Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)

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INVESTIGATION INTO ELECTRON CLOUD EFFECTS IN THE ILC DAMPING RING DESIGN

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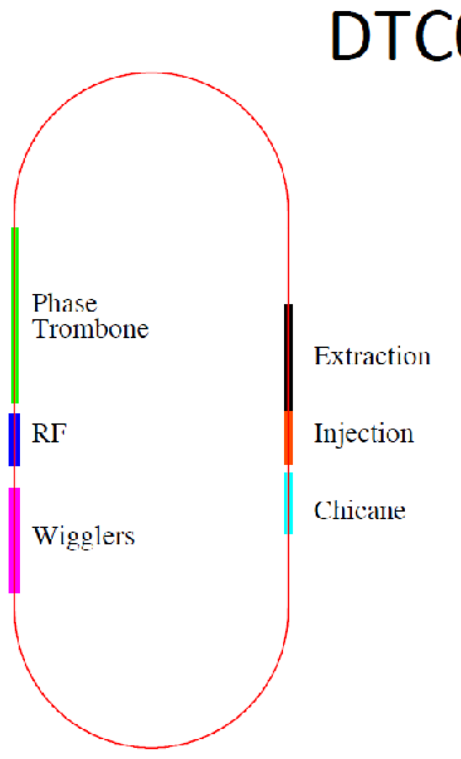
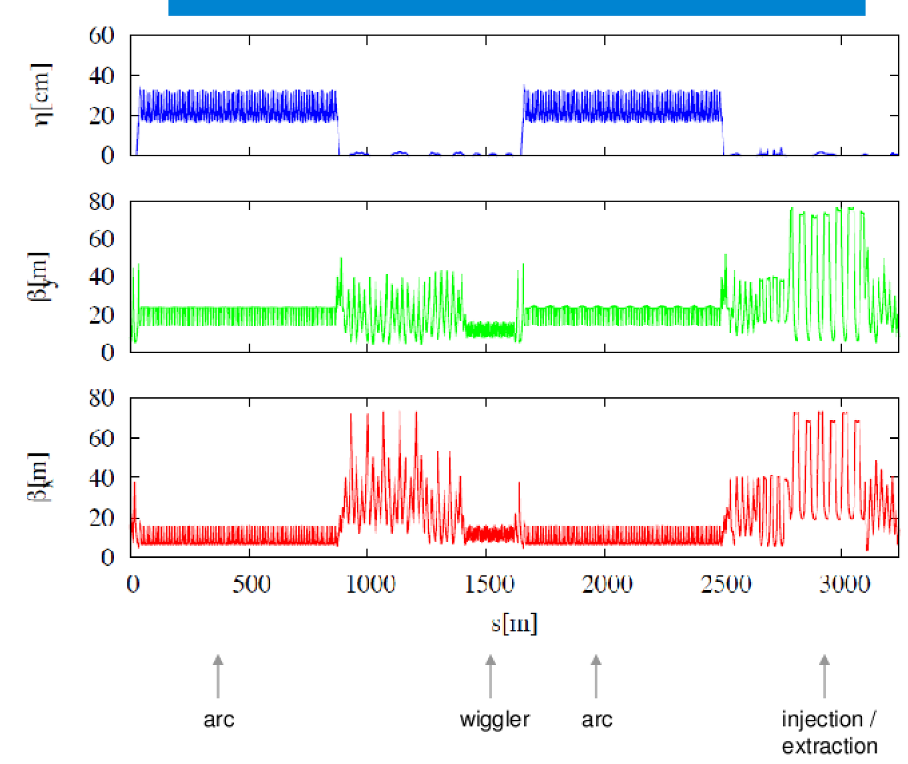
We report modeling results for electron cloud buildup in the ILC damping ring lattice design. Updated optics, wiggler magnets, and vacuum chamber designs have recently been developed for the 5 GeV, 3.2-km racetrack layout. An analysis of the synchrotron radiation profile around the ring has been performed, including the effects of diffuse and specular photon scattering on the interior surfaces of the vacuum chamber.

