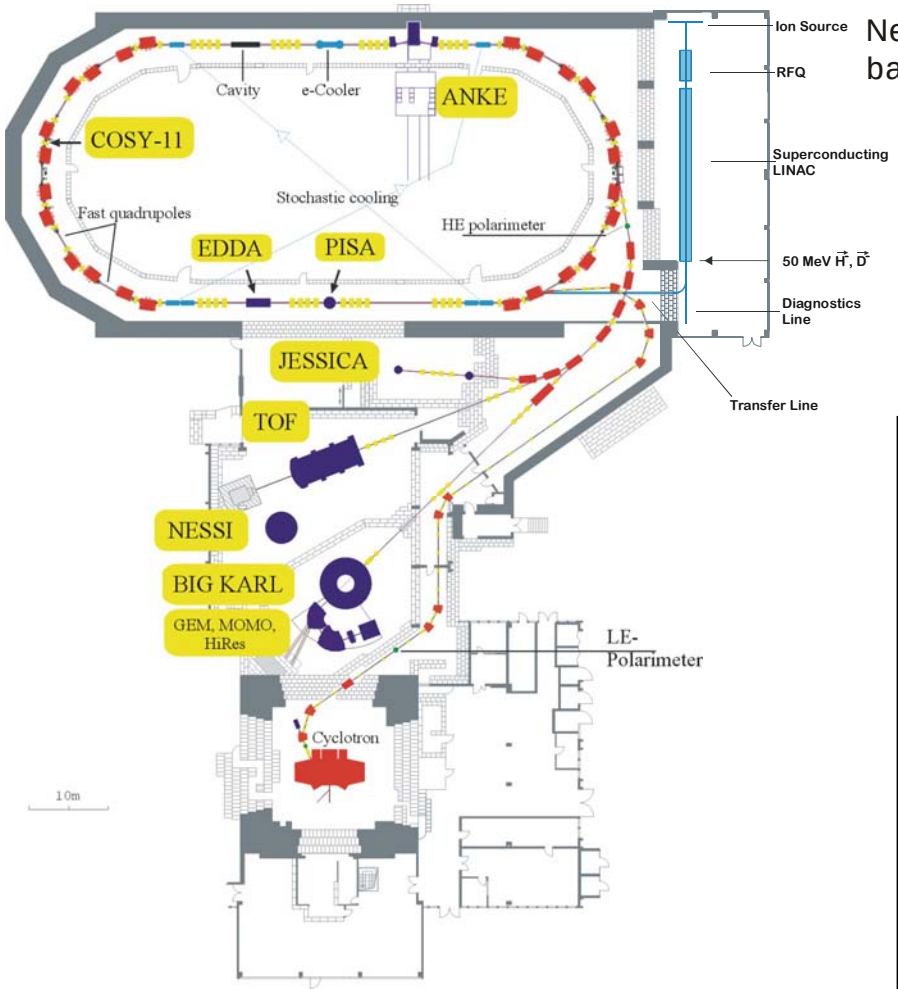
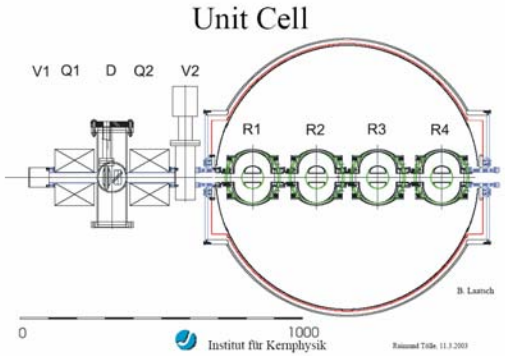
The HW resonators in Juelich

- *The Halfwave-Resonator*
  - *RF Main-coupler*
  - *Tuner*
- *RF-Measurements*
  - *Cw operation*
  - *Pulsed mode: mechanical resonances, LFD, I/Q-control*
- *Outlook*

Accelerating facility COSY: new injector



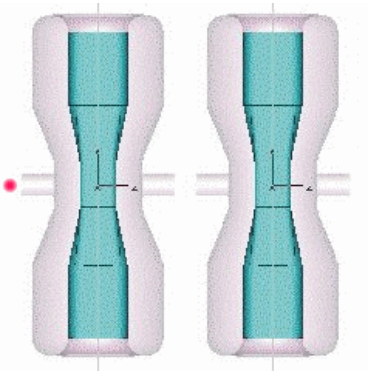
New injector
based on SC-HWR



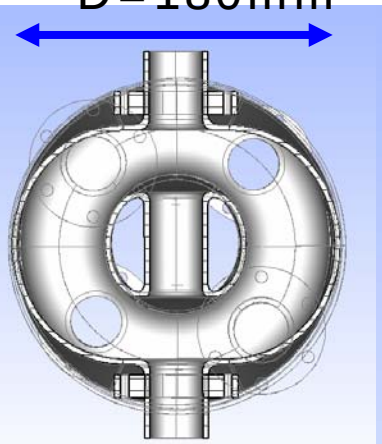
- pulsed operation (2 Hz, 500 µs beam)
- beam-current = 2mA
- Injection-energy = 2.5 MeV/u
- 20 resonators 160 MHz, ß = 0.11
- 24 resonators 320 MHz, ß = 0.2
- 4 resonators (same type) each cryostat @4K
- final-energy 52 MeV (H-) / 56 MeV (D-)
- E_{acc} = 8 MV/m (B_{peak}=80mT, E_{peak}=38MV/m)
- Focusing quadrupoles and diagnostic outside the cryostats

