Geospace Dynamics Constellation
Frequently Asked Questions

Categories of Questions

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Change Log		
Rev.	**Date**	**Description of Changes**
01	2/1/21	Added S-1, S-2, S-3, T-1, T-2, T-3, E-1, P-1
02	2/16/21	Updated S-1, T-1, T-2; added S-4, E-2
03	3/9/21	Updated E-2; added T-4
04	3/15/21	Added S-5, S-6, S-7, S-8
05	3/25/21	Updated S-7; added S-9, S-10, S-11, S-12, S-13, T-5, T-6, T-7, M-1, M-2, C-1, C-2, C-3, E-3, E-4, O-1
06	4/12/21	Updated S-6, S-10; added S-14, S-15, S-16, S-17, T-8, T-9, T-10, O-2, O-3
07	6/3/21	Updated S-9, C-3, E-4; added S-18, S-19, S-20, T-11, T-12, M-3; struckthrough C-1
08	6/22/21	Added M-4
09	7/1/21	Updated S-15; added S-21, S-22, S-23, T-13, T-14, T-15, M-5, M-6, M-7, M-8, M-9, C-4, E-5, E-6, O-4
10	7/13/21	Updated M-2; added M-10
11	7/29/21	Updated S-8, M-10; added S-24, C-5, P-2
12	8/20/21	Updated M-1, M-2
13	9/3/21	Added S-25, T-16, P-3
14	9/7/21	Added E-7

Science

S-1. Does the Community Announcement (Acquisition Process, posted 1/12/21) supersede the GDC STDT report? If the Community Announcement (or a subsequent document) levies a requirement or constraint that the STDT report does not (or in a different way), is an investigation that follows the STDT report and not the Announcement (or subsequent document) compliant? [Updated 2/16/21, generalized the question.]

The Community Announcement and subsequent documents supersede the GDC STDT Final Report. Investigations must follow requirements and constraints in the Announcement, even if the STDT report does not have that requirement or constraint (or describes it differently).

S-2. Is there a minimum number of GDC Science Objectives that an investigation must address?

There is not a minimum number of GDC Science Objectives that a single investigation is required to address.

S-3. The Community Announcement (Acquisition Process, posted 1/12/21) states "Investigations must include a single instrument type and may not include an instrument suite. NASA will follow community standards for the identification of instrument suites, and proposals will need to convincingly show adherence to this requirement (as appropriate and necessary for each proposal)". What distinguishes a single instrument from an instrument suite?

The difference between a single instrument and a suite is governed by community standards, and the exact demarcation between the two may be different for different instrument systems. For the GDC solicitation, a single instrument is one that is composed of one of the following:

a) A single sensor
b) Multiple sensors that are not physically separable
c) Multiple sensors that have interdependencies for a significant fraction of the GDC physical parameters to be measured by the instrument

S-4. For specified measurement requirements without an accompanying altitude range, is there a restriction on the altitude that the measurement is made at?

Unless an altitude range is specified, the measurement must be made at the spacecraft.

S-5. If a single institution wants to propose flight hardware that measures multiple physical parameters, will that require multiple proposals? Does it depend on whether multiple institutions are involved?

Investigations are restricted from proposing suites (see PEA, Section 1.1), which is not the same as proposing an instrument that measures multiple physical parameters, and

the guidelines for suites are given in Question S-3 (of this document). This restriction applies regardless of the number of institutions involved.

S-6. Are the parameters and their measurement characteristics (e.g., dynamic range, accuracy, precision, sample rate, energy range, other identified quantities) in Table 1 of the PEA (repeated as Table 2-1 of the Proposal Information Package) restrictive of what can be proposed or do they represent the minimum capability that should be proposed? [Updated 4/9/21, clarified response]

Proposed instruments must measure at least one of the identified physical parameters (see Section 1.1) and proposals must "detail each physical parameter's measurement characteristics (accuracy, precision, resolution, etc.; including those given in the aforementioned table)" (see Requirement 7). There is no requirement that limits an instrument to Table 2-1's values for the identified measurement characteristics. NASA expects that proposed instrument performance will meet or exceed those levels.

S-7. Are investigations required to acquire measurements for the entire orbit, or just the sections of the orbit necessary for their proposed science investigation? [Updated 3/26/21, clarified the response.]

The GDC Science Objectives require the use of data not acquirable by a single instrument; therefore, the mission science return as a whole is maximized by ensuring as complete data coverage as possible, even if that implies that a single investigation acquire measurements outside of the spatial/temporal range required for the completion of its own proposed science. Section 2.2, *GDC Measurement Requirements*, of the PIP states, "All measurements are expected to be acquired globally, although it is understood that some Physical Parameters will only be significant at high latitudes." It is understood that, for some instruments, it also may not be technically feasible to measure those Physical Parameters at mid-/low-latitudes within a cost-effective, resource-efficient implementation.

S-8. Can investigation proposal teams include a Principal Investigator or a Co-Investigator who also is on an IDS team if it can be convincingly demonstrated that there is no overlap in the proposed duties? Can that individual be included if they are only a Collaborator on the IDS proposal team? [Updated 7/28/21, clarified GDC investigations team roles and definition of IDS team]

No, the prohibition on the same individual participating on an investigation team and an IDS team is complete. Section 4.2.2, *Ineligibility of GDC Interdisciplinary Scientists*, of the PEA states, "Proposals may not designate individuals as Principal Investigator or Co-Investigator who are part of a selected IDS team." This restriction applies even if the individual is a Collaborator on the selected IDS team.

S-9. The draft PEA (Requirement TBD-12) states that "Proposals shall clearly demonstrate how their Threshold Investigation will be achievable with the GDC threshold implementation of four spacecraft". What should proposals assume for the GDC threshold implementation in terms of 1) primary and secondary measurements, and 2) the constellation configuration? [Updated 6/3/2021, permitted the use of the investigation's secondary Physical Parameters in the final PEA.]

For GDC threshold implementation, proposed Threshold Investigations may only assume

1. the measurement of the primary Physical Parameters~~, even if the investigation's instrument only measures secondary Physical Parameters~~;
2. the measurements of all Physical Parameters by the investigation's instrument (see Requirement P-12); and
3. a constellation configuration identical to the GDC DRM (available through the Program Library's *Science Planning Resources*), but without spacecraft #3 and #5.

