Construction and Commissioning of a 215-meter-long Beamline at SPring-8

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Abstract

The 215-m-long beamline (BL20B2) has been constructed as the first medium-length beamline at SPring-8 for the purpose of ***R&D of imaging techniques, development of X-ray optics, computer tomography for mineral science, medical imaging, and X-ray topography***. It has been opened to public users since October 1999.

By using the long beamline, ***large field and spatially coherent beam*** can be obtained. At the end of the long beamline, ***ratio of sample-detector to source-sample can be set extremely small enabling to carry out high-spatial-resolution imaging***.

Beamline features

- Total length: 215 m
- Front end: standard type for the bending-magnet beamline
- Horizontal acceptance angles: 1.5 mrad
- Transport channel in the optics hutch: standard type for the bending-magnet beamline
- Monochromator

  SPring-8 standard double-crystal monochromator

  Position from the source: 36.8 m

  Energy range: 4.4～113 keV (using Si 111, 311, and 511 reflections)

  Cooling with heat contact InGa (1st crystal), 0.1-mm-thick In (2nd crystal)
- 160-m-long transport to the Biomedical imaging center

  Diameter: 400 mm

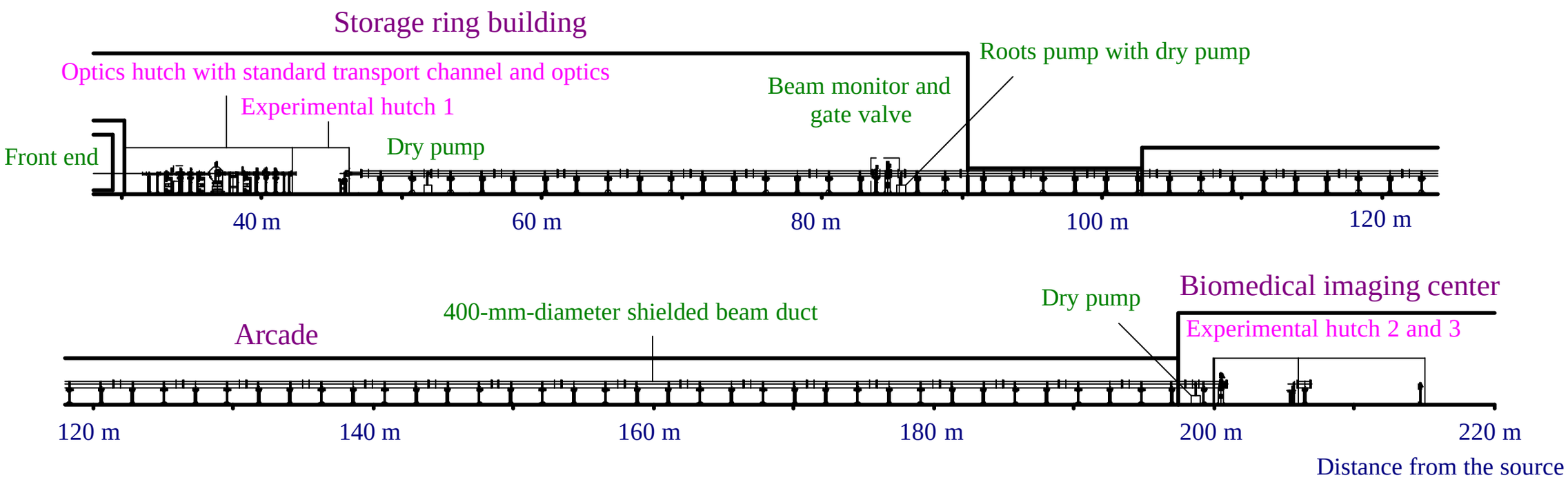
  Shielding: 1-mm-thick lead

  Exhaust units: one roots pump and three dry pumps (No pump in the open)

