6th-ICATT

ROSPA

CROSS VALIDATION OF THE PLATFORM-ART AND ORBIT TEST FACILITIES FOR CONTACT DYNAMIC SCENARIO SETUP AND STUDY

INNOVATING SOLUTIONS

OVERVIEW

1. Introduction
2. Facilities set-up and hardware involved
3. Scenarios definition
4. 3 DOF tests results
5. 6 DOF tests results
6. Conclusions

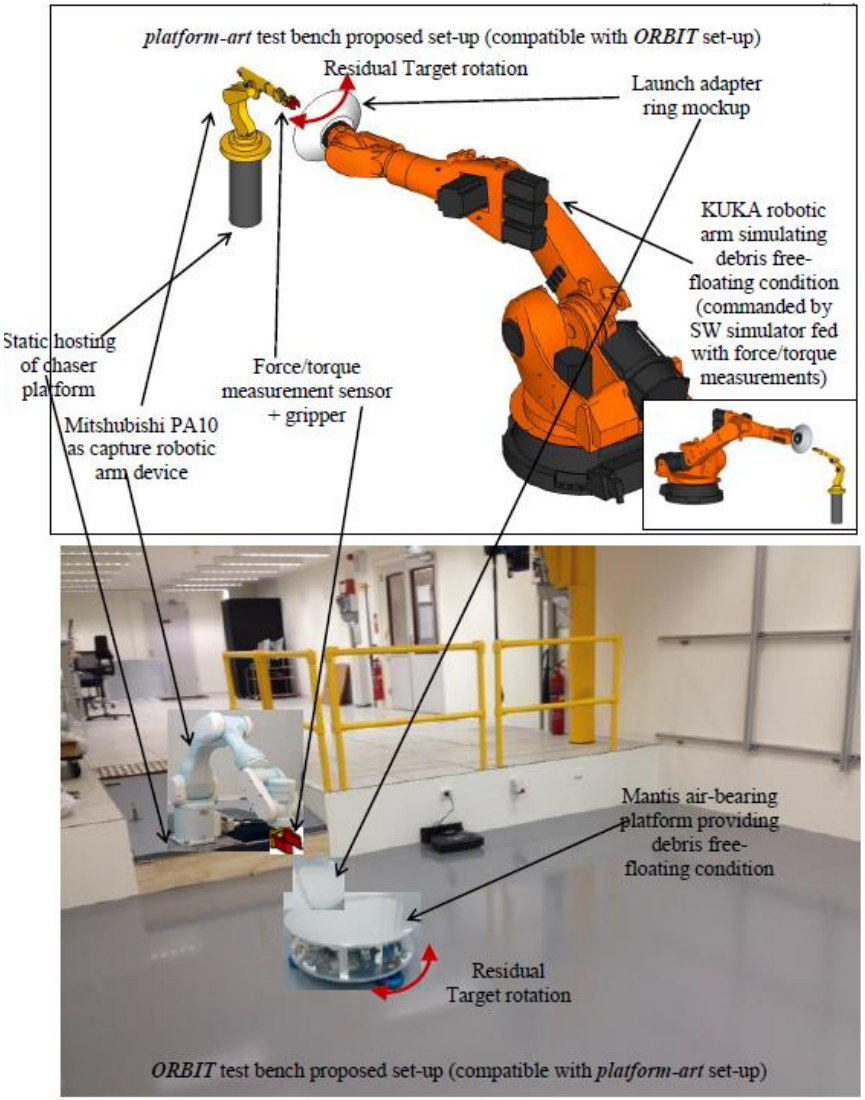
Introduction

INNOVATING SOLUTIONS

INTRODUCTION

Purpose of the activity: cross-validation of the ORBIT and the ***platform-art*** facilities for contact dynamic scenarios.

In the scope of the activity also a database of representative images of a debris removal scenario is generated, recreating several types of disturbances and with realistic illumination conditions.



