UNIVERSITÄT
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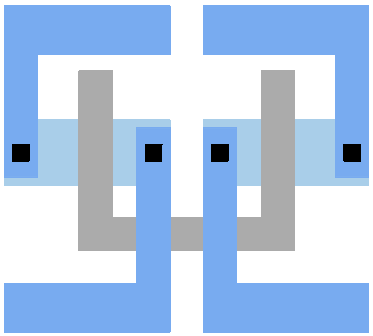
Irradiation of Switcher3 and DCD2



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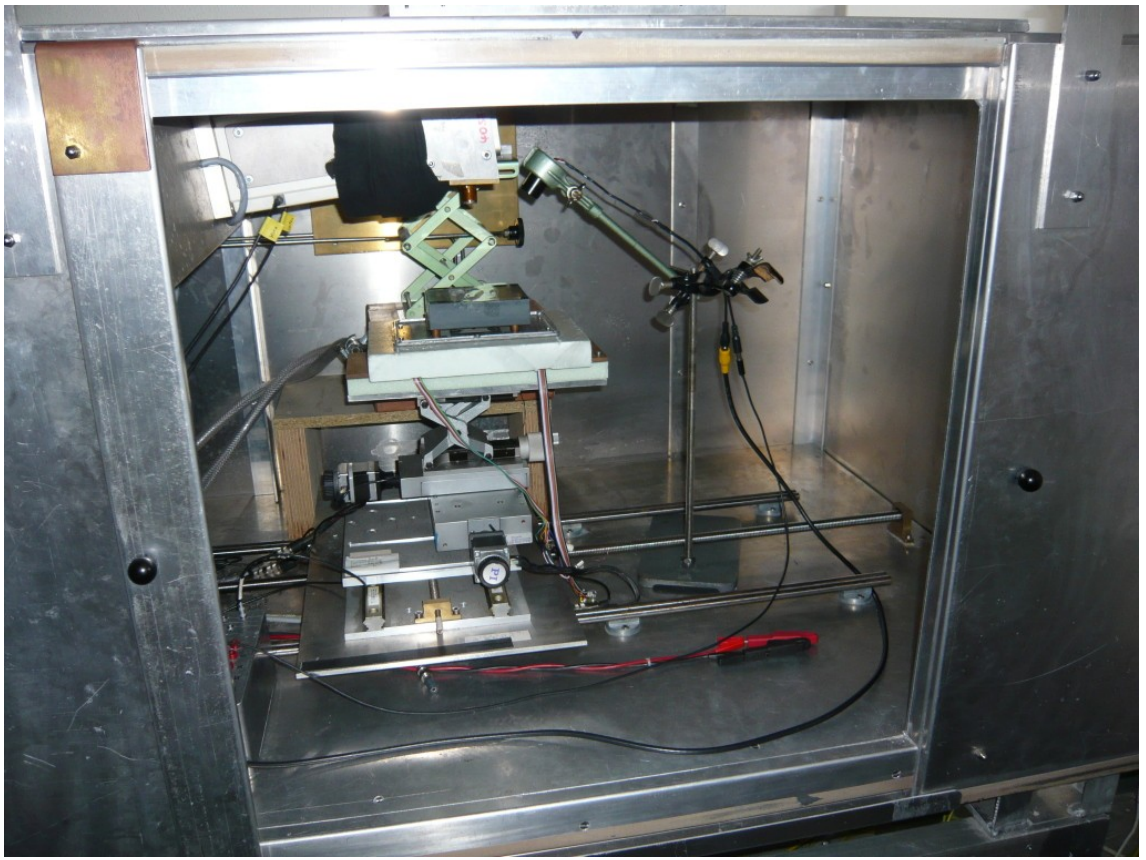
International Workshop on DEPFET detectors and applications

Heidelberg

10. - 12.09.2008

Irradiation Facility

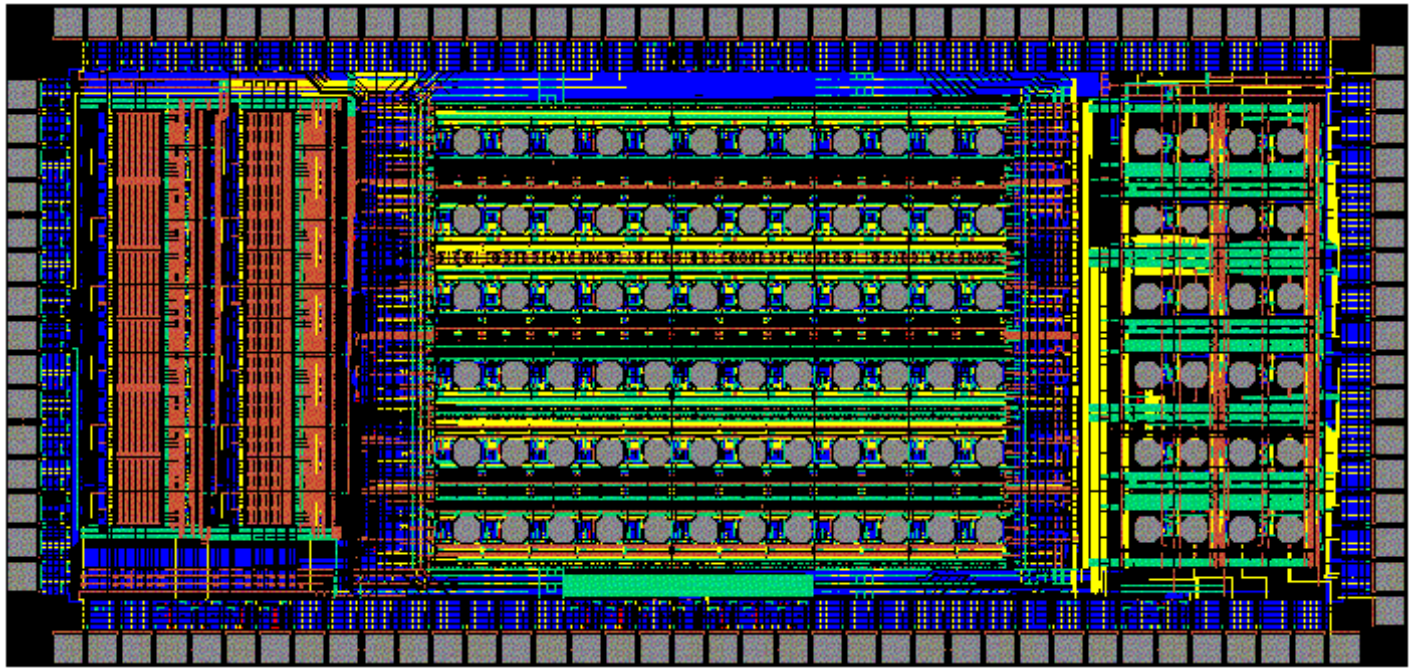
- 60 keV X-Ray
  - 100-250krad/h (depending on distance), calibrated setup
- Institut für experimentelle Kernphysik, University of Karlsruhe
  - Thanks to Dr. Simonis, Mr. Dierlamm and Mr. Ritter for the help



DCD2 Irradiation

DCD2 Reminder

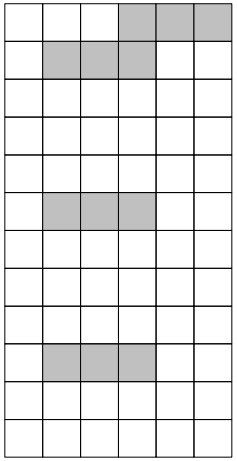
- test chip for new readout design
- UMC 0.18µm technology
- 72 inputs, each with:
  - a regulated cascode
  - two current memory cells for pedestal substraction
  - two 8bit algorithmic ADCs
- high speed LVDS outputs



