EP Performance Verification (PV) Targets Recommendation Form

Submission Due Date: 27th October 2023

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

1. TITLE

Using galaxy cluster PKS 0745-191 to verify the overall performances of EP-FXT.

2. ABSTRACT *(< 250 words)*

PKS 0745-191 is a relaxed, cool core cluster of galaxies at z=0.1028 with T ~ 8 keV, M_{500} ~ 7.1 x 10^{14} $M_{\odot}$ and f ~ 6.2 x 10^{-11} erg/s/cm^2. It is the brightest cluster beyond z=0.1 with a luminosity of 3 x 10^{45} erg/s in 2-10 keV. ROSAT survey shows it is a very extended cluster.

The X-ray emission from the outskirts of PKS 0745-191 out to ~ 1.5r_{200} (~24') has been detected by Suzaku (George et al. 2009). The FOV of EP-FXT is about 1° x 1°, beyond the virial radius of PKS 0745-191, and the EP-FXT observation can provide the information of the cluster assembly and the diffuse intracluster medium. Thus, using EP-FXT to observe PKS 0745-191 is a good way to understand the physics in the outskirts of the cluster.

In the EP PV phase, PKS 0745-191 is visible and it can be used to calibrate the overall performance of EP-FXT, such as the E-C, arf, rmf, psf and so on, with its continuous spectrum and the Fe emission line. Furthermore, PKS 0745-191 is a good calibration source recommended by IACHEC, the joint data analysis of EP-FXT with other satellites can improve the calibration accuracy of EP-FXT.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
***Recommender' Name**	Shumei Jia
***Recommender' Email Address**	jiasm@ihep.ac.cn
***Recommender' Expertise**	Shumei Jia is a member of EP Science centre and an expert of the observational study of galaxy clusters
***Recommender' STP(s)**	STP5
Co-Recommenders	
***Recommenders' Names**	Chengkui Li, Heng Yu, Yong Chen, Xiaofan Zhao, Jingjing Xu, Weimin Yuan
***Recommenders' Email Addresses**	lick@ihep.ac.cn, yuheng@bnu.edu.cn, ychen@ihep.ac.cn, zhaoxf@ihep.ac.cn, xujingjing@ihep.ac.cn, wmy@nao.cas.cn.

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***Recommenders' Expertise**	Weimin Yuan is the PI of EP. Yong Chen is the PI of EP-FXT The other recommenders are experts of the observational study of cluster of galaxies and/or EP-FXT data analysis.
***Recommenders' STP(s)**	STP4, STP5

4. TARGET FORM

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

***Target Name**	PKS 0745-191			
***Target Type**	Galaxy cluster			
***Target Coordinates**	***RA:**	07h47m31.32s	***DEC:**	-19d17m40.0s
***Expected Flux in 0.3-10 keV**	~ 6.2 x 10^{-11} erg/s/cm^2			
***Primary Instrument**	EP-FXT			
FXT Configuration ***(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)***	**FXT-A**	full-frame thin	**FXT-B**	full-frame thin
***Exposure Time**	30 ksec			
Suggest Joint Observation with Other X-ray Telescopes	NO			
Other remarks	(any other remarks)			
*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**

PKS 0745-191 is a relaxed, cool core cluster of galaxies at z=0.1028 with T ~ 8 keV, M_{500} ~ 7.1 x 10^{14} $M_{\odot}$ and f ~ 6.2 x 10^{-11} erg/s/cm^2. It is the brightest cluster beyond z=0.1 with a luminosity of 3 x 10^{45} erg/s in 2-10 keV. ROSAT survey gives the X-ray image of PKS 0745-191, as shown in the left panel of Fig.1. The X-ray emission from the outskirts of PKS 0745-191 out to ~ 1.5r_{200} (~24') has been detected by Suzaku with 5 mosaic pointing observations (~30 ks for each point) as shown in the right panel of Fig.2 (George et al. 2009).

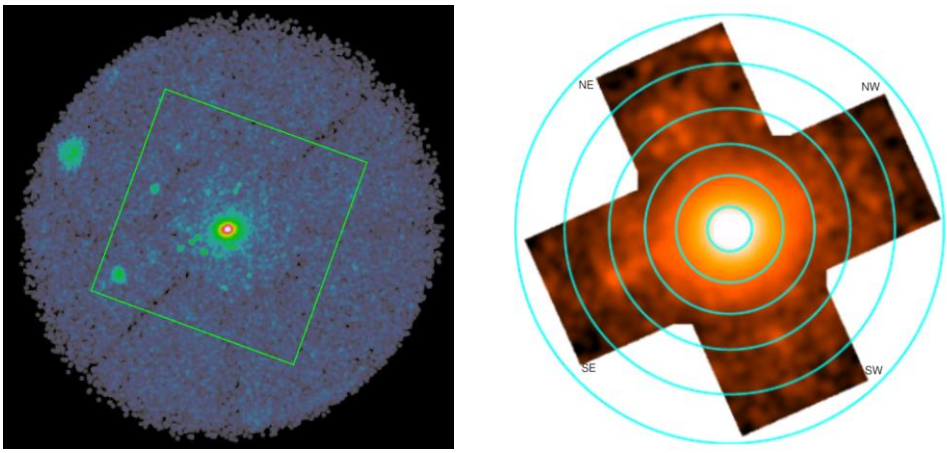

Fig.1: Left – The X-ray image of PKS 0745-191 from ROSAT survey, the scale of the green box corresponding to the FOV of EP-FXT, 1° x 1°.
Fig.1: Right – The Mosaic observations of SUZAKU for PKS 0745-191, and the ring radii are 2.5, 6, 9.5, 13.5, 18.5 and 24 arcmin (George et al. 2009)

To measure the thermodynamic properties of its intracluster medium (ICM) out to and beyond r_{200}, Walker et al. (2012) studied the10 Suzaku X-ray Imaging Spectrometer (XIS) pointing observations as shown in the left panel of Fig.2. But it still cannot cover the whole cluster. The FOV of EP-FXT corresponds to the green box in Fig.2, and it covers almost the whole one. Thus, it is better for PKS 0745-191 to be observed with EP-FXT to explore the radial profiles of density, temperature, entropy, gas fraction and mass for the whole cluster, from center to outskirt.

