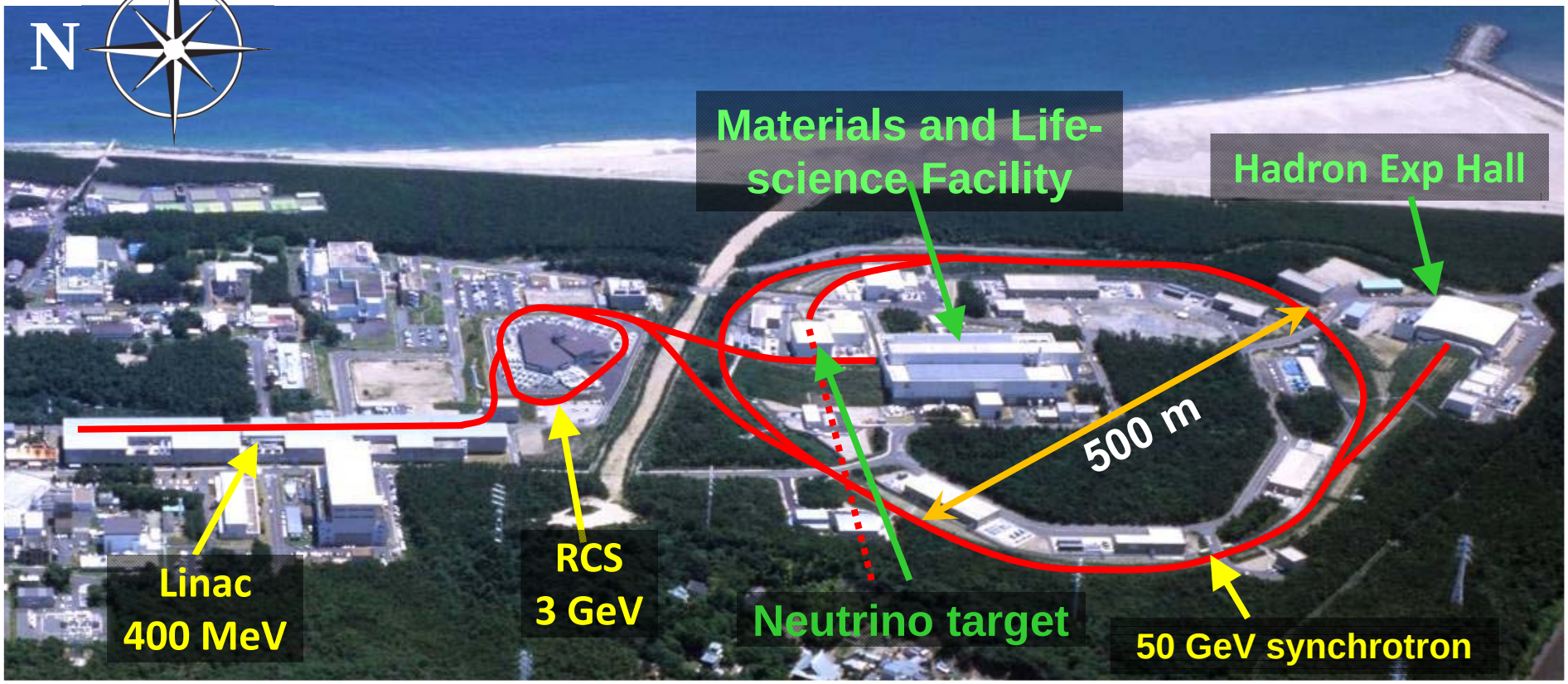
KEK activity on J-PARC neutron facility and compact neutron sources

KEK/J-PARC

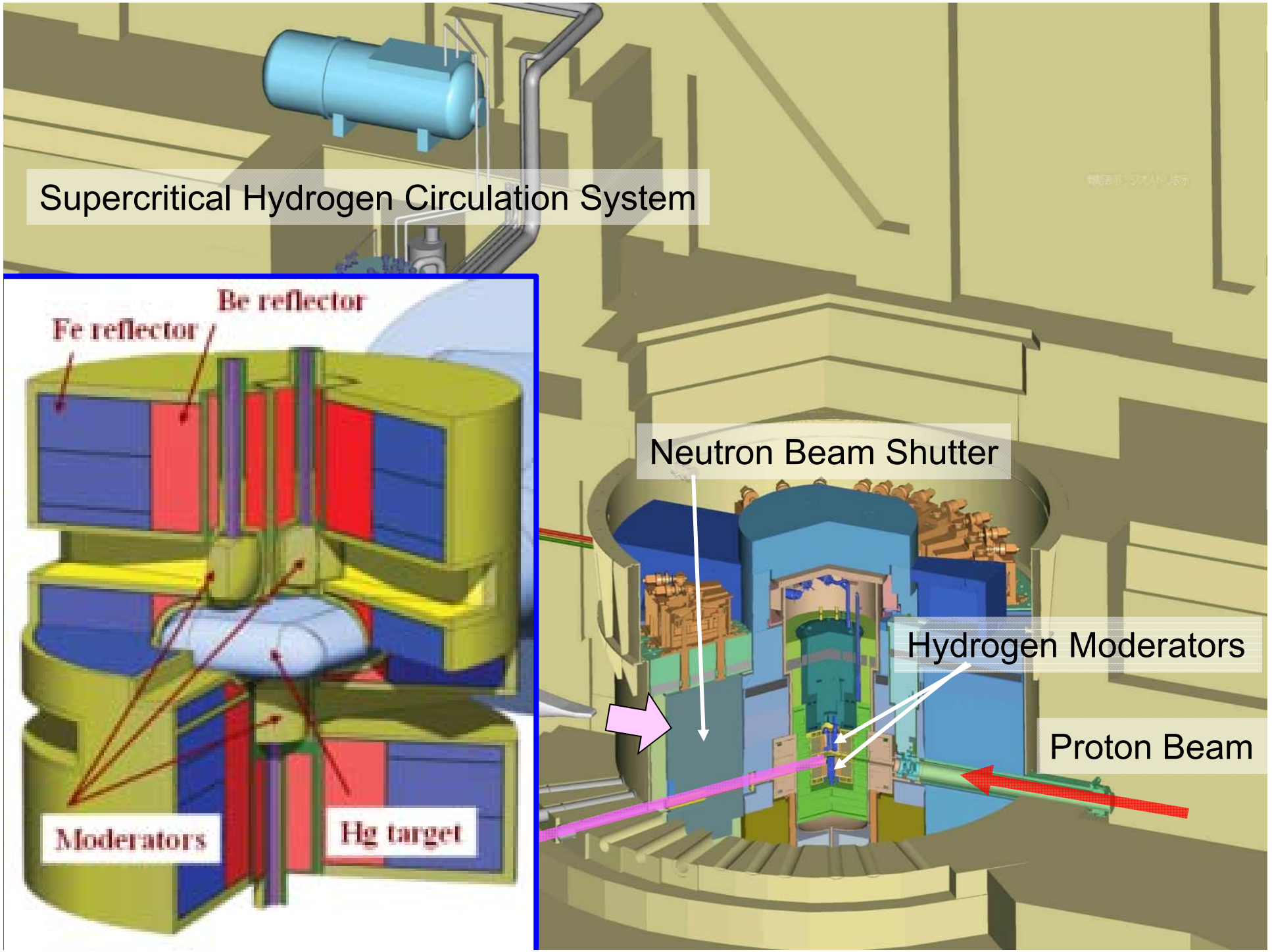
Takashi Ino

UCANS-V, May 12-15, 2015
at Laboratori Nazionali di Legnaro (Padova), Italy

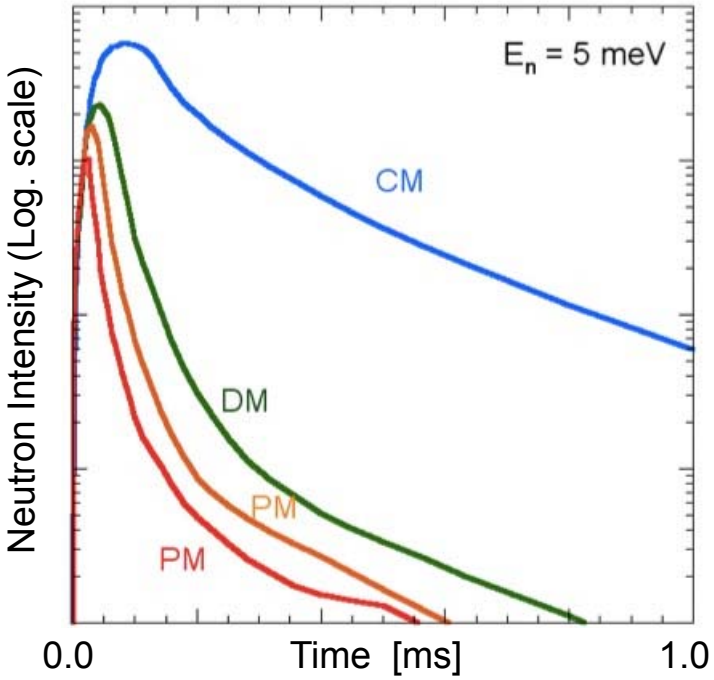


3 stage proton accelerators

for nuclear and particle physics, materials and life science, engineering studies, etc.

