README: AeroCube-6 Response Function Files

This README document describes the AeroCube-6 (AC6) dosimeter sensor response function files. These files provide the sensor's response to protons and electrons as a function of energy and angle of incidence. AC-6 is a pair of CubeSats identified as AC6-A and AC6-B. For further information contact Paul O'Brien, paul.obrien@aero.org.

Six response files are provided:

- ac6a_response.h5 – AC6-A energy-angle response in PRBEM format (HDF5)
- ac6a_response_elec_iso.csv – AC6-A energy response to isotropic electron flux (CSV)
- ac6a_response_prot_iso.csv – AC6-A energy response to isotropic proton flux (CSV)
- ac6b_response.h5 – AC6-B energy-angle response in PRBEM format (HDF5)
- ac6b_response_elec_iso.csv – AC6-B energy response to isotropic electron flux (CSV)
- ac6b_response_prot_iso.csv – AC6-B energy response to isotropic proton flux (CSV)

A description of the data set and mission is provided in TOR-2016-0155. The GEANT4 simulation is described in TOR-2016-03260. A bowtie analysis to approximate each sensor channel as an integral energy channel is described in TOR-2017-02598.

Energy-angle (PRBEM) response files

The Energy-angle response files are provided using the Panel on Radiation Belt Environment Models (PRBEM) response file format (v1.1.1) which can be found here: prbem.github.io/docs/. In these files, the proton and electron response of the AC-6 sensor is given for each of the three on-board dosimeters, DOS1, DOS2, and DOS3 described in TOR-2016-01155, TOR-2016-03260, and TOR-2017-02598. The sensor is represented provided as a function of energy and two angles: a polar angle THETA (θ), and an azimuth PHI (ϕ) measured anticlockwise from the X to the Y axis depicted in Figure 1. Normally incident particles having an incident angle THETA (θ) of 0.

DOS1 and DOS2 have identical responses between AC6-A and AC6-B. DOS1 is a low energy electron and proton dosimeter, while DOS2 uses an elevated electronic energy deposit threshold to remove its electron response. DOS3 is different between the two, as AC6-A has a lower electronic energy deposit threshold in DOS3 than does AC6-B. The AC6-B DOS3 responds mainly to protons, while the AC6-A DOS3 responds to both protons and electrons.

For proton response, supplemental E0 (E_0), G, and DE (δE) values are provided from the bowtie analysis in ATR-2021-02018 are also provided. E0 is the bowtie channel energy and DE is the bowtie channel bandwidth, where each channel is approximated as an idealized differential channel. The PRBEM response files are provided both in NASA CDF (.cdf) and HDF5 (.h5) format.

The HDF5 format PRBEM response files (.h5 extension) were produced from Matlab and have some subtleties in their structure. The following information may be helpful:

- HDF5 written from Matlab does not store strings. So, strings are stored in UTF-8 encoding as uint8 data. String variables have an attribute isString.
- Boolean variables are stored as uint8 and have an attribute isBoolean.
- Matlab stores arrays of strings as "cell arrays." These are captured in HDF5 as groups with an isArray attribute. Members of the group have variable names 000, 001, 002, … Enough digits are used to accommodate all members of the group with zero-padded variable names of the same length. When reading the group, the members should be sorted (by increasing variable name number) to restore the original order in the array.
- Most of the data are stored in groups and sub-groups, with isStruct attribute set.
- Matlab treats all variables as double precision and matrix by default. Thus, even scalars will have size 1x1, and many integers will be stored as double precision.