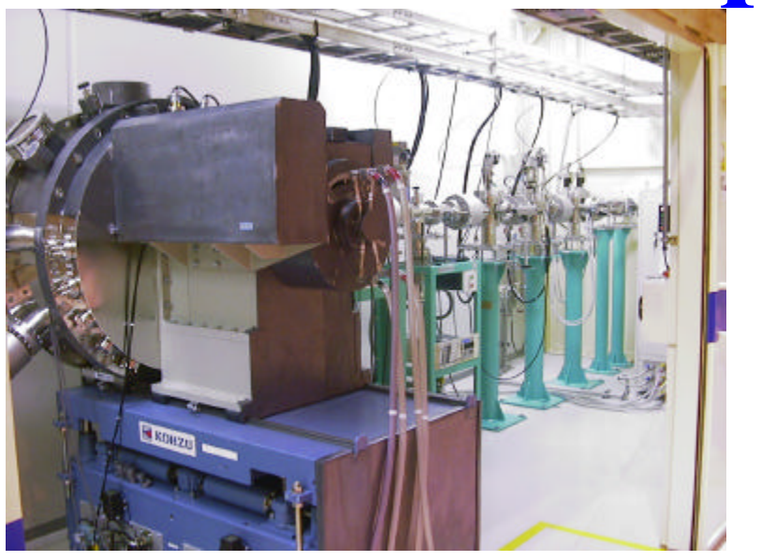
  Ultimate vacuum pressure: 10^{-2} Pa (Ohashi et al., in this conference)
- Window at the end of the shielded ducts in the experimental hutch 2

  200-mm-wide beryllium window / 300-mm-wide Kapton window

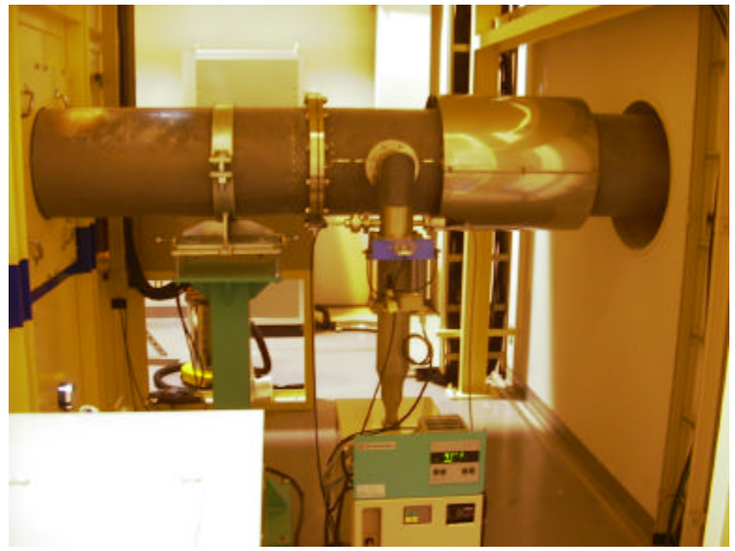
Transport channel of BL20B2



Parts of the transport channel

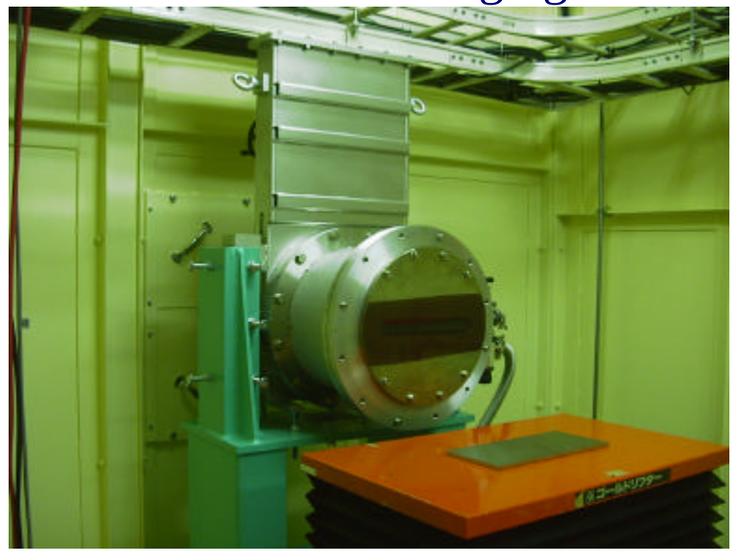


Standard double-crystal monochromator and transport channel components in the optics hutch



