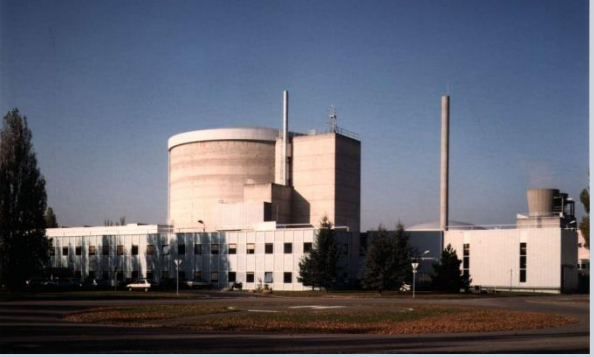


Engineering Challenges in Single Crystal Neutron Diffraction

Arsen Gukasov,
Laboratoire Léon Brillouin
CEA-CNRS, Saclay, France

Best performing SC Diffractometer

Highest possible luminosity (monochr., guide)

Lowest acceptable angular and λ resolution

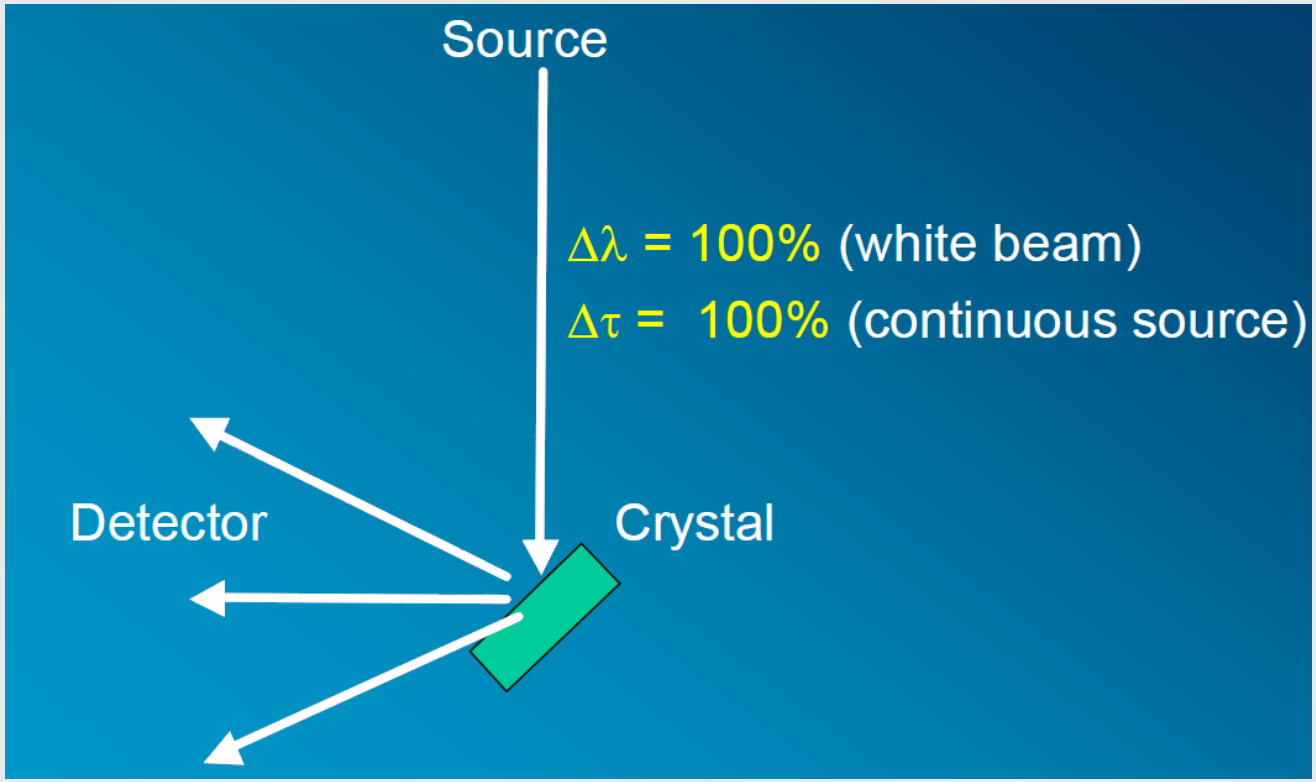
Largest possible detector coverage

Versatile sample environment

Polarized beam

White Beam (Laue) Neutron Diffraction from a single crystal

Multiple reflections sorted by the Crystal itself



DIFFRACTOMETRE VIVALDI ,ILL

Laue diffraction

difference patterns

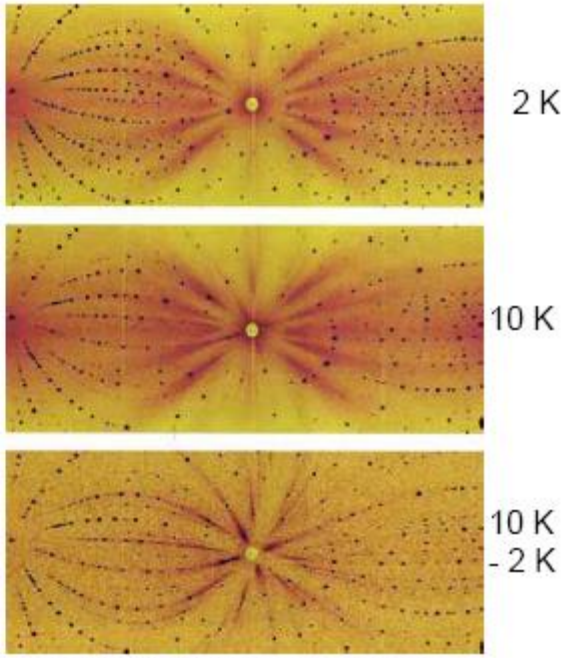
short-range magnetic correlations

Tapiolite

$FeTa_2O_6$

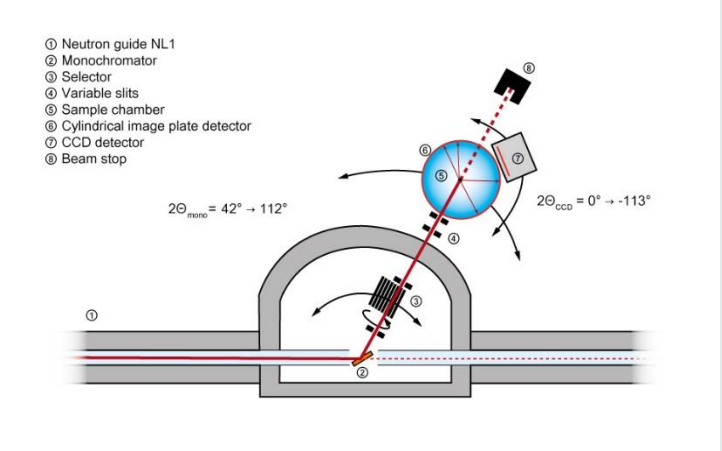
rods of magnetic scattering

Vivaldi ILL



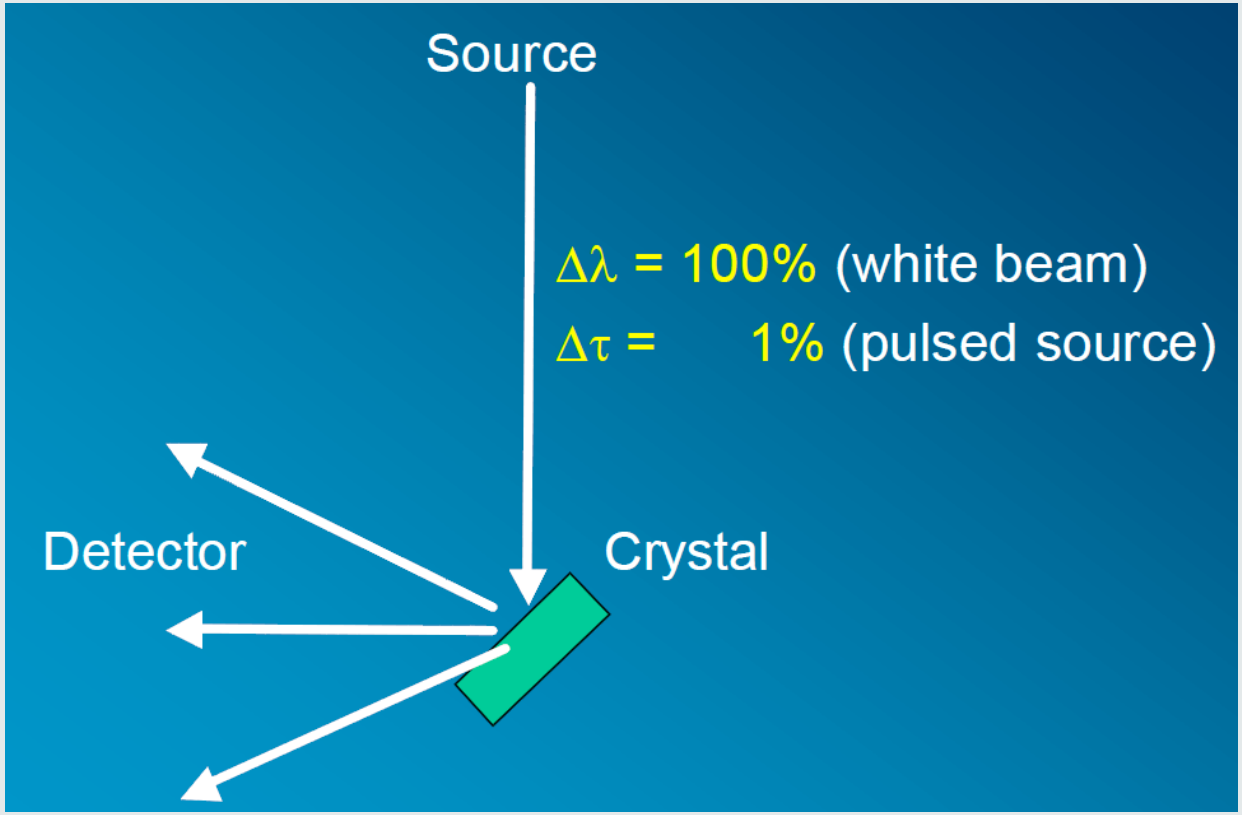
E.M.L. Chung et al. to be published

CYCLOPS (ILL) BIODIFF (FRMII)