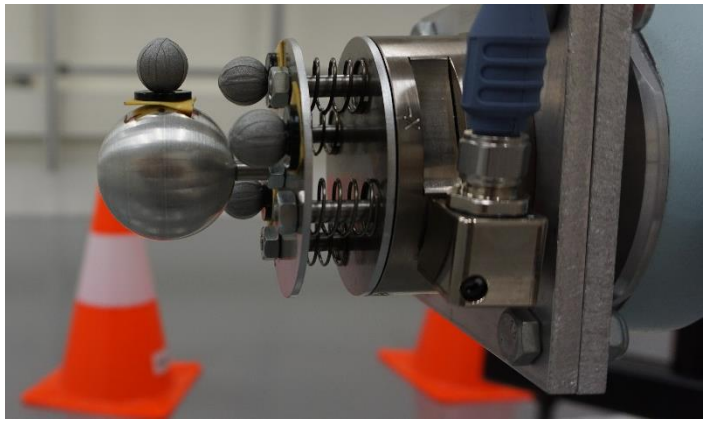
Facilities set-up and hardware involved

INNOVATING SOLUTIONS

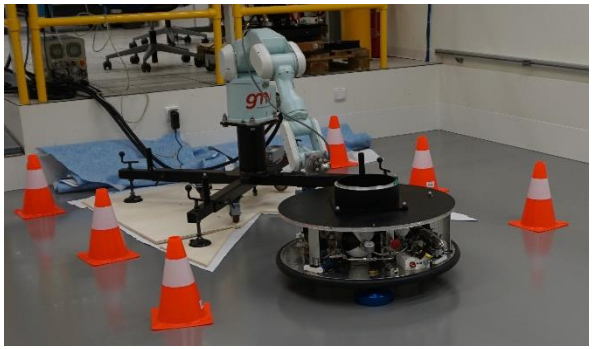
FACILITIES SET-UP AND HW INVOLVED -1

ORBIT:

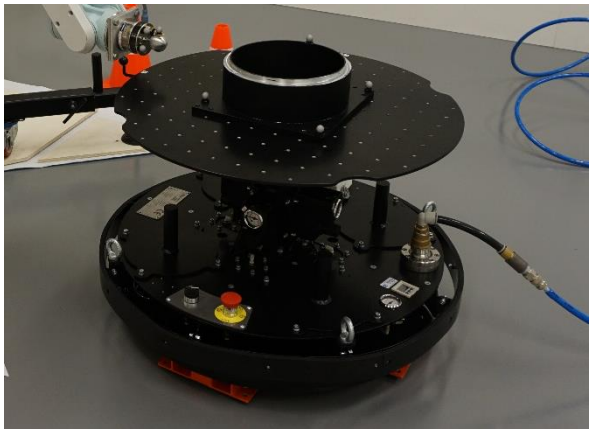
- Mitsubishi PA10
- Vicon system
- Load cell and compliance device
- 3 air-bearing platforms



