Cornell University
Laboratory for Elementary-Particle Physics

ECLOUD Calculations of Coherent Tune Shifts for the 6.4 km ILC Damping Ring

- Including an estimate of the rediffused SEY component contribution -

With reference to Theo Demma's talks of 15 Dec 2009 and 10 Jan 2010 and Mauro Pivi's talk of 3 Feb 2010

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Theo's ECLOUD input parameters for the 6.4 km ILC damping ring

Bunch population	N_b	2.1×10^{10}
Number of bunches	N_b	45 x 4 trains
Bunch gap	$Ngap$	15
Bunch spacing	$L_{sep}[m]$	1.8
Bunch length	$\sigma_z\ [mm]$	6
Bunch horizontal size	$\sigma_x\ [mm]$	0.26
Bunch vertical size	$\sigma_y\ [mm]$	0.006
Photoelectron Yield	Y	0.1
Photon rate (e^-/e^+/m)	dn_γ/ds	0. 204
Antechamber protection	η	90%; 97%
Photon Reflectivity	R	20%; 50%
Max. Secondary Emission Yeld	δ_{max}	1.2
Energy at Max. SEY	$E_m\ [eV]$	300
SEY model	Cimino-Collins $(\delta(0)=0.5)$	

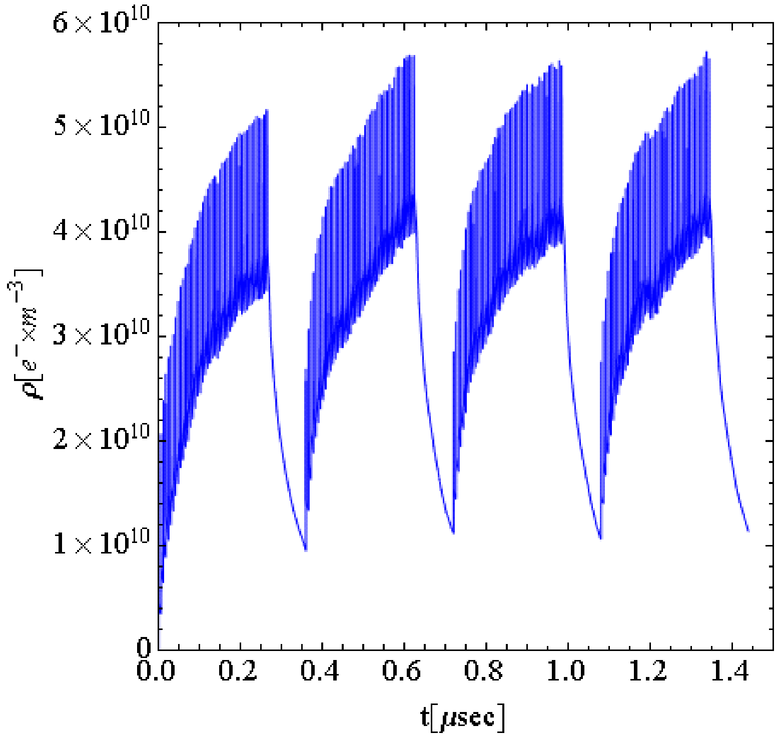
CesrTA ECLOUD development version used for the case η=90%, R=20%.
Primary p.e. model for this version differs in the generated 2D angular distribution.
Also, the SEY model for true secondaries has a slightly different energy dependence (à la POSINST).

