VLTI Observing Preparation Sequence

EuroWinter School

Observing with the Very Large Telescope Interferometer

Les Houches, France
February 3-8, 2002

F. Malbet

Laboratoire d'Astrophysique de Grenoble

7 February 2002

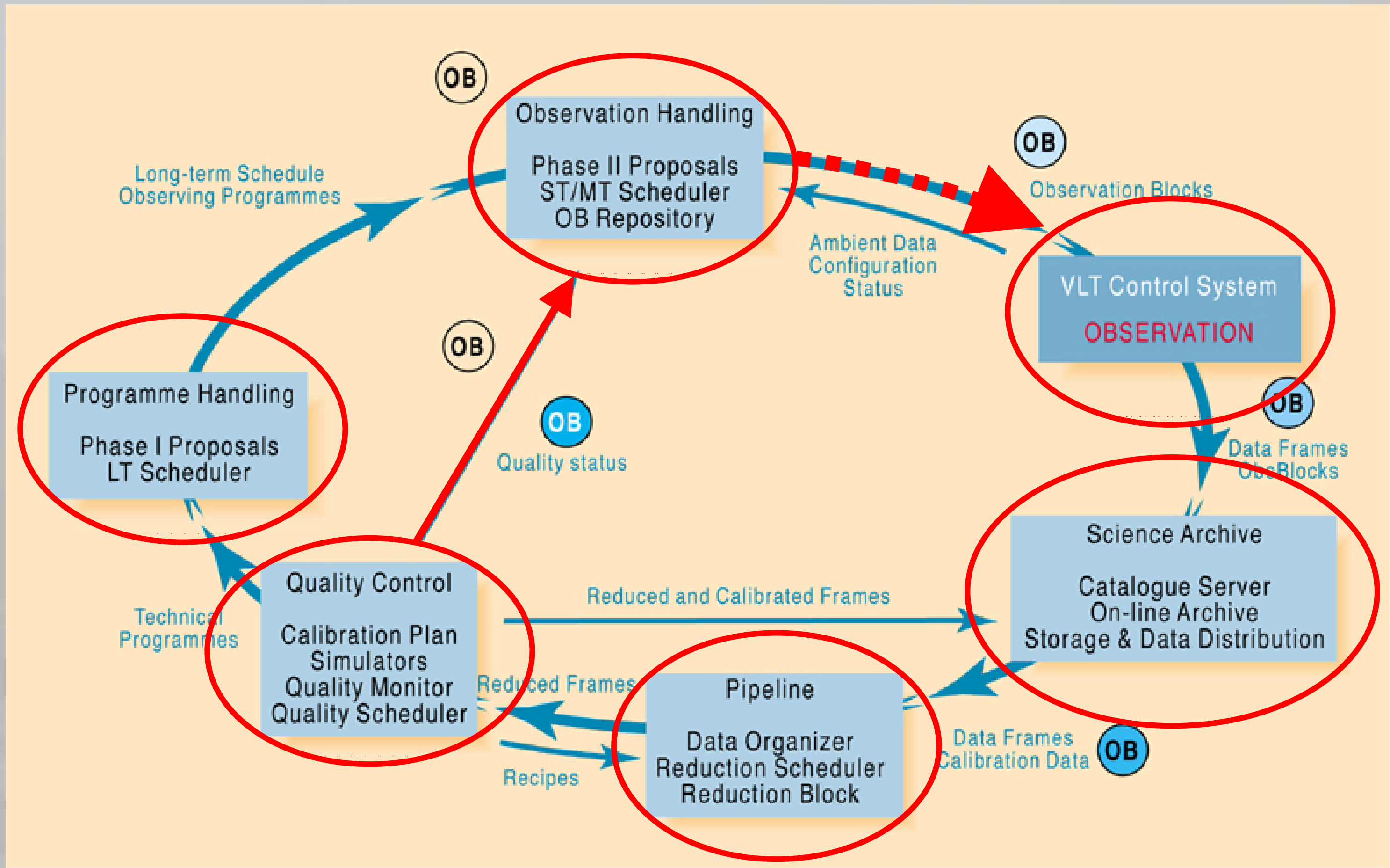
Outline

I. Context of interferometric observations with the VLTI
   - ✓ VLT data flow system (DFS)
   - ✓ VLTI status
   - ✓ Phase 1 proposal preparation

II. Observing preparation sequence:
   - ✓ Definition of astrophysical objectives
   - ✓ Estimation of technical feasibility
   - ✓ VLTI configuration
   - ✓ Instrument configuration
   - ✓ Calibration stars
   - ✓ Estimation of required time
   - ✓ Data reduction

III. Practical working session

VLT data flow system (DFS)



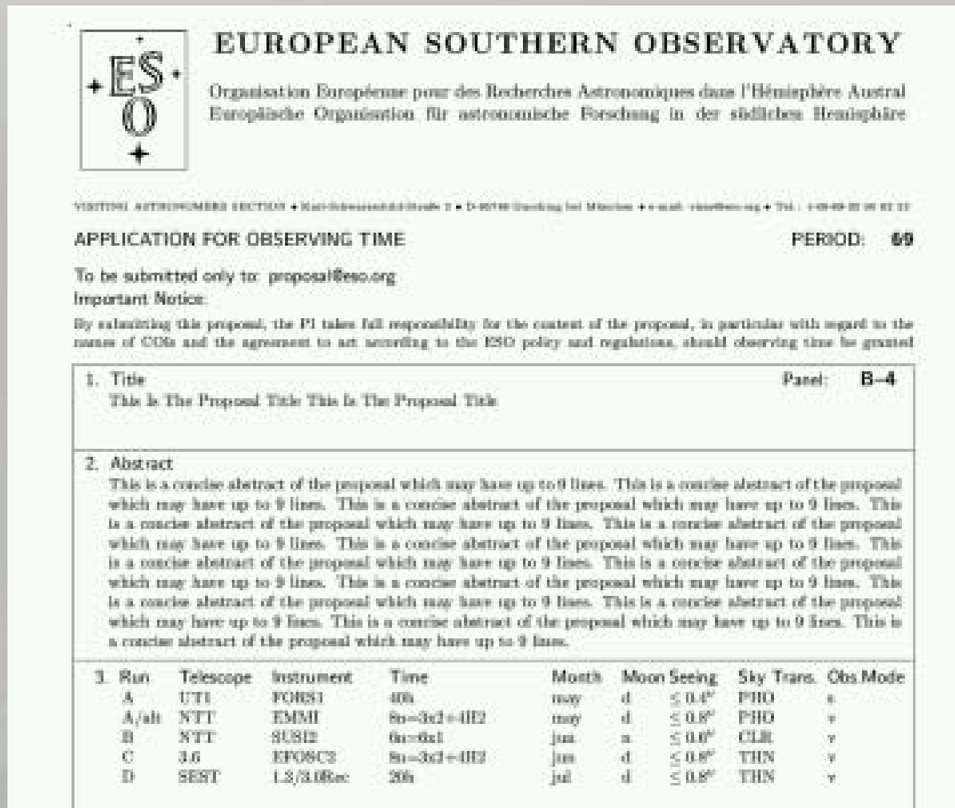
The VLT Data Flow System

ESO PR Photo 25a/99 (21 June 1999)

