International Space Station: A Program Overview

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International Space Station
Deputy Program Manager
February 2011

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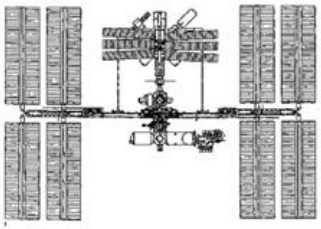
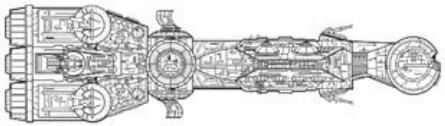
Sizemodo: How big is the International Space Station?

20 m.

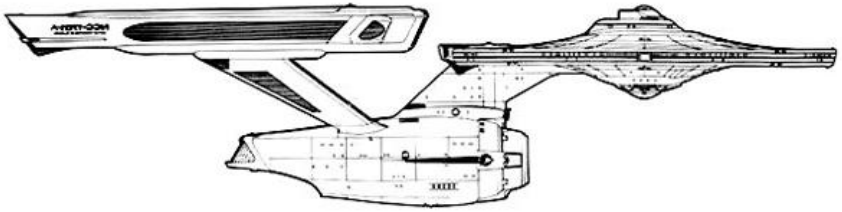
Colonial Viper Mk I: 8.7 meters



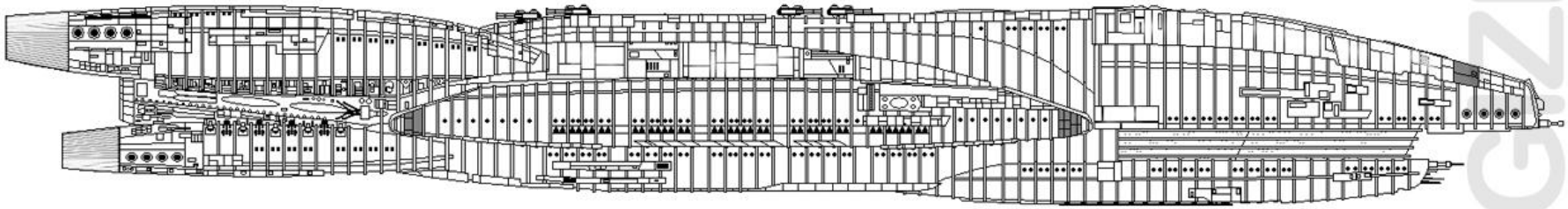
Interational Space Station: 107.4 meters



Corellian corvette: 150 meters



USS Enterprise (NCC-1701-A): 288.6 meters



Assembly Complete*

Module Length	51.0 m (167.3 ft)
Truss Length	109.0 m (357.5 ft)
Solar Array Length	73.0 m (239.4 ft)
Mass	367,539 kg (810,285 lb)
Habitable Volume	343 m^3 (12,118 ft^3)
Pressurized Volume	892 m^3 (31,510 ft^3)
USOS Power Generation	8 solar arrays = 84 kW

Orbital Inclination / Path	51.6 degrees, covering 90% of the world's population
Altitude	200 nautical miles (on average) above the Earth

Jesús Díaz – Gizmodo

GIZMODO

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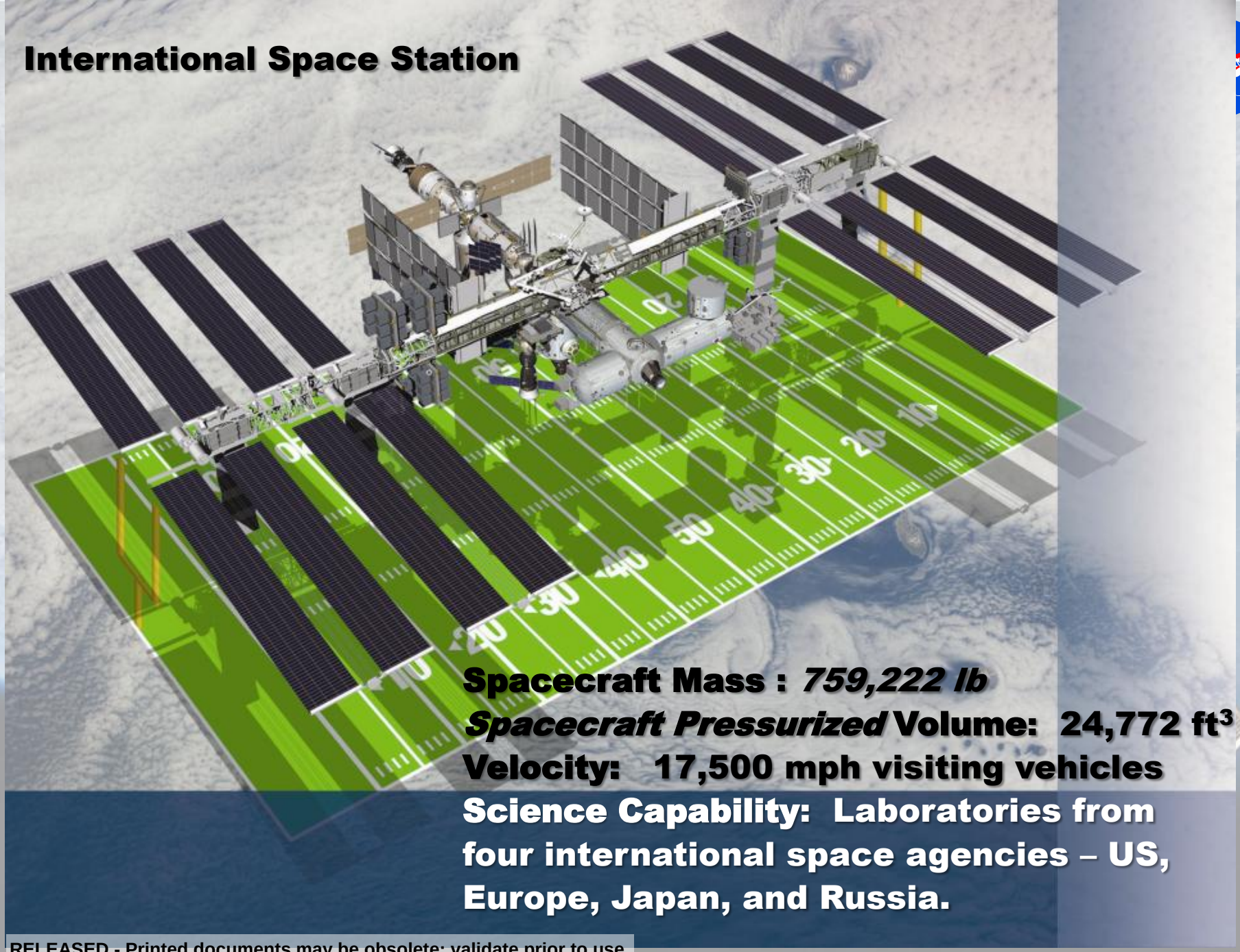
International Space Station



Spacecraft Mass : *759,222 lb*

***Spacecraft Pressurized* Volume: 24,772 ft^3**

Velocity: 17,500 mph visiting vehicles

Science Capability: Laboratories from four international space agencies – US, Europe, Japan, and Russia.

