. Takeda, N. Yamada,
Y. Yamagata, T. Hosobata,
T. Oda, J. Guo, J. Kato,
M. Hino, *et al*

Hokkaido Univ., Riken, KUR, KEK

for low-Q

A focusing SANS instrument

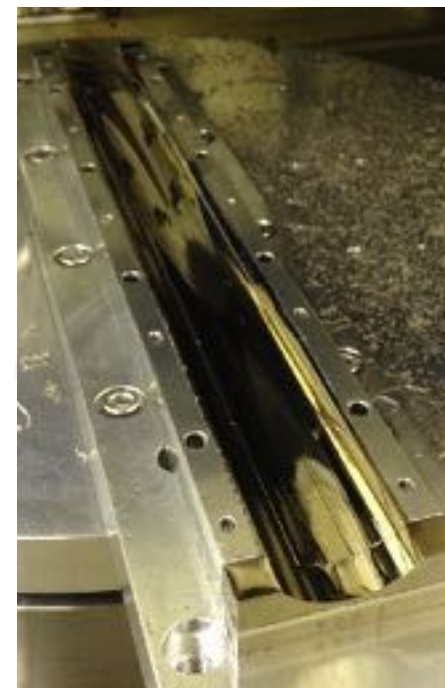
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Scintillation
detector
ZnS+RPMT

