



Telescopio Nazionale Galileo

INTERFACE SPECIFICATION FOR VISITING INSTRUMENTS AT TNG OBSERVATORY

Report

TNG-SPE-TEC-001-0001-V1.0-Technical_Specification_for_Visiting_Instrument

Issue: 1.0

Date: January 28th, 2010

Rev.2: March 10th, 2010

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LIST OF ACRONYMS

AOT, Announcement of Opportunity for Telescope time
DNA, Direct Nasmyth A Focus
FNA, Folded Nasmyth A Focus
FNB, Folded Nasmyth B Focus
INAF, Istituto Nazionale di Astrofisica
NI, Nasmyth Interface
TCR, Telescope Control Room
TNG, Telescopio Nazionale Galileo

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1 Introduction

TNG Observatory is open to regular Visiting Instrument. A Visitor Instrument is attached to a telescope, for the duration of a run of observation and then is removed from the telescope. Special agreement can be made with TNG Director and INAF Headquarters to maintain an instrument beyond the observation run, also offering the same instrument to other applicants.

Purpose of this document is to specify the focus where the Visitor Instrument can be attached, define the technical interfaces, the facilities offered and the rules the Visitor scientists have to follow.

2 TNG Visiting Instrument proposed foci

Starting semester 2010B, aka AOT22, TNG will be offered to host Visitor Instruments both in the A and B Nasmyth stations.

In the Nasmyth A station, two foci locations are possible:

- direct NasA focus (DNA)
- folded NasA focus (FNA)

while in the Nasmyth B only one possibility is offered:

- folded NasB focus (FNB)

3 Characteristics common to all foci

3.1 TNG Optical Configuration

The optical design of the TNG is a Ritchey-Chretien configuration, which gives an aplanatic field of view, which means that is free of coma and spherical aberration, with two Nasmyth foci.

The 3 main mirrors are made by Schott in Zerodur ceramic and polished by Zeiss.

Their characteristics are:

1. M1, concave hyperboloid, $\varnothing = 3580\text{mm}$, $R_1 = 15400\text{mm}$, $F/2.2$, $K_1 = -1.024$, meniscus shape (240mm thick). The active support is made by 75 axial actuators, 3 fixed points and 24 lateral actuators.
2. M2, convex hyperboloid, $\varnothing = 875\text{mm}$, $R_2 = 4416.4\text{mm}$, magnifying factor $m=5$, $K_2 = -2.453$. The produced central obstruction is of $\varnothing 1160\text{mm}$.
3. M3, flat, elliptic, with axes $a = 840\text{mm}$, $b = 600\text{mm}$, redirects light towards one of the 2 Nasmyth foci.

The file with the optical design of the main mirrors of the TNG can be downloaded from the web page: http://www.tng.iac.es/docs/TEC/TNG-DWG-TEC-001-0002-TNG_Main.zmx