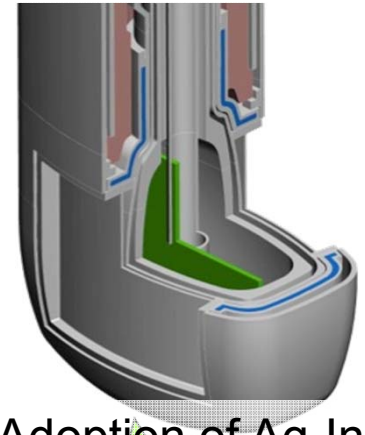

Supercritical Hydrogen Circulation System
Be reflector
Fe reflector
Moderators
Hg target
Neutron Beam Shutter
Hydrogen Moderators
Proton Beam

Supercritical Hydrogen Moderators



Poisoned Decoupled moderator (PM)

for high resolution



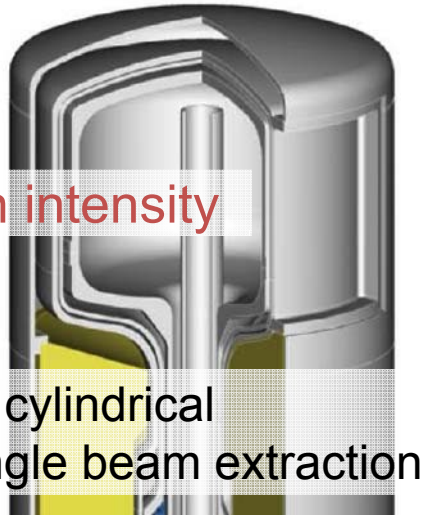
Decoupled moderator(DM)

for balanced performance

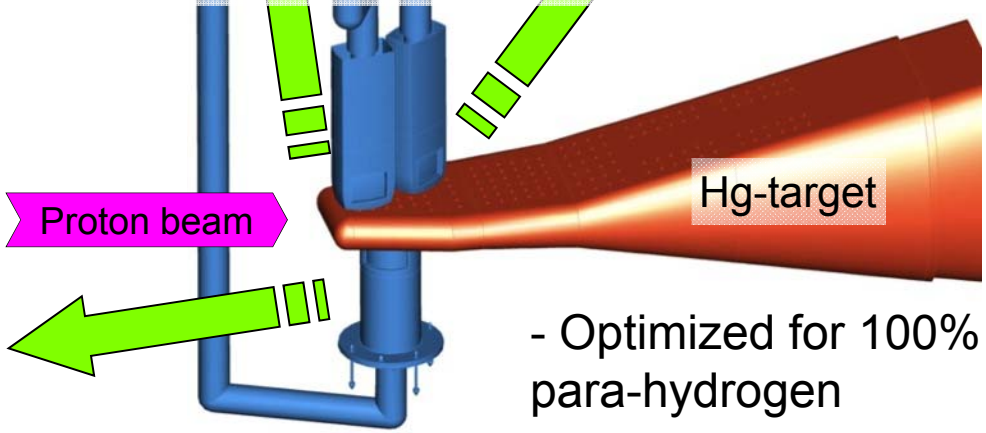
- Adoption of Ag-In-Cd (AIC) alloy for high decoupling energy at 1 eV
- optimized decouple coverage for lower pulse tail
- Adoption of Cd poison

Coupled moderator (CM)

for high intensity

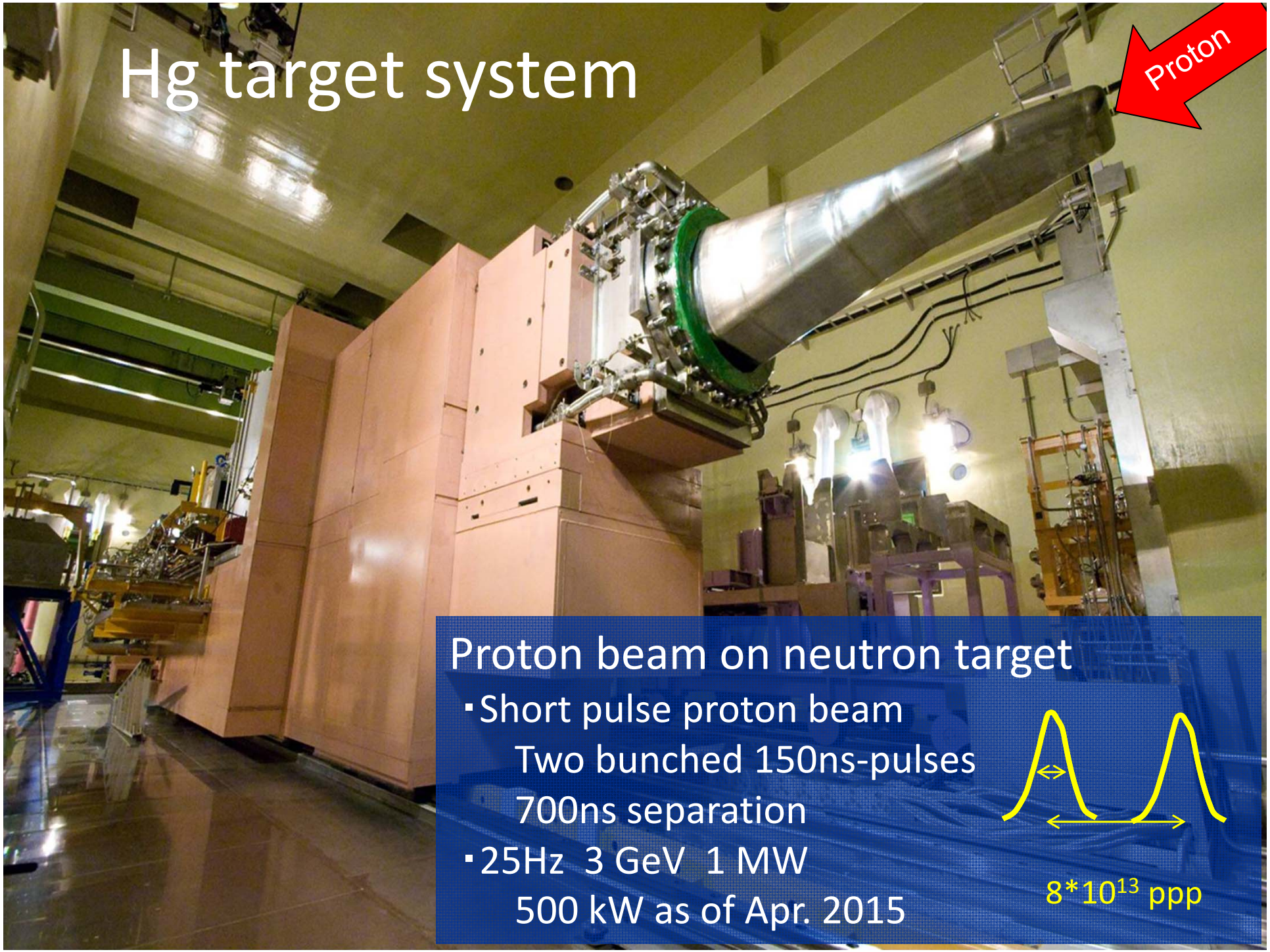


- large & cylindrical
- wide angle beam extraction



- Optimized for 100% para-hydrogen

Hg target system

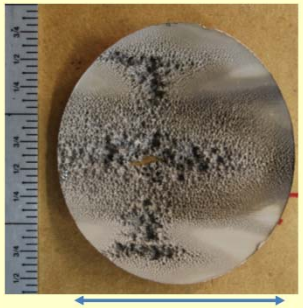


Proton beam on neutron target

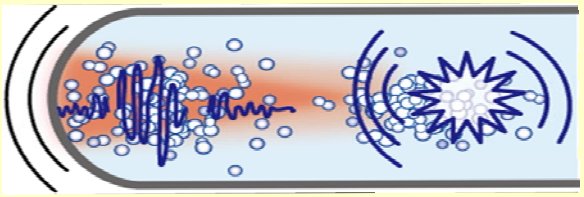
- Short pulse proton beam
  - Two bunched 150ns-pulses
  - 700ns separation
- 25Hz 3 GeV 1 MW
  - 500 kW as of Apr. 2015

