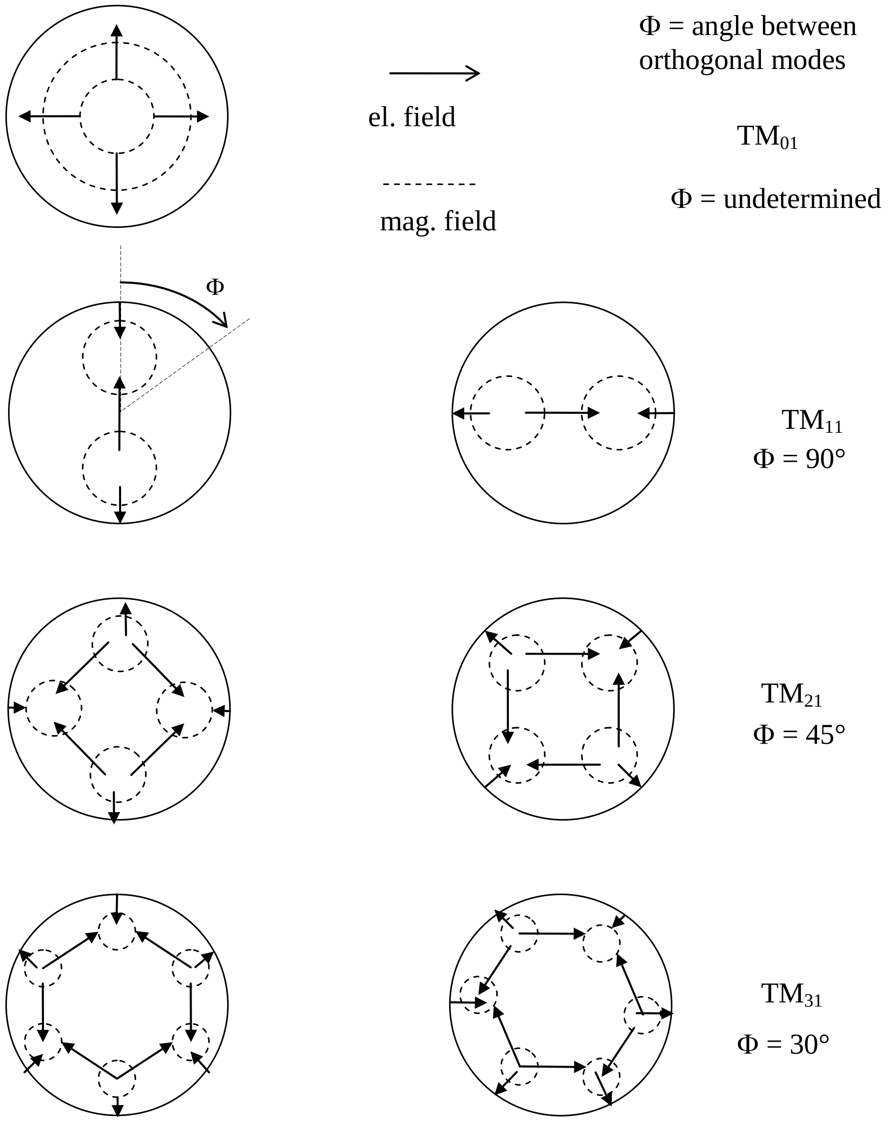
Spare slides

Cavity geometry position of HOM ports

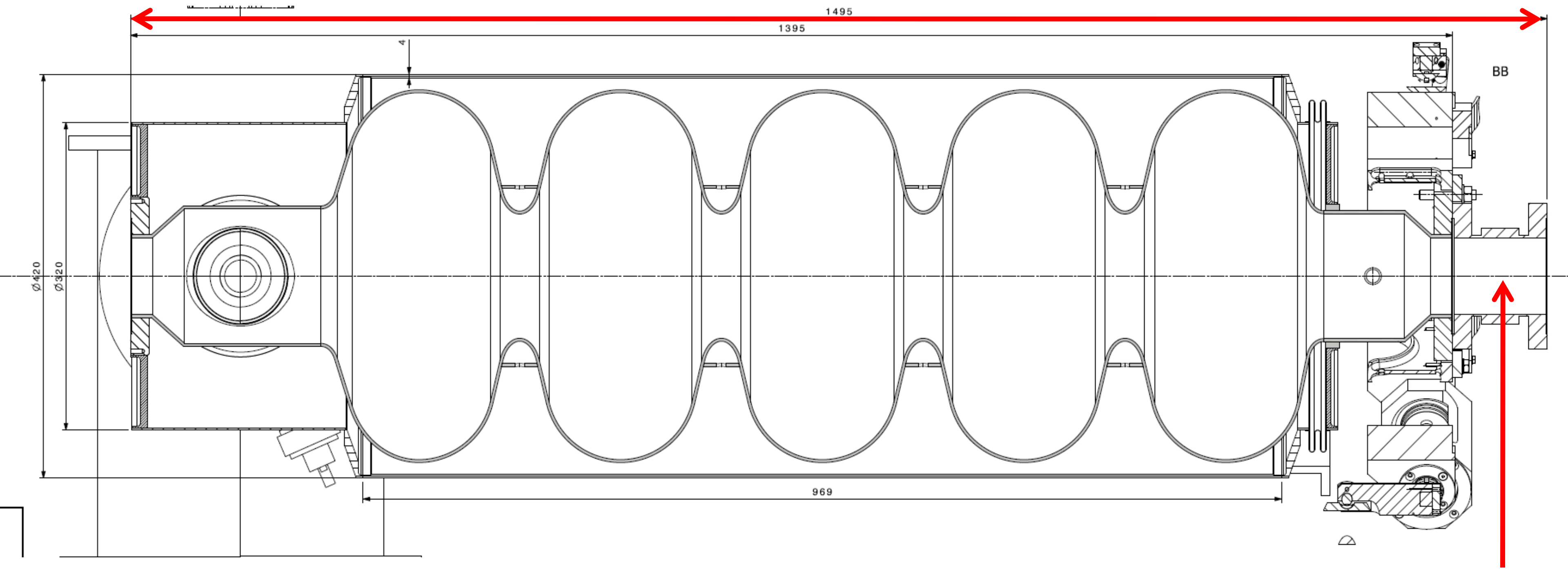
- For considerations of mechanical design and manufacturability, the HOM port on main power coupler will be symmetrical to the power coupler
- The HOM has to be vertical for possible future cooling considerations => the Power coupler will be downwards
- The other HOM port will be positioned at 60 deg / vertical
- The pick-up port downwards



Condition for identical E-field at HOM antenna for dipole and quadrupole mode:
$\sin\Phi = \sin(2\Phi) \Rightarrow \Phi=60°$

