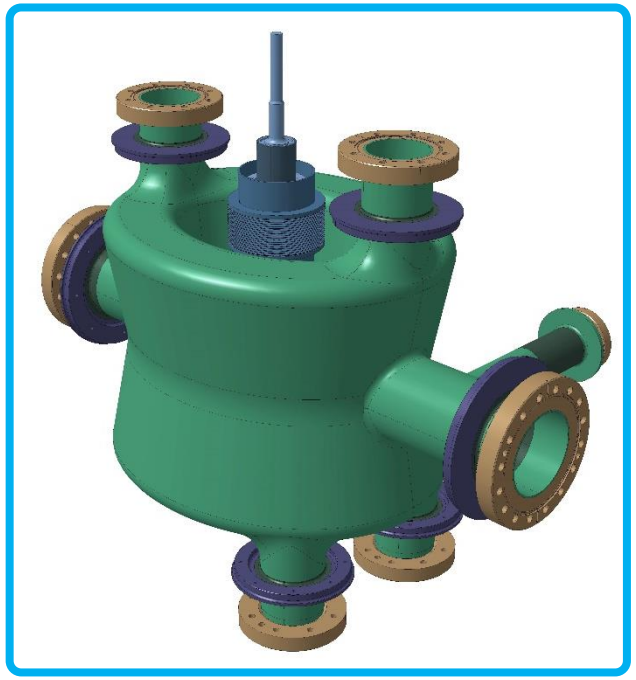
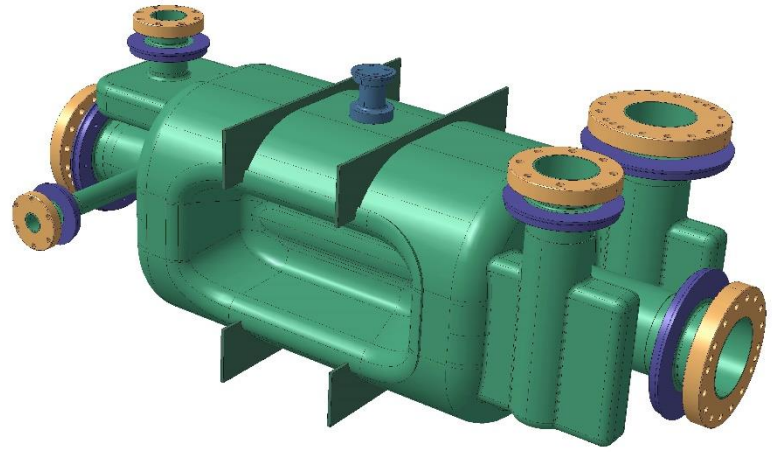
Offset studies
DQW (Vertical Crabbing)



