Irradiated Read Out Chips: Procedure

Samvel Khalatyan
Eric Stachura

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Irradiated ROCs

1. **Read Out Chip in a Nutshell**
2. **Pulse Shape**
3. **Efficiency Plots**
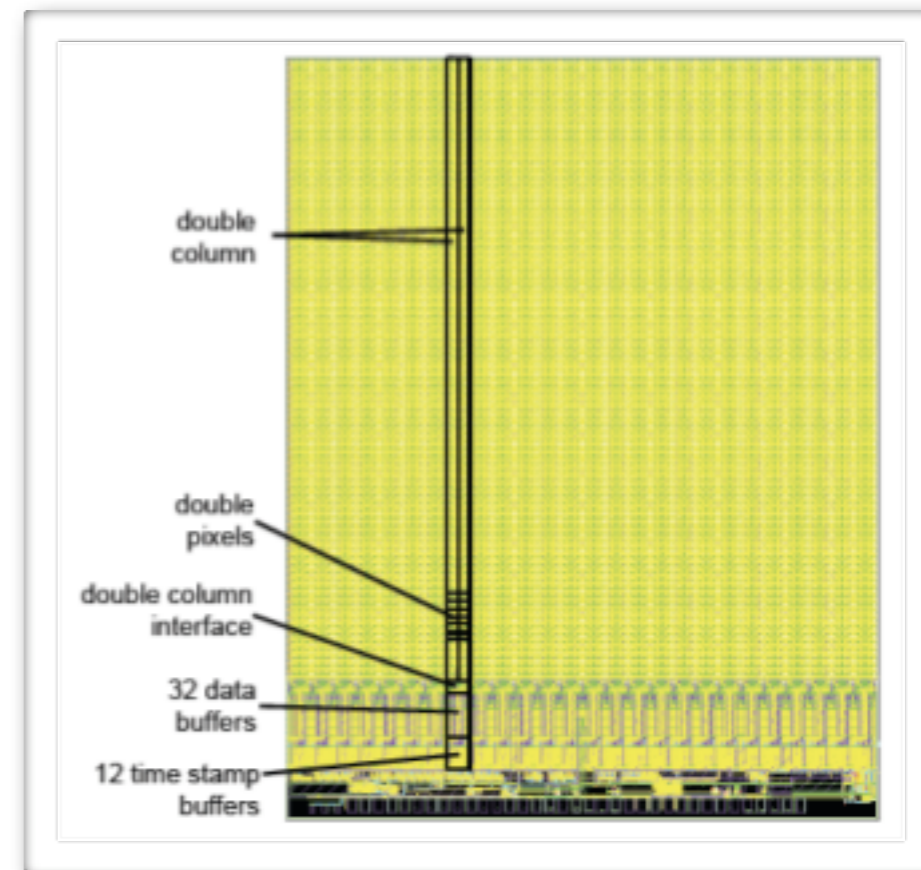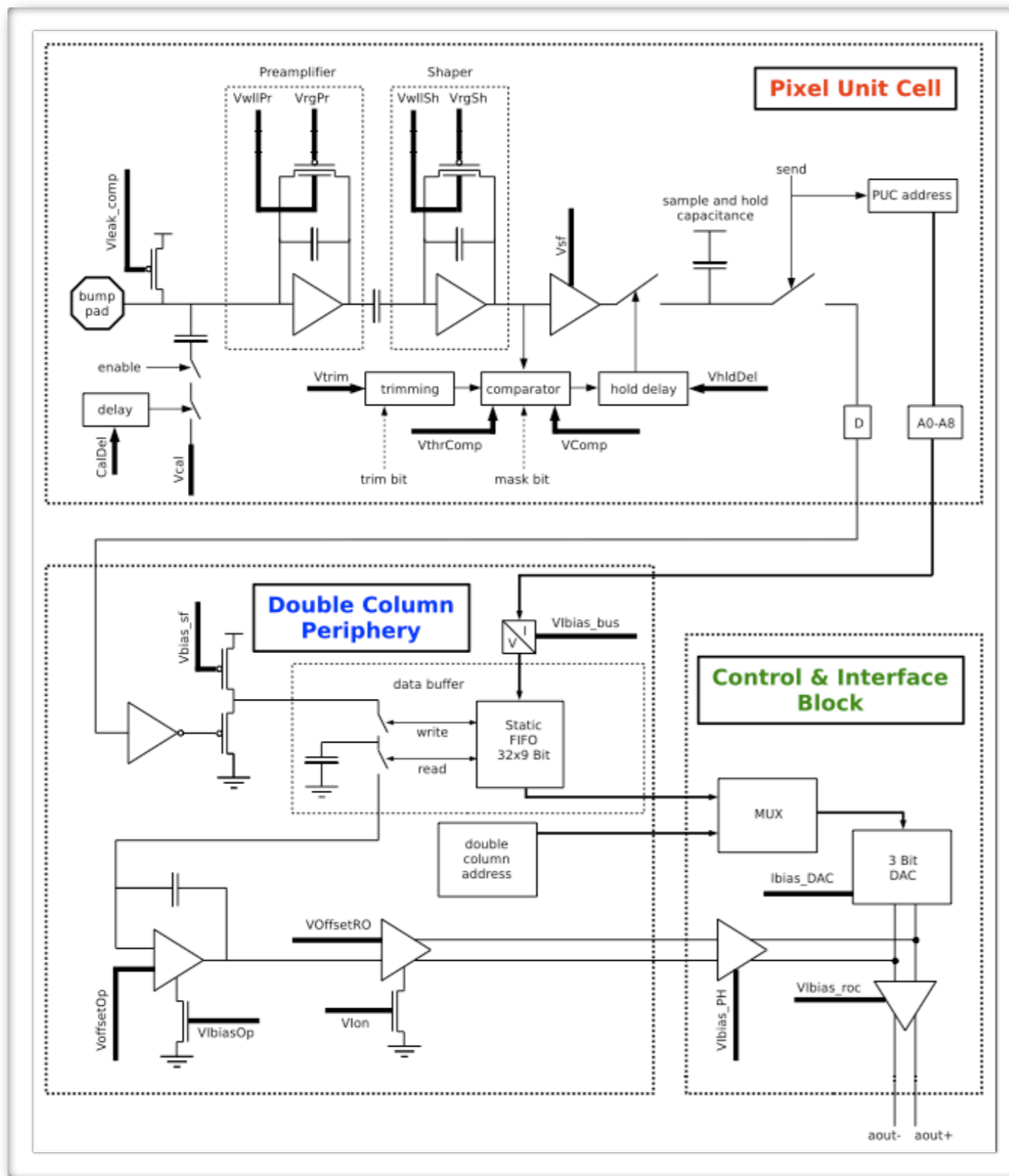4. **Readout Procedure**
5. **Results**

READ OUT CHIP IN A NUTSHELL

ROC in a Nutshell

ROC - Read Out Chip for CMS Tracker Pixels to measure particles position crossing the detector. It includes:
- Si Layer (sensitive to crossing charged particles)
- Underlying electronics processing deposited charge