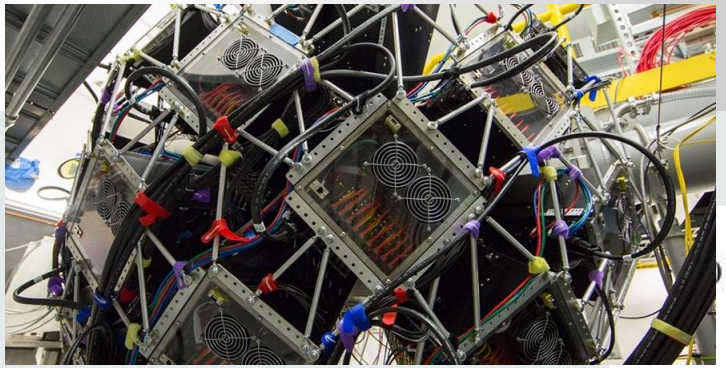


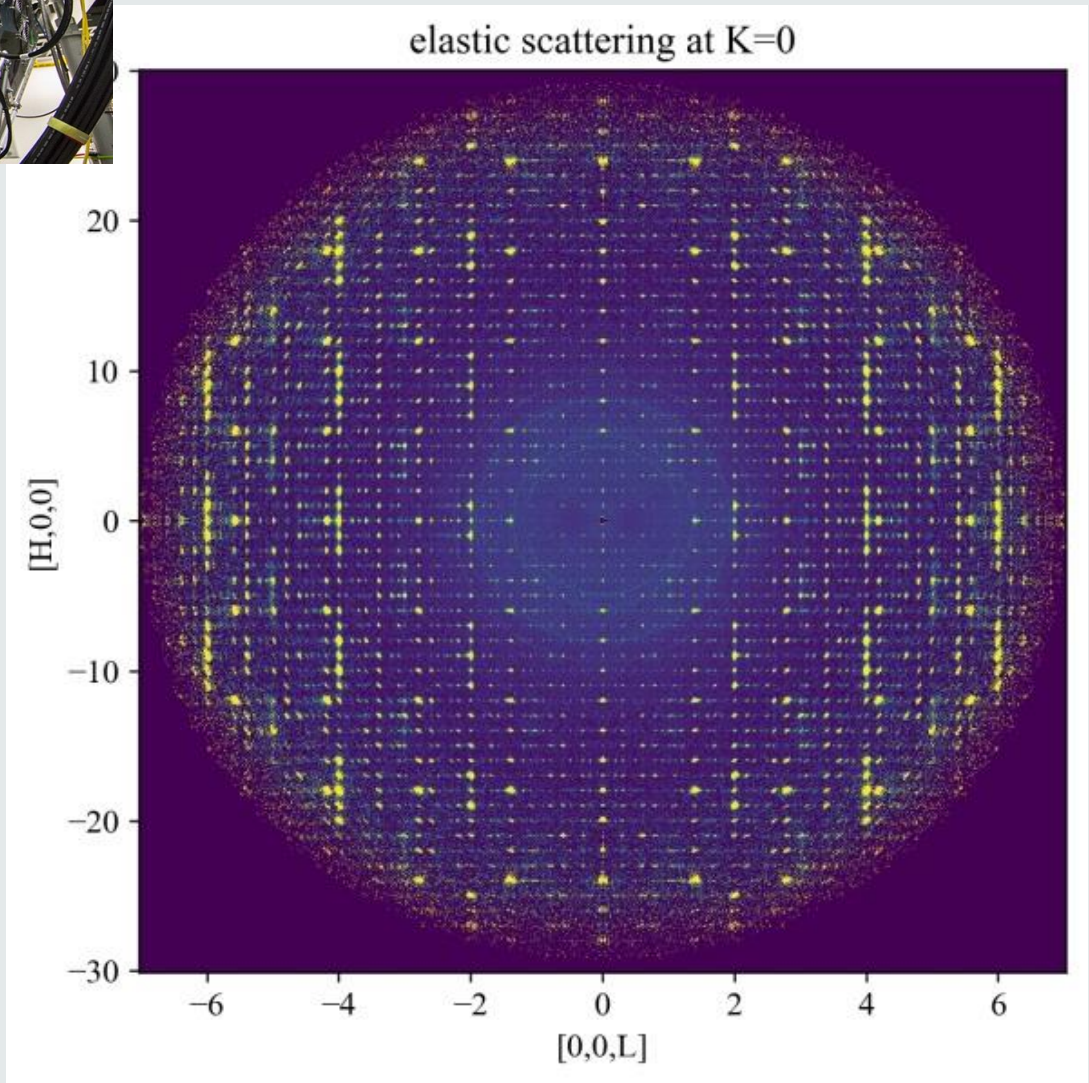
Time of flight (TOF) neutron Diffraction from a single crystal

Multiple reflections sorted by Time-Of-Flight

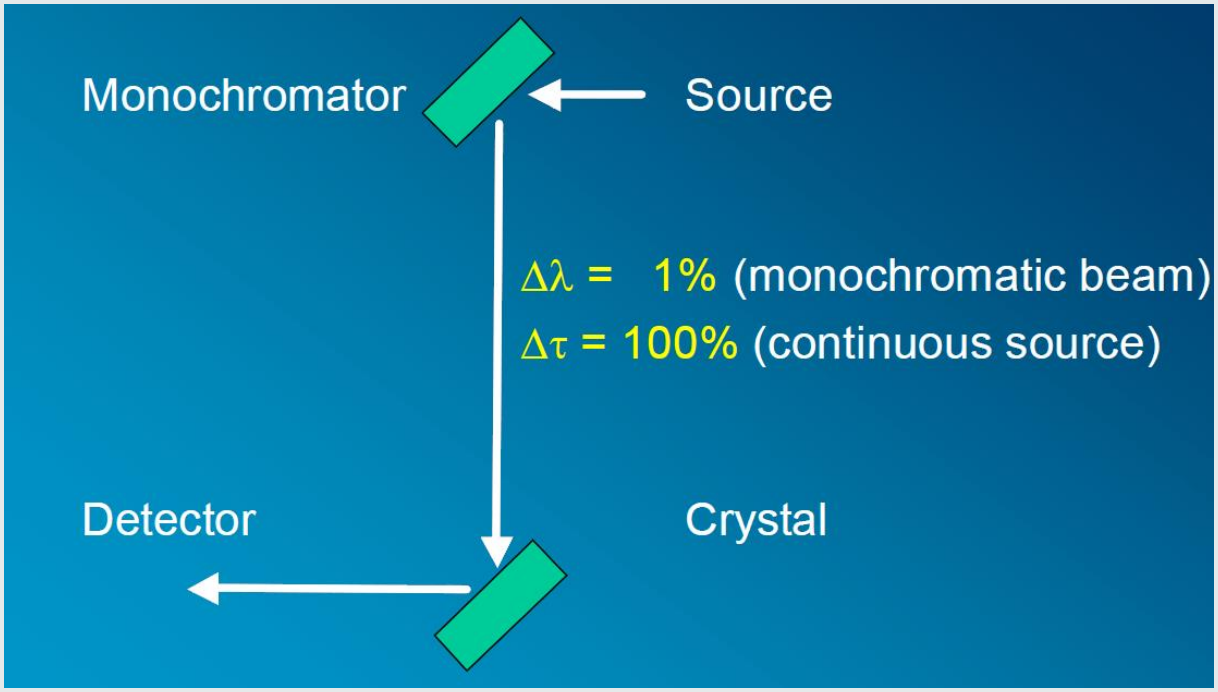


TOPAZ and CORELLI at SNS

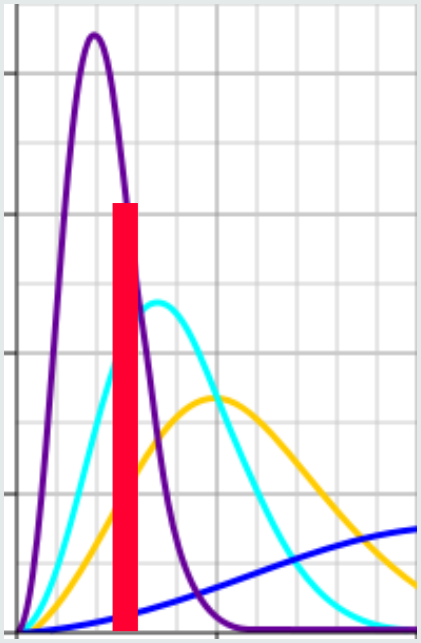


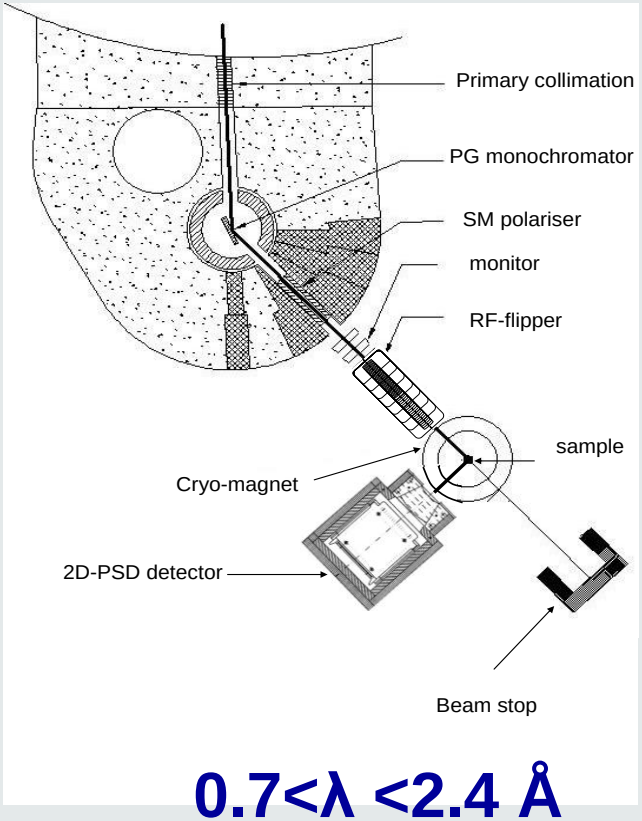


Monochromatic Neutron Diffraction from a single crystal



Monochromatic diffractometers



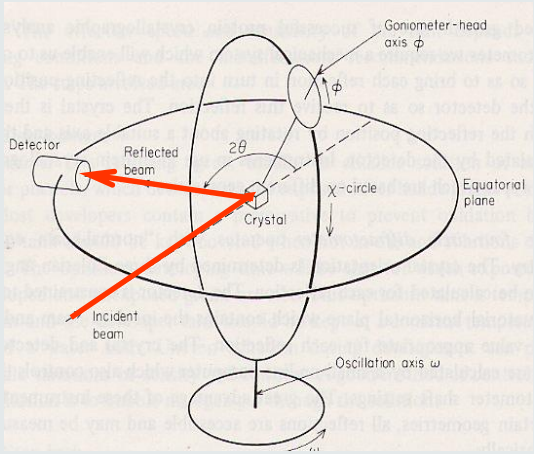


0.7<λ <2.4 Å

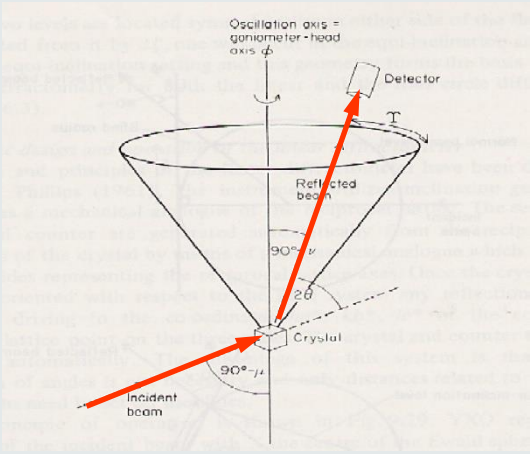
Short λ, big number of hkl, high resolution (low intensity)

