Climate Change Experiments on ISS

Human Spaceflight
SPACE FOR LIFE

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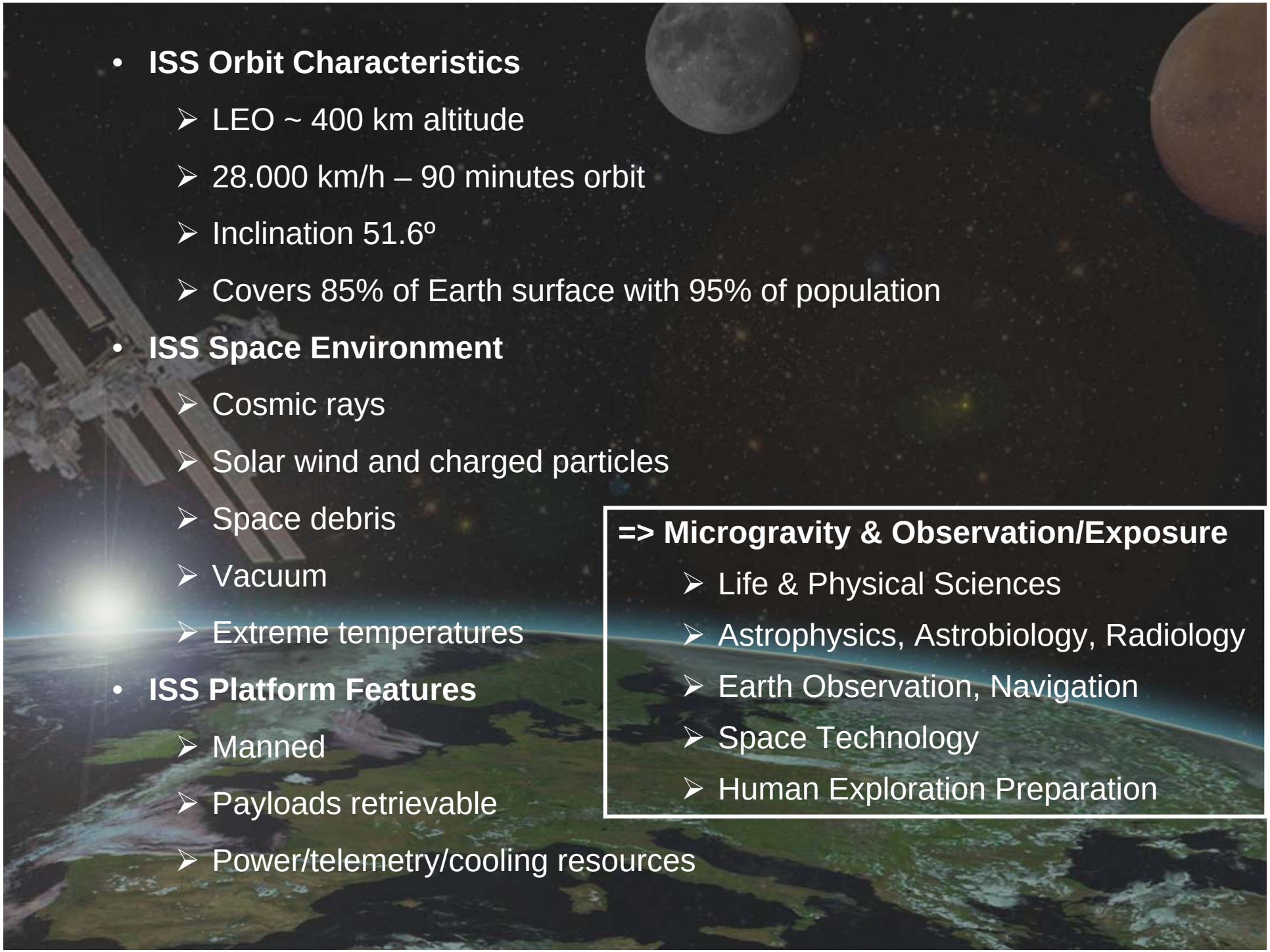

- **ISS Orbit Characteristics**
  - LEO ~ 400 km altitude
  - 28.000 km/h – 90 minutes orbit
  - Inclination 51.6º
  - Covers 85% of Earth surface with 95% of population
- **ISS Space Environment**
  - Cosmic rays
  - Solar wind and charged particles
  - Space debris
  - Vacuum
  - Extreme temperatures
- **ISS Platform Features**
  - Manned
  - Payloads retrievable
  - Power/telemetry/cooling resources