S-10. The PIP shows sub-objectives that the PEA does not, but the PEA is stated to take precedence over the PIP (Requirement TBD-1). This leads to the following questions:

1. **What is the purpose of the sub-objectives?**
2. **Do the PIP sub-objectives take precedence over the PEA Objectives?**
3. **Are proposals limited to the PIP sub-objectives?**
    i. **If the answer to (2) is no, will proposals that propose science outside of the sub-objectives be evaluated in a fair manner consistent with the evaluation of other proposals?**

[Updated 4/9/2021, added language to address similar questions.]

The PEA does not show the sub-objectives, but it does reference them in Section 2.4: "(For clarity and traceability in this solicitation, the Objectives retain the STDT-defined numbering and NASA has identified key sub-objectives for these Objectives, located in the GDC Proposal Information Package in the Program Library.)". Similar to other parts of the PEA that reference the PIP or other documents in Program Library, the PEA's pointer carries the same weight as if the referenced material were in the PEA itself (with the caveat, as always, that contradictions are decided in favor of the PEA itself).

1. The sub-objectives provide clarity and traceability in the solicitation. They separate a tightly coupled and nonlinear science topic into key aspects that can each be analyzed. They provide an explicit method for formulating GDC in a manner that keeps to the STDT's written scope for each Objective.
2. Per the response to (1), above, there is no contradiction between the sub-objectives in the PIP as the PEA directly points to them.
3. No. Per Section 2.4 of the PEA: "NASA is only soliciting investigations that address this subset of the STDT-identified Objectives". There is no language restricting proposals to only the identified sub-objectives, and investigations are encouraged to include compelling objectives that address the specified subset of the STDT-identified Objectives.
    i. Yes.

S-11. The PEA gives in Table 1 the primary and secondary GDC Physical Parameters. However, the GDC Objectives and sub-objectives are not explicitly linked to the Physical Parameters. How are the Physical Parameters expected to be used to address the Objectives and sub-objectives?

The STDT report linked Physical Parameters to the Objectives, but that linkage was not carried over to the GDC PEA. That choice was in order to remove potential confusion, the potential impression of constraining proposals, and the potential appearance of requirements sufficient to define a statement of work. Proposals shall state their Investigation objectives (Requirement 18 of the SALMON-3 AO), demonstrate that the Investigation objectives address GDC Objectives (Requirement TBD-6 of the draft PEA), and the measurements necessary to complete the Investigation objectives (Requirements TBD-8 and TBD-16).

S-12. If a proposed investigation would address the GDC Objectives and sub-objectives with GDC Physical Parameters not mentioned in the Objective or sub-objective text, or if with physical parameters outside of the GDC Physical Parameters, would that constitute an ability to address additional science?

There is no PEA-imposed linkage between the GDC Objectives (or sub-objectives) and the GDC Physical Parameters. The PEA states that proposals must address the GDC Objectives and must measure at least one GDC Physical Parameter, but does not require any particular Physical Parameter for an Objective. The PEA's language of "will not receive a more favorable evaluation" means that a proposal will not receive a strength for providing something outside of the GDC Objectives and Physical Parameters, but a proposal will be perceived as more risky if it requires a measurement that is not anticipated to be available to the investigation.

Arguing the ability to address additional science is where a proposal states/implies its own impact with science outside of the Investigation objectives that could also be accomplished.

Arguing an ability to make additional measurements is where a proposal states/implies its own impact with measurements outside of the GDC Physical Parameters; however, if an Investigation objective requires a physical parameter outside of the GDC Physical Parameters, that must still be identified.

S-13. The draft PEA provides in Table 1 the GDC Physical Parameters. That table classifies the STDT-identified measurements as primary or secondary. This leads to the following questions:

1. **How and by whom were the GDC Physical Parameters assigned to one of these two categories?**

2. **Is this pre-proposal classification of the measurements into these two categories consistent with and appropriate for an "Announcement of Opportunity"?**

The answers to this question are:

1. The Physical Parameters were classified by NASA during GDC pre-formulation. They were based on the balancing of the STDT's prioritization of Objectives, the measurement needs for the preponderance of those prioritized Objectives, and the possibility of descopes towards the mission threshold implementation in the face of development challenges (see Section 2.4 of the draft PEA). The classification of a Physical Parameter as secondary should not be inferred to mean unimportance; all GDC Physical Parameters are important for the completion of the maximum amount of the GDC Objectives.
2. Yes. An Announcement of Opportunity (AO) does not imply that NASA is unable to set requirements on science, measurements, or other aspects of the investigations (see NFS 1872). The setting of requirements is a necessary aspect of AOs, and this type of measurement requirement has been used in previous Focused Missions of Opportunity for non-NASA flight opportunities and for targeted instrument-specific NASA opportunities.

S-14. If an investigation's objectives or physical parameters require knowledge of a specific aspect of the space environment (such as the background magnetic field), can that be used even though it is not in the list of GDC Physical Parameters?

The draft PEA states in Requirement TBD-16 that proposals shall state any observations required for completion of the Baseline Investigation. That Requirement does not limit itself to measurements the investigation provides or the GDC Physical Parameters.

S-15. The draft PEA states in Requirement TBD-5 that all software and tools must be released under an open source license. This leads to the following questions:

1. **Does this requirement forbid the use of proprietary languages (e.g., IDL, MATLAB)?**
2. **How does this requirement apply to on-board instrument software, calibration and processing software, and scientific software and tools?**

[Updated 7/1/21 to address additional open source questions.]

The answers to these questions are:

1. Although there are benefits to the use of non-proprietary languages, the draft PEA does not require them. The open source license requirement applies to the investigation's software and tools, not the language.
2. The open source requirement is levied on scientific software and tools. This PEA does not levy requirements regarding the publishing of on-board instrument software. Requirements on calibration and processing software are addressed by calibration and measurement algorithm document (see Section 4.3.3 of the GDC

PEA). For investigations where software does not clearly delineate between calibration/processing tasks and scientific tasks, proposals must demonstrate that they are in compliance to the open source requirement.

S-16. Individuals are prohibited from being a PI or Co-I of a GDC investigation and a member of an IDS team (Section 4.2.2 of the draft PEA). Is there any prohibition on an individual being a member of multiple GDC investigation teams or of multiple IDS teams?

No.

