^{3}He neutron spin filters at J-PARC

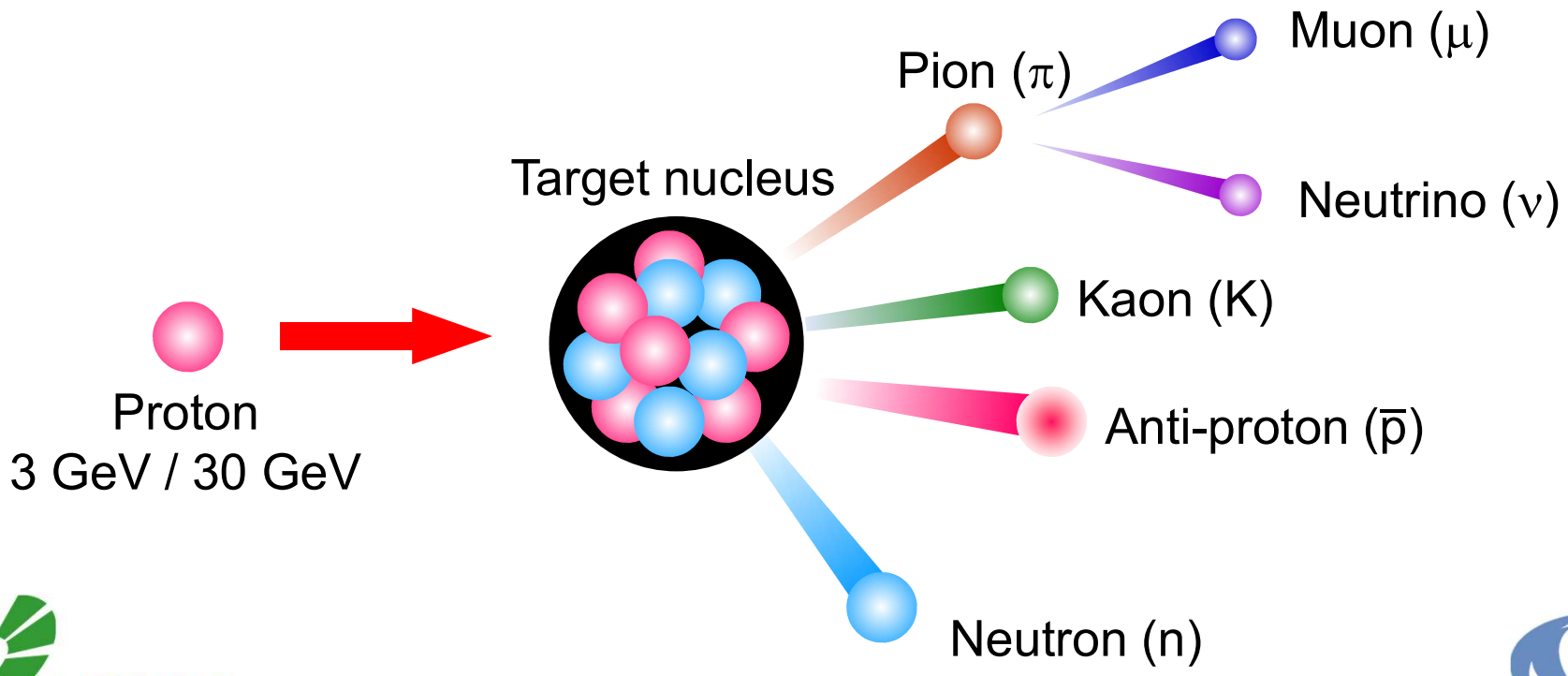
Takashi Ino

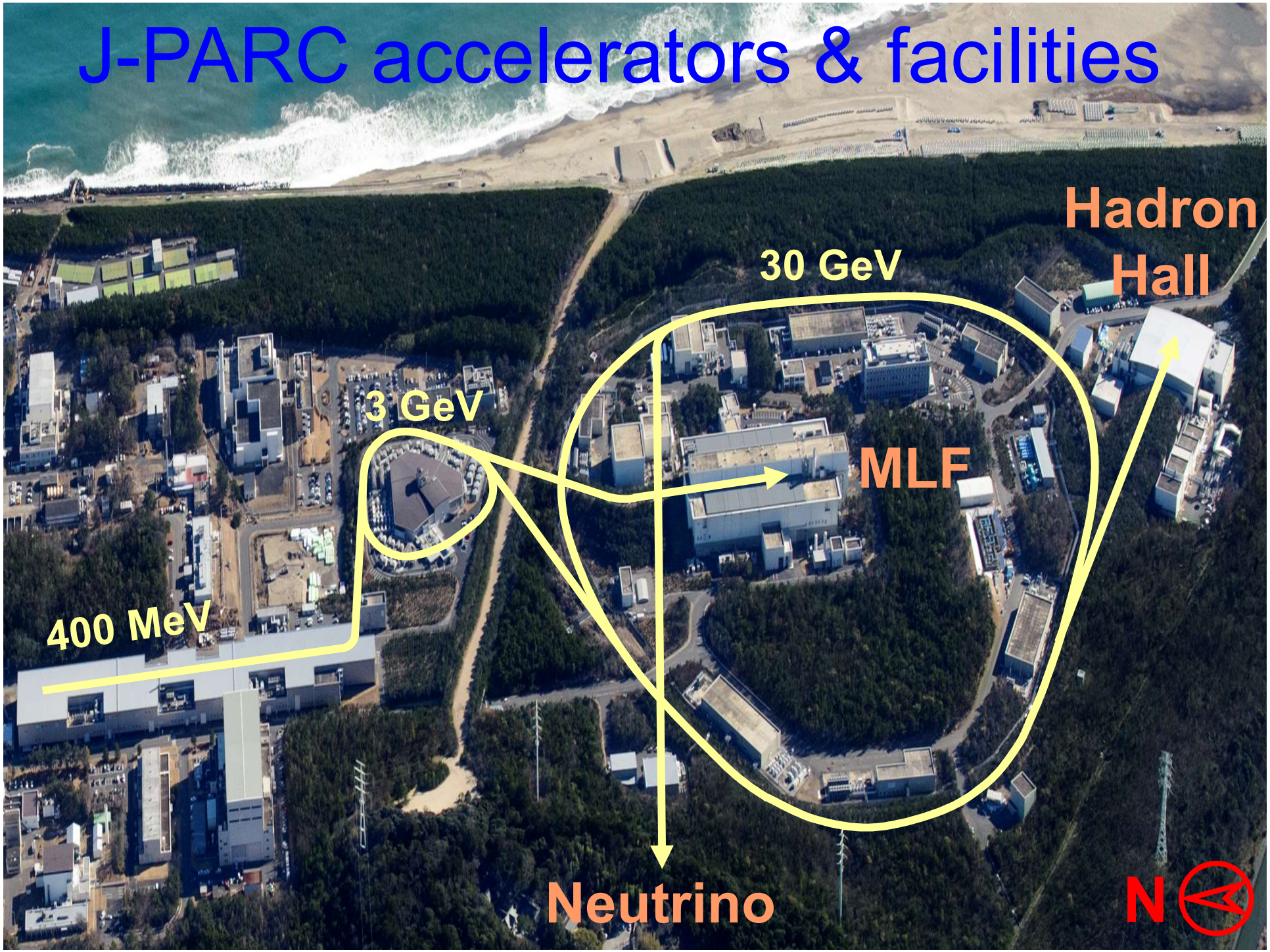
KEK / J-PARC

What's J-PARC?

n, μ, **K**, ν, …

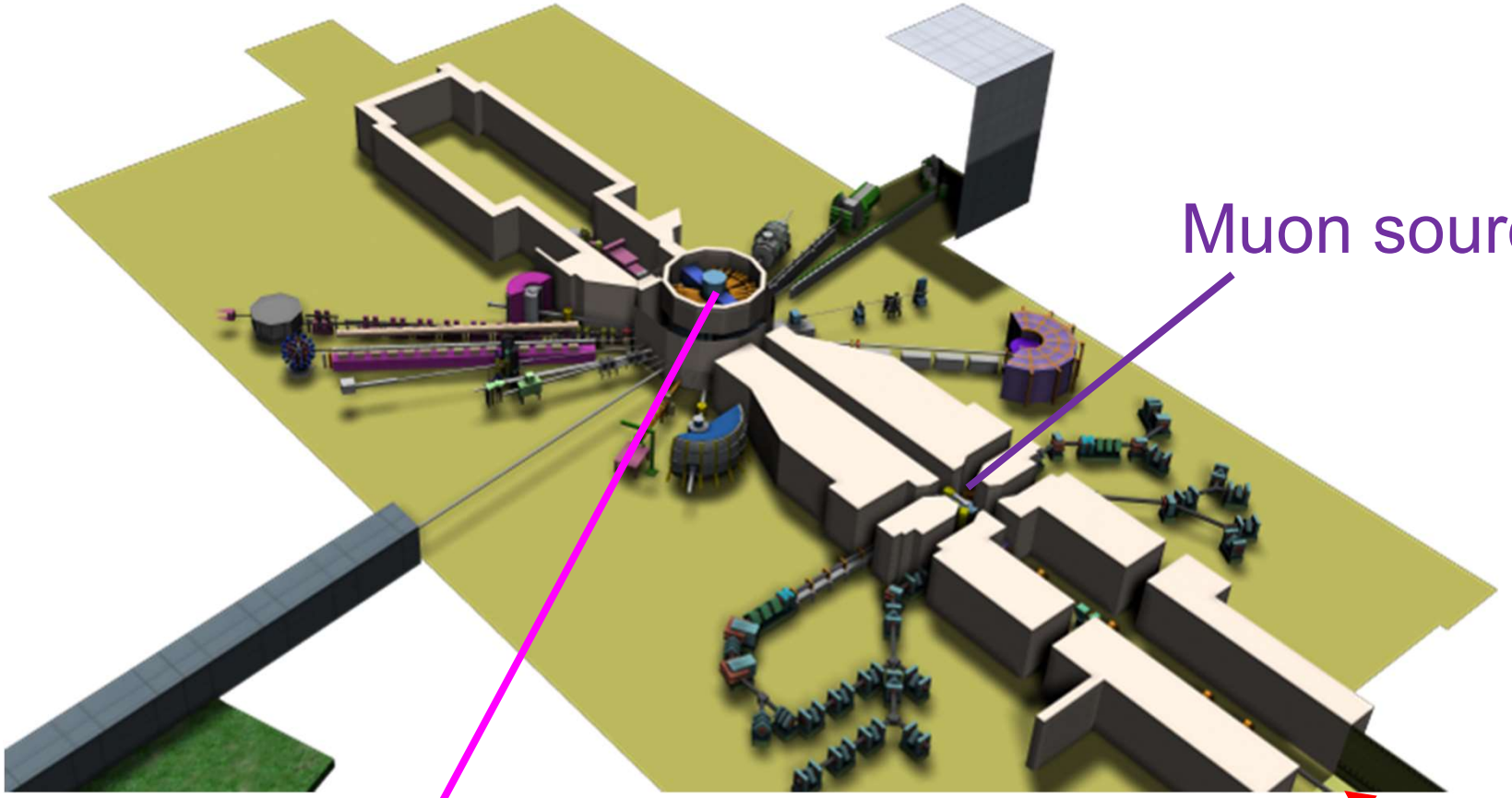
for solid state physics, chemistry,
nuclear physics, particle physics, …