=> Microgravity & Observation/Exposure

- Life & Physical Sciences
- Astrophysics, Astrobiology, Radiology
- Earth Observation, Navigation
- Space Technology
- Human Exploration Preparation

ISS Configuration & External Payload Accommodations

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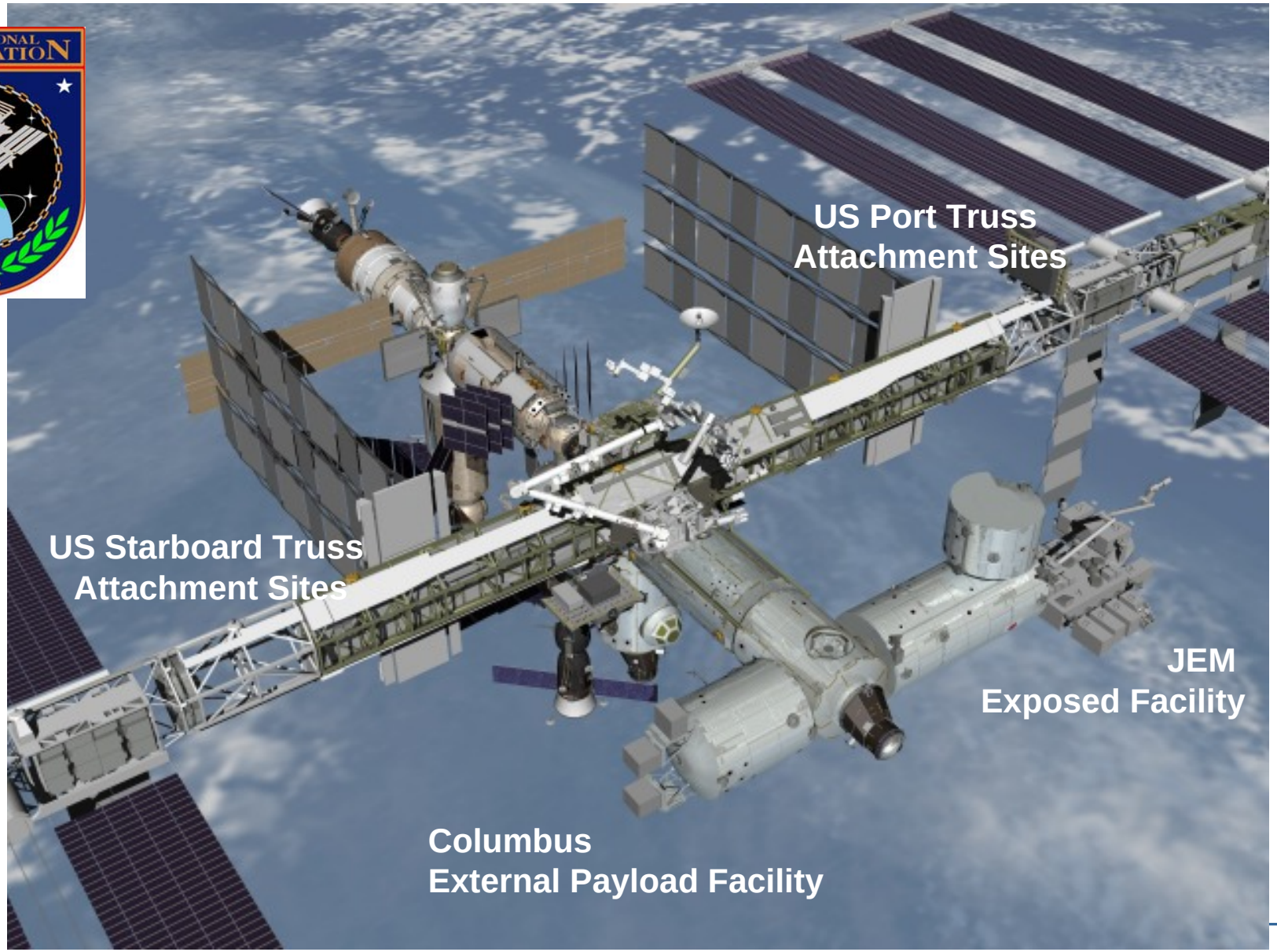


ISS Exploitation Key Objectives

- Optimum long-term exploitation of ESA's ISS assets (Columbus module and research infrastructure, ATV/ARV, Astronauts)
- Execution of the European Life & Physical Sciences Programme (ELIPS) with a broad ISS utilisation spectrum in fundamental, applied and industrial research
  - Exobiology / Biology / Human adaptation and performance
  - General Physics / Materials sciences / Physics of fluids and combustion
  - Medical - Materials – Environment – Energy – Processes
  - Space & Earth Observation – Technology
  - Education/Outreach
- Significant use of the permanent ISS testbed in Low Earth Orbit (LEO) as a first major step for Human Exploration of Space
- Long-term fruitful ISS collaboration within International Partnership as an invaluable experience basis for future global Human Exploration endeavours
- High European interest in ISS lifetime extension to expand yield in all areas of space research and experience in space operations for Human Spaceflight endeavours beyond LEO