Focusing mirror

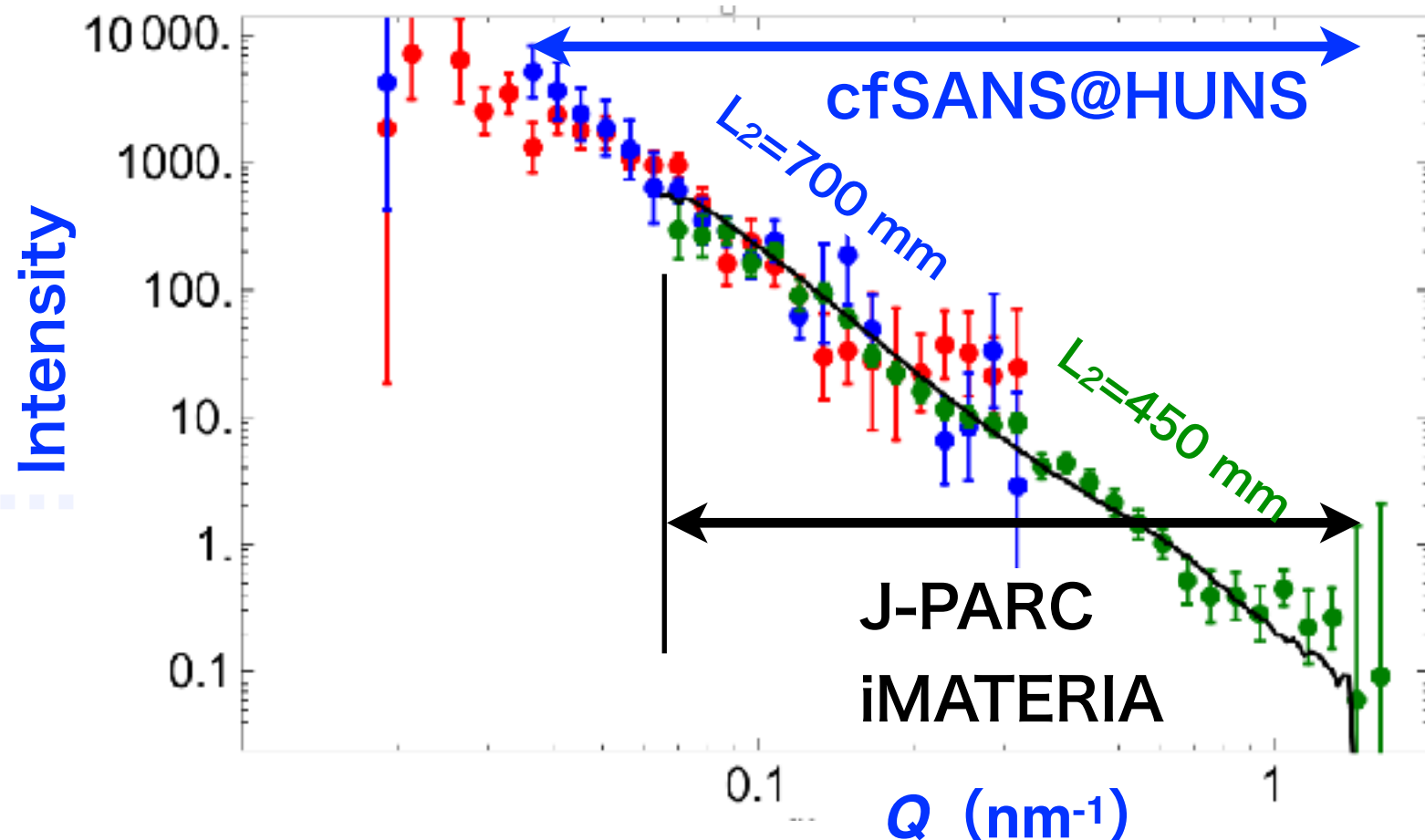
- Ellipsoidal mirror



Compact Focusing SANS@HUNS

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- Nano precipitates in an Ni alloy
