

Development of Doppler Shifter for J-PARC BL05

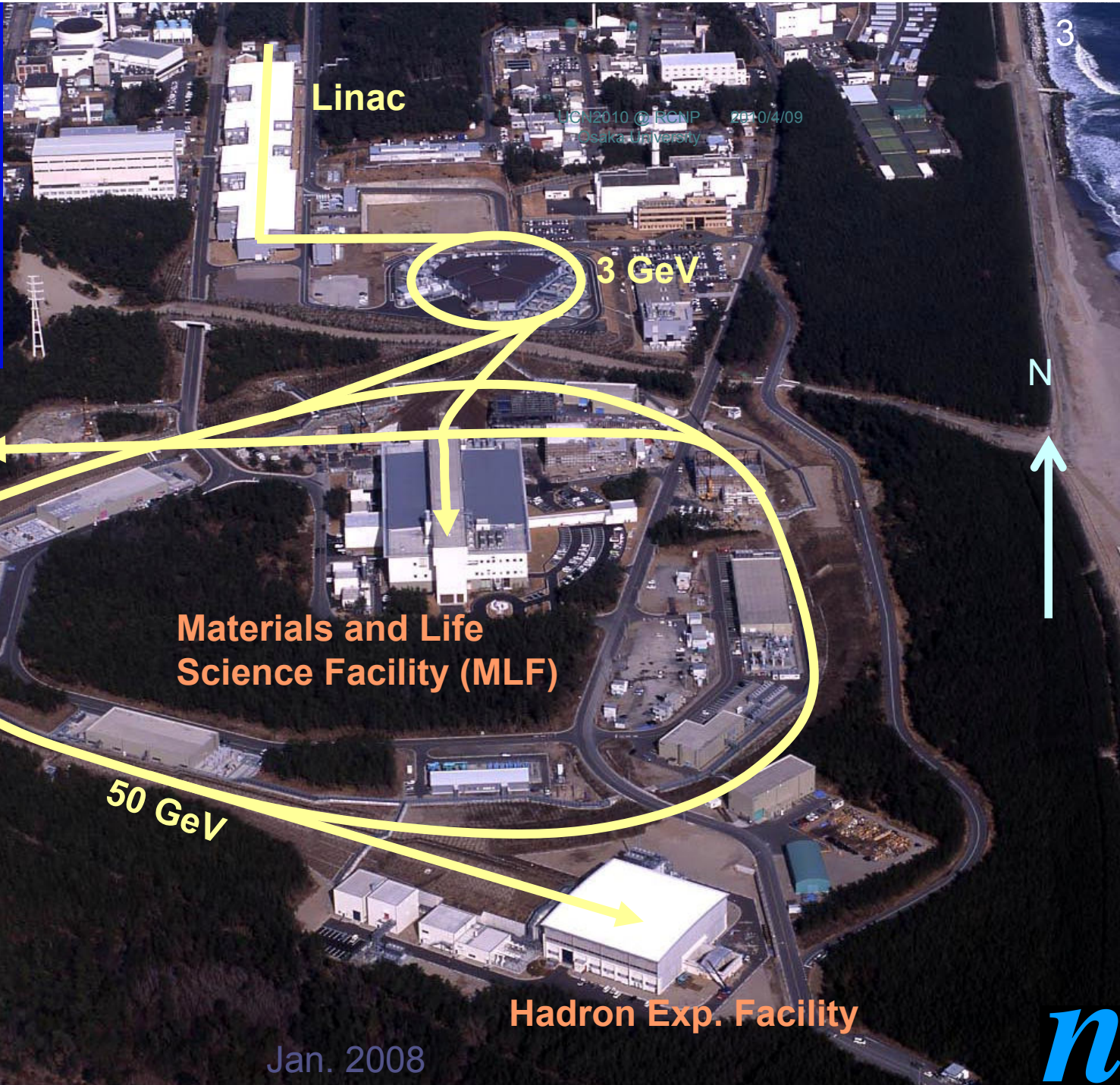
K. Mishima (KEK) and the NOP Collaboration

(*) Most of simulation work in this talk has been done by
S. Imajo, graduate student of Kyoto Univ..

