Feasibility study of making a large size beam at BL20B2

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At experimental hutch 2 and 3 of BL20B2, 300 mm-width beam can be used. The large width beam is useful for large field topography and X-ray imaging for large samples. Recently some digital image detectors for X-rays which have very large field of view are developed. The largest one has a field of view of 22.0 cm x 17.5 cm with the pixel size of 50 µm in addition the weight is less than 5 kg. They can take one shot image of small animals like rats or rabbits with very high spatial resolution. However the height of the beam is restricted by the divergent angle of the X-ray which is about 60 mrad. Therefore the height of the beam is about 15 mm at experimental hutch 3 (EH3). This prevents us from taking the one shot images of large samples.

The purpose of this experiment is to make an effectively large area beam using a double mirror system.

The schematic illustration of the setup is shown in figure 1. The mirrors and the detector were set at EH1 and EH3, respectively. The mirrors (100 mm x 100 mm x 20 mm) were made of silica glass and the surfaces were Pt coated 2000 Å thickness. The second mirror was rotated ±0.6 mrad then the X-ray was expanded to about 200 mm vertically at EH3.

The obtained image is shown in figure 2. The image was taken at EH3 with imaging plate. X-ray energy was 20 keV. The exposure time was 30 sec. for rotating of the second mirror.

In many respiratory diseases, significant compliance abnormalities mainly occur in localized regions of bronchi and bronchioles, and thus the localized deformations based on small scale observations must be identified. Especially, asthma is characterized by chronic inflammation (airway remodeling) of airway walls. Recently, we developed fast synchrotron radiation CT system to analyze the localized airway deformations of an intact mouse under quasi-static inflation process (1). In this study, we compared the localized deformations in healthy control and asthma model mice.

In this study, control and asthma groups (n = 10) were imaged using fast synchrotron radiation CT. Asthma model mice were induced by the previous protocol (2). Euthanized mice were mounted on the rotation stage. The X-ray energy and exposure time were set to 20 keV, and each pixel size was 11.6 µm. To analyze the morphometric deformation of the same airway networks, the same branching networks were visualized under quasi-static inflation process. Before CT images, we measured the serum IgE of each group, and the level was significantly higher in asthma group than control group (Fig. 1). Fig. 2 shows the same airway deformations of control and asthma model mouse at FRC (functional residual capacity) and at VT (end of tidal inspiration). The lung density was higher in asthma groups than in control group. And the airway deformations were lower in asthma group than in control group.

Reference
(1) Sera et al. SPring-8 User Report.
(2) Shinagawa et al. Am J Respir Crit Care Med.

Fig. 1 The IgE level of control and asthma model mice.

Fig. 2 The zoomed CT images of asthma model (A&B) and control mouse(C&D) at FRC (A&C) and VT (B&D). The diameter increased 24–46 % in asthma mouse, and 35–52 % in control mouse. Bars: 500 µm.