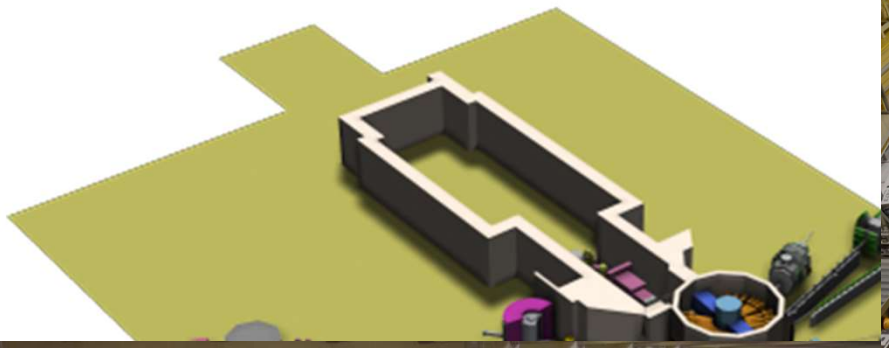

J-PARC accelerators & facilities
Hadron Hall
30 GeV
3 GeV
MLF
400 MeV
Neutrino
N

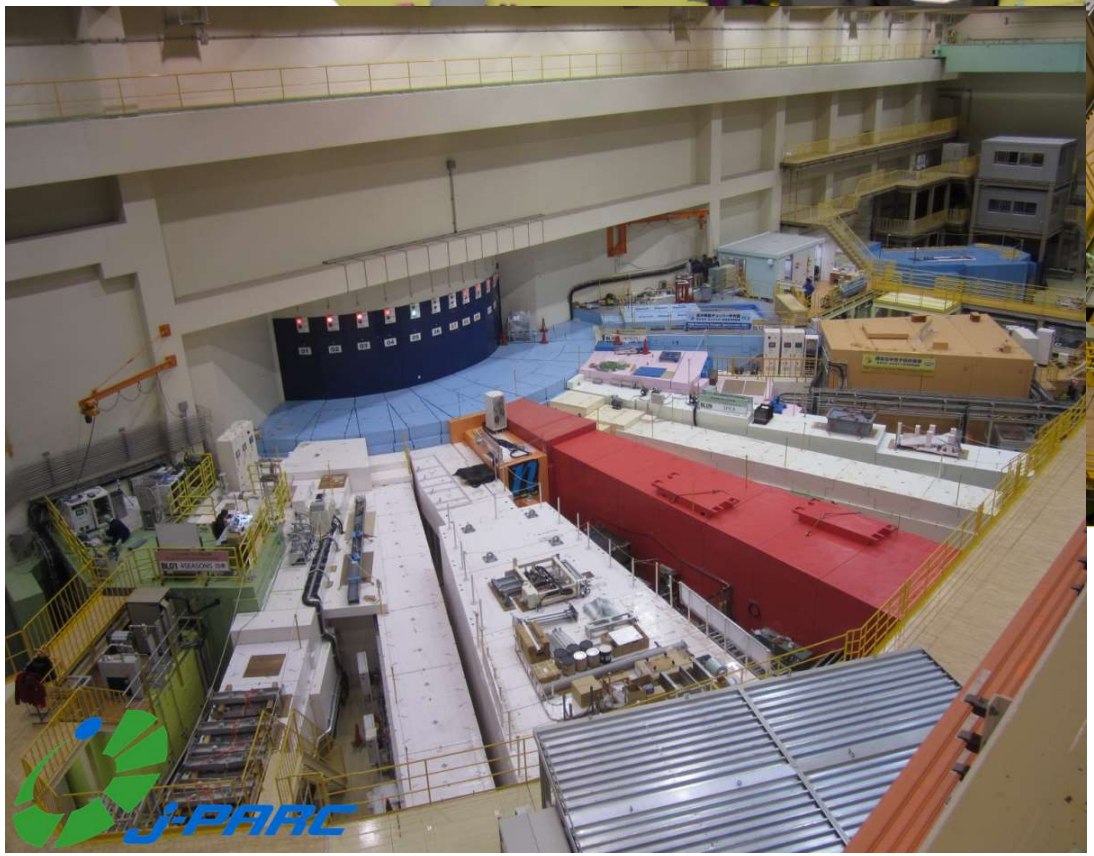
MLF at J-PARC

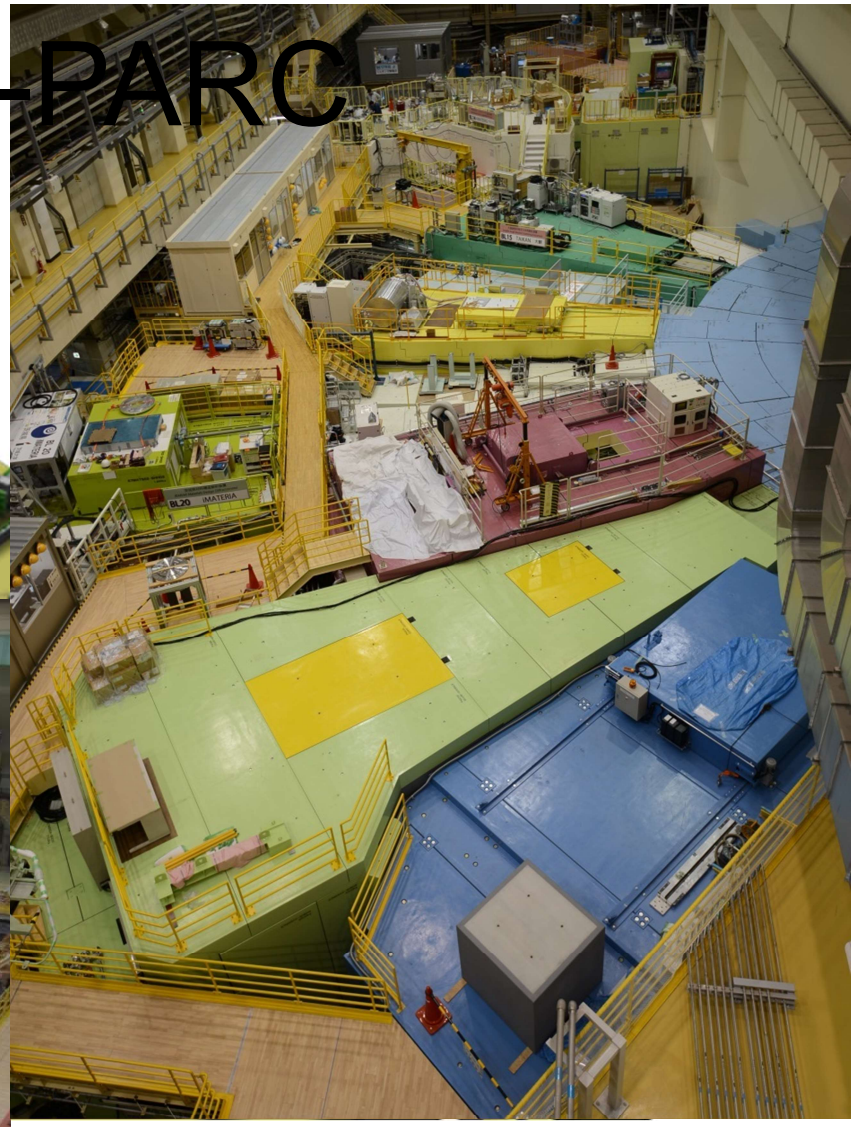
Materials and life science experimental facility



