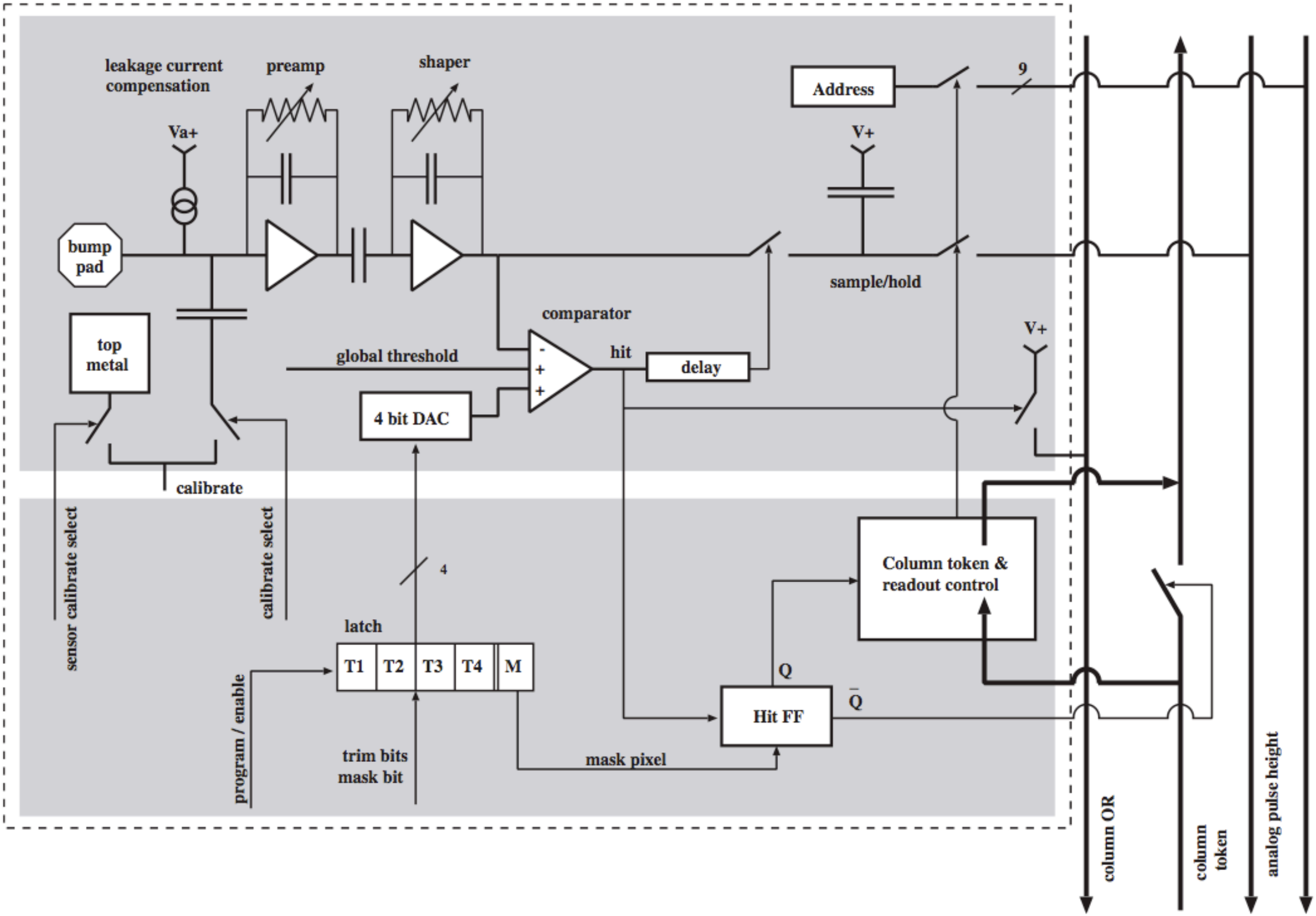
CMS Experiment: Pixel Sub-Detector

VCal Injection Temperature Studies

Tony Kelly

The Pixel Unit Cell



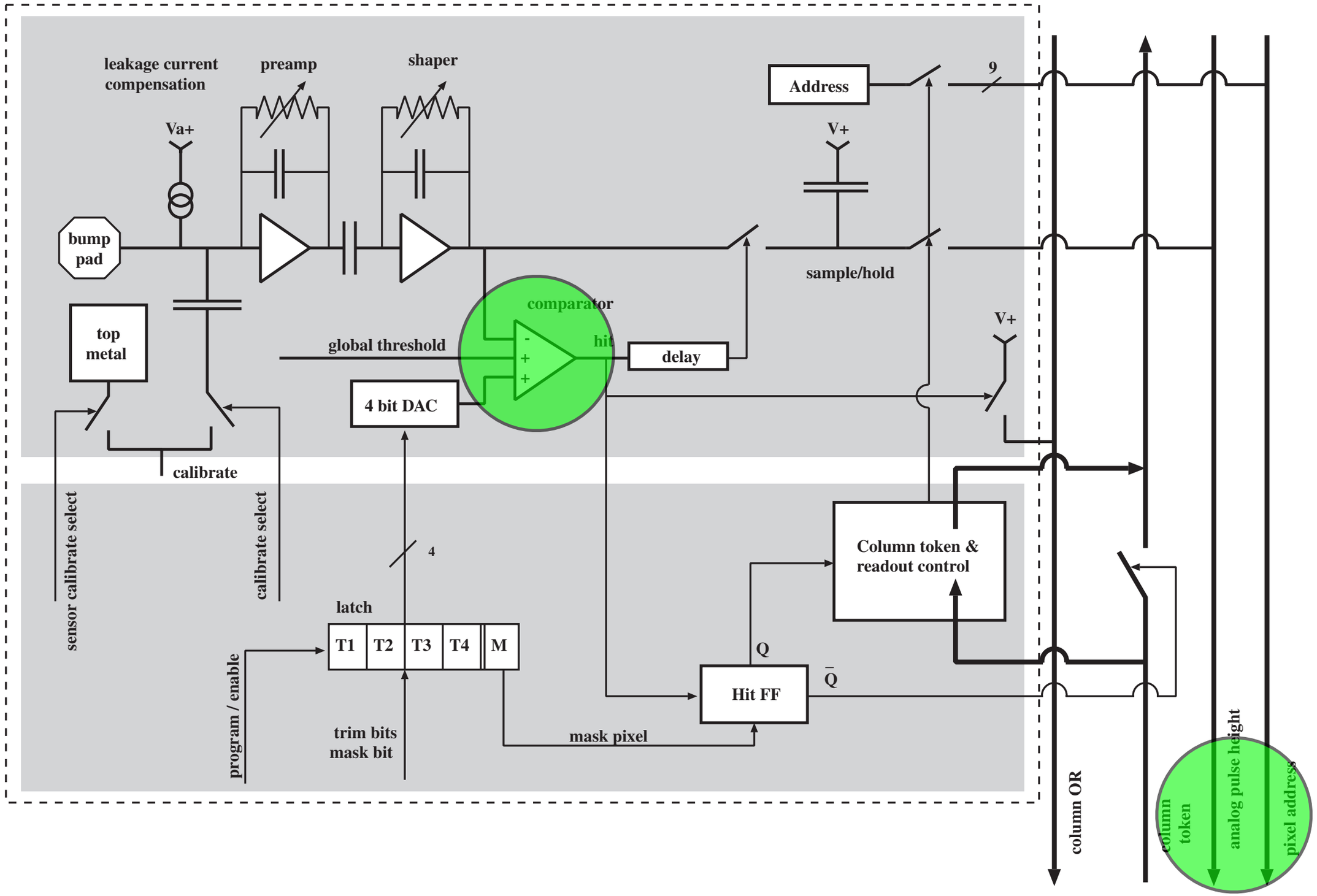
The VCal

- Associated with a calibration capacitor
- An 8 bit DAC (values 0 - 256).
- Can run in two modes
  - Low VCal Mode (Each DAC = ~ 65 e-)
  - High VCal Mode (Each DAC = ~ 455 e-)

