New Cavity Shape Developments for Low Beta Applications

September 25th 2009

14th Conference on RF Superconductivity

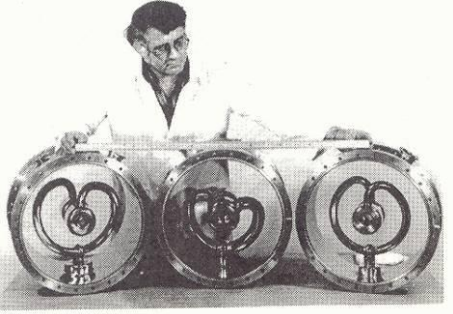
Berlin/Desden

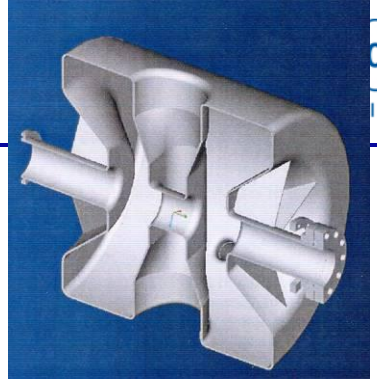
H. Podlech

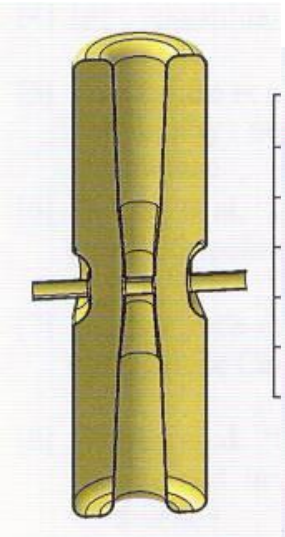
Institute for Applied Physics (IAP)
Goethe University Frankfurt

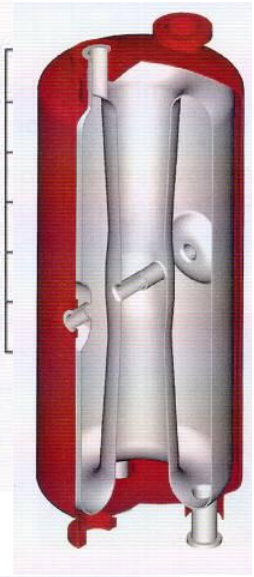
Overview

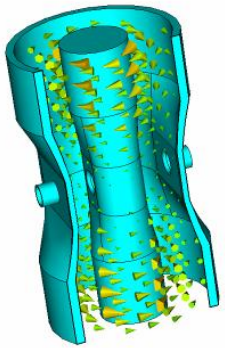
- Ladder-Resonator
- CH-Structure
- cw Linac for Super Heavy Elements
- Nuclear Waste Transmutation (EUROTRANS)

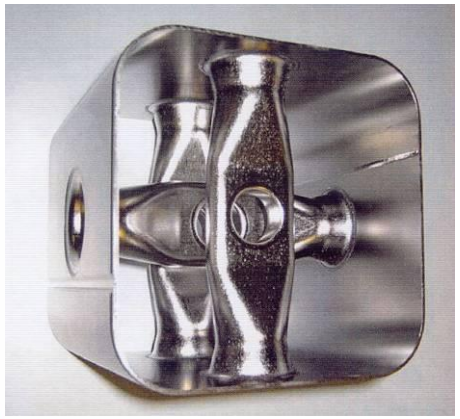


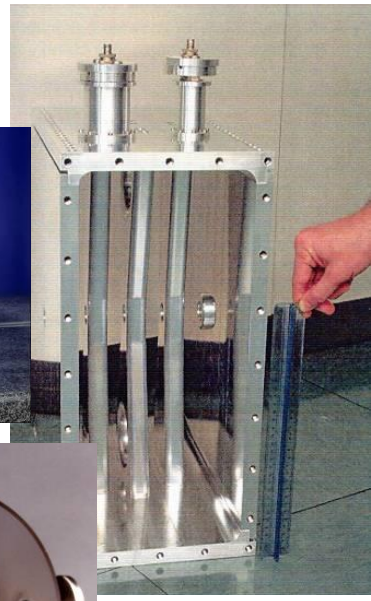


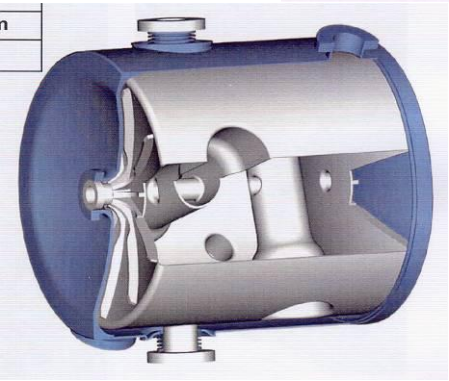


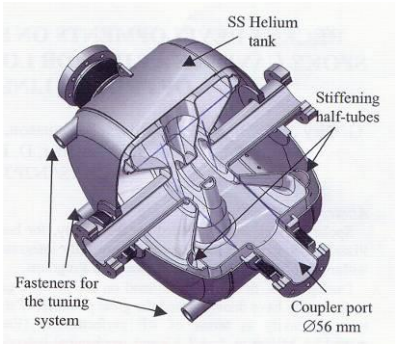


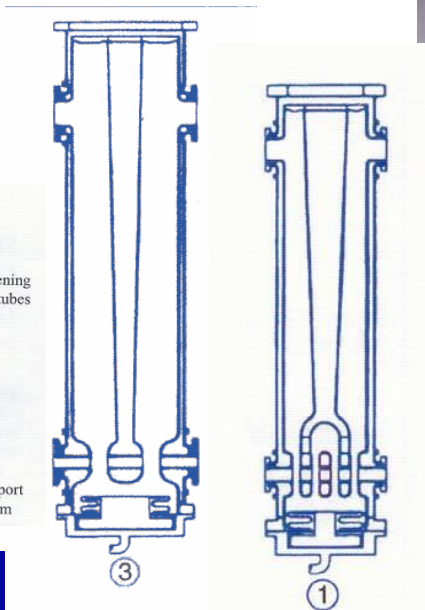


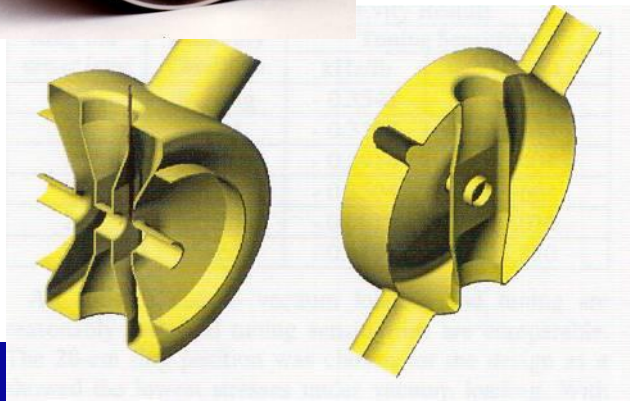







SS Helium tank
Stiffening half-tubes
Fasteners for the tuning system
Coupler port Ø56 mm


3
1



Papers related to Low-β-Cavities at SRF 2009

MOOCAU04
MOOCAU05
MOODAU03
MOODAU04
MOODAU05
TUPPO003
TUPPO009
TUPPO011
TUPPO016
TUPPO025
TUPPO029
TUPPO031
TUPPO062
THOAAU06

