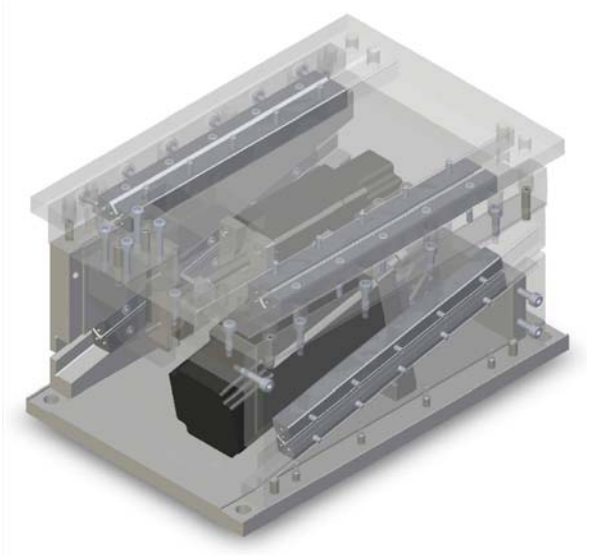
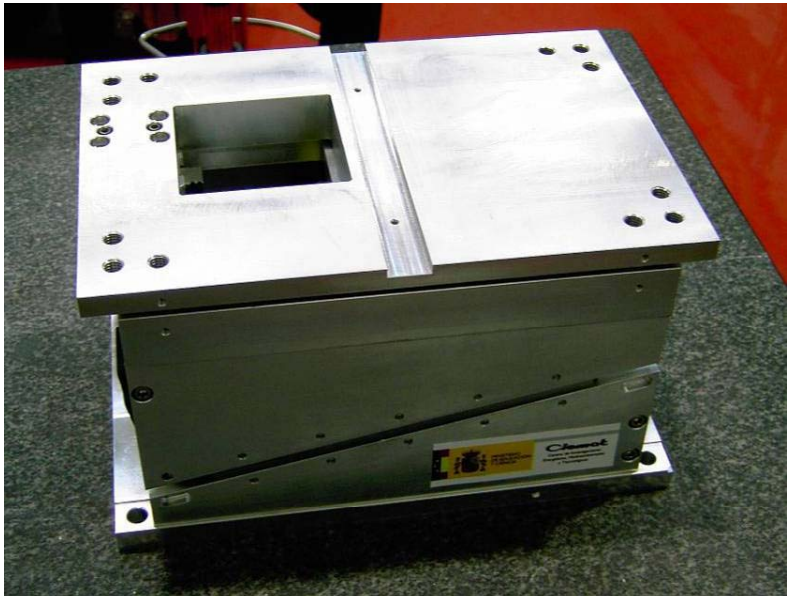
TBL quadrupole mover prototype development





MINISTERIO DE EDUCACIÓN Y CIENCIA
Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

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Outline

- ✓ Technical specifications
- ✓ Layout
- ✓ Fabrication and assembly
- ✓ Tests
- ✓ Future work
- ✓ Conclusions

