

NASA's Van Allen Probes RBSP-ECT and NSF's FIREBIRD Data Products and Access to Them: An Insider's Outlook on the Inner and Outer Belts

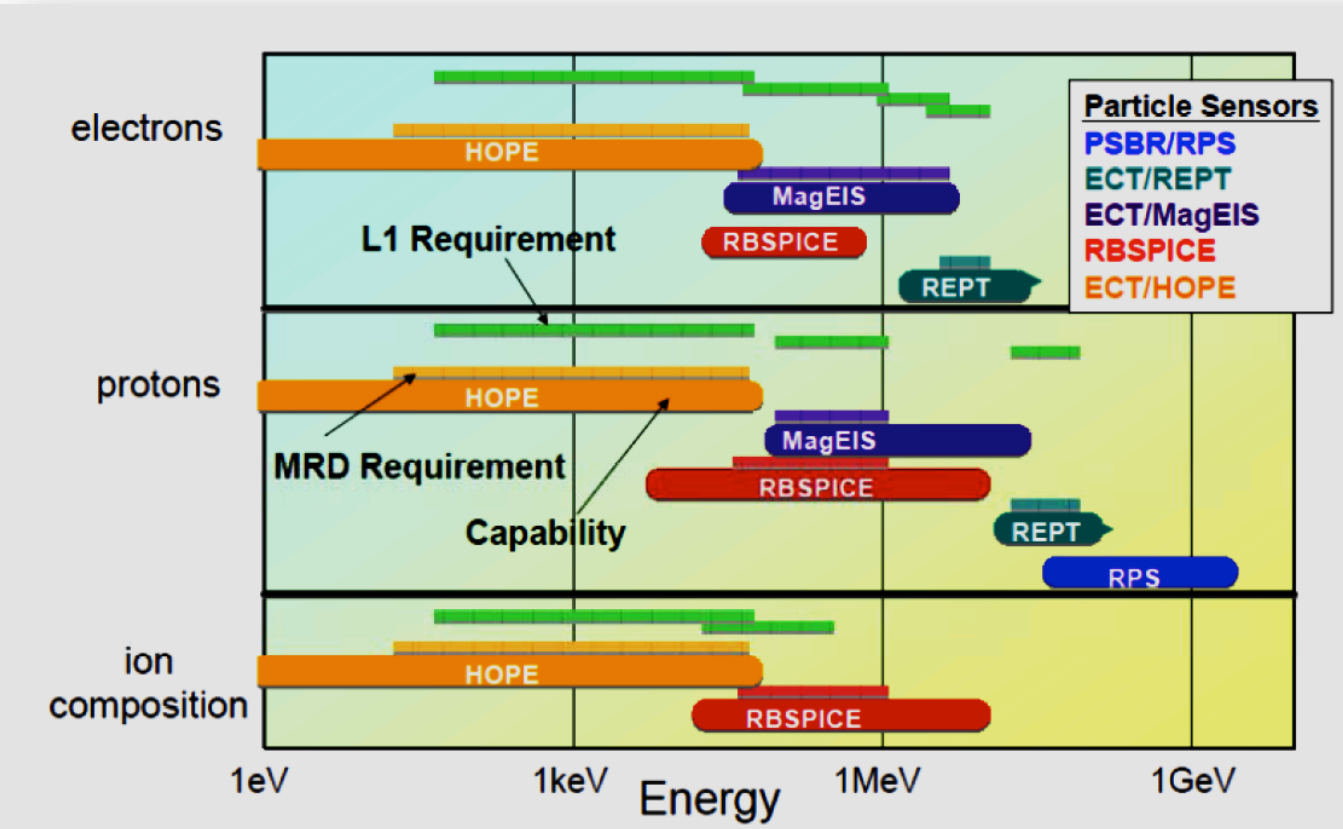
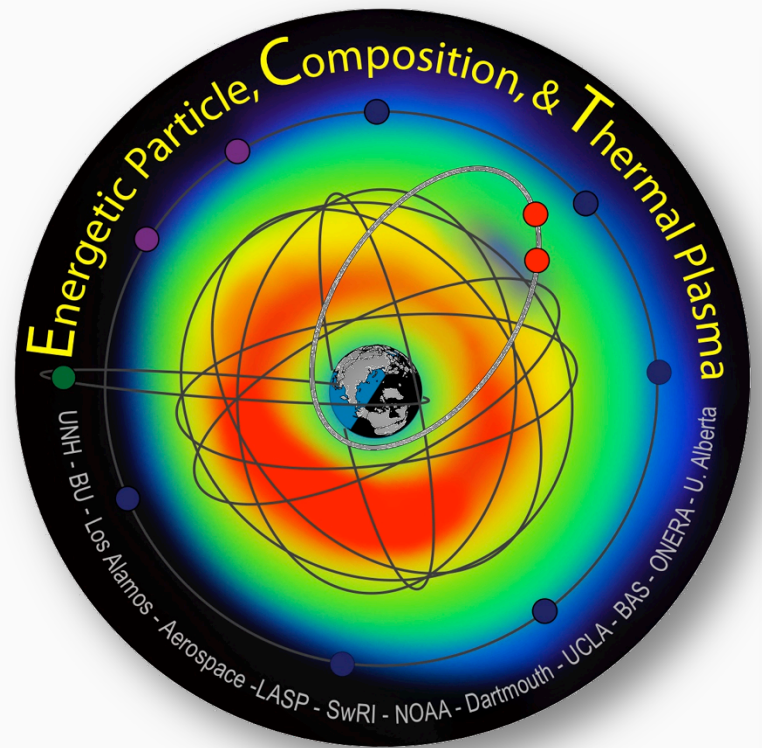
Sonya Smith¹, Harlan Spence¹, Geoff Reeves², Dave Klumpar³ on behalf of the entire RBSP-ECT and FIREBIRD II Team

