Strategic Investments: an Integral Component to Achieving Our Mission

Overview of Goddard Space Flight Center's Vital Strategic Investment Process

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GSFC Invests for the Future in Order to:

Enable GSFC to Meet New Technological & Scientific Challenges

Significantly Reduce Mission Risk or Costs

Make GSFC More Competitive in Securing Targeted Opportunities

Provide Unique Technology Capabilities for Science & Exploration

Win External Funding for Technology or Mission Development

Overview of GSFC Strategic Investments

- **GSFC's R&D investments align with capability leadership and agency goals.**
  - GSFC is principally a science center with the thrust of its charter being to "provide scientific research, technology and missions that transform our knowledge of Earth and space".
  - GSFC fulfills this charge by fully engaging the science communities both as a collaborator and also as a strong competitor with our vision fixed on the goal of scientific progress.
  - One aspect of that engagement is competing for the latest state of the art instruments and scientific space flight missions.
  - GSFC invests internally to ensure that we can provide the community with the most relevant and impactful missions and instruments to advance science.

Overview of GSFC Strategic Investments

- **GSFC's strategic business development process facilitates communication and collaboration** between the Center's internal organizations, and prioritizes Center Investment resource allocations. *The goal is to maximize ROI supporting the strategic objectives of the Center.*

- The business model is structured around the Center's primary and enabling Lines of Business (LOBs).
  - GSFC's LOBs represent the areas in which the Center is expected to play a leadership role for the Agency, and the areas in which the Center has unique core competencies or capability leadership.

- The Center business capture processes and activities target both competed and directed opportunities. These activities includes:
  - annual development and prioritization of strategic goals and objectives
  - responding to identified opportunities
  - guiding Center investments which sustain and enhance our capabilities and readiness for new opportunities
  - routine mechanisms to communicate status and resolve issues related to business capture.

Overview of GSFC Strategic Investments

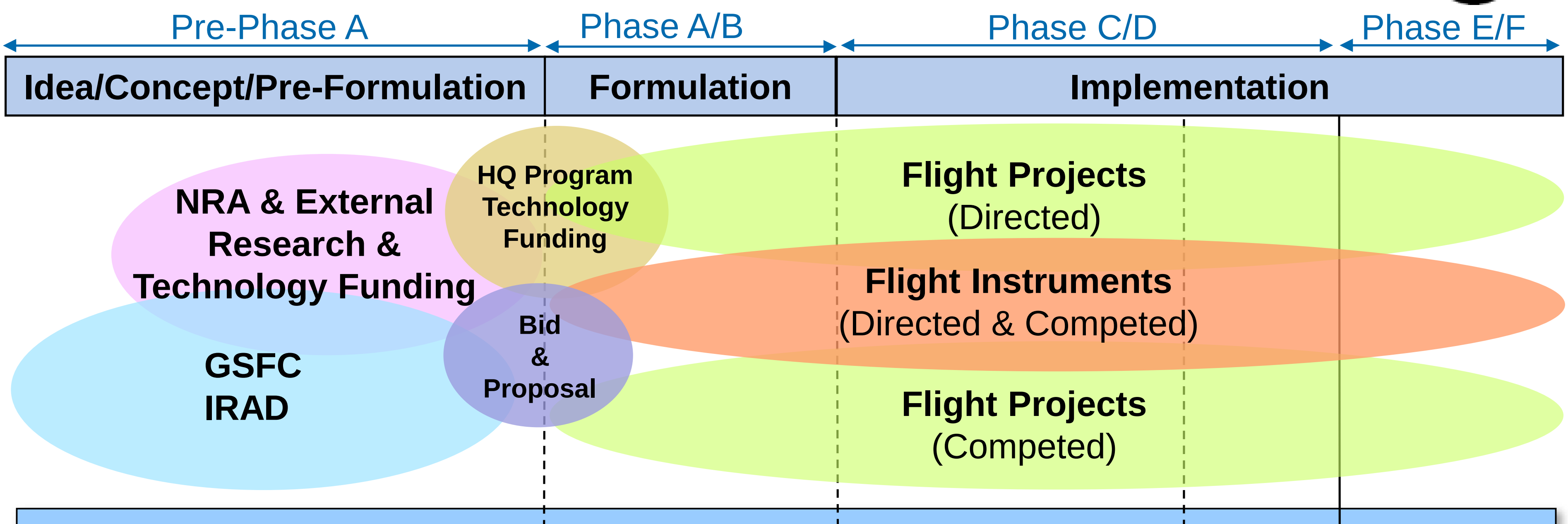
- **To enable an external partnerships**, we identify Goddard-unique capabilities to complement the unique roles of the external partner.
  - As an example, internal investment funds developed an innovative and never-before-used lunar-resonant orbit for the competitively selected TESS Mission in the SMD Explorers Program.
- **To leverage a sponsored investment**, which we understand as a down-stream partner/stakeholder investment or a non-assigned, mission-specific investment by an external organization, we occasionally provide institutional cost share for proposals when required.
  - Examples include the NASA Astrobiology Institute Cooperative Agreement Notice (CAN) and the Hands-On Project Experience (HOPE) training opportunity.

