ILC International Linear Collider

Type IV Cryomodule (T4CM) Vibration Analysis Update

July 19, 2007

Mike McGee

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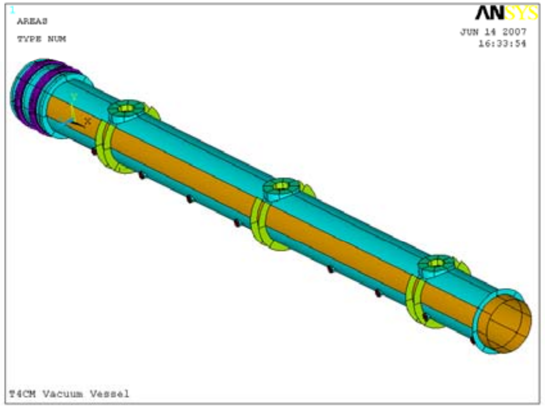
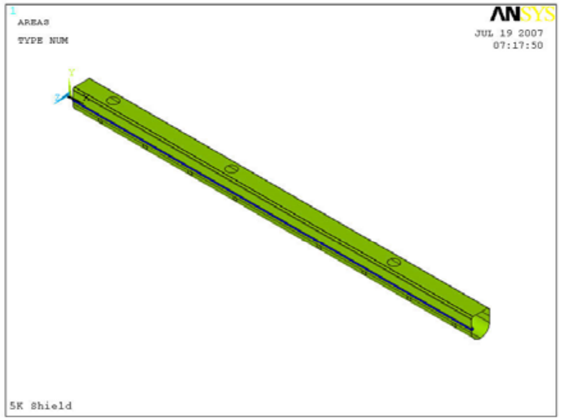
Status of T4CM & TTF Models

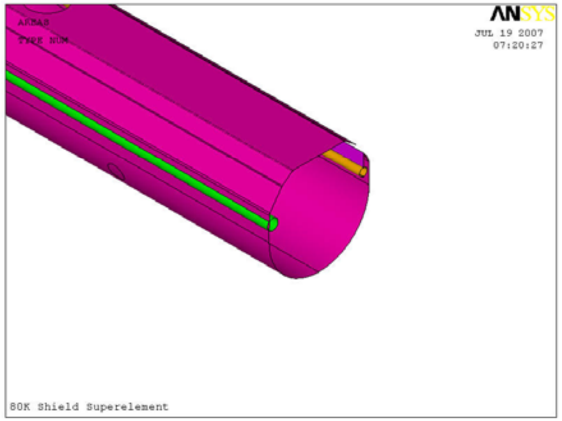
- Overhaul of TTF and T4CM models
  - INFN-Pisa Support:
    - Alessandro Vigni and Marco Cherubini
  - FNAL Support:
    - Ryan Doremus (U of I)



Vacuum Vessel



5 K Shield



80 K Shield

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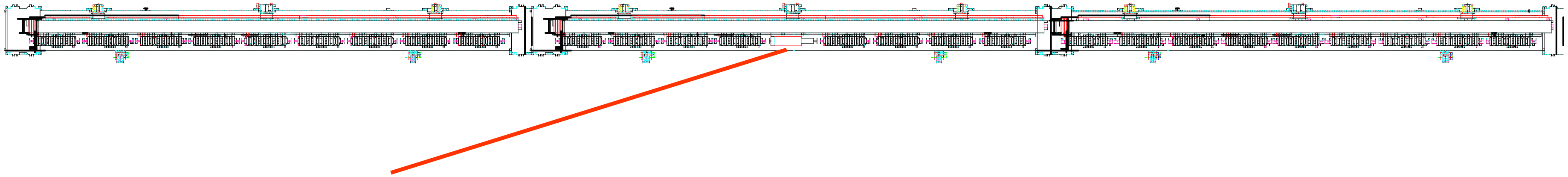
Model Assumptions

