



愛因斯坦探針
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

Using Mrk 421 to verify the EP observational capability of Extragalactic source

2. ABSTRACT (< 250 words)

(summarize the target properties, the EP capabilities to be verified, and justify why the proposed observations and targets should be considered for the PV phase)

Blazar is a kind of relativistic jet that is pointing to observer. Mrk 421 is a well-known blazar. As it is a bright source in the X-ray band, Mrk 421 can be used to verify the EP capabilities for the extragalactic research. The EP observation for Mrk 421 will be accompanied by the observation of the ground-based optical telescopes in Yunnan Observatories, and this observation in EP PV phase can be also a training of multi-wavelength observation for the joint observation between EP and optical telescopes in Yunnan Observatories. In addition, the short-timescale variability and the time-resolved spectra of Mrk 421 can be applied to investigate particle acceleration and radiation mechanism in relativistic jet.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
*Recommender' Name	Jirong Mao
*Recommender' Email Address	jirongmao@mail.ynao.ac.cn
*Recommender' Expertise	Jirong Mao is an astronomer of X-ray astronomy. One major research is related to relativistic jet. In particular, Jirong Mao with the research group in Yunnan Observatories have devoted multi-wavelength observation and theoretical investigation on blazars.
*Recommender' STP(s)	STP2, STP3, STP6
Co-Recommendors:	

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

*Recommenders' Names	Guobao Zhang, Xian Hou, Kaixing Lu, Dingrong Xiong, Feifan Song, Ruizhi Li, Boting Wang
*Recommenders' Email Addresses	zhangguobao@ynao.ac.cn, xhou@ynao.ac.cn, lukx@ynao.ac.cn, xiongdingrong@ynao.ac.cn, songfeifan@ynao.ac.cn, liruizhi@ynao.ac.cn, Wangbaiting@ynao.ac.cn
*Recommenders' Expertise	Guobao Zhang is an expert on the X-ray observation, Xian Hou is an expert on the gamma-ray observation, Kaixing Lu and Dingrong Xiong are experts on the optical observation, Feifan Song is a student working on the X-ray data analysis, Ruizhi Li and Boting Wang are two students working on the X-ray and optical observation.
*Recommenders' STP(s)	STP2, STP3, STP4, STP6

4. TARGET FORM

- TARGET 1 (mandatory)**

*Target Name	Mrk 421			
*Target Type	AGN, blazar, transient			
*Target Coordinates	*RA:	11:04:27.2	*DEC:	38:12:32
*Expected Flux in 0.3-10 keV	>1.e-11 erg/cm ² /s			
*Primary Instrument	FXT			
FXT Configuration	FXT-A	full-frame	FXT-B	full-frame

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<i>(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)</i>		<i>thin</i>		<i>thin</i>
*Exposure Time	10 ksec			
Suggest Joint Observation with Other X-ray Telescopes	The X-ray observation of Mrk 421 can be performed for the joint observations, such as the observation by the ground-based optical telescopes in Yunnan observatories.			
Other remarks	(any other remarks)			
<i>Note: * mandatory items</i>				

- 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**

(briefly describe the properties of targets, scientific motivations and values, and explain why the proposed target and observation should be considered for a PV program rather than a regular observing program)

Particle acceleration and radiation mechanism in blazars are important topics in the high-energy astrophysical research field. Multi-wavelength light curves and spectral energy distribution have been studied for blazars. Mrk 421 is a famous blazar with fruitful observations. It is one of the brightest blazars in the X-ray band. Long-term monitoring of Mrk 421 has been performed by space telescopes and ground-based telescopes. In principle, the observation of Mrk 421 in the EP PV phase should be considered. In addition, as Mrk 421 has very bright X-ray flux, it provides a good opportunity to examine the short-time variability and the time-resolved spectrum of Mrk 421 by the EP instruments (both FXT and WXT). In the meanwhile, EP observation can be joined by the observation of ground-based optical telescopes in Yunnan Observatories, and it can be adopted as a training of multi-wavelength observation.

- **EP Capabilities to be Verified**

(briefly describe the capabilities that can be verified by the recommended targets and observations. For example: this target can demonstrate WXT's imaging capability of large field-of-view and sensitivity)

Mrk 421 as a typical example can be applied to demonstrate EP's capability for the detection of extragalactic sources. Some deliberate features, such as the short-timescale variability and the time-resolved spectrum, can be examined by FXT and WXT.

- **Immediate Objectives**

(listed the main objectives of the recommended targets and observations)

Target: Mrk 421

Average flux: about 1.0×10^{-10} erg/cm²/s

Exposure time: 10 ks

When the source is in the flaring state, the quick-response observation to catch the flaring feature of the source can be required.

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- **Technical Justification (e.g. target visibility during the PV phase)**
(briefly justify the technical feasibility of the recommended target and observation, such as the target visibility during the PV phase, brightness, variability, etc.)

Although Mrk 421 has strong variability, its flux in the 0.2-10 keV energy band can be usually above 1.0×10^{-11} erg/cm²/s. Thus, Mrk 421 can be easily detected by both FXT and WXT. Given an total exposure time of about 10 ks, the light curve with short-timescale variability and the time-resolved spectrum can be archived. In the meanwhile, for optical observation, Mrk 421 can be observed from January to June in 2024 in Lijiang observational Station.

- **References**
(list relevant references for the recommended targets and observations)

There are many references on the X-ray observation of Mrk 421. Here we list some recent publications.

Aggrawal, V., et al. 2018, MNRAS, 480, 4873
Das S. & Chatterjee, R. 2023, MNRAS, 524, 3797
Hota, J., et al. 2021, MNRAS, 508, 5921
Kapanadze, B., et al. 2020, ApJS, 247, 27
Markowitz, A. G., et al. 2022, MNRAS, 513, 1662
Mondal, S., et al. 2022, A&A, 663, A178
Noel, A. P., et al. 2022, ApJ, 262, 4