



REXUS / BEXUS

Experiment Preliminary Design Review

Flight: BEXUS 30

Payload Manager: TBC

Experiment: BoB

Location: Esrange, Kiruna

Date: 10 Feb 2020

1. Review Board members

DLR Agency:



SSC:



ESA:

ZARM:

2. Experiment Team members



3. General Comments

- PRESENTATION
 - The presentation was good and balanced.
- STUDENT EXPERIMENT DOCUMENTATION
 - In overall, the SED is well presented and complete for PDR level.
 - The team should replace the sentence “The following requirements have been created for the BEXUS committee at PDR level” by “The following requirements have been created for the Preliminary Design Review” or similar.

4. Panel Comments and Recommendations

- EDITORIAL
 - **ACTION 1:** The team shall remove the EuroLaunch and error message from the header.
 - o The team may use the updated template from the teamsite.
 - **ACTION 2:** The team shall remove blank pages between sections when there are there.
 - **ACTION 3:** The team shall change the document name to BX30_BoB_v1-0_26Jan20 in order to be conformed to the guidelines.
 - **ACTION 4:** The team shall replace “*first version*” by “*PDR*” in the remarks column of the change record.
 - **ACTION 5:** The team shall use the golden sentence in the preface for describing the programme.

The REXUS/BEXUS programme is realised under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Agency (SNSA). The Swedish share of the payload has been made available to

Students from other European countries through a collaboration with the European Space Agency (ESA). EuroLaunch, a cooperation between the Esrange Space Center of SSC and the Mobile Rocket Base (MORABA) of DLR, is responsible for the campaign management and operations of the launch vehicles. Experts from DLR, SSC, ZARM and ESA provide technical support to the student teams throughout the project. REXUS and BEXUS are launched from SSC, Esrange Space Center in northern Sweden."

- **ACTION 5:** The team shall replace "This document is the first of four issues of the Student Experiment Documentation" by "This document is the first of five issues of the Student Experiment Documentation". The team shall ensure to update this sentence at each new version release of the document.
- The document should be ideally approved by a professor or supervisor.
- The document should be preferably issued by one person responsible for editing, formatting and ensuring consistency of the whole document even though all team members can contribute to the document.
- The team should consider including diagrams and figures for explaining the experiment concept rather than long sections of text.

- **REQUIREMENTS AND CONSTRAINTS** (SED chapter 2)
- **ACTION 6:** (FC-02 10c/20c) The team shall split the requirements for each environment characteristics (i.e. Temperature, absolute pressure, humidity, O₂ concentration, fluidic pressure, fluidic volumetric rate and solar illumination).
- (FC-04 10c) The team should consider that this requirement is not needed for a biological experiment or the team should justify it. Furthermore, it is believed that this requirement is difficult to achieve.
- **ACTION 7:** (PR-01 10c) The team shall split the requirement into two requirements:
 - o Functional requirement: The system shall segregate the C. elegans population in chambers in the MCSD.
 - o Performance requirement: The system shall segregate the C. elegans population into 16 groups of 10 +/- 5 L4 stages C. elegans.
- **ACTION 8:** (PR-02 10c/20c/30c) The team shall move these requirements from Performance Requirements to Design Requirements.
- **ACTION 9:** (PR-06 10c) The team shall split accuracy and frequency separately into two requirements.
- **ACTION 10:** (PR-07 20c) The team shall split accuracy and frequency separately into two requirements.
- **ACTION 11:** The team shall complete requirements for all measurements by including the range, the accuracy and the frequency.
- In general, the team should consider what is a system level function or comes into the design and operation.
- **ACTION 12:** The team shall include design requirements related to the BEXUS flight and launch environment (Please refer to the BEXUS user manual for extracting them).
- **ACTION 13:** The team shall include a design requirement concerning the experiment mass.
- (CT-01 10c) It is not a constraint.
- (CT-02 10c) It is a function.
- (CT-03 10c) It is not a constraint.
- **ACTION 14:** The team shall replace all the "TBD"s in the requirements for the SED v2-0.

- **MECHANICS**

- **ACTION 15:** The team shall consider that the proposed accommodation is now on top of the gondola as defined during the accommodation session.



- **ACTION 16:** The team shall design a clamp mechanism for fixing the experiment on top of the gondola.
- **ACTION 17:** The team shall detail the performance of the characteristics of the pump and its performance (flow rates, etc) as well as the flow rate sensor wanted.
- The team should consider who manufacture the housing.