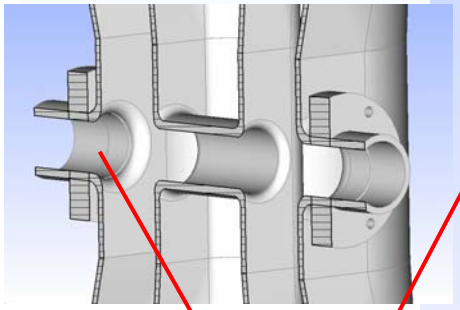
Cyclotron Julic:
Limits quantity of polarized particles (2E10)

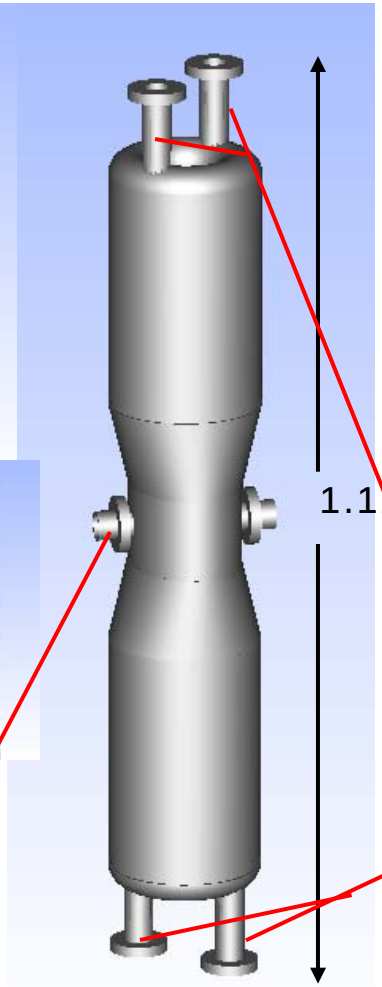
HWR Parameter (160MHz, ß=0.11)



D=180mm



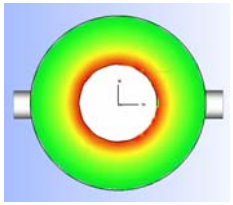


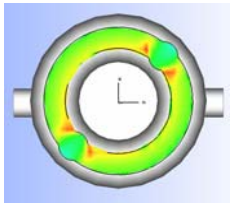


1.125 m

Beamports

B-Field





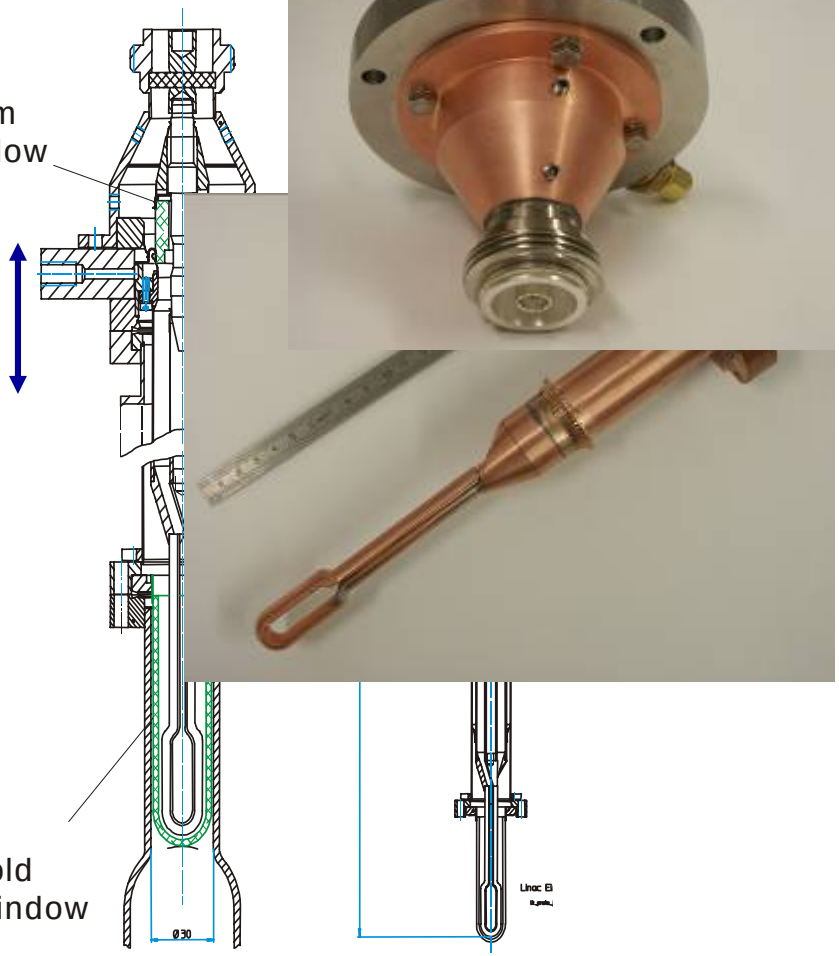
$$E_{acc} = \frac{\int_{-\infty}^{\infty} E_z(z,t(z))dz}{\beta_{str}\lambda}$$

