

# The NASA-DOE Joint Dark Energy Mission (JDEM) A Dark Energy Science Investigation

## A Joint NASA-DOE Proposal

Note: This strawman plan is the result of discussions between the NASA Office of Space Science and the DOE Office of Science. It forms the starting point for ongoing discussions and further definition.

### **Basic Principals**

- Both NASA and DOE have made the nature of dark energy a high priority science objective.
- Precision measurements require a dedicated mission. A space based dedicated dark energy investigation requires a space observatory with a telescope and appropriate focal plane instruments.
- NASA brings to the NASA/DOE partnership its successful experience in developing space observatories and space based science investigations. Proven processes for developing space observatories will be used to ensure the success of the joint mission.
- DOE brings to the NASA/DOE partnership its successful experience in science investigations of fundamental physics conducted by PI-led collaborations. Through it's broad mission to understand the basic laws of matter, energy, space, and time, DOE has invested in the development of technology that could be used in a space based dark energy investigation.
- The Joint Dark Energy Mission will be a joint mission between NASA and DOE.
- The dark energy science investigation will be a PI-led effort.
- The dark energy science investigation is the joint responsibility of DOE and NASA.
- NASA is responsible for the overall success of the space mission.
- Competitive selection will be used to the maximum extent practical, in full support of the President's Management Agenda. All competitions will be open.

### **Components of the Joint Mission**

- The Joint Dark Energy Mission will be a joint mission between NASA and DOE.
  - A joint mission means that NASA and DOE will together take responsibility for policy decisions, management reviews, providing the required resources, meeting the challenges that arise, and solving the inevitable problems.
- The Joint Dark Energy Mission will be an observatory containing a telescope and appropriate focal plane instruments.
  - This is justified by the results of NASA's open solicitation for space-based mission concepts to determine the nature of dark energy. It is supported by the recommendations of the NRC Committee on the Physics of the Universe (the "Turner Committee"), by the Astronomy and Astrophysics Advisory Committee (AAAC), and the National Science and Technology Council's Interagency Working Group on the Physics of the Universe.

- The first ~3 years of the mission will be dedicated to a dark energy science investigation. The remainder of the mission will be used for general astronomical observations selected through an open, peer-reviewed competition.
- A joint oversight group (JOG) between NASA Headquarters and DOE Headquarters will provide mission oversight. NASA will retain responsibility and authority for ensuring the successful development of the mission within the guidelines set by the JOG.
- Overall project management will be at a NASA center. The appropriate NASA center will be identified through established NASA processes.
  - The designated NASA center will be responsible for overall project management including procurement of a prime contractor (a spacecraft, integration and test of the observatory, launch services, etc.).
  - If required, the NASA center will issue the RFP for the prime contractor. DOE may appoint civil servant(s) to the source evaluation board (SEB).
- Science oversight of the Joint Dark Energy Mission will be by a science oversight group (SOG). The SOG is responsible to the agencies and to the community for ensuring the scientific success of the mission; this includes both the dark energy investigation and the general astronomical observatory.
  - A strawman list of SOG members includes: Mission scientist (SOG chair), NASA project scientist, DOE project scientist, PI of dark energy investigation, observatory scientist, and 4-6 interdisciplinary scientists (IDS's). IDS's will bring expertise from a broad range of the science community, including dark energy, theory, and other communities that will be served by the JDEM.
  - NASA and DOE will each appoint a project scientist to the SOG.
  - All other members will be selected through the joint NASA/DOE Announcement of Opportunity (AO).
- The dark energy science investigation is the centerpiece of the Joint Dark Energy Mission.
  - A joint NASA/DOE AO will solicit a dark energy science investigation requiring a space-based observatory.
  - The dark energy science investigation will be a PI-led investigation. The selected PI will be fully responsible for the success of his/her science investigation. A successful proposer will have to provide the science payload necessary to realize his/her proposed investigation, conduct the science investigation using the data acquired during the dark energy phase of the mission, as well as assemble the science team necessary to realize these goals.
  - The primary criterion for selection of a dark energy science investigation will be the scientific merit of the proposed dark energy science investigation and the merit of the proposed implementation approach.
  - A secondary criterion will be the ability of the proposed science payload to support a vigorous general observer (GO) program in the general astronomical observatory phase of the mission.
  - Whether the telescope is managed as part of the science payload, and therefore the responsibility of the dark energy science investigation PI, or is managed by the JDEM project office will be determined through appropriate trade studies.