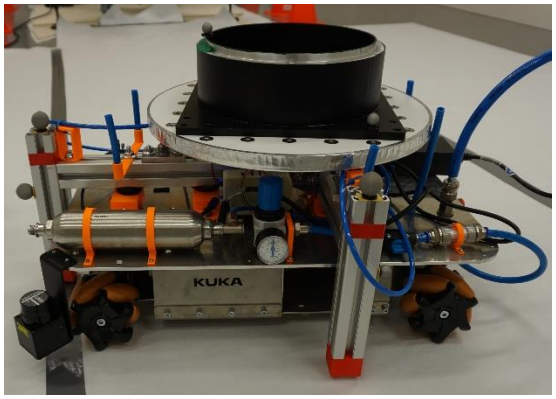
Mantis



Acrobat



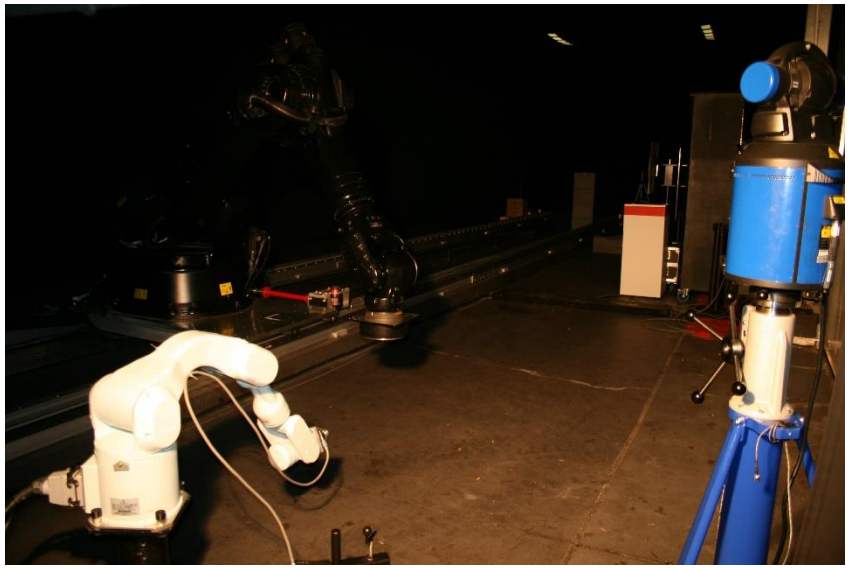
Rootless

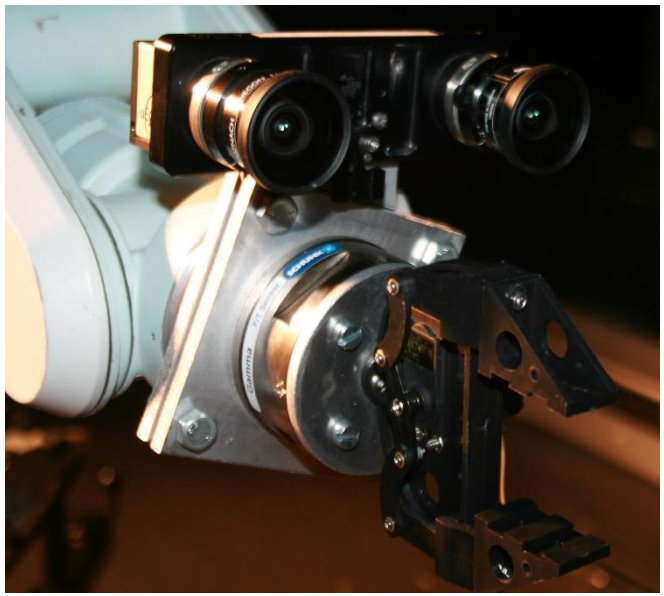


FACILITIES SET-UP AND HW INVOLVED -2

***Platform-art*:**

- Mitsubishi PA10 and KUKA (closed loop configuration)
- FARO system
- Load cell and compliance device
- Gripping device
- 6 DOF mock-up and cameras





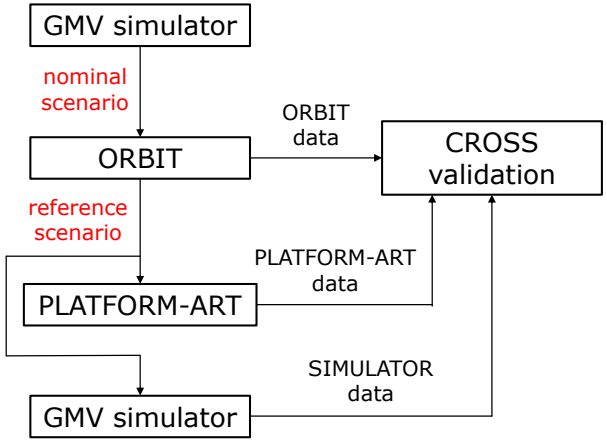
Scenarios definition

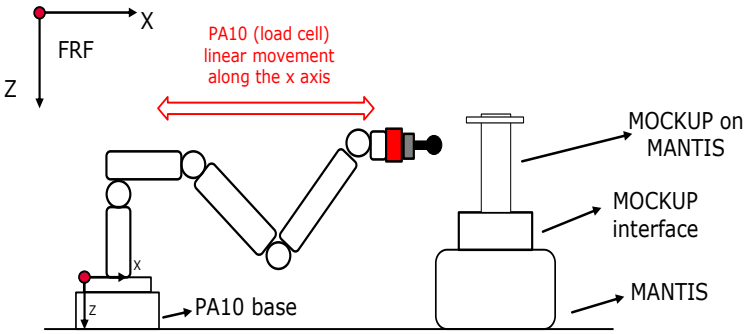
INNOVATING SOLUTIONS

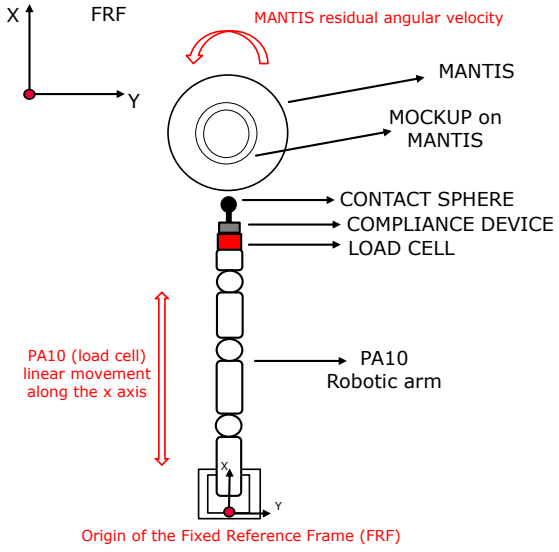
SCENARIOS DEFINITION -1

3 DOF test scenario:

- Both in ORBIT and ***platform-art*** for the cross-validation
- Test results also compared to simulation results using contact models
- Simple linear open loop trajectory of the PA10
- The mass of the chaser (PA10) is assumed to be significantly higher than the one of the target: no effect of the contact forces on the PA10 trajectory.



