ILC International Linear Collider

Type IV Cryomodule (T4CM) Vibration Analysis Update

January 23, 2007

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DESY Cryomodule Measurements

Quadrupole Vibration Measurements of a TESLA Type II Cryomodule

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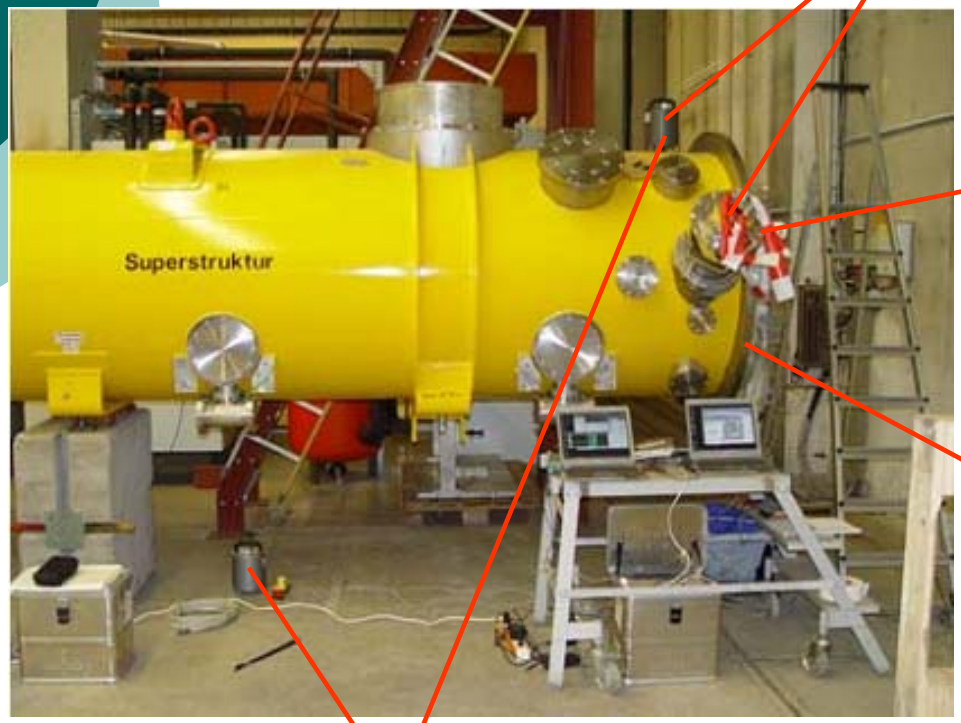
ANSYS Model Validation

- Applying Harmonic Study (involving measured frequencies & displacements) using CMS Method
- Using DESY measurement (as input) and comparing ANSYS output to corresponding (transfer function) DESY measurement