THOBAU04
THOBAU05
THPPO010
THPPO011
THPPO012
THPPO013
THPPO014
THPPO015
THPPO016
THPPO017
THPPO019
THPPO020
THPPO021
THPPO026

THPPO027
THPPO028
THPPO093
FROAAU01
FROAAU02
FROAAU05
FROBAU03

"Conventional" Superconducting Low-β-Cavities

Most of the existing superconducting low-β cavities are QWR or HWR

Alpi INFN Legnaro: QWR/HWR (80-160 MHz)

Spiral-2 : QWR (88 MHz)

IFMIF: HWR (175 MHz)

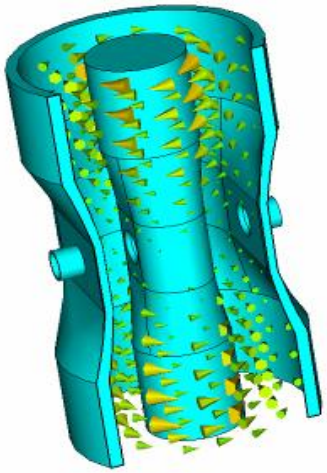
SARAF: HWR (160 MHz)

ISAC-II: QWR (106 MHz)

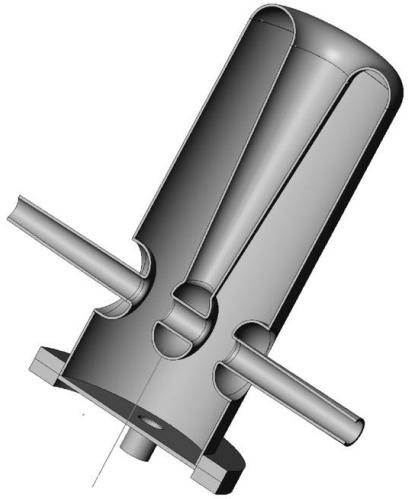
FRIB: QWR, HWR (80.5-322 MHz)

MSU ReA3: QWR (80.5 MHz)

HIE ISOLDE at CERN: QWR (101 MHz)

