Basic Parameters, Recap

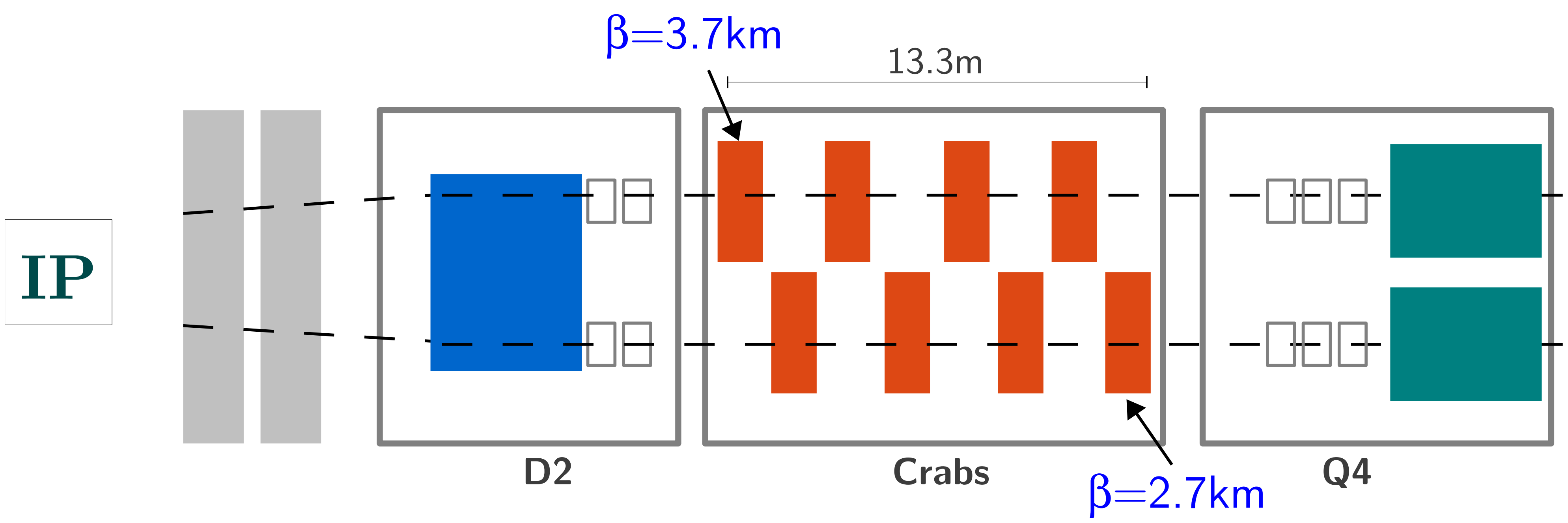
R. Calaga, March 21 2014

Voltage = 3.4 MV/cavity (4 cavities /module)

Frequency = 400.079 MHz (h=35640)

Qext = 5×10^5 (Assuming R/Q=400Ω)

RF power source = 80 kW (assuming x2 margin)