SCHEMATIC VIEW

REAL MODULE

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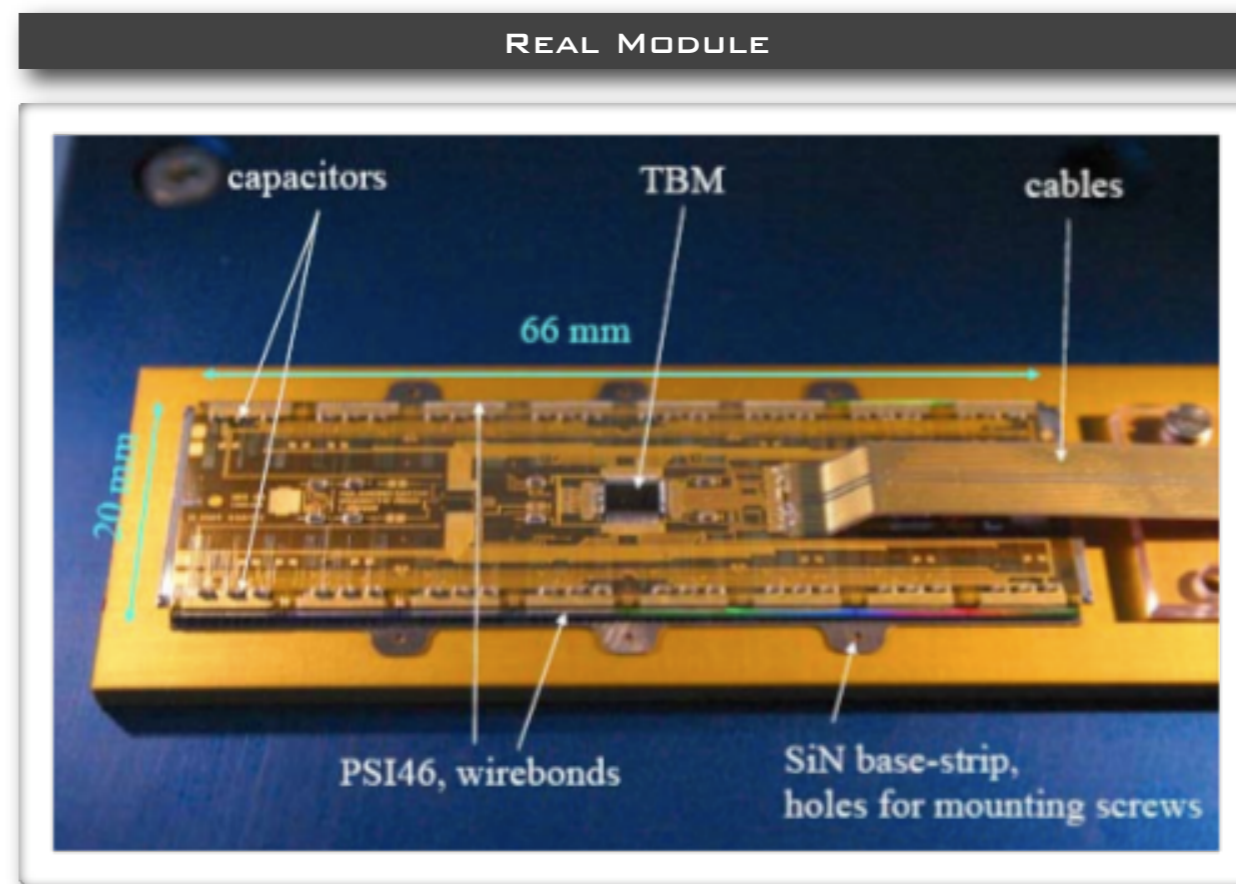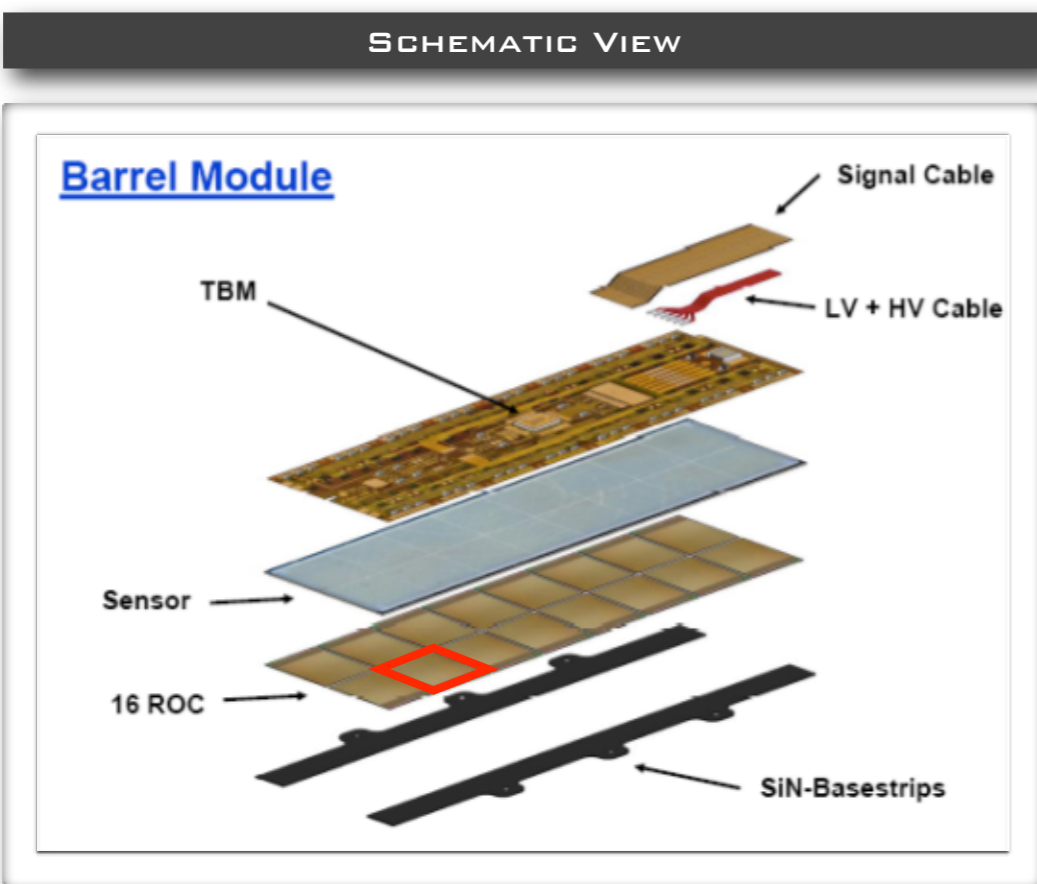
Key Moments
* Signal (from Si or Calibration) gets processed by a set of electronics that alter pulse shape and send to output.
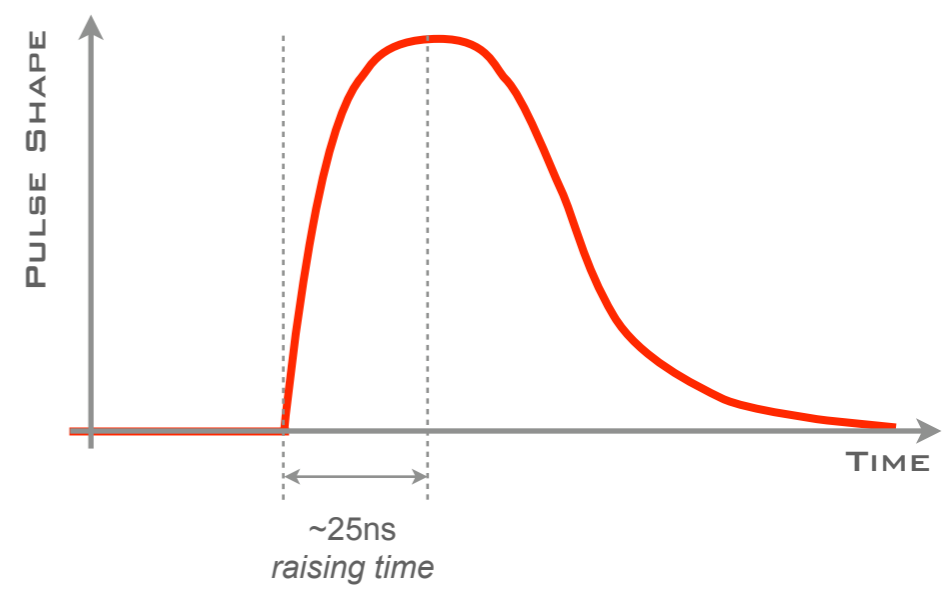* Input voltages adjust operation of units.

PULSE SHAPE

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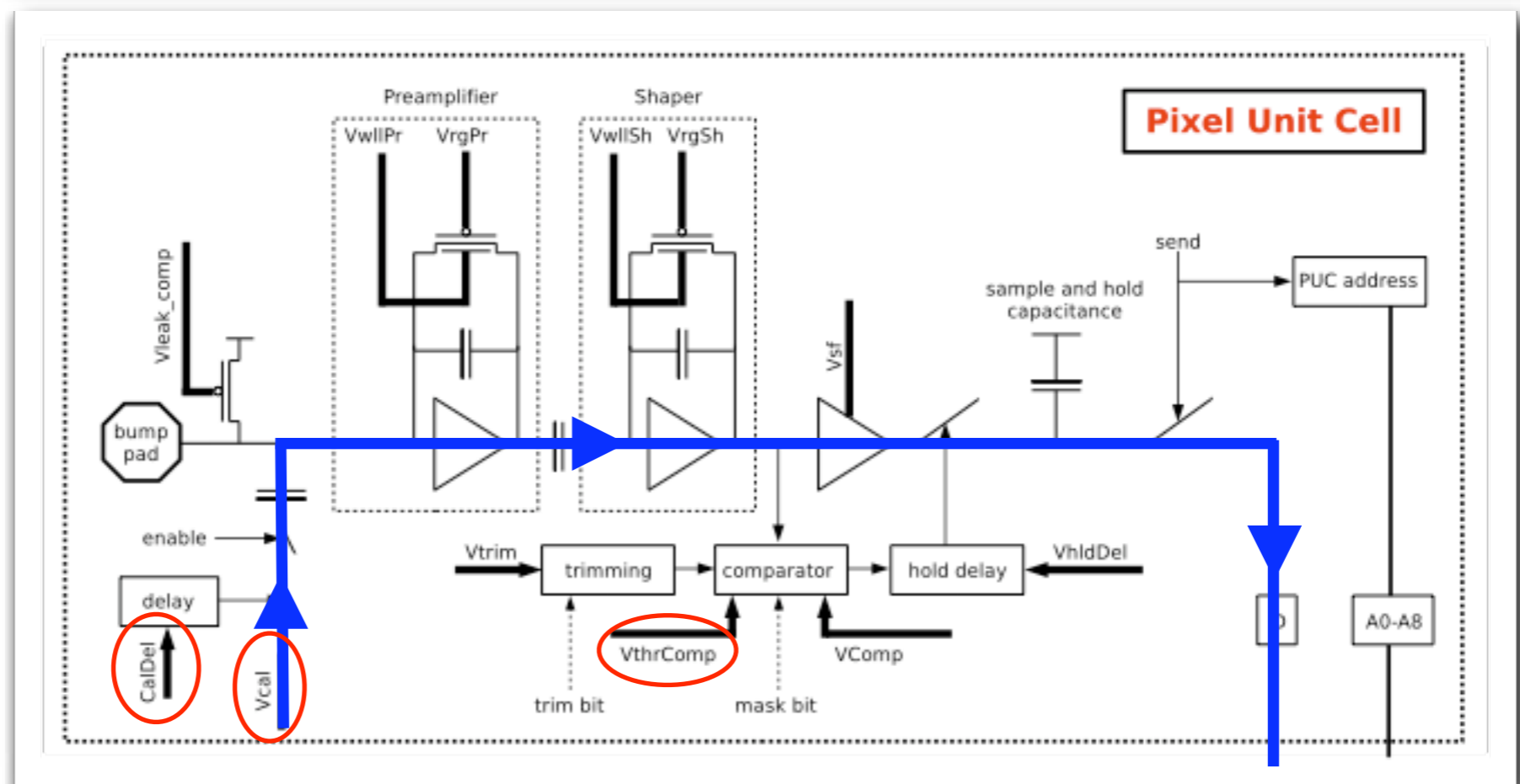
WANT TO SEE

