Insertion Devices at the CLS

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Installed Insertion Devices – Effect on Electron Beam and Corrective Measures

Phase I and II beam lines included seven insertions devices of the types described below. Plans for Phase III are under development and may include up to six more IDs.

Ideally, the electron beam should exit an ID with the same angle, offset and profile as it had upon entering it. Simple air coils mounted on the magnetic girders or the undulator support structure can be used to correct the first (angular kick) and second (spatial offset) field integrals as well as normal and skew quadrupole components that are generated by the ID as the gap and/or polarization are changed. Feed-forward tables for the 1st and 2nd integrals are generated based on minimizing perturbations to the electrons beam position around the entire ring. Tables for normal quadrupole corrections are generated based on tune shift (not currently implemented) and for skew quadrupole component from vertical/horizontal beam size.

With the exception of the in-vacuum undulator, injections can take place at operating gaps with no appreciable decrease in injection efficiency.

Permanent Magnet Undulators
Two permanent magnet devices were the first IDs installed in Phase I. These devices share a straight section (see figure) with a 1.2 m-rad magnetic chicane used to direct x-rays from each device to separate beam lines. The planar magnetic structure is made with NdFeB magnet blocks.

Elliptically Polarizing Permanent Magnet Undulators
Two elliptically polarizing undulators with identical Apple-II type magnetic structures have been installed in Phase I and Phase II. All four sub-girders can move allowing for linear polarization selection between -90° to +90° and left and right circular light polarization. A unique chicaning scheme allows for the light from these devices installed in the same straight sections to be directed down either of two adjacent beamlines.

In-Vacuum Small Gap Hybrid Undulator
One in-vacuum device was installed in Phase I. The minimum gap of this device is 5.5 mm and is a 20 mm period hybrid magnetic structure consisting of Vanadium Permendur® poles and Sm-Co magnet blocks. This device has an operating range of 6.5-18 kV.

Quasi-Periodic APPLE-II type IDs
Phase III will include two 3.6m IDs in the same 4m straight section on one beam line. The user will be able to select either device which can be moved in place in the storage ring on a horizontal translation system. The devices will be optimised for a high and low energy range ± to maximise photon flux. The Apple-II design will allow full variable linear and circular polarised radiation and a quasi-periodic modification will suppress higher harmonics to reduce contamination of the experimental data from higher energy harmonics which can not be filtered out by the monochromator.

Selection of h blocks for quasi-periodic modification using the fundamental Fibonacci sequence:

\[ z_n = \frac{1}{\phi^{n-1}} \]

where \( \phi = \frac{1 + \sqrt{5}}{2} \)

Selection of \( h \) blocks is either 1 or 1/1 when 1/1.

the mth block is moved vertically by distance \( \delta \)