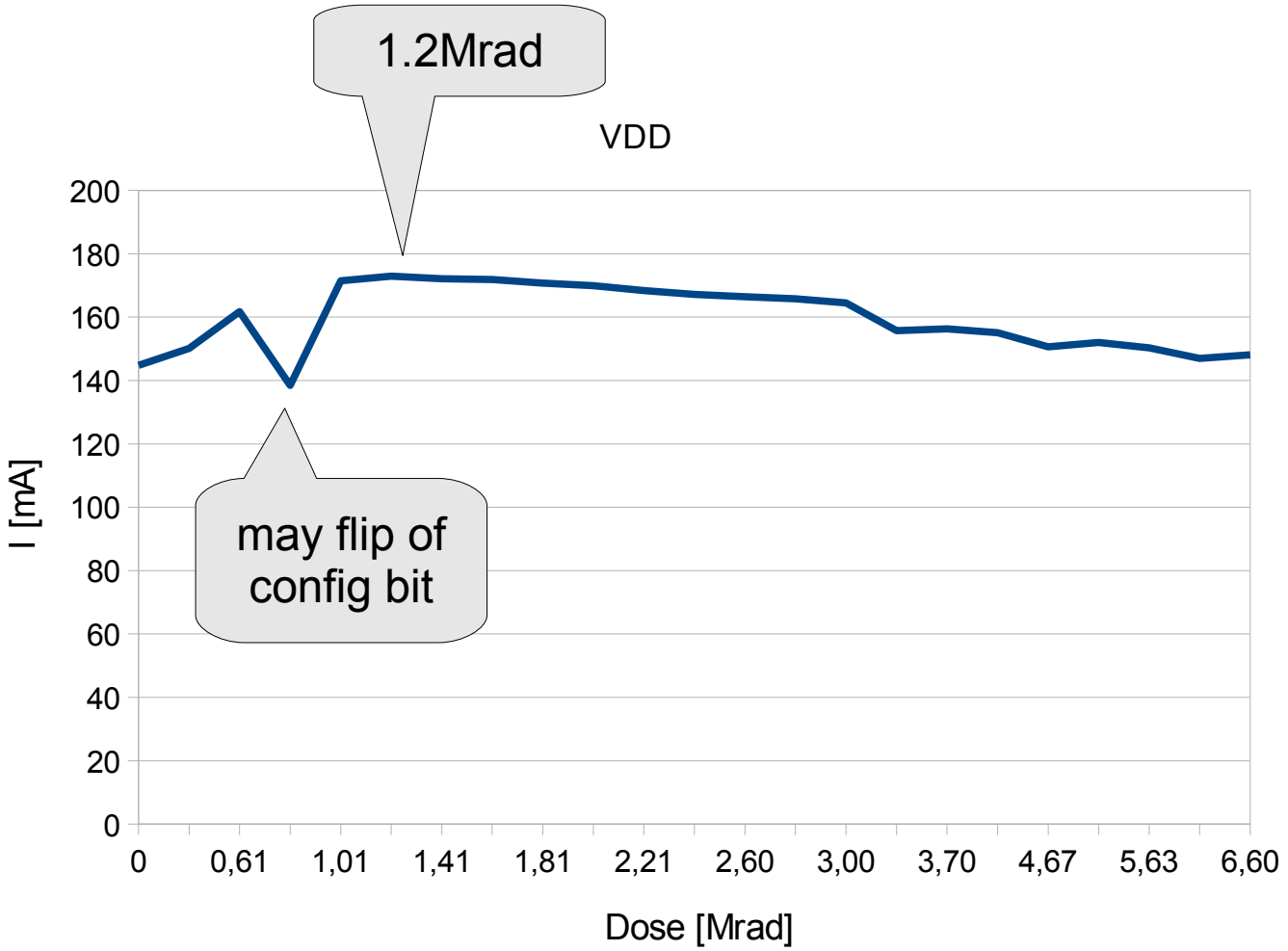
Irradiation details

- Dose
  - 31h @99.5 krad/h (d=180mm) = 3.1 Mrad
  - 18h @241 krad/h (d=100mm) = 4.4 Mrad
  - Total = 7.5 Mrad

- DCD Operation Mode
  - clock running permanently
  - control registers loaded every 30s with default values
- Measurements (during irradiation):
  - current consumption on VDD
  - on selected pixels
    - ADC characteristics
    - Current memory cell operating range
    - Test injection current value

