Status of the HOM Damped Cavity Project

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for the HOM Damped Cavity Collaboration
BESSY, Daresbury Lab, DELTA, MaxLab, NTHU

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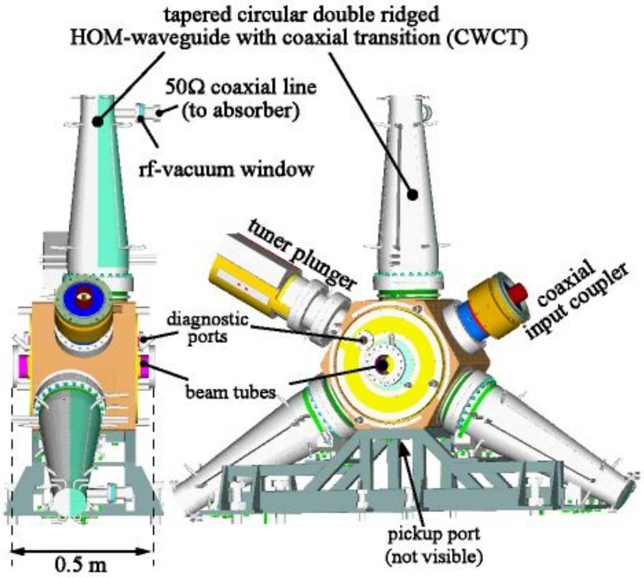
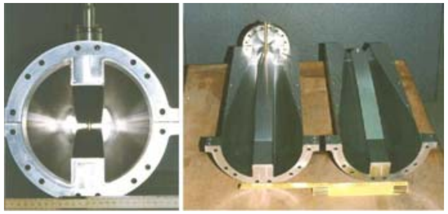
- Cavity concept and design goals
- Simulations and impedance measurement results
- Prototype cavity conditioning and first beam tests
- What lessons have we learned so far?
- Further developments
- Summary and outlook

Design Goals

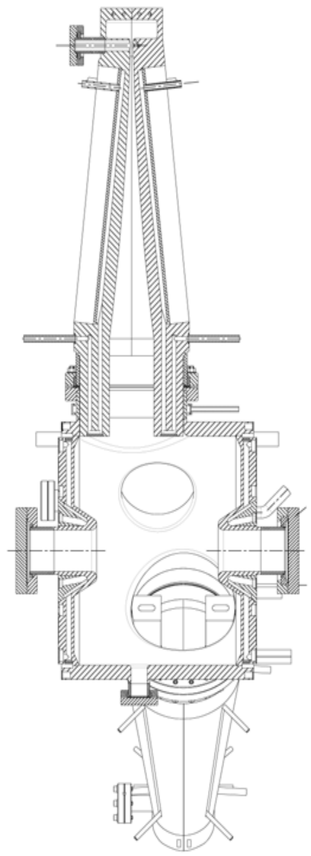
- Fundamental mode frequency f = 500 MHz
- Insertion length L $<$ 0.7 m
- Shunt impedance R $>$ 4 MΩ
- Max. thermal power P = 100 kW
- Compact design to fit into existing SR source tunnels

