Cornell University
Laboratory for Elementary-Particle Physics

Bug Found and Fixed in BMAD Calculations of Orbit Distortions Induced by Cavity Offsets

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Example of HOM Kicks Distorting Orbit in the CERL 8.2 Lattice and Effectiveness of Orbit Correction

J.A. Crittenden, Georg Hoffstaetter, Chris Mayes and David Sagan

Cornell Laboratory for Accelerator-Based Sciences and Education

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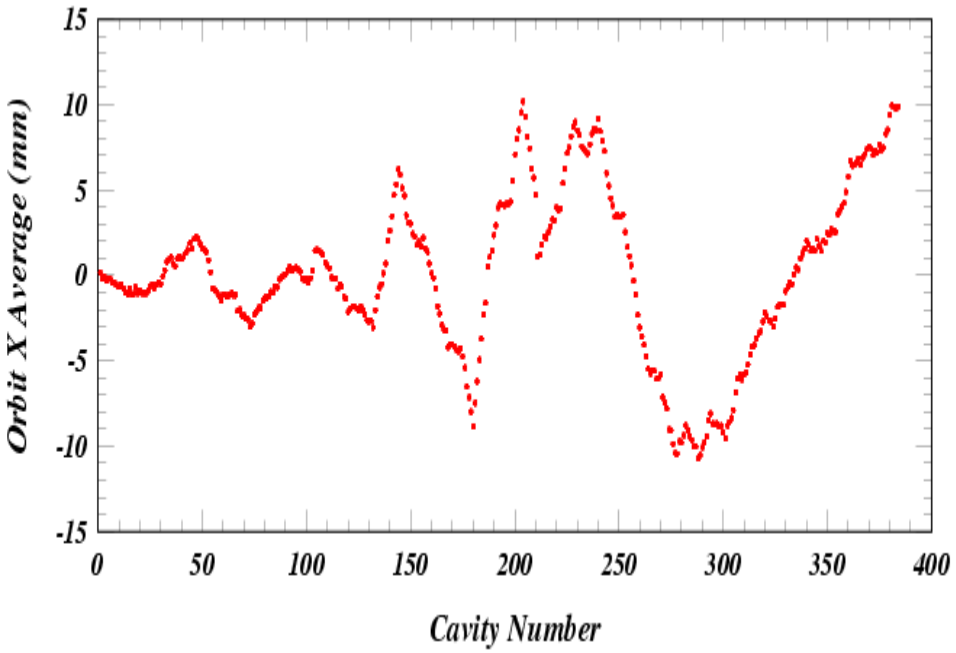
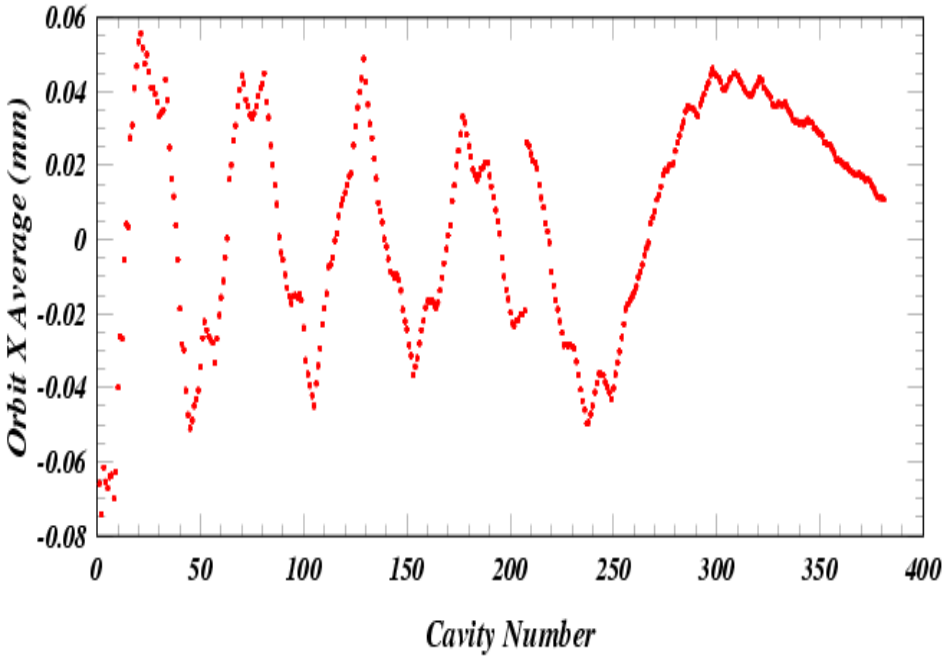
Effect of bug on full CERL8.2 equilibrium orbit calculation with 5 HOMS in all cavities and 0.3 mm rms offsets

