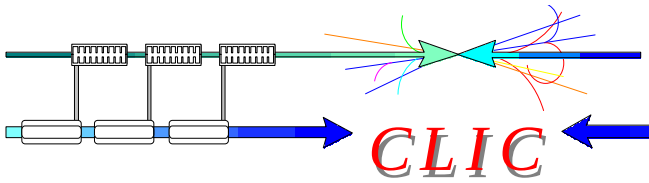
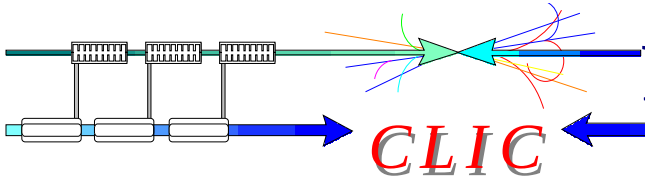


Conservative Beam Emittances for CLIC Damping rings

Y. Papaphilippou

Thanks to H. Braun, J.-P. Delahaye and D. Schulte

February 19th, 2008



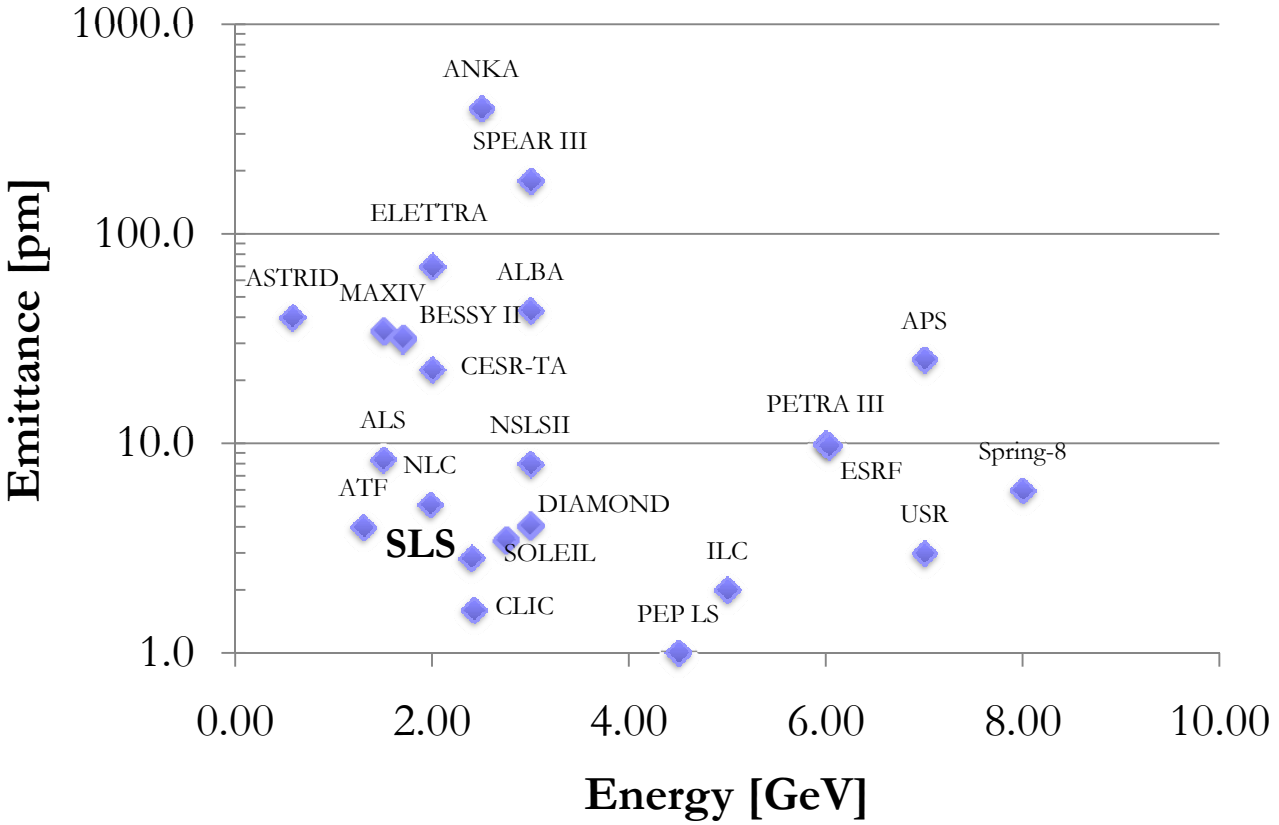
Parameters for CLIC @ 500GeV

J.-P. Delahaye, CLIC PWG, 06/11/07

Epsx/Epsy	ATF single bunch		CLIC DR	NLC	ILC	CLIC	CLIC 500 GeV		Comments
(10-6 m-rad/10-9m-rad)	achieved	Goal	Design			3 TeV	present	prop	
Charge/bunch (10^9)	3.8	?		7.5	20	3.72	3.72	3.72	
DR	4.2/21	3/2.5	0.38/4	2.2/13	8/20	0.55/5	0.55/5	5/10	ATFgoal*1.33/4
