# In-situ Crystal Alignment at Low Temperature

*J. Allibon, E. Bourgeat-Lami, L. Chapon, Ph. Decarpentrie, J.-P. Gonzales, J. Halbwachs, E. Lelièvre-Berna, J. Ollivier, B. Ouladdiaf, G. Pastrello*

*The non-magnetic eulerian cradle mounted inside the 3 K pulse-tube cryostat.*
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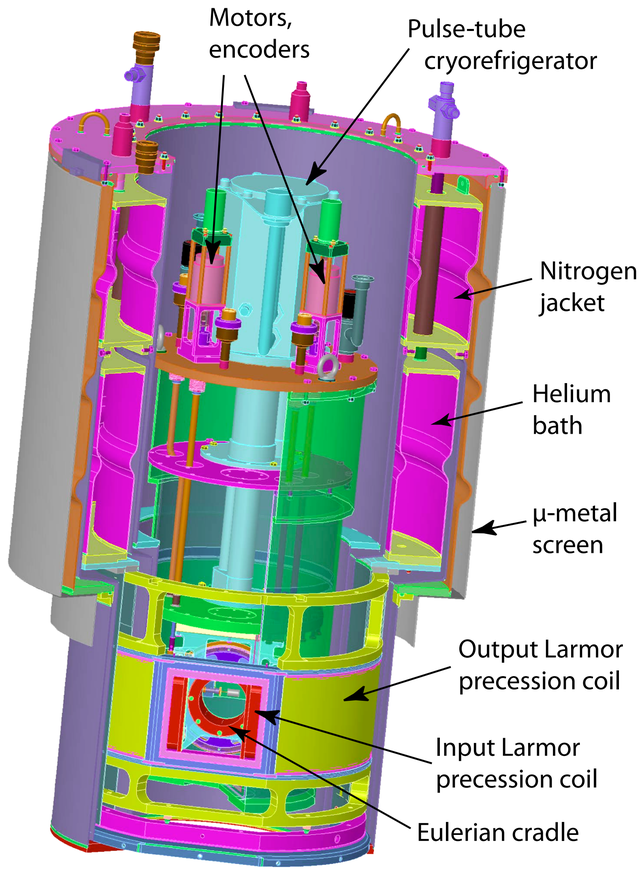
To carry out elastic Spherical Neutron Polarimetry experiments, 3D access to Bragg peaks in different scattering planes is required to elucidate complex magnetic structures from a few specifically chosen Bragg reflections [1] and to determine magnetisation distributions from many reflections [2]. For these reasons, we decided to build a cryostat containing a fully non-magnetic Eulerian cradle called ***Cryocradle***.

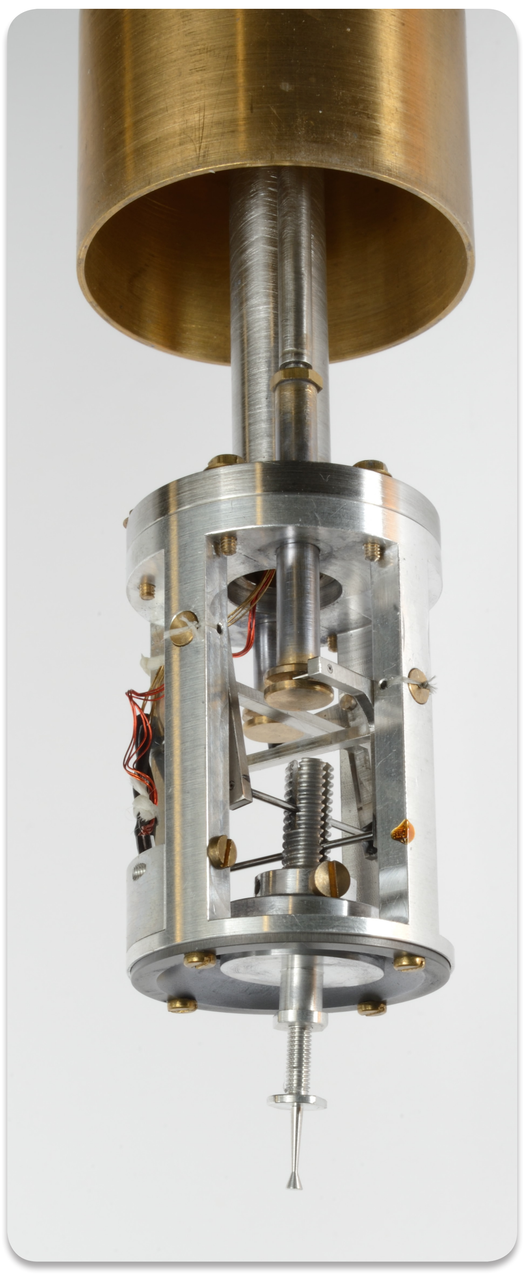
The prototype consists of two circles mounted inside a 0.5W @ 4.2K pulse-tube cryorefrigerator. The first circle supports the sample and fixes the angular position χ. The second circle controls the φ axis of the sample by means of a gear. Both circles are motorised using tangential axes, with the motors and encoders outside the zero-field sample chamber of Cryopad [3].

