Type IV Cryomodule Vibration Model
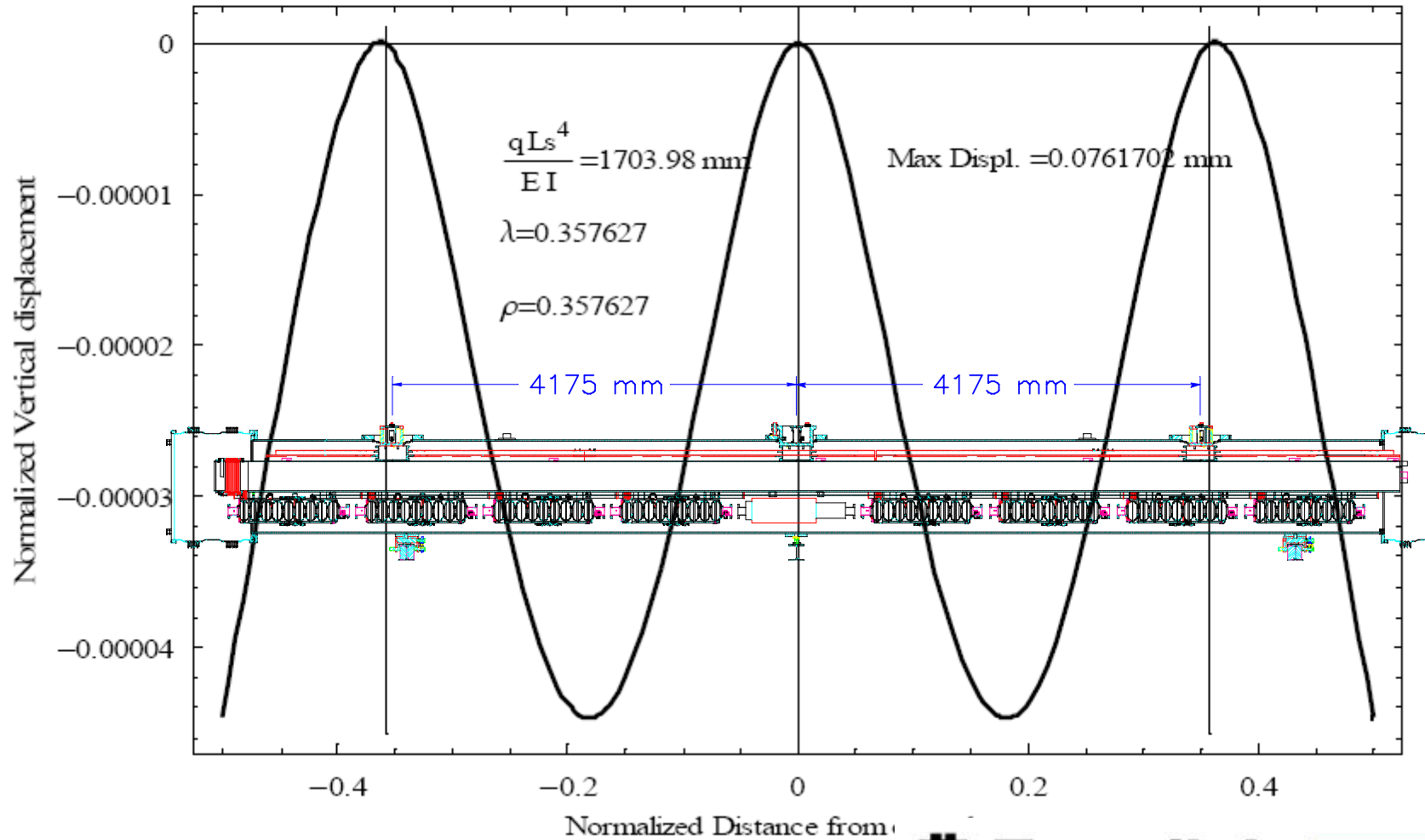
July 13, 2006

Mike McGee

Fermilab

Vertical uniform load = 1173 N/m
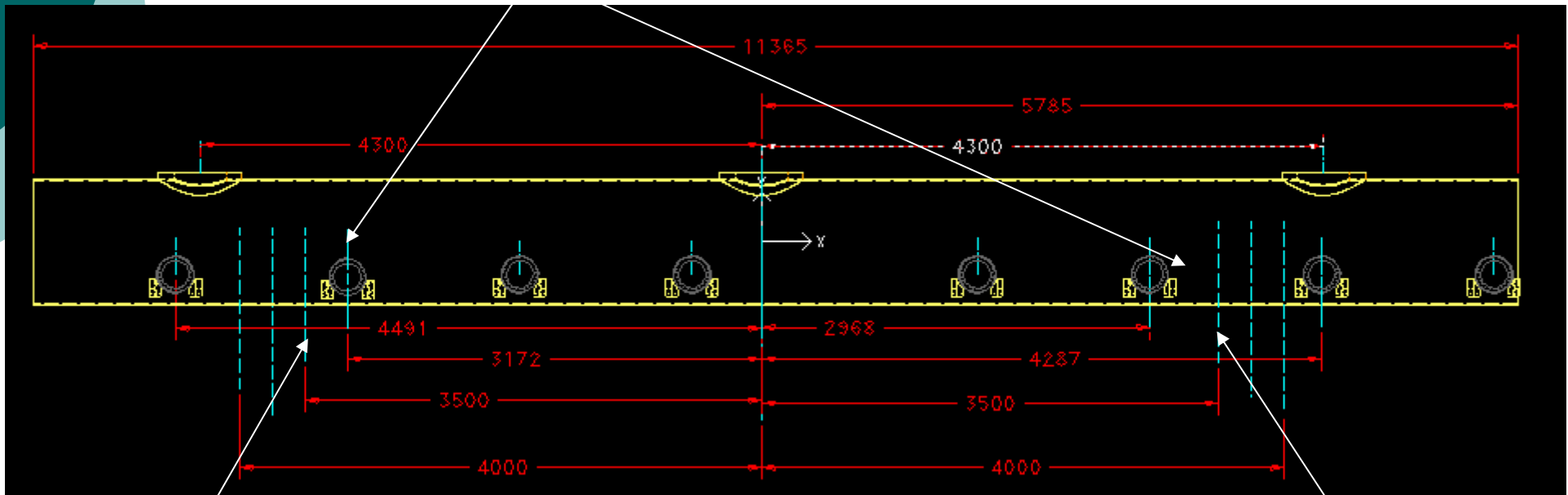Lateral post distance = 4184 mm

Nicola Panzeri
INFN Milano - LASA

$$\frac{qLs^4}{EI} = 1703.98 \text{ mm}$$

Max Displ. = 0.0761702 mm

$\lambda = 0.357627$

$\rho = 0.357627$

4175 mm   4175 mm

Two External Supports (INFN-Milan)

Analytical solution A/2=3300 mm

Vessel Support Position   Vessel Support Position

by Andrea Basti (INFN-Pisa)

Andrea's Conclusion (INFN-Pisa)

- To minimize the displacements the distance of these two supports from the centre must be 3500 mm
  - Max. calculated displacements are below 0.2 mm
  - Evaluate T4CM 2 external support configuration
  - System can be realigned after the installation

