爱因斯坦探针
einstein probe

EP Performance Verification (PV) Targets Recommendation Form

Submission Due Date: 15th October 2023

NOTE: Please do not change or delete the words marked in blue.

1. TITLE

Studying the stripping process of M86 into the Virgo cluster to verify FXT's imaging capability

2. ABSTRACT *(< 250 words)*

M86 is in the process of merging with the nearby bright Virgo Cluster, along with closely neighbouring galaxies of M84, NGC4338 and NGC 4438. These galaxies are undergoing ram pressure stripping as they interact with the intracluster medium of Virgo. The stripped gas from M86 can be seen in the form of a tail in existing XMM images. This object would make an excellent PV target as verifies the wide-field imaging capabilities of EP's FXT, would produce a very good press release image, and is well suited to the field of view of the FXT. The observation will also verify the background level of EP and the ability to measure low level surface brightness fluctuations. The science aim will to be better study the science of stripping gas of merging subclusters.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
***Recommender' Name**	Jeremy Sanders
***Recommender' Email Address**	jsanders@mpe.mpg.de
***Recommender' Expertise**	J Sanders is an expert at the study of physical processes in nearby clusters. He is the chair of STP5.

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***Recommender' STP(s)**	STP5
Co-Recommenders	
***Recommenders' Names**	
***Recommenders' Email Addresses**	
***Recommenders' Expertise**	
***Recommenders' STP(s)**	

4. TARGET FORM

- **TARGET 1** ***(mandatory)***

***Target Name**	M86			
***Target Type**	Elliptical galaxy / group			
***Target Coordinates**	***RA:**	12:26:11.7 (central pointing) 12:25:33.0 (NW pointing)	***DEC:**	+12:56:46.4 (central) +13:03:43.0 (NW)
***Expected Flux in 0.3-10 keV**	1.4×10^{-10} erg cm^{-2} s^{-1}			
***Primary Instrument**	FXT			
FXT Configuration ***(mandatory if the primary instrument***	**FXT-A**	*full-frame* *medium*	**FXT-B**	*full-frame* *medium*

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is FXT, optional if the primary instrument is WXT)				
***Exposure Time**	2×20ks (total 40 ks, split into two offset pointings)			
Suggest Joint Observation with Other X-ray Telescopes	No			
Other remarks	Two separate offset, overlapping pointings			
*Note: * mandatory items*				

- **TARGET 2 and more…**
  (optional, if there are more than one target in this recommendation, copy the entire target form above to the empty space below; note that this is only for the case that one observing proposal includes multiple targets; for targets of a different proposal with distinct technical and scientific goals, please submit them in separate proposals.)

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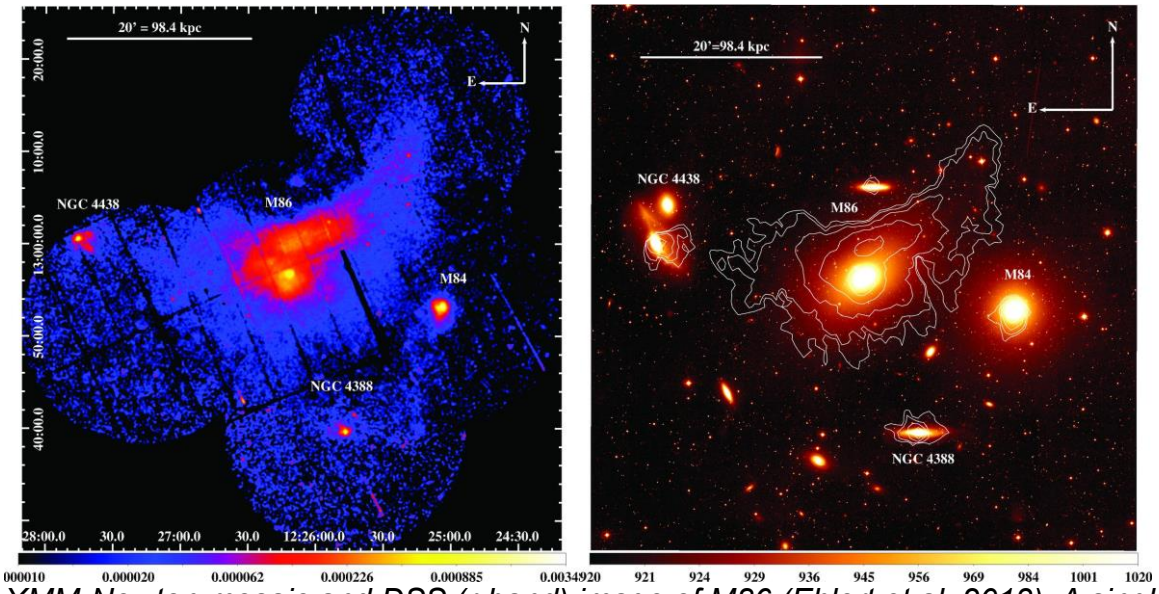
5. SCIENTIFIC AND TECHNICAL JUSTIFICATION

(< 2 pages in total for this session, including figures, tables and references)

- **Scientific Motivations and Values**

M86 and three neighbouring galaxies are merging with the Virgo galaxy cluster. There is a tail of stripped gas behind the main galaxy M86 (see e.g. Ehlert et al. 2013 and Randall et al. 2008), spanning 100-150 kpc. M86 lies around 1 deg west of M87, the central galaxy of Virgo, and is likely travelling through Virgo at a Mach number of at least 2. There are other galaxies M84 and NGC 4388 and NGC 4438 located close to M86, which are also merging with Virgo.