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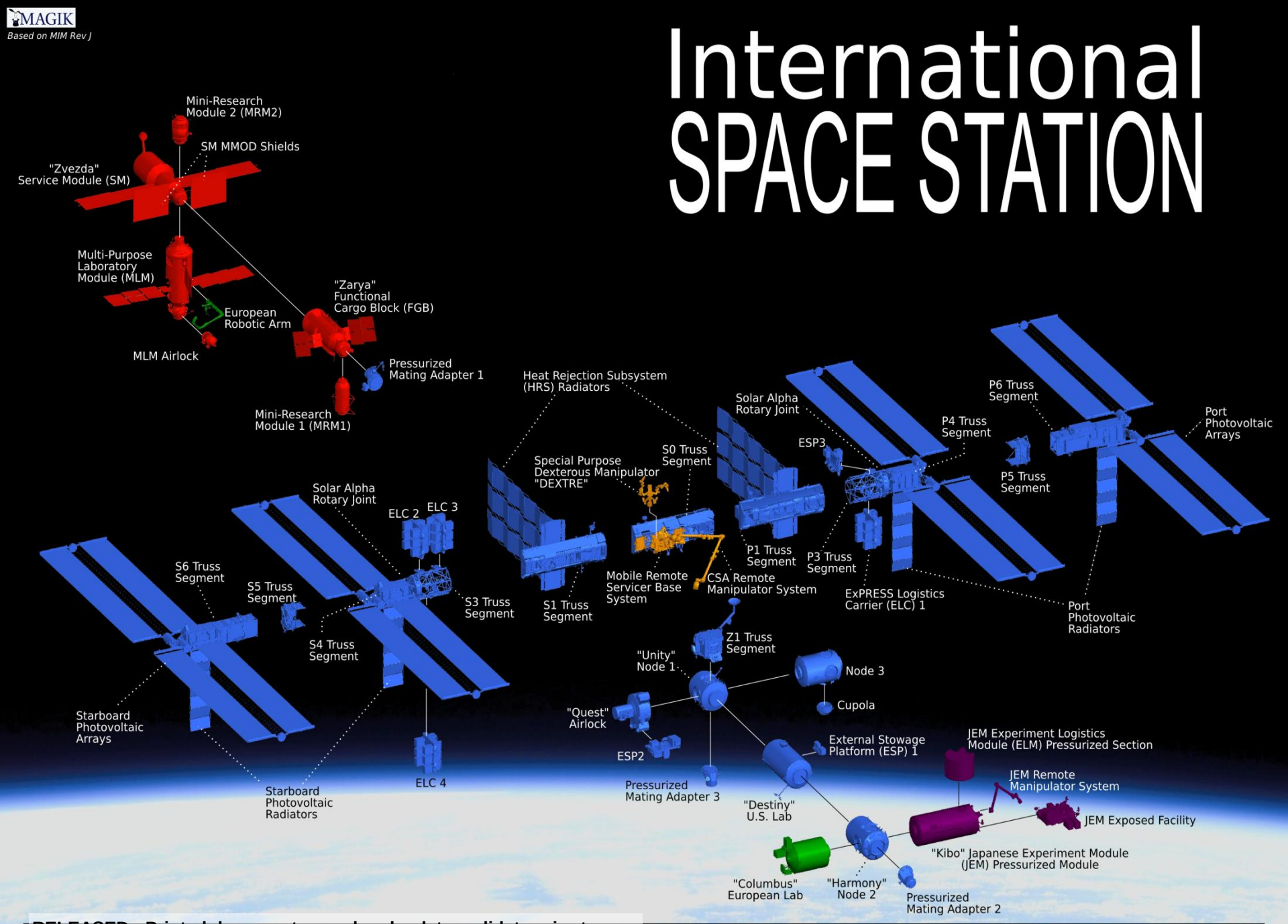
MAGIK
Based on MIM Rev J

International SPACE STATION



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NASA Elements | ROSCOSMOS Elements | CSA Elements | JAXA Elements | ESA Elements

U.S. Led International Operations

United States | Russia | Canada | Europe | Japan

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ISS Launch and Logistics

Space Shuttle

Proton

ROSCOSMOS

Soyuz and Progress

Ariane 5/ATV

HII/HTV

An International fleet of space vehicles:

- Rotates crews
- Delivers propellant & supplies
- Replenishes science experiments

Future Launch Capabilities
- **Commercial Cargo Resupply**
- **Commercial Crew Transportation**
- **Orion rescue vehicle**

esa
European Space Agency

JAXA

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104 Flights to ISS

31 Shuttle flights

STS-88/2A (U.S. Node)
STS-96/2A.1 (Logistics)
STS-101/2a.2a (Logistics)
STS-106/2B.2B (Logistics)
STS-92/3A (Z-1 Truss)
STS-97/4A (P6 Solar Array)
STS-98/5A (Destiny Lab)
STS-102/5A.1 (MPLM, Expedition 2)
STS-100/6A (CanadArm2)
STS-104/7A (U.S. Airlock)
STS-105/7A.1 (MPLM, Expedition 3)
STS-108/UF1 (Expedition 4)
STS-110/8A (S0 Truss)
STS-111/UF2 (Science and Expedition 5)
STS-112/9A (S1 Starboard Truss)
STS-113/11A (P1 Port Truss)
STS-114/LF1 (Logistics)
STS-121/ULF1.1 (Logistics)
STS-115/12A (P3/P4 Truss)
STS-116/12A.1 (P5 Truss)
STS-117/13.A (S3/S4 Truss)
STS-118/13A.1 (S5 Truss)
STS-120/10A (Node 2)
STS-122/1E (Columbus)
STS-123/1J.A (DEXTRE, JLP)
STS-124/1J (Japanese Experiment Module-Pressurized Module)
STS-126/ULF-2 (MPLM, 6 person crew hardware)
STS-119/15A –S6
STS-127/ 2J/A
STS-128/17A
STS-129/ULF-3
STS-130/20A
STS-131/19A
ULF-4

