JSC Engineering Overview For New Employee Orientation

February 2011

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Topics

- Overview
- History
- Organization
- Infrastructure
- Current Focus

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What is Human Spaceflight really about?.....

Inspiration!

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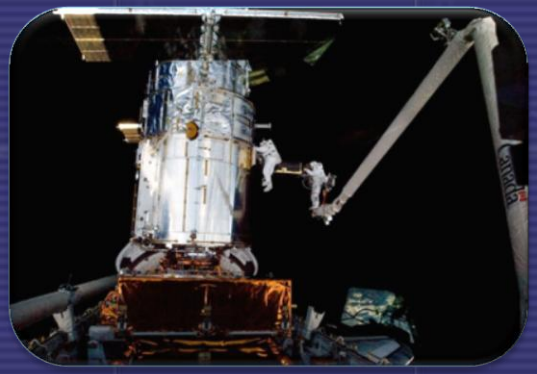
*We **Achieve** the **Impossible** with Bold Explorers and Incredible Machines!*



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Engineering's Core Work

- **Maintain technical oversight for spacecraft systems**
  - System and subsystem management functions performed with CS/contractor teams
  - Systems Engineering and Integration
  - Critical Domain Expertise
- **In-house design, development, test, analysis & evaluation for large scale spacecraft systems**
  - GFE systems for major programs
  - Capability demonstration projects
- **Technology Maturation**
  - Improve domain expertise
  - Advance systems capabilities for future missions

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JSC Engineering Approach

- We internally manage our civil servant engineering workforce at **saturation** (CS ceiling ~ 850)
- We maintain an inventory of contracts to provide the expertise and skill mix appropriate to augment support spaceflight programs (~2100 contractors)
- To protect surge capability, we manage the contracts at <90% "cost saturation"
- Major contractors include Jacobs Technology Inc., Wyle Labs., Charles Stark Draper, Oceaneering, and L3. etc.
  - Aggregate contract value: ~$1.5B for 5 years, or ~$300M/year

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Engineering History

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Premise

- This organization has played a significant role in every human spaceflight program in NASA's history
  - Mercury, Gemini, Apollo, Skylab, Shuttle, Station, X-38, OSP, NGLT, Constellation,……..
- The basis on which this organization was founded remains intact today and our core values and purpose of the organization persist regardless of changing political, social, or economic environment
- By looking into the past, we discovered what lies at the core of who we are today

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How we got here

Illustration of relative sizes of Mercury, Gemini and Apollo spacecraft

- Mercury, Gemini and Apollo
  - In the 60's when Engineering at JSC (MSC) was organized, Mercury was already developed and Engineering was working manufacturing and flight problems
  - Gemini was a big Mercury and used the same contractor. The program office was largely self contained. When problems developed in the landing systems and propulsion systems, Engineering became heavily involved.
    - The peak for Engineering during Gemini was 300 civil servants, and no contractors.
  - The center was organized around Apollo
    - Every technical discipline required either a technical breakthrough or major improvement for the program to succeed.
    - Every laboratory at JSC was specifically designed to support Apollo independent design and test capability.

In the Beginning . . .

DR. GILRUTH

". . . Dr. Gilruth indicated at the beginning that he wanted a strong technical supporting organization to exist at the Manned Spaceflight Center, with laboratories that would essentially support all various requirements for manned space flight."

MAX FAGET

" . . . In the case of Apollo, the Center organized its expertise in various spacecraft systems within E&D, and when it came to technical advise, the best technical advise and consultation would be from these people. . ."

- Max Faget

Who Were We in 1964?

Responsible for the technical support in depth for the Gemini and Apollo Manned Space Flight Programs. The systems work with the respective project is supplemented by extensive in-house test and evaluation programs which are a part of the program development milestones. The Directorate is also charged with directing the Center's Supporting Research and Technology programs and for conducting the required Advanced Studies necessary for progressing Manned Space Flight as an outgrowth of current programs.

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Our Core Ideology

- **We exist to provide essential engineering for the advancement of human space exploration**
- **In doing so, we grow premier engineers and technical leaders who are:**
  - *. . . curious, critical, and credible in their thinking*
  - *. . . commitment to finding solutions*
  - *. . . excited, eager and proud of their contribution to the Space Program and the global community*

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Our Core Values

- Dedication
- Integrity
- Respect
- Technical Excellence
- Teamwork

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Strategic Goals:

1. We will establish ourselves as an integral partner with the programs, with technical responsibility during all phases of development from concept through flight operations

2. Our systems' work will be supplemented by extensive in-house Design, Development, Test & Evaluation activities which are a part of the program development milestones

3. We will be recognized for delivering timely & cost-effective engineering solutions and technologies for human exploration systems

4. We will infuse innovative design and development strategies and foster a collaborative and inclusive environment

5. JSC Engineering will be synonymous with Engineering Excellence

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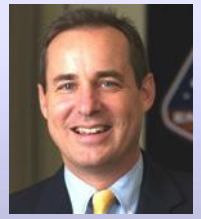
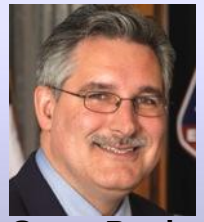
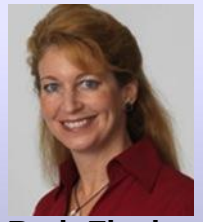
Engineering Organization



Stephen Altemus, Director



Steve Poulos, Dep. Dir.



Beth Fischer, Assoc. Dir.

Douglas Terrier, Assoc. Dir.

