Cornell University
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ECLOUD Calculations of Coherent Tune Shifts for the April 2007 Measurements

- Thanks to Marco Venturini for clarifying the drift/dipole weighting -

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Electron Cloud Simulations Meeting

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Conversion of Space-charge Field Values to Tune Shifts

$$\Delta f_x = f_{rev}\frac{e}{4\pi E_{beam}}\oint \beta_x \left\langle \frac{dE_x}{dx}\right\rangle_{beam} ds \approx f_{rev}\frac{e}{4\pi E_{beam}} C\langle \beta_x\rangle_{ring}\left\langle \left\langle \frac{dE_x}{dx}\right\rangle_{beam}\right\rangle_{ring}$$

I. ECLOUD input parameters

1. *Sync rad photon rate per meter per beam particle at primary source point (Drift R=0.23, Dipole R=0.53)*
2. *Quantum efficiency (12%)*
3. *Beam particles per bunch (0.75 mA/bunch -> 1.2e10 e/bunch)*
4. *Contribution of reflected sync rad photons uniform in azimuth (15%).*
   - *This contribution is also subtracted from the primary source point.*
5. *Secondary emission peak yield (SEY=2.0) at peak energy (E_{peak}= 310 eV)*

II. Field difference or gradient --> tune shift conversion parameters

1. *E_{beam} = 1.885e9 eV*
2. *f_{rev} = 390 kHz*
3. *Ring circumference C=768 m ($C f_{rev} = c$ = 2.998e8 m/s)*
4. *Ring-averaged β values (from sync rad summary tables, see my presentation 18 Feb 09)*
   - *e+ beam: Drift $\beta_X(\beta_Y)$= 19.6(18.8), Dipole $\beta_X(\beta_Y)$ = 15.4(18.8)*
   - *e- beam: Drift $\beta_X(\beta_Y)$ = 19.4(19.3), Dipole $\beta_X(\beta_Y)$ = 15.3(19.4)*

III. Relative drift/dipole weighting (from sync rad summary tables)

1. *Ring length fraction*
   - *Drift: (174.9/768) = 0.228*
   - *Dipole: (473.9/768) = 0.73 (MV used 377.99 m. I weight his tune shift by 473.9/377.99 in this talk.)*
2. *β-averaged photon rate values*
   - *e+ beam: Drift $R_X(R_Y)$ = 0.987(1.061), Dipole $R_X(R_Y)$ = 1.100(0.911)*
   - *e- beam: Drift $R_X(R_Y)$ = 0.957(1.030), Dipole $R_X(R_Y)$ = 1.098(0.911)*

Example Tune Shift Calculation

$$\Delta f_x = f_{rev}\frac{e}{4\pi E_{beam}}\oint \beta_x \left\langle \frac{dE_x}{dx}\right\rangle_{beam} ds \approx f_{rev}\frac{e}{4\pi E_{beam}} C\langle \beta_x\rangle_{ring}\left\langle \left\langle \frac{dE_x}{dx}\right\rangle_{beam}\right\rangle_{ring}$$

Example: $\Delta E/\Delta Y$ = 1000 V/m², β_Y = 20 m => Δf = 253 Hz

<u>April 2007 Conditions</u>
<u>Positron beam beam-averaged field values for vertical offsets +- 5 mm</u>

