

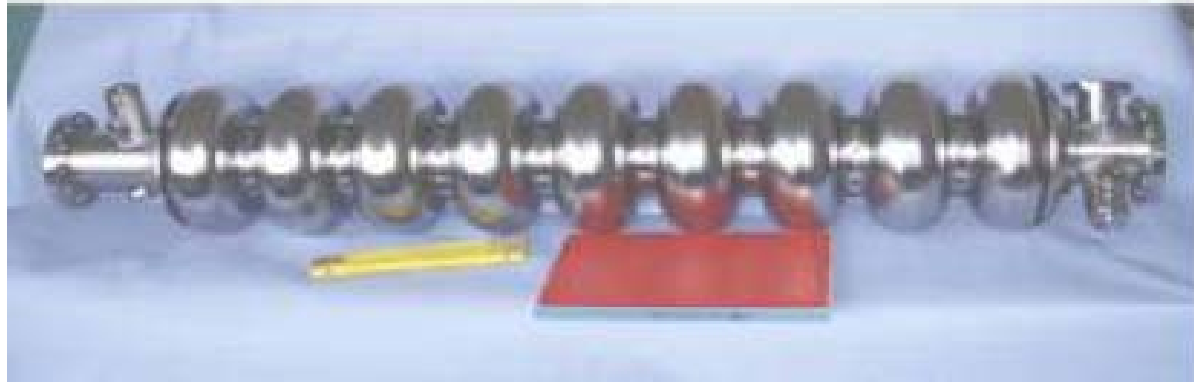
Modeling Imperfection Effects on Dipole Modes in TESLA Cavity

Liling Xiao

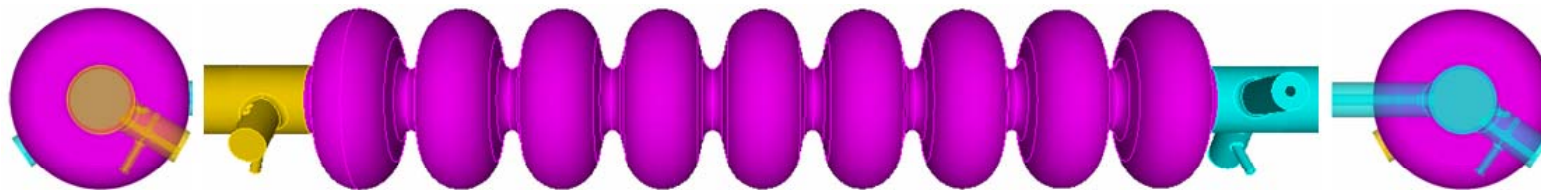
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SLAC



TDR prototype cavity



Ideal TDR cavity Computational model



The actual cell shapes of the TESLA cavities differ from the ideal due to *fabrication errors*, the addition of *stiffening rings* and the *frequency tuning process*.

