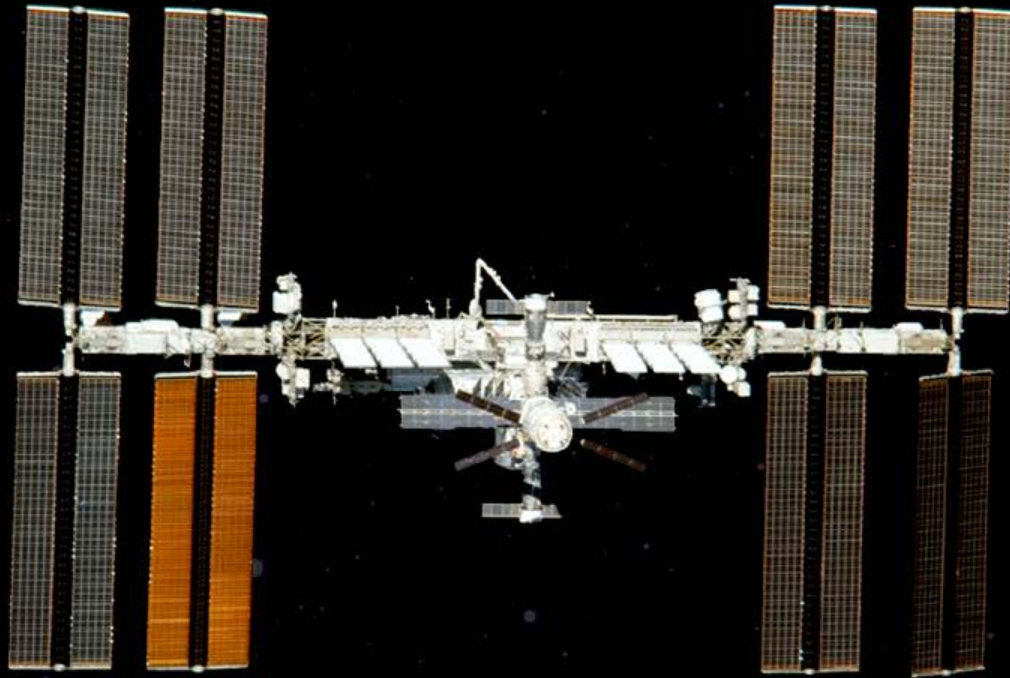


Introduction to the International Space Station



Presenter: Donna L. Dempsey

Outline



International Partners and Crew



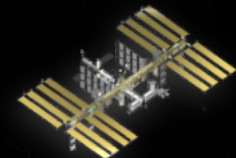
Research Modules and External Payloads



Airlocks and Robotics



More Modules



ISS Video Tour and Assembly Sequence

**International
Partners**

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



INTERNATIONAL PARTNERS AND CREWS

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

International Partners

- NASA (National Aeronautics & Space Administration)
- RSA (Russian Space Agency)
- CSA (Canadian Space Agency)
- JAXA (Japanese Aerospace Exploration Agency)
- ESA (European Space Agency)
 - *Comprised of 22 member states, 11 of which are participating in ISS*
- International effort of 15 countries



United States



Russia



Canada

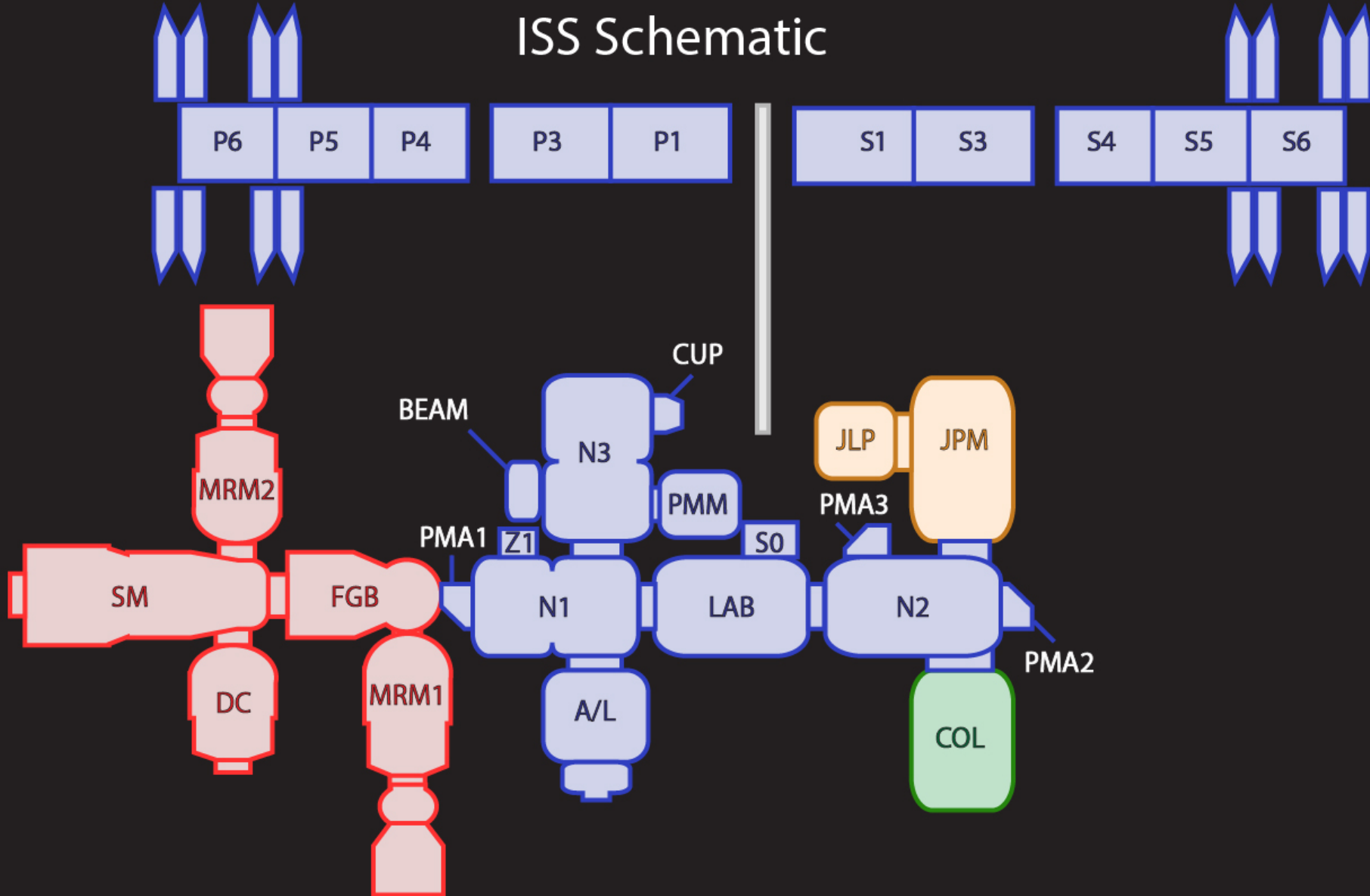


Japan



Europe

ISS Schematic



Legend (Colored by IP Element)

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

Crew Complement

- Proportional to IP's contribution to program's operation
 - The crew compliment in a typical year is:
 - 6 Russian cosmonauts
 - 4 NASA astronauts
 - 1 ESA astronaut
 - 1 JAXA astronaut
 - Every few years, there is
 - 1 CSA astronaut



International
Partners

Core
Systems

More
Modules

**Research
Modules**

Airlocks/
Robotics

ISS Video/
Assembly



RESEARCH MODULES AND EXTERNAL PAYLOADS

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

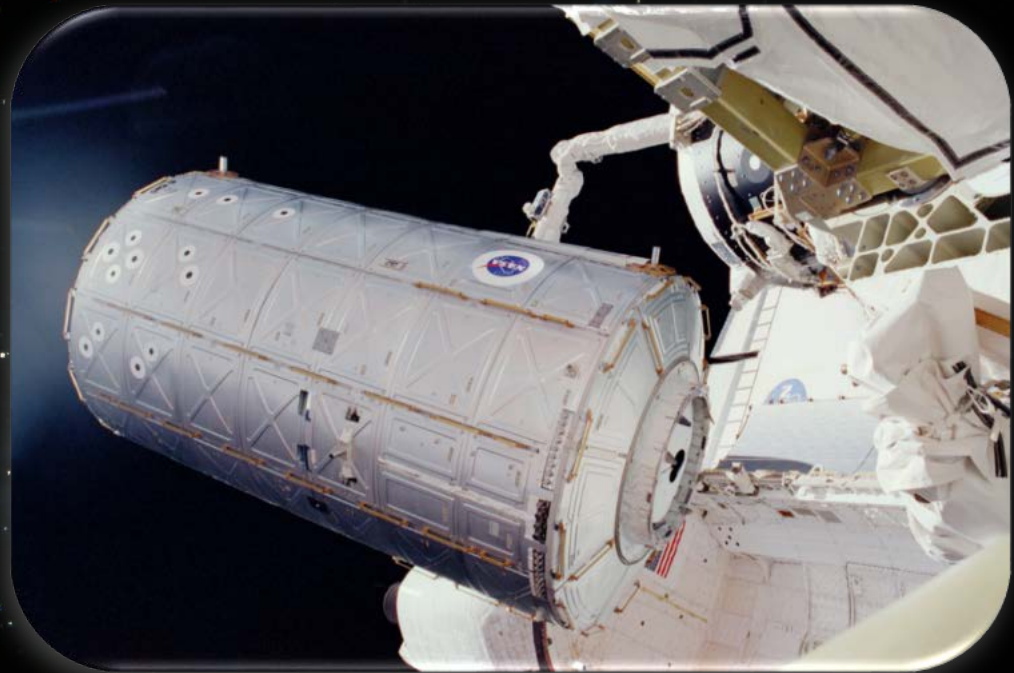
LAB

US Laboratory

- NASA research laboratory
 - 24 rack locations, 13 designated for payload racks
 - Launched with 5 racks
- Contains many distributed systems
- Built and launched by NASA
- aka "Destiny"



