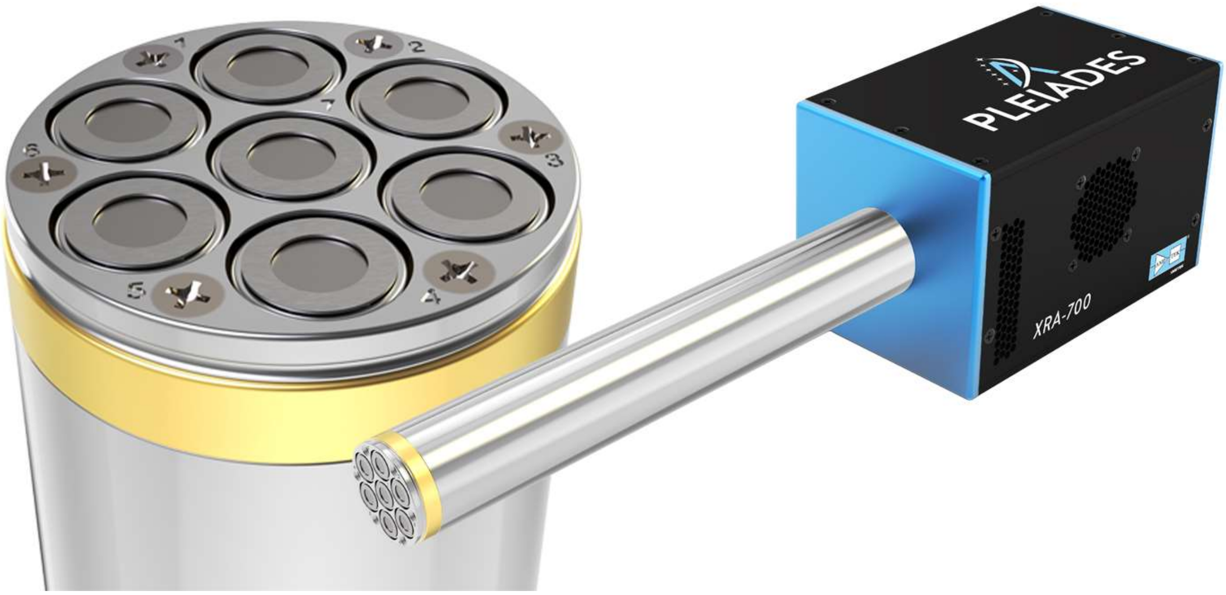
XRA-700 Pleiades User Manual



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1. Warnings and Precautions

CAUTION: READ MANUAL BEFORE USING THE PLEAIDES ARRAY

DO NOT DROP THE DETECTOR ARRAY, CAUSE MECHANICAL SHOCK TO THE ARRAY, OR CAUSE DAMAGE TO THE ARRAY EXTENDER AND ENCLOSURE

Mechanical shock can damage components inside individual detector packages.

The interior of the individual detector packages are under vacuum, necessary for proper detector operation. DAMAGE TO THE ARRAY IS NOT COVERED UNDER WARRANTY.

DO NOT TOUCH THE THIN WINDOW AT THE END OF EACH DETECTOR

BROKEN WINDOWS DAMAGED BY IMPROPER HANDLING WILL NOT BE COVERED BY WARRANTY.

Detector windows are thin to insure best efficiency. Windows can be extremely brittle and shatter easily.

Do not permit any object to come into contact with the windows.

Detector windows cannot be repaired or replaced. If a window breaks, the detector must be replaced.

Keep the protective cover installed over the end of the array extender when not in use.

MINIMIZE POSSIBLE OCCURRENCE OF RADIATION DAMAGE TO THE DETECTORS

A RADIATION DAMAGED DETECTOR WILL NOT BE COVERED UNDER WARRANTY.

The detector will experience radiation damage if it is exposed to a high flux environment for a significant amounts of time. Also, avoid radiation exposure to the preamplifiers and the enclosure electronics.

HIGH VOLTAGE IS PRESENT INSIDE THE ARRAY ENCLOSURE

Voltages to 800 V may be present.

AVOID ELECTROMAGNETIC INTERFERENCE

For best performance, pay attention to possible sources of electromagnetic interference. Use a single point electrical ground, use the shortest length cables possible, and keep the array far from sources of EMI, such as computer monitors, high power high voltage power supplies, etc. The signals from the detector are very small so performance can be degraded by EMI.

This product contains the following chemicals, which are known to the State of California to cause cancer,

WARNING

birth defects or other reproductive harm if exposed to them through improper use, storage, or disposal of the product:

Prop 65 Chemical	Type of Toxicity	CAS No.	Product part containing the chemical
Beryllium	Cancer	--	Detector window

Please consult this owner’s manual for proper use, storage, care, and disposal of the product. For more information, go to: https://www.p65warnings.ca.gov/

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2. Description

The Pleiades array is a single-unit assembly that is designed to house and operate up to seven (7) individually packaged Amptek detectors. Its primary use is to provide high efficiency measurement capability through a tightly packed detector arrangement that users can apply to optimize source measurement geometry.

The unit is compatible with most Amptek detector offerings. This includes both 0.5 mm and 1.0 mm thick versions of FAST SDD®s, and CdTe detectors. Each of the seven detector positions is definable and selectable at the time of ordering. Any combination, including FAST SDD® with CdTe, amongst compatible detector types may be chosen. Choices also extend to all varieties of detector window types – Be, C-series Si_3N_4, and B_4C – which are all compatible with the array. Appropriate preamplifiers and biasing supplies are implemented during manufacture assembly to provide potentially unique capabilities for each array unit.

Note: Detector types not available with the Pleiades are all versions of SiPIN detectors and the 160 mm^2 version of the FASTSDD.

The mechanical design of the array consists of a 2” diameter extender that houses the individual detectors in a hexagonal-plus-centered arrangement. The detectors all lie in an orthogonal focal plane on the extender. Detectors are rear mounted to a singular heatsink that provides a uniform point of reference for all detector projections from the extender. The nominal extender length is 300 mm. The extender terminates into the main array enclosure, a 6” x 6” x 12” box which holds heatsinking, a cooling fan, main control electronics, distributive connections, and power supply management. All connectivity exists on the rear face of the enclosure. The array sits on a mounting plate with integral feet for benchtop use. The overall weight of the array is 11 lbs.