R/Q / Ω	245
G / Ω	26
B_{peak}/E_{acc} / mT/MV/m	10.4
E_{peak}/E_{acc}	4.8

4 Accessports (chemical preparation, HPR)
Used for couplers and additional pumping

RF main coupler

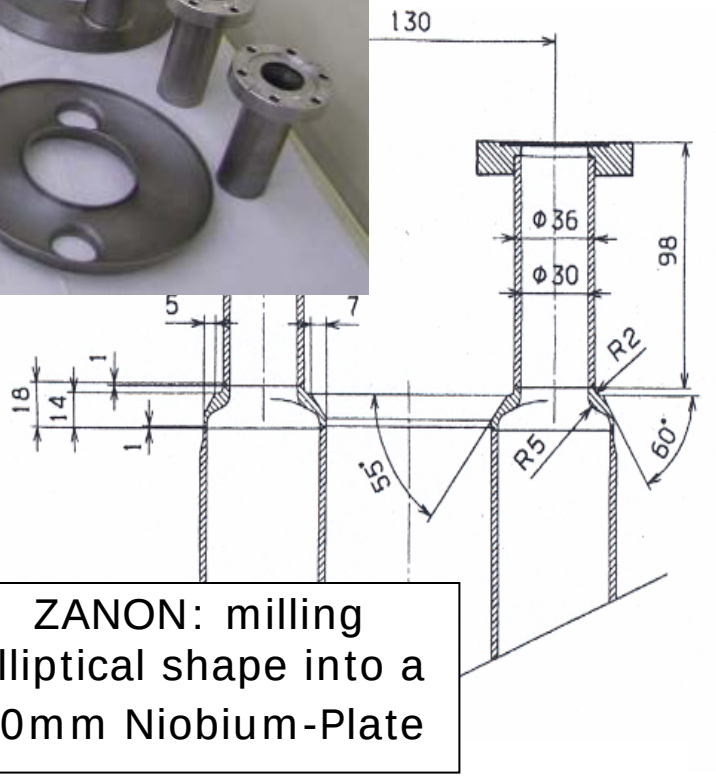
- Inductive
  from the t
- 4 kW Peak
  100% Ref
- 150 W avg
- adjustable:
  $10^6 < Q_{ext} < 10^9$
- 2 RF windows (warm/cold)
- < 5 mW
  cold wir
  layer

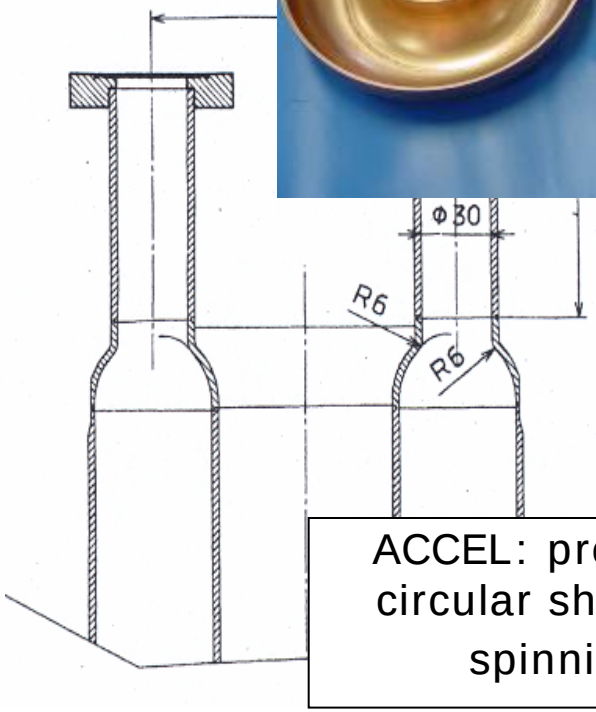


Two different prototypes from two manufactures

1. difference:

Fabrication of endplates

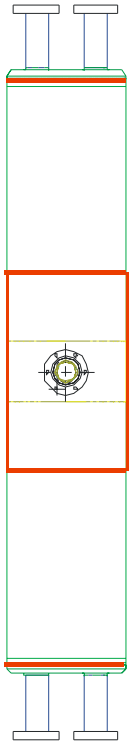


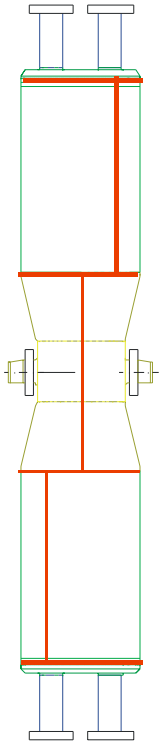


ZANON: milling elliptical shape into a 20mm Niobium-Plate

ACCEL: preferred circular shape by spinning

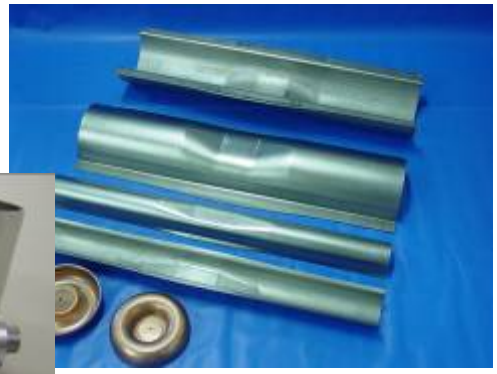
Two different prototypes from two manufactures (2)