70 Russian flights

2 Proton, (FGB, Service Module)
41 Progress re-supply ships
25 Manned Soyuz
2 Unmanned Soyuz (DC, MRM2)

3 IP flights

1 ATV (ESA)
2 HTV (JAXA)

Spacewalks (EVAs)

76 US
27 Russian

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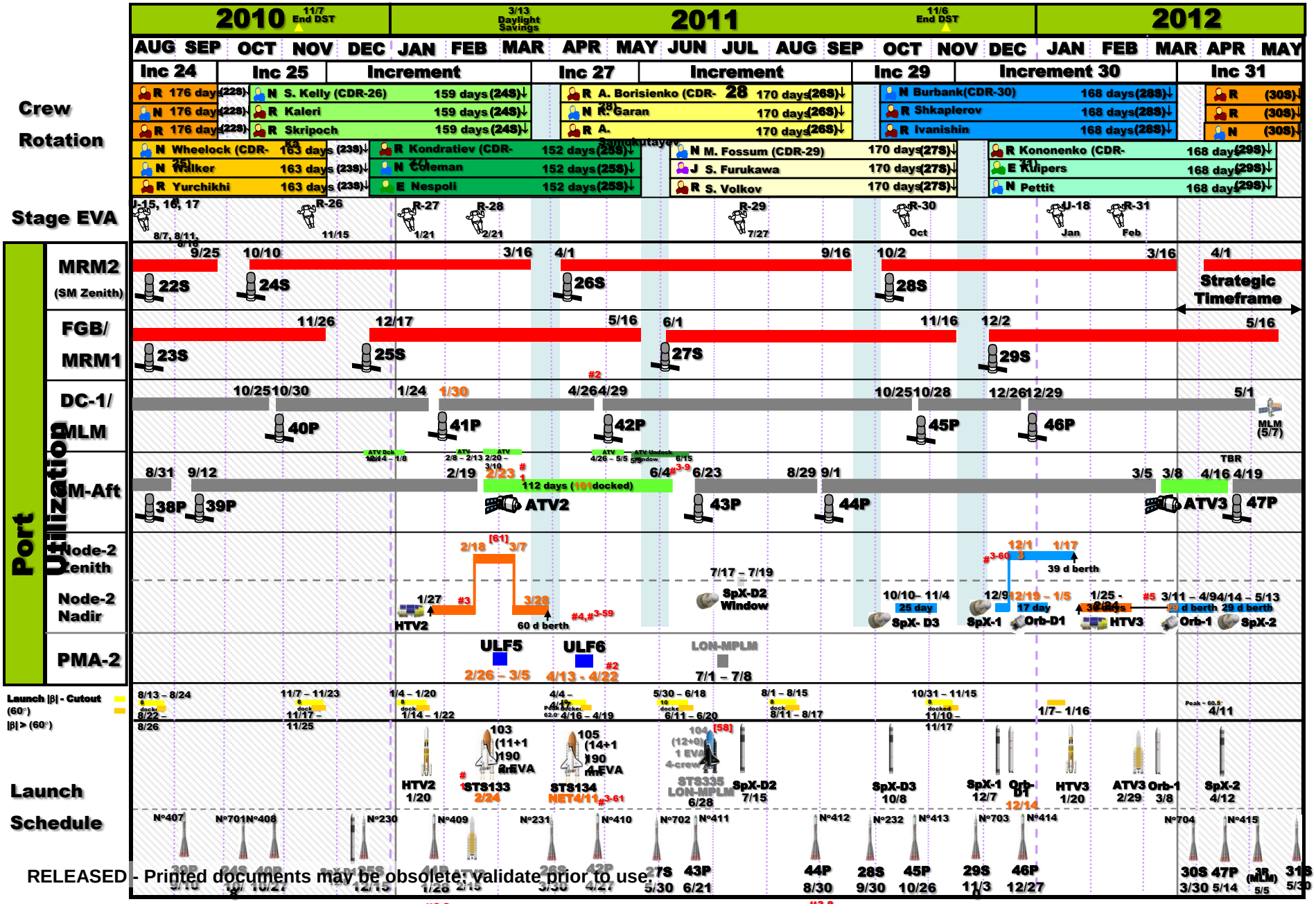
Crew Rotation & Traffic Baseline



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Expedition 26 Astronauts

Vehicle: 25 Soyuz, TMA-21

Launch: December 15, 2010

Docking: December 17, 2010

Undock/Landing: May 16, 2011

Dmitri Kondratyev

Commander Soyuz and Expedition 27

Catherine Coleman

ISS Flight Engineer

Paolo Nespoli (ESA)

ISS Flight Engineer

25 Soyuz crew will join Expedition 25 crew already on-c

Scott Kelly Expedition 26 Commander

Alexander Kaleri ISS Flight Engineer

Oleg Skripochka ISS Flight Engineer

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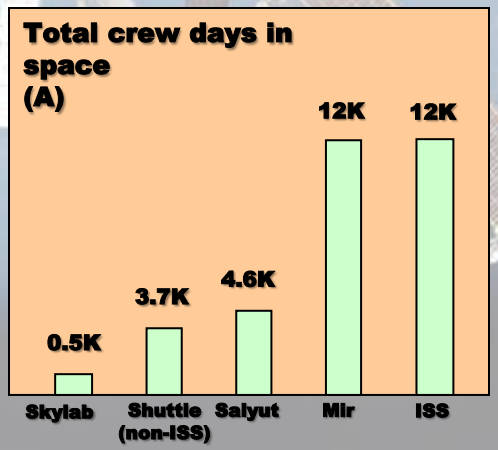
Everyday the ISS is setting records

- **Total Crew Days in Space**
- **Number of Space Station Visitors**
- **Spacecraft Volume**
- **Spacecraft Mass**
- **Power Generation Capability**
- **Number of EVA's**

"For everyday of my life there have been humans living and working on the ISS"



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ISS Utilization for Expedition 25/26

