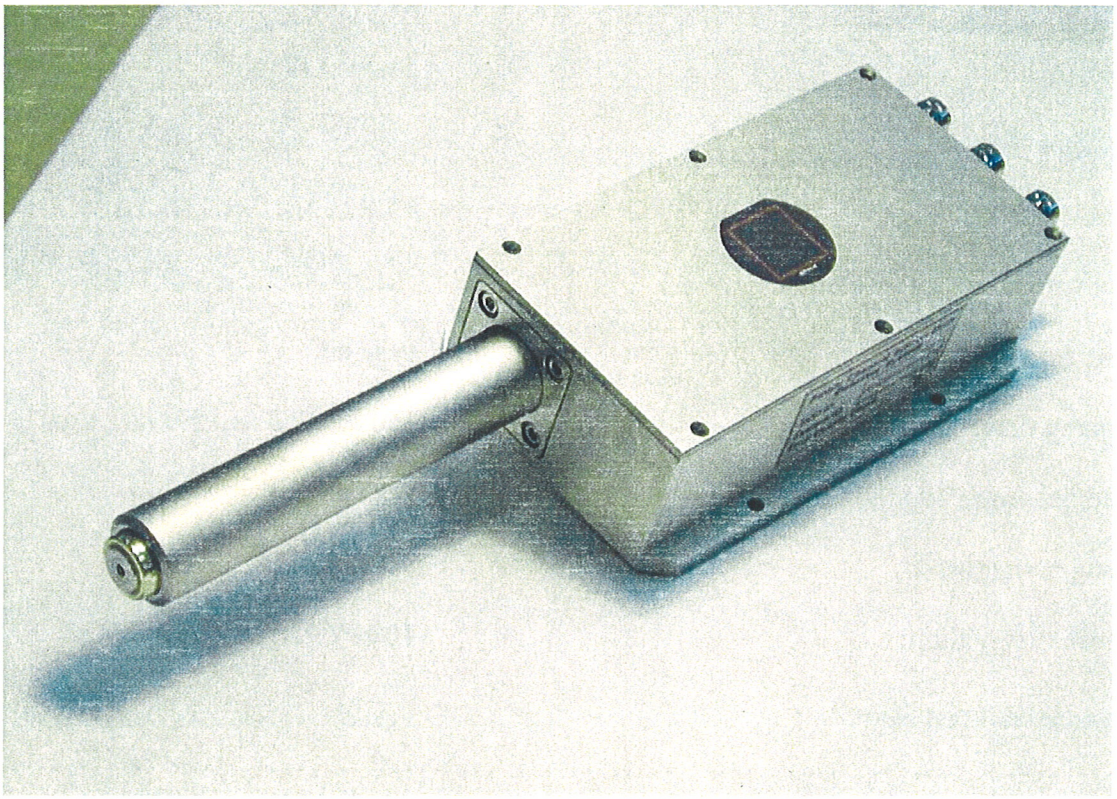
AXAS

(Analog X-ray Acquisition System)



Operating Manual

KETEK

Creative Detector Solutions

Custom specifications

AXAS no. 00041

Radiation entrance window:	Beryllium / AP3.3
Snout length:	50 mm / 100 mm
Detector area:	5 mm^2 / 10 mm^2
Detector type:	SDD 5 - 145500
Serial number:	SDD 01849
Guaranteed energy resolution:	143 - 147 eV
Shaping amplifier:	yes / no
Shaping time:	150 ns / 250 ns / 500 ns / 1 µs
External power supply:	yes / no
Vacuum tightness:	yes / no
Upper energy limit:	10 keV / 20 keV / 30 keV

Other special features:

additional shaping time plug in boards
0.5 / 0.25 / 0.15 µs

In case of questions or warranty please contact:

KETEK GmbH
Gustav-Heinemann-Ring 125
D-81739 Munich

Mail: support@ketek.net
Tel.: ++ 49 89 67346770
Fax.: ++ 49 89 67346777

Caution

- This document contains data valid only for the AXAS system you purchased it with. Please do not use it as a reference to operate any other devices you purchased earlier or later on from our company.
- Do not drop or cause mechanical shock to the AXAS, especially if you purchased a system with an open detector module.
- Avoid any kind of high forces and/or torques during mounting of the AXAS, especially if you purchased a system with an open detector module.
- Do not operate the AXAS at a temperature (measured at the steel electronics case) above 35 °C. Apply additional cooling to the steel case if necessary (contact to heat sink, gills, PC air cooler etc.). The performance of the system will noticeably worsen above this temperature.
- Do never change the settings of the sealed potentiometers inside the electronics case. Every system is adjusted carefully before delivery. We will not take any warranty for systems damaged by manipulation of these potentiometers or adjust the system a second time for free, if you did not contact us first.
- Do not touch or apply any mechanical force or shock to the radiation entrance window (Beryllium or Ap3.3) integrated at the front end of the AXAS. The integrity of each window is checked carefully before delivery and no warranty will be taken if it is damaged by the customer. Moreover breaking the window during operation of the system will most probably destroy the whole detector.
- Take care to connect the output contacts and the test input properly as it is described in this manual later on.
- Take care to follow the instructions regarding the power input to the system given in this manual. Otherwise the system may be destroyed. KETEK recommends a power supply described in this manual later on.
- Do never operate a windowless detector in a moist ambient (air is a moist ambient). It will most probably be destroyed due to the formation of water/ice on the detector surface.
- Do not touch or apply mechanical force or shock to the detector chip or mounting components if you purchased a windowless detector system. These parts are very fragile and are easily damaged.
- It is recommended to store a windowless detector under dry nitrogen atmosphere to avoid moisture and contaminations.
- Do not expose the detector to a high particle flux (such as ions or electrons). Damages done by incident particles will not be covered under warranty.
- Concerning radiation damage done by photons a maximal dose is guaranteed for each detector. In case of malfunction it is due to the customer to bring evidence that this dose has not been applied.

KETEK

* The picture on the title page shows the AXAS detector system (left) and the optional power supply (right) recommended by KETEK.

Operating instructions

The AXAS-detector system should be kind of plug and play. That means you should not have to change anything on the system itself. If this though is necessary contact us first in any case! After you unpacked the different components please connect them to each other and the components you supply by yourself regarding to the connection diagram inside this manual.

Packing list:

You should have received the following components:

- AXAS detector system, including detector, preamplifier, shaping amplifier (removed on customers demand), temperature control and internal power supply
- External ± 12 V power supply if purchased.
- Additional shaping time boards if purchased.
- This manual. (Invoice will be sent with separate mail!)

Dimensions and SUB-D connector:

A technical drawing inside this manual gives the dimensions of the AXAS system, the pin definition of the integrated male SUB-D9 connector, and the definitions of the other input and output connectors in detail. Please never connect any pin, input or output in a different way or you may destroy the detector. Please note that the drawing corresponds to an AXAS system with a 100 mm snout. So this dimension may vary if you purchased a system with a different snout length.

Shaped output / radiation entrance window:

The BNC / Shaper OUT output provides an amplified, shaped signal (see example inside this manual / typical rise and fall time curves are attached too) within a voltage range from 0 to the value you specified (maximal 10 V, input impedance 1 mega ohm). It can be used as input signal to a standard ADC. The detector is calibrated in a way that the mentioned voltage spread covers a spread of x-ray energies from 0 to the upper energy limit you specified. The theoretical lower limit of the detector is about 200 eV but due to the entrance window you purchased the practical lower limit may be higher (e.g. for Beryllium about 1 keV). For more detailed information on the transmission of your entrance window please have a look at the attached transmission curves.

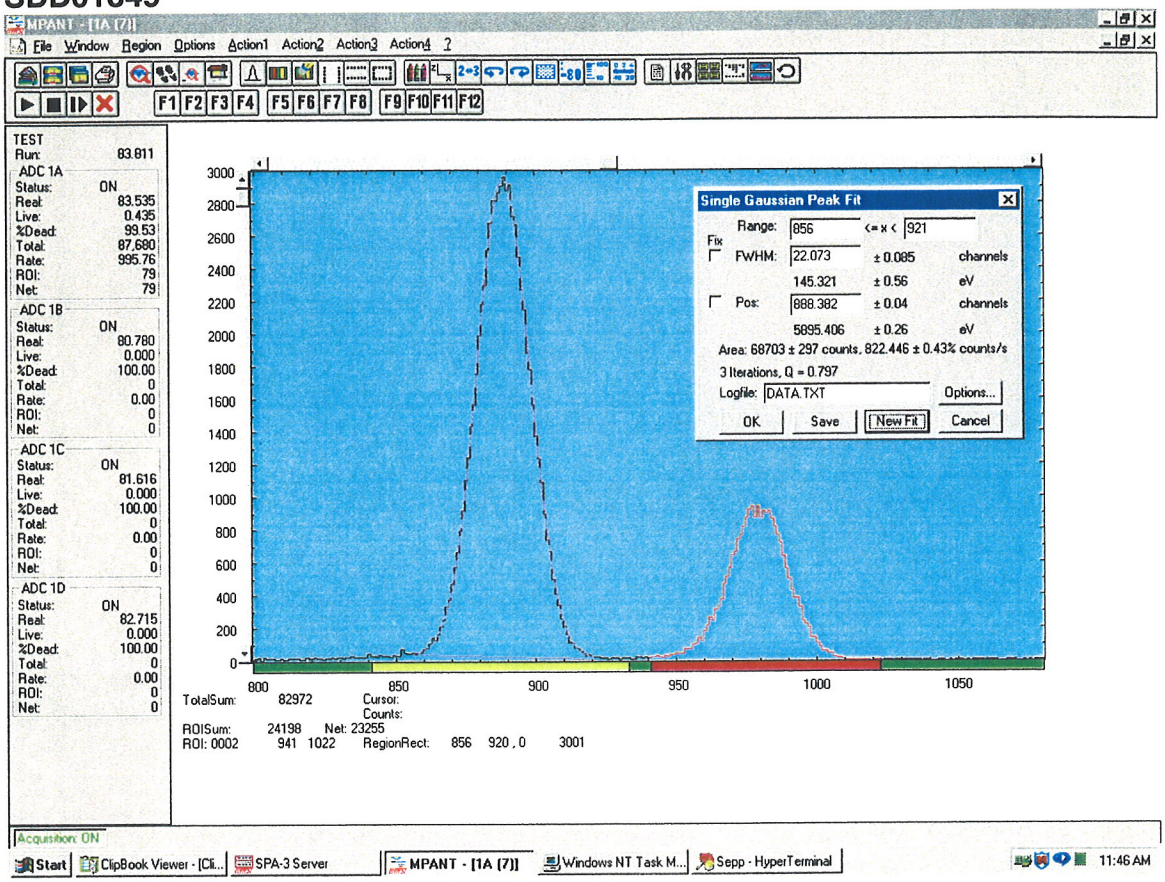
Pre-amplified output / test pulse input:

If you did not purchase our shaper the BNC / Shaper OUT does not provide any signal. In any case a pre-amplified signal is provided by BNC / Preamp. OUT. BNC / Test Input allows the user to connect a pulse generator to the system and test the output by applying different test pulses.

Pile-up rejection:

The pins 3 and 5 of the SUB-D9 connector each provide a TTL signal as input for an ADC with integrated pile-up rejection (not_PUR is inverted with respect to PUR / see attached oscilloscope screen shot).

AXAS 00041
SDD01849



KETEK GmbH
Halbleiter- und
Reinraumtechnik

AXAS Datasheet

Every detector system produced by KETEK GmbH is tested electrically and spectroscopically. Testing parameters and results achieved in the final qualification are reported below.
A leackage test (MIL-STD-883, Method 1014.10) was performed and passed.

AXAS-Serial-NO: 00041
AXAS-Batch-NO: 2002.02
TO8-Serial-NO: 01849
Class: SDD5-145500

Spectroscopic results

FWHM: 145 eV @ 1 µs @ -20 °C
(chip temperature)

P/B ratio: 382

Count rate [cps]: 996

Specifications

Snout length [mm]:	100
Shaping time [µs]:	1
Vacuum tightness:	NO
Upper energy limit [keV]:	20
Power supply:	YES

The spectroscopic results can be achieved, when the temperature of the AXAS housing is +20°C.

TO8 housing

Cap Type:		Entrance window:	MOXTEK DuraBeryllium 8 um
Collimator:	Dual collimator	Window diameter:	2.4 mm
Collimator support:	Covar + Gold Layer	Auxiliary Colli. dia.:	

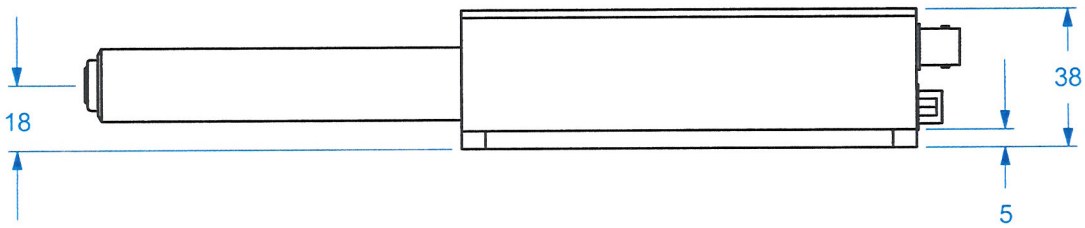
WARNING:

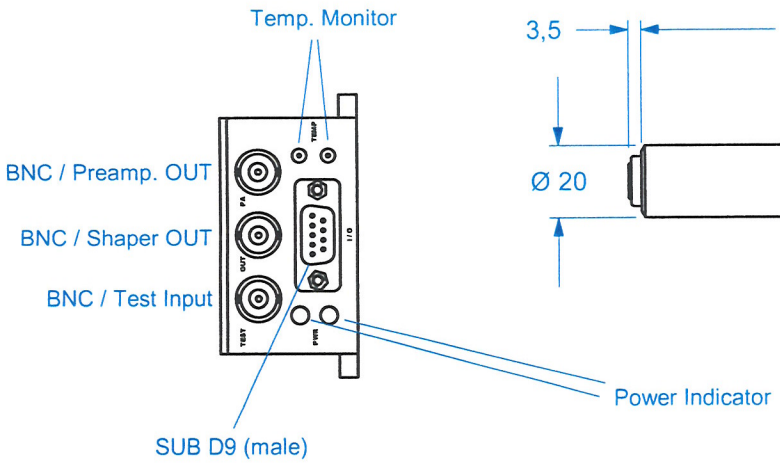
1. Sealing
The TO8-housing is closed hermetically. A leakage test MIL-STD-883 was performed. However every mechanical stress on the detector module can damage the module entrance window or the PIN s introducing a leakage in the housing.

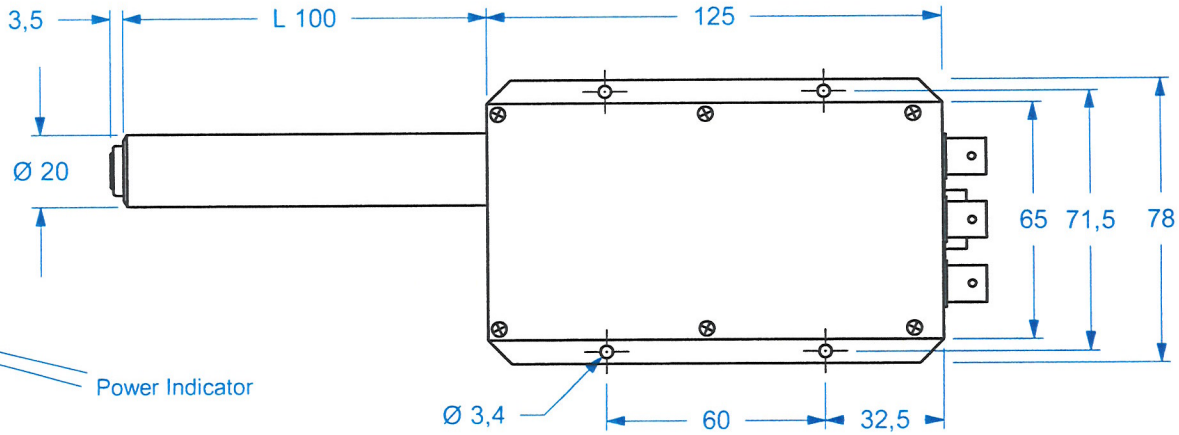
2 Radiation hardness
Radiation hardness of the silicon drift detector has been investigated using synchrotron radiation.
With a total dose of 1012 absorbed photons on the SDD active area, typical variation of the energy resolution in terms of FWHM are less than 2% and peak/background ratio variation are less than 10%.
Radiation hardness is energy dependent. The analyses made represents the worst case, assuming incoming x-rays in an energy range between 10 and 15 keV, where the damage on the integrated electronics is maximized. Outside this energy range is the detector radiation harder.

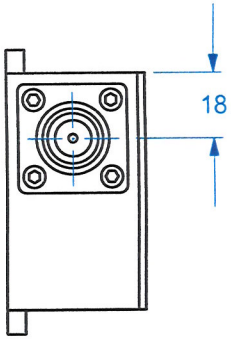
Our technical staff is at your disposal for any kind of questions
mail to: support@ketek.net
http://www.ketek.net

Technical drawing of an AXAS system with a 100 mm snout









1	2	3	4	5	6	7	8	9
GND	GND	$\overline{\text{PUR}}$	+12V	PUR	NC	NC	NC	-12V

Ambient temperature:

Please note that the detector performance depends on the ambient temperature you provide. The metal housing of the AXAS system acts as a heat sink for the cooling mechanism of the detector. The housing should not have a temperature above 35 °C during operation. Anyway it is optimal if the housing stays at room temperature or somewhat below. So if possible attach an additional heat sink or apply active cooling to the housing.

Detector temperature:

You can monitor the current temperature of the SDD detector integrated into your AXAS system by reading the voltage given at the two temperature monitor output connectors (see technical drawing). This voltage is calibrated to deliver 3.00 V at 300 K and will in-/decrease 0.01 V per K (e.g. 273 K = 2.73 V or 312 K = 3.12 V).

Resolution (at high count rates) / shaping time:

Each detector has been tested carefully at the KETEK laboratory at Munich/Germany to redeem the guaranteed specifications. The guaranteed energy resolution was checked with reference to a measurement using the Mn K_α line of a Fe55 x-ray source and a shaping time of 1 µs. Please note that the best resolution you will observe depends on the shaping time and the count rate you use. For more detail have a look at the attached diagram giving the resolution of an example AXAS system in dependence of count rate and shaping time.

Peak shift at high count rates:

For high count rates a peak shift in the recorded spectra may occur depending on the applied count rate. The attached "AXAS – Peak Shift" diagram gives an example of this peak shift. Please note that the example we attached represents a kind of worst case scenario. The actual peak shift is different for every detector and should not exceed the given example by much.