Mike McGee, 13 Jul 2006

Andrea's Conclusion (INFN-Pisa)

○ **Normal mode studies**

- Concerns about normal modes close to 60 Hz
- Needed more investigations

○ **Perform Study using ANSYS at Fermilab**

Initial T4CM Model Results

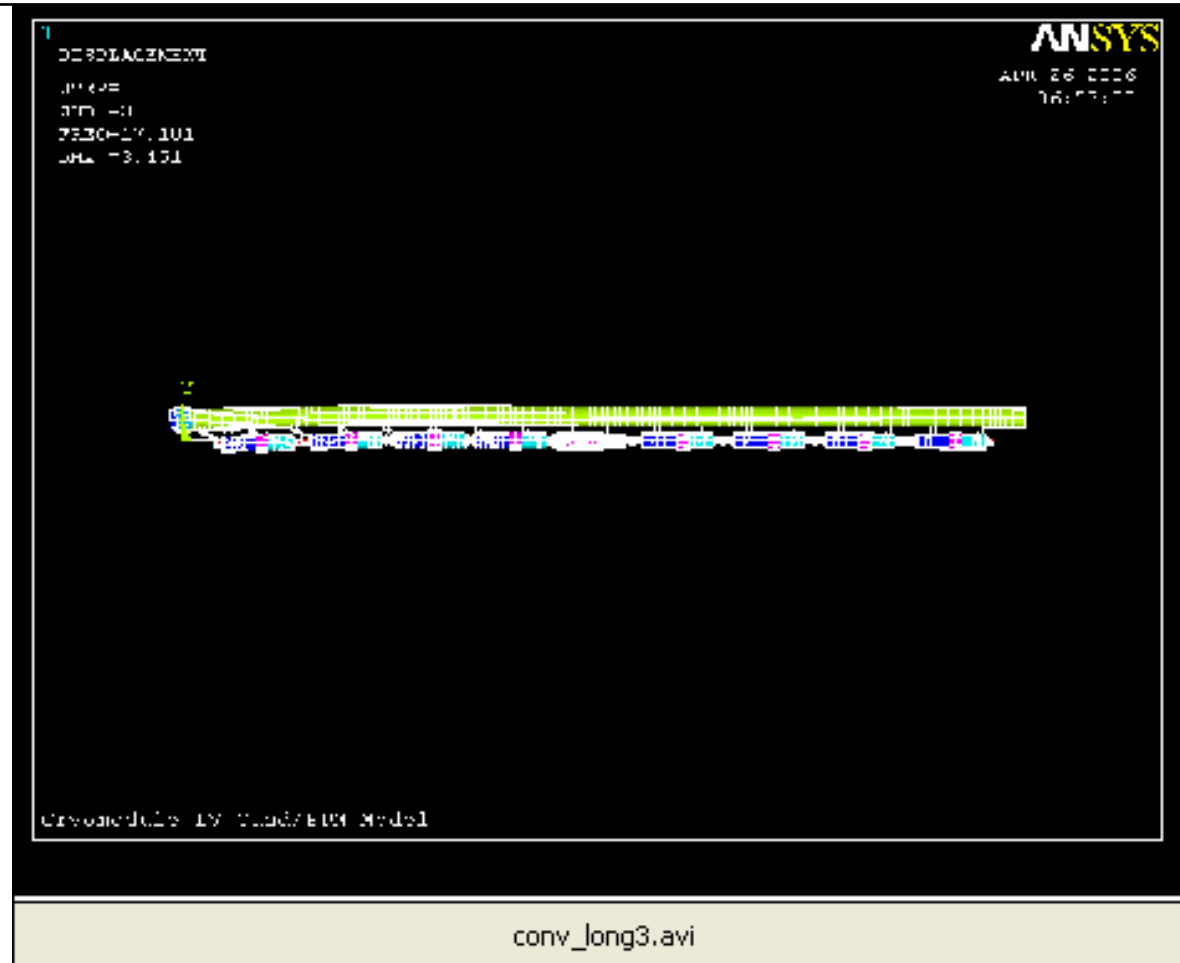Modal Analysis

Mode 1
12.9 Hz
Transverse Hinging

conv_hinge2.avi

Constrained only at column support locations

Mode Shape 2 (conventional)

Modal Analysis

Mode 2
14.3 Hz
Longitudinal Motion

conv_long3.avi

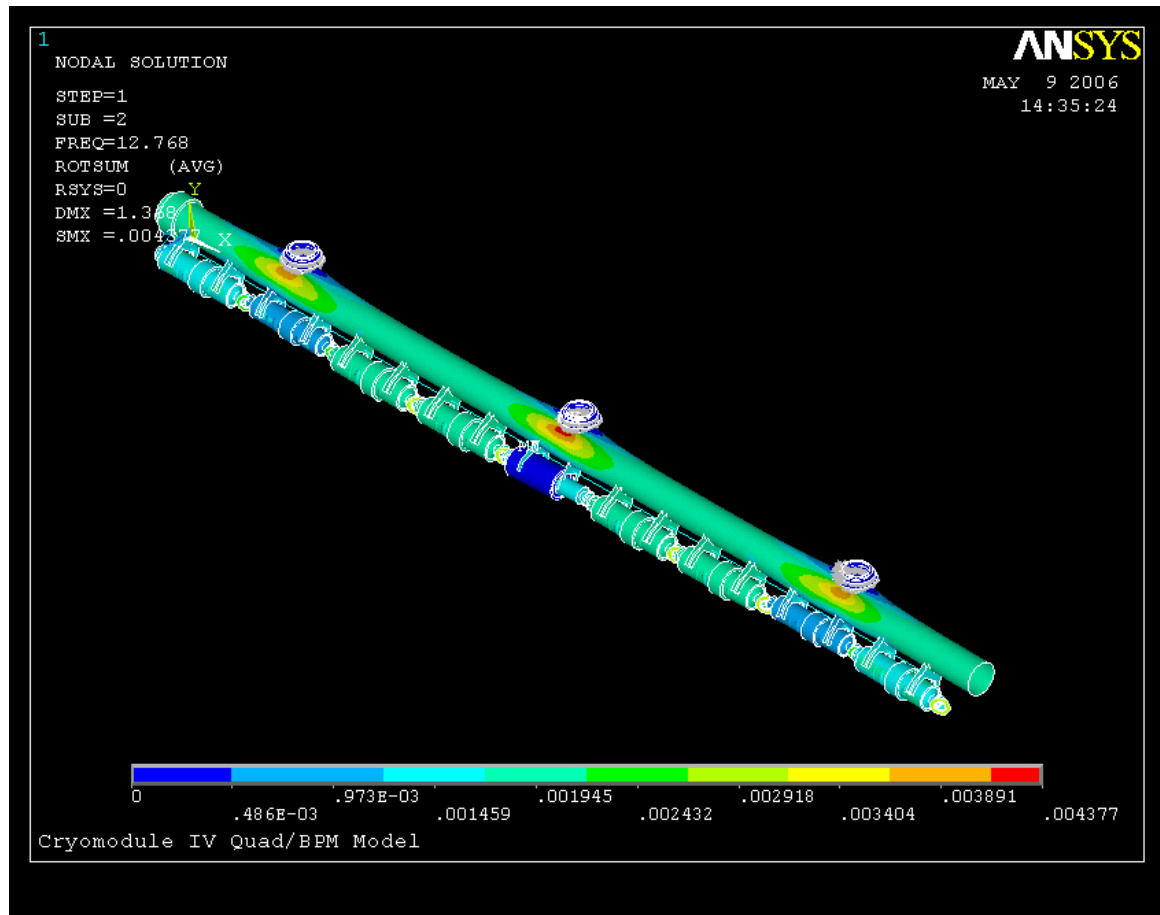No end conditions assumed

Mike McGee, 13 Jul 2006

Refined (conventional) Model

- Model Refinements
  - Added Column Geometry
  - Distributed mass of shield onto columns
  - Added Invar
  - Added Vacuum Vessel
  - Added Input Couplers
  - Modified cavity bracket connection for free movement along beam line

