

National Aeronautics and
Space Administration



The International Space Station: The Decade of Results



Presentation to the Committee on Biological
and Physical Sciences in Space
March 23, 2022
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NASA Headquarters

2021 STATION HIGHLIGHTS



IROSA
INSTALLED
FIRST ROLLOUT
SOLAR ARRAY
OVER 3 EVAS



FULL HOUSE
11 ON STATION
APRIL 2021



13 EVAS
MOST SINCE
2010



23 TOTAL
ON BOARD



PARAGUAY
DEPLOYED FIRST
SATELLITE
FROM STATION



EVA HOURS
3.73 DAYS OR
89.5 HOURS



EXPEDITIONS:
64 (PARTIAL)
65 (FULL)
66 (PARTIAL)



8 CARGO
RESUPPLY MISSIONS
3 PROGRESS
3 DRAGON
2 CYGNUS



5 CREWED
LAUNCHES
CREW-2 DRAGON
CREW-3 DRAGON
SOYUZ MS-17
SOYUZ MS-18
SOYUZ MS-19



STATION SCIENCE
CHIEF HARVEST
COOL FLAMES
BISHOP AIRLOCK
GITAI ROBOTIC ARM
EARTH CLIMATE STUDIES
COLD ATOM LAB AR
ASTROBEE WAKES UP
DNA RESEARCH



CREW-1
FIRST SPLASHDOWN
OF U.S. CREWED
SPACECRAFT
SINCE APOLLO 8



CREW-2 LAUNCH
APRIL 23, 2021
KIMBROUGH, MCARTHUR,
HOSHIDE, PESQUET



CREW-3 LAUNCH
NOV. 11, 2021
CHARI, MARSHBURN,
BARRON, MAURER

ISS Mission Goals – The Decade of Results

Enable Deep Space Exploration

Validate Exploration Technologies and Reduce Human Health Risks

Conduct Research to Benefit Humanity

Life-saving medical research & applications, understanding climate change, sharing discoveries with all

Enable International Collaboration

Maintain & expand international partnerships, set norms & standards

Foster Commercial Space Industry

In partnership with Commercial LEO Office

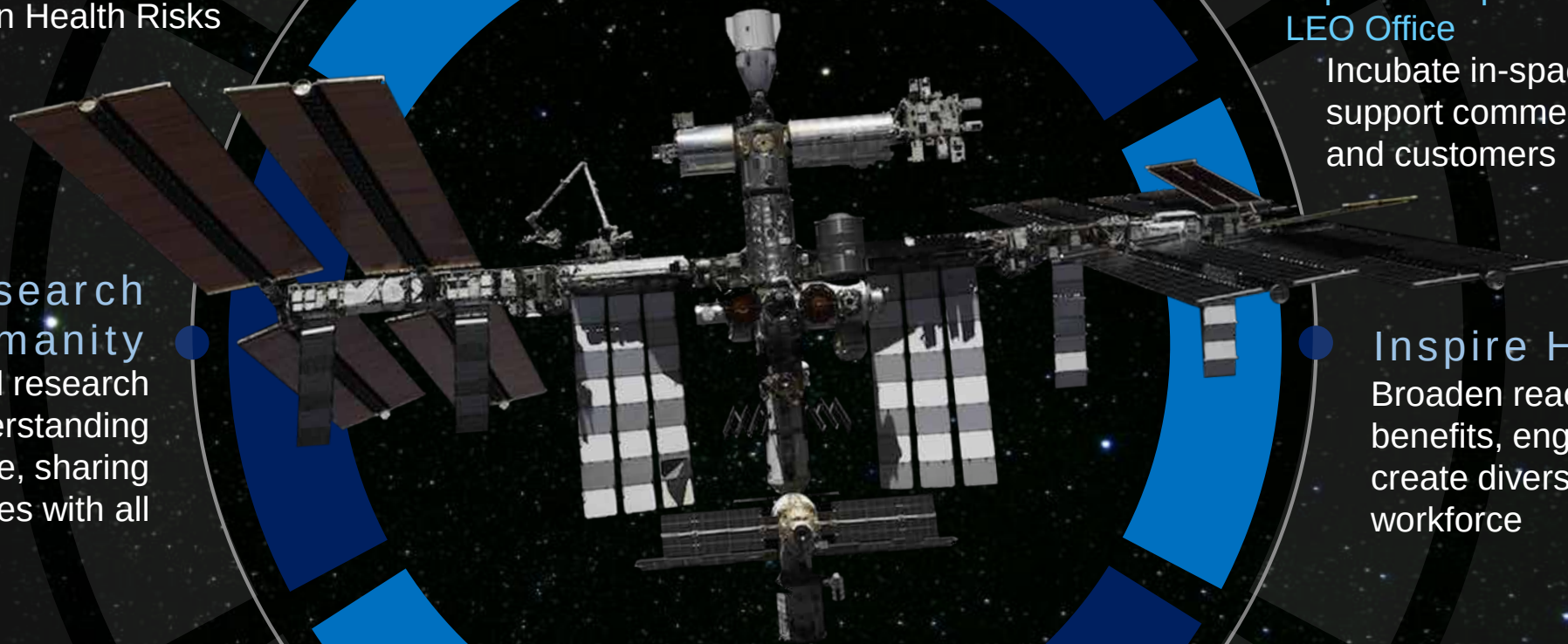
Incubate in-space manufacturing, support commercial LEO facilities and customers