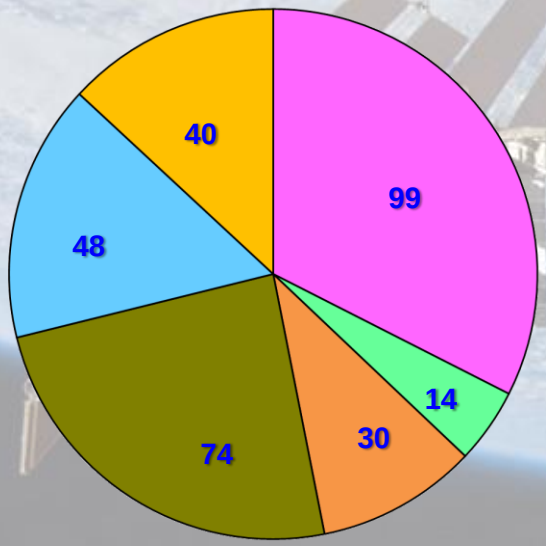
121 USOS Investigations (47 new)*

- 75 NASA
- 44 USOS
- 2 Joint

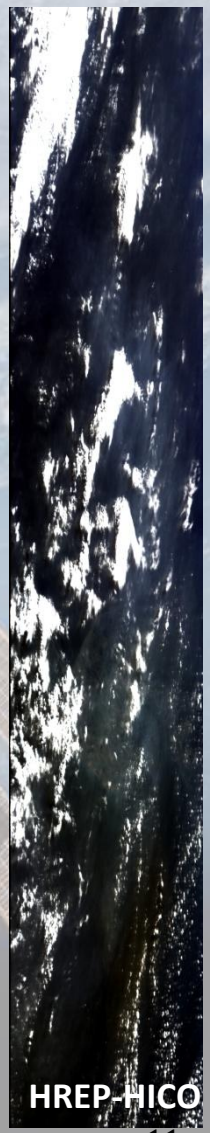
337 Crew Utilization hours*

- 260 NASA
- 77 USOS

*Planned. Data is accurate as of 1/14/2011.

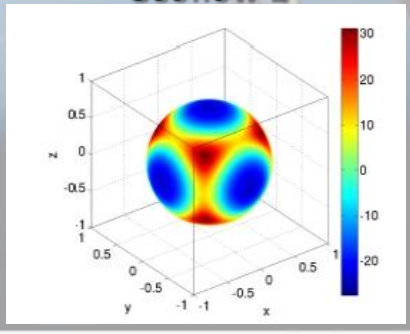


Technology Development
Human Research
Physical Sciences
Biology and Biotechnology
Educational Activities
Earth and Space Sciences



SAME

Geoflow-2



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Space X Progress

Accomplishments

- **Demo Flights**
  - C1 – Successful launch on 12/8/10
  - C2 - Engine section is complete through nine engine installation and leak checks
  - C2/C3 - Held Comm TIM to discuss communication coverage solutions
  - C3 – Completed Atmosphere Circulation and Acoustics Test on 10/31 and Power Qual Test (Part B) for IPCU on 12/10/10
  - C3 - Forward Hatch demonstration and IVA Egress completed 10/25/10; conducted FRGF loads test on 12/17/10 at SpaceX
- **CRS**
  - Completed Grapple Bar Rocker Test on 12/8/10
  - Completed FRAM Manufacturing Readiness Review on 12/16/10

External Cargo TIM on

C1: F9-002 First and Second Stages

C1 Launch 12/08/2010

Near Term Activities:

- Continuing to work resolution of Delta CDR RIDs by May 2011
- C2: First stage tank is nearly completed with assembly for proof test. Propulsion pressurization lines are being installed on the stage.
- C3: Merlin engines – Fabrication continues on engine hardware components for the remaining 7 first stage engines. Plan to ship engines 3 and 4 to Texas mid-January for static fire acceptance testing.
- COTS/CRS Quarterly scheduled for 1/20/11
- CRS Cargo TIM scheduled for 2/2/11 @ JSC
- C3 training sim rendezvous dry run (SpaceX/NASA) planned for 02/04/11

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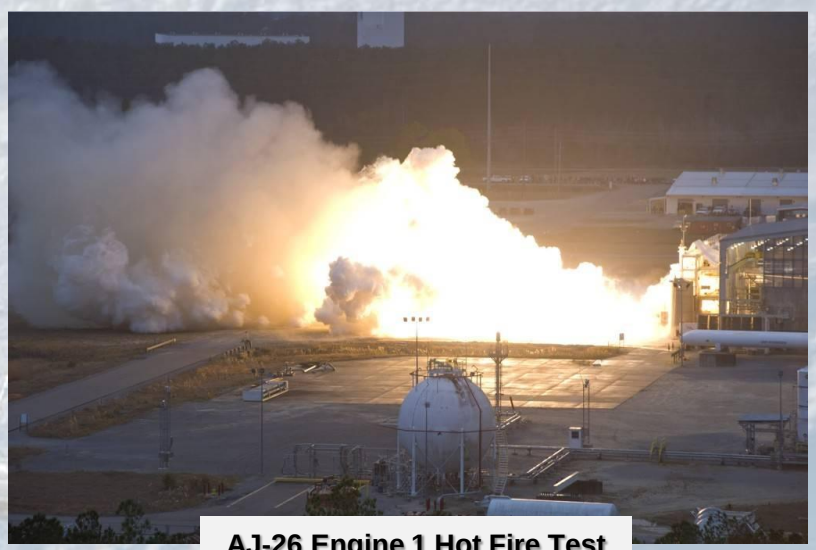
Orbital Progress

Accomplishments

- **Demo Flight**
  - **PROX Ops TIM #6 at JAXA completed October 2010**
  - **Taurus II Stage 1 Test Core arrived at WFF on 12/3/10**
  - **Cargo Demonstration/Flight Crew Interface on PCM performed early Dec. in Italy**
  - **Joint Test Dry Runs at SDIL completed in early December**
  - **Taurus II Stage 1 AJ-26 Acceptance Hot Fire at Stennis completed 12/17/10 (~40 sec. duration)**
- **CRS**
  - **Launch date set for 12/14/11**
  - **Orb-1 Mission Integration Review (MIR) completed 12/8/10**
  - **Orb-2 Vehicle Baseline Review (VBR) completed 12/10/10**



AJ-26 Engine 1 Hot Fire Test

Horizontal Integration Facility

Near Term Activities:

- **Demonstration Flight**
  - **JAXA PROX TIM planned for week of 1/10/11 to discuss full contract definitization and JAXA PROX support re-planning**
  - **Taurus II Engine E2 delivery to Stennis planned for 1/14/11**
  - **Taurus II Engine E1 return to Sacramento for feedline replacement planned for 1/26/11**
- **CRS**
  - **SRP TIM Planned for 1/20/11 to begin discussions on major Orb-2 configuration changes (LIDAR and radio updates)**
  - **HIF Ribbon Cutting Ceremony planned for 1/21/11**

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What is the Future of ISS?

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ISS Future

- Fully Utilize ISS for the benefit of the U.S. and it's International Parteners
  - NASA research
  - National Laboratory
  - US Commercial Industry
  - International research
- Use ISS as a basis for Technology Development, maturation, and demonstration as part of the President's vision.
  - Technology projects
  - Flagship Technology demonstration
  - May include ISS as a point of departure for beyond LEO uncrewed missions
  - Testbed for space systems required for long duration space
    - Carbon dioxide removal sytems
    - Regenerative Life support
    - Exercise countermeasures
    - Medical support items
    - Robotics (R2).

