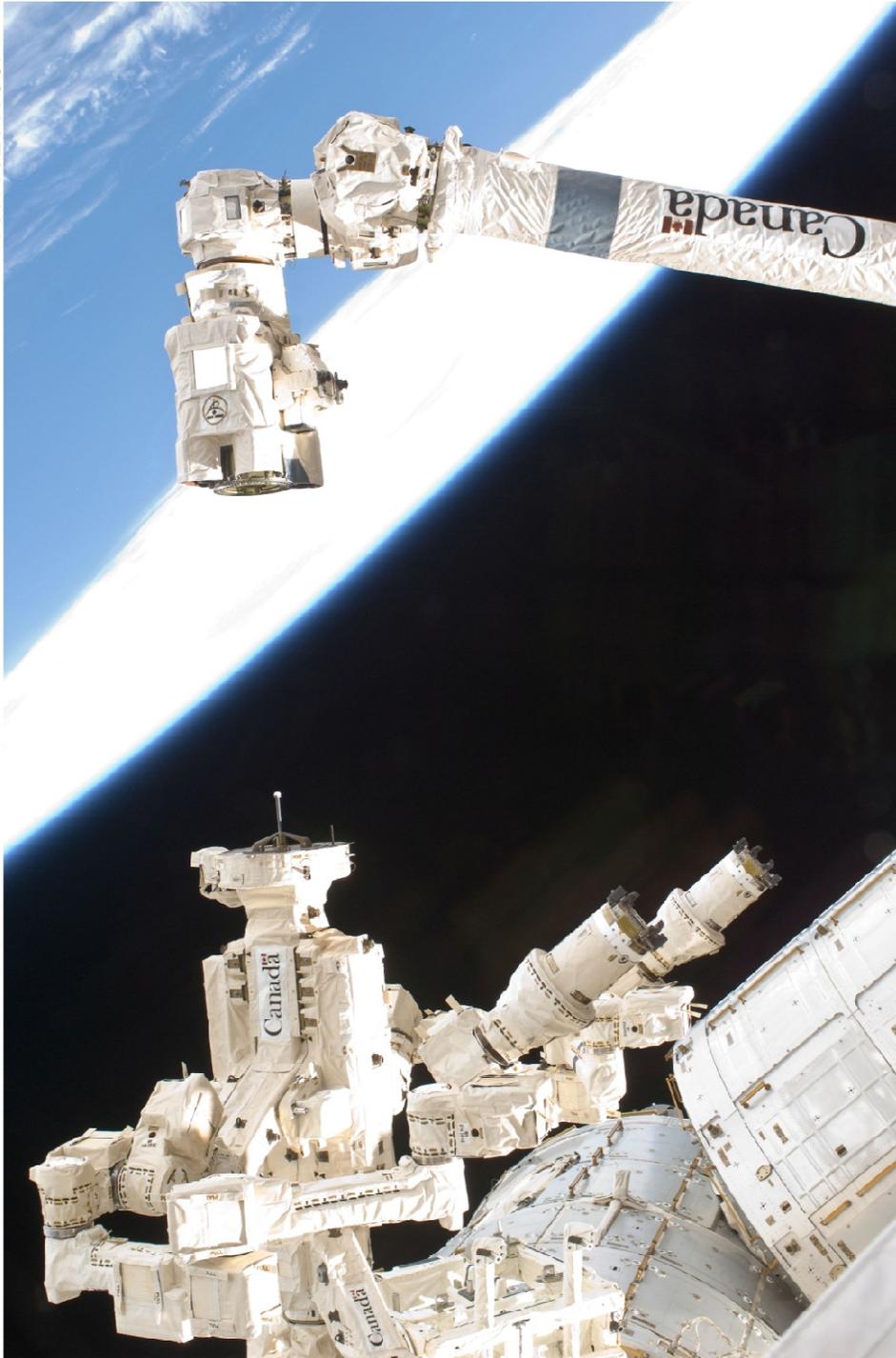


ISS026E011834



# Dexterous Execution of RRM on ISS

## Satellite Servicing Workshop

Goddard Space Flight Center

P. Andrew Keenan

Canadian Space Agency

24May2012



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# MSS and GSFC's RRM



1 03 S1LOOB P: -131.2 T: 44.3 NONE  
Z: 8.5 F: 1000.0 I: 1.0 Safed



24-May-2012

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# Canadian Space Robotics Today



