



UNIVERSITY OF
Nebraska
Lincoln

PIRE Activities

Aaron Dominguez

CMS Tracker Phase-I Upgrade Meeting 10/28/2009



NSF PIRE Collaboration

- I'm reporting today on the activities and plans of a group funded by a collaborative NSF grant
- Funding from the NSF through the Partnerships for International Research and Education (PIRE) began on 10/1/07 and will last for 5 years
- This funds KU, KSU, UIC, UNL, UPR Mayagüez, PSI, ETHZ for travel, students, postdoc for 5 years. US students can attend ETHZ for a semester. R&D work is based at PSI and US home institutes. Grant doesn't pay for equipment
- PIRE is a studies abroad, education-based program; we've tried to leverage this to help with CMS pixel R&D, specifically the Phase-I upgrade
- This is a fairly new program and so far we're the only HEP PIRE grant. Alice Bean is the PI and she is doing a very good job managing this group in my opinion.

PIRE-Related Talks Today

- Hans-Christian talked earlier about modifications to the ROC. He and Beat helped organize PIRE students who worked on some of these studies
- Tilman talked about sensor radiation studies. He helped organize PIRE students for these studies
- Sandra Oliveros will talk about studies for light weight micro-twisted pair cables.



The PIRE Group



- NSF's Partnership for International Research and Education (PIRE) program
- List of represented institutions
 - Paul Scherrer Institut (PSI), Institut für Teilchenphysik (ETH-Zürich), University of Nebraska at Lincoln (UNL), Kansas University (KU), Kansas State University (KS), University of Illinois at Chicago (UIC), University of Puerto Rico at Mayagüez (UPRM)
- Professors involved in the program
 - A. Dominguez (UNL), Ken Bloom (UNL), A. Bean (KU), T. Bolton (KS), I. Chakaberia (KS), C. Gerber (UIC), A. Lopez (UPRM)
- Post-docs
 - Valeria Radicci (KU) and Jose Lazo-Flores (UNL)
- List of graduate students
 - T. Kelly (UNL), J. Acosta (UPRM), S. Khalatian (UIC), S. Oliveros (UPRM), J. Sibille (KU), S. Shrestha (KS)
- List of undergraduate students
 - D. Olseson (UNL), C. Martin (KU), A. McVea (KU), N. Krzyzanowski (UIC), Eric Stachura (UIC), L. Rivera (UPRM), A. Al-Rawi (KS)

2008/2009

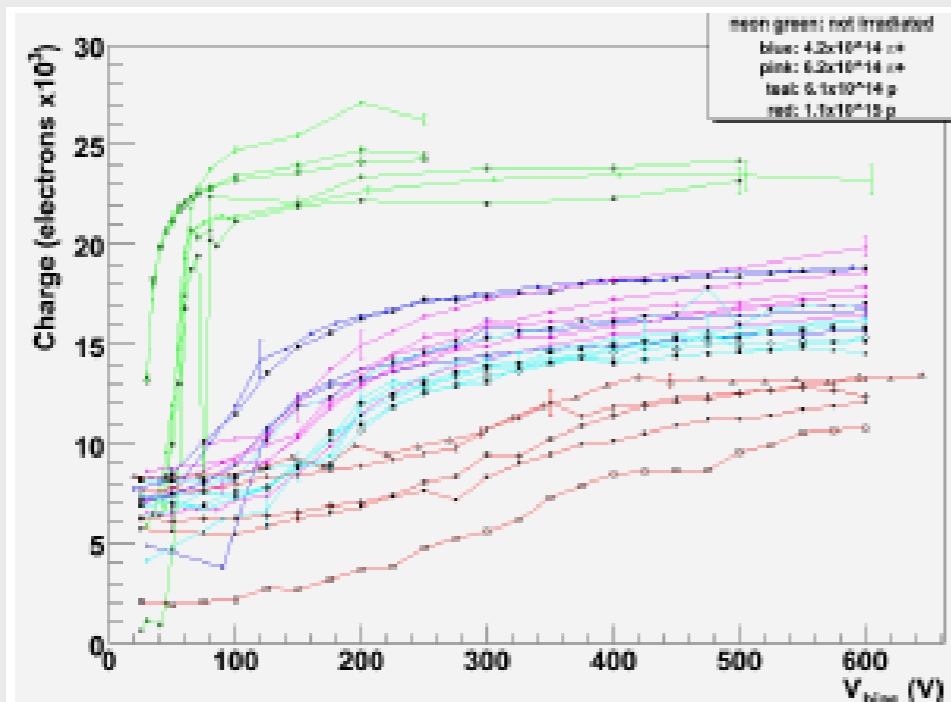
- 10 students participated in the PIRE program in Switzerland in 2008:
 - Spring: 3 grad, 1 undergrad
 - Summer: 6 grad, 4 undergrad
 - Fall: 2 grad, 1 undergrad
 - 1 KU and 1 KSU student studied at ETH
- 11 students participated in 2009
 - Spring: 3 grad, 1 undergrad
 - Summer: 4 grad, 7 undergrad
 - Fall: 2 grad
 - 1 KSU and 1 UIC student studied at ETH
- Postdocs at PSI: Valeria Radicci (KU) and Jose Lazo-Flores (UNL). Both are 100% CMS (upgrade and analysis)
- Just had annual meeting at UNL in September. Please see these talks for in-depth results:
 - <http://indico.cern.ch/event/PIRE09>