DESY Measurement Transfer Functions

2) Vacuum Vessel Top vs HeGRP



3) HeGRP vs Quad

1) Ground vs Vacuum Vessel Top

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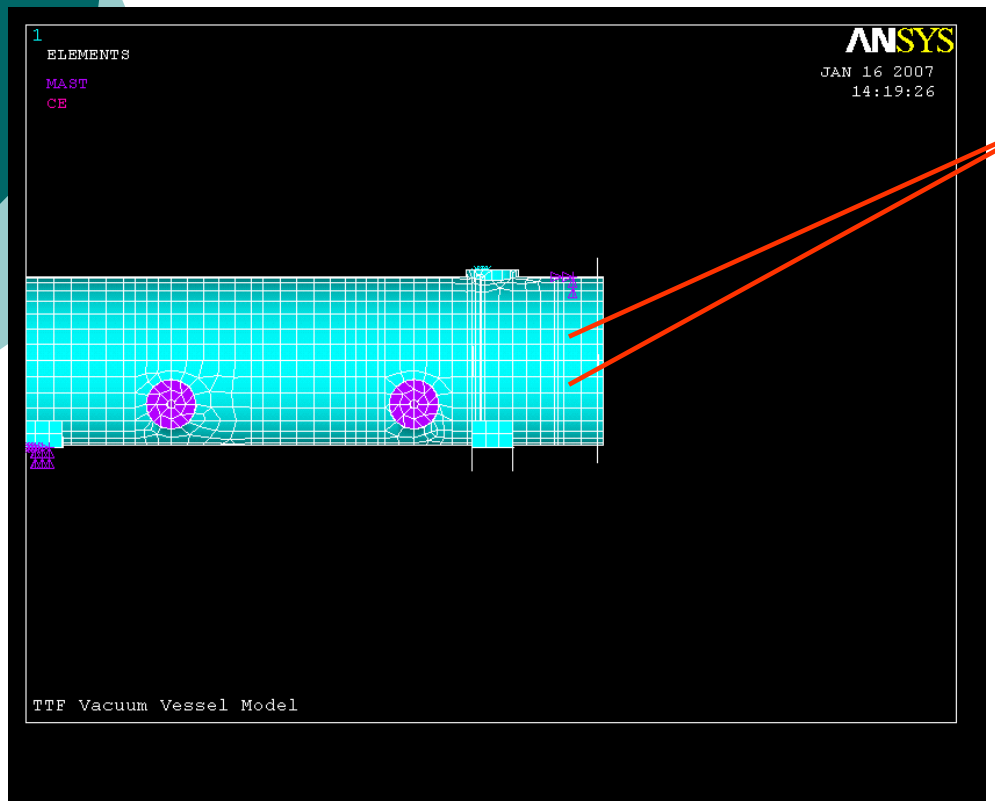
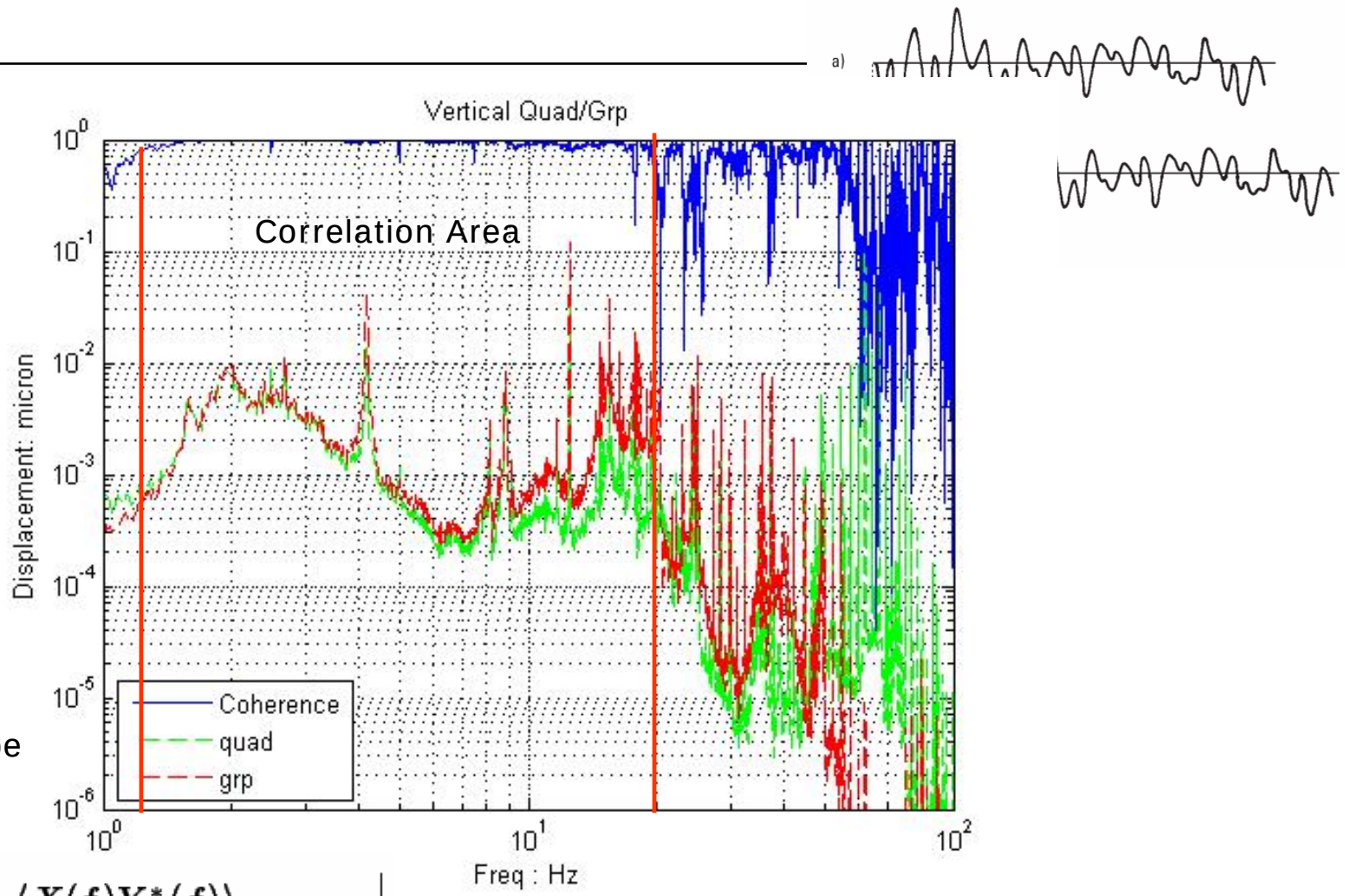
TTF Single ANSYS Model Applied



Example: Transfer function between HeGRP and Quad

Consider the DESY vertical measurement, by applying sine wave input with displacement (amplitude) at specific frequencies.

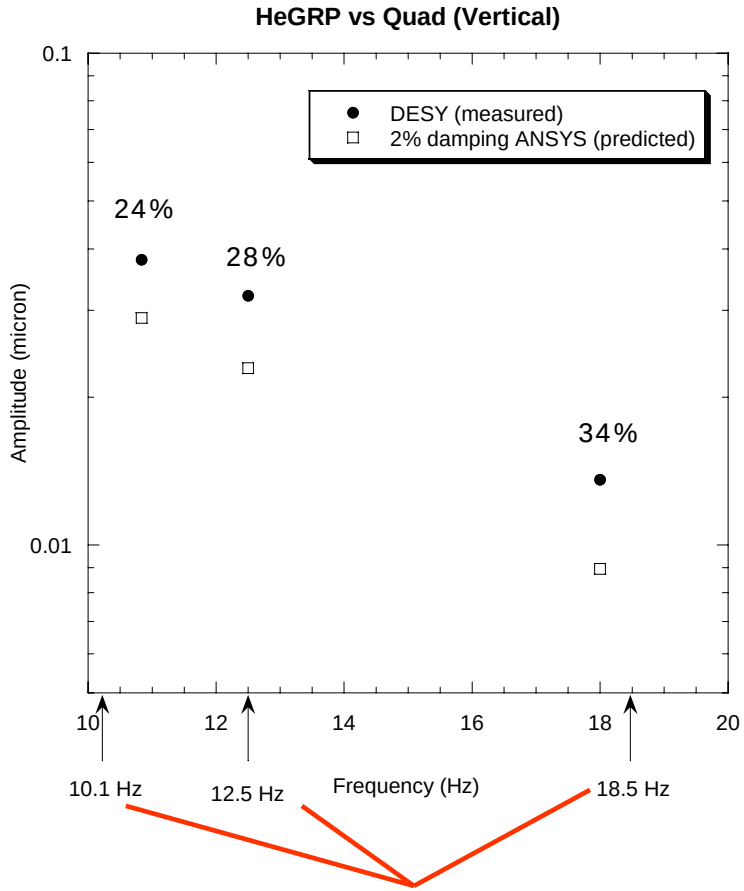
Vertical Excitation & Response



Two signals can be correlated:

$$C(f) = \left| \frac{\langle X(f)Y^*(f) \rangle}{\sqrt{\langle X(f)X^*(f) \rangle \langle Y(f)Y^*(f) \rangle}} \right|$$