Cavity geometry
shorter length of bellows

proposed new layout with inter-cavity bellows of **89.4 mm** length:
should be possible from the mechanical point of view



1484.4

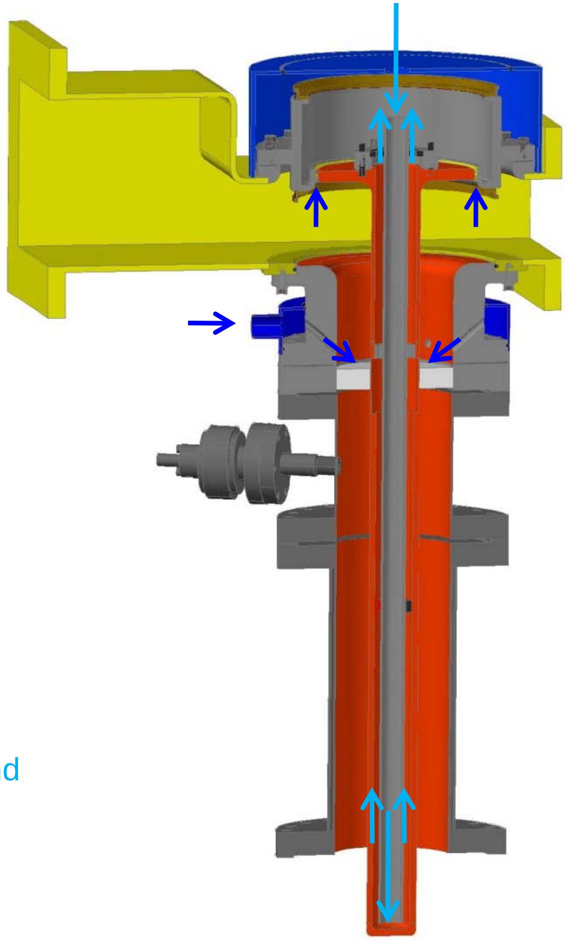
Length of bellows 89.4 mm

Power coupler
coaxial disk air cooled window

- Design based on a coaxial disk ceramic window similar as the one in operation on the CERN SPS TWC 200MHz power load

- Advantages
  - Very simple and well mastered brazing of ceramic onto a titanium flange
  - High power capability (500kw cw)
  - Very easy to cool with air
  - Waveguide as “plug and play” mounting, absolutely no stress to the antenna
  - DC HV biasing very simple, with again a “plug and play” capacitor fitting, and again no stress to the ceramic due to finger contact
  - Least expensive of the three couplers !

- Minor drawback
  - Ceramic is part of the matching system, fixes the waveguide position



→ Ceramic and waveguide air cooling

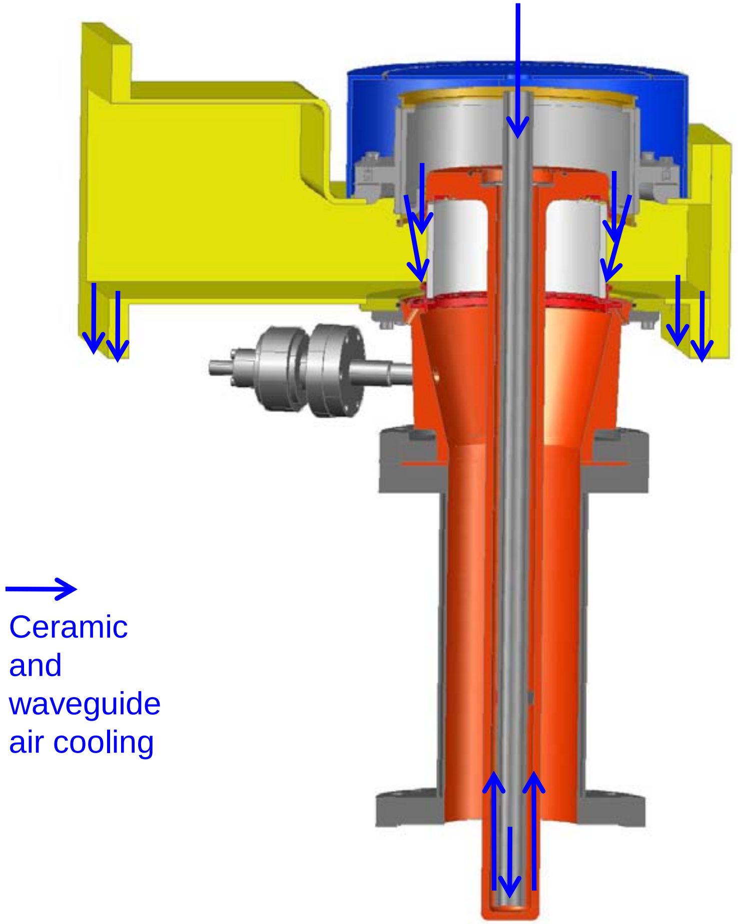
→ Antenna and outer ceramic air cooling

Power coupler cylindrical air cooled window

- Design based on the same cylindrical window as the LHC couplers:
  - Long and difficult process to achieve reliability of the window, the final design was obtained after more than six years of studies
  - As the design was complex, we keep it exactly as it is
  - Instead of changing the ceramic design we have adapted the line to the ceramic

- Advantages
  - High power capability window, LHC proven (575kW cw full reflection, could be more…)
  - Simple to cool with air
  - Absolutely free of mechanical stress on the antenna
  - Same “plug and play” waveguide and DC capacitor as previous design, no stress to the ceramic
  - Simplest version to assemble !

- Drawbacks
  - Ceramic is part of the matching system, fixes the waveguide position
  - Possible multipacting due to the outer conical outer line



→ Ceramic and waveguide air cooling

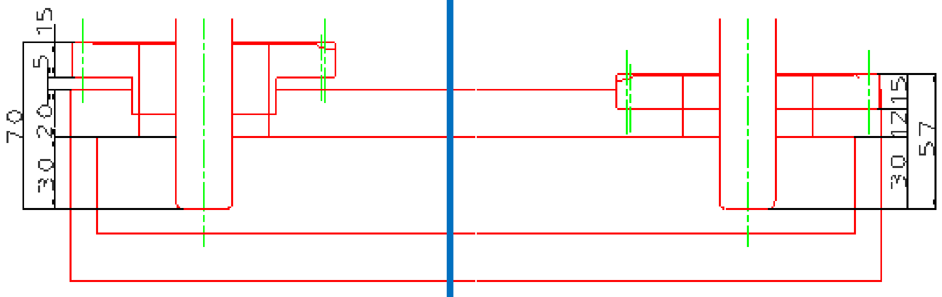
Power coupler tests cavity design / conclusion

