Last improvements in the coaxial tuner for ILC

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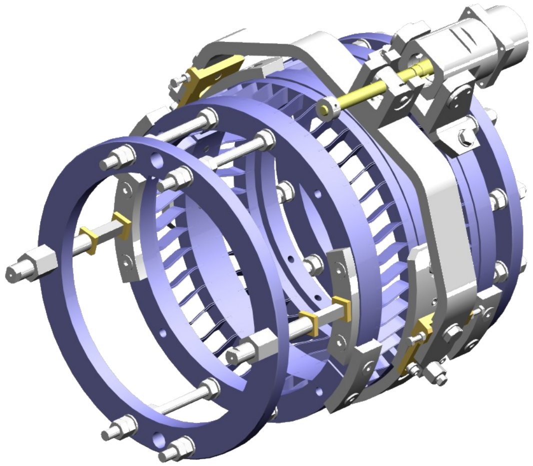
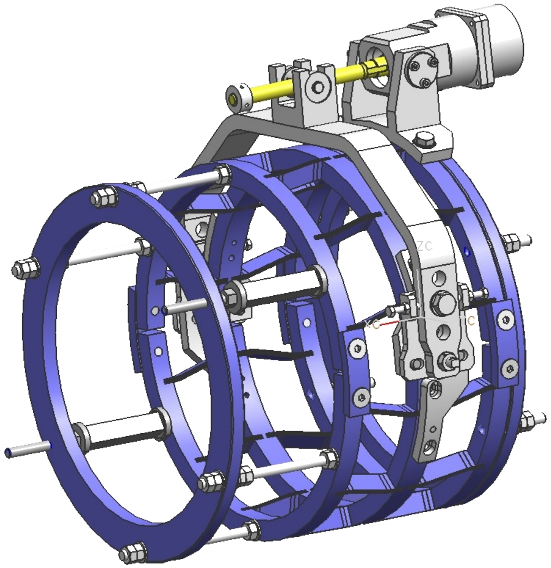
Milano, January 22, 2006

Blade tuner improvements



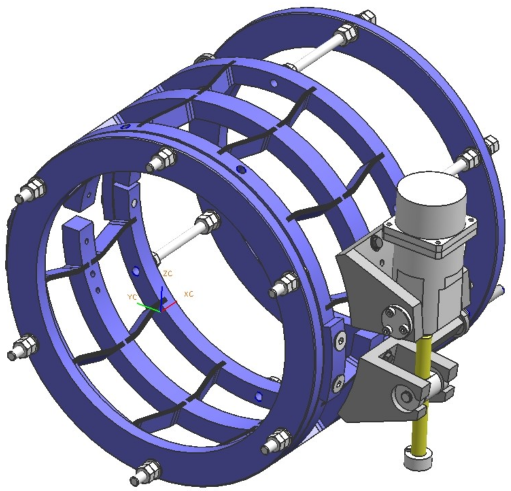
Existing Piezo Blade Tuner
(june 2006)

- Different ring profile
- New blade geometry
- Review of all particulars like the bolt position, materials, piezo support



Slim Tuner
(december 2006)

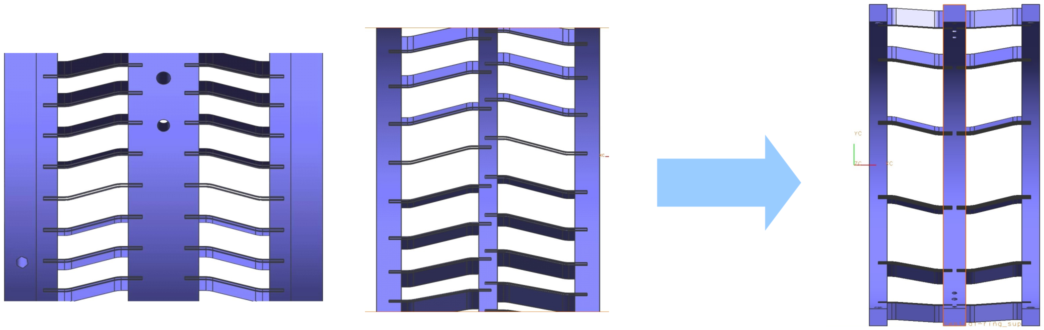
- New motor position
- Simpler mechanism