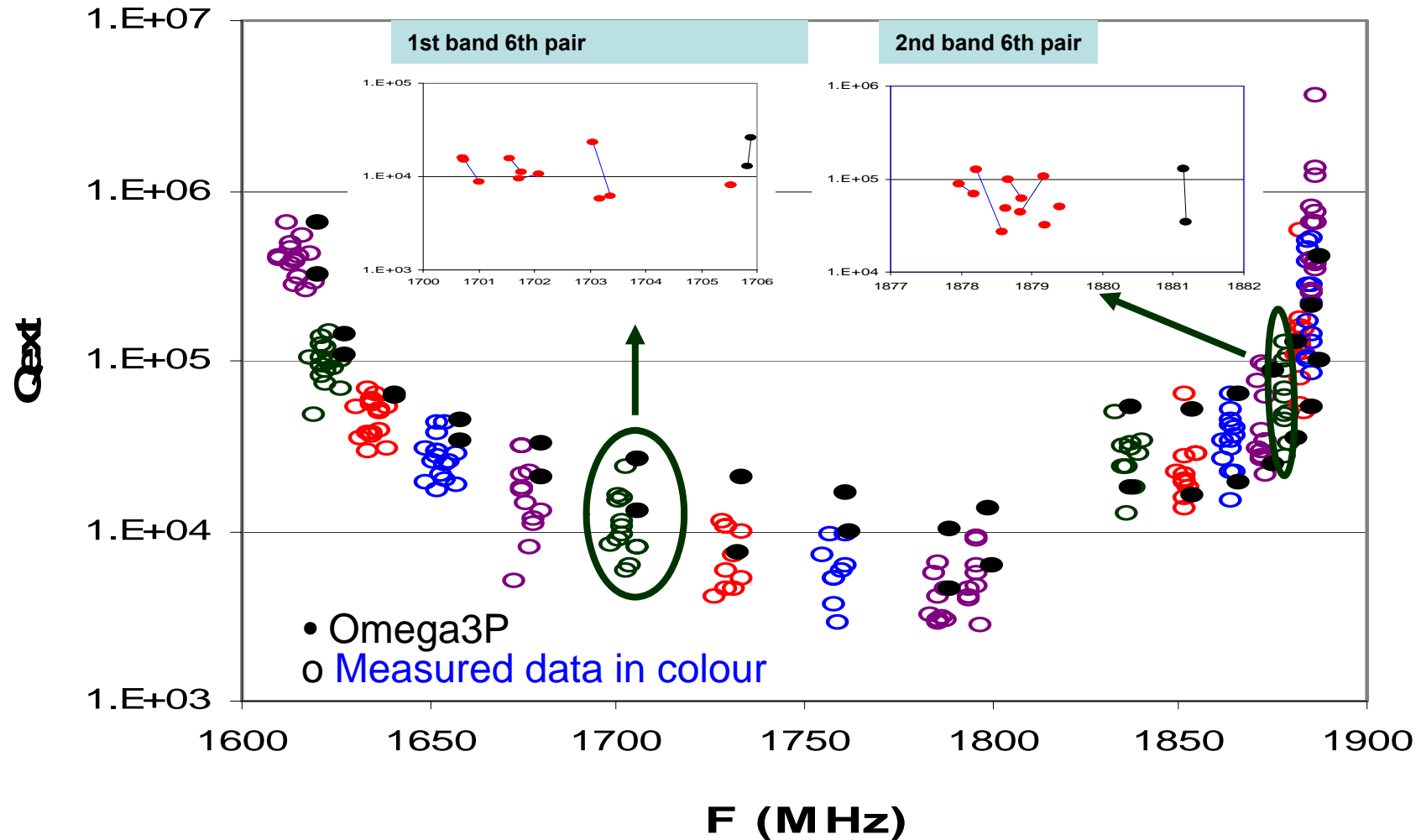
The main concern of cavity imperfection is its effects on wakefields.

OUTLINE

- 1. TESLA Cavity Dipole Mode Measurement Data**
- 2. TESLA Cavity Imperfection Model**
- 3. Simulation of Imperfection on Dipole Modes**
- 4. Wakefield with TESLA Cavity Imperfection**
- 5. Conclusion**

