Moving forward from this workshop to an experiment on Mars: Programmatic challenges and solutions

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February 23, 2009

Topics

1: Defining a geochronology experiment concept that you believe will address high-value science

2: Developing community advocacy for making *in situ* geochronology a high-priority element of the Mars Exploration Program

3: Developing *your* experiment concept to TRL 5-6 before the release of a NASA mission AO

1: Defining a high-value experiment

- **First: Some background**
  - Mars program of the past decade
  - Mars program for the coming decade
- **Then: An approach to defining a high-value end-to-end flight experiment**
  - The concept of the "traceability matrix"
  - The criticality of tying your experiment to the "big picture"

The Mars Science Strategy: “Follow the Water”

- When was it present on the surface?
- How much and where?
- Where did it go?
- Did it persist long enough for life to have developed?

Understand the potential for life

Characterize the present and past climate and climate processes

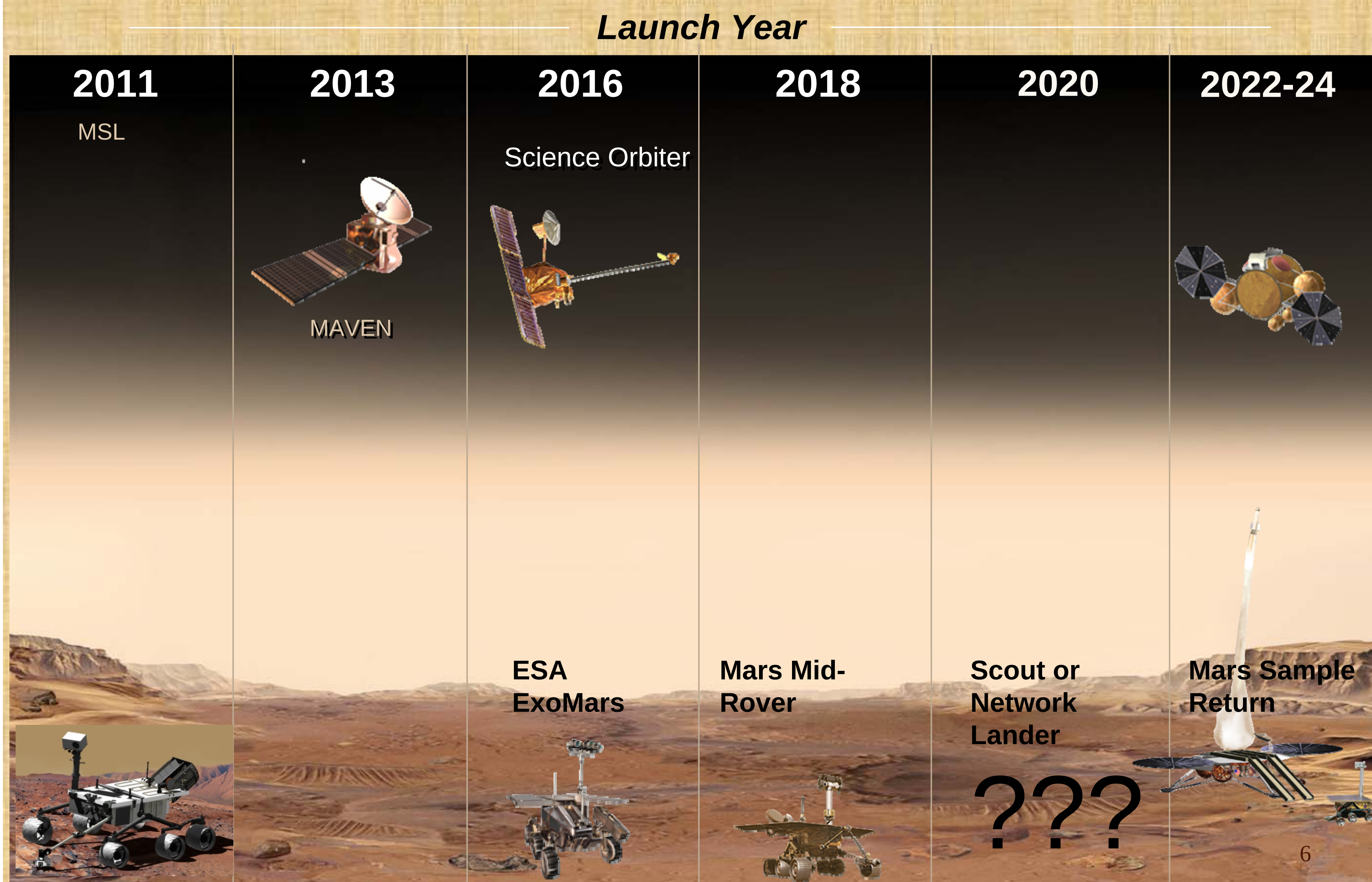
Understand the geological processes

Support Future Human Exploration

When • Where • Form • Amount

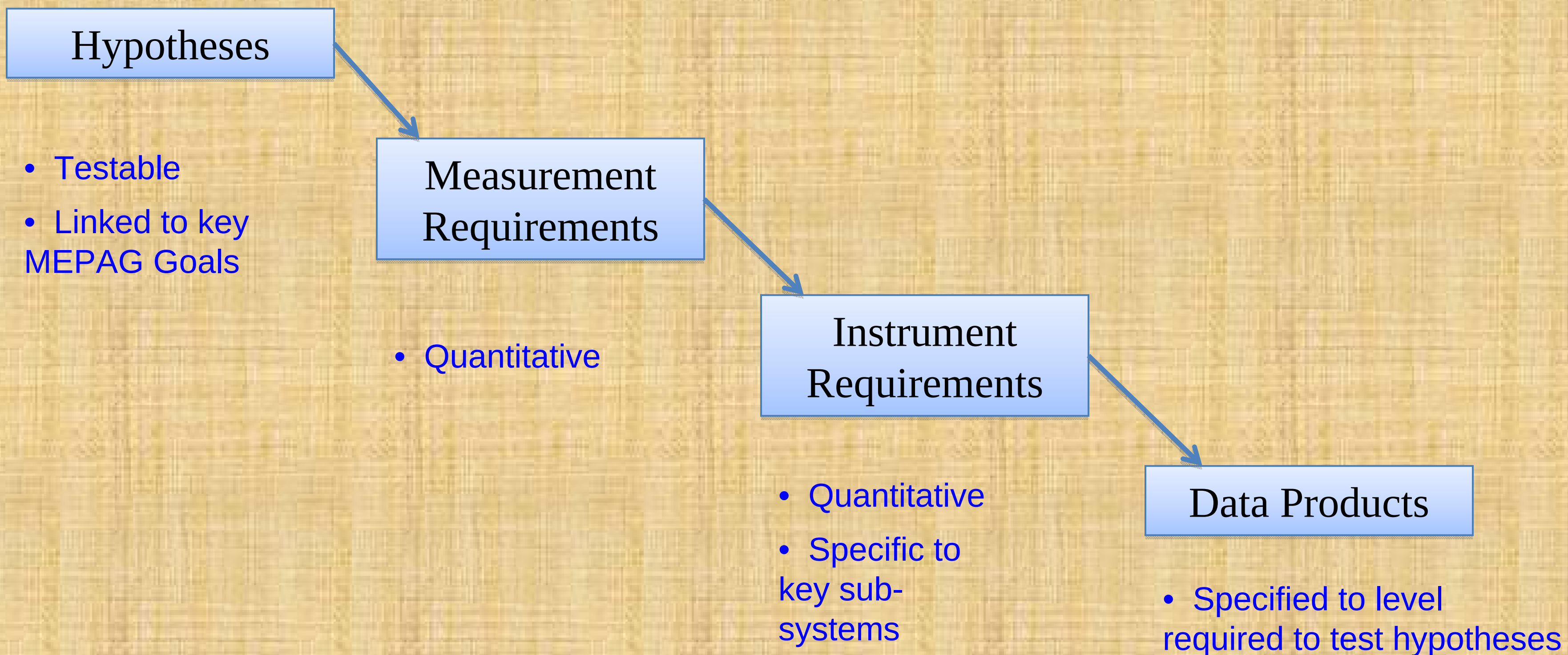
Mars Exploration Program

Possible Second Decade Mars Missions



Approach

- Inasmuch as you will someday have to propose to a NASA mission AO, you should know that:
  - *The community expects to see a proposal to test a hypothesis, with a logical flow-down of requirements to a complete experiment design.*



1: Defining a high-value experiment

Approach - continued

- The hypothesis you wish to test MUST be tied directly to high-priority, board program goals
- **You have a dual challenge:**
  - Defining goals that the broad community will buy into
  - Then…getting them to actually buy into them so they become a central part of the program plan for the next decade.
- Inasmuch as *in situ* geochronology will require essentially a dedicated mission, you must develop *broad community advocacy*
  - Geochronology is only Priority 3 in the current (9/08) MEPAG Goals
  - This is NOT SUFFCIENT to justify a dedicated mission

2: Developing community advocacy

- Assuming your workshop successfully ends Wednesday with the key elements of a high-value *in situ* Mars experiment, you also need a “marketing plan”
- The goal of the marketing plan:
  - Get the community to raise the priority of geochronology to at least #2, preferably #1
- The elements of the marketing plan should include:
  - One-on-one education of key community members
  - Workshops dedicated to geochronology and the board science it would enable
  - Conference sessions
  - Lobby key NASA program managers for a mechanism to fund instrument and technique development (PIDDP, MIDP, ASTID, ASTEP)

3: Developing your experiment to an adequate maturity level

- Short “tutorial” on “technology readiness levels (TRLs)”
- A case history: Jeff Bada’s Urey ExoMars experiment
- Where you are today *versus* where you need to be in a few short years