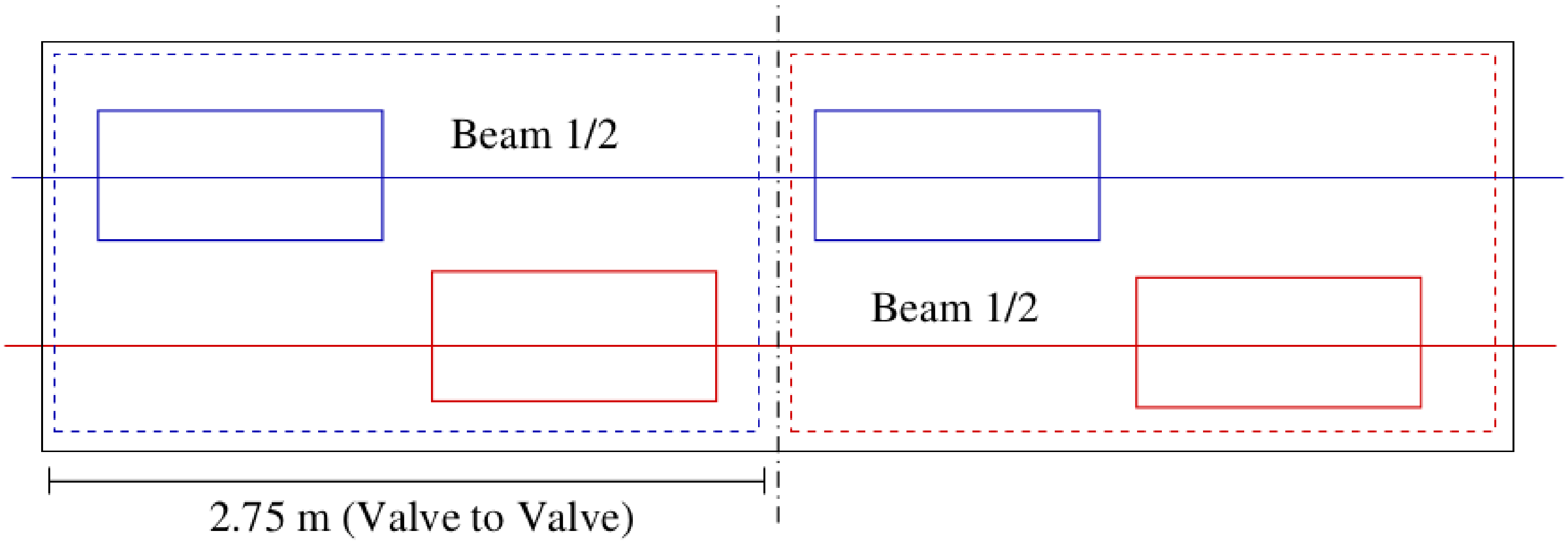


LHC Layout Options

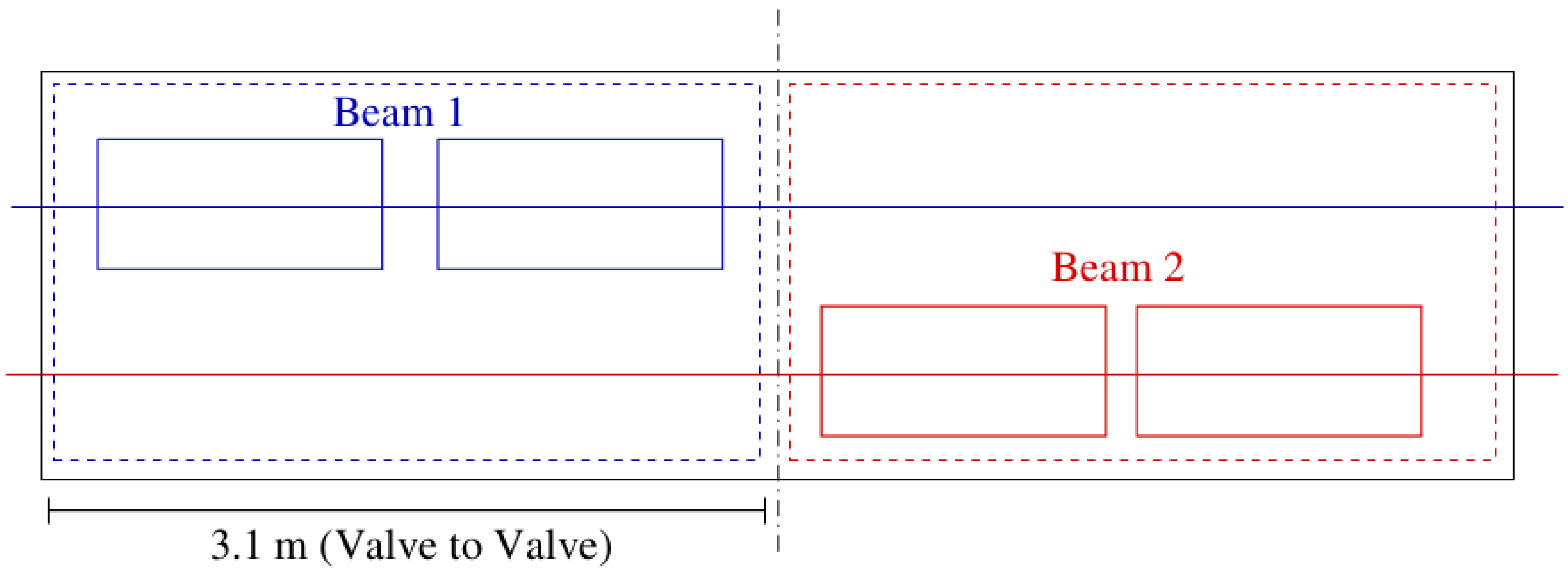
Difference in voltage <3% per cavity

(use same voltage for all cavities de Maria)

Baseline



SPS-Type Cryomodule (Preferred)

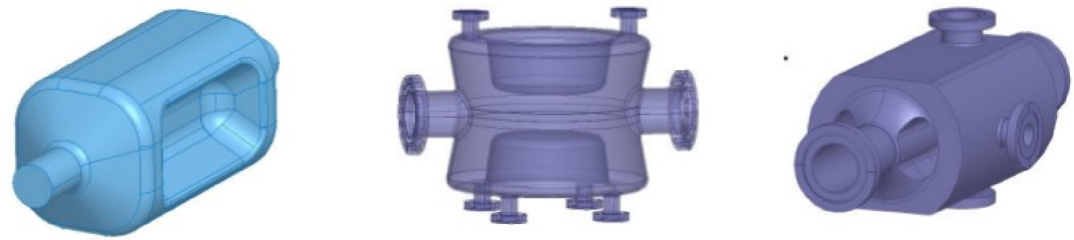


Thanks to EN-MME for Integration