¹UNH/Space Science Center, ²New Mexico Consortium Science Operations Center, ³Montana State University



RBSP-ECT Instrument Suite Overview

Radiation Belt Storm Probes Energetic Particle, Composition, and Thermal Plasma Suite (RBSP-ECT) on NASA's Van Allen Probes mission



Spence et al., 2013

Making Definitive Particle Measurements in a Harsh Radiation Environment

RBSP-ECT Science Operation Center

All RBSP-ECT Data, Documentation, and Science Activity Available Through Single Suite SOC



What's New On the RBSP-ECT Science & Data Portal? 2017 August-September Data Loss on MagEIS LOW Spacecraft...

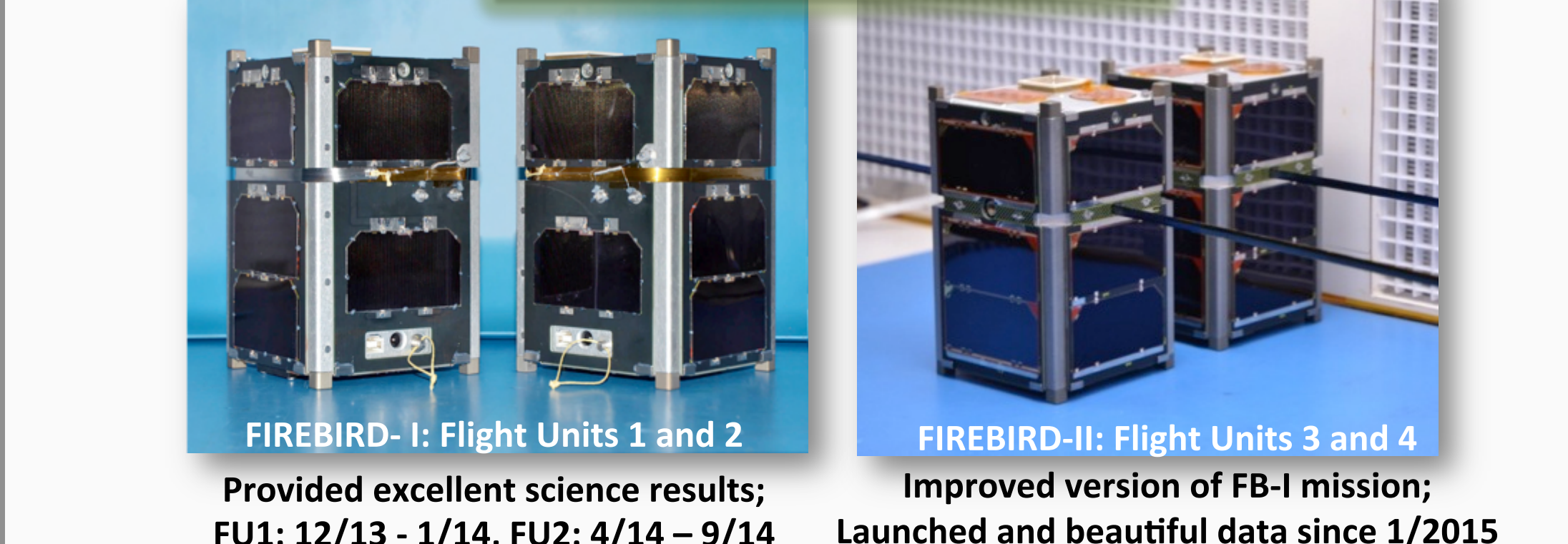
- RBSP-ECT SOC at NMC provides access to:
- Public data including summary plots, digital data directories, as well as data descriptions
- Autoplot for ECT
- Publications and Rules of the Road