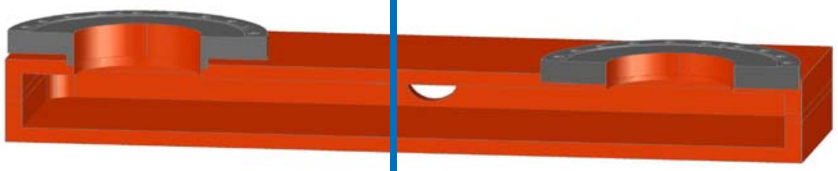
- With 130 mm from beam axis to flange (left part of the drawing):
  - Flange to end of antenna = 70 mm
  - Test cavity flange will be easier to assemble
  - Flange out of test cavity body
  - Possible correction by slightly adjusting the position of the flange
- With only 117.2 mm from beam axis to flange (right part of the drawing):
  - Flange to end of antenna = 57.2 mm
  - Test cavity flange will have to be part of the cavity body
  - Much more difficult to build
  - Less (perhaps no) possible correction by slightly adjusting the position of the flange
- Conclusion:

  Please increase the position of the flange to a minimum of 130 mm (140 mm would be perfect)

130 mm design

117 mm design



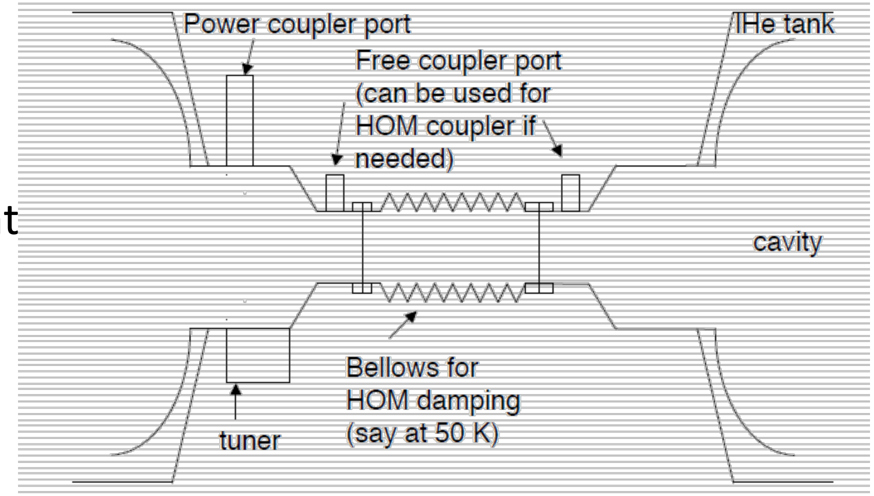


Easier for test cavity flange integration

More difficult for test cavity flange integration

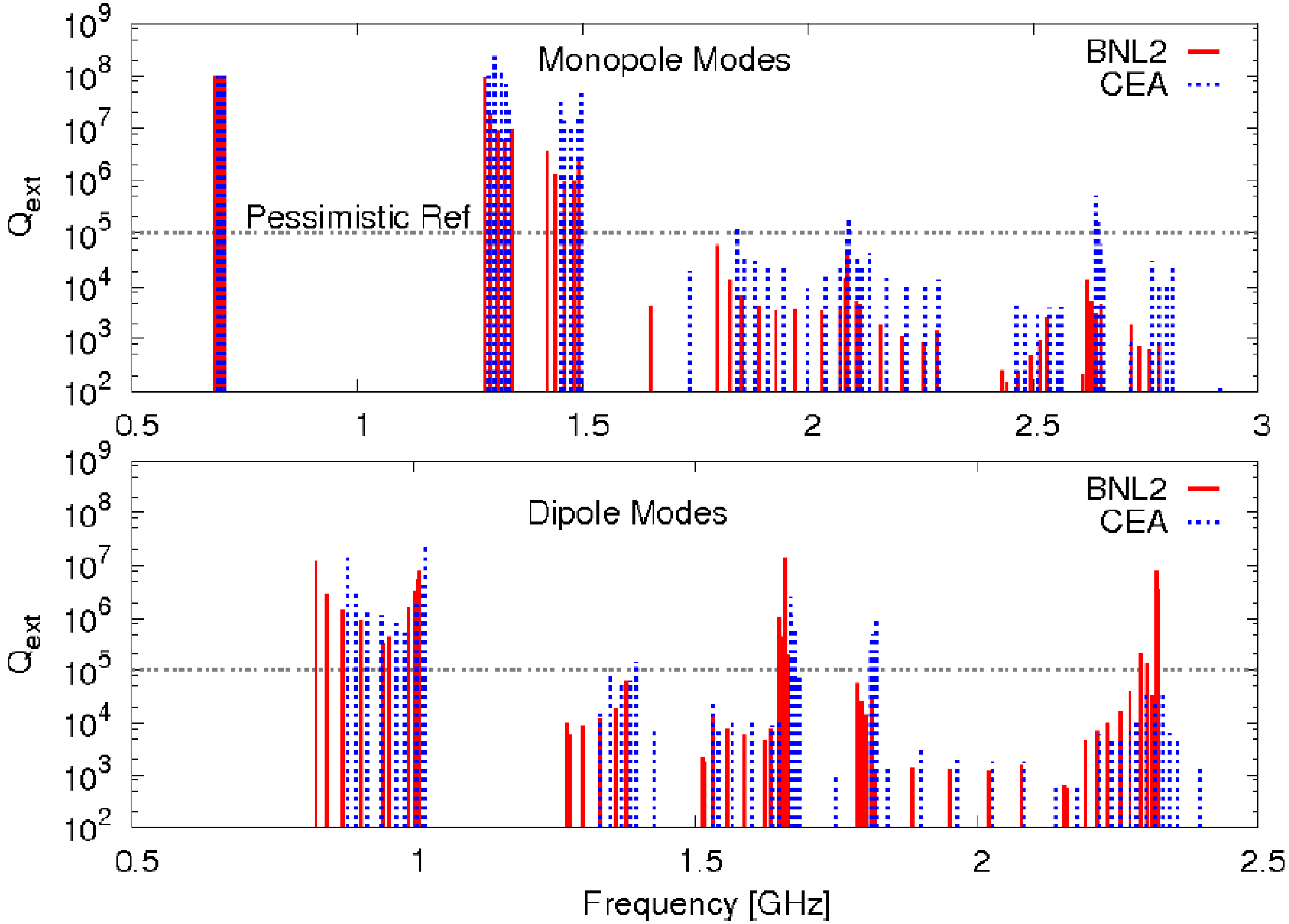
Higher Order Mode (HOM) issues conclusions from HOM workshop

1. **HOM spectrum:** clustering around only few frequency bands: TE_{111}, TM_{110} and TM_{011}.
2. **Upper tolerable limit for Q_{ext} from the beam break up point of view:** Q_{ext} of 10^6 - 10^8 seems tolerable.
3. **Worst case maximum tolerable RF power absorbed by the HOM coupler:** cavity geometry must be chosen in such a way that machine lines must not coincide with frequencies of HOM with large R/Q.
4. **"Most elegant solution":** let pass the HOMs into the beam tubes to be damped there.
5. **"Next but less elegant solution":** tapered beam tube with antenna type dampers if needed (without notch filter).



