E U R O P E A N S O U T H E R N O B S E R V A T O R Y

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
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LA SILLA OBSERVATORY

DANISH 1.54 MAINTENANCE PLAN

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1. INTRODUCTION

1.1. PURPOSE AND SCOPE

This document is intended to serve as a maintenance guide-plan for the drive system of the Danish 1.54 telescope, focused on the electronics, electro-optical and electro-mechanical components of the drive.
The mechanics is briefly covered where relevant and shall be covered somewhere else in detail.
Appended to the document you could find useful information for servicing and diagnosing the drive system of the telescope together with references to the available documentation and presently defined maintenance tasks under Remedy.

1.2. REFERENCE DOCUMENTS

[RE1] Telescope Control Module Hardware Documentation JAL November 1993.
[RE2] Telescope Control Module vxWorks Drivers v1.0 JAL August 1994

1.3. APPLICABLE DOCUMENTS

[AP1] Optical Incremental Rotary Encoder ROD 1/45.7 (data sheet) Dr. Johannes Heidenhain Traunreut Germany.
[AP2] Direct Drive DC Motors Catalogue Kollmorgen Inland Motor.
[AP3] DC Tachometers Catalogue Kollmorgen Inland Motor.

1.4. ACRONYMS & ABBREVIATIONS

DC	Direct Current
VME	Versa Module Europe
TCM	Telescope Control Module
LCU	Local Control Unit
RIOS	Remote Input Output System
IRIG	Inter Range Instrumentation Group

2. TELESCOPE OVERVIEW

2.1. History

The Danish 1.54 starts operation in 1975, till 1994 the telescope control system was based on a HP2100 mini computer and RIOS interface. In 1994 the control system was modernized to VME under vxWorks and HP workstation under HP-UX environment. The telescope mechanics, motors, tacho-generators and rotary encoders still are the original ones installed in 1975.
Recently the telescope operation was restricted to the west side of the pier with only a single instrument.

2.2. Mount

The telescope mount is an equatorial German type mount. This is the telescope tube and the declination drive assembly are mounted on one side of the polar axis with a huge counterweight on the other side for balancing the system. Additionally the counterweight includes an adjustable motorized counterweight for fine tuning.

Another set of motorized counterweights are mounted over the telescope tube itself for balancing the declination axis.

Both the right ascension and declination axes of the telescope are mounted over a set of big maintenance free roller type bearings lubricated with grease, no hydrostatic bearings are used. The oil pump installed inside the telescope base serves the only purpose of lubricating the main worm and gear of both the right ascension and declination axes.

2.3. Drive System

2.3.1. Right Ascension

The right ascension drive is composed by a 540 tooth worm-gear combination. The gear is rigidly coupled to the telescope axis, no protection is implemented e.g. clutch system. The worm is directly driven by a DC motor and directly sensed by both a tacho-generator and an incremental optical rotary encoder for velocity and angular position respectively.
The incremental system initialization is accomplished by a high resolution optical sensor mounted directly to the axis.
Additionally an amplification gear train 1:5 is coupled to the worm axis and on the amplified side a flywheel is mounted, this device act as a mechanical viscous dumper over the worm, and the rotation of the flywheel provides visual feedback for the movement of the axis at low speeds.

2.3.2. Declination

The declination drive is composed by a 450 tooth worm-gear combination. The gear is rigidly coupled to the telescope axis, no protection is implemented e.g. clutch system.

The worm is directly driven by a DC motor and directly sensed by both a tacho-generator and an incremental optical rotary encoder for velocity and angular position respectively.
The incremental system initialization is accomplished by a high resolution optical sensor mounted directly to the axis.
Additionally an amplification gear train 1:5 is coupled to the worm axis and on the amplified side a flywheel is mounted, this device act as a mechanical viscous dumper over the worm, and the rotation of the flywheel provides visual feedback for the movement of the axis at low speeds.

2.4. Preload System

Both the right ascension and declination axes of the telescope utilizes pulley and steel cable suspended counterweights for preloading the worm-gear and thus avoid backlash. The steel cables are wrapped around each axis and guided via pulleys to the telescope's base roof where the counterweights are suspended.

3. DRIVE SYSTEM MAINTENANCE TASKS

3.1. Right Ascension (Alpha)

3.1.1. DC Motor

Description:

Inspect the motor thermally and acoustically [AP2]. Note that these motors are extremely reliable. The rotor is rigidly coupled over the worm axis and the worm axis is mounted over high reliability and precision bearings. Except for the brushes with a life expectancy of 10E7 revolutions there are no other serviceable parts.

