HELMHOLTZ GEMEINSCHAFT

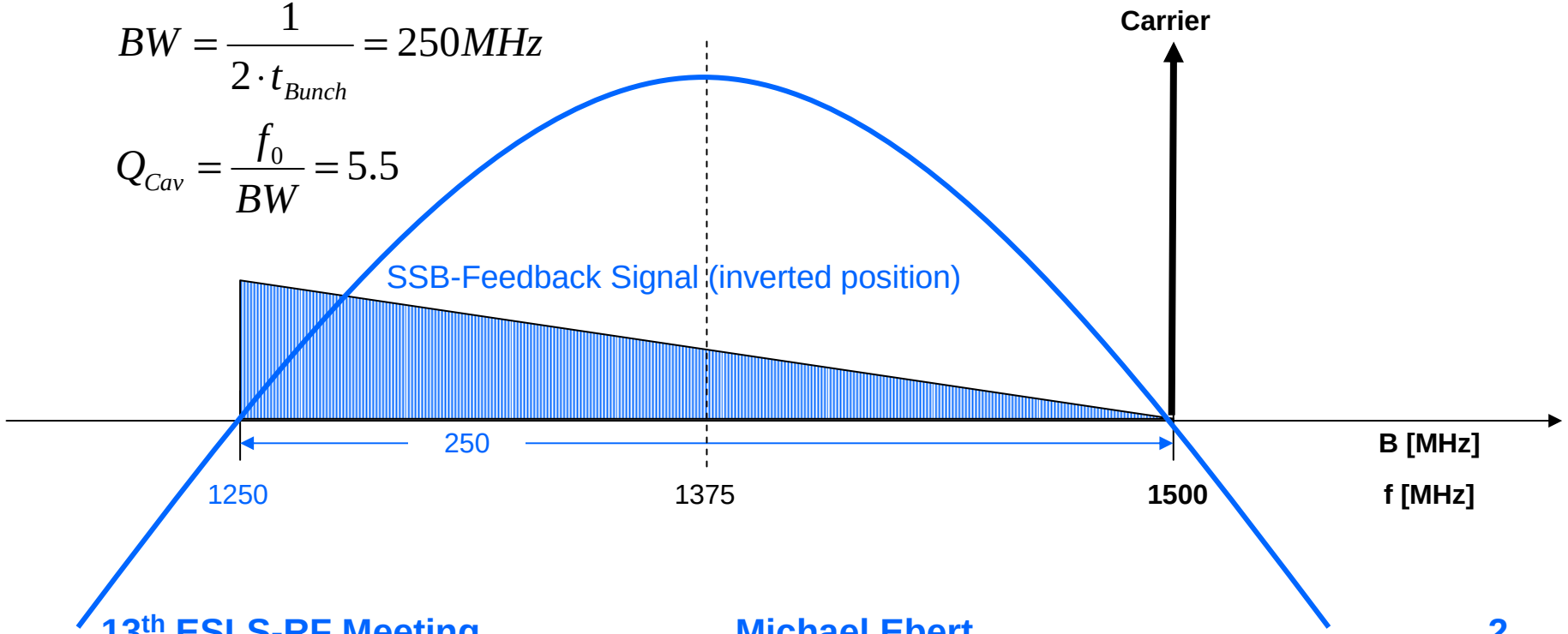
DESY

PETRA-III
Longitudinal Feedback RF

Chosen Carrier Frequency and Required Bandwidth

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

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



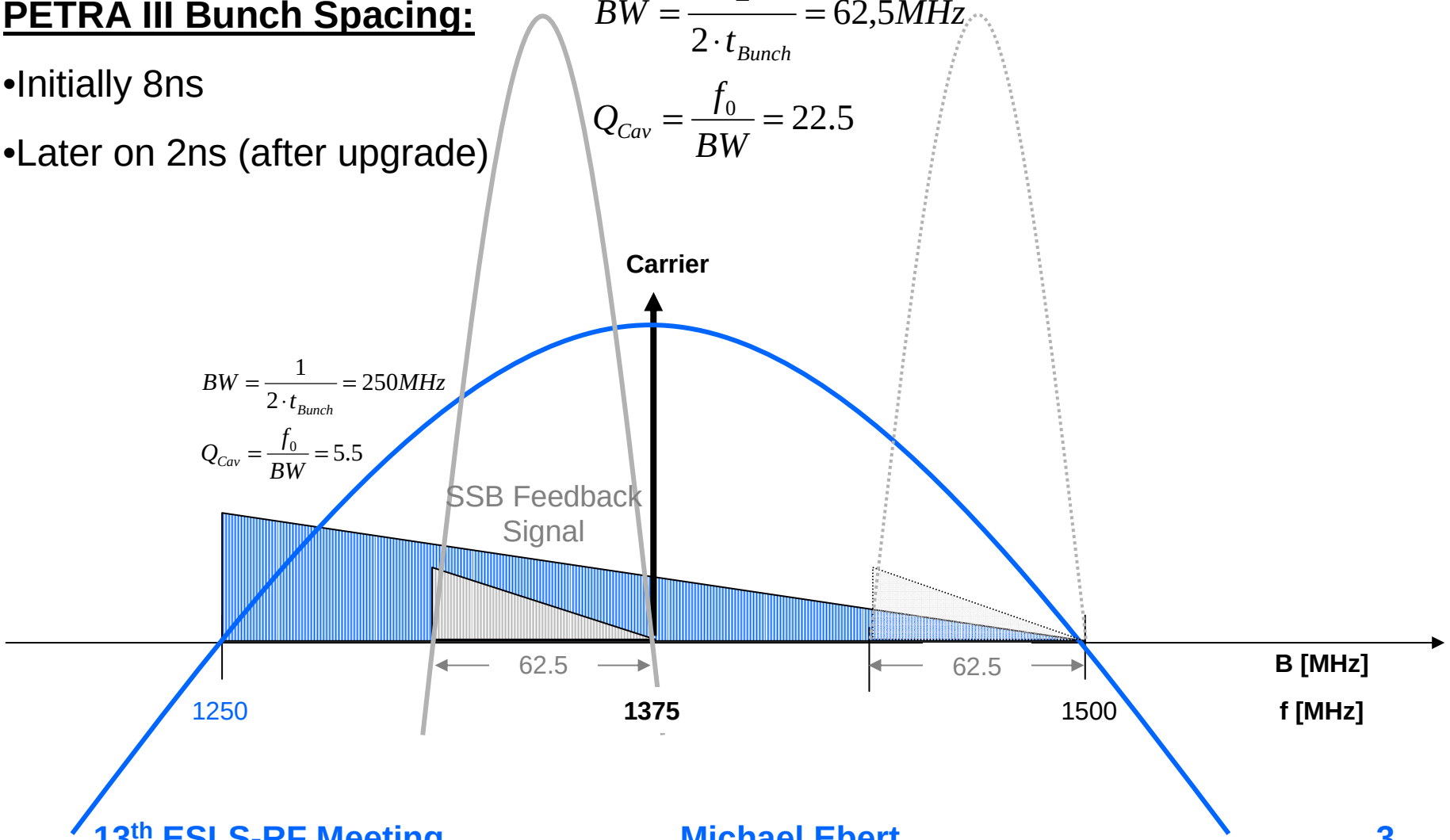
Required Feedback Bandwidth for 8ns Bunch Spacing