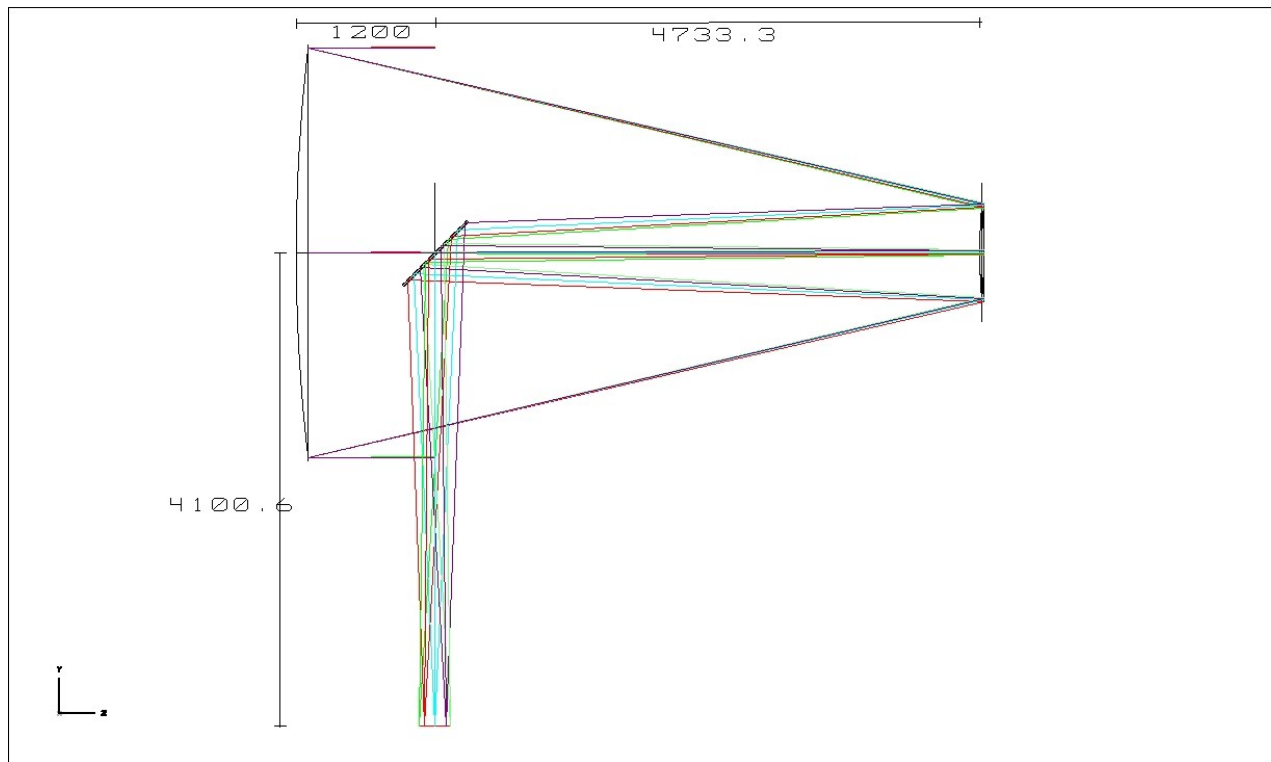


Fig 1: optical layout of TNG

The final focal ratio is F/11, with an overall focal length of $f=38500\text{mm}$ and a plate scale of 5.35905 arcmin/mm, or 187micron/arcsec .

The diameter of the usable Field of View (FoV) is 30 arcmin or 336.6mm .

The Exit pupil is placed 10443.3mm before the focal plane with a diameter of 963mm .

Even in passive mode the superb Image Quality gives 80% energy (dEE_{80}) in $0.15''$ in all the FoV, while with the AO system the dEE_{80} can go to $0.08''$.

FoV is dominated by off-axis field astigmatism which corresponds to an astigmatism line of $\sim 1.5''$ (or 270micron) at the edge of the FoV.

The focal plane is curved with a Radius $R=-1890\text{mm}$.

The average pointing accuracy is 1.0 arcsec rms with pointing model over most of the sky. Degradation occurs close to the zenith and at zenith angle larger than 60 degrees.

3.2 De-rotator Mechanics and Moving Parts

Both Nasmyth sides of the telescope have a mechanical de-rotator. Inside the de-rotator there are the Acquisition and Guiding system and the Shack-Hartmann Wavefront Sensor for active optics.

Scientific Instruments can be mounted on the de-rotator (like NICS, DOLORES) or on the fork of the telescope and fed through relay optics (like SARG or GIANO). The presence of native instruments at the TNG limits the available space and weight for visiting instruments.

The Maximum axial load on the de-rotators bearings is: 12kNm .

The Maximum unbalanced torque on the de-rotator is: 40Nm .

