Jupiter Icy Moons Orbiter

Forum on Concepts and Approaches for Jupiter Icy Moons Orbiter
Science Capabilities & Workshop Goals

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"…the navigation of interplanetary space depends for its solution on the problem of atomic disintegration…"

Robert H. Goddard, 1907

Project Prometheus Program

The Bottom Line

- Successor to Nuclear Systems Initiative
- Science-driven effort to develop Nuclear Electric Power and Propulsion (NEPP) capabilities for solar system exploration in response to identified limitations of current paradigm:
  - SSES TAG identified three fundamental areas limiting exploration: transportation, power, and communications
    - Solar power limits power budgets and is of limited use in outer planetary system
    - Chemical propulsion limits maneuverability and destinations
    - Existing comm capability limits data rates and science
- Managed at HQ by Al Newhouse as a Program Office within Code S
  - Similar to the Mars Exploration Program
- Solar System Exploration Division holds responsibility for mission science

The first mission within Project Prometheus Program is the Jupiter Icy Moons Orbiter (JIMO)

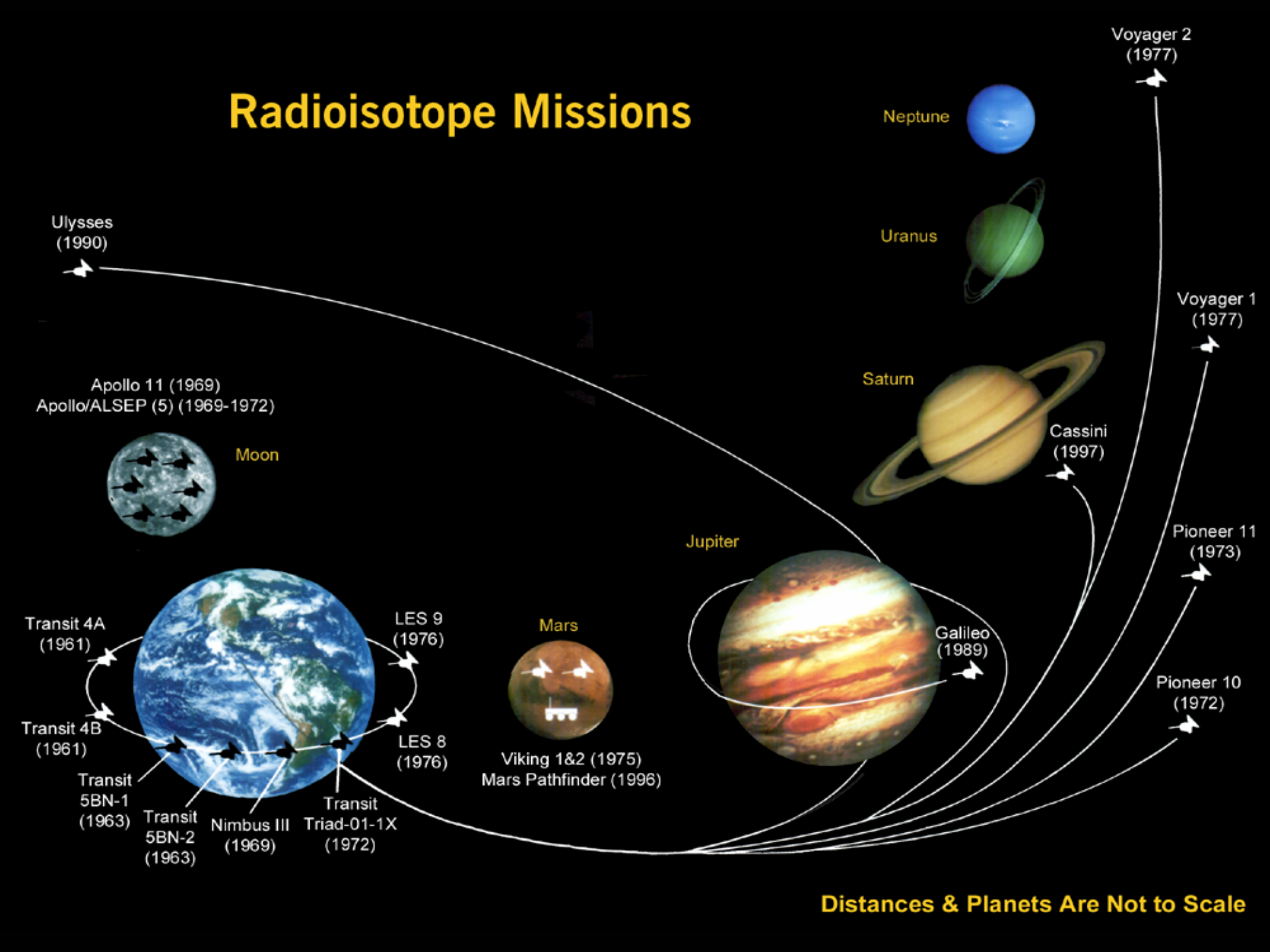
Match the Power System to the Destination