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

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

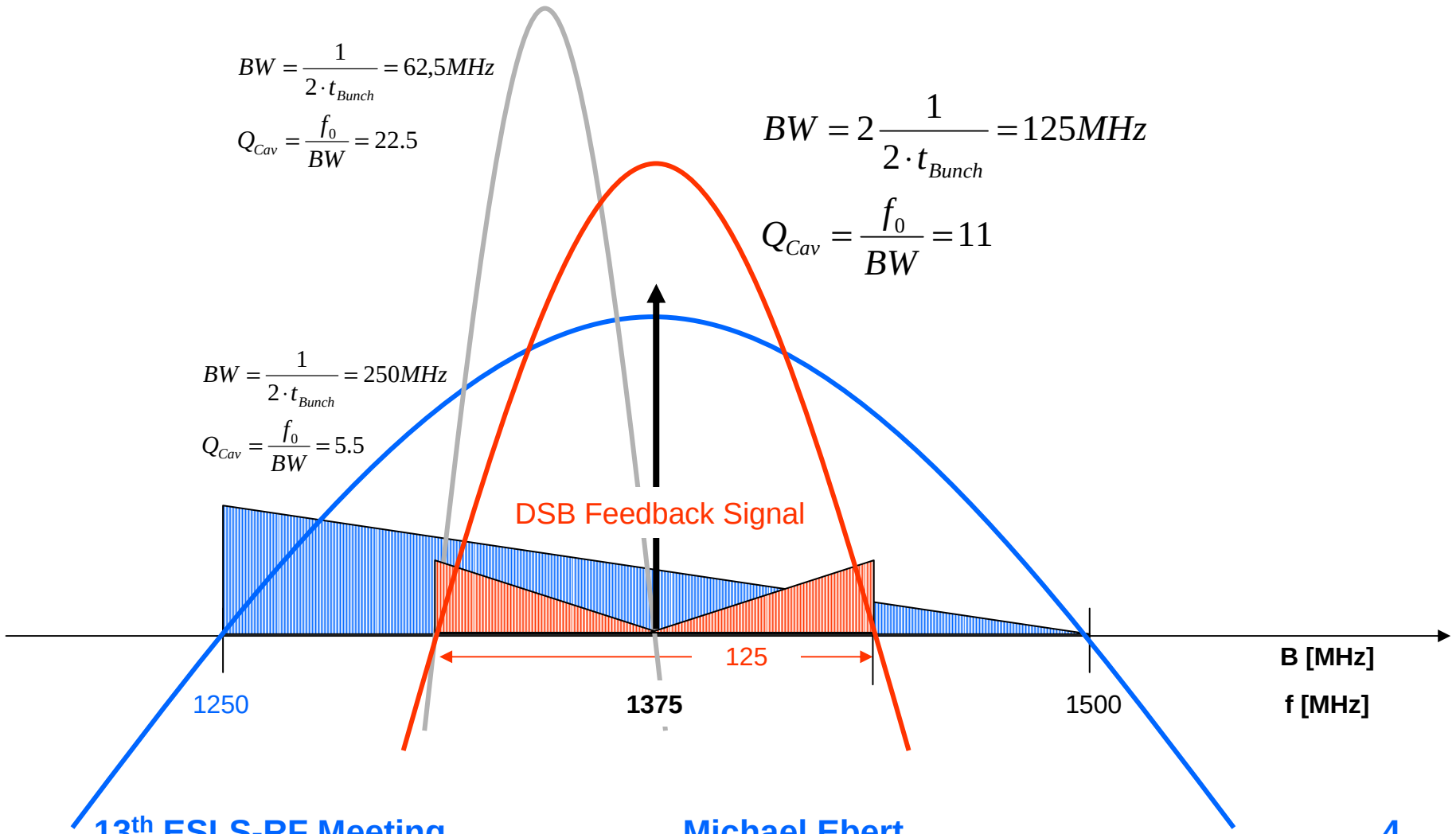
$$Q_{Cav} = \frac{f_0}{BW} = 22.5$$

$$BW = 2\frac{1}{2 \cdot t_{Bunch}} = 125MHz$$

$$Q_{Cav} = \frac{f_0}{BW} = 11$$

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

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

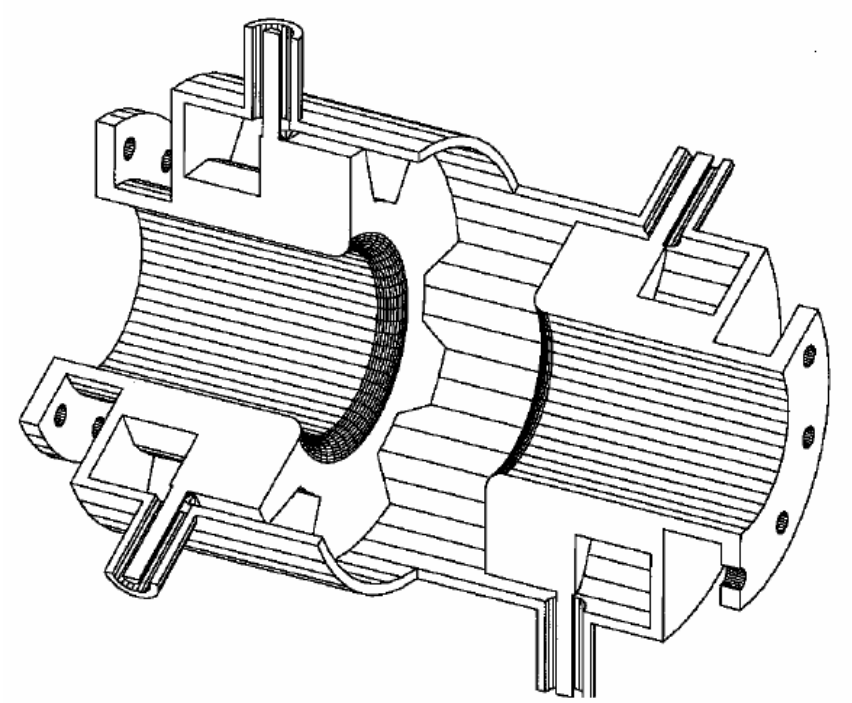


Chosen Cavity Design

Original DAΦNE long. kicker-cavity.

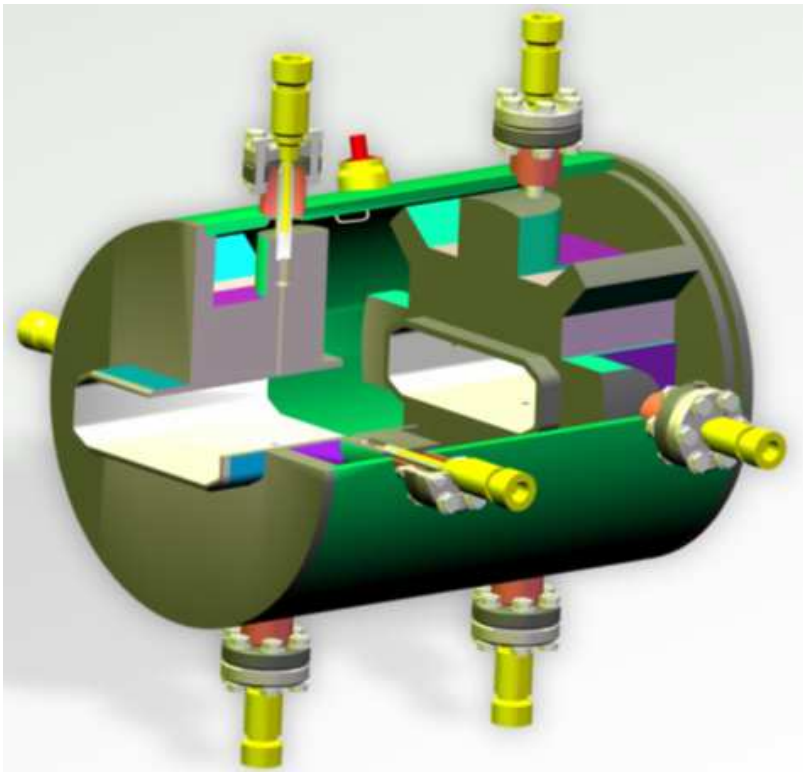
Developed 1995 at INFN, Frascati

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



Modified DAΦNE long. kicker-cavity for ELETTRA/SLS

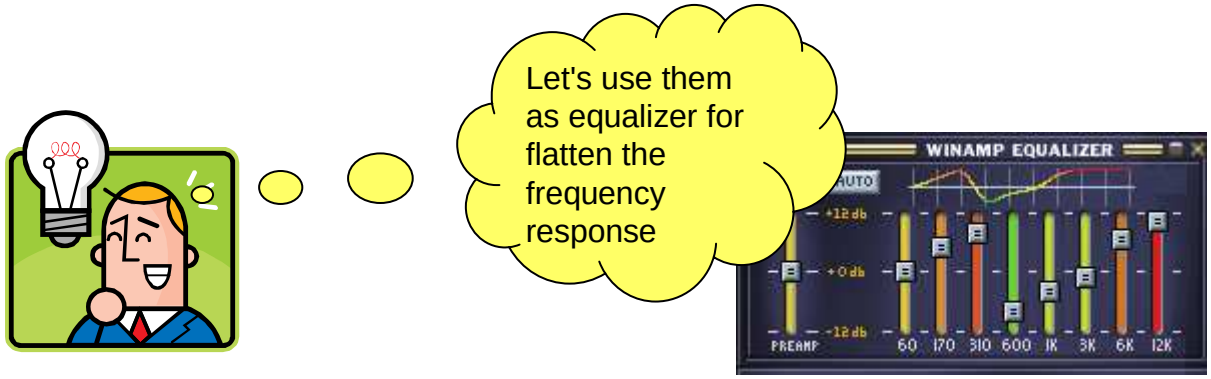
Micha Dehler, PSI, Villingen,CH



Required Feedback Voltage

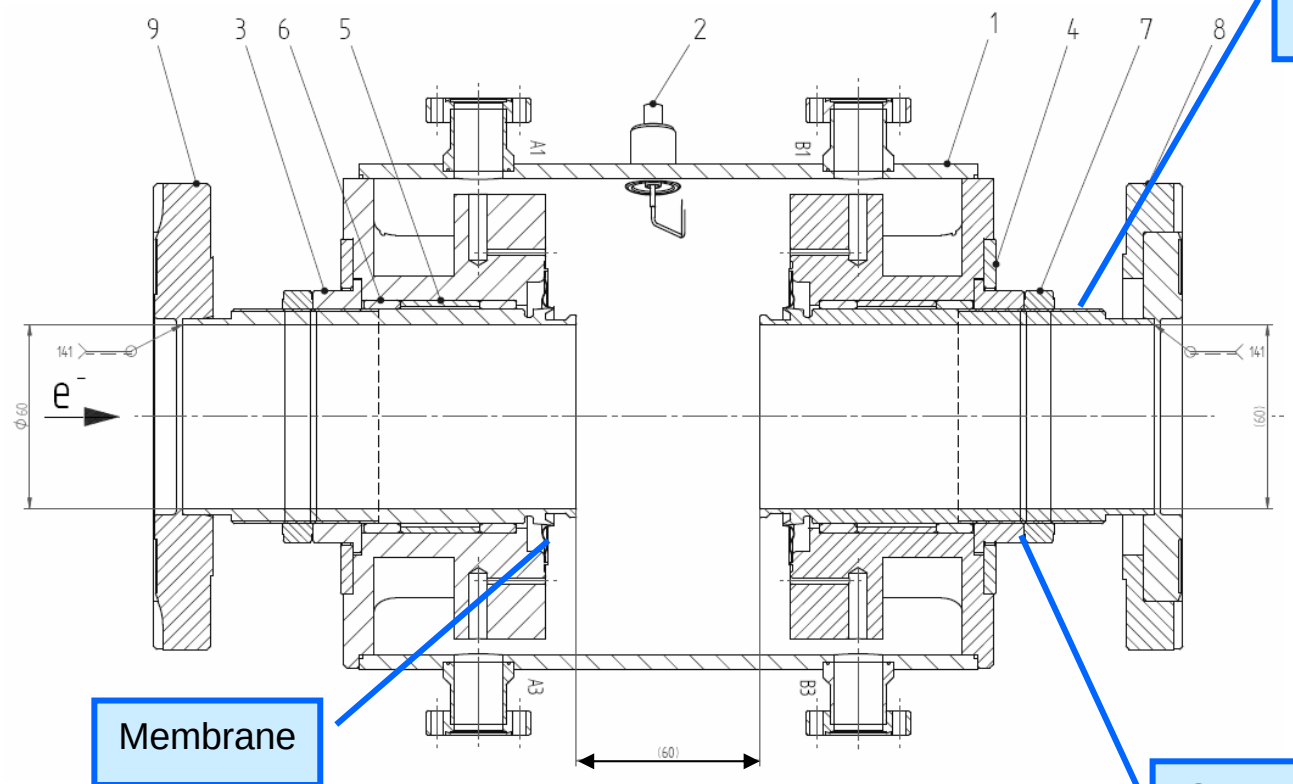
- ≈14 kV feedback voltage required
- DAΦNE type cavity:
  - 0.9kV at BW=250MHz (R_S=800Ω), P_{RF}=500W,
  - 1.8kV at BW=125MHz (R_S=1600Ω), DSB, P_{RF}=2*250W

