



LS7: Observing with VLTI, it is easier than you think!

Speakers: Farin Drewes (Southampton U., UK) - Evgenia Koumpia (ESO, CL)
- Emma Bordier (Cologne U., DE) - James Leftley (Southampton U., UK) -
Jens Kammerer (ESO, DE)

Organisers: Antoine Mérand (ESO) - Rebeca Garcia-Lopez (University
College Dublin) - Claire Lykou (Konkoly Observatory)



Find me on github!



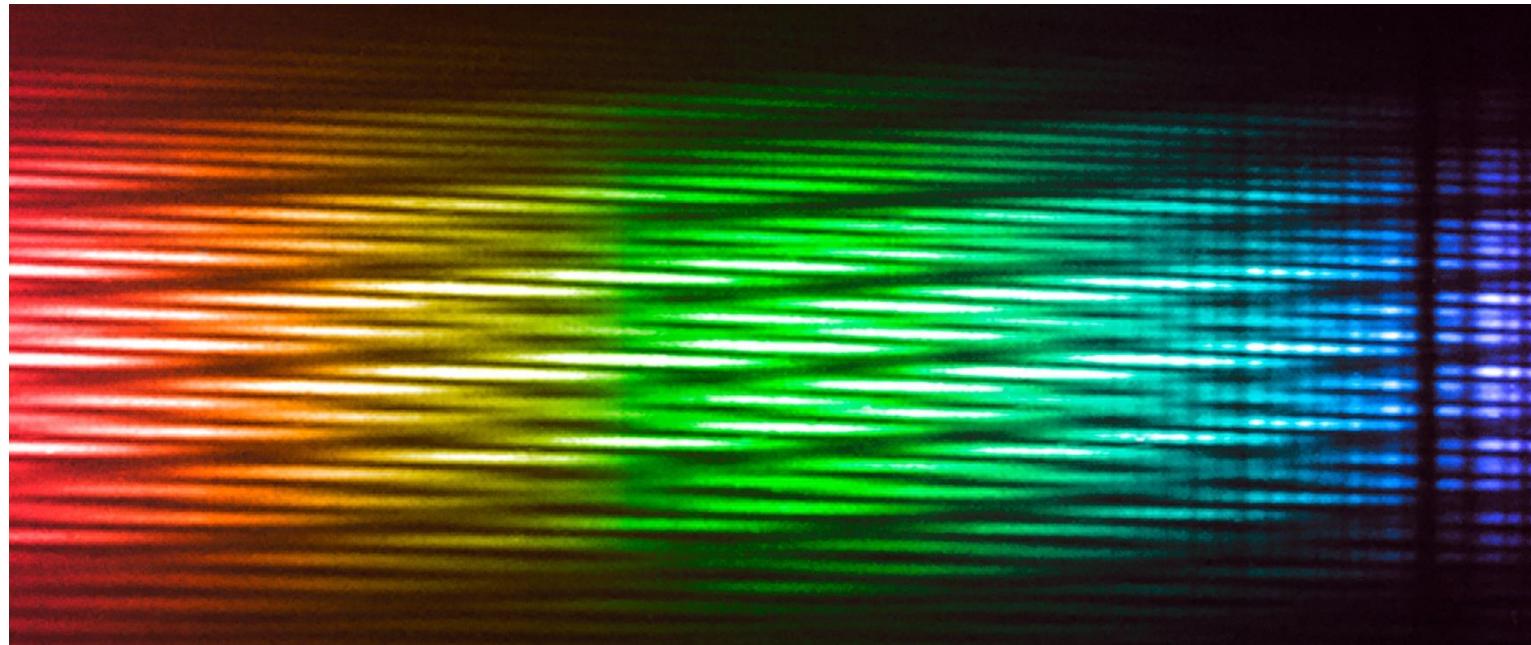
An introduction to VLTI

Farin Drewes (he/they)



What is Optical Interferometry?

- Interference of light from several telescopes to obtain extremely high angular resolution data

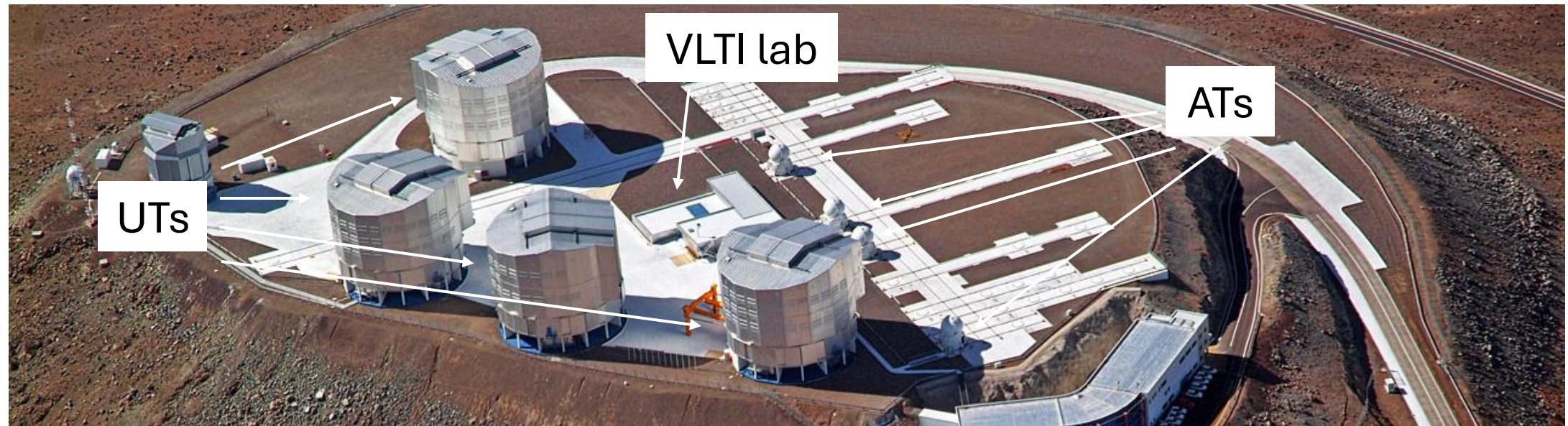


MATISSE first fringes; ESO/MATISSE Consortium



What is the VLTI?

- Very Large Telescope Interferometer – interferometry infrastructure at the VLT
- Can combine either 4 ATs (1.8 m) or 4 UTs (8.2 m)



Credit: J.L. Dauvergne & G. Hüdepohl/ESO

LS7@EAS2025 - easy VLTI -
www.github.com/amerand/easyVLTI2025

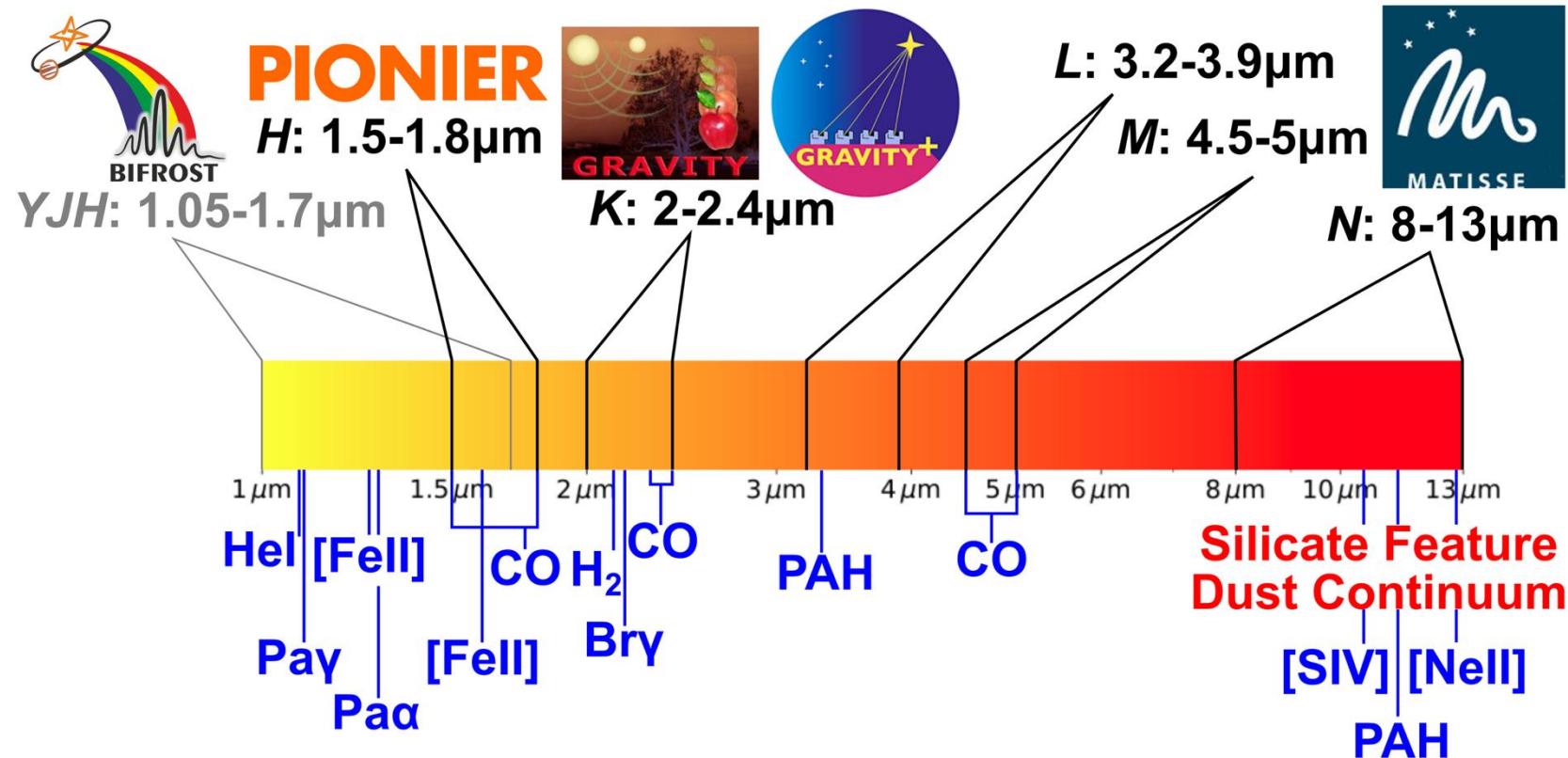


Why use the VLTI?

- Study source morphologies and geometries inaccessible with any other technique!
- *Nominal* resolution limits (λ/B)*
 - ATs: $H - 1.7$ mas; $K - 2.3$ mas; $L - 3.5$ mas; $N - 8.3 - 13$ mas
 - UTs: $H - 2.5$ mas; $K - 3.5$ mas; $L - 5.4$ mas; $N - 13 - 20$ mas
- Large wavelength range: $1.5 - 13 \mu\text{m}$
 - Probe temperature/chemical radial profiles
- High sensitivity (better than it used to be, especially from 2026)*
 - $H: 6 - 9$ mag; $K: 8 - 18$ mag; $L: 0.01 - 1$ Jy; $N: 0.1 - 17$ Jy
- Simple data analysis – really!



VLTI Instruments Wavelength Coverage



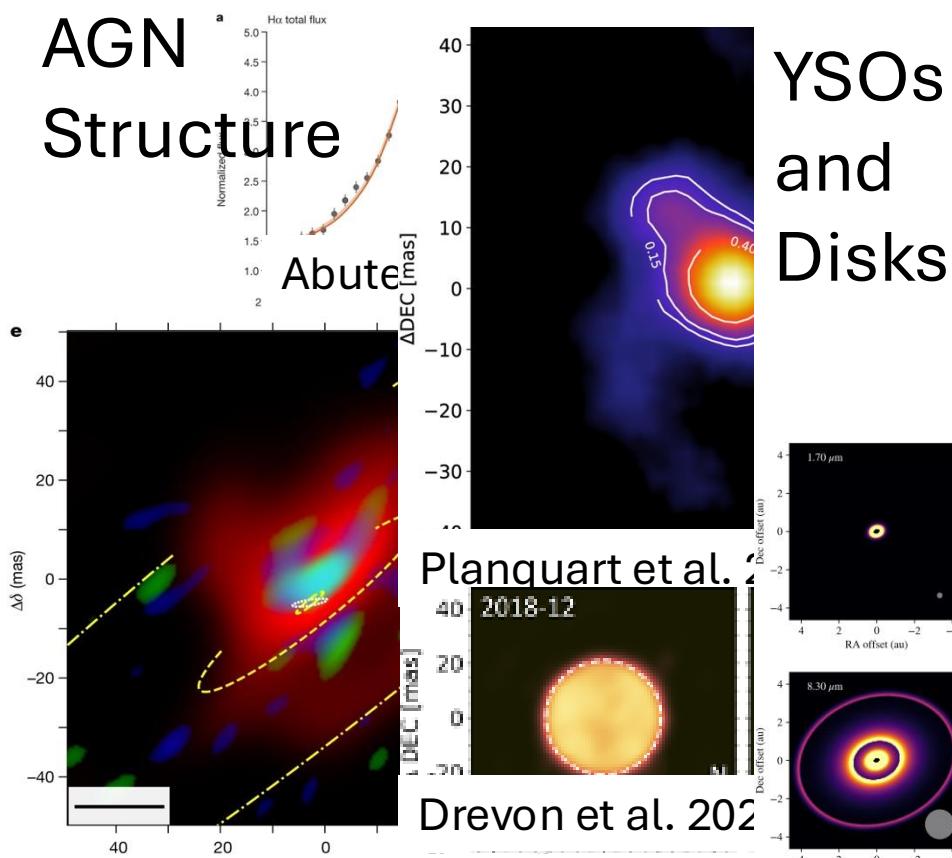


Some VLTI Science until now...

Internal
AGN
Structure

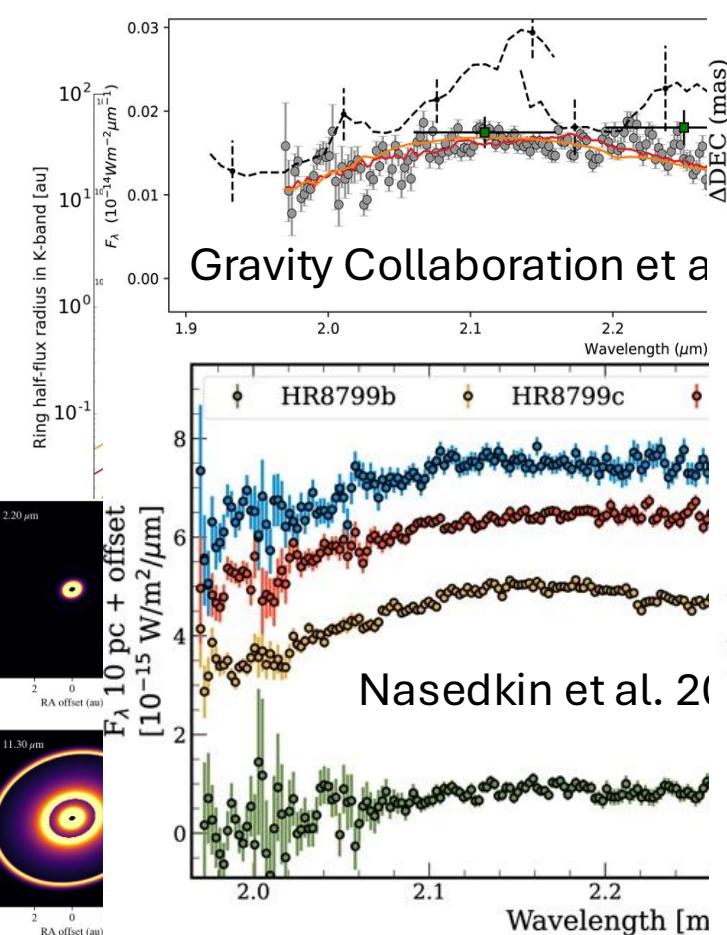
Stellar Surfaces and
Environments

YSOs
and
Disks



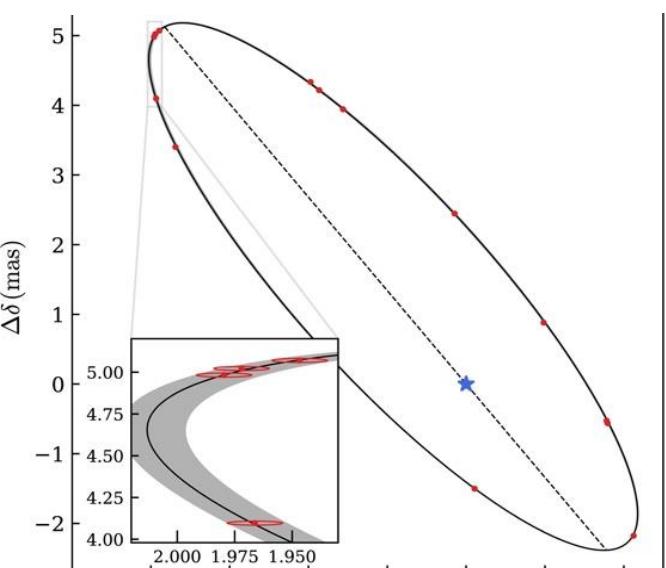
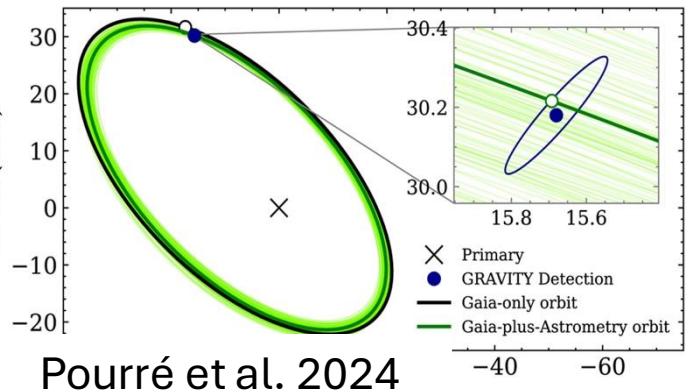
Gámez Rosas et al. 2022

