Instructions for Setting Up the Linear Detector for GIXD Measurements
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Getting started with MEDM panels
See Appendix A for sample MEDM panels.
- MCA.ADL Double click on x-axis to set ‘user-defined’ range to 0-500. Click on “setup” tab and select 512 channels
- ADC.ADL Select 512 channels and set lower and upper discrimination levels to 5 and 100% respectively.
- TCA/AMP.ADL Enter LOW% and HIGH% to define boundaries of ROI #1. For example, if the peak spans channels 400-450 and the total channel setting is 512, then you would set the ROI boundaries to 78%-88%. For initial setup, set values to 5 and 100% and roi will give the total count rate into the detector.

Getting started with SPEC
All macros associated with the Canberra multichannel analyzer (eg. linear and vortex detectors) may be found in the chemmat28 folder: /usr/local/lib/spec.d/user_macros/mca/
The following macros are required to use linear detector:
- mca_run.mac collects a spectrum
- mca_peak.mac determines center value for direct or specularly reflected beam
- gid.mac scans dth and collects spectrum (for GIXD measurements)

Enter a value for the global variable corresponding to total number of channels. Then, initialize the other three global variables associated with the MCA using dummy values (otherwise, mca_run.mac will generate an error that says, “can’t assign array to scalar.”)

SURF>ch=512
SURF>mca_slope=1; mca_int=1; sdd=560
Signal Processing Schematic
See Appendix B for pictures of this setup.

General comments about electronics

- Refer to schematic on the following page
- The output of the time-to-amplitude converter in the NIM bin must be routed out of the hutch (via patch panel CC’ CA 08) to "AMP IN" on front panel of TCA/AMP.
- Use the TCA/AMP to collect signal in a particular ROI (region of interest). Up to three ROIs may be selected from the MEDM panel.
- Connect the LEMO plug on rear of 2016A to scalar input #7 on the C-rack.
- Connect "AMP OUT" on front panel of TCA/AMP to "ADC IN" on front panel of the ADC. No 50 ohm terminator is needed.

Module settings

- Ortec DGG: dial 2.4 on toggle setting of 1.1 microseconds
- Ortec TAC: range 10x100 ns (or 500 ns if TCA/AMP is not used)
- Delay loop: 16 ns
- TCA/AMP: coarse gain=5 (min), fine gain=0.5 (min), 1 us shaping, gaussian
Getting started with x-rays
The following procedure is based on the assumption that you have found the reflection from the surface and aligned the surface spectrometer with the Oxford detector (i.e. determined the geometry parameters).

- Turn on vibration isolation table
- Remove guard tube on output arm and also S2
- Place linear detector/soller slit assembly on rail, and push against S3. In this position, the distance from sample center to linear detector is approximately 560 mm.
- Adjust high voltage on detector anode to +2.2 kV (do this slowly)
- Open experimental shutter and turn on feedback

SURF>absclose
SURF>_sleep=0
SURF>s1v 0.030 0.030; s1h 1.5 1.5
SURF>s2v 1 1; s2h 1 1
SURF>s3v 0 0
SURF>umk 0 0 0
SURF>umv sh -2
SURF>umv sx -42
SURF>abs 63; absopen

Slowly remove absorbers until ROI (scalar #7) ~ 400 cps. Note: maximum count rate = 500 cps.

Align soller slits using direct beam
Be careful! The direct beam counts to detector may increase drastically as sollers are aligned. Be ready to close shutter quickly if this occurs.

SURF>plotselect roi; DET=roi
SURF>dscanb dth -0.1 0.1 20 1
SURF>umv dth CEN;set dth 0

Record CEN value in notebook (so you can reset dth when going back to reflectivity) and also record the number of absorbers required for a count rate of 500 cps.

Determine the channel density and offset using the direct beam
SURF>umv oh 0
SURF>mca_run 5; mca_peak

Repeat for oh = -10, -20, ..., -50 and record the channel of direct beam. Note: the direct beam channel # should increase as oh moves down. If it instead decreases, then you need to swap the cables that attach to the detector preamplifiers. From plot of oh versus channel, determine the number of mm/ch.

SURF>mca_slope=slope determined above
SURF>mca_int= center channel measured for oh=0
Align output arm with S2 in front of linear detector
SURF\texttt{>>s2v 0.3 0.3}
SURF\texttt{>>dscanb oh -1 1 20 1}
SURF\texttt{>>umv oh CEN}
SURF\texttt{>>s2v 0.1 0.1}
SURF\texttt{>>dscanb oh -0.2 0.2 20 1}
SURF\texttt{>>umv oh CEN;set oh 0}

Find reflection from water with S2 in front of linear detector
SURF\texttt{>>umvr sh +? to cut direct beam intensity by half}
SURF\texttt{>>set sh 0}
SURF\texttt{>>umi 0.5 0.5}
SURF\texttt{>>shscan 0.1 20 1}
SURF\texttt{>>umv sh CEN;set sh NOM}

Determine accurate sample-to-detector distance using reflection from water
Remove S2. Move to a series of different incident angles, Alpha, while keeping Beta=0. Record channel number as reflected beam walks up the detector. Channel number will be proportional to the sign of the incident angle plus a constant (mca\_int).