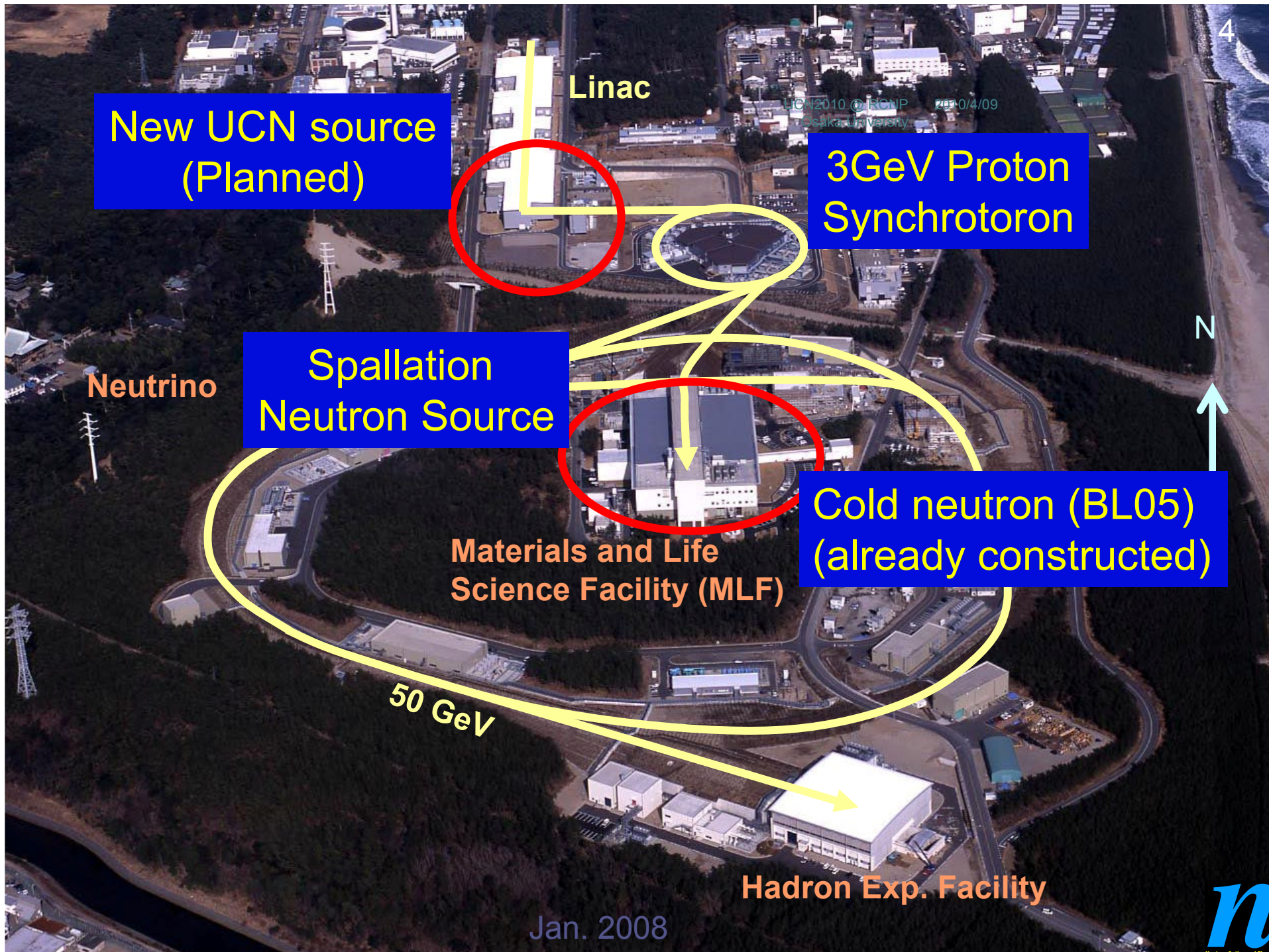
Motivation

- We are planning to construct new superthermal UCN source and perform nEDM experiment at J-PARC.
 - Before (and also during) the construction, easily usable UCN source is highly desired for various R&D studies.
 - We have already constructed cold neutron beamline (BL05) at J-PARC and some amount of VCNs are expected to exist in the beam.
- We can convert the VCNs into UCNs using a Doppler shifter with high Qc mirror.

J-PARC
J apan
P roton
A ccelerator
R esearch
C omplex



Jan. 2008



New UCN source
(Planned)

Linac

3GeV Proton
Synchrotron

Spallation
Neutron Source

Neutrino

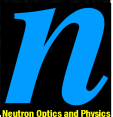
Materials and Life
Science Facility (MLF)

Cold neutron (BL05)
(already constructed)

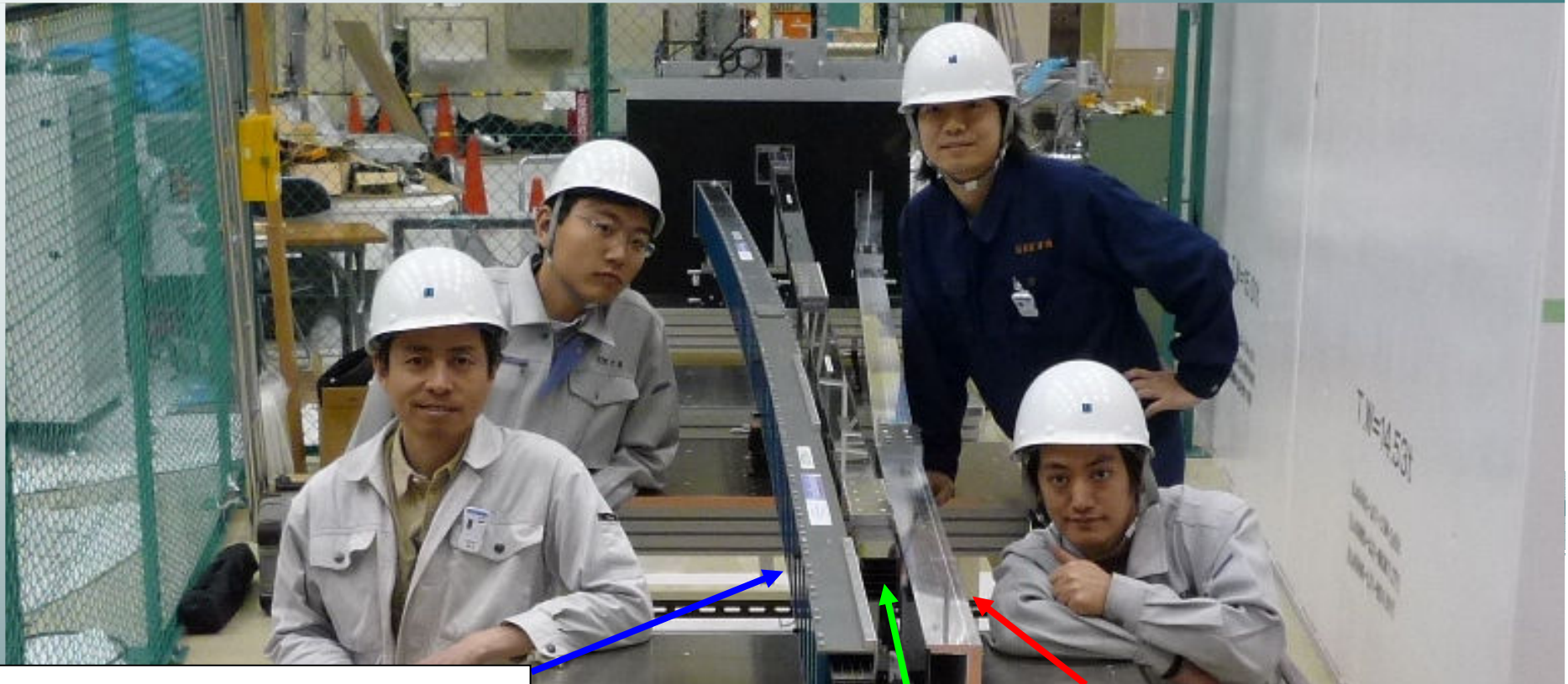
50 GeV

Hadron Exp. Facility

Jan. 2008



Supermirror Benders in Assembly



Polarization Branch

Experiment	Beta decay
Mirror	Magnetic Supermirror(2.8Qc)
Configuration	Polygonal approximation 12unit \times 0.262 deg. (R=82m)
Cross-section	40mm \times 100mm
Channel	4ch
Bender Length	4.5 m (375mm \times 6 \times 2)
Bending Angle	3.14 deg.

Unpolarized-beam Branch

Experiment	Scattering
Mirrors	Supermirror (3Qc)
Configuration	Real Curve
Curvature	100m
Cross-section	50mm \times 40mm
Channel	5ch
Bender Length	4.0 m (2.0m \times 2)
Bending Angle	2.58 deg.

Low Divergence Branch

Experiment	Interferometer
Mirrors	Supermirror (3Qc)
Configuration	2 mirrors
Critical Angle	0.95 deg.
Bending Angle	3.85 deg.

