



72" Optics Kottamia

Manual

**Introduction:**

This manual describes the design and the parameter of the Cassegrain system and the M1 support. The necessary instructions for maintenance and handling of the mirror will be given.

Technical Description:

The support design of the primary mirror is optimised to make sure the surface quality of the mirror. The old mirror mount lies upon nine axial circular pads, arranged in three groups. This type of support contributes to the mirror budget at least 20.3nm RMS on the mirror surface equals 40.6nm wave front error for an ideally polished 1.88m mirror with a diameter/ thickness ratio of 6.2. The required quality goal is practically not to be achieved with this mirror mount, leaving only 20% of the error budget for the mirror itself.

The new mount has an support quality of 4.66nm rms wavefront.

To accomplish the necessary support quality, the old support structure has been replaced by a new axial and radial support system. The mirror is floating on eighteen axially and sixteen radially weight balancing system each. The axial support points are located on optimum circles. The equilibrium of the mirror is thus guaranteed by the counterweights in all the positions of the telescope. The position of the mirror is defined by three fixed, adjustable points at the mount which, however, due to the weight relief are loaded no longer by the direction dependent components of the mirror mount, but by the permanent contact forces which press resiliently on the mirror.

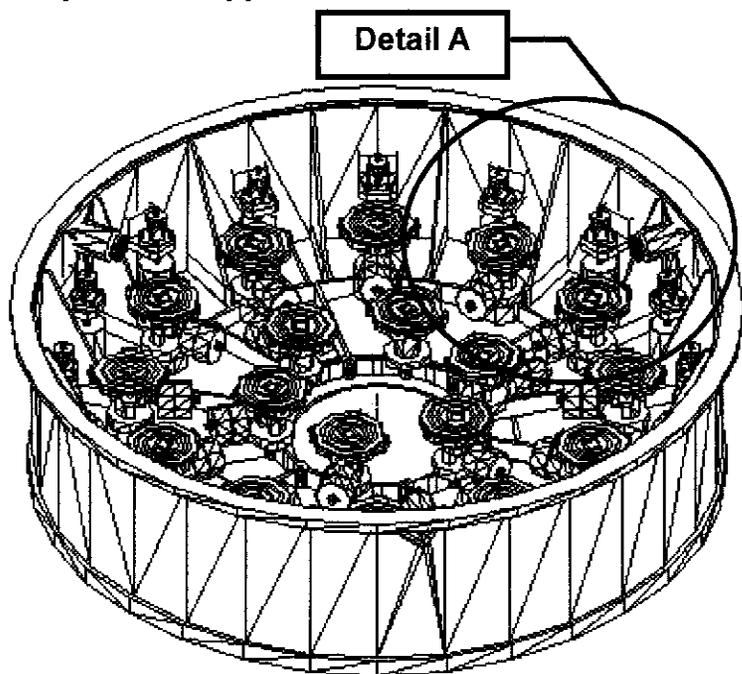
In radial direction the position is defined by three adjustable elements, which compensate the different thermal coefficient between the glass ceramic and the cell material.

For renewing of the cell, the cell body was stabilized by use of more and more stiff steel ribs. The use of the old cell body save the interface conditions between the mirror cell and the telescope tube.

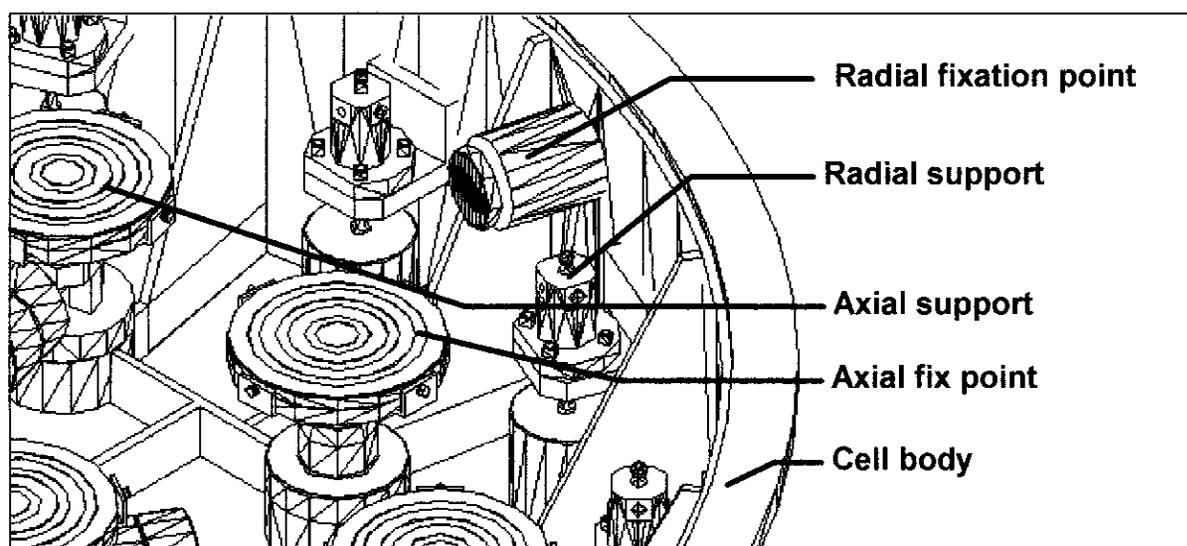
The instrument rotator has been demounted, cleaned and repaired.

Detailed description:

Primary mirror support



Detail A



Axial supports:

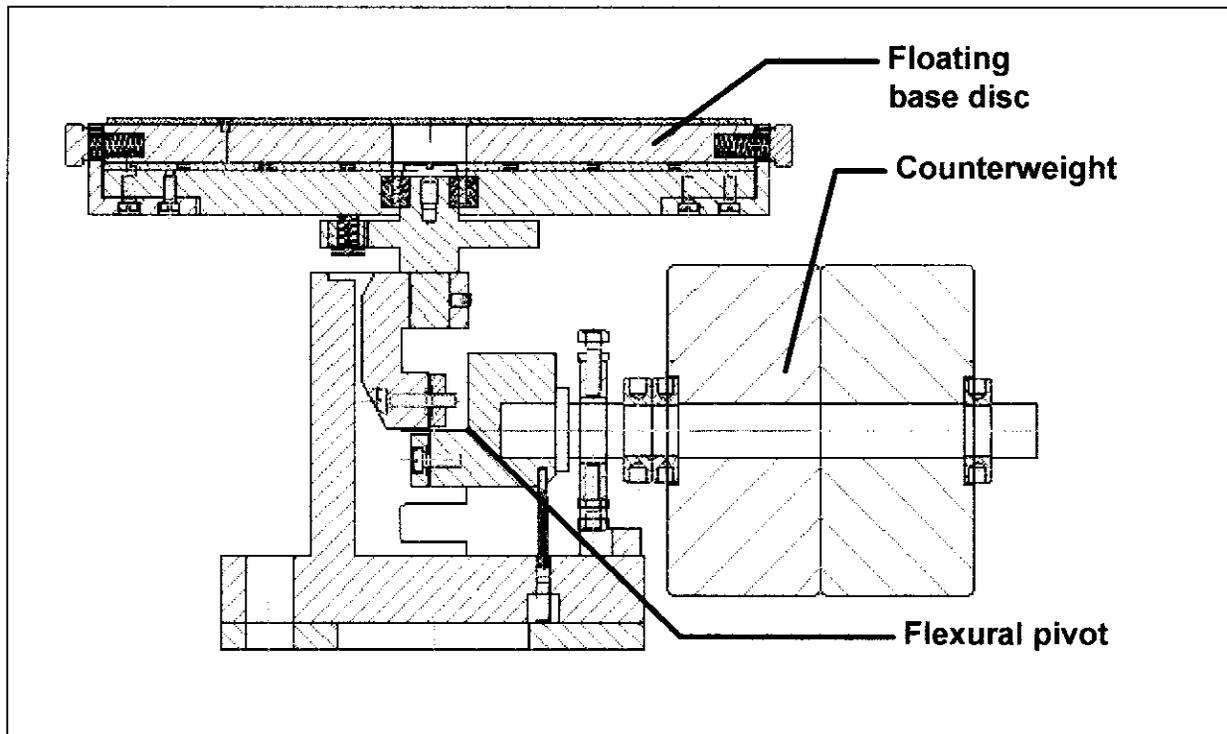
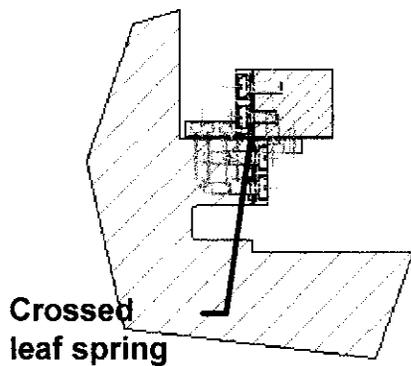
see drawing 161499:001.14(1)

The mirror is supported axially at 18 support points. These points are distributed on an inner ring with 6 supports and an outer ring with 12 supports.

Three points are fix, adjustable units, which define the axially position of the mirror.

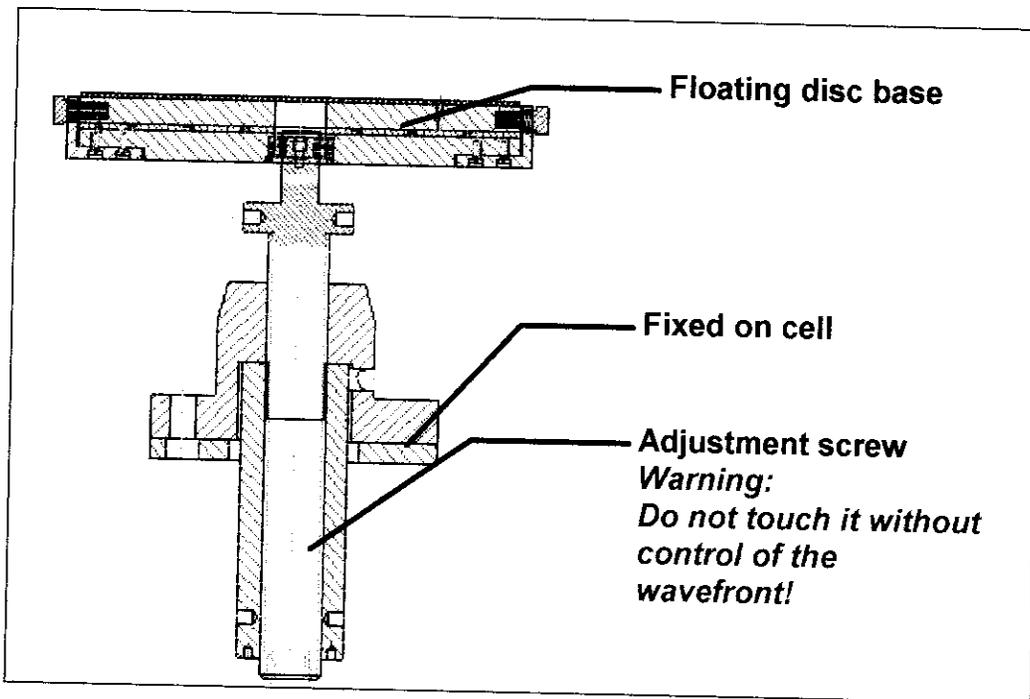
The support units are counterweighted lever systems with flexural pivots. The counterweight moment will be adapted for the actually mirror weight.

Floating base discs disposed between the mirror backside and the support systems prevent radial pressure from the supports to the mirror.

**Flexural pivot
Detail view**

Axial fix point:

see drawing 161499:005.14(2)



