HELMHOLTZ GEMEINSCHAFT

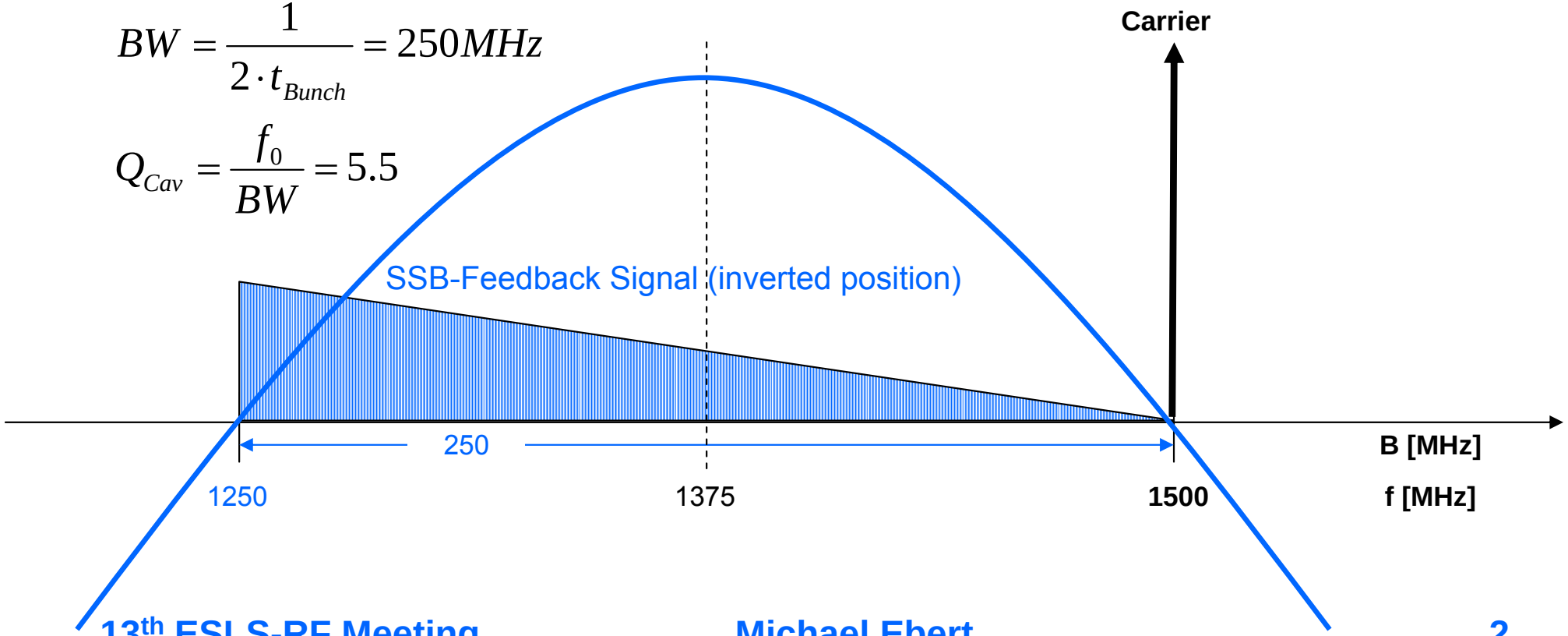
DESY

PETRA-III
Longitudinal Feedback RF

Chosen Carrier Frequency and Required Bandwidth

$$BW = \frac{1}{2 \cdot t_{Bunch}} = 250MHz$$

$$Q_{Cav} = \frac{f_0}{BW} = 5.5$$



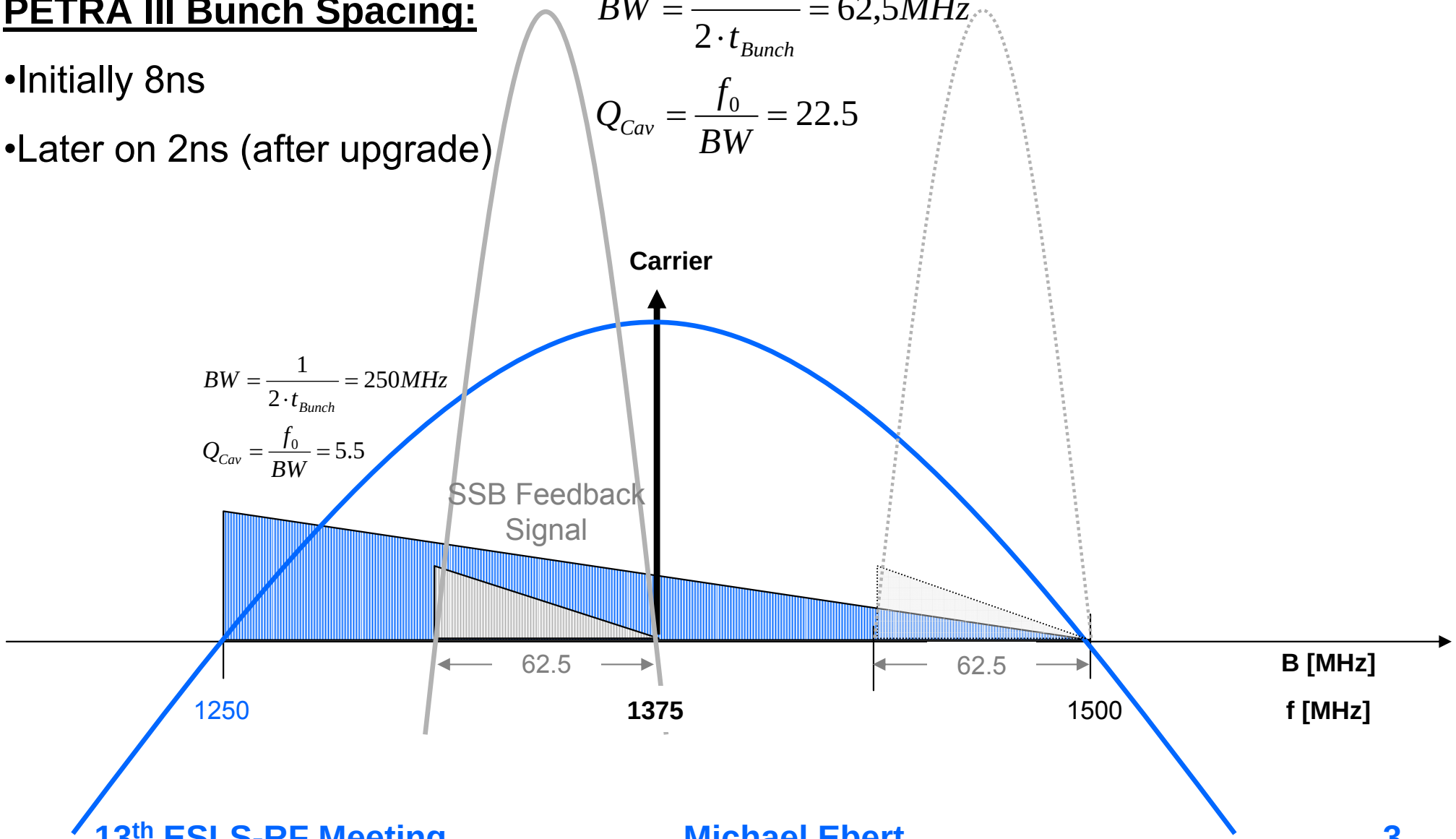
Required Feedback Bandwidth for 8ns Bunch Spacing

PETRA III Bunch Spacing:

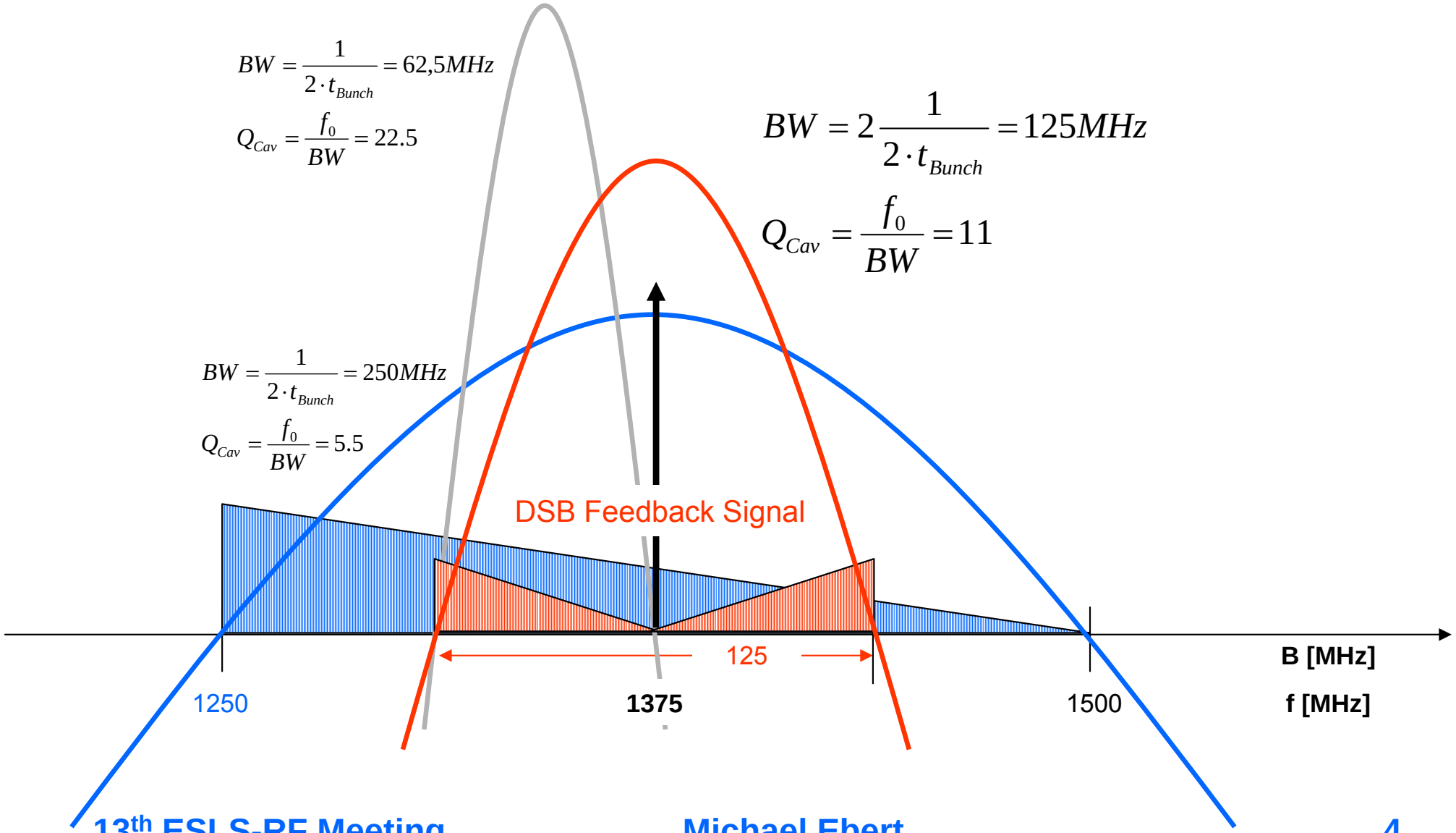
- Initially 8ns
- Later on 2ns (after upgrade)