1. TESLA Cavity Dipole Mode Measurement Data

TTF module 5: 1st/2nd dipole band

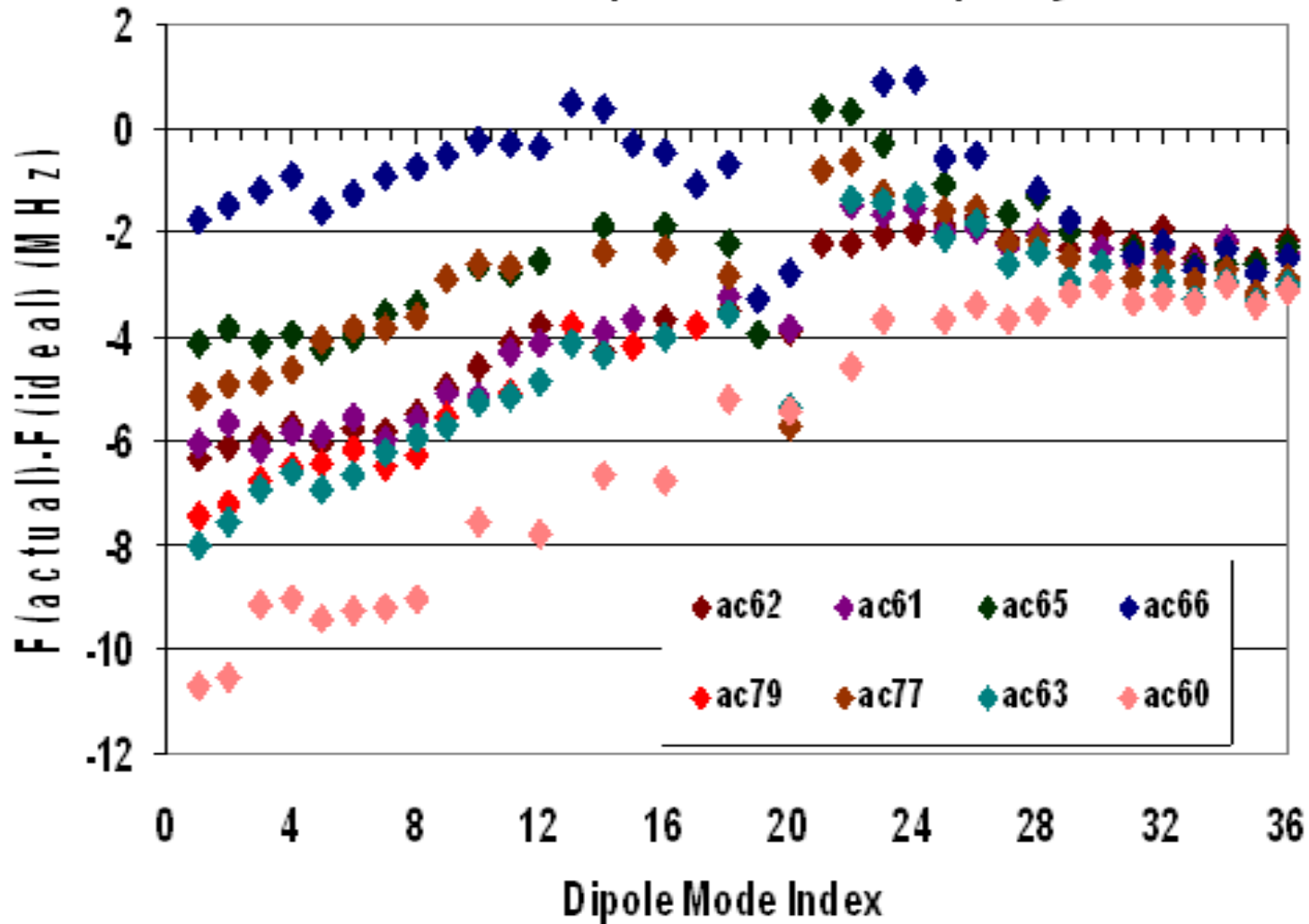


Dipole mode frequencies