3.3 Instrument Integration: Logistic, Access, Maximum Load, Cranes

- Bridge:
 - The main and direct entrance to the telescope observing floor is through the bridge. This is the usual access for the primary mirror and its box. The door to the dome is nearly 3m high ($h=2.96\text{m}$) and 6m wide. Access is available only when the telescope is not moving.
- Lift:
 - The access to the observing floor from base level through the inside of the dome is limited to the sizes of the lifts. There are two lifts, the first one for the annex building and the second one for the dome. The smaller one is the lift of the dome, where the entrance doors are 2m high x 1.20m wide. The lift is 1.40m long. The minimum travel distance between the 2 lifts is when the azimuth of the dome is at -17deg .
- Cranes:
 - At the entrance of the building through the bridge there is a 12.5Ton crane used for lifting M1.
 - Each of the Nasmyth rooms is equipped with a 2Ton crane that covers most of the Nasmyth floor. The minimum distance to the de-rotator is roughly at the focal plane.
 - A 3Ton manual crane is available upon request to be installed in the same girder of the Nasmyth cranes room and allows access up to 500mm in-focus, that is between focal plane and derotator.
 - Another 3Ton crane is available in the garage/storing floor at base level for basic movements or download of boxes.
 - TNG can provide lifting equipment as flat loaders or manual hydraulic fork lifts, in addition there are standard lifting equipments (slings, shackles, etc.)
- Floor maximum load:
 - In the dome the floor capacity is limited to 10 kN/m^2 evenly distributed.
- Limits on the sizes of boxes, crates etc:
 - Nasmyth A.
 1. From the bridge to this room there is a door which is $2 \times 1.80\text{m}$ ($h \times w$). After the door the minimum width is in correspondence of the Fan, where space is again 1.80m.
 2. From the lift the constrain is the lift itself, $2 \times 1.20\text{m}$ ($h \times w$).
 - Nasmyth B
 1. From the bridge to this room there is a door which is $3 \times 2.50\text{m}$ ($h \times w$).
 2. From the lift there are 2 routes but the wider one is through the Nasmyth A room.

3.4 Power and Communication Interfaces

Stabilized Power (UPS) is available on the de-rotators and on wall outlets:

- 220 VAC, 10A, 50Hz single phase, on three outlets. Necessary connector type: SCHUKO (CEE7) plug.
- A few of these plugs (4 or 5) on the derotator can be remotely switched from the control room

Normal Power (non UPS) is also available on wall outlets:

- 220 VAC, 10A 50Hz single phase, on three outlets. Necessary connector type: SCHUKO (CEE7) plug.
- 380 VAC, 10A, 50Hz, 3phase, on one outlet: Necessary connector type: IEC60309 (CEE17), 3P+N+E, 16A.
- 380 VAC, 6A, 50Hz, 3phase, on one outlet: Necessary connector type: IEC60309 (CEE17), 3P+N+E, 16A.

Optical fibres, coaxial or custom communication data lines on board of the de-rotator must be provided by the visiting instrument owner. They will be long enough to be enrolled around the de-rotator and allow a turn of +/-270 deg (The de-rotator cable holder diameter is ~2m, that means at least 8-10m of cable including the distance from the de-rotator to the on-board instrument and from the de-rotator to the instrument controller).

Floating cables, fibres and pipes should be avoided to minimize risk of twisting, braking, snapping, etc. during the rotation of the de-rotator or during normal maintenance operations in the Nasmyth rooms.

Both de-rotators are equipped with 100Mb Ethernet switches with RJ45 type connectors.

Internet connection is available and provided through a DHCP server on private or public network; Anyway instrument controllers will receive a static IP address within the TNG network.

3.5 Air Conditioning, cooling and cryogenics

The whole dome of the TNG is cooled with A/C to the temperature of the previous night, this means that in winter it can be close to 0C during daylight. Furthermore dew point must be monitored always to prevent water vapour condensation on most delicate parts (as optics and electronics).

Glycol water connections are not available at the moment.

Liquid nitrogen is available in 50 or 200 litres dewars and a LN plant is under set up to allow self production of LN. Native instruments are equipped with automatic refilling every 8 hours, with T and P monitoring. Automatic refilling is not available for Visiting instruments.

Pump system: turbo-molecular vacuum pumps are available upon request, with ISO 16-25-40 DN-KF pipe fitting.

3.6 Safety rules and requirements

There are several hazardous elements within the telescope building as pressurized devices (CO₂, He bottles, N₂ dewar and liquid nitrogen plant), chemical products (glues, solvents, spry grease, etc.) or poisoning elements.

The entrance is limited to staff and authorized personnel only.

The Visiting Instrument owner has to provide a list of potentially dangerous things such as: type of chemicals used, devices under pressure, mechanical systems to be handled with care and by specially trained manpower, requirement of cryogenics liquids for the instrument, etc. The list must include solution for problems that could arise during Instrument integration and operation. Also notice shall be made of any need for special insurance. VI staff should bring its own personal safety equipment, including boots, antistatic devices, gloves, goggles, etc.