MLF at J-PARC

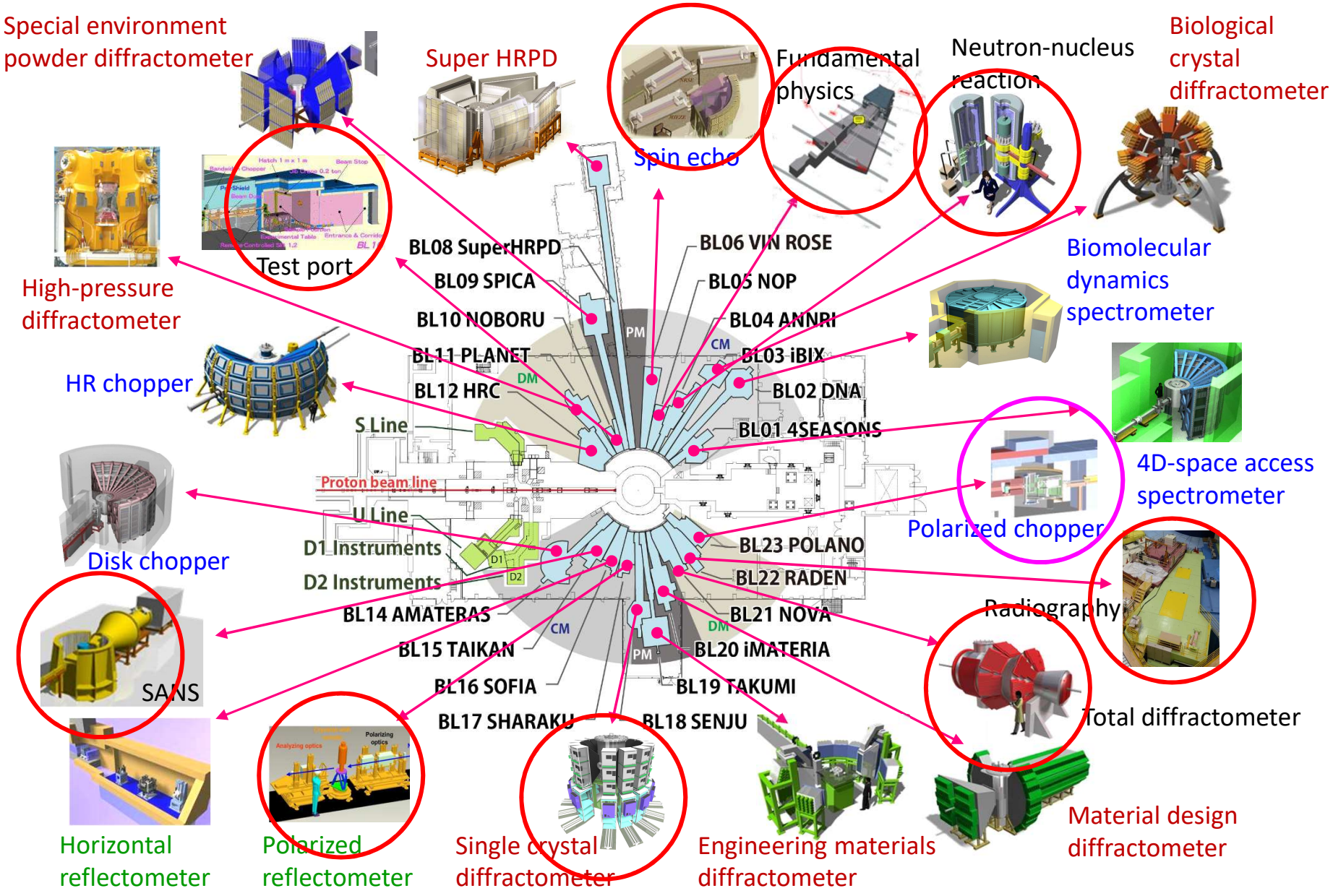






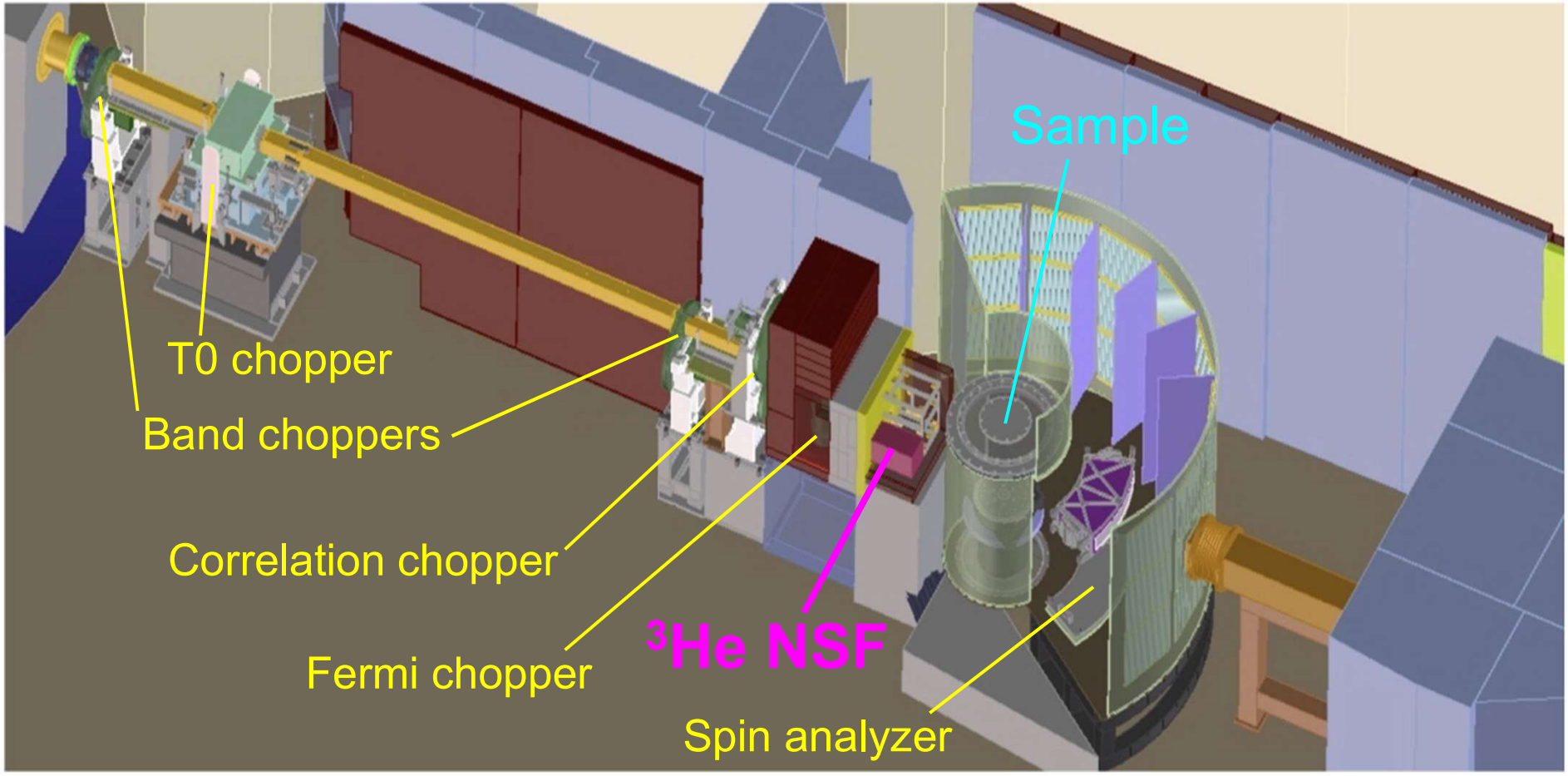
23 neutron beamlines
21 neutron instruments

Neutron instruments in MLF



^{3}He NSF in POLANO

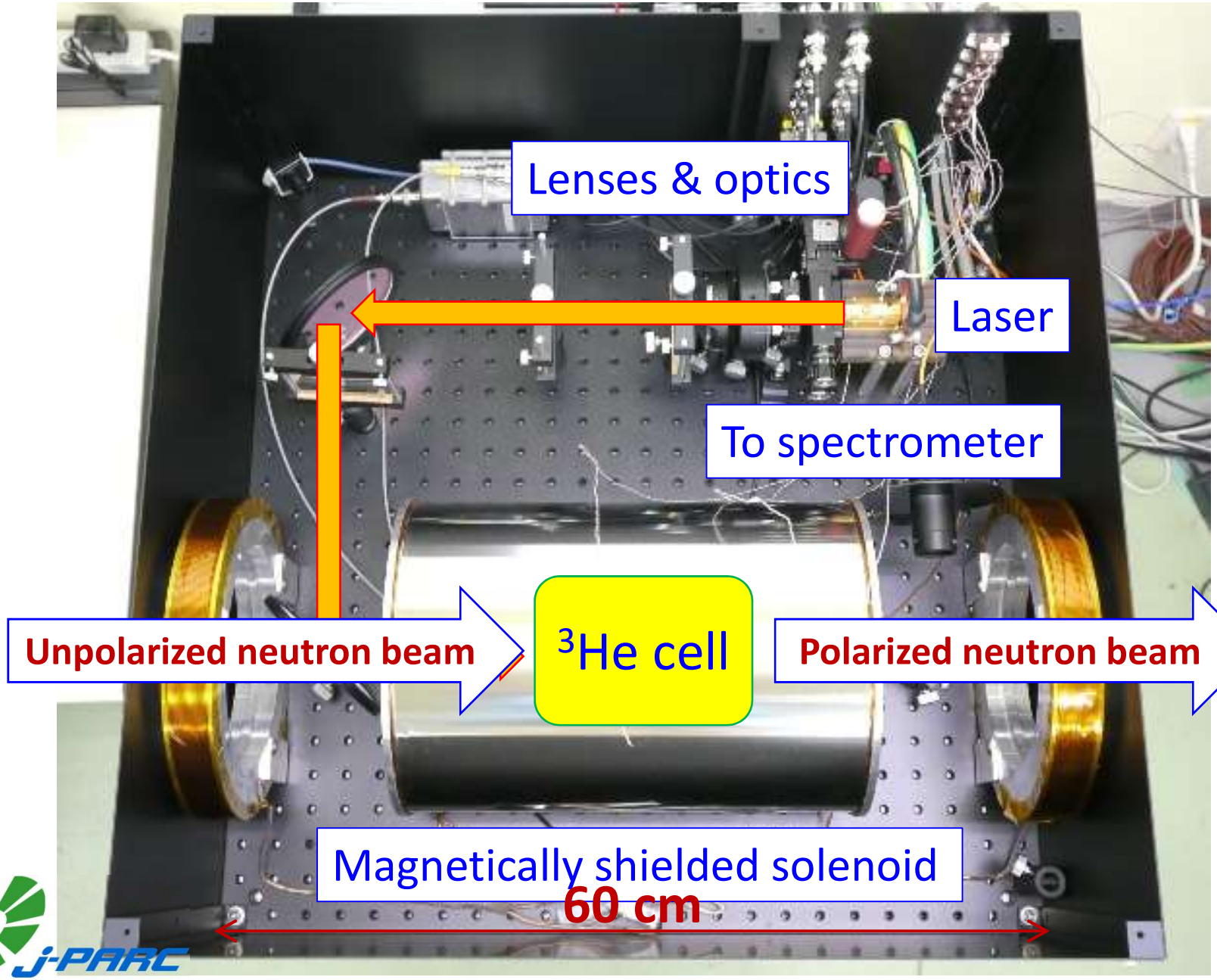
Inelastic scattering spectrometer with polarized neutrons



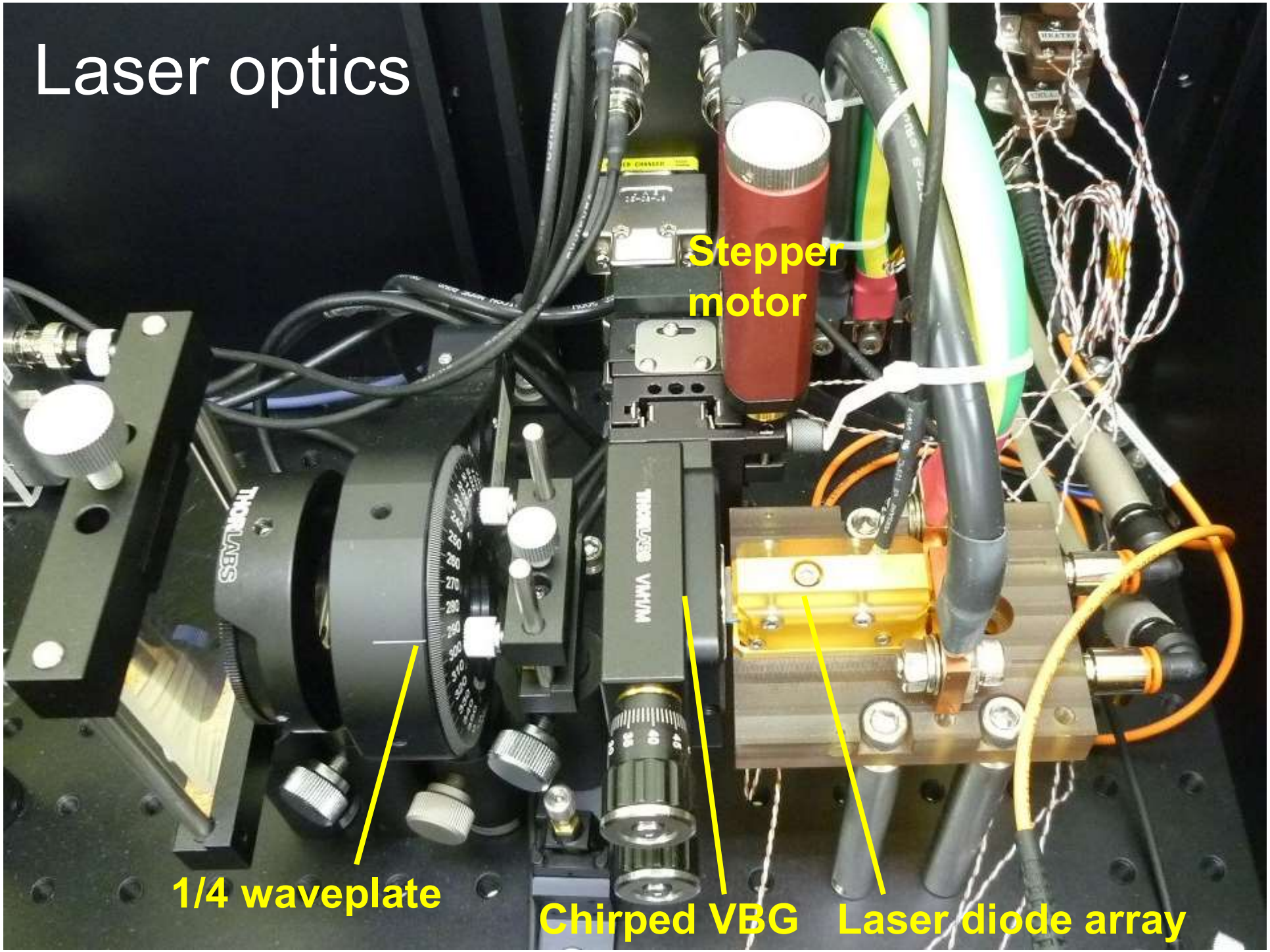
^{3}He NSF in POLANO

- *In-situ* SEOP of ^{3}He
- Incident neutron beam polarization
- AFP spin flip of ^{3}He
- Remotely controlled