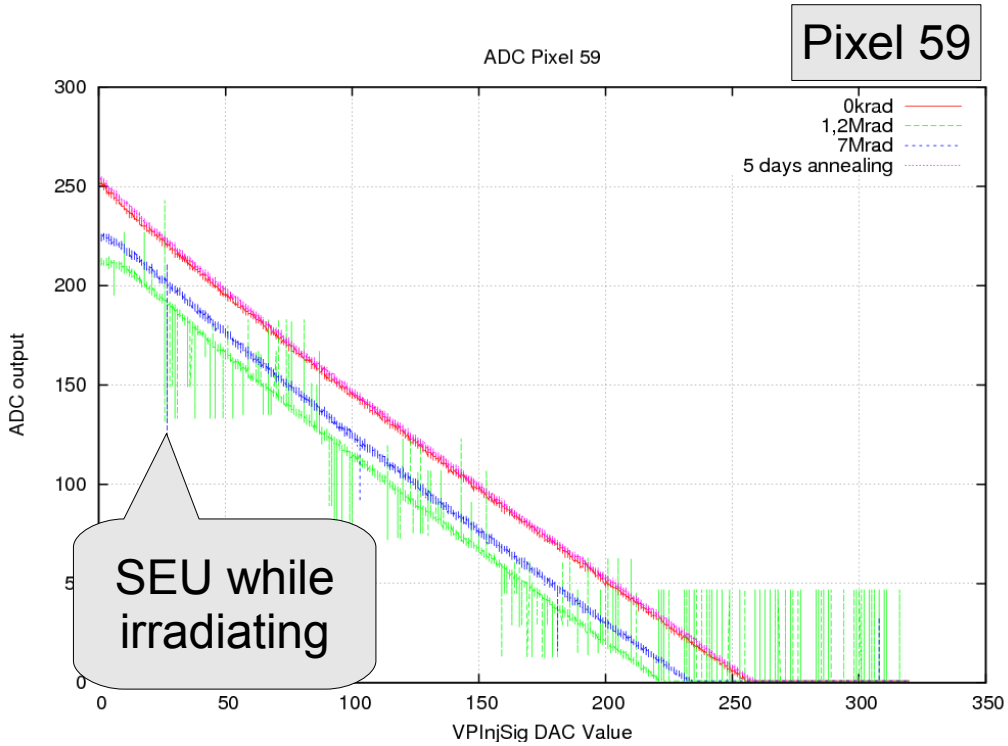


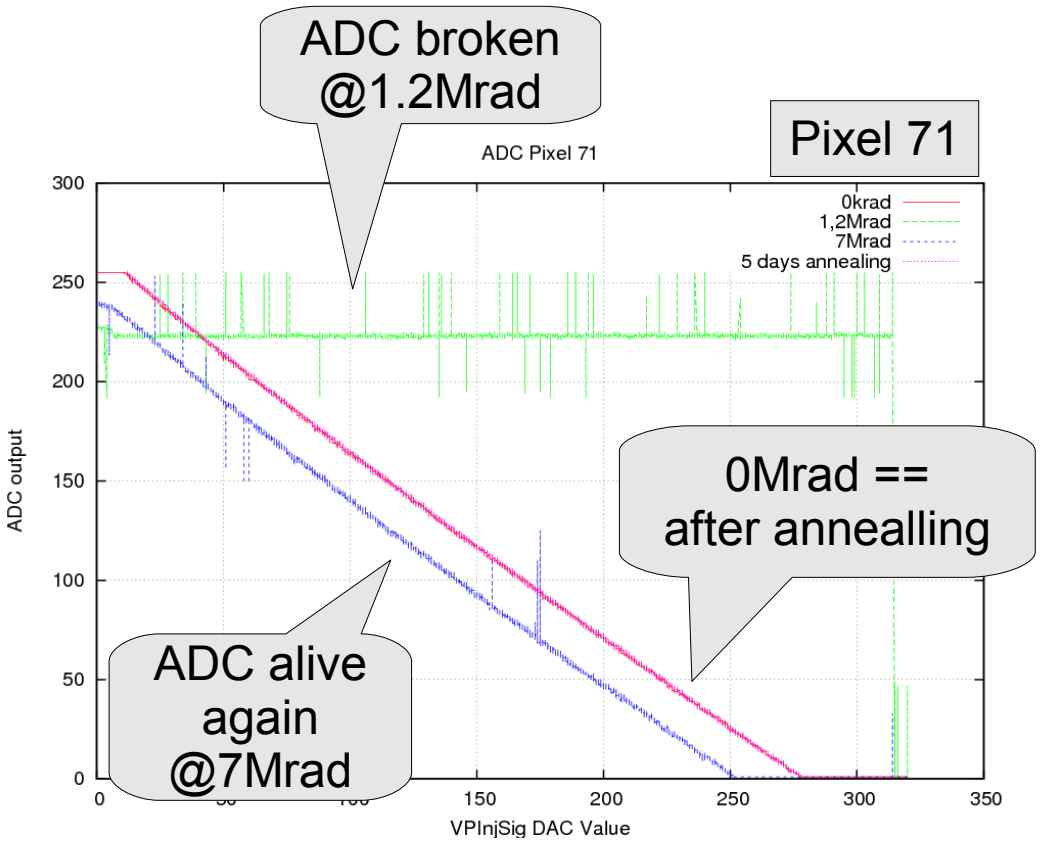
Current Consumption



- VDD Current rises until 1.2Mrad
- then settles to pre-irradiation value

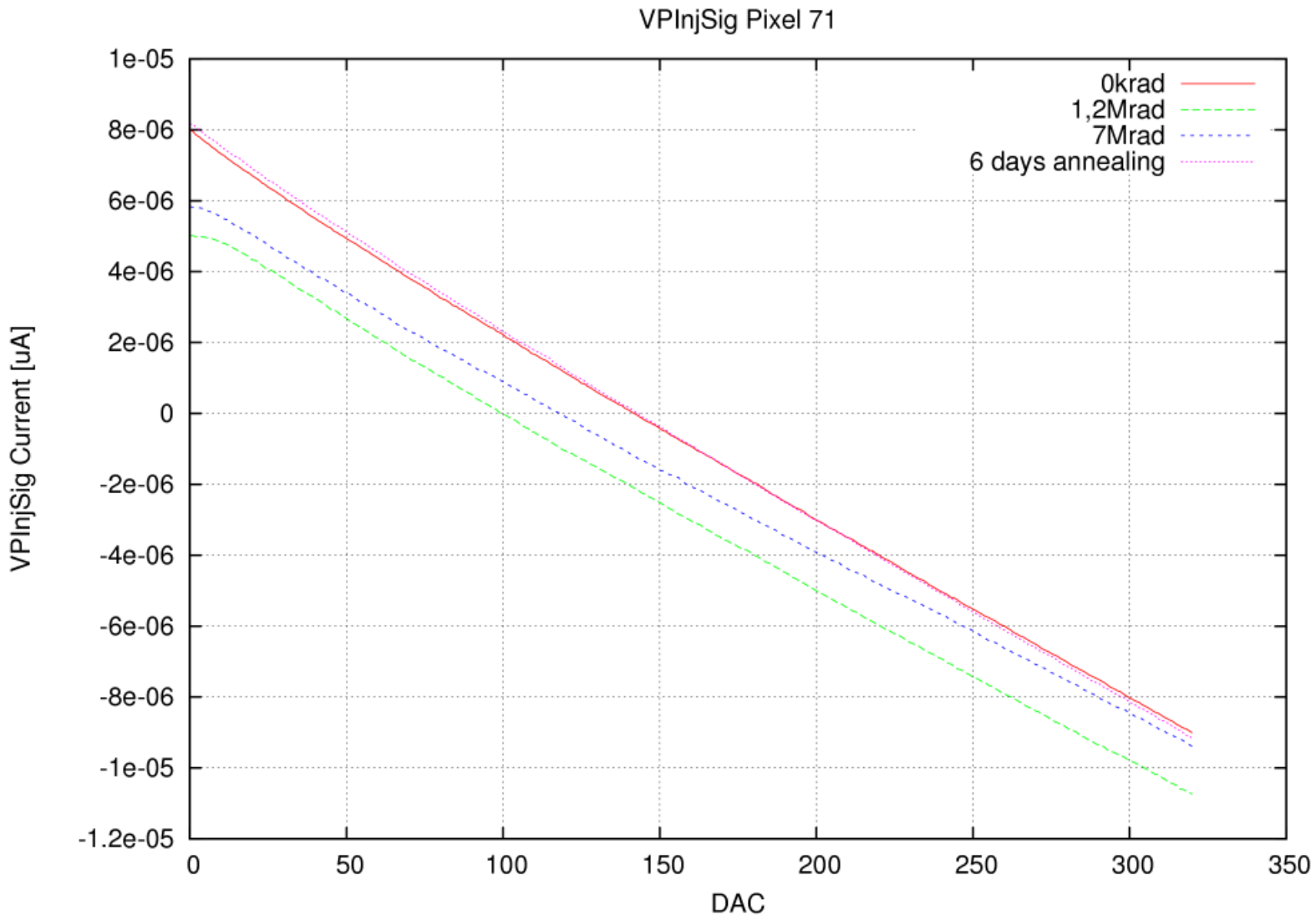
ADC: output code vs. test injection DAC





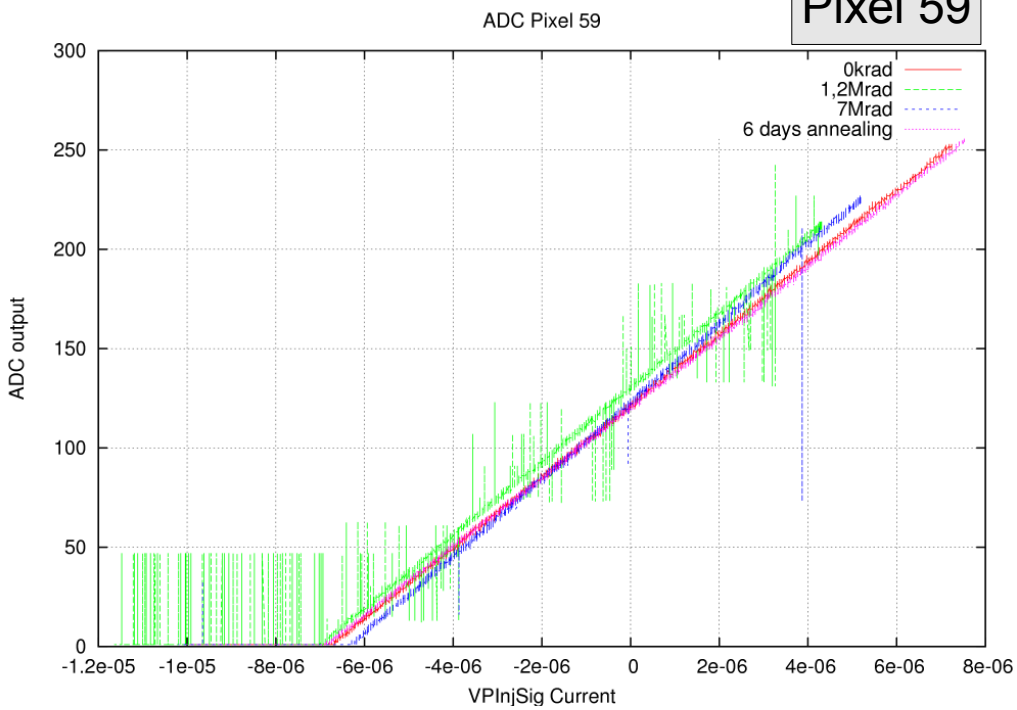
- SEU while irradiating (more at 1.2Mrad then at other dose)
- most radiation effects for <1.2Mrad
- >1.2Mrad : effects recover
- after 7Mrad and 6 days annealing: back to pre-irradiation behavior

