Observations constraints

Markus Wittkowski

ESO User Support Department

VLTI operations compared to VLT operations

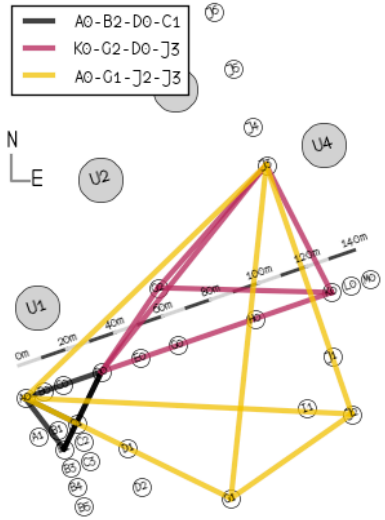
- VLTI operations follow the VLT operations scheme and use the same infrastructure (ETCs/Prep. tools, Phase 1 preparation, Phase 2 rules, OBs, p2pp, etc)
- However, there are a few specific needs and constraints for VLTI operations compared to VLT operations, as outlined in the following slides
- VLTI user manual in addition to the instrument user manuals –> Instrument pages
- Choices to make: Selection of the instrument, selection of the instrument mode, selection of the baseline configuration, computation of the feasible LST range, Sequences of science targets and calibrators
- Preparation tools: VisCalc (Computation of visibilities and of the feasibility of the observations), GRAVITY/MATISSE ETCs (computation of visibilities and signal/noise estimates specifically for GRAVITY & MATISSE), CalVin (Selection of calibration stars
- ESO Preparation tools: www.eso.org/observing/etc

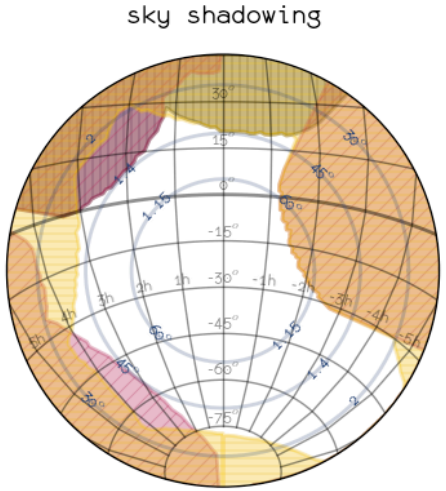
VLTI Operations - Instruments

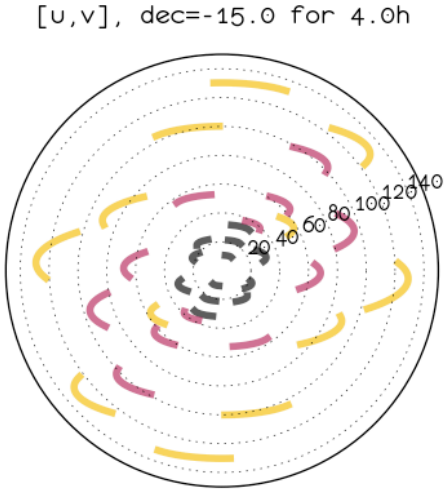
- MIDI – mid-infrared 8-13 mu, First fringes Dec. 2002; decommissioned in March 2015
- AMBER www.eso.org/sci/facilities/paranal/instruments/amber.html
  - First fringes March 2004 ; decommissioning planned after P101
  - Near-IR (J), H, K bands, spectral resolutions ~30 (LR)/1500 (MR)/12000 (HR), 3 beams
  - Lim. magnitudes up to Kcorr=6.5/9
- PIONIER www.eso.org/sci/facilities/paranal/instruments/pionier.html
  - First fringes as visitor instrument Oct 2010; PICNIC detector replaced by RAPID detector
  - Offered like an ESO instrument since 2015 (P96) per agreement with IPAG/Grenoble
  - Near-IR H-band, one or six spectral channels (spectral resolution 5 or 30), 4 beams
  - Lim. Magnitudes up to H=8/ (8.5)
- GRAVITY www.eso.org/sci/facilities/paranal/instruments/gravity.html
  - First fringes 2015; SV in P97 (June & Sep 2016)
  - Offered in spectro-imaging modes with the ATs since P98 (Oct 2016); with UTs & MACAO from P99
  - CIAO & Astrometry being commissioned
  - Near-IR K-band, single field and dual field (sep <2 arcsec (UTs)/ <4 arcsec (ATs), spectral resolutions 20 (low), 500 (medium), 4000 (high) , 4 beams
  - Lim. magnitudes up to 7.5 (ATs)/10.5 (UTs) for FT, +3 mag for SC
- MATISSE
  - Mid-IR LMN bands, spectral resolution 20-1000, 4 beams
  - AIV/Commissioning planned for Q4 2017 – Q2 2018; GRAV4MAT planned for 2018

