



LIGO Laboratory / LIGO Scientific Collaboration

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LIGO

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Natural Vibration Modes of ITM number 11

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1 Introduction

As part of the research to support an advanced LIGO, core optic material selection decision, Phil Willems is measuring the mechanical loss factors associated with some of the natural modes of a polished, uncoated fused silica optic of approximately initial LIGO dimensions. The optic is designated ITM number 11. It has an initial LIGO diameter (250 mm), but has no wedge angle and is slightly thicker than an initial LIGO test mass optic (108 mm thick versus 100 mm at the thickest point for an initial LIGO test mass). Finite element calculations of the unconstrained, natural mode frequencies and mode shapes are presented in this memo.

2 Frequencies and Strain Energy Fractions

Frequencies and strain energy ratios for the first 25 modes (to 22 kHz) are summarized in the Table below. The strain energies¹ are for unit (1 mm) peak displacement of the mode. The strain energy is partitioned into the fraction associated with the barrel and with the overall surface (barrel plus faces). These ratios are rather approximate. The strain energy of all elements with a face on the barrel (or face) is simply added, i.e. there is no explicit boundary layer thickness associated with the surface. The typical element dimensions are about 15 mm, so the surface related strain energies are associated with a volume extending from the surface into the right circular cylinder a distance of about 7 mm.

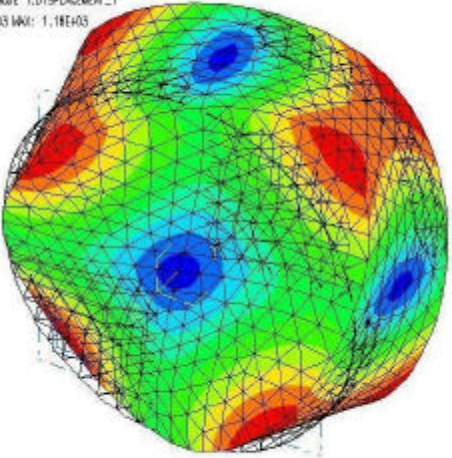
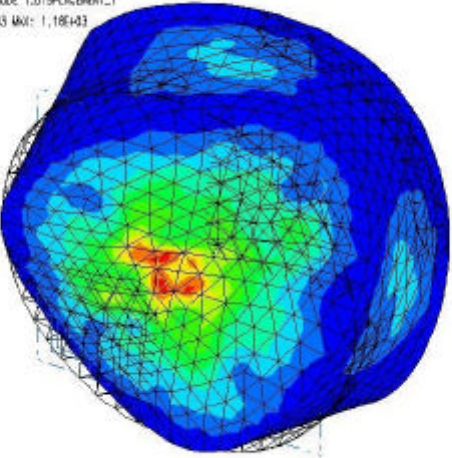
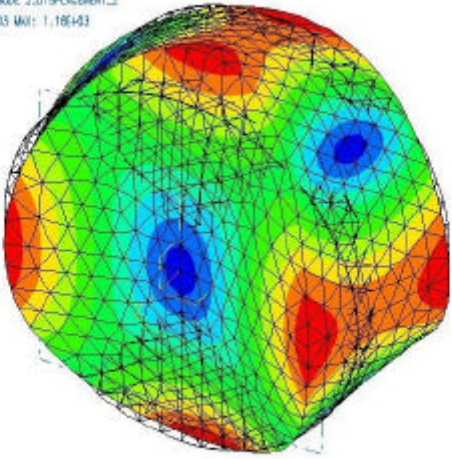
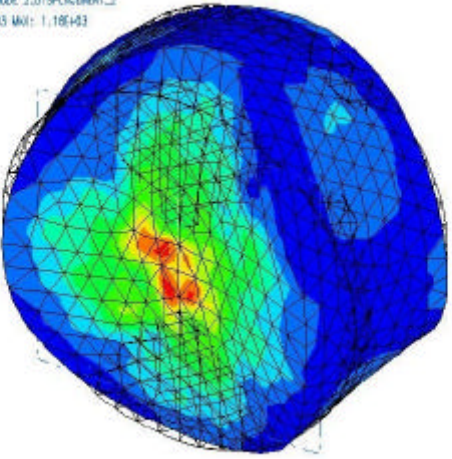
Note the very low strain energy associated with the barrel for modes 4 and 5 (11.2 kHz). This mode is a radial compression/expansion mode (depicted in the next section). The frequency of this mode is same (to 3 significant figures) as that for the initial LIGO end test mass, with a 2 degree wedge angle and 100 mm thickness (see LIGO-T970191-03).

