PCOS Program Technology Capability Gap Input Form

Technology Capability Gap Name: ??????? **High-efficiency X-ray grating arrays for high-resolution spectroscopy**	Date Submitted: 6/30/2016
Your Name: Alexey Vikhlinin	Organization: X-ray Surveyor STDT
Telephone:	Email Address:

PATR Prioritization Information (instructions on next page)

Brief Description of the Technology Capability Needed (100 – 150 words):

Light-weight, high-efficiency (> 40-50%), large-format X-ray grating arrays enable high spectral resolving power R > 5000 in the soft X-ray band (~ 0.2 - 2 keV) for absorption- and emission-line spectroscopy using large X-ray telescopes.

These would provide the resolving power needed to address key science goals in the soft X-ray band, such as studying the physical state of baryons in galactic halos and in Cosmic Web, detailing matter and energy feedback from supermassive black holes, and characterizing stellar lifecycles from birth to death.

NOTE: The needs of X-ray Surveyor lead to more ambitious requirements than those typically discussed for explorer-class missions. In particular, we are interested in resolving powers of R=5000 at the minimum. The grating arrays should be able to intercept between 50 and 100% of the input beam, and they should be insertable and retractable.

Assessment of the Current State-of-the-Art (SOTA) (100 – 150 words):	Current TRL of SOTA:	
Proven technologies (grating spectrometers on Chandra and XMM-Newton) fall short in efficiency, collecting area, and resolving power, by factors of 5-10. High-efficiency gratings have been demonstrated that place > 40% of the incident soft x-ray light into the diffracted orders. Separately, high-spectral-resolving- power gratings have achieved spectral resolving powers > 10,000 in the soft X-ray band. Current technology readiness is assessed to be at TRL-4.	Current TRL of Full Solution:	

Target Goals and Objectives to Fill the Capability Gap:

Large-format grating arrays with high efficiency (~40% or more) in the 0.2-2 keV energy band.

Dispersion must be large enough to allow R > 5000.

Gratings must be scalable in size, with the goal of covering at least 50% of the X-ray Surveyor beam. STDT is particularly interested in exploring approaches for facilitization in manufacturing and assembly of gratings arrays of the size required for X-ray Surveyor.

Gratings must be insertable and fail-safe retractable.

Scientific, Engineering, and/or Programmatic Benefits (100 – 150 words):

Spectrometers achieving R > 5000 throughout the soft X-ray band are mission-enabling, as micro-calorimeters cannot achieve that. Priority science goals for soft X-ray spectroscopy are studying the physical state of baryons in galactic halos and in Cosmic Web, detailing matter and energy feedback from supermassive black holes, and characterizing stellar lifecycles from birth to death.

Applications and Potential Relevant Missions for PCOS, COR, and ExEP:

A spectrometer using gratings with this performance is envisioned for X-ray Surveyor, has been studied by NASA as a probe, has been proposed for an Explorer, and will be flown on the Off-plane Grating Rocket Experiment.

Time to Anticipated Need (time to anticipated or estimated launch date for enabled/enhanced missions):

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