TFIPS: Next Generation Space Plasma Spectrometry

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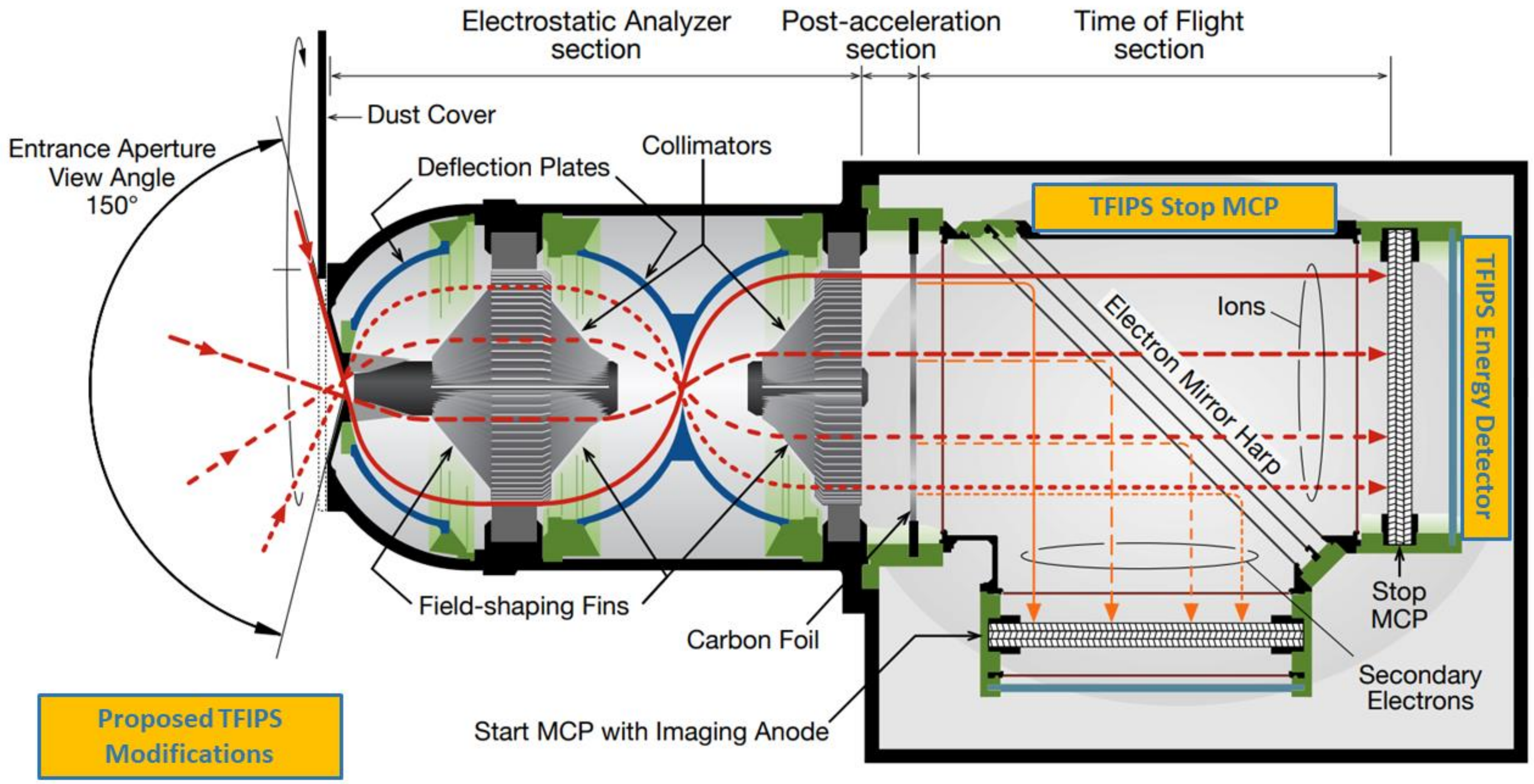
Abstract