3: Developing your experiment to an adequate maturity level

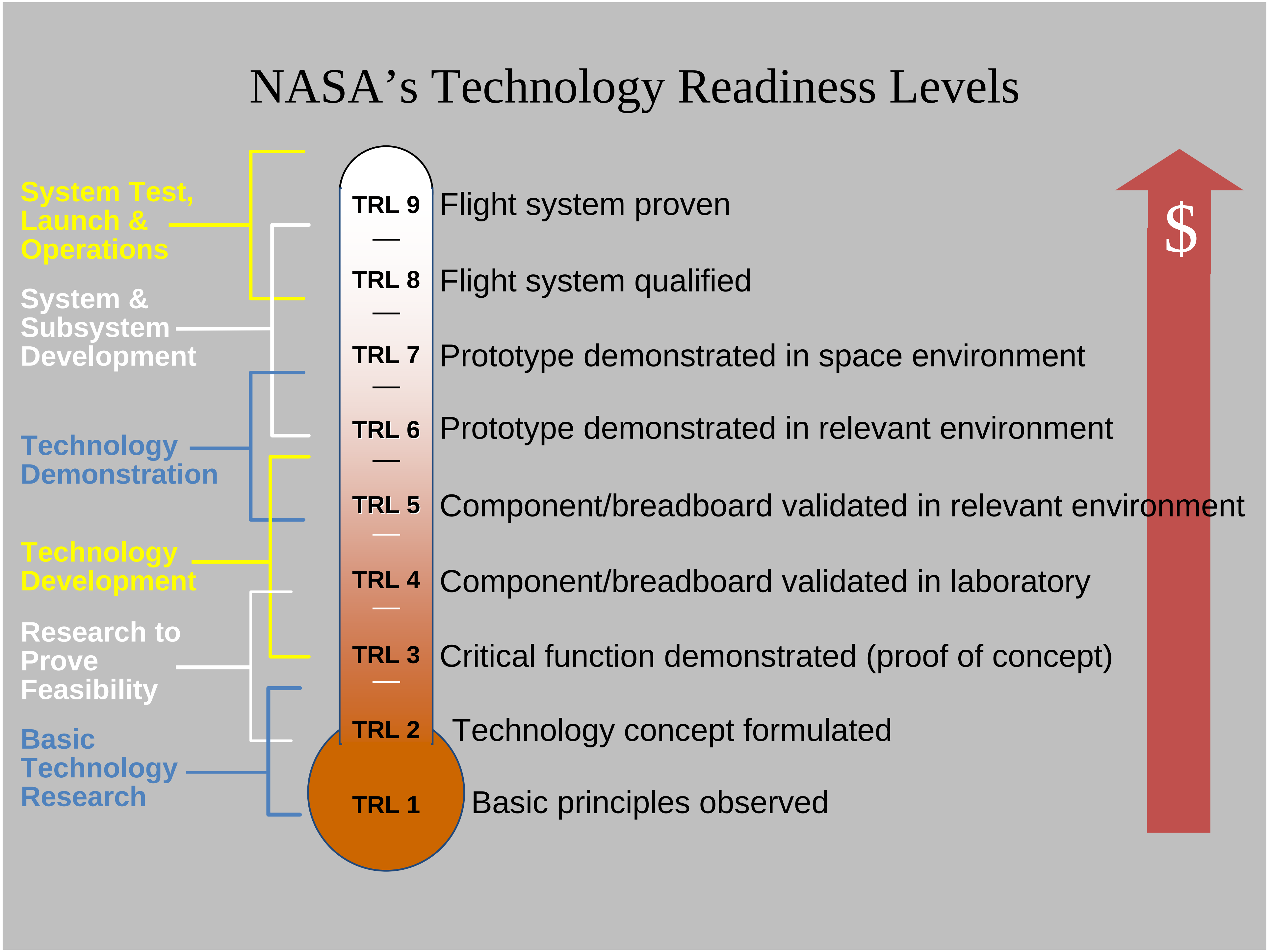
Some key realities you must deal with

- NASA is averse to taking risks
- Science payloads have traditionally been the most challenging mission system
- New, “first-of-a-kind, one-of-a-kind” instrument systems have an especially troubled history, with respect to on-cost, on-schedule, on-spec performance
- Therefore, your instrument system must be at a high level of technical readiness *by the date of mission AO release*

3: Developing your experiment to an adequate maturity level

How NASA assesses technical readiness

- An independent team of instrument experts evaluates each instrument sub-system and the overall system according to it's "Technology Readiness Level," *a.k.a.* TRL
  - Scaled from TRL 1 (theory) to TRL 9 (successfully flown in space)
  - Details on next chart
- It is a rigorous assessment
- It is designed to find "false claims" of technology readiness
- When a proposed instrument fails to achieve *at least* TRL 5, and preferably TRL 6 at the proposal stage, it is generally rated "high risk" and almost never selected by NASA


