Gravitational Waves Architecting Study

Study Overview

Ken Anderson (Study Manager) and Tuck Stebbins (Study Scientist)

GW Study Overview Outline

- Study Objectives
- Study Participants
- Roles and Responsibilities
- Role of CST
- Schedule

Study Objectives

- **Objectives (as stated by PCOS office)**
  - Determine the range of LISA science objectives that can be achieved at a variety of lower cost points
  - Explore mission architectures and technical solutions that are fundamentally different from the heritage designs
  - Fully engage the community and ensure that all voices are heard, all perspectives considered
  - Create data for a report to the CAA that describes options for science return at multiple cost points for Gravitational Wave astronomy
- **Deliver final report to NASA HQ that**
  - Describes and analyzes trade space of science return vs. mission cost
  - Summarizes the mission concepts developed during the study and how they relate to the trade space and other mission concepts that were not developed in a design lab
  - Summarizes the RFI responses and the workshop and describes how they were folded into the whole study

Approach

- Execute a concept study to map the trade space of science return versus mission cost. Study plan designed to encourage broad community participation and innovation

- Major Study Elements:
  - **Request for Information (RFI)**: broadly solicit ideas related to missions. Release through NSPIRES.
  - **Community Science Team (CST)**: Select ~10 members of the community to serve as the science team for the study.
  - **Workshop**: host an open workshop where the work to be done is vetted through the community
  - **Notional Missions**: Define up to three mission concepts at different cost points
  - **Design Labs**: Study team develops concepts through mission design lab runs. Lab focus is on identifying the technical and cost drivers of each concept.
  - **Final Report:** Summarizes study activities and results for HQ and CAA

Study Participants

- **Study Manager** – Ken Anderson (GSFC), Steve Benner (Deputy, GSFC)
- **Study Scientist** – Tuck Stebbins (GSFC)
- **Core Team** –
  - Science:
    - GSFC: Jeff Livas, John Baker, Jordan Camp, Ira Thorpe
    - JPL: Curt Cutler, Michele Vallisneri, Bill Klipstein, Bob Spero, Glenn De Vine, Kirk McKenzie, Brent Ware
    - Universities: Guido Mueller (Florida), Pete Bender (Colorado)
  - Engineering:
    - GSFC: Ed Brinker, Steve Leete, Gary Welter, Rob Gallagher, Babak Saif,
    - JPL: John Ziemer
- **Community Science Team**
- **Support & oversight from:**
  - PCOS Program Office (GSFC)
  - NASA HQ: Wilt Sanders, Rita Sambruna (PCOS Program Scientist), Jaya Bajpayee (PCOS Program Executive), Bill Danchi

Roles, Responsibilities, Authority: Study Team

- **Study Team**: Study Manager, Study Scientist, Core Team, Community Science Team (CST), some additional engineers as budget allows (e.g., staff from design labs), PO/ACTO support staff
- Responsibility and Authority for implementing the study resides with the Study Manager in consultation with the Study Scientist
- **Study manager** receives this study plan, budget, schedule and has authority to make changes that do not compromise the objectives of the study (comparable to Level 1 requirements) or affect top level budget or due date of final report.
  - Delivers detailed, specific study plan
  - Primary POC and interface with ACTO, PO and HQ (as needed)
  - Manages the Study Team (CST + Core Team)
  - Manages each design lab run
  - Manages the workshop
  - Manages the analysis, writing, and delivery of the final report
- **Study scientist** is responsible for all science aspects of the study and is the primary point of contact for the CST and the broader community
  - Manages the science team (Core + CST), defining and ensuring delivery of all science products
  - CST: Ex officio member; works in consultation with the CST Chair to define objectives and deliverables, supports the work to ensure delivery
  - Workshop: Host and primary responsibility for content
  - Responsible for science content of design lab runs
  - Manages all science analyses and input to the final report
  - Primary POC for all communication with the broader science community

Community Science Team (CST)

- **CST Description**: The Study Team is comprised of the Core Team and the CST. The CST participates in the full study process, analyzing RFI responses, organizing and participating in the workshop, determining concepts to study, participating in design lab runs, and writing final reports.
- **Purpose**: Engage new stakeholders and new approaches, encourage the incorporation of new ideas into the study
- **CST Roles:**
  - Evaluate the RFI responses for the degree to which they allow fulfillment of the LISA science objectives, and technical readiness
  - Assist in the organization of and participate in a concept study workshop
  - Based on input from the RFI and workshop, identify a small number (≤3) of concepts for further study
  - Participate in the mission studies, including potential involvement in the mission design laboratory activities
  - Participate in the writing of a report summarizing the study findings and present the report to NASA and the CAA

