Progress of x-ray tests at ETH

Marco Rossini

Institute for Particle Physics, ETH Zürich

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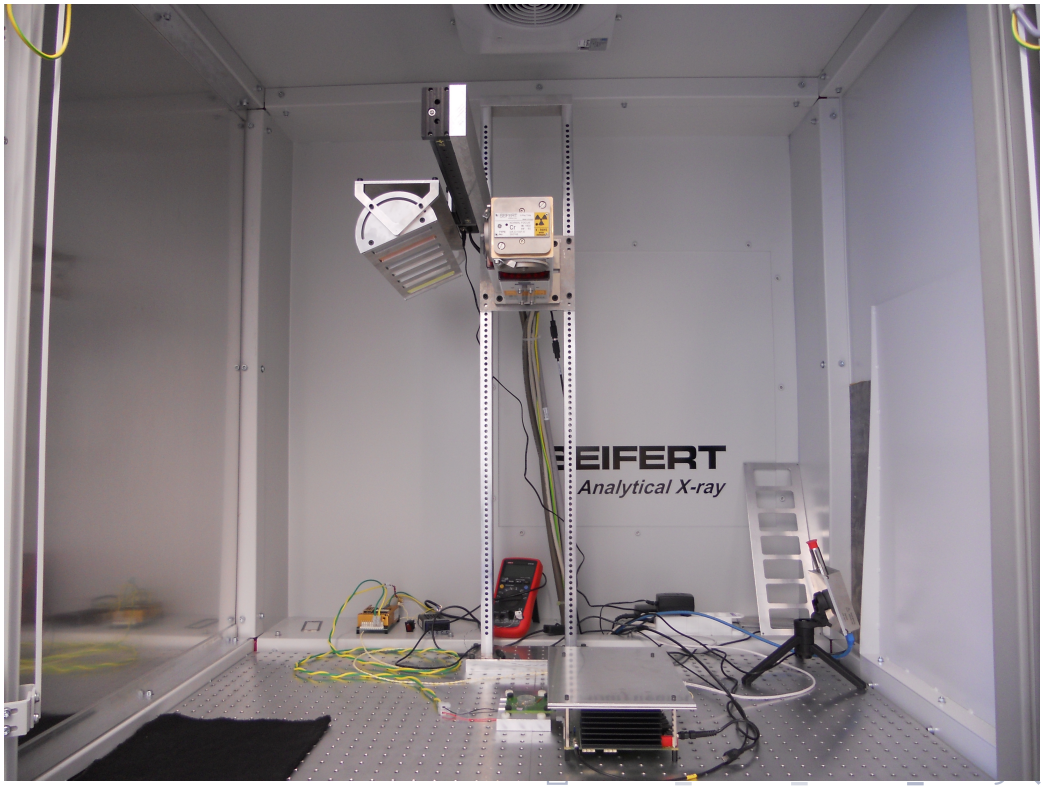
Setup progress

