ACC1 Beam Orbit Influence on BC2 Transverse Tilt

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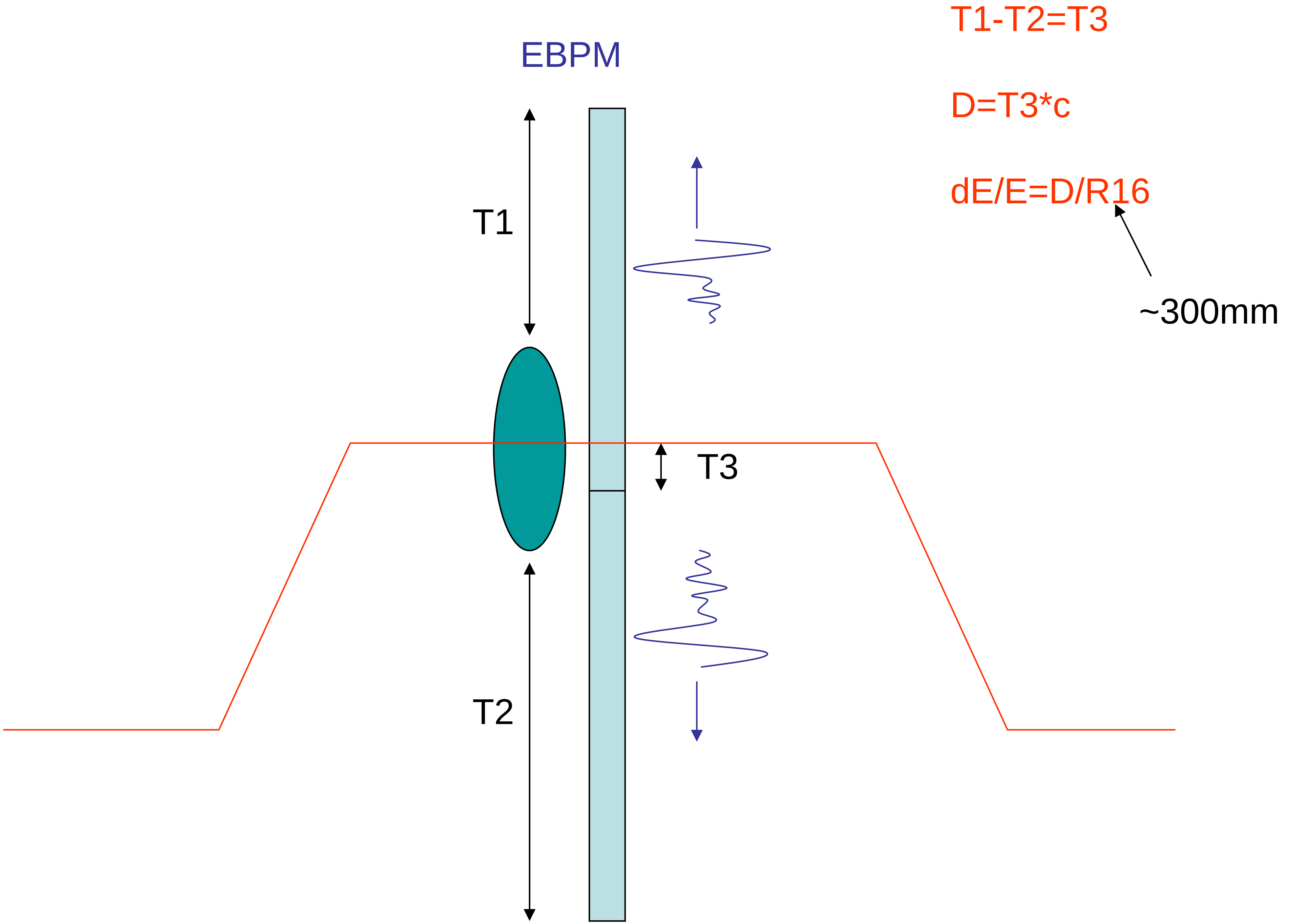
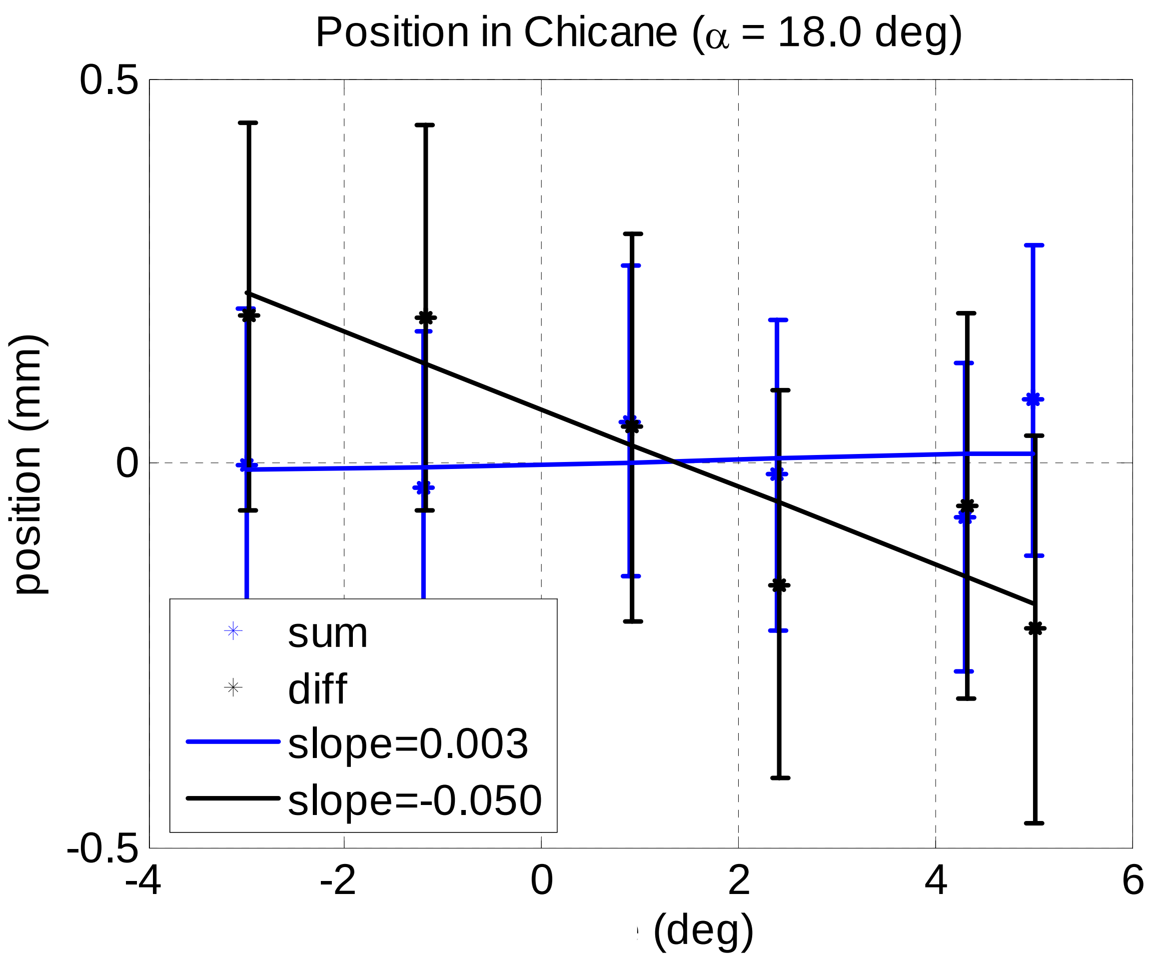
22 Jan ‘07