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

~25ns
raising time

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

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PIXEL UNIT CELL (PUC) IS AN ELECTRIC LAYOUT OF ELECTRONICS THAT IS PRESENT AT EACH PIXEL

Pulse Shape gets altered as signal propagates through electronics and we'd like to understand how it changes, then modify correspondingly Inputs so that original shape is restored (the same as for non-radiated chips). Vcal was assumed to remain the same with fluence.
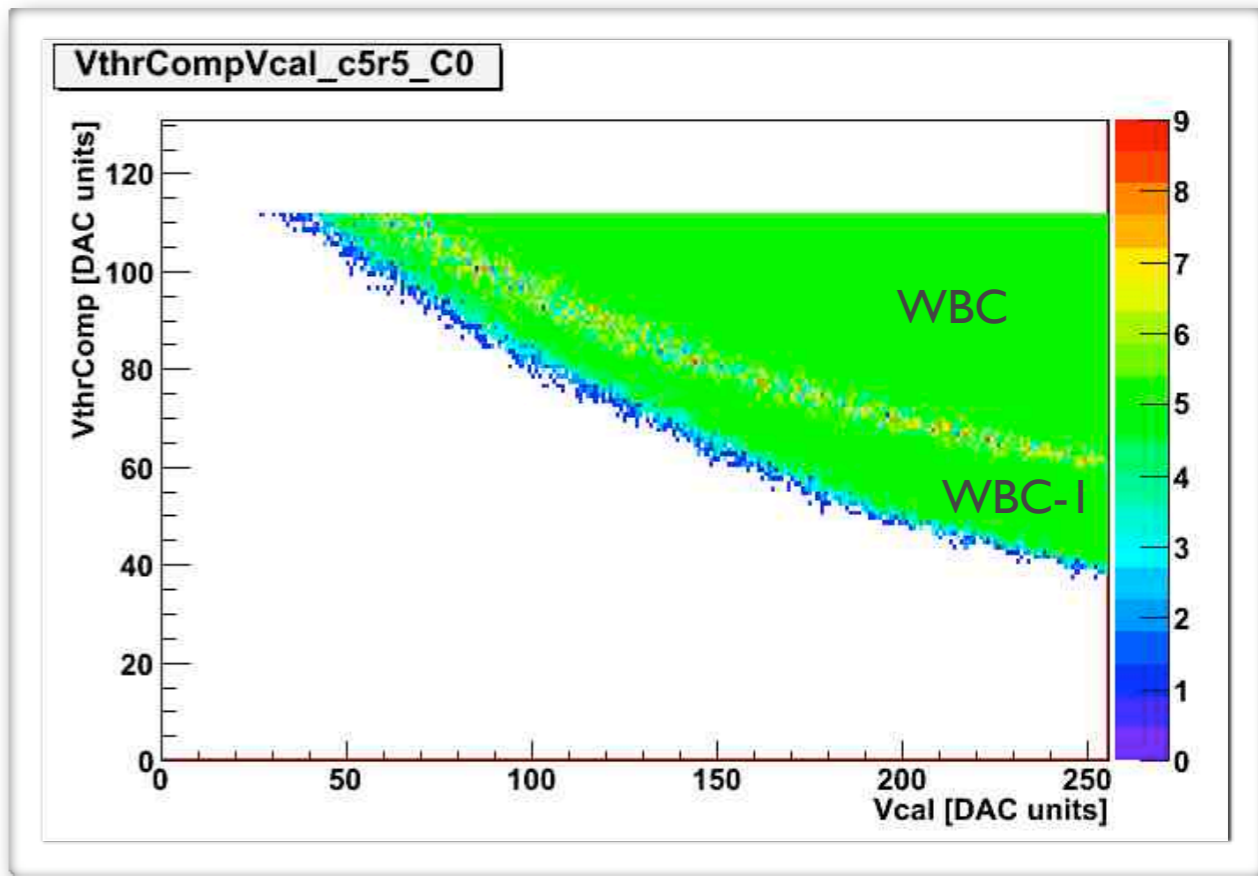
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Pulse Shape

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

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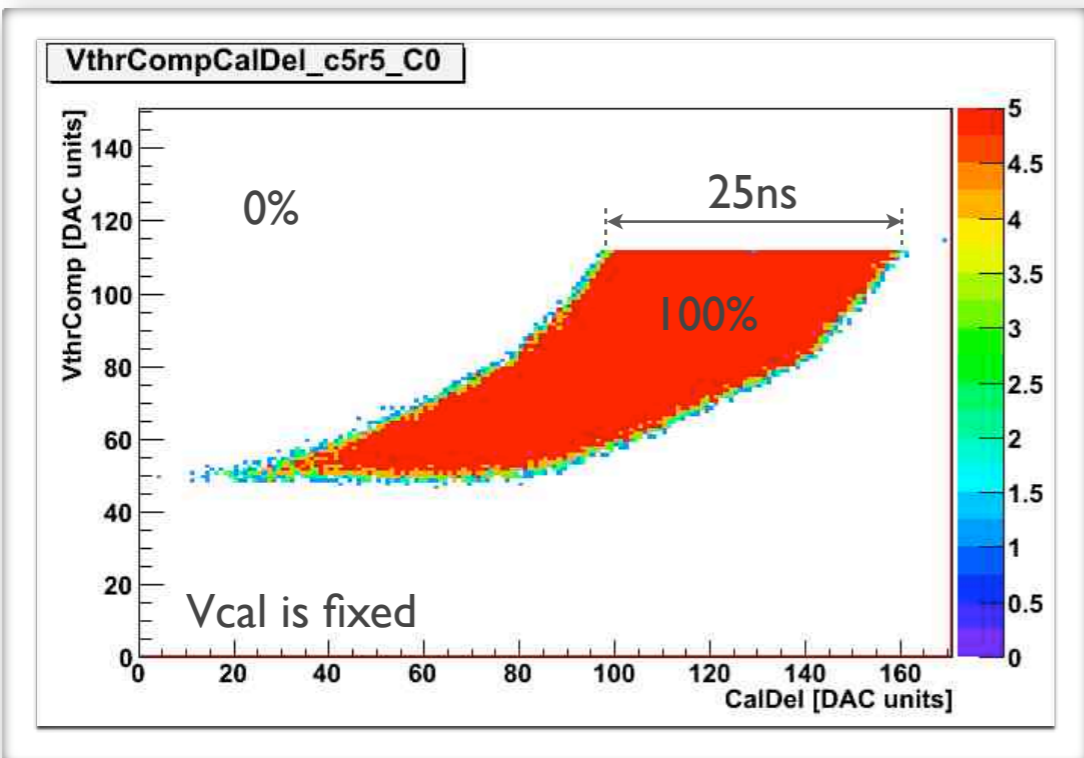
These are efficiency plots and can be fitted by Error Function.
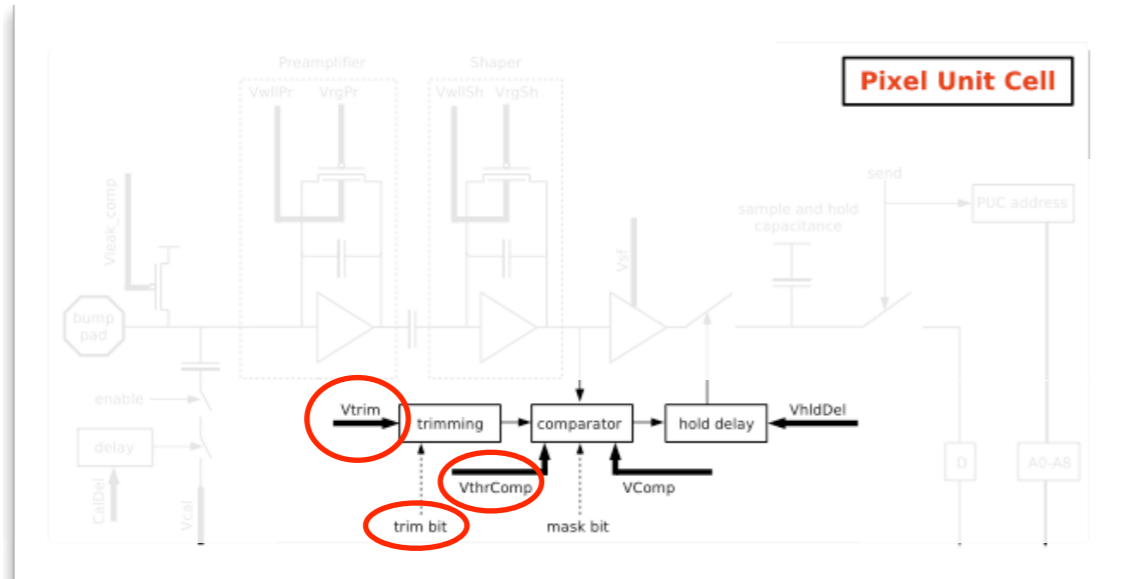

PulseShape is a signal development in time. Next conversions are needed:
1. from CalDel DAC units to ns
    can be extracted from "tornado"
2. $V_{thrComp}$ to V_{cal}
    separate plot is necessary

Threshold measurement to get value of injected signal in electrons.