Purpose of Study

- The VCal (Calibration Injection) is associated with a small capacitor.
- As with most electronics, this capacitor is temperature sensitive.
- It is important to understand the capacitor's behavior as a function of temperature (and radiation exposure)
    - The VCal is essential to the ROC Calibration procedures in setting/determining DAC Values, circuit delays, gain calibrations, ...

Two Ways to Study the VCal Injection



Photon Source Information

Tb -> 44.23 keV --> ~ 12286 electrons | ~ Vcal 189

Ba -> 32.06 keV --> ~ 8905 electrons | ~ Vcal 137

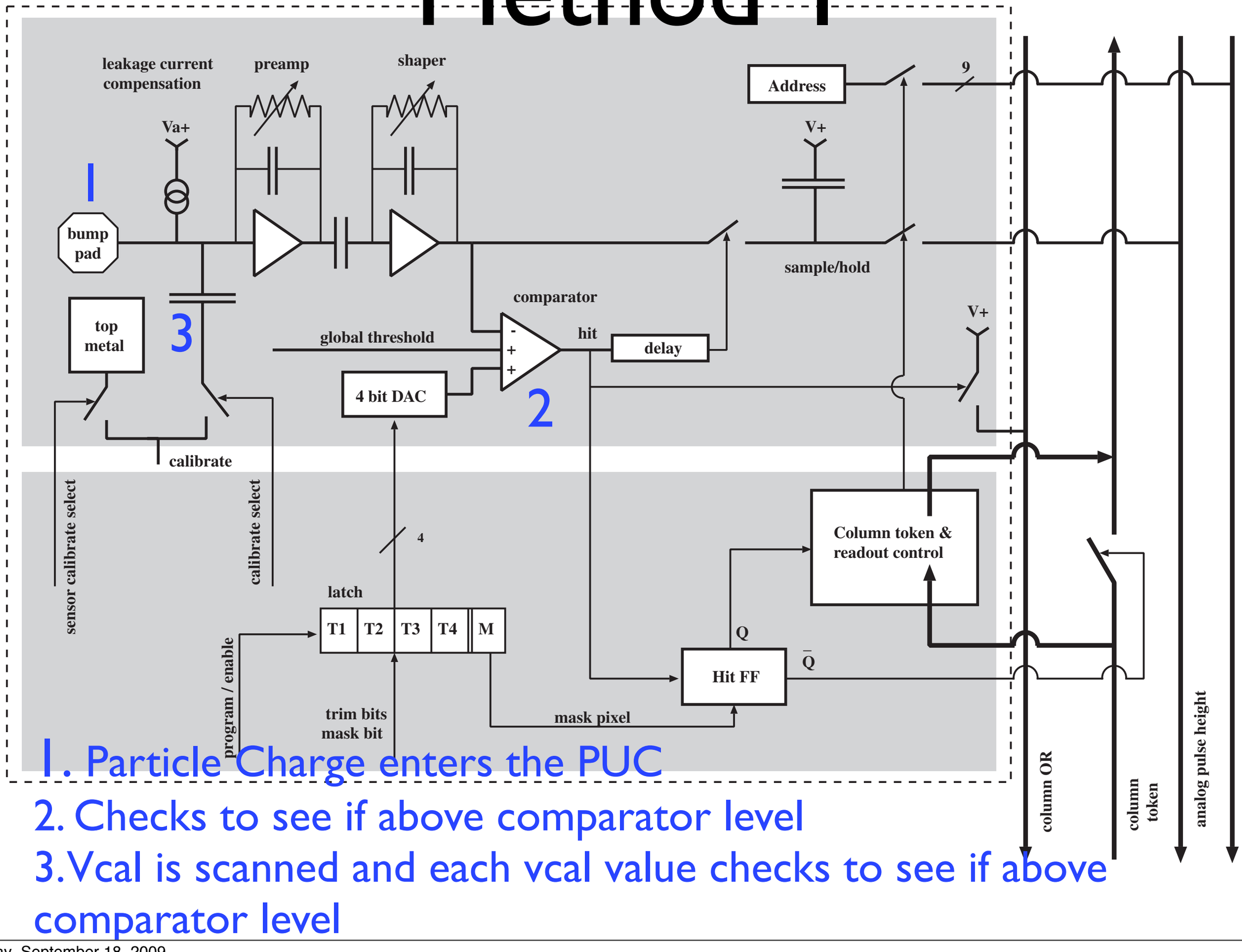
Ag -> 22.10 keV --> ~ 6138 electrons | ~ Vcal 94

Mo -> 17.44 keV --> ~ 4844 electrons | ~ Vcal 74

Rb -> 13.37 keV --> ~ 3713 electrons | ~ Vcal 57

Cu -> 8.04 keV --> ~ 2233 electrons | ~ Vcal 34

Method I



1. Particle Charge enters the PUC
2. Checks to see if above comparator level
3. Vcal is scanned and each vcal value checks to see if above comparator level

