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Luminosity with a single 2.1T wiggler

1 Scaling

We suppose that specific luminosity (instantaneous luminosity/beam current) scales linearly with beam energy and as the cube root of the damping decrement. We assume that the lattice can be designed to yield the desired emittance as long as there is at least one high field wiggler.

It is even more speculative to scale beam current. In machine studies we managed to store 2mA/bunch in a subset of bunches in counterrotating beams. The corresponding total beam current in 9 trains of 5 bunches is 90mA at $E = 1.84$GeV. Total current is limited by parasitic beam-beam effects that scale with energy. So we will use that scaling in the vicinity of 1.84GeV.

Then

$$L = L(E_0)\frac{E}{E_0}\left(\frac{\delta}{\delta_0}\right)^{1/3}\frac{I}{I_0}$$

$$I = I_{1.84}\frac{E}{1.84} = 90\frac{E}{1.84}$$

and

The injection repitition rate will likely be limited to 15Hz with a single wiggler (as compared to 60Hz at 5.6GeV). But total beam current at low energy is about 1/3 of the 5.6GeV value. So we anticipate that filling time will not be very different. At 5.6GeV we integrated $44pb^{-1}$ in a single day with peak luminosity of $L = 7.2 \times 10^{32}cm^{-2}s^{-1}$. That is

$$L_{day} = 6.1\left[pb^{-1}/10^{32}cm^{-2}s^{-1}\right]L_{peak}$$

2 Parameters

The scaling is based on machine performance at $E_0 =$ 5.6GeV, with measured peak $L = 7.2 \times 10^{32} cm^{-2} s^{-1}$ at $I_{beam} = 226mA$. The parameters at energies of interest with the single 1.3m long, 2.1T wiggler that will be installed this summer are tabulated.

Energy[GeV]	5.6	2.5	1.89	1.55
Damping decrement[$\times 10^{-6}$]	120	14.4	7.4	5.0
Specific luminosity[$10^{33} cm^{-2} s^{-1}/A$]	3.2	0.70	0.43	0.31
Beam current[mA]	226	120	90	74
Luminosity[$10^{31} cm^{-2} s^{-1}$]	72	8.4	3.8	2.3
Luminosity/day [pb^{-1}]	44	5.1	2.3	1.4
Energy spread[$\times 10^{-4}$]	6.9	6.0	6.0	5.8

We expect that it will take at least a month of machine studies and tuneup before CESR delivers the luminosity indicated in the table.