Co... Beamline (BL05)



7m
12m
16m
20m

Proton Beam

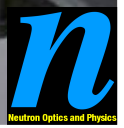
Neutron Beam

Direct beam dump

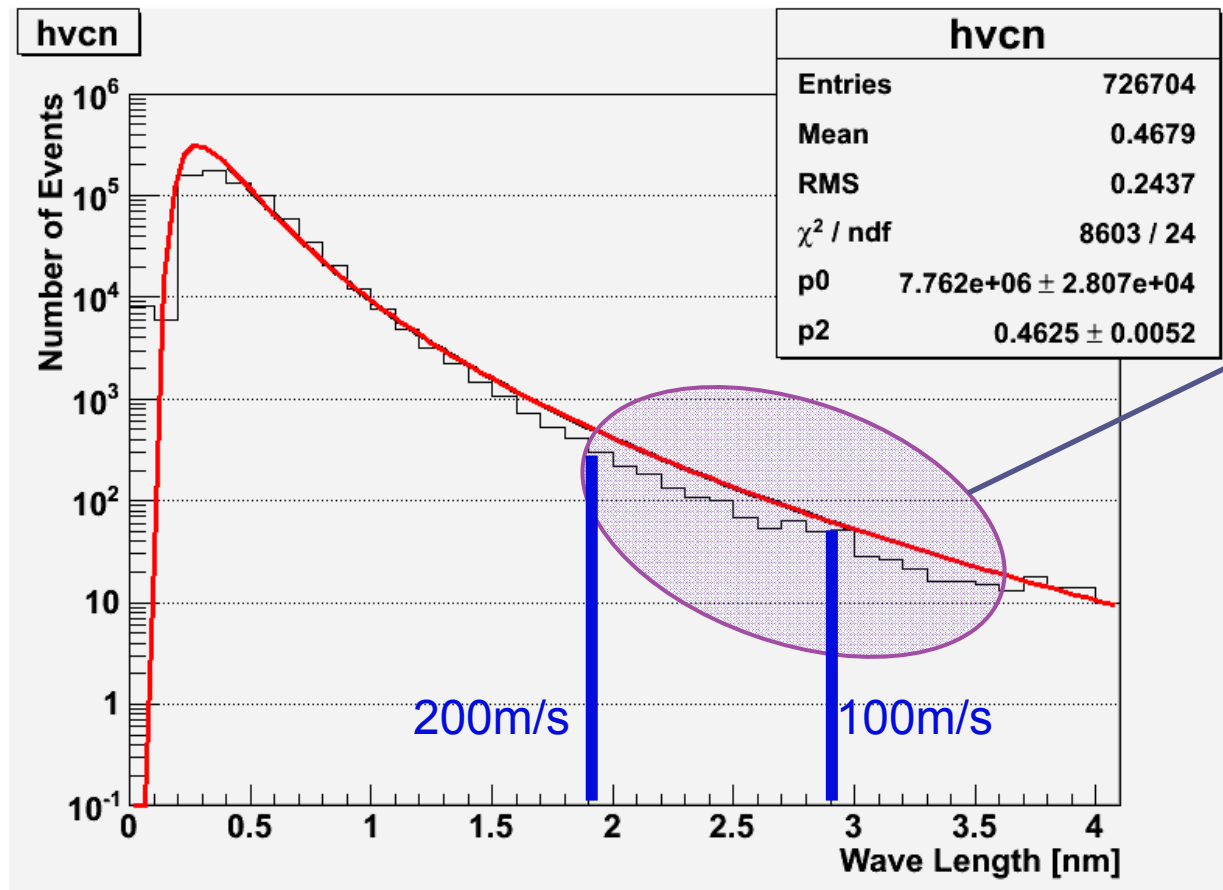
Low-Divergence branch

Polarized-beam branch

Unpolarized-beam branch

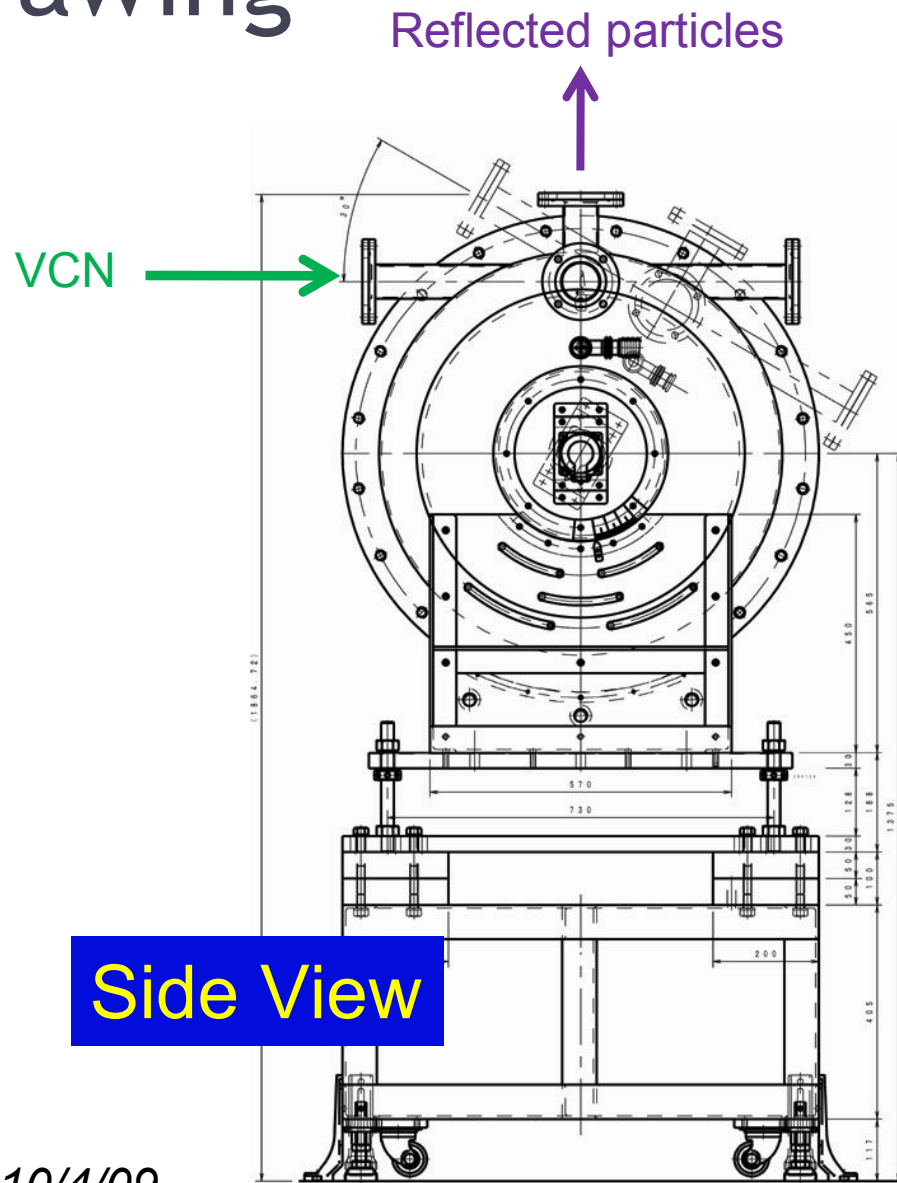