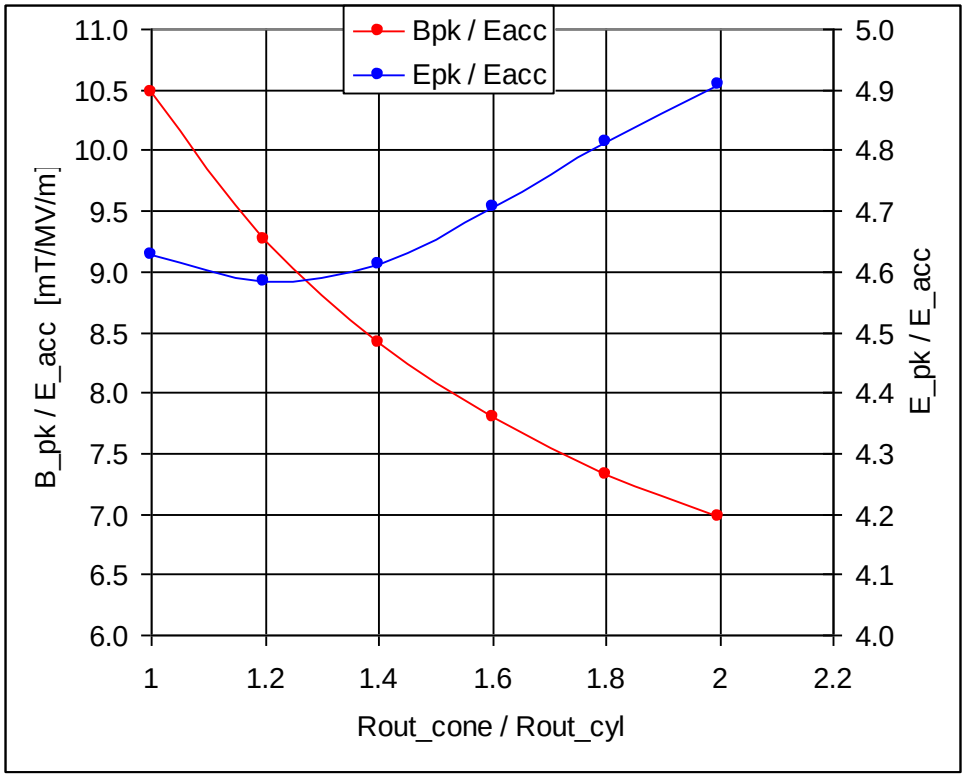


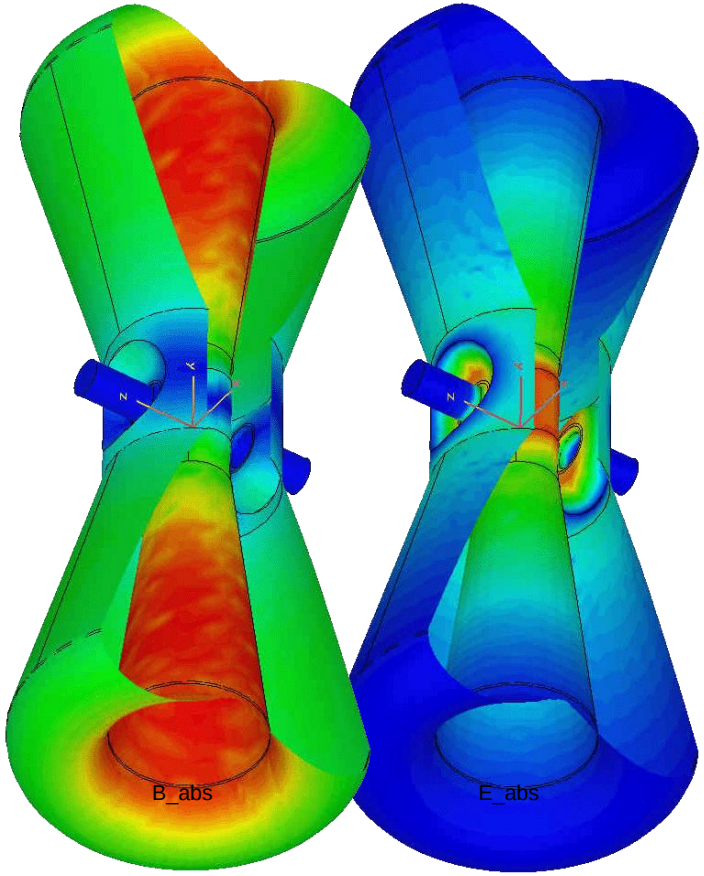
MSU
f=322 MHz
β=0.28



Spiral-2
f=88 MHz
β=0.07

Improvements on Half-Wave-Resonators





175 MHz HWR, β=0.094
Conical-HWR

E. Zaplatin THPPO014

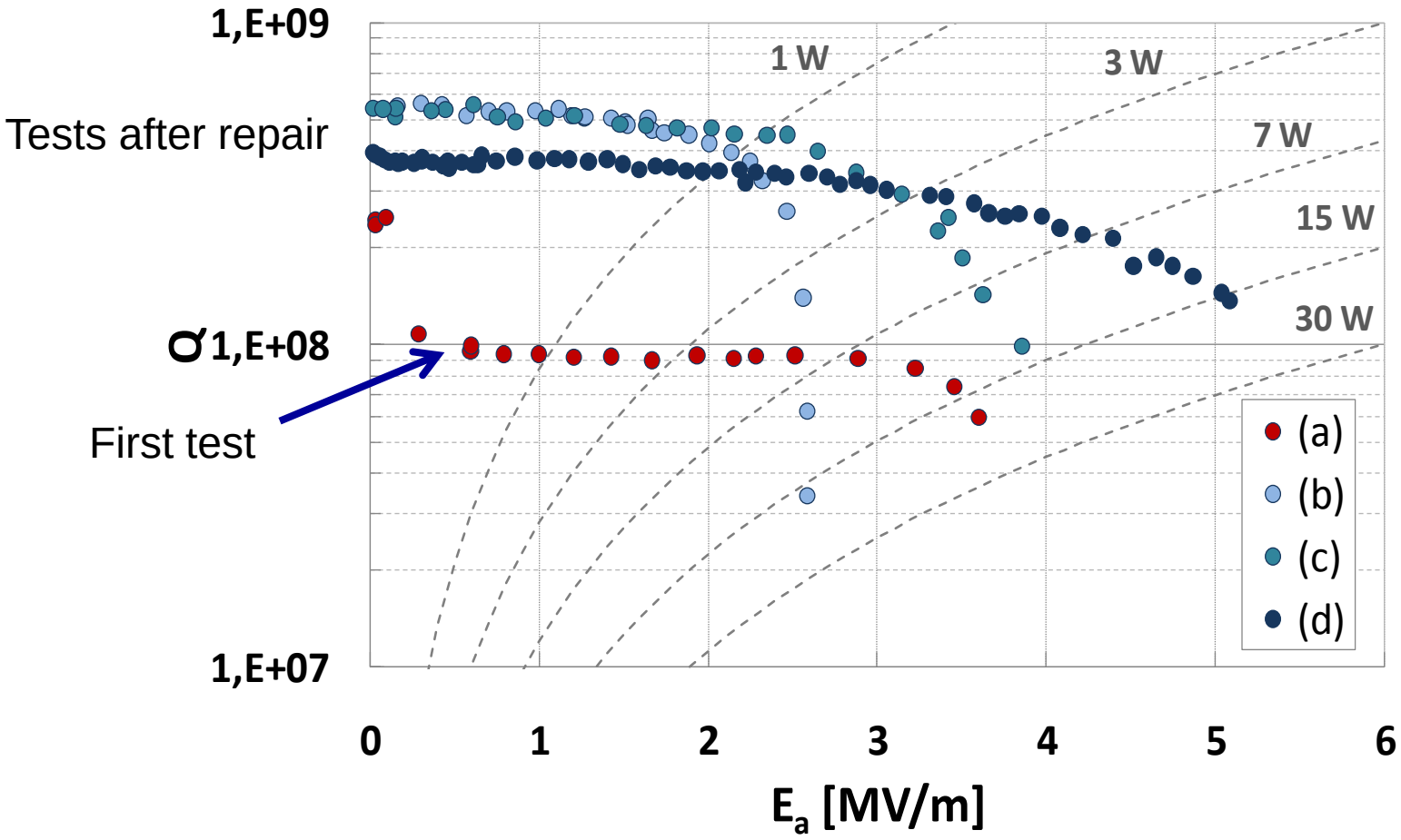
The Ladder-Resonator

A 4-gap Ladder-Resonator has been developed at INFN Legnaro for β=0.12 and f=352 MHz

	COMSOL 3.5	HFSS 11.1
RF Coupling	1.2%	1.2%
Ep/Ea	4.0 (±0.6)	3.7 (±0.3)
