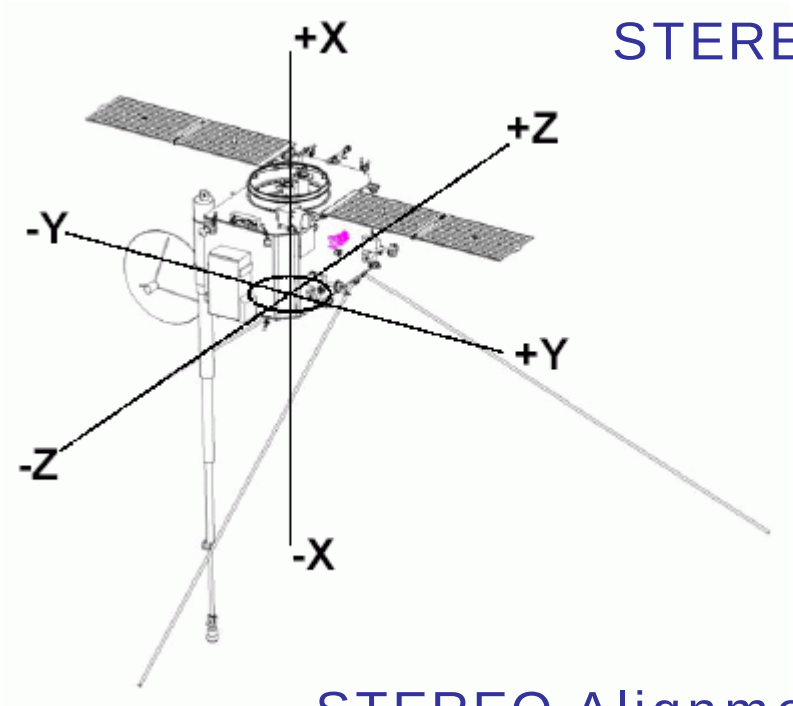
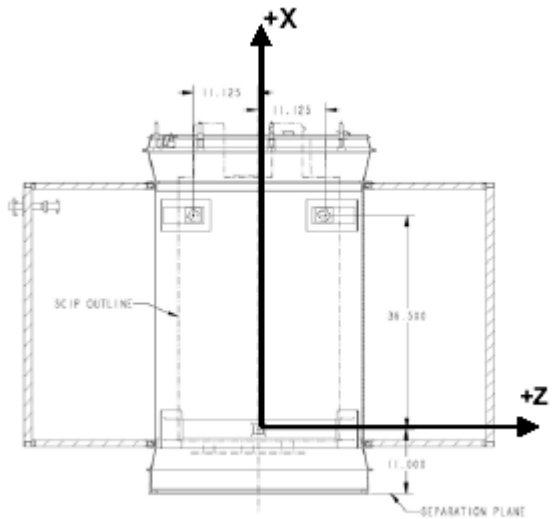



## STEREO Observatory Coordinate Frame

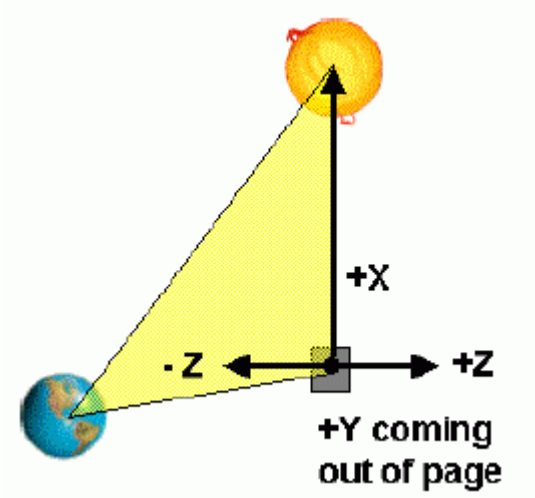
- Used for mechanical layout
- Origin at base of bottom adaptor ring
- X axis through center of adaptor rings, going from bottom to top.
- X-Z plane parallel to SCIP optical bench.
- +Z points opposite of SECCHI HI

