A.28 ADVANCED COMPONENT TECHNOLOGY PROGRAM

1. Scope of Program

1.1 Introduction

Proposers interested in submitting in response to this program element are encouraged to also read Appendix A.1 for an overview of the Earth-Sun System Division (ESSD) research program.

The ESSD was formed as part of the NASA transformation in the summer of 2004, and incorporates the former Office of Earth Science and the Sun-Earth Connection theme of the former Office of Space Science. The scientific documentation underlying these two programs provides a comprehensive documentation of the science addressing these programmatic components while integrated scientific planning for the newly-formed ESSD is underway. Proposers may find more information about ESSD by going to http://science.hq.nasa.gov.

1.1.1 Earth Science

NASA Earth scientists continue to focus on understanding and protecting our home planet by using our view from space to study the Earth system and improve predictions of Earth system change. By working with domestic and international partners, Earth Scientists provide accurate objective scientific data and analyses, to advance our understanding of Earth system processes and help policy makers and citizens achieve economic growth and effective, responsible stewardship of Earth's resources. The Earth Science research program aims to acquire deeper scientific understanding of the components of the Earth system, their interactions, and the consequences of change in Earth system for life. The interactions occur on a continuum of spatial and temporal scales ranging from short-term weather to long-term climate and motions of the Earth, and from local and regional to global.

The frontiers of Earth system science are to: (i) explore interactions among the major components of the Earth system, namely, the continents, oceans, atmosphere, ice, and life, (ii) distinguish natural from human-induced causes of change, and (iii) understand and predict the consequences of change. NASA has established six scientific focus areas for these complex processes: Atmospheric Composition, Carbon Cycle and Ecosystems, Climate Variability and Change, Earth Surface and Interior, Water and Energy Cycle, and Weather.

1.1.2 Sun-Solar System Connection

The Sun-Solar System Connection (S^3C) science program supports investigations of the Sun and planetary space environments, including the origin, evolution, and interaction of space plasmas and electromagnetic fields in the heliosphere and in connection with the galaxy. Understanding the origin and nature of solar activity and its effect on the space

environment of the Earth is a particular focus. The traditional S^3C discipline interests have been:

> Solar and Heliospheric Physics, which treats the Sun as a typical dwarf star, as the dominant, time-varying source of energy, plasma, and energetic particles in the Solar System (especially concerning its influence on the Earth) and the origin and behavior of the solar wind, energetic particles, and magnetic fields in the heliosphere and their interaction with the interstellar medium; and
>
> Geospace Science, which treats the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles (the Earth's magnetosphere is emphasized, but studies of the magnetospheres of planets, comets, and other primordial bodies are also supported); and the physics of the mesosphere, thermosphere, ionosphere, and auroras of the Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

1.2 Advanced Component Technology (ACT) Program

The objectives of the ACT Program are to research, develop, and demonstrate component and subsystem level technology developments that:

- Reduce the risk, cost, size, and development time for ESSD observing instrument and platforms, and
- Enable new ESSD observation measurements.

The program brings instrument and platform components to a maturity level that allows their integration into other NASA technology development programs such as the Instrument Incubator Program (IIP). Some components are directly infused into mission designs by NASA flight projects. Other components "graduate" to other technology development programs for further development. Within this development environment, the ACT Program can rely upon other NASA and external technology programs for very low technology readiness and complementary advanced instrument components and subsystems, and the IIP for technology infusion opportunities.

Technology Readiness Level (TRL) is a systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology (see section 2.2 below for TRL definitions). Figure 1 shows the Technology Readiness Levels for these programs and future ESSD missions.