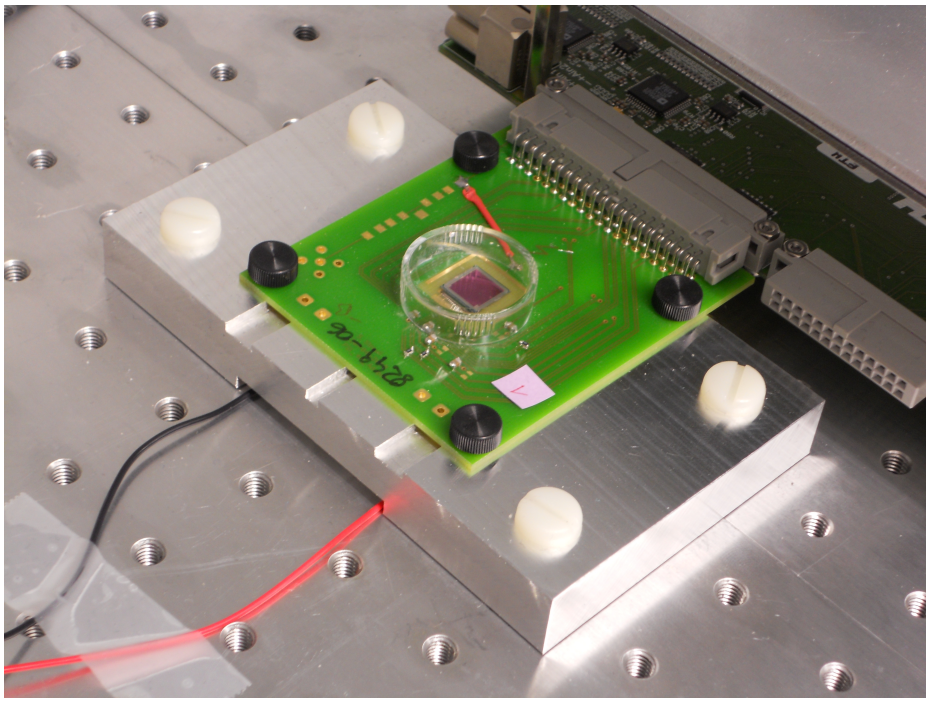
The x-ray setup currently consists of

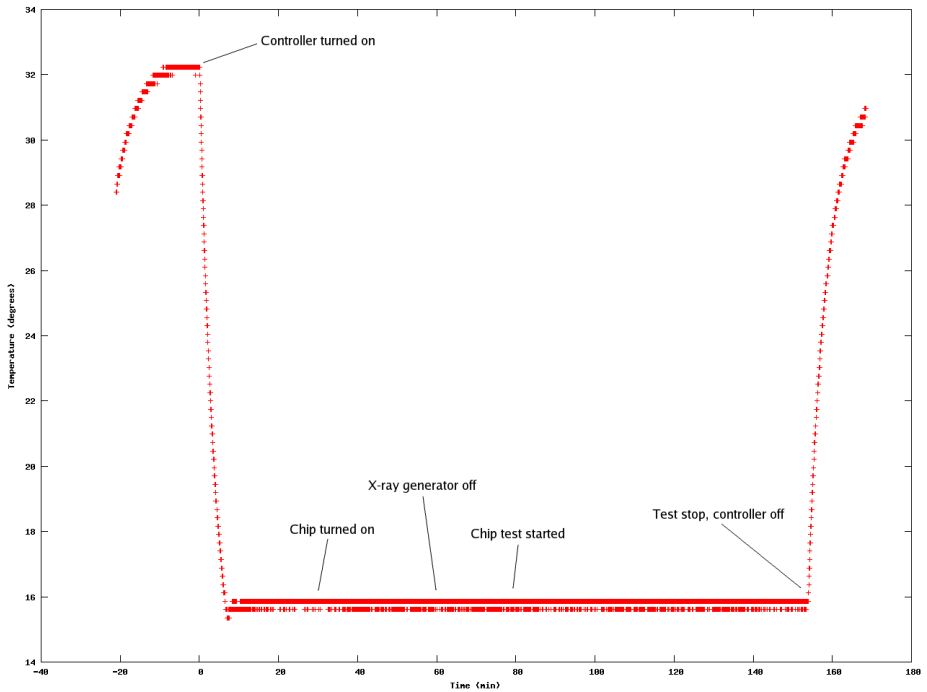
- X-ray tube, generator, cabin
- Single ROC setup with temperature control (17° C) with shielded testboard
- Movable array of fluorescence targets
- Spectrometer



Single ROC setup

- ROC in thermal contact with cooling plate
- Plate cooled with peltier element, measured with Pt1000
- Temperature controller establishes stable conditions
- Not in final state yet



