# The International Space Station Urine Monitoring System (UMS)

Daniel L. Feeback, Ph.D.[1], Branelle R. Cibuzar[2], Jeffery R. Milstead[3], Robert A. Pietrzyk, M.S.[4], Mark S.F. Clarke, Ph.D.[5]

[1]National Aeronautics and Space Administration, Johnson Space Center, Human Adaptations and Countermeasures Division, Houston, Texas; [2]National Aeronautics and Space Administration, Johnson Space Center, Life Support and Habitability Systems Branch, Houston, Texas; [3]Lockhead Martin Mission Services, Houston, Texas; [4]Wyle, Houston, Texas; [5]University of Houston, Department of Human Health and Performance, Houston, Texas.

## ABSTRACT

A device capable of making in-flight volume measurements of single void urine samples, the Urine Monitoring System (UMS), was developed and flown on seven U.S. Space Shuttle missions. This device provided volume data for each urine void from multiple crewmembers and allowed samples of each to be taken and returned to Earth for post-flight analysis. There were a number of design flaws in the original instrument including the presence of liquid carry-over producing invalid "actual" micturition volumes and cross-contamination between successive users from residual urine in "dead" spots". Additionally, high or low volume voids could not be accurately measured, the on-orbit calibration and nominal use sequence was time intensive, and the unit had to be returned and disassembled to retrieve the volume data. These problems have been resolved in a new version, the International Space Station (ISS) UMS, that has been designed to provide real-time in-flight volume data with accuracy and precision equivalent to measurements made on Earth and the ability to provide urine samples that are unadulterated by the device. Originally conceived to be interfaced with a U.S.-built Waste Collection System (WCS), the unit now has been modified to interface with the Russian-supplied Sanitary Hygiene Device (ASY). The ISS UMS provides significant advantages over the current method of collecting urine samples into Urine Collection Devices (UCDs), from which samples are removed and returned to Earth for analyses. A significant future advantage of the UMS is that it can provide an interface to analytical instrumentation that will allow real-time measurement of urine bioanalytes allowing monitoring of crewmember health status during flight and the ability to provide medical interventions based on the results of these measurements. Currently, the ISS UMS is scheduled to launch along with Node-3 on STS-130 (20A) in December 2009. UMS will be installed and scientific/functional verification completed prior to placing the instrument into operation. Samples collected during the verification sequence will be returned for analyses on STS-131 (19A) currently scheduled for launch in March 2010. The presence of a UMS on ISS will provide the capability to conduct additional collaborative human life science investigations among the ISS International Partners.

## WHAT IS THE ISS UMS?

- Space flight qualified hardware that interfaces with on-board waste collection facilities to allow the measurement of the volume of each urine void and the capability to acquire samples (ambient and frozen) for stowage and subsequent analysis.
- The ISS UMS is provided by EC3 as GFE to the Human Research Program (HRP) as a science payload.
- In the next enhancement, it is envisioned that analytical equipment will be developed to interface directly with the UMS in order to provide near real-time analyte measurements incorporating the volume data provided by UMS.

## WHAT ARE THE SCIENCE/OPERATIONS NEEDS?

- ***Urine samples enable non-invasive protocols to assess human physiology during space flight (provides health/welfare information about crew):***
  - Facilitates monitoring/evaluation of crew health
  - Critical for countermeasure validation
  - Reduce need for blood samples
- **For interplanetary exploration missions, the only viable approach for assessing crew health and the efficacy of in-flight medical interventions is to develop in situ analytical technologies**
- **Mitigate renal stone risk and bone loss during long duration space flight**
- **Provides headstart for technologies/hardware required for use on a Mars CEV and explorational outposts**
- ***Overarching science "need":***
  - Determine individual void volume (e.g., fluid output)
  - Determine 24-h volume (e.g., clearance data)
  - Determine and measure urine constituents (e.g., solute concentrations)
  - Real-time analyses of urine constituents (countermeasure evaluation and validation, real-time medical intervention) in enhanced version (future development)

## LIMITATIONS OF CURRENT SYSTEM (UCDs)

**Urine Collection Devices (UCDs), although simple, have multiple shortcomings including:**

- Significant crew time requirement
- Negative crew comments
- Gender interface issues
- UCD imperfections – leakage
- Significant launch up mass for collection and trash storage supplies
- On-orbit stowage and disposal of large quantities of leftover and potentially hazardous urine
- Lithium (volume marker) limitations – disposal and mixing issues
- Impact on water system – Voids are "lost" to water reclamation system when UCDs are used; lithium would be introduced into reclamation system if UCD contents are reclaimed

## SPECIFICATIONS

- **Mass (Mechanical Module)**
  50 lb (23 kg)
- **Dimensions (Mechanical Module)**
  17" x 9" x 9" (43.2cm x 22.9cm x 22.9cm)
- **Vehicle Connections**
  - Electrical power: 28 VDC; 10 Amps
  - Urine/air: 0.875-in internal diameter hose connections
  - Potable (flush) water: 0.250-in diameter quick disconnect
  - Requires air flow from downstream fan (ACY & Kabine)
- **Crew Interface**
  - IBM A31p Laptop (Space Station Laptop)
  - Runs application specific hardware
  - Software display provides real-time volume data, sample ID stamp for each acquired sample, system status and crew intervention messages when required
  - Urine funnel is similar to Space Shuttle WCS, no gender specific interfaces

## UMS DEPLOYED CONFIGURATION WITH ASY & KABINE