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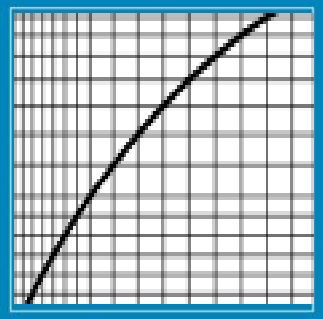
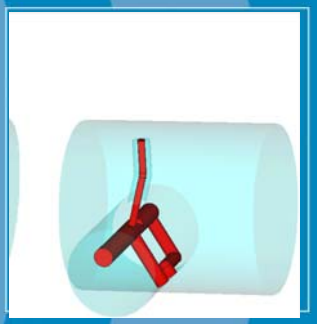
UNIVERSITÄT ROSTOCK





HOM Studies for TESLA (and some ideas for SPL)

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CERN, SPL-Meeting 11./12.12.08

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=

3 mathematicians, 2 with long term accelerator experience

+

2 physicists, both working theoretically and experimentally

+

1 engineer, combined accelerator and software competence

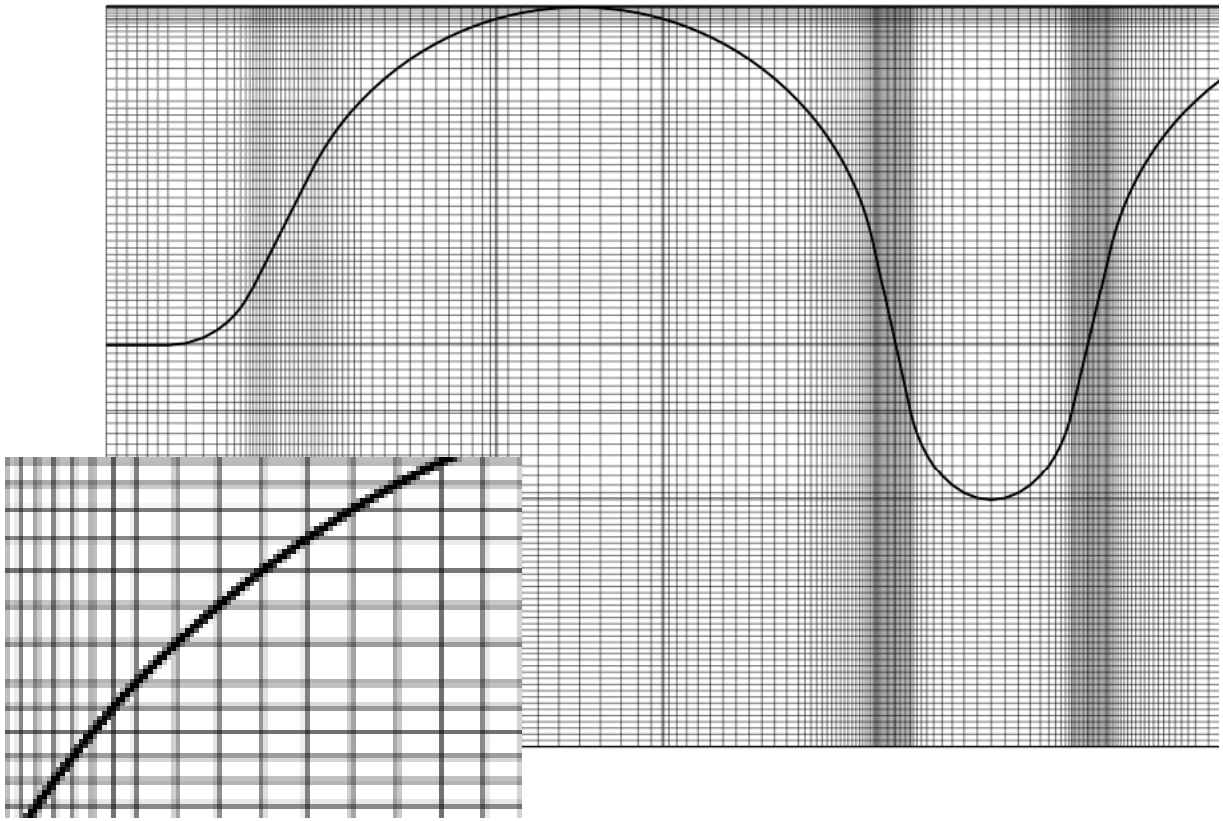
Some time stamps of (incomplete) TESLA HOM history