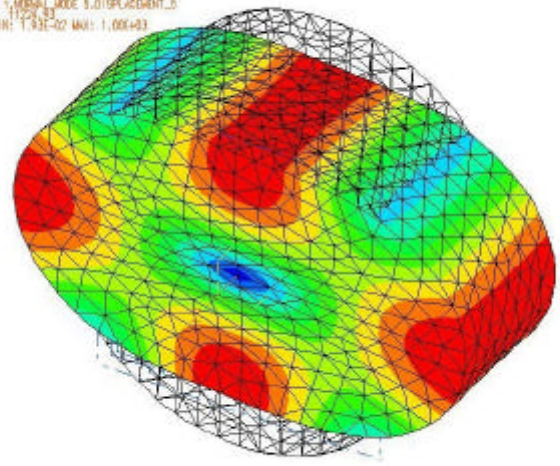
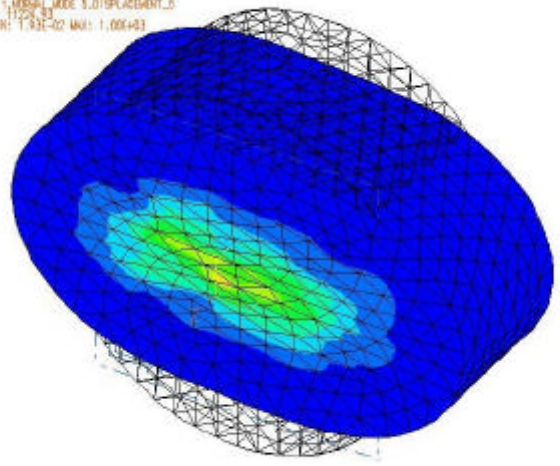
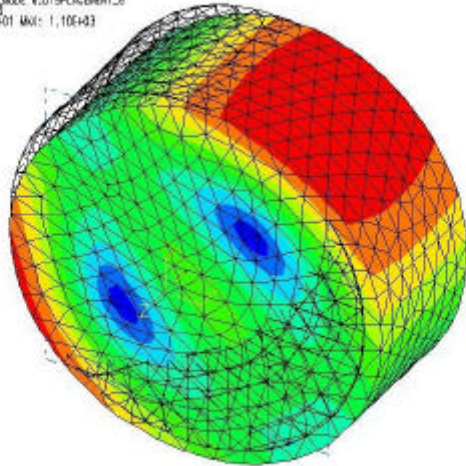
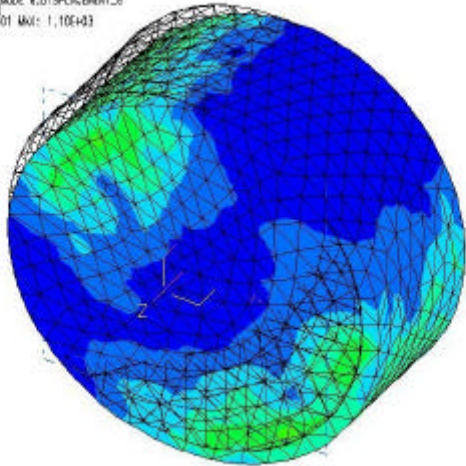
¹ Based on the I-DEAS documentation, the strain energy should be in units of Joules and normalized to unit displacement – in this case 1 mm. However, this has not been confirmed by independent check and it is known that the normalized mode shapes reported by I-DEAS, are in fact not normalized to unit amplitude even when this option is selected. For the relative (% of total) results reported here, this point is probably not important.

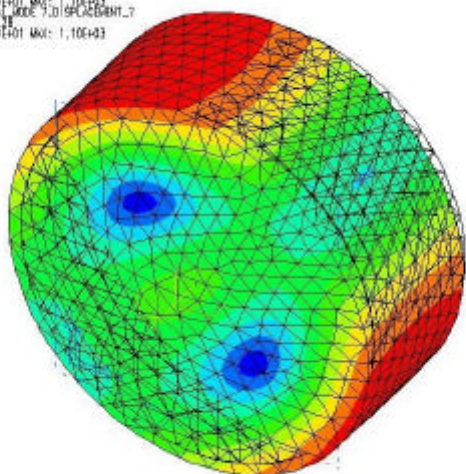
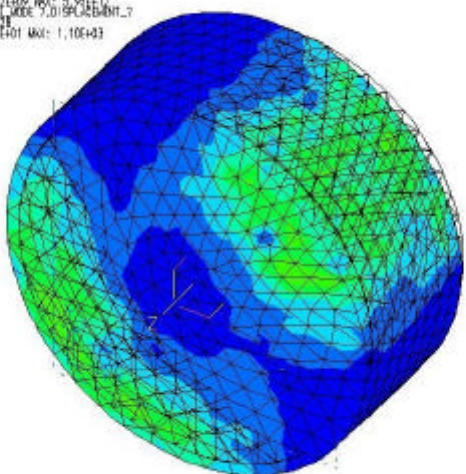
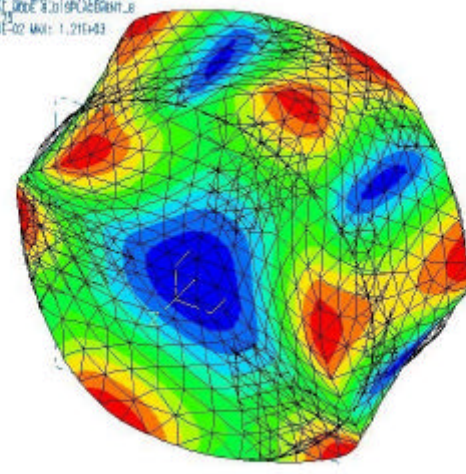
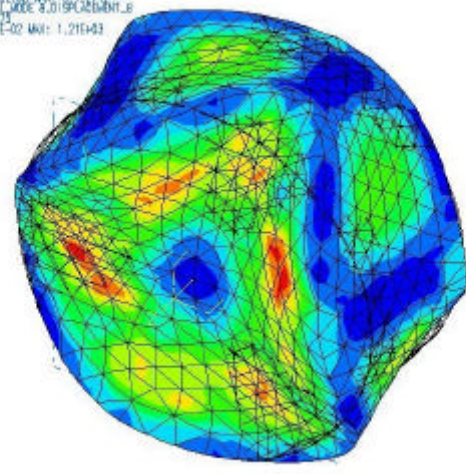
date	23-Apr-03						
FEA code	I-DEAS, version 9; filename: ITM11						
run time	0:11						
converged?	probably, based on previous experience, to ~0.2% frequency, ~4% strain energy (not checked)						
material model	isotropic, linear						
element type	parab., tetra.						
# nodes	11716						
# elements	7481						
FEM name	fem2						
mesh type	free mesh (15mm? size)						
	Note: mapped mesh (fem1) failed during analysis; singularity?						
			Strain Energy (J for unit displacement?)				
	shape	freq (Hz)	total	barrel	surface	barrel %	surface %
Mode No	1	7095	3.10E+15	1.61E+14	7.90E+14	5.2%	25.5%
	2	7095	3.09E+15	1.63E+14	7.91E+14	5.3%	25.6%
	3	9866	7.61E+15	1.78E+14	1.75E+15	2.3%	23.0%
	4	11225	2.46E+16	1.14E+14	2.48E+15	0.5%	10.1%
	5	11225	1.44E+16	6.69E+13	1.45E+15	0.5%	10.1%
	6	12590	1.11E+16	1.03E+15	1.95E+15	9.3%	17.6%
	7	12590	1.11E+16	1.03E+15	1.94E+15	9.3%	17.5%
	8	12799	8.46E+15	7.40E+14	2.27E+15	8.7%	26.8%
	9	12799	8.46E+15	7.38E+14	2.27E+15	8.7%	26.8%
	10	14451	3.39E+16	9.99E+14	3.70E+15	2.9%	10.9%
	11	14982	1.29E+16	1.67E+14	1.62E+15	1.3%	12.6%
	12	14982	1.29E+16	1.63E+14	1.64E+15	1.3%	12.7%
	13	17156	2.27E+16	5.33E+14	2.77E+15	2.3%	12.2%
	14	17156	2.27E+16	5.31E+14	2.77E+15	2.3%	12.2%
	15	17427	1.75E+16	2.63E+15	2.69E+15	15.0%	15.4%
	16	18266	1.42E+16	1.64E+15	4.09E+15	11.5%	28.8%
	17	18266	1.43E+16	1.66E+15	4.11E+15	11.6%	28.7%
	18	19249	1.48E+16	2.14E+15	3.11E+15	14.5%	21.0%
	19	19249	2.28E+16	3.32E+15	4.81E+15	14.6%	21.1%
	20	19745	1.64E+16	3.24E+14	1.96E+15	2.0%	12.0%
	21	19745	2.13E+16	4.19E+14	2.54E+15	2.0%	11.9%
	22	20637	1.59E+16	2.21E+15	3.00E+15	13.9%	18.9%
	23	20637	1.59E+16	2.23E+15	3.00E+15	14.0%	18.9%
	24	22186	1.47E+16	1.51E+14	1.67E+15	1.0%	11.4%
	25	22225	2.81E+16	1.38E+15	4.42E+15	4.9%	15.7%

