

# Physical Property Lab Cookbook

## Whole Core Multi-Sensing Track NGR Sensor Array Tuning

### *About this Document*

Version 1.0 location: \\JR1\TECH\PhysProps Folder\Maestro\NGRtuning.doc 10/23/2001 Leg 198 David Fackler, reviewed Patrick Riley. Updated 01/08/2002, Leg 200 Patrick Riley.

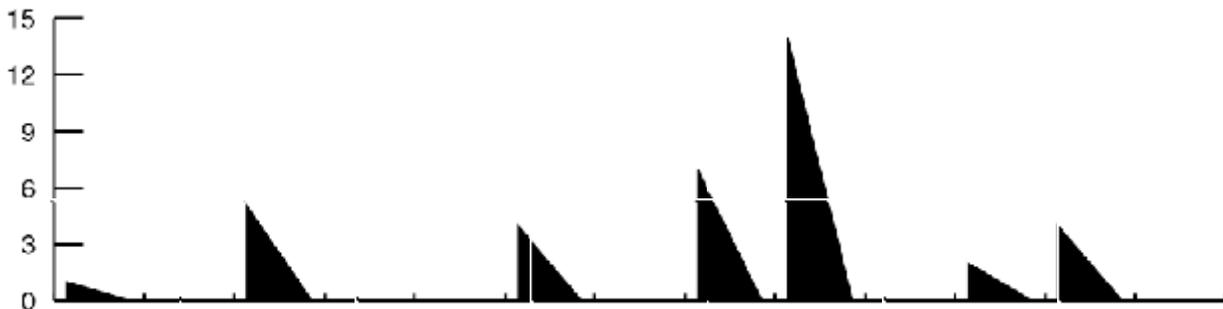
### *Content*

Notes about and practical procedures for tuning the amplified signals from the sodium-iodide-based natural gamma detectors using a PC installed with Maestro v5.31 multi-channel analyzer software.

### *Why Tune the Amplifiers?*

The amplitude of the output signal of the natural gamma ray (NGR) sensor array drifts over time from its original calibration point. To obtain internal consistency across multiple legs of NGR data the source signal must be tuned (calibrated) to a known state.

The NGR system consists of four sensors. Every time a gamma ray event is detected, a cascade of photons is generated, sensed and turned into an electrical signal (voltage vs. time):



Each gamma event is represented by an electrical spike. The amplitude of each spike is proportional to the energy of a detected gamma-ray event. The materials that ODP measures typically generate gamma events at rates of 3-5 thousand per second.

Each electrical spike is counted and sorted based on its height. The counting and sorting process is handled by high-speed computing hardware known as a multi-channel buffer (MCB). The ODP system connects two MCB's to the sensor array outputs. One feed goes from the amplifier array to the 917 MCB (rack-mounted NIM panel) and then feeds via a serial-GPIB link into the WCMST Control Station. The other feed goes directly to the 916a MCB (full-length ISA computer board) within the MST workstation.

When the gamma-event counts are plotted on a graph (number of counts vs. signal amplitude) a characteristic curve appears with many valleys and peaks. All gamma emitters generate specific curve patterns (emission spectra). ODP uses a combination Thorium Oxide and Potassium (K-40) standard as its gamma emission source for calibrating the NGR sensor array and MCB electronics. See the spectrum plots in the "Physical Properties Handbook"; also see screen prints from the Maestro software in the PP Tech Help (handbook /binder) or in \\JR1\TECH\Phys Prop Folder\Maestro\NGR Amp Tuning.

When the amplifier gain is turned up (amplitudes increase in the source signal), the spectra plot translates to the right. Vice versa is also true. The characteristic curve however is unchanged. Tuning of the NGR amplifier system allows us to guarantee that the gamma spectral plots from one leg will be directly comparable to the plots on another leg.

## ***Required Tools and Equipment***

The equipment required for tuning the NGR amplifier array is installed at the MST workstation:

- the 916A MCB
- version 5.31 of the Maestro multi-channel analyzer (for producing spectra plots)
- a coaxial feed from the “OUTPUT B” feed of the ORTEC 533 Dual Sum and Invert amplifier into the ADC (analog/digital converter) input on the 916a MCB

Note: the 916a board has a toggle-switch nearby the ADC input. This switch should be centered (neither up nor down).