- **< 91: various HOM-coupler designs (CERN, DESY, ...)**
- **94: HOM coupler design + position fixed (Tesla Reps. 94-7, 94-16, Sekutowicz, Proch)**
- **98: "trapped" modes analysis (Marhauser, PhD, Frankfurt)**
- **98: Superstructure 4x7, entire recalculation (Tesla Rep. 98-8, Sekutowicz)**
- **98: Absorber design (Jöstingmeier, Dohlus)**
- **99: 2.585-GHz-Mode at TTF (Baboi, Napoly, ... EPAC 00)**
- **01: Proposal of mirroring one HOM coupler (Dohlus)**
- **04 .. now: HOM signal for BPM (Baboi, Eddy, ...)**

A few tools developed in the TESLA framework

- **Discretization**
- **Field dynamics in large structures**
- **Coupling calculations based on multidimensional scattering properties (CSC)**

Shape-adopted 2D-grid (MAFIA)

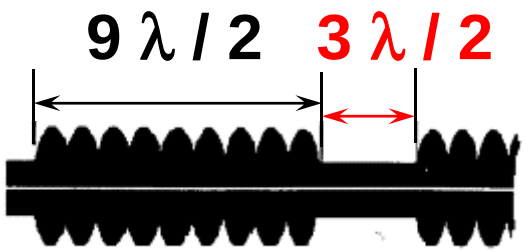


... up to 36 cells

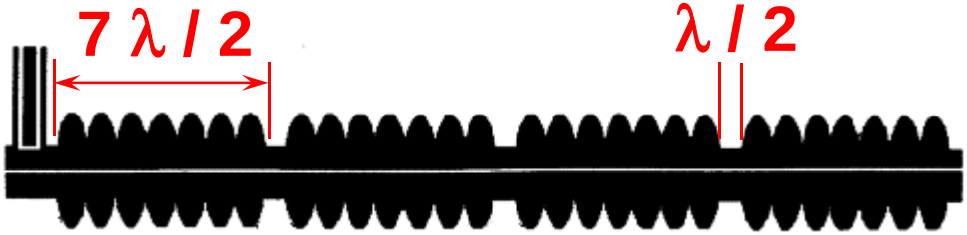
Mesh line crossings exactly at cavity shape:

- **important for tuning/field flatness calculations**
- **Automatic mesh construction**

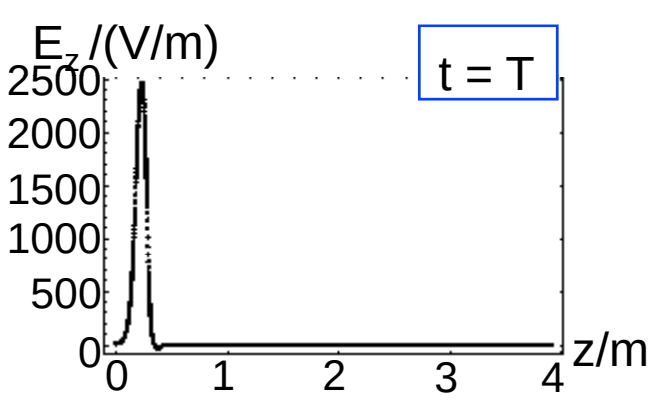
Filling of TESLA
"Superstructure"- Semi-analytical calculation