Test Injection Current vs. DAC value

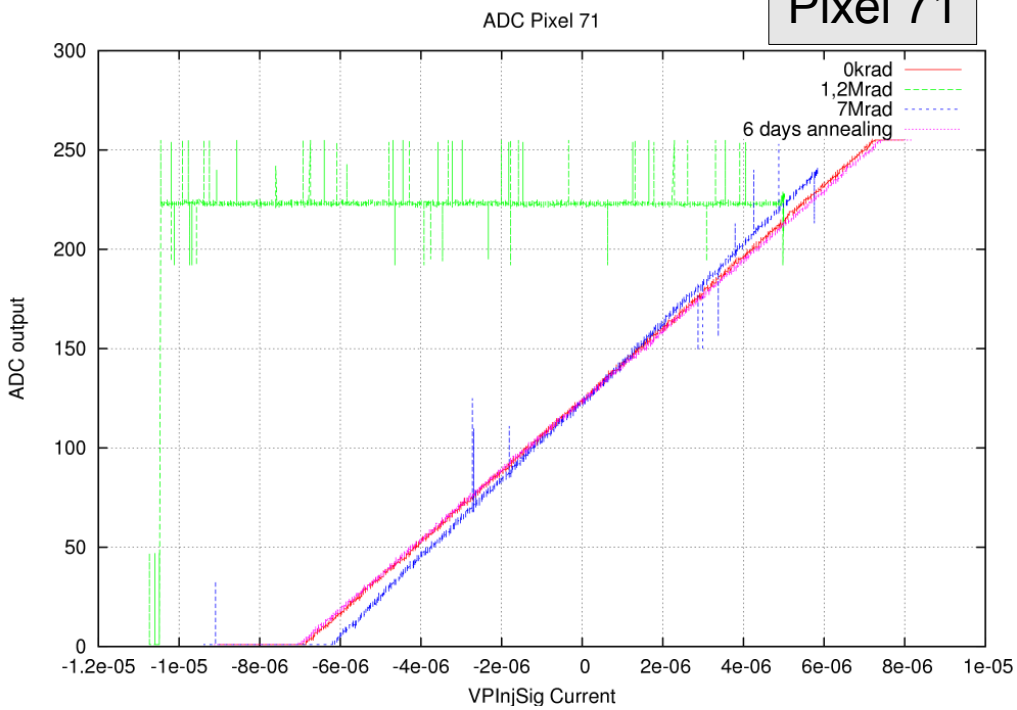


ADC

Pixel 59

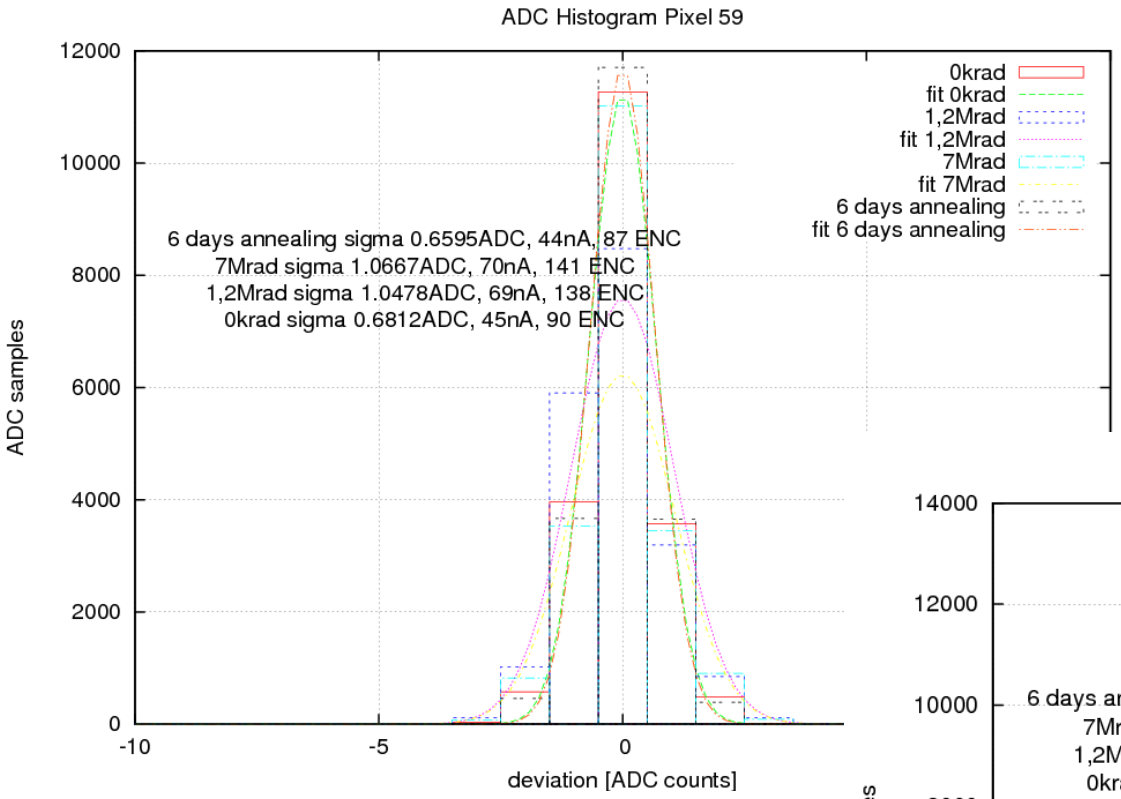


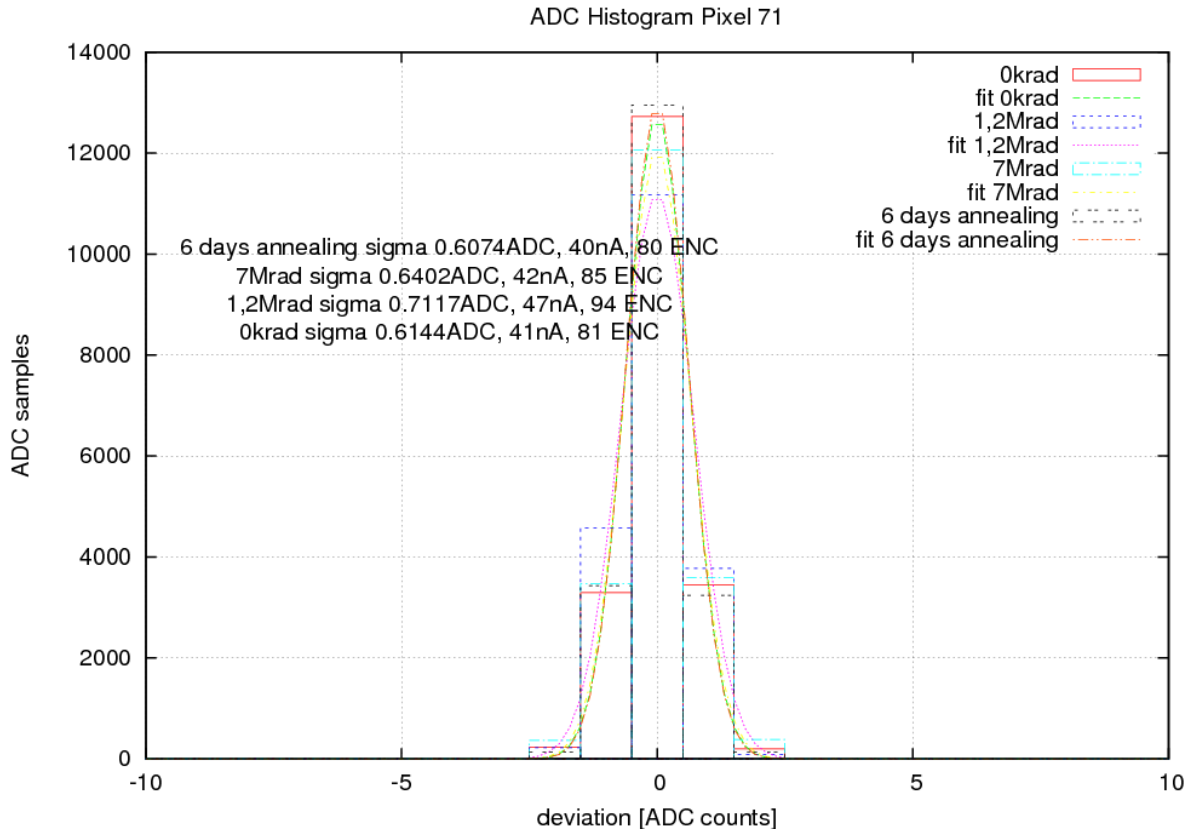