Bp/Ea [mT/(MV/m)]	9.0	8.8
Bjoint [μT]	182	188
G [Ω]	35.8	36.5
U/E^2_a [mJ/(MV/m)^2]	38	38
L_{active}	193 mm	

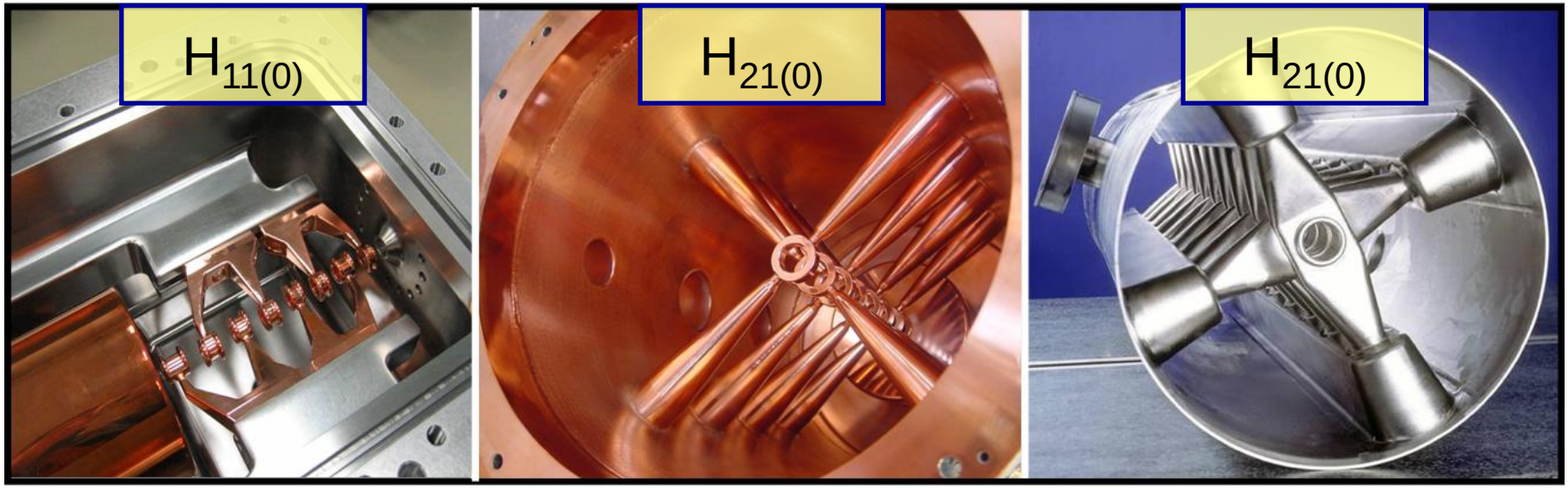
G. Bisoffi THPPO019

Test of the Ladder-Resonator

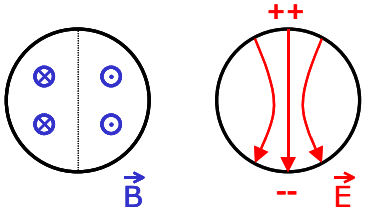


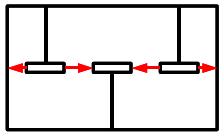
G. Bisoffi THPPO019

The Family of H-mode DTL Cavities



r.t. IH-DTL

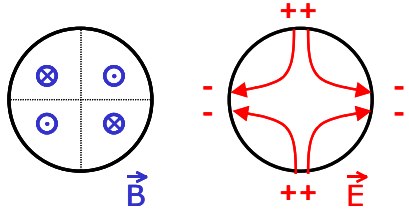


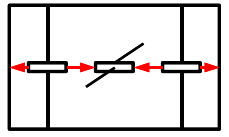


Interdigital H-Mode (IH)