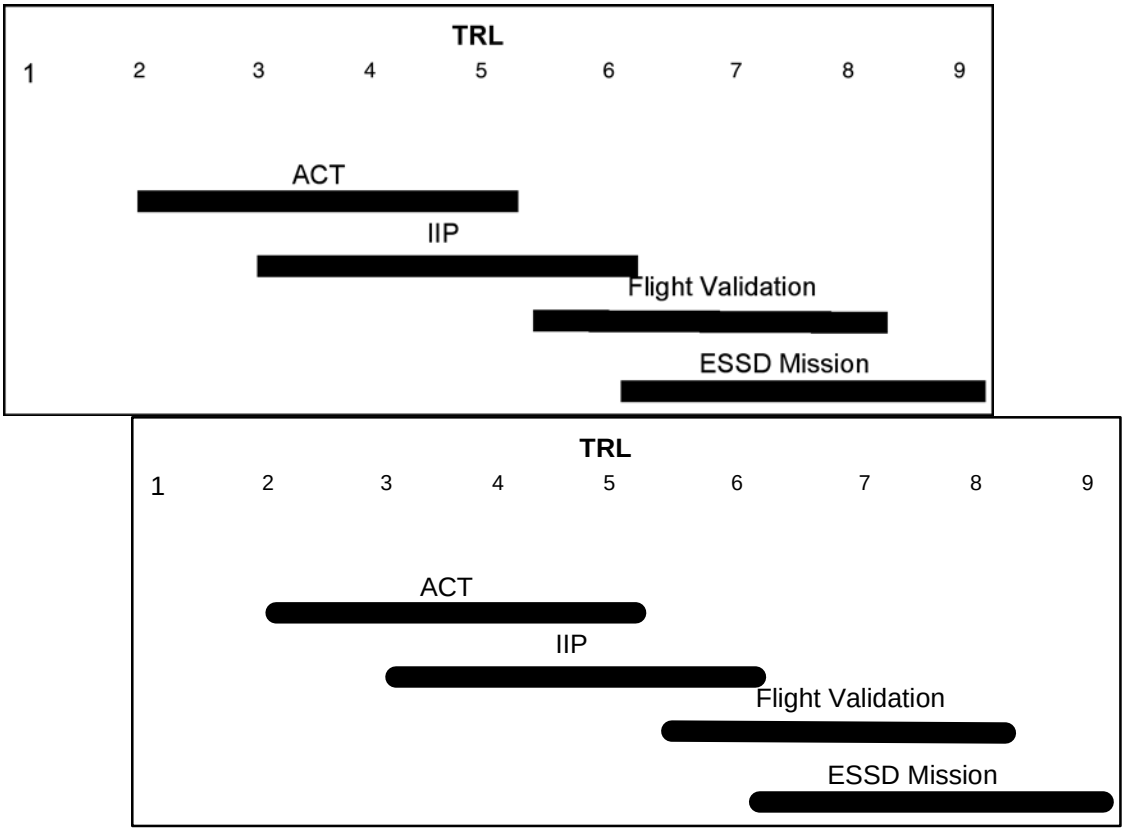

Figure 1. TRL Ranges for NASA Technology Development Programs & ESSD Missions.

1.3 Technologies Sought

The ACT program is envisioned to be flexible enough to accept technology developments at various stages of maturity, and through appropriate risk reduction activities (such as requirements analysis, conceptual design, laboratory breadboards, and pre-engineering models), advance the TRL of the component or subsystem. The proposer must define the starting point for the component and subsystem technology or measurement technique and the exit or success criteria for the proposal activity. The results at the exit point must provide convincing evidence that the component or subsystem can make the proposed measurement and can be integrated into an on-going technology development program for infusion into an instrument design.

Priority for selection is given to those proposals that most clearly demonstrate the potential for making significant contributions in these component and subsystem technology areas:

- In the areas of S^3C *in situ* measurements, highly compact instrument electronics are important for multi-spacecraft missions and low power electronics are sought for spacecraft subsystems.

- In the area of S^3C remote sensing instrumentation, investments in large format, fast read out, array detectors and light weight, precision optics and coatings have the largest payoff. Of these two technology developments the detector array devices have the most benefit and are of highest priority.

- In the area of active microwave antennas for Earth Science instruments, lightweight, large antenna structure technologies, deployable and inflatable technologies, reflector and phased array structure technologies, and adaptive waveform sensing and correction technologies yield the highest return. Low cost phase array technologies and multiple beam technologies also provide medium payoff.

- In the area of passive microwave antennas for Earth Science instruments, lightweight, low insertion loss array feeds, lightweight structures and structural elements and active and passive feeds/systems technologies provide the highest return on investment. Antenna metrology, trade studies (e.g., spinning vs. non-spinning real aperture) and thermal control technologies provide medium return.