⇨ 8 DAΦNE type cavities required



The Umpteenth Redesign of the DAΦNE Cavity

The tuneable one



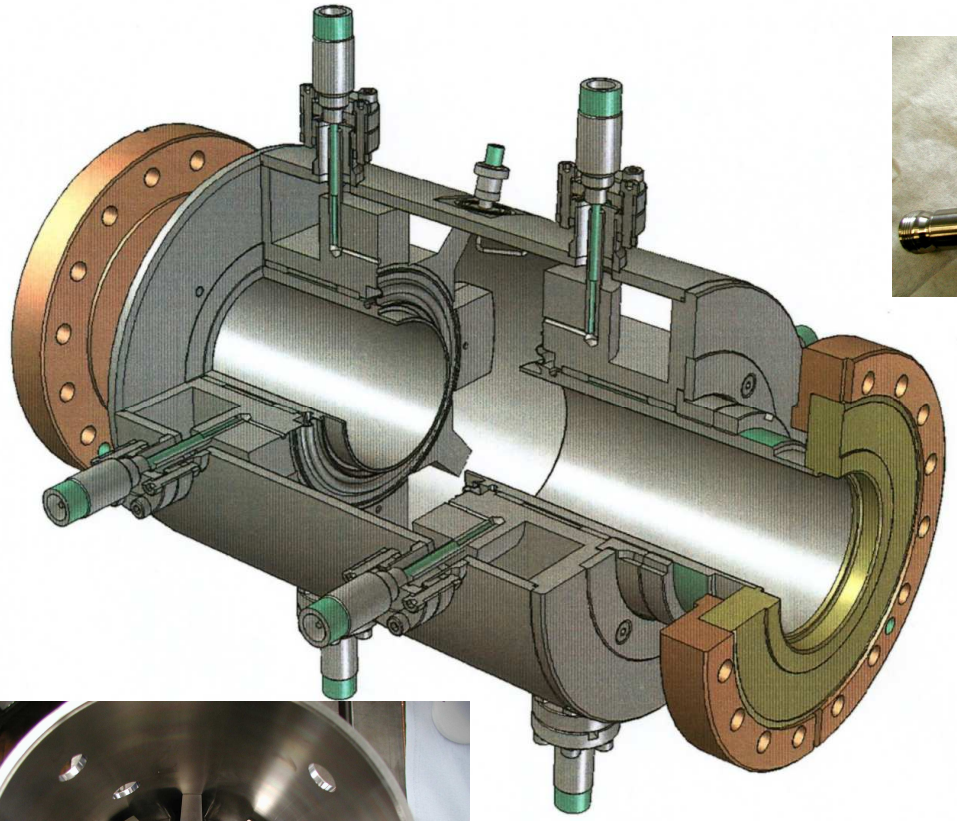
variable gap width 52…68mm

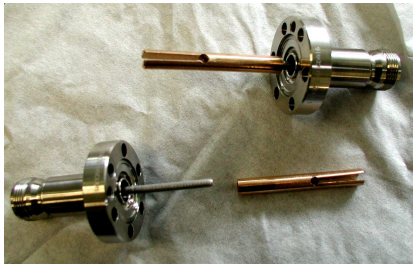
Tuning range about 100 MHz

Modifications with respect to the SLS-Design

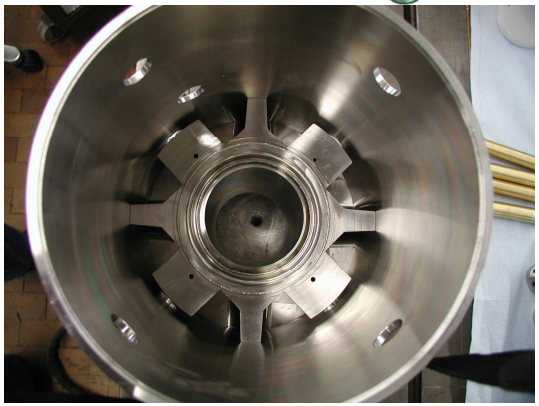
1. Beam tube from 86*26mm² to D=60mm
2. Welded joints changed to brazed joints
3. Tuneable centre frequency via movable nose cones