Internal Research and Development

Internal Research and Development (IRAD) is:

- **Used for developing technologies needed to reduce risk or demonstrate technology readiness**, not for the full lifecycle technology development.
- **Focused on enabling science missions** and instrumentation research & development.
- **Used to pursue low-TRL technology of interest**.
  Past examples of low-TRL investments that led to implementation include H2RG detectors, GMSEC, nanosensors, and SpaceCube.
- **Not used to keep a particular capability whole**, but for core capability enhancement/advancement or related R&D that leads to follow-on funding or infusion.
- Used to keep practitioners **focused on next generation capabilities** to maintain competitive advantage in core competency areas.
- **Used to enable an external partnership**.
  There are many examples where GSFC successfully leveraged IRAD resources with external organizations with no exchange of funds and both sides directly and measurably benefited from the collaborations. One example is the Core Flight Executive work with both APL and JSC.

Center Investment Life Cycle



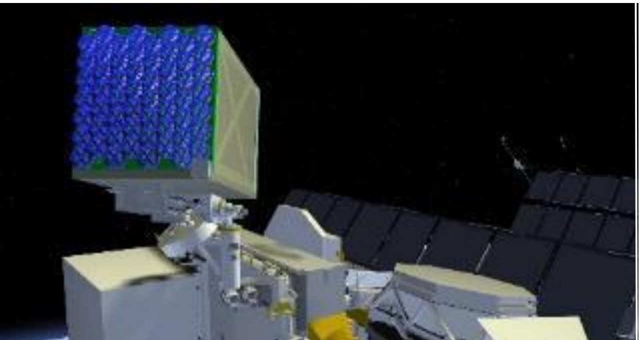
Internal Research And Development (IRAD) provides <u>seed funds</u> for:

- Applied Research
- Technology Development
- Systems & Other Concept Formulation Studies
- Risk reduction activities (technology maturation, concept development, architecture studies)

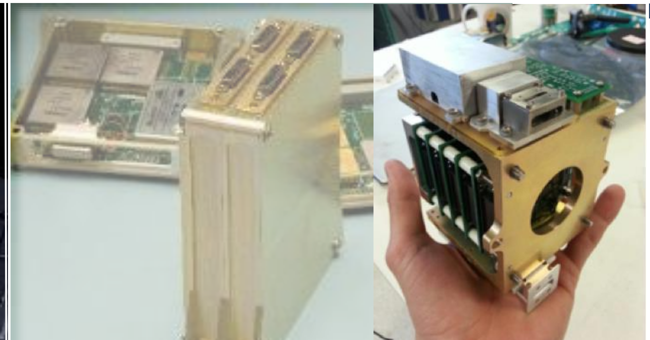
Bid and Proposal (B&P) provides funds for:

- Line of Business Investment Planning and Management
- Research, Analysis & Technology Proposal Development
- Mission & Instrument Concept & Proposal Development
- Expenses incurred in preparing, submitting, and supporting bids & proposals for potential new work (competed and directed).