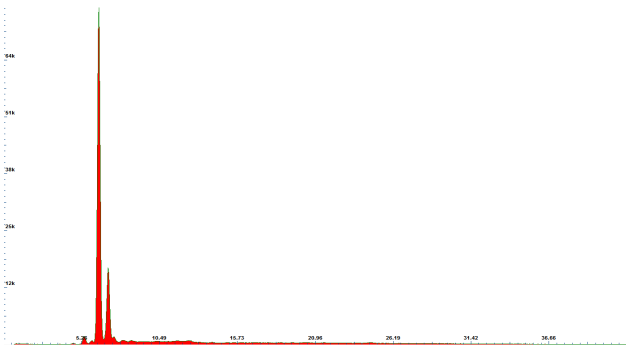


Fluorescence setup

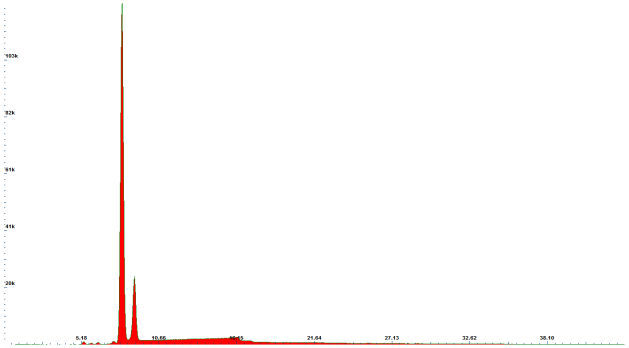
- Array with 7 slots for target materials
- Target change through motion of entire array with linear stage
- Construction designed for minimal parasitic fluorescence emission and for large yield
- Option for K_β filtering (attachment not shown in picture)
- Targets obtained until now:
  Iron (Fe), Copper (Cu), Molybdenum (Mo), Silver (Ag), Tin (Sn)
- Target under evaluation: Barium (Ba) compound (powder)

Fluorescence spectra

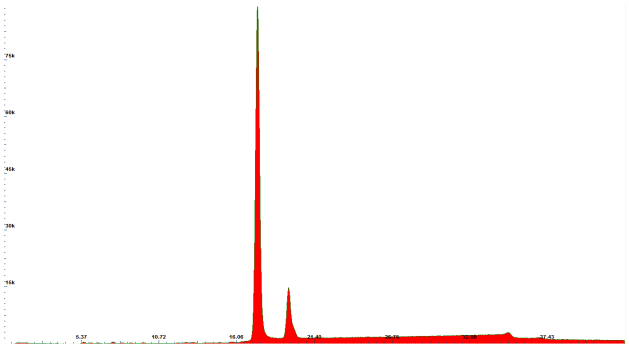
Spectra of all materials using current setup:



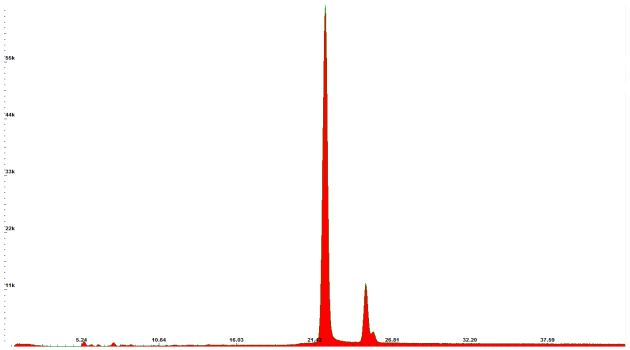
Steel (Fe)



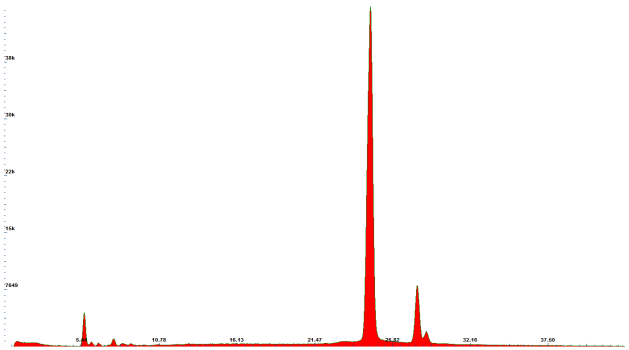
Copper (Cu)



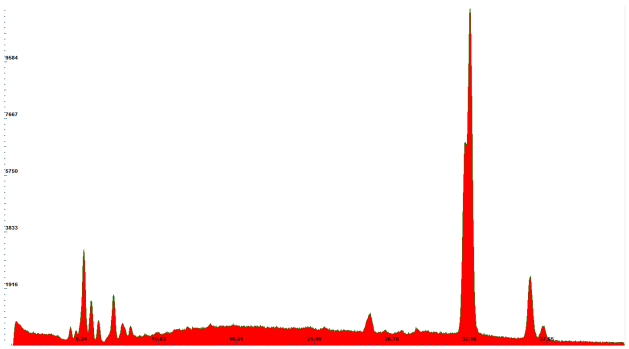
Molybdenum (Mo)



Silver (Ag)



Tin (Sn)