(From Alice Bean) PSI Research Projects 2008



- Installation and Commissioning of pixel detector
Tony, Samvel, Codi
- New Readout chip design
Irakli
- twisted pair cable characterization
Sandra, David, Nick
- sensor testing after radiation exposure
Jennifer, Jhon, Chris





PSI Research Projects 2009



- Current Readout Chip (ROC) calibration

Measurement of irradiated ROC

Samvel, Eric

Trimming at low threshold – Luis

Study charge vs temperature and radiation -

Tony

- New Readout chip design

ADC, PLL – Shruti, Dane

- High rate module testing with X-ray boxes – Ali, Chris

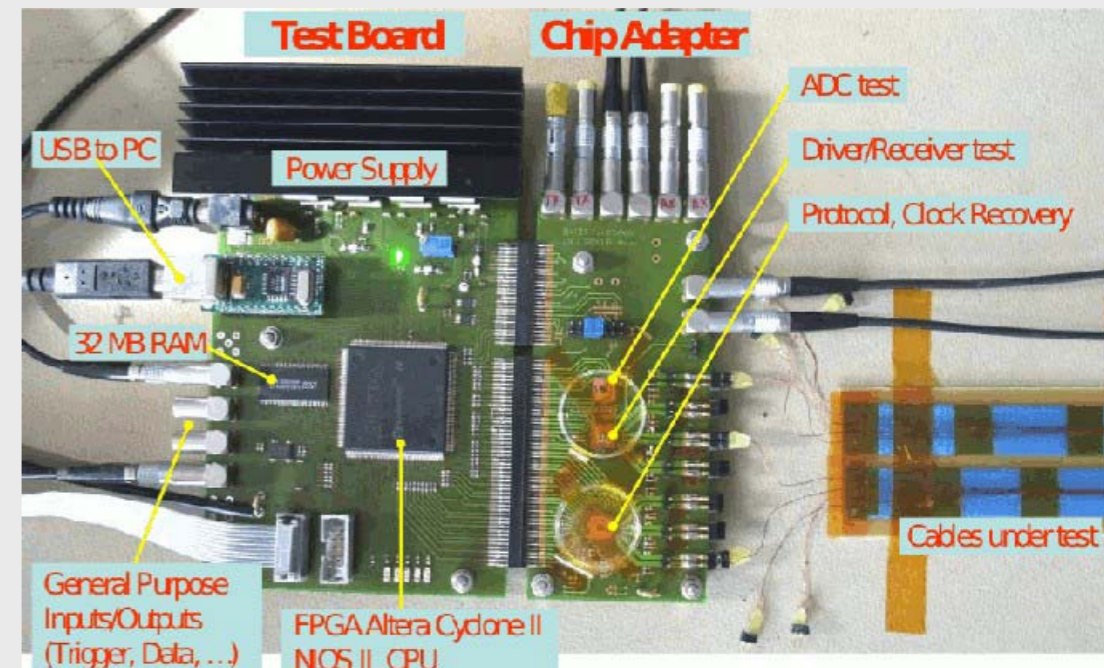
- Pixel sensor design

Irradiated sensor efficiency

Jennifer, Natalie, Asma

Interpixel capacitance and electrical

discharge in one-sided detectors - Jennifer

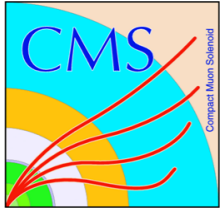




Summer '09 Program



- Projects list (continue)
 - New digital read out architecture (Valeria, Beat, and Wolfram)
 - 3) Chip design by Shruti (K-State) and Dane (UNL)
 - ADC and PLL simulation and test
 - New ROC simulation
 - 4) Micro-twisted pair cables tests (Angel Lopez)
 - Tested different lengths of cable by Sandra (UPRM)
 - » Work done at UPRM
 - 5) Module test with X-Ray box (Alice and me)
 - Experimental setup by Ali (KU)
 - Pixel sensor design and performances (Tilman)
 - 6) Inter-pixel capacitance measurements (Jennifer and Tilman)
 - Fanout board for the inter-pixel capacitance
 - 7) Irradiated sensor efficiency measurements (Jennifer and Tilman)
 - Measurements and analysis by Jennifer (KU) and Natalie (UIC)