Windowless detector:

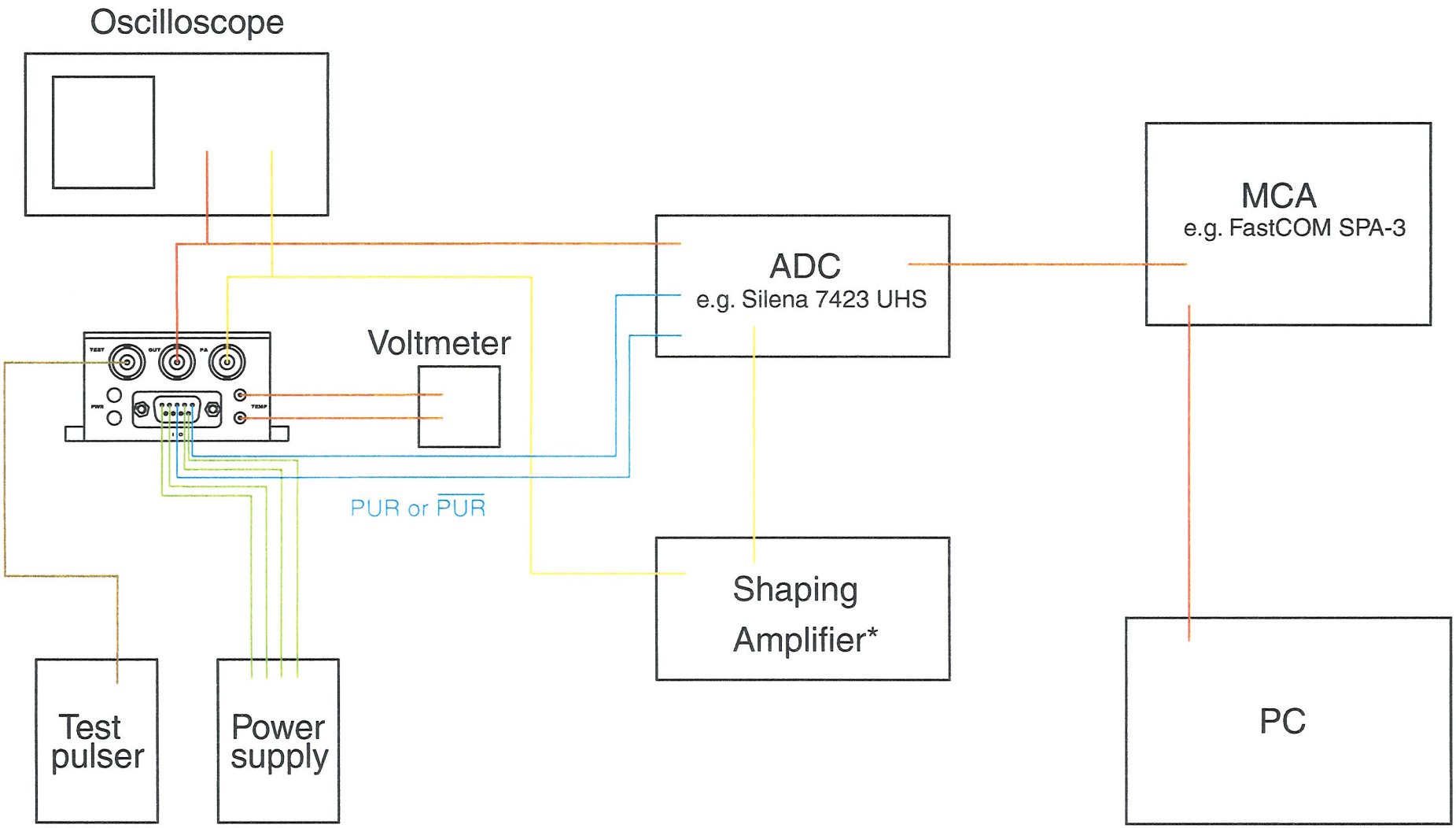
If you purchased a windowless detector never operate it during venting or at any moist atmosphere (air is a moist atmosphere) or it will most probably be destroyed.

Check the connection diagram:

If your system does not operate properly, please check all the connections referring to the connection diagram. If everything is connected the right way, please contact us before you open the AXAS and change any internal settings. YOU MAY DESTROY THE DETECTOR!!!

