Parker Solar Probe (PSP)
FIELDS status

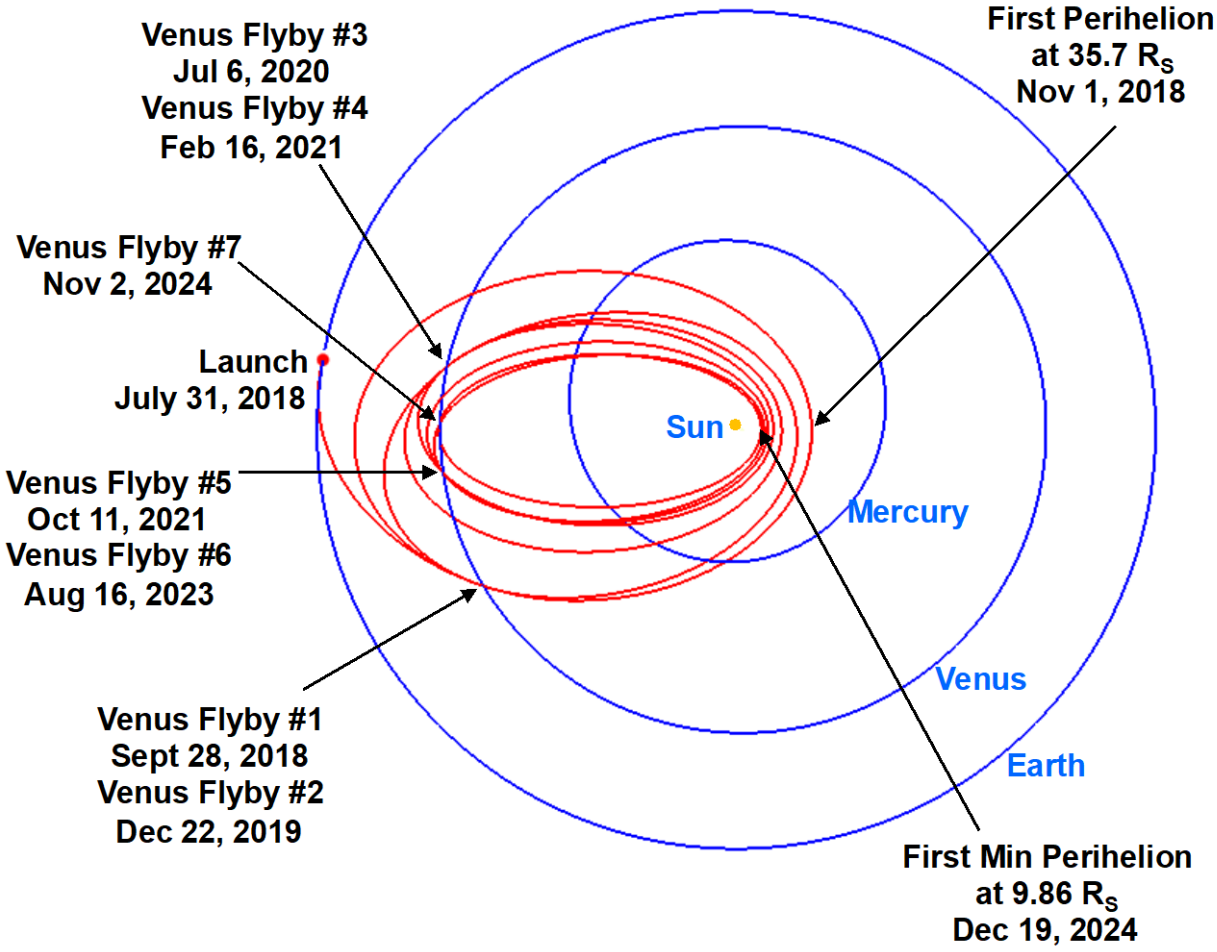
Stuart D. Bale



- Launch in 2018 on Delta IV-H
- Mostly *in situ* instruments
- 3 axis stable
- Perihelion at 9.8 Rs
  – within the Alfven radius (~15 Rs)

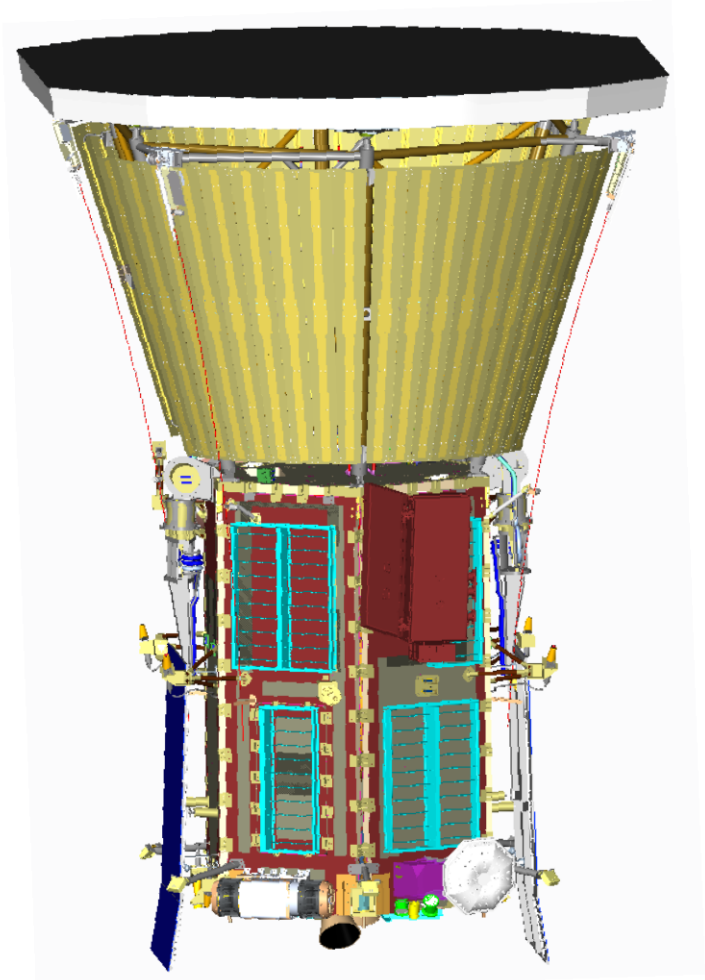
2018 Baseline Mission Design
Mission Trajectory

Venus-Venus-Venus-Venus-Venus-Venus-Venus-Gravity-Assist (V^7GA) Trajectory



- Repeated 7 Venus gravity assists to lower orbit to reach the Sun
- Switching between resonant and non-resonant Venus encounters to minimize mission duration
- Orbit phasing matched between flybys so that no deep space maneuvers are required
- Multiple solar encounters at various distances
- Solar distances not beyond Earth for a solar powered spacecraft

Spacecraft Overview



- NASA selected instrument suites
- 685kg max launch wet mass
- Reference Dimensions:
  - S/C height: 3m
  - TPS max diameter:2.3m
  - S/C bus diameter: 1m
- C-C Thermal protection system
- Hexagonal prism s/c bus configuration
- Actively cooled solar array
  - 388W electrical power at encounter
  - Solar array total area: 1.55m^2
  - Radiator area under TPS: 4m^2
- 0.6m HGA, 34W TWTA Ka-band science DL
- Science downlink rate: 167kbps at 1AU

PSP Level 1 Science Objectives

L1 Science Objectives	Sample Processes	Needed Measurements	Instruments
1. Trace the flow of energy that heats and accelerates the solar corona and solar wind. 2. Determine the structure and dynamics of the plasma and magnetic fields at the sources of the solar wind. 3. Explore mechanisms that accelerate and transport energetic particles.	- heating mechanisms of the corona and the solar wind; - environmental control of plasma and fields; - connection of the solar corona to the inner heliosphere. - particle energization and transport across the corona	- electric & magnetic fields and waves, Poynting flux, absolute plasma density & electron temperature, spacecraft floating potential & density fluctuations, & radio emissions - energetic electrons, protons and heavy ions - velocity, density, and temperature of solar wind e-, H+, He++ - solar wind structures and shocks	FIELDS - Magnetic Fields - Electric Fields - Electric/Mag Wave/Radio ISIS - Energetic electrons - Energetic protons and heavy ions - (10s of keV to ~100 MeV) SWEAP - Plasma e-, H+, He++ - SW velocity & temperature WISPR - White light measurements of solar wind structures

The SPP Plasma Environment

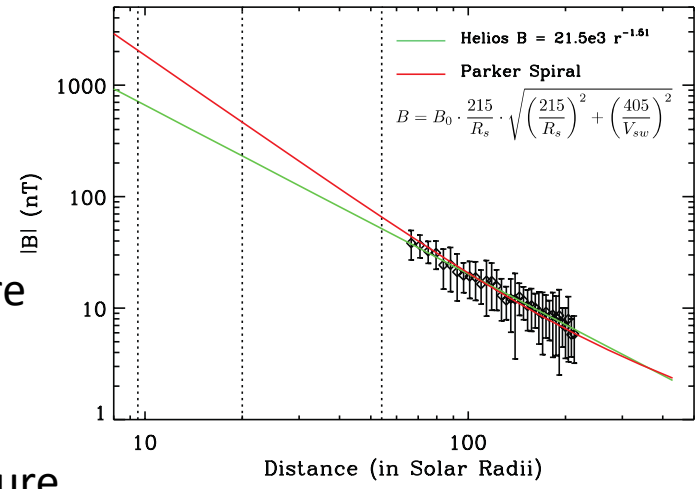
Helios (0.29 AU) and remote sensing measurements extrapolated into 10 Rs

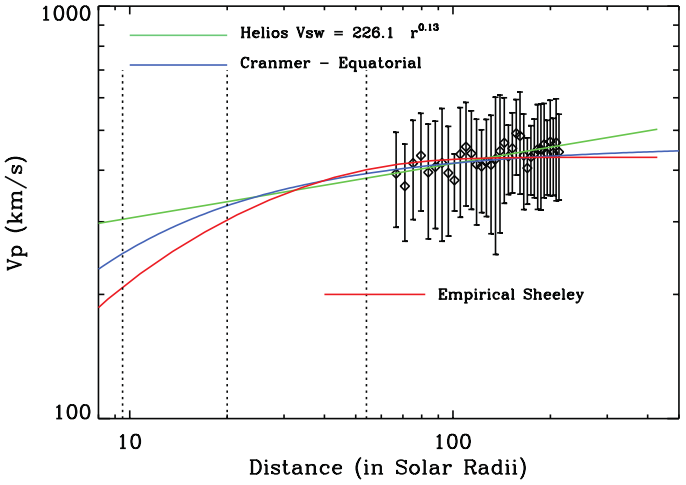
Helios

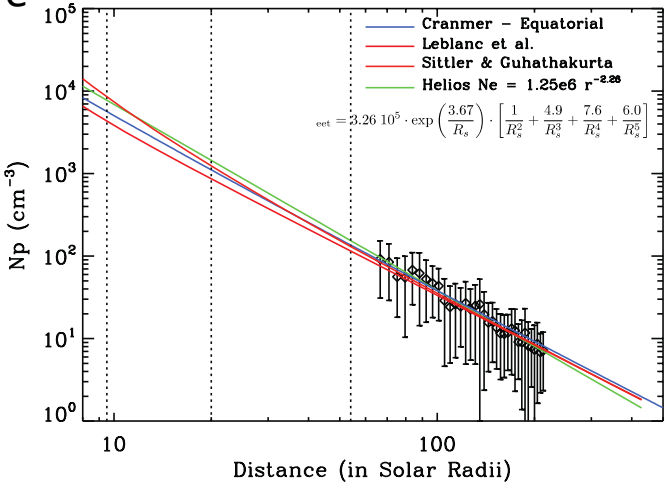
- Magnetic field
- Velocity
- Proton density
- Proton temperature