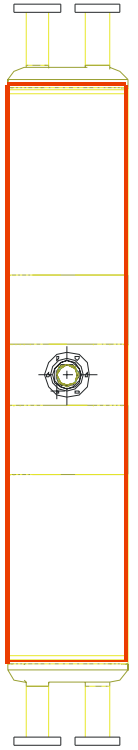


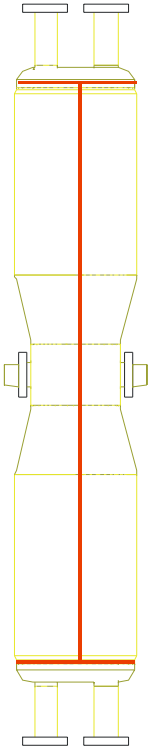


2. difference:

quantity and
position of weldings



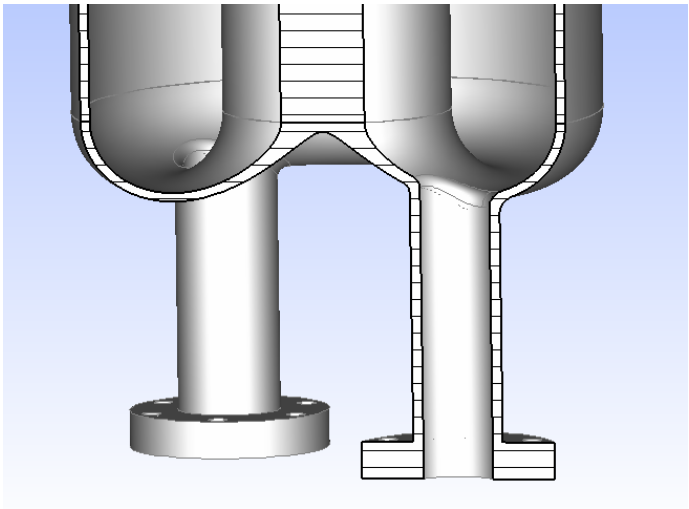




ZANON:	ACCEL:
Eight pieces + endplates	Four halfcells + endplates

Preparation for both cavities done by ACCEL

- Ultrasonic cleaning
- 120µm BCP in closed pumped system (temperature controlled), cleaning and filling with pure water
- High pressure rinsing via access-ports (30min each port)
- Drying by pumping in clean-room

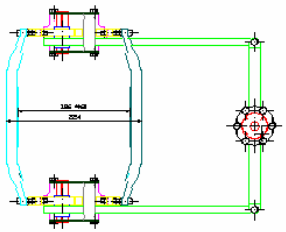


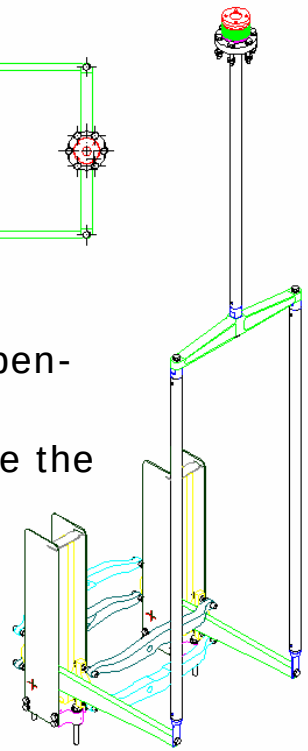
- No heat treatment
- No baking

4K-Measurement: Multipacting

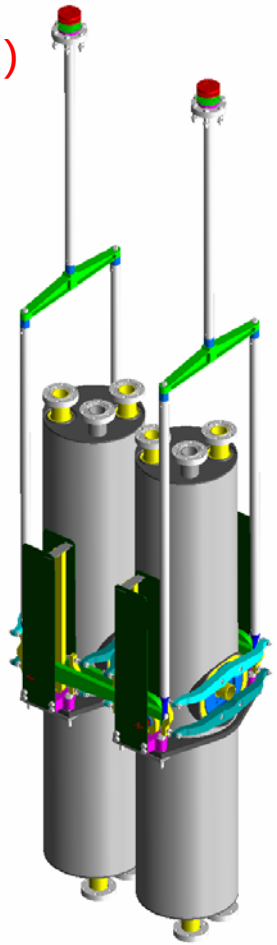
- First Multipacting barrier at some mW (E_{acc} ~ keV)
- Conditioning with 5W RF-Power for about 3 weeks

Tuningrange: +/- 1mm (+/- 120kHz)
Initial tension possible

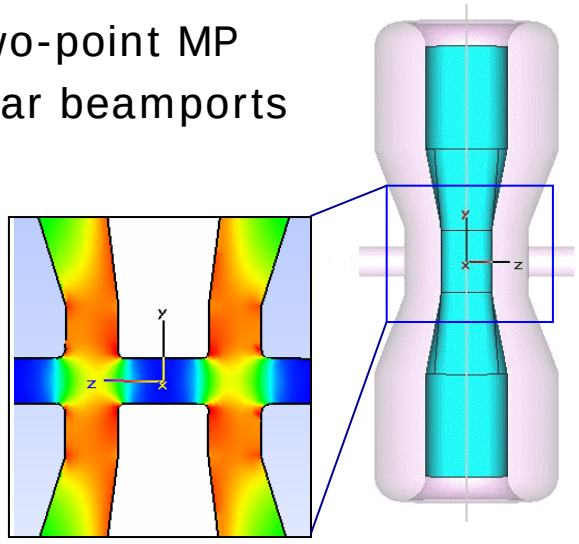




- Stepper motor
- Piezo actuators: compen-sation of LFD
- All active parts outside the cryostat