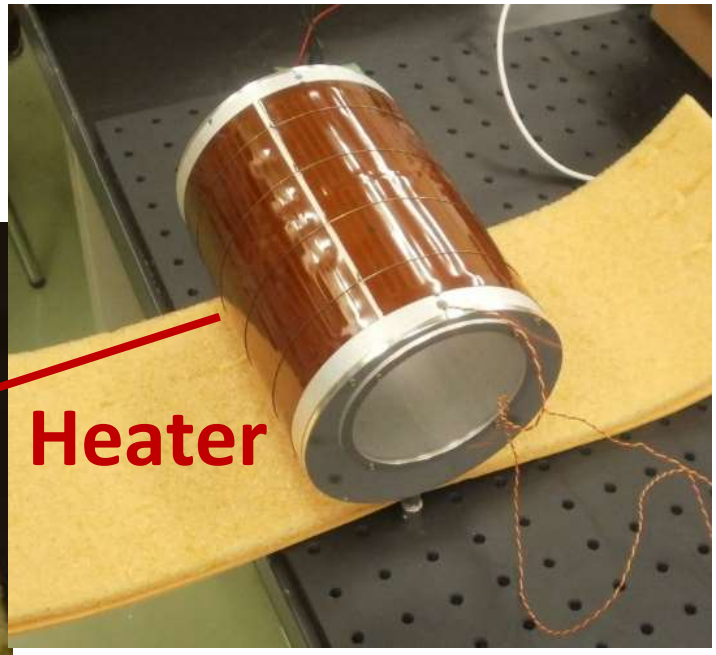
In-situ polarized ^{3}He NSF

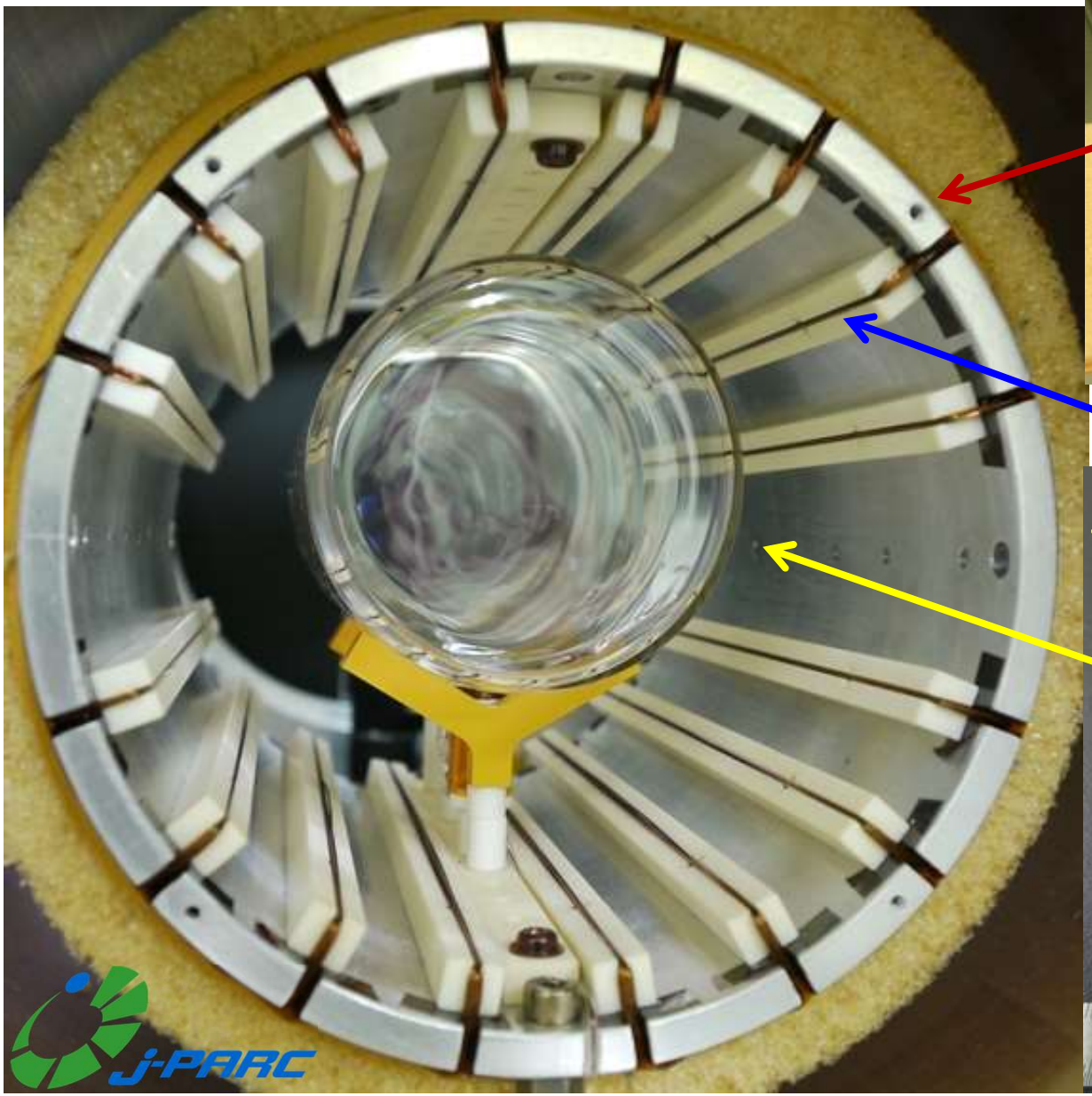


Laser optics



^{3}He cell in oven



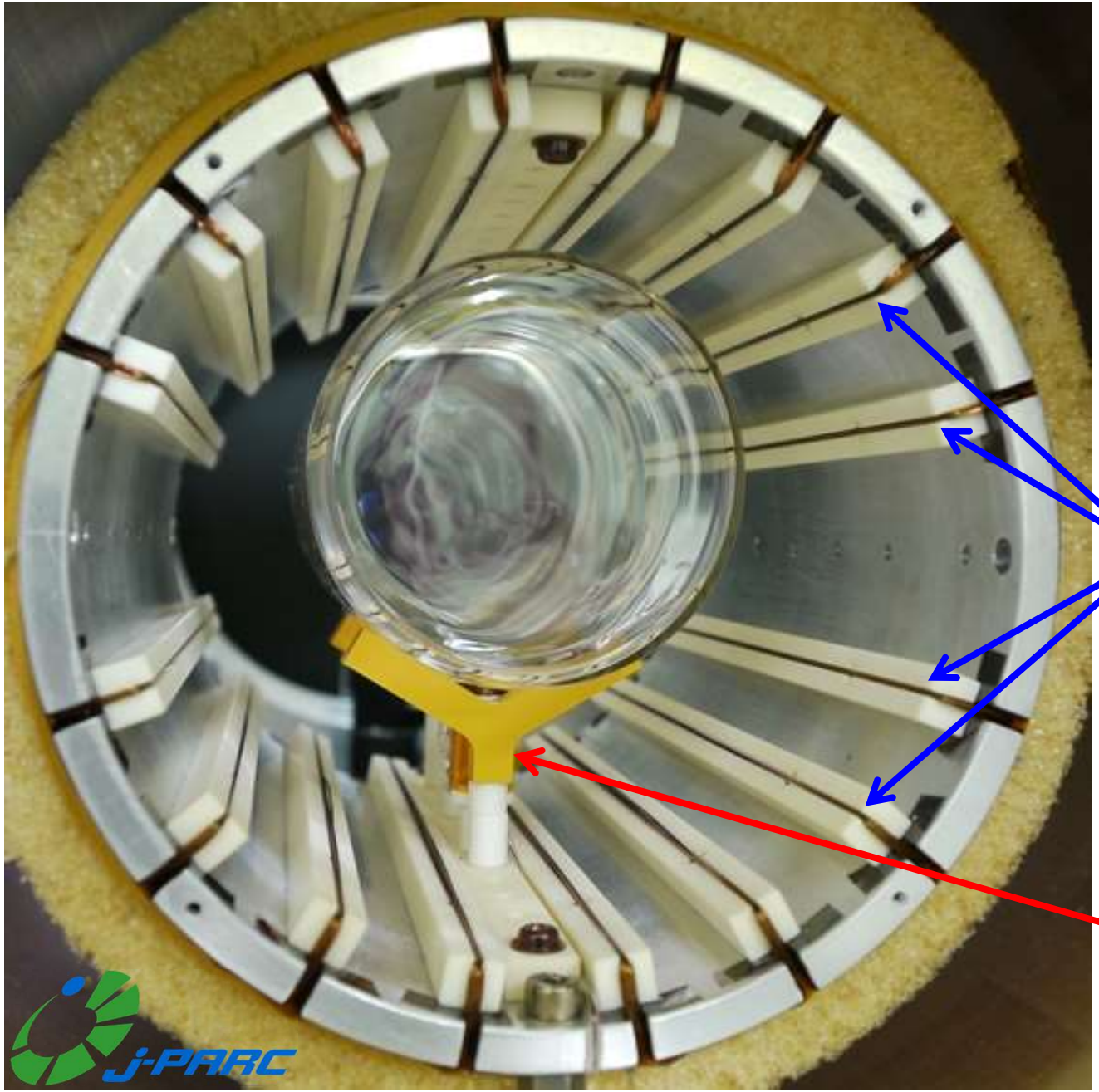


Non-magnetic flexible heater

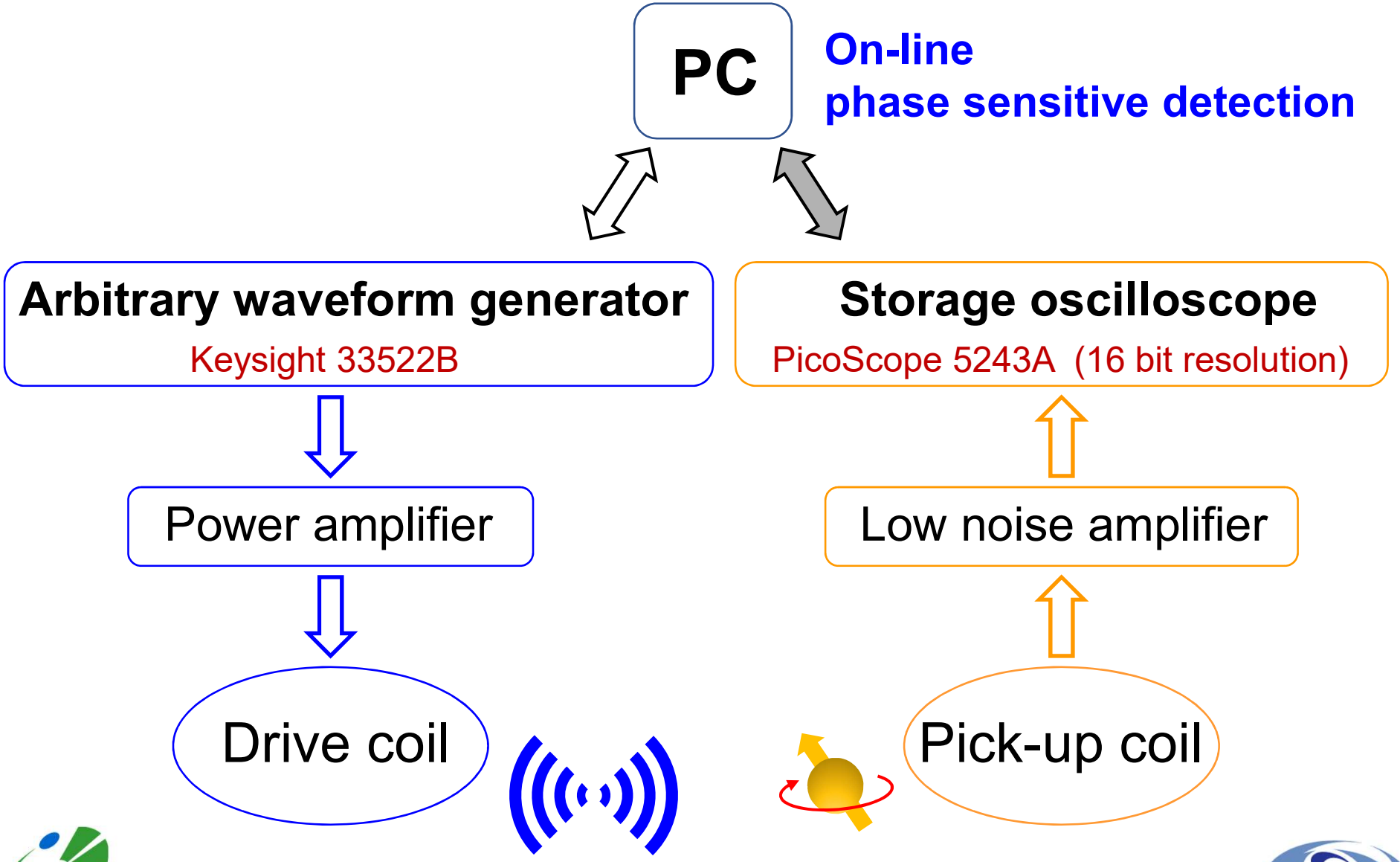
t ~ 0.5 mm

T. Ino *et al.*, Rev. Sci. Instrum. **87**, 115108 (2016)

Frequency-sweep AFP NMR

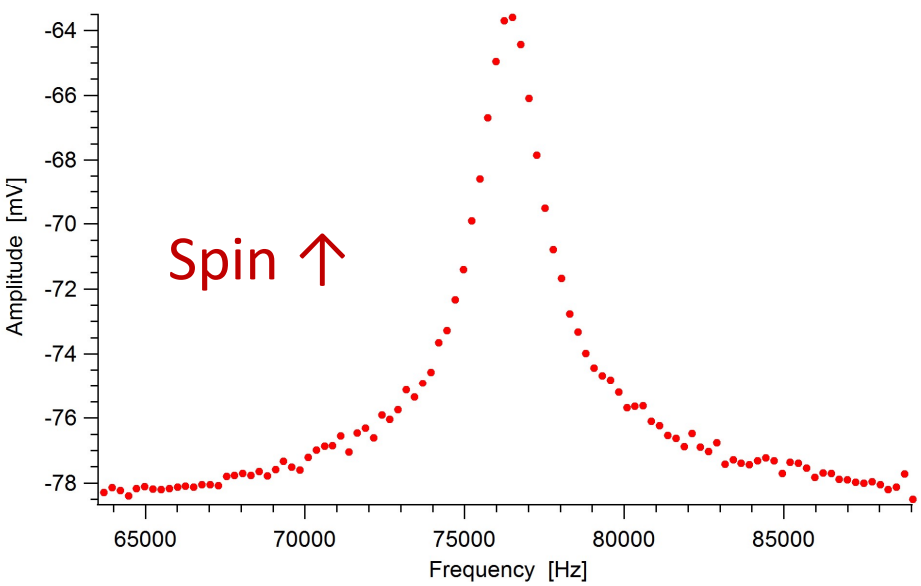


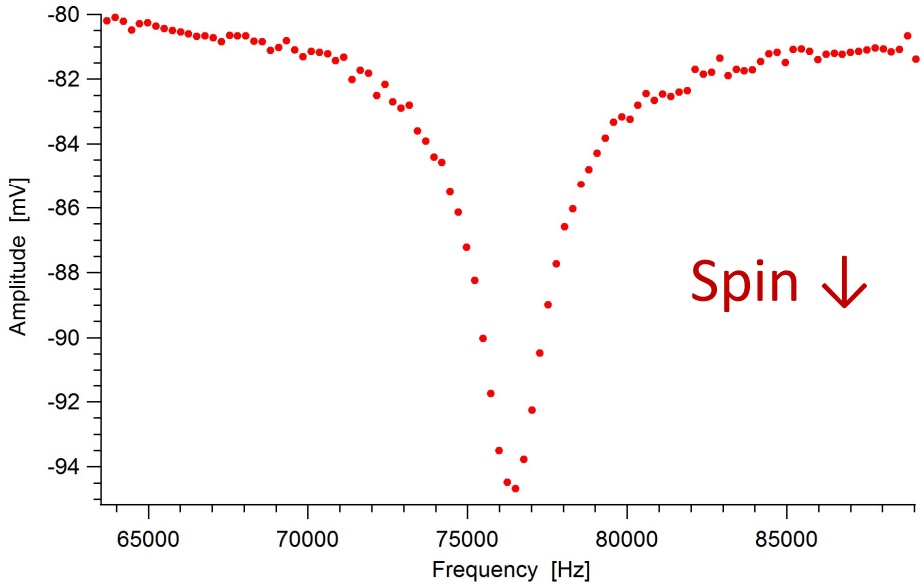
Frequency-sweep AFP NMR

