Eccentricity correcting module for CTM and Project X buncher modeling

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FNAL
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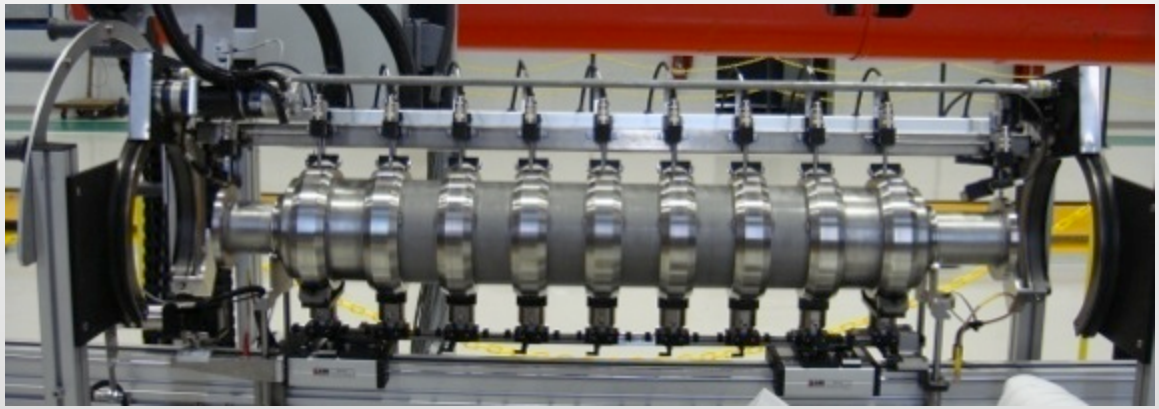
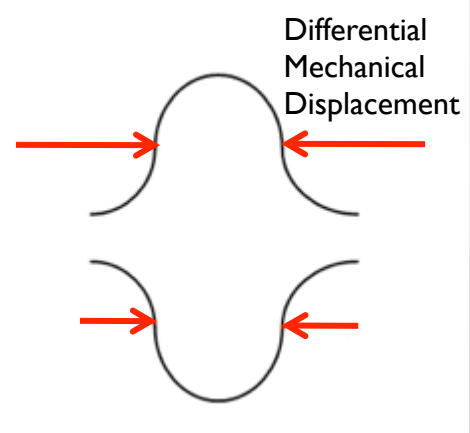
Cavity Tuning Machine

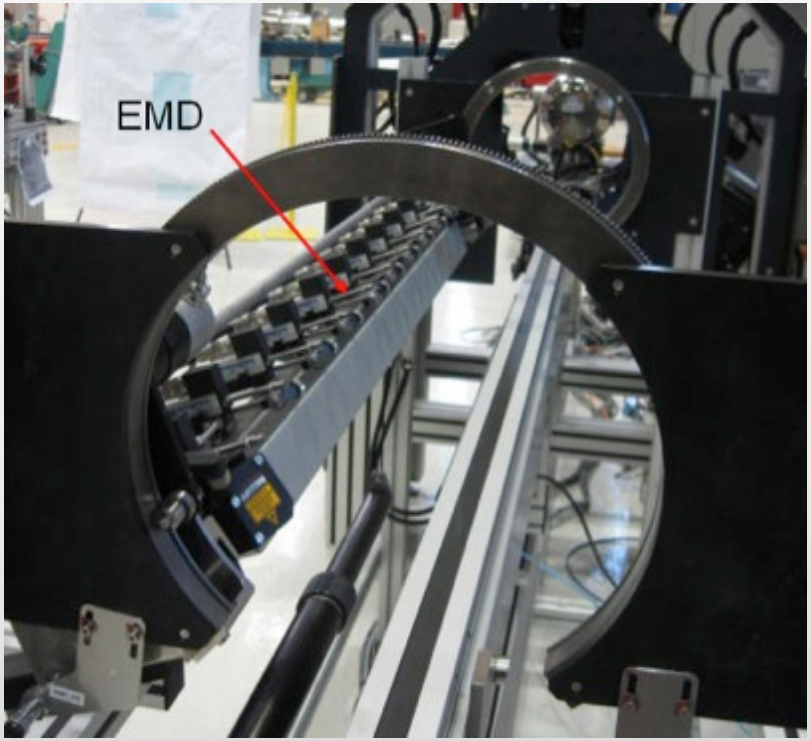
- Tuning to target frequency
- Field flatness tuning
- Correcting eccentricity
  1. Measuring displacement
  2. Estimating differential deformation
  3. Applying differential displacement