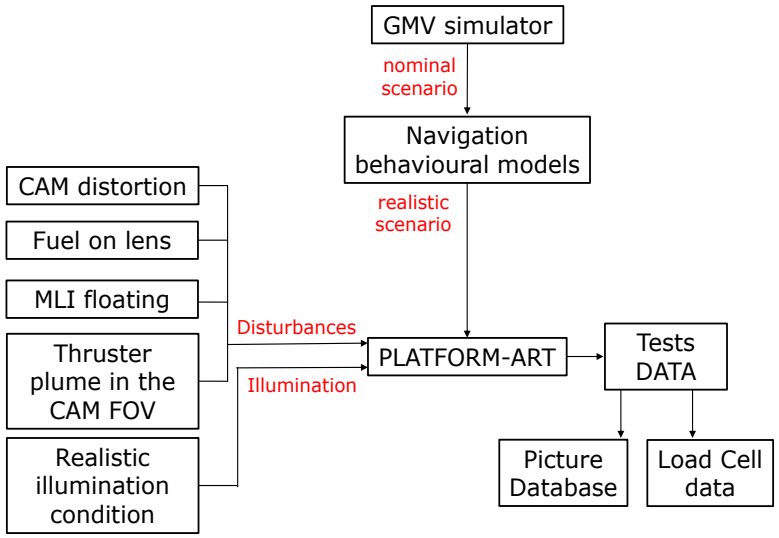


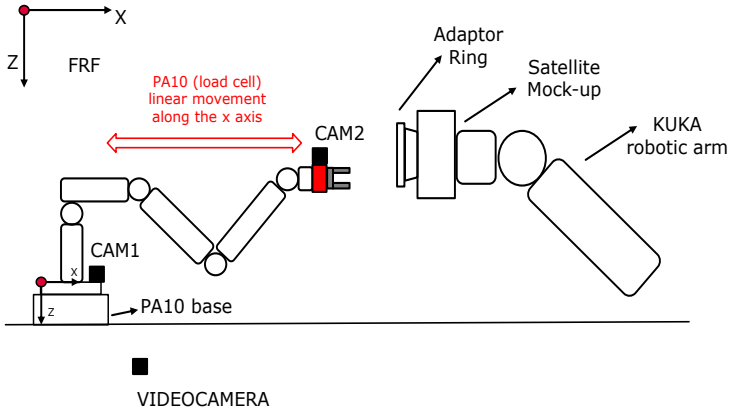


SCENARIOS DEFINITION -2

6 DOF test scenario:

- Only performed in ***platform-art***
- Test results are a pictures database and load cell data during gripping
- CAM1 is the navigation camera (MANTA industrial camera)
- CAM2 is a uEye camera for the gripping confirmation
- Simple linear open loop trajectory of the PA10
- Open loop trajectory of the KUKA to simulate angular synchronization with a tumbling debris
- Gripping at the end of the trajectory