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ISS027E006921



# External Maintenance and Dextre



Dextre's "hand"  
with tool

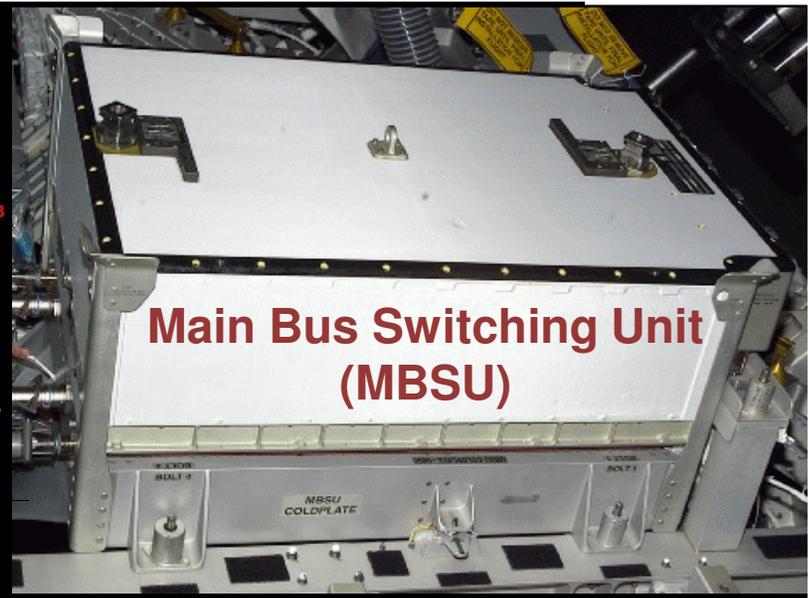
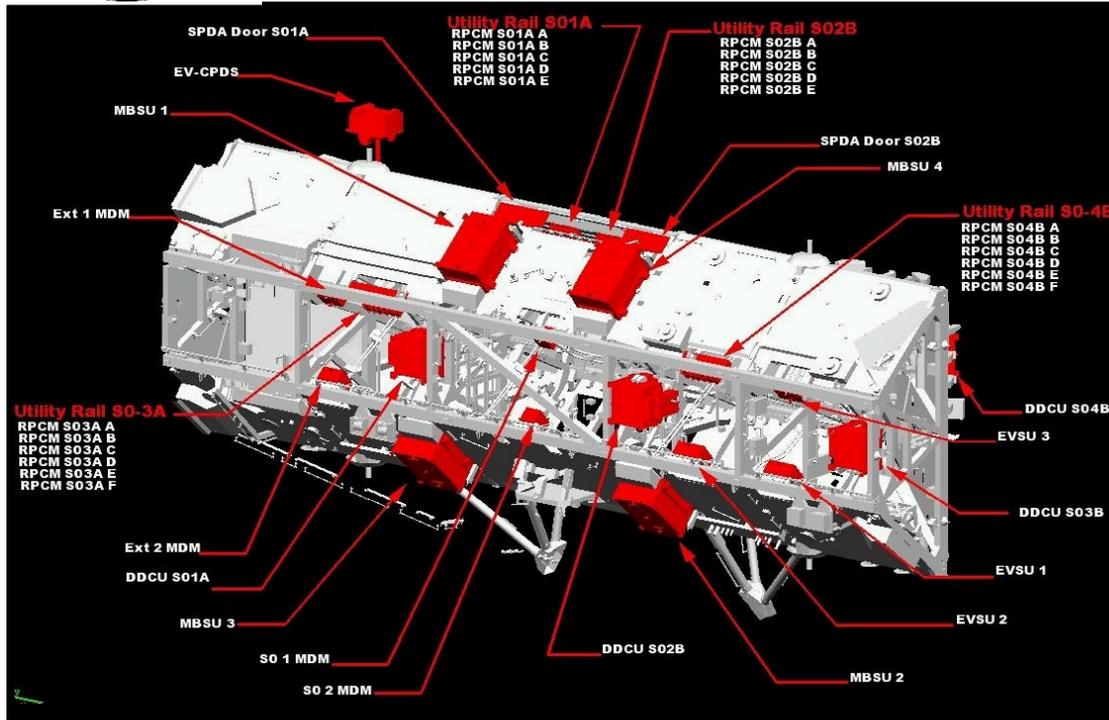
Failed Remote Power  
Control Module (RPCM)

