README FOR HELIUM (He^{++}) PHASE SPACE DENSITIES FROM PLASTIC / STEREO

Last update: November 1, 2019

1. Data Usage

Data provided by the PLASTIC team at the University of New Hampshire is under NASA grants NNX15AU01G and 80NSSC17K0556.

Alpha Particle (He^{++}) data provided here is courtesy of B. Klecker, L. Ellis, and A. B. Galvin.

STEREO alpha particle (He^{2+}) phase space densities (PSD) presented here are in the spacecraft frame of reference. The data sets provide 1hr averages of He^{+} phase space density as a function of V/Vsw in 51 velocity ranges, where V and Vsw are the particle speed and bulk speed of solar wind protons, respectively.

These data are delivered to the public domain on a regular basis. Efforts are made to include the latest known calibration and background determinations, however, these are expected to undergo revision. We therefore suggest that users regularly return to this page, and make sure to get the most recent revision.

If used in presentations or publications:

We strongly suggest that Dr. A. B. Galvin (toni.galvin@unh.edu) and Dr. B. Klecker (berndt.klecker@mpe.mpg.de) be contacted to ensure that you are working with the latest release.

Please acknowledge STEREO PLASTIC Investigation (A.B. Galvin, PI), NASA contracts NNX15AU01G and 80NSSC17K0556.

For reporting purposes, we request bibliography information for any publication, etc., using these data. Please send information on the use of this data to the PLASTIC PI:

Dr. A.B. Galvin
toni.galvin@unh.edu

If you have questions regarding the data formats, please contact the PLASTIC Data System Manager:

Lorna Ellis
lorna.ellis@unh.edu

2. Computation of Helium (He^{2+}) Phase Space Densities

Alpha particle (He^{2+}) phase space densities and total counts are provided in the spacecraft frame of reference as a function of w=V/Vsw, with particle speed V and solar wind speed Vsw. The phase space densities are computed from 10 minute averages of normalized counts and 10 min averages of the solar wind velocity for 51 bins (5% resolution) in the velocity range 8 > w > 0.66. Normalized counts are computed by summing over selected ranges in M/Q (double coincidences) and M/Q-M (triple coincidences), using the priority rates for normalization (s. a. Galvin et al., 2008). M and M/Q are the mass and mass per charge of the ions, respectively.

The phase space density F_Vsw is computed from

$$F\_Vsw\ [s^3/km^6] = CTS / eff * K1 * K2 * 1 / (E/M)^2, \quad (1)$$

- CTS are the normalized counts per second
- eff is the efficiency of PLASTIC for He (energy and time dependent, derived from in-flight calibration)
- K1 is a constant, determined by the PLASTIC geometry and energy resolution (= 317)
- K2 is a constant, determined by cross-calibration with ACE / SWICS in 2007 (=1.09, s. paragraph 5)
- E/M is the energy per nucleon of the particle in units of keV/nucleon

3. File Format

3.1 Naming convention

The file names have the following format:

STx_L3_PLA_He2Pl_F_Vsw_XXhr_YYYY_Vzz.TXT

Where

"STx" is given as "STA" or "STB" for STEREO A and STEREO B, respectively.

"L3" indicates Level 3 data in the STEREO PLASTIC convention.

"PLA" indicates Plasma and Suprathermal Ion Composition (PLASTIC) Investigation.

"He2Pl" indicates doubly ionized helium (He^{2+}) as determined by PLASTIC.

"XXhr", indicates the time averaging interval (01 hour). (*)

"YYYY" represents Year

“Vzz” represents the version number

(*) Note: For higher time resolutions (minimum: 10 minutes) please contact the PI.

3.2 File Header

The 3 file header lines provide information on the spacecraft, production date, software version number, in-flight calibration file name and column headers.

3.3 Data

The files with 01hr averages provide the data for 1 year. The data are organized in 113 columns, with

Column

1	year
2	month
3	day of month
4	day of year
5	hour (start time of time bin)
6	min (start time of time bin)
7	day of year (decimal)
8	maximum # of instrument cycles in time bin
9	solar wind proton speed (km/s)
10	solar wind proton thermal speed [km/s]
11	solar wind proton density [p/cm^3]
12	phase space density [s^3/km^6], for mean V/Vsw= 7.80, s. a. column header
13	total counts for this V/Vsw bin
14-113	same as 12-13 for other V/Vsw bins

