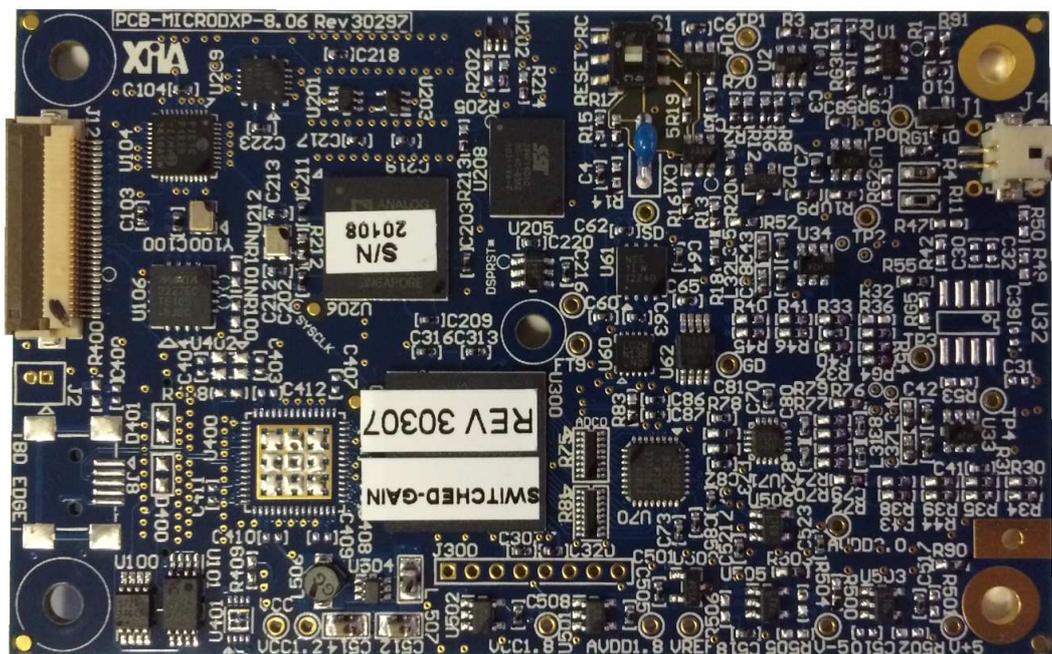


# microDXP 8.0 Quick Start Guide

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This document is intended to help beta users get started with the re-designed microDXP 8.0 digital x-ray spectrometer, as we prepare more thorough documentation for the main release.

## OVERVIEW OF THE SYSTEM

### MICRODXP 8.0

The microDXP design has been recently overhauled. The ADC, FGPA, analog, power and interface circuits and devices have been upgraded, yielding significant performance improvements. The new hardware was designed to be a drop-in replacement for the old microDXP: Connectors and pinouts, mounting holes and power-supply specifications have been maintained. Software and drivers, however, will need to be updated to work with the new hardware.

- Analog Devices AD9649 14-bit, 40 MSPS (up to 80 MSPS) Analog to Digital Converter
- New variable gain architecture, with better noise, linearity and temperature drift performance
- Spartan 6 LX9 FPGA
- Option for on-board USB interface

Please refer to online documentation for a more thorough description of microDXP features and specifications: [http://www.xia.com/microDXP\\_Downloads.html](http://www.xia.com/microDXP_Downloads.html)

### MICROCOM-U INTERFACE

The microCOM-U interface card includes power-supply and interface circuitry, providing for USB 2.0 communication with the microDXP, as well as access to the auxiliary digital I/O. It is included for ease of use as part of the development kit, however, OEM customers typically design their own interface.

## QUICK START GUIDE

### SYSTEM SETUP

#### SOFTWARE INSTALLATION

Run the microManager 2.3 executable and follow the steps as indicated within the installer.