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# Maintenance Task List



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# Ground Control and MSS



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# RRM Overview



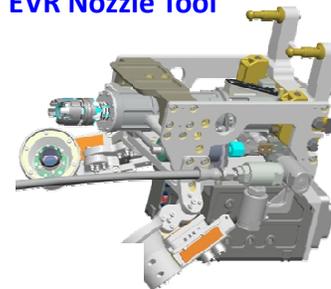
**Each RRM Tool has cameras designed to maximize situation awareness for the ground operators**

**Dextre provides camera power and supports video transfer to ground**

**Safety Cap Tool**

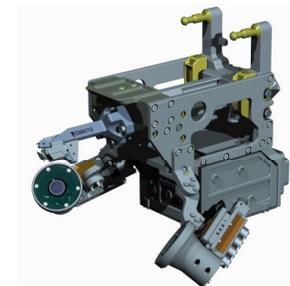


**EVR Nozzle Tool**

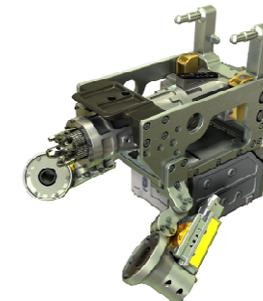


**Imagery courtesy NASA/GSFC**

**MLI/Wire Cutter Tool**



**Multi-Function Tool**





# RRM Delivery to ISS on Atlantis

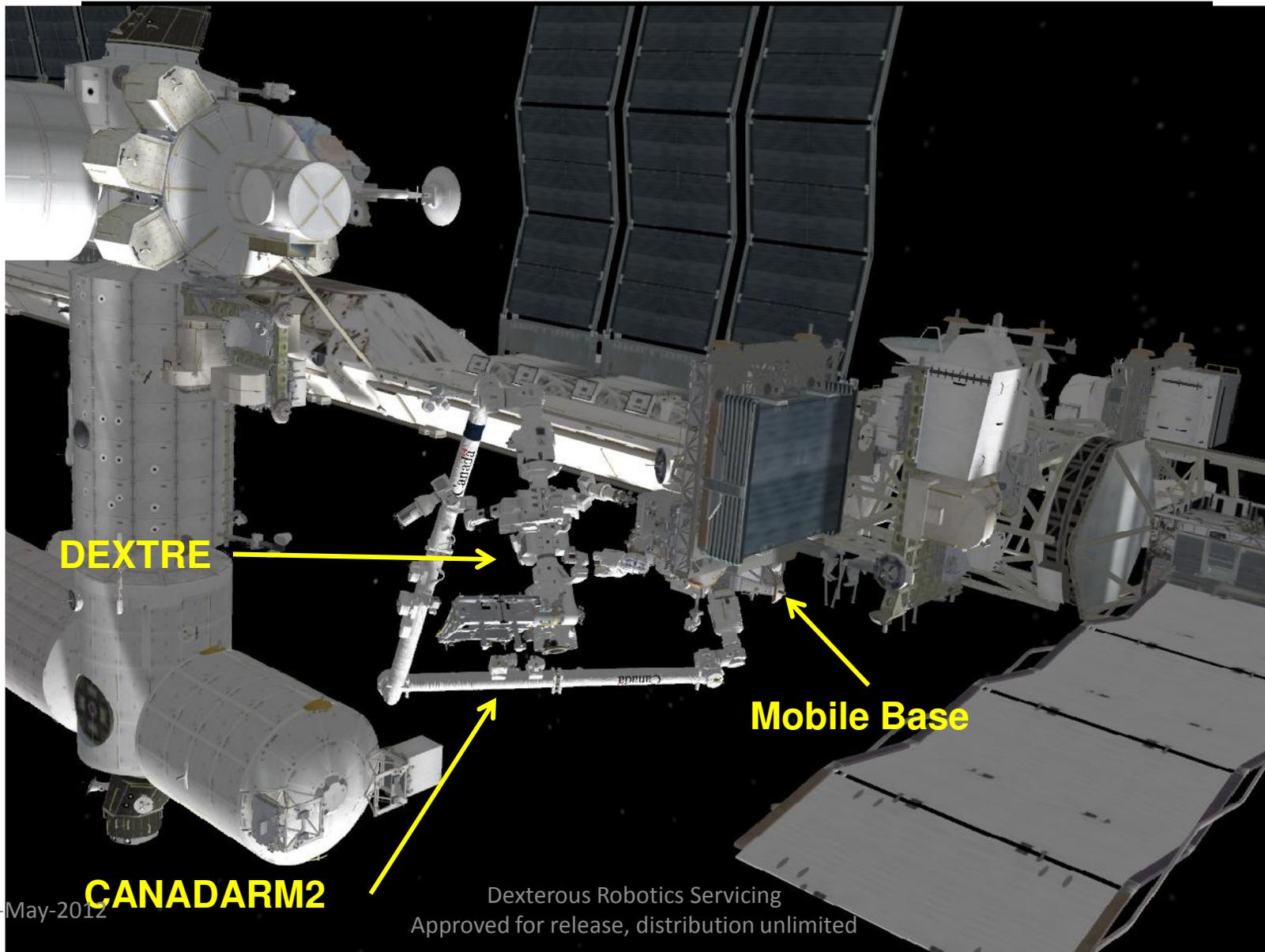


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# ISS Landscape



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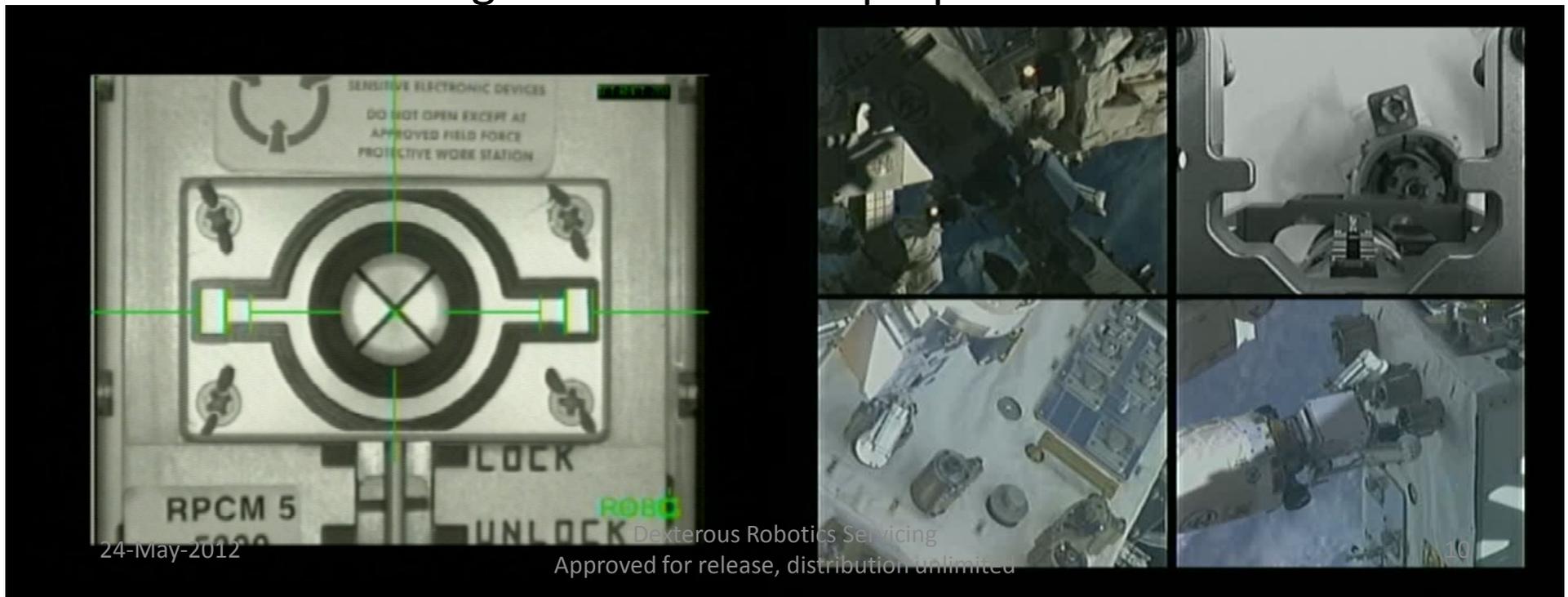
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# RRM Readiness & Challenges