Obtain a copy of the document \\JR1\TECH\Phys Prop Folder\Maestro\NGR Amp Tuning (NGR\_TI-208peak, NGRdisplay1, NGRdisplay2). These screen-shots from the Maestro software will be helpful for tuning the amplifiers.

Identifying the other equipment:

The NGR sensor array is the last, large, heavily shielded instrument to the far right of the WCMST system as you face the control system monitor.

The amplifiers being adjusted are in the upper instrument rack (over the GRA and PWL sensor hardware). Look for the densely populated calibration knobs and input/output feeds on the central two panels (ORTEC Dual Spec Amp 855). For tuning purposes only the knobs marked “Fine Gain” will be adjusted.

During the tuning process, only one NaI (sodium iodide crystal) detector of the NGR sensor will be on-line at a time. Look for the ORTEC 533 Dual Sum and Invert panel on the instrument bin. Immediately to its right are the signal lines to be tuned individually. Unplugging one of the orange-dotted output connectors will take one sensor off-line.

ODP uses Thorium-Oxide Standards as gamma emission sources. These are stored in a shielded yellow wooden box underneath the WCMST table, clearly marked with the radiation hazard symbol.

## ***Process***

1. Load the Maestro program at the MST(V) station. Start>>Programs>>MAESTRO 32>>MAESTRO for Windows.
2. Set Maestro to a ready state by:
  - Select 2 MSTV MCB 25 from the drop-down list at the right of the program toolbar.
  - Press the “Stop” button.
  - Then press the “Clear” button (to the immediate right of “Stop”).
  - Under the Display menu, select the “Fill All” option so that it is dotted or checked.
3. Load both of the thorium-oxide emission source vials into the NGR sensor. Center them in the array as best you can.
4. Unplug all but one NGR sensor signal feed. Keep “1” connected initially. As this step is repeated, cycle through the remaining outputs “2” through “4”. For the last check-out cycle, all sensors will be connected.
5. Conduct a measurement cycle: press the “Go” button. Vertical lines will appear on-screen as gamma events are counted, sorted and plotted. Over a long time (24-hours) you will obtain a smooth plot like the one seen in the NGR\_TI-208peak document. For tuning purposes, a run time of 5-10 minutes is sufficient.
6. During the measurement run, move the cursor (vertical yellow line) to Marker 414\*. Use the left or right arrow keys to place the cursor.
  - Consistently (always) use this same channel marker.
  - This channel is being tuned to the center of the characteristic peak for a TI-208 gamma source.
  - The energy content of gamma events at this marker corresponds to 2614.47 keV (+/- error due to digitizing of the original signal).
  - Use the up and down arrow keys to adjust the vertical expansion of the plot.
  - Use the numeric keypad +/- keys to adjust the horizontal resolution of the plot display.
  - Use the numeric keypad 5 to center the marker cursor on the display.
  - Adjust the display so you see something like the TI-208 peak recorded in the NGR\_TI-208peak document.