Pixel 71



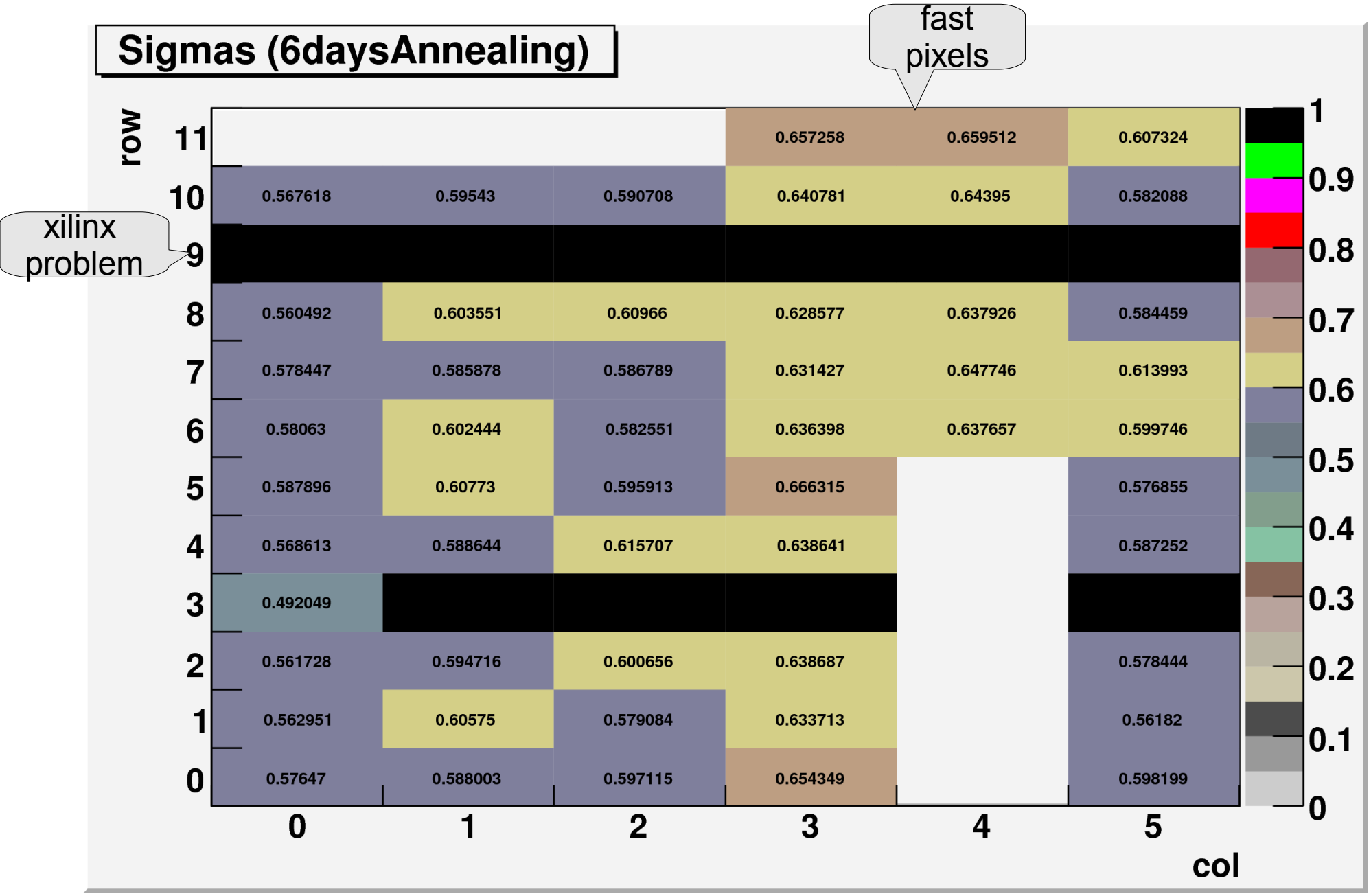
- plotted against the measured injection current
- shift in ADC characteristics mainly caused by shift in inj. current