3.7 Control Room

The main Telescope Control Room (TCR) is in the annex building. Power and Internet connections are available and have the same characteristics as in the Nasmyth rooms. A desk with chairs and spare monitors will be available for the visiting instrument staff and scientists.

There is an auxiliary Telescope Control Room (ATCR) just below the telescope observing floor. This room is cooled with A/C to keep the observing floor at low temperature, and thus minimize warm air and turbulence. The use of this ATCR by visiting instruments should be justified in deep.

3.8 Other facilities

- 3.3.1 **Air:** Both Nasmyth rooms are equipped with a line of normal compressed air at 8Atm and Dry Air at 1Atm.
- 3.3.2 **Gas:** should there be any need of CO₂ or He, there are pressurized bottle available, but their use is constrained to emergency situations. Any visiting instrument that uses these gases should take its own bottles.
- 3.3.3 **Telephones and walkie-talkie** are available at the telescope in every Nasmyth room and in the control room
- 3.3.4 **Webcams:** there are webcams looking at the focal plane instruments and de-rotators and at the front and back of the telescope.
- 3.3.5 **Tables and chairs:** If accorded in advance with TNG staff, a control desk close to the de-rotators can be set-up
- 3.3.6 **Electric and Mechanical workshops** are available during daylight working time for emergency fixes.
- 3.3.7 **Kitchen and Toilets** are also available at the telescope, while bedroom, as well as lunch and dinner must be reserved at the Residencia (<http://www.iac.es/>).
- 3.3.8 **Clean Room:** the general quarter of FGG-TNG at San Antonio (sea level) has an optical laboratory and a Class1000 clean room with a Class100 laminar flow bench.

4 Proposed foci

4.1 Direct focus on Nasmyth A Interface (DNA)

The Nasmyth A focal station is equipped with a mechanical interface, mounted on the de-rotator, where several instruments were (OIG, Arnica, AdOpt) and can be mounted. It has a rectangular shape and obviously rotates together with the de-rotator, which means that the weight distribution must be radially balanced within 40Nm. On the Nasmyth Interface (NI) there are 3 focal stations available; one of them is used by NICS, the native IR camera of the TNG, the other two are offered for VI.