$$BW = \frac{1}{2 \cdot t_{Bunch}} = 62{,}5MHz$$

$$Q_{Cav} = \frac{f_0}{BW} = 22.5$$



Required Feedback Bandwidth for 8ns Bunch Spacing at DSB

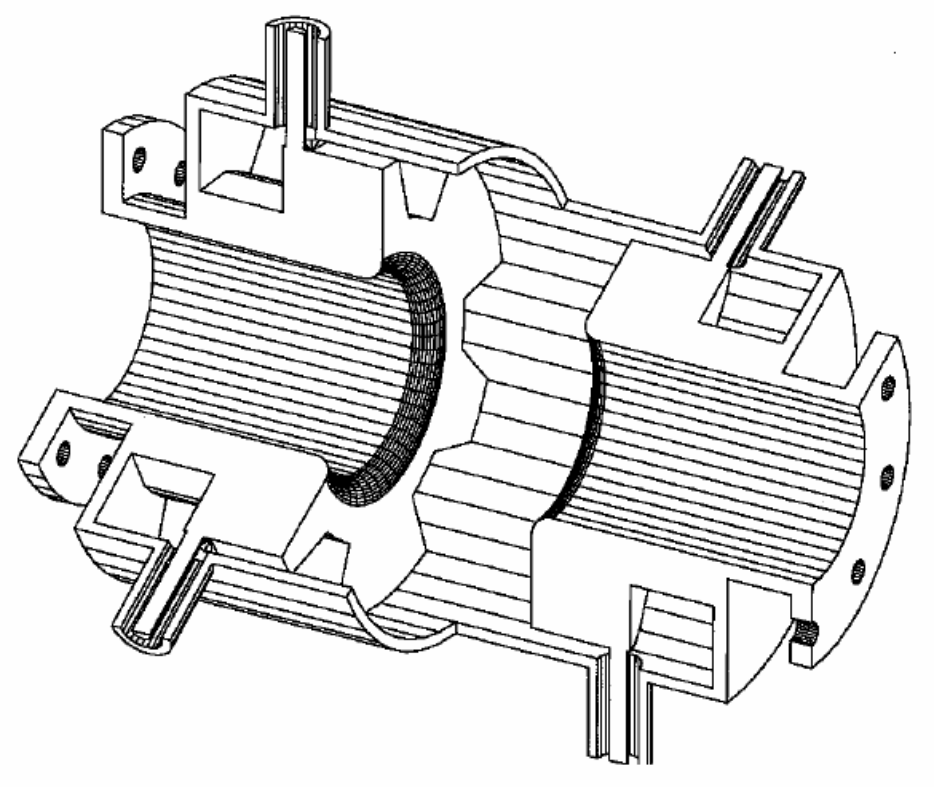


Chosen Cavity Design

Original DAΦNE long. kicker-cavity.

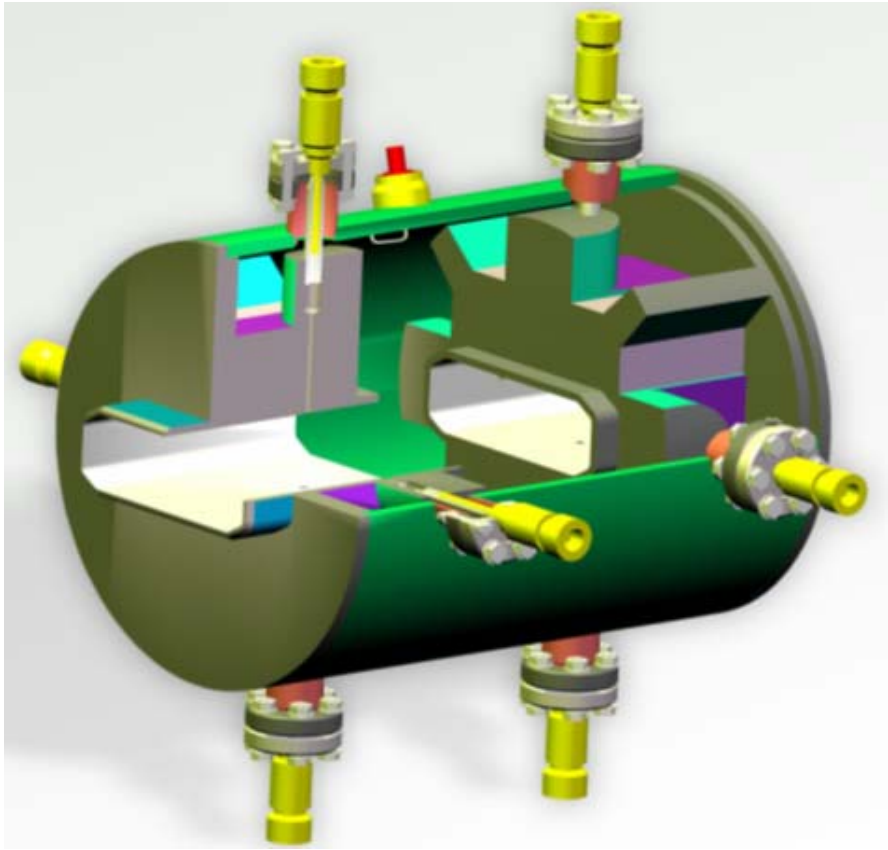
Developed 1995 at INFN, Frascati

by R.Boni, A.Gallo, A.Ghigo, F. Marcellini, M.Serio, M.Zobov



Modified DAΦNE long. kicker-cavity for ELETTRA/SLS

Micha Dehler, PSI, Villingen,CH



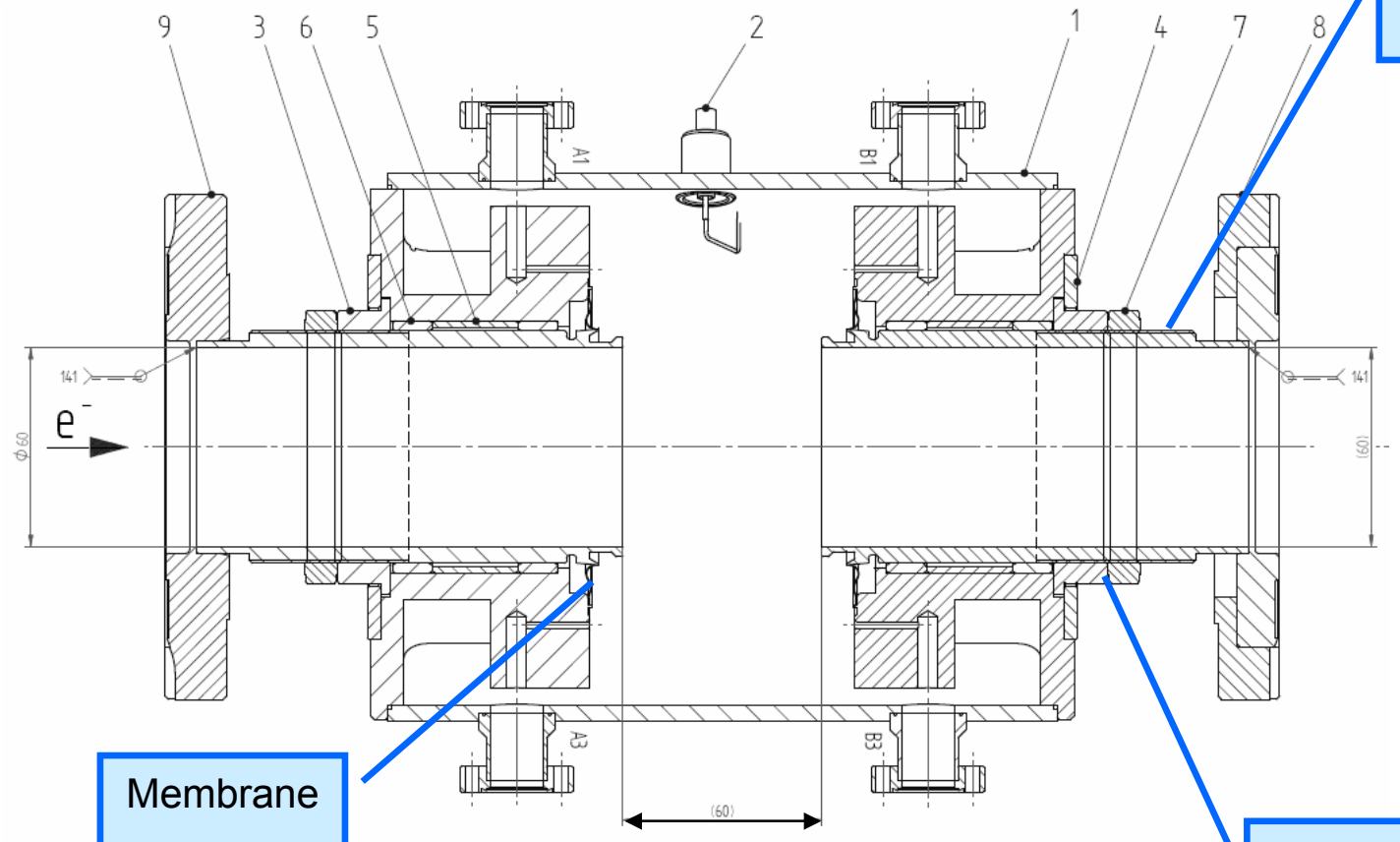
Required Feedback Voltage

- ≈14 kV feedback voltage required
- DAΦNE type cavity:
  - 0.9kV at BW=250MHz (R_S=800Ω), P_{RF}=500W,
  - 1.8kV at BW=125MHz (R_S=1600Ω), DSB, P_{RF}=2*250W