ADC Histogram

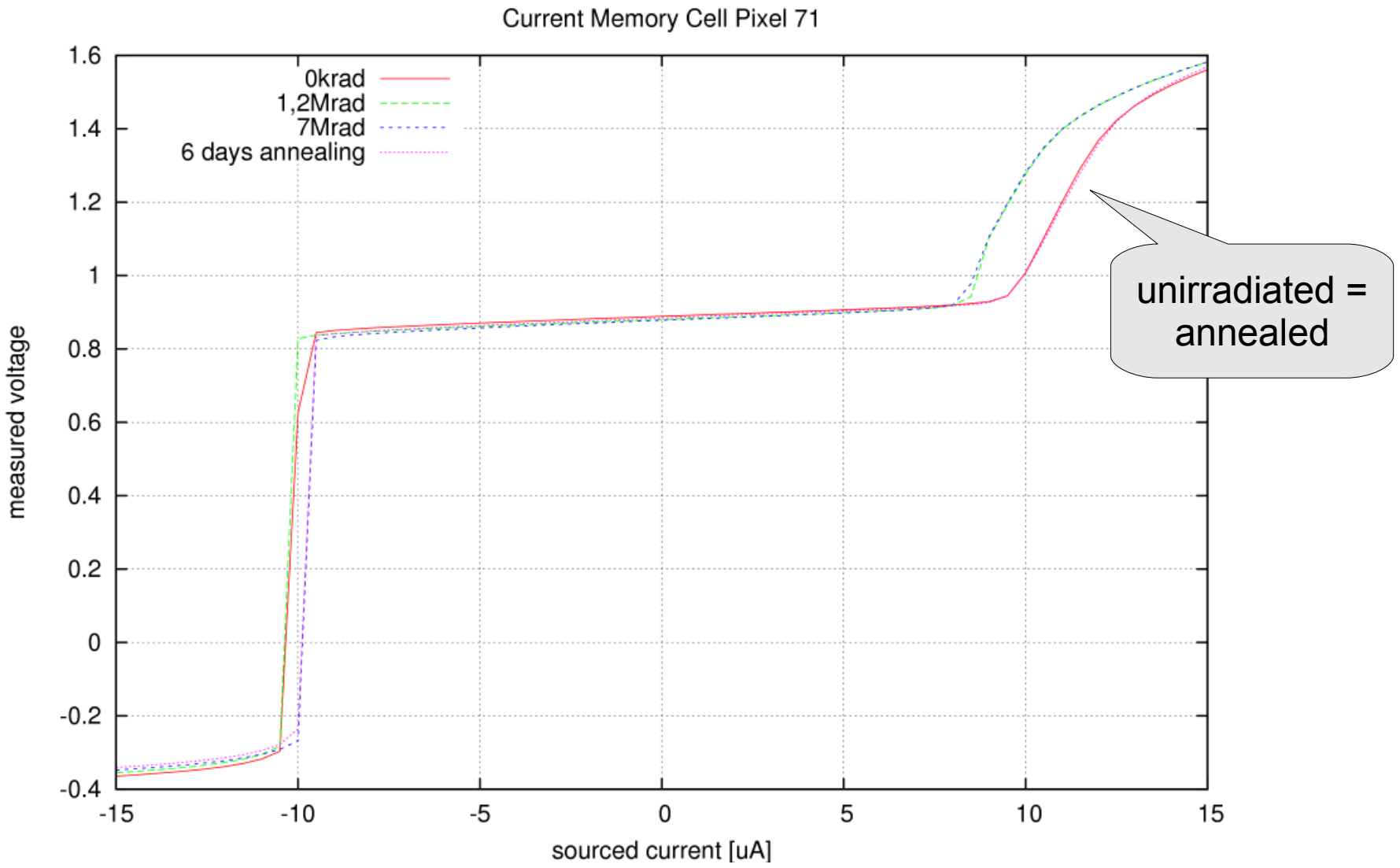




ADC Histogram Map



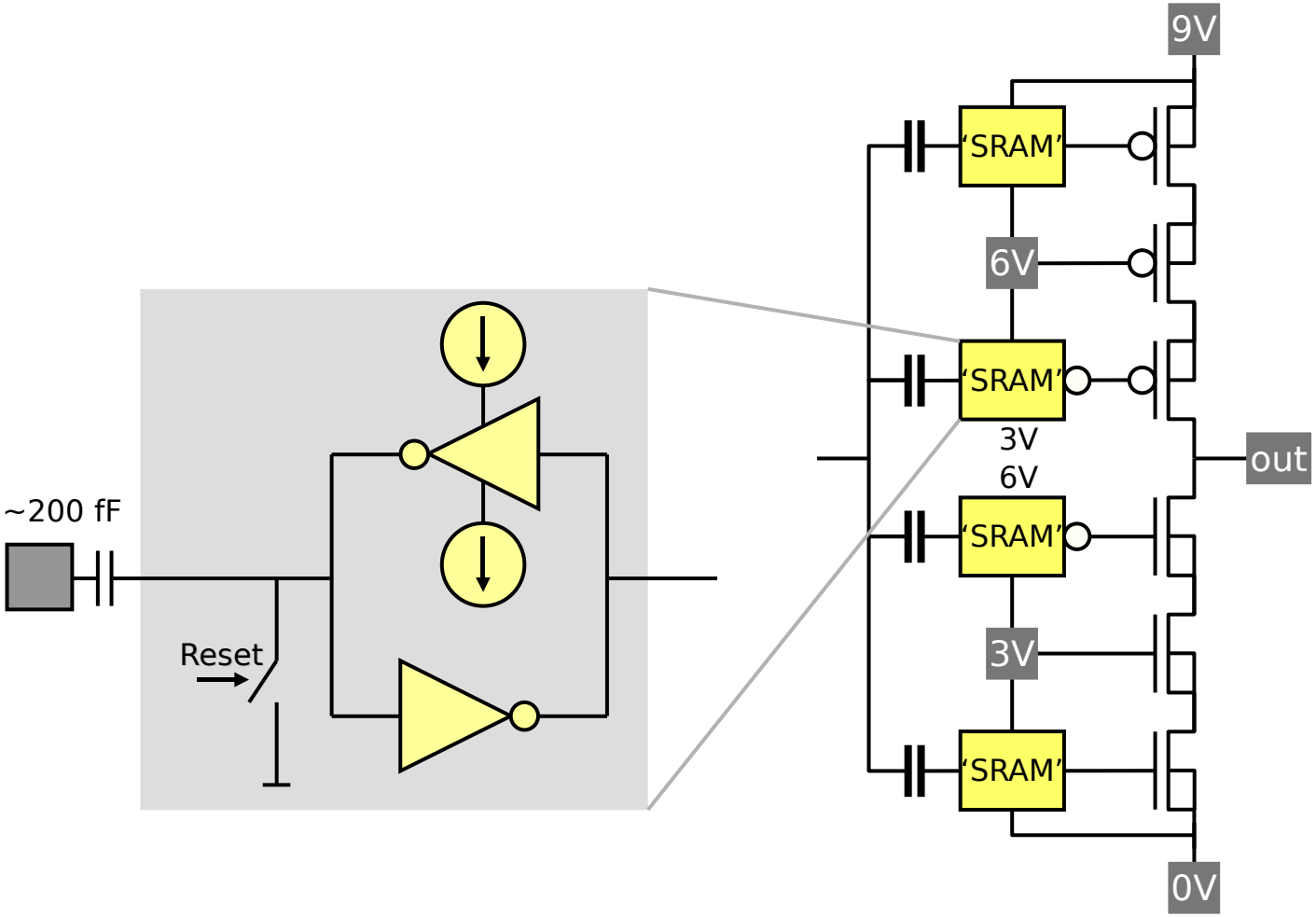
Current Memory Cells

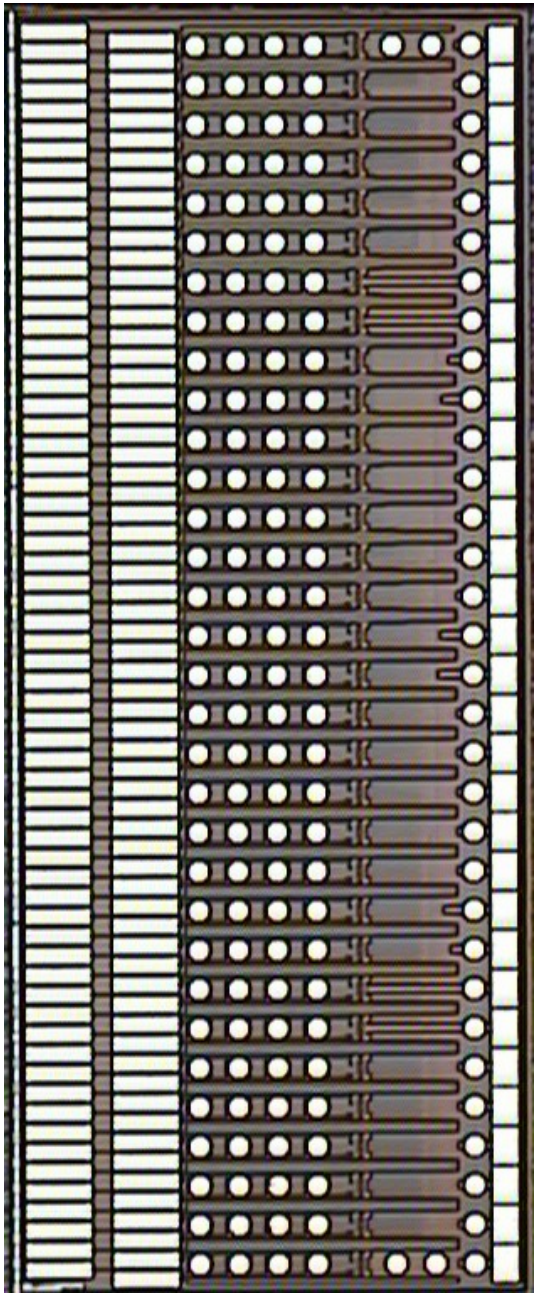


Switcher3 Irradiation

Cap Coupling

- 9V switching using three stacked 3.3V transistors
- AMS 0.35µm twin well technology



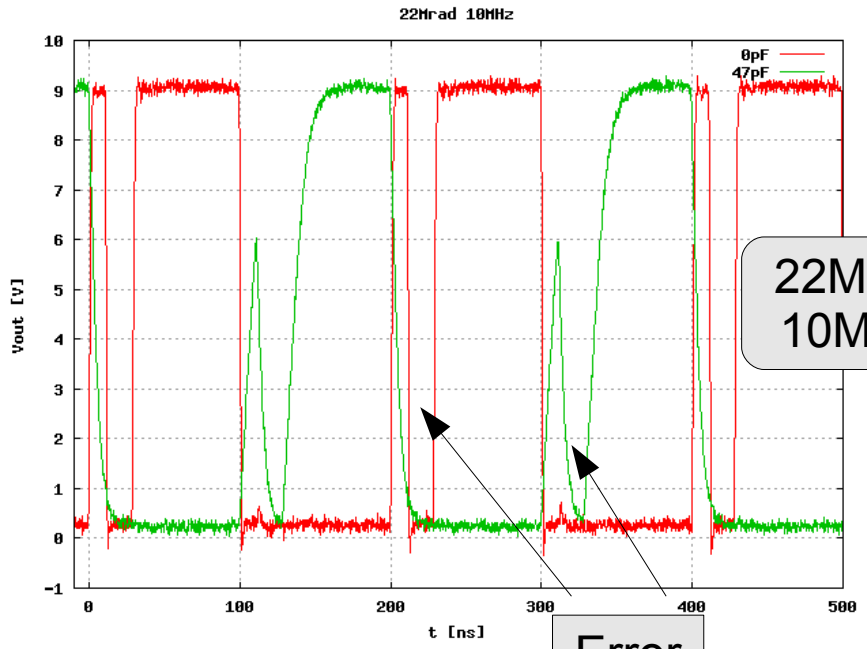