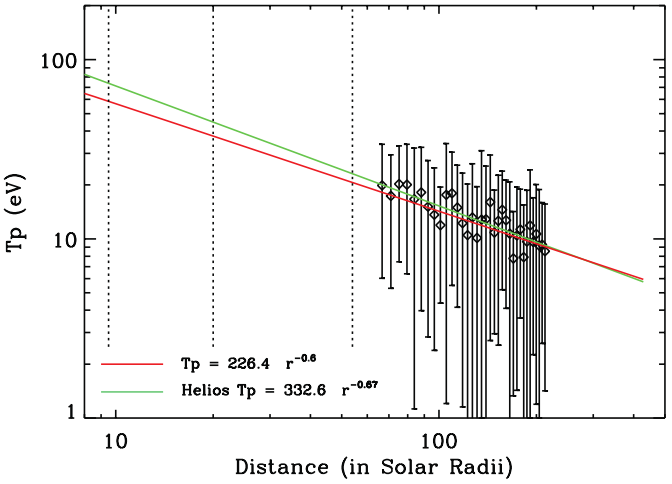
Helios + models

- Electron temperature









5

SPP Plasma Environment

- **High cadence sampling**
- **Burst memory system**
- **Floating voltage preamps**
- **Large dynamic range**

arameters		10 R_s Typical	55 R_s Typical	1 AU Typical

6

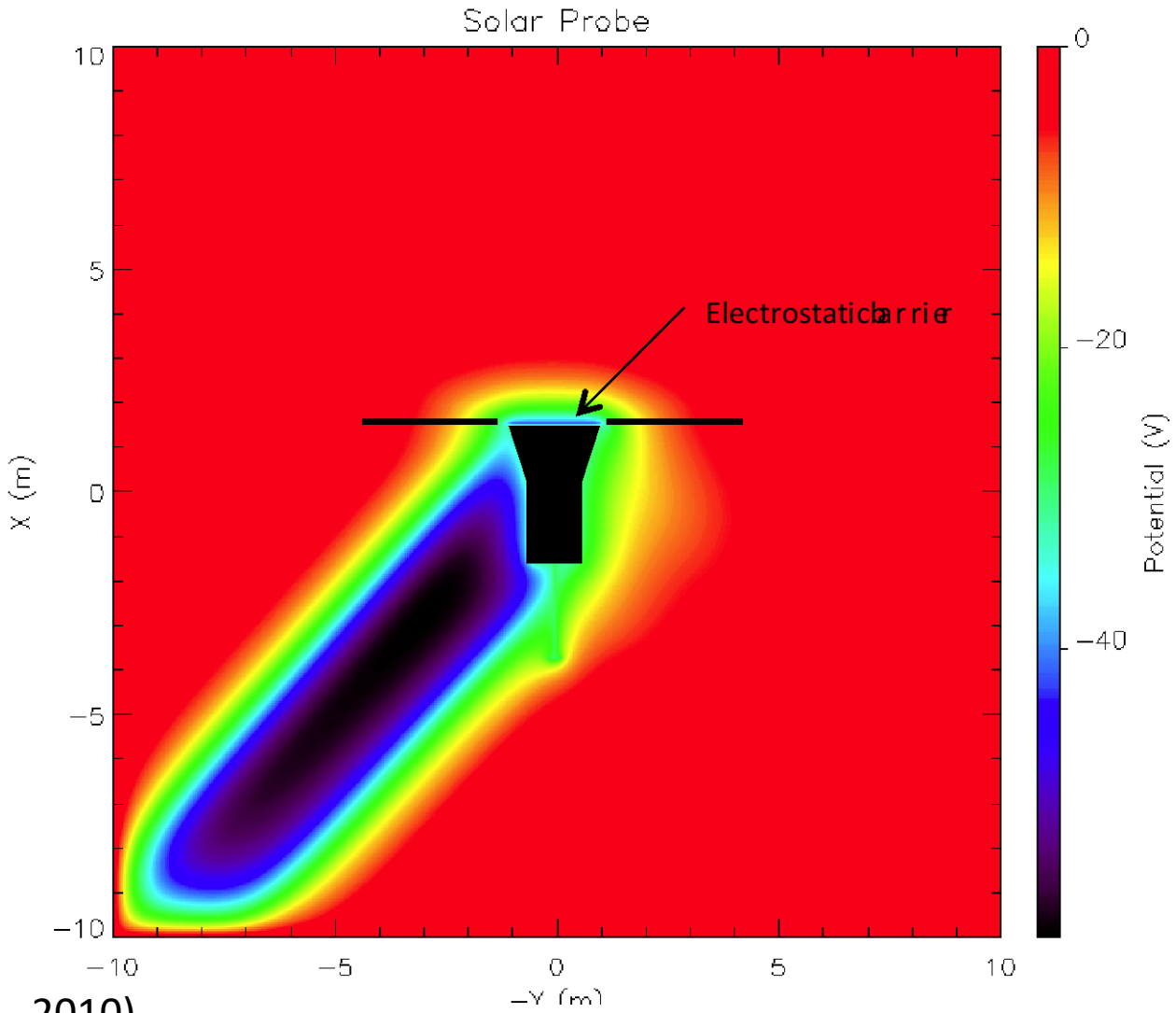
Spacecraft Plasma Wake

Major dynamical electrostatic disturbances in the (anti-ram) wake of the spacecraft

Density fluctuations
Electric field fluctuations
Plasma potential structure

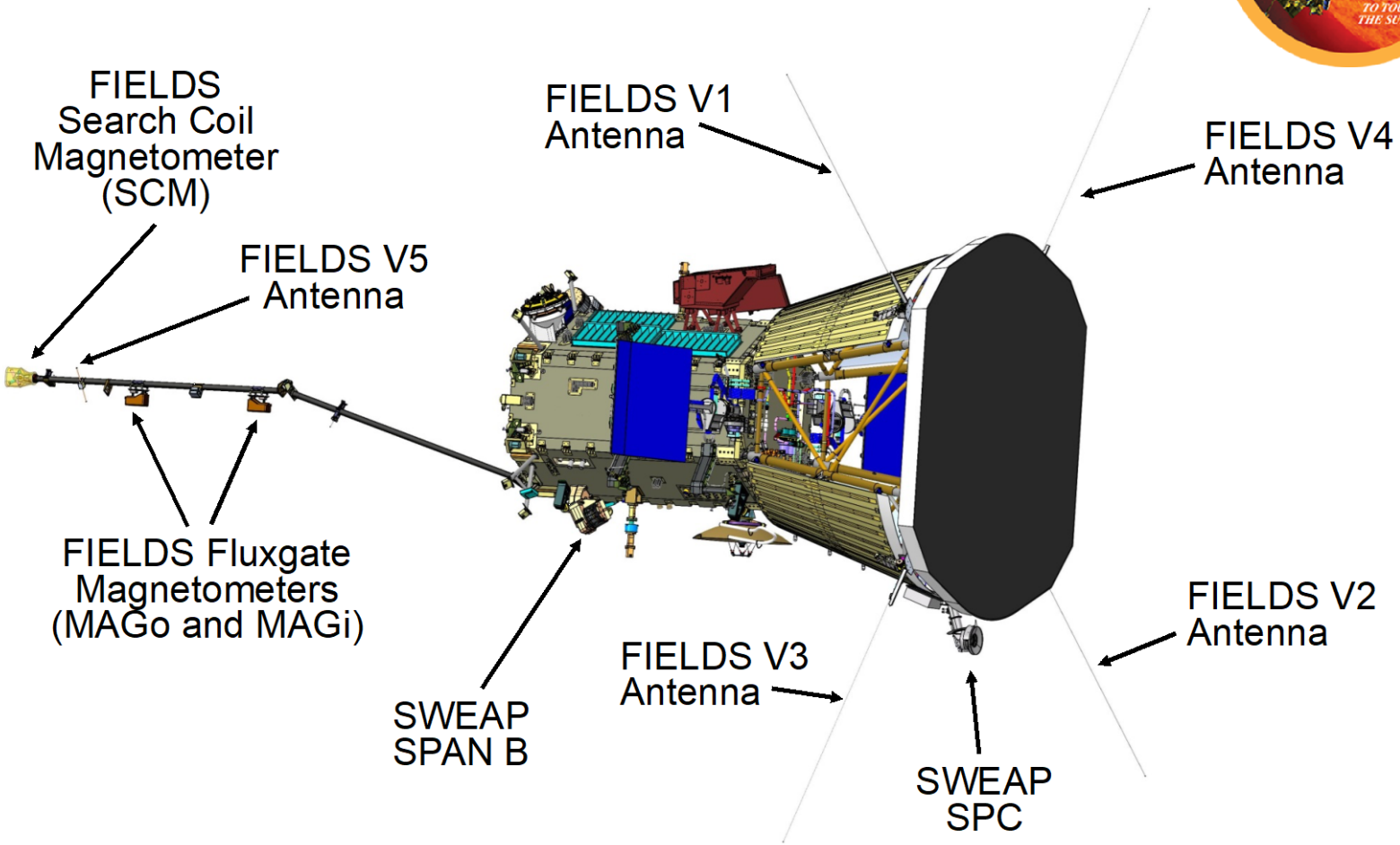
Space-charge (double layer) effects near perihelion

Electric field sensor orientation is driven by wake physics



(Ergun et al., 2010)

Payload Accommodation on S/C (1/3)



Electric field measurements

current variations - this is historically the case for SW experiments

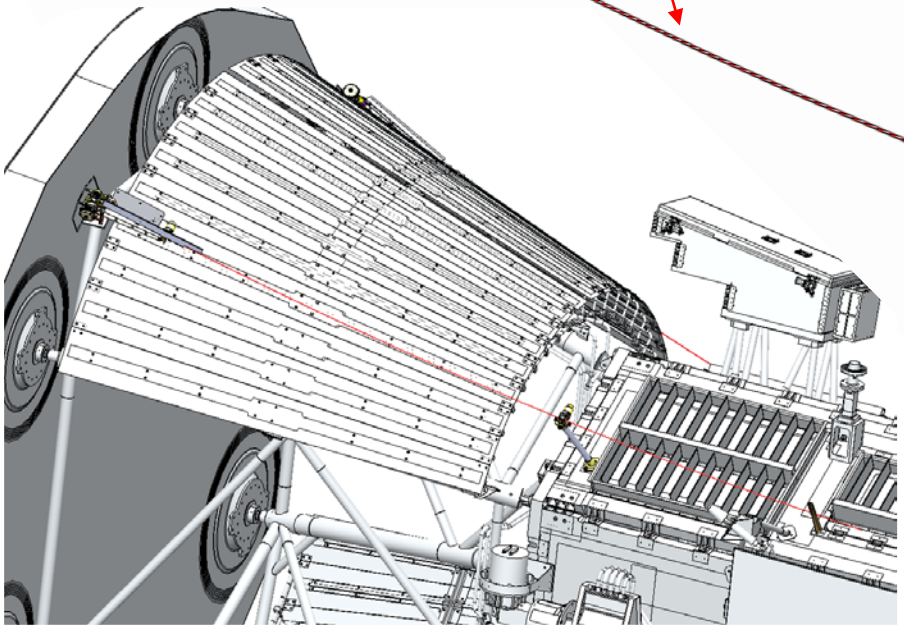
V1-V4 electric sensors

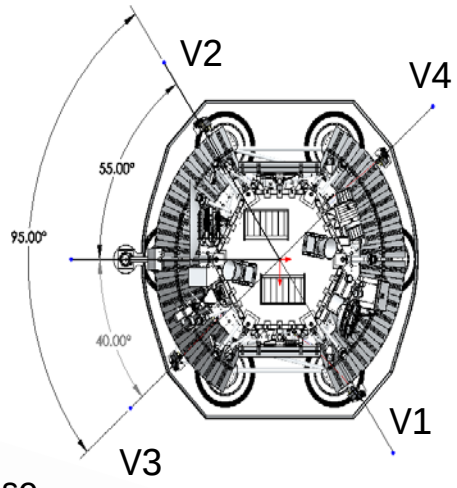
Base/Hinge and stub (30 cm) – voltage biased