Calculated orbit distortion before fix

(see talk of 23 September 2010)



After fix



This bug affected ONLY cases of HOM elements in RF cavities with position offsets.

CERL 8.2 calculation with 0.3 mm randomized cavity offsets

5 HOMs (MUL 2009) in each of 384 cavities

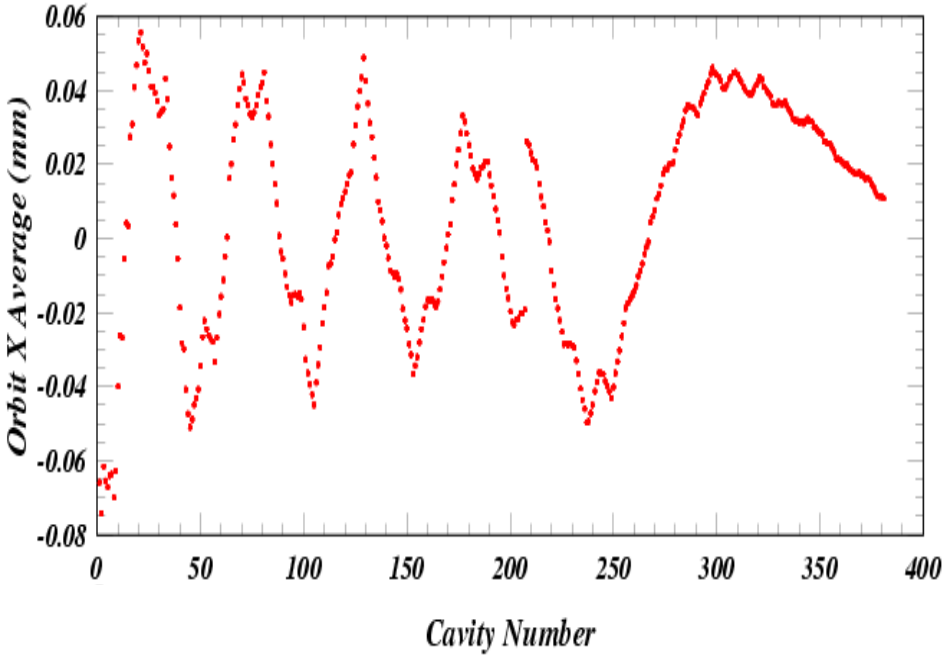
	Frequency [Hz]	R/Q [Ohm/m^(2n)]	Q	n	Polarization_Angle [Radians/2pi]
&long_range_modes					
lr(1) =	2.512896E+009	21180	8867	1	0.00
lr(2) =	2.513556E+009	76777	1472	1	0.00
lr(3) =	2.514671E+009	81083	8557	1	0.00
lr(4) =	3.068192E+009	632	186198	1	0.00
lr(5) =	3.073245E+009	3971	64567	1	0.00

The frequency spread is 0.4%, i.e. 10-12 Mhz.

