Update on beam stability due to HOMs and beam induced heating reflecting the recent changes in RFD crab cavity

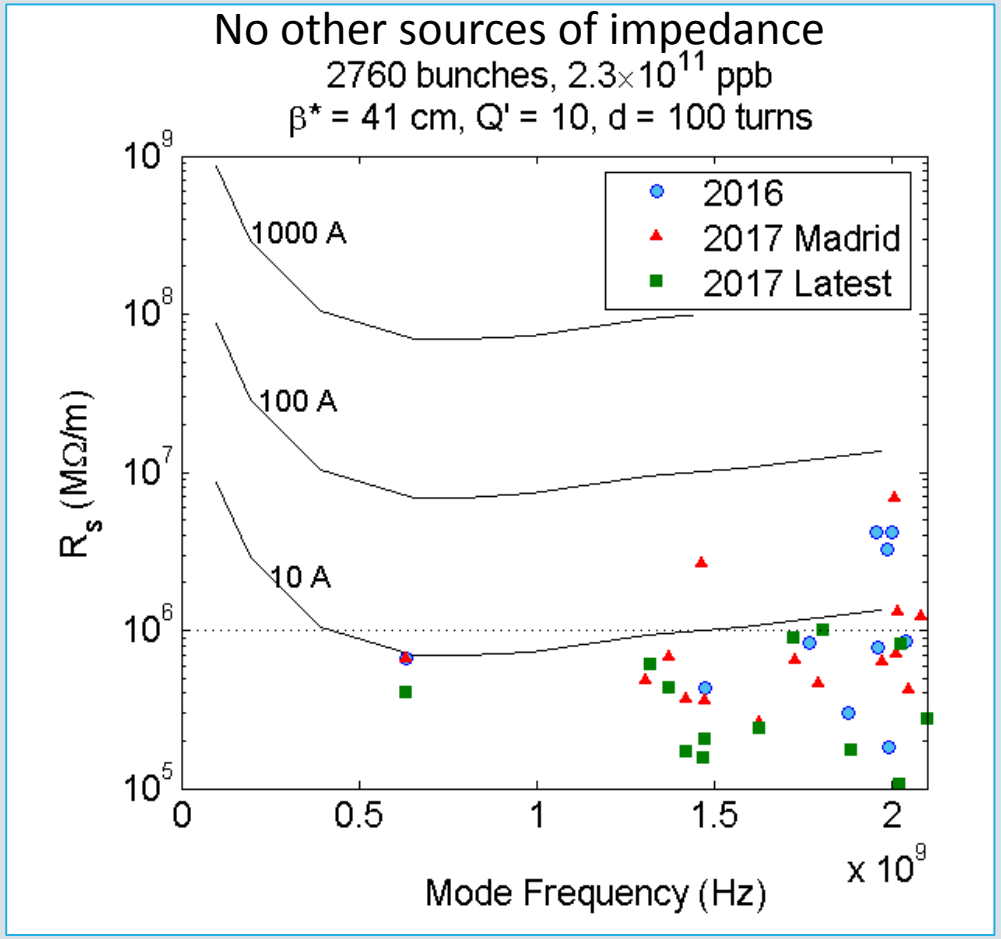
S. ANTIPOV, N. BIANCACCI, E. METRAL, B. SALVANT