WP2 Meeting, 22nd May 2018

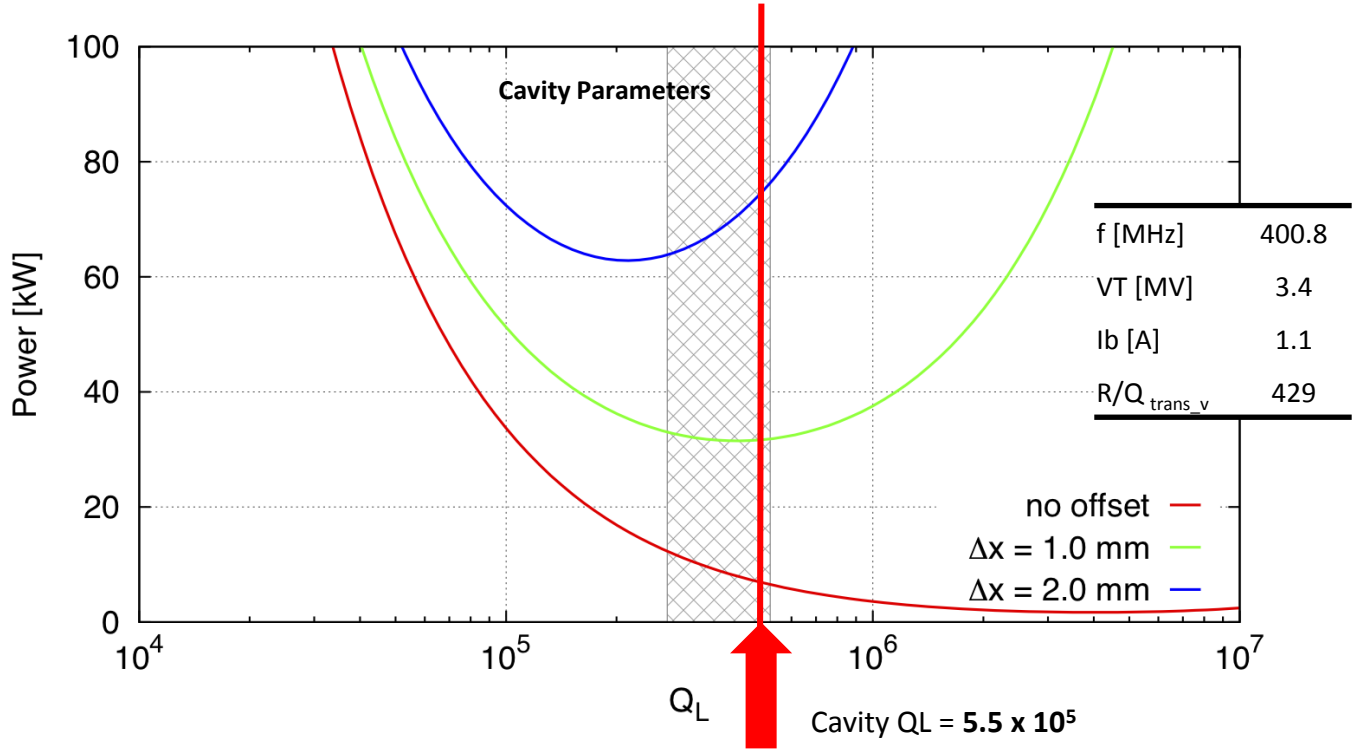
J. Mitchell



Beam Loading

$$V_b = Q_L I_b \frac{R_\perp}{Q}(k\Delta x)$$

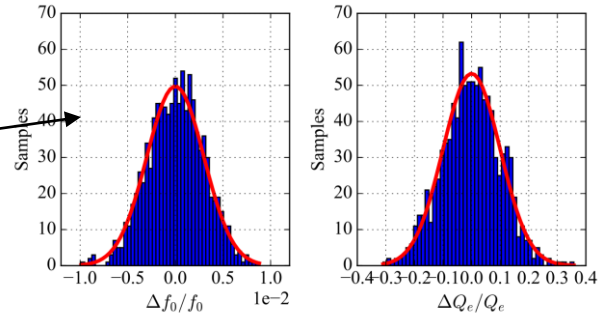
- Beam can drive the dipole mode in the cavity.
- No effect at 0 mm offset.
- Beam induced voltage due to offset in crossing plane calculated:
- The power requirement from the IOT to maintain the deflecting voltage will hence differ with offset.

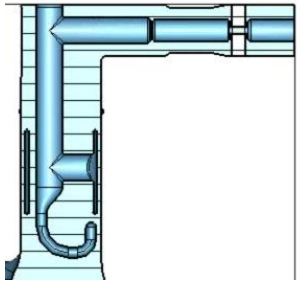


+-1 mm in the crossing plane.

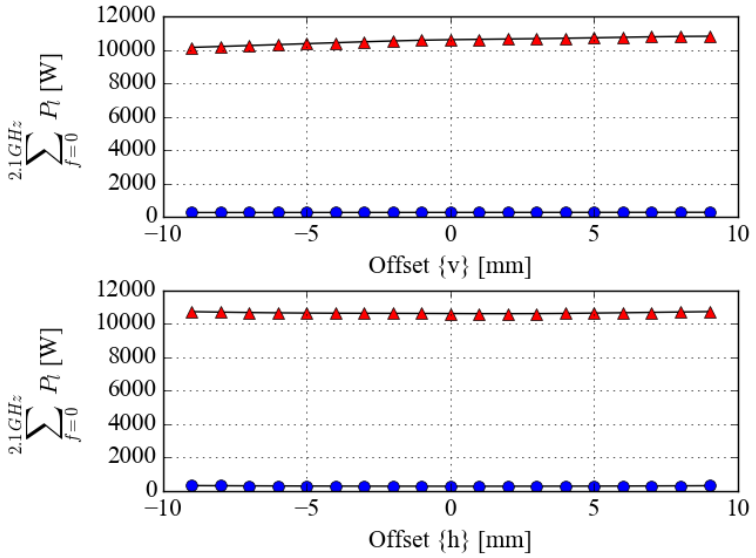
HOMs

- HOM power at multiple beam offsets calculated.
  - Bunch spectra parameters from [1].
  - Average and maximum from 1000 stochastic variations of f and Qe (varied within measured values).
- For transverse impedance, all modes except 1 are below 1 MOhm/m/cavity.