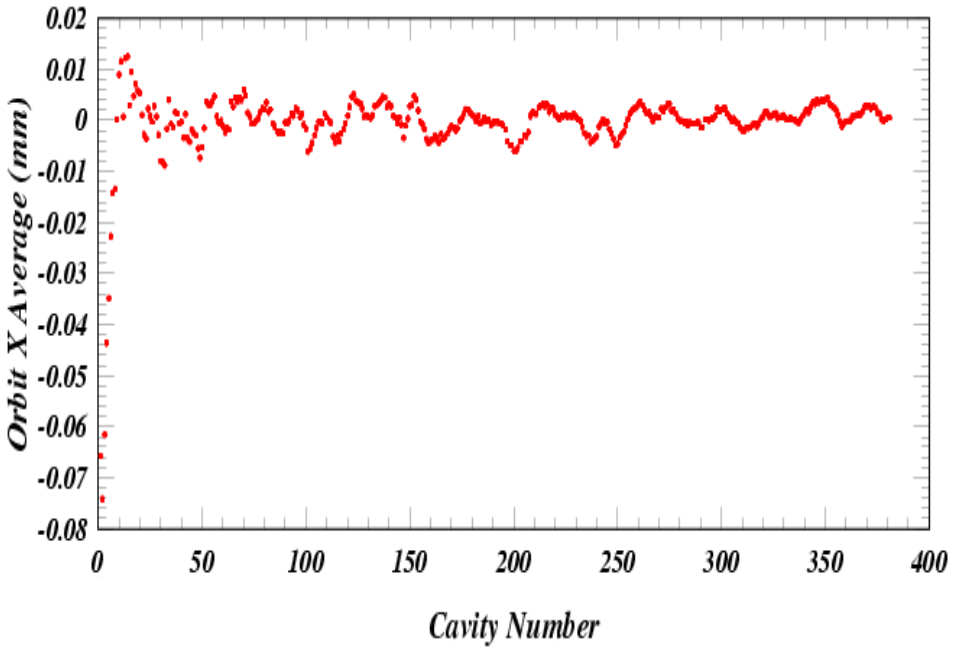
The randomization of the HOM frequencies is limited to +- $3\sigma_f$

Orbit correction in CERL 8.2 with 5 HOMS in all cavities and 0.3 mm rms offsets

Before orbit correction



After orbit correction

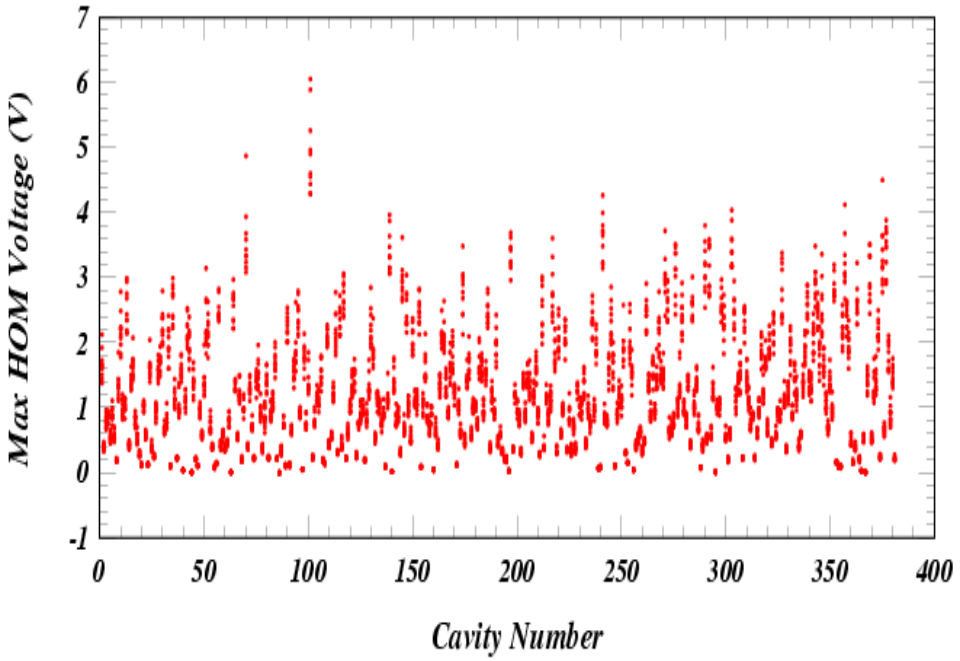


Correction only possible downstream of kickers.

