Contribution ID: **160**

Type: **Oral presentation**

Analysis of Channeling Experiments in Diamond and Silicon Single Crystals with the Aid of the Fokker-Planck Equation

Monday, 24 September 2018 09:30 (15 minutes)

The formula of Baier et al. for the de-channeling length of electrons in single crystals
Lee = 2U_0 pvX_0/E_s^2 [1] was frequently used for a comparison with various calculations, including simulation calculations. It will be pointed out in this contribution, that the fundamental parameter E_s^2 = (2π/α)(m_ec^2)^2 = (15 MeV)^2 must be replaced by E_s = 10.6 MeV if thin crystals are used. The same parameter Lde appears also as a scaling length in the Fokker-Planck equation if written in a dimensionless form. This fact has the consequence that both, the formula of Baier et al. as well as the solution of the Fokker-Planck equation, overestimate the de-channeling length by more than a factor of two in comparison with recent simulation calculations, e.g. [2].
It is well known that in the photon spectra of diamond at electron beam energies below 110.2 MeV pronounced line structures appear. Such structures were recently also observed at a beam energy of 195 MeV at the Mainz Microtron MAMI [3]. Since it is an open question whether quantum state phenomena may enhance the de-channeling length even at such high beam energies, we performed de-channeling length measurements for plane diamond single crystals. The analysis requires model assumptions. We rely on the solution of the Fokker-Planck equation for plane crystals. In addition, results obtained for silicon [4] have been reanalysed.
The Fokker-Planck equation has been modified also for bent crystals [5]. Measurements at the National Accelerator Laboratory SLAC, USA, at electron beam energies in the multi-GeV range for a bent (111) silicon single crystal (bending radius 0.15 m) [6] can be reproduced. This result provides confidence to apply solutions also for a typical bending radius of 6.6 mm for our Si_1-xGe_x undulator crystal in (110) orientation (four periods with 9.9 µm each) resulting in small de-channeling lengths at MAMI beam energies in accord with observations [7].

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Session Classification: S1.1 Channeling & Radiations in Crystals