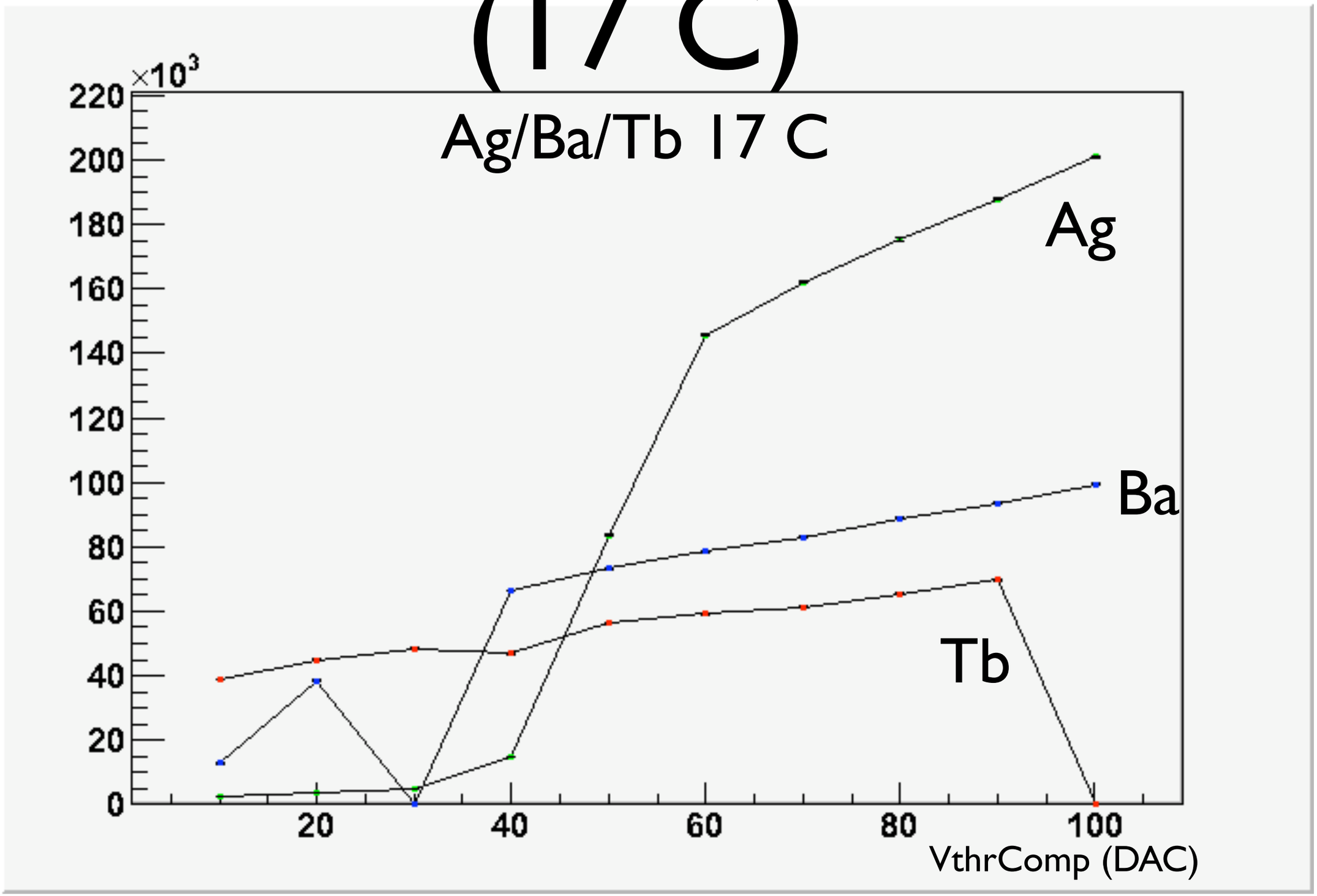
Method 1 Procedure

- Choose a source particular known energy
- Set the VthrComp DAC to a value
    - The VthrComp is a DAC associated with the comparator. The greater the value, the lower the threshold (since pulse is negative when passed through Shaper).
- Take data for some time
- Count the hits (read outs) that were found
- Change the VthrComp value, repeat

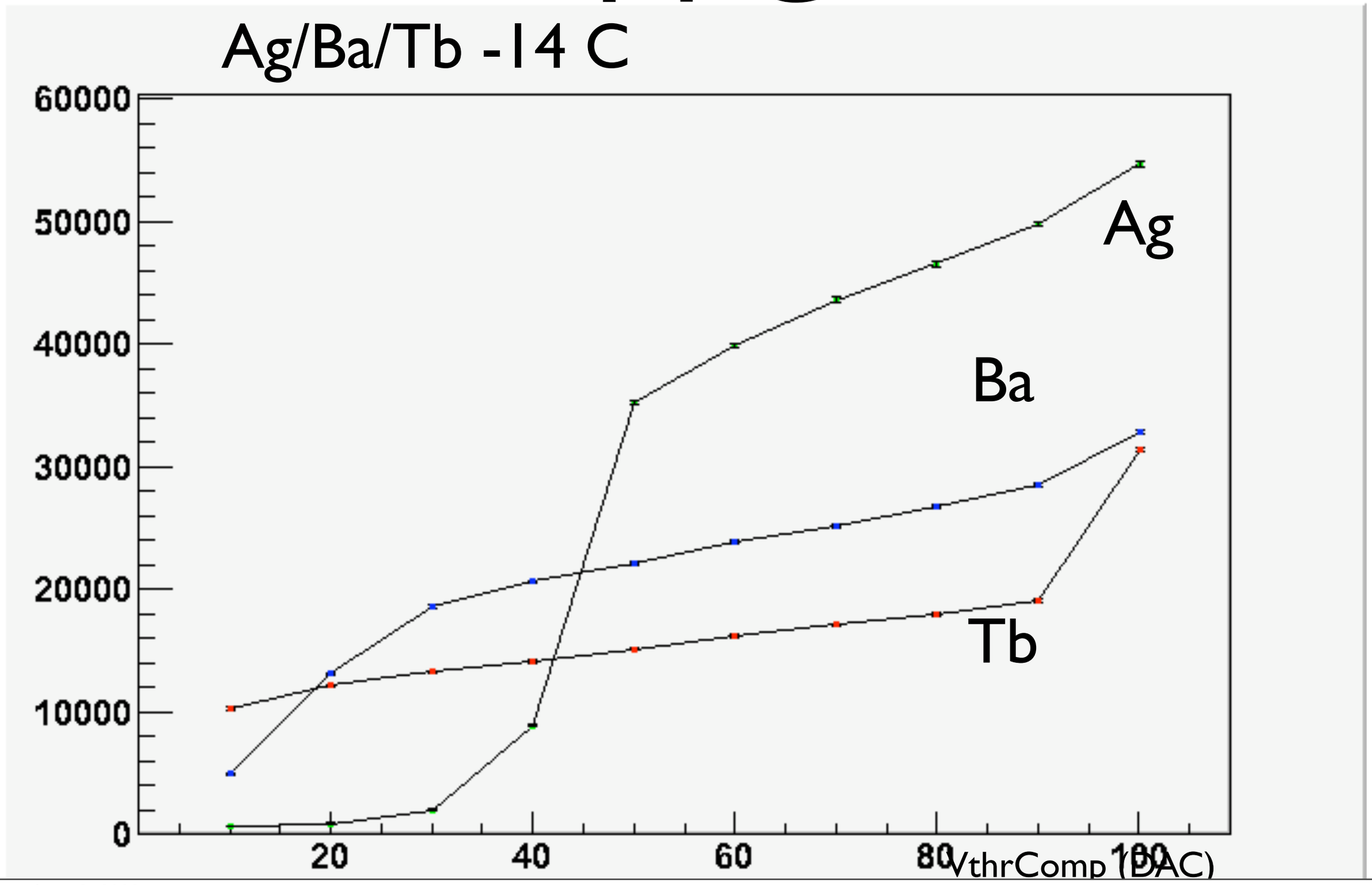
Method 1 Procedure Cont.

- At high thresholds (corresponding to low VthrComp DAC values), expect to see zero to few hits for a discrete energy source
- At some point, expect to see a jump in the hits at a threshold, as the threshold is lowered enough to collect enough charge to pass the comparator cut.
- This VthrComp value can be associated with a VCal value. Knowing the energy of the external source, the Vcal value can then be calibrated.

