Observation preparation with X-Shooter

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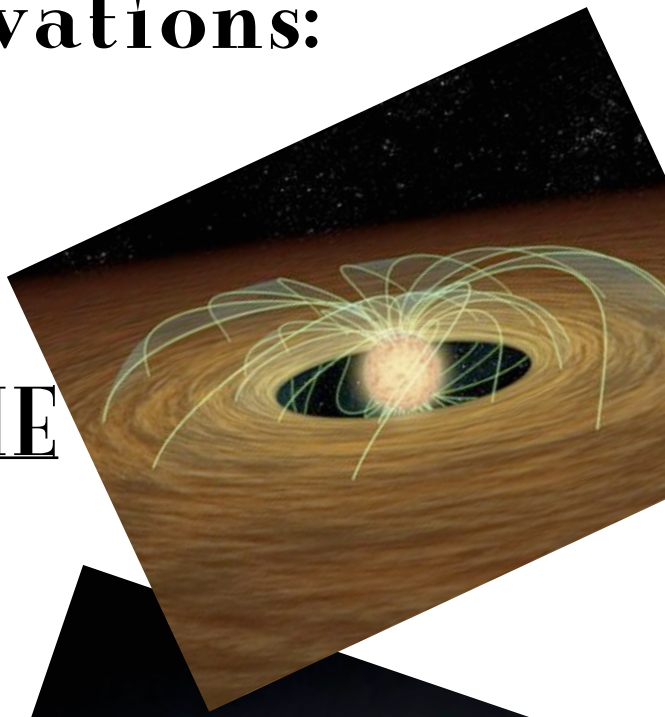
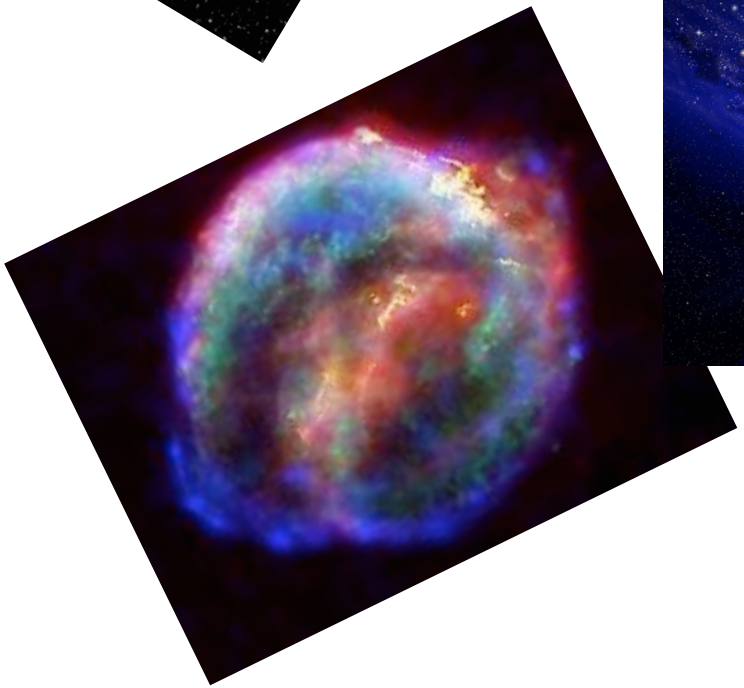
Planning your observations

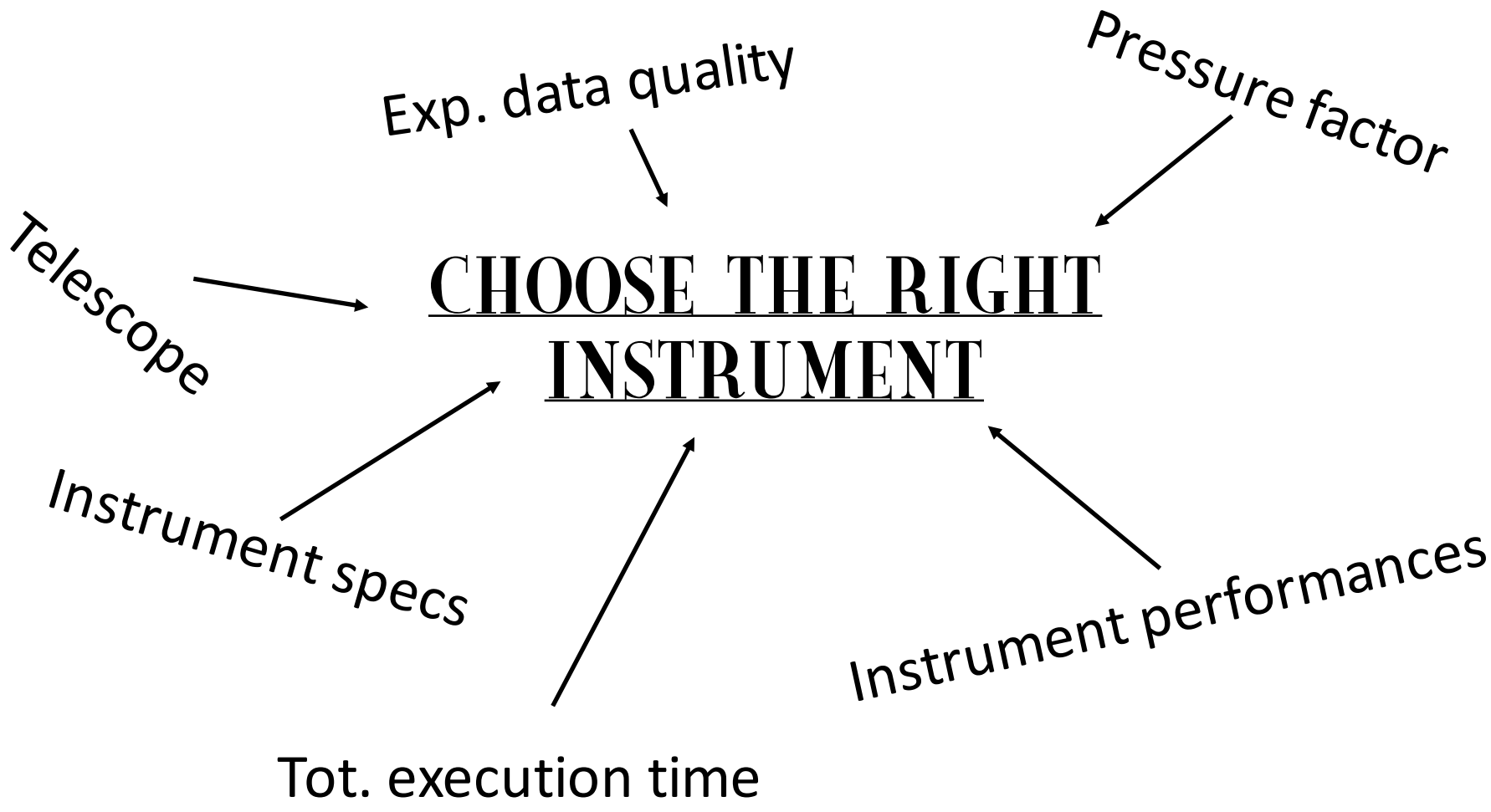
Planning the observations:



LET SCIENCE BE THE DRIVER



Planning the observations:



Planning the observations: find your instrument

http://www.eso.org/sci/facilities/paranal/instruments.html

Paranal Instrumentation

The currently offered Paranal telescopes and instruments and their location are listed in the following table

valid for Period 96, October 1, 2015 - March 31, 2016.

The links to the different instruments provide an overview of the respective instrument capabilites and the offered instrument modes. For details please refer to the Call for Proposals for Period 96.

Information on Paranal decommissioned instruments is available on a separate page.

Please refer to the Call for Proposals for Period 97 for Paranal telescopes and instruments offered in Period 97.

Telescope	Focus			
	Nasmyth A	Cassegrain	Nasmyth B	Interferometric
UT1 (Antu)	NACO	FORS2	KMOS	
UT2 (Kueyen)	FLAMES	XSHOOTER	UVES	AMBER
UT3 (Melipal)	SPHERE	VISIR	VIMOS	PIONIER
UT4 (Yepun)	HAWK-I	SINFONI	MUSE	
AT1				
AT2				AMBER
AT3				PIONIER
AT4				
VISTA		VIRCAM		
VST		OmegaCAM		

Planning the observations: meet your instrument

X-SHOOTER

Summary

XSHOOTER is the first of the second generation instruments at VLT. It it has been built by a Consortium of Institutes in Denmark, France, Italy and The Netherlands together with ESO.

Everything that is necessary to know about XSHOOTER toprepare a successful observing run will be posted in these pages.
XSHOOTER web-pages will be continuously updated.

Publications based on data obtained with XSHOOTER should quote the following reference paper: Vernet et al. 2011, A&A, 536A, 105.

Contact Information

- Questions related to service mode observations and proposal preparation should be addressed to the User Support Department.
- Questions related to visitor mode observations should be addressed to Paranal Science Operations
- Please send us your comments, suggestions and report errors and inaccurate statements in the web pages and manuals.

Content of these pages

The following items are available on all the XSHOOTER pages, using the bar on the left.

- Overview: a short description of the instrument (Overview: XSHOOTER in a nutshell).
- News: list of changes affecting the instrument and/or its pages (XSHOOTER News).
- Instrument Description: all the important parameters of the instrument (XSHOOTER numbers and facts).
- Known Problems, (see here).
- Manuals: links to all the documents related to XSHOOTER (XSHOOTER User Manuals).
- Tools: a collection of useful tools and informations for preparing and analyzing the XSHOOTER observations, about the spectrophotometric standard stars and telluric standard stars observations, etc (XSHOOTER tools and tips).
- Instrument Operations Team (who is working behind ...).
- Visitor Instructions: Instrument specific instructions for Visiting Astronomers (what to be aware of before flying to Paranal).
- XSHOOTER internal pages XSH PSO

Planning the observations: meet your instrument

Instrument's Characteristics

This page lists the main characteristic of XSHOOTER. The instrument reference guide and complete document is the XSHOOTER User Manual. The resolving power values presented below for the UVB/VIS arms still need to be refined, in particular for the 1.0" UVB and 0.9" VIS slits.

Spectrograph characteristics

Arm	λ-range (nm)	N. of orders	scale[1] ("/pix)	AB limit [2] (mag)
UVB	300-560	12	0.16-0.20	21.2 (at 356.1 nm, ord N.21) 21.7 (at 438.8 nm, ord N.17)
VIS	550-1020	15	0.16-0.18	20.9 (at 653.8 nm, ord N.35) 20.8 (at 777.6 nm, ord N.21)
NIR [3]	1020-2480	16	0.21-0.28	21.0 (at 1245.2 nm, ord N.21) 20.6 (at 1634.4 nm, ord N.16) 18.7 (at 2179.2 nm, ord N.12)

[1] Approximate value along the slit. [2] The data collected during the UVB and VIS arm commissioning are not sufficient to provide reliable limit magnitudes. The limit magnitudes in the table are predicted by the XSHOOTER ETC which relies on the observed instrument efficiency. The accuracy of the ETC is currently limited to ~20% in the UVB and VIS arm, but is subject to continuous update and improvements. The posted values have been computed for a SNR ~ 10 in 1 hr integration time. Input parameters were: slit=1" (for the UVB, 0.9" for the VIS and the NIR), airmass= 1.2, seeing=0.8", 3 days from new moon and a power low spectrum with index =-2. [3] NIR arm values are predicted by the instrument physical model.

Spectrograph resolution, for the NIR arm with the new slits wheel [1]

arm	slit width [2] (")	R=(λ/Δλ)	sampling (pix/FWHM)	arm	slit width (")	R=(λ/Δλ)	sampling (pix/FWHM)	arm	slit width (")	R=(λ/Δλ)	sampling (pix/FWHM)
UVB	0.5	9900	3.2	VIS	0.4	18200	2.9	NIR	0.4	10500	2.2
	0.8	6200	5.2		0.7	10600	4.9		0.6	7780	2.9
									0.6JH [4]	7760	
	1.0	4350	5.4		0.9	7450	7.1		0.9	5300	4.2
									0.9JH [4]	5300	
	1.3	4000	8.1		1.2	6700	7.9		1.2	3890	5.8
	1.6	3300	9.9		1.5	5400	9.7				
UVB	IFU [3]	8400	3.9	VIS	IFU [3]	13200	4.0	NIR	IFU [3]	8300	2.7

[1] The values in this table have been measured for all slits in each arm but the 1.3" and 1.6" for the UVB and 1.2" and 1.5" for the VIS. [2] All the slits have a fixed length of 11". [3] The IFU FoV is 4"x1.8 " which are re-sampled in a 0.6" x 12 " slit in the spectrographs. [4] The 0.6"JH and 0.9"JH are the 2 new slits with the K band blocking filter

Planning the observations: meet your instrument

- Paranal Facilities
- Emergency Procedures
- Call for Proposals
- Paranal News
- Contact Information
- Paranal Telescopes
- Paranal Instrumentation
  - CRIRES
  - FLAMES
  - FORS
  - HAWK-I
  - KMOS
  - MUSE
  - NACO
  - SINFONI
  - SPHERE
  - UVES
  - VIMOS
  - VISIR
  - X-SHOOTER
    - Overview
    - News
    - Instrument Description
    - Manuals
    - Tools
    - Instrument Operation Team
    - Visitor Instructions
    - Science

XSHOOTER News

On this page, we list the main changes that affected the instrument and its current status.