Refined T4CM (conventional) Result

Modal Analysis

Mode 1
12.78 Hz
Transverse Hinging

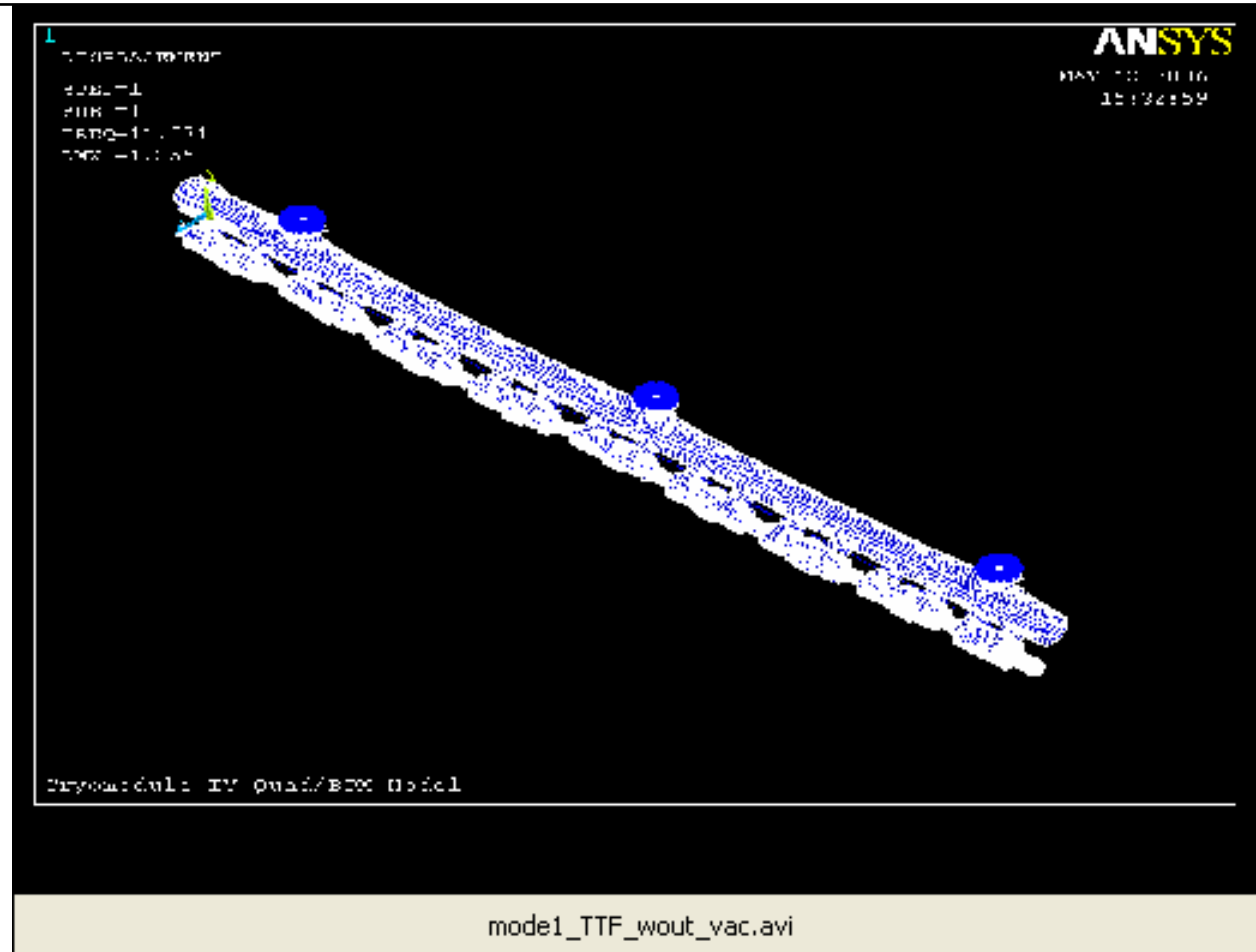

Again, no end conditions assumed

Mike McGee, 13 Jul 2006

Application of ANSYS CMS

○ Input file driven ANSYS modeling

○ Efficient Model Generation

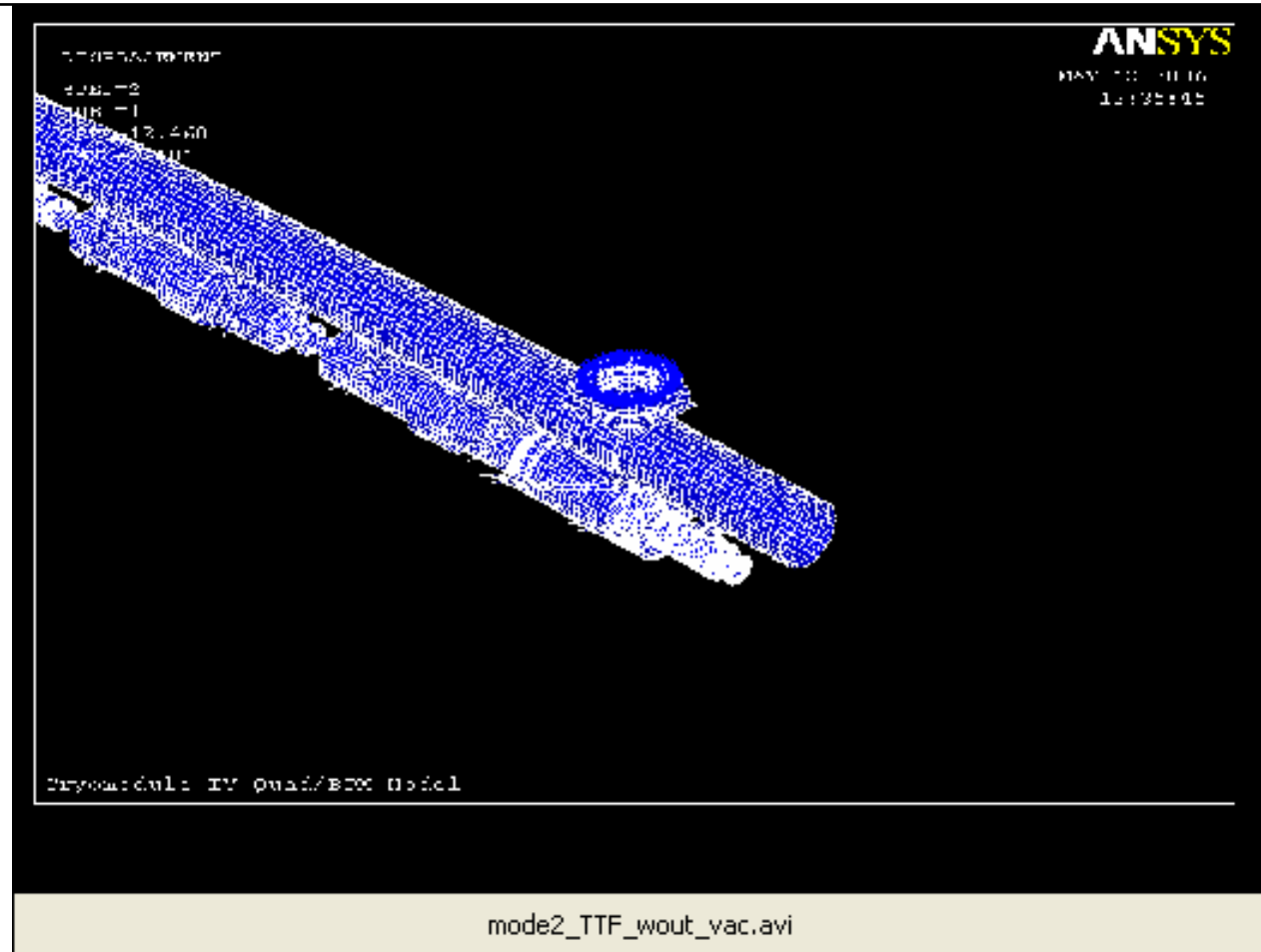○ Ability to Generate Large (Millions of dof) and Complex Models