Exoplanets



LS7@EAS2025 - easy VLTI -
www.github.com/amerand/easyVLTI2025

High Precision
Astrometry





From Idea to Proposals

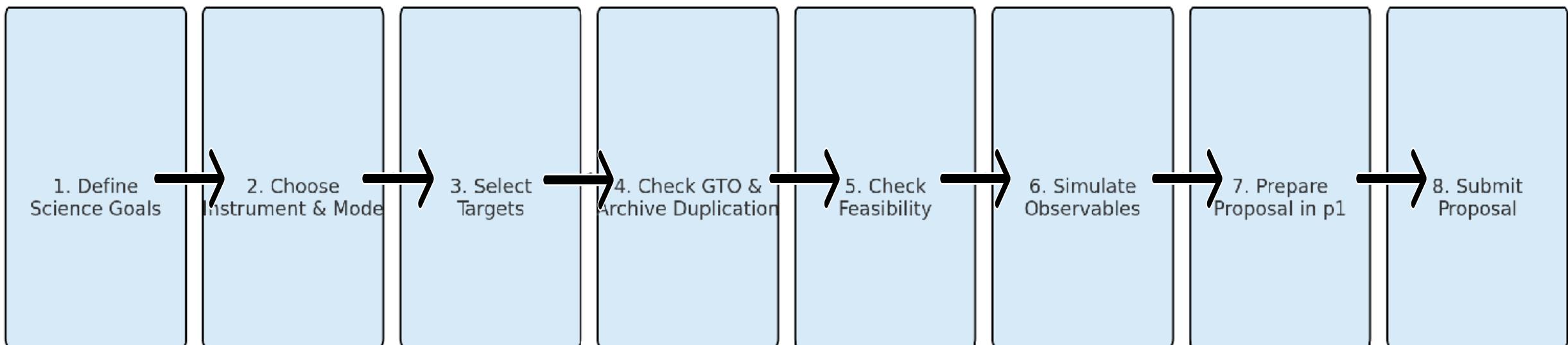
Evgenia Koumpia



Feasibility Checklist – From Idea to Proposal

- **Key message:** Match your science goal to the VLTI instrument and configuration.

Science question → spatial scale → wavelength → instrument





Feasibility Checklist – From Idea to Proposal

Target feasibility

- Is my target technically observable? Is the **RA/Dec** of the target observable from Paranal? <https://www.jmmc.fr/english/tools/proposal-preparation/getstar-61/> (information from Simbad & Vizier catalogs)
- Can my target be tracked? (AO/Guiding Feasibility)
https://www.eso.org/sci/facilities/paranal/telescopes/vlti/documents/VLT-MAN-ESO-15000-4552_v116.pdf

For UTs (GPAO):

- Is the **V-band (Grp) magnitude** ≤ 12.5 for **on-axis GPAO guiding**?
- If using **off-axis guiding**, is there a suitable guide star within 57.5" of the target?

For ATs (NAOMI):

- Is the **Gaia G magnitude** ≤ 12.5 (service mode)?
- Is the guide star within 50" of the science target and correctly offset in RA ($\pm 10''$)?



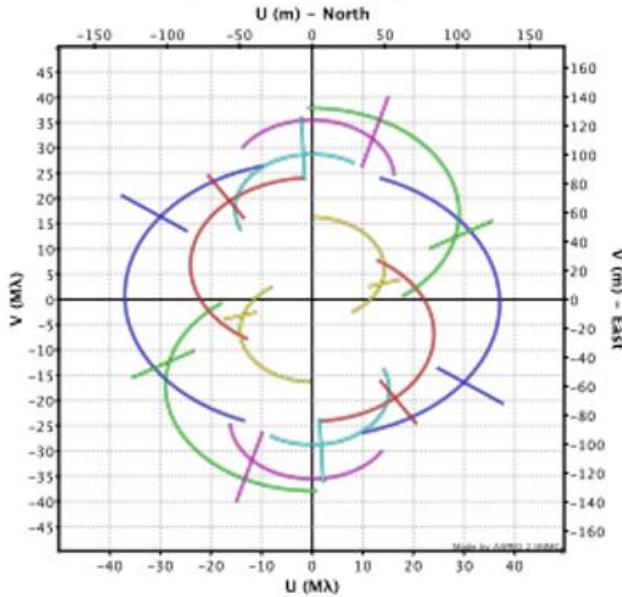
Feasibility Checklist – From Idea to Proposal

Instrument Setup

- Which **instrument** is best for my science? (PIONIER: H-band; hot photospheric emission, **GRAVITY**: K-band, **MATISSE**: L/M/N bands; thermal dust, extended emission, ASGARD (visitor instrument))
- What resolution/accuracy is required (visibility vs. phase)?
- Do I care about lines too or only continuum?
- What **spectral resolution** do I need to achieve my science goals? (up to R~4000 for GRAVITY and MATISSE)
- What is the optimal **observing mode**? (snapshots, imaging, time-series?)

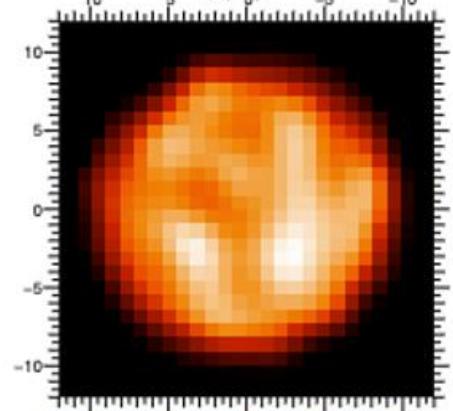
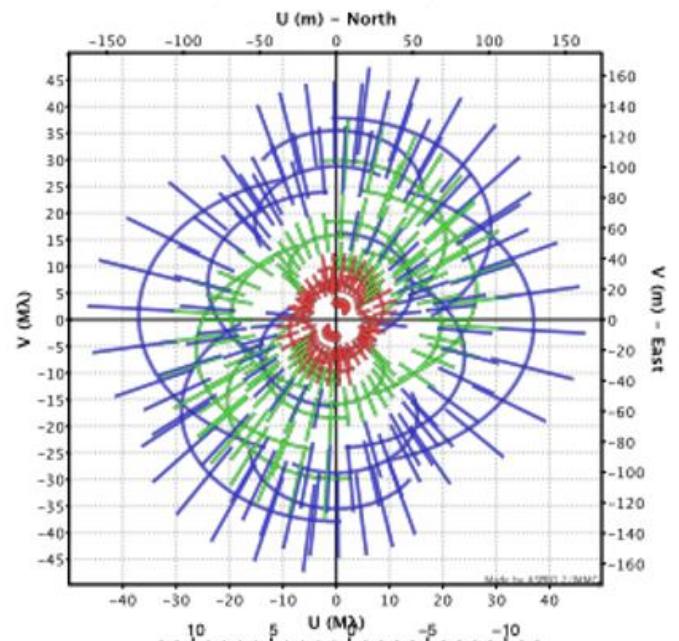


VLTI Period 104 - MATISSE_LM - A0 G1 J2 J3
Day: 2019-09-09 - Source: pi1 Gru



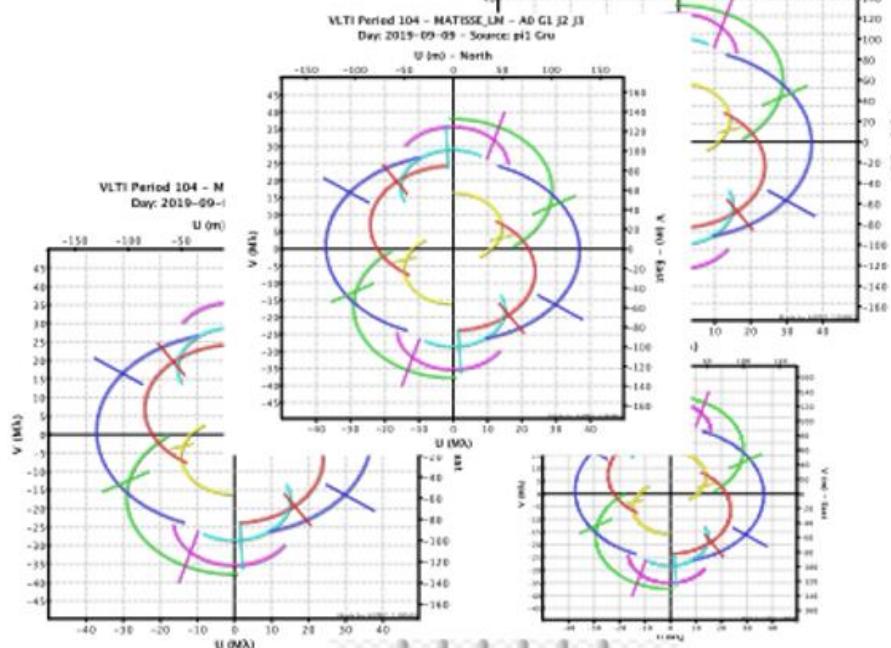
snapshot

VLTI Period 104 - MATISSE_LM - A0 G1 J2 J3 / D0 G2 J3 K0 / A0 B2 C1 D0
Day: 2019-09-09 - Source: pi1 Gru



imaging

Paladini++2018



CALENDAR

X	1	2	3
4	5	6	7
8	X	9	10
11	12	13	14
15	X	16	17
18	19	20	21
22	23	24	25
26	27	28	29
X	30	31	

Time-series



Feasibility Checklist – From Idea to Proposal

Target feasibility : *Duplication Checks*

- Has my target already been observed with VLTI?
- Are similar instrumental setups or science goals already covered?

*Search the ESO Science Archive to avoid
duplication! http://archive.eso.org/eso/eso_archive_main.html*

- Is my target on a GTO list (<https://www.eso.org/sci/observing/teles-alloc/gto/116.html>)? Check if the required observing mode or configuration is blocked (relevant for GRAVITY and MATISSE)

When in doubt, ask! You can raise a Helpdesk ticket to inquire whether your proposed target or mode conflicts with a protected GTO program.



Feasibility Checklist – From Idea to Proposal

Target feasibility

- *Does my target meet instrumental sensitivity limits?* --> check the most recent documentation **ALWAYS!**
(<https://www.eso.org/sci/facilities/paranal/instruments.html>)

Table 1. K-band limiting correlated magnitudes on the ATs

		$T \leq 10\%$	$T \leq 30\%$	$T \leq 50\%$	$T \leq 85\%$
		seeing \leq	seeing \leq	seeing \leq	seeing \leq
		0.6"	0.8"	1.0"	1.4"
single-field on-axis	SC (=FT)	9.0 ^m	8.5 ^m	8.0 ^m	7.0 ^m
single-field off-axis	FT (no SC)	9.5 ^m	9.0 ^m	8.5 ^m	7.5 ^m
dual-field on-axis <i>(sep. < 2.7")</i>	FT	9.0 ^m	8.5 ^m	8.0 ^m	7.0 ^m
	SC	16.0 ^m	15.5 ^m	15.0 ^m	14.0 ^m
dual-field off-axis <i>(1.17" < sep. < 4.0")</i>	FT	9.5 ^m	9.0 ^m	8.5 ^m	7.5 ^m
	SC	16.5 ^m	16.0 ^m	15.5 ^m	14.5 ^m
dual-field wide <i>(4.0" < sep. < 30.0")</i>	FT	9.5 ^m	9.0 ^m	not offered	
	SC	14.0 ^m	13.0 ^m	not offered	

Table 2. K-band limiting correlated magnitudes on the UTs (updated for P116 with new GPAO limits [+1 mag])

		$T \leq 10\%$	$T \leq 30\%$	$T \leq 50\%$	$T \leq 85\%$
		seeing \leq	seeing \leq	seeing \leq	seeing \leq
		0.6"	0.8"	1.0"	1.4"
single-field on-axis	SC (=FT)	11.0 ^m	10.5 ^m	10.0 ^m	9.0 ^m
single-field off-axis	FT (no SC)	11.5 ^m	11.0 ^m	10.5 ^m	9.5 ^m
dual-field on-axis <i>(sep. < 0.6")</i>	FT	11.0 ^m	10.5 ^m	10.0 ^m	9.0 ^m
	SC	18.0 ^m	17.5 ^m	17.0 ^m	16.0 ^m
dual-field off-axis <i>(0.27" < sep. < 2.0")</i>	FT	11.5 ^m	11.0 ^m	10.5 ^m	9.5 ^m
	SC	18.5 ^m	18.0 ^m	17.5 ^m	16.5 ^m
dual-field wide <i>(2.0" < sep. < 30.0")</i>	FT	11.5 ^m	11.0 ^m	not offered	
	SC	18.0 ^m	17.0 ^m	not offered	



Feasibility Checklist – From Idea to Proposal

Target feasibility

- *Does my target meet instrumental sensitivity limits?* --> check the most recent documentation **ALWAYS**! (<https://www.eso.org/sci/facilities/paranal/instruments.html>)

*GRAVITY and MATISSE users should use the **dedicated ETC** for visibility calculations and their feasibility (<https://www.eso.org/observing/etc/>)*

- *Are calibrators available?* (**SearchCal** <https://www.jmmc.fr/english/tools/proposal-preparation/search-cal/> or **CalVin** <https://www.eso.org/observing/etc/bin/gen/form?INS.NAME=CALVIN+INS.MODE=CFP>)
- Is there a calibrator star nearby? (the closer the better)
- Is it unresolved and are its spectral type and brightness similar to the target?



Feasibility Checklist – From Idea to Proposal

Configuration - *Telescope Choice (UTs vs. ATs)*

- Does my science case require the higher sensitivity of the 8-m UTs or the flexible baseline configurations of the 1.8-m ATs?
- If ATs, is the configuration compatible with my science? (small, medium, large, extended)
- Have I verified the **uv-coverage and visibility amplitude** with **Aspro2** or **VisCalc**?



Simulating your VLTI observables

- **Key message:** Simulate what your model would look like to predict visibilities and closure phases.
- **TOOLS:**
- Use **radiative transfer** or just toy models (e.g., disc, binary)
- Simulate:
 - Intensity map → FFT → visibilities
 - Use JMMC tools [https://www.jmmc.fr/english/tools/proposal-preparation/**Aspro2**](https://www.jmmc.fr/english/tools/proposal-preparation/Aspro2) (simulate uv-sampled observables)
 - Model → predicted V^2 /closure phases → match to Aspro2 coverage

Simulating your observations - Aspro



Aspro2 - Aspro2_sample_rawobs.asprox

Main settings
Interferometer: VLT
Period: VLT Period 106
Instrument: GRAVITY

Configuration(s)
UT1 UT2 UT3 UT4
A0 G1 J2 K0
A0 G1 J2 J3
K0 G2 D0 J3
A0 B2 D0 C1

Constraints
Night restriction checked
Date: 2020/04/14
Min. Elevation: 45 Wind: 0
Status: Warning

Targets
Simbad
DoAr 44 (selected)
Sky

File Edit Interop Help

Notebook Obs plan Targets Map Observability UV coverage Ofits viewer

VLT Period 106 - GRAVITY - UT1-UT2-UT3-UT4
Day: 2020-04-14 - Moon = 47.0%

DoAr 44

UV coverage plot showing baselines and observation log for target DoAr 44.

