CTF3 RF DEFLECTORS
(D. Alesini)

SUMMARY

INTRODUCTION

- CTF3 RF Deflectors Parameters
- Choice of the Lengeler-like structures for the Combiner Ring:

MULTIBUNCH DYNAMICS

- Single passage out-of-phase wake and multibunch regime
- Multi-passage tracking

  1) ***Tracking code scheme***
  2) ***Results***
  3) ***Conclusions***
  4) ***Further analysis***

DEFLECTOR DESIGN

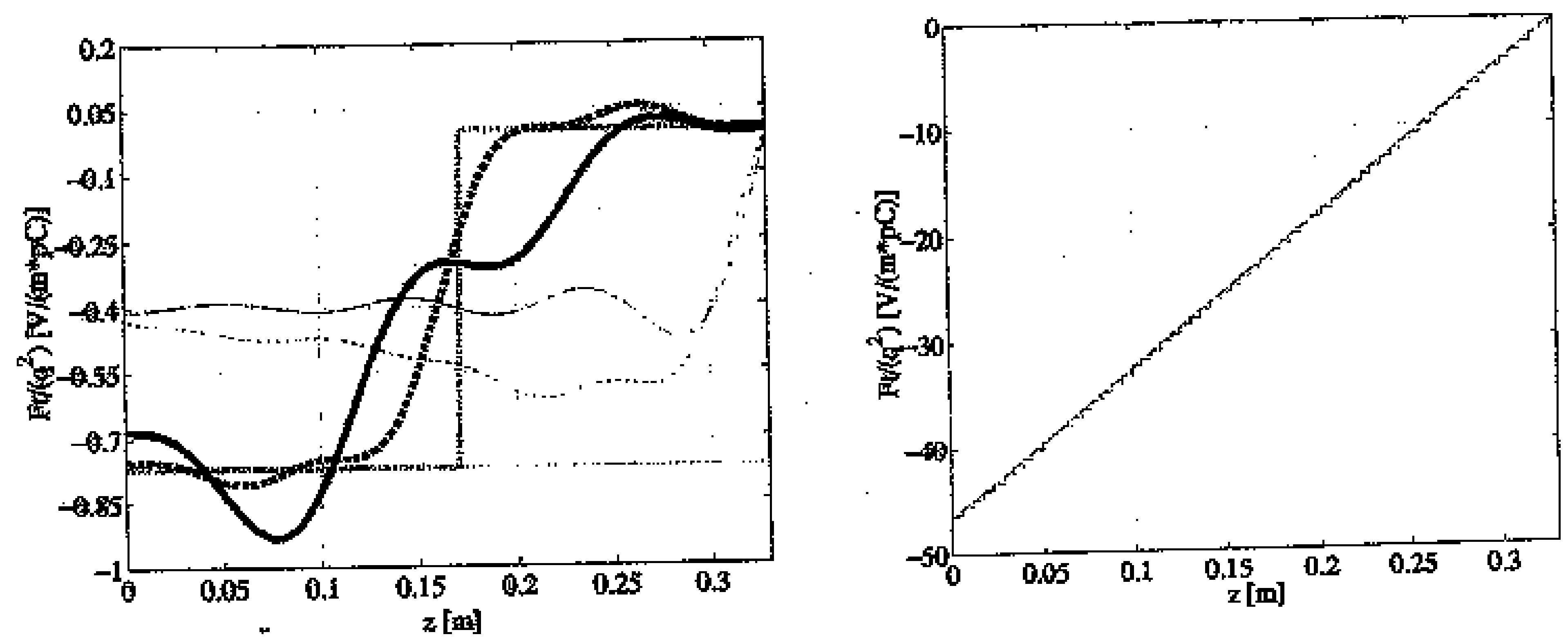
- 2D cell simulations
- HFSS 3D Cell simulations
- HFSS 3D simulations of the RF coupler
- HFSS 3D simulations of the single cell tuning
- Simulations of a SW cavity for the delay line