 - 8) Study the Cal inject charge vs temperature
 - Tony's Masters thesis



Summer Program Report



- Irradiated ROCs (Eric and Samvel)
 - Pulse shape analysis package written
 - Re-analyzed existing data
 - Tested additional ROCs
 - Results will be written in a CMS Internal note
- Cal inject studies
 - Experimental setup completed
 - Now taking cosmic and source data
- TBM Problem
 - Only existing TBM board burned
 - Used for testing single chips
 - Solution was to implement the TBM in test the boards FPGA
 - Implementation done by Chris (KU)
- New chip components testing (Dane and Shruti)
 - Dane completed the test board for the 4 and 8 bit ADC
 - Now testing the chips
 - Shruti completed the test board for the PLLs (Phase Lock Loop)
 - Now testing and taking measurements



Summer Program Report



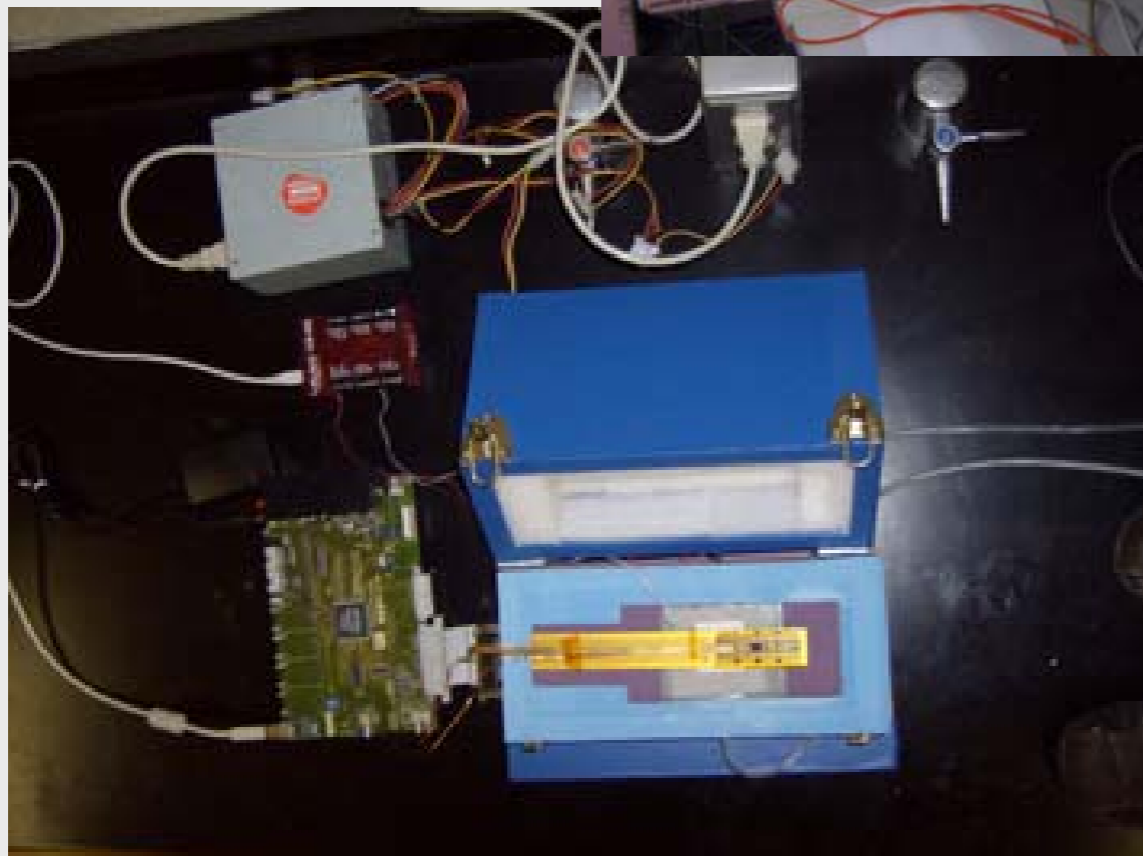
- Charge collection efficiency measurements (Natalie & Jennifer)
 - Now finished with the testing of the samples irradiated at highest fluence (5×10^{15} neq/cm²)
 - Analyzed the data they have
 - Will be written as part of Jennifer's thesis
- Trimming exercise (Luis and Ali)
 - Checked trim bits differences after trimming at different Vcal values
 - Studied Vcal S-Curves for different VthrComp values
 - Results will be written in a CMS Internal note
- Module test in X-ray box (Ali)
 - Ali finished setting things up
 - Ran out of time
- Inter-pixel capacitance measurements (Asma)
 - Tilman and Silvan prepared the chips for these measurements
 - Asma did some testing