Tilt messes up my measurement



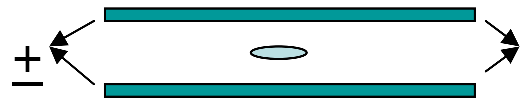
Measured w/ EBPM and Synch-Light



Scope Trigger Jitter:
~500 fs
~0.15 mm
~5*10^{-4}

Energy Stability:
~5*10^{-4}

Scope Data RMS:
~5*10^{-4}



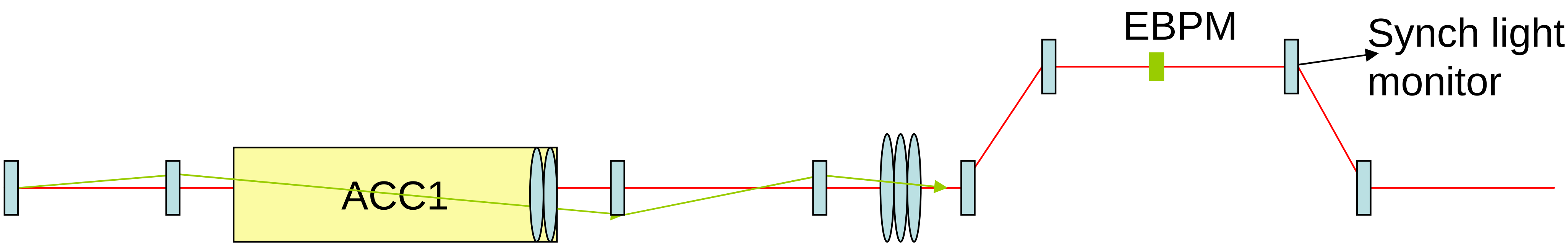
~5 mm orbit change in ACC1
causes 5 degree tilt of beam
causes 200 um BPM error

?

100 um orbit jitter in ACC1
causes small tilt of beam
causes 4 um BPM error

Creating a transverse tilt

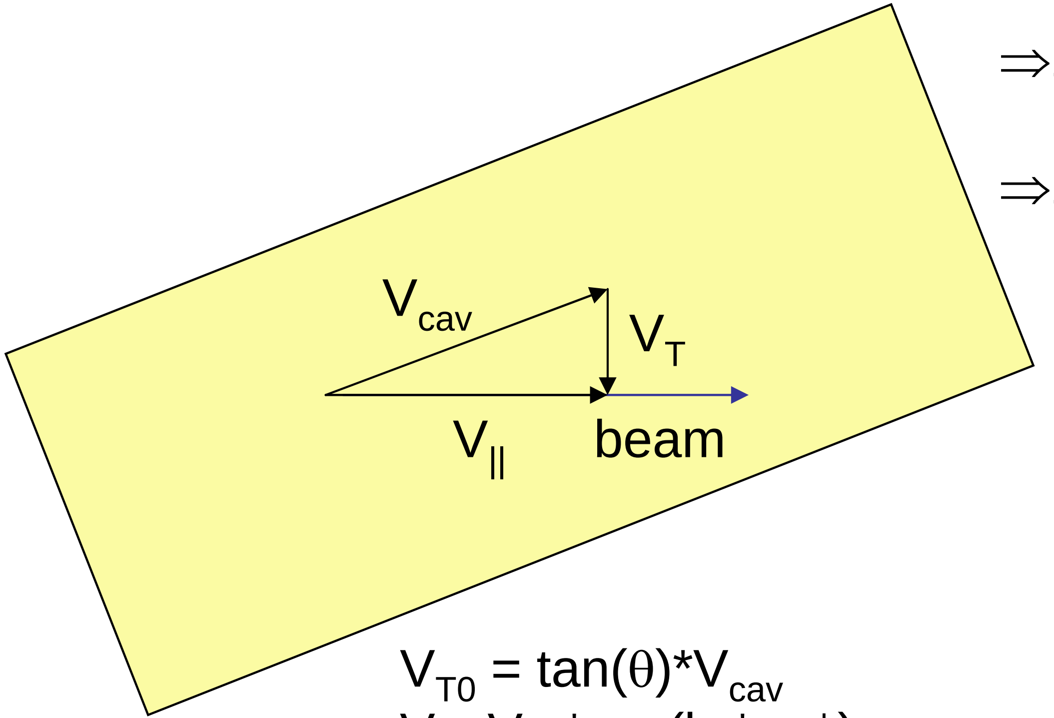
- Make a bump to produce some dispersion
- Go diagonally through the accelerating module
- Modify the tilt with wakefields and coupler kicks