DEVICES UNDER CONSTRUCTION

- Alluminium prototype
- Vacuum-tight copper device

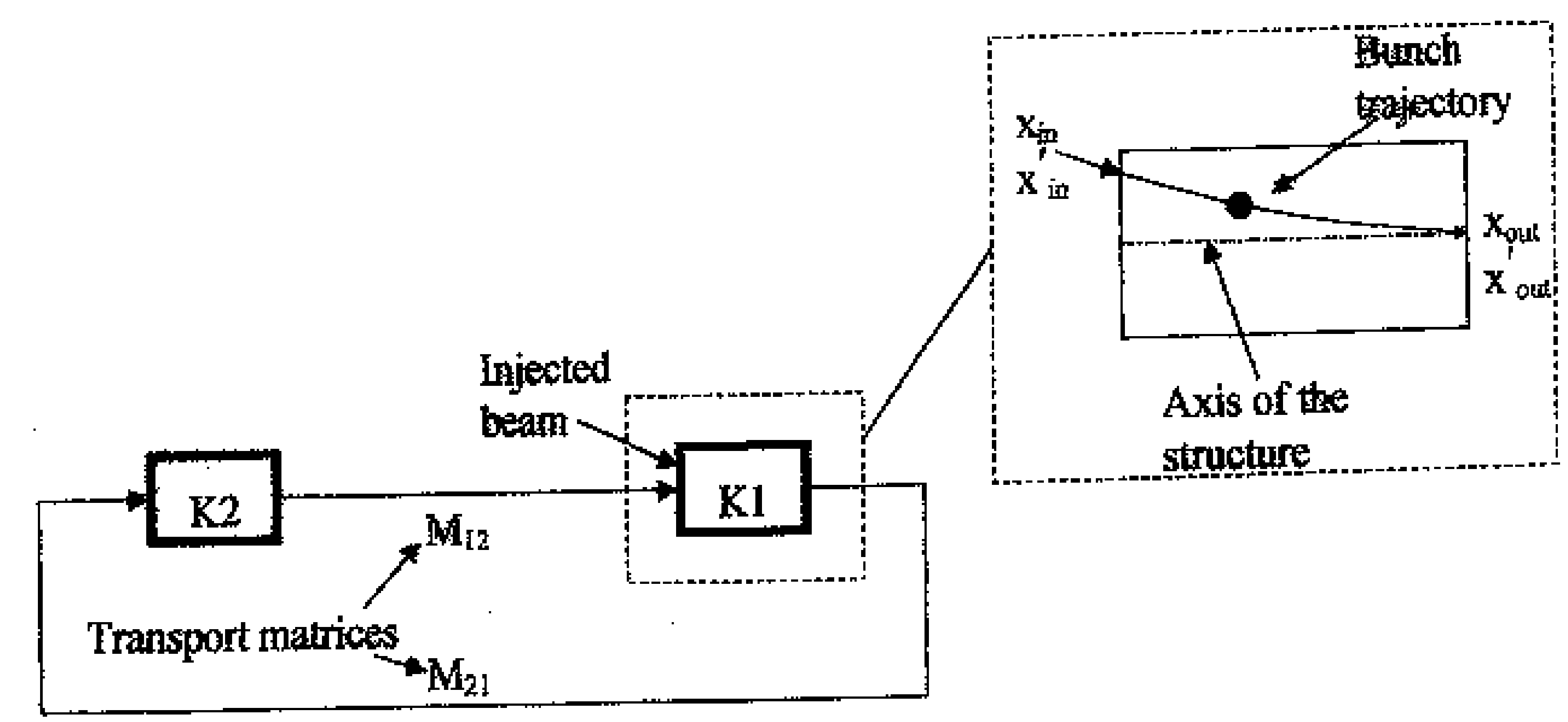
MULTIBUNCH DYNAMICS

- Single passage out-of-phase wake and multibunch regime



- Multi-passage tracking

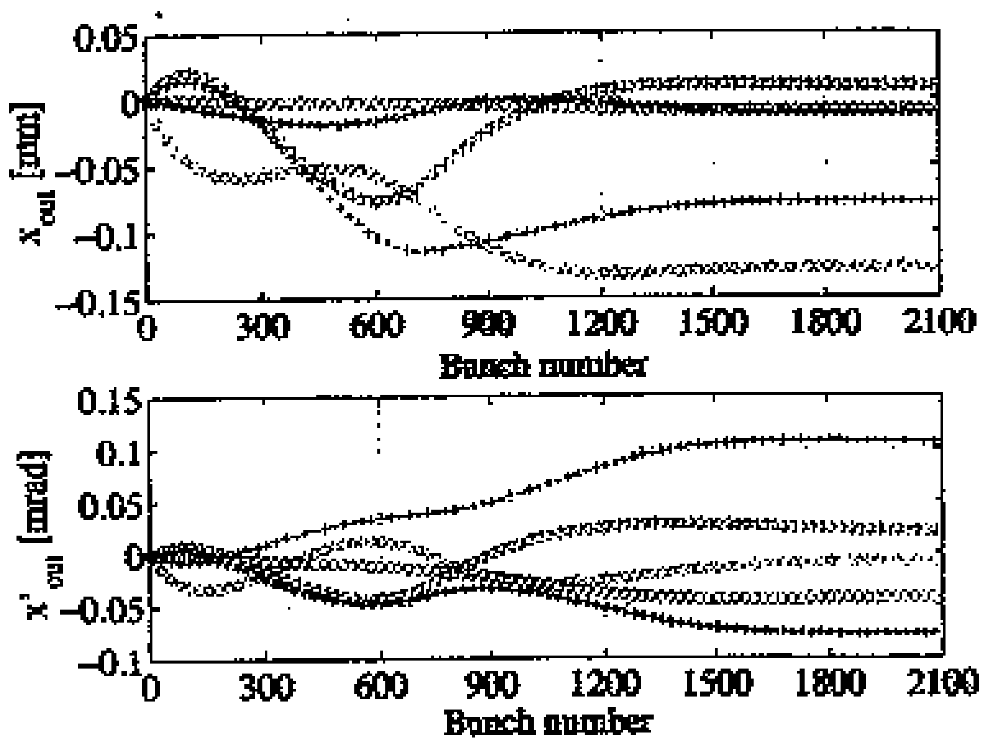
1) ***Tracking code scheme*** → the bunches are modeled as macroparticles
→ rigid profile model of the wake

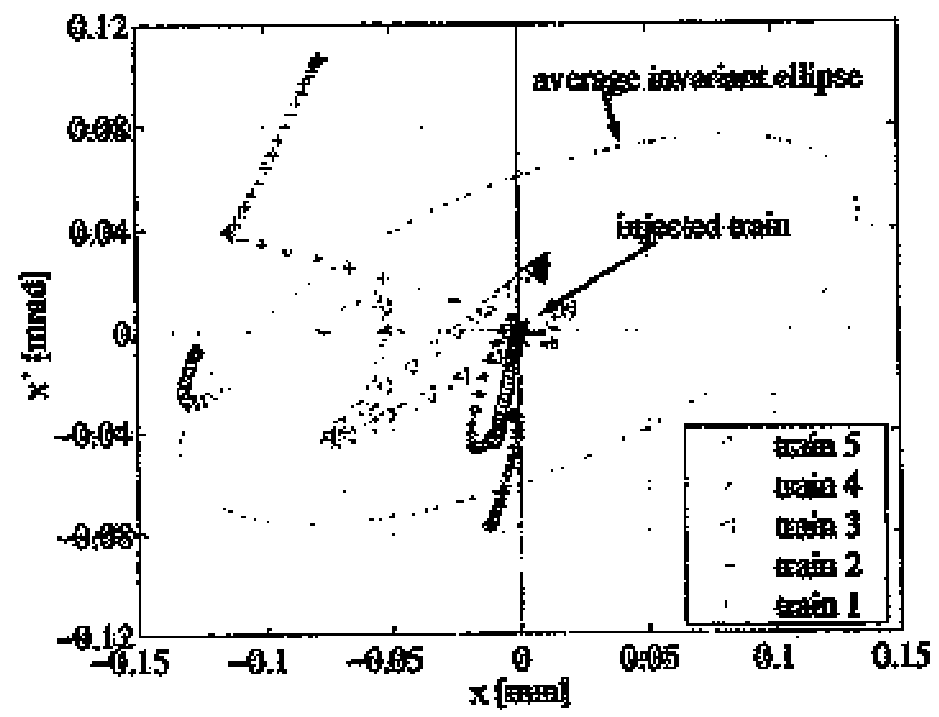


2) *Results*

a) **Perfect injection** of the 5 trains ($x_{in}=0$, $x'_{in}=0$):

→ $I_{o\text{-}av}=8\cdot10^{-3}$ mm mrad $I_{o\text{-}max}=4.2\cdot10^{-2}$ mm mrad
→ bunch design emittance $\varepsilon\approx0.5$ mm mrad @ 180 MeV