VthrComp SCurve (17 C)



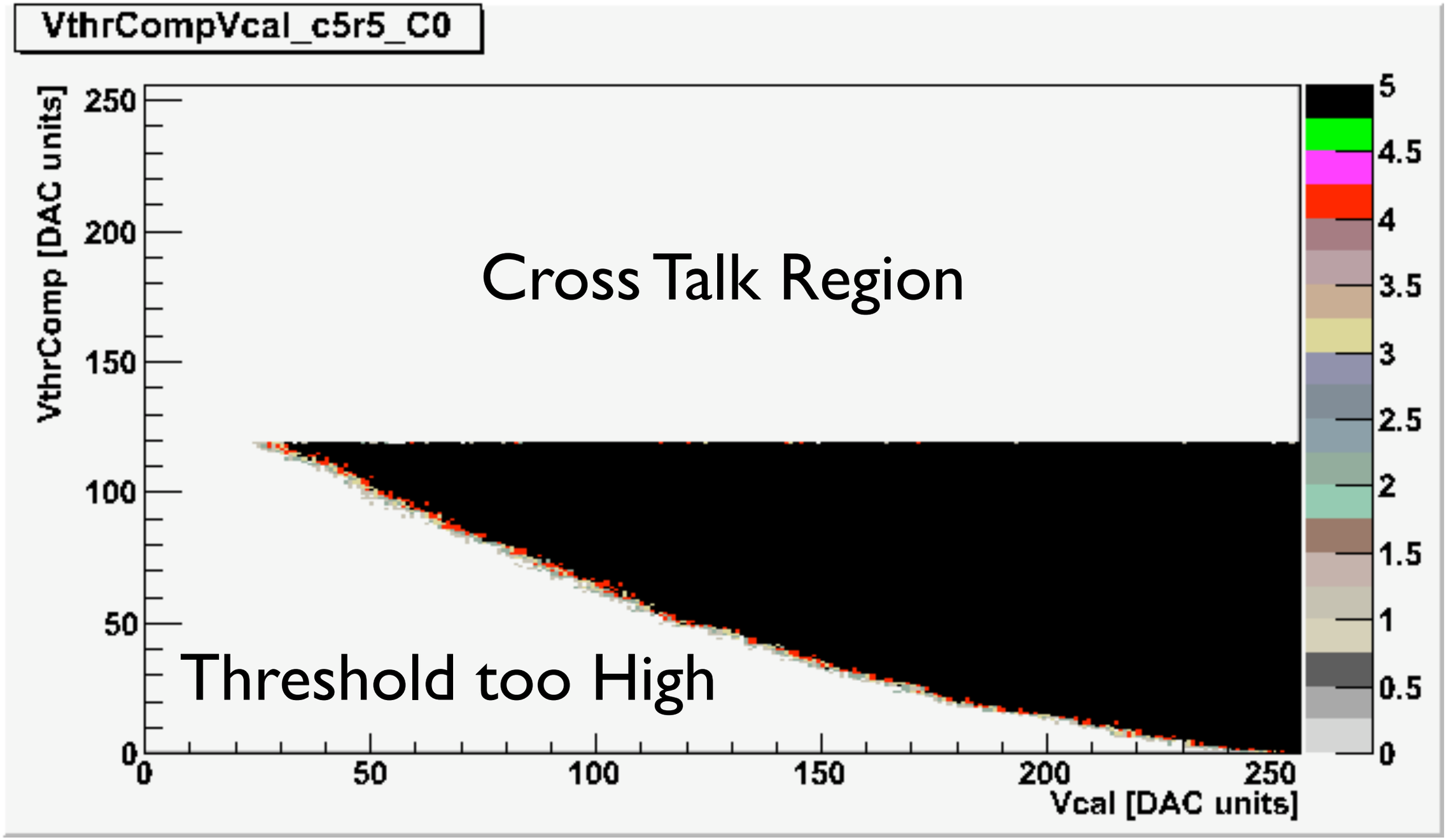
VthrComp SCurve -14 C



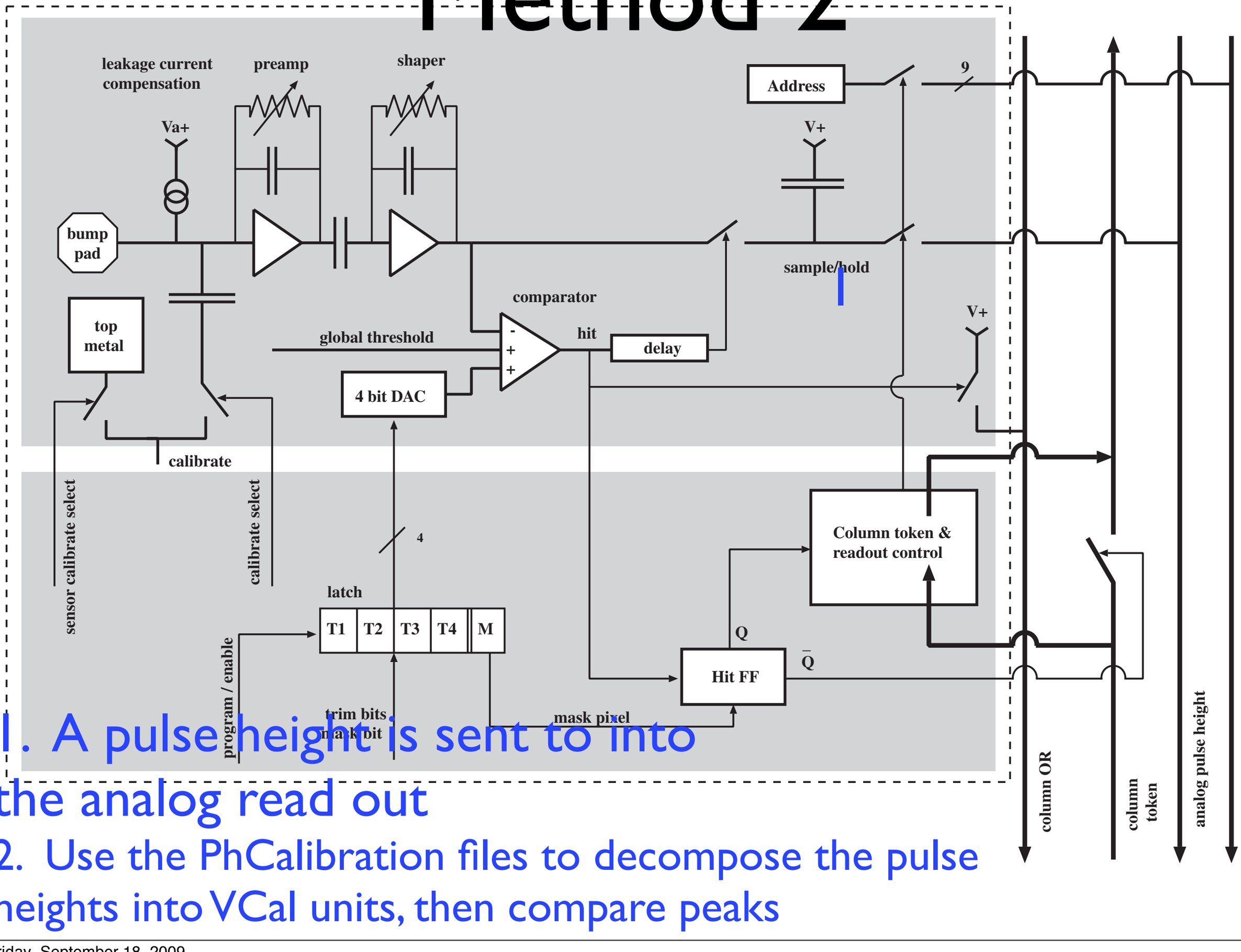
Two Reasons for "Flatness"