Mike McGee, 13 Jul 2006

T4CM CMS Mode Shape 1

Modal Analysis

Mode 1
13 Hz
Transverse Hinging

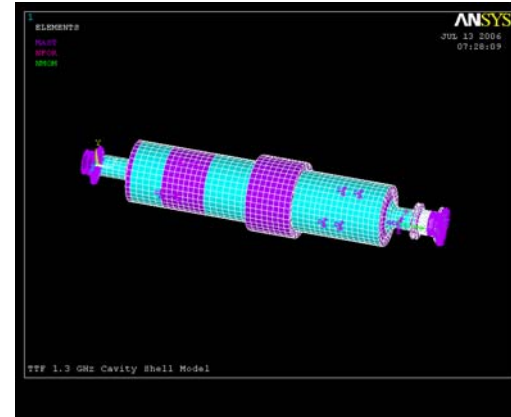mode1_TTF_wout_vac.avi

T4CM Design Meeting #2

Mike McGee, 13 Jul 2006

CMS Mode Shape 2

Modal Analysis

Mode 2
15.2 Hz
Transverse
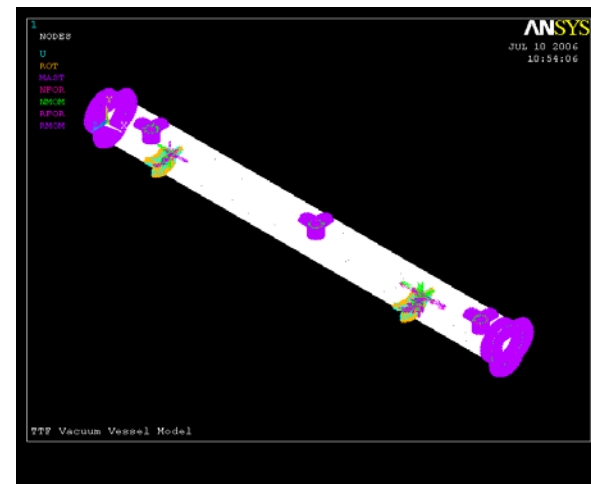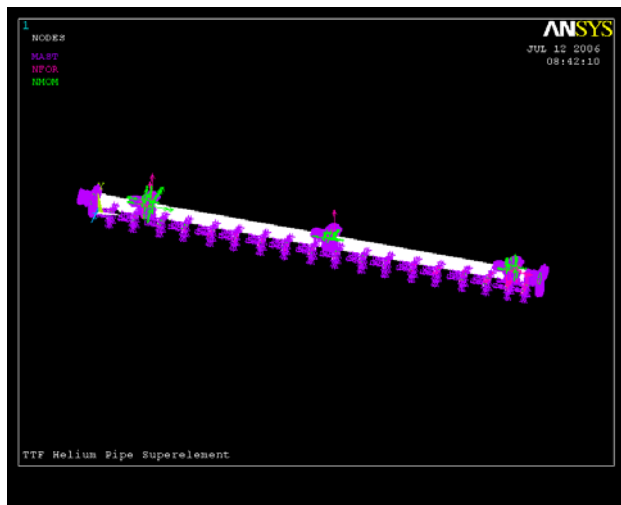Pendulum

mode2_TTF_wout_vac.avi

Mike McGee, 13 Jul 2006

TTF CMS "Super Elements"
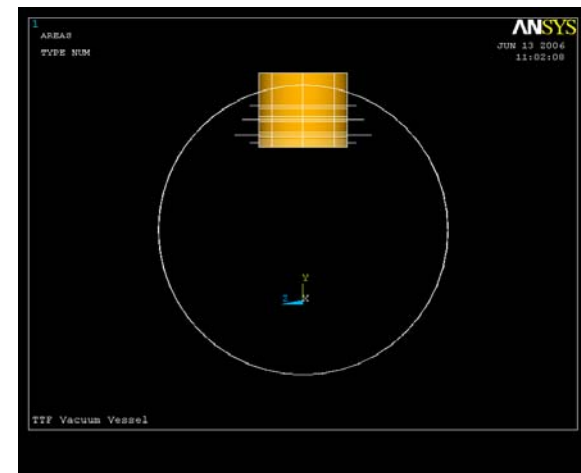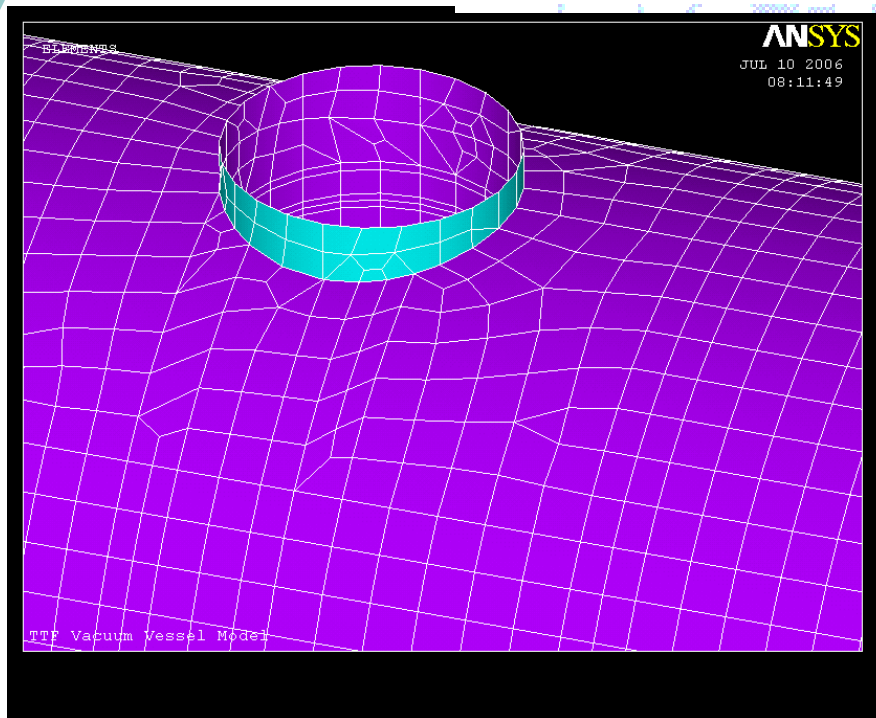
End Quad
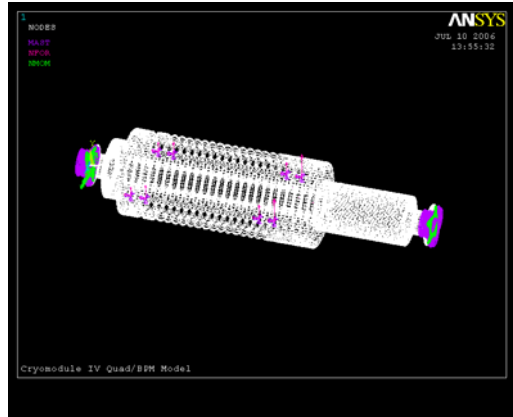
8 Cavities