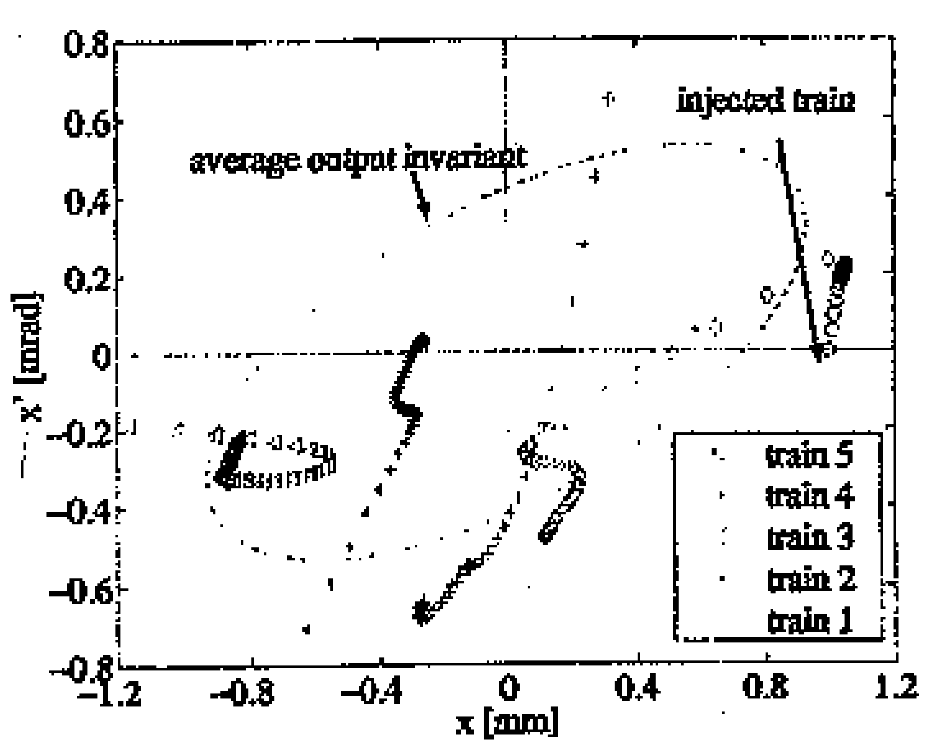


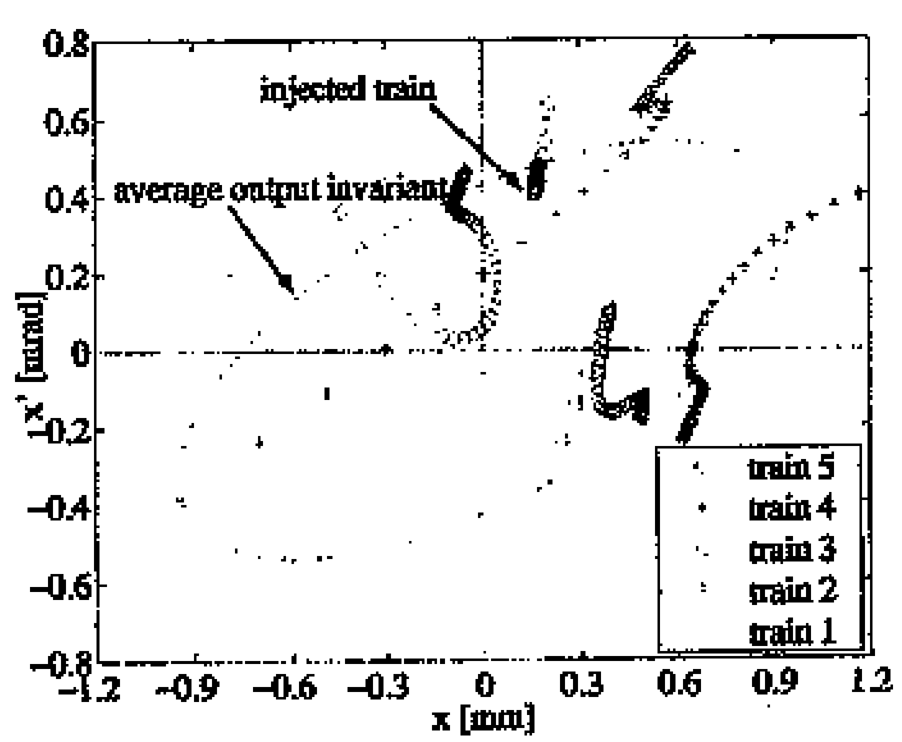
b) **Injection errors:**

Same Invariant I_{in}

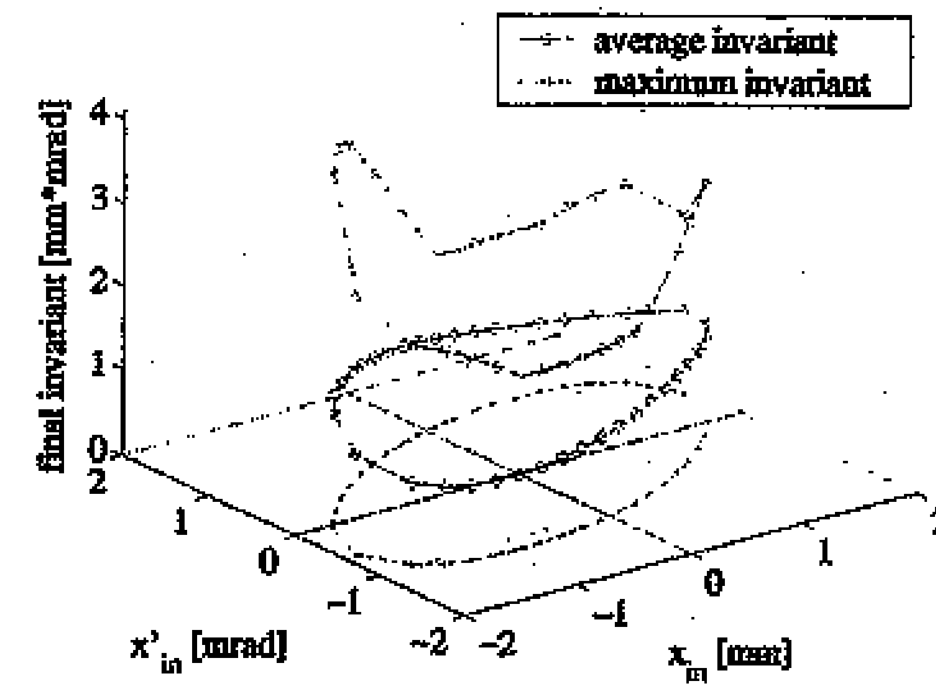
$x_{in}=1$mm, $x'_{in}=0$ → $I_{o\text{-}av}=0.392$ mm mrad
→ $I_{o\text{-}max}=0.814$ mm mrad

$x_{in}=0$, $x'_{in}=0.633$ mrad → $I_{o\text{-}av}=0.405$ mm mrad
→ $I_{o\text{-}max}=0.850$ mm mrad

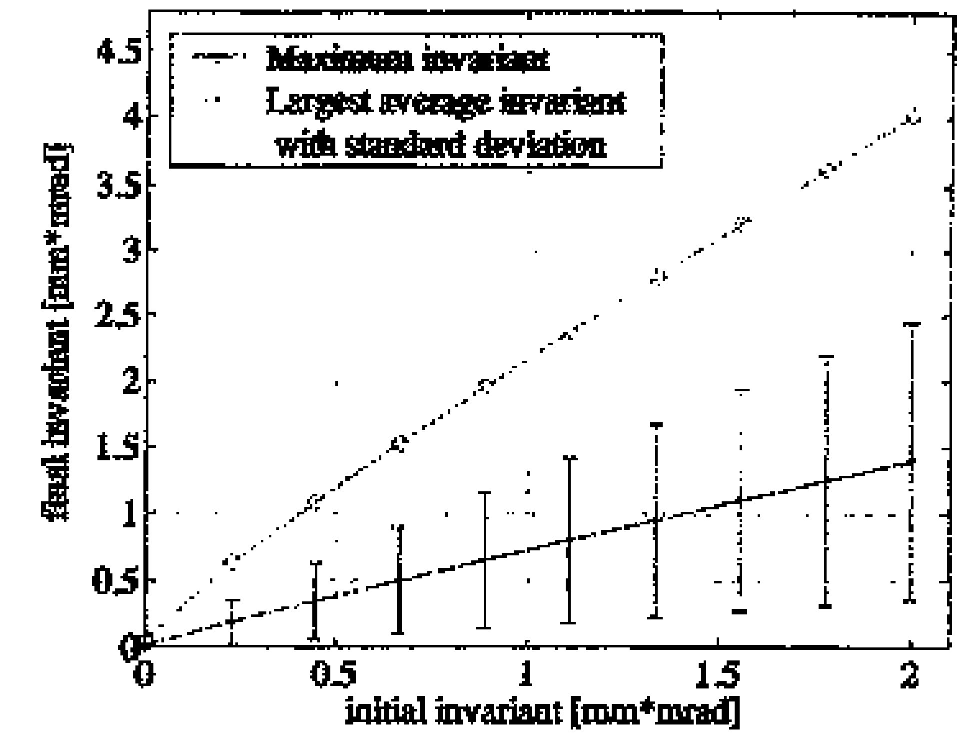




c) **Injection errors scan**

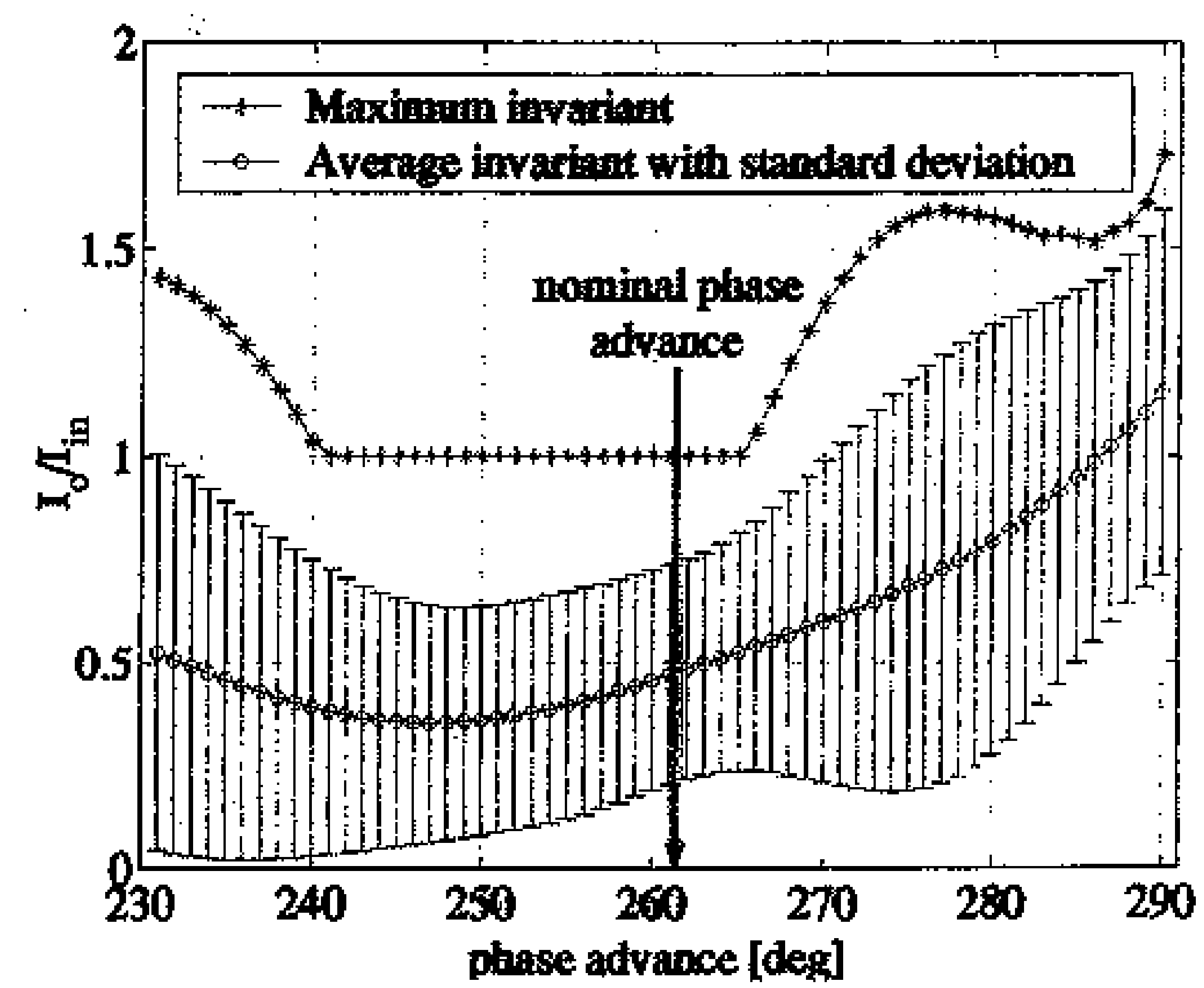


$I_{o\text{-}max}$ and $I_{o\text{-}av}$ for a given I_{in} and various betatron phases