Barium chloride

High rate pixel map test

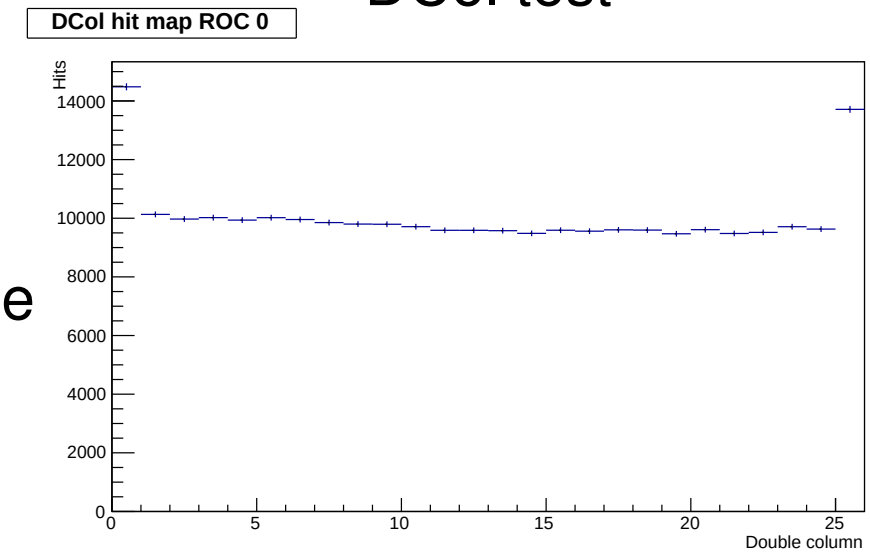
Features:

- Triggers at a user set frequency
- Test duration user set
- Accumulated pixel hits sent to the computer
- Pixel hits histogrammed in 2d and 1d
- Pulse height histogrammed
- Hit multiplicity histogrammed
- Time $<$ 1 min total