S-17. The draft GDC PEA, in Table 1, lists the GDC Physical Parameters with measurement characteristics. This leads to the following questions:

1. **Can investigations assume that the GDC Physical Parameters (Table 1 of the draft PEA) will be available for their use?**
2. **Can investigations assume the measurement characteristics' values specified for the purposes of demonstrating their data sufficiency?**
3. **Are investigation instruments required to meet the measurement characteristics exactly? If the investigation requires a different set of measurement characteristics, can the instrument's capabilities be below or above the stated characteristics?**

The answers to this question are:

1. This question has two aspects that need to be treated separately.
   a. *Terms of the solicitation.* For process reasons, the draft PEA does not describe the GDC Physical Parameters (and their measurement characteristics) as capabilities that investigations may assume will be available. Instead, the draft PEA states in Section 5.3.2 (and Requirement TBD-16) that proposals shall identify all observations necessary for the completion of the science investigation (including those provided within the GDC observatories). Any measurements, including the GDC Physical Parameters, that an investigation requires must be clearly identified within the proposal.
   b. *Planning, practical considerations.* NASA has identified the primary Physical Parameters based on their as part of the GDC threshold implementation. As stated in Section 2.4 of the draft PEA, the primary measurements will be prioritized for selection; therefore, a proposal that relies on secondary Physical Parameters may be perceived as being less able to complete its Baseline Investigation.
2. Investigations should state the physical parameters, and their measurement characteristics, that are necessary for the completion of their science objectives. With the caveats from #1 (above), those measurement characteristics were based on the STDT report and are not likely to be unmet by the final GDC payload. As in every previous directed mission, part of the selection process is

maximizing the science return within the available resources, considering both the science investigation objectives and the instrument capabilities.

3. No, they are not required to exactly meet the measurement characteristics; yes, they are permitted to deviate from them. Each investigation must balance the needs of their science investigation and the instrument performance that would maximize the GDC science return, both within the mission's available resources. As in every previous directed mission, part of the selection process is maximizing the science return within the available resources, considering both the science investigation objectives and the instrument capabilities.

S-18. The draft PEA's Physical Parameters table appears to contain some inconsistencies in the measurement characteristics, and they did not include all of the physical parameters from the STDT report identified for the draft PEA's Science Objectives. Are those intentional, and is there a meaning behind them?

The Physical Parameters were based upon the STDT report, with some updates from NASA's subsequent pre-formulation work. There were some discrepancies in the calculations, and those are being resolved for the final version of the table. There is the appearance of missing physical parameters because the draft PEA simplified the physical parameters to be closer to measurement requirements; this was done to provide objective criteria in response to community questions about the definition of an instrument suite (see Question S-3), and the GDC PEA's Physical Parameters.

S-19. What is the difference between science objectives, high-level science requirements, and physical parameters? Are the high-level science requirements and the mission architecture requirements already defined?

Defining each one separately:

- Science objectives are narrowly focused scientific efforts that are part of a strategy to achieve a goal. Proposed investigations must achieve their proposed objectives. (SALMON-3 AO, Section 5.2.1)
- High-level science requirements are not mission implementation or measurement details. They are the high-level scientific determinations necessary in order to complete the science objectives, and they flow down into mission implementation and measurement details.
- Physical parameters, for the purposes of the GDC PEA, are the scientific measurements that are used to fulfill the science objectives.

S-20. What do the primary and secondary categories for Physical Parameters mean? What will affect the selection of investigations that provide the measurement capability of only secondary Physical Parameters?

The primary Physical Parameters represent the GDC mission's threshold implementation for the payload (similar to the measurement requirements in proposals' Threshold

Investigations; see Questions S-13, S-17). The primary and secondary Physical Parameters, combined, represent the baseline implementation for the payload in NASA's pre-formulation work. NASA will prioritize the primary Physical Parameters and intends to select investigations that provide only secondary Physical Parameters within the available resources in order to maximize the mission science return.

S-21. Should proposals state which GDC Science Objectives the investigation would address? Where is that information required to be placed?

The GDC PEA requires that proposals only include appropriate science objectives that address the PEA-identified GDC Science Objectives (GDC PEA, Requirement P-6). The SALMON-3 AO requires that proposals state the relationship between objectives and data, and show traceability from the investigation goals down to top-level mission requirements in the Science Traceability Matrix (SALMON-3 AO, Requirements 16, B-17).

Although the GDC PEA does not explicitly require traceability between the GDC Science Objectives and the investigation science objectives, it is the proposal's responsibility to meet the above requirements and it is to the proposal's advantage to meet those requirements in a way that enables a reviewer to more easily understand the proposed investigation. Including the mapping to the GDC Science Objectives in the Science Traceability Matrix is one way that a proposal could contribute to achieving those ends.

S-22. For investigations that require ground-based observations for on-orbit calibration and validation, do these need to be included in the proposal?

No, proposals are not required to include the ground-based observations but are required to describe the needs and possible ground-based instrumentation that could meet those needs (GDC PEA, Requirement P-17). Fuller consideration of the on-orbit validation needs will be a Phase A/B activity for the GDC science team (GDC PEA, Section 2.3.1).

S-23. What should proposals do if they measure a Physical Parameters where a specification of measurement characteristics requires details on the spacecraft and final science payload (e.g., electromagnetic cleanliness)?

The PIP provides expectations on the observatory's impact on an instrument, although it is understood that some relevant details will be dependent on the spacecraft and/or final science payload. Proposals should provide their investigation's requirements and their instrument's performance best estimates, describing any assumptions about the observatory. If these estimates are significantly assumption-dependent, a proposal might reasonably identify that an associated risk to the science investigation.

S-24. The GDC Interdisciplinary Scientist solicitation (offered under ROSES-2021) is for IDSs to join the GDC science team for Phases A-D, but states an expectation for a later solicitation for Phases E-F. This leads to two questions:

1. **Are proposals to the PEA able to assume that Phases E-F IDS teams will be in place, and will be available to execute aspects (e.g., modeling, data analysis) of the proposed science investigation?**
2. **Are proposals to the PEA able to add members of a selected IDS team to the proposal for Phases E-F only?**

The answer to these questions are:

1. No. NASA has not released a solicitation for Phase E-F IDS teams, and proposals to the GDC PEA may not assume that the IDSs would contribute some necessary aspect of the proposed complete investigation (SALMON-3 AO, Section 5.3.2).
2. No. Proposals to the GDC PEA must include a complete investigation, which would include the investigation team (SALMON-3 AO, Section 5.5.1). Including a member of a selected IDS team would fulfill those requirements but violate the prohibition on designating them as a Principal Investigator or Co-Investigator.