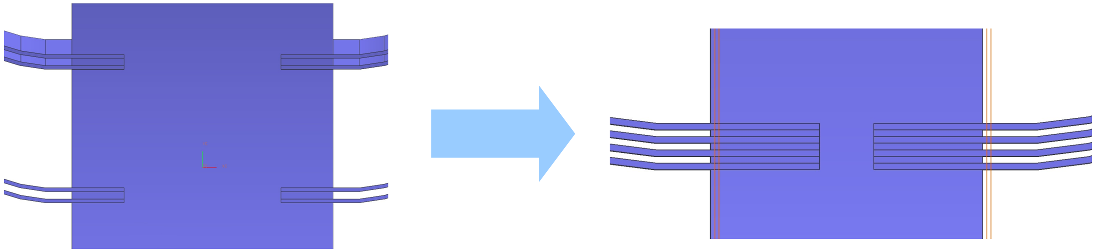
New driving system
(in progress)

Modifications

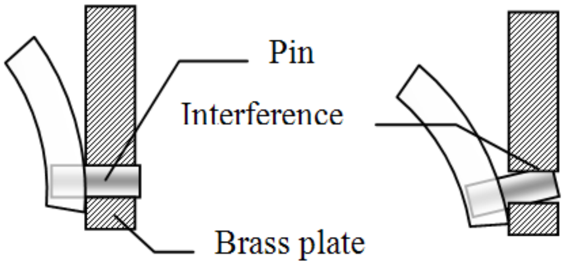
The ***collinear*** blade position has been preferred to the ***alternate*** one.



Different ***blade pack***: lower number of welds and more space for fasteners.



The pin interference problem should be solved with the adoption of the new driving mechanism: no more friction and reduced backslash

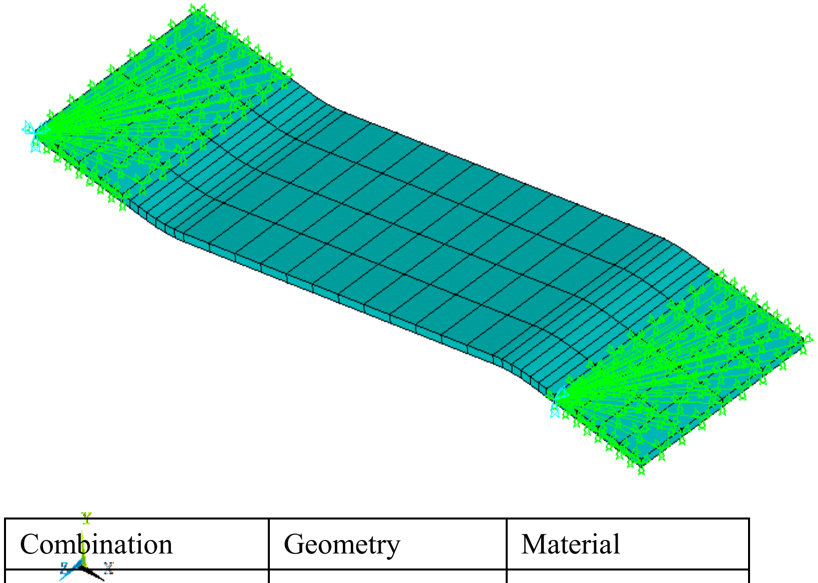


Blade study

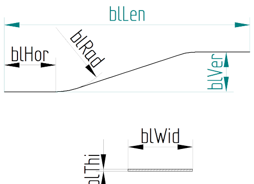
We want include all improvement to the new Slim Tuner.

Several blade configurations (geometry and materials) have been analyzed

Final decision on what adopt based on performance (tuning capabilities) and cost.

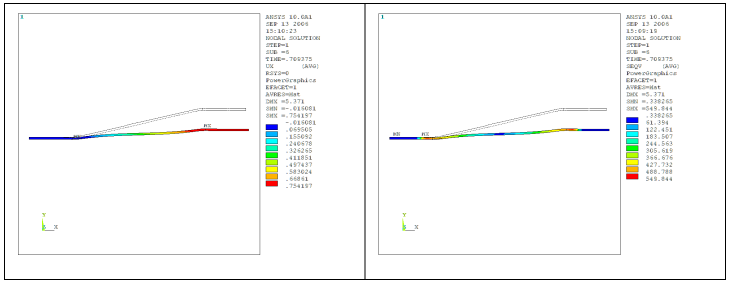


Combination	Geometry	Material
A	Original	Ti
B	Original	AISI 316
C	New	Ti
D	New	AISI 316
E	New thin	AISI 316