HOM issues

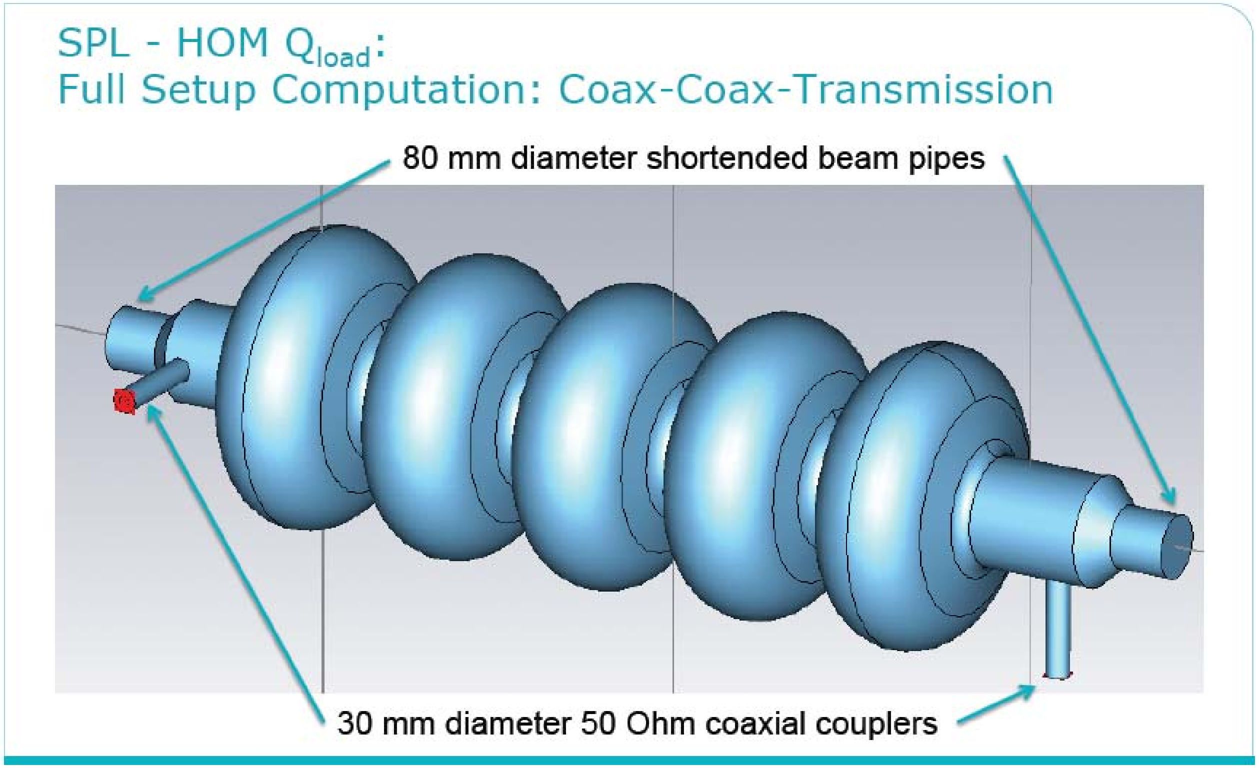
CASE I: BNL2 VS. CEA



HOM issues
coupled S-parameter calculation (CSC)

H.-W. Glock; : K. Rothemund; U. van Rienen. CSC – A System for Coupled S-Parameter Calculations, TESLA-Report 2001-25

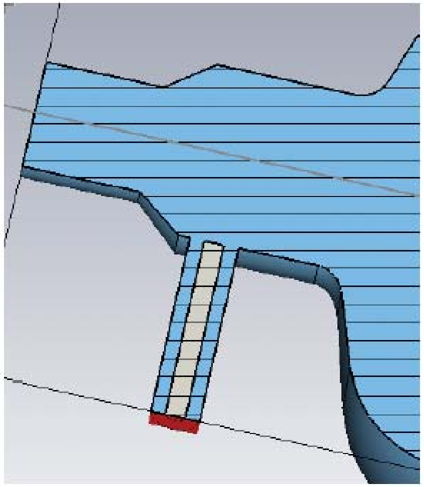
Coax with antenna tip depth = 0:
- to avoid extreme Q-values
- scaling in second step using coupler section's S-parameters



SPL - HOM Q_{load}:
Full Setup Computation: Coax-Coax-Transmission

80 mm diameter shortended beam pipes

30 mm diameter 50 Ohm coaxial couplers



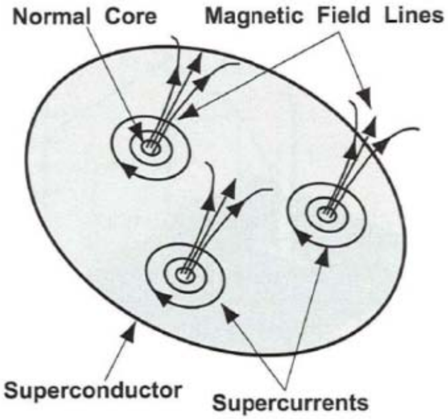
Magnetic shielding
Why do we need a magnetic shielding?

