Fabrication, field measurement, and testing of a compact RF deflecting cavity for ELBE

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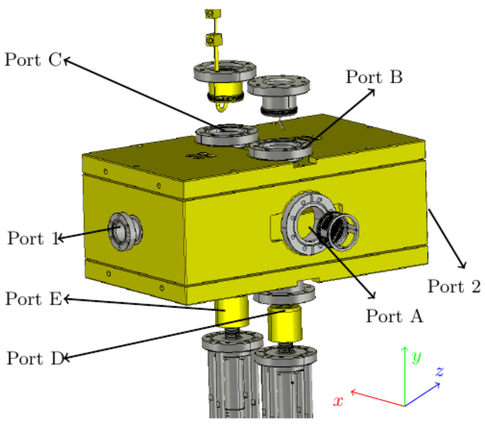
Design of the RF deflecting cavity

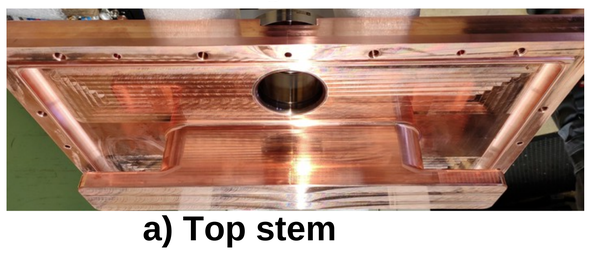
A normal conducting deflecting cavity has been developed for beam separation. The cavity kicks the alternating bunches from a single beam into two beamlines.

Electromagnetic design and multiphysics analysis of the cavity → **Poster: MOPORI21**

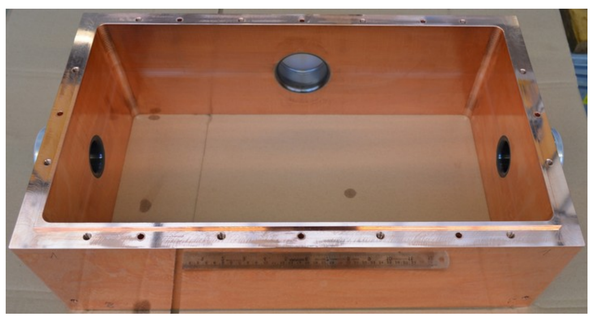


Parameter		Value	Unit
Cavity: width x height x length		275x181x500	mm
Cavity aperture	V_{ap}	30	mm
Resonance frequency	f_0	273	MHz
Transverse R/Q	$R_\perp/Q$	9.96	MΩ
Intrinsic Q-factor	Q_0	11188	-
Geometry factor	G	57.03	Ω
Deflecting voltage	$V_\perp$	300	kV
RF power loss	P_0	810	W
Peak electric field	E_{pk}	2.49	MV/m
Peak power loss density	S_{pk}	1.21	W/cm2