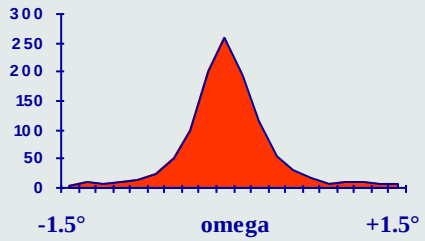
Monchromatic diffractometers

4-cercles



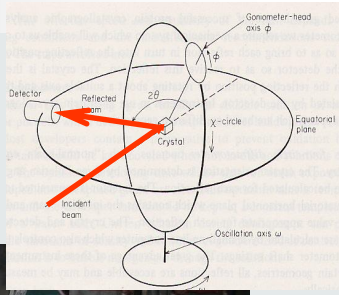
Normal Beam geometry



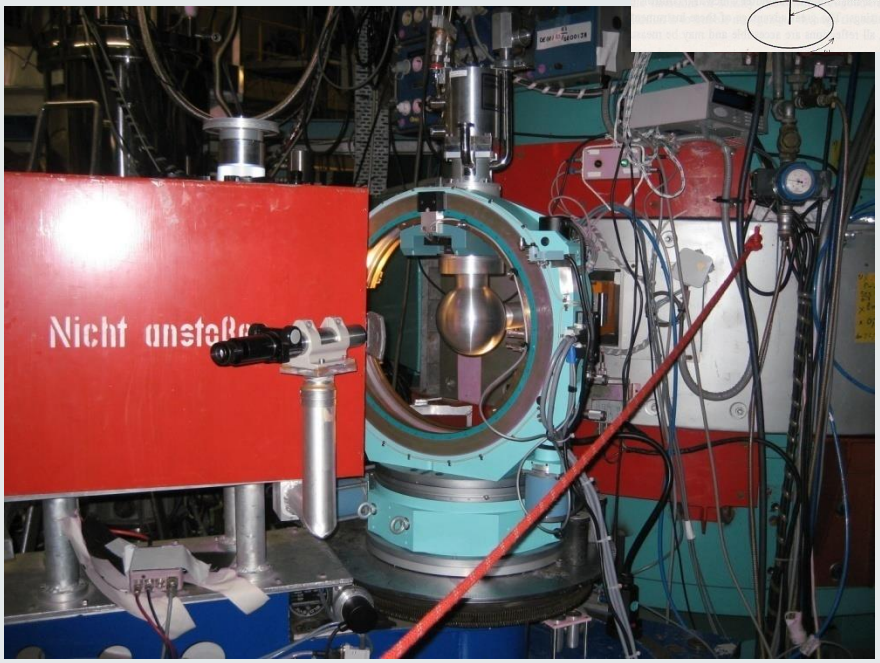


$$sin(\theta_{hkl}) = \lambda / 2D_{hkl}$$

5C2 (LLB) High resolution crystallography
D9 (ILL), HEIDI (FRMII)

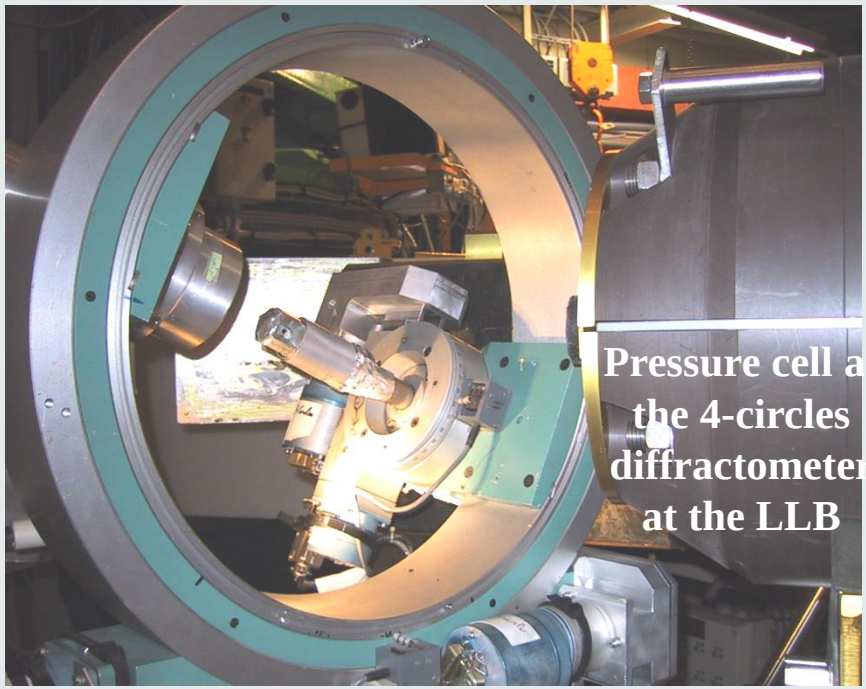


- 4-circles
- Cu (220) 0.84 A
- 5-1000K



6T2 High pressure diffraction

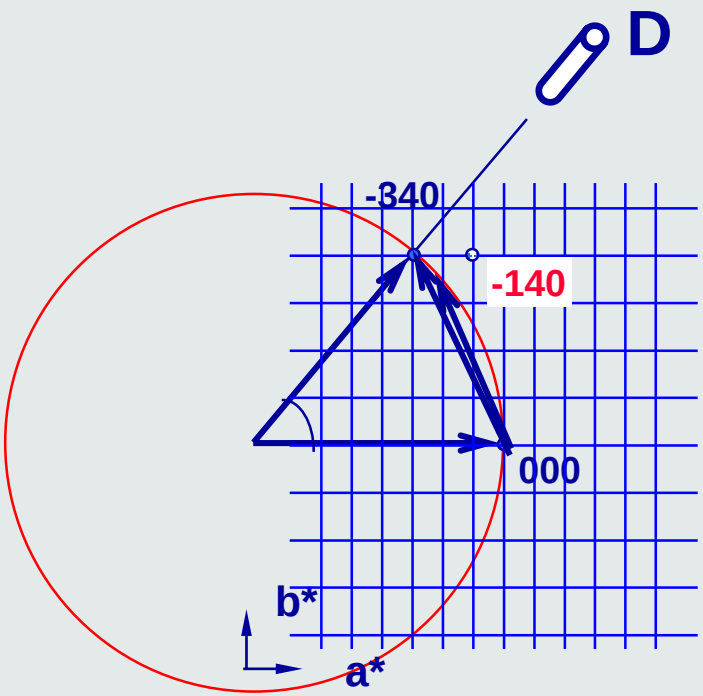
- 6T2, 4-circles mode
  - Cu (220) 0.90 A
  - PG 1.55, 2.35 A
    - 5-300 K



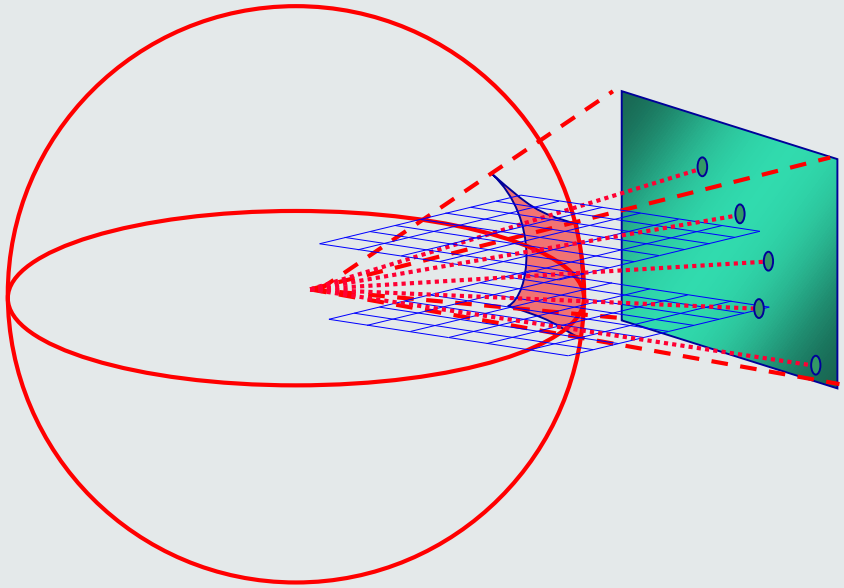
Pressure cell at the 4-circles diffractometer at the LLB

DIFFRACTION USING PSD

Diffraction conventionnelle:



Diffraction using PSD :