	Main Asteroid Belt	Trojan Asteroids	Centaur Minor Planets	Trans-Neptunian Objects	Kuiper Belt Objects / Comets

Inner Planets	Jupiter and Moons	Saturn and Moons	Uranus and Moons	Neptune and Moons	Pluto/Charon
Solar Electric Confined to Inner Solar System – Also limited reach to large outer planetary bodies with aerocapture (Jupiter, Saturn, Uranus, Neptune only)	Radioisotope Electric for New Frontiers Class Outer Solar System Missions –Targets with low Mass – 500 W Class RTG – <50 kg payload –Delta II Launchers		Nuclear Electric for Large Flagship Missions to Outer Planets –Large Targets –100 kW Class Reactor –>500 kg Payloads –Delta IV Launch Vehicles		

RTG for Surface Lander

Radioisotope Missions



Distances & Planets Are Not to Scale

Jupiter Icy Moons Orbiter

- JIMO is a ***science-driven*** mission using new nuclear power technologies to enable science return far beyond previous outer planets missions
  - Advanced high power instruments
  - High data rate communications
  - Global orbital reconnaissance of all Jupiter's icy Galilean moons
  - Improved characterization of sub-surface environment & probable sub-surface oceans
  - Extended Jupiter science observations
- JIMO exceeds the recommendation from the National Research Council Decadal Survey for a Europa orbiter mission as a high priority for a flagship mission in Solar System exploration.

Jupiter Icy Moons Orbiter
Science Commitment

- New R&A Programs:
  - **Outer Planetary Systems Fundamental Research Program**
  - High Capability Instruments for Planetary Exploration Program
  - High Capability Instrument Technology Risk Retirement Program
  - High Capability Mission Concepts Program
- High Capability Instrument Study (December 2003)
- JIMO Instrument Workshop (Fall 2003)
  - Present community with information in preparation for AO response
- JIMO technology development builds for the future
  - Enhanced capabilities for future missions
  - JIMO follow on missions
  - Advances the ability to address multiple NRC Decadal Survey priorities with single missions

JIMO/NEPP provides revolutionary capabilities for science far exceeding previous missions

- High power for instruments
  - Including active Instruments
- High data rates during acquisition and transmission
- Large payload mass
- High duty cycle
- Increased observation time at moons and in Jupiter system
- Spacecraft maneuverability enabling multi-target rendezvous and orbits