Possible Actions:

Check the brushes – Replace the brushes.

Frequency: 5 years.

Caveats:

Assuming an average of 30 presets per night and 60degrees swing per preset the brushes life expectancy is 10.1 years.
Model T10042 - Inland Motor.

3.1.2. Tacho-Generator

Description:

Inspect the signal output with an oscilloscope, measure the ripple amplitude and check for strange noise patterns [AP3]. Note that these tacho-generators are extremely reliable. The rotor is rigidly coupled over the worm axis and the worm axis is mounted over high reliability and precision bearings. Except for the brushes with a life expectancy of 3X10E6 revolutions there are no other serviceable parts.

Possible Actions:

Check the brushes – Replace the brushes.

Frequency: 1.5 years.

Caveats:

Assuming an average of 30 presets per night and 60degrees swing per preset the brushes life expectancy is 3 years.
The telescope has been operating for 29 years!
Accessing the brushes support ring is a major mechanical intervention.
Model TG5723 - Inland Motor.

3.1.3. Rotary Encoder

Description:

These are extremely reliable parts with no serviceable parts except for the lamp. The lamp life expectancy is 12000 hours or 1.4 years.

Possible Actions:

Replace the encoder lamp.

Frequency: 1.2 year.

Caveats: Model ROD 1/45.7 Heidenhein.

3.1.4. Initialization Sensor

Description:

The axis utilizes the init sensor for defining the zero position of the incremental encoder counter.

Possible Actions:

Clean the stainless steel reflective sector surface.
Inspect the cable to the sensor head.
Check the sensor head to the reflective surface gap.
If needed adjust the gap.

Frequency: 6 month.

Caveats: N/A.

3.2. Declination (Delta)

3.2.1. DC Motor

Description:

Inspect the motor thermally and acoustically [AP2]. Note that these motors are extremely reliable. The rotor is rigidly coupled over the worm axis and the worm axis is mounted over high reliability and precision bearings. Except for the brushes with a life expectancy of 10E7 revolutions there are no other serviceable parts.

Possible Actions:

Check the brushes – Replace the brushes.

Frequency: 5 years.

Caveats:

Assuming an average of 30 presets per night and 60degrees swing per preset the brushes life expectancy is 12.2 years.
Model T10042 - Inland Motor.

3.2.2. Tacho-Generator

Description:

Inspect the signal output with an oscilloscope, measure the ripple amplitude and check for strange noise patterns [AP3]. Note that

these tacho-generators are extremely reliable. The rotor is rigidly coupled over the worm axis and the worm axis is mounted over high reliability and precision bearings. Except for the brushes with a life expectancy of 3X10E6 revolutions there are no other serviceable parts.

Possible Actions:

Check the brushes – Replace the brushes.

Frequency: 1.5 years.

Caveats:

Assuming an average of 30 presets per night and 60degrees swing per preset the brushes life expectancy is 3.7 years.
The telescope has been operating for 29 years!
Accessing the brushes support ring is a major mechanical intervention.
Model TG5723 - Inland Motor.

3.2.3. Rotary Encoder

Description:

These are extremely reliable parts with no serviceable parts except for the lamp. The lamp life expectancy is 12000 hours or 1.2 years.

Possible Actions:

Replace the encoder lamp.

Frequency: 1 year.

Caveats: Model ROD 1/45.7 Heidenhein.

3.2.4. Initialization Sensor

Description:

The axis utilizes the init sensor for defining the zero position of the incremental encoder counter.

Possible Actions:

Clean the stainless steel reflective sector surface.
Inspect the cable to the sensor head.
Check the sensor head to the reflective surface gap.
If needed adjust the gap.

Frequency: 6 months.

Caveats: N/A.

4. TCS ELECTRONICS MAINTENANCE TASKS

4.1. Electronics Rack

4.1.1. Dome Interface

Description:

At the top of the rack there is a 19 inch panel with DIN rail mounted PCBs and power supplies.

Possible Actions:

Measure the power supply voltages, all the voltages shall be within +/-5% of the written values over the power supplies.
Visually inspect the cables and connectors.

Frequency: 2 years.
Caveats: N/A.

4.1.2. Kepco Delta Power Amplifier

Description:

Drive power amplifier, this is a linear power amplifier utilizing forced air cooling.