shift and Q_{ext} scatter



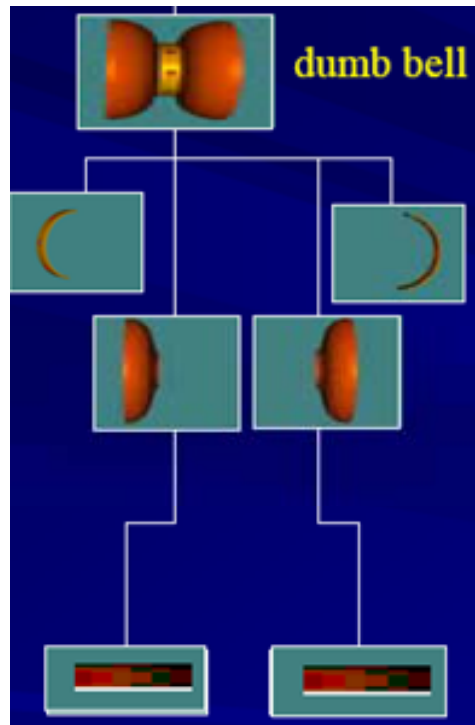
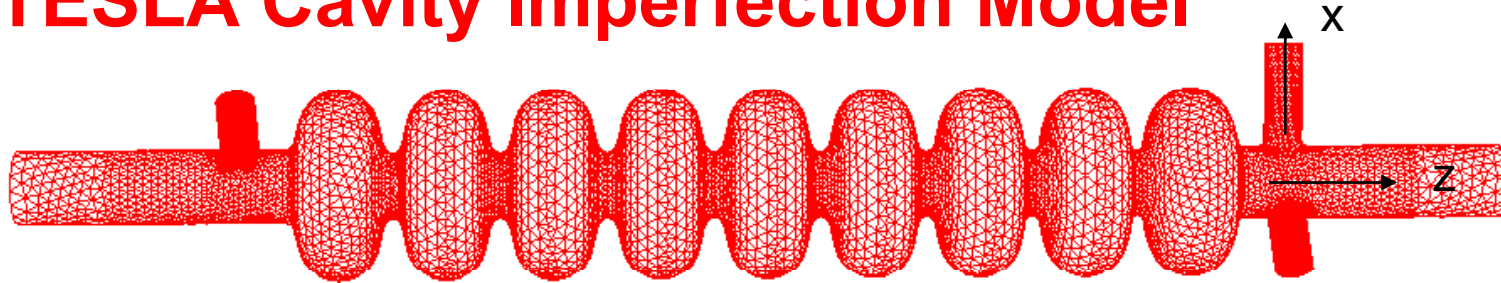
Frequency shift from ideal cavity

