DESY Cavity Status + Results

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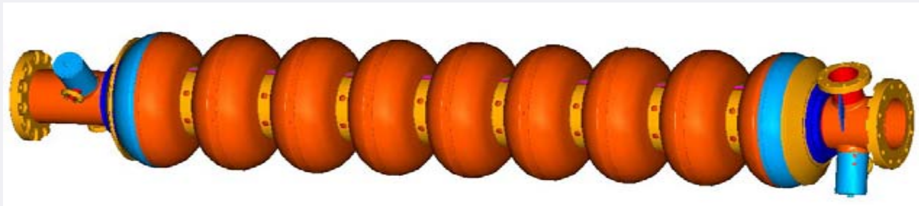
for the DESY cavity team

TTC meeting, New Delhi 2008

- 6th cavity production: Status and Results
- 3.9 GHz Cavity Status (Flash + XFEL)
- New Tuning Machine (FNAL + DESY)
- XFEL cavity
- Transportation tests



- Open Argon Bake
- Results on Large Grain + Hydroformed Cavities

6th cavity production: Overview (LINAC08: THP014)

- **30 cavities fabricated by 2 vendors** (Accel + Zanon) of Tokio Denkai Nb
- final production series before XFEL

Goals:

- cavities for TTF/Flash modules
- ongoing training of manufacturing companies
- establishing industrial EP (Accel + Henkel)
- test of optimized, "streamlined" preparation and test procedures for XFEL
  - early He tank welding
  - vertical cw test with He-tank
  - vertical cw test with HOM antennas assembled
- comparison of final preparation => EP vs. "Flash-BCP"
  - improved statistics necessary for XFEL cavity preparation decision
  - > 10 cavities with ILC recipe

6th cavity production: Treatment

- 110 µm or 150 µm inside EP
  - 2 companies => Accel + Henkel (+ inhouse)
- 10 µm etching (BCP) outside
- 800 C firing

final EP:

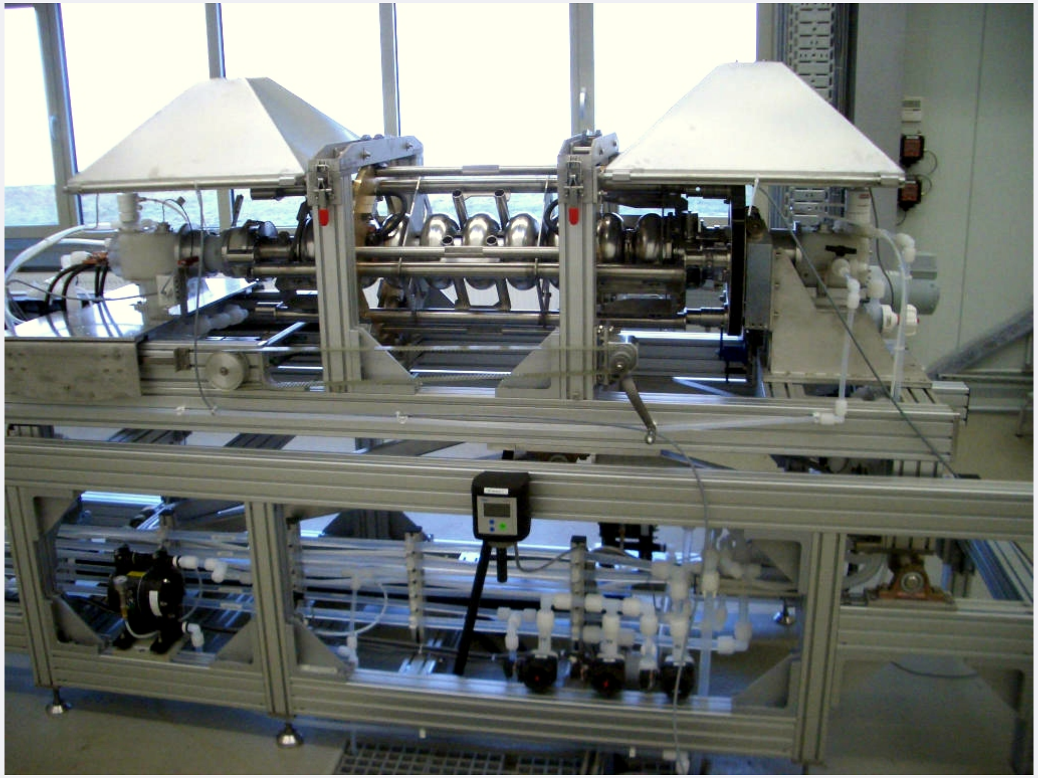
- final 50 µm EP + ethanol + HPR
- tank welding
- assembly + HPR
- 120 °C "bake"
- Low power cold test

final short BCP:

- tank welding
- final 10 µm BCP + assembly + HPR
- 120 °C "bake"
- Low power cold test

6th cavity production: Industrial EP

- Industrial EP: 2 x 10 cavities processed => works well

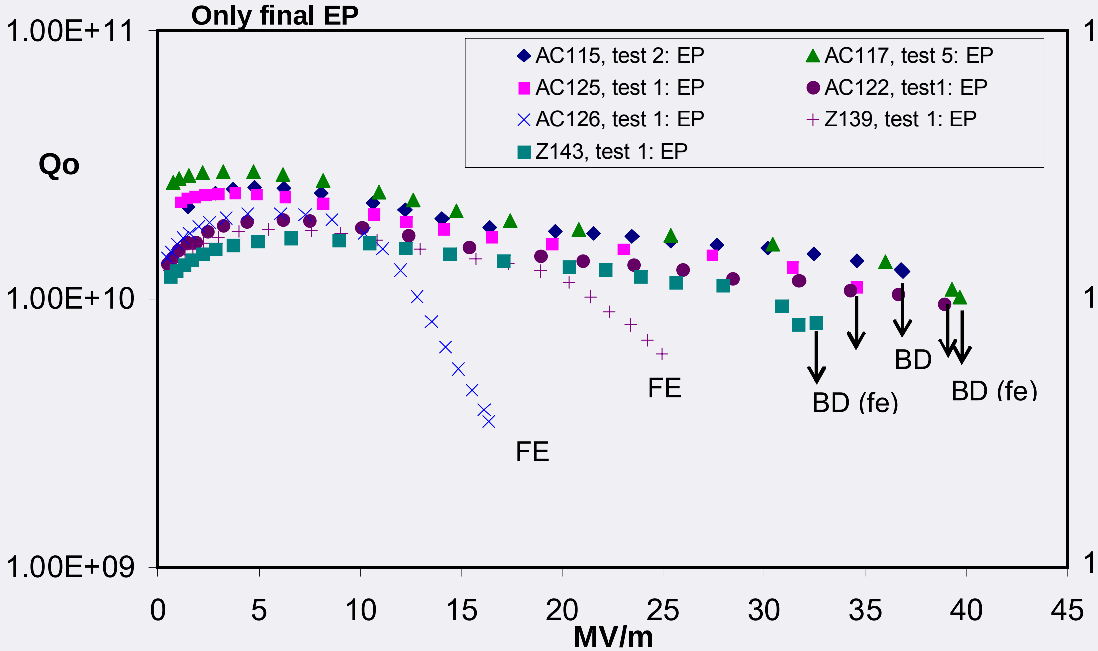


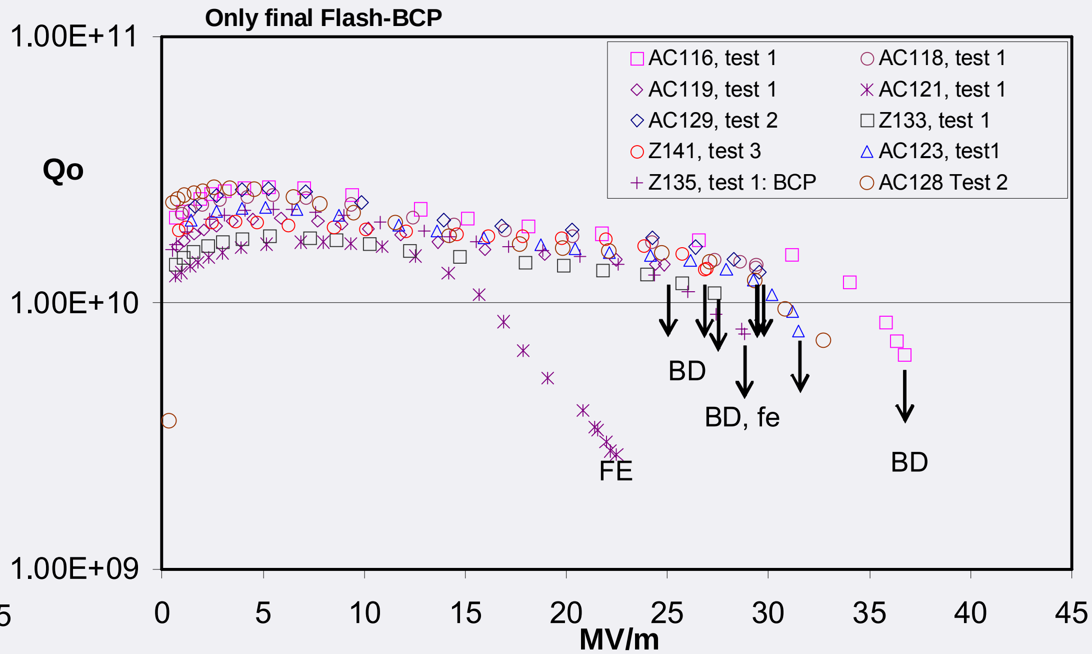
Rough EP at ACCEL (courtesy of M. Pekeler)