- **EP Capabilities to be Verified**

PKS 0745-191 is a good calibration source recommended by IACHEC, used by XMM-Newton, Chandra, ROSAT, SUZAKU, SWIFT, so there are lots of calibration data can be used to carry out the cross calibration analysis with EP-FXT.

1) The Fe line can demonstrate FXT's E-C and rmf (Chen et al. 2003).
2) The continuous spectrum can demonstrate FXT's E-C, rmf and arf (Chen et al. 2003).
3) The Point sources in FOV can demonstrate FXT's PSF and positioning accuracy.
4) The joint data analysis with other satellite can improve FXT calibration accuracy.

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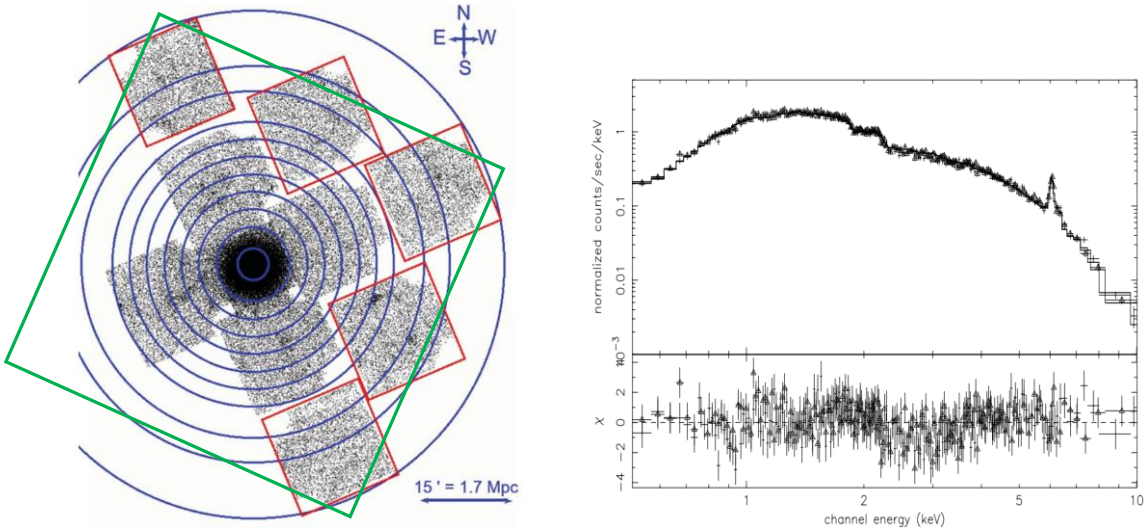

Fig.2: Left - The SUZAKU Mosaic observations of PKS 0745-191 (Walker et al. 2012). The green box corresponds to the FOV of EP-FXT, 1° x 1°, and the radius of the outmost ring is 41'.

Fig.2: Right - The spectrum of PKS 0745-191 from XMM-Newton/MOS (Chen et al. 2003)

- **Immediate Objectives**

The main objectives of PKS 0745-191 observation are:

1) To explore the information of the cluster assembly and the diffuse intracluster medium, and to understand the physics in the outskirts of the cluster.
2) To verify the EP-FXT overall performance, such as the arf, rmf, E-C and psf, with its continuous spectrum, Fe line and the point sources in FOV.
3) It is a good calibration source, and the joint data analysis of EP-FXT with other satellites can improve the calibration accuracy.

- **Technical Justification (e.g. target visibility during the PV phase)**

PKS 0745-191 is visible (>90 deg) during the PV phase (visibility: 2023-10-28 ~ 2024-4-24). Its flux is about 6.2 x 10^{-11} erg/s/cm^2 in the 0.1-2.4 keV, suitable for EP-FXT observation in the Full-Frame mode and the thin filter

- **References**

1) George, M. R.; Fabian, A. C.; Sanders, J. S.; Young, A. J.; Russell, H. R. X-Ray Observations of the Galaxy Cluster PKS0745-191: To the Virial Radius, and Beyond. Monthly Notices of the Royal Astronomical Society 2009, 395, 657–666.
2) Walker, S. A.; Fabian, A. C.; Sanders, J. S.; George, M. R. Further X-Ray Observations of the Galaxy Cluster PKS 0745-191 to the Virial Radius and Beyond. Monthly Notices of the Royal Astronomical Society 2012, 424, 1826–1840.
3) Chen, Y.; Ikebe, Y.; Böhringer, H. X-ray spectroscopy of the cluster of galaxies PKS 0745-191with XMM-Newton 2003, A&A, 407,41C
4) Eckert, D.; Molendi, S.; Gastaldello, F.; Rossetti, M. X-Ray Observations of PKS 0745-191 at the Virial Radius: Are We There Yet? Astronomy and Astrophysics 2011, 529, A133

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