https://rbsp-ect.newmexicoconsortium.org/rbsp_ect.php

FIREBIRD-I, -II Mission Summary

Focused Investigations of Relativistic Electron Bursts: Intensity, Range, and Dynamics

NSF CubeSat missions PIs: Harlan Spence (UNH), David Klumpar (MSU)

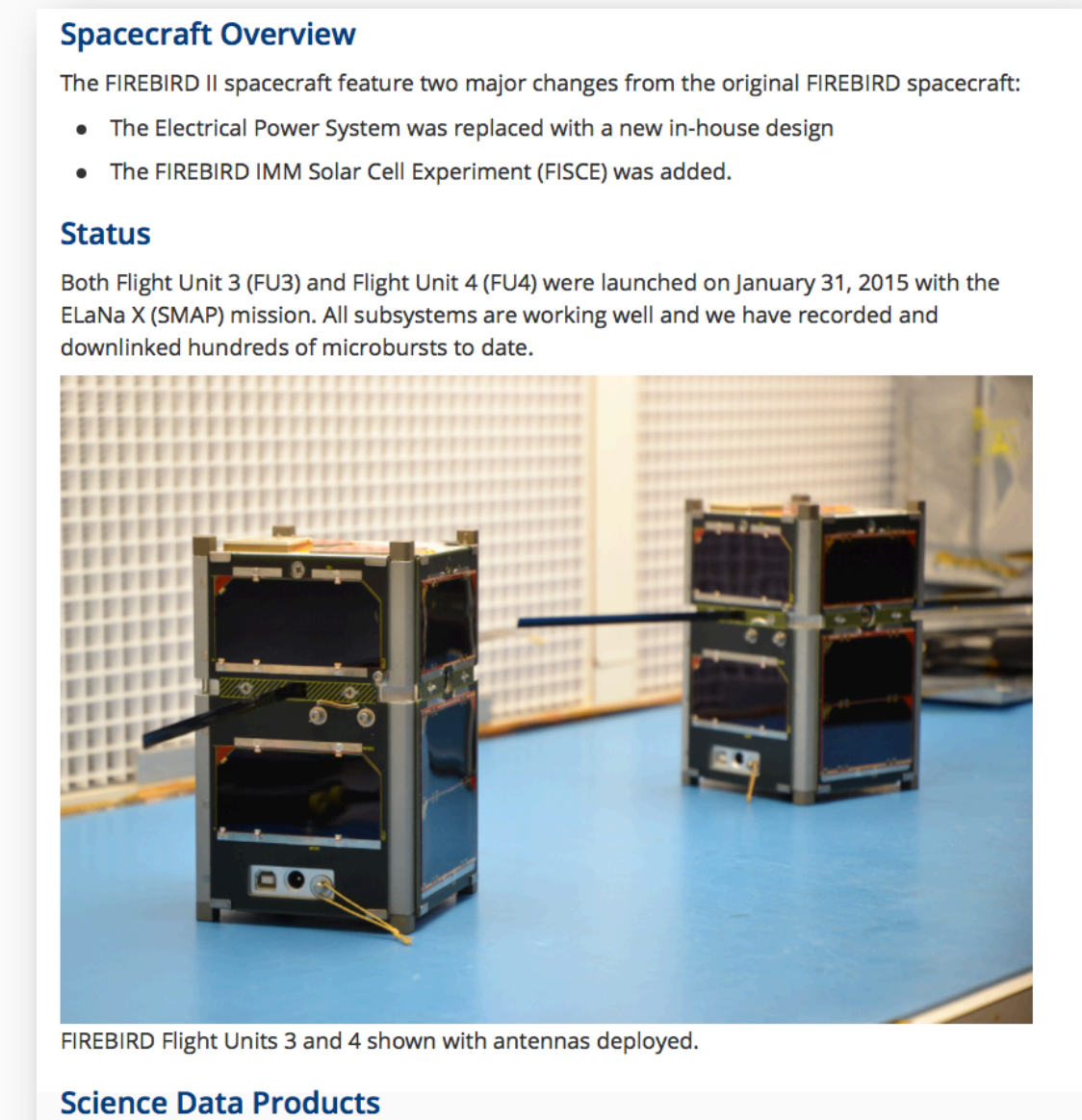


University of New Hampshire, SSEL, MONTANA STATE UNIVERSITY, AEROSPACE, Los Alamos NATIONAL LABORATORY