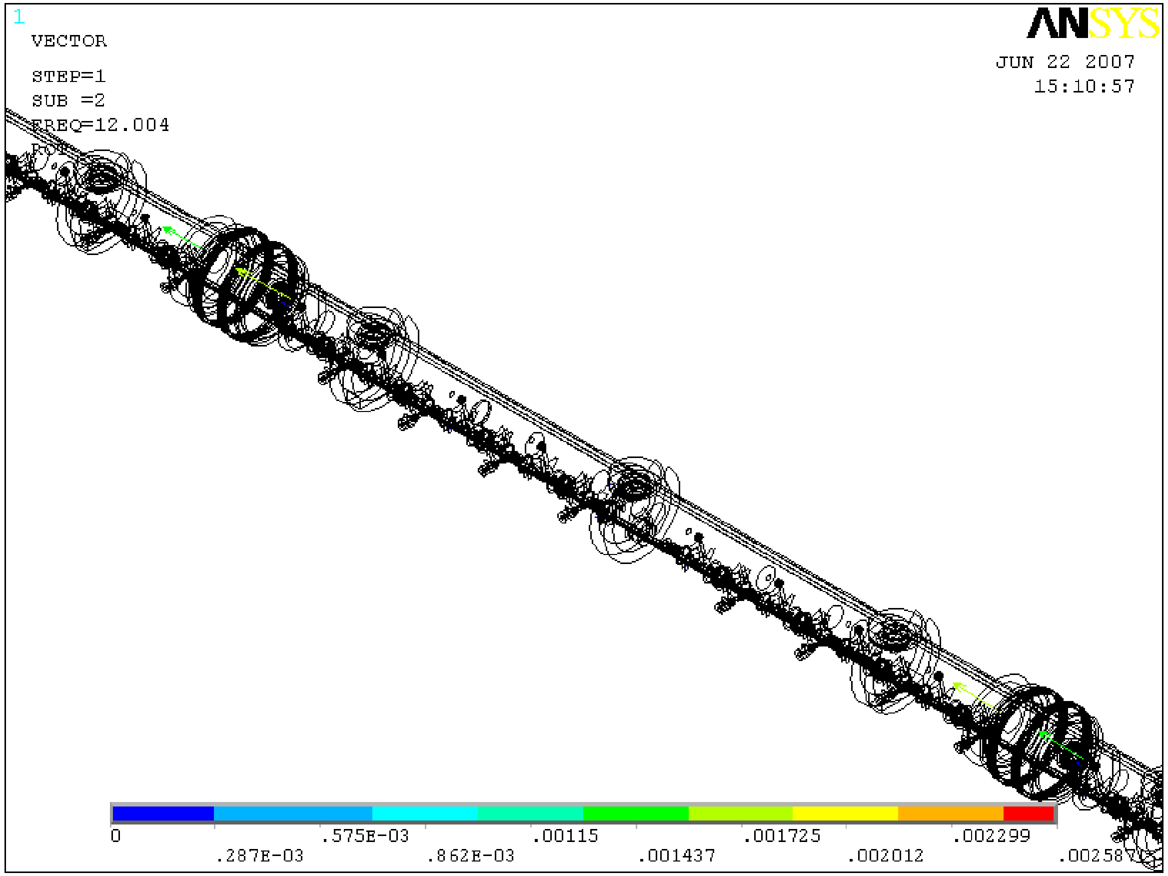
All results are provided in 3-in-series with (fixed-fixed) end condition to address effects of unknown end conditions.



Center quad

for T4CM 9-8-9 configuration was used

Modal Example from Use Pass (combination of superelements)



Vector plots (view of center cryomodule)

Modal Comparison Between T4CM and TTF

Mode	T4CM		TTF	
	f (Hz)	Shape	f (Hz)	Shape
1	11.0	L	**8.4**	**VL**
2	**12.0**	**T**	**8.4**	
3	12.2	LQ	**8.6**	
4	12.2		9.4	LV
5	14.2	LV	10.4	
6	14.9		10.9	
7	14.9		**11.2**	**T**
8	15.1		**11.3**	**VL**
9	15.2	LQ	**11.4**	
10	15.2		13.2	LV
11	15.6		13.2	
12	**15.9**	**VL**	13.4	
13	16.7	LV	**14.2**	**T**
14	17.5		15.1	LV
15	**17.8**	**T**	15.1	
16	**17.9**		15.4	
17	18.6	LQ	16.1	LV
18	19.4		**18.3**	**T**
19	19.5		**18.4**	**T**
20	**20.2**	**VL**	**18.6**	**VL**