I_{po_max} and $I_{po\text{-}av}$ as a function of the injection Courant-Snyder Invariant

d) **Tune dependence** of the Courant-Snyder invariant magnification I_o/I_{in} ($x_{in}=1$mm, $x'_{in}=0$)



3) *Conclusions*

→ The spread of the macroparticle Courant-Snyder invariant values caused by the **systematic effect** (x_{in}=0, x'_{in}=0) is a **small fraction** of the CTF3 bunch design emittance;

→ The $\mathbf{I_{o\text{-}max}}$ **and the** $\mathbf{I_{o\text{-}av}}$ of the final distribution are **not constant** for a given I_{in} but **depend on the betatron phase** of the bunch **train at the injection** and on the **horizontal tune**;

→ For our **nominal phase advance** the scenario is good: the $I_{po\text{-}av}<I_{in}$ ("cooling"), $I_{po\text{-}max}/I_{in}\leq 2.6$;

→ **Modifications of the phase advance** of the order of ±10° ($\Delta Q_x\approx\pm0.03$) does not significantly change the scenario;

→ Anyway, some tune values may give magnification factors larger than 10;

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4) *Further analysis*

→ Effects of the **other modes** of the structure on the beam dynamics;

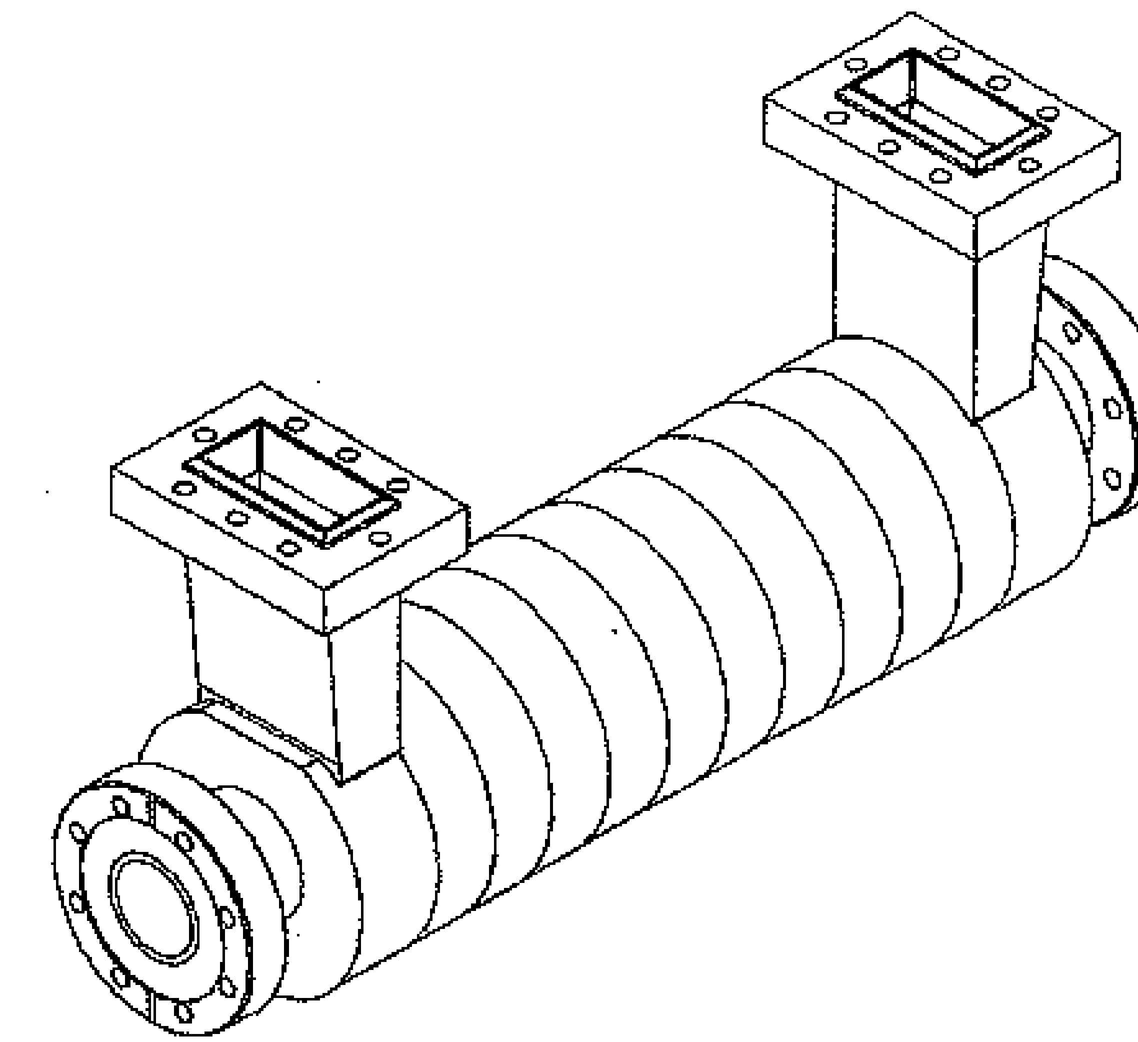
→ Beam loading effects due to **off-time injection** and finite **bunch length**;

→ Effects of **different injection conditions** for "odd" and "even" bunches in each incoming train due to the "memory" of the different paths in the delay loop;

→ ....