⇨ 8 DAΦNE type cavities required

The Umpteenth Redesign of the DAΦNE Cavity

The tuneable one



Thread

Membrane

Groove Nuts

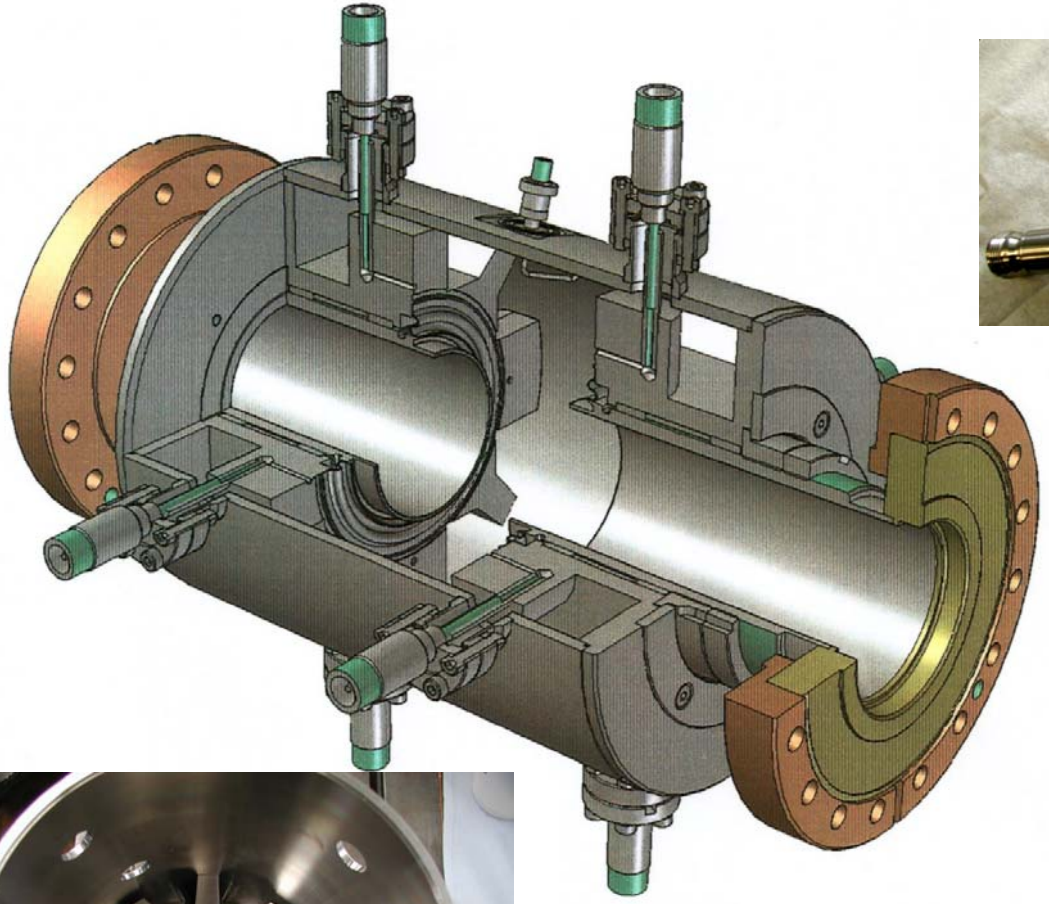
variable gap width 52…68mm

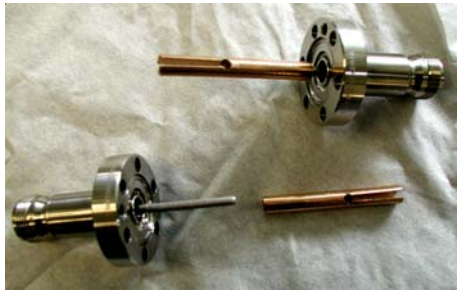
Tuning range about 100 MHz

Modifications with respect to the SLS-Design

1. Beam tube from 86*26mm² to D=60mm
2. Welded joints changed to brazed joints
3. Tuneable centre frequency via movable nose cones