- Spectro-astrometry technique performed with XSHOOTER: Whelan et al., 2015, 579, A48.
- Aug 2015: A document about the historical wavelength shift between the arms has been released. It presents their origin and the corrective actions that were performed. It is available from the manuals page.
- Two mapping templates (slit and IFU modes) are offered since P96. They facilitate mapping observations and the data reduction with the REFLEX workflow.
- In April 2015, a new pipeline version will be released. It corrects several bugs in the wavelength calibration due to non optimal correction of the flexures leading to offsets of a few km/s. There are still small residuals in the radial velocity depending on the position in the slit, which need to be fully characterized.
- In P96, the ETC will take into account the difference between image quality and seeing.
- Due to a software issue, the target centering was inaccurate in the y direction by 0.25" for g_prime and U band filter acquisitions between Dec 2013 and 2 Sep 2014. The centering was possibly not optimum at some point between 2008 and 2013 for all filters with a shift of 0.17".
- In Period 94, XSHOOTER is offered again at UT2. The instrument will be dismounted from UT3 early September 2014. The re-commissiong of the instrument on UT2 is scheduled for mid-October 2014. X-shooter will be operational starting on October 16.
- Some tests were performed of a diaphragm mode that allows to observe very bright objects by diaphragming the entrance of the instrument. A small report is available here and some reduced data obtained during the technical night are available there.
- Since an upgrade of the VLT SW in January 2014, the quality of the aquisition images is suboptimal (higher bias and noise level). The imaging mode is not affected.
- Oct 2013: XSHOOTER is now installed at UT3. The efficiency of the telescope + instrument is better by 5-10% in all arms compared to UT2.
- In P93, a light imaging mode performed with the fourth channel (A&G camera) will be offered.
- No Large Programs are accepted from P93 onwards to allow for an eventual intervention to repair the ADC drives.
- In P92, XSHOOTER will be moved from the UT2 to the UT3 Cassegrain focus.
- The XSHOOTER pipeline version 2.2.0 has been released and its REFLEX 2.4 support as well. You may want to find it here.
- In P91, the policy regarding the telluric standard stars observations will be modified (see User manual).
- **IMPORTANT: ADCs problems** Due to mechanical problems with the ADC (atmospheric dispersion corrector) drives, the ADCs were disabled on August 1st 2012. During the previous months the ADCs for the UVB and VIS arms have been first occasionally and then increasingly failing. Incorrect position of ADCs leads to slit losses worse than if they are not used. An intervention to fix this problem is under evaluation. To minimize the slit losses, we advise to prepare observations as follows:
  1) Put the slit at parallactic angle (default value 9999), if possible.
  2) Observe the target close to the meridian, at low airmass. The mimimum airmass of your target will depend on its declination. As a reference a plot of the airmass vs. target declination corresponding to observing +/-2h from the meridian is shown on the VIMOS Phase 2 web page: VIMOS visibilities
- The XSHOOTER pipeline version 1.4.5 has been released and its first REFLEX support as well: here.
- A document describing the NIR readout mode, its regimes, and the impacts is available here.

Planning the observations: meet your instrument

XSHOOTER Instrument Operation Team

IOT members

Garching	
Instrument Scientist	Joel Vernet
User Support Scientist 1	Giacomo Beccari
User Support Scientist 2	Markus Wittkowski
Quality Control Scientist	Wolfgang Hummel
Instrument Responsible	Hans Dekker
Pipeline Responsible	Andrea Modigliani
SDP Responsible	Sabine Moehler
Paranal	
Instrument Scientist 1	Andrea Mehner
Instrument Scientist 2	Christophe Martayan
Instrument Fellow 1	Jorge Lillo Box
Instrument Fellow 2	
Mechanical Engineer Instrument Responsible	Roberto Castillo
Instrument Software Responsible 1	Eduardo Pena
Instrument Software Responsible 2	Claudio Reinero

...+ USD + ESO Archive...

Planning the observations:
READ THE....MANUAL!!!

European Organisation
for Astronomical
Research in the
Southern Hemisphere

Organisation Européenne
pour des Recherches
Astronomiques
dans l'Hémisphère Austral

Europäische Organisation
für astronomische
Forschung in der
südlichen Hemisphäre

VERY LARGE TELESCOPE

X-shooter
User Manual

2 Technical description of the instrument

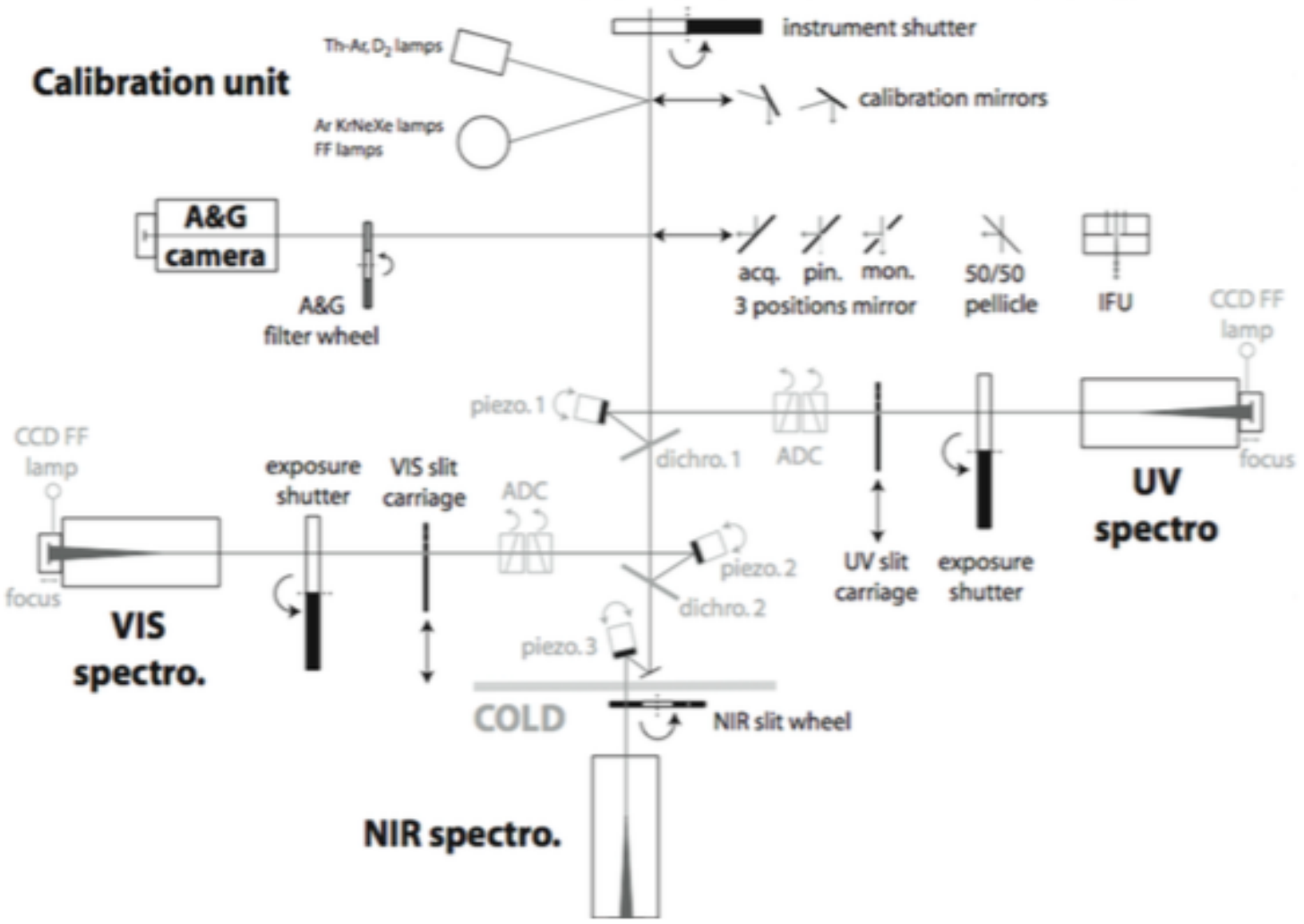


Figure 2: Schematic overview of the opto-mechanical design of X-shooter

1.3 Shortcuts to most relevant facts for proposal preparation

- The fixed **spectral format** of X-shooter: see Table 12 on page 33
- **Spectral resolution** as a function of slit width: see Table 11 on page 31
- Information on the **IFU**: see Section 2.2.1.3 on page 17
- Information on **limiting magnitudes** in the continuum: see Section 2.3.3 on page 30
- Information on **observing modes**: see Section 3.2 on page 44
- Observing strategy and **sky subtraction**: see Section 3.3 on page 55
- **Overhead** computation: see Section 3.4 on page 58

The instrument's calibration plan

Calibration Frames to take care of **instrument's systematics**:

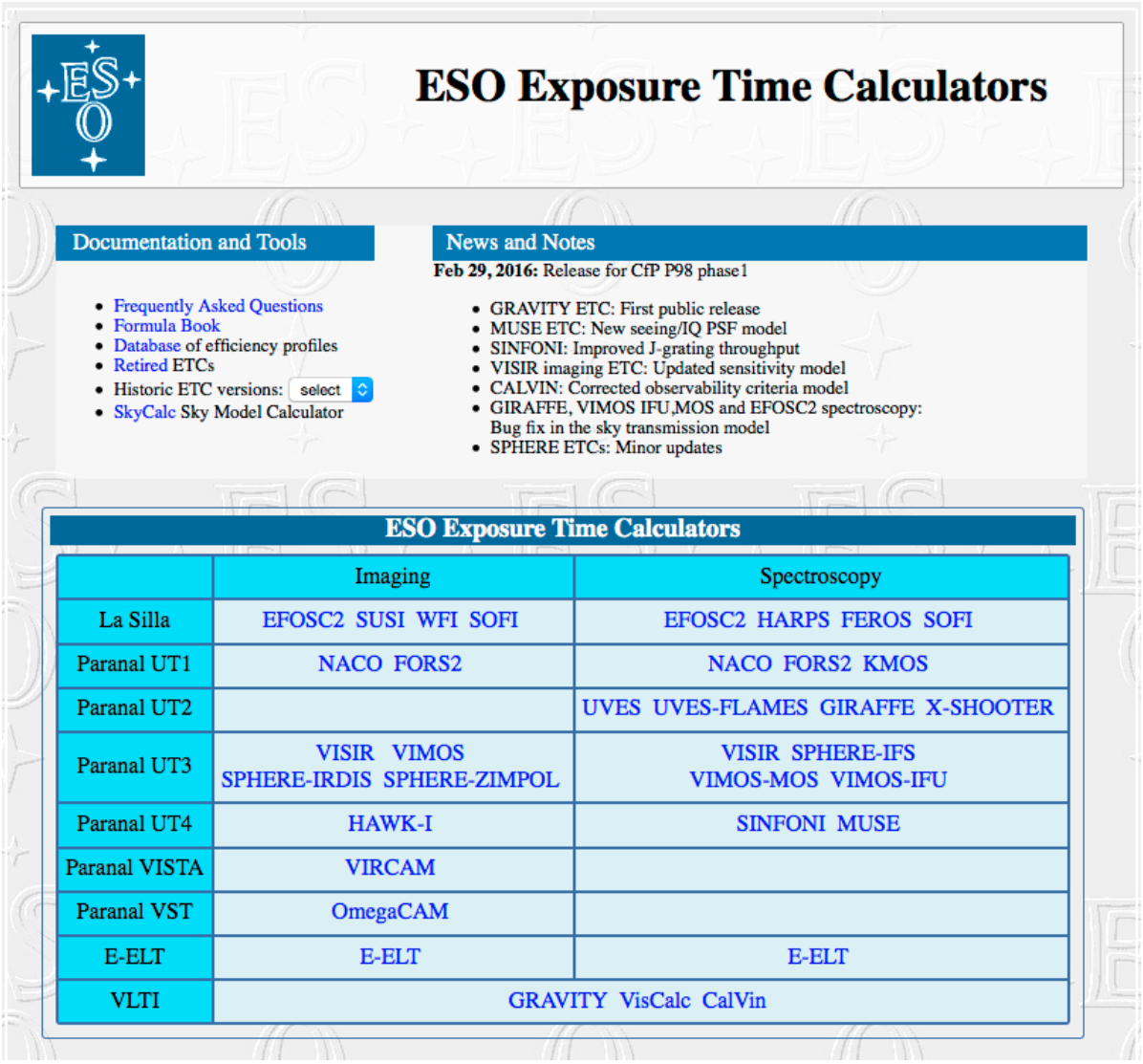
BIAS
DARK
FLAT FIELD
...