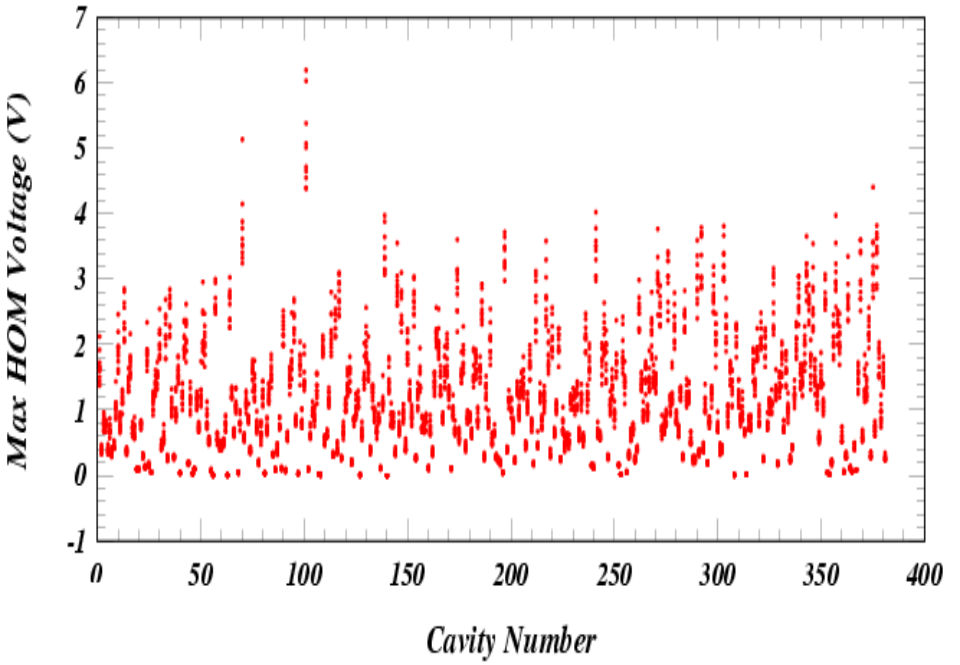
NB: Orbit distortion is much smaller than the cavity offsets.

