Statement of Work
BIRDY Test Bench's Transponder

1. BIRDY test bench

BIRDY is a concept of cubesat accompanying an interplanetary mission to characterize a celestial body in proximity operations. Using radio-science during close flybys of the body and orbit reconstruction algorithms on ground, the mission derives the trajectory deflection from echo and Doppler measurements in order to retrieve the mass and, further, other parameters of its internal structure.
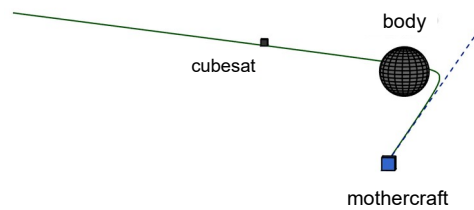

Figure 1.1 - Trajectory deflection prediction during a celestial body flyby

In the current development phase, we are designing a test bench to assess key performances of the mission concept from the ground.
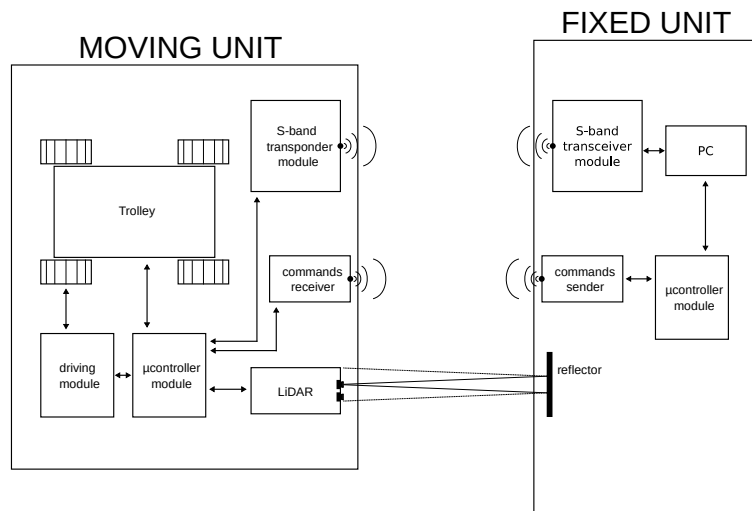

Figure 1.2 - Test bench module overview

The bench consists in a moving transponder and a stationary transceiver mimicking the expected mothercraft-cubesat ranging and radial speed values during a flyby scenario. The fixed unit is in charge of the integration of the echo and Doppler measurements, the moving unit only responds to the fixed

unit's signal. The bench will produce the echo and Doppler measurements as expected for the real mission.

The transponder and its S-band patch antenna (not part of the call) are carried on a small wheeled vehicle. Each run of the bench produces a set of echo and/or Doppler measurements. For each run, the vehicle is given a speed to reach, and drives for 60 s. The trolley moves in a straight line.

Preliminary studies have been performed to assess the needed performances of a transponder in the context of this test bench. They result in the following requirements. Possible redundant studies by the applicant should be avoided in the quotation, or should be quoted separately.

2. Transponder quotation request

Technical requirements

1. Support two-way coherent Doppler measurement (integration by the fixed unit) as described in ECSS-E-ST-50-02C

2. As an option for a possible later upgrade: Support two-way transparent ranging as described in ECSS-E-ST-50-02C

3. Support ranging tone of at least 500 kHz. A higher tone frequency as supported by the standard is desirable (up to 1.5MHz) as an option.

4. Reception frequency band shall be 2025-2110 MHz. The deadline and price for a late change of this band should be quoted separately.

5. Transmitter frequency band shall be 2200 – 2290 MHz. The deadline and price for a late change of this band should be quoted separately.

6. Coherent transponder ratio shall be 221/240.

7. The device shall meet all requirements described in ECSS-E-ST-50-02C for performing measurements in the standard's accuracy class A.

8. Telemetry functionalities are not needed

9. The device shall be equipped with a duplexer for connecting to a single antenna with an SMA(f) connector

10. The device shall perform necessary analog filtering to attenuate out-of-band noise

11. The device shall be controlled via one of these digital interfaces: I2C, UART, SPI, RS-232.

12. The device shall have a maximum power consumption less than 13 W.

13. The device shall fit in a volume of 100 x 100 x 60 mm3 .

14. The mass of the device shall be less than 1 kg.

15. The device shall be implemented at an "engineering model" level: form factor and component selection are not required at "flight model" level, i.e. a "breadboard model" is considered sufficient.

Deviations from the standard shall be justified.

Any preliminary studies deemed necessary shall be identified and quoted separately.

The offer

1. must include as an option, and be quoted separately, the minimum hardware and software setup that is required to commission the device at the customer's facility, considering the commissioning to occur in a laboratory environment (no open-air emission). For standard tooling, the offer must specify such tooling if not provided in the option.

2. must include as an option any customer support by phone or on-site. If a training is deemed necessary, it must be also quoted separately.

3. can include as an option, if applicable by the vendor, the use of a telecommunication license operated by the vendor for the frequencies identified above and for use in France.

Deliverables

1. Transponder and its documentation in English

2. Reports in English for any preliminary studies

3. Example software (to be used during commissioning)

4. Customer support in English (or in French if cheaper)

5. Confirmed options

3. Commercial details

In case of selection, the contract will be prepared in French, according to the following principles, all technical specification and all technical exchanges can use English language alone.

1. Except for the embedded code in the device itself, the entire deliverable shall become the sole property of the customer who is entitled to use it without any kind of restrictions.

2. Limited advanced payments are possible upon due justification (e.g. vendor's procurement). Final payment is due at full delivery.

3. In some circumstances, for instance necessary settings with the customer at vendor's facility, we may consider a formal delivery, i.e. ownership transfer, at the vendor's facility. In this case, the

vendor is considered responsible for any damage that could occur between the delivery at vendor's facility and its shipment to customer's facility.

4. Attached documents:

    ○ "CCERES_2020-113_CCTP_BIRDY.pdf": the present document.

    ○ "CCERES_2020-113_CCTP_BIRDY_FR.pdf": French translation of the present document.

    ○ "Purchase_conditions.pdf": English certified translation of the French contractual conditions, provided for information, not part of the contract.

    ○ "Conditions_d'Achat.pdf": French contractual conditions for the future contract.

    ○ "CCERES_2020-113_CPA.odt": project of contract to be filled in by the applicant.

    ○ "Appendix_2.pdf": Information letter to use the French administration portal CHORUS refered to in the purchase conditions.

Note: as an alternative to this contract, a "procurement order" can be used instead that does not allow any advanced payments.

Detailed offers are kindly requested no later than the 30th of November 2020, 10:00 (French time).

Contacts:

• Grégoire HENRY <gregoire.henry@obspm.fr>

• Boris SEGRET <boris.segret@observatoiredeparis.psl.eu>