Diagonal Path Through Cavity

1 mrad cav. tilt at 25 MeV gradient
$k_{rf} * \sigma_z$ ~ 3 deg
Off-crest acceleration 10deg

$\Rightarrow$25 keV transverse acceleration voltage
$\Rightarrow$227 V effect for 1 sigma

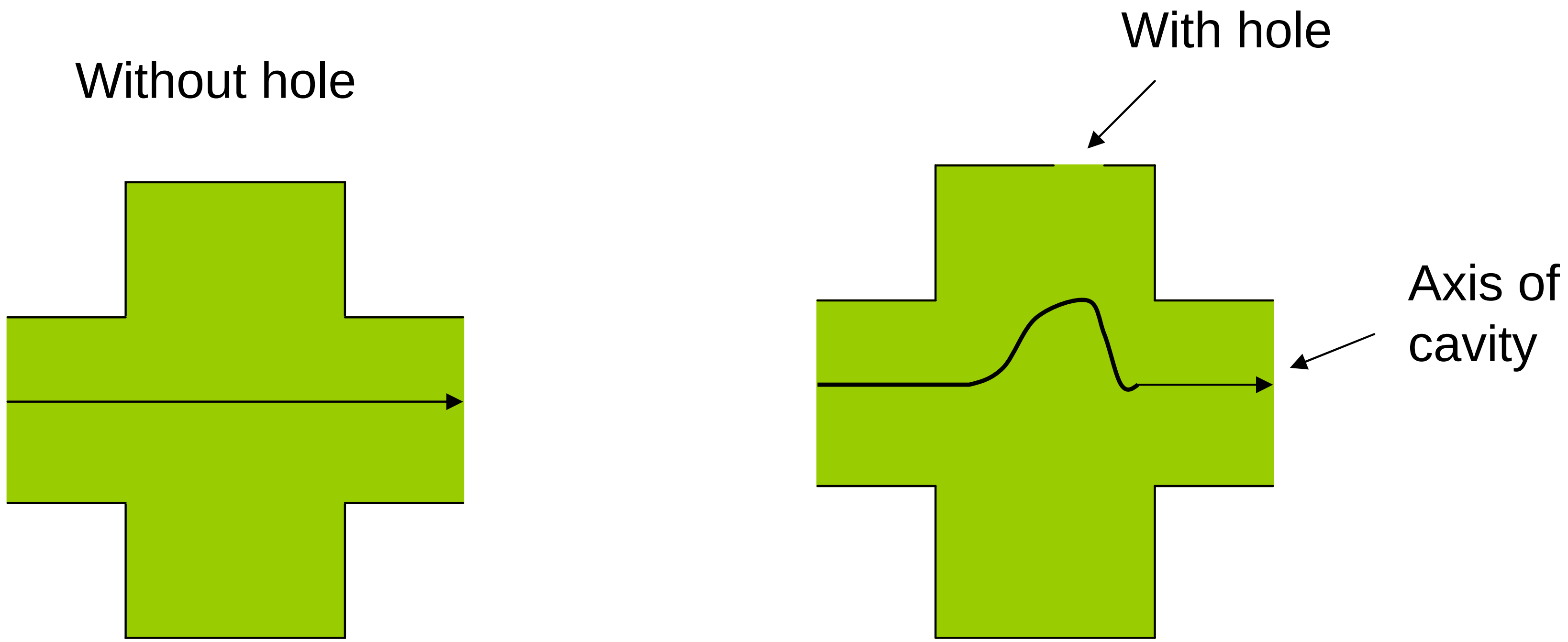