Boundary Conditions

- The basis for discussion and selection of concepts for further study is the degree of compliance with LISA objectives, as endorsed by NWNH
- We are **NOT** revisiting decadal survey decisions regarding science questions or mission priorities
- We are studying *representative* missions for the various cost classes. The goal is to assess the fraction of LISA science that can be performed vs. mission cost. There are no winning or losing concepts.
  - The workshop is NOT selecting candidate missions
    - Selection by the workshop does not indicate the mission will happen, nor does non-selection imply the mission will not happen
- No recommendation for a specific mission or a preferred cost class will be given in the final report
- External constraints (e.g., NGO) will need to be taken into consideration

Workshop

- **Purpose**: Provides the community an opportunity to comment on the study and shape the missions that will be developed in design labs. Also provides a forum for discussion and exchanging information between the study team and the community.
- **Description**: 2-day workshop, 20-21 December at Maritime Institute, Linthicum, MD
  - Planned by Study Team
  - Presentations by RFI respondents
  - Open to community (assume ~100 attendees)
  - Tentative agenda to be distributed

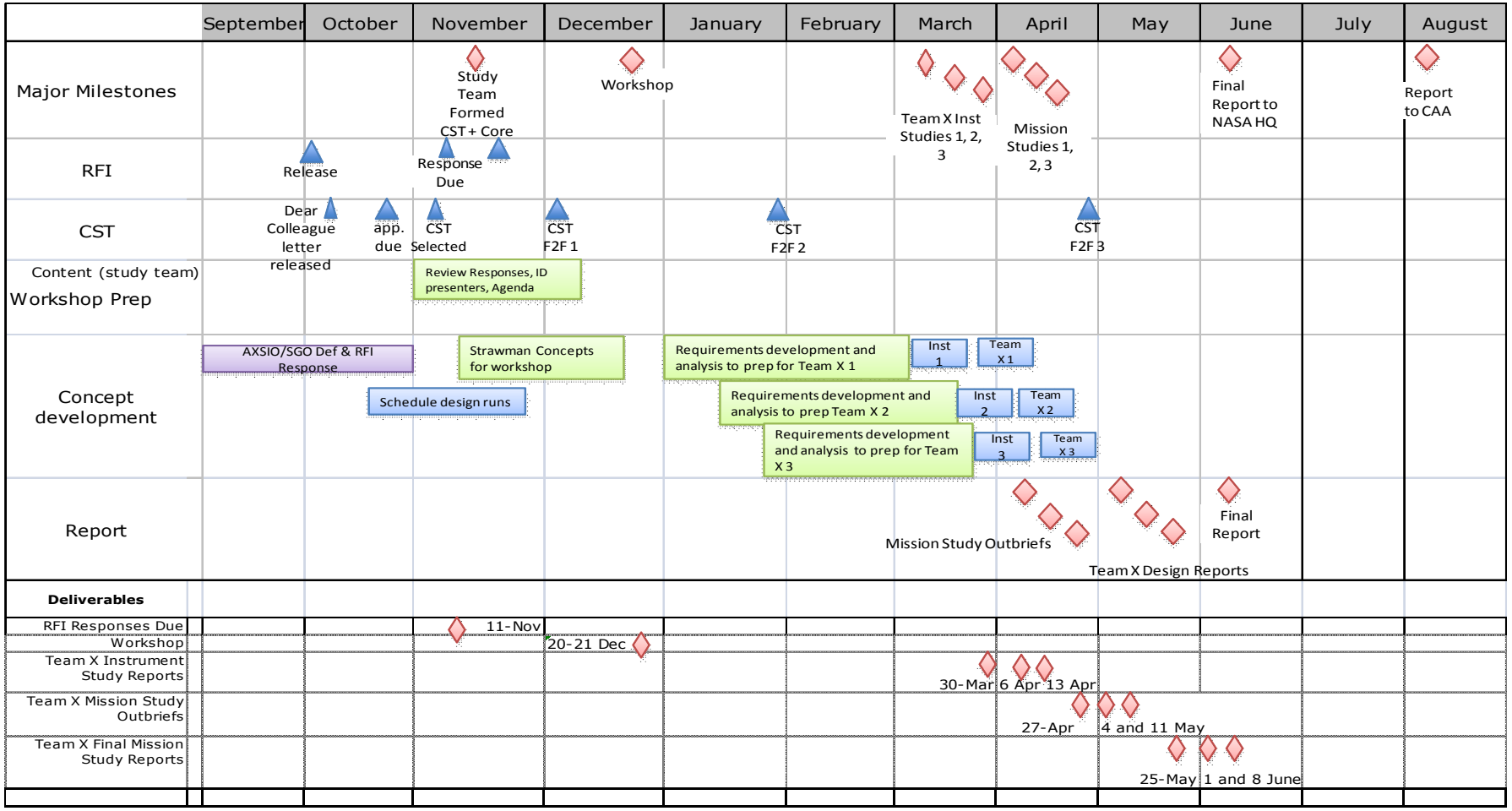
Design Lab Runs (Team X at JPL)