Jupiter Icy Moons Orbiter

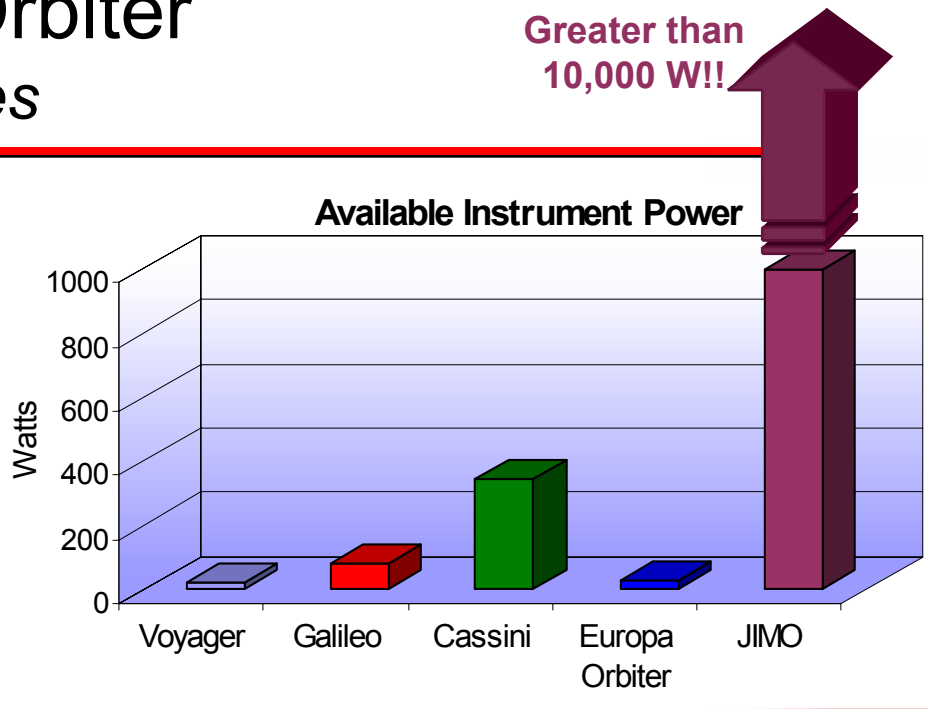
Comparison of Capabilities

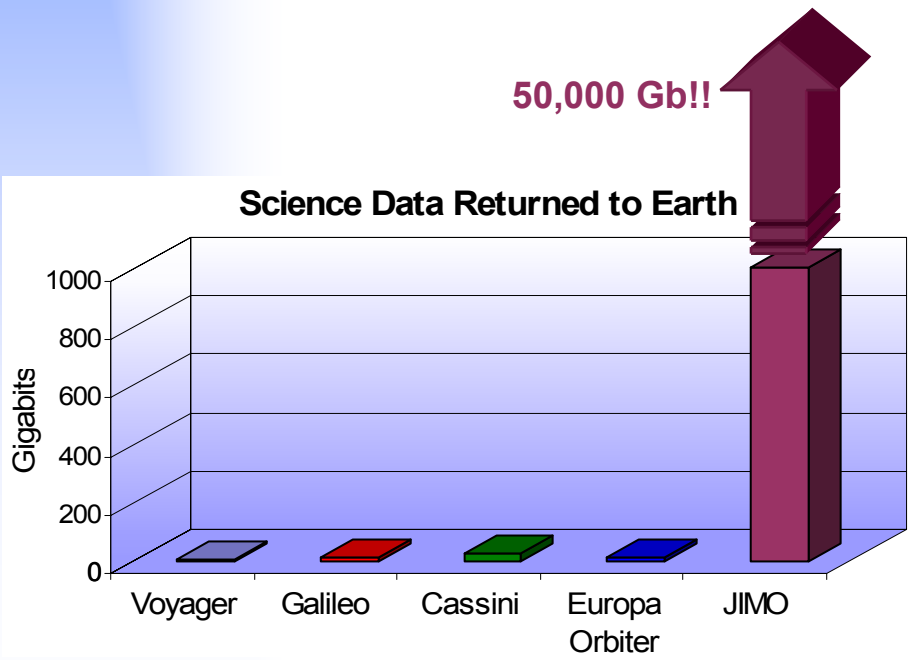
	Voyager	Galileo	Cassini	JIMO	Future Capabilities
On-Board Power Generation (Watts)	480	570	875	~100,000	~250,000
Power for Science Instruments (Watts)	<100	<100	290	~10,000	> 10,000
Power for Telecomm (Watts)	~70	~60	60	~1,000-5,000	> 5,000
Telecom Data Rate (kbps)	115	134 (w/ HGA)	165	~10,000	10,000 – 100,000
Propulsive DeltaV (km/sec)	0	1.4	2	~40	50-70
Observation Time (within 1,000 km)	~1 hr	< 5 hrs	< 5 hrs	~ 7 months	> 6 months at each target

