



Future NASA Venus Exploration Opportunities

**Presentation to
Venus Exploration and Analysis Group
(VEXAG)**

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Topics

- Objectives of Presentation
- Recent Solar System Exploration Strategic Plans
 - NRC Decadal Survey of 2002
 - NASA Solar System Exploration Road Map 2003
 - NASA Strategic Road Map for Solar System Exploration 2005
- Venus Surface Explorer
- New Technology/Capability Needs
- Acknowledgments
- Summary



Objectives of Presentation

- To review NASA's future plans for Venus Exploration including the Discovery, New Frontiers and Flagship mission programs
- To engage the VEXAG in providing guidance on future flagship mission concepts for Venus that were identified in 2005 by NASA's Strategic Road Map team for solar system exploration



Recent NASA Solar System Exploration Strategic Plans

- NRC Decadal Survey of 2002
- Solar System Exploration Roadmap of 2003
- Strategic Road Map for Solar System Exploration 2005



Solar System Exploration Decadal Survey- 2002

New Frontiers in the Solar System

An Integrated Exploration Strategy

Solar System Exploration Survey

Space Studies Board

Division on Engineering and Physical Sciences

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Integrated Exploration Strategy

- Presents key scientific questions
- Ranked list of conceptual missions
- Recommendations for the decade 2003-2013
- A set of “deferred high priority flight missions for decades beyond that
- Recommended significant investments in advanced technology to enable high priority flight missions

Implementation Approach

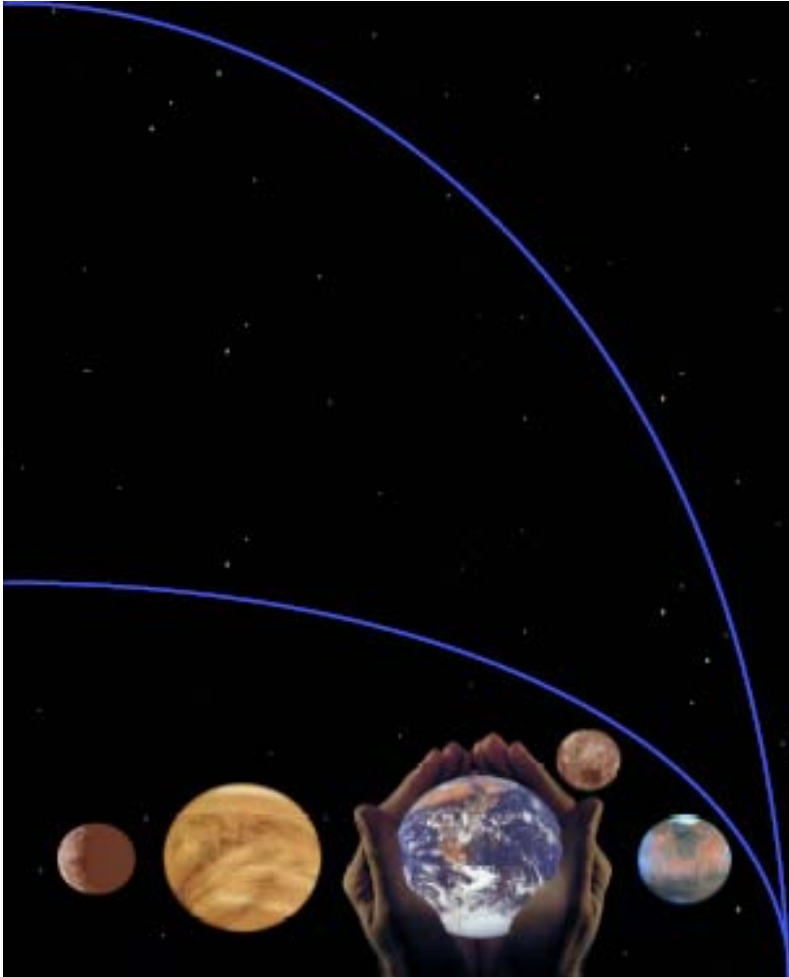
- **Discovery Program** (<\$350M) PI-led and competitively selected (6 to 7 per decade)
- **New Frontiers Program** (<\$650M) PI-led and competitively selected but to a specified set of targets (4 per decade) – Jupiter Orbiter Probe, Lunar Sample Return, Comet Sample Return and *Venus In Situ Explorer*
- **Flagship missions** (>\$650M) – directed missions – like Cassini Huygens, 1 per decade