ANSYS TTF Model Results



Resonant frequencies found using modal analysis

ANSYS model predicts the DESY measurement to within ~ 30% in most cases

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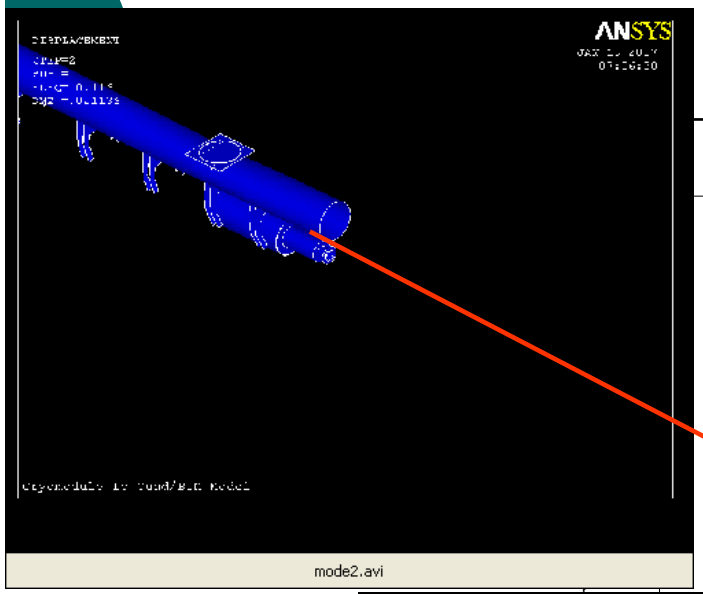
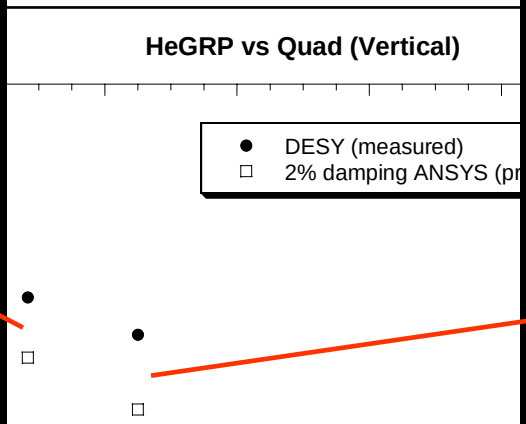
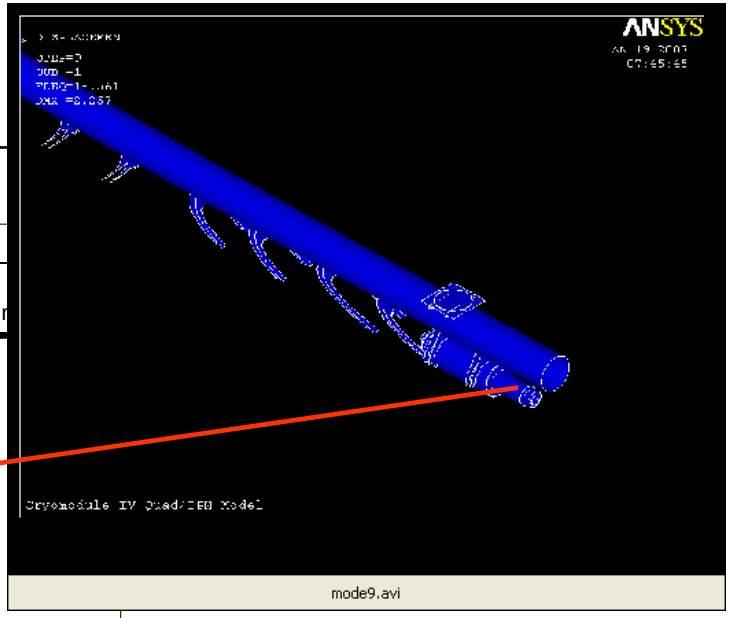
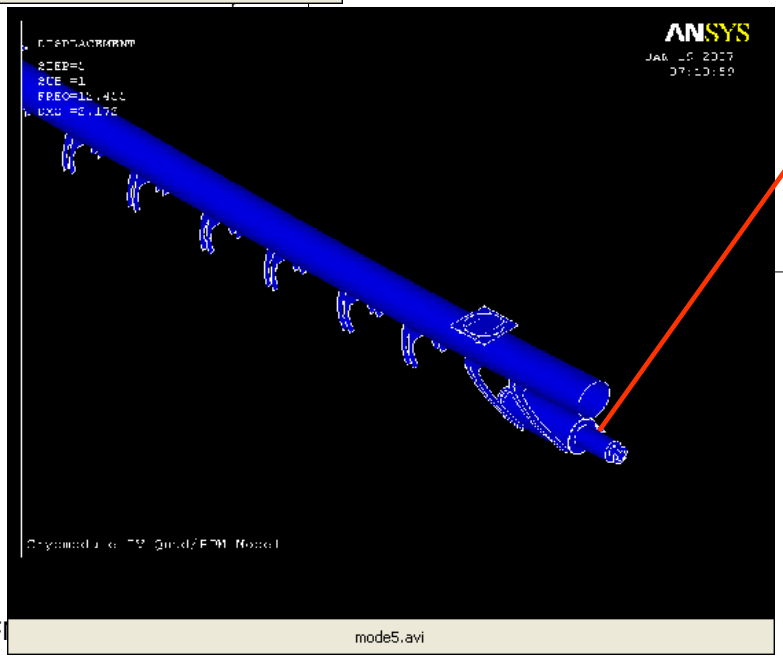
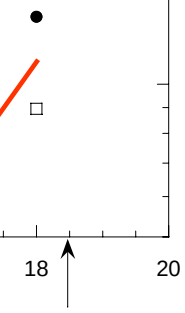
TTF Modal Shapes