Research in US



- Building pixel teststands
 - Making PC based testboards
 - X-ray teststand at KU
 - Thermal/Cosmic teststands at UPRM, UNL
- Microtwisted pair readout of modules at UPRM
- CMS commissioning
- NSF MRI R² proposal submitted Aug 2009



9/17/09

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Pulse Shape

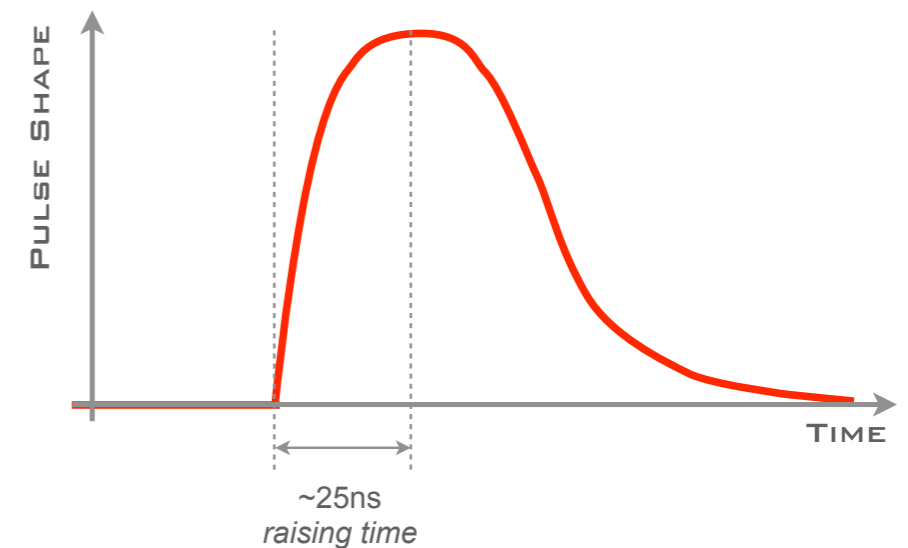
Problem Definition

ROC electronics radiation study starting point is a Pulse Shape that is a registered charge deposited in sensor or injected V_{cal} .