- A science support and mission operations center will be established to operate the Joint Dark Energy Mission through all phases of the mission.
  - The management of the science support and mission operations center remains TBD. This center could be established by sole sourcing it to an existing science support and mission operations center or it could be selected through competition.
  - During the dark energy phase of the mission, the selected dark energy team will be responsible for providing the observing priorities and working with the science support and mission operations center to carry out the proposed observing program. During the general astronomical observatory phase of the mission, the observing priorities will be set by the selected general observer proposals.
- All data will be archived in an established astrophysics data archive. All data will be made public after an appropriate proprietary data period.
  - Data required for the dark energy science investigation (as defined in the dark energy science investigation proposal) and acquired during the dark energy phase of the mission will be proprietary to the dark energy science investigation team for an appropriate period of time (6 months) following the end of the dark energy phase of the mission.
  - All data acquired during the dark energy phase of the mission that is not required for the dark energy investigation will be made public immediately (or as soon as practical,).
  - All data obtained during the general astronomical observing phase of the mission will remain proprietary to the selected General Observer for 1 year before being made public.
  - A vigorous archival data analysis program, which provides opportunities for analysis of archival JDEM data through peer reviewed competition, will be included in the mission.
- The JDEM project will have a vigorous Education and Public Outreach program.

### **Descriptions of envisioned competitions**

- The joint NASA/DOE AO.
  - The AO will be jointly issued by NASA and DOE. The peer review will be jointly managed by NASA and DOE. The selection will be jointly made by NASA and DOE. The selected investigations will be jointly funded by NASA and DOE.
  - The AO will solicit (i) the dark energy science investigation which includes provision of the required science payload, determining the observing program during the dark energy phase of the mission, proprietary rights to the data required to carry out the dark energy science investigation, analysis of the required data, and publication of the results in the refereed literature; (ii) science investigations and project contributions by identified members of the SOG such as mission scientist, observatory scientist; (iii) science investigations by IDS members of the SOG.
  - The primary criterion for selection of a dark energy science investigation will be the scientific merit of the proposed dark energy science investigation and the merit of the proposed implementation approach. A secondary criterion will be the

- ability of the proposed science payload to support a vigorous general observer program in the general astronomical observatory phase of the mission.
- Allocation of funding responsibility must be accompanied by a joint management plan that includes (a) empowering the Joint Dark Energy Mission project manager's ability to manage the entire project including the dark energy science investigation and (b) protocols and policies for handling cost and schedule issues.
  - The NASA issued RFP for a prime contractor, unless the spacecraft can be acquired through the Rapid Spacecraft Development Office catalog.
    - NASA will solicit a prime contractor to perform the usual prime contractor functions for a space observatory including providing a spacecraft and I&T of the observatory.
    - NASA civil servants will serve on the Source Evaluation Board (SEB). DOE may provide DOE civil servants to the SEB.
  - The joint call for general observer proposals.
    - During the general astronomical observing phase of the mission, a Call for Proposals (CfP) will be issued. This CfP may be issued by the operations center or by NASA and DOE, depending on the nature of the tasks contracted to the operations center. (The current mode is for the operations center to handle this as is done for HST, CXO, and SIRTf.)
    - If the selected dark energy science investigation proposes GO opportunities during the dark energy phase of the mission, then there would also be CfP's during that phase.
    - Archival analysis proposals would also be handled through the CfP.
  - (Possible) NASA or NASA/DOE issued RFP for the science support and mission operations center.
    - This RFP would solicit a center to provide all science support and mission operations functions including science planning, command load generation, management of satellite communications, flight operations, data capture and level 0 processing, pipeline processing for archiving, conduct of general observer programs, etc.

### Next Steps

- Near term:
  - NASA and DOE brief communities on the JDEM plan.
  - NASA will select mission concept study investigations after consultation with DOE.
  - NASA will discuss the JDEM plan with the Beyond Einstein Program Office in order to apply appropriate engineering resources to pre-planning the space mission.
- Mid term:
  - Form a science definition team (SDT) for JDEM. The purpose of the SDT is to establish the science requirements for JDEM that will be used to frame the AO. For example: JDEM must determine parameters ( $w$ ,  $w'$ ,  $\Omega_\Lambda$ , etc) to a given accuracy. The SDT will debate whether these requirements are written in terms of science (like parameter accuracy) or capability (like a particular photometric

- accuracy). The SDT will also determine what precursor knowledge is required to validate potential dark energy methods.
- The SDT will include the PI's in NASA's selected mission concepts and DOE's selected studies. NASA and DOE will also issue a joint "Dear Colleague" letter for additional members that the agencies will select together. The SDT would have, perhaps, 20-25 members.
  - In anticipation of a new initiative:
    - NASA will form a pre-project study office within the Beyond Einstein Program Office to turn these paper plans into real plans.
    - NASA and DOE will form a pre-JOG and start negotiating appropriate management plans, etc., in anticipation of an MOU.