VLT Data Flow System: Programme Handling (1)

▶Usual proposal preparation (phase 1)

- Scientific rationale
- Immediate objectives
- Instrument configuration
- Technical feasibility
- Estimation of required time



EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

[illegible]

APPLICATION FOR OBSERVING TIME — PERIOD: 69

To be submitted only to: proposal@eso.org
Important Notice:

By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of COIs and the agreement to act according to the ESO policy and regulations, should observing time be granted

1. Title — Panel: B–4
This Is The Proposal Title This Is The Proposal Title

2. Abstract
This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines. This is a concise abstract of the proposal which may have up to 9 lines.

3. Run	Telescope	Instrument	Time	Month	Moon	Seeing	Sky Trans.	Obs.Mode
A	UT1	FORS1	40h	may	d	≤ 0.4"	PHO	s
A/alt	NTT	EMMI	8n=3x2+4H2	may	d	≤ 0.8"	PHO	v
B	NTT	SUSI2	6n=6x1	jun	n	≤ 0.6"	CLR	v
C	3.6	EFOSC2	8n=3x2+4H2	jun	d	≤ 0.8"	THN	v
D	SEST	1.3/3.0Rec	20h	jul	d	≤ 0.8"	THN	v

VLT Data Flow System: Programme Handling (2)

Preparation tools:

- VLT user guide
- Instrument manual
- Exposure time calculator (provide SNR estimates)

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

▶ **OPC (Observing Programmes Committee) ranking:** A, B, C

VLT Data Flow System: Observation Handling

▶ **Phase 2 Proposal Preparation (P2PP)**

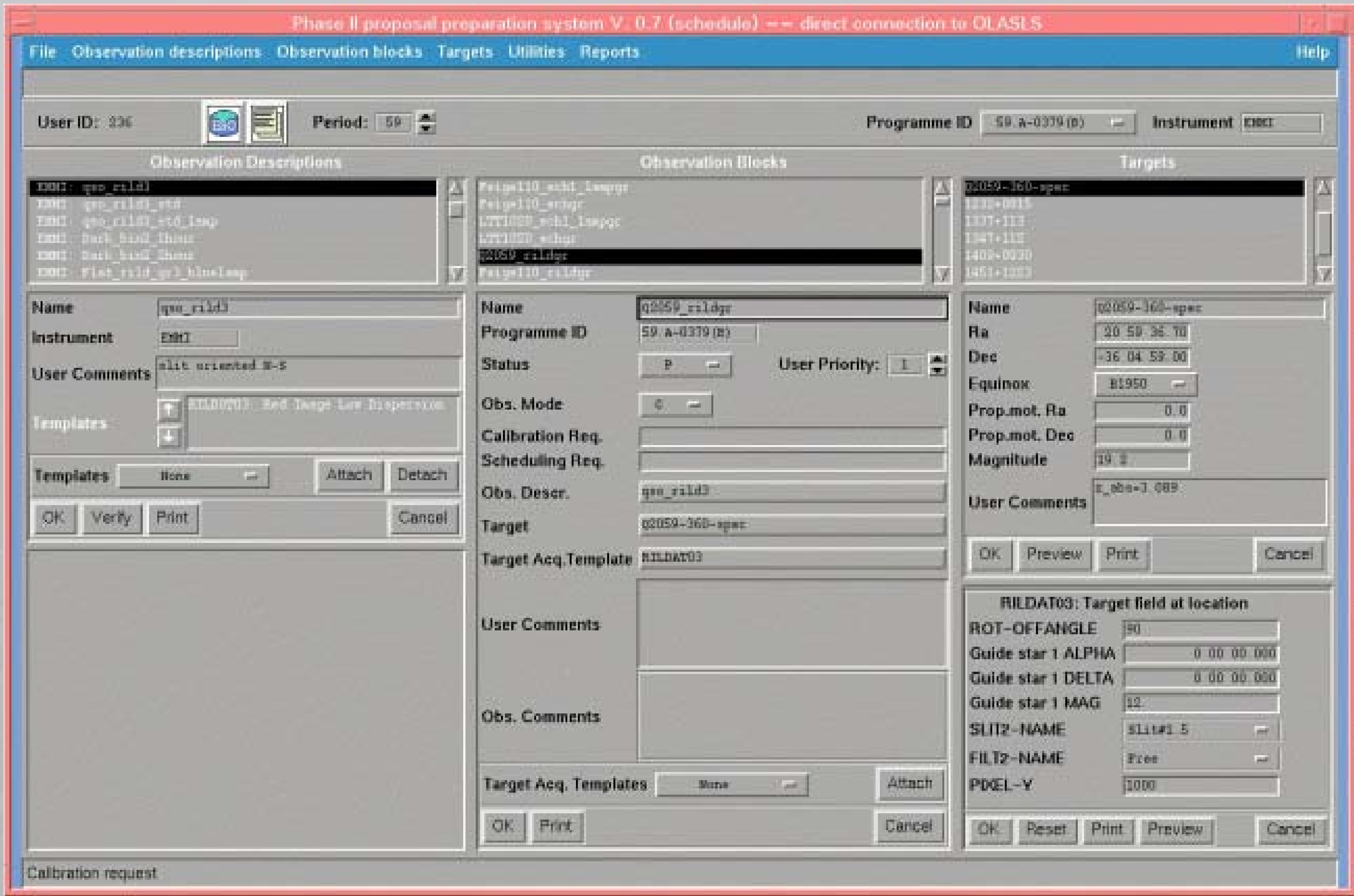
Observation block (OB) = target information + instrument setup

- OBs are the smallest schedulable unit of telescope resources
- OBs are quantum of data that flow within the DFS

Even in **visitor mode**, astronomers are requested to use OBs.

In **service mode**, OBs are stored in an **OB repository** from where a schedule can be constructed.