## STEREO Alignment Coordinate Frame

- Used for mechanical alignment and pointing
- Essentially equivalent to the Observatory Coordinate Frame
- X-Z plane defined by SCIP kinetic mount
- Origin and X axis defined by dowel pins
- Sign conventions are the same as above

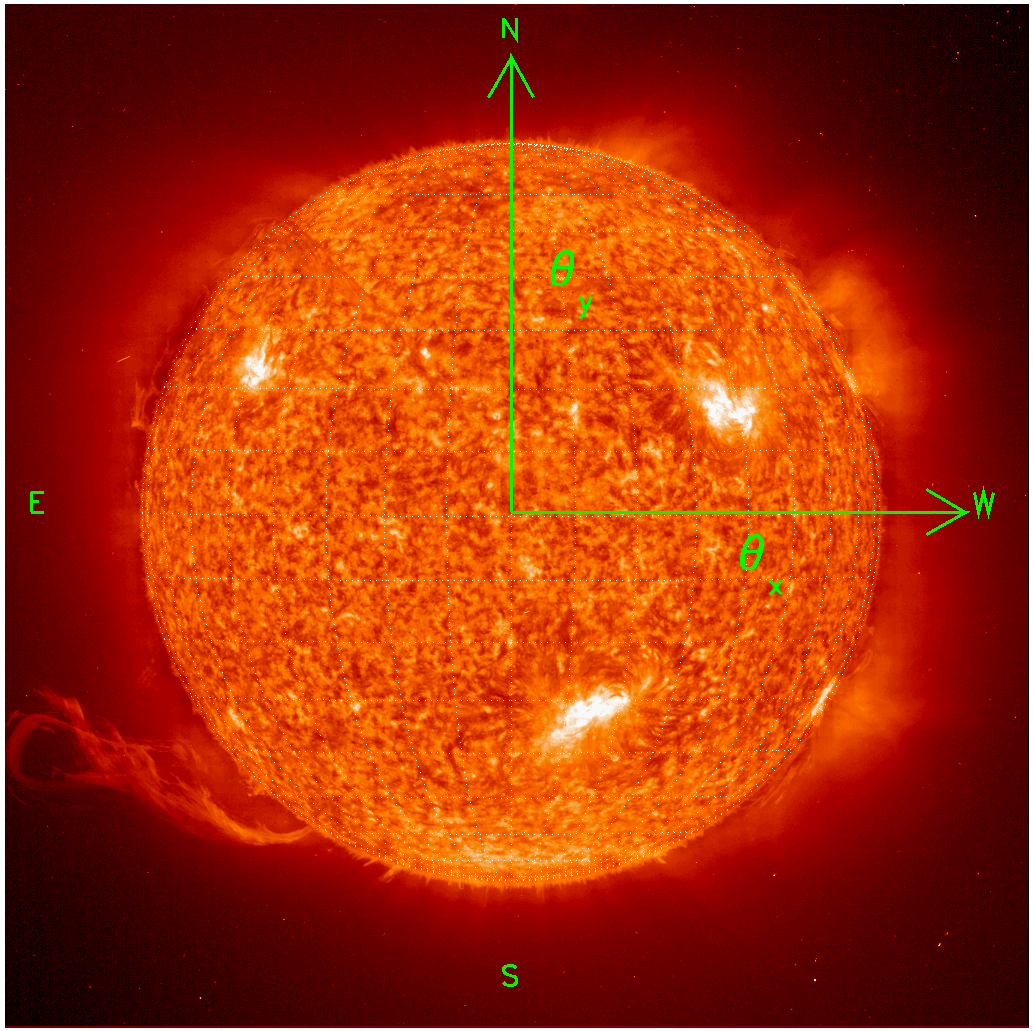


# STEREO Science Pointing Coordinate Frame




- Defines nominal pointing reference frame during science operations.
- Origin at observatory center of mass
- X axis points at center of Sun
- X-Z plane contains observatory, Sun, and Earth
- +Z points away from Earth.
- *When nominally oriented*, same sign convention as in Observatory and Alignment frames
- Ahead and Behind spacecraft have ***opposite*** sign conventions for Y and Z axes relative to the Sun

