

## **SO/PHI-HRT, fourth data release. L2 level, first version.**

The fourth data release includes all L2 SO/PHI-HRT datasets from 2024, in particular for [LTP 15](#) (RSWs 13, 14, 15) and [LTP 17](#) (RSWs 16, 17, and 18), version 1.

The on-ground processing pipeline includes correction for optical aberration. However, reconstruction for diffraction at the entrance pupil is not applied. The quality of the correction is variable, depending on the availability of suitable phase-diversity calibration files (not always available, mostly due to off-pointing) and on the status of the instrument across the orbit (see [Kahil et al., 2023](#) and [Bailén et al., 2024](#)). Only the continuum is used for the flat field correction, while a cavity-map based wavelength correction is applied and a cross-talk correction which allows a variation of the cross-talk along the image (2D plane) to account for a gradient over the field of view (FoV). The RTE inversion is applied with different input parameters and polarimetric weights depending on whether the pixel is considered magnetically active or not and depending on the noise level of the dataset.

With respect to previous releases, the main difference in the reduction is the application of the straylight correction during the removal of the optical aberrations. Starting with the present release, the HRT pointing information of each dataset (WCS keywords in the header) are significantly improved by cross-correlating with Low-Latency or L2 SO/PHI-FDT images, whichever is more suitable. However, the WCS correction process may be inaccurate or even fail on occasion if the context image is too far in time.

In spite of these corrections, small residuals of dust grains in the optical path are still visible. In a few cases, weak residual signatures of the prefilter and cavity map error remain at the edges of the FoV. Few SOOPs in RSW 17 and 18 are also affected by higher noise and small artifacts due to a failure in the image stabilization system. At this point in time almost all, but not quite all of the data is released to SOAR. The criteria for SOAR upload is that either data is properly calibrated, or it is not expected that the calibration will improve in the near future. Nevertheless, the data are in a state suitable for scientific exploitation. The datasets uploaded to SOAR belong to the following SOOPs:

- RSW 13: Full Disk Mosaic (SPICE), Full Disk Mosaic (EUI), Major Flare (2 instances), Composition Mosaic, Sunspot Oscillations, Prominence

- RSW 14: Fast Wind (2 instances), Major Flare (4 instances), Nanoflares
- RSW 15: Fast Wind (2 instances)

- RSW 16: CH Boundary Expansion, Earth Quadrature, Filaments
- RSW 17: Earth Quadrature, Filaments, AR Long Term, Major Flare
- RSW18: Fast Wind (3 instances), Polar Observations, RS-burst, Full Disk Mosaic (EUI), AR Heating (2 instances), Sunspot Oscillations

The remaining data will be uploaded to SOAR as soon as better calibrations are attained. This includes the SOOPs Probe Quadrature (RSW 14, 16), Composition vs Height (RSW 18), Full Disk Mosaic (SPICE) (RSW 18).

All standard observables are released:

- *icnt*: continuum intensity computed by the RTE inversion;
- *vlos*: longitudinal velocity computed by the RTE inversion;
- *bmag*: magnetic field strength computed by the RTE inversion;
- *binc*: magnetic field inclination computed by the RTE inversion;
- *bazi*: ambiguous magnetic field azimuth computed by the RTE inversion;
- *blos*: longitudinal magnetic field computed from *bmag* and *binc* (note that *blos* is typically more robust than either *bmag* or *binc*);
- *stokes*: full Stokes vector (I, Q, U, V) measured in 5 points within the absorption line and in one point in the near continuum (measured continuum).

Unreconstructed Stokes vectors and other ancillary data, such as spatial PSF and disambiguation of the azimuth, are available on request.

If any publications are produced to which SO/PHI data contribute in any way, we would request you to cite the relevant instrument papers:

- Solanki, S. K., del Toro Iniesta, J. C., Woch, J., et al. 2020, A&A, 642, A11, DOI: [10.1051/0004-6361/201935325](https://doi.org/10.1051/0004-6361/201935325);
- Gandorfer, A. M., Grauf, B., Staub, J., et al. 2018, in Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, Vol. 10698, Space Tele-scopes and Instrumentation 2022: Optical, Infrared, and Millimeter Wave, 1403–1415, DOI: [10.1117/12.2311816](https://doi.org/10.1117/12.2311816).

Please also add the following acknowledgment:

“Solar Orbiter is a space mission of international collaboration between ESA and NASA, operated by ESA. We are grateful to the ESA SOC and MOC teams for their support. The German contribution to SO/PHI is funded by the BMWi through DLR

and by MPG central funds. The Spanish contribution is funded by AEI/MCIN/10.13039/501100011033/ and European Union “NextGenerationEU”/PRTR” (RTI2018-096886-C5, PID2021-125325OB-C5, PCI2022-135009-2, PCI2022-135029-2) and ERDF “A way of making Europe”; “Center of Excellence Severo Ochoa” awards to IAA-CSIC (SEV-2017-0709, CEX2021-001131-S); and a Ramón y Cajal fellowship awarded to David Orozco-Suárez. The French contribution is funded by CNES.”

We would appreciate receiving a copy of any publication you produce that profits from SO/PHI data at this email: [sophi\\_support \[at\] mps.mpg.de](mailto:sophi_support@mps.mpg.de)

We would be glad if you can report to us about any problem or issue encountered in using SO/PHI data. Please contact [sophi\\_support \[at\] mps.mpg.de](mailto:sophi_support@mps.mpg.de)

Further information is given at:

<https://www.mps.mpg.de/solar-physics/solar-orbiter-phi>