Van Allen Probes SWG Telecon
29 May 2015

• Project news
• Van Allen Probes - MMS coordination during the upcoming lapping event on June 12 (Roy Torbert)
• June 10 high-speed solar wind MMS ‘campaign’ (Dan Baker)
• Van Allen Probes special poster session & data workshop at GEM Summer Workshop poster submission deadline June 1
• Publication update
• In-person SWG meeting (July 29-31) and Instrument team meetings (July 29) at APL
• Weekly and Monthly Status Reports
• N-S pointing angle
SWG Telecon (Van Allen Probes)
Host: Aleksandr Ukhorskiy

When it's time, start your meeting from here:
https://apl-webex.jhuapl.edu/orion/joinmeeting.do?
ED=rxL3LTnpeocjnuOmjfOehA==&PW=BgAAAGigzjo0IoPk_ypMerrzqxS_iw9bKi-
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When: Friday, May 29, 2015, 3:00 pm (2 hrs), Eastern Daylight Time (New York, GMT-04:00).

Access Information
Meeting Number:
997 140 028

Password:
RBSP

Host Key:
296096 (Use this key during the meeting if you ever need to reclaim the host role.)

Audio Connection
8-1000 (Internal)
(240)228-1000 (Washington, DC)
(443)778-1000 (Baltimore, MD)
(844)275-9323 (Toll Free)

Access Code:
997 140 028

The apl-webex.jhuapl.edu team

Need help?

2) The window for adjusting the apogee of either Probe B or Probe A to achieve the proposed separation of the lines of apsides is **June 1 - July 30**. The maneuver is going to cost ~6 months of the lifetime of one of the spacecraft

**Nominal Expected EOL:**
SCA June, 2019 ± 4 months
SCB November, 2018 ± 4 months

The decision must be made soon!
Upcoming Lapping Event on June 12

$\Delta \rho_{SM} = 27.9 \text{ km}; \Delta z_{SM} = 460 \text{ km}; z_{SM} \approx 4000 \text{ km}$
RBSP-MMS on June 12
Poster Session & Data Workshop at GEM  
deadline June 1

Submit all your posters at http://www.cpe.vt.edu/gem/poster.html for Thursday (June 18)  
Contributions so far:

**BARREL**
"Science Highlights from the BARREL Antarctic Balloon Campaigns" R. Millan

**ECT**

*possible contribution*: “Ultra-Relativistic Inner Belt: Reality of Myth?” ECT Team

**EFW**

"Recent Science Results from the Van Allen Probe Electric Field and Waves Instrument” J. Wygant  
“Electric fields and Poynting Flux in the PSBL during Major storms: Relation to Injection Events, Auroral Arcs,  
and Ion Outflow” J. Wygant

**EMFISIS**

“The Van Allen Probes EMFISIS Investigation: Overview, Recent Findings, and Data Access” D. Hartley and S. De Pascuale

**RBSPICE**

“Van Allen Probes Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE) recent results and data access information” J. Manweiler  
“RBSPICE observations of the March 2015 solar storm” J. Manweiler  
“RBSPICE observation of possible interplanetary oxygen during the May 2013 solar storm” D. Patterson

**Project Science Team**

“Van Allen Probes: Understanding Energetic Particle Processes at Earth in the Evolving Solar Cycle” A. Ukhorskiy  
"Nowcasting of the radiation belts and empirical magnetic field modeling for the Van Allen Probes mission" G. Stephens
Publication Update (April 2015)
see attached document