EP system at Henkel (courtesy of. C. Hartmann)

6th cavity production: Results

- Available data: 7 (of 10) final EP cavities; 10 final short BCP cavities



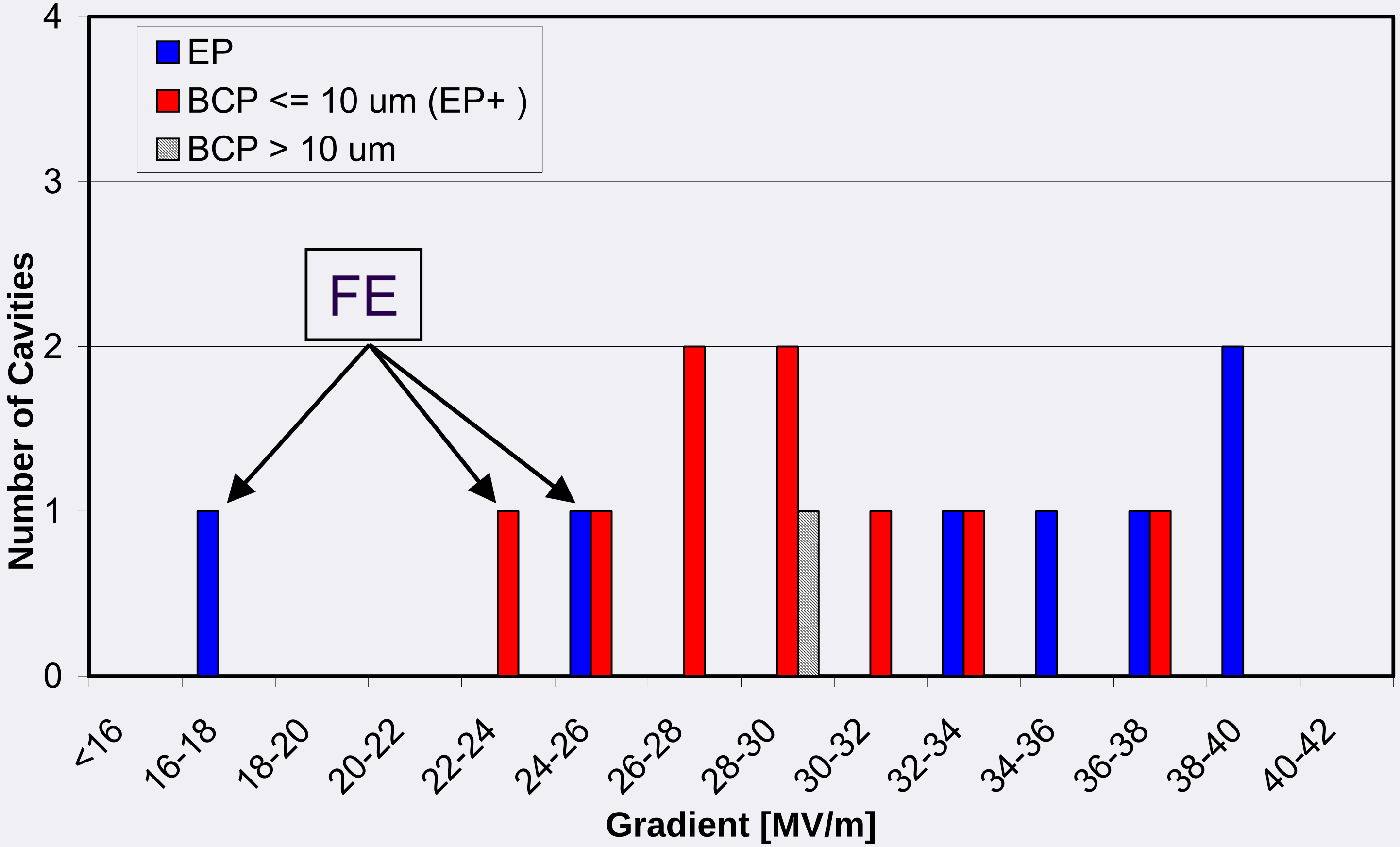


=> Flash BCP shows some Q-slope after bake

=> FE is still a problem !!

- FE loaded cavities will be HPR re-rinsed => in preparation
- 3 more EP cavities follow soon

6th cavity production: Results II



=> test series + final results to be completed in the next weeks

6th cavity production: Problems

- **some cavities with unexpected low-gradient quench**

  - T-mapping investigation requires removal of He-tank
  - first affected cavity tested with T-map

  - negotiations with manufacturer ongoing

- **cw test with assembled HOM pick-ups *partially* resulted in Q-switches**

  - heating of HOM long side observed => reason unclear
  - dedicated test program in preparation

Rough EP at ACCEL (courtesy of M. Pekeler)

- assembled HOM pick-up's do not allow full passband mode measurement
- with He-tank no T-mapping possible

3.9 GHz for FLASH + XFEL (LINAC08; THP019, THP028, THP029, THP030)

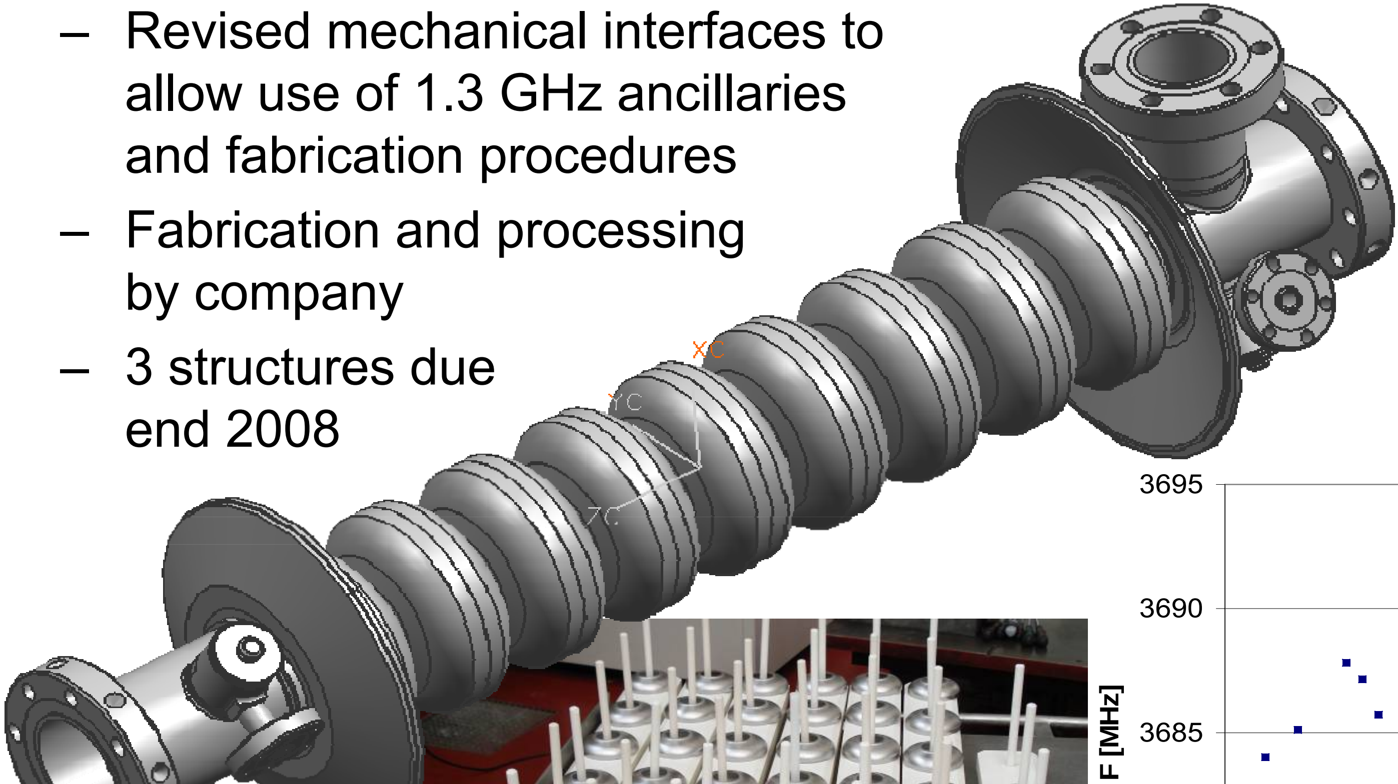
- close collaboration between FNAL, INFN Milano + DESY