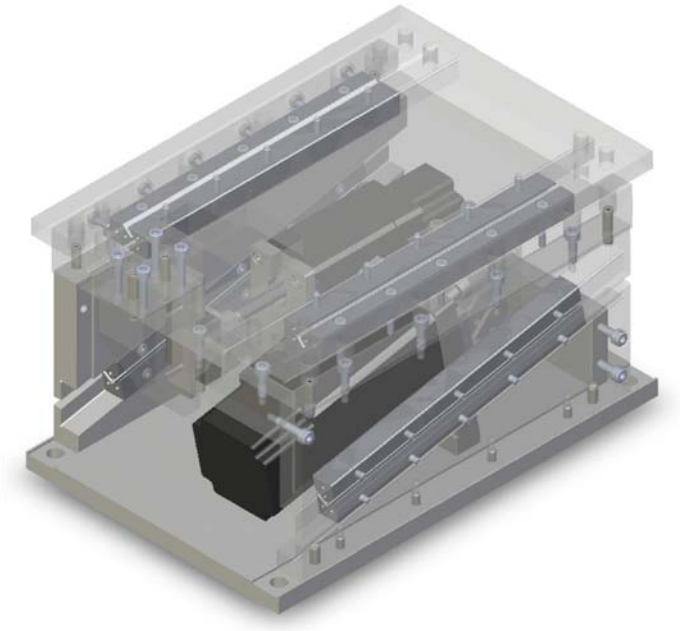
Technical specifications

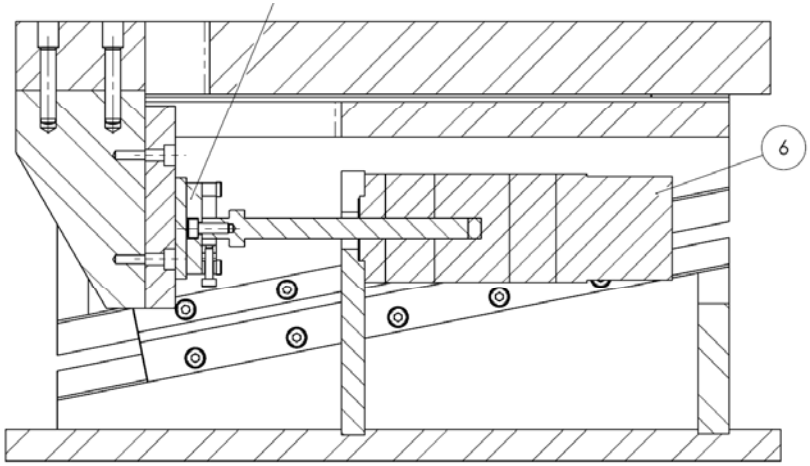
Length	<200	mm
Stroke	+/- 4	mm
Position resolution	1	micron
Position reproducibility	+/- 5	micron
Movement speed	>0.5	mm/s
Distance from driver to motor	up to 50	m
Mass to move	~50	kg
Number of units	16	

Challenges:

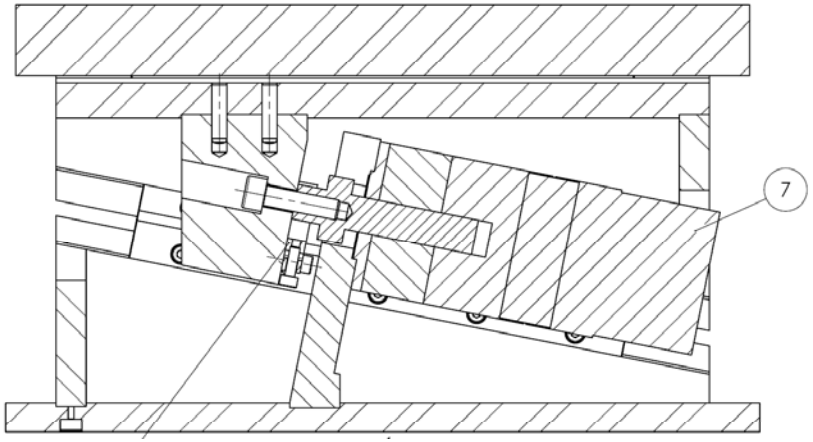
- ✓ Compact design
- ✓ High accuracy
- ✓ Moderate price for series production

Layout (I)





Horizontal actuator



Vertical actuator

- Actuators based on 5-phase step motors with integrated screws and electromagnetic brakes.
- Pairs of precision linear guides.
- Mechanical micro-switches: home position and end-of-movement detectors.