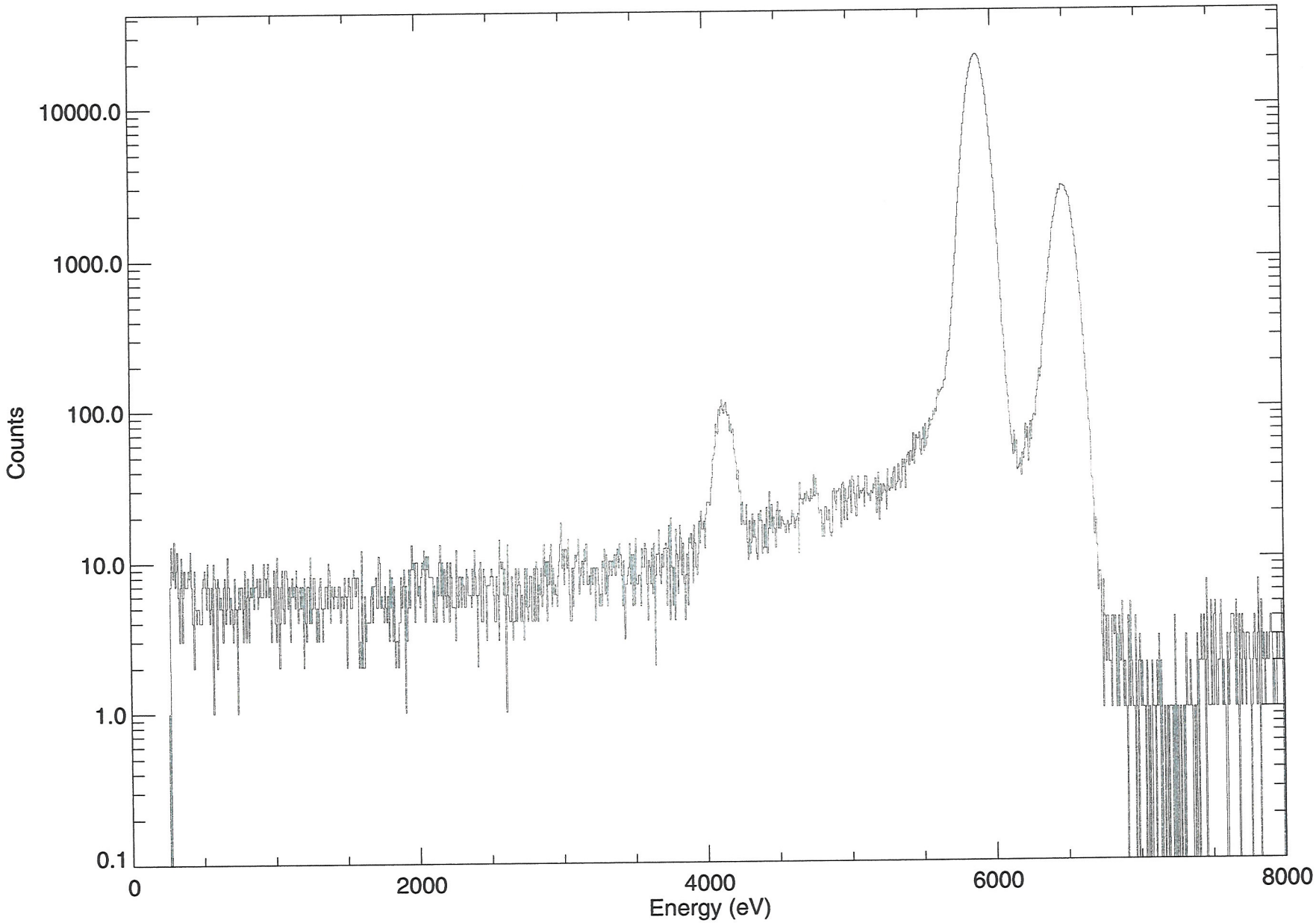
KETEK

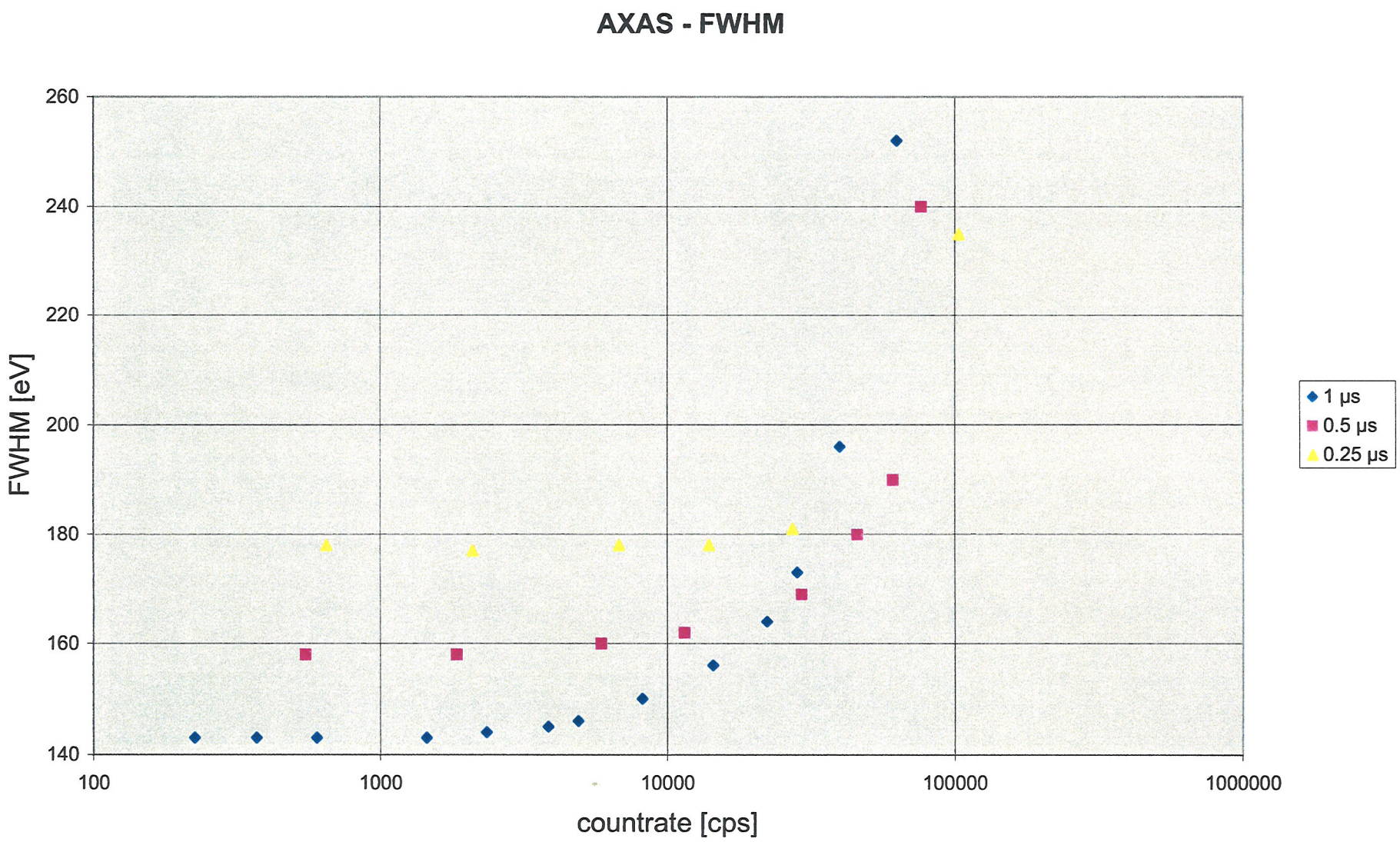
Connection diagram

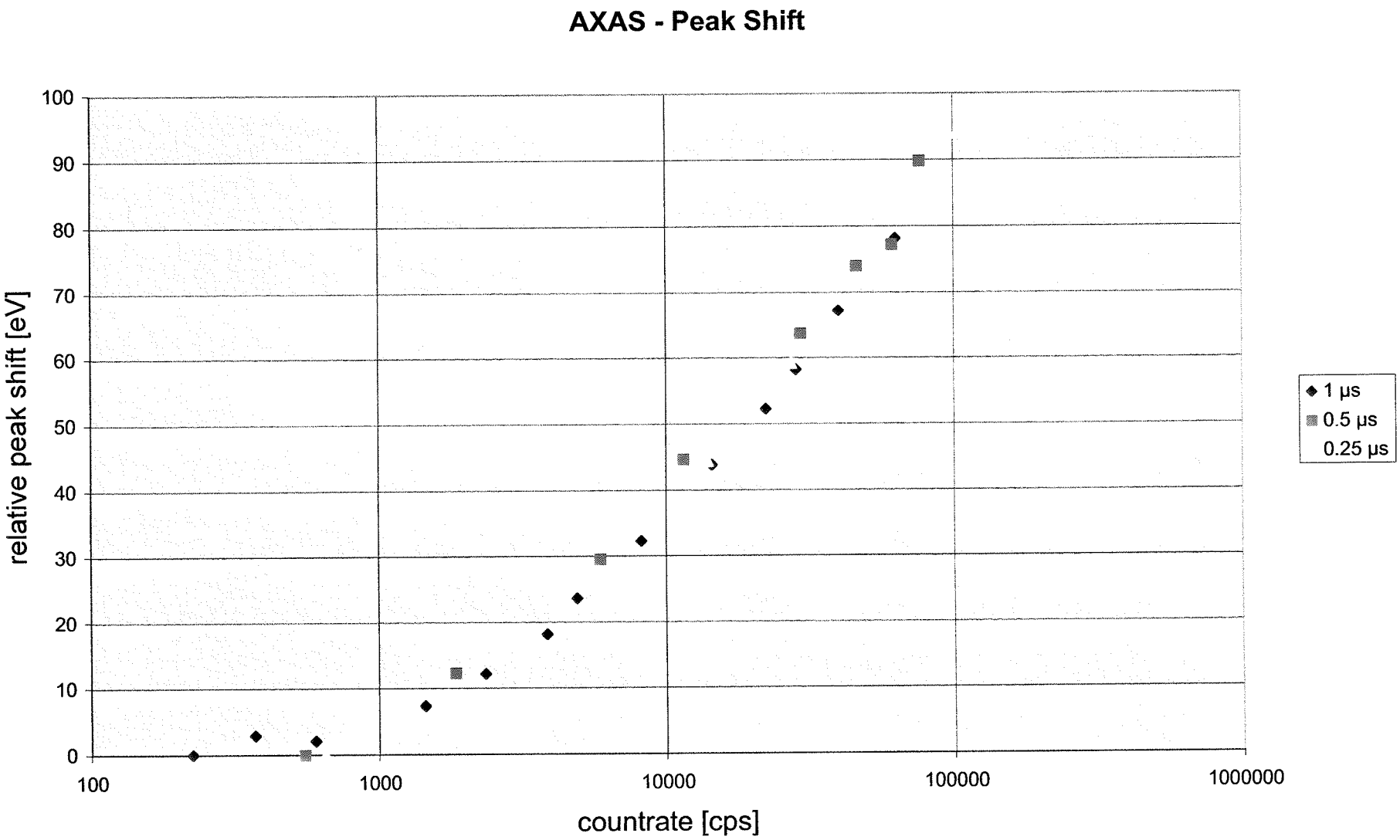


*It is recommended to use Keteks shaping amlifier integrated in the AXAS system

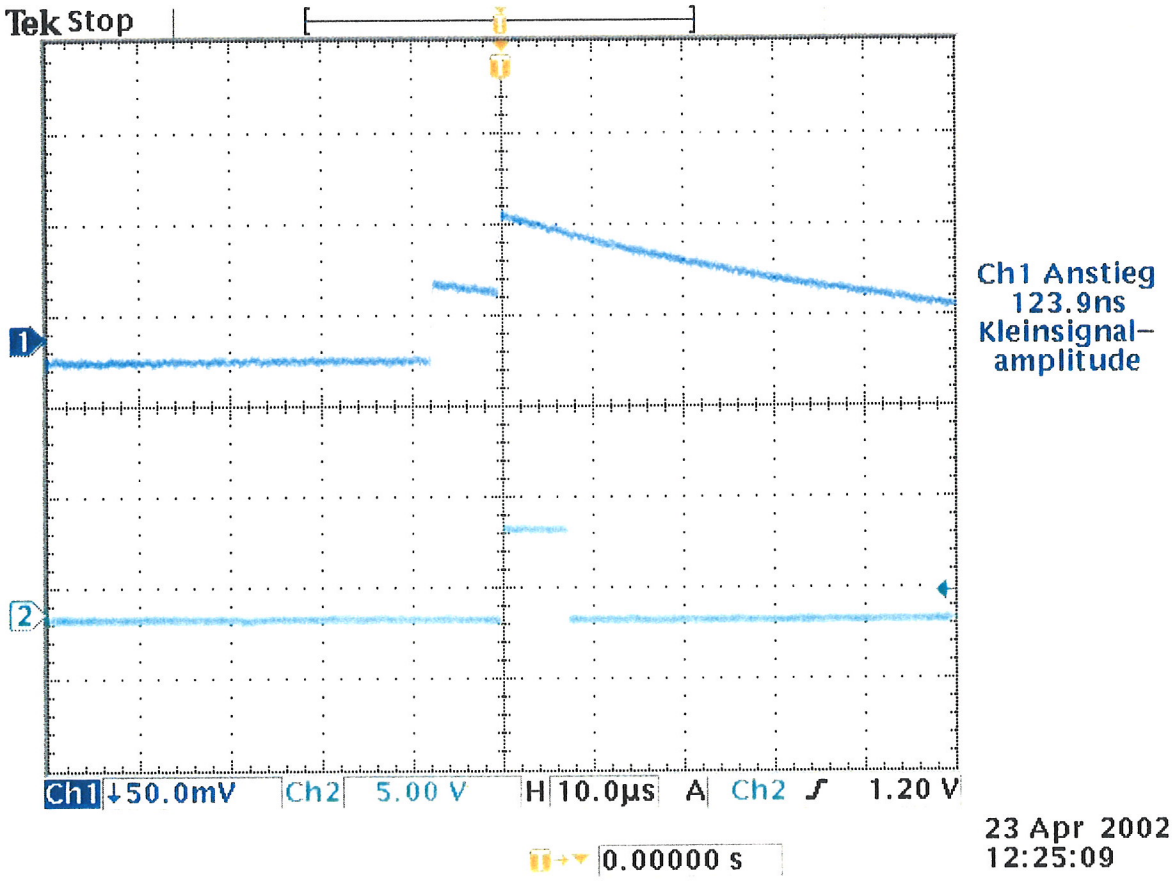
Example spectrum of a Fe55 radiation source $\sigma(\text{Mn } K_\alpha) = 141$ eV FWHM