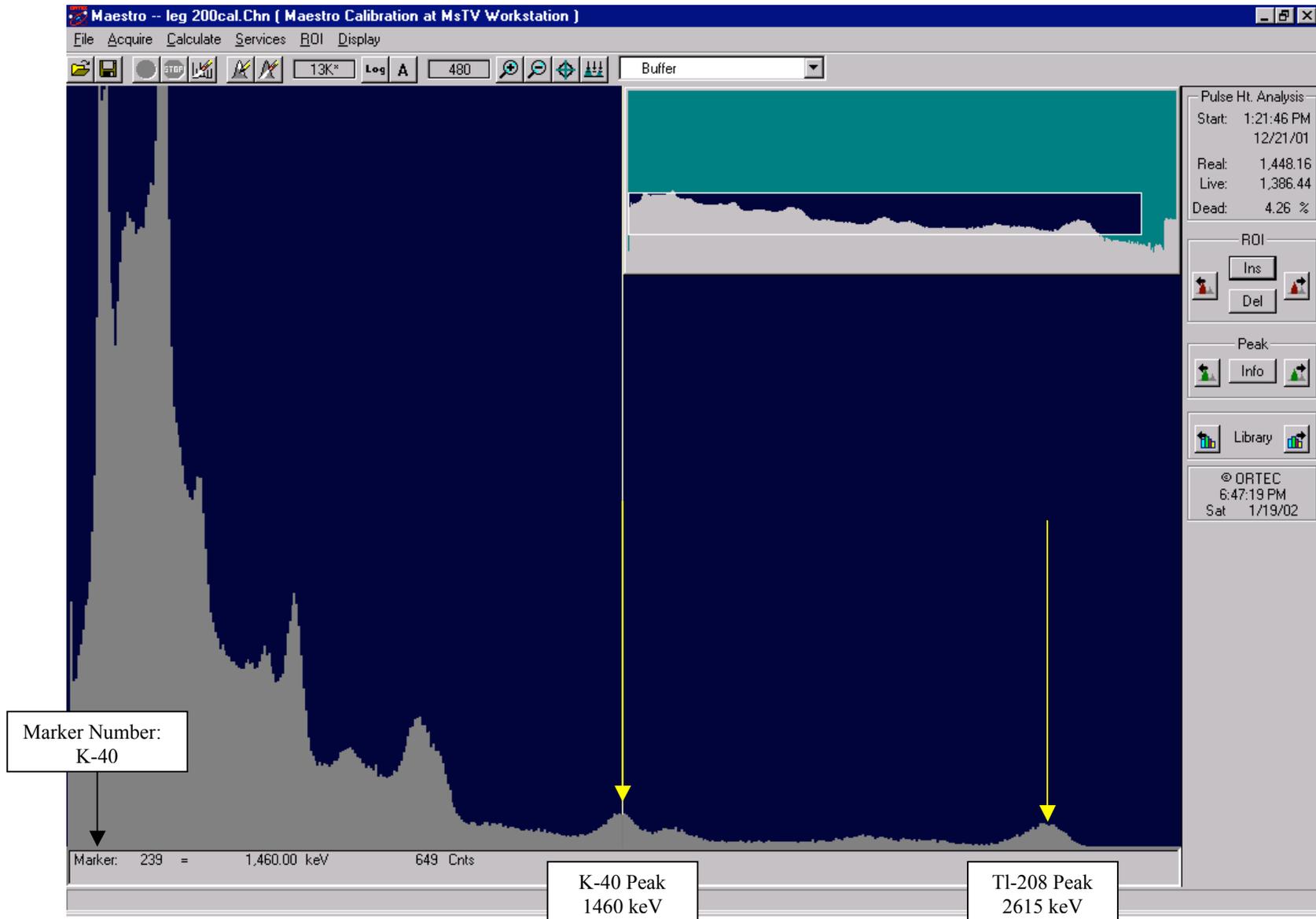
7. If the Tl-208 peak is not centered as shown in the NGR\_Tl-208peak document, then stop the current acquisition and adjust the “Fine Gain” for that sensor signal.
  - Press “Stop” to halt the Maestro data acquisition.
  - Assess how many channels left or right (if any) that the Tl-208 peak has shifted from the 414 marker.
  - Rotating the fine gain clockwise approximately a quarter turn will cause the peak to shift one channel to the right.
  - Rotating the fine gain counter-clockwise approximately a quarter turn will cause the peak to shift one channel to the left.
8. Repeat the measurement cycle in steps 5-7 until you are satisfied that the Tl-208 peak is centered as shown in the NGR\_Tl-208peak document at marker 414.
  - Each “Fine Gain” knob has a black lever, that locks the knob when placed in the down position.
  - Lock each gain knob in place when you are done with that sensor.
9. Repeat the entire measurement cycle from steps 4-8 for each sensor output individually, and then check the peak location with all sensors connected. It should be centered at the Marker 414.

That’s it.

For historical reference, as of 10/23/2001, the fine gain knobs for each sensor are tuned as follows: Sensor 1—8.46; Sensor 2—6.93; Sensor 3—6.30; Sensor 4—4.73.