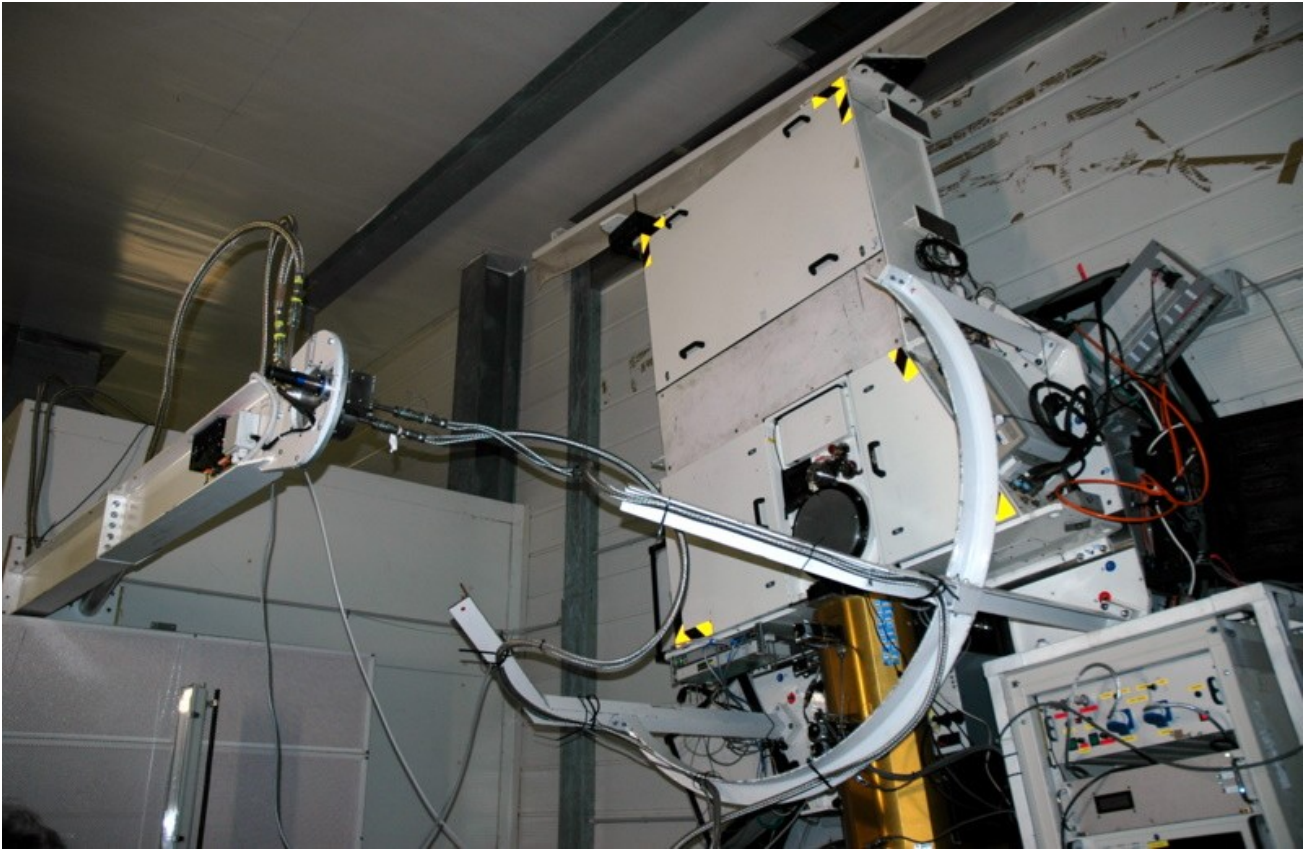


Fig 2: View of the Nasmyth Interface. At the bottom the dewar of NICS, with electronic rack on its left and He pipes going to the co-derotator (left of the image). The central round flange is the mechanical interface for the direct focus visiting instrument (DNA), while in the upper part the box for the folded focus instrument is visible (FNA).

The Direct focus on the Nasmyth Interface (DNA) is directly fed from M3 and the maximum available **FoV diameter is 8.4arcmin** (there is a D=109mm aperture on a filter wheel, 145mm before focus). The optical axis is located roughly at 2.74m above the observing floor; stairs will be needed in order to have easy access to the instrument when mounted. The optical design of this configuration can be downloaded from the web page:

http://www.tng.iac.es/docs/TEC/TNG-DWG-TEC-001-0003-TNG_DNA.zmx

Instrument will be mounted on the mechanical interface following the scheme below.

The interface is a round steel flange placed 38 mm before the F/11 focal plane, with a 310mm H7 internal diameter; fixation is through 8 tapped holes, M8x13mm, equally spaced at 45 degs, on a 325mm diameter. See figure 3; also the corresponding DWG file can be downloaded from:

http://www.tng.iac.es/docs/TEC/TNG-DWG-TEC-001-0004-Nasmyth_Interface.dwg

The maximum allowed depth of the instrument towards M3 is of 45mm from the flange, that is 83mm before focus. Further depth must be consulted with TNG staff.

Weight: The maximum weight of the visiting instrument with accessories on the DNA must not exceed 4kNm. Considering that the mounting flange is 670mm from the de-rotator bearing, this is equivalent to approximately 400Kg at 300mm from the flange ($670+300=970\text{mm}$, $0.97*0.4*9.81 = 3.8\text{kNm}$).

Size: The maximum diameter and length of the instrument mounted at the flange is limited to a

cylinder of D=350mm and L=1000mm (the limit is given from the He pipes of NICS towards the rotating joint).