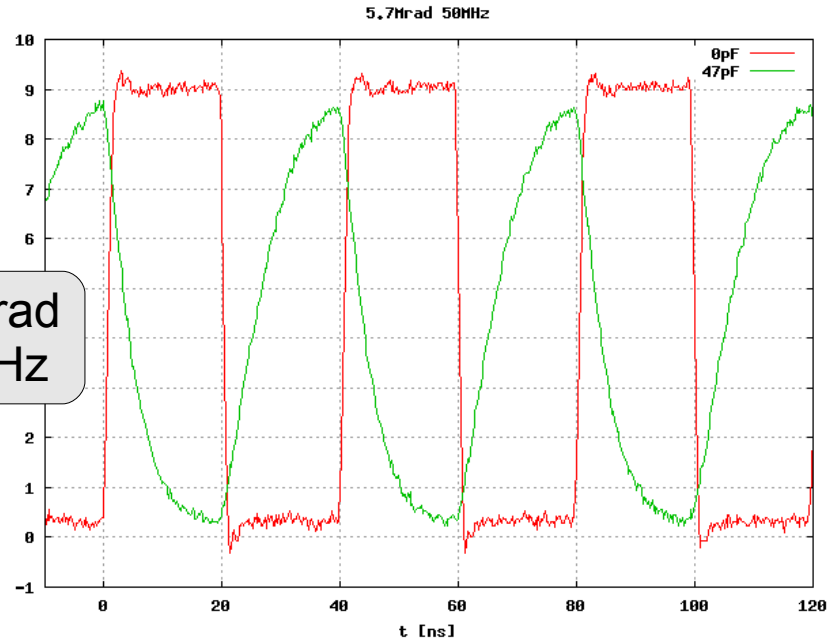
Irradiation details

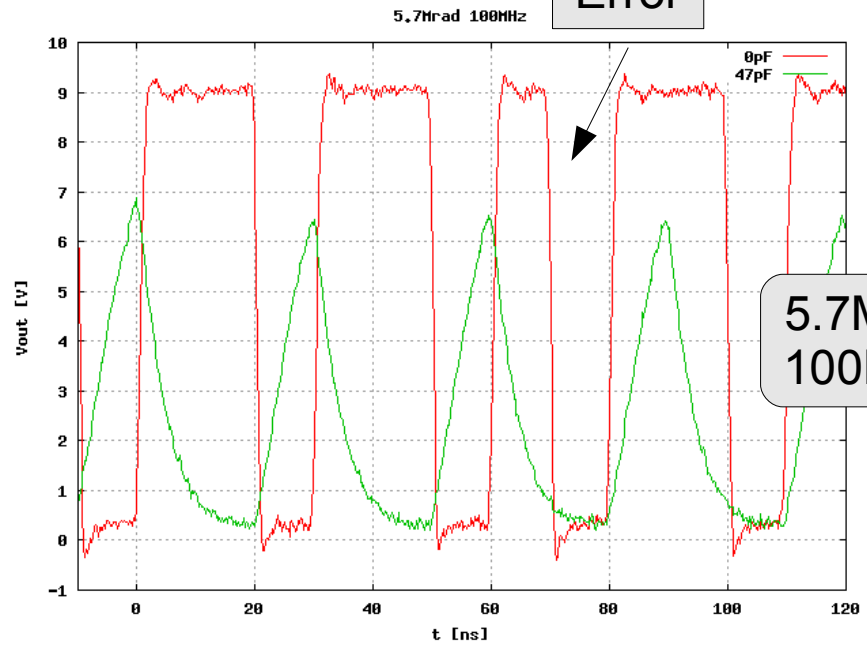
- Dose
  - 93.5h @241 krad/h = 22.5 Mrad
- Switcher Operation Mode
  - sequencer running (switching between 0pF and 47pF)
  - default register values loaded
- Measurements
  - current consumption of chip on VDD and 9V
  - rise times