HeGRP with brackets

Vacuum Vessel with input couplers

Mike McGee, 13 Jul 2006

Applying CMS to TTF Model

"Super Elements" Combined

Mike McGee, 13 Jul 2006
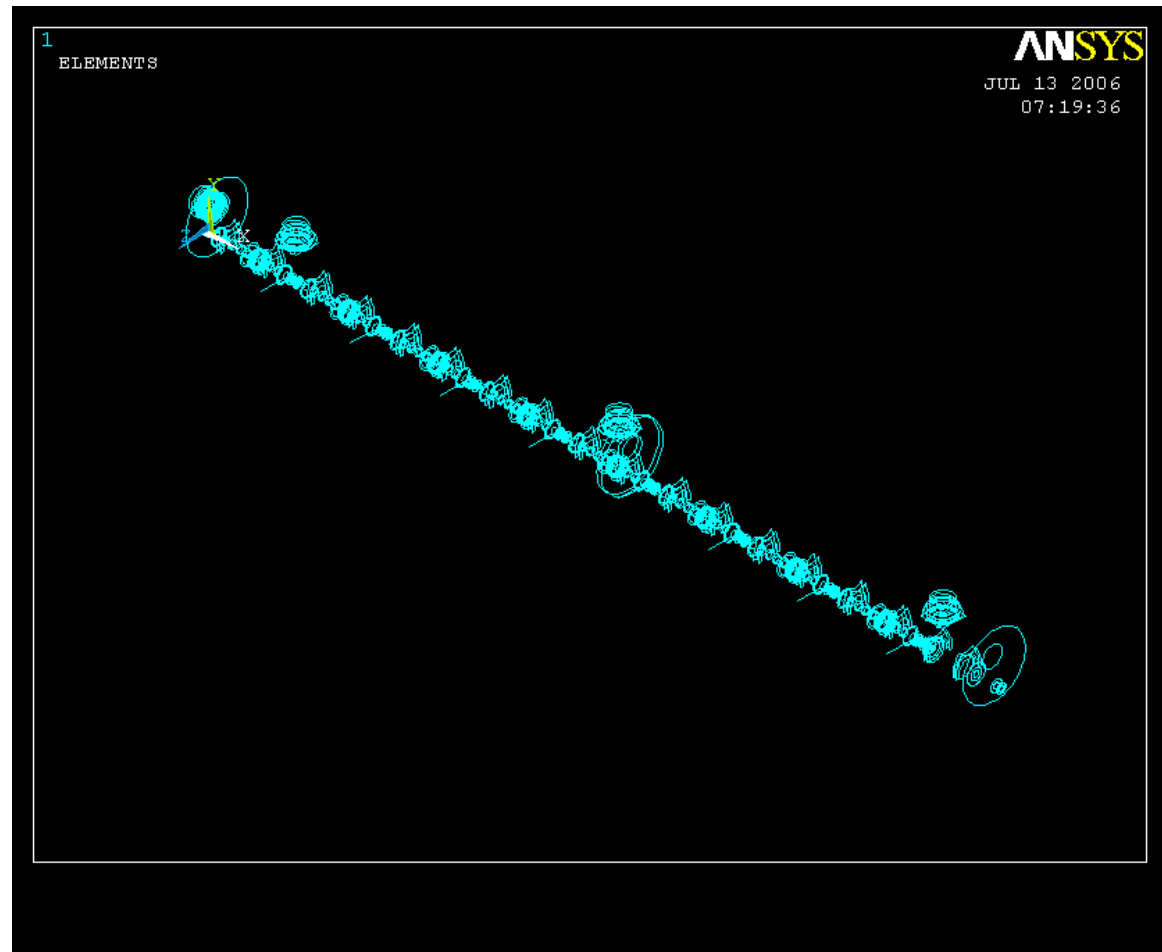
TTF CMS Model as Benchmark