VLT DFS: phase 2 proposal preparation (P2PP)



VLT Data Flow System: other steps

- **Execution of Observing Blocks (OBs)**
- **Data archiving**
- **Data reduction pipeline**
- **Quality control: quick-look tools & off-line analysis**

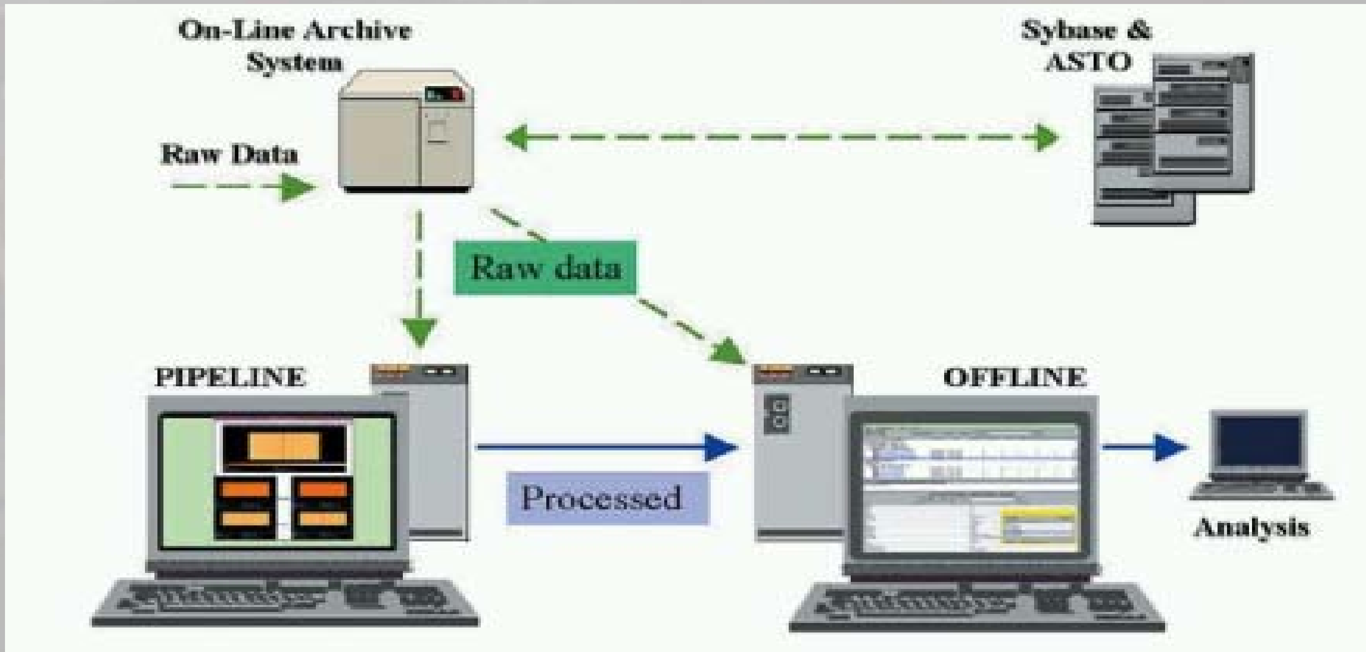


Figure 2: VLTI Data Flow System at Paranal.

What about the VLTI?

Described in Ballester et al. (The ESO Messenger 106, 2, Dec 2001)

Motivations:

- High level of automation
- Service mode mandatory with interferometry
- Similar to VLT standard for maintenance

But there are some specifics:

  - VLTI array configuration (telescopes, DL,…)
  - Instrument configuration
  - Valid observations require calibration stars