FIREBIRD-I and -II Data Access

All FIREBIRD Data Available Through Science Operations Center at MSU

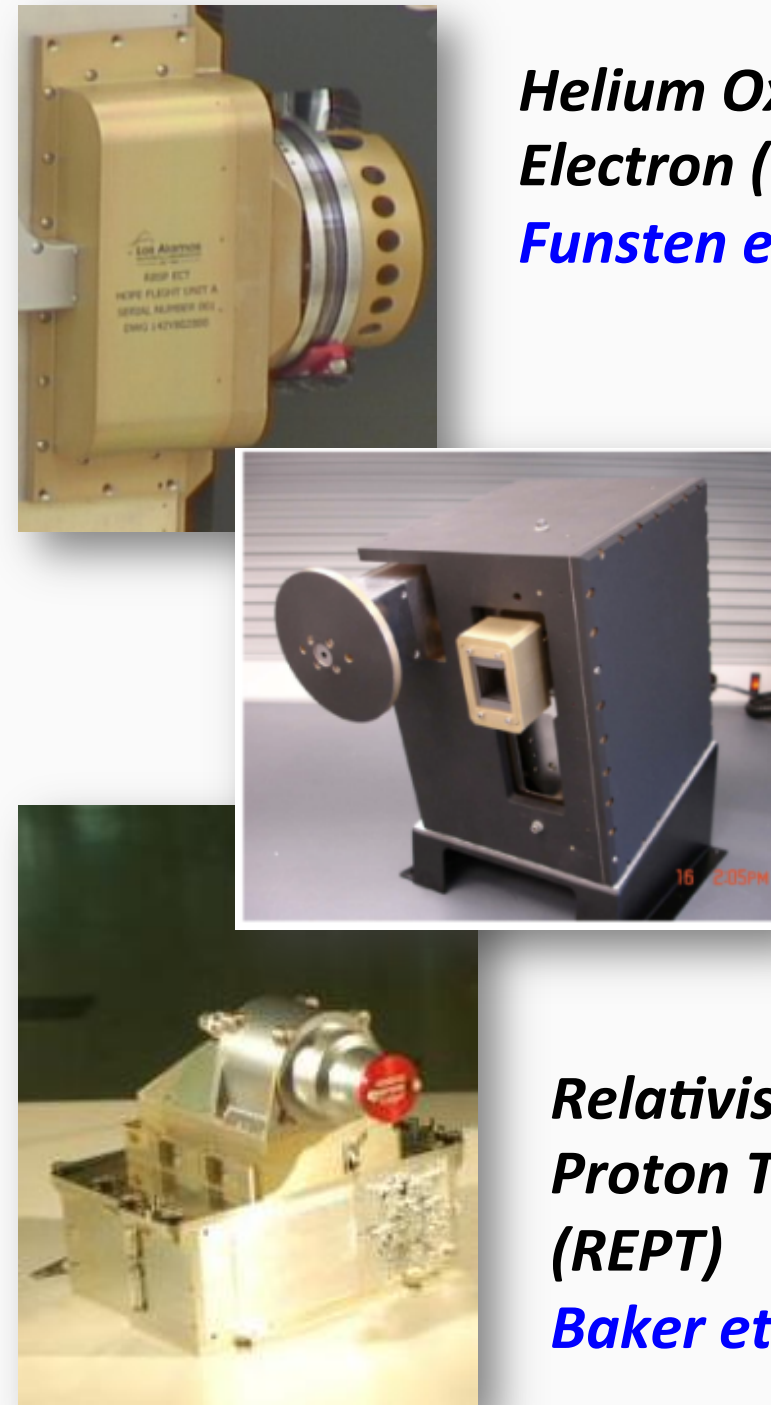
- FIREBIRD site at MSU provides access to:
- All FIREBIRD-I and -II data (context and hi-res) as well as ephemeris files
- FIREBIRD Rules of the Road for data usage and co-authorship
- Please contact the FIREBIRD team if you plan to use the data!



