Solar System Exploration Strategic Road Map and Venus Exploration

Presentation at

Lunar and Planetary Science Conference

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Purpose of this briefing

- To inform the Venus Science community about the status of the solar system exploration strategic planning process that is currently being carried out by NASA

- To seek inputs on future priorities for Venus exploration for inclusion in the nation's solar system exploration program for input to this process

Strategic Planning and Venus Exploration?

- NASA is conducting a strategic planning activity that builds upon the President's Vision for Space Exploration published in January 2004.

- Three Strategic Road Map teams are formulating plans for exploration of the solar system.
  - Mars Exploration
  - Lunar Exploration
  - **Solar System Exploration (covering Venus exploration)** – co chaired by
    - Orlando Figueroa (Assoc Director, Science NASA HQ)
    - Scott Hubbard (Director, ARC)
    - Jonathan Lunine, University of Arizona and Chair of NASA Solar System Exploration subcommittee

- The Solar System Exploration Road Map team is on a very aggressive schedule. It is scheduled to submit its report for review by the National Research Council by June 1, 2005

An important function of this plan will be to guide the NASA investment in new technologies and related capabilities over the next decade.

Strategic Road Map - Solar System Exploration Committee Members

Orlando Figueroa, NASA Science Mission Directorate ***co-chair***
G. Scott Hubbard, NASA Ames Research Center, ***co-chair***
Jonathan Lunine, University of Arizona, LPL ***co-chair***

Andrew B. Christensen, Northrop Grumman
Jerry Chodil, Ball Aerospace (retired)
Ben Clark, Lockheed Martin Astronautics
Greg Davidson, Northrop Grumman
David DesMarais, NASA Ames Research Center
Douglas Erwin, National Museum of Natural History
Wes Huntress, Carnegie Institution of Washington
Torrence V. Johnson, Jet Propulsion Laboratory
Thomas D. Jones, Consultant
Melissa McGrath, NASA Marshall Space Flight Center
Karen Meech, University of Hawaii
John Niehoff, Science Applications International Corporation
Robert Pappalardo, University of Colorado
Ellen Stofan, Proxemy Research, Inc.
Meenakshi Wadhwa, The Field Museum

Carl Pilcher, Directorate Coordinator, Designated Federal Official
Judith Robey, Advanced Planning and Integration Office Coordinator

Ex Officio and Liaison
Andrew Dantzler, NASA Science Mission Directorate
Heidi Hammell, Space Science Institute, Education Roadmap Committee Liaison
Chris Jones, Jet Propulsion Laboratory
Jason Jenkins, NASA Exploration Systems Mission Directorate

Strategic Road Map - Solar System Exploration Committee Charter

- The Committee shall draw on the expertise of its members and other sources to provide advice and recommendations to NASA on conducting robotic exploration across the solar system to search for evidence of life, to understand the history of the solar system, to search for resources, and to support human exploration.

- Recommendations, to be provided by the Committee, will help guide Agency program prioritization, budget formulation, facilities and human capital planning, and technology investment.

Strategic Road Map - Solar System Exploration Meeting Schedule

- Meeting 1: February 3-4, 2005 (8 a.m. to 5 p.m.) Ames Research Center, California

- Meeting 2: March 21-22, 2005 (8 a.m. to 5 p.m.), Tucson, Arizona

- Meeting 3: Date coming soon. Planned for Washington DC in May 2005..