$\Delta E/\Delta Y$ averaged over bunch 11

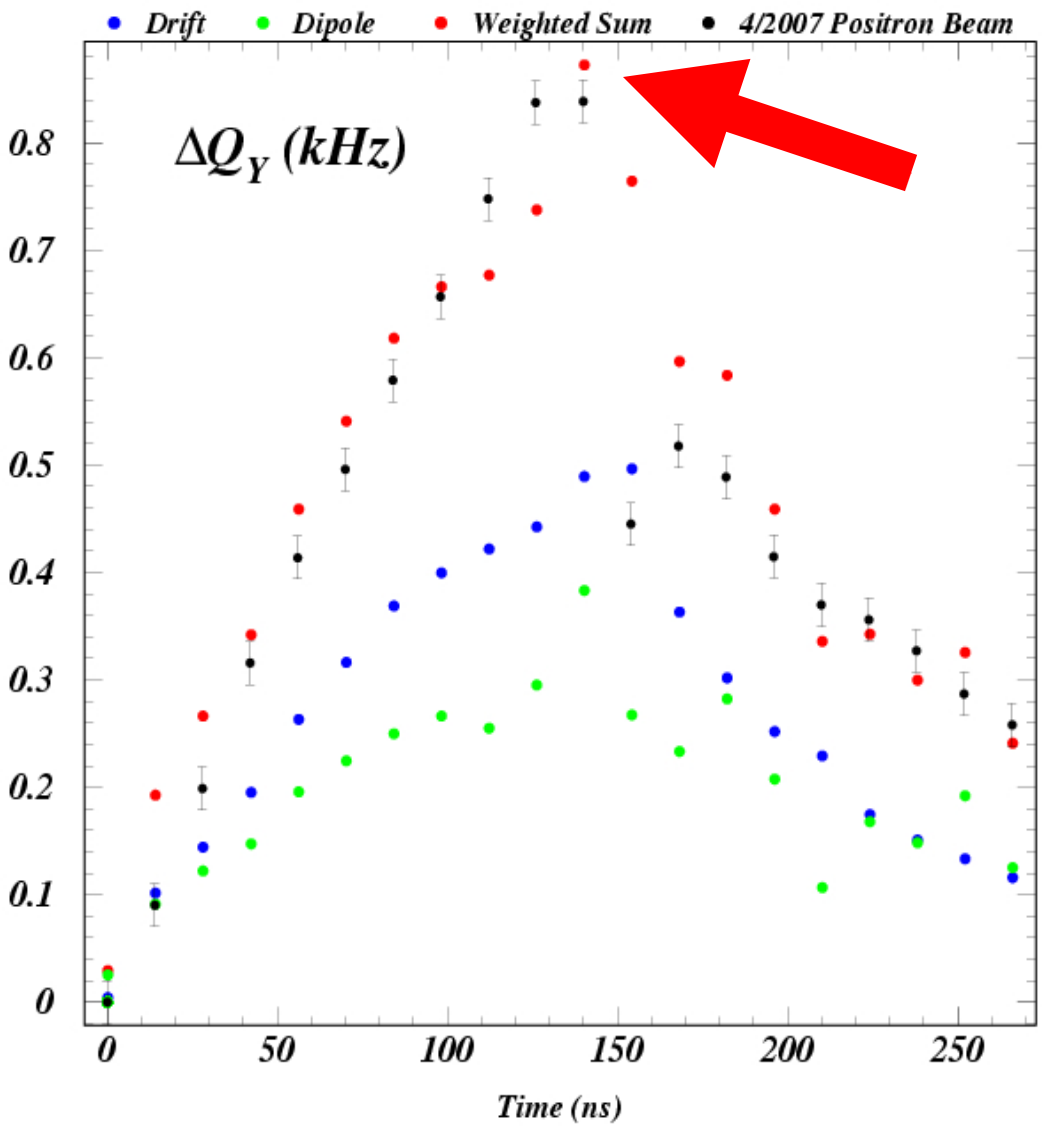
Drift: 9.038e3 V/m² Dipole: 2.610e3 V/m²

(Omit β-weighted photon rate correction for purposes of this comparison)

$$\Delta f_Y = \frac{2.998e8}{4\pi\, 1.885e9}(0.228*18.8*9.038e3 + 0.617*18.8*2.610e3)$$

$$\Delta f_Y = 0.873\, kHz$$

ECLOUD Vertical Tune Shift Calculations



GD LBNL/Cornell
POSINST Comparison
11 Feb 09
11 bunches offset, bunch 11

Drift ΔY=+5mm

	E_Y	Δf_Y
Cornell:	42.35 V/m	0.426
LBNL:	-41.06 V/m	0.445
ECLOUD:	48.05 V/m	0.490

Dipole ΔY=+5mm

	E_Y	Δf_Y
Cornell:	13.77 V/m	0.589
LBNL:	-11.52 V/m	0.34
ECLOUD:	9.62 V/m	0.383