- In the area of active electronics for Earth Science instruments, large aperture Synthetic Aperture Radar (SAR) technologies focusing on electronics for lightweight, electronically-scanned array (ESA), particularly L-band and Ku-band, provide the highest returns. Highest priority technologies in this area are transmit/receive (T/R) modules, rad-hard, low power chirp generators and digital receivers, components required for wavefront sensing and control, and lightweight, reliable signal distribution. Ku, Ka-band interferometer technologies focusing on developing electronics for phase-stable ESA also provide high returns. Millimeter wave ESA (Ka, W, G-band) technologies benefit single-pass interferometer missions and atmospheric radar missions. Technology priorities are phase stable T/R modules and Monolithic Microwave Integrated Circuits (MMIC) devices.

- In the area of passive electronics for Earth Science instruments, MMIC/Miniature plus low mass/power radiometers, Micro-Electromechanical System (MEMS) filters and radio frequency (RF) switches, and analog radio frequency interference (RFI) mitigation technology provide the highest return. Calibration subsystems for correlation radiometers, on-board RF signal distribution, combined active/passive system design, 3- and 4-Stokes polarimetric receiver design, and ultrastable low loss radiometers provide the next highest return. High frequency low noise amplifiers (LNAs) operating at frequencies higher than 160 GHz, local oscillator sources operating at frequencies higher than 50 GHz, down conversion techniques operating at frequencies higher than 900 GHz, and mmW/smmW detectors provide medium return.

2. Programmatic Information

This solicitation provides additional details governing the proposed activities that supersede the general guidelines announced in the *Summary of Solicitation* of this NRA.

2.1 Proposal Content and Submission

2.1.1 Proposal Content

The Project Description must include the following content information in subsections that use the same titles. Failure to provide any of this material may be a cause for the proposal being judged as non-compliant and returned without further review.

1. Applicability to ESSD Measurements – Describe the benefits to future Earth Science or S^3C measurements that could utilize the proposed component of subsystem technology.

2. Description of Proposed Technology – Provide a description of the proposed component or subsystem level technology. Describe the technical approach and include an operational concept or use scenario of the proposed technology that addresses ESSD needs. Discuss any possible commercial benefits.

3. Comparative Technology Assessment – Describe the anticipated advantages of this component or subsystem level technology compared to those currently in use - e.g., reduction of size, mass, power, volume or cost, improved performance, or enabling of a new capability not previously possible. Review the current state of the art and relate to the proposed work.

4. TRL Assessment – Provide the current TRL assessment of the component technology and the anticipated progression of TRL levels throughout the proposed effort (see Section 2.2 below for guidance on Technology Readiness Levels). All TRL assessments must be substantiated.

5. Research Management Plan – Provide a statement-of-work that concisely describes each task or milestone to be accomplished in the course of the research and development. Define the success criteria associated with each task or milestone. Also, include a milestone chart that identifies critical dates in the research and development program. At least two milestones per 12 month period must be defined; the first midway and the second near the end of the period. Identify the roles of key personnel.

6. Quad Chart: Provide a quad chart that contains the following information:
   (a) First Quadrant: Include a visual, graphic, or other pertinent information of the proposed component or subsystem level technology;
   (b) Second Quadrant: "Description and Objectives" – provide a short summary of the design and measurement approach;

(c) Third Quadrant: "Approach" and "Co-Is/Partners"; and
(d) Fourth Quadrant: "Schedule and Deliverables" and "Applications/Mission" provide a summary of a few key deliverables (final designs, hardware completion, major tests, etc.) and identify potential future applications/measurements or missions for which the proposed instrument would be applicable.

.
Subcontracting portions of the research project is acceptable.

2.1.2 Proposal Submission

A printed, signed, original of the entire proposal, five hard copies, and a magnetic or optical disk containing a softcopy of the proposal submitted via the postal service or equivalent means constitutes the proposal submission.

2.2 Proposal Technology Readiness Level (TRL) Requirement

For this solicitation, the entry TRL shall be 2 or greater. The proposer shall identify the entry TRL, the planned exit TRL, and success criteria in their proposal. Past and ongoing work on the research activity should determine the entry TRL; the proposer shall substantiate the entry TRL in the proposal.

The proposal shall demonstrate at least one TRL advancement over the duration of the research; if the proposal duration for more than a year, one TRL advancement per year is desirable.

