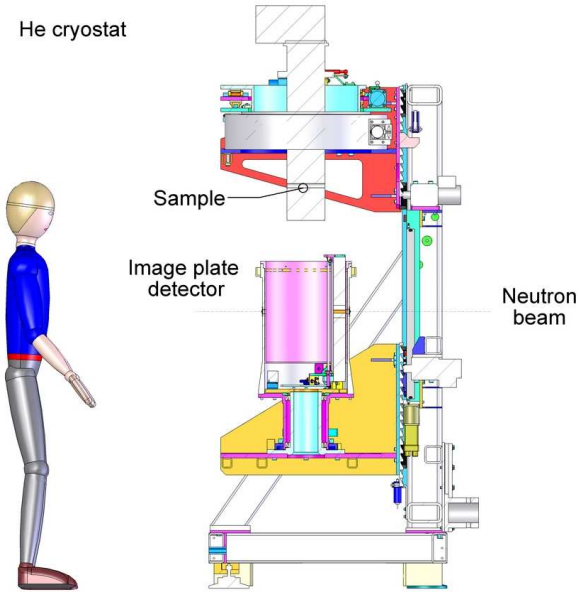
QLD QUASI-LAUE DIFFRACTOMETER

General view of the QLD

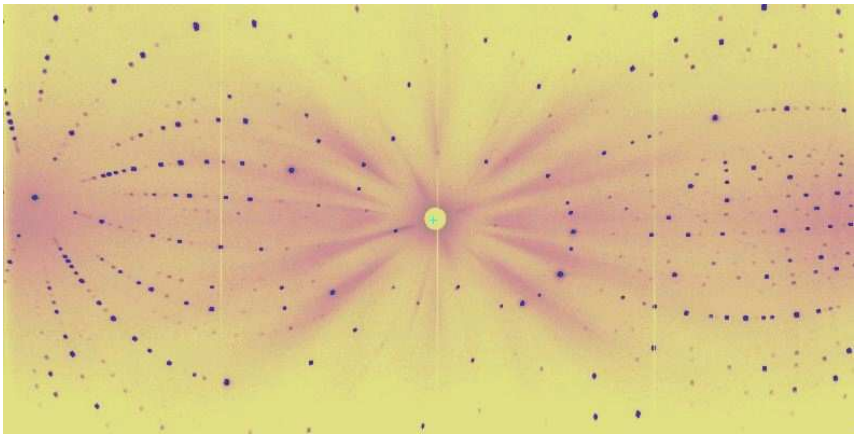


QLD schematic (open position)

The quasi-Laue diffractometer (QLD) is designed to collect rapidly diffraction data from single crystals, even of small dimensions. It uses a large-solid-angle cylindrical detector based on neutron-sensitive image plates.

It can cover many fields of interest either in materials science (thermal neutrons) or biology (cold neutrons).

Crystal diffraction done using X-rays is a widely used technique; neutron diffraction gives access to essential and complementary information.



A typical Laue diffraction pattern from $FeTa_2O_6$ just above the 3-D ferroelectric ordering temperature (Chung et al. J. Phys.: Condens. Matter, 16 (2004) 1-17). The faint cross of radial streaks about the central hole, which allows passage of the transmitted neutron beam, arises from 2-D magnetic ordering. Results from the Laue diffractometer VIVALDI at the ILL

CONCEPT

The sample crystal can be precisely positioned at the center of the detector drum and rotated around the drum axis.

Neutron-sensitive image plates cover the internal surface of the drum. Image plates offer high spatial resolution and a wide dynamic scale over very large angles at specimen. They are reusable after erasure by exposure to visible light.

Different sample holders can be installed including cryo-coolers, furnaces and pressure cells

CYCLE OF FUNCTIONING

1. the neutron beam passes through a hole in the cylindrical detector and hits the sample. The diffraction pattern is recorded on the image plates
2. the drum is scanned by a reading head in a phonographic mode. Duration: 3 minutes.
3. an intense orange light erases the image plates and a new diffraction pattern may be recorded. Duration: 1 minute.

Entire detector

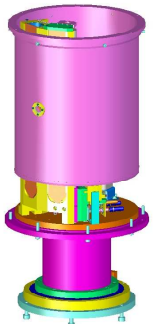
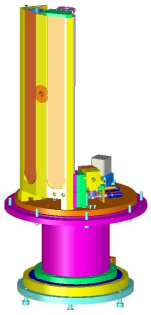


Image plate supporting drum



Erasure and reading system

READING PRINCIPLE

- A red spot emitted by a laser diode excites the blue photostimulable luminescence stored in the IP after exposure to neutrons.
- Resulting blue light is recorded by a photomultiplier tube (PMT) placed in front of the IP.
- The entire drum surface is scanned by the PMT in a phonographic mode (the reading head moves vertically while the cylinder rotates at high speed).
- The image is then reconstructed for diffraction pattern analysis.
- IPs are then erased by exposure to visible light and a new exposure process may start.

