Synrad3D Photon propagation and scattering simulation
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As part of the Bmad software library, a program called Synrad3d has been written to track synchrotron radiation photons generated in storage rings. The purpose of the program is primarily to estimate the intensity and distribution of photon absorption sites, which are critical inputs to codes which model the growth of electron clouds. Synrad3d includes scattering from the vacuum chamber walls using X-ray data from an LBNL database. Synrad3d can handle any planar lattice and a wide variety of vacuum chamber profiles.

Synrad3d uses Monte Carlo techniques to generate photons based on the standard synchrotron radiation formulas for dipoles, quadrupoles and wigglers. Photons are tracked to the wall, where the probability of being scattered is determined by the angle of incidence and the energy of the photon. Currently, only specular reflection is included. The vacuum chamber wall is characterized at a number of longitudinal positions by its cross-section. In between the cross-sections, linear interpolation or triangular meshing can be used. Linear interpolation is faster but is best suited for convex chamber shapes.

Example 1:
Photon emission only in CESR dipole B12W, 2.1 GeV positron beam, elliptical chamber, no antechamber

Example 2:
Full ring photon emission in CesarT, for 2.1 GeV positron beam, elliptical chamber, no antechamber

Vacuum chamber cross-section for an elliptical chamber with an antechamber on the +x side of the chamber and an aperture on the -x side.

* X-ray reflectivity vs. grazing angle data from: B.L. Henke, E.M. Gullikson, and J.C. Davis. X-ray interactions: photoabsorption, scattering, transmission, and reflection at 6<phi>3000 eV, J=1-29, Atomic Data and Nuclear Data Tables Vol. 54 (no.2), 181-342 (July 1993).

Energy distribution

Distribution of photon absorption sites vs. vacuum chamber perimeter, for different magnet types. Top-bottom symmetry assumed.