PURPOSE(S) OF MEETING:

- Review EPI-Hi Autonomy design vs. team understanding, science requirements, and S/C interface design

PARTICIPANTS:

- In person:
  - Eric Christian, GSFC, EPI-Hi Co-PI
  - Andrew Davis, CalTech, EPI-Hi FSW
  - Kris Fretz, APL, S/C Deputy Payload SE
  - Adrian Hill, APL, S/C Autonomy Lead
  - Ronnie Killough, SwRI, ISIS S/W SE, Reviewer
  - Dave McComas, GSFC, Reviewer
  - Maarten Versteeg, SwRI, Reviewer
- Via WebEx:
  - Nigel Angold, Angold Consulting, ISIS Deputy SE
  - John Hanley, SwRI, EPI-Hi FSW
  - Al Reiter, APL, S/C Payload SE
  - Scott Weidner, SwRI, ISIS PM

LIST OF MATERIALS DISTRIBUTED

- 1_EpiHi_AutonomyRvw_Agenda_WebEx_Objectives.pptx
- 2_EPI-Hi-Sensor_OverviewV03.pptx
- 3_EPIHI_SCAutonomy_151110.pptx
- 4_EPI-Hi_Software_OverviewV03.pptx
- 5_EPI-Hi-AutonomyV04.pptx
- Andrew also made FSW documents available

MEETING NOTES

1. Agenda/Intro/Objectives – Ronnie Killough/SwRI

2. EPI-Hi Overview – Eric Christian/GSFC

3. S/C Autonomy & Instrument Interface – Kris Fretz/APL

Q/Ronnie & Maarten: How manage complexity/conflicts in all the autonomy rules and responses? Their autonomy subsystem is quite sophisticated/feature-rich – almost a programming language in its own right.

A: No clean answer to this – they have about 400 rules. They have an autonomy/fault management engineer, rules are reviewed, the fault mgmt engineer does an "interference analysis" of the rule to see if rules conflict with them, and they do "stress testing" where they intentionally fire multiple rules to test interactions.

Q/Andrew: Will any Instrument telemetry be used in these rules?

A: Yes – looking at the ITF header information, critical HK etc. In general not doing much of this other than the ITF header bits/keep alive etc. This is covered later in this presentation. S/C can only access the critical HK – the other instrument HK is inaccessible – so per ICD the instrument only has to define the criticial HK – all other is pass-thru.

Kris said instruments can change their critical HK if they need to add something that they want monitored for autonomy response.

Q/Dave: How would an instrument communicate a need for an autonomy rule or change to critical HK?
A: There are two ICDs: a general instrument ICD and an instrument-specific one – so a CR to the instrument-specific one would be made.

Eric Christian was concerned that they only try to power instruments back on once – after that need ground intervention. So, if try to power instrument back on, and a couple of days later (but in the same orbit) something happens that then clears up, that they won't try to power the instrument back on again. The things that occurred that caused the instruments to be powered off may be completely unrelated. Adrian said that the reason is that if an instrument is drawing too much power they don't want to turn it back on, and adding logic for varying causes would add complexity. But agreed if the reasons were completely different we have lost a lot of science.
Kris said that they pushed hard to get the single "second chance power on". Adrian agreed – adding more complexity to allow multiple power-ons is a non-starter.

Q/Andrew: What if the "power me down" or "power cycle me" bit gets set spuriously?
A: There is persistence check on that bit in the S/C, and also the ITF is CRCd so there is a check to make sure it isn't just a bit flip.

Q/Several: Why monitoring LVDS voltage – haven't seen that before.
A: Monitoring LVDS voltage is being done because the specific part has a failure mechanism so wanted to make sure it was monitored/handled somewhere each place it is used – either in the S/C or the subsystem. The S/C is not monitoring EPI-Hi LVDS voltage because they are handling this internally – this is in the ICD and S/C is happy with how it is being handled.

Q/Dave: What is conveyed to the ground wrt what rules fired, and what those rules mean in terms of what the FSW did?
A: What rules fired does come down in telemetry, with a descriptive name. Don't have any sort of slick graphical representation of what each rule does "at the ready" but the S/C team can tell Ops what happened based on the telemetry.

The S/C has "maintenance rules" and "fault rules". "Maintenance rules" are handled differently – they aren't reported in the same way so they don't fill up their fault reporting telemetry, and the "how many times to fire" doesn't apply because these rules are firing all the time (e.g. rules are used to control the instrument survival heaters via bang-bang set points).

4.   EPI-Hi FSW Overview & Changes Since CDR – Andrew Davis/APL

Q/Dave: Is there any autonomy involved in the PHASIC settings, or is all that done by the ground?
A: These are settings in the FSW, but there is a "patch" region of MRAM that can be loaded after boot that can change these default settings so they can be changed on orbit without reloading all FSW.

Their SCALC uses a 2D table to define regions (the "curves") so they can use a binary search and see if an event lies within one of the defined curves that identifies the species. So the curves are defined via table lookup. They then increment a counter based on where it fell in the table – so, it is Helium 3 with energy X so not just one bin (counter) for ^{3}He. Then they log-compress them down from 24 bits to ~16 bits, then also do zero compression since there may be lots of zeros.