Not yet completely finalized

VLTI Visibility calculator

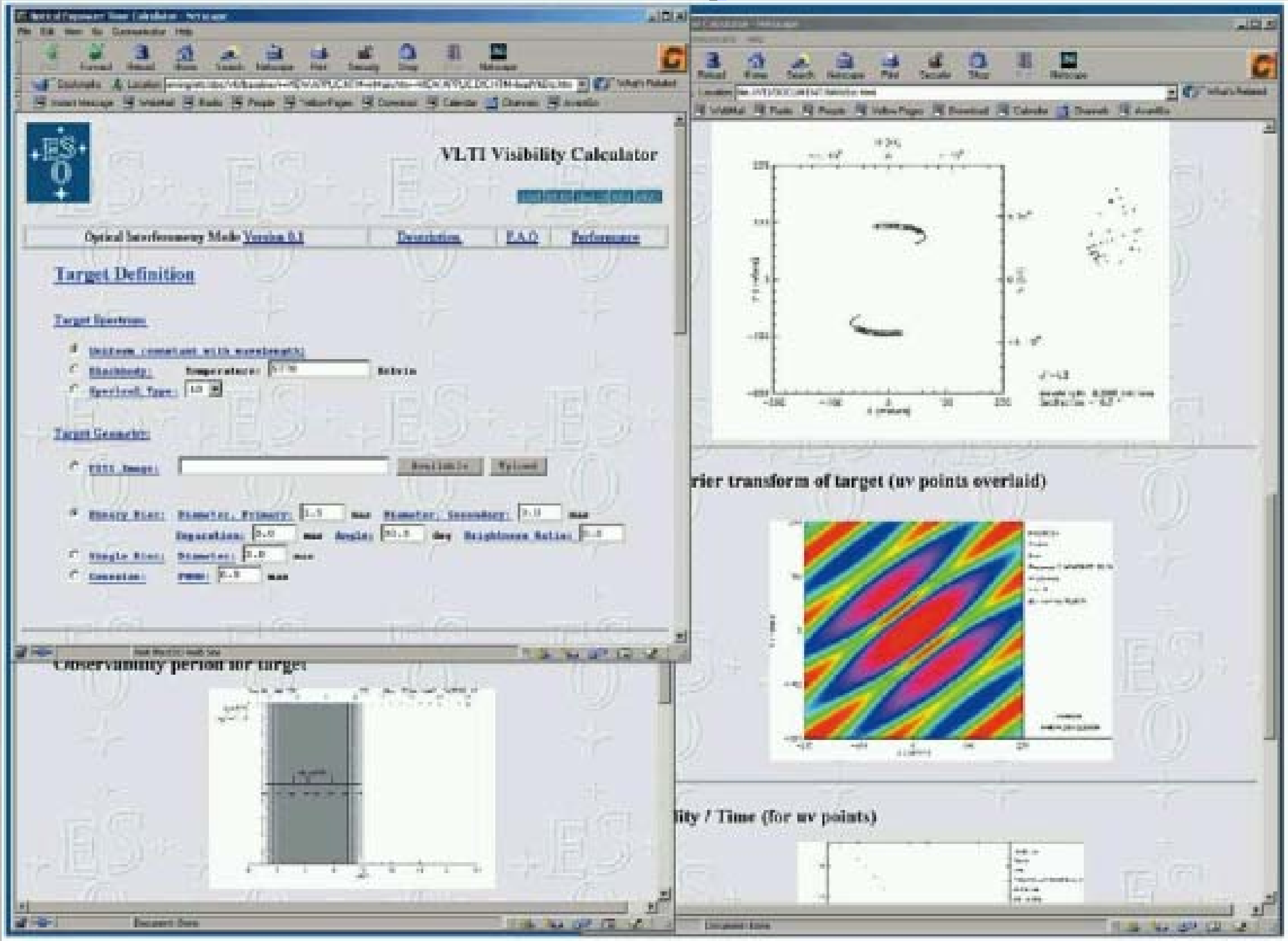
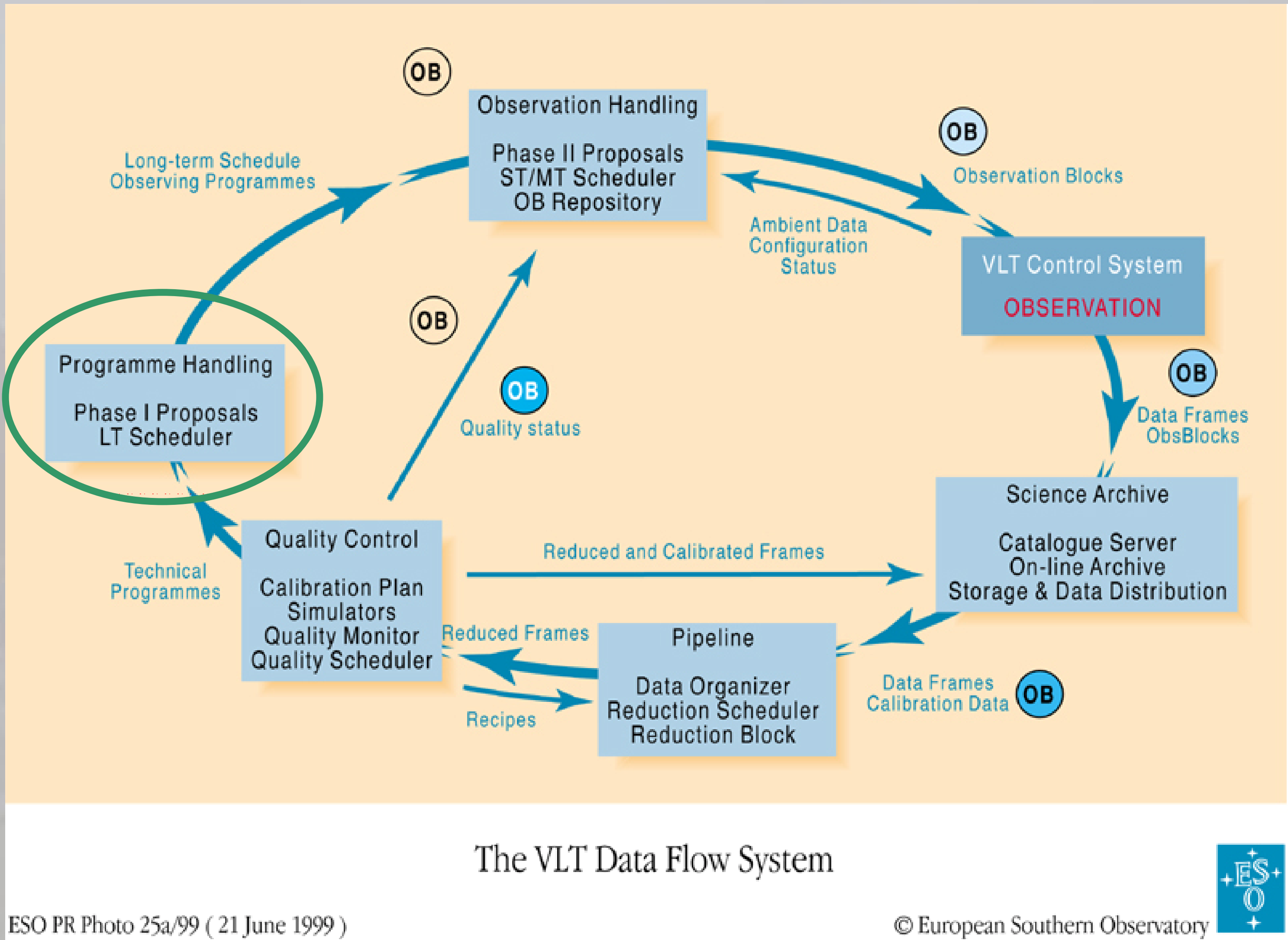
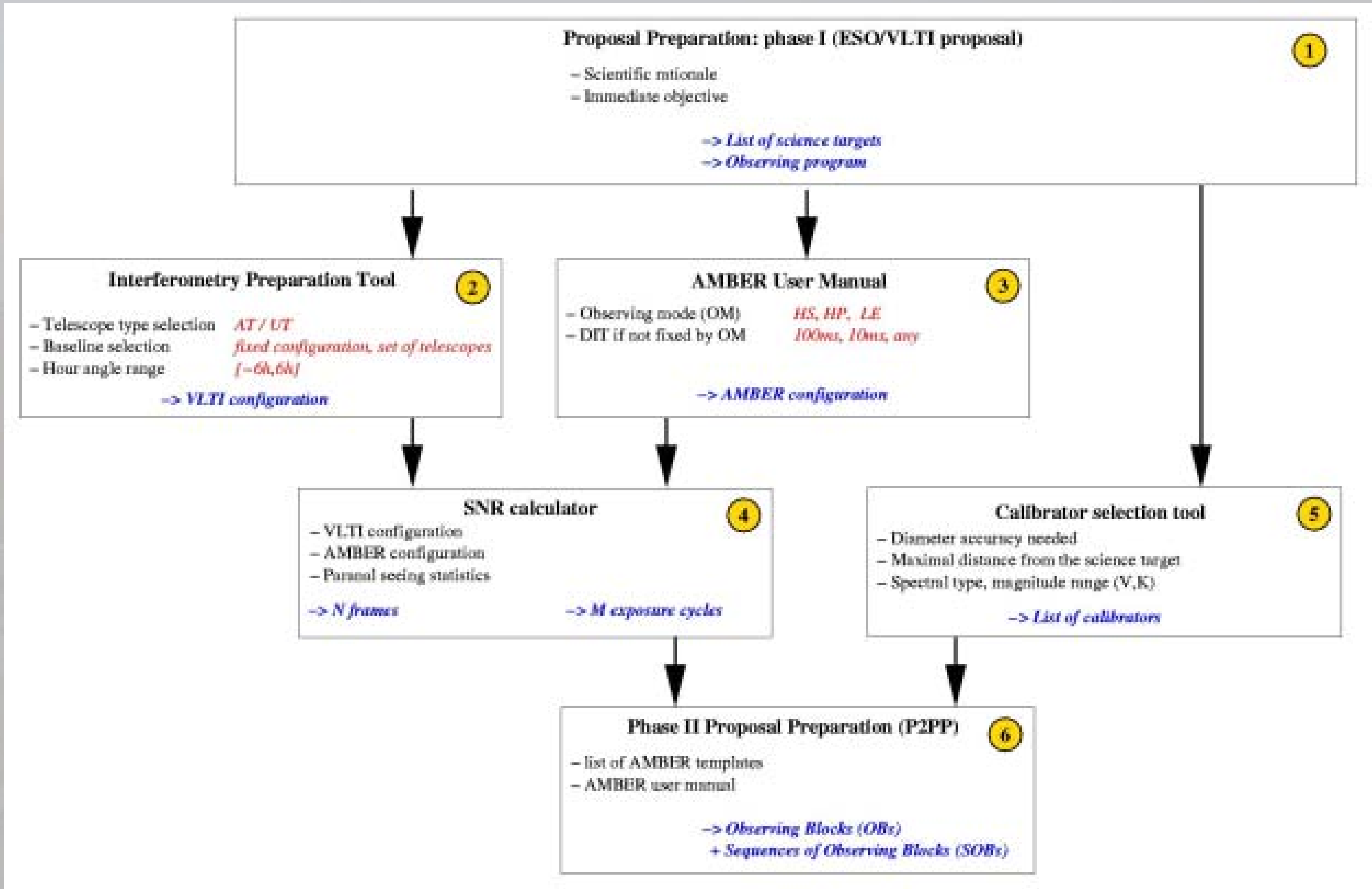