#### HARDWARE SETUP

- **Connect your detector output signal to the SMA input connector**
- **Connect your computer to the mini-USB connector**
- **Connect +5V @ 1A power supply to the barrel connector (center conductor positive)**
- **Make sure your detector is power on, and a weak or moderate x-ray source is present**

## START MICROMANAGER

If the microManager is properly powered and has been detected via USB, microManager 2.3 should start up. Several error dialogs can pop up if the hardware isn't properly connected. **Do not attempt to 'repair' or 'restore' the microDXP firmware via these dialogs.** Instead cancel out of the dialogs and check the connections and power before trying again. Please also check that the "XIA microDXP USB2 Spectrometer" shows up in the Windows Device Manager, under Universal Serial Bus controllers

## USING MICROMANAGER 2.3

microManager is a legacy Windows application that runs with XIA's Handel drivers. We are developing new software to go along with the main microDXP 8.0 release, which will fully support all of the new hardware features. In the meantime, we have modified microManager to support the most important features for our beta customers.

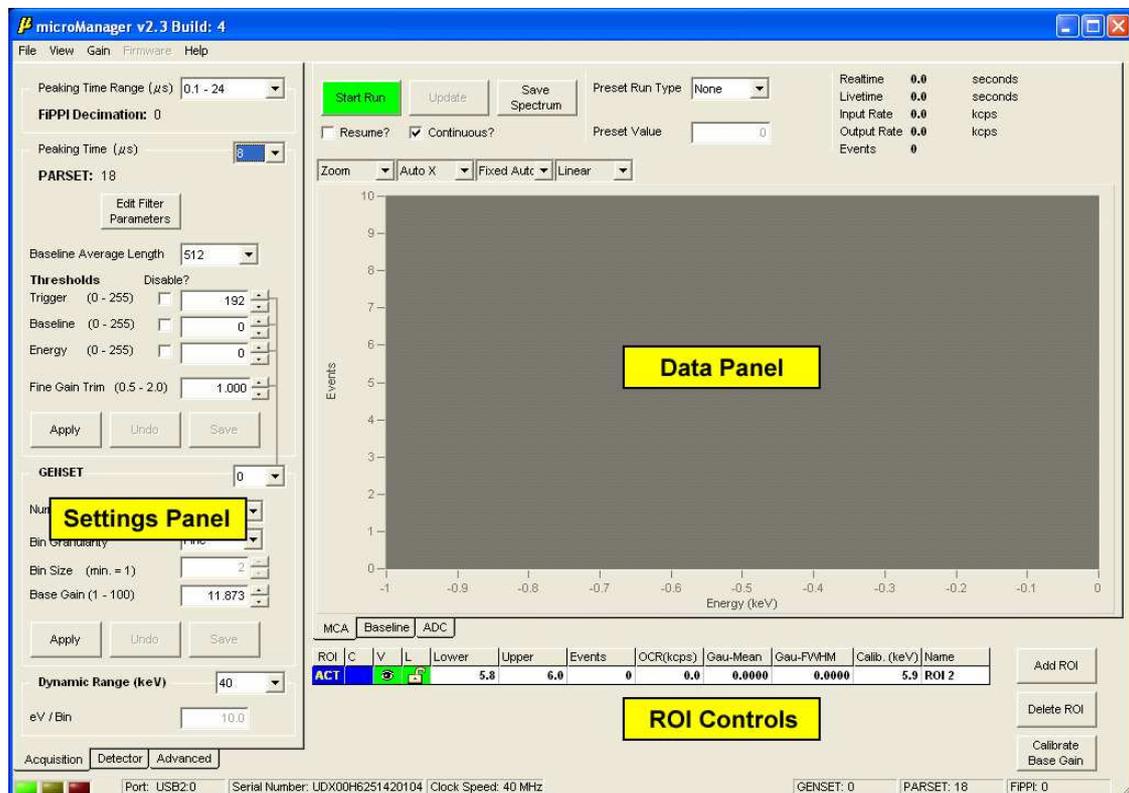


Fig 1: microManager is organized into three main areas: Settings, Data and ROI controls. The Settings and Data areas are further divided into several tabs, selected along the bottom of the screen.