Inspire Humankind

Broaden reach of space benefits, engage public, create diverse future STEM workforce

Provide National Human Space Flight Infrastructure

Ensure continuous human presence in LEO - no gap; provide destination for crew & cargo transportation



ISS Extension Through 2030

- On December 31, 2021, the White House announced a decision to extend operations of the ISS through 2030*
- Extension through 2030 will allow time to complete critical exploration development activities while bringing new commercial LEO capabilities online
- The ISS International Partners are working with their respective governments to extend through 2030
- There are no technical constraints to operating through 2030



* <https://blogs.nasa.gov/spacestation/2021/12/31/biden-harris-administration-extends-space-station-operations-through-2030/>

Benefits of Extension

- ü Supporting goals in LEO and beyond requires a continuous on-orbit LEO platform
- ü The ISS is well-equipped technically to continue operations through 2030
- ü 2030 reduces risk of achieving transition readiness
 - • CLDs available
 - • Non-NASA demand developed
 - • Exploration objectives on ISS completed
 - • International partnership transitioned
 - • Ongoing research transitioned to CLDs
 - • Allows time for overlap between ISS and CLDs



Utilization Transition from ISS to CLD (notional)



ISS



CLD

Users

International Partner
Utilization

Through ISS Intergovernmental Agreement
(IGA) and bilateral agreements

Bilateral government to government
agreements and arrangements directly
with industry

NASA Technology
Demonstration

Long-duration microgravity testing of
exploration systems (ECLSS, Crew Health
Systems, Food Production, etc.)

Accommodation for ongoing subset of
testing, possible incorporation into
CLD designs

NASA Human Research

HRP risk reduction plans - multiple
subjects for varied durations

Ongoing research with NASA crew and
possibly private astronauts, exploration
analog

NASA Science

Biological, Physical, Earth, Planetary
decadal-driven science

Purchase accommodation for ongoing
decadal-driven science; transfer hardware or
purchase commercial facility services

Other Government Agency
Research

Through ISSNL or NASA collaboration
(NIH, NSF, DoD, others)