TTF Module 5: 1st/2nd dipole band mode frequency shift

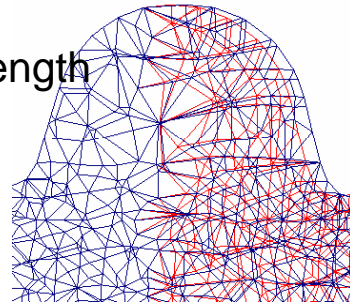


Dipole mode frequencies shift to lower values

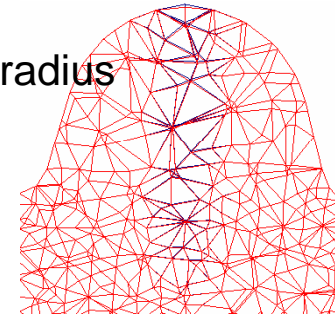
2. TESLA Cavity Imperfection Model



a) Cell length error

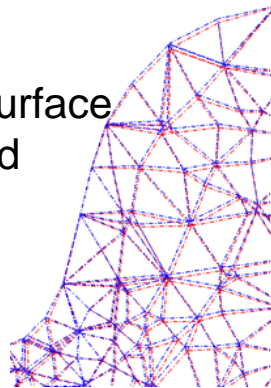


b) Cell radius error

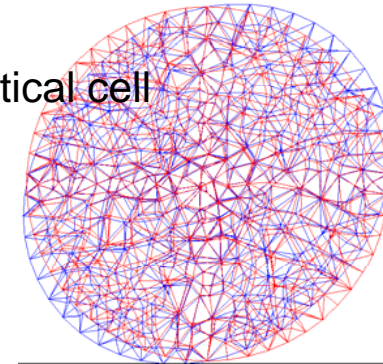


Red: ideal cavity, Blue: deformed cavity

c) Cell surface deformed



d) Elliptical cell shape



1st ILC Workshop at KEK

A. Matheisen



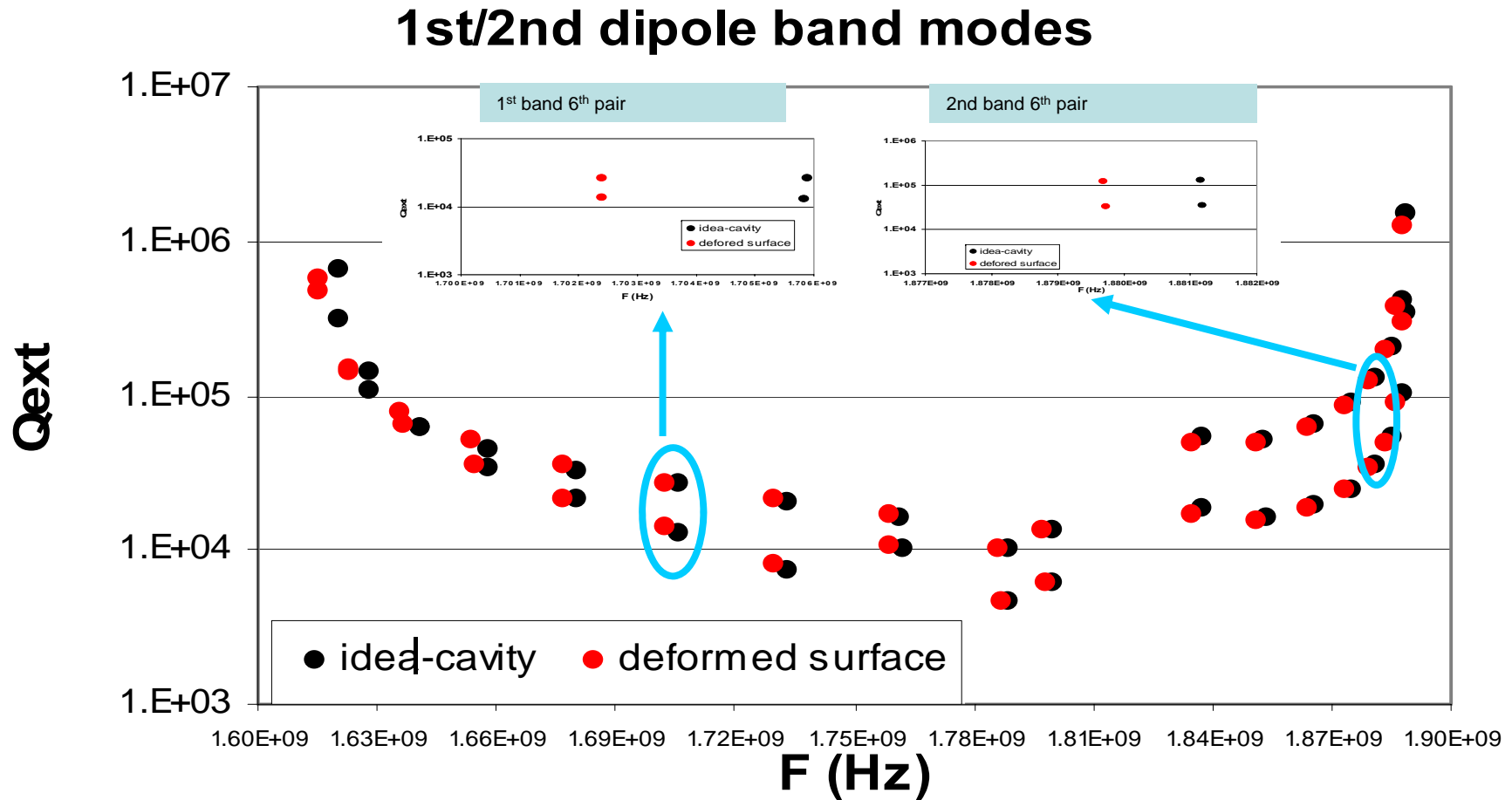
Distorted mesh for the cavity imperfection model

Wake Fest 07, Liling Xiao

3. Simulation of Imperfection on Dipole Modes

Example 1: Surface Deformed (0.2mm on top/0.607mm on disk)