 - Only 300 mm × 20 mm focusing mirror, $3.5Q_c$
 - 2, 4, 6.2 mm ϕ pinhole choice

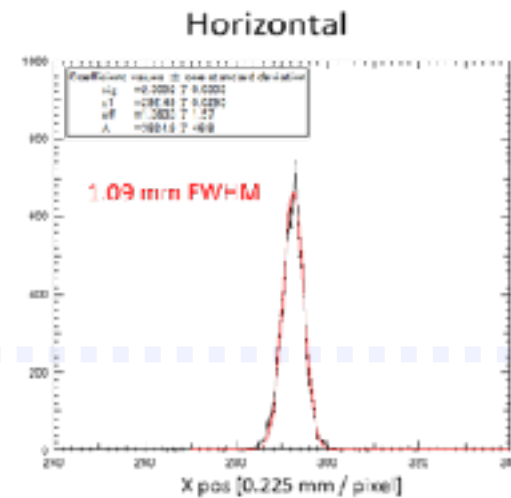
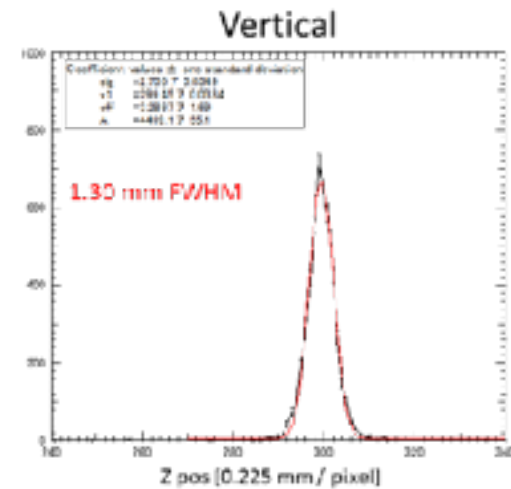
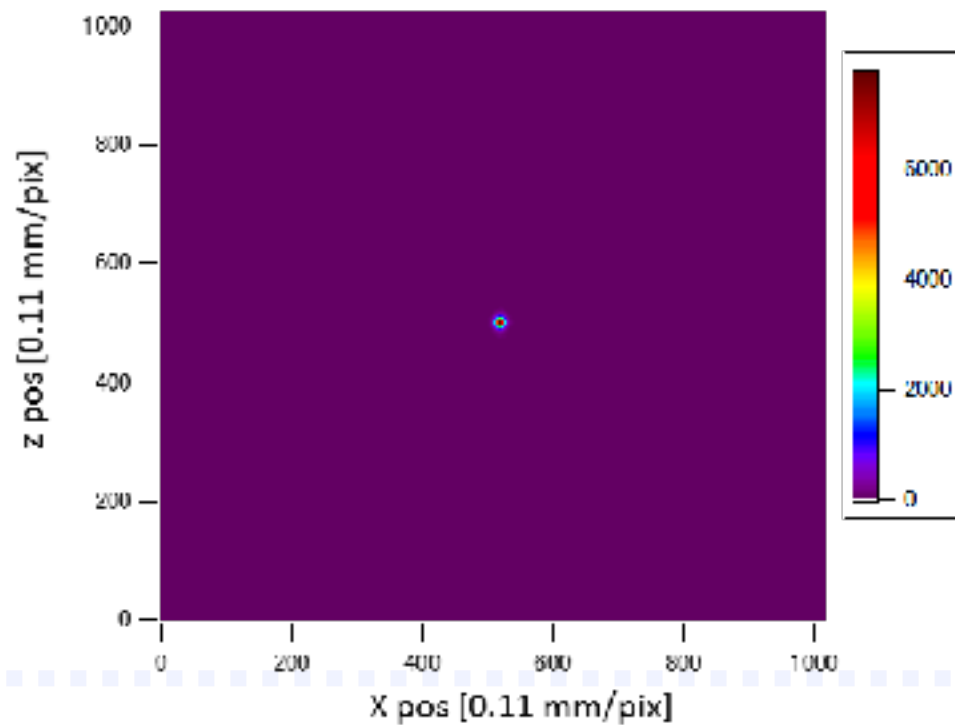