Sectional View

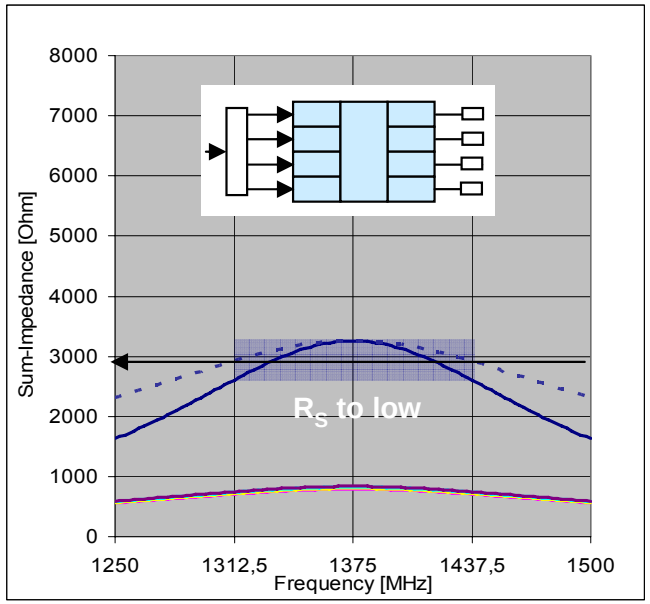




…and photos from production

ΣR_S vs Wiring & Tuning

of one Cavity Quartet



1.) Standard Wiring

f_C: 1375 MHz

Q_L: 5.5

ΣR_{Smax}: 3255 Ω

ΣR_{Smin}: 2600 Ω

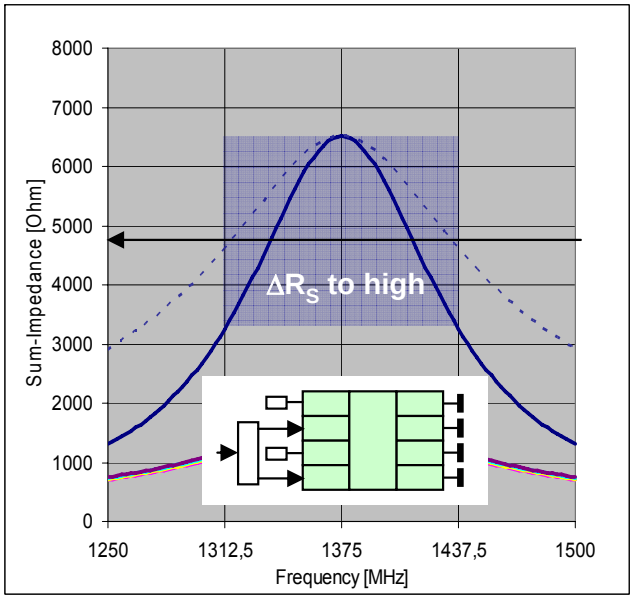
2.) Half BW Wiring

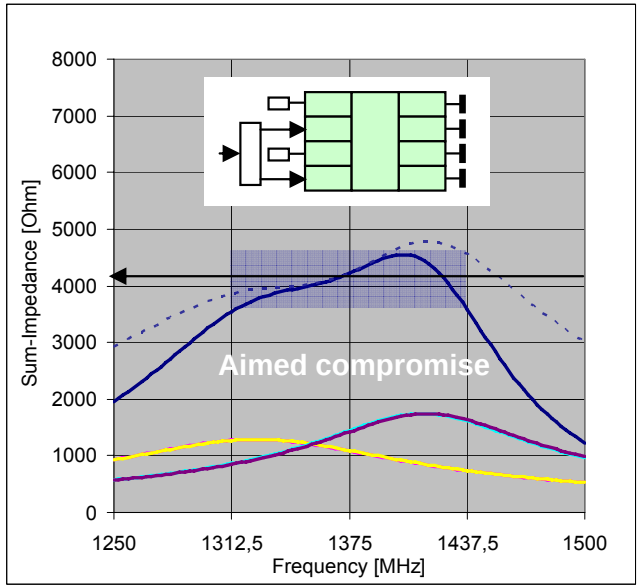
f_C: 1375 MHz

Q_L:11

ΣR_{Smax}: 6510 Ω

ΣR_{Smin}: 3260 Ω





3.) Half BW Wiring

f_C: 1325-1415 MHz

Q_L: 8.5 – 12.3

ΣR_{Smax}: 4700 Ω

ΣR_{Smin}: 3580 Ω

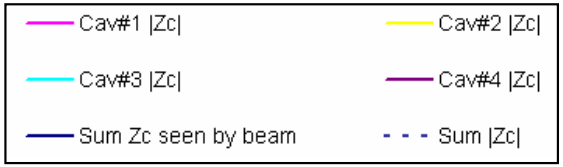
4.) Half BW Wiring

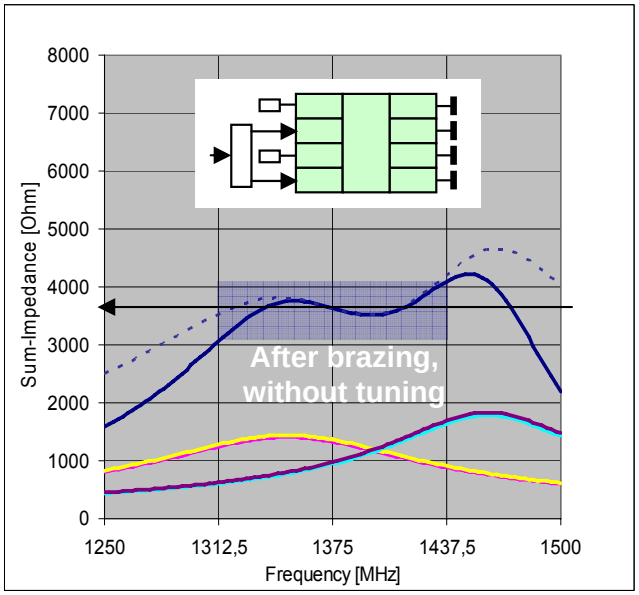
f_C: 1350-1460 MHz

Q_L: 9.5 – 13.7

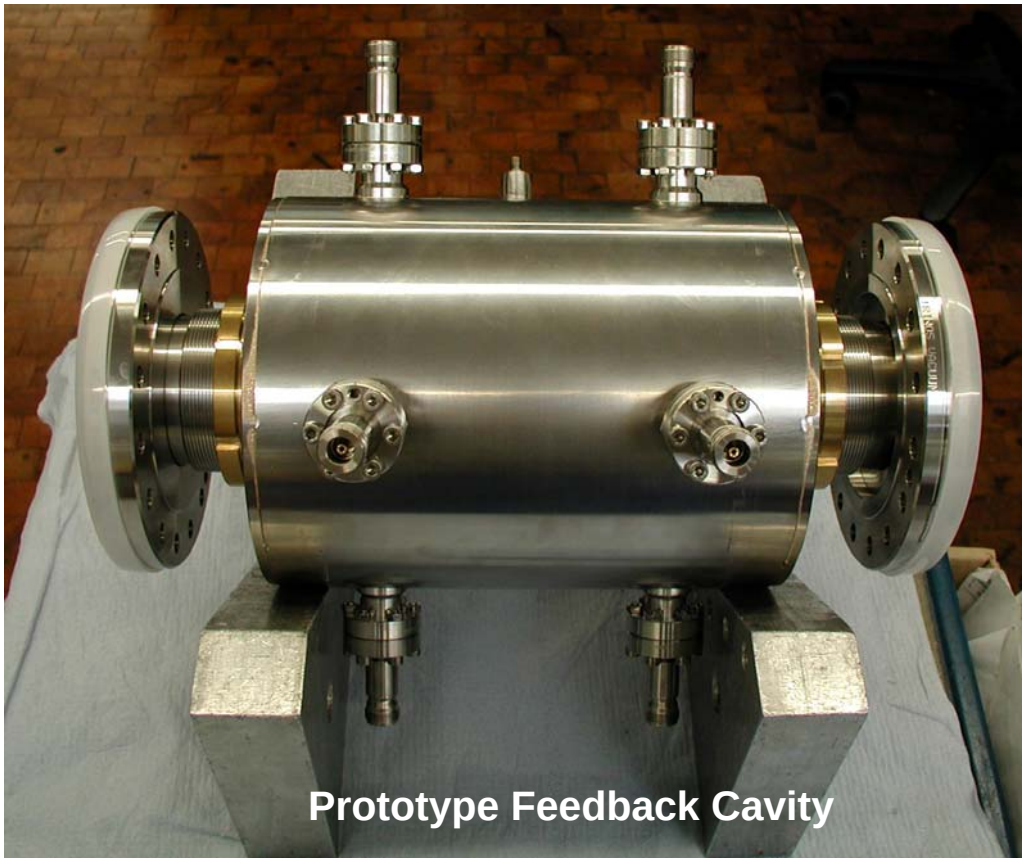
ΣR_{Smax}: 4420 Ω

ΣR_{Smin}: 3150 Ω





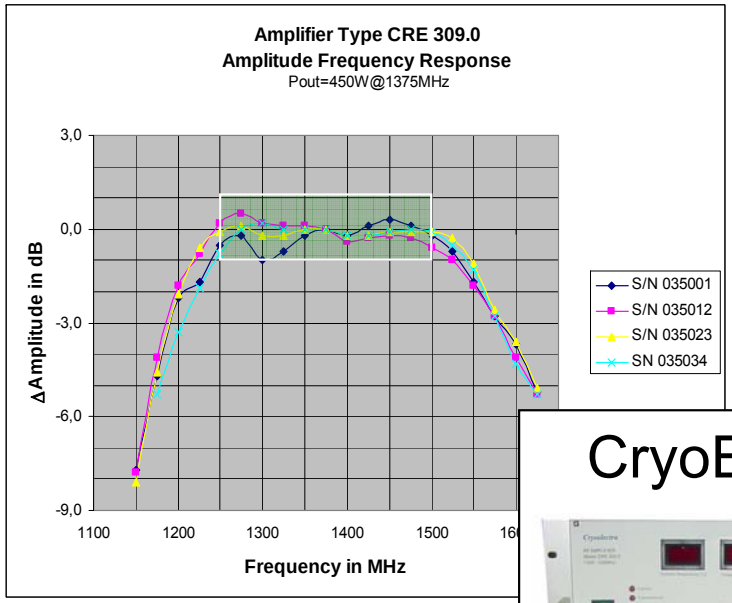