Q/Ronnie: Comfortable with interface/CONOPS with SOC (re: I didn't get a good feeling wrt the interface between the instruments and the SOC at the IWT meeting earlier this year)? Also, are you testing the GSEOS/Instrument $\leftrightarrow$ SOC interfaces?
A: Eric said haven't done testing yet but is planned. Andrew said they expect the MOC to send L0 data to SOC and the SOC to send it to them in some defined/recognizable format – no concerns here.

Q/Maarten: Algorithm has been drafted and under review by science team – any concerns that will grow beyond capacity of the FSW design to accommodate?

A: They are working closely together, the FSW team drafted the algorithm and that is their initial proposal. Also drafted John Hanley to "chase" the scientists to make sure this doesn't drag on and cause problems later [see additional later discussion and action item on this topic].

5.   EPI-Hi FSW Autonomy – Andrew Davis/APL and Eric Christian/GSFC

Q/Ronnie: The manual/autonomous bit issue that was raised with EPI-Lo – is that an issue with EPI-Hi?

A: The S/C treats EPI-Hi and EPI-Lo as two instruments – not as a suite. So the manual/autonomous bit sent to EPI-Lo is not used with EPI-Hi – they have different bits as described in Andrew's slides.

Lots of discussion on "fail silent" requirement if the virtual PPS is not received by the instrument. This has been a hot topic on this mission. The S/C made the decision to require instruments to fail silent. Scott Weidner is particularly opposed to it because it masks information - if the PPS is absent the instrument can't tell you anything about what is going on in the instrument and what it is or isn't seeing. Scott asked S/C to send out a formal response on this.

By using an MET-based algorithm to control instrument data collection, you create a ground maintenance activity vs. using the inbound/outbound AU distances from the S/C. However, there are several months between encounters so there is time to generate the MET-based load.

Andrew clarified that their "macros" are really MET-based time tagged commands. They don't use the "macro" terminology (except in these slides). A Forth command can be one or many commands. But, currently they have not need for the time-tagged commands.

Q/Ronnie: Is the MET-based mode switching algorithm completely separate then from the MET-based time tagged command functionality?

A: Yes. They could implement the mode switching logic as a time-tagged command, but since they know they will have the MET-based algorithm implemented, they decided to implement it "natively" with the METs as table parameters rather than as time-tagged commands – those are reserved for late-arriving requirements, or post-launch needs.

Q/Ronnie: is there a way to disable both the MET and AU algorithms so that you can then use the time-tagged command capability instead, if you get on orbit and don't like either of them?

A: Yes – you can just zero out the parameters is one way to do it. There may be other ways to disable both algorithms.

Q/Ronnie: So does your proposed algorithm allow the instrument to use up the excess S/C SSR bandwidth (if solar activity is low during the encounter) by turning up the rate just prior to the next inbound? Or does it only allow this during the outbound, or distributed throughout the cruise? At the SWT it was discussed that it was preferable to use this excess bandwidth on approach to the next encounter (i.e. turn on the encounter rates early on the inbound).

A: During discussion it was clear that this was unclear between Andrew's understanding and Eric's. Andrew said Hanley is working this and will add this issue to Hanley's task on this.

There is a lack of clarity on whether there is always the same SSR allocation on each orbit or if data can build up resulting in a smaller allocation on subsequent orbits. Fretz to clarify. In further discussions, it was noted that other instruments store more data than they can downlink. EPI-Hi produces information in early downlink data that can help other instruments decide what data to downlink.   Perhaps could also use this to decide whether to keep aging prior-orbit data vs. the newer data re: Action Item 4 below.

ACTION ITEM WRAP-UP

6. Wrap-Up Discussions

Q/Adrian: Any instrument interactions?

A: EPI-Hi produces some bits that other instruments may use but do not use any information from the other instruments. EPI-Hi essentially runs in one mode.

Q/Ronnie: Are there any CPU rollover items that EPI-Hi is assuming are carried over that may not be?

A: Adrian said that on reset the default is "Science" mode, which is the bit that EPI-Hi monitors, so they should be OK.

Maarten pointed out that while the S/C maintains a rational/always incrementing MET, that may not be true on the Flatsat – so need to consider that in test planning.

There is currently no pre-integration testing between the instruments and the S/C. This does carry some risk (e.g. could necessitate changes to FPGAs late in the game).

7. Action Item Review

AI #	Who	What	When
1	Fretz	Ping other instrument teams to see how they are handling the A/B UART side monitoring & switching to make sure there aren't differing assumptions or incompatible (with the S/C) implementations. Consider an early i/f test or possibly add a risk.	
2	Fretz	Generate official response to the instrument teams re: S/C-Instrument ICD requirement to fail silent in absence of virtual PPS.	
3	Davis/Hanley	Work with the science team to determine the correct algorithm such that the residual SSR space following the encounter can be used in the period just prior to the next inbound encounter autonomously, instead of being used up "uniformly" throughout the non-encounter period.	
4	Fretz	Clarify whether residual data not downlinked from one orbit can result in a smaller SSR allocation on the third orbit. How does the S/C or ground handle "aging"/built-up data in the SSR?	