EUROPEAN SYNCHROTRON RADIATION FACILITY

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A light for science ESRF

New Generation Mirror Systems for the ESRF Upgrade Beamlines

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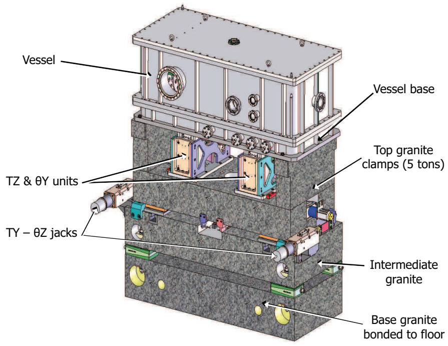
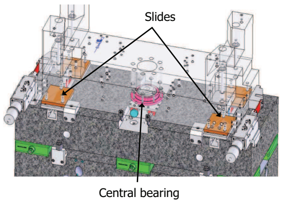
Mirror support & ex vac displacements

The base granite is bonded to the floor for maximum stiffness. A manual pre alignment stage provides height and level adjustment of the system. Four motorised degrees of freedom are then available for fine positioning.

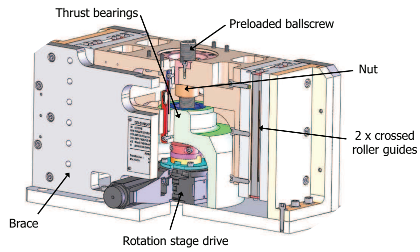




Ex vacuum TY + RZ		
Stroke TY	50	mm
Accuracy TY	2	µm
Resolution TY	2	µm
Stroke RZ	60	mrad
Accuracy RZ	10	µrad
Resolution RZ	20	µrad

TZ Mirror Mover

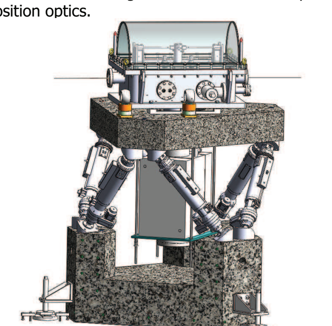
Linear positioning TZ		
Accuracy over 9mm travel	1.2	µm
Repeatability	0.1	µm
Resolution	6	nm
Reverse motion error	<2	nm
Angular accuracy over 9mm travel		
θX	15	µrad
θY	9	µrad
θ	3	µrad
Linear accuracy over 9mm travel		
TX	3.7	µm
TY	6.3	µm
Linear repeatability		
TX over 9mm travel	0.26	µm
TY over 9mm travel	0.27	µm
Resonant frequency		
Vertical	73	Hz
Horizontal	72	Hz



- Up to 50mm vertical travel
- 150kg load capacity
- Generic design adapted to all ESRF upgrade mirror systems
- Double preloaded crossed roller bearing guides
- Ballscrew or satellite roller screw drive options
- Integrated linear encoder
- High stiffness over constrained concept
- High thermal stability, optional thermal shield

New generation Hexapods

A new hexapod, developed in collaboration with *Symétrie* (*) will be used in cases where more than 3 precise motorized degrees of freedom are required to position optics.



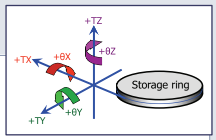
Improvements

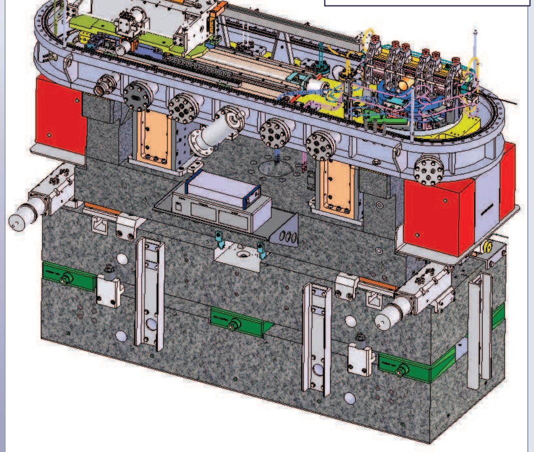
- Angular resolution by a factor 10
- Thermal stability =
  - Motor outside the jack
  - Optimized jack length
  - Materials
- Vibration stability =
  - Stiffness increased by a factor 2 (vibration measurement in progress)