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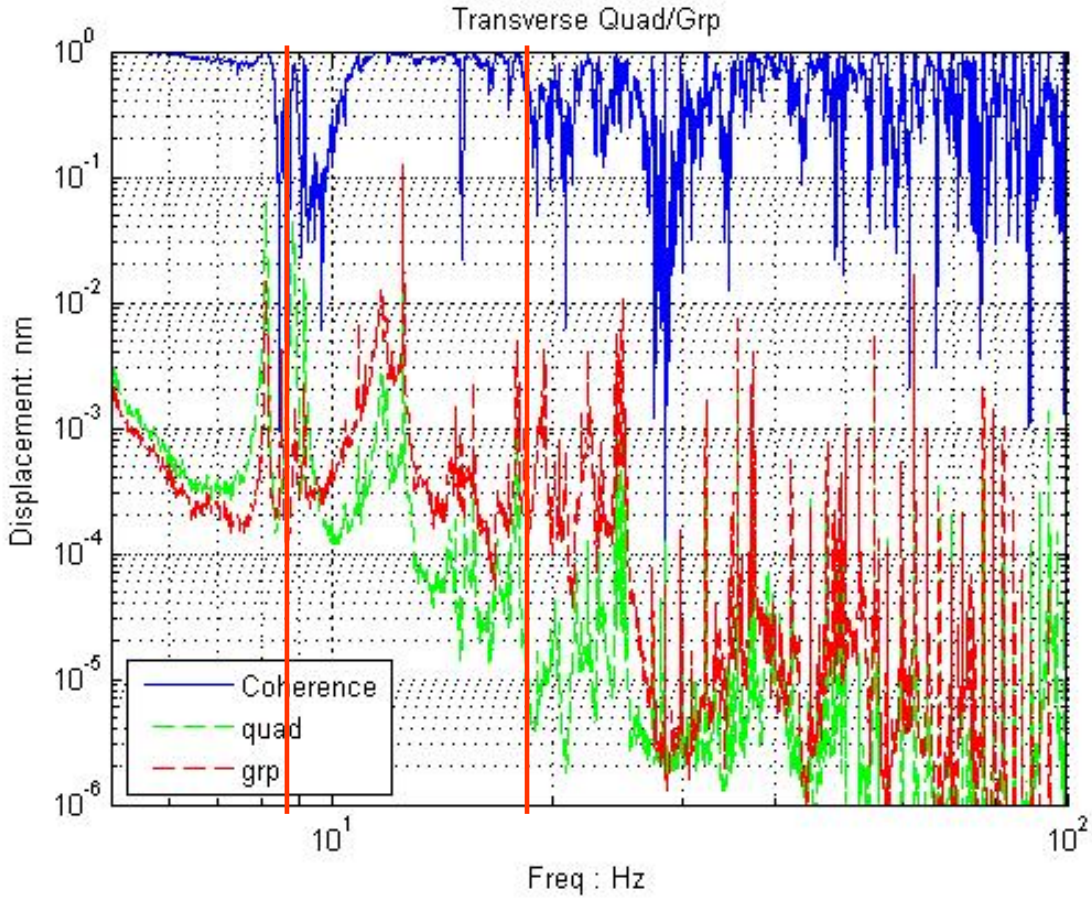
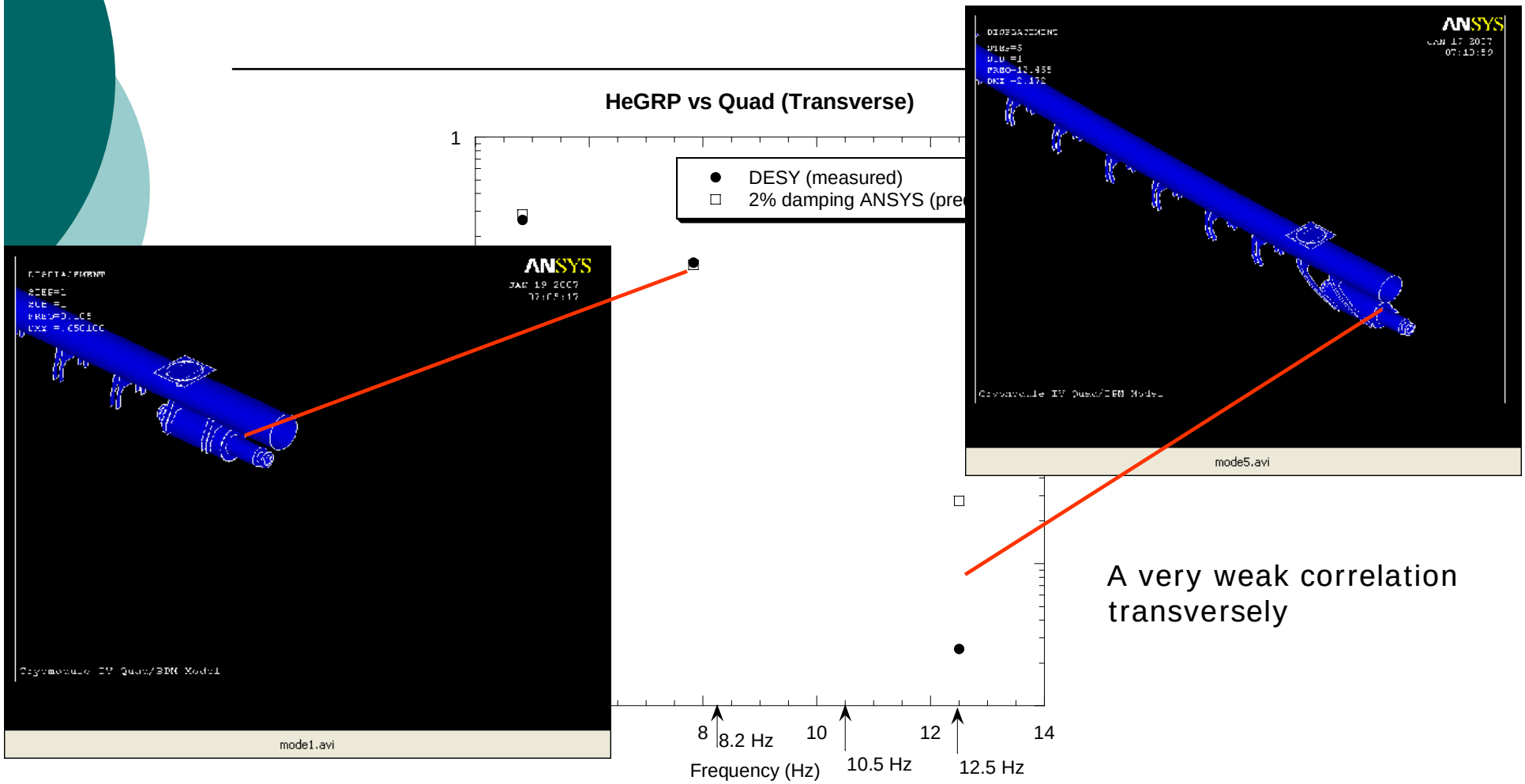
Transverse Excitation & Response

