



Experiment title: Parametric Conversion of X-Rays

Experiment number:
MI247

Beamline:
ID18

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Shifts:
11

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Report:

The object of the experiment was to detect parametric down conversion of x-rays by a phase matching scheme which was originally used by Eisenberger and McCall. Being a nonlinear-optical effect, it is very weak and hard to detect.

Due to a small nonlinearity in the electrical susceptibility of free electrons, there is small cross section for the process of an x-ray photon spontaneously decaying into two whose energies add up to that of the incident photon. The converted photons become directed to two detectors if a phase matching condition is fulfilled by detuning a crystalline sample by about 0.01 degrees (depending on the exact experimental geometry) from a Bragg reflex. The converted photons then exit the sample at angles of ca. 1 degree on opposite sides of the (rather weak) reflected beam of unconverted photons.

The experimental setup is shown in fig. 1. In order to separate the converted photons from the background, a time correlation technique and energy discrimination were used. Since energy discrimination can never be 100 percent perfect, there is always a background of events produced by photons which are scattered elastically at the sample. These events produce a statistical coincidence rate which can be determined from the rate of statistical time correlations at time differences other than zero.

The conversion process shows up in the time correlation spectra as a peak at zero time delay above a Background of statistical correlations. Fig. 2 shows such a time correlation spectrum, collected within 3 hours at an incident flux of $1.5 \cdot 10^{11}$ photons of 14.4keV per second. The detuning angle was 0.0217° for which the maximum conversion rate was expected.

At a detuning angle of -0.0217° for which no conversion was expected, the corresponding time correlation spectrum, also taken within 3 hours, shows no coincidence peak (fig. 3).

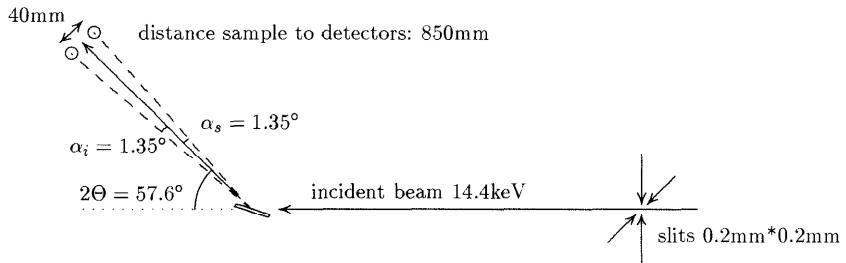


Fig. 1: The experimental setup.

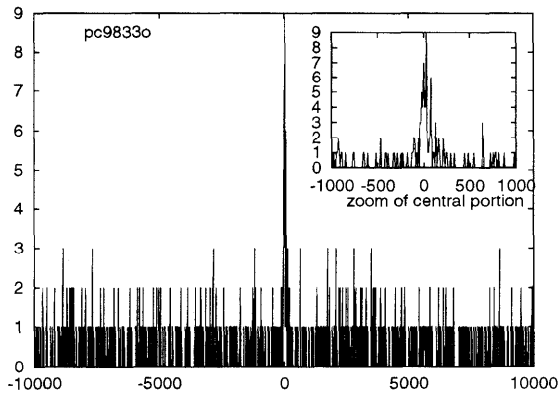


Fig. 2: Time correlation spectrum showing coincidence. The abscissa is in ns.

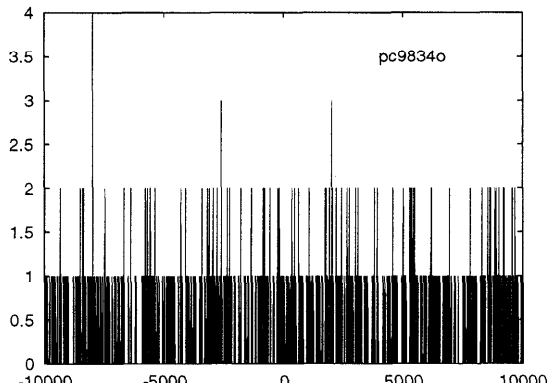


Fig. 3: Time correlation spectrum at a detuning angle for which no conversion was expected. There is no coincidence peak. The abscissa is in ns.