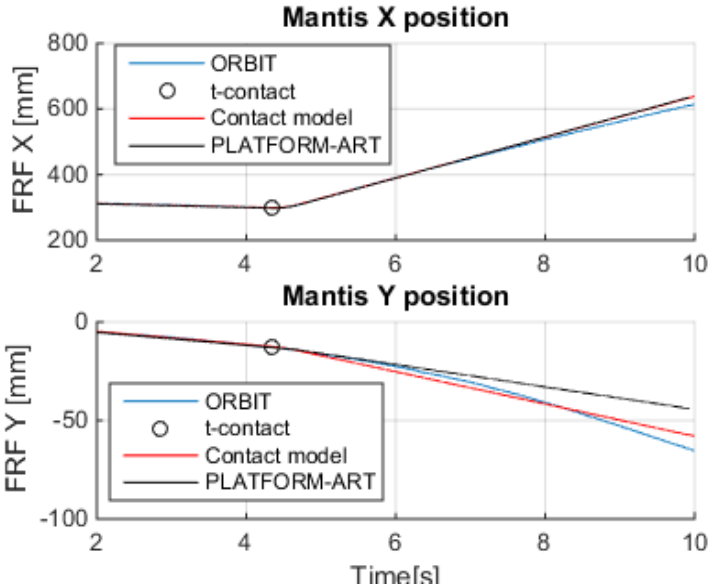
3 DOF tests results

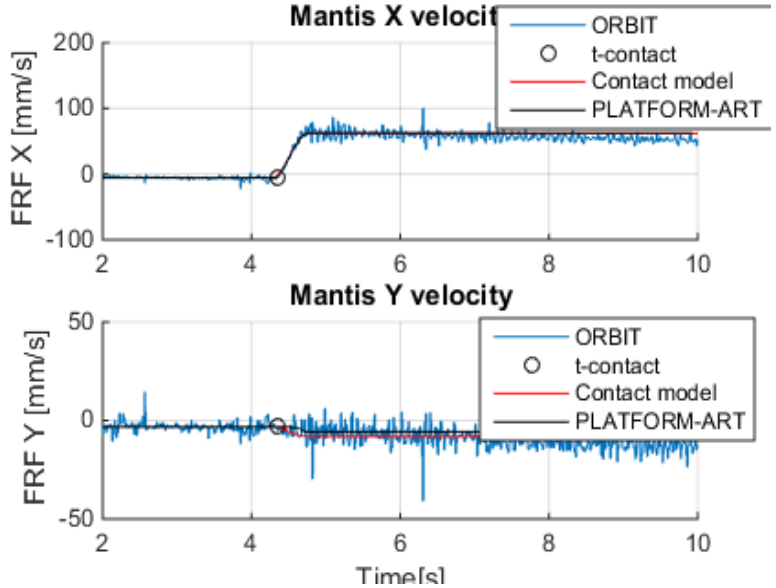
INNOVATING SOLUTIONS

3 DOF TESTS RESULTS -1

ORB-3DOF-SCT-002-A and PLT-3DOF-SCT-021-A

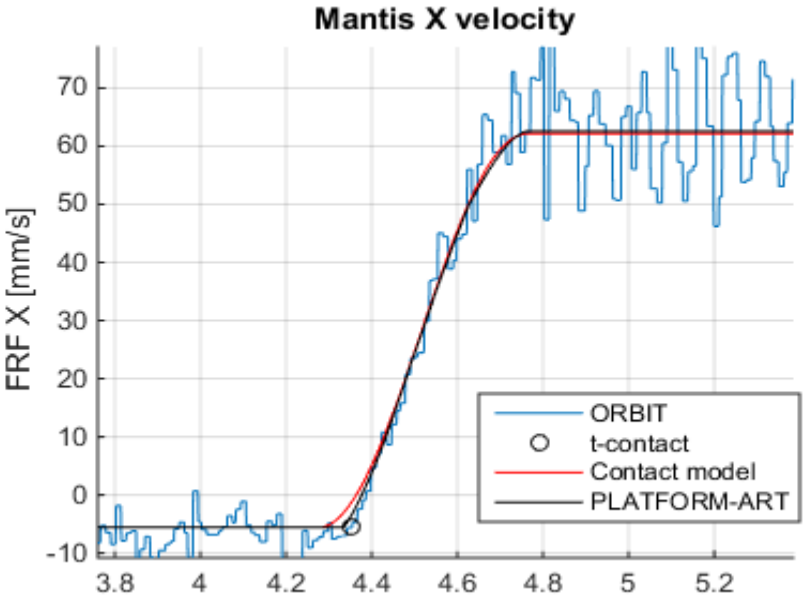
In these tests the Mantis (mass of 30 kg) air-bearing platform was adopted, with a linear velocity of the PA10 of 3 cm/s