Multipole Update

Courtesy M. Navarro et al.

2012 updated geometries



	RF Dipole		$\frac{1}{4}$-wave		4-rod	
$V_x = 10$ MV	$\Re(b_2)$	$\Im(b_2)$	$\Re(b_3)$	$\Im(b_3)$	$\Re(b_4)$	$\Im(b_4)$
$b_2[mTm/m]$	0	0	0	0	0	0
$b_3[mTm/m^2]$	4500	0	1100	0	1160	0
$b_4[mTm/m^3]$	0	0	0	0	0	0

b_3 is within specification for 1mm orbit

(similar to beam-loading requirements)

Tolerance studies show negligible effects from fabrication errors of ~600 μm IPAC13.

Measurement Setup

Courtesy M. Navarro et al.

Goal

Measure field linearity with offset

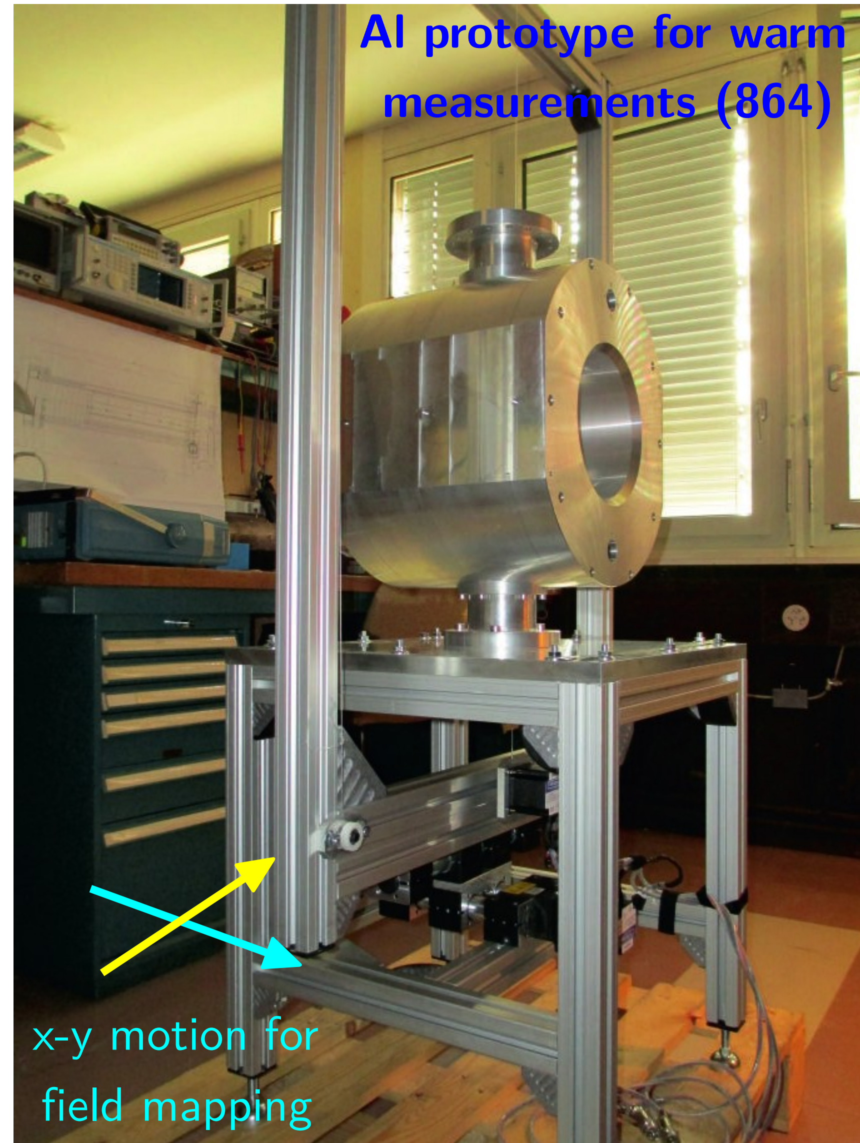
Field is deduced from $\Delta U/U \; \mu \; E^2/H^2$