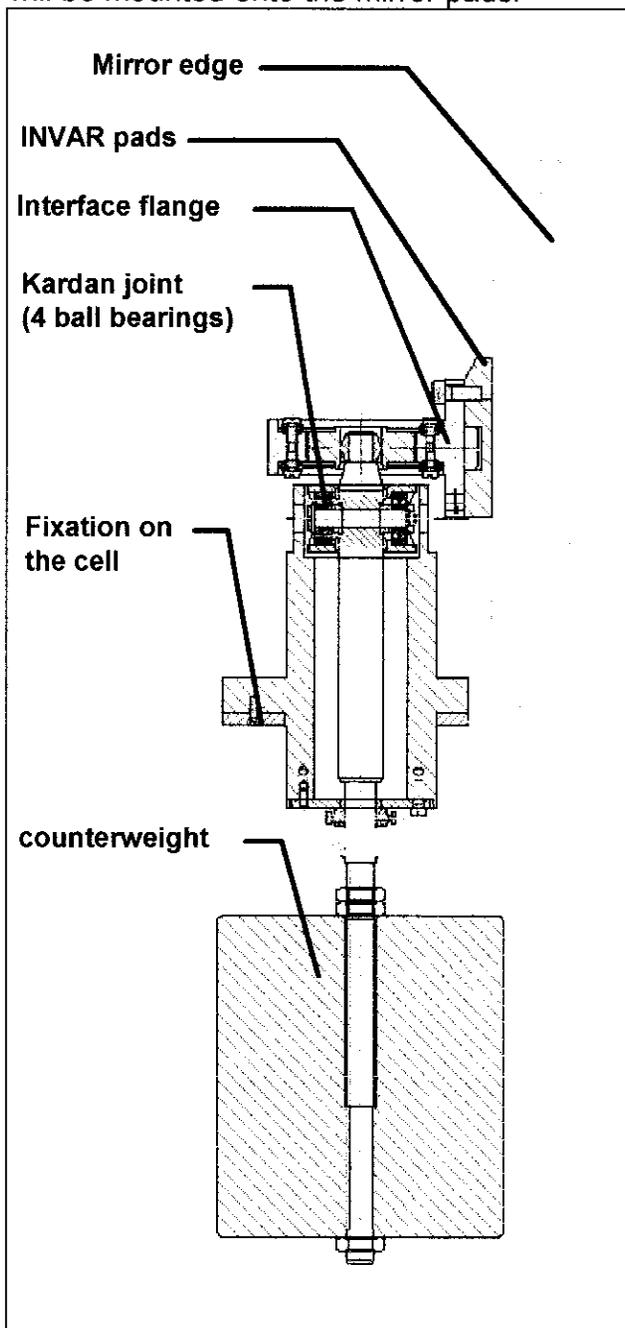
Radial supports:

see drawing 161499:004.14(2)

The mirror is supported by 16 counterweighted radial support units. The units are fix on the inner edge of the mirror cell. The pivots are ball bearings. The counterweight moment is adapted for the actual mirror weight.

At the mirror edge 16 INVAR pads are glued.

A spherical plug on the front end of the support lever is intervened in an exactly worked hole in a flange, which will be mounted onto the mirror pads.



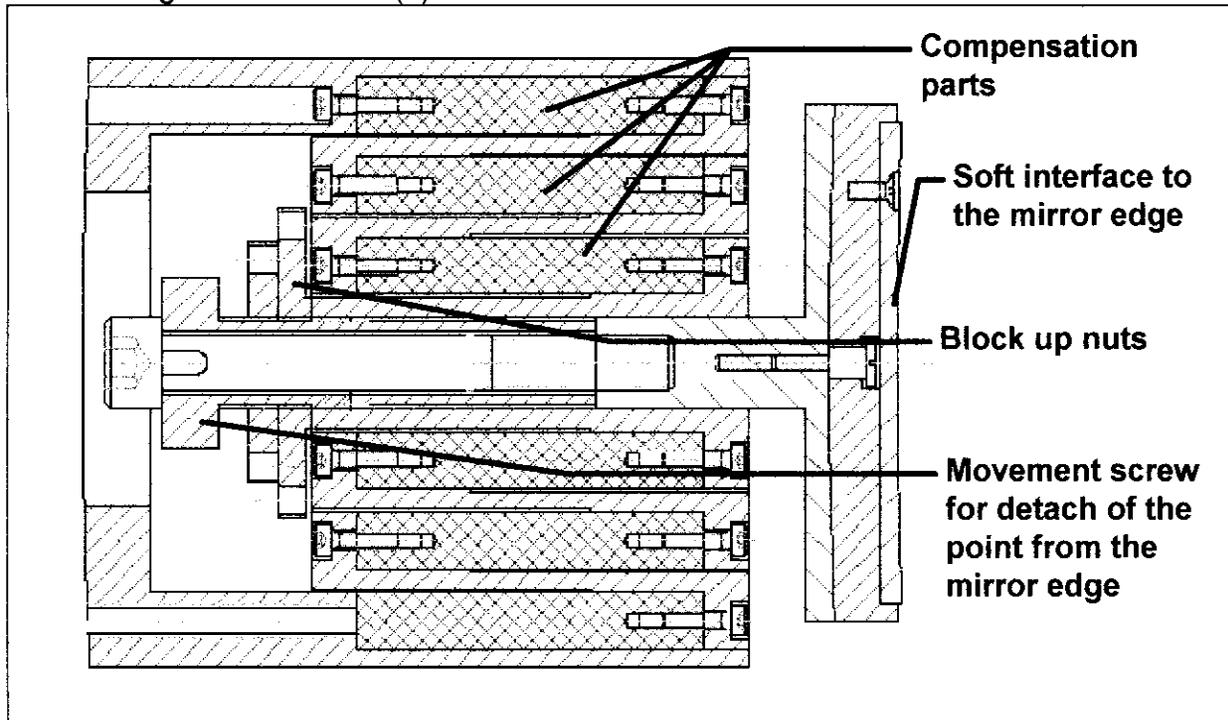
Radial fixation points:

The radial position of the mirror in the cell defines three units, which will be attached at the mirror edge in an angle distance of $3 \times 120^\circ$. The use of parts with a high thermal expansion coefficient compensate the different thermal expansion between the mirror cell and the ZERODUR mirror.

Two fixation points are „hard“ points, that means, they are fix, adjustable stops. The third point give a „soft“ pressure to the mirror edge by using of a spring.

Radial fixation point, fix:

see drawing 161499:002.14(3)