Jupiter Icy Moons Orbiter
Revolutionary Capabilities

Amount of **power** available to science instruments

One bedside reading lamp compared to stadium lights



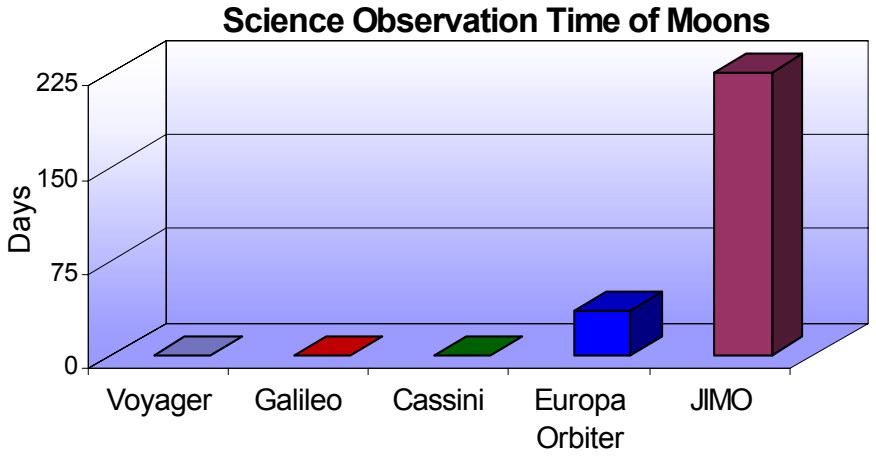


Amount of science **data** returned

1 floppy disk as compared to >20 CD-ROMs

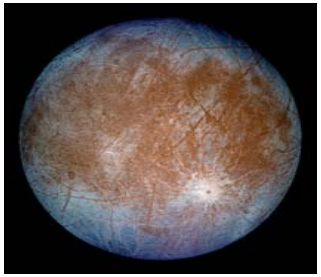
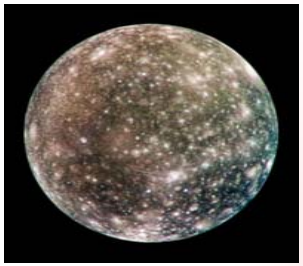
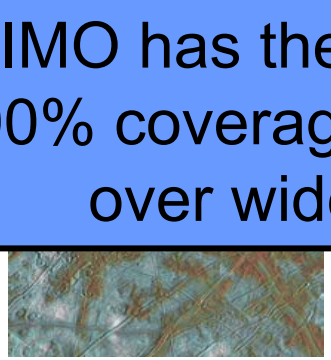
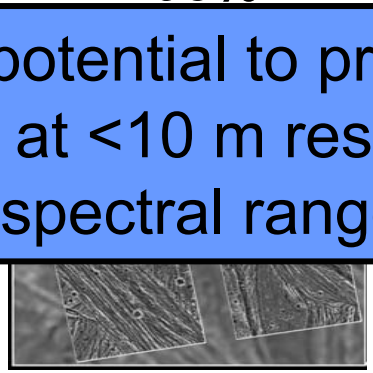
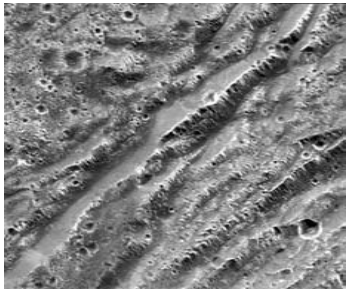
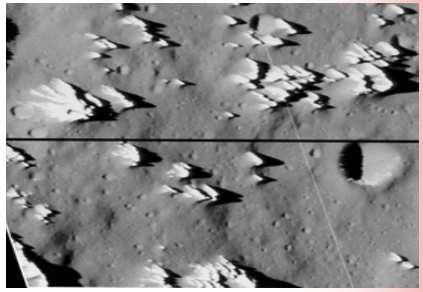
Time available for science observation of moons