Calibration for **Science**:

SpecPhot Standards
Telluric Standards

The Exposure Time Calculator (ETC)

https://www.eso.org/observing/etc/



ESO Exposure Time Calculators

Documentation and Tools

- Frequently Asked Questions
- Formula Book
- Database of efficiency profiles
- Retired ETCs
- Historic ETC versions: select
- SkyCalc Sky Model Calculator

News and Notes

Feb 29, 2016: Release for CfP P98 phase1

- GRAVITY ETC: First public release
- MUSE ETC: New seeing/IQ PSF model
- SINFONI: Improved J-grating throughput
- VISIR imaging ETC: Updated sensitivity model
- CALVIN: Corrected observability criteria model
- GIRAFFE, VIMOS IFU,MOS and EFOSC2 spectroscopy: Bug fix in the sky transmission model
- SPHERE ETCs: Minor updates

ESO Exposure Time Calculators

	Imaging	Spectroscopy
La Silla	EFOSC2 SUSI WFI SOFI	EFOSC2 HARPS FEROS SOFI
Paranal UT1	NACO FORS2	NACO FORS2 KMOS
Paranal UT2		UVES UVES-FLAMES GIRAFFE X-SHOOTER
Paranal UT3	VISIR VIMOS SPHERE-IRDIS SPHERE-ZIMPOL	VISIR SPHERE-IFS VIMOS-MOS VIMOS-IFU
Paranal UT4	HAWK-I	SINFONI MUSE
Paranal VISTA	VIRCAM	
Paranal VST	OmegaCAM	
E-ELT	E-ELT	E-ELT
VLTI	GRAVITY VisCalc CalVin	

X-SHOOTER Exposure Time Calculator

X-SHOOTER Echelle Spectroscopy Mode Version 6.0.1

Description FAQ

Target Input Flux Distribution

(•) Template Spectrum	A0V (Pickles)	Redshift z = 0.00	Target Magnitude and Mag.System: V = 17.00 (•) Vega ( ) AB
( ) MARCS Stellar Model	Teff=4000 log(g)=-0.5 [Fe/H]= 0 M= 1		
( ) Upload Spectrum	Select...		
( ) Blackbody	Temperature: 11000 K		*Magnitudes are given per arcsec^2 for extended sources*
( ) Power Law	Index: 0.000 $F(\lambda) \propto \lambda^{index}$		
( ) Emission Line	Lambda: 650.00 nm Flux: 2.000 10^{-16} ergs/s/cm^2 *(per arcsec^2 for extended sources)* FWHM: 0.100 nm		

Spatial Distribution: (•) Point Source ( ) Extended Source

Sky Conditions

Moon phase: 3 days *from new Moon*

Airmass: 1.20

Seeing/Image Quality:

For point sources, the resulting Image Quality FWHM is approximated by a gaussian in the ETC considering the transfer functions of the atmosphere, telescope and instrument. See the helpfile for details.

(•) Seeing: 0.80 arcsec *FWHM in V-band at zenith* ***(use this value in the proposal)***

Probability ***60%*** *of realising the seeing ≤ 0.8 arcsec*

( ) IQ: 0.80 arcsec *FWHM at the airmass and wavelength of observation* ***(to be used for the OB constraint set)***

Instrument Setup

Arm selection, Exposure Times and Detector modes:

Arm	Slit Width	Exp.Time	NDIT	NEXP or NINT	Detector Mode (gain) (spectral×spatial binning) (readmode)
☑ UVB:	1".0	Texp: 900.000 s		NEXP: 1	high 1x1 slow
☑ VIS:	0".9	Texp: 900.000 s		NEXP: 1	high 1x1 slow
☑ NIR:	0".9 (see note below)	DIT: 900.000 s	NDIT: 1	NINT: 1	

Note! *The current version of the ETC includes the 0.6" and 0.9" NIR slits without the K band blocking filter. For the preliminar*
to the X-shooter User Manual.

In UVB and VIS, the total exposure time is the product of DIT (Detector Integration Time) and NEXP (Number of EXPosures):

In NIR, the total exposure time is the product of DIT (Detector Integration Time), NDIT (Number of DITs) and NINT (Number o

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Results

☐ Include exposure times for S/N: 10.000 *(currently not enabled for NIR)*

Tables: ☑ *Toggle All / No Tables*

- ☑ Spectral Format
- ☑ Expected Counts

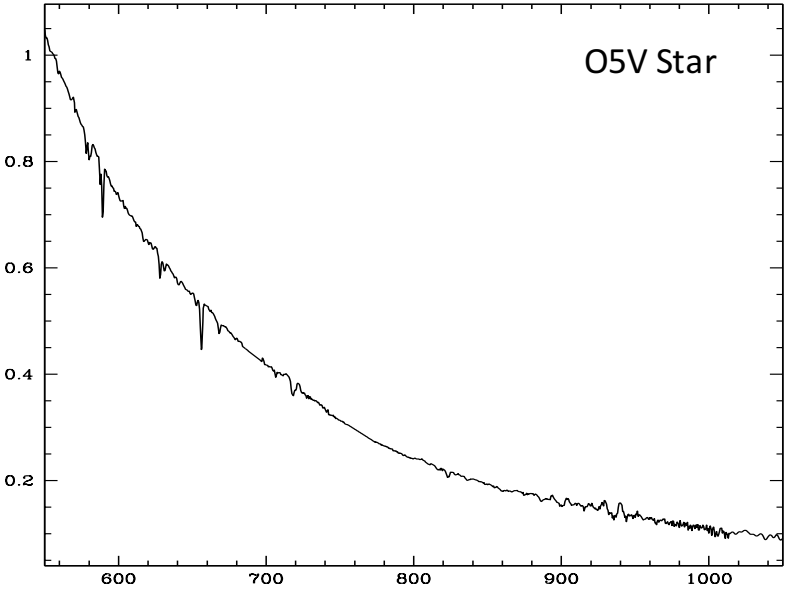
Graphs: ☐ *Toggle All / No Graphs*

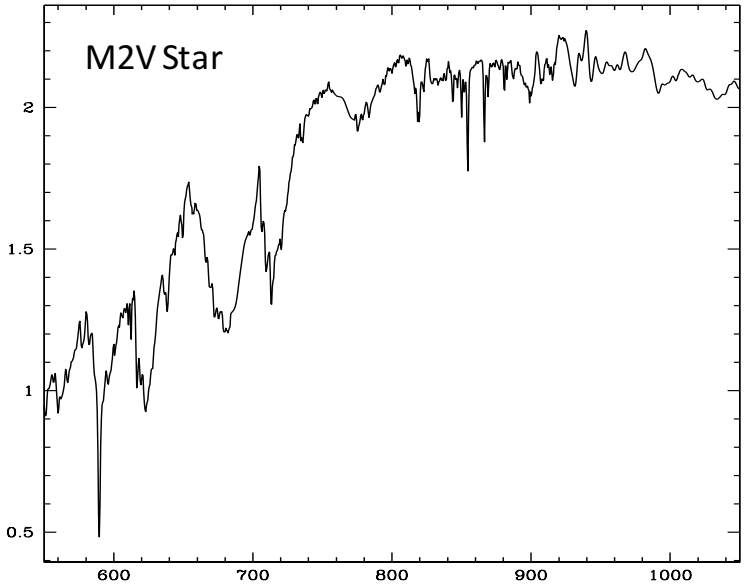
- ☐ Input Spectrum
- ☐ Efficiency
- ☐ Obj
- ☐ Sky
- ☐ Maximum Intensity
- ☐ S/N

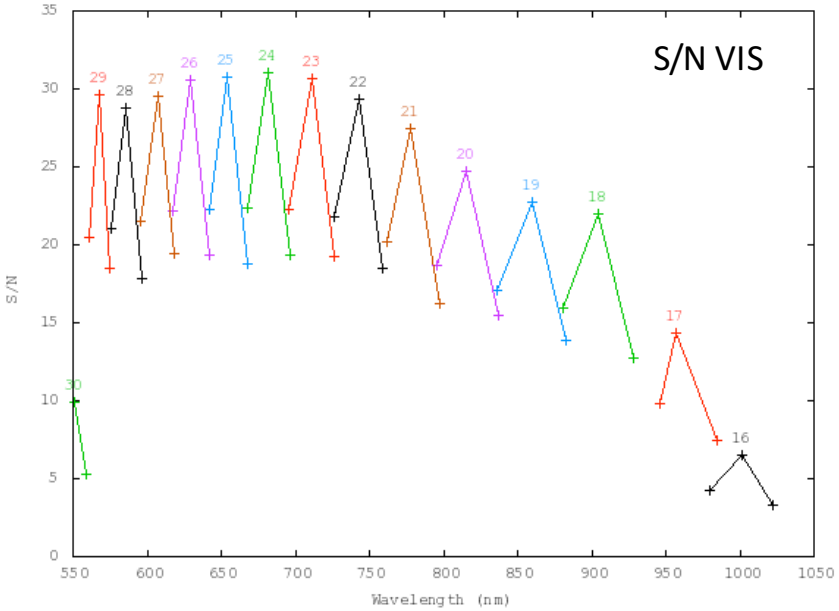
The Exposure Time Calculator (ETC)

https://www.eso.org/observing/etc/

Input Parameters		Output Parameters
Input Flux Distribution		...
Spatial Distribution		Exposure Time
Sky Conditions	⟶	S/N
Instrument Setup		Sky background value
Requested S/N		Detector saturation
		...


O5V Star
1
0.8
0.6
0.4
0.2
600
700
800
900
1000


M2V Star
2
1.5
1
0.5
600
700
800
900
1000


S/N VIS
S/N
Wavelength (nm)
35
30
25
20
15
10
5
0
550
600
650
700
750
800
850
900
950
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1050
29
28
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22
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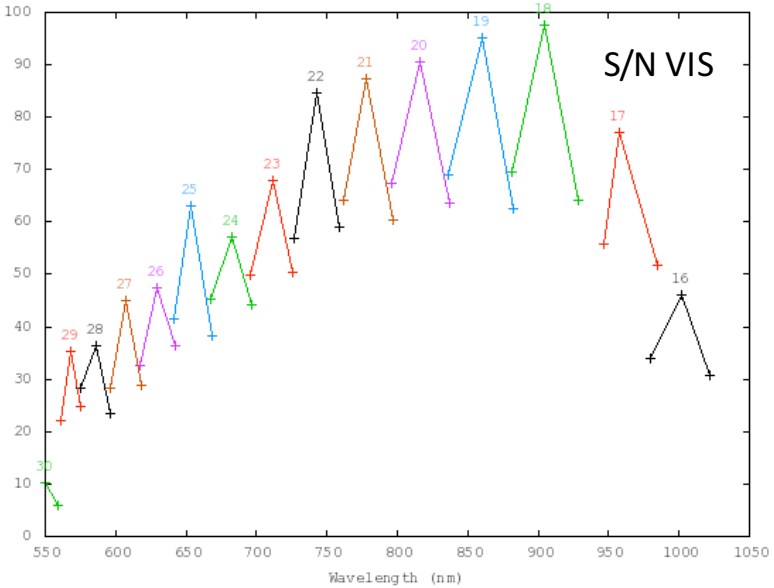
19
18
17
16
30


S/N VIS
Wavelength (nm)
100
90
80
70
60
50
40
30
20
10
0
550
600
650
700
750
800
850
900
950
1000
1050
29
28
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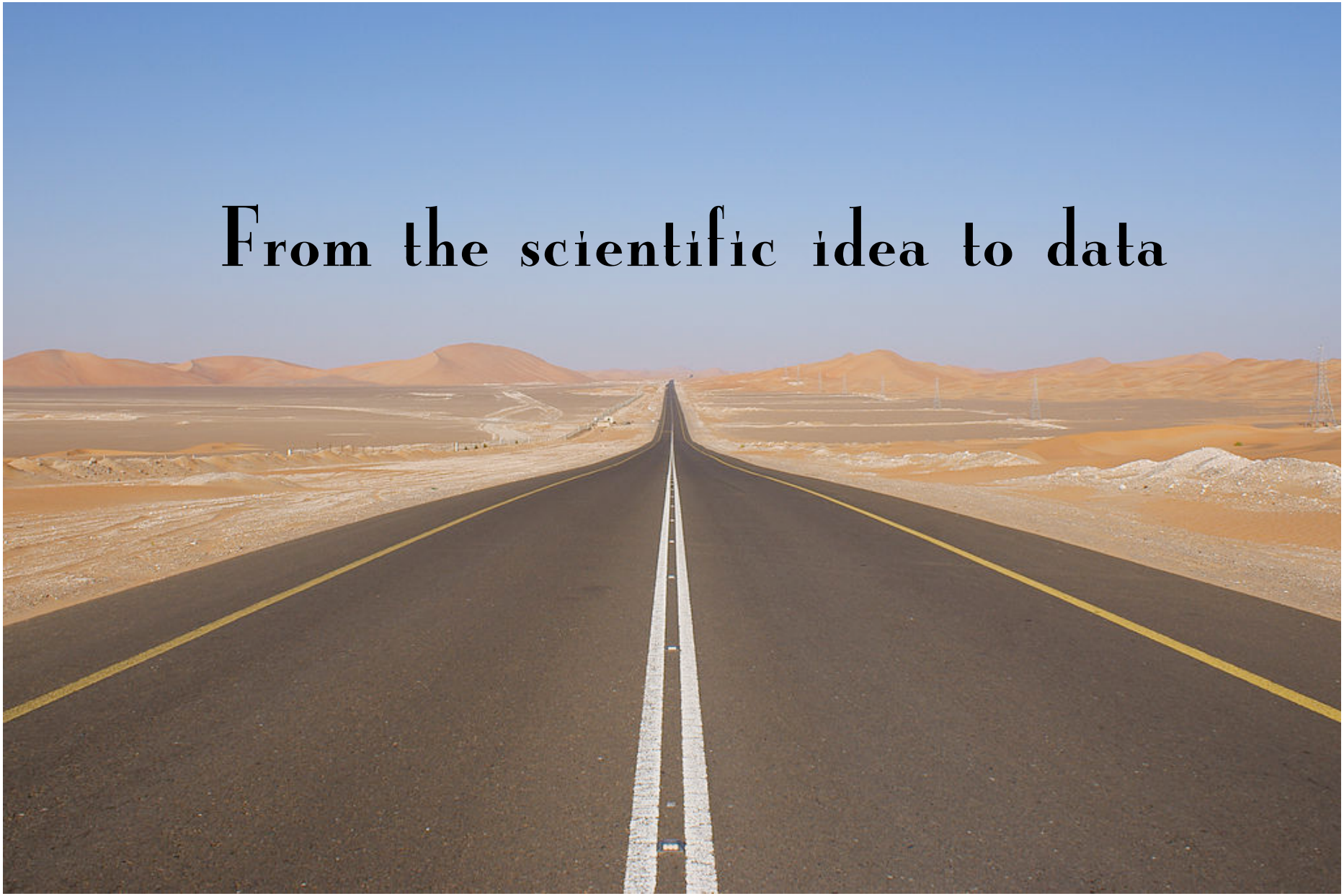
26
25
24
23
22
21
20
19
18
17
16
30


From the scientific idea to data

From the scientific idea to data

The data I need are in the ESO archive

☺
☺
☺
☺

Done!!!