Equilibrium HOM kicks with and without orbit correction

Before orbit correction



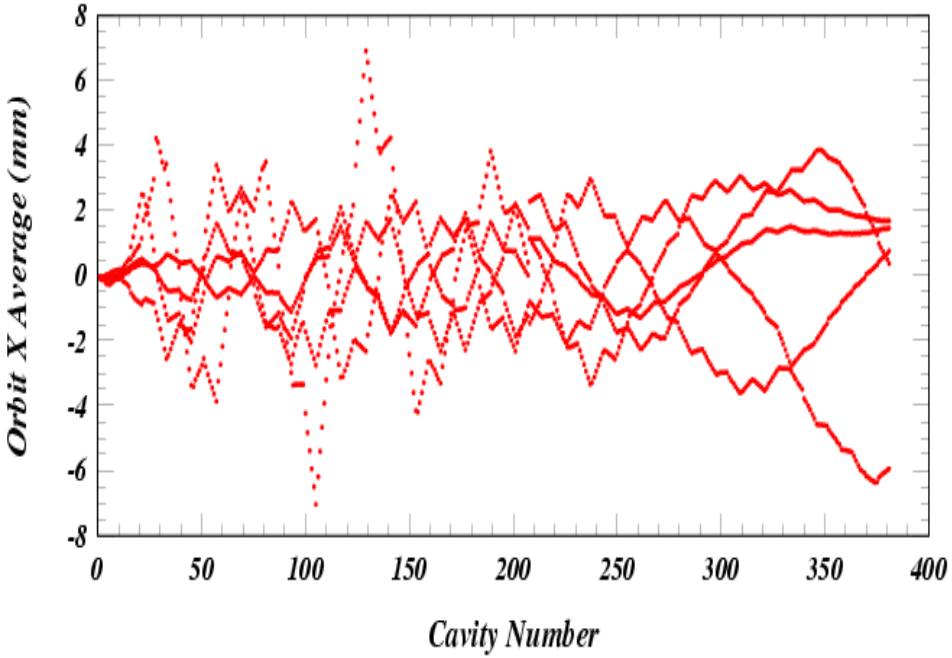
After orbit correction



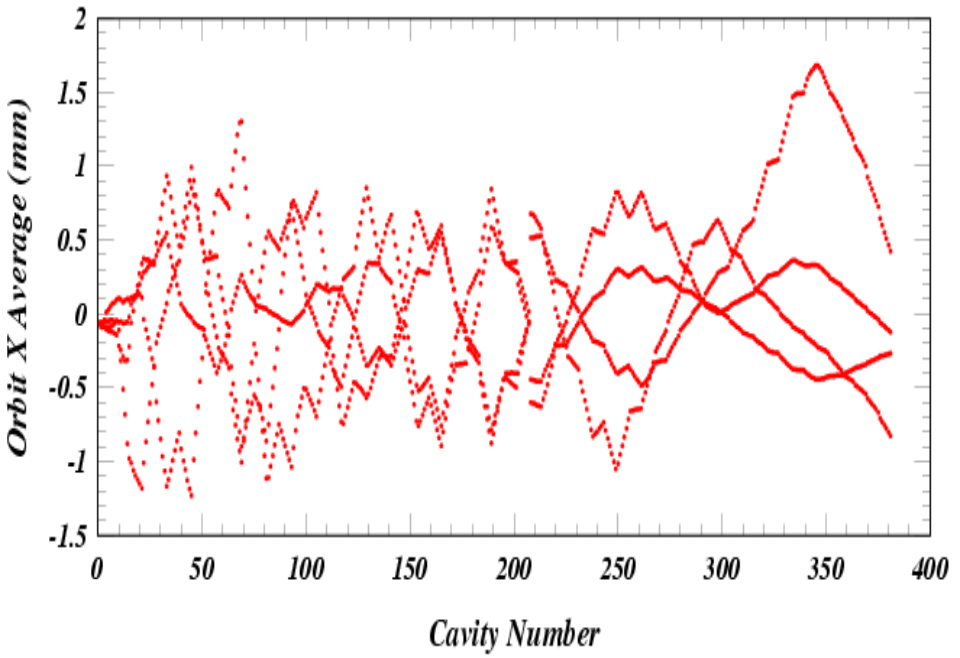
The effect of the orbit correction is negligible, because the cavity offsets are much larger.
Let's apply unrealistically large HOM kicks to see their effect and the effect of the orbit correction.

Resonant HOM: 2.6 GHz with R/Q raised factor 20 to 4e6 ohm/m^2) with and without orbit correction