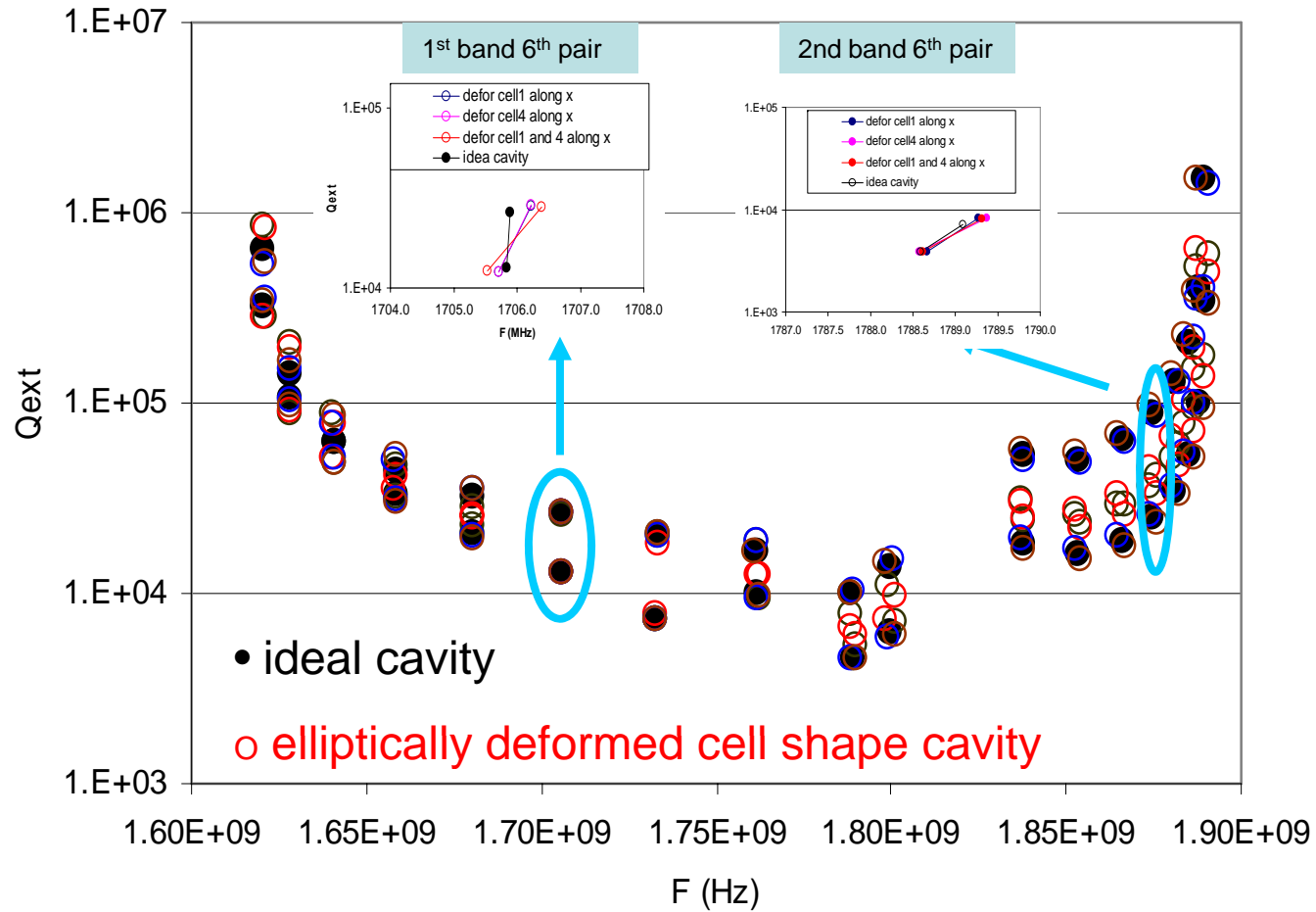
- cause dipole mode frequencies shift



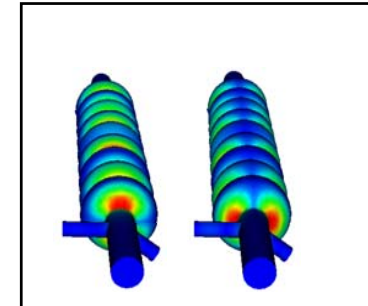
Example 2: Cell shape elliptical deformed (dr=0.25mm)

- cause mode polarization change and mode splitting

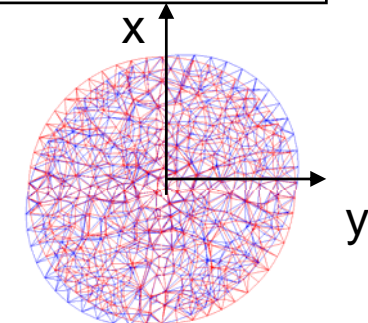
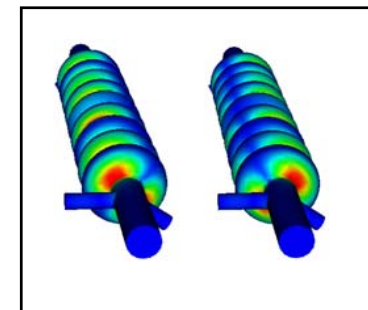
TDR cavity with elliptical cell shape