Citation Report: 187
(from All Databases)
You searched for: TOPIC: (Van Allen Probes) OR TOPIC: (RBSP mission) OR TOPIC: (Radiation Belt Storm Probes) OR TOPIC: (Radiation Belt Storm Probe) OR TOPIC: (RBSP spacecraft) OR TOPIC: (Relativistic Electron Storage Ring Embedded) OR TITLE: (Rapid local acceleration of relativistic radiation) OR TITLE: (Unusual stable trapping of ultrarelativistic electrons) OR TITLE: (Discovery of the action of a geophysical synchotron) OR TITLE: (Direct Observation of Radiation-Belt Electron Acceleration) OR TITLE: (AE9, APS, and SPM) OR TITLE: (On the storm-time evolution of relativistic electron phase space) OR TITLE: (impenetrable barrier to ultrarelativistic electrons) OR TOPIC: (EMFISIS) OR TOPIC: (RBSPICE) OR TOPIC: (ETC/REPT) OR TITLE: (EFW) OR TOPIC: (MagEIS)

This report reflects citations to source items indexed within All Databases.

Published Items in Each Year

Citations in Each Year

Results found: 187
Sum of the Times Cited [?] : 1017
Sum of Times Cited without self-citations [?] : 489
Citing Articles [?] : 419
Citing Articles without self-citations [?] : 309
Average Citations per Item [?] : 5.44
h-index [?] : 17
July 28, 2015
Team meetings: EFW, EMFISIS, RBSPICE
July 29-30, 31 (half day)
SWG Meeting

Doodle poll registration is open (http://doodle.com/dyauhm4yfi7bmamv):
Register by specifying your Name and Organization **no later than July 21**
*Foreign nationals*: email your citizenship information and the date of birth to ukhorskiy@jhuapl.edu **no later than July 17**
**RE-003 Weekly Instrument Status Report** (due date to APL: Tuesdays at close of business EST)

Weekly SOC reports form the basis for MOC reports to GSFC and NASA Headquarters. These reports will be reduced to operational issues only and the availability of Level 0 data. Level 1-3 science data product availability will be moved into the Monthly reports.
Weekly and Monthly Status Reports
effective June 5, 2015

RE-002 Monthly Status Report (due date to APL: 5th of each month)

Monthly Status Reports are for the Project Science team only; they are not reported to NASA Headquarters. According to the SOW Monthly Status Report, each report “summarizes instrument operation, instrument data collection, scientific meetings supported, papers submitted for publication, anomalies, and identified risks”. To optimize the communication among the Project and the Instrument teams, the Monthly reports will use the following common structure.

Monthly Report will cover four areas:

1. Recent papers and presentations by the team
2. Instrument performance
   • Did all instruments operate successfully during the month? If not please describe any anomalies and the extent to which data were lost.
   • How is instrument performance trending? Are there changes in sensitivity or energy/frequency response? Is instrument noise increasing? For identified changes/trends, is there a remediation? Are new calibration coefficients being provided? Will instrument operation be adjusted?
   • What is the status of inter-calibration with other sensors, both within the team and externally? Where are there disagreements between sensors? What is being done to resolve any discrepancies, and who is the point of contact for more information?
3. SOC science data product availability
   • Describe the availability of each Level 1-3 science data product. Ideally, a statement that “Data product X is current through mm/dd/yy”.
   • For each data product that lags the required availability, please identify the cause and what is being done to address the issue. Estimate when the lag will be eliminated.
   • Specify whether ongoing data processing uses calibration information that is up to date with respect to instrument performance tends.
   • Specify any calibration changes or any re-processing of data products.
   • Specify changes to file formats.
   • Please provide a timeline for the generation of planned data products
4. Planned coordination operations
   • Describe any plans for coordinated operations with other instruments or missions

Monthly Operation Status Telecon
A monthly telecon (including representatives from the Project and all Instrument teams) will be introduced to discuss these reports.
The Analysis of the N-S Sun Offset Angle Reduction Engineering Impact

May 12, 2015
Madeline Kirk
G&C Lead Engineer
Background

• Semi-Annual N-S maneuver has been eliminated to save fuel
• The purpose of the N-S maneuver was to better align the single look-direction particle instruments with the Earth’s Dipole during winter and summer (for better pitch-angle coverage).
• It was deemed more valuable to save fuel that continue this maneuver
• Motivated by possible SC operation reasons (e.g., saving fuel) an adjustment of the N-S angle from 19° to 10° is considered.
• A smaller N-S angle might be beneficial for the particle pitch-angle coverage.
• A negative consequence: 10° would shadow the aft EFW Z-boom by more than ½ the time
Proposal