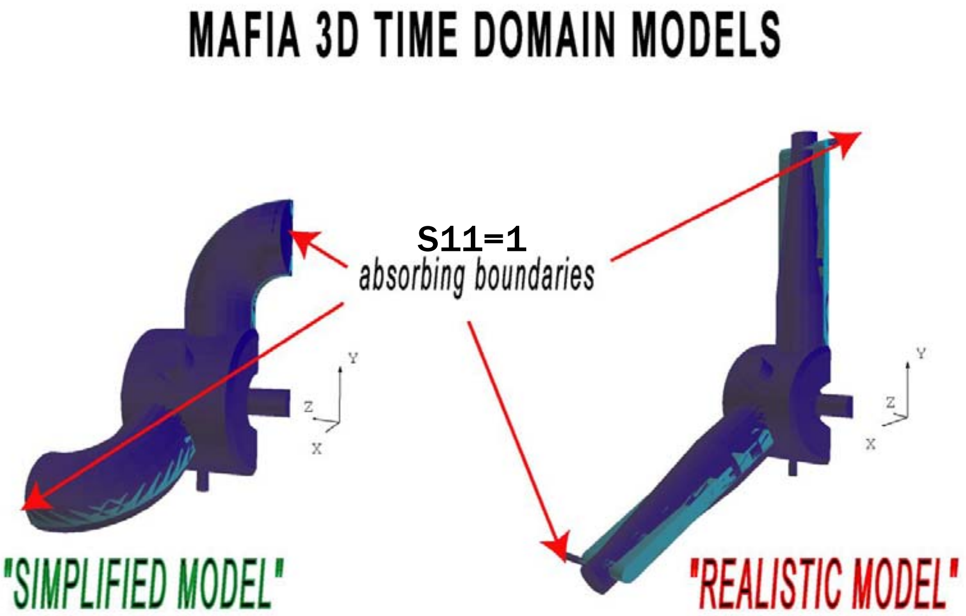
Cavity Concept





Simulation Models

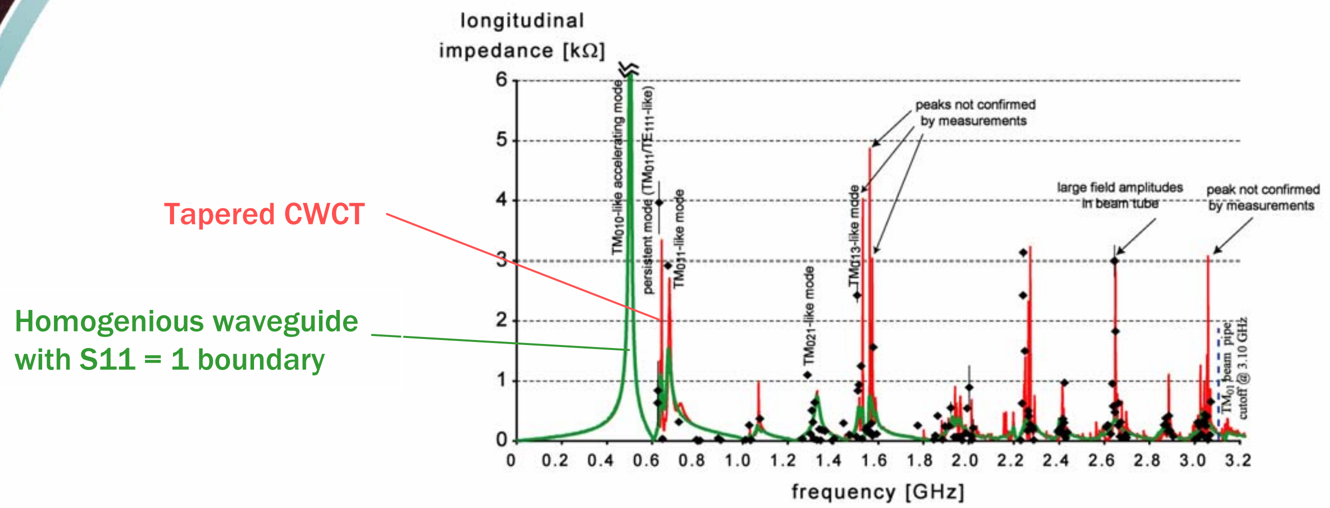


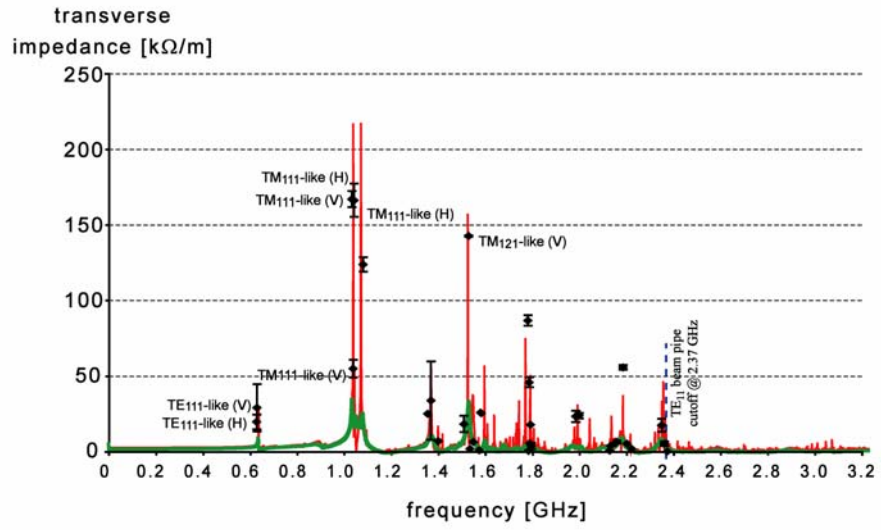


~ 10^6 mesh points
2-3 days cpu time

~18* 10^6 mesh points
6-7 weeks cpu time

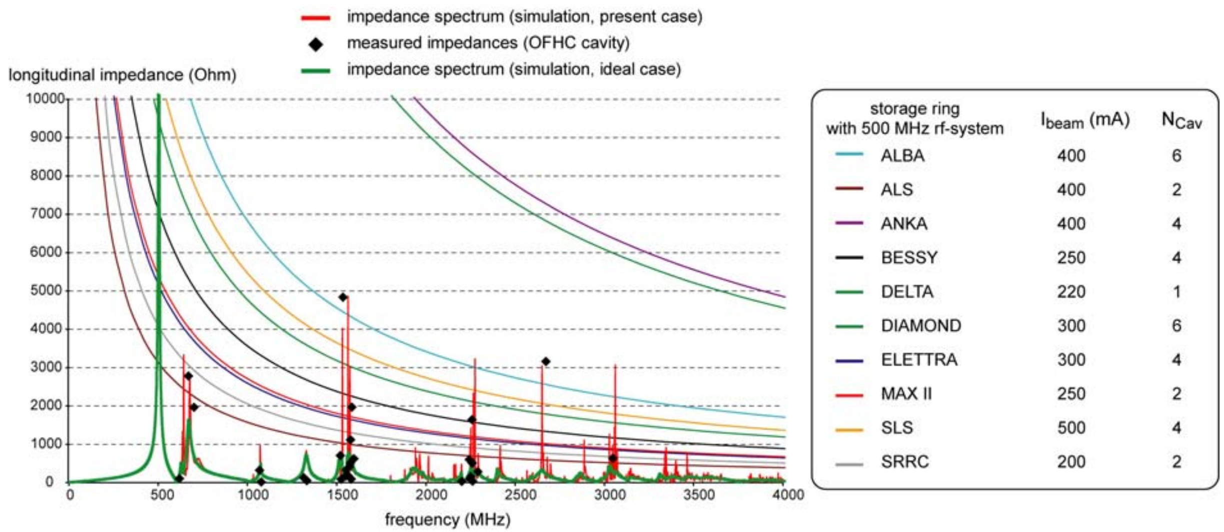
Simulations and Impedance Measurement Results