Through LEO National Lab

In-Space Product
Manufacturing

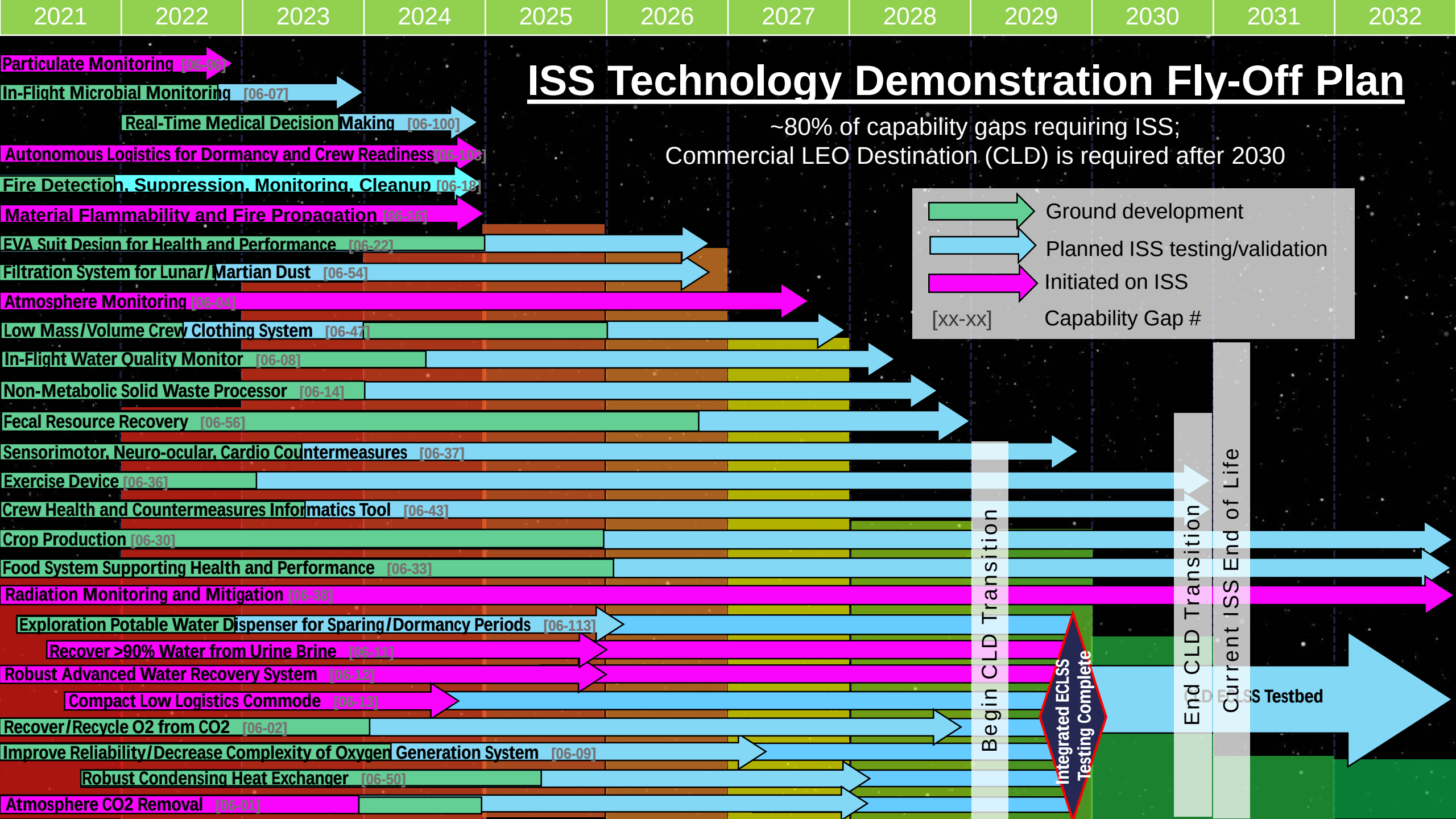
NASA in-space production + ISSNL

Development through LEO National Lab ;
commercial production business to
business

