**LST Data Release Notes**

March, 2025

The White-light Solar Telescope (WST) [level 1.2](#WSTLevel12) data are released (c.f. [data level definition](#DataLevel)), which are generated from level 1.0 data with image quality significantly improved. Both the data analysis software available in Solar Software (SSW) and the data analysis guide for WST level 1.0 data remain applicable to the level 1.2 data. Additionally, the radiometric calibration coefficients are also applicable with the level 1.2 data..

Similar to the Solar Disk Imager (SDI), in-flight calibration and performance assessments of the WST have indicated a spatial resolution that is notably lower than its nominal specification. To address this, we employ an algorithm akin to [SPIBOA](https://iopscience.iop.org/article/10.1088/1674-4527/ada425), which was developed to enhance the image quality of the SDI instrument using the point-spread function (PSF). This algorithm effectively estimates the PSF of the WST imaging system directly from a comprehensive set of observational data. The estimated PSF is then utilized to perform deconvolution correction on the WST level 1.0 data, resulting in the generation of level 1.2 data. This process not only significantly improves the spatial resolution but also reduces the inherent noise present in the observed WST images.

January, 2025

SDI (Solar Disk Imager) [level 1.2](#SDILevel12) data are released (c.f. [data level definition](#DataLevel)), which are generated from level 1.0 data with image quality significantly improved. Both the data analysis software in Solar Software (SSW) and the data analysis guide for SDI level 1.0 data are applicable to SDI level 1.2 data. Meanwhile, both the background data derived from level 1.0 FITS files and the radiometric calibration data are applicable to level 1.2 data.

The in-flight calibration and performance of SDI suggested a much lower spatial resolution than the nominal one. We developed the SDI point-spread function (PSF) and Image Bivariate Optimization Algorithm ([SPIBOA](https://iopscience.iop.org/article/10.1088/1674-4527/ada425)) to improve the quality of SDI images, which smartly combines deep learning with optical system modeling. This algorithm effectively estimates the PSF of the SDI imaging system directly from a large sample of observational data. We use the estimated PSF to conduct deconvolution correction to observed SDI images, and the resulting images show that the spatial resolution after correction has increased by a factor of more than three with respect to the observed ones. Meanwhile, our method also significantly reduces the inherent noise in the observed SDI images. The SPIBOA has now been successfully integrated into the routine SDI data processing, providing important support for the scientific studies based on the data.

**IMPORTANT**: Some essential factors and precautions in applying the SPIBOA method are also discussed in the dedicated paper. Users are requested to read the paper carefully to know the methodology pro and con before using level 1.2 data for scientific study. Users can download the paper from the [publisher](https://iopscience.iop.org/article/10.1088/1674-4527/ada425) or [arXiv](https://arxiv.org/abs/2501.00231) for reference.

October, 2023

All SDI and WST level 1.0 data since 1 April 2023 are reproduced utilizing updated engineering information. Headers of FITS files of SDI and WST level 1.0 data are updated. CROTA2 in FITS header is corrected, and some statistical parameters/information of data are added.

June, 2023

All the SDI and WST [level 1.0](#DataLevel) SDI and WST data since April 1st 2023 are released. Please go to the following webpages for more details.

Daily movie webpage <http://aso-s.pmo.ac.cn/sodc/asos.jsp>

Image browser webpage <http://aso-s.pmo.ac.cn/sodc/imageBrowser.jsp>

Data download webpage <http://aso-s.pmo.ac.cn/sodc/dataArchive.jsp>

Analysis software via Solar Soft-Ware (SSW) or

 <http://aso-s.pmo.ac.cn/sodc/analysisSoftware.jsp>

Please not that there are still some level 1.0 FITS files with incorrect CROTA2 values in header (to be updated) inherited from the level 0 data. When using the image browser, the solar north is not properly rotated to the image north for these FITS files.

Please be aware that due to the absorption of the earth atmosphere around the time period of the earth eclipse, a small amount of SDI images may look like images in visible light. Meanwhile, due to the instrumental contamination, some SDI images may have weak stripes.

Currently if you want to use the data for scientific publications, please contact the LST science team to make sure the data is processed correctly and interpreted appropriately. It is also required by the data policy.

