REXUS / BEXUS
Experiment Preliminary Design Review

Flight: BEXUS 28

Payload Manager: TBC

Experiment: IRISC

Location: DLR MORABA, Oberpfaffenhofen **Date:** 11 Feb 2019

1. Review Board members

Kristine Dannenberg, SNSA
Michael Becker, DLR
Katharina Schüttauf, DLR MORABA
Stefan Völk, DLR MORABA
Alexander Kinnaird, ESA
Rodrigo Avila de Luis, ESA
Koen Debeule, ESA
Stefan Krämer, SSC
Maria Snäll, SSC
Simon Westerlund, SSC
Fredrik Rosenberg, SSC
Simon Mawn, ZARM
Dieter Bischoff, ZARM

2. Experiment Team members

Kimberly Tuija Steele
Anja Moslinger
Eligius Franciscus Maria Weterings
Diego Octavio Talavera
Niklas Josef Ulfvason

3. General Comments

- **PRESENTATION**
  - Clear and within the time given.
  - Mechanical design lacking in the presentation.

- **STUDENT EXPERIMENT DOCUMENTATION**
  - The document delivered was incomplete (some information was missing, too many TBDs) ACTION: The team shall follow the template provided and include all the tables, chapters, sections, subsections and required information.
  - The team shall stay consistent with the units used through the document.
  - The type of document (on the front page) shall state: 'SED' and not 'Spec'.
  - ACTION: The team should double-check and correct for spelling mistakes.

4. Panel Comments and Recommendations

- **REQUIREMENTS AND CONSTRAINTS** (SED chapter 2)
  - Requirement F1 has been miscategorised, should be a mission statement.
  - Requirement F2 has been miscategorised, should be a performance requirement.
  - Requirement P5 is unclear.
  - Requirement P6 has been miscategorised, should be a functional requirement.

- Requirement P7 is evident, the team should consider disregarding it.
- Requirement D4 has been miscategorised, should be a performance requirement.
- Requirement D6 has been miscategorised, should be an operational requirement.
- Requirement D8 has been miscategorised, should be a performance requirement.
- Requirement D9 imposes an unrealistic data rate, which should be lowered down or negotiated with the payload manager and the rest of the teams on board BEXUS 28.
- Requirement D12 states an unrealistic limitation on volume of 0.11 cubic centimetres. **ACTION:** The team shall investigate this and correct it or disregard this requirement (unnecessary design restriction).
- **ACTION:** The team is encouraged to include a performance requirement regarding the measurement system for checking the Gondola orientation.
- **ACTION:** The team is encouraged to include a performance requirement regarding the gimbal system which holds the camera in position (indicated as P6).
- **ACTION:** The team is encouraged to include a performance requirement regarding the pointing error system using an additional camera.
- **ACTION:** The team is encouraged to include a performance requirement regarding the thermal control system for the overall experiment.
- The team should consider categorizing the proposed constraints as targets, rather than actual constraints for the project.
- **ACTION:** The team should consider defining a requirement for the exposure time as a balance between getting good enough results and feasibility.
- Scientific goals shall drive a set of requirements for the gimbal system to ensure valid data is obtained from the optical system.

▪ **MECHANICS**

- The design is completely changed from the original proposal which went from a NIR camera to a Newtonian telescope.
- The team shall accept that the space available for the telescope inside the Gondola might be limited and therefore it could be moved towards the exterior of the structure and/or mounted on an external platform. The team is encouraged to check the SED of team BX25 SUNBYTE.
- The mechanical design of the gimbal is lacking.
  ACTION: The team should provide a complete mechanical design of the pointing mechanism, including the following points:
  - Type of mechanism that is going to be used.
  - Materials that are going to be in contact.
  - Gearbox.
  - Expectable forces.
- The team may use a double arm gimbal for supporting the telescope.
- The team shall consider carefully the tolerances of the pointing system and have a clear idea on the tolerance chain in order to ensure proper data could be obtained from the optical system.
- **ACTION:** The team should provide a clear plan on the control system, accuracy required for the measurements and how are they going to ensure this accuracy is possible.
- The team shall consider that the Gondola will be rotating in an unpredictable manner and therefore the control system must take this condition into consideration.
- The team shall consider that using CFRP on the gimbal with the size proposed might make it hard to achieve the requirement of 0.1 degree twist of the structure.
- The team shall provide details of the electronic box design, in particular:
  - Location of the power plug and the LAN plug, considering accessibility.
  - Fixation of the electronic components inside the box.
- The team is encouraged to keep the centre of mass of the system as low as possible and as close as possible to the rails.
- The team is encouraged to keep the moment of inertia of the telescope as low as possible.

▪ **ELECTRONICS AND DATA MANAGEMENT** (SED chapter 4.2.2, 4.2.3, 4.5, 4.7, 4.9)

- The team could face difficulties when trying to conceive an attitude determination system and control loop.
- The team shall consider how to detect the very slow rate of turning of the Gondola.
- Compasses won't be the preferred solution for attitude determination both for precision and perturbation of the magnetic field issues (the launch pad is magnetic and the magnetic and geographic north will change a few degrees during flight).
- The team is encouraged to investigate the use of different sensors such as seismometers, sun sensors or star trackers.

- **ACTION:** The team should provide a detailed plan on how they are going to acquire the attitude of the Gondola.
- The power that is stated to be used in the SED is not compatible with what the batteries of the BEXUS could provide.
  ACTION: The team shall take a deeper look into it (look at the curves provided in the manual and consider the lower capacity at lower temperature and higher currents) and propose a feasible power budget.
- The team is suggested to increase the data storage volume on board.

