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OBJECT                          = INSTRUMENT
 INSTRUMENT_HOST_ID             = RO
 INSTRUMENT_ID                  = "RPCIES"

 OBJECT                         = INSTRUMENT_INFORMATION

  INSTRUMENT_NAME               = "
    ROSETTA PLASMA CONSORTIUM - ION AND ELECTRON SENSOR"
  INSTRUMENT_TYPE               = "PLASMA INSTRUMENT"
  INSTRUMENT_DESC               = "

    Instrument Overview
    ===================
    The Ion and Electron Sensor (IES) is one of the 5 instrument
    members of Rosetta Plasma Consortium (RPC). The objective of the
    instrument is to measure the flux of ions and electrons as a
    function of energy and direction in the solar wind, and in the
    environment during the flybys of Earth, Mars, the two asteroids,
    and comet 67p/Churyumov-Gerasimenko.

    Scientific Objectives
    =====================
    The scientific objectives of the instrument are to measure and
    understand the dynamics, structure, and evolution of the plasma
    properties in these environments.  Of particular interest is the
    interaction of the solar wind with the comet, especially the
    formation of pickup ion structures and their relation to the local
    magnetic field.

    Calibration
    ===========
    The IES instrument was calibrated on the ground in the ion
    calibration facility at the Southwest Research Institute,
    San Antonio, TX, USA. In addition cross-calibrations are performed
    in flight with the RPC-LAP and RPC-ICA instruments.

    Operational Considerations
    ==========================
    RPC-IES should be operated continuosly as long as power and
    telemetry rate permit.  When possible, all other RPC instruments
    should be operated while RPC-IES is in operation in order to allow
    joint analysis of the resulting data. RPC-IES high voltages should
    be turned off 5 min before until 5 min after thruster firings to
    prevent arcing.

    RPC-IES Instrument Description
    =========
    The Rosetta Ion and Electron Sensor (RPC-IES) instrument is
    comprised of a double toroidal top-hat electrostatic analyzer
    (ESA), one analyzer for electrons, the other for ions, arranged
    back-to-back.  The common entrance aperture has a 360 degree
    field of view in the symmetry (denoted here by azimuth) plane.
    Electrostatic angular deflection optics give a scanned field of
    view of +/- 45 degrees normal to the azimuth plane (denoted here
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sensor symmetry axis

by the elevation angle).

The instrument objective is to obtain ion and electron distribution functions over the energy range from 4.32 eV/e to 17.67 keV/e, with a basic time resolution of 128 s. This geometry allows IES to analyze both electrons and positive ions with a single entrance aperture, simultaneously. The IES top hat analyzers have toroidal geometry with a smaller radius of curvature in the deflection plane than in the orthogonal plane. This toroidal feature results in a flat deflection plate geometry at the poles of the analyzers and has the advantage that the focal point is located outside the analyzers rather than within them, as is the case with spherical top hat analyzers. The IES field of view (FOV) thus encompasses a total solid angle of 2.8 Pi steradians.

Ions and electrons approaching the IES first encounter a toroidal-shaped grounded grid encircling the instrument. Once inside the grid the electric field produced by bipolar electrodes deflects ions and electrons with a range of energies and incident directions into a field-free entrance aperture containing serrated walls to minimize scattering of ultraviolet light and stray charged particles into the instrument. The particles then enter the top hat region and the electric field produced by the flat electrostatic analyzer segments of the ion and electron analyzers.

Particles with an energy accepted by the ESA and within a narrow 4% energy pass band will pass through the analyzers and be focused onto either the electron or ion microchannel plates (MCPs), which produce charge pulses on 16 discrete anodes for each, which define the azimuth acceptance angles. For electrons the anodes are of equal width so the azimuth resolution is 22.5 degrees. (It was discovered after launch that electron channel 11 was noisy so it was decided not to download the data from that channel. Hence only fill data appear for that channel.) For ions the 16 anodes are divided unequally in size, with 9 of them each 5 degrees wide oriented ~~in the instrument~~ in a direction expected to view the solar wind most of the time (anodes 3 to 11). ~~The remaining~~ 7 anodes are each 45 degrees wide. For both electrons and ions the nominal resolution in the elevation direction is 5 degrees. This resolution would provide 18 measurement bins over the 90 degrees full elevation FOV. However, in order to simplify the instrument electronics, the FOV has been divided into 16 (=24) bins. This results in a small gap in coverage between bins.

The selected energy will correspond to a particular 5 degree elevation entrance angle, depending on the ratio of voltages on the angle deflectors and the ESAs. Note that the use of the terms 'azimuth' and 'elevation' angle for IES differs from the conventional terminology of 'polar' and 'azimuth', ~~and is essentially the reverse useage. This arises from the location and attitude of the FOV relative to the Rosetta spacecraft. See the description of the IES location, below.~~

Viewing Maps (from the RPC-IES IK data)
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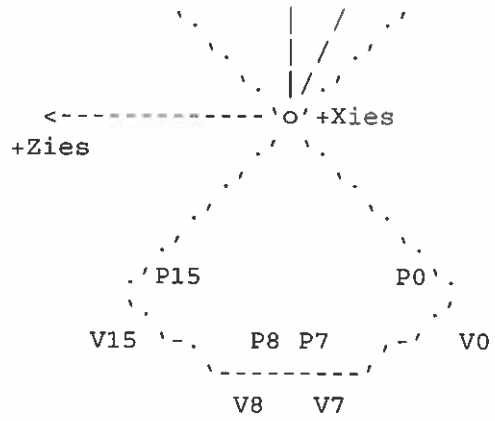
IES/Electron Sector Layout

the rest of this is out-of-date text. changes were made to orient the definitions so that they are the same



For example, for polar Sector 3 the view direction is the vector emanating from the aperture center through the point designated by V3.

Electronics

Pulses from the segmented ~~MCPs~~ anode are amplified by charge-sensitive preamplifiers (CSPs) and recorded in the 16 x 24 bit ion and electron counters. The data are buffered before being sent to the output serial register for transmission to the RPC Plasma Interface Unit (PIU) as serial telemetry packets. The stepping sequences of the angle and energy deflection voltages of the instrument are fixed in memory.

The IES instrument contains a single micro-controller (RTX20X10) which communicates with the RPC-PIU over the IEEE 1355 bus, transmits the collected science data, and monitors the instrument status. The flight software is written in the C and Forth programming languages. The PIU stores and re-transmits to the spacecraft the data stream that the instrument produces. No special data handling is required. Commands and command sequences for IES are formulated by the IES team, sent to Imperial College, where they are translated to the proper format and sent to the project ground system. They are eventually uploaded to the spacecraft and are stored for later execution. In some cases the command may be executed immediately. The sequence provides for selection of one or more operational modes (see below) or in some cases repeated cycling through a series of modes.

High Voltages

The voltages for the ESAs, deflector (DEF), and MCPs are derived from a single supply of 8514 volts. The ESA and DEF voltages are stepped according to LUTs. The ESA sweeps between 0.407 V and 1667 V in 128 approximately logarithmically spaced steps. The DEF steps between -6667 and +6667 V, alternating negative to positive and positive to negative between the 2 deflector plates. The MCP potentials can be set to a potential between +/- 2500 V and +/-3500 V, the positive level for the electrons and negative for the ions. Except for a short test on May 1-2, 2010, the levels have been at 2500 V based on measurements on the ground before flight.

Data Binning

Since IES produces more data than can be transmitted within its telemetry allocation, in order to compress the data they are