Inner Solar System: Keys to Habitable Worlds

Exploration Strategy

- Sample Return Missions from targets of increasing difficulty
 - Moon first
 - Mars next
 - Mercury-Venus
- In Situ Exploration of Venus
 - Investigate surface and Atmospheric Chemistry
 - Demonstrate key technologies for sample return
- Network Science at Venus and Mercury
 - Seismology and magnetic fields
 - Heat Flow
 - Atmospheric circulation for Venus
 - Technologies for extreme environments





Chronological Sequence of Missions

Criteria for Setting Priorities

- **Scientific Merit**
 - Significance of progress on high priority science objectives
 - Creates new or changes existing paradigms
 - Affects direction of future research
 - Improves predictive models
- **Opportunity**
 - Orbital Mechanics
 - Relationship to other missions
 - International cooperation
 - Scientific discovery making this the right time for the mission
 - Public Interest
- **Technological Readiness**
 - Often drives choices between missions with equal scientific merit and no clear opportunity based discriminators
 - Major element of cost risk equation
 - Requires intensive mission trades and projection of future technological progress



Status of Competitive Program

- **Discovery Program**

- Venus concepts have been proposed at each opportunity
- Include orbiter, probe, lander and balloon concepts
- No Venus concept has been selected to date
- Because the competition continues (Discovery 12 AO is expected soon) no information on current concepts is available.

- **New Frontiers Program**

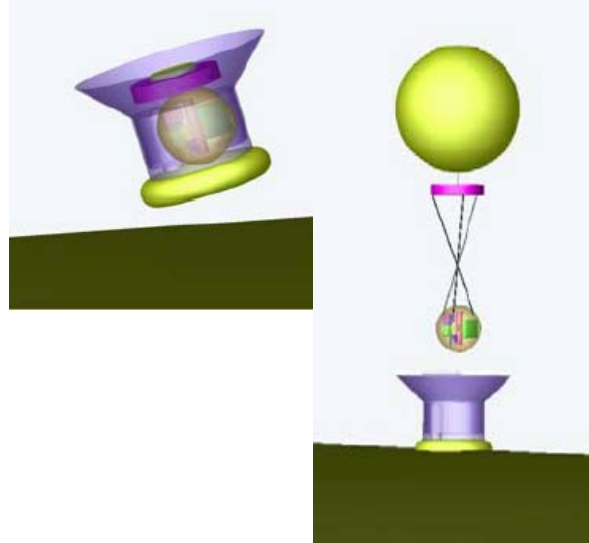
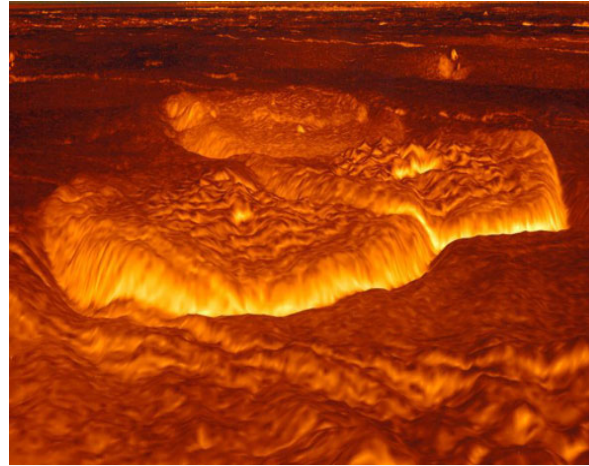
- Decadal Survey called for a Venus In Situ Explorer (VISE) mission that would be targeted on Venus geochemistry and also be a precursor for a Venus Surface Sample Return (VSSR)
- New Frontiers call dropped the precursor requirements reducing demands for new technology
- Only the Jupiter Orbiter and Lunar Sample Return deemed technologically ready in New Frontier 2 (2004) competition
- Expect another NF opportunity in two to three years where VISE proposals would be expected to be invited again.



Venus In Situ Explorer – VISE

Scientific Objectives:

- Composition and isotopic measurements of surface and atmosphere
- Near IR descent images
- Acquire and characterize a core sample.
- **Demonstrate key technologies for VSSR**



Mission & LV Class:

- Intermediate Class
- TBD

Science Payload:

- Neutral mass spectrometer with enrichment cell.
- Instruments to measure elements and mineralogy of surface materials.
- Imaging microscope

Technology & Heritage:.