### **Strawman assignment of funding responsibility**

- JDEM budget requirements will be discussed assuming full cost budgeting, accounting, and reporting.
- NASA will fund NASA center managed activities (project management, prime contractor, launch services).
- NASA and DOE will both fund the dark energy science investigation including development of the science payload, obtaining and analyzing the required science data, and communicating the results to the science community through publication in the peer reviewed science literature.
- NASA and DOE will fund the science support and mission operations center.
- NASA will fund a general observer (GO) program.
- NASA will continue to fund an (existing) data archive to include Joint Dark Energy Mission data.

Strawman plan endorsed by

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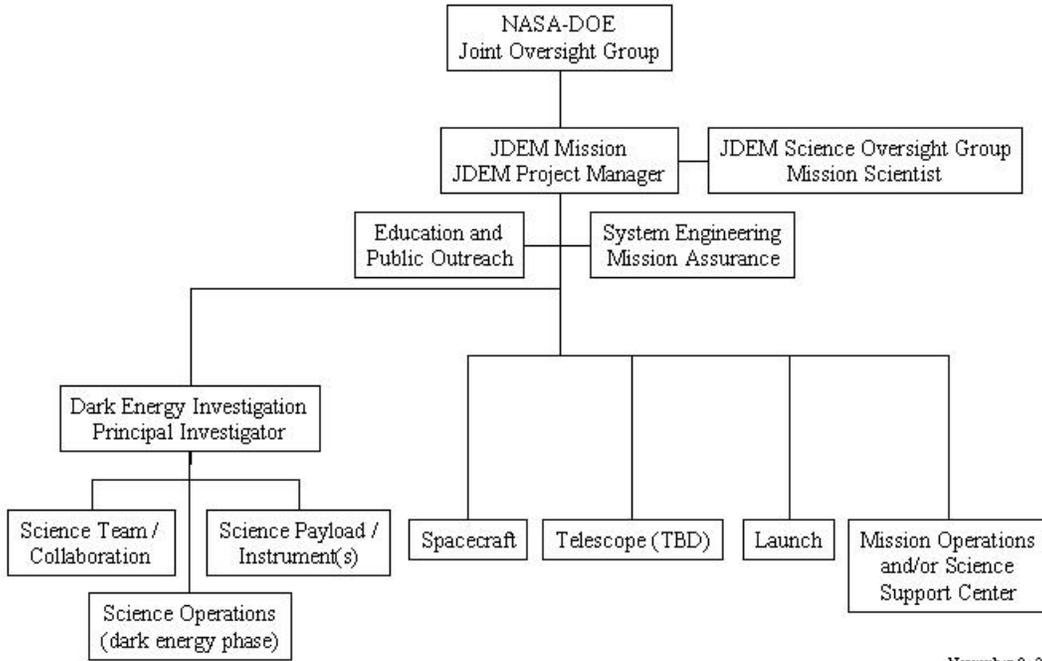
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## NASA/DOE Joint Dark Energy Mission Strawman Timeline

Strawman schedule (assumes a new initiative beginning in Year 0)