- **Reduce the targeted north-south Sun offset from 19° N to 10° N**
- **Either maintain E-W angle at +/- 11.6° or widen to +/- 18°**
  - By starting at a lower N-S angle and increasing the E-W angle we increase the total time the spacecraft has to precess before it hits the 28 degree limit. The figure shows a rough sketch of the difference between the 19N,11.6E and 10N,18E over the precession period. The dotted line is an approximated path of the spacecraft spin axis.
  - The plot shows how the total sun offset angle changes over time for the various targets. The yellow, red, and black horizontal lines indicate our current alarms and go-safe rule. The black vertical lines indicate the next planned precession maneuver.
• Aft boom tip is 7 meters from center of spacecraft
• Boom tip will be in shadow at Sun offset angles <15.43 degrees

Updated 5/14/15
Sun Sensor Errors

- The Sun crossing knowledge requirement is that the error be less than 1 degree with a goal of less than 0.5 degrees [MIS-339]
- Sun sensor crossing (timing) error increases as the Sun offset angle decreases.
- Errors derived from Adcole bench test data assuming 5.5 RPM S/C spin rate

<table>
<thead>
<tr>
<th>Sun Offset Angle</th>
<th>Max Error based on Hardware Test* (RBSPA)</th>
<th>Max Error based on Hardware Test* (RBSPB)</th>
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<tbody>
<tr>
<td>30°</td>
<td>0.2369°</td>
<td>-0.1291°</td>
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<tr>
<td>19° (est)</td>
<td>0.3859°</td>
<td>-0.2241°</td>
</tr>
<tr>
<td>10°</td>
<td>0.5109°</td>
<td>-0.3041°</td>
</tr>
<tr>
<td>5°</td>
<td>0.6409°</td>
<td>-0.5901°</td>
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</table>

*No test data below 5°. Error is a combination of geometric, internal circuitry, sun sensor timing, and IEM timing errors. Data for 19 degrees is estimated from available test data.
Conclusions

• Preliminary analysis show that spacecraft health and safety can be maintained at a 10 degree N Sun offset angle
  – Lifetime benefits are negligible
  – May have increase in Sun sensor detection timing error, but still within requirements
  – Power, Thermal, Communications, and Autonomy changes are manageable

• Science Effects
  – Lower offset angle will improve alignment for MagEIS and REPT
  – EFW Aft boom will be in shadow to some degree
  – Relative phase angle difference will increase on RBSPB which may cause timing jumps in REPT data. G&C can update onboard parameters to mitigate issue as done in the past.

• Target Implementation Date
  – July 9th precession maneuver if decision is made by June 1st
  – July 30th precession maneuver if decision is made by June 26th
Decreasing the NS Angle:
Impact of Shadowing Aft Spin Axis Electric Field Sensor (and Other Effects)

Wygant and EFW Team
impacts of Decreasing the N-S angle of the Van Allen Probe Spacecraft Spin Axis

Double probe instruments and the RBASP instrument in particular is a current biased instrument that requires solar illumination of the sensors and nearby boom elements to operate successfully.

Current attitude adjusts of NS pointing were designed to accomodate this requirement.

The shadowing of the anti-sunward spin axis E-field boom as a consequence of the change in the N_S angle would severely degrade the wave measurements of the spin axis electric field. The anti-sunward sensor will saturate.

For a 10 degree NS angle, based on Tom's plots, this would happen almost 1/2 half of the time during the remainder of the mission. The remaining 1/2 of the time the shadowing would be worse than what we have now because the shadowing would perturb the potential of the boom in the immediatevicinty of the aft probe.

We would lose the three dimensional measurements at least half the time and quite probably much more.