\texttt{SURF>>umi 0.05 0; mca\_run 5; mca\_peak}
\texttt{SURF>>umi 0.10 0; mca\_run 5; mca\_peak}
\texttt{...}
\texttt{SURF>>umi 0.25 0; mca\_run 5; mca\_peak}

Plot of channel number versus alpha (radians) will have a slope=\(\text{sdd/mca\_slope}\).
Value of \text{sdd} should be close to the one measured with tape. The intercept of the graph should equal \text{mca\_int}\ measured with direct beam and specular reflection. See Appendix C for example.

Determine Linear Response Range
Test linear range of detector for sharp (direct beam) and diffuse (reflected, \text{dth}≠0) features
Do this by removing absorbers and measuring peak intensity with selected ROI counts.

Collect Data (see experiment-specific instructions from Binhua)
Use command \texttt{umi} to increase Beta so that specular reflection moves to the bottom of the range allowed by the soller slits. This will maximize acceptance range of linear detector. No need to change of any global parameters in SPEC! For example, at a typical sample-to-detector distance of 560 mm, the soller slits limit the angular acceptance of the linear detector to a maximum of 10 degrees.
Appendix A: MEDM screens
### MCA Setup

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. number of channels</td>
<td>2048</td>
</tr>
<tr>
<td>Number of channels</td>
<td>512</td>
</tr>
<tr>
<td>Preset Live Time</td>
<td>600.00</td>
</tr>
<tr>
<td>Preset Real Time</td>
<td>30000.00</td>
</tr>
<tr>
<td>Preset Start Channel</td>
<td>0</td>
</tr>
<tr>
<td>Preset End Channel</td>
<td>1280</td>
</tr>
<tr>
<td>Preset Counts</td>
<td>0</td>
</tr>
<tr>
<td>Dead Time Warning (%)</td>
<td>40.00</td>
</tr>
<tr>
<td>Dead Time Error (%)</td>
<td>0.00</td>
</tr>
<tr>
<td>Mode</td>
<td>PHA</td>
</tr>
<tr>
<td>Channel Advance</td>
<td>Internal</td>
</tr>
<tr>
<td>MCS Int. Dwell Time</td>
<td>0.00e+00</td>
</tr>
<tr>
<td>MCS Ext. Prescale</td>
<td>1</td>
</tr>
<tr>
<td>Read spectrum every</td>
<td>1 second</td>
</tr>
<tr>
<td>Check done every</td>
<td>0.1 second</td>
</tr>
<tr>
<td>Wait for client</td>
<td>Disable</td>
</tr>
<tr>
<td>Client wait</td>
<td>Done</td>
</tr>
</tbody>
</table>
Appendix B: Pictures of linear detector setup
Appendix C: Example of how to determine global parameter, sdd
(KaYee run, Feb 2006, file 02.13.06b, Be window detector at +2.2 kV.)

Read and process scans into IDL using commands below:
IDL> res1=scan_ld_read(1)
IDL> print, peak_cent(res1,/roi)
IDL> res2=scan_ld_read(2)
IDL> print, peak_cent(res2,/roi)
et cetera...

<table>
<thead>
<tr>
<th>scan (#)</th>
<th>alpha (degrees)</th>
<th>alpha (radians)</th>
<th>direct beam** (channel)</th>
<th>reflected beam (channel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2*</td>
<td>0.0000</td>
<td>0.000</td>
<td>211.704</td>
<td>----</td>
</tr>
<tr>
<td>3</td>
<td>0.0566</td>
<td>9.879e-4</td>
<td>----</td>
<td>213.518</td>
</tr>
<tr>
<td>4</td>
<td>0.1000</td>
<td>1.745e-3</td>
<td>----</td>
<td>215.013</td>
</tr>
<tr>
<td>5</td>
<td>0.2500</td>
<td>4.363e-3</td>
<td>206.601</td>
<td>219.637</td>
</tr>
<tr>
<td>7</td>
<td>0.5000</td>
<td>8.727e-3</td>
<td>200.098</td>
<td>227.535</td>
</tr>
<tr>
<td>8</td>
<td>0.7000</td>
<td>1.222e-2</td>
<td>194.620</td>
<td>233.743</td>
</tr>
</tbody>
</table>

Notes
*Scan #2 was recorded with HKL=0 0 0.01, and ALPHA=BETA. BETA=0 in all other scans.
**Do not use the direct beam centers in the fit. These values are systematically high, since they are result of overshoot of direct beam across sample. This is evident when one attempts to average the direct and reflected beam centers, and obtains an average which is always greater than 212.

Intensity vs Channel
Channel versus Alpha (radians)

Scan order (left to right): 8,7,5,2,3,4,5,7,8

plot_slope=1801.82
plot_intercept=211.77
sdd = plot_slope * mca_slope
sdd = 1801.82*0.3125
sdd = 563.07 mm