

Location of the Observatory:

The Observatory is located in Chile, at Cerro Murphy (about 2900 m) next to the Cerro Aramazones where the ESO ELT telescope is under construction. The place is located about 100 km from the nearest city (Antofagasta).

1. Telescopes

1.5 m Telescope

Optics:

Ritchey Chretien

Clear aperture ≥ 1500 mm

System focal ratio f/6

Focal length 9000 mm

Field of view ≥ 200 mm (1.25 degree), vignetting < 15%

Mirror material fused silica + protective coating
 reflection better than 85% in the range of $400 \text{ nm} < \lambda < 1000 \text{ nm}$
 accuracy M1, M2, M3: > 90 Strehl, $< \lambda/20$ (rms) at $\lambda = 632 \text{ nm}$
 slope Error M1, M2, M3: $< 15 \text{ nm}$ (rms) for slope sampling 2% aperture

Interferometric System performance:
 FWHM (FullWidthHalfMax) < 0.3 arc seconds
 interferometer resolution $\geq 950 \times 950$ pix
 phase sensor interferograms ≥ 30 averages for final measurement

Focus control through the secondary mirror assembly with respect to a fixed focal plane referenced to the primary mirror
 control by a stepper motor in dual loop,
 absolute position encoder with $\leq 0.16 \mu\text{m}$ resolution

Protection mirror covers, baffles/shrouds, fans, etc. to greatly reduce the collection of dust, dirt, dew, etc. on the mirrors

Mount:

Alt/AZ four foci including two Nasmyth foci
 direct on-axis absolute encoding

Pointing accuracy $< 8''$ RMS with pointing model (for altitude 20° to 85°)
 Pointing model must be supplied with the telescope control software

Tracking accuracy $< 0.25''$ RMS within 5 minutes (at good ambient and sky conditions)
 over 5 min $0.05''$ RMS/min

Slewing speed $4^\circ/\text{sec}$

Settle time after a slew < 3 seconds

Additional equipment

a) Ritchey-Chrétien field flattener

4 inch, 1.0 x
 fused silica
 transparency down to 250 nm with corresponding coatings
 90% transparency in the U band

Expected spot diagrams:	λ [nm]	300	450	650
PSF diameter [μm] at center		< 2	< 4	< 3
	center + 20 mm	\sim 2	< 4	< 3
	center + 42 mm	\leq 4	\leq 5	\leq 6
	center + 65 mm	\leq 6	< 8	\leq 8

b) Off-axis guider

Light drawn from the main optical path of the telescope
 Camera and associated software & hardware must be included
 Closed-loop tracking using inputs from the included guiding camera
 RMS radius sidereal tracking error of $\leq 0.3''$ over 3 hours

c) De-rotator

two units
 absolute encoder
 adapter

d) Double filter wheel

9 positions for 10x10cm filters (one free) each wheel
 wheel adapter

e) Empty slot

location before the filter wheel
 manual plug-in module for a (customer made) diffusor

f) CCD camera

4k x 4k (62 x 62 mm)
 Camera will be provided by CAMK PAN a year after signing the contract.
 The following costs must be included:

- adapter for one of the Nasmyth foci
- installation of the camera
- installation of the filter wheel

g) Remote rack

control computer (standard PC) Linux
 UPS at least 15 minutes hold time

h) Emergency issues

shut-off (kill) switches strategically placed around the dome
 OTA software kill switches incorporated in each screen within the telescope control software
 UPS sufficient to park the telescope

i) Installation

customers check of the telescope after assembling at the premises of the delivering company,
 transportation to the observatory location, including customs clearance according to the rules
 governing import of equipment to ESO observatories in Chile.
 Installation of the telescope at the observatory. Testing and fine-tuning of the system
 to achieve the agreed specifications at the observatory
 1 week of customer training with the telescope

The telescope together with the whole
 equipment (dome, weather, station, all software, etc) should be turn-key and ready for
 immediate professional observations.

j) Maintenance

Laser re-collimating hardware, software (LINUX), and user documentation

0.8 m Telescope**Optics:**

Ritchey Chretien

Clear aperture ≥ 800 mm

System focal ratio f/7

Focal length 9000 mm

Field of view ≥ 70 mm, vignetting < 15% relative to central vignetting

Mirror material fused silica + protective coating
 reflection better than 85% in the range of $400 \text{ nm} < \lambda < 1000 \text{ nm}$
 accuracy (M1, M2, M3), $\lambda/24$ at $\lambda = 632 \text{ nm}$
 slope error less than 15 nm (rms) for slope sampling 2% aperture