Dry pump at the end of the transport channel in the Biomedical imaging center

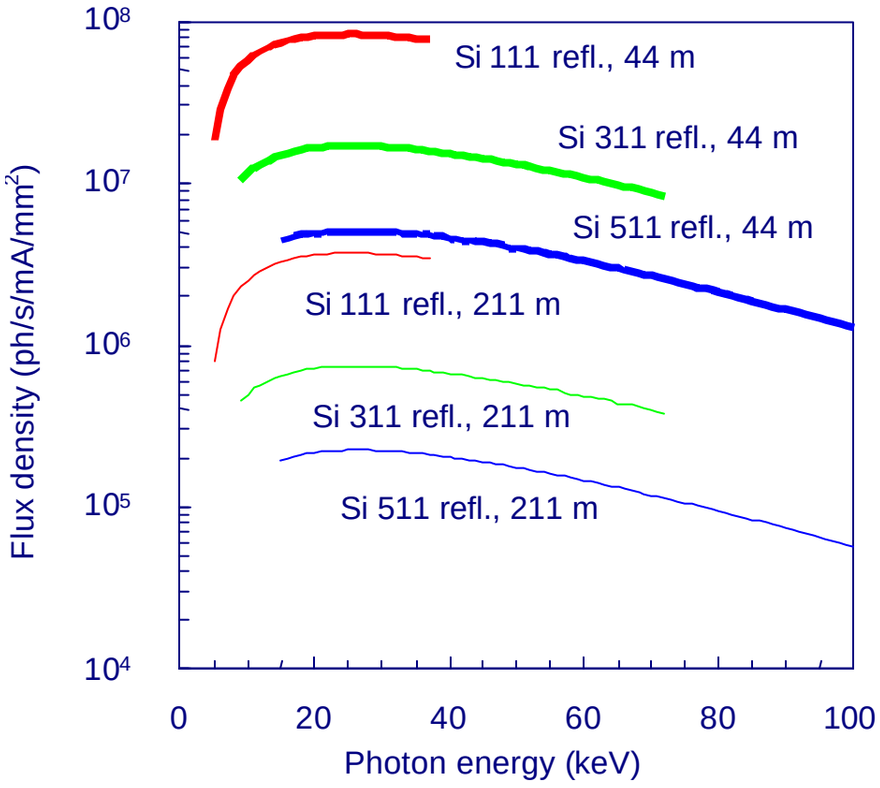
100-meter-long transport channel covered by the arcade in the open (seen from the Biomedical imaging center to the Storage ring bulding)



300-mm-wide and 50-mm-high Kapton window at the experimental hutch 2 with a large gate valve