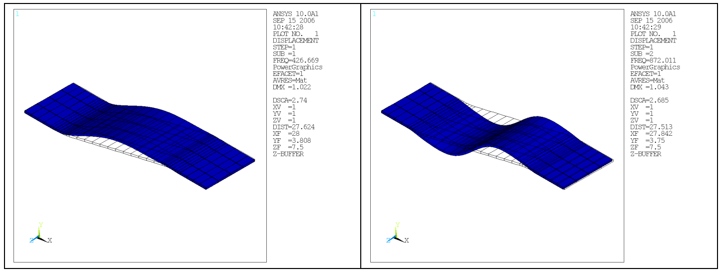


	Configuration	blHor	blCla	blVer	blLen	blRad	blWid	blThi
	Original	12	8	7.5	56	15	15	.5
	New	12	8	10	66	15	16	.5
	New thin	12	8	10	66	15	16	.2

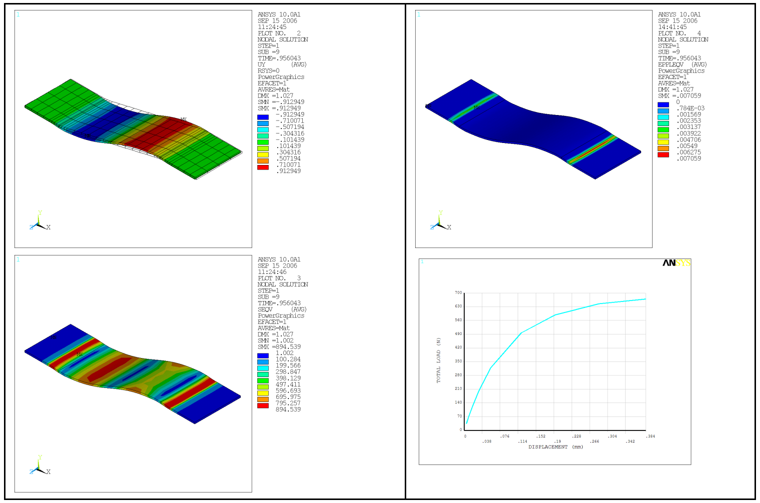
Static analyses



Buckling analyses



Non-linear analyses



Different choices

FE Results

Combination	Limit load in stressed state	Max load without plastic strains	Limit load in non-stressed state	Buckling load (undeformed state)
A	786	709	669	427
B	527	0 (plastic strains)	481	704
C	486	456	496	290
D	480	0 (plastic strains)	424	479
E	46	39	43	31

