

## CRG B - Time of Flight Neutron Spectrometer for Small Angle Inelastic Scattering BRISP

BRISP is a new concept thermal neutron Brillouin scattering spectrometer which exploits the time-of-flight technique and is optimized to operate at small scattering angles with good energy resolution.



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BRISP

### Instrument Description

Reactor hall, thermal beam IH3	
<b>Monochromator</b>	
<p><b>Double focusing</b> - horizontal variable focusing.  <b>Incident beam area</b> at the monochromator: 6 x 6 cm<sup>2</sup>.  <b>Monochromator surface</b>: 20.8 x 8.6 cm<sup>2</sup>            20 crystals in a 4 x 5 matrix: <b>crystal size</b> 4 x 2 cm<sup>2</sup>, <b>mosaic spread</b> 0.4° (PG) and 0.25° (Cu)</p>	
<b>crystal</b>	<b>d-spacing (Å)</b>
PG(002)	3.355(nominal)
Cu(111)	2.087
PG(001)	1.677(nominal)
<b>λ0 (Å)</b>	<b>E0(meV)</b>
1.977(expt.)	20.9 (expt.)
1.28 (expt.)	49.9 (expt.)
0.989(expt.)	83.6 (expt.)
<b>Collimation</b>	
<p><b>Soller Collimator</b>      α1 = 0.4°            700 mm length - 5 mm slit spacing            16 Gd<sub>2</sub>O<sub>3</sub> coated Kapton sheets, 75 μm thick</p> <p><b>Honeycomb Collimator</b>      α2 = 0.4°            - 2000 mm length, Gd<sub>2</sub>O<sub>3</sub>-coated aluminum            - honeycomb arrangement of converging tubes of hexagonal section            - 3 different collimators for convergence at 2**, 4(recommended), 6 m from the sample position            - collimators are maintained under vacuum and selected by means of a 4-sector revolver            - one sector is used for coarse collimation using 2 Cd diaphragms (in: 81x81mm<sup>2</sup>, out: 67x67mm<sup>2</sup>)</p>	
<b>Choppers</b>	
<b>Background chopper</b>	5000 rpm max
<b>Fermi chopper</b>	15000 rpm max
<b>Sample</b>	
Beam area at the sample depending on the monochromator and honeycomb collimator adjustment	
Sample chamber	<b>diameter</b> 500mm, <b>height</b> 550mm <b>Silicon windows</b> for vacuum separation.
Vacuum level in the sample chamber:	10 <sup>-4</sup> mbar <b>Orange MAXI cryostat:</b> <b>T=1.5-300 K</b> <b>sample access diameter:</b> 100mm
Ancillary equipment	<b>Furnace:</b> <b>T=300-1500K</b> <b>Sample access diameter:</b> 40mm
<b>Detectors</b>	
PSD Reuter-Stockes <sup>3</sup> He multi-tube assembly 100 <sup>3</sup> He filled (15 bar) tubes, φ=1/2" 1m length	
Available detection area	2.1m <sup>2</sup>
Detector arrangement	<b>128 central tubes:</b> diameter 12.7mm, length 1118mm <b>Side wings of 16 tubes</b> each: diameter 12.7mm, length 600mm
Pixel size	<b>Height:</b> 0.43mm <b>Width:</b> 12.7mm 0.86mm
<b>Distances, useful ranges and resolution (approximate values)</b>	
Monochromator - Fermi chopper	5540 mm
Fermi chopper - Sample	1000 mm
Sample - Detector D <sub>sd</sub> (variable)	2000-6000 mm