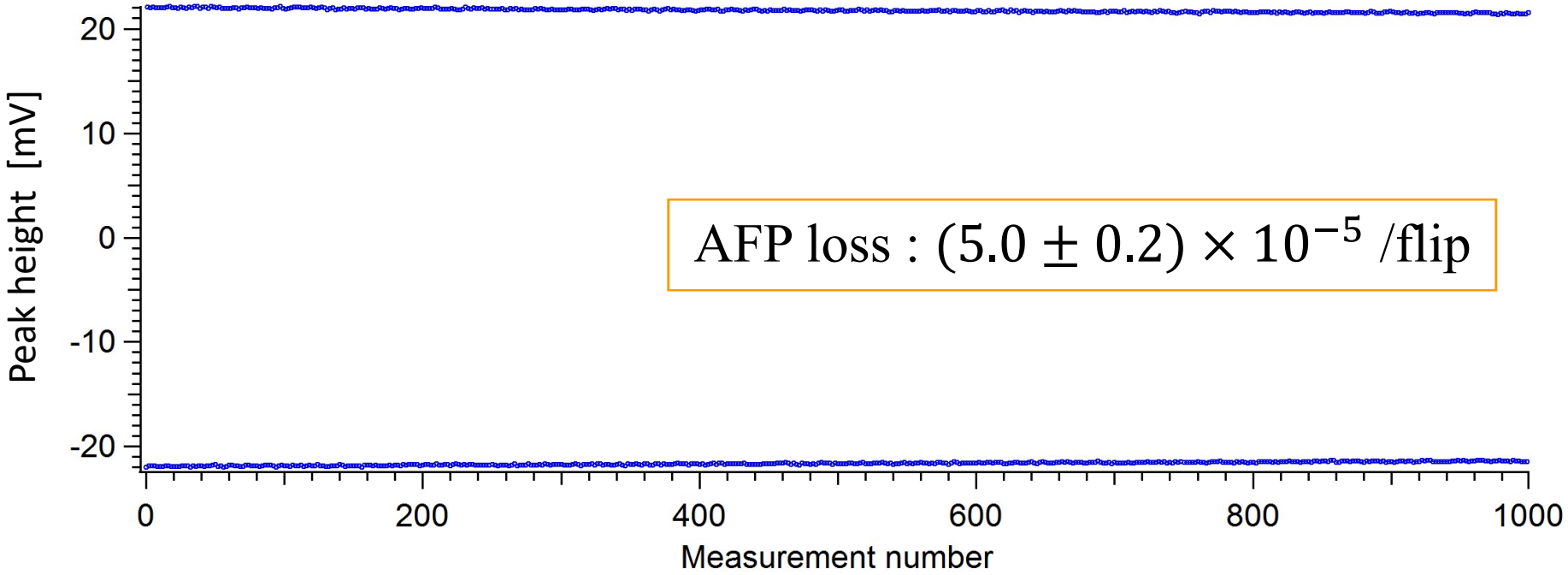


T. Ino, JPS Conf. Proc. **22**, 011016 (2018)

NMR signals





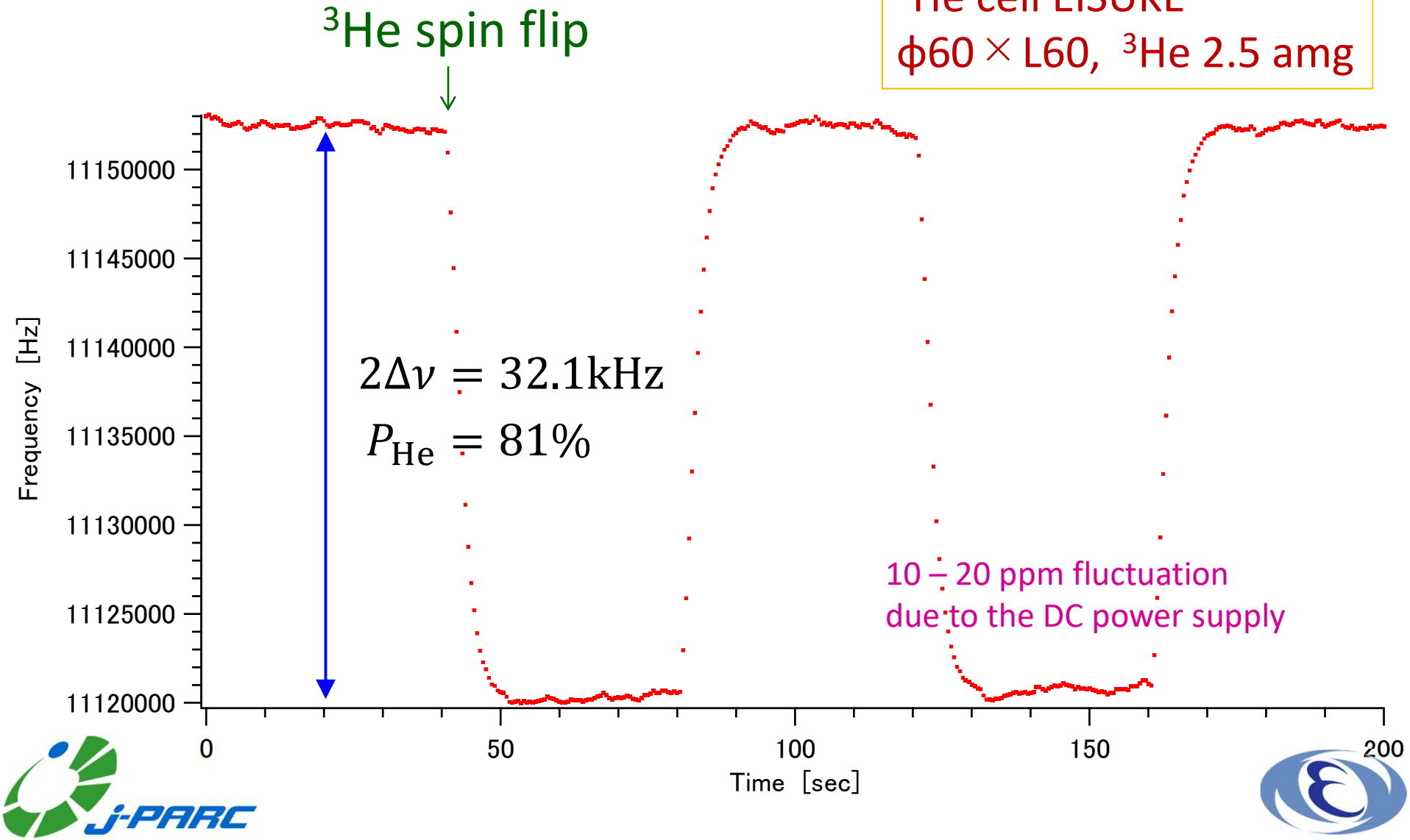


AFP loss : $(5.0 \pm 0.2) \times 10^{-5}$ /flip

^{85}Rb EPR frequency shift

Low energy state (m_F = -3)

^{3}He cell EISUKE
ϕ60 × L60, ^{3}He 2.5 amg



Digital EPR system

Microcomputer

⇕ USB

Storage oscilloscope

CH-A FG OUT

⇑ ⇓

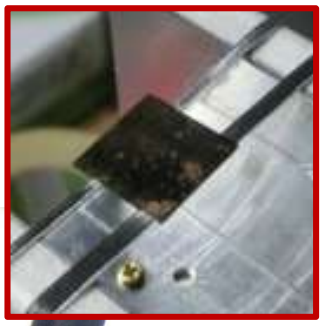
PD
w/ BPF

Frequency modulated RF field