Strategic Road Map - Solar System Exploration Approach and Status

Sources of Science Input

- NRC Decadal Survey of 2002
- Outer Planet Assessment Group – recommendations Feb 2005
- Venus Science Community – through ***Steve Saunders***

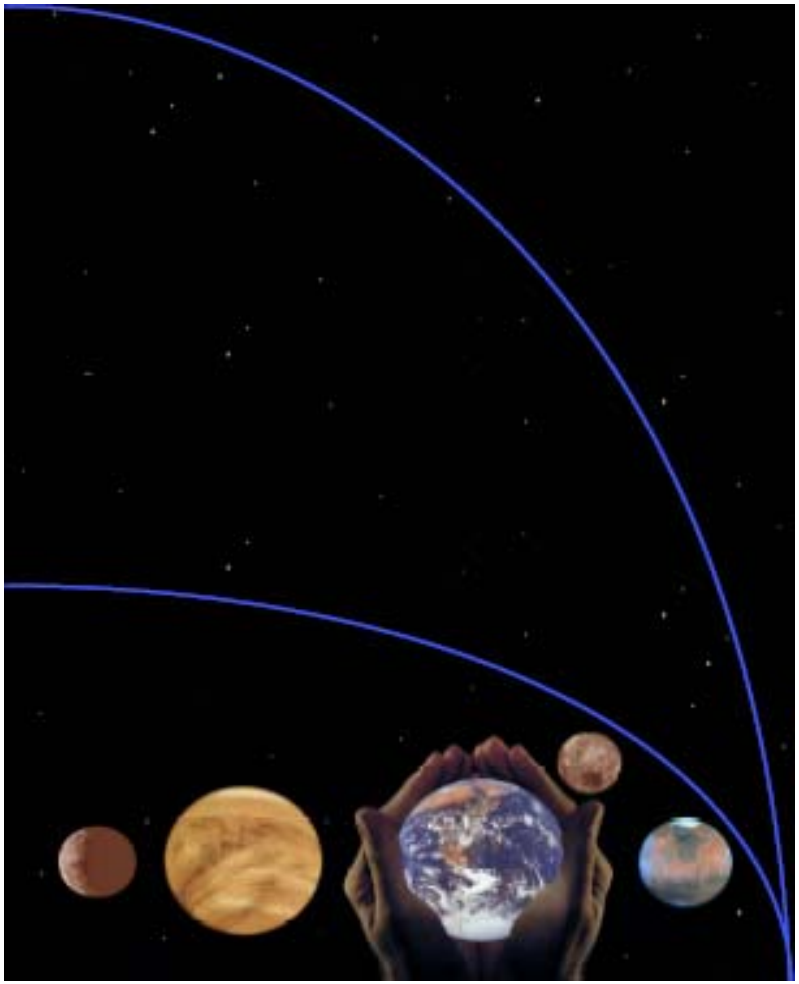
Mission Categories Considered

- **Prime emphasis** is on moderate and large missions:
  - New Frontiers class <$700M
  - Flagship Class >$700M

  Several candidate Venus missions are in these categories

- **General guidance** sought on small missions in the Discovery class
  - A number of Venus missions have been proposed to the NASA Discovery program but has none has been selected to date.