Before orbit correction



After orbit correction

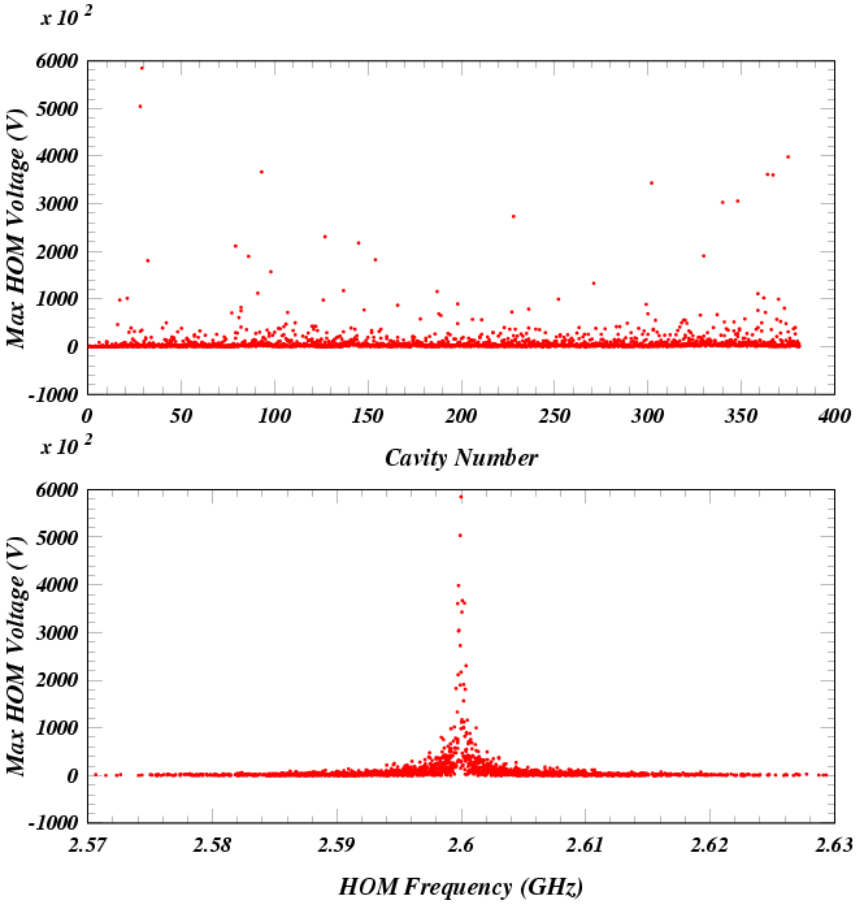


The orbit correction works well, despite the randomized HOM frequencies.

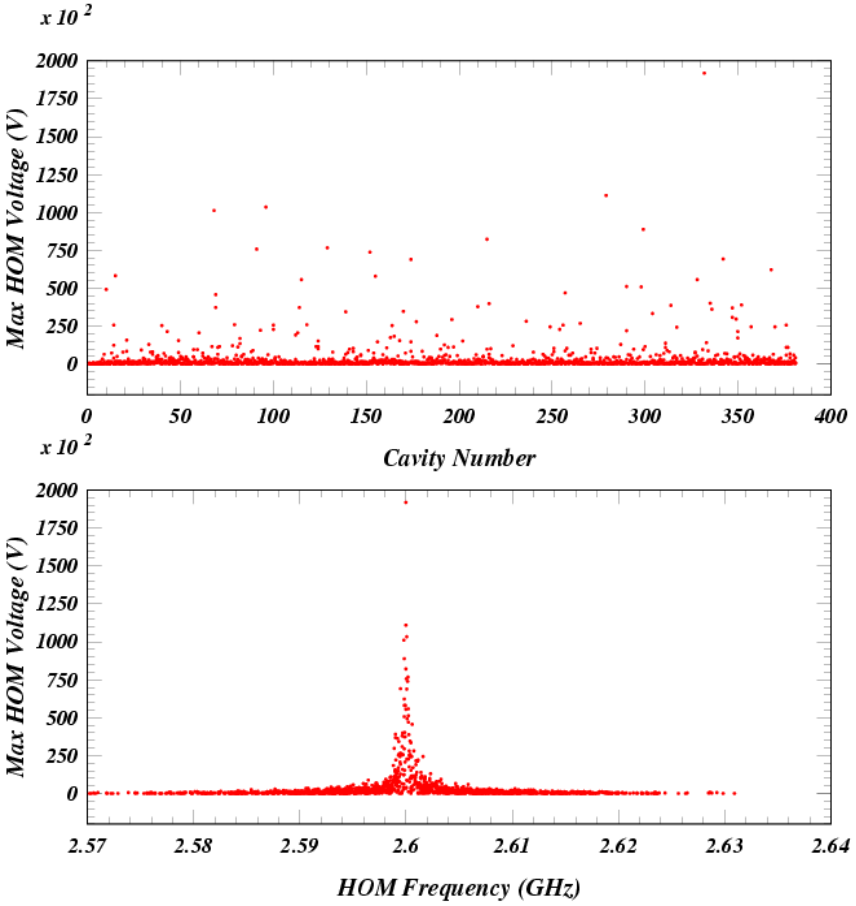
NB: The offsets are random, but the same in each cavity for the ten cases plotted here.

