# UHV Superconducting Magnet System for Low Energy X-ray XMCD Experiments

Jùlio Criginski Cezar[2], Peter van der Linden[1], Flora Yakhou-Harris[1], Nicholas B. Brookes[1], Laurent Eybert[1], Andrea Fondacaro[1], Marc Savey-Bennett[3]

• 1 ESRF – European Synchrotron Radiation Facility, 6 rue Jules Horowitz, 38043 Grenoble , France

• 2 ESRF and Laboratório Nacional de Luz Síncrhotron – LNLS, CP6192 Campinas, SP Brazil 13083-920

• 3 Cryogenic Limited, Acton, London W3 7Qe, United Kingdom

A light for science ESRF

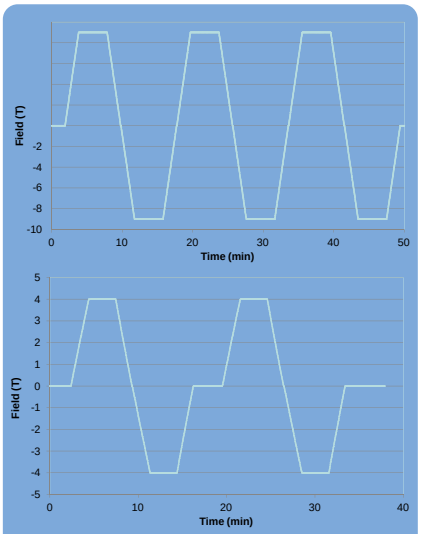
**In the framework of the ESRF upgrade programme, the soft X-ray beamline ID08 will be equipped with a new superconducting magnet system dedicated to study the electronic and magnetic properties of matter using soft X-rays from 300 up to 1500 eV. The magnet system comprises two nested UHV cold bore split-coil magnets of ±9T along the X-ray beam and ± 4T perpendicular to the X-ray beam and a variable temperature insert with a temperature range of 1.5 to 400 K. The VTI wiring will include possibilities to measure total electron yield, sample transport properties or the application of an electric field. The system will be further equipped with a UHV sample preparation facility allowing in-situ application of surface science techniques.**

Here jpg of the coils and bore tube? (would be nice)

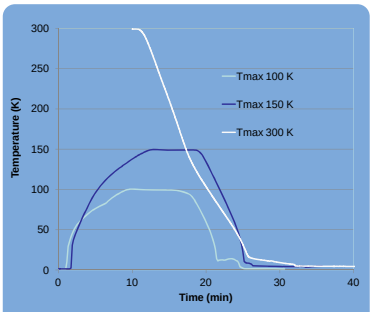
## Magnets

The main specifications of the magnets include a very high sweep rate and operation in exclusive OR mode: only one magnet at a time can be energised. The inner coil producing the field of 9T along the beam is wound in $Nb_3Sn$ wire, the outer coil producing 4T perpendicular to the beam is wound in NbTi wire. Both magnets are running off a single power supply providing 200 A. The coils are operated in a liquid He bath at 4 K. Even though cooling is very efficient in the liquid bath, a certain thermalisation time has to be respected after a fast sweep.

| Magnet | Field direction | Bore (mm) | Split (mm) | Sweep time -max to +max | Homogeneity 1cm DSV |
|---|---|---|---|---|---|
| 9T | Along the beam | 60 | 50 | 140 sec | <1% |
| 4T | Perpendicular horizontal | ……. | 50 | 240 sec | <1% |




Time sweeps of the 9T coil (top) and 4T coil (bottom)




VTI temperature sweeps

## Variable Temperature Insert

Based upon previous experience the VTI was designed for optimum serviceability. There is no internal capillary for sample cooling; Helium for sample cooling is supplied to the VTI from the main bath through a short syphon. Thus the VTI can be simply pulled out of the system once it is at room temperature. The VTI contains a 4K pot plus needle valve to bring the cold source close to the sample. The base temperature depends on the radiation heat load, during factory testing 1.43 K was reached. The maximum temperature is 400K. Warm-up from base temperature to room temperature is achieved in 20 minutes; from 300K to 400 K is another 20 minutes. cooldown from 300 to 4K is achieved in 30minutes but the last step to 1.5 K takes another 60 minutes. The VTI can be rotated around the vertical axis over an angle of 360 degrees, and translated vertically over ± 25mm.

The system during factory testing at Cryogenic limited

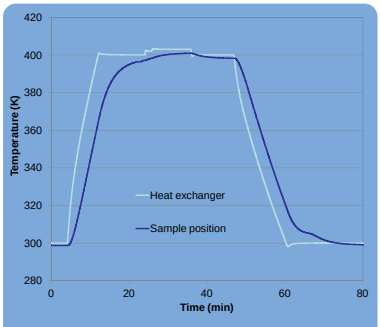
The system control rack

## UHV conditioning

The system was built to UHV specifications. As the coils are potted in epoxy the baking temperature has to stay below 80 °C. A vacuum of $3x10^{-10}$ has been reached, with an RGA showing the presence of water but no oxygen or hydrocarbons. The VTI rotation and translation stages were supplied by VG Scienta, and we are still waiting to get an answer on the specs they are supposed to reach.

## System control unit

The system control rack contains a purpose built power supply and switching unit, two Lake Shore temperature controllers (336 and 340), LHe and $LN_2$ level meters and needle valve control electronics, the bakeout unit and control computer. The magnet power supply consists of a non standard 200A power supply featuring an increased voltage of 20 V to reach the required magnet sweep speed, a magnet switching unit and a current direction switching unit. The latter is controlled by the power supply and achieves switching at the zero passage without causing glitches on the output as can be seen in the above plots.




VTI temperature sweep 300 to 400K

## Conclusions

The system is currently undergoing factory testing; most of the specifications have been met. And then still some more.

ESRF, 6 rue Jules Horowitz,
BP220, 38043 GRENOBLE CEDEX, FRANCE
Tel +33 (0)4 76 88 20 00 - Fax +33 (0)4 76 88 20 20

Acknowledgements: more people. Names?

[1] What are the references to be given? Where?