Inner Solar System:
Exploration Strategy Defined by Decadal Survey

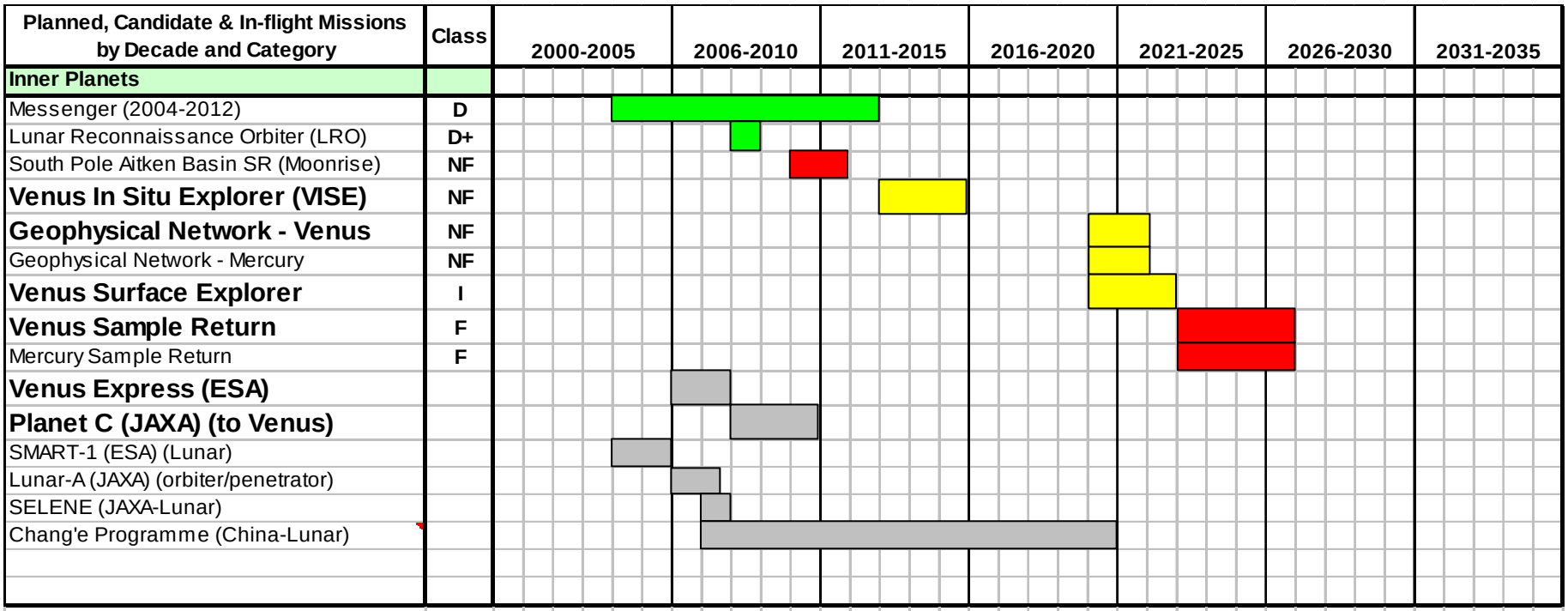


Exploration Strategy

- 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**

Inner Planets Exploration

Existing Missions and Design Reference Missions 2000 to 2035



LEGEND

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

- Fly By
- Orbiter
- In-Situ Exploration
- Sample Return

Earliest Flight Opportunities

New Frontier Mission Opportunities occur on 2.5 year centers

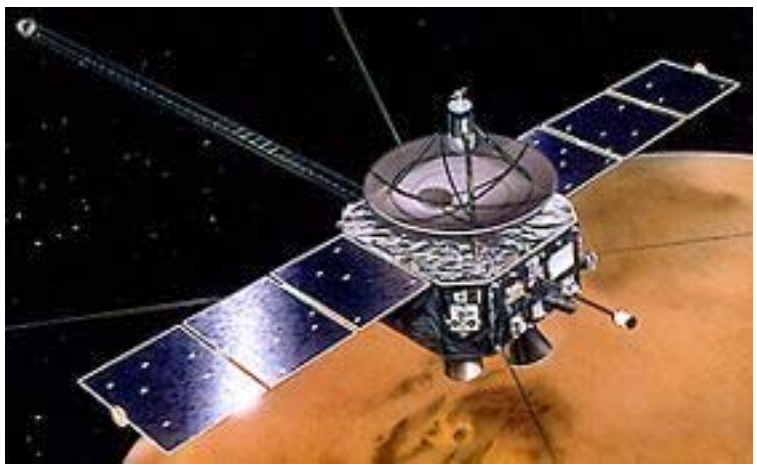
The opportunities designated A-2, A-3 and B-1 are the *earliest* flight opportunities for specific missions shown here

I-1 is the *earliest* Intermediate flight opportuntity-same as NF B-1

F-1 - first Flagship mission - set in last year of first decade

Upcoming Venus Missions

ESA Venus Express will be based on the ESA Mars Express mission



ISAS Venus Climate Orbiter (Planet C) will inherit characteristics of the Nozomi (Planet B) spacecraft

a. ESA Venus Express (VEX: 2005)