- Sample acquisition and handling in Venus environment
- Passive insulation and survival at Venus

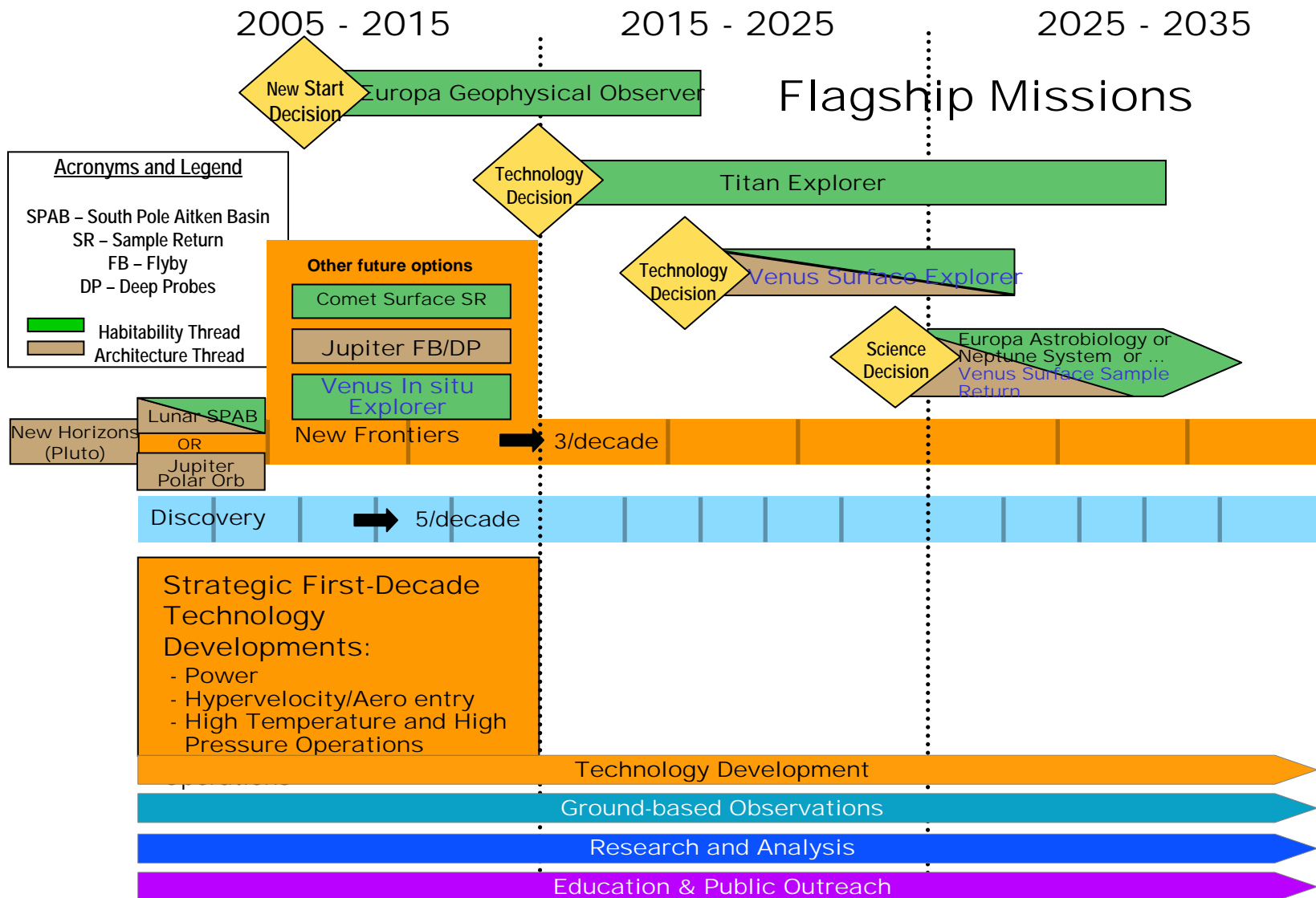
Mission Technology Studies:

- Decadal Survey 2002 of *Surface & Atmospheric In Situ Explorer (SAIVE)*
- JPL proposal in response to New Frontier Mission solicitation.
- Technology studies in In Space Propulsion, Low temperature materials and autonomy.