Correlation Area



Modal Shapes of Resonant Frequencies



A very weak correlation transversely

Model Improvement and Further Measurement

- Slight damping initially considered in ANSYS model
- Promising prediction of actual DESY vibration measurements have been realized, however continued measurements are needed
- Ringing measurements at DESY are needed to define system damping estimate

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Modal Analysis (fixed-fixed) Summary

Lowest (fundamental) frequency vertical with longitudinal mode shape is not present.

T4CM		TTF	
f (Hz)	Modal Shape	f (Hz)	Modal Shape
---	**- - -**	**10.1**	**Vertical w/ Longitudinal**
12.7	**Transverse Pendulum**	**12.4**	**Transverse Pendulum**
16.3	**Transverse S-shape**	**15.7**	**Transverse S-shape**
17.9	**Transverse S-shape**	**19.2**	**Transverse S-shape**

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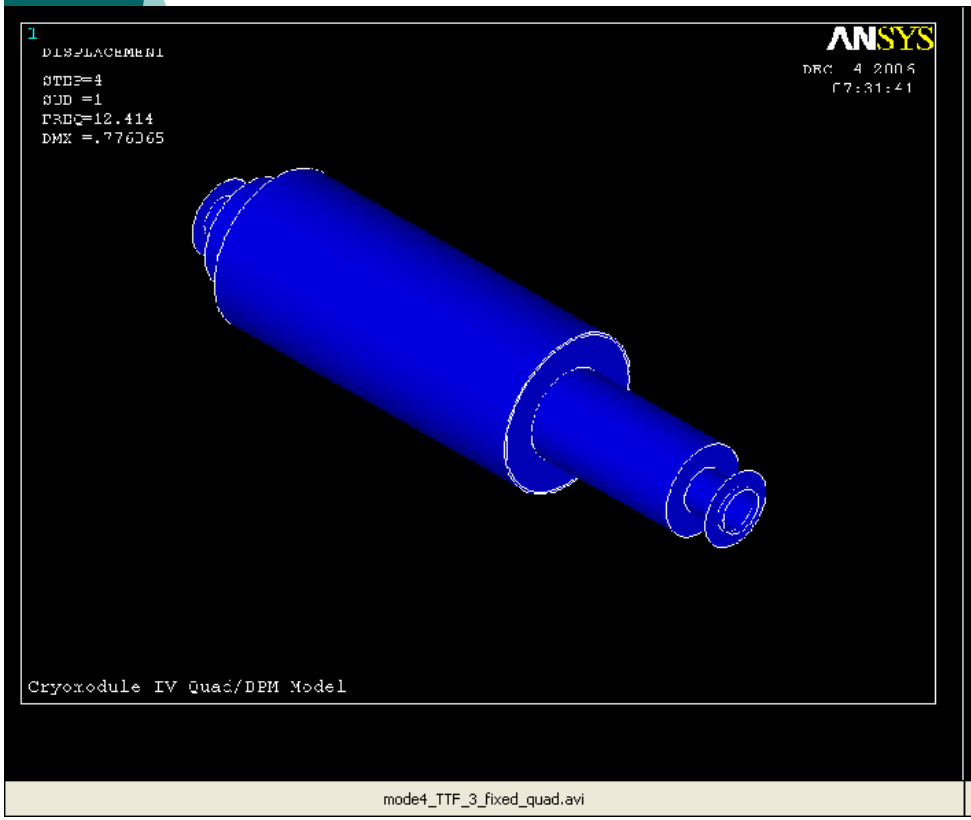
3-in-Series w/ ends: Fixed-Fixed