L – Longitudinal

T - Transverse

VL – Vertical w/ Longitudinal Component

LQ –Longitudinal Quad Quiescent

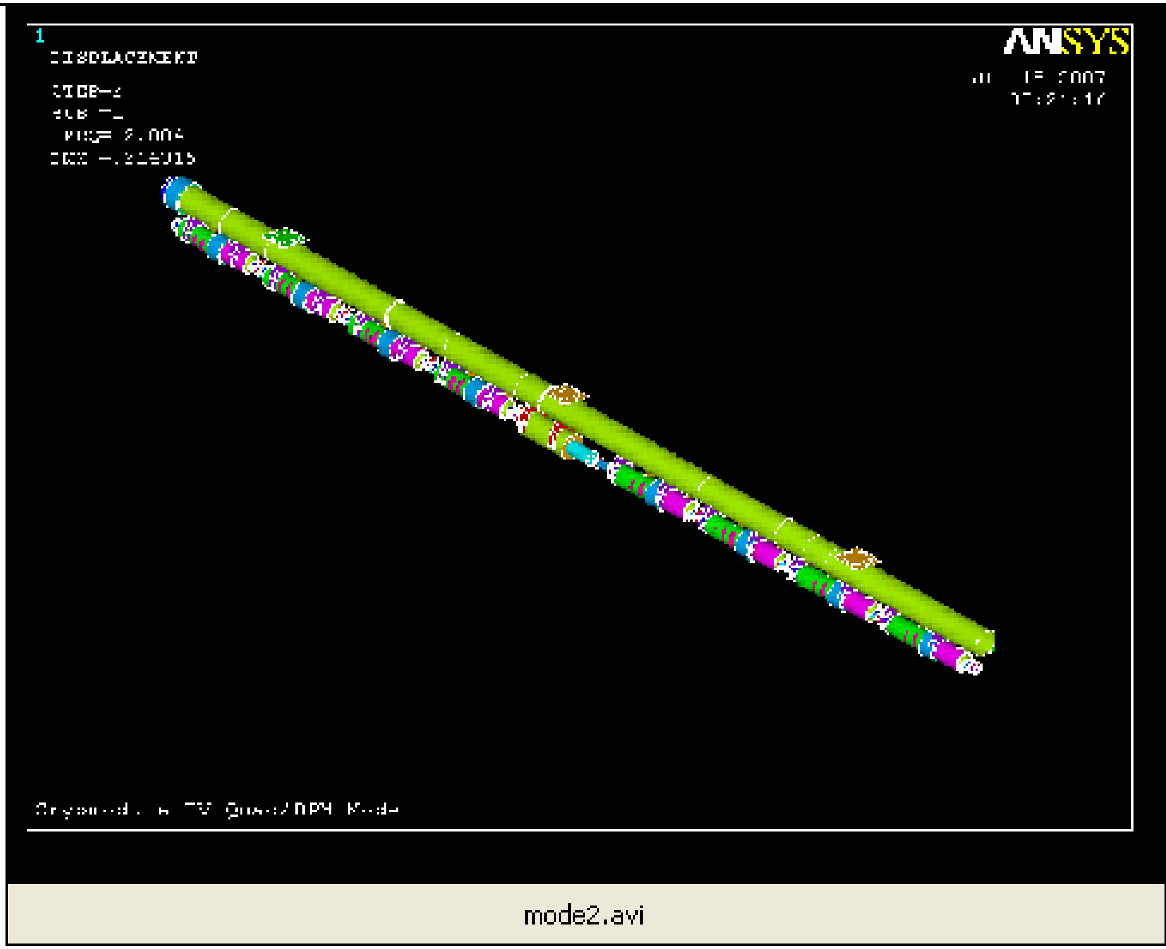
LV –Longitudinal w/ Vertical Component

Primary

Secondary

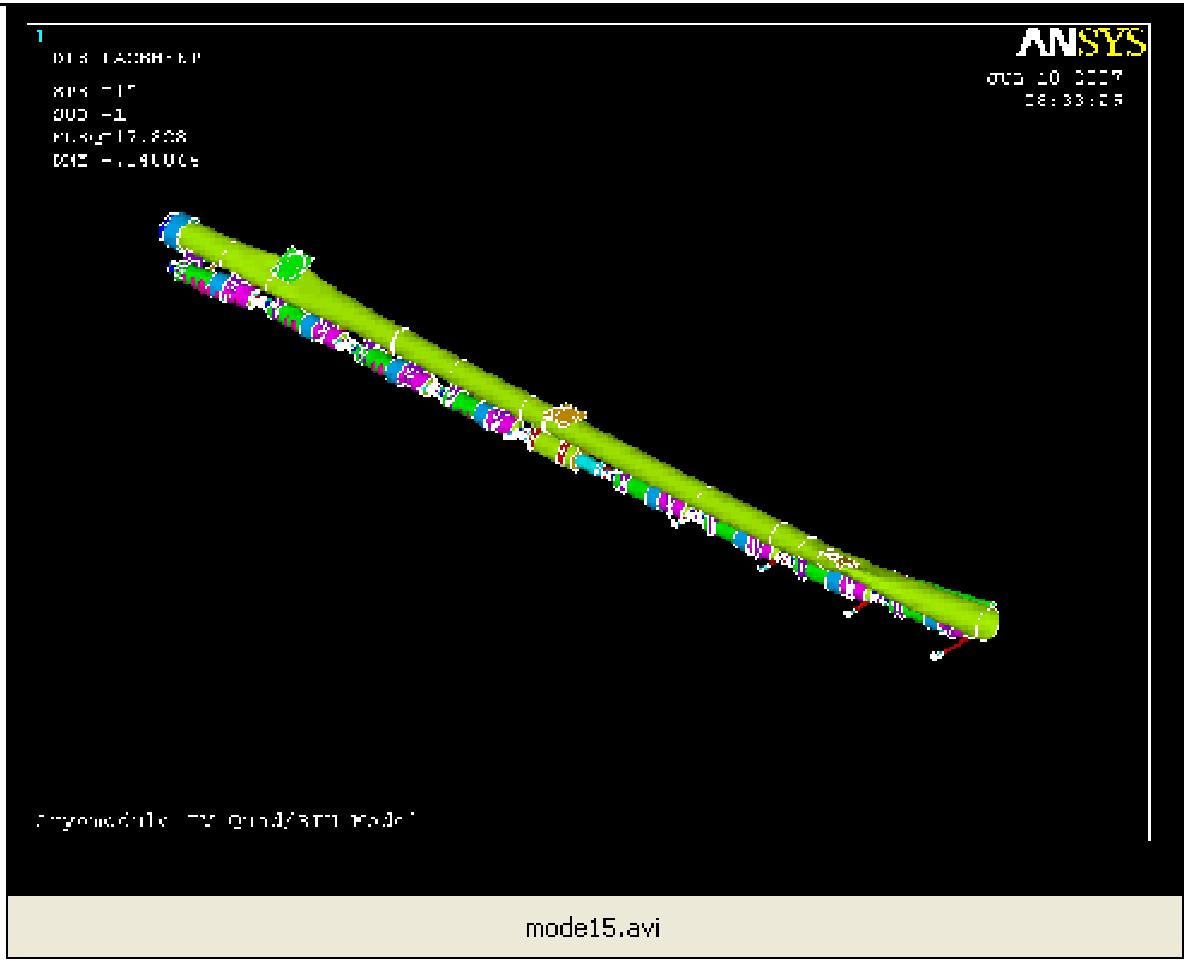
Ternary