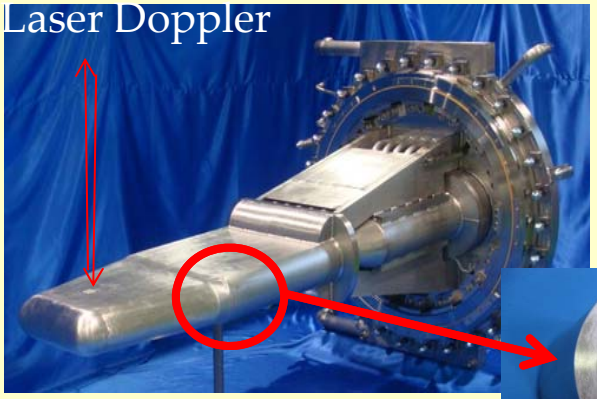
$8*10^{13}$ ppp

He-gas bubbling to mitigate the pitting problem

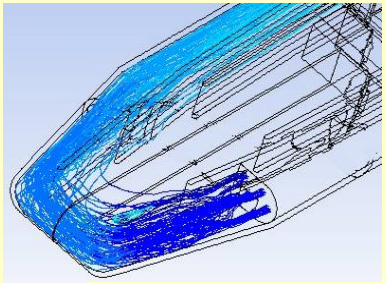


Pitting Damage on a SNS target



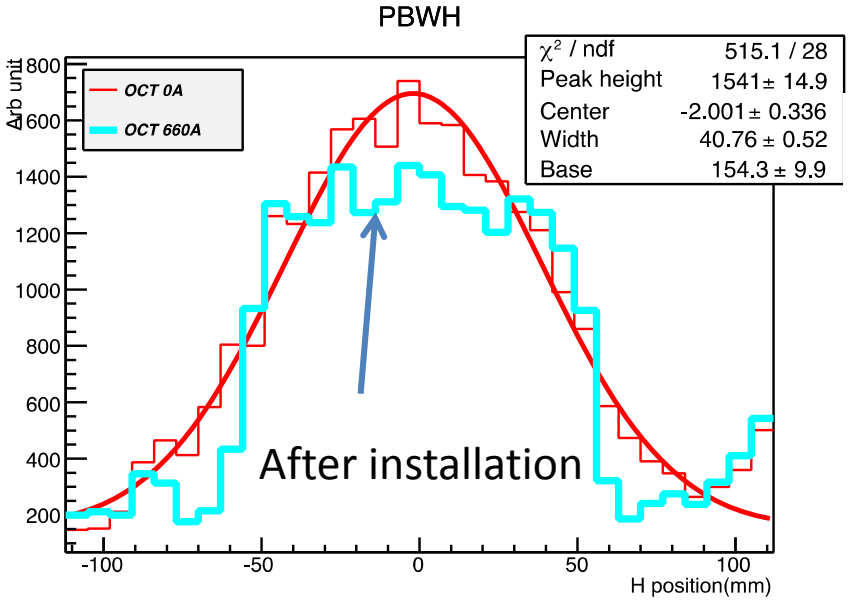


He-gas bubbler injecting into Hg target



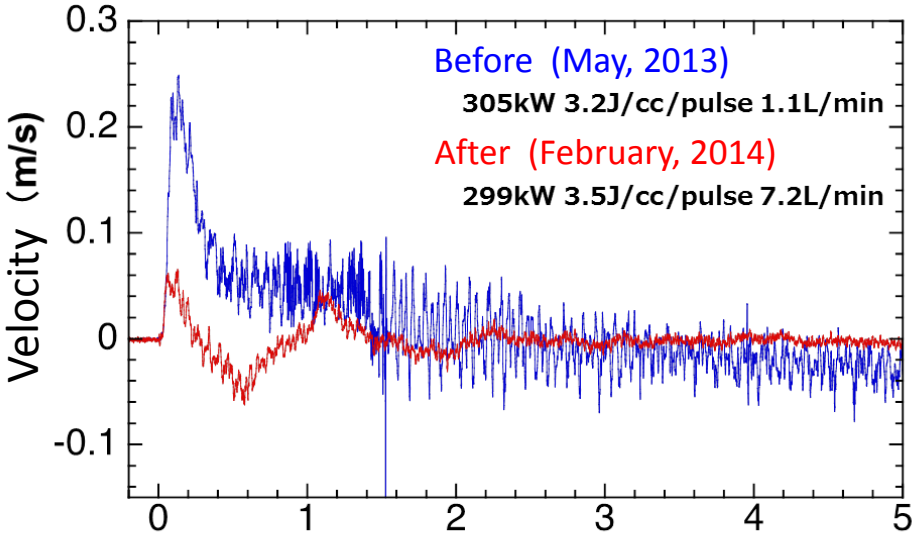
Bubbling distribution

Bubbler: swirler



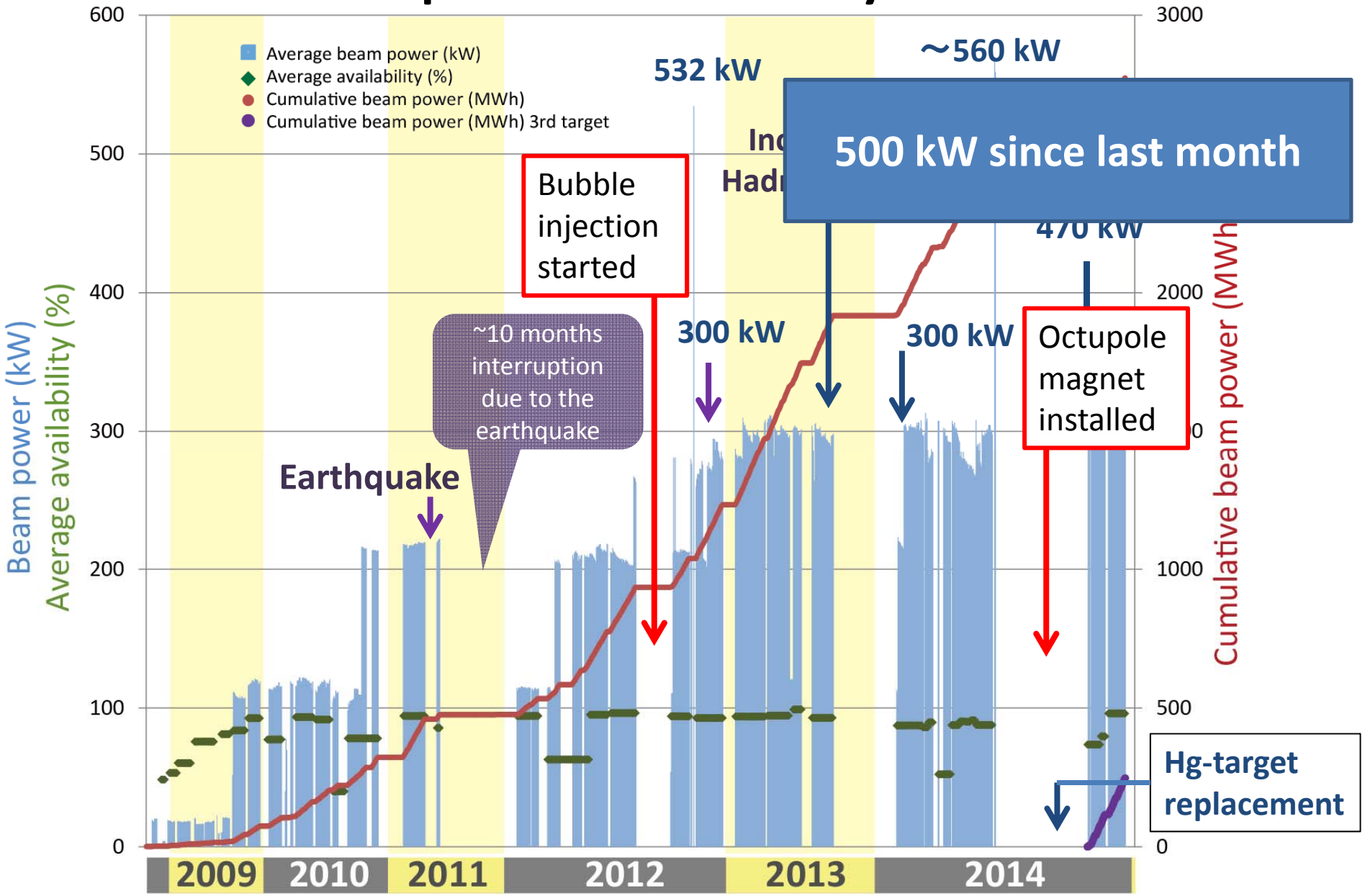
Beam was flattened
To reduce the power density

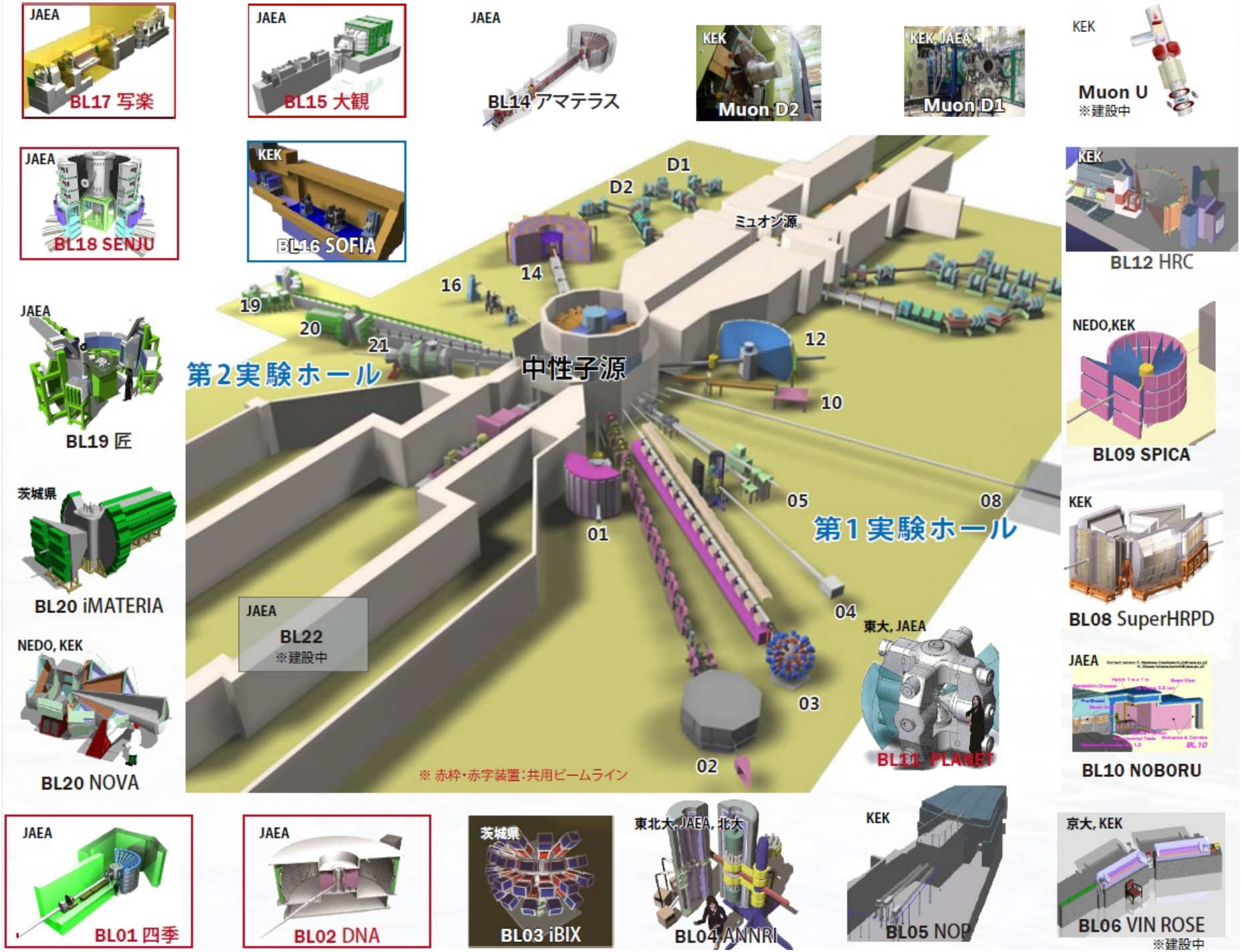
Vibration on the target container



Time after proton bomberdment (ms)

Beam power history at MLF




JAEA
BL17 写楽
JAEA
BL15 大観
JAEA
BL14 アマテラス
KEK
Muon D2
KEK, JAEA
Muon D1
KEK
Muon U
※建設中
JAEA
BL18 SENJU
KEK
BL16 SOFIA
KEK
BL12 HRC
D1
D2
ミュオン源
14
16
19
20
21
第2実験ホール
中性子源
12
10
JAEA
BL19 匠
NEDO,KEK
BL09 SPICA
茨城県
BL20 iMATERIA
05
08
第1実験ホール
01
KEK
BL08 SuperHRPD
JAEA
BL22
※建設中
04
東大, JAEA
NEDO, KEK
BL20 NOVA
03
JAEA
BL10 NOBORU
※ 赤枠・赤字装置：共用ビームライン
02
BL11 PLANET
JAEA
BL01 四季
JAEA
BL02 DNA
茨城県
BL03 iBIX
東北大, JAEA, 北大
BL04 ANNRI
KEK
BL05 NOP
京大, KEK
BL06 VIN ROSE
※建設中

Neutron instruments

18 operation for user program

4 powder diffraction
2 single crystal diffraction
4 inelastic
2 reflectometer
1 SANS
1 stress analysis
1 high pressure

