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

Detecting type I X-ray bursts from 4U 1820-30 and 4U 1636-536 to verify the timing and energy capabilities of FXT

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)

4U 1820-30 and 4U 1636-536 are two persistent and bright low-mass X-ray binaries, which have showed type I X-ray bursts due to unstable thermonuclear burning of accreted material. The burst recurrence time are 2-4 hr and 1-2 hr, respectively. For each source, we propose to carry out 10 ksec exposure to catch at least one type I X-ray burst for the PV phase. The algorithm will be tested for the burst event. The proposal will verify the energy and absolute time calibration and resolution on orbit. Moreover, the data will be used to study the burst-disk interaction and search for the low frequency QPOs.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
***Recommender' Name**	Zhaosheng Li
***Recommender' Email Address**	lizhaosheng@xtu.edu.cn
***Recommender' Expertise**	Zhaosheng Li is an expert of the observational study of XRBs.
***Recommender' STP(s)**	STP4
Co-Recommenders	
***Recommenders' Names**	Renxin Xu

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***Recommenders' Email Addresses**	r.x.xu@pku.edu.cn
***Recommenders' Expertise**	Renxin Xu is an expert of the theory study of compact star.
***Recommenders' STP(s)**	STP4

4. TARGET FORM

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

***Target Name**	4U 1820-30			
***Target Type**	X-ray Binary, UCXB			
***Target Coordinates**	***RA:**	18:23:40.57	***DEC:**	-30:21:40.6
***Expected Flux in 0.3-10 keV**	3e-9~9e-9 erg/cm^2/s			
***Primary Instrument**	FXT			
FXT Configuration ***(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)***	**FXT-A**	Full-frame, thick filter	**FXT-B**	Timing model, thick filter
***Exposure Time**	10 ksec			

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Suggest Joint Observation with Other X-ray Telescopes	Joint observation with Insight-HXMT
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.)

- **TARGET 2** ***(mandatory)***

***Target Name**	4U 1656-536			
***Target Type**	X-ray Binary, X-ray burster			
***Target Coordinates**	***RA:**	`16:40:55.598`	***DEC:**	`-53:45:04.95`
***Expected Flux in 0.3-10 keV**	2.3e-9 erg/cm^2/s			
***Primary Instrument**	FXT			
FXT Configuration ***(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)***	**FXT-A**	Full-frame, thick filter	**FXT-B**	Timing model, thick filter
***Exposure Time**	10 ksec			
Suggest Joint Observation with Other X-ray Telescopes	Joint observation with Insight-HXMT			
Other remarks	(any other remarks)			
*Note: * mandatory items*				

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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)

  4U 1820-30 and 4U 1636-536 are persistent and bright low-mass X-ray binaries, and also belongs to atoll sources (Galloway et al. 2008, Zhao et al. 2022). They showed unstable thermonuclear X-ray bursts, known as type I X-ray bursts, which is characterised by its fast rise and exponential decay of the light curve and a blackbody spectrum. It is only during the low states that 4U 1820-30 shows X-ray bursts. While for 4U 1636-536, it can occur X-ray bursts in all spectral states. It was found that the burst recurrence time of 2-4 hr for 4U 1820-30, and 1-2 hr for 4U 1636-536.

  During an X-ray burst, the peak flux increases a factor of 30 compared with persistent emission. Therefore, it is urgent to carry the observations to optimize the algorithm for possible misjudge an X-ray burst as a flare background during the PV phase. Spectral features in the FXT band, such as an emission line around 1 keV, two absorption lines ~ 1.7 keV and 3 keV (Keek et al. 2018), during bursts have been observed in 4U 1820-30, which can be used to verify the on orbital energy resolution and calibration.

  In addition, by comparing the peak of a burst captured by two FXTs, the absolute timing accuracy can also be tested. During X-ray burst, several types of burst-disk interaction have been found, such the Poynting- Robertson drag, leading to enhanced persistent emission, the reflection emission from the surrounding disk and so on. We will analyze the time-resolved spectra to distinguish these effects.

  For the persistent emission, we will carry out the search of QPOs. Combined with the simultaneous HXMT observations, the physical mechanism will be studies in a very broadband energy range.

- **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)

  These two targets can test the timing accuracy and spectral resolution and calibration of FXT.

- **Immediate Objectives**
  (listed the main objectives of the recommended targets and observations)

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We suggest to observe 4U 1820-30 and 4U 1636-536 to study the burst and disk interaction. The time and spectral capabilities of FXT can also be tested.

- **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.)

  4U 1820-30 and 4U 1636-536 are bright sources, with persistent fluxes of 2~8E-9 erg/cm^2/s, which are visible for FXT during the PV phase. During an X-ray burst, the peak flux can reach 6E-8 erg/cm^2/s.

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

Zhao, Li, Pan et al., 2020, A&A 660, A31
Keek, Arzoumanian, Chakrabarty et al. 2018, ApJ Letter 856:L37
Galloway D K, Muno M P, Hartman J M, et al. ApJS, 2008, 179(2): 360

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