T4CM Mode 2 – 12 Hz (transverse pendulum)



Note: vacuum vessel and other components are present but not shown

T4CM Mode 15 – 17.8 Hz (transverse pendulum 2^{nd} harmonic)

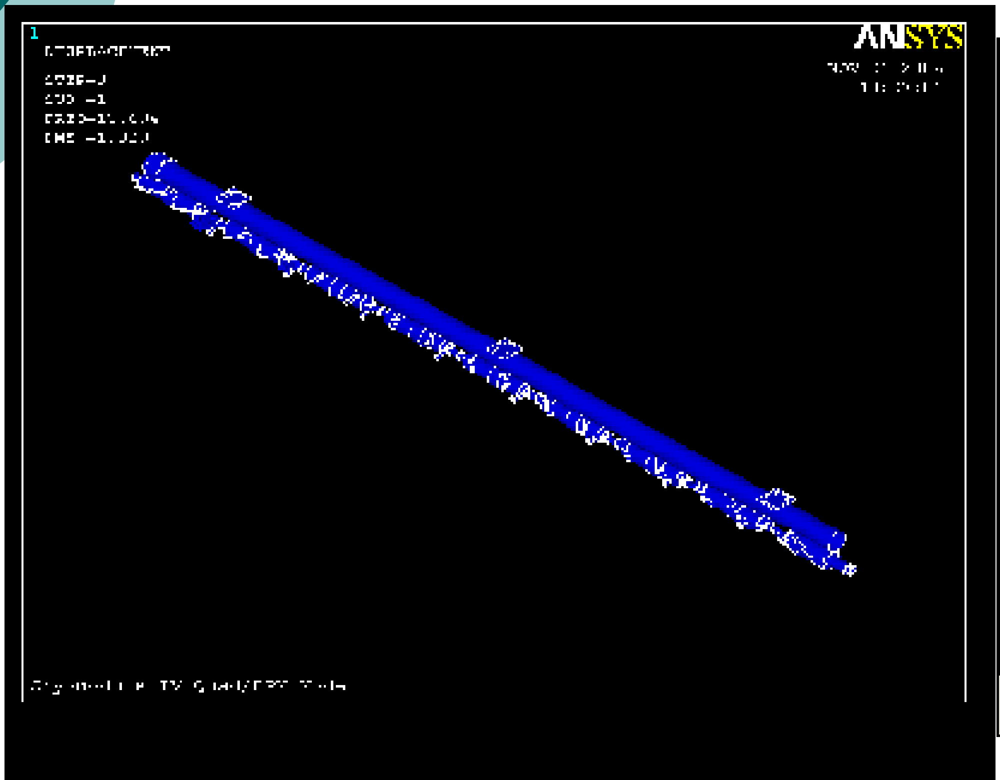


T4CM Mode 16 – 18 Hz (transverse pendulum 2nd harmonic)

