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

(e.g. Using galaxy cluster A1234 to verify the energy resolution of FXT)

The Cyclotron line of 1E1207.4-5209

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)

1E 1207.4−5209 is a unique source in CCO, which have cyclotron resonance scattering feature (CSRF) and glitch behaviours. We propose 20 ks the EP-FXT observations of 1E 1207.4−5209 to study the possible evolution line energy and glitch behaviour, especially for the weak magnetic filed pulsar. This observation could also be used to check the energy scale using the absorption line structures. The spin signal also could be used to check the time system.

3. RECOMMENDERS' INFORMATION

Principal Recommender	
***Recommender' Name**	Mingyu Ge
***Recommender' Email Address**	gemy@ihep.ac.cn
***Recommender' Expertise**	Mingyu Ge is an expert of the observational study of Pulsars
***Recommender' STP(s)**	e.g. STP4
Co-Recommenders	
***Recommenders' Names**	Liqiang Qi and Juan Zhang

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***Recommenders' Email Addresses**	qilq@ihep.ac.cn zhangjuan@ihep.ac.cn
***Recommenders' Expertise**	Liqiang Qi and Juan Zhang is an expert of the observational study of pulsar.
***Recommenders' STP(s)**	SPT4

4. TARGET FORM

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

***Target Name**	1E1207.4-5209			
***Target Type**	Pulsar			
***Target Coordinates**	***RA:**	12:10:00.88	***DEC:**	−52:26:28.4
***Expected Flux in 0.3-10 keV**	2.08E-12 erg cm^{-2} s^{-1}			
***Primary Instrument**	FXT			
FXT Configuration ***(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)***	**FXT-A**	(choose window mode between *full-frame*, *partial-window*, *timing* mode) *partial-window* (choose filter between *thick* and *medium* filter; can be different from FXT-B) *Thin*	**FXT-B**	(choose window mode between *full-frame*, *partial-window*, *timing* mode) *partial-window* (choose filter between *thick* and *medium* filter; can be different from FXT-A) *Thin*
***Exposure Time**	25 ksec			

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Suggest Joint Observation with Other X-ray Telescopes	e.g. joint observation with Insight-HXMT, XMM-Newton, INTEGRAL, Swift
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)

CCOs are young NSs associated with SNRs defined by their steady surface thermal X-ray emission, lack of surrounding pulsar wind nebula, and non-detection at any other wavelength[1]. The central compact object (CCO) 1E 1207.4−5209 in the supernova remnant (SNR) PKS 1209−51/52 has been studied intensively because of its unusual timing and spectral properties. It was the first CCO pulsar discovered [2], the first isolated neutron star (NS) to display strong absorption lines in its X-ray spectrum [3,4,5]. 1E 1207.4−5209 is one of the three known CCO pulsars, all of which have a characteristic weak surface dipole magnetic field strength, (2.9, 3.1, and 9.8)x10^{10} G, the smallest known among young pulsars [6] as shown in Figure 1. Most recently, 1E 1207.4−5209 show small glitch activity as plotted in Figure 2 [7,8].