Observation Log (10):
Type: SCIENCE Program ID: 0103.C-0097(B)
Interferometer: VLT Baseline: U1 U2 U3 U4 Instrument: GRAVITY Mode: HIGH-COMBINED 1628 channels [1.969 - 2.4 μm] (res: 4134)
Target: V2062Oph Coords: 16:31:34.0488 -24:27:37.548 Dist: 7.996 as
ID: GRAVI.2019-06-23T01:48:25.340_1 Exp. time: 300 s Start time: 2019/06/23 01:48:25 LST: 15.176 h Tau: 3 ms Temp: 16.9 °C Seeing: 0.9 as
ID: GRAVI.2019-06-23T02:49:58.495_1 Exp. time: 300 s End time: 2019/06/23 02:54:58 LST: 16.288 h Tau: 2 ms Temp: 16.7 °C Seeing: 1.3 as

Filter by: MIDI AMBER PIONIER GRAVITY MATISSE

Gro...	Id	Type	P...	Program	Array	P...	Stations	P...	Ins. Name	Ins. Ins.	DEC
19	GRAVI.2019-06-22T02:04:59.138_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46
19	GRAVI.2019-06-22T02:16:14.167_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46
19	GRAVI.2019-06-22T02:21:53.180_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46
19	GRAVI.2019-06-22T02:27:26.194_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46

uv coverage done. 230 M Provided by JMMC

Aspro2 - Aspro2_sample_rawobs.asprox

Main settings
Interferometer: VLT
Period: VLT Period 106
Instrument: GRAVITY

Configuration(s)
UT1 UT2 UT3 UT4
A0 G1 J2 K0
A0 G1 J2 J3
K0 G2 D0 J3
A0 B2 D0 C1

Constraints
Night restriction checked
Date: 2020/04/14
Min. Elevation: 45 Wind: 0
Status: Warning

Targets
Simbad
DoAr 44 (selected)
Sky

File Edit Interop Help

Notebook Obs plan Targets Map Observability UV coverage Ofits viewer

VLT Period 106 - GRAVITY - UT1-UT2-UT3-UT4
Day: 2020-04-14 - Source: DoAr 44

Instrument mode: LOW-COMBINED
Atmosphere quality: Average
AO setup: MACAO
Fringe Tracker mode: FringeTrack GRAVITY
Sampling Periodicity (min): 60
Total Integration time (s): 600.0
HA min: -3.32
HA max: 2.03
U-V range to plot (m): 139.00
Plot rise/set uv tracks: checked
Show the model: checked
axis: SQUARE
Compute Ofits data: checked
Add error noise to data: checked

UV coverage plot showing baselines and observation log for target DoAr 44.

Observation Log (10):
Type: SCIENCE Program ID: 0103.C-0097(A)
Interferometer: VLT Baseline: U1 U2 U3 U4 Instrument: GRAVITY Mode: HIGH-COMBINED 1628 channels [1.969 - 2.4 μm] (res: 4134)
Target: V2062Oph Coords: 16:31:34.06272 -24:27:37.368 Dist: 8.179 as
ID: GRAVI.2019-06-22T02:32:56.209_1 Exp. time: 300 s Start time: 2019/06/22 02:32:56 LST: 15.855 h Radius: 128.9 m Pos. angle: 55.7 deg
ID: GRAVI.2019-06-22T02:32:56.209_1 Exp. time: 300 s End time: 2019/06/22 02:37:56 LST: 15.938 h Radius: 129.2 m Pos. angle: 56.4 deg
Tau: 8 ms Temp: 18.8 °C Seeing: 0.7 as

Filter by: MIDI AMBER PIONIER GRAVITY MATISSE

Gro...	Id	Type	P...	Program	Array	P...	Stations	P...	Ins. Name	Ins. Ins.	DEC
19	GRAVI.2019-06-22T02:04:59.138_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46
19	GRAVI.2019-06-22T02:16:14.167_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46
19	GRAVI.2019-06-22T02:21:53.180_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-C			892 -24.46
19	GRAVI.2019-06-22T02:27:26.194_1	SCIENCE	0103.C-0097(A)	VLT	U1 U2 U3 U4		GRAVITY	HIGH-COMBINED	SINGLE	V2062Oph	247.892 -24.46

uv coverage done. 222 M Provided by JMMC

Simulating your observations - Aspro



Main settings

Configuration(s)

Constraints

Target Editor

Targets **Models** **Groups**

Simbad

Targets

- HIP1234
- ETA TAU
- HD 1234**

Name: HD 1234 RA [HMS]: 00:16:27.6598684930 DEC [DMS]: -36:47:46.635648661 PMRA: -15.397 PMDEC: -16.553

Magnitudes:

B	9.65	V	9.19
G	9.0923	R	
I		J	8.318
H	8.131	K	8.112
L		M	
N			

Flux unit: mag jy

Radial Velocity: -10.44 Parallax: 4.8283 Error: 0.0361

Spectral type: F3V Object types: *IR

Identifiers: 2MASS J00162766-3647467, CD-37 56, CPC 18 68, CPD-37 14, GSC 06996-00075, HD 1234, HIC 1311, HIP 1311, PPM 275860, SAO 192435, SRS 3031, TYC 6996-75-1, uvby98 100001234, Gaia DR1 2308678821500431368, GEN# 11_00001234

Target notes: [i]

Targets **Models** **Groups**

Simbad **SED** **GetStar** **SearchFTT**

Model

Mode: Analytical User Model

Name: Add

Model type: punct

Telescope FOV: 231.6 - 298.2 mas

Model description

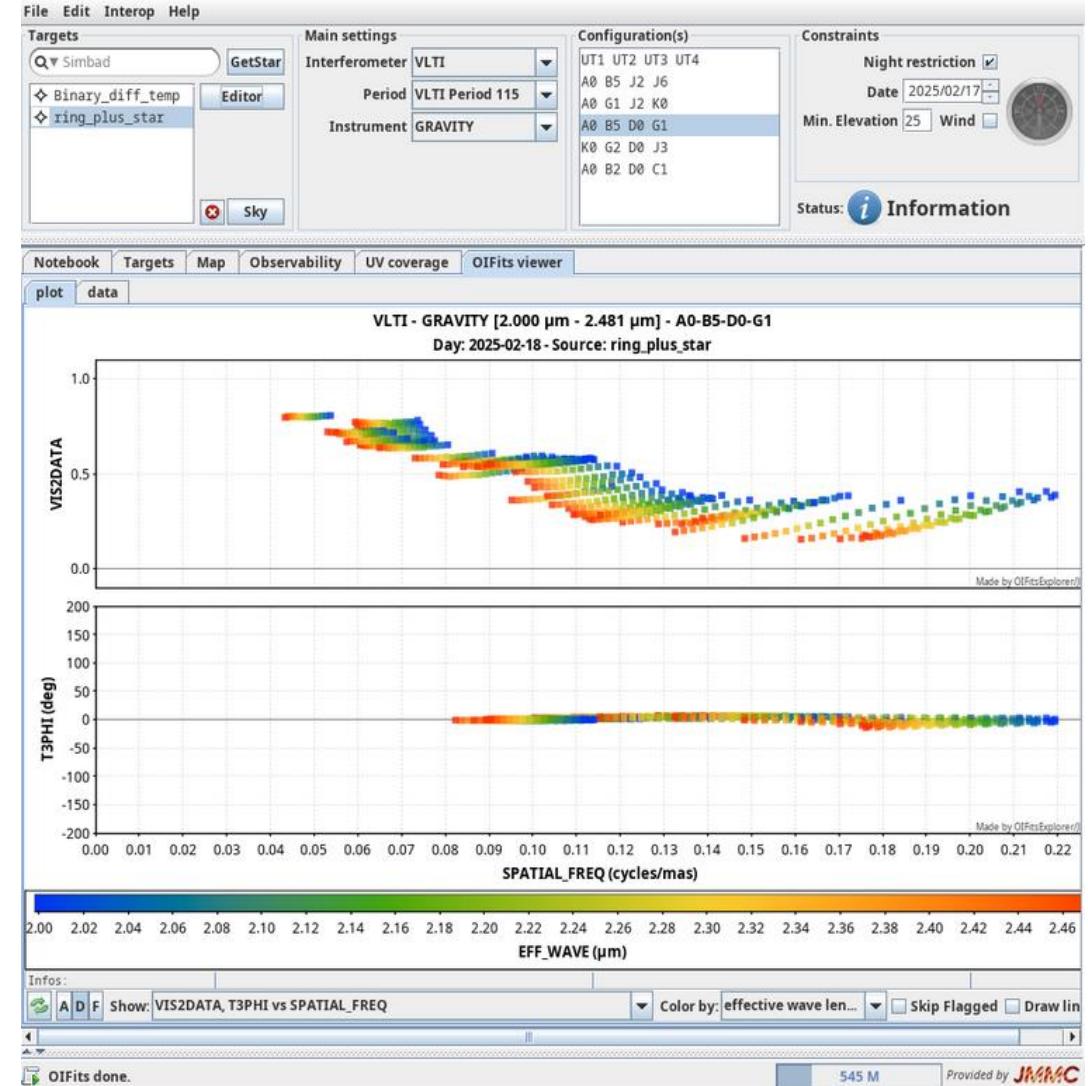
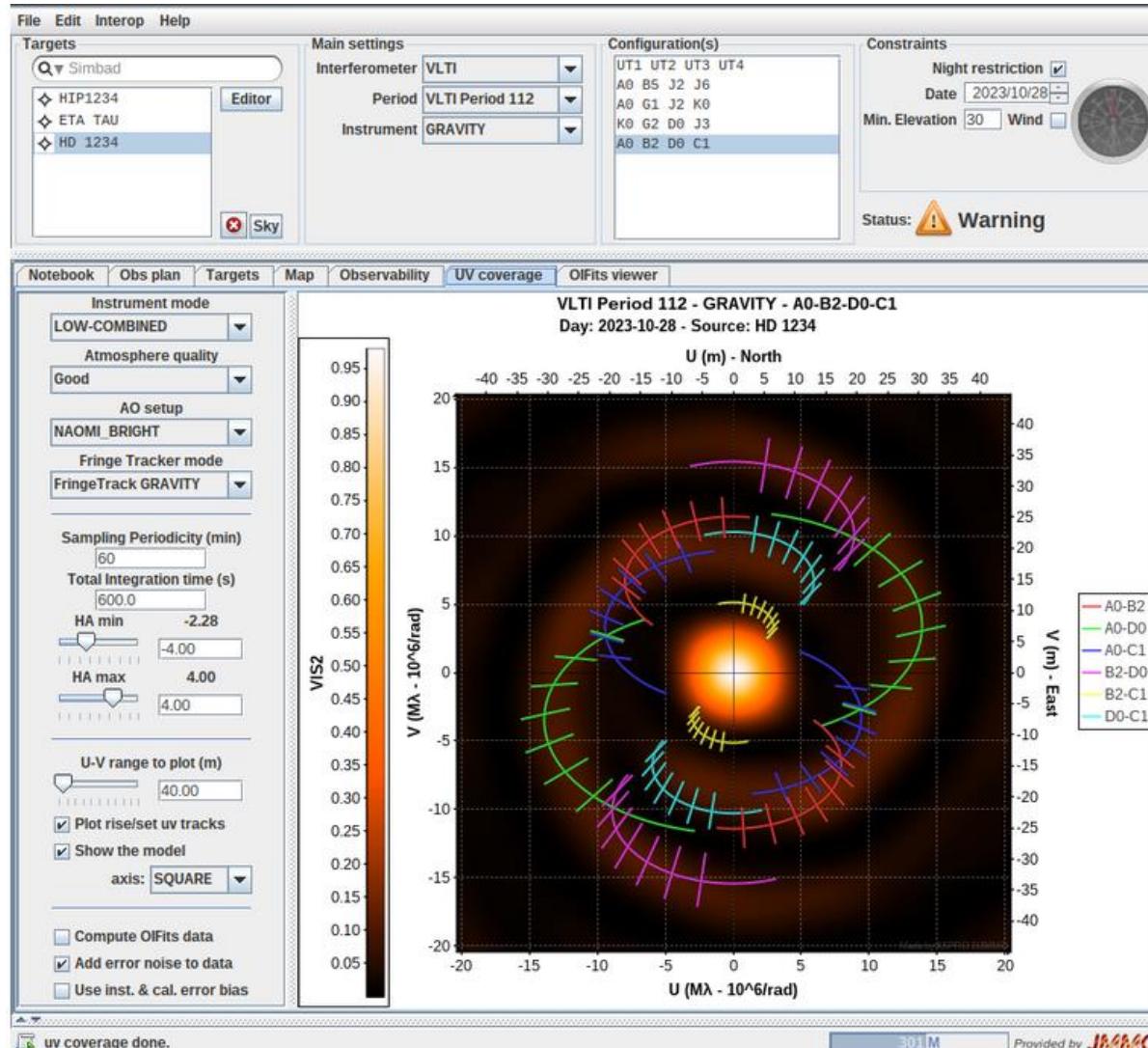
Returns the Fourier transform of a punctual object (Dirac function) at coordinates (X,Y) (milliarcsecond). FLUX_WEIGHT is the intensity coefficient. FLUX_WEIGHT=1 means total energy is 1.

Model Parameters

Model	Name	Units	Value
disk_BB1	flux_weight1		1
	temperature1	Kelvin	10,000
	x1	mas	0
	y1	mas	0
	diameter1	mas	0.5
flatten_ring_BB2	flux_weight2		1
	temperature2	Kelvin	1,500
	sep2	mas	0.5
	pos_angle2	deg	0
	major_internal_diameter2	mas	7
	flatten_ratio2		1.3

edit positions: x / y (mas) sep. (mas) / pos. angle [-180°; 180°]

Simulating your observations - Aspro





From Idea to Proposal - Takeaways

- *Let your science case guide the VLTI setup*
 - Choose the instrument, mode, and configuration that best addresses your scientific goals.
- *Always test feasibility early*
 - Use tools like **Aspro2** and **ESO ETC** to validate observability, fluxes, and visibility coverage.
- *Simulate your observables*
 - Generate mock data to check if your signal is detectable and to prepare your analysis workflow.



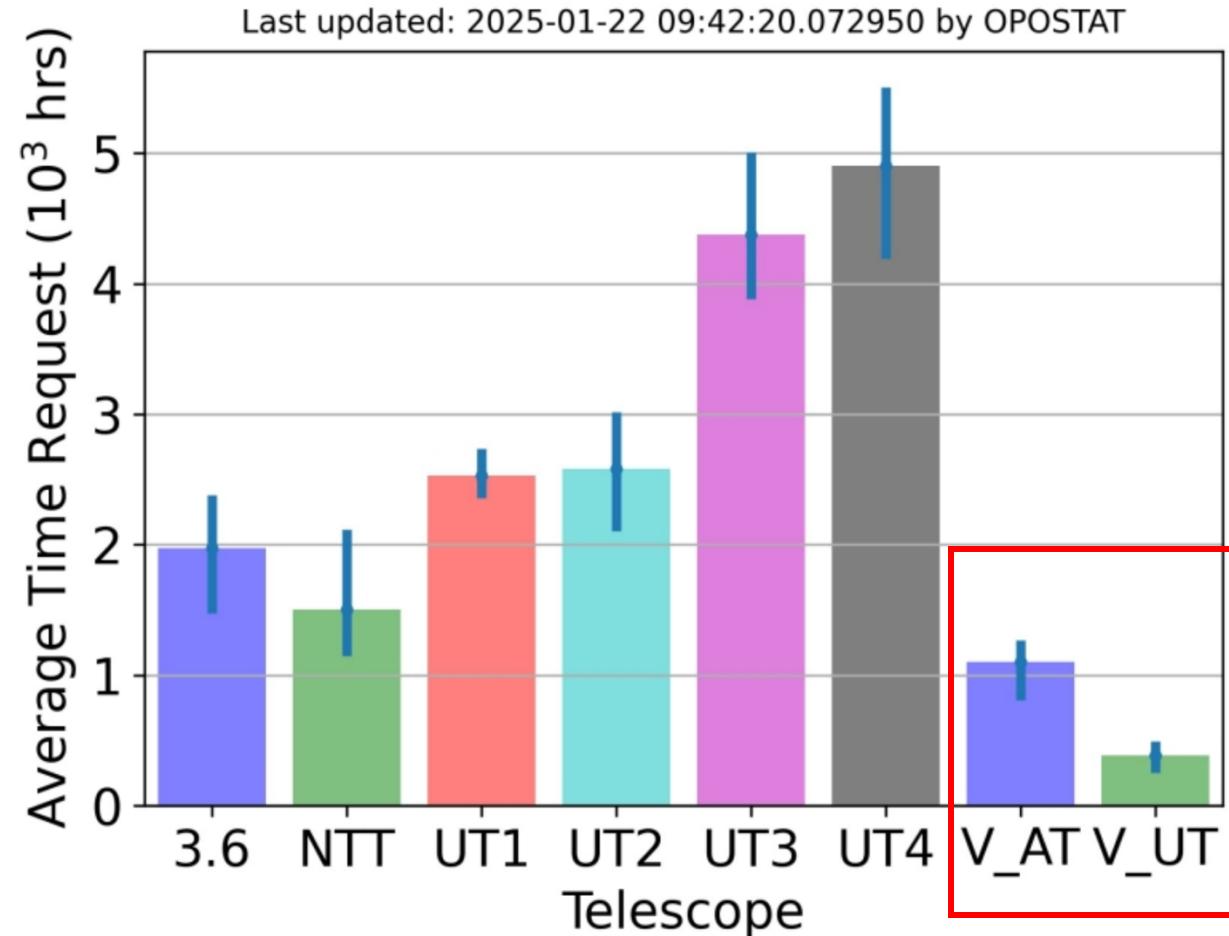
Your proposal: preparing phase 1

Emma Bordier (she/her)