Engineering Services & Management Integration Office

Jon Olansen, Manager

EA2

Systems Architecture Integration Office

Bruce Sauser, Manager

EA3

Program Engineering Integration Office

Linda Bromley, Manager

EA4

Crew and Thermal Systems Division

Patricia Petete, Chief

EC

Aerosciences and Flight Mechanics Division

Steve Labbe, Chief

EG

Energy Systems Division

Bill Hoffman, Chief

EP

Automation, Robotics, and Simulation Division

Rob Ambrose, Chief

ER

Structural Engineering Division

Edgar Castro, Chief

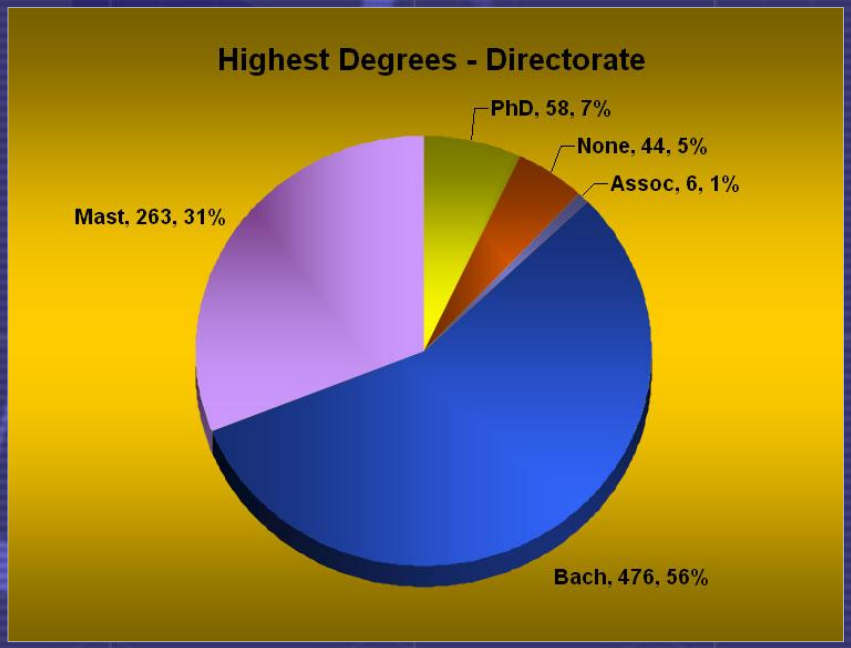
ES

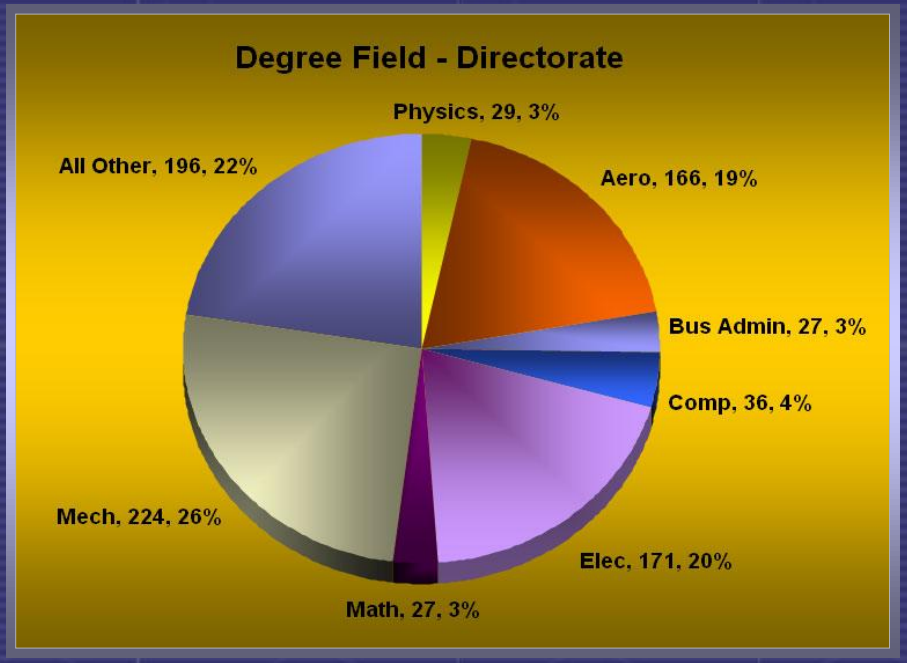
Avionics Systems Division

Pat Pilola, Chief

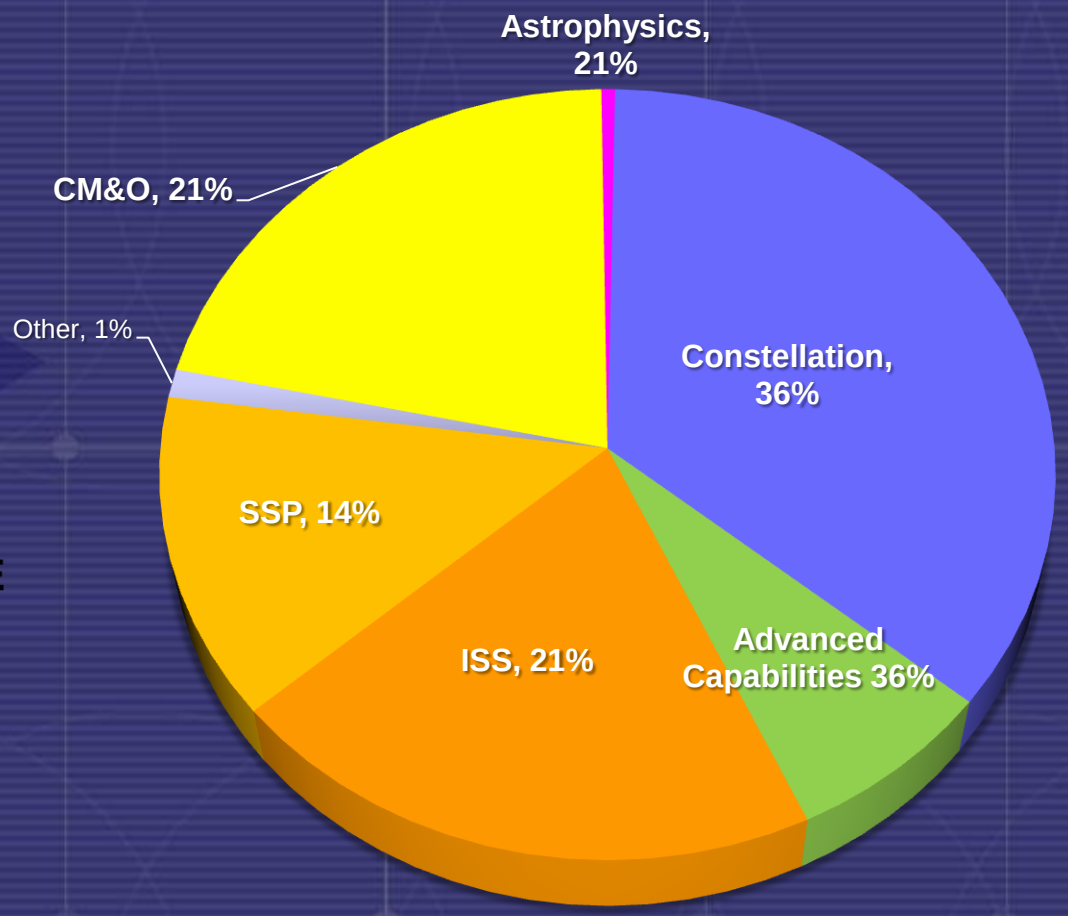
EV

Engineering Directorate Degree Fields





Workforce Distribution



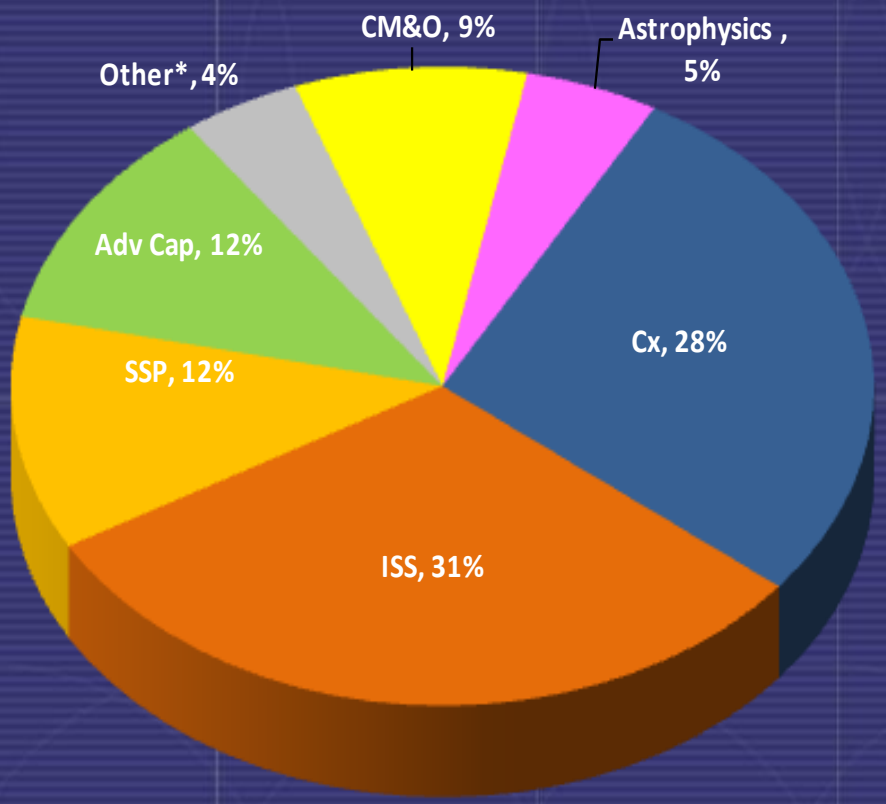
ENGINEERING CIVIL SERVICE FTE AVERAGE ACTUALS THROUGH FY10

(Total average ~850 FTEs)

Directorate Portfolio

FY '10 EA Budget (~$360M)

FUNDING	$(K)
CM&O	31,657
Astrophysics	18,211
Cx	100,345
ISS	112,147
SSP	43,074
Adv Cap	41,839
Other*	16,077
Grand Total	363,353



Environment / Focus

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Changing Environment

Priorities

1. Retire the Space Shuttle no later than 2010
2. Complete the International Space Station
3. Develop and fly the Crew Exploration Vehicle by2014
4. Return to the Moon no later than 2020
5. Extend human presence across the solar system and beyond

Policy Focus:

Advance U.S. Scientific, Security, Economic interests

Priorities

1. Protect the Earth's Environment
2. Enhance Relevance to Earth Science
3. Green Aeronautics
4. Human Spaceflight Technology Development

Policy Focus:

Tech., Environment, Commercial, Int'l

ESMD

SOMD

SMD

ARMD/Tech

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Feb 2010: Administration proposes major realignment from Constellation to Technology Development and Commercial

- Critical technology development and demonstrations (Flagship+ETDD)
  - **$7.8 billion over five years**
- Heavy-lift technologies
  - **$3.1 billion over five years**
- Robotic precursor missions to multiple destinations
  - **$3.0 billion over five years**
- U.S. commercial cargo and crew spaceflight capabilities
  - **$6.0 billion over five years**
- Extension and increased utilization of the International Space Station
  - **$15.0 billion over five years**
- Cross-cutting technology development in a new Space Technology
  - **$5.0 billion over five years**

Fall 2010: Congressional Authorization committee weighs in

- Propose restoring funding for Crew vehicle and Heavy Lift
- Reduce commitment to Commercial Space
- Continue Technology Investment

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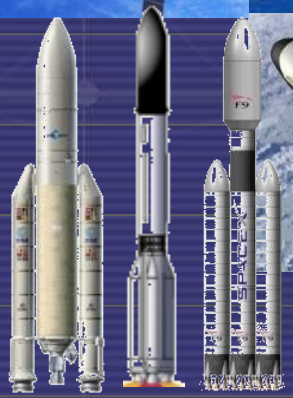
Trend is increasing commercial, multinational collaboration

- Complex Integration, Systems Engineering, Partnership
- International Space Station is pace-setter