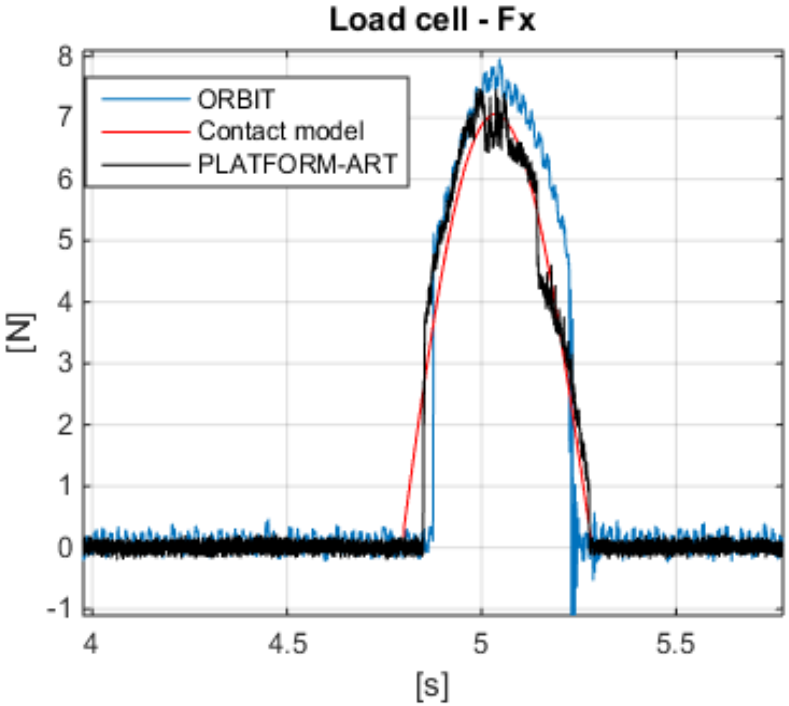


Evolution of the Mantis dynamic during and after the contact

3 DOF TESTS RESULTS -2



Zoom on the velocity evolution at the moment of contact

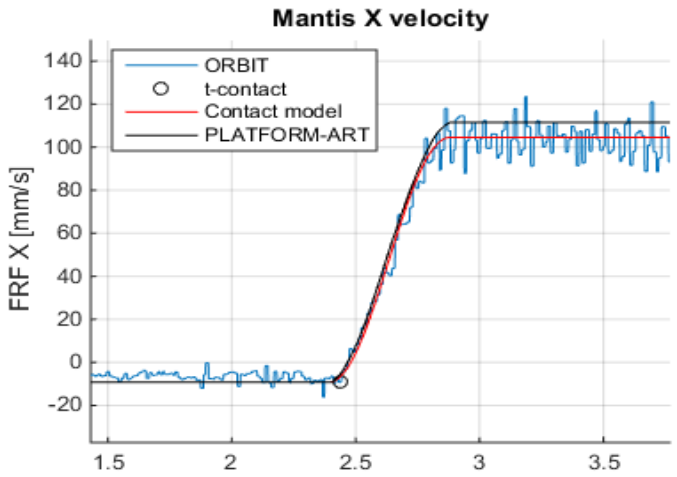


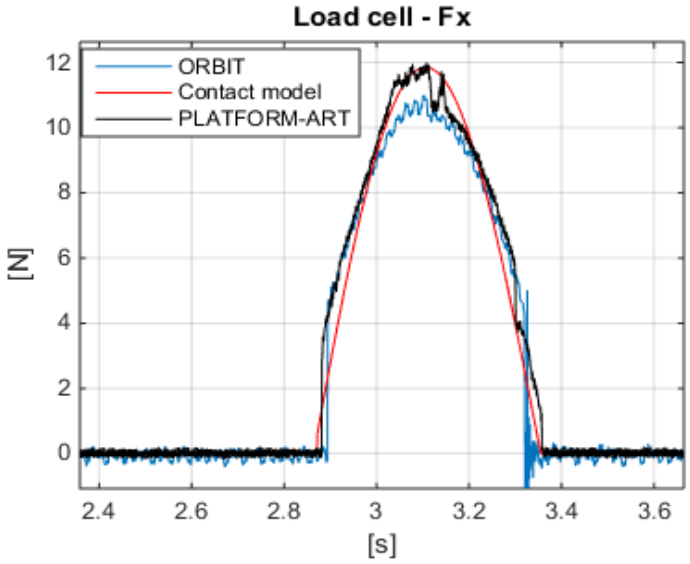
Load cell measurements recorded in both facilities and compared to the one resulting from the contact models

3 DOF TESTS RESULTS -3

ORB-3DOF-SCT-003-A and PLT-3DOF-SCT-022-A

In these tests the Mantis (mass of 30 kg) air-bearing platform was adopted, with a linear velocity of the PA10 of 5 cm/s





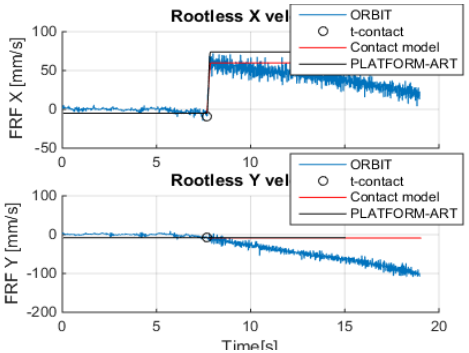
Still very good matching between experimental data in the two facilities and the simulated contact scenario

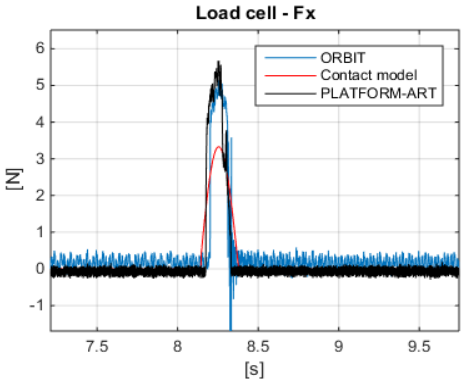
The data collected during the experiments will be further post-processed in order to find a figure of merit for the matching definition in all the cases.