Presentation from Magda Arnaboldi

The data I need are NOT in the ESO archive

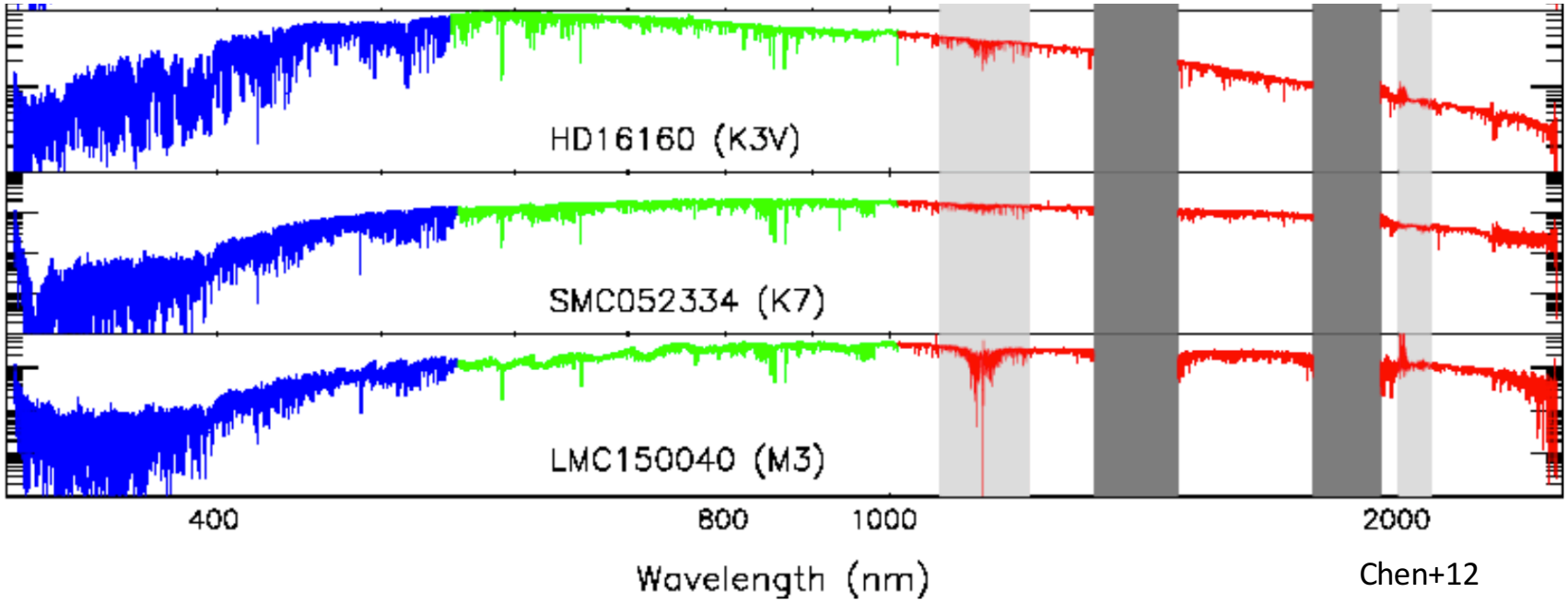
☹
☹
☹
☹

Proposals

Presentations from Gaitee Hussain and Marina Rejkuba

Setting-up X-Shooter

Setting-up X-Shooter



Chen+12

UVB → NIR

Chapter 3

Observing in the IR

3.1 The IR Sky

Observing in the IR is more complex than observing in the optical. The difference arises from a higher and more variable background, by stronger atmospheric absorption and telluric emission throughout the 1 to 2.5 micron wavelength region.

Short-ward of 2.3 microns, the background is dominated by non-thermal emission, principally by aurora, OH and O_2 emission lines. The vibrationally excited OH lines are highly variable on a time scale of a few minutes. Pronounced diurnal variations also occur. The lines are strongest just after sunset and weakest a few hours after midnight. A complete description and an atlas of the sky emission lines can be found in the paper by Rousselot et al. (2000, A&A 354, 1134).

Long-ward of 2.3 microns, the background is dominated by thermal emission from both the telescope and the sky, and is principally a function of the temperature. The background in K_s can vary by a factor of two between the winter and summer months but is more stable than the J or H band background on minute-long time-scale. It also depends on the cleanliness of the primary mirror. Imaging in broadband K_s and the wide field objective can result in backgrounds of 600-700 ADU/sec, depending strongly on the temperature and humidity.

The IR window between 1 and 2.5 microns contains many absorption features that are primarily due to water vapor and carbon dioxide in the atmosphere. These features are time varying and they depend non-linearly with airmass. The atmosphere between the J and H bands and between the H and K bands is almost completely opaque. The atmospheric transmittance between 1 and 2.5 microns as seen by SOFI is plotted in Appendix B. As the amount of water vapor varies so will the amount of absorption. The edges of the atmospheric windows are highly variable which is important for the stability of the photometry in J and K_s filters.

These difficulties have led to the development of specific observing techniques for the IR. These

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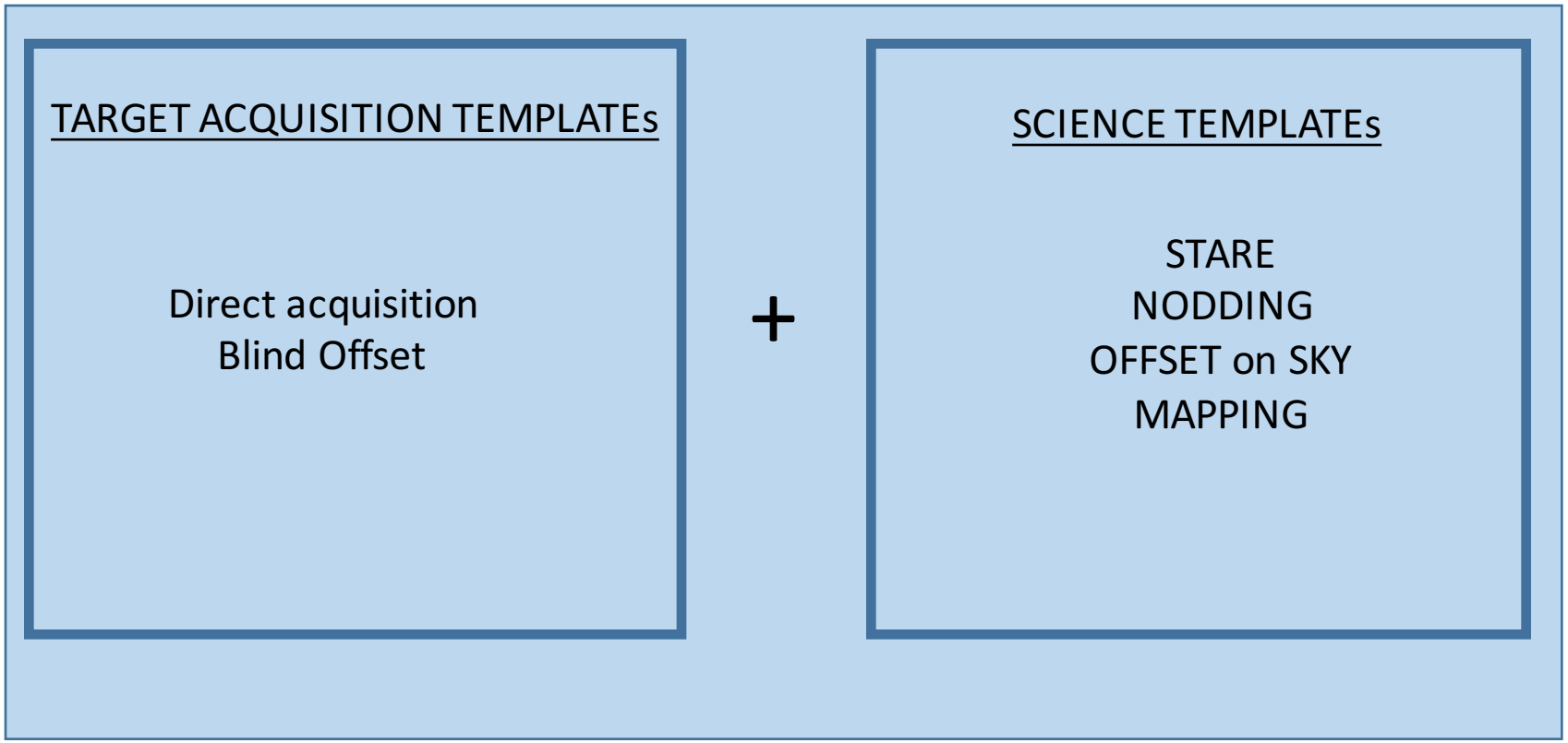
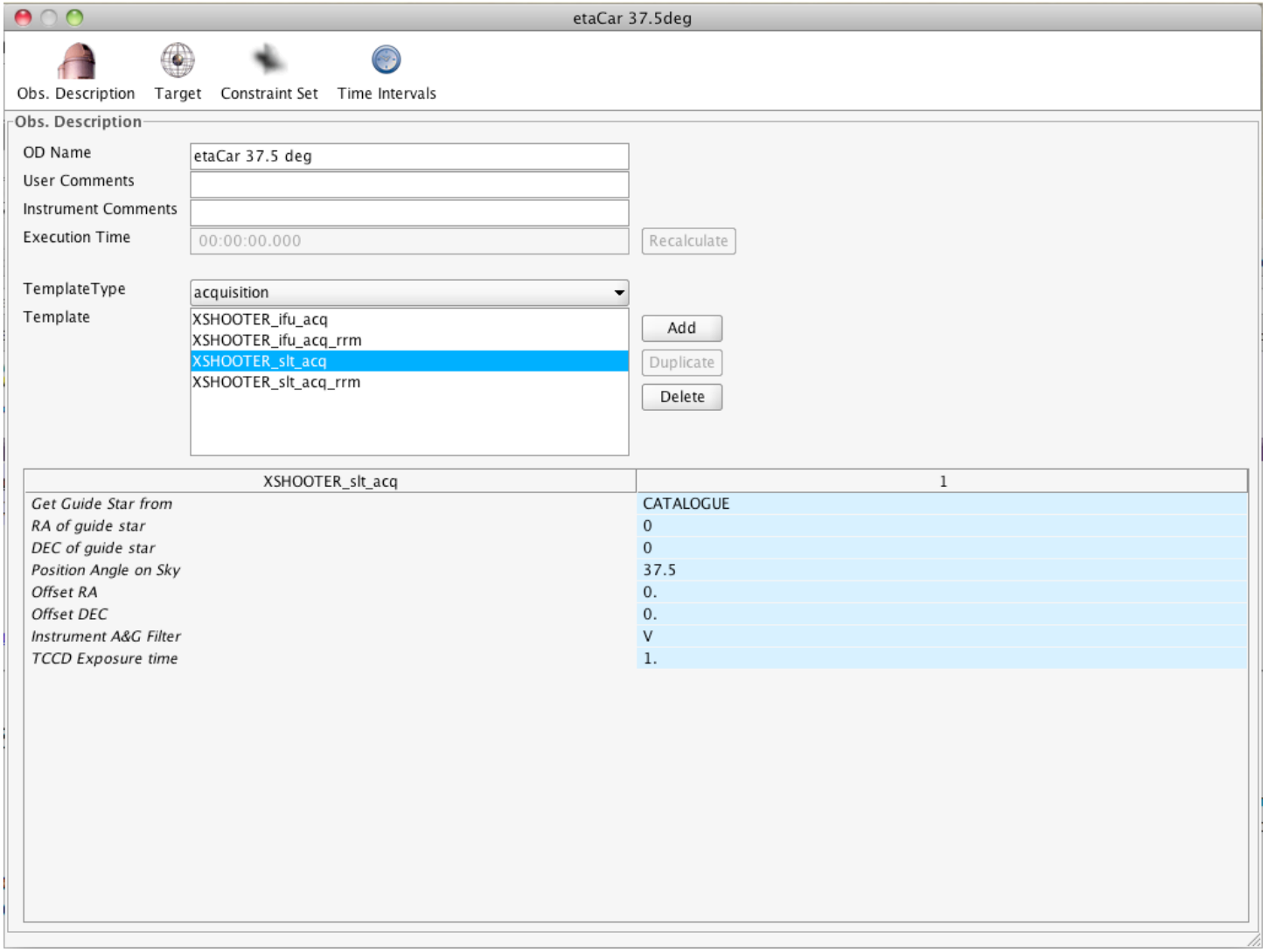
Setting-up X-Shooter: OB design and P2PP