1 imaging
1 fundamental physics
1 nuclear engineering
1 test port

3 commissioning/constructing

BL06 NSE, BL09 powder diffraction, BL23 polarized inelastic

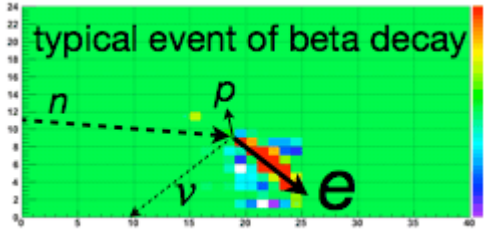
2 beam ports still available

BL05/NOP: Fundamental physics

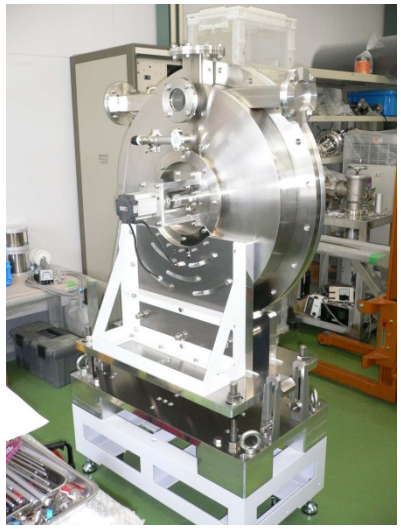
BL05/NOP: Fundamental physics

Neutron lifetime measurement

Detect electrons from neutron decays in flight



UCN

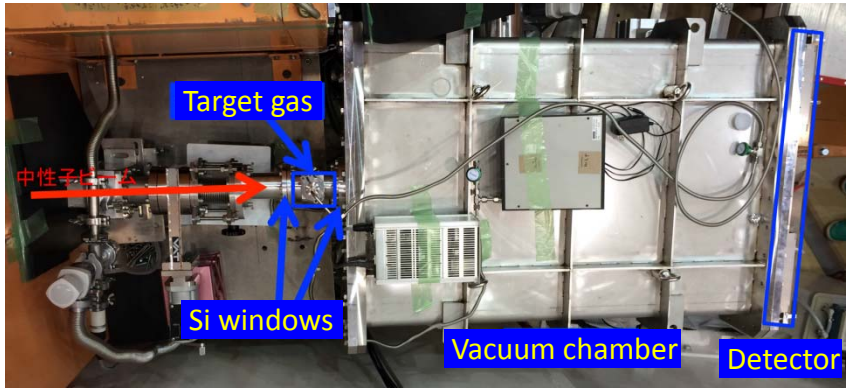


Container material studies

Efficient transportation

Search for LED or new forces

Precise measurements of neutron scattering from rare-gas nuclei

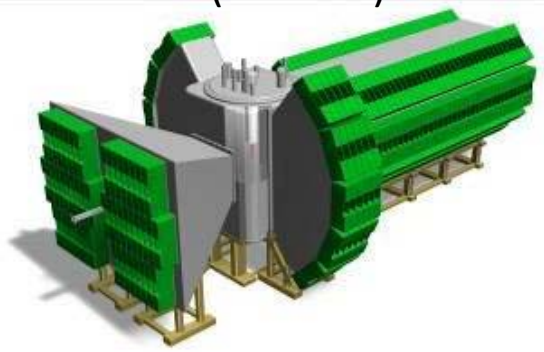


Interferometry, crystal EDM, etc.

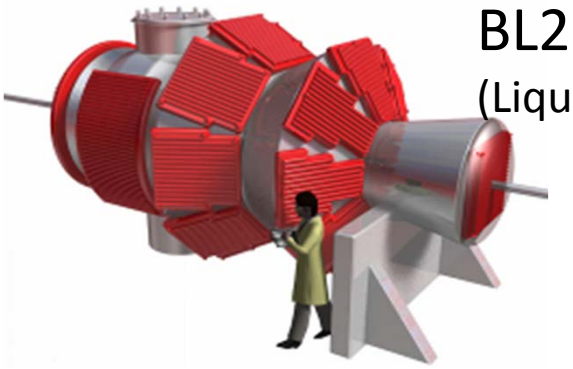
Covering a Very Wide Dynamical Range in one time
(advantage of cold source with sharp epithermal n. with 25Hz Rep.)

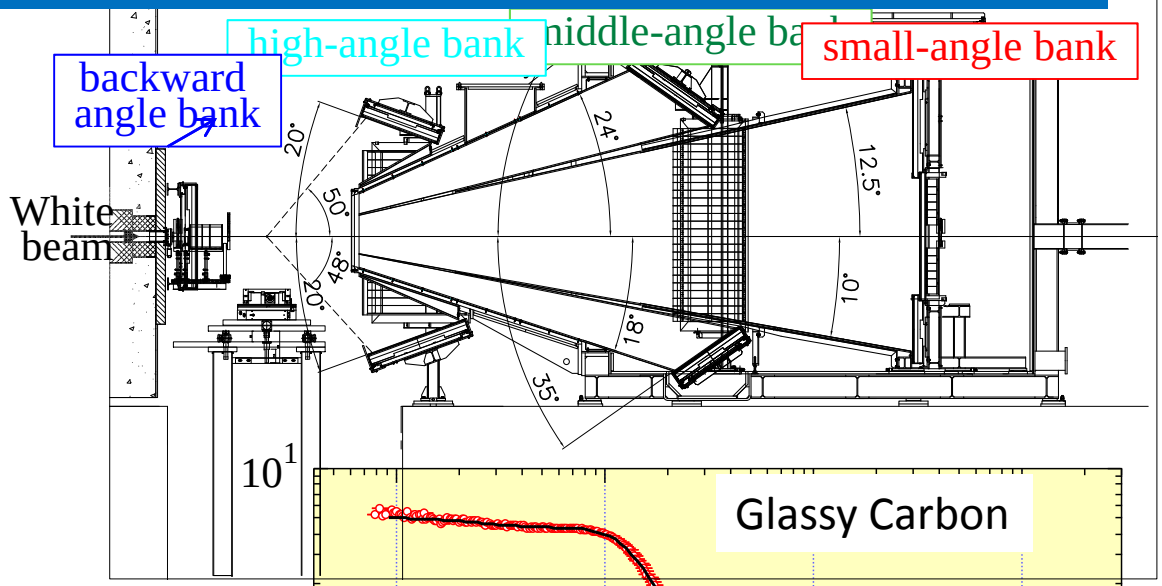
BL15 TAIKAN
(SANS)

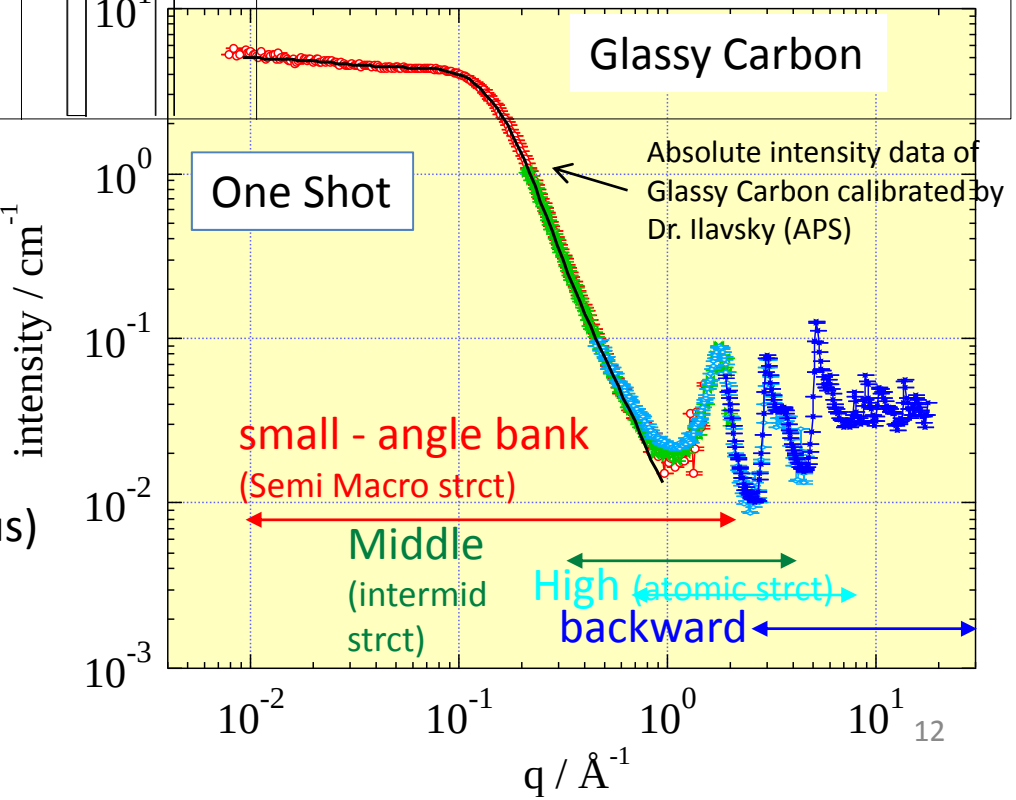
BL20 iMATERIA
(Powder)



BL21 NOVA
(Liquid Amorphous)