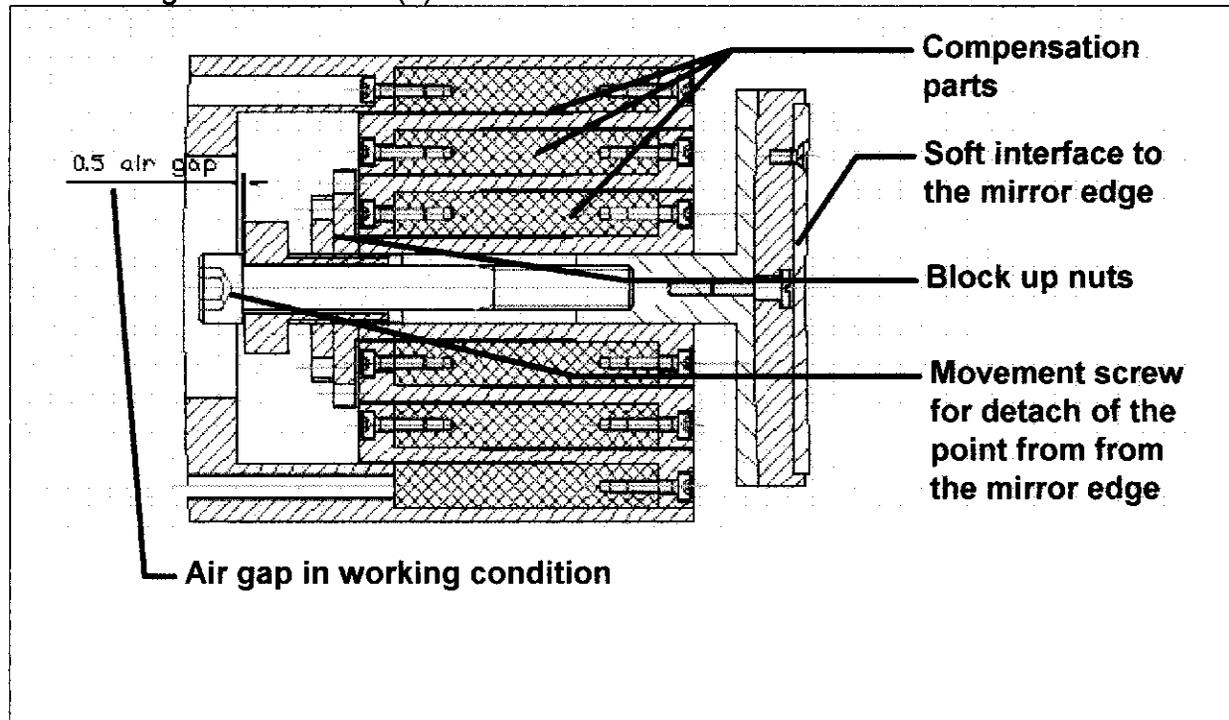


The movement screw will be used for detach of the fixation point from the mirror edge in case of dismount of the mirror from the cell.

Note:

Do not change the position of the block up nuts, because they fix the adjusted position of the mirror in the cell.

Radial fixation point, flexible:
see drawing 151499:002.14(3)



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Note:

Do not change the position of the block up nuts, because they fix the adusted position of the mirror in the cell.

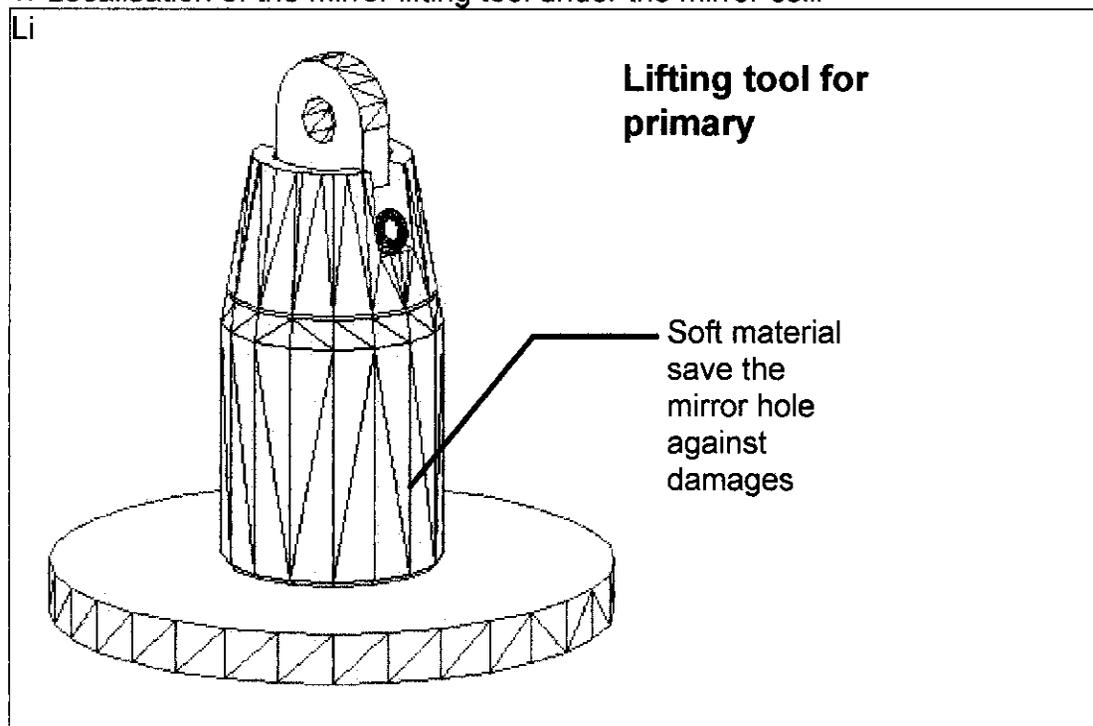
Instructions for maintenance and handling:

Basically the support system is free of maintenance. All operation besides the here written manipulations for the dismounting of the mirror for recoating violate the guaranty conditions.

Steps for dismounting/ mounting of the mirror from the cell for recoating:

In principle the steps for dismounting are the same procedures like with the original mirror.

1. Localisation of the mirror lifting tool under the mirror cell:



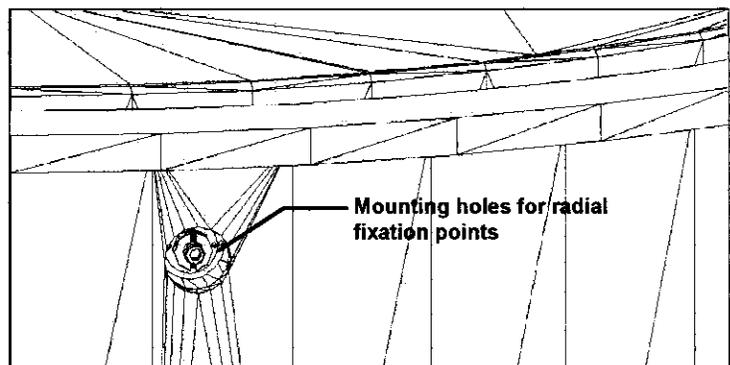
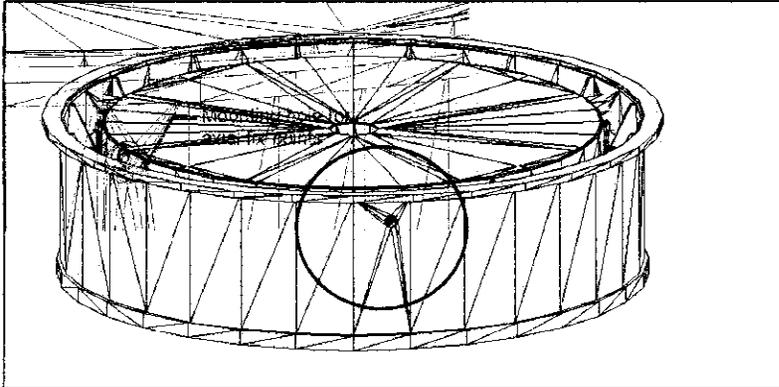
Check: The position of the tool has to be centered to the center hole of the mirror.

