ESRF	**Experiment title:** **Investigation of the coherence properties of the X-ray Delay Line**	**Experiment number**: MI-923
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Report:

The aim of the experiment MI-923 was the investigation of the coherence properties of radiation passing the X-ray delay line unit [1], a device manufactured with the aim to conduct Split&Delay X-ray Photon Correlation Spectrcopy(XPCS) [2,3] at future X-ray Free Electron Laser (XFEL) sources.

The experiment was carried out at the beamline TROIKA ID10C using the 16 and 4 bunch mode operation of the storage ring. Figure 1 shows a sketch of the experimental setup. An X-ray radiation of 8.39 keV coming from the undulator source was monochromatized in the horizontal scattering geometry by a Si(111) channel cut monochromator. The energy resolution of 1.4×10^{-4} was further improved to 8.8×10^{-6} by mounting downstream a Si(333) channel cut monochromator. The monochromatized beam was split by the symmetric Si(511) crystal in Laue geometry and traveled around two unequal path lengths defined by Bragg crystals. The two beams were recombined and brought back on the common path by the Laue beam mixer. Detailed description of the delay line experimental setup can be found elsewhere [1].

The coherence properties of X-ray radiation were investigated initially by taking a Fraunhofer diffraction patterns from a rectangular aperture, located downstream the delay line unit. The scattered intensity from the aperture was collected by a point detector located at the end of the flight tube. The detector was mounted on a translation stage, which allows movements in the horizntal and vertical plane. Figure 1b shows a Fraunhoffer diffraction pattern from 5x5 μm^2 rectangular aperture. The resulting horizontal and vertical patterns

reveal oscillations with a gradually dimishing amplitude. The visibility of these oscilations is 62%.

In the second stage of the experiment a speckle pattern was recorded from a disordered sample. The coherent part of the radiation was selected by a 5x5μm^2 rectangular slit. Silica powder sample was placed in a capillary in a custom designed SAXS chamber, mounted downstream the slits. The static speckle pattern was recorded by a direct illumination CCD Princeton camera which comprised 1340 x 1300 pixels of dimension 20 x 20 μm^2. Figure 1c shows a resulting speckle pattern. The contrast of the speckle pattern was determined by performing the statistical analysis at q=3x10^{-3} Å^{-1}. Contrast values larger than 23% were obtained.

High fringe visibility and contrast values of the speckle pattern indicate the feasibility of performing coherence based experiments with the delay line unit. The colleced data is under further analysis.

We would like to thank Dr. Federico Zontone for his help during the experiment.

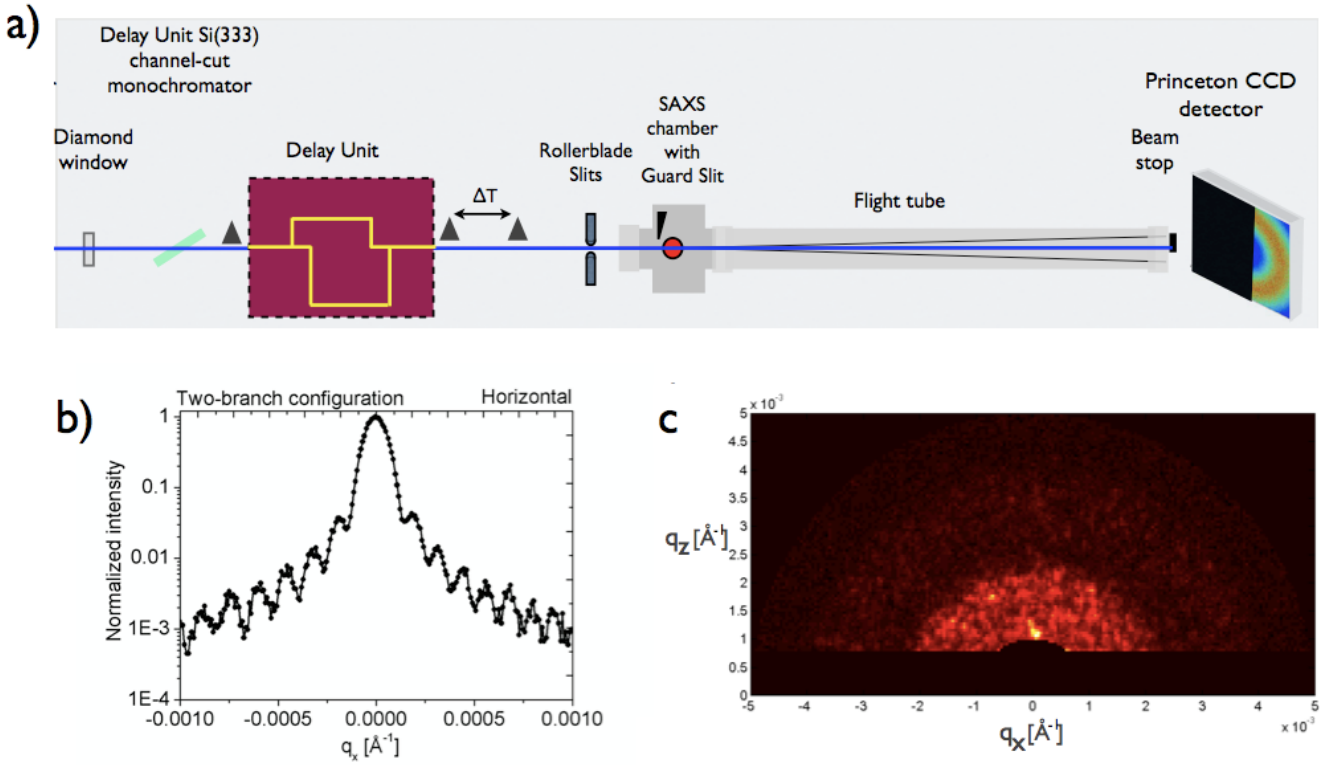

Figure 1. a) Arrangement of the experimental components used in the experiment. b) Fraunhofer diffraction pattern measured with 5x5 μm^2 rectangular aperture in horizontal plane. c) Speckle pattern of the silica powder sample recorded with 5x5 μm^2 beam defining slit.

References:

[1] X-ray Delay Unit *Hasylab Annual Report* 2006

[2] XFEL *Technical Design Report* DESY 2006

[3] First Experiments, *Technical Report* LCLS 2000