https://ssel.montana.edu/firebird2.html

RBSP-ECT Instrument Overview

ECT In-flight Instrument Performance Meets or Exceeds all Requirements



- All 12 ECT instrument packages performing beautifully: 1 HOPE, 4 MagEIS (1 "Lo", 2 "Meds", 1 "Hi", 1 REPT per s/c)
- Inflight performance meets or exceeds L1 measurement requirements
- Background rejection techniques successful on all instruments
- Continuous Cross-cal improvements

RBSP-ECT Data Access Overview

The RBSP-ECT SOC Provides Links to Level 2 and Level 3 RBSP-ECT Data and Ancillary Data

- Public access to Level 2 and 3 data from each ECT instrument on both spacecraft
- SOC provides extensive ephemeris information for both spacecraft
- Access to ancillary data (such as Qin-Denton parameter files)
- Please refer to "Data Quality and Caveats" section before using data!

Direct Links to Level 2 Data Directories Spin-Averaged & Directional Fluxes

RBSP-A	RBSP-B
HOPE-A Data	HOPE-B Data
MagEIS-A Data	MagEIS-B Data
REPT-A Data	REPT-B Data

Direct Links to Level 3 Data Directories With Pitch Angle Distributions

RBSP-A	RBSP-B
HOPE-A Data	HOPE-B Data
MagEIS-A Data	MagEIS-B Data
REPT-A Data	REPT-B Data

Other ECT Data Services

- RBSP-A Magnetic Ephemeris
- RBSP-B Magnetic Ephemeris
- Qin-Denton Parameter

Data Quality and Caveats We recommend and request that you contact the ECT team early in your studies so that we can help assess if there are any data issues that might affect the results of your analysis...

FIREBIRD Mission and Data Products

FIREBIRD-II continues to exceed all wildest expectations: 3 month mission now in year 3!

- 650 x 430km orbit, 99° inclination
- CubeSats aligned near B-field direction with two large FOV energetic particle detectors to measure precipitating electrons in 6 channels from 200 keV to >1 MeV

From Crew et al., 2016

2nd (Final!) Extended Mission Phase

Van Allen Probes Science Plan Articulated in 2017 Senior Review Traceability Matrix