- BCS surface resistance R_s^{BCS} of 704 MHz cavity @ 2 K: 3 nΩ
- BCS Cavity $Q_0 = 275/R_s = 9 \cdot 10^{10}$
- Assumed residual resistance: 24 nΩ
- Total surface resistance: 27 nΩ corresponds to $Q_0 = 1 \cdot 10^{10}$

➡

- The magnetically induced residual resistance should be small compared to 24 nΩ, say 3 nΩ, corresponding to $\color{red}{\mathbf{B_{ext} = 1\ \mu T}}$

$$\frac{R_s^{BCS}}{\mathrm{n\Omega}} = 10^5 \cdot \left(\frac{f}{\mathrm{GHz}}\right)^2 \cdot \frac{\exp\left(-\frac{18}{T/\mathrm{K}}\right)}{T/\mathrm{K}}$$



$$R_{mag} = \frac{H_{ext}}{2H_{c2}} R_n$$

$$R_{mag}[n\Omega] = 3H_{ext}[\mu T]\sqrt{f[GHz]}$$

for RRR=300

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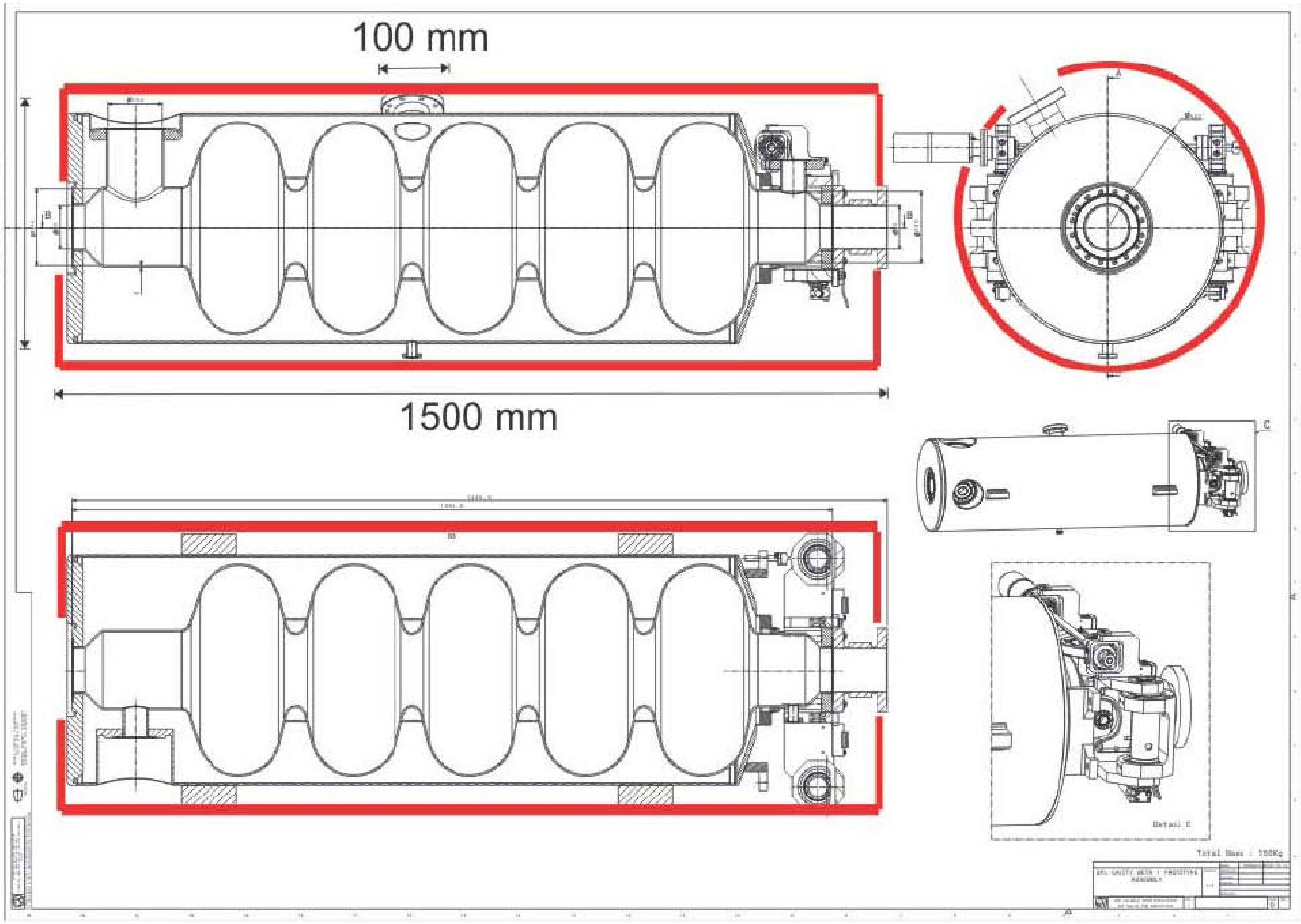
Source: Update of presentation
http://indico.cern.ch/conferenceOtherViews.py?view=standard&confId=63935

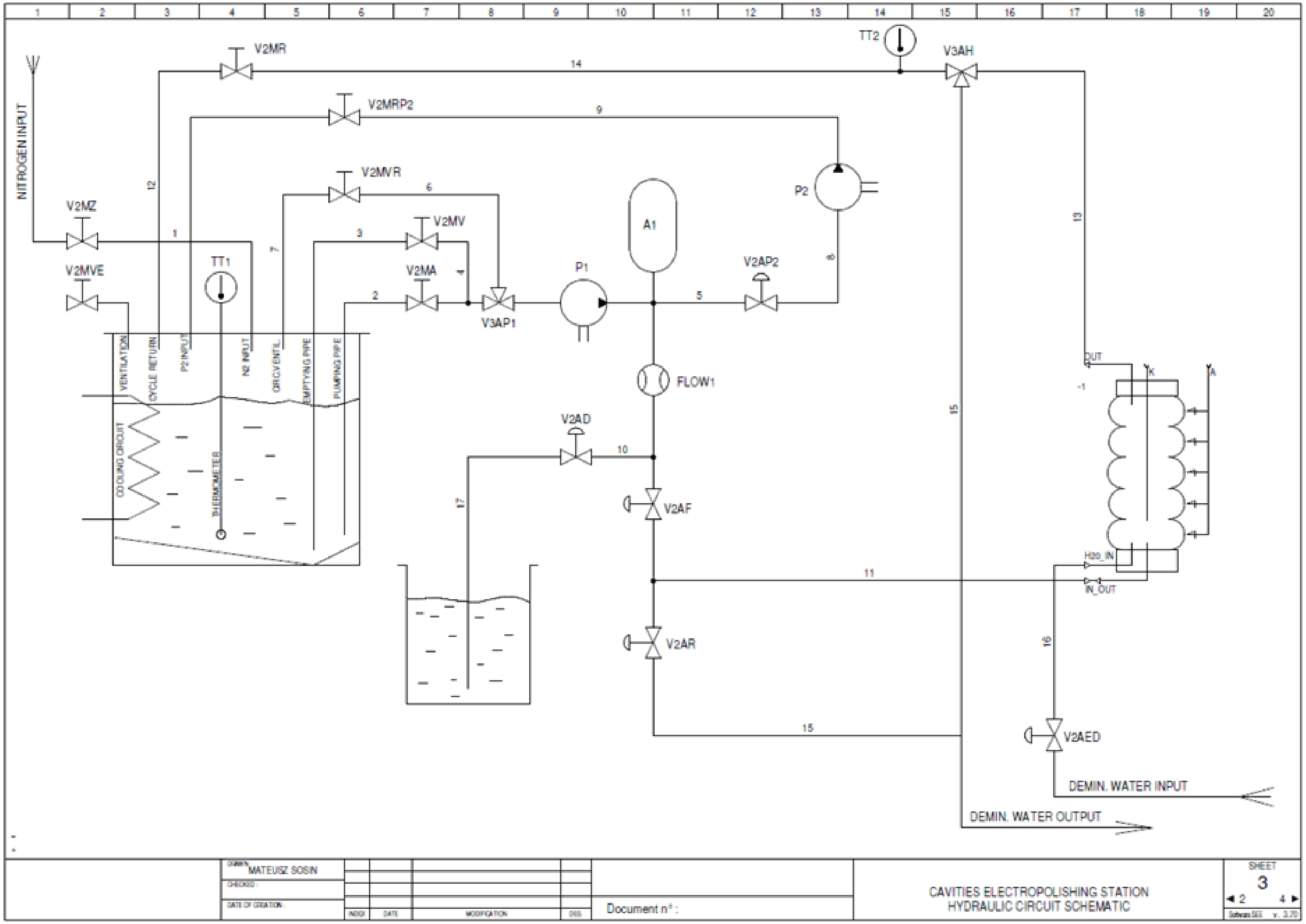
Magnetic shielding
Design of magnetic shield