NASA,
International,
Commercial,

Competition → Collaboration

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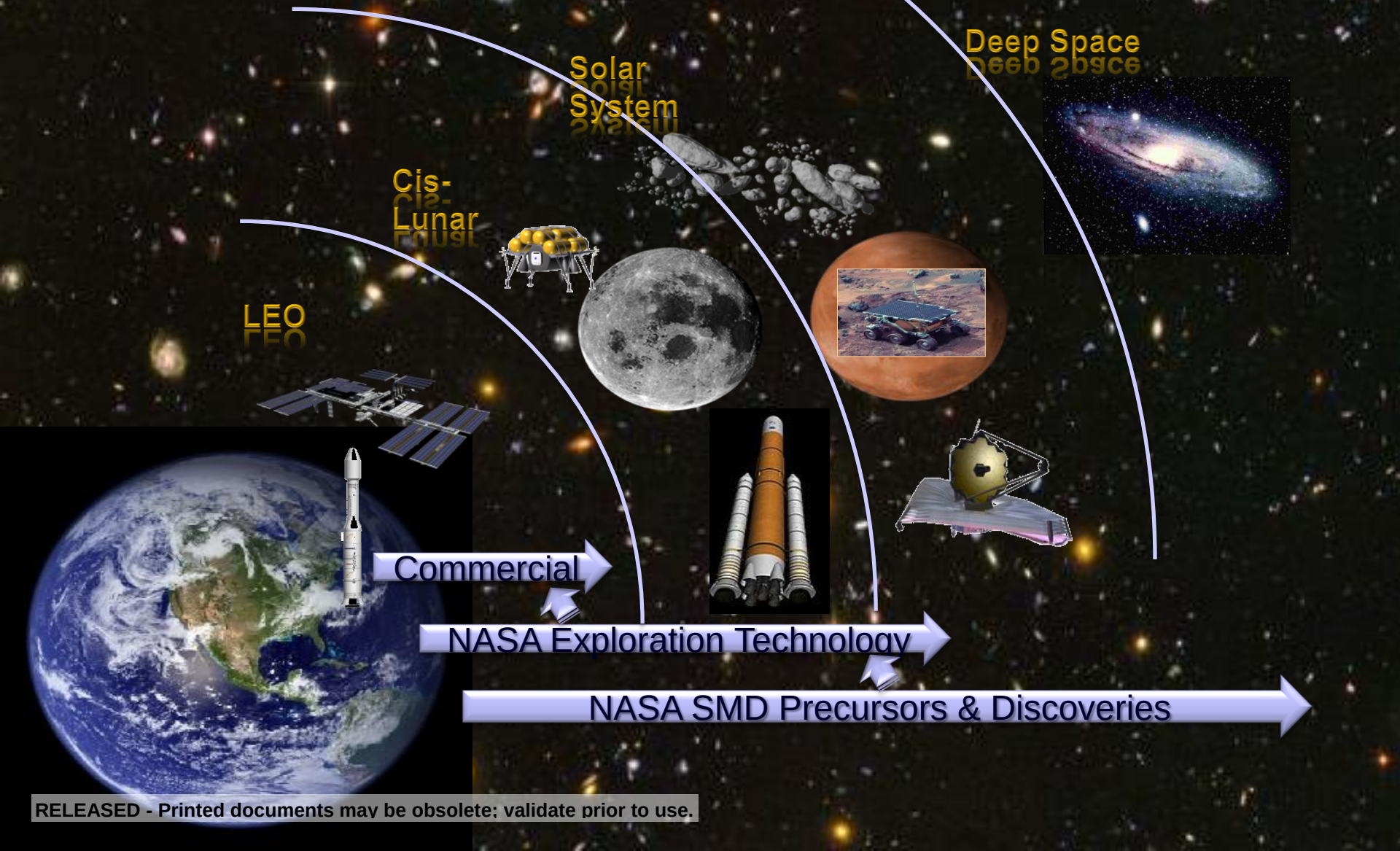
Space Exploration Domain Evolution



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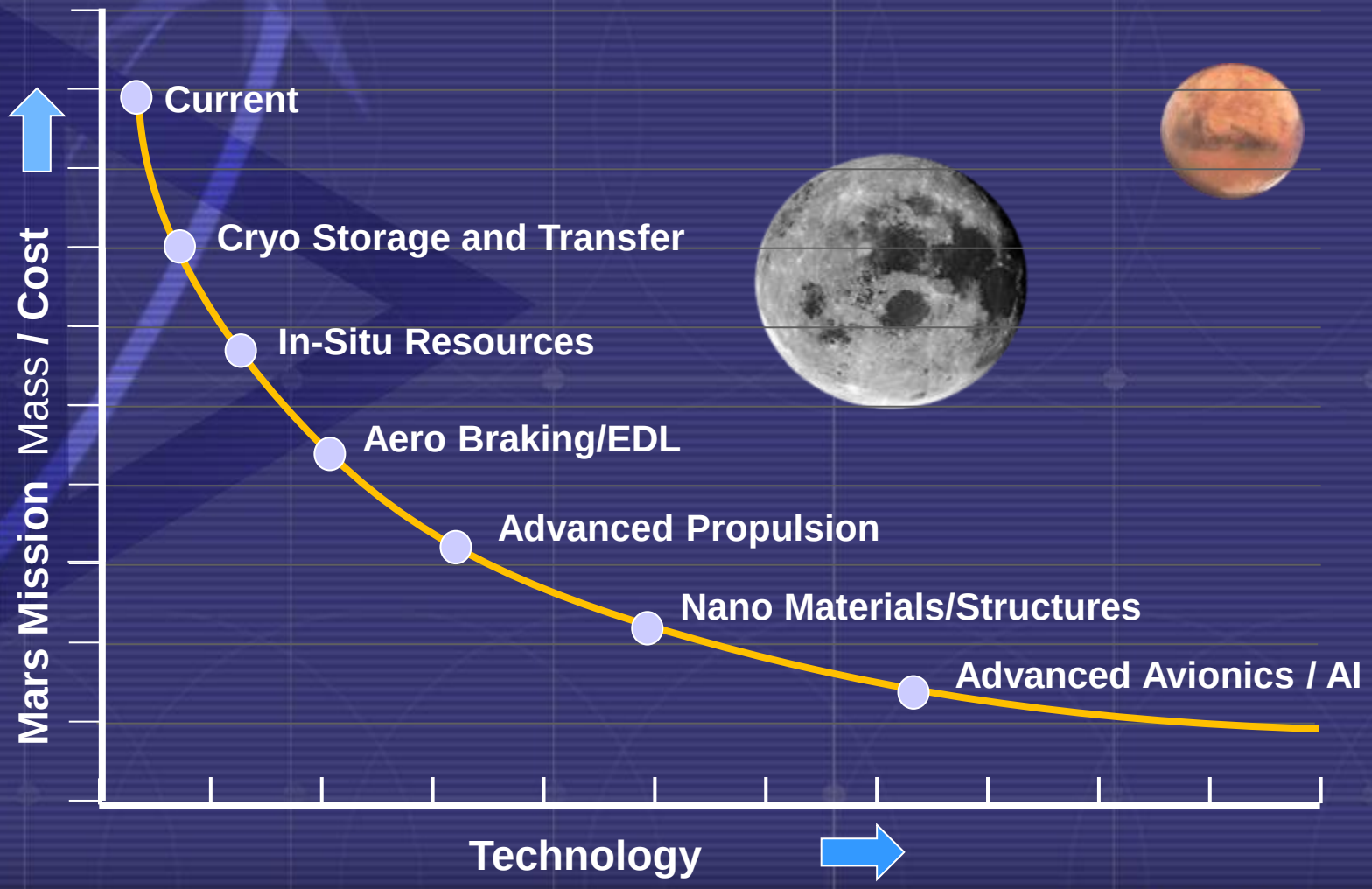
Advanced Technology Can Reduce Cost of Spaceflight
(Notional)