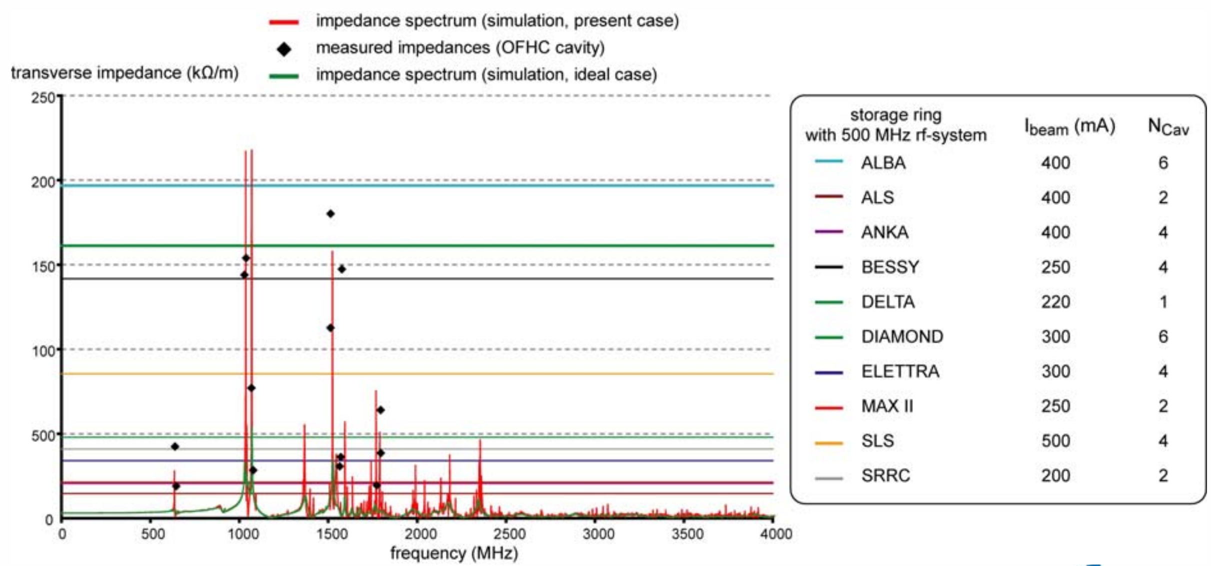


Threshold impedances for different rings

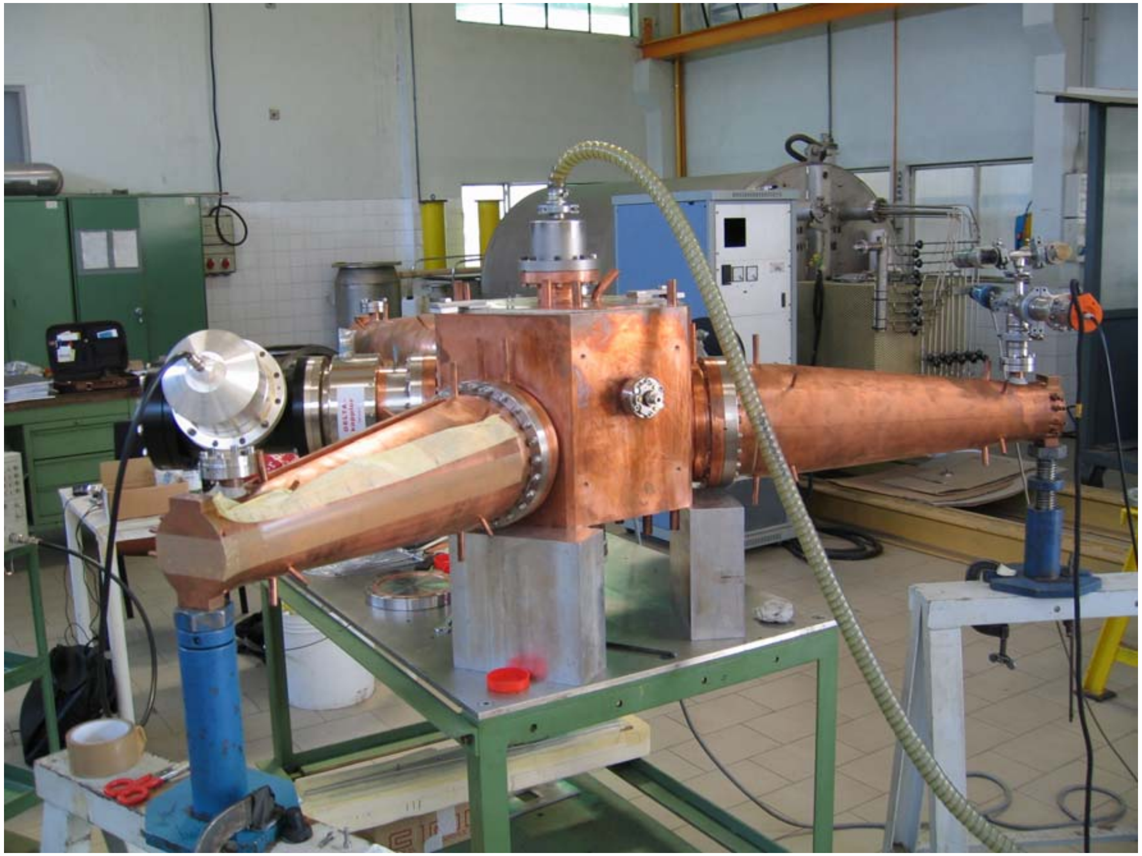
$$Z_{\parallel}^{thresh.} = \frac{1}{N_C} \cdot \frac{1}{f_{\parallel,HOM}} \cdot \frac{2 \cdot E_0 \cdot Q_s}{I_b \alpha \, \tau_s}$$