Observing Block



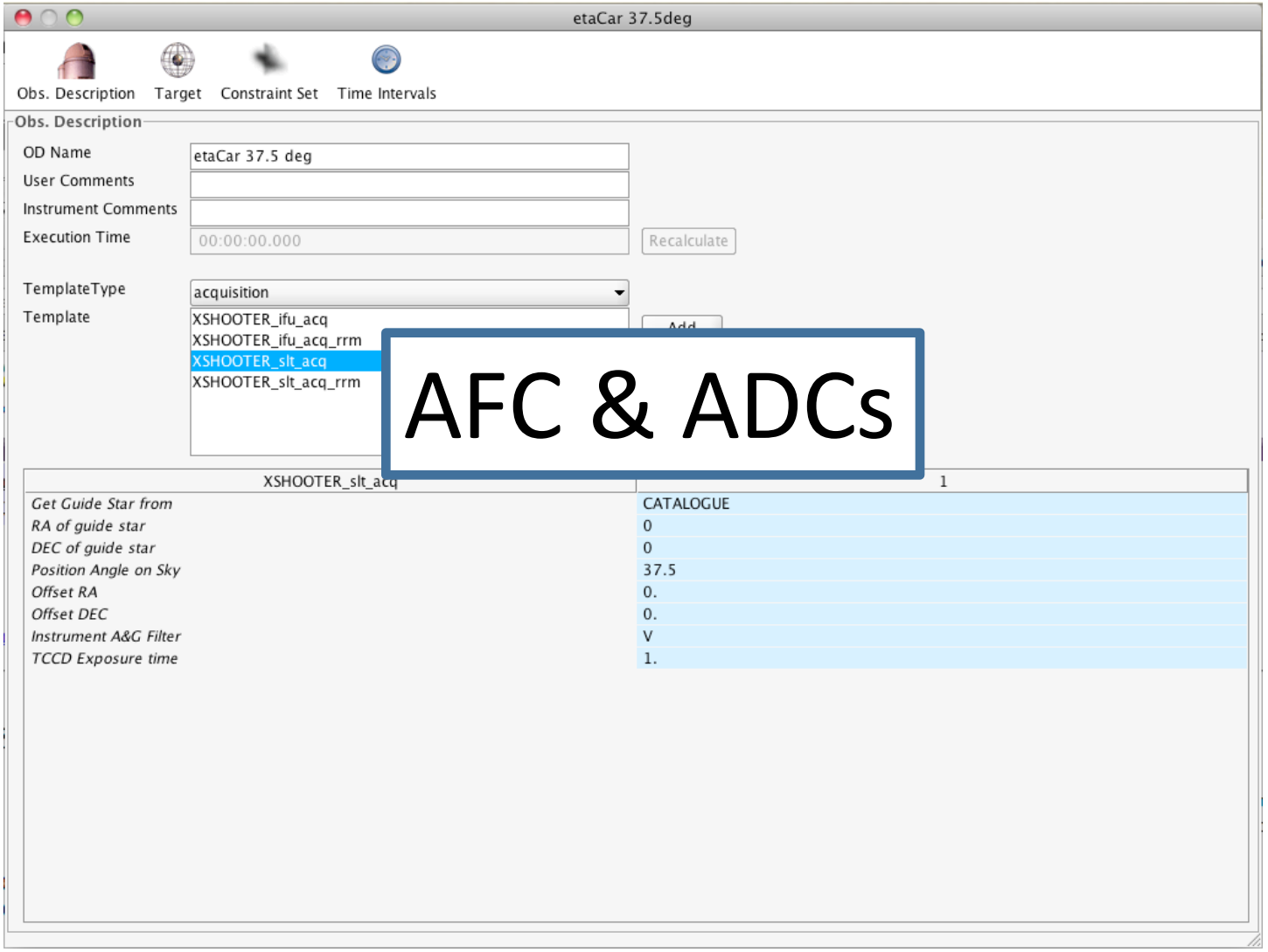
Setting-up X-Shooter: OB design and P2PP

TARGET ACQUISITION



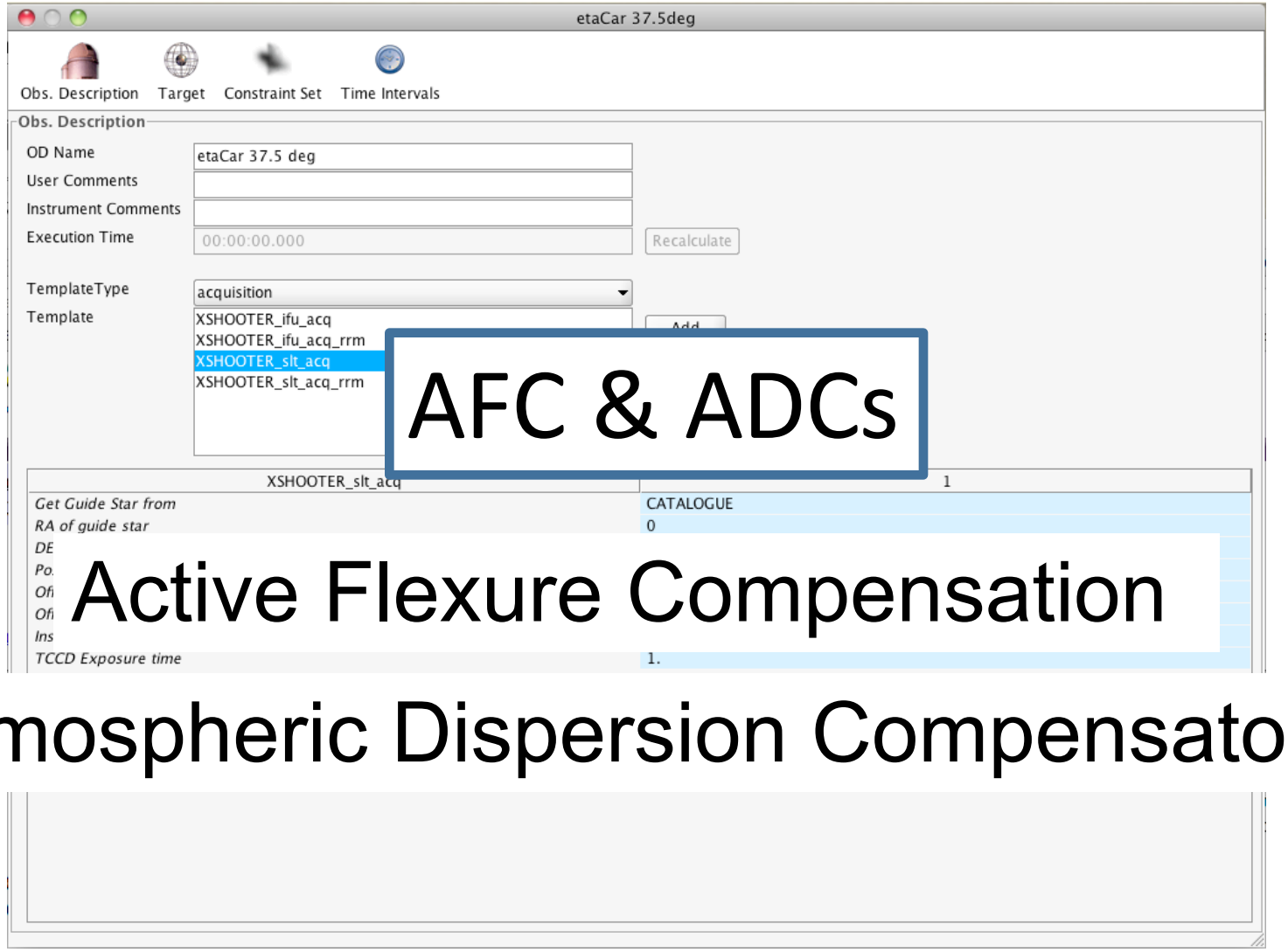
Setting-up X-Shooter: OB design and P2PP

TARGET ACQUISITION



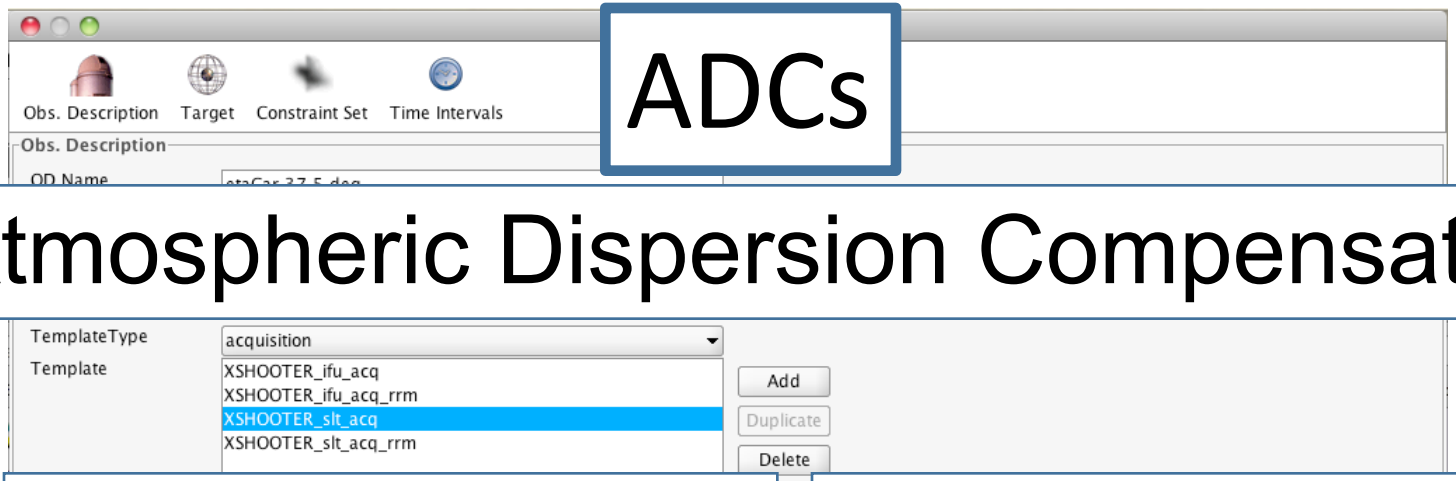
Setting-up X-Shooter: OB design and P2PP

TARGET ACQUISITION



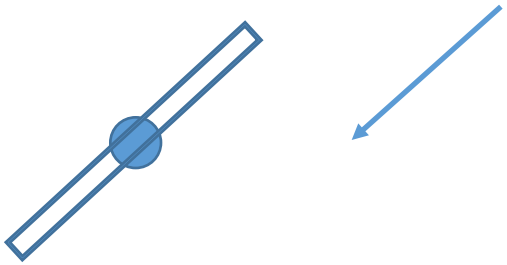
Setting-up X-Shooter: OB design and P2PP