Cavity Installation in PETRA Tunnel


Prototype Feedback Cavity

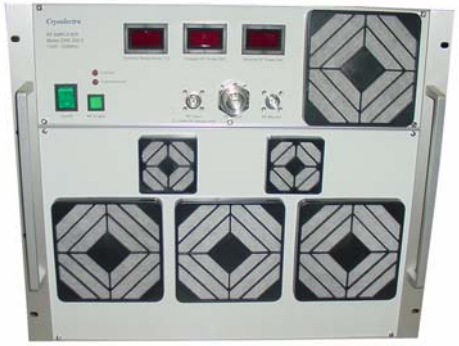

Feedback Cavity Quartet PETRA-OL

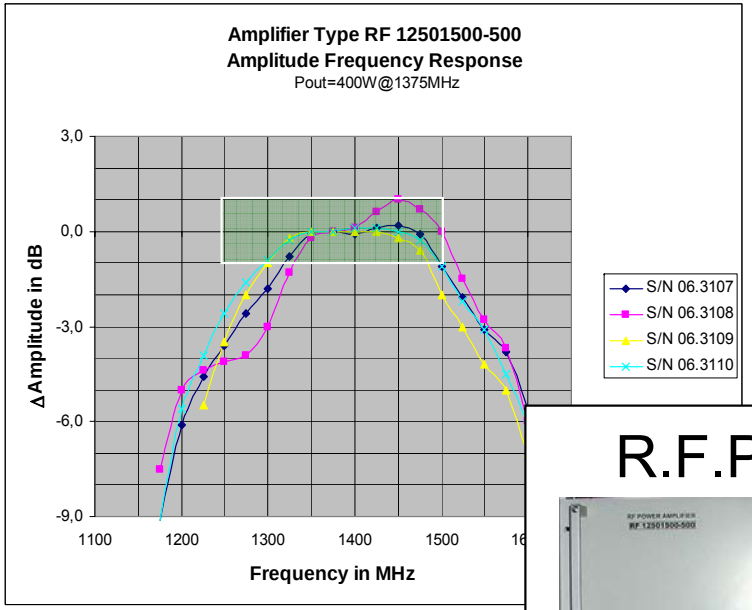

Feedback Cavity Quartet PETRA-OR

PowerAmp Frequency Response

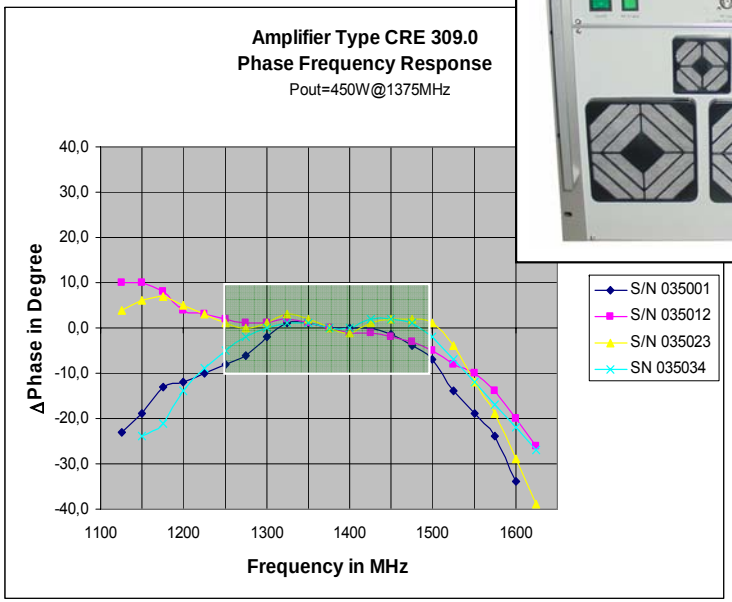


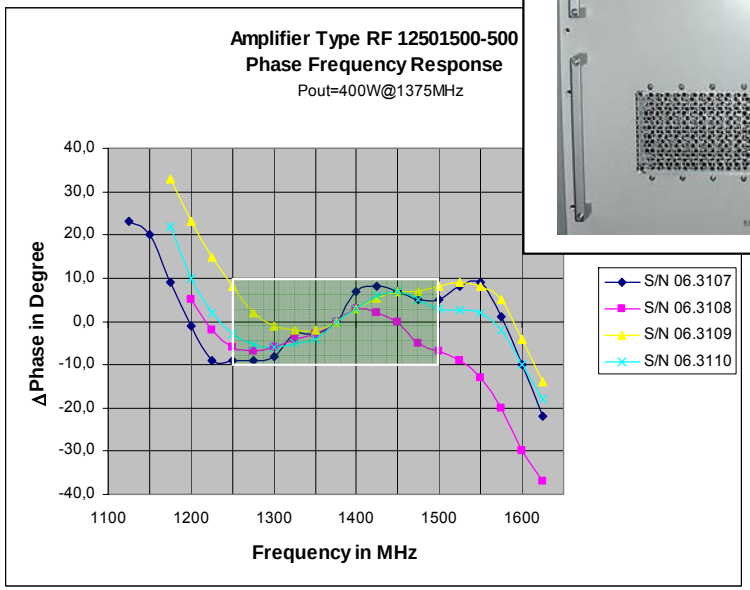
CryoElectra ☺



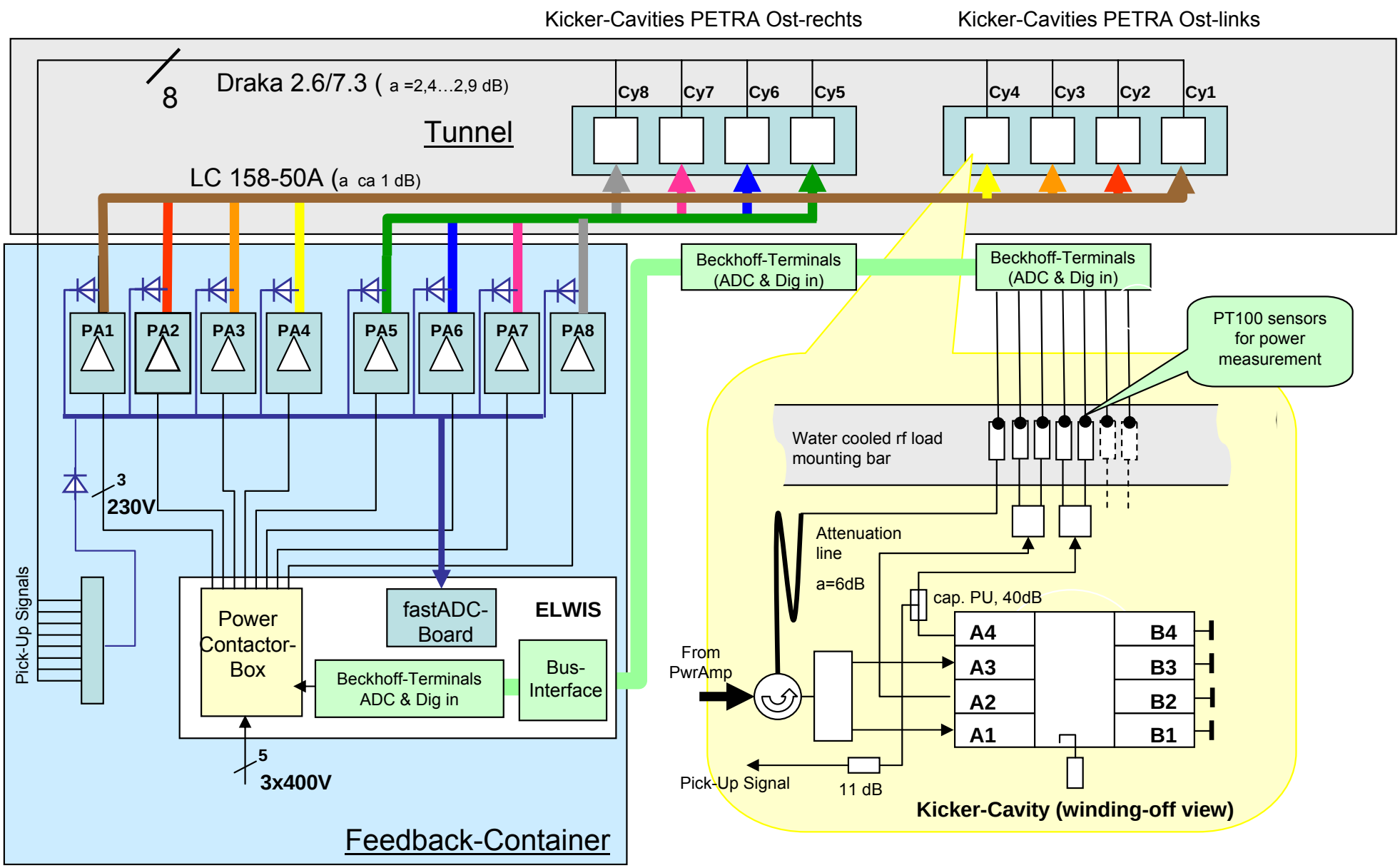


R.F.P.A. ☹





Cavity Supply and Control



Current Status

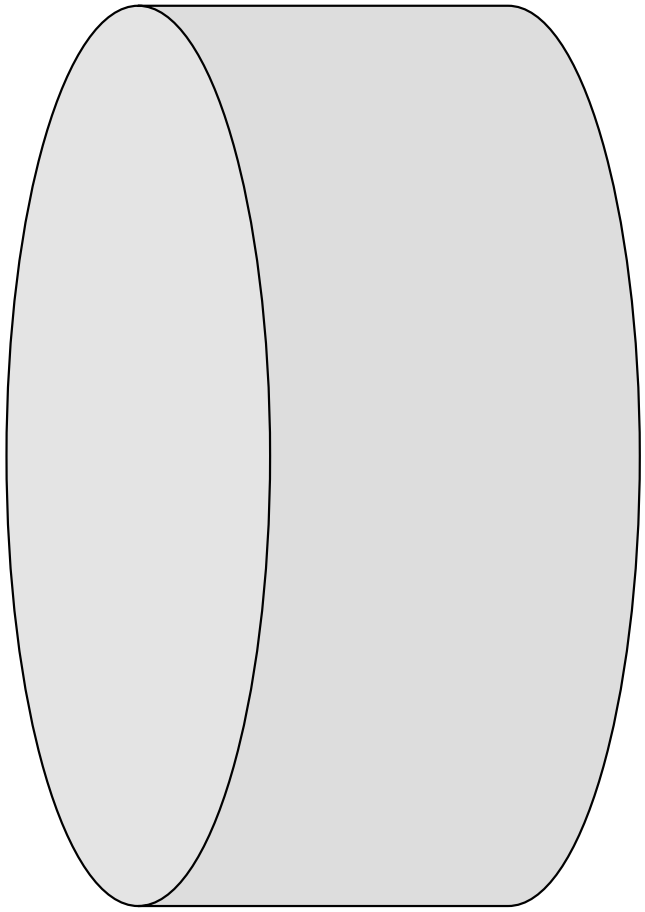
- ✓ Signal path delays with respect to the bunch transition adjusted.
- ✓ Over-all frequency response adjusted (is properly within specifications)
- ✓ Control & monitor system is working

? But whether the feedback is able to damp beam oscillations could not be proven yet.

