ESRF

Experiment title: Experiment to evaluate the spatial resolution performance of the Rayleigh-to-Compton imaging technique using a germanium multistrip detector

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Local contact (s):

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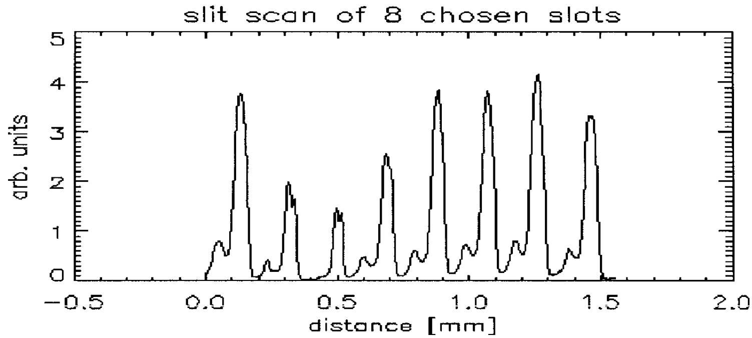
Report:

In this experiment we used the 200 μm pitch of a germanium multistrip detector and a Soiler slit to perform direct imaging with a high spatial resolution. By resolving the elastic scattered photons from Compton scattered photons the ratio of the integrated peak values gives information about the so called effective atomic number of the volume element under inspection [1]. The aim of this experiment was to investigate this imaging system under the following aspects:
1. Spatial resolution : Characterizing the Soiler slits separatly by slit scans and testing the combined (Soiler slits plus detector) imaging system via a wire scan.
2. Coincidence : Using the coincidence of events to reconstruct splitted events on neighbored strips (specifically for hits on the isolation zone on the crystal surface (50 μm wide)).

In order to map a continous line of volume elements onto 16 neighbored strips on the germanium crystal we built a Soiler slit system made out of copper spacing foils (50 μm thick) and tungsten blades (150 μm thick) pressed together by rectyfied stainless steel blocks. This multislit has an opening angle of 1 *mrad* and therefore careful characterization had to be done.
The Soiler slit was scanned with a small (20 μm wide) beam at 60 *keV*. A thorough study by slit and tilt scans under different angles was performed. The effect of forward scattering was at that energy enhanced (compared to a former 17.5 *keV* test) and the partially disorientation of the blades allowed us just to use 8 slots in a row. Figure 1 shows a typical slit scan of the 8 used slots.
Already by microscopic inspection we could see a rough surface of the tungsten blades, which was probably the reason for the strong forward scattering on the blades filling the valleys between the slots. The non-parallism of the blades originate likely from a slight overall bending of the material due to mechanically cutting by the company.

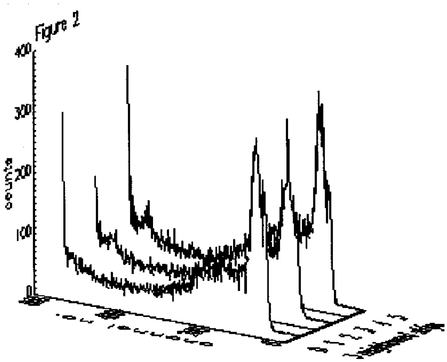
Figure 1:

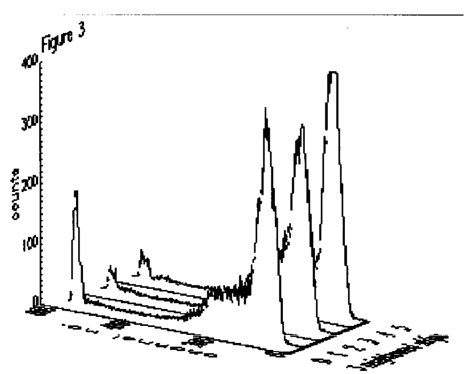


After characterization of the slits the detector-slit assembly was mounted under a 60 deg scattering angle in respect to the sample stage. A wire scan should have given information about the spatial response of this imaging system but we found it extremely difficult to align a wire in respect to the Soiler slit and detector strips. Finally a thick steel screw could be mapped on the detector strips. The raw data for the 3 neighbored strips (chosen out of the 8) are shown in Figure 2. The data have poor statistics but nevertheless the main features are visible. The elastic and the Compton peak could be resolved within the scope of the detector resolution (in average 1.3 *keV* for all strips). The broad feature below the Compton peak stems very likely (beside good lead shielding) from backscattered background. It could have been also from splitted charge collection effects but the coincidence analysis (figure 3) left this feature nearly untouched (on the other hand the low energy events disappeared after the the coincidence analysis).

Because of lack on time (due to several circumstantes all prealignment ment to be done on the xray tube were done on the beamline during the experimental time) the imaging system could not been tested fully. For further investigation the Soiler slits have to be improved (maybe using different blade material as eg. Au) and the setup has to be premounted on an optical table with a possibility to rotate the detector-slit system around the sample stage. But we feel that the use of coincidence will improve the efficiency on such a system and might it make usable for medical applications.

Figure 2 and 3:





Reference :

(1) S. Manninen, T. Pikanen, S. Koikkalainen, T. Paakkari, Study *of* the *Ratio of* Elastic to Inelastic *Scattering of* Photons, Int. J. Appl. Radiat. Isot. Vol. 35, No. 2, pp. 93-98, 1984

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