Beamline performances

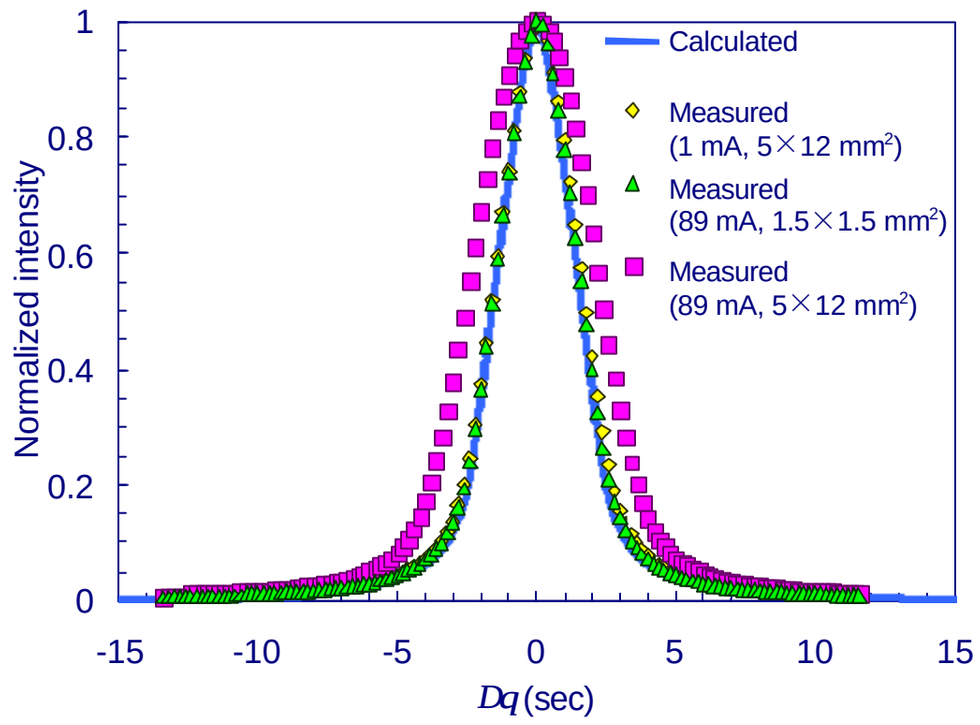
Calculated photon flux density



Calculated on-axis photon flux density at experimental hutch 1 (44 m) and hutch 3 (211 m) through double-crystal monochromator and 0.75-mm-thick beryllium window.

Measured densities were 10～80% of calculated.