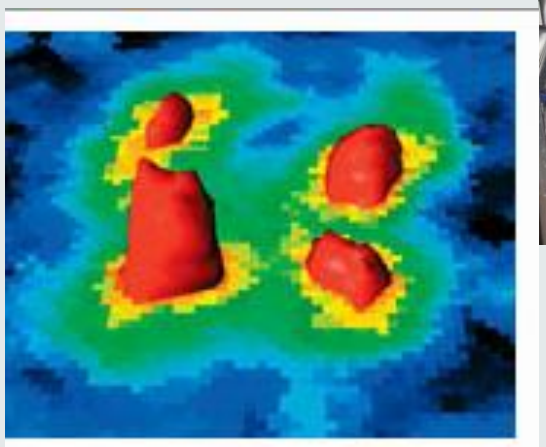


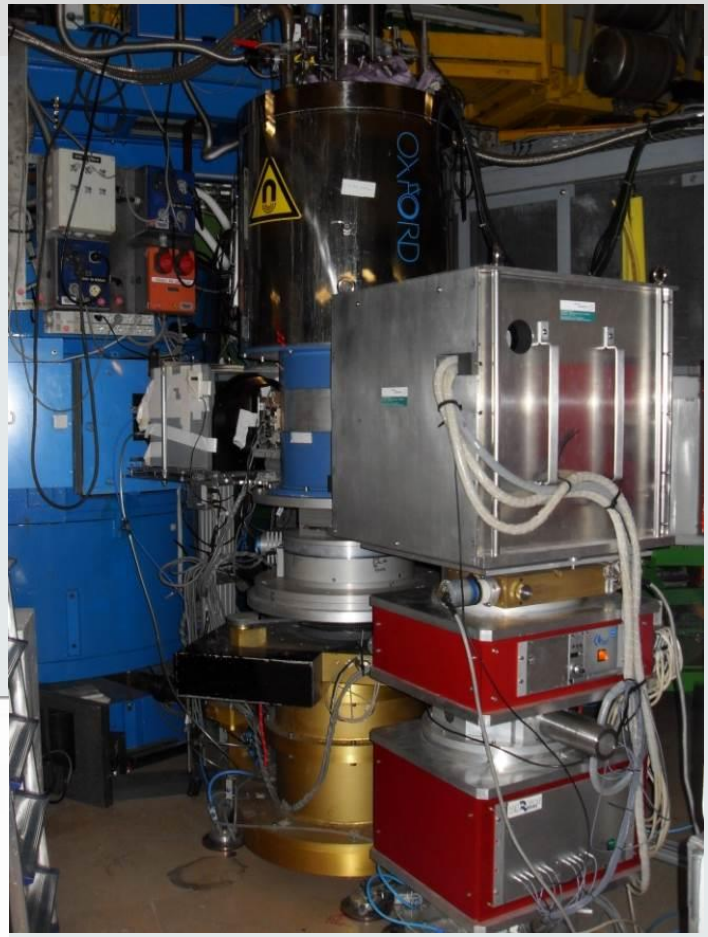
5C2 Hot neutron 4-circles diffracto

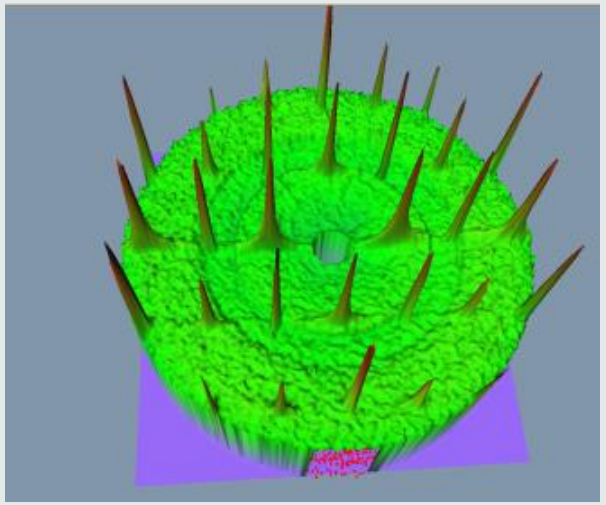
- 0.84 Å
- Cu (220)
- 8-800 K

6T2 thermal neutron diffractome

- 0.9, 2.4, Å
- 1.4 A PN
- RF flipper
- 7.5 T magnet
- -5°< ν< 20°
- >50 mK

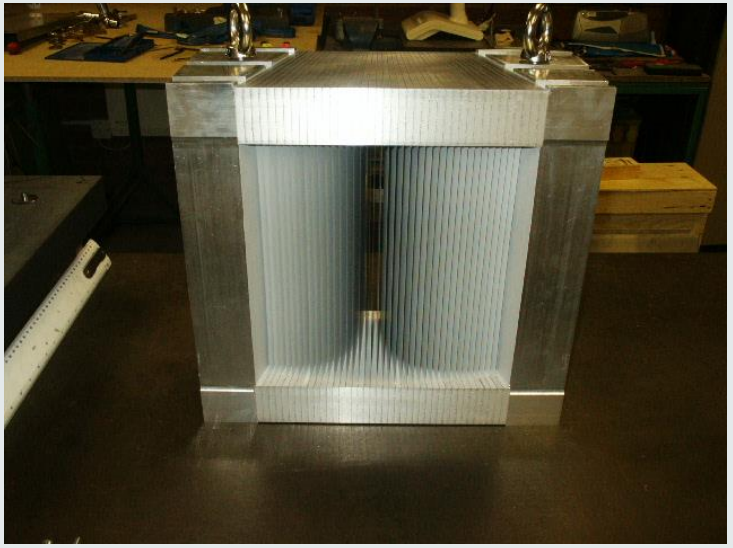


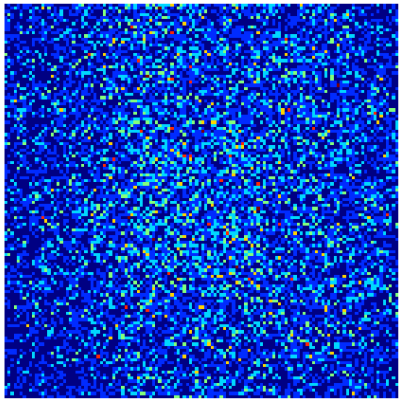




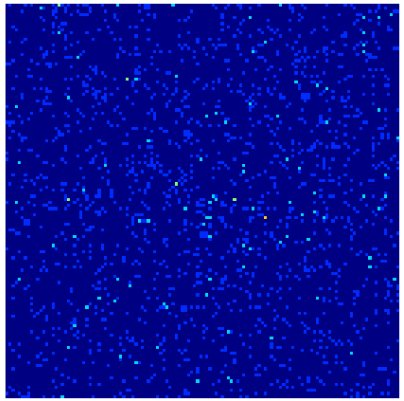
RADIAL COLLIMATOR

BG reduction by 8





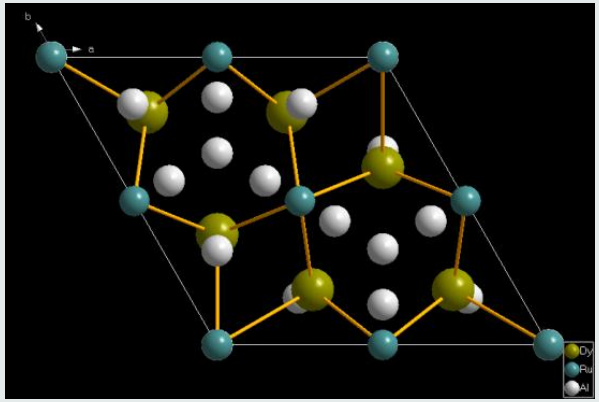
55% of pixels full

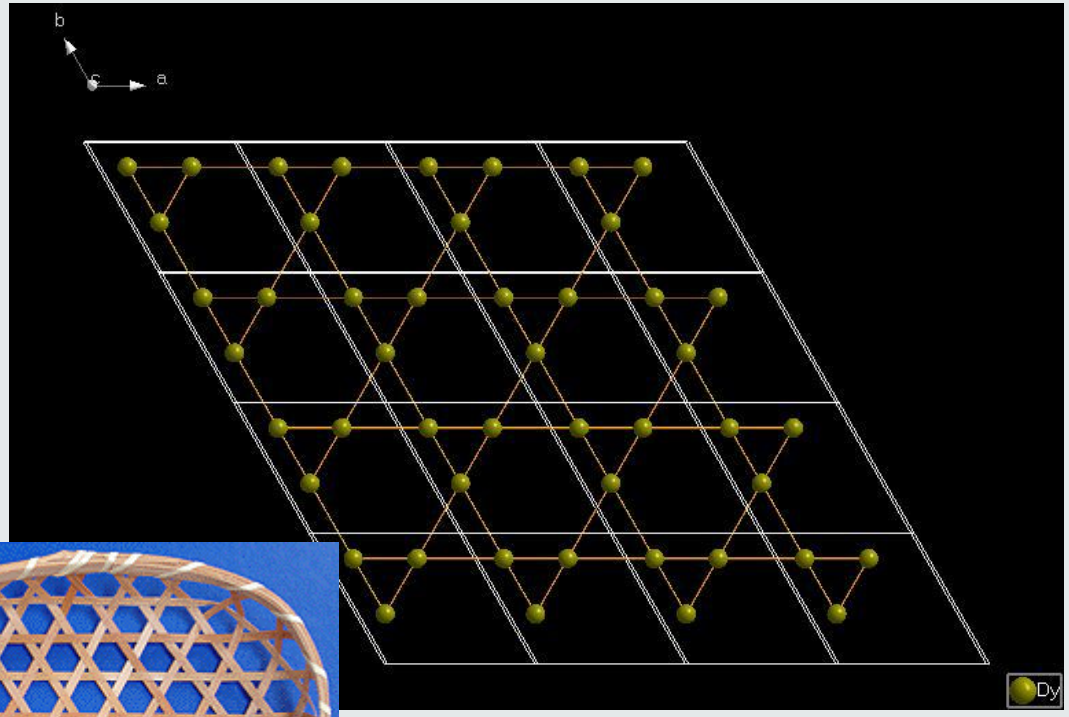


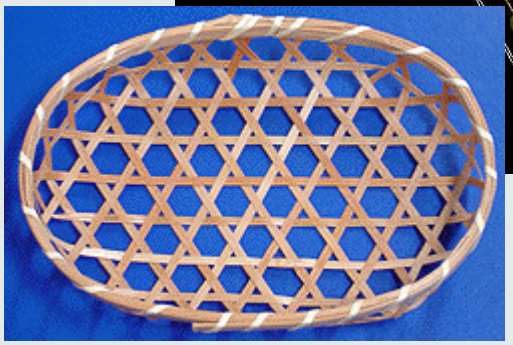
90 % of pixels empty

4f Magnetism and its Effects on Electronic Properties of $Dy_3Ru_4Al_{12}$

D.I. Gorbunov[1,2*], M.S. Henriques[3], A.V. Andreev[1], A. Gukasov[4], V. Petříček[1], N.V. Baranov[5], Y. Skourski[6], V. Eigner[1], M. Paukov[2]