Whip (2 m length) – current-biased

Mid-Mount Whip Release

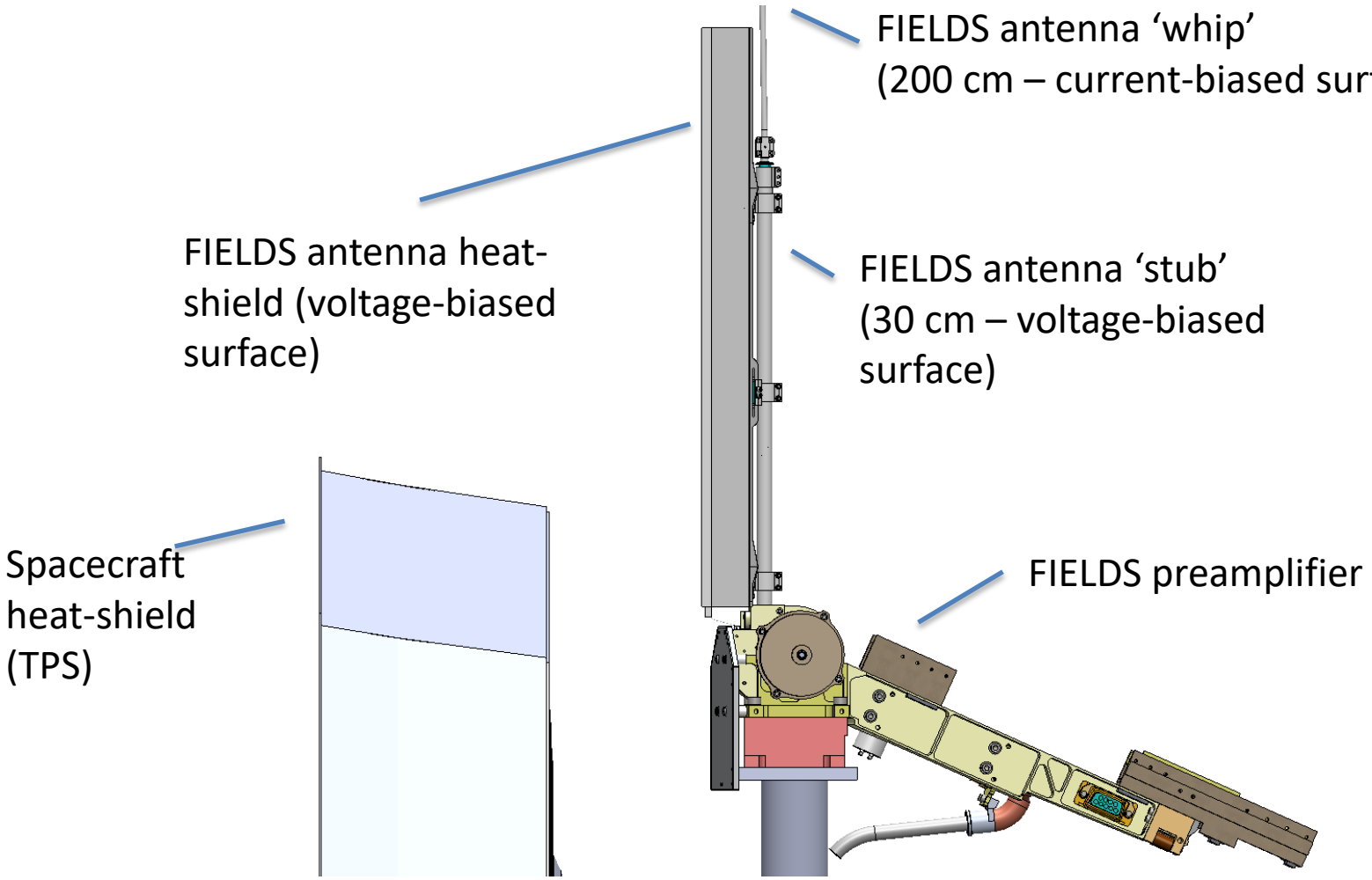
Tip fork





(currently being worked given new Delta IV-H launch load specs)

FIELDS Electric Antenna Design



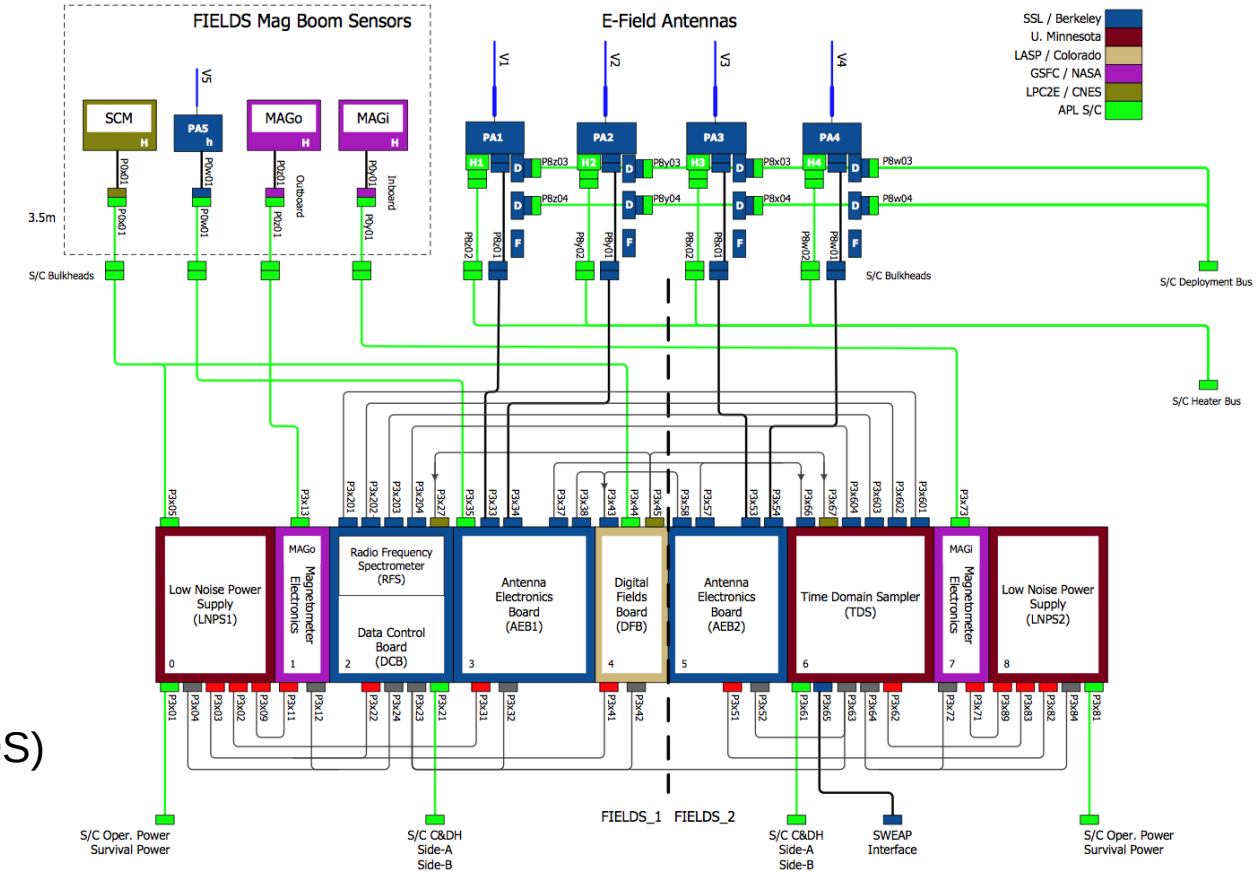
FIELDS Block Diagram

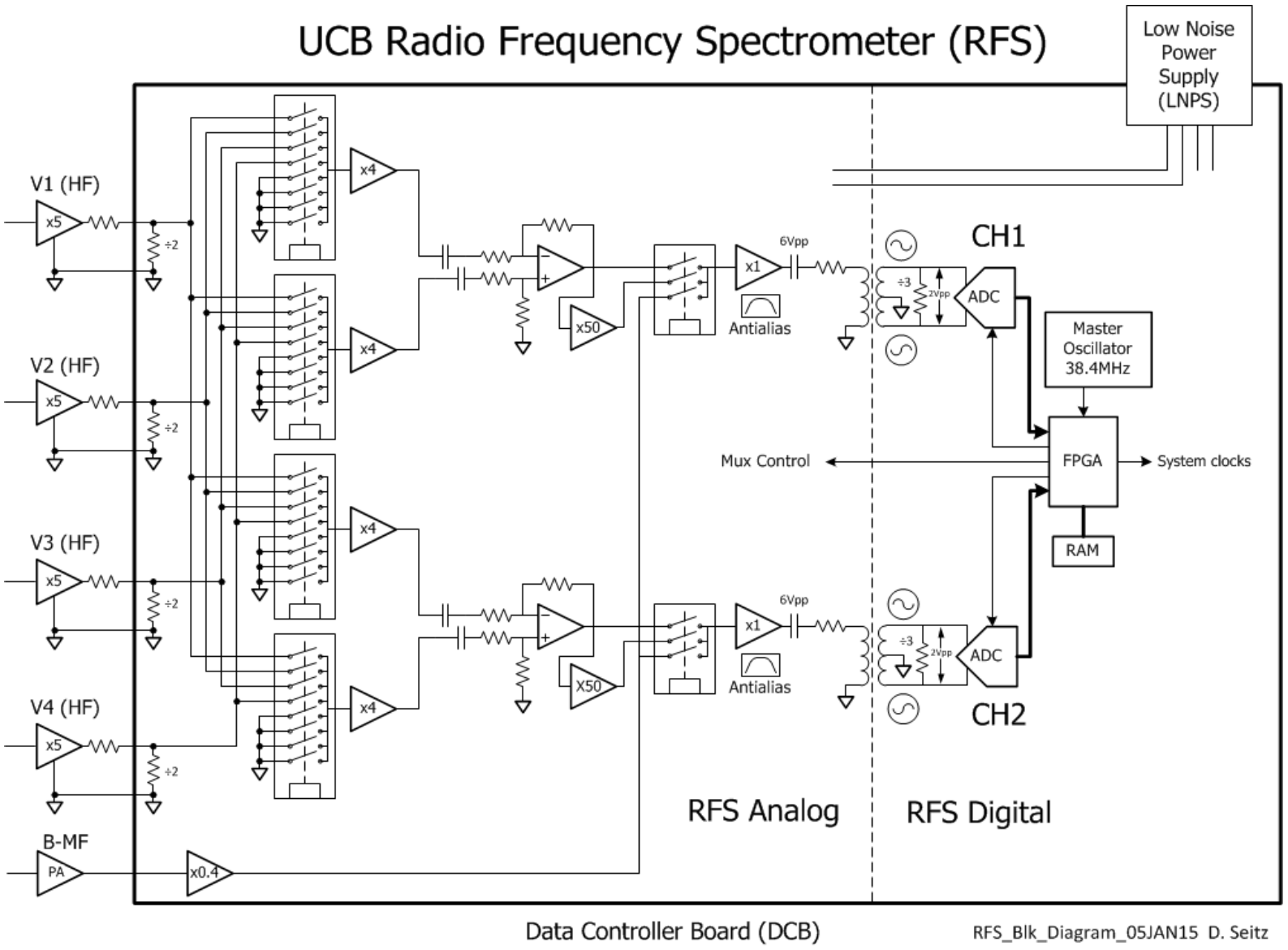
FIELDS System

Two Sides
- Each has Spacecraft I/F
- Each has Magnetometer
- Each has Antenna Elect.
- Each has Power Supply

FIELDS1 also has
- Radio Freq Spect. (RFS)
- Digital Fields Board (DFB)
- SCM Calib Control
- Absolute Time Sequencer
- TDS I/F