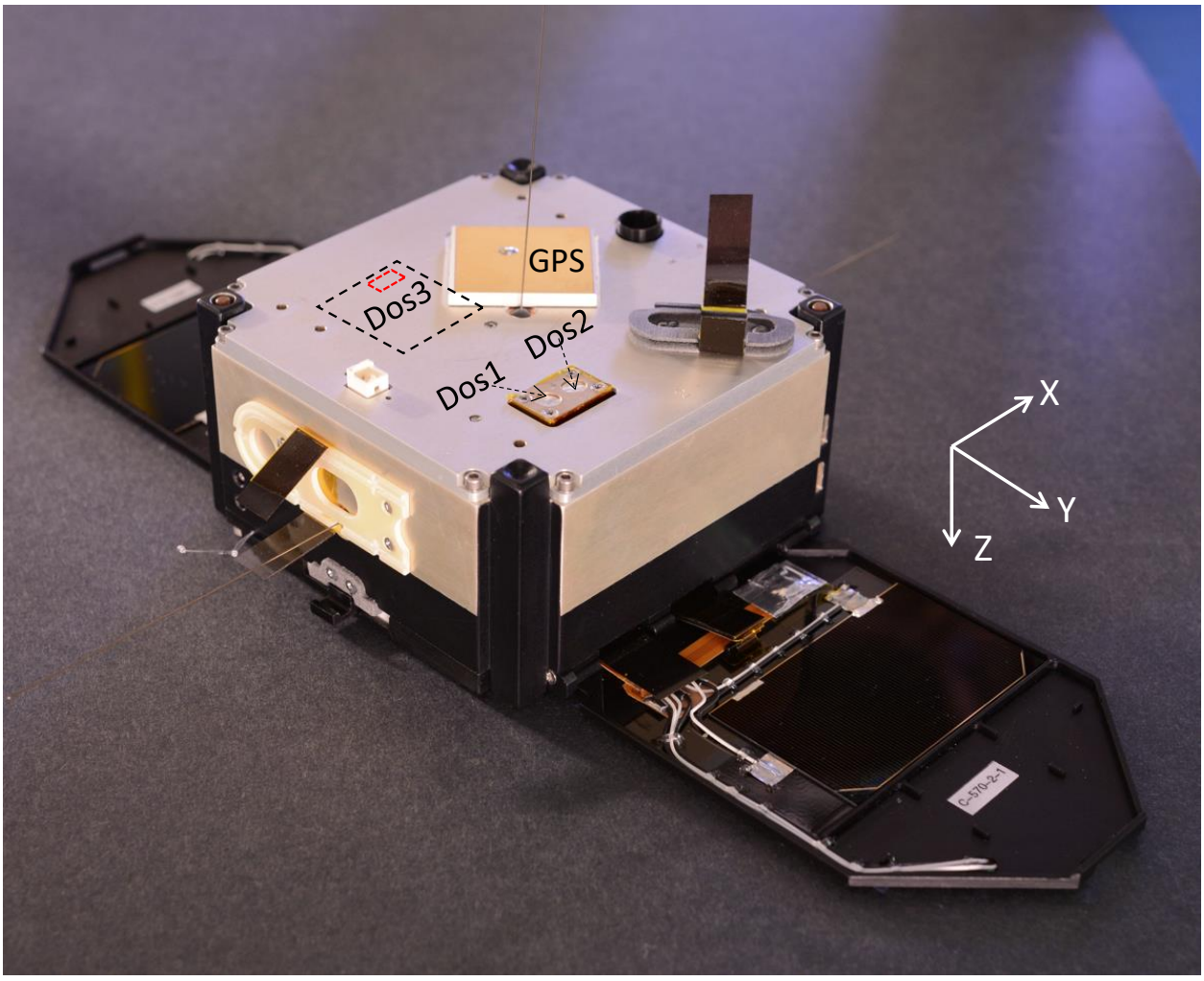

Figure 1. Location of dosimeters. The photograph depicts the location of the three dosimeters on each AC6. Dos3 is internal to the spacecraft, just below the top faceplate. The red rectangle indicates the approximate location of its silicon detector. The GPS antenna is the largest component near the Dos3 field of view.

Isotropic response files

Isotropic response files are provided for both protons and electrons by numerically integrating the energy-angle response over the angular dependence. Each of these files has a single column providing the energy value in MeV and the one column per sensor channel. Note that the response units cm^2sr. The numerical values in the sensor channel columns are the response of the specified channel at the associated energy. Figure 2 plots the channel response for isotropic electrons, and Figure 3 plots the channel response for isotropic protons.

