RPW ANTENNA-3 Anomaly (SOL_SC-153) ARB. 26-04-2024

Participants:

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A detailed presentation involving different RPW teams has been prepared and presented. The presentation is attached to these minutes.

Most relevant information is on the presentation. Here below some notes to accompany or underline the content of the presentation:

- At the moment of the anomaly the RPW ANT-3 signal changed to constant voltage ~0.7 V, but not zero during a Bias Sweep. (Slide 4).
- Anomaly occurred during a Slew. (Slide 4).
- Anomaly detected by LF (low frequency) measurements. (Slide 5).
- Also HF (high frequency) measurements observe a change in the background. (Slice 6).
- THR data sees a change in the signal after the anomaly (THR at the time of the anomaly was not measuring Ant-3, but Antennas 1-2 dipole). A type-III burst is observed on Jan. 22, 2024, on V1-V2 dipole but also a weaker signal on Antenna-3. (Slice 7).
- As additional notes on the science impact detailed in the presentation (Slices 8 to 10):
    - V1/V2 still allow BIAS team to compute S/C potential and plasma density.
    - Configurations have been changed on TDS and THR to limit the impact of the anomaly.
    - Main Impact on LFR science.
- Signal on Ant-3 is back on Feb. 27th @ 22:40. Ant-3 lost several times afterwards during sweeps (Slide 11). Only as from March 13th 2024, ANT-3 is behaving nominally. Actions have been taken to minimise risks (see table in the presentation, slides 13 to 15).
- The RPW science data since the occurrence of the anomaly has not been distributed. It will be delivered in the future, but RPW wants to add enough metadata to flag the degraded science data (CDF data has to be updated).
- Additional information provided by the BIAS team (Anders Eriksson):
    - To be noted that the voltage does not exactly go to 0V when the anomaly happens, but to ~0.7V. This could be an offset onboard. It is not clear what the real voltage difference between the antenna and the S/C body is. So, it could well be a real short.
    - Performing sweeps through calibration resistors works fine, therefore the BIAS electronics are intact.
    - Data seems to point to a short external to RPW electronics. (Slide 22).
    - There are exposed external conductors in the vicinity of the MLI. Fringes of MLI caused by micro-meteoroid impact could cause the short if attracted by the electrostatic field between the antenna and the components around during the sweep. (Slide 23).

    - The short is not a risk for the instrument, but because of low resistance (estimated 61 ohms), the voltage drops very rapidly when the short happens creating a spike in voltage. (Slide 24).
    - The BIAS team seems to be convinced that the short is not a design problem, but caused by an external cause (MLI?), and therefore they do not see a reason to worry about Ant 1 & 2.
- Additional information provided by the THR team:
    - At the time of the anomaly THR-HFR was not configured to measure V3. (Slide 28).
    - It was configured on 22/01/2024. On that day type III burst were seen, which were not obvious in Ant-3 but still some signal could be observed. (Slide 29). (Type III burst is created by an electron beam through plasma emission).
    - The radio emission tracks the electron beam as it travels through the decreasing plasma density of the solar corona and solar wind. Type III burst frequency (related to background electron density) decreases as a function of distance from the Sun.
    - No strange behaviour is observed in the temperature of the hinges.
    - At the time of the anomaly (bias sweep) a peak (18 mA) in current on Ant-3 is observed. The profile of the peak is different from the one observed in Ant 1 and Ant 2. This is the current used to power the preamplifier. Observing an overconsumption at the time of the sweep is normal, but the shape and the extent of the one observed for Ant-3 is abnormal. (Slide 34).
    - A detailed HF preamplifier analysis during sweeps (+/-100V) is shown (Slides 38 to 40). The conclusion is that no stress on the preamplifier system is observed and that the current peaks can be explained at the start of the sweeps. To be noted though that the model is assuming a duration of few hundreds of milliseconds, while the worst case could be much shorter (order of microseconds for the short). Further simulations should be performed.
    - In principle it is possible to continue with the bias as up to now but would be good to smooth the bias profile.
    - A latch-up in the HF preamplifier can be discarded (Slide 40).
- Additional information provided by the TDS team:
    - TDS set to monopole on 16th December allows to observe single signals from each antenna. No signal seen from Ant-3. On 13th November TDS was in dipole configuration.
    - V1-V3 observes an increase in background interferences due to changing from dipole to monopole (as Ant-3 is not working). (Slide 44)
    - TDS operated in monopole configuration is not that bad from science. (Slide 45).
    - Intermittent V3 loss on 3rd March 2024. Low frequencies were lost, high frequency signal still present but attenuated. (Slide 46-47).

- A table with possible root causes of the anomaly is presented (Slides 49-50).
    - Most likely cause is an external loose element in contact with the antenna causing a short.
    - S/C debris caused by dust impact could be fixed by increasing the bias current slightly, which was not the case.
    - Milan Maksimovic has not got an answer yet from the manufacturer about the min distance between the antenna and the tube from which it sticks out.

- Christopher Watson wants to add discharge (between biased elements and a ground component) as potential other reason. This would vaporize metallic elements and they would condense again on the antenna and could potentially cause a conductive path.
- The MLI/SLI materials are only slightly conductive, having a resistance of hundreds of Ohms (>60 Ohm calculated). It does not seem possible that a part of MLI/SLI has been lost without noticing an impact in the temperature of the preamplifier.

- As part of the final discussion:
  - A plot was presented with the S/C-Sun distance. To be noted that when the anomaly occurred (13th November 2023) and the first time that signal was back (27th February 2024) the S/C was at ~0.7 AU from the sun. This could indicate a possible link with temperature. The S/C will be at the same distance on 10th/11th May 2024. To be noted that since 13th March (0.5 AU) no anomalies have been observed. On 28th March also a sweep has been performed on all 3 antennas.
  - Doing sweeps are most useful close to perihelion - they could be eliminated entirely outside 0.7au. It is not clear if there could be a relationship between sweeps and temperature. As long as root cause not known the S/C-Sun distance shall be taken into account when performing bias sweeps.
  - Anik De Groof confirms after discussions with SoloHi team that dust impacts on heat shield are observed on the instrument images. SoloHi camera takes images close to the ANT2 side, not ANT3. But dust impacts might also happen close to the ANT3 side. SoloHi stays available if RPW team has questions related to these impacts.
  - Would it be possible to identify groundings that of the order of seconds or sub seconds in science data (not possible in HK)? -> This could be seen in science data but would look like a dust impact or a EMC event from the S/C.
  - **General conclusion**: Origin of the anomaly not fully understood. Mitigation actions in place according to the current knowledge.

- Actions:
  - AI-1: Milan Maksimovic to organise a meeting with manufacturer (STELLAR) in order to investigate minimum distance between antenna and tube from which it sticks out. Christopher Watson and Xavier Bonnin want to be present.
  - AI-2: Eric Lorfevre to prepare a short report detailing PA photos and related data analysis results.
  - AI-3: Moustapha Dekkali to perform new simulations with High Frequency Preamplifiers considering shorter (microseconds) time scales for the stimuli.
  - AI-4: Jan Soucek to analyse TDS data for shorter spikes.
  - AI-5: ROC team with the support of Bias team to find best times to perform Ant-3 sweeps.