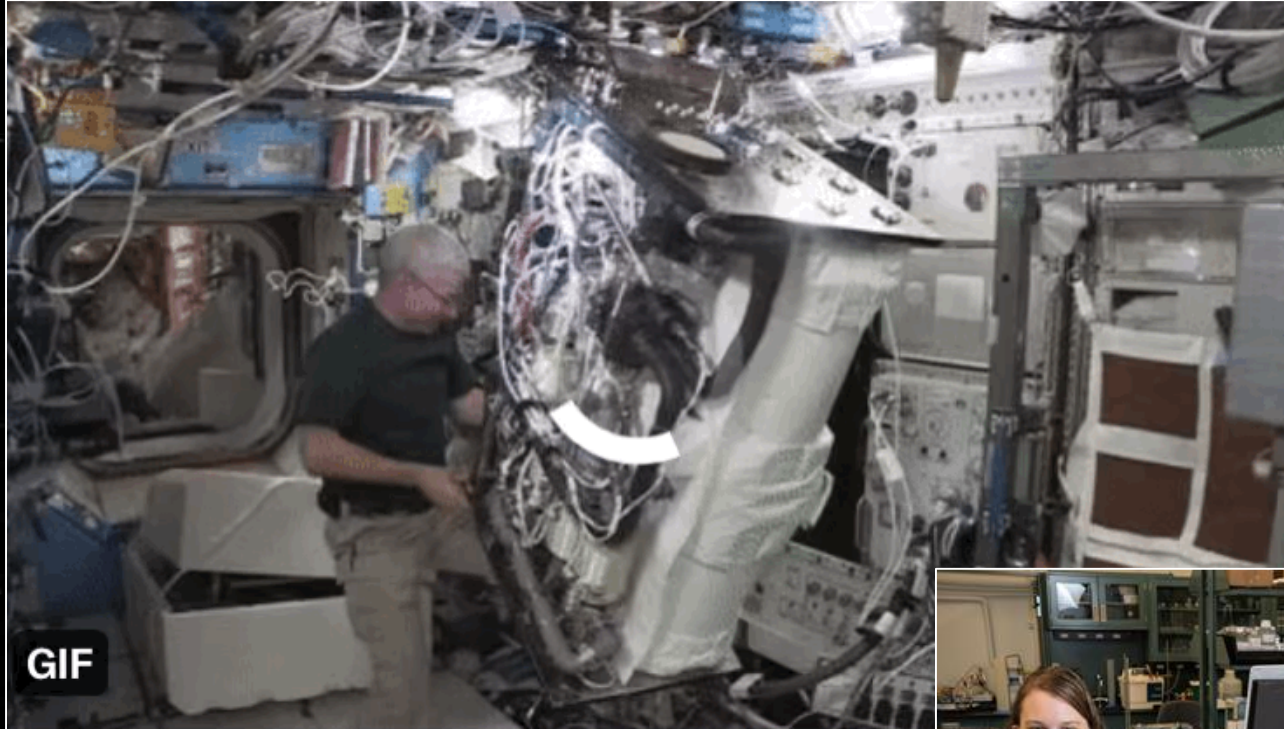
Commercial Tourism,
Marketing

ISS Private Astronaut Missions, Commercial
Use Policy, reimbursement of resources

Business to business



Exploration Capabilities Development Technology Demonstrations



GIF

Above: Mark Van de Hai installing 4-Bed CO₂ Scrubber in the US Laboratory

Right: Space Suit Evaporation Rejection Flight Experiment (SERFE)