- First, the silicon is more responsive to ranges of photon energies.
    - Photons are a Pass/Fail procedure. The xray photon either deposits all of its energy into charge creation, or passes through the sensor material.
- Second, the more energetic photons from sources such as Tb and Ba easily pass the highest thresholds when trimmed at a Vcal of 60.
    - Tb -> 44.23 keV --> ~ 12286 electrons | ~ Vcal 189
    - Ba -> 32.06 keV --> ~ 8905 electrons | ~Vcal 137

Why Flat?
Plot at 17 C



Method 2

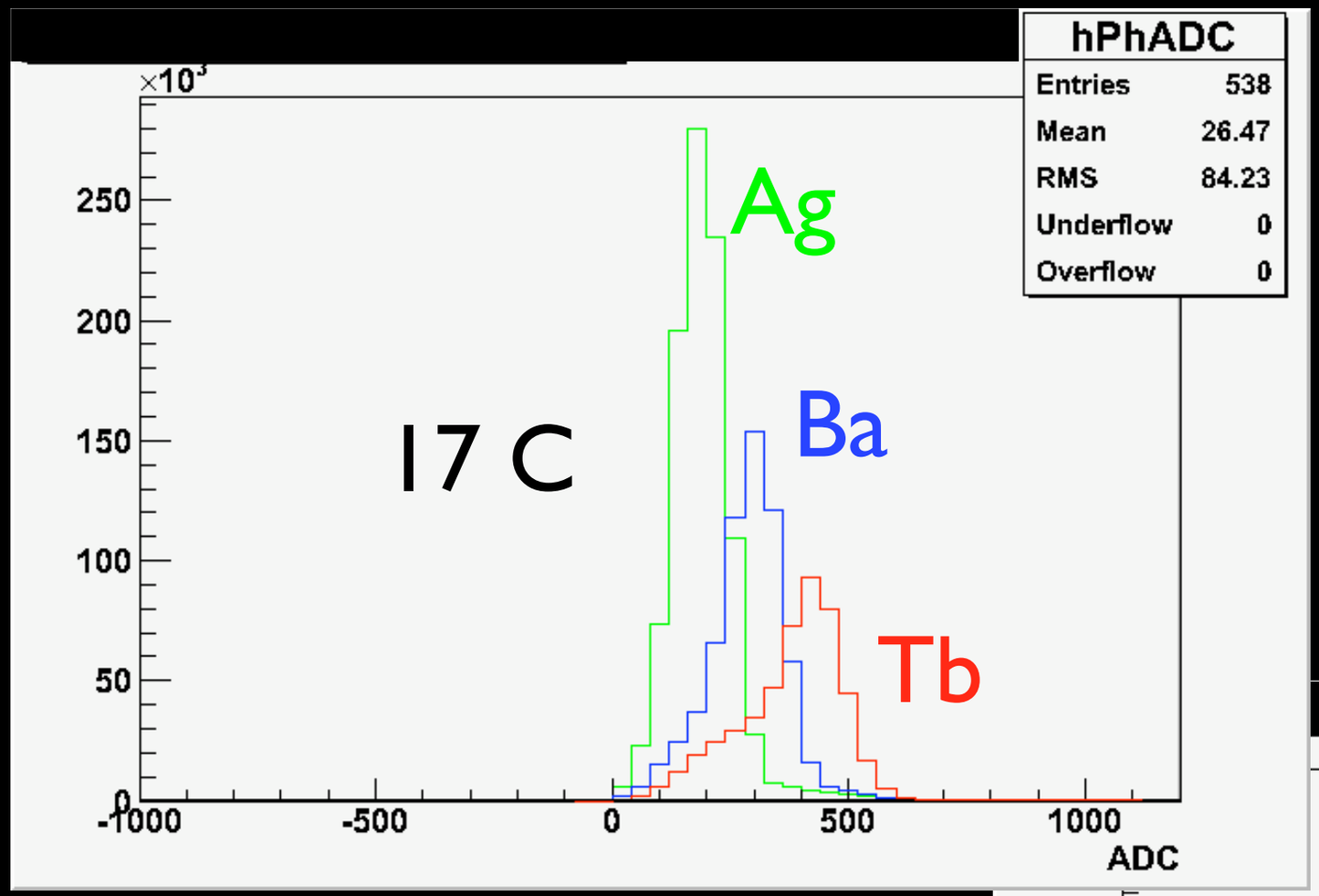


1. A pulse height is sent to into the analog read out
2. Use the PhCalibration files to decompose the pulse heights into VCal units, then compare peaks