FIELDS2 also has
- Time Domain Sampler (TDS)
- DCB I/F
- SWEAP I/F

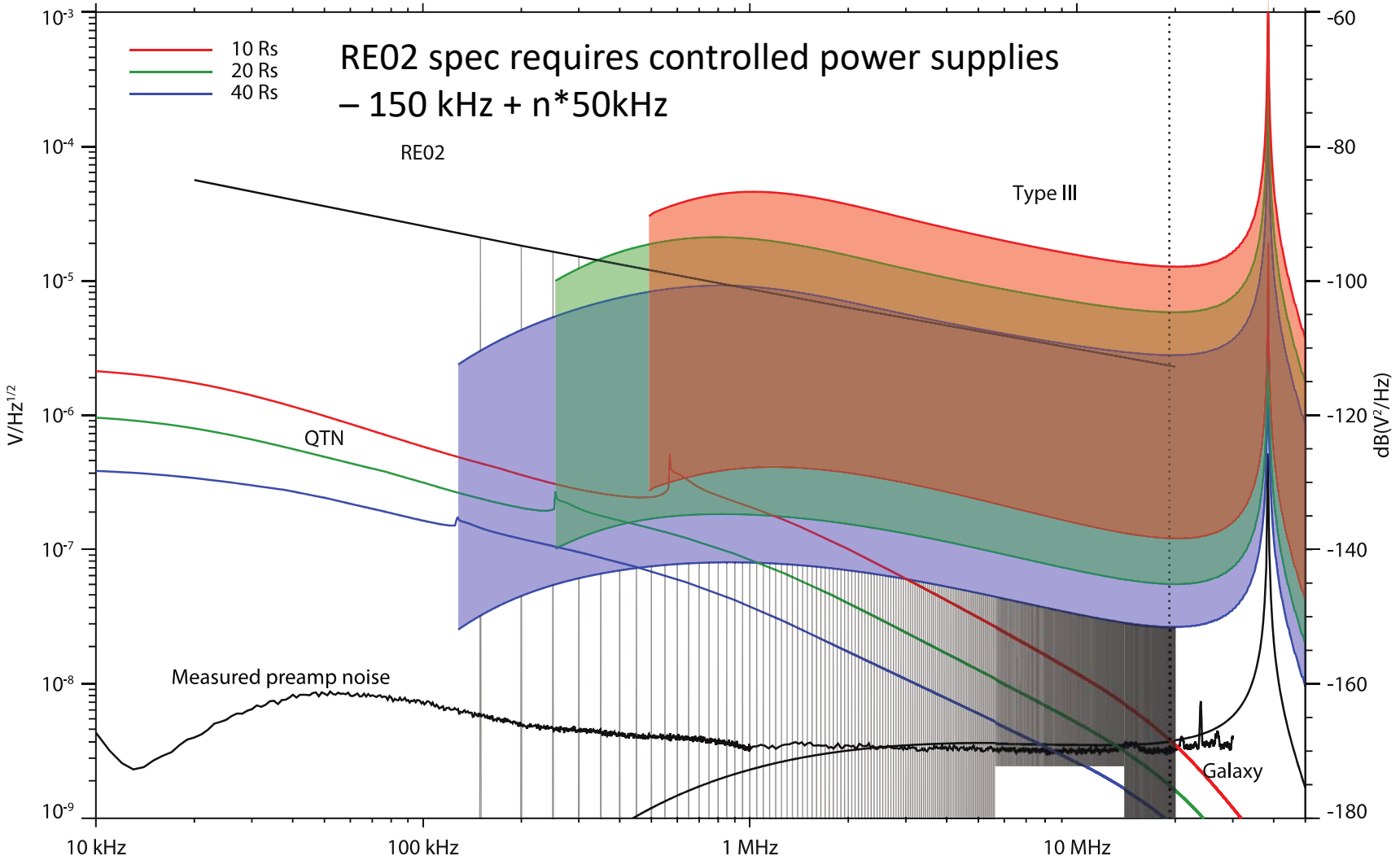




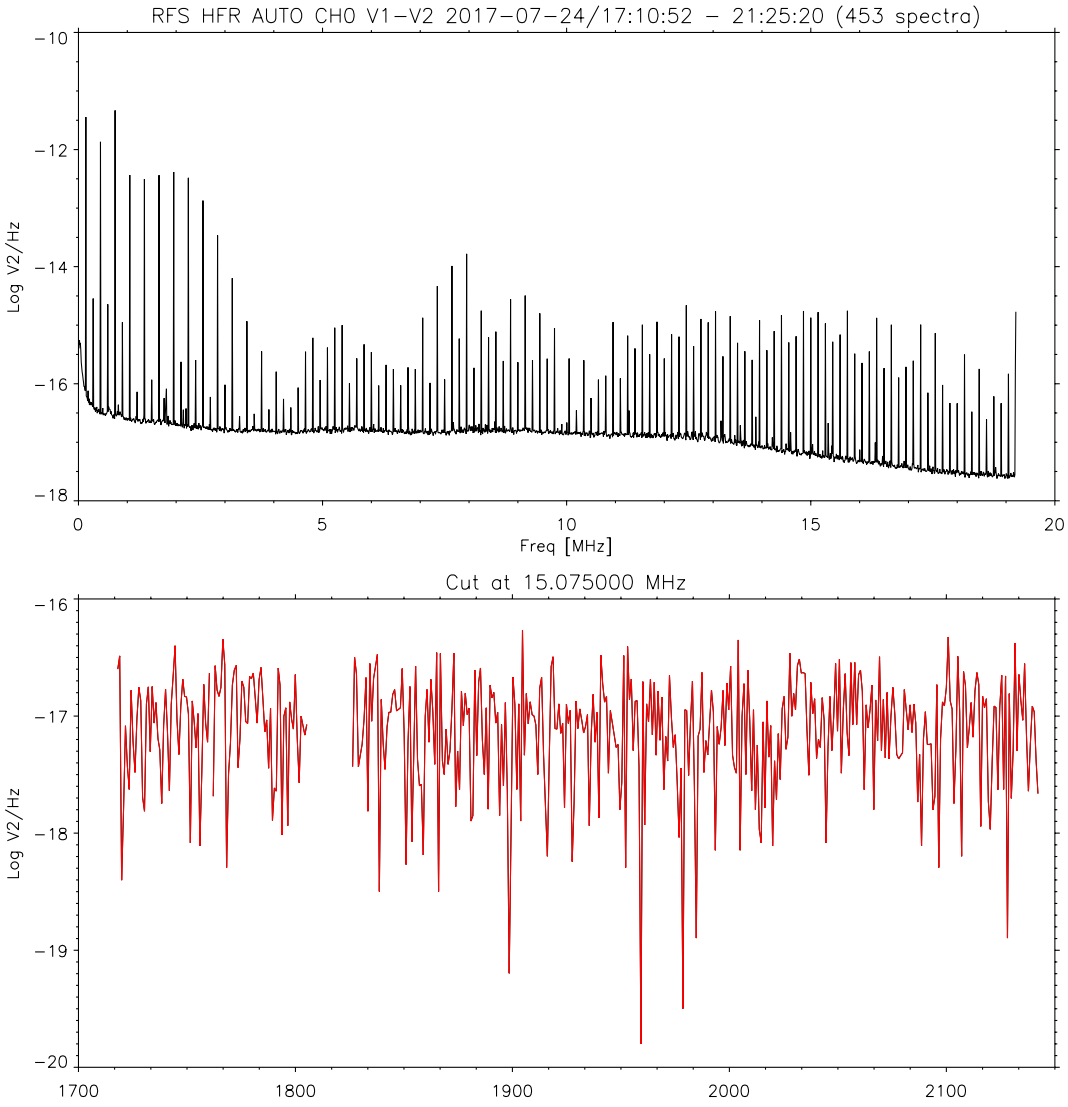
2 channel, 40 MSPS, baseband digital receiver

Polyphase Filter Bank provides >120dB narrowband rejection

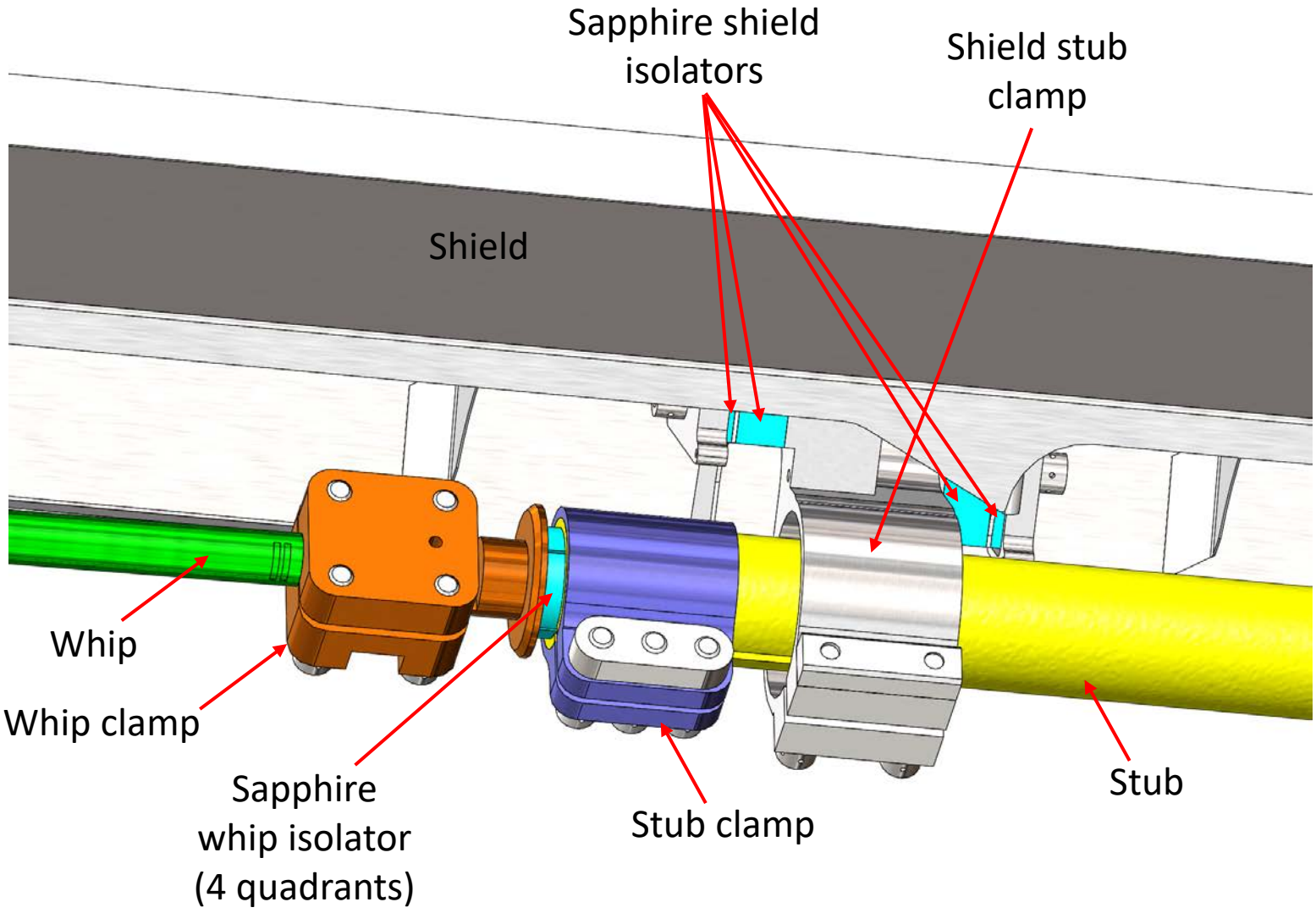
Sensitivity and electromagnetic cleanliness



Sensitivity and electromagnetic cleanliness

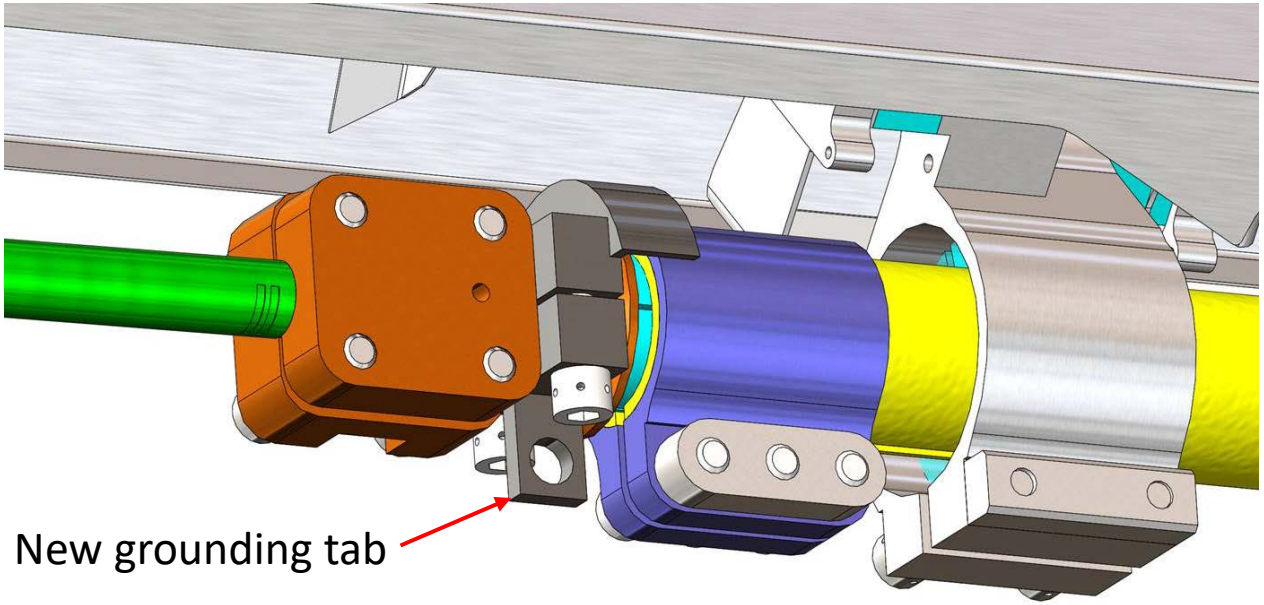


Whip-to-Stub Isolator Geometry

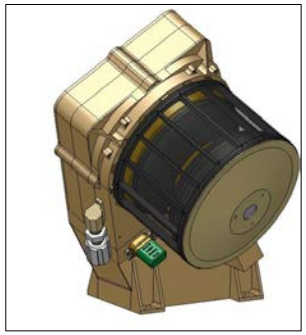


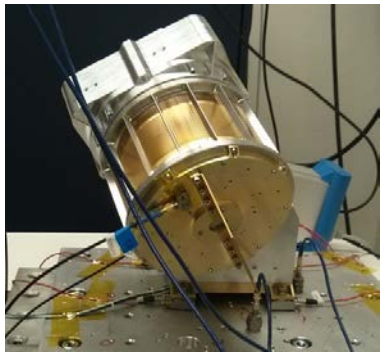
Impact

- Visor weighs 1.7g including screws
- Adds ~1pF each to the whip/stub and whip/heat shield capacitances. This is acceptable fro ma science standpoint.
- Adding a tab to the bottom will let us get rid of the RBF moly grounding wire.