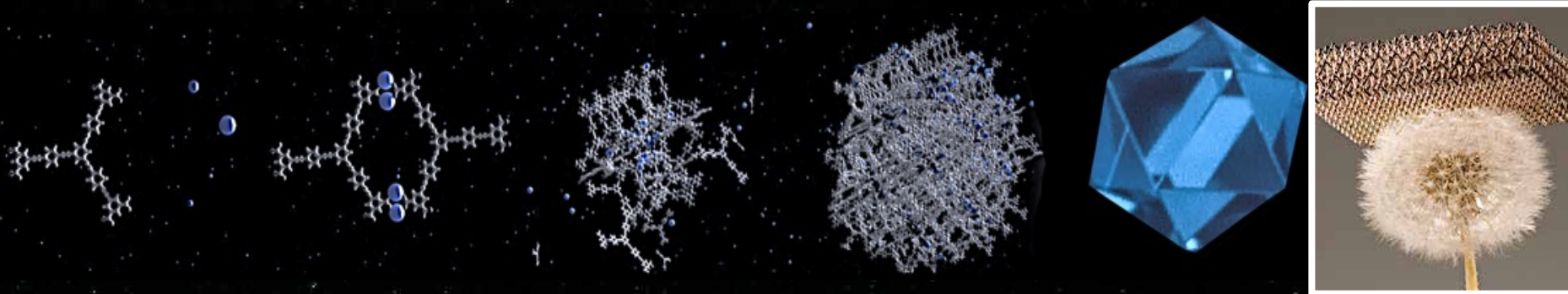


Below: Brine Processor Assembly installed in March 2021

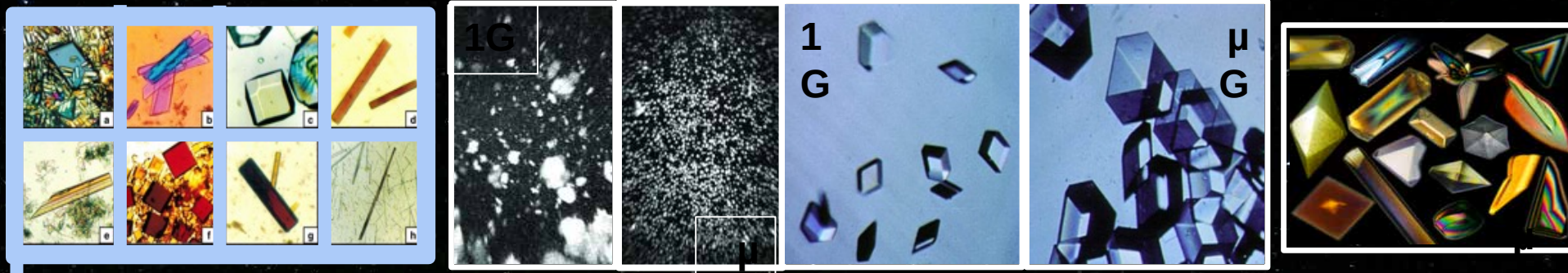




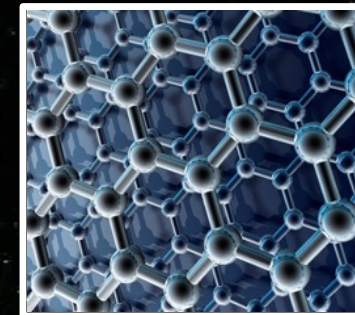
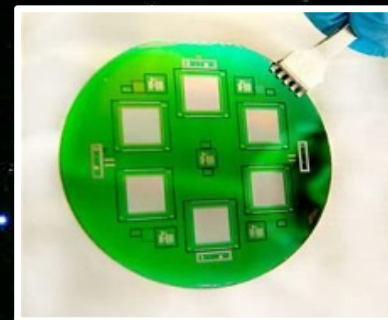
Advanced Materials



