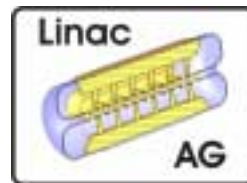


# Development of Superconducting CH-Structures

Holger J. Podlech

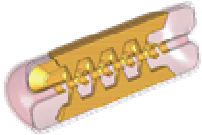
IAP, University of Frankfurt





## Overview

- H-mode cavities
- The CH-structure
- Superconducting CH-structures
- Applications of s.c. CH-structures
- Summary and outlook

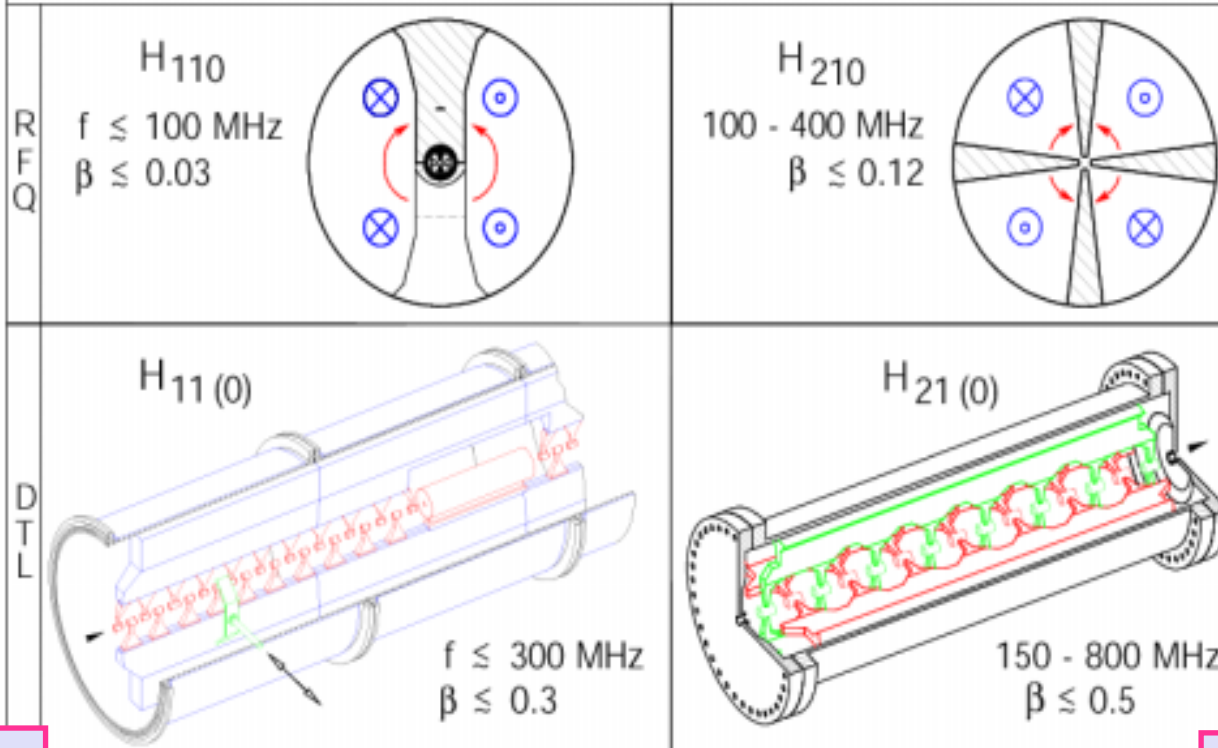


## The Family of H-mode Resonators

IH-RFQ

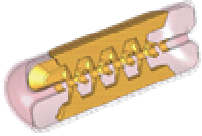
4-vane RFQ