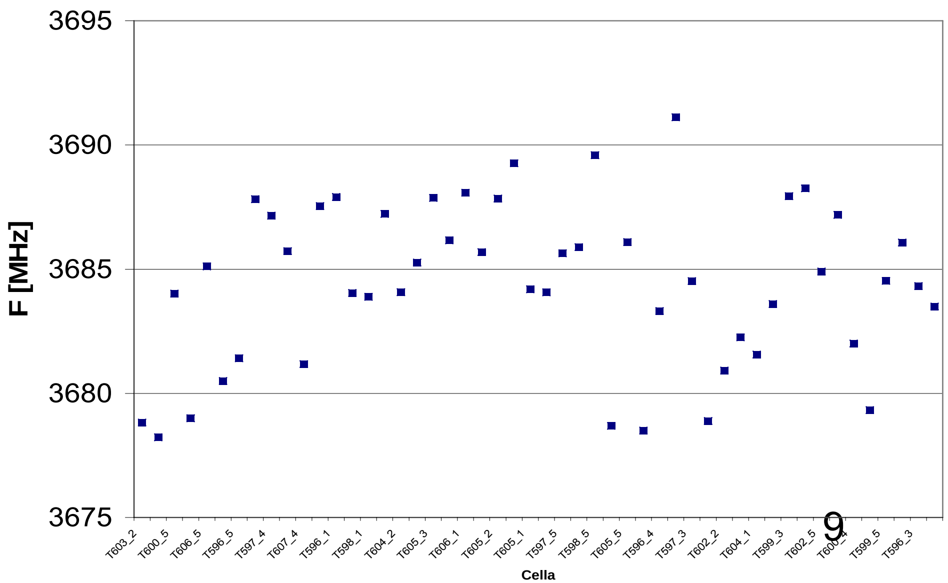
- **ACC39 for FLASH:**
- module ready at FNAL in Jan 09
- module test incl. assembly: Mar 09 – Jul 09
- assembly to FLASH: Sep 09
- beam commissioning: Dec 09

- **3.9 GHz cavities for XFEL** (=> INFN Milano)
- Simplified industrial production:
  => modified cavity + He-vessel design based on FNAL design

XFEL 3.9 GHz (3rd Harmonic) Cavities

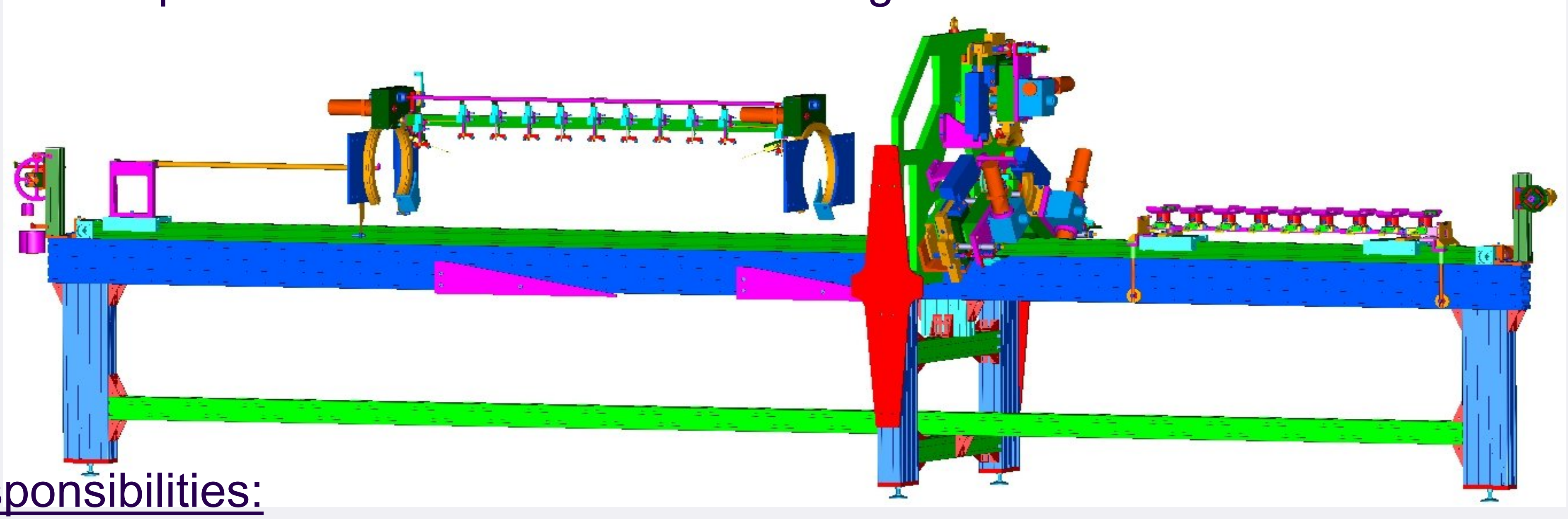
- Started the production of the structures for the XFEL 3rd Harmonic section
  - FNAL baseline design (new HOM antennas)
  - Revised mechanical interfaces to allow use of 1.3 GHz ancillaries and fabrication procedures
  - Fabrication and processing by company
  - 3 structures due end 2008





Cavity Tuning Machine for XFEL

Based on the tuning machine design for “FLASH”
FNAL and DESY jointly
develop and fabricate 4 automated tuning machines for 1.3GHz cavities



Responsibilities:

DESY ➔ providing a complete mechanical assembly

FNAL ➔ providing the control system, consisting of a complete set of electronics and software

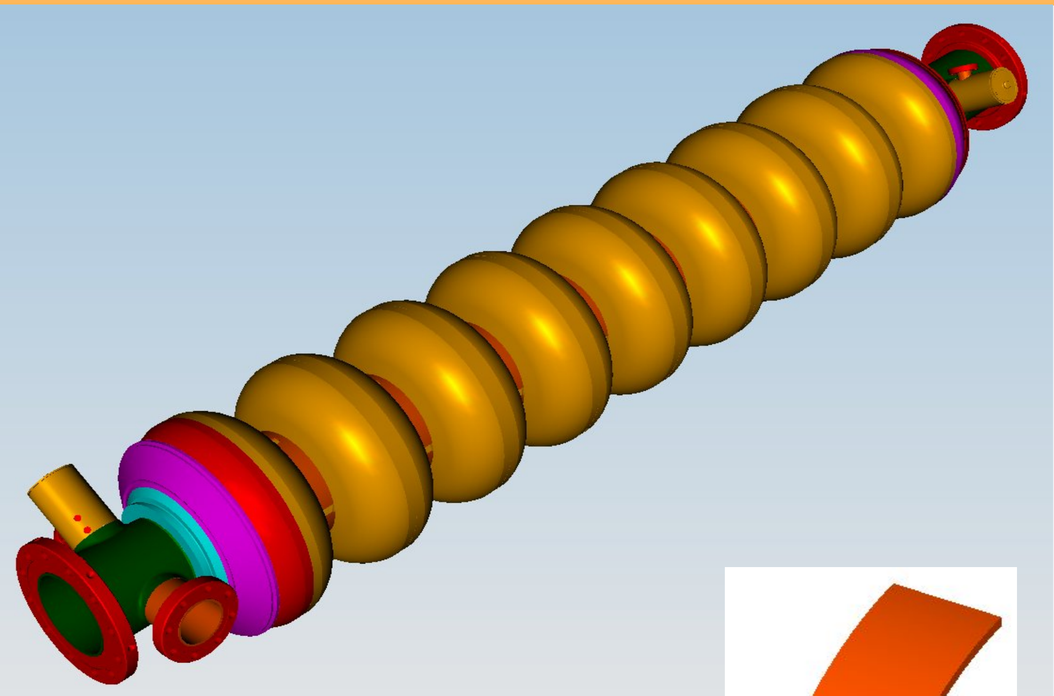
FNAL and DESY ➔ integrated commissioning of the machine

Cavity Tuning Machine for XFEL

Four machines will be fabricated!