The Pleiades array allows independent control for each detector, covering : 1) ON/OFF operational status, 2) operating voltage, and 3) operating temperature. It does not provide signal processing which must be supplied by the user. Each detector position is connected to a distinct preamplifier, referenced by positions 1 through 7, and is provided with a BNC output for independent data acquisition. Pleiades has Ethernet, RS232 and USB connectivity to allow configurability. A configuration file that describes the installed detectors is loaded at the factory, which in turn ensures that the operator selectable settings are conforming. The array is intended for use in typical interior, laboratory conditions. Normal precautions for handling the array include those associated with the installed detector windows, including sensitivity to mechanical breakage, possible chemicals and contaminants, and light-tightness for type C2 windows.

The preamplifiers installed within the Pleiades share the same operational characteristics as those supplied in standard Amptek single-detector measurement platforms. These include the X-123 integrated system, the XR100 preamplifier designed for use with the benchtop PX5 digital pulse processor, or PA230/PA210 preamplifier assemblies used in custom and OEM arrangements. Configuration and operation of the array is controlled through a simple PC-based application. Power is provided through a USB type-C connected external power supply.

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3. Package Contents

The Pleiades array is shipped in a single ruggedized and padded case which holds all standard accessories. Please retain for any future storage or transportation needs.

Items within the shipping case:

- (1) Pleiades array
- (1) protective end-cap cover
- (7) BNC cables, 6 ft length
- (1) USB, type A to B, 6 ft length
- (1) external power supply, type-C USB connector, 45 watts, with international AC adapters

Figure 1 Pleaides array and accessories as shipped.

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4. SETTING UP THE XRA700

4.1. Array Components

Refer to the below Figure 2 to understand the various parts of the XRA700 that are referred to in further parts of this documentation.

Array enclosure	holds the primary electronics, cooling fan and power distribution
Array extender	cylindrical support for the detectors and enclosing preamplifiers
Detectors	(up to) seven individually packaged Amptek detectors
Endcap cover	removable cover providing protection to detector windows
Base foot	removable sub-base on enclosure

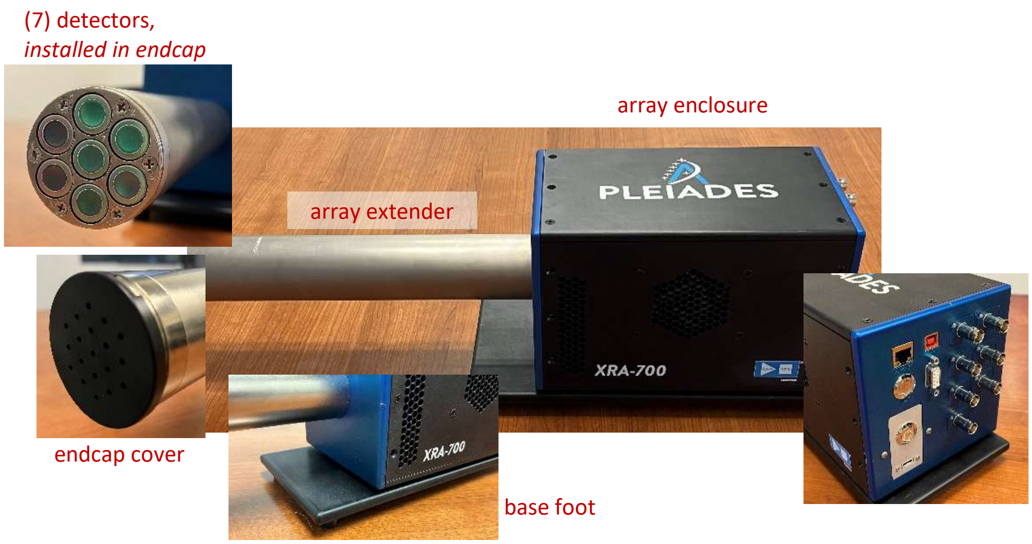

Figure 2 Understanding the components of the XRA700 array.

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4.2. Array Placement

The XRA700 is intended for operation in an indoor environment and free of physical hazards that may damage the sensitive detectors. The provided protective endcap is intended to be removed during use but should be re-installed whenever 1) the device is to be moved, 2) other instrumentation may come in contact, 3) the device is not in routine use, and 4) the device is placed into its storage case. The area of operation should be free of notable dust or particulate matter that may either settle on the detector windows or collect within the array enclosure via the fan aperture.

The integrated detectors utilize individual thermoelectric coolers (TECs) to reduce and regulate detector operating temperature. Setpoint temperatures for the detectors are individually configurable. The detectors are mounted within the extender which acts as a heatsink and is further actively cooled by a fan within the enclosure. Continuous operation of the fan is recommended for best thermal performance but is optional. It is the responsibility of the user to provide a reasonable operating environment for the array. High external operating temperatures may compromise cooling capability and ultimate detector performance (resolution).

The array may be situated at any angle (tilted), provided that there are assurances of protecting the detector windows and that the air flow of the fan is not hindered. The array should be supported through its base and not by clamping the extender. The base foot is removable (Figure 3), and it reveals two sets of threaded hole patterns (one SAE, one metric) that can be utilized for a custom mount. (See details elsewhere within the documentation). The enclosure itself is not intended for use as support for other equipment.

Figure 3. Removable base foot. If re-installing, ensure that the long end is positioned under the extender.

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4.3. Array Connections

Refer to Figure 4 below to understand the electrical connections which can be made to the XRA700.

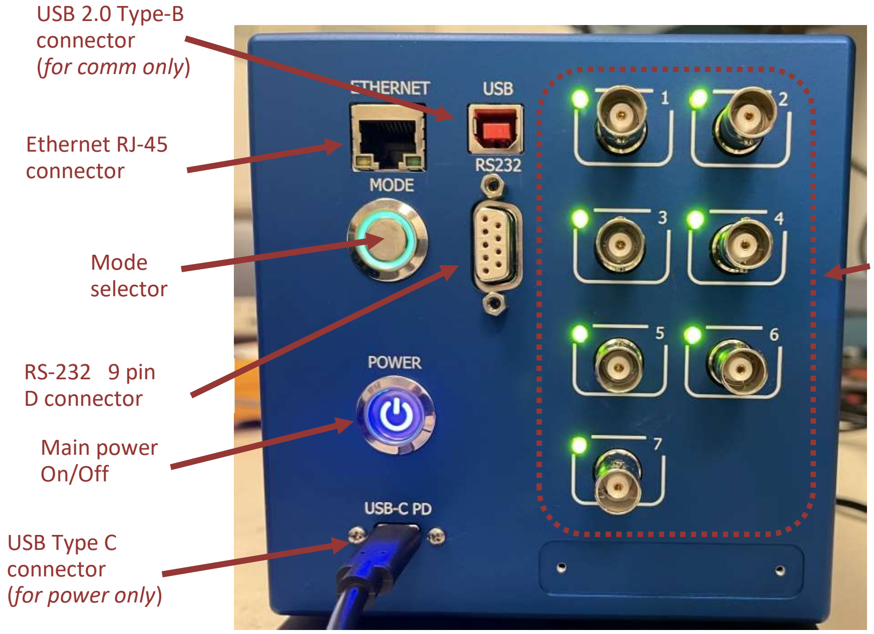

Figure 4. Rear panel connections on the XRA700.