- ❑ Required positional and trajectory accuracy requirements exceed normal dexterous operational requirements
  - +/-6mm -> +/-2mm or less
  - +/-1deg -> +/- 0.5deg or less
- ❑ ISS H/W is designed or “prepared” for dexterous manipulation whereas existing satellites are “unprepared”





# Mission Overview

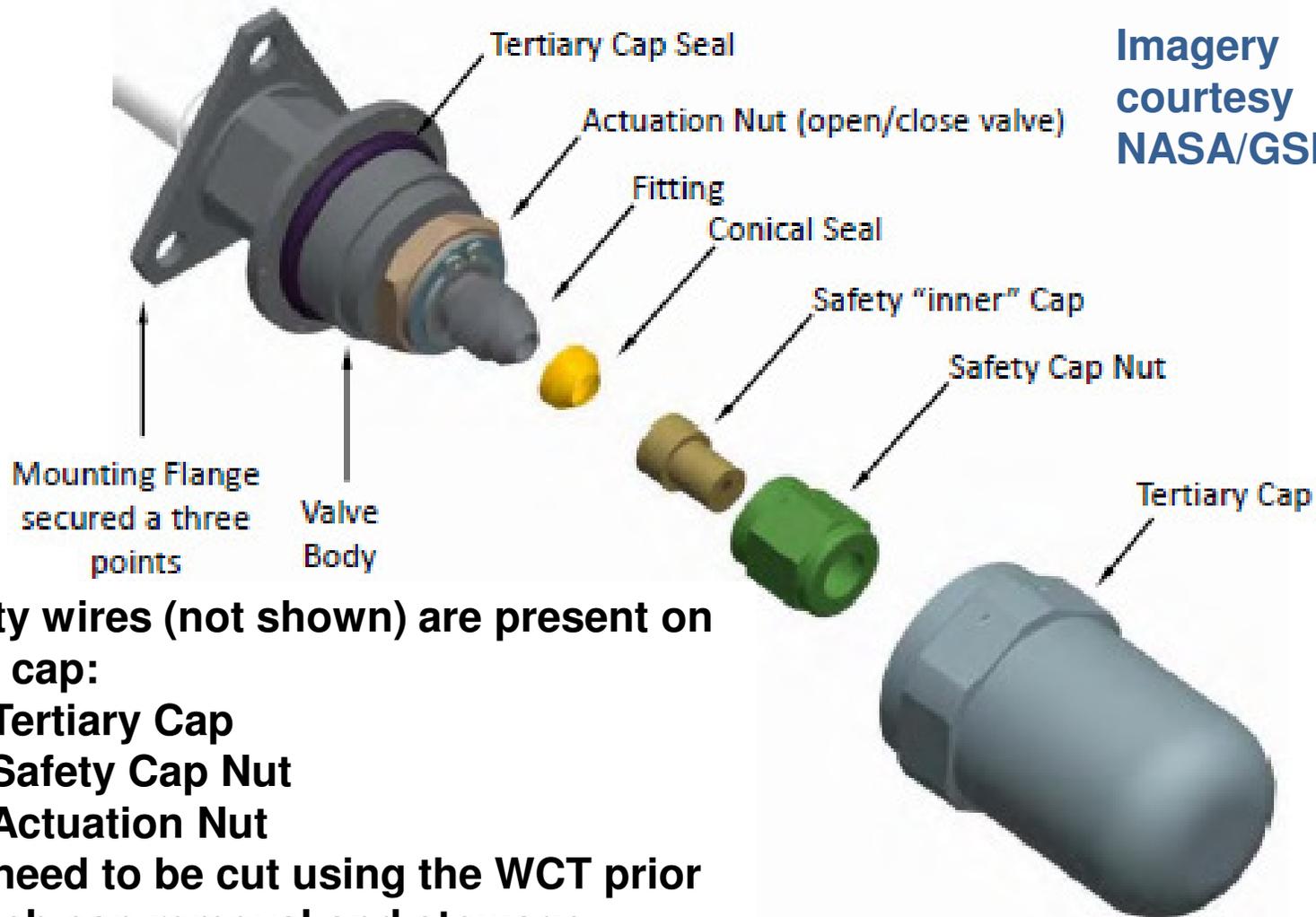
## Coolant Valve Manipulation





# Mission Overview

## Refuelling



**Safety wires (not shown) are present on each cap:**

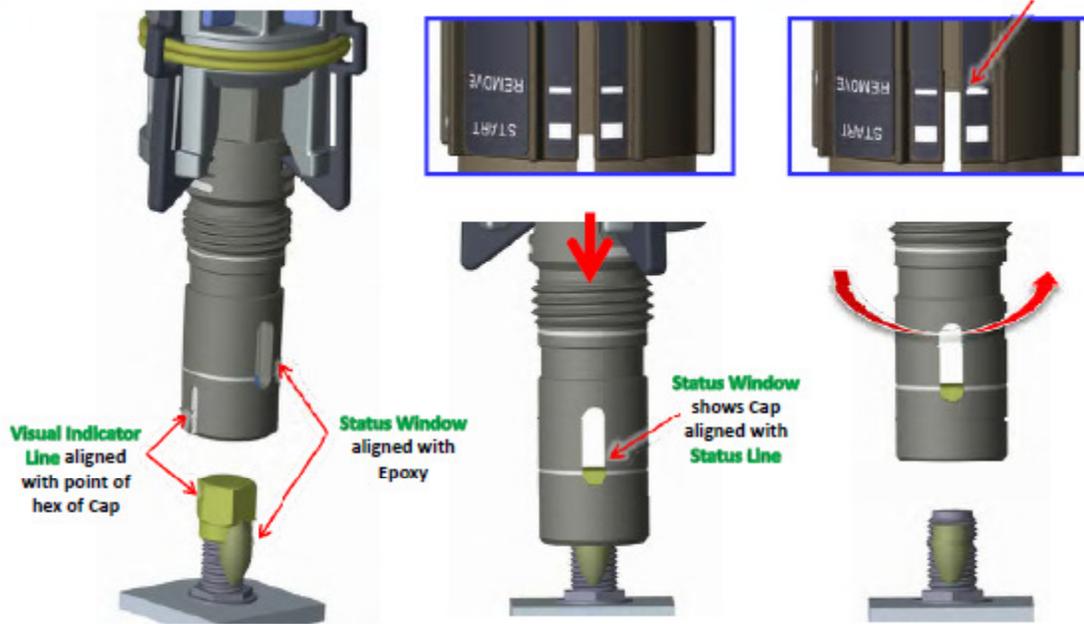
- Tertiary Cap**
- Safety Cap Nut**
- Actuation Nut**