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Program Focus

Tactical

- HTV 2 launch
- ATV 2 launch
- ULF5 & 6 integration/execution
- Maintain/increase crewtime & resources for utilization
- Utilize all near term upmass to provide margin for the second half of FY11 and FY12
- SpaceX & Orbital Demo and first Commercial Resupply Service (CRS) flights
- On orbit stowage
- FY12 budget posture

Strategic

- Utilize ISS as a National Lab
- Technology development
- Increase utilization on ISS as a test bed for exploration
- Crew transportation plan
- Technical analysis & planning of ISS life extension

ISS complete

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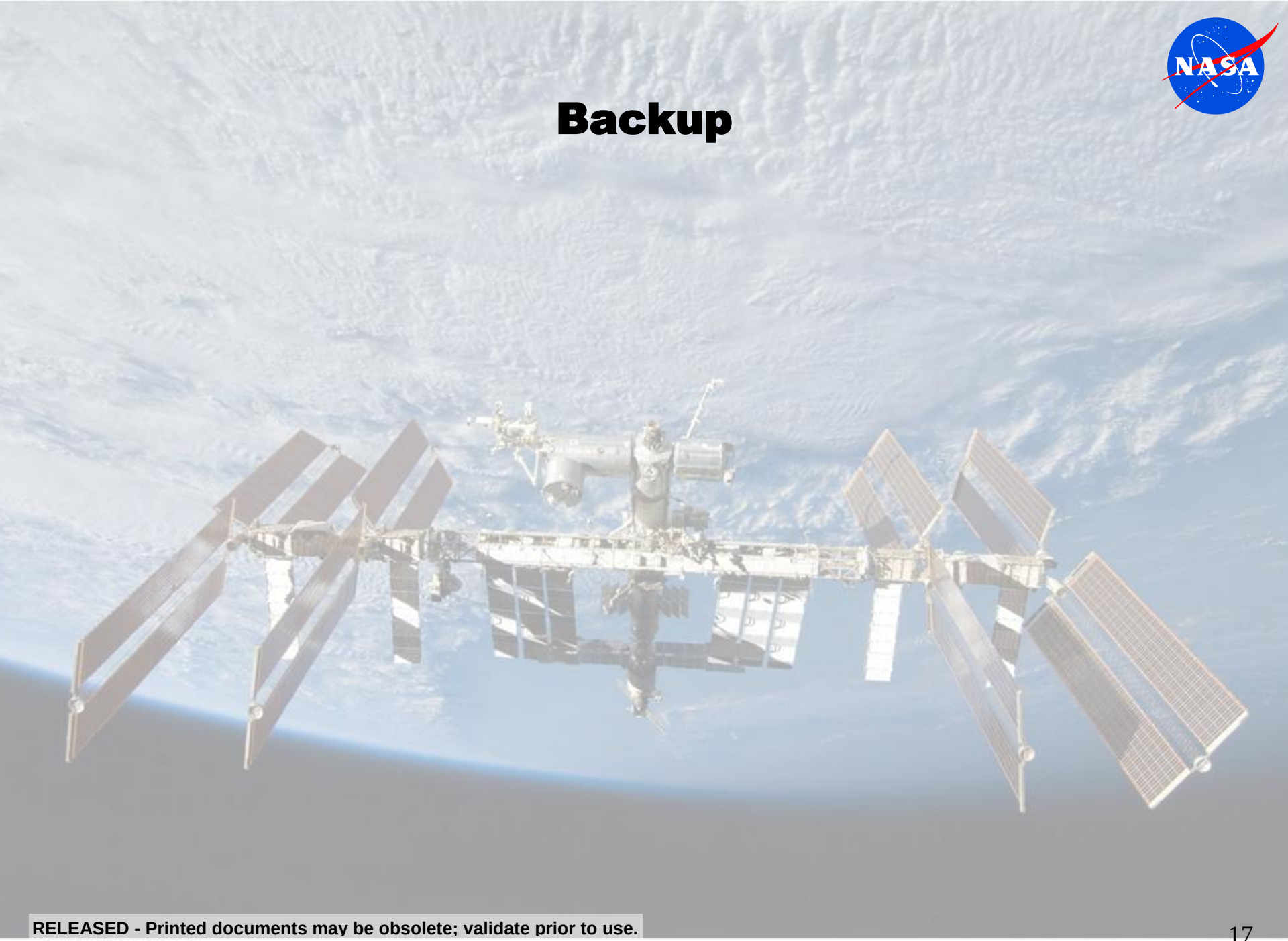
Backup



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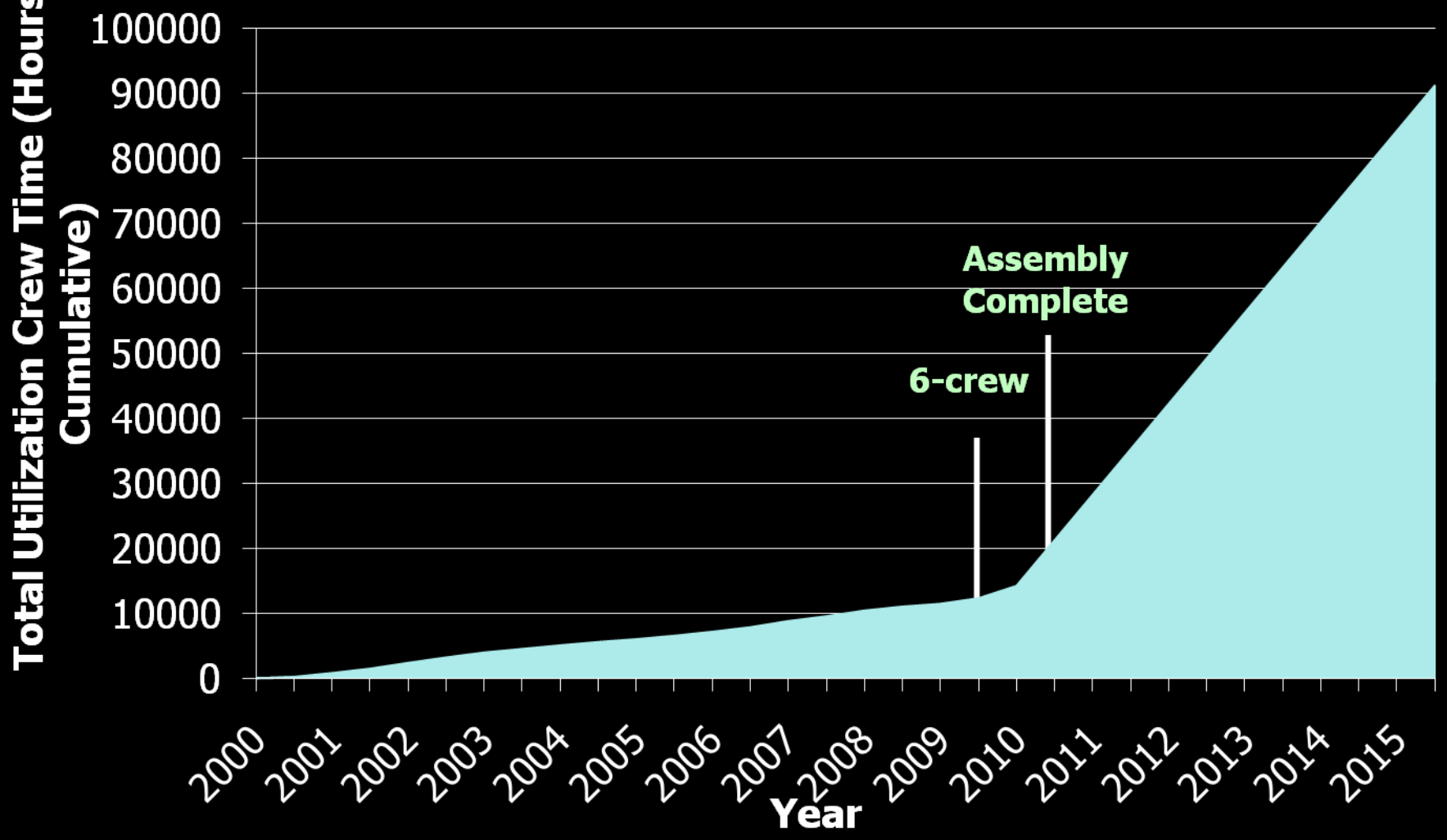
Cumulative ISS Utilization Crewtime
(US and Russian Operating Segments, All Partners)



