Questions for HEX-P:

"When did SMBH grow?" is a main science topic, and up to 90% of the hard x-ray background could be resolved with HEX-P. However, there are uncertainties in the models, pending NuSTAR results. How large are these uncertainties?

Response:
90% of the XRB at 10-30 keV basically requires a sensitivity of 1e-15 erg/cm2/s in that band.

The number density at that sensitivity for the different XRB models we considered in the Ballantyne et al. (2011) paper are:

Model	*10-30 keV #/deg2*
DB10	*3463*
Aird09	*2581*
U03	*3129*
LaFranca05	*3935*
Treister09	*2084*

At these depths you are probing the faint end of the LF which is the most uncertain, so the variation in model predictions is larger than for NuSTAR. The biggest difference (the Treister09 and LaFranca05 models) is about a factor of 2.

To give you an idea of the uncertainty of the resolved fraction, the Aird09 model says that a sensitivity of 1e-15 erg/cm2/s only gives you 82% of the XRB, and you would need to go down to 4e-16 erg/cm2/s to get to 90%. Even in the worst case scenario you are still resolving >80% of the XRB in the energy range it peaks, and detecting >10x the number of AGNs than NuSTAR.

How will source confusion affect the number of sources detected in the deep 1x1 degree survey?
For 15" HPD (corresponds to a FWHM of 8") resolution at the depth limit of the survey there are ~20 beams/src (using the HPD, about double that if you use the FWHM). Simulations show that this will not affect the number of sources detected nor the ability to obtain localizations sufficient for follow-up.

Can you add more details on the cluster science? It is unclear what will really be measured.

HEX-P will map the non-thermal hard X-ray components in galaxy clusters. These may have multiple origins.

1) Cluster radio halos (associated with clusters undergoing mergers) demonstrate there is a population of relativistic electrons that has a similar distribution to the hot

X-ray emitting gas. The acceleration process is not known; it may be that existing CR electrons are reaccelerated by merger-induced turbulence, or alternately the electrons may arise from collisions of CR protons with hot gas (hadronic models). In hadronic models the correlation with merging activity is explained by merger-induced enhancement of the cluster magnetic field. The radio synchrotron emission constrains the product of particle density and magnetic field. The relativistic electrons in halos will upscatter CMB photons to the X-ray band. By detecting and mapping this emission relativistic particle density and magnetic field can be determined.

2) *Particles in radio relics are likely associated with merger shocks. Combining radio and hard X-ray measurements enables B field to be determined*

3) *Accretion shocks will accelerate electrons which upscatter CMB photons and are predicted to result in a detectable hard X-ray signal (see e.g. Kushnir & Waxman 2010). This emission will have a very different spatial distribution – being isolated to a thin shell at the shock position – very different from the case of cluster radio halos or relics which are associated with steep spectrum radio structures and which trace the thermal gas distribution.*

The intent was not to argue that measuring these non-thermal components would replace high resolution spectroscopy performed by Astro-H, Athena or a rescoped IXO, but that X-ray spectroscopy will provide information on the kinematics of the accreting gas, and HEX-P would provide information on the distribution of non-thermal particles and structure of the shocks.

How is your science affected if the mirrors can only achieve 30" angular resolution?

The primary effect would be on the survey confusion limit, which would limit the survey depth to be about 2 times the current target value.

Please clarify the time resolution and physical size of the soft-band detectors. The response says that eRosita detectors will be used. We understand these to be pn CCDs, which on eRosita will provide 50msec time resolution. Is it required that these detectors provide 0.1 msec time resolution for HEX-P, and if so, can they do so? If not, will some technology development be required in this area?

The timing science discussed in the WP relies on the E>10 keV timing, which is determined by the CdTe detectors, so there is no requirement for 0.1msec for the CCDs. The active pixel sensors being developed for Athena will have 1.3 ms time resolution, and if these progress as expected they would be an option for HEX-P that would improve the low-energy time resolution. Since this is concept study, part of the study could involve a trade involving including one focal plane with a very high time resolution soft X-ray detector.

The RFI response indicates that MPE Si detectors will be used, but there are no MPE people listed on the document. Has MPE has been consulted about providing the detectors, or are those detectors are just intended to be a strawman selection?

Informal discussions have taken place, however at the current time these are a strawman selection. If there is interest in pursuing a concept study all options would be considered.