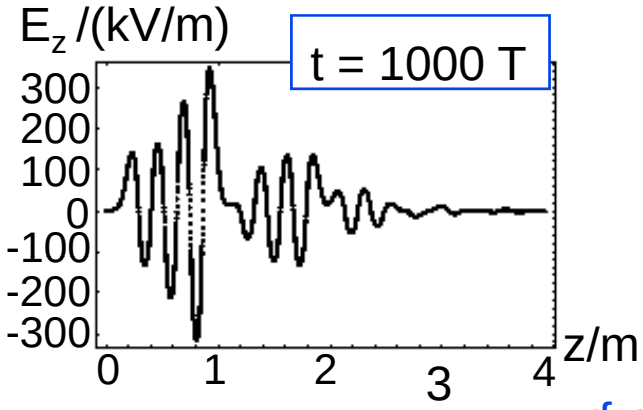


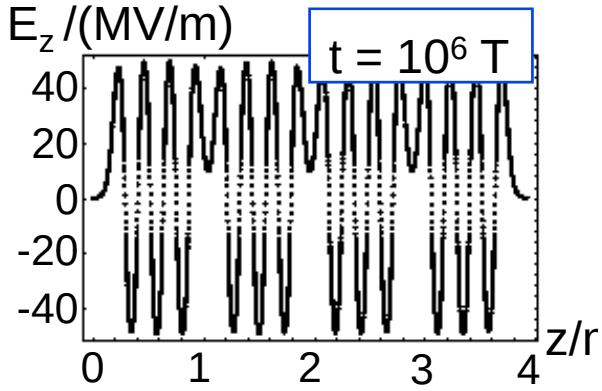
Structure of CDR



„Superstructure", J. Sekutowicz 1997



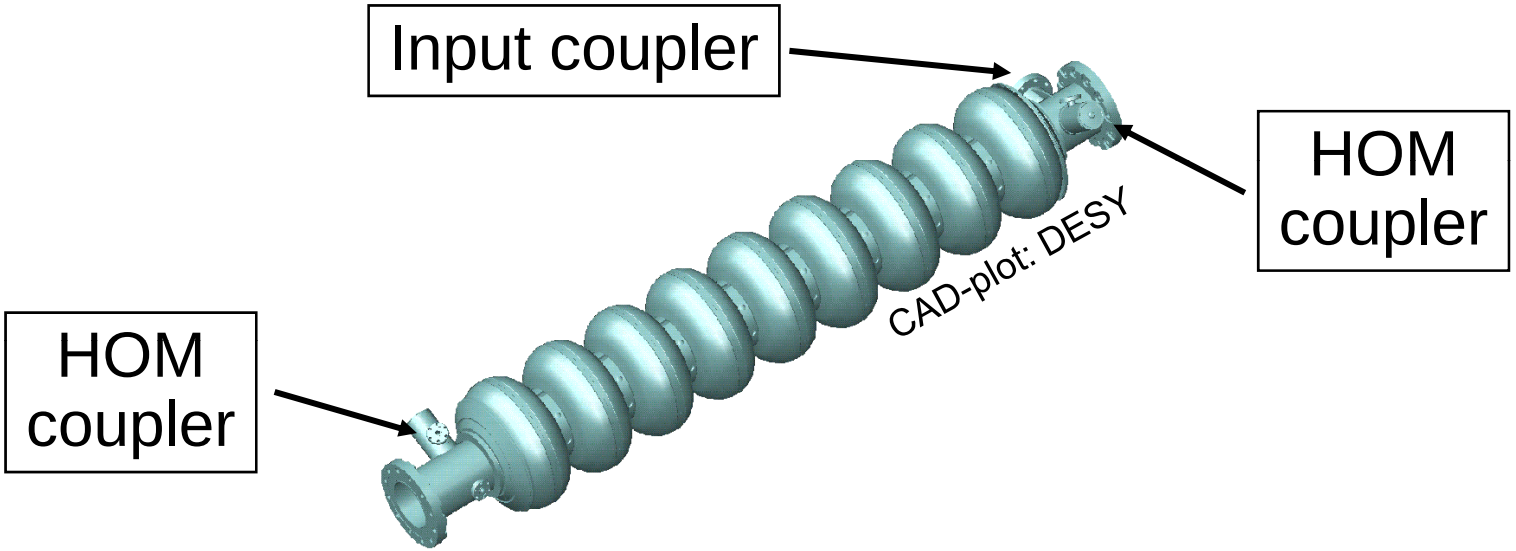




rf period T = 0.7688517112 ns

H.-W. Glock; D. Hecht; U. van Rienen; M. Dohlus. Filling and Beam Loading in TESLA Superstructures. Proc. of the 6th European Particle Accelerator Conference EPAC98, (1998): 1248-1250.