4.3.1. Power

Power is provided to the XRA700 through an external 65 W AC power supply. It is important to use the power supply provided with the array and not an alternative. The power connection is made to the XRA700 via a USB Type C socket. There are two USB connections on the rear panel of the array – one for power delivery (bottom left) and one for communications (top center). ***These are chosen to have different connection styles and are not interchangeable.***

4.3.2. Detector Outputs

There are seven (7) individual detector preamplifier outputs on the rear panel, each with a standard BNC connection. The outputs are numbered to match the detector positions labeled on the detector endcap (Figure 5). Each of these outputs should be connected to a pulse shaping circuit that provides further signal processing, and spectroscopic data collection.

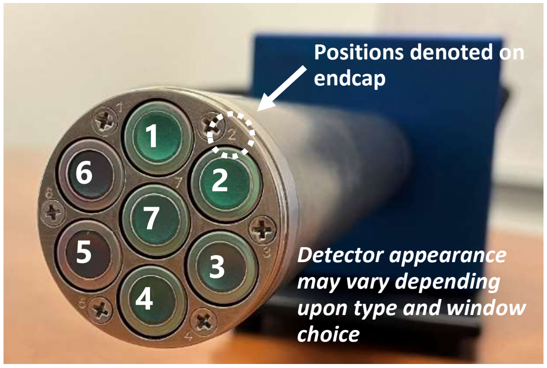

Figure 5. Detector positions and numbering, related to detector outputs on rear panel.

The end user is responsible for providing this capability as it is not an integral part of the XRA700 capabilities or package. Below is a non-exhaustive list of vendors of multichannel signal processors that may be considered. Custom systems and multiple implementations of single channel systems are also options.

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From Amptek [https://www.amptek.com]. Amptek offers the PXA700 system to users of the XRA700 system. It is a 7-channel version of Amptek's standard DP5 signal processing system. For those who have experience with the Amptek DPP platform, this may offer the most direct solution.

From XIA [https://www.xia.com]. XIA offers the FalconX system as a digital signal processor available in desktop and rack mount forms. It has a variable capacity of handling from 1 – 8 channels. The XRA700 has been evaluated to be compatible with the FalconX system.

From XGLabs [https://www.xglab.it]. XGLabs offers the Dante digital pulse processor that is specially designed for high end X-ray spectroscopy. It is a benchtop unit that provides 8 channels of input and may be daisy-chained to additional units. The XRA700 has been evaluated to be compatible with the Dante system.

The user is instructed to consult the instructions for each system to understand its capabilities and installation. Contact Amptek support when needed for further support when choosing a system or method.

4.3.3. Communications

There are 3 possible methods of establishing communications with the XRA700 – USB, RS-232, and Ethernet. All use standard connectors located on the rear panel. When the XRA700 control application is started, a dialog box will open that requires the user to identify which port is being selected. Only a single interface can be established at one time.

5. Basic Operation

The XRA700 is designed to operate with a configuration that is loaded into the instrument through one of the aforementioned communication protocols. When received, the unit will contain an initial configuration that was loaded during factory setup. The configuration format is a series of ASCII commands grouped together that are executed sequentially. The control application (described in Section 6) is the primary method for issuing these ASCII commands, as a new configuration, to the XRA700. Alternatively, each of these individual ASCII commands can be delivered singly, but such operation requires a customized application and is beyond the scope of this manual. See the XRA700 Programmer's Guide as the complete reference to all available ASCII configuration commands. It is up to the user to decide if the initial shipped settings are appropriate for actual usage. The unit will retain a configuration until it is replaced by a subsequent version. On system start-up, there is the option as to whether the unit should immediately 'boot' into the known loaded configuration, or to simply establish communications and await further interaction. Further description of boot options is described in Section 5.2.

5.1. Detector Voltage

The Pleaides array is assembled according to user specifications that primarily denote detector type and each detector position within the endcap. Detector choice implies a specific possible range of operating voltage to the detector, along with voltage polarity. If an array is specified to contain (at least one) 0.5 mm thick FASTSDD, then an appropriate HV supply for such detectors will have been installed and is controlled through ASCII command HVS2. Similarly, if 1.0 mm thick FASTSDDs are specified, then a distinctly separate supply will also have been installed also (controlled via command HVS3), or altogether instead of HVS2 if all 7 detectors are specified as such. Likewise, CdTe detectors have their own distinct HV supply (command HVS1). Thus, each individual Pleaides array may contain from one to three possible HV power supplies. In operation,

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the HV power supply corresponding to each *detector type* may be set by the user to a value within a preconfigured range (Table 1). It is not possible to set different HV values to detectors of the same type, nor possible to set which HV power supply is connected to a particular detector.

Description	Command	Parameter(s)
HV for CdTe detectors	HVS1	= [{+|-}###|OF{F}]; where ### is the value in volts, within the permissible range of 0 to 800 = OF{F} turns off the HV supply
HV for 0.5 mm thick FASTSDDs	HVS2	= [{+|-}###|OF{F}]; where ### is the value in volts, within the permissible range of 0 to -200 = OF{F} turns off the HV supply
HV for 1.0 mm thick FASTSDDs	HVS3	= [{+|-}###|OF{F}]; where ### is the value in volts, within the permissible range of 0 to -500 = OF{F} turns off the HV supply

Table 1. Detector HV power supply ASCII commands and settings.

5.1. Detector Temperature

Each Amptek detector possesses its own thermoelectric cooler and temperature sensor. Both are integrated into the basic TO-8 package that all Amptek format detectors share. Temperature control is enacted through regulating the voltage applied to the TEC in a closed-loop feedback system. The user needs only to select a setpoint temperature for each detector.

Recommended setpoint temperatures for detectors are as follows (Table 2). These are based on expectations that the array will be operated in an environment maintaining a customary room temperature (e.g., 292 -297 K). The suggested scheme is to choose a setpoint temperature that is slightly higher than the minimum achievable. This allows the TEC to operate at a voltage below its maximum allowable and thus provides a capacity to maintain a consistent detector temperature if the environment should rise beyond this typical range. Note that detectors are typically able to provide nearly equivalent performance over a wide temperature range below 250 K. See Figure 6 for resolution versus temperature curves and note the similar behavior for a range of temperatures up to 250 K for shaping times less than ~ 2 µs.