- **ELECTRONICS AND DATA MANAGEMENT** (SED chapter 4.2.2, 4.2.3, 4.5, 4.7, 4.9)
- **ACTION 18:** The team shall reconsider the chosen power connector. As stated in the BEXUS user manual: "the experiment must have a 4 pin, male, box mount receptacle MIL – C-26482P series 1 connector with an 8-4 insert arrangement (MS3112E8-4P)".

- The team should be careful using a raspberry pi type camera. Especially if there is a need to access it for connecting/disconnecting the camera.
- The team aims at having a very short focus. It is believed that this type of camera might not match the required performance. The team should consider looking for assistance in optics in order to ensure a success of this part of the mission.
- **ACTION 19:** In the preliminary electronic design scheme (Figure 4-22), the team shall change the value of pull-up resistors from $\mu\Omega$ to $k\Omega$.
- **THERMAL** (SED chapter 4.2.4 & 4.6)
 - For on ground calculation the team should consider that temperatures are as low as -15°C instead of -50°C as stated in the thermal calculations.
 - The team should consider a removable before flight cover on the experiment if necessary.
 - During the float phase, the outer temperature depends on the weather conditions. The main drop of temperature occurs right after getting out of cloud and outer temperature can reach -60°C . The team should investigate the duration of this phase with the available data on the teamsite.
 - If the thermal calculation takes into account the solar radiation effect, then the team is reminded that the black area will absorb a part of the solar radiations.
- **SOFTWARE** (SED chapter 4.8)
 - The team should be very careful in handling emergency mode(s) in order to avoid the experiment to be unreachable or none resettable.
 - The frame of the software is well defined but not the details (i.e. data and main process). The team should consider the need of a state machine.
 - **ACTION 20:** The team shall detail the data flow.
 - It is believed that implementing emergency routine is highly complicated. Thus, the team is advised to start by implementing the basic routine and then develop emergency routine if needed and/or there is time left to do so.
- **VERIFICATION AND TESTING** (SED chapter 5)
 - The inspection as verification method is misused (e.g. concerning pump).
 - The team should note that the test as verification method is not a stand-alone verification method and is most of the time complemented by another method at an earlier stage in the development.
 - (PR-03-11c) The verification of this requirement by analysis is considered as extremely hard to perform correctly.
 - **ACTION 21:** A number of tests are missing on the specific environment (vacuum chamber, etc). The team shall add those tests.
 - **ACTION 22:** The team shall cross reference the verification matrix and the test plan.
 - **ACTION 23:** The team shall define the term "leakage" (i.e. what is the acceptable range of gas flow rate release).
 - In order to ensure that the box will not leak each time the box is opened and closed, the team should gain confidence by training and testing it 10 times in a vacuum chamber using a common, pre-determined and standardized process. By doing so, the team would be reasonably sure that the process will work at Esrange.
 - **ACTION 24:** For determining the accuracy of sensor (in particular for temperature), the test shall be performed according to standards.
- **SAFETY AND RISK ANALYSIS** (SED chapter 3.5)
 - No remarks.
- **LAUNCH AND OPERATIONS** (SED chapter 6)
 - **ACTION 25:** The team shall investigate the regulations concerning GMO *C. elegans* for shipping and launching at Esrange and over Norway and Finland.
 - **ACTION:** SSC needs to plan access to labs / autoclave to share the lab with Stardust team.
 - **ACTION 26:** The team shall request at least 2 IP addresses.
 - The team is advised to bring its own HDMI wires.
 - The team should consider bringing spare worms.
 - The team do not need a fast recovery.
- **ORGANISATION, PROJECT PLANNING & OUTREACH** (SED chapters 3.1, 3.2, 3.3 & 3.4)
 - **ACTION 27:** The team shall add a progress line.
 - **ACTION 28:** The team shall develop resources availability. In particular to ensure that the right resources will be available at the right time (material, components, manpower).
 - The team is reminded that the REXUS/BEXUS programme is not an ESA programme.
 - **ACTION 29:** The team shall implement the lessons learned section since lessons can be learned all along the programme at the different events (Selection Workshop, Student Training Week) as well as during your work on the project.
 - The team should consider to develop a dedicated outreach plan as well as providing the links to the different social network accounts.

5. Internal Panel Discussion

- Summary of main actions for the experiment team
 - **The team shall find help for ensuring a good implementation of the camera.**
 - **The team shall finalise their mechanical placement and fixation to the gondola (in coordination with SSC, if required).**
- PDR Result: **PASS**
- Next SED version due: **SED v2-0 due two weeks prior to CDR (exact date TBC).**