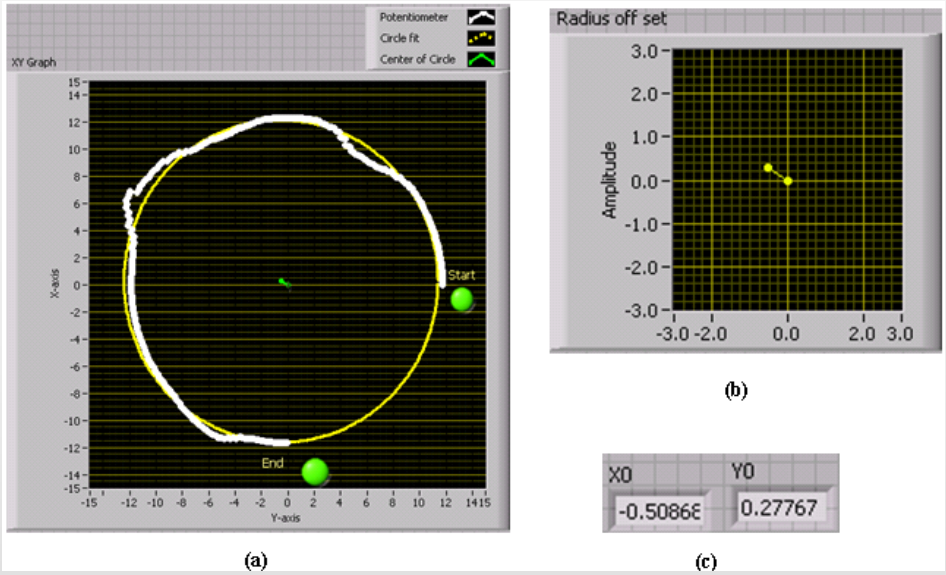




Measuring eccentricity

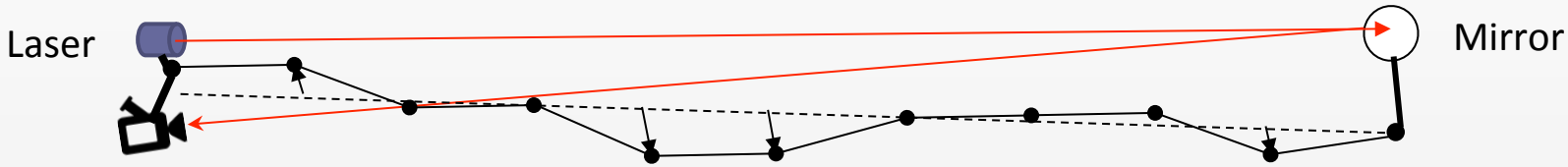
- Mounting on Cavity Train
- Measuring cell equator position
- Calculating cell center position