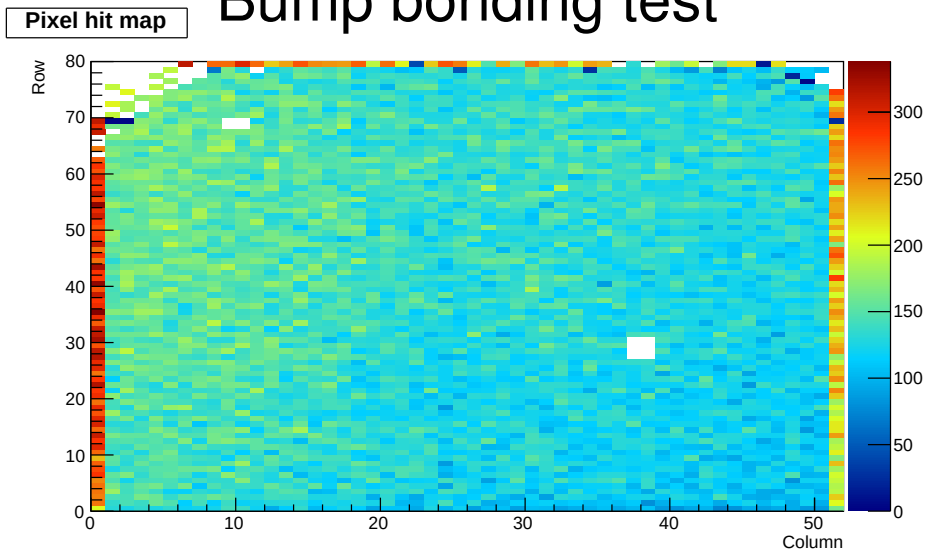
Used for

- Double column test
- Bump bonding test

DCol test



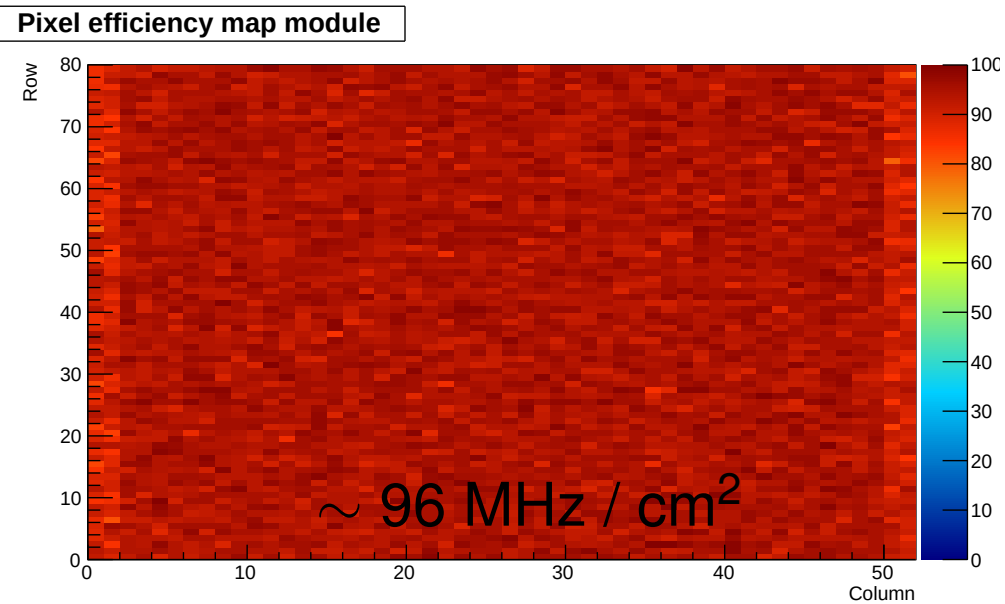
Bump bonding test

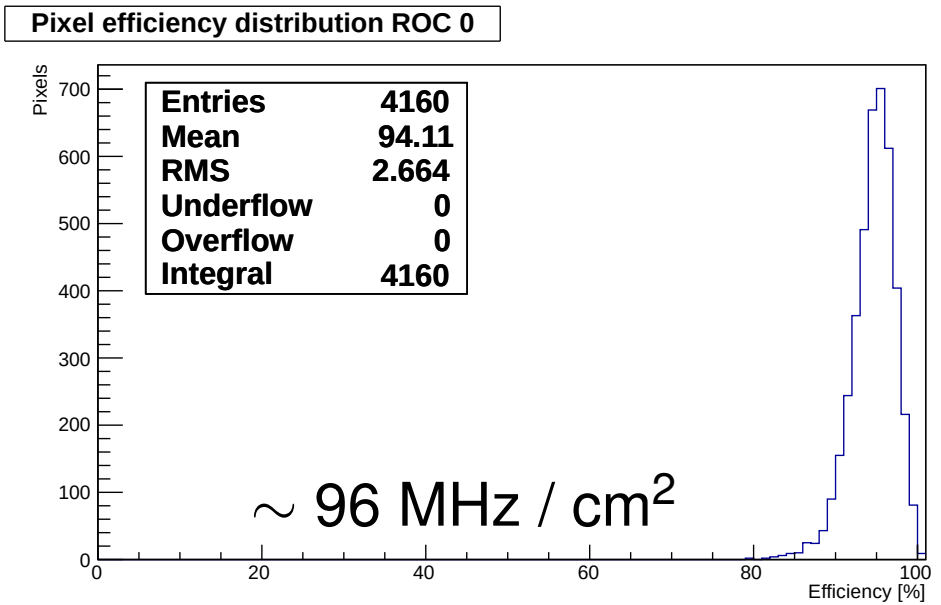


High rate efficiency test

Features

- Uses calibrate signal to inject each pixel N times along with x-rays
- Reads out hits, distinguishing pixels
- Compares number of read out pixels with N to compute efficiency
- Time $\sim$ 2 min (1 ROC, bandwidth limited)