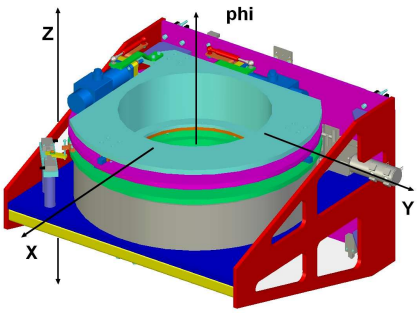
MAIN SPECIFICATIONS

Turnkey system easily adaptable to most user environments

- Compact design: 2x1x1m on air cushions
- Beam height: from 1100 to 1600mm*
- Detector:
  - Useful internal dimensions at phosphor surface: Ø 319 mm, H 400 mm *
  - Sensitive area: Fuji Image plate(s) 400 x 800 mm mounted on a removable intermediate cylinder *
  - Rotating speed: adjustable from 100 RPM to 600 RPM*
  - Pixel size: Software adjustable, 100 µm, 200 µm, 400 µm on edge (8000x4000 pixels to 2000x1000 pixels)*
- Beam path holes: Ø20 mm with removable zirconium windows
- Two optical pointing devices fitted on the tapered holes of the windows can be used to center the sample
- Sample rotation range: 360°, limited to one turn, precision: 0.01°

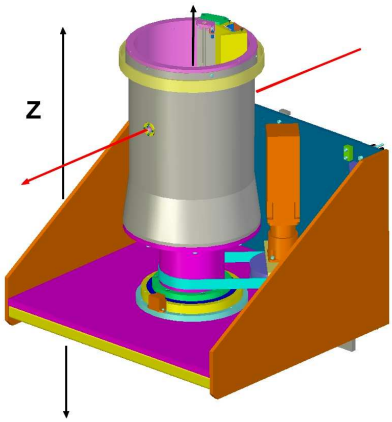
* other upon request

SAMPLE HOLDER MOTORIZATION



- The cryostat support fits on a rotation/translation system mounted on the upper translation table (Z translation)
- This system includes two horizontal translation stages (X,Y) and a rotation stage (Phi)
- This allows centering of the sample relative to the detector drum and rotation of the sample during data collection
- Except for the Z axis translation (DC motor), all axes are motorized by stepper motors

DETECTOR MOTORIZATION



- The drum detector is mounted vertically on the lower translation table (Z translation).
- The table can be adjusted to the beam axis height
- The drum has its upper end open to allow access by the sample holder.
- The drum can be set at any angular position and rotated at constant speed during the reading phase.
- During the exposure and reading phases, the drum must be light tight.
- Drum rotation and Z-axis translation are driven by DC motors while the read head translation is driven by a stepper motor.

ELECTRONICS

- Control electronics
- Front-end electronics
- PC (OS: Windows XP).

Control electronics is located in an electrical cabinet that can be installed at up to 10 m from the QLD:

- PMAC control axis station (Delta Tau) coupled with the PC via optical fibers
- Digital and analog I/Os
- DC and stepper motor controllers
- Power supplies
- Safety interlock system