The impact will be on wave electric fields starting above 100 Hz. The waves impacted includes kinetic Alfven waves, large amplitude non-linear waves, chorus, and plasmaspheric hiss.

The EFW team has used this capability on a significant fraction our publications (8 papers) and science results. Nonlinear structures and Parallel electric fields are a major target of our burst operations.

The NS change would often reduce pitch angle coverage during the main phase of major geomagnetic storms when spacecraft apogee is on the night side.
Proposal

• Reduce the targeted north-south Sun offset from 19° N to 10° N

• Either maintain E-W angle at +/- 11.6° or widen to +/- 18°
  – By starting at a lower N-S angle and increasing the E-W angle we increase the total time the spacecraft has to precess before it hits the 28 degree limit. The figure shows a rough sketch of the difference between the 19N,11.6E and 10N, 18E over the precession period. The dotted line is an approximated path of the spacecraft spin axis.
  – The plot shows how the total sun offset angle changes over time for the various targets. The yellow, red, and black horizontal lines indicate our current alarms and go-safe rule. At 10N,18E the total angle decreases further before increasing again.
Measurement of spin axis component of the electric field is an important capability of the Van Allen Probe Mission. It is most important for wave observations above ~ 100 Hz. It is necessary to get parallel electric fields.

References for Papers Related to Parallel Electric Fields on RBSP

The discovery paper:
Mozer F. et al. Megavolt Parallel Potentials Arising from Double Layer Streams in the Earth’s outer Radiation Belts PRL 2013 (Above article also highlighted in PRL Commentary Section)

Mozer et al., Direct Observation of Radiation Belt Acceleration from Electron – Volt Energies by Nonlinear Whistles, PRL 2014

Artemyev A V et al., Thermal electron acceleration by localized bursts of electric fields in the radiation belts, GRL 2014

Agapitov, Generation of nonlinear electric fields bursts in the outer radiation belts thorugh the parametric decay of whistler waves, GRL 2015

Mozer F., Time Domain Structures: what and where they are, what they do, and how they are made, Frontier Article in GRL, 2015

Malaspina D, Non-linear Electric Field Structures in the Inner Magnetosphere, GRL, 2014

Drake J. et al., The development of a bursty precipitation front with intense localized parallel electric fields driven by whistler waves. (This is a theory paper with simulated parallel electric fields based on RBSP data)

Boardsen S. and coworkers are now working on a paper investigating Fast magnetosonic modes with Van Allen Probe data that requires the parallel electric field component (see Boardsen et al., 2014 for earlier paper on magnetosonic waves).
RBSP Aft Axial Boom
Sensor and Pre-Amp Illumination

Note: Currently showing two Solar Array Substrate options

Presentation by Jeff Kelley and John Troll (APL)
This figure (Agapitov et al. 2015) shows the relation between large amplitude whistler pulses as seen in the magnetic field and parallel electric field structures (expanded view bottom two panels).

The parallel electric field structures may be related to mechanisms responsible for the growth and saturation of the waves.
Experimental evidence for the close relation between large amplitude non-linear parallel electric fields and whistler waves.

Figure 2. Dynamics of the (a) perpendicular $X$ component of the magnetic field and the (b) parallel $Z$ component of the electric field. (c) Spectra of the magnetic (black curve) and electric (red curve with the scale in the right) field perturbations during the time interval presented in Figures 2a and 2b. The Poynting flux direction is indicated in the bottom of Figure 2c with red being along the background magnetic field and blue in the opposite direction. The expression $0.5f_{ce}$ is indicated by the dotted line.
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<th>Req. Title</th>
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<td>Instrument Design life</td>
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Many RBSP papers focus on major geomagnetic storms. Here is an example of the June 1, 2013 storm magnetic field configuration (apogee near midnight) Notice the tail like configuration during the main phase over a significant portion of the orbit.

During some of the most interesting storms decreasing the NS angle will actually limit pitch angle coverage.

We have looked at plots like this during about 4 of the storm of 2013

This example is not unusual