Detector type	Temperature
For 0.5 mm thick x 25 mm^2 FAST SDD® (*HSH3AMD)*	235 K
For 1.0 mm thick x 25 mm^2 FAST SDD® (*HSH4AMD)*	235 K
For 0.5 mm thick x 70 mm^2 FAST SDD® (*HS63CMD)*	235 K
For 1.0 mm thick x 70 mm^2 FAST SDD® (*HS64CMD)*	240 K
For all CdTe detectors	240 K

Table 2. Suggested detector setpoint temperatures.

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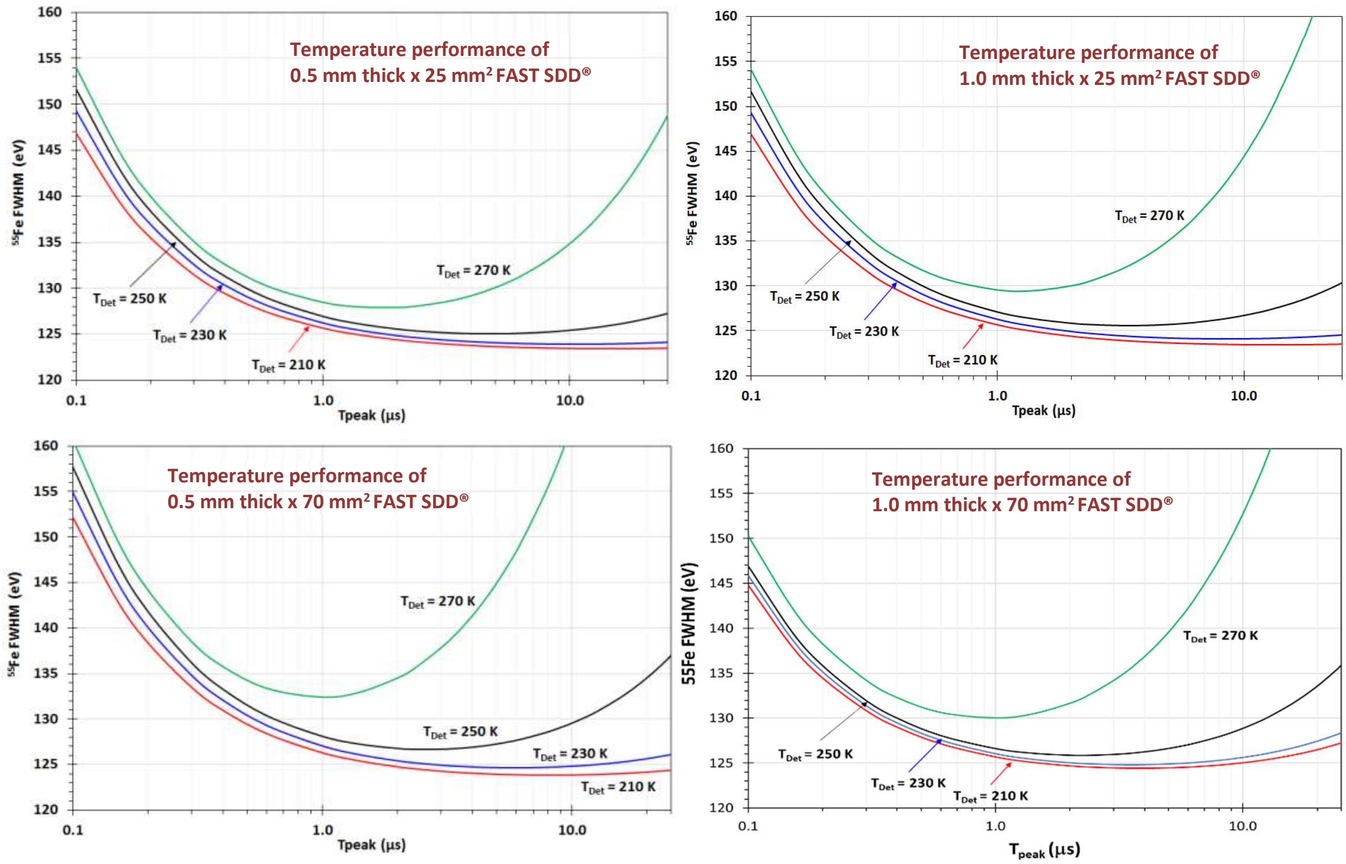

Figure 6. Resolution performance of varied FAST SDD ® models at differing temperatures.

The ASCII commands for controlling the individual detector temperatures are listed below in Table 3.

Description	Command	Parameter(s)
Setpoint temperature for detector (channel) #1	TEC1	= [####|OF{F}]; where ### is the value in Kelvin (K), within the permissible range of 0 to 299 = OF{F} turns off the TEC power supply
Setpoint for detector #2	TEC2	Similar to TEC1
Setpoint for detector #3	TEC3	Similar to TEC1
Setpoint for detector #4	TEC4	Similar to TEC1
Setpoint for detector #5	TEC5	Similar to TEC1
Setpoint for detector #6	TEC6	Similar to TEC1
Setpoint for detector #7	TEC7	Similar to TEC1
Setpoint for all detectors	TECS	Allows setting the same setpoint for all detectors in a single command

Table 3. Detector temperature (TEC) ASCII commands and settings.

5.2. Array Boot Behavior

The XRA700 can be configured to turn on ('boot') in one of three distinct manners. These are known as 'boot modes' and they involve interaction between the main power button and the MODE button. The power button provides straightforward operation of powering up/down the unit (and becomes illuminated

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when 'ON'). The MODE button can be pressed (operated) at the same time to provide specific behavior regarding the loading of a configuration. It is typically the act of loading a configuration (grouped ASCII commands) that initiates the cooling of the detectors and application of HV to the detectors. The specific modes are described below in Table 4. The XRA700 will be shipped with the boot mode set to AUTO, such that the unit will automatically load a configuration when powering on. It is easiest to understand if a configuration has been loaded by appearance of the MODE button. It will be RED if a configuration has not been loaded and will be GREEN if one has been loaded. When it is desired to turn the XRA700 off, it is only necessary to depress the power button again until the button illumination disappears.

Description	Command	Parameter(s)
Boot mode, describing functionality of MODE button	BTMD	= [DEF|DEL|AUT] Where if DEF{AULT}, no configuration is automatically loaded unless done simultaneously with MODE button depressed Where if DEL{AY}, no configuration is automatically loaded but depressing MODE afterwards will load the configuration unless done simultaneously with MODE button depressed Where if AUT[O], configuration is automatically loaded but can be prevented if done simultaneously with MODE button depressed. (AUT and DEF are essentially opposite boot modes)

Table 4. Boot mode settings.