r.t. CH-DTL

s.c. CH-DTL



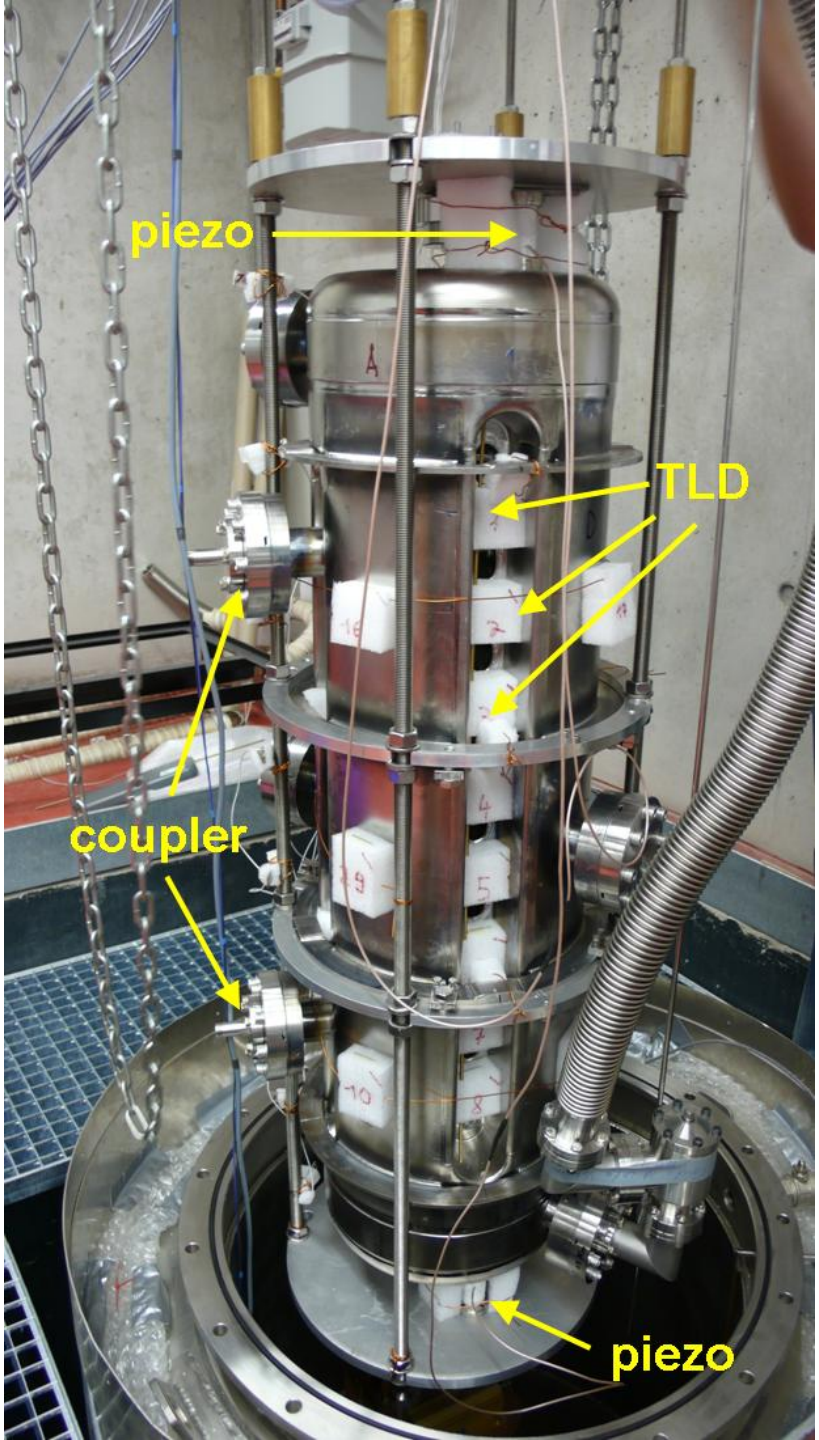


Crossbar H-Mode (CH)

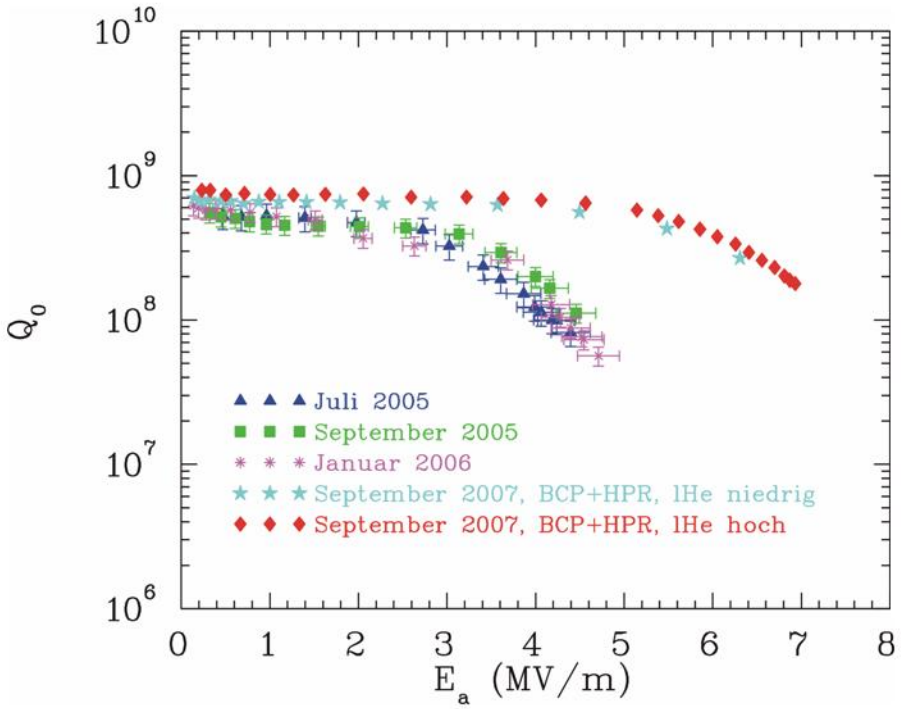
Superconducting CH-Prototype

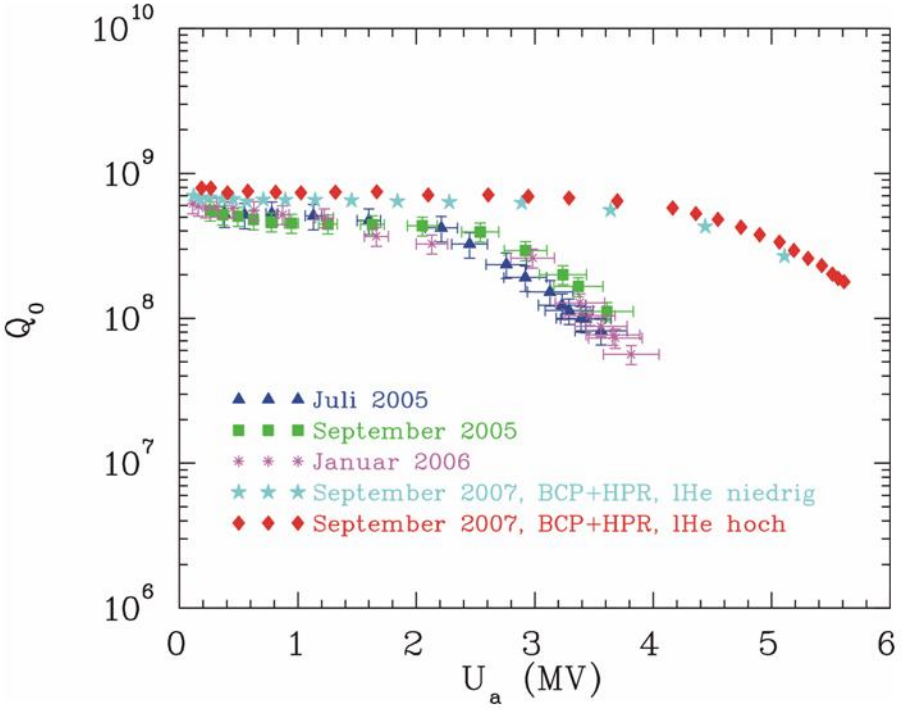
The first sc „real“ **multi cell** cavity for the low energy range