**Scientific Data Level Definitions of the LST payload onboard ASO-S Mission**

**SDI - Solar Disk Imager:**

Level 0.0 - uncalibrated data in DN generated from grouped telemetry packets, that are uncompressed, decoded, reorganized and formatted in standard FITS format. The FITS headers contain only information that is available from the telemetry packet headers and some engineering information.

Level 1.0 - uncalibrated data in DN, corrected for dark current and flat-field. Data from low- and high-gain channels are synthesized to obtain high dynamical range (HDR) image. Abnormal (cosmic ray, bad, missing) pixels are marked. The FITS files/headers contain information for scientific use and more information engineering data from housekeeping telemetry packet.

Level 1.2 - uncalibrated data in DN, generated from level 1.0 FITS file with image quality improved via the [SPIBOA](#SDILevel12) method. Abnormal, hot and dark pixels are corrected.

Level 1.5 - uncalibrated data in DN, generated from level 1.0 data with image registered and north-up.

Level 2.0 - radiometric calibrated data in erg s-1 cm-2 sr-1 from level 1.0 data.

Level 2.5 - radiometric calibrated data in erg s-1 cm-2 sr-1 from level 1.5 data.

Level Q1 - Quick-look images and movies from level 2.5 data.

**WST – White-light Solar Telescope:**

Level 0.0 - uncalibrated data in DN generated from grouped telemetry packets, that are uncompressed, decoded, reorganized and formatted in standard FITS format. The FITS headers contain only information that is available from the telemetry packet headers and some engineering information.

Level 1.0 - uncalibrated data in DN, corrected for dark current and flat-field. Abnormal (cosmic ray, bad, missing) pixels are marked. The FITS files/headers contain information for scientific use and more information engineering data from housekeeping telemetry packet.

Level 1.2 - uncalibrated data in DN, generated from level 1.0 FITS file with image quality improved via similar process to the [SPIBOA](#SDILevel12) method. Abnormal, hot and dark pixels are corrected. Not routinely produced to save resources, but can be produced as needed.

Level 1.5 - uncalibrated data in DN, generated from level 1.0 data with image registered and north-up.

Level 2.0 - radiometric calibrated data in erg s-1 cm-2 sr-1 from level 1.0 data.

Level 2.5 - radiometric calibrated data in erg s-1 cm-2 sr-1 from level 1.5 data.

Level Q1 - Quick-look images and movies from level 2.5 data.

**SCIUV - Solar Coronal Imager (Ly channel):**

Level 0.0 - uncalibrated data in DN generated from grouped telemetry packets, that are uncompressed, decoded, reorganized and formatted in standard FITS format. The FITS headers contain only information that is available from the telemetry packet headers and some engineering information.

Level 1.0 - uncalibrated data in DN, corrected for dark current and flat-field. Data from low- and high-gain channels are synthesized to obtain high dynamical range (HDR) image. Abnormal (cosmic ray, bad, missing) pixels are marked. The FITS files/headers contain information for scientific use and more information engineering data from housekeeping telemetry packet.

Level 1.5 - uncalibrated data in DN, generated from level 1.0 data with image registered and north-up.

Level 2.0 - radiometric calibrated data in erg s-1 cm-2 sr-1 from level 1.0 data.

Level 2.5 - radiometric calibrated data in erg s-1 cm-2 sr-1 from level 1.5 data.

Level Q1 - Quick-look images and movies from SDI and SCIUV level 2.5 data (composed).

**SCIWL - Solar Coronal Imager (white-light channel):**

Level 0.0 - uncalibrated data in DN generated from grouped telemetry packets, that are uncompressed, decoded, reorganized and formatted in standard FITS format. The FITS headers contain only information that is available from the telemetry packet headers and some engineering information.

Level 1.0 - uncalibrated data in DN, corrected for dark current, flat-field and stray-light. Only data from low-gain channel are used due to saturation of high-gain channel. Abnormal (cosmic ray, bad, missing) pixels are marked. The FITS files/headers contain information for scientific use and more information engineering data from housekeeping telemetry packet.

Level 1.5 - uncalibrated data in DN, generated from level 1.0 data with image registered and north-up.

Level 2.0 - radiometric calibrated data in MSB (mean solar brightness) from level 1.0 data.

Level 2.5 - radiometric calibrated data in MSB from level 1.5 data.

Level 3.0 - science data derived from level-2 data after scientific analysis, parameters for CME, such as total brightness, polarized brightness, polarization degree, etc.

Level Q1 - Quick-look images and movies from level 2.5 data.