TARGET ACQUISITION



ADCs

Atmospheric Dispersion Compensators



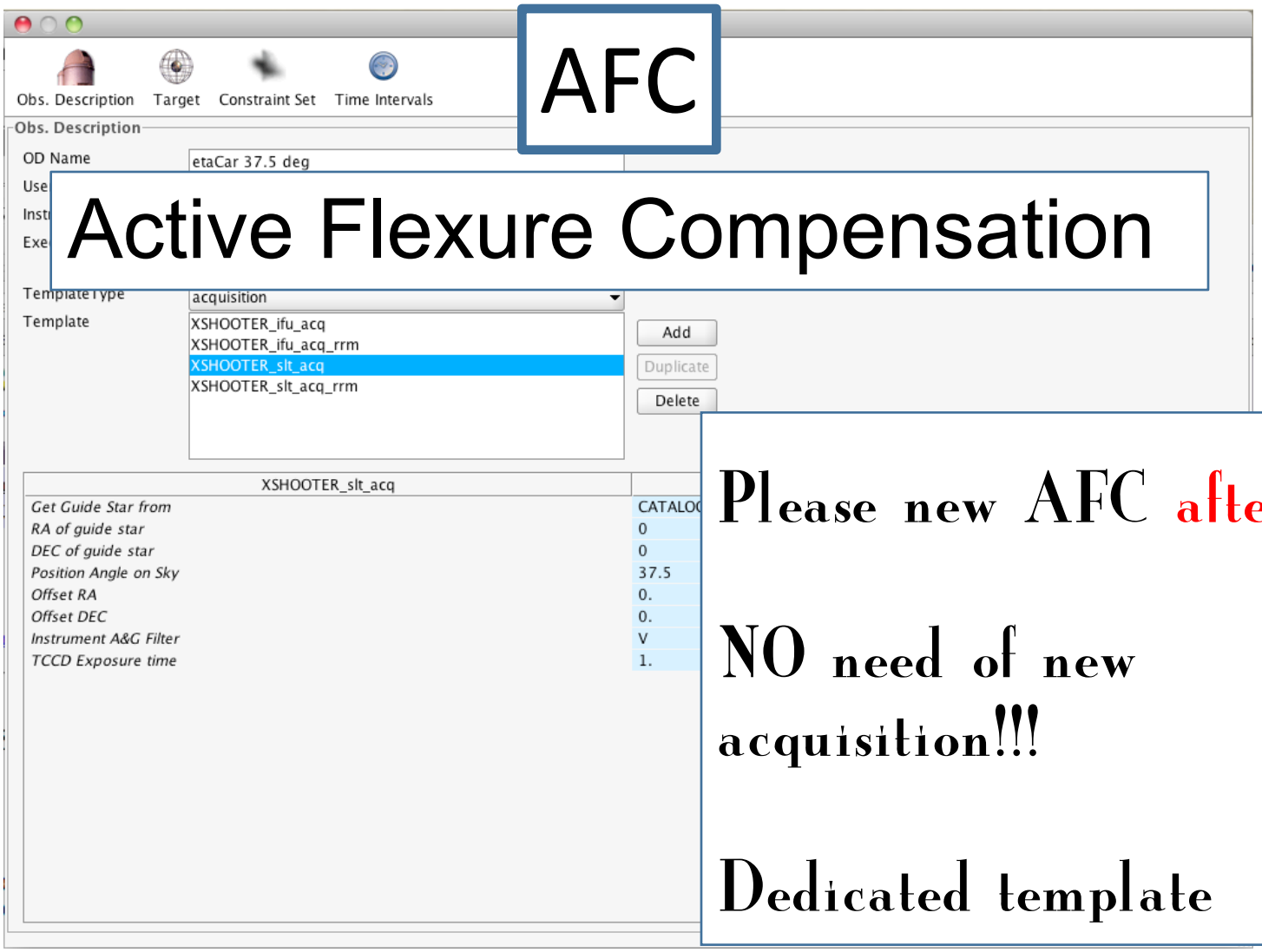
NOT following the PA

Please re-align after 1h

i.e. new acquisition!!!

Setting-up X-Shooter: OB design and P2PP

TARGET ACQUISITION



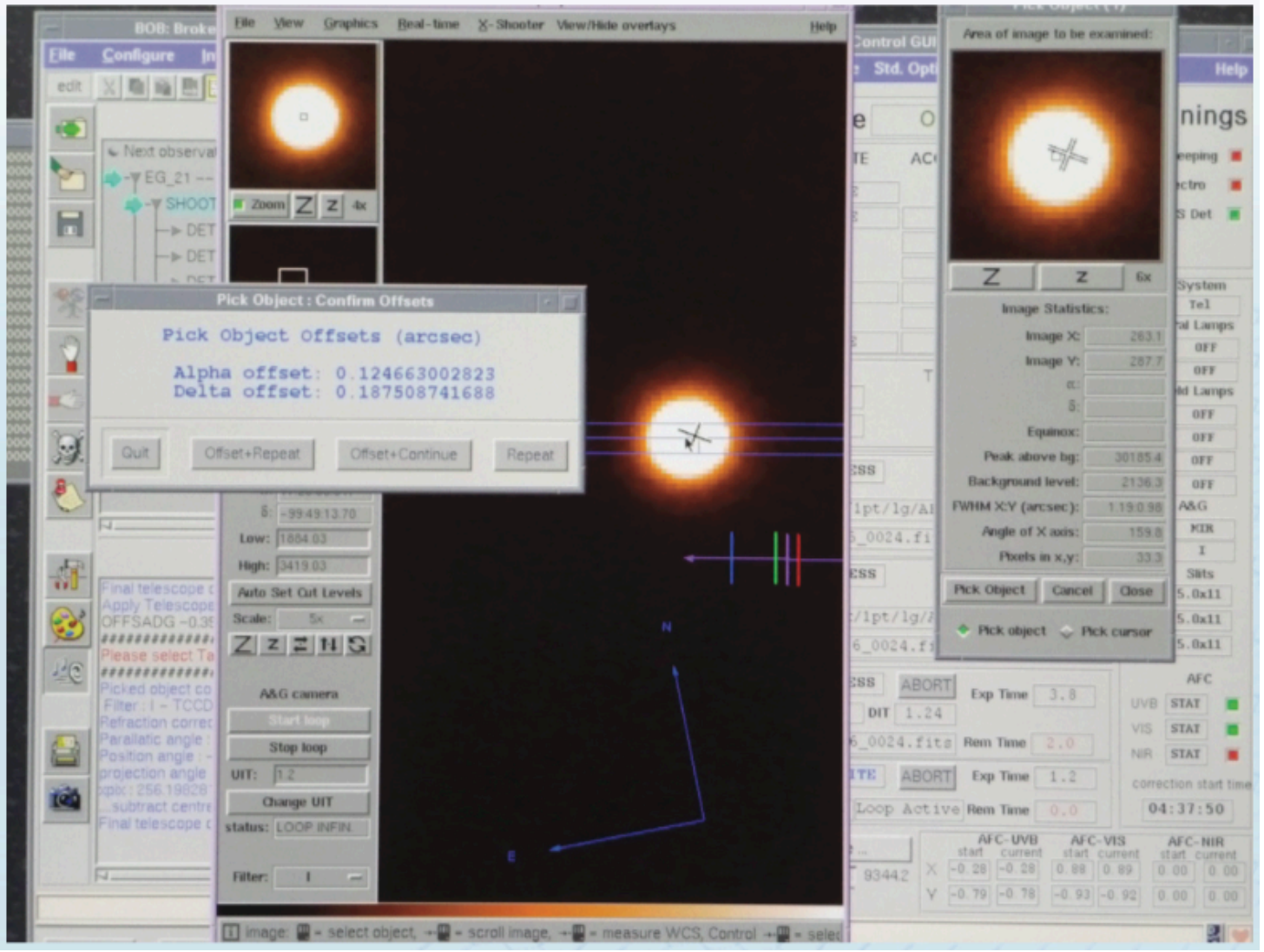
Please new AFC after 1h

NO need of new acquisition!!!

Dedicated template

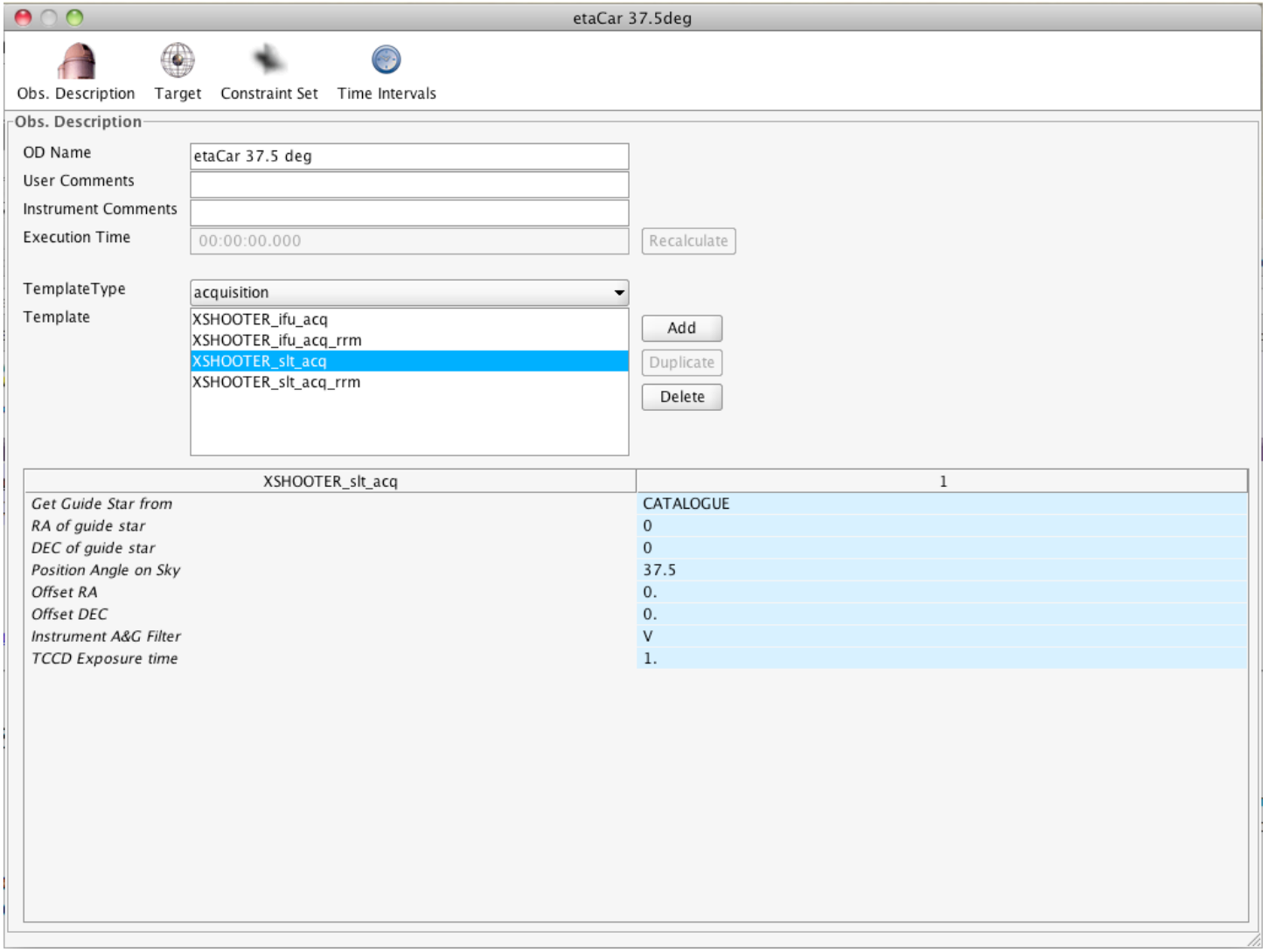
TARGET ACQUISITION

Acquisition Camera: NO IR FILTERS!!!



Setting-up X-Shooter: OB design and P2PP

TARGET ACQUISITION



TARGET ACQUISITION

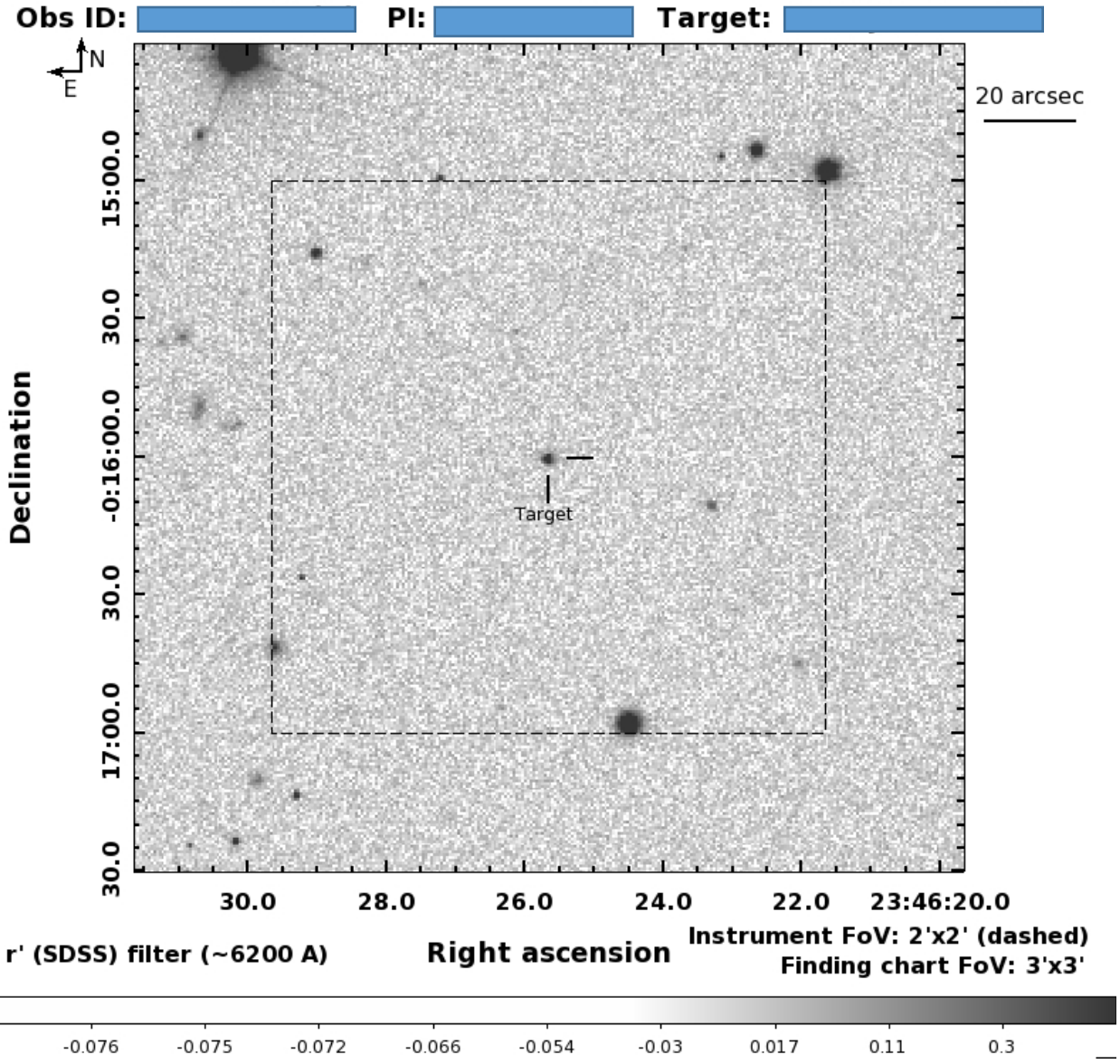
Direct Acquisition vs Blind Offset

Table 3: Limiting magnitudes for direct acquisition (TCCD exposure times of 60-120 s).