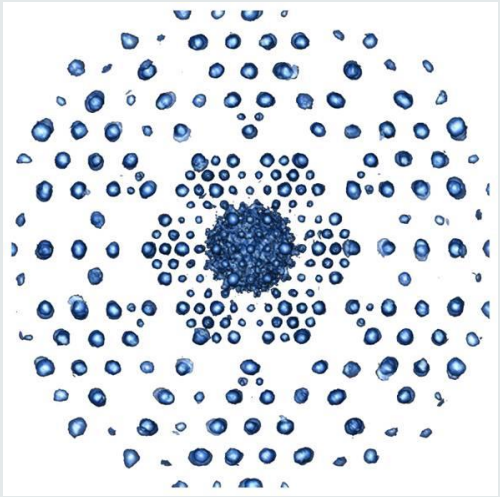


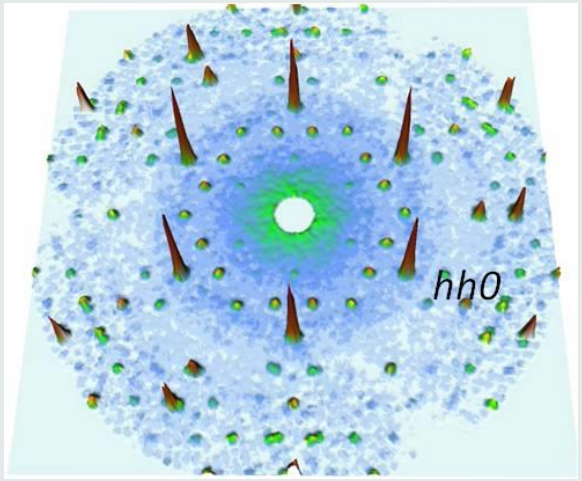




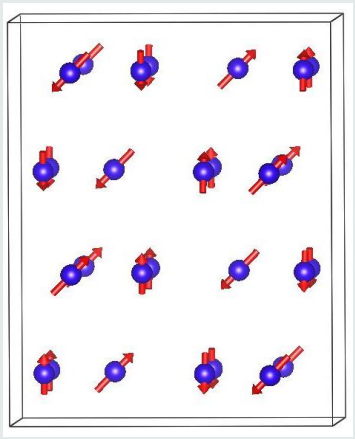
4f Magnetism and its Effects on Electronic Properties of $Dy_3Ru_4Al_{12}$

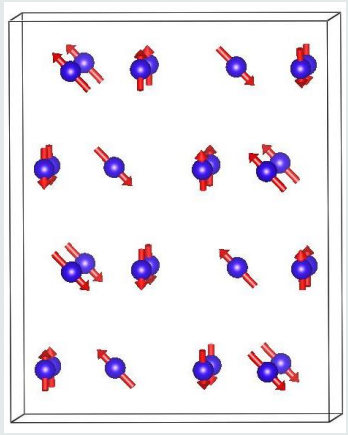
D.I. Gorbunov[1,2*],. Henriques[3], A.V. Andreev[1], A. Gukasov[4], V. M.S Petříček[1], N.V. Baranov[5], Y. Skourski[6], V. Eigner[1], M. Paukov[2]

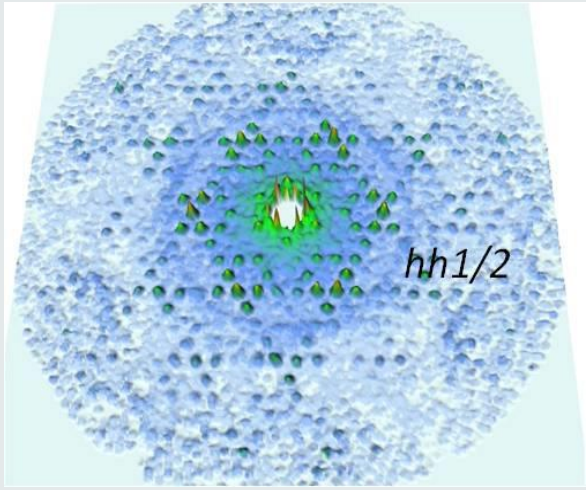




k=(1/2 0 1/2)

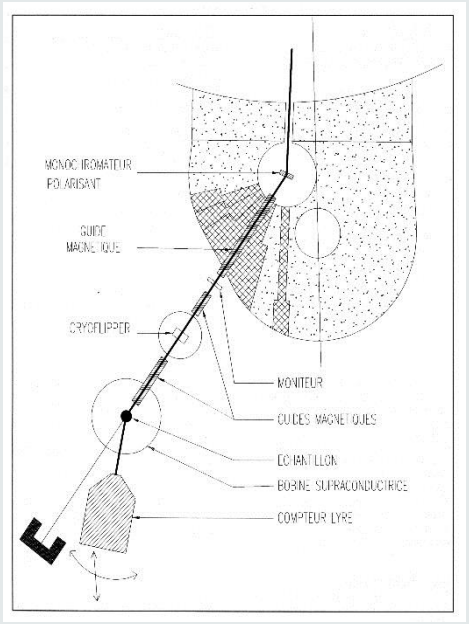


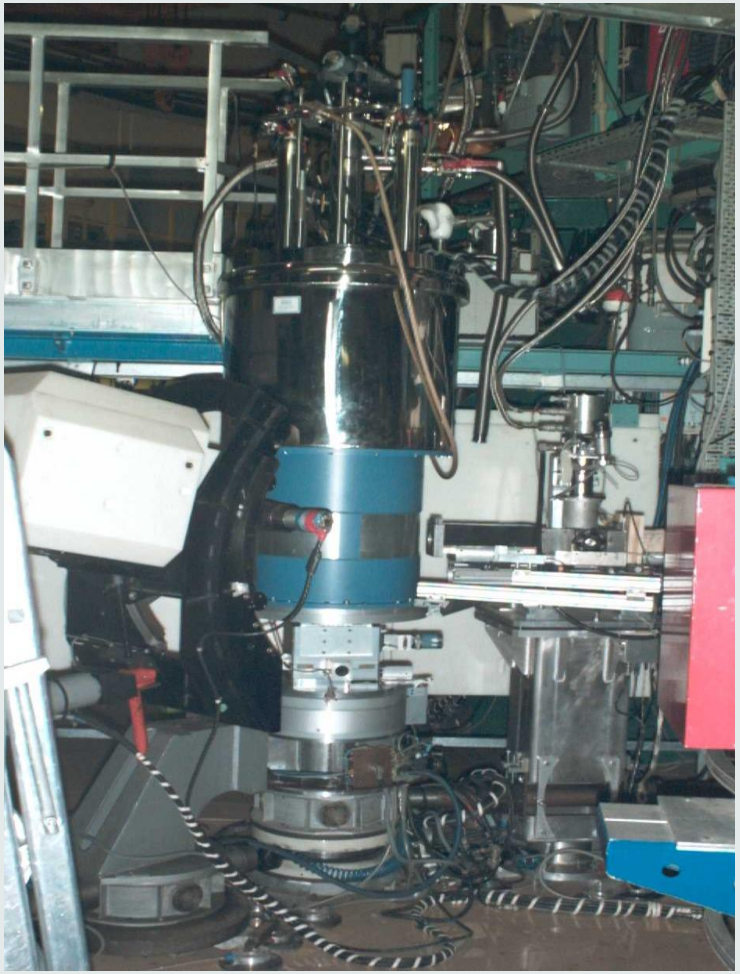




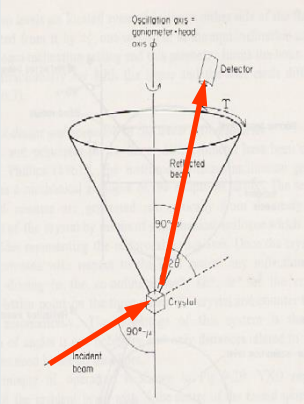
5C1 DIFFRACTOMETER (LLB)
D3 (ILL) POLI (FRMII)

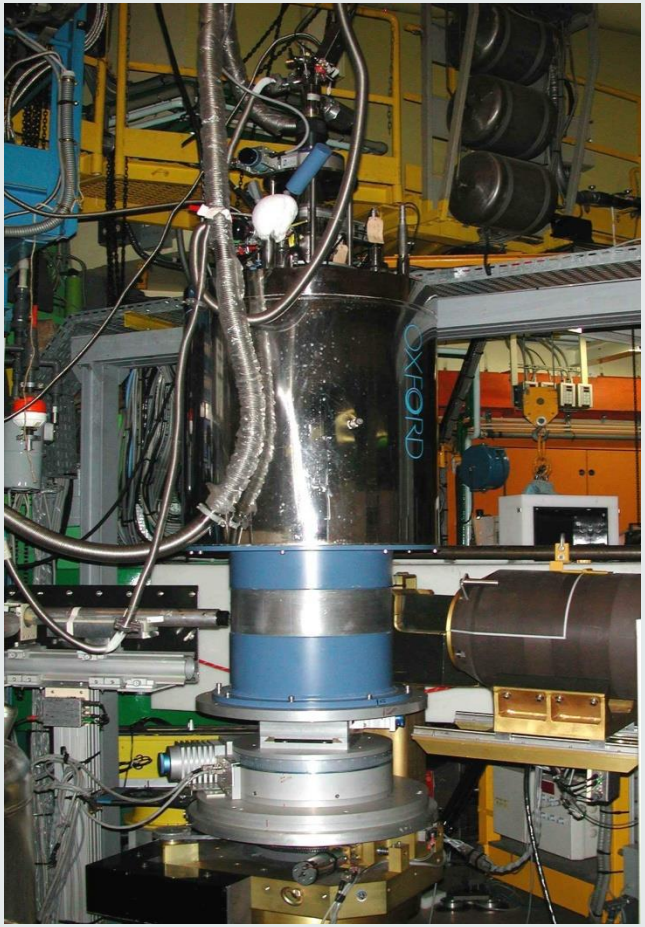
- 0.84 Å
- Heussler 50x50 mm^2 in transmission
- Cryoflipper
- Asymmetric 7.8 T magnet
- -5°< ν< 20°
- lifting counter





Lifting counter





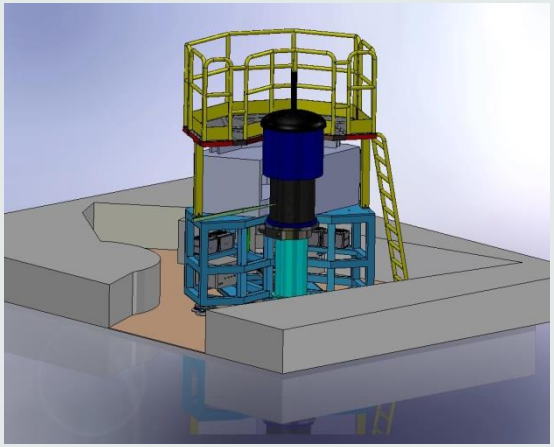
- 6T2, Lifting counter mode
  - 7.5 T + 40 mK
  - 7.5 T +10 Gpa+40 mK
  - Split magnet -5°+20°