AXAS - FWHM
FWHM [eV]
260
240
220
200
180
160
140
100
1000
10000
100000
1000000
countrate [cps]
1 µs
0.5 µs
0.25 µs

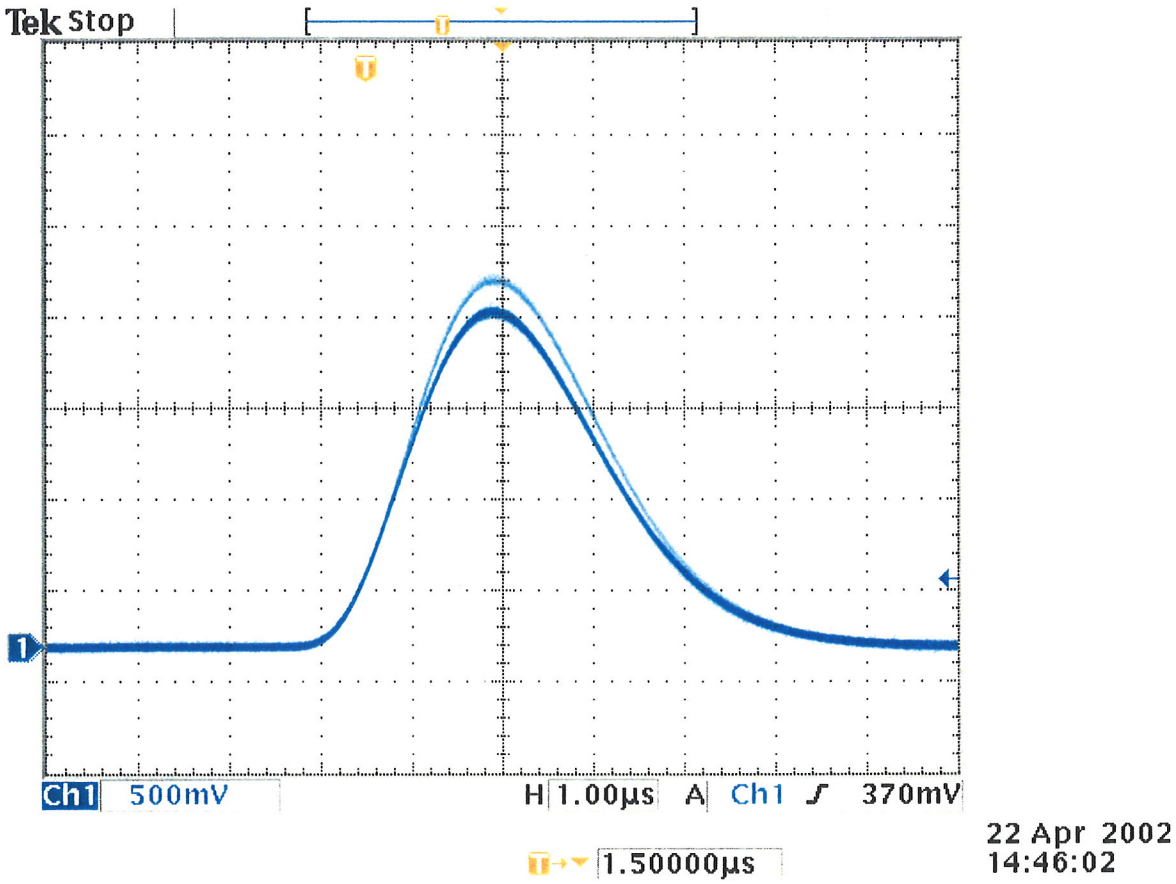

AXAS - Peak Shift
relative peak shift [eV]
countrate [cps]
100
90
80
70
60
50
40
30
20
10
0
100
1000
10000
100000
1000000
1 µs
0.5 µs
0.25 µs

Double pulse and PUR TTL pulse



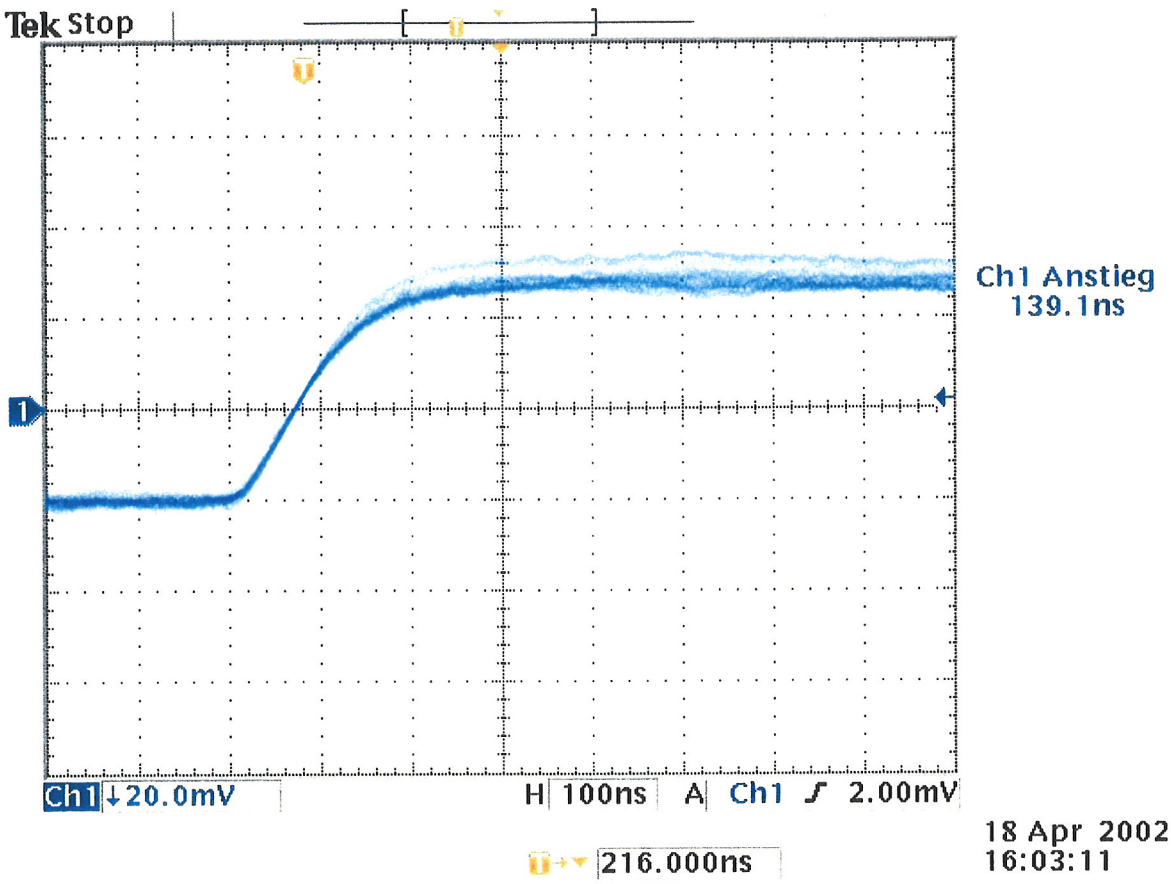
This screen shot shows a typical double (pile up) pulse (upper curve) and the subsequent TTL pulse produced by the AXAS system (lower curve) as input to an optional pile up rejection feature of your ADC. Please note, that the original output is inverted with respect to this picture.