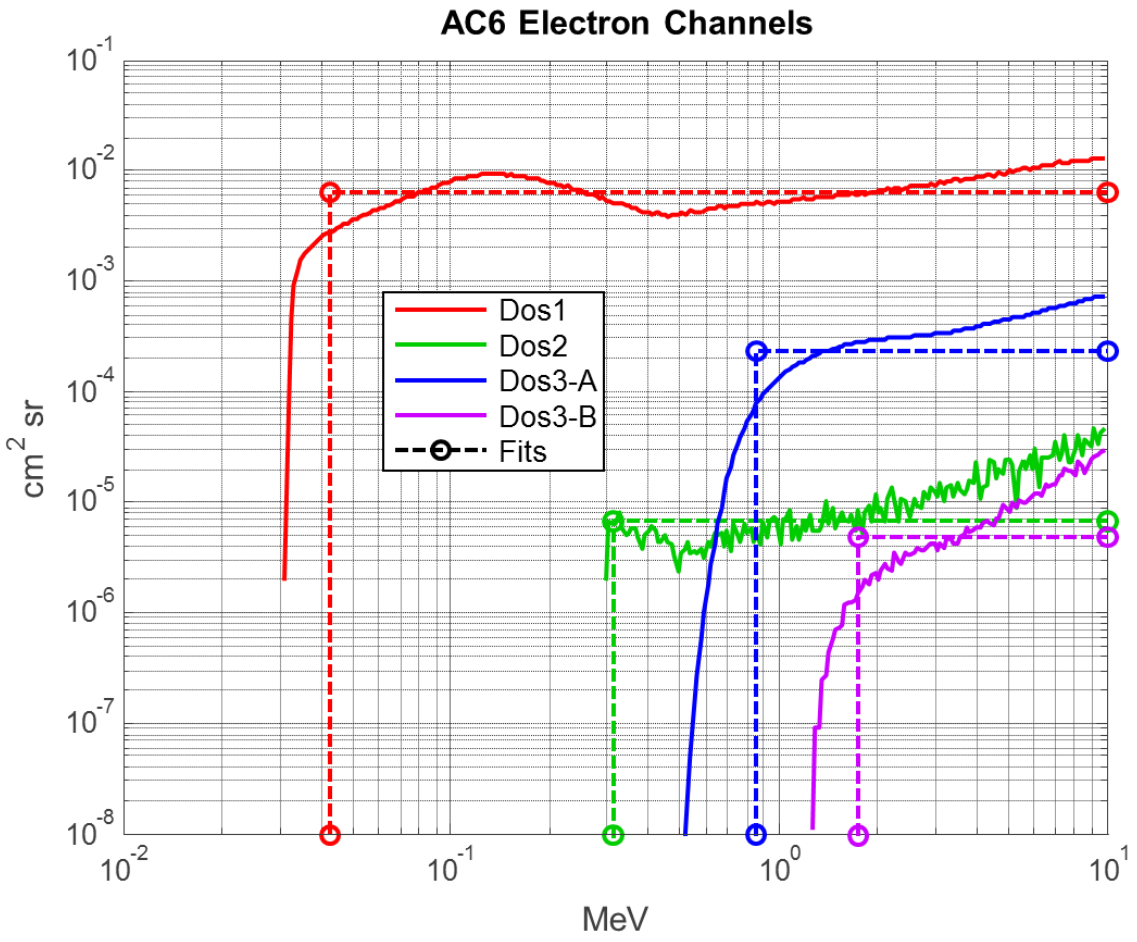

Figure 2. AC6 isotropic electron response. Note that DOS1 and DOS2 are identical between AC6-A and AC6-B. However, DOS3 differs by the electronic threshold required for a count. Bowtie approximations to integral channels are included as dashed lines (see TOR-2017-02598)