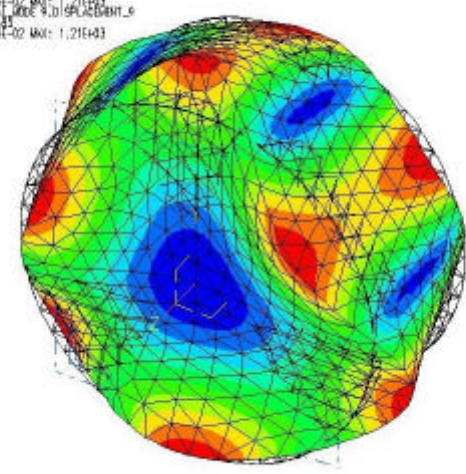
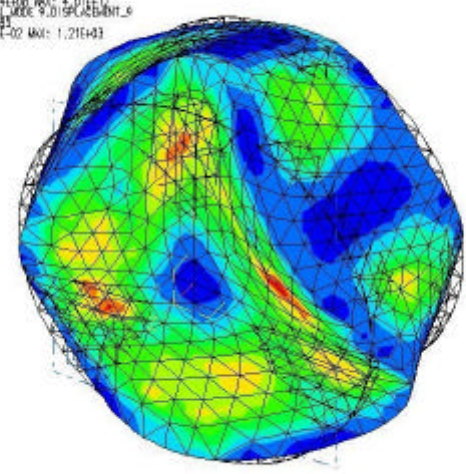
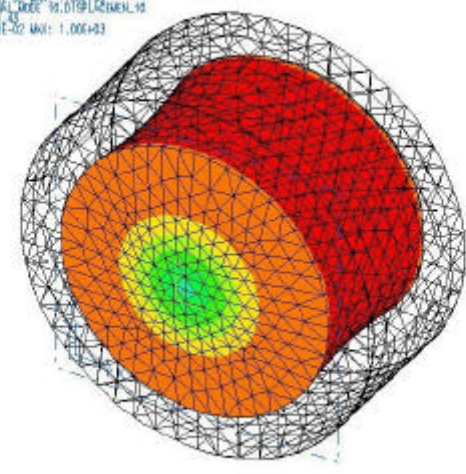
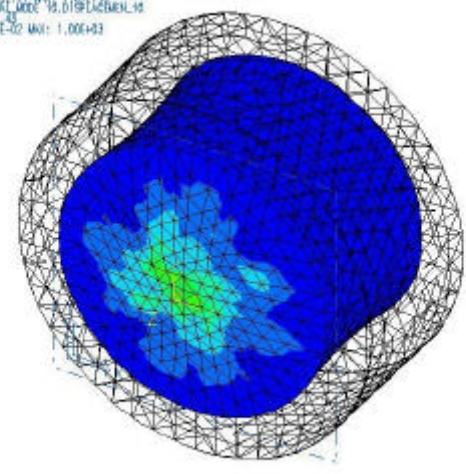
3 Mode Shapes