Figure 1: The VLTI Visibility Calculator (preliminary design). The VLTI Visibility Calculator will be an Internet application similar to the ESO Exposure Time Calculators. The prototype is using the ASPRO/JMMC software as a calculation engine.

Objective of the tutorial / work session

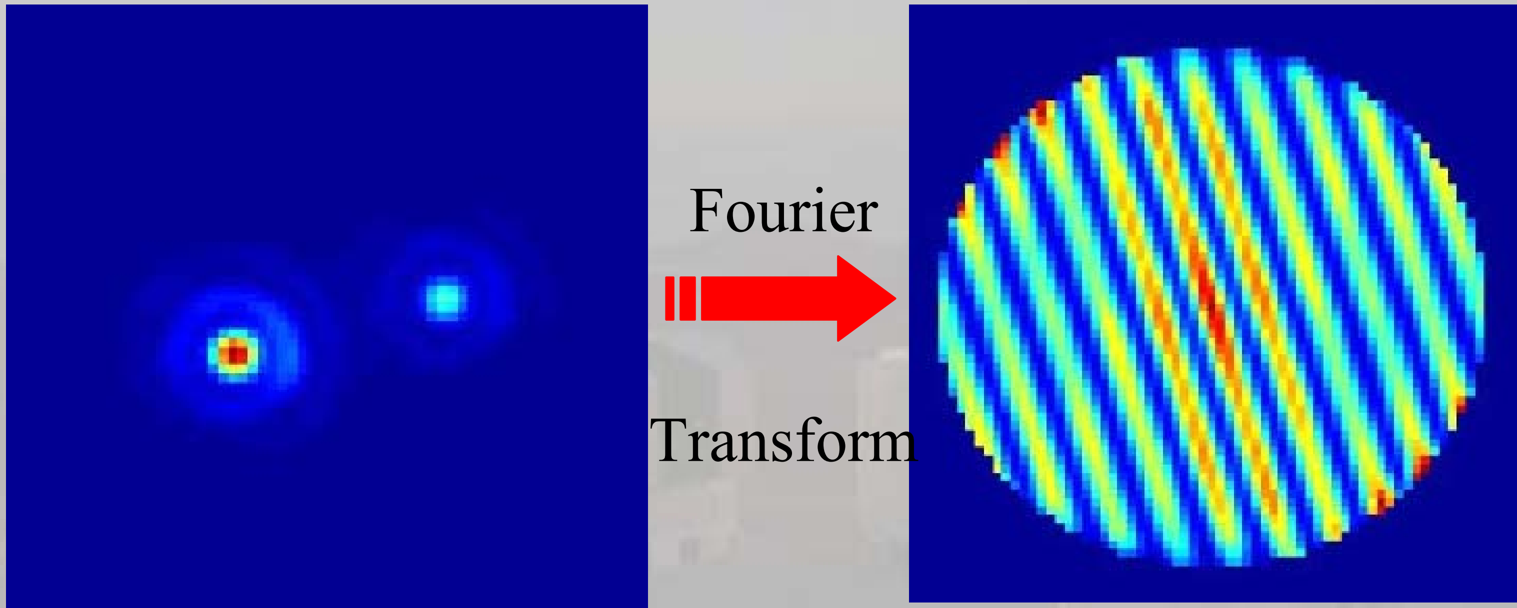


Example of preparation sequence with AMBER



Scientific objectives

Not images, but **complex visibilities** : **think in Fourier space** (cf. PWS-1)



Observables:

- *Visibility amplitudes*: AMBER & MIDI (cf. Berger, seminars, PWS-1,2)
- *Differential phases*: AMBER & MIDI (cf. Stee)
- *Closure phases*: AMBER (cf. Buscher, Monnier)

Immediate objectives

What do you want to do?

- Wavelength: AMBER or MIDI
- Number of targets: few ones or survey
- Magnitude of the objects: AT/UT, fringe tracking, spectral resolution
- Type of object structure:
  - simple (binary, photosphere, …) → visibility amplitudes
  - asymmetry → closure phases
  - high contrast → high accuracy
  - Spectral signature → differential phases
- Type of *(u,v)* coverage: few points, *(u,v)* tracks, full *(u,v)* coverage