DTC03 layout

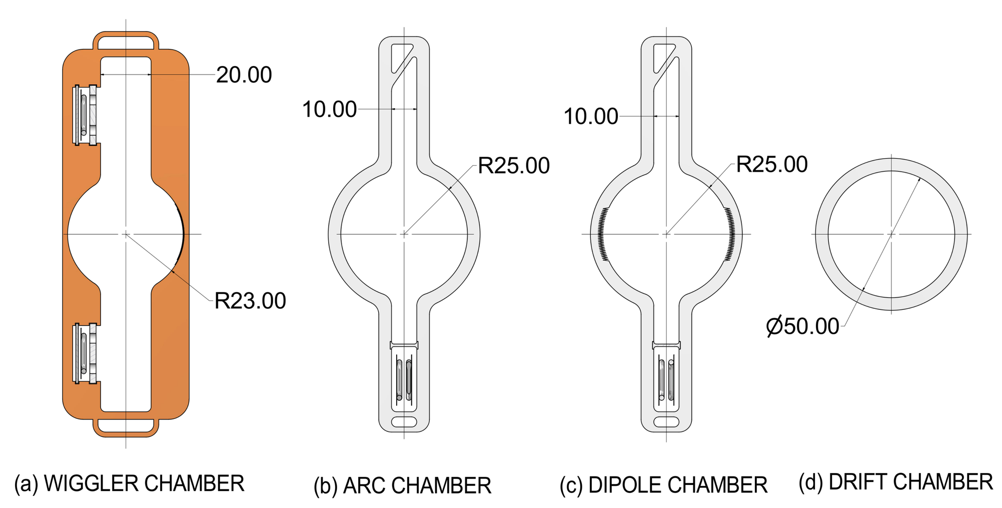


1. Circumference = 3238.68m, 710.22m straights
2. ~ 6 phase trombone cells
3. 54 – 2.2 m long wigglers
   wiggler period = 30cm
   14-poles
   B_{max} = 2.16 T
4. Space for 16 RF cavities
   Cryostats for upper and lower positron rings are interleaved

DTC03 Optics



Vacuum Chamber Development (ECLOUD10 Workshop)

