Q&A YURI - Orbital BioWorks Challenge SPRIND

Containers & form factor

1. What are the container dimensions?
    - The outer Container has 80mm x 40mm x 30mm
2. How many containers are allocated per team, and what is the maximum mass per container and per team?
    - There are 24 Containers on total. If there are 4 teams selected, every team gets 6 Containers for flight
3. Can two containers be combined, for example by connecting them with tubing?
    - Not foreseen so far
4. Is a different form factor than the standard containers possible?
    - Not foreseen, but possible with extra work
5. Can roughly 2 ml of medium be sustained over about 7 days within the standard container envelope, or does that exceed the available budget?
    - The HW that is foreseen promotes a culture chamber with about 13,5ml, and two tanks with 11ml each connected with a pump.
6. Will more detailed specifications of the available Yuri hardware be shared?
    - Yes, there is a Science workshop planned for the first chosen teams

Fluidics, sensing & analytics

7. What pumps are available, and is active flow control possible? (Passive flow is insufficient for organoids.)
    - The system is supported by a peristaltic pump. The system was already used for organoids and is approved.
8. What flow rates do the pumps support?
    - 2.2 ml/min, but could be also adjusted slightly
9. What sensors, analytics, and control parameters does each container provide for data validation?

- We measure temperature, humidity, radiation and can control temperature and pump cycles.

10. Is a bubble trap at or in the chip feasible under microgravity?

    - Not for the first mission for which it is planned to minimize HW adjustments, but for the second and third one such custom developments are feasible. From past experience, air bubbles in the fluidic system were minimized through specific filling procedures, therefore not requiring bubble traps. Pending the specific requirements, it should be checked what the best approach is

11. How is contamination prevented in cell-culture containers?

    - Active training is done with everybody on the hardware to integrate sterile under the bench. All HW parts are autoclavable.

Environmental control

12. Is temperature control available in the payload, including sustained active incubation at 37 °C ± 0.5 °C over about 7 days?

    - 37°C is possible, the range of all containers will be +/-1°C

13. What are the limits for thawing and storage, and is cooling — including sample freezing — supported?

    - No, due to limited capacity in the Polar Facilities

14. What thermal control applies during the dormant phase between payload handover and launch, and how long does that phase last?

    - HW Handover to Launch takes max. 3 days (1 day launch scrub included) and will be stored at ambient conditions.

15. What are the temperature limits for the controlled upload and download?

    - For the first Flight Up- and Down load will be ambient and soft-stowed, also due to limited Facility capability.

16. Is a gas supply (CO_2, O_2, N_2) available?

    - No, we use normally enhanced liquids. There is the possibility of having vented containers for O2 and CO2 exchange with the environmental air.

17. Is vacuum (a vent line) available for experiments?

- All Containers have 3 Level of Containment and are airtight. There is the possibility of having vented containers for O2 and CO2 exchange with the environmental air.

Pressurized hardware & safety

18. What are the requirements and limitations for pressurized hardware — specifically maximum stored energy, MEOP (maximum expected operating pressure), burst-pressure factor, certification requirements, and double or triple sealing for liquids?

    - Double or triple sealing of liquids is provided by the Yuri provided experiment containers. They also meet all pressure limitations. Yuri provides safety certified containers with 2 levels of containment and a safety certified fluidic system for a third level of containment. These cover all safety requirements and do not require the applicants of the challenge to take further limitations into account. Other pressure devices are currently not foreseen. Generally, all designs must comply with NASA Safety Standards (SSP 51721 and SSP 52005) to be certified for VAST. If custom designs are considered, please refer to these standards to check the limitations.
    - Requirements on safety for toxic substances may be even stricter compared to the SSP51721 as the overall volume of the VAST space station is significantly smaller than ISS. VAST is currently assessing this together with NASA.

19. What g-force and pressure must the setup withstand?

    - The Containers will be transported soft-stowed. Ambient pressure of 1 bar applies. G-forces are according to SSP57000 for launch:

TABLE E.3.1.5-1 ACCELERATION LOADS FOR LAUNCH ON VISITING VEHICLES

Nx (g)	Ny (g)	Nz (g)	Rx (rad/sec²)	Ry (rad/sec²)	Rz (rad/sec²)
±7.0	± 4.0	± 4.0	N/A	N/A	N/A

For return:

TABLE E.3.1.6-1 ACCELERATION LOADS FOR RETURN ON VISITING VEHICLES

Axial (Nx) (g)	Lateral RSS (Ny & Nz) (g)
± 9.2	± 9.3

20. How strong are the vibrations during the experiment in orbit?

    - It is expected to be at a similar level to ISS, as it is a crewed space station.
    - For reference, this publication provides insights into the vibration levels encountered on the ISS: https://doi.org/10.1016/j.actaastro.2004.05.057
    - However, as Haven-1 is a new space station, the environment will likely differ. It is expected to be in the same order of magnitude as ISS however.

21. Are the flight vehicles and/or the containers radiation-protected?

- The experiment will be inside an aluminum housing, inside a metal facility and inside a space station. Hence radiation impact is limited to similar levels compared to ISS. Passive radiation measurements on container level can be performed. Yuri also has active radiation sensors available that fit into the containers, however these do not fit together with the fluidic system.
- As reference ISS radiation data for external sensors (higher radiation than inside the space station) can be found in https://doi.org/10.1002/2016SW001580 and report radiation dose values in the range of 340 µGy/day to 844 µGy/day. The average is reported to be 567 µGy/day. These values can likely serve as conservative estimates, as they are for external unshielded environment. Based on past experience the actual dose is likely around 200 µGy/day. If radiation is a more prominent factor for the experiment, specific estimates for the radiation environment can be created. However, the specific radiation dose also depends on fluctuations of e.g. sun activity.

Modification & integration

22. To what extent may teams replace or supplement Yuri's hardware with their own subsystems? For example, can a team integrate its own miniaturized microfluidic subsystem into the ScienceShell to build it out into a fully active microfluidic incubator?

- The Containers are flight proven and it is the easiest to fly inside those. We will try to implement as much as possible if there is existing hardware.

23. When a team integrates its own hardware or subsystem into Yuri's platform, to what extent does Yuri gain visibility into that design?

- Yuri will need to support the safety against NASA and needs to know roughly, NDA's can be put in place.

24. Who can access the methods and experimental data generated during the mission?

- Only the teams itself will have the data.