- **THERMAL** (SED chapter 4.2.4 & 4.6)
  - **ACTION:** The team shall provide more insight in which are the specific components that they would like to protect from the thermal environment of the stratosphere.
  - **ACTION:** The team shall provide more details on how the Thermofoil will be implemented (need to be conducted on heat sinks with appropriate thermal capacity, otherwise they will burn) and their control loop.
  - The team is encouraged to discuss with Dieter Bischoff about the thermal design.
  - **ACTION:** The team shall compute the internal heat (electronic heat dissipation) and compare it with an estimation of the loss of heat through the insulation cover.
  - **ACTION:** The team shall propose a thickness and include the material properties of the insulation.
  - **ACTION:** The team shall provide information about the temperature sensor(s) and the expected temperature conditions to keep/reach with the proposed thermal design.

- **SOFTWARE** (SED chapter 4.8)
  - The team should consider using the GPS altitude signal (or similar) for triggering the start of the experiment instead of / apart from using a telecommand (SOE) signal.

- **VERIFICATION AND TESTING** (SED chapter 5)
  - Requirement D6 should also be verified through review. It is not clear from the test plans that these tests will really verify this requirement.
  - Requirement D12 (mass) is not verifiable by inspection.
  - Test 2 is unclear. The team might be referring to a thermal vacuum facility.
  - Test 8 does not verify requirement D3. Drop tests do not verify vibration requirements.
  - Regarding drop test, the team shall keep in mind that the preparation of the ground is crucial: components could be totally destroyed if dropped on harsh grounds such as stones.
  - Some of the requirements proposed are not linked to a verification plan.
    ACTION: The team shall provide a verification plan for all the requirements.
  - The methodology proposed to verify the requirements are in some cases very expensive.
    ACTION: The team should consider looking into less expensive verification methods (analysis, calculation, etc., rather than test).
  - The team shall consider including a thermal vacuum test for the gimbal mechanism as well as for the optical system.

- **SAFETY AND RISK ANALYSIS** (SED chapter 3.5)
  - The team shall consider including the risk of not achieving its scientific objectives it they are not able to reach the level of accuracy required on their system (continuous pointing).
  - The team shall consider cutting out double risks. Keep risks consistent with the requirements.
  - Regarding operation of the experiment, the team shall consider keeping the experiment working the whole time rather than having a sleep mode, stowage mode in case of e-link failure, etc. This increases the risk of preventing the experiment from gathering data.
  - Risks MS20, MS30 and VE20 are similar to each other.
    ACTION: The team should consider grouping them into one risk.
  - Risk MS20 is unclear, as it seems to refer to an additional system pulling the optical system inside the frame for protection, of which there is no information on the SED.
  - Risk VE20 is unclear as it refers to a “landing mechanism” of which there is no information.
  - Risk EN10 is unclear as it relates to “rays focused on someone”. The team shall reconsider if their experiment is indeed able to harm a person due to this reason.
  - The team shall consider the risks of overheating of the components, specially of the CMOS sensor.
  - The team shall consider the risk of jamming of the mechanism.

- **LAUNCH AND OPERATIONS** (SED chapter 6)
  - Information on data rates and power consumption is missing from Chapter 6.
  - Data rates of 0.9 Mbit/s exceeds the realistic values. It could be possible to offer the team specific windows in time when the team can request to download a picture. For the rest of the time the data rate should be lowered.
  - The team shall accept that the launch won't happen during night time.
  - The team shall consider including safety wires on the design for elements protruding outside the Gondola.
  - The team shall aim for reducing the mass of the experiment as much as possible.
  - The team should accept that the telescope might be damaged or destroyed when landing.

- **ORGANISATION, PROJECT PLANNING & OUTREACH** (SED chapters 3.1, 3.2, 3.3 & 3.4)
  - The team size and skill set is considered good enough.
  - The mechanical design responsible was not present during the PDR.
    ACTION: The team should bring a mechanical design responsible for CDR.
  - The presented work breakdown structure and Gantt chart are very basic.
    ACTION: The team should consider defining basic phases and responsible persons for all areas. As the project progresses more details of the work packages should be defined and scheduled.
  - **ACTION:** The team is encouraged to prepare a detailed calendar with everyone's availability and look at how/if this affects project planning (include vacations, exam periods, etc.).
  - The team have presented a rather simple budget.
    ACTION: The team shall indicate where and when is the money coming and ensure sufficient funding early in the project.
  - The team have presented weak external support.
  - **ACTION:** The team should ensure there is sufficient external support in terms of critical advice from experts and access to labs and/or facilities.
  - There is not much content yet regarding outreach.
  - **ACTION:** The team should aim to increase their number of followers on social media.
  - **ACTION:** The team should consider publishing articles and/or posts about Selection Workshop, Student Training Week, etc.
  - The team is encouraged to have the project name spelt out in the logotype.
  - The URL for twitter is missing in Appendix B.
  - The team website is simple but functional.
  - The team is required to think about the audience they would like to target with the website and introduce some lines/sections explaining what is BEXUS, why to fly experiments on it, when it will fly and/or where will it fly to.
  - **ACTION:** 'SNSB' (old name) shall be corrected for 'SNSA' on the website.

5. Internal Panel Discussion

- Summary of main actions for the experiment team
  - **The team should provide a clear plan on the control system, accuracy required for the measurements and how are they going to ensure this accuracy is possible.**
  - **The team should provide a detailed plan on how they are going to acquire the attitude of the Gondola: sun sensor, star tracker?**
  - **The team should provide a complete mechanical design of the pointing mechanism.**
  - **The team should complete the chapter 6 of the SED.**

- PDR Result: **CONDITIONAL PASS**

- Next SED version due: v1-1, 16th March 2019