Possible Actions:

Clean the amplifier specially the air inlet and outlet.
Acoustically inspect the cooling fans for strange noises.
If necessary replace the fans.

Frequency: 1 year.
Caveats: N/A.

4.1.3. Kepco Alpha Power Amplifier

Description:

Drive power amplifier, this is a linear power amplifier utilizing forced air cooling.

Possible Actions:

Clean the amplifier specially the air inlet and outlet.
Acoustically inspect the cooling fans for strange noises.
If necessary replace the fans.

Frequency: 1 year.
Caveats: N/A.

4.1.4. VME - LCU

Description:

VME chassis containing control computer and interface modules. The unit utilizes forced air cooling.

Possible Actions:

Remove the VME modules clean the modules and contacts.
Clean and check the fans acoustically.
Clean the air inlet and outlet.
Measure the VME chassis power supply voltages.

Frequency: 1 year.

Caveats:

From left to right the VME modules are:

1) MVME167 - CPU.
2) TCMDIG - Telescope Control Module Digital.
3) TCMANA - Telescope control Module Analogue.
4) DC-DC - DC to DC Converters for the TCMANA.
5) MPV-901P – A/D for temperature and humidity sensing.
6) MVME340 – Dig. I/O Auto-guider
7) MVME340 – Dig. I/O Auto-guider
8) MVME340 – Dig. I/O Auto-guider
9) MVME340 – Dig. I/O Delta oil lube valve, ST, Dome.

When removing VME modules 3 and 4 remove FIRST #4 unplug the power supply cable and remove #3. Do the inverse when plugging the modules. Take care of carefully accommodating the umbilical cord, between modules 3 and 4, on the back of the VME chassis to avoid mechanical interference and/or cable stress.
Exercise special care when plugging and unplugging modules 2, 3 and 4 since they wire-wrap prototype boards.

4.1.5. Encoder Power Supply Panel/Chassis

Description:

The rotary encoders utilizes +/-12V and +4.5V for the encoder electronics and lamp respectively. Each encoder utilizes independent power supplies.

Possible Actions:

Check the voltage to be within +/- 5% of the specified nominal value written in the front panel.
If necessary trim the +4.5V power supplies.

Frequency: 1 year.

Caveats: N/A.

4.1.6. Cross-Hair Generator

Description:

A dedicated hardware generates the necessary video signals for producing the auto-guider reference box and cross hair, this subsystem is digitally controlled via a MVME340 digital I/O module.

Possible Actions:

Make a functionality check from the software.
Check all the boards inside the chassis to be firmly inserted.
Clean contacts.
Check the routing of the parallel interface cables to the VME.
Measure the internal power supply voltages.

Frequency: 1 year.
Caveats: N/A.

4.1.7. Auto Guider

Description:

A dedicated hardware responsible for generating the correction signals for auto-guiding. This is digitally controlled via a MVME340 digital I/O module.

Possible Actions:

Make a functionality check from the software.
Check all the boards inside the chassis to be firmly inserted.
Clean contacts.
Check the routing of the parallel interface cables to the VME.

Frequency: 1 year.
Caveats: N/A.

4.1.8. Video Memory

Description:

Dedicated hardware responsible for integrating the video signal generated by faint stars. This is digitally controlled via a MVME340 digital I/O module.

Possible Actions:

Make a functionality check from the software.
Check all the boards inside the chassis to be firmly inserted.
Clean contacts.
Check the routing of the parallel interface cables to the VME.
Measure the internal power supply voltages.

Frequency: 1 year.
Caveats: N/A.

4.1.9. Cerme Sidereal Clock Display

Description:

This unit decodes the IRIG-B ST time signal coming from the 3.6m telescope and presents it both in a seven segment display and via parallel lines in BCD format to the VME LCU.

Possible Actions:

Check the ST error to be less than 1 second, a suitable reference for comparison is the NTT Tutankamon.
Visually inspect the 7 segments for burn-outs or degradation.
If necessary replace the display.
If necessary readjust the ST at the source.

Frequency: 1 year.

Caveats:

Recently an independent GPS based ST display unit was made available. For installation it would be necessary to install a GPS antenna in the cat-walk together with a coaxial cable for delivering the GPS signal to the unit inside the rack.

4.2. Rack Cooling

Description:

The rack utilizes a heat exchanger with water recirculation for removing the heat from the rack.

Possible Actions:

Check the temperature inside the rack to be less than 12ºC.
Check for the proper operation of the big recirculation fans.
If necessary replace the fans.