Standard bead-pull maybe too noisy

May need rotational degree of freedom

With careful setup $\rightarrow$ b3 might be feasible

Still need software development



Operational Aspects

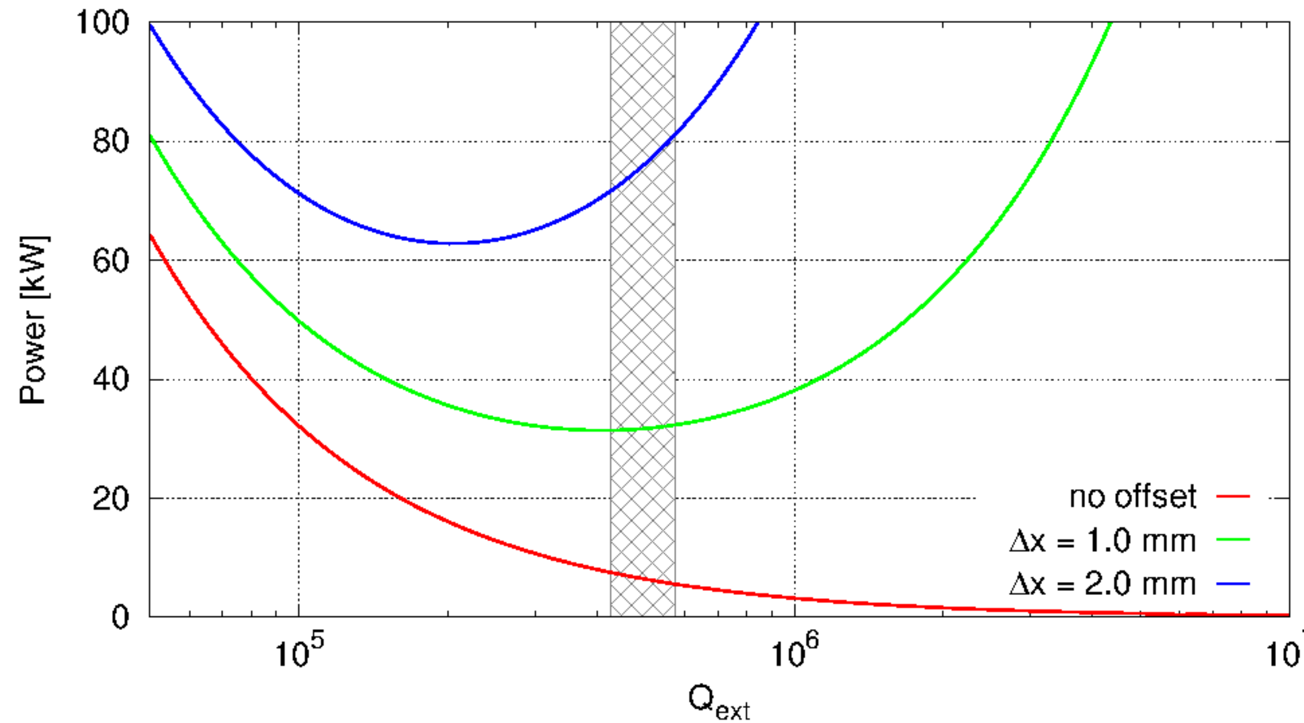
Orbit Offset: $$V_b \simeq Q_L I_b \frac{R}{Q}(\Delta x)$$