Estimating deformation

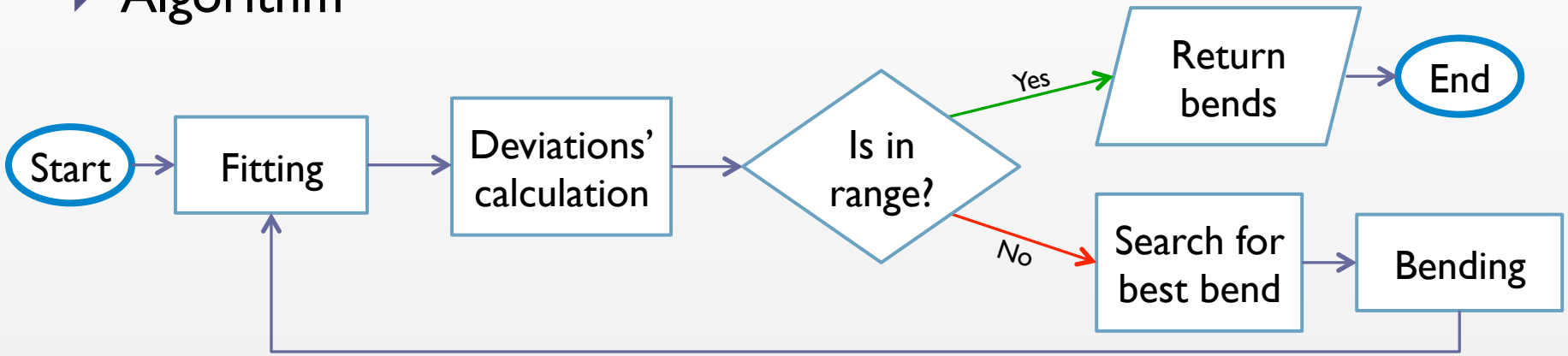
- Mechanical model - each cell center is a hinge



- Goals
  - ✓ Development of the algorithm for eccentricity tuning
    1. Tolerance range ($\Delta r \leq 0.5$ mm)
    2. Minimization of the number of bends
    3. Minimization of the bend magnitude
  - ✓ C-code implementation
  - ❑ Integration as DLL library in the existing LabVIEW program

Algorithm and results

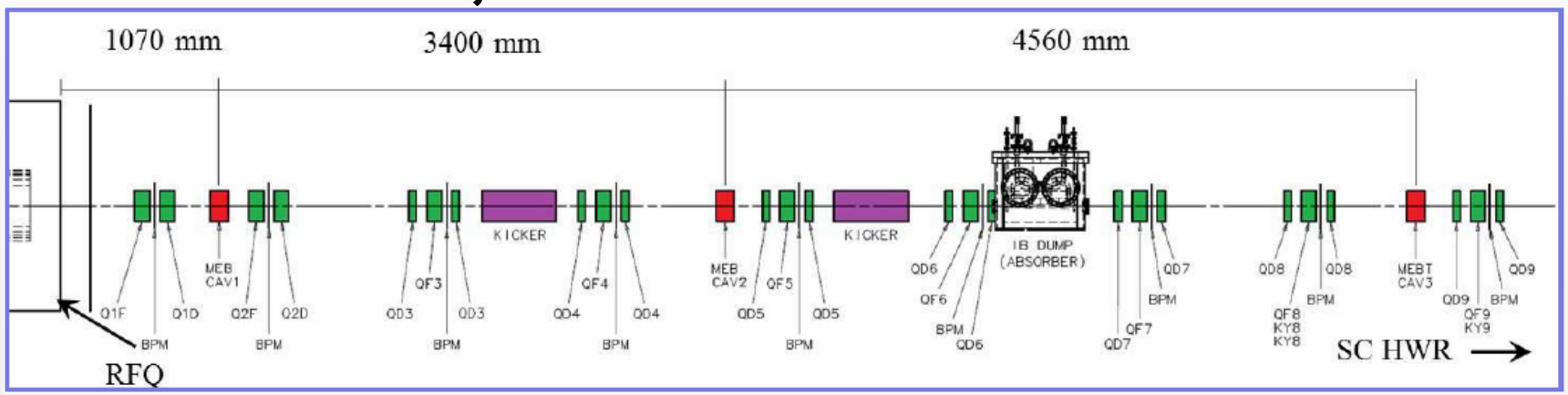
- Algorithm



- Results
  - Do not deform cavity within tolerance range
  - Bends do not exceed maximal value
  - Deform not all cells
  - Do not minimize number of bends