2. Lifting of the cell from the telescope:

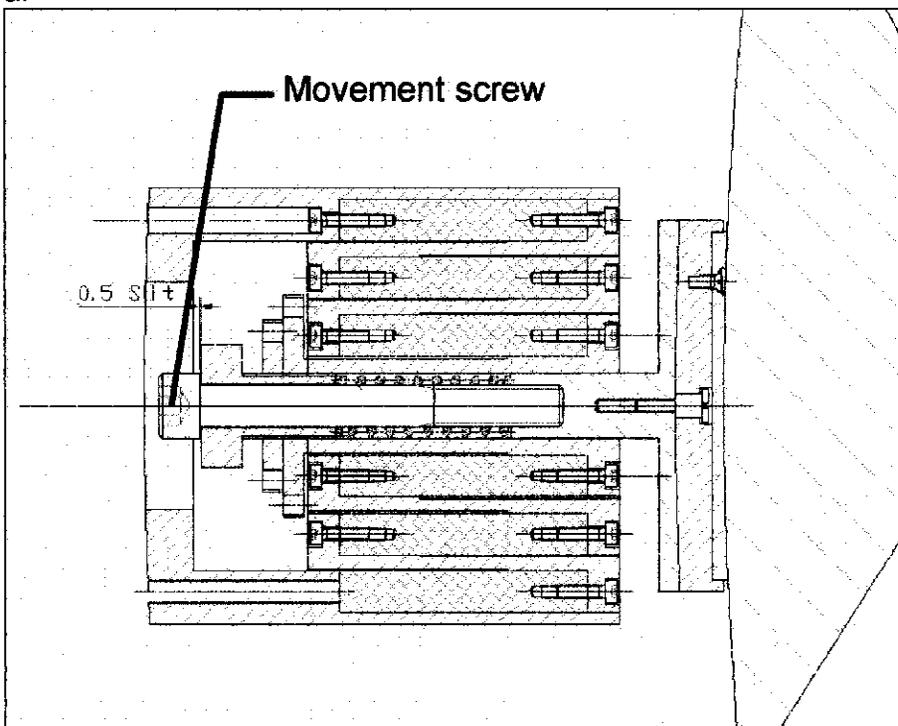
Same procedure like the original mirror

3. Removement of the radial fixation points:

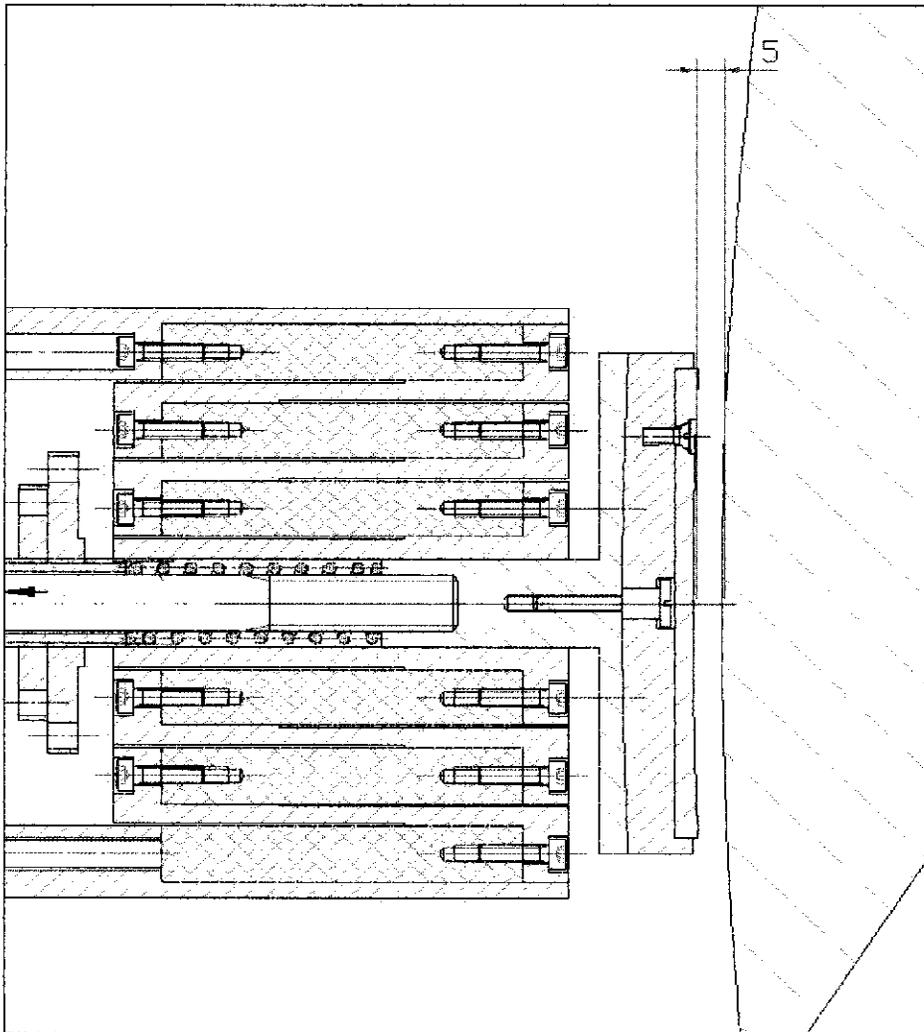
At first the flexible axial points have to be moved off from the mirror edge. This point is marked with a red point near the mounting hole. The movement screw (a) will be rotated clockwise, until there is a gap (b) between interface and mirror edge (maximal 5mm)



a.



b.