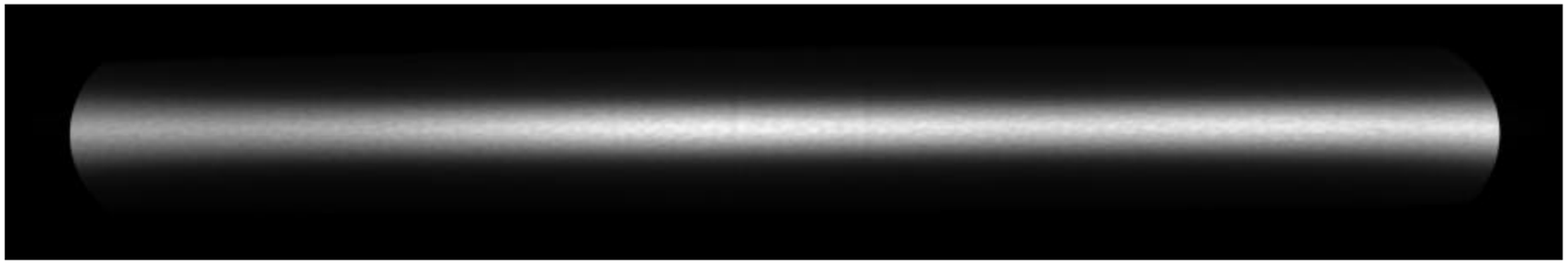
Rocking curve

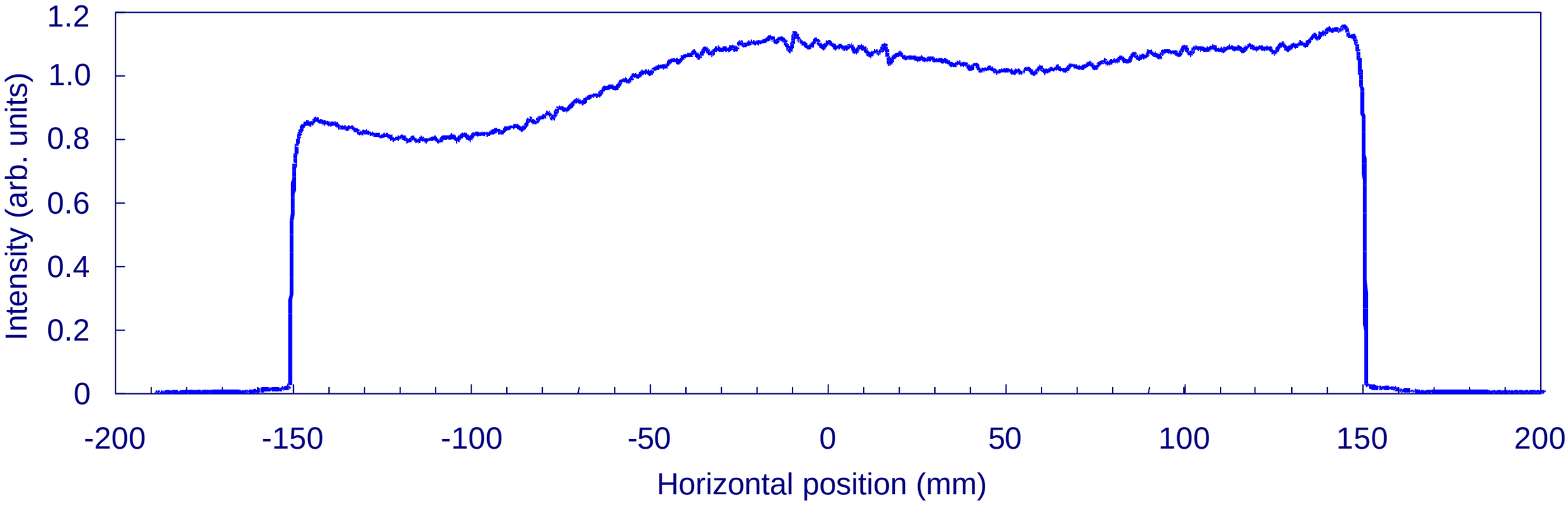


Rocking curves for Si 311 reflections of double-crystal monochromator for 10-keV photon energy. Measured curves were taken for various ring currents and incident beam sizes showing the broadning due to crystal deformation for wider beam and high current.

Further tuning must be done!

300-mm-wide beam profile



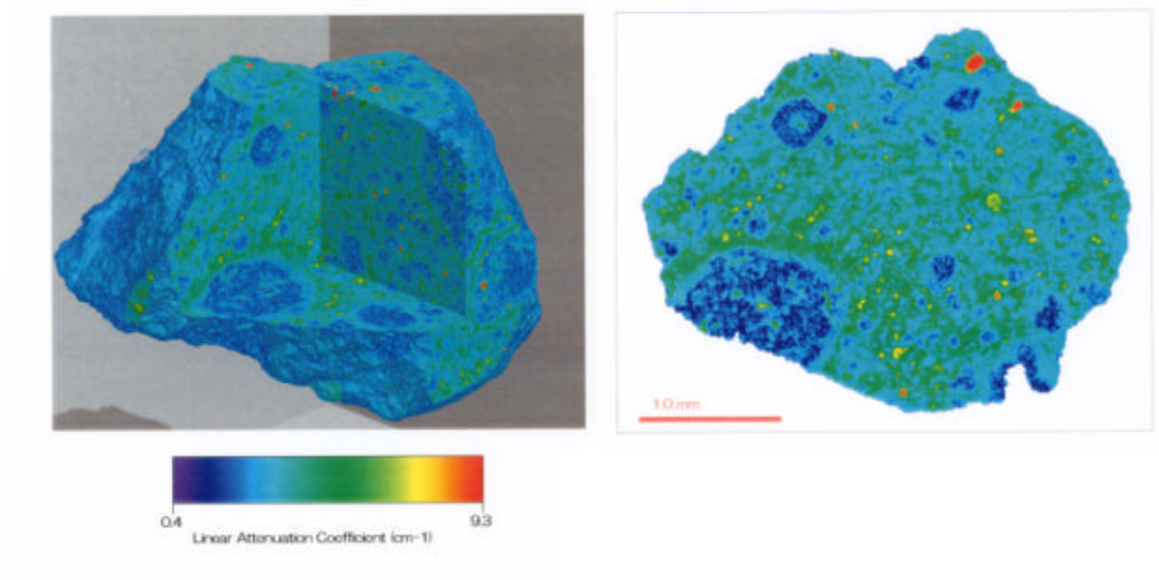


A 300-mm-wide direct beam image recorded by Imaging Plate at 201 m from the source point (upper) and intensity distribution in the horizontal direction for 15-keV photons from Si 311 reflection (lower). Non-uniformity of ±20% was observed due to deformation of monochromator crystal.