2x for DESY (XFEL), 1x for FNAL, 1x for KEK

Cavity for XFEL – minor design changes

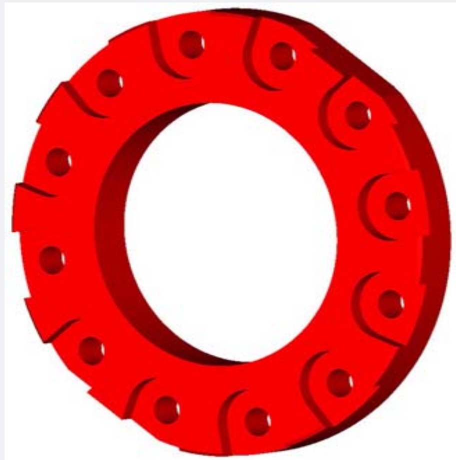


Stiffening ring

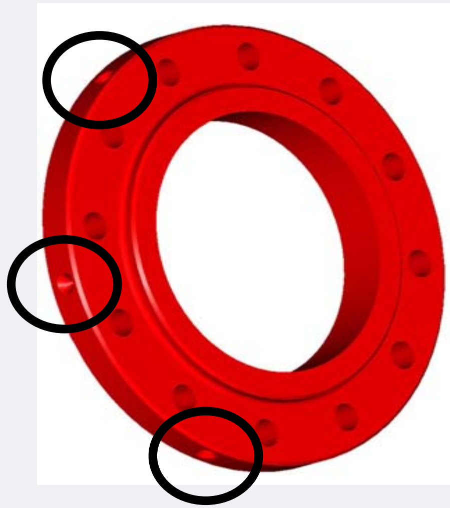
• reduced thickness
• only one borehole

Flange NW78

“old“ FLASH design

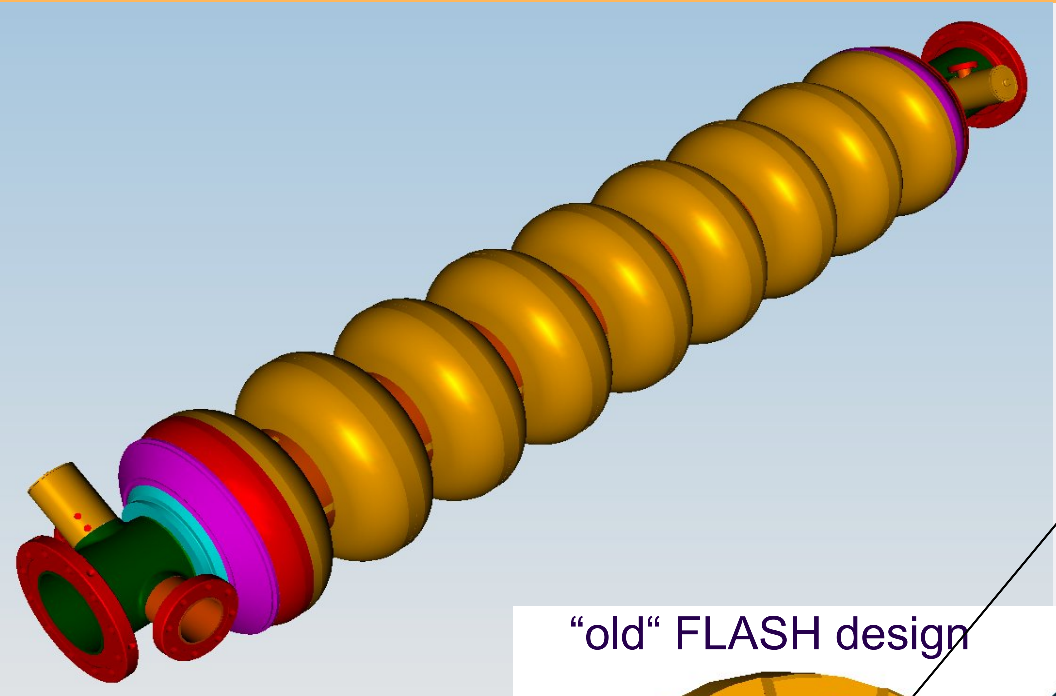


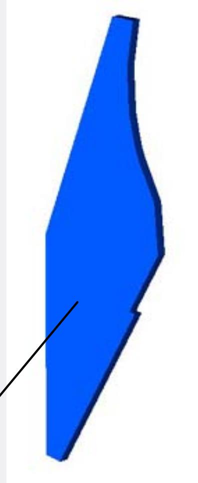
XFEL design



• simplified geometry
• new reference boreholes for cavity-string-alignment

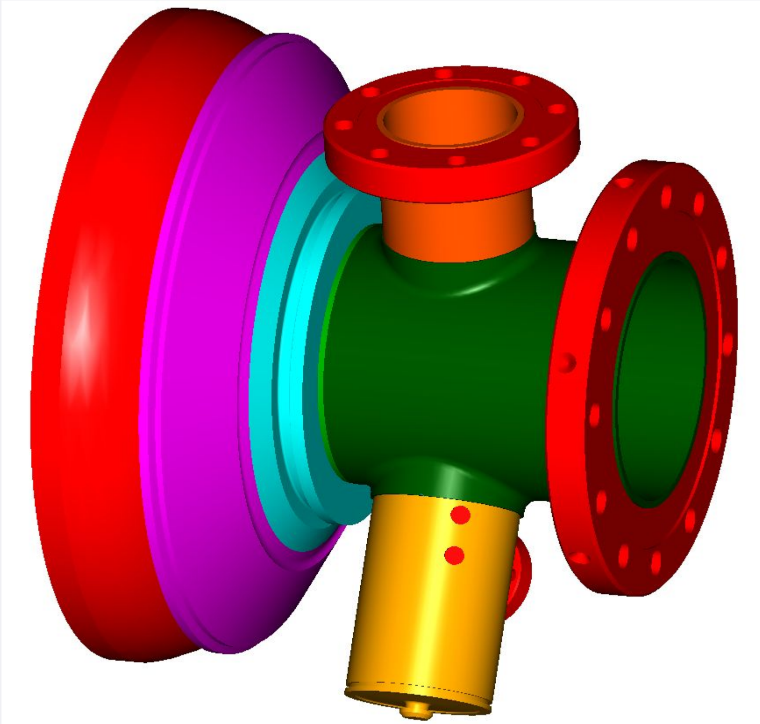
Cavity for XFEL – minor design changes



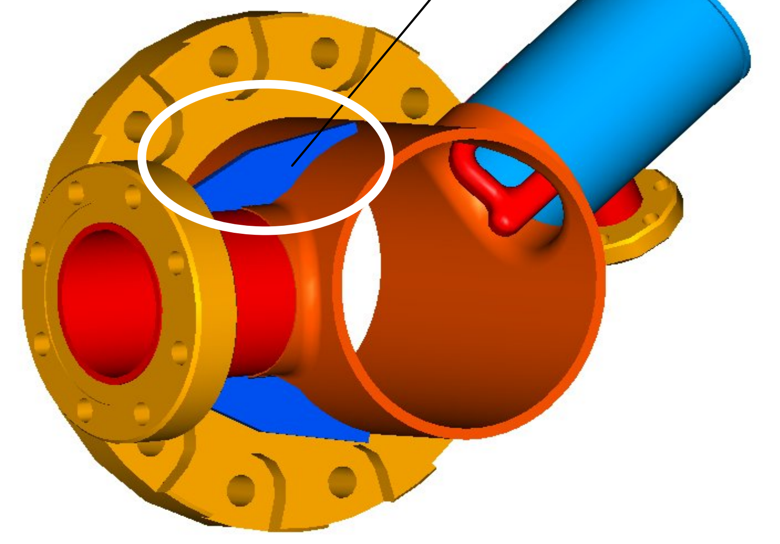


“Rib” taken away

XFEL design



“old“ FLASH design

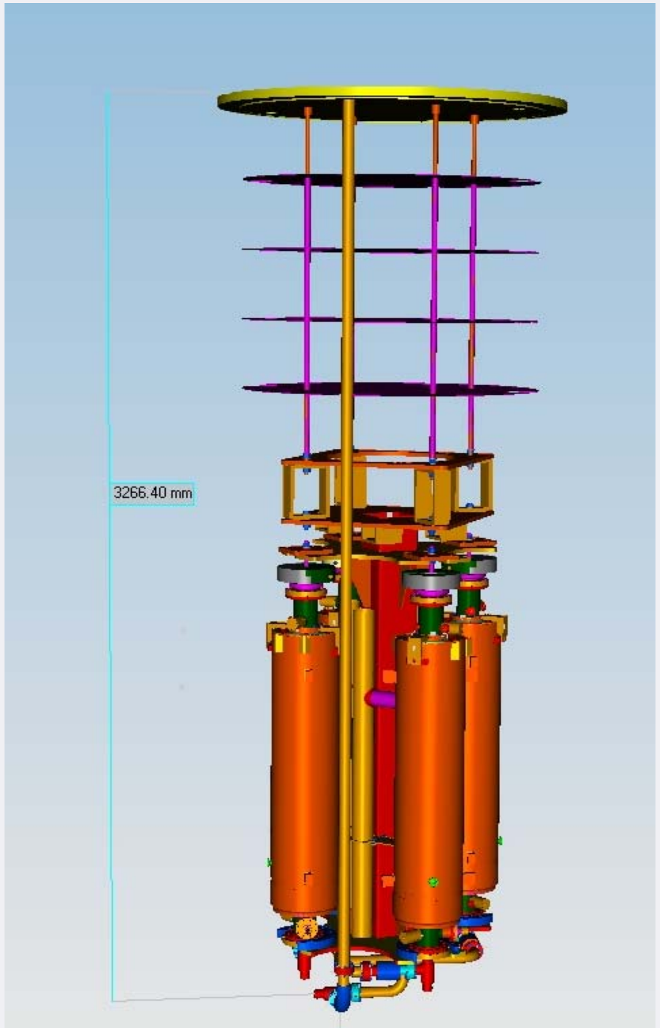


Transport Simulation: XFEL Vertical Insert

The vertical insert for testing XFEL series production is designed for 4 CV’s (with and without He tank).

The lower part needs to be transported between manufacturer and test facility (AMTF) at DESY.