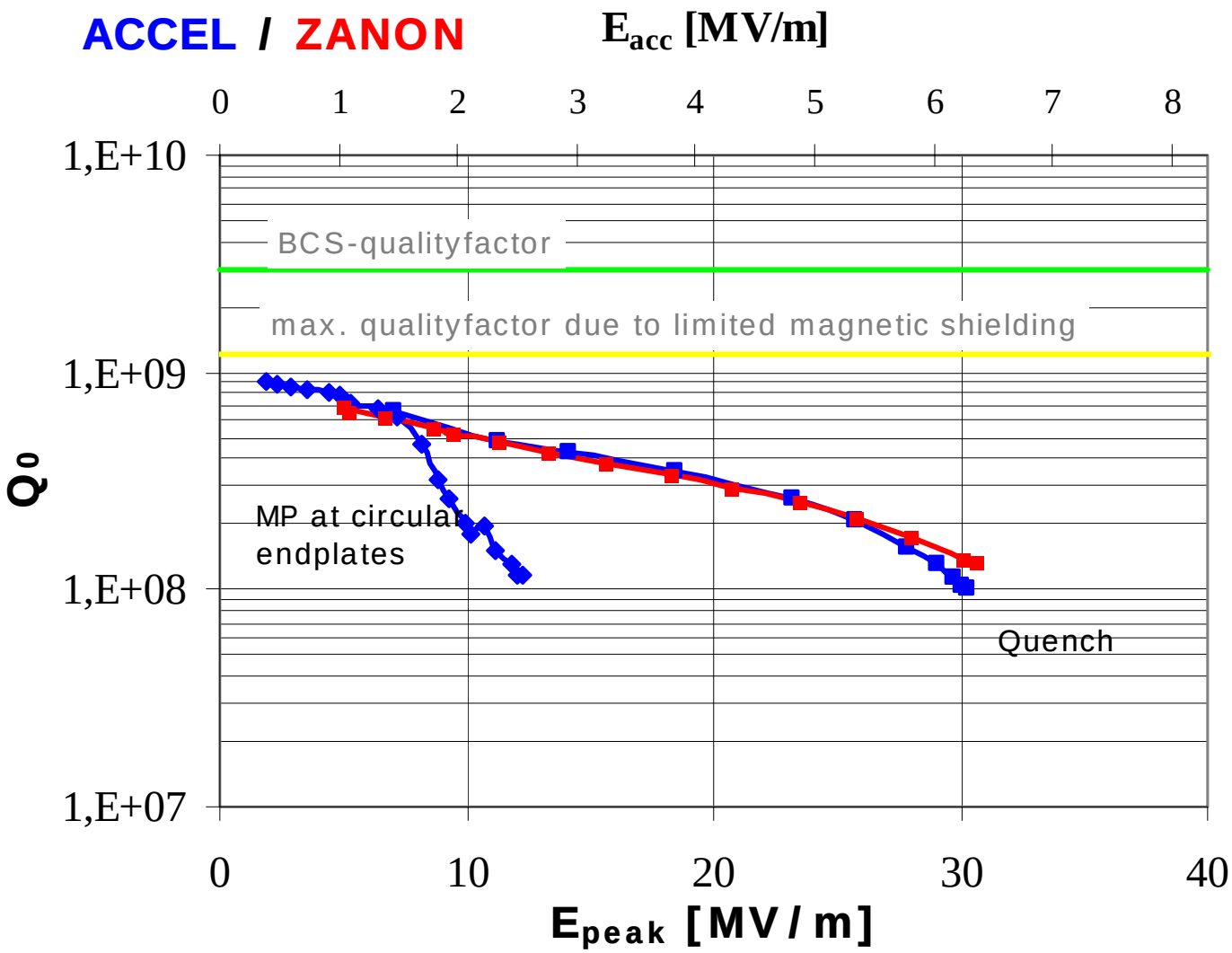


Two-point MP
near beamports



For details see Poster TuP32: R.Eichhorn

Q_o-E_{peak}