Sectional View



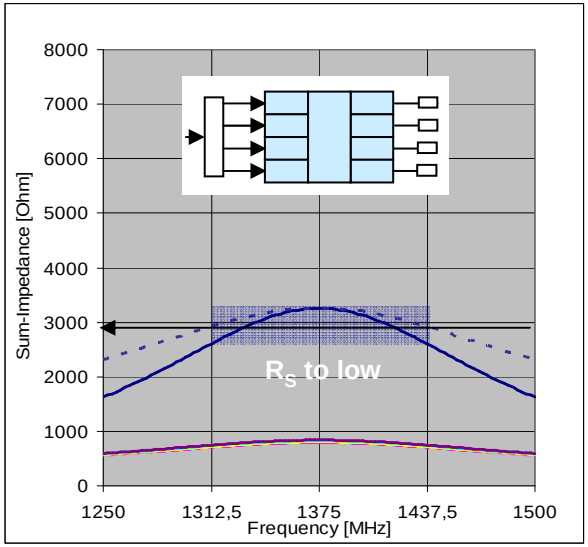


…and photos from production



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

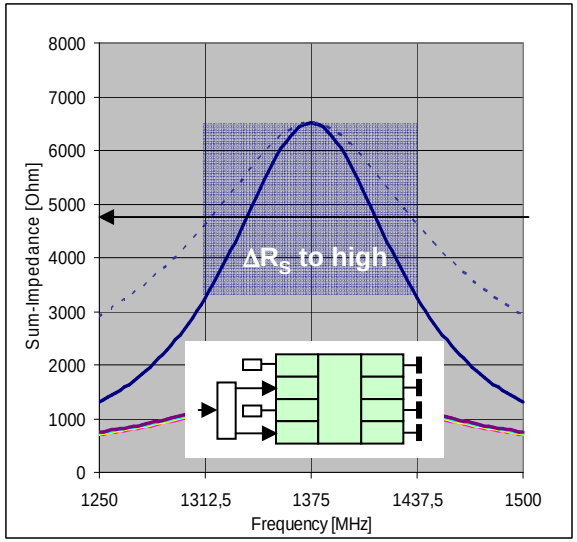
2.) Half BW Wiring

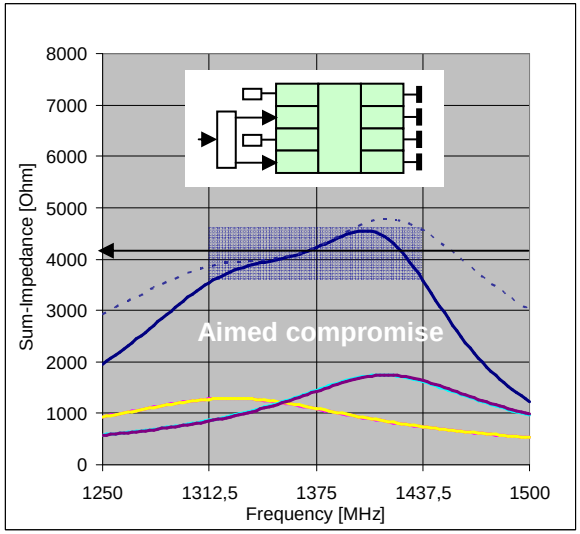
f_C: 1375 MHz

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

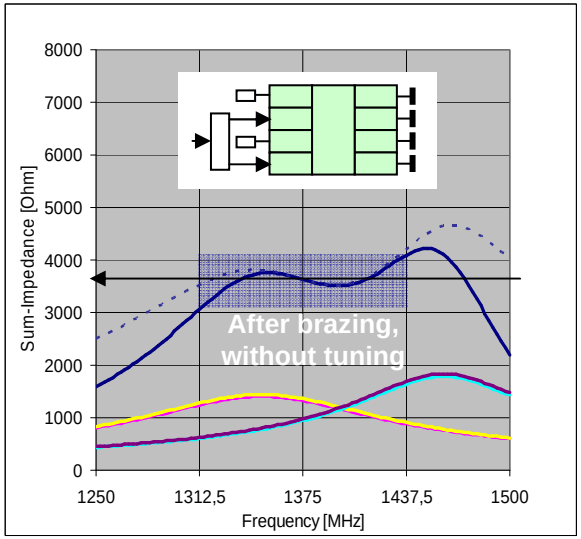
4.) Half BW Wiring

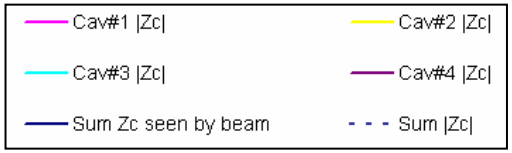
f_C: 1350-1460 MHz

Q_L: 9.5 – 13.7

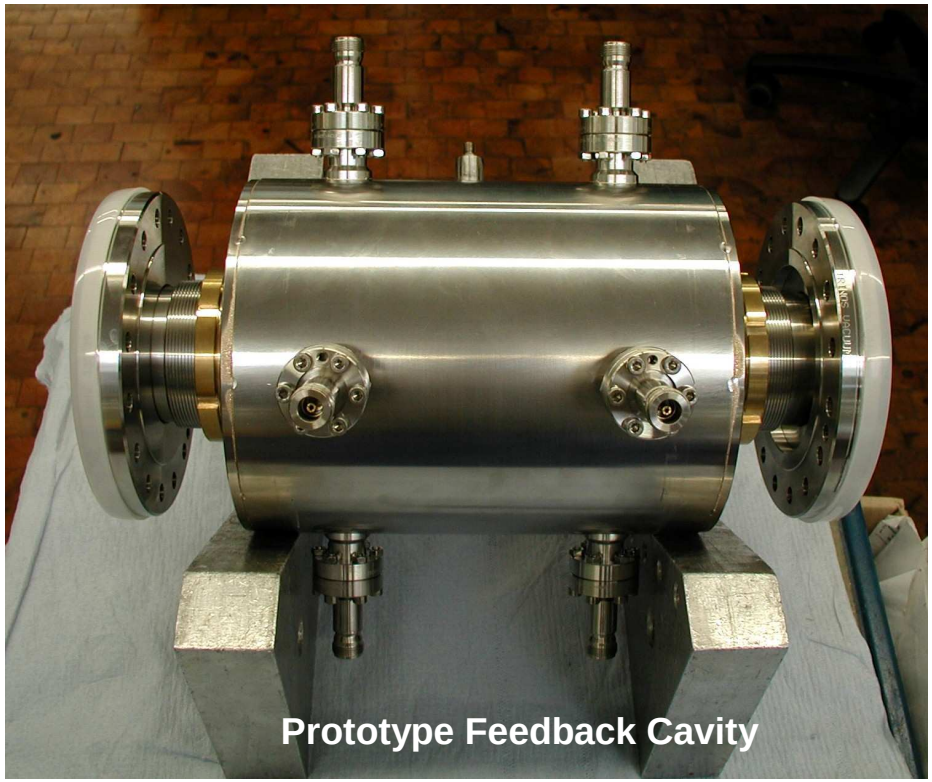
ΣR_{Smax}: 4420 Ω

ΣR_{Smin}: 3150 Ω

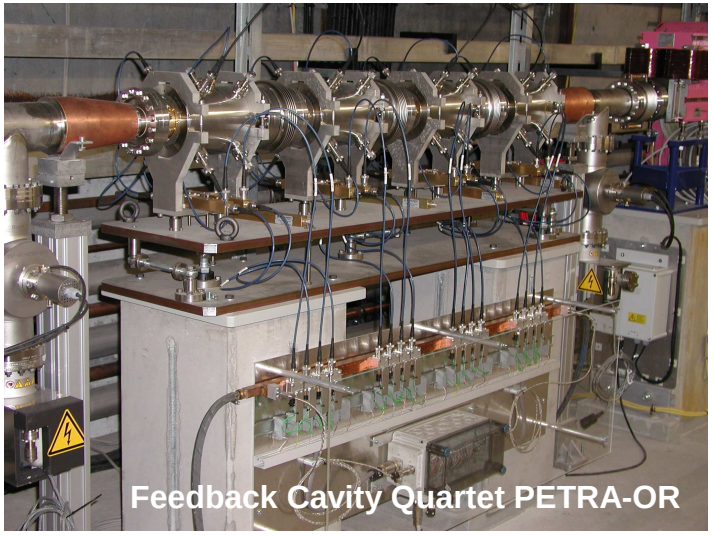




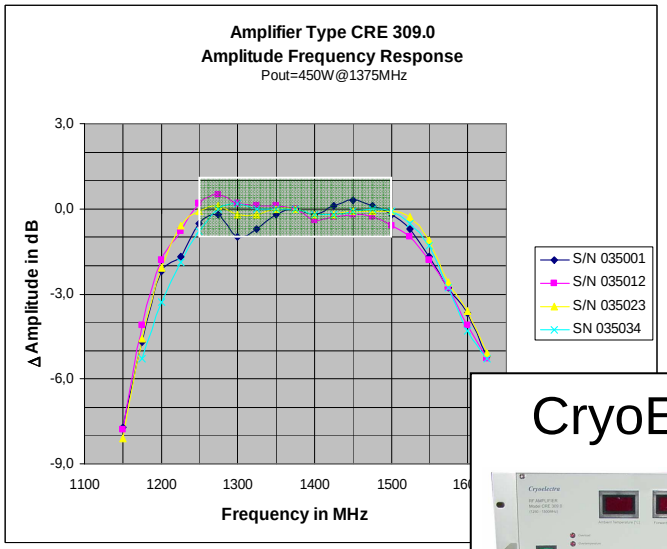
Cavity Installation in PETRA Tunnel