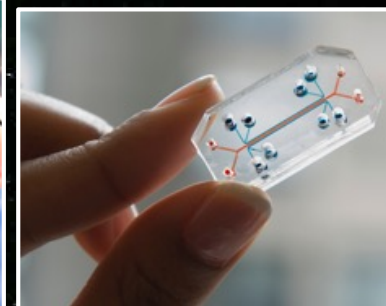
Crystals



Thin Film Deposition



Tissue Engineering and Regenerative Medicine



ISS Research Statistics



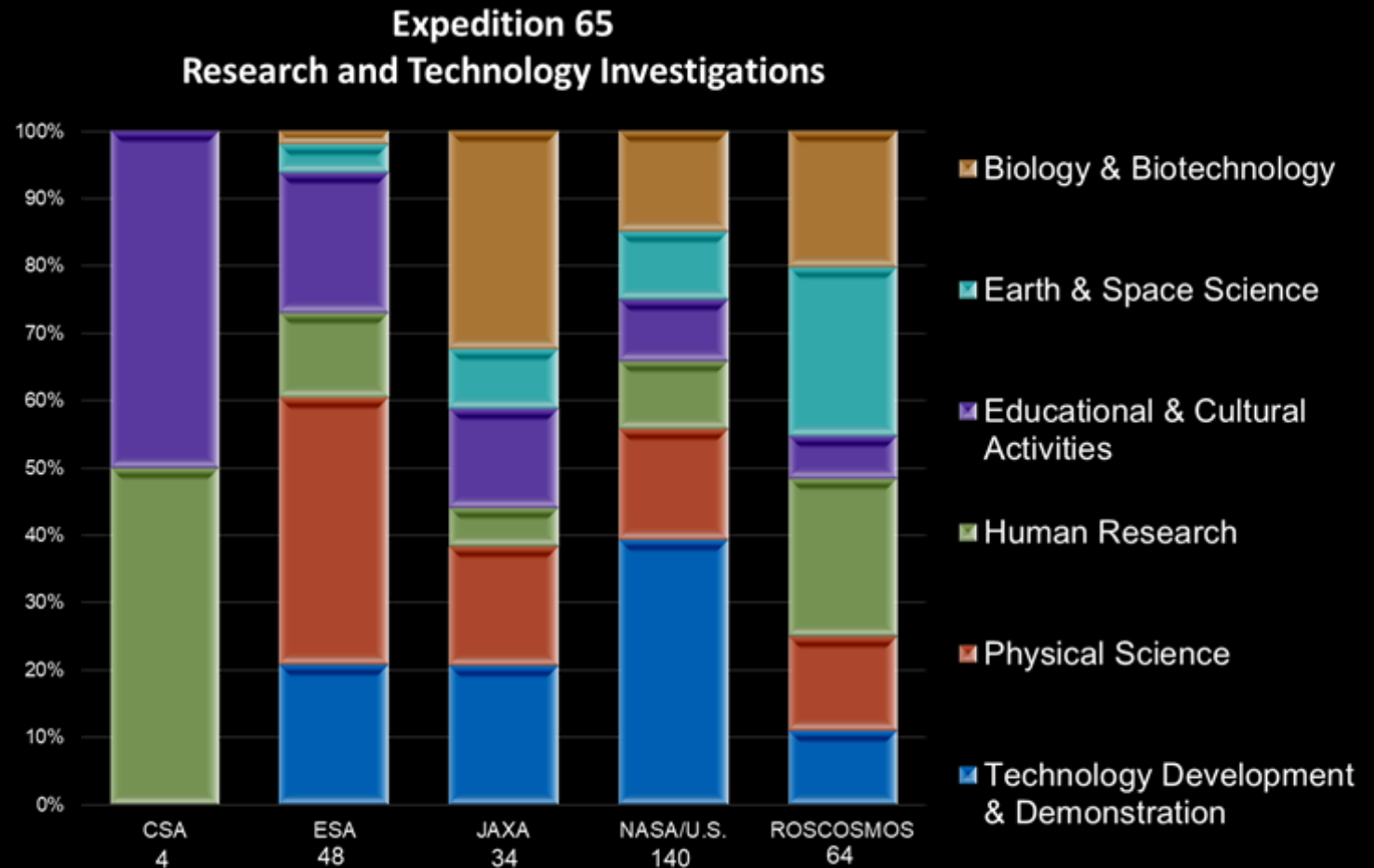
Estimated Number of Investigations Expedition 0-65: 3202*

Investigations for 65: 290

- 140 NASA/U.S.-led investigations
- 150 International-led investigations
- 81 New Investigations
 - 0 CSA
 - 24 ESA
 - 11 JAXA
 - 43 NASA/US
 - 3 ROSCOSMOS