Q_L=3-5x10^5, I_b=1.1A, R/Q=400Ω

1mm offset ~0.2 MV/mm beam induced voltage

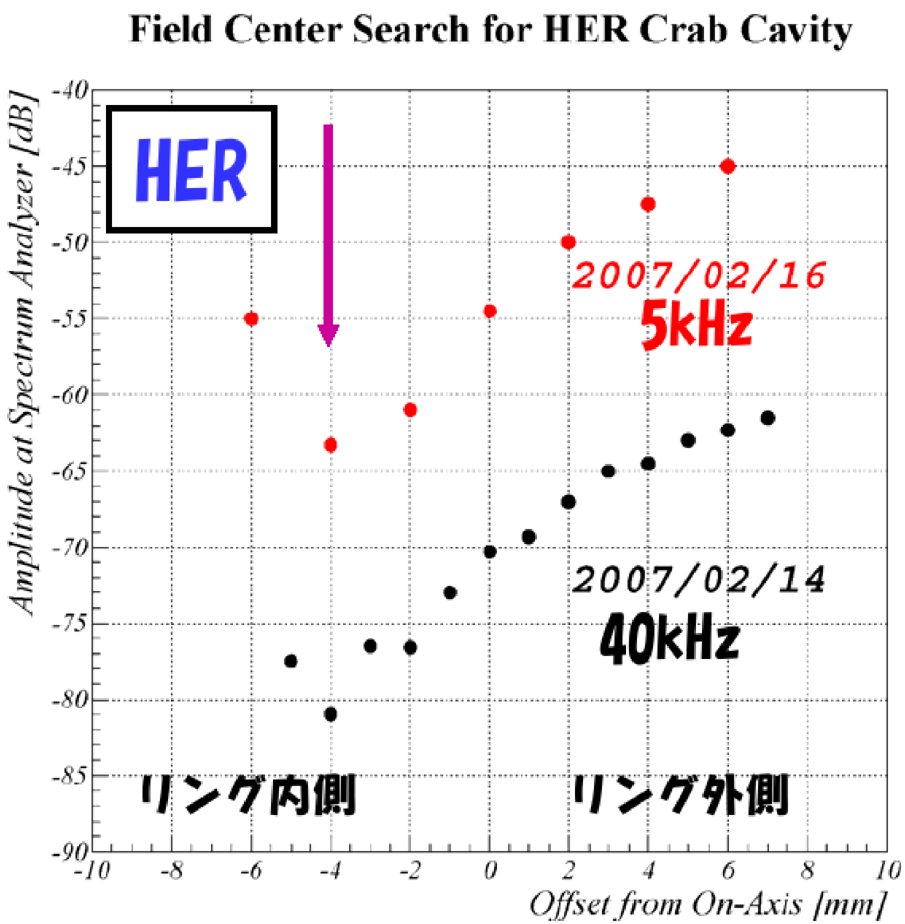
Amplifier Max →

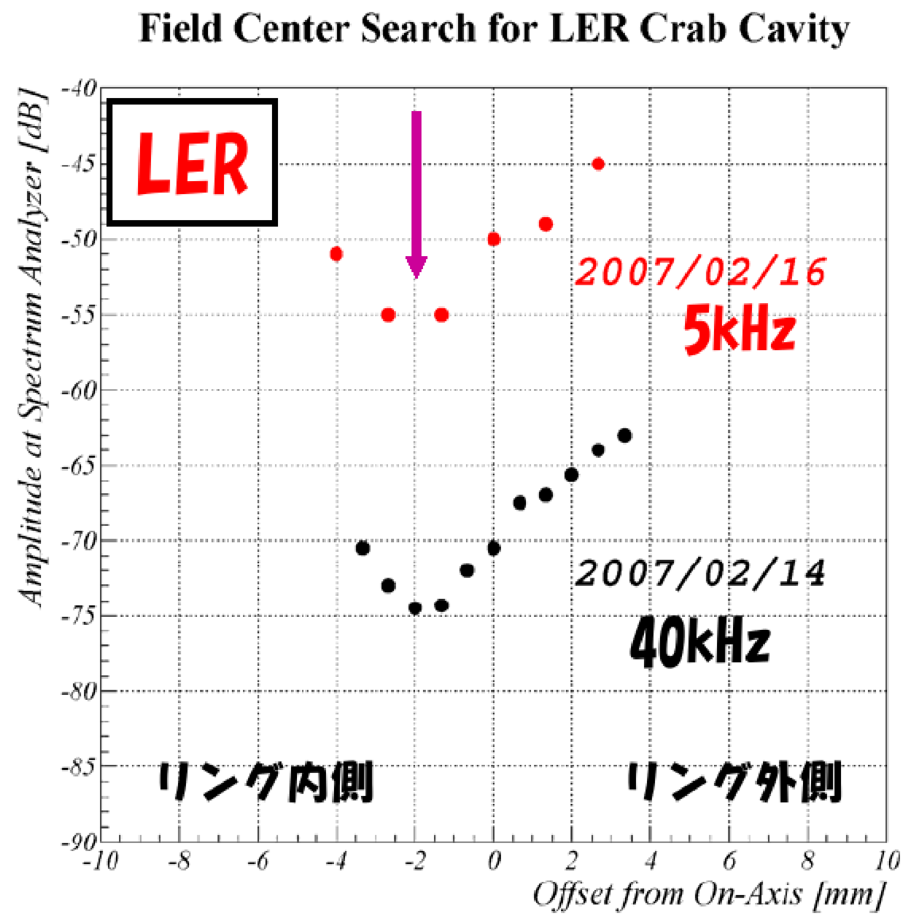
(25-50% overhead)