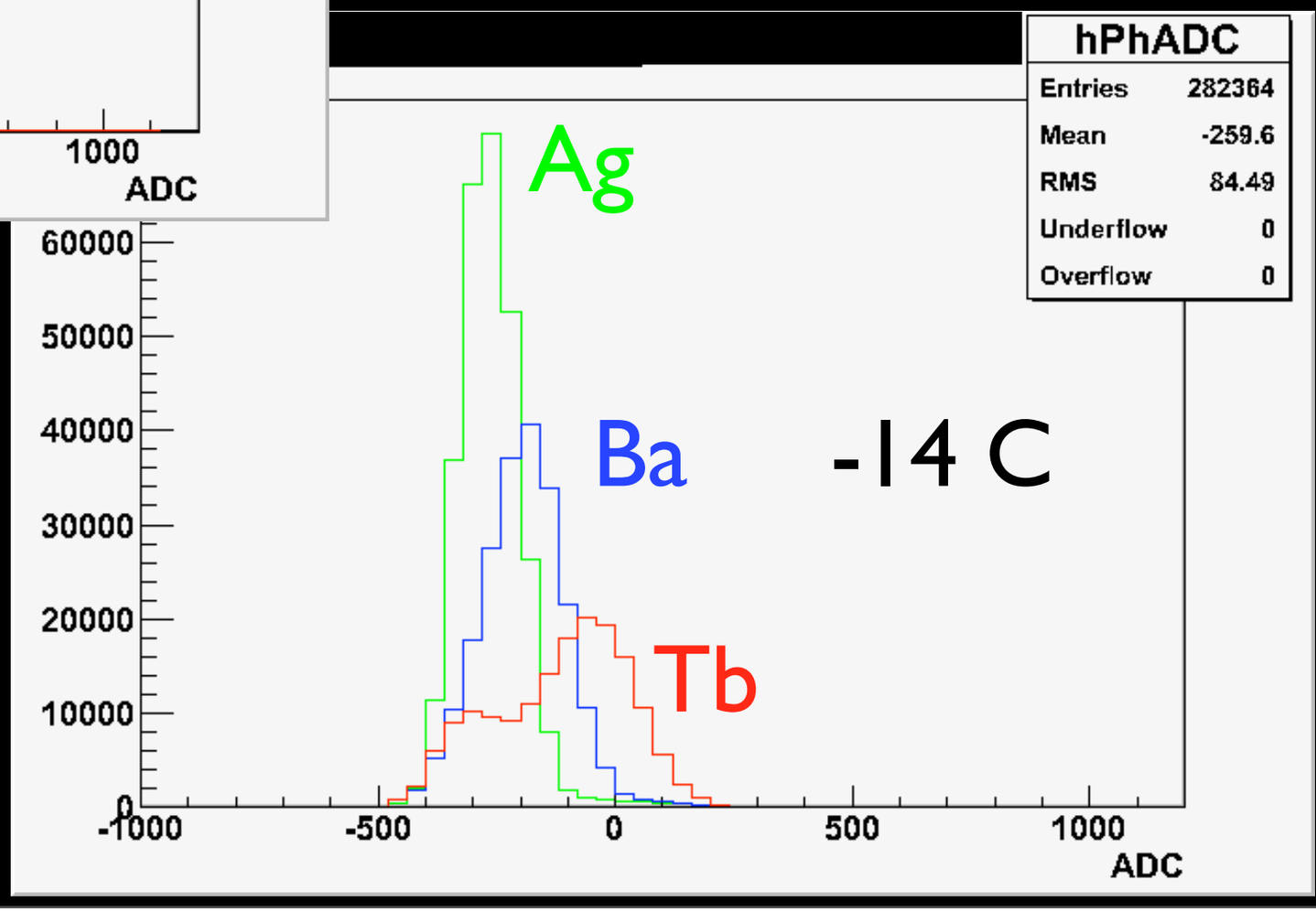
Method 2 Procedure

- Take data with a known energy source
- Consider the analog signal out of the TBM read out
- Convert these raw ADC peaks into VCal peaks using a so-called Gain Calibration (or PhCalibration) Curve.
    - Done for each pixel on a ROC
- Knowing the energy associated with the peak, tag a number of electrons or charge to the VCal value.

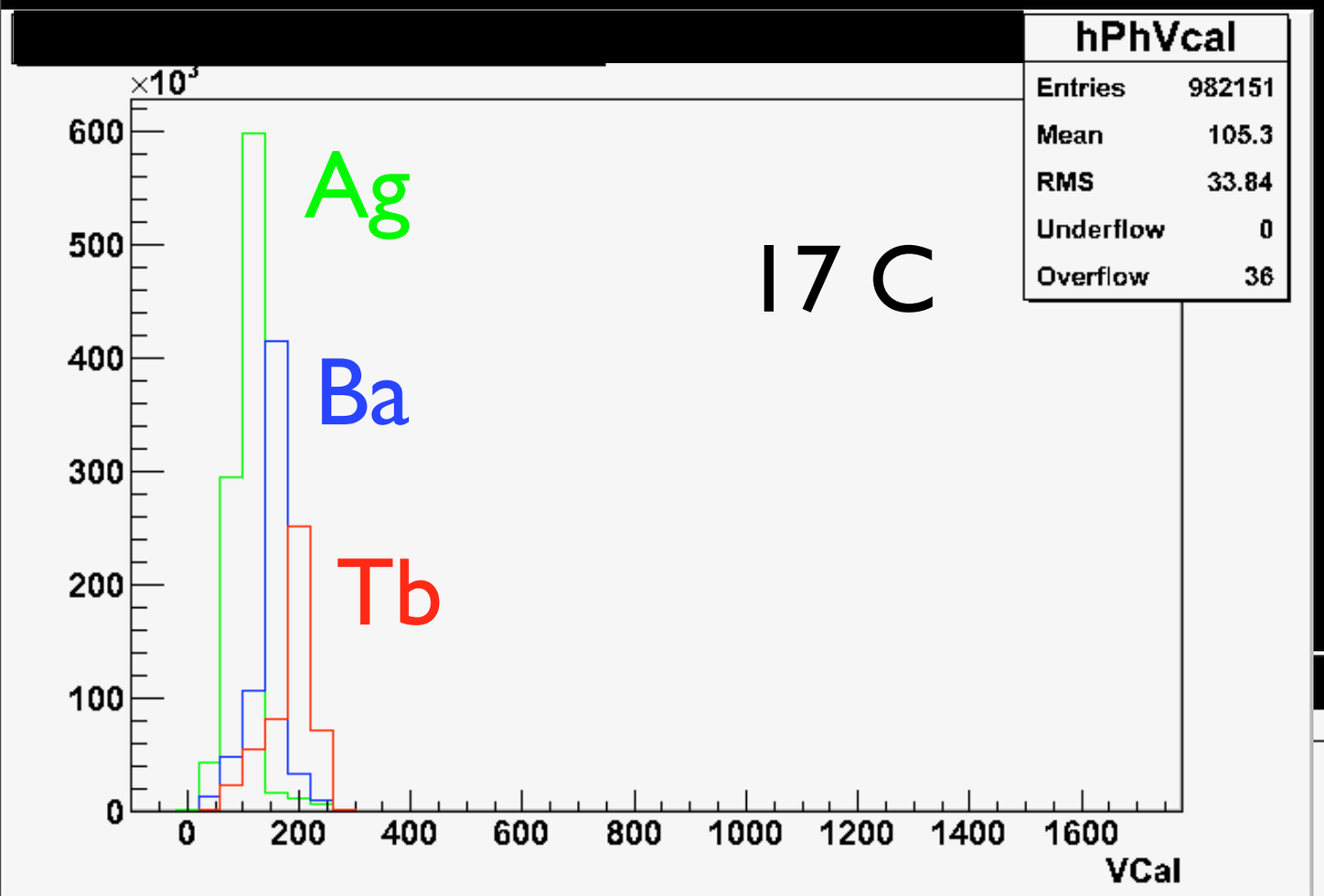
Some Results (ADC)