In short, what are you going to demonstrate…

An example…

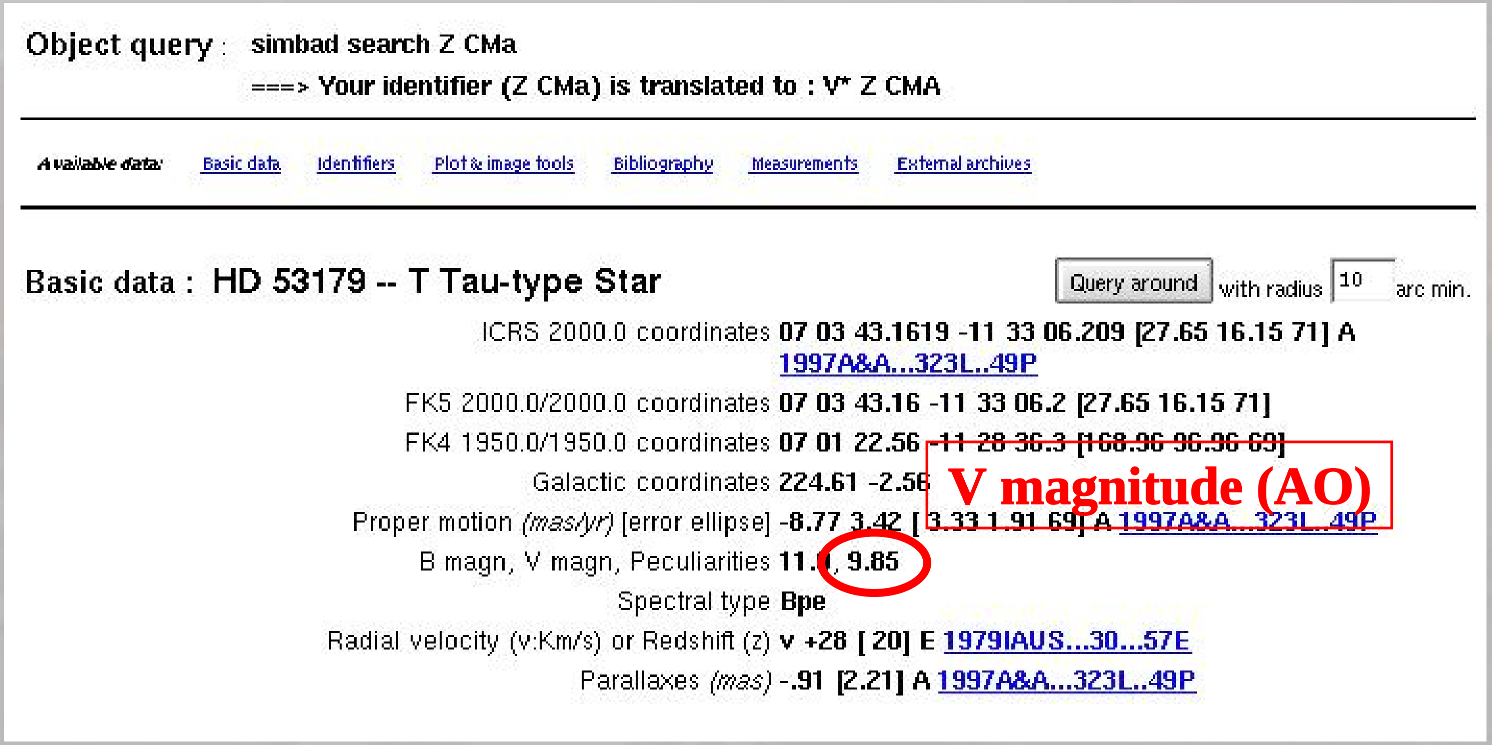
Detection of the binary Z Canis Majoris at 10 microns.

- separation 0.1”,
- PA 120 degrees,
- flux ratio, 10%?

► detect the flux ratio in order to separate the contribution between the 2 components and eventually detect the accretion disk...

Observability

- •Object magnitudes are within instrument sensibility
- •Reference objects for tracking: self-reference or off-axis
- •Position in the sky → observing time slots


Object query : simbad search Z CMa
===> Your identifier (Z CMa) is translated to : V* Z CMA

Available data: Basic data Identifiers Plot & image tools Bibliography Measurements External archives

Basic data : HD 53179 -- T Tau-type Star
Query around with radius 10 arc min.

ICRS 2000.0 coordinates 07 03 43.1619 -11 33 06.209 [27.65 16.15 71] A 1997A&A...323L..49P
FK5 2000.0/2000.0 coordinates 07 03 43.16 -11 33 06.2 [27.65 16.15 71]
FK4 1950.0/1950.0 coordinates 07 01 22.56 -11 28 36.3 [168.96 96.96 69]
Galactic coordinates 224.61 -2.56
Proper motion (mas/yr) [error ellipse] -8.77 3.42 [3.33 1.91 69] A 1997A&A...323L..49P
B magn, V magn, Peculiarities 11.[illegible], 9.85
Spectral type Bpe
Radial velocity (v:Km/s) or Redshift (z) v +28 [20] E 1979IAUS...30...57E
Parallaxes (mas) -.91 [2.21] A 1997A&A...323L..49P

CDS Home Page

VizieR Result Page

VizieR Help

CDS * Simbad * VizieR * Aladin * Catalogues * Nomenclature * Biblio * StarPages * AstroWeb

Result of VizieR Search within **10arcsec** of **Z CMa** (J2000=07:03:43.2-11:33:06) with 1 constraint (**lambda**: "**10..10.2**")
ordered by increasing **_r**

Modify the Query

Max. Entries: 100 | Output layout: HTML Table | **ALL** columns

ReSubmit

II/225/catalog — Catalog of Infrared Observations, Edition 5 (Gezari+ 1999) (ReadMe)
*CIO main catalog

To get all details for a row, just click on the row number in the leftmost 'Full' column.
The 3 columns in ***color*** are computed by VizieR, and are ***not part of the original data***.

Full	_r	_RAJ2000	_DEJ2000	name	RAB1950	DEB1950	lambda	F(IR)	x_F(IR)	r_F(IR)
	arcsec	"h:m:s"	"d:m:s"		"h:m:s"	"d:m:s"	um			
1	1.0	07 03 43.2	-11 33 06	Z CMA	07 01 22.6	-11 28 36	10.00	-1.040	M	820108
2	1.0	07 03 43.2	-11 33 06	Z CMA	07 01 22.6	-11 28 36	10.00	-1.160	M	911208
3	1.0	07 03 43.2	-11 33 06	Z CMA	07 01 22.6	-11 28 36	10.00	-1.250	M	911228
4	1.0	07 03 43.2	-11 33 06	Z CMA	07 01 22.6	-11 28 36	10.20	-0.300	M	700302

N magnitude

H magnitude (FT): ~ 4

Available Visualisations:

- Plot of II/225/catalog in this region with Aladin-Java
- Optical Image of this region with Aladin-Java