EA Priorities this year:

- Safely and successfully conduct remaining Space Shuttle missions
- Support expanded use of the International Space Station for technology demonstrations and science
- Establish JSC/EA leadership role in new technology demonstration programs
- Enable success of new Commercial Space
- Continue to grow and emphasize our systems engineering and technology innovation capability through in-house projects
- Expand relationships with other Centers , NASA MD's, Govt. Agencies , and unconventional partnerships

Engineering Infrastructure

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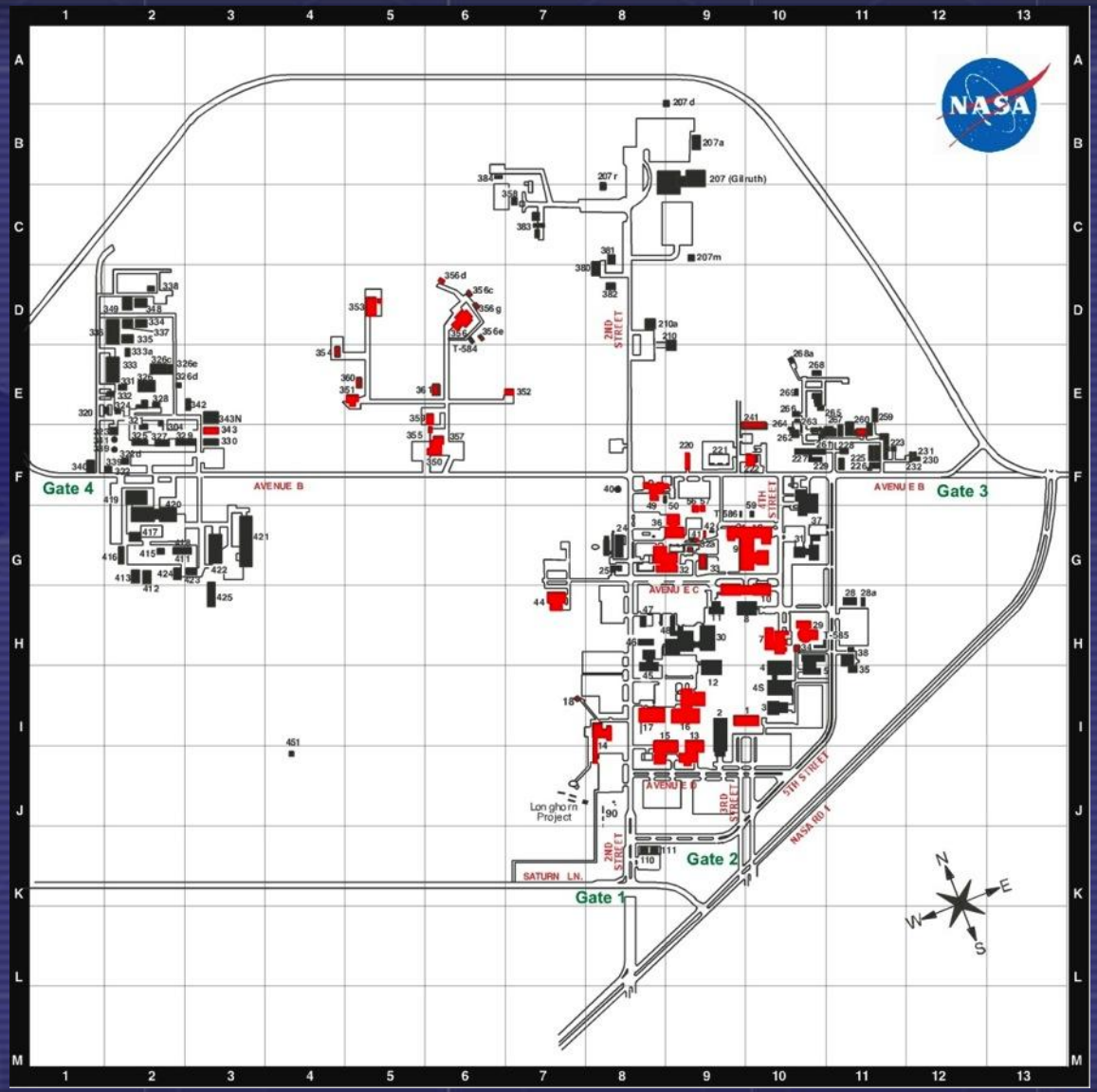
Where we are located



Facilities Functional Categories

- **The Engineering Directorate's facilities can be grouped into 8 functional categories, based on the development and test capabilities provided**
  - GFE Flight Systems Design and Development Laboratories
  - Flight Systems Integration and Test Facilities
  - End-to-end Integrated Systems Test Facilities
  - Environmental Test Facilities
  - High Fidelity Simulation and Analysis Facilities
  - Long Duration, Integrated Simulation Facilities
  - Advanced Technology Development Laboratories
  - General Infrastructure Support Facilities

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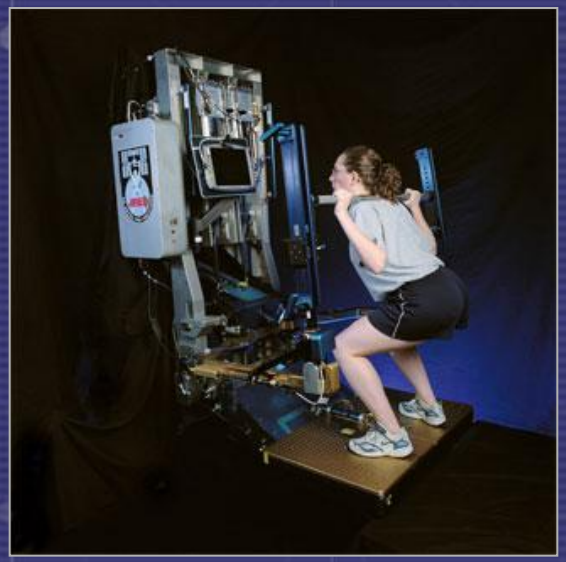
Facilities Functional Categories

- GFE Flight Systems Design and Development Laboratories
  - Support the design, development, integration, test and sustaining engineering of GFE hardware and software flight systems.