Success Stories



NICER/SEXTANT – x-ray navigation (or pulsar navigation) algorithms, soft x-ray concentrators

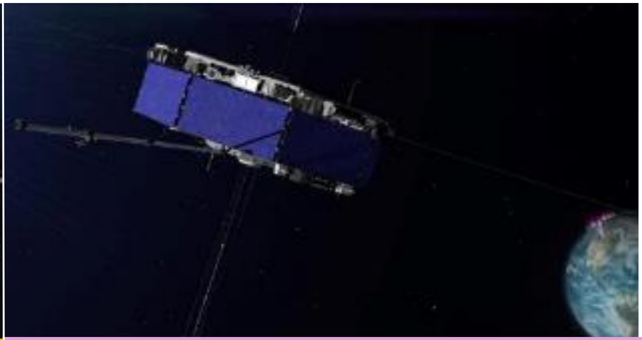


CubeSat technologies – Ion and Neutral mass Spectrometer, microwave radiometer, processors, etc.

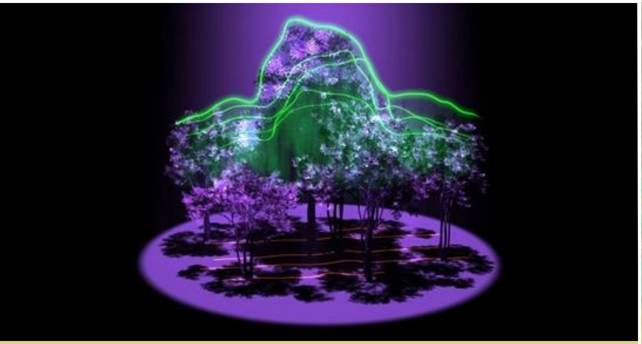
LLCD/LCRD – photon counting detectors, precise pointing (attitude control)

OSIRIS REx - OSIRIS risk reduction

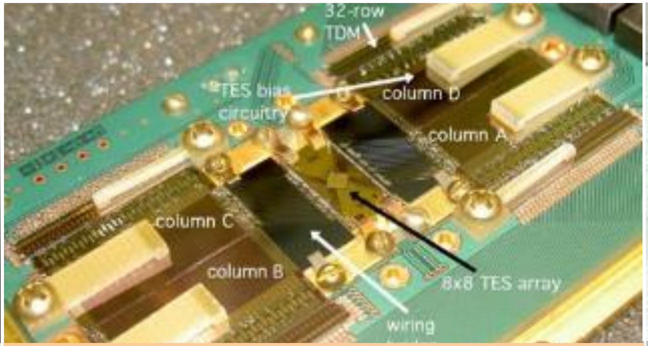
TESS – never-before-used lunar-resonant orbit development



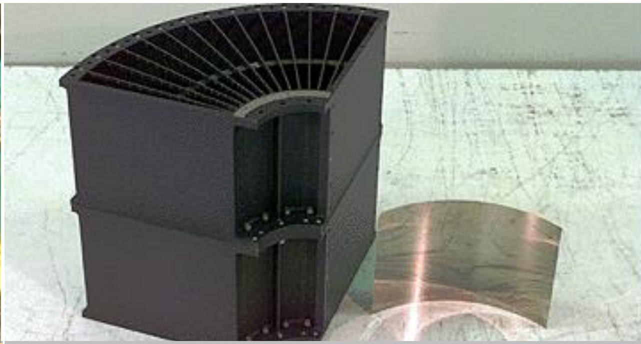
MMS – data compression, Goddard Enhanced On-board Navigation System, new S-band comms antenna



GEDI – lidar to study Earth's carbon cycle and biodiversity



X-Ray Microcalorimeter Technology – for Constellation X, IXO, Astro E, Suzaku, and Astro-H



NuSTAR – thin x-ray mirror fabrication and alignment

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DAVINCI – A Competed Mission Success Story