Focussed beam

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1 mm first aperture

Colorbar: linear

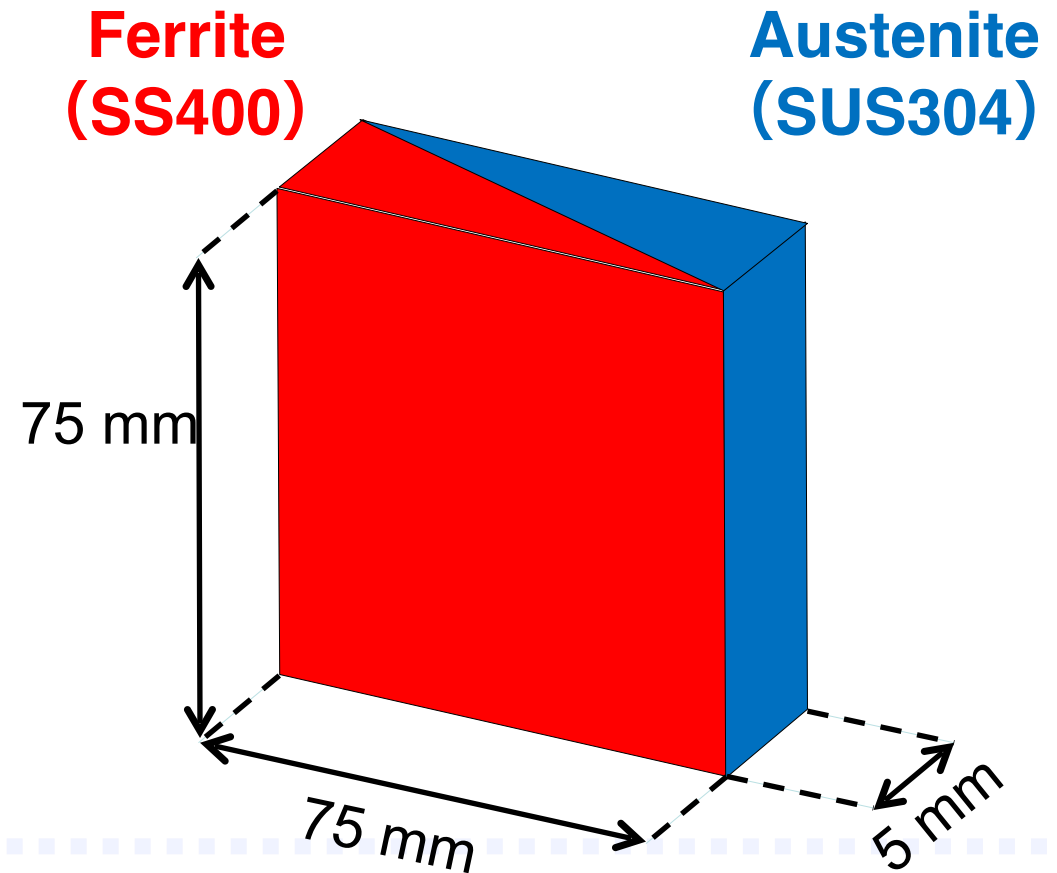


Bragg-Edge Transmission Imaging

H. Sato, M. Sato *et al*, Hokkaido
University

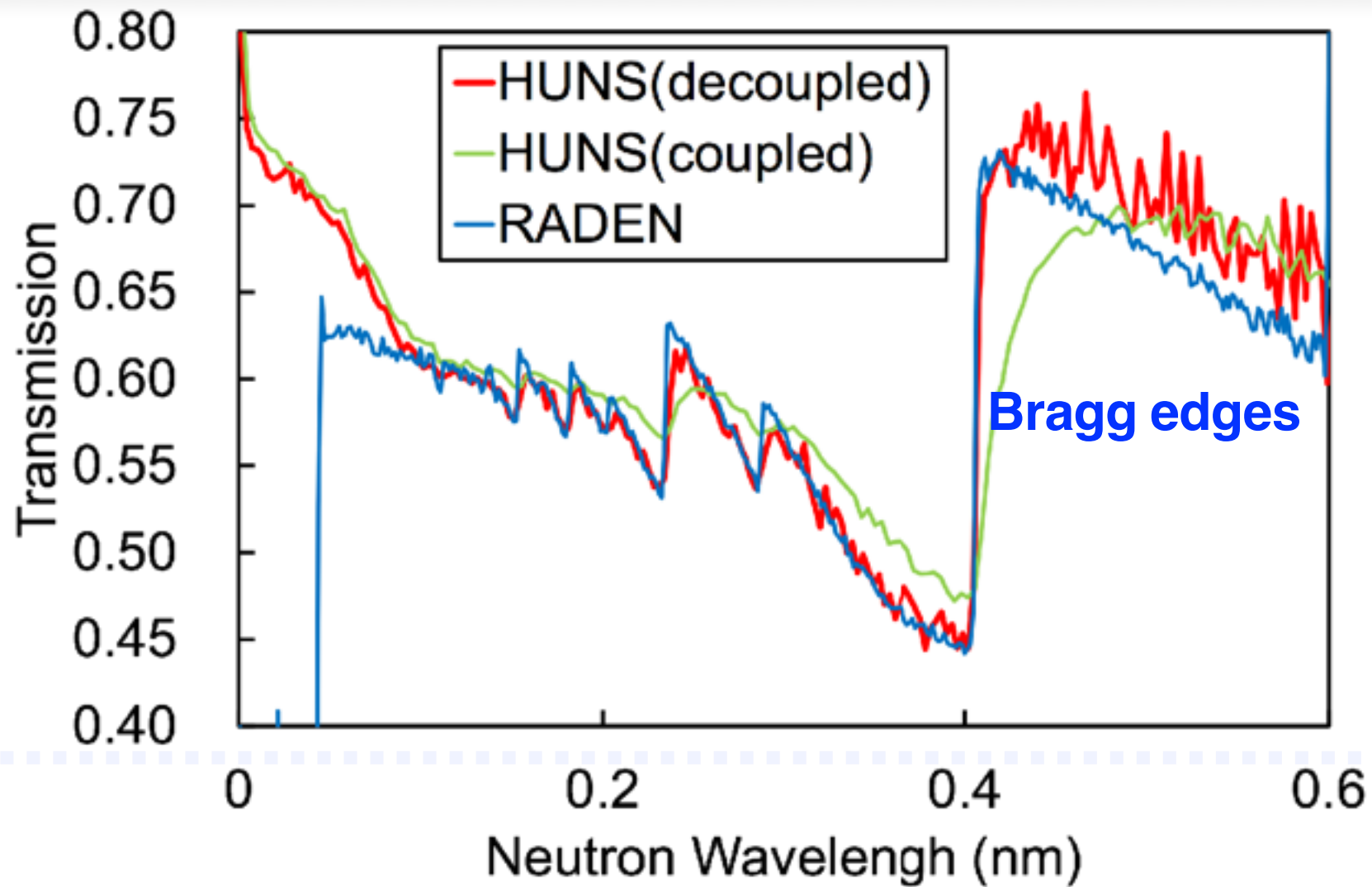
Ferrite-Austenite volume fraction test sample

