Update on emittance evolution through ILC e+ source undulator

W. Liu, W. Gai

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Beam Parameters and Undulator parameters

- Using the beam parameters at IP, with assumed beta function, the beam parameters at undulator can be obtained as (J. Sheppard):

  Sig_x_und=37 microns
  Sig_y_und=2.4 microns
  Sig_xprime_und=0.9 micron-radians
  Sig_yprime_und=0.06 micro_radians

	K	λu(cm)
UK1	0.92	1.15
UK2	0.79	1.1
UK3	0.64	1.05
Cornell 1	0.42	1.0
Cornell 2	0.72	1.2
Cornell 3	0.3	0.7

Elegant simulation results beam without energy spread

- Using the beam parameters at undulator with 0 energy spread:

	enx (%)	eny (%)
UK1	**-1.37464**	**-1.06E+00**
UK2	**-1.10608**	**-9.12E-01**
UK3	**-0.79802**	**-6.79E-01**
CO1	**-0.38277**	**-3.95E-01**
CO2	**-0.77138**	**-6.52E-01**
CO3	**-0.39768**	**-3.82E-01**

The emittance of input e- beam: enx is ~ 7.84e-6 and eny is ~ 4.26e-8

Typical ration on input and output:

σxin / σxout = 2.99e-5 / 9.42e-5
σyin / σyout = 2.40e-6 / 6.48e-6
σx'in / σx'out = 9e-7 / 8.93e-7
σy'in / σy'out = 6.05e-8 / 6.01e-8

A simple explanation

- Normalized emittance should not change by acceleration
- wiggler is used in damping ring for energy and emittance damping.
- Helical undulator can be considered as a combination of two planar wiggler.

Consider it as a damping ring without RF cavities.

Results with off axis e- beam

- Undulator investigated: UK1, length ~100m. No energy spread

Offset	Δenx (%)	Δeny (%)	$\sigma x_{in}/\sigma x_{out}$	$\sigma y_{in}/\sigma y_{out}$	$\sigma x'_{in}/\sigma x'_{out}$	$\sigma y'_{in}/\sigma x_{out}$
0,10μm,50μm	-1.37	-1.06	2.99e-5 /9.42e-5	2.40e-6 /6.48e-6	9e-7 /8.93e-7	6.05e-8 /6.01e-8
1mm in x	-1.59	-1.13	2.99e-5 /9.40e-5	2.40e-6 /6.48e-6	8.94e-7 /8.83e-7	6.05-8 /6.01e-8
1mm in y	-1.59	-1.14	2.99e-5 /9.42e-5	2.40e-6 /6.46e-6	8.94e-7 /8.88e-7	6.05e-8 /5.98e-8

$$By = -|B0|\sum_{m,n} Cmn \cos(k_{xl}x) \cosh(k_{ym}y) \cos(k_{zn}z + \theta_{zn}),$$

$$Bx = -|B0|\sum_{m,n} Cmn \cosh(k_{xl}x) \cos(k_{ym}y) \cos(k_{zn}z + \theta_{zn}),$$

Offset cause beam seeing stronger field and thus radiated more energy into photon and damping at a higher rate

Result with energy spread

- Undulator investigated: UK1, 25MeV sigma of energy spread

configuration	Δenx (%)	Δeny (%)
~100m	-1.36	-1.36
~200m in 2 piece	-2.67	-0.81
~300m in 3 piece	-3.89	1.58
~300m in 1 piece	-3.89	0.7

Dispersion matching for vertical wiggler component is still having problem and need improvement

Summary

- When condition is right, the emittance damping will happen in undulator.
- Still debugging the code.
- More works need to be done to improve the accuracy