VLTI Operations – Baseline configurations

- UTs – UT1/UT2/UT3/UT4 – 47-130m
- Small – A0/B2/C1/D0 – 10-40m
- Medium – D0/G2/J3/K0 – 40-100m
- Large – A0/G1/J2/J3 – 60-140m / A0/G1/J2/J3 (GRAVITY DF)







www.eso.org/sci/facilities/paranal/telescopes/vlti/configuration

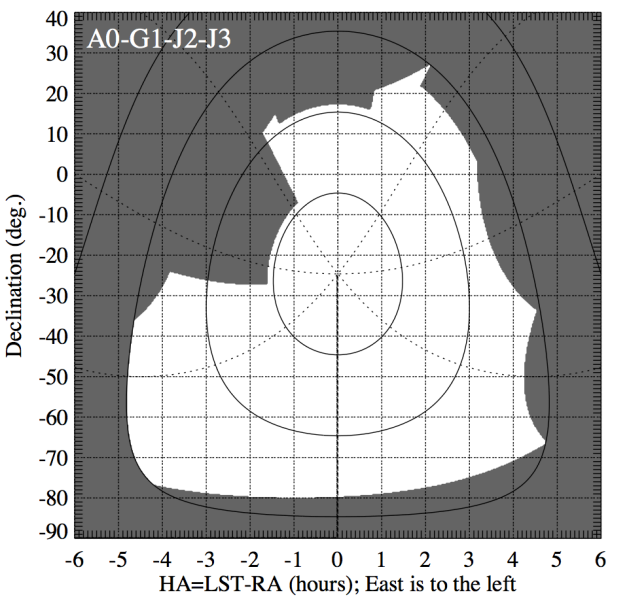
VLTI Operations – Constraint I - Baselines

- VLTI OBs have the baseline configuration as an additional constraints
- The baseline constraint makes operations less flexible compared to VLT instruments, and complicateth e schedule
- Increase of SM fraction is encouraged, which leads to a higher flexibility both for the long-term schedule and for the medium/short-term schedule

VLTI Operations – Constraints II - Observability

- The observability is constrained by delay line restrictions and shadowing of ATs by Uts, in addition to the usual visibility criteria like airmass and sun altitude.
- The LST range is used to encode the observability, so that the observer knows at which LST a certain OB can be executed.
- The LST slots have to be consistent

  across SCI and CAL OBs
- Supported by VisCalc/CalVin/ETCs



VLTI Operations – Constraints III – Sequences

- Sequences of Science/Calibrator (C-S, C-S-C, C-S-C-S-C)
  - VLTI observations need to be calibrated by the interferometric transfer function
  - Concatenations if science (S) and calibrator (C) OBs are mandatory. We offer C-S/ C-S-C / C-S-C-S-C sequences
  - For the time being no possibility for time-linked containers
  - Workaround with absolute time intervals taking into account the schedule
  - The choice of the calibrator is supported by the ESO tool CalVin