Earliest Launch Opportunity: Technology Readiness: 2010 Programmatic Slot: 2013



Solar System Exploration Strategic Road Map- 2005

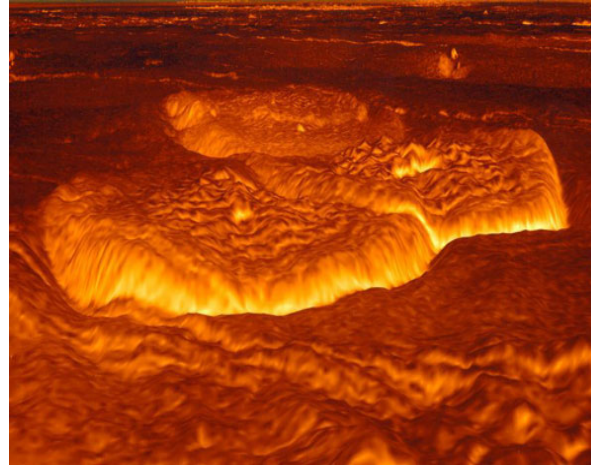




Venus Surface Explorer

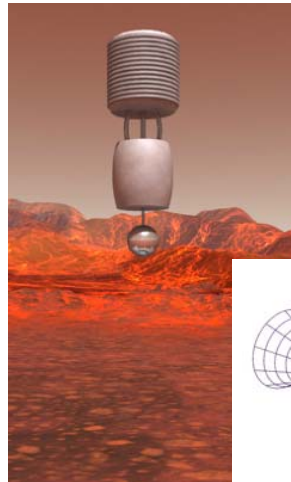
Scientific Objectives:

- Composition and isotopic measurements of surface and atmosphere
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- Acquire and characterize a core sample.
- **Demonstrate key technologies for VSSR**



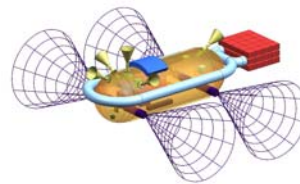
Exploration Metrics:

- Operate in Venus surface environment for 90 days
- Range across surface if rover TBD
- Range and altitude if aerial vehicle TBD



Mission & LV Class:

- Intermediate Class
- LV: TBD



Science Payload:

- Neutral mass spectrometer with enrichment cell.
- Instruments to measure elements and mineralogy of surface materials.
- Imaging microscope

Technology & Heritage:.

- Sample acquisition and handling in Venus environment
- Passive insulation and survival at Venus

Mission Technology Studies:

- Decadal Survey 2002 - none.
- Technology studies for definition of advanced RPS systems, 2005.

Earliest Launch Opportunity: Technology Readiness: 2013 Programmatic Slot: 2013



Venus Surface Explorer Needed Capabilities

Technologies for Extreme Environments

- Protection against high temperatures and pressures
- Electronics for high temperature operation
- Sample Acquisition mechanism
- Mobility – aerial and surface
- Power – only radioisotope power
- Active Thermal Control – at Venus surface



Venus Surface Explorer Study Plan: Science

- Open discussions with VEXAG (action: T. Balint)
 - **First meeting of** the Venus Exploration and Analysis Group (**VEXAG**)
 - **November 4th, 2005**, 8 a.m.–5 p.m.
 - Piazza Atrium, Sheraton Pasadena, Pasadena, CA
- Establish **Venus In-Situ Exploration Science Definition Team** (Venus SDT) (action: VEXAG Venus SDT)
 - October/November 2005
- Receive **Venus SDT recommendations** for the Venus In-Situ Study:
 - Identify **science objectives and strawman payload** for Venus In-situ exploration (action: VEXAG Venus SDT)
 - November/December 2005



Acknowledgments

- Solar System Exploration Road Map Team
 - Ellen Stofan
- Planetary Program Support Team
 - Tibor Balint
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 - Elizabeth Kolawa
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 - Ajay Misra
 - Steve Saunders
 - Adriana Ocampo



Conclusions

- The Solar System Exploration Road Map has laid the ground work for a future solar system program with a strong Venus emphasis including long duration in situ exploration.
- Success of Mars Exploration Rover has demonstrated the capability of long duration mobile vehicles for achieving significant science objectives
- A long duration mobile exploration capability for Venus must be tailored to the surface conditions at Venus. This will require new capabilities for tolerating and in some cases exploiting the severe environment.
- This capability will require substantial investment and will not be achieved soon. However, a credible long range strategy will animate a set of prior missions some of which will permit validation of technologies needed for this mission.
- Science guidance is now needed to help formulate the in situ exploration of Venus.