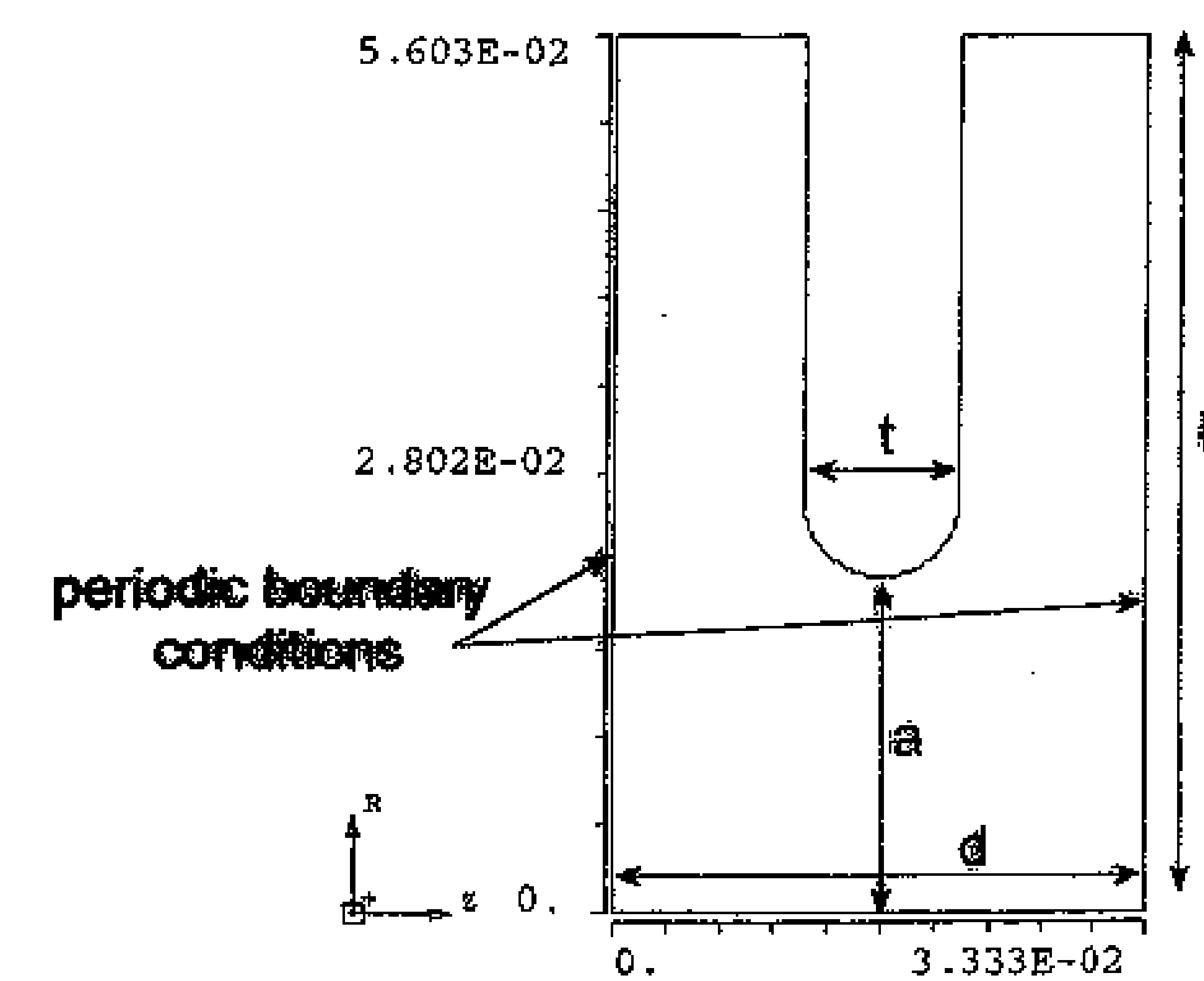
DEFLECTOR DESIGN

• Sketch of the 10 cell deflector



• 2D cell simulations

→ **MAFIA simulated structure**



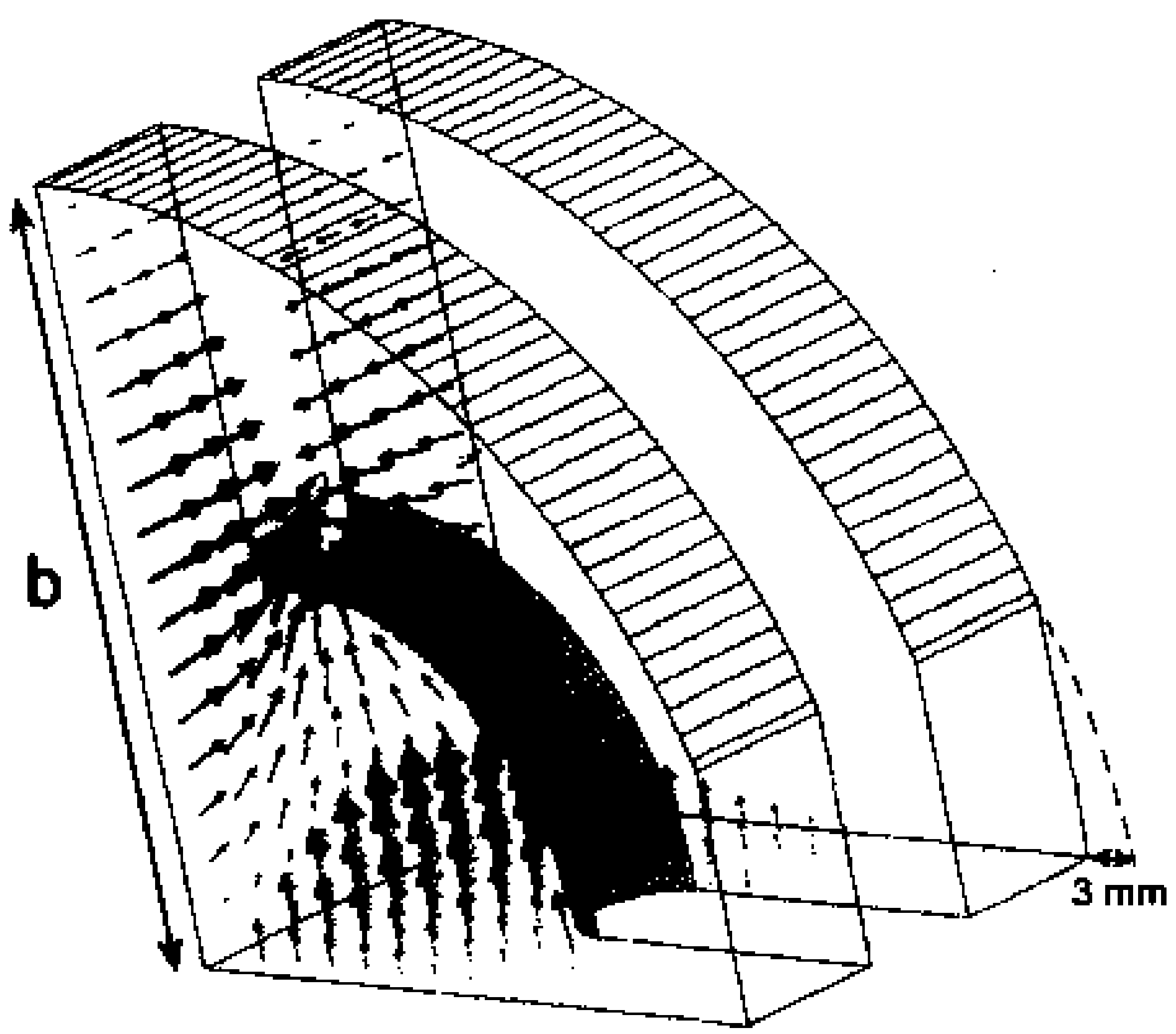
→ **Check of the resonant frequency of the scaled structure**

→ **Parameters sensitivity:**

$\Delta f/\Delta a = -13.2$ MHz/mm
$\Delta f/\Delta b = -49.7$ MHz/mm
$\Delta f/\Delta t = 2.9$ MHz/mm
$\Delta f/\Delta d = 1.2$ MHz/mm

- HFSS 3D Cell simulations

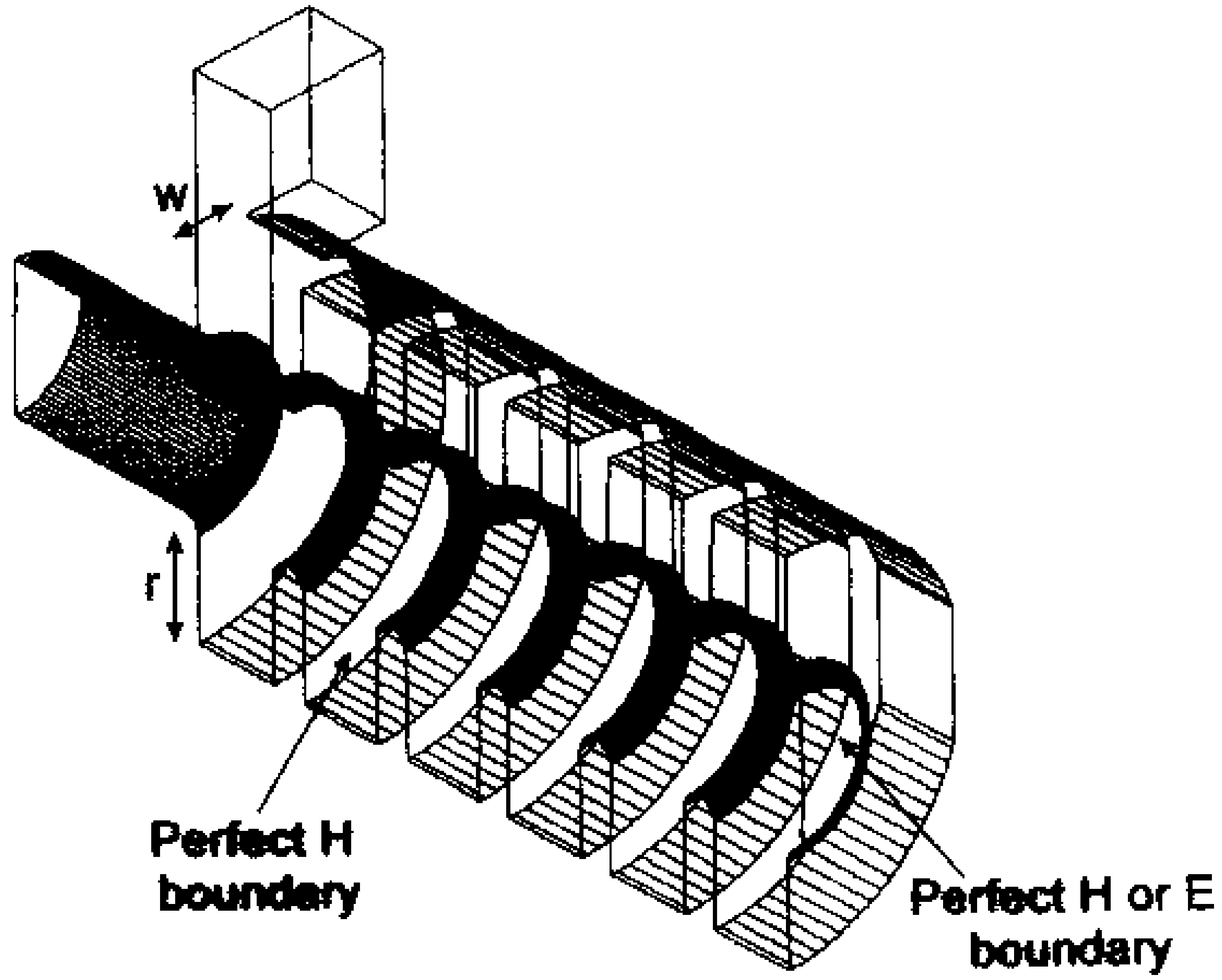
→ **Azimuthal asymmetry for vertical and horizontal deflecting mode splitting**