LAB Installation

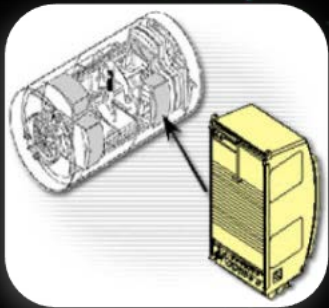


LAB on Shuttle Remote Manipulator System (SRMS)

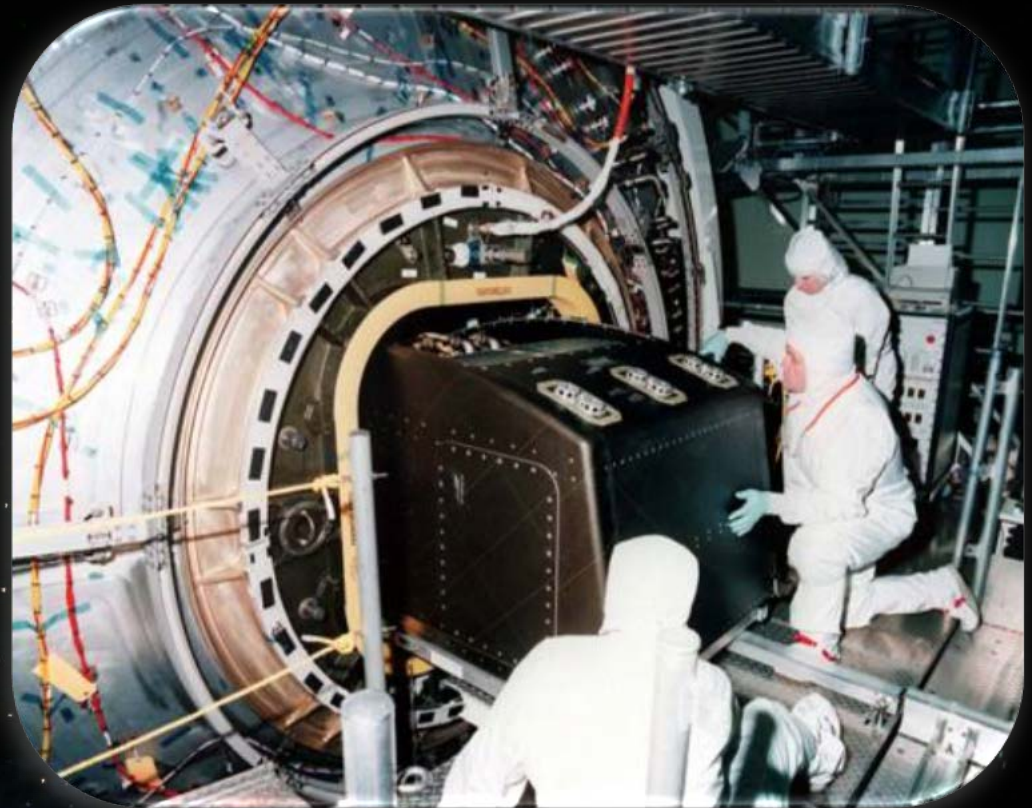
International Standard Payload Racks



Rack Installation in LAB

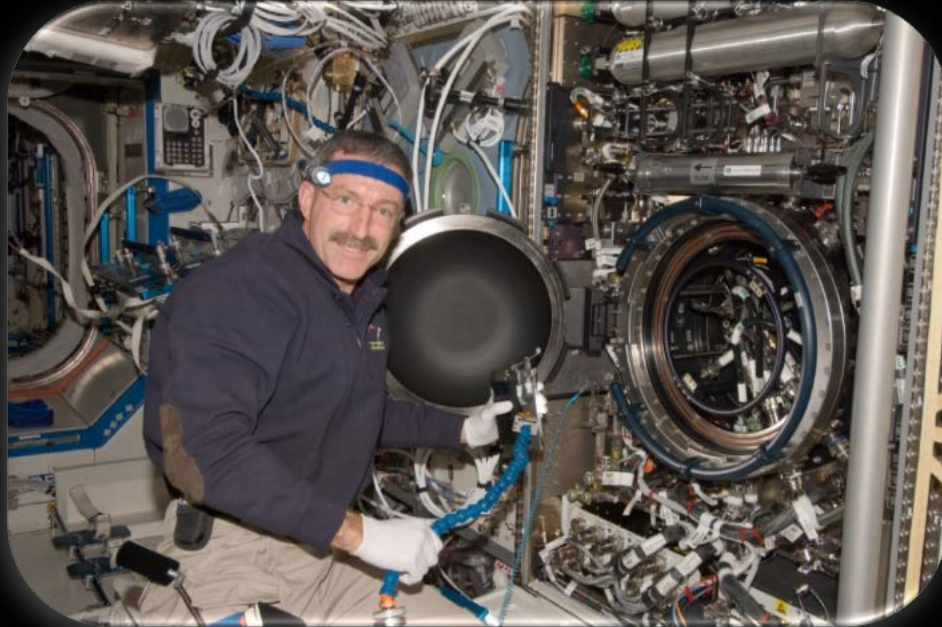


Rack Shape



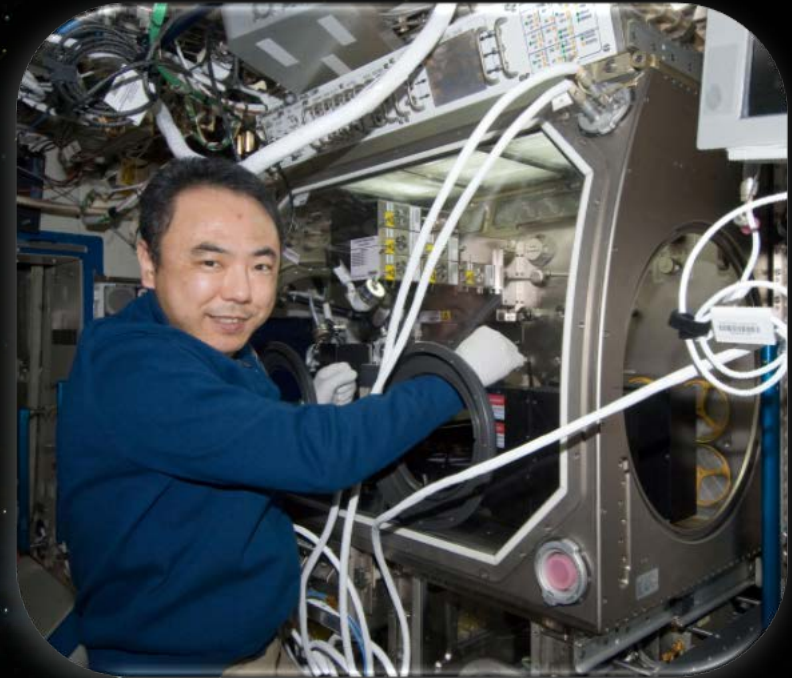
Loading Rack on the Ground

NASA Payload Racks



Combustion Integrated Rack

Exp. 30 Dan Burbank



Microgravity Science
Glove Box Rack

Exp. 29 Satoshi Furukawa



MELFI Rack

Exp. 16 Clay Anderson

International
Partners

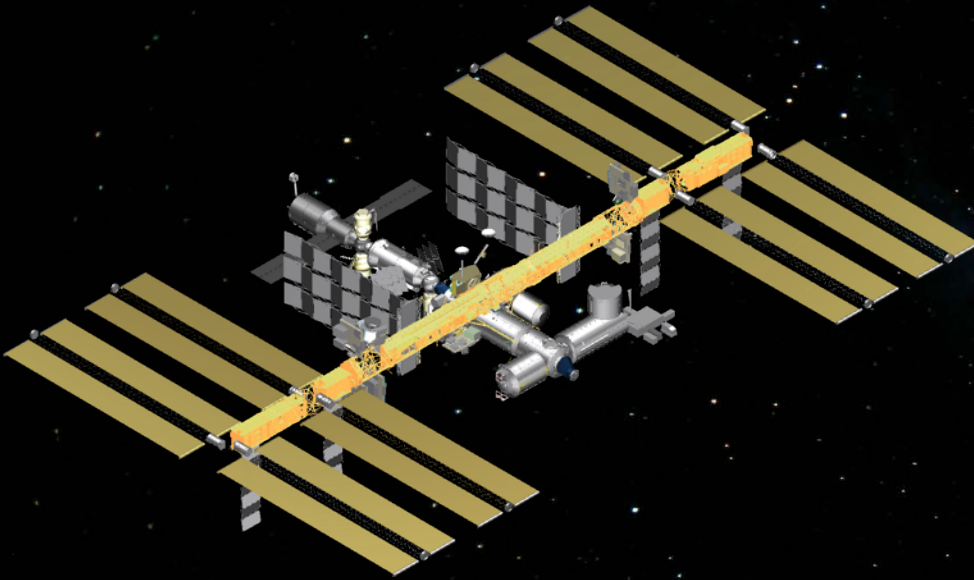
Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