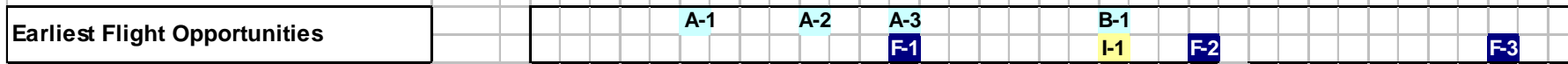
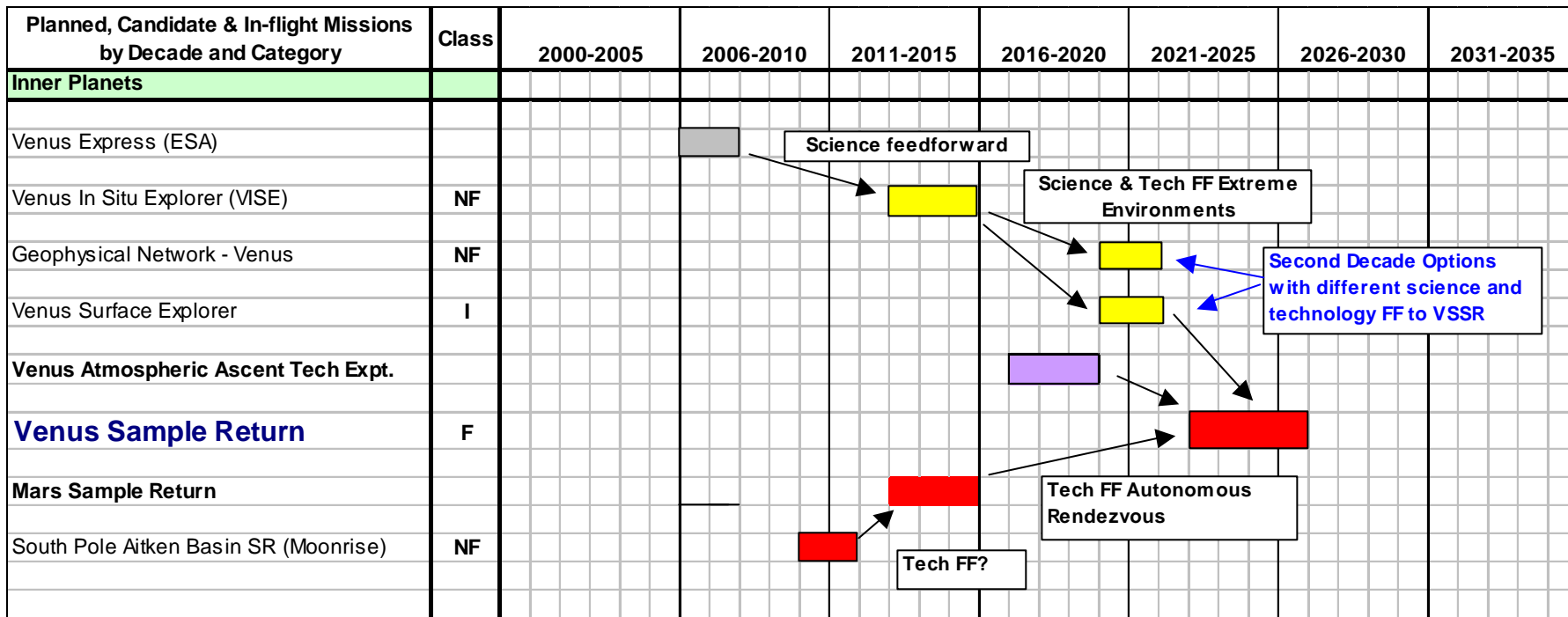
Back Up Charts

- Scenarios leading to Venus Surface Sample Return.