Low and Medium -  $\beta$  Structures in H-Mode Operation



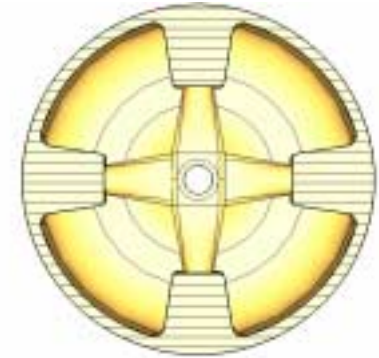
IH-Structure

CH-Structure

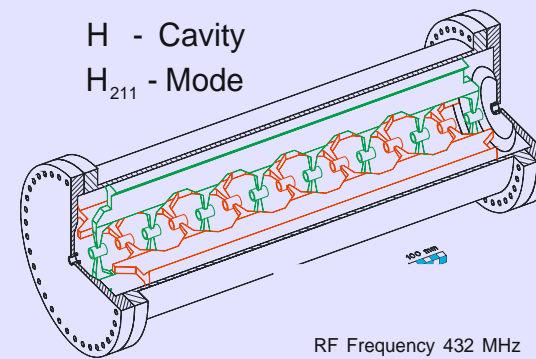


## The CH-Structure

Cross-Bar H-mode-structure



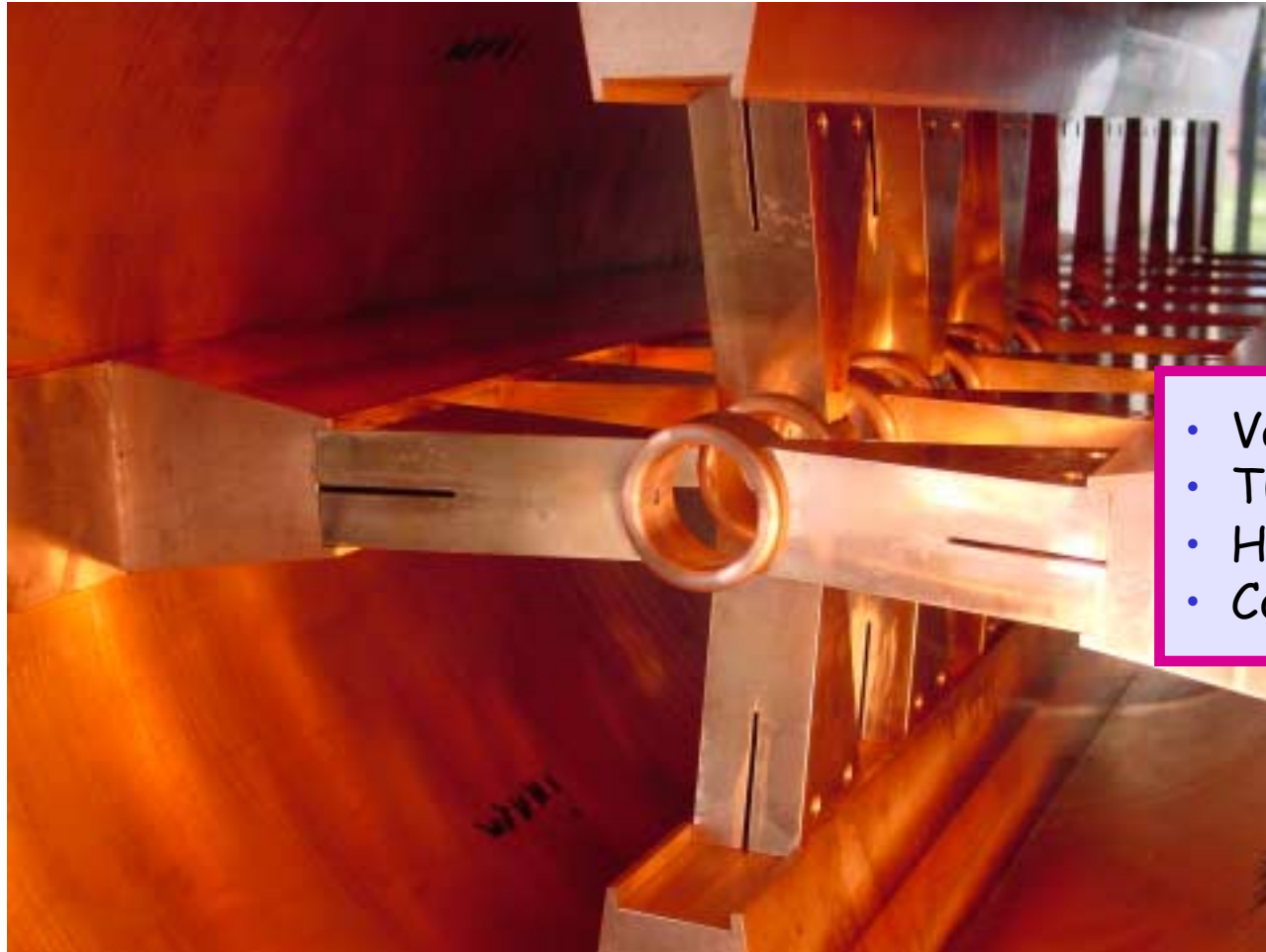
- High efficiency ( $Z$ ) for low and medium energies ( $0.1 \leq \beta \leq 0.5$ )
- Homogeneous distribution of losses
- High real estate gradients
- Possible cw operation
- High mechanical stability
- Room temperature- and **superconducting** operation