The insert is equipped with:
- Cryogenic requirements
- Radiation shields
- Vacuum system
- mechanical requirements



Transport simulation – vertical

Vertical tests:

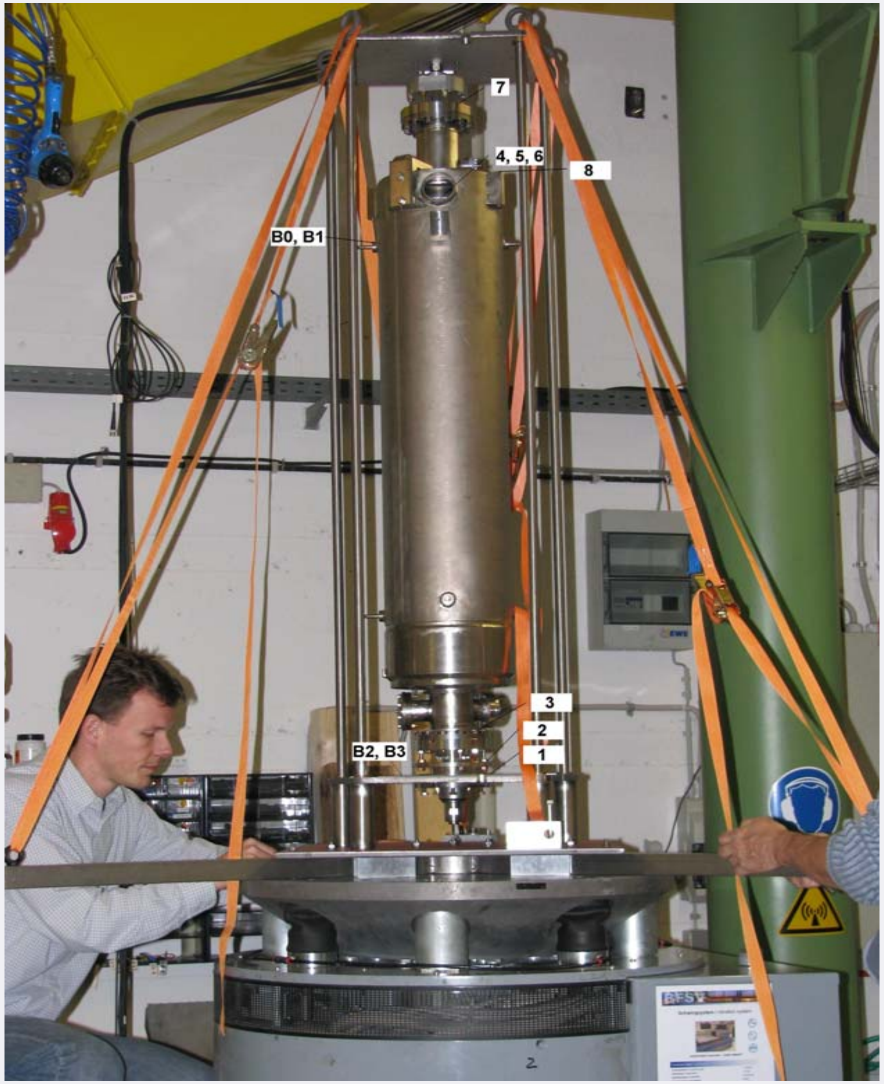
a) Determination of the resonance frequencies (5Hz…200Hz)

b) Transport simulation (3h ≈ 1200km):

i) repeated shock tests of 11ms (84x4g, 42*5g, 12*6g)

ii) 6 shocks of 11ms á 7g, 8g, 9g, 10g, 11g, 12g, 13g, 14g und 15g

iii) 6 shocks of 20ms á 7g



Transportsimulation – horizontal

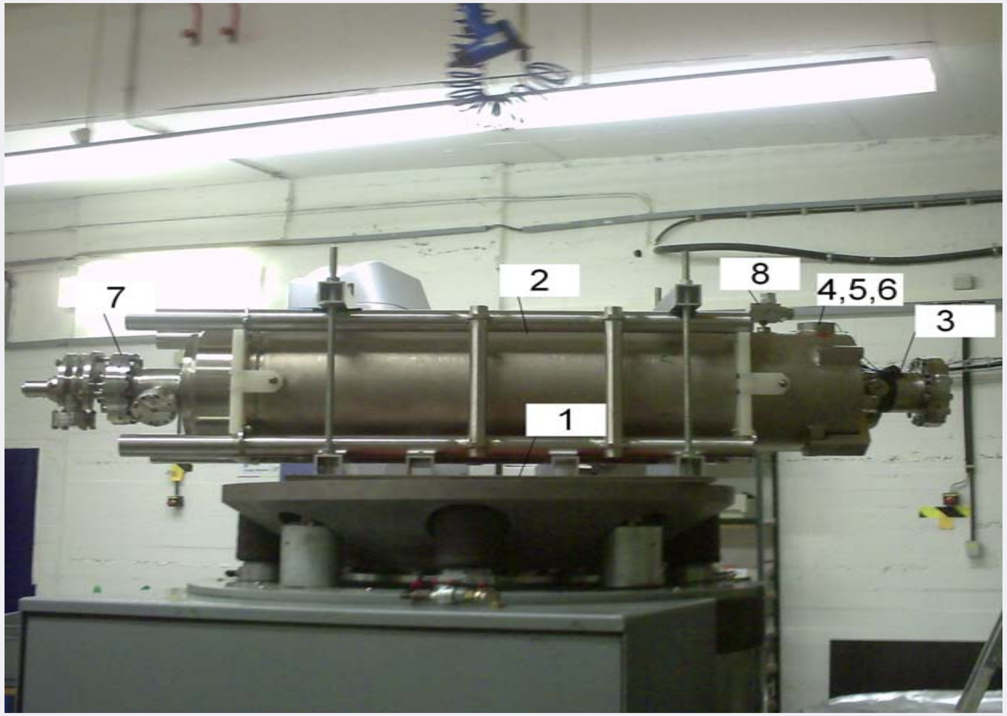
Horizontal Tests:

CV was fixed in horizontal position (shocks vertical)

a) Determination of the resonance frequencies

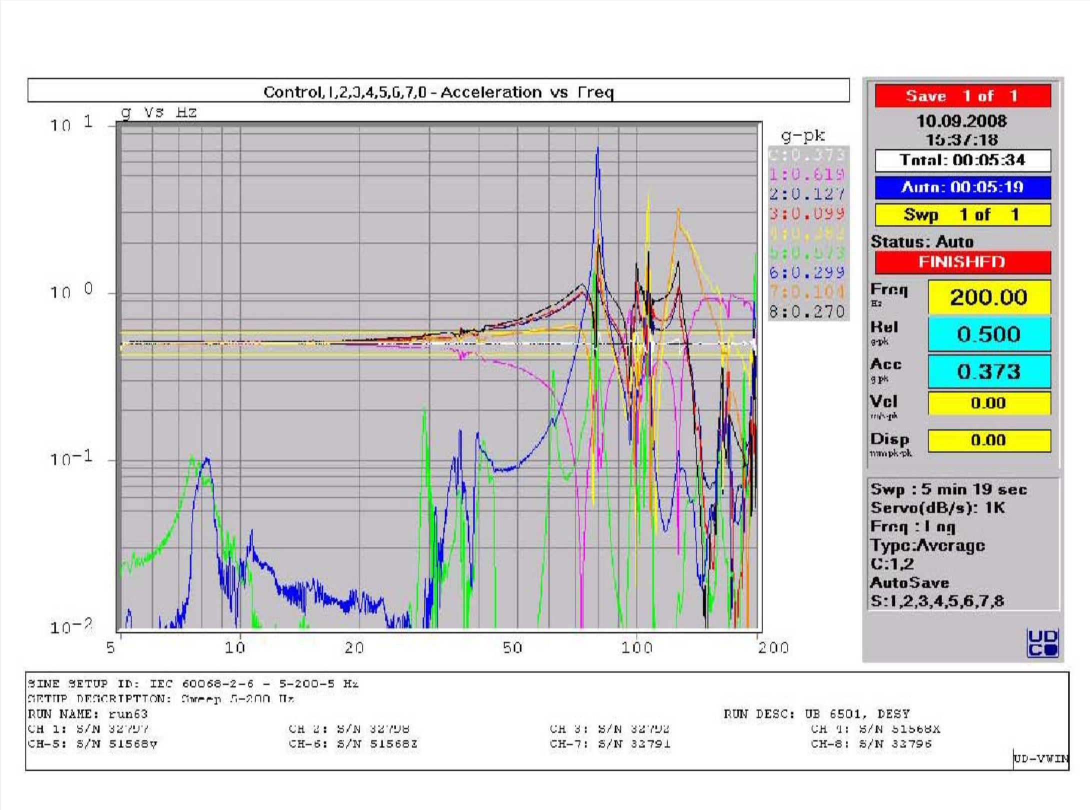
b) Transport simulation (1h ≈ 400km)

i) Shock tests of 11ms (84x4g, 42*5g, 12*6g)



Transport simulation – searching the resonances

CV was stimulated with 0.5g and frequencies 5Hz… 200Hz in vertical position:



• main resonance frequency is 80Hz

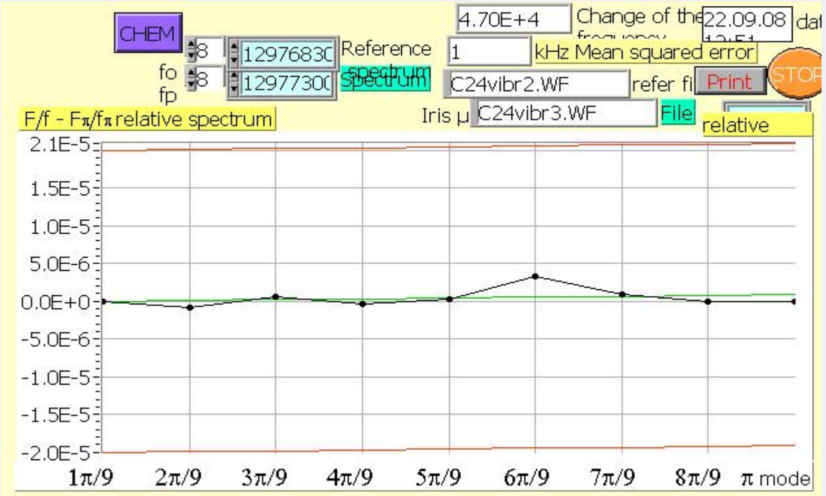
• further one at 104Hz bzw. 124Hz

Transport simulation – Mode measurement

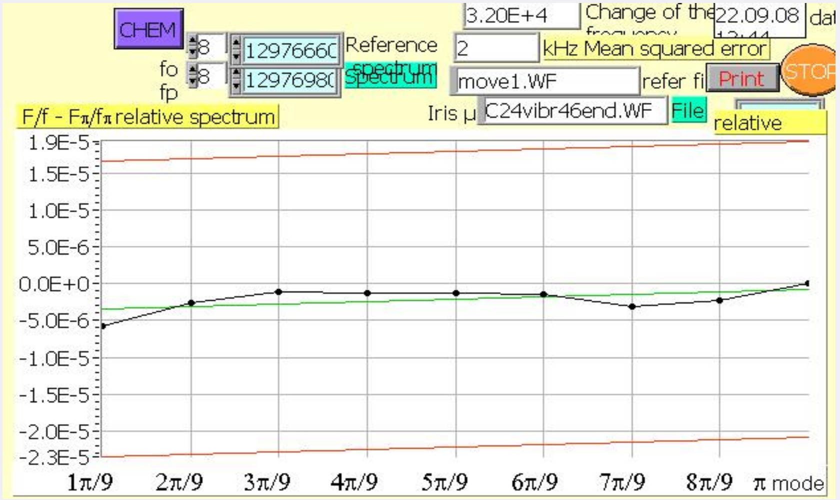
- Several mode measurements during the tests done:

=> no significant mechanical deformations of the CV

=> to be repeated with a rf tested cavity !



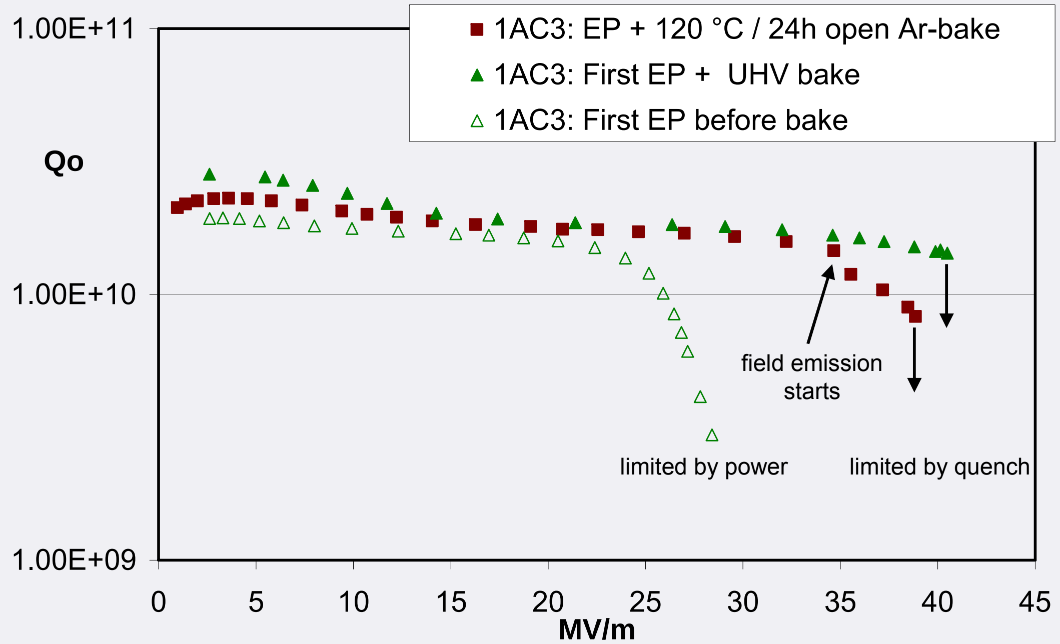
Startmessung

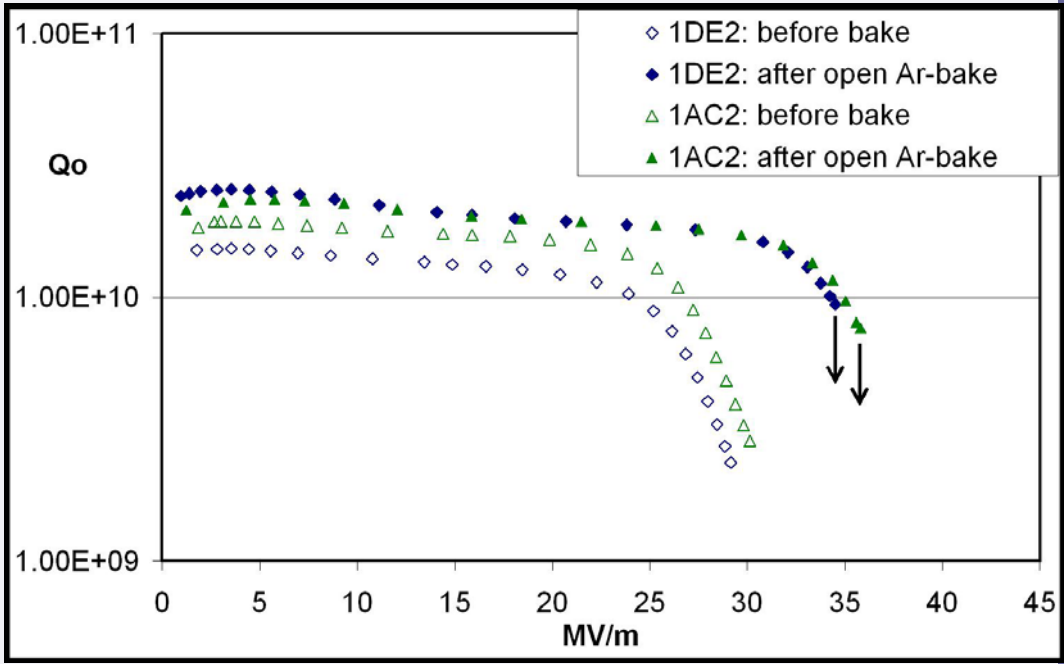


Abschlussmessung

Open 120 °C bake in Argon atmosphere (LINAC08, THP015)

- Successful tests of open Ar-bake after final EP (left) + final short BCP (right):





Advantages of open Ar-Bake:

- Simple implementation in the cavity preparation sequence before final HPR
- No additional vacuum handling of the fully assembled cavity + no additional thermal stress of the gaskets
- Commercial vacuum drying cabinet instead of special set-up

Large Grain Nb: Update

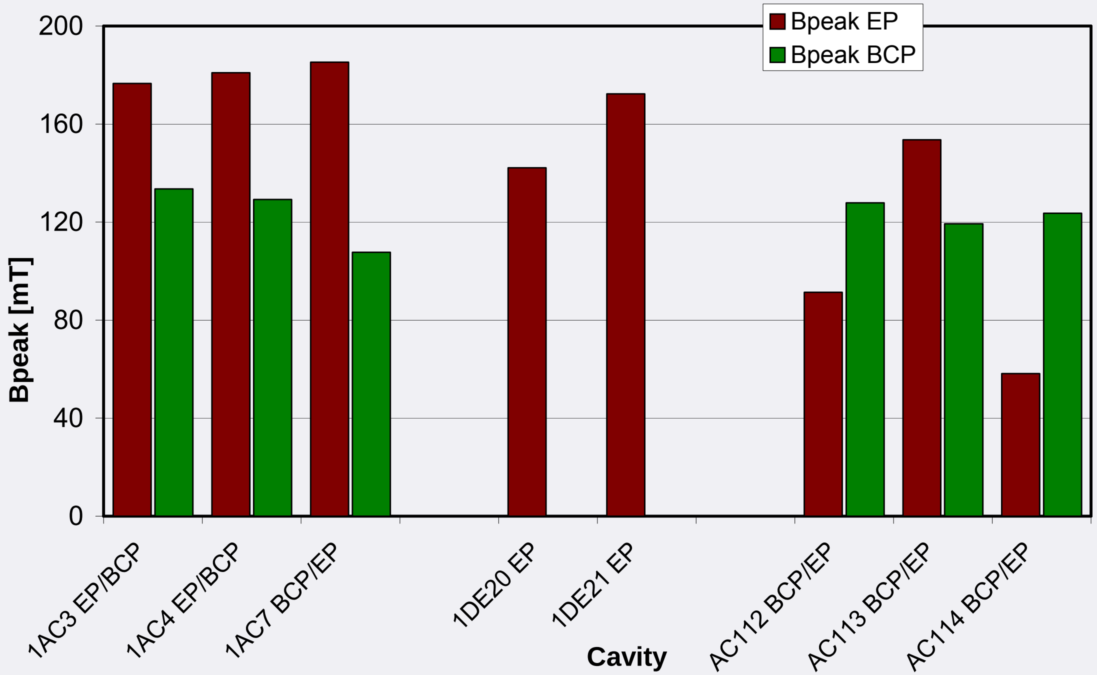
(LINAC 08: THP016)