→ **re-tuning of the fundamental mode by the sensitivities obtained by MAFIA (modified b radius)**

Dimensions	**Simulation results**
a = 21.43 mm	
b = 56.03 mm	$f_{2\pi/3} = 2998.7 \pm 0.3$ MHz (code uncert.)
d = 33.33 mm	$\Delta f = f_{vert} - f_{hor} \approx 48$ MHz
t = 9.53 mm	

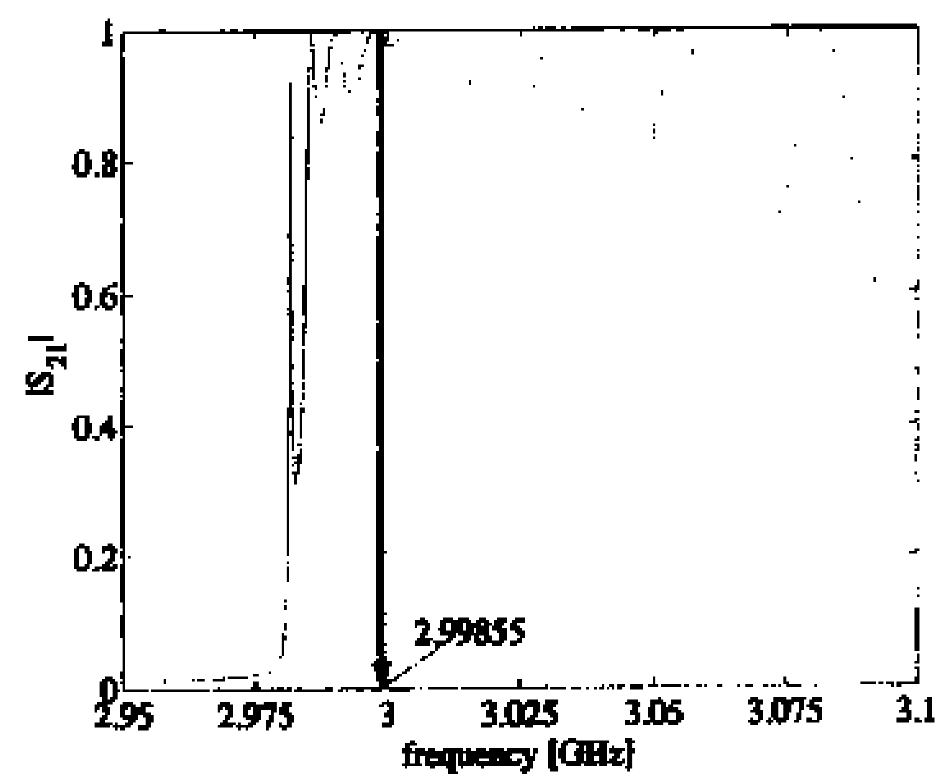
- HFSS 3D simulations of the RF coupler

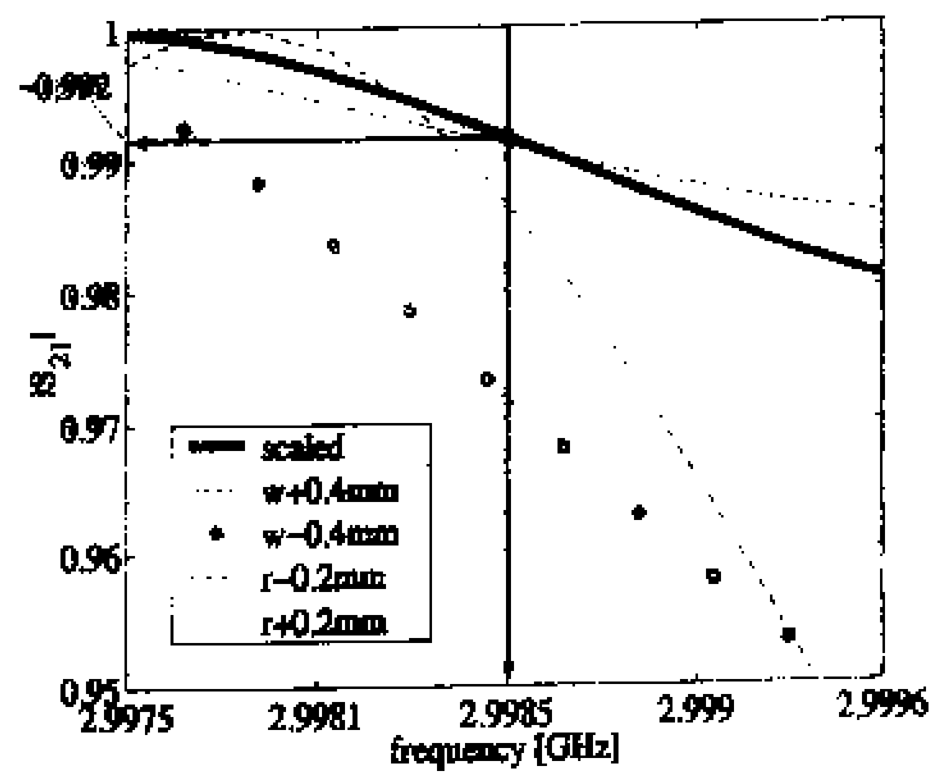


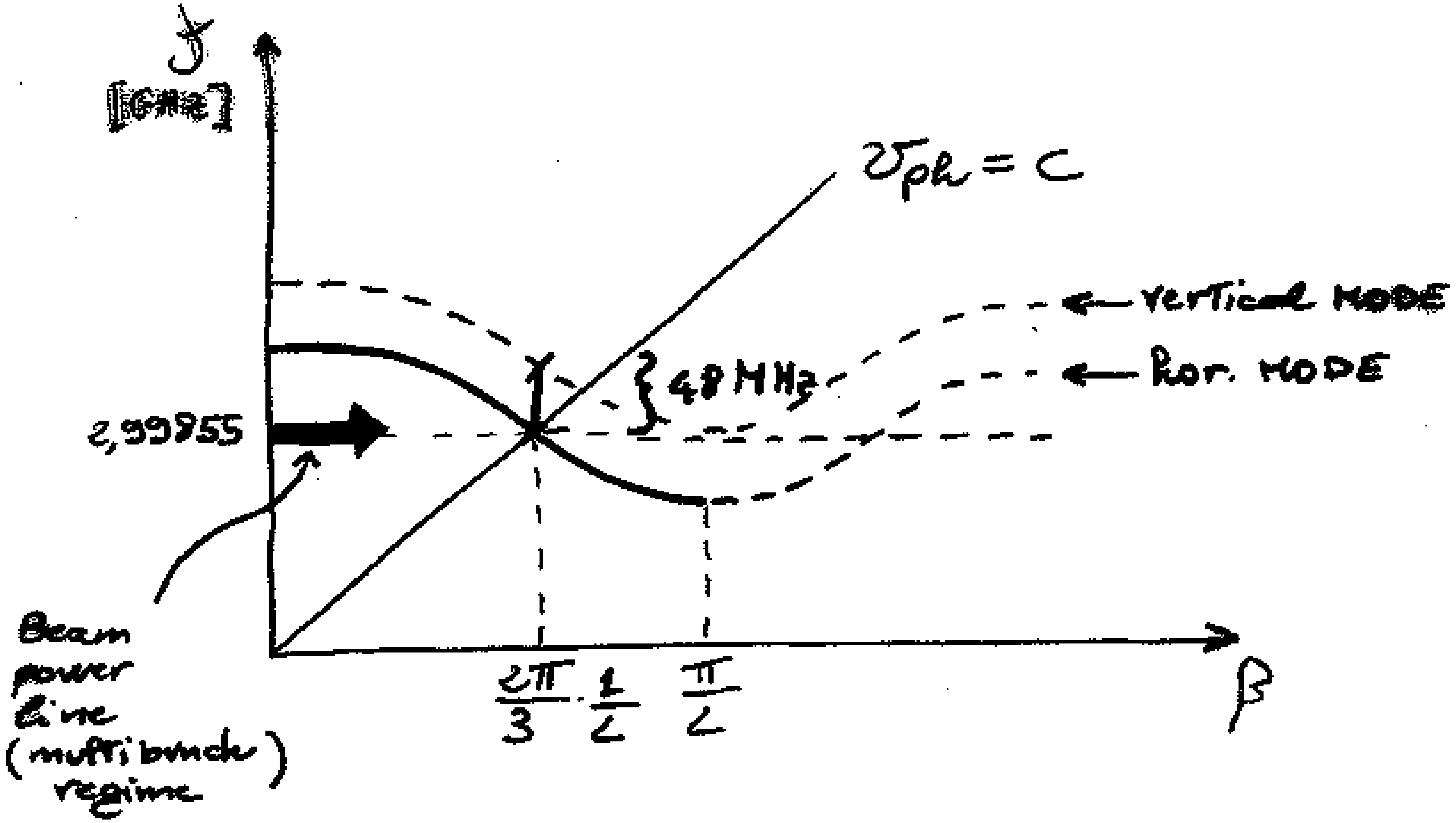