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Efficiency Plots

DACs AFFECTING THRESHOLD

Pixel Unit Cell

Threshold

$$V_{thrComp} - \alpha \cdot V_{trim}$$

trim bits
(individual per pixel)
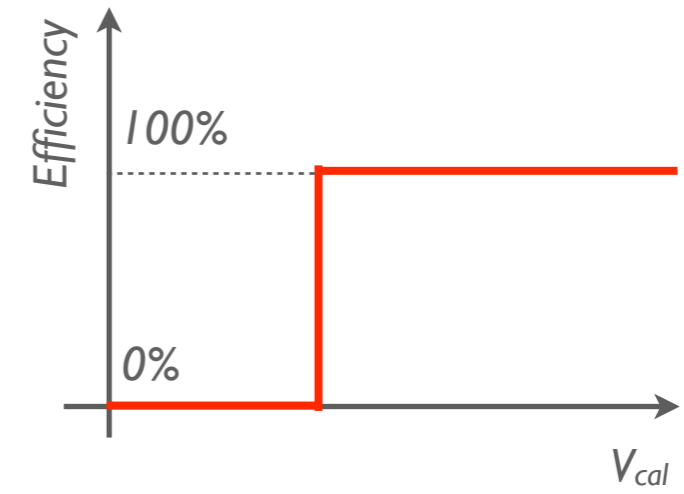
Threshold is used to check whether signal is above some level to mainly reduce noise.

$V_{thrComp}{}^{1}$	0..255
$V_{trim}{}^{1}$	0..255
trim bits[2]	0..15

[1] *per ROC*
[2] *per pixel*

pass   **fail**
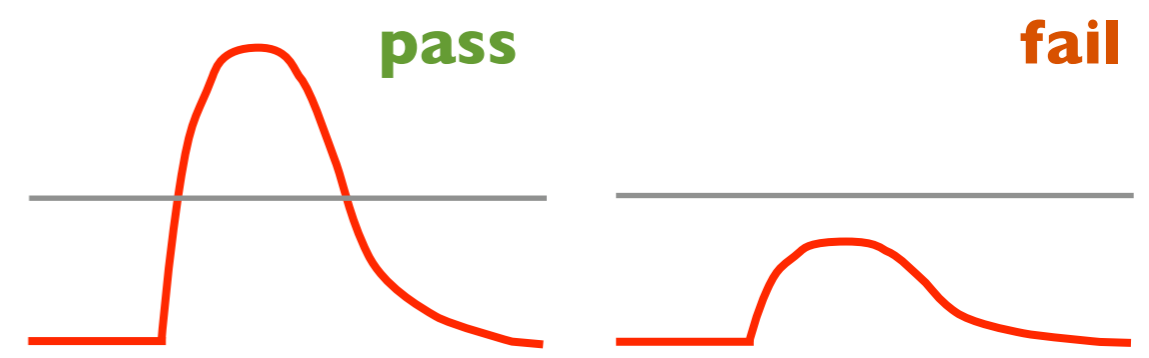
Fix threshold and vary V_{cal}.

TOO HIGH

TOO LOW

EXACT

IDEALLY

Efficiency

100%

0%
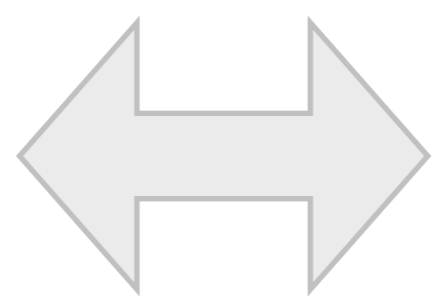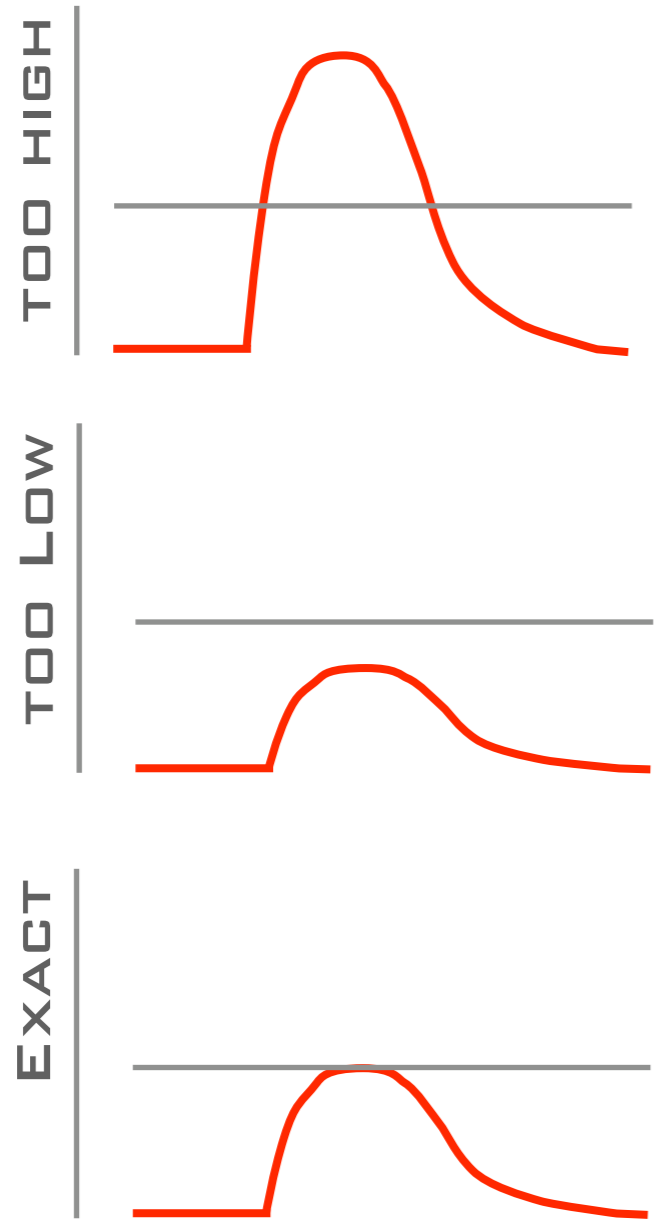
V_{cal}

Unfortunately noise spoils threshold measurement. It is added to V_{cal}.

IN REALITY

Efficiency

100%

0%

V_{cal}

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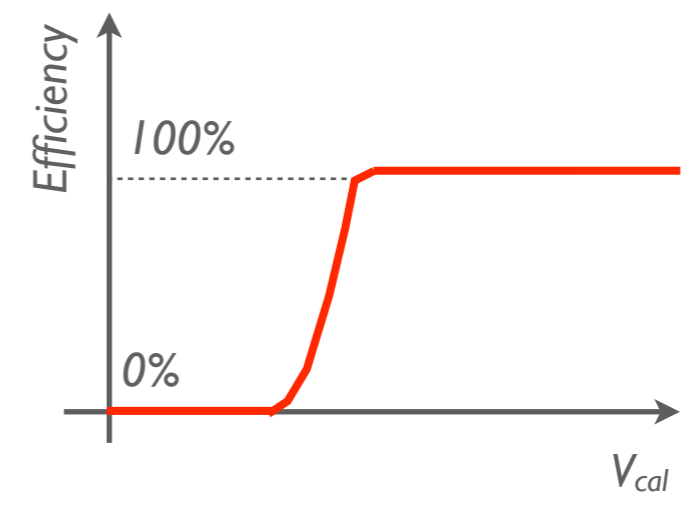
Noise has a gaussian distributed pdf (probability density function).

$$pdf(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$
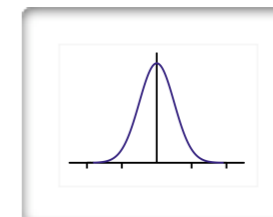
pdf(x) dx   is a probability of getting noise in range [x , x+dx]
   μ   is a mean noise value
   σ   is a standard deviation (distribution spread)

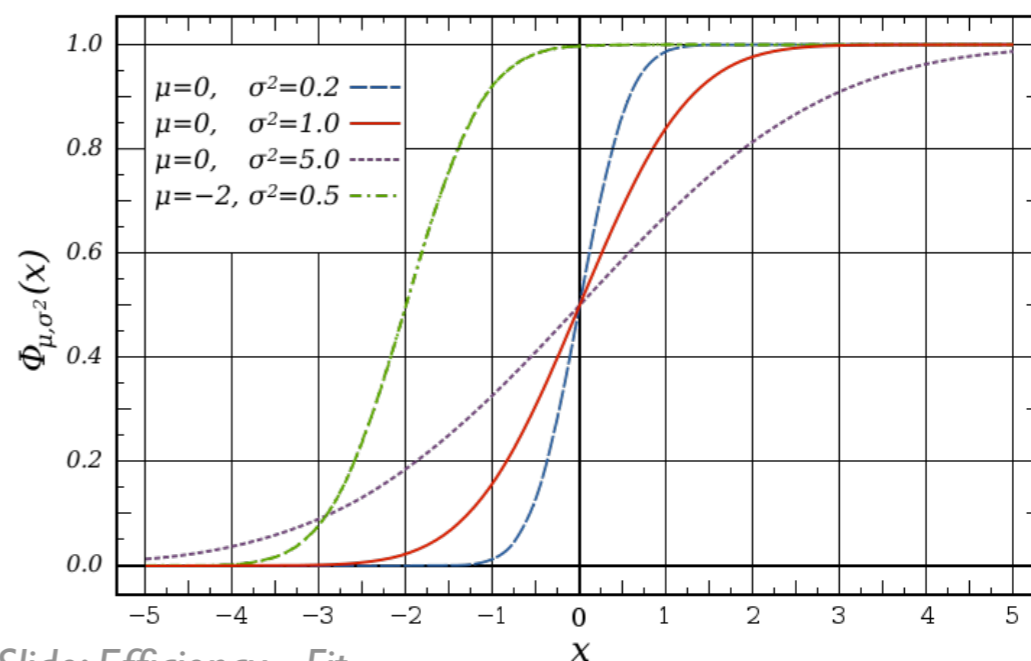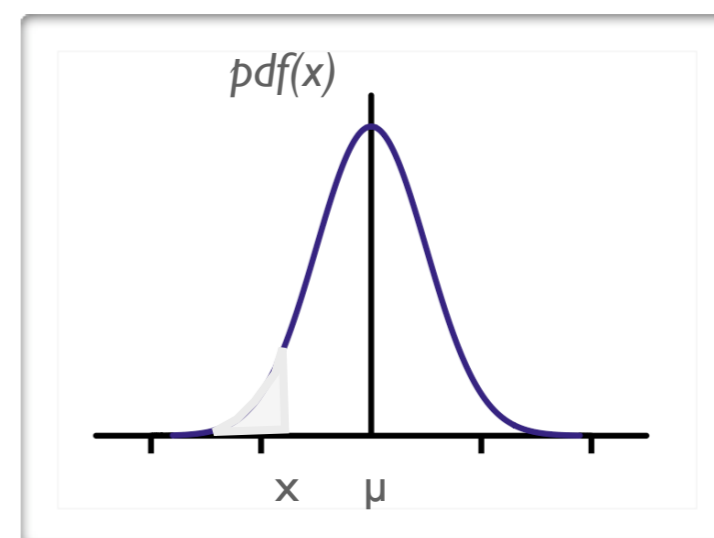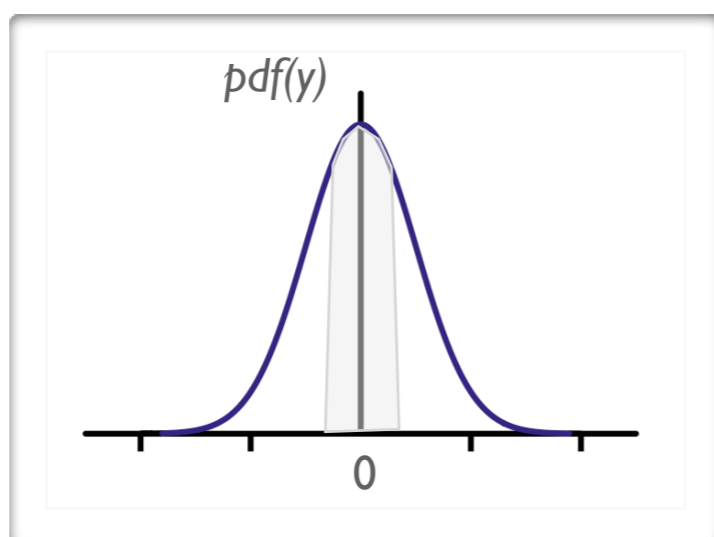**Normalization**