## SETTINGS

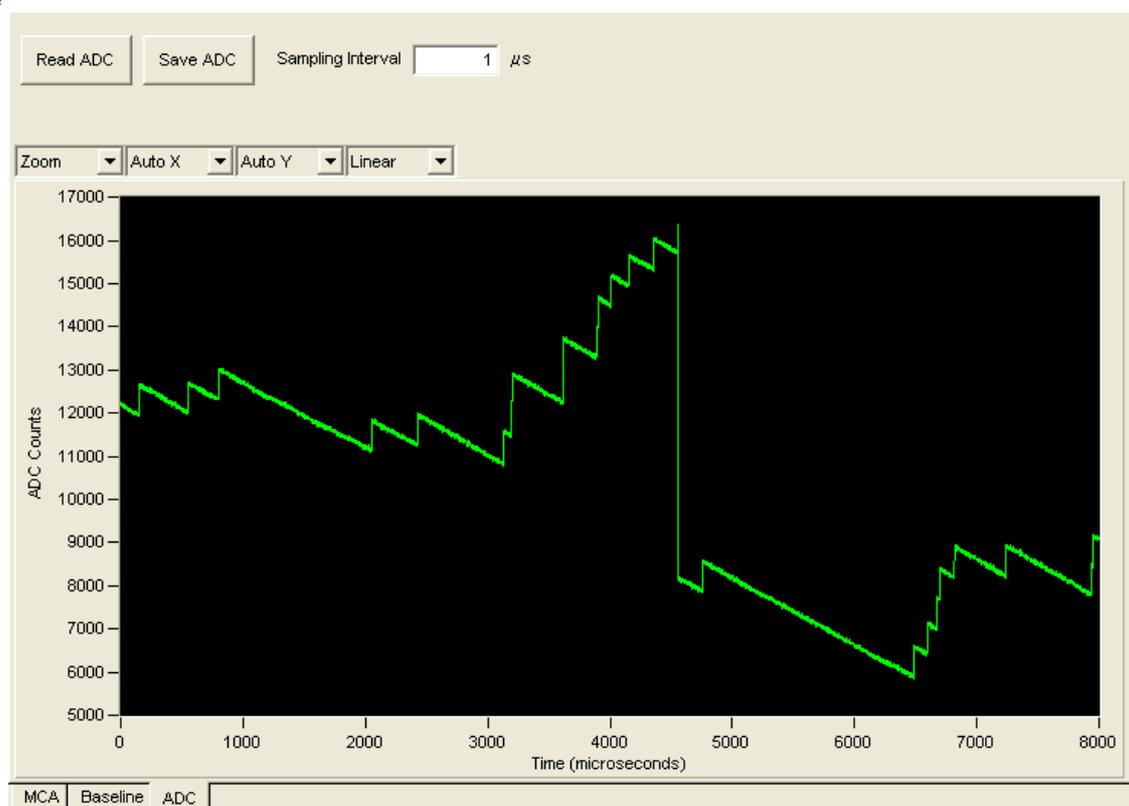
The demonstration hardware that you have received is already largely customized for your intended detector, but you may want to further optimize settings. This section highlights only the most important settings for the microDXP 8.0. For a thorough description of microDXP settings, please refer to the online documentation: [http://www.xia.com/microDXP\\_Downloads.html](http://www.xia.com/microDXP_Downloads.html)

## PARSETS AND GENSETS

The microDXP employs nonvolatile flash memory to store a unique array of settings, or a PARSET, for each peaking time. These settings are automatically retrieved when the peaking time is selected. The PARSET includes all thresholds and trapezoidal filter settings, as well as fine gain trim. We recommend taking the time to optimize the PARSET settings for any peaking times that you intend to use.

The microDXP also provides for five unique arrays of MCA settings, or GENSETS. These settings include the number of MCA bins, the bin granularity and the so-called Base Gain, which combines with the fine gain trim to achieve energy calibration at each peaking time. The desired GENSET can be selected from the drop-down list. For now, you likely will only need to work with a single GENSET, i.e. GENSET 0.