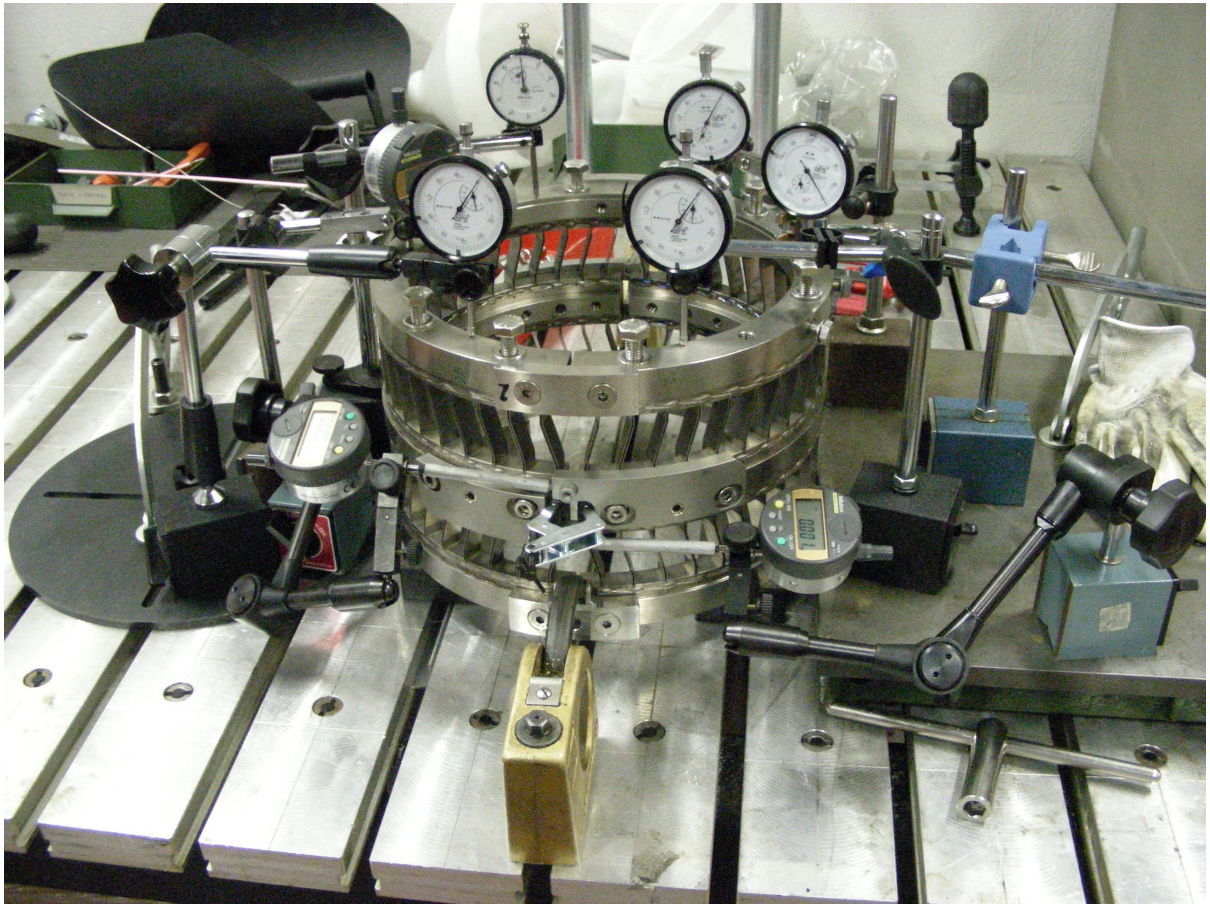
Choices

Tuner type	Blade type	Blade adopted	Admissible axial load (N)	Expected blade stiffness (kN/mm)
Existing	A	2x2x(2x23)*	20510	298
Slim alternate† C	C	2x2x(3x8)	7776	130
Slim alternate E	E	2x2x(10x14)	4200	138

- Improved tuning capabilities (50% more expected)
- 40% lighter (if in Titanium)
- We plan fatigue tests on blades

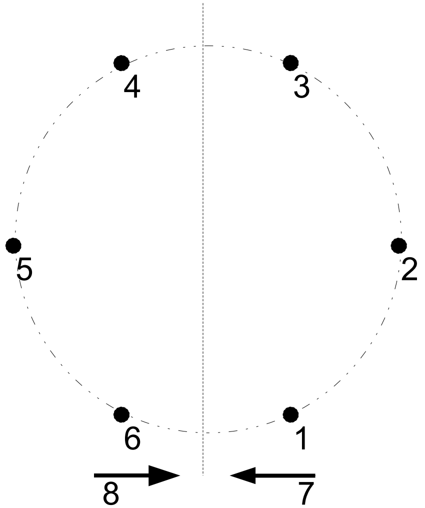
New driving system: experimental test

- A preliminary test has been performed
- A screw mechanism substitutes the motor
- Several dial gauges have been used to monitor the displacements
- TTF tuner rings used



New driving system: experimental test

- Position of dial gauges (1 to 6 vertical direction)