Focus control through the secondary mirror assembly with respect to a fixed focal plane referenced to the primary mirror
 control by a stepper motor in dual loop,
 absolute position encoder with $\leq 0.16 \mu\text{m}$ resolution

Protection mirror covers, baffles/shrouds, fans, etc. to greatly reduce the collection of dust, dirt, dew, etc. on the mirrors

Mount:

Alt/AZ two Nasmyth foci
 direct on-axis absolute encoding

Pointing accuracy < 8" RMS with pointing model (for altitude 20° to 85°)
 Pointing model must be supplied with the telescope control software

Tracking accuracy < 0.25" RMS within 5 minutes (at optimal ambient and sky conditions)
 over 5 min 0.05" RMS/min

Slewing speed $6^\circ/\text{sec}$

Settle time after a slew < 3 seconds

Additional equipment**a) Ritchey-Chrétien field flattener**

4 inch, 1.0 x

fused silica

transparency down to 250 nm with corresponding coatings

90% transparency in the U band

b) Off-axis guider

light drawn from the main optical path of the telescope

Camera and associated software & hardware must be included

Closed-loop tracking using inputs from the included guiding camera

RMS radius sidereal tracking error of $\leq 0.3''$ over 3 hours

c) De-rotator

two units
1 fixed / 1 flexible
absolute encoder
adapter
inner diameter 160 mm

d) Filter wheel

10 filters (for 65 x 65 mm filters)
adapter

e) Empty slot

location before the filter wheel
manual plug-in module for a (customer made) diffusor

f) CCD camera

front illuminated, at least 8000 x 6000 6 μm pixel
cooled to $\leq 45^\circ$ below ambient
peak quantum efficiency $\geq 60\%$
read noise ≤ 12 electrons
65 mm shutter

g) Remote rack

control computer (standard PC) Linux
UPS at least 15 minutes hold time

h) Emergency issues

shut-off (kill) switches strategically placed around the dome
OTA software kill switches incorporated in each screen within the telescope control software
UPS sufficient to park the telescope

i) Installation

customers check of the telescope after assembling at the premises of the delivering company
transportation to the observatory location, including customs clearance according to the rules governing import of equipment to ESO observatories in Chile.
installation of the telescopes at the observatory
Turn-key and ready for immediate observations
testing and fine-tuning of the system to achieve the agreed specifications at the observatory
1 week of customer training with the telescope

j) Maintenance

Laser re-collimating hardware, software, and user documentation

All software has to run under LINUX.

2. Buildings

Buildings to be located at the Observatory, according to a plan attached below.

Type 1

two units
 Dome 4.1 m diameter
 Walls (cylinders) 2.2 m height
 Door (2 m x 1 m) with insulation (similar to the walls)

Type 2

Dome 7.5 m diameter
 Wall (cylinder) 6 m height
 Floor between ground and upper floor insulated
 Thickness of the floor surface at least 3 mm with anti-slide "pattern"
 Door (2 m x 1 m) with insulation (similar to the walls)
 Stairs to access upper floor, door between upper and lower floor

Type 3

Separate dome (cupola only!) 4.1 m diameter
 To be mounted on an existing building:
 Footprint of existing concrete walls: 5 m x 5 m, 2.8 m height, 20 cm width
 Existing sliding roof has to be removed
 New insulated roof to close the gaps between square building and circular dome.

Extension room

Footprint 4.2 m x 3.5 m,
 Walls 2.2 m height
 accessible from building type 2
 Door with insulation (similar to the walls)
 Internal door (2 m x 1 m) between dome and extension room
 Insulated roof

Building specifications

Walls, domes, and roofs must be insulated by means of three layers: aluminum (stainless steel) profiles inside, then insulation (e.g. expanded polystyrene or similar), and aluminum (stainless steel) profiles outside, painted white.