VCN Measurement @ BL05

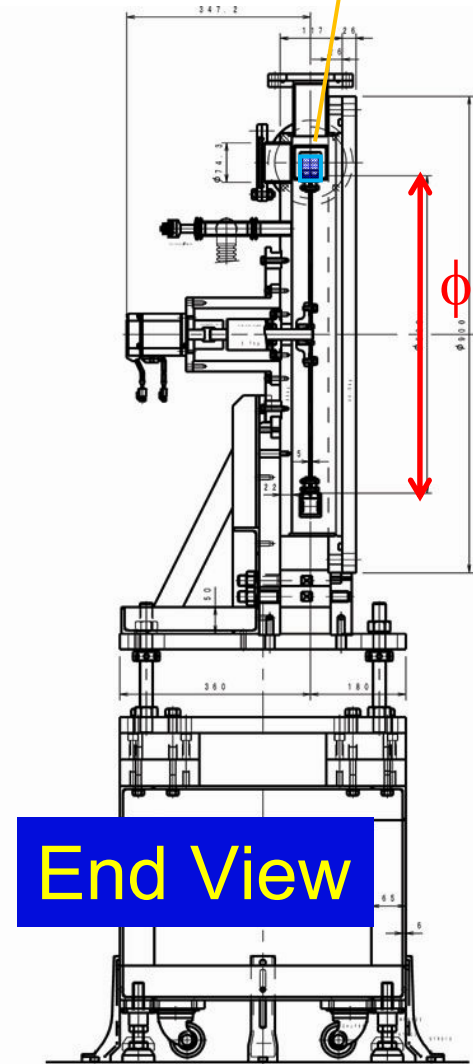


By using 10Qc monochromatic mirror, 136 m/sec (29 Å) neutron can be converted into UCN.

Drawing

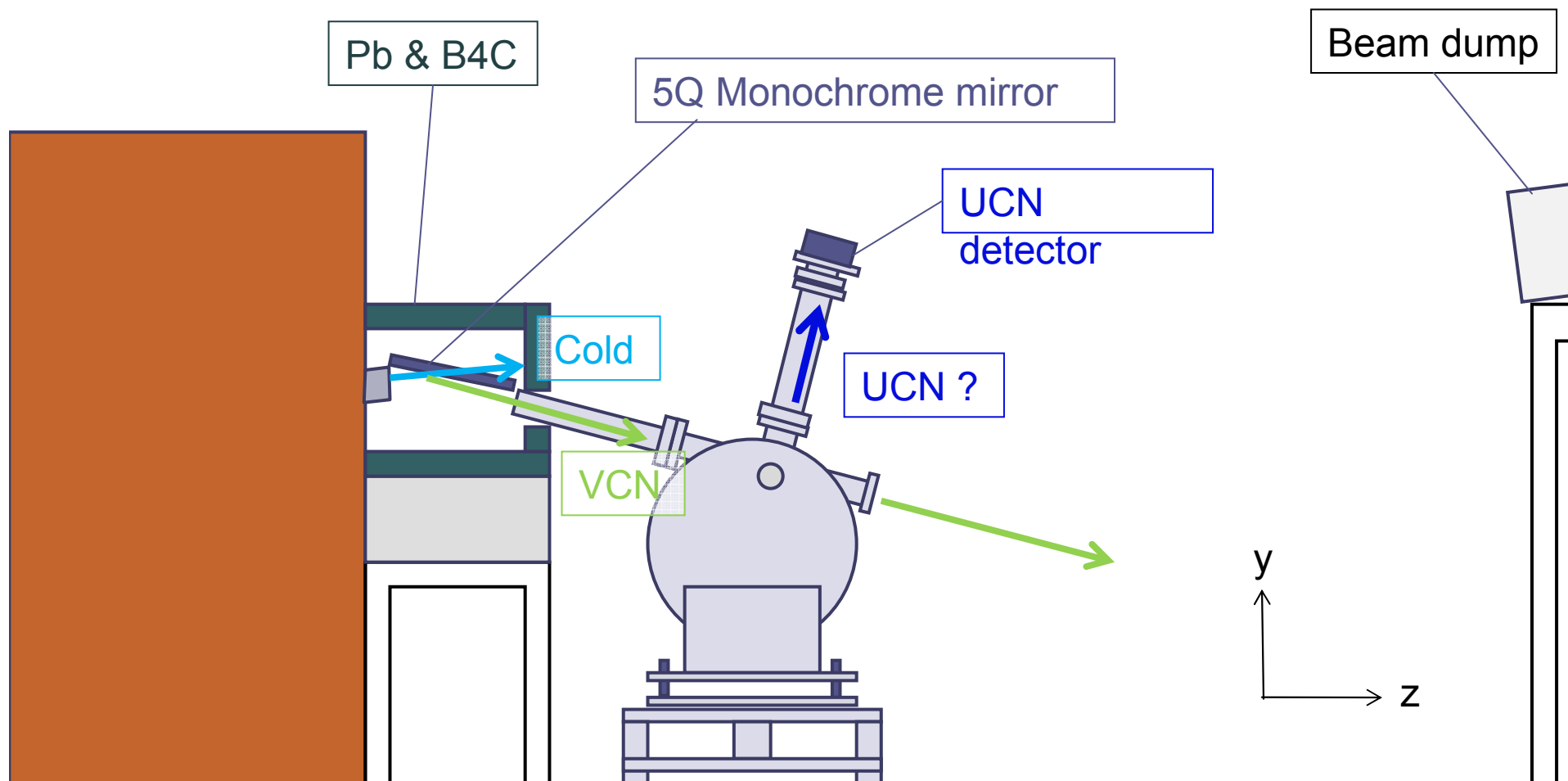


30 mm × 30 mm 10Q
Monochrome mirror



~2000 rpm !