- Middle atmosphere temperature and trace gas composition
- Cloud level winds
- Cloud particle properties
- Lower atmosphere (bulk) cloud and trace gas composition

b. JAXA Venus Climate Orbiter (Planet C: 2008)

- Cloud-level wind fields
- Cloud particle size distributions
- Possible exospheric/space physics instrumentation

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**

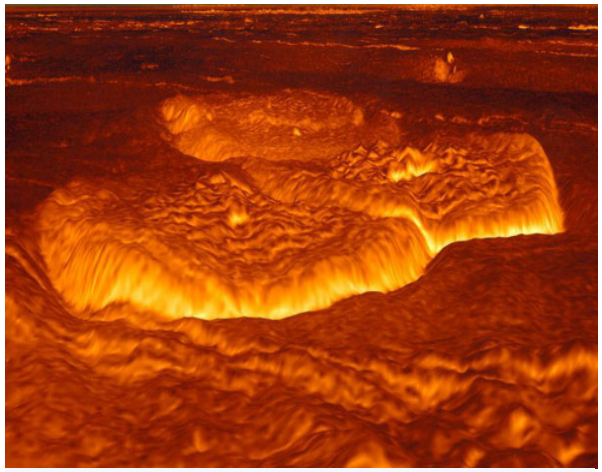
Exploration Metrics:

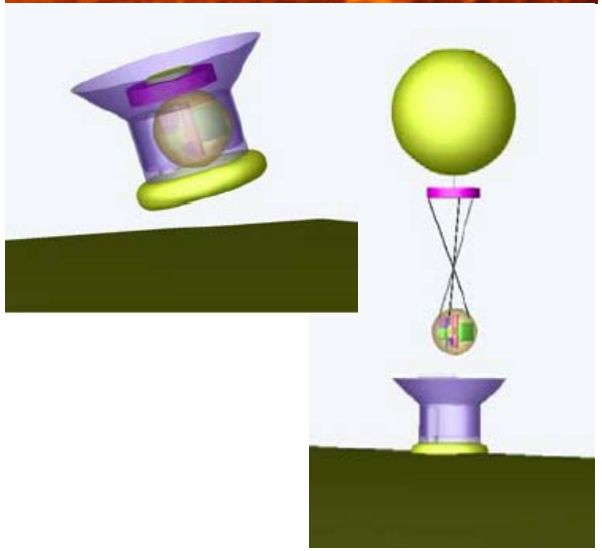
• Operate for several hours on the surface of Venus

Mission & LV Class:

• Intermediate Class

• TBD





Science Payload:

• Descent imager/Imaging microscope

• Neutral mass spectrometer with enrichment cell.

• Instruments to measure elements and mineralogy of surface materials.

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: 2013

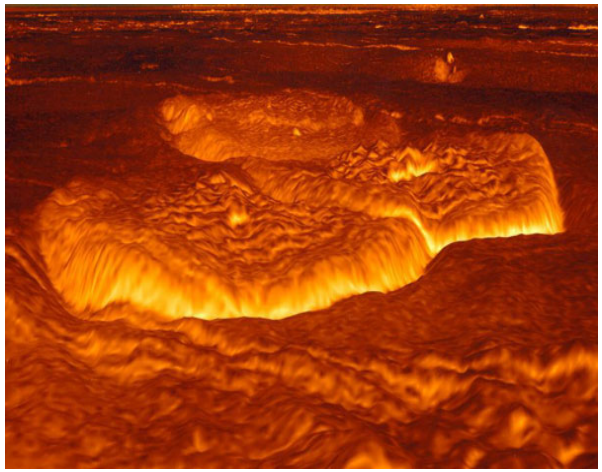
POC: Tibot.Balint@jpl.nasa.gov

Geophysical Network - Venus

Scientific Objectives:

• Determine the internal structure and seismic activity of the planet

• Monitor the circulation of the atmosphere.