Comparison of beam-pipe averaged cloud density buildup calculations

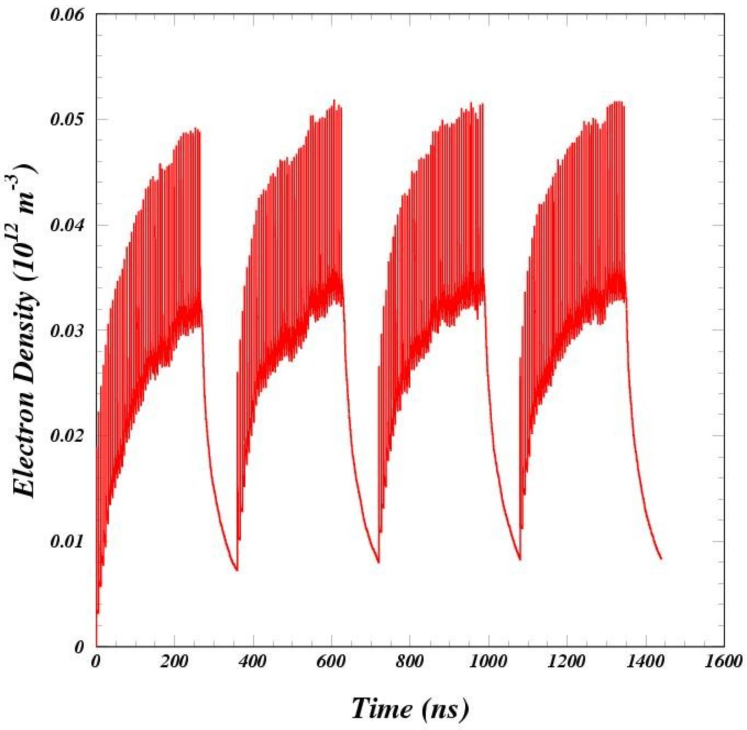
Theo's presentation of 15 Dec 2009

By=0.27 T; R=20%

η=90% η=97%



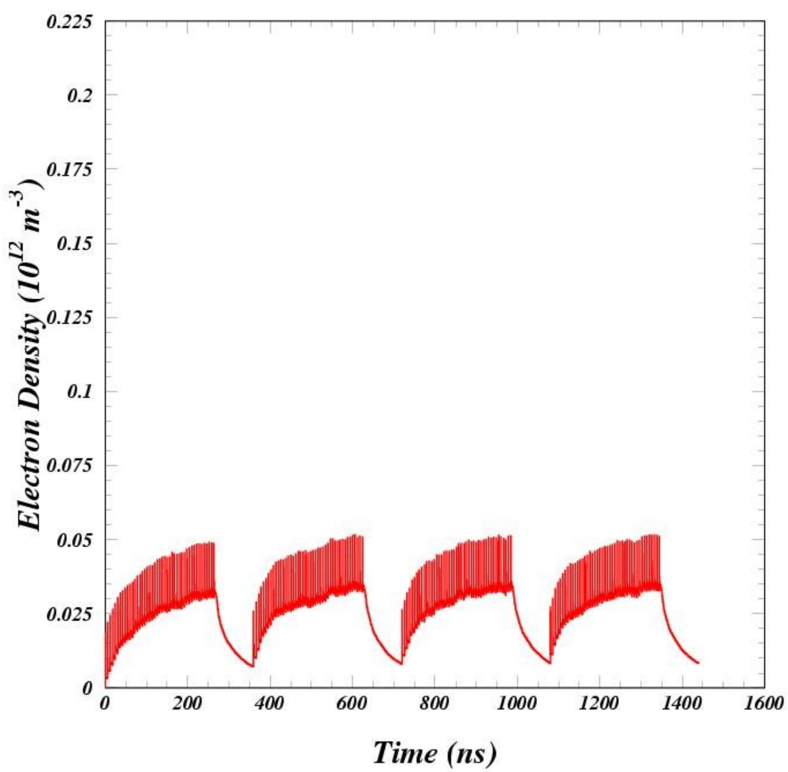
Calculation repeated with CesrTA development ECLOUD version for By = 0.27 T, η = 90%, R = 20%



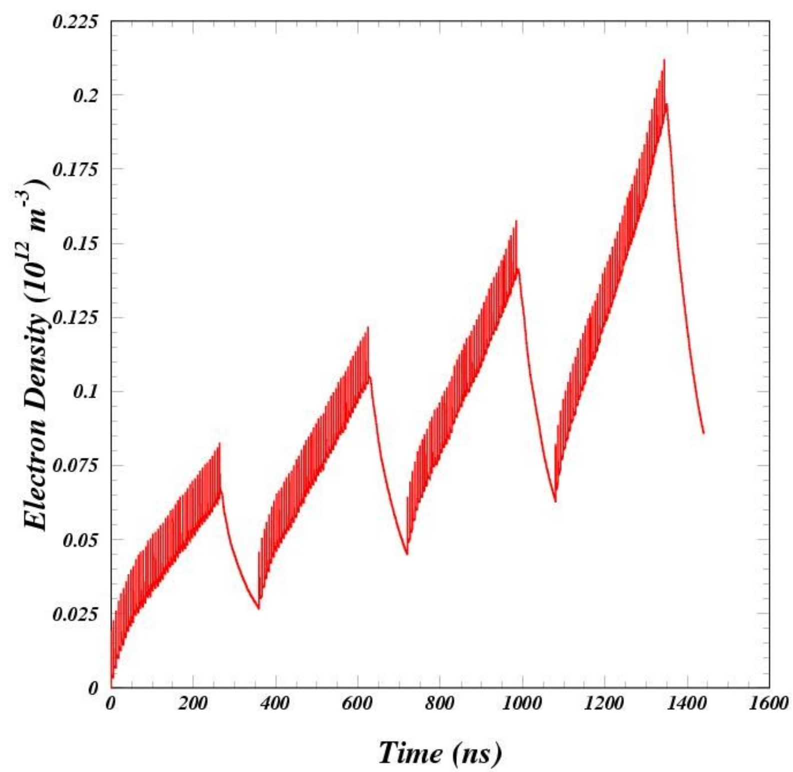
The two calculations agree reasonably well.
ECLOUD default primary angular distribution produces more grazing incidence, thus higher secondary yield.