S-25. The GDC PEA, in Requirement P-12, states that proposals must clearly demonstrate how their investigation would be achievable with the GDC threshold implementation. It includes the statement "The use of measurements obtained outside of the GDC observatories are not restricted by this requirement." Does that mean that investigations are permitted to use non-GDC measurements to reach closure on the Threshold Investigation?

Yes, the text in Requirement P-12 states that non-GDC measurements are not included in the descoping towards the GDC threshold implementation.

Section 5.3.2 discusses the use of data acquired outside of the GDC observatories. Specifically, Requirement P-16 states "Proposals shall clearly describe which observations *(regardless of whether acquired on the GDC observatories or not)* are required for the proposed investigation to achieve its baseline investigation." [emphasis added].

Technology

T-1. Is an investigation responsible for providing the boom for the proposed instrument's deployment on the spacecraft? What is the maximum boom length that can be proposed? [Updated 2/16/21, clarified definition of 'boom'.]

Investigations are not responsible for providing a boom that is required only for their instrument's deployment. Booms for instrument deployment will be provided by the spacecraft; investigations may propose using a spacecraft-provided boom that is 1.2m

long (as defined in the *Proposal Information* Package, which can be found in the Program Library).

- Note: There was a typographical error in the original Community Announcement (Acquisition Process, posted 1/12/21), under *Technology/Deployables*, that stated that the planned boom length was 1.5m. The correct length is 1.2m, and has been fixed in the announcement.
- Note: In the Announcement and other GDC documents, the term "boom" refers to purely structural unit that is separable from the instrument. Anything that is inherently part of the instrument function (e.g., is a non-separable part of the sensor) is referred to as a deployable and not as a boom.

T-2. May an investigation include a deployable that is not a boom? [Updated 2/16/21, clarified definition of 'boom'.]

Yes, an investigation can include a non-boom deployable that is inherent to the function of the instrument. Investigations are responsible for the delivery of all such deployables.

- Note: In the Announcement and other GDC documents, the term "boom" refers to purely structural unit that is separable from the instrument. Anything that is inherently part of the instrument function (e.g., is a non-separable part of the sensor) is referred to as a deployable and not as a boom.

T-3. The Community Announcement (Acquisition Process, posted 1/12/21) states that investigations should propose to deliver six instrument flight units (twelve for potential additional observatory options). Does that imply that the GDC satellites will be identical in terms of science payloads? Is there a possibility that a proposal is selected but will only be asked to supply instruments for a subset of the constellation?

NASA intends to implement GDC as six identical observatories. NASA does not intend to solicit or select investigations to deliver instruments for a subset of the observatories.

T-4. The GDC Instrument Mission Assurance Requirements (IMAR) requires Level 2 parts, but NASA policy (NPR 8705.4, GSFC 8705.4) does permit the use of Level 3 parts. Can investigations propose to use Level 3 parts?

The GDC IMAR's requirement of Level 2 parts is correct. Any relaxation of that requirement for an investigation would be through a waiver process after investigation selection.

T-5. Can the engineering test unit (ETU) be built to proto-flight levels such that it could be considered as a flight unit?

No. The instrument ETUs and prototype units will be used to support observatory-level I&T (Section 8.4.1 of the PIP), and thus would not be available for use as a proto-flight unit.

T-6. Can the flight spare be considered as an additional flight unit in the event that an investigation is required to deliver more than six flight units?

No. Investigations must deliver the required flight units and also one space flight unit (Section 8.1.3 of the PIP).

T-7. The PIP describes accommodation challenges for instruments (Section 4.3). Are these exhaustive, and can it be assumed that any accommodation need not in conflict with the spacecraft description elsewhere in Section 4 and not identified in Section 4.3 would not create an accommodation risk?

The GDC spacecraft has not yet been selected, so there is not a definitive spacecraft design. The spacecraft description is based on common elements of a NASA-produced proof-of-concept design and current commercial spacecraft, and the potential accommodation challenges are based on anticipatable characteristics of the final spacecraft.

Instruments that have accommodation needs present in or similar to those aspects listed in Section 4.3 may drive cost and schedule impacts. Therefore, per Sections 2.6 and 7.2.1 of the PEA, may impact the assessment and selection decisions.

T-8. What attitude knowledge of the GDC observatory will be provided to the investigation teams, and when will it be provided? Table 4-2 of the PIP states that the observatory pointing knowledge (post processing) shall be less than 40 arcsec (< 0.011 degrees) whereas Section 4.2.5 of the PIP states that the pointing knowledge is less than 0.2 degrees.

The PIP describes both the total observatory budget (Table 4-2) and the expectations for each instrument (Section 4.2.5). For clarity for the proposer, the final PIP will only include the pointing knowledge for each instrument. Investigations can expect < 0.02 deg pointing knowledge at the sensor, and the final attitude knowledge is expected to be delivered to the investigation teams within one week of data downlink.

- Note: There was a typo in the draft PIP that stated 0.2 deg pointing knowledge instead of the correct figure of 0.02 deg pointing knowledge. This is being fixed in the final PIP.

T-9. The PIP, in Table 8-1, states that an instrument flight spare must be tested to prototype levels prior to delivery. Please confirm that prototype was the intended testing level and clarify when the flight spare is to be delivered.

The flight spare must be tested to acceptance levels prior to delivery; the testing to prototype levels was a documentation error and will be fixed in the final PIP. The flight spare must be delivered one month after the final flight unit is delivered, per the right-

hand column of Table 8-1 of the PIP. The flight unit delivery schedule is set by Requirement TBD-22 of the draft GDC PEA.

T-10. The draft PIP does not include jitter control requirements for the GDC observatories. Have those been set?

This was an unintended omission from the draft PIP and the values will be included in the final PIP.