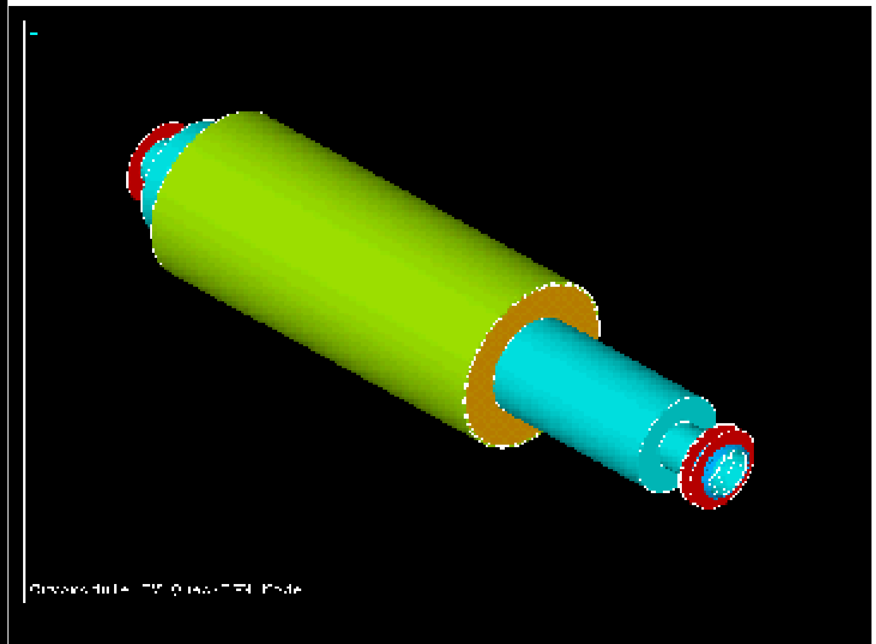
Modes 15 & 16 are symmetric

T4CM Modes (longitudinal quad quiescent)

Large contribution to fundamental modes of 3 (12.2 Hz), 4 (12.2 Hz), 9 (15.2 Hz), 10 (15.2 Hz), 11 (15.6 Hz), 17 (18.6 Hz), 18 (19.4 Hz) and 19 (19.4 Hz)

