Instrument Considerations for Pre-Phase A Proposals

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Instrument Considerations for Pre-Phase A Proposals

Areas Addressed

- Science Traceability Matrix
- Signal-to-Noise Ratio
- Instrument Constraints on the Spacecraft System and Vice Versa
- Instrument Design
- Instrument Alignment Requirements and Performance
- Instrument Calibration Requirements
- Instrument System Thermal Requirements
- Field-of-View and Scanning Requirements
- Instrument/spacecraft Pointing Requirements
- Supporting instrumentation needed for mission implementation
- Technology Readiness Level
- Contamination Effects
- Radiation Effects on Instrument System Performance
- Test requirements, Plans and Schedules
- Radar Remote Sensing Systems
- Radio Science
- Surface Measurements

Instrument Considerations for Pre-Phase A Proposals

Science Traceability Matrix

Proposals should fully complete the Science Traceability Matrix defined in the AO showing traceability from the end measurements back to NASA goals and objectives. Show required accuracies and precisions for all geophysical parameter measurements needed to meet the science objectives. The STM should show projected science performance based on end-to-end simulations, i.e. the process of going from instrument signals observed to geophysical parameters using errors estimated from the pre-Phase A design. It is especially important that the projected science performance exceeds the required with margin in the presence of realistic instrument errors.

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Signal-to-Noise Ratio

Proposals should include sufficient information to justify the required and expected SNRs. Expected signal levels in scientific units and results of calculations such as SNR versus altitude or wavelength should be provided. Enough information should be included to show that the pre-Phase A studies were adequately thorough to give confidence in the SNRs stated in the proposal. Key system parameters assumed in the SNR estimate such as optics size, optical efficiency, and detector parameters should be included.

Instrument Constraints on the Spacecraft System and Vice Versa

The proposal should provide pre-liminary information on constraints that any instrument imposes on the rest of the flight system such as for example, spacecraft magnetic or electric field limitations, outgassing effects, radioactive emissions, etc. The discussion should also include potential effects of instrument induced spacecraft motions on science data collection by other instruments on the spacecraft.

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Instrument Design

Provide an instrument block diagram for all instruments, showing the basic design and describe the instrument transfer function, detector types and layouts, spectral filtering approaches, and where calibration sources are located. Provide tabular instrument requirements and predictions. For systems dealing with low contrast scenes, provide a preliminary discussion of the approach to achieve sufficient stray light rejection performance. Discuss any special purpose encoding. Show dimensions on drawings and discuss all mechanisms.

Instrument Alignment Requirements and Performance

Describe internal alignment specifications, alignment stability requirements and design features to ensure that the instrument and intra-instrument alignments will be maintained in the presence of the expected thermal environment, and payload launch and landing loads

Instrument Considerations for Pre-Phase A Proposals

Instrument Calibration Requirements

Show instrument calibration requirements and capabilities including what calibration sources will be used, how often calibrations will be performed, how the in-orbit calibrations are tied to ground standards and describe any calibration method heritage

Instrument System Thermal Requirements

Clearly state the instrument system and detector thermal requirements including detector temperature and stability requirements, top level thermal design, instrument system thermal stability requirements, system assumptions, cooling approaches, and effects of warm objects in the FOV on system cooling including the assumed thermal properties of the object being observed. To support any cooling margin claims, provide sufficient definition of heat flow paths, parasitic heating sources and approaches to compensate for cooler temperature changes either in hardware or mission design.

Instrument Considerations for Pre-Phase A Proposals

Field-of-View and Scanning Requirements

Describe FOV overlap requirements for all instruments, clear instrument and radiator FOV requirements on the spacecraft, and sun avoidance constraints. Clearly describe how altitude scans will be accomplished for limb viewing by emission, solar occultation or stellar occultation instruments (e.g. scanning by the instrument scan mirror or by the spacecraft).

Instrument/spacecraft Pointing Requirements

Describe instrument and/or spacecraft jitter, stability and pointing accuracy specifications in relation to detector and science field-of-view sizes and state any instrument-to-instrument or instrument-to-spacecraft boresight specifications. Provide a top level discussion of how S/C motion, such as uncompensated attitude drift in a limb sounder scan direction for example, effects science results and discuss how these effects are mitigated by the system design or by a software correction approach.