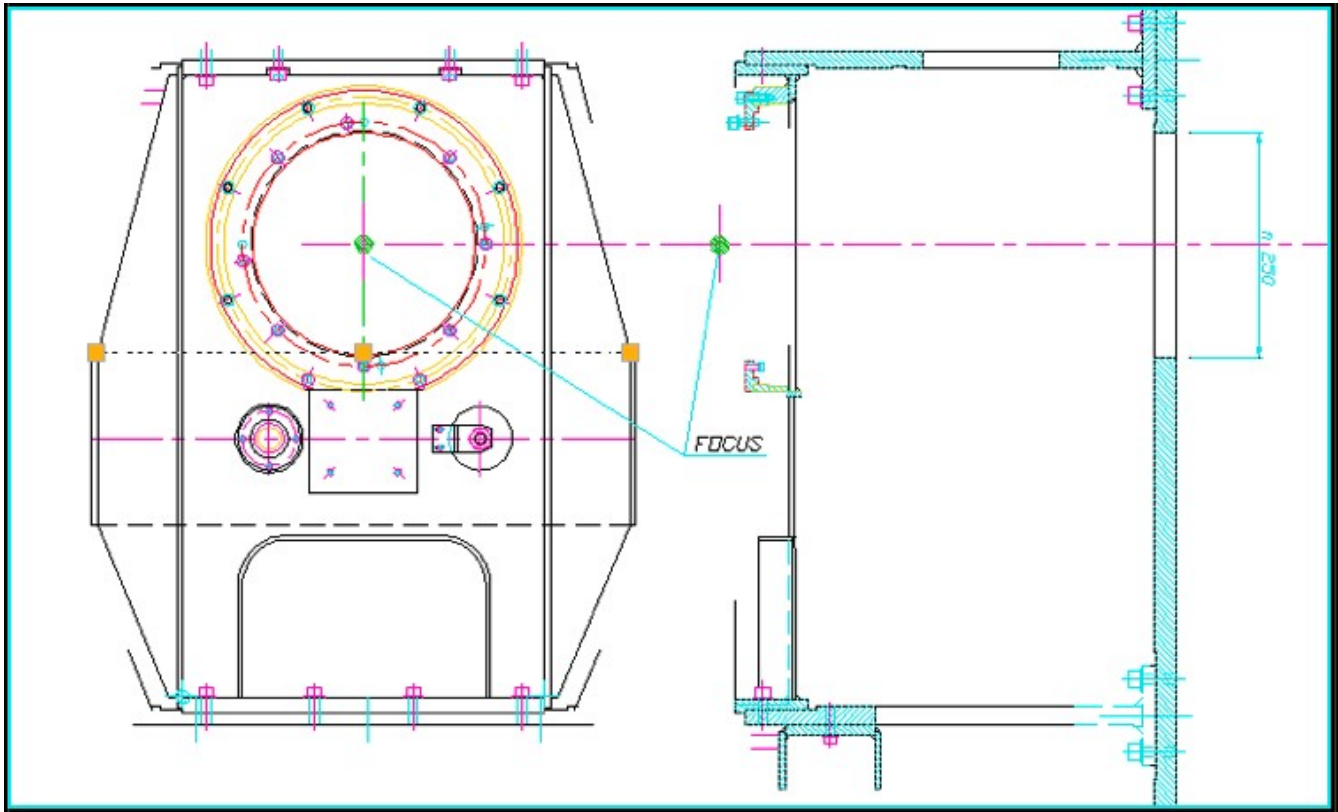


Fig 3: The mechanical interface for the direct focus at the Nasmyth Interface DNA. See DWG file for better details

4.2 Folded focus on the Nasmyth A Interface (FNA)

The folded focus FNA on the NI is located opposite side of NICS with respect to the de-rotator axis, that is where the AdOpt module previously was installed. The same translation stage that introduces into the optical axis the folding mirror that feeds NICS, hosts another flat folding mirror, minor axis is 80mm. The folding mirror is placed at 300mm before nominal focus with protected silver coating and a $\lambda/40$ optical quality.

The available **FoV is in this case limited to the size of the mirror, and corresponds roughly to 4.5x4.5arcmin**. The file with the optical design of this configuration can be downloaded from the web page: http://www.tng.iac.es/docs/TEC/TNG-DWG-TEC-001-0005-TNG_FNA.zmx

The mechanical mount of the instrument inside the FNA box (where AdOpt was hosted) allows for the installation of a small optical bench or equivalent board on 6 dedicated threaded holes (M8). As respect to Fig.4 distances between holes is 690mm on the long side and 780mm on the short side. The available space inside the box is maximum 1100mm x 1600mm, and extends 175mm above and below the folded optical axis.

The VI can get close up to 160mm from the optical axis, or 140mm before the focal plane.

Weight: Even if in the FNA focus the VI is mounted closer to the de-rotator bearing (thus allowing a greater load while keeping the total axial momentum within the limit of 4kNm), the maximum weight of the VI is now limited by the need of a radially balanced distribution of weights.