Further tuning must be done!

Preliminary results

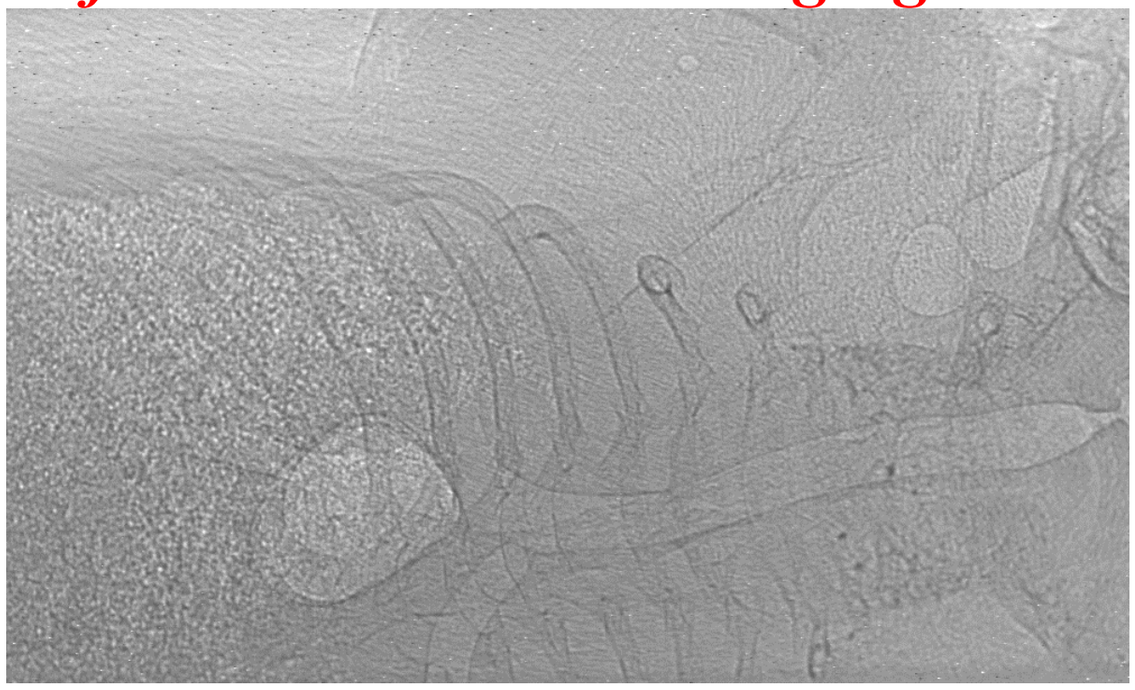
Computed tomography



At experimental hutch 1
Sample: Murry meteorite (3 mm chip)
Photon energy: 35 keV
Detector: Gd_2O_2S with CCD
Voxel size: 6 μm×6 μm×6 μm
Exposure: 10 s/projection×360 projections

(Courtesy of K. Uesugi)