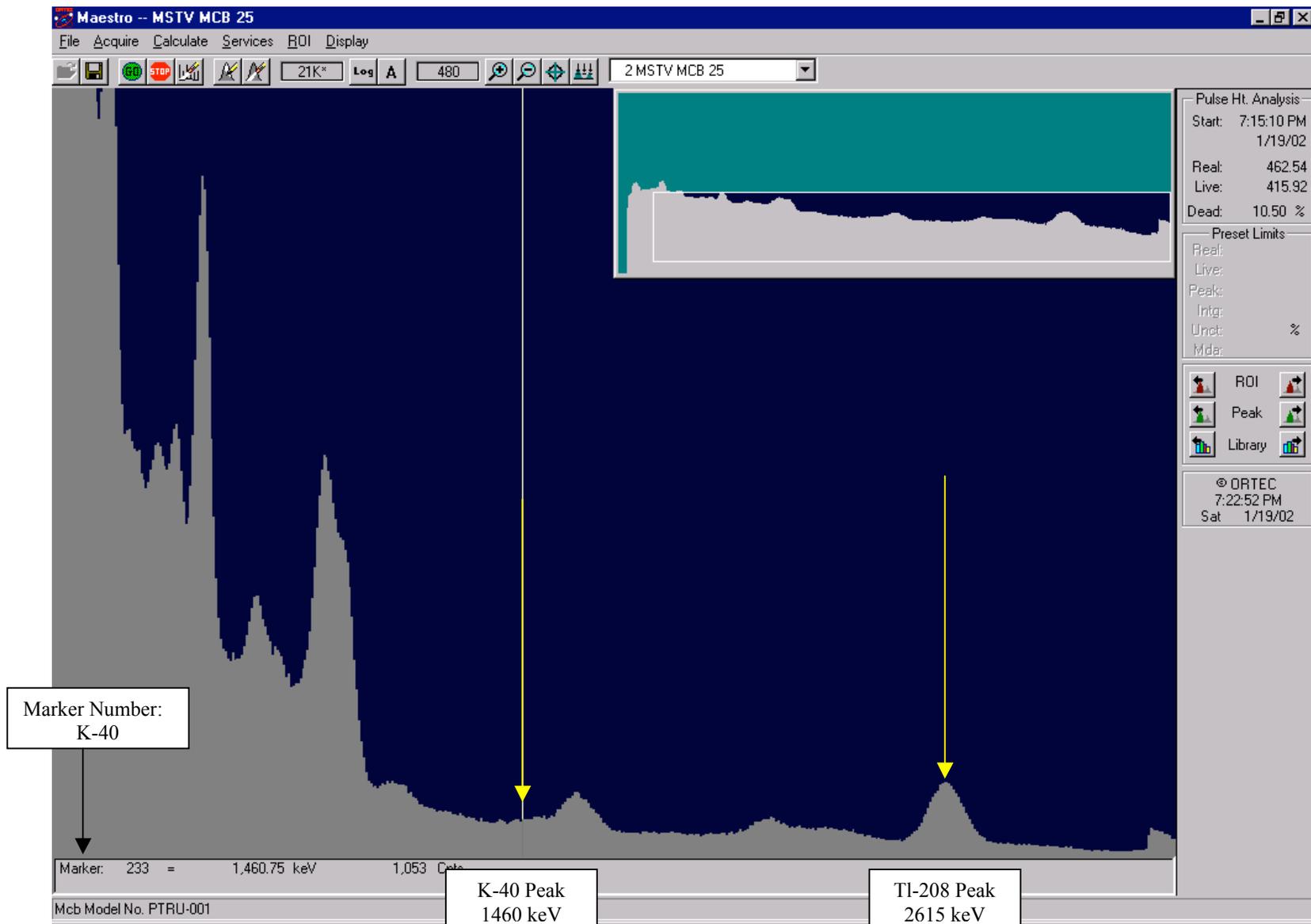
To verify your tuning, you can check for the K-40 peak found at Marker 233\* (1460 keV) by placing the Potassium Standard into the NGR Sensor.

**Note: (\*)** The markers listed in this document are valid only for the current Maestro calibration. There is no need to change the Maestro calibration, but if it is done, realize that subsequent calibrations will yield slightly different marker numbers.