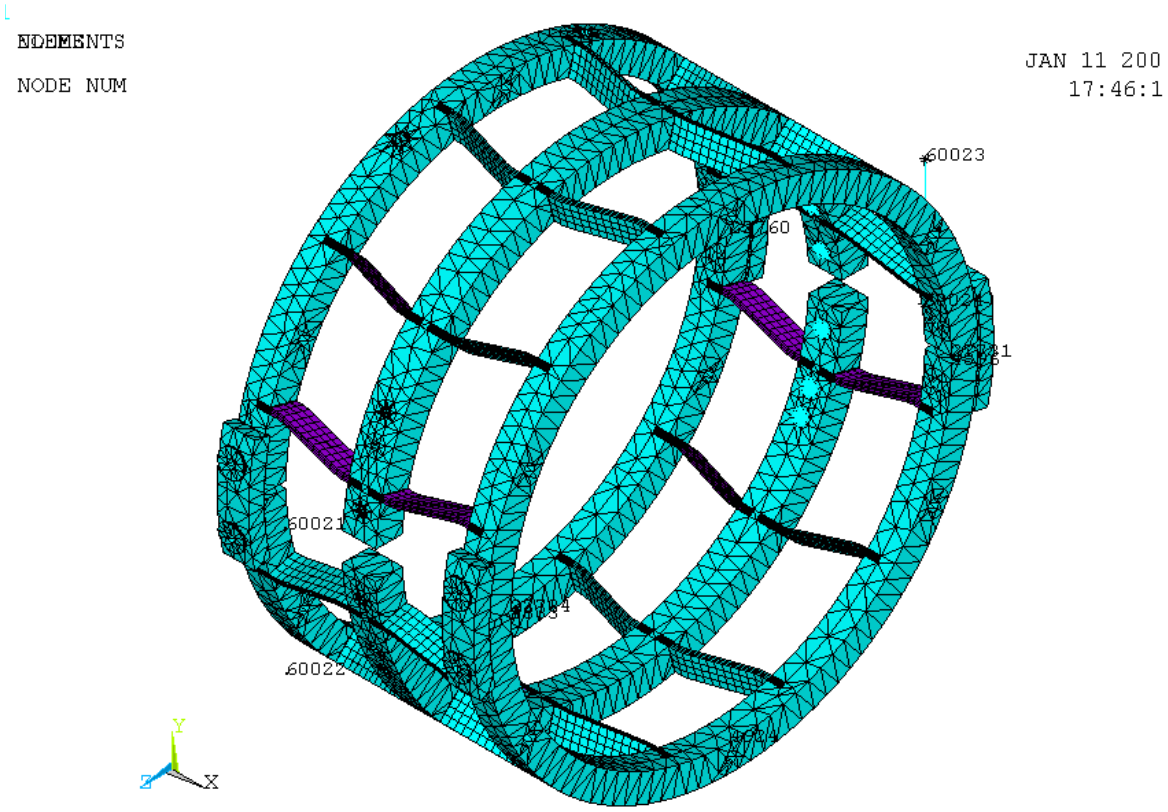
gauge position	1	2	3	4	5	6	7	8
Start position (mm/100)	0	0	0	0	0	0	0	0
1st step (mm/100)	12	10	12	13	12	12	-33	-33
2nd step (mm/100)	22	22	22	23	23	23	-62	-63
3rd step (mm/100)	32	31	32	33	33	33	-89	-91
4th step (mm/100)	41	41	41	41	42	43	-116	-119
5th step (mm/100)	50	50	50	50	51	51	-143	-146
6th step (mm/100)	59	61	59	59	61	61	-171	-177
7th step (mm/100)	67	68	66	66	68	69	-193	-196

Table 1: gauge acquisition

- The vertical displacements are almost the same in all the points monitored
- Optimal behavior with the lateral actuator

New driving system: finite element simulation

- On the new geometry a FE simulation has been performed with the right motor position
- Check of axial (X) and in plane (Y, Z) displacements