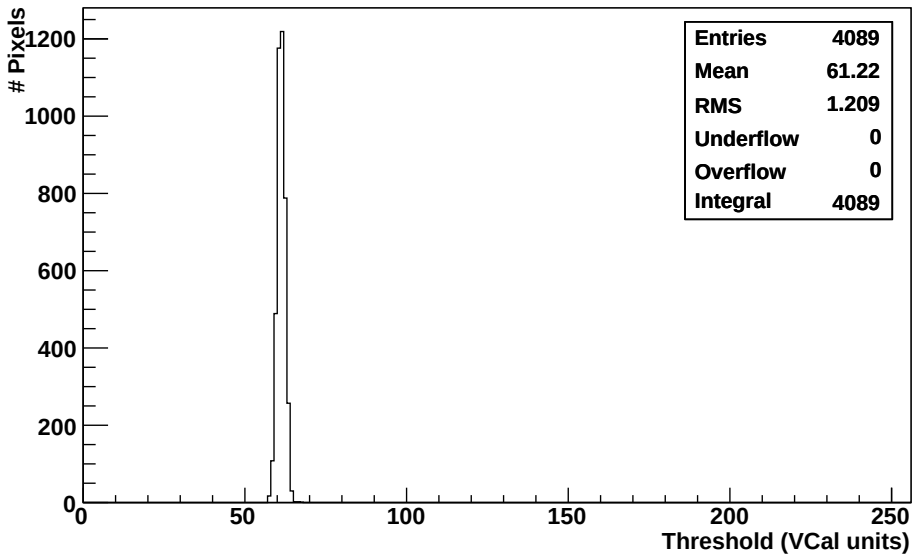


High rate s-curve test

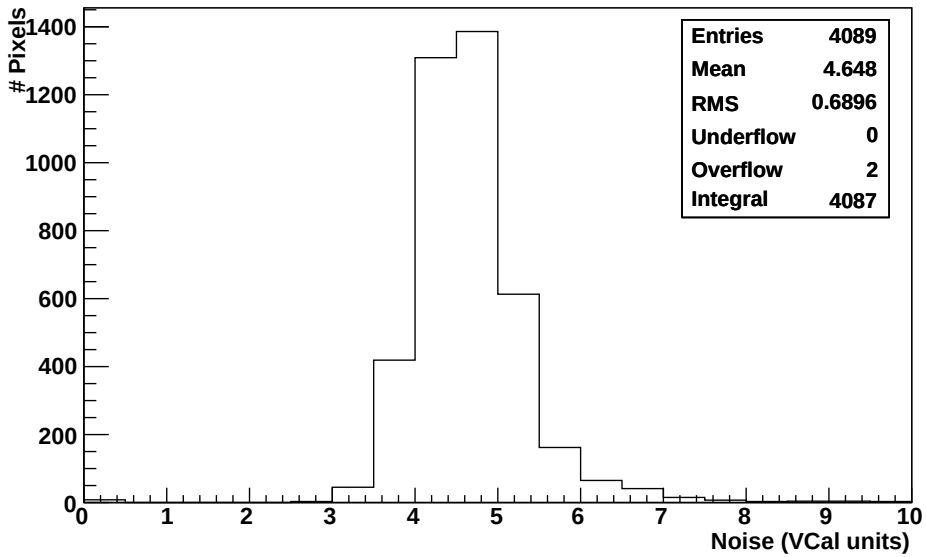
Features

- Determines the s-curve for each pixel in terms of VCal by injecting the calibrate signal with varying strength
- Works while under x-ray radiation
- Time $\sim$ 30 min (1 ROC, bandwidth limited)

Threshold (xray) $\sim$ 93 MHz / cm^2



Noise (xray) $\sim$ 93 MHz / cm^2



VCal calibration

Using existing test:

- VcThr scan while under monochromatic x-rays $\rightarrow$ s-curve
- Set found value of VcThr
- Threshold map in terms of VCal for all pixels
- Averages over all pixels on a chip
- Yields VCal corresponding to x-ray energy
- Use multiple x-ray lines to make linear calibration