Tobias.Junginger@quasar-group.org

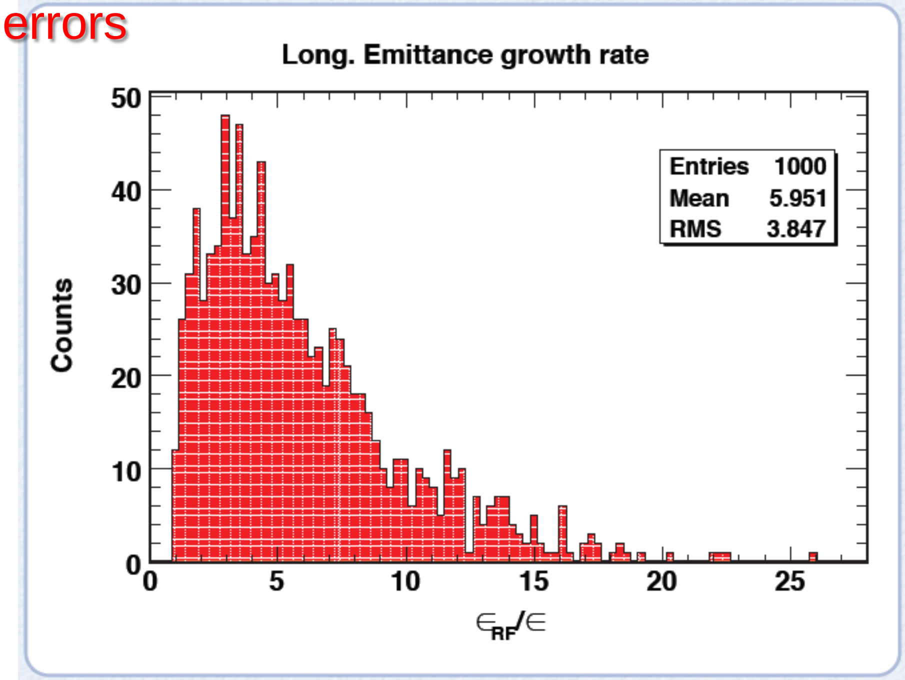
EP status at CERN
layout of EP circuit

Leonel Marques Antunes Ferreira
Sergio Calatroni/CERN-TE-VSC



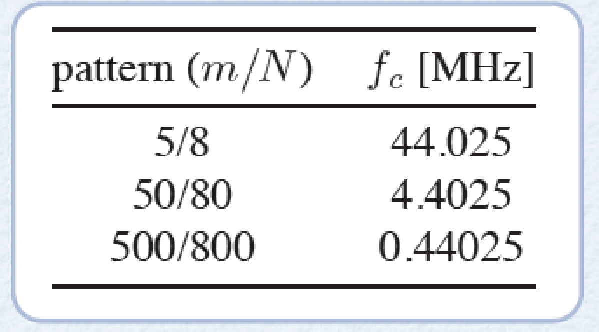
HOM issues
beam break up simulations under various conditions

RF errors

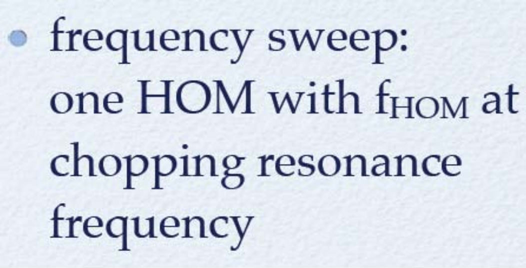


- ±0.5 deg / ±0.5 % amplitude
- uniform distributed
- normalised to case without RF errors