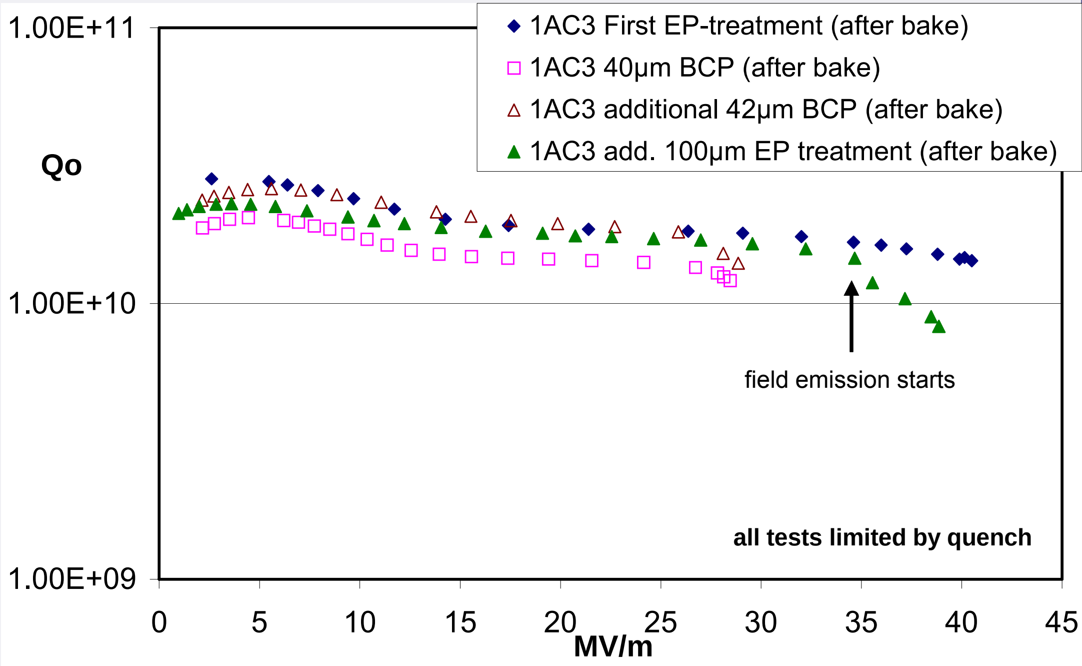
- Three nine-cells (AC112 – AC114) + five single-cells of large-grain Heraeus

		1AC3	1AC4	1AC7	1DE20	1DE21	AC112	AC113	AC114
EP before bake	Eacc	28 (FE)	29 (pwr)	-	-	-	-	-	-
	Qo	3e9	3e9	-	-	-	-	-	-
+ bake (+ HPR for 1AC3)		41 (BD)	37 (BD,fe)	-	33 (BD)	39 (BD)	-	-	-
		1,4e10	6,3e9	-	1,4e10	1,1e10	-	-	-
+ BCP (~40µm or pure BCP) + HPR		31 (pwr)	30 (pwr)	25 (BD)			30 (BD)	27 (BD)	29 (BD,fe)
		2,2e9	2,2e9	1,5e10			6,6e9	1,7e10	7,3e9
+ bake		29 (BD)	28 (BD)						
		1,2e10	1,2e10						
+ BCP (~40 µm) + HPR + bake		29 (BD)							+20 µm BCP: 27 (BD)
		1,4e10							1,6e10
+ EP (~100µm) + HPR + bake		39 (BD, fe)	41 (BD)	27 (BD, fe)			20 (FE)	+ 48 µm EP: 37 (pwr,fe)	14 (BD)
		8,3e9	1,3e10	1,5e10			1.9e9	6,5e9	1,6e10
+ EP (~20µm) + HPR +bake				43 (BD)			+90 µm EP: 17 (FE)	-	
				1,4e10			1,5e9	-	

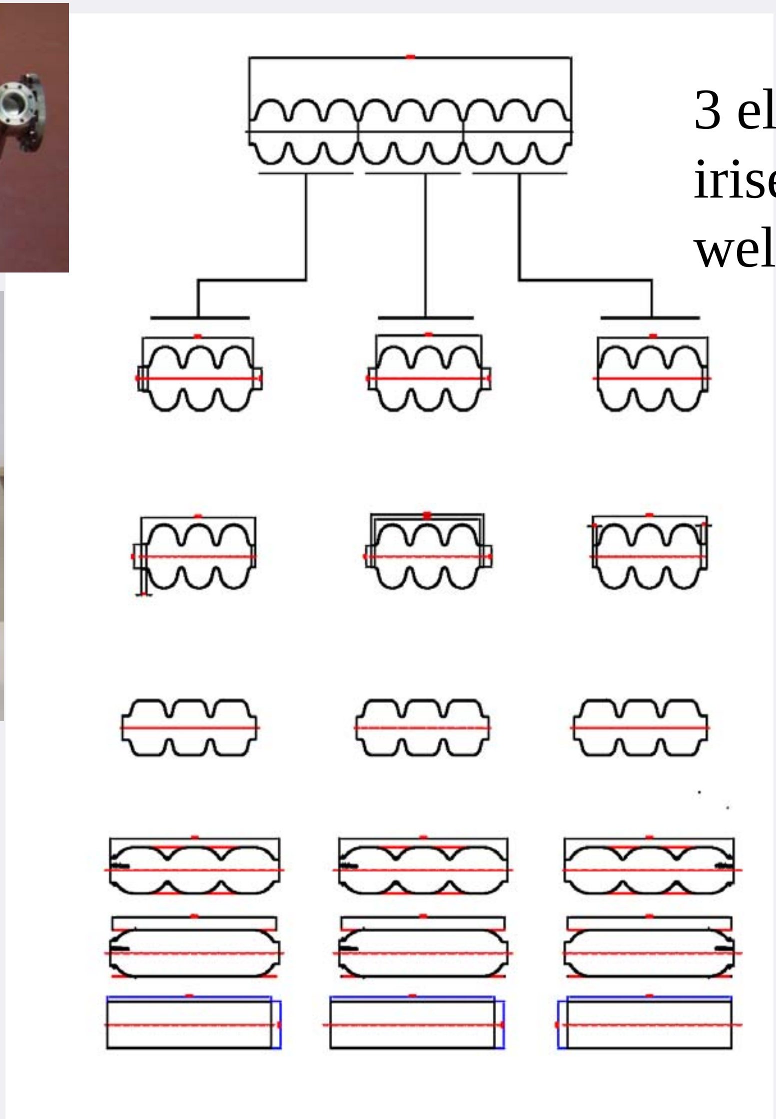
Large Grain Nb: EP vs. BCP

- **Final BCP** (> 40 µm removal) : reproducible gradients of **(25 – 30) MV/m**
- **Final EP** (> 40 µm removal) : gradients of **(33 – 43) MV/m in 6 of 8 cavities**
  but: two nine-cells with low gradient (1x FE; 1x BD) => new preparation
- **Full EP – BCP – EP cycles** in 2 single-cells: **gain of > 10 MV/m after EP**
- **Characteristic scrf parameters identical to fine grain !**





Hydroformed ("seamless") cavity (LINAC08: THP043)