Beamline Configuration

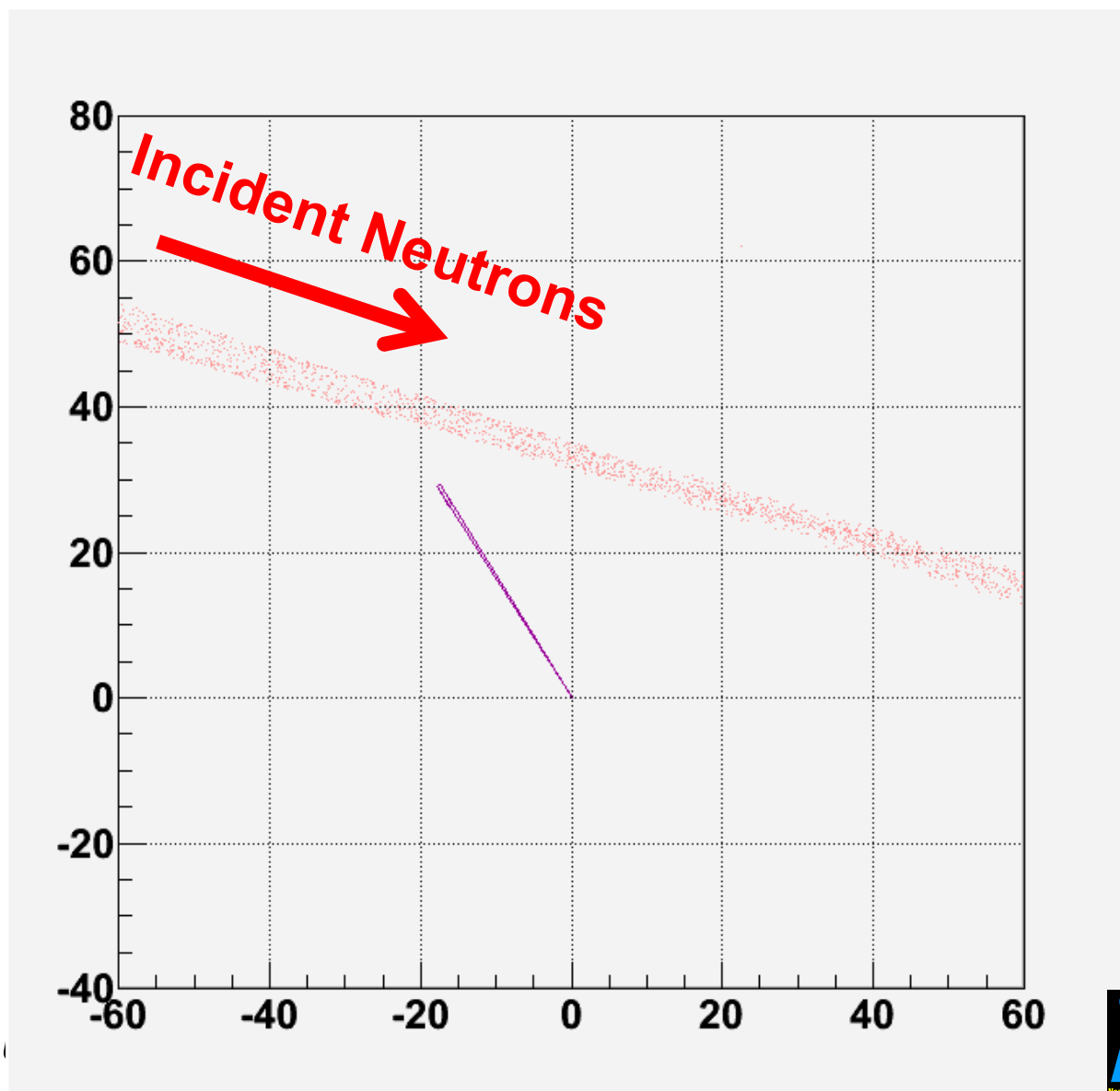


Simulation Setup

- Incident neutrons
 - Energy Spectrum : measured spectrum (pervious page)
 - Velocity : 100 m/s ~ 200 m/s
 - Divergence : +- 10 mrad
- Supper Mirror
 - 10Qc (will/can be made using IBS in KUR)
 - Mirror size : 30 mm x 30 mm
 - Assuming 100% reflectivity for <137 m/s neutrons

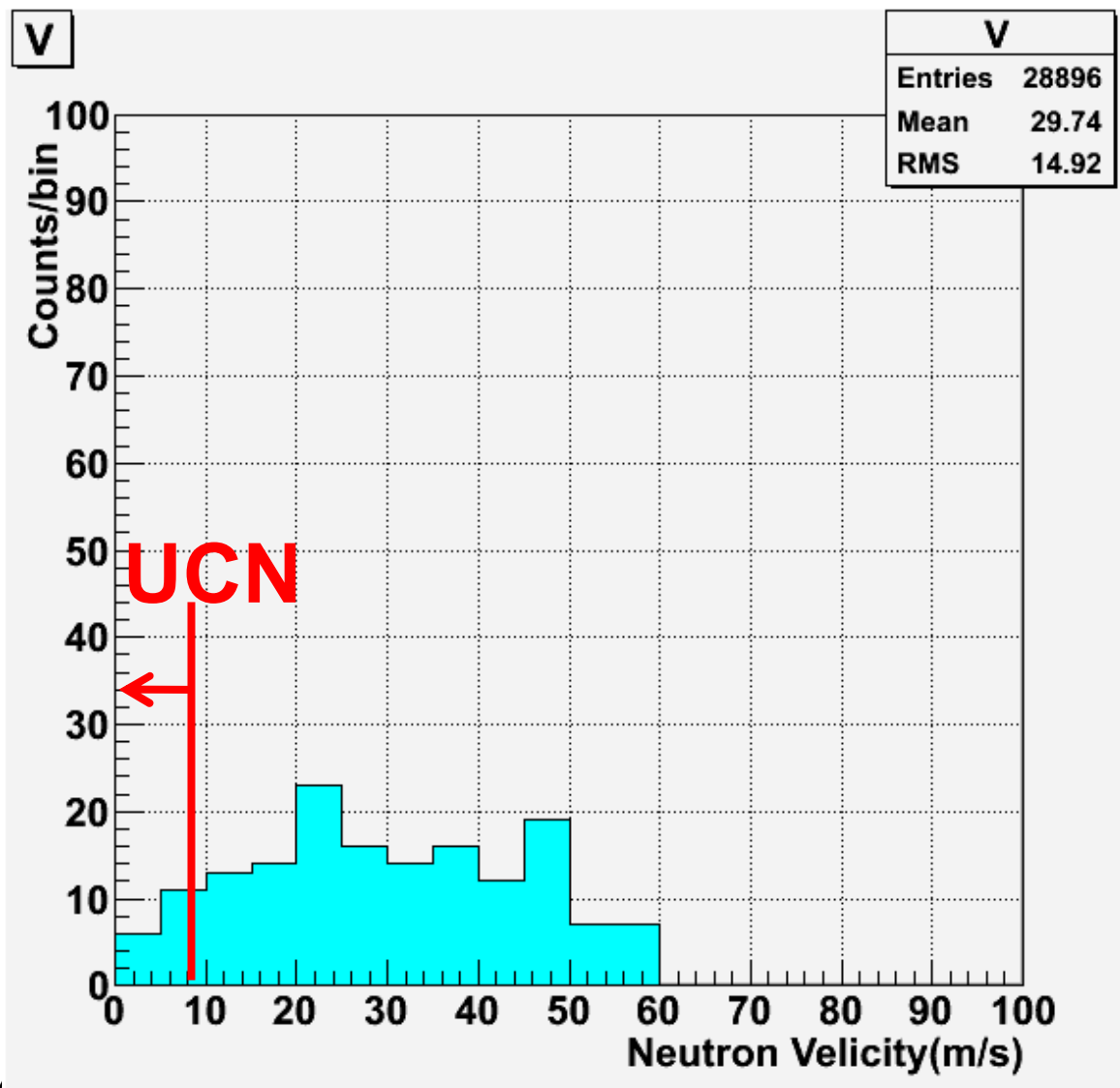
Reflection Animation

- 0 m/s ~ 10 m/s
- 10 m/s ~ 20 m/s
- 20 m/s ~ 30 m/s
- 30 m/s ~ 40 m/s
- 40 m/s ~ 50 m/s
- 50 m/s ~ 60 m/s
- 60 m/s ~ 70 m/s
- 70 m/s ~ 80 m/s
- 80 m/s ~