Exploration Metrics:

• At least three stations on the surface of Venus

• Operate for at least one Earth year.

Mission & LV Class:

• Intermediate Class

• LV- TBD

Science Payload:

• Camera, descent imager

• Seismometer network.

• Pressure, temperature and wind velocity sensors

Technology & Heritage:.

• Passive insulation and survival technology **from VISE**

• High temperature electronics for telecom

• RPS power and refrigeration system

Mission Technology Studies:

• **No** in depth study for Decadal Survey 2002

• Technology studies now focusing on Venus surface power and temperature control.

Earliest Flight Opportunity: 2020

POC: Tibot.Balint@jpl.nasa.gov

Venus Surface Explorer

Scientific Objectives:

• Explore Venus surface with wheeled or aerial vehicle

• Composition and isotopic measurements of surface and atmosphere

• Acquire and characterize a core sample.

• **Demonstrate key technologies for VSSR**

Exploration Metrics:

• Operate in Venus surface environment for 90 Earth days

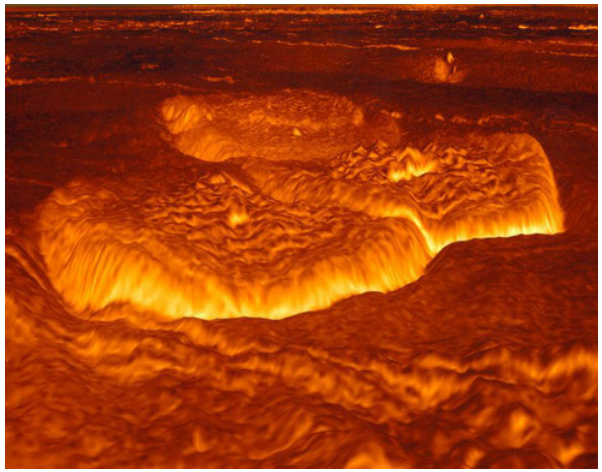
• Range across surface if rover

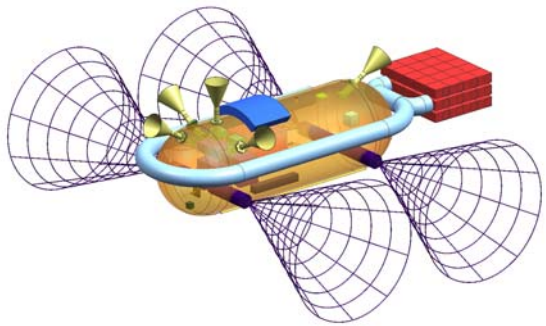
• Range and altitude if aerial vehicle

Mission & LV Class:

• Intermediate Class

• LV: TBD





Science Payload:

• Surface and descent visible and IR imaging and imaging microscope

• Neutral mass spectrometer with enrichment cell.

• Instruments to measure elements and mineralogy of surface materials.

Technology & Heritage:.

• Sample acquisition and handling in Venus environment from VISE

• Insulation and survival from VISE

• High temperature electronics for telecom

• RPS power and active cooling.

Mission Technology Studies:

• Decadal Survey 2002 - none.

• Technology studies for definition of advanced RPS systems, 2005.

Earliest Launch Opportunity: 2020

POC Tibot Balint@jpl.nasa.gov

Venus Surface Sample Return – VSSR

Science objectives:

• Measure isotopic composition of oxygen in surface rocks

• Measure isotopic composition of trace elements to characterize core and mantle formation.

• Determine the age of returned rocks.

Exploration Metrics:

• Return samples of Venus rock soil and atmosphere for analysis on Earth

• TBD year turnaround mission

• TBD weeks on the surface

Mission & LV Class:

• Flagship Class

• LV- TBD

Science Payload:

• Camera and Descent imager

• As needed for sample identification.

