

# Irradiated Read Out Chips: Procedure



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## IRRADIATED ROCs

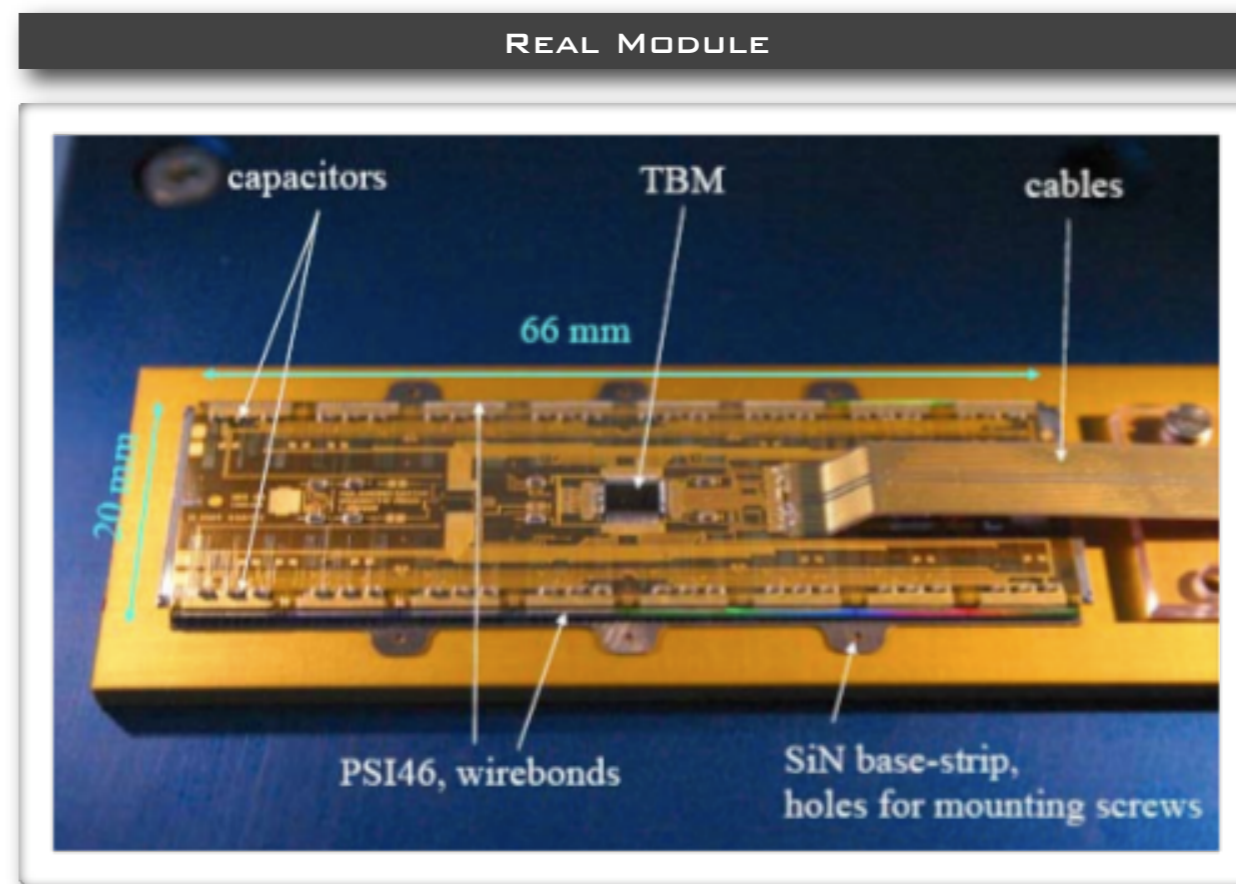