Goals

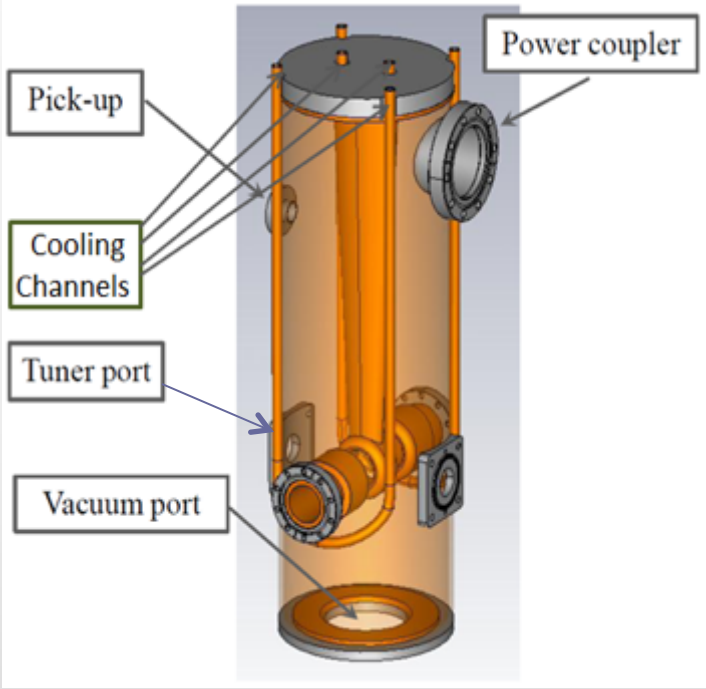
- Buncher for Project X MEBT line

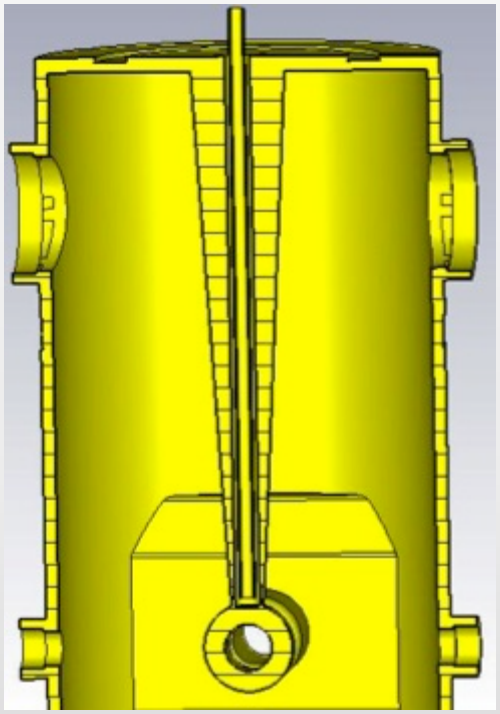


- Goals:
  - ✓ Studying CST and COMSOL multiphysics software
  - ✓ Accomplishment all modelling steps in both programs
  - ✓ Comparison of results

Buncher

- Effective voltage: 70 kV
- Frequency: 162.5 MHz
- Beam aperture: 30mm

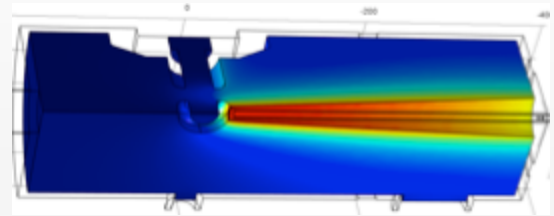




Buncher cavity modelling

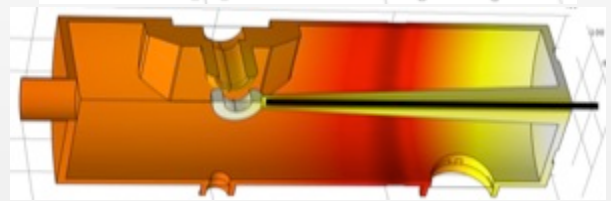
- Modelling is a part of cavity design
- Main steps:
  - Eigenmode simulation
  - Heat transfer simulation
  - Deformation simulation
  - Eigenmode simulation