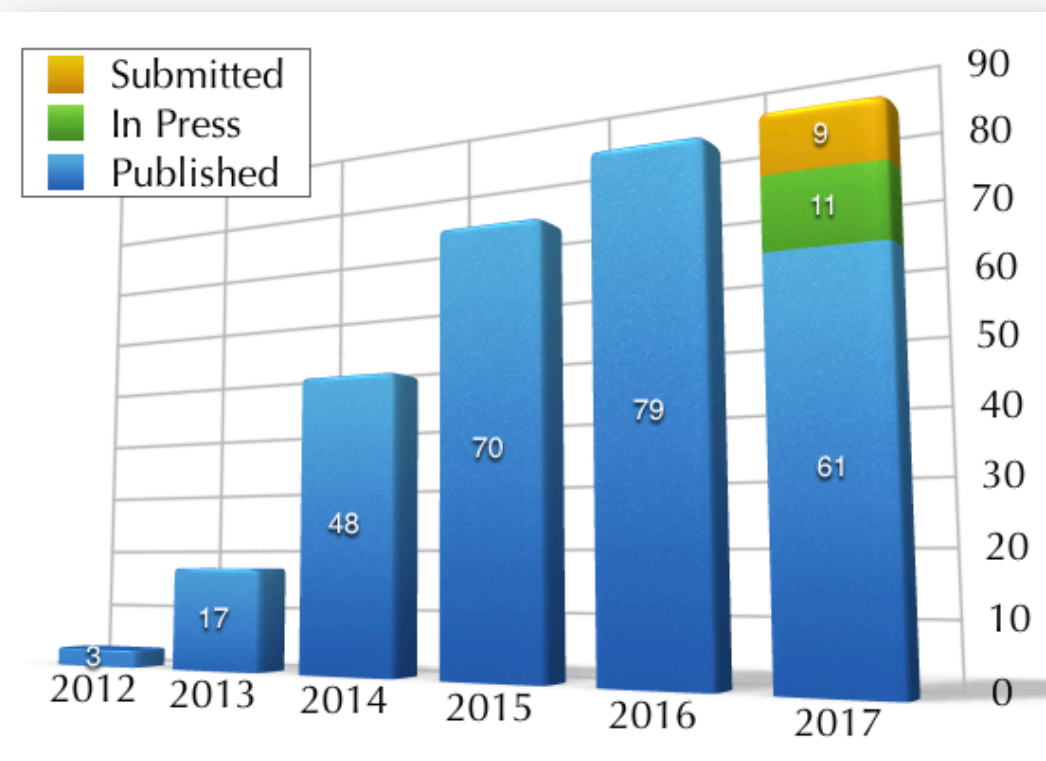
- RBSP-ECT contributes strongly to 2nd Extended Science Mission Phase goals with the overarching objective of "Understanding Energetic Particle Processes at Earth as the Solar Cycle Transitions into the Declining Phase"

Extended Mission 2 (2017-2019)	
New Elements	Contributions
New Orbit: increased MLT separation	Increased number of conjunctions for injection analysis (PSG3, SQ3.1), ULF wave analysis (PSG1, SQ1.2)
Arase (ERG) 2017-	Complementary MLT measurement (PSG1-3), 3-point field-aligned sampling (PSG1, SQ1.1)
DSX 2018-	Complementary wave and particle measurements in the slot region (PSG1, PSG2)
Coordination with HAARP 2017-2019	Triggered VLF waves and wave-particle interaction analysis (PSG2, SQ2.2)
GOES-R 2017-	Continuous monitors of ring current and rad-belt intensities in the outer zone (PSG1-3)
GPS & LANL GEO	Global array of precipitation measurements at LEO (PSG2, SQ2.2)
LEO Dosimeter Program (LDP) 2017-	Nonlinear wave-particle interactions (PSG1, SQ1.1; PSG2, SQ2.2)
Lab experiments NRL, UCLA	magnetosphere-ionosphere coupling
ICON 2017-	

RBSP-ECT Publication Summary

A Hearty Thank You to All Who Contributed to a Growing List of High Impact Publications

As of 1 December 2017, a total of ~300 (*) papers including ECT data as a significant element, many in high impact journals:



https://rbsp-ect.newmexicoconsortium.org/publications/Publications_Journals.php

- Submitted and in review: 9
- In press: 11
- Published in 2017: 61
- Published in 2016: 79
- Published in 2015: 70
- Published in 2014: 48
- Published in 2013: 17
- Published in 2012: 3

(*) Please help us accurately credit your contributions by letting us know about your papers at the RBSP-ECT website noted above