1 to 5 hours compared to >210 days at 1,000 km or less distance



Jupiter Icy Moons Orbiter

Icy Satellites: Orbital Coverage

	Europa	Ganymede	Callisto
Voyager: Global ~10 km resolution			
	95%	**95%**	**95%**
Galileo: Regio ~100 m resol			
	10%	**5%**	**1%**
Galileo: Local ~10-20 m resolution			
	<1%	**<1%**	**<1%**

JIMO has the potential to provide 100% coverage at <10 m resolution over wide spectral range

Jupiter Icy Moons Orbiter

NRC & Europa Orbiter

- The Academy endorsed the previous Europa Orbiter mission, with the caveat that the mission must address both Group 1 and Group 2 science objectives defined by the EO SDT:

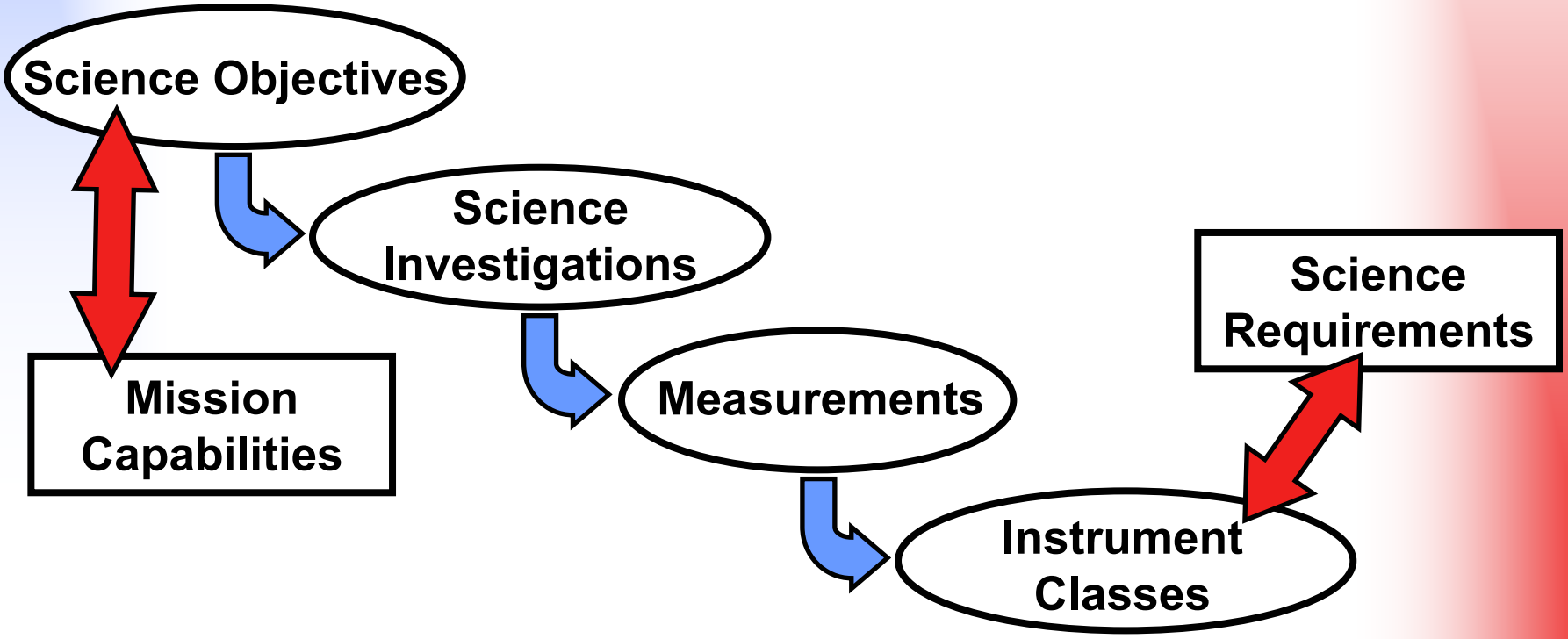
  Group 1
  - Characterize the three-dimensional distribution of any subsurface liquid water and its overlying ice layer;
  - Understand the formation of surface features, including sites of recent or current activity; and
  - Identify candidate landing sites for future lander missions.