Field and power loss distribution →



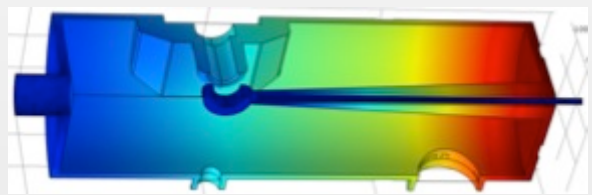
0.7 KV

Temperature distribution →



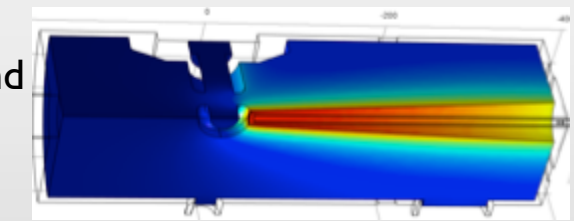
8 K

Deformed geometry →



0.05 mm

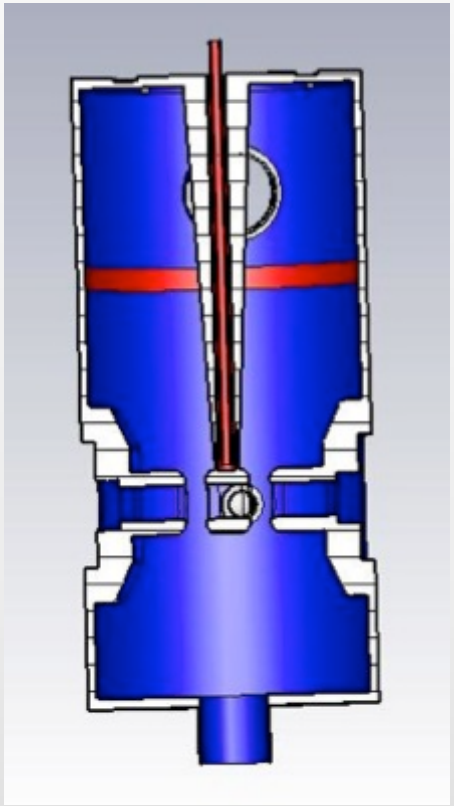
Field distribution and frequency shift →