UIC
University of Illinois
at Chicago

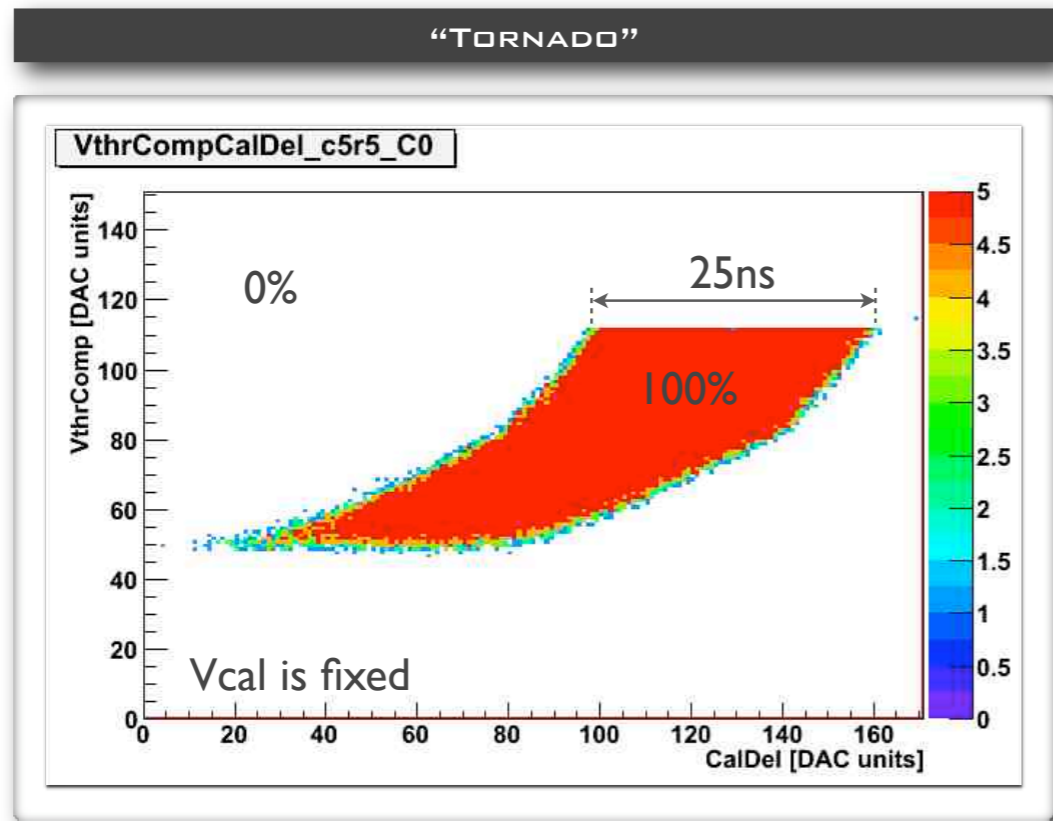
WANT TO SEE

How Pulse Shape changes with fluence. **Time-walk** is used as a description.