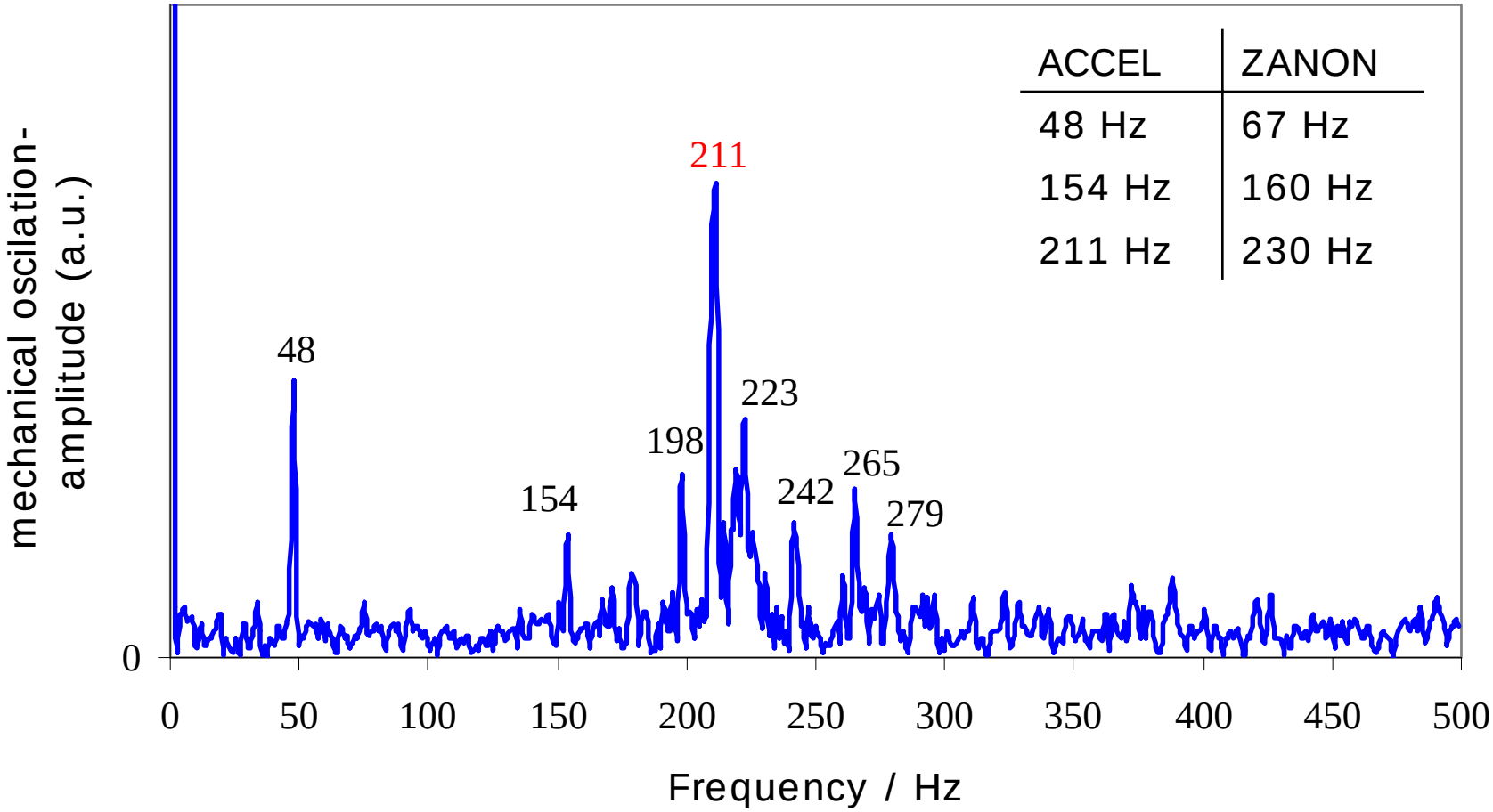
Pulsed operation (10ms, 2Hz):

E_{acc} = 7.5 MV/m

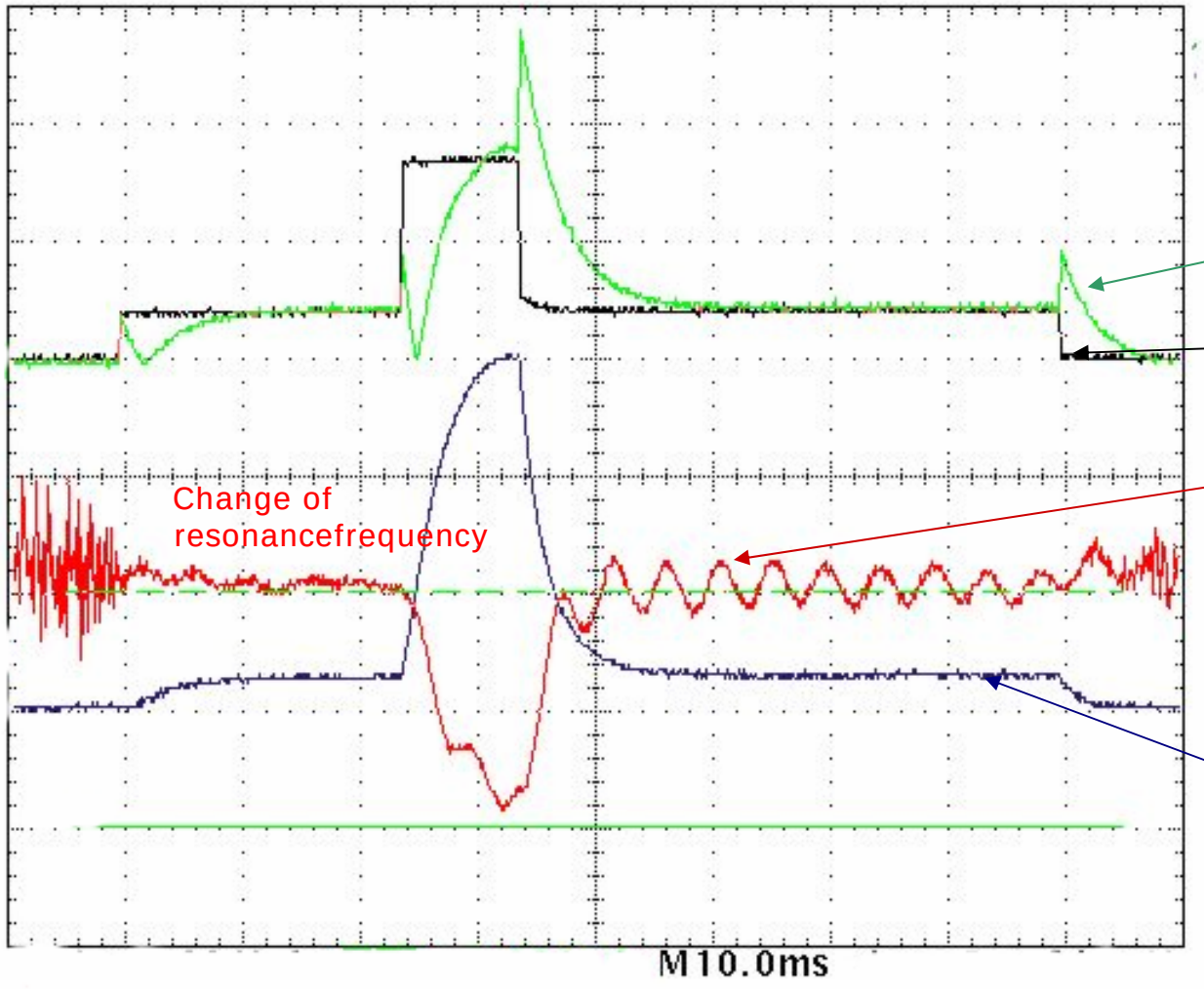
(E_{peak} = 36 MV/m)