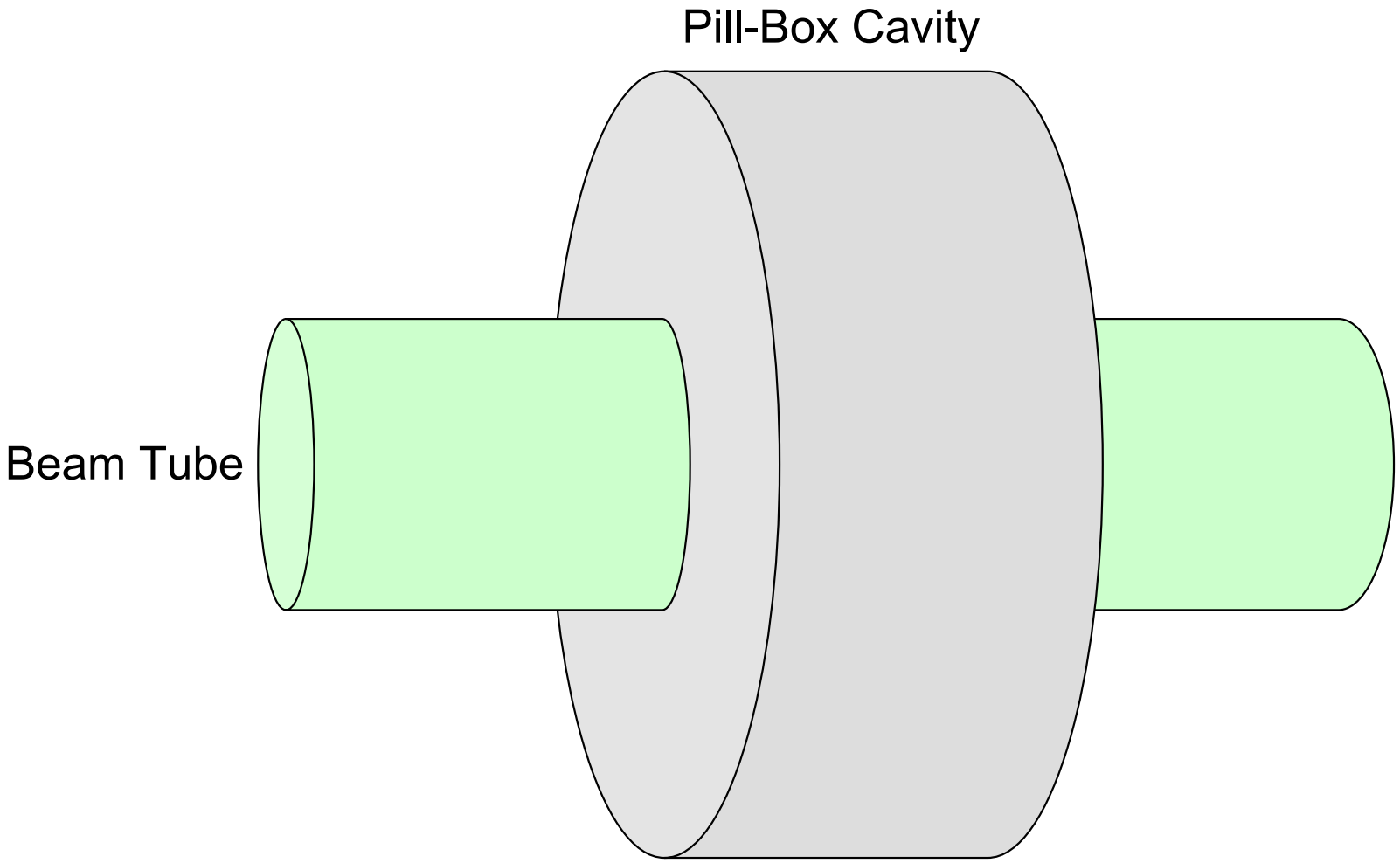
APPENDIX

Design Illustration 1

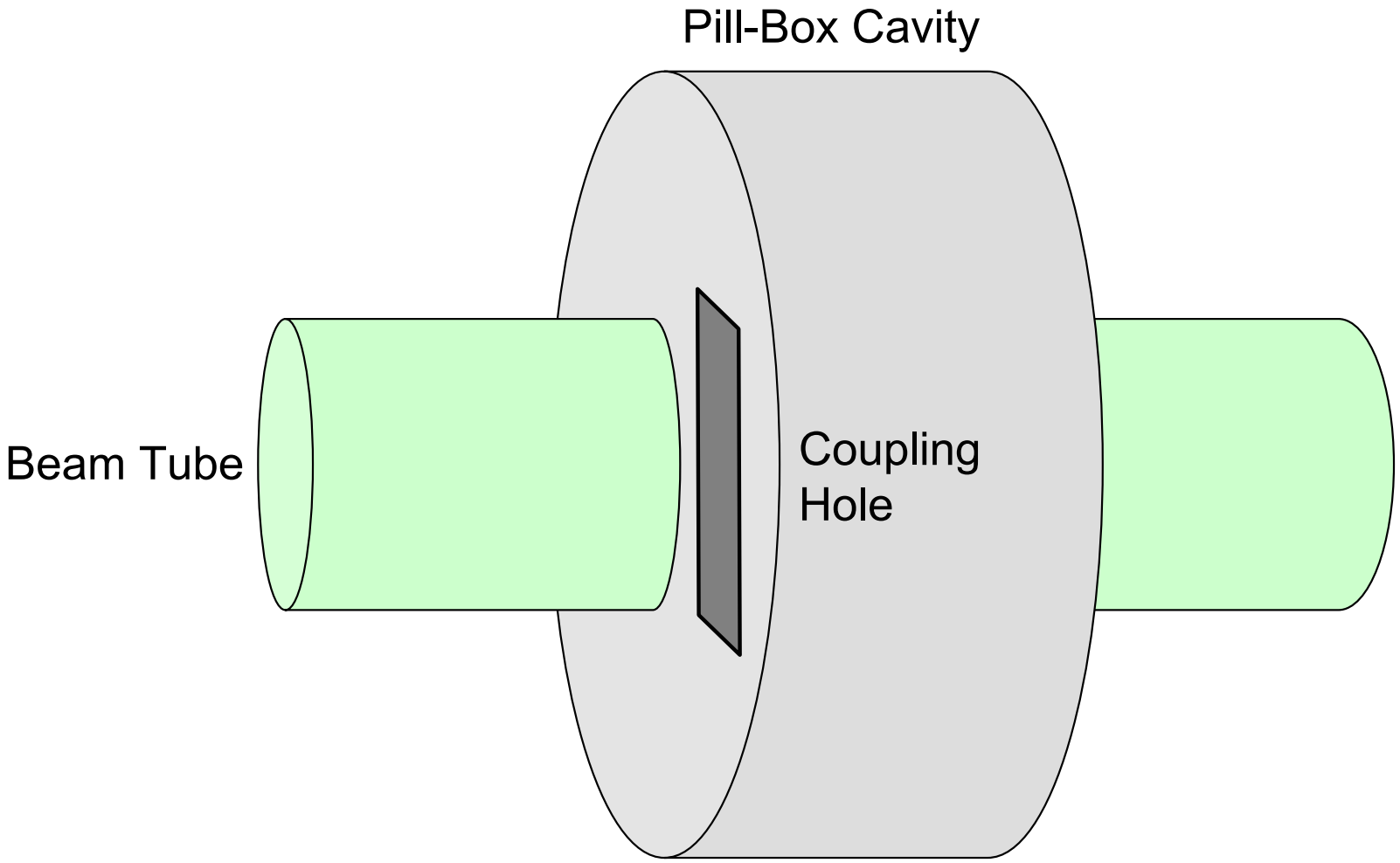
Pill-Box Cavity



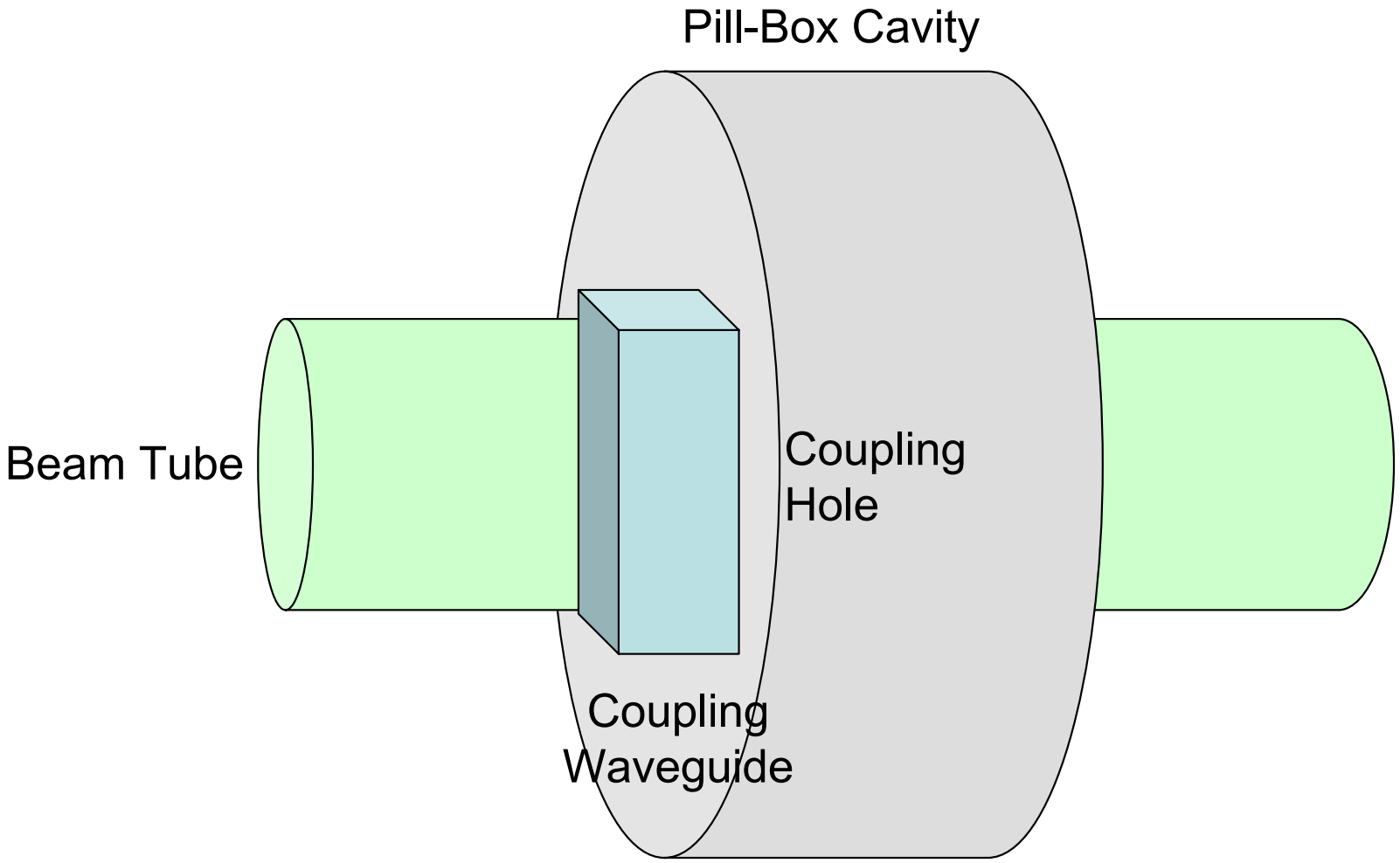
Design Illustration 2



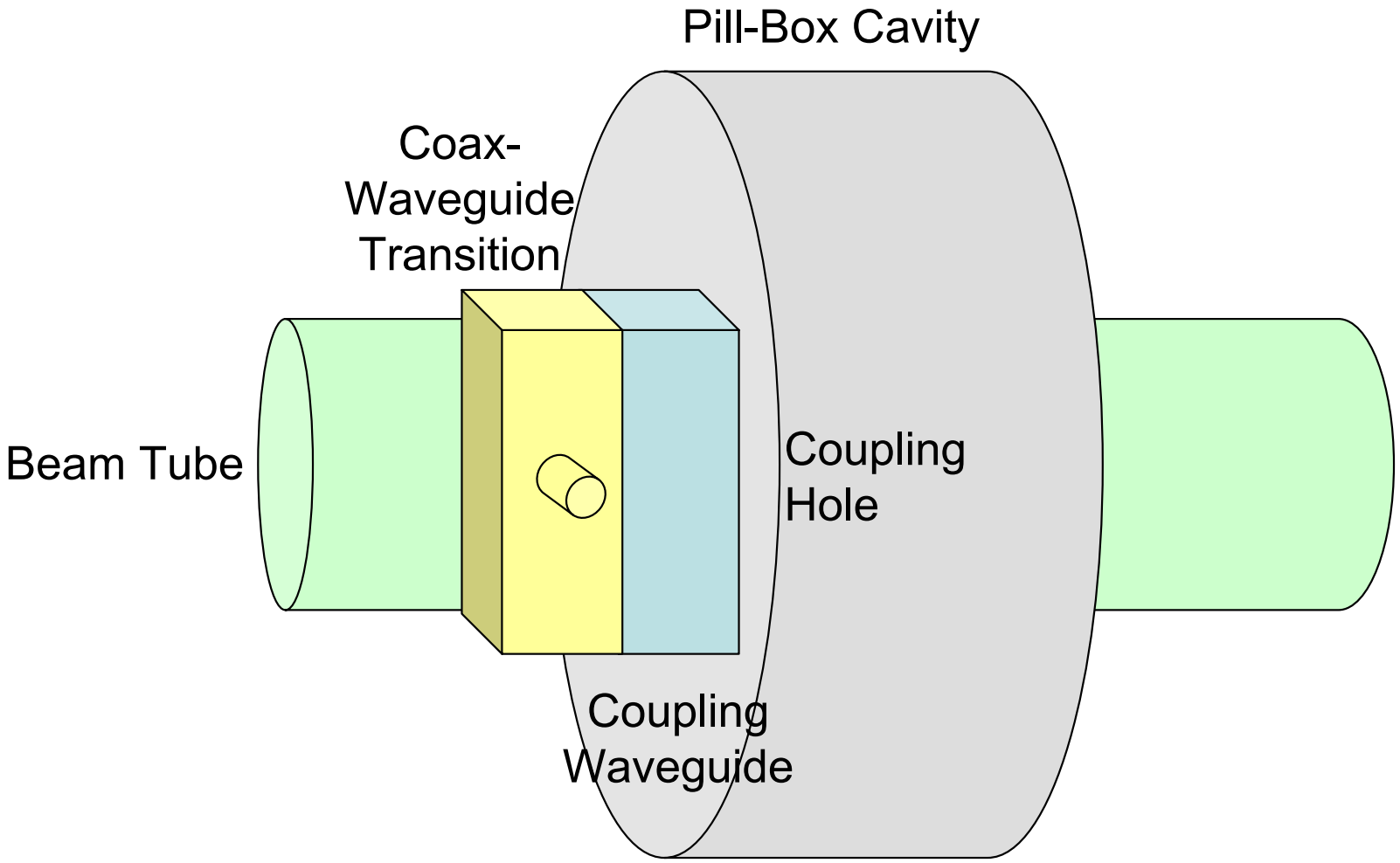
Design Illustration 3



Design Illustration 4

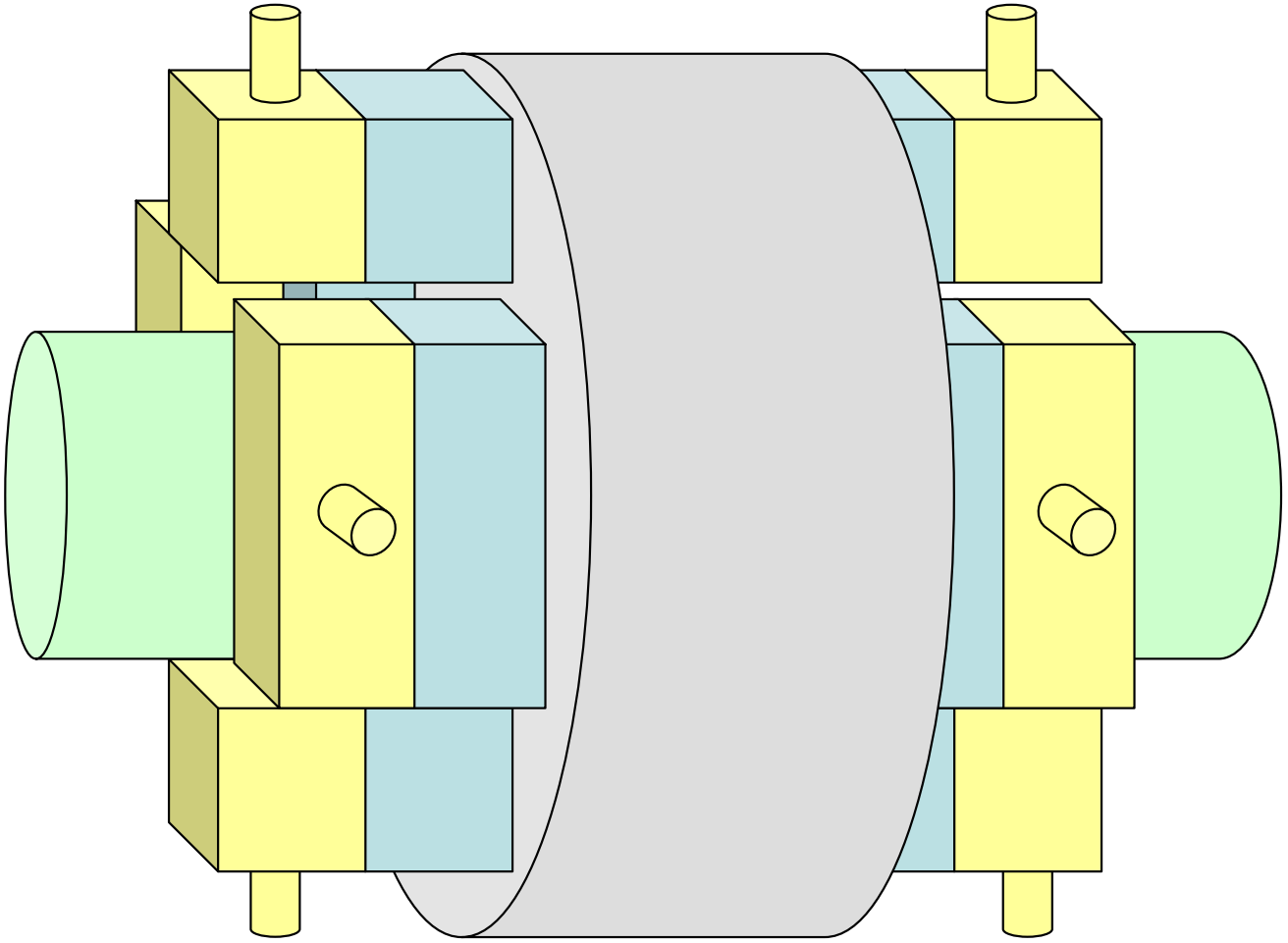


Design Illustration 5