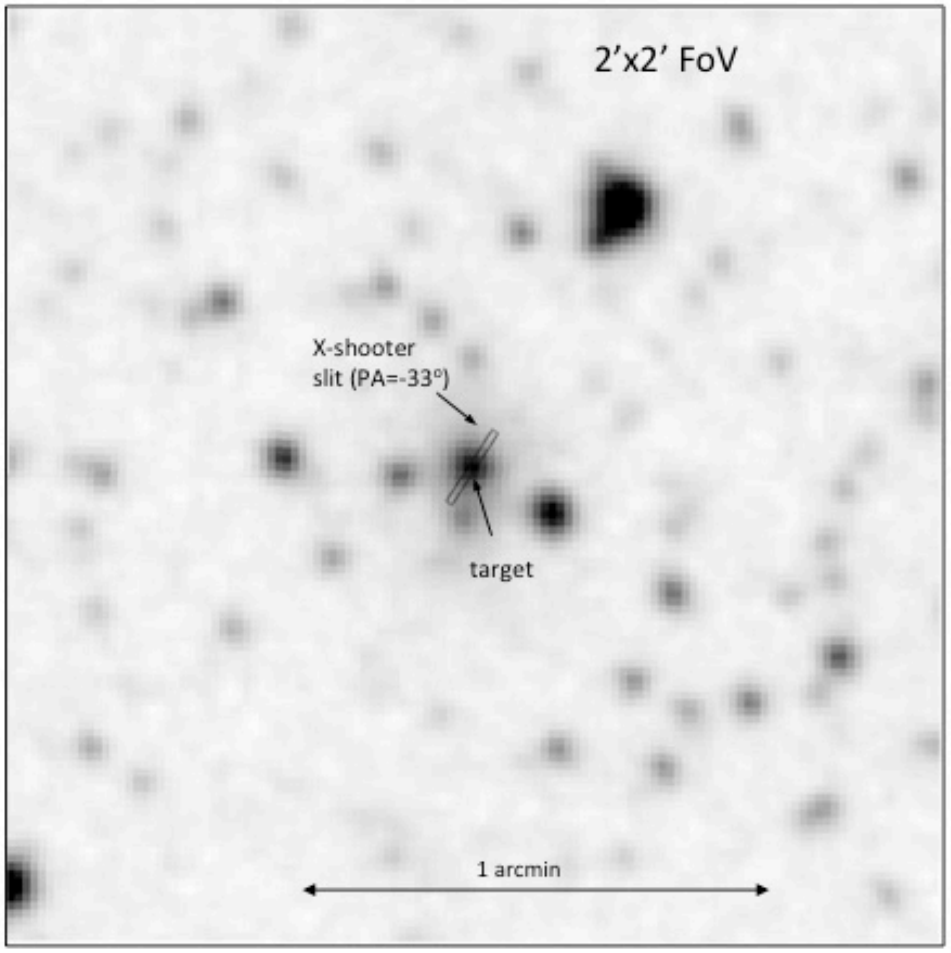
Band	**U**	**B**	**V**	**R**	**I**
Limiting magnitude (mag)	22	22	22.5	22.5	22.5
Limiting magnitude (mag)	30	30	20	20	20
Band	**u_prime**	**g_prime**	**r_prime**	**i_prime**	**z_prime**
Limiting magnitude (mag)	21	21	21	20	20
Limiting magnitude (mag)	30	30	30	30	30

Recommended exposure times for the acquisition of bright targets:
V = 6 mag: 0.001 s
V = 7 mag: 0.005 s
V = 16-20 mag: 1 to 5 s
V = 23 mag: 60-120 s
V >= 24 mag: ≥ 180 s

TARGET ACQUISITION
The Finding Chart

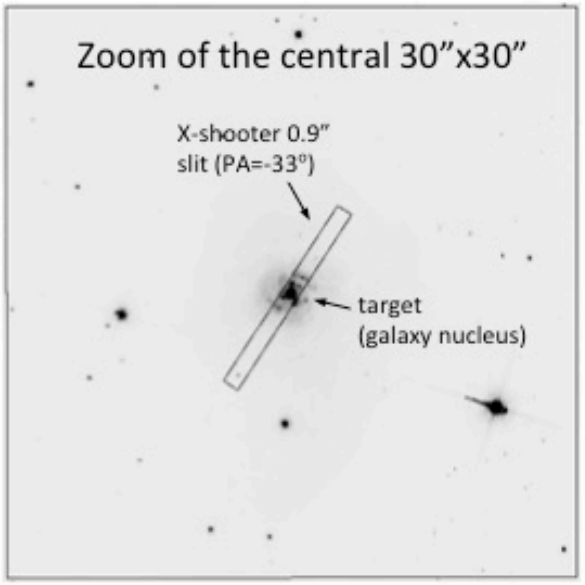


TARGET ACQUISITION
The Finding Chart

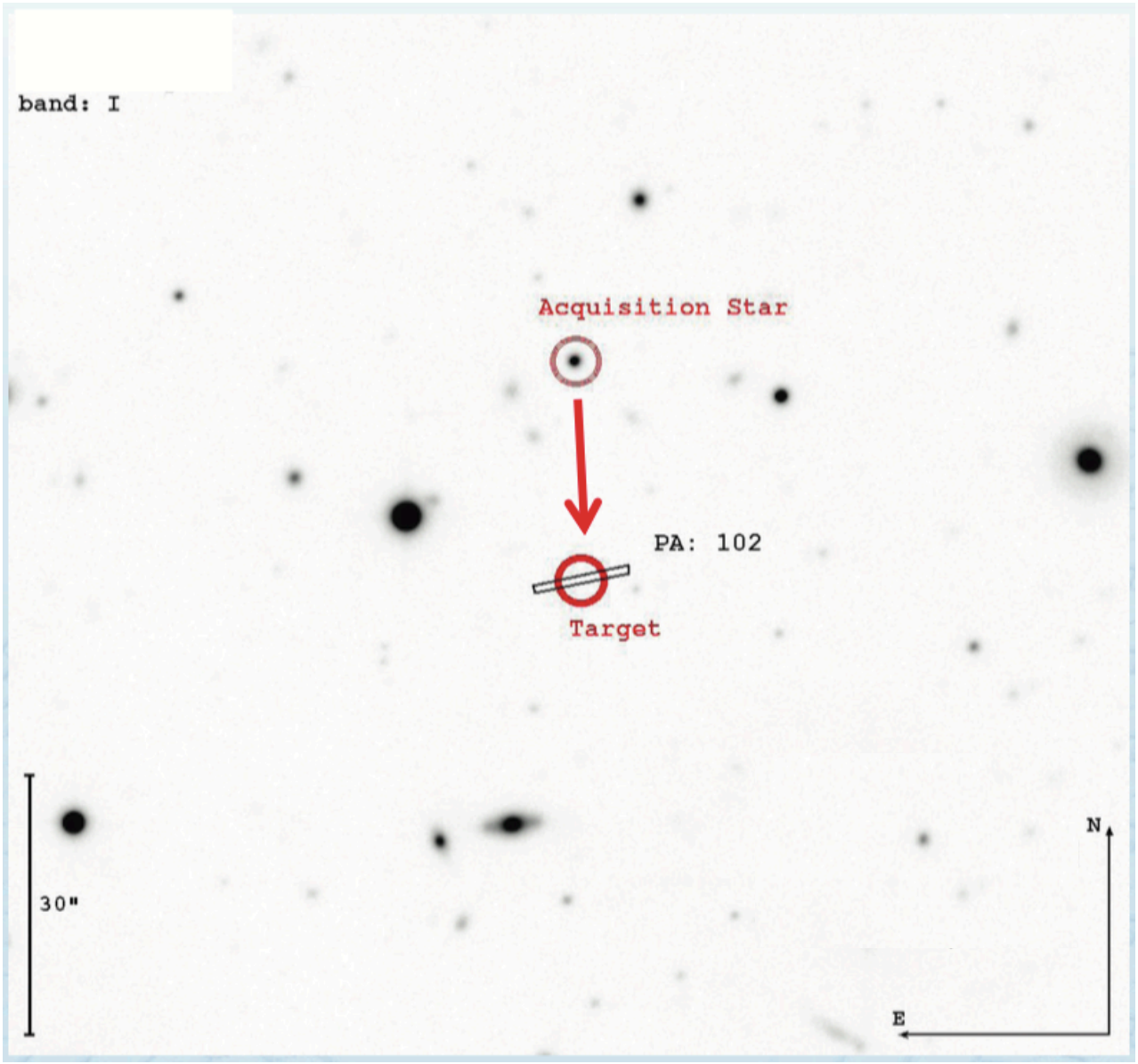


Prog. ID: [redacted]
PI: [redacted]
OBs: [redacted] *
Target: [redacted]

Images in I-band

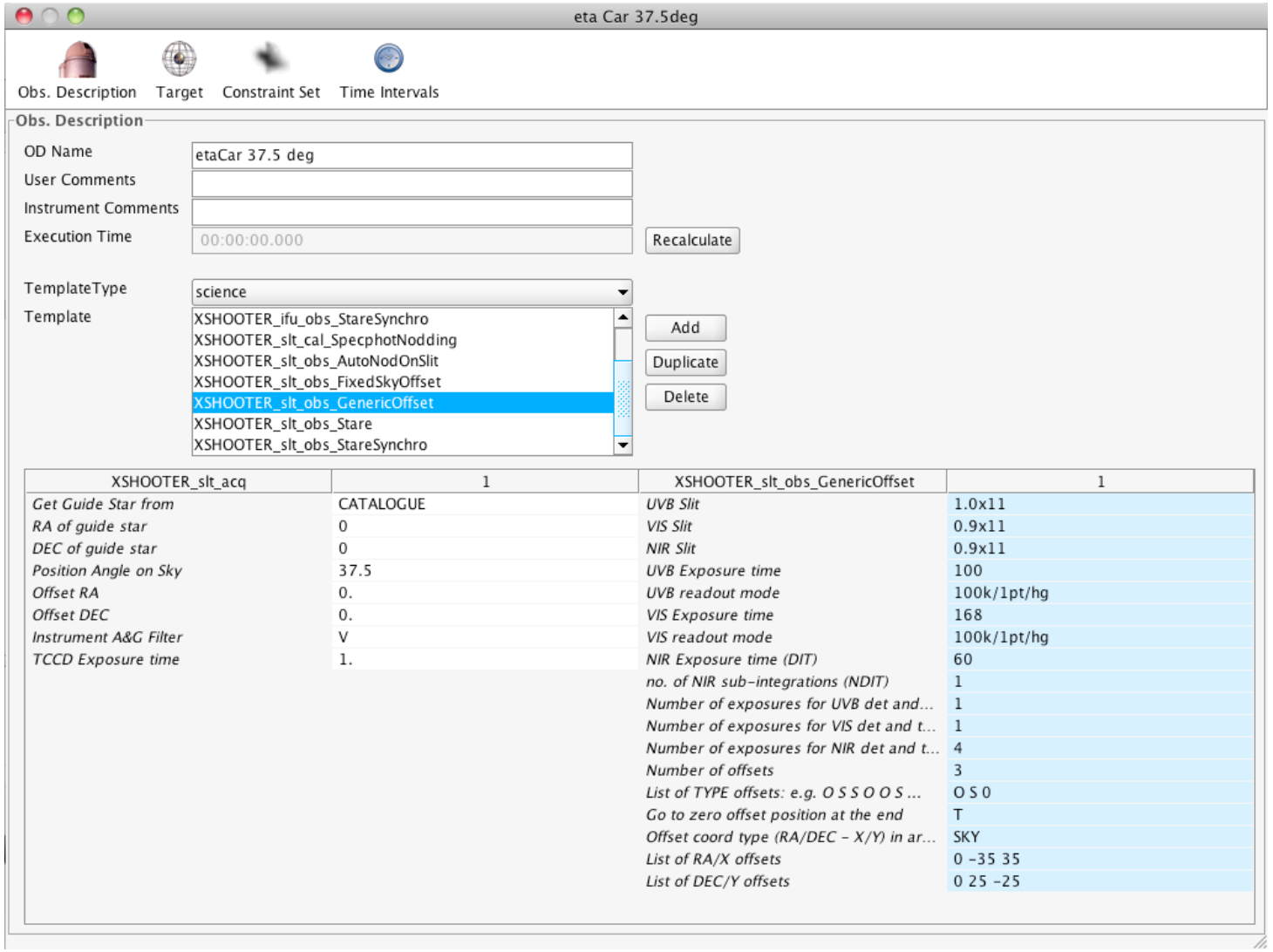


TARGET ACQUISITION
The Finding Chart



Setting-up X-Shooter: OB design and P2PP

SCIENCE TEMPLATE



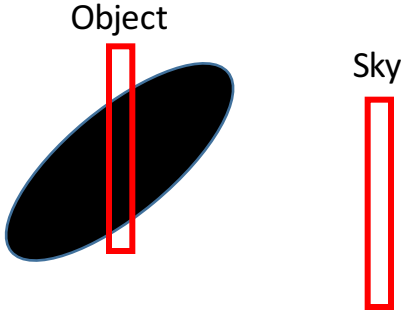
Setting-up X-Shooter

Staring, nodding or on-off?