→ **scaled coupler**

→ **azimuthal and longitudinal symmetries of the structure: tetrahedral mesh reduction**

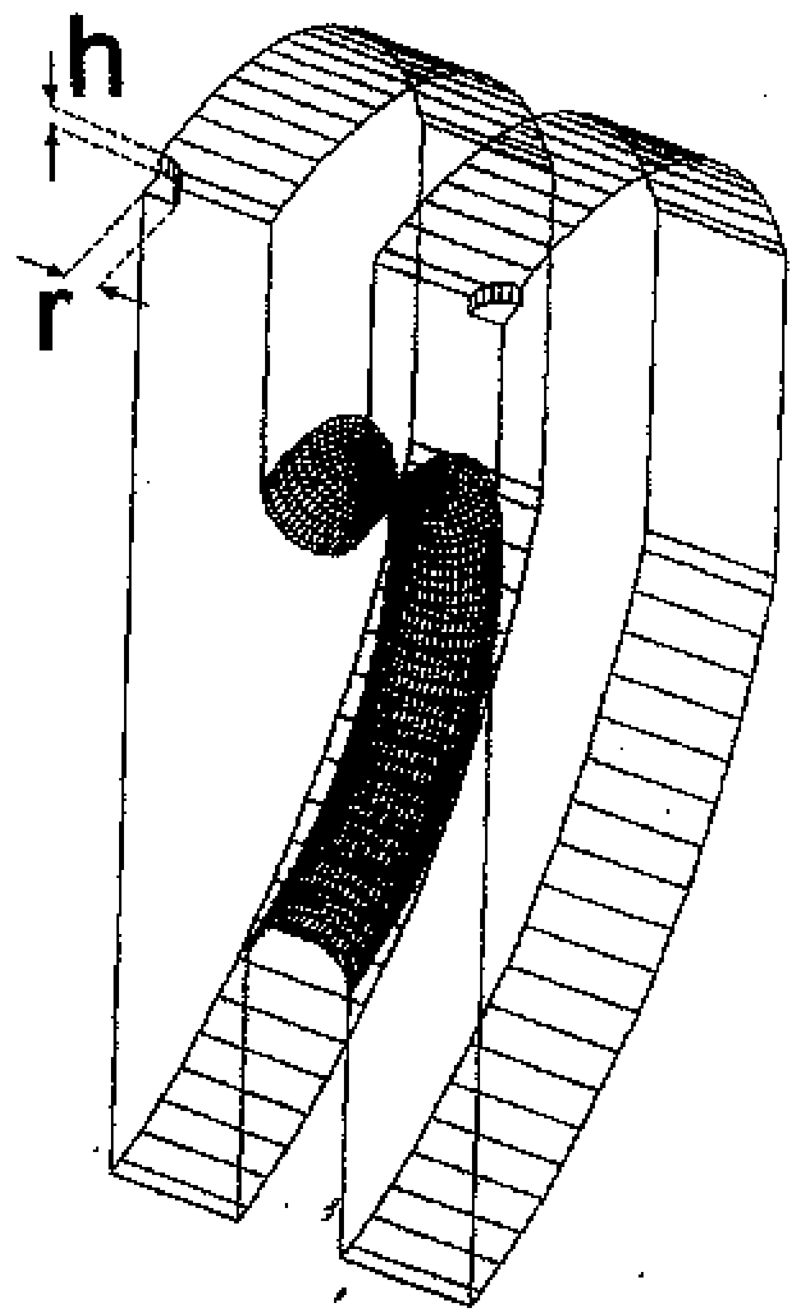
→ **coupling cell parameters variation (w, r)**







<u>HFSS 3D simulations of the single cell tuning</u>



→ **tuning of the single cell resonant frequency (r=3mm)**

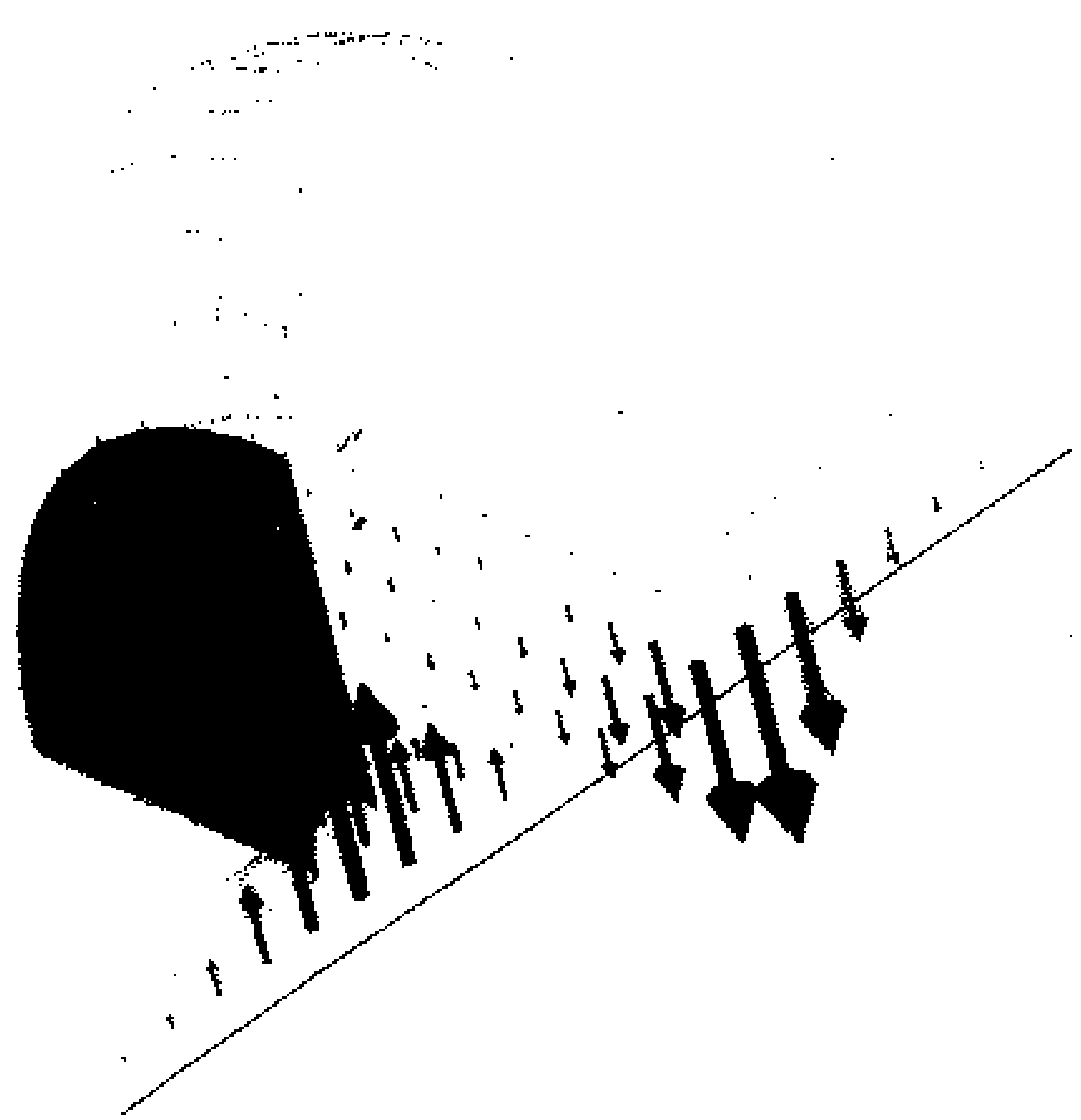
tuner position (h)	Δf
1mm	≈ 0.5 MHz
2mm	≈ 1 MHz

