The X-ray Technology Development Plan (TDP)

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Technology Development Plan - Background

- Need for a TDP suggested by outcome of 2012 X-ray Mission Concepts Study
  - Primary conclusion was that ~$1B class X-ray missions that address a substantial share of NWNH science are feasible for a start this decade, but only if technology is advanced to high TRL before mission start
  - Report sketched out technology needs for all notional missions and beyond
  - TDP expressly requested from the PCOS Project Office by NASA HQ
- The objective of the TDP is specific: answer the question: "What are the timescale and cost for maturing those technologies that would support a mid decade selection of an X-ray probe-class mission?
- The decision to broaden the TDP to include other, longer term technology needs was a decision made by the X-ray SAG, and is not required by NASA HQ
- The split between near term and longer term technology needs is reflected in separate funding mechanisms
  - Near term – SAT
  - Longer term – APRA

Technology Development Plan - Contents

- The TDP addresses those technologies that support mid decade selection of AXSIO-based Probe Class mission (and serve as the foundation for longer term – next decade mission- needs)
  - Light Weight arc second Slumped Glass Optics
  - Kilo-pixel Calorimeter Arrays
  - Gratings; Critical Angle and Off Plane Technologies
  - X-Ray CCD's
- All of these technologies are currently funded through successful SAT proposals
- These are the same technologies supported by NASA for IXO
  - The TDP is similar to many technology roadmaps developed for Con-X/IXO (but updated)

Technology Development Plan – Process and Schedule

- Inputs were sought from key technology developers
- Inputs integrated into common format
- Activities necessary for probe-class mission identified, and distinguished from other input from developers
  - Example – activities leading toward sub-arc second segmented mirrors were removed, and will be covered in longer term needs section
- TRL 5 and 6 demonstrations are clearly identified
- Schedules and costs developed and integrated for all technologies
  - Example on next slide
- Schedule
  - Full draft by end of April
  - Final version by end of May

Mirror Technology Development Schedule w/ Budget

Task		2013	2014	2015	2016	2017	2018
Substrate Fabrication	Slumped Glass	Mature technique at 6" Level for each pair of substrates to meet 10" mission requirements					
	Single Crystal Silicon	Proof of concept; Single Wolter-I Pairs at 2“ Level to meet 5” for mission performance margin					
Coating	Magnetron Sputter	Experiments to determine which of the two is better; Downselect one to pursue	Develop the selected method to meet 10“ mission requirements	Further development to meet 5” for mission performance margin			
	Atomic Layer Deposition						
Mirror Segment Integration	Alignment	Improve thermal control to 0.5 degrees C over a week	Improve thermal control to 0.1 degrees C over a week				
	Bonding	Improvement of smart-bonding to meet 10" mission requirements	Investigation & downselect between edge-bonding and kinematic bonding	Development of bonding technique to meet 5” for mission performance margin			
Module Design, Analysis, Testing		Achieve TRL-5 for making modules meeting 10“ mission requirements		Achieve TRL-5 for making modules meeting 5” for mission performance margin			
			Preparation for TRL-6 demo to meet 10“ mission requirements		Construct and test high fidelity modules to meet TRL-6 for 10” mission requirements and 5” for mission performance margin		
Budget Amount/Estimate		$1.9M	$2.3M	$2.3M	$4.0M	$4.0M	$4.0M

TRL 5 development
TRL 6 development
Risk reduction/performance margin increase

SAT already awarded
New funding required

Technology Development Plan – Anticipated Outcome

- Identified technologies will be recommended as SAT funding priorities
- NASA HQ will use TDP as input when establishing X-ray priorities and the funding level for the SAT program for FY15 and possibly beyond
  - (It is hoped that sufficient resources are available for relevant high ranking proposals for FY14)
- If X-ray probe is selected in 2015, funds needed beyond ~2016 could be directed rather than competed.
- If a probe is not selected, TDP provides a guide for resources needed to have these technologies ready to be part of a mission to be proposed to the 2020 decadal survey
  - NWNH recommended ~$180M for IXO technology; we'll have to live with less
- Long term needs will help to define APRA funding priorities

PCOS-Funded X-ray Study Activities

- **X-ray Technology Development Plan (TDP)**
  - Draft by end of April; final by end of May
- **Preparations for FY2014 Probe-class mission study**
  - Revisit science case (via X-ray SAG subcommittee)
    - Compare IXO priorities with NWNH science questions
    - Determine if X-ray investigations can help answer additional NWNH questions
  - Determine key technical and mission trades using notional mission concepts (AXSIO and N-CAL) as starting point
- **Discussions with European counterparts about participation in L2/L3 X-ray mission**
  - ESA call for L2/L3 white papers is out; responses due In late May
  - European X-ray community is preparing white paper on science associated with Athena+
  - Subset of high priority IXO science
  - NASA has offered to participate in L2/L3 missions at the ~15 percent level

X-ray Probe-class Mission Study (FY 2014-15)

- **X-ray probe class mission study**
  - Called for in NASA Astrophysics Implementation Plan
  - Goal is to develop reasonably well defined concept for an X-ray mission with cost to NASA of ≤$1B, that fulfills a substantial share of highly ranked IXO science
- Input needed for NASA midterm decision in 2015
- Will include science trades, technical studies, design lab sessions, and independent costing
- Anticipate that NASA will form a Science Definition Team in fall 2013
- Rough timeline:
  - Form SDT, initiate study – fall 2013
  - First design lab session – December 2013
  - Interim report to NASA HQ – March 2014
  - Final science/technical report to NASA HQ – January 2015
  - Final independent costing results – February 2015
- **Study is contingent upon NASA HQ having adequate funding**