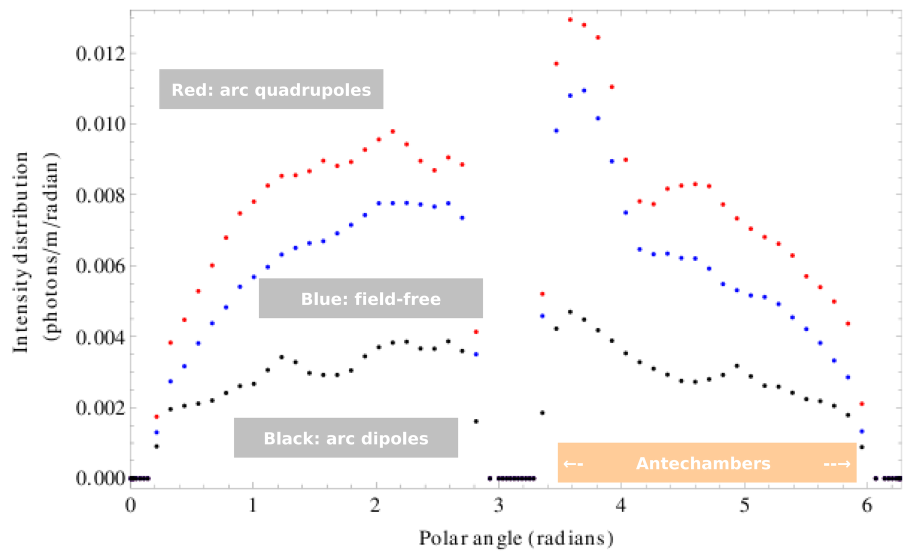


Damping Ring Operating Parameters

Parameter	10 Hz(Low)	5 Hz (Low)	5 Hz (High)
Circumference	3.238 km	3.238 km	3.238 km
RF frequency	650 MHz	650MHz	650 MHz
τ_x/τ_y [ms]	12.86	23.95	23.95
T_z [ms]	6.4	12.0	12.0
σ_s [mm]	6.02	6.02	6.02
σ_δ	0.137%	0.11%	0.11%
α_p	3.3 X 10^{-4}	3.3 X 10^{-4}	3.3 X 10^{-4}
$\gamma\varepsilon_x$ [μm]	6.3	5.8	5.8
RF [MV] (12 cavities) Total/Per cav	20.4/1.7	13.2 /1.1	13.2/1.1
ξ_x/ξ_y	-50.9/-44.1	-51.3/-43.3	-51.3/-43.3
Wigglers- N_{cells}@B[T]	27@2.16	27@1.51	27@1.51
Energy loss/turn [MeV]	8.4	4.5	4.5
sextupoles	3.34/-4.34	3.34/-4.23	3.34/-4.23
Power/RF coupler @400mA [kW]**	280	150	300

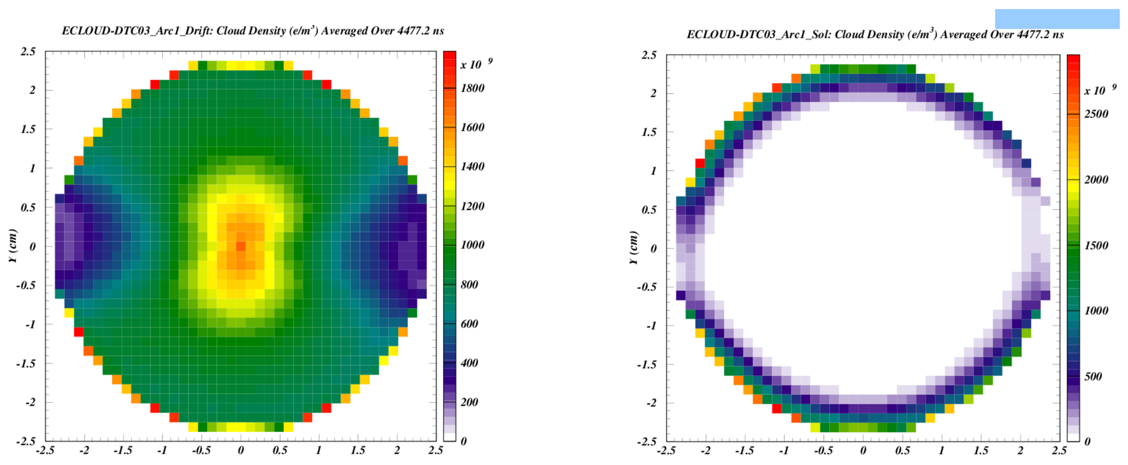
Radiation parameters (damping times, emittance, energy spread, etc. based on map-type wiggler
**(400mA X 8.4 MeV/turn)/12

Azimuthal s.r. photon absorption distributions from newly developed photon transport modeling code Synrad3D including full ring-wide vacuum chamber design and specular and diffuse photon scattering