# Helioprojective-cartesian coordinates




- Part of a FITS/WCS proposal for solar image data
- Angle $\Theta_y$ (latitude) measured from disk center in direction of solar North rotational axis.
- Angle $\Theta_x$ (longitude) measured towards solar West limb.
- Matches conventions currently used for solar image data.
- Helioprojective-radial variation has radial angle $\Theta_\rho$ and position angle $\psi$ measured CCW from solar north.
- Requires knowledge of S/C orientation (roll) relative to Sun

- Helioprojective-cartesian is an angular coordinate system—related spatial system is heliocentric-cartesian

*http://orpheus.nascom.nasa.gov/~thompson/papers/coordinates.pdf*

# Radial-Tangential-Normal (RTN) Coordinates

- Heliocentric-cartesian is functionally equivalent to Heliocentric RTN System (HGRTN), where $X_{HC}=Y_{HGRTN}$, $Y_{HC}=Z_{HGRTN}$, $Z_{HC}=X_{HGRTN}$.
- HGRTN coordinates are defined as follows:
  - **X** axis points from Sun center to spacecraft
  - **Y** axis cross product of solar rotational axis and X axis, and lies in the solar equatorial plane (towards the West limb).
  - **Z** = **X**$\times$**Y**, and is the projection of solar rotational axis
- RTN is same as HGRTN, but with origin at spacecraft
- HGRTN (or RTN) used by numerous heliospheric missions, including Ulysses, Cassini, and ACE.
- Proposal is to use position-dependent HGRTN (or RTN) coordinates to express local conditions at spacecraft, and convert to an existing standardized system to relate the measurements to the global heliosphere.

# Helioecliptic RTN Coordinates

- A possible variation of HGRTN coordinates is to use the ecliptic north pole instead of the solar rotational pole. The acronym for this system would be HERTN (M. Fränz, private communication).
- HERTN coordinates would be defined as follows:
  - **X** axis points from Sun center to spacecraft
  - **Y** axis cross product of ecliptic axis and X axis, and lies in the ecliptic plane (in the prograde rotational direction).
  - **Z = X**$\times$**Y**, and is the projection of north ecliptic axis
- Details of how ecliptic precession would have to be worked out (e.g. use J2000?)
- System would be heliocentric
- Has some similarity to coordinate system used by Helios mission, but is not well established as a standard.
- May be closer match to the natural orientation of the STEREO particle instruments. (HGRTN would be closer match to science.)

# Standard Heliocentric Coordinate Systems

- **HAE: Heliocentric Aries Ecliptic**
  - X=First point in Aries
  - Z=Ecliptic North Pole
  - Can use either J2000 ecliptic, or mean ecliptic of date (D)
- **HEE: Heliocentric Earth Ecliptic**
  - X=Sun-Earth line
  - Z=Ecliptic North Pole
  - Based on mean ecliptic of date (D)
- **HEEQ: Heliocentric Earth Equatorial**
  - Z=Solar rotation axis
  - X=intersection of solar equator and central meridian as seen from Earth
  - Related to heliographic coordinates, as seen from Earth
- **HCI: Heliocentric Inertial**
  - Z=Solar rotational axis
  - X=Solar ascending node on ecliptic of J2000
  - Used by Ulysses mission

# Carrington Coordinates

- Usually expressed as angular longitude and latitude
- Artificial coordinate system which rotates at an approximation to the solar rotation rate.
- *Sidereal* rotation rate of 25.38 days
- If expressed in Cartesian terms, then:
  - Z=Solar rotation axis
  - X=Intersection of solar equator and Carrington prime meridian

# References


- Russell, C.T. (1971), “Geophysical Coordinate Transformations”, *Cosmic Electrodynamics* **2**, 184–196.
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- Fränz, M. and Harper, D. (2002), “Heliospheric Coordinate Systems”, *Planet. Space Sci*. **50**, 217–233.
- Thompson, W. T. (2005), “Coordinate systems for solar image data”, to be submitted to *Astron. Astrophys*.