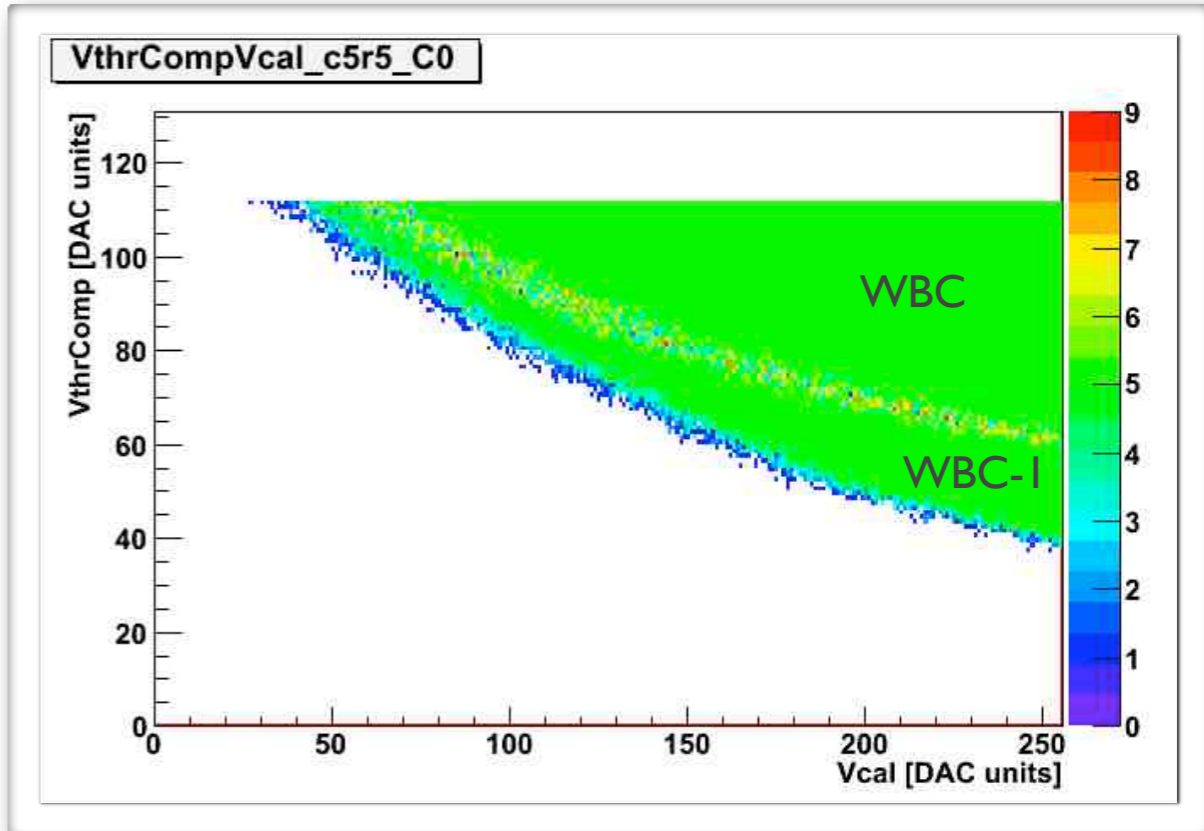


Ideally Pulse Shape should remain the same for different fluence but because of radiation damage it would change it's raising time.

Inner part of “tornado” is contents of Time Window frame (25 ns).
Edge is a Pulse Shape raising side.



These are efficiency plots and can be fitted by Error Function.



PulseShape is a signal development in time. Next conversions are needed:
1. from CalDel DAC units to ns
can be extracted from “tornado”
2. $V_{thrComp}$ to V_{cal}
separate plot is necessary

Threshold measurement to get value of injected signal in electrons.



Irradiated chips up to $5E14$ fluences

4 Pixels were tested per ROC in results below
2 unirradiated ROCs were tested giving (26.0 ± 0.5) ns raising time
1-2 ROCs per fluence giving $\sim (31.0 \pm 1.9)$ ns (avg for all fluences) raising time.

There is clear evidence of increase

Next step is to try to adjust input parameters of Preamplifier and Shaper to restore original raising time.

Gain and VCAL vs T

- Tony Kelly is doing a M.S. thesis on the response of the ROC amplifier and VCAL circuit vs temp
- Not strictly R&D for the upgrade, but useful nevertheless and can be used to qualify the performance of new ROC +Sensor
- Using a temperature controlled box and an x-ray source that provides known energies

