NASA Planetary Science Division’s Instrument Development Programs, PICASSO and MatISSE

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Strategic Goal: Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.

It seeks to answer five fundamental questions:

- How did the Sun's family of planets and minor bodies originate?
- How did the solar system evolve to its current diverse state?
- What are the characteristics of the solar system that led to the origin of life?
- How did life begin and evolve on Earth and has it evolved elsewhere in the solar system?
- What are the hazards and resources in the solar system environment that will affect the extension of human presence in space?
Instrument Development Strategy

I have this crazy idea
TRL 1-3

→

I can make it work
TRL 4-6

→

How did we ever do without it?
TRL 7-9
Planetary Instrument Concepts Advancing Solar System Observations (PICASSO)

**PICASSO** supports the development of spacecraft-based instrument systems that show promise for use in future planetary missions.

**Program goal** to develop low TRL technology to feed MatISSE, etc.
- science instrument feasibility studies
- concept formation
- proof of concept instruments
- advanced component technology

**Program objectives** to develop new technologies that significantly improve instrument measurement capabilities for planetary science missions.

**Proposals** are typically sought every year.

**The budget** is ~$3.5 M per year.
- Average award ~ $250 - $300K/year
- Typically ~ 12 awards
Maturation of Instruments for Solar System Exploration (MatISSE)

**MatISSE** supports the maturation of spacecraft-based instrument systems that show promise for use in future planetary missions.

Program goal to develop instrument to point where they can be proposed to flight programs:
- Must address specific science objectives
- Retire major technological risk

Program requires higher level of oversight:
- Quarterly reviews
- Site visits
- External reviewers

Proposals are typically sought on even numbered years.

The budget is ~$6 M per year.
- Average award ~ $1.0M/year
- Typically ~ 6 awards
PICASSO Entry TRL’s 1-3

- **TRL 9**: Actual system “flight proven” through successful mission operations
- **TRL 8**: Actual system completed and “flight qualified” through test and demonstration (Ground or Flight)
- **TRL 7**: System prototype demonstration in a space environment
- **TRL 6**: System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)
- **TRL 5**: Component and/or breadboard validation in relevant environment
- **TRL 4**: Component and/or breadboard validation in laboratory environment
- **TRL 3**: Analytical and experimental critical function and/or characteristic proof-of-concept
- **TRL 2**: Technology concept and/or application formulated
- **TRL 1**: Basic principles observed and reported

System Test, Launch and Operations

System/Subsystem Development

Technology Demonstration

Technology Development

Research to Prove Feasibility

Basic Technology Research

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MatISSE TRL’s 4-6

TRL 9
Actual system “flight proven” through successful mission operations

TRL 8
Actual system completed and “flight qualified” through test and demonstration (Ground or Flight)

TRL 7
System prototype demonstration in a space environment

TRL 6
System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

TRL 5
Component and/or breadboard validation in relevant environment

TRL 4
Component and/or breadboard validation in laboratory environment

TRL 3
Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 2
Technology concept and/or application formulated

TRL 1
Basic principles observed and reported

System Test, Launch and Operations

System/Subsystem Development

Technology Demonstration

Technology Development

Research to Prove Feasibility

Basic Technology Research

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TRL Summary

TRL’s are quantized
TRL 2-3 does not exist
If the technology is between 2 & 3, it is 2

PICASSO
Entry TRL must be 1, 2, or 3
Advance the TRL at least 1 level.

MatISSE
Entry TRL 3 or higher
Advance the TRL to 6
Evaluations

- All compliant proposals are discussed (no triage)
- There is only one PI
- Proposers receive only the final panel review, not the individual ones
- No response to previous reviews required
- Training components are not required
- An overall score of “Good” is fundable
- The review panel does not rank proposals
  - Done later by in conjunction with NASA program leads
  - Selection Official does final selection
The prime directive...

- Reviewers do not guess, infer, interpolate, extrapolate, or read between the lines.

- They evaluate only what is written in the proposal.
Evaluation Criteria

- **Intrinsic Merit**
  Scientific/technical merit (including qualifications of team and TRL assessment)

- **Relevance**
  to program (assuming success as proposed)

- **Cost Reasonableness**
  (for what they proposed)
Intrinsic Merit

Questions to consider:

Can the proposed instrument concept achieve the proposed measurement goal?

Can the development achieve the progress proposed?

Does the proposal acknowledge potential pitfalls and propose alternatives?

Does the team have the necessary expertise?
Assume that everything works as proposed.

Question to consider:

- How compelling and articulate is the argument presented in the proposal for the relevance of the proposed development to NASA’s and PSD’s strategic goals?
- Are specific NASA planning documents cited?
  - Decadal Survey
  - NASA Science Plan
  - Etc.
Cost Reasonableness

Questions to consider:

- Are the resources requested (FTEs, travel and supply costs, etc.) reasonable for the scale and type of work proposed?
- Is the budget clearly described and justified
  - All major sub-contracts or sub-awards?
  - Quotes for items > $5,000?

Detailed Work Plan
- Milestones
- Schedule
- Budget

“Cost reasonableness” ≠ “bang for buck.”
Strengths and Weaknesses

- Each proposal has strengths and weaknesses

- Strengths and weaknesses may be major or minor.
  - “Major” and “minor” are fairly broad categories so not all “majors” are equally important.
  - Some major weaknesses, though, are fatal flaws.
Strength and Weakness

Major strength distinguishes it and provides a justification for selection

Major weakness is a deficiency that is not correctable in a subsequent negotiation process. A proposal with a fatal flaw in any evaluation category is not selectable.

- **Minor** Strength and Weakness
  - Comments of value to the selecting official or the proposers which are noteworthy.
  - Minor weakness is correctable if addressed early during period of performance.
Early Career Fellowship (ECF)

- Intended to help make planetary science post-docs more attractive to hiring institutions.
- Application is literally checking a box
  - Additional information supporting ECF request in the CV portion of the proposal
  - Accomplishments to date
  - Current research
  - Ideas for future research directions
  - How future research will support planetary science research goals
ECF Process

- Proposal must first be selected to be eligible
  - Does not affect proposal selection
  - ECF candidate must be recommended by review panel

- Separate application process
  - When offered tenure-track equivalent positions can apply for up to $100k in start-up funds over and above proposal award
Historical Success

- Virtually all US instruments on planetary probes started in PSD instrument development programs
- Nearly all instrument PI’s were funded by instrument development programs
- Instruments rapidly becoming smaller and more capable

With your help, PICASSO and MatISSE are on track to continue that success