Mechanical Eigenmodes

1) FFT of phase-signal after step-function at Piezo-Tuner
2) Sinusoidal excitation



Mechanical resonances in pulsed operation



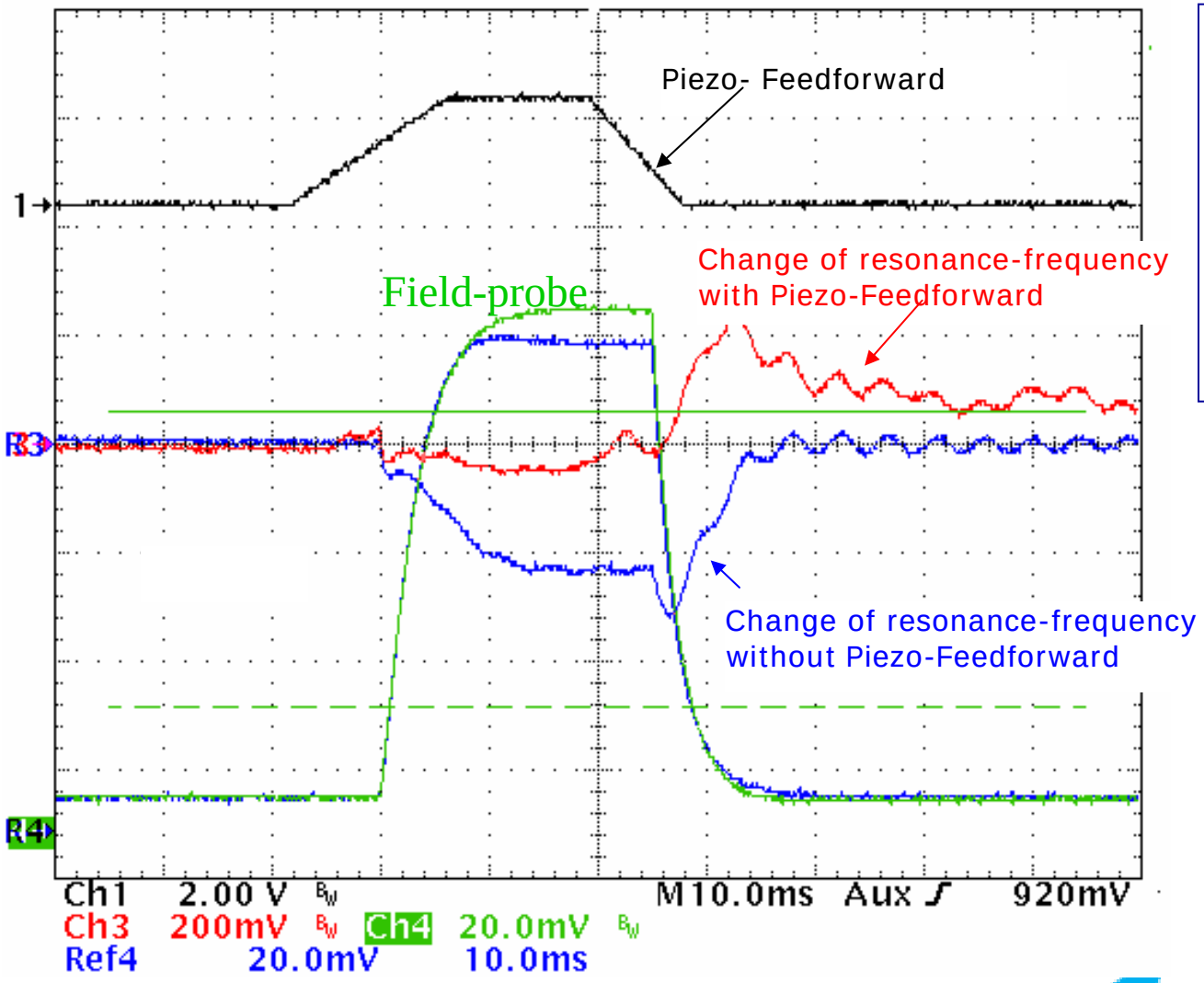
$P_{reflected}$

$P_{forward}$

Excitation of strongest mechanical eigenmode (211 Hz)