3 DOF TESTS RESULTS -4

ORB-3DOF-SCT-010-C and PLT-3DOF-SCT-029-C

In these tests the Rootless (mass of 7.5 kg) air-bearing platform was adopted, linear velocity of the of 3 cm/s



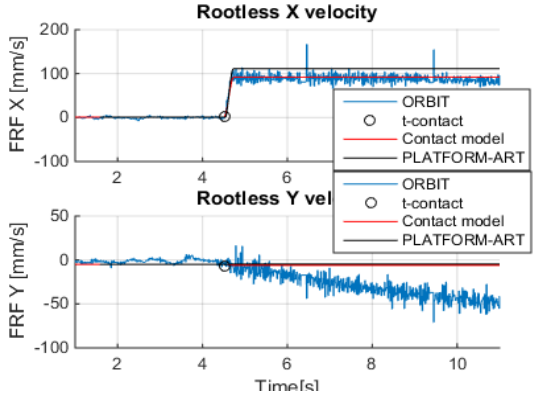


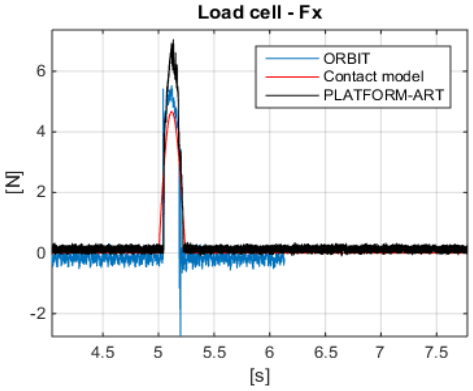
- Compliance device structural and operational errors not negligible

- Air-bearing more reactive to floor flatness imperfection

ORB-3DOF-SCT-011-C and PLT-3DOF-SCT-030-C

In these tests the Rootless (mass of 7.5 kg) air-bearing platform was adopted, linear velocity of the of 5 cm/s





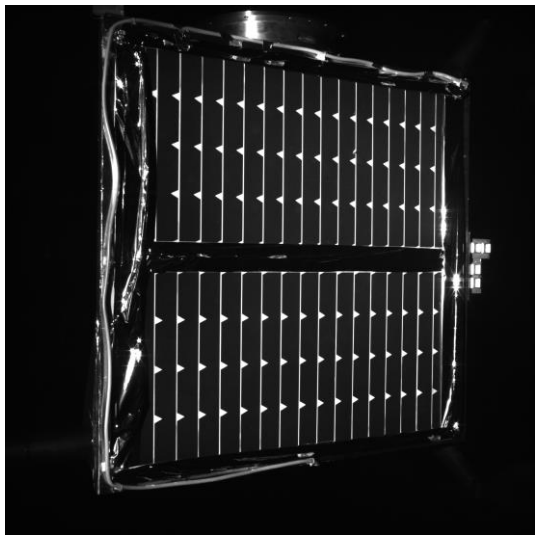
- Compliance device structural and operational errors not negligible

- With higher approach velocity and higher contact forces the relative impact of such errors is reduced (matching similar to the ones obtained for the Mantis platform)

6 DOF tests results

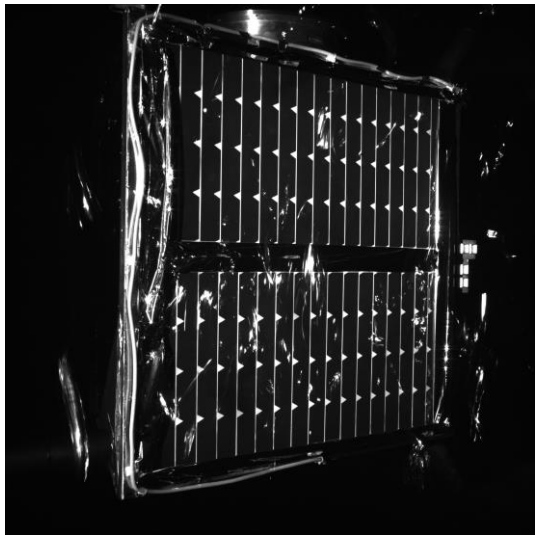
INNOVATING SOLUTIONS

6 DOF TESTS RESULTS -1



PLT-6DOF-GRI-IL1-042-D

(good illumination conditions – phase angle of 45 deg)