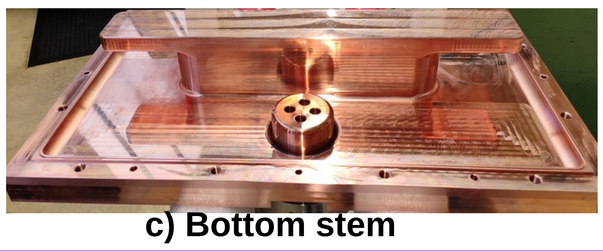
Cavity fabrication



a) Top stem



b) Middle part

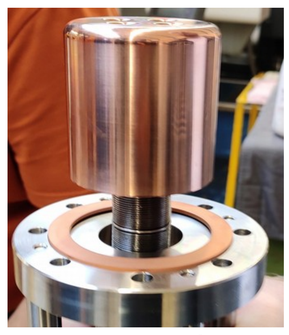


c) Bottom stem

RF filter
Port A

Pick-up probe
Port B

Main coupler
Port C



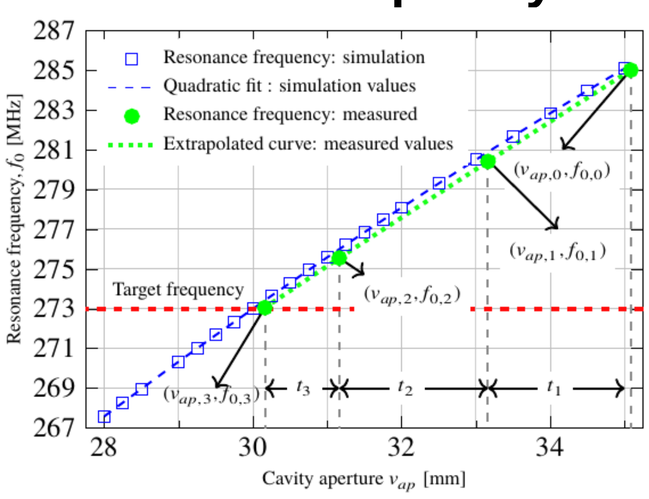
Frequency tuner
Port D and E

Pre-tuning of the resonance frequency

- Fabrication error shifts the resonance frequency
- Stems were machined to the exact dimension
- The middle part of the cavity was machined with an excess length of 2.5 mm on both sides where it joins the stem
- Frequency sensitivity:

  2.7 MHz/mm
- Three machining steps
- Final frequency after 3rd step:

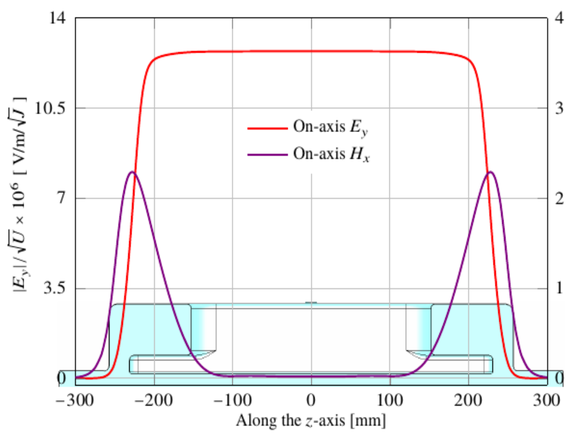
  273MHz + 56 kHz
- Subsequently, the cavity parts were vacuum brazed



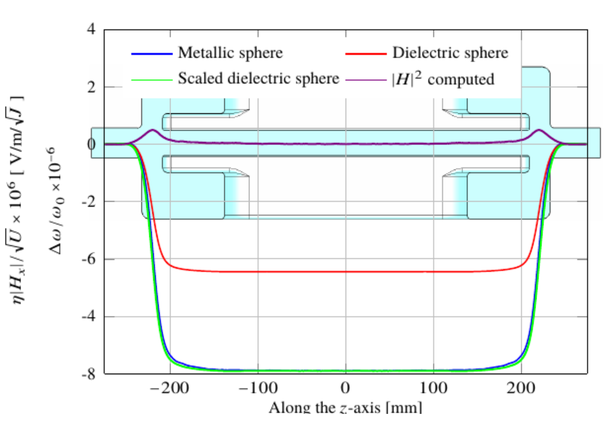
Machi-ning step	Trim height t [mm]	Aperture v_{ap} [mm]		Frequency f_0 [MHz]	
		Expec.	Measu.	Expec.	Measu.
0	-	35.08	35.08	285.237	285.002
1	2.00	33.08	33.16	280.830	280.407
2	2.00	31.16	31.16	275.966	275.554
3	0.98	30.18	30.16	273.000	273.056

Field measurement

- The deflecting mode field profile along the beam axis was obtained using the bead-pull technique
- Spherical beads (ϕ 5 mm) were used
- Dielectric sphere perturbs only electric field
- Metallic sphere perturbs both electric and magnetic field
- Only electric field exists at the middle of the cavity (z=0). Thus, the dielectric sphere values are scaled to match the metallic sphere at z=0.
- Subtracting the values obtained from the metallic sphere with the scaled values corresponds to $|H|^2$