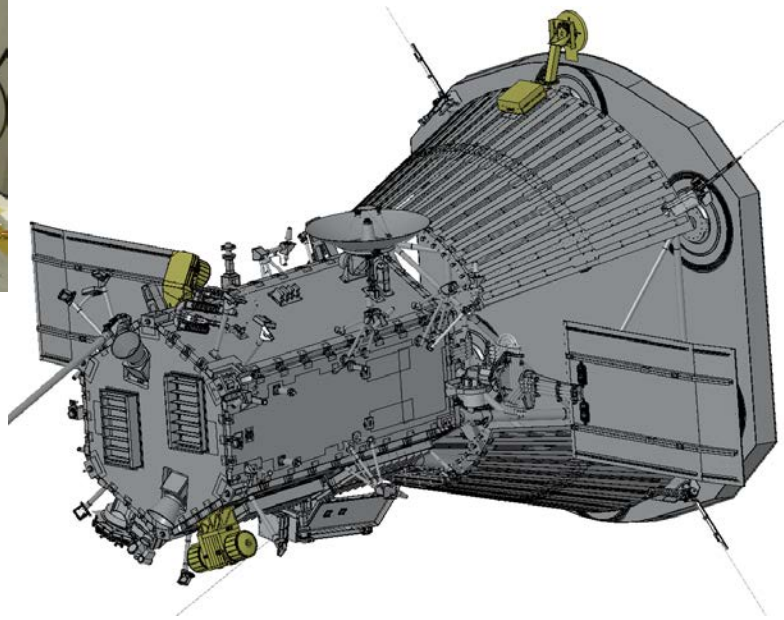
SWEAP Suite Overview

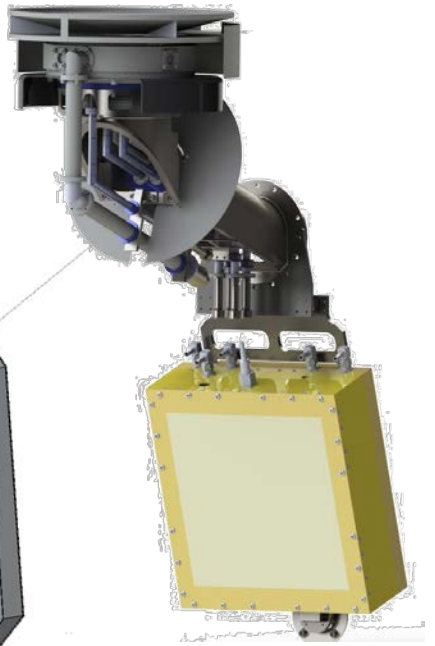




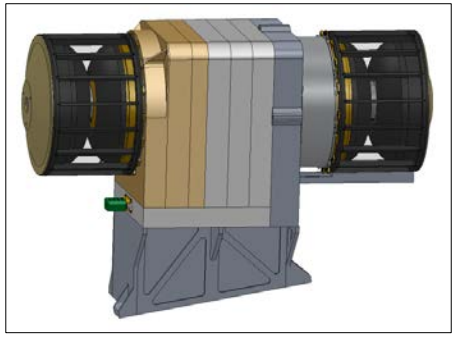
SPAN-B “behind” electrons

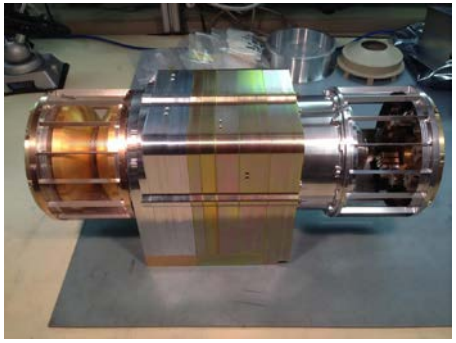
SPC ions+electrons



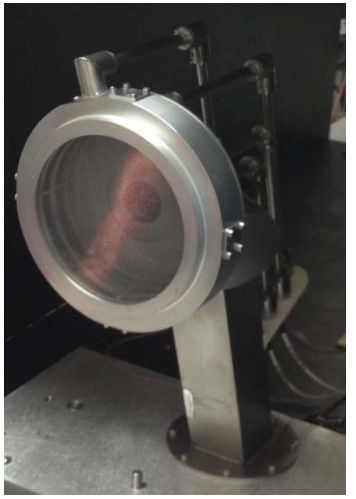


SPAN-A “ahead” ions+electrons





SWEAP Electronics Module (SWEM) inside bus

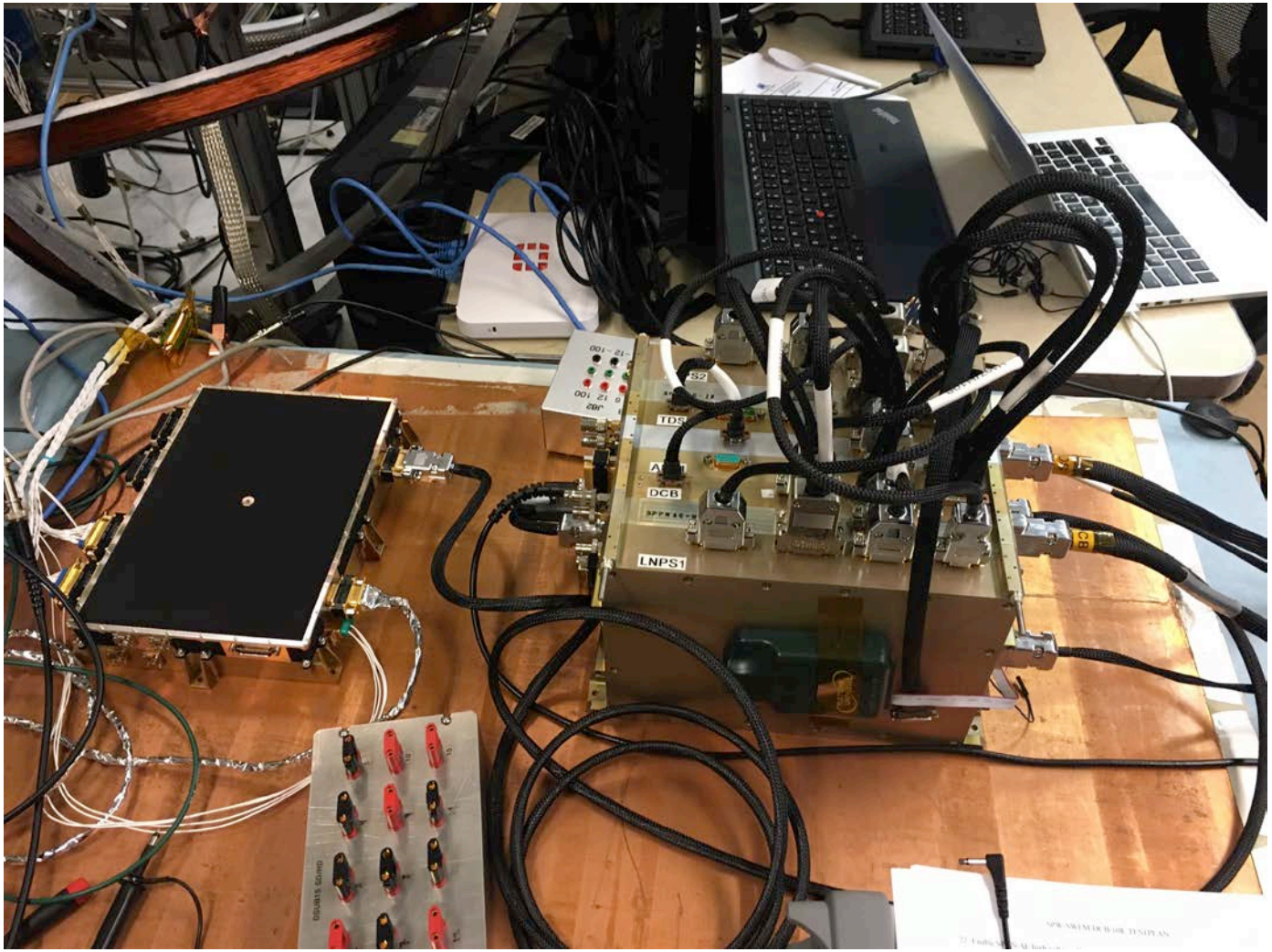


SWEAP measurement capability

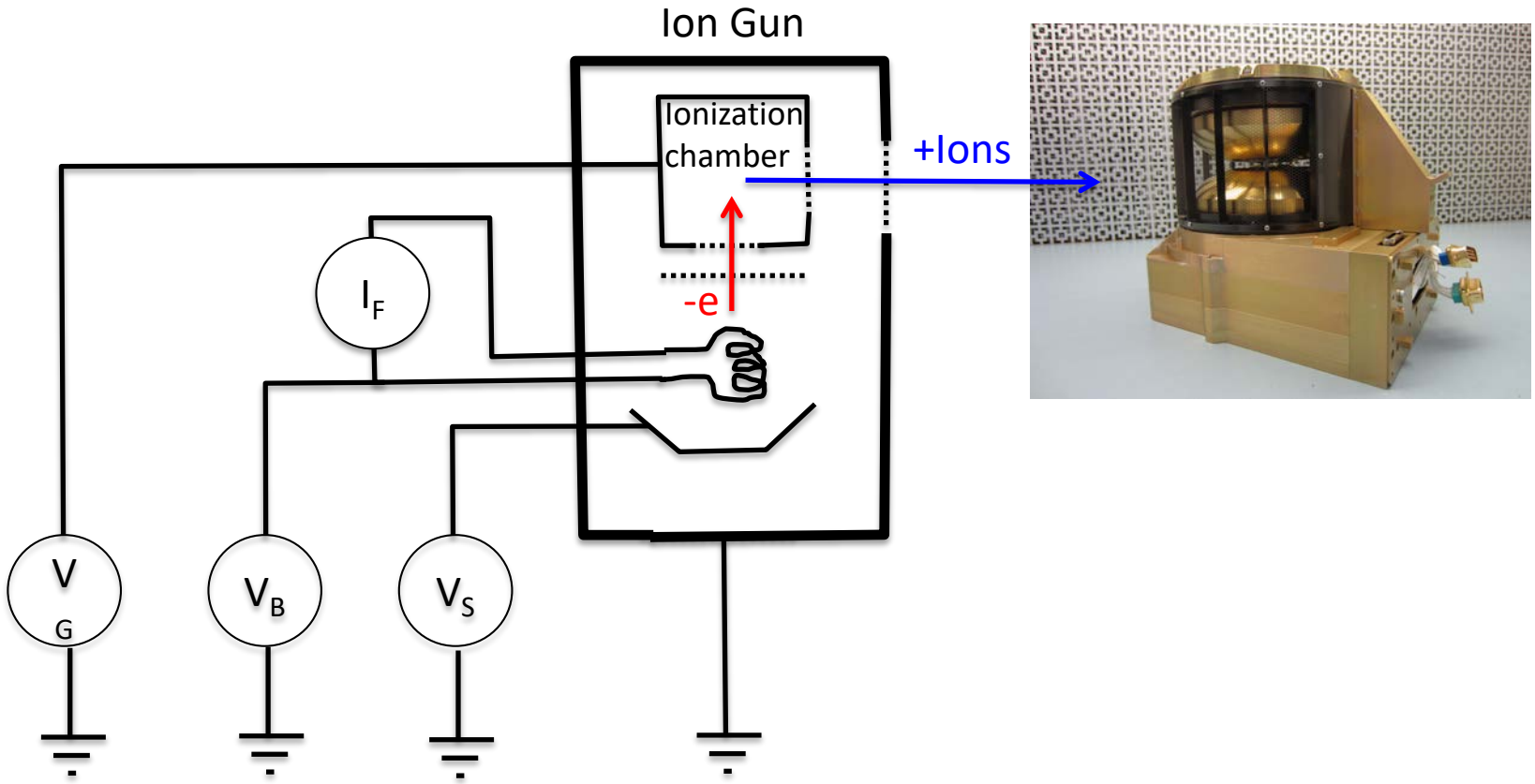
	Parameter	Requirement	SPC	SPAN-A i+	SPAN-A/B e-
Ions	Field of View	Nadir and ram directions	28° half width cone nadir	180°x30° in ram(1)	
	Energy range*	10 eV – 20 keV	150 eV – 6 keV(2)	10 eV – 20 keV	
	Energy resolution	< 20%	< 20%	< 20%	
	Angular resolution*	10° x 25°	10°	10°x25°	
	Cadence	1 Hz	1 Hz	1 Hz	
	(m/q) resolution*	< 25%		< 25%	
Electrons	Field of view	> 75% of the sky	28° half width cone nadir		200°x90° each > 75%(3)
	Energy range*	5 eV – 20 keV	100 eV – 1.5 keV		5 eV – 20 keV
	Energy resolution	< 20%	< 20%		< 20%
	Angular resolution*	10° x 10°	10°		10°x10° (4)
	Cadence	1 Hz			