Additional requirements

Domes fully automatized and ready for full robotic use
 (e.g. full control of shutter, dome, screens and lamps for dome flats, etc. from the software),
 Fully integrated with telescope control software (TCS) and data acquisition systems
 (including weather station)

Domes with fans to allow efficient ventilation, controlled by the TCS
 Screens and lamps for dome flats for full robotic use, controlled by the TCS
 Emergency software switches "shutter closing", controlled by the TCS
 UPS sufficient to close the shutter + possibility for manual closing

Domes and extension room equipped with lights and electric plug sockets (220 V + 400 V).
 All electric instalations should complain with the Chilean rules.
 Turn-key and ready for immediate observations

Weather station (temperature, humidity, wind speed/direction) for the observatory

All software has to run under LINUX.

3. Data acquisition system

Standalone systems (for four domes and three telescopes), not physically integrated into a telescope control chassis or box. This salient characteristic is to enable easier future upgrades to the Data Acquisition System.

Fanless (natural convection, passive cooling)

Processor:	QuadCore 6/8 MB Cache, minimum 2.5 GHz frequency
Memory:	8 GB
Operating system:	Linux
Graphics interface:	DVI-D and HDMI ports; resolution up to 1920x1200. Integrated graphics card is acceptable; assuming that DVI and HDMI external ports are available, otherwise secondary standalone graphics card is required. Include Ethernet and wireless network connections.
Audio ports:	line-in, line-out, mic-in
IO interfaces:	2 x RS232 ports, 4 x USB 3.0 ports, 2 x USB 2.0 ports
Expansion:	At least 2 x PCI slots and 3 x PCIe slots
Hard drives:	separate drives for boot and storage
Boot drive:	256 GB SSD, sequential Read \leq 2500 MB/s, sequential Write \leq 2000 MB/s
Storage drive:	8 TB 7200 RPM 256 MB CACHE 6 GPS SATA III

Computer timing provided by GPS card (PCIe) with minimum 1-millisecond timing precision. Dual monitors (LCD, minimum 19-inch diagonal display), keyboards, and mice for both control room and dome level.

All software has to run under LINUX.

4. Installations

The observatory is located in an extremely dry and seismic area. The corresponding requirements for stability and quality of the concrete (e.g. extremely fast drying) have to be taken into account!

Ground excavation

- Basements for three domes
- Basements for three telescopes (1.5 m, 2 x 0.8 m)
- 100 m empty PVC tube (100 mm \varnothing) for data and electrical power cables to connect telescopes and control room; tubes shall be buried about 50 cm below ground plane

Concrete work

- Basements for three domes
- Basements for three telescopes (1.5 m, 2 x 0.8 m)
- Piers for the 1.5 m and two 0.8 m telescopes

All civil works (for the three new domes)

5. Warranty and documentation

The warranty should be at least 24 months for all parts and labour, starting from the date of the signature of the Provisional Acceptance.

During the guarantee and post guarantee period, CAMK will gain right and ability to install new versions of software components, when ASA releases such new versions free of charge.

Full documentation and manuals as well as tools to fully mount and dismount the telescopes

6. Software Requirements

6.1 API (Application Programming Interface)

In order to provide interface to all telescopes sub-systems for custom software, all the subsystem should expose it's functionality via documented API.

API should be completely Windows independent (e.g. via ASCOM Alpaca, ALMA Common Software). All the functions, and all the information about telescope state should be exposed on API. That includes:

- CCD (state, temperature, cooling, shutter)
- Filter wheels (status, name of the selected filter, etc)
- Mirrors, gudiers covers,
- Mount Mount slewing/tracking/pointing
- Derotators
- Foci section
- Focuser
- Guider
- Dome rotation
- Dome slit
- Dome Ventilation
- Lights
- Dome flats lamps
- Weather station

Telescope Mount Limits, Weather limits, Parking/Home Position should be set and controlled on the mount software level, i.e. API user should not have the possibility to set position out of the limits (intentional override may be possible), API user should be able to park telescope without knowing park position coordinates.

6.2 GUI (Graphical User Interface)

Software with Graphical User Interface should be provided. GUI software should be able to be operated from Linux machine. GUI software should cover at least functionality for convenient manual observation, and for operating integrated subsystems:

- Dome
- Mirror covers
- Focusing
- Guiding
- CCD

b) – ESO rules for routing and packing

1. Shipping, Import, Export and Customs procedures

The procedure laid down in this document shall apply to all imports, exports and shipping to and from Chile under the Agreement. In this Annex, CAMK PAN is referred to as “the Project” or “the Contractor”.

