DRAGONS – A Micrometeoroid and Orbital Debris Impact Sensor on the ISS

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The Debris Resistive/Acoustic Grid Orbital Navy-NASA Sensor (DRAGONS) is intended to be a large area impact sensor for in situ measurements of micrometeoroids and orbital debris (MMOD) in the sub-millimeter to millimeter size regime in the near Earth space environment. These MMOD particles are too small to be detected by ground-based radars and optical telescopes, but still large enough to be a serious threat to human space activities and robotic missions in the low Earth orbit (LEO) region. The nominal detection area of DRAGONS is 1 m^2, consisting of four 0.5 m × 0.5 m independent panels, but the dimensions of the panels can easily be modified to accommodate different payload constraints. The approach of the DRAGONS design is to combine three particle impact detection concepts to maximize information that can be extracted from each detected impact. The first is a resistive grid consisting of 75-µm-wide resistive lines, coated in parallel and separated by 75 µm gaps on a 25-µm thin film. When a particle a few hundred micrometers or larger strikes the grid, it would penetrate the film and sever some resistive lines. The size of the damage area can be estimated from the increased resistance. The second concept is based on polyvinylidene fluoride (PVDF) acoustic impact sensors. Multiple PVDF sensors are attached to the thin film to provide the impact timing information. From the different signal arrival times at different acoustic sensors, the impact location can be calculated via triangulation algorithms. The third concept employs a dual-layer film system where a second 25-µm film is placed 15 cm behind the resistive-grid film. Multiple PVDF acoustic sensors are also attached to the second film. The combination of impact timing and location information from the two films allows for direct measurements of the impact direction and speed.
The DRAGONS technology development has been funded by several NASA organizations since 2002, first by the NASA Science Mission Directorate and the NASA Exploration Systems Mission Directorate, then by the NASA JSC Innovative Research and Development Program and the NASA Orbital Debris Program Office. The NASA Orbital Debris Program Office leads the effort with collaboration from the U.S. Naval Academy, Naval Research Laboratory, University of Kent at Canterbury in Great Britain, and Virginia Tech. The project recently reached a major milestone when DRAGONS was approved for a technology demonstration mission by the International Space Station (ISS) Program in October 2014. The plan is to deploy a 1 m^2 DRAGONS on the ISS with the detection surface facing the ram-direction for 2 to 3 years. The tentative launch schedule is in early 2017. This mission will collect data on orbital debris in the sub-millimeter size regime to better define the small orbital debris environment at the ISS altitude. The mission will also advance the DRAGONS Technology Readiness Level to 9 and greatly enhance the opportunities to deploy DRAGONS on other spacecraft to high LEO orbits in the future.