MCB Approved Statistics Exp. 0-62

- 3040 Investigations
- 4418 Investigators Represented
- 109 Countries/Areas with ISS Research and Education Participation
- Over 2377 Scientific Results Publications (Dec 1998 – Nov 2021)

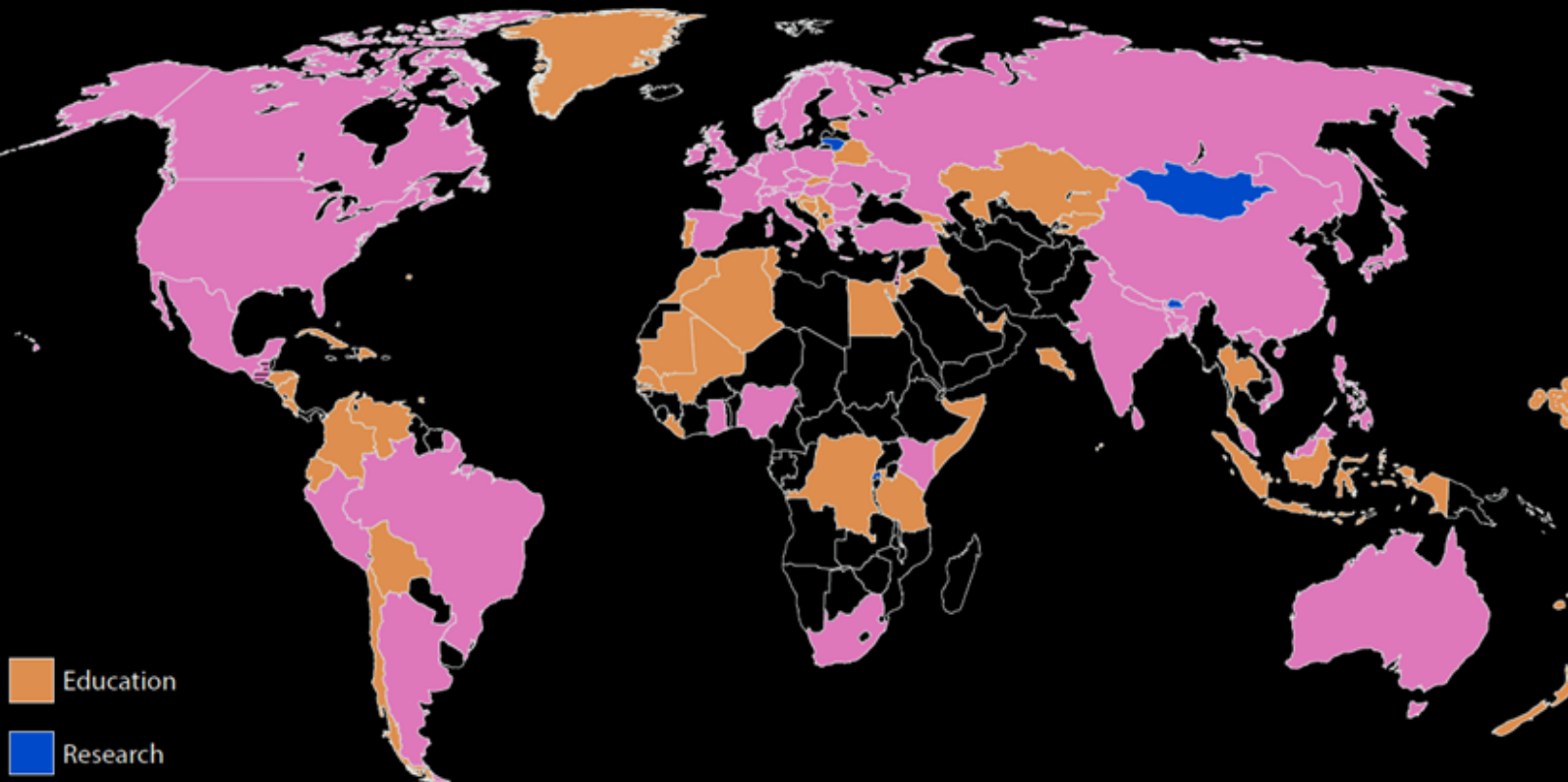


*Pending Post Increment Adjustments

International Participation on ISS



Albania
Algeria
Argentina
Armenia
Australia
Austria
Bangladesh
Belarus
Bermuda
Bhutan
Bolivia
Bosnia
Brazil
Bulgaria
Chile
China
Columbia
Costa Rica
Croatia
Cuba
Cyprus
Czech Republic
Democratic Republic of the Congo
Dominican Republic
Ecuador
Egypt
Estonia
Fiji
Finland
Georgia
Ghana
Greece
Greenland
Guatemala
Honduras
Hungary
India
Indonesia
Iraq
Ireland
Israel
Jordan
Kazakhstan
Kenya
Kuwait
Kyrgyzstan
Lebanon



109 highlighted countries and areas have participated in ISS Research and Education Activities

Belgium
Canada
Denmark
France
Germany

Italy
Japan
Netherlands
Norway
Russia

Spain
Sweden
Switzerland
United Kingdom
United States

*New participating country

Liberia
Lithuania
Luxembourg
Macedonia
Malaysia
Maldives
Mali
Marshall Islands
Mauritania
Mexico
Monaco
Mongolia
Montenegro
Morocco
Nepal
New Zealand
Nicaragua
Nigeria
Peru
Philippines
Poland
Portugal
Qatar
Republic of Malta
Republic of Korea
Republic of South Africa
Romania
Rwanda*
Senegal
Serbia
Singapore
Slovakia
Slovenia
Somalia
Sri Lanka
Taiwan
Tanzania
Thailand
Trinidad and Tobago
Tunisia
Turkey
Ukraine
United Arab Emirates
Uruguay
Vatican City
Venezuela
Vietnam

NASA's FUTURE LEO NEEDS



Human Research

NASA anticipates to meet these needs as it transitions from International Space Station operations to new commercial LEO destinations that are commercially-owned and operated.



Science



Technology Demonstrations



Crew Accommodations & Training



National Lab Services



Physical & Biological Research