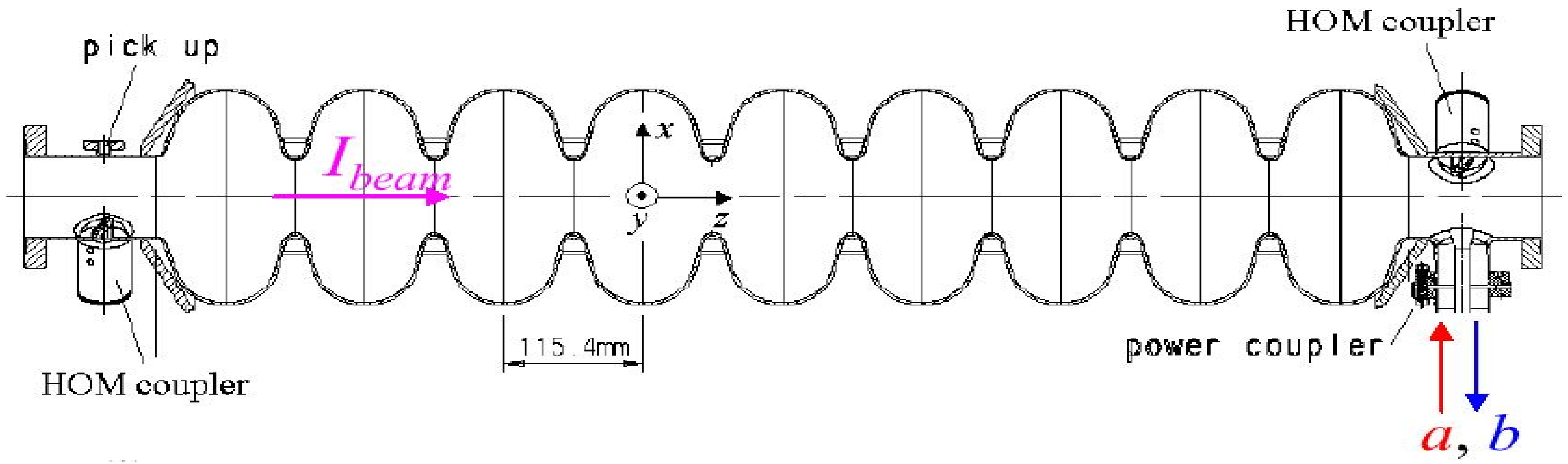
$V_{T0} = \tan(\theta) * V_{cav}$
$V_T = V_{T0} * \cos(k_{rf} * z + \phi)$
$= V_{T0} * (\cos(\phi) - k_{rf} * z * \sin(\phi) - (k_{rf} z)^2 \ldots)$
$\Delta y' = V_T(z)/E$

Transverse Integrated Field (M. Dohlus)