NASA's Technology Readiness Levels
System Test, Launch & Operations
System & Subsystem Development
Technology Demonstration
Technology Development
Research to Prove Feasibility
Basic Technology Research
TRL 9
Flight system proven
TRL 8
Flight system qualified
TRL 7
Prototype demonstrated in space environment
TRL 6
Prototype demonstrated in relevant environment
TRL 5
Component/breadboard validated in relevant environment
TRL 4
Component/breadboard validated in laboratory
TRL 3
Critical function demonstrated (proof of concept)
TRL 2
Technology concept formulated
TRL 1
Basic principles observed
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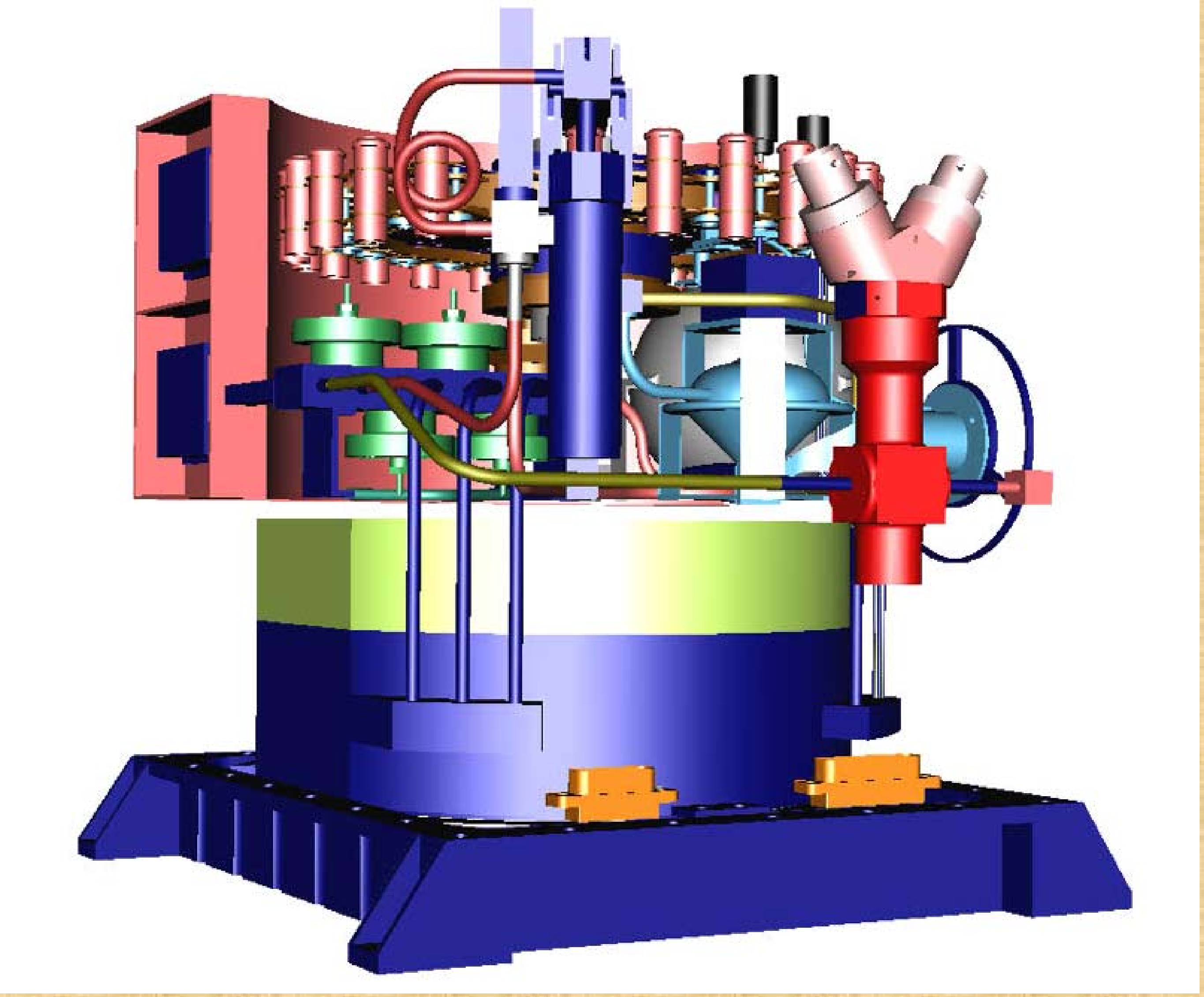
3: Developing your experiment to an adequate maturity level

A case history: Jeff Bada's ExoMars "Urey"



3: Developing your experiment to an adequate maturity level

Jeff's 11-year (and counting) "Mars odyssey"