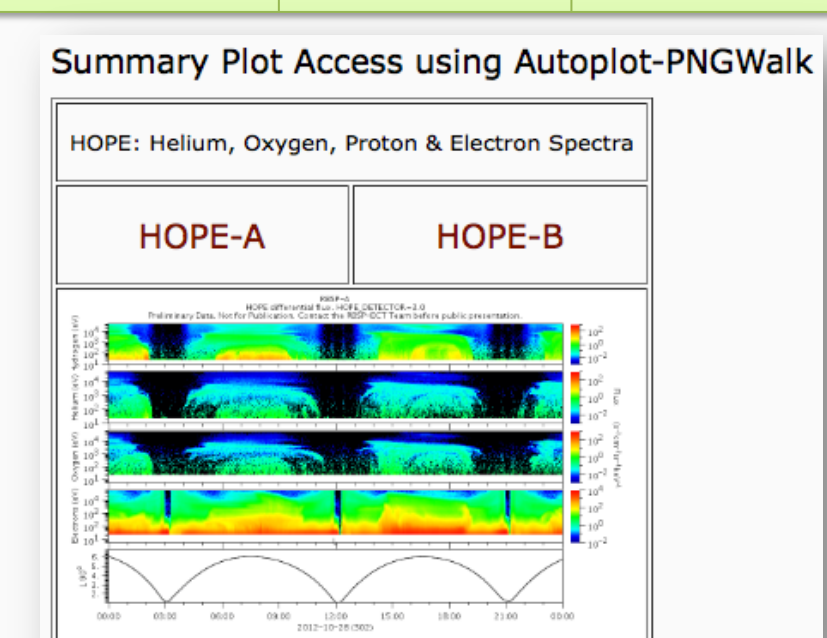
RBSP-ECT Data Overview

RBSP-ECT Data Available on SOC Site Once Data Verification and Validation is Complete

Level 2 and Level 3 data Availability as of December 2017

	HOPE-A	HOPE-B	MagEIS-A	MagEIS-B	REPT-A	REPT-B
Level 2	2017-12-04	2017-12-04	2017-12-03	2017-12-03	2017-12-04	2017-12-04
Level 3	2017-11-29	2017-11-29	2017-11-29	2017-11-29	2017-11-29	2017-11-29

- Summary plots of Level 2 and Level 3 also available through Autoplot interface
- Access to Autoplot provided for easy access



FIREBIRD-II Campaign Summary

Campaign #13 presently underway

- FB-II operating as a pair from immediately after turn-on (10-km separation) to present. They are currently about 3,800 km apart.
- Campaign duration set by quality and quantity of science data stored onboard satellites
- Science data storage capacity allows northern hemisphere operation for ~4 weeks
- Between campaigns selected high-value science data is downloaded to ground
- Data is uploaded daily at https://ssel.montana.edu/ Navigate to Missions: FIREBIRD and FIREBIRD-II

Campaign #	Dates	Primary Science Goal
1	2015/2/1 -> 2015/2/21	Spatial Scale of Individual Microbursts
2	2015/3/21 -> 2015/4/19	St. Patrick's Day Storm
3	2015/5/16 -> 2015/6/15	Van Allen Probes Conjunctions
4	2015/7/3 -> 2015/8/4	July 4th Storm
5	2015/8/8 -> 2015/9/4	BARREL Campaign Conjunctions
6	2015/11/15 -> 2015/12/15	Conjunctions, Lightning induced precipitation
7	2016/1/15 -> 2016/2/3	12.5ms time resolution, EFW and GRIPS conjunctions
8	FU3: 2016/5/20 -> 2016/6/14 FU4: 2016/6/9 -> 2016/6/20	50ms time resolution, context and CQSI conjunctions
9	2016/8/12 -> 2016/9/7	50 ms time resolution, BARREL conjunction.
10	2016/12/21 -> 2017/1/4	12 ms cadence for improved dispersion, caught geomagnetic storm, looking in the bounce loss cone.
11	2017/5/1 -> 2017/5/21	Conjunction event on May 2nd
12	2017/7/1 -> 2017/7/21	RBSP and ARASE conjunctions, July 16th shock

Opportunities to Collaborate

Please Join Us in the Continuing Excitement of Radiation Belt Discoveries!

- Increased Van Allen Probes T/M capability during Prime and Extended Mission Phases has already and will allow us to produce better and new science into 2nd Extended Phase
- Continued FIREBIRD-II mission is focusing on joint operations with other missions (Van Allen Probes, Arase, etc.) and can tailor operations during future campaigns to optimize science goals
- We encourage you to participate in accomplishing radiation belt science during the coming few years by using our high quality mission data but ask that you abide by our "Rules of the Road" (links for both missions provided above) so that we may:
- Maintain the high quality of publications by ensuring consultation with members of the teams who are familiar with the operation of the instruments, subtleties in the instrument response, and any potential pitfalls;
- Acknowledge work put into design and development of mission instruments to produce the capable and calibrated instruments now available for science;
- Coordinate the efforts across the team to avoid duplication of effort and maximize science return.