TTF CMS Model Results

Mode 1:
12.2 Hz
longitudinal
motion

mode1_w_vac.avi

With no end constraint

Mike McGee, 13 Jul 2006
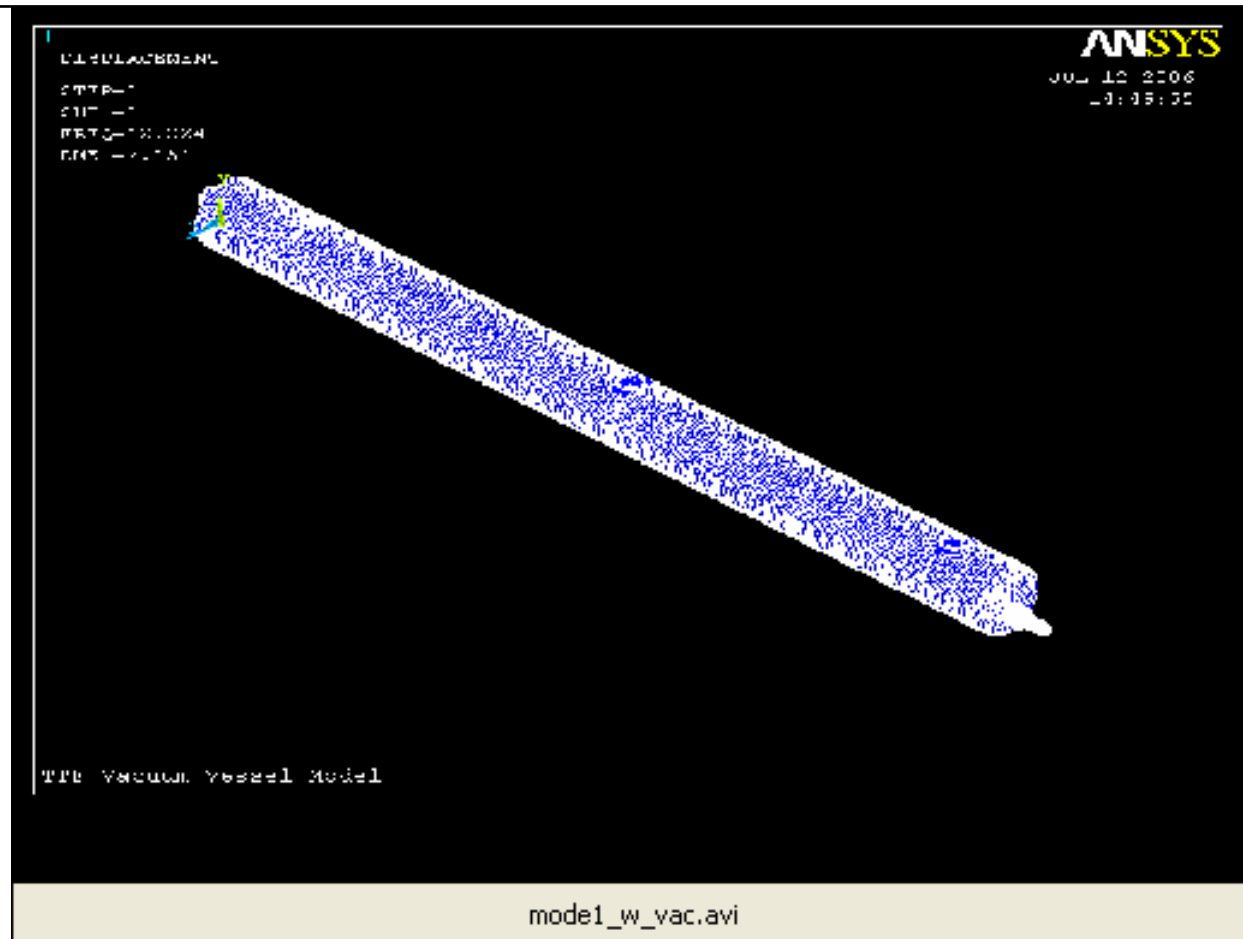
TTF CMS Model Results