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NASA Research Infrastructure

2 Human Research Facility Racks

6 ExPRESS Racks

Materials Science Rack

Fluids Integrated Rack (FIR)

Combustion Integrated Rack (CIR)

Microgravity Science Glovebox (MSG)

2 Minus Eighty-Degree Laboratory Freezers for ISS (MELFI)

2001-2009

Window Observational Research Facility

Muscle Atrophy Research Exercise

MELFI-3

Added for Future Users

ExPRESS-7 & 8

2010

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Microbial Vaccine Development – Scientific findings from *International Space Station* research have shown increased virulence in *Salmonella* bacteria flown in space, and identified the controlling gene responsible. AstroGenetix, Inc. has funded their own follow-on studies on ISS and are now pursuing approval of a vaccine as an Investigational New Drug (IND) with the FDA. They are now applying a similar development approach to methycillin-resistant *Staph aureus* (MRSA).

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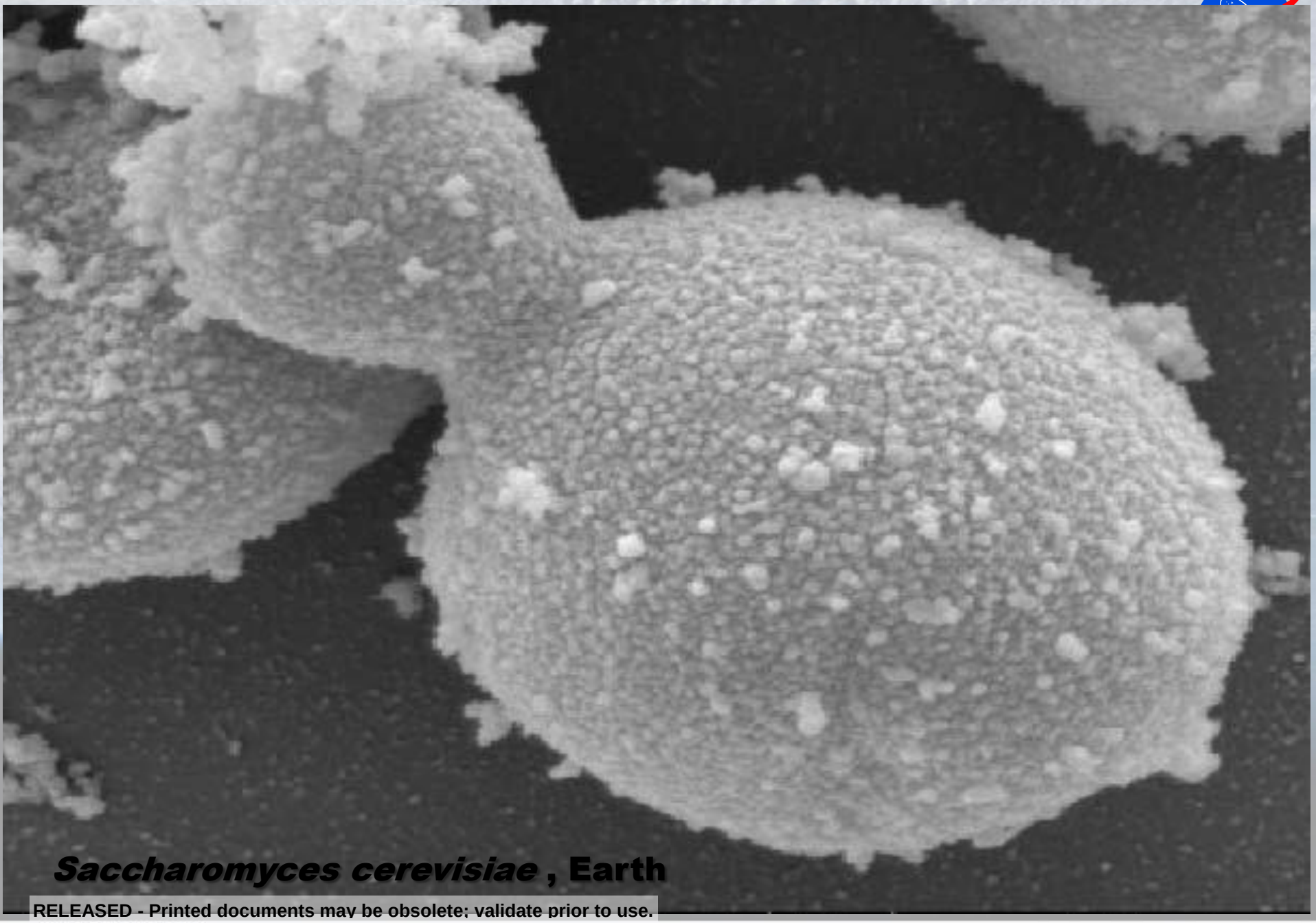