The whole cradle is made from hardened BeCu to reduce the cool-down time. The tangential axes are mounted on flexible arms to compensate the thermal expansion. These flexible supports prevent the displacement of the axes and minimise the hysteresises. The friction is reduced with a DLC coating (Diamond-Like Carbon) and using BN powder as lubricant.




Schematic overview of the Cryocradle inside the zero-field chamber of Cryopad (max field required of 100 nT).

The ***Cryocradle*** was commissioned on the polarised neutron diffractometer D3 in July 2013. We measured the polarisation matrix of 27 Bragg peaks of the langasite $BaNbFe_3Si_2O_{14}$ at 3.2 K in 5 days. We verified that the absolute angular resolution is 0.1° from 3 to 300 K.



Goniostick with sample holder inclined with both levers
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Goniometer heads are an alternative solution for aligning crystals in cryostats and cryomagnets:

- the inclination of a cryostat can be very restricted on some instruments, especially when focusing optics are installed inside the sample environment,
- the alignment of lattice planes with a magnetic field or the incident neutron polarisation can only be performed inside a cryostat/cryomagnet,
- the precession of a tilted cryostat creates non-homogeneous background,

We have therefore proposed to build a new eucentric system called ***Goniostick*** and based on the idea developed by Berneron *et al.* in the 80s [4]. Basically, this is a special stick for top-loading cryostats with two motors or micrometer screws at the top and a goniometer at the bottom.

The inclination of the sample is driven by the translation of two rods protruding from the top flange of the stick. At the lower end of these rods, there is a groove which acts as a push rod on right-angled levers positioned on orthogonal axes.

The combined displacement of these levers provokes the inclination of the sample around a pivot (point located on the main vertical axis of the stick). The sample holder is identical to those used on ILL diffractometers and allows the centring of the crystal on the pivot.

The prototype shown on the photos hosts a Cernox sensor to measure the temperature near the sample in the exchange gas. This ***Goniostick*** fits inside a Ø49 mm top-loading cryostat and allows sample inclination of ±7°.

The tests performed on the time-of-flight spectrometer IN5 revealed a backlash of 0.14° which is easily compensated by always finishing movements in the same direction. That way, we measured a precision of 0.02° between 20 and 300 K.

Goniostick with sample holder not inclined
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[1] P.J. Brown, *Physica B* **297** (2001) 198 — [2] P.J. Brown, J.B. Forsyth, E. Lelièvre-Berna and F. Tasset, *J. Phys. Cond. Matter* **14** (2002) 1957
[3] E. Lelièvre-Berna, E. Bourgeat-Lami, Y. Gibert, N. Kernavanois, J. Locatelli, T. Mary, G. Pastrello, A. Petukhov, S. Pujol, R. Rouques, F. Thomas, M. Thomas and F. Tasset, *Physica B* **356** (2005 )131 — [4] M. Berneron, A. Filhol, J.-J. Vernier and M. Thomas, *Revue Phys. Appl.* **19** (1984) 795