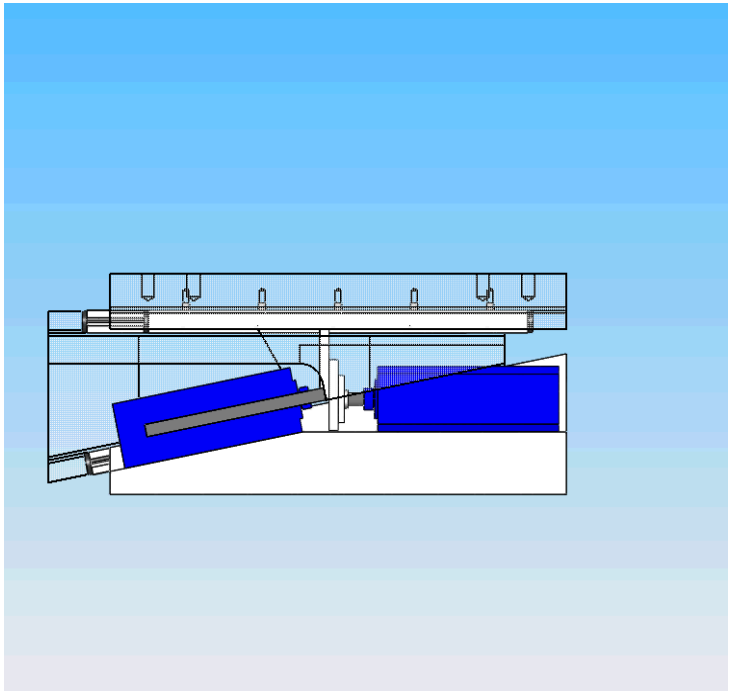
Layout (II)

Vertical actuator

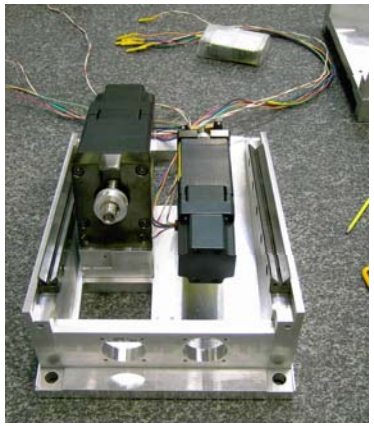
✓ The inclination of the **wedge** enhances the vertical force, allowing a smaller motor, and improving accuracy.

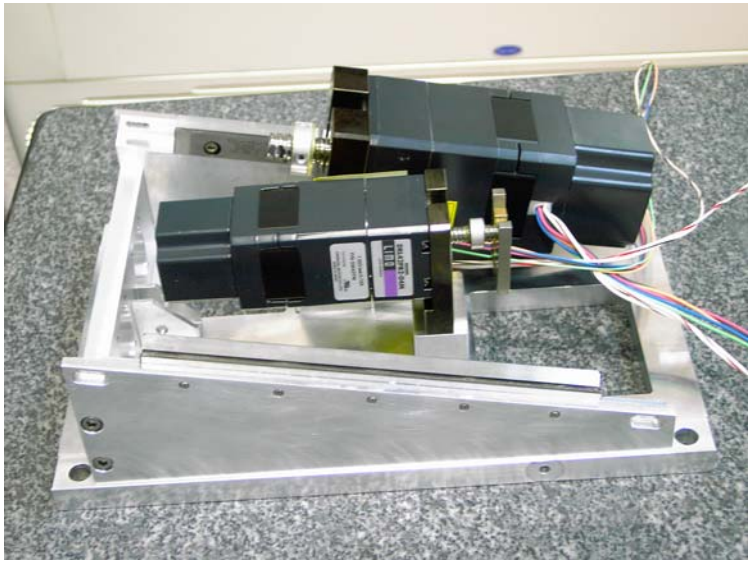
✓ There is a **vertical linear guide**, blocked by the horizontal actuator, which makes vertical and horizontal movements independent.