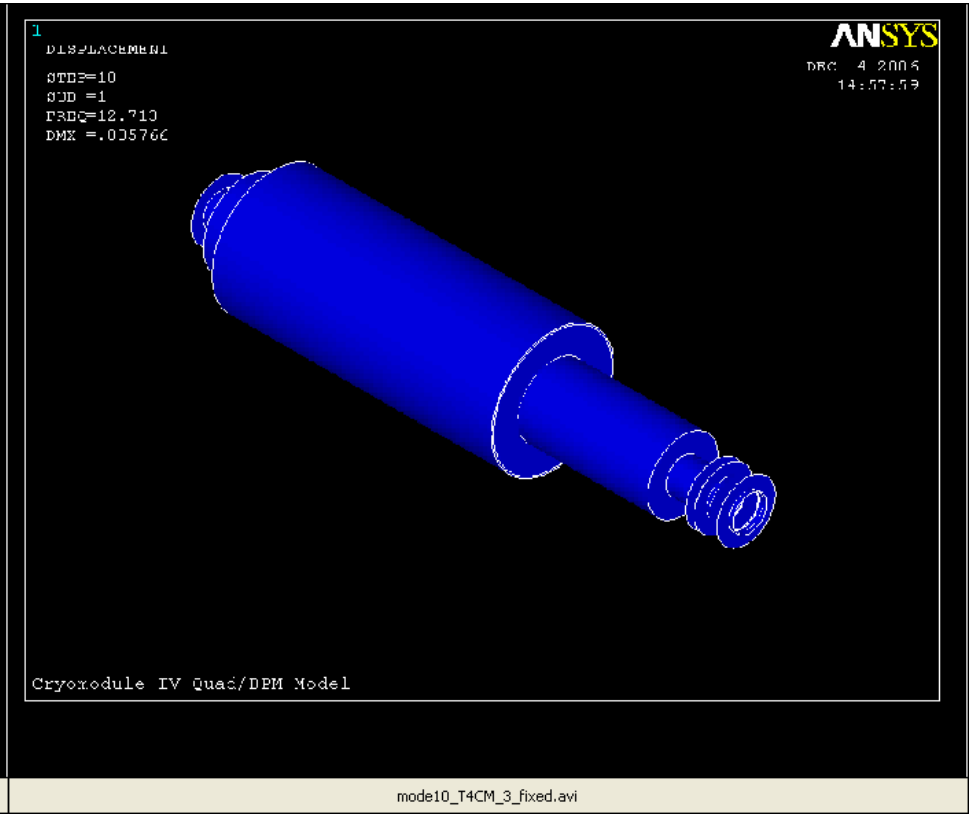
TTF Model

T4CM Model



mode4_TTF_3_fixed_quad.avi

12.4 Hz



mode10_T4CM_3_fixed.avi

12.7 Hz

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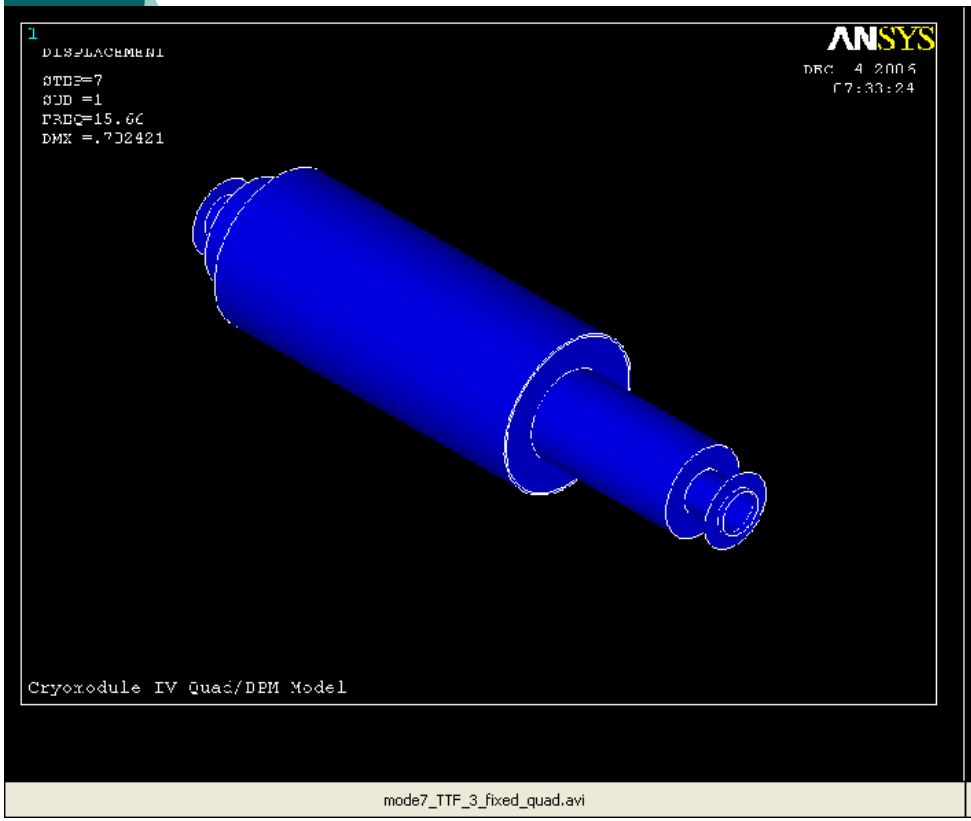
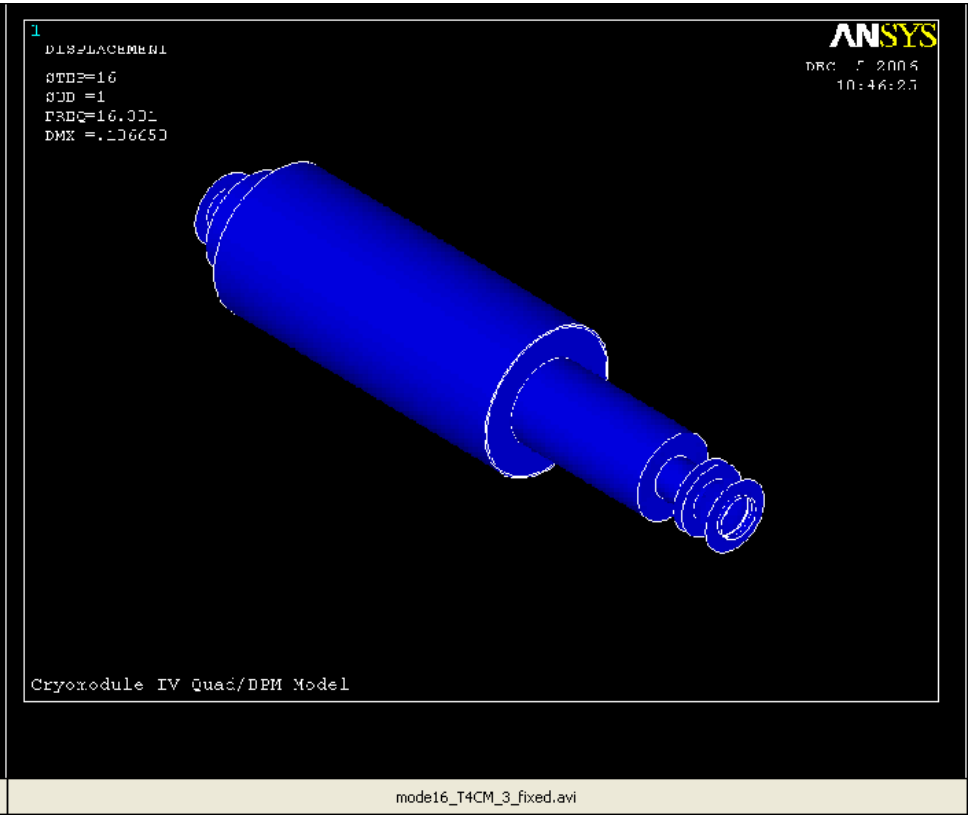
3-in-Series w/ ends: Fixed-Fixed