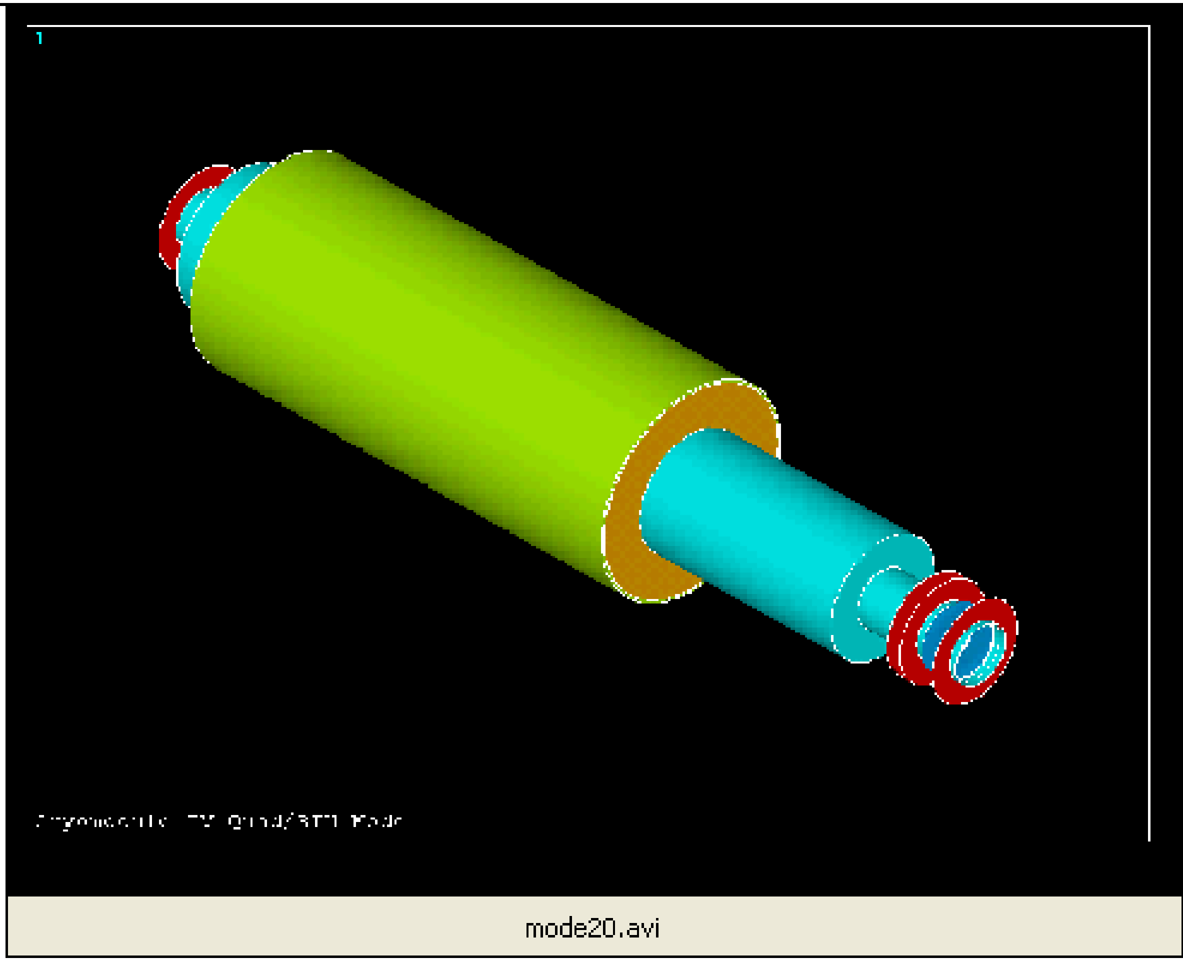


Long_Qin center_for_TTF.avi



mode3.avi

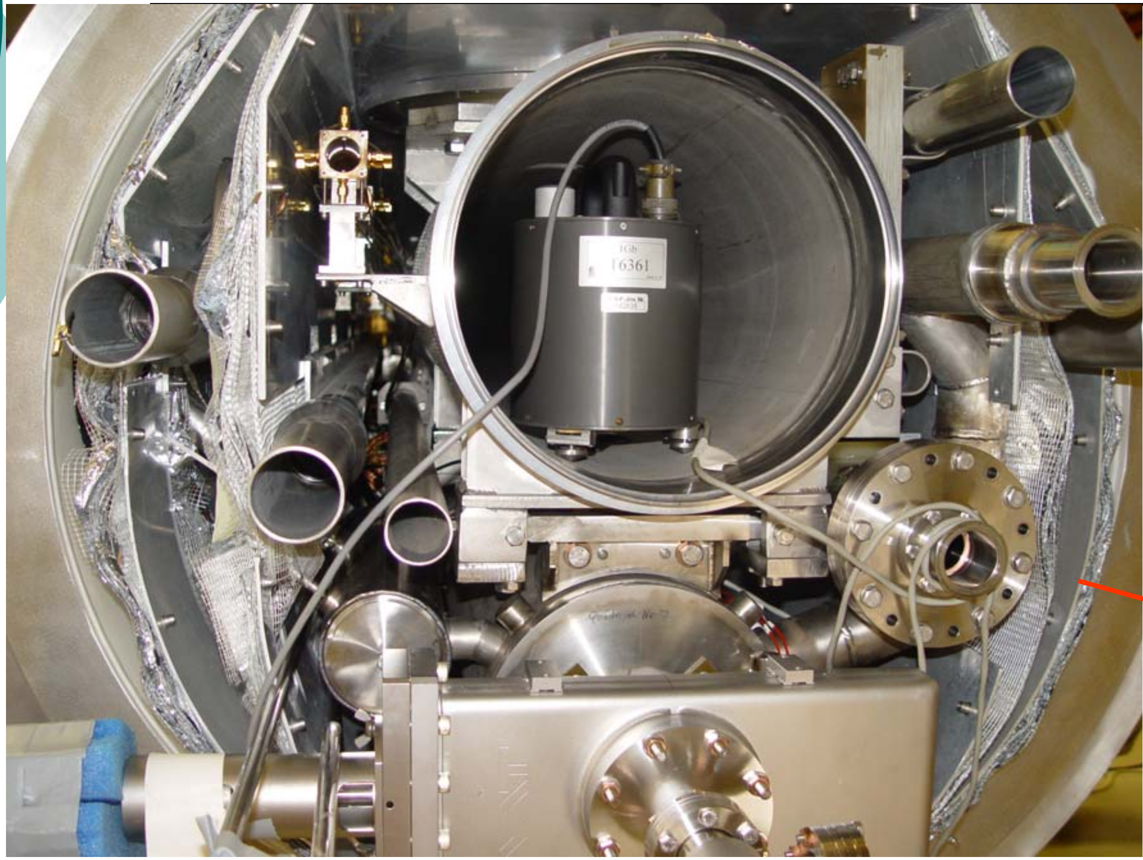
T4CM Mode 20 – 20.2 Hz (vertical longitudinal 1st harmonic)



Study Effect of Additional Transverse Stiffness and Damping

- Adding transverse spring constant and damping to CM at IC locations
  - Elements defined at interconnection between vacuum vessel and 80 K shield
  - Elements defined at interconnection between 80 K shield and 5 K shield
- Single TTF Model considered
- TTF and T4CM 3-in-series Study in progress