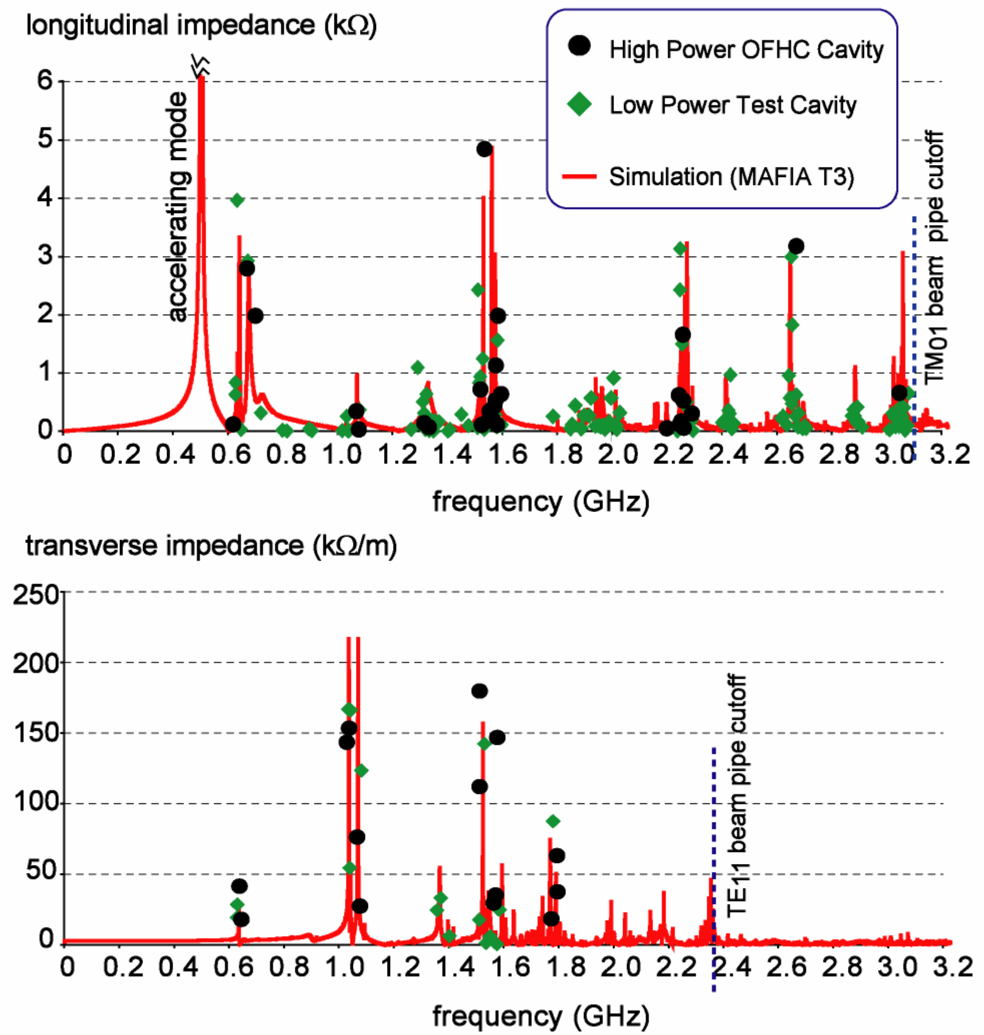
$$Z_{x,y}^{thresh.} = \frac{1}{N_C} \cdot \frac{2 \cdot E_0}{f_{rev} I_b \, \beta_{x,y} \, \tau_{x,y}}$$



Tuning and Cavity Test at ZANON S.p.A. / Italy



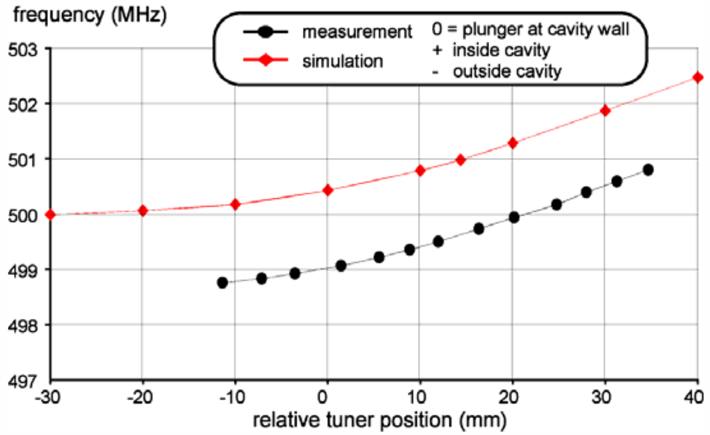
Measured Impedance Spectra of



Measured Cavity Parameters

Parameter	3D MWS Simulation Standard/New Method	Measurement
f0 (MHz)	500.98	499.65
Q0	32557 / 28410	26692
Reff/Q0 (Ω)	114.5	115.4
Reff (MΩ)	3.73 / 3.25	3.1

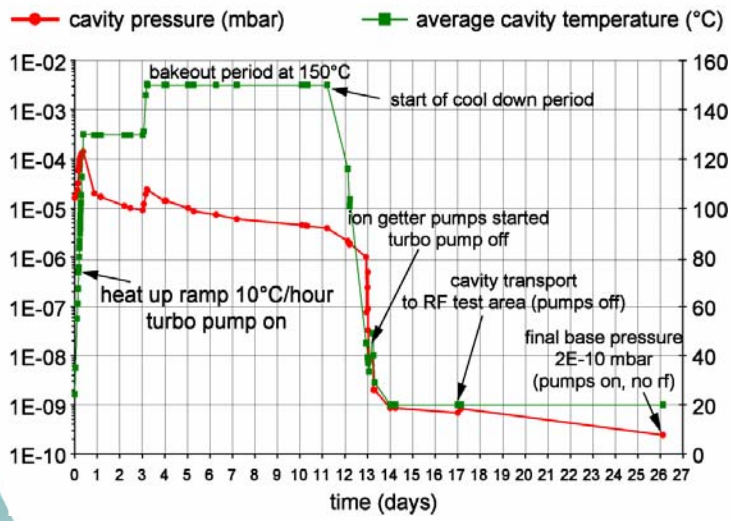
Nominal Frequency	499.65	MHz
Tuning Range	2	MHz
Shunt Impedance	3.1	MΩ
Unloaded Q	26692	
Thermal Power Capability	100	kW
Longitudinal HOM Impedance	≤ 4.8	kΩ
Transverse HOM Impedance	≤ 180	kΩ/m
Waveguide cut-off	615	MHz
Coupling Range	0-8	
Insertion Length	50	cm
Beam Hole Diameter TE11 cut-off TM01 cut-off	74 3.74 2.31	mm GHz GHz