In the FNA focus that the distribution of the VI and accessories plus the balancing weights must not exceed 1000Kg (if mounted at 350mm from the bearing, which means that the center of gravity is roughly 120mm before the unfolded focus).

VI must take into account that any object mounted in the NI will rotate with the gravity vector moving on a plane parallel to the optical bench.

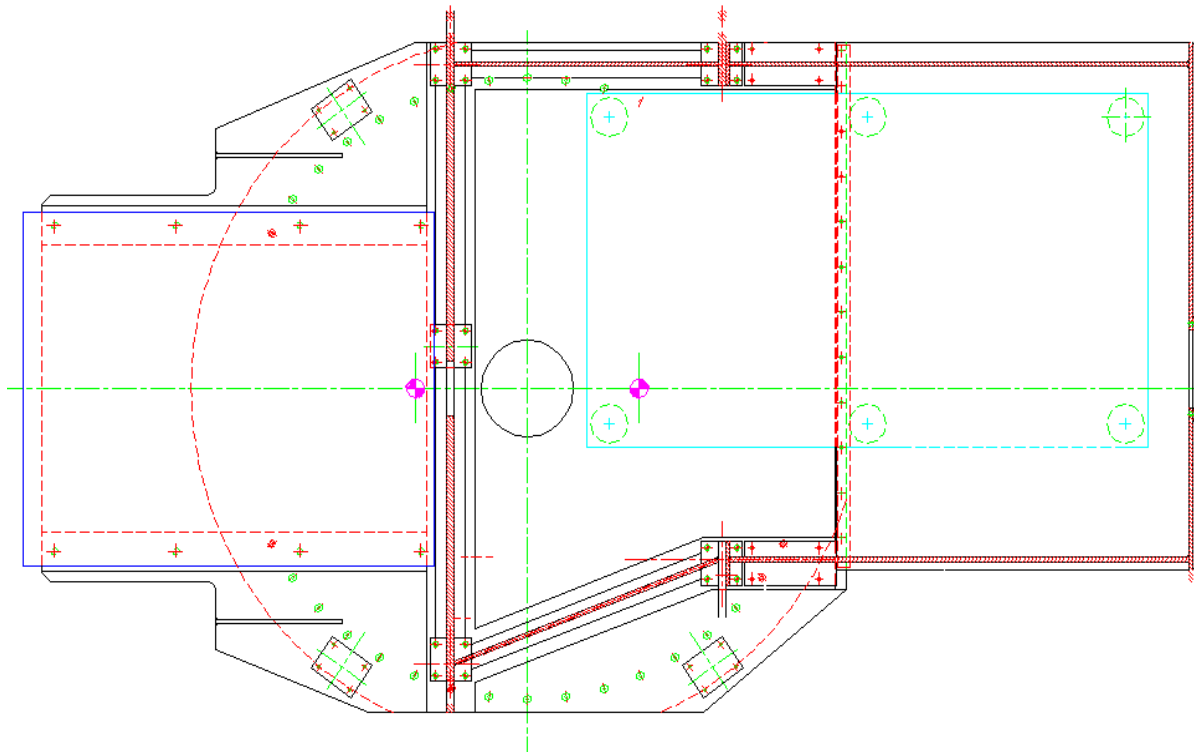


Fig 4: Front view of the Nasmyth A Interface, looking along optical axis, towards M3. In this picture the visiting folded focus on the NI is on the right (300mm) of the optical axis, while on the left there is the focus of NICS. The maximum allowed depth of the visiting instrument towards the optical axis is 160mm from folding mirror, or 140 before focus. On the right the rectangle representing the previously mounted optical bench of AdOpt is visible (1500x900mm), together with the six M8 threaded holes for the mounting.

4.3 Folded focus on Nasmyth B Interface (FNB)

On de-rotator B there is permanently mounted the Dolores instrument (a low resolution long slit and multi-object spectrograph and imager). 300mm before the focal plane there is a translation stage with optics to feed SARG (the high resolution spectrograph fixed on the telescope fork) through the side of Dolores. A mechanical drawing of the translation stage where fibres or optics should be mounted is available at the web page:

http://ww.tng.iac.es/docs/TEC/TNG-DWG-TEC-001-0006-Dolores_Entrance_Slider.dwg

While other instruments cannot be mounted on the de-rotator, there is the possibility to feed through fibres or other optical relay, mounted on the previously mentioned translation stage, any visiting instruments that will be fixed at the telescope fork.