Frequency: 1 year.

Caveats: N/A.

5. GLOBAL MAINTENANCE TASKS

5.1. Cable Wrap

Description:

Check the cable package hanging from the fixed part of the telescope to the tube. Move the telescope in the whole range and verify that the package is not subject to any stress or strain.

Possible Actions:

Accommodate the cables to hang freely at all the telescope positions. If necessary unpack untwist and repack the cable package.

Frequency: 3 months.

Caveats:

Unfortunately the access to the cable twister, to properly accommodate the cables, implies dismounting the whole telescope. Due to this during the 1994 upgrade it was preferred the hanging cable package solution.

5.2. Telescope Balance

Description:

Check the telescope balance both for the Alpha and Delta axis. This is done by lowering the preload counterweights and checking that the telescope axis has no tendency to “fall” in any particular direction within the backlash range of the gear. The counterweights for adjustment/compensation are electrically actuated by buttons in the base of the telescope. The position is measured by huge rotary mechanical counters coupled to the lead screws that move the counterweights.

Possible Actions:

If the balance of any axis is out of range might be necessary to add fixed weights in strategically selected zones.

Frequency: 12 months.

Caveats:

Since the telescope is operating in a fixed instrument configuration, no degradation should be expected.
Normally the balance is checked in several axis positions, every time the telescope is moved to a new position the preload counterweights must be lifted, fail to do so could cause serious damage to the drive mechanism.
After doing the “Telescope Balance” do a “Preload System”.

5.3. Pointing Model Check

Description:

Check the telescope pointing model using 20 stars evenly distributed across the whole sky.

Possible Actions:

If RMS pointing error > 15”

- Check sidereal time for <1sec error.
- Check polar axis alignment.
- Redo the pointing model.

If RMS pointing error < 15”

- OK.

Frequency: 3 months.

Caveats:

Since the telescope is operating in a fixed instrument configuration, no degradation should be expected, except for the polar axis alignment natural degradation.

5.4. Preload System

Description:

Steel cables inspection, the cable path for both Alpha and Delta shall be inspected. Starting from the cable spool around each axis along every pulley down to the base of the telescope where the counterweights are suspended.

Possible Actions:

If the cable is damaged

- Replace the cable run.

If the cable is mounted over itself at the cable spool

- Move the axis to unwind and wind until OK.

If the cable is dismounted from a pulley

- Mount it.

Frequency: 12 months.

Caveats: N/A.

5.5. Drive System Current Consumption

Description:

One by one move Alpha and Delta axes in the whole range. While moving verify the current consumption looking at the Kepco amplifier ammeter. Use the occasion to carefully listen for strange noises in the drive, and verify that the ammeter needles moves smoothly while accelerating and decelerating.

Possible Actions:

If (-3A < I_Alpha < +3.5A) steady state and (-6.5A < I_Alpha < +7A) peak while accelerating

- OK.

If not, check the balance.
If (-4A < I_Delta < +3A) steady state and (-6.5A < I_Delta < +7A) peak while accelerating

- OK.

If not, check the balance.

Frequency: 6 months.

Caveats:

The difference in current consumption between +/- corresponds to the preload counterweight lifting or lowering, obviously higher current means lifting.
Any jumps in the ammeter needles means hard points in the mechanism. Sometimes this is caused by excessive static loading of the gears when changing instruments e.g. the support strut was not installed in Alpha axis during a change over. Frequently this problem can be cured by patiently moving the axis several times in analogue mode over the whole range. The telescope must be properly balanced.

6. APPENDIX

6.1. Error Messages in the TCS of Danish 1.54

The low level error diagnostics, that are generated by the TCM driver, and that are displayed upon request on the LCU console, are automatically logged into the GUI in the workstation ("UILOG" panel). Most of the error messages are self explanatory however a more detailed explanation for some of them, together with some guidelines on the actions to be taken are given below.

Note that the following list does not cover all possible problems but it certainly could give valuable information for the troubleshooting and/or diagnosing.

1) *"TCM is switched on ANALOG ..; cannot init."*
   Explanation: the switch DIGITAL/ANALOG in the TCM module has been left on analogue.
   Actions: put the switch on "digital" and reissue the "init" command.

2) *"TCM cannot be initialized. Check emergency"*
   Explanation: an emergency condition has been detected in the hardware needed by the TCM. See TCM documentation for more details.