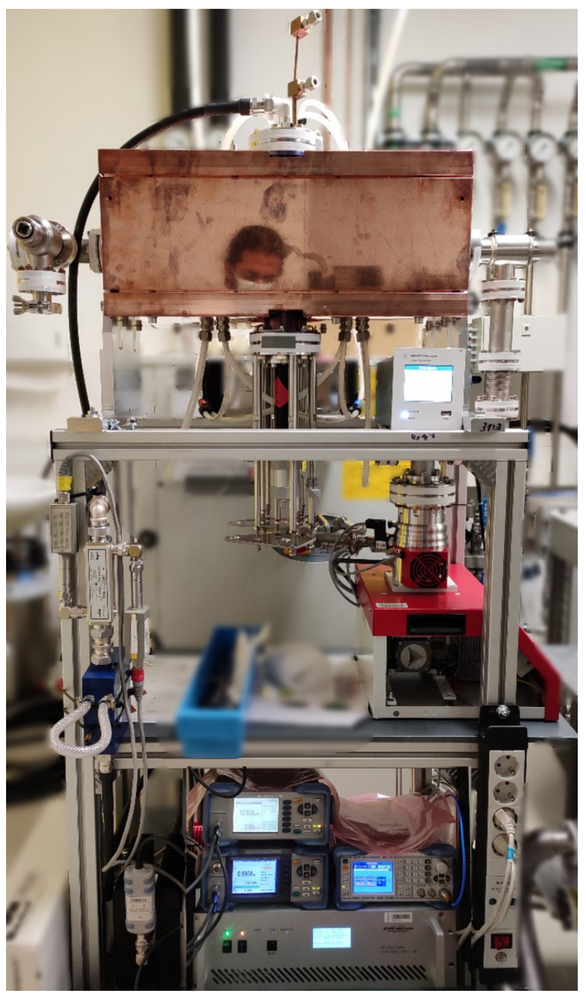


Simulation

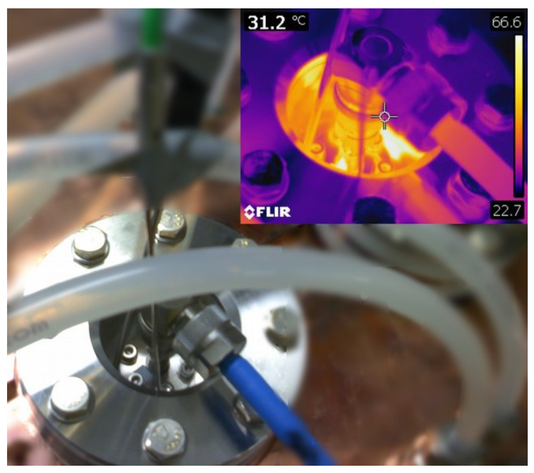


Bead-pull measurement

Testing of the cavity



RF test setup

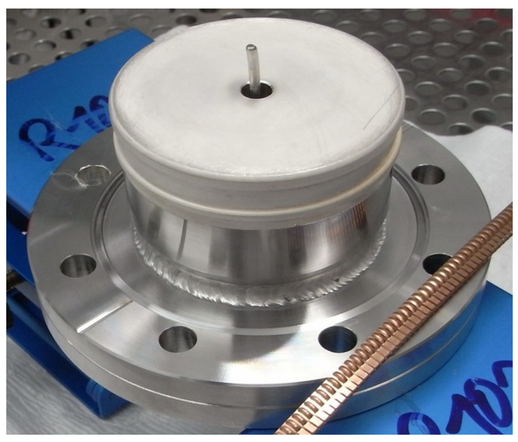


Infrared image of the pick-up at an RF power of 400 W

At an RF power of 400 W, the temperature on the pick-up increased to 67 °C.

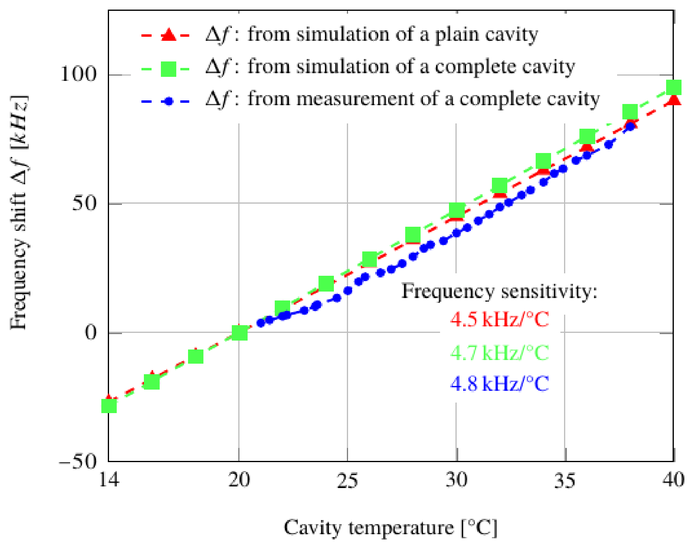
Reason: Stainless steel pick-up no active cooling

Solution: Silver coating



Silver coated pick-up cup

The cavity was vacuum conditioned at 1 kW and a maximum temperature of 43 °C was measured on the pick-up.



The cavity is ready for testing in the beamline

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