Resonant HOM: 2.6 GHz with R/Q raised factor 20 to 4e6 ohm/m^2) with and without orbit correction

Before orbit correction



After orbit correction



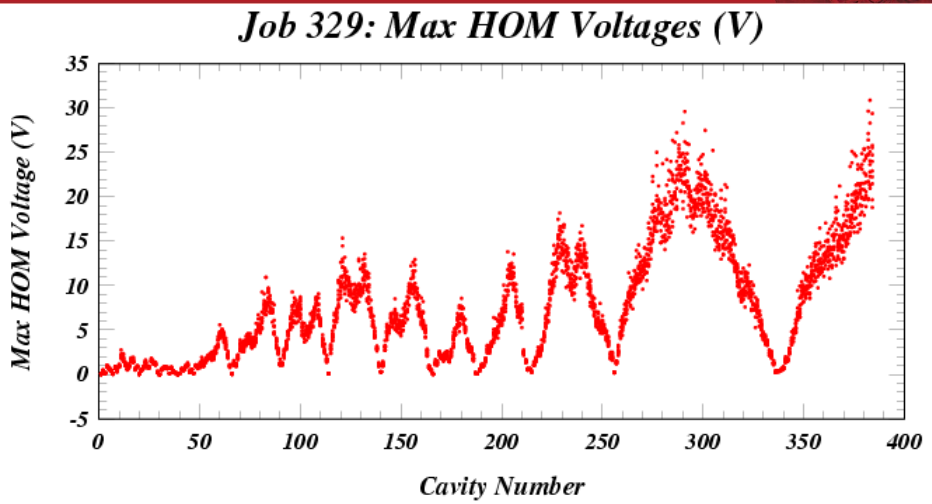
The HOM kicks are now as high as 600 kV.

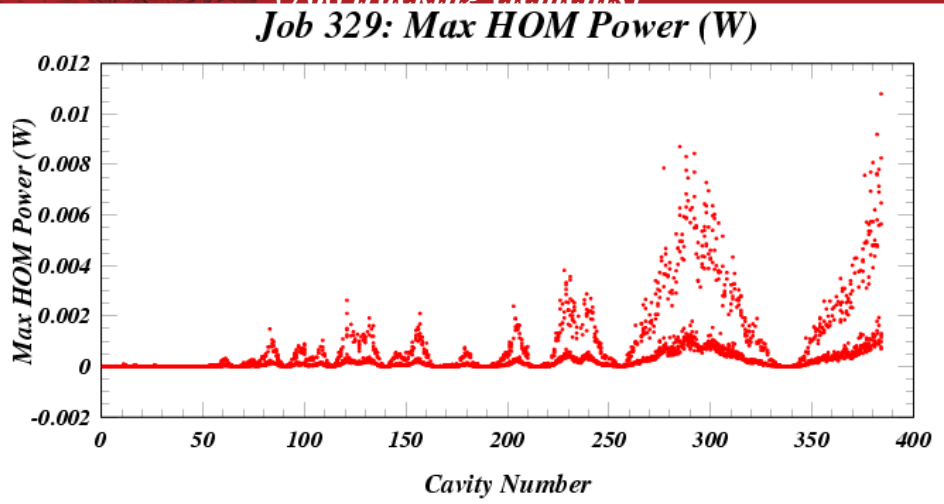
The orbit correction now works well, since the orbit distortions are larger than the offsets.