Mult Fact: FF/DR				1.6/3	1.25/2	1.2/4	1.2/4	1.25/3	
FF				3.6/40	10/40	0.66/20	0.66/20	7.5/30	
Betax/Betay (mm)				8/0.11	20/0.4	4/0.09	15/0.1	4?/0.1?	Larger Beta?
Sigmax/Sigma/y (nm)				243/3	640/5.7	40/1	142/2	247/2.5	
L prop N/(sigx*sigy)				0.785	0.42		1	0.46	

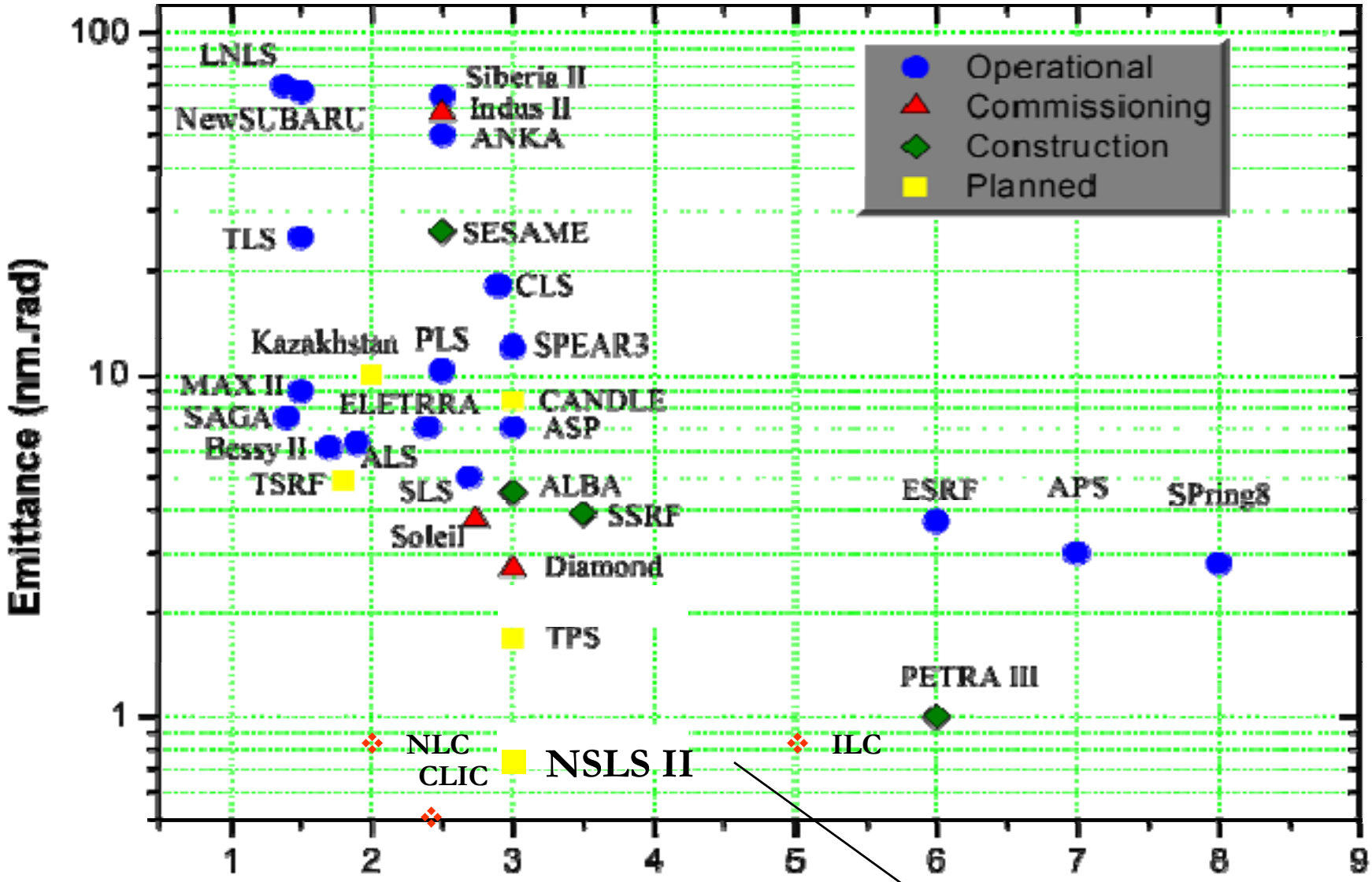
- What is a reasonable set of "conservative" emittances for the CLIC damping rings
- Instead of using scaling based on ATF experience or other linear colliders, consider present or future **synchrotron light sources**

