



愛因斯坦探針  
einstein probe

## EP Performance Verification (PV) Targets Recommendation Form

**Submission Due Date: 15<sup>th</sup> October 2023**

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

## 1. TITLE

A UCXB with bright X-ray radiation and a short orbital period: 2S 0918-549

## 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)

2S 0918-549 is an Ultra-compact X-ray binary (hereafter: UCXB) with an orbital period of only 17.4 minutes. The X-ray spectral data show that its donor is Ne-rich, and further composition diagnostics are needed. There are no disturbance sources around this target, so the FXT of EP satellite can precisely detect its X-ray radiation properties. Moreover, its peak flux is  $1.12 \times 10^{-10}$  erg/s/cm<sup>2</sup> in the 2-10 keV band. Therefore, the FXT detector can obtain the details about this target in a short exposure time. This target with a very short period can enhance our understanding of UCXB and test EP capabilities for observing UCXB. The observations of EP can investigate the donor of 2S 0918-549, which will advance the formation and evolution of UCXBs. Especially, the FXT can provide very valuable data to study the possible variation of UCXB in the time series. And a comparison with Chandra, XMM-Newton and Swift will help us understand the variation of UCXB in the time-domain observations.

## 3. RECOMMENDERS' INFORMATION

Principal Recommender	
*Recommender' Name	Jinzhong Liu
*Recommender' Email Address	liujinzh@xao.ac.cn
*Recommender' Expertise	Jinzhong Liu is an expert in the observation and theoretical study of related objects in the evolution of binary stars.
*Recommender' STP(s)	STP4

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Co-Recommendors	
<b>*Recommendors' Names</b>	Minghua Chen
<b>*Recommendors' Email Addresses</b>	chenminghua@xao.ac.cn
<b>*Recommendors' Expertise</b>	Minghua Chen is a master's student in Jinzhong Liu's science group.
<b>*Recommendors' STP(s)</b>	None

#### 4. TARGET FORM

- TARGET 1 (mandatory)**

<b>*Target Name</b>	2S 0918-549			
<b>*Target Type</b>	X-ray Binary			
<b>*Target Coordinates</b>	<b>*RA:</b>	09:20:26.95	<b>*DEC:</b>	-55:12:24.7
<b>*Expected Flux in 0.3-10 keV</b>	1.12E-10 erg/cm <sup>2</sup> /s			
<b>*Primary Instrument</b>	FXT			
<b>FXT Configuration</b> <i>(mandatory if the primary instrument is FXT, optional if the primary instrument is WXT)</i>	<b>FXT-A</b>  (choose window mode between <i>full-frame</i> , <i>partial-window</i> , <i>timing</i> mode)  window mode:full-frame filter: medium filter	<b>FXT-B</b>  (choose window mode between <i>full-frame</i> , <i>partial-window</i> , <i>timing</i> mode)  window mode:full-frame filter: medium filter		
<b>*Exposure Time</b>	5000 sec			

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<b>Suggest Joint Observation with Other X-ray Telescopes</b>	None
<b>Other remarks</b>	We hope that this target can be observed by the FXT of EP once a day(~7 times, because the PV phase will last for about one week).
<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.)*

None.

## 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)

UCXBs are undoubtedly important gravitational wave source for the space GW detectors[1]. More X-ray band details can enhance our understanding of UCXBs. What's more, these targets are meaningful to test binary evolution theory and help us refine UCXBs' accretion model[2]. 2S 0918-549 is a typical UCXB. X-ray spectral data of EP can give a comprehensive analysis of the donor in UCXB [3], which is significant to research the accretion and model the binary evolution.

- **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)

The peak flux of our target is about  $1.12 \times 10^{-10}$  erg/s/cm<sup>2</sup> [4], which can verify FXT's capabilities in 2-10 keV band, especially its angular resolution.