T-11. The draft GDC PIP, in Section 4.2.12 regarding the "Electrostatic Properties" of the spacecraft, states "and no exposed positive potentials on its exterior." There are several questions related to this statement:

1. **Should Section 4.2.12 of the PIP be interpreted to mean that that total spacecraft potential relative to the ambient plasma will only be zero or negative and never positive during science operations?**
2. **Will the GDC observatories measure the spacecraft potential relative to the ambient plasma? Will the knowledge of the spacecraft potential be made available to instruments?**
3. **Will the GDC observatories actively control the spacecraft potential?**
4. **Will there be any constraint on the spacecraft charging amplitude with respect to ambient plasma during science operations?**
5. **Are positive potentials allowed at the end of sufficiently long deployable structures, which won't distort potential fields near the spacecraft?**

Answers follow for each of the questions:

1. Yes, the expectation is that the spacecraft potential will never be positive during science operations under any expected thermal plasma density.
2. There is no spacecraft-driven requirement to measure or know the spacecraft potential, and measurement of the spacecraft potential is not a planned deliverable to the investigations. Any investigations that needs to know the spacecraft potential must identify that requirement (see draft GDC PEA Requirement TBD-16), and investigations that produce a spacecraft potential data product are responsible for including it in their data management plans (see draft GDC PEA Requirements TBD-3 and TBD-4).
3. There is no spacecraft-driven requirement to actively control the potential, and no active control of the spacecraft potential is planned. Any investigation that requires control of the potential of its instrument is responsible for providing that capability. Proposers should be aware that the GDC mission requires the operations of multiple, separate instruments and any instrument that interferes with the operation of other instruments may present an accommodation challenge (see Sections 2.6 and 7.2.1 of the draft GDC PEA).
4. It is expected that the spacecraft potential will reach values consistent with those of previous missions with good electrostatic control practices in low Earth orbit (a few tenths to a few volts negative, relative to the ambient plasma).

Answers #2 and #3 address knowledge of the spacecraft potential and control of the spacecraft potential, respectively. Instruments that require active control of the spacecraft potential or that may interfere with the operation of other instruments may be assessed to pose accommodation challenges (see Sections 2.6 and 7.2.1 of the draft GDC PEA).

5. Instruments that may interfere with the operation of other instruments may be assessed to pose accommodation challenges (see Sections 2.6 and 7.2.1 of the draft GDC PEA). Positive potentials create two issues: 1) distortion of potential fields near the spacecraft (which also occurs for negative potentials), and 2) the potential to attract electron currents which can drive the spacecraft potential negative.

T-12. The draft GDC PEA, in Table 2-2, states values for the expected maximum spacecraft resources for each instrument and overall payload. Those values may limit the type, number, and capability of potential instruments. Can the science payload and individual instruments exceed the listed values? This question is split between:

1. **Instrument accommodation resources (e.g., mass, volume, power)**
2. **Data rates**

As described in the draft GDC PEA, Section 2.6, the spacecraft resources were developed in NASA's pre-formulation implementation study, building off of the STDT report, based upon flight-heritage instruments to meet the measurement requirements (multiple instruments for each measurement) and spacecraft capabilities in-family with commercially available spacecraft buses. For the specific resources, the following sub-responses apply:

1. The resources identified in the draft GDC PEA are adequate to accommodate those example instruments. However, it is understood that those resources may not be adequate to accommodate all instruments capable of meeting the measurement requirements. As discussed in the draft GDC PEA, Sections 2.6 and 7.2.1, and the GDC PIP, Section 4.3, an instrument that would cause the entire payload to exceed the estimated spacecraft resources may be assessed as presenting a challenge for accommodation.
2. Investigations should identify their data rate requirements. These values were based on the pre-formulation implementation study and the predicted capacity of NASA's Near Earth Network.

T-13. The GDC PIP in Section 4.2 states that a 1.2m boom is expected to be furnished by the spacecraft, and then in GDC-PIP-4.2 states that proposals may encumber reserves for a boom longer than the anticipated 1.2m length. How will this boom be managed? Will the boom mass be counted with the investigation's resource requirements?

The boom will be managed as described in Section 4.2 of the GDC PIP. The boom mass will be managed by the Project Office and will not be counted with the investigation's resource requirements.

T-14. The GDC PIP in Section 4.2.10 states the expected limits on spacecraft-generated magnetic fields. Are those limits for the spacecraft alone or do they include expectations for the spacecraft-mounted instruments? If the former, are there magnetic cleanliness requirements from those expected limits that are levied on instruments?

The limits given in Section 4.2.10 are expectations for the magnetic field generated by the spacecraft and spacecraft-mounted instruments together. There is no magnetic cleanliness requirement levied on instruments, but instruments that produce a significant electromagnetic interference may be assessed as being a challenge to accommodate (GDC PEA, Section 2.6). As an early design phase activity, selected investigations will refine and implement magnetic cleanliness design mitigations and best practices (GDC PIP, Section 7.3).

T-15. Are expectations for the 1.2m spacecraft-furnished boom sufficient to provide additional characteristics and planning information? The questions are as follows:

1. **Will the boom be deployed? Will it be a rigid structure?**
2. **The PIP indicates an attitude knowledge (3-sigma) of 20 arc-sec and the answer to Q&A T-8 indicates an attitude knowledge to better than 0.02 degrees. What is the attitude knowledge accuracy at the end of the spacecraft-provided 1.2 m boom?**

For each of the questions, proposers should use the following information:

1. It will be a deployed, rigid boom.
2. Investigations may assume that, when the spacecraft is acquiring science data, the attitude knowledge at the end of the boom is 0.02 degrees.

T-16. The GDC PEA, in Table 2, gives maximum expected values for a single instrument and for the entire science payload. The values for the single instruments, if multiplied by the maximum number of expected instruments (Section 1.1), exceed the value for the entire science payload. Is it expected that not every instrument will require the maximum expected value given for a single instrument?

The values for a single instrument are the maximum values expected for any instrument in each of those categories. It is not expected that every instrument will require up to those values in each category. The entire payload is expected to have the listed maximum values, and no one instrument will exceed the single instrument values given for each category.

As discussed in the GDC PEA, Sections 2.6 and 7.2.1, and the GDC PIP, Section 4.3, an instrument that would cause the entire payload to exceed the estimated spacecraft resources may be assessed as presenting a challenge for accommodation.

Question T-12 provides additional information on the formulation of those values, and makes additional comments on the listed data rate.

Management and Schedule

M-1. The draft PEA, on page TBD-27, states that the formulation to delivery of the selected instruments will span the years of FY2021 to FY2025. Should proposers assume September 2021 as the start date of Phase A? If not, then what date should proposers assume as the start of Phase A? [Updated 8/20/21, shifting award start date following Amendment 1.]