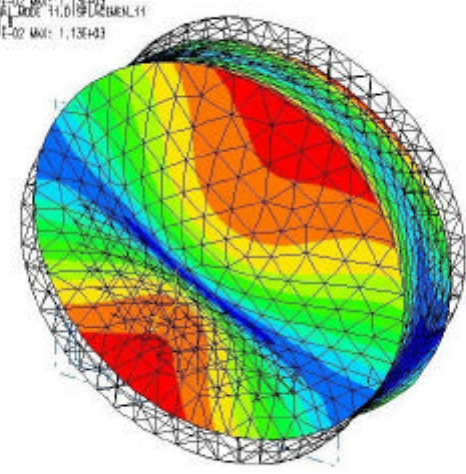
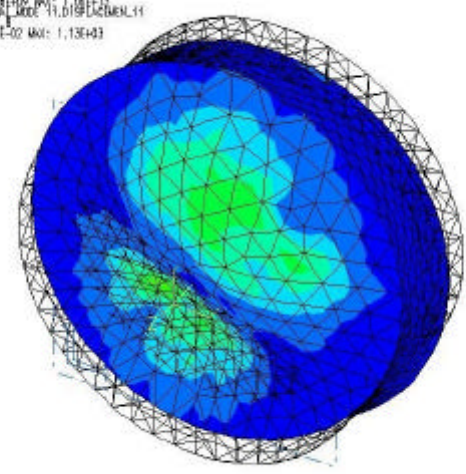
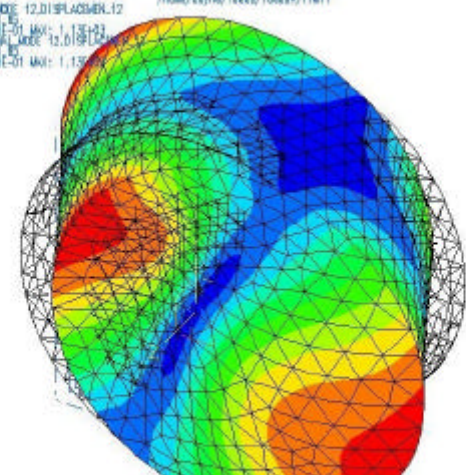
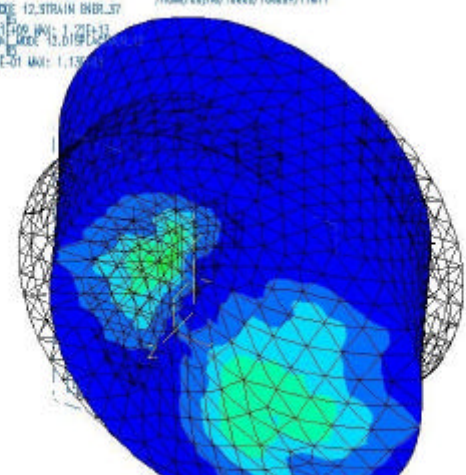
Each of the first 15 mode shapes are depicted as a deformed geometry with contours of displacement and contour of strain energy in the following table.