$$1 = \int_{-\infty}^{\infty} pdf(x)dx$$

Transform variable and get normal distribution (Gaussian with mean at zero):

$$y = \frac{x - \mu}{\sqrt{2}\sigma} \quad \Rightarrow \quad pdf(y) = \frac{1}{\sqrt{\pi}} e^{-y^2}$$

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$$Erf(x) = 2 \int_0^x pdf(y)dy \quad \Rightarrow \quad cdf(x) = \frac{1}{2}(1 + Erf(\frac{x - \mu}{\sqrt{2}\sigma}))$$

normal distribution

pdf(y)

0

pdf(x)

x   μ

$\mu=0, \quad \sigma^2=0.2$
$\mu=0, \quad \sigma^2=1.0$
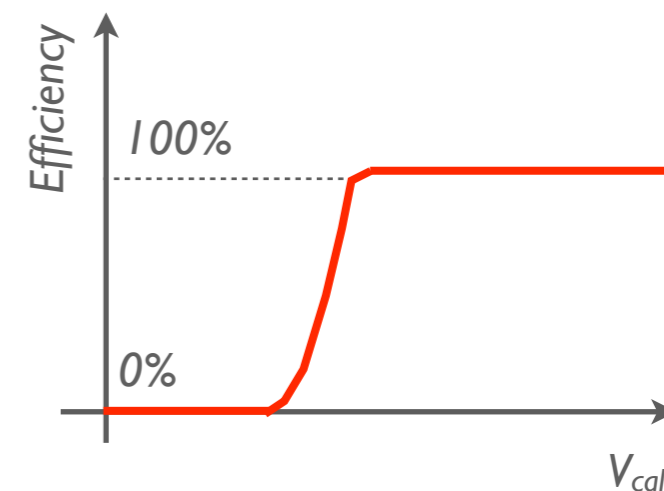$\mu=0, \quad \sigma^2=5.0$
$\mu=-2, \sigma^2=0.5$

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FITTING FUNCTION

$$[0] \cdot Erf([2] \cdot (x - [1])) + [3]$$

$$\frac{1}{\sqrt{2}\sigma}$$

μ

[0],[1],[2],[3]   Fit parameters to be estimated in fitting procedure.

Thus for In-time Threshold measurement Efficiency plot should be <u>fitted</u> with Error Function.

[1]   is a value of threshold
[2]   noise standard deviation (spread)

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Efficiency

"Tornado"

Efficiency is 100% inside and 0% outside. Vcal is injected 5 times into pixel for given value of $V_{thrComp}$ and CalDel.

DAC-DAC SCAN: TORNADO

Comparator Threshold Voltage ⟶

S-CURVE: THRESHOLD MEASUREMENT
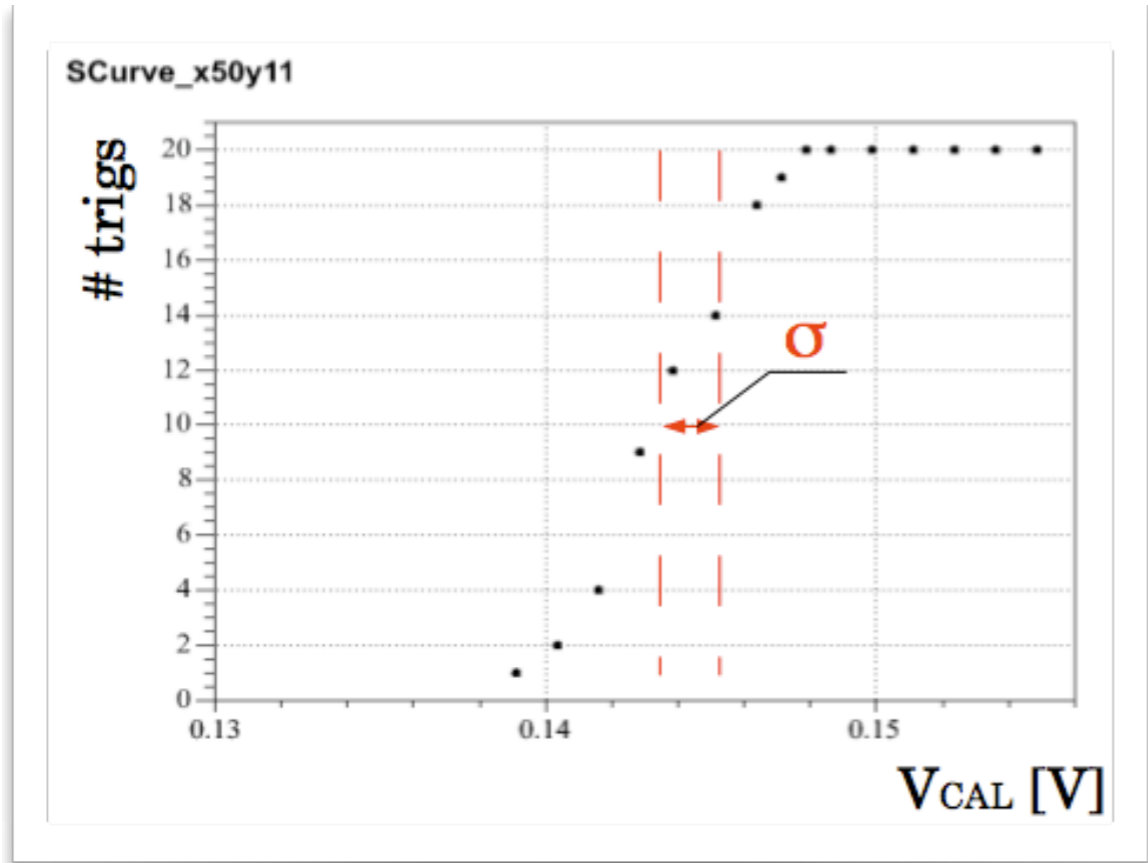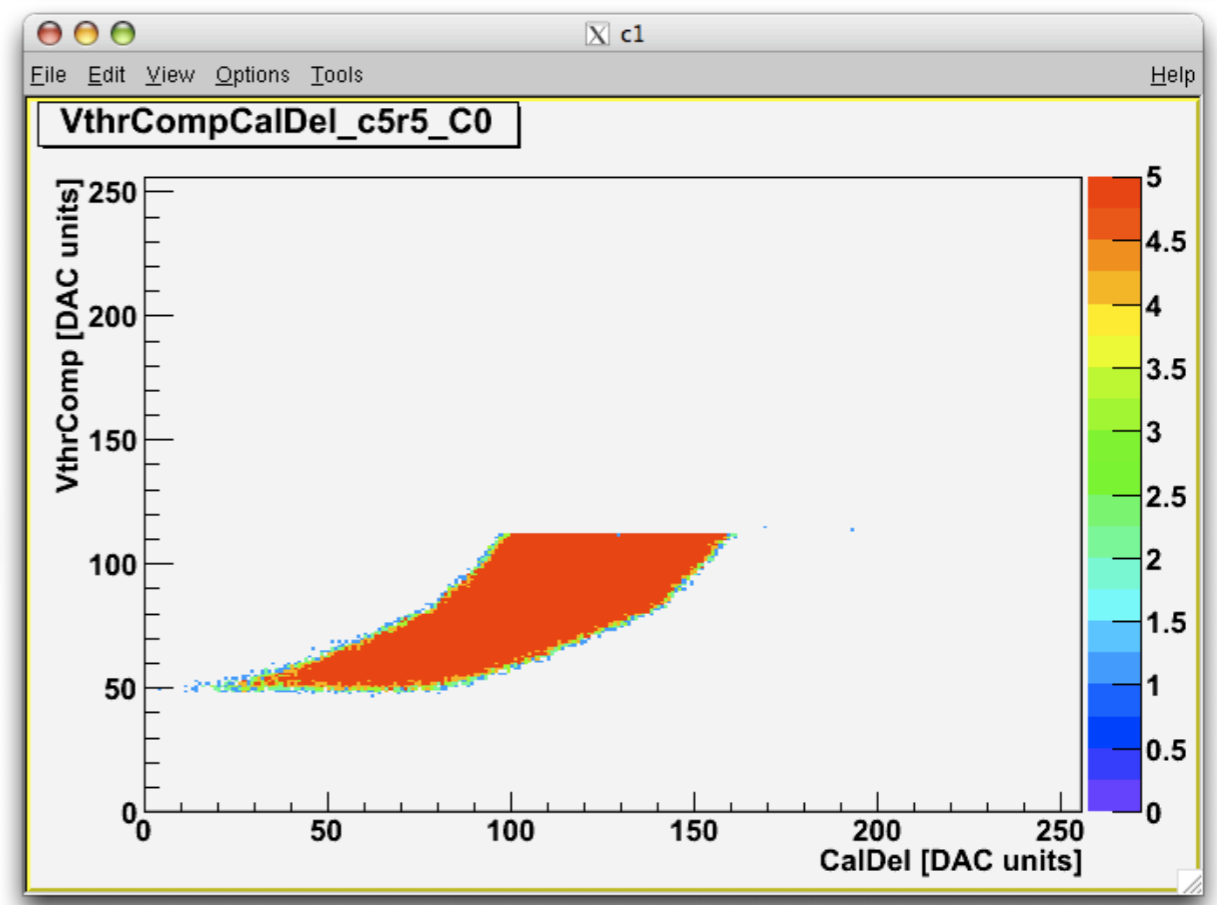
↑ Calibration Signal injection Delay