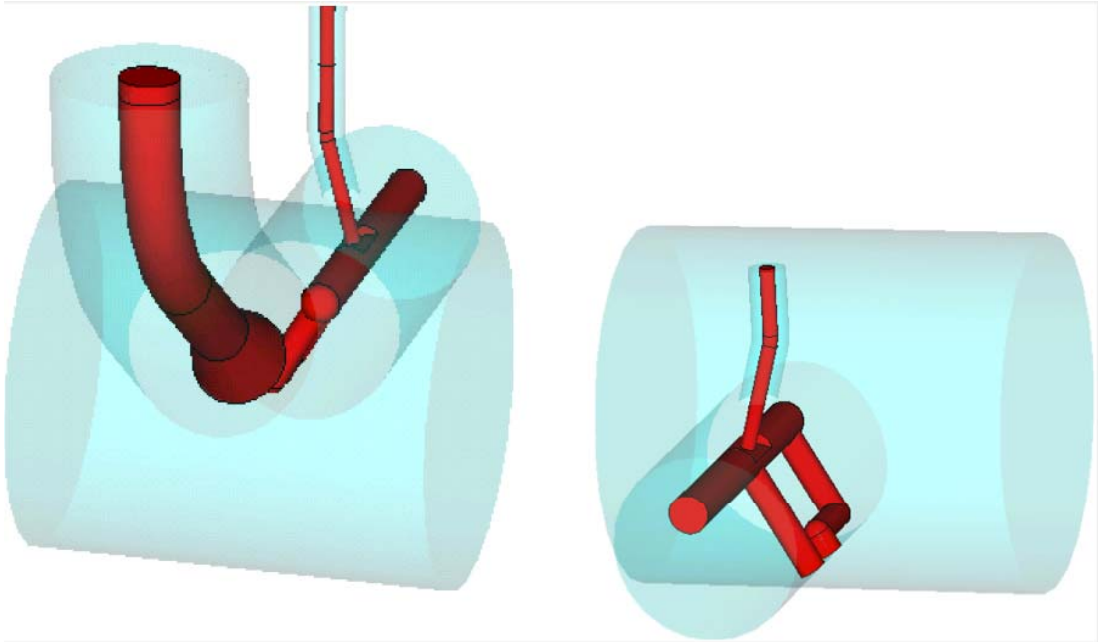
CSC - 9-Cell Resonator with Couplers

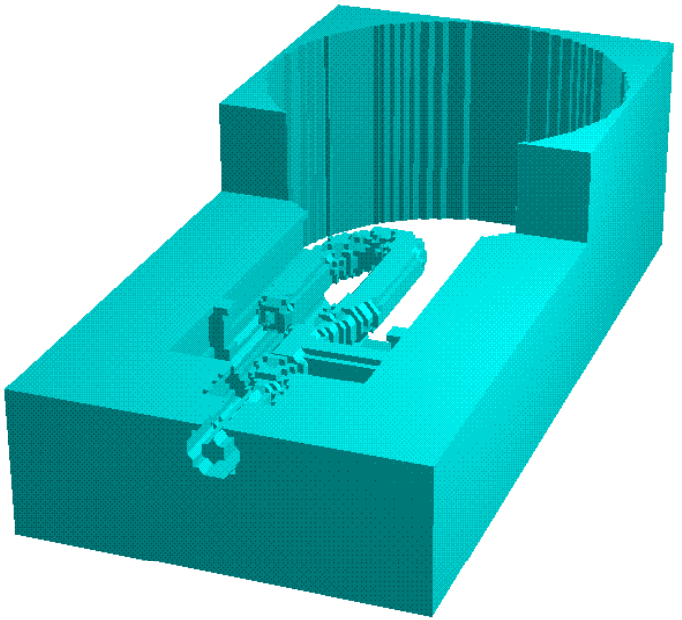


- Resonator *without* couplers: N ~ 29,000 (2D)
  N ~ $12 \cdot 10^6$ (3D)
- Resonator *with* couplers: N ~ $15 \cdot 10^6$ (3D)
  $\Rightarrow$ N increases by ~ 500
- CSC: „Coupled S-Parameter Calculation“ allows for combination of 2D- and 3D-simulations