TRUSS

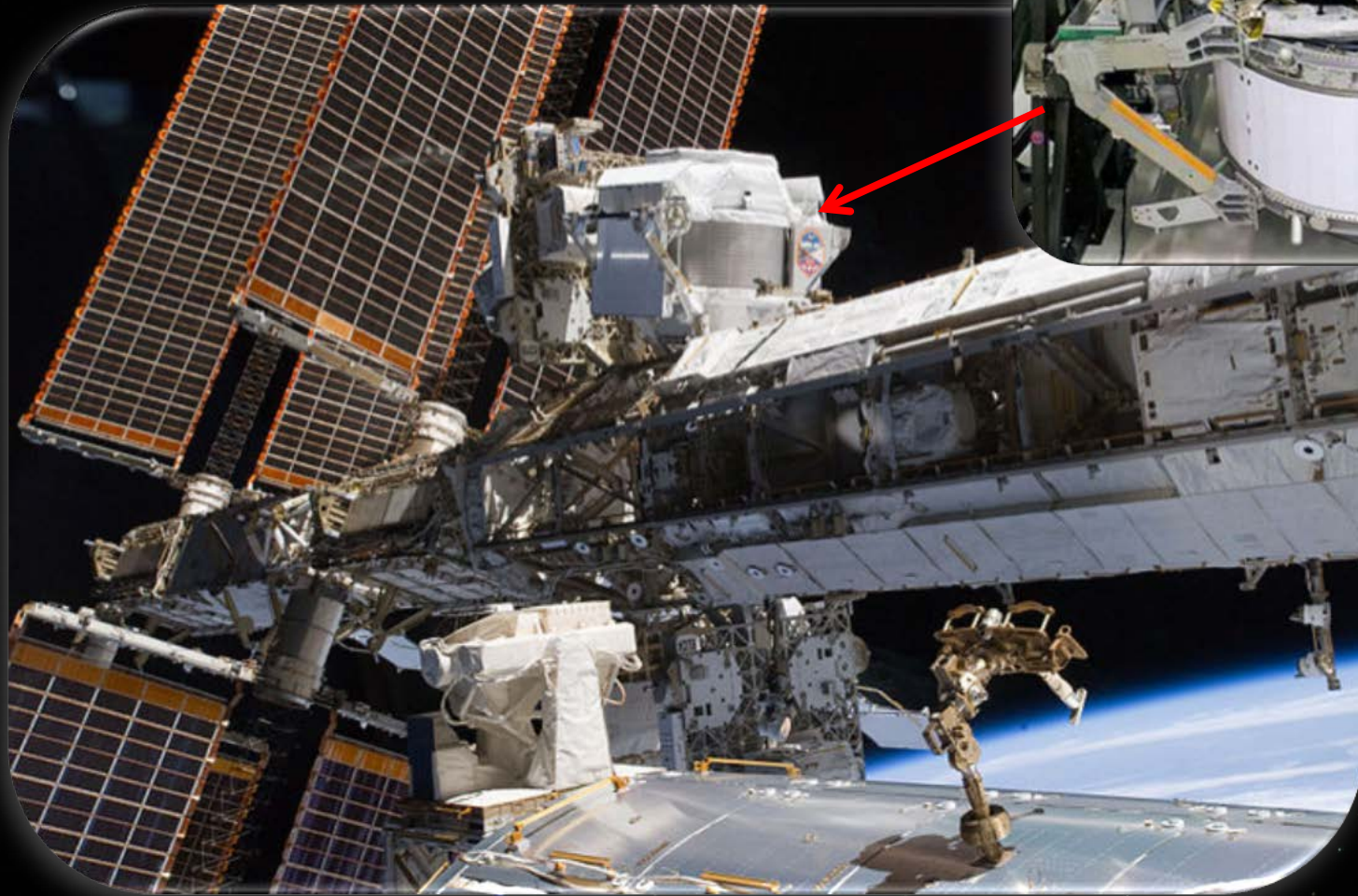
Truss

- Provides attachment points for solar arrays and external payloads
- Based on pre-integrated truss design comprised of bulkheads, longerons and diagonals
- Built and launched by NASA



Truss Segment

EVA Astronauts on the Truss (Before the addition of the solar arrays)



Alpha Magnetic Spectrometer (AMS-02)

Particle physics payload mounted on the Truss

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

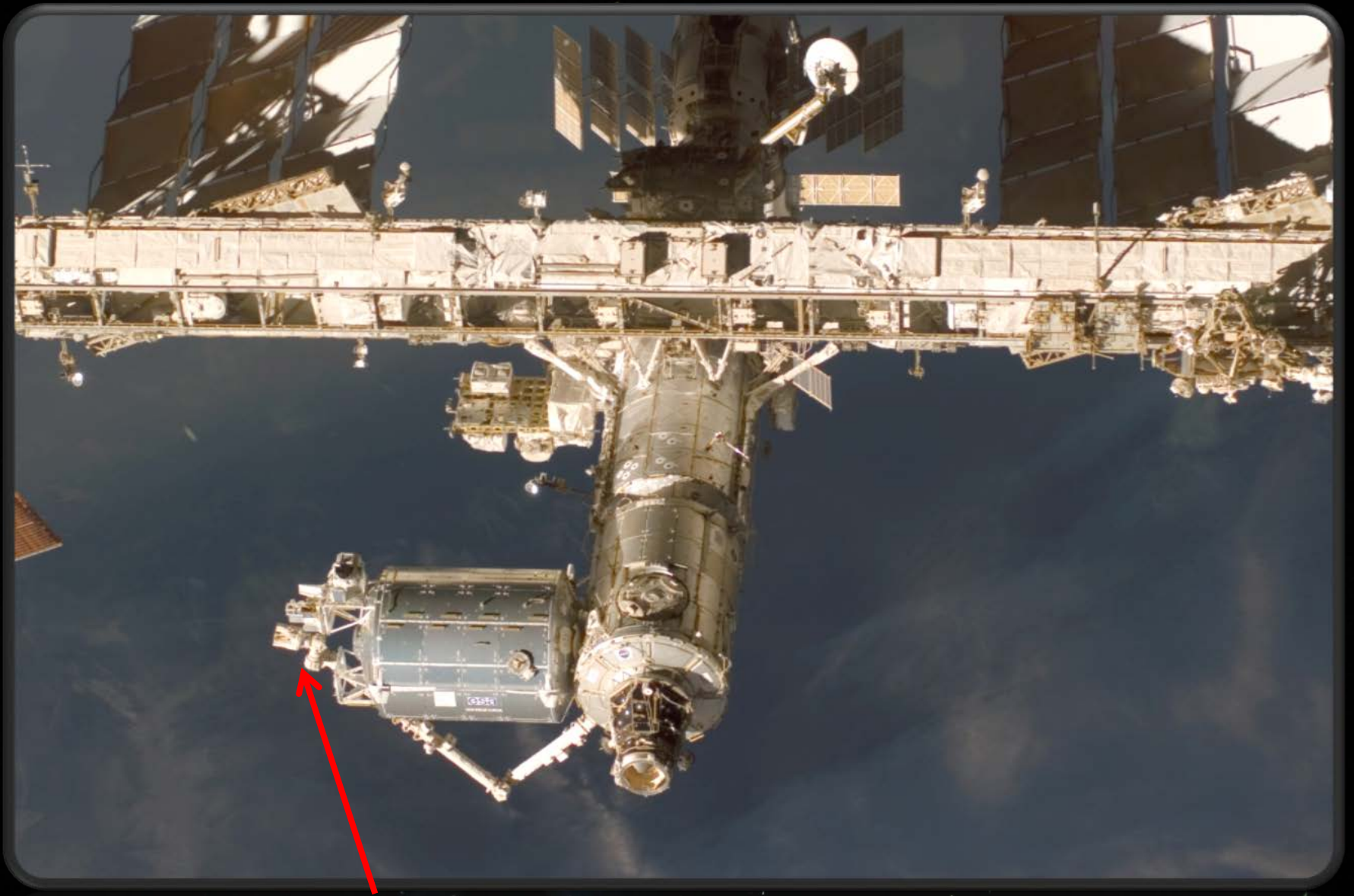
ISS Video/
Assembly

Columbus Orbital Facility

- ESA research laboratory
 - 16 rack locations, 10 designated for payload racks
- External payload facility on the starboard end cone
- Built by ESA, launched by NASA
- aka "Columbus"