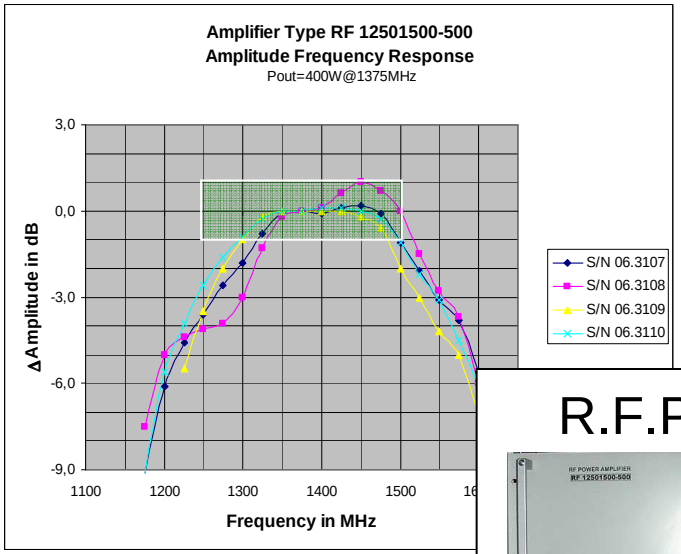

Prototype Feedback Cavity


Feedback Cavity Quartet PETRA-OL

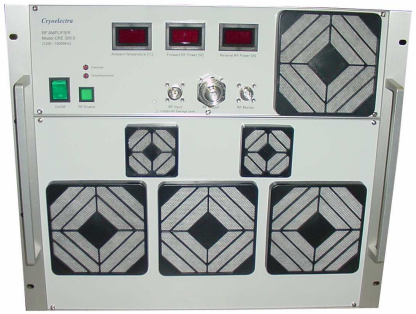

Feedback Cavity Quartet PETRA-OR

PowerAmp Frequency Response

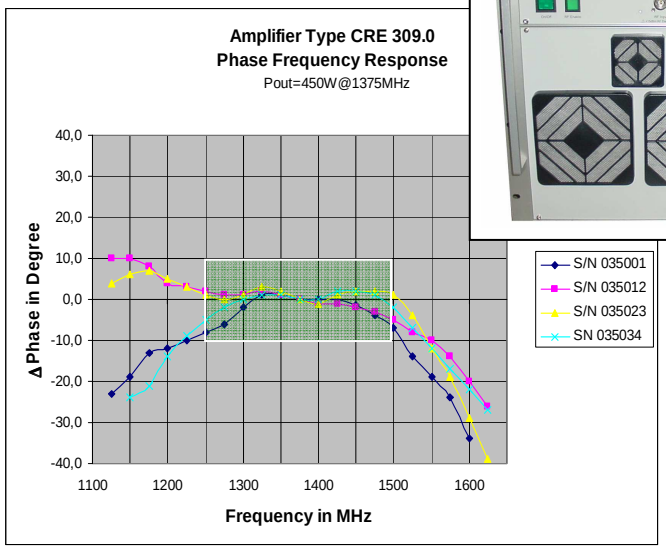


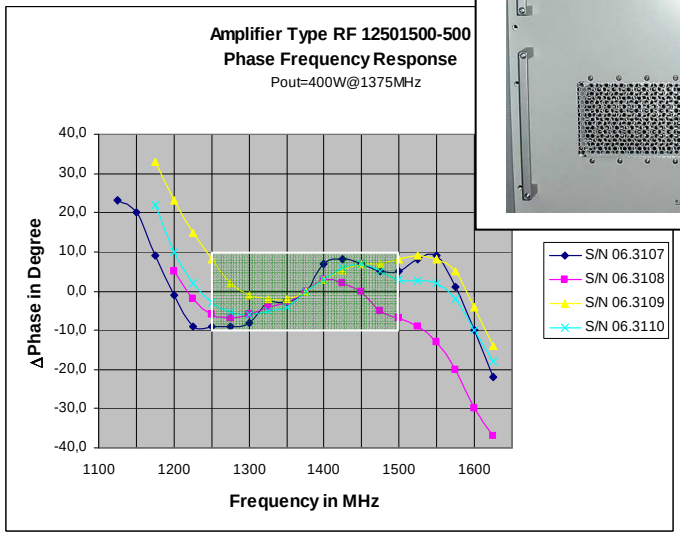


CryoElectra ☺

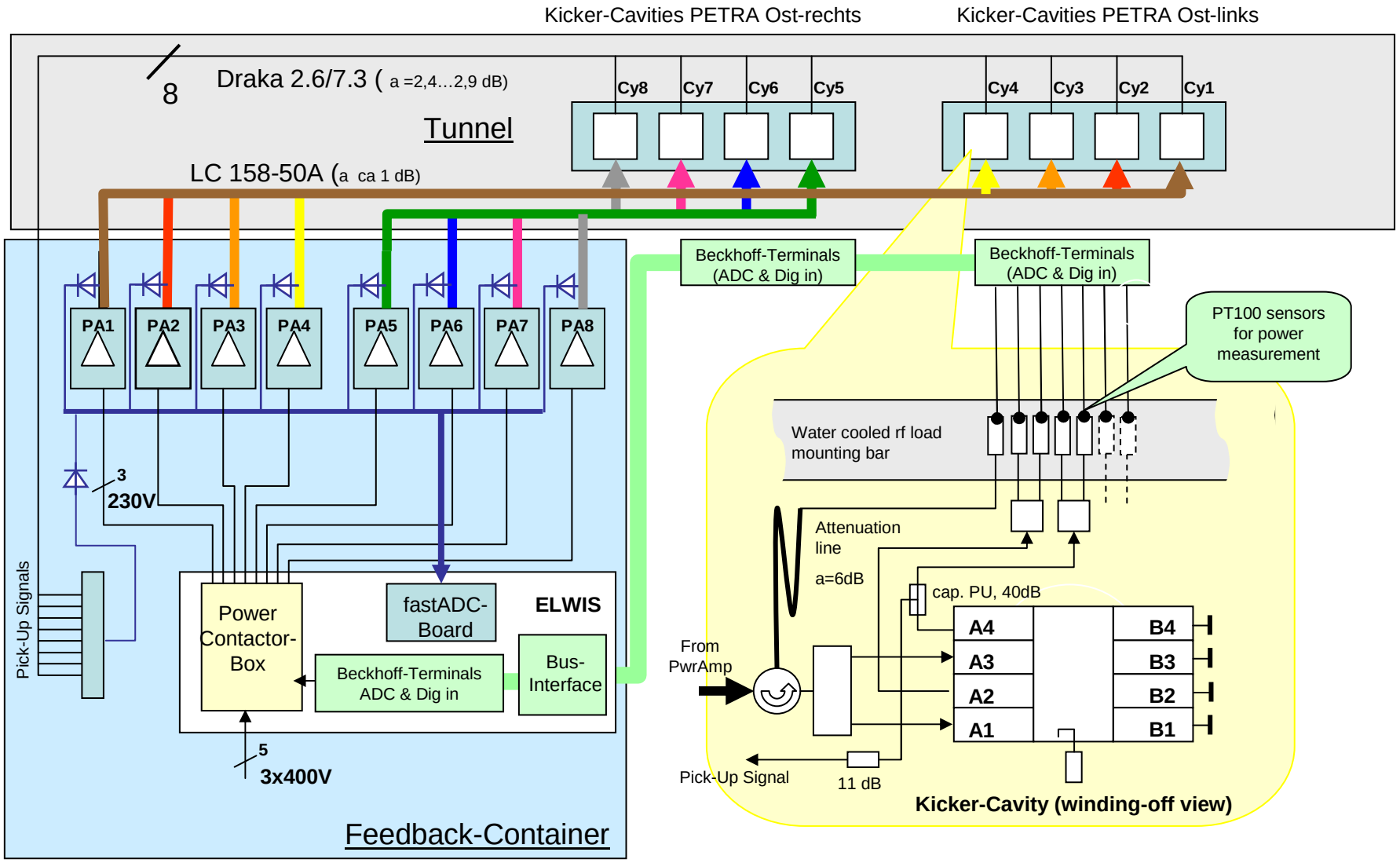


R.F.P.A. ☹





Cavity Supply and Control



Current Status

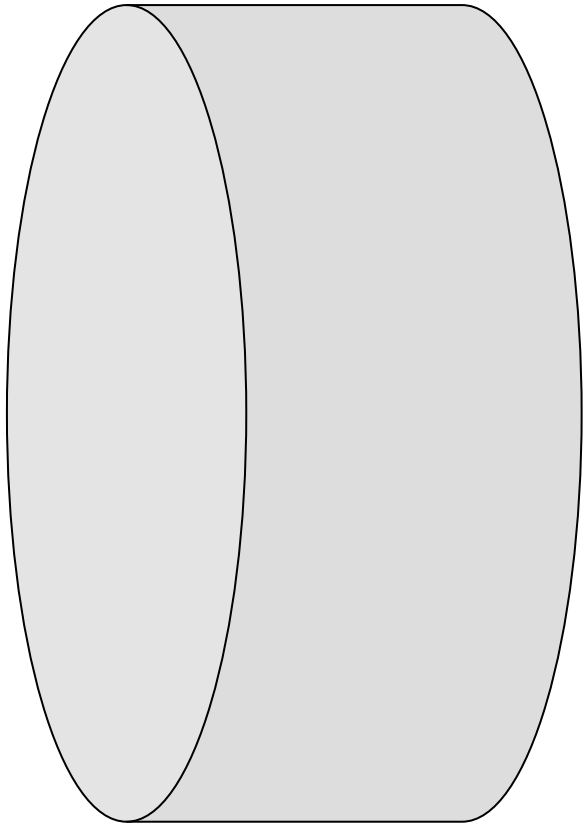
- ✓ Signal path delays with respect to the bunch transition adjusted.
- ✓ Over-all frequency response adjusted (is properly within specifications)
- ✓ Control & monitor system is working