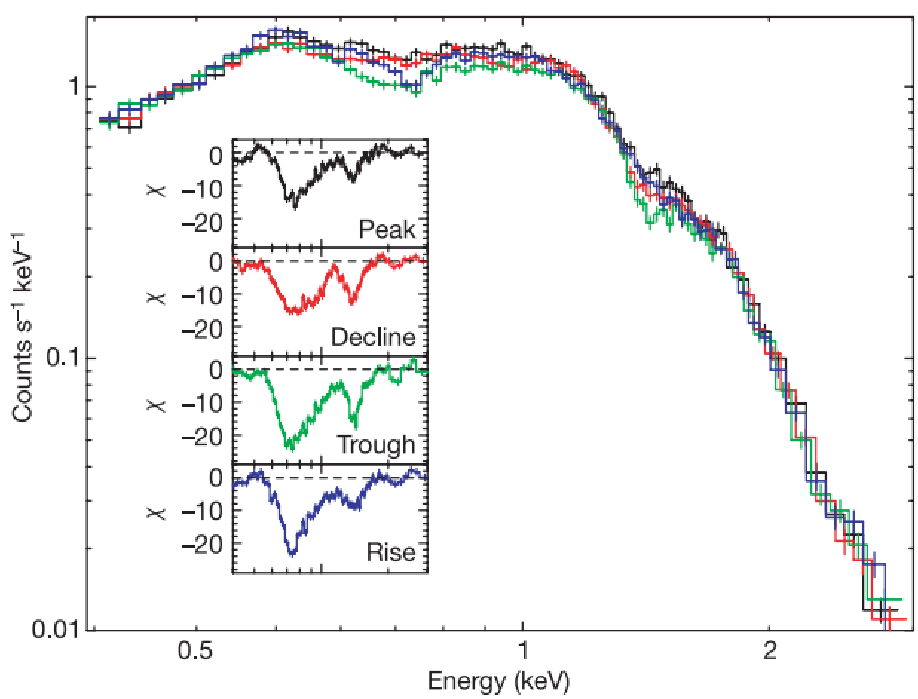

Figure 1 The spectrum of 1E1207.4-5209 from XMM-Newton observation[1]

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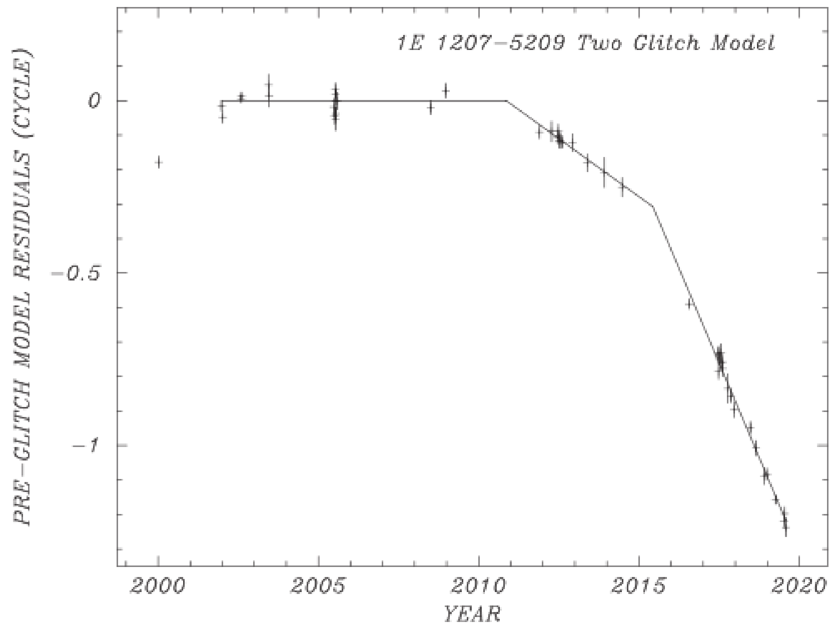

Figure 2 The timing residuals of 1E1207.4-5209[2,3]

As the young pulsar, the evolution might be faster the other type of isolated pulsars. How magnetic field evolves is still unknown. Here we propose the EP-FXT observations to measure and study the possible evolution of cyclotron absorption line together with previous observations. The glitch amplitude detected in 1E 1207.4−5209 is very small ~1E-10 Hz, which is even smaller than PSR B1821-24[9]. Besides, we measure spin frequency with EP-FXT to study the possible new glitch in 1E 1207.4−5209. The purpose of this study is role of magnetosphere to the trigger mechanism of glitch.

- **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)

  There are three absorption lines , e.g. 0.7, 1.4 and 2.1 keV, which could be used to calibrate the energy relation of EP-FXT. The spin information could also be used to check the time sysyem.

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

  In this proposal, only one source is proposed and 1E1207.4-5209 could be observed according to the plan.

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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.)

  1E1207.4-5209 would be visible for EP-FXT considering the avoidance of Solar and Lunar as plotted in the following figure. Its flux and spectrum are stable around 0.5 mCrab, which is also suitable for the observation of EP-FXT.