12/01/17

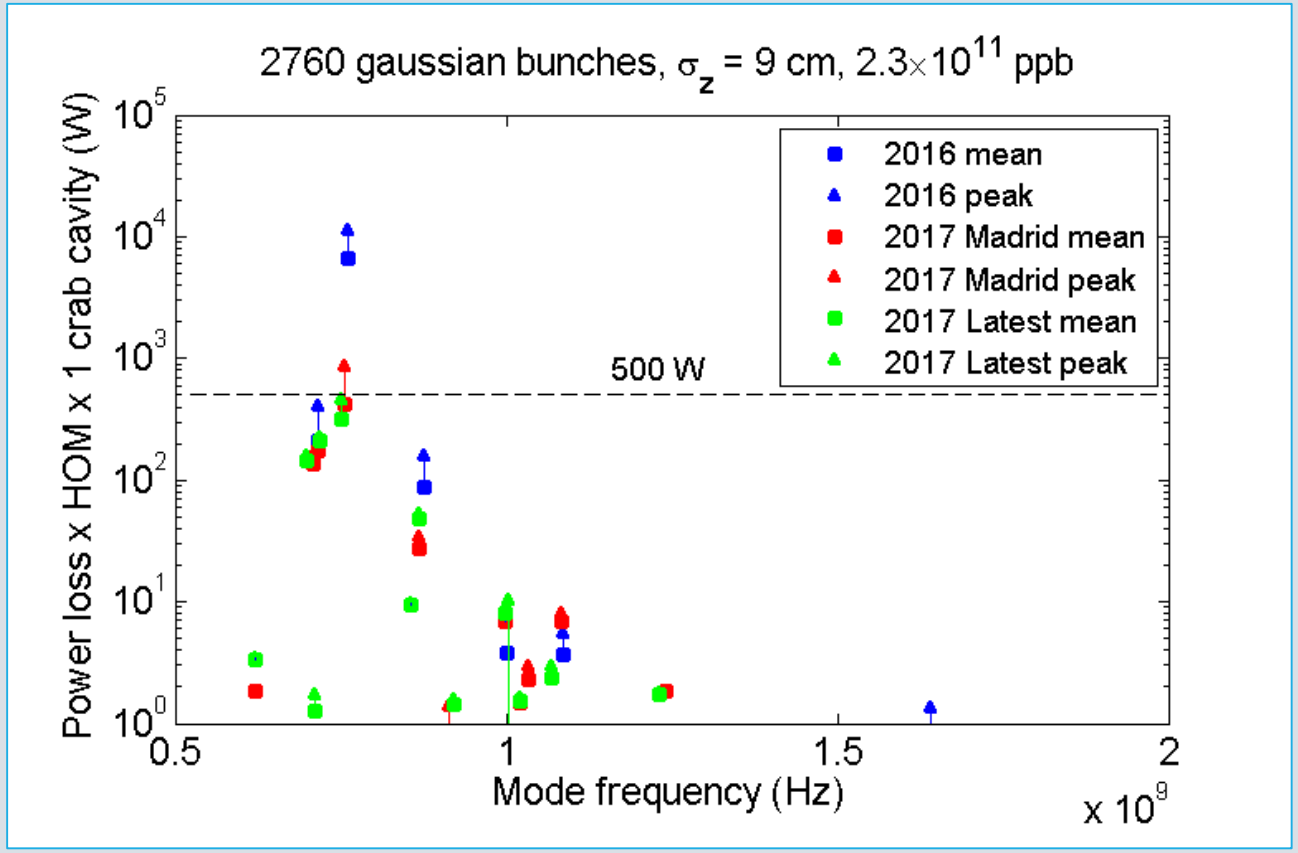
Studying the most challenging parameters

OP Scenario	Ultimate, standard beam
Energy, β^*	E = 7 TeV, 41 cm
Beam intensity	M = 2760, N_b = 2.3x10^{11} p
Beam emittance Bunch length	ε_n = 2.1 μm (injection) σ_z = 9.0 cm, rms, Gaussian
Damper, chroma	d = 100 turns, Q' = 10
Octupole SD	Negative polarity, no ATS Tails cut at 3 rms beam size
Collimator settings	Nominal (2.5 μm ref. ε): TCP – 6.7σ TCSG – 9.1σ