⟵ Calibration Signal

PROCEDURE

BY ERIC STACHURA

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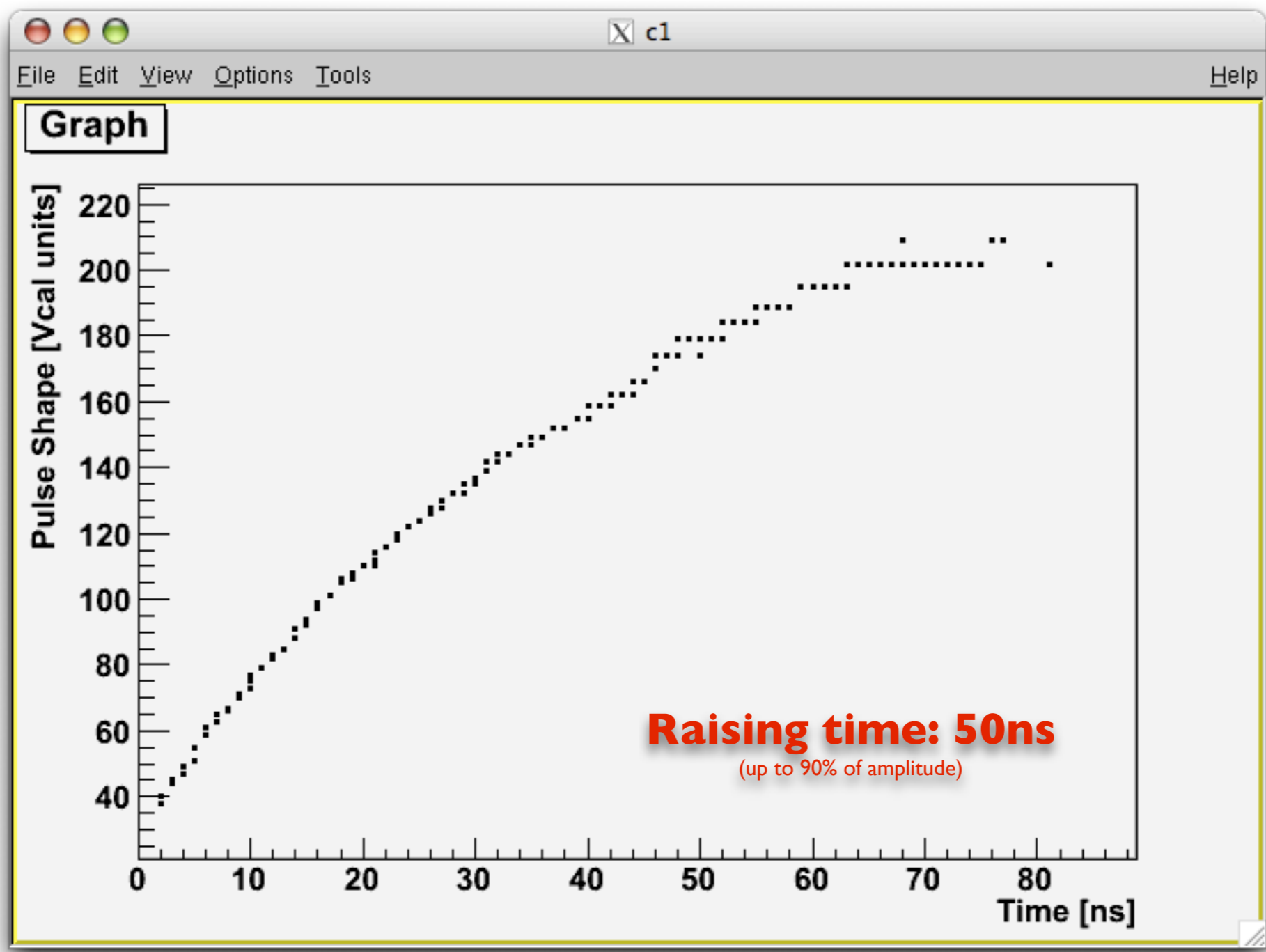
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Results