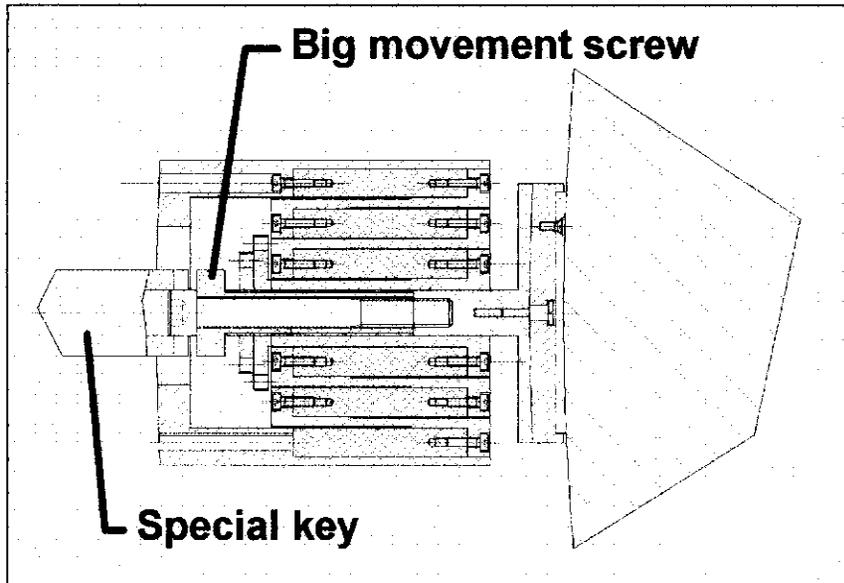


Then the hard fixation points will be removed with the special tool. The big movement screw (c) will be rotated counterclockwise, until there is a gap (d) between interface and mirror edge (maximal 5mm)

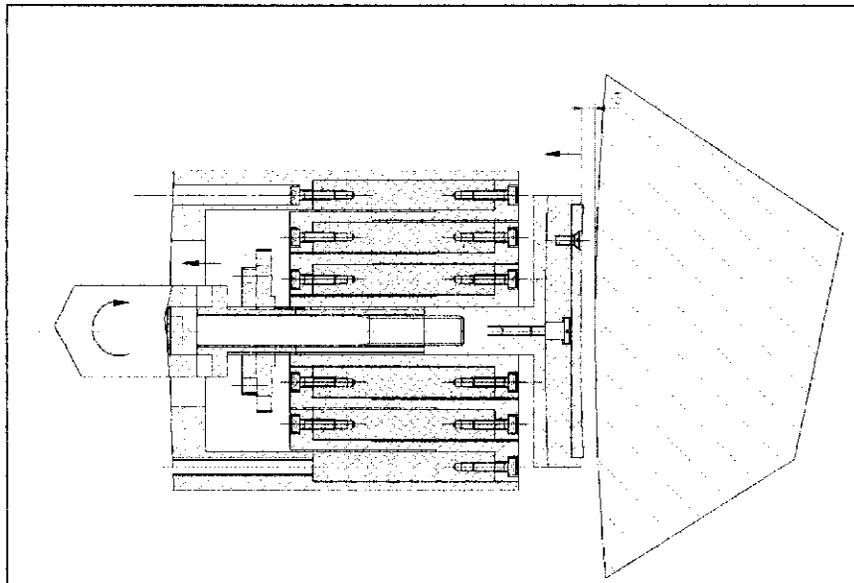
Note:

Do not change the position of the block up nuts, because they fix the adjusted position of the mirror in the cell.

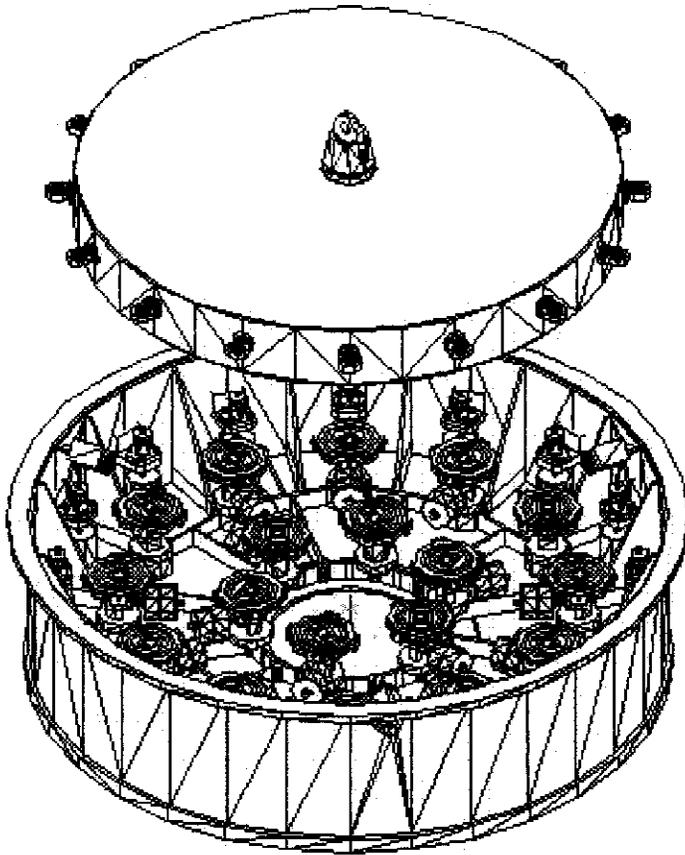
c.