XMM-Newton mosaic and DSS (r-band) image of M86 (Ehlert et al. 2013). A single pointing of EP-FXT would cover this region, approximately.

The scientific aim is to detect the faint low surface brightness structures of stripped gas from these galaxies as they pass through the cluster. We will examine the thermodynamics of the material, such as the temperature and density, as it is stripped, to better understand these physical processes. We will compare the amount of stripping for the different galaxies. We will also compare the X-ray maps with the Hα filaments (Kenney et al. 2008) and intracluster light (Rudick et al. 2010).

In particular, it would be interesting to see how far the stripped tail extends beyond M86 into the cluster and search for shock-heated gas in the system. To improve our ability to detect the detail, we use two pointings, one offset towards the tail.

The observation would make an excellent PV target, as the morphologically-complex system would make a very good press release image. The observation also tests the FXT's imaging capability, its background and spectroscopic capability.

- **EP Capabilities to be Verified**
  The morphologically complex target is an excellent demonstration of the imaging capabilities of FXT. The low temperature gas in these galaxies (~1 keV) and high metallicity (~solar) mean that we will test the spectroscopic capabilities in the soft and Fe-L band. The low surface brightness features will test how well we can understand the FXT background. It will also verify the soft X-ray sensitivity.

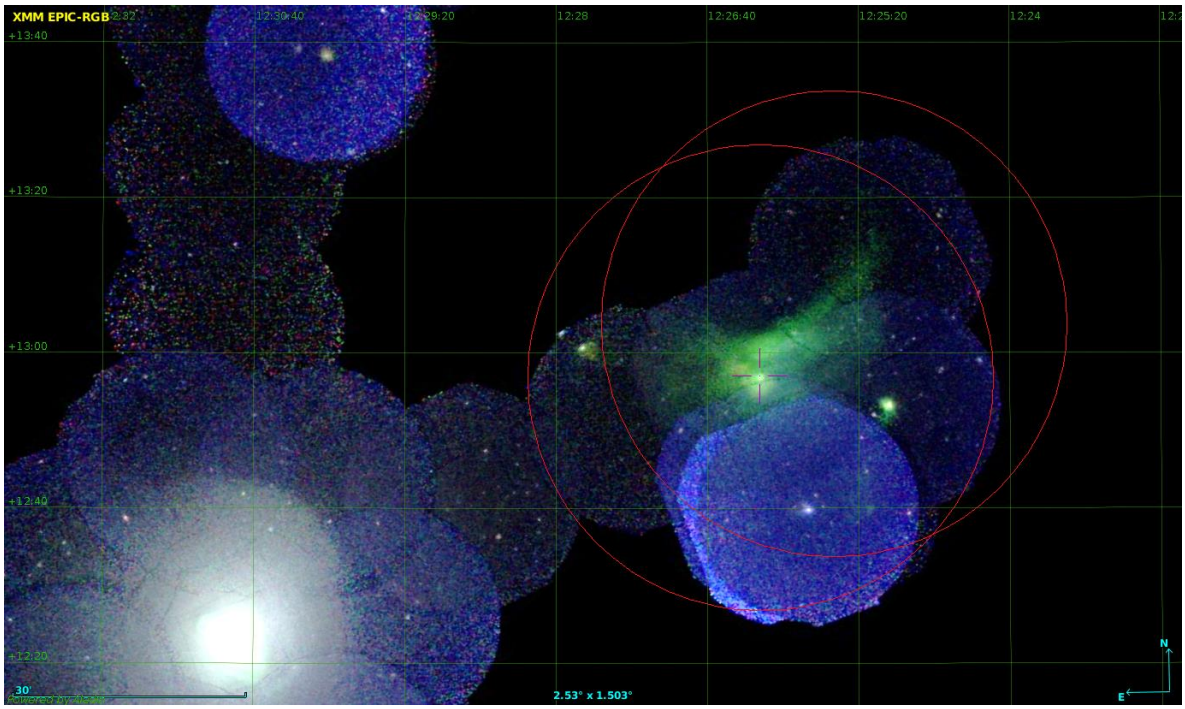
- **Immediate Objectives**
  Image the low surface brightness features. Examine the stripping process of the galaxies through imaging and spectroscopy.

- **Technical Justification (e.g. target visibility during the PV phase)**
  We split the observation into two pointings of equal length, a central one pointed at M86, and a second one offset towards the north-west by 10 arcmin, to help look for extended stripped material away from the cluster centre (See figure below).

  Extrapolating from eROSITA survey count rates, scaled by the number of telescopes, we estimate that the central pointing will give around 120k counts in 20ks in the soft 0.2-2.3 keV band within an aperture of 30 arcmin radius. The NW pointing will similarly give 100k counts in 20ks.

  At the peak of the X-ray emission we get around 2000 counts per 16 arcsec radius region (~PSF size) in the soft 0.2-2.3 keV band, allowing us to do spectroscopy on these scales. In the tail region we will get around 16 counts per PSF element above the X-ray background, allowing us to see surface brightness structures on approximately these scales.

  The target is visible for most of the PV phase (March or April 2024).



XMM view of the Virgo cluster and M86, taken from the XMM-Newton full sky HiPS map. The two red circles are the proposed EP pointings (30 arcmin radius).

- **References**

Ehlert, S., Werner, N., Simionescu, A., et al. 2013, MNRAS, 430, 2401
Kenney, J.D.P., Tal, T., Crowl, H.H., et al. 2008, ApJL, 687, L69
Randall, S., Nulsen, P., Forman, W.R., et al. 2008, ApJ, 688, 208
Rudick, C.S., Mihos, J.C., Harding, P., et al. 2010, ApJ, 720, 569

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