Action: call an electronic technician. When the error condition disappears restart the system.

3) *"TCM alpha plus 12V encoder power supply fail"*
Explanation: self explanatory.
Action: call an electronic technician. When the error condition disappears restart the system.

4) *"TCM alpha minus 12V encoder power supply fail"*
Explanation: self explanatory.
Action: call an electronic technician. When the error condition disappears restart the system.

5) *"TCM alpha encoder lamp or power supply fail"*
Explanation: no pulses are coming from the encoder, and the most likely causes are a burned lamp or the lamp the lamp power supply failure.
Action: call an electronic technician. When the error condition disappears restart the system.

6) *"TCM delta plus 12V encoder power supply fail"*
Explanation: self explanatory.
Action: call an electronic technician. When the error condition disappears restart the system.

7) *"TCM delta minus 12V encoder power supply fail"*
Explanation: self explanatory.
Action: call an electronic technician. When the error condition disappears restart the system.

8) *"TCM delta encoder lamp or power supply fail"*
Explanation: no pulses are coming from the encoder, and the most likely causes are a burned lamp or the lamp the lamp power supply failure.
Action: call an electronic technician. When the error condition disappears restart the system.

9) *"TCM emergency button pressed"*
Explanation: this should never happen, because the emergency is controlled switching off the Kepco Power Amplifier and not directly with this signal.
Action: Switch off and on the LCU. Restart the system. If the problem persists, carefully exchange the TCM boards with spare ones.

10) *"TCM init wrong position or sensor failure"*
Explanation: the sensor detects the absence of the metallic sector in front of it, and therefore the TCM refuse to start the init position.
Action: if the telescope is not pointing approximately to the zenith, use the analogue handset to position it and give the init command once again. If the

telescope is in the appropriate position and still refuse to initialize an electronic technician should check the sensors and sensor signals.

11) "TCM alpha axis not initialized"
Explanation: an attempt of moving an axis which is not, or which is no longer initialized has been done by the TCS program. It may happen only due to a BUG in the TCS program.
Action: describe the circumstances in Remedy and restart the system.

12) "TCM delta axis not initialized"
Explanation: an attempt of moving an axis which is not, or which is no longer initialized has been done by the TCS program. It may happen only due to a BUG in the TCS program.
Action: describe the circumstances in Remedy and restart the system.

13) "TCM alpha preset in progress"
Explanation: an attempt to change the modality of TCM during a preset has been done by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy and restart the system.

14) "TCM delta preset in progress"
Explanation: an attempt to change the modality of TCM during a preset has been done by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy and restart the system.

15) "TCM alpha axis zero pulse not detected"
Explanation: the end of the sector has not been detected within the given time during initialization.
Action: restart the system. If the problem disappears report it via Remedy and proceed. If the problem persists call an electronic technician in order to check the sensor.

16) "TCM delta axis zero pulse not detected"
Explanation: the end of the sector has not been detected within the given time during initialization.
Action: restart the system. If the problem disappears report it via Remedy and proceed. If the problem persists call an electronic technician in order to check the sensor.

17) "TCM cannot move properly alpha axis"
Explanation: this is by far the most frequent problem reported. It means that the TCM has lost control over the axis, while it was trying to move it. Every movement is continuously monitored (approximately every 300 microseconds). If the error between the desired position, or speed, and the reference ones,

defined by a trapezoidal profile, exceeds a given threshold, the TCM put that axis in a "not initialized" state. Axis coordinates are reset too.

Actions:

- Check if the Kepco power amplifiers are switched on.
- Check if there is any physical obstruction which prevents the telescope from moving freely. Do not forget to look at the top-ring, which may have collided with the crane.
- Try to move the axis in analogue mode, in the direction against the preload. Look at the current meter of the Kepco, if the limit is reached, or if the axis does not move at all, very likely there is a hard point in the gear. If it does not move, try the other direction (with the help of the preload). Hard points may appear in unusual positions, and they disappear just moving the axis back and forth a few times.
- If the problem persists after this for all the preset in a given area or beyond a certain point, balance has to be checked.

Once the cause has been identified and cured, restart the system.

18) "TCM cannot move properly delta axis"

Explanation: this is by far the most frequent problem reported. It means that the TCM has lost control over the axis, while it was trying to move it. Every movement is continuously monitored (approximately every 300 microseconds). If the error between the desired position, or speed, and the reference ones, defined by a trapezoidal profile, exceeds a given threshold, the TCM put that axis in a "not initialized" state. Axis coordinates are reset too.