* not required in all directions; (1) For e/q < 4 keV/q; (2) 1 keV below 15 R_s, 4 keV below 20 R_s; (3) For e- < 4 keV; (4) within 30° nadir for SPAN-A, within 15° ecliptic SPAN-B

FIELDS/SWEAP Interface

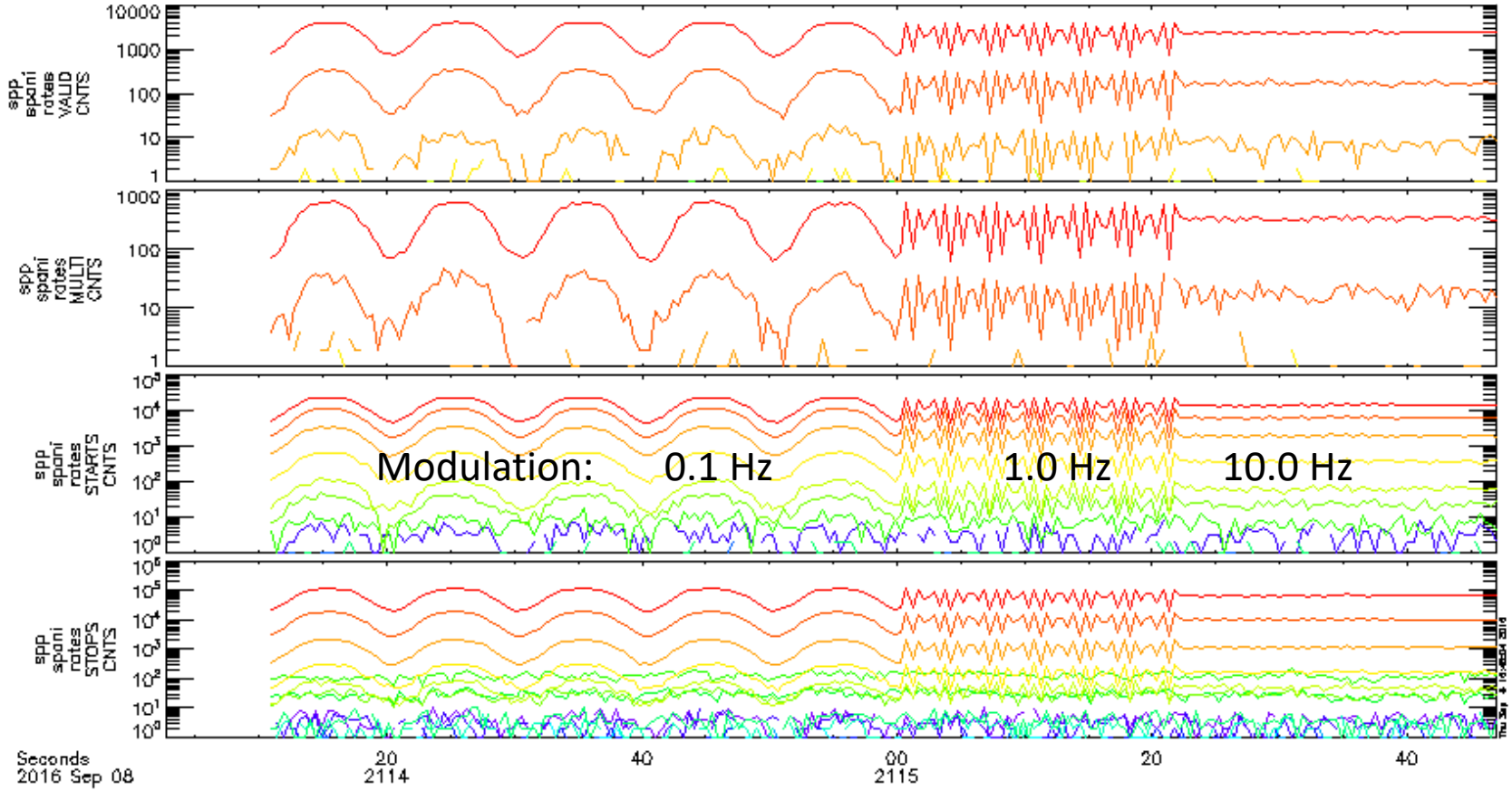


Wave/Particle Correlator tests



- Ion Flux can be modulated by applying a varying voltage (Vs) on the shield

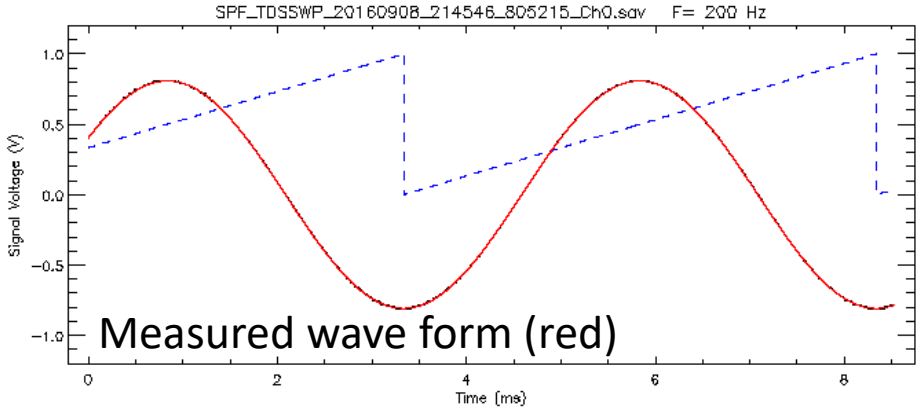
SPAN-A – Ion Correlator tests

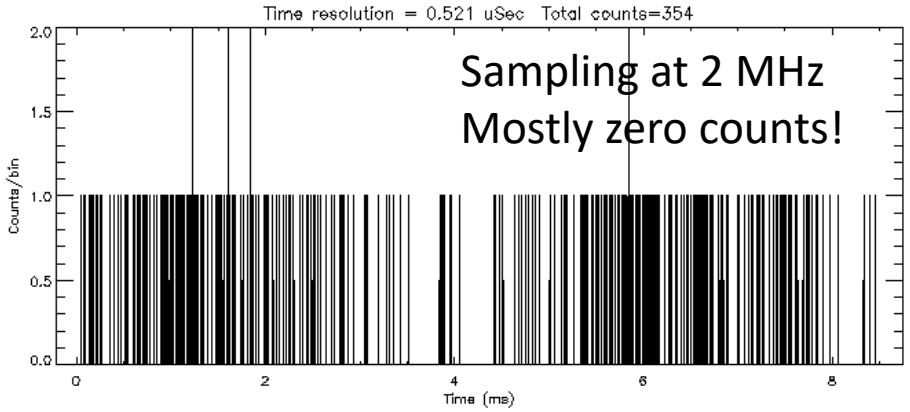


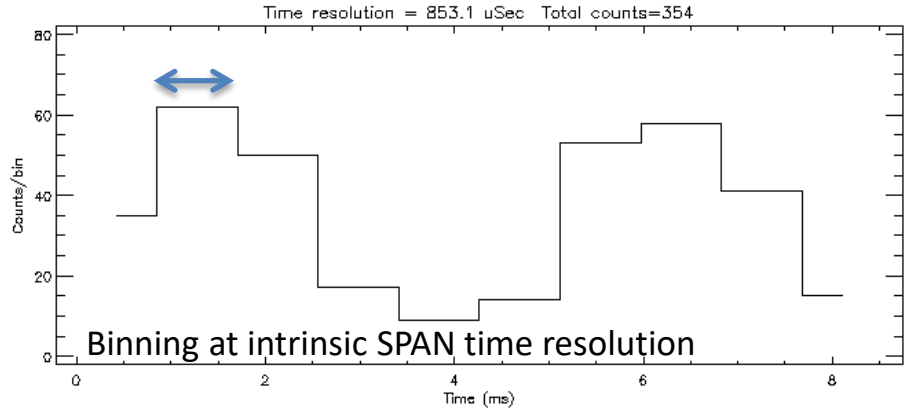
- Sampling rate: 4.6 Hz (4 NYHz)
- Modulating the Ion Gun flux at various rates by applying sinusoidal Vshield

Wave/particle correlations

- Modulating ion flux with 200 Hz signal.
- Ions detected by SPAN-A-Ions
- Particle pulses directed to SWEM and FIELDS-2
- Vs waveform also delivered to TDS instrument.