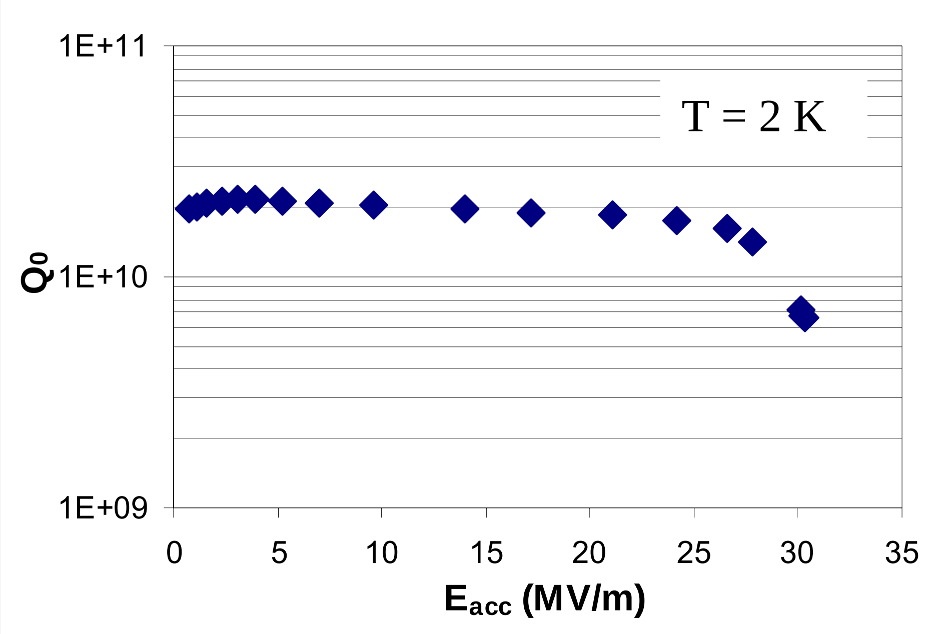
3 electron-beam welds at irises + stiffening rings + welded end-groups

Hydraulic expansion of the equator

Tube reduction at iris

Hydroformed (“seamless”) cavity: rf result

- Surface treatment at DESY:
  - 40 µm BCP, 800 °C heat treatment, tuning
  - 170 µm Electropolishing (EP), ethanol rinsing, 800 °C heat treatment
  - 48 µm EP, HPR, assembly and evacuation



- Status: He-tank welding done; 120 °C bake on the way
=> new rf test upcoming

Thanks!

Thanks to all external and internal colleagues, who provided me data, plots, information or any other support !!

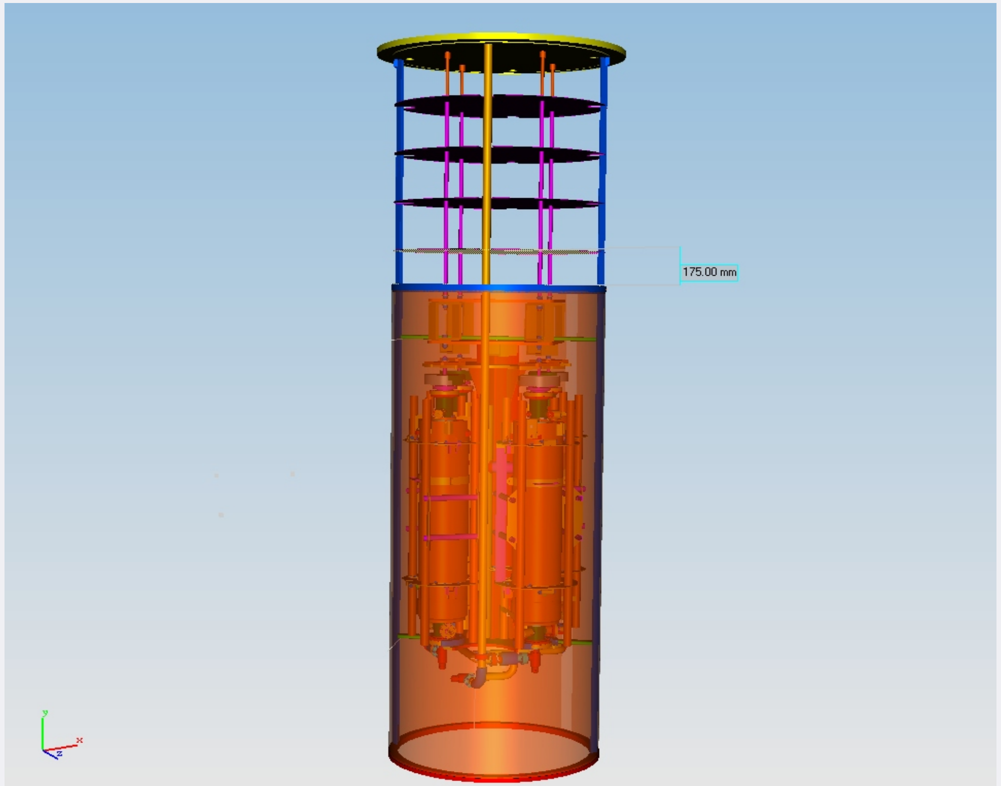
Addendum:

Additional transparencies for explanation!

Design of the inner magnetic shielding

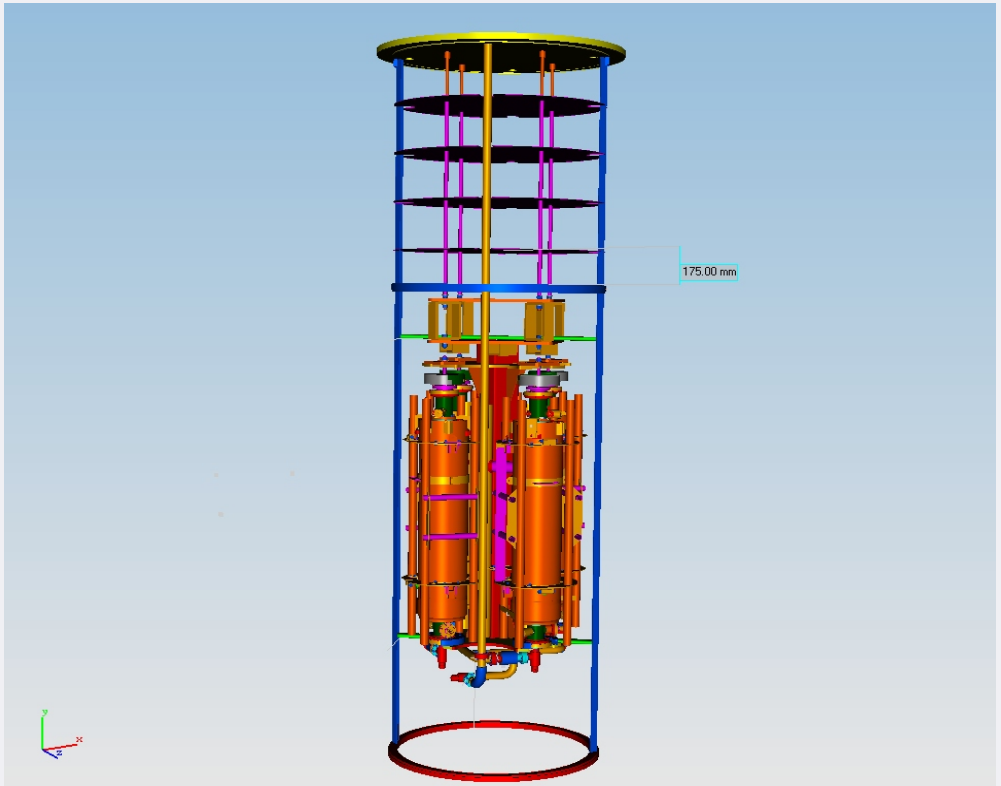
The shield is fixed inside the cryostat.

The cylinder is closed on the bottom and ends on the top to have enough space for the He-supply and -return line.



Sliding system

The insert can be moved into the cryostat with a sliding system (two rails)



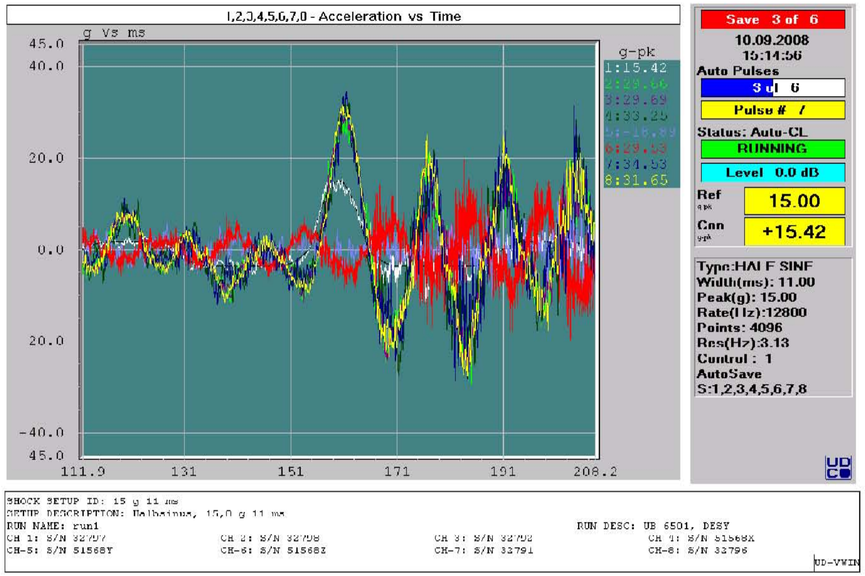
Transportsimulation at BFSV

Picture: complete test area

Transport simulation – vertical shock test

Excitation with 15g (11ms):

-> gain on the CV of
factor 2 (up to 30g)



Transport simulation - next

Are further tests on a CV with a higher gradient necessary?

Has the transportation influence on the gradient?

Goal:

Transport test on a measured CV (25MV)

cost €1200

-> 2nd cold measurement and comparision