    Examples include:
    - Wireless Instrumentation Development Laboratory
    - Crew Health Care System Development Laboratory

EMU Processing and Testing Lab



Resistive Exercise Device Development Lab

Facilities Functional Categories

- Flight Systems Integration and Test Facilities
  - Support the integration of flight hardware and software systems, and the functional/performance testing of flight systems.

    Examples include:
    - GN&C Rapid Development Lab
    - Pyrotechnics Lab

Electrical Power Systems Lab

11 Ft. Chamber

8 Ft Chamber

Facilities Functional Categories

- End-to-end Integrated Systems Test Facilities
  - Provide high fidelity, end-to-end, integrated hardware and software systems testing and evaluation of critical functions and performance. These facilities are reconfigurable and may include flight hardware and software systems, ground-based systems and facilities, and functional simulations.

    Examples include:
    - Electronic Systems Test Lab (ESTL)
    - CEV Avionics Integration Lab

ETA Airlock Human Rated Chamber

Electronic Systems Test Lab

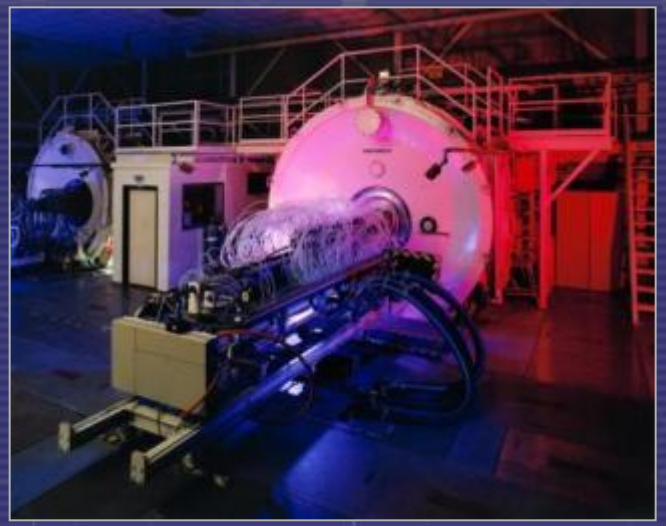
Facilities Functional Categories

- Environmental Test Facilities

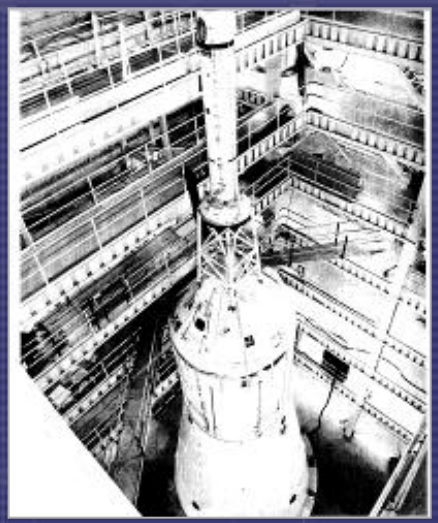
Chamber A

- Provide high fidelity, simulated flight environments (thermal, vacuum, aero, vibration, acoustic, etc.) for engineering unit testing, and qualification and acceptance testing of flight hardware systems (GFE and CFE) and spacecraft.

  Examples include:
  - Chamber A/B Vacuum/Thermal/Solar Human-Rated Test Facility
  - Arc Jet Test Facility
  - Vibration and Acoustic Test Facility



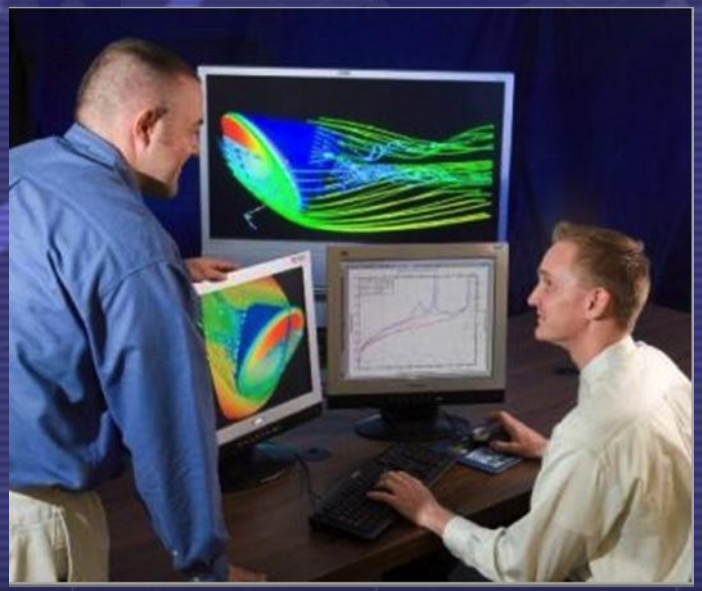
Arc Jet Test Facility



Vibration Acoustic Test Facility

Facilities Functional Categories

- High Fidelity Simulation and Analysis Facilities
  - High fidelity multi-system simulation facilities for engineering evaluations, operations procedures development and crew training. Examples include:
    - Aerosciences Lab
    - Systems Engineering Simulator (SES)



Facilities Functional Categories

- Long Duration, Integrated Simulation Facilities
  - High fidelity multi-system simulation facilities for long duration testing of integrated systems including advanced technology hardware/software systems, integrated real-time simulation systems, crew accommodations and crew
    - 20 foot Human-Rated Chamber Advanced Life Support and Long Duration Test Complex
    - Advanced Integrated Test Facility

20 foot Human-Rated Chamber

Advanced Integrated Test Facility

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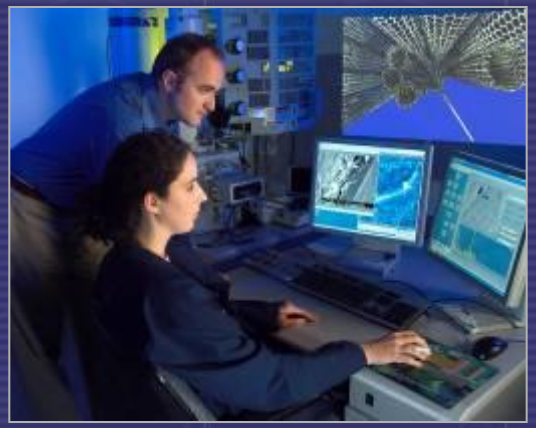
Facilities Functional Categories