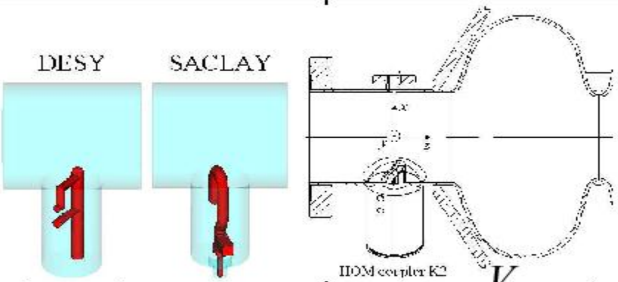
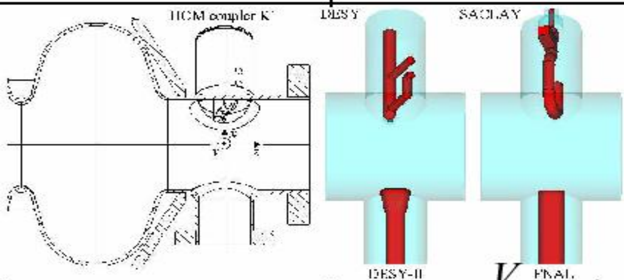
dipole modes, single bunch kick, short range source: bunch with offset, $Q = 1\text{nC}$ $\sigma = 1$ mm, offset = 1mm $\quad\rightarrow\ V_\perp \propto 20$ V ($\propto$ offset)
Main+HOM coupler, single bunch kick, short range source: bunch (without offset), $Q = 1\text{nC}$ $\sigma = 5$ mm $\rightarrow\ V_\perp \propto 20$ V scaled to $\sigma = 1$ mm $\quad\rightarrow\ V_\perp \propto 50$ V
main & HOM couplers source: accelerating field $V_{acc} = 25$ MV/m (each coupler) $\quad\rightarrow\ V_\perp \propto 750$ V
main coupler source: biasing voltage $V_{bias} = 2.5$ kV $\quad\rightarrow\ V_\perp \propto 750$ V

Coupler kicks





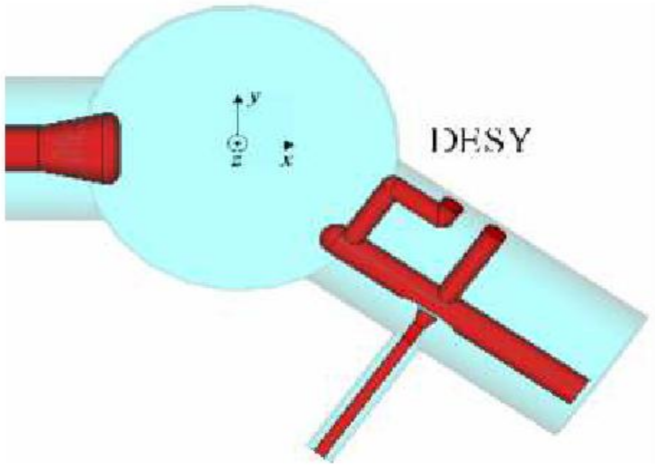
Values for transverse voltages: HOM-coupler

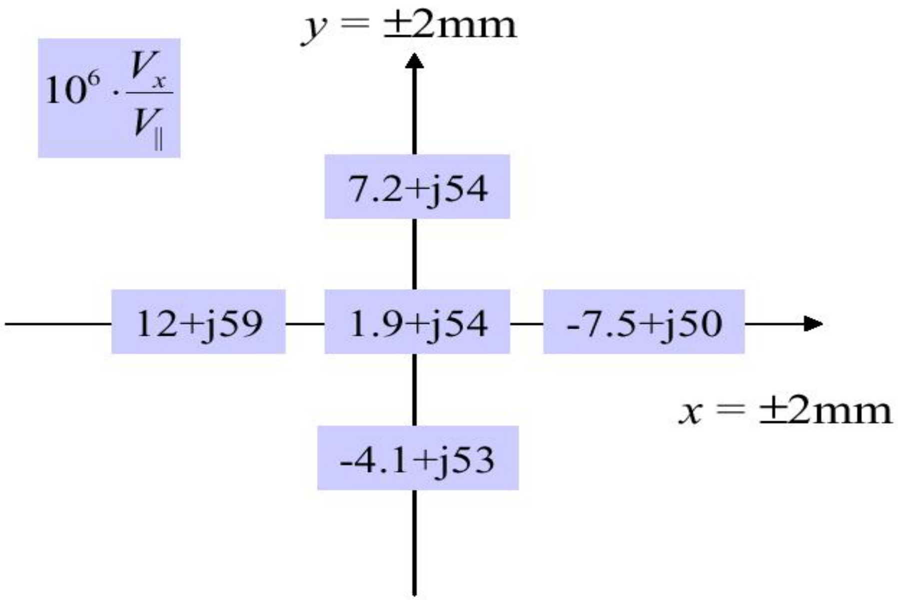
	desy	saclay
upstream	 $\frac{V_x}{V_\parallel} = (-53.0 + j14.3) \cdot 10^{-6}$ $\frac{V_y}{V_\parallel} = (-33.4 + j2.8) \cdot 10^{-6}$	$\frac{V_x}{V_\parallel} = (-20.1 + j24.5) \cdot 10^{-6}$ $\frac{V_y}{V_\parallel} = (-26.2 + j12.5) \cdot 10^{-6}$
downstream	 $\frac{V_x}{V_\parallel} = (2 + j54) \cdot 10^{-6}$ $\frac{V_y}{V_\parallel} = (32 + j6) \cdot 10^{-6}$	$\frac{V_x}{V_\parallel} = (34 + j45) \cdot 10^{-6}$ * $\frac{V_y}{V_\parallel} = (28 + j15) \cdot 10^{-6}$