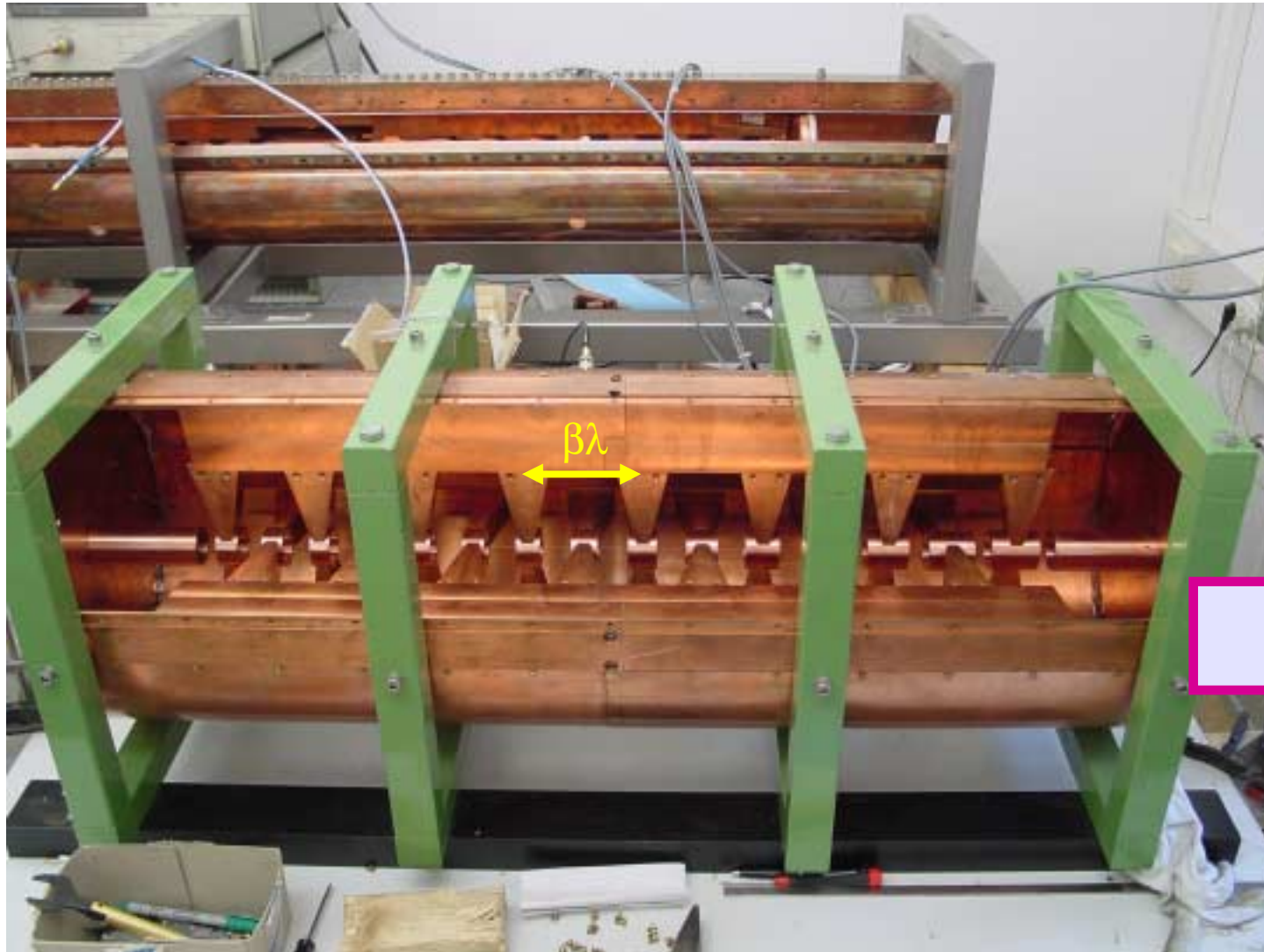
## Efficiency of CH-Structures

- Slim drift tubes (without focusing elements inside)
- Use of KONUS beam dynamics (Combined  $0^\circ$ -Structure)
- Less rf defocusing
- Longer lens free sections (s.c. cavities)
