Books & Reports

⚙ High-Efficiency Nested Hall Thrusters for Robotic Solar System Exploration

This work describes the scaling and design attributes of Nested Hall Thrusters (NHT) with extremely large operational envelopes, including a wide range of throttleability in power and specific impulse at high efficiency (>50%). NHTs have the potential to provide the game changing performance, power-processing capabilities, and cost effectiveness required to enable missions that cannot otherwise be accomplished. NHTs were first identified in the electric propulsion community as a path to 100-kW class thrusters for human missions. This study aimed to identify the performance capabilities NHTs can provide for NASA robotic and human missions, with an emphasis on 10-kW class thrusters well-suited for robotic exploration. A key outcome of this work has been the identification of NHTs as nearly constant-efficiency devices over large power throttling ratios, especially in direct-drive power systems. NHT systems sized for robotic solar system exploration are predicted to be capable of high-efficiency operation over nearly their entire power throttling range.

A traditional Annular Hall Thruster (AHT) consists of a single annular discharge chamber where the propellant is ionized and accelerated. In an NHT, multiple annular channels are concentrically stacked. The channels can be operated in unison or individually depending on the available power or required performance. When throttling an AHT, performance must be sacrificed since a single channel cannot satisfy the diverse design attributes needed to maintain high thrust efficiency. NHTs can satisfy these requirements by varying which channels are operated and thereby offer significant benefits in terms of thruster performance, especially under deep power throttling conditions where the efficiency of an AHT suffers since a single channel can only operate efficiently (>50%) over a narrow power throttling ratio (3:1).

Designs for 10-kW class NHTs were developed and compared with AHT sys-tems. Power processing systems were considered using either traditional Power Processing Units (PPU) or Direct Drive Units (DDU). In a PPU-based system, power from the solar arrays is trans-formed from the low voltage of the arrays to the high voltage needed by the thruster. In a DDU-based system, power from the solar arrays is fed to the thruster without conversion. DDU-based systems are attractive for their simplicity since they eliminate the most complex and expensive part of the propulsion system.

The results point to the strong potential of NHTs operating with either PPUs or DDUs to benefit robotic and human missions through their unprecedented power and specific impulse throttling capabilities. NHTs coupled to traditional PPUs are predicted to offer high-efficiency (>50%) power throttling ratios 320% greater than present capabilities, while NHTs with direct-drive power systems (DDU) could exceed existing capabilities by 340%. Because the NHT-DDU approach is implicitly low-cost, NHT-DDU technology has the potential to radically reduce the cost of SEP-enabled NASA missions while simultaneously enabling unprecedented performance capability.

This work was done by Richard R. Hofer of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48400

〰 High-Voltage Clock Driver for Photon-Counting CCD Characterization

A document discusses the CCD97 from e2v technologies as it is being evaluated at Goddard Space Flight Center's Detector Characterization Laboratory (DCL) for possible use in ultra-low background noise space astronomy applications, such as Terrestrial Planet Finder Coronagraph (TPF-C). The CCD97 includes a photon-counting mode where the equivalent output noise is less than one electron. Use of this mode requires a clock signal at a voltage level greater than the level achievable by the existing CCD (charge-coupled-device) electronics.

A high-voltage waveform generator has been developed in code 660/601 to support the CCD97 evaluation. The unit generates required clock waveforms at voltage levels from –20 to +50 V. It deals with standard and arbitrary waveforms and supports pixel rates from 50 to 500 kHz. The system is designed to interface with existing Leach CCD electronics.

This work was done by Robert Baker of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15059-1

Σ Development of the Code RITRACKS

A document discusses the code RI-TRACKS (Relativistic Ion Tracks), which was developed to simulate heavy ion track structure at the microscopic and nanoscopic scales. It is a Monte-Carlo code that simulates the production of ra-diolytic species in water, event-by-event, and which may be used to simulate tracks and also to calculate dose in targets and voxels of different sizes. The dose deposited by the radiation can be calculated in nanovolumes (voxels).

RITRACKS allows simulation of radiation tracks without the need of extensive knowledge of computer programming or Monte-Carlo simulations. It is installed as a regular application on Windows systems. The main input parameters entered by the user are the type and energy of the ion, the length and size of the irradiated volume, the number of ions impacting the volume, and the number of histories. The simulation can be started after the input parameters are entered in the GUI. The number of each kind of interactions for each track is shown in the result details window. The tracks can be visualized in 3D after the simulation is complete. It is also possible to see the time evolution of the tracks and zoom on specific parts of the tracks.

The software RITRACKS can be very useful for radiation scientists to investigate various problems in the fields of radiation physics, radiation chemistry, and radiation biology. For example, it can be used to simulate electron ejection experiments (radiation physics).

This work was done by Ianik Plante and Francis A. Cucinotta of Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-25076-1