<b>FY</b>	<b>NASA – phase</b>	<b>DOE - phase</b>
Yr -1	Start Pre-phase A Conduct mission concept studies in anticipation of an AO Establish pre-project study office DOE passes CD0 NASA signs Formulation Authorization Document	Pre-conceptual planning
Yr 0	Phase A – Mission Concept NASA in-house mission concept definition study Write AO	Conceptual Design
Yr 1	Phase A – Mission Concept Issue AO; select investigations Industry participation in spacecraft Phase A studies DOE passes CD1 NASA holds Initial Confirmation Review	Conceptual Design
Yr 2	Phase B – Prelim Design Issue RFP or use RSDO; select prime contractor	Prelim Design
Yr 3	Phase B – Prelim Design Preliminary Design review (PDR)	Prelim Design
Yr 4	Phase C/D – Final Design DOE passes CD2 NASA holds Confirmation Review Confirmation Develop the mission, on time and on schedule DOE passes CD3 Critical Design Review (CDR)	Final Design
Yr 5	Phase C/D – Construction	Construction
Yr 6	Phase C/D – Construction	Construction
Yr 7	Phase C/D – I&T (instrument)	Construction
Yr 8	Phase C/D – I&T (spacecraft) DOE passes CD4	Construction
Yr 9	Launch Readiness Review (LRR) Phase E – launch/commissioning Dark Energy science operations	
Yr 10	Phase E – Dark Energy science operations	
Yr 11	Phase E – Dark Energy science operations	
Yr 12	Phase E – General science operations	
Yr 13	Phase E – General science operations	
Yr 14	Phase E – General science operations	
Yr 15	Archiving and End of Prime Mission	

# Joint Dark Energy Mission Notional Organization Chart



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## APPENDIX A

### A NASA-DOE Dictionary

Archival data analysis program	A grants program that provides funding for science investigations using the publicly available JDEM data archive.
Announcement of Opportunity	A solicitation for science investigations that involve providing flight instrumentation or providing science oversight during development of a flight mission. For JDEM, the AO will solicit the dark energy science investigation and the members of the science oversight group.
Archived	Made available to the science community and the public in a form that can be used by the science community and the public. Archiving is done in standard formats and includes appropriate calibration data.
Competitive selection	A selection that takes advantage of an open solicitation and an evaluation by peers of the proposers.
Observatory scientist	The observatory scientist, in addition to carrying out a proposed scientific investigation, will provide support for the end-to-end JDEM system engineering effort, act as an astronomical community advocate, provide an independent assessment of the expected scientific performance of JDEM, and serve as a senior scientist on the SOG.
General observing program	A program for awarding observing time to the most meritorious observing proposals. Merit is determined by a peer review of openly solicited proposals. Grants to conduct science research by analyzing the resulting data are also provided as part of the program.
General Observer	A general observer is an investigator who is awarded observing time, data rights, and funding to carry out an investigation using JDEM during the general science operations phase of the mission.
Interdisciplinary scientist	Interdisciplinary scientists are full members of the SOG and should possess a broad knowledge of astronomy and astrophysics and be effective user-community advocates for JDEM. They should be able to assess observatory capabilities with respect to broad areas of scientific interest.

Mission	The spacecraft plus the activities involved with managing, operating, and using the spacecraft. On the ground, a mission might be called an experiment.
Mission scientist	The chair of the SOG and the science and user communities advocate for ensuring that JDEM remains capable of meeting all science requirements as decisions are made during the design and construction phases.
Observatory	A telescope plus the required focal plane instruments plus the infrastructure required to operate and use it. For a space observatory the observatory requires a spacecraft.
Open competition	A competitive selection where the solicitation of proposals is open to all categories of organizations, domestic and foreign, including educational organizations, industry, nonprofit organizations, NASA Centers, and other Government agencies.
PI-led investigation	A science investigation led by a single individual, the PI.
Prime contractor	The organization charged with providing the contracted support to the government; typically this support includes providing the spacecraft, integrating the science payload into the spacecraft, testing the integrated observatory, and providing support for launch operations and in orbit checkout.
Principal investigator	The individual who will be responsible for the quality and direction of the entire proposed investigation and for the use of all awarded funds.
Project scientist	An employee of the implementing center/laboratory who is a member of the project management team and is responsible, on a day-to-day basis, for the science integrity of the mission during development and operation.
Science investigation	A program of science research that leads to a specified science goal.
Science payload	The flight instruments required to conduct a science investigation.

## APPENDIX B

### Acronym List

AAAC	Astronomy and Astrophysics Advisory Committee
AO	Announcement of Opportunity
CfP	Call for Proposals
CXO	Chandra X-ray Observatory
DOE	Department of Energy
GO	General Observer
GSFC	Goddard Space Flight Center
HST	Hubble Space Telescope
IDS	Interdisciplinary Scientist
I&T	Integration and Test
IWG	Interagency Working Group
JDEM	Joint Dark Energy Mission
JPL	Jet Propulsion Laboratory
JOG	Joint Oversight Group
MOU	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NRC	National research Council
PI	Principal Investigator
RFP	Request for Proposals
SEB	Source Evaluation Board
SIRTF	Space Infrared Telescope Facility
SOG	Science Oversight Group