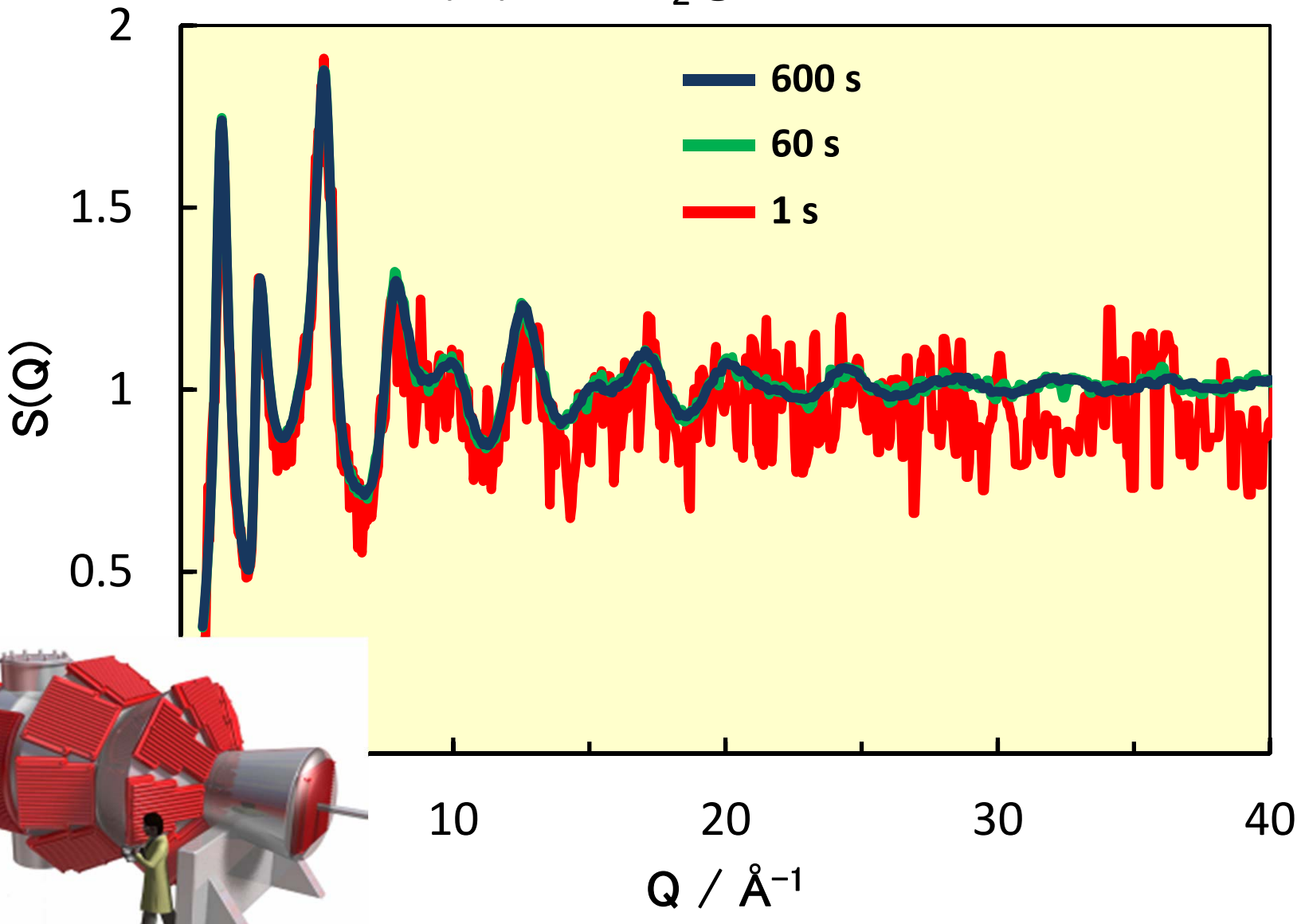




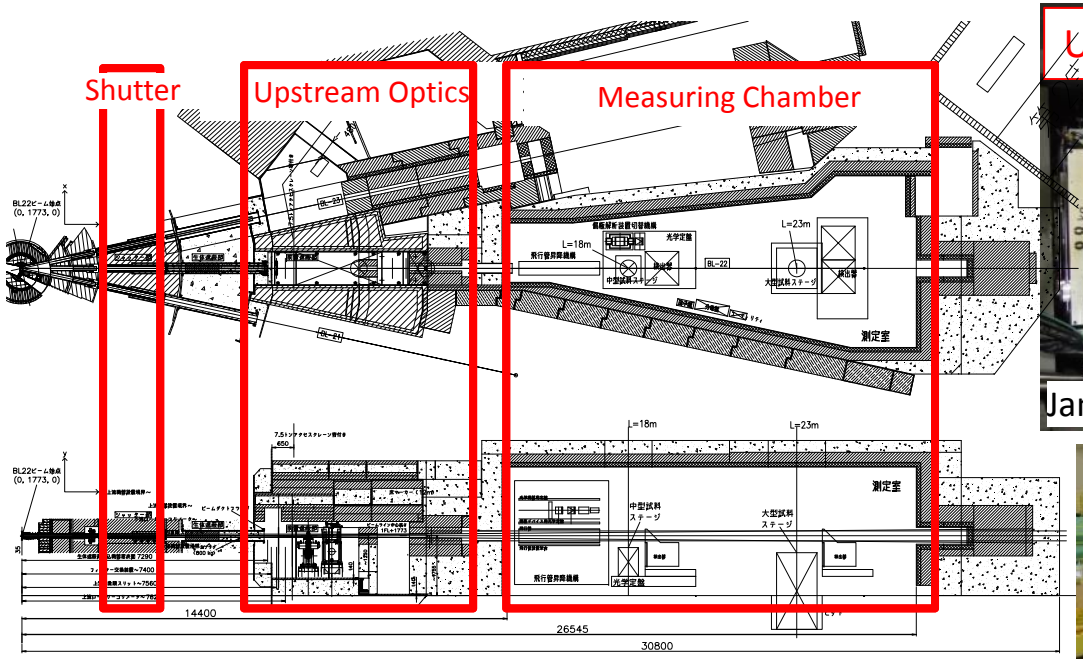


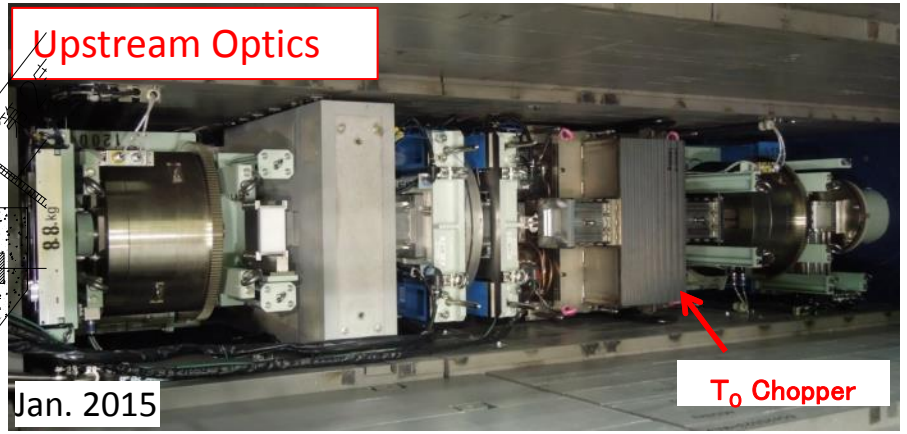
BL21/NOVA

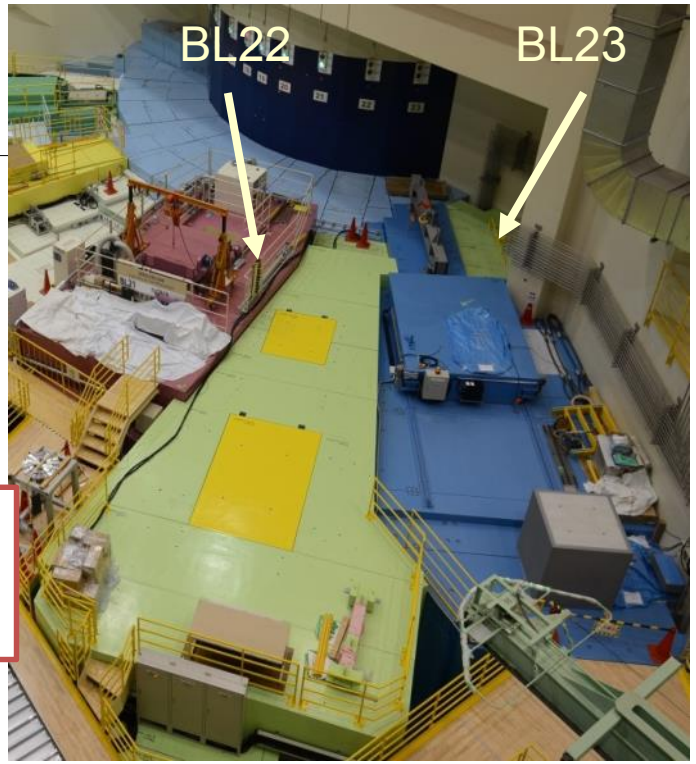
Good statistics in S(Q) of SiO_2 glass at 300kW on NOVA