Vertical emittance



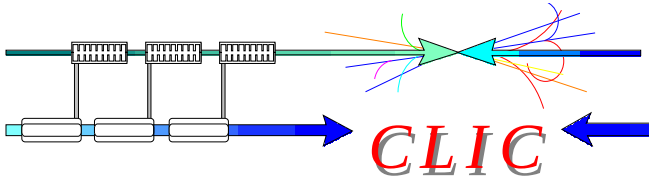
- Swiss Light Source achieved **2.8pm**, the lowest geometrical vertical emittance, at 2.4 GeV, corresponding to ~**10nm** of normalised emittance
- Below 2pm, necessitates challenging alignment tolerances and low emittance tuning (coupling + vertical dispersion correction)
- Seems a "safe" target vertical emittance for CLIC damping rings

Horizontal emittance vs. energy



Z. Zhao, PAC'07

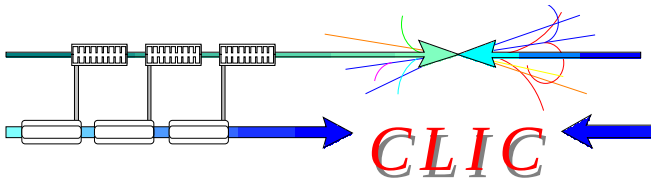
0.6nm @ 3GeV, including damping wigglers and IBS



Scaling of NSLS II parameters

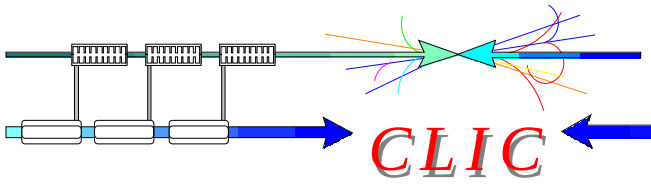
- Assuming constant dipole bending angle (i.e. increasing dipole length with bending radius), **horizontal normalized emittance** proportional to γ^3
- The "zero-current" equilibrium emittance scaled to CLIC DRs energy is **1.6μm**
- Under previous assumptions, **bunch length** is **energy independent** and **rms energy spread** scales with $\gamma^{1/2}$ to give longitudinal emittance of **6256eV.m** @ 2.424 GeV
- Taking into account scaling of horizontal emittance with bunch population and longitudinal emittance $\gamma\epsilon_x \propto \sqrt{N_b/\sigma_z}$ the hor. norm. emittance for CLIC DR parameters (4.1x10^{9}p/bunch and 5000eV.m) is **1.3μm**
- This is an **optimistic value** as the IBS growth was not scaled with energy

PARAMETER	Values
energy [GeV]	3
circumference [m]	791.5
bunch population [10^9]	7.9
bunch spacing [ns]	1.9
number of bunches	1056
rms bunch length [mm]	2.9
rms momentum spread [%]	0.1
hor. normalized emittance [μm]	2.99
ver. normalized emittance [nm]	47
lon. normalized emittance [eV.m]	10395
coupling [%]	0.64
wiggler field [T]	1.8
wiggler period [cm]	10
RF frequency [GHz]	0.5



Scaling of IBS growth with energy

- At equilibrium, the emittance under the influence of IBS is $\epsilon_x = \frac{\epsilon_{x0}}{1 - \tau_x / T_x}$
- Considering a beam which **is not** IBS dominated $\frac{\epsilon_x}{\epsilon_{x0}} \approx 1 + \tau_x / T_x$
- The horizontal damping rate versus the IBS growth rate can be estimated taking Bane's approximation and will provide a complicated scaling with the transverse emittances and the energy
- The final horizontal emittance after scaling the IBS growth with the energy and the vertical emittance, is **2.5μm**
- This is a **pessimistic** estimate due to various considerations in the previous approximations
- In this respect the final value may lie around **2μm** providing a safe compromise



Concluding remarks

- Using scaling from existing and future light sources, conservative normalised emittances of **2μm** horizontal and **10nm** vertical were estimated for the CLIC damping rings
- These emittances are very close to the normalised emittances of NLC damping rings (~10% lower)
- They can be further reduced by relaxing the longitudinal emittance
- They provide some margin to relax the final focus beam size requirements, and still achieve luminosities close to the ones of ILC
- Next steps
  - Verify the numerically the IBS growth scaling with energy
  - Relax the damping ring design in order to achieve such output emittances