Transverse Spring-Damping Study



Attempt to account for added stiffness of thermal straps and cables

Add stiffness and damping

Transverse frequencies beneath ~20 Hz were not measured on Cryomodule #6

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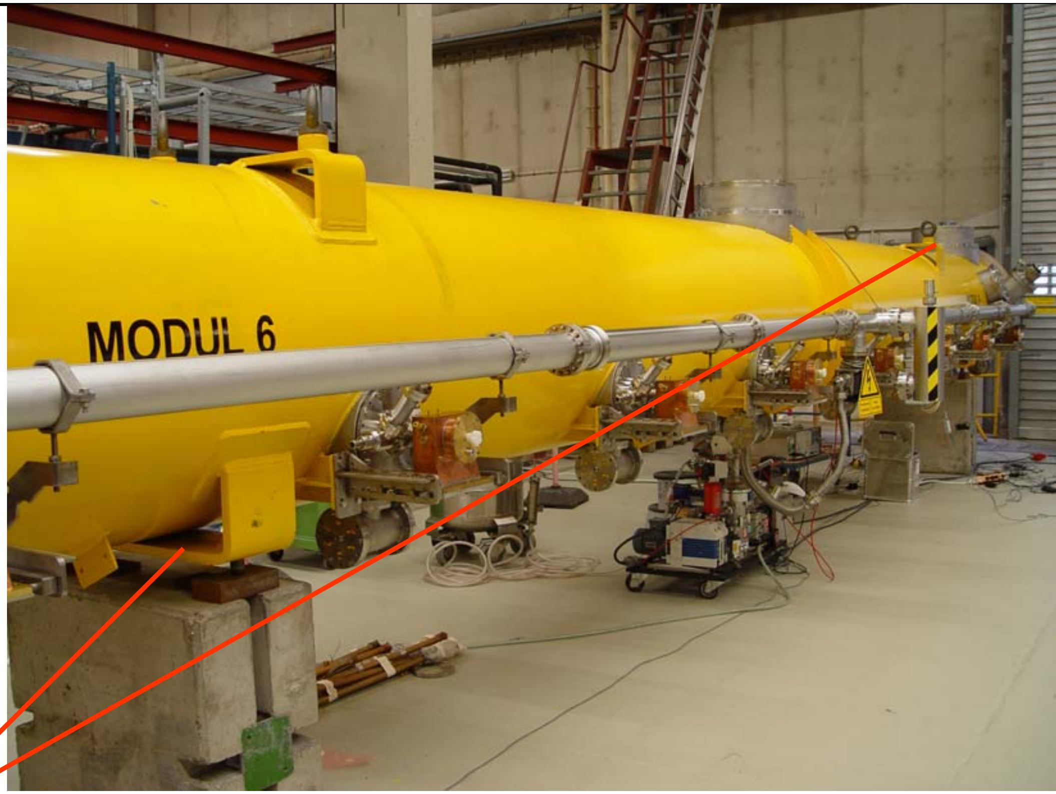
Preliminary Transverse Stiffness and Damping Results

Table 2. Summary of Transverse Stiffness Study.

Mode	Frequency (Hz)	
	No Transverse Stiffness	50 (N/mm)
1	11.1	13.1
2	12.2	15.1
3	13.1	17.1
4	14.3	19.4
5	15.1	19.5