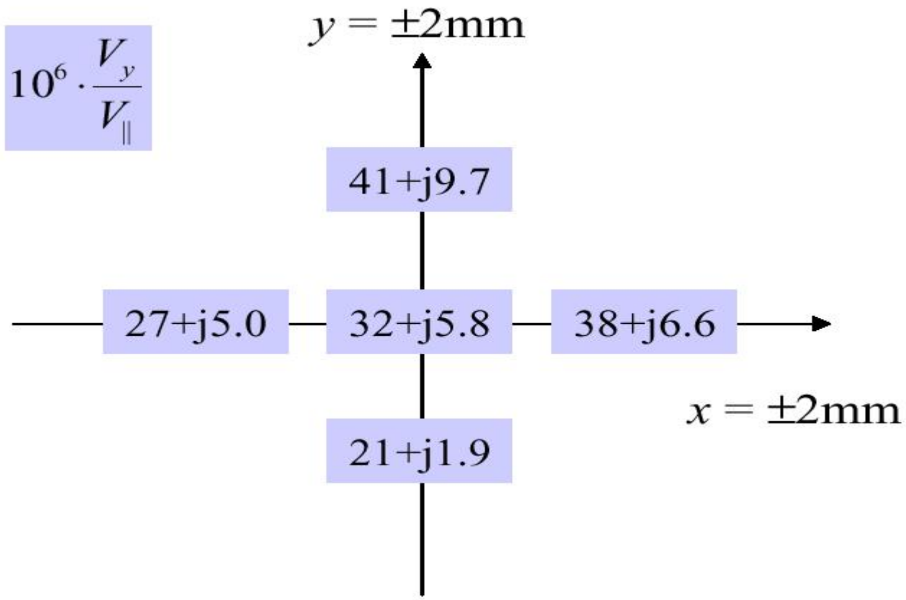
(phase reference is center of cell 1, all numbers ±10·10-6)
* independent calculation of main & HOM coupler

(From M. Dohlus)

Dependence on transverse coordinates







→ Xy-dependence: data only for DESY-downstream-coupler

(From M. Dohlus)