K. Rothemund; H.-W. Glock; U. van Rienen. Eigenmode Calculation of Complex RF-Structures using S-Parameters. IEEE Transactions on Magnetics, Vol. 36, (2000): 1501-1503.

Coupler 3D-calculation: MAFIA or CST-Studio





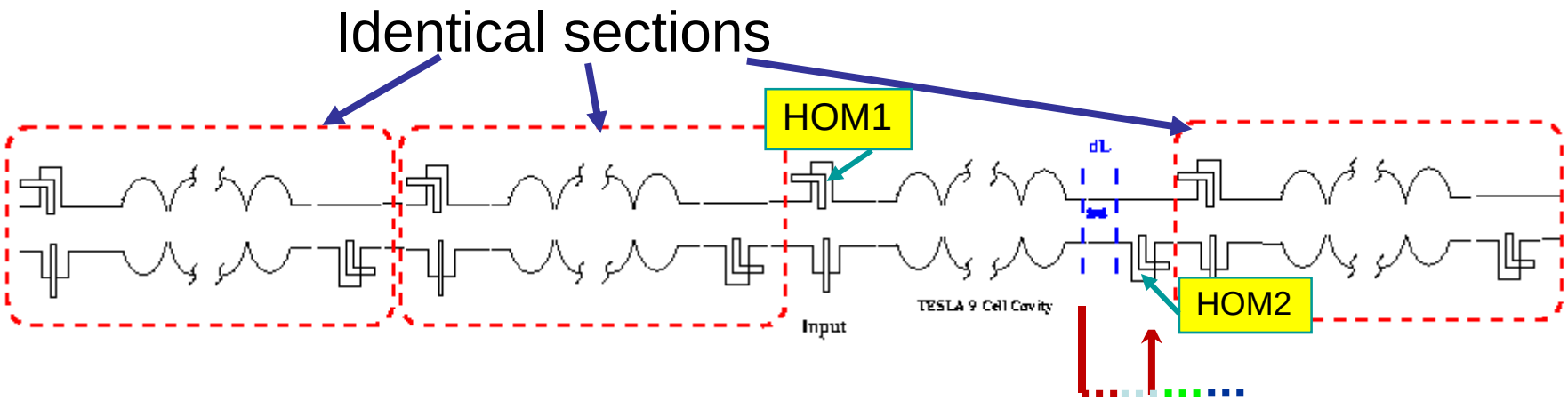
Determine scattering properties regarding

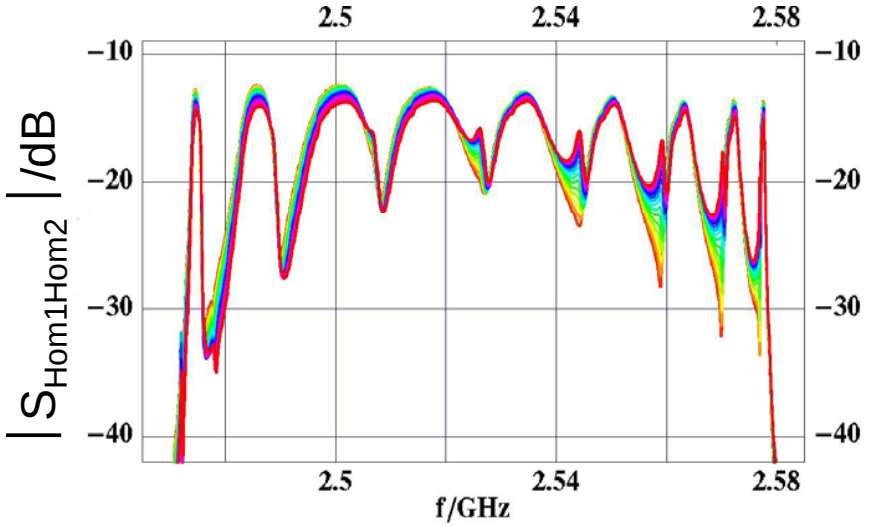
- sufficient number of modes in beam pipe ports