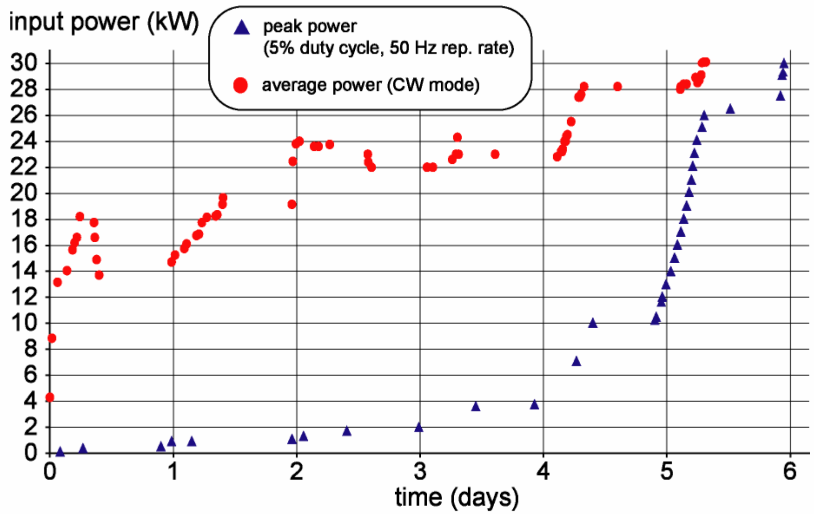
Resonant frequency vs. plunger position
as measured and calculated.

Prototype Cavity Conditioning

Vacuum conditioning procedure

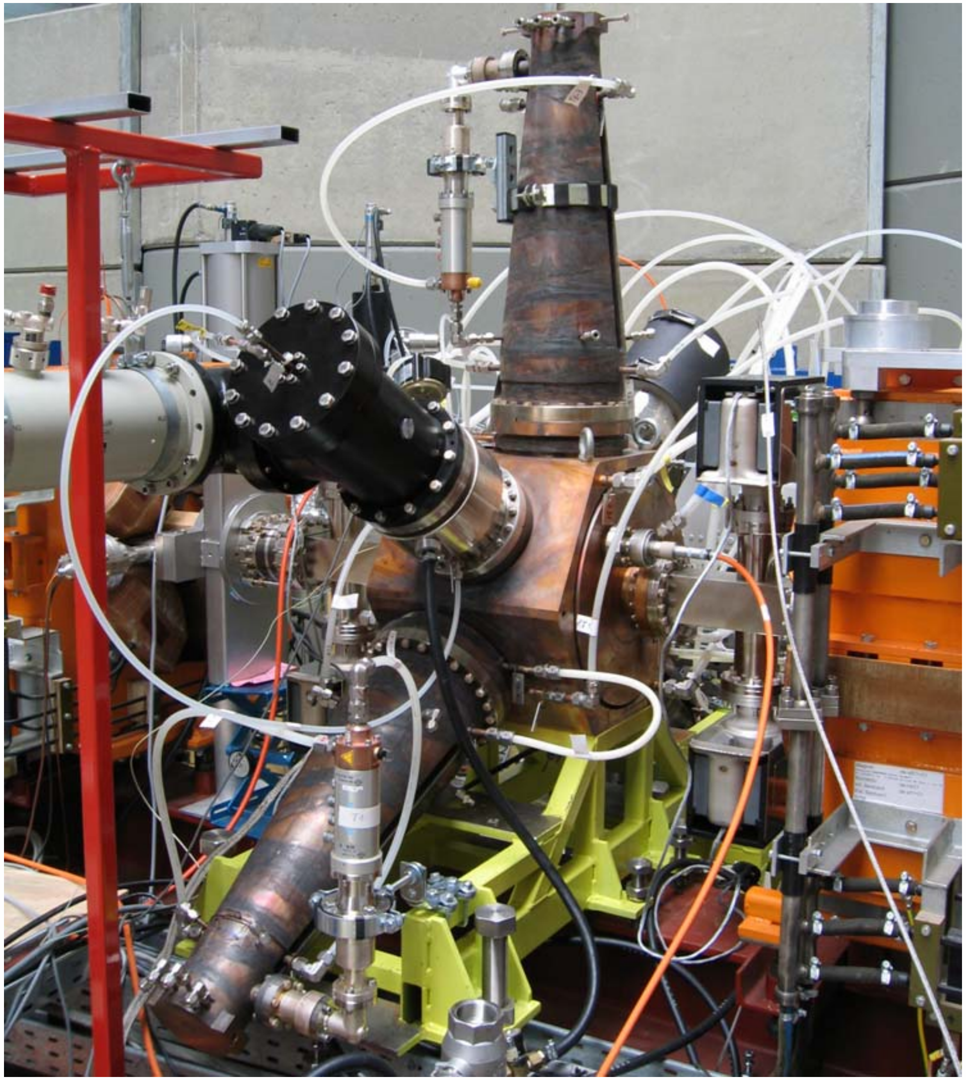


Peak and average cavity input power during RF conditioning (p_{vac}< 5*10^{-7} mb)



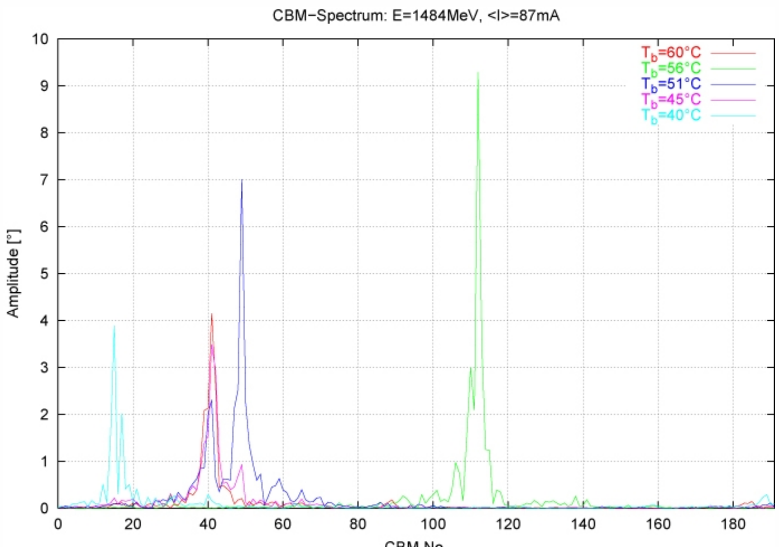
Increase in vacuum pressure around 200W and 600 W, however no serious multipacting thresholds observed