Effect of the rediffused SEY component on the beampipe-averaged cloud density buildup

Original ECLOUD SEY model excludes the rediffused SEY component



Cloud buildup including the rediffused SEY component used in the CesrTA tune shift model ($\delta = 0.2$)

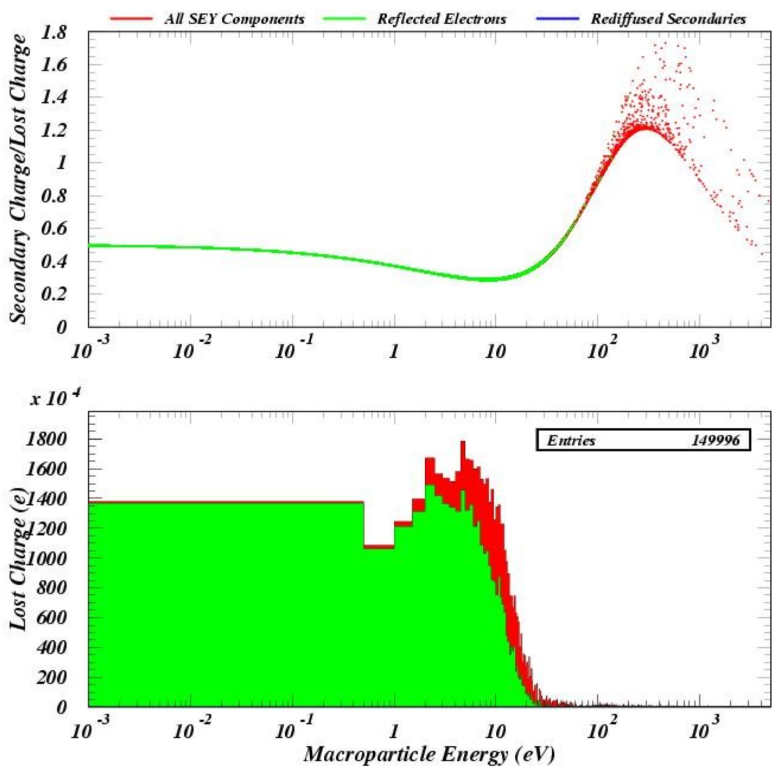


The rediffused component has a particularly strong effect in dipole magnets, where the cloud particles are trapped on vertical field lines. The kinematics of the rediffused secondaries raise the average energy of the cloud particles hitting the wall and therefore the secondary yield (in some circumstances).