$E_0$ (meV)	$D_{sd}$	Energy Transfer $E$ (meV)	Angular and $Q_{el}$ ranges		Resolution	
					$DE / E_0$	$DQ$ ( $\text{\AA}^{-1}$ )
20.9 meV	2 m	$\pm 18$	$1^\circ - 15^\circ$	0.05-0.8 $\text{\AA}^{-1}$	3%	0.02
	4 m	$\pm 14$	$1^\circ - 15^\circ$	0.05-0.8 $\text{\AA}^{-1}$	2.9%	
	6 m	$\pm 12$	$1^\circ - 9^\circ$	0.05-0.5 $\text{\AA}^{-1}$	2.4%	
49.9 meV	2 m	$\pm 50$	$1^\circ - 15^\circ$	0.09-1.3 $\text{\AA}^{-1}$	3.8%	0.03
	4 m	$\pm 45$	$1^\circ - 15^\circ$	0.09-1.3 $\text{\AA}^{-1}$	3%	
	6 m	$\pm 35$	$1^\circ - 9^\circ$	0.09-0.8 $\text{\AA}^{-1}$	2.7%	
83.6 meV	2 m	$\pm 80$	$1^\circ - 15^\circ$	0.1-1.7 $\text{\AA}^{-1}$	4.5%	0.04
	4 m	$\pm 70$	$1^\circ - 15^\circ$	0.1-1.7 $\text{\AA}^{-1}$	3.2%	
	6 m	$\pm 60$	$1^\circ - 9^\circ$	0.1-1.0 $\text{\AA}^{-1}$	3.1%	
** Please ask the instrument responsible for this configuration						

#### Keywords in the design of the BRISP spectrometer were :

- *Thermal neutron energies*: allowing for investigations in systems characterized by sound velocities up to 3000 m/s (three different incident energies between 20 and 80 meV are presently available).
- *Easy small-angle access*: enabling low- $Q$  spectroscopy with thermal neutrons. Elastic wavevector transfer values  $Q_{el}$  as low as 0.03  $\text{\AA}^{-1}$  at 20 meV incident energy can be reached. The position of the two-dimensional detector can be adjusted to cover different small-angle ranges between  $1^\circ$  and  $15^\circ$ .
- *Time-of-Flight technique*: for an efficient data collection allowing also for accurate neutron measurements as a function of external parameters such as temperature, pressure and magnetic field.
- *Careful optimization of monochromator-collimators-Fermi chopper*: leading to 0.5 meV energy resolution and 0.02  $\text{\AA}^{-1}$   $Q$  resolution in a typical configuration (20 meV incident energy and 4 m sample-detector distance), along with acceptable counting rates (flux at the sample  $10^4 \text{ n s}^{-1} \text{ cm}^{-2}$ ). For this purpose, innovative solutions were specially developed for some of the BRISP components.

#### Main components

- a **Soller collimator** defining the beam impinging on the monochromator, with a collimation angle of  $0.4^\circ$
- two focusing **multi-crystal monochromators**, PG and Cu(111), that allow for the selection of three incident energies in the range from 20 to 80 meV. Fixed/variable curvatures are adopted in/outside the Brisp vertical scattering plane.
- a **disk chopper** used for background reduction and selection of the desired monochromator reflection through proper phasing with the Fermi chopper.
- three **honeycomb converging collimators** [1] to define the incident beam on the sample with a collimation angle of  $0.4^\circ$ , and to optimize convergence at three detector positions (2, 4, 6 m from the sample). A coarse resolution option is also available, without honeycomb collimator.
- a **Fermi chopper** producing short neutron pulses which enable the time-of-flight analysis.
- a **high-vacuum sample chamber** possibly equipped with 1.5-300 K MAXI Orange cryostat (100 mm) and 300-1900 K furnace
- a  $\sim 2 \text{ m}^2$ -area **position sensitive gas detector** ( $^3\text{He}$ ) whose distance from the sample can be varied between 2 and 6 m in order to access the required  $Q$ -range. A huge vacuum tank hosts the detector. An elastobore - polyethylene shielding surrounds the vacuum tank to reduce the environmental background.
- the **long vacuum line** ensures an under-vacuum neutron flight path from the background chopper to the detector.

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