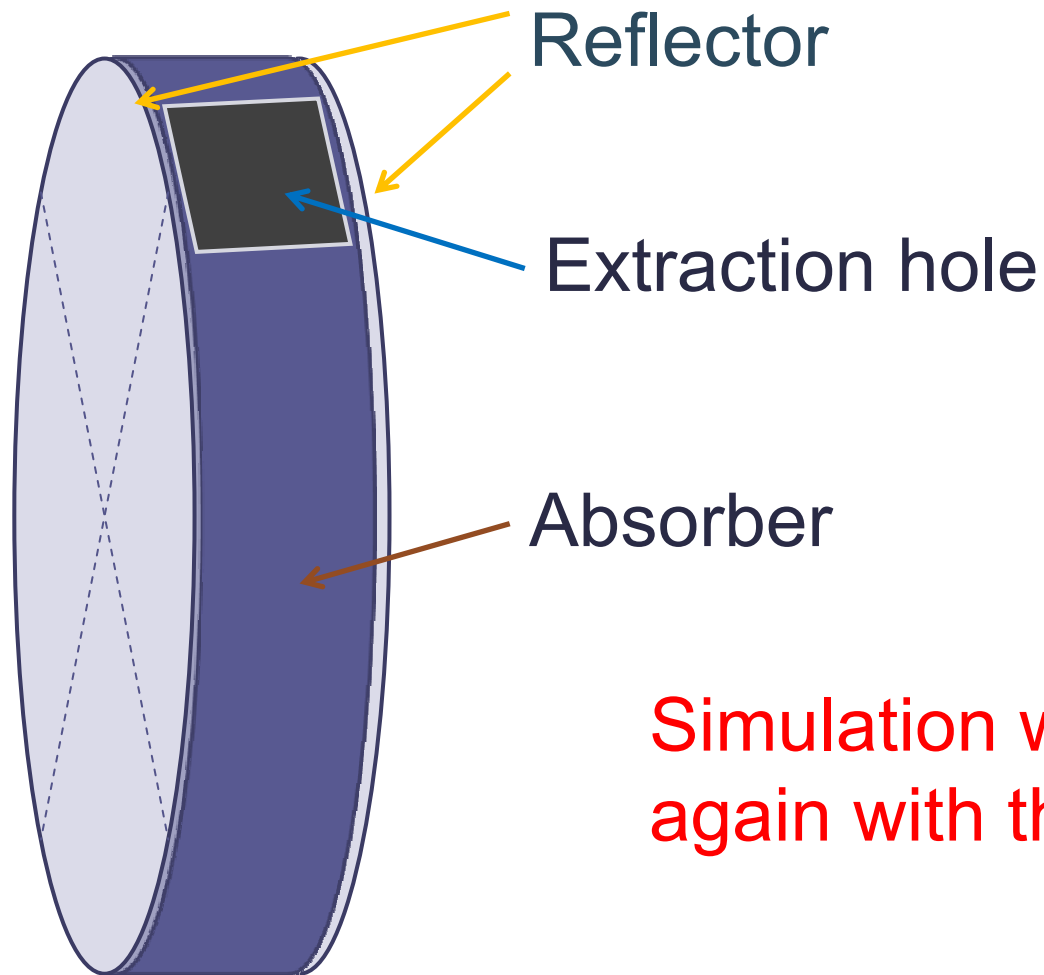
2010/4/09

Velocity distribution after conversion



Conversion
Efficiency
~0.03%

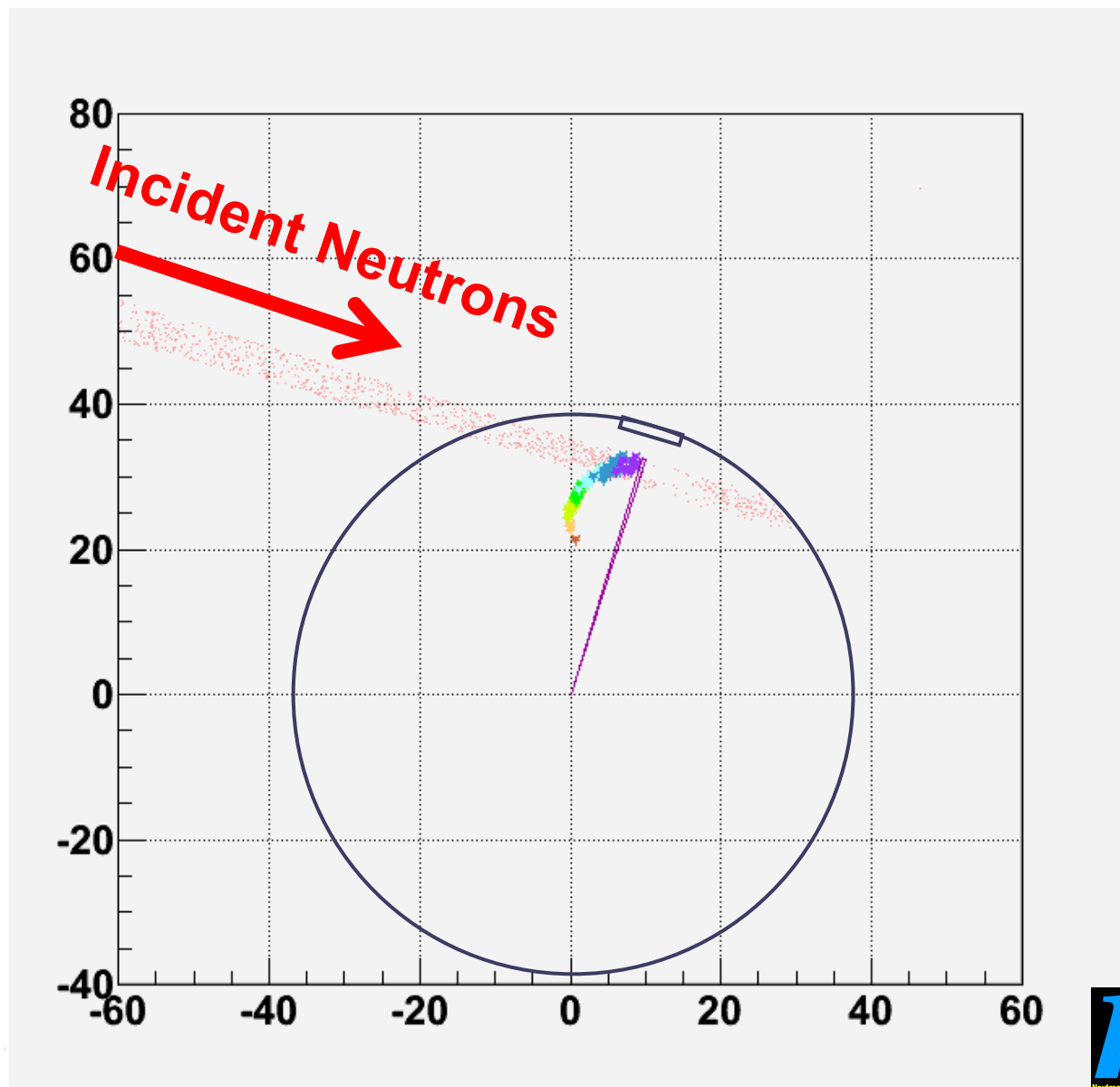
Simulation w/ extraction hole



Simulation was performed again with this setup.

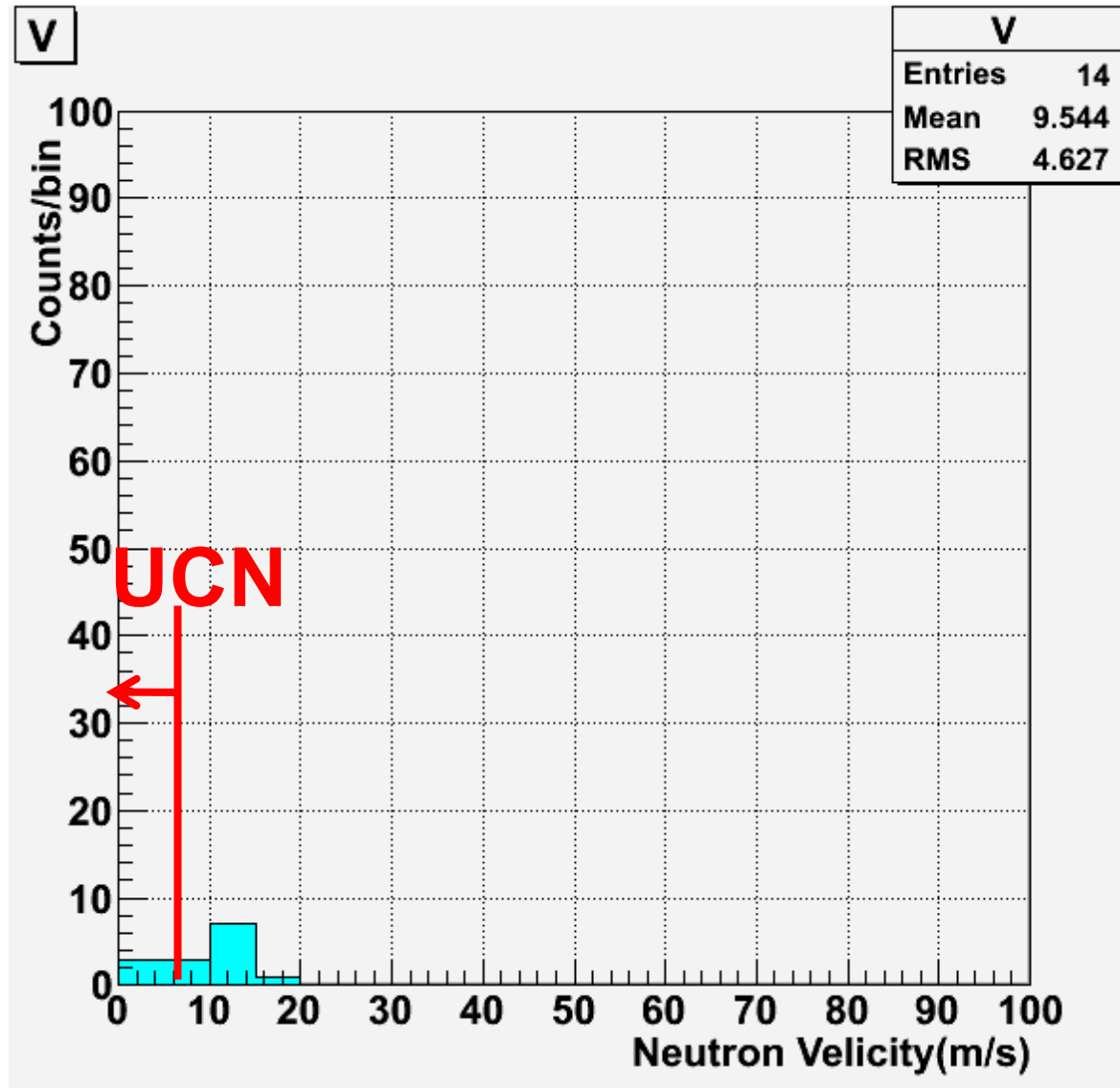
Simulation w/ extraction hole

- 0 m/s ~ 10 m/s
- 10 m/s ~ 20 m/s
- 20 m/s ~ 30 m/s
- 30 m/s ~ 40 m/s
- 40 m/s ~ 50 m/s
- 50 m/s ~ 60 m/s
- 60 m/s ~ 70 m/s
- 70 m/s ~ 80 m/s
- 80 m/s ~



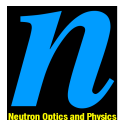
2010/4/09

Extraction Efficiency



2010/4/09

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UCN Flux and Density

- Total flux : 2×10^8 n/cm²/sec/MW with 10 mrad divergence
- Velocity 100 m/sec ~ 200 m/sec : 1.2% of total flux.
- 3GeV synchrotron repetition : 25Hz

- UCN Conversion efficiency = 3×10^{-4}
- UCN production = 720 UCN/cm²/s with 100% reflection
- UCN production length ~ 5cm (0.8ms)