COL



External Payload Facility on Columbus

International
Partners

Core
Systems

More
Modules

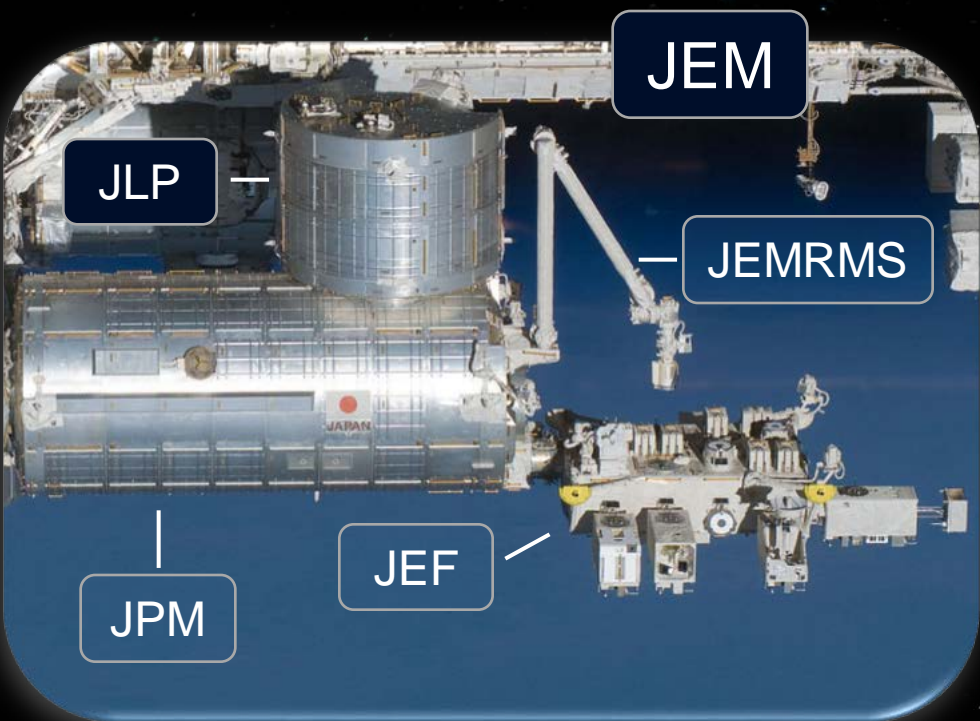
Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

Japanese Experiment Module

- JEM is a multi-component research module:
 - JEM Pressurized Module (JPM)
 - JEM Exposed Facility (JEF)
 - JEM Logistics Module Pressurized Section (JLP)
- JEM includes a robotic arm:
 - JEM Remote Manipulator System (JEMRMS)
- Built by JAXA, launched by NASA
- aka "Kibo"



International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

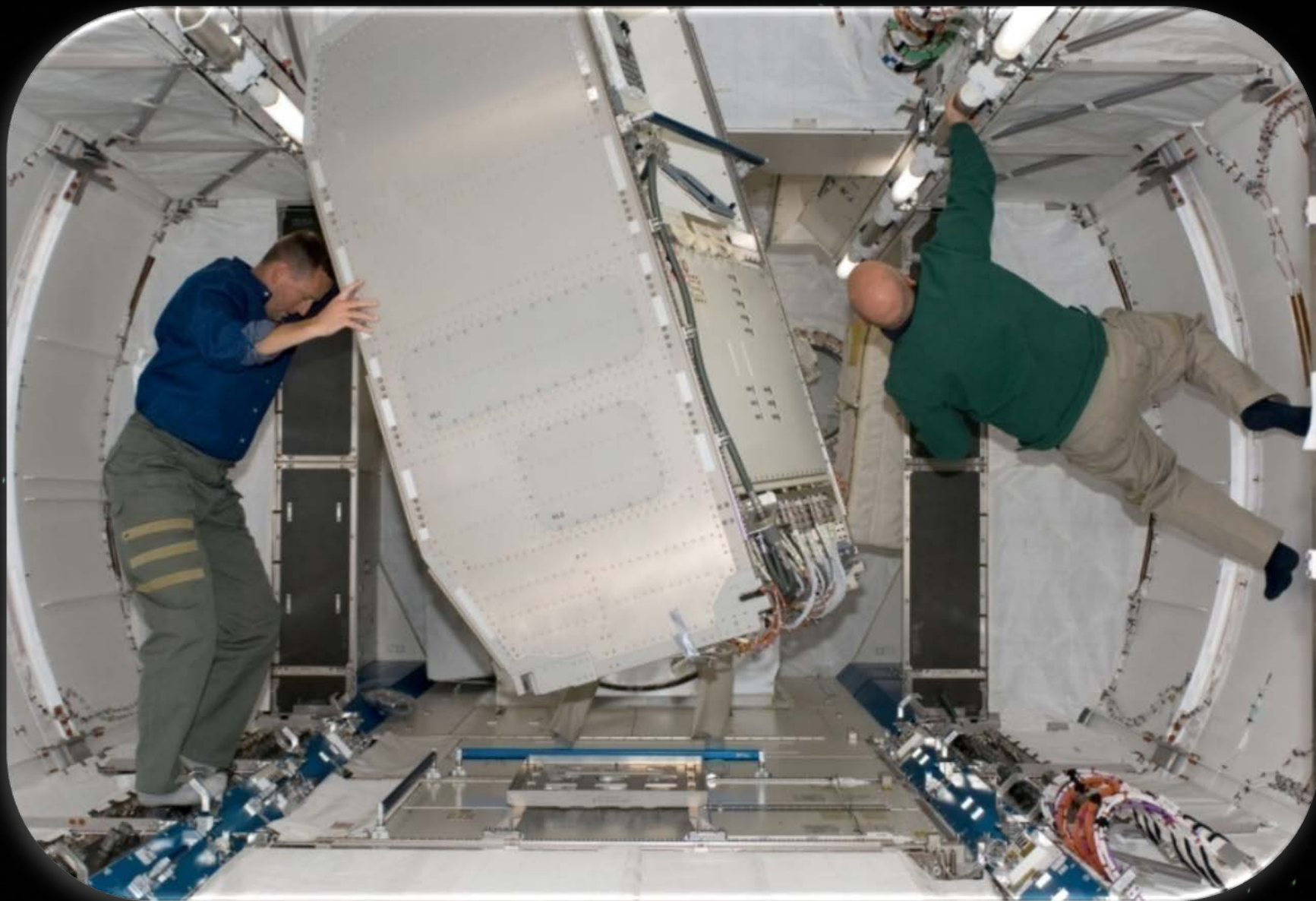
ISS Video/
Assembly

JEM Pressurized Module

- JAXA research module
 - 23 rack locations, 10 designated for payloads
- Provides payload airlock