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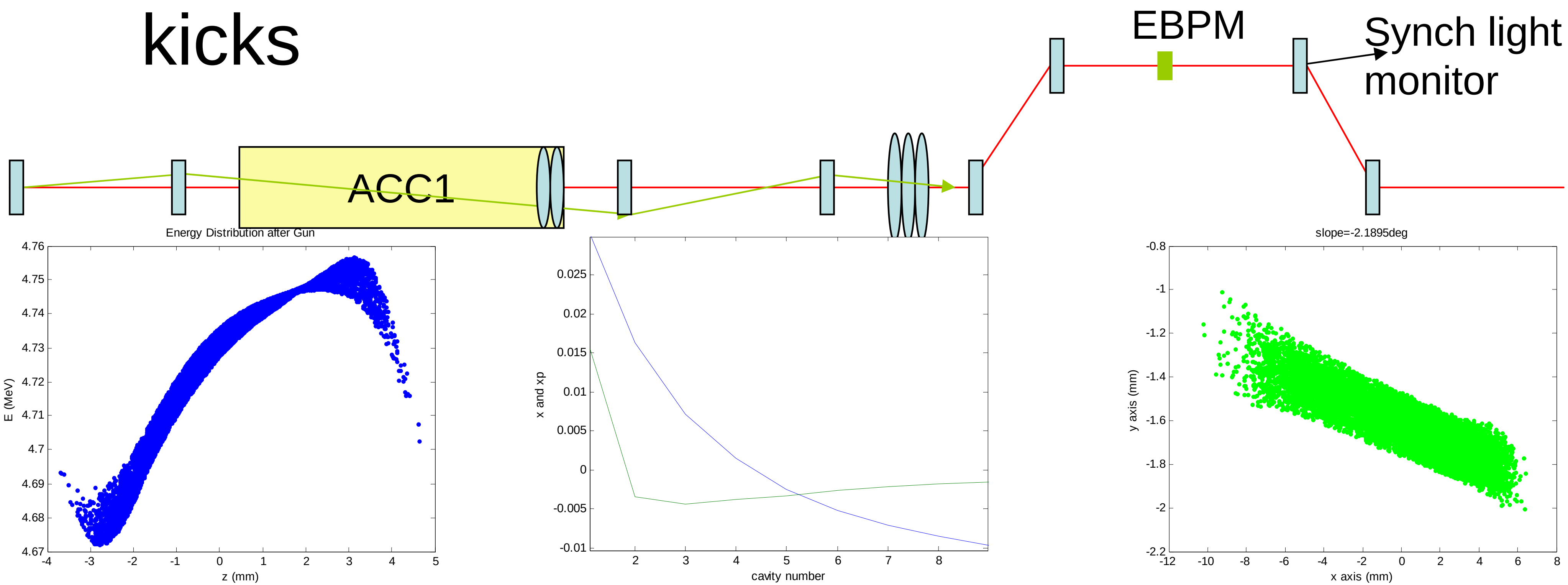

Quick and Dirty Simulation

- Enter ACC1 with no offset and no angle
  - Dispersion -> 0.00 degrees
  - Wakefields -> 0.00 degrees
  - Coupler Kicks -> 0.04 degrees
- Enter ACC1 with 30mm offset and 15mrad angle
  - Dispersion -> 2.38 degrees
  - Wakefields -> 2.34 degrees
  - Coupler Kicks -> 2.46 degrees
- Add ASTRA gun energy distribution
  - Dispersion -> 2.09 degrees
  - Wakefields -> 2.12 degrees
  - Coupler Kicks -> 2.19 degrees

Elegant simulation

- Dispersion only -> 2.5 degrees
- Add Wakefields -> 3 degrees
- Didn’t have an energy chirp out of the gun
- No coupler kicks added

(Courtesy of : Eduard Prat)

One way to measure coupler kicks might be to…

- Go on crest and on axis to reduce dispersion effects
- Look for tiny asymmetries on OTR screen or synch light monitor in chicane
- Change charge and gradient to determine wakefield contribution

Measuring the kicks has been attempted several times, but success is elusive (changing phase of cavity and studying effect on synch light monitor)

Some Experts on Coupler Kicks:

- M. Zhang and Ch. Tang (PAC1999): Beam Dynamic Aspects of the TESLA Power Coupler

- Martin Dohlus (2004): Field Asymmetries and Kicks (ppt) http://tesla.desy.de/fla/publications/talks/seminar/FLA-seminar_090904.pdf

- Michael Roehrs (2004): The Effects of Coupler Kicks on the Beam (ppt) http://tesla.desy.de/fla/publications/talks/seminar/FLA-seminar_101204.pdf