The TFIPS (Triple Fast Imaging Plasma Spectrometer) concept is a spaceborne ion mass spectrometer used for advanced study of the charged particles emitted by the sun into the solar wind. Solar wind conditions in the heliosphere can change rapidly and demand fast detection systems to characterize small scale structures and processes. These solar wind disturbances present considerable danger to Earth's infrastructure and astronauts in space. The importance of this work is to establish connections between the energies and types of particles seen in space to the source regions at the sun from which they are accelerated. The TFIPS design provides the scientifically-driven performance characteristics that must be met by next generation spaceborne particle instruments through its high-cadence, high-fidelity measurements. Moreover, TFIPS requires two to six times less power than instruments currently in operation that make similar detections. We seek to develop the TFIPS concept that adds energy resolving solid state detectors to a design based on the FIPS heritage model that was successfully employed on the *MESSENGER* mission sent to Mercury. We present our instrument concept and expected instrument performance.

Performance Characteristics

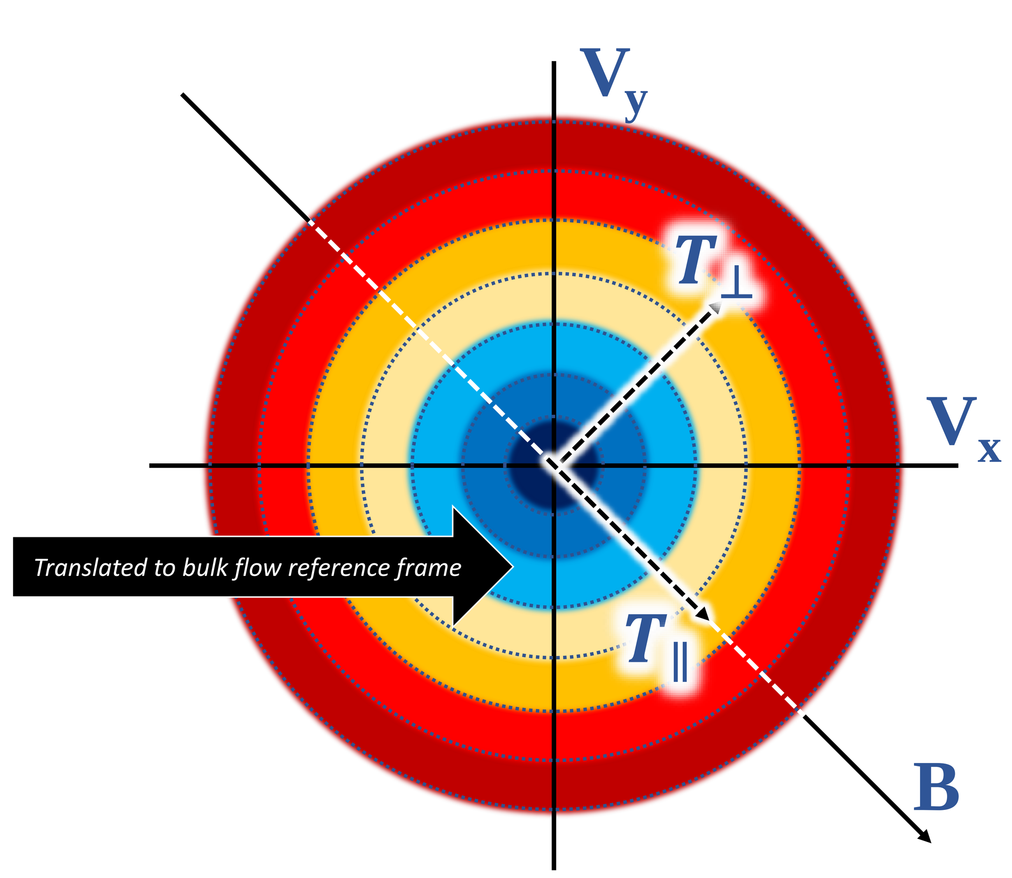
Range	50 eV/e – 20 keV/e
Measured Quantities	3D Velocity, mass, charge
FOV	150°
Mass	1.5 kg
Cadence	< 1m (normal), 10s (fast)
Composition	H, HE, C, N, O, Ne, Mg, Si, S, and Fe
Power	2-2.5 W