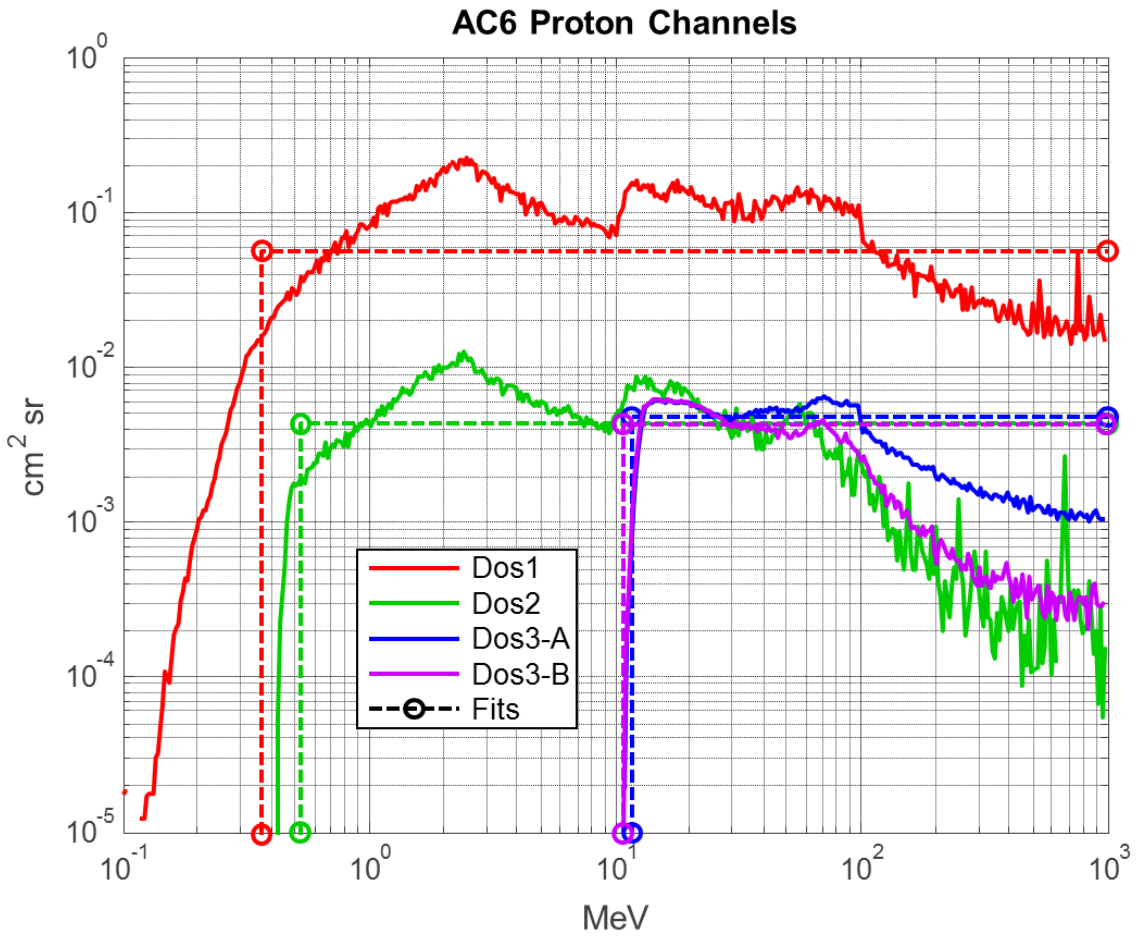

Figure 3. AC6 isotropic proton response. Note that DOS1 and DOS2 are identical between AC6-A and AC6-B. However, DOS3 differs by the electronic threshold required for a count. Bowtie approximations to integral channels are included as dashed lines (see TOR-2017-02598)

References

TOR-2016-01155, T.P. O'Brien, J.B. Blake, and J.W. Gangestad, AeroCube-6 Dosimeter Data README (v3.0), The Aerospace Corporation, 2016.

TOR-2016-03260, M.D. Looper, Updated Geant4 Simulations of AeroCube 6 Microdosimeters, The Aerospace Corporation, 2016.

TOR-2017-02598, T.P. O'Brien, M.D. Looper, and J.B. Blake, AeroCube-6 Dosimeter Equivalent Energy Thresholds and Flux Conversion Factors, The Aerospace Corporation, 2019.

These reports may be obtained from library.mailbox@aero.org.