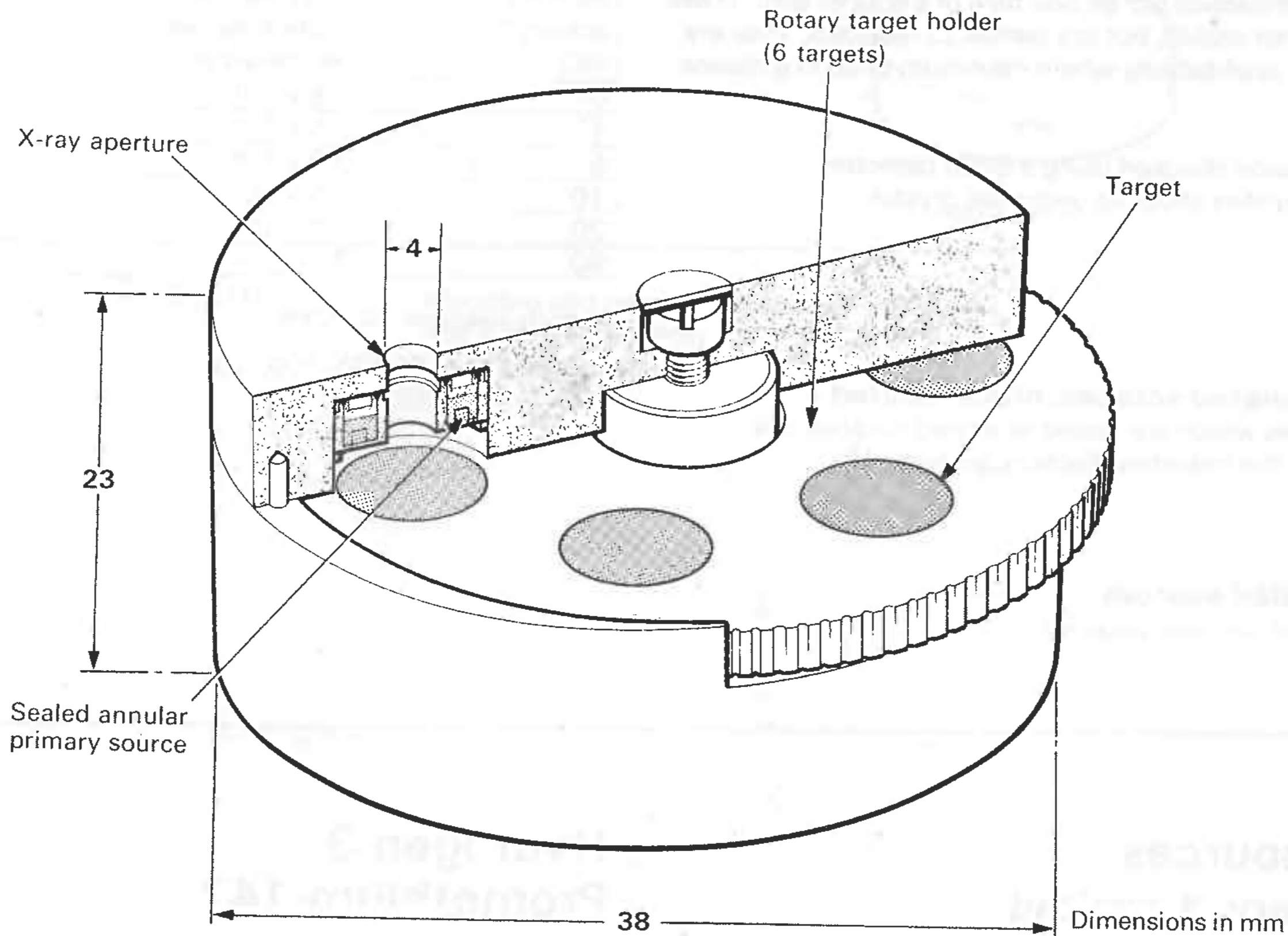
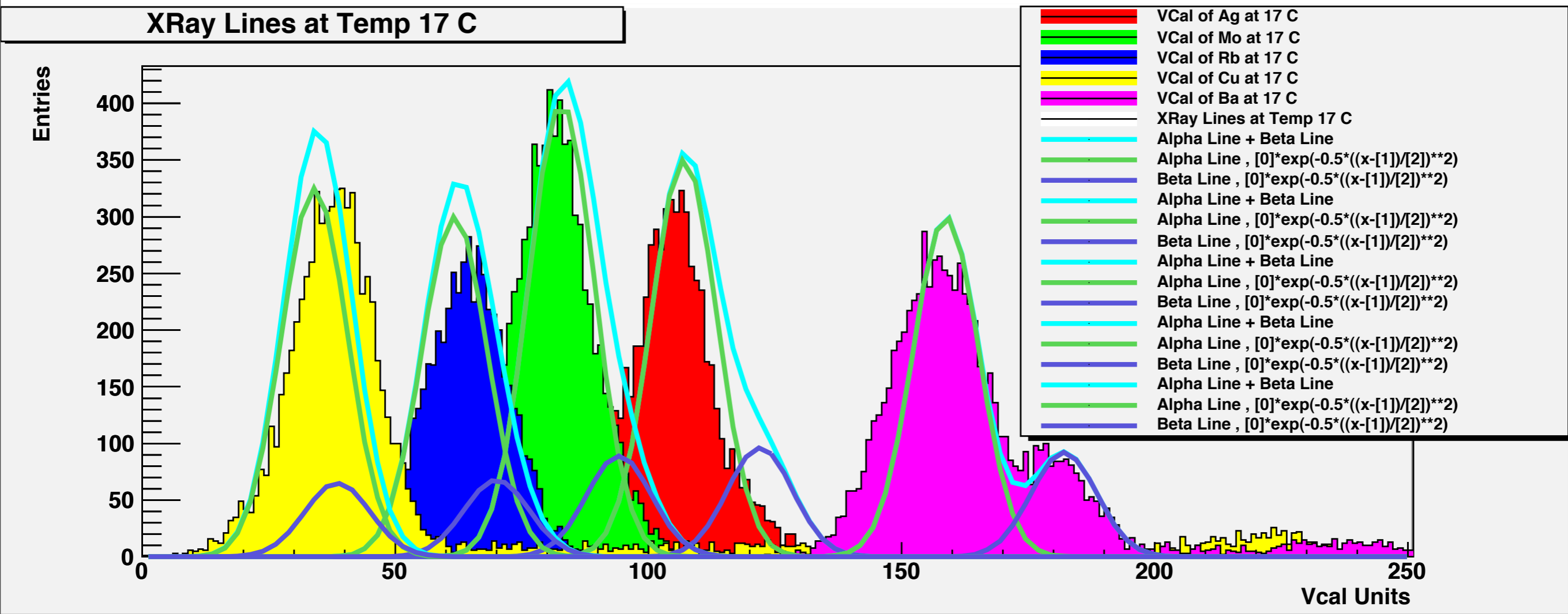