JPM





JPM Outfitting

STS-124 Ken Ham and Mark Kelly



JPM Airlock

Exp. 19 Koichi Wakata



International
Partners

Core
Systems

More
Modules

Research
Modules

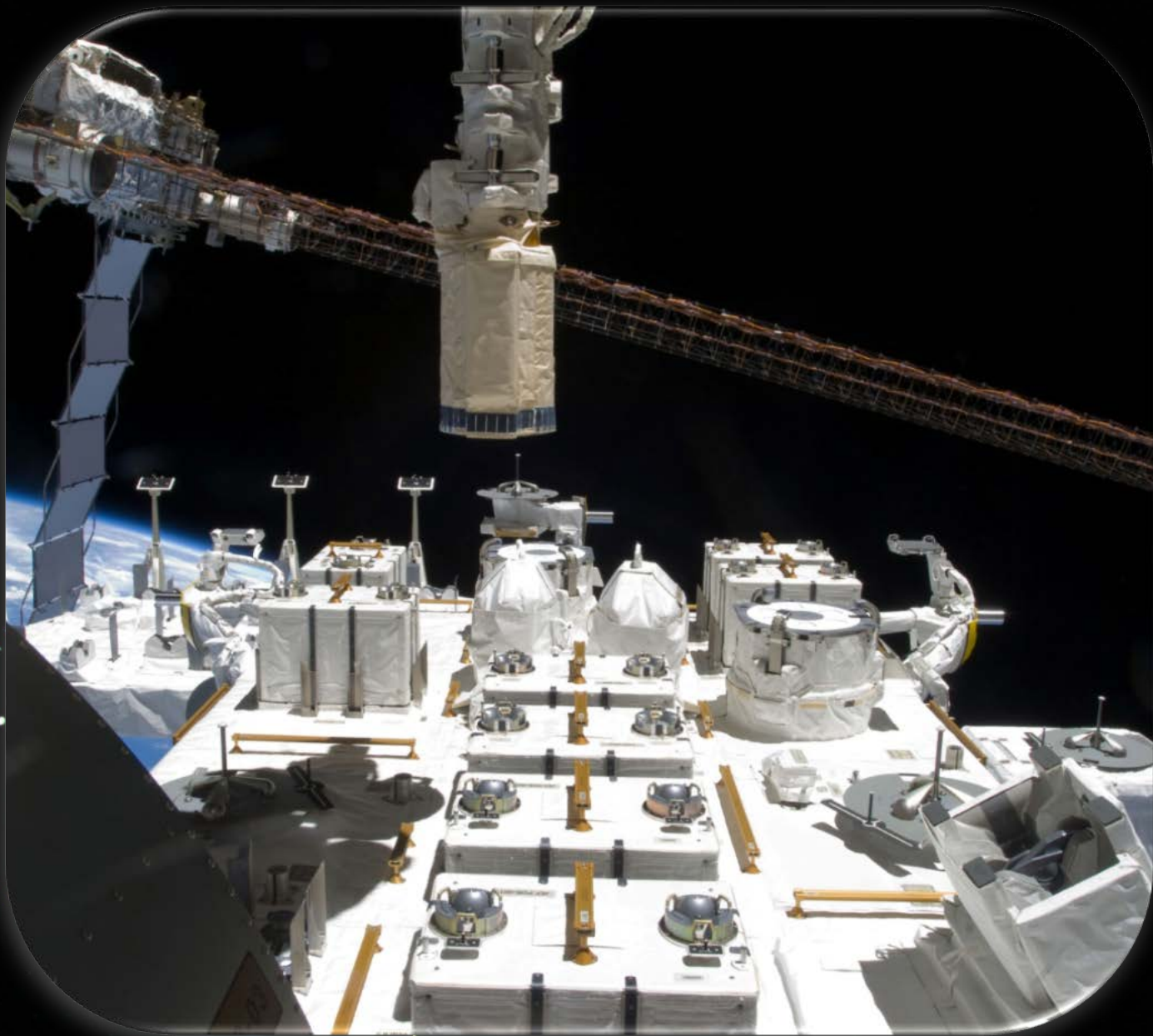
Airlocks/
Robotics

ISS Video/
Assembly

JEF

JEM Exposed Facility

- JAXA external payload facility
- Payloads are deployed and retrieved via the JPM airlock



JEM Exposed Facility (JEF)

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

MRM1

Mini-Research Module 1

- Russian research laboratory
- Provides Soyuz or Progress docking port
- Built by RSA, launched by NASA
- aka "Rassvet"



MRM 1

Launched with experiment airlock for MLM and elbow joint for ERA

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

Multipurpose Laboratory Module

- Russian research laboratory
- Provides experiment airlock
- Provides Soyuz or Progress docking port (replacing the Docking Compartment port)
- Built by Russia, launched by Russia NET 2017
- aka "Nauka"

MLM

Will replace DC



International
Partners

Core
Systems

More
Modules

Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly



AIRLOCKS AND ROBOTICS

International
Partners

Core
Systems

More
Modules

Research
Modules

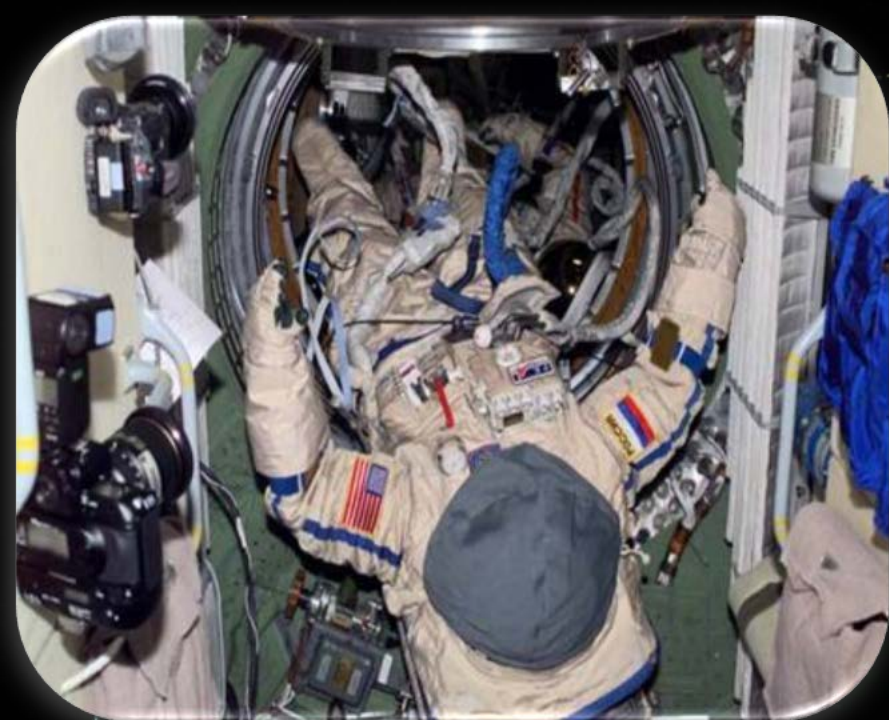
**Airlocks/
Robotics**

ISS Video/
Assembly

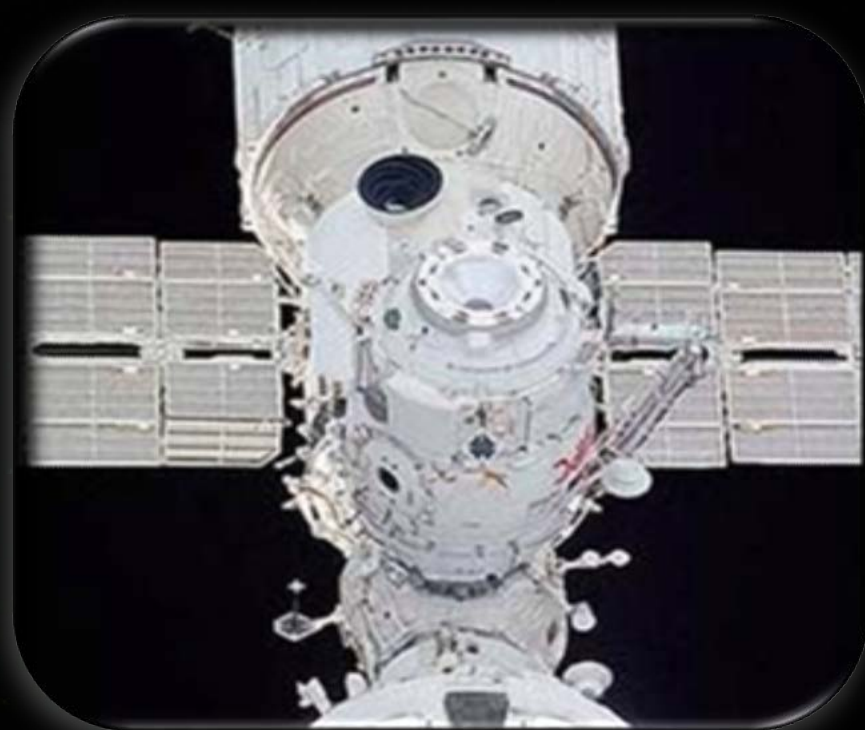
DC

Docking Compartment

- Provides station based spacewalk capability from the Russian segment using Russian Orlan-M suits
- Provides Soyuz and Progress docking port
- Provides two "Strella" cargo booms for moving cargo and cosmonauts
- Built and launched by RSA
- aka "Pirs"