www.eso.org/observing/etc

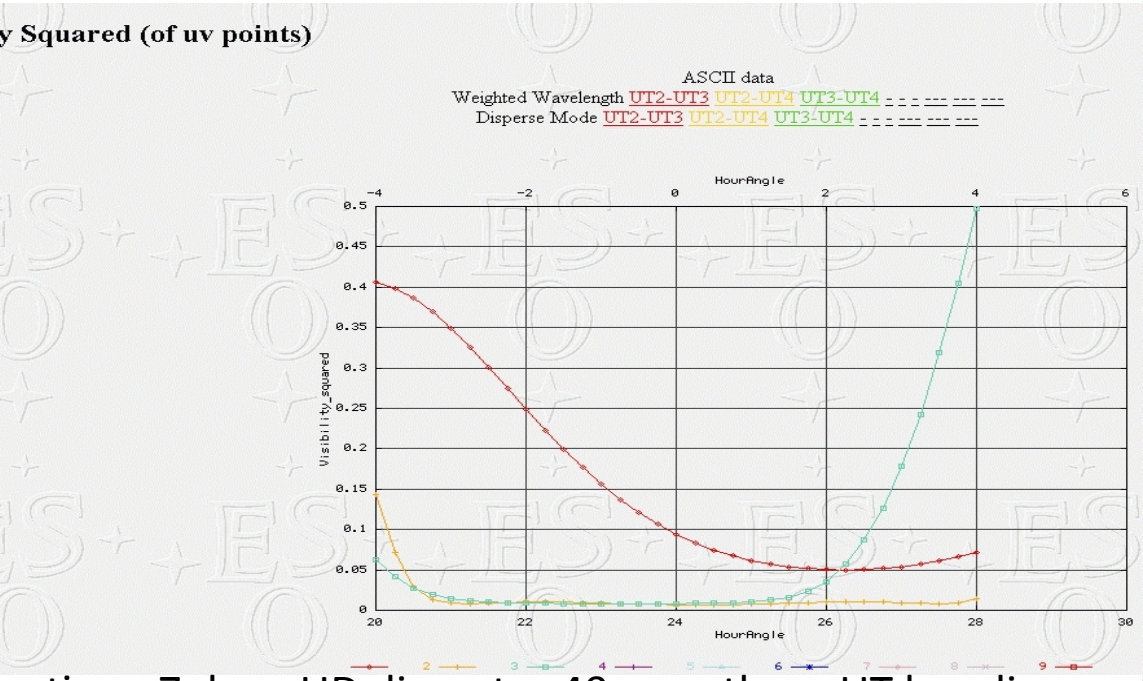
Combination of different baselines (aperture synthesis)

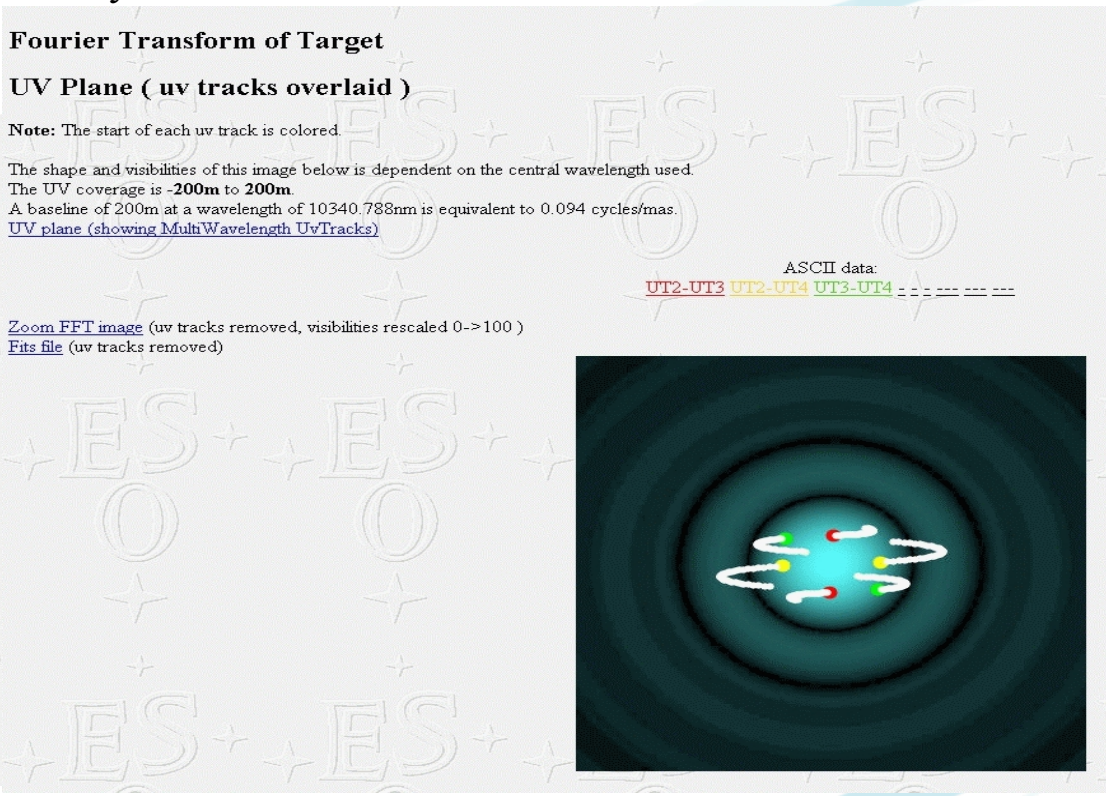
- Each instantaneous visibility measurement requires the submission of one OB. Multiple observations of the same source, possibly with different baseline configurations require the submission of multiple OBs.
- For each OB, the local sidereal time (LST) and the baseline configuration has to be specified, as part of the instrument-specific constraint set.
- The concatenations of science/calibrator OBs can effectively be considered as stand-alone entities, and are executed independently (for service mode).
- The choice of baselines and LST ranges is supported by the visibility calculator VisCalc (AMBER) or the GRAVITY & MATISSE ETCs.