DEFINITION OF TECHNOLOGY READINESS LEVELS

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

2.3 Period of Performance

The minimum period of performance is 12 months. The total proposed period of performance must not exceed 36 months. The Government will award grants, cooperative agreements or contracts for a 1-year base period, with up to two 1-year options exercisable by the Government. Grants and cooperative agreements are subject to annual reviews according to the criteria specified in the *NASA Grant and Cooperative Agreement Handbook* (14 CFR 1260). Contracts are subject to bi-annually and bimonthly reporting. Proposals must define clear, measurable achievements for each year of performance.

2.4 Proposal Funding

The funding available for each solicitation under this solicitation will limit the number and magnitude of the proposals awarded. The Earth Science Technology Office (ESTO) expects that a total of 5 to 10 proposals will be awarded, with values in the approximate range of $150to $300K per year per award.

Note: The *NASA Grants and Cooperative Agreement Handbook*, Section A, 1260.4 (b), specifies that awards to commercial firms via grants and cooperative agreements require 50% cost sharing when the commercial firm is expected to receive substantial compensating benefits for performance of the work.

2.5 Evaluation Criteria

Proposers are reminded that the evaluation criteria for this solicitation are given in the *NASA Guidebook for Proposers* (Appendix C, Section C.2).

The first criterion, relevance to NASA's objectives, includes the applicability of the proposed investigation to ESSD Measurements and Technology Needs (40% of total evaluation weight) and specifically includes the following factors:

1. The proposal's relevance and potential contribution to NASA's Earth-Sun System Division research.
2. The potential for component or subsystem level technology development to reduce the risk, cost, size, and development time of ESSD instruments, or to enable a new measurement that cannot now be made. Potential cost reductions should be clearly stated and substantiated to the extent possible, with supporting analysis that indicates scalability.
3. The potential of the component or subsystem level technology to be integrated, once matured, into an ESSD instrument system.
4. The potential for the component or subsystem level technology development to have commercial benefits.

The second criterion, intrinsic merit, includes the technical merit of the proposed investigation (30% of total evaluation weight) and specifically includes the following factors:

1. Feasibility and merit of the proposed technical approach to achieve the technology development objectives.
2. Degree of innovation of the proposed study or technology development concepts and approach.
3. Substantiated justification and appropriateness of the entry and exit technology readiness level (TRL).

The third criterion, cost and programmatic realism (30% of total evaluation weight) specifically includes the following factors:

1. Adequacy and realism of proposed milestones.
2. Realism and reasonableness of the proposed cost, and comparison of costs to available funds.
3. Adherence to sound and consistent management practices appropriate to the TRL level of the proposed task.
3. Past performance and related experience in the proposed area of technology development.
4. Qualifications of key personnel, and adequacy of facilities, staff, and equipment to support the proposed activity.
5. Commitment of the organization's management to the proposed technology development (evidenced by cost and resource sharing, prior teaming arrangements, etc.). Proposers should identify any previous investment by the organization/program and provide supporting documentation.

2.6 Technical Reporting Requirements

The following deliverables shall be required of awarded proposals. In cases where subcontract arrangements exist, consolidated project reports are the responsibility of the PI. In this context, "Annual" refers to a twelve-month task effort that commences at award.

I. Initial Plans and Reports

Within 15 days of award, the awardee shall upload the Research Management Plan, initial Quad Chart and initial TRL assessment to the ESTO e-Book. Access the e-Book website at https://esto.reisys.com/esto/.

The Quad Chart shall contain the following information:

First Quadrant: A visual, graphic, or other pertinent information
Second Quadrant: "Description and Objectives"
Third Quadrant: "Approach" and "Co-Is/Partners"

Fourth Quadrant: "Schedule and Deliverables", "Applications/Missions", and "Entry TRL".

The Quad Chart shall be updated at least annually, more often if appropriate. An initial TRL assessment, and the basis for that assessment, shall be provided for the critical technology developments of the activity. The TRL assessment shall be updated at least annually, more often if appropriate.

II. Monthly financial reports (Required for contract awards only):

The following shall be included in the monthly financial reports:

A. Summarize planned vs. actuals: The monthly financial report shall show the planned versus actual obligations and costs for the preceding month and explain any deviations from the plan. Include work that has been completed and cost incurred from the project (should be traceable to the schedule).

B. Summarize procurements: The PI shall report the status of major procurements that have been incurred to date.

C. Format: Monthly financial reports may be submitted in Microsoft Excel compatible formats.

D. Due date: The financial report shall be submitted to the ESTO Financial Manager by the 10th of. the month or the close of business of the first workday following the 10th if the 10th is on a weekend or a federal holiday.