Modal Analysis

Mode 2
13.2 Hz
Vertical motion

With no end constraint

Mike McGee, 13 Jul 2006
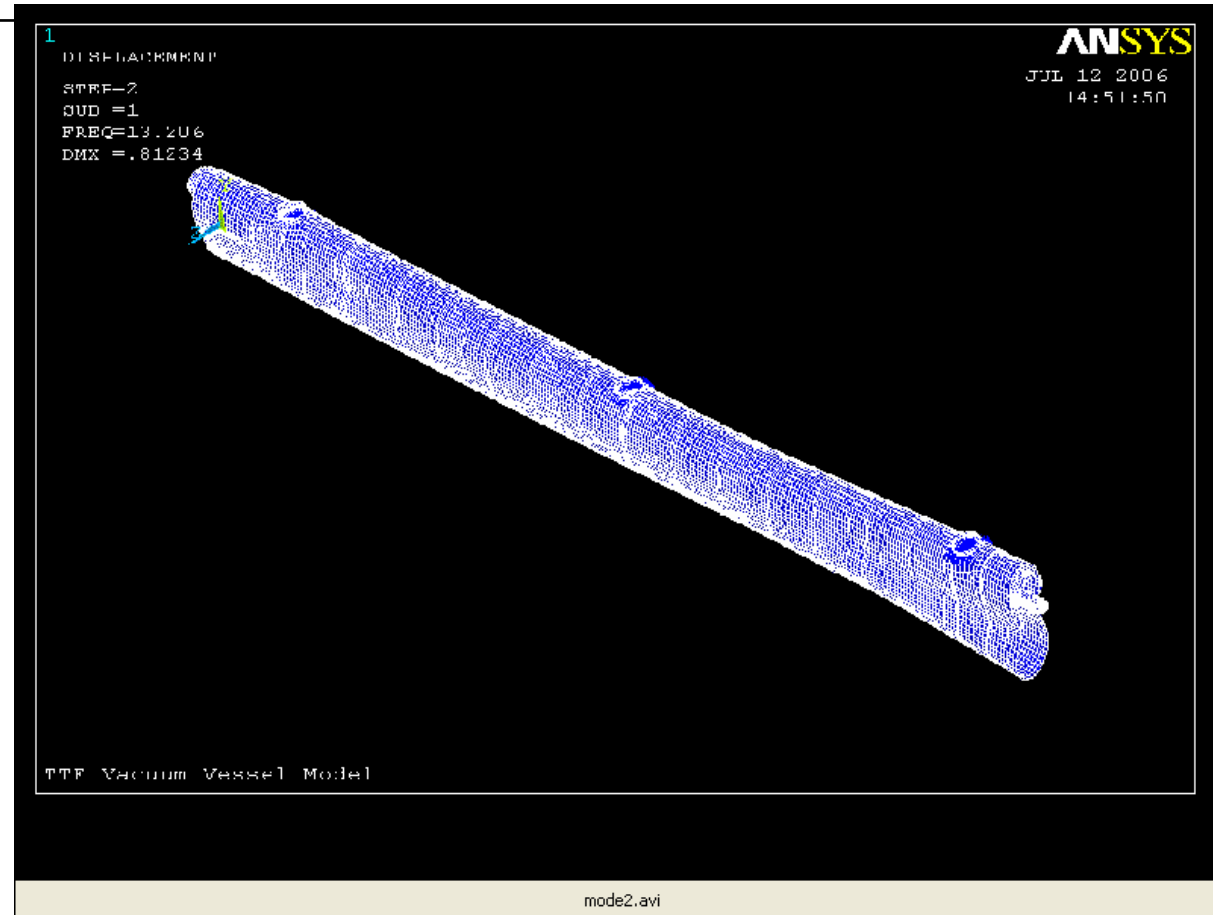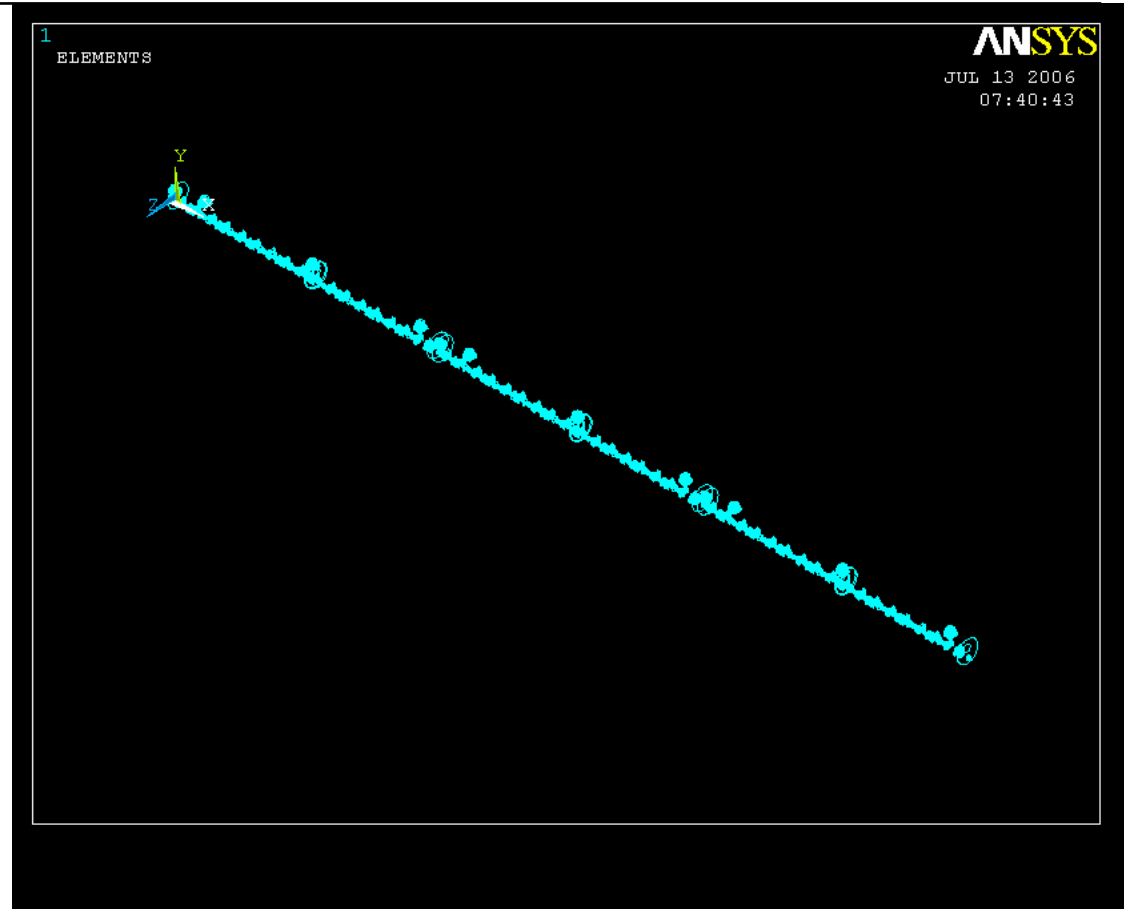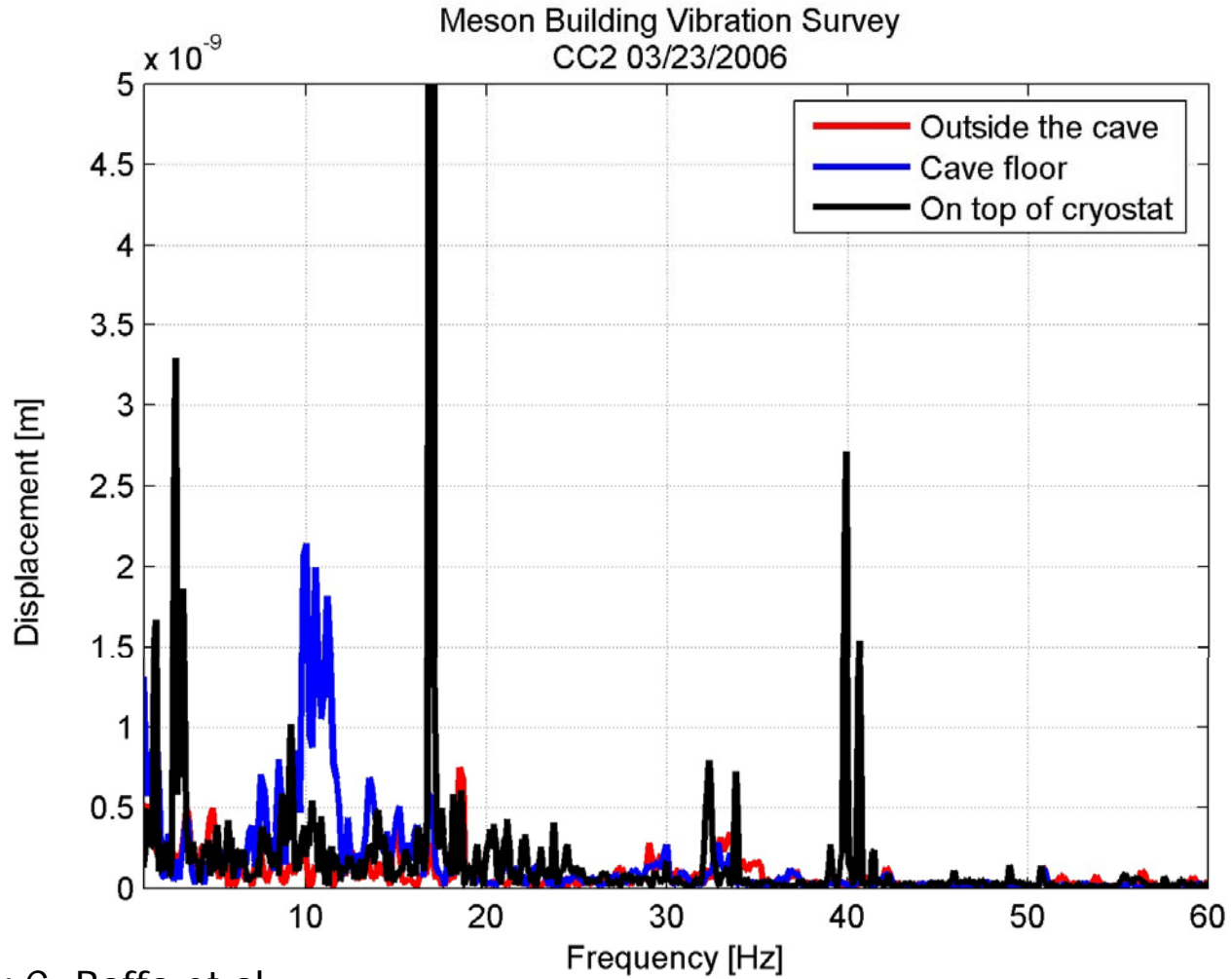
TTF CMS 3 Cryomodule Model