If fibres are used they must be long enough to allow de-rotator movements, following the specification of paragraph 3.4.

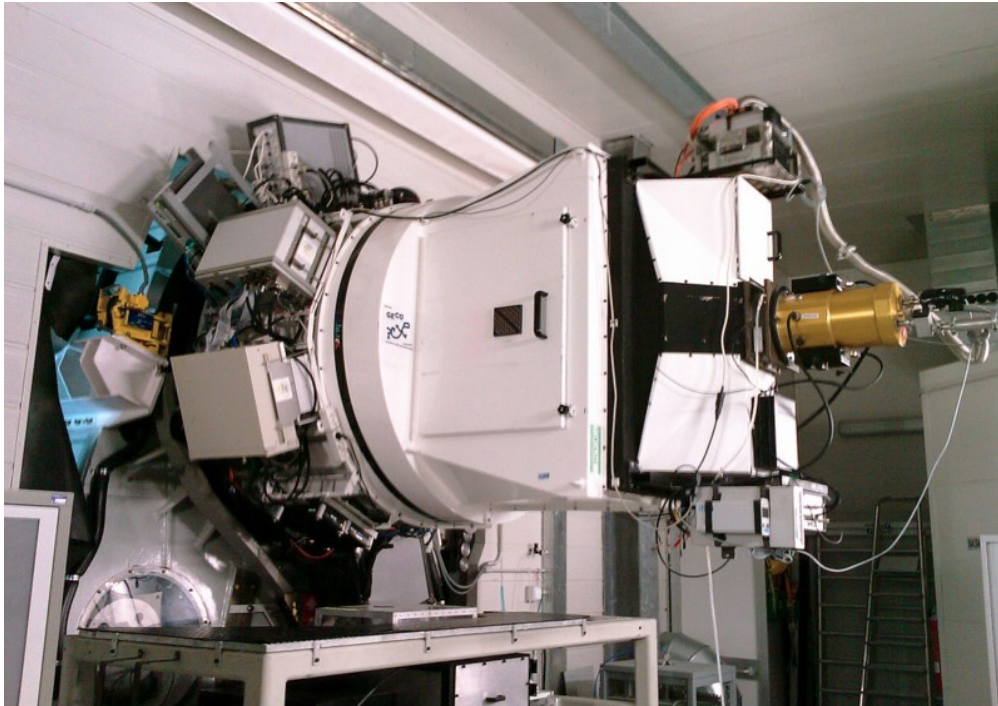


Fig 5: Nasmyth B with Dolores mounted on the de-rotator and SARG below it.

Mechanical de-rotation will not be possible in case the optical relay is used, thus an optical de-rotator will be necessary if needed. Furthermore being the entrance slider 300mm before the F/11 focal plane the **folded F/11 focal plane will be inside** the de-rotator.

If an optical relay is used to re-image the focal plane further constraints must be taken into account:

- the de-rotator must be able to rotate when the visiting instrument is mounted but not in use;
- the available space between Dolores and SARG is of 350mm;

Being the instrument fixed on the telescope fork or fed through fibres there are no limitation about the weight, apart from the weight on the floor. Anyway, should the instrument weight more than 1000Kg,

special preparation of the floor will be needed to spread the load over the greatest available surface. If the option is to fix the instrument on the telescope fork the TNG staff should be contacted before.

Anyway due to the crowding of the Nasmyth B station, the lack of an already mounted optical relay and the limits imposed by the presence of SARG we strongly suggest the use of Nasmyth A station foci.

5 Further informations

Should the VI need further informations or suggestion about instrument logistic or mounting do not hesitate in contact TNG staff for more detailed technical specification, mechanical or optical drawings or pictures.

This document is available at the following web page:

<http://www.tng.iac.es/>

[docs/TEC/TNG-SPE-TEC-001-0001-V1.0-Technical_Specifications_for_Visiting_Instrument.pdf](http://www.tng.iac.es/docs/TEC/TNG-SPE-TEC-001-0001-V1.0-Technical_Specifications_for_Visiting_Instrument.pdf)

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