Amplified, shaped output of the AXAS system



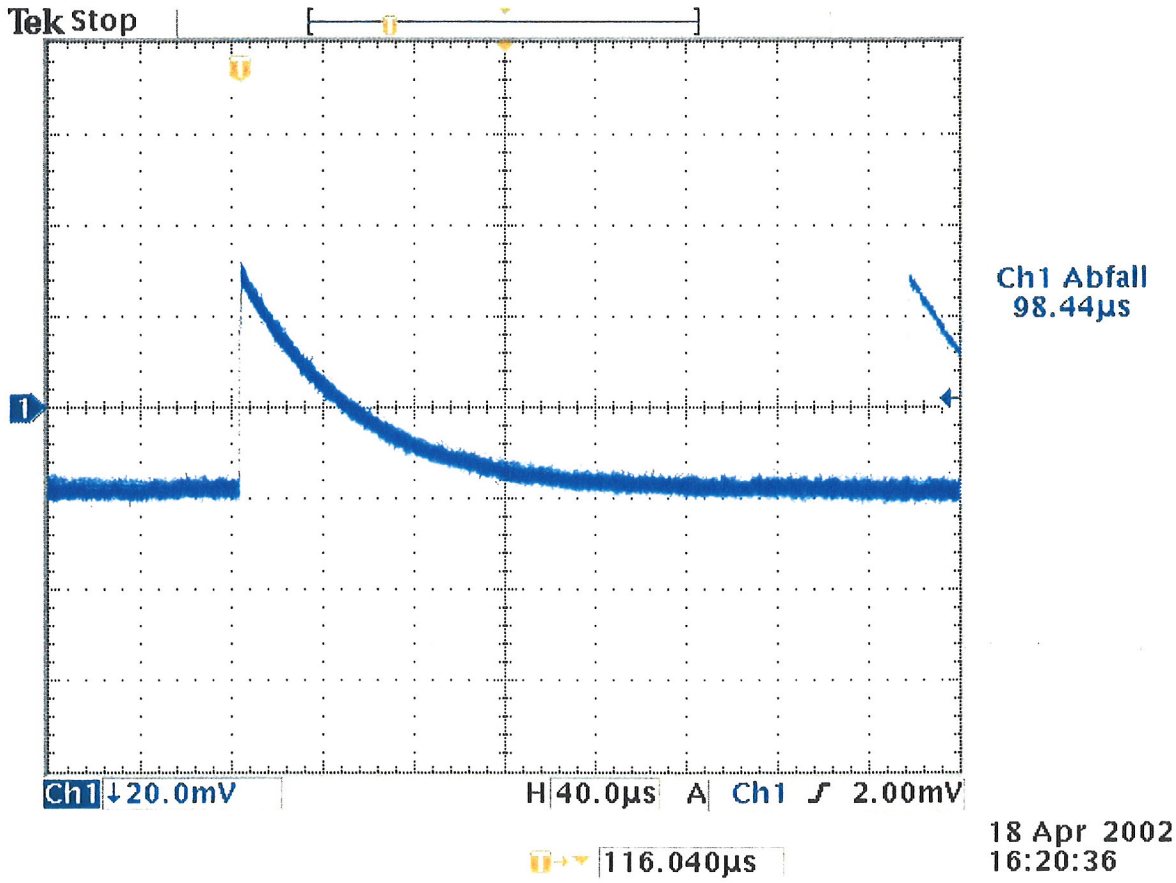
This oscilloscope screen shot shows a typical shaped and amplified output signal of the AXAS system (BNC / Shaper OUT). A Fe^{55} x-ray source was used for irradiation of the detector. The Mn K_α and K_β lines are clearly separated. Please note that the amplitude of the signal depends on the adjusted gain voltage range and the x-ray energy.

Rise time of the pre-amplified signal

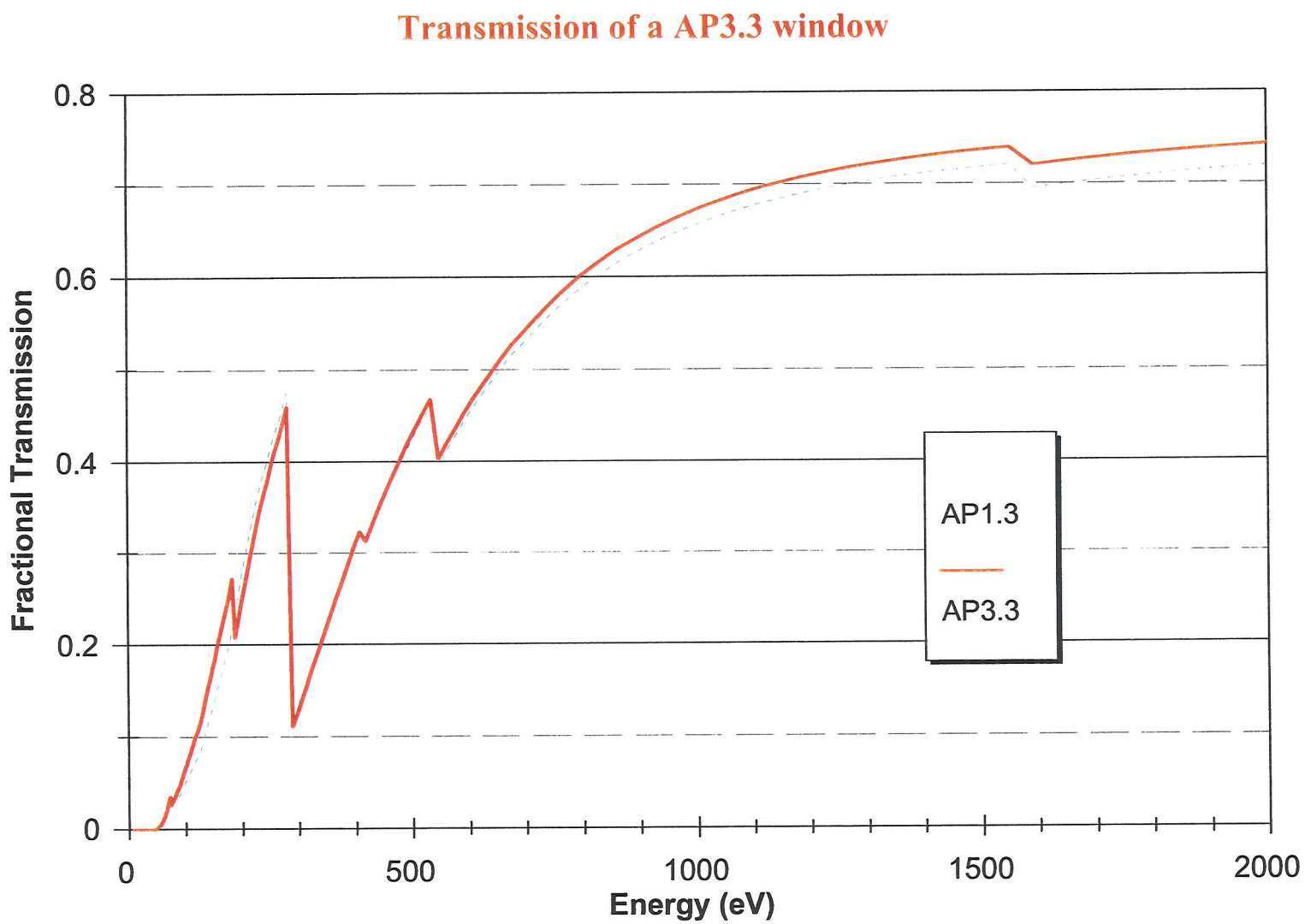


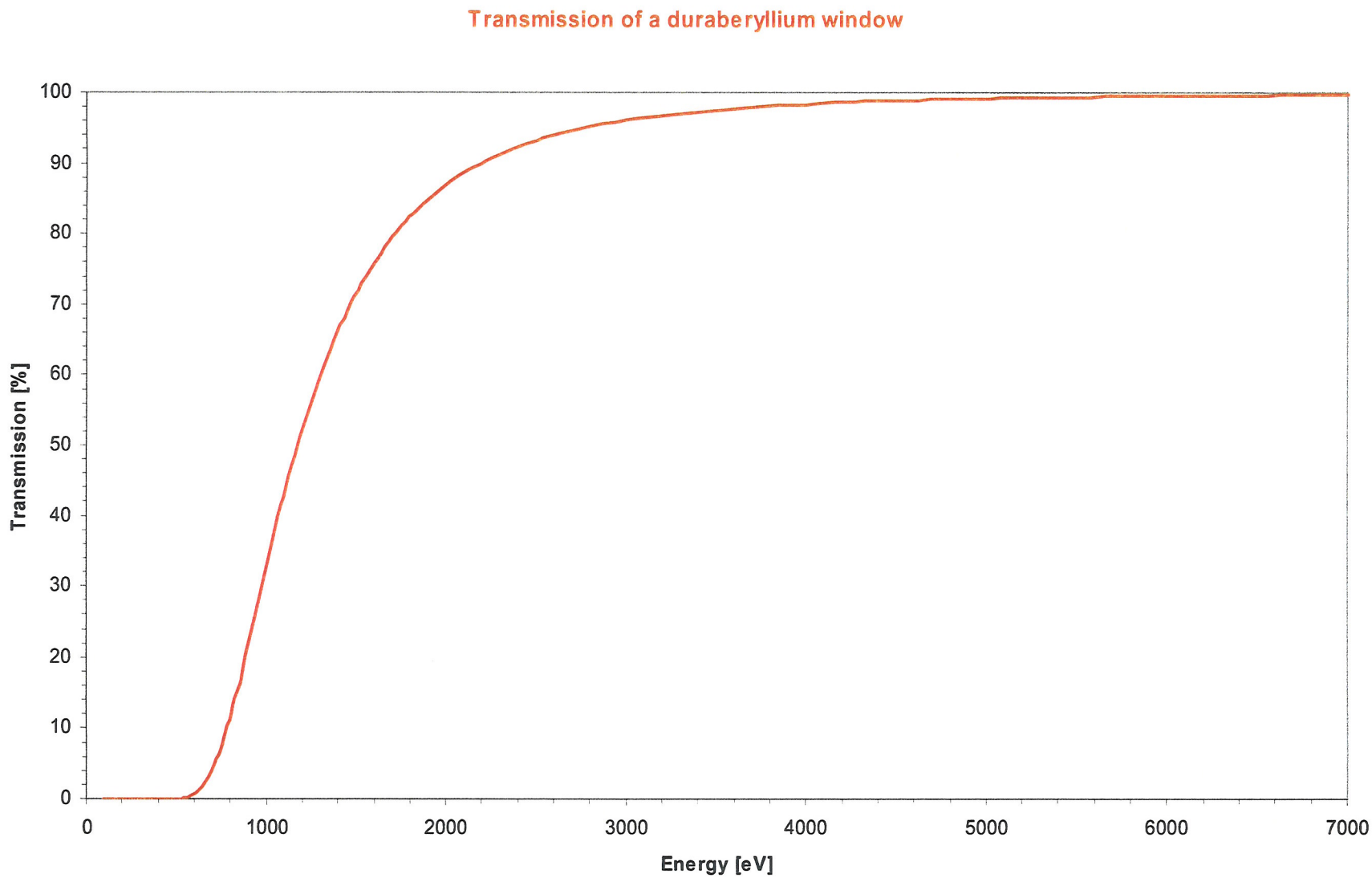
This picture shows the typical rise time (139.1 ns in this case) of a pre-amplified signal (BNC / Preamp. OUT). Again a Fe^{55} x-ray source was used to irradiate the detector. Please note that the amplitude and the total rise time of the signal depend on the x-ray energy and that the original output is inverted with respect to this picture.