- **Description:** The Team X design lab runs provide the bulk of study data. Study Team develops NM concepts through mission design lab runs. Lab focus: identifying the technical and cost drivers for each concept.
- **Lab Input and Output**:
  - **Intake:** Package that defines mission objectives, requirements, constraints, operations, and payload elements to the greatest detail possible.
  - **Output**: Each lab run produces list of drivers relevant to the trade space, a mission concept (may not close on solution) of sufficient resolution to understand the drivers for the trade space, cost products and ~200 pages of presentation material and design package.
- **Tasks** Study Team January - April 2012
  - Prepare input package (each run) defining mission objectives, requirements, constraints, risks, operations and payload elements to the greatest detail possible
  - Pre-brief one week before design lab run
  - Spend one week in design lab performing all trades and making all decisions needed to close on a functional design if possible. If not possible, make assumptions that allow team to discover main drivers for that case with respect to trade space. Final products lab usually received ~4 weeks after run.
  - Review lab run and findings and identify any lessons that apply to the next lab run in the queue
  - Draft summary report on each design lab run

Final Report

- **Description:** The final product of the study is a report that:
  - Describes and analyzes the trade space of science return vs. mission cost
  - Summarizes the mission concepts developed during the study and how they relate to the trade space and other mission concepts that were not developed in a design lab.
  - Identifies key technologies, summarizes current state, and degree of development needed
  - Summarizes the RFI responses and the workshop and describes how they were folded into the whole study
- **Tasks:** Study Team March – June 2012
  - Outline the final report
  - Draft and review summary report for each design lab run
  - Review RFI responses and Workshop summary for any additional information and connections to the lessons from the design labs
  - Analyze all data and map the trade space of science return versus mission cost. Identify major drivers, break points and broader connections and conclusions.
  - Draft final report and deliver to HQ for review **June 7**
  - Report to CAA (format and due date TBD)

Schedule



Note: schedule for a single study; PO will be running two simultaneously

Implementation Challenges

- Aggressive workshop schedule
  - CST has two weeks to review RFI responses, and plan the workshop
- Aggressive final report schedule
  - Schedule shows less than 6 weeks between the end of the last design lab and the report due date
  - Team will have to sketch the outline of the final report before starting the labs and press hard afterwards
- Aggressive Design Labs Schedule
  - A single team completing (up to) three labs in four months will be brutal
  - Schedule required because design lab runs are "garbage-in, garbage-out"
    - Meaningful products out of a design lab requires meaningful input material at kickoff. A team requires two (to six) months to prepare input package
    - NM suite defined at the Workshop => 4 months total to develop the input packages for (up to) 3 design lab runs, run them, and summarize the results. Leaves 1 month to write final report
- The engineering team performing this work is small, constrained by the FTEs allocated to the Core Teams
  - The combined effects of the team size and schedule mean that the deliverables will be lower fidelity than the schedule alone implies

Technology

- RFI called for responses regarding enabling technology
- Nothing specific in charter about how to address technology input
- Use technology responses to:
  - Inform discussion about notional missions
  - Provide input to NASA about key areas to be addressed through PCOS funding
  - Identify in final report key technology areas where support needed for short and long term needs