Submitting a VLTI Proposal? Your odds are better than you think

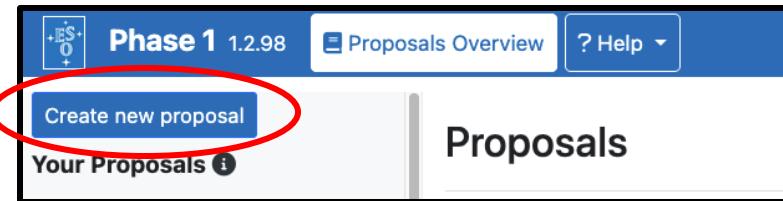
Statistics between P108
and P116



VLTI proposals: submit like any other ESO proposal on the p1 tool



<https://www.eso.org/p1/>



What you need to know before starting:

- Telescope configuration
- Instrument set up
- Type of interferometric observations
- Coudé Guide Star (CGS)

What you DON'T need to provide for p1:

- Calibrators
- Detailed integration settings like science DIT, number of science and sky frames

Phase 1 – proposal submission interface



- Create an account on the ESO user Portal and access the P1 tool

<https://www.eso.org/p1/>

The screenshot shows the Phase 1 1.2.98 interface. On the left, there's a sidebar with 'Create new proposal' and 'Your Proposals' sections. The main area is titled 'Proposals' and lists three entries:

Programme ID	Cycle	Title	Abstract	Status	PI	Actions
116.292S	P116 - P116 PanelMeetings	Constraining the cosmic dance of massive stars in triple systems	ⓘ	Valid	Dr. Laurent Mahy	pdf
116.28R6	P116 - P116 PanelMeetings	Tracing variability at the inner astronomical units in protoplanetary disks with GRAVITY	ⓘ	Valid	Dr. Joel Sanchez	pdf
115.27WM	P115 - P115 CommentCards	Are we witnessing the fragmentation of a massive disk in the embedded high-mass protostellar object G327.3-0.6	ⓘ	Valid	Prof. Lucas Labadie	pdf

- If you don't have an ESO account, you can alternatively open the P1 demo tool

<https://www.eso.org/p1demo/>

(No submission can be done through the demo)

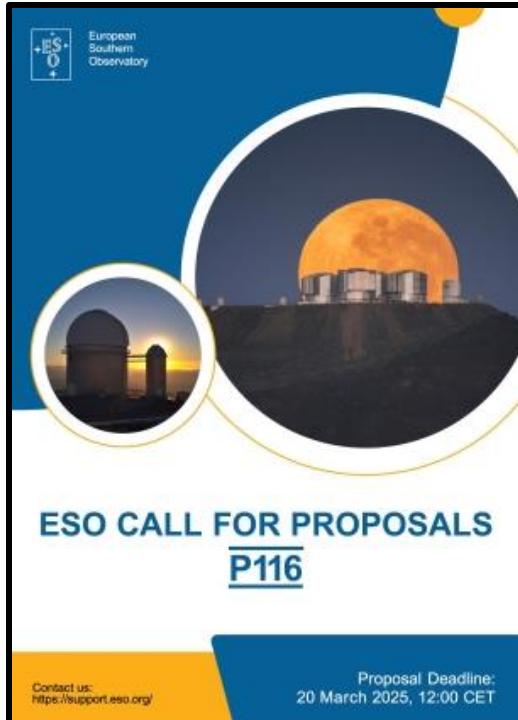
The screenshot shows the Phase 1 1.2.101 interface in DEMO ENVIRONMENT mode. The main area is titled 'Proposals' and lists two entries:

Programme ID	Cycle	Title	Abstract	Status	PI	Actions
to be assigned	P116 - P116 ProposalSubmission	test ignore too	ⓘ	Draft	Phase 1/2 Tutorial Account	X Delete pdf
to be assigned	P111 - P111 Inactive	test ignore	ⓘ	Invalid	Phase 1/2 Tutorial Account	X Delete pdf

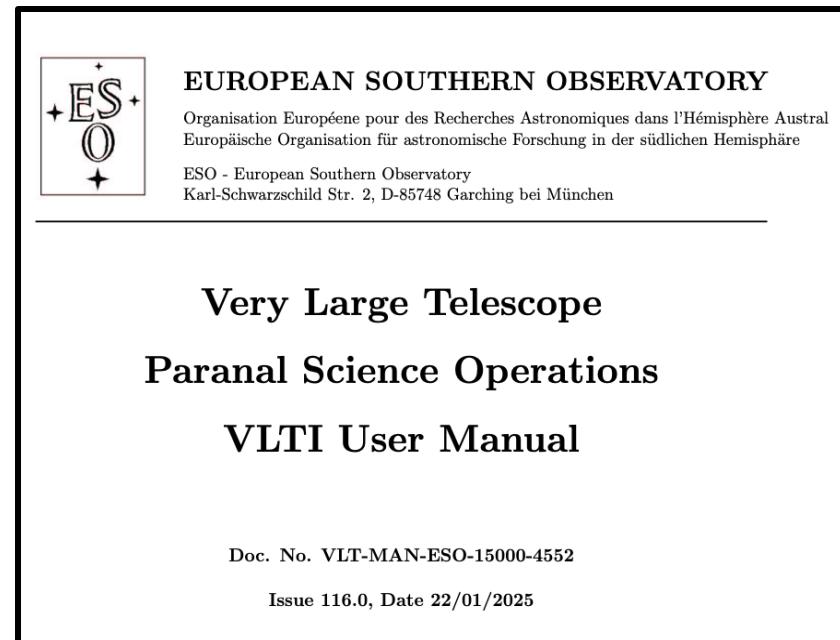
When the ESO call is out, check these 2 manuals:



<https://www.eso.org/sci/observing/phase1/p116/CfP116.pdf>



https://www.eso.org/sci/facilities/paranal/telescopes/vlti/documents/VLT-MAN-ESO-15000-4552_v116.pdf



Why is it important?

- Telescope configurations can change from one period to another (for the ATs)
- New observing modes may be introduced (e.g. GRAVITY-WIDE, use of GPAO etc)
- Updated instrument performance
- Some modes may no longer be available (e.g. MACAO)



VLTI proposals: no new tool to learn

If you have written ESO
proposals before, **the
process is the same as for
any other instrument.**

The screenshot shows a proposal structure with the following sections:

- 115.283H Testing bina ..
- Summary
- Title & Abstract
- Scientific Keywords
- Tags
- Investigators
- Rationale
- Targets
- Runs
- Targets Runs
- Observations
- Remarks & Justifications
- Awarded & Future Time Requests
- Previous Usage
- Applicants' Publications
- DPR Feedback

Tips:

- Don't hesitate to include Co-I(s) who are familiar with VLTI and can support you throughout the proposal process

VLTI proposals: what is critical for phase 1?



- 115.283H Testing bina ..
 - [Summary](#)
 - [Title & Abstract](#)
 - [Scientific Keywords](#)
 - [Tags](#)
 - [Investigators](#)
 - [Rationale](#)
 - [Targets](#)
 - [Runs](#)
 - [Targets](#) [Runs](#)
 - [Observations](#)
 - [Remarks & Justifications](#)
 - [Awarded & Future Time Requests](#)
 - [Previous Usage](#)
 - [Applicants' Publications](#)
 - [DPR Feedback](#)

Targets:

- Ensure your targets meet the sensitivity requirements
- Provide the Coude Guide Star in the target list if different from the Science target
 - Find all these details in the instrument user manual and VLTI user manual

It can be a critical point for certain science cases, e.g. MYSOs, science cases in the Galactic Centre and in highly extincted regions

- **No need to provide calibrators at this stage.**
- **HOWEVER:** make sure there is a suitable star for calibration (e.g. SearchCal)

VLTI proposals: what is critical for phase 1?



- 115.283H Testing bina ..
- [Summary](#)
- [Title & Abstract](#)
- [Scientific Keywords](#)
- [Tags](#)
- [Investigators](#)
- [Rationale](#)
- [Targets](#)
- [Runs](#)
- [Targets](#) [Runs](#)
- [Observations](#)
- [Remarks & Justifications](#)
- [Awarded & Future Time Requests](#)
- [Previous Usage](#)
- [Applicants' Publications](#)
- [DPR Feedback](#)

Runs:

- Weather constraints (driven by your target and instrument sensitivity -> check the manuals!)
- Template (single/dual- field, on-axis/off-axis etc)
- What AO system do you need? Mainly depends on the V mag. No choice on the ATs (NAOMI)
- The interferometric array (e.g. check with ASPRO)
- Type of interferometric observations (snapshot, time series/ image reconstruction)

[Add Observing Run](#)

Run Name	Instrument	Telescope Setup	Run Type	Observing Mode	Period	Proprietary Time
Run 1	MATISSE	VLTI-AT	Normal	SM	105	12 months

MATISSE Observing Constraints

Sky Transparency	PWV (mm)
Photometric	30

Turbulence
50% (Seeing < 1.0 arcsec, t0 > 3.2 ms)

[Cancel](#) [Add Run](#)

VLTI proposals: what is critical for phase 1?



- 115.283H Testing bina ..

- [Summary](#)
- [Title & Abstract](#)
- [Scientific Keywords](#)
- [Tags](#)
- [Investigators](#)
- [Rationale](#)
- [Targets](#)
- [Runs](#)
- [Targets](#) [Runs](#)
- [Observations](#)
- [Remarks & Justifications](#)
- [Awarded & Future Time Requests](#)
- [Previous Usage](#)
- [Applicants' Publications](#)
- [DPR Feedback](#)

Observations:

- Check the ETC for the telescope time
- Typical time for one snapshot (including calibrator) is 1h.
- **No need to provide NDIT*DIT at this stage**, nor number of science and sky frames → done in P2.

Execution times

The policy on execution times is similar to the other VLTI instruments with standard slots of 1h which include a calibrator and a science observation. The GRAVITY ETC is available and provides visibility calculations and feasibility calculations for an observation with a given target geometry, magnitude, and baseline configuration.

Observations [Show all](#) [Show all with details](#) [Collapse all](#)

Tel. Time: 2h00m

▼ 1. UT+MACAO (V<15) + BRIGHT (K<9) · P109 · GRAVITY · SM
FLI: 100% · Turb.: 50% (Seeing < 1.0 arcsec, t₀ > 3.2 ms) · pwv: 30mm · Sky: CLR

▼ NGC6618 A16, 18:21:01.124, -16:05:47.179 **Tel. Time: 1h00m** [Night](#) [Period](#) [Propagate Tel. Times](#)

► **Observation 1: OS 1**

Telescope Time [s] * Repeat = **3600s**

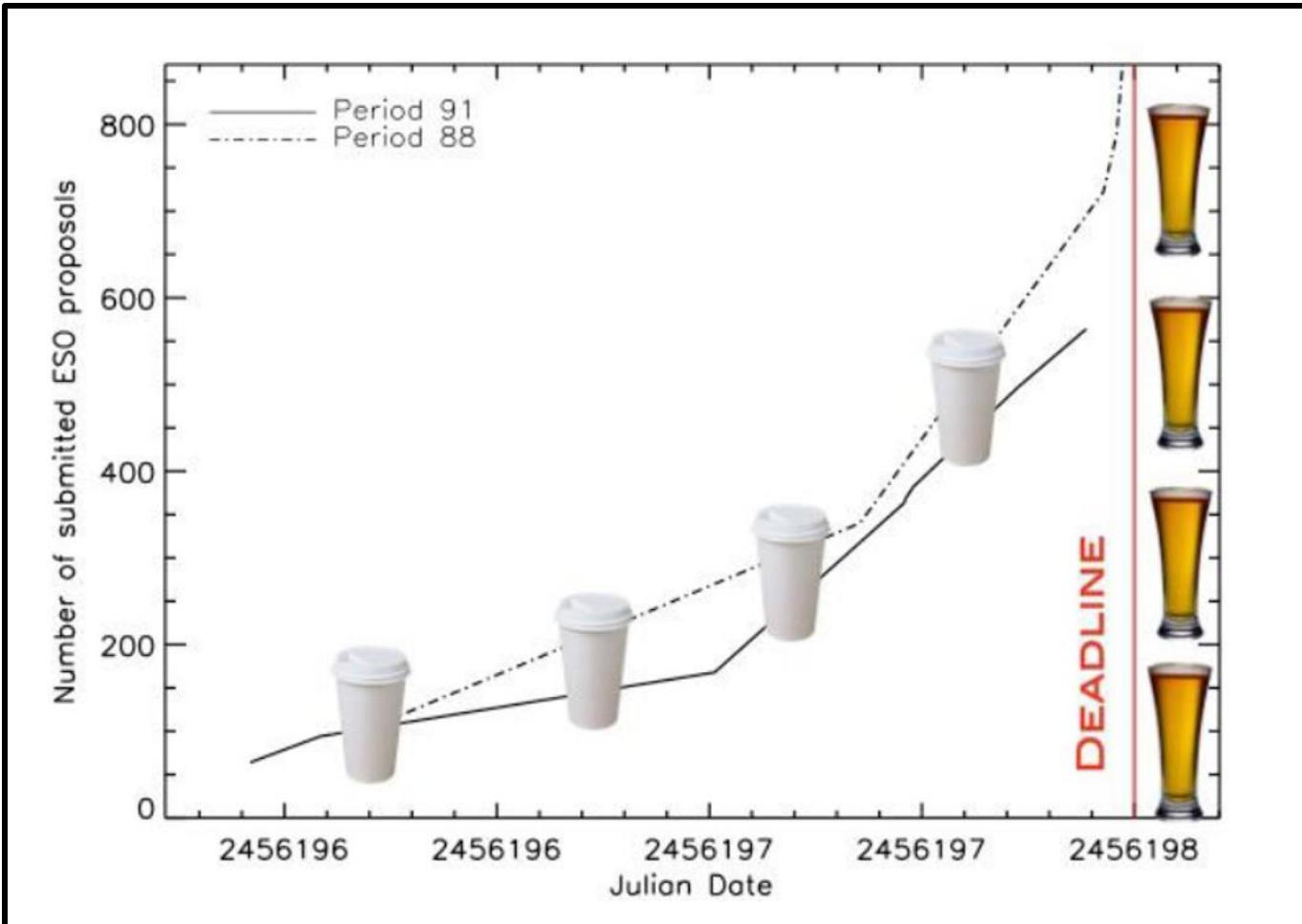
Reference Targets

Type	Name	RA	Dec	Mags
Coude Guide Star	CoudeGS_for_A16	18:21:01.124	-16:05:47.179	

▼ NGC6618 B311, 18:20:22.700, -16:08:34.170 **Tel. Time: 1h00m** [Night](#) [Period](#) [Propagate Tel. Times](#)



Final tips



- When you have an idea try first to convince your collaborators
- **Check carefully your targets**
- Read the manuals, contact VLTI expertise centers, watch videos of the previous VLTI schools, approach VLTI users that can and will surely help you throughout the process
- Do not start the day before the deadline (at least try)...
- **SUBMIT WITHIN THE DEADLINE!**



Preparing observations: phase 2

James Leftley (he/him)



Resources

- You are not alone, help is always available
 - **USD** (user service department) help desk is an official ESO service to help with observation setup (p1+p2)
 - **JMMC help desk** is also available to help with any part of your VLTI project, including setting up proposals
 - Links at end of presentation
- Setup is less VLTI specific than you might think
 - Nearly everything is similar to other observing techniques
- Almost all technical considerations will be selected in P1



**DON'T
PANIC**



P2 for VLTI

- If you have observed with ESO, you will most likely have encountered P2
- If not, ESO provide full tutorials on how to use it
- In this talk, I will present important parts specific to the VLTI

The screenshot shows the ESO Phase 2 Preparation (P2) tool interface. The top navigation bar includes the ESO logo, a "User Portal" button, and links for "Contact", "Search", and "Go!". The main content area is titled "p2 - Help". It features a sidebar with a tree view of documentation categories such as "Phase 2 Preparation", "Observing conditions", "Service Mode Philosophy", and "Help". The main pane displays a "Your Observing Runs" section showing a list of observations. Annotations highlight specific elements: "Currently selected items are highlighted in light-blue" points to a blue-highlighted item; "Greyed-out OBs are read-only" points to a greyed-out item; and "Once created the OB get an OB-ID and is fully editable" points to a blue-highlighted item with an "OB-ID" label. A "Watch on YouTube" button is visible at the bottom left of the main pane.

European Southern Observatory

Public Science User Portal

Science Users Information > Observing with ESO Telescopes > Phase 2 Preparation > The p2 Tool > Help

13 Jun 2025

p2 - Help

In the following we provide some key definitions which will help the users to familiarize with the ESO Phase 2 basic concepts.

We recommend our users to refer to the instrument user's manuals or template manuals for an extensive description of the templates of a specific VLT instrument. All manuals are available for download from the [ESO Paranal instruments web pages](#).

Before starting to use p2 please familiarize yourself [here](#) with the general concepts related to the preparation of the Phase 2 material.

p2 is implemented using Google's angular framework [<https://angular.io>]. Please check [here](#) for a complete list of supported browsers.

Please see the 2 minutes video showing the basic concept of OB preparation and notification report.