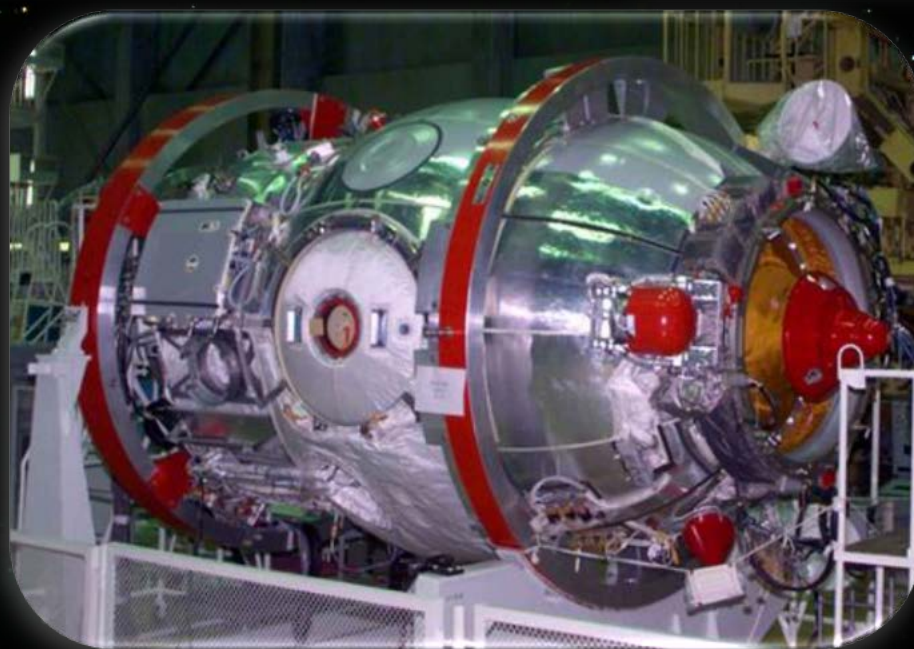


Orlan-M Suit



Docking
Compartment

As seen from below



Docking
Compartment

On the ground

International
Partners

Core
Systems

More
Modules

Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly

Airlock

Joint Airlock

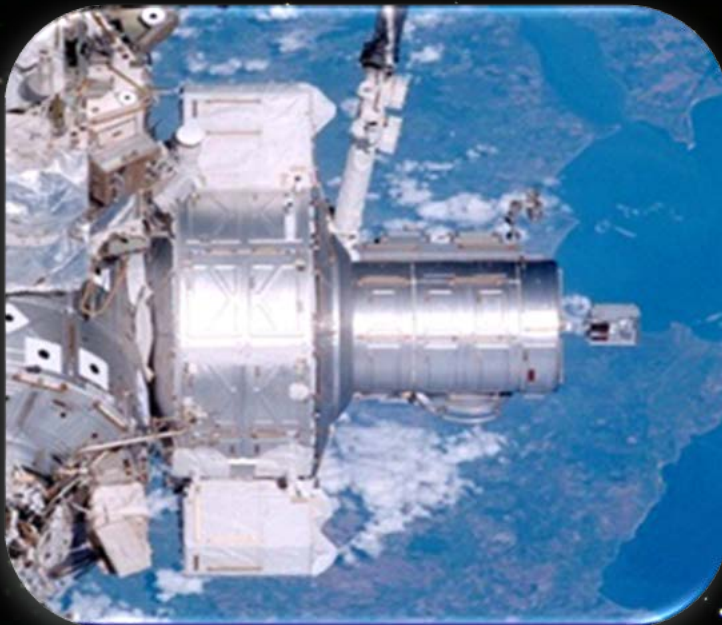
- Supports EMU-based EVAs and servicing EMUs
- Potential future capability for servicing Orlan-M suits
- Two pressurized, cylindrical chambers
 - Equipment Lock
 - Crew Lock
- Built and launched by NASA
- aka "Quest"



Airlock Installation
Installed using the SSRMS



EMU Suit



Airlock



Egressing
the Airlock

International
Partners

Core
Systems

More
Modules

Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly



MRM 2

Mini-Research Module 2

- Provides station based spacewalk capability from the Russian segment using Russian Orlan-M suits
- Provides Soyuz and Progress docking port
- Built and launched by RSA
- aka "Poisk"

International
Partners

Core
Systems

More
Modules

Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly

Space Station Robotic Manipulator System



SSRMS

- Self-relocatable robotic arm with seven joints and two latching end effectors, and 10 power and data grapple fixtures on ISS
- Pivotal in ISS assembly and maintenance
- Used for module installation, visiting vehicle berthing, and EVA crewmember translation
- Built by CSA, launched by NASA



SSRMS EVA Translation

EVA Crewmember on SSRMS



SSRMS HTV-3 Berthing

HTV-3 Berthed to Node 2 Nadir

International
Partners

Core
Systems

More
Modules



Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly



CUP

Cupola

- Provides a pressurized observation and work area
 - Robotics workstation for SSRMS
 - External viewing
- Built by the Italian Space Agency for NASA, launched by NASA



Looking out of Cupola
Dmitri Kondratyev and Paoli Nespoli



Looking into Cupola
Doug Wheelock

International
Partners

Core
Systems

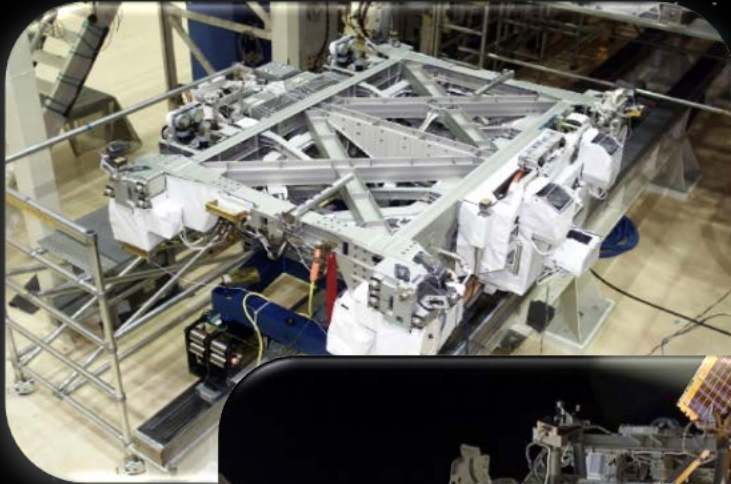
More
Modules

Research
Modules

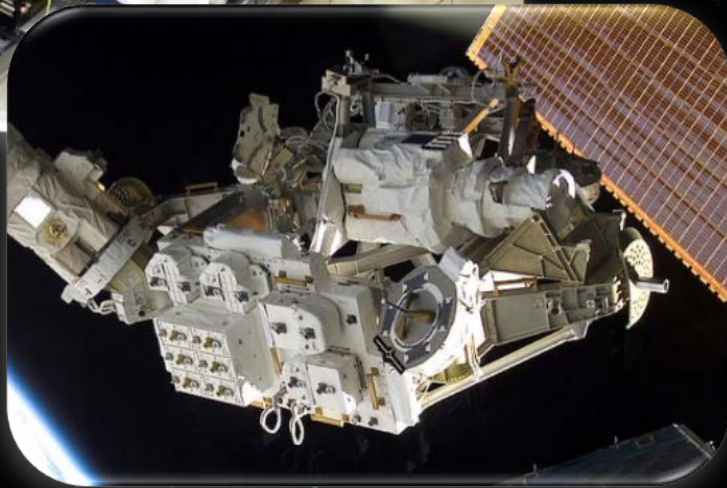
**Airlocks/
Robotics**

ISS Video/
Assembly

Mobile Transporter and Mobile Base System



MT



MBS

- Mobile Transporter
 - Provides lateral mobility for the SSRMS
- Mobile Base System
 - Sits atop the Mobile Transporter and has 4 power and data grapple fixtures
 - Provides two attachments locations for external payloads
- Built by CSA, launched by NASA

International
Partners

Core
Systems

More
Modules

Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly

Special Purpose Dexterous Manipulator

- Two armed robot
- Built by CSA, launched by NASA
- aka "Dextre"



SPDM



DEXTRE with Payload

International
Partners

Core
Systems

More
Modules

Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly

JEMRMS

JEM Robotic Manipulator System

- Robotic arm with six joints
 - Used to move experimental hardware
 - Small fine arm (SFA) can attached to the end of JEMRMS as needed
- Built by JAXA, launched by NASA

International
Partners

Core
Systems

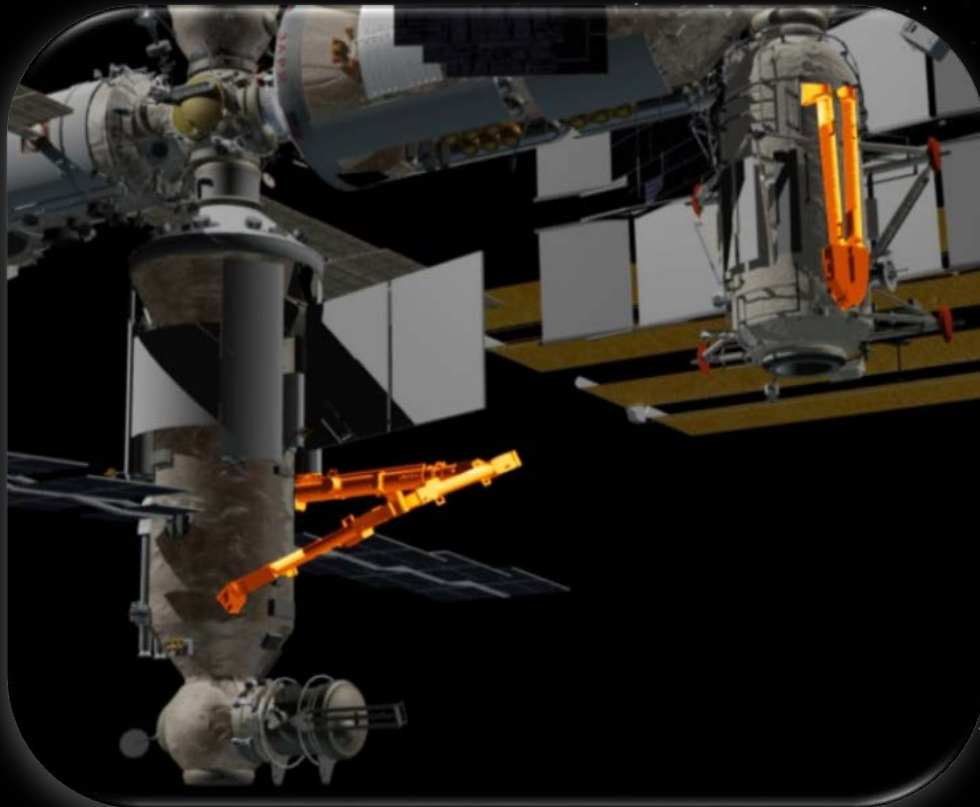
More
Modules



Research
Modules

**Airlocks/
Robotics**

ISS Video/
Assembly



European Robotic Arm

- Self-relocatable robotic arm
 - Launches installed on the MLM NET 2017
 - Spare joint stored on MRM1
- Built by ESA, launched by RSA