Gap number	19
Length (mm)	1048
Frequency (MHz)	360
β	0.1
E_p/E_a ($\beta\lambda$-definition)	5.2
B_p/E_a [mT/(MV/m)]	5.7
$G=R_sQ_0$ (Ω)	56
R_a/Q (Ω) (T incl.)	3180
$(R_a/Q)G$ (Ω^2)	178000
Q_0 (BCS, 4.2K, 360 MHz)	1.5×10^9
Q_0 (total R_s=88 nΩ)	6.8×10^8
W [mJ/(MV/m)^2]	92


piezo
TLD
coupler
piezo

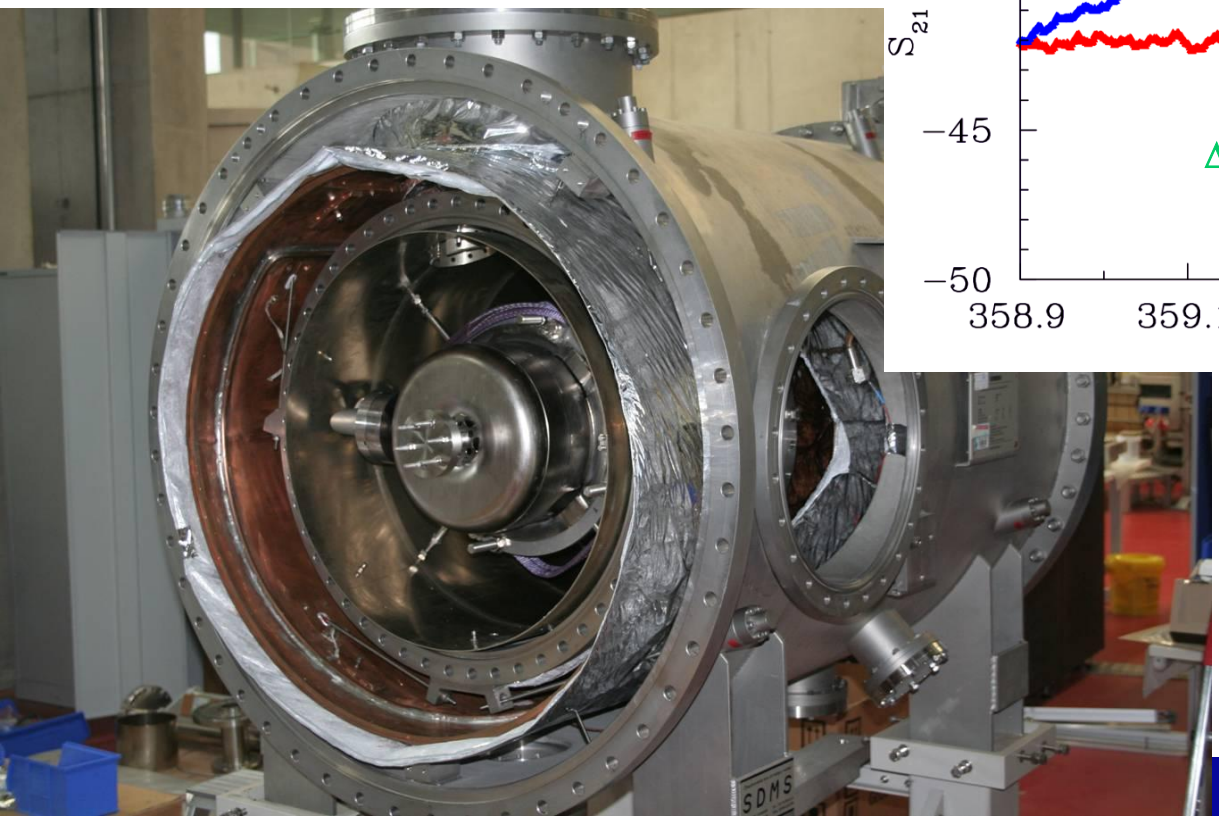
Performance of the First CH-Protoype

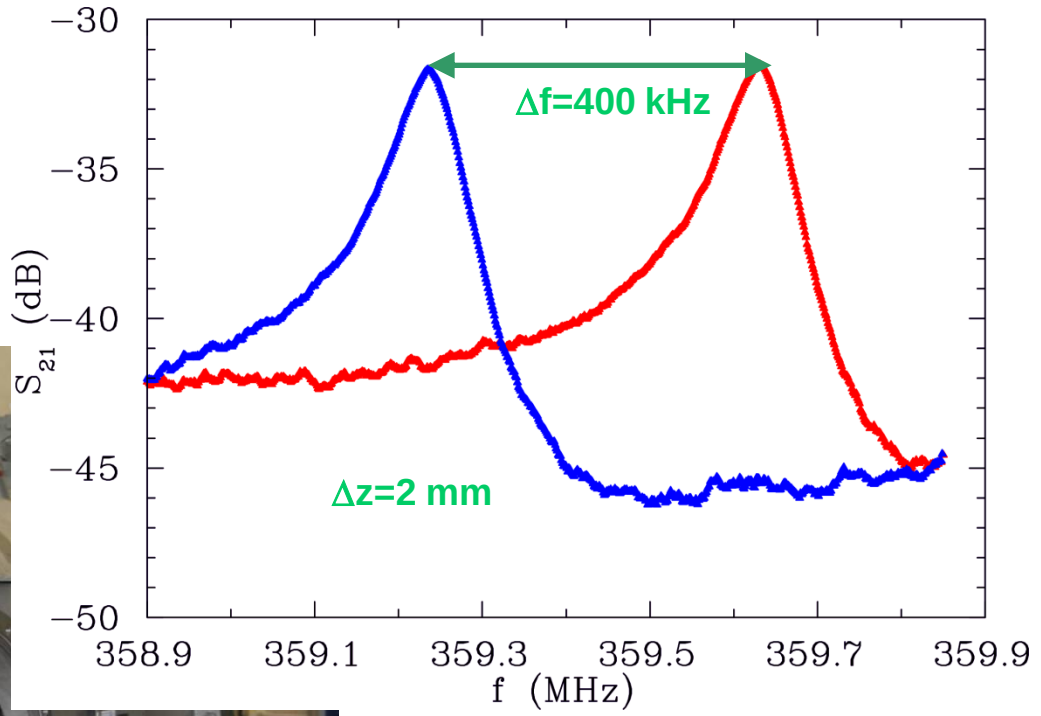




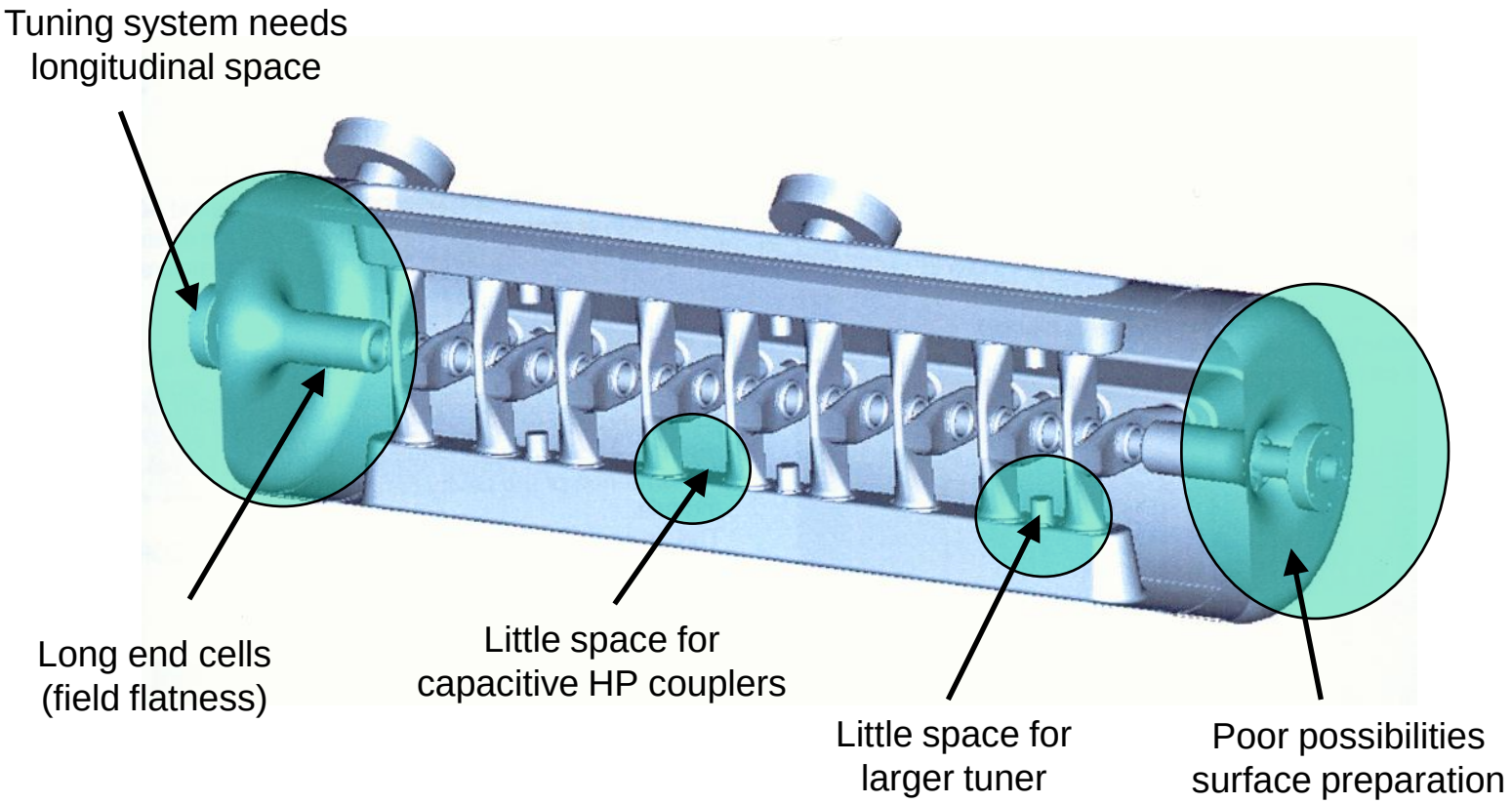
E_a=7 MV/m E_p=36 MV/m B_p=40 mT Q_0=6.8e8 (low fields)

First Horizontal Tests (Slow Tuning)





„Weak Points“ of the Superconducting Prototype Cavity:



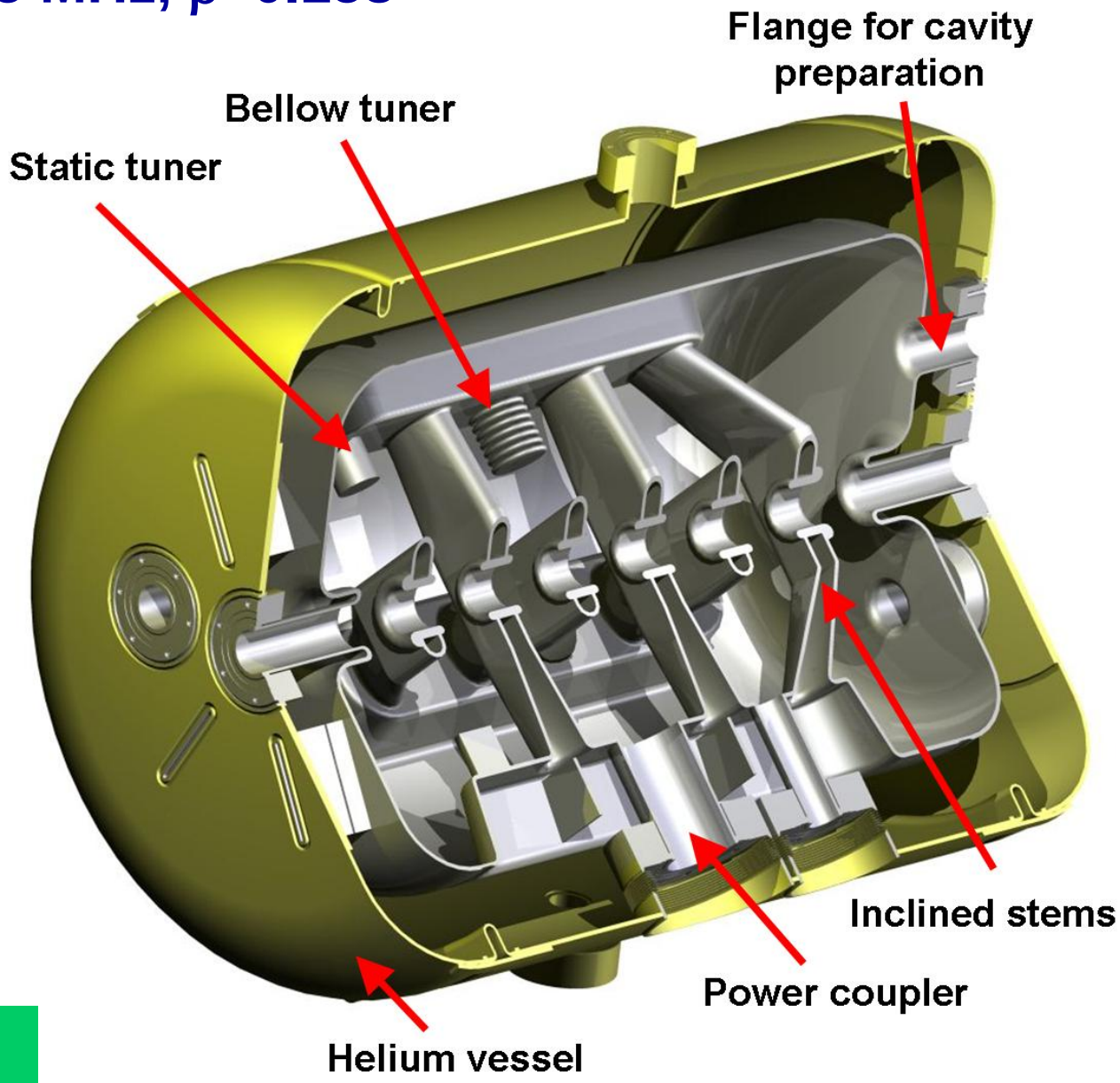
New sc CH-cavity 325 MHz, β=0.158

Material ordered

Production will start this year

Beam test in 2011 at GSI

Gap number	7
Length (mm)	550
Frequency (MHz)	325
β	0.158
E_p/E_a (βλ-definition)	5.1
B_p/E_a [mT/(MV/m)]	13
$G=R_sQ_0$ (Ω)	64
R_a/Q (Ω) (T incl.)	1250
$(R_a/Q)G$ (Ω^2)	80000
Q_0 (BCS, 4.2K, 325 MHz)	1.9×10^9
Static tuner	4
Bellow tuner	2



THPPO016, M. Busch et al.

Applications

CW Linac for Super-Heavy-Element Production

EUROTRANS

Sc cw-Linac for Super Heavy Element Production (SHE) at GSI

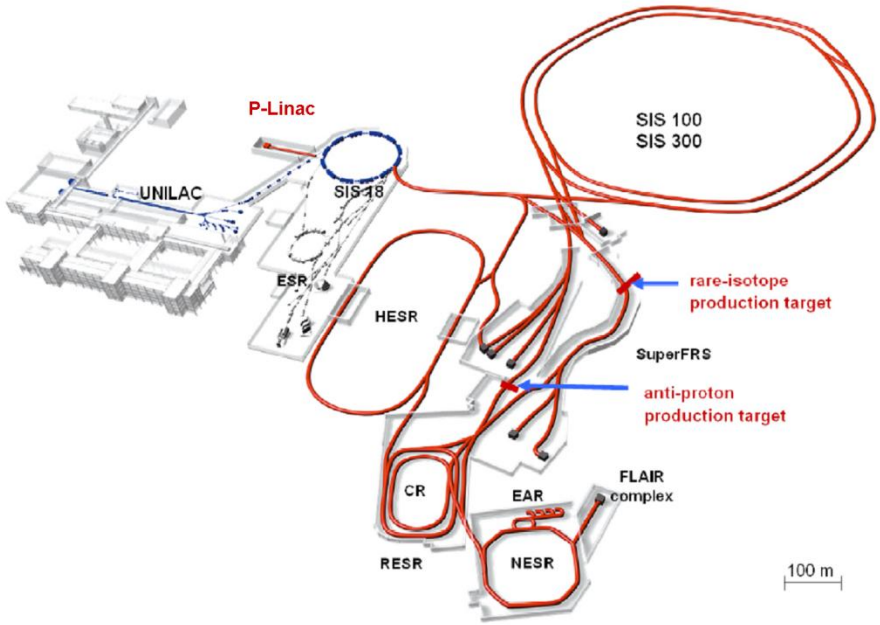
110
Ds
(281)