## DETECTOR: SIGNAL POLARITY, RISETIME AND RESET INTERVAL



**Fig 2: ADC trace with positive x-rays, i.e. the correct polarity setting. A corrective ADC-centering negative step is also visible.**

To verify signal polarity, first select the ADC data tab and acquire some ADC traces. You should see x-ray steps going in the positive direction, with a compensating background downward slope. You may also see occasional larger steps, either positive or negative, associated with the preamplifier reset or with local ADC-centering circuitry.

- **Click on the ADC tab and press the Read ADC button to acquire a set of 8000 ADC data points**
- **Increase the Sampling Interval to inspect over a longer period of time**
- **If the x-ray steps are negative, change the Polarity setting in the Detector settings panel**

It's important to measure the signal risetime at this point, so that we can optimize the energy filter gap time in the next section. This is best accomplished by resetting the Sampling Interval to the minimum,  $0.025\mu\text{s}$ , as this will allow for the most accurate measurement. Click and drag within the data panel to zoom in or out, or right-click to reset to full-scale, or to place cursors.

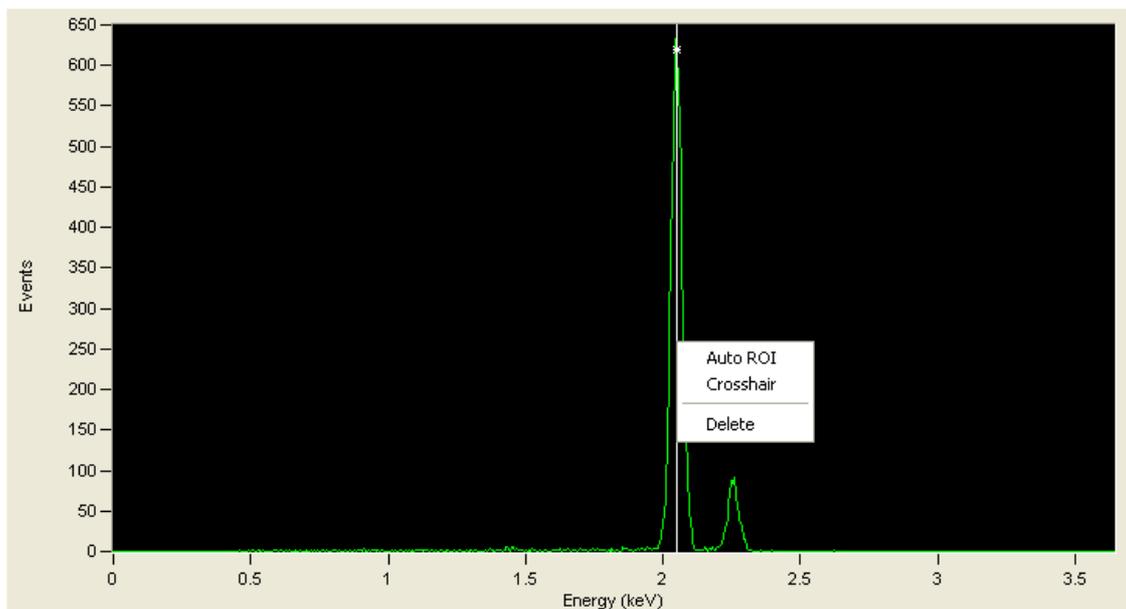
- **Reduce the Sampling Interval to the minimum,  $0.025\mu\text{s}$**
- **Zoom in on an x-ray pulse and use the cursors to measure the 0-100% risetime**

The Reset Interval settings must encompass the entire time required for the detector preamplifier to reset. If this number is not specified by the detector manufacturer, it can be measured using an external oscilloscope. If the Reset Interval is set too short, the microDXP front-end tracking circuitry could malfunction, leading to spurious MCA peaks and unexpected count rate statistics. If it is set to long, it will contribute unnecessarily to dead time.