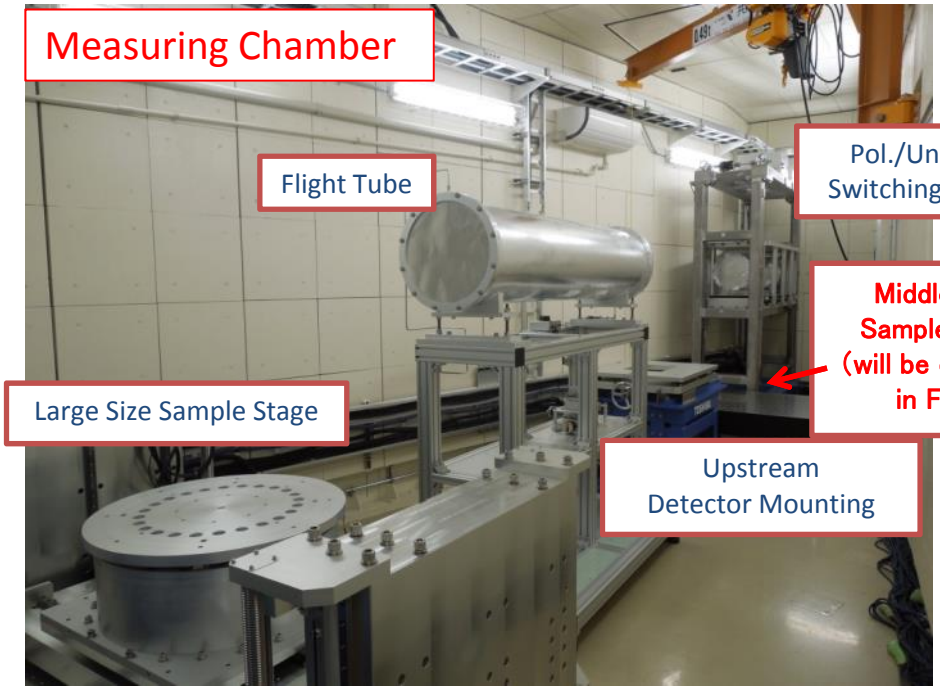


BL22/RADEN: World's first energy selective neutron imaging instrument

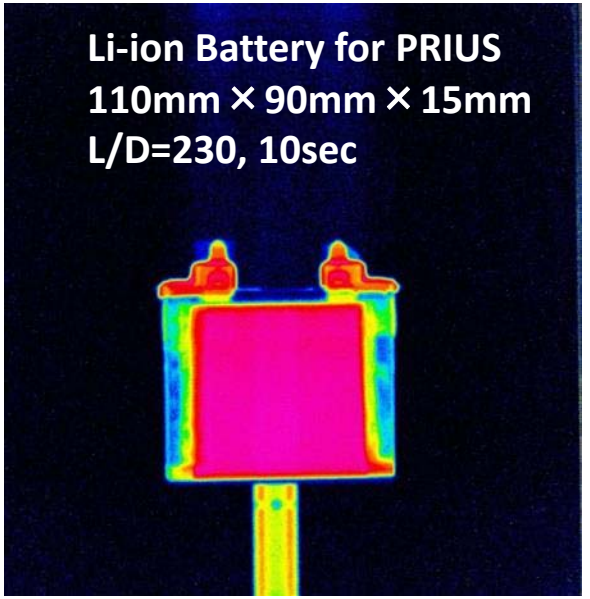




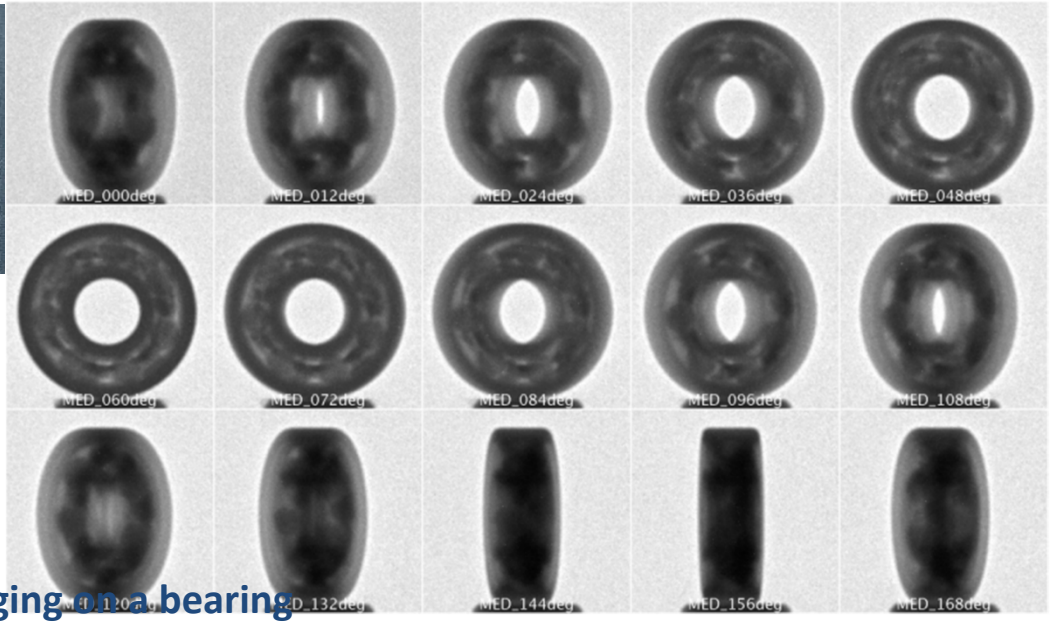


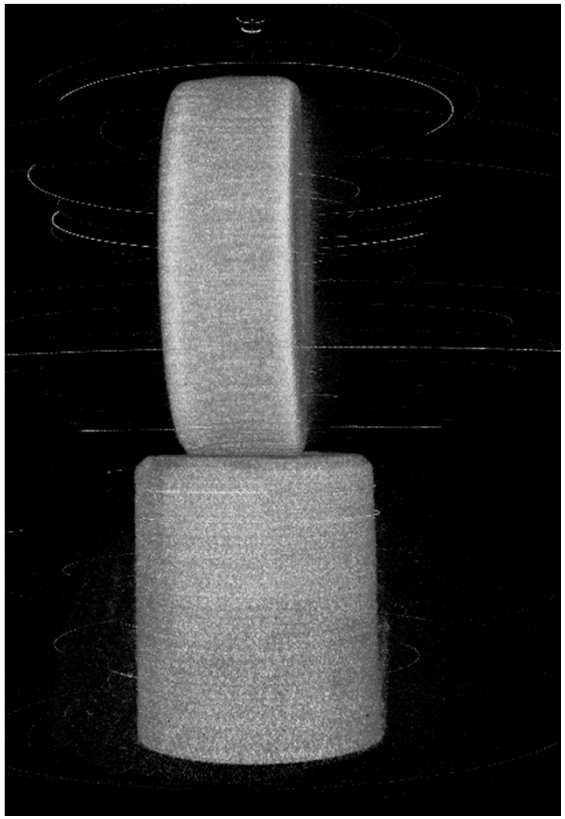


BL22/RADEN: Neutron imaging



Bearing
Diameter
30mm
Thickness
5mm



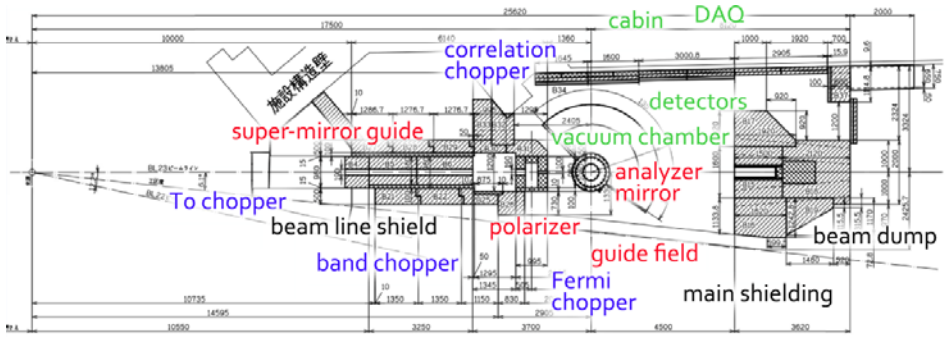


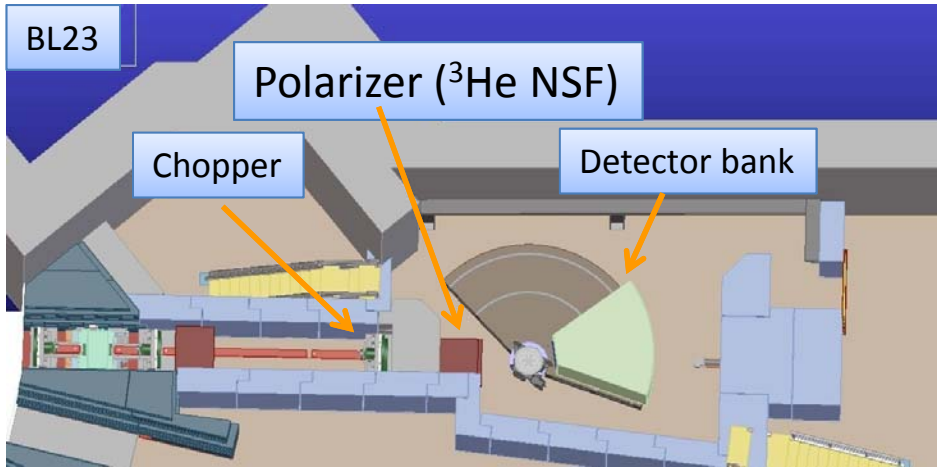
Test of CT imaging on a bearing
L/D=398, Meas. time: 90 sec. per step, Step: 1deg., Span: 180deg.

BL23/POLANO: Polarization Analysis Spectrometer

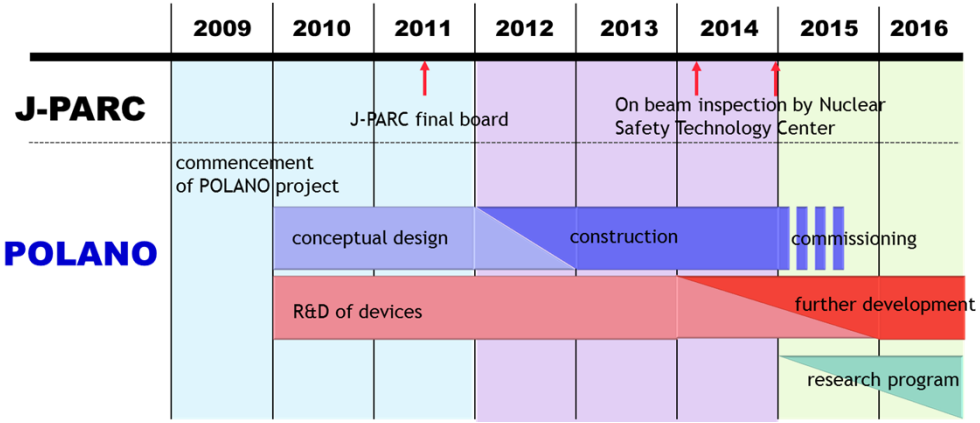
- Chopper spectrometer with higher flux and middle resolution
- Dedicated spectrometer for polarization analysis
- Will be ready from 2015-

^{3}He neutron spin filter
Supermirror analyzer

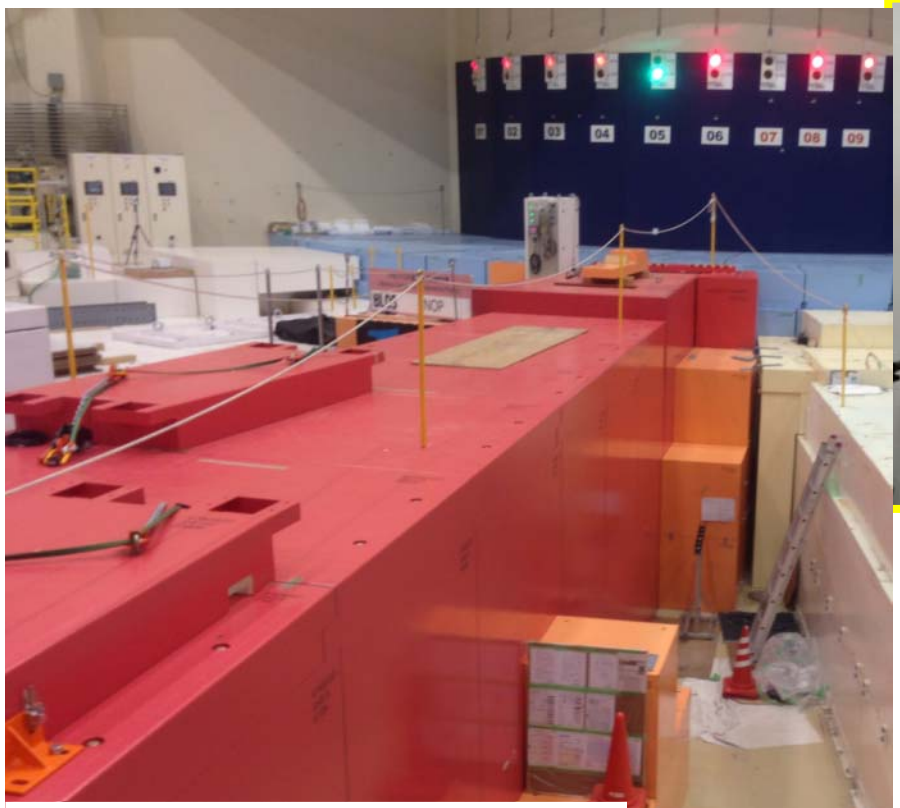




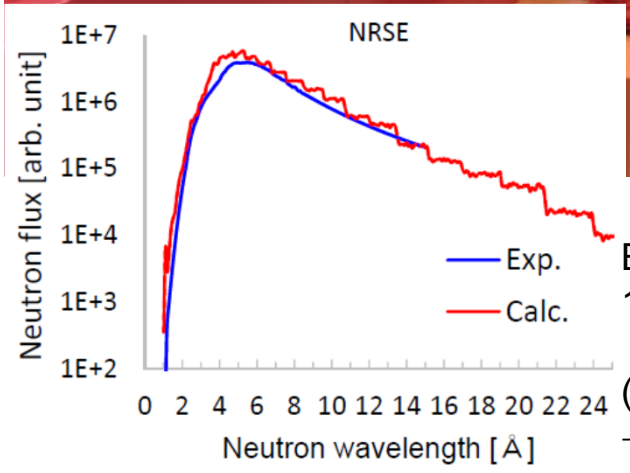
POLANO Specifications	
moderator	decoupled (BL23)
L1, L2, L3 [m]	17.5, 2.0, 1.85
scattering angle [deg]	-8° (-25°)<ver<8° (25°)
	-20° <hol< 130°
sample size	2cm × 2cm
resolutions	ΔE/Ei=4%(@E=0) and ΔQ/ki=2%



BL06/VIN-ROSE: Neutron spin echo



MIEZE: Polarized neutrons have been achieved.
(➔NSE signal will be tested as a next step.)
NRSE: Outer magnetic field has been evaluated.