**and need to be cut using the WCT prior to each cap removal and stowage**



# Mission Overview

## Electrical Connection Access



Imagery  
courtesy  
NASA/GSFC





# CSA Involvement with RRM



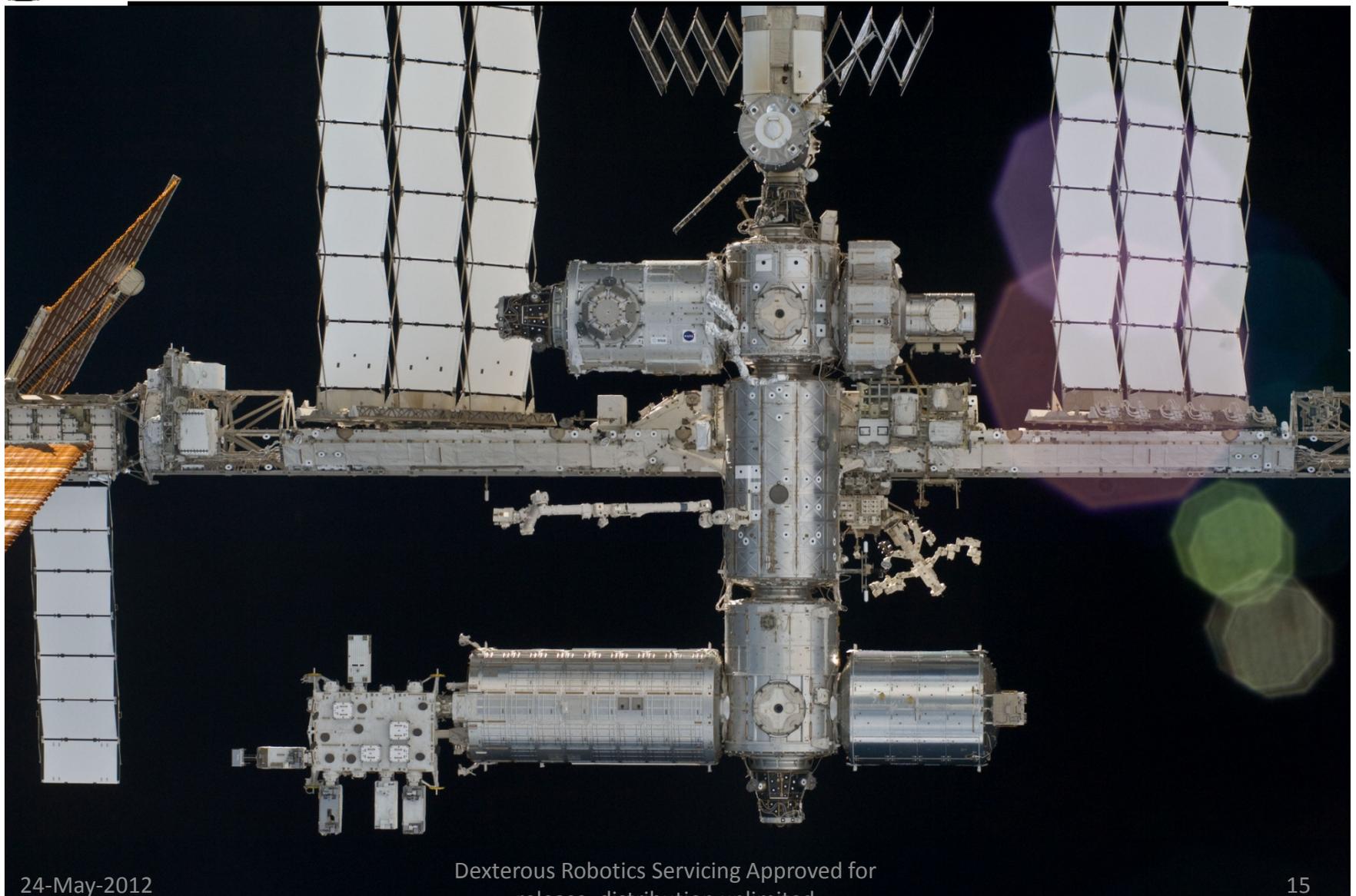
**Astronauts Samantha Cristoforetti (ESA) and David Saint-Jacques (CSA) with CSA robotics trainer Daniel Katzman in the MSS Operations and Training Simulator (MOTS)**

**MacDonal Dettwiler & Associate's (MDA's) Ground Testbed (GT) simulator for Dextrous robotics in Brampton, Ontario – used to perform operational tests with RRM hardware**





# MSS at Work



24-May-2012  
S130E012215

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