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http://www.nasa.gov/goddard

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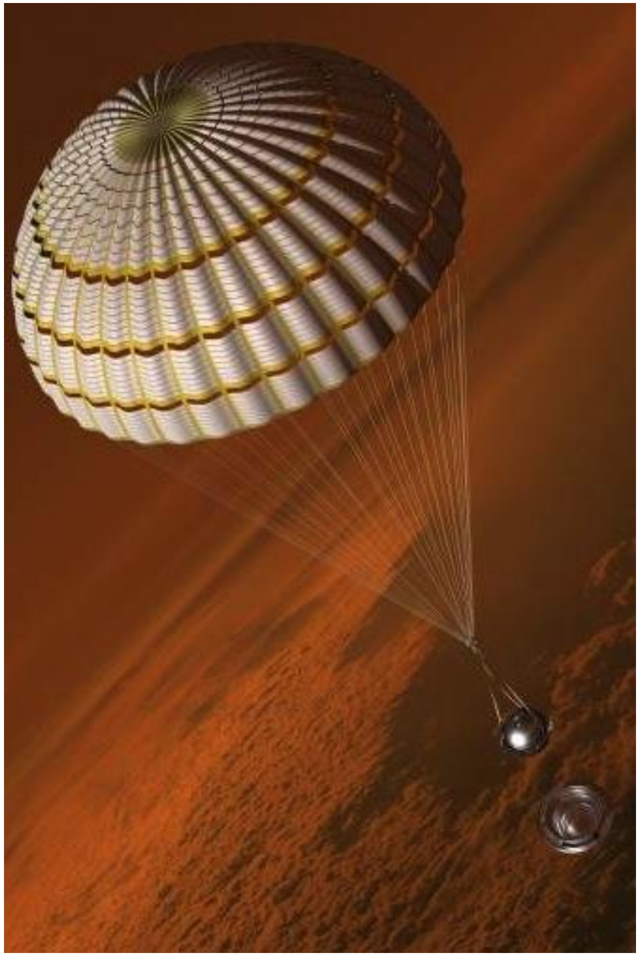
“Failure is not an Option”

- Competition ensures a broad canvas of the community for innovative ideas.
- NASA Discovery Missions cost >$450M; NASA New Frontiers Missions cost >$850M.
  - These are risky ventures to new and hostile environments.
- DAVINCI plans to drop a probe to the surface of Venus, collecting and returning data throughout its 63 minute descent.
  - The Venus environment consists mainly of carbon dioxide with clouds of sulfuric acid. The surface temperature is 863° F, and its atmospheric pressure is 90 times that of earth.
- In order to get selected, we must convince NASA Headquarters that this investment has a high likelihood of success.



Persistent Technology Investment Leads to Success

- In order to achieve challenging mission objectives, each project needs innovative technology. The earliest step in mission formulation is development and validation of the individual technologies needed.
  - New/improved instruments and subsystem components (i.e.. communication, thermal, detector, optics, avionics…) must be demonstrated to work in their intended environment.

- DAVINCI technology development started in 2007 with numerous individual investments (IRAD, SBIR, NIAC, PICASSO, MATISSE, …) to develop and demonstrate the most challenging mission elements.

The Long Road to Success

- Once all of the pieces are mature enough, the team will develop the full mission concept (including schedule & budget) and propose it.
  - It is unusual for these types of proposals to be selected on the first try. Most teams spend 4-6 months intensely developing a proposal for the mission concept, receive feedback, and try again at least once - and sometimes many times…
  - Each time the concept is re-proposed it becomes more mature and ready for substantial NASA investment.
  - Each proposal requires substantial investment from all partners.

- The DAVINCI concept was initially proposed for a New Frontiers AO in 2009, then Discovery 2010, and then Discovery 2014 when it finally was selected to move to Phase A and compete with 4 other concepts.
  - The team will now spend the next year bringing the concept to the maturity required at the end of Phase A.
  - The funding provided by Headquarters for Phase A is roughly ¼ of what is needed. The rest is provided through Center B&P and Partner investment funding.