The FY2021 was a typographical error and should have read FY2022. Proposals should assume ~~March 2022~~May 2022 as the start date of Phase A for the GDC science payload.

M-2. Does the expected payload delivery date start of ~~October 2025~~December 2025 include instrument schedule reserves? [Updated 7/13/2021, edited delivery start date to reflect date in Final PEA. Updated 8/20/21, edited delivery date to reflect date in Amendment 1.]

Yes.

M-3. The draft PIP gives in Figure 3-1 a notional schedule with key instrument development milestones, but lacks dates and a clear definition for when the decision for the number of GDC observatories will be made. Can that information be added?

The notional milestones for instrument development are provided in Table 10-1 of the GDC PIP. Updates and clarifications on anchoring milestones (e.g., decision on number of GDC observatories, instrument deliveries) will be provided in the final GDC PEA.

M-4. The GDC PEA in Requirement P-22 states that Notices of Intent shall include the entire proposal team, and the SALMON-3 AO in Section 4.2.5 states that replacement of Key Management Team members requires concurrence by NASA. However, certain proposal team members may still be under institutional workforce negotiation at the time of NOI submission. In these cases, what should the NOI contain?

The final GDC PEA in Section 6.1.2 (in the paragraphs following Requirement P-22) states that is it understood that some changes may need to be made between the NOI and the proposal submissions. Per the SALMON-3 AO (Section 2.4; Appendix B, Introduction), Section 6.1.2 in the GDC PEA takes precedence over related text in SALMON-3 for the

NOI.

NOIs should specify the proposer's current best estimate of the individuals that will fill those roles. In addition to notifying NASA of any changes in the NOI-submitted information as they are made (per Section 6.1.2), it would be helpful for NASA's planning purposes if the NOI abstract ended with a note identifying any proposal team members that may change before proposal submission.

M-5. Are proposals permitted to use the Project Scientist role?

No. Proposals are not permitted to use the Project Scientist role in order to avoid potential confusions with the GDC Project Scientist (a role filled by a NASA GSFC individual working for the GDC Project Office and independent of the GDC investigations). Proposals are permitted use the Instrument Scientist, Deputy PI, and task-specific Co-Is to properly manage their investigation teams.

M-6. How do the instrument development timelines map to the project development timeline? This question has the following specific sub-questions:

1. **Can instruments begin design and fabrication prior to mission KDP C?**
2. **Is the project's Phase C correctly placed in CY2024 and lagging the instrument development timeline?**
3. **How is the start of the project's Phase D coupled to the instruments' flight unit delivery schedules?**

The GDC PEA (and accompanying documents) deliberately do not provide a detailed project development timeline and do require that proposals describe the development timeline for their instruments to deliver the instrument flight units on schedule (GDC PEA Section 5.6; GDC PEA Requirement P-21; GDC PIP, Table 10-1). The GDC Project Office will work with selected investigations to ensure readiness for instrument lifecycle reviews and proper integration into the project development timeline.

The answers to the sub-questions are as follows:

1. It is expected that the instrument development activities will lead the project development timeline. This includes design and fabrication activities prior to mission KDP C.
2. Yes, per the above answer.
3. The start of the project's Phase D is not coupled to the delivery of the flight unit delivery schedules. The spacecraft development schedule will not be known until the spacecraft selection decision has been made. However, the intent is that the spacecraft will be prepared to integrate instruments as the latter are delivered.

M-7. What activities are investigations expected to plan in the direction to budget Phase D support during and following instrument deliveries (GDC PEA Section 5.5.1)? Will the

integration of instruments onto the GDC observatories begin only after the last flight unit is delivered?

The Phase D support activities include instrument I&T (GDC PIP Sections 8.1, 8.2) and post-delivery support (GDC PIP Sections 8.3, 8.4).

Instrument I&T begins when an investigation's first flight unit instrument is delivered and ends after its final flight unit completes observatory integration.

Post-delivery support begins when an investigation's first flight unit is delivered for observatory integration and ends after early orbit check-out (launch+3 months).

M-8. For the potential 7th and 8th instrument flight units (Requirement P-19), proposals must encumber reserves and must schedule for their delivery (Requirement P-21). How should information on the 7th and 8th flight units be presented in the proposal? What happens if delivery of the 7th or 8th flight unit requires additional delivery time beyond six months?

The encumbered reserves must be identified and justified in the proposal. The schedule impacts of the 7th and 8th flight units should be presented as a supplemental schedule, with identified and justified schedule impacts. The supplemental schedule should give an honest assessment of the impacts, including necessary extensions beyond the planned delivery window for the first 6 flight units.

The SALMON-3 AO does not require explicitly phasing information for encumbered reserves, but does require that cost estimates and schedules be adequately supported. It is the proposal's responsibility to meet that requirement and it is to the proposal's advantage to meet those requirements in a way that enables a reviewer to more easily understand the proposed investigation. Including a mapping to the instrument development timeline is one way that a proposal could contribute to achieving those ends.

As these are supplemental plans, it is expected that proposals will not go into the level of the detail used for the first six flight units or for the Integrated Master Schedule.

M-9. What should proposals assume for the instrument reviews? Will each review (ITRR, IPER, IPSR) contain one meeting for the flight unit and a shorter process for subsequent flight units (assuming no outstanding issues)? How long should be scheduled for each review?

Proposals should assume a half-day review for each flight unit. The initial reviews for the first flight unit will be half-day reviews. Reviews for the subsequent flight units should be shorter, but proposals should plan for the full half-day review in case issues remain or are realized.

M-10. The instrument development timeline is slightly aggressive in the early part of the mission (GDC PIP, Table 10-1). Is that timing for the instrument SRR (ISRR) correct? [Updated 7/28/2021, clarified Table 10-1 and references to instrument development timeline]

The timing for the ISRR in the PIP was not fully updated following continued Project Office work between the draft and the final PEA. The PIP (Rev C) has been published, with an update that 1) moves ISRR later by 2 months, 2) specifies when awards are expected (consistent with Q&A M-1), 3) adds the timing of selection, and 4) clarifies that dates are relative to instrument lifecycle reviews and not the project-level lifecycle reviews.

Cost

C-1. ~~The draft PEA, Requirement TBD-21 states that the proposals shall include pricing for the delivery of flight units for four additional GDC observatories. Is this for a total of 12 units or 10 units (baseline + 4)?~~ [Struckthrough 6/3/2021, removed option for twelve units in final PEA.]