  Group 2
  - Characterize the surface composition, especially compounds of interest to prebiotic chemistry;
  - Map the distribution of important constituents on the surface; and
  - Characterize the radiation environment in order to reduce the uncertainty for future missions, especially landers.

These objectives are a starting point for the science to be accomplished by JIMO

Jupiter Icy Moons Orbiter
Science Community Role

- Community is expected to take an active role in JIMO mission development!
  - Science Definition Team
  - Provide input to SDT to develop science framework that is supported by the unique capabilities JIMO offers
  - Identify where mission capabilities and requirements fall short of science needs



JIMO Capabilities

Preliminary Science Requirements

√	**Science payload mass of 600 kg, including scan platform(s), turntable(s), and booms**
√	**Extensive high resolution mapping of Callisto, Ganymede, and Europa**
√	**High data rates (>10 Mbps returned from a distance of 6.2 A.U.)**
√	**High pointing accuracy for the remote sensing science payload (on a scan platform): 1.0 mrad control, 0.1 mrad knowledge, 0.0035 mrad/sec stability**
√	**Science data-taking during Icy Moon spiral-in and spiral-out**
√	**Magnetic field instrument, and possibly other instrumentation, must be isolated from the electromagnetic environment of the spacecraft**
√	**Simultaneous high data rate collection and telecom downlink**
√	**Power required for science investigations up to 45 kWe**
√	**Downlink data volume: 230 Gb/day, 50 Tb total**
√	**On-board storage data volume: one Earth-day of science data collection**

JIMO Forum

Expectations & Ground Rules

- Provide SDT with community input on JIMO science
- Begin crafting science objectives for JIMO that can be supported by its unique capabilities
  - Europa Orbiter science objectives as a starting point
  - Utilize active, high capability instruments
  - Identify where science requirements are inadequate
  - Don't forget Jupiter!
- Develop feedback on science requirements and capabilities to project office

Solar System Exploration Division

Job Announcements

LOOKING FOR A FEW GOOD WOMEN AND MEN!

- **Job Announcements in Solar System Exploration ($66-$119K)**
  - JIMO Program Scientist
  - NEOO Discipline Scientist
  - In-Space Propulsion Program Executive
  - New Frontiers Program Executive
- Senior Executive Job Announcement
  - Senior Executive Deputy for Flight Projects

- **New Hires:**
- Dr. Michael New, Astrobiology Scientist
- Dr. Curt Niebur, Mars Discipline Scientist, JIMO Program Scientist
- Dr. Susan Niebur, Program Scientist for Discovery

- IPA Bill Knopf - PDS
- IPA Dr. Lindsley Johnson - NEOO IPA and Planetary Astronomy (mid-April start)