Single TTF CM with fixed ends

DESY Cryomodule #6 Measurements and Validation



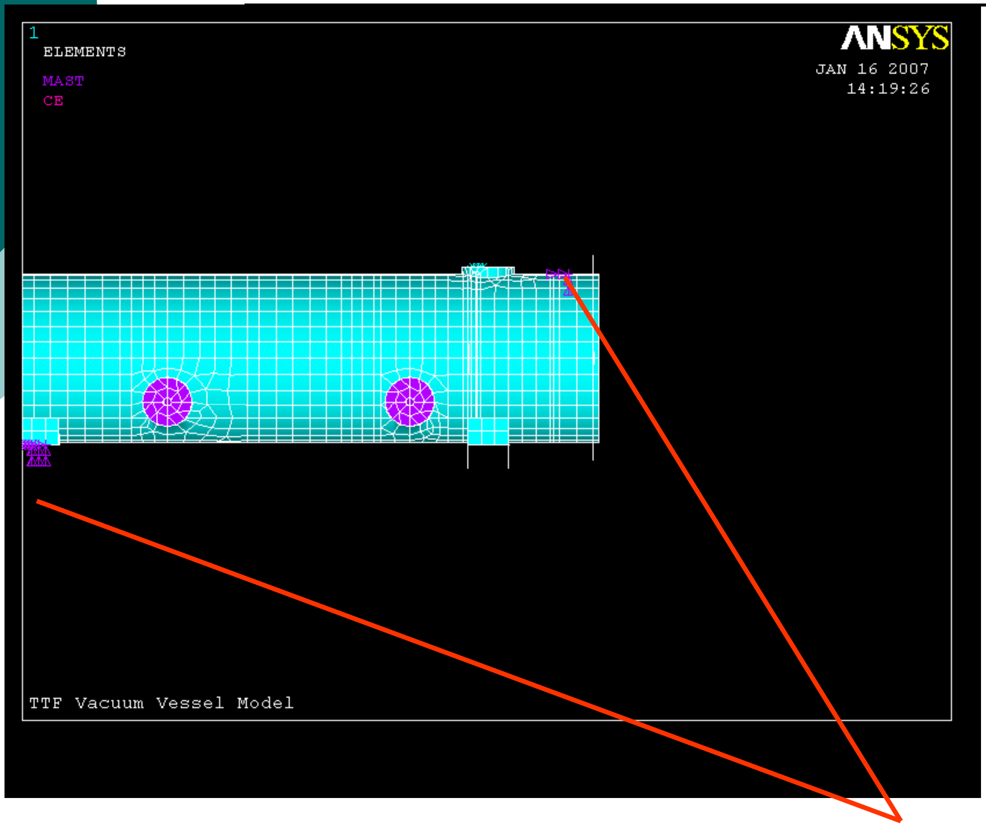
1) Ground vs Vacuum Vessel Top

DESY Measurement Transfer Functions

2) Vacuum Vessel Top vs HeGRP

3) HeGRP vs Quad

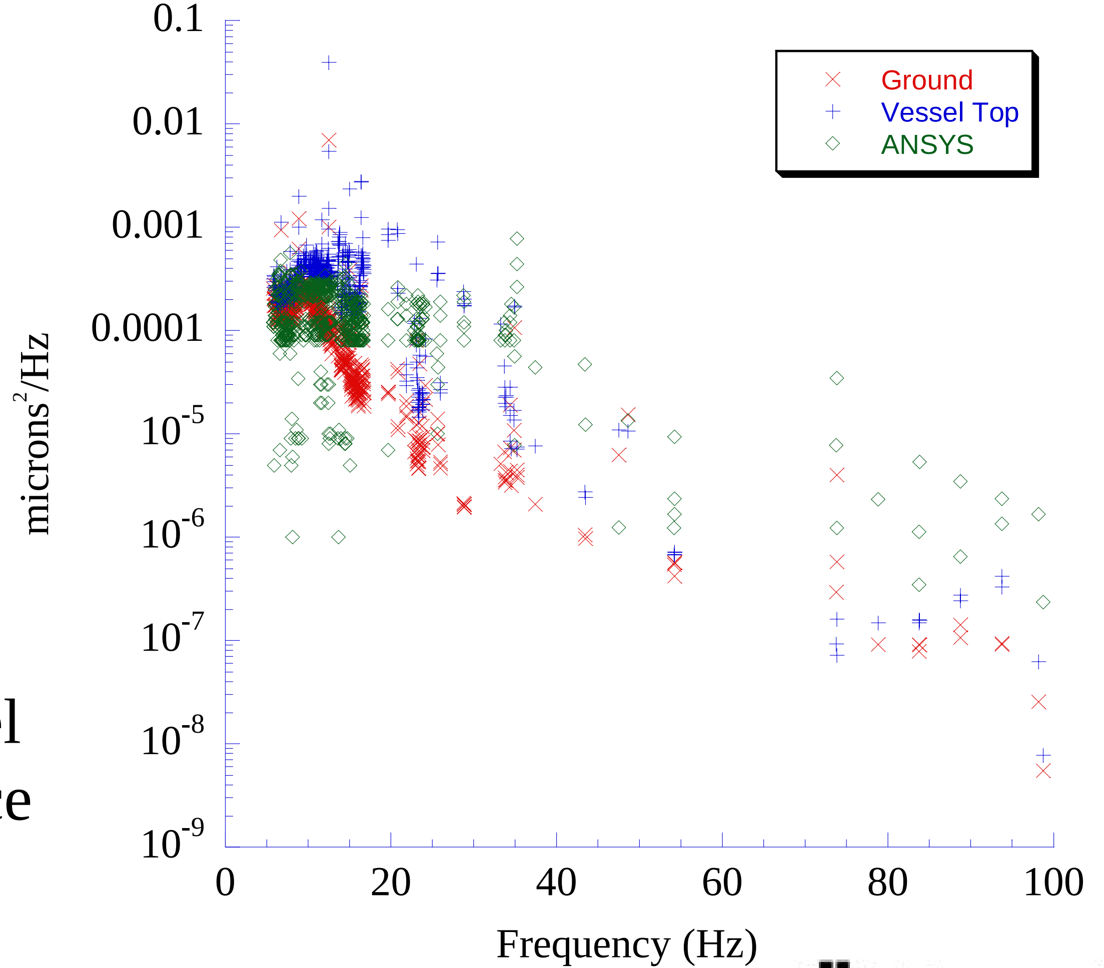
TTF Single ANSYS Model Applied



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

Example: Transfer function between ground and vessel top

FEA Model Validation Results Ground Versus Vessel Top



Ground/Vessel Top Coherence > 0.8

Cryomodule Instrumentation Team

- TD Members (Ruben Carcagno, Chair)
  - Mark Champion
  - Joe Ozelis
  - Darryl Orris
  - Yuriy Pischalnikov
  - Warren Schappert
  - Dmitri Sergatskov
- AD Members
  - Christine Darve
  - Mike McGee
  - Shavkat Singatulin
  - Jim Volk

Cryomodule Instrumentation Tasks

- Develop experience with cold geophones using HTS
- Apply cold geophones to cryomodule measurement
  - Define geophone locations within CM (implement cold calibration as developed by DESY)
  - Provide DAQ support
- Instrument TTF and T4CM Coldmass prior to installation at New Muon Lab (NML)

Future Work

- Begin Sensitivity Studies using T4CM model
- Study external floor support
- Implement instrumentation for cryomodules geophone and differential pressure transducer (TTF style and T4CM)
- Perform flow induced vibration studies through experiment at HTS and FEA (possible collaboration with INFN-Pisa)