~~Requirement TBD-21 states that the pricing "shall be for flight units outside of those for a constellation of eight (six planned and two potential additional) observatories". The four flight units added to the eight observatories totals twelve flight units.~~

C-2. How shall proposals provide the cost and schedule savings associated with providing only four instruments (the threshold mission)?

Proposals should include a descope plan towards the threshold that includes the cost and schedule savings associated with providing less than six flight units.

C-3. How will budgets be adjusted if there is a change in the number of spacecraft, such as a descope down to four or an increase up to eight or more? What assumptions should be made for when the decision about the number of flight units for delivery will be made? [Updated 6/3/2021, clarifying timing of decisions for budget estimates and removed option for more than eight flight units.]

Proposals should include a descope plan towards the threshold that includes the cost savings associated with providing fewer than six flight units. The encumbered reserves will be used for the potential seventh and eight flight units (Section 5.2.1, Section 5.5.1). ~~Flight units beyond eight flight units will be addressed by the additional pricing information, outside of the PIMMC (Section 5.5.1).~~ The decision on the number of GDC observatories is expected to be made early enough in Phase A/B to affect parts ordering (see the final GDC PEA for dates).

C-4. If a proposal has a total cost of less than $20M FY21, is the investigation responsible for using Earned Value Management (EVM)?

EVM and EVM reporting is a mission-level requirement that is applied to GDC per 7120.5E. While selected investigations will not be responsible for their own EVM reporting, they will be required to support the Project Office in fulfilling the mission's EVM requirements.

This investigation-level requirement is levied on all proposals, regardless of the investigation contract value (GDC PIP Requirement GDC-PIP-8.1; GDC-PYLD-CDRL-0002, PM-16).

C-5. The SALMON-3 AO, in Requirement 75, states that no more than 25% of the PIMMC shall be spent prior to KDP C. However, as the instrument development timelines is leading the project development timeline (e.g., Q&A M-6), should Requirement 75's reference to KDP C be understood to refer to the instrument PDR (IPDR)?

Yes, for investigations selected through the GDC PEA, Requirement 75 of the SALMON-3 AO refers to IPDR.

Proposal Evaluation

E-1. The Community Announcement (Acquisition Process, posted 1/12/21) states "Investigations must include a single instrument type and may not include an instrument suite. NASA will follow community standards for the identification of instrument suites, and proposals will need to convincingly show adherence to this requirement (as appropriate and necessary for each proposal)". What is the process that NASA will utilize for assessing whether an investigation has proposed a single instrument or an instrument suite?

A proposed investigation's adherence to this requirement will be assessed at multiple points in the proposal evaluation and selection process. This assessment will be based on the proposed design, any arguments offered by the proposal, and community standards.

- Notice of Intent (NOI) submissions
    - NASA will review NOIs for a description of the instrument system. Any proposer whose NOI appears to deviate from the single instrument requirement, I.e., describes an instrument suite, will receive a notification from NASA.
        - A notification would not prevent a proposer from submitting a full proposal that fulfills the single instrument requirement.

        - The lack of a notification would not constitute an affirmation that the proposed instrument system is not a suite.
    - NOI submitters that were deemed to deviate from the single instrument requirement may decide to split their instrument system to be submitted in multiple investigations (i.e., multiple proposals) . The initial single NOI will be taken by NASA to meet any NOI requirement for all resulting proposals.
- Full proposal submissions
    - NASA reserves the right to deem a proposal that includes an instrument suite as non-compliant and to return it without review.
- Proposal evaluation process
    - On the event that an Evaluation Panel deems that the proposal deviates from the single instrument requirement, the evaluation findings regarding an instrument system being an instrument suite will be communicated to the proposer during the Potential Major Weaknesses clarification process. Proposers will have the opportunity to respond to any such findings.
- Selection process
    - Affirmation of proposals adherence to the single instrument requirement (prohibition on instrument suites) will be part of the process that begins with the Categorization Committee and ends with the Selection Decision.

E-2. In light on the prohibition of an individual being a member of both a GDC investigation team and a GDC Interdisciplinary Scientist (IDS) team (draft GDC PEA, Section 4.2.2), what happens if a member of the investigation team is part of a selected IDS team? [Updated 3/9/21, clarified question and added reference to GDC PEA language.]

During the review process, the investigation will receive a Preliminary Major Weakness (PMW) due to that individual not being available to complete the assigned tasks. The investigation would then be able to respond to that finding within the PMW process.

E-3. The draft PEA states in Sections 1.1 and 7.2.1 that accommodations will be considered a programmatic factor, but states in Section 2.6 (and suggests in other sections) that instrument accommodation needs will be associated with a risk. Will accommodations also be considered as a review criterion? Given that the complete science payload will not yet have been selected, how can a proposed instrument be evaluated for risk against remaining resources that are not yet defined?

There are three aspects of the accommodation and each is addressed in a different manner. The PEA and PIP provides guidance based on pre-formulation work for all three aspects:

- NASA has identified likely design characteristics for the GDC observatories (Section 4 of the PIP). As part of Factor C-1 (Requirement TBD-1 of the draft PEA, Section 7.2.4 of the SALMON-3 AO), proposals will be evaluated on their adherence to those requirements. This evaluation will contribute to the proposal's Criterion C rating.

- NASA has identified potential instrument design characteristics that could create challenges for the instrument to be accommodated on the observatory (Section 4.3 of the PIP). Those will be will part of Criterion C (without contributing to the rating; Section 7.2.4 of the SALMON-3 AO) and the pre-selection accommodation study (Section 7.2.1 of the draft PEA).
- NASA has identified the likely resource envelope for the entire science payload. Optimizing the balance of payload performance and resource requirements will be part of the pre-selection accommodation study. This aspect is the same as for previous Focused and Partner Missions of Opportunity.

E-4. Under what evaluation criteria will the ability to deliver eight ~~(or twelve)~~ instruments be evaluated? [Updated 6/3/2021, followed removal of more than eight flight units from the final PEA.]

The draft PEA discusses in Section 7.1, *Scientific/Technical Evaluation Factors*, the addition of evaluation criterion Factor C-6, Adequacy and robustness of the instrument manufacturing plan. The description of that evaluation criterion reads "This factor includes the ability to build, test, and integrate the required number of flight instruments with repeatable quality and performance standards on the required schedule."