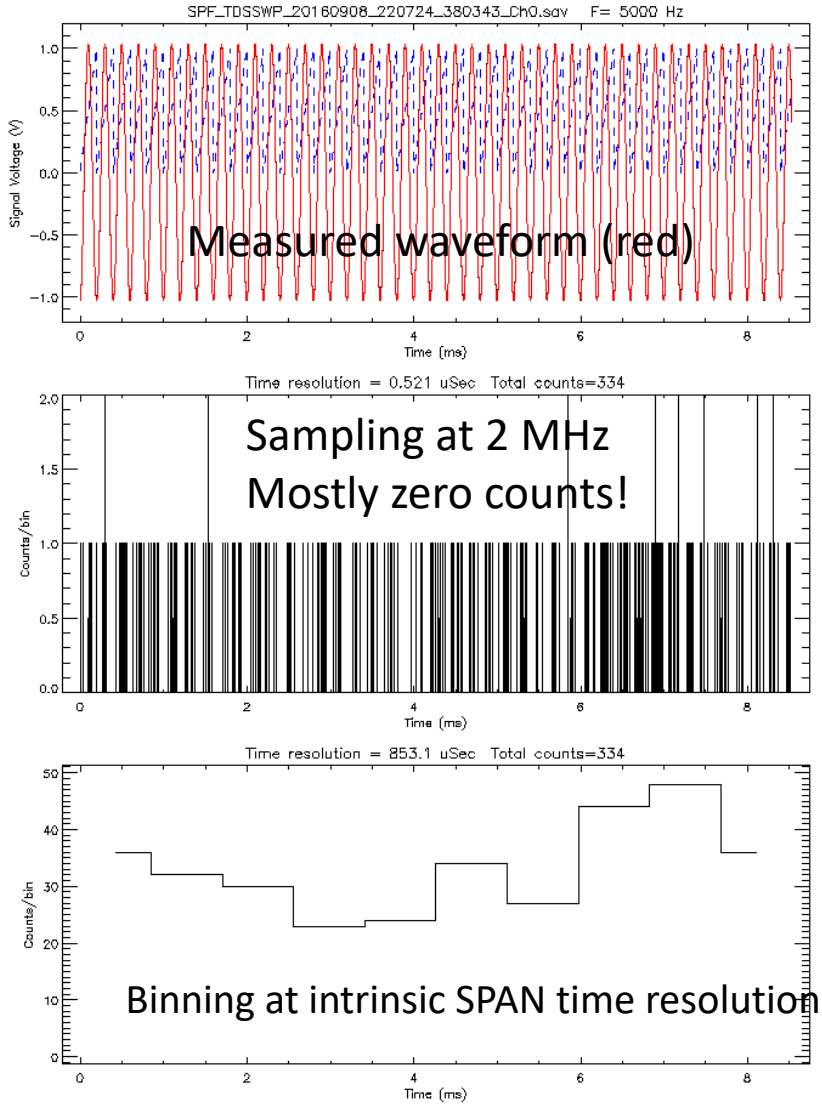




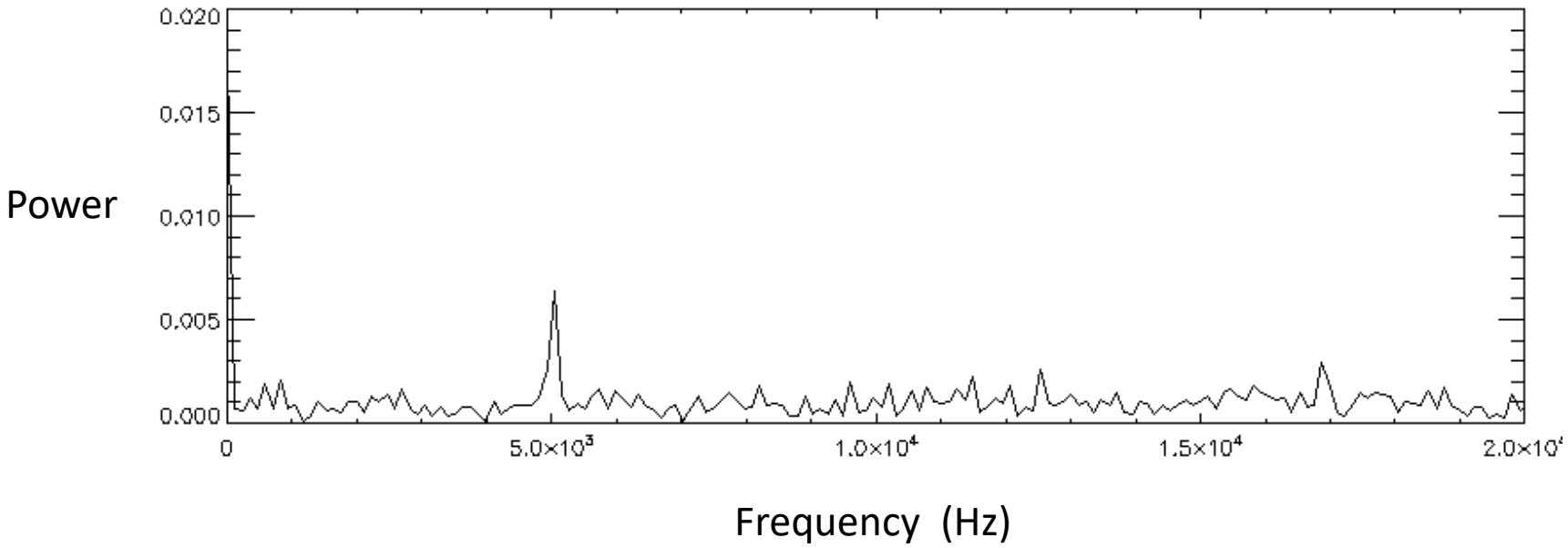


Wave/Particle correlations

- Modulating ion flux with 5000 Hz signal.
- Ions detected by SPAN-A-Ions
- Particle pulses directed to SWEM and FIELDS-2
- V_s waveform also delivered to TDS instrument on FIELDS preamp input



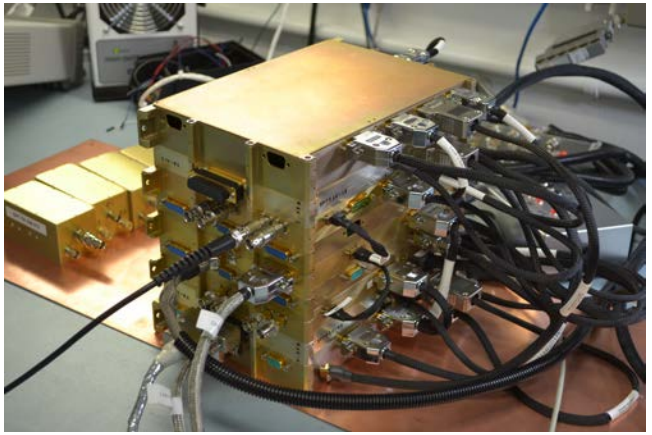
FFT of ion counts



- Proper technique would be to use cross wavelet correlation techniques. But… easier to bin by phase again.

Summary

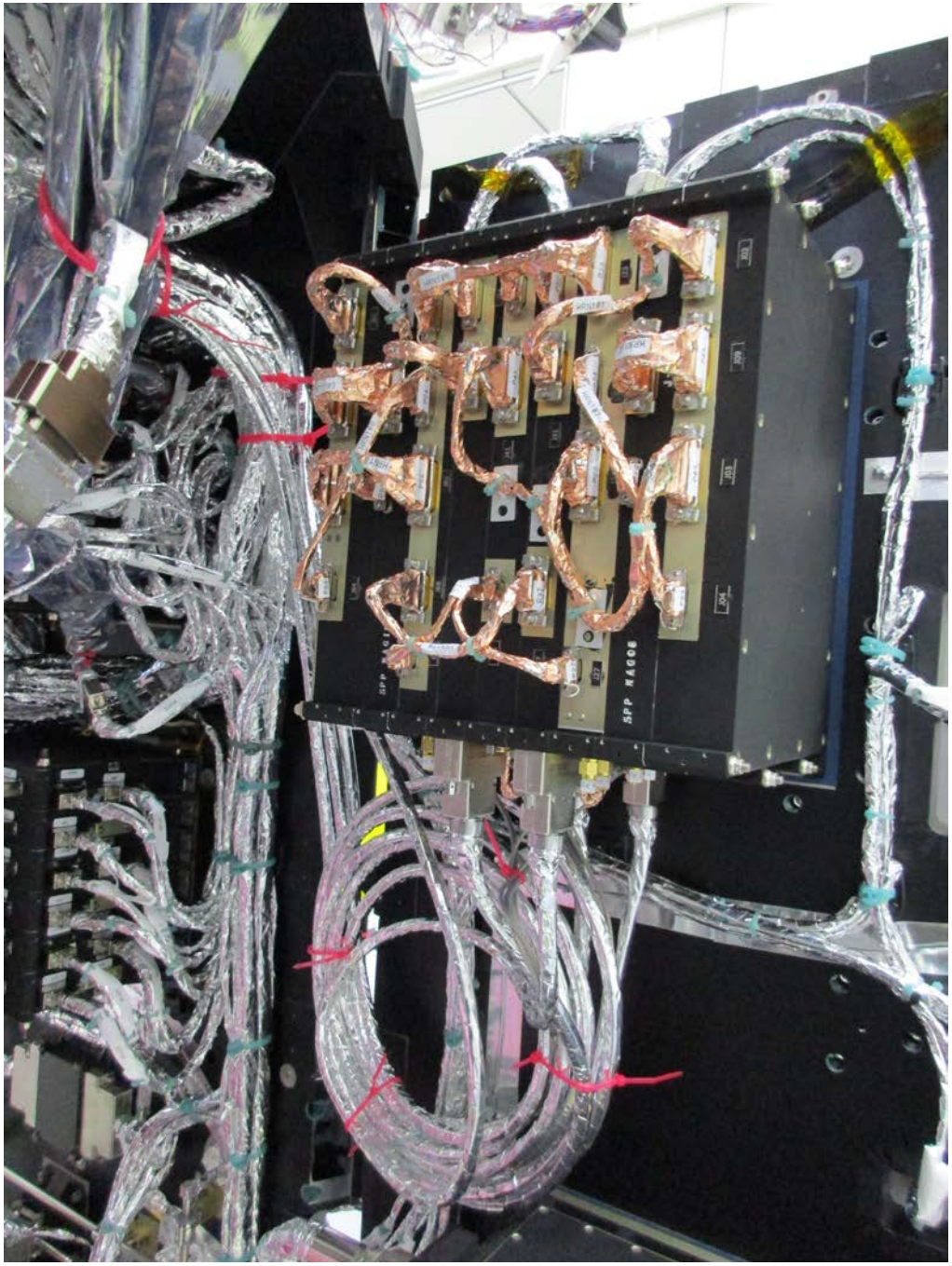
- FIELDS is on the spacecraft
- Spacecraft seems to be acceptable for EMC
- C103 issues
- Launch July 31, 2018
- 1st perihelion (36 Rs) on Nov 1, 2018!



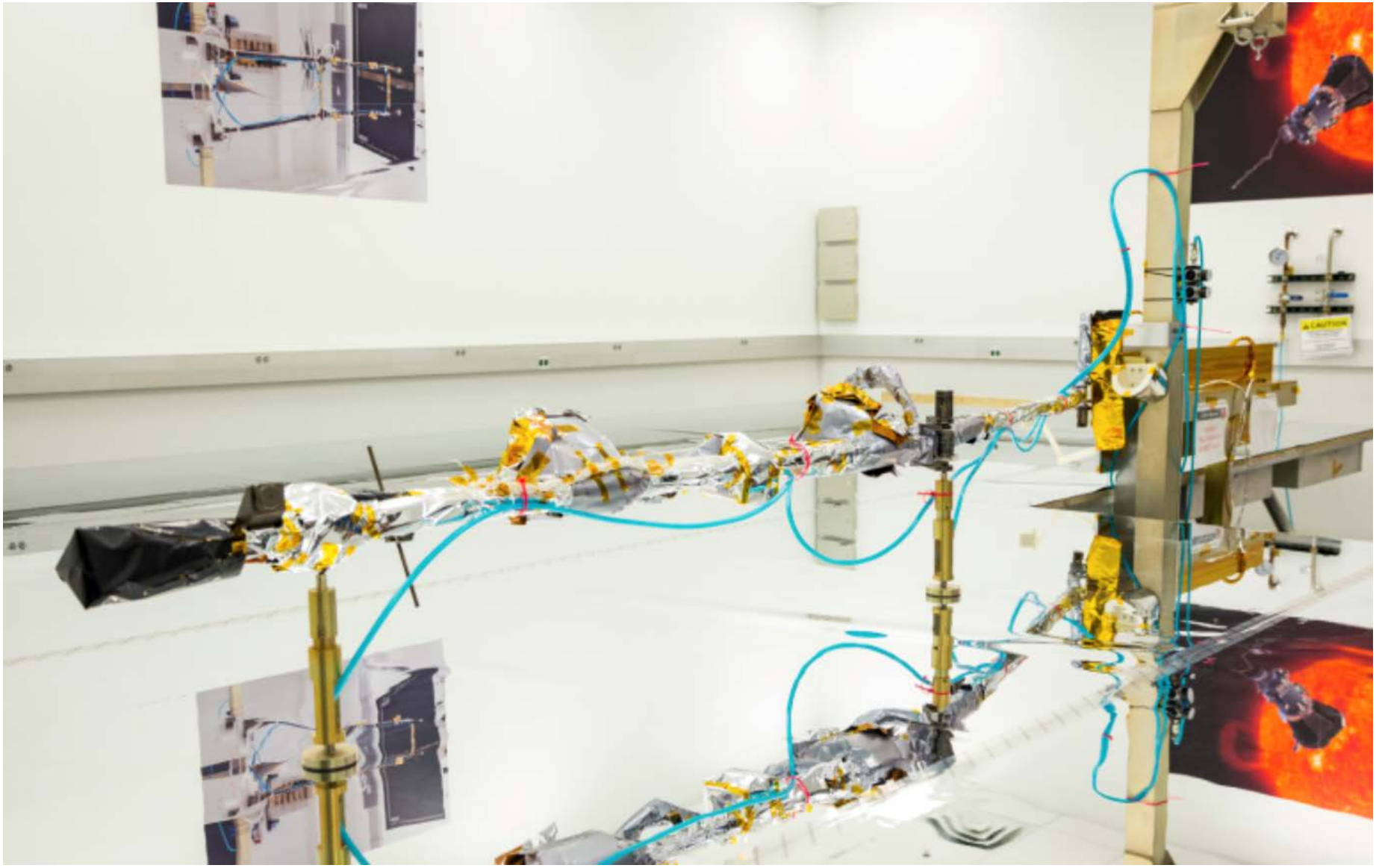
Spacecraft build-up – Mu-metal boxes with boom sensors on bottom left