If a fixed price contract is awarded, no financial reporting is required.

III. Quarterly Technical Reports

The quarterly technical report shall focus on the preceding three month's efforts. Each report shall address:

A. Technical status: The awardee shall summarize accomplishments for the preceding three months, including technical accomplishments (trade study results, requirements analysis, design, etc.), technology development results, and results of tests and/or demonstrations.

B. Schedule status: The awardee shall address the status of major tasks and the variance from planned versus actual schedule, including tasks completed, tasks in process, tasks expected to complete later than planned, and tasks that are delayed in starting, with rationale for each, and recovery plans as appropriate.

Technical Reports shall be uploaded quarterly to the appropriate location in the ESTO e-Book for the subject mini-solicitation. Reports shall be submitted in PDF, Microsoft Word or PowerPoint compatible formats by the 10th of the required month, or the close of

business of the first workday following the 10th if the 10th is on a weekend or a holiday. A teleconference or brief meeting may be conducted between the ESTO and the awardee to review and discuss each report

IV. Interim Review

For activities equal to or greater than 12 months in duration, the awardee shall provide an Interim Review at the end of the first 6-month calendar period, commencing from the date of award. The awardee must provide a presentation summarizing the work accomplished and results leading up to this Interim Review and must:

A. Describe the primary findings, technology development results, and technical status, e.g. status of elements, construction of breadboards or prototype implementations, results of tests and/or proof-of-concept demonstrations, etc.

B. Describe the work planned for the remainder of the project and critical issues that need to be resolved to successfully complete the remaining planned work.

C. Summarize the cost and schedule status of the project, including any schedule slippage/acceleration. A schedule milestone chart of all major task activities shall be created and maintained and shown at all reviews. A cost data sheet shall be created and maintained, showing total project costs committed, obligated, and costed, along with a graphical representation of the project cost run outs.

The ESTO will conduct the Interim Review via teleconference. The presentation provided at the review will constitute the Interim Report. The presentation shall be uploaded to the appropriate location in the ESTO e-Book at least two (2) working days prior to the review.

V. Annual or Final Review

For activities equal to or greater than 18 months, the awardee shall provide an Annual Review at the end of the first 12-month calendar period, commencing from the date of award, and a Final Review at the completion of the activity. For activities shorter than 18 months, the awardee shall provide a single Final Review. The awardee shall provide a review summarizing the work accomplished and anticipated results at the end of the task. Each review must include:

A. A description of the work accomplished and the results leading up to this review.

B. A summary of the primary findings, technology development results, and technical status, e.g., status of elements, construction of breadboards or prototyping implementations, results of tests and/or demonstrations, etc. The PI may provide a laboratory demonstration, if appropriate, to show technical results and status.

C. A summary of the cost and schedule status of the project *since inception*.

D. The Final Review must provide conclusions of the work performed and make recommendations for follow-on activities that should be pursued, with estimates of the cost and schedule to achieve TRL 7 (see Appendix F for TRL definitions).

The ESTO will conduct the review at the PI's facility, or a mutually agreed to location, with length of presentation tailored, as appropriate, depending on the amount of work to be discussed. The Annual or Final Review should be comprehensive, and should include a discussion of the planned content of the written report. In addition to hard copy handouts at the review, the review package shall be uploaded to the appropriate location in the ESTO e-Book at least two (2) working days prior to the review.

VI. Annual or Final Report

The Annual or Final Report shall include the following:

A. Results of all analyses, element, subsystem, or system designs, breadboards and/or prototyping implementations and designs.

B. Performance analysis results of tests and/or demonstrations; estimation of reduction(s) in size, mass, power, volume and/or cost; improved performance; description of newly enabled capability; and documentation of technology dependencies.

C. Tables, graphs, diagrams, curves, sketches, photographs and drawings in sufficient detail to comprehensively explain the results achieved.

D. An updated TRL assessment, including a rough order of magnitude cost and a description and estimate of the duration of the follow-on activities necessary to achieve TRL 7.