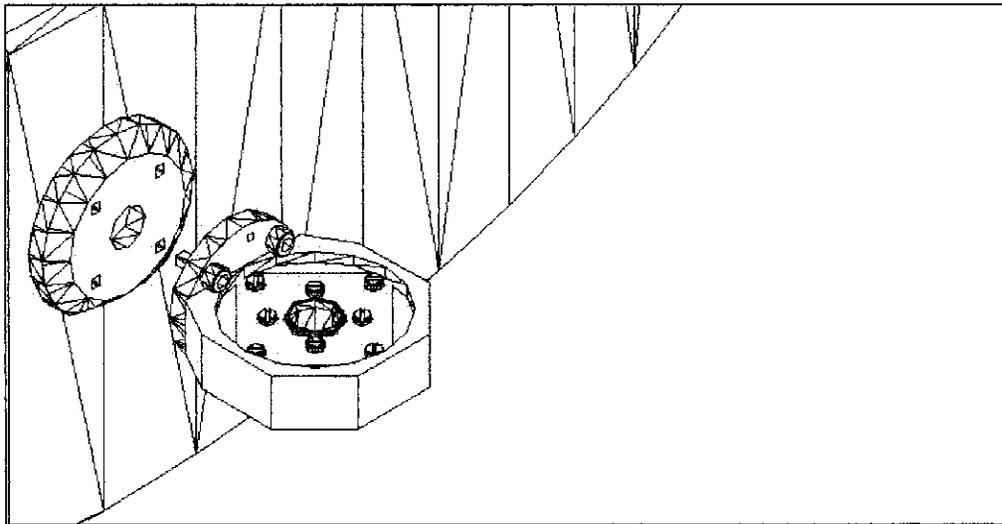
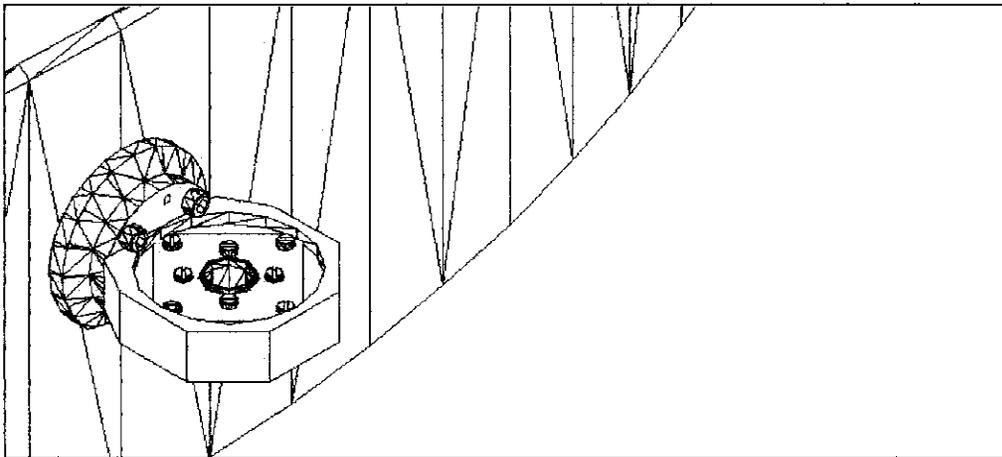
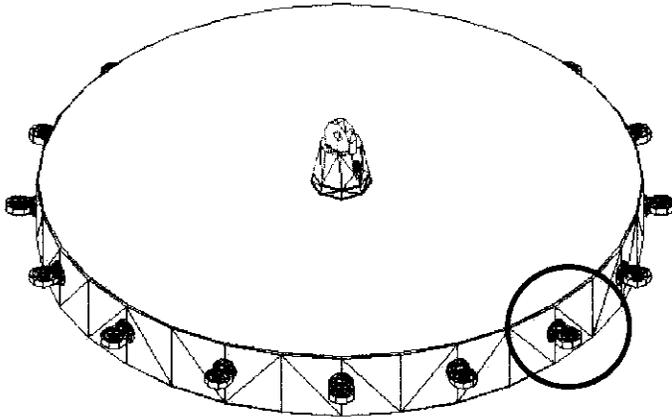
d.



4. Then the mirror is to be lifted very slowly and careful out of the mirror cell in vertical direction. Before you start, check the centering of the lift equipment! For the lifting the same equipment can be used like for the old mirror.



5. When the mirror is outside, the interface flanges for the radial supports are to be dismantled.



6. The reassembly will be made in revers order:

Note:

Check the vertical movement of the mirror!

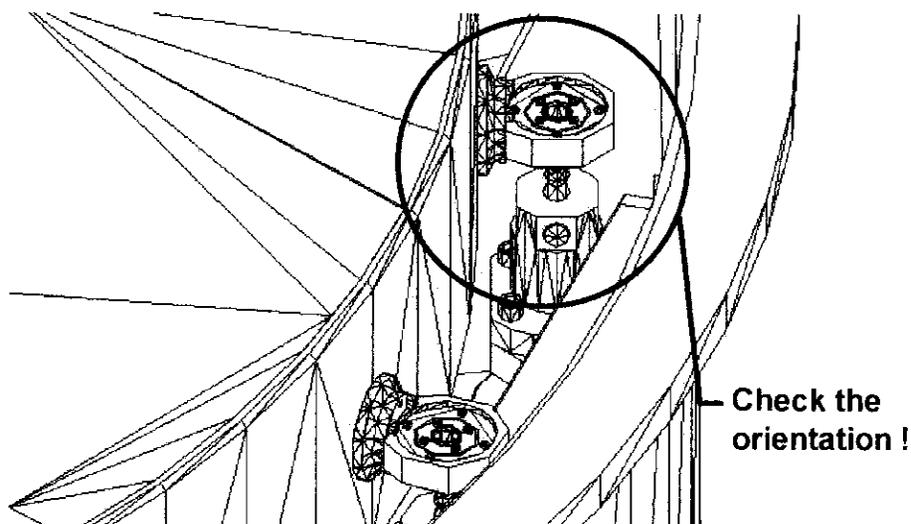
Check the horizontal position of the mirror and the cell!

Check, that the mirror is centered against the cell!

100 mm above the cell, stop the lifting movement and check the centering against!

Then lift very slowly and careful down!

10 mm, before the interface flanges reaches the radial system, stop against and check the accurate center position of every flange to the radial system! Then move very slowly and check moretimes again!



General Information about Care and Maintenance of Astronomical Instruments

Astronomical equipment is of high precision which shows high reliability and long life when being handled carefully and according to specifications. Apart from the generally valid maintenance instructions for these instruments, here is some additional information how to handle astronomical equipment specifically telescopes.

- Depending on the frequency of use, clean the instrument from dust and other pollutions with the usual aids (dustbrush or dust rubber distinguisher).
- When using the instrument make sure, that the stress caused by temperature changes remains fewl only, since otherwise condensation water might occur outside and inside the instrument.
- When not using the instrument, cover it with the available means (e.g. dew cap) and, if possible, place it in the storage case.
- Carefully clean and degrease spots with lacquer defects. Have them paint with the original lacquer, if possible.