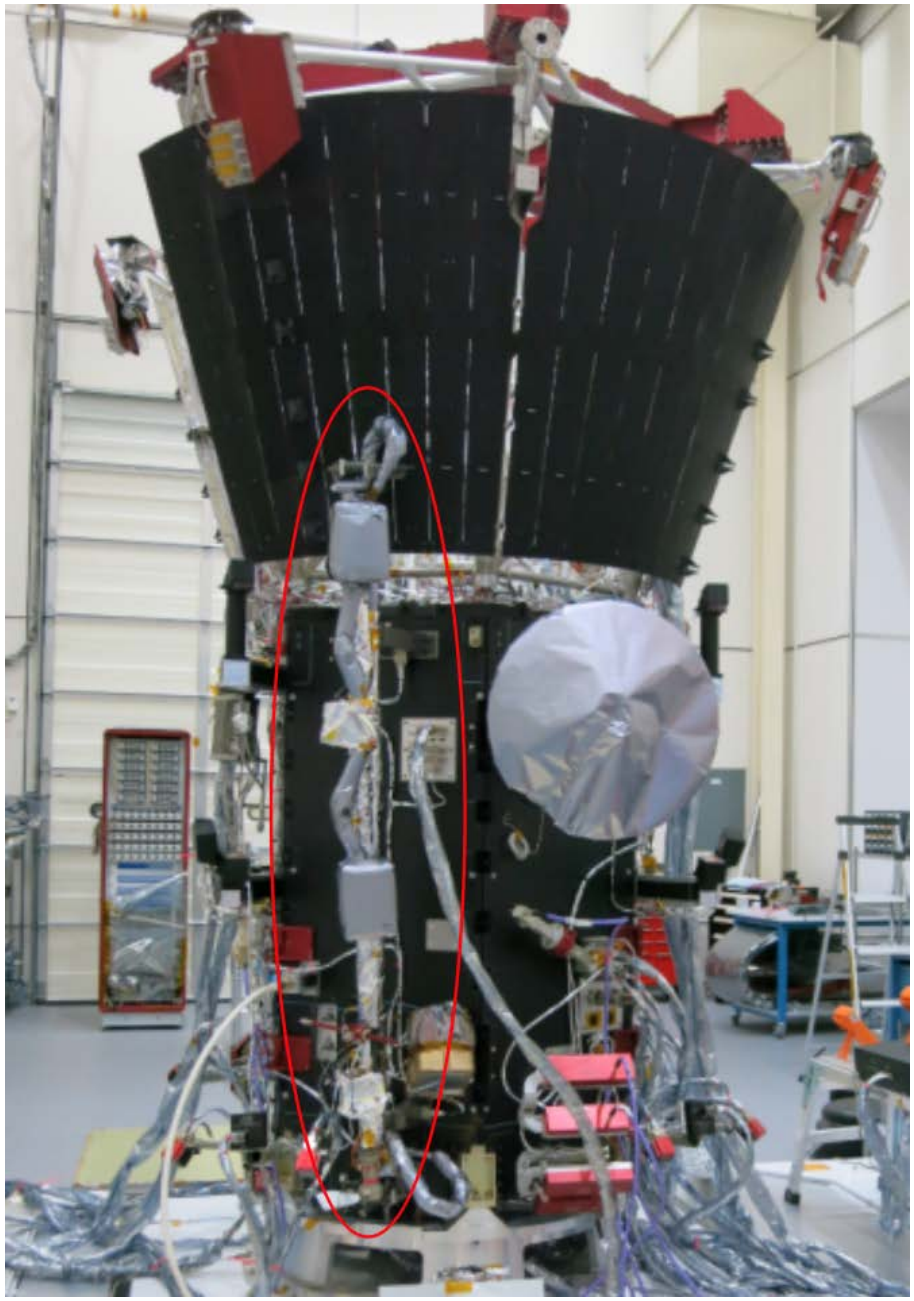
FIELDS MEP



MAG boom deployed on air-table



MAG Boom on S/C
V2 and V3 on the top corners



MAG Swing Test



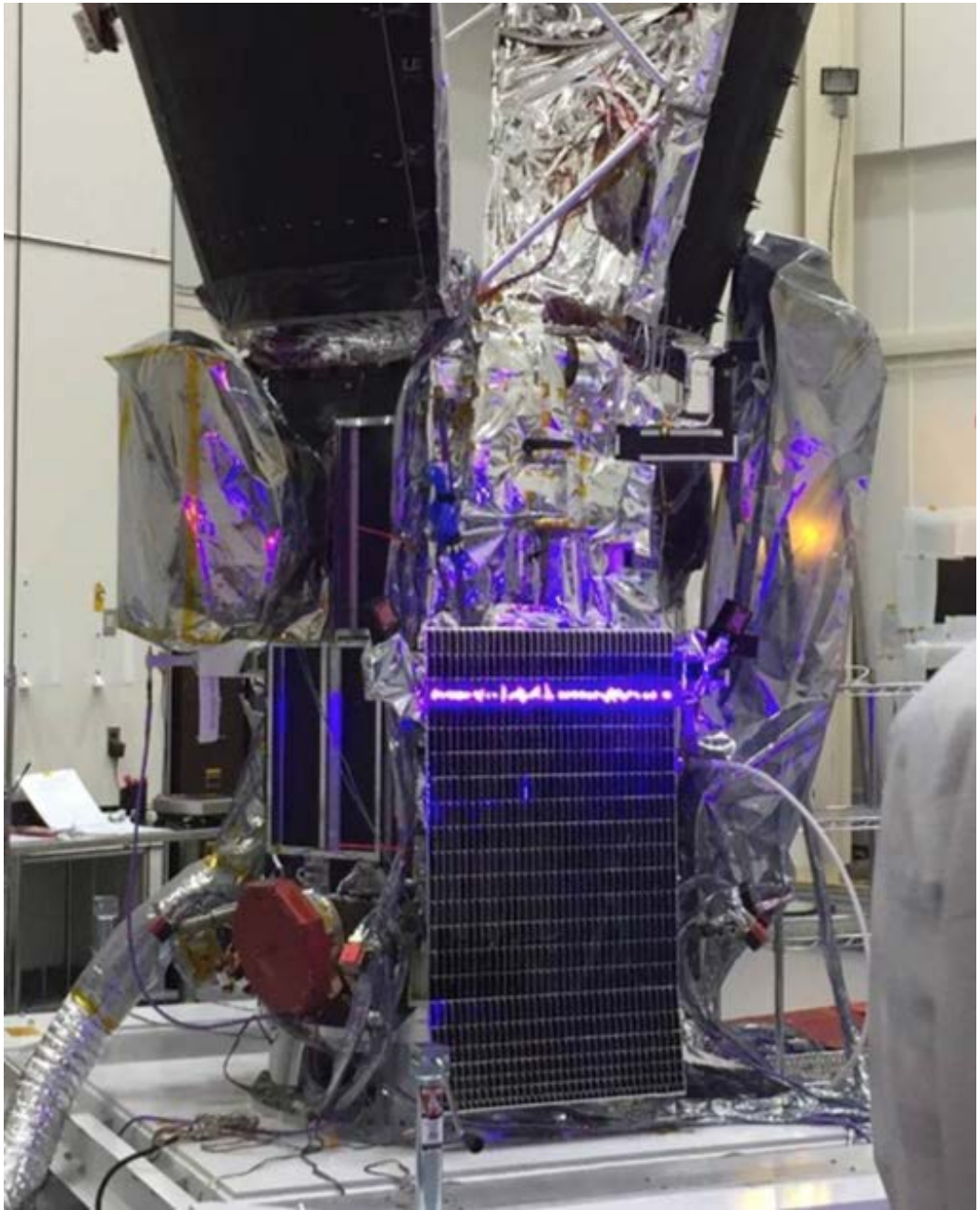
EMC – Vertical – Note Deployed 50cm Antennas Simulators



EMC – Horizontal



Solar Arrays - Illuminated



With the REAL TPS



Getting Ready for Vibe



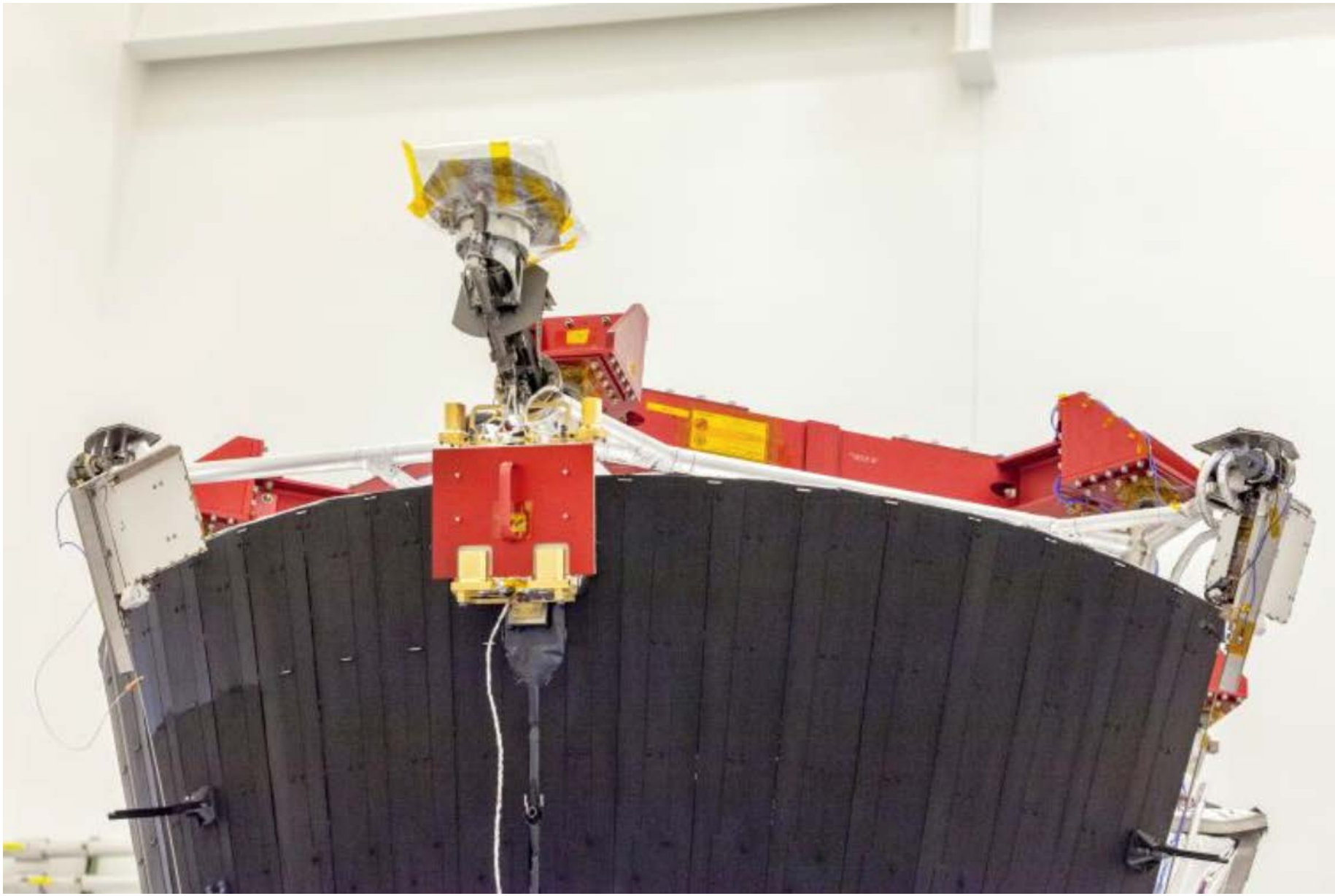
More Vibe



MAG Boom – Almost Ready for S/C Vibe



V2 and V3 (and SWEAP's SPC)



A Booster



At the Cape