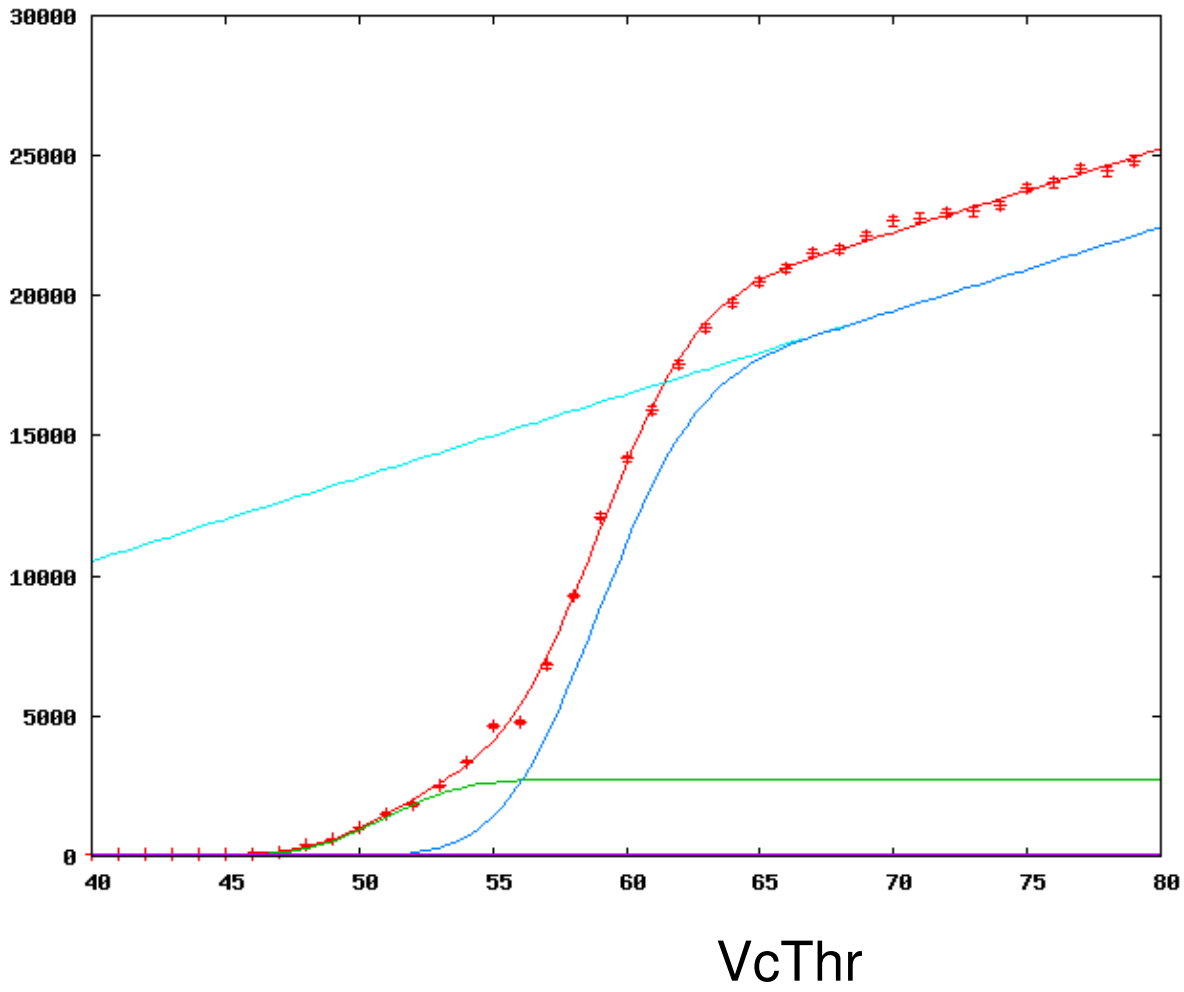
Time:

- Takes 3 minutes per line (clock stretch 100, 30k Triggers)
- Yields 20k Hits above threshold (in old module test: $<$ 1k)
- Can increase trigger frequency by factor of 10 (firmware change)
- Can live with only 2k Hits or increase time spent
- Can test multiple modules at once

S-curve for VCal calibration

VcThr scan with monochromatic x-rays (Molybdenum fluorescence)

$a = 51.0142$	± 0.6055	(1.187%)
$b = 2.37153$	± 0.2979	(12.56%)
$c = 2754$	± 567	(20.59%)
$d = 58.7048$	± 0.1589	(0.2707%)
$e = 2.82404$	± 0.2015	(7.135%)
$f = 297.546$	± 25.95	(8.721%)
$g = 17782$	± 767.7	(4.318%)
$h = 56.7872$	± 9.378	(16.51%)



Summary

- A working setup exists for single ROCs
- Setup for direct and fluorescence illumination is done
- Many tests are implemented and working

Outlook:

- Measure fluorescence and direct spectra (with Daniel Narrias)
- Measure beam profile for designing module setup (with Daniel)
- Understand some issues that measurements show

More distant outlook:

- Verify tests work with full modules
- Design module setup
- Implement more tests (?)