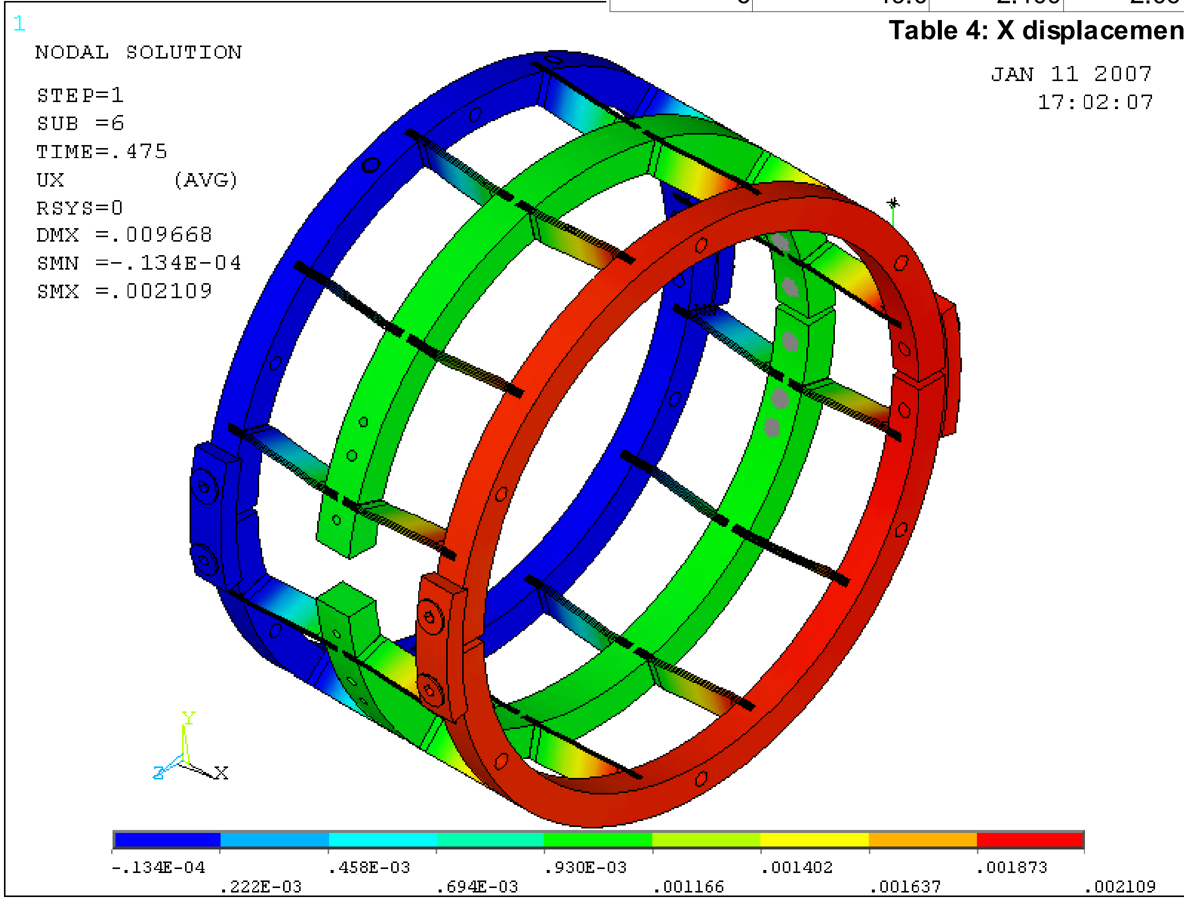


New driving system: finite element simulation

- Axial displacements

		X displacements (mm) at node:					
SUBSTEP	Elong. (mm)	22731	22760	22734	4896	4924	4833
1	2.0	0.322	0.310	0.303	0.322	0.322	0.303
2	4.0	0.620	0.598	0.586	0.620	0.620	0.586
3	7.0	1.021	0.989	0.971	1.021	1.021	0.971
4	10.0	1.369	1.332	1.310	1.369	1.369	1.310
5	14.5	1.793	1.753	1.730	1.793	1.793	1.730
6	19.0	2.100	2.064	2.042	2.100	2.100	2.042