TTF Model

T4CM Model



mode7_TTF_3_fixed_quad.avi



mode16_T4CM_3_fixed.avi

15.7 Hz

16.3 Hz

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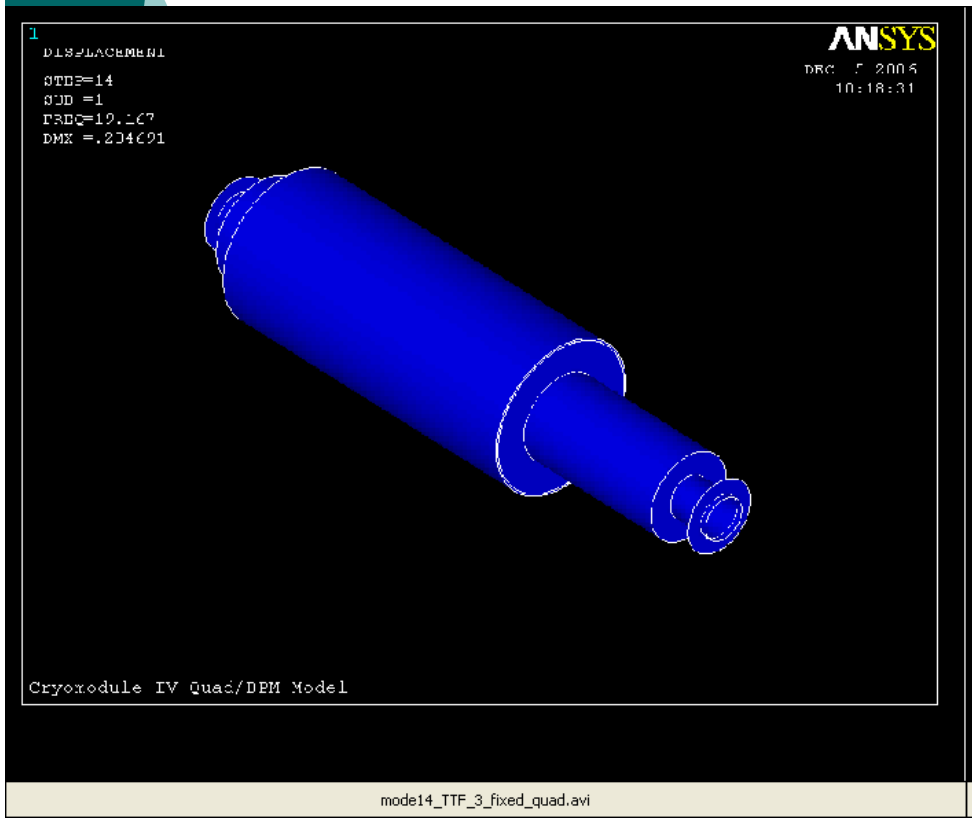
3-in-Series w/ ends: Fixed-Fixed