- Advanced Technology Development Laboratories
  - Support the design, development integration and testing of advanced technology hardware and software systems. Examples include:
    - Advanced Portable Life Support System (PLSS) Development Testing Laboratory
    - Regenerative Waste Water Processing Systems Development Laboratory
    - Wireless and Radio Frequency Identification Laboratory

Advanced Portable Life Support Development Lab

Regenerative Waste Water Processing Systems Development Laboratory



Nanotube Development Lab

Facilities Functional Categories

- **General Infrastructure Support Facilities**
  - Provide infrastructure support services required by multiple Engineering Directorate core competencies and facilities, including manufacturing, integration, and assembly, clean rooms, NDE, calibration and metrology, bonded storage, gas and chemical analysis, etc. Examples include:
    - Building 9 and 10 Manufacturing Facilities
    - Materials Evaluation Labs
    - Avionics Development Laboratory

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Backup

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Domain of NASA's Mission
- NASA Mission Directorates
Explore the Known Universe

Aeronautics
Space Operations
Exploration Systems
Earth Science / Helio
Planetary Science
Astrophysics

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Mission Domain

-Time and Distance Dictate Command, Control, Communication and Intelligence

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Technology Influence

-Technology Will Extend Domains in Distance and Time

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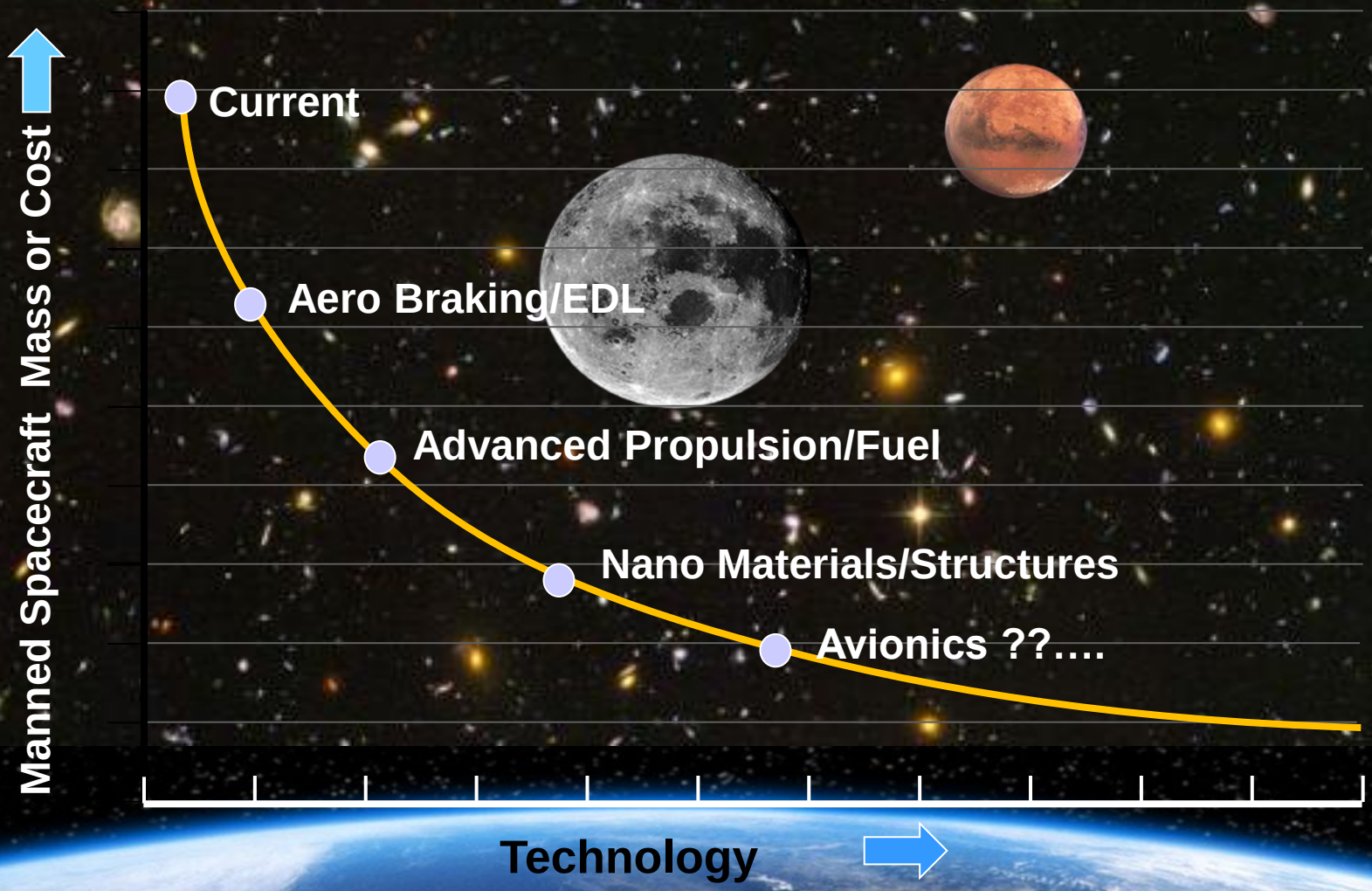
Technology Influence on Mission Cost - Manned Mars Mission (Notional)