The Project shall be solely responsible for any consequence resulting from non-compliance with the present procedure.

ESO shall be timely advised of shipments arriving to Chile and may issue special instructions, if necessary.

Dangerous or hazardous shipments must comply with the IATA regulations and is expressly understood that is under the complete responsibility of the Project.

The Project shall be solely responsible for obtaining up to date information concerning the required fumigation for wooden crates, pallets or any other wooden packing material being imported to Chile, to comply with the rules in force at the time of shipment, including the provision of any necessary fumigation certificate.

1.1 Import and Customs procedures

It shall be the responsibility of the Project to export to Chile the equipment, materials, etc. under DAP Paranal Observatory (incoterms) in accordance with existing laws and regulations.

ESO is exonerated from customs duties in Chile only for materials, equipment and apparatus, etc. Duty free imports can only take place in the name of ESO.

Duty free imports into Chile in the name of ESO shall not be used for any other purpose than for the Project in Chile.

Prior to effecting any shipment the Project shall send to the ESO Logistic department copies of the corresponding invoice(s)/ proforma, packing list(s), Material Data Safety Sheet, Declaration of Dangerous goods (if any) and anticipated shipping details or, alternatively, the shipment plan. All shipping documents must be provided in English.

Three original Bills of Lading of any such overseas shipment, together with invoices and packing lists shall be sent to the ESO Santiago Office (cf. Articles 3 and 5 hereafter). In case of shipment by airfreight, the Contractor shall notify the Logistic Department at ESO Santiago office (cf. Article 5 hereafter) of corresponding flight details.

ESO's Santiago office will prepare the documents for customs clearance under ESO's privileges and exemptions, apply for approval by the appropriate Chilean authorities, and transmit them to the customs agent in Chile designated by ESO.

After customs clearance by ESO's agent in Chile, the original clearance/shipping documents shall be returned to ESO Santiago office.

All costs other than strictly own cost that ESO may sustain in connection with these import operations will be borne by the Project.

It is expressly understood that under no circumstances ESO shall be liable or responsible for any delays, damage, theft and consequential costs resulting from the import operations.

The Project should take notice that goods imported under ESO exemptions cannot be sold to third parties (not being ESO) during the first five years after the import took place without ESO's prior written approval.

1.2 Export and Customs procedures

After termination of operations, the Project shall export or re-export from Paranal Observatory in Chile at their cost. ESO will be in charge of the export customs clearance documents.

All goods imported under ESO's privileges and exemptions remain in Chile unless export or re-export is authorized in writing by ESO

Prior to effecting any shipment, the Project shall send to the ESO Logistic department copies of the corresponding invoice(s)/proforma, packing list(s), Material Data Safety Sheet, Declaration of Dangerous goods (if any) and anticipated shipping details or, alternatively, the shipment plan. All shipping documents must be provided in English.

Duty free exports from Chile in the name of ESO shall not be used for any other purpose than for USB in Chile. No extra equipment, material, etc. shall be included in the export shipment without authorization of ESO.

This operation will be performed under the instructions and supervision of ESO.

It is expressly understood that under no circumstances ESO shall be liable or responsible for any delays, damage, theft and consequential costs resulting from the export operations.

Any item which the Project would not wish to export or re-export; ESO Santiago office will then take up the matter with the Chilean authorities to clarify procedures, requirements and actions necessary.

2. Shipping instructions for overseas shipments

Final delivery shall be made to the ESO Paranal Observatory in Chile. The address of the ESO office dealing with all transport related matters in Chile is as follows:

European Southern Observatory (ESO)
Alonso de Córdova 3107,
Vitacura
Santiago / CHILE
Telephone: Santiago +56 2 24633160
Telefax: Santiago +56 22 2285132

3. Bills of Lading

Consignee:

ESO - European Southern Observatory
Alonso de Cordova 3107, Vitacura
Santiago
Chile

In case of container shipments: net weight and TARA to be indicated separately on the B/L.

4. Shipping marks

USB Telescope Project
Contract No.
Box No.:
Net weight:kg
Gross weight:kg

In case of more than one packages these have to be numbered consecutively.

For packages to be handled with cranes, the position of the centre of gravity shall be indicated on all four sides of the package.