Instrument Considerations for Pre-Phase A Proposals

Supporting instrumentation needed for mission implementation

Fully identify all instruments needed to meet science objectives, including not only direct science instruments but also all science supporting instruments (e.g. optical navigation, laser altimetry) and provide supporting instrument requirements versus performance capabilities

Technology Readiness Level

The proposal should justify the TRL value assigned to a given instrument using tables that address key subsystems. When an instrument is not at TRL 6 describe an approach to bring it to TRL 6 by the end of Phase B. Describe the proposer's criteria used to classify the hardware as having reached TRL 6. When inheritance is claimed from an ongoing program discuss the development status of the heritage equipment. Describe qualification rationale and plans including how many and what kinds of units will be built and what tests will be done on each unit.

Instrument Considerations for Pre-Phase A Proposals

Contamination Effects

Discuss instrument contamination protection rationale, requirements and design approaches to meet requirements including contamination covers, protection system heritage and design features. Where applicable, address the effects on the science of water vapor trapped in the system and at a top level discuss approaches to drive water out of the system. When the mission sequence could lead to contamination effects (e.g., flying through a comet tail), mitigation approaches should be discussed.

Radiation Effects on Instrument System Performance

Discuss the effects of radiation dose and dose rate on the performance of instrument system detectors, and electronics and describe top level planned approaches to sufficiently mitigate these effects on mission science. Even though a detailed design is not needed at this stage, enough information should be provided to demonstrate a thorough understanding of the problems to be solved and that feasible design solutions exist.

Instrument Considerations for Pre-Phase A Proposals

Test requirements, Plans and Schedules

Describe instrument performance, thermal, and mechanical testing requirements including any stressing tests needed to show proper operation in the expected environments encountered in orbit, during entry, during landing, and on the surface (including dust and atmospheric effects). Describe, top level tests planned, testing schedule and facilities in place or planned to address testing issues. State the number of development, engineering, qual and flight units and how they will be used. Show top level activities for these models and critical components. Define the relationship of the development units to the flight hardware.

Instrument Considerations for Pre-Phase A Proposals

Radar Remote Sensing Systems

Describe the rationale for band selection (e.g. C-band) and provide a block diagram of the system along with a description of the function of the major blocks. For any on-board processing, discuss available test results as well as heritage of the algorithms. Include a link budget and describe how this budget supports SNR claims. Describe the antenna design and any unusual characteristics. For Radar systems whose antenna pattern is affected by the presence of the spacecraft, describe how the impedance match between the antenna and the feed are determined. Demonstrate how the alignment of antenna and feed are maintained during the mission (e.g. are changes in spacecraft shape accounted for in the SNR error budget). Discuss both ground and in-flight radiometric calibrations. If there are any related airplane or earth orbiting results from a similar system, explain how that data supports proposed performance claims. Discuss long-term storage issues and associated test plans for any deployable items.

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Radio Science

The proposal should provide radio occultation system modeling to show that the assumptions made and science parameter results accuracies stated are consistent with the capability and availability of the needed resources both on the ground and on the spacecraft. Describe interactions with the spacecraft telecom system, the selection and justification for the radio band used (e.g. X- or Ka- band), the capabilities and availability of the USOs selected, projected SNRs, and required timing accuracy. Fully describe duty cycles that show when the radio science measurements will be made and how these measurements affect the science timeline.

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Surface Measurements

Discuss the contamination issues involved in sampling material on the surface of the body of interest and how the selected sampling approach mitigates these issues. Define platform stability requirements and how local gravity affects the sampling approach. Provide the sequence of events leading up to sampling after landing. Describe the method of surface sampling employed and discuss what requirements this places on other elements of the system (e.g. dust protection). Discuss how the sampling environment affects the choice of lubricants. Provide mechanism stiffness and torque margins on articulating elements. Describe the mechanism test environments. If cameras are employed to support surface operations, provide their requirements for spatial coverage and depth-of-field relative to the work space. Discuss how camera perform-ance is assured over the environmental extremes. Discuss how the work space is illuminated and define the camera alignment with the working volume. If samples are taken in various locations, discuss how cross contamination is avoided. Describe lifetime limitations for surface operations.