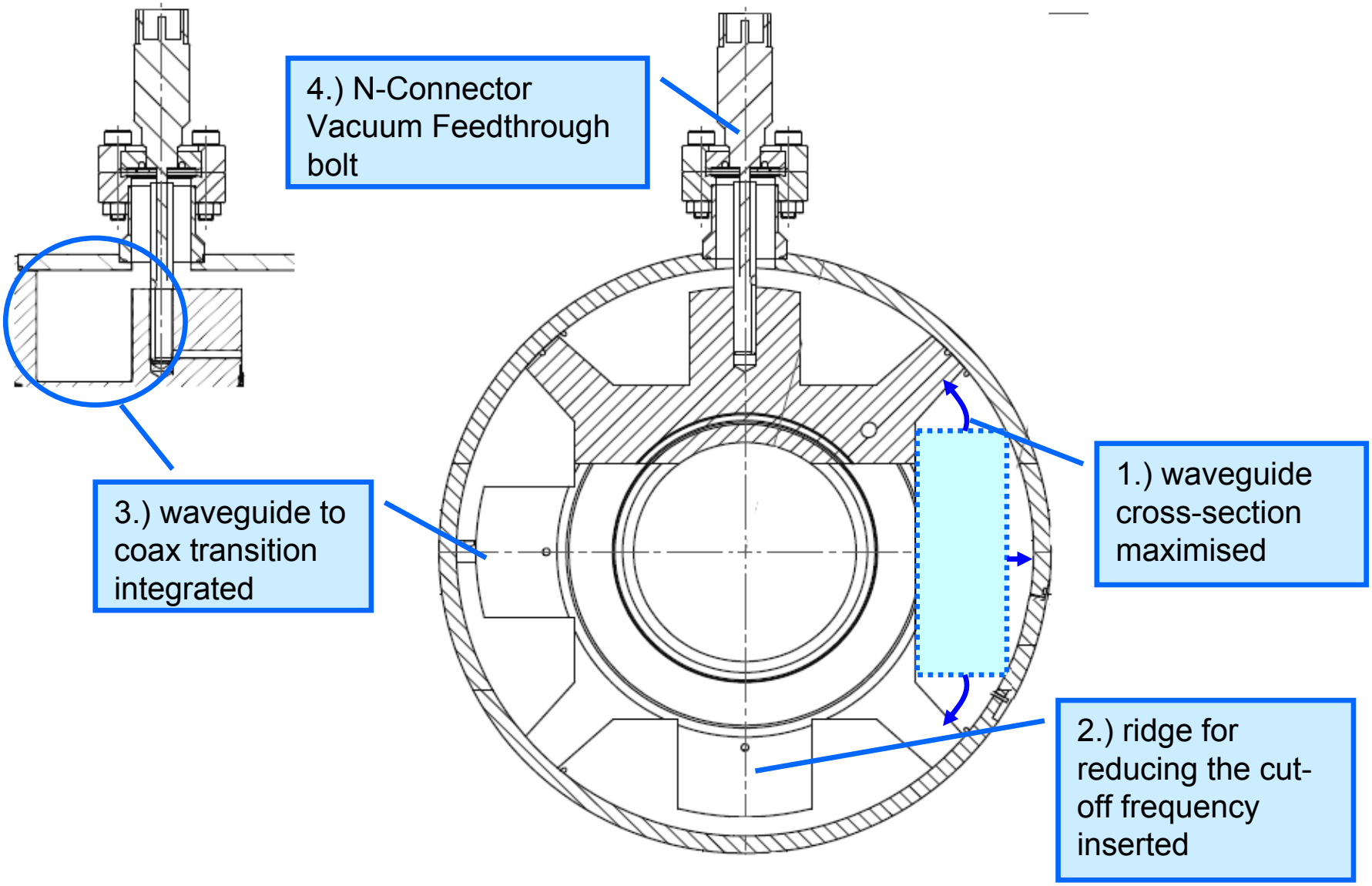


Design Illustration 6

Eightfold coupling for increasing the Bandwidth

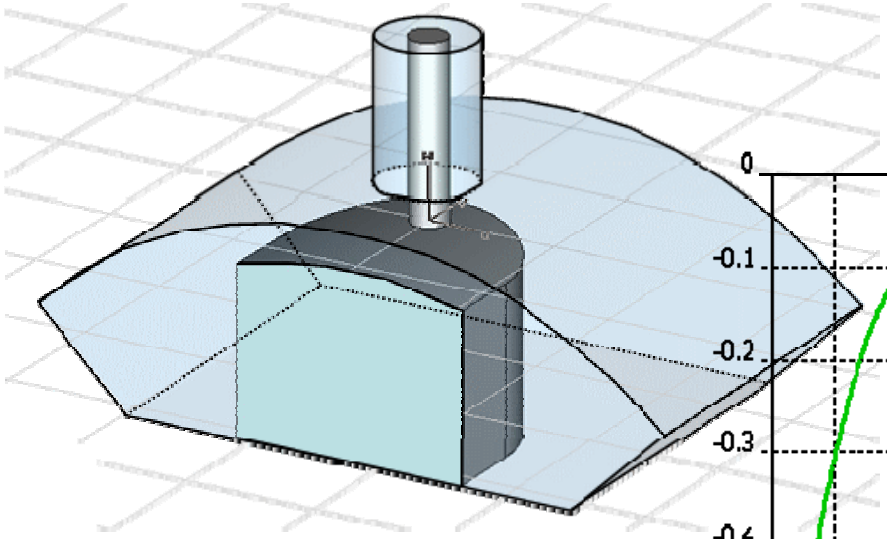


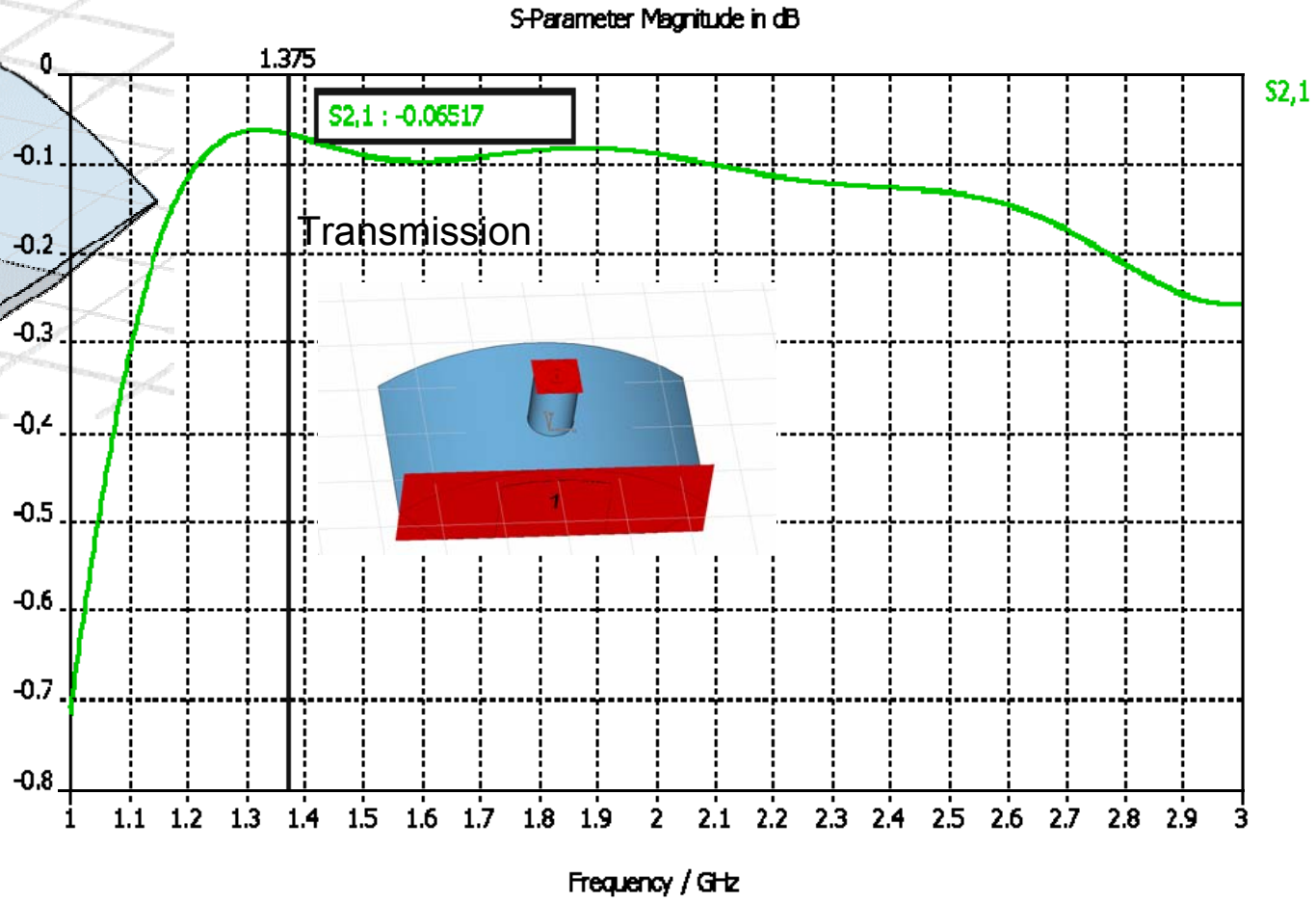
Last Trifles



Effect of the Ridge

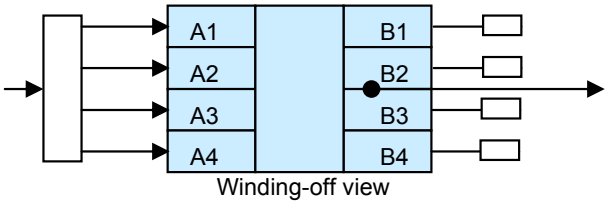
Simulated using CST-MWST





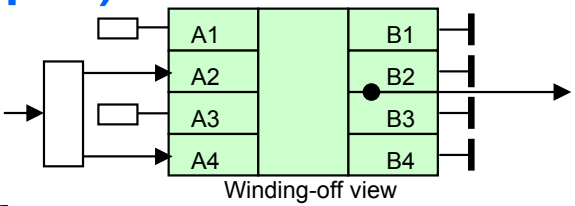
Wie groß wäre der f-Bereich ohne Ridge?