COMMERCIAL LEO DEVELOPMENT PROGRAM ROAD MAP

Near Term

Mid-Term

Far Term

International Space Station (ISS) Operations

Commercial LEO Destinations Development

CLD Operations

Phase 1: Early Design Maturation

Phase 2: Certification & Services

Design and Development

LEO economy developed by enabling a supply side and actively maturing a sustainable demand side

S
U
P
P
L
Y

Commercial Destinations
on ISS (CDISS)

Commercial Destinations
Free Flyer (CDFF)

D
E
M
A
N
D

Demand Stimulation (In-Space Manufacturing, R&D to Applications)

ISS National Lab/CASIS (Science, Applied R&D, Tech Dev, STEM)

Commercial Use of ISS (Commercial and Marketing Activities)

Private Astronaut Missions (Tourism)

Gov't LEO Requirements (Human Research, Life & Physical Sciences)

Transition

*Plan based on NASA
readiness,
maturation of
destinations, and
market demand*

End Goal

*Sustainable
Commercial
Operations with
multiple customers*

**Transition LEO Economy
Activities from ISS to
Commercial Destinations**

ISS National Lab Status (CASIS)

- **All Independent Review Team Actions Completed**

- o Primarily new Board and new acting Executive Director
- o User Advisory Committee established and meeting
- o Transparent, peer-reviewed project evaluation process established
- o NASA liaison transitioned to ISS Director
- o Cooperative Agreement simplified
- o Annual Performance Goals restructured to reflect priorities and outcome-based



ISS National Laboratory

CENTER FOR THE ADVANCEMENT OF SCIENCE IN SPACE

- **88 payloads delivered in FY21, second most in single year (despite COVID)**
- **85% of total costs for selected projects were externally funded**
- **Beginning to see more demand than resources available**
- **NASA-CASIS partnership is strong**
- **NASA studying potential future models of a national laboratory in LEO**