December 2014

Beam Flux:
1.9×10^8 n/cm^2/s
@ z=22.9m
(275 kW)
→81%@calc.

Soller slit polarizer

Total reflection angle:
80mrad@MIEZE,
120mrad@NRSE

Double reflection:
Soller type:
30x60x0.6mm 4x2@MIEZE
20x60x0.6mm 8x2@NRSE

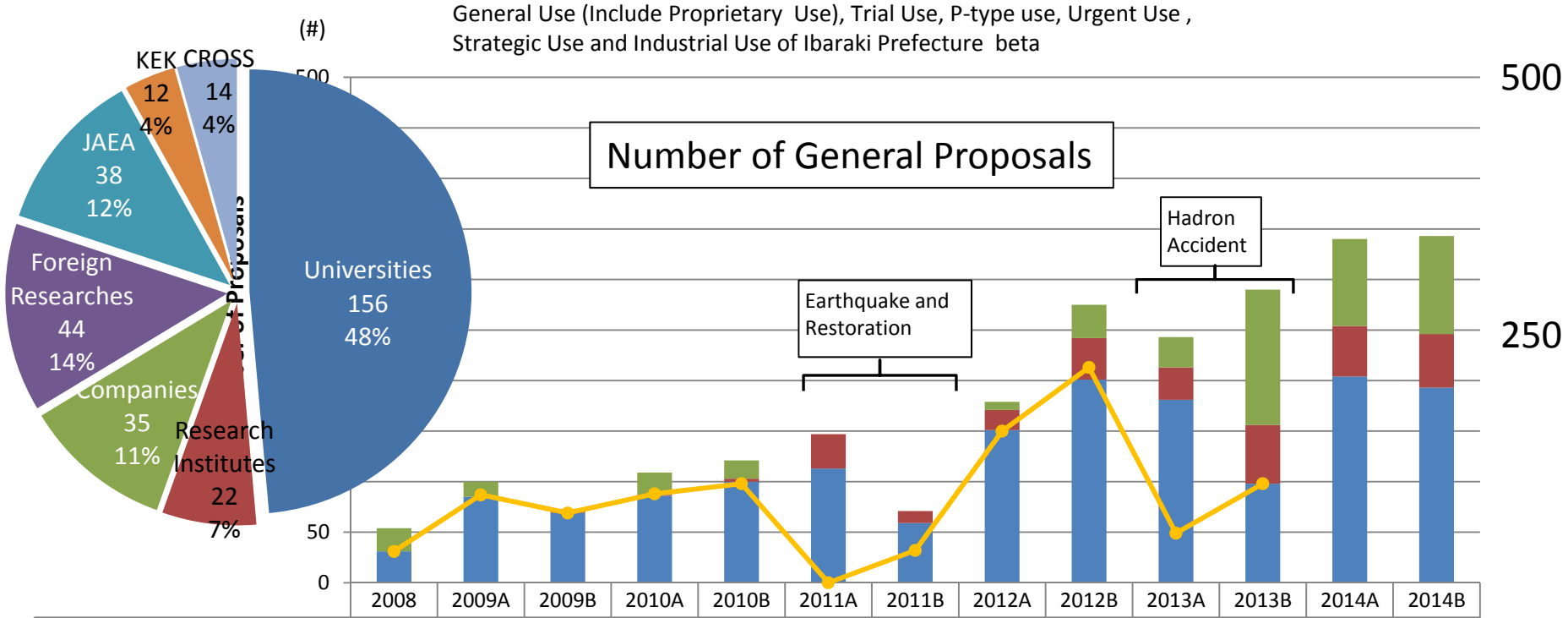
Single reflection:
150x60mm

Pb shielding box coverd with B_4C ruber.
We can open the Pb lid by hand

USER PROGRAM

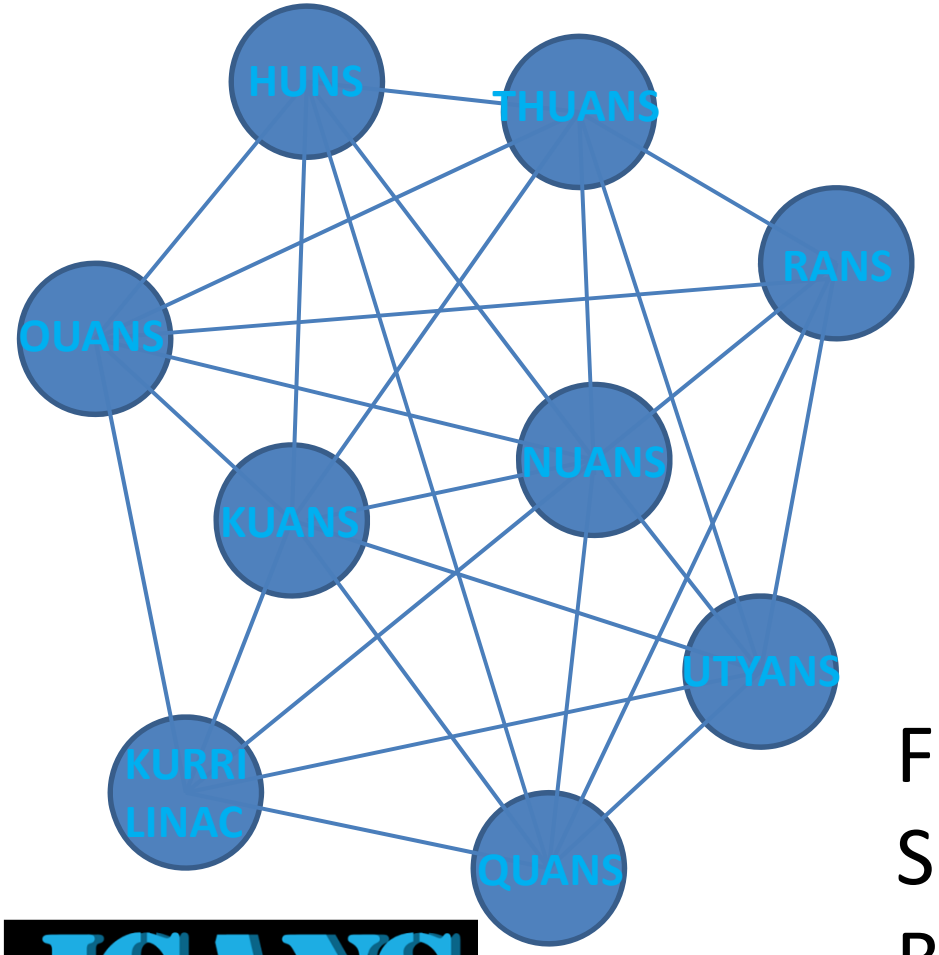
General Proposals to MLF

343 proposals (2014B) -> 193 approved and 53 reserved



	2008	2009A	2009B	2010A	2010B	2011A	2011B	2012A	2012B	2013A	2013B	2014A	2014B
Not Approved Proposals (#)	23	15	0	22	18	0	0	8	33	30	134	86	97
Reserved Proposals (#)	0	0	4	1	3	34	12	20	41	32	58	50	53
Approved Proposals (#)	31	85	69	86	100	113	59	151	201	181	98	204	193
Total Applied Proposals (#)	54	100	73	109	121	147	71	179	275	243	290	340	343
Conducted Proposals (#)	31	87	69	88	98	0	32	150	213	49	98		
Instruments (#)	5	8	9	9	11	12	16	18	18	18	19	19	19
Initially Scheduled BT (days)	32	44	40	50	60	88	44	88	97	96.5	38.5	85	80