- **Set the Reset Interval conservatively, to encompass the entire preamplifier reset time**

#### ACQUISITION: PEAKING TIME, GAP AND THRESHOLDS

Select the Acquisition tab in the settings area, and the MCA tab in the data area. The Peaking Time and other Filter Parameter settings control the trapezoidal digital filtering algorithms, as described in detail in our online documentation. Only the most common settings and procedures are described here.



**Fig 3:** An un-calibrated spectrum acquired with an Fe55 source. The cursor has been placed within the Mn  $K\alpha$  peak, and an ROI is being automatically assigned to find the centroid.

Note that the microDXP 8.0 offers a range of peaking times, from  $0.1\mu\text{s}$  to  $24\mu\text{s}$ , in twenty-four discrete steps. We recommend first selecting the expected optimum peaking time, i.e. where you expect the best energy resolution.

- **Select the expected optimal Peaking Time**
- **Set the Dynamic Range to match the energy range of interest**

- Open the 'Edit Filter Parameters' dialog and set the Energy Filter Slow Gap value to conservatively encompass the 0-100% risetime measured in the previous section
- Un-check the 'Resume?' checkbox, and check the 'Continuous' checkbox
- Press the Start Run button to acquire a preliminary, uncalibrated energy spectrum
- Right-click in the spectrum window and select 'Set to Logarithmic'

The software should display a recognizable, but uncalibrated energy spectrum. If you see a significant noise peak, or if the Livetime (at the upper right of the data area) measurement is much lower than the Realtime, you may need to adjust the Trigger threshold upwards. We'll more carefully adjust the thresholds after the gain has been calibrated.

The first task is to calibrate the Base Gain. This is achieved by fitting a known energy peak within a region-of-interest (ROI), and assigning an energy value to the peak centroid. The ROI controls are located below the MCA spectrum panel.

- Zoom in on a peak in the spectrum for which the energy is known
- Place a cursor in the center of the peak, right-click and select 'Auto ROI'. The center of the peak should now be enclosed in a color-coded ROI, corresponding to the active row in the ROI table.
- Enter the known energy in the 'Calib. (keV)' field in the row corresponding to the active ROI (typically at this point there is only one row in the table).

