



Contribution ID: 49

Type: **Invited oral presentation**

Environmental Quality Control in space systems: the experience of the International Space Station

Wednesday, November 30, 2011 6:15 PM (30 minutes)

Human spaceflight is a challenging endeavor, requiring a high degree of environmental control and life support for astronauts comfort and safety. The control of environmental conditions in a broad sense is of paramount importance, involving the monitoring of both natural and artificial environmental parameters. The International Space Station (ISS) is the main current human space infrastructure, in Low Earth Orbit, displaying an array of monitoring and control features for the control of its confined environment.

Ionizing radiation from Solar and Galactic sources is a major threat in space, monitored via a set of particle detectors and dosimeters.

The control of the confined atmospheric environment includes monitoring of e.g.:

- Total pressure
- Major constituents (N₂, O₂, CO₂, ...)
- Trace gas contaminants
- Cabin air temperature

Smoke detectors ensure early warning for potential fires on board.

Measurements are fed into control logics locally, within a pressurized module, or centrally, in the core station. They can assist Fault Detection, Isolation and Recovery (FDIR), and be transmitted to ground via telemetry. This paper describes in particular the Columbus approach, which is under direct European control.

The ISS environment monitoring experience is of special interest when looking at future long duration exploration missions. In fact, for such missions there will be challenging and possibly conflicting requirements of increased control and crew versus ground autonomy.

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Session Classification: Measurements of Temperature and Density