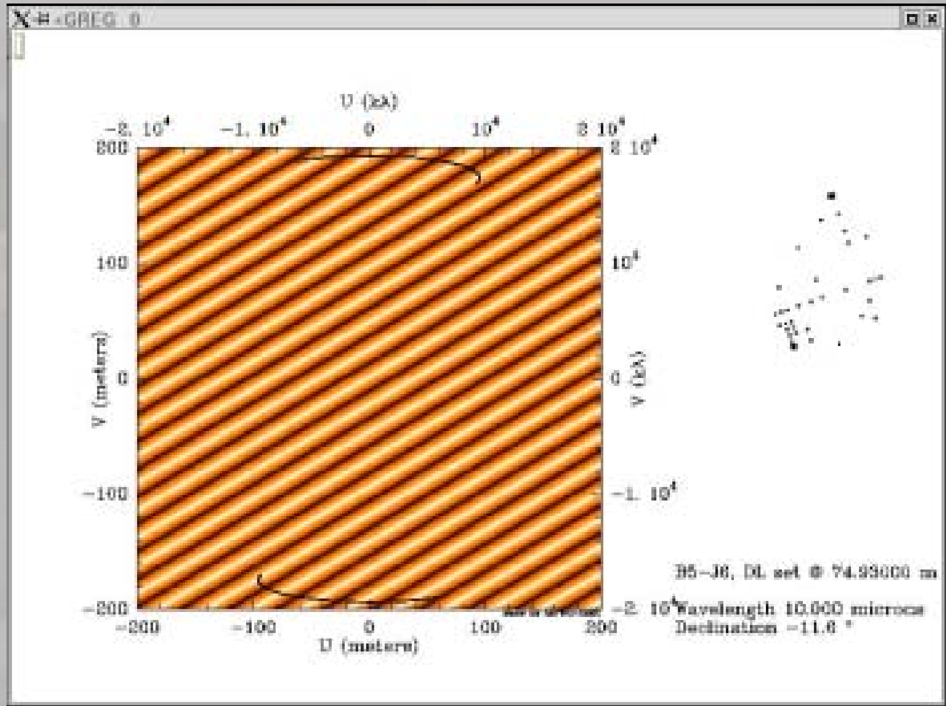
VizieR Service at Centre de Données astronomiques de Strasbourg

VLTI configuration

- Hardware: 2 or 3 telescopes, ATs or UTs, AO and FT or not,….
- Baseline strategies:
  - short, intermediate or long ones
  - Earth synthesis: North-South, East-West or mixed?