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

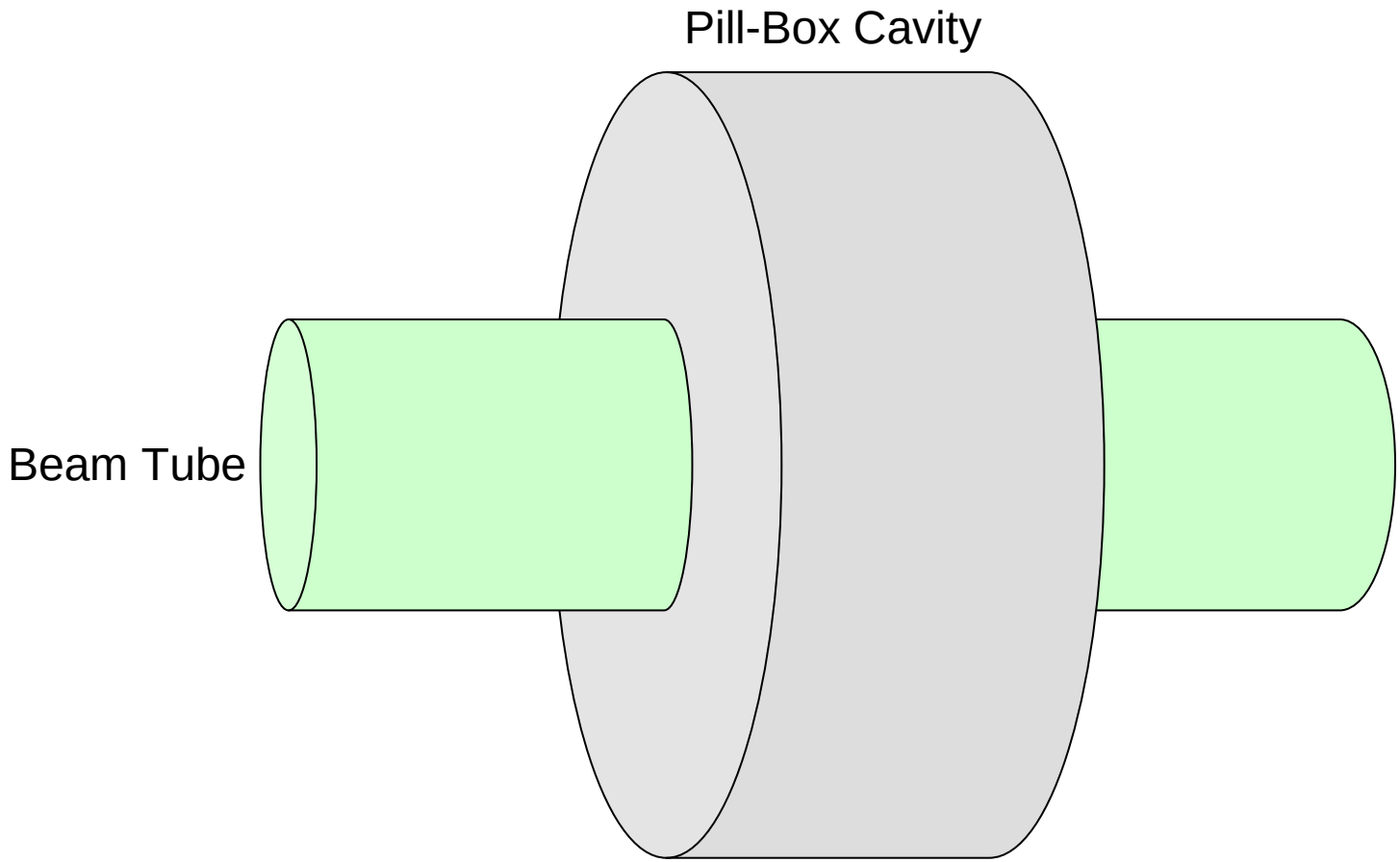
APPENDIX

Design Illustration 1

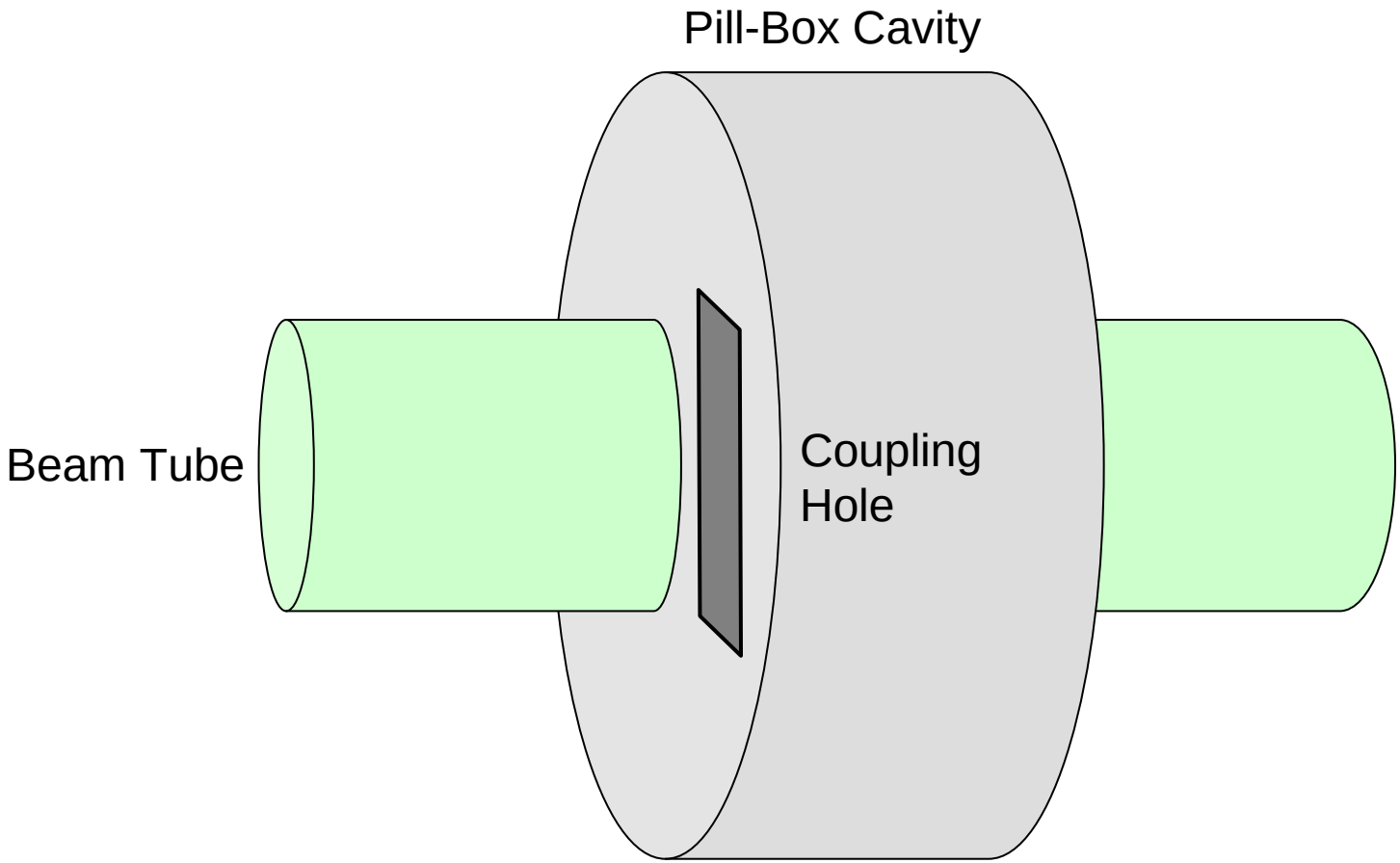
Pill-Box Cavity



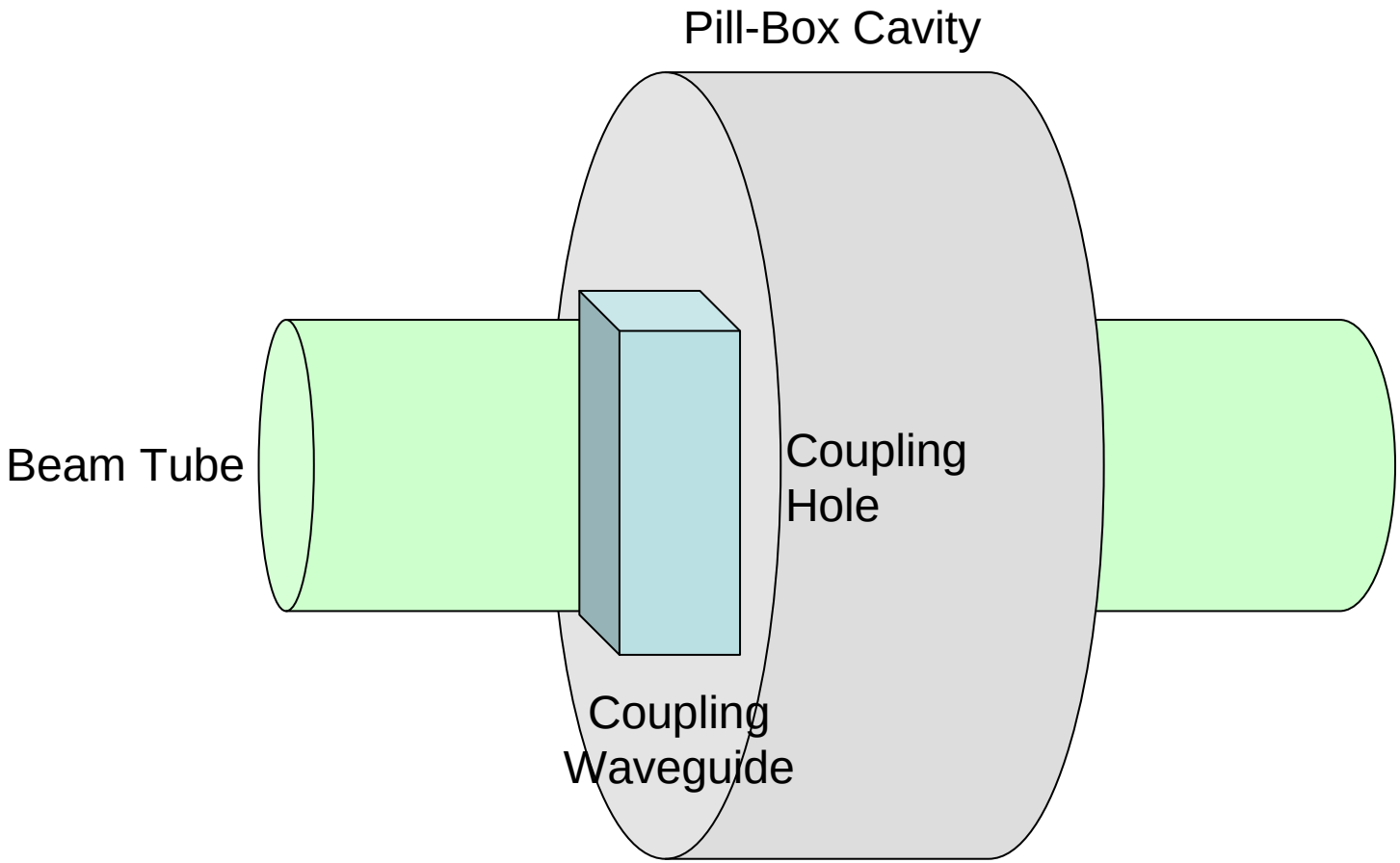
Design Illustration 2



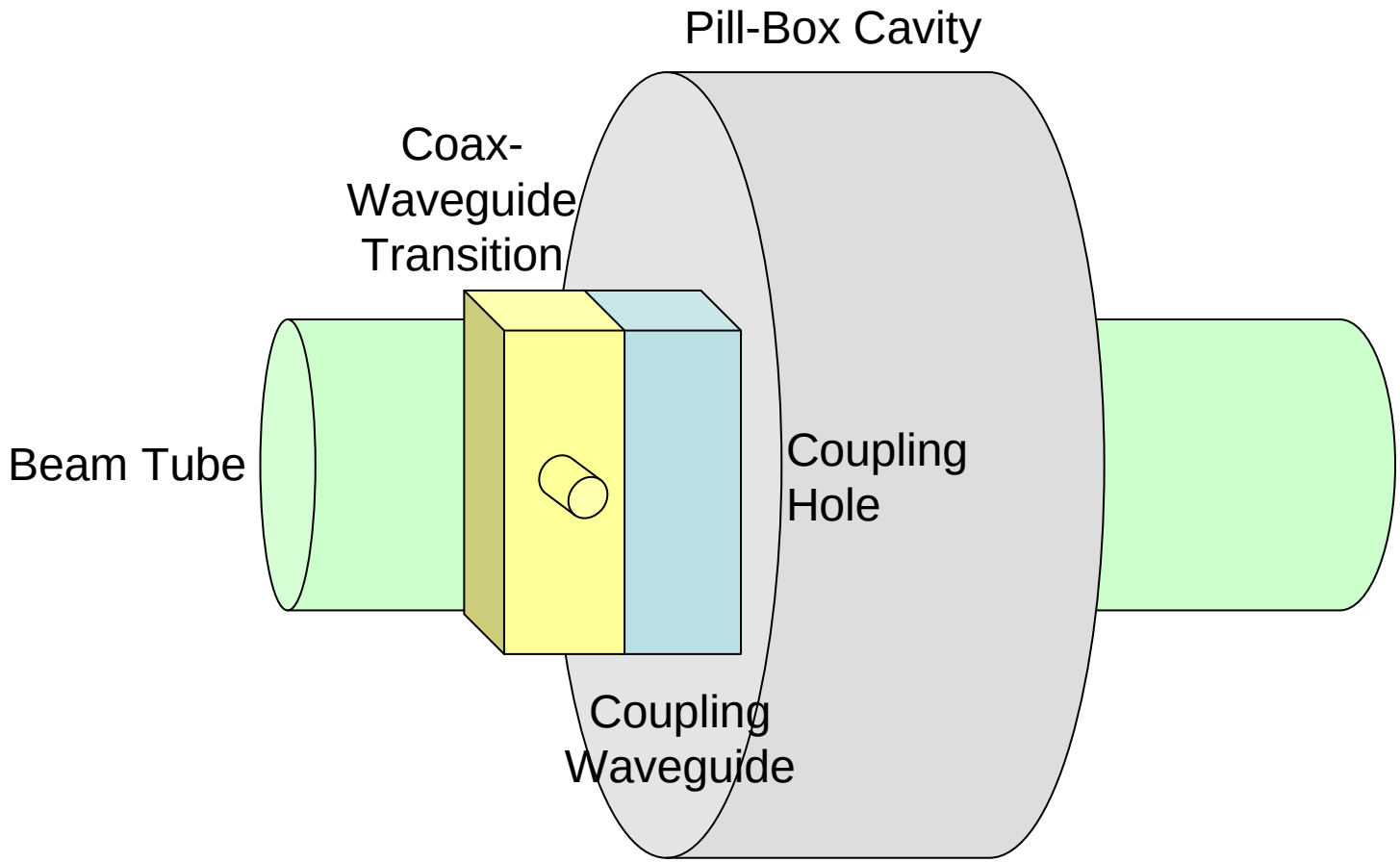
Design Illustration 3



Design Illustration 4

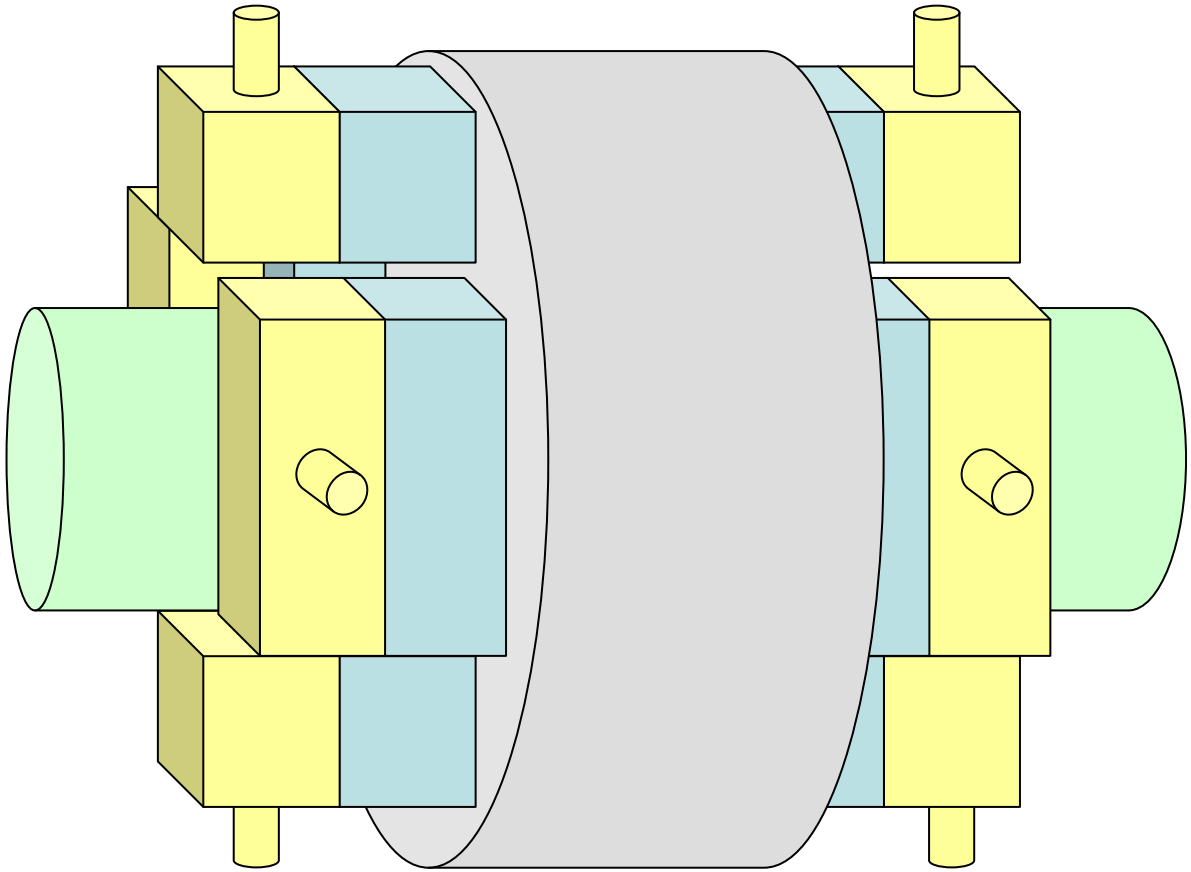


Design Illustration 5

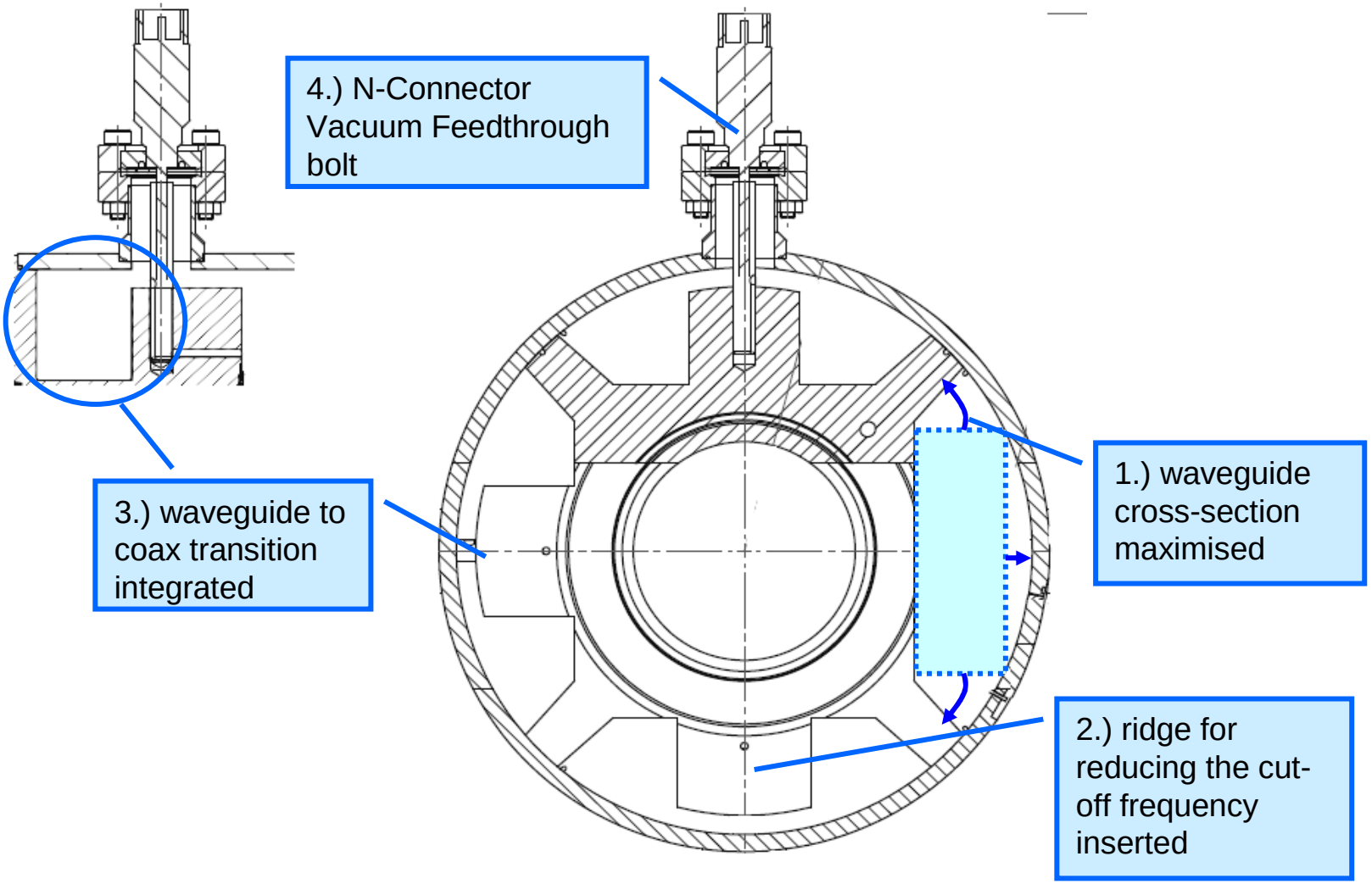