The proton bulk parameters V_{sw}, V_{therm} and Density (N_p) are derived from a 1D Maxwellian fit to a single detector rate (no coincidence required), and are corrected for background and dead time. The software version number used to derive the proton bulk parameters is shown in the file header (Version V06 and later). The most recent update of the proton bulk parameters can be found on the following STEREO website:

- https://stereo-ssc.nascom.nasa.gov/data/ins_data/plastic/level2/Protons/

Note of caution: Helium fluxes are calculated with the geometric factor of the main sensor. At low V/V_{SW} (typically for $V/V_{SW} < 1.2$), depending on the switch from main sensor to solar wind sensor, the fluxes may be affected by the switch and need to be evaluated on a case by case basis. Note also that for high solar wind speed, the measurement range in V/Vsw is limited, for example for He^{2+} to V/Vsw < 4.3 for Vsw = 650 km/s (see Fig. 1 below).

4. Measurement range (V/Vsw) for He^{+} PUI and He^{2+}

Figure 1 shows the range of maximum and minimum V/Vsw values for ESA step 2 (maximum energy 81 keV/q), and ESA step 91 (minimum energy 1.17 keV/q), selected for processing He^{+}. The maximum value of V/Vsw for He^{2+} is shown for comparison.

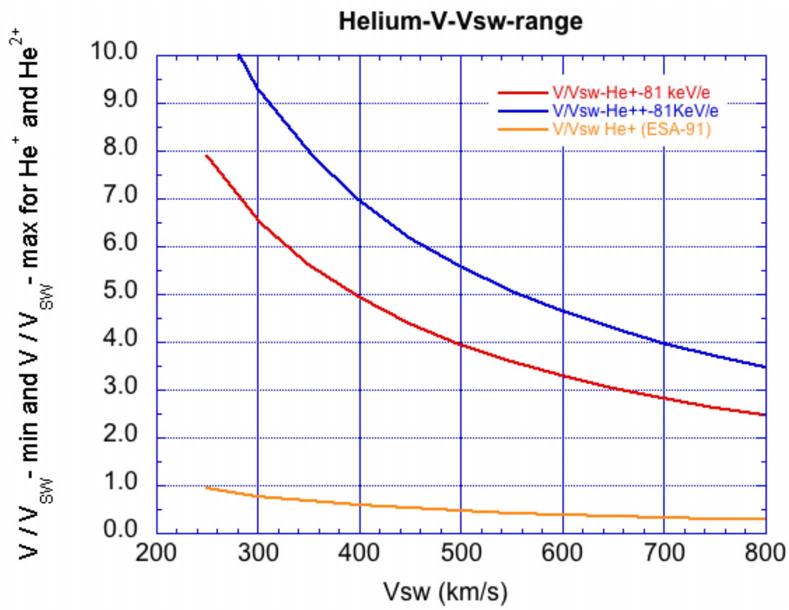

Fig. 1 V/Vsw range for He^{+} and He^{2+} as a function of maximum energy (81 keV/e) and minimum energy (ESA step 91, 1.17 keV/q) selected for processing He^{+}.

5. PLASTIC Inflight Calibration - Efficiency for Helium

The detection efficiency of the PLASTIC sensor system for ions is subject to time variations, because of a slow degradation of the MCPs during flight. This degradation can be partly compensated by an increase of the MCP HV supply voltage. Therefore, in order to obtain absolute fluxes, the efficiency needs to be continuously monitored during flight. To obtain this efficiency for He^{+}, the ratio of single and coincidence rates in the SW main channel of the PLASTIC time-of-flight system are used, at an energy just below the He^{+} cutoff energy. Thus, the variation of the He^{+} cutoff energy with solar wind speed provides the energy dependence of the He^{+} efficiency. For details of the sensor system, see Galvin, et al., 2007.

The efficiency for He is provided as function of total energy/nuc E_{tot} in the energy range 6 to 20 keV/nuc, where E_{tot} is defined as

$E_{tot} = (E/Q + PAC) * Q/M$,

with post acceleration voltage PAC (usually 20kV), M=4 for He and Q=1 and Q=2 for He^{+} and He^{2+}, respectively.

The PLASTIC He efficiencies and details of the evaluation of the in-flight efficiency can be found in the files STA_L3_PLA_HEEFF_Rev15.txt, READ_ME_PLASTIC_He_Efficiency_Rev15.pdf, and READ_ME_PLASTIC_HePlus_PSD.pdf in the SSC directory https://stereo-ssc.nascom.nasa.gov/data/ins_data/plastic/level3/