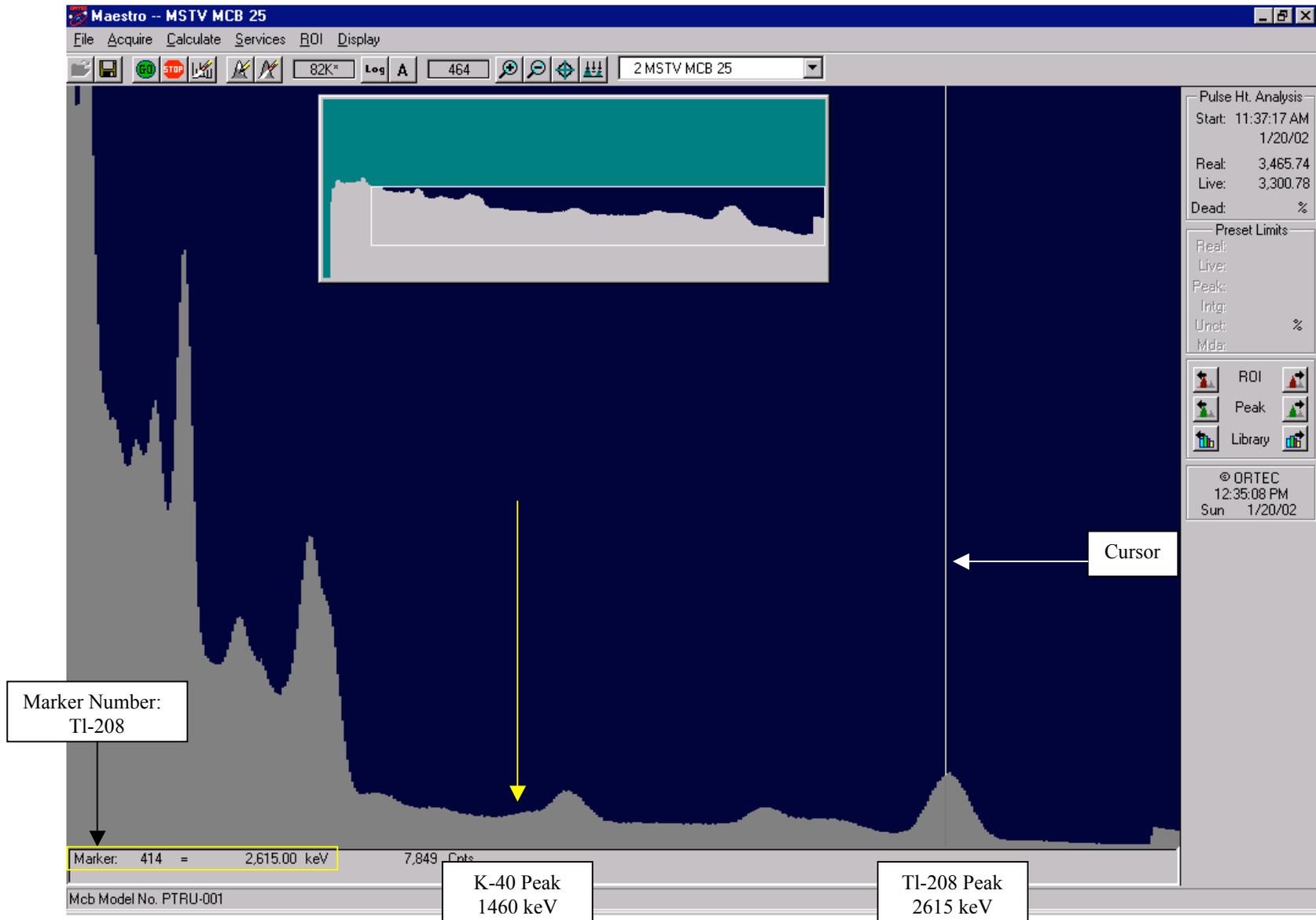
**NGR Spectrum showing K-40 and Tl-208 Peaks:**

The Marker Number for each peak will change slightly with spectrum calibration within the Maestro Program, but the peaks will remain in their relative location.



**NGR Spectrum showing K-40 and Tl-208 Peaks: (Thorium Oxide Standard)**

This display shows the K-40 Peak overshadowed by the Bismuth Peak. This is why it is easier to use the more distinct Tl-208 Peak for amp tuning. Note the change in the K-40 Marker Number.



**Tuning the NGR Amplifiers to the Tl-208 Peak: (Thorium Oxide Standard)**

Set the cursor to Marker 414 = 2615 keV in Maestro (MSTV Computer).  
 By using the fine gain adjustment, center the Tl-208 Peak to where the cursor marks the correct energy window. This needs to be done for each amp, individually.