Expected increase of octupole threshold due to HOMs is below 10 A

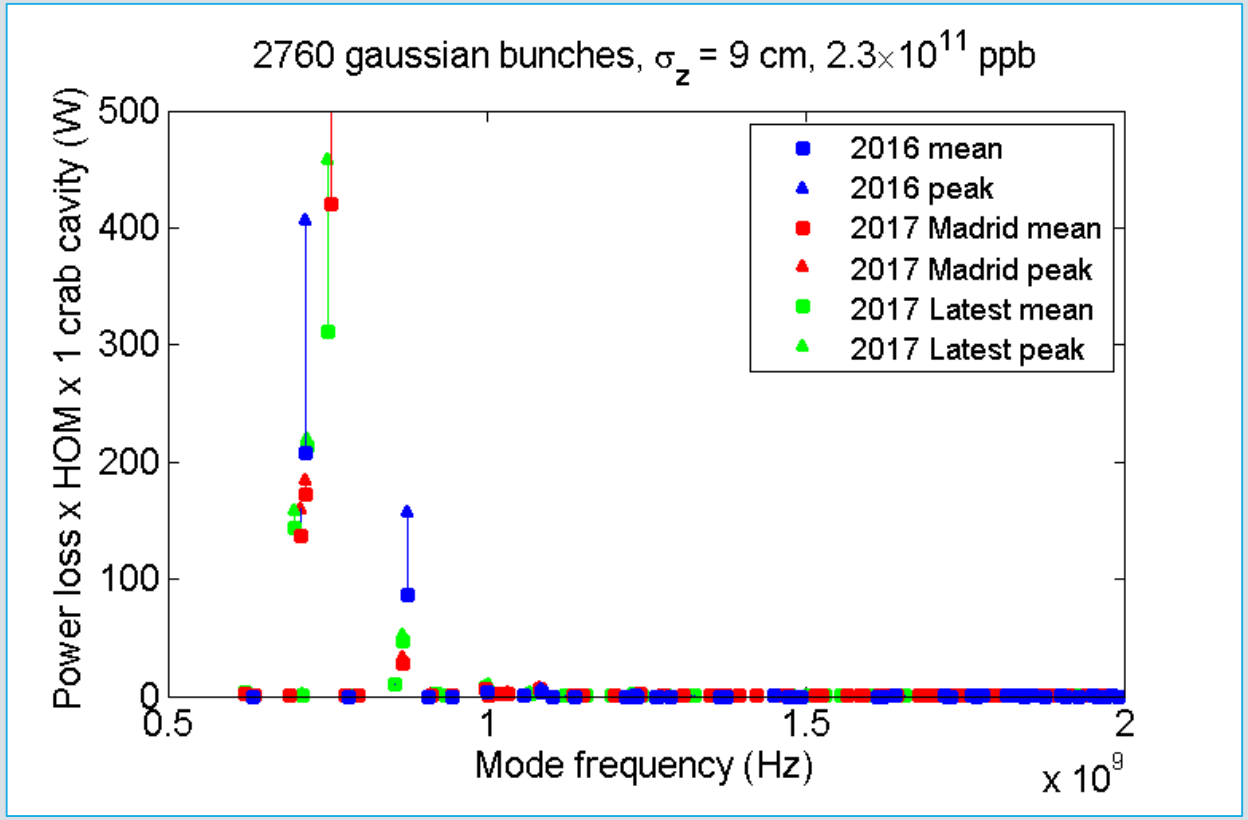


Thanks to HOM optimization the expected power is below the threshold



Peak values calculated assuming ±0.3% frequency uncertainty (based on CERN DQW test)

The most dangerous modes



Frequency	Q-factor	Shunt Imp.
698 MHz	68	1.6 kΩ
719 MHz	32	0.4 kΩ
752 MHz	218	20 kΩ

Peak values calculated assuming ±0.3% frequency uncertainty (based on CERN DQW test)

Summary

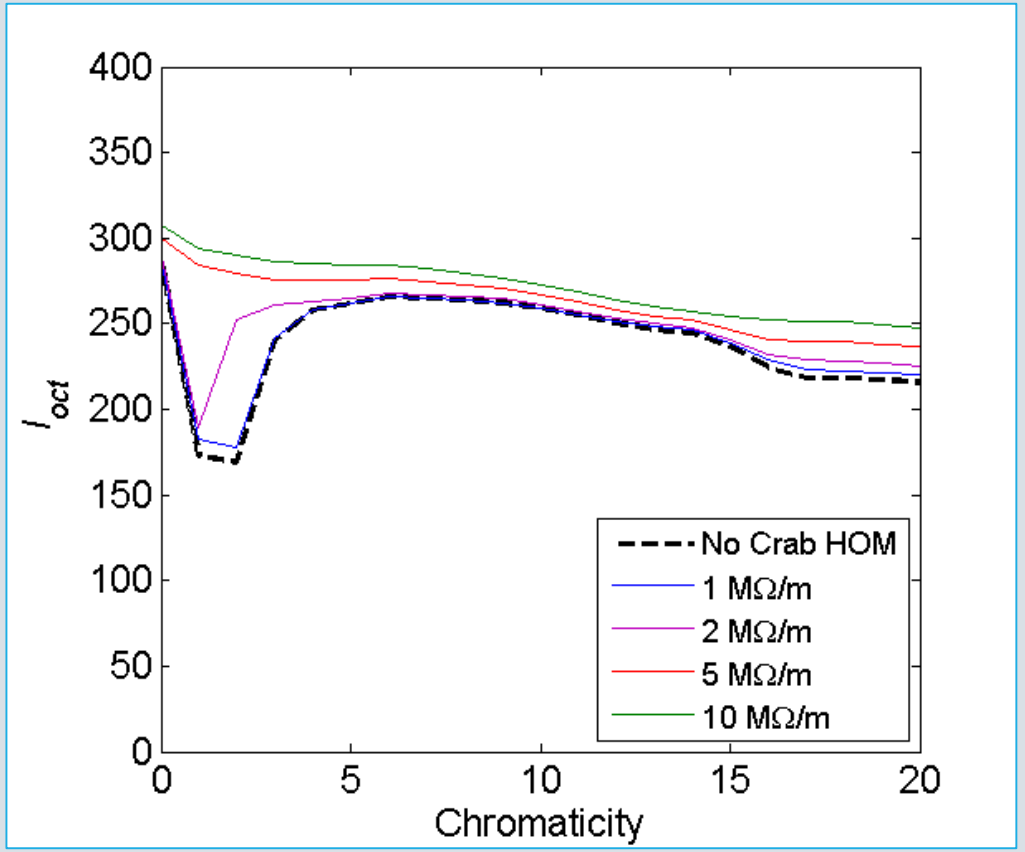
Crab cavity HOMs might affect coupled-bunch stability

- Transverse feedback and chromaticity are inefficient at fighting high-frequency modes
- Transverse shunt impedance below 1 MΩ/m is required for the HOMs not to increase the octupole threshold significantly
- The latest RFD design complies with the transverse beam stability requirement

If a high-impedance CC HOM is close to a beam spectrum line, it may lead to a high power loss

- Thanks to recent improvement, the nominal power loss is below 500 W threshold for the RFD cavity
- The manufacturing tolerances could affect mode frequencies, increasing the power loss
- The actual mode frequency should not vary from the design value by more than 0.3%

Reminder:
Need to keep HOM shunt impedances below 1 MΩ/m



$\beta^* = 40$ cm
$N_b = 2.3 \times 10^{11}$ p
M = 2760
$\varepsilon_n = 2.0$ μm
$\sigma_z = 9.0$ cm
d = 100 turns
Q' = 10
Negative polarity
Tight coll. settings