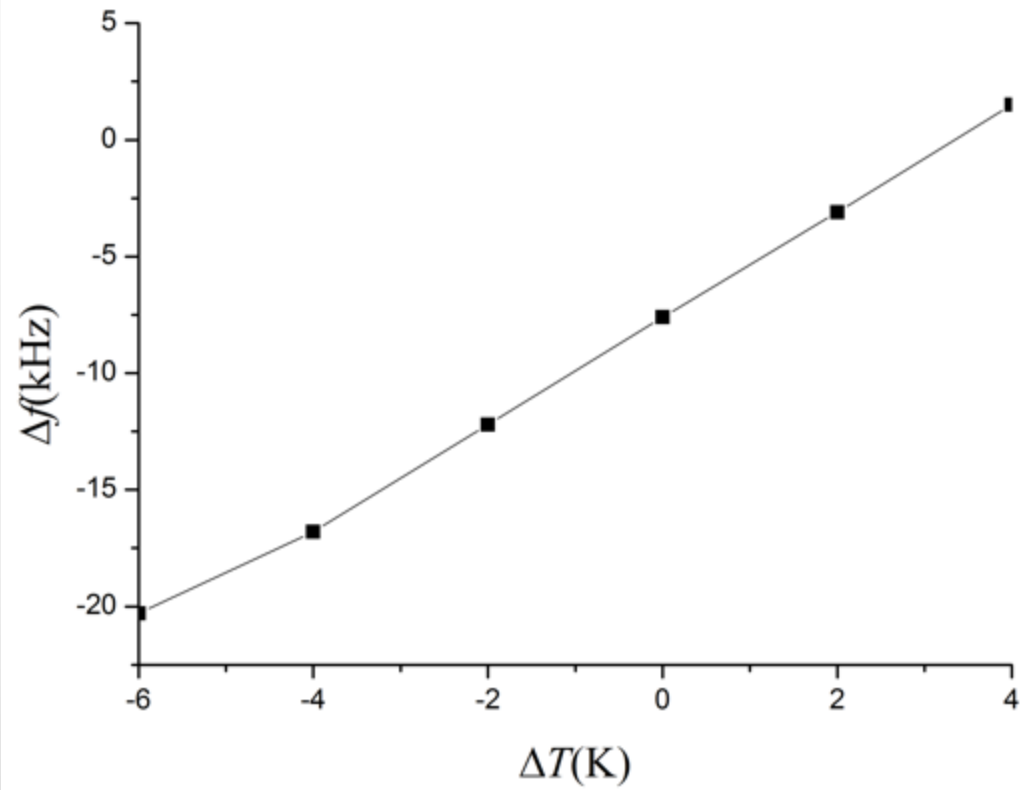


-7.8 kHz

Results

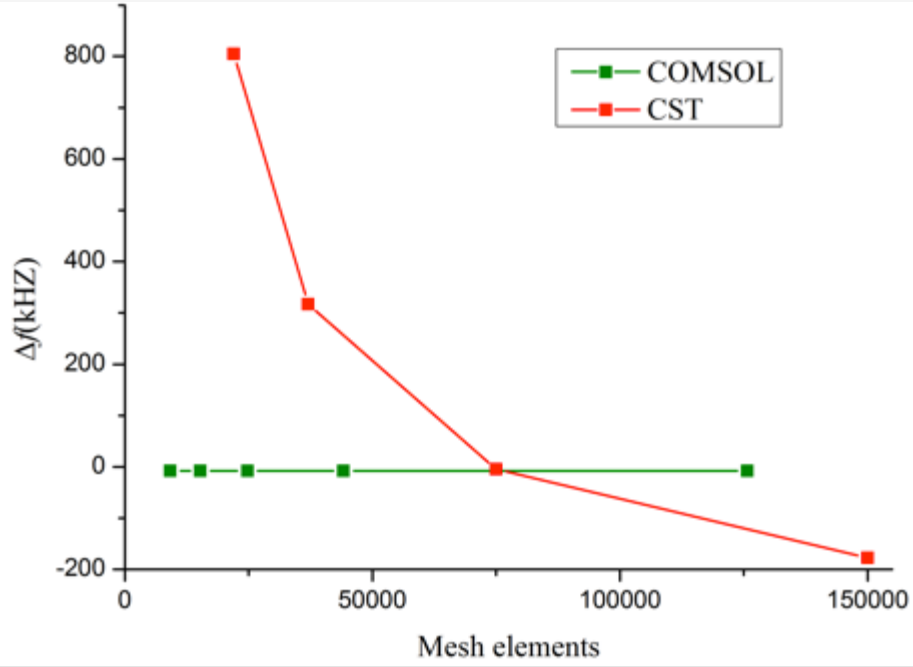
- Linear frequency shift dependence from cooling temperature





Results comparison

- Results of first 3 modeling step are very similar
- Frequency shift is totally different:
  - COMSOL:
    - Don't depend from mesh
    - Close to expected value
  - CST:
    - Varies a lot from mesh to mesh
    - Much bigger than expected



Thank you for attention!