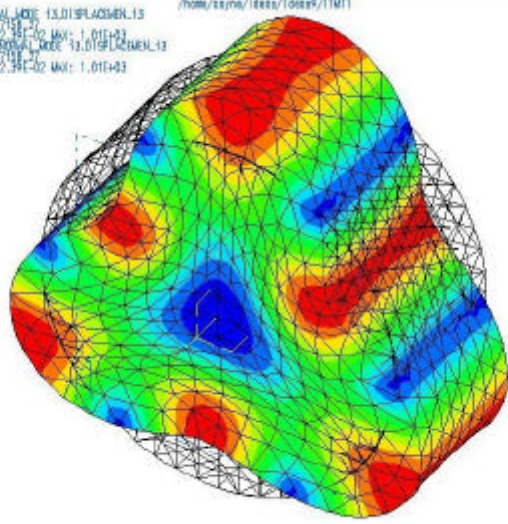
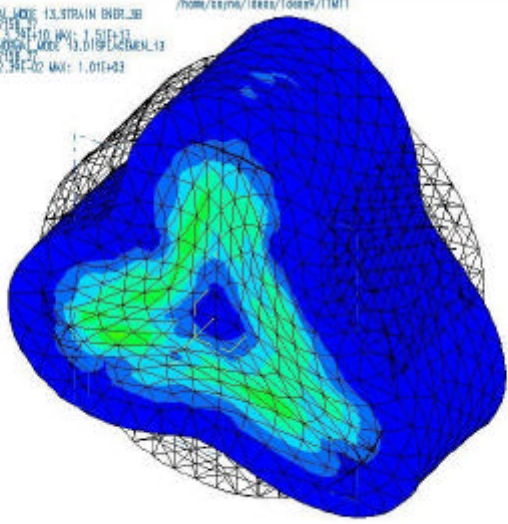
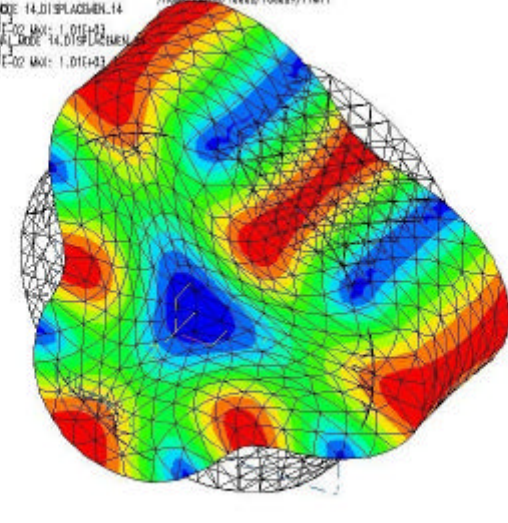
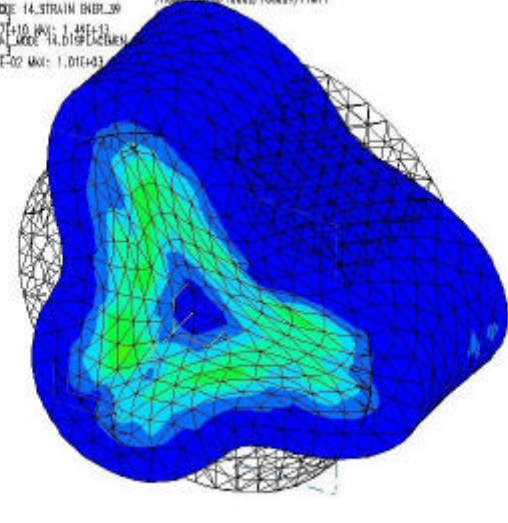
No.	Hz	Displacement Contour	Strain Energy Contour
1	7095	<p>RESULTS: 1- B.C. 1 NORMAL MODE 1,DISPLACEMENT_1 /home/ssyma/ideas/ideas9/TIM1</p> <p>MODE 1 FREQ: 7094.838</p> <p>DISPLACEMENT - MAX MIN: 1.37E-03 MAX: 1.18E+03</p> <p>DISPLACEMENT - MIN MIN: 1.37E-03 MAX: 1.18E+03</p> <p>MODE OF REF: FREE</p>  <p>VALUE OPTION:ACTUAL</p> <p>1.18E+03</p> <p>1.05E+03</p> <p>9.30E+02</p> <p>8.13E+02</p> <p>6.97E+02</p> <p>5.81E+02</p> <p>4.65E+02</p> <p>3.49E+02</p> <p>2.33E+02</p> <p>1.18E+02</p> <p>1.0E+02</p>	<p>RESULTS: 28- B.C. 1 NORMAL MODE 1,STRAIN ENERGY_28 /home/ssyma/ideas/ideas9/TIM1</p> <p>MODE 1 FREQ: 7094.838</p> <p>STRAIN ENERGY - MAX MIN: 2.21E+09 MAX: 2.51E+12</p> <p>DISPLACEMENT - MIN MIN: 1.37E-03 MAX: 1.18E+03</p> <p>MODE OF REF: FREE</p>  <p>VALUE OPTION:ACTUAL</p> <p>2.51E+12</p> <p>2.38E+12</p> <p>2.25E+12</p> <p>2.12E+12</p> <p>1.99E+12</p> <p>1.86E+12</p> <p>1.73E+12</p> <p>1.60E+12</p> <p>1.47E+12</p> <p>1.34E+12</p> <p>1.21E+12</p> <p>1.08E+12</p> <p>9.5E+11</p> <p>8.2E+11</p> <p>6.9E+11</p> <p>5.6E+11</p> <p>4.3E+11</p> <p>3.0E+11</p> <p>1.7E+11</p> <p>4.0E+10</p>
2	7095	<p>RESULTS: 3- B.C. 1 NORMAL MODE 2,DISPLACEMENT_3 /home/ssyma/ideas/ideas9/TIM1</p> <p>MODE 1 FREQ: 7094.838</p> <p>DISPLACEMENT - MAX MIN: 3.74E-03 MAX: 1.18E+03</p> <p>DISPLACEMENT - MIN MIN: 3.74E-03 MAX: 1.18E+03</p> <p>MODE OF REF: FREE</p>  <p>VALUE OPTION:ACTUAL</p> <p>1.18E+03</p> <p>1.04E+03</p> <p>9.29E+02</p> <p>8.13E+02</p> <p>6.97E+02</p> <p>5.81E+02</p> <p>4.65E+02</p> <p>3.49E+02</p> <p>2.33E+02</p> <p>1.18E+02</p> <p>1.0E+02</p>	<p>RESULTS: 27- B.C. 1 NORMAL MODE 2,STRAIN ENERGY_27 /home/ssyma/ideas/ideas9/TIM1</p> <p>MODE 1 FREQ: 7094.838</p> <p>STRAIN ENERGY - MAX MIN: 2.21E+09 MAX: 2.51E+12</p> <p>DISPLACEMENT - MIN MIN: 3.74E-03 MAX: 1.18E+03</p> <p>MODE OF REF: FREE</p>  <p>VALUE OPTION:ACTUAL</p> <p>2.51E+12</p> <p>2.38E+12</p> <p>2.25E+12</p> <p>2.12E+12</p> <p>1.99E+12</p> <p>1.86E+12</p> <p>1.73E+12</p> <p>1.60E+12</p> <p>1.47E+12</p> <p>1.34E+12</p> <p>1.21E+12</p> <p>1.08E+12</p> <p>9.5E+11</p> <p>8.2E+11</p> <p>6.9E+11</p> <p>5.6E+11</p> <p>4.3E+11</p> <p>3.0E+11</p> <p>1.7E+11</p> <p>4.0E+10</p>