• Sampling arm and in situ instrumentation

Technology & Heritage:

• Ascent, Rendezvous and Sample Return Systems inherited from ***Mars Sample Return 2013***

• Prior VISE, Venus Network and Venus Surface Explorer missions

• Balloon technology to deliver sample to ascent vehicle launch altitude

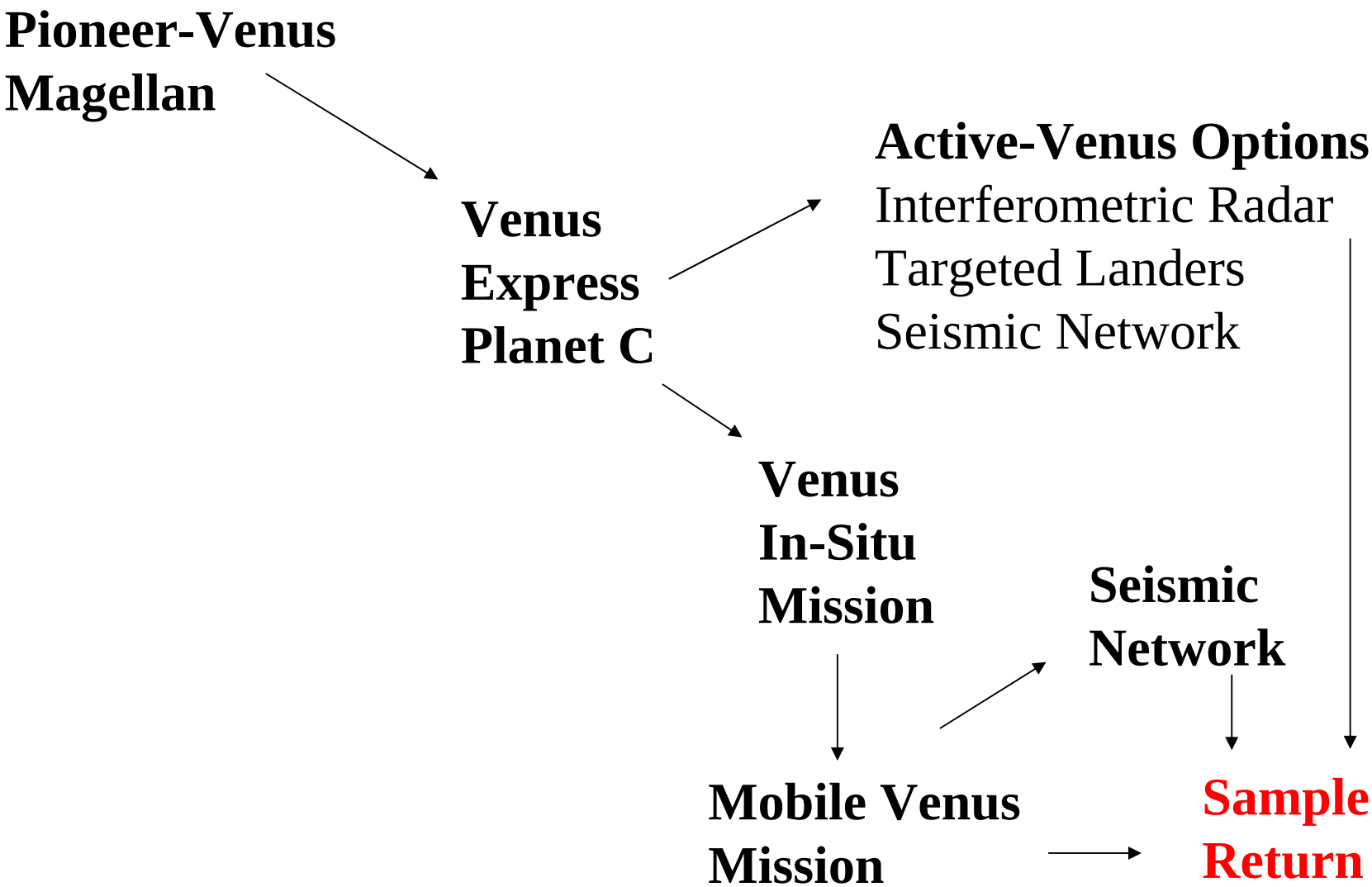
Mission Technology Studies:

• Decadal Survey, 2002

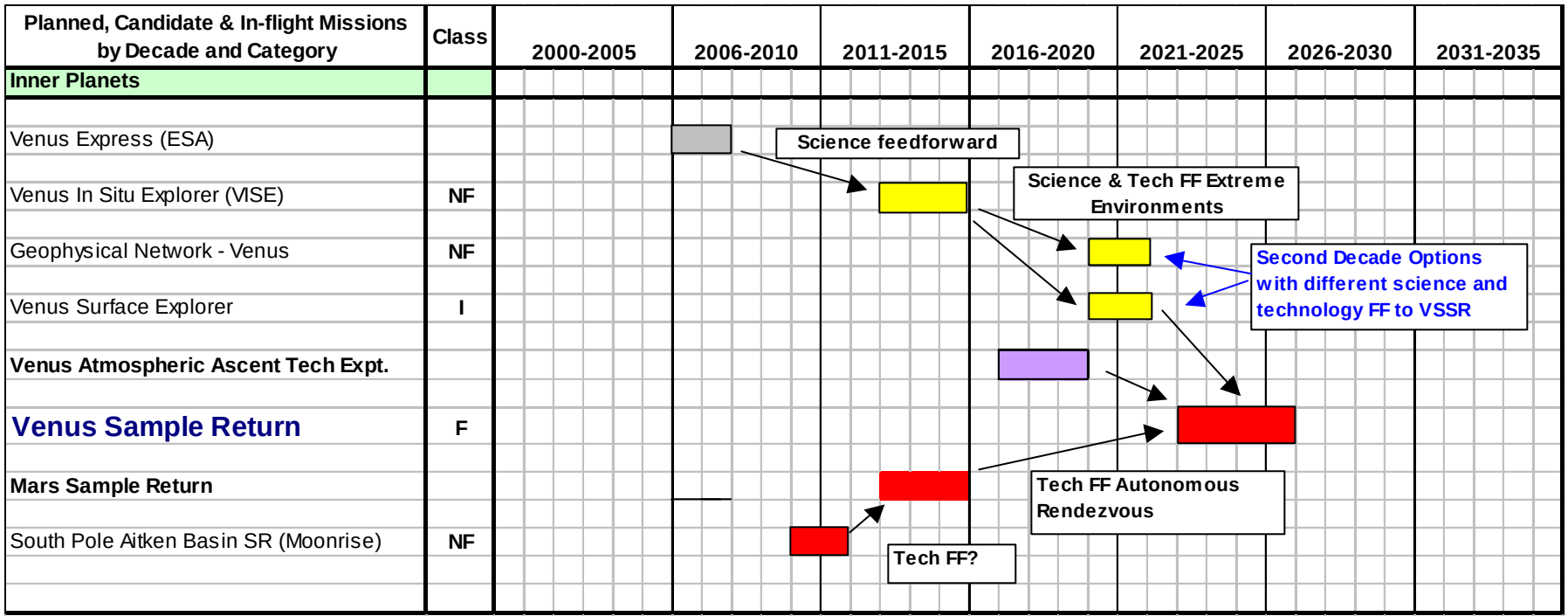
Earliest Launch Opportunity: 2023

POC: Tibot.Balint@jpl.nasa.gov

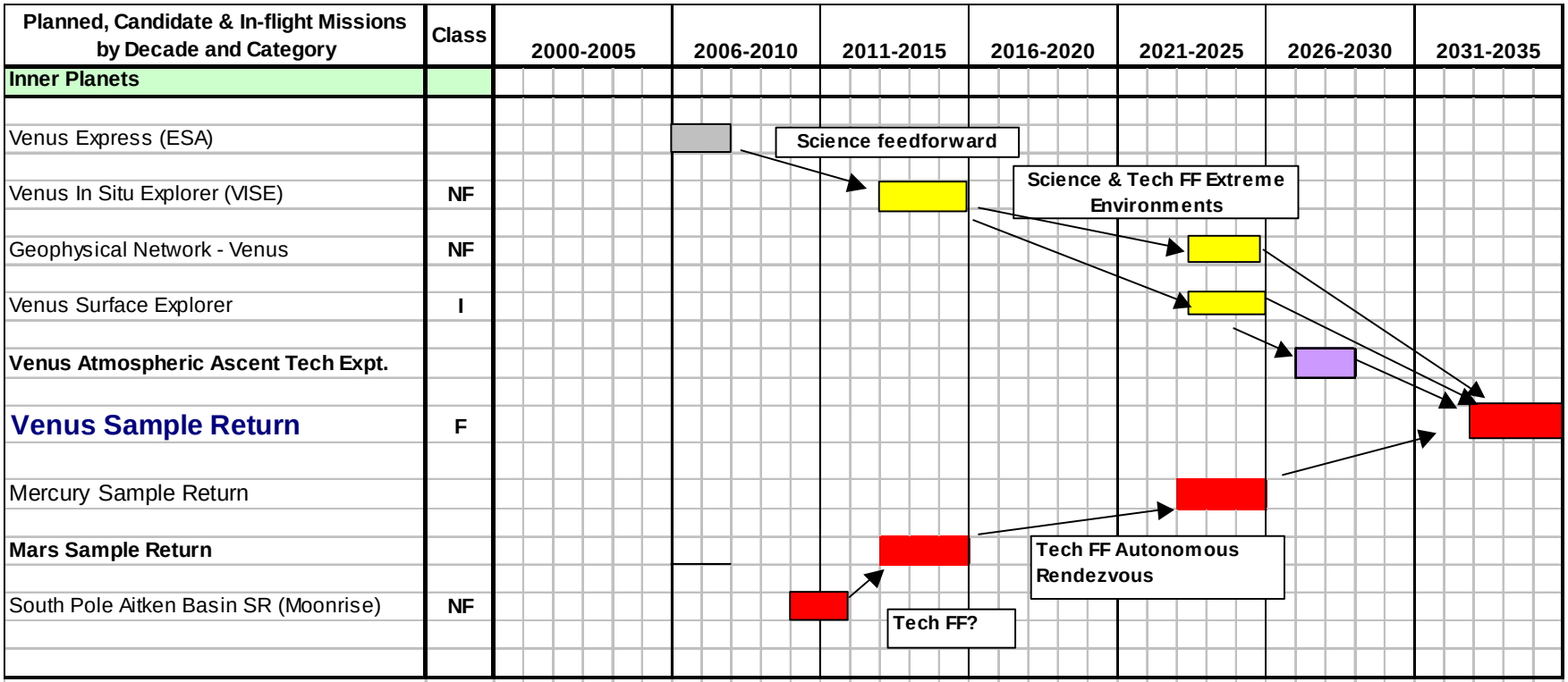
Anastomosing Venus Exploration Roadmap



Inner Planets Exploration
Scenarios Leading to Venus Surface Sample Return -1



Inner Planets Exploration
Scenarios Leading to Venus Surface Sample Return -2



Technology Gap Areas
In Situ Exploration and Sample Return

- Technologies for severe environments
  - High temperature and high pressure (Venus, also applicable to Jupiter)
  - Initial emphasis on extended life time to 20 hours on surface
  - Longer term emphasis on operation for months or year.
- Planetary Mobility
  - Aerial mobility
  - Surface mobility
- Entry Descent and Landing
- Sample return technologies
  - Sample acquisition, transfer and handling
- In Situ Instruments
  - Operation in Venus environment

How to provide your input?

- Please e mail your ideas on the future Venus Exploration Program to Steve Saunders (stephen.saunders@nasa.gov)