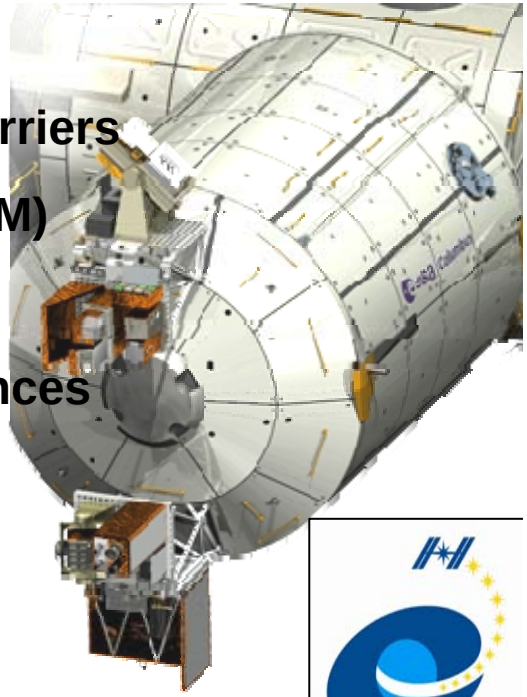
ISS System & Utilization Achievements

- Launch of complete Columbus laboratory (Feb 2008) outfitted with 4 multi-user Research Racks (Biolab, EPM, FSL, EDR) and 2 External Payloads (EuTEF, SOLAR)
- Maiden mission of ATV Jules Verne (March-Oct 2008)
- Flight of 6 ESA astronauts, ISS commander Incr 21
- Re-Location of 4 NASA Research Racks from Destiny to Columbus (….) and deployment of further ESA research elements in Destiny, Kibo and RS labs
- Continuous execution of broad experimental programme with a total of more than 100 ESA experiments performed on ISS to date
- Increasing implementation rate of applied research projects and Human Exploration related activities
- Very active European user community with multi-national research teams
- Very promising augmentation of European utilisation envelope in the frame fruitful science collaboration with International Partners
- Continuous gain of invaluable ISS ops experience

International Collaboration

- ISS Memorandum of Understanding with NASA provides 8.3% of USOS resources to ESA
- Numerous ESA-NASA barters and cooperative science projects
- Joint ISS research calls with numerous proposals from international teams
- ISS Programme Science Forum fosters international science collaboration and promotes broad use of ISS for research
- ESA DG and NASA Administrator push for enhancement of Climate Change study efforts at international level
- ISS Utilisation Framework Agreement between ESA and Roscosmos allows to implement joint science experiments
- High interest of collaboration between ESA and JAXA
- Canadian Space Agency (CSA) participating in ELIPS programme
- ISS lifetime extension to 2020/2025 will further expand the perspectives for international collaboration and pooling of ISS research capabilities and resources

2010-2015 ISS Utilisation Outlook



- Shuttle retirement and adaptation to new ISS cargo carriers
- Launch of major ESA payloads (EML, PK-4, ACES/ASIM)
- Functional evolution of on-orbit payloads
- Start of advanced on-orbit analysis tools for Life Sciences
- Continuation of advanced biology programme
- Start of 2nd generation physiology experiments
- Execution of Human Exploration preparation research
- Start of Climate Change experimentation
- Advanced physical science experimentation (complex plasma, colloids, emulsions, heat & mass transfer, etc.)
- Enhancement of applied research and industrial R&D activities
- Expansion of international collaboration

2015+ ISS Utilisation Plans & Ambitions

- **Use of new ISS crew vehicles (also for science logistics)**
- **Launch of new COL P/L facilities (2nd generation, new research themes incl. Climate Change)**
- **Functional evolution of on-orbit payloads**
- **Full implementation of advanced on-orbit analysis tools**
- **Biotechnology and rodent research programme**
- **Enhancement of biomedical and physical research for Human Exploration**
- **Deployment of EuTEF-2 platform for accommodation of technology testing and other External P/L elements**
- **Advanced physics experimentation (complex plasma, atomic clocks)**
- **Full deployment of applied research and industrial R&D activities**
- **Full scheme of broad international research collaboration**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