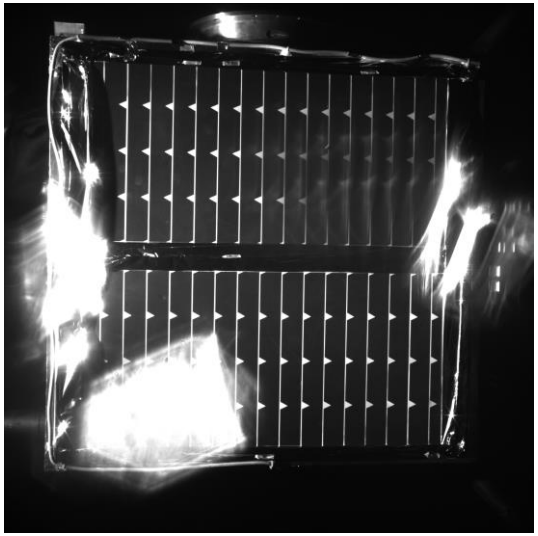


PLT-6DOF-GRI-MLI-040-D

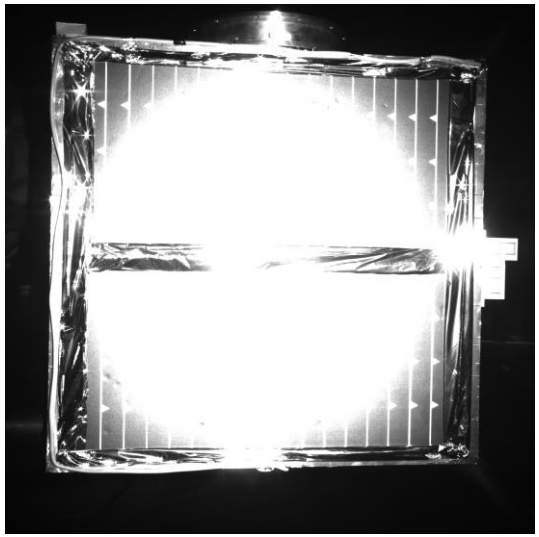
(pieces of MLI floating in the target vicinity)

PLT-6DOF-GRI-FOL-039-D

(fuel on the navigation camera lens)

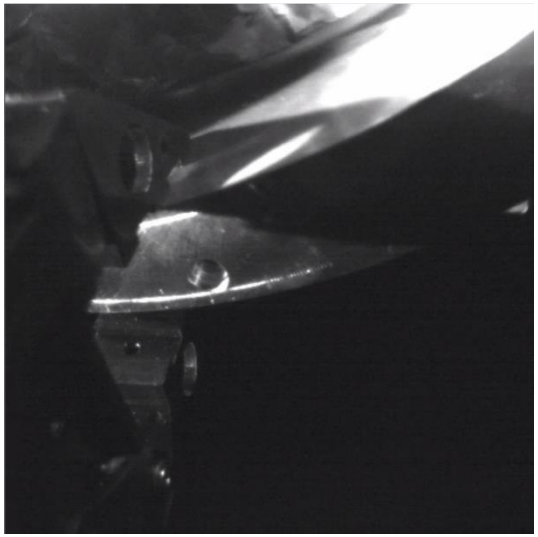


6 DOF TESTS RESULTS -2



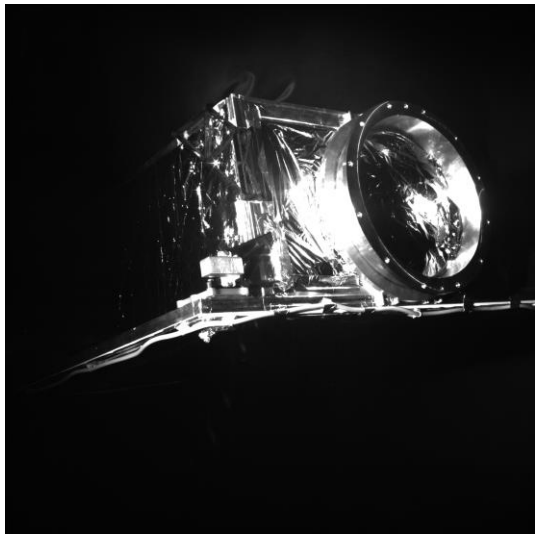
PLT-6DOF-GRI-IL4-045-D

(remarked MLI reflection – phase angle of 0 deg)



PLT-6DOF-GRI-IL1-042-D

(view from the tip camera)



PLT-6DOF-GRI-PLU-041-D

(thrusters in the FoV that resulted as an overexposed picture)

Conclusions

INNOVATING SOLUTIONS

CONCLUSIONS

General outputs of the cross-validation tests:

ORBIT operates with real contact and can be considered ground truth for contact forces. Items under test in ORBIT are also subject to small residual external forces after the initial impact, especially when low mass, inertia and velocity is involved and the experiment is run for an extended amount of time.

The ***platform-art*** facility considering safety and space limitations is more suitable for velocity in the range between 1-5 cm/s.
For reasons of stability of the closed-loop in ***platform-art***, the experiments should be defined using low stiffness and high damping values of the compliance device. Furthermore, low masses of the order of a few kilos should be avoided.
In case of low mass platform and low contact velocity, the design of the compliance device should be optimized. Structural and operational imperfections may have a not negligible effect on the experiment results.

The cross-validation has been carried out with very good results:

The cross-validation between the ORBIT test facility and the platform-art has been performed, showing promising results that should be considered as a first step for the contact dynamic study of even more complex scenarios.

6 DOF tests and picture database:

The activity also remarked the platform-art capability of re-creating a space-like scenario in terms of illuminations and disturbances reproduction. The database of images has been generated and it is ready to be used to test the robustness of image processing algorithms.


Thank you
gmv
INNOVATING SOLUTIONS