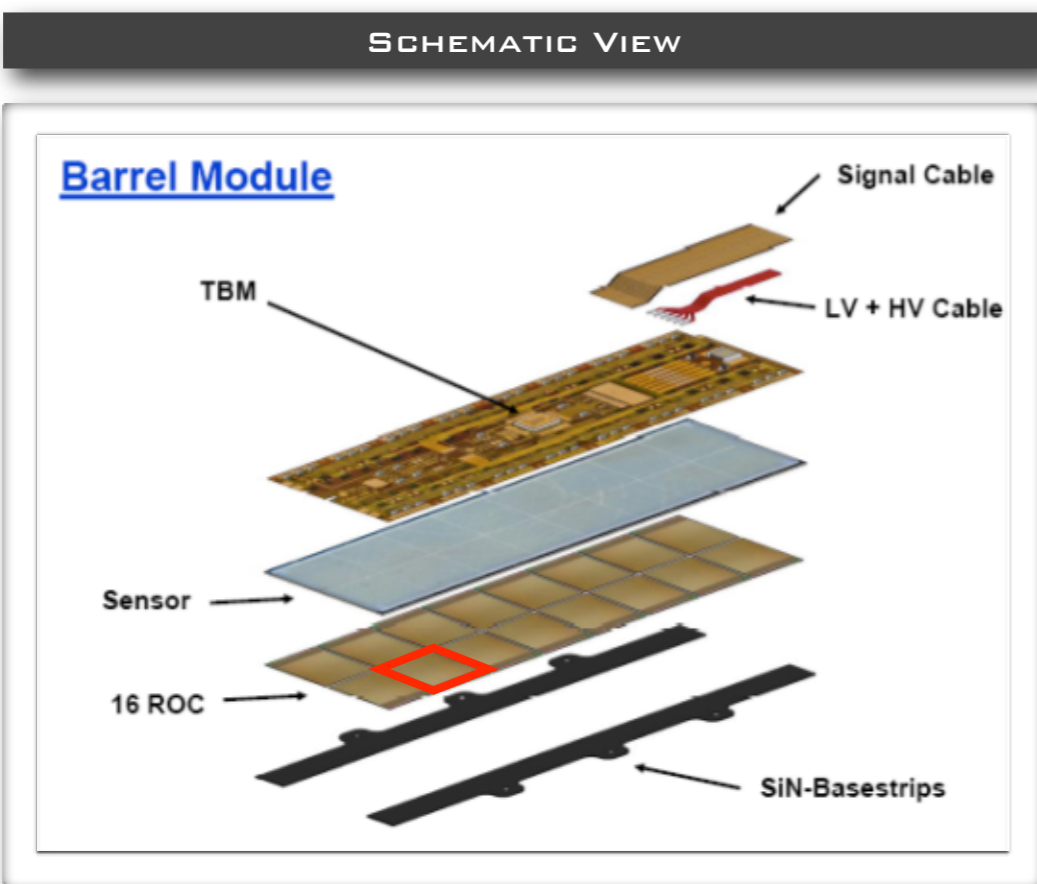
- 1. Read Out Chip in a Nutshell**
- 2. Pulse Shape**
- 3. Efficiency Plots**
- 4. Readout Procedure**
- 5. Results**