Inner Planets Exploration

Scenarios Leading to Venus Surface Sample Return -1



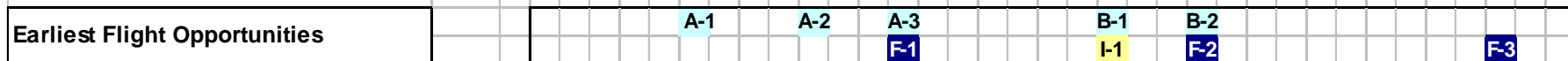
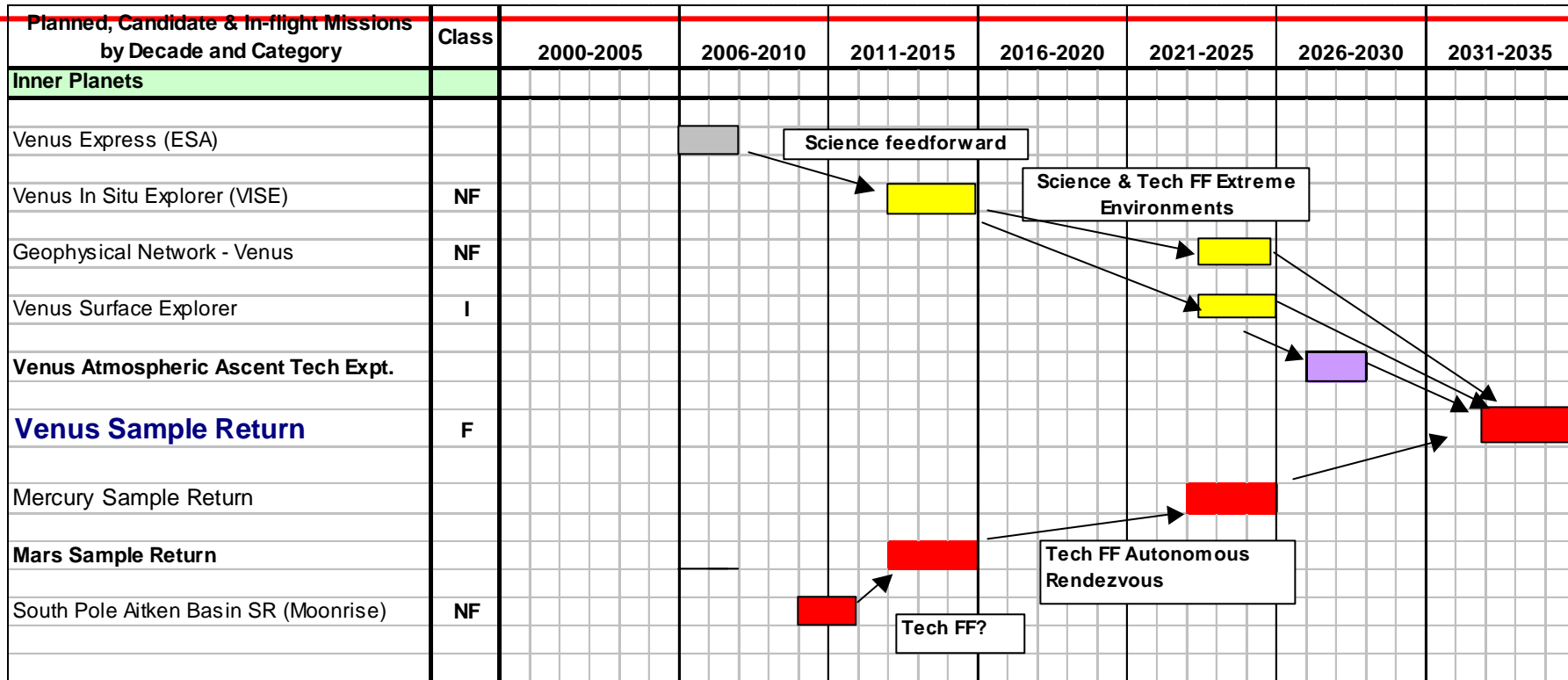
LEGEND
 Class: NF - New Frontiers, D - Discovery, I - Intermediate, F - Flagship

- █ Fly By
- █ Orbiter
- █ In-Situ Exploration
- █ Sample Return
- █ Technology Experiment



Inner Planets Exploration

Scenarios Leading to Venus Surface Sample Return -2



LEGEND

Class: NF - New Frontiers, D - Discovery, I - Intermediate, F - Flagship

- Fly By
- Orbiter
- In-Situ Exploration
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- Technology Experiment