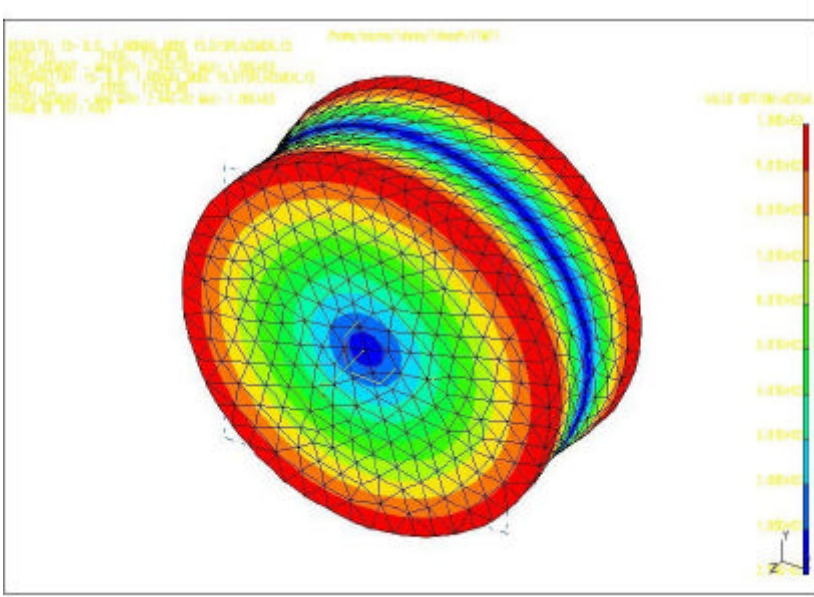
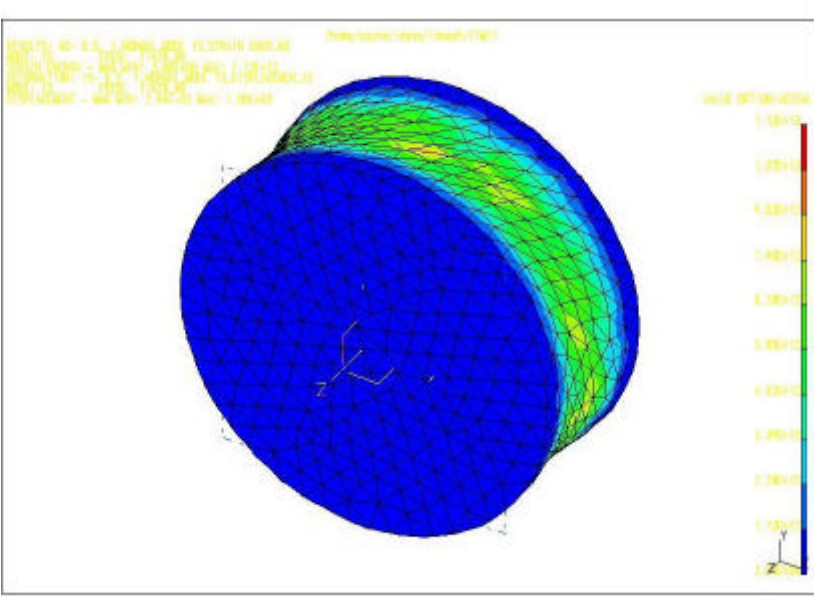
5	11225	<p>RESULTS: 3- B.C. 1 NORMAL MODE 5, DISPLACEMENT_3 /home/casmo/idea/idea9/TM11</p> <p>MODE: 3 FREQ: 11225.93</p> <p>RESULTS: ENERGY - MAX MIN: 2.28E+09 MAX: 1.25E+11</p> <p>DEFORMATION: C B.C. 1 NORMAL MODE 5, DISPLACEMENT_3</p> <p>MODE: 3 FREQ: 11225.93</p> <p>DISPLACEMENT - MAX MIN: 1.93E-02 MAX: 1.00E+03</p> <p>SCALE OF REF: FEM1</p>  <p>VALUE OPTION: ACTUAL</p> <p>1.00E+03</p> <p>9.00E+02</p> <p>8.00E+02</p> <p>7.00E+02</p> <p>6.00E+02</p> <p>5.00E+02</p> <p>4.00E+02</p> <p>3.00E+02</p> <p>2.00E+02</p> <p>1.00E+02</p> <p>1.00E+01</p>	<p>RESULTS: 30- B.C. 1 NORMAL MODE 5, STRAIN ENERGY_30 /home/casmo/idea/idea9/TM11</p> <p>MODE: 30 FREQ: 11225.93</p> <p>RESULTS: ENERGY - MAX MIN: 2.28E+09 MAX: 1.25E+11</p> <p>DEFORMATION: C B.C. 1 NORMAL MODE 5, DISPLACEMENT_3</p> <p>MODE: 3 FREQ: 11225.93</p> <p>DISPLACEMENT - MAX MIN: 1.93E-02 MAX: 1.00E+03</p>  <p>VALUE OPTION: ACTUAL</p> <p>1.20E+13</p> <p>1.10E+13</p> <p>1.00E+13</p> <p>8.70E+12</p> <p>7.50E+12</p> <p>6.20E+12</p> <p>5.00E+12</p> <p>3.70E+12</p> <p>2.50E+12</p> <p>1.30E+12</p> <p>4.80E+01</p>
6	12590	<p>RESULTS: 8- B.C. 1 NORMAL MODE 8, DISPLACEMENT_8 /home/casmo/idea/idea9/TM11</p> <p>MODE: 8 FREQ: 12590.13</p> <p>RESULTS: ENERGY - MAX MIN: 2.14E+09 MAX: 1.10E+11</p> <p>DEFORMATION: C B.C. 1 NORMAL MODE 8, DISPLACEMENT_8</p> <p>MODE: 8 FREQ: 12590.13</p> <p>DISPLACEMENT - MAX MIN: 1.28E-01 MAX: 1.10E+03</p> <p>SCALE OF REF: FEM1</p>  <p>VALUE OPTION: ACTUAL</p> <p>1.00E+03</p> <p>9.00E+02</p> <p>8.00E+02</p> <p>7.00E+02</p> <p>6.00E+02</p> <p>5.00E+02</p> <p>4.00E+02</p> <p>3.00E+02</p> <p>2.00E+02</p> <p>1.00E+01</p>	<p>RESULTS: 31- B.C. 1 NORMAL MODE 8, STRAIN ENERGY_31 /home/casmo/idea/idea9/TM11</p> <p>MODE: 31 FREQ: 12590.13</p> <p>RESULTS: ENERGY - MAX MIN: 2.14E+09 MAX: 1.10E+11</p> <p>DEFORMATION: C B.C. 1 NORMAL MODE 8, DISPLACEMENT_8</p> <p>MODE: 8 FREQ: 12590.13</p> <p>DISPLACEMENT - MAX MIN: 1.28E-01 MAX: 1.10E+03</p>  <p>VALUE OPTION: ACTUAL</p> <p>6.90E+12</p> <p>6.20E+12</p> <p>5.50E+12</p> <p>4.80E+12</p> <p>4.10E+12</p> <p>3.40E+12</p> <p>2.70E+12</p> <p>2.00E+12</p> <p>1.40E+12</p> <p>1.00E+11</p> <p>1.00E+01</p>