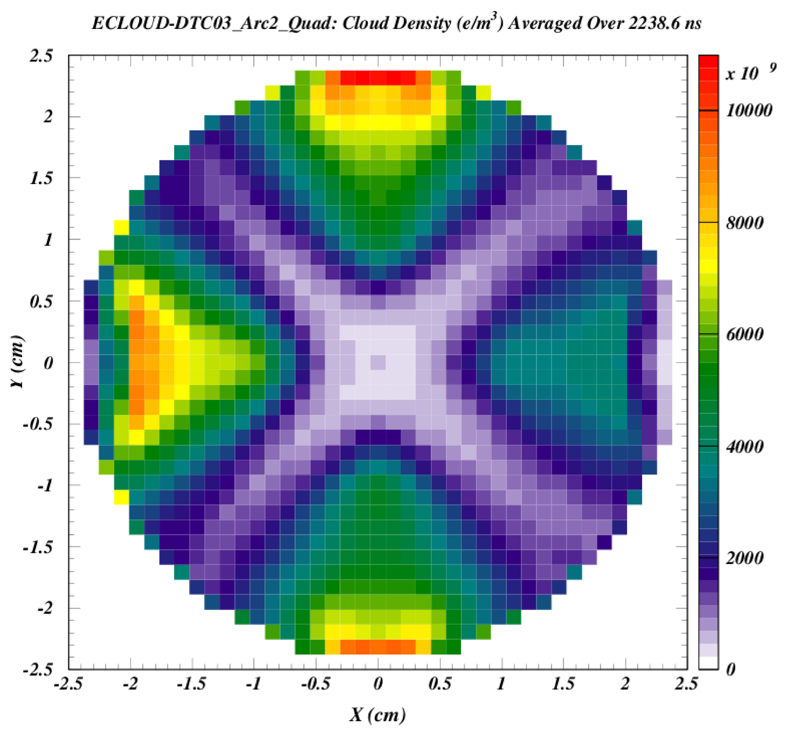
Cloud densities are calculated with the buildup modeling codes POSINST, ECLOUD and CLOUDLAND

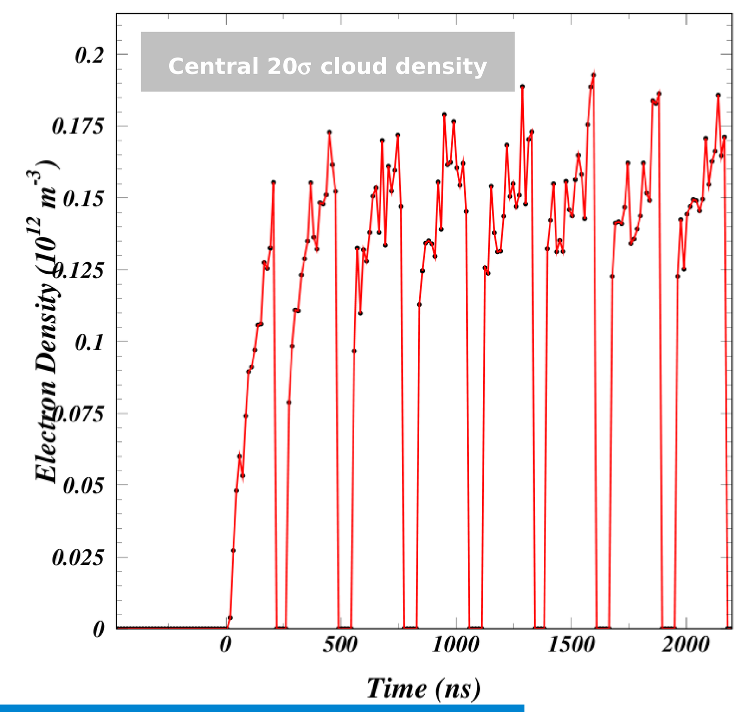
The example below shows the effectiveness of imposing 40-G solenoid fields to remove the cloud from the beam region in the arc field-free regions