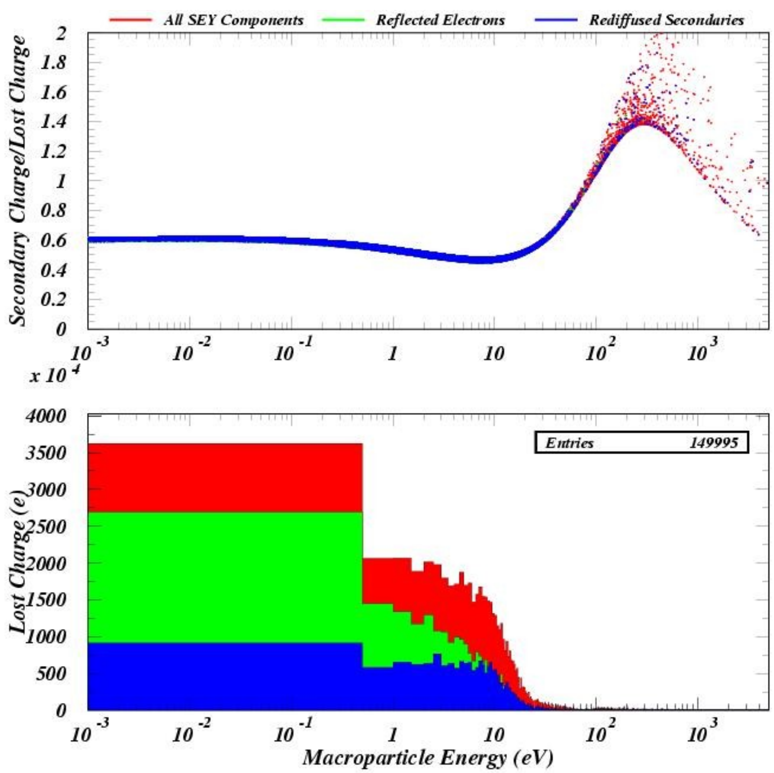
SEY-curve populations

Cloud buildup, snapshot, profile and SEY plots available at http://www.lepp.cornell.edu/~critten/ilcdr/23feb10. Also for an electron beam.

Rediffused SEY component excluded



Rediffused SEY component included

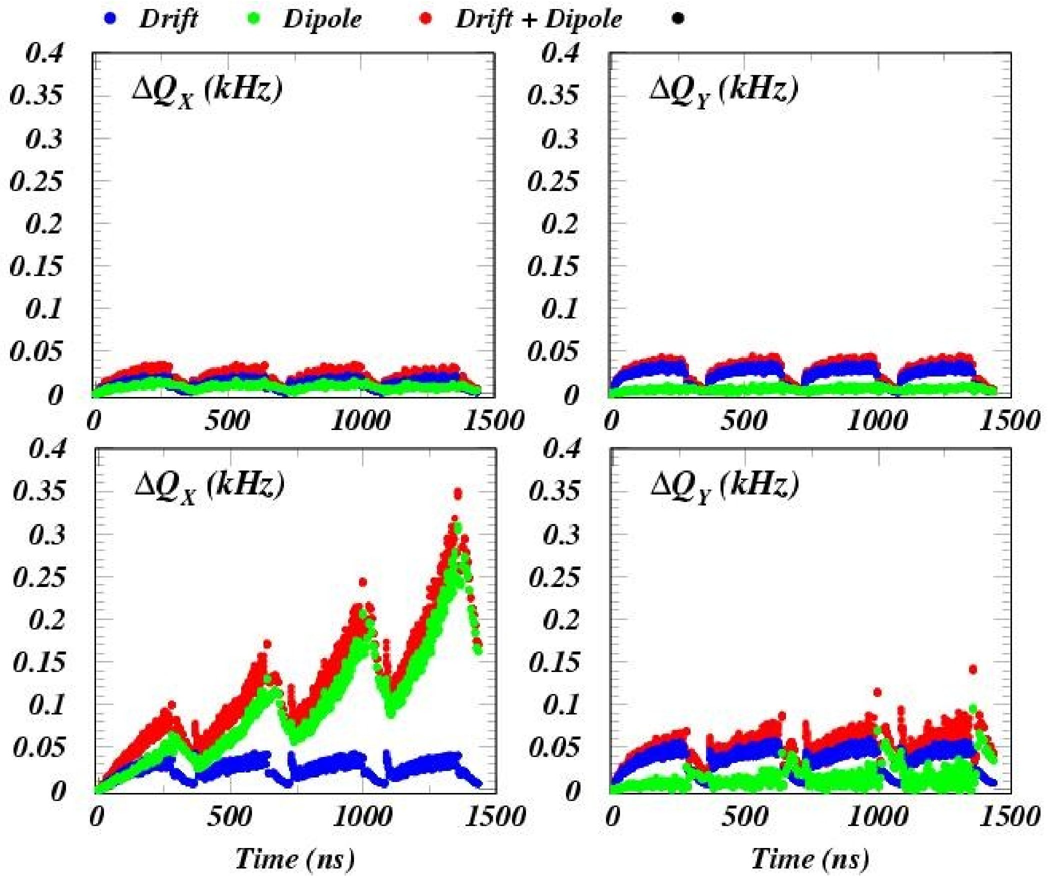


NB: The true secondary yield was not scaled down by the rediffused yield, as POSINST does.

Coherent tune shift calculated from space charge field gradients
Compare to revolution frequency of 47 kHz

No rediffused SEY component

Rediffused SEY component included



Assumed 80% dipole and 20% drift. Assumed average beta functions of 10 m.
Better values can be obtained from Kiran's synchrotron radiation analysis of the lattice file, which will also provide detailed element- and beta-averaged photon flux values.

Also need to decide on more realistic values for the rediffused SEY yield.