Design Illustration 6

Eightfold coupling for increasing the Bandwidth

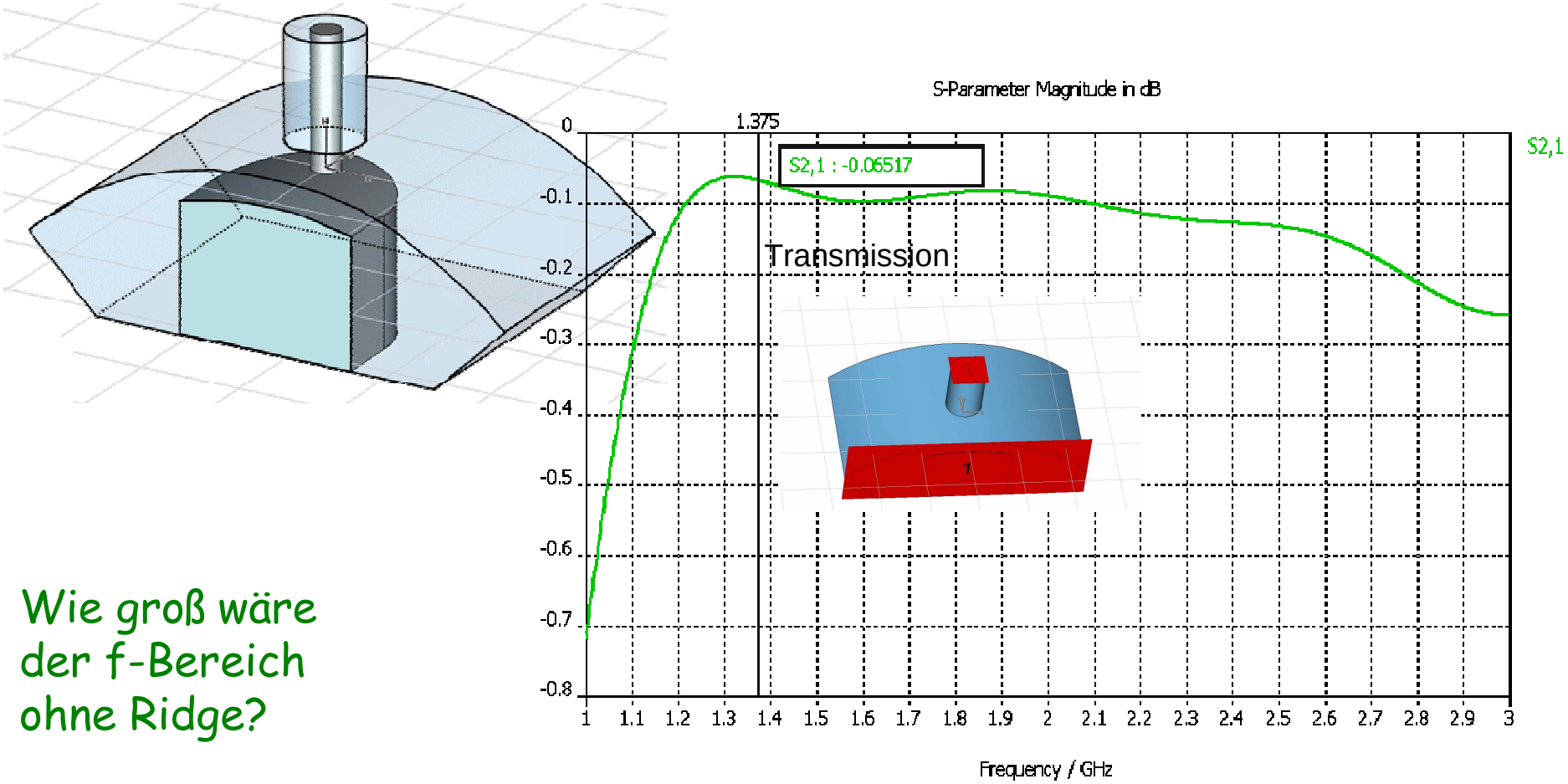


Last Trifles



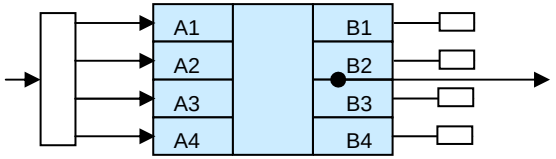
Effect of the Ridge

Simulated using CST-MWST



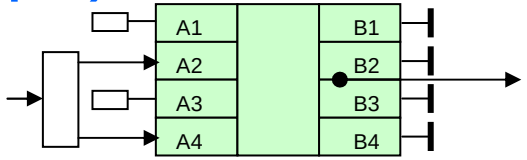
Wie groß wäre der f-Bereich ohne Ridge?

Single Cavity Frequency Response (Prototype)

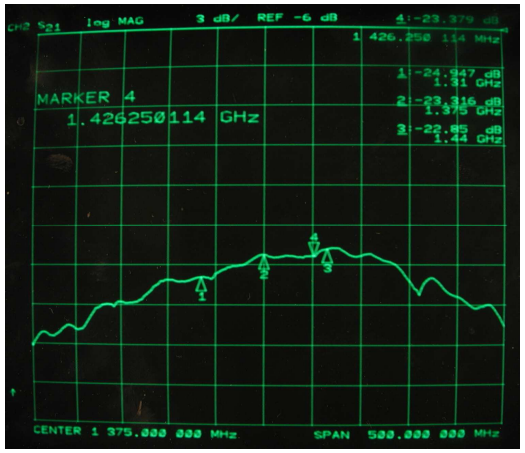


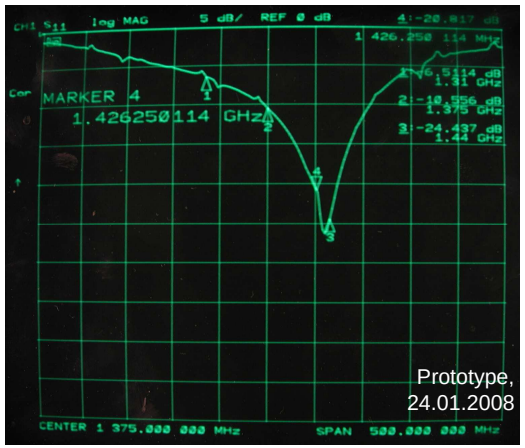