- coaxial ports

as input for coupling calculations

CSC - Resonator Chain – Variation of Tube Length





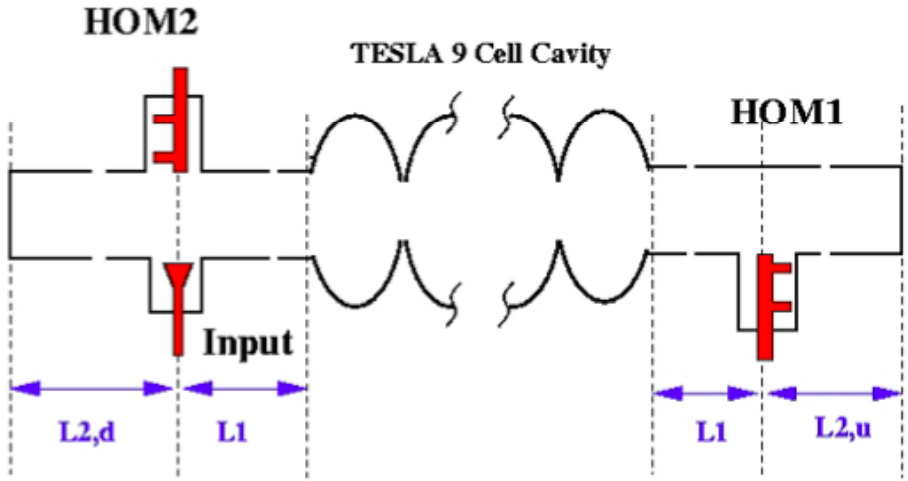
Weak dependence on position

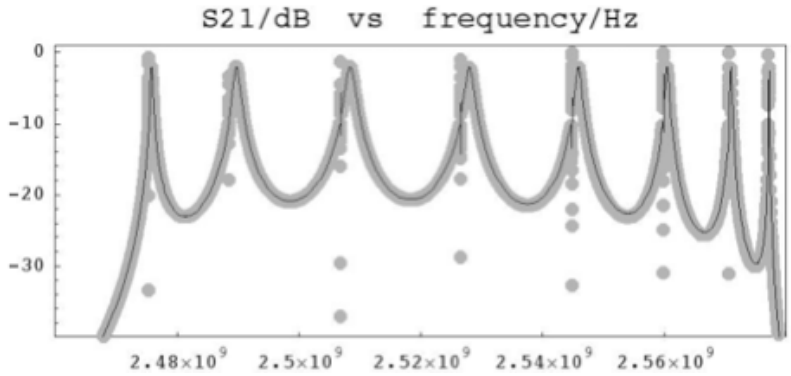
Variation of coupler position

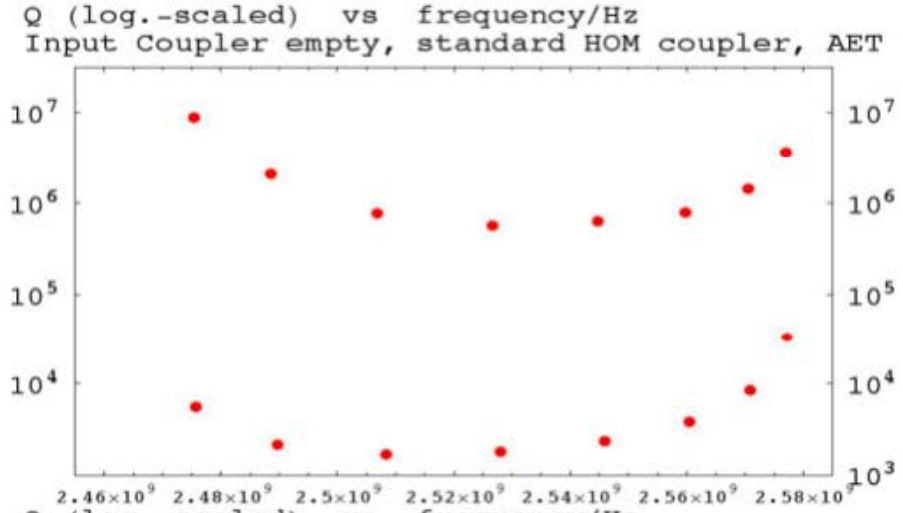
1,000 frequency points
31 lengths
resulting S-matrix: 16 x 16