HOM issues
beam break up simulations under various conditions

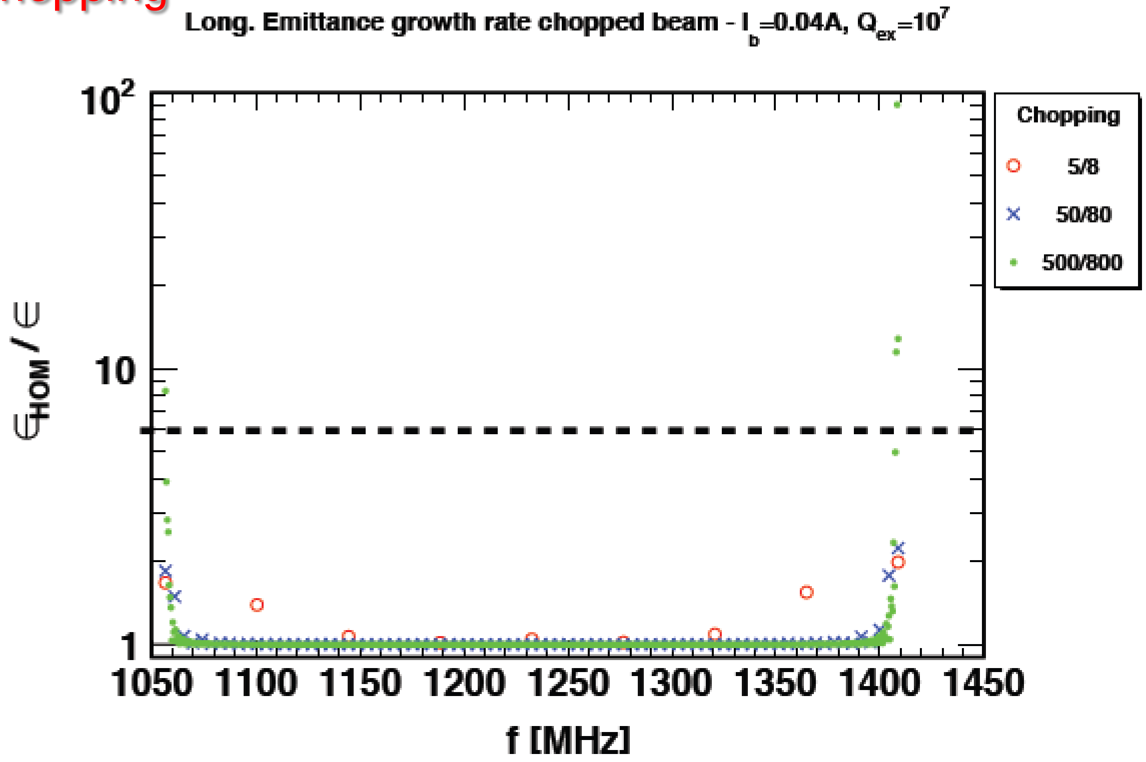


pattern (m/N)	f_c [MHz]
5/8	44.025
50/80	4.4025
500/800	0.44025



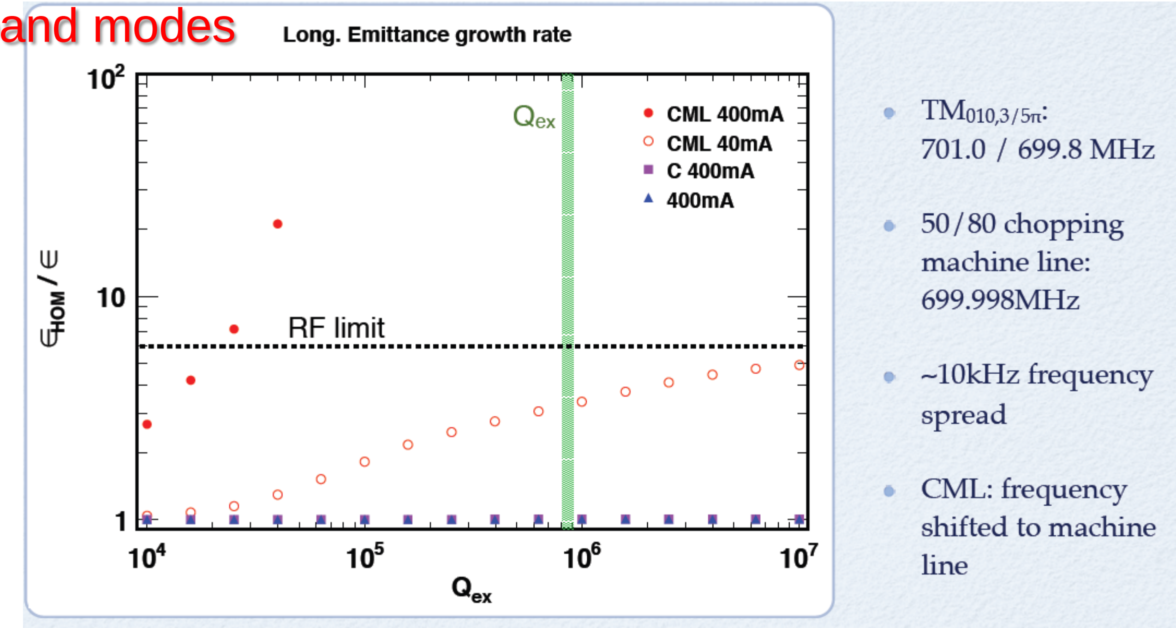
- frequency sweep: one HOM with f_{HOM} at chopping resonance frequency

chopping



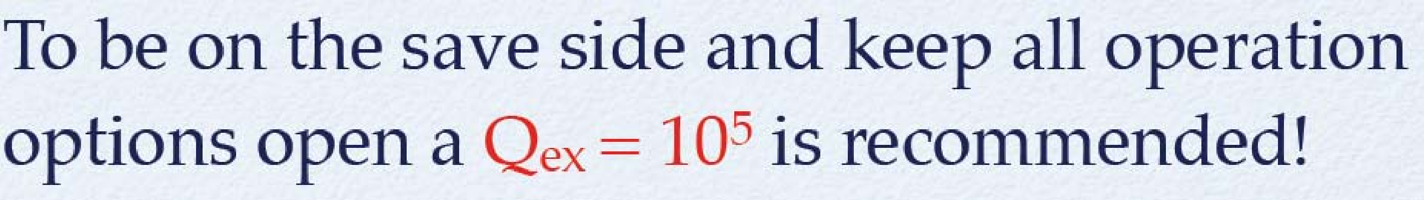
HOM issues beam break up simulations under various conditions

fundamental passband modes



- $TM_{010,3/5\pi}$: 701.0 / 699.8 MHz
- 50/80 chopping machine line: 699.998MHz
- ~10kHz frequency spread
- CML: frequency shifted to machine line

Overall conclusion:

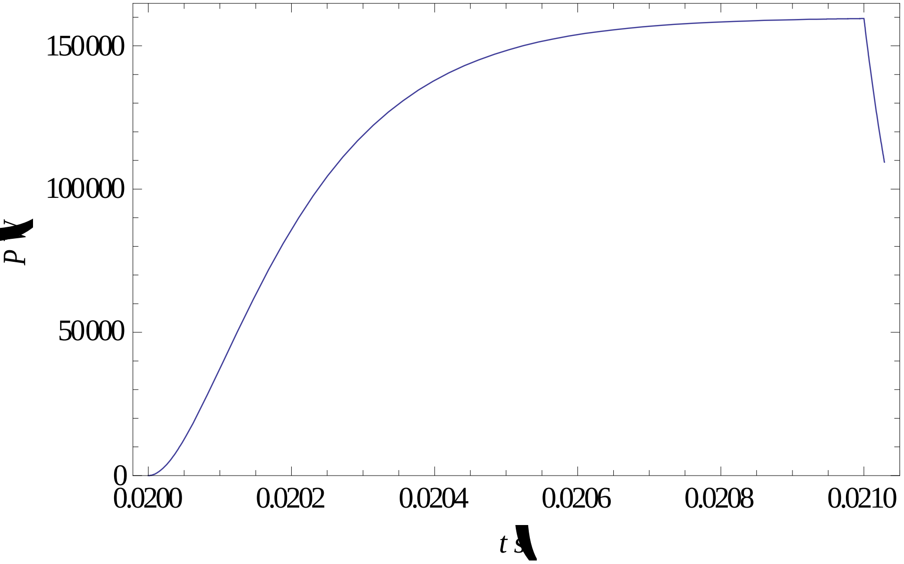

To be on the save side and keep all operation options open a $Q_{ex} = 10^5$ is recommended!