5.3. Detector Status

On the rear panel adjacent to each detector output, a multicolor LED displays the status of each detector. If a configuration has not yet been loaded, all the LEDs will be OFF (not illuminated). If a configuration has been loaded, the LEDs will indicate status as described in the below Table 5.

Detector Status	LED Appearance
Initial state (no configuration loaded)	LED = OFF
Detector is cooling	LED = blinking GREEN
Detector at setpoint	LED = steady GREEN
Detector fault	LED = steady RED
Detector disabled in configuration	LED = steady AMBER

Table 5. Detector status indicators.

Another group of ASCII commands that could be useful in the event of a damaged or inoperable detector is 'C{x}EN = OFF', where {x} is the detector channel 1-7. This command disables the channel completely, so that other group commands can be subsequently issued (such as TECS) without the unit attempting to cool the disabled channel. The detector channel will remain in this disabled state until it is re-enabled with a 'C{X}=ON' command.

5.4. Fan Usage

The XRA700 enclosure incorporates a fan with the purpose of augmenting heat dissipation from the extender and detectors. Noted earlier, the entrance/exit vents of the enclosure should be kept free from obstruction in order to maintain air flow when operating the fan. Use of the fan is not mandatory for

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operation of the array; however, it is generally beneficial if the array is to be operated in a warm environment and it provides greater temperature stability. When shipped, the array holds a configuration that will enable the fan usage. The ASCII command to enable/disable fan operation is 'FANE = [ON|OFF]'.

5.5. Basic Configuration

The Pleaides array is shipped with a loaded configuration that should provide optimal performance under typical operating conditions. Though each system may be assembled and delivered differently (reflecting user detector choices), this section describes how the basic ASCII commands should be assembled in the configuration text file to produce this performance. The ability to change configurations is further described in the Control App section of this document and the XRA700 Programmer's Guide can also be referenced for more specifics . For simplicity, the example (Figure 7) shows use of the Notepad.exe editor included with Microsoft Windows. The below Table 6 explains the contents of the above configuration file.

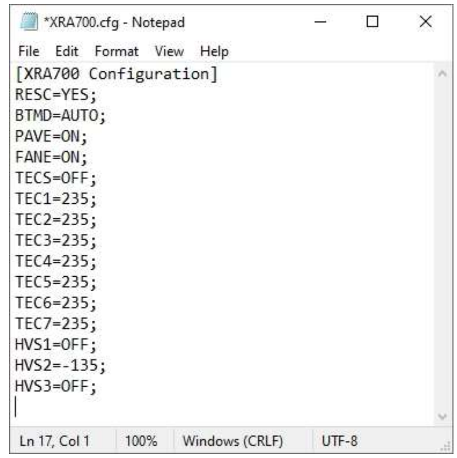
*XRA700.cfg - Notepad
File Edit Format View Help
```
[XRA700 Configuration]
RESC=YES;
BTMD=AUTO;
PAVE=ON;
FANE=ON;
TECS=OFF;
TEC1=235;
TEC2=235;
TEC3=235;
TEC4=235;
TEC5=235;
TEC6=235;
TEC7=235;
HVS1=OFF;
HVS2=-135;
HVS3=OFF;
```
Ln 17, Col 1 100% Windows (CRLF) UTF-8

Figure 7. Example configuration file. This example is for an array having only 0.5 mm thick FAST SDD® installed, thus only HVS2 is defined.

[XRA700 Configuration]	A title block that needs to be the first line.
RESC=YES;	**Reset Configuration**. Set to YES in order to remove settings from previous configuration commands stored in non-volatile memory.
BTMD=AUTO;	**Boot Mode.** Set to AUTO so that the previous configuration will be automatically loaded at power up; unless the MODE button is simultaneously pressed**.**
PAVE=ON;	**Preamp Voltage Enable**. Set to ON to turn on power to preamplifiers.
FANE=ON;	**Fan Enable.** Set to ON to turn on fan.
TECS=OFF;	**TECS** (All detectors TECs). Initially set all to zero power (voltage).
TEC1=235;	**TEC1.** Set detector #1 (channel #1) to 235 K setpoint.
TEC1=235;	**TEC2.** Set detector #2 (channel #1) to 235 K setpoint.
TEC1=235;	**TEC3.** Set detector #3 (channel #1) to 235 K setpoint.
TEC1=235;	**TEC4.** Set detector #4 (channel #1) to 235 K setpoint.
TEC1=235;	**TEC5.** Set detector #5 (channel #1) to 235 K setpoint.
TEC1=235;	**TEC5.** Set detector #6 (channel #1) to 235 K setpoint.
TEC1=235;	**TEC5.** Set detector #7 (channel #1) to 235 K setpoint.
HVS1=OFF;	**High Voltage Supply #1 Setpoint.** HV supply for CdTe detectors set to OFF (presuming no CdTe detectors installed).
HVS2=OFF;	**High Voltage Supply #2 Setpoint.** HV supply for 0.5 mm thick FAST SDD® set to -135 V.
HVS3=OFF;	**High Voltage Supply #3 Setpoint.** HV supply for 1.0 mm thick FAST SDD® set to OFF (presuming no 1.0 mm thick FAST SDD® installed).

Table 6. Explanation of example configuration file.

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6. PXA700 CONTROL APP

6.1. Software Installation

The XRA700 array comes with a Windows PC-based control app for remote monitoring of the array status and uploading different operational configurations. All Amptek software is made available for downloading by visiting the site https://www.amptek.com/software.

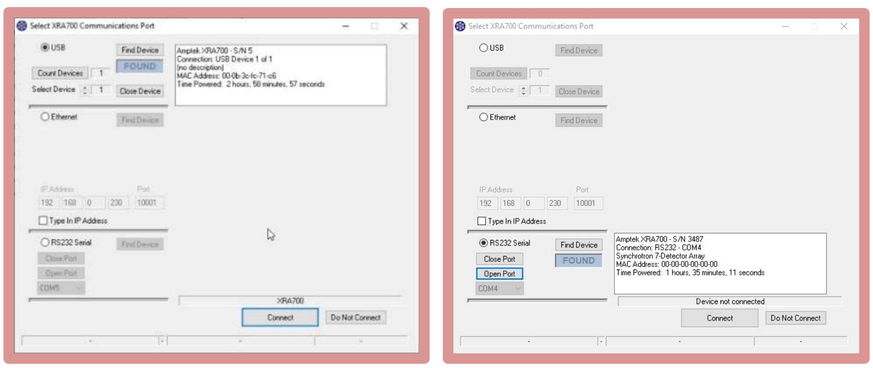
For users that intend to utilize USB communication, a USB driver must first be installed. Visit the above webpage and scroll to the Software Download page to find the WINUSB Driver for X123/DP5/PX5/Mini-X2. If you are already a user of Amptek products, such as an X123 or PX5 digital pulse processor, this step is not necessary since these devices share the same driver. Note that it is best to keep this driver up to date. The required minimum version must reflect FW6 compatibility for most current Amptek products. More information about driver updates is found in the instructional file within the downloaded ZIP file.