With no end
constraint:
Mode 1: 12.5 Hz

With end
constraint:
Mode 1: 13.6 Hz

Input couplers attached

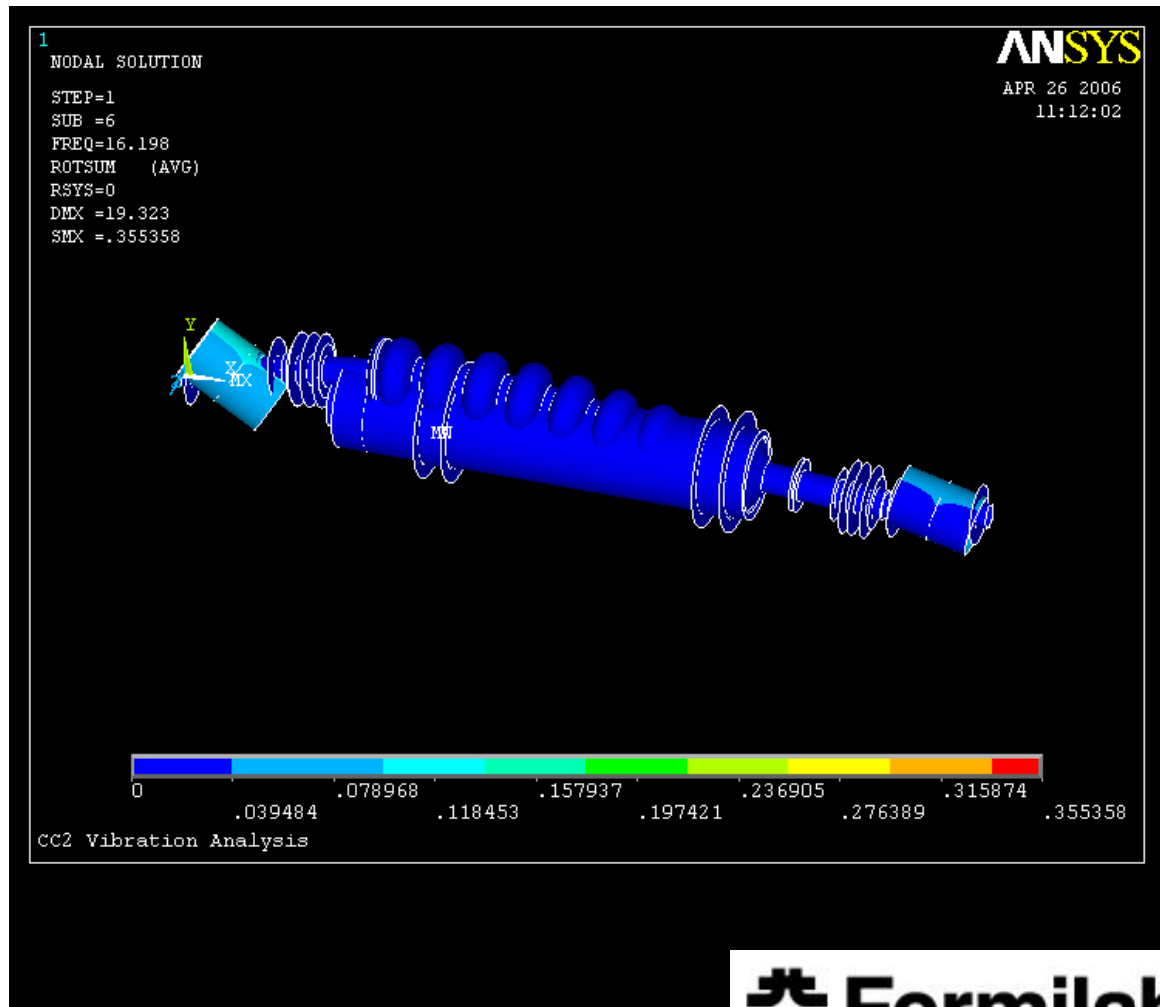# Capture Cavity 2 (Meson-Fermilab)

Meson Building Vibration Survey
CC2 03/23/2006

Legend:
- Outside the cave
- Cave floor
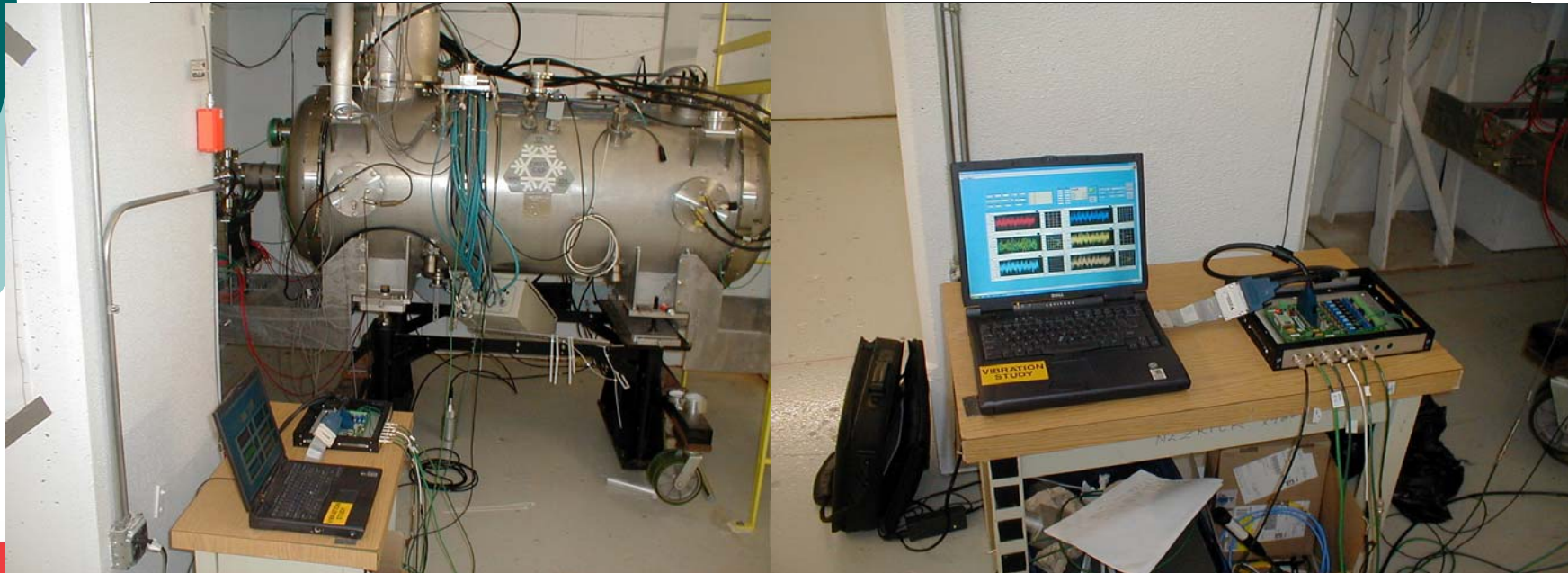- On top of cryostat

Measurements by C. Boffo et al.

CC2 Model - 16.2 Hz vertical mode

CC2 Cold Mass Measurements

- Vertical & Horizontal piezoelectric accelerometers mounted near tuner
  - For Cryogenic service
  - Radiation shields

‡ Fermilab

Mike McGee, 13 Jul 2006

Instrumentation for CC2 Cold Mass

Piezoelectric Accelerometer

Model 2271A/AM20

- Low Temperature Operation
- Hermetically Sealed
- Flat Temperature Response (-269°C)
- Ground Isolated
- Vibration at Cryogenic Temperatures

ENDEVCO MODEL 2271A/ AM20

Actual size

DESY Vibration Measurements

Accelerator component vibrations studies and tools

Ramila Amirikas, Alessandro Bertolini, Wilhelm Bialowons
DESY

ILC Project Meeting June 23rd 2006

Mike McGee, 13 Jul 2006

Future Work and Discussion

○ Benchmark
  ● TTF Cryomodule (using INFN & DESY data)
  ● Capture Cavity 2 (using Meson data)
○ Evaluate T4CM 2 external support configuration
○ Evaluate stability of TTF vs. T4CM Cryomodule
○ Begin Harmonic (forcing function) simulations
○ Begin Sensitivity Studies

‡ Fermilab

Mike McGee, 13 Jul 2006