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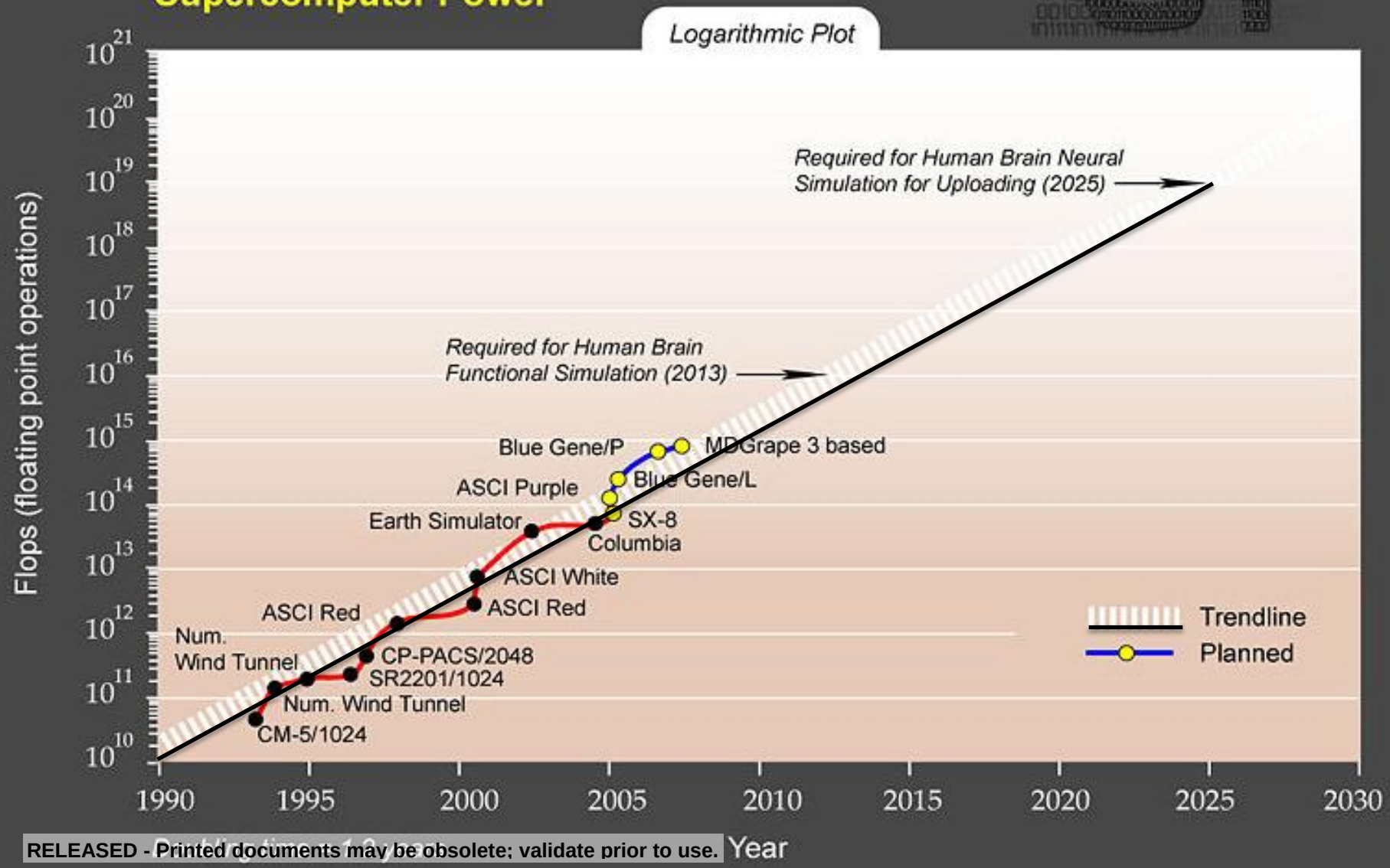
Growth in
Supercomputer Power



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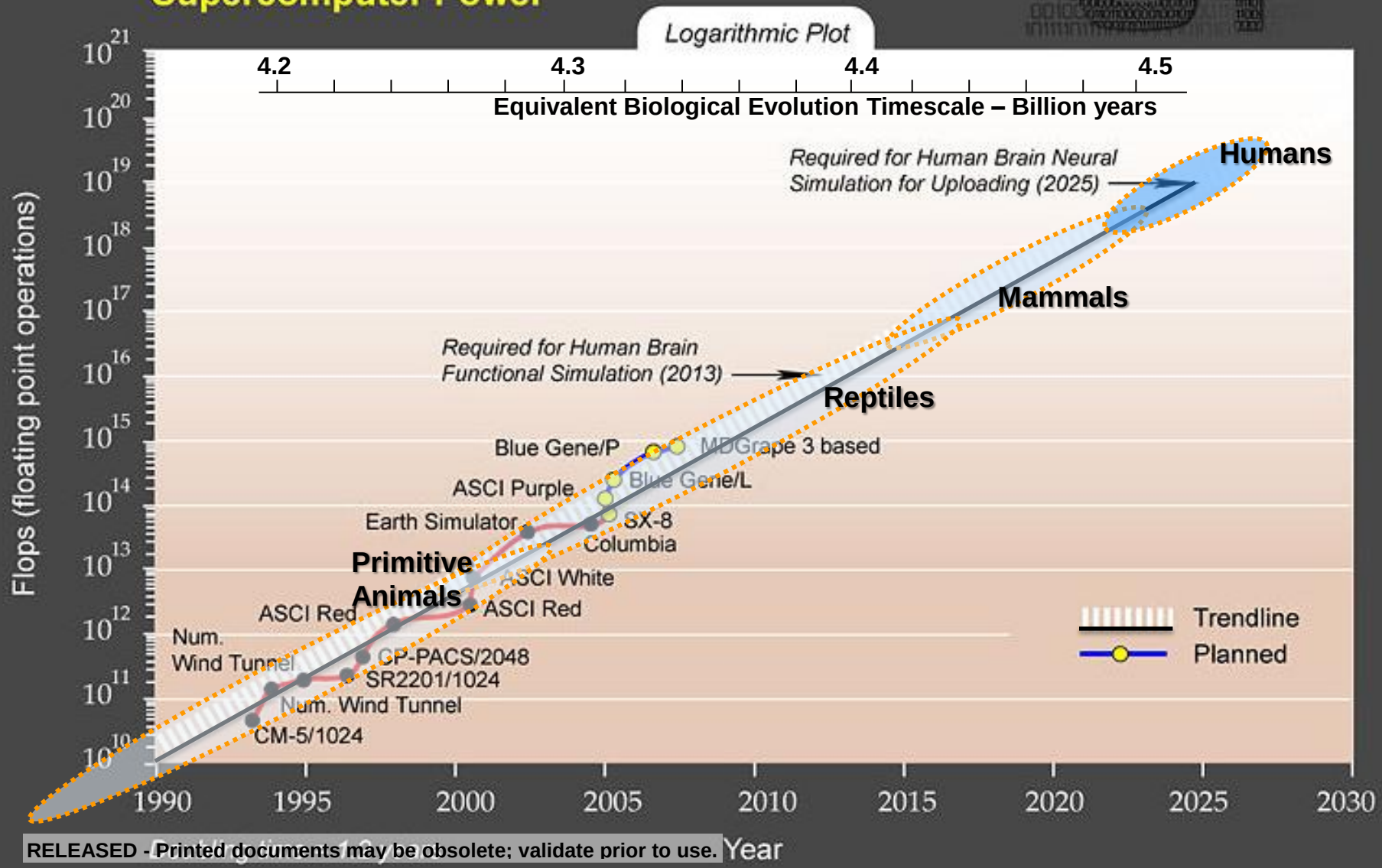
Growth in Supercomputer Power



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