

ESO Phase 3 Data Release Description

Data Collection	PIONIER
Data Provider	Institut de Planétologie et d'Astrophysique de Grenoble (IPAG)
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Abstract

As part of the agreement between ESO and IPAG to offer the PIONIER interferometric instrument attached to the VLTI in service and visitor mode for periods 96 to 99, IPAG has committed to process the raw data and deliver calibrated visibility data (squared visibility amplitudes and closure phases) to the ESO archive. The data files conform to the ESO Science Data Products Standard, and more specifically to the specifications for interferometric data, including the use of OIFITS1 (Pauls, T.A., Young, J.S., Cotton, W.D., Monnier, J.D., 2005, PASP, 117, 1255) for the FITS binary tables.

The instrument modes covered are all modes offered for service, currently including modes FREE_H and GRISM_H. The data are processed by IPAG with the PNDRS pipeline (Le Bouquin, J.-B., Berger, J.-P., Lazareff, B., et al. 2011, AAP 535, AA67) and calibrated using stars listed in the JSDC catalog (Lafrasse, S., Guillaume, M., Bonneau, et al. 2010, Proceedings of the SPIE, Vol. 7734, 4E).

The calibrated data can be used to fit models of stellar sources, including stellar diameters and shapes, disks and companions, to name a few. Larger data sets for individual targets may also be used to produce maps independent of specific source models (image reconstruction).

Disclaimer:

Data have been processed by the pipeline with the best available calibration data. However, please note that the adopted reduction strategy may not be suitable for the original scientific purpose of the observations.

Data Content

As the number of data products increases while PIONIER is in operation, new data are planned to be processed and published every six months and added to a Phase 3 data stream. Data processing is automatic and may not include non-standard observations. PIONIER records fringes either in a single broad-band channel ("FREE_H" mode) or several narrow-band channels ("GRISM_H" mode) as indicated by the INSMODE main header keyword, and with polarization splitting ("Pup" or "Pdown") or without ("Pnat") as specified in the INSNAME keyword of the OI_WAVELENGTH table.

Data Selection

Data are from both visitor and service mode observations using supported modes. Only data sets with non-zero error estimates for valid visibility amplitude and phase data points, i.e. science grade products, will be added to the stream. Data sets need to include both visibilities and closure phases, implying observations using at least three telescopes.

Release Notes

The data for this release were processed by Jean-Baptiste Le Bouquin of IPAG, Grenoble, using the PNDRS pipeline written and maintained by him. The main processing steps are described in the following section. The following files were not included in this release and will be published later, due to issues having to do with their provenance keywords in the file headers:

PIONI.2018-12-23T05:23:13.109, PIONI.2019-04-08T06:34:35.404, PIONI.2019-05-31T08:45:59.944, PIONI.2019-07-20T01:14:20.975, and PIONI.2019-08-09T23:29:17.380.

Master Calibrations

The following master calibrations have been used: Darks, Kappa matrix, wavelength table.

Pipeline Description

The pipeline name is PNDRS and is distributed by JMMC at the following URL:

http://www.jmmc.fr/data_processing_pionier.htm.

At the same address, manuals and tutorials can be obtained.

Data Reduction and Calibration

The first step is the reduction of the raw data (scans of interferograms) to uncalibrated measurements of visibilities and closure phases. The measurements of the raw fluxes for each of the 24 outputs of the beam combiner are corrected for dark current and the flux levels normalized using measurements of the combiner split ratios with one shutter open at a time. The cleaned interferograms are sampled in phase bins, each consecutive set of four totaling 2π at the observed wavelength. The Fourier transform of the bin counts yields the complex visibility for each of the six baselines resulting from the pair-wise combination of four telescopes. The closure phases are computed from the complex triple products of visibilities measured over closed triangles of baselines. The (squared) visibility amplitudes are computed from the amplitude of the power spectrum for each baseline. The spatial frequencies of the visibility measurements are computed from the projected baseline lengths and orientations in the direction of the source, divided by the wavelength.

Calibration of the visibility amplitudes and closure phases is achieved by observing stars of small angular sizes after each science observation. Any deviations of the measured amplitudes from unity and phases from zero for the calibrators are applied to the data of the science targets based on the principle that unresolved sources should produce a visibility amplitude of unity and phase of zero in the absence of atmospheric and instrumental degradation of the interferograms. The pipeline uses an internal calibrator catalog and does not rely on the value of the DPR.CATG keyword assigned via the corresponding observing block parameters.

Data Quality

The quality of the data is rated by computing visibility and phase errors based on photon noise and reproducibility of calibrator observations.

Known issues

The visibility calibration relies on calibrator stars well known from other observations. If the diameter estimates are incorrect or the stellar disks are not circular or display spots, the visibilities of the science targets will suffer from systematic errors.

Data Format

The data format follows the ESO Science Data Products Standard for interferometric data from PIONIER, available at <https://www.eso.org/sci/observing/phase3/p3sdpst-PIONIER.pdf>.

Files Types

The binary extensions of the data files follow the OIFITS1 standard with a main header following

the OIFITS2 standard. The associated PDF files provide plots of the transfer functions versus time of night for each setup used. A setup is defined as a specific selection of instrument mode including the choice of dispersion, scanning parameters, detector integration time, gain and read-out mode. Observations of one setup cannot be calibrated with observations of another setup. The transfer functions are the closure phase ($t3\phi$) for up to four baseline triples and (squared) visibility (vis^2) for up to six baselines of the calibrators (corrected for their non-zero diameters), plotted with black symbols. The plots also show the closure phases and visibilities of the science targets with colored symbols unique to any given target of the night as shown in the plot headers.

File Size

The file size is typically less than 100 Kbyte.

Acknowledgments

Users are kindly requested to acknowledge Le Bouquin, J.-B., Berger, J.-P., Lazareff, B., et al., 2011, AAP 535, AA67 in any publication based on these data.

All users of the ESO SAF are required to acknowledge the source of the data with an appropriate citation in their publications.

Any publication making use of this data, whether obtained from the ESO archive or via third parties, must include the following acknowledgment:

- Based on data obtained from the ESO Science Archive Facility with DOI: <https://doi.eso.org/10.18727/archive/48>
- Based on data obtained from the ESO Science Archive Facility under request number <request_number>.