E. Updated Quad Chart.

F. At the end of the period of performance, the awardee shall provide a final Accomplishments Quad Chart which contains the following information:

First Quadrant: A visual, graphic, or other pertinent information
Second Quadrant: "Description and Objectives"
Third Quadrant: "Accomplishments"
Fourth Quadrant: "Milestone Schedule", "Entry TRL", and "Exit TRL".

The Annual or Final Report, updated Quad Chart or Accomplishments Quad Chart, and updated TRL assessment shall be uploaded to the appropriate locations in the ESTO e-Book within 10 days of the review.

VII. Annual Technology Conference

If held, the awardee is encouraged to participate in an annual technology conference. The Technology Conference is an opportunity for NASA planners, managers, technologists and scientists to review the research funded by the Earth Science Technology Office. It is also an opportunity for researchers from NASA, academia and industry to meet with their peers and to better understand NASA Earth Science and Sun-Solar System Connection requirements. Travel expenses for non-government participants will be provided to those awardees selected to participate. Therefore, no costs for participation in the conference should be included in the proposal. If selected for participation in the conference, the awardee should be prepared to make a presentation, provide a paper, or create a poster providing a description of the project, the objectives, approach, technical status, and schedule information.

2.7 Demonstration of Relevance to NASA's Objectives

Proposals for all of NASA sponsored research programs are judged on three criteria: Scientific and technical merit of the proposed work, cost realism and reasonableness, and relevance of the proposed work to NASA missions and science goals (see also Appendix C of the *Guidebook for Proposers Responding to NASA Research Announcement – 2005* at http://www.hq.nasa.gov/office/procurement/nraguidebook/). To enable the NASA Science Mission Directorate to properly evaluate the relevance of proposals submitted to its programs, as well as track its progress toward achieving its goals as mandated by the Government Performance Review Act (GPRA), it is mandatory that all research supported by NASA's programs demonstrate its relationship to NASA strategic goals and/or science objectives as stated in the latest version of its Strategic Plan; see the discussion in Section I(a) of the *Summary of Solicitation* of this NRA. Therefore, in addition to addressing the specific goals of this program, all proposers must provide as expository text in the main body of their proposal a statement of the relevance of their proposed work to NASA's *Strategic Objectives* given in Table 1 in the *Summary of Solicitation* of this NRA. This discussion need not exceed the order of a quarter page of text and is to be included in the introduction to the Science-Technical-Management section of proposal.

Note that this NRA references NASA's 2005 strategic objectives (see Section I(a) and Table 1 for references).

2.8 Summary of Key Information

Expected total program budget for new awards	~ $10 M (Section 2.4 above)
Number of new awards pending adequate proposals of merit	~ 5-10 (Section 2.4 above)
Maximum duration of awards	Minimum 1-year / Maximum 3-year awards

Page length for the central Science-Technical-Management section of proposal	15 pp; see also Chapter 2 of *Guidebook for Proposers Responding to NASA Research Announcement – 2005*
Submission medium and number of copies	Hard copy (5 copies plus signed original) and a magnetic or optical disk containing a softcopy (see Section 2.1.2 above); see also Chapter 3 of *Guidebook for Proposers Responding to NASA Research Announcement – 2005*
NASA Strategic Objectives to which proposals to this program must state and demonstrate relevance	See Table 1 in the *Summary of Solicitation* of this NRA.
General information and overview of this solicitation	See *Summary of Solicitation* of this NRA.
Detailed instructions for the preparation and submission of proposals	*Guidebook for Proposers Responding to NASA Research Announcement – 2005* at http://www.hq.nasa.gov/office/procurement/nraguidebook/.
Web site for submission of proposal Cover Page:	URL: http://nspires.nasaprs.com (help desk available at nspires-help@nasaprs.com or (202) 479-9376)
Due Date for Notice of Intent to Propose	See Tables 2 or 3 in *Summary of Solicitation* of this NRA.
Due Date for delivery of proposals	See Tables 2 or 3 in *Summary of Solicitation* of this NRA.
Address for the delivery of proposals	Advanced Component Technology Program ROSES-2005 NRA Science Mission Directorate NASA Peer Review Services Suite 200 500 E Street, SW Washington, DC 20024 Telephone: (202) 479-9030
Point of contact concerning this program	Janice L. Buckner Earth Science Technology Office Code 407 NASA Goddard Space Flight Center Greenbelt, MD 20771 Telephone: (301) 286-0171 E-mail: Janice.L.Buckner@nasa.gov