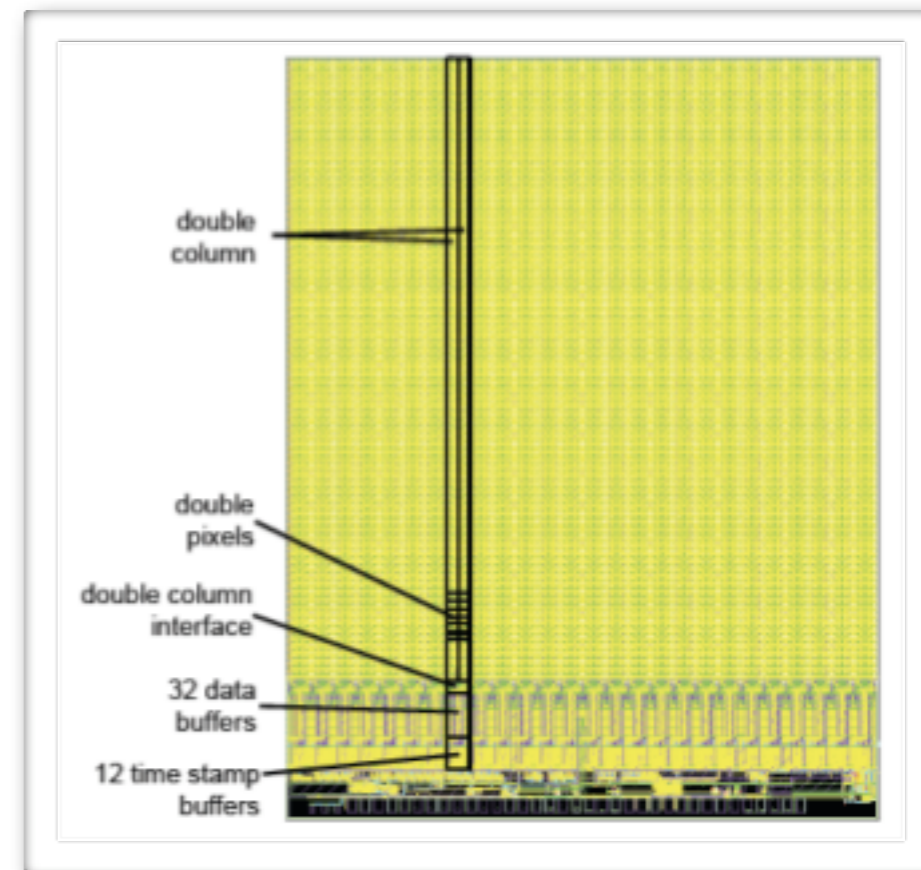
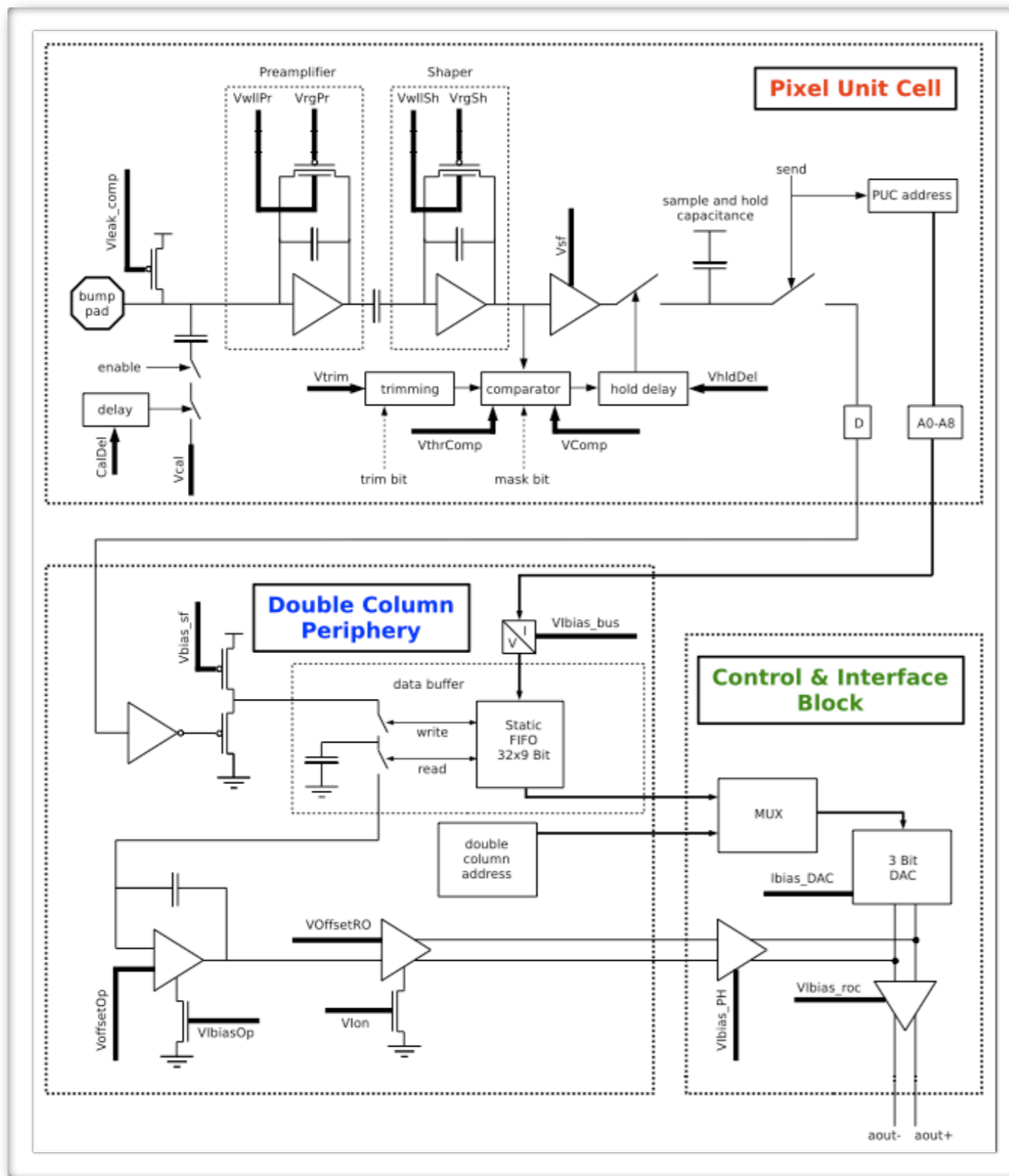


# READ OUT CHIP IN A NUTSHELL

ROC - 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





## 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.