2 - p2 basic introduction

Watch Later Share

Your Observing Runs

60A-9052(A)-XSHOOTER

NGC104_2*

1864692 - NGC104

+ New Group

+ New Concatenation

✓ 1864681 - NGC104_3

OB CD FL G T C

Watch on YouTube

p2 Tutorials Service Mode Guidelines Instrument User Manuals

Phase 2 preparation: principles The Phase 2 API Ask for HELP

OBs and scheduling container status

Last Update: 21.12.21 © ESO

Contact us | Subscribe to Newsletter | Privacy Statement



Programme organisation

Aquisition

Observation

Your Observing Runs

Sort by: Nothing selected

- + 115.282E.001 - GRAVITY (4)
- + 115.282E.002 - GRAVITY (5)
- + 114.277L.002 - VISIR (16)
- 114.277L.004 - MATISSE (2)
 - Akn 120 (3)
 - OB 3958720 - CAL_AKN120_L
 - OB 3958703 - SCI_AKN120
 - OB 3959163 - CAL_AKN120_N
 - NGC3227 (3)
 - OB 3959179 - CAL_NGC3227_L
 - OB 3959176 - SCI_NGC3227
 - OB 3959182 - CAL_NGC3227_N
- + 114.27NR.001 - XSHOOTER (1)
- + 113.26A5.002 - VISIR (17)
- + 112.25ND.001 - MATISSE (4)
- + 111.24TE.001 - MATISSE (3)
- + 111.24TE.002 - MATISSE (1)
- + 111.24U7.001 - MATISSE (1)
- + 111.2505.001 - MATISSE (2)
- + 111.2505.002 - MATISSE (1)
- + 110.24BT.001 - MATISSE (5)

Check Certify Revise Edit Import/Export Delete Refresh OB Reveal in folder

114.277L.004 · MATISSE · ob 3959163 CAL_AKN120_N Exp. Time: 00:12:24 · Exec. Time: 00:30:24 (Partially Defined)

Obs. Description Target Constraint Set Time Intervals Ephemeris Target Visibility Finding Charts

Obs. Description: HD 290135 GRA4MAT

Observing Description Name: HD 290135 GRA4MAT

User Comments

MATISSE_img_acq_ft #1 acquisition 2675511

L band flux in Jy	0.8
N band flux in Jy	0.172
H band magnitude	6.643
K band magnitude	6.517
Differential tracking in RA	0
Differential tracking in DEC	0
RA of guide star if COU guide star is SETUPFILE	05:15:55.553
DEC of guide star if COU guide star is SETUPFILE	-00:04:39.634
Epoch	2000
Equinox	2000
COU guide star	SETUPFILE
Off-axis Coude Proper Motion Alpha	0.002432
Off-axis Coude Proper Motion Delta	0.000676
Guiding Type	ADAPT_OPT
G5 mag	10.088815
Interferometric Array	UTS
Types of interferometric observations	snapshot

MATISSE_hyb_obs_ft #2 science 2675512

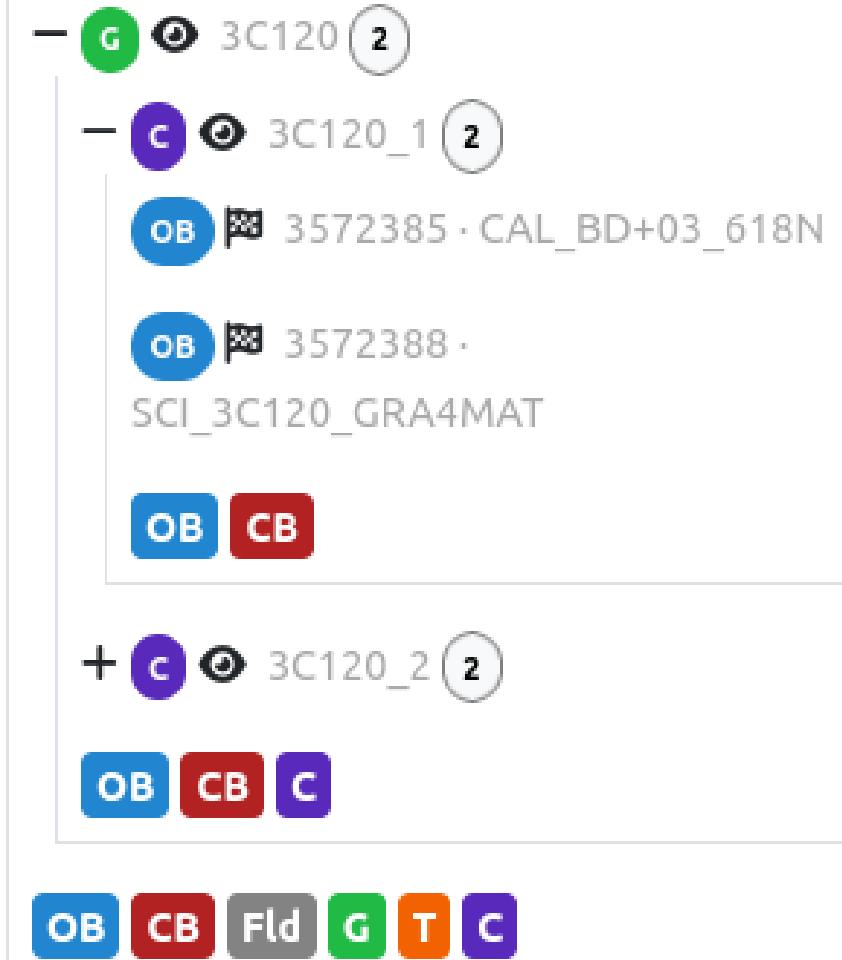
Integration time for L&M detector	3.0
Frame mode for L&M detector	SCI-SLOW-SPEED
Predefined central wavelengths for L&M bands	4.1
Number of exposures cycles	3
Relative offset in RA (mas)	0
Relative offset in DEC (mas)	0
Do photometry sequence (T or F)	no
Sky offset, right-ascension	1
Sky offset, declination	15
Master band for coherencing (L or N)	L
Spectral mode for L&M bands	LOW
Spectral mode for N band	LOW
Observation type	CALIB

Template Type: science Template: MATISSE_hyb_obs Add Template



P2 for VLTI

- Unlike some instruments, **concatenations** are necessary in almost all cases
 - Calibrators must be requested and observed close in time
 - **Concatenations** >1hr require a waiver
 - Waiver will be needed in many/most cases
- Just like for other instruments:
 - You can use **groups** to link multiple observations of one target
 - Needed for observations with multiple snapshots
 - **Timelinks** can be used but they are more restrictive, usually for time series





- Otherwise, rest of P2 is very similar to any instrument

Your Observing Runs

Sort by: Nothing selected

+ 115.282E.001 - GRAVITY 4

+ 115.282E.002 - GRAVITY 5

+ 114.277L.002 - VISIR 10

- 114.277L.004 - MATISSE 2

- Akn 120 3

OB 3958720 - CAL_AKN120_L

OB 3958703 - SCI_AKN120

OB 3959163 - CAL_AKN120_N

OB CB

- NGC3227 3

OB 3959179 - CAL_NGC3227_L

OB 3959176 - SCI_NGC3227

OB 3959182 - CAL_NGC3227_N

OB CB

OB CB Fld G T C

+ 114.27NR.001 - XSHOOTER 1

+ 113.26A5.002 - VISIR 17

+ 112.25ND.001 - MATISSE 4

+ 111.24TE.001 - MATISSE 3

+ 111.24TE.002 - MATISSE 1

+ 111.24U7.001 - MATISSE 1

+ 111.2505.001 - MATISSE 2

+ 111.2505.002 - MATISSE 1

+ 110.24BT.001 - MATISSE 5

Check Certify Revise Import/Export Delete Refresh OB Reveal in folder

114.277L.004 - MATISSE - ob 3959163 CAL_AKN120_N Exp. Time: 00:12:24 · Exec. Time: 00:30:24 (Partially Defined)

Obs. Description Target Constraint Set Time Intervals Ephemeris Target Visibility Finding Charts

Obs. Description: HD 290135 GRA4MAT

Observing Description Name: HD 290135 GRA4MAT

User Comments

MATISSE_img_acq_ft

#1 acquisition 2675511

L band flux in Jy: 0.8

N band flux in Jy: 0.172

H band magnitude: 6.643

K band magnitude: 6.517

Differential tracking in RA: 0

Differential tracking in DEC: 0

RA of guide star if COU guide star is SETUPFILE: 05:15:55.553

DEC of guide star if COU guide star is SETUPFILE: -00:04:39.634

Epoch: 2000

Equinox: 2000

COU guide star: SETUPFILE

Off-axis Coude Proper Motion Alpha: 0.002432

Off-axis Coude Proper Motion Delta: 0.000676

Guiding Type: ADAPT_OPT

G5 mag: 10.088815

Interferometric Array: UTs

Types of interferometric observations: snapshot

MATISSE_hyb_obs_ft

#2 science 2675512

Integration time for L&M detector: 3.0

Frame mode for L&M detector: SCI-SLOW-SPEED

Predefined central wavelengths for L&M bands: 4.1

Number of exposures cycles: 3

Relative offset in RA (mas): 0

Relative offset in DEC (mas): 0

Do photometry sequence (T or F): no

Sky offset, right-ascension: 1

Sky offset, declination: 15

Master band for coherencing (L or N): L

Spectral mode for L&M bands: LOW

Spectral mode for N band: LOW

Observation type: CALIB

Duplicate Delete

Template Type: science Template: MATISSE_hyb_obs Add Template

tpl size: normal small tpl/row: 1 2 3 4 5

Select array and observation type

Guide star mag is in GAIA rp



Observation templates

▼ [PIONIER_obs_science](#)

#2 science 2012086

Number of fringe tracks Duplicate  Delete 

▼ [GRAVITY_dual_obs_exp](#)

#2 science 2012089

Science integration time (DIT in s) ↴ ↵

Number of science frames (NDIT) ↴ ↵

Number of sky frames (NDIT) ↴ ↵

Sky dRA offset in milliarcsecond

Sky dDEC offset in milliarcsecond

Sequence of HWP offsets (deg)

Sequence of observations Object (O) and Sky (S)

Sequence of SC relative RA offsets (mas)

Sequence of SC relative DEC offsets (mas)

Duplicate  Delete 

▼ [MATISSE_hyb_obs](#)

#2 science 2011894

Integration time for L&M detector ↴ ↵

Frame mode for L&M detector ↴ ↵

User central wavelength for L&M bands ↴ ↵

Predefined central wavelengths for L&M bands ↴ ↵

Number of exposures cycles ↴ ↵

Do photometry sequence (T or F) yes

Sky offset, right-ascension ↴ ↵

Sky offset, declination ↴ ↵

Master band for coherencing (L or N) ↴ ↵

Spectral mode for L&M bands ↴ ↵

Spectral mode for N band ↴ ↵

Observation type ↴ ↵

Duplicate  Delete 



Manuals

- Similarly to any ESO instrument, manuals are available
- Unlike other instruments, there is a manual for the instrument AND the VLTI
 - VLTI is common to all VLTI instruments
- Template manual is for details on p2 templates

The screenshot shows the ESO Paranal Facilities page. The left sidebar lists various instruments and facilities under the heading "Paranal Facilities". The "Manuals" section is highlighted with an orange border. The main content area is titled "GRAVITY Documentation" and contains a paragraph about preparing and analysing observations with GRAVITY. It lists several "Instrument User Manual" entries, each with a link to its PDF version. There are also sections for "Template User Manual" and "VLTI User Manual". A note at the bottom refers to the "GRAVITY p2 tutorial".

European Southern Observatory

Public Science User Portal

Science Users Information > Observing Facilities > Paranal Facilities > Paranal Instrumentation > VLTI GRAVITY > Manuals

Contact Search Go! 13 Jun 2025

Paranal Facilities

- Contact Information
- Paranal Science Operations
- Quality Control
- Call for Proposals
- Paranal Telescopes
- Paranal Instrumentation
- CRIRES
- ERIS
- ESPRESSO
- FLAMES
- FORS
- HAWK-I
- KMOS
- MUSE
- SPHERE
- UVES
- VISIR
- X-SHOOTER
- Visitor Focus
- VLTI GRAVITY**
- Overview
- News
- Instrument Description
- Manuals**
- Tools
- Instrument Operation Team
- Visitor Instructions
- Science
- VLTI MATISSE
- VLTI PIONIER
- VLTI Visitor Instrument
- OmegaCAM @ VST
- Mascot
- Decommissioned Instruments
- Paranal ASM Website
- Paranal Site Information, Logistics, Safety

GRAVITY Documentation

To prepare and analyse observations with GRAVITY at the VLT interferometer, the user can find all the necessary information in the various manuals listed on this page. Please be sure to use the version of the manuals which is relevant to the period(s) in which the observations will take place. In case there are no changes, the latest version of the respective manual is still valid. All the manuals are in pdf format.

- **Instrument User Manual.** All the information about the instrument itself, its modes and their characteristics.
 - Issue 098, to be used for the P098 call for proposal (deadline March 31th, 2016) and the science verification runs in P97.
 - Issue 099, valid for Period 099 (deadline September 30th, 2016).
 - Issue 100, valid for Period 100 (deadline March 31th, 2017).
 - Issue 101, valid for Period 101 (deadline September 30th, 2017).
 - Issue 102, valid for Period 102 (deadline March 28th, 2018).
 - Issue 103, valid for Period 103 (deadline September 27th, 2018).
 - Issue 104, valid for Period 104 (deadline March 28th, 2019).
 - Issue 105, valid for Period 105 (deadline September 26th, 2019).
 - Issue 106, valid for Periods 106 - 109 (P106 deadline March 26th, 2020)
 - Issue 110, valid for Periods 110 - 111 (P110 deadline March 25th, 2022)
 - Issue 112, valid for Period 112 Phase 1 (P112 deadline March 28th 2023)
 - Issue 112b, valid for Period 112 Phase 2 onwards (Phase 2 of P112 and P113 Call for Proposals in September 2023)
 - Issue 114, valid for Period 114 Phase 1
 - Issue 115, valid for Period 115 Phase 1
 - Issue 115b, valid for Period 115 Phase 2
 - Issue 116, valid from Period 116 Phase 2 onwards
- **Template User Manual.** Detailed information on the acquisition and observing templates.
 - Issue 098, to be used for Science Verification in P097 and P098 phase 2.
 - Issue 099, to be used for P099 (updated version 2017-01-31).
 - Issue 100, to be used for P100 (updated version 2017-08-01).
 - Issue 101, to be used for P101.
 - Issue 102, to be used for P102.
 - Issue 103, to be used for P103.
 - Issue 104, to be used for P104 and P105.
 - Issue 106, to be used for P106 - P109
 - Issue 109b, to be used from GRAVITY Wide Science Verification onwards (SV in P109, normal call in P110 and P111)
 - Issue 112, to be used for P112
 - Issue 114, to be used for P114
 - Issue 115, to be used for P115
 - Issue 116, valid from Period 116 Phase 2 onwards
- **VLTI User Manual.** The VLTI User Manual is to be used in addition to the GRAVITY User Manual for VLTI aspects and system limits common to the VLTI instruments.
 - VLTI user manual for Period 111
 - VLTI user manual for Period 112
 - VLTI user manual for Period 113
 - VLTI user manual for Period 114
 - VLTI user manual for Period 115
 - VLTI user manual for Period 116

Instructions on how to prepare OBs using the p2 web application are available at the [GRAVITY p2 tutorial](#).