Orbit Centering, KEKB

Courtesy KEKB, 2007

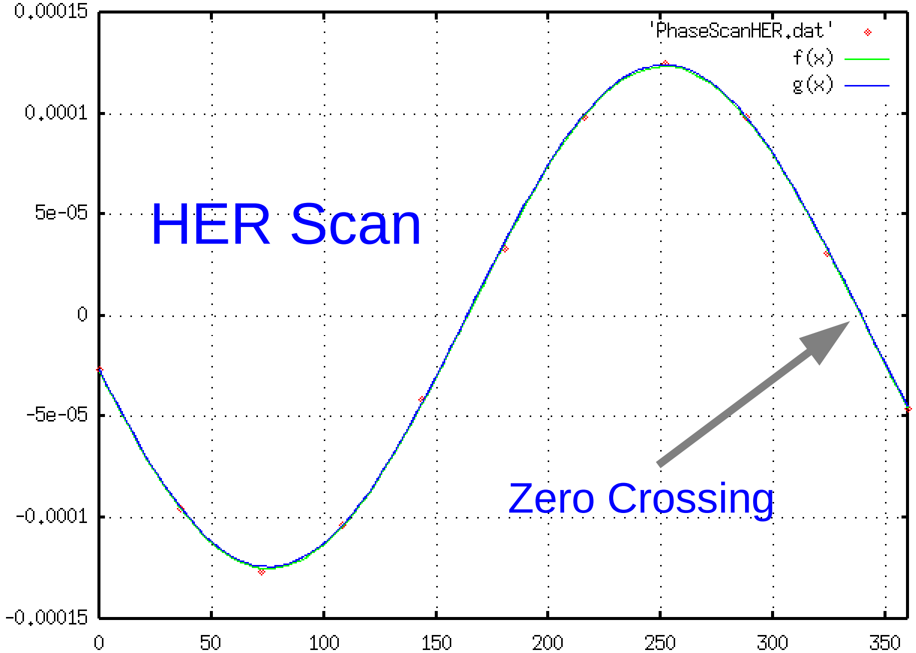


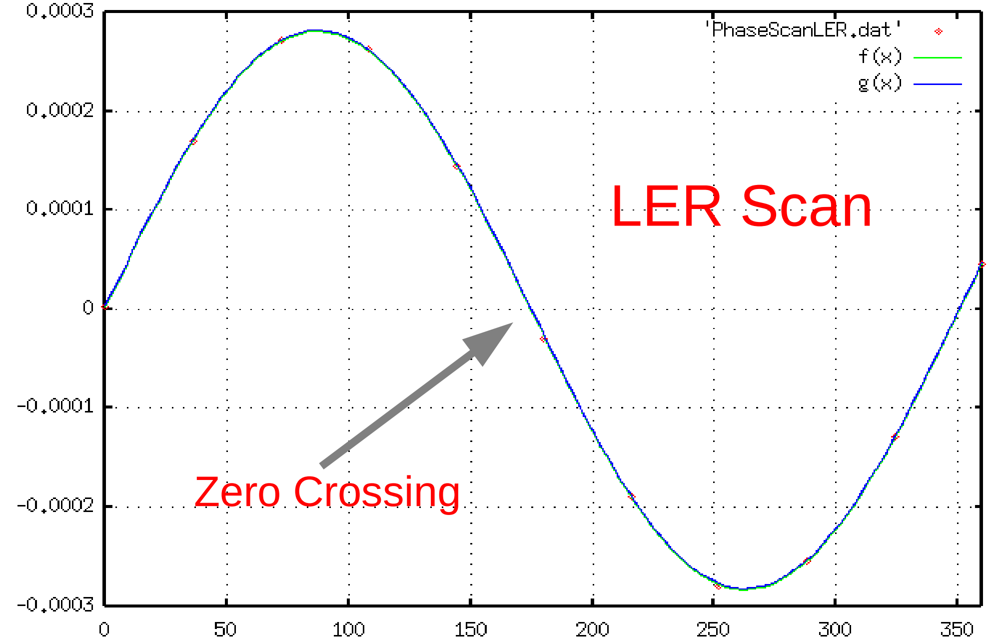


Record input/output power vs. orbit (dipole mode)