Competition Leads to Excellence

- These missions are challenging, and quite literally push the edge of technology.
- Each element must be the best.
  - Selections are made to maximize technical capability and maturity and minimize resource utilization (mass, power, and cost)
- Each selection is unique. Our partner on one proposal may be our competitor on another.

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JWST: A Directed Mission Success Story

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JWST Competitions, GSFC leadership

- By 1995, GSFC-led astronauts had repaired defective Hubble and data were spectacular
- AURA committee wrote “HST and Beyond”, asked for >4m IR telescope, technology for exoplanets
- HQ assigned study to GSFC in 1995, with instruction to develop multi-center and international partnership including STScI. GSFC is effectively the Prime Contractor.
- Major early contributions from MSFC (optics) and JPL (in-flight focusing)
- GSFC job initially: negotiate partnerships, complete mission definition (with a HQ appointed science team), technology definition, manage competitions for 10 major technology developments (mirrors delegated to MSFC) and observatory contractor, provide expert guidance to contractors (aka, back them up when they fail)

JWST Competitions, GSFC leadership

- GSFC instrument module: we're in charge of the whole thing, mechanical, thermal, electrical, procuring the US part, defining interfaces for international parts, preparing US contributions to international instruments (detectors, microshutters), integrating, testing, delivering to attach to the telescope
- GSFC job later: make it work! Includes detailed oversight of contractors, management of changes, budgeting, scheduling, technical reviewing, risk analysis (especially single-point failures), planning test program
- GSFC job now: put it together! (telescope + instrument module here), take it to JSC and test it. Make sure EVERY item is OK, overseeing observatory contractor (NGAS), all instrument teams
- GSFC job future: oversee contract to Operations Center (STScI), which operates observatory, manages scientific proposal selection, processes data, prepares info for public distribution

A 30+ Year Investment Strategy Success Story

1980s

1980s Informal designs for non-cryogenically cooled space observatory to follow ESA's Infrared Space Observatory (ROE)

Cryogenic capabilities developed on IRAD and funded activities to develop both active and passive cooling techniques.

1989 POIROT (ROE proposal to ESA M2)

1989 "The Next Generation Space Telescope" Conference (STScI) discussion of multiple options for post-HST/SIRTF missions

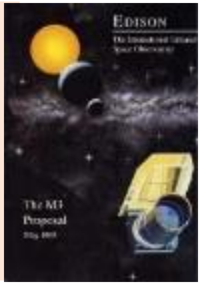
GSFC-funded science team and engineering team support in the late 1980s to develop concepts for the then Next Generation Space Telescope

Funded selected technology capabilities from IRAD for detectors, coolers, and teaming

1990s

1993 *Edison* (RAL/UWyo proposal to ESA M3)

1994 HIGH-Z (STScI proposal to NASA

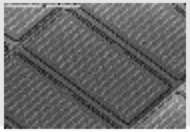


1995/96 AURA study, "HST and Beyond" (The Dressler Committee) recommends 4 m IR observatory

1996 Goldin's challenge to <u>double</u> the diameter of Dressler recommendation

1997 NASA HQ funds three design studies of ~8 m IR observatory (studies managed by GSFC; teams were GSFC, TRW, LM)

Late 1990s GSFC IRAD (and other) funds detector development, microshutter, etc.



Partnerships with ESA, and industry, to develop the technologies. GSFC funded studies in the 1990s to develop concepts for NGST

2000s

Early 2000s discussions in greater depth with international partners

2001 NRC Decadal Survey recommends 8 m IR telescope as highest priority next major space mission

2002 NGST re-named after former NASA Administrator James Webb

2003 NASA launches *Spitzer*

Utilized industry, Air Force funds to develop mirror technologies.

2003 JWST descoped to 6.5m

2004 HQ chose JWST with GSFC lead Center, Northrop Grumman prime contractor

2008 Confirmation Review

2010s

2011. Replan (NASA budget now $8.7 billion and 2018 launch date). GSFC assumes responsibility for systems engineering.