Actions:

- Check if the Kepco power amplifiers are switched on.
- Check if there is any physical obstruction which prevents the telescope from moving freely. Do not forget to look at the top-ring, which may have collided with the crane.
- Try to move the axis in analogue mode, in the direction against the preload. Look at the current meter of the Kepco, if the limit is reached, or if the axis does not move at all, very likely there is a hard point in the gear. If it does not move, try the other direction (with the help of the preload). Hard points may appear in unusual positions, and they disappear just moving the axis back and forth a few times.
- If the problem persists after this for all the preset in a given area or beyond a certain point, balance has to be checked.

Once the cause has been identified and cured, restart the system.

19) "TCM alpha tracking mode not selected"

Explanation: an attempt to change the tracking speed of TCM while not in tracking mode has been done by the TCS program. It may happen only due to a bug in the TCS program.

Action: describe the circumstances in Remedy. Restart the system.

20) "TCM delta tracking mode not selected"

Explanation: an attempt to change the tracking speed of TCM while not in tracking mode has been done by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy. Restart the system.

21) "TCM alpha slew speed out of range"

Explanation: a speed exceeding the maximum slew speed has been requested by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy. Restart the system.

22) "TCM delta slew speed out of range"

Explanation: a speed exceeding the maximum slew speed has been requested by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy. Restart the system.

23) "TCM alpha tracking speed out of range"

Explanation: a speed exceeding the maximum tracking speed has been requested by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy. Restart the system.

24) "TCM delta tracking speed out of range"

Explanation: a speed exceeding the maximum tracking speed has been requested by the TCS program. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy. Restart the system.

25) "TCM the switch is on Analogue Mode"

Explanation: self-explanatory.
Action: none, if this is the wanted status.

26) "TCM not initialized"

Explanation: the TCM has fallen into this status due to an emergency condition. This may be caused by a static discharge on the handset.
Action: check if the red led on the TCM is on. If it is off, it was caused by a random event that already disappeared. Restart the system.
If the led is permanently on, switch off and on the LCU. If the condition persists, check the rack temperature and call a technician.

27) "TCM an out-of-range value has been entered"

Explanation: a wrong value has been passed to the TCM by the TCS. It may happen only due to a bug in the TCS program.
Action: describe the circumstances in Remedy. Restart the system.

6.2. Maintenance Tasks Actually Under Remedy

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Short-Description: CO2 Cleaning
Equipment:         1m54D Main Mirror

Short-Description: Reflectivity measure
Equipment:         1m54D Main Mirror

Short-Description: Aluminization
Equipment:         1m54D Main Mirror

Short-Description: Aluminization
Equipment:         1m54D M2 Mirror

Short-Description: Optical Quality Check
Equipment:         1m54D Optics

Short-Description: Chassis inspection
Equipment:         1m54D Power Amplifiers

Short-Description: Fans replacement
Equipment:         1m54D Power Amplifiers

Short-Description: Chassis inspection
Equipment:         1m54D TCS-VME

Short-Description: Chassis inspection
Equipment:         1m54D Autoguider

Short-Description: Chassis inspection
Equipment:         1m54D CCD controller

Short-Description: Chassis inspection
Equipment:         1m54D Cross Hair Generator

Short-Description: Chassis inspection
Equipment:         1m54D DFOSC/Rot control

Short-Description: System check
Equipment:         1m54D Dome electronics

Short-Description: Chassis inspection
Equipment:         1m54D Encoders Power Supply

Short-Description: System check
Equipment:         1m54D Ventilation system

Short-Description: Limit switches check
Equipment:         1m54D Mirror cover

Short-Description: CCD test
Equipment:         1m54D DFOSC CCD

Short-Description: Polar axes alignment
Equipment:         1m54D telescope

Short-Description: Pointing Model check
Equipment:         1m54D telescope
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Short-Description: Setup
Equipment:         1m54D DFOSC Instrument

Short-Description: CCD refilling
Equipment:         1m54D DFOSC Instrument

Short-Description: Cables and Fans Check: DFOSC CCD Controller
Equipment:         1m54D CCD controller

Short-Description: DAN154 telescope balance check
Equipment:         1m54D telescope

Short-Description: Warm Up Danish CCD
Equipment:         1m54D DFOSC CCD

Short-Description: Cool down of Danish CCD
Equipment:         1m54D DFOSC CCD
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