CC Phase Scan, KEKB

Courtesy KEKB, 2007





Zero crossing & sign of the slope not known

2π phase scan vs. relative orbit deviation

Impedance Aspects

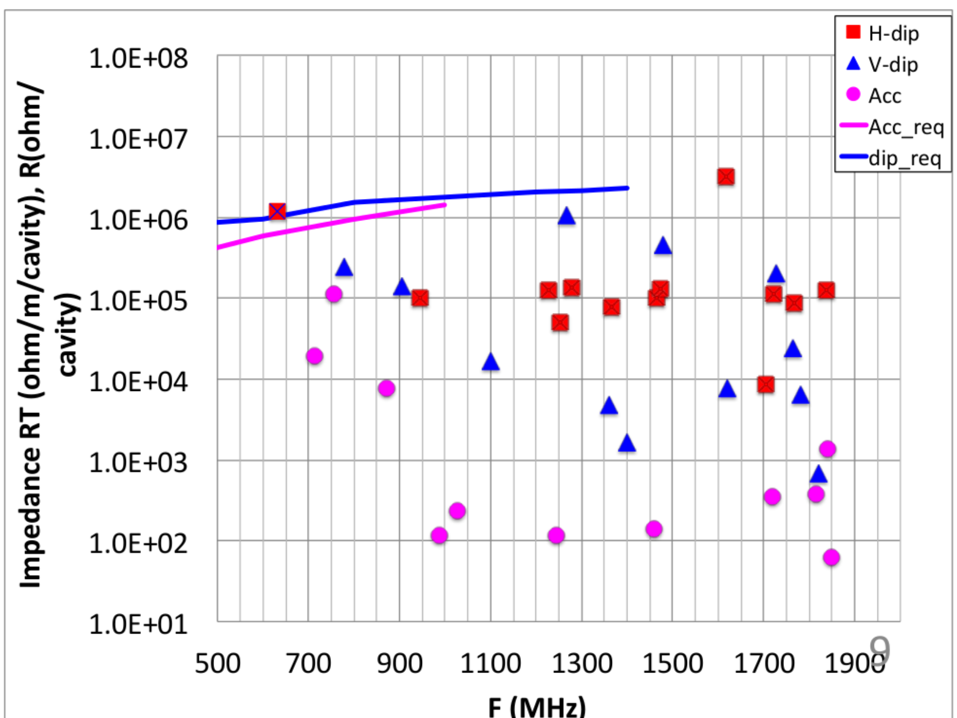
Updated by B. Salvant
HiLumi Frascati

Longitudinal criteria:

Threshold of 200 kΩ ($E=7TeV$, $N_b=2.2x10^{11}$, $\sigma_z=1ns$)

Transverse criteria:

Threshold of 5.8 MΩ/m (determined by damping time of 5ms)
(thresholds have changed from 2 to 5.8 MW/m since 2010)



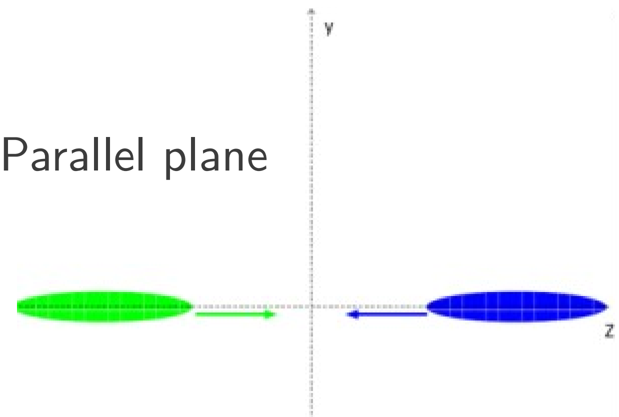
Example ODU-cavity

	Freq [GHz]	R/Q [Ω]	Q_{ext}
Monopole	0.54	35.17	~10-100
	0.69	194.52	
Dipole	0.4	400	10^6
	0.81	0.46	~10^2-10^3
	0.89	93.4	
	0.90	6.79	

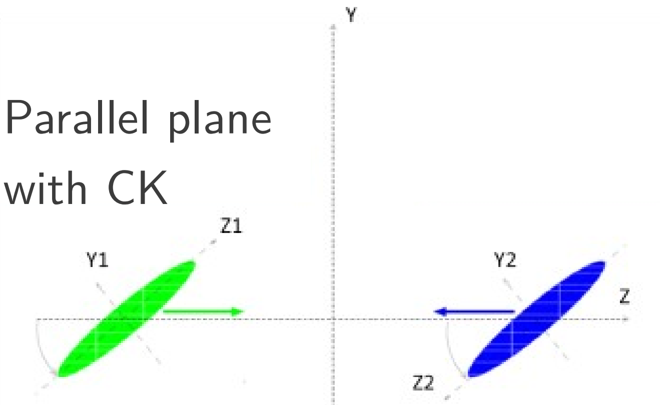
** Main RF cavities, $Q_{ext} \sim 10^2$ - 10^3

CC Vs CK Schemes

Parallel plane



Parallel plane
with CK



S. Fartoukh, LHC-CC13

- Crab Cavities "required" in both transverse planes
    - ~½ the crossing angle in parallel plane for density leveling

- For the option proposed: 7 MV + 7 MV in each (flat optics + BBLR)
    - Number of cavities remain same (4 /IP/beam) - impedance
    - RF system & controls are similar

- Is the crab bump across IP in both planes closed efficiently ?
- Having both planes at the same IP → "effectively" 2 types of cavities
- Less voltage margin less flexibility on counter-phasing but overall feasible

Appendix: SPS RF Power

Q_L=3-5x10^5, I_b=0.34A, R/Q=400Ω

(assuming 1.7x10^{11} p/bunch, 72x4 bunches)