Fall time of the pre-amplified signal



This picture shows the typical fall time (98.44 µs in this case) of a pre-amplified signal (BNC / Preamp. OUT). Again a Fe^{55} x-ray source was used to irradiate the detector. Please note that the amplitude and the total fall time of the signal depend on the x-ray energy and that the original output is inverted with respect to this picture.


Transmission of a AP3.3 window
0.8
0.6
0.4
0.2
0
Fractional Transmission
0
500
1000
1500
2000
Energy (eV)
AP1.3
AP3.3


Transmission of a duraberyllium window
Transmission [%]
100
90
80
70
60
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
6000
7000
Energy [eV]

Atomic Mass

Atomic Number → Element → Line*, Energy (keV) →

21 44.96
Sc
Kα 4.091
Kβ 4.461
Lα 0.395

KETEK

Creative Detector Solutions

H 1.008																	He 2 4.003
Li 6.941 Kα 0.054	Be 4 9.012 Kα 0.109											B 5 10.81 Kα 0.183	C 6 12.01 Kα 0.277	N 7 14.01 Kα 0.392	O 8 16.00 Kα 0.525	F 9 19.00 Kα 0.677	Ne 10 20.18 Kα 0.849
Na 1 22.99 Kα 1.041	Mg 12 24.31 Kα 1.254											Al 13 26.98 Kα 1.487	Si 14 28.09 Kα 1.740 Kβ 1.836	P 15 30.97 Kα 2.014 Kβ 2.139	S 16 32.07 Kα 2.308 Kβ 2.464	Cl 17 35.45 Kα 2.622 Kβ 2.816	Ar 18 39.95 Kα 2.958 Kβ 3.191
K 9 39.10 Kα 3.314 Kβ 3.590	Ca 20 40.08 Kα 3.692 Kβ 4.013 Lα 0.341	Sc 21 44.96 Kα 4.091 Kβ 4.461 Lα 0.395	Ti 22 47.87 Kα 4.511 Kβ 4.932 Lα 0.452	V 23 50.94 Kα 4.952 Kβ 5.427 Lα 0.511	Cr 24 52.00 Kα 5.415 Kβ 5.947 Lα 0.573	Mn 25 54.94 Kα 5.899 Kβ 6.490 Lα 0.637	Fe 26 55.85 Kα 6.404 Kβ 7.058 Lα 0.705	Co 27 58.93 Kα 6.930 Kβ 7.649 Lα 0.776	Ni 28 58.69 Kα 7.478 Kβ 8.265 Lα 0.852	Cu 29 63.55 Kα 8.048 Kβ 8.905 Lα 0.930	Zn 30 65.41 Kα 8.639 Kβ 9.572 Lα 1.012	Ga 31 69.72 Kα 9.252 Kβ 10.26 Lα 1.098	Ge 32 72.64 Kα 9.886 Kβ 10.98 Lα 1.188	As 33 74.92 Kα 10.54 Kβ 11.73 Lα 1.282	Se 34 78.96 Kα 11.22 Kβ 12.50 Lα 1.379	Br 35 79.90 Kα 11.92 Kβ 13.29 Lα 1.480	Kr 36 83.80 Kα 12.65 Kβ 14.11 Lα 1.586
Rb 7 85.47 Kα 13.40 Kβ 14.96 Lα 1.694	Sr 38 87.62 Kα 14.17 Kβ 15.84 Lα 1.807	Y 39 88.91 Kα 14.96 Kβ 16.74 Lα 1.923	Zr 40 91.22 Kα 15.78 Kβ 17.67 Lα 2.042 Lβ 2.124	Nb 41 92.91 Kα 16.62 Kβ 18.62 Lα 2.166 Lβ 2.257	Mo 42 95.94 Kα 17.48 Kβ 19.61 Lα 2.293 Lβ 2.395	Tc 43 (98) Kα 18.37 Kβ 20.62 Lα 2.424 Lβ 2.538	Ru 44 101.1 Kα 19.28 Kβ 21.66 Lα 2.559 Lβ 2.683	Rh 45 102.9 Kα 20.22 Kβ 22.72 Lα 2.697 Lβ 2.834	Pd 46 106.4 Kα 21.18 Kβ 23.82 Lα 2.839 Lβ 2.990	Ag 47 107.9 Kα 22.16 Kβ 24.94 Lα 2.984 Lβ 3.151	Cd 48 112.4 Kα 23.17 Kβ 26.10 Lα 3.134 Lβ 3.317	In 49 114.8 Kα 24.21 Kβ 27.28 Lα 3.287 Lβ 3.487	Sn 50 118.7 Kα 25.27 Kβ 28.47 Lα 3.444 Lβ 3.663	Sb 51 121.8 Kα 26.36 Kβ 29.73 Lα 3.605 Lβ 3.844	Te 52 127.6 Kα 27.47 Kβ 31.00 Lα 3.769 Lβ 4.030	I 53 126.9 Kα 28.61 Kβ 32.29 Lα 3.938 Lβ 4.221	Xe 54 131.3 Kα 29.78 Kβ 33.62 Lα 4.110 Lβ 4.423
Cs 5 132.9 Kα 30.97 Kβ 34.97 Lα 4.287 Lβ 4.620	Ba 56 137.3 Kα 32.19 Kβ 36.38 Lα 4.466 Lβ 4.828	La 57 138.9 Kα 33.44 Kβ 37.80 Lα 4.651 Lβ 5.042	Hf 72 178.5 Lα 7.899 Lβ 9.023 Mα 1.645	Ta 73 180.9 Lα 8.146 Lβ 9.343 Mα 1.710	W 74 183.8 Lα 8.398 Lβ 9.672 Mα 1.775	Re 75 186.2 Lα 8.653 Lβ 10.01 Mα 1.843	Os 76 190.2 Lα 8.912 Lβ 10.36 Mα 1.910	Ir 77 192.2 Lα 9.175 Lβ 10.71 Mα 1.980	Pt 78 195.1 Lα 9.442 Lβ 11.07 Mα 2.051	Au 79 197.0 Lα 9.713 Lβ 11.44 Mα 2.123	Hg 80 200.6 Lα 9.989 Lβ 11.82 Mα 2.195	Tl 81 204.4 Lα 10.27 Lβ 12.21 Mα 2.271	Pb 82 207.2 Lα 10.55 Lβ 12.61 Mα 2.346	Bi 83 209.0 Lα 10.84 Lβ 13.02 Mα 2.423	Po 84 (209) Lα 11.13 Lβ 13.45 Mα 2.502	At 85 (210) Lα 11.43 Lβ 13.88 Mα 2.581	Rn 86 (222) Lα 11.73 Lβ 14.32 Mα 2.662
Fr 7 (223) Lα 12.03 Lβ 14.77 Mα 2.743	Ra 88 (226) Lα 12.34 Lβ 15.24 Mα 2.825	Ac 89 (227) Lα 12.65 Lβ 15.71 Mα 2.910	Rf 104 (261)	Db 105 (262)	Sg 106 (266)	Bh 107 (264)	Hs 108 (269)	Mt 109 (268)									