E-5. Will NASA request clarifications from proposers during the evaluation process, as discussed in Section 7.1.1 of the SALMON-3 AO? If so, there are several specific sub-questions that arise:

1. **How will the clarification process be conducted? How much time will proposers be given to respond to the request for clarification?**
2. **Will the clarification process include all weaknesses that may appear on the final evaluation?**
3. **Is it possible for proposals to receive new strengths and weaknesses that arise from material provided by proposers in the clarification process? If so, will proposers have an opportunity to clarify the weaknesses?**

NASA does expect to request clarifications from proposers during the evaluation process. The response to the specific sub-questions are as follows:

1. Details on the final clarification process, including the time that proposers will be given to respond will be published in the GDC PEA Evaluation Plan. The GDC PEA *may* use the clarification process being implemented for the EVM-3 AO (see Slides 46-51 of the EVM-3 AO Evaluation Plan), although perhaps in a modified form based upon EVM-3 lessons learned.
2. Not necessarily. It is possible for new weaknesses to be recognized during the evaluation process after the clarifications are requested.
3. Yes, it is possible. No, proposers will not receive an additional clarification request.

E-6. How does instrument heritage factor into the evaluation process? How do the evaluation and selection processes consider the trade-off between science and instrument heritage?

The evaluation of proposals is split into three parts:

- Form A examines how compelling the science investigation is.
- Form B examines how feasible it is for the science investigation to be completed with the technical implementation.
- Form C examines how feasible the technical implementation is.

The investigation science return is assessed in Form A and the instrument heritage is assessed in Form C. These forms are assessed independently, so the evaluation process does not consider the trade-off between science and instrument heritage. That trade-off is considered as part of the selection process (GDC PEA, Sections 1.1, 2.6, 7.2.1).

E-7. The GDC PEA, in Requirement P-2, states that proposals must include an Organizational Conflict of Interest Avoidance and Mitigation Plan (OCIAP). What is to be include in that Plan and how will it be evaluated?

The OCIAP must cover

- Both proposal development (past) and instrument development (future)
- Contracts and companies that were involved in the development of PEA requirements
- Actions to avoid and mitigate OCIs due to those contracts'/companies' involvement

Each Plan will be evaluated by NASA outside of Forms A, B, and C. This evaluation will not be included in the Preliminary Major Weakness process. Plans will be finalized, addressing any NASA-identified issues, and must be accepted before contract awards are put in place.

Proposal Submission

P-1. Is there a limit to the number of proposals that can be submitted by a single institution?

No, NASA does not intend to limit the number of proposals a single institution may submit.

P-2. The page limits for Sections D and E are discussed in the SALMON-3 AO (page B-2, the *Proposal Structure and Page Limits* table) and the GDC PEA (page P-37, the *Exceptions to General SALMON-3 Requirements* table; Requirement P-25). What is the total page limit for Sections D and E, specifically with regards to the following points:

- **SALMON-3 (page B-2) states 20 pages, +2 pages for SEO (if applicable) and +3 pages for TDO (if applicable)**
- **GDC PEA (Requirement P-25) states a page limit of 26 pages**
- **GDC PEA (Section 8.2) states +2 pages for science data management plans, including real time and software, and calibration plans**

Proposals to the GDC PEA have a Sections D and E page limit of 26 page before any potential additions (i.e., SEO, TDO). This does include the +2 pages science data management plans and calibration plans. Section 8.2 states an expectation that at least 2 pages would be dedicated to science data management plans, including real time and software, and calibration plans in Sections D and E.

The GDC PEA states in Section 5.2.5 that SEOs are not applicable to any proposal, so the +2 pages for an SEO identified in the SALMON-3 AO are not granted.

If a proposal does include a TDO, the +3 pages identified in the SALMON-3 AO are granted (for a total of 29 pages).

P-3. The GDC PEA (Section 6.2.2) requires that the proposal and relevant files be submitted through Box by the submission due date. How do we submit those documents via Box?

Box is a file transfer application that is new to SMD AOs. Instructions are currently being generated using the new NASA policies, and NOI submitters will receive a copy of that document when it is completed. It will be sent sufficiently ahead of the due date for proposers to verify that they can use the application.

Other

O-1. If a selected investigation's instrument is descoped from the observatories, will the investigation team remain on the GDC science team? If an investigation's instrument provides only a secondary Physical Parameter, does a proposal need to provide a Threshold Investigation?

NASA evaluates each descope individually and makes a decision appropriate for that particular situation. If a proposal does not provide a Threshold Investigation, it will be in violation of Requirements TBD-10 and -12. If a proposal does not provide a compelling Threshold Investigation, it is likely to be assigned a higher Category (see Section 7.1.2 of the SALMON-3 AO).

O-2. Typographic issues were identified in the PEA and associated documentation. There include:

- **The draft PEA references "Section 0" in certain places.**

- **The draft PEA, Section 1.1, has the sentence "Proposed investigations will be evaluated and selected through a single step competitive process (Section 2.5)." but Section 2.5 discusses the GDC Project Teams.**
- **The draft PEA, Section 8.2, seems to indicate an additional 2 pages for science data management plans, but neither Requirement 5 nor Requirement 27 address this.**

These typographic issues will be fixed in the final PEA. For clarity before the final release, those resolutions include:

- The reference to (the non-existent) Section 0 should be to Section 9.
- The reference to Section 2.5 should be to Section 3.
- The two additional pages are included in Requirement TBD-27.

O-3. The draft GDC PEA, in Requirement TBD-14, requires proposals to put in Section E the instrument information that the SALMON-3 AO, Requirements B-27 and B-28, requires proposals to put in Section F. Does the PEA Requirement supersede SALMON-3 Requirements such that that information is not required in Section F for GDC proposals?

Yes, as stated in Section 2.4 of the SALMON-3 AO, "A PEA may contain deviations or exceptions from SALMON-3 standard requirements; any such deviations or exceptions will take precedence over their corresponding requirements in the main body or other appendixes of the SALMON-3 AO".

O-4. Will descope options be determined after investigations are selected, and is it likely that the descope options include the reduction to the threshold implementation of four spacecraft?

The descope options for instruments include performance degradation and descoping from observatory payloads; the descope options for the project include descoping instruments and reducing the number of observatories. There are currently no assumptions or expectations about which descope options would be exercised and in which order.