	Stroke	Resolution	Repeat.
TX	0 mm		
TY	50 mm	0.1 µm	± 0.4 µm
TZ	10 mm	0.1 µm	± 0.75 µm
Rx	10 mrad	0.2 µrad	± 1.5 µrad
Ry	40 mrad	0.1µrad	± 1.5 µrad
Rz	10 mrad	0.1 µrad	± 1.5 µrad

(*): O.Lapierre – Th Roux – B. Hromadka

Overview



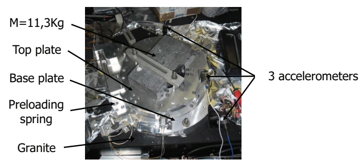


14 Mirrors/Multilayers based on a generic design solutions

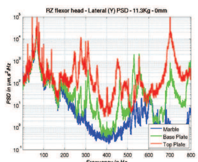
Absorbed power up to 830W

Lab tests, vibration studies

Dynamic analysis of the θZ flexural mirror mover



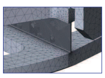
Horizontal mode frequencies in different configurations					
Configuration	Spring 0mm 21.3Kg	No spring 11.3Kg	Spring 3mm 11.3Kg	Spring 0mm 11.3Kg	No spring No load
1st mode	230 Hz	242 Hz	246 Hz	246 Hz	454 Hz
2nd mode	251 Hz	274 Hz	276 Hz	277 Hz	503 Hz

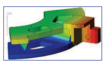


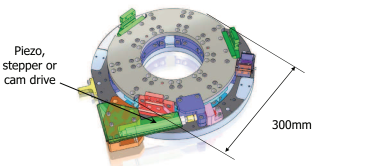
Acceleration PSD

UHV fine tune incidence θZ

- Generic design
- Low profile
- UHV compatible
- Theoretical angular resolution : 10 nrad

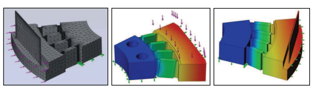


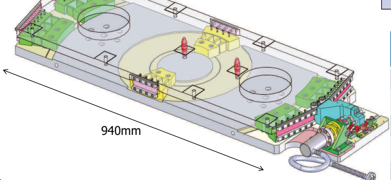




Small fine tune θZ UHV flexure with encapsulated stepper motor drive		
Total stroke	+/- 300	µrad
Backlash	5	µrad
Load capacity	30	kg
Stability over 10 hours	2	µrad
Repeatability (unidirectional)	0.4	µrad
Resolution (half motor step)	200	nrad
1st resonant frequency (4kg load)	127	Hz

For fine tune of incidence angle in large horizontally reflecting mirror systems





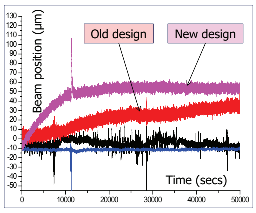
Large fine tune θZ UHV flexure with encapsulated stepper motor drive		
Total stroke	+/- 200	µrad
Load capacity	120	kg
Repeatability (bidirectional)	2	µrad
Resolution (half motor step)	0.75	µrad
1st resonant frequency (100kg load)	70	Hz

Cooling,Thermalisation & material choice

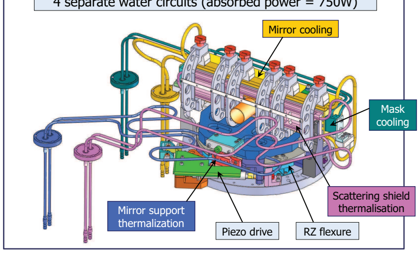
ID24 old & new mirror system settling time comparison

- Careful material choice
- Athermal design principles
- Extensive thermalisation
- Cooled Compton shield
- ESRF "SMART" mirror profile

Commisioning the thermal response time



Typical high heat load mirror cooling & thermalisation.
4 separate water circuits (absorbed power = 750W)



Material choice for optimal thermal stability

α = Coeff. of thermal expansion
ρ = Material density
C_p = Specific heat
K = Thermal conductivity

Material s commonly used in UHV mirror systems	
Material	α.ρ.Cp/k²
SiC	0.16
Si	0.2
Copper	0.35
Aluminium	1.9
Brass	5.3
Mild steel	21.5
Invar	50.7
Corroplast *	220
Zerodur	355
St. St.	734
Granite	1421
Peek	1690

Best ↑ … ↓ Worst

** pre-hardened, 400 series matensitic stainless steel. CTE = 10.3 10⁻⁶/°C*

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