• Staring:
mostly UVB and VIS

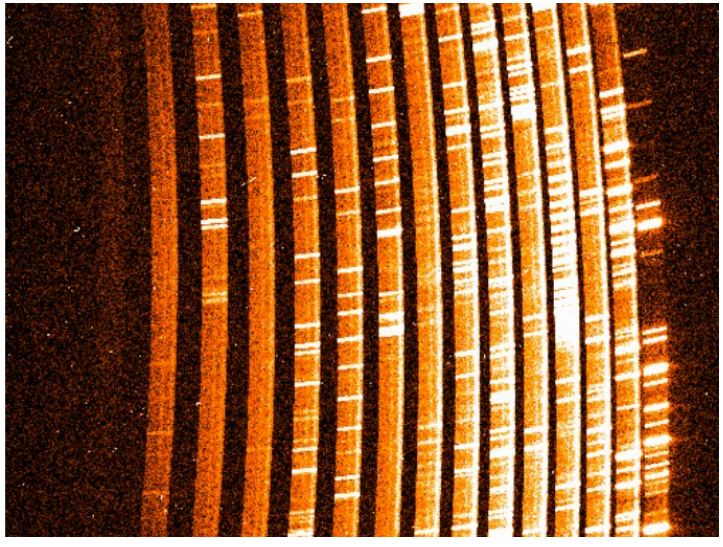
• Nodding:
NIR sky subtraction

• Fixed or Generic offset:
extended objects, mapping

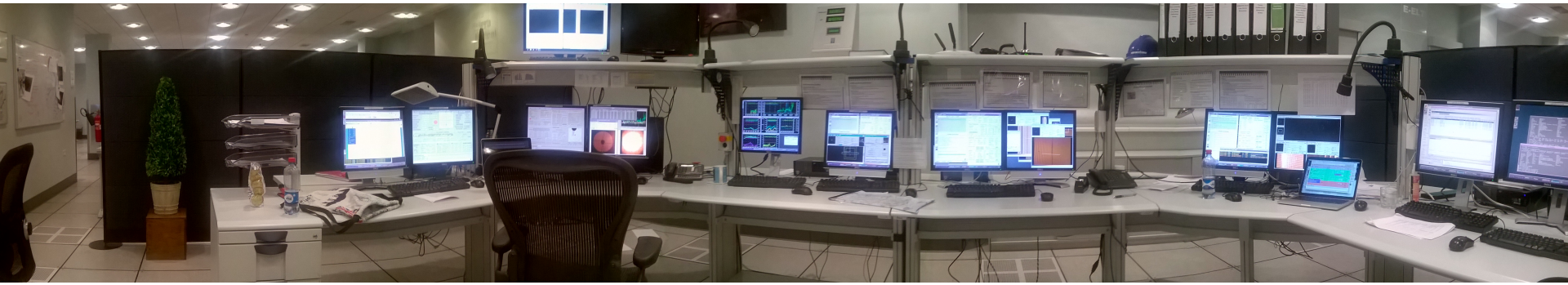


Binning : 1x1, 1x2, 2x2

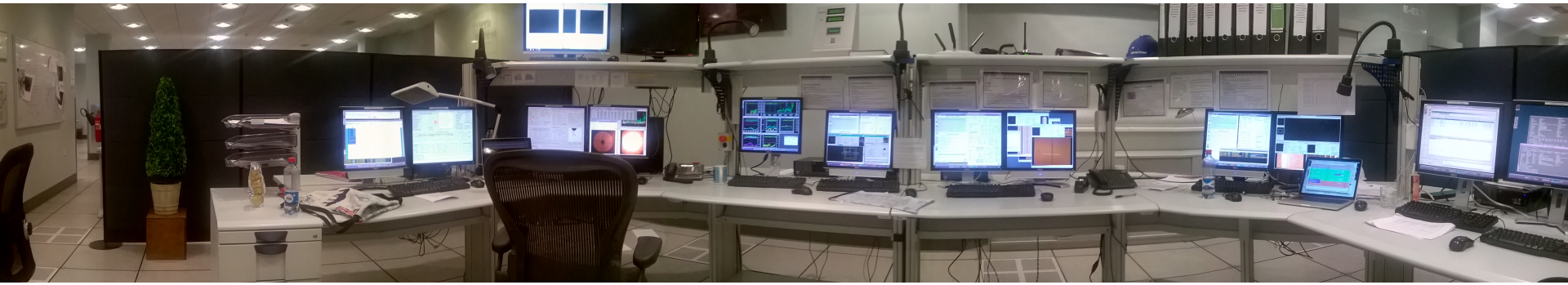
• 2x2: in the red part of the VIS order spacing is minimum (~4 pixels), binning in the spatial direction can compromise a good inter-order background subtraction



Welcome to Paranal!!!

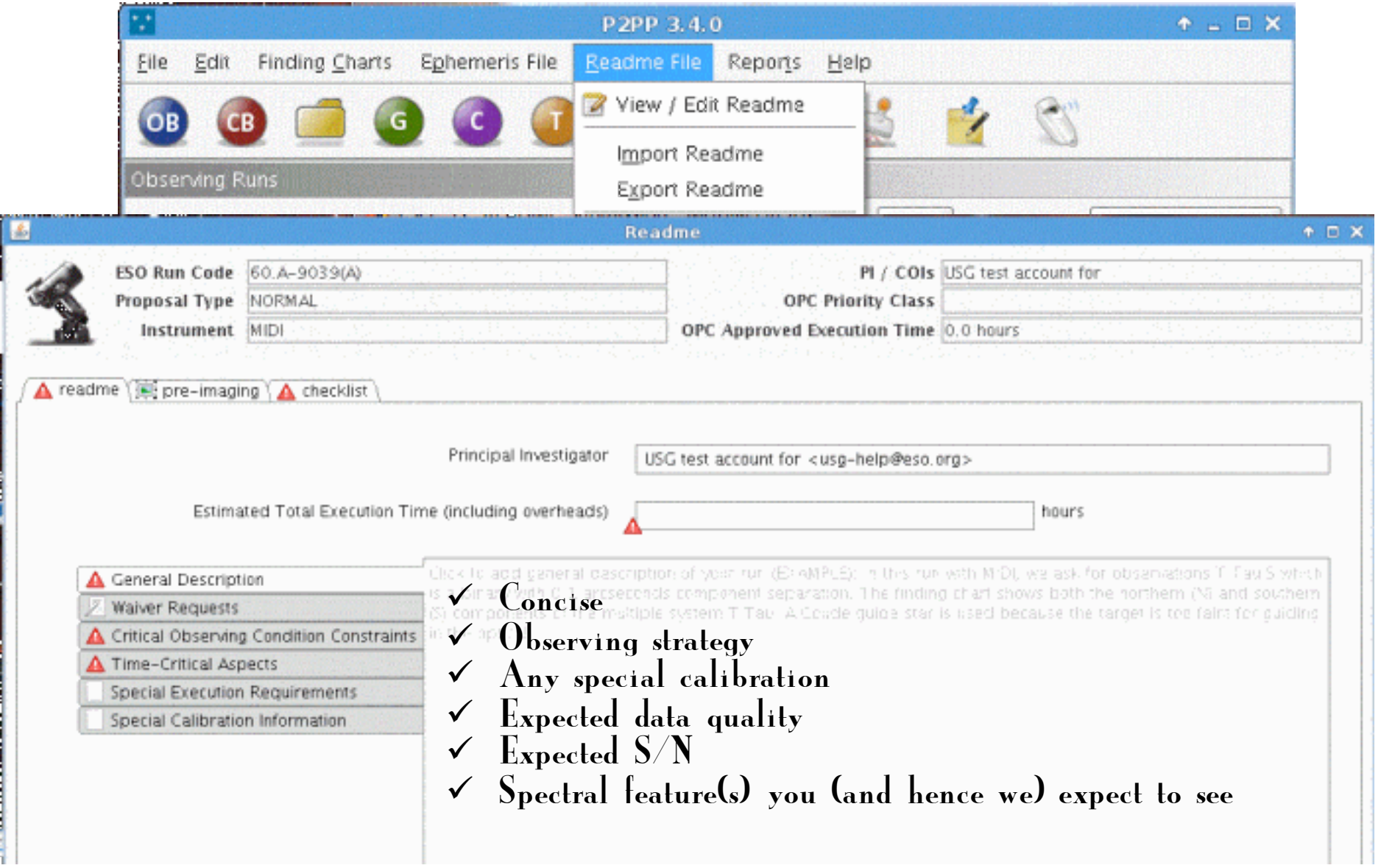


Welcome to Paranal!!!



- ✓ Telescope Operator and Astronomers are very busy
- ✓ Weather conditions can change very rapidly
- ✓ There are more than 100 programs to run at the telescope
- ✓ We care about your data and your science

Please write a good README!!!



- ✓ Concise
- ✓ Observing strategy
- ✓ Any special calibration
- ✓ Expected data quality
- ✓ Expected S/N
- ✓ Spectral feature(s) you (and hence we) expect to see

Conclusion:

1- start with a "clear" science goal

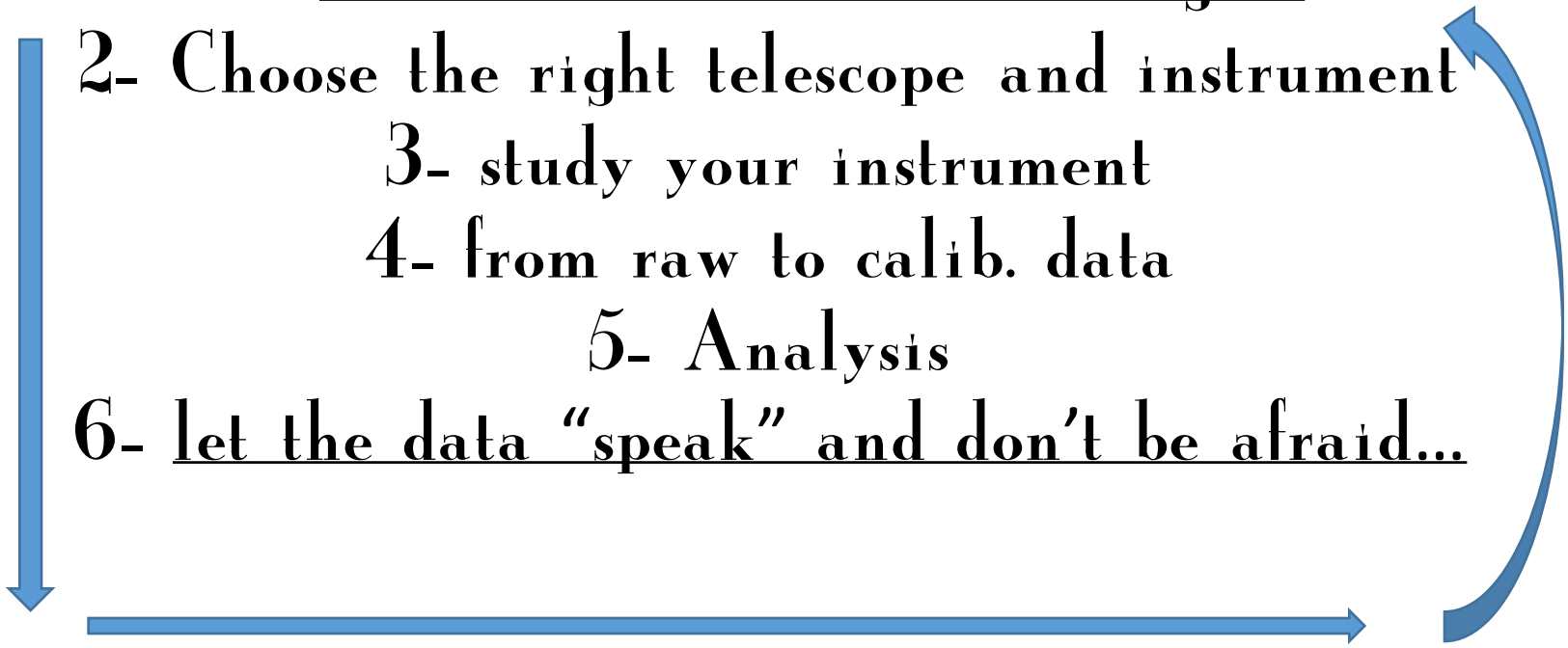
2- Choose the right telescope and instrument

3- study your instrument

4- from raw to calib. data

5- Analysis

6- let the data "speak" and don't be afraid...



The END