Winding-off view

s21 via antenna on beam axis

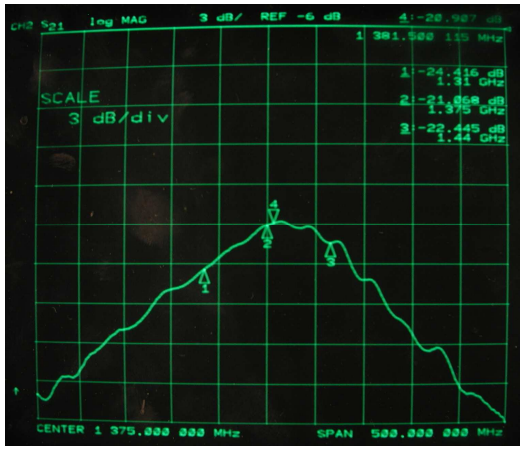


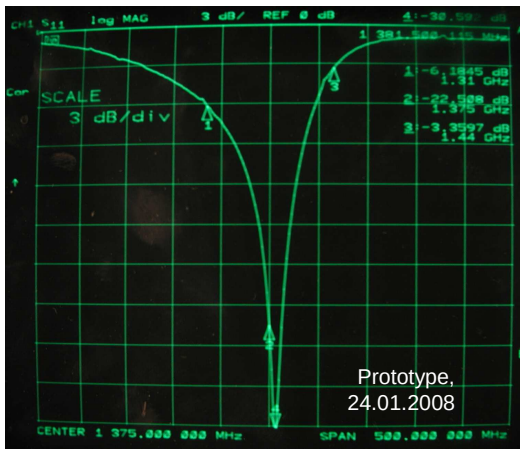
Winding-off view





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

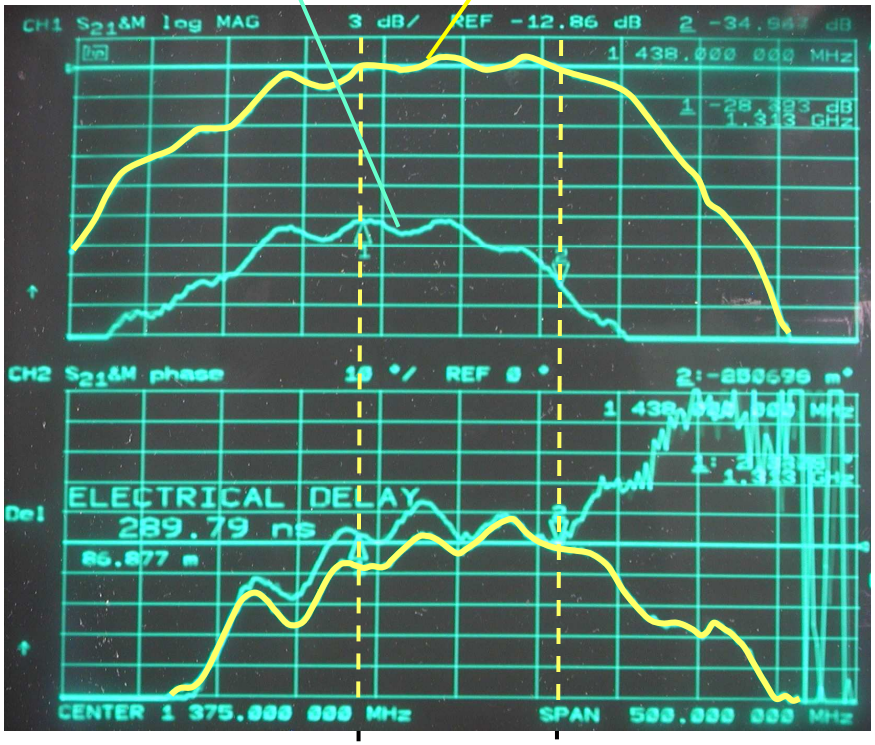




Over All Frequency Response

Eight Amp.-Cav. Frequency Response

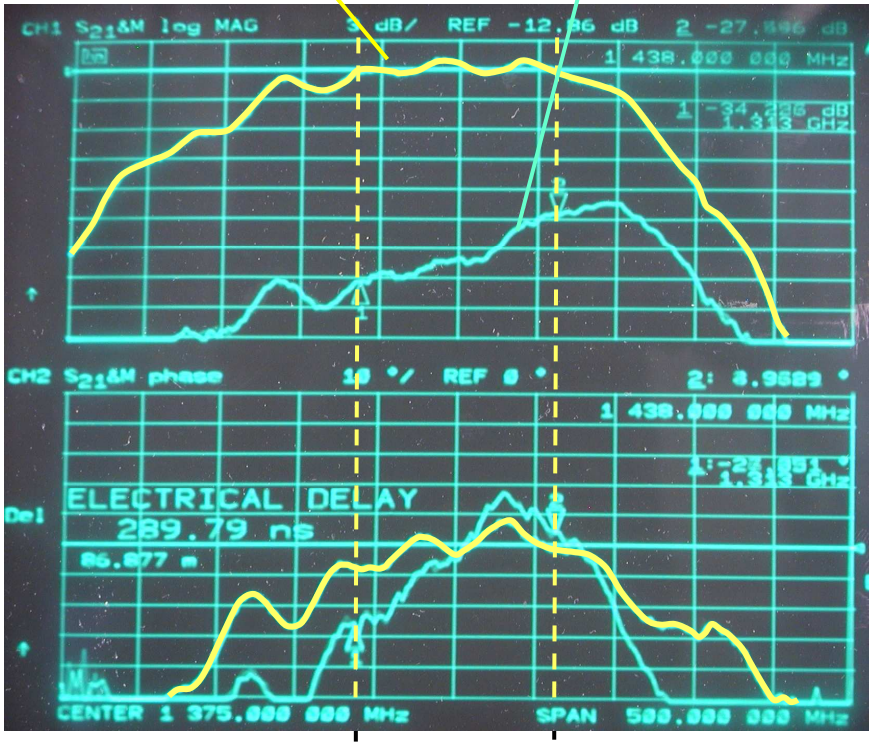
Cav4, Gap: 52mm



125 MHz

1313 MHz 1438 MHz

Cav7, Gap: 68mm



125 MHz

1313 MHz 1438 MHz