

NCD-SWEET Beamline Upgrade

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Abstract

The SAXS/WAXS Experimental End Station (NCD-SWEET) at ALBA Synchrotron has undergone major improvements in three main areas, beam performance, SAXS detector data quality and beamline operability, in order to perform state-of-the-art SAXS/WAXS experiments. A new channel-cut monochromator system has improved the beam quality and stability, with current vibration amplitudes under 1% of the beam size. Two sets of refractive beryllium lenses have been installed for focussing the beam. One of the sets allows to microfocus the beam size. Besides this, the former SAXS CCD detector has been replaced by a single-photon counting pixel detector, a Piltatus3 S 1M. In the end

station, a full re-design of the mechanical elements with sub-micron resolution movements together with the installation of new equipment has been completed, resulting in an improved beamline configuration, and a faster and safer rearrangement of the flight tube length. New upgraded configuration also allows for GISAXS experiments. Finally, other auxiliary improvements have been done in areas like radiation protection, air conditioning, health and safety, cable management, electronics and control.

End Station Layout

GISAXS Beamstop:

- Tungsten rod.
- Lateral piezo stage.

Kapton Window Safety Shutter:

- Pneumatic Actuated.

Beamstop [1]:

- Tungsten Cylinder.
- X-Y motions.
- Photodiode.

SAXS Detector:

- Piltatus3 S 1M.

Flight Tube:

- Length 2-7m.

WAXS Detector Support:

- 90° roll motion.
- Insertion motion.

WAXS Detector:

- Rayonix LX255-HS.

Beam Conditioning Optics [2]:

- Fast shutter.
- Guard slits.
- Three filters.
- Transmissive photodiode.
- Refractive beryllium lenses.

Pumping Unit

SAXS Detector Table:

- Granite block.
- Lateral plates.
- Flexure hinges.

	X	Z	Pitch
Range	515.5 mm	300 mm	±7 mrad
Avg. resolution	0.781 μm	0.313 μm	0.78 μrad
Repeatability	0.859 μm	5.934 μm	-

Downstream Flight Tube Support

Main Cable Chain

Upstream Flight Tube Support

Floor Rails

Sample Table:

- Granite block.
- Lateral plates.
- Tapered roller bearings.

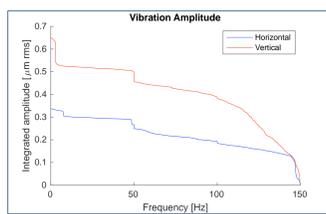
	Z	Pitch
Range	200 mm	±87 mrad
Avg. resolution	0.195 μm	0.27 μrad
Repeatability	1.225 μm	2.063 μrad

Translation Stages:

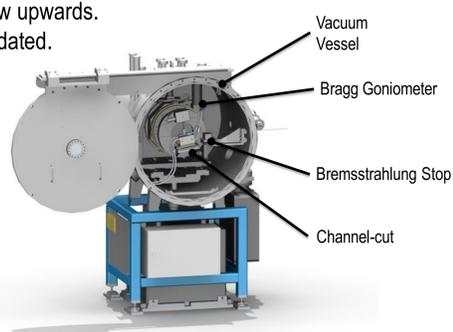
- Lateral, pitch, yaw and roll motion.

Channel-cut Monochromator

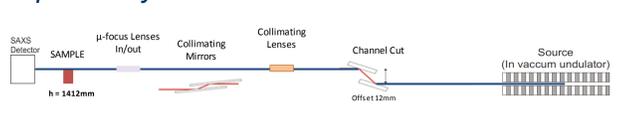
- A channel-cut mechanism replaced a former DCM monochromator.
- Beam path downstream of monochromator is now upwards.
- Some radiation protection shielding elements updated.



- Integrated spectral amplitude of the vibrations of the beam at the sample position.



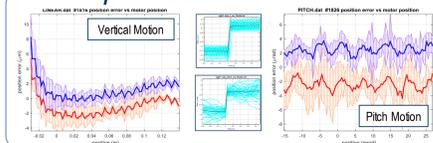
Optical Layout



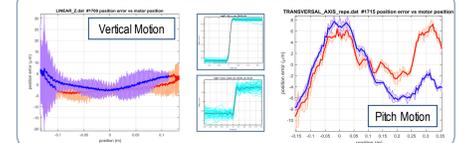
Metrology Tests

- Position error vs motor position measured with a Renishaw ML10 interferometer in open loop.
- Resolution tests in dynamic mode performed to test the mechanical response of the system to the minimum achievable step size.

Sample Table



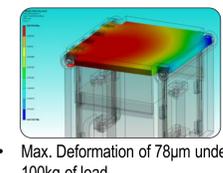
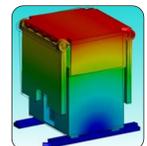
SAXS Detector Table



FEA Simulations

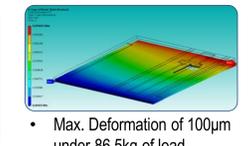
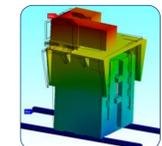
Sample Table

- 1st Mode at 46 Hz.



SAXS Detector Table

- 1st Mode at 29 Hz.



Installation



Auxiliary Projects

Cryogenics

- Cryocooler outside of Optics Hutch.



Cable Chain

- Main cable chain in the End Station.



HVAC

- Air sock distribution controls uniformity of temperature.



[1] J. González et al., "Two-rotation Mechanism for an in Vacuum Beamstop", in Proc MEDSI'16, Barcelona, Spain, September 2016, pp. 378-380, doi:10.18429/JACoW-MEDSI2016-WEPE40.

[2] N. González et al., "Beam Conditioning Optics at the ALBA NCD-SWEET Beamline", presented at MEDSI'18, Paris, France, June 2018, paper THP14.