Results

ROC 260962-11-06
Fluence: 4.2E+14

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Results

ROC 260962-11-06
Fluence: 4.2E+14

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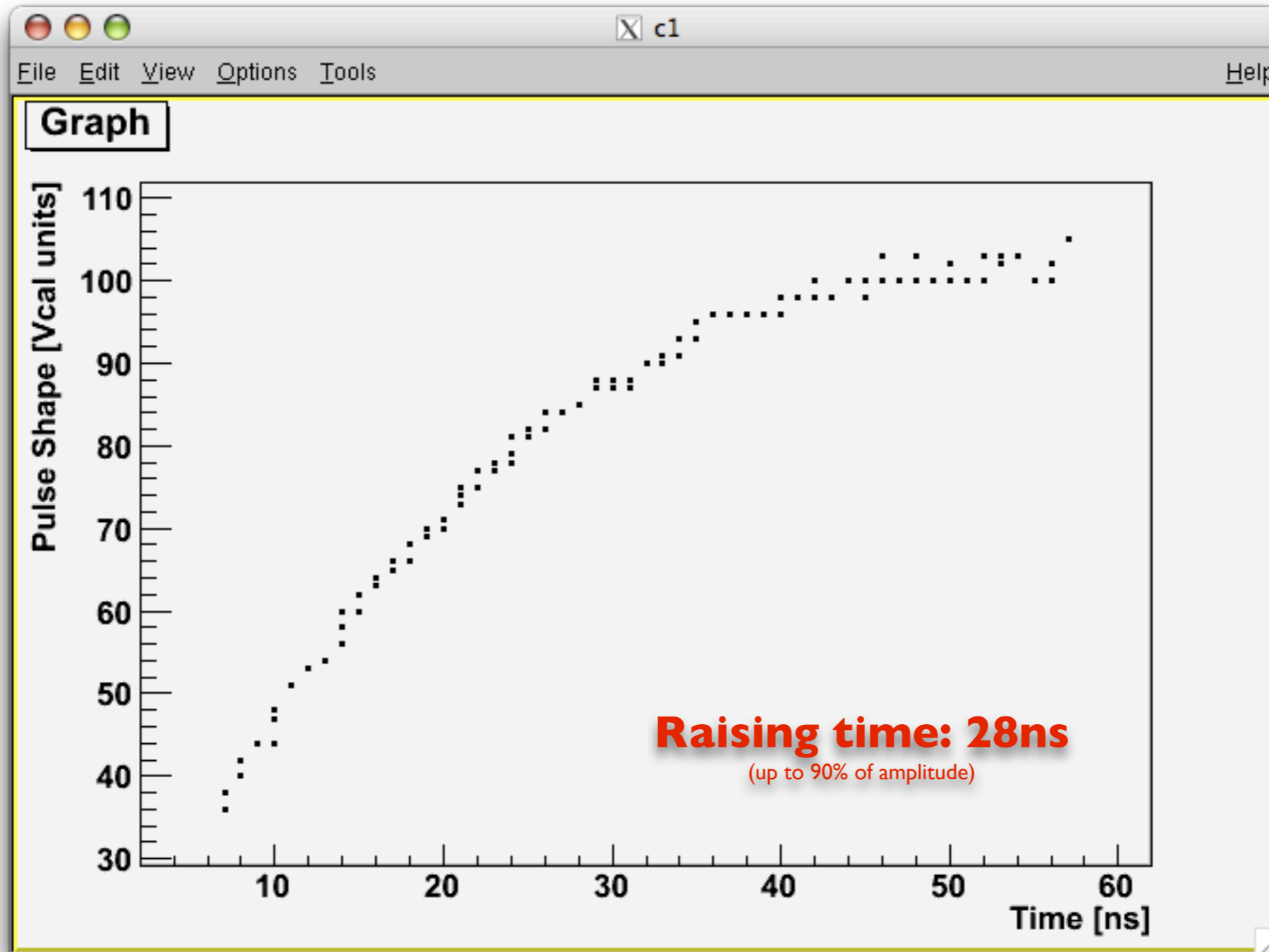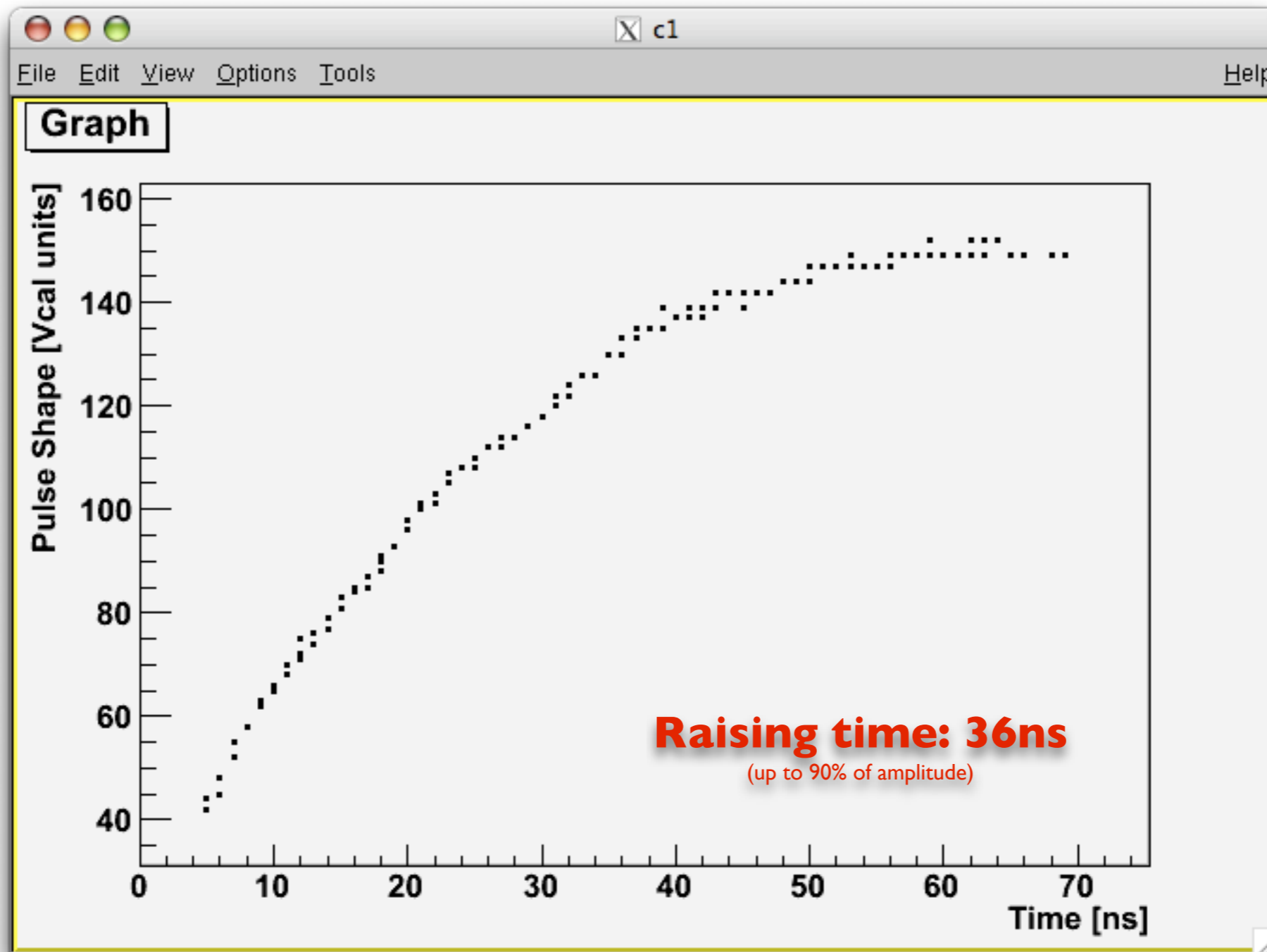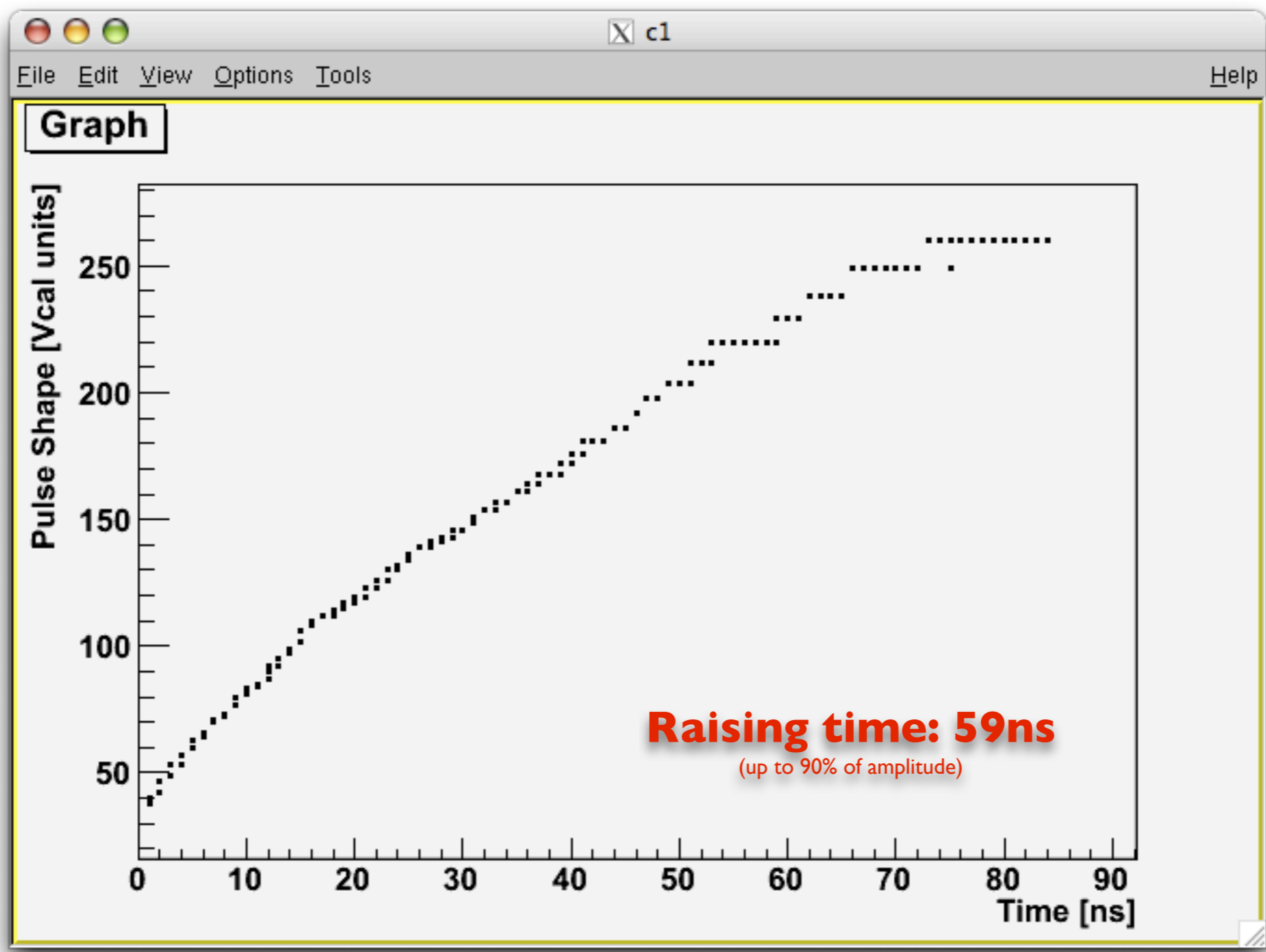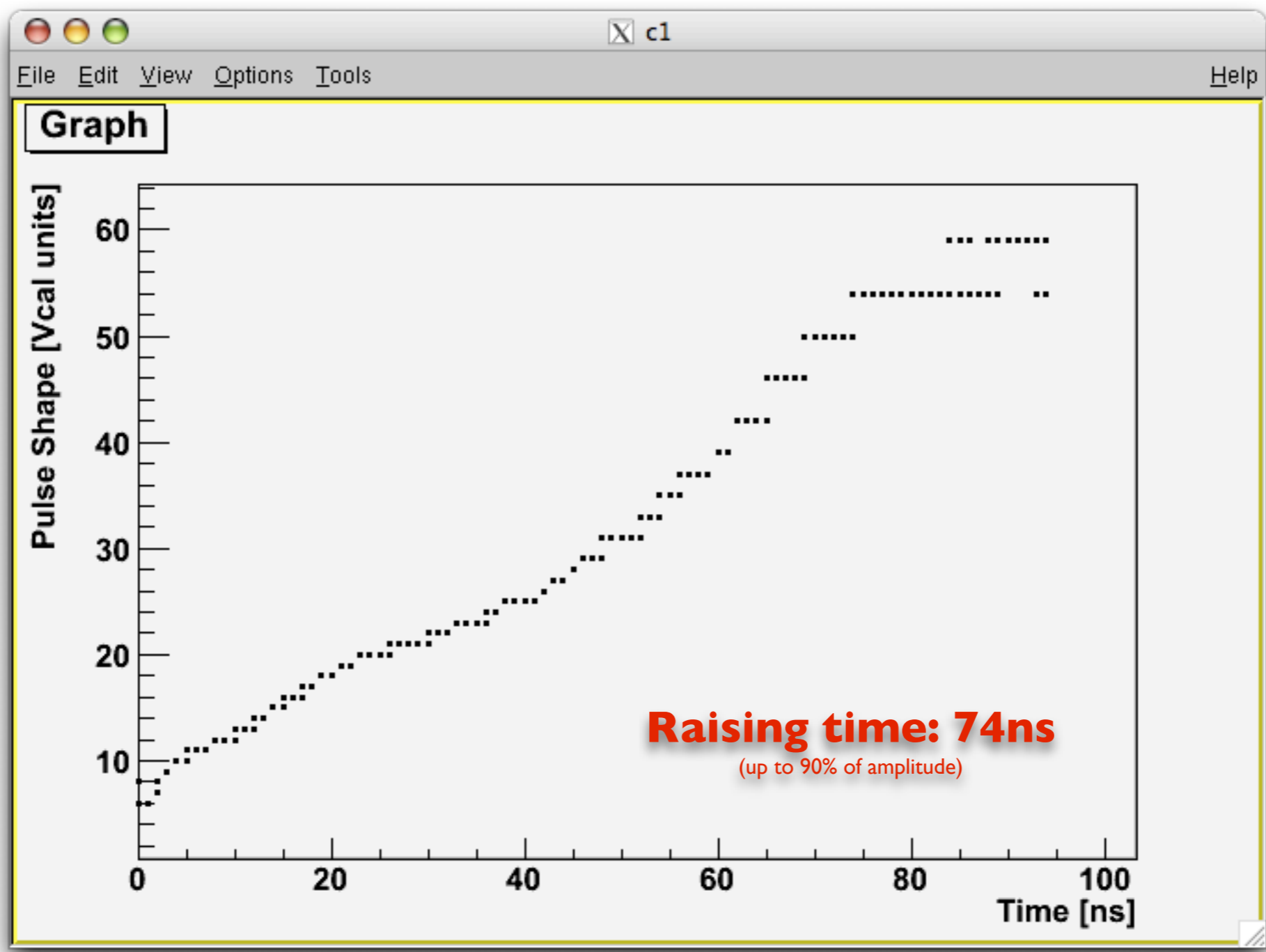
Results