UCN density : 5.7 UCN/cm³

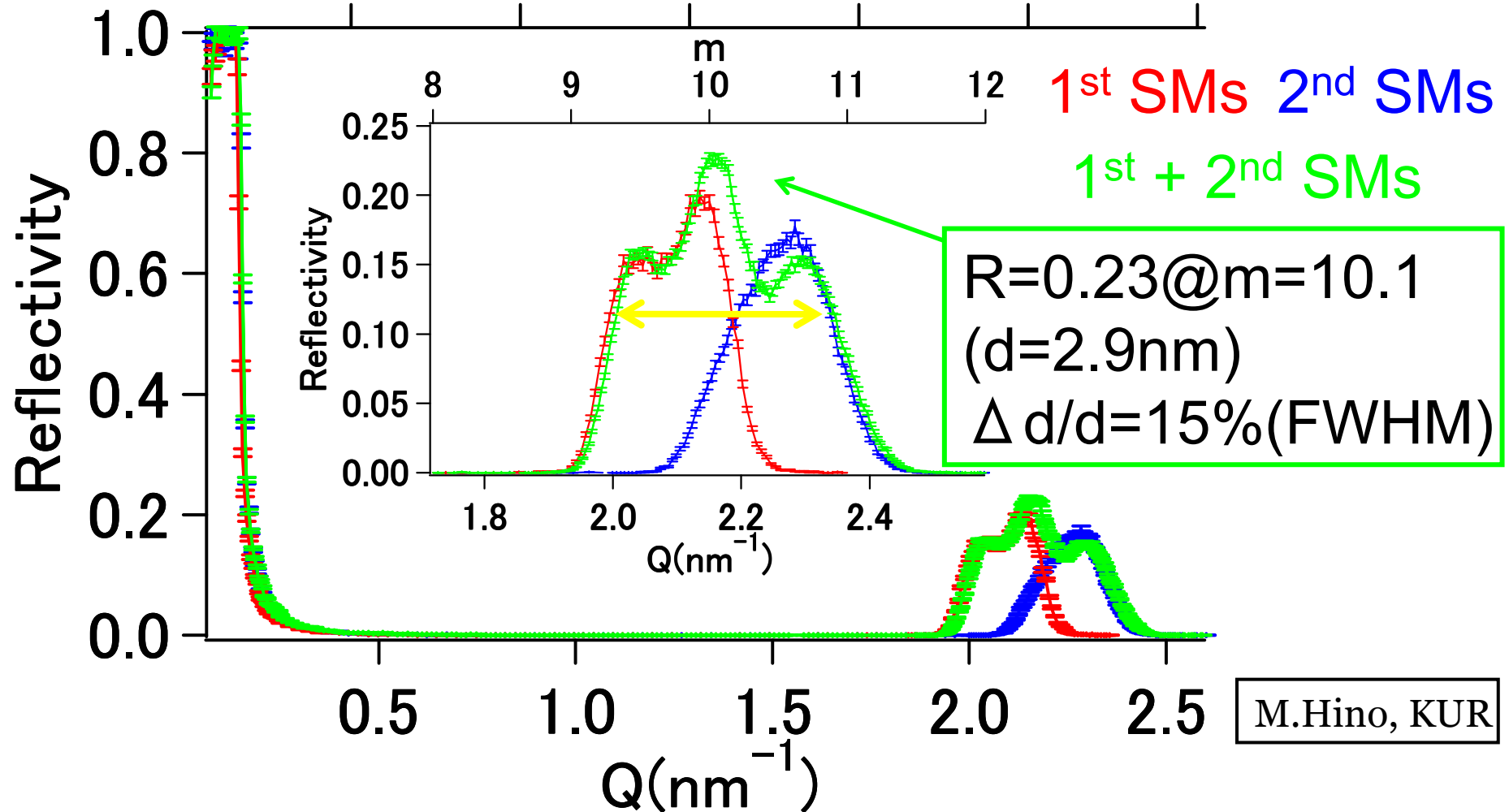
UCN density with focusing option

30~140 UCN/cm³

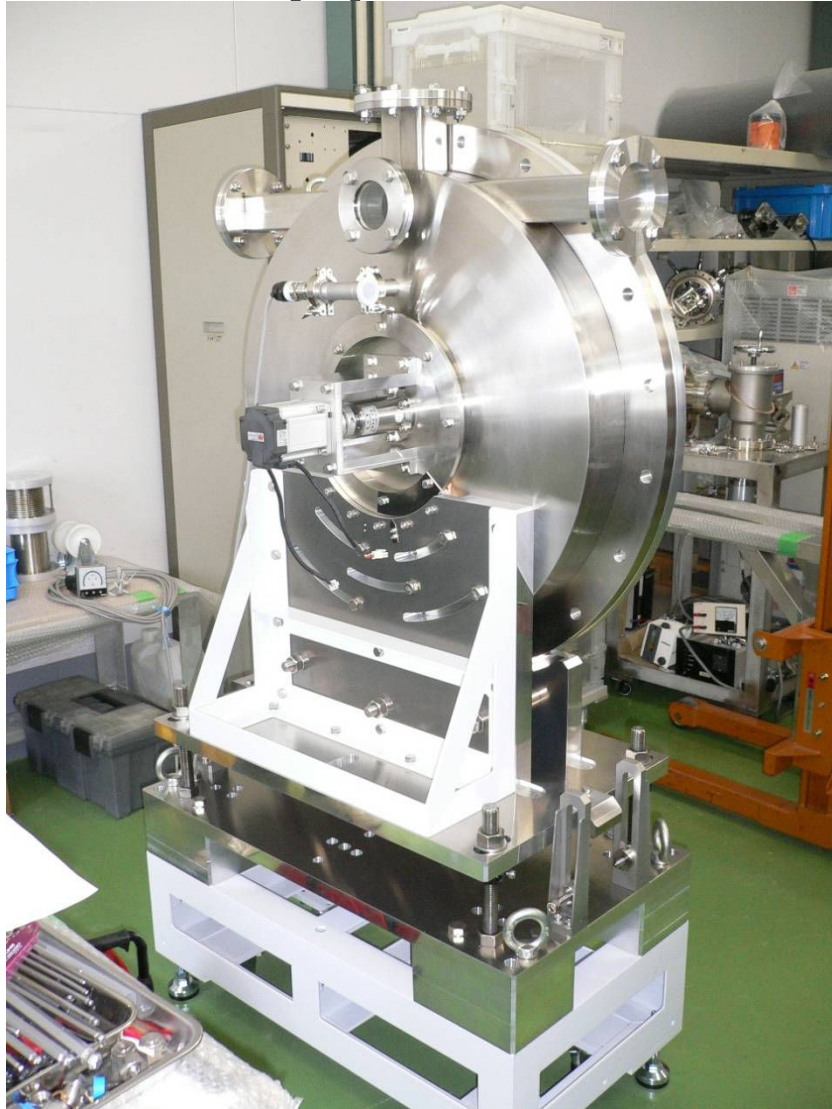
m=10 stacknig NiC/Ti wide band multilayers

m (10929+10336) layers

2 4 6 8 10 12



The Doppler Shifter



2010/4/09

UCN2010 @ RCNP Osaka University

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Summary

- We are developing a Doppler shifter to generate UCNs for R&D study use, and planning to install our cold neutron beamline (BL05).
- We confirmed the existence of VCNs in our beam, and simulation shows that those VCNs can be converted into UCNs by using a Doppler sifter with 10Qc Suppermirror.
- The Doppler sifter will be ready by the end of April, and will be hopefully installed in May.