Saccharomyces cerevisiae **, Earth**

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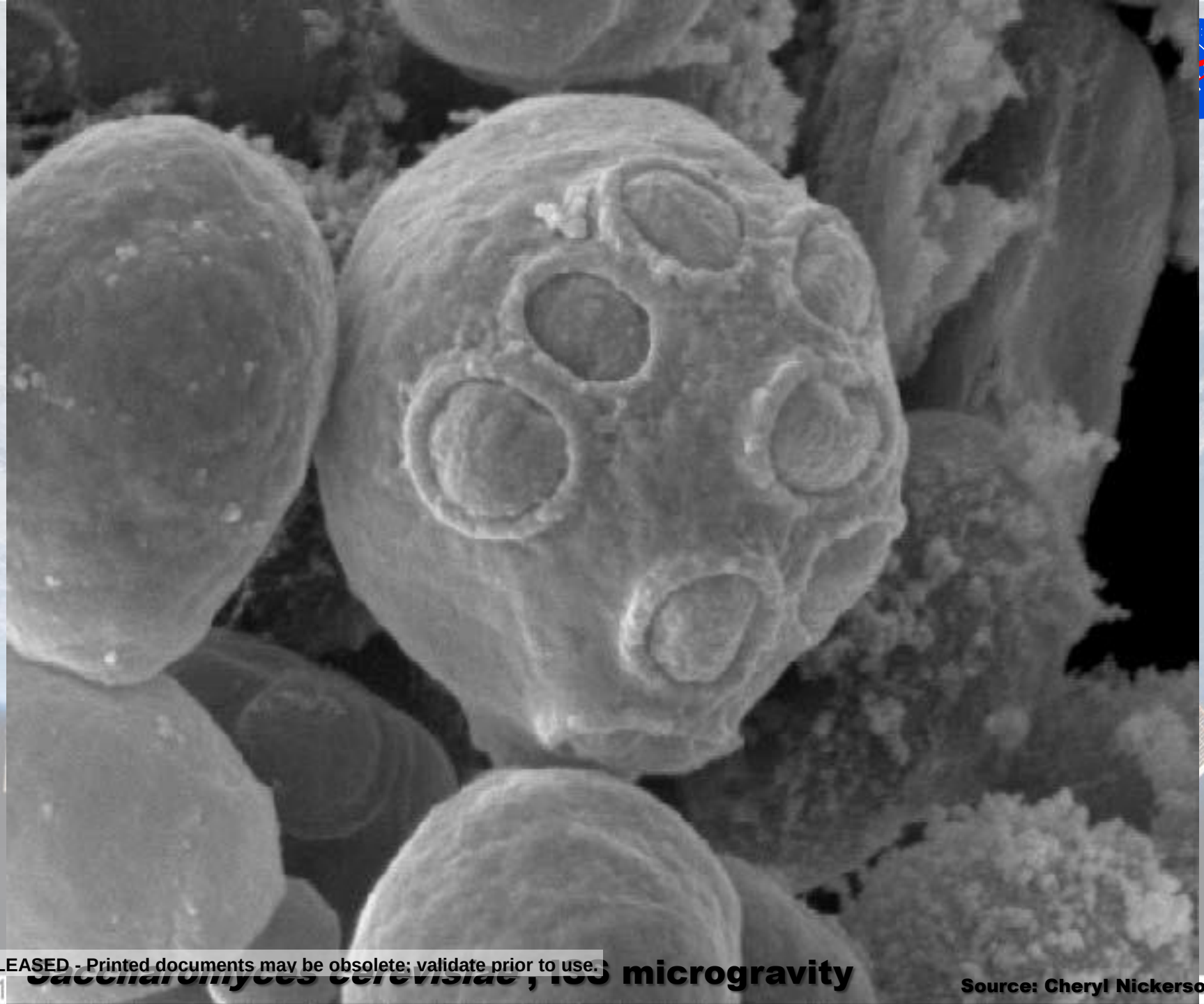
Source: Cheryl Nickerson, ASU



Saccharomyces cerevisiae, ISS microgravity

Source: Cheryl Nickerson, ASU

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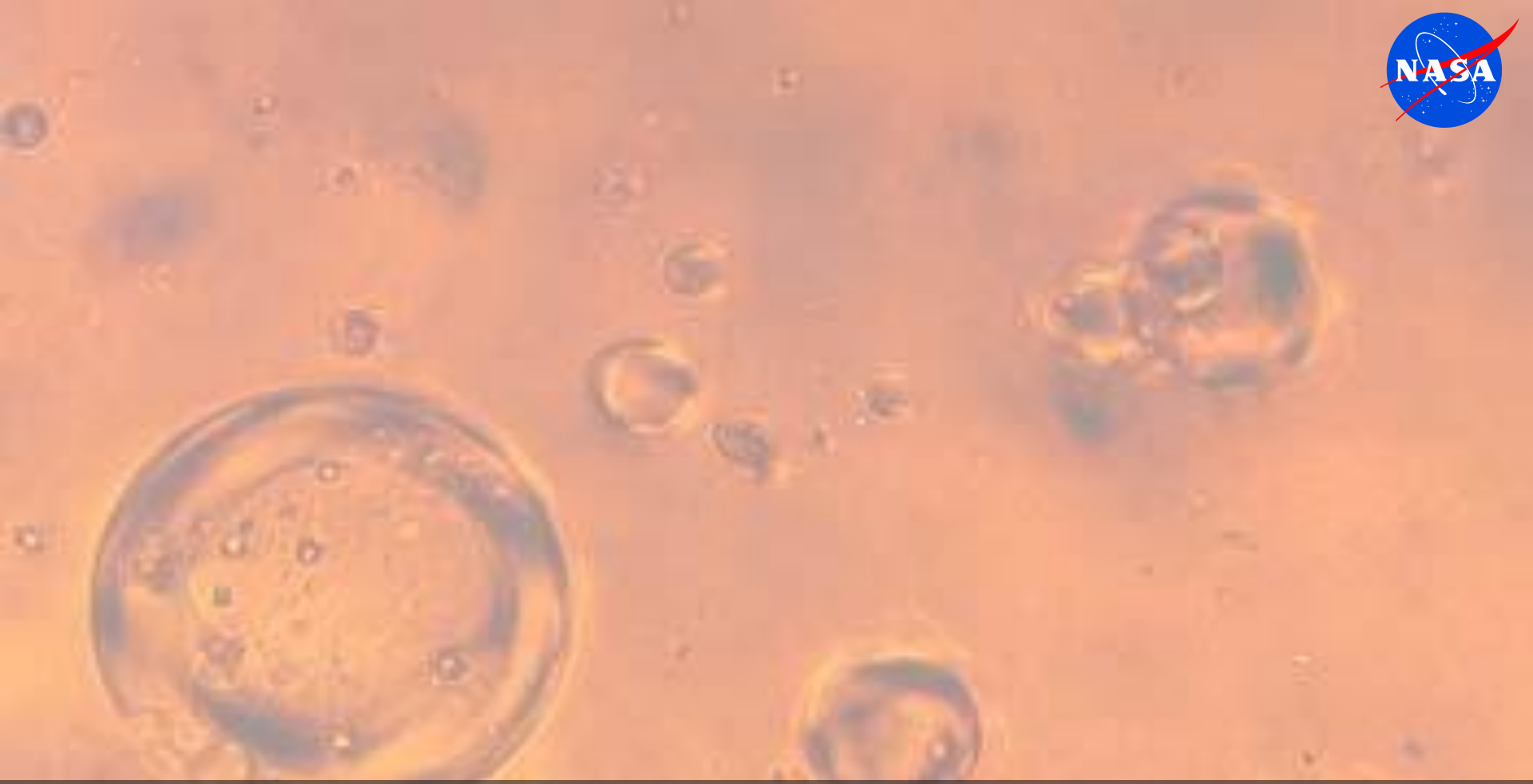