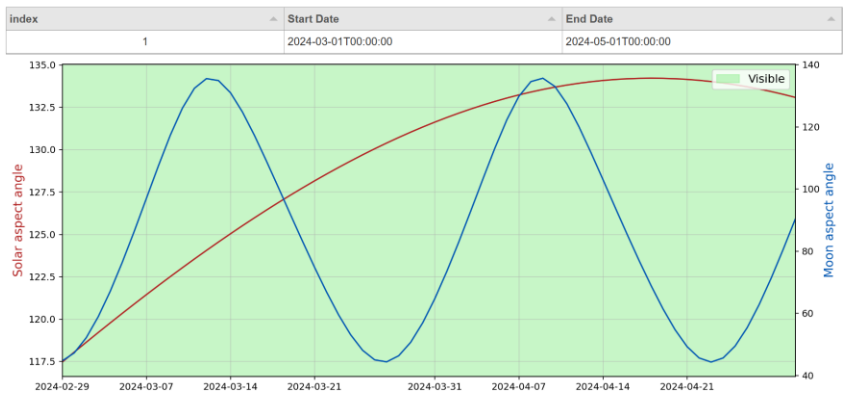

Figure 3 Visibility of 1E1207.4-5209

The simulated sky map and spectrum are shown in Figure 4.

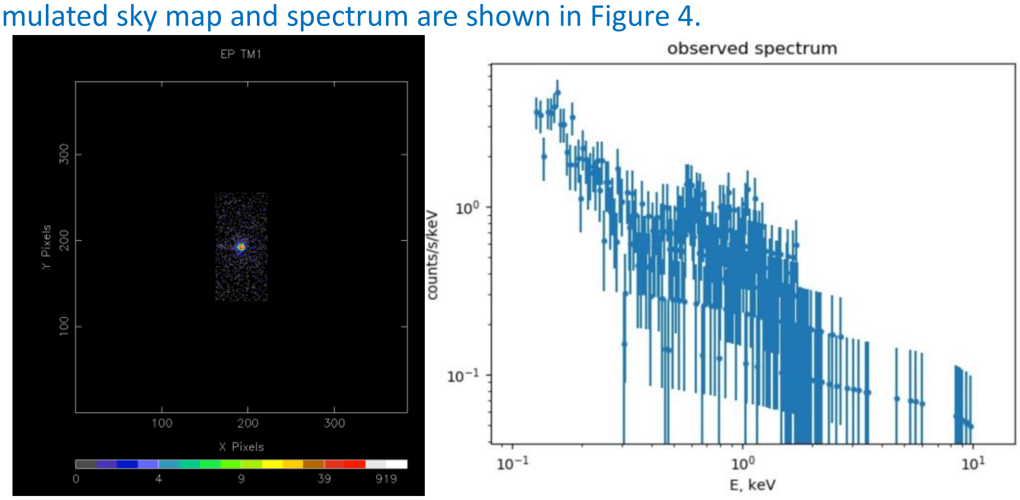

Figure 4 The simulated results of 1E1207.4-5209. Left panel: image of partial window. Right panel: the simulated spectrum

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

[1] De Luca, A. 2017, Journal of Physics Conference Series, 932, 012006.

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[2] Zavlin, V.~E., Pavlov, G.~G., Sanwal, D., et al. 2000, apjl, 540, L25.
[3] Mereghetti, S., De Luca, A., Caraveo, P.~A., et al. 2002, apj, 581, 1280.
[4] Sanwal, D., Pavlov, G.~G., Zavlin, V.~E., et al. 2002, apjl, 574, L61.
[5] Bignami, G.~F., Caraveo, P.~A., De Luca, A., et al. 2003, Nat, 423, 725.
[6] Gotthelf, E.~V. & Halpern, J.~P. 2007, apjl, 664, L35.
[7] Gotthelf, E.~V. & Halpern, J.~P. 2018, ApJ, 866, 154.
[8] Gotthelf, E.~V. & Halpern, J.~P. 2020, ApJ, 900, 159.
[9] Cognard, I. & Backer, D.~C. 2004, apjl, 612, L125.

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