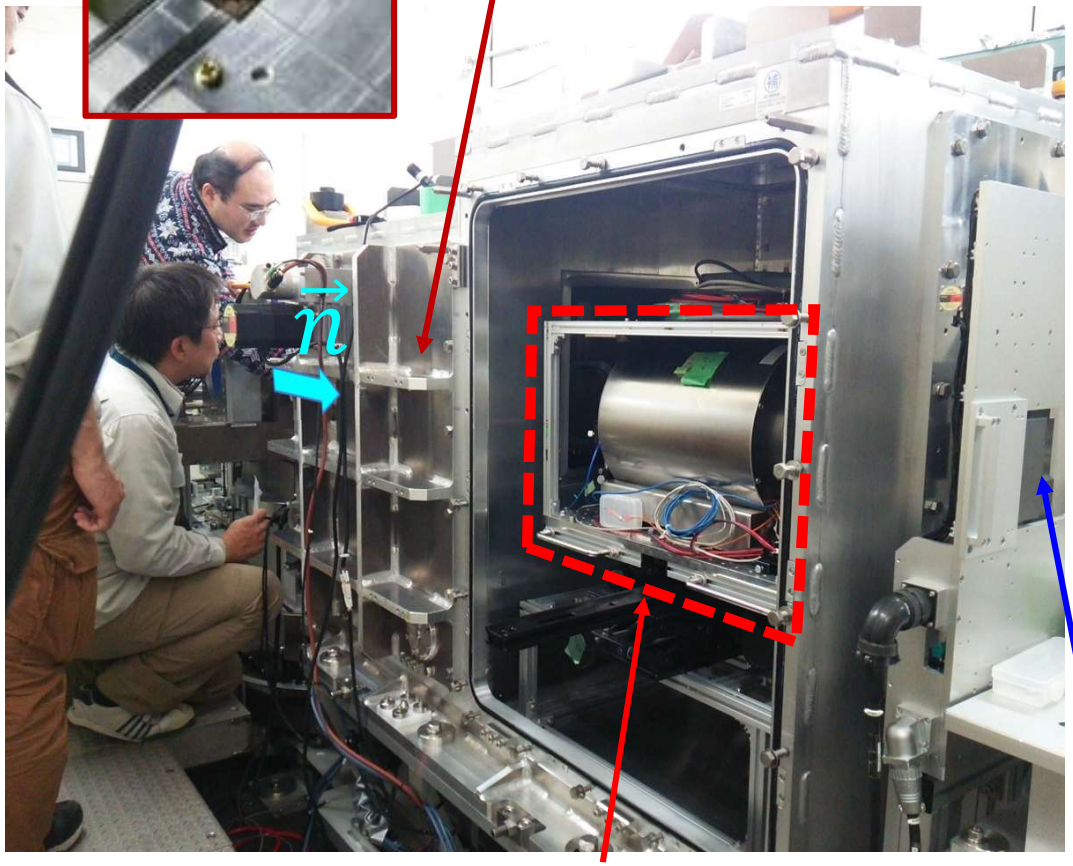
Fluorescence from ^{3}He cell

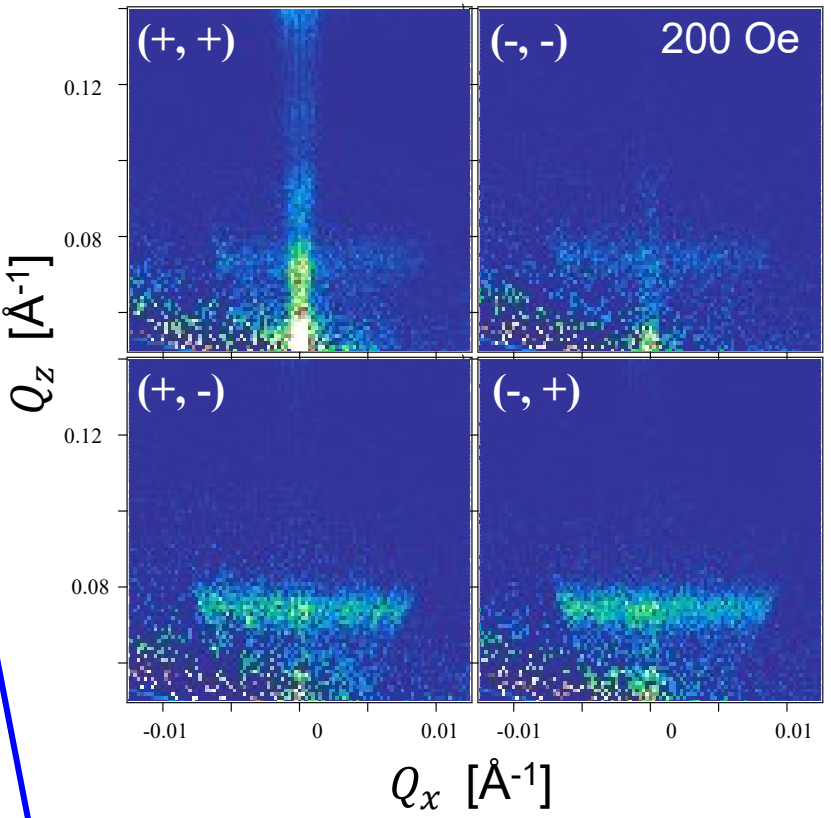
On-line phase sensitive detection on a microcomputer.

SHARAKU – Polarized reflectometer



Fe/Cr multilayer sample in magnet





***In-situ* polarized ^{3}He NSF as a spin analyzer**

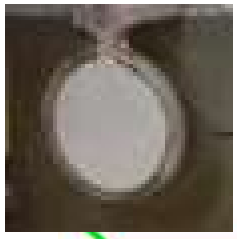
2D detector comes here

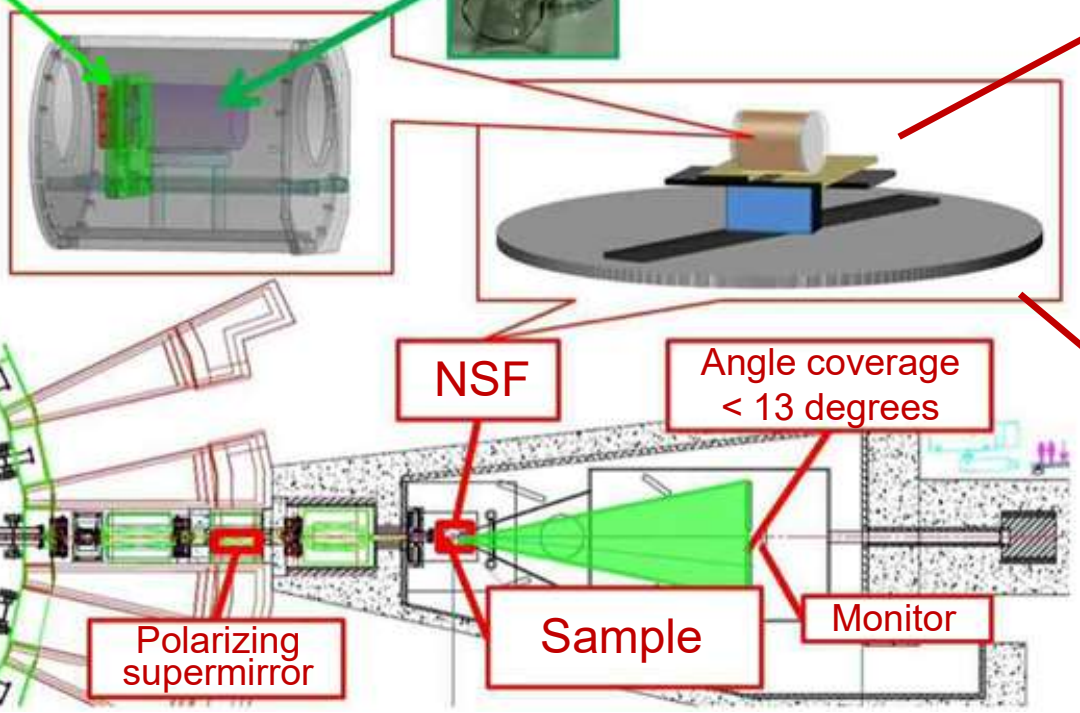
H. Hayashida *et al.*, J. Phys. Conf. Ser. **528**, 012020 (2014)

