



ITER-India
(Institute For Plasma Research)



Title	Enquiry No. I-I/ET-TPT/GTE/22001/22-23 dated 06-07-2022 for “Supply of Vacuum compatible Hybrid Pixel Photon Counting (HPC) detector head and other items”
Sub Title	PART-A (II): Scope of Supply, work and technical specifications


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Background


This is a proposal for procuring hybrid pixel photon counting detector which is to be used at ITER-India, IPR, India. This document describes the complete technical and application details to the manufacturers or suppliers. This is to enable the vendors to quote all relevant products with complete details, complying ITER-India requirements.

I. Application Details

Institute for Plasma Research is a premiere research institute pursuing research on plasma science and technology in India. ITER-India is an Indian domestic agency (In-DA, a center of IPR, carries out research and development to deliver the in-kind components/systems to the International Thermonuclear Energy Reactor (ITER). As a part of IN-DA deliverable, ITER-India needs to design, develop and deliver a high resolution X-Ray Crystal Spectrometer (XRCS-Edge) and a broad band X-Ray survey spectrometer to ITER (XRCS-Survey). These spectrometers will be used to measure ion temperature and impurity concentration of the ITER plasma, respectively.

These XRCS spectrometers have set of crystals and detector assemblies and operated in high vacuum. X-ray line radiation emitted from ITER-Plasma are dispersed using set of crystals and detected on a set of large area photon counting detectors. For the XRCS-Edge, the measurable energy is ~ 3keV and for XRCS-Survey, the measurable energy range is 2keV-13 keV. The X-Ray signals will be recorded with a time resolution of ~ 10 ms so typically few hundreds of frame per sec are required to fulfil this requirement.


This application proposes to purchase a detector system, to be used in prototype developmental activities carried out at the ITER-India laboratory.

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II. Technical specifications Hybrid Pixel Photon Counting detector

ITER-India intends to procure one integrated system comprising of detector head (free standing), detector electronics, detector server, cooling unit and other required accessories for the detection of X rays emitted in the range of 2 keV to 13 keV. The required technical specifications are given below.

Sr.No	Parameter	Unit	ITER-India specification	Additional Remark
A. Detector head				
1.	No. of detector modules	no	1	
2.	Detector Head type	-	Suitable for operation inside high vacuum	
3.	Sensor material and thickness	μm	Silicon ≥ 300	
4.	Number of Energy Thresholds	-	One	Lower energy threshold required and upper energy threshold desired.
5.	Minimum Energy threshold	keV	1.6	
6.	Area of detection (WxH)	mm ²	At least 85x30	Detection area must be free of gaps larger than the size of 1 pixel.
7.	Photon counting mode	-	Single photon counting	
8.	Read out time	ms	~ 1	
9.	Frame rate	Hz	Up to 500	
10.	Maximum count rate per pixel	cts/s	≥ 10 ⁷	
11.	Typical Quantum efficiency	%	> 50 at 2 keV > 90 at 6 keV	

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			> 70 at 13 keV	
12	Vacuum compatibility of head	mbar	At least 10^{-5} or better	
13	Leak rate for vacuum feed throughs	mbar l/s	10^{-8} or better	
B. X-ray Window				
14	X-ray window type	-	Removable mounting	
15	Window material	-	Preferably Mylar /PET	Please specify the coating material, provided for protection
16	Window thickness	μm	~ 10	
C. Detector Electronics				
17	Detector Electronics	-	To be provided along with the detector head	
D. Detector Controller				
18	Detector server /controller	-	To be supplied along with the detector head	Software to operate and control the integrated system.
19	External Triggers	-	Provision for external trigger	The integrated system should be operable in synchronization with an external trigger for each frame.
20	Data Communication port	-	Optical/ Ethernet	Specify the available option.
21	Calibration	-	Flat field calibration over the energy range of interest and threshold.	
E. External cooling for detector head				
22	Cooling Unit	-	To be supplied for cooling the detector head.	