ideal cavity



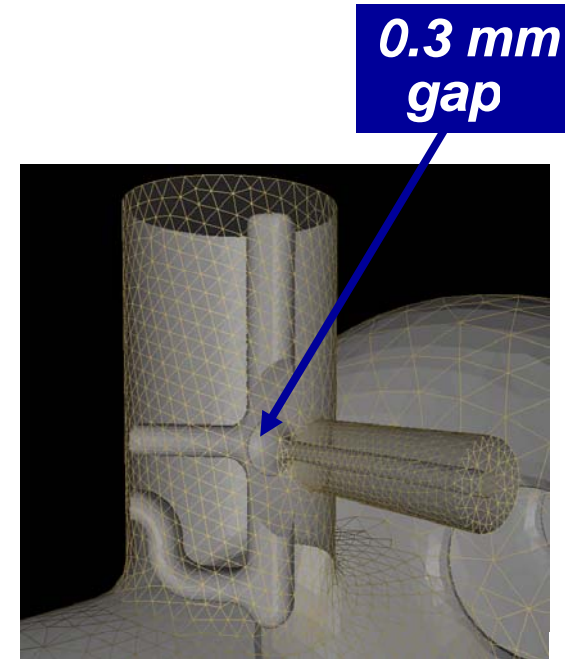
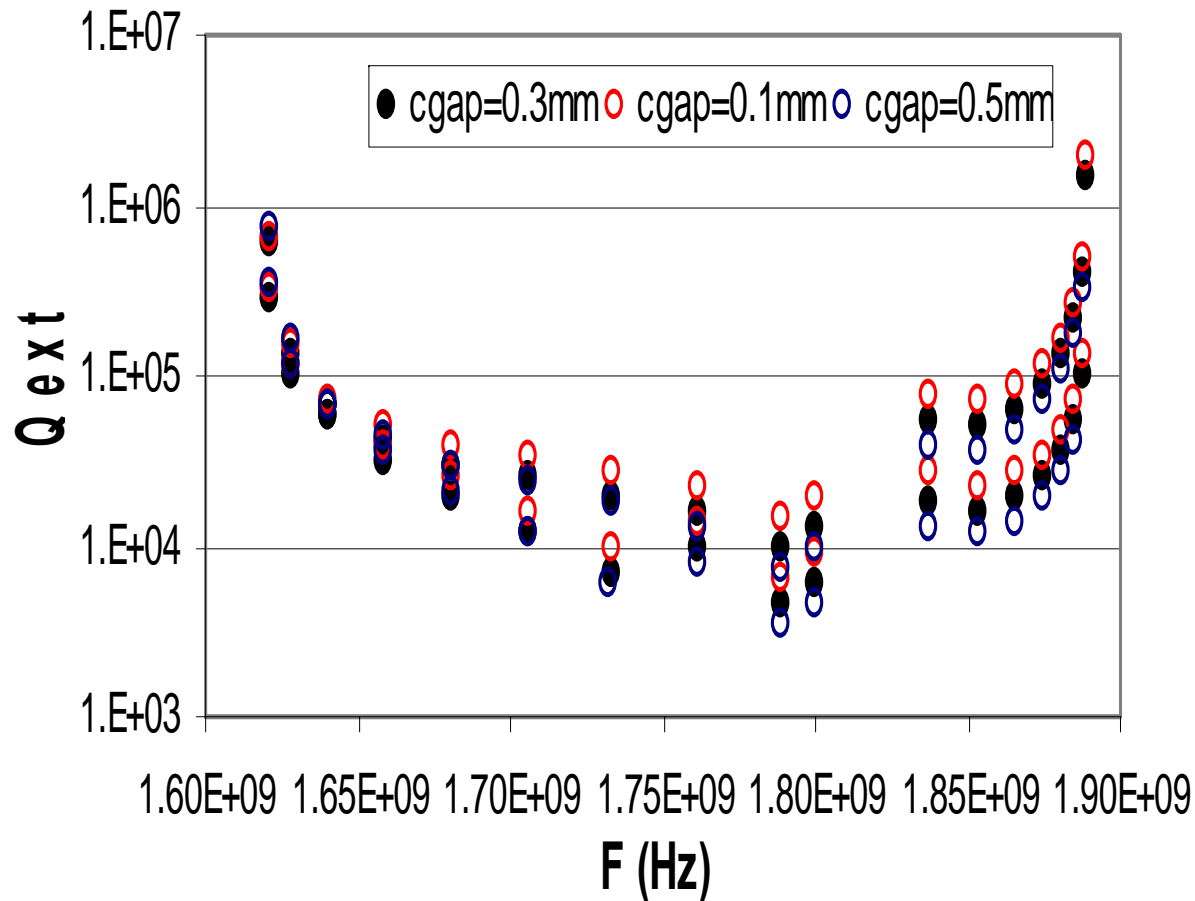
Elli. deformed cavity



Example 3: HOM coupler pick up gap dimension error ($\Delta c_{gap}=0.2\text{mm}$)