5C1 polarised neutron diffractom

- 0.84 Å
- Heussler
- Cryoflipper
- 7.8 T magnet
- -5°< ν< 20°

Very Intense Polarized Neutron DIFFRACTOMETER (5C1) at LLB

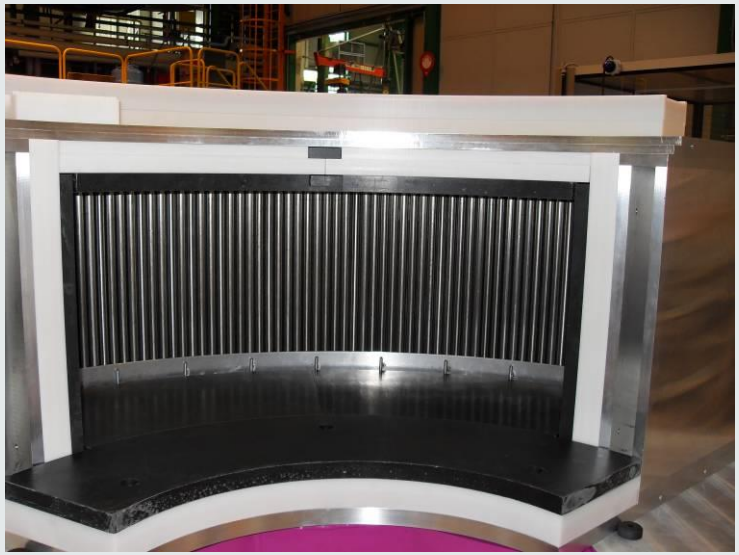
project started in 2006

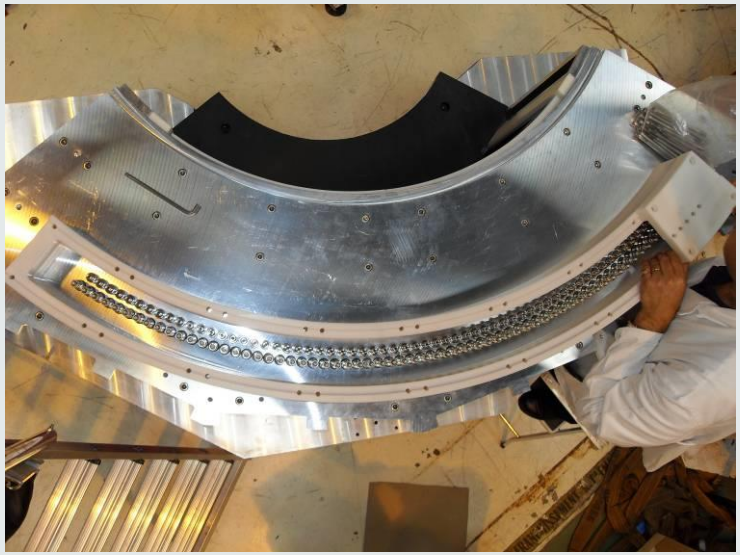


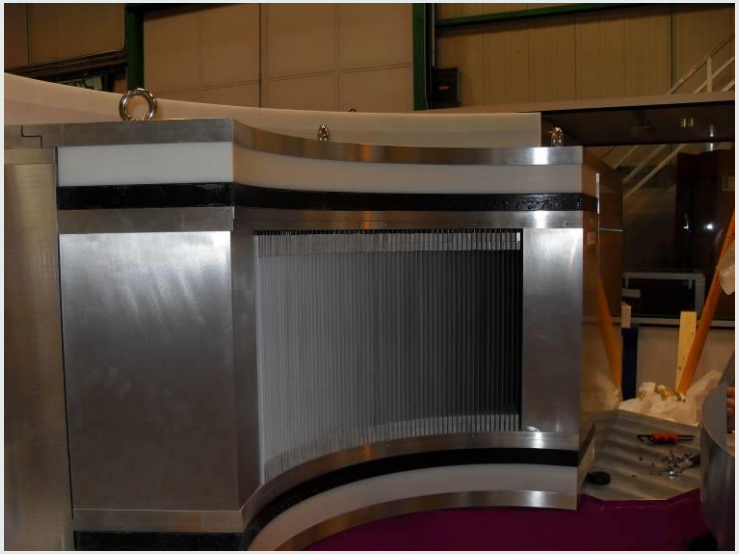
25°x90°

0.7 rad

VIP NEUTRON DIFFRACTOMETER (5C1)

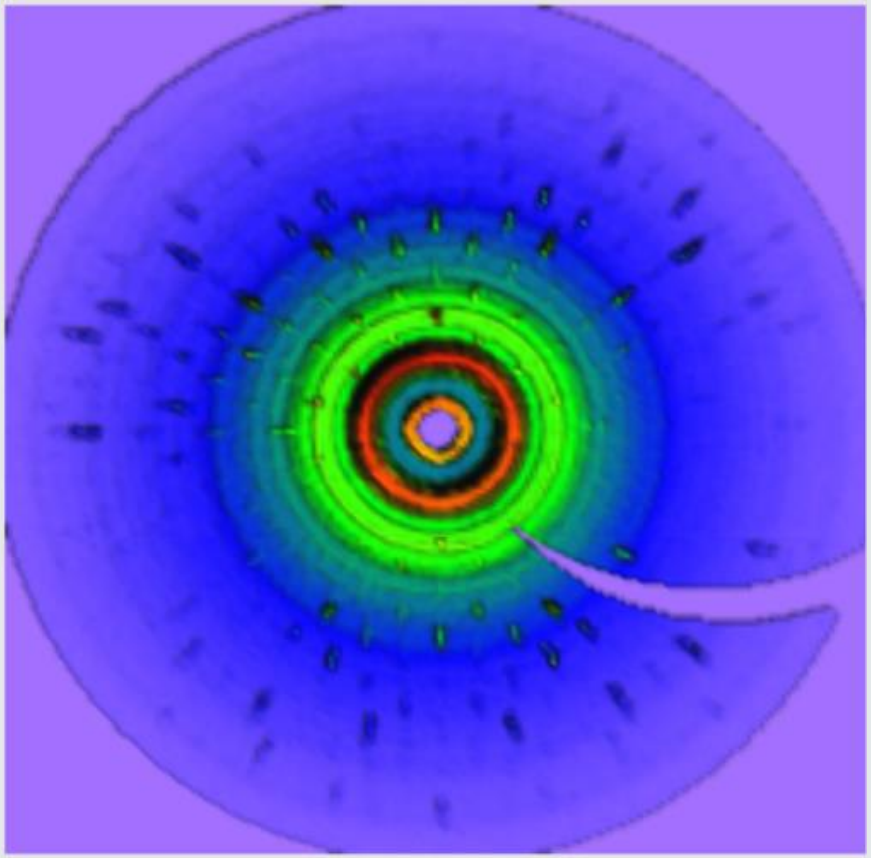






2x19 mm resolution (0.2°x1.2°)