Z CMa

- ATs
- AO/FT ok but are they mandatory?
- long baselines: B5-J6



MIDI/AMBER configuration

cf. AMBER and MIDI presentation

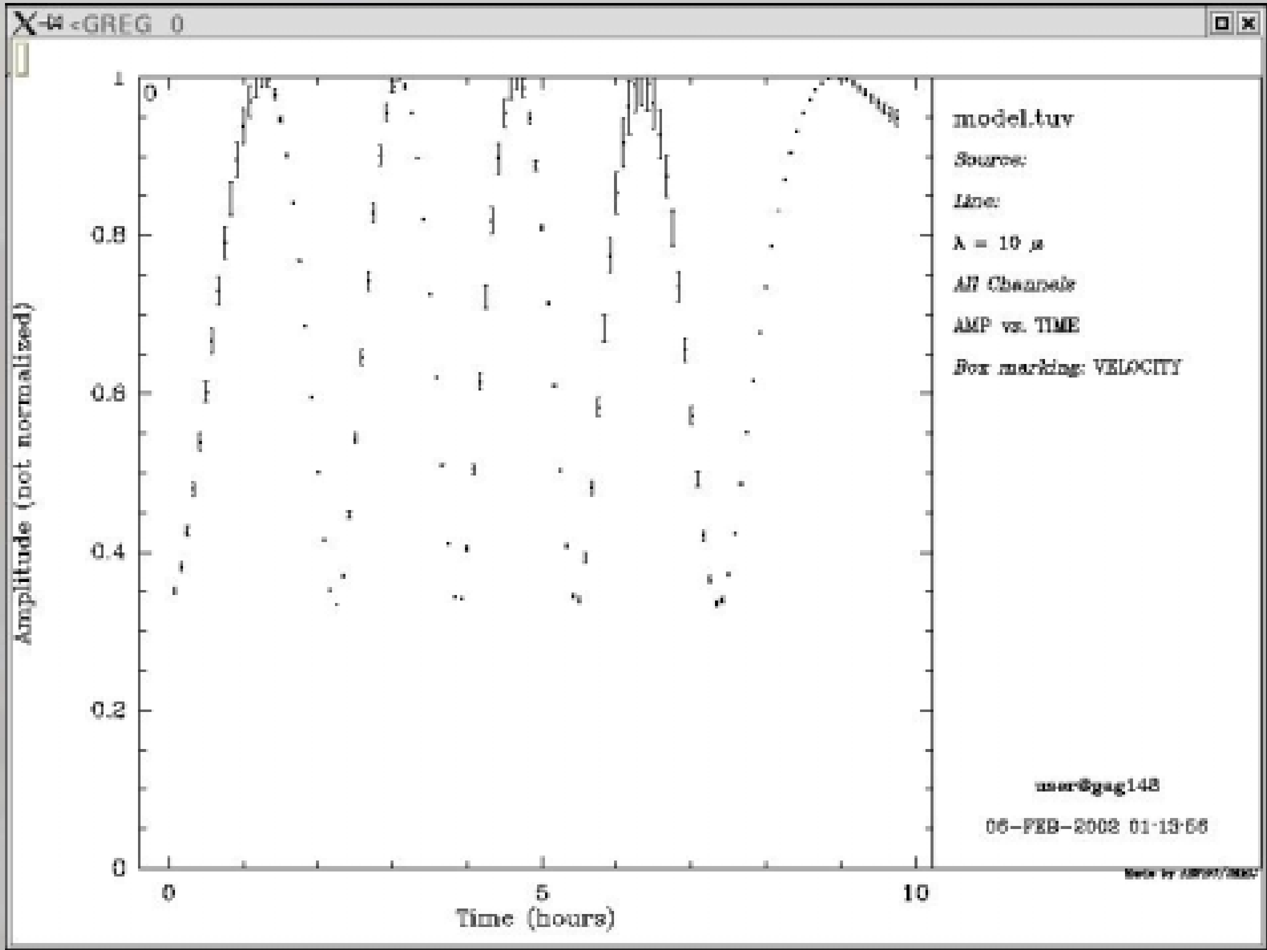
MIDI standard

200 spectral pixels

N= -1.1

5% time on source

5% accuracy requested



External references / calibration stars

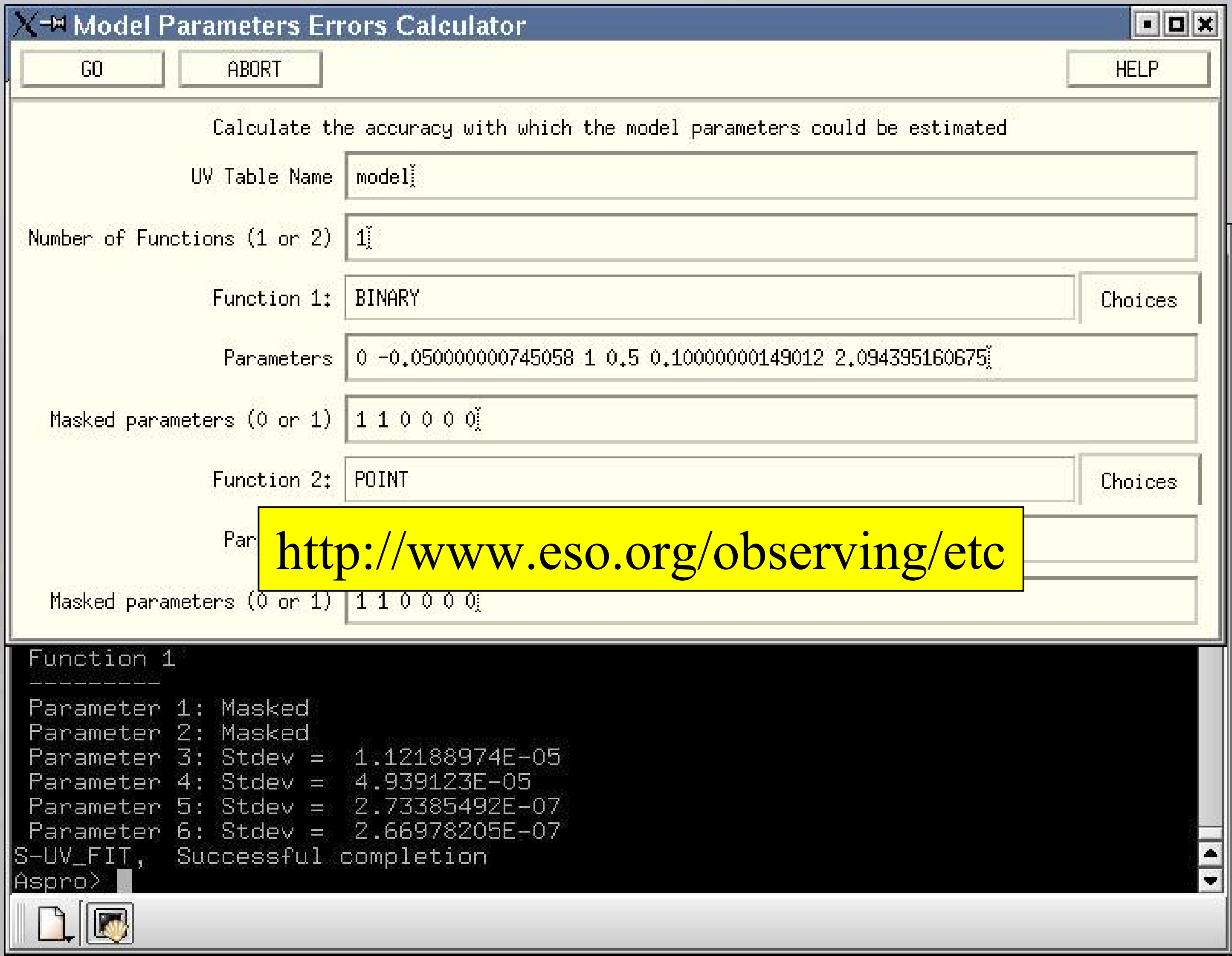
We need stars of about the same brightness, but no tools exist yet for 10 microns calibrators...

getCal Return -- Z CMa

```
/home/user/getCal/getCal-2.4/getCal -targetName Z_CMa -lClass V

### GUI catalog from getCal v2.4pre3 ###
# Resolving target Z CMa via SIMBAD
# target HD 53179
# HIP 34042 (HD 53179) has his multiple component flag set to V
#  Warning: the V designation indicates suspected variability-induced movement
HDC53179 07 03 43.162 -11 33 06.209 -0.009  0.003 9.8 9.8 Bpe 0.0 xxx   xxx  trg
# HIP 30867 (HD 45725) has his variability flag set (2)
#  with 0.022 mag scatter in 159 observations
# HIP 30867 (HD 45725) has his multiple component flag set to C
#  the C designation indicates solutions were found for individual components
#    3 components:
#    A component -- V= 4.630
#    B component -- V= 4.996 at sep 7.161 arcsec/PA 133 deg
#    C component -- V= 5.385 at sep 9.91 arcsec/PA 125 deg
HDC45725 06 28 49.070 -07 01 59.025 -0.007 -0.005 3.8 4.3 B3Ve 9.7 0.29+/-0.1  cal HDC5317
HDC46304 06 32 23.129 -05 52 07.752 -0.001 -0.042 5.6 4.9 F0Vnn+... 9.6 0.36+/-0.1  cal HD
HDC50281 06 52 18.050 -05 10 25.367 -0.547 -0.003 6.6 4.2 K3V 7.0 0.77+/-0.1  cal HDC53179
HDC58461 07 25 08.315 -13 45 07.120 -0.209 -0.001 5.8 4.9 F3V 5.7 0.39+/-0.1  cal HDC53179
# HIP 36186 (HD 58954) has his variability flag set (1)
#  with 0.017 mag scatter in 110 observations
# HIP 36186 (HD 58954) has his multiple component flag set to C
#  the C designation indicates solutions were found for individual components
```

Exposure time calculator



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

Technical and astrophysical feasability

In case of the example

- require at least a full transit, maybe two nights
- bright source and the accuracy depends on the source contrast

- Interpretation plan:
  - SED complete up to 10 microns for the two stars
  - Detection of a possible accretion disk: disk models

Summary: sequence of the preparation

1. scientific rationale
2. immediate objectives
3. list of the targets with the appropriate magnitudes (JHK for AMBER, N for MIDI) but also the V magnitude and spectral type for active guiding
4. requested VLTI configuration:
   a. Telescopes: UT/AT
   b. Baseline(s)
   c. Hour angle range
   d. Schedule constrains: dark moon, part of the night
   e. Fringe tracker, dual-feed
5. requested instrument configuration (cf. instrument presentations):
   a. spectral configuration
   b. other parameters
   c. required accuracy (visibility or phase)
6. calibrators: strategy, list of calibrator stars
7. technical feasibility:
   a. expected visibility range
   b. date of observations
   c. total observing time
8. preparation tasks if any
9. plan for interpreting the data
10. general conclusion on the exercize

Conclusion

- The ESO data flow system allows to concentrate on Phase 1 and Phase 2 proposal preparation
  - Service mode mainly
  - Observing Blocks are the smallest schedulable quanttity
  - Data reduction pipeline

The sequence of preparation is almost always the same:

Use of a program to:

- configure the array,
- compute the SNR,
- test some ideas (with ad-hoc or homemade models),
- find calibrators