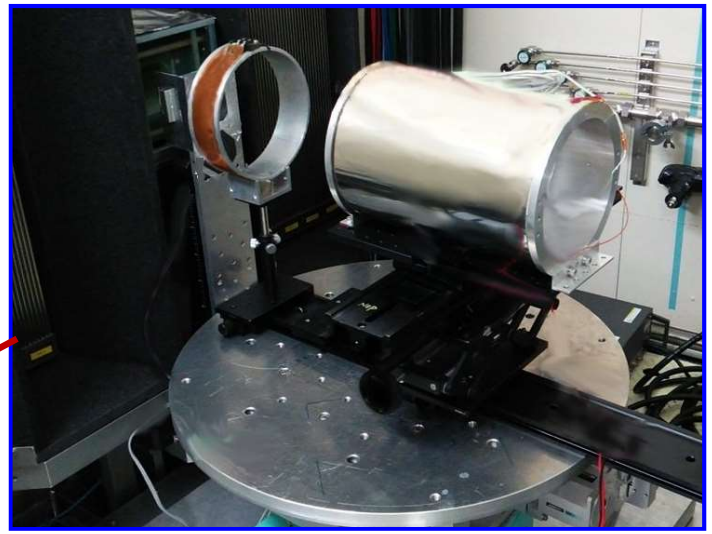
TAIKAN

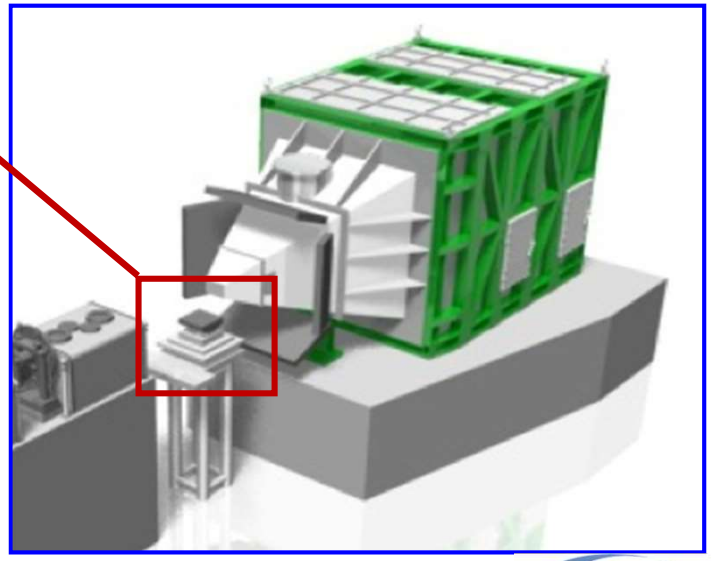
Small and wide angle neutron scattering instrument

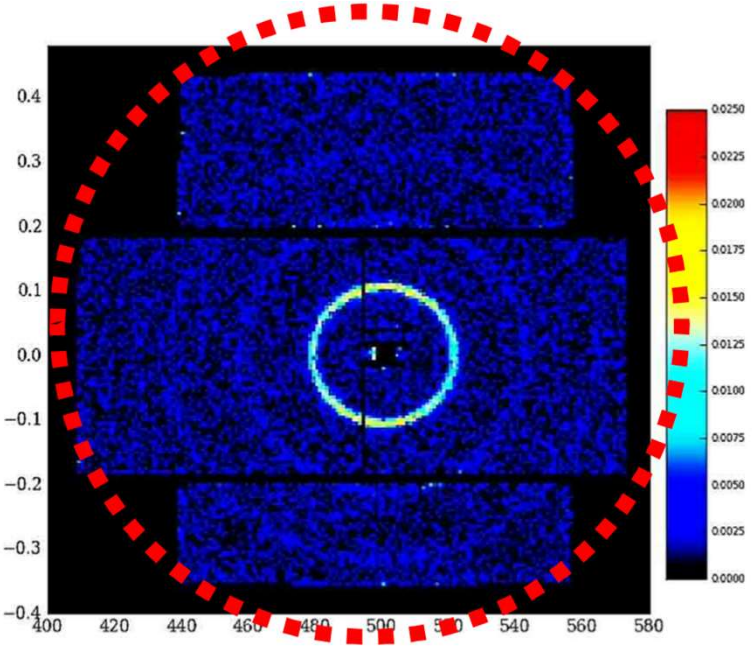
Silver behenate ($C_{22}H_{43}AgO_2$)