Single Cavity Frequency Response (Prototype)

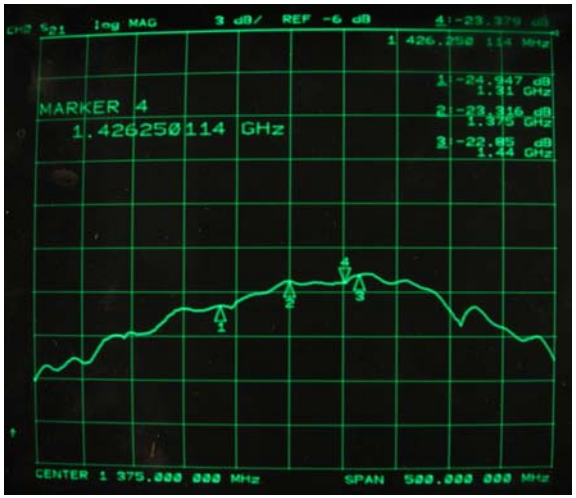


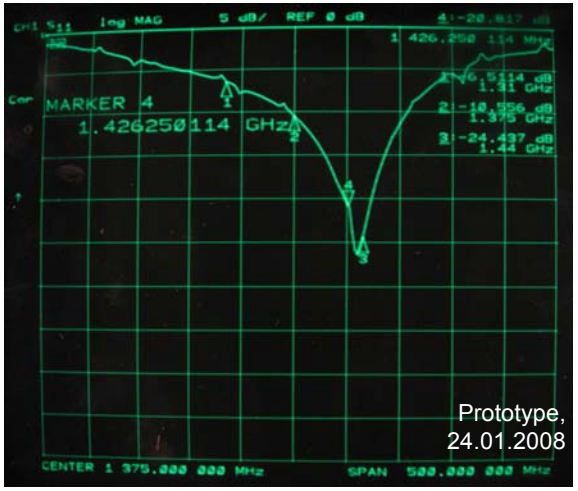
Winding-off view

s21 via antenna on beam axis

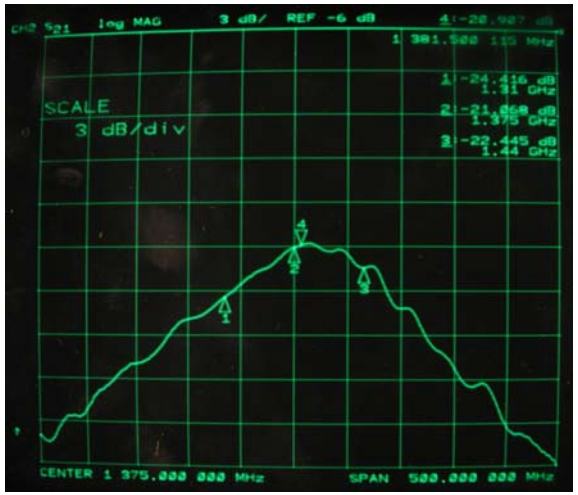


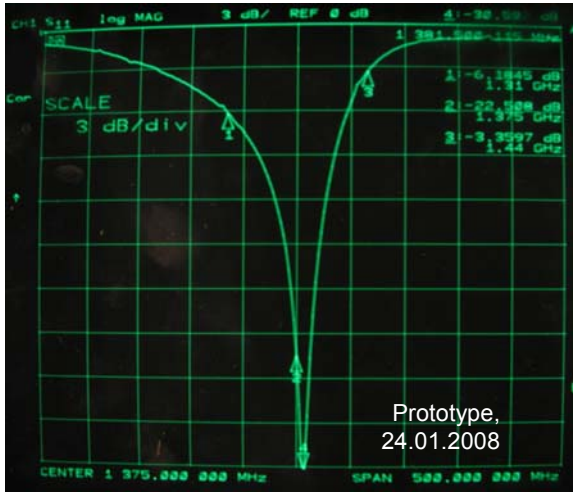
Winding-off view





Standard Wiring	Half BW Wiring
f_0=1435 MHz	f_0=1382 MHz
BW=320 MHz	BW=140 MHz
Q_L = 4.5	Q_L = 10
E_z/E_{zstd} = 1	E_z/E_{zstd} = 1.25
s_{11} = -26dB	s_{11} = -30dB

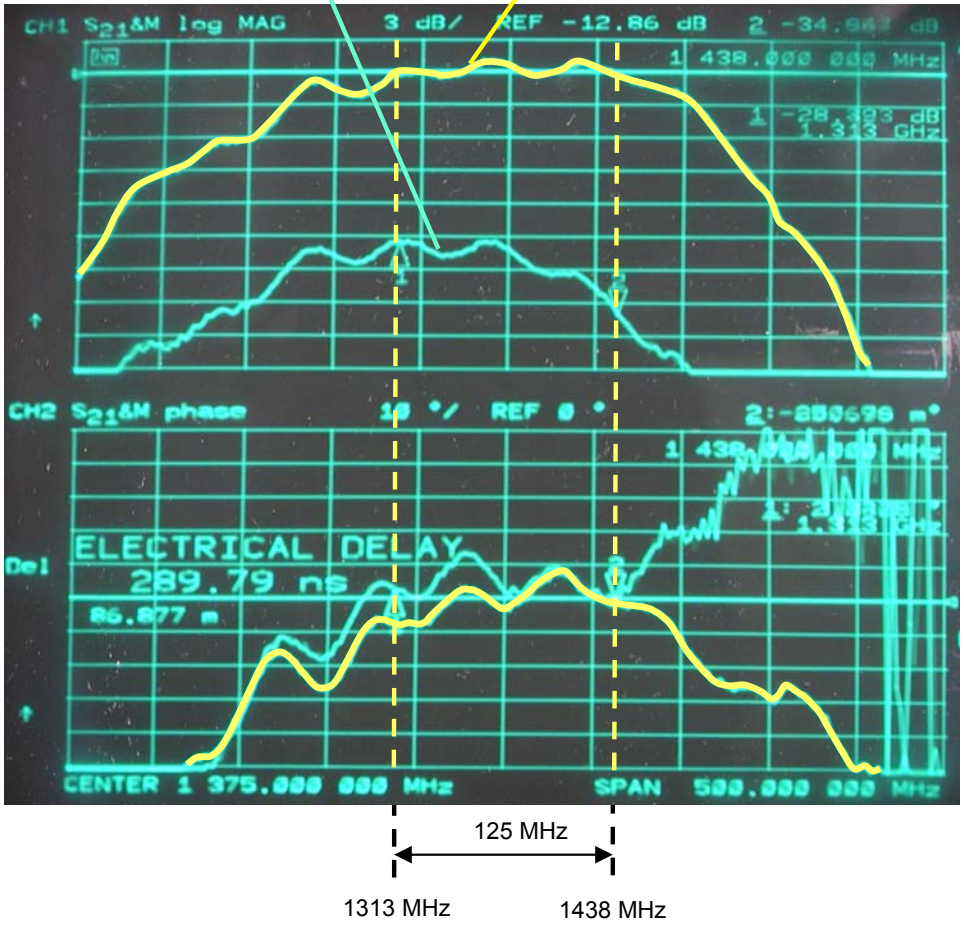




Over All Frequency Response

Eight Amp.-Cav. Frequency Response

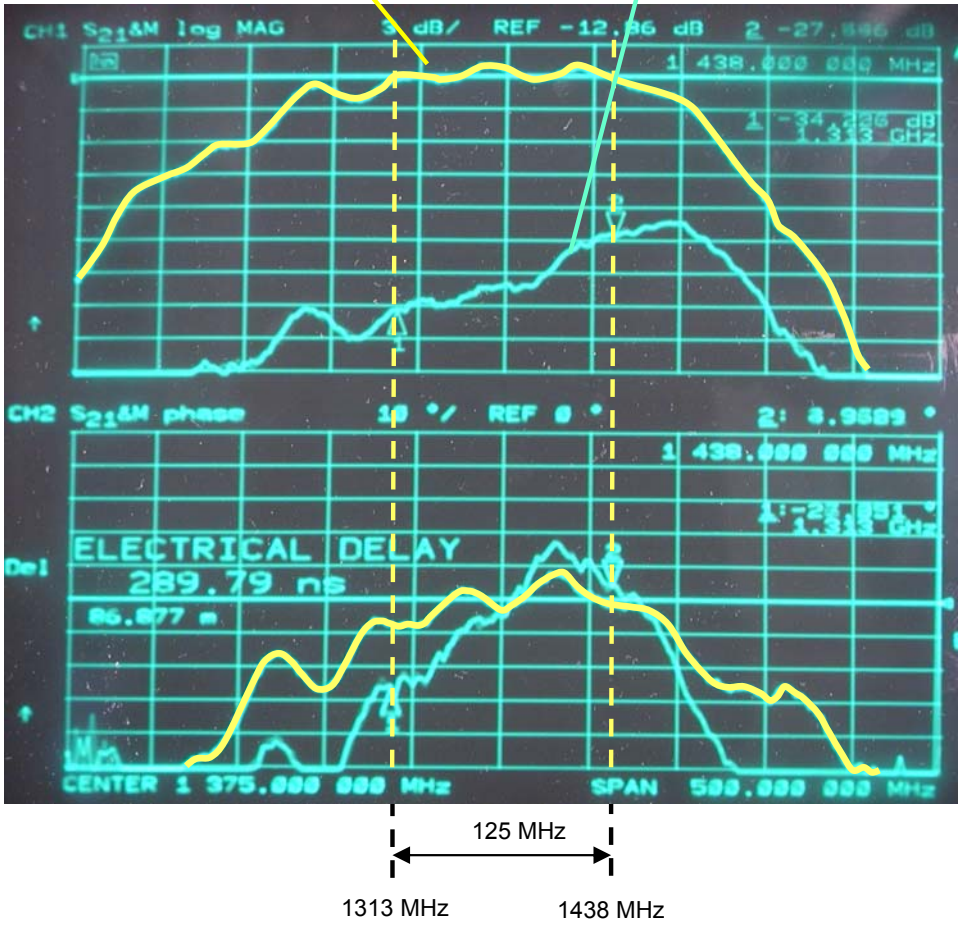
Cav4, Gap: 52mm



125 MHz

1313 MHz 1438 MHz

Cav7, Gap: 68mm



125 MHz

1313 MHz 1438 MHz