- Higher real estate gradients (long active length)



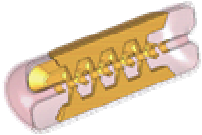
## r.t. CH-Model

- Validation of the Simulations
- Tuning (frequency- und field)
- Higher Order Modes (HOM)
- Coupling

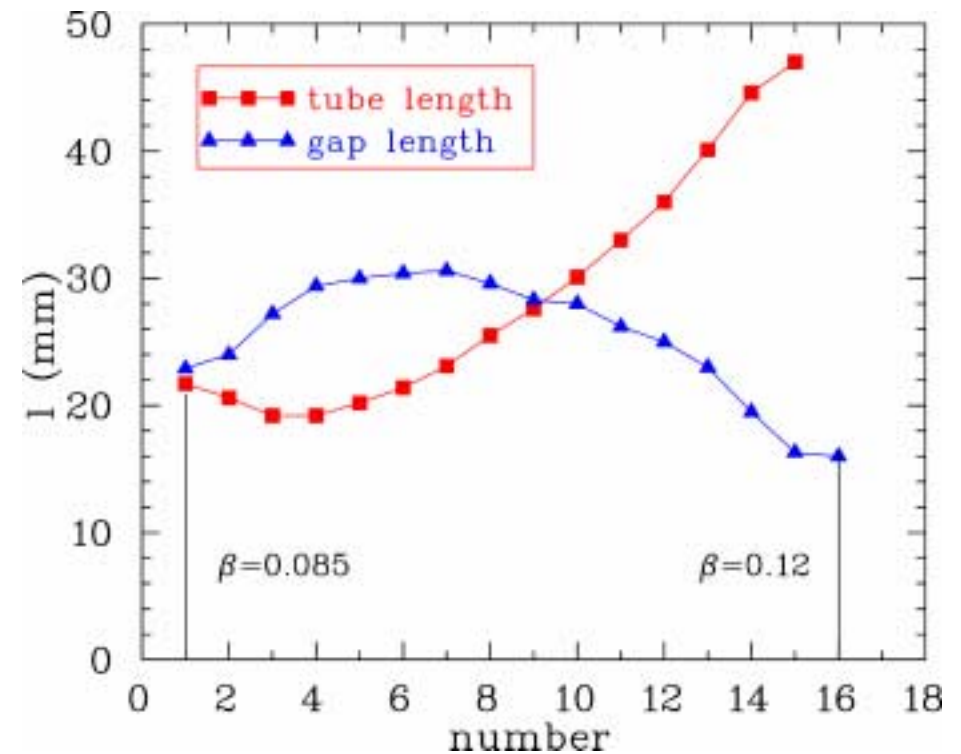
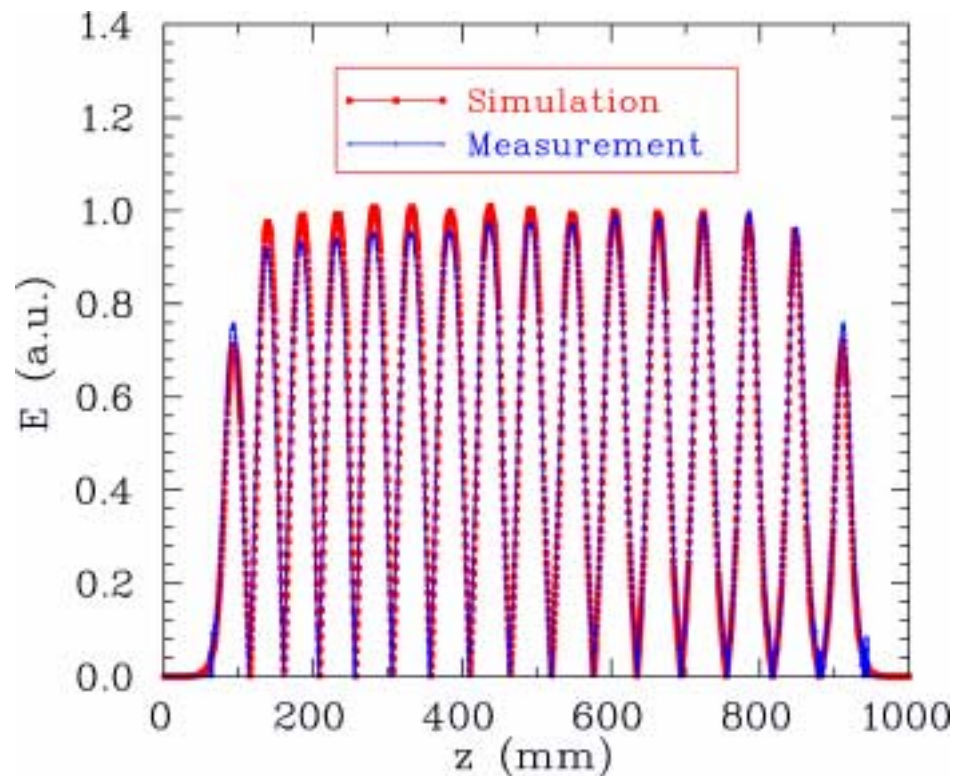