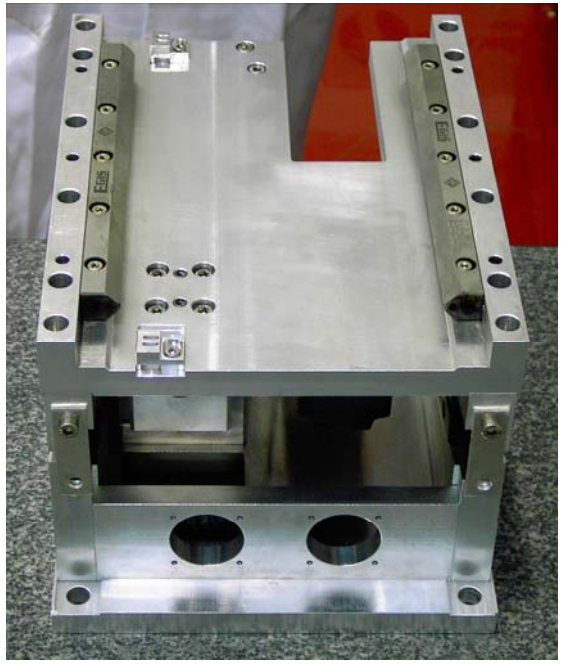
✓ Problems with the overall length of the screw for the requested stroke.



Fabrication and assembly







Tests (I)

✓ Drivers can properly power the motors **50 m away**.

✓ No problems to achieve the requested **speed** for the nominal mass.

✓ Preload is critical to minimize the **backlash**: springs.

✓ Reproducibility achieved for **horizontal movement**, for any distance.

✓ However, tests showed that left side movement was not accurate during **vertical movement**.

Tests (II)

✓ We checked the micrometers accuracy.

✓ We found no clues for the problem when moving short distances: random errors.

✓ However, errors showed saturation for long distances.

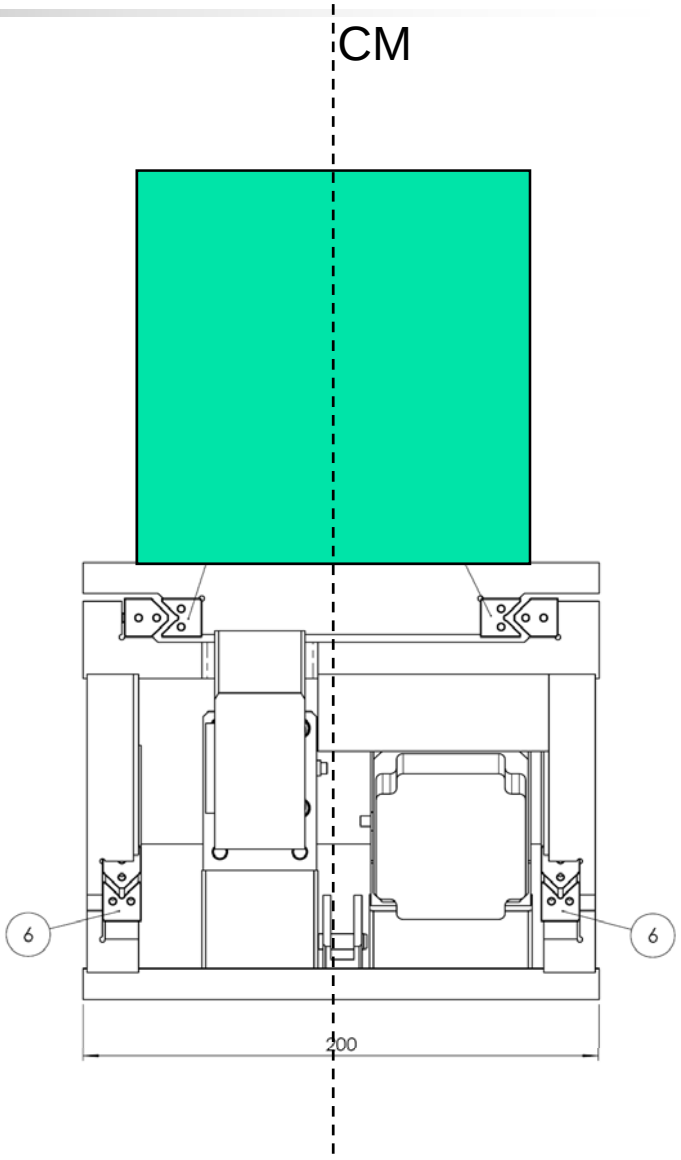
	LEFT HAND SIDE		RIGHT HAND SIDE	
	FORWARD	*BACKWARD*	*FORWARD*	*BACKWARD*
	186	198	203	194
	184	195	204	198
	187	192	208	198
	182	196	203	197
	193	194	202	194
	189	189	202	200
	187	189	202	202
	190	185	197	202
	195	187	195	203
	197	193	194	203
	193	177	195	202
	193	181	196	205
	193	185	194	204
	197	185	195	205
	198	187	200	208
	194	180	195	207
	194	185	195	205
	199	175	197	207
AVERAGE	191.72	187.39	198.72	201.89