Mechanical Parts

- Protect uncovered metal faces with a thin grease film. We recommend hydrophobic grease, e.g. calcium soap grease or anti-corrosive grease.
- **Pivot bearings and pivots**
Regrease them if required. Clean them in case of heavy pollution.
- **Cleaning of dirty bearings**
For cleaning of roller bearings it is possible to use, petroleum ether, petroleum, spirit, dewatering fluids, chlorinated hydrocarbon, hydrous neutral or alkaline cleaning agents. See to it that petroleum ether, petroleum, spirit and dewatering fluids are inflammable. Chlorinated hydrocarbons develop harmful vapours and alkaline means are caustive. Use brushes or non-fuzzy cotton clothes for washing. After the washing and evaporizing of the fresh solvents, the bearings have to be immediately preserved to avoid corrosion. Should a bearing contain resinified residue of oil and grease, it is recommended to clean it meachanically or to emolly the dirt with a chlorinated hydrocarbon or with a hydrous, strongly alkaline cleaning agent.
- **Greasing and Regreasing**
Basically, greases with identical thickeners and basic oils can be mixed without any disadvantage.
For bearings with f£ 60mm a soft universal grease is recommended; in the temperature range from -30°C to ³+40°C lithium soap greases show no



modification relative to water, have a good adhesion and also serve as sealing grease against pollution. For bearings with $f > 60\text{mm}$, a stronger universal grease is recommended, e.g. lithium soap grease.

- Gears

Mainly, sodium based saponified, long-fibre soft to semi-fluid greases are used. If required, the grease or oils has to be completed or exchanged according to the maintenance instructions. If there is no information about the lubricant or its life within the gear, cleaning has to be performed, if necessary. Afterwards, the usual gear grease or oil can be applied. When selecting a lubricant primarily see to good lubricating properties within the temperature range.

- Sealings

If sealings are installed, they have to be checked for wear of the sealing lips and to be replaced if necessary. Older equipment often used felt sealings, which have to be kept smooth with oil or grease since otherwise friction might rise considerably.

Optical Parts

Measures for maintaining optical elements are normally restricted to cleaning.

Extraordinary cleanliness of the cleaning means (dust brush, cotton clothes, solvents) and clean, dry hands are the necessary prerequisites to successfully clean optical surfaces. You should always check carefully which cleaning measures are required and should stick to the less intensive stage of cleaning; the more and optical, possibly coated face is mechanically stressed, the longer its life. The following cleaning stages should be performed in the given order only up to that stage where the surface is clean again:

1. First clean the surface with an airwipe to remove loose dust particles, do not touch the face.
2. Remove sticking dust with a fine hair brush. See to it that only the hair tips touch the faces.
3. Carefully remove firmly sticking pollutions with a wet swab (distilled water). Then remove water traces with a dry swab. Turn or change swab every time you contacted the surface.
4. Remove adhering pollutions with a soft rag: breath on to the surface - clean immediately. Use another part of the rag each time you breathed and cleaned. (In difficult cases wet the rag with distilled water). The same way, it is possible to remove sweaty fingerprints when cleaned immediately after applied.
5. To remove pollutions of grease, oil etc. wet the rag with spirit, alcohol, ether or benzine. Afterwards reclean with a dry rag and breath on to the surface. Also in this case, use another part of the rag.



Hints:

Brushes

Prior to use wash the brush in pure ether and keep it in closed condition (dust-free) when not being used. A well closed glass tube is recommended. To avoid fatty traces in the brush, the hair should not be touched by the hand or contact other objects (e.g. table plate).

Rags

Soft, clean non-fuzzy linen rag washed at least once which has to be shaken carefully since even finest hard particles cause scratches during wiping.

Solvents

The solvents must not be used before and must be pure specifically free of grease.

**Technical parameters:****Primary mirror:**

Diameter	1930mm
Diameter of center hole	188 mm
Thickness on the edge	230 mm
Optical aperture	1880 mm
Radius of curvature	5883 mm
Material	ZERODUR
Thermal expansion coefficient	$0 \pm 0.10 \times 10E-6 /K$

Secondary mirror:

Diameter	496.8 mm
Thickness in center	80.1 mm
Optical aperture	483 mm
Radius of curvature	7380 mm
Conical constant	$k = -3.012377$
Material	ZERODUR
Thermal expansion coefficient	$0 \pm 0.10 \times 10E-6 /K$

Optical system

Focal ratio	f/18
Focal length	33984 mm
Distance M1 M2 vertex	6989.9 mm
Distance M1 vertex -focal plane	1000 mm

Primary mirror Support

Number of axial supports	18
Number of radial support	16
Distance focal plane- instrument rotator flange	417.5 mm
Maxmal load onto Instrument rotator flange	400 kg with 1000 mm distance to center of gravity



Steps for coating of astronomical mirrors by aluminizing

1. *Detaching of old mirror coating*

- dislying:

Potassium lye (NaOH) 20% carefully lay it onto the mirror equally spreading

Warning: Danger of chemical injuring !!!

It is necessary to arrange for precautionary measures by using protective clothes such as:

Rubberboots, rubberapron, rubbergloves, safety goggles.

Leave the potassium suds affecting for 30 minutes at least.

Check whether the layer begins to disly.

Repeat eventually the procedure.

The surface should be kept wet in order to avoid drying spots.

- Rinsing:

Rinse excessively with ordinary water by using a water hose pipe.

Rinse with distilled water after and polish it with clean cottoncloth free of particles until becoming dry without spots.

2. *Preparation for coating*

Wipe the mirror with clean smooth cottoncloth and cleaned opticswater.

Take off the dust particles with optic brush and rubberpuff.

Lines of wipings, spots and dustclouds must not remain.

Immediately after this the mirror has to be inserted into the coating unit and has to be evacuated.

3. *Smouldering and coating*

- The coating unit has to be evacuated until endvacuum minimum to be $2 \cdot 10^{-5}$ mbar but as good as possible.

Smouldering for about 10 minutes with nitrogen gas.

The parameters have to be determined by trials of coatings by using testglasses.

- The following highend vacuum should be reached within 30 minutes maximum.

- The gained endvacuum of $< 2 \cdot 10^{-5}$ in conjunction with the speed of coating of the Aluminium layer is responsible for the good quality of the mirror layer especially at shorter wavelengths.

- Evaporating of pure aluminium out of spirales very fast but without splashes.



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Astronomical Instruments

Carl Zeiss Jena GmbH

Service Instructions

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- The evaporating spirales have to be moistened before, e.g. dullyevaporating before aluminizing is necessary.
- Evaporating of about $\lambda/2$ protective layer MgF₂. by choice of the wavelength (layer thicknes) of the protective layer.

The spectral reflection can be influenzed by choice of the wavelenght (Layerthicknes) of the protective layer (Shifting of the reflection maximum)

4. Control

- Checking about cleanness, errorsspots, splashes.
- Judging of the equality, measurement of the spectral reflection given by testglasses jointly coated.