Speed

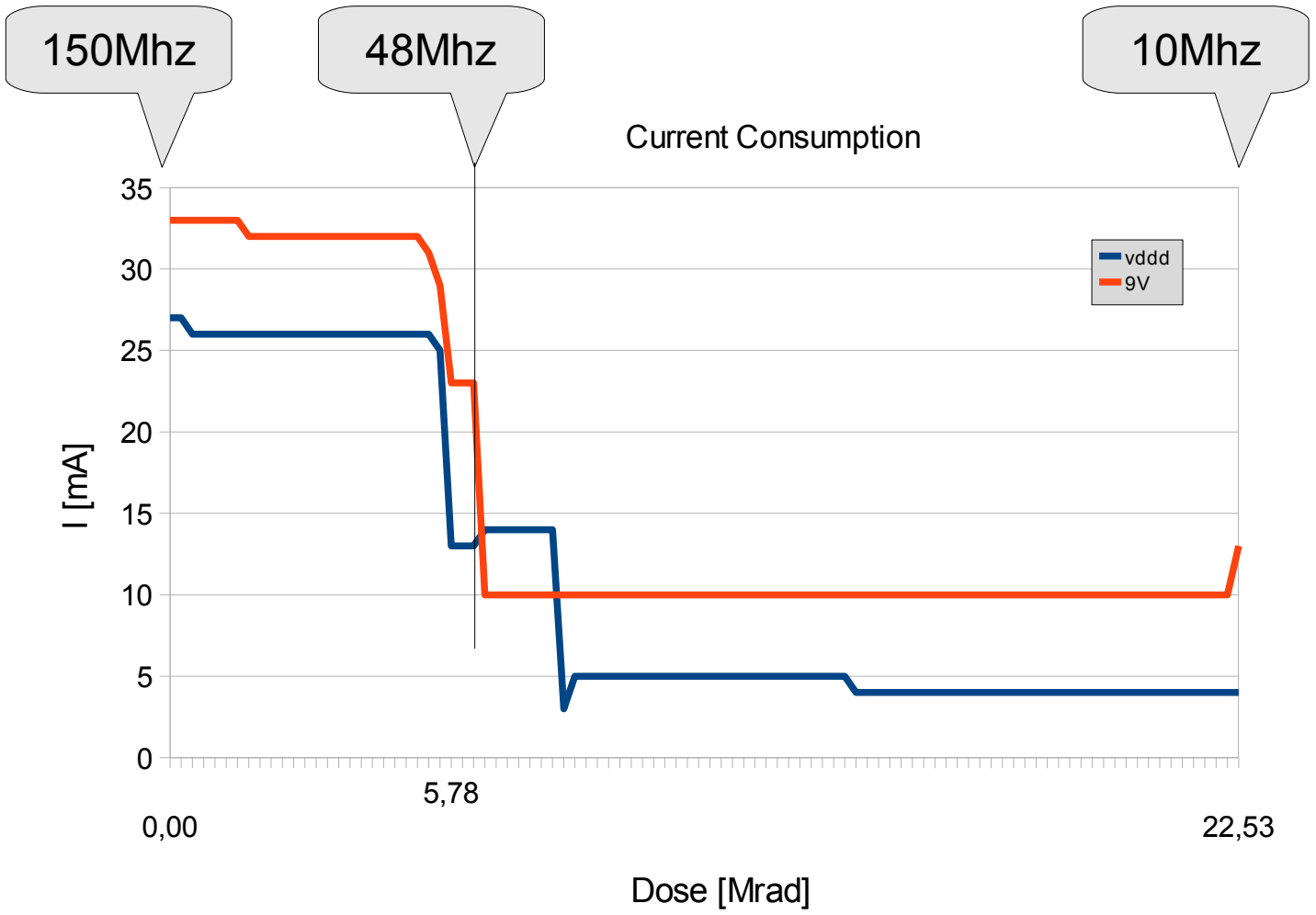
- 0Mrad → 150MHz
- 5.7Mrad → 50MHz
- 22Mrad → <10MHz





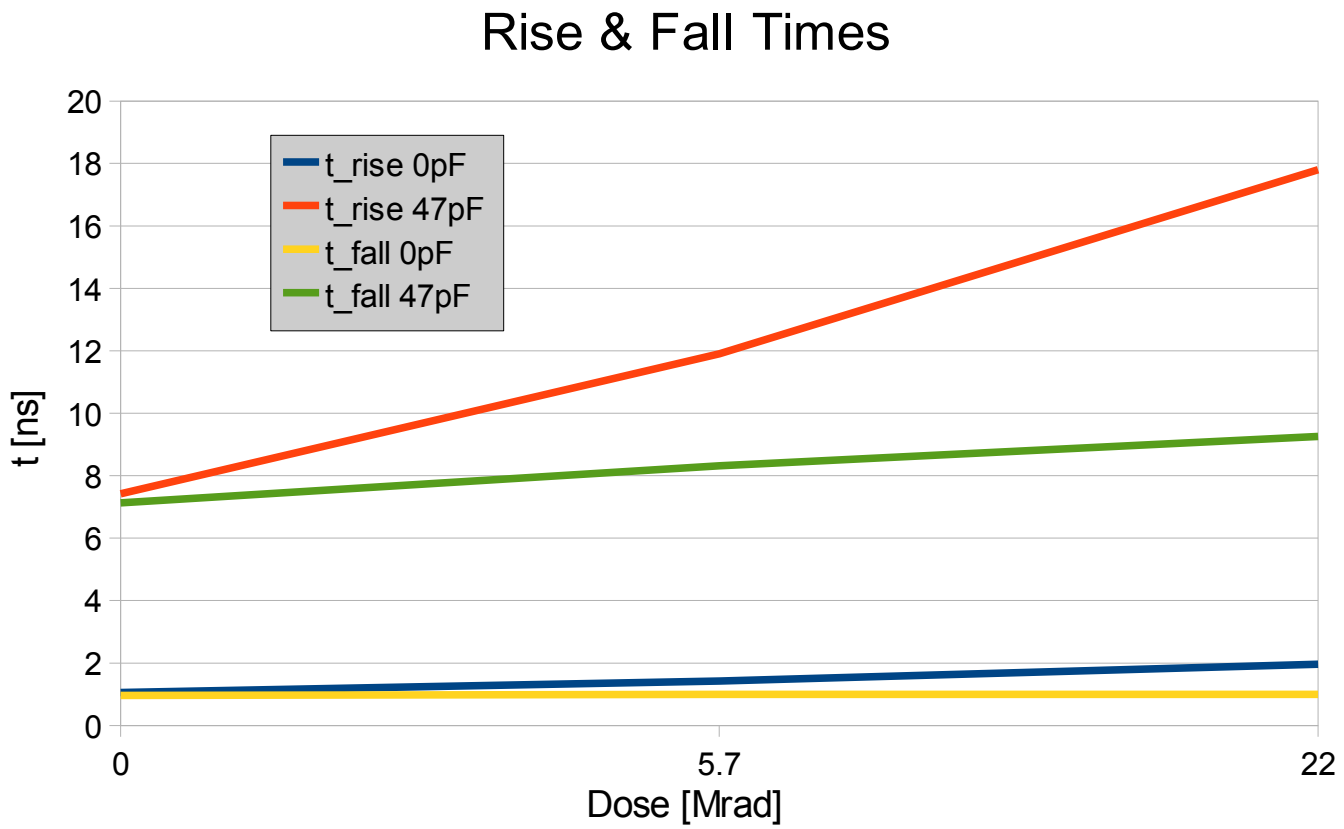


Current Consumption



Rise & Fall Times

- 9V output
- Oscilloscope reading



Summary

- DCD2
  - most effects saturate at 1.2Mrad
  - vdd increase by 14%
  - noise increase by 7%
  - all values back to pre-radiation after 6days annealing!
  - strange effects:
    - many corrupted ADC values at 1.2Mrad
    - some ADCs are dead at 1.2Mrad and recover with higher dose
- Switcher3
  - running after 5.7Mrad
  - risetimes double (7ns → 12ns)
  - after 22Mrad:
    - still errors at 10MHz → chip dead

Karlsruhe Irradiation Experience

- USB readout setups make irradiation easy
- flexible access to Karlsruhe facility
- very good support from staff!
- short distance between Mannheim and Karlsruhe is convenient
- stable beam during weekend allows high doses

Thank you!