The Triple Fast Imaging Plasma Spectrometer Design



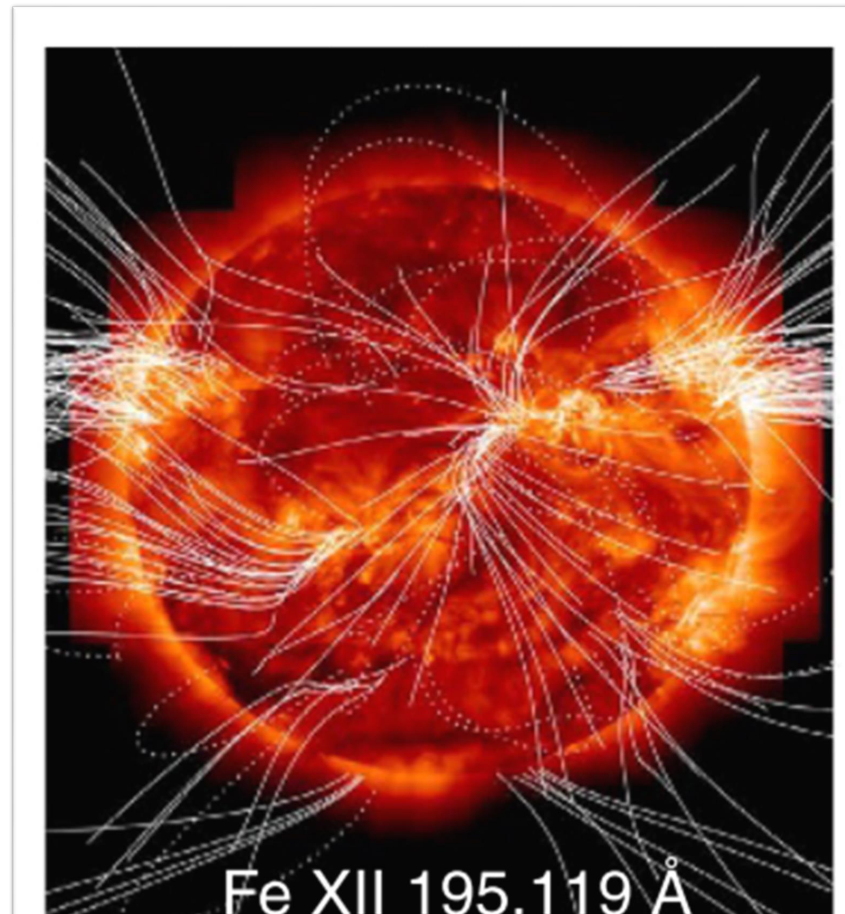
Scientific Objectives

1. Determine the acceleration mechanisms in the Solar Corona.
2. Resolve the plasma-wave interactions, turbulence, and heating mechanisms in the Solar wind.
3. Discover the source regions of the Slow and Fast Solar Wind.
4. Sample diverse environments such as moons, magnetospheres, and the interplanetary medium.



The Future of Solar and Heliospheric Detection

One factor driving the next generation of instruments is the need for smaller, reliable models ideal for streamlined production and an increased number of active science missions in space. This research ultimately serves to advance technology conducive for expanding the Heliospheric System Observatory through a fleet of new science probes. Making connections between detections made by multiple spacecraft dispersed around the Sun is critical to NASA's objectives to understand the processes that accelerate particles, the creation and variability of the solar magnetic dynamo, and the origin and evolution of the supersonic plasma emitted by the sun. The image on the right taken from Brooks et al. 2015 is an image of the Sun at 119 Å representing light emitted from iron ionized to the twelfth charge state. Overlaid is the magnetic field lines determined from potential field source surface models and ballistic mapping traced out into the local heliosphere where the veracity of their predictions can be detected. For every additional detector in operation the outflowing particles emitted by the Sun can be uniquely identified with a particular source region allowing advancement in our knowledge of acceleration processes and transport models.



Brooks et al. 2015