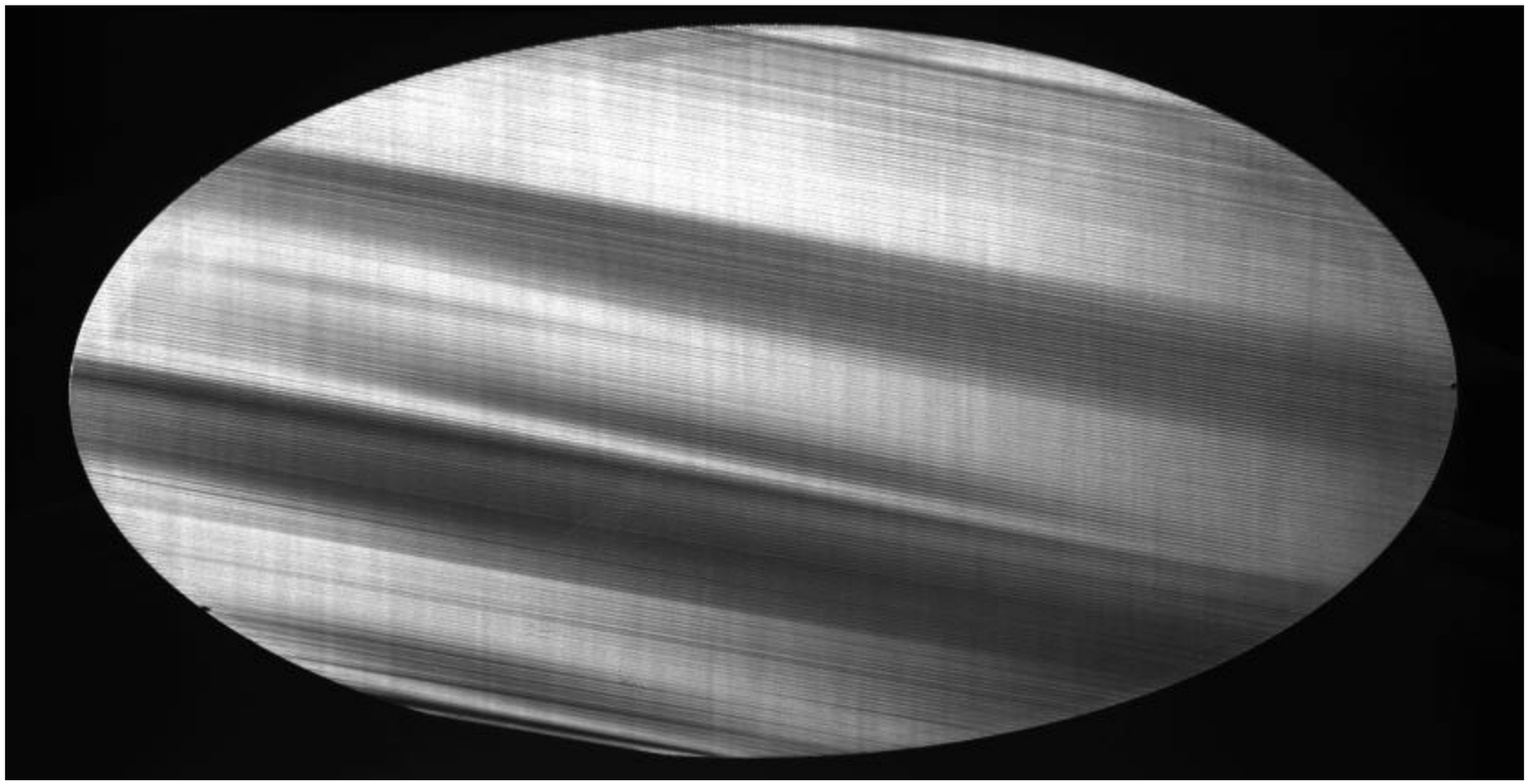
Refraction-enhanced imaging



At experimental hutch 2 and 3
Sample: Lung of mouse
Photon energy: 45 keV
Sample-detector distance: 14 m
Image width: 24 mm (pixel size 24 μm)

Single shot image!

Topograph of 300-mm-diameter silicon crystal



At experimental hutch 2
Sample: 300-mm-diameter silicon crystal
Photon energy: 21 keV
511 asymmetric reflection with glancing angle of 0.6 degrees
Detector: Imaging Plate (pixel size 100 μm×100 μm)