Tests (III)

✓ **SOLUTION**: the center of mass was out of the symmetry axis, due to the positioning of the micrometers.

✓ We are concerned about the accuracy for few-micron movements (<5 micron), because we cannot measure them properly.

✓ We have found some problems with the reliability of the micro-switches.



Future works (I)

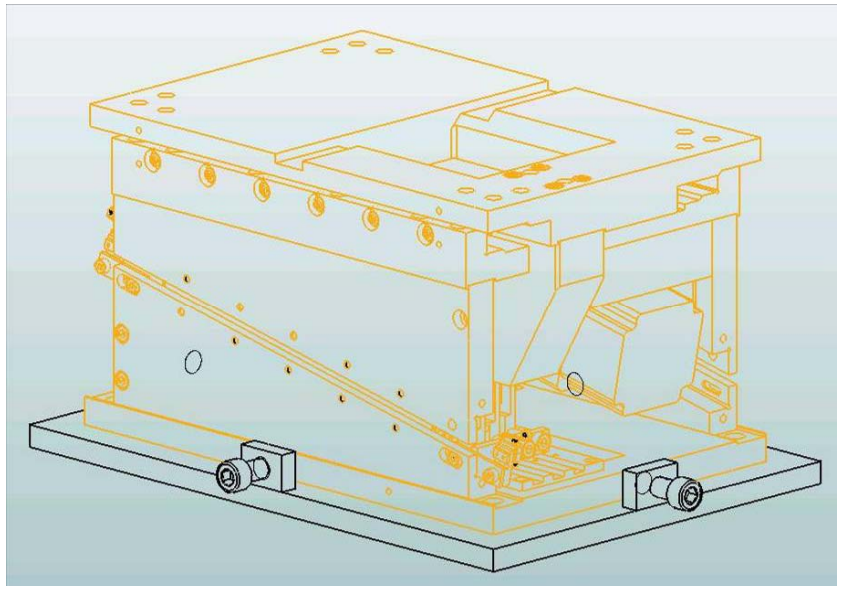
✓ TBL quad mover has just arrived at CERN.

✓ It will be controlled by a PLC-based system.

✓ Tests should be performed with a dummy quadrupole. Resonances due to the water cooling of the magnet are possible!

✓ Special attention is also necessary for very short movements and micro-switches reliability.

✓ The mover will lay on a plate bolted to the girder, with screws to regulate x-y position.



Future works (II)

✓ References for alignment will be placed in the symmetry axis, on top of the magnet.

✓ The design must be updated with the detected mistakes for series production.

✓ In principle, series must be finished by the end of 2008.

Conclusions

✓ TBL quadrupole mover has been successfully designed, fabricated and tested at CIEMAT.

✓ It has just arrived at CERN for acceptance. Control will be done by means of a PLC.

✓ The design must be updated to start with the series production, which should be delivered by the end of 2008.

✓ Hopefully, this development will be transferred to CLIC quadrupole movers.