<p>7</p> <p>12590</p>	<p>RESULTS: 7- B.C. 1 NORMAL MODE 7, DISPLACEMENT_7 /home/cxjms/ideas/ideas9/TM11</p> <p>MODE: B DISPLACEMENT - MAX MIN: 1.35E+01 MAX: 1.10E+03 INFORMATION: 7- B.C. 1 NORMAL MODE 7, DISPLACEMENT_7 MODE: B DISPLACEMENT - MAX MIN: 1.35E+01 MAX: 1.10E+03 PHASE OF REF: F001</p>  <p>VALUE OPTION: ACTUAL</p> <p>1.10E+03 9.80E+02 8.60E+02 7.20E+02 6.80E+02 5.50E+02 4.40E+02 3.30E+02 2.30E+02 1.30E+02 1.35E+01</p>	<p>RESULTS: 22- B.C. 1 NORMAL MODE 7, STRAIN ENERGY_22 /home/cxjms/ideas/ideas9/TM11</p> <p>MODE: B STRAIN ENERGY - MAX MIN: 8.11E+09 MAX: 5.95E+12 INFORMATION: 7- B.C. 1 NORMAL MODE 7, DISPLACEMENT_7 MODE: B DISPLACEMENT - MAX MIN: 1.35E+01 MAX: 1.10E+03</p>  <p>VALUE OPTION: ACTUAL</p> <p>5.95E+12 5.38E+12 4.78E+12 4.17E+12 3.57E+12 2.98E+12 2.39E+12 1.79E+12 1.30E+12 6.03E+11 5.95E+09</p>
<p>8</p> <p>12799</p>	<p>RESULTS: 8- B.C. 1 NORMAL MODE 8, DISPLACEMENT_8 /home/cxjms/ideas/ideas9/TM11</p> <p>MODE: B DISPLACEMENT - MAX MIN: 1.01E+02 MAX: 1.21E+03 INFORMATION: 8- B.C. 1 NORMAL MODE 8, DISPLACEMENT_8 MODE: B DISPLACEMENT - MAX MIN: 1.01E+02 MAX: 1.21E+03 PHASE OF REF: F001</p>  <p>VALUE OPTION: ACTUAL</p> <p>1.21E+03 1.09E+03 9.80E+02 8.40E+02 7.20E+02 6.04E+02 4.80E+02 3.80E+02 2.40E+02 1.30E+02 1.01E+02</p>	<p>RESULTS: 33- B.C. 1 NORMAL MODE 8, STRAIN ENERGY_33 /home/cxjms/ideas/ideas9/TM11</p> <p>MODE: B STRAIN ENERGY - MAX MIN: 1.01E+09 MAX: 3.92E+12 INFORMATION: 8- B.C. 1 NORMAL MODE 8, DISPLACEMENT_8 MODE: B DISPLACEMENT - MAX MIN: 1.01E+02 MAX: 1.21E+03</p>  <p>VALUE OPTION: ACTUAL</p> <p>3.92E+12 3.53E+12 3.14E+12 2.74E+12 2.35E+12 1.98E+12 1.57E+12 1.18E+12 7.84E+11 3.92E+09 1.01E+09</p>

9	12799	<p>RESULTS: 9- B.C. 1 NORMAL MODE 9,DISPLACEMENT_9 /home/casrn/idea/idea9/TM11</p> <p>MODE: 9 DISPLACEMENT - MAX MIN: 2.94E-02 MAX: 1.21E+03 FORMATION: 9- B.C. 1 NORMAL MODE 9,DISPLACEMENT_9 MODE: 9 DISPLACEMENT - MAX MIN: 2.94E-02 MAX: 1.21E+03 PAGE OF REF: P01</p>  <p>VALUE OPTION:ACTUAL</p> <p>1.2E+03 1.0E+03 9.8E+02 8.4E+02 7.2E+02 6.0E+02 4.8E+02 3.8E+02 3.4E+02 2.9E+02 1.9E+02</p>	<p>RESULTS: 34- B.C. 1 NORMAL MODE 9,STRAIN ENER_34 /home/casrn/idea/idea9/TM11</p> <p>MODE: 9 DISPLACEMENT - MAX MIN: 2.94E-02 MAX: 1.21E+03 FORMATION: 9- B.C. 1 NORMAL MODE 9,DISPLACEMENT_9 MODE: 9 DISPLACEMENT - MAX MIN: 2.94E-02 MAX: 1.21E+03</p>  <p>VALUE OPTION:ACTUAL</p> <p>4.0E+12 3.8E+12 2.8E+12 2.6E+12 2.4E+12 2.0E+12 1.8E+12 1.2E+12 8.1E+11 4.0E+11 1.9E+11</p>
10	14451	<p>RESULTS: 10- B.C. 1 NORMAL MODE 10,DISPLACMEN_10 /home/casrn/idea/idea9/TM11</p> <p>MODE: 10 DISPLACEMENT - MAX MIN: 1.94E-03 MAX: 1.0E+03 FORMATION: 10- B.C. 1 NORMAL MODE 10,DISPLACMEN_10 MODE: 10 DISPLACEMENT - MAX MIN: 1.94E-03 MAX: 1.0E+03 PAGE OF REF: P01</p>  <p>VALUE OPTION:ACTUAL</p> <p>1.0E+03 9.0E+02 8.0E+02 7.0E+02 6.0E+02 5.0E+02 4.0E+02 3.0E+02 2.0E+02 1.0E+02 1.0E+01</p>	<p>RESULTS: 35- B.C. 1 NORMAL MODE 10,STRAIN ENER_35 /home/casrn/idea/idea9/TM11</p> <p>MODE: 10 DISPLACEMENT - MAX MIN: 1.94E-03 MAX: 1.0E+03 FORMATION: 10- B.C. 1 NORMAL MODE 10,DISPLACMEN_10 MODE: 10 DISPLACEMENT - MAX MIN: 1.94E-03 MAX: 1.0E+03</p>  <p>VALUE OPTION:ACTUAL</p> <p>1.8E+13 1.7E+13 1.5E+13 1.3E+13 1.1E+13 9.0E+12 8.0E+12 6.2E+12 4.9E+12 3.5E+12 1.0E+12</p>