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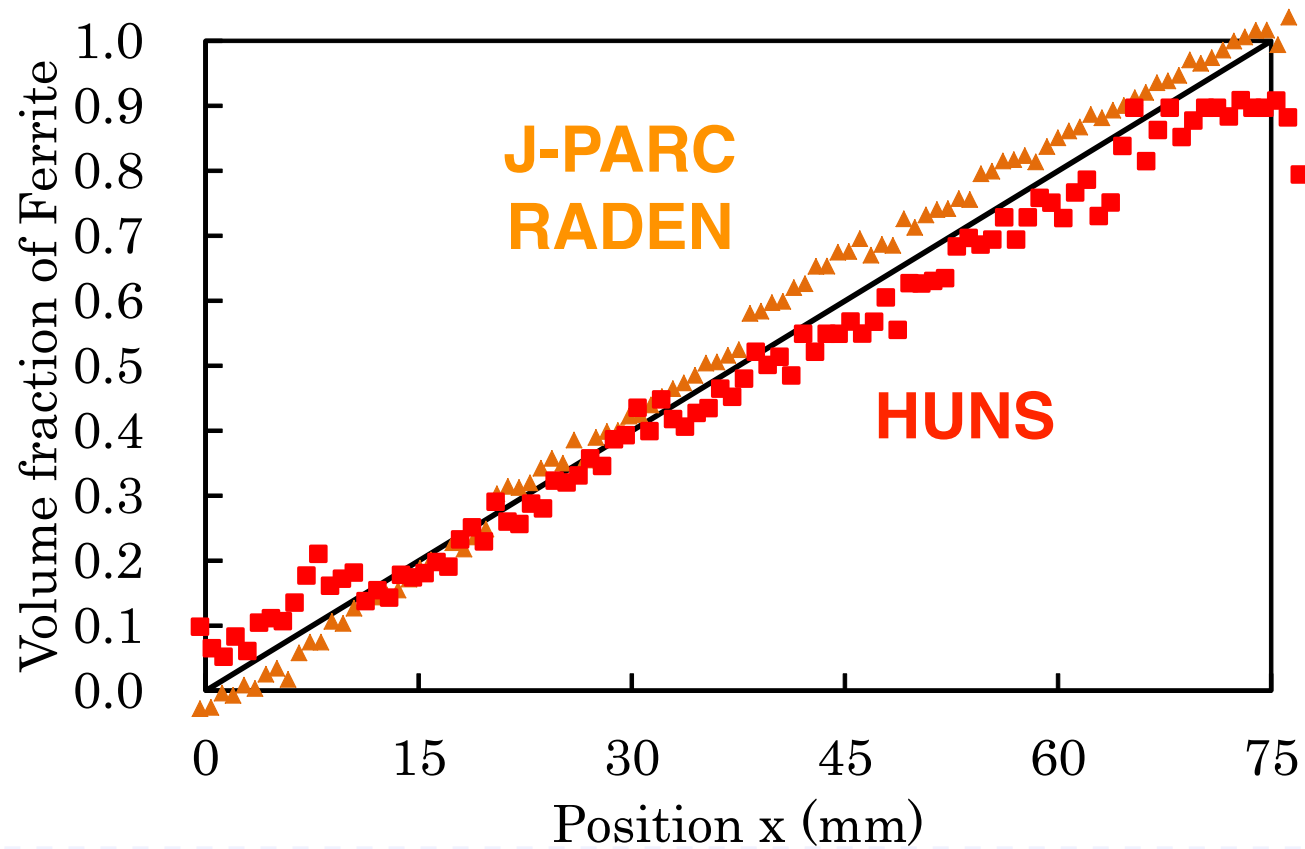
Transmission spectra

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Calibration curves

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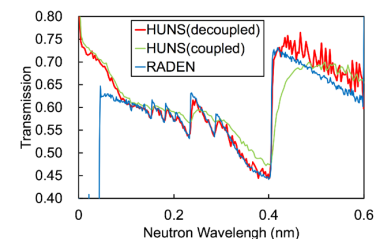
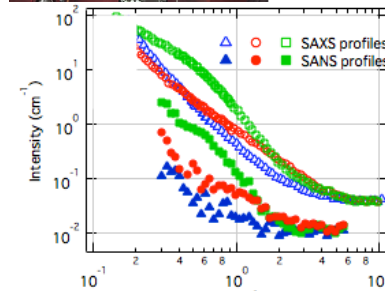
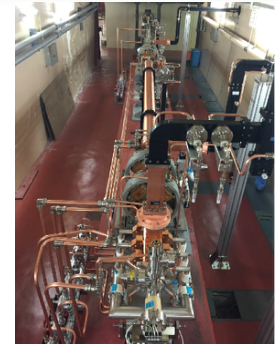


Summary

Summary

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- Hokkaido University Neutron Source, HUNS
 - **Stopped** operation in Oct. 2017.
- **HUNS accelerator upgrade to 3 kW**
 - Major components installed.
- Intermediate-angle neutron scattering instrument, **iANS**
 - Working with **3+ major steel making companies.**
- Compact **focusing SANS**
 - Successfully got low-Q data in Ni-alloy
- Bragg-edge transmission instrument
 - Much improved resolution, 0.5%
- (Single event effects; Routine operation)



Summary

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- Hokkaido University Neutron Source, HUNS

- 1.2 kW, since 1974

- HUNS accelerator upgrade to 3 kW

- Major components in the upgrade

- Intermediate

- Working

- Bragg-

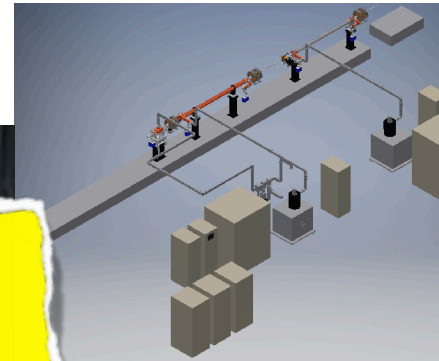
- Much in

- Compact

- Success

- Single event effects; Routine operation

**We can do many
REAL
measurements!**



ent, iANS