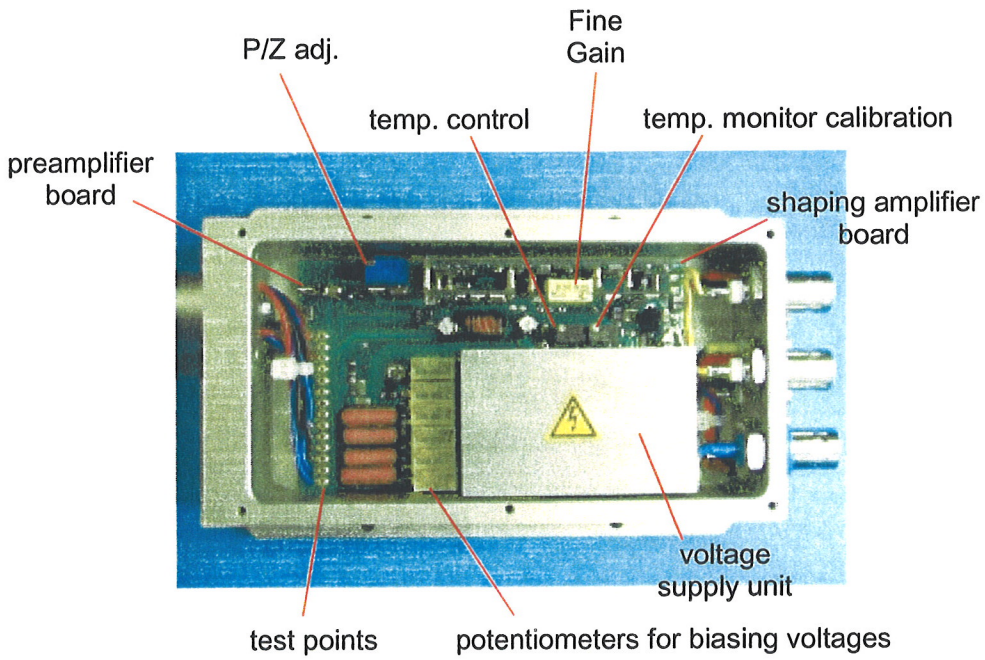
Actinides	Ce 58 140.1 Lα 4.840 Lβ 5.262 Mα 0.883	Pr 59 140.9 Lα 5.034 Lβ 5.489 Mα 0.929	Nd 60 144.2 Lα 5.230 Lβ 5.722 Mα 0.978	Pm 61 (145) Lα 5.433 Lβ 5.961 Mα 1.029	Sm 62 150.4 Lα 5.636 Lβ 6.205 Mα 1.081	Eu 63 152.0 Lα 5.846 Lβ 6.456 Mα 1.131	Gd 64 157.3 Lα 6.057 Lβ 6.713 Mα 1.185	Tb 65 158.9 Lα 6.273 Lβ 6.978 Mα 1.240	Dy 66 162.5 Lα 6.495 Lβ 7.248 Mα 1.293	Ho 67 164.9 Lα 6.720 Lβ 7.525 Mα 1.348	Er 68 167.3 Lα 6.949 Lβ 7.811 Mα 1.406	Tm 69 168.9 Lα 7.180 Lβ 8.101 Mα 1.462	Yb 70 173.0 Lα 7.416 Lβ 8.402 Mα 1.521	Lu 71 175.0 Lα 7.656 Lβ 8.709 Mα 1.581
Lanthanides	Th 90 232.0 Lα 12.97 Lβ 16.20 Mα 2.996	Pa 91 231.0 Lα 13.29 Lβ 16.70 Mα 3.082	U 92 238.0 Lα 13.61 Lβ 17.22 Mα 3.171	Np 93 (237) Lα 13.94 Lβ 17.75 Mα 3.260	Pu 94 (244) Lα 14.62 Lβ 18.85 Mα 3.351	Am 95 (243) Lα 14.62 Lβ 18.85 Mα 3.443	Cm 96 (247) Lα 14.96 Lβ 19.43 Mα 3.537	Bk 97 (247) Lα 15.31 Lβ 20.02 Mα 3.632	Cf 98 (251) Lα 15.66 Lβ 20.56 Mα 3.727	Es 99 (252) Lα 16.02 Lβ 21.17 Mα 3.824	Fm 100 (257) Lα 16.38 Lβ 21.78 Mα 3.923	Md 101 (258)	No 102 (259)	Lr 103 (262)

Quoted are the Kα1, Kβ1, Lα1, etc. energies. The observed energies may/will slightly vary because of (not resolved) α2, β2, etc. contributions.

AXAS

Setup and Operation

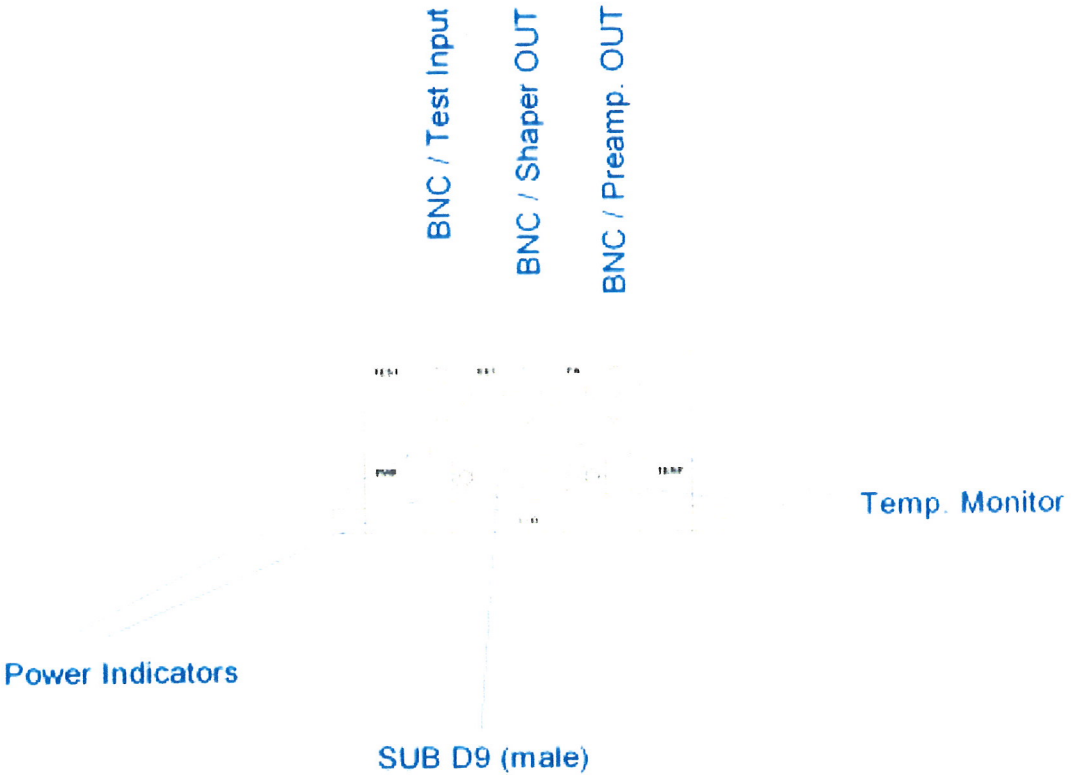
Each unit of drift detector and AXAS board is shipped with supply voltages adjusted for optimum energy resolution. **It is not recommended to change any of the voltage settings.**
In case the correct voltage settings have been lost or a detector shall be used together with a differently adjusted electronics board adjust the potentiometers as showed in the picture below. Every short circuit which can arise during this operation may destroy the silicon drift detector.



KETEK

Creative Detector Solutions

Backside Connectors



1	2	3	4	5	6	7	8	9
GND	GND	PUR	+12V	PUR	NC	NC	NC	-12V

KETEK

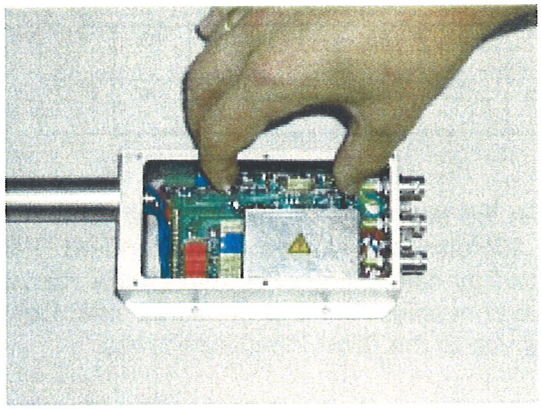
Creative Detector Solutions

Changing the shaping time constant on AXAS system

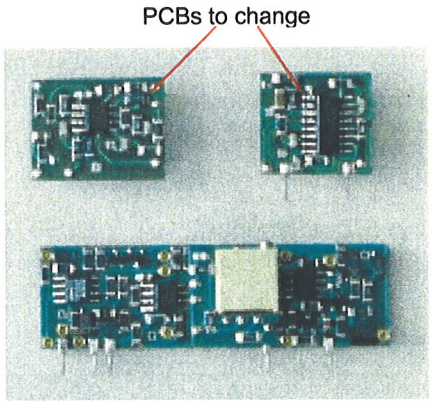
CAUTION

The AXAS PCBs contain static-sensitive components. Handle the boards at a static-free work area.

- disconnect electrical connections
- open the case
- remove shaper unit as shown in figure



- change left and right PCB
- the shaping time constant is written on the solder side of the PCBs



- reinsert the shaping module

KETEK

Detector Voltage and Other Trimming

The 6 trimmers behind the test points (the PCB detector connector) adjust the same first 6 voltages that are listed in the test point table below. Rotating the trimmer screws clockwise increases all the voltages. The Back voltage is derived from the Ring 18 voltage so the R18 voltage has to be trimmed first, provided that the Back voltage is initially decreased. After trimming the R18 voltage, the back voltage is increased to the desired value.

test points:

1	2	3	4	5	6	7	8	9	10	11	12	13	14
R18	Back	Reset	TDGR	R1	IGR	TD-n	TD-p	+12V	GND	GND	P+	-9V	FFD

As comparatively high ohm resistors are used in the detector voltages filter networks, it is a good idea to use a voltmeter of higher than 10Mohm input impedance. Standard DMM can be used if a 1:100 voltage divider is realized by connecting of a 1Gohm 1% resistor serially to the active DMM terminal. This is most convenient to do at the DMM side. Doing so, the voltages can be measured without errors due to the DMM input impedance.

Rotating the temperature control set trimmer clockwise cools the detector. The system is delivered with maximum cooling. The relation between the voltage of the temperature monitor output on the back side and the temperature is 10mVper degree K. For instance 300K (27degrees C) are read as 3.000V. An offset of this temperature monitor can be adjusted with the “temp. monitor calibration” trimmer.

Fine gain control trimmer clockwise rotation increases the gain of the shaping amplifier. However, it should be kept in mind that the Coarse Gain (fixed) is about 0.25 V/keV (0.5, 0.33 or 0.17 V/keV). With a maximum output voltage of 5 V the shaper gives signal for up to 20 keV (10, 15 or 30 keV).

The trimmer on the preamplifier board can be used for fine P/Z adjustment.