J-CANS or J-PARC

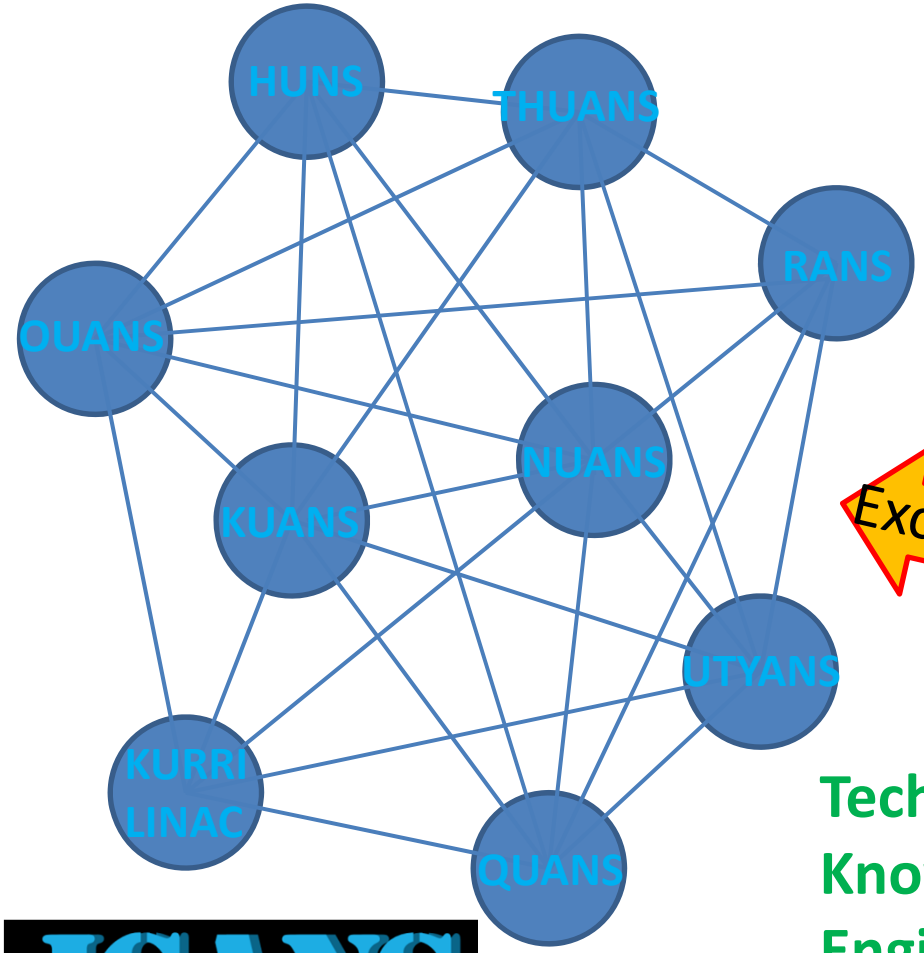


JCANS
Japan Collaboration on Accelerator-driven Neutron Sources

J-PARC

	J-PARC	J-CANS
Flux	👍	
Support	👍	
Beamtime		👍
Flexibility		👍

J-CANS AND J-PARC



JCANS
Japan Collaboration on Accelerator-driven Neutron Sources

Science
R & D
Users

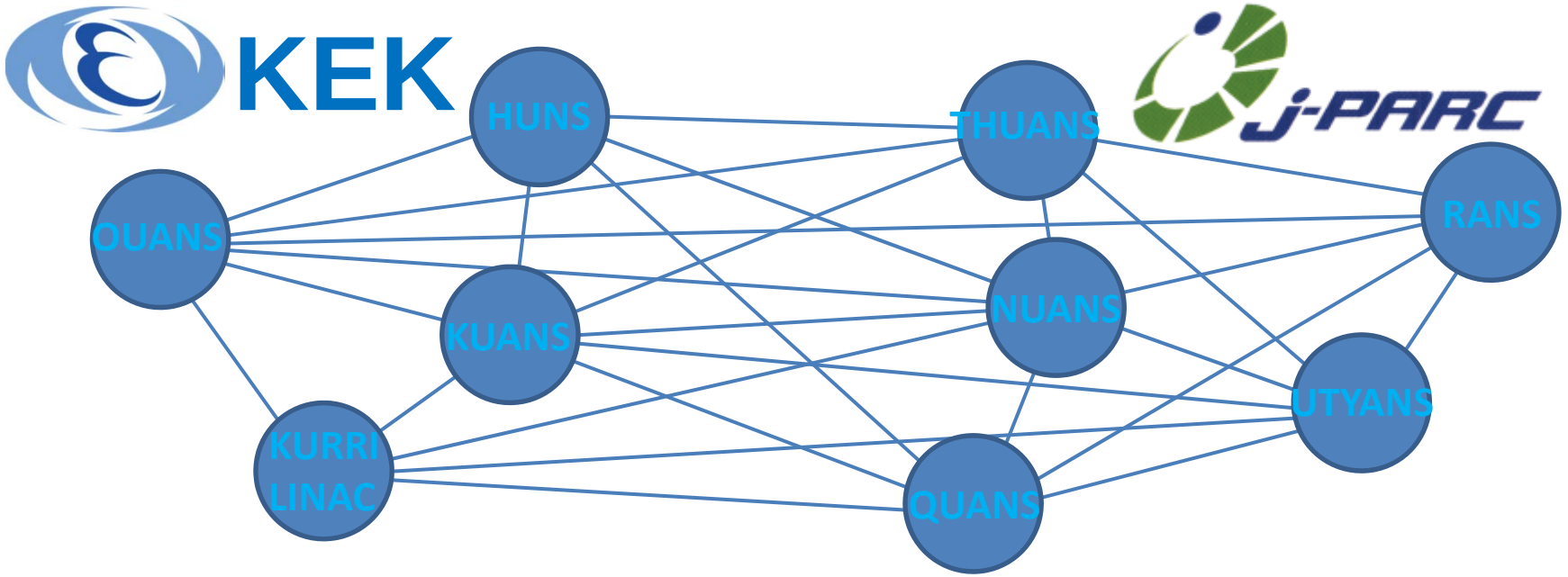
Exchange

J-PARC

Technology
Knowledge
Engineering
Human resources
and more …

Beyond J-PARC

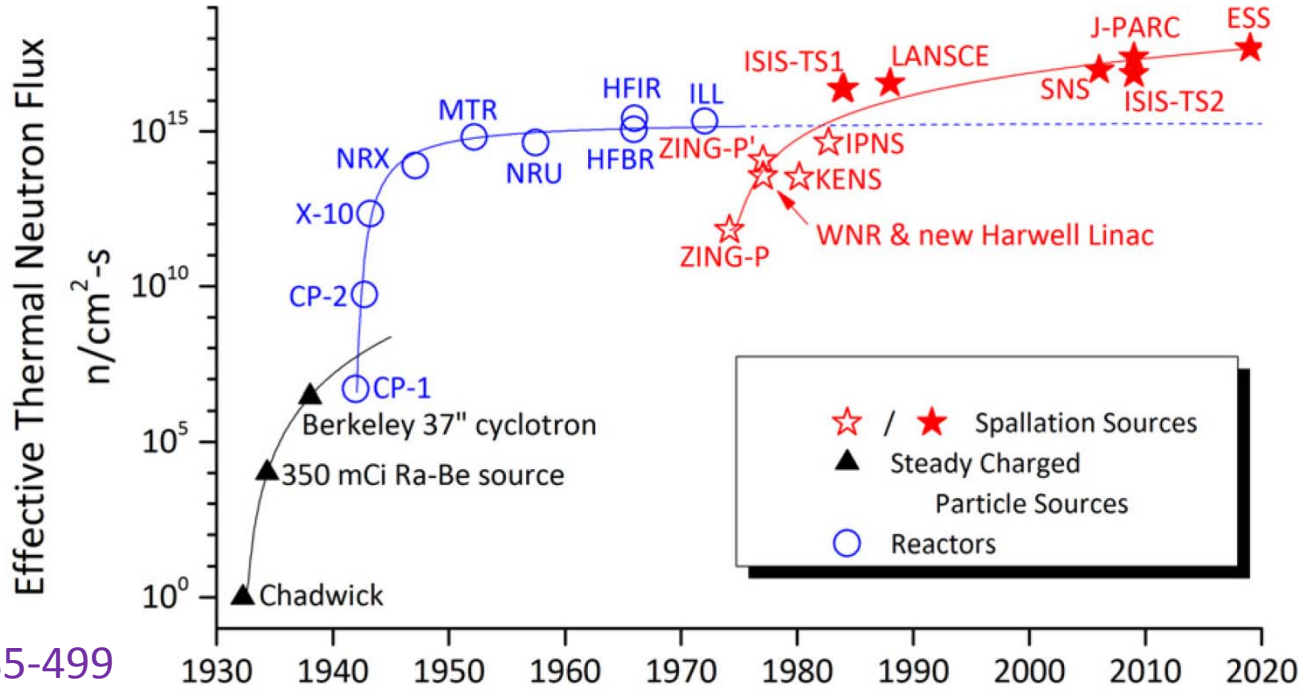
R&D on novel neutron sources
for the next generation neutron science



Human network & infrastructures
expertise, accelerators, science and engineering, ...

Goals beyond J-PARC?

Goals are not necessarily to exceed J-PARC or other MW-class spallation neutron sources.
But to achieve something superior in beam characteristics such as neutron density, pulse structure, polarization, energy, efficiency, clean/green,
… something new!

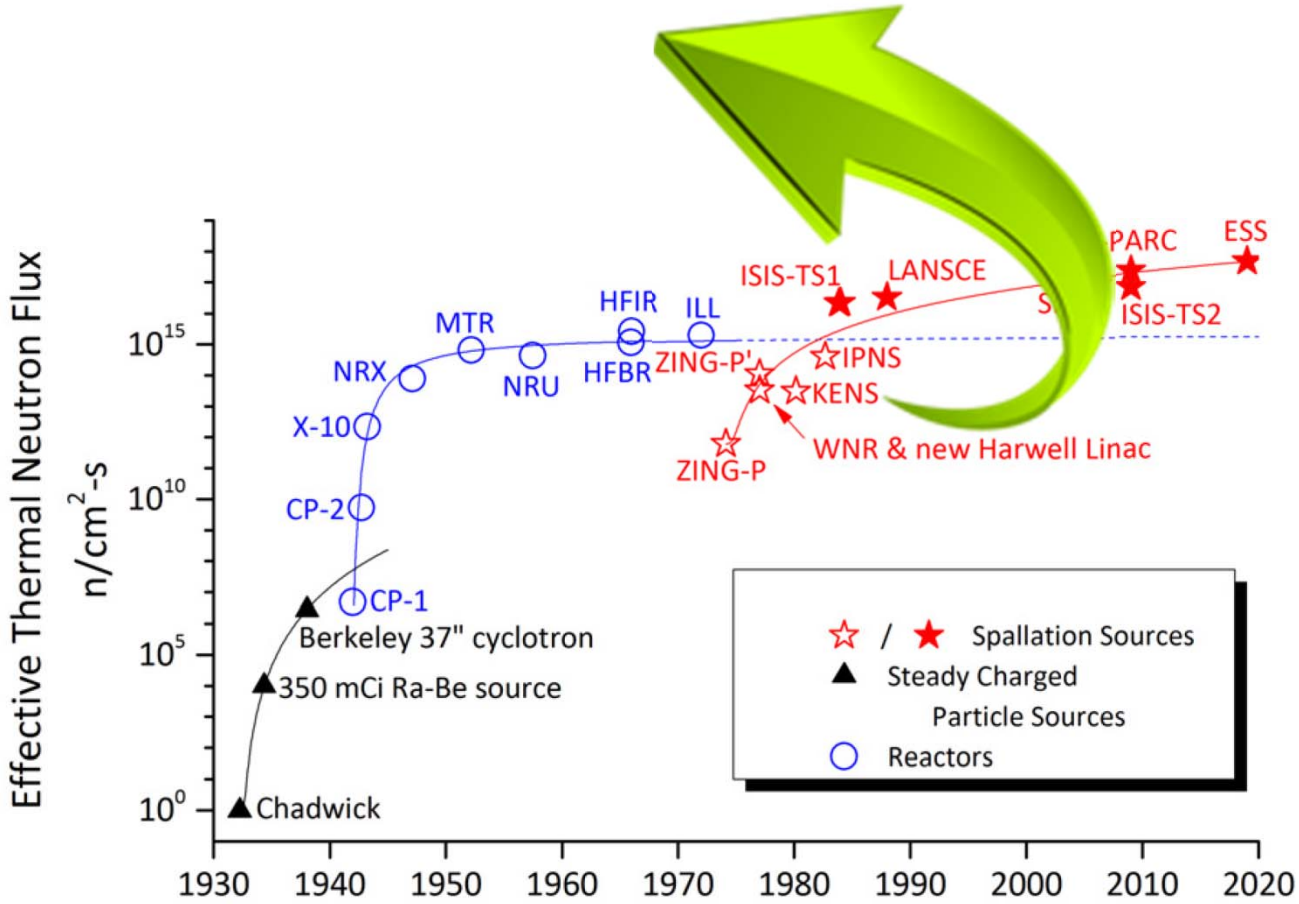


D. Habs *et al.*,
Appl. Phys. B (2011) 103: 485-499

Goals beside J-PARC

To the different dimensions

Laser-fusion ?
Neutron halo
isomers ?
Dense UCN ?
or …



Summary

- The J-PARC pulsed spallation neutron source operating at a beam power of 500 kW, producing the brightest neutron beams.
- 18 neutron instruments for user program and 3 construction/commissioning.
- Stronger collaboration between J-PARC and J-CANS, studies for next generation neutron sources.