The main XRA700 control app is provided as a simple ZIP file (XRA700.ZIP) that contains: 1) the executable application, 2) an initial configuration file, 3) an INI file, and 4) an example status report file. There is not an installation application; the included executable file is the actual application. The user should choose a convenient location to create a folder (e.g., 'XRA700') and unzip the 4 files into this folder. When creating new configuration files that may be uploaded to the array, it is best if they are kept within this same folder. Also, when status report files are generated, they will also reside in this folder.

6.2. Initial Startup

When starting the XRA700 control application, the user must first identify to which communication port the XRA700 is connected. Options are USB, Ethernet, and RS-232. Once the port is selected, it may be necessary to instruct the application to find the proper device (Figure 8) if it is not identified automatically. Once the protocol and device are selected, choose **Connect**. The application should respond by opening the main screen with an initial status update on the detectors.

Figure 8. Selection of XRA700 Communications Port. Examples shown of USB (at left) and RS-232 (at right).



The XRA700 app has a simple user interface which automatically starts to display various system settings without any prompting. The main window lists for each detector (channel) its: Status, HV feedback, temperature feedback (in K), and TEC voltage. In typical operation, these values will be regularly updated at ~1 second intervals. The Status value will correspond to the colored LEDs on the array rear panel. The 'HV Mon(itor)' is the feedback of the high voltage on the detector. Since each detector produces its own feedback and is subject to variations due to its own specific electronic components, it is normal for all

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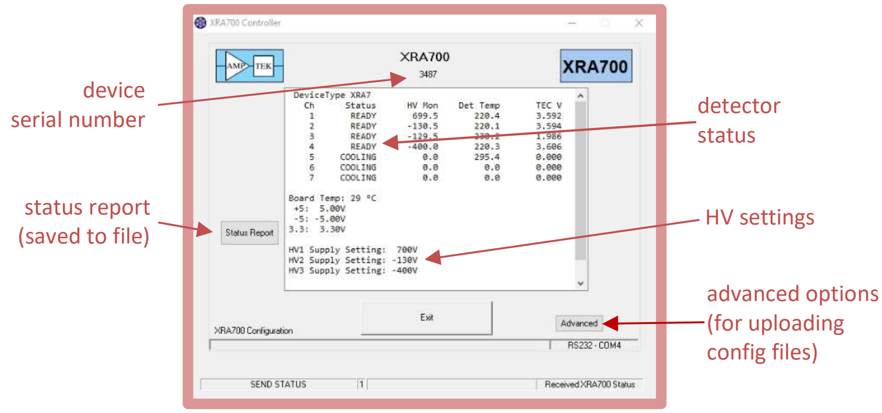
detectors of a similar type to not show the exact same value. These instead may be within a few volts of the target value (listed further below in the HV settings section). The ‘Det Temp(erature)’ values will fluctuate within typically 1-2 K when they reach a steady ‘Ready’ state. If the detectors have not yet fully reached their individual target setpoint, they will show a ‘Cooling’ status. Irrespective of temperature status (Cooling vs Ready), the detector output will provide valid signals (although performance may not yet be optimized).

Figure 9. Main XRA700 application window showing detector and system status.



6.3. Uploading Configurations

The operating configuration that is loaded onto the array as originally shipped should provide superlative performance over a range of operating conditions. However, if different settings are desired, the control app provides the ability to load a new configuration file. Noted earlier, configuration files are simple ASCII text files that can be edited using common utilities. Before uploading a new configuration, it is recommended that the user run a Status Report (from the main app window) since it will contain a full listing of the current version. The process can then be repeated after loading the new version, to verify success. Status Report files are automatically generated whenever the button is pushed from the main window. The naming convention is “XRA700StatusReport_XXXXXXXX_YYYYYY.txt” where “XXXXXX” is the date in the format of [year][month][day] (e.g., “20240501” is May 1st, 2024) and “YYYYYY” is the time in the format of [hr][min][sec] (e.g., “141824” is 2:18:24 PM). They are placed in the same folder as the main application.

To load a new configuration, move to the Advanced functions window, and then put a checkmark in the ‘Select Read/Write File’ block. If the checkmark is not utilized, then the application will look to load a default file named “XRA700.cfg” located in the same folder. Checking the “Select …” option allows one to load files that may be differently named or located in different folders. Follow by clicking on the “Write Configuration” button directly beneath. Once this occurs, the new configuration will become active. Check that it has been successfully loaded by exiting from this Advanced options window (no other functionality is intended for user access) and then run a new Status Report from the main window.

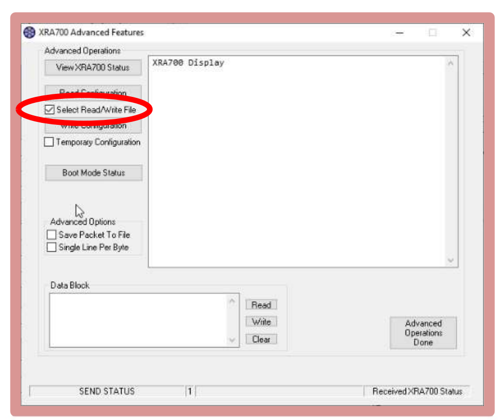


Figure 10. Advanced Options window where new configuration can be loaded. Note the checked "Select Read/Write File" option. When complete, use the button at lower right to return to main window.