- *cause Q_{ext} scatter*

TDR cavity: 1st/2nd dipole band modes

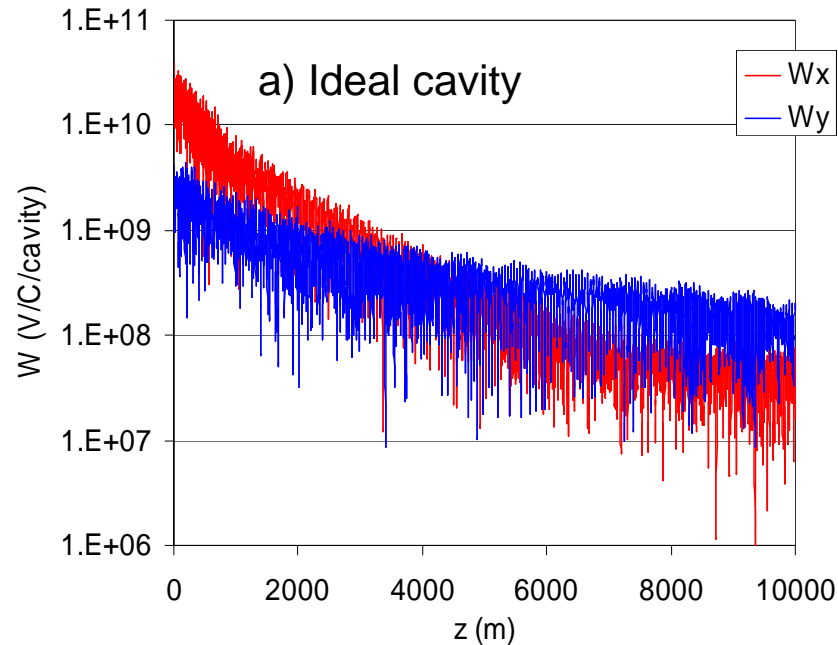


Q_{ext} can vary by a factor of 5 for some dipole modes.

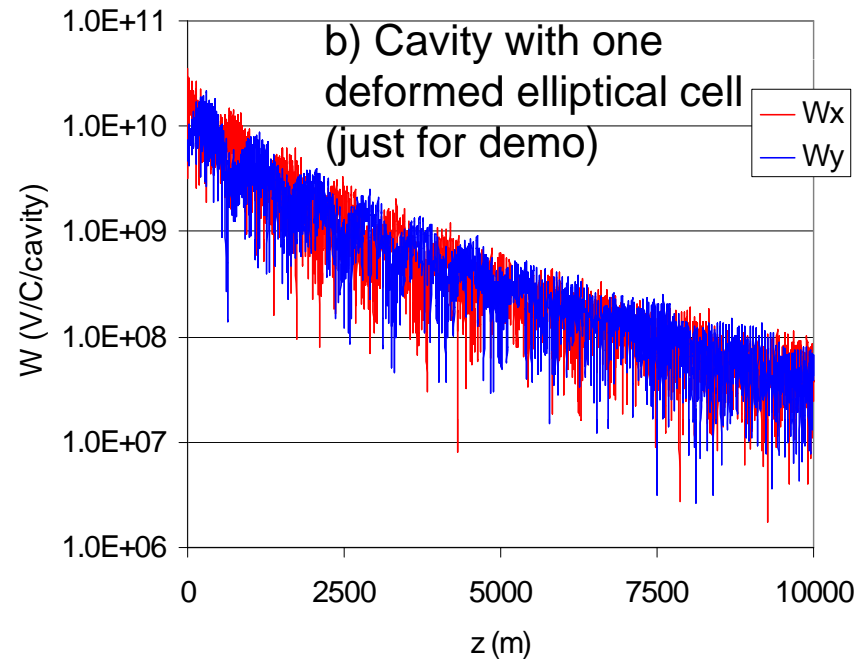


4. Wakefield with TESLA Cavity Imperfection

Wakefield with x-y coupling (a beam offset of 0.5mm in the x-direction)



x-y coupling arising from 3D asymmetry of the coupler configurations



Elliptical cell shapes could enhancement of x-y coupling for wakefield effects

The effects on x-y coupling are more significant for deformed elliptical cell shape than for couplers.

5. Conclusion

- Cell surface shape affects mostly the frequency shifts and pair separations of dipole modes;
- The scatter in Q_{ext} is more sensitive to the variation of the pickup gap in the HOM coupler and cell unsymmetry;
- Actual cavities will include all the imperfections. A program which generates sets of different imperfection cavities was written;
- The wakefields in different imperfection cavities input into the beam tracking code Lucretia to study the effect on beam dynamic;

(Andreas Kabel's talk "3D x-y coupled wakefield effects on beam dynamics")

- Studies of cavity imperfection will be useful to determine the tolerance requirements for the cavity shape during the fabrication process.