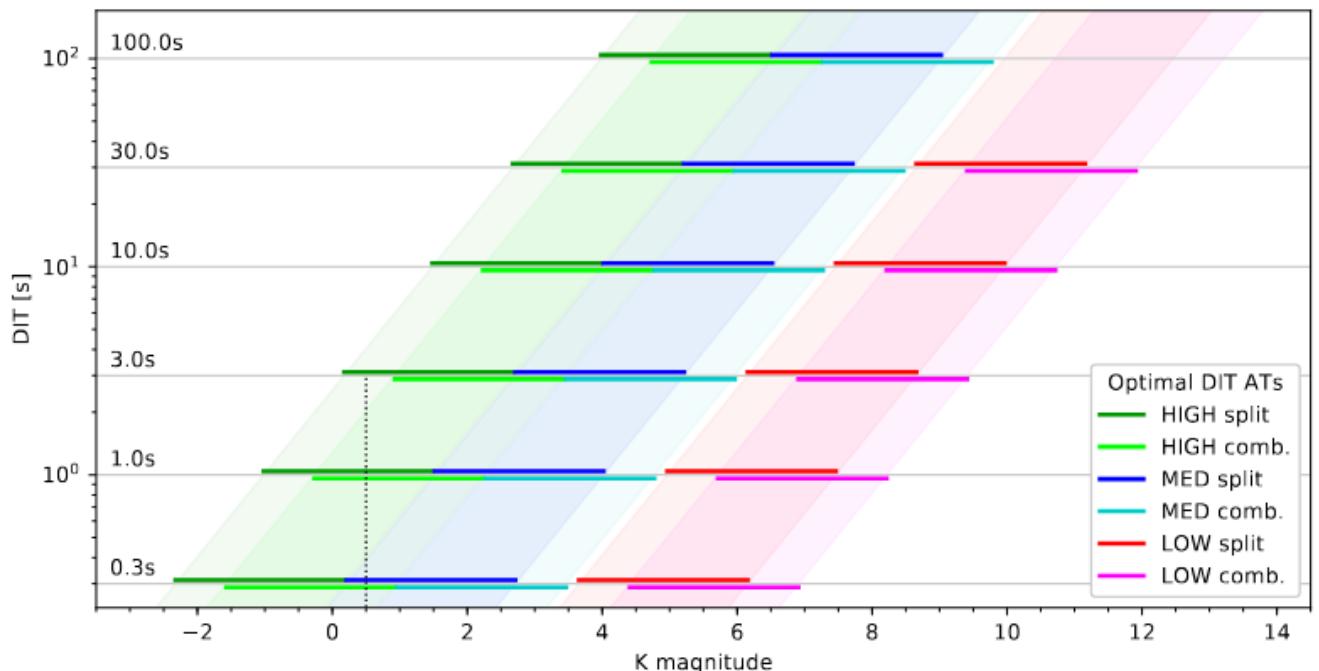
Last Update: 26.05.25 © ESO

Send comments to Paranal Science Operations | Subscribe to Newsletter | Privacy Statement



Setup choices

- In P1 you will have already mostly selected your setup
 - P2 will have some fine additional details but the broad strokes are already complete
 - e.g. Integration time will be known, but DIT*NDIT can be finetuned
 - Manuals explain all the options





Selecting a calibrator

- Perhaps most important in P2 is calibrator selection
 - True for all observing, doubly so for interferometry
- Similar to other methods but there are a few key differences
- Fluxes per band
 - Similar flux to science is helpful
 - CAL/SCI/CAL?
- Spectroscopic requirements?
 - Unusually, most cases don't need one
 - Visibility and phase are ratios
 - Only if you need absolute or correlated flux
 - Probably want CAL-SCI-CAL if needed
- Sizes!
 - A resolved star adds uncertainty
 - Most spectroscopic calibrators are resolved to some baselines
- Avoid binaries
- **JSDC/SearchCal**

Home > TOOLS > Proposal Preparation > Search Cal

Search Cal

The screenshot shows the SearchCal software interface. At the top, there are three main sections: 'Instrumental Configuration' (Magnitude Band: V, Wavelength (V) [μm]: 0.55, Max. Baseline [m]: 102.45), 'Science Object' (Name: ETA.TAU, Get Star, RA 2000 [hh:mm:ss]: 03:47:29.0765, DEC 2000 [+/-dd:mm:ss]: +24:06:18.494, Magnitude (V): 2.83), and 'SearchCal Parameters' (Min. Magnitude (V): 2.0, Max. Magnitude (V): 4.0, Scenario: Bright, RA Range [mm]: 60.0, DEC Range [deg]: 5.0). Below these are sections for 'Progress' and 'Found Calibrators'. The 'Found Calibrators' table lists four stars with columns: Index, dist, HD, RAJ2000, DECJ2000, vni2, vni2Dr, diam.vk, e_diam.vk, SpType, and V. The table rows are:

Index	dist	HD	RAJ2000	DECJ2000	vni2	vni2Dr	diam.vk	e_diam.vk	SpType	V
1	0.65	23630	03 47 29.08	+24 06 18.5	0.0010	-0.0029	0.947	0.065	K7III	2.87
2	0.486	23107	03 45 49.61	+24 22 03.1	0.0114	-0.0021	0.948	0.065	K3III	3.22
3	0.46	23408	03 45 49.61	+24 22 03.9	0.998	0.038	0.418	0.029	B8III	3.87
4	0.595	23302	03 44 52.54	+24 06 43.0	0.71	0.035	0.407	0.028	B6III	3.706

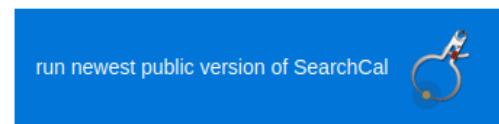
Below the table are 'Filters' and 'Status' sections.

SearchCal is a tool developed to assist the astronomers in this calibrator selection process for long baseline interferometric observations.

The science behind SearchCal is described in the 2016 paper ["Pseudomagnitudes and differential surface brightness: Application to the apparent diameter of stars."](#) by Chelli A., Duvert G., Bourgès L. et al., 2016, A&A, 589, 112.

The SearchCal user interface (check download link below) gives access to the complete JSDC catalog for stars having a spectral type estimate and to a less precise estimate for the other 2 million stars of the Tycho list for which the spectral type has not been measured (yet).

Additional help in using SearchCal results can be found on the [SearchCal Wiki Page](#).



or [find other release packages](#)

Documentation:

You can get the [user manual in pdf format](#) or access it online (from Help menu)

Query Parameters

1) Instrumental Configuration

Magnitude Band : L
 Wavelength (L) [μm] : 3.5
 Max. Baseline [m] : 102.45

Nearby is better

Ideally 1 or close

2) Science Object

Name : Q▼ESO323-G77
 RA 2000 [hh:mm:ss] : 13 06 26.1214861728
 DEC 2000 [+/-dd:mm:ss] : -40 24 52.595604396
 Flux [L] (Jy) : 0.1

3) SearchCal Parameters

Max. Flux [L] (Jy) : 0.631
 Min. Flux [L] (Jy) : 0.0158
 Scenario : Bright Faint
 RA Range [mn] : 240.0
 DEC Range [deg] : 20.0



Similar to sci

Progress :

Found Calibrators (4958 sources, 4907 filtered)

Index	dist	HD	RAJ2000	DEJ2000	vis2	vis2Err	diam_chi2	LDL	e_LDL_rel	GroupSize	SIMBAD	SpType	ObjTypes	flux_L	flux_M	flux_N	UD_L	UD_M	UD_N
1	0.549	113599	13 05 20.8776	-39 54 24.9480	1.0	1.996E-5	1.09	0.083	2.93	0	HD 113599	K1 III	,Star,*IR,	0.104	0.062	0.013	0.082	0.082	0.083
2	0.759	114229	13 09 42.4898	-40 51 06.7032	0.998	8.823E-5	1.0	0.193	2.417	0	HD 114229	K0/I III	,Star,*IR,	0.487	0.276	0.061	0.19	0.191	0.192
3	0.891	113644	13 05 41.5260	-41 17 40.8444	0.998	9.399E-5	0.05	0.196	2.496	0	HD 113644	K0(III)	,Star,*IR,	0.481	0.281	0.06	0.193	0.194	0.195
4	0.952	113257	13 02 56.6933	-39 44 09.3804	0.999	6.119E-5	0.554	0.16	2.455	0	HD 113257	K0 III	,Star,*IR,	0.352	0.202	0.044	0.157	0.158	0.159
5	1.503	113776	13 08 28.8948	-38 54 43.4232	0.997	1.383E-4	0.083	0.231	2.659	0	HD 113776	K2 III	,Star,*IR,	0.606	0.352	0.076	0.227	0.228	0.229
6	1.648	113765	13 06 27.0480	-42 03 43.9884	0.998	1.399E-4	1.0	0.221	2.942	0	HD 113765	K1/2 III	,Star,*IR,	0.579	0.336	0.072	0.217	0.218	0.219
7	1.743	114693	13 12 43.6248	-39 09 32.7528	0.999	7.014E-5	0.706	0.174	2.356	0	HD 114693	K1 III(CNIV/V)	,Star,*IR,	0.398	0.221	0.047	0.172	0.173	0.173
8	1.795	113572	13 05 05.3671	-38 38 18.5892	0.998	7.564E-5	0.024	0.182	2.339	0	HD 113572	K1 III	,Star,*IR,	0.434	0.236	0.052	0.179	0.18	0.181
9	1.925	112345	12 56 26.8915	-40 08 08.4948	0.998	9.491E-5	1.542	0.202	2.378	0	HD 112345	K0 III	,Star,*IR,	0.523	0.306	0.067	0.199	0.2	0.201
10	1.935	112777	12 59 41.7384	-41 52 30.5148	0.998	7.813E-5	1.0	0.182	2.416	0	HD 112777	K0/2(III)	,Star,*IR,	0.42	0.235	0.051	0.179	0.18	0.181
11	1.943	112315	12 56 13.6745	-40 29 11.0544	0.998	8.326E-5	1.0	0.193	2.283	0	HD 112315	K0/1(III)	,Star,*IR,	0.476	0.276	0.059	0.19	0.191	0.192
12	1.997	113790	13 06 44.8980	-42 24 38.9304	0.999	8.17E-5	0.303	0.164	3.118	0	HD 113790	K0 III	,Star,*IR,	0.354	0.197	0.043	0.161	0.162	0.163
13	2.152	115008	13 14 54.4450	-39 00 32.8716	0.998	1.226E-4	0.217	0.227	2.427	0	HD 115008	K2 III	,Star,*IR,	0.62	0.345	0.076	0.224	0.225	0.226
14	2.275	113233	13 02 54.3170	-42 35 27.6504	0.998	9.33E-5	0.101	0.201	2.356	0	HD 113233	K1 III	,Star,*IR,	0.512	0.287	0.063	0.198	0.199	0.2
15	2.302	115327	13 17 07.1806	-39 21 53.9208	0.998	7.361E-5	0.32	0.179	2.339	0	HD 115327	K0 III	,Star,*IR,	0.437	0.245	0.053	0.177	0.177	0.178
16	2.338	115579	13 18 36.3269	-40 08 11.2848	0.997	1.213E-4	0.036	0.228	2.386	0	HD 115579	K2 III	,Star,*IR,	0.614	0.355	0.077	0.225	0.226	0.227
17	2.374	113821	13 06 54.2083	-42 47 13.2072	0.999	7.472E-5	0.104	0.171	2.623	0	HD 113821	K0 III	,Star,*IR,	0.373	0.21	0.046	0.168	0.169	0.169
18	2.427	112531	12 57 52.8634	-42 14 05.6184	0.998	9.121E-5	0.795	0.206	2.197	0	HD 112531	K0 III	,Star,*IR,	0.549	0.327	0.068	0.203	0.204	0.205
19	2.47	115526	13 18 22.6865	-39 29 09.7800	0.999	5.242E-5	0.576	0.15	2.394	0	HD 115526	K0 III/IV	,Star,*IR,	0.306	0.173	0.037	0.147	0.148	0.149
20	2.523	112683	12 59 00.2458	-42 31 09.3288	0.998	9.9E-5	0.861	0.214	2.21	0	HD 112683	K0 III	,Star,*IR,	0.567	0.341	0.073	0.211	0.212	0.213
21	2.544	115481	13 18 02.1271	-41 42 57.2940	0.998	1.11E-4	0.447	0.221	2.334	0	HD 115481	K0 III	,*inCl,*IC,*IR,	0.619	0.377	0.096	0.217	0.218	0.219
22	2.687	112630	12 58 33.6883	-38 12 03.3012	0.998	9.472E-5	0.324	0.208	2.247	0	HD 112630	K1 III	,Star,*IR,	0.541	0.315	0.068	0.205	0.205	0.206
23	2.985	115129	13 15 50.4718	-42 49 40.2960	0.998	8.031E-5	0.562	0.18	2.528	0	HD 115129	K0 III	,Star,*IR,	0.428	0.242	0.052	0.178	0.178	0.179
24	2.991	114021	13 08 05.9513	-37 26 28.6476	0.999	6.467E-5	0.596	0.157	2.668	0	HD 114021	K0 III	,Star,*IR,	0.335	0.189	0.041	0.155	0.156	0.156
25	3.552	112454	12 57 13.8290	-43 31 38.2728	0.998	8.04E-5	0.088	0.189	2.302	0	HD 112454	K0(III)	,Star,*IR,	0.494	0.266	0.058	0.186	0.187	0.188
26	3.555	113234	13 02 53.1859	-43 54 29.9772	0.998	9.731E-5	0.09	0.206	2.355	0	HD 113234	K0 III	,Star,*IR,	0.535	0.315	0.068	0.203	0.203	0.204
27	3.641	114752	13 13 14.6179	-43 49 47.5644	0.998	1.016E-4	0.446	0.193	2.782	0	HD 114752	K0 III	,Star,*IR,	0.499	0.286	0.061	0.191	0.191	0.192

Filters

Reject stars farther than : Maximum RA Separation (mn) : 10.0 Maximum DEC Separation (degree) : 10.0

Reject stars with magnitude : below : 0.0 and above : 10.0

Reject Spectral Types (and unknowns) : O B A F G K M I II III IV V VI

Reject Luminosity Classes (and unknowns) :

Reject Visibility below : vis2 : 0.5

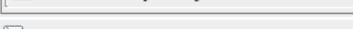
Reject Visibility Accuracy above (or unknown) : vis2Err/vis2 (%) : 2.0

Reject Variability

Reject Multiplicity

Reject Invalid Object Types

Diameter quality : Maximum chi square : 2.0 Maximum relative error (%) : 10.0

 searching calibrators... done.

127 M Provided by JMMC



Take home points

- Ensure good calibrator selection with available tools
- Concatenations are important for CAL-SCI
- Manuals provide choices for setups dependent on science

If in doubt, contact the help desks



Data reduction and VLTI Expertise Centres

Claire Lykou



Data reduction

- **BEFORE** thinking about applying for time or even reducing data, look at Phase3 products in the archives!

- ESO archive: archive.eso.org
- Most of PIONIER data already reduced and ready to use
- GRAVITY data curation will be available soon
- Optical Interferometry Database (incl. CHARA):
<http://oidb.jmmc.fr/index.html>

Science Users Information > Archive Home

Archive Home

- Data Portal
- ESO Data
- Virtual Observatory
- Catalogues, Plates and DSS
- Tools and Documentation
- Related External Services
- ESO & HST Image Galleries
- News and Updates
- FAQ
- ESO Data Access Policy

Welcome to the ESO Science Archive Facility

The ESO Science Archive Facility (SAF) contains, and provides access to, data from ESO telescopes at [La Silla Paranal Observatory](#), including the [APEX](#) submillimeter telescope on Llano de Chajnantor. All raw data from the La Silla Paranal Observatory are stored together with the corresponding calibrations, as well as selected products both contributed by the [community](#) or generated at [ESO](#). Processed data downloaded from the ESO Archive are assigned a [Digital Object Identifier \(DOI\)](#). The list of the DOIs currently available can be found [here](#). In addition, the raw UKIDSS/WFCAM data obtained at the UK Infrared Telescope facility in Hawaii are available in the ESO Archive.

The Principal Investigators of successful proposals for time on ESO telescopes have exclusive access to their scientific data for the duration of a proprietary period, normally of one year, after which the data becomes available to the community at large. Please read the [ESO Data Access Policy](#) statement for more information, along with the [relevant FAQs](#).

Browsing the archive does not require authentication. Please [acknowledge the use of archive data](#) in any publication.

There are various ways to access the archive, varying for content and presentation/interface: via a web browser, the Raw Data query form gives access to the raw frames and their calibrations, the Science Portal allows to browse and access the processed data, and the Catalogue Facility to browse and access the catalogue data produced by PIs of ESO programmes; the Programmatic and Tools access layer permits direct access to the raw and process data and metadata, to the ambient condition measurements, and to the catalogues, in a scriptable and VO-compatible manner. Other query forms are available in the table at the bottom of this page.

Raw Data

Programmatic
Raw, Processed, Catalogue, and Ambient Data

Science Portal
Processed Data

Support
Knowledgebase, Feedback

Catalogue Facility
Catalogue Data

JMMC OiDB

Home Search Submit new data Help Sign in

Optical interferometry DataBase



Target name or position

Enter target name or visit the advanced form

Please use next url to use OiDB's TAP server : <http://tap.jmmc.fr/volt/tap/>



Data reduction

- **Easy-to-use with ESOREflex**

- Install software (<https://www.eso.org/sci/software/esoreflex/>)
- Install pipelines (https://www.eso.org/sci/software/pipe_aem_table.html)
- **Read the manuals/cookbooks!**
- Try the demo data!



						Demo Data: 0.9		on hold
	GRAVITY	2024-03-12	1.9.0	1.9.0		Tutorial: 1.6.0 Demo Data: 0.9	yes	Active
●	HARPS	2025-02-27	3.3.6	3.3.6	Static Calibration WAVE & DLL Matrixes (17 MB)	Tutorial: 3.3.6 Demo Data: 0.2.0		Active
	HAWKI	2025-03-27	2.5.11	2.5.11		Tutorial: 2.5.11 Demo Data: 0.5	yes	Operational on hold
	ISAAC	2024-05-15	6.2.5	6.2.4	Static Calibration Files (50 MB)			End of maintenance
	KMOS	2025-03-12	4.5.1	3.6		Tutorial: 5.1 Demo Data: 2.2.0	yes	Active
	MATISSE	2025-02-07	2.2.0	2.2.0		Tutorial: 2.2.0 Demo Data: 0.4	yes	Active
	MIDI	2024-05-15	2.9.6	2.9.5				End of maintenance
		2025-02-		Tutorial: 4.4.2		...

r)



Data reduction

- **Easy-to-use with ESOReflex**
 - Install software (<https://www.eso.org/sci/software/esoreflex/>)
 - Install pipelines (https://www.eso.org/sci/software/pipe_aem_table.html)
 - **Read the manuals/cookbooks!**
 - **Try the demo data!**
 - Before you reduce your data:
 - Make sure to check observing conditions (night logs, ASM)
 - Make sure you download all auxiliary files per instrument, as well as calibrator data
 - Happy reducing!
 - What you get are OIFITS files (modeling, analysis, image reconstruction)
- **For more advanced users:** try the consortia/community toolboxes (e.g. MATISSE Fcorr)
 - *ExoGravity*: <https://gitlab.obspm.fr/mnowak/exogravity>
 - *MATISSE Python tools*: <https://github.com/Matisse-Consortium/tools>
- **Ask for help! Reach out to the VECs**



VLTI Expertise Centres

- **What we do...**

- Organise the VLTI schools
- Co-organise ESO VLTI Open days
- End-point for staff exchange visits

- **What we offer...**

- Preparation of VLTI observing proposals
 - *Tools for your science case!*
- Help with data reduction
- Help with data quality assessment
 - *Modelling software*
 - *Image reconstruction*



<https://european-interferometry.eu/vlti-expertise-centers/>



Data analysis

Jens Kammerer



Van Cittert-Zernike theorem

- For constructive (phase-referenced) interferometry (current VLTI instruments):
- Interferometer measures mutual spatial coherence function $V(u)$, or "complex visibility"
- Van Cittert-Zernike theorem:

$$\int I(\vec{\alpha}) e^{-ik\vec{u} \cdot \vec{\alpha}} d\vec{\alpha} = V(\vec{u}),$$

- $I(\alpha)$ is sky brightness distribution ("the image")



Model fitting

- Construct a model for the source (e.g., star + Gaussian disk)
- Calculate its Fourier transform
- Fit it to the observed visibilities (the measured data)
- *Shape of visibility function can provide information on the target (e.g., stellar surface, binary, disk)*

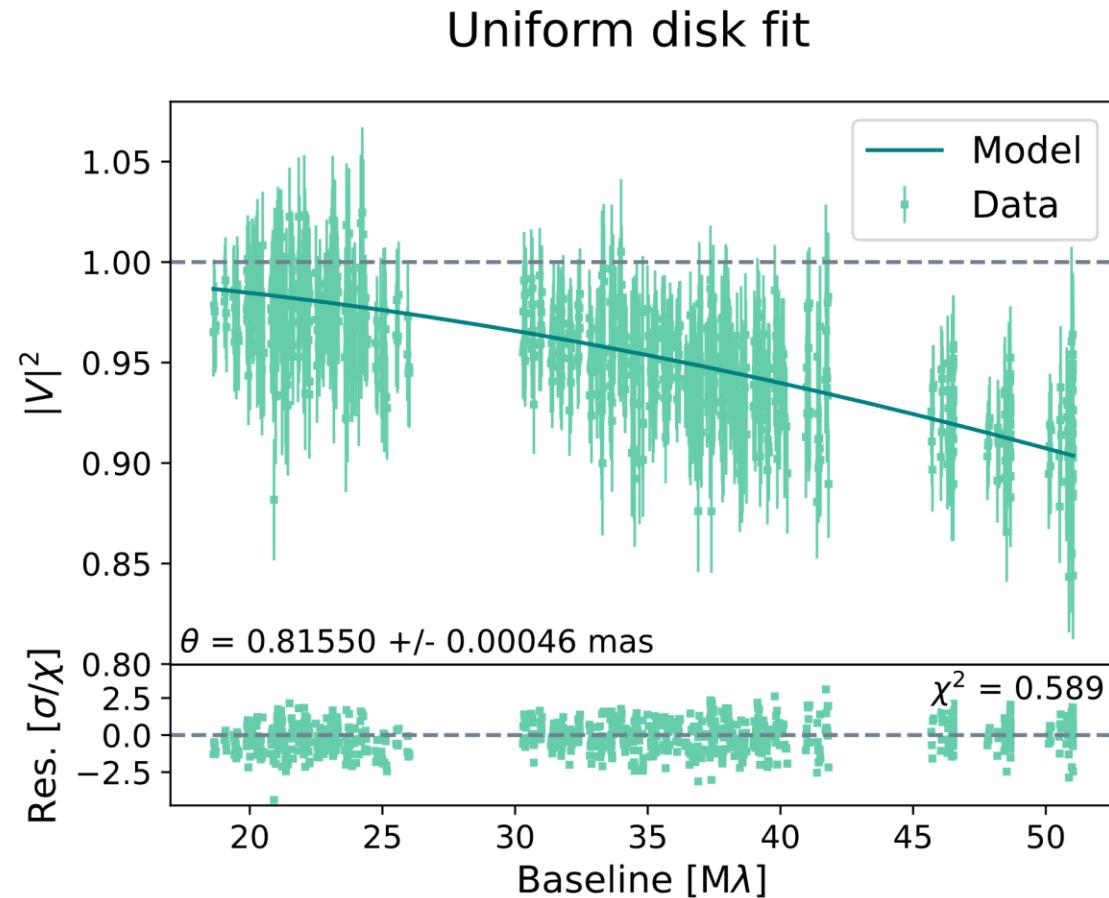


Model fitting

- Some examples:
- Unresolved point source (Dirac function) $V(\rho) = 1$
- Uniform disk $V(\rho) = 2 \frac{J_1(\pi a \rho)}{\pi a \rho}$
- Binary $V(\vec{u}) = \frac{1 + f e^{-2\pi i \vec{\alpha} \cdot \vec{u}/\lambda}}{1 + f}$



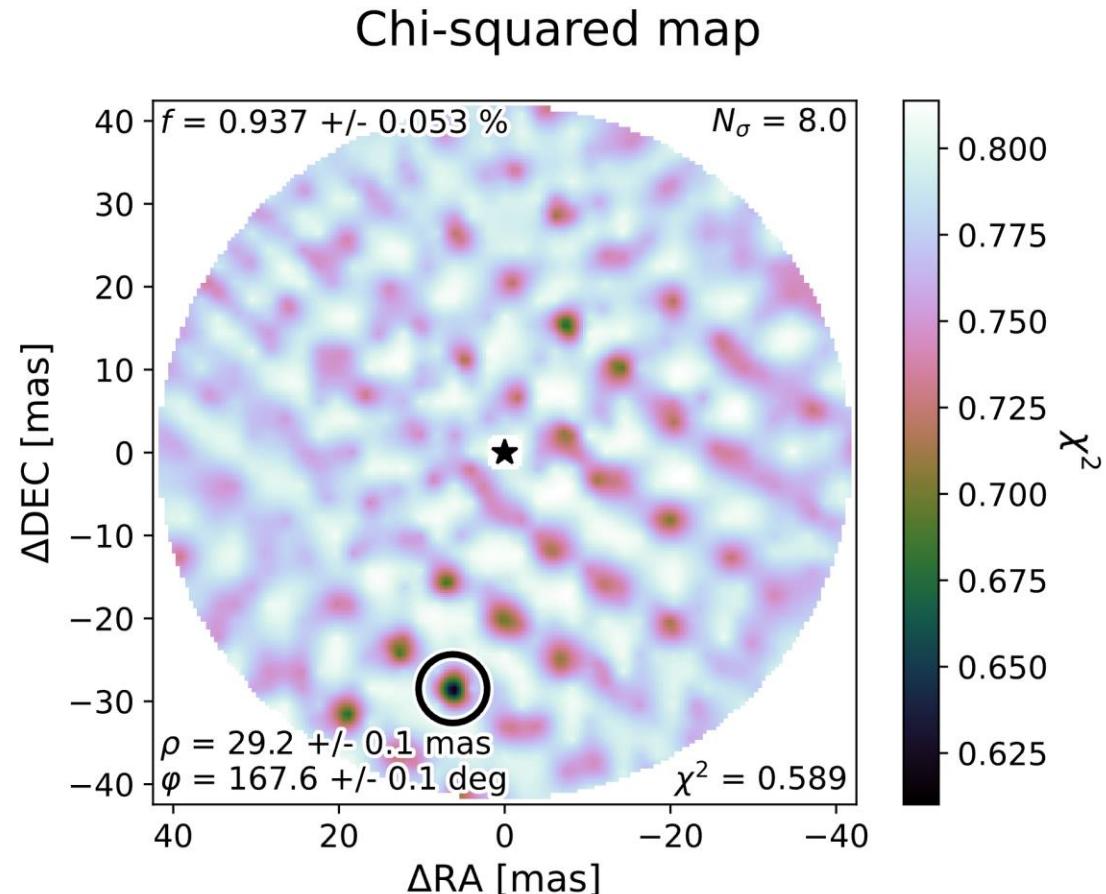
Model fitting





Model fitting

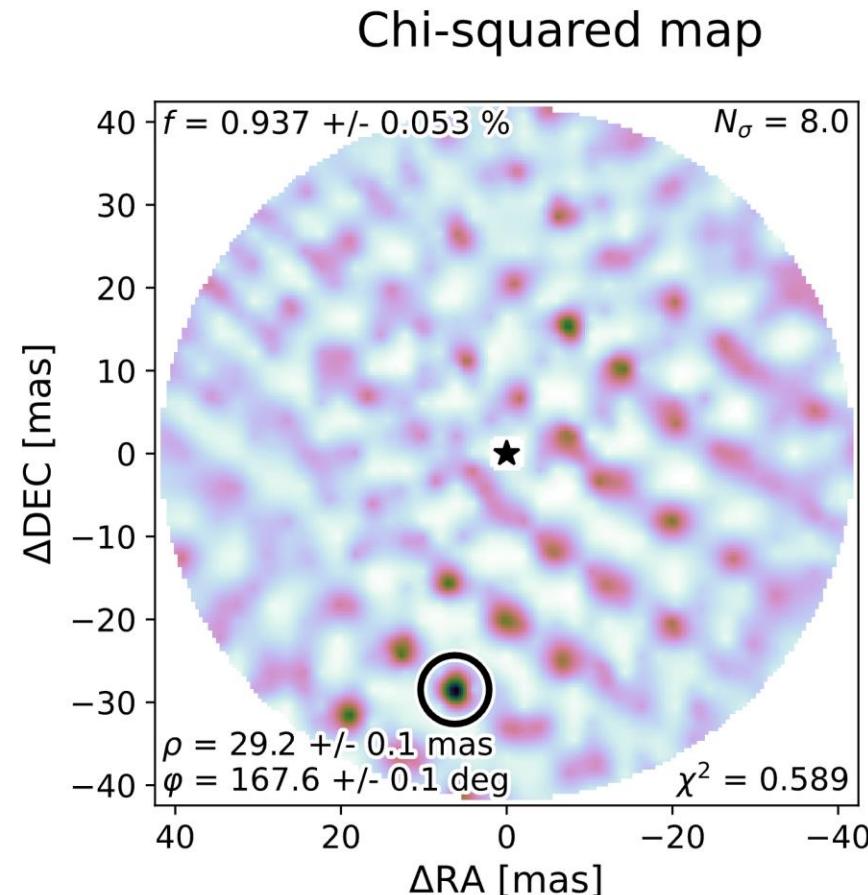
Companion search



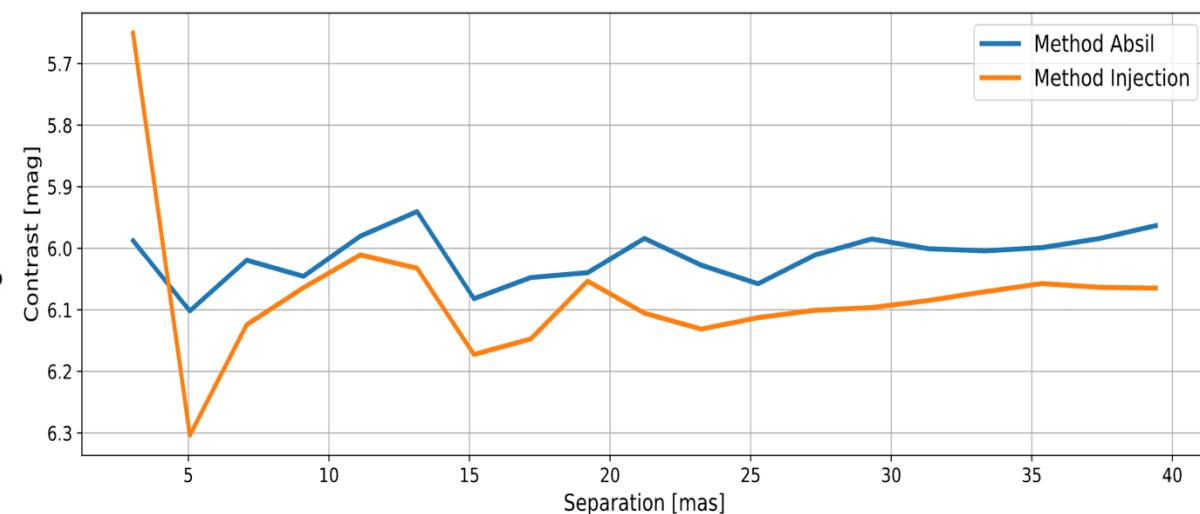


Model fitting

Companion search



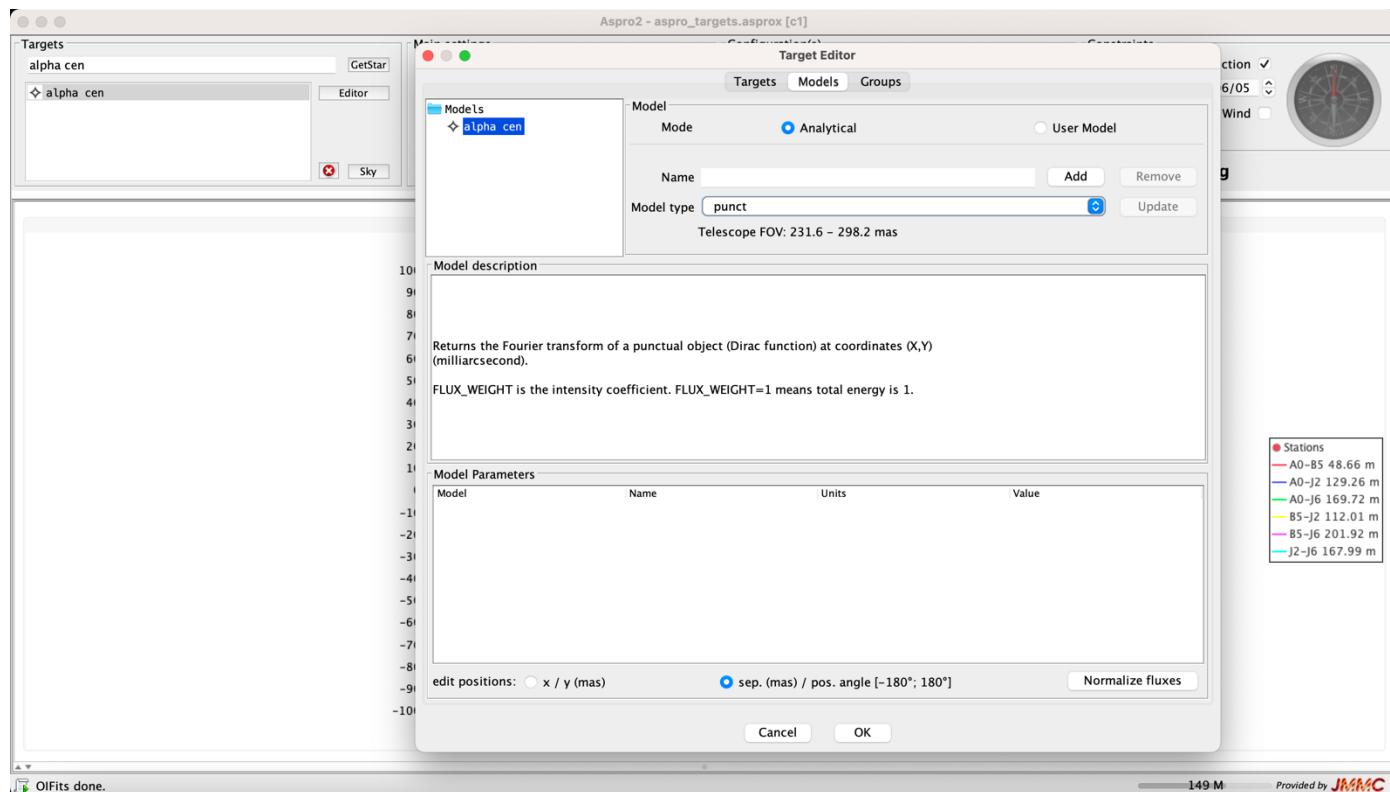
Detection limits





Model fitting

Aspro can simulate & visualize a lot of different models





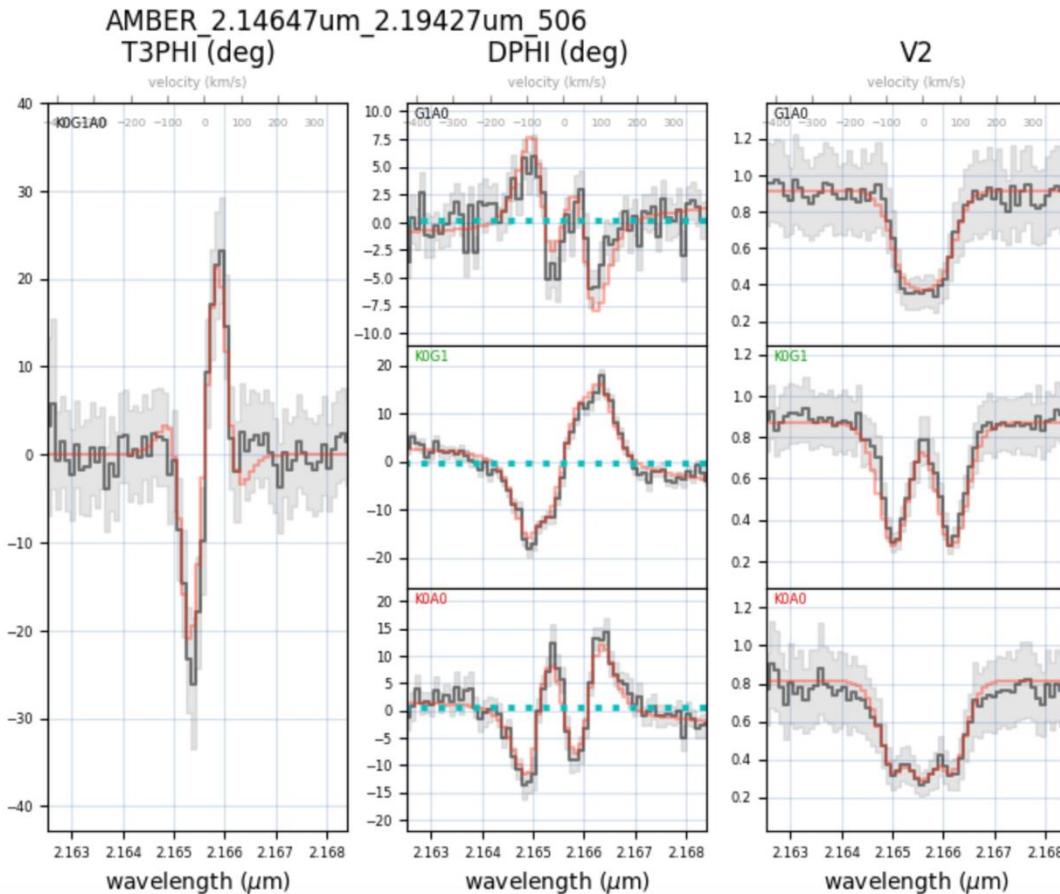
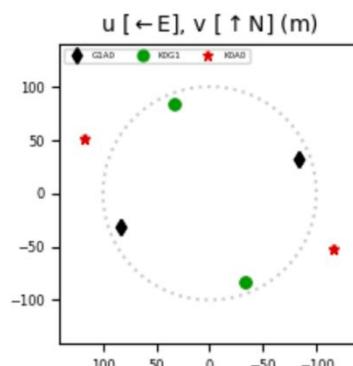
Model fitting

- So far, we have looked at the visibility as a function of spatial frequency
- Through spectroscopy, we can measure a range of baselines simultaneously
- However, so far, we looked at monochromatic models
- We can also construct more complex models with chromatic features, e.g., emission lines
- This is called "spectro-interferometry"



Model fitting

Tools like PMOIRED,
OIMODELER, or LITpro
can model
more complex scenes:
e.g., star + Gaussian disk
+ Keplerian disk with
emission line (Br-gamma)



<https://oimodeler.readthedocs.io/>

<https://github.com/amerand/PMOIRED>

```
chi2 with Meilland+2012 parameters: 3.789
[dpf] 7 FITTED parameters: ['V0', 'ac', 'al', 'kep,Vin', 'kep,incl', 'kep,line_1_EW', 'kep,projang']
[dpf] epsfcn= 1e-08 ftol= 1e-05
```



Image reconstruction

- Attempt to solve the (inverse) Fourier transform
- Problem: $V(u)$ is only measured (constrained) on some spatial frequencies so the solution is not unique
- Need:
 - As much uv-coverage as possible (imaging observations)
 - Regularization to enforce convergence of the minimization problem
- Remember: the VLTI is not like ALMA!
 - 6 vs 2145 baselines is a huge difference



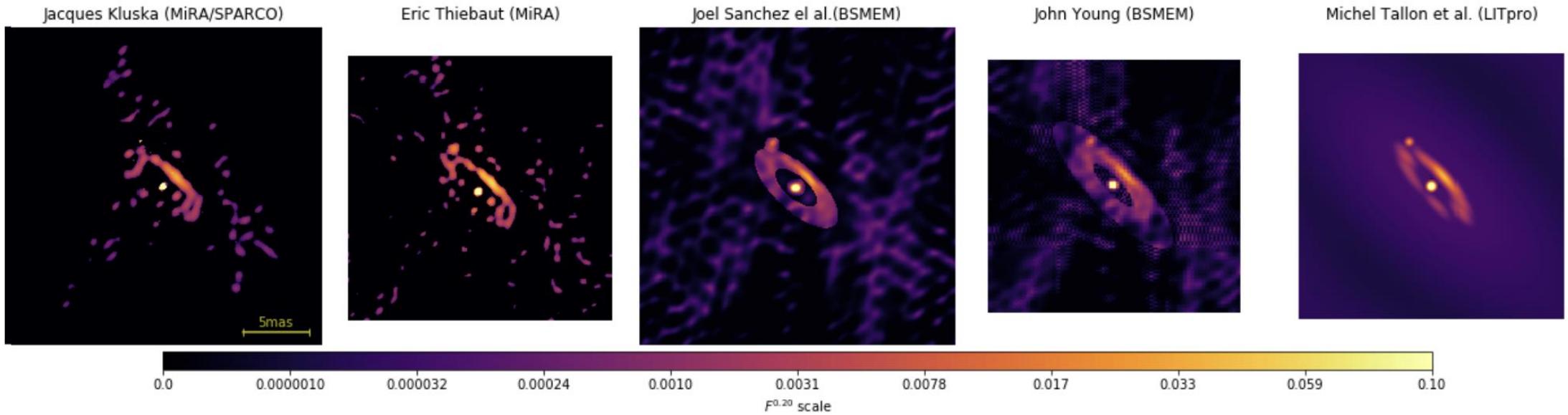
Image reconstruction

- Non-ML tools
 - MiRA: direct minimization of a penalized likelihood using regularization term; language: Yorick
 - SQUEEZE: based on Markov Chain Monte-Carlo (MCMC) exploration of the imaging probability space; language: C
 - SPARCO: semi-parametric approach for image reconstruction of chromatic objects; describe spectral characteristics of both the central object and the extended structure
 - BSMEM: BiSpectrum Maximum Entropy Method
- ML tools
 - Organic: Object Reconstruction with Generative Adversarial Networks from InterferometriC data; language: Python
 - CASSINI-AUTOMAP: Neural Network with adaptive activation functions to find an optimal mapping system between the infrared interferometric data and the reconstructed images; language: Python



Image reconstruction

A good overview can be found in the OI Image Reconstruction Contest at SPIE every 2 years



Mérand et al. 2018



Image reconstruction

An example with Olmaging

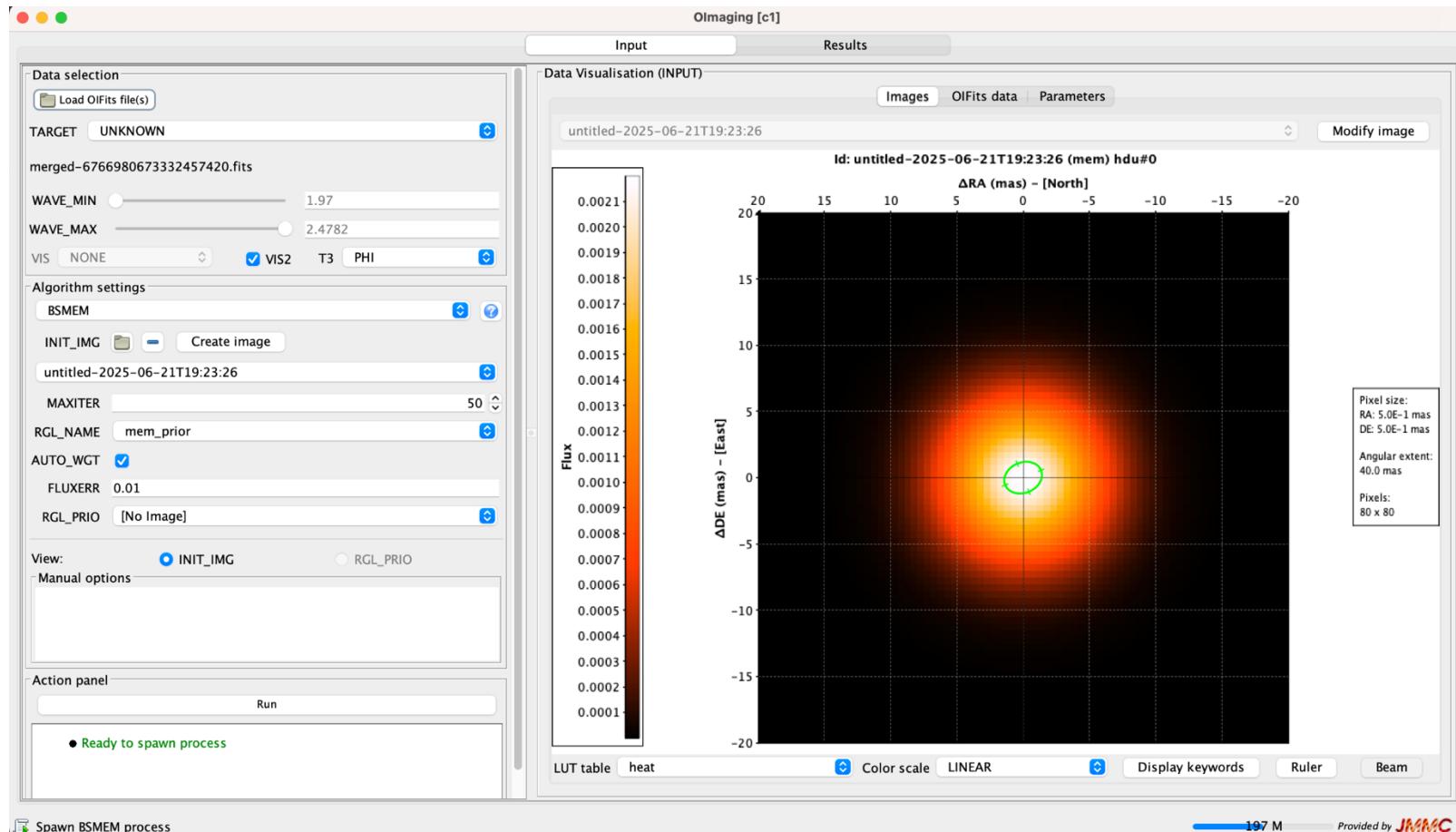
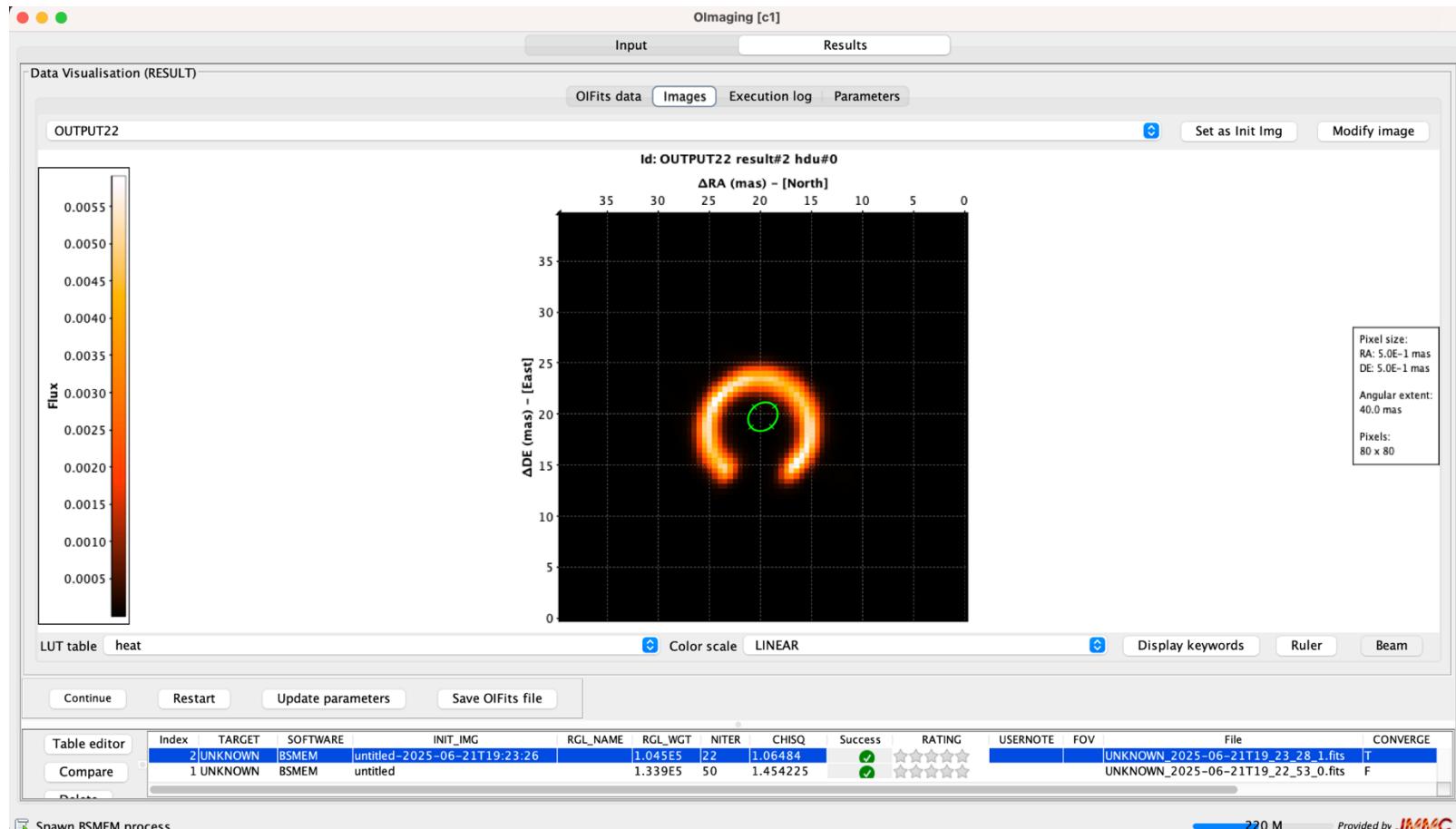




Image reconstruction

An example with Olmaging





Useful links



- Support and assistance:

- ESO USD <https://support.eso.org/en-GB>
 - P1 + P2 support
- JMMC helpdesk <https://www.jmmc.fr/english/user-support/expertise-center/>
 - Support for any step

- Trainings, JMMC tools and tutorials:

- VLTI Summer School 2021 material: <https://www.jmmc.fr/schools/vltischool2021/>
- VLTI Summer School 2024 material: <https://zenodo.org/communities/vltischool2024/records?q=&l=list&p=1&s=10&sort=newest>
- JMMC tools (Olfits Explorer, ASPRO, SearchCal, OIDB): <https://www.jmmc.fr/>
- Video tutorials: <https://www.jmmc.fr/english/training/tools-tutorials/>

- P1

- Call for proposals: <https://www.eso.org/sci/observing/phase1/p116/proposalsclosed.html>
- P1 tool: <https://www.eso.org/p1/>
- P1 demo tool: <https://www.eso.org/p1demo/>
- Anonymisation rules: <https://www.eso.org/sci/observing/phase1/dual-anonymous-guidelines.html>
- Manuals for a given period can be found on the webpages of the instruments: e.g. GRAVITY: <https://www.eso.org/sci/facilities/paranal/instruments/gravity/doc.html>

- P2

- SearchCal <https://www.jmmc.fr/english/tools/proposal-preparation/search-cal/>
- P2 demo <https://www.eso.org/p2demo>

- Data analysis

- Useful in general
 - Aspro: <https://www.jmmc.fr/~betaswmgr/Aspro2/>
- Model fitting
 - LITpro: <https://www.jmmc.fr/apps/public/LITpro/>
 - CANDID: <https://github.com/amerand/CANDID>
 - PMOIRED: <https://github.com/amerand/PMOIRED>
 - fouriever: <https://github.com/kammerje/fouriever>
 - OIMODELER: <https://github.com/oimodeler/oimodeler>
- Image reconstruction
 - MiRA: <https://github.com/emmt/MiRA>
 - SQUEEZE: <https://github.com/fabienbaron/squeeze>
 - Organic: <https://github.com/DePrinsT/organic>
 - CASSINI: <https://github.com/cosmosz5/CASSINI>
 - OIMAGING: <https://www.jmmc.fr/english/tools/data-analysis/oimaging/>
 - BSMEM:
<https://www.astro.phy.cam.ac.uk/research/ResearchFacilities/software-for-astrophysics/bsmem>