Figure 46 X.208

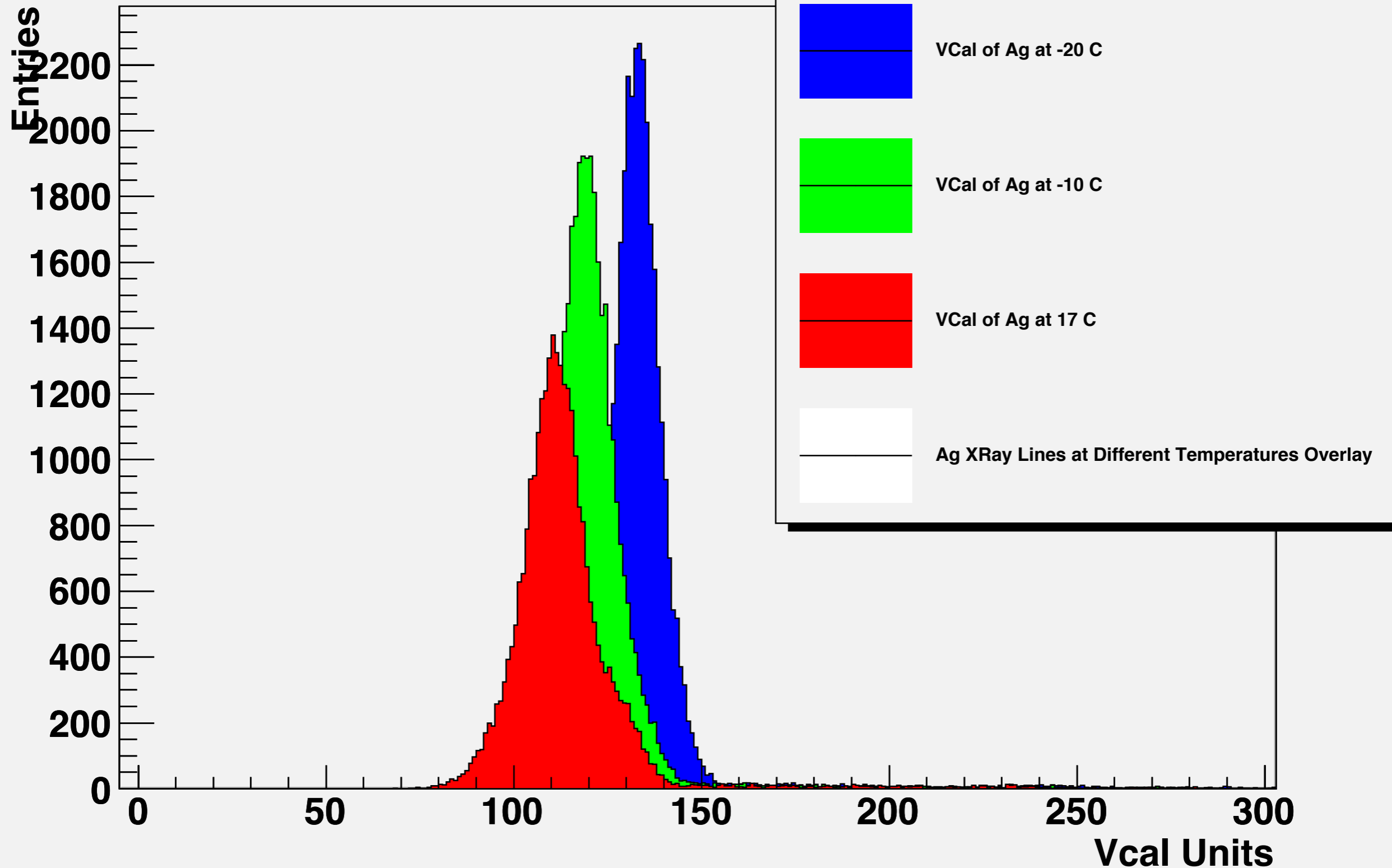
Measured and Expected X-Ray Spectra



(Assuming full deposition of photon energy, 3.6 eV/pair, 55 VCAL/e-)

Response vs Temp

Ag XRay Lines at Different Temperatures Overlay



Summary

- We have some available manpower to help with pixel R&D.
- Two postdocs at PSI working with PSI group
- Students are coming home to US institutions and much work will continue locally
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