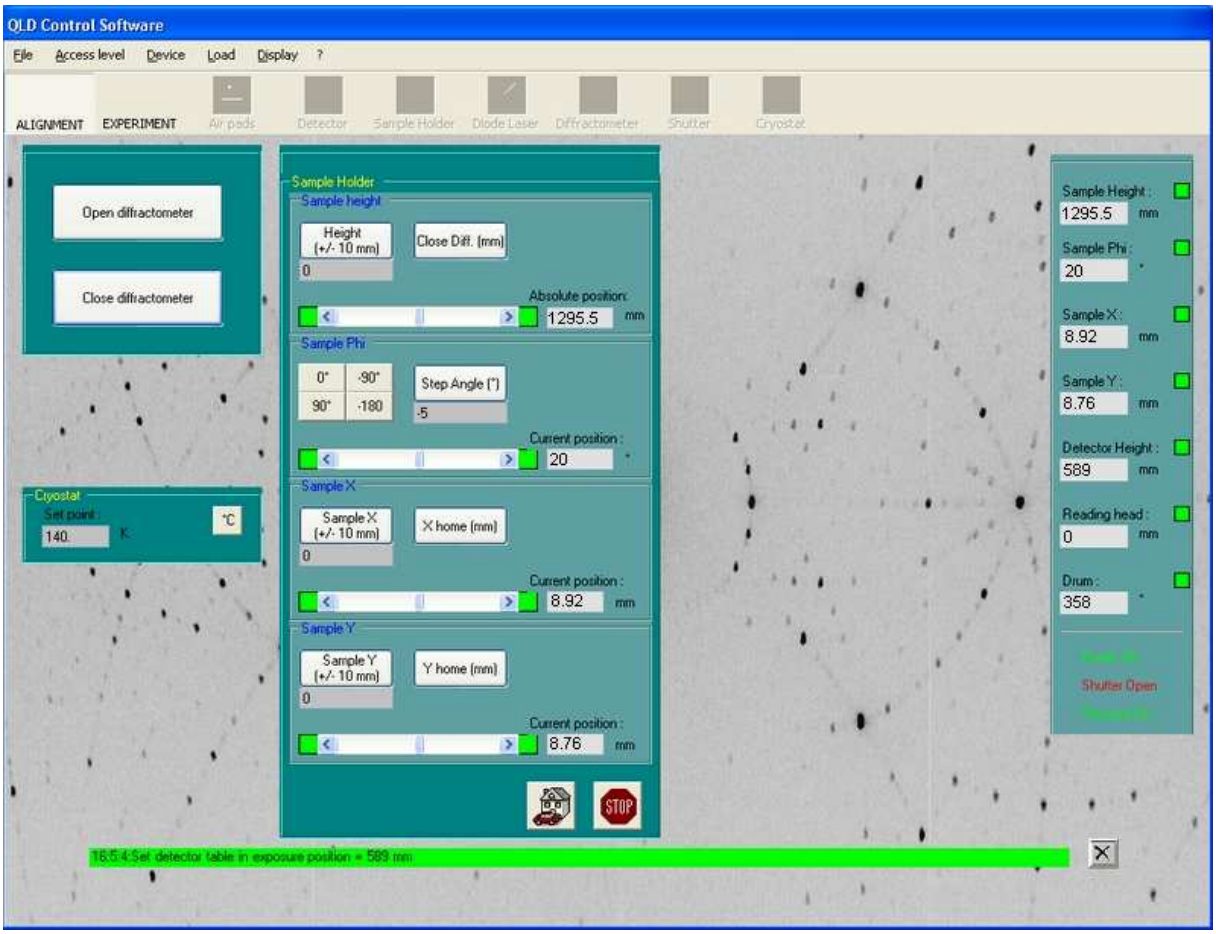
Front-end electronics is fitted in a rack located below the lower translation table:

- Laser diode supply
- Metal can PMT
- PMT HV supply: 0-1 KV
- Drum encoder: 16 pulses/100µm at IP
- ADC module with serial output, current input: 0-200µA, dynamic range: 16 bits, sampling rate: 2 or 3 MHz
- Serial data transmission module optically coupled to a PC

CONTROL SOFTWARE

QLD can be controlled from the PC through a GUI (coded in VB.net). Three-level access protected by passwords:

- User level: allows sample alignment and experiment management
- Power-user level: allows to drive separately each function of the QLD and to tune them
- Administrator level: same as power-user level but allows access to additional preferences



View of the sample alignment frame before launching an experiment

EXISTING DEVICES

LADI station at ILL (Institut Laue-Langevin, Grenoble, France): prototype version developed by EMBL Grenoble, and used principally for protein crystallography.
VIVALDI station at ILL (Institut Laue-Langevin, Grenoble, France): improved industrial design for an extended field of use.
KOALA station at ANSTO (Australian Nuclear Science and Technology Organization, Menai, Australia): upgrade of the VIVALDI design
LADI III station at ILL (Institut Laue-Langevin, Grenoble, France): in production.

MAATEL website: www.maatel.fr/scientific_instrumentation/
EMBL Website: www.embl-grenoble.fr/groups/instr
VIVALDI website www.ill.fr/YellowBook/VIVALDI/
ANSTO website www.ansto.gov.au/ansto/bragg/2005/sxd/instrument_qld.html

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MAATEL has a strong background in design and manufacturing of high-technology instruments. Feel free to contact us for specific prototype manufacturing or further development of existing devices.

Technical information subject to change without notice