Cancer Treatment Delivery– Microcapsules (micro-balloons) for drug with desirable properties developed on the *International Space Station* were reproduced on Earth and were successful in targeting delivery of anti-cancer drugs to successfully shrink tumors in ground tests. A device to produce similar capsules on Earth has now been patented, and clinical trials of the drug delivery method are beginning.

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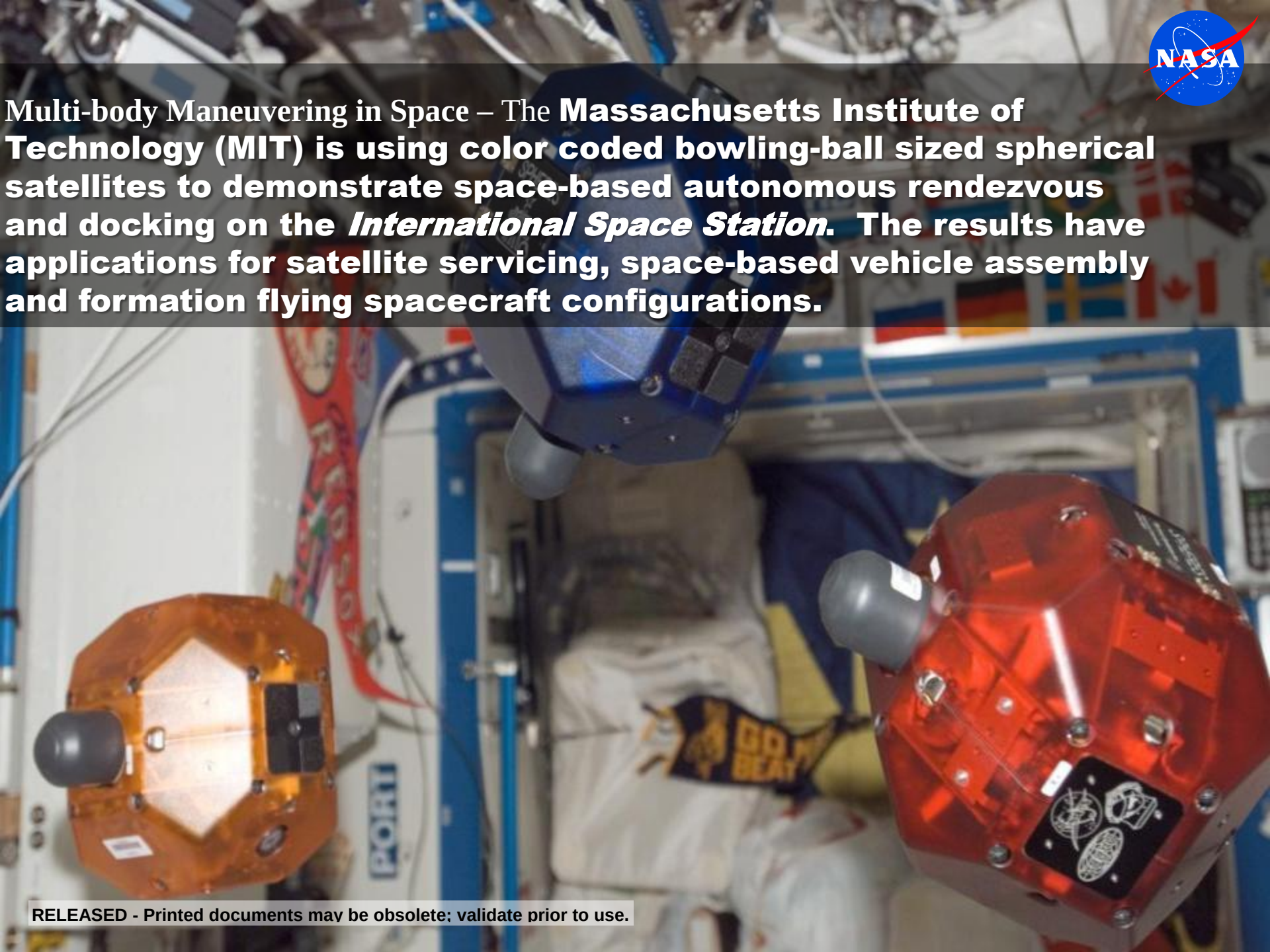

Multi-body Maneuvering in Space – The **Massachusetts Institute of Technology (MIT) is using color coded bowling-ball sized spherical satellites to demonstrate space-based autonomous rendezvous and docking on the *International Space Station*. The results have applications for satellite servicing, space-based vehicle assembly and formation flying spacecraft configurations.**

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International Space Station Program

Why do we need an ISS?

- Scientific Research
- Engineering Research
- Operations Research
- International Cooperation on large scale Projects

Push the Boundaries of Knowledge “close” to home

Prepare for Human exploration beyond our Planet

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What's Happening Today

- Framing the Commercial Human Transportation Industry
  - What is NASA's role
  - What is the FAA's role
  - What are NASA's requirements for Low Earth Orbit?
  - What will the Government Provide vs. Commercial Providers
    - Search Rescue
    - Crew pre/post flight facilities
- On April 15, the President announced that NASA would pursue an Orion-lite vehicle to launch uncrewed and provide rescue services to the ISS
  - What is the operational scenario and requirements for this vehicle
  - How does this capability work with the Commercial crew
  - Where does the budget come from?
- How does NASA keep Human Spaceflight Alive until the US is ready to continue with Space exploration?
  - Within NASA
  - NASA stakeholders
  - U.S. public

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