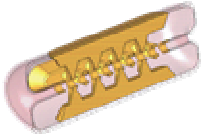
## CH-Model with $\beta$ -profile

$$0.085 \leq \beta \leq 0.12$$

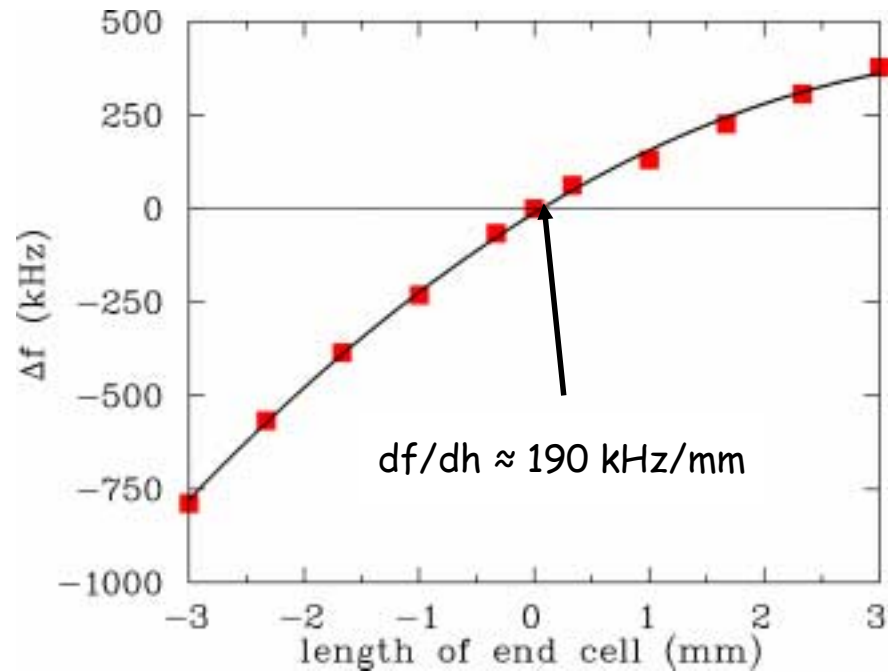


## CH-Model Measurements



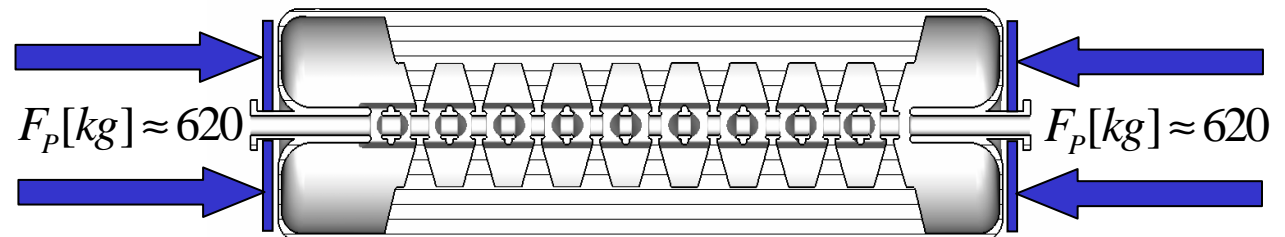


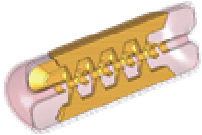
## Tuning of the CH-cavity



Changing the length  
of the end cells

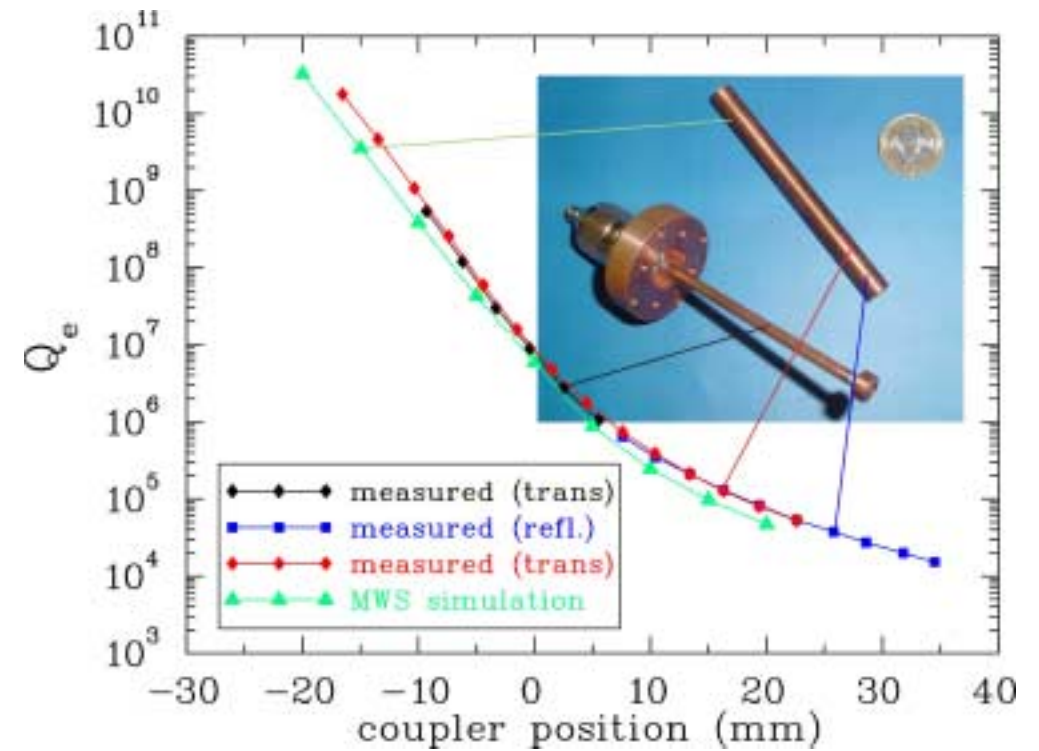
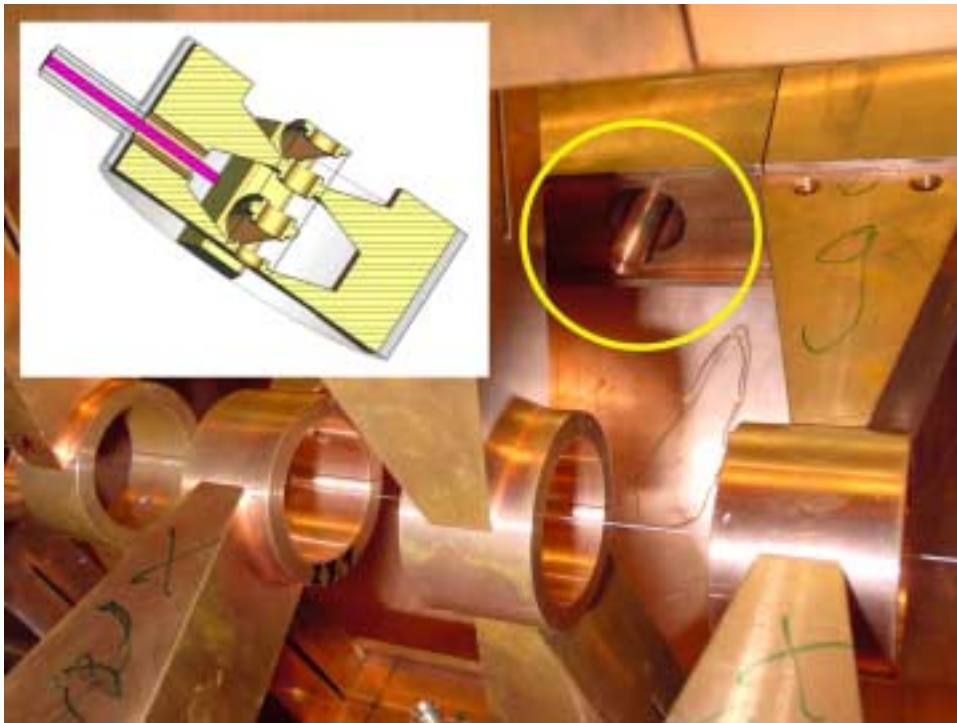
Development of a  
tuner has started  
within HIPPI