www.eso.org/observing/etc

VLTI Preparation Tools (I) – VisCalc
www.eso.org/observing/etc

ation of observability and visibility amplitudes for a given target geometry and
VLTI configuration.





nation +7 deg., UD diameter 40 mas, three UT baselines.

VLTI Preparation Tools (II) – CalVin www.eso.org/observing/etc

ion of suitable calibrators from an underlying fixed list based on different user criteria.

List of Calibrators

6 calibrators found

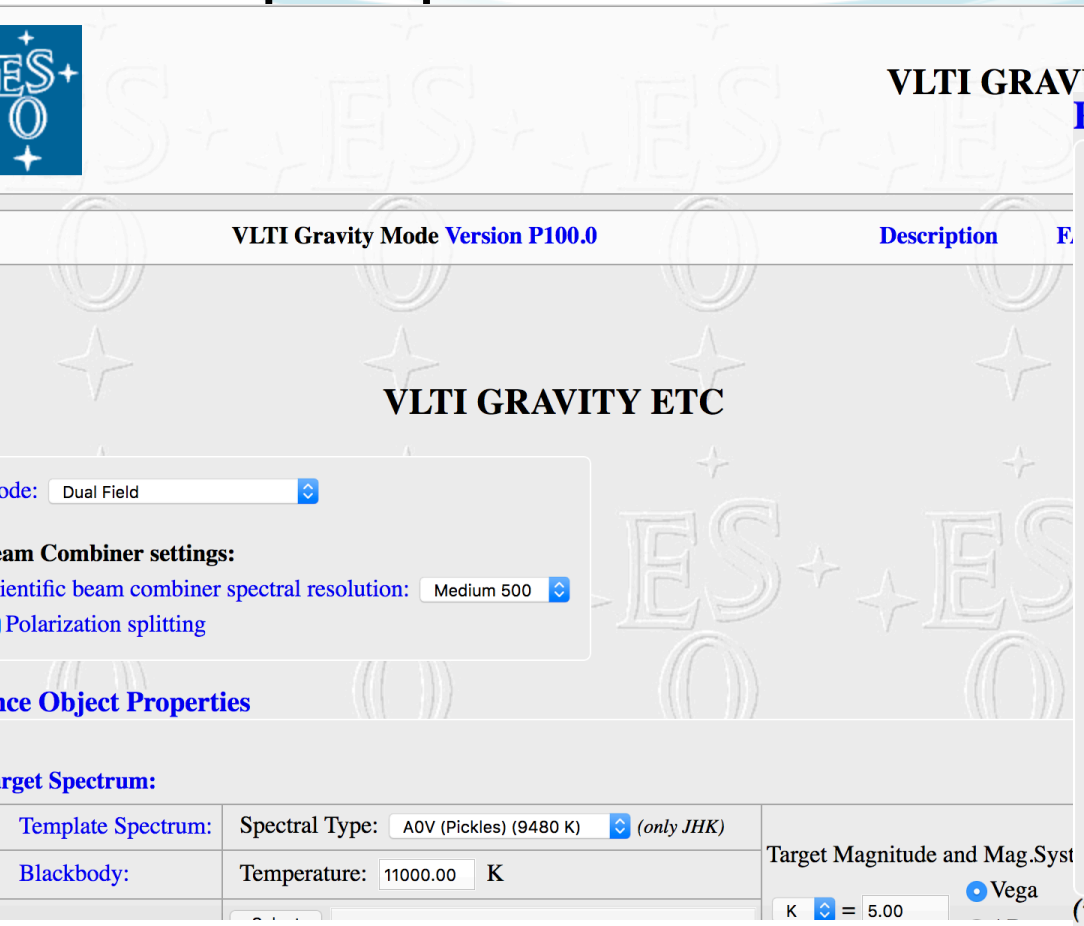
ASCII file format - the first column is the universal time