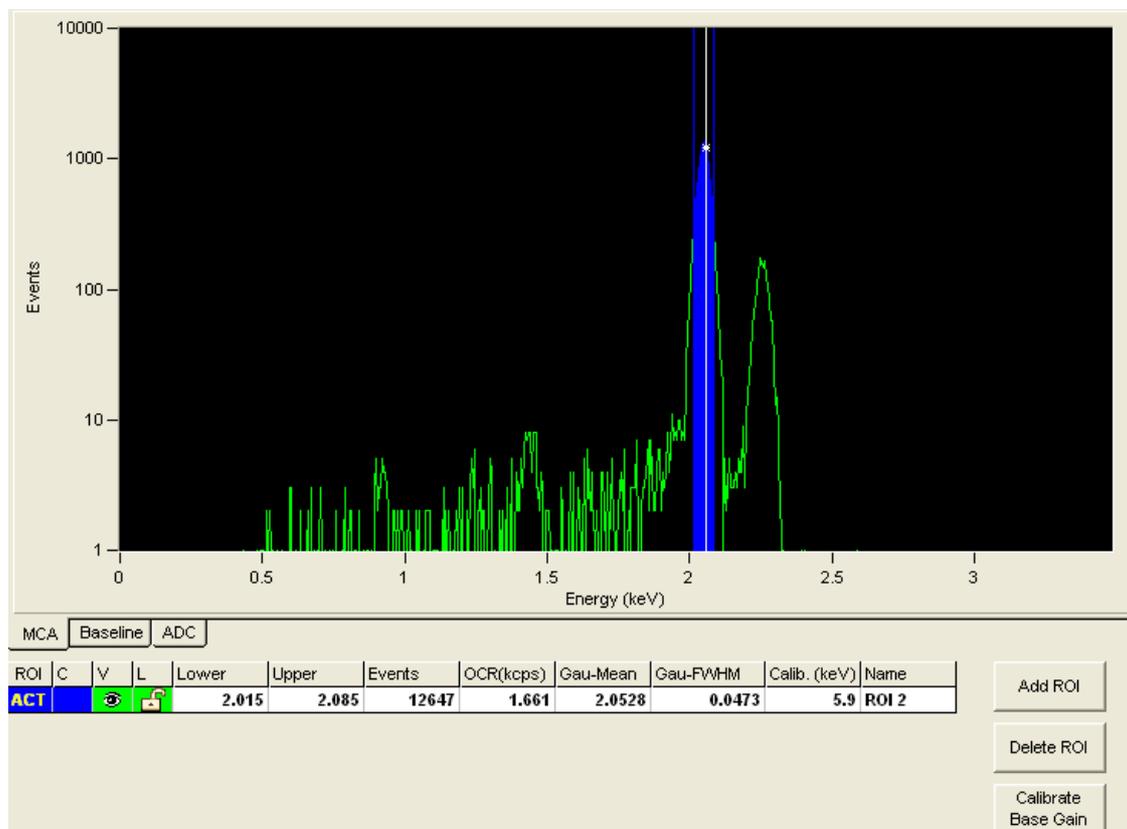


Fig 4: An ROI has been fitted to an uncalibrated peak at 2.0529 keV, and the known energy 5.9 keV has been entered.

- Click on the top-level Gain menu and verify that 'Calibrate Base Gain' is selected.
- Press the Calibrate Base Gain button in the ROI controls area. Acquire more data to confirm that the new calibration is acceptable. Repeat the process a second time if desired.

Note that the calibration routine can modify the analog gain of the hardware. If the operation increased the analog gain significantly, you may notice that a noise peak appeared after the calibration routine. We'll adjust thresholds in the next section.

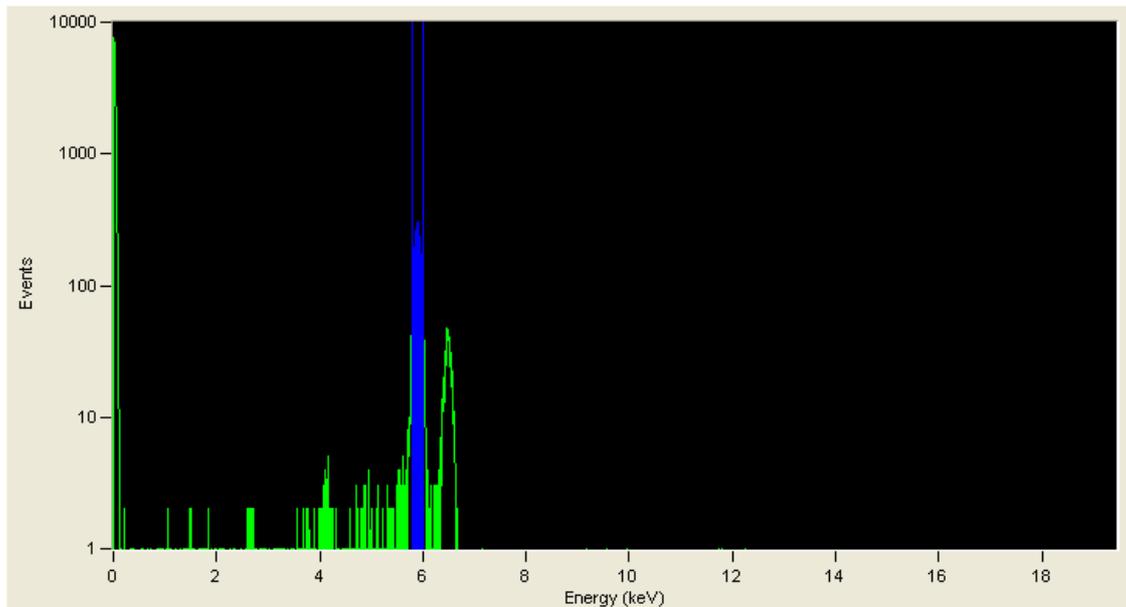


Fig 5: The spectrum has been calibrated, but a noise peak appeared after the analog gain was modified

We recommend optimizing both the Trigger and Baseline thresholds individually. Note that each threshold can be disabled either by setting it to 0, or by checking the adjacent 'Disable?' checkbox.

