## The SUPVIS Justin Mars Experiment
"To Mars via ISS"

For the first time a humanoid robot called Justin, developed by the DLR Institute for Robotics and Mechatronics was demonstrated to have matured to an intelligent co-worker for astronauts. Justin could be remotely controlled via the international space station (ISS) to perform tasks in a simulated Mars solar farm environment during the SUPVIS experiment. During the experiment ESA astronaut Paolo Nespoli operated "rollin' Justin" in the analog Mars solar farm simulator at DLR Oberpfaffenhofen, Germany from the ISS on 25 August 2017.
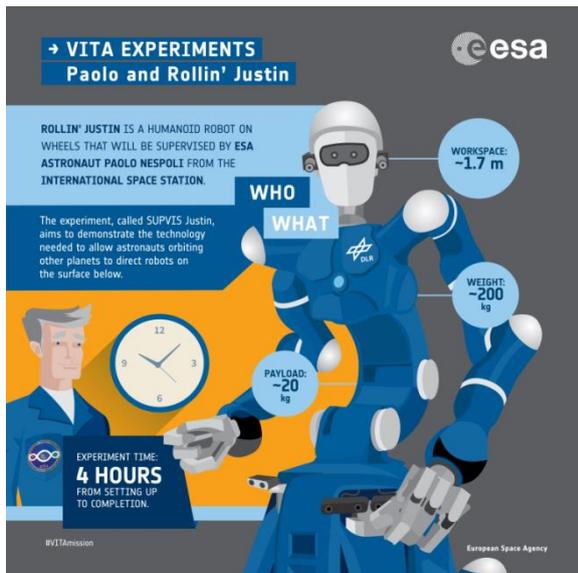
SUPVIS Justin experiment infographic [4]
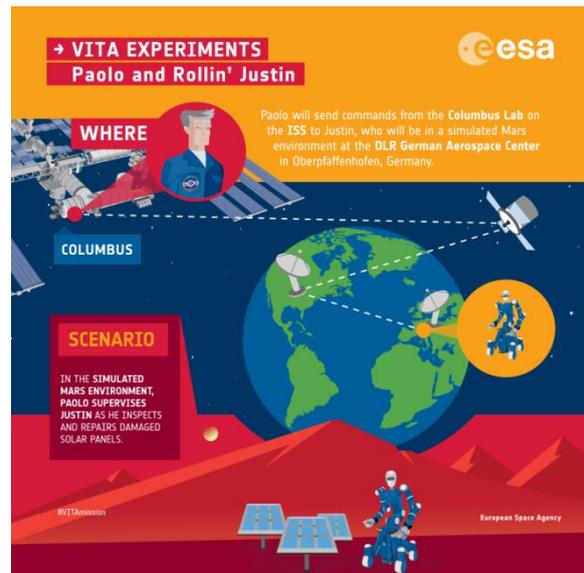
*SUPVIS Justin communications set-up [4]*

The experiment was part of ESA's METERON (Multipurpose end-to-end Robotic Operations Network) project, a project which aims to develop strategies to allow astronauts to control robots from orbit to carry out complex dexterous tasks with significant communication round-trip times as pioneered by the DLR Institute for Robotics in in 1990's with the ROTEX experiment during the D-2 spacelab mission.

The SUPVIS Justin experiment as part of a series of other experiments successfully demonstrated the supreme local intelligence of the robot required to interpret and execute an astronaut's command: the control concept consisted of high level commands issued by the supervising astronaut, relying on the robot to autonomously diagnose (and report) any problems and rely on his built-in "artificial" intelligence to perform the next appropriate subsequent steps – thus circumventing possible delay-time and loss of communications problems (disruption tolerant system - DTS). [2]

The experiment tasked Justin, based in the Mars analog simulator Oberpfaffenhofen, with finding and diagnosing faulty solar panels of the solar farm. Paolo, orbiting at 28 800 km/h at an altitude of 400 km in low earth orbit (LEO), used a tablet PC to work with Justin and instructed him to inspect three solar panels of the Mars–farm to find a solar panel anomaly. He then instructed Justin to plug in a diagnostic tool generate and upload an error log.

Justin approaching one of the solar panels for inspection at the simulator at DLR Oberpfaffenhofen. [1]
Justin pluggin in a diagnostic tool for checking and analyzing the simulated solar panel anomaly.[1]
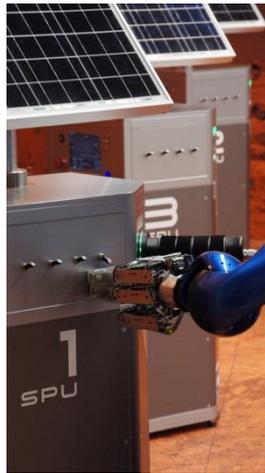
Paolo Nespoli on board the ISS during the experiment showing the SUPVIS experiment logo with the mobile control tablet PC in the background. [5]

With limited crew time available, the SUPVIS Justin teams, both in space and on the ground, had to become very efficient in running the experiment. With an additional 15 minutes crew time and with the help of two other astronauts (Jack Fischer, and Randy Bresnik) the team was able to successfully complete the last of the four scheduled protocols during the last minute of the time slot, and it looks like that all the hard work in the past several years to design and implement a nimble and robust robot-system really paid off. [3]

In summary, the four scheduled protocols were carried out, and de-briefing questionnaires from the three crew members were collected. It is now up to the SUPVIS-Justin team to study these unique data and the astronauts' inputs to design the next SUPVIS Justin experiment protocol, slated for the next 3-6 months from now. [3]

These METERON-Justin tests were chosen to enact future scenarios in which astronauts orbiting distant planets and moons can instruct robots to do difficult or dangerous tasks like setting up base before astronauts might be landing on uncharted territory for further exploration.

However, it should be mentioned that the "intelligent co-worker" concept will also be helpful for future terrestrial applications ("free the robots from their safety-cage") with emphasis on the development of intelligent, intrinsically compliant humanoid robots to cooperate with their supervisors on an "eyeball to eyeball" level.

References:

[1] http://m.esa.int/spaceinimages/Images/2017/09/Justin_during_experiment

[2] http://meteron.dlr.de/supvis-justin/

[3] http://meteron.dlr.de/iss-crew-have-a-blast-with-supvis-justin/

[4] justin/http://blogs.esa.int/VITAmission/2017/08/25/supvis-justin-experiment-an-infographic/

[5] Reference: Internal DLR/GSOC Col-CC Report, August 2017