Cavity installed in the DELTA Ring



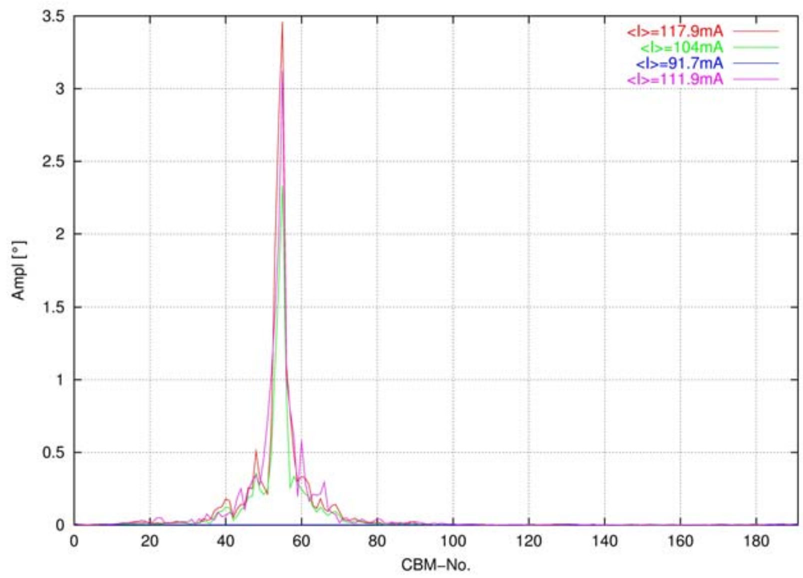
First Beam Observations at 1480 MeV

DORIS Cavity

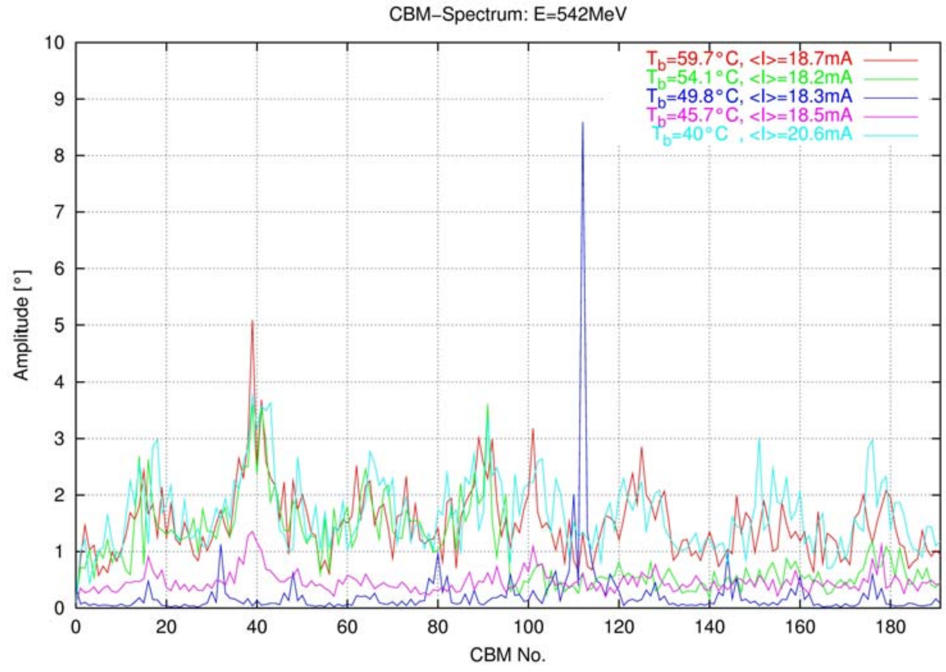


HOM Damped Cavity

CBM 55 is not driven by the cavity !!



DORIS Cavity beam spectrum at low energy



Final beam tests: measurement of coupled bunch instability thresholds at 540 MeV

What lessons have we learned so far ?

♦ The tapered waveguides are the most critical components of the cavity
  - about 60% of total manufacturing costs
  - small tolerances
  - vacuum brazing is a subtle technique, to be avoided where possible

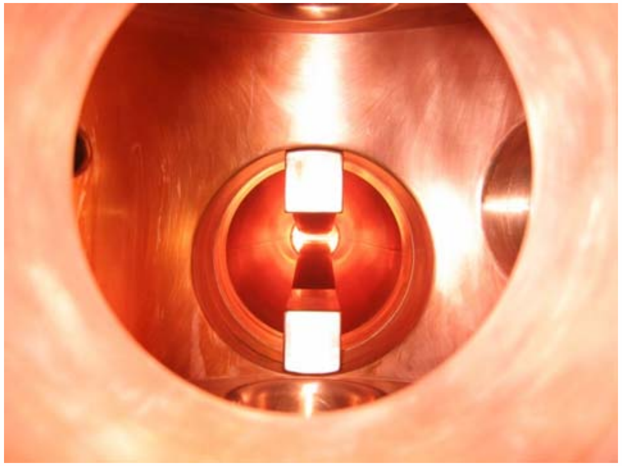
♦ Engineering layout of e-beam welds and quality control during manufacturing must be improved