- **Disable the Baseline and Energy thresholds, either by setting them to 0, or by checking the adjacent 'Disable?' checkbox, then press the Apply button.**
- **Adjust the Trigger threshold just above the point at which a noise peak occurs**
  - Acquire MCA data using the Start Run/Stop Run button
  - If there is no noise peak, reduce the Trigger threshold.
  - If there is a noise peak, increase the Trigger Threshold
- **Now enable and adjust the Baseline threshold just above the point at which a noise peak occurs**
  - Acquire MCA data using the Start Run/Stop Run button
  - If there is no noise peak, reduce the Baseline threshold.
  - If there is a noise peak, increase the Baseline Threshold

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## SAVE YOUR SETTINGS

At this point all settings have been optimized for the first Peaking Time. It's now time to save these settings and move on to the next peaking time.

- **Press the Save button in the PARSET area of the Acquisition tab to save the gap time and thresholds**
- **Press the Save button in the GENSET area of the Acquisition tab to save the calibrated Base Gain**
- **Note that if you attempt to change the Peaking Time or the GENSET before settings have been saved, microManager will throw up a dialog warning you that settings will be lost.**

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## BASE GAIN VS FINE GAIN TRIM

The overall calibration consists of the Base Gain, as part of the GENSET, and the Fine Gain Trim, as part of the PARSET. This separation allows for a unique overall gain setting for each PARSET/GENSET combination, i.e. for each Peaking Time and for each MCA setup. The section above described how to calibrate the Base Gain for the first Peaking Time. The Fine Gain Trim should now be used to calibrate the energy for other peaking times, such that the original calibration is preserved.

- **Select Calibrate Gain Trim from the top-level Gain menu**
- **Repeat the optimization of settings described in the previous sections for each Peaking Time of interest**

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## DIAGNOSTICS

At this point the microDXP should be set up properly, however, you may still want to adjust settings if the performance is inadequate.

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## ENERGY RESOLUTION

Improper system grounding can lead to excess noise and thus degraded energy resolution. Experiment with connecting the detector power supply ground to the microDXP ground. There is a dedicated grounding tab (adjacent the lower-right mounting hole in the photo on the title page of this document) for this purpose. Alternatively, the two plated mounting holes on the microDXP card (not the microCOM-U card!) can be used to connect to the ground plane.

The following settings can also affect energy resolution:

- **The Energy Filter Slow Gap Time must be set to a value larger than the 0-100% detector signal risetime, such that the peak energy is properly sampled. This setting can be found in the Edit Filter Parameters dialog.**
- **Make sure that Peak Sensing mode is selected. This setting can be found in the Edit Filter Parameters dialog.**
- **A high Dynamic Range setting, corresponding to a low analog gain setting, can result in insufficient quantization of the signal and noise at the ADC.**

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## INPUT COUNT RATE

Improper system grounding (see the previous section) can also introduce transients which interfere with the input count rate measurement. Thresholds must also be set properly.

- **Make sure your Trigger and Baseline threshold are optimized, as described previously**

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## OUTPUT COUNT RATE AND PILEUP REJECTION

The following settings affect the output count rate and rejection of piled-up events from the energy spectrum:

- **A low Dynamic range setting, corresponding to a high analog gain setting, can result in excessive deadtime being consumed by the front-end tracking circuitry, and thus yield a lower-than-expected output count rate. This setting can be found at the bottom of the Acquisition settings tab.**
- **The Peak Interval should be set equal to the sum of the Slow Length and Slow Gap. Smaller values will introduce excess pileup, while larger numbers will incur excessive deadtime. This setting can be found in the Edit Filter Parameters dialog.**
- **The Max Width should be set to a value that is greater than the sum of twice the Fast Length and the detector signal risetime. Smaller values may significantly reduce the output count rate, while larger numbers introduce excessive pileup. This setting can be found in the Edit Filter Parameters dialog.**