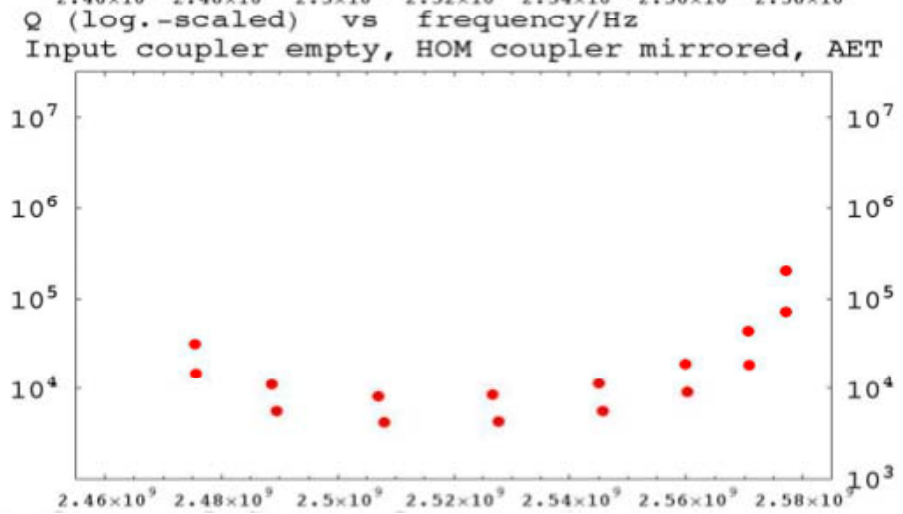
1h 12min, Pentium III, 1 GHz

Demonstration of high-Q-modes in HOM-damped cavity









Significant Q reduction due to mirrored HOM coupler

A few ideas according SPL, inspired by TESLA

- **Different wakefield regimes**
- **Coupler vs. Absorbers**
- **NC measurement cavity model**

Different wakefield regimes

i) localized in single resonator, well coupled to neighbouring coupler

ii) localized in inner cells ("trapped"), poorly coupled

iii) coupling between (strings of) neighbouring resonators

iv) propagating though beam pipe

... need adopted methods for counteraction and calculation

Coupler vs. absorber?

+ absorber: easier construction, insensitive to polarizations

- absorber: power deposition "inside" structure, needs "warm(er)" section => access to "inner" fields may be difficult (if shared for more than single cav.), vacuum

+ coupler: external power dissipation, attachs every cavity, allows for signal monitoring

- coupler: more complicated, cooling, multipacting may be a problem

NC measurement cavity model ?

+:

cheap (but by far not for free)

easy to perform field profile measurements (bead pull), no clean room

easy modification, e.g. additional coupling holes

no sc infrastructure needed for experiments

-:

poor Q (~10^4) => poor mode separation, damping due to weakly coupled couplers/absorbers difficult (impossible) to measure

coupling through a resonator may have much larger bandwidth than in sc case

It is not the same.

Outlook

- **Very recent application to BMBF (German Federal Research Ministry) together with CERN: SPL HOM damping measures (start hopefully 1.7.09)**
- **Approved project within EuCard framework together with DESY, Cockroft Institute: HOM signals for BPM (start 1.4.09)**

Thank you!