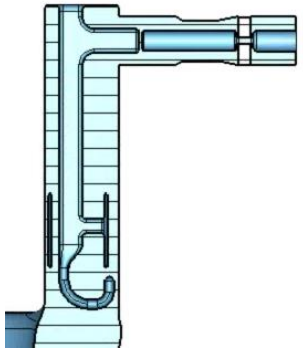




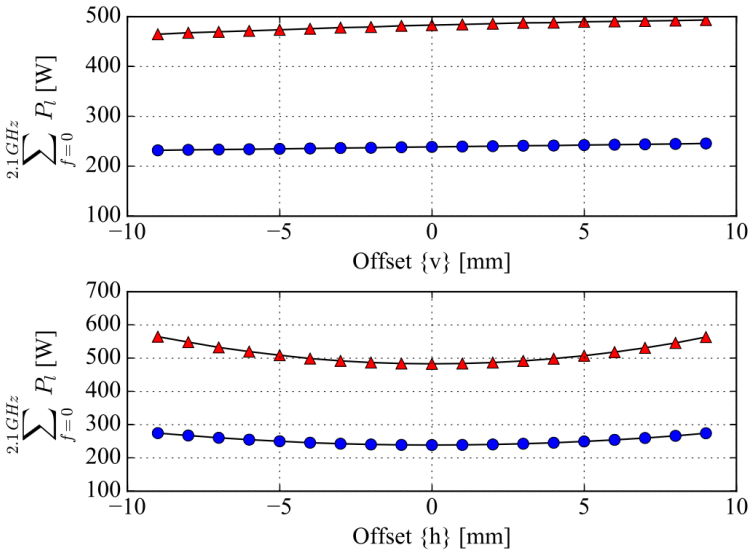
SPS HOM Couplers



Maximum
Average



LHC HOM Couplers



Maximum
Average

1 kW threshold.

[1] R. Tomas, "Parameter update for the nominal HL-LHC: Standard , BCMS , and 8b + 4e Current HL-LHC Parameters table," no. March, 2017.

- Linear variation of power in vertical plane due to 680 MHz mode.
- Quadratic increase of power in horizontal plane due to 960 MHz mode.

Frequency of modes (manufacture tolerances) is much higher influence than offset.
+- 5 mm - unless 680 or 960 MHz modes are near bunch harmonic.

Multipoles

- Multipole component evolution calculated – Using Panofsky-Wenzel decomposition method.
- Scaled to 10 MV deflecting voltage.
- Measurements on SPS cavities inconclusive, further improvements are currently in work.

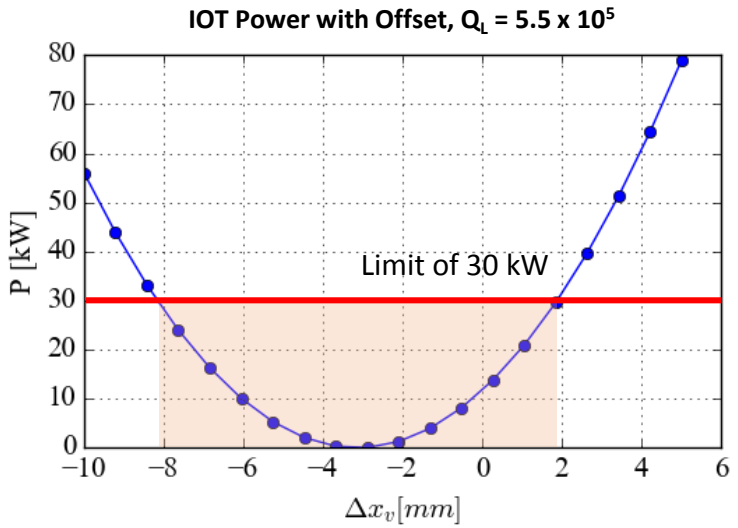
	$b_2\ [mTm/m]$		$b_3\ [mTm/m^2]$		$b_4\ [mTm/m^3]$	
	$\Re b_2$	$\Im b_2$	$\Re b_3$	$\Im b_3$	$\Re b_4$	$\Im b_4$
PoP DQW (Bare) 2011 - M. Navarro-Tapia	111.34	0.00	1266.75	-0.15	1821.02	11.48
PoP DQW (Bare) 2012 - M. Navarro-Tapia	0.36	0.06	1076.75	0.01	90.86	-17.94
PoP DQW (Bare)	-0.23	0.00	1047.65	-0.06	-166.21	1.86
SPS_DQW (Bare)	-5.93	2.41	1502.51	32.28	-1241.28	-1077.45
SPS_DQW + PU Port (Bare)	-5.98	2.50	1507.54	36.33	-1591.31	-963.17
SPS_DQW + FPC + SPS HOM Couplers + PU	-5.96	2.53	1495.88	27.52	-870.69	552.95
SPS_DQW + FPC + LHC HOM Couplers + PU	-5.80	2.33	1494.09	56.09	-829.58	135.51
@ 3.4 MV	**-1.97**	**0.79**	**507.99**	**19.07**	**-282.06**	**46.0**

Need to assess with new estimates:
TDR: 'the b_3 component should be limited to approximately 1000 mTm/m^2'
TDR: 'For $n \geq 4$, … Better estimates are pending; results from long-term tracking are needed'

Conclusion

- For vertical crabbing.
- Aperture evaluation to be looked at, from +- 5 mm in non-crossing plane.

Factor	Vertical [mm]		Horizontal [mm]		Notes
Beam Loading	-1	+1			
HOMs	-5	+5	-5	+5	Have to assess mode frequencies when cavities are manufactured.
Multipoles	-1	+1			Need to discuss limitations on b4 component.
Aperture					
Limitation	**-1**	**+1**	**-9**	**+9**	


IOT Power with Offset, Q_L = 5.5 x 10^5
80
70
60
50
40
30
20
10
0
P [kW]
Limit of 30 kW
−10
−8
−6
−4
−2
0
2
4
6
$\Delta x_v[mm]$