Super Heavy Element Research at GSI

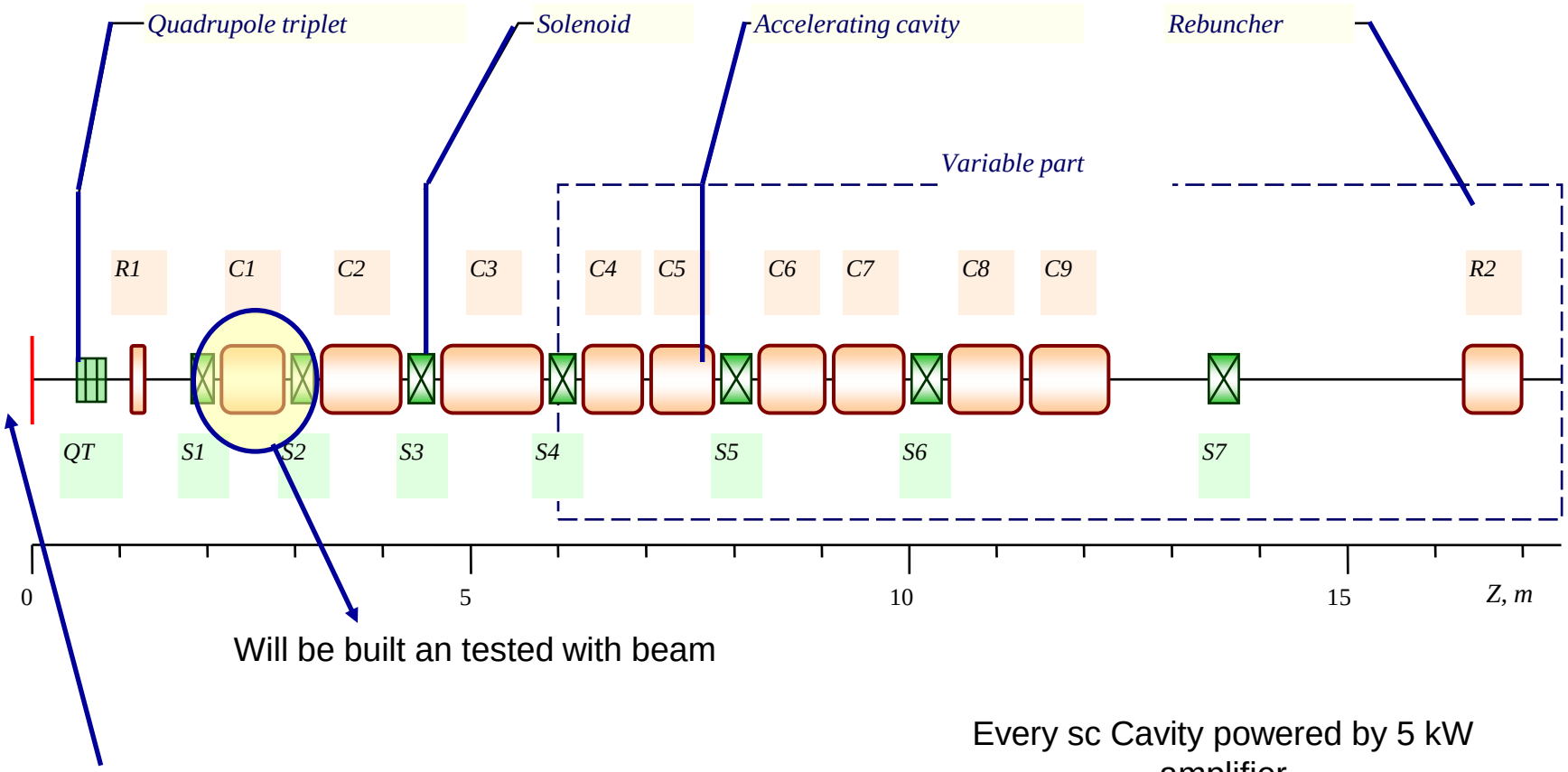
Element „Darmstadtium“

SHE research is contrary to FAIR operations

Dedicated cw linac



Sc cw-Linac for Super Heavy Element Production (SHE) at GSI



Will be built an tested with beam

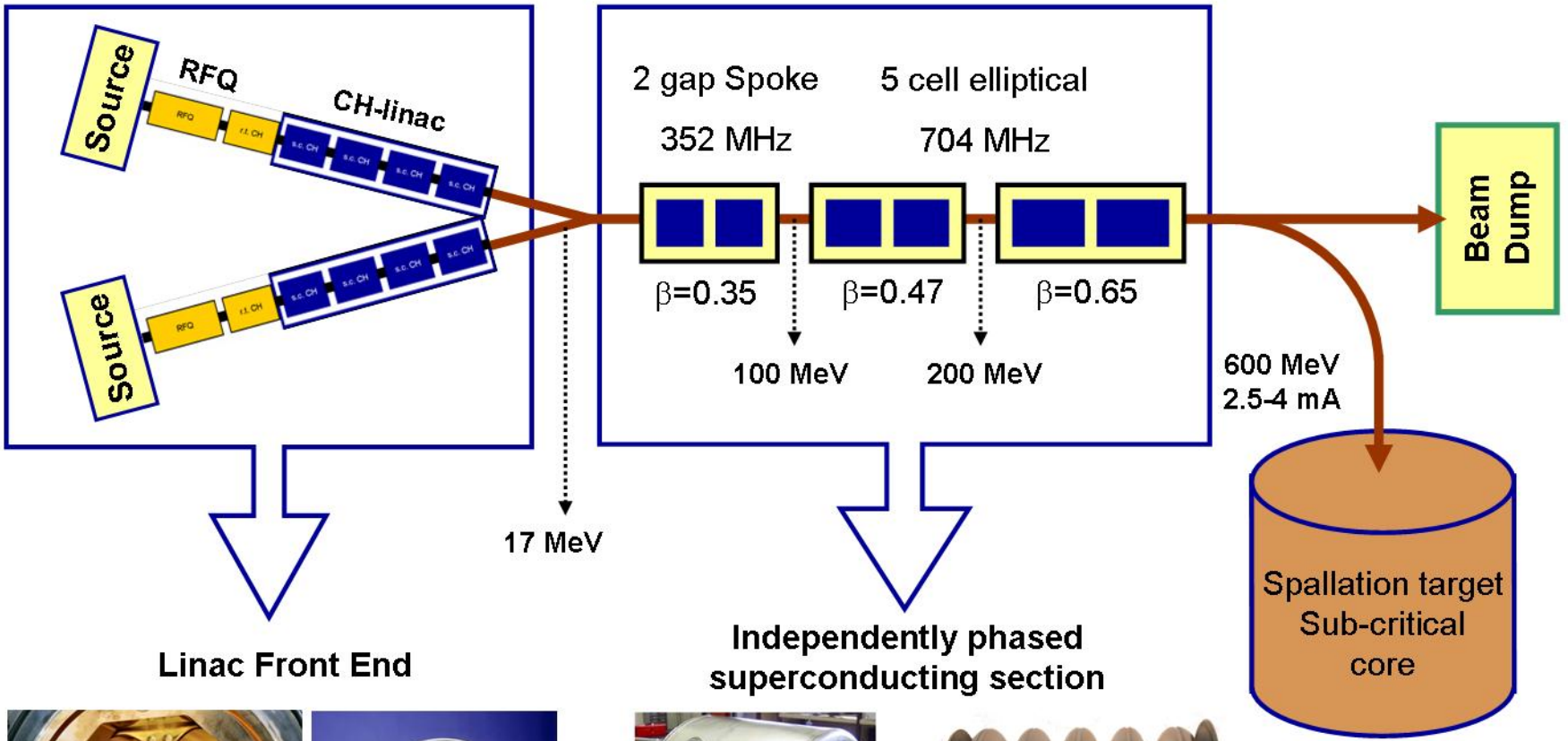
Front End: High-Charge-Injector, 108.48 MHz, E_{out}=1.4 AMeV

W_{max}=7.3 AMeV
f=216.96 MHz
A/Q=6.5

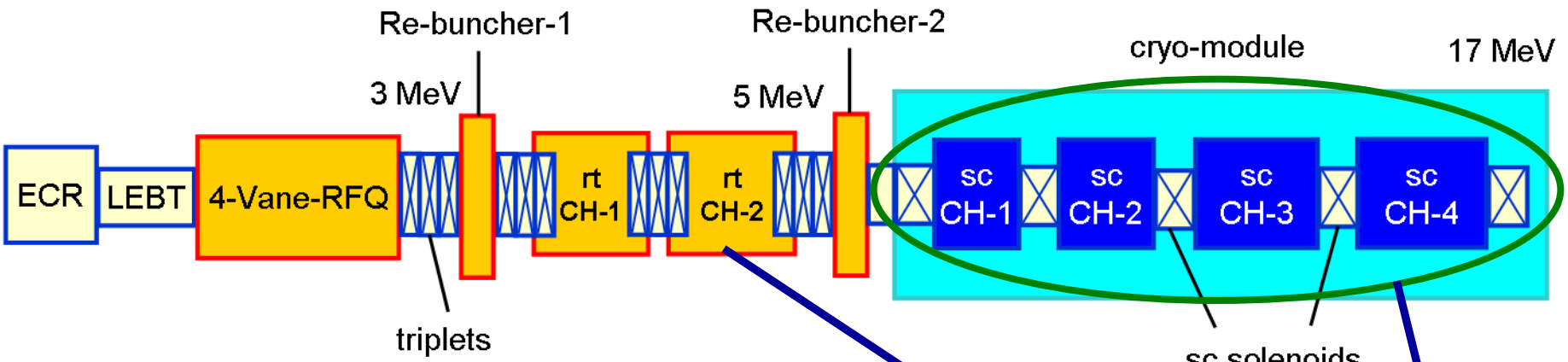
Every sc Cavity powered by 5 kW amplifier

Above W=3.5 AMeV full energy variability

Reference Design EUROTRANS Linac

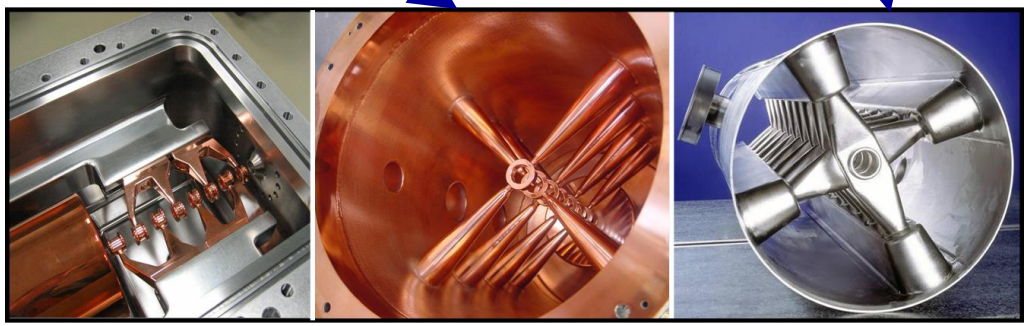


The EUROTRANS 17 MeV Front End



Superconducting CH-cavities

Frequency	352 MHz
Effective voltage	2.5-3.5 MV
Gradient	3.9 MV/m
Nr. of cells:	13-14
Focusing	Sc solenoids



Summary

- **Ladder-Resonator**
- **CH-Cavity**
- **Experimental Results**
- **Applications**

Thank you