Table 4: X displacements at reference nodes



New driving system: finite element simulation

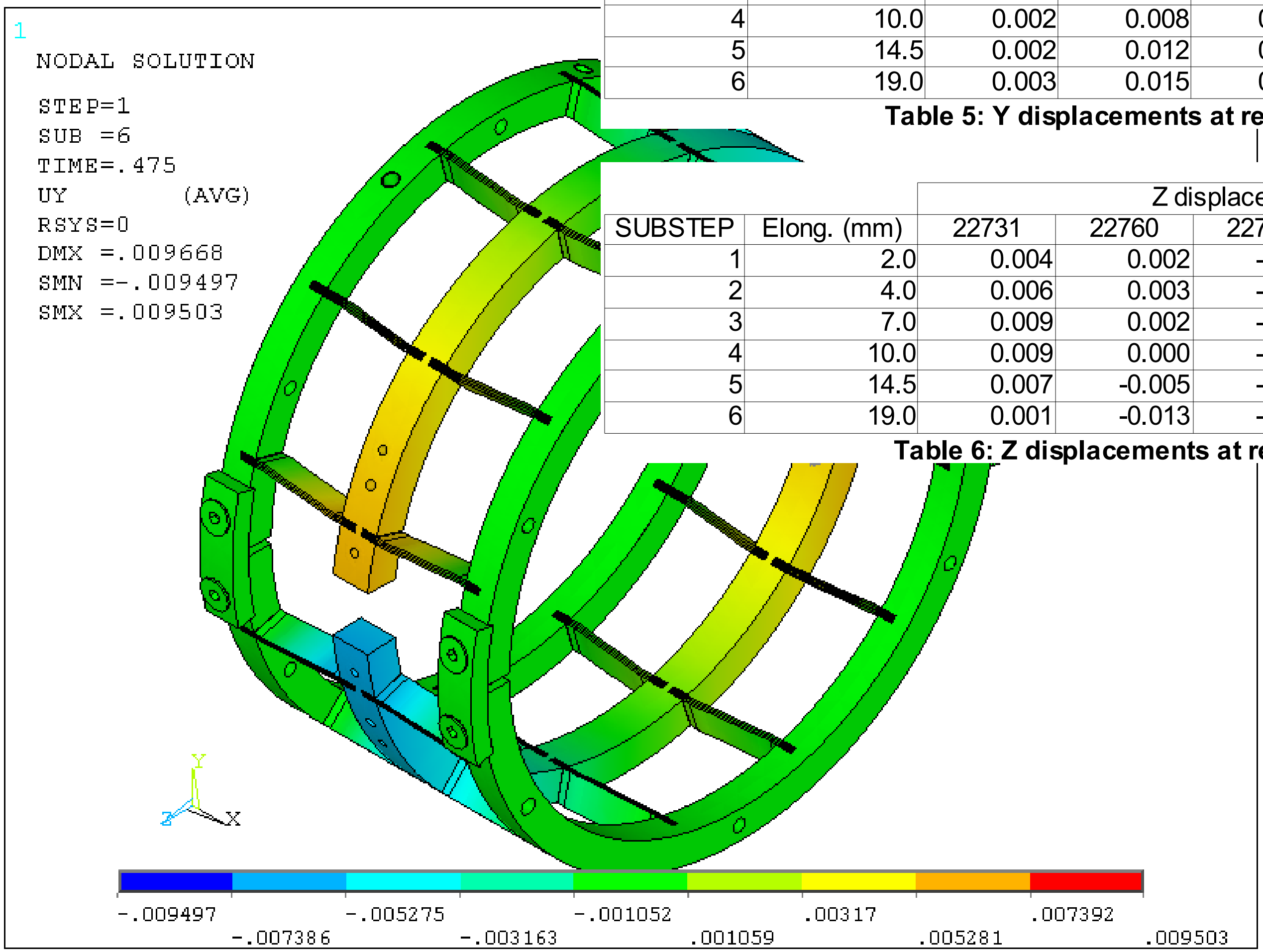
- In plane displacements

SUBSTEP	Elong. (mm)	Y displacements (mm) at node: 22731	22760	22734	4896	4924	4833
1	2.0	0.000	0.002	0.000	0.000	0.000	0.000
2	4.0	0.001	0.004	0.001	0.001	0.001	0.000
3	7.0	0.001	0.006	0.001	0.002	0.002	0.001
4	10.0	0.002	0.008	0.001	0.002	0.002	0.001
5	14.5	0.002	0.012	0.001	0.003	0.003	0.001
6	19.0	0.003	0.015	0.001	0.003	0.003	0.001

Table 5: Y displacements at reference nodes

SUBSTEP	Elong. (mm)	Z displacements (mm) at node: 22731	22760	22734	4896	4924	4833
1	2.0	0.004	0.002	-0.001	0.004	0.004	-0.001
2	4.0	0.006	0.003	-0.002	0.006	0.006	-0.002
3	7.0	0.009	0.002	-0.005	0.009	0.009	-0.006
4	10.0	0.009	0.000	-0.010	0.009	0.009	-0.010
5	14.5	0.007	-0.005	-0.019	0.007	0.007	-0.019
6	19.0	0.001	-0.013	-0.029	0.001	0.001	-0.029

Table 6: Z displacements at reference nodes



Conclusions

- an effort has been done in order to:
  - reduce the weight of the tuner
  - reduce the cost
  - improve the driving mechanism
  - improve the tuning range
- the new slim tuner will be available in Ti and SS
- strength verified against the maximum expected forces
- axial force on motor: 400 N for Ti blades and 800 N for Steel blades
- expected required torque: 1.1 Nmm (Ti) and 2.2 Nmm (SS) + friction
  - the VSS52.200.2.5 motor has a maximum torque > 50 Nmm