<p>11</p>	<p>14982</p>	<p>RESULTS: 11- B.C. 1 NORMAL MODE 11.D1SPACMEN.11 /hom/casms/idea/idea9/TM11 MODE 11 FREQ: 1498.1 DISPLACEMENT - MAX MIN: 5.77E-02 MAX: 1.13E+03 INFORMATION: 11- B.C. 1 NORMAL MODE 11.D1SPACMEN.11 MODE 11 FREQ: 1498.1 DISPLACEMENT - MAX MIN: 5.77E-02 MAX: 1.13E+03 PHASE OF REF: PMT</p> 	<p>RESULTS: 28- B.C. 1 NORMAL MODE 11.STRAIN ENER.38 /hom/casms/idea/idea9/TM11 MODE 11 FREQ: 1498.1 STRAIN ENERGY - MAX MIN: 6.38E+06 MAX: 1.06E+13 INFORMATION: 11- B.C. 1 NORMAL MODE 11.D1SPACMEN.11 MODE 11 FREQ: 1498.1 DISPLACEMENT - MAX MIN: 5.77E-02 MAX: 1.13E+03</p> 
<p>12</p>	<p>14982</p>	<p>RESULTS: 12- B.C. 1 NORMAL MODE 12.D1SPACMEN.12 /hom/casms/idea/idea9/TM11 MODE 12 FREQ: 1498.1 DISPLACEMENT - MAX MIN: 1.13E+03 INFORMATION: 12- B.C. 1 NORMAL MODE 12.D1SPACMEN.12 MODE 12 FREQ: 1498.1 DISPLACEMENT - MAX MIN: 1.13E+03 PHASE OF REF: PMT</p> 	<p>RESULTS: 37- B.C. 1 NORMAL MODE 12.STRAIN ENER.37 /hom/casms/idea/idea9/TM11 MODE 12 FREQ: 1498.1 STRAIN ENERGY - MAX MIN: 4.31E+06 MAX: 1.22E+13 INFORMATION: 12- B.C. 1 NORMAL MODE 12.D1SPACMEN.12 MODE 12 FREQ: 1498.1 DISPLACEMENT - MAX MIN: 1.13E+03</p> 

13	17156	<pre>RESULTS: 13- B.C. 1 NORMAL MODE 13.D1SPACEMEN.13 /hom/casms/idea/10ear9/TM11 MODE: 13 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 DEFORMATION: 13- B.C. 1 NORMAL MODE 13.D1SPACEMEN.13 MODE: 13 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 MODE OF REF: FEM1</pre>  <p>VALUE OPTION:ACTUAL</p> <p>1.0E+03 9.0E+02 8.0E+02 7.0E+02 6.0E+02 5.0E+02 4.0E+02 3.0E+02 2.0E+02 1.0E+02 0.0E+00 -1.0E+02 -2.0E+02</p>	<pre>RESULTS: 39- B.C. 1 NORMAL MODE 13.STRAIN ENER.39 /hom/casms/idea/10ear9/TM11 MODE: 39 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 DEFORMATION: 13- B.C. 1 NORMAL MODE 13.D1SPACEMEN.13 MODE: 13 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 MODE OF REF: FEM1</pre>  <p>VALUE OPTION:ACTUAL</p> <p>1.5E+15 1.3E+15 1.2E+15 1.0E+15 9.0E+14 8.0E+14 7.0E+14 6.0E+14 5.0E+14 4.0E+14 3.0E+14 2.0E+14 1.5E+14 1.0E+14 0.0E+00 -1.0E+14 -2.0E+14</p>
14	17156	<pre>RESULTS: 14- B.C. 1 NORMAL MODE 14.D1SPACEMEN.14 /hom/casms/idea/10ear9/TM11 MODE: 14 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 DEFORMATION: 14- B.C. 1 NORMAL MODE 14.D1SPACEMEN.14 MODE: 14 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 MODE OF REF: FEM1</pre>  <p>VALUE OPTION:ACTUAL</p> <p>1.0E+03 9.0E+02 8.0E+02 7.0E+02 6.0E+02 5.0E+02 4.0E+02 3.0E+02 2.0E+02 1.0E+02 0.0E+00 -1.0E+02 -2.0E+02</p>	<pre>RESULTS: 39- B.C. 1 NORMAL MODE 14.STRAIN ENER.39 /hom/casms/idea/10ear9/TM11 MODE: 39 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 DEFORMATION: 14- B.C. 1 NORMAL MODE 14.D1SPACEMEN.14 MODE: 14 DISPLACEMENT - MAX MIN: 2.39E-02 MAX: 1.01E+03 TOTAL ENERGY - MAX MIN: 1.45E+13 MODE OF REF: FEM1</pre>  <p>VALUE OPTION:ACTUAL</p> <p>1.4E+15 1.3E+15 1.1E+15 1.0E+15 9.0E+14 8.0E+14 7.0E+14 6.0E+14 5.0E+14 4.0E+14 3.0E+14 2.0E+14 1.5E+14 1.0E+14 0.0E+00 -1.0E+14 -2.0E+14</p>

15	17427	 <p>3D surface plot of a lens-like structure. The plot shows a color gradient from blue (low values) to red (high values). A vertical color scale on the right indicates values from 1.00e+00 to 1.50e+01. The plot includes a coordinate system with x, y, and z axes.</p>	 <p>3D surface plot of a lens-like structure, similar to the one on the left but with a different color gradient. The vertical color scale on the right indicates values from 1.00e+00 to 1.10e+01. The plot includes a coordinate system with x, y, and z axes.</p>