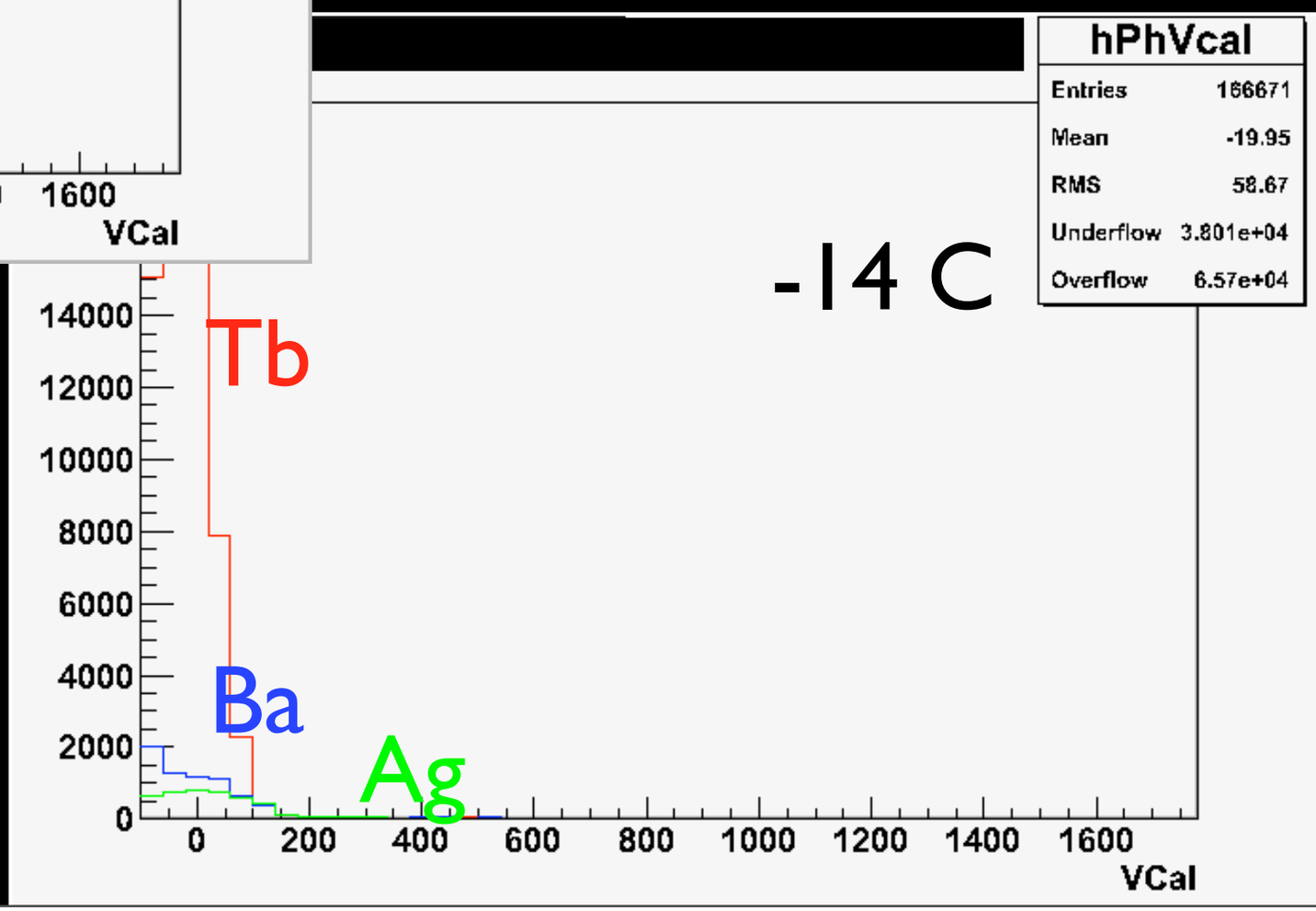


An ADC shift due to temperature.

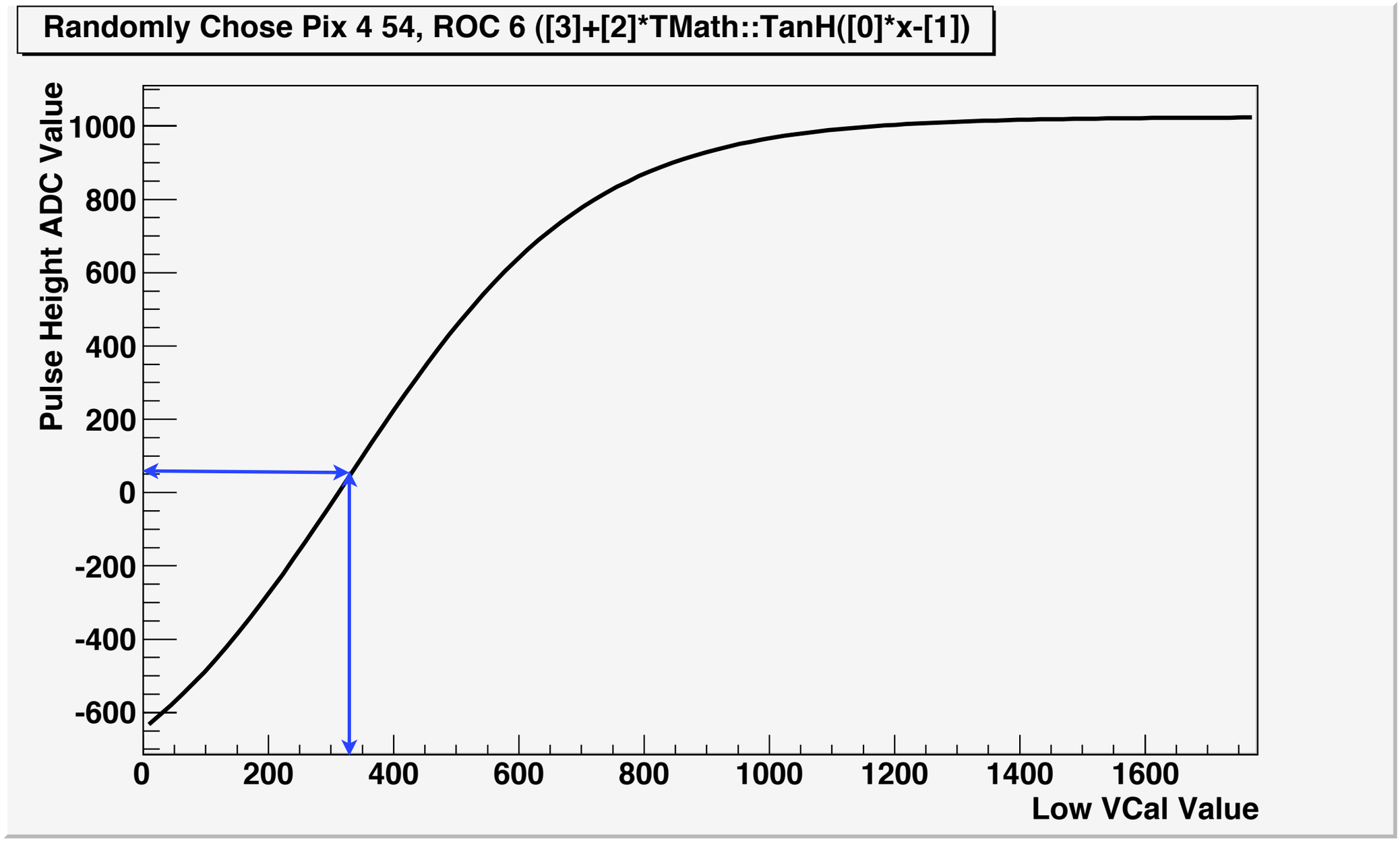


Some Results (Vcal)