HOM issues
On longitudinal HOM excitation for pulsed beams

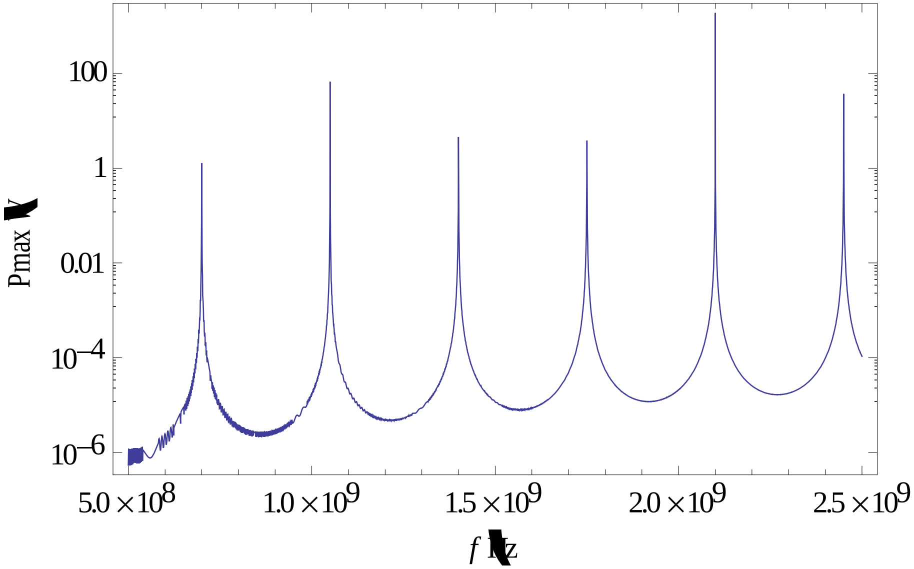
I = 40 mA; pulse length 1 ms, R/Q = 100 Ω ;

Rep. rate 50 Hz; f_{HOM} = 2.1 GHz; $Q_0 = 10^{10}$

Power built-up/decay during pulse of 1 ms

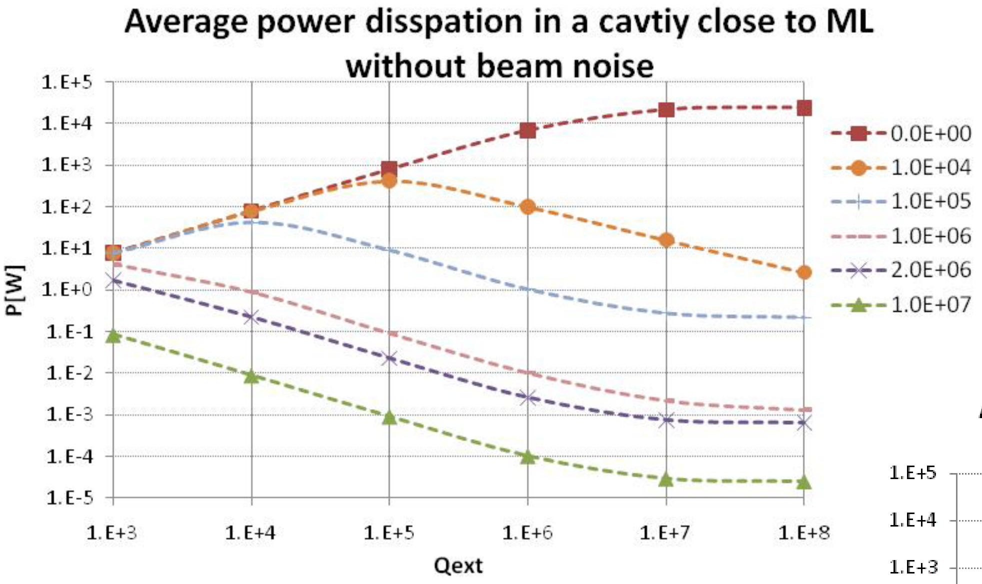


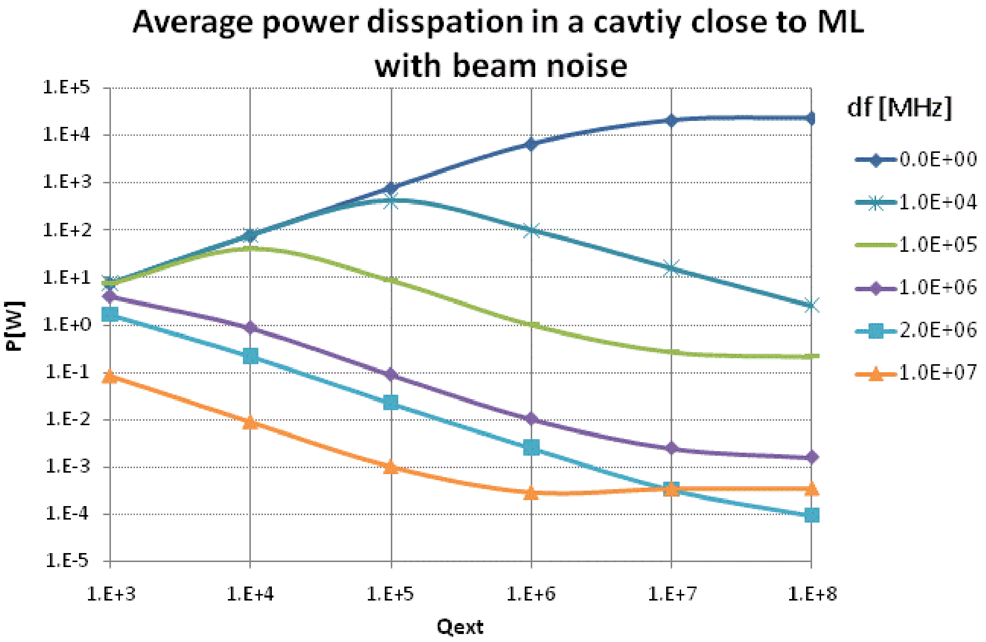
Maximum power vs. frequency showing principal Fourier components of beam



HOM issues
On longitudinal HOM excitation for pulsed beams power dumped by beam into the HOM load

Marcel Schuh / CERN-BE-RF


Average power disspation in a cavtiy close to ML without beam noise


Average power disspation in a cavtiy close to ML with beam noise