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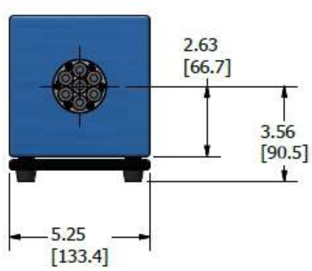
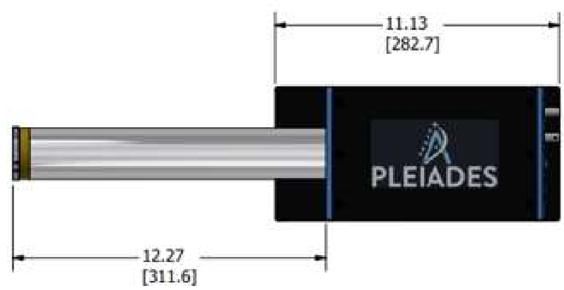
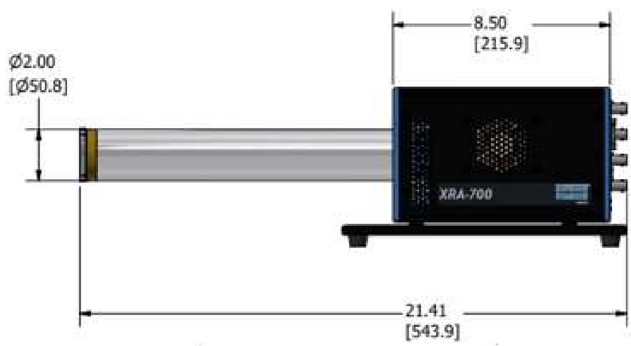
7. Specifications

7.1. Physical & Miscellaneous Attributes

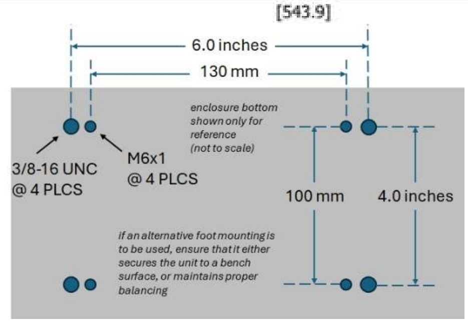
Overall length	544 mm [21.4”]
Overall height	157 mm [6.2”] (base foot included) 133 mm [5.25”] (base foot excluded)
Base foot length	283 mm [11.1”]
Extender diameter	50.8 mm [2”]
Extender length	312 mm [12.3”]
Extender height	90.5 mm [3.6”], bottom of base to extender axis 67 mm [2.6”, bottom of enclosure to extender axis
Weight	5.1 kg (11.3 lb.)
Temperature	operating: -35 °C to +80°C storage: -40 °C to +85°C *note that operating the array at elevated temperatures will impact its ability to cool detectors to recommended setpoints*
RoHS	compliant
Warranty	1 year







base foot
hole pattern



7.2. Mechanical Interface

Power Entry	USB Type C
Power Switch	Push button; illuminated BLUE when power is applied
(Boot) Mode Switch	Push button; illuminated RED if no previous configuration loaded, illuminated GREEN if configuration successfully loaded
Ethernet Communication	Standard Ethernet RJ-45 connector
USB Communication	USB 2.0 Type B connector
Serial Communication	9 pin DE connector, female
Detector Outputs (7)	BNC
Detector Status (7)	Illuminated LEDs, multicolor

7.3. Preamplifiers

The preamplifier installed within the XRA700 for all compatible Amptek FAST SDD® utilizes a reset design. This is consistent with all other Amptek preamplifier designs in other formats, such as the XR100 or OEM-style PA210/PA230. Supply voltages to the preamplifiers and the temperature control circuits are all integral to the XRA700 design and do not require any user invention. High voltages are generated internally and passed through the preamplifiers to the detectors.

The output of a FAST SDD® preamplifier is seen as a ramping (sawtooth) signal that decreases in frequency as the leakage current of the detector lessens. The signal ramp resets within a typical range of -1 to +2 V for FAST SDD®. Correspondingly, detector leakage current decreases with temperature. Thus, if one observes the resetting signal as the detector is cooling (without any radiation incident), the reset period will gradually lengthen, ultimately reaching a value of tens of ms (Figure 11, left). Shortened in time and when radiation is introduced, each interaction produces a positive step-wise increment, proportional in height to the deposited energy (Figure 11, right).

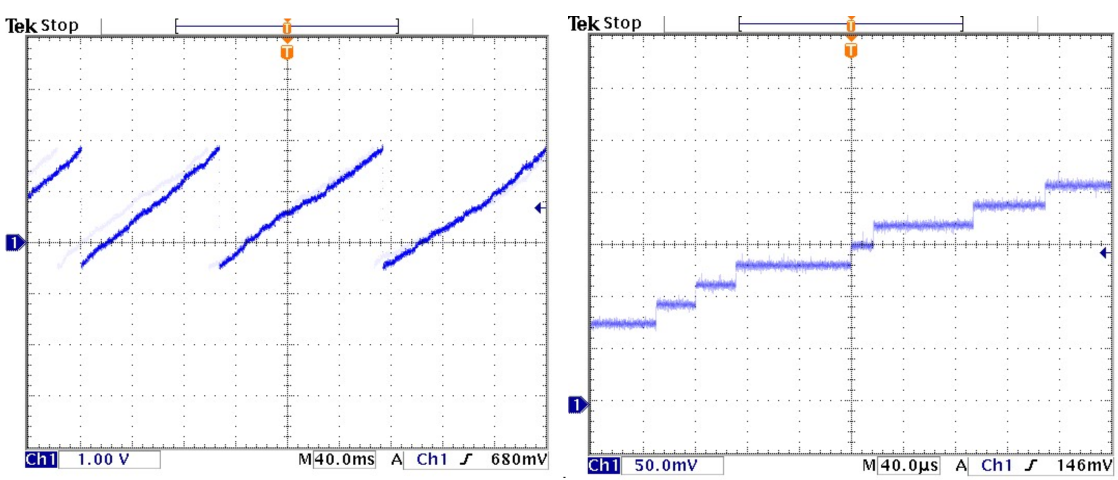


Figure 11. FAST SDD® signal outputs. On left: typical full reset ramp. On right: typical signals seen from a FAST SDD® preamplifier with each X-ray interaction resulting in a positive going step of ~3.6 mV/keV.

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8. Detector Reference

8.1. Core Detector Technology

Amptek provides a family of high performance, compact X-ray detectors and associated signal processing electronics. The radiation detectors are custom photodiodes, including traditional Si-PIN diodes, **S**ilicon **D**rift **D**etectors (SDDs), and CdTe Schottky diodes. The detector is mounted on a two-stage thermoelectric cooler along with the key preamplifier components. The cooler keeps the detector and key components at -25°C or below, reducing electronic noise without cryogenic liquid nitrogen and drawing <1W. This cooling permits high performance in a compact, convenient package, and has been critical to the development of portable XRF analyzers and of high performance, benchtop XRF and EDS systems.

Amptek's detectors represent the state-of-the-art in X-ray spectroscopy, delivering the best energy resolution, best efficiency at low energies, highest count rates, highest peak to background ratios, all at low cost and suitable for portable systems, vacuum systems, etc.