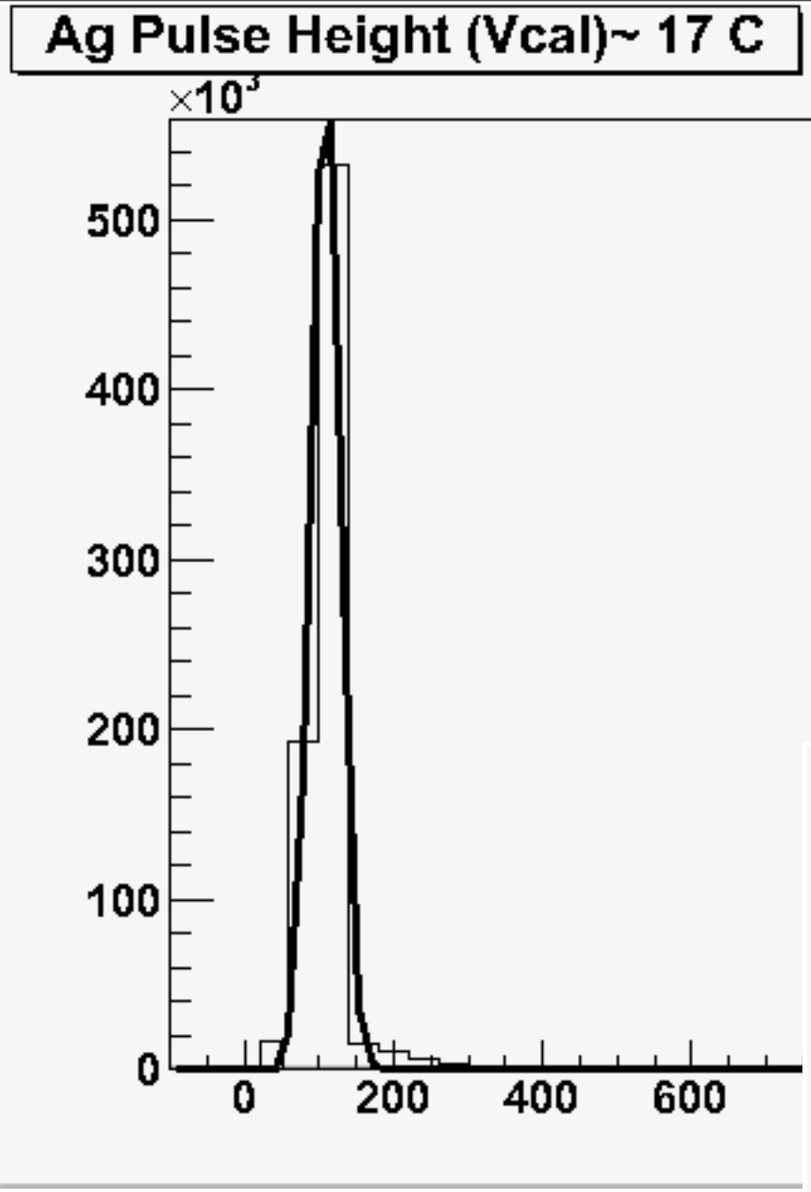




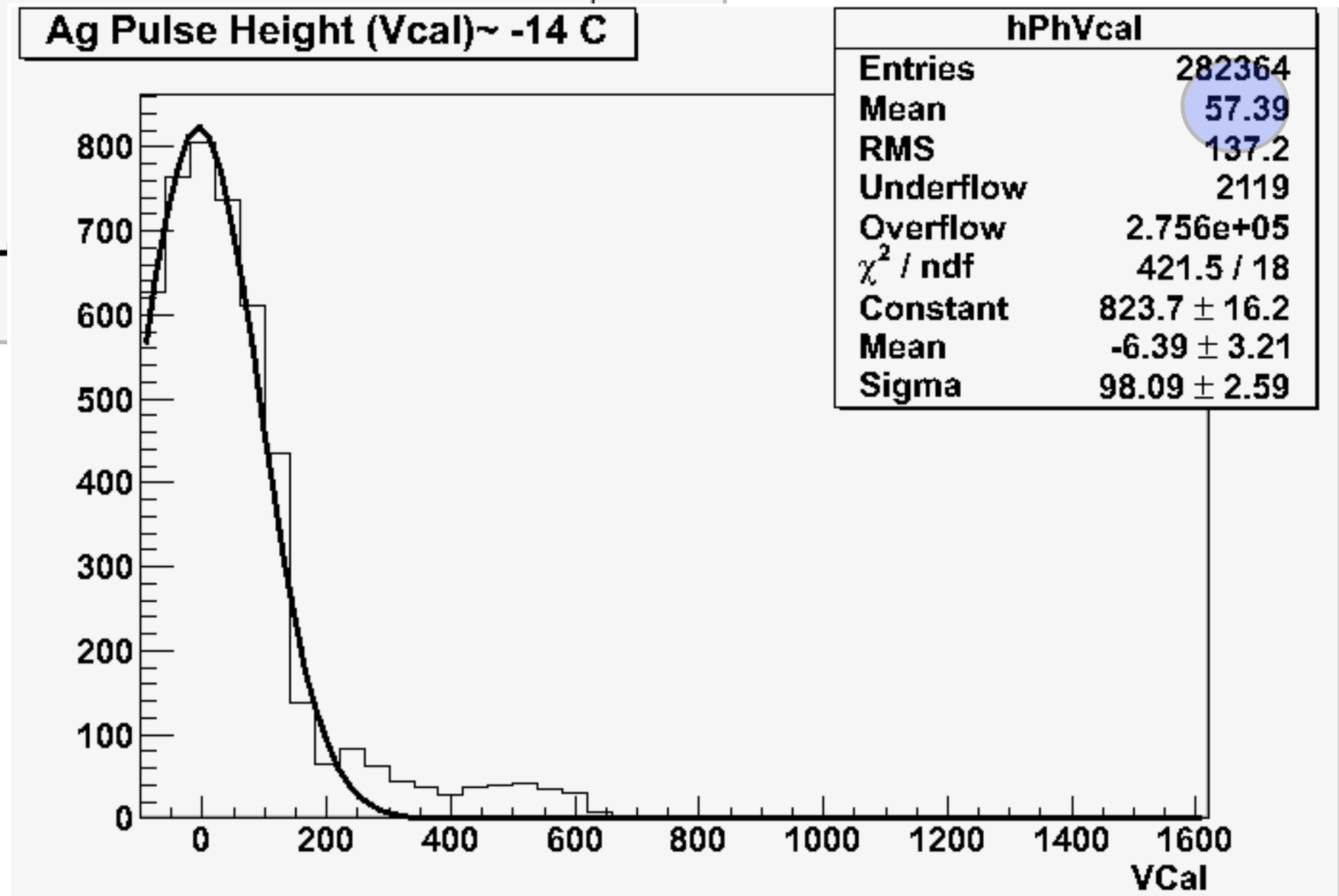
Convert to Vcal units with PhCalibration files.



PhCalibration Curve



- For: Ag -> 22.10 keV --> 6138 electrons --> ~ Vcal 94



Conclusions Thus Far

- There IS a temperature affect being noticed
- The function of Vcal vs Temperature yet to be determined
  - Need to use lower energy photon sources to make better "S-Curve" shapes
  - Take data also at 0 C and -20 C to make Energy/Photons/Vcal plots vs Temperature
- Have muon data, "repairing" the binary to Tree Converter