International
Partners

Core
Systems

**More
Modules**

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



**MORE MODULES
(CREW SUPPORT/NODES/
LOGISTICS)**

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

SM

Service Module

- Russian critical systems and crew support module
 - O₂ generation, CO₂ removal, galley, toilet, exercise equipment, two каюта (crew quarters)
- Provides motion control and reboost capability
- Provides Soyuz or Progress docking port
- Initially, Russian research laboratory
- Built and launched by RSA
- aka "Zvezda"



SM Solar Array Deploy



ISS Automated Rendezvous
and Docking

SM maintained station keeping orbit



Elektron O₂ Generation Units in the SM

Exp. 28 Andrei Borisenko, Aleksandr Samokutyayev, Sergei Volkov

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



Node 3

Node 3

- Six-way connecting module and passageway to which other modules attach
- Crew support module
 - Toilet, exercise equipment, water reclamation, O₂ generation, CO₂ removal
- Built by the Italian Space Agency for NASA, launched by NASA
- aka "Tranquility"



ARED in Node 3

Exp. 30 Dan Burbank

(Rotated in 2015, so footplate is now forward)



WHC in Node 3

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



Node 2

Node 2

- Six-way connecting module
 - Connects Lab to JPM & COL
- Crew support module
 - Four crew quarters
- Nadir and zenith ports provide CBM berthing port for cargo visiting vehicles
- In 2015, forward port reconfigured to provide docking port for future manned vehicle. Zenith port will be reconfigured as a backup docking port.
- Built by the Italian Space Agency for NASA, launched by NASA
- aka "Harmony"



Crew Quarters in Node 2

Exp. 26 Ron Garan, Paulo Nespoli, Aleksandr Samokutyayev, and Cady Coleman

International
Partners

Core
Systems

More
Modules



Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

Node 1

Node 1

- Six-way connecting module and passageway to which other modules attach
- Launched with two pressurized mating adapters (PMAs) attached
- In 2015, nadir port upgraded to provide CBM berthing port for cargo visiting vehicles
- Built and launched by NASA
- aka "Unity"



Node 1

International
Partners

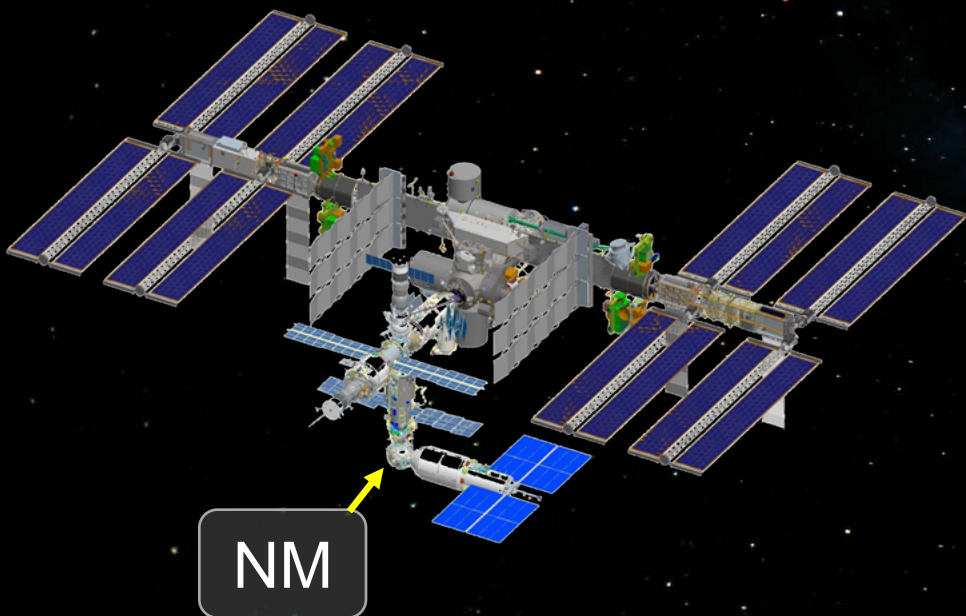
Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



Nodal Module

- Six-way connecting module and passageway to which other modules attach
 - (Image shows SPM attached to starboard port on NM, actual port TBD)
- Provides Soyuz or Progress docking ports
- Will launch NET 2017 and attach to MLM nadir
- Built and launched by RSA

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

FGB

Functional Cargo Block

- Provides internal stowage for cargo and external propellant storage
- First element launched
- Provided initial propulsion and power
- Built by the Russians for NASA, launched and controlled by RSA
- aka "Zarya"



FGB

First Element Launched



International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

JEM Logistics Module Pressurized Section

- Provides internal stowage
 - 8 rack locations
- Built by JAXA, launched by NASA

JLP



International
Partners

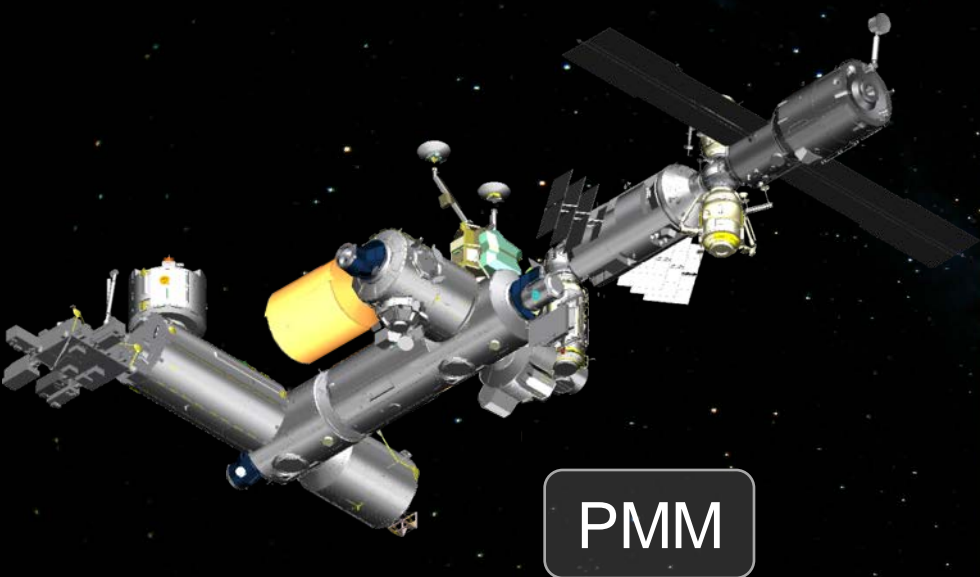
Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



PMM

Permanent Multipurpose Module

- Provides internal stowage
 - 16 rack locations plus end cone
- In 2015, relocated to Node 3 forward
- Formerly the reusable Leonardo Multi-Purpose Logistic Module (MPLM)
- Built by the Italian Space Agency for NASA, launched by NASA

International
Partners

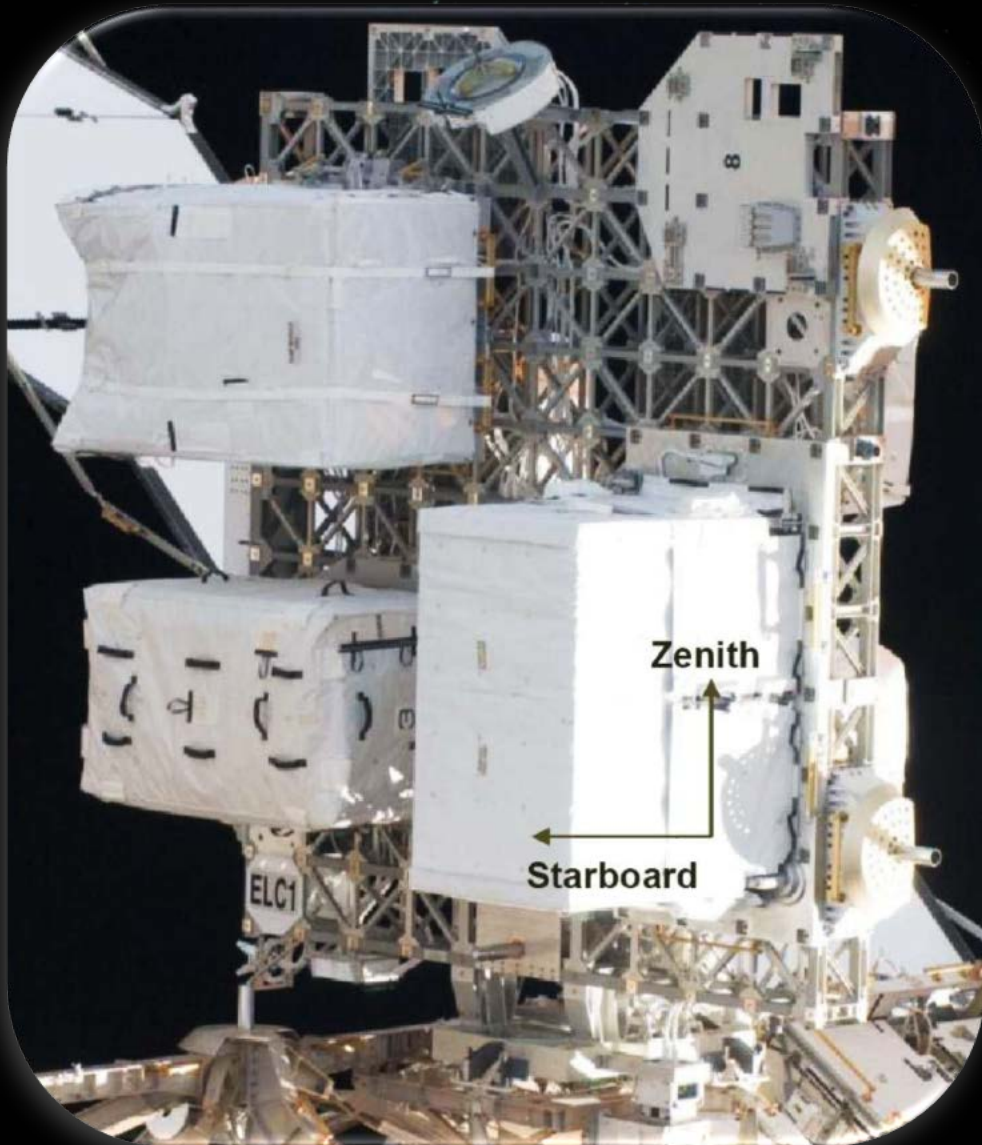
Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly



External Logistics

- ExPRESS Logistics Carriers (ELCs) attach to the Truss
 - Provide mounting surfaces, power, and data connectivity for orbital replacement units (ORUs) and unpressurized payloads

International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

ISS Video/
Assembly

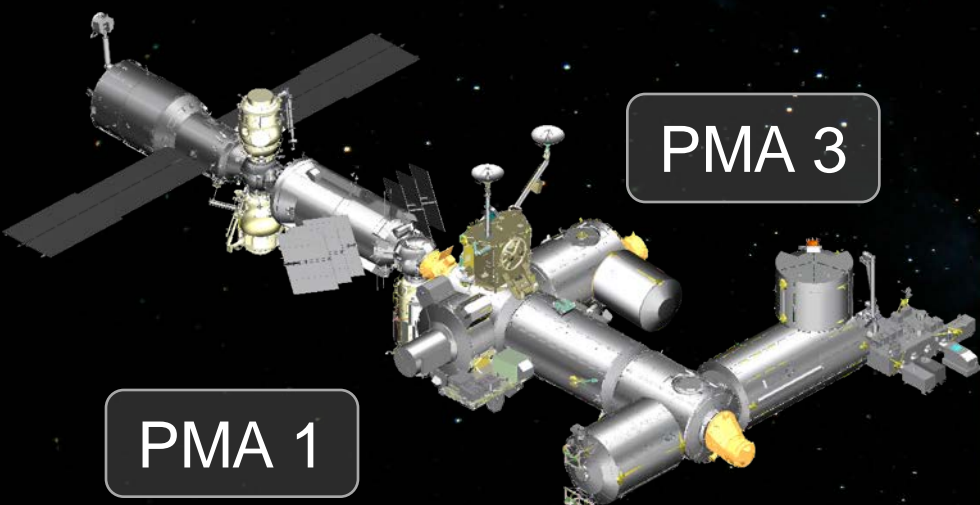
Pressurized Mating Adapters

- PMA1 is attached to Node 1
 - Connects the USOS to the ROS
- PMA2 is attached to Node 2
 - Provided Shuttle docking port
 - In 2016, installed IDA1 (international docking adapter) to provide new docking port for future manned vehicles
- PMA3 is attached to Node 3
 - Provided Shuttle docking port for Lab installation
 - Will be relocated to Node 2 zenith and will install IDA2 to provide new docking port
- Built and launched by NASA

PMA 1

PMA 3

PMA 2



International
Partners

Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

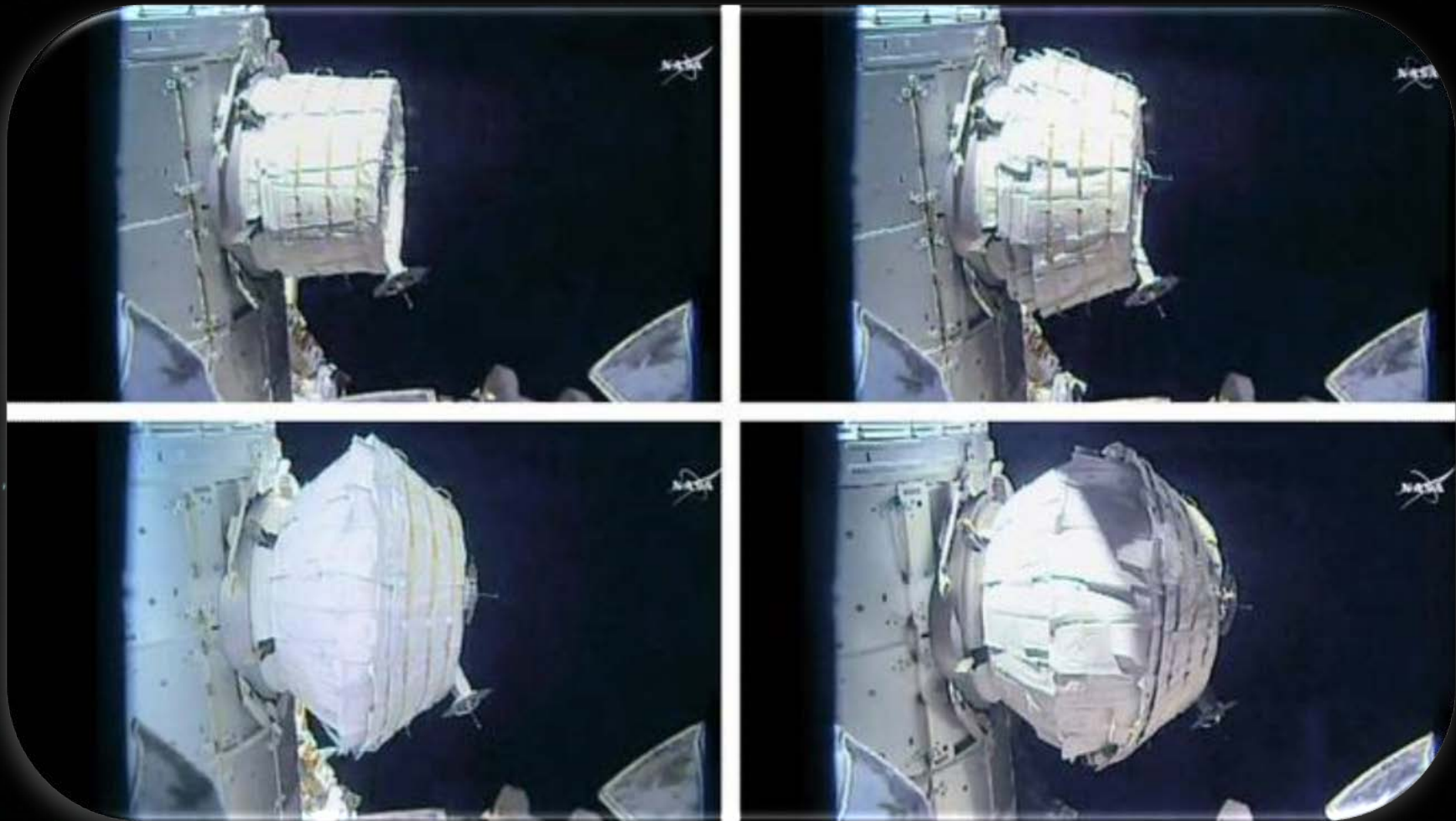
ISS Video/
Assembly



BEAM

Bigelow Expandable Activity Module

- Temporary 2-year module, berthed to Node 3 aft
- Built by Bigelow Aerospace, launched by SpaceX in 2016



BEAM Expansion

International
Partners

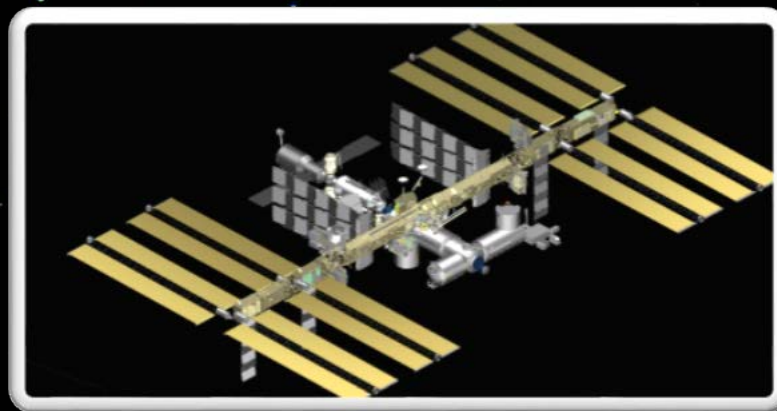
Core
Systems

More
Modules

Research
Modules

Airlocks/
Robotics

**ISS Video/
Assembly**



ISS VIDEO TOUR AND ASSEMBLY

ISS Video Tour



Summary

- State the International Partners and identify their ISS modules or elements
- Describe the primary functions of each ISS modules or elements
- Describe the functions of the ISS core systems

Resource:

<http://spacestationlive.jsc.nasa.gov/>



Scott Kelly with International Partner Flags