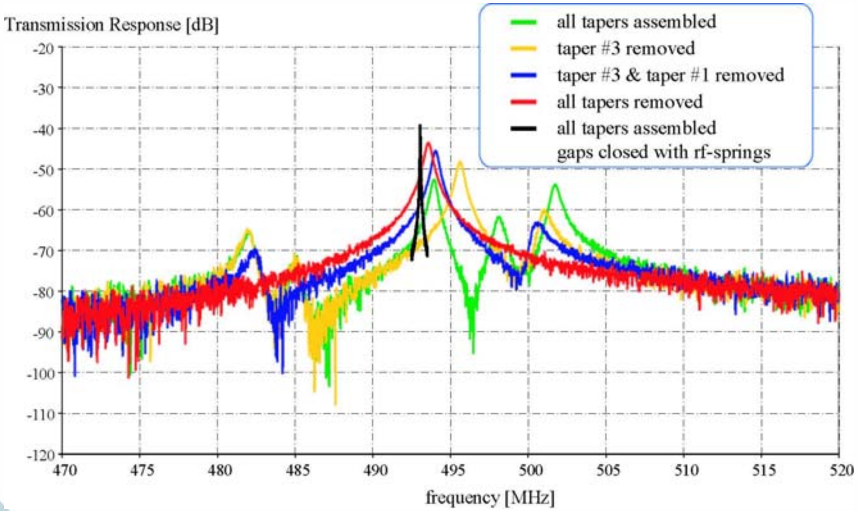
♦ Gaps between the ridges and the waveguide port wall should not be longer than 80 mm to avoid resonances coupling to the fundamental mode

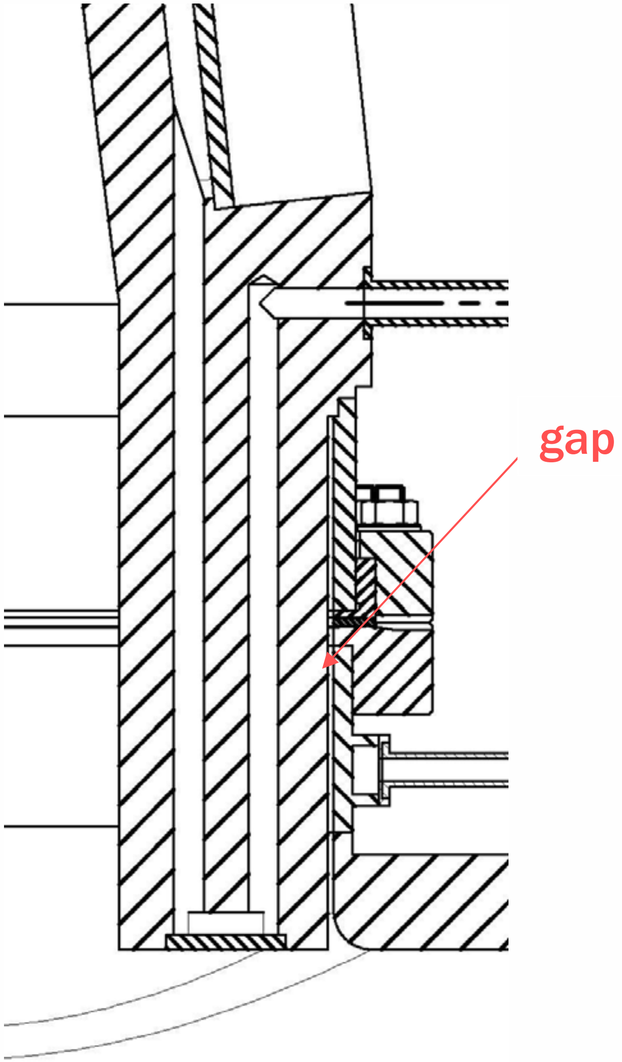
♦ A CF 63 flange should be added at the end of the tapered waveguide

♦ Homogenous damping waveguides allow further reduction of HOM impedances

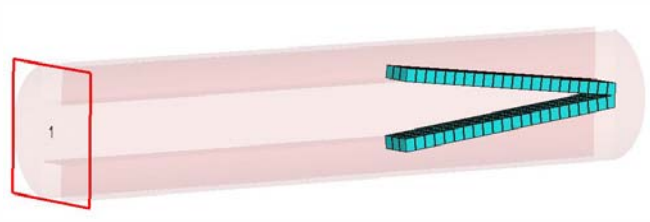
Avoid long gaps coupling to fundamental mode