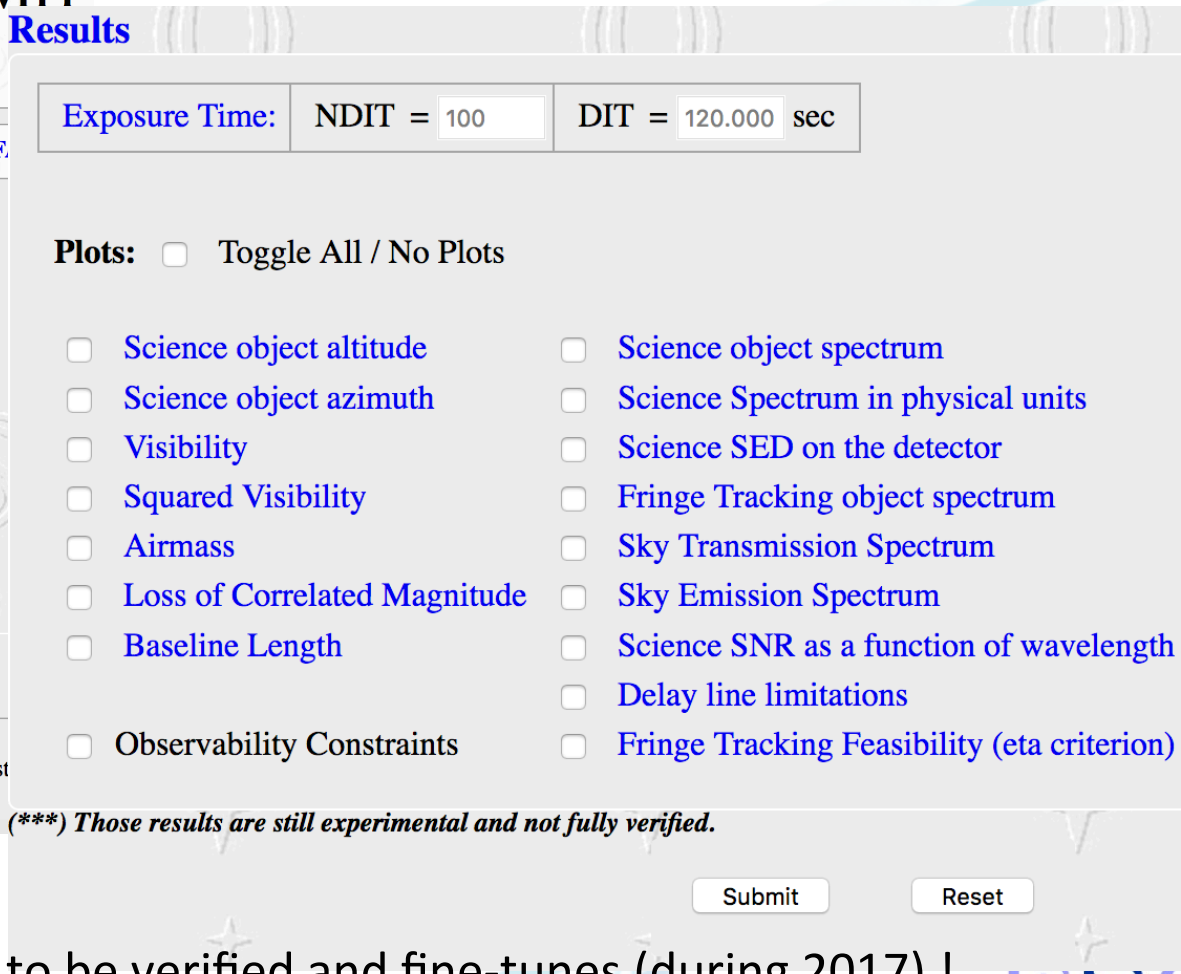
Comparative graphs for *"Target"* vs. 7 calibrators:- Normalized Visibilities Loss of Correlated Magnitudes Target Altitudes Shadow