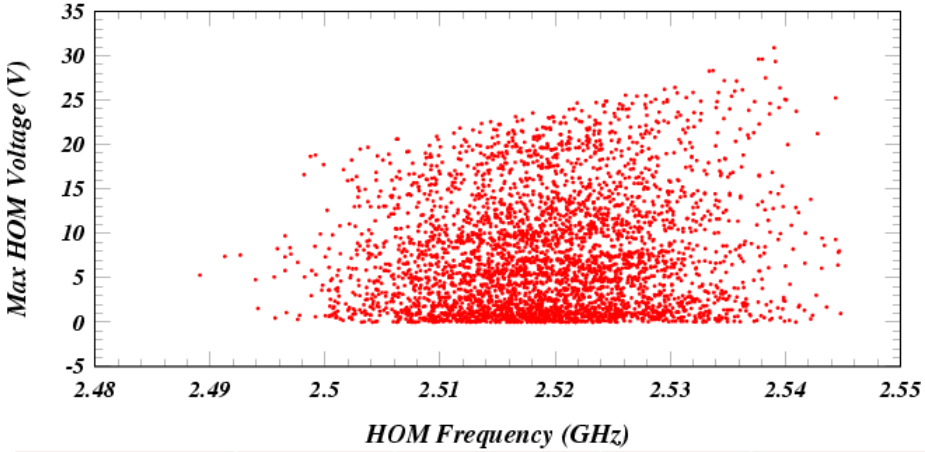
CERL 8.1 calculation with 0.1 mm randomized cavity offsets

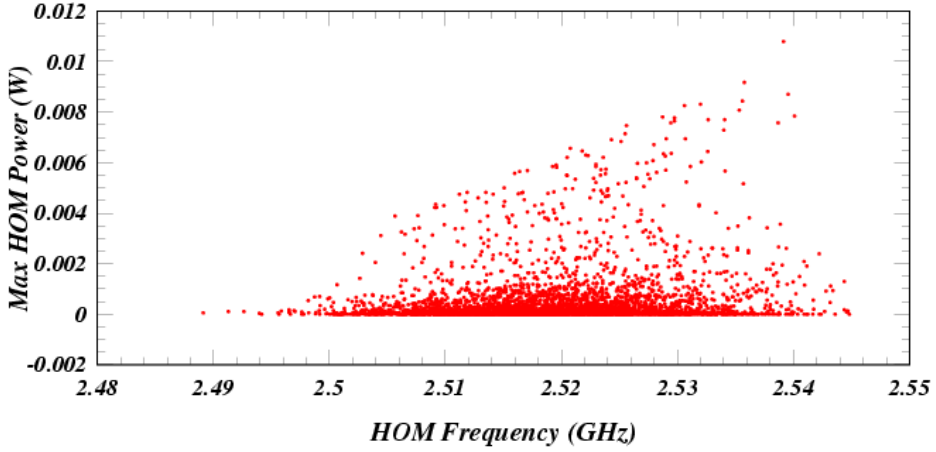
5 HOMs (MUL 2009) in each of 384 cavities

(768 tracking elements)









For each cavity the HOM voltage and power are plotted for the mode with the highest excitation.

Induced HOM voltages increase along linacs, reaching 30 V. HOM power less than 12 mW.

The higher HOM power values correspond to the HOM with (Q,R/Q) = (1472, 76777 Ohms/m^2)

HOM excitation higher for frequencies closer to twice the fundamental.