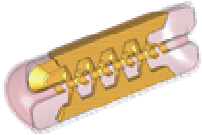




## Coupling rf to the CH-Structure I

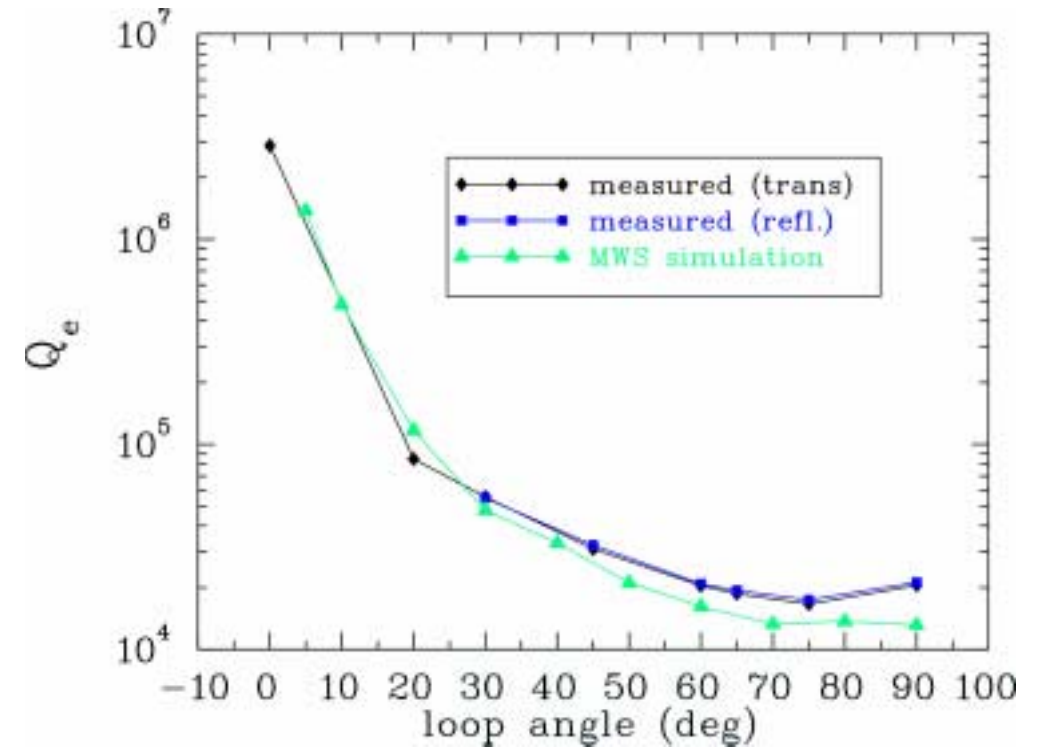
Capacitive coupling

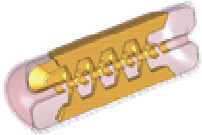




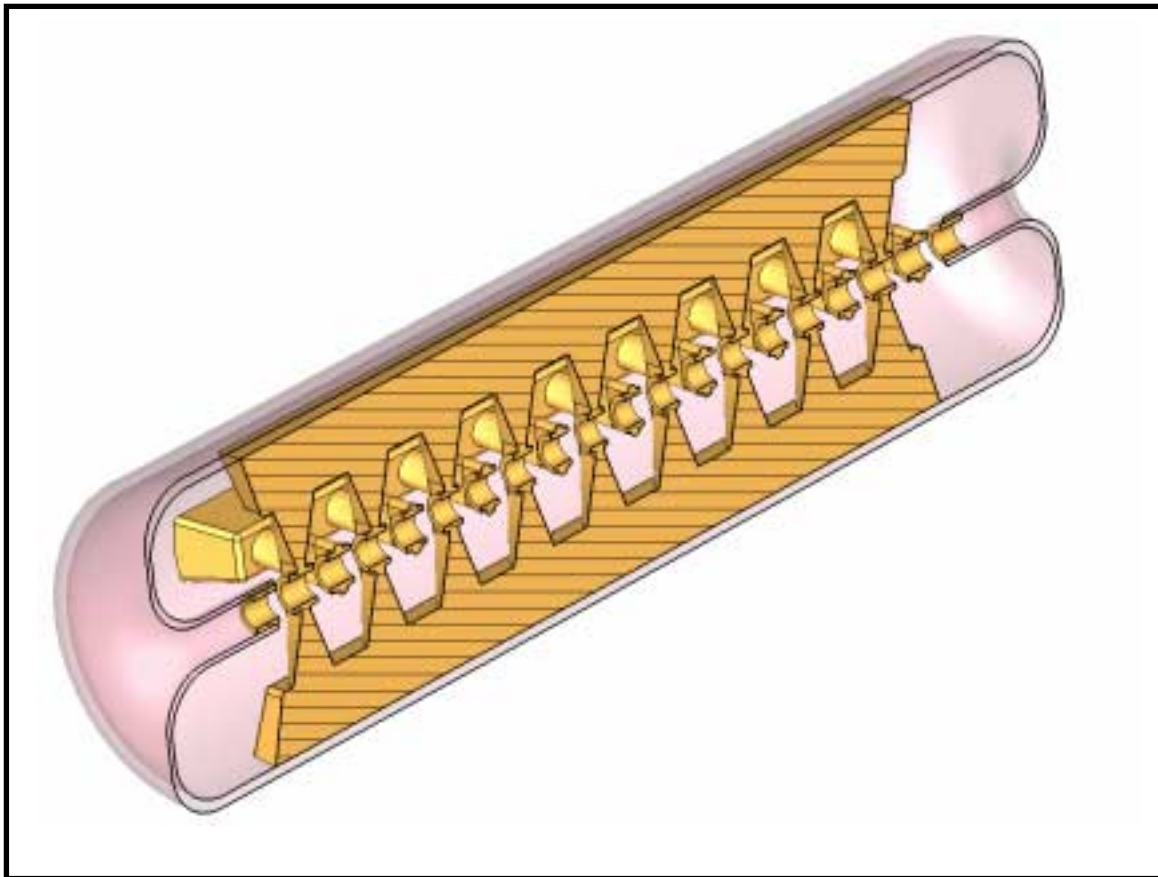
## Coupling rf to the CH-structure II

Inductive coupling





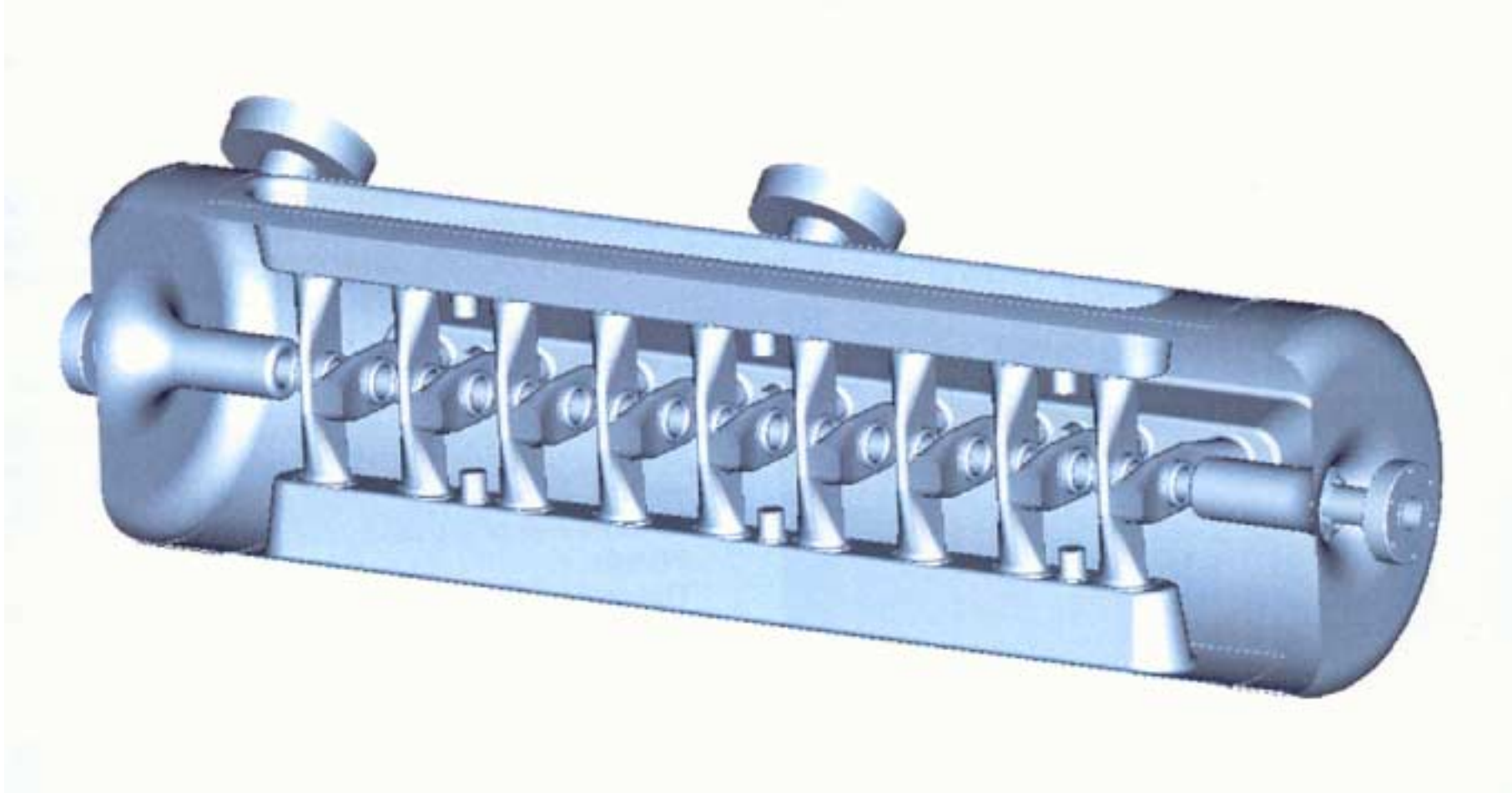
## Superconducting CH-Prototype



Gap number	19
Length (cm)	105
Frequency (MHz)	352
$\beta$	0.1
Material	bulk Niobium
$E_0$ (MV/m)	4
$E_a=ET$ (MV/m)	3.2
$E_p$ (MV/m) @ 3.2 MV/m	21.0
$B_p$ (mT) @ 3.2 MV/m	23.3
$G=R_s Q_0$ ( $\Omega$ )	56
$R_a/Q$ ( $\Omega$ ) (T incl.)	3220
$(R_a/Q)G$ ( $\Omega^2$ )	180000
$Q_0$ (BCS, 4K, 352 MHz)	$1.5 \times 10^9$
$Q_0$ (total $R_s=140$ n $\Omega$ )	$4 \times 10^8$
$W$ (mJ/(MV/m) <sup>2</sup> )	155
$W$ @ 3.2 MV/m (J)	1.58
$P$ @ 3.2 MV/m und $R_s=140$ n $\Omega$ (W)	9