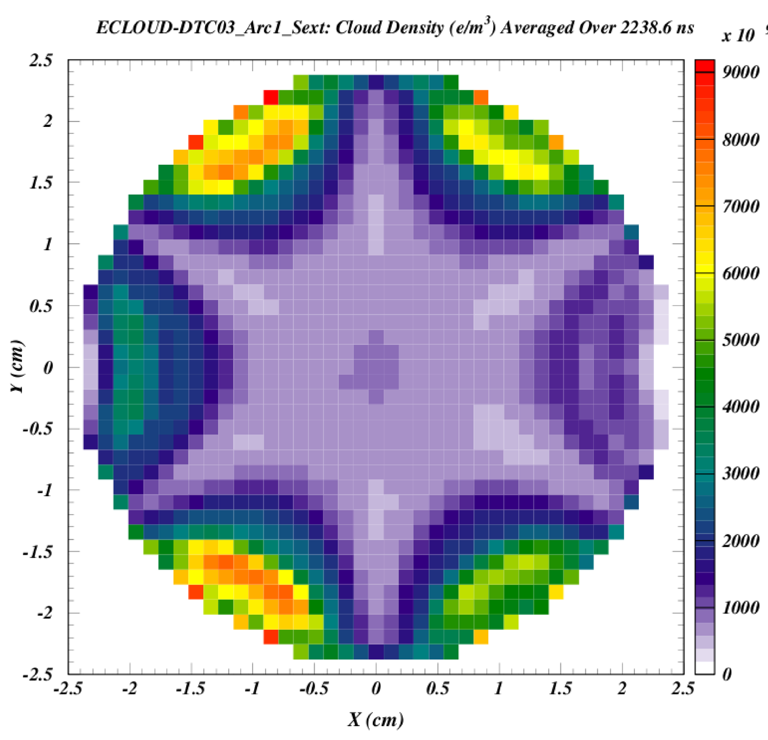
Arc Quadrupoles

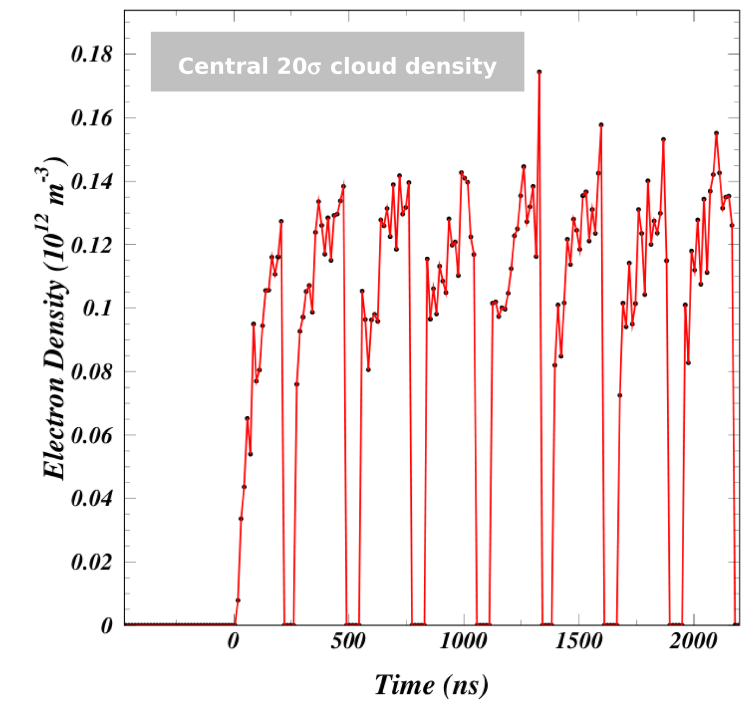
The buildup models exhibit cloud trapping, but not in the central region within 20s of the beam





Arc Sextupoles





Central Cloud Densities in Each Magnetic Environment in Each Region of the Ring

Table 2: POSINST and ECLOUD modeling results for the 20σ density estimates N_e (10^{11} m^{-3}) just prior to each bunch passage in the DTC03 lattice design

	Field-free		Dipole		Quadrupole		Sextupole	
	Length (m)	N_e	Length (m)	N_e	Length (m)	N_e	Length (m)	N_e
Arc region 1	406	2.5	229	0.4	146	1.5	90	1.4
Arc region 2	365	2.5	225	0.4	143	1.7	90	1.3
Wiggler region	91	40	0		18	12	0	

Conclusions and Future Work

The modeling work on EC buildup described above provides estimates of the cloud density in the region of the beam at the time of a bunch passage. The estimates are encouraging, placing an upper limit on the ring-averaged density of about 4 × 10^{10} m^{-3}, about a factor of three lower than assumed in earlier instability simulations.

The additional suppression provided by the grooved surfaces recommended for the arc dipole regions remains to be calculated for the DTC03.

Based on these results, the simulation code CMAD will be used to estimate instabilities arising due to the effect of the cloud on the beam bunches.

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