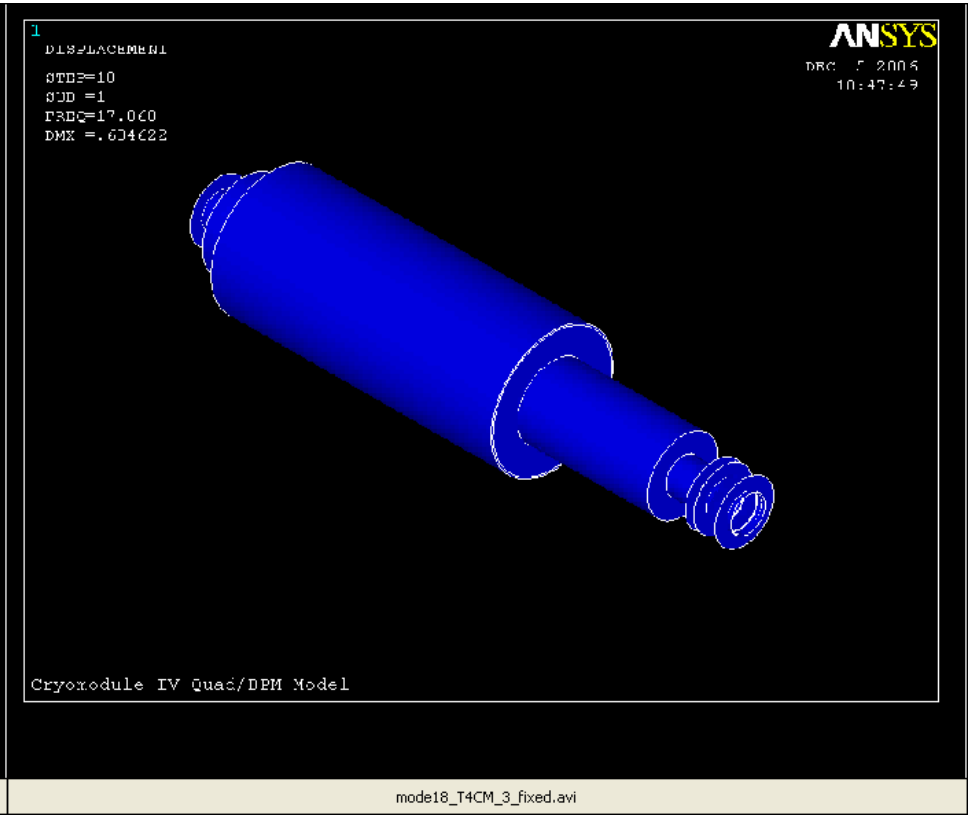
TTF Model



mode14_TTF_3_fixed_quad.avi

19.2 Hz

T4CM Model



mode18_T4CM_3_fixed.avi

17.9 Hz

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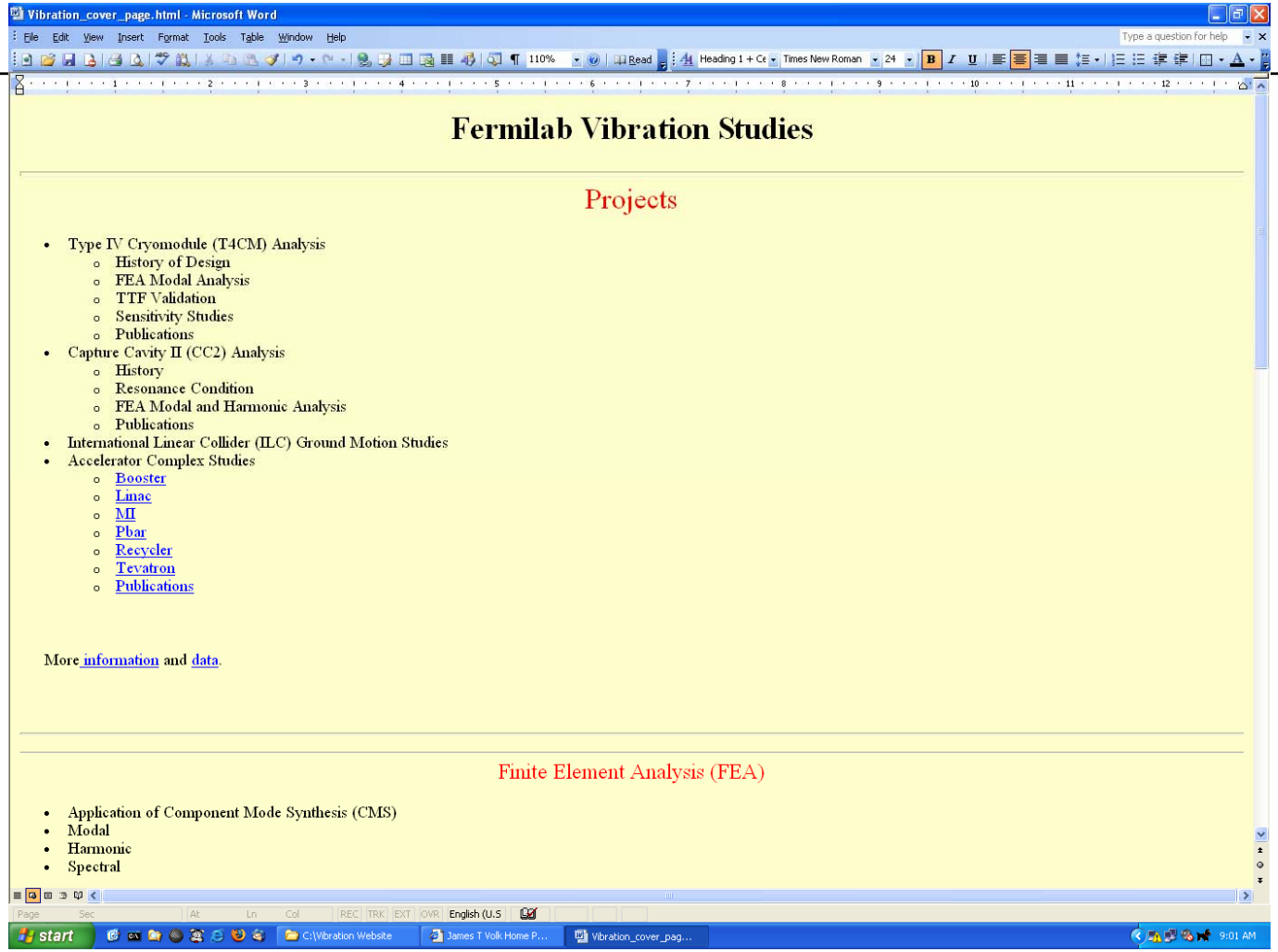
ANSYS Results given in picture and movie files

ANSYS Input Code files

Measurements



Future Work

- Perform more specific vibration measurement on TTF cryomodule at DESY
- Begin Sensitivity Studies using T4CM model