1995: Jeff proposed amino acid detector for NASA Champollion comet mission

- NASA: "great science, technically 'not ready to go'"

1996: Jeff teams with JPL for help

- JPL DRDF one-year grant to design a flight instrument concept

1997: Proposal to NASA PIDDP to mature the concept

- Two-year grant, ~$1.1M
- Zent and Quinn join team with their own PIDDP grant for a complimentary instrument to measure oxidants

1998: Proposal to NASA MIDP to expand development to field-testable version

- Two-year grant, ~$1.1M

1999: "Mars Organic Detector (MOD)" proposed to NASA for MSP2003 lander

- Good news: Proposal selected!
- Bad news: Mission cancelled in 2000!

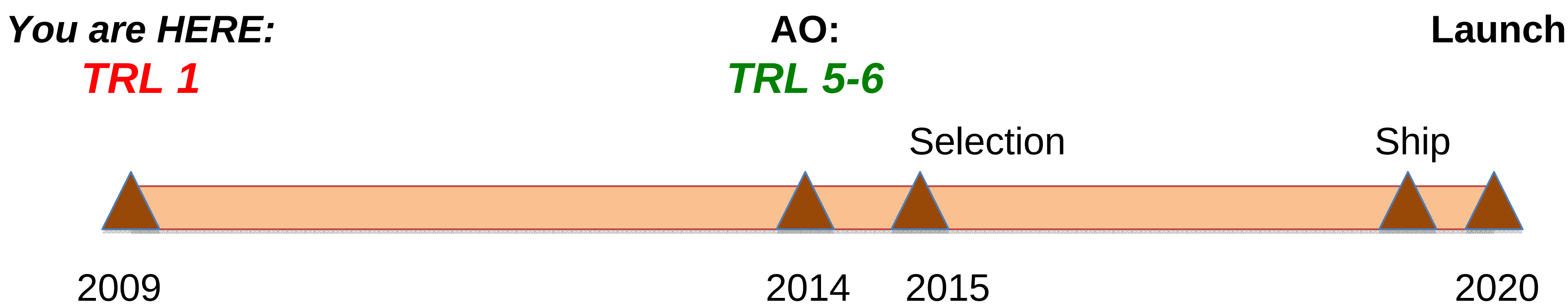
3: Developing your experiment to an adequate maturity level

Jeff's 11-year (and counting) "Mars odyssey" con't

- 2001: ASTID proposal funded for 2 years, about $1M
  - Sub-critical water extractor
  - Micro-capillary electrophoresis system
- 2002: Two ASTEP proposals funded
  - $1.6M for field deployable organic detector
  - $1M for micro-fabricated organic analyzer
- 2004: ASTEP proposal funded for 3 years, $2M
  - Field portable version of the future ExoMars Urey instrument
- 2004: A version of Urey was proposed to MSL
  - Highly rated by the NASA peer review boards
  - Not selected due to lower priority *vis-a-vis* MSL mission objectives
- 2006: Urey proposed to NASA for ExoMars, via Mars Scout MoO AO
  - Selected for technology and development funding in 2007
  - Urey *appears* to now have a secure ride to Mars on ExoMars, 2016

3: Developing your experiment to an adequate maturity level

Where you are today *vs* where you need to be



5 years from TRL 1 to TRL 5/6.

It took Jeff Bada <u>~11 years!</u>

4 years to build, test, & deliver a complete flight system

CONCLUSION: YOU HAVE NO TIME TO WASTE

Recommendations:
What you should strive to accomplish by Wed PM

1. Definition of a scientific experiment that will have large impact on the board understanding of Mars as a planet and it’s potential for harboring life

2. Outline of a plan for getting broad community support to raise the priority of *in situ* geochronology to at least priority #2 and better, priority #1 in the next revision to the MEPAG Goals and the Decadal Survey

3. A plan for developing a testable instrument system to validate technical design and validate experimental methodology for extracting the information required to achieve your scientific goals