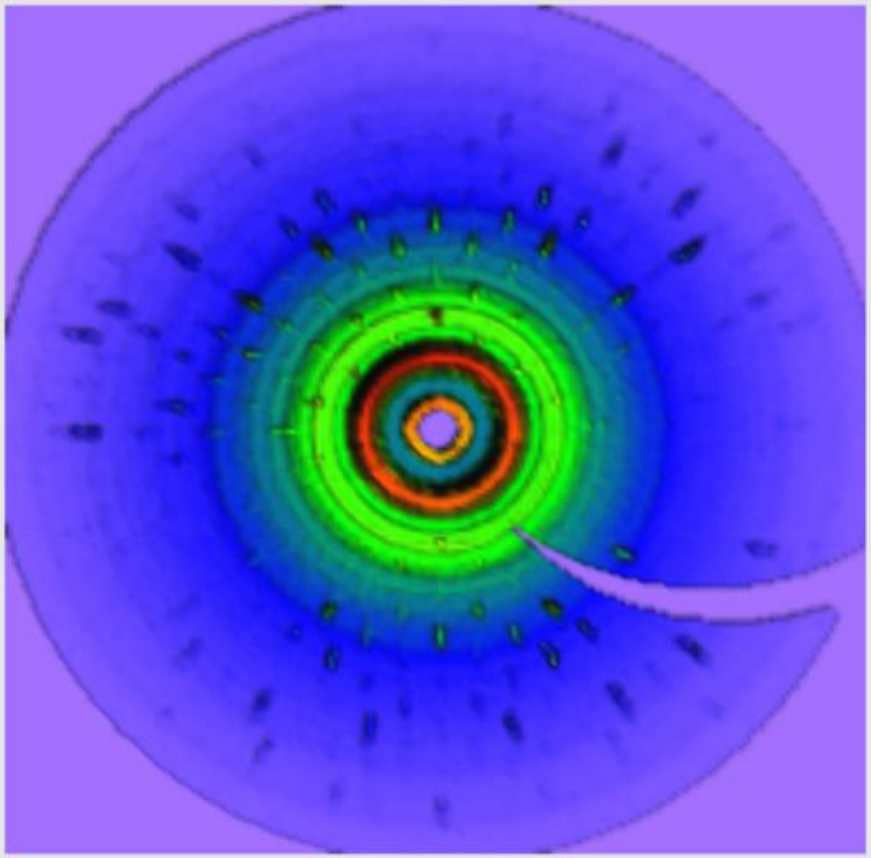
VIP Neutron DIFFRACTOMETER (5C1) LLB



Tb2Ti207 2 K, 1T
A=10.12 Å Fd3m
V~60mm3

3500 steps of 0.1°
Exposition 4 sec/frame

VIP Neutron DIFFRACTOMETER (5C1) LLB



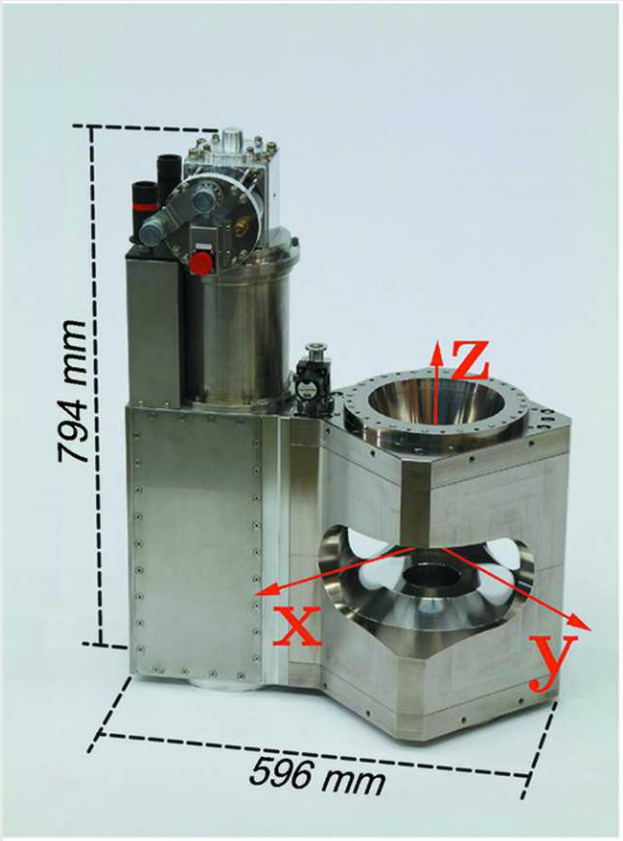
Tb2Ti207 2 K, 1T
A=10.12 Å Fd3m
V~60mm3

3500 steps of 0.1°
Exposition 4 sec/frame

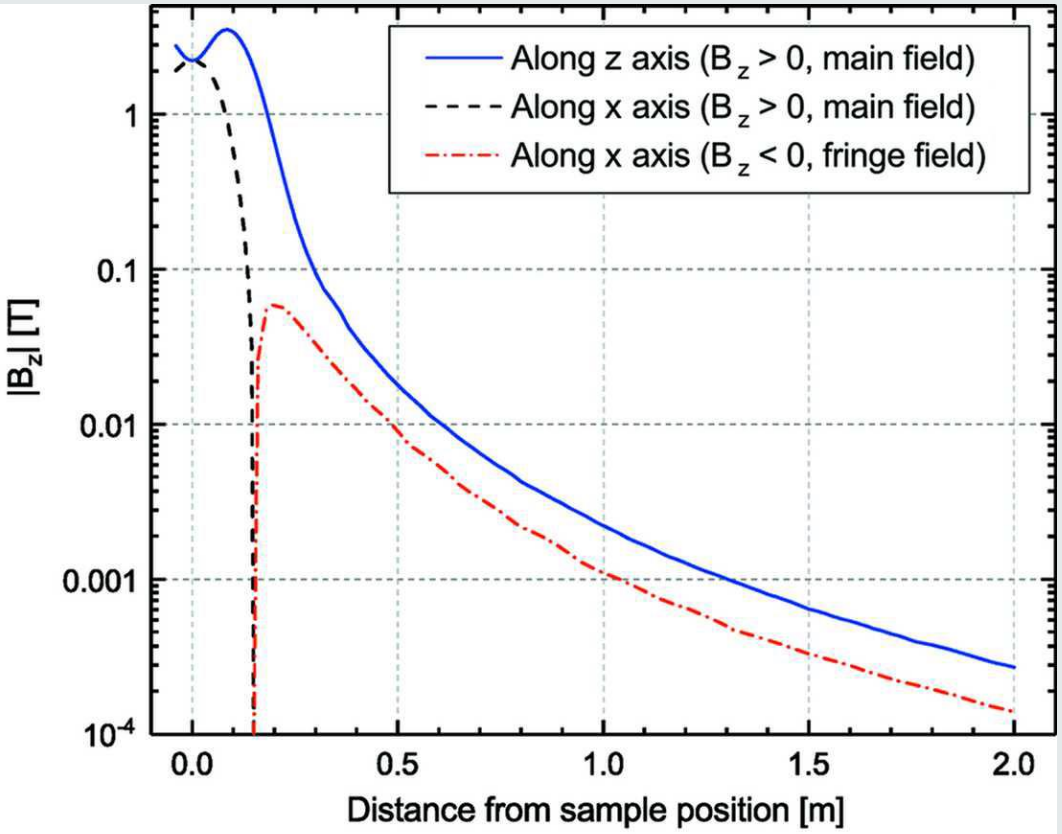
951 reflections observed

726 FR> 3σ

MLZ HTS 2.2 T magnet



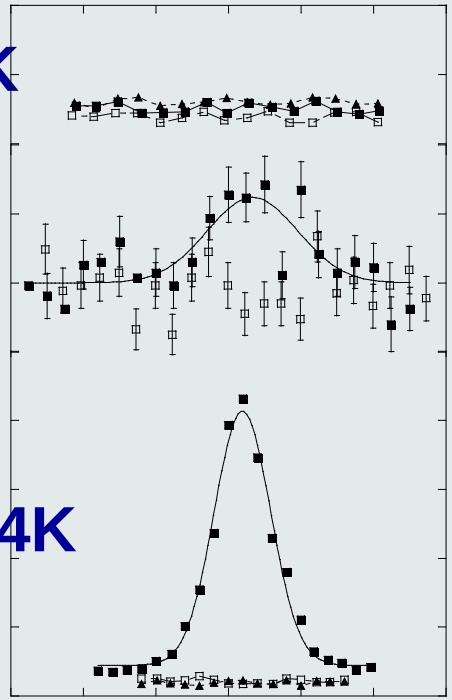
(a)



(b)

$Tb_2Ti_2O_7$a spin liquid single crystal under pressure and applied field

- 6T2, Lifting counter mode
  - 7.5 T + 40 mK
  - 7.5 T +10 Gpa+40 mK



T=0.14K

P_i=2.8 GPa;
P_u=0

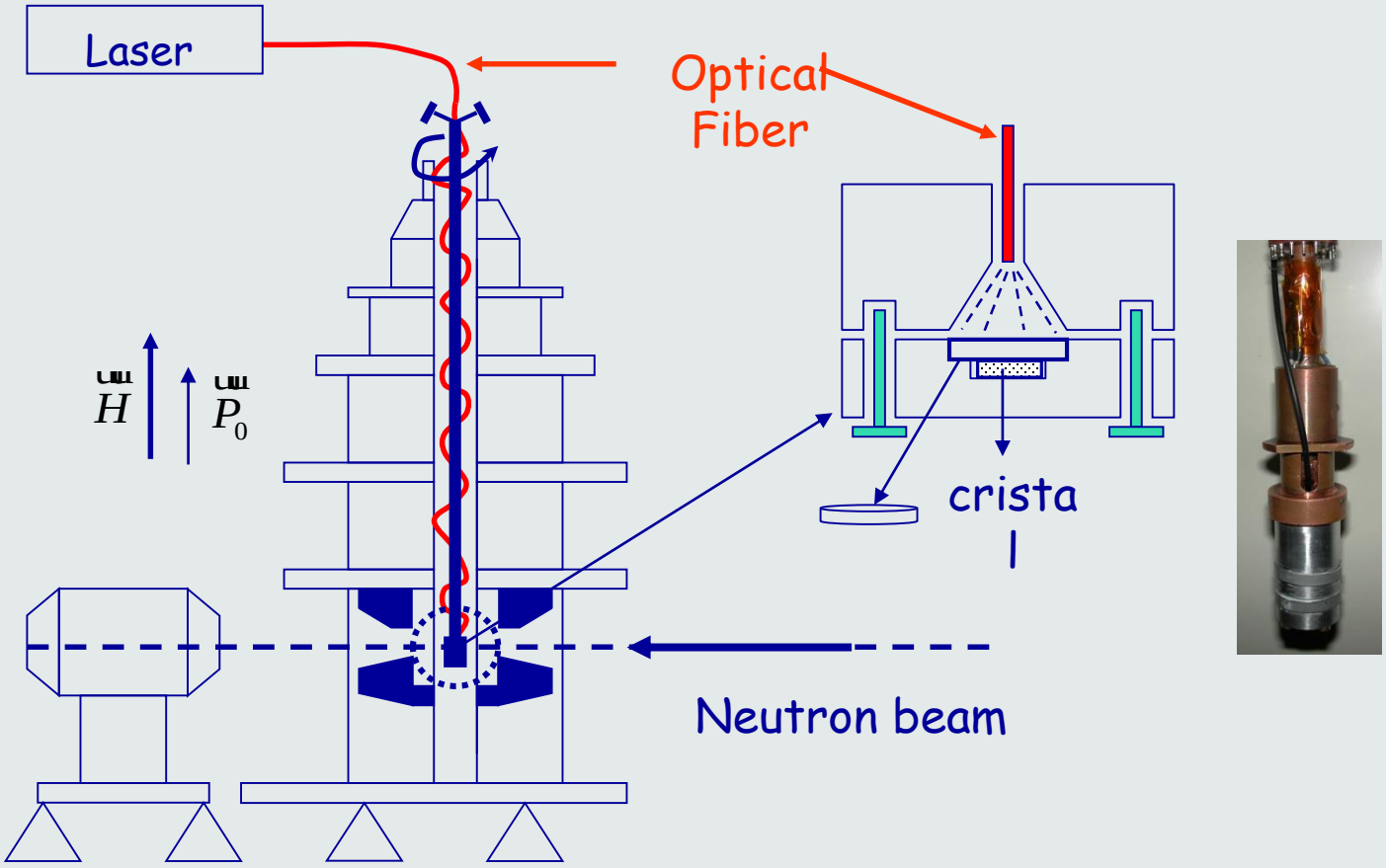
P_i=2.0 GPa;
P_u=0.3 GPa
along 111

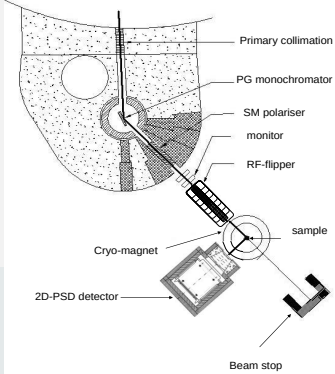
P_i=2.4 GPa;
P_u=0.3 GPa
along 011

I.Mirebeau, I. N. Goncharenko, G. Dhalenne, A. Revcolevschi, Phys. Rev. Lett. 93, 187204 (2004).