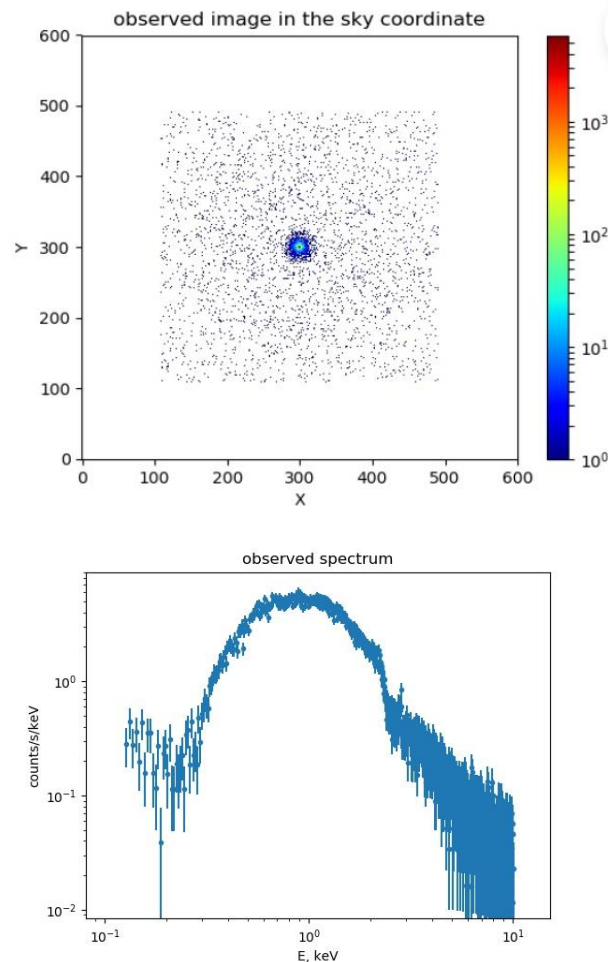
**NOTE: Please do not change or delete the words marked in blue.**

- **Immediate Objectives**

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

We hope EP can find the possible variation of the target's fluxes and obtain high quality X-ray spectrum. These studies can help us understand the composition of the donor of 2S 0918-549[5,6].

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



We use the FXT simulator and obtain a simulated observation result of 2S 0918-549. The above diagram shows that FXT can observe the target. The following graph displays the spectrum observable by FXT. These simulated results demonstrate that FXT is suitable for our observation request.

- **References**

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

- [1]Armas Padilla, M., "UltraCompCAT: A comprehensive catalogue of ultra-compact and short orbital period X-ray binaries", *Astronomy and Astrophysics*, vol. 677, 2023. doi:10.1051/0004-6361/202346797.
- [2]Zhong, J. and Wang, Z., "The Likely Orbital Period of the Ultracompact Low-mass X-ray Binary 2S 0918-549", *The Astrophysical Journal*, vol. 729, no. 1, 2011. doi:10.1088/0004-637X/729/1/8.
- [3]Koliopanos, F., Péault, M., Vasilopoulos, G., and Webb, N., "The chemical composition of the accretion disc and donor star in ultra-compact X-ray binaries: A comprehensive X-ray analysis", *Monthly Notices of the Royal Astronomical Society*, vol. 501, no. 1, pp. 548–563, 2021. doi:10.1093/mnras/staa3474.
- [4]Juett, A. M. and Chakrabarty, D., "X-Ray Spectroscopy of the Low-Mass X-Ray Binaries 2S 0918-549 and 4U 1543-624: Evidence for Neon-rich Degenerate Donors", *The Astrophysical Journal*, vol. 599, no. 1, pp. 498–508, 2003. doi:10.1086/379188.
- [5]Nelemans, G., Jonker, P. G., and Steeghs, D., "Optical spectroscopy of (candidate) ultracompact X-ray binaries: constraints on the composition of the donor stars", *Monthly Notices of the Royal Astronomical Society*, vol. 370, no. 1, pp. 255–262, 2006. doi:10.1111/j.1365-2966.2006.10496.x.
- [6]Juett, A. M., Psaltis, D., and Chakrabarty, D., "Ultracompact X-Ray Binaries with Neon-rich Degenerate Donors", *The Astrophysical Journal*, vol. 560, no. 1, pp. L59–L63, 2001. doi:10.1086/324225.