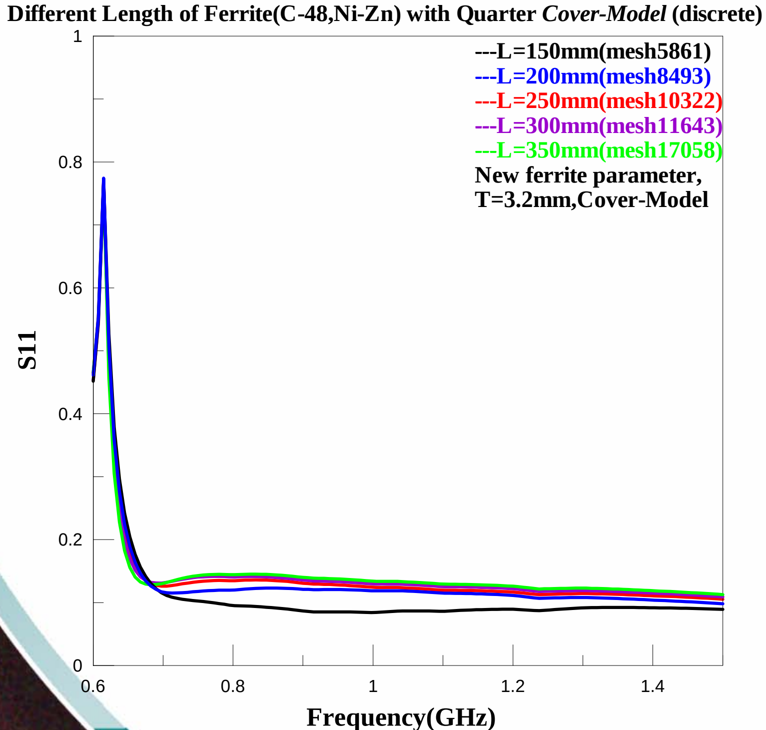


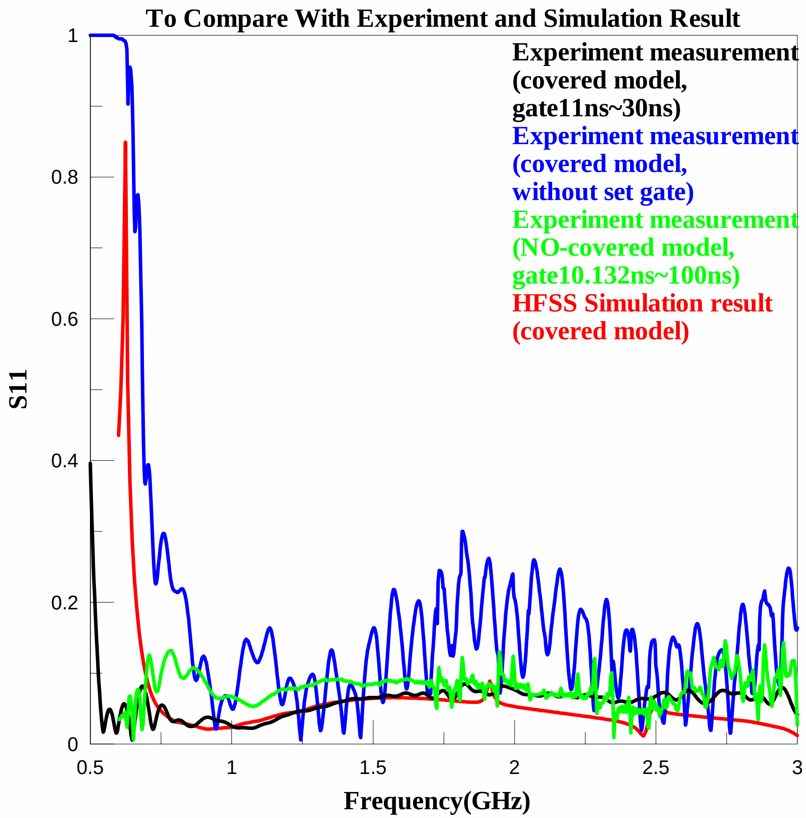


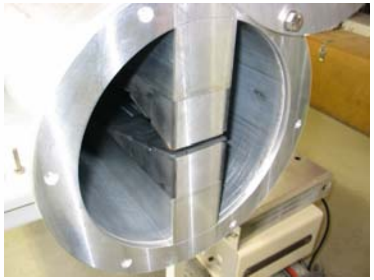


Further Development: Homogenious ferrite loaded waveguide



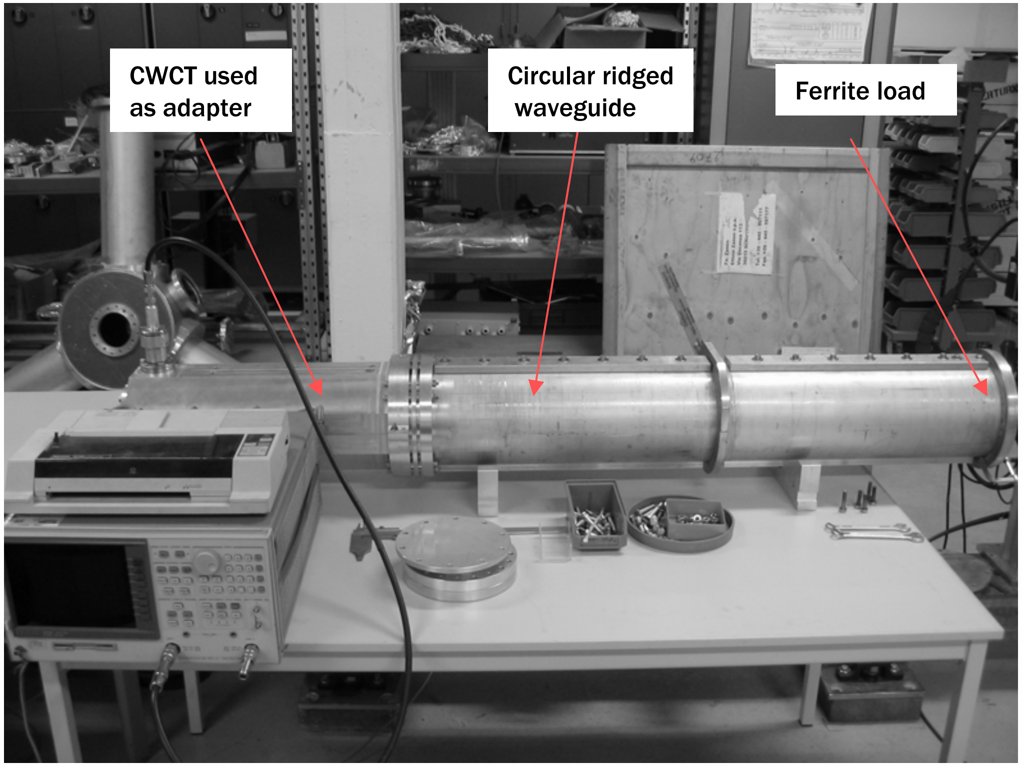






TDR measurement set-up

Low power model of a homogenous ridged waveguide load



Summary

♦ A HOM damped prototype cavity has been built and tested under low and high power conditions

♦ Impedance measurements show that
- longitudinal HOM impedances < 4.8 kΩ
- transverse HOM impedances < 180 kΩ/m
- fundamental mode impedance 3.1 MΩ

♦ Measurements are in good agreement with calculations: Simulation tools are reliable

♦ Successful high power operation up to 30 kW thermal power, no serious multipacting thresholds found

♦ Technical improvements
- modifications e-beam welds, avoid vacuum brazing where possible
- reduced gaps between ridges and CWCT port
- CF 63 flange at the end of the CWCT

♦ Conceptual and technical layout has been verified. Cavity design is ready for use.

Outlook

♦ Final beam test of the cavity in DELTA at 540 MeV early in 2005

♦ Development of a high power prototype for a homogenious wavegude load is under way to reduce manufacturing cost and further reduce HOM impedances by a factor 3-4