ROC 260962-11-06
Fluence: 4.2E+14

Results

ROC 260962-11-06
Fluence: 4.2E+14

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Results

ROC 260962-11-06
Fluence: 4.2E+14

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Results

Raising time is Pulse Shape development up to 90% of its plateau.

ROC	Pixel		Vcal	Raising T (ns)	Comments
260962-11-06	5.5	Jul 27, 2009	200		
		Jul 28, 2009	**100**		
		Aug 6, 2009	**100**	**28**	
		Aug 6, 2009	150	**36**	
		Aug 6, 2009	200	**50**	*no plateau is seen on Pulse Shape plot*
		Aug 6, 2009	250	**59**	*no plateau is seen on Pulse Shape plot*
		Aug 6, 2009	50	**74**	*hight range, Pulse Shape is failed*

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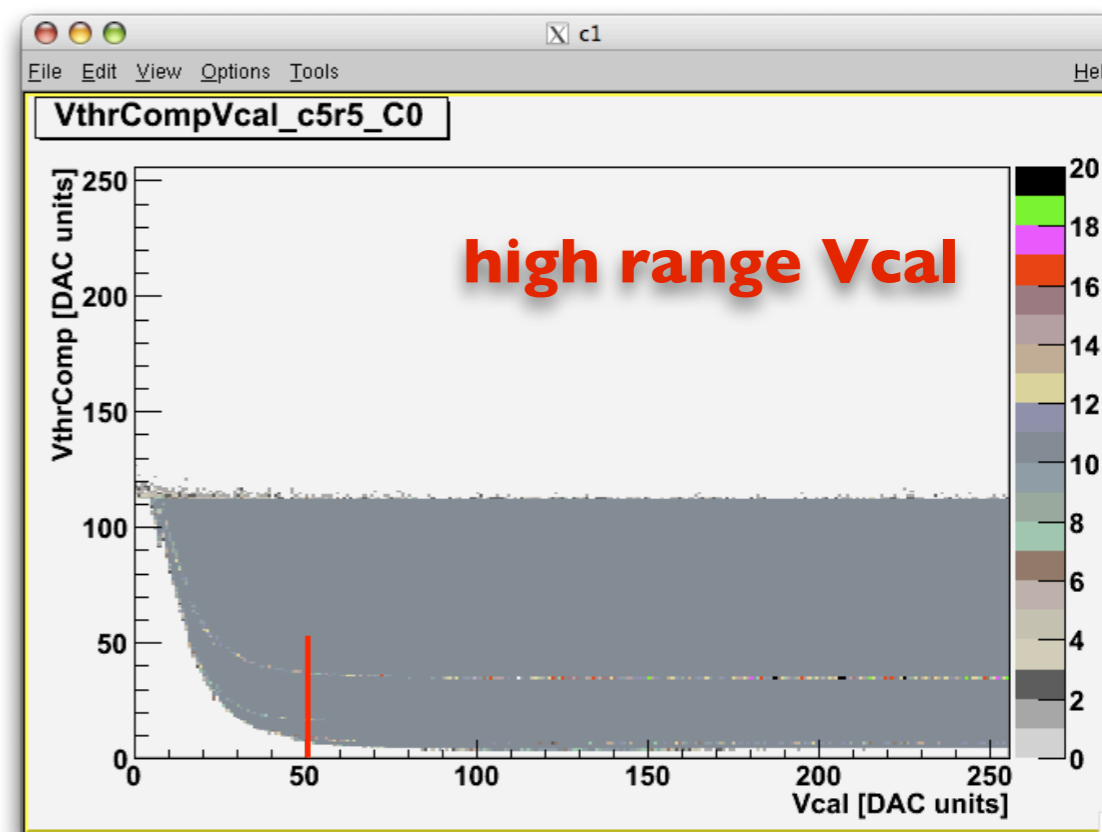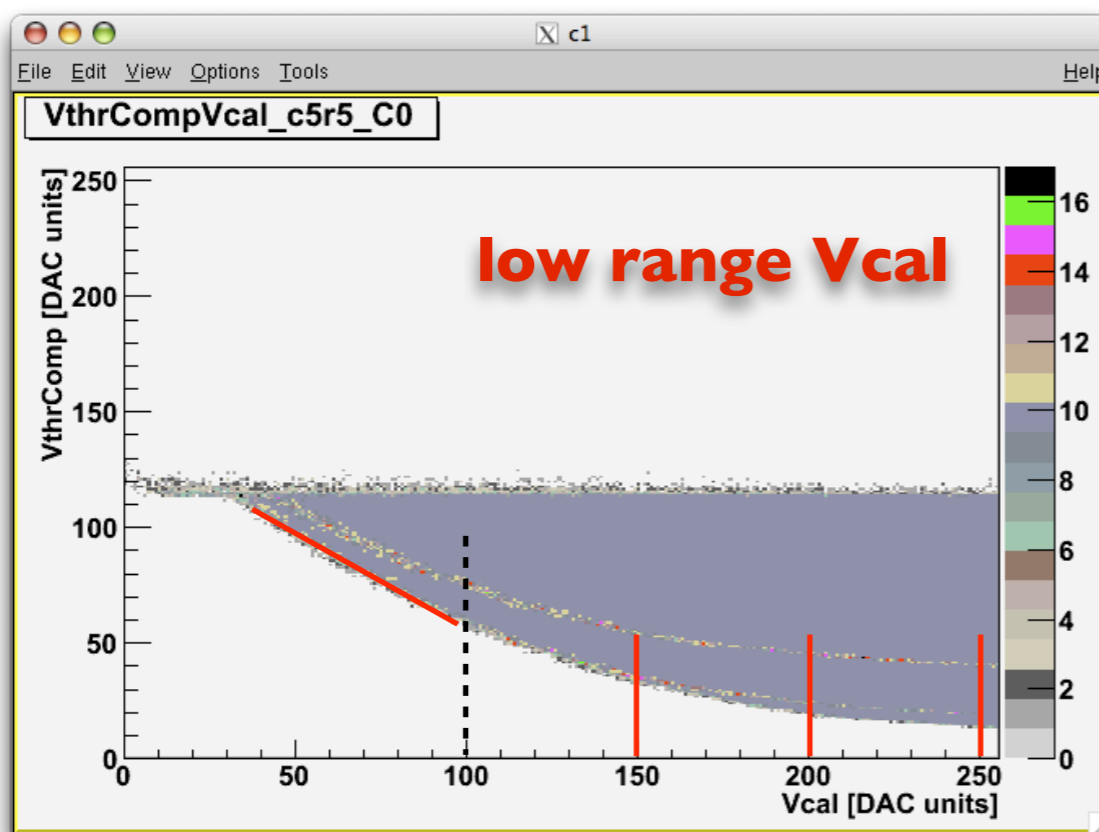
4 Pixels were tested per ROC in results below
2 unirradiated ROCs were tested giving (26.0+/-.5) ns raising time
1-2 ROCs per fluence giving ~(31.0+/1.9) ns (avg for all fluences) raising time.

There is clear evidence of increase

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

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Online Logger

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- All loggs in PIRE Group are hand written
- No affordable Logging system available
- Should be very **simple** and **intuitive**
- Must allow to **add** entries and **reply** to them

- **Web 2.0**
- **Authentication**
  - Add Entry
  - Reply
- **Search**
  - by ID
  - in Dates range (coming soon)
  - Author (coming soon)
- **Auto Update**
- **Permalink** (coming soon)
- Supported in **Opera 9+**, **FF 2+**, **Safari 4+** (IE is coming soon)

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Author

Date

Title

Number of Replies

Samvel Khalatyan - samvel@uic.edu

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Expandable   w/ Authentication

Searchable

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