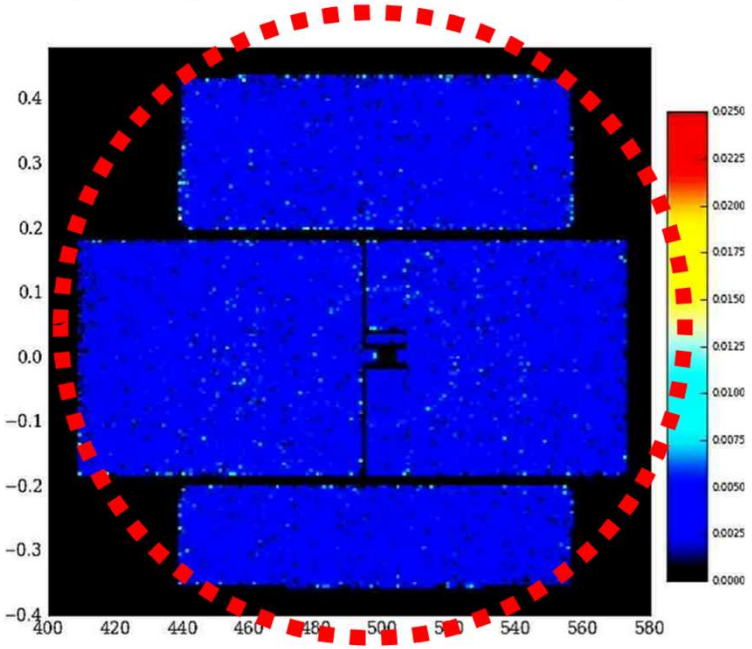




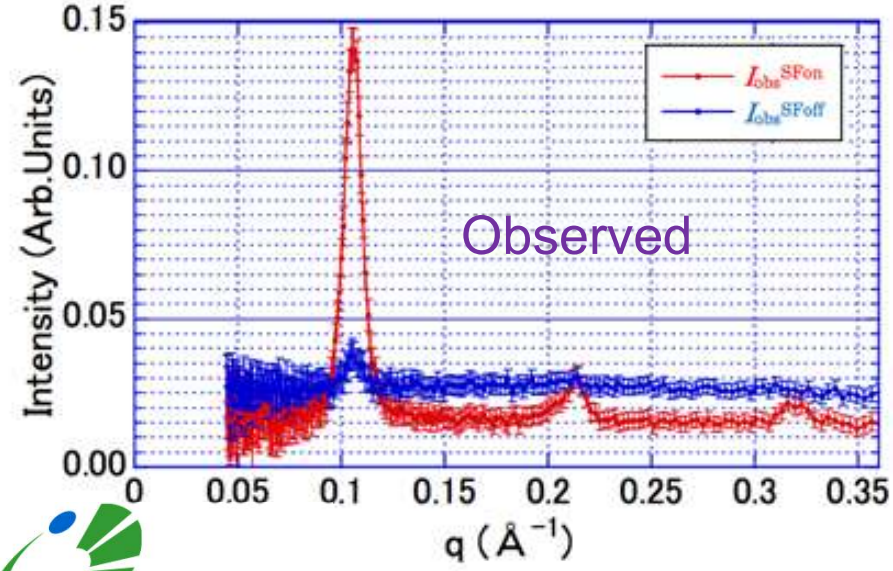


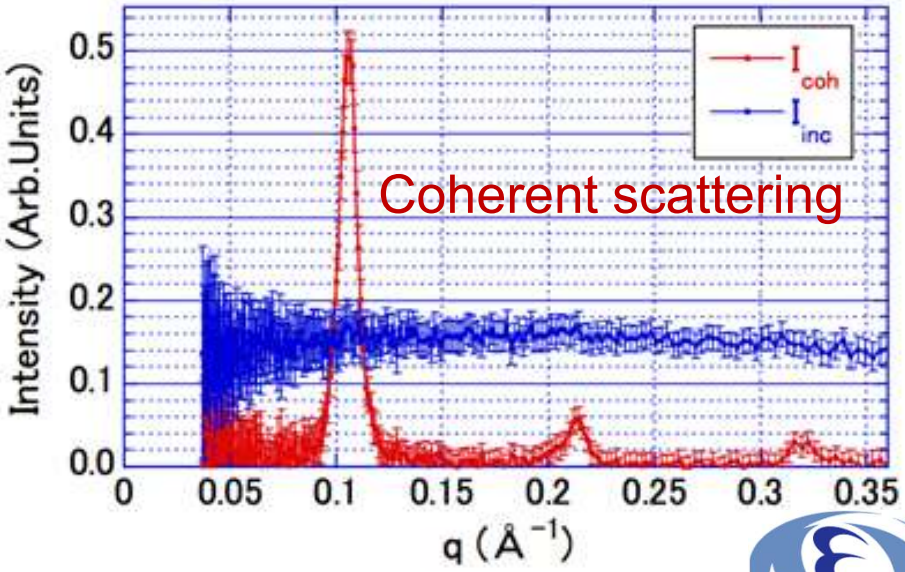


Spin flip scattering



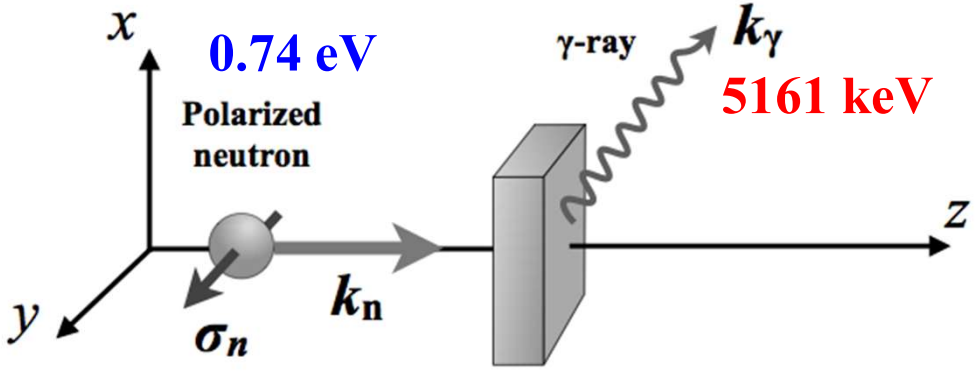
Non-spin flip scattering





H. Kira *et al.*, JPS Conf. Proc. **8**, 036008 (2015)

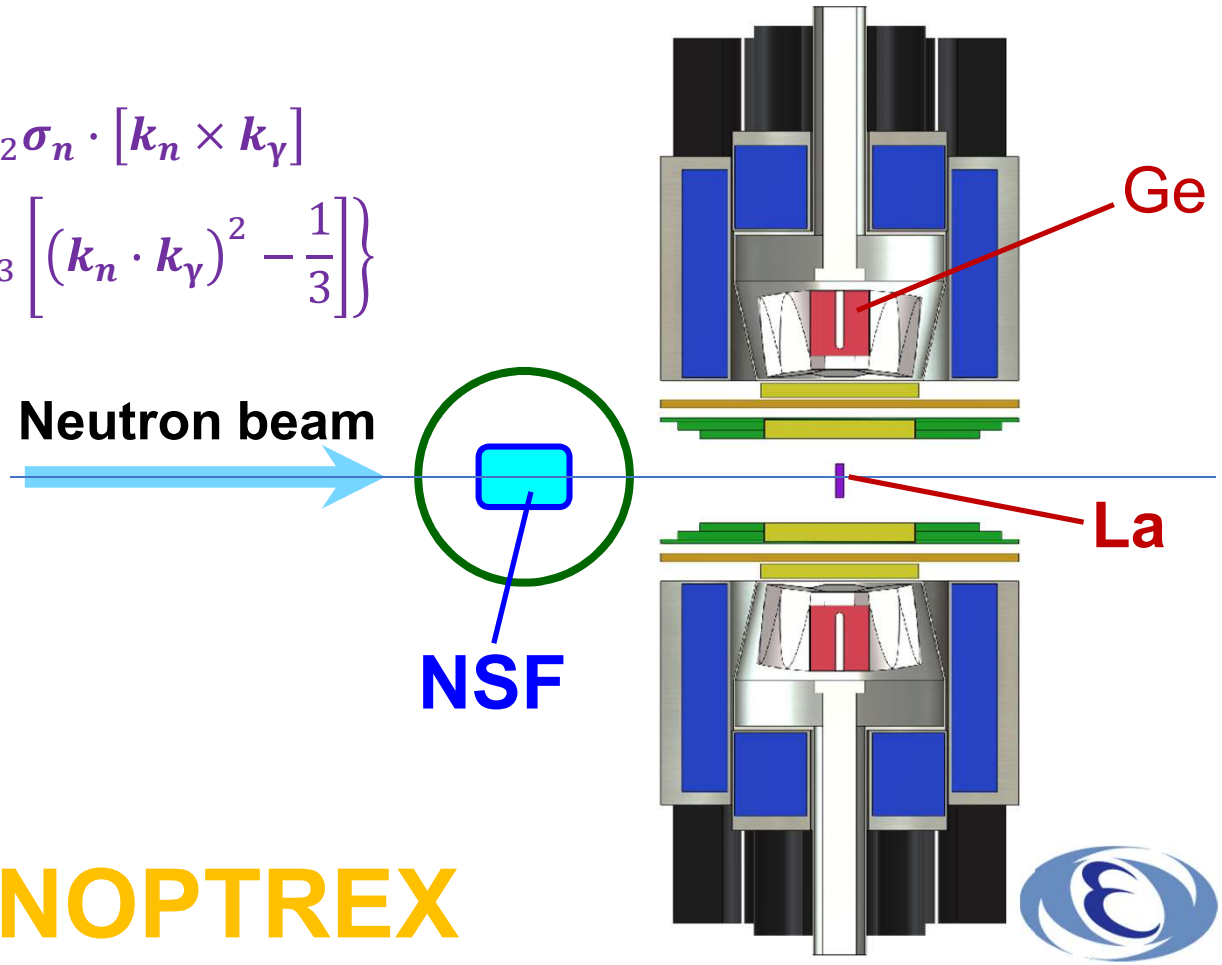
Gamma asymmetry in $^{139}\mathrm{La}(\vec{n},\gamma)$



$$\frac{d\sigma}{d\Omega} = \frac{1}{2}\left\{a_0 + a_1(\boldsymbol{k_n}\cdot\boldsymbol{k_\gamma}) + \tilde{a}_2\boldsymbol{\sigma_n}\cdot[\boldsymbol{k_n}\times\boldsymbol{k_\gamma}] + a_3\left[(\boldsymbol{k_n}\cdot\boldsymbol{k_\gamma})^2 - \frac{1}{3}\right]\right\}$$

$\kappa(J)$

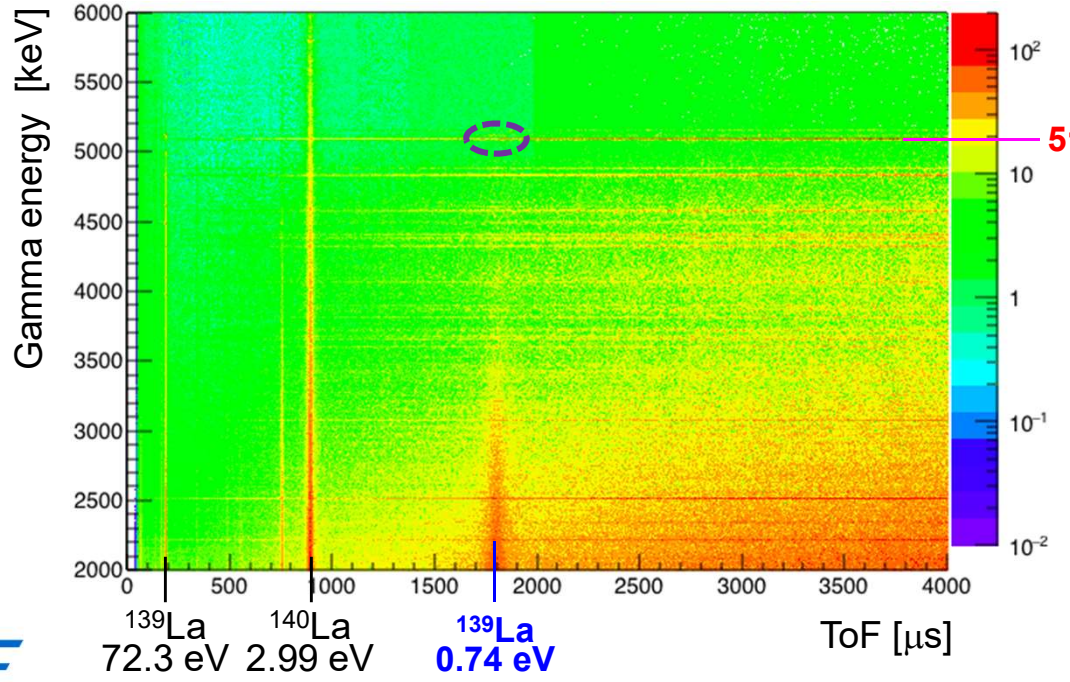
An important parameter for studying **time reversal invariance.**



NOPTREX

Measurement at ANNRI γ-ray spectrometer

^{3}He NSF with AFP spin flipper



$^{139}\mathrm{La}(\vec{n},\gamma)$
p-wave resonance to
$^{140}\mathrm{La}$ ground state

Collaborators

^{3}He NSF group

T. Okudaira, S. Takahashi, T. Oku, K. Sakai, K. Kakurai

POLANO

T. Yokoo, S. Itoh, N. Kaneko, M. Ohkawara, Y. Ikeda, M. Fujita, K. Ohoyama

TAIKAN

H. Kira, K. Hiroi, H. Iwase, K. Ohishi, J. Suzuki, S. Takata

SHARAKU

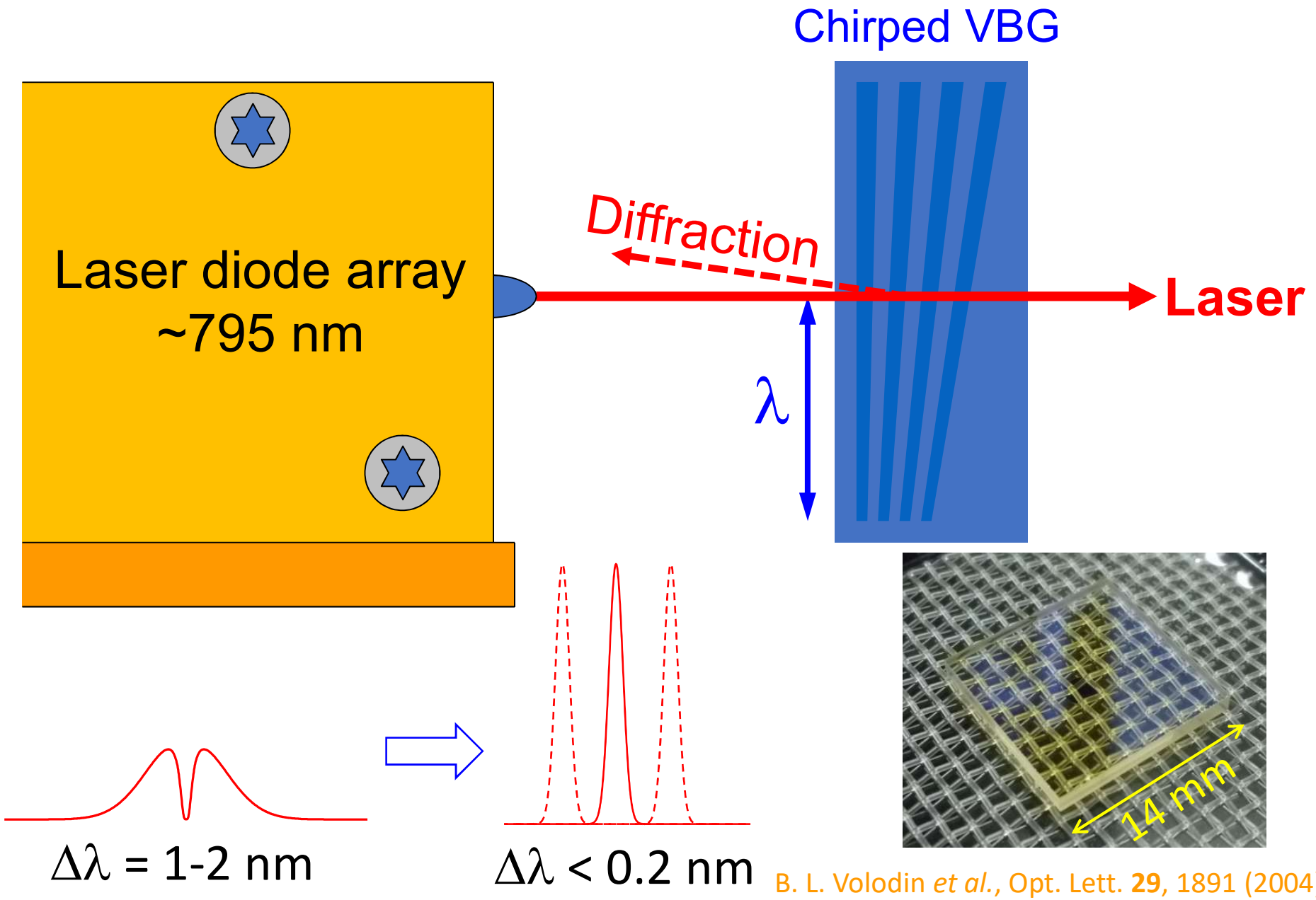
H. Hayashida, R. Maruyama, N. Miyata, M. Mizusawa, Y. Sakaguchi, K. Soyama, M. Takeda, D. Yamazaki

NOPTREX

T. Yamamoto, K. Ishizaki, M. Kitaguchi, H. M. Shimizu, A. Kimura, and NOPTREX collaboration

Backup

LDA with chirped volume Bragg grating (VBG or VHG)



B. L. Volodin *et al.*, Opt. Lett. **29**, 1891 (2004)