- Simulations of a SW cavity for the delay line

→ **Reasonable dimensions @ 1.49928 GHz compared with a scaled Lengeler structure**

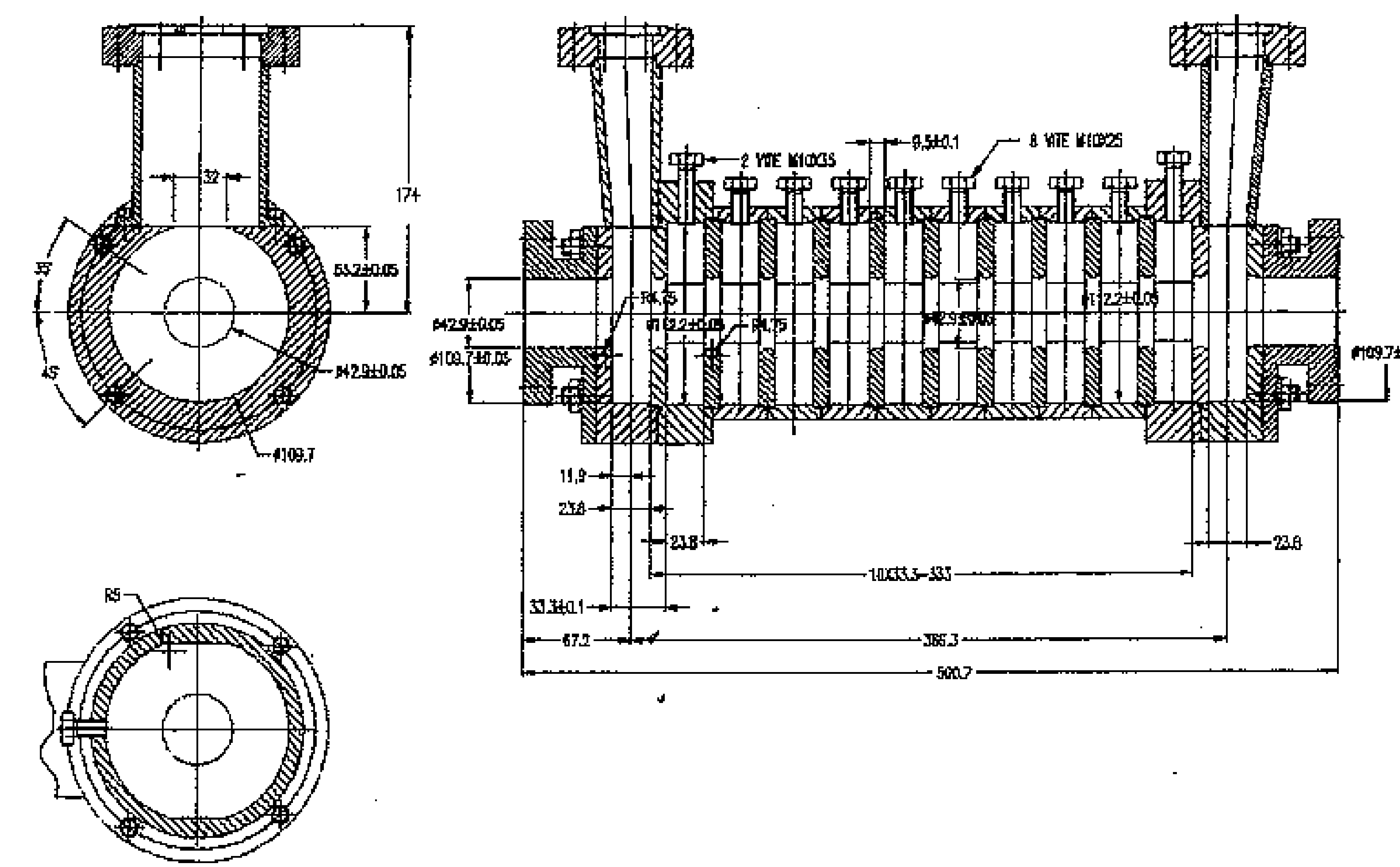
→ **Efficiency**

→ **No bunches probing the out-of-phase wake**



DEVICES UNDER CONSTRUCTION

- Alluminium prototype

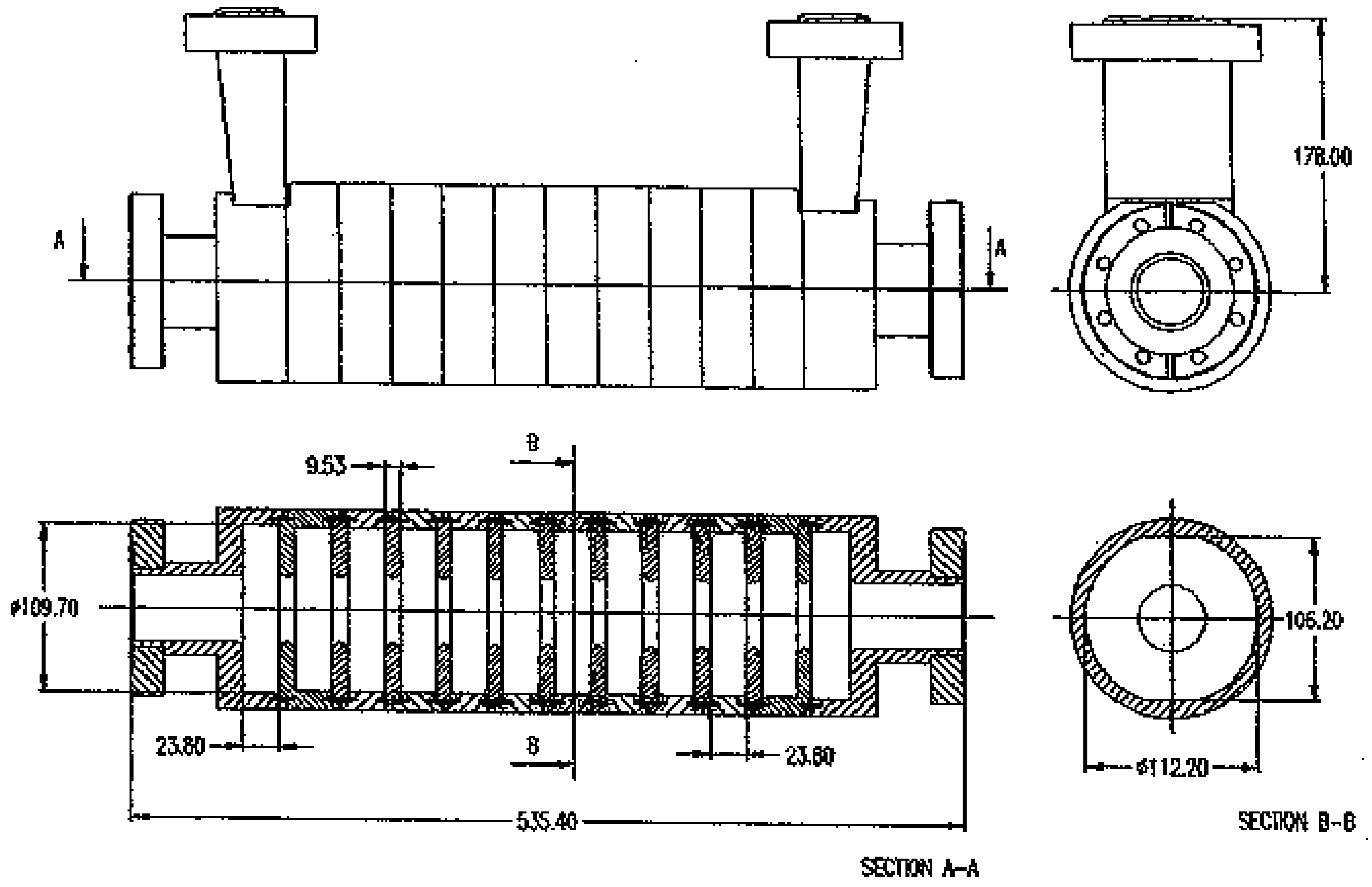


→ **Dispersion curve measurements**

→ **Coupler efficiency measurements**

→ **Field flatness and cells tuning**

- Vacuum-tight copper device



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FOR: CONSTRUCTION AND TESTING OF TWO TRAVELLING WAVE SECTIONS OPERATING IN DEFLECTOR MODE

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