## Superconducting CH-Prototype

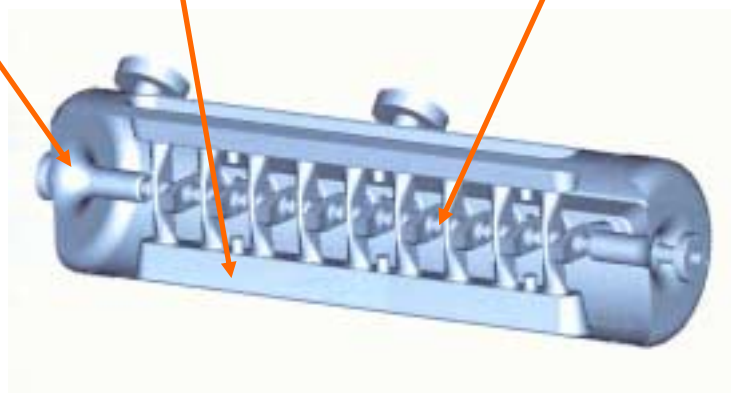
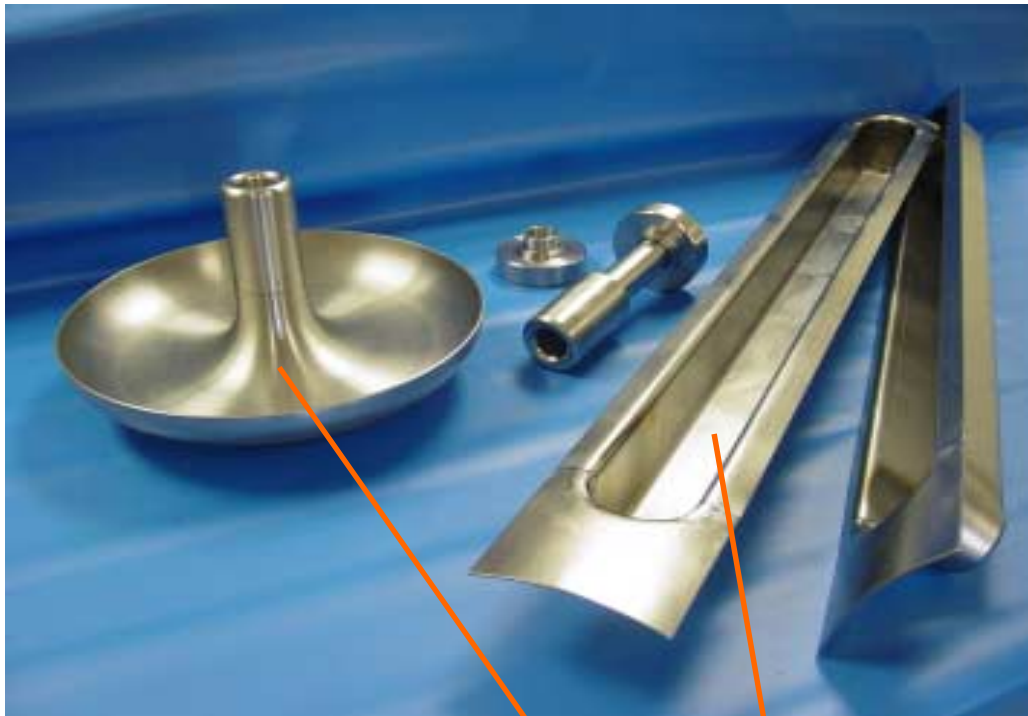




## Copper Model of the CH-Prototype



Built by ACCEL The logo for ACCEL, featuring a stylized blue and white wave or 'E' shape.



**Niobium parts of the  
s.c. CH-Prototype**



Niobium parts of the  
s.c. CH-Prototype





## s.c. CH-Prototype in the final stage of production (Oct. 2004)

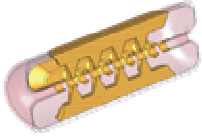




## The New Cryogenic Laboratory in Frankfurt



- 3 m vertical cryostat
- transport dewars
- Helium recovery system
- magnetic shielding
- control system (developed at IAP)



## Possible Applications of s.c. CH-Structures

- cw or high duty cycle Proton and Ion Linacs
- Accelerator Driven Systems (ADS)
- Neutron Sources like IFMIF (40 MeV, 125 mA D<sup>+</sup>)
- cw production of SHE
- maybe other



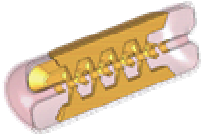
## Time schedule

- Final welding: End of October 04
- Chemical preparation: November 04
- First cold tests: Beginning of December 04



## Summary

- The CH-structure is a multi cell H-mode cavity
- Suitable for the low and medium beta range
- Very promising properties
- r.t. and s.c. operation
- s.c. CH cavity development



## Acknowledgement

- U. Ratzinger
- H. Deitinghoff
- H. Klein
- H. Liebermann
- A. Sauer

The technical staff of the IAP