Accelerating field

Lorentz-Force-Detuning



Static detuning:

$\Delta f = -\mathbf{k} * E_{acc}^2$

ZANON: 6 Hz/(MV/m)²

ACCEL : 10 Hz/(MV/m)²

First ANSYS®-Simulation: 1 Hz/(MV/m)²

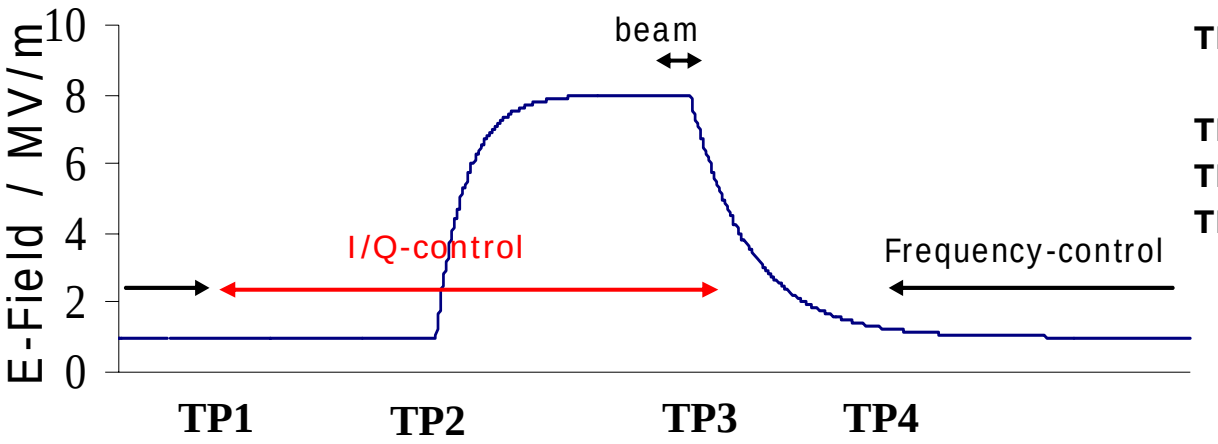
E_{acc} = 3,1 MV/m

=> LFD = 60 Hz

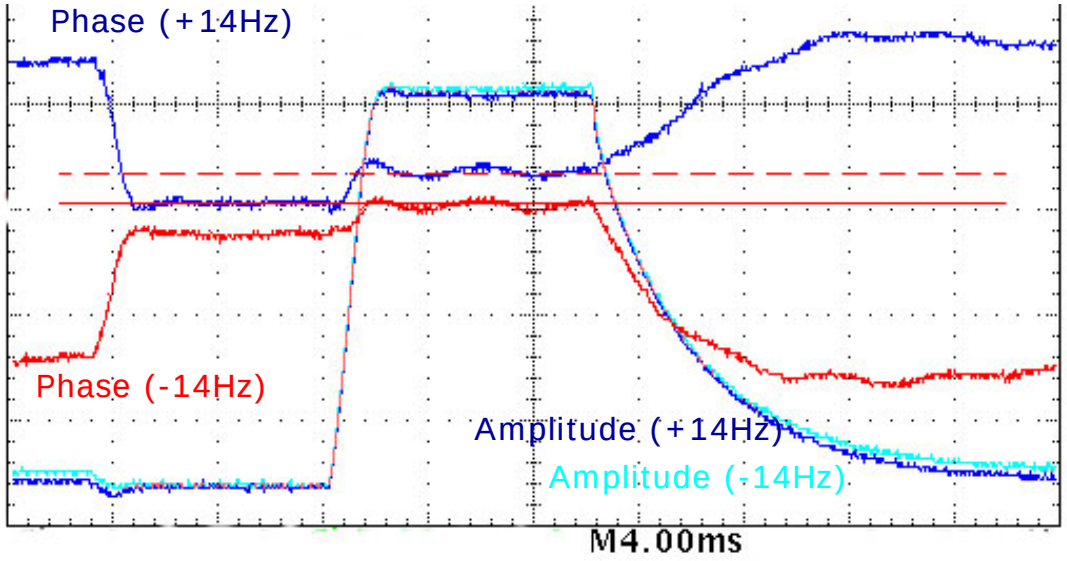
Pulse-length: 25ms

Limited by mechanical inertia

Analogue I/Q-control



TP1: Activating the I/Q-control, frequency-control switched off
TP2: Triggering the highfield-puls
TP3: I/Q-control and pulsing switched off
TP4: Activating the frequency-control loop



Field accuracy:

Achieved (worst case)		**Goal**
+/- 0,6%	Amplitude	(+/- 0,5%)
+/- 1,4°	Phase	(+/- 0,5°)

Conclusion and next steps

- 8 MV/m possible but up to now not serious in a 7000 h/a linac operation
- Mechanical stability requires modifications

- RF-conditioning, baking, (He-processing)
- 2K-operation
- Installation of one prototype including lHe-cover in the new cryostat

Thanks to:

R. Eichhorn, F. Esser, B. Laatsch,

G. Schug, H. Singer

MAC members:

B. Aune, A. Facco, D. Proch, U. Ratzinger,

S. Schriber, K. Shepard, M. Vretenar