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Additional requirements:

- Operating software compatible with window /Linux OS, EPICS support is desirable.
- All Standard accessories required for the operation of the detector in vacuum (e.g water feedthrough (CF)s, electrical feedthroughs (CF), Cu gaskets (Cu), optical converters etc.)
- Power supplies compatible with to power rating 230 V AC, 50 Hz and cables & connectors.
- Operation manual, technical manuals, and technical drawings (in English language).

III. A) Acceptance test criterion (FAT&SAT)

The final acceptance of the integrated systems will be given after the following two tests:


1. Pre-dispatch test at factory site by the supplier (ITER-India reserves the right to do Pre-dispatch Inspection (PDI) of the ordered item by ITER-India personnel at factory site)
2. Final acceptance test at ITER-India.

Part I: Pre-dispatch tests/Factory Acceptance Tests (FAT)

Before dispatching the detector system, the supplier needs to send a complete test report (details of the proposed tests are given in Appendix-1). If further modifications are necessary in the test procedures, supplier can suggest the same to ITER-India. The test criteria can be mutually agreed between both the parties within one month of placing the purchase order. The test report will be evaluated by ITER-India and if found satisfactory, ITER-India will send the dispatch clearance certificate. However, if it is necessary, Factory Acceptance Tests will be witnessed by ITER-India personnel at factory site.

Part II: Acceptance tests at ITER-India laboratory/Site Acceptance Tests (SAT)

At ITER-India lab, installation, testing and demonstration of system’s performance must be carried out either physically or remotely by the principal or by their Indian representative. After successful commissioning at ITER-India, a final acceptance will be given only when it complies with all the technical specifications.

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Appendix-1

Proposed Acceptance tests

Acceptance test report/certificate containing the following information:

1. Test for no or dead/bad pixels.
2. Detector stability for long operation of at least few hours (detector-burn test).
3. Detector calibration: energy threshold and flat field across energy range of interest.
4. Vacuum leak tightness of the feed throughs.
5. Detector response in the energy range of interest using suitable X ray source (2keV to 13 keV)
6. Trigger Test for checking the external synchronization.
7. Achievable frame rates.


The test no 4-6 will be performed at ITER-India lab as a part of Site Acceptance Tests.

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Appendix-2

Technical Compliance Matrix

Sr.No	Parameter	Unit	ITER-India specification	Offered Specifications	Compliance Yes/No
A. Detector head					
1.	No. of detector modules	no	1		
2.	Detector Head type	-	Suitable for operation inside high vacuum		
3.	Sensor material and thickness	μm	Silicon ≥ 300		
4.	Number of Energy Thresholds	-	One Note: Lower energy threshold required and upper energy threshold desired.		
5.	Minimum Energy threshold	keV	1.6		
6.	Area of detection (WxH)	mm ²	At least 85x30 Note: Detection area must be free of gaps larger than the size of 1 pixel.		
7.	Photon counting mode	-	Single photon counting		
8.	Read out time	ms	~ 1		
9.	Frame rate	Hz	Up to 500		
10.	Maximum count rate per pixel	cts/s	≥ 10 ⁷		
11.	Typical Quantum efficiency	%	> 50 at 2 keV > 90 at 6 keV		

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12.	Vacuum compatibility of head	mbar	At least 10^{-5} or better		
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B. X-ray Window					
14.	X-ray window type	-	Removable mounting		
15.	Window material	-	Preferably Mylar /PET Note: Please specify the coating material, provided for protection		
16.	Window thickness	μm	~ 10		
C. Detector Electronics					
17.	Detector Electronics	-	To be provided along with the detector head		
D. Detector Controller					
18.	Detector server /controller	-	To be supplied along with the detector head Note: Software to operate and control the integrated system.		
19.	External Triggers	-	Provision for external trigger Note: The integrated system should be operable in synchronization with an external trigger for each frame.		

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20.	Data Communication port	-	Optical/ Ethernet Note: Specify the available option.		
21.	Calibration	-	Flat field calibration over the energy range of interest and threshold.		
E. External cooling for detector head					
22	Cooling Unit	-	To be supplied for cooling the detector head.		