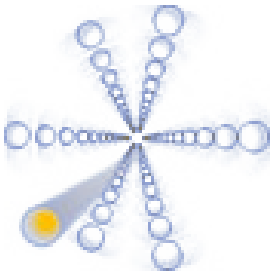

Contribution ID: **102** Type: **Oral**

Channeling of Sub-GeV Electrons in Bent and Periodically Bent Single Crystals

Tuesday, 7 October 2014 15:00 (15 minutes)

Experiments have been performed at the Mainz Microtron MAMI to investigate planar electron channeling in bent [1], and in periodically bent silicon single crystals [2-4]. The low emittance electron beam of MAMI providing energies below 0.855 GeV is well suited to prepare a beam with small angular divergence which is mandatory for channeling experiments.

A very important prerequisites for experimental studies of undulator-like radiation in periodically bent crystals is the knowledge of the dechanneling length of electrons for the (110) crystallographic plane. Because of the fact that even for undistorted plane crystals only little is known experimentally, we have performed and recently reanalyzed dechanneling length measurements at various beam energies [3]. Both, radiation spectra as well as dechanneling length measurements at low electron beam energies feature quantum state phenomena which enhance the dechanneling length.

Beam deflection studies at (111) channeling of electrons in a 30.5 thick curved crystal with a bending radius of 33.5 mm, produced at the Department of Physics of the Ferrara University, allows to extract information on the dechanneling length via simulation studies [1]. In addition, we have developed an analytical model with which the observed scattering distribution has been fitted. The scattering distribution as function of the crystal thickness has been derived from the solution of a differential equation which takes into account rechanneling. From this solution dechanneling, rechanneling, volume deflection, and ejection distributions can be derived. It turns out that the dechanneling and rechanneling lengths are strongly correlated. In order to restrict the parameter space, it has been tried to solve the Fokker-Planck equation in curved coordinates.

Radiation emission spectra have been studied from crystalline undulators at electron beam energies between 195 and 855 MeV [2,3]. The graded composition strained layer Si1-xGex undulator, epitaxially grown at the Department of Physics and Astronomy of the Aarhus University, had 4 periods with a period length of 9.9 μm and amplitudes between 2 and 4 Angstroms. All spectra taken at various beam energies at channeling in the undulating (110) planes exhibit a broad excess yield around the theoretically expected photon energies. Analysis with a simple analytical model suggests that the gross structure can be explained by synchrotron-like radiation emission component from small arc elements of the undulator. Why the coherent radiation component is so small is presently still an open question and will be discussed.

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Session Classification: S1: Channeling & Radiations in Crystals