They are used by OEMs and by laboratory researchers. The core enabling technologies include the detectors themselves (which are designed and manufactured by Amptek), the low noise JFET and CMOS technology, and the packaging which enables good cooling in a robust system.

Figure 12 illustrates a detector mounted on a thermoelectric cooler, on a TO-8 header. The input FET and other components are also mounted on the cooler. A nickel cover (also shown) is welded to the TO-8 header with vacuum inside the enclosure for optimum cooling. In the cover is a window (shown as green) to enable soft X-ray detection. This is typically beryllium for energies > 2 keV. Newer options from Amptek include 'C-series' Si_3N_4 windows available for lower energies and general purpose B_4C windows for Be-free usage. The entire assembly shown above is sometimes called the "detector", though strictly speaking it is the photodiode which detects the X-rays.

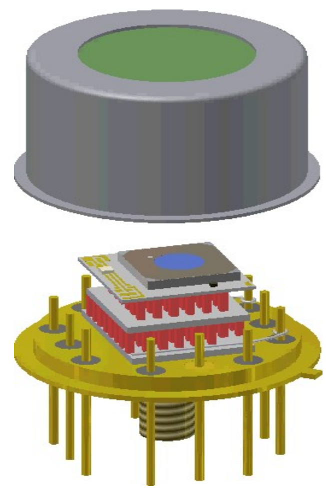

Figure 12. Amptek construction common to multiple sizes and types of detectors.

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8.2. FAST SDD® Options

The below Table 7 compares the four Amptek FAST SDD® models that are compatible with the XRA700 Pleiades array. Note that there may be multiple window options available for each detector; contact Amptek sales for the most up-to-date information on availability.

	25 mm^2 × 0.5 mm thick **HSH3AMD**	25 mm^2 × 1.0 mm thick **HSH4AMD**	70 mm^2 × 0.5 mm thick **HS63CMD**	70 mm^2 × 1.0 mm thick **HS64CMD**
General Specifications				
Detector Size	25 mm^2	25 mm^2	70 mm^2	70 mm^2
Collimated Area	17 mm^2	17 mm^2	50 mm^2	40 mm^2
Thickness	0.5 mm	1.0 mm	0.5 mm	1.0 mm
Collimator Type	internal multilayer			
Preamplifier Type	CMOS reset design			
Energy Resolution at 5.9 keV (55Fe)				
Guaranteed at T_{pk} = 4 µs	≤ 129 eV FWHM	≤ 131 eV FWHM	≤ 135 eV FWHM	≤ 135 eV FWHM
Typical at T_{pk} = 1 µs	126 eV	128 eV	127 eV	129 eV
Typical at T_{pk} = 0.2 µs	134 eV	136 eV	139 eV	
Energy resolution @ C Kα (typical)	44 eV		47 eV	
Other Performance				
Peak-to-background (typical, Be & Si_3N_4)	≥ 20,000:1	≥ 20,000:1	≥ 20,000:1	≥ 20,000:1
Signal Risetime	< 35 ns	< 35 ns	< 60 ns	< 35 ns
Maximum input count rate	> 1 Mcps	> 1 Mcps	> 1 Mcps	
Signal Output				
Sensitivity	3.6 mV/keV			
Gain Stability	< 20 ppm/°C			
Polarity	positive			
Reset range	-1 to 2 V (typical)			
Cooling				
Cooling capability, ΔT_{max}	75 °C	75 °C	75 °C	70 °C
Cooler type	2-stage thermoelectric (TEC)			
Temperature monitor	diode			
Power				
HV Bias (typ. operable range)	-100 to -180 V	-375 to -450 V	-100 to -180 V	-375 to -450 V
Other				
Operating range	-35 °C to +80°C; performance degrades at elevated temperatures			
Storage & shipping	-40 °C to +85°C, 10% to 90% RH noncondensing			
RoHS	compliant			
Lifetime	typical 5 to 10 years, depending on use			
Warranty Period	1 year			

Table 7. Comparison FAST SDD detectors for the XRA700.

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8.3. CdTe Options

The XRA700 can also be configured to use one or more CdTe detectors. The 1 mm thick CdTe detectors that Amptek offers provides a higher sensitivity to x-rays above 20 keV. It is packaged similarly to the FAST SDD® detectors (TO-8 style) but utilizing window materials that are more robust and appropriate for higher energy radiation. Please contact Amptek sales for specifics.

	$25\ mm^2 \times$ 1.0 mm thick **CC5420D**
General Specifications	
Detector Size	$25\ mm^2$
Thickness	1.0 mm
Collimator Type	uncollimated
Preamplifier Type	Amptek custom reset design
System Performance	
Energy res. at 122 keV (^{57}Co) (guaranteed)	$\leq$ 1.5 keV for T_{pk} = 2.8 µs
Energy res. at 60 keV (^{241}Am) (typical)	$\leq$ 0.7 keV for T_{pk} = 2.8 µs
Energy range	5 – 150 keV
Maximum input count rate	50 kcps
Signal Output	
Gain Stability	< 20 ppm/°C
Polarity	negative
Cooling	
Cooling capability, ΔT_{max}	> 75 °C
Cooler type	2-stage thermoelectric (TEC)
Temperature monitor	diode
Power	
HV Bias	500 to 800 V
Other	
Operating range	-35 °C to +70°C; performance degrades at elevated temperatures
Storage & shipping	-40 °C to +85°C, 10% to 90% RH noncondensing
RoHS	compliant
Lifetime	typical 5 to 10 years, depending on use
Warranty Period	1 year

Table 8. CdTe detector option for the XRA700.

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9. Warranty and Technical Questions

9.1. Warranty

AMPTEK, INC. warrants the original purchaser of this instrument to be free from defects in materials and workmanship for a period of one year from shipment. AMPTEK, INC. will, without charge, repair or replace (at its option) a defective instrument upon return to the factory. This warranty does not apply in the event of misuse or abuse of the instrument or unauthorized alterations or repair. AMPTEK, INC. shall not be liable for any consequential damages, including without limitation, damages resulting from the loss of use due to failure of this instrument. All products returned under the warranty must be shipped prepaid to the factory with documentation describing the problem and the circumstances under which it was observed. The factory MUST be notified prior to return shipment. The instrument will be evaluated, repaired, or replaced, and promptly returned if the warranty claims are substantiated. A nominal fee will be charged for unsubstantiated claims. Please include the model and serial number in all correspondence with the factory.

9.2. Technical Questions

- Please refer to http://amptek.com/technical-support/
- Please have the model and serial numbers of your Amptek device(s) available. Please have available a description of the signal processing and other electronics used with the device.
- Contact Amptek at amptek.sales@ametek.com or +1 781-275-2242.

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