Photo-excited state in $[Fe(ptz)_6](BF_4)_2$

A. Goujon, B. Gillon A Gukasov, J Jeftic, and F Varret Phys. Rev. B 67, 2003



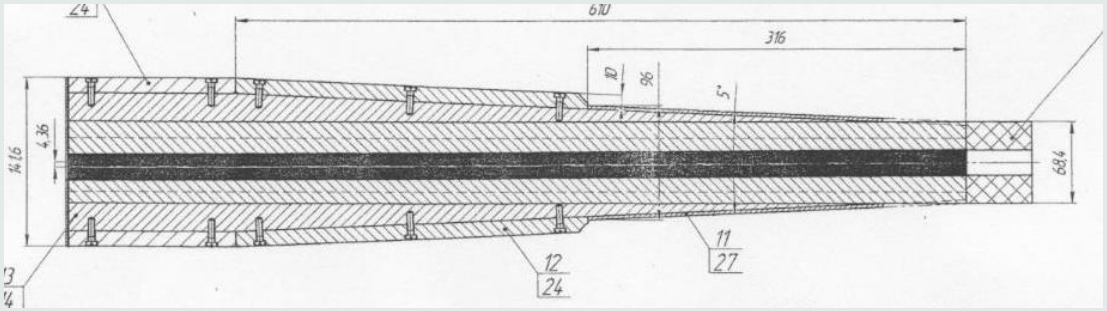


POLARIZING BENDER

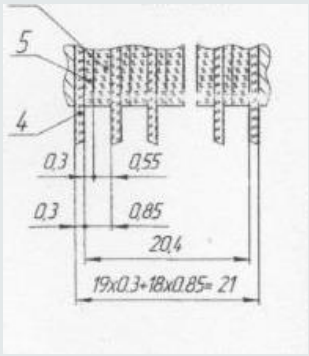
PNPI, GATCHINA (delivered in 2005)

- ***A.F. Schebetov et al. Nucl. Instr. Meth. B94 (1994) 575.***

Beam cross section:
20x50 mm L=780 mm



780 mm



FeCo –V Supermirrors ***m=2.5*** ***λ= 1.4Å***

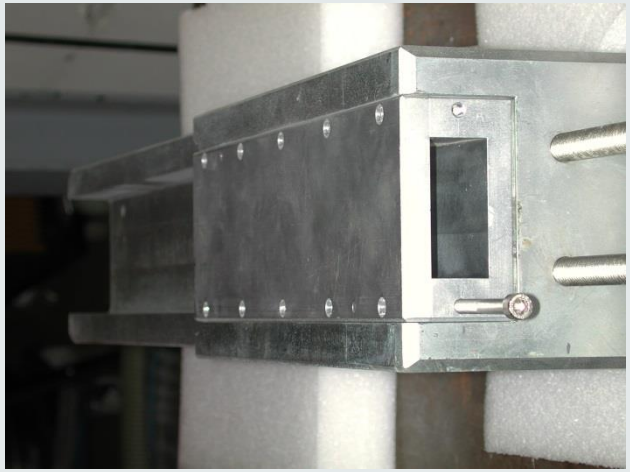
$\mathbf{P_0}$=97% R= 70

Count rates 10-15 times higher than that on 5C1

Sin (θ/λ) < 0.6 Å $^{-1}$ Sin (θ/λ) < 1 Å -1 for 5C1

POLARIZING BENDER

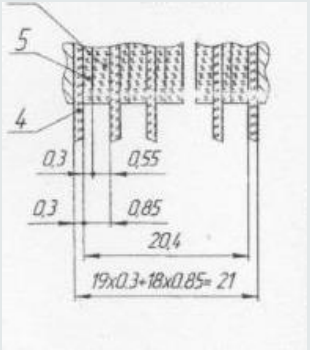
PNPI, GATCHINA

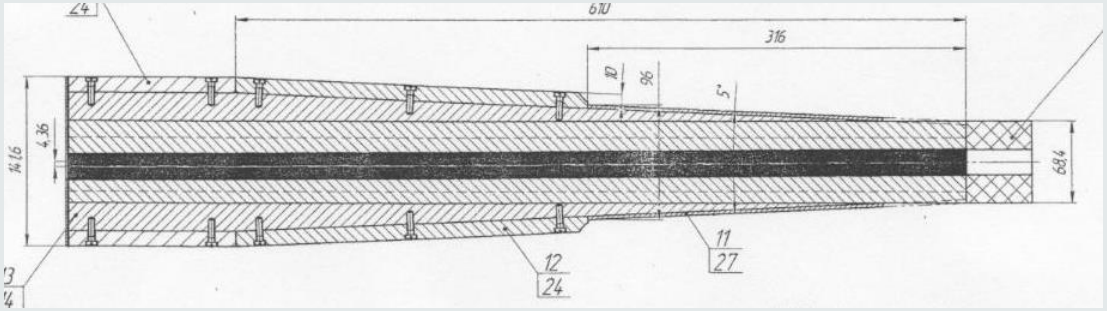


780 mm

- ***RSD FeCo –V Supermirrors*** ***m=2.5***

Beam cross section:
20x50 mm L=780 mm





Optimum SC Diffraction suite

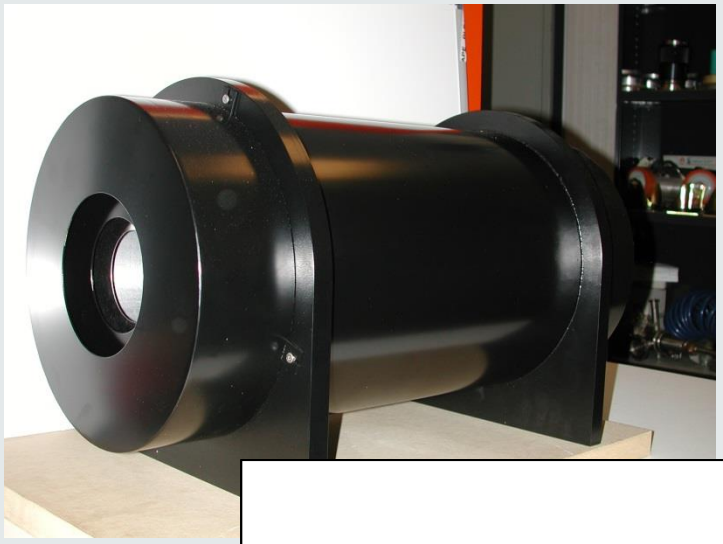
Hot (thermal) 4-circles diffractometer (T,P)

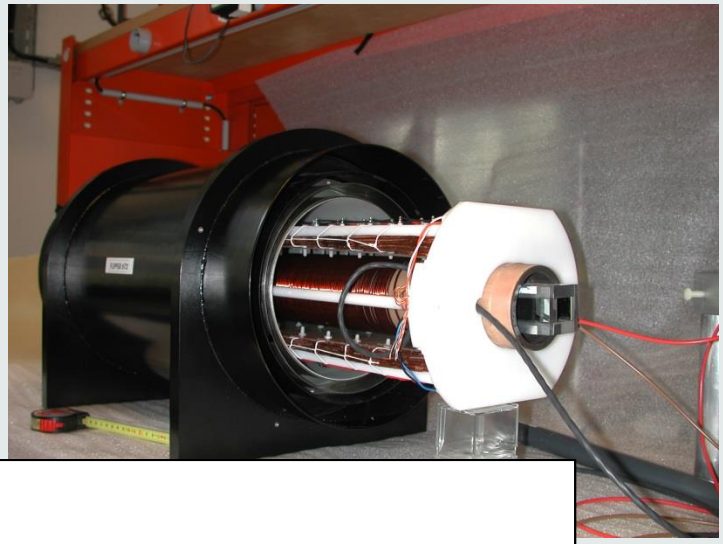
High-field magnetism diffractometer (H,T, P, etc)

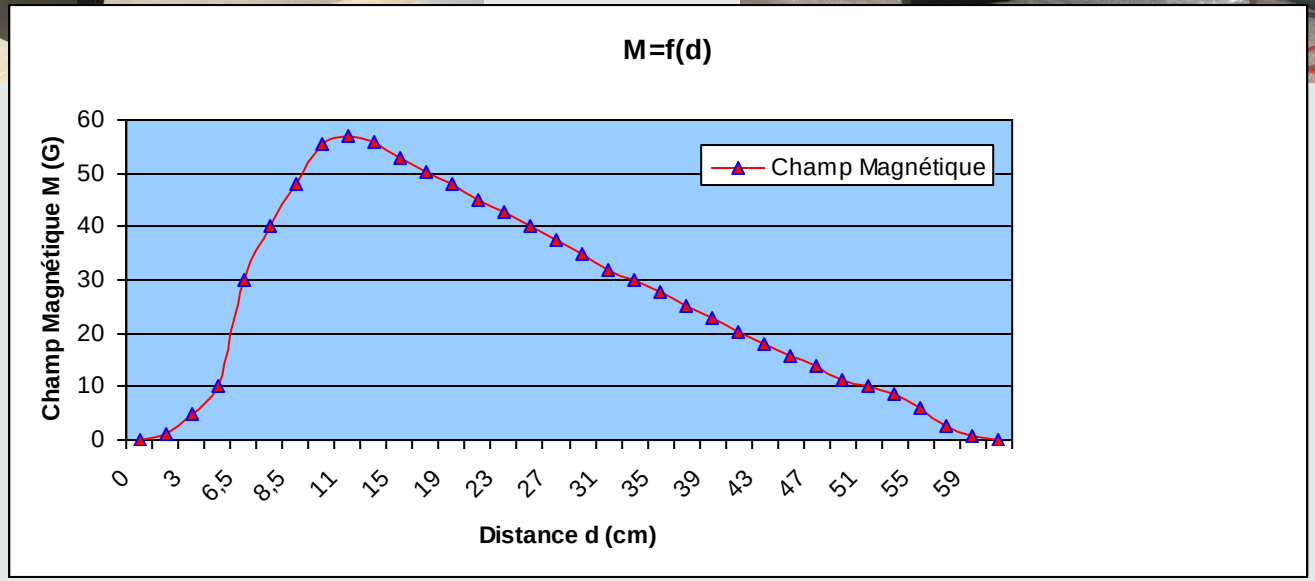
Laue diffractometer

Cold neutron (bio) diffractometer

RADIO-FREQUENCY ADIABATIC FLIPPER

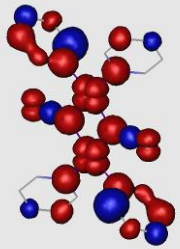




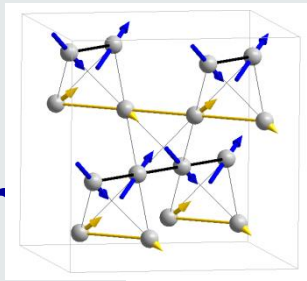


PND PROVIDES

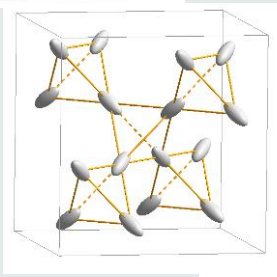
- Spin Densities



- Magnetic structure refinemer



- Atomic Susceptibility Parameters



- Non-collinear Magnetization Densities ?