Photon Flux around CESRc Wigglers
DHR 3/10/06

Prompted by discussion in the machine studies meeting 3/10/06 I estimated the photon flux around the CESRc wigglers to give a more accurate input condition for ECLOUD calculations of EC densities.

A calculation in 2002 by Dave Rubin of the synchrotron radiation power density around the wigglers is given in a brief note by Dave and Yulin:
http://cesrelog.lns.cornell.edu/documents/charm/vac/sr_power011217.html
Dave Sagan’s SYNRA program was used to calculate the linear power density on inside and outside walls with the pretzel orbits. A typical plot is on the next page.

What is left is to calculate the photon characteristics.

The critical energy of the wiggler synchrotron radiation is about 5 keV with 2.1 T field and 1.9 GeV beam.

Sands gives the rate of photon emission as:

\[ N' = \frac{15\sqrt{3} P \gamma}{8 u_c} \]  

(5.12) where \( N' \) is the number of photons per second, \( P \) is the s.r. power, and \( u_c \) the critical energy.

This equation lets us use the watts/meter curve on Rubin’s plots directly.

If we convert watts to eV/sec and put into the formula above we get:

\[ N' \text{ / m / s} = \frac{15\sqrt{3} P \gamma / m}{8 u_c} = 3.25 \times 10^{18} \times \frac{w}{m} \]

\[ = 4.06 \times 10^{15} \times w / m \]

For example, 500 w/m corresponds to 2x10^{18} photons/sec/m. Since 100 mA is approximately 6.24x10^{17} electrons/second, each electron is emitting ~3 photons striking the 1 m section on each pass through the wigglers. (This would be for a single beam only. For a single beam the radiation will be on one side of the wigglers only.)

Measurements at KEK* found a reflectivity, \( R \), of 33% and basic (per electron) photoelectric yield of 0.434 for \( Ec = 4 \) KeV photons incident at a 52 mrad angle. This would give more than 1 primary photoelectron per meter per beam electron on each pass.

* Y. Suetsugu et al., “Reduction of the Photoelectron Yield from a Copper Beam Chamber by Saw-Tooth Machining,” PAC01, p.2179-2181 Chicago, 2001
SR Power from Wigglers @1.9 GeV, 100mA/beam
DLR, 12/07/2001

- Total Linear SR Power (W/m)
- Orbit and Walls (cm)

Distance from IP (m)

L5
Q1W Sliding Joint
Q19 W Sliding Joint
Positron beam
Wigglers
electron beam

Total Linear SR Power (W/m)

Distance from IP (m)

L1
Q19E Sliding Joint
Q13E Sliding Joint
Positron beam
Wigglers
electron beam

SP_in
SP_out