No.	Name	R.A. (h,m,s)	Dec. (d,m,s)	Ang. Dist. (deg°)	Ang. Diam. (mas)	Mag_N	Spec. Type	Lum. Class	Qual. Flag	Normalized Visibility ave ± err range	Loss of Correlated Magnitude ave ± err range	RiseTime SetTime Duration	Culmination MaxAltitude	Shadowing
1 (0)	*Target*	5 55 10.30	7 24 25.40	0.0	40.00 ± 0.00					0.45 ± 0.000 0.30-0.69 graph ascii	1.72 ± -0.00 2.62-0.82 graph ascii	25.25UT 33.75UT 8.50hrs	29.75 UT max = 57° graph ascii	max = 1% graph ascii
2 (195)	hd50778	6 54 11.40	-12 2 19.10	24.4	3.95 ± 0.22	0.67	K4III	III	1	0.99 ± 0.001 0.99-0.99 graph ascii	0.02 ± 0.00 0.02-0.01 graph ascii	25.75UT 33.75UT 8.00hrs	30.75 UT max = 77° graph ascii	max = 0% graph ascii
3 (197)	hd61421	7 39 18.12	5 13 30.00	26.0	5.25 ± 0.21	-0.58	F5IV-V	IV-V	1	0.99 ± 0.001 0.98-0.99 graph ascii	0.03 ± 0.00 0.04-0.01 graph ascii	27.00UT 33.75UT 6.75hrs	31.50 UT max = 60° graph ascii	max = 0% graph ascii
4 (193)	hd48915	6 45 8.92	-16 42 58.00	27.1	6.06 ± 0.13	-1.23	A1	V	1	0.98 ± 0.001 0.98-0.98 graph ascii	0.04 ± 0.00 0.05-0.04 graph ascii	25.50UT 33.75UT 8.25hrs	30.75 UT max = 81° graph ascii	max = 0% graph ascii
5 (182)	hd29503	4 38 10.82	-14 18 14.50	28.9	2.58 ± 0.12	1.30	K1III	III	2	1.00 ± 0.000 1.00-1.00 graph ascii	0.01 ± 0.00 0.01-0.00 graph ascii	23.25UT 33.75UT 10.50hrs	28.50 UT max = 79° graph ascii	max = 1% graph ascii
6 (199)	hd36079	5 28 14.72	-20 45 34.00	28.9	2.97 ± 0.16	0.90	G5II	II	2	1.00 ± 0.001 0.99-1.00 graph ascii	0.01 ± 0.00 0.01-0.01 graph ascii	24.00UT 33.75UT 9.75hrs	29.25 UT max = 85° graph ascii	max = 0% graph ascii
7 (200)	hd65953	8 1 13.33	- 1 23 33.40	32.6	3.05 ± 0.59	1.07	K4III	III	2	1.00 ± 0.002 0.99-1.00 graph ascii	0.01 ± 0.00 0.01-0.01 graph ascii	27.00UT 33.75UT 6.75hrs	32.00 UT max = 66° graph ascii	max = 0% graph ascii

Cal. for Betelgeuse. Angular distance < 35 deg., diameter 0..8 mas, magn 1.3.. -5

VLTI preparation tools III – GRAVITY ETC





ience SNR and fringe feasibility (eta criterion) still to be verified and fine-tunes (during 2017) !

FORMATION NEEDED AT PHASE1 PREPARATION

- Scientific case
- Target information (coordinates)
- Feasibility of the science case: Brightness in V (off-axis guide star). Brightness at instrument band (H for PIONIER, K for GRAVITY).
- Expected angular size
- Baseline configuration(s)
- Number of visibility points and execution time
- Absolute visibility calibration (cal-sci-cal or cal-sci-cal-sci-cal sequences) or relative visibility (cal/sci pairs)
- Instrument mode/ spectral resolution
- Required weather conditions for the desired correlated magnitude

FORMATION NEEDED AT PHASE 2 PREPARATION

- All the information from Phase 1
- Precise coordinates and proper motions
- Definition of individual OB concatenations
- Definition of LST constraint for each concatenation
- Selection of a calibration star that is observable at the same LST

Practical session: GRAVITY ETC & CalVin www.eso.org/observing/etc

- Use your own favorite target, or the example of the GRAVITY p2pp tutorial: S Orionis (Ang. diameter 8 mas, K=-0.15, H=0.30, V=7.2, RA 05:29:00.89 -04:41:32.75, PM 11.57 mas -11.34 mas)
- Find the required information using the GRAVITY ETC and CalVIN
- Feasibility with the different offered configurations (small, medium, large) and spectral resolutions (MR, HR)
- Expected visibility and correlated magnitude
- Feasible LST range, depending on baseline configuration

Practical session “How to make OBs with P2PP”

- If needed, install the P2PP tool version 3.4.2 available at www.eso.org/sci/observing/phase2/P2PP3.html
- Have a look at the service mode guidelines for Period 99 at www.eso.org/sci/observing/phase2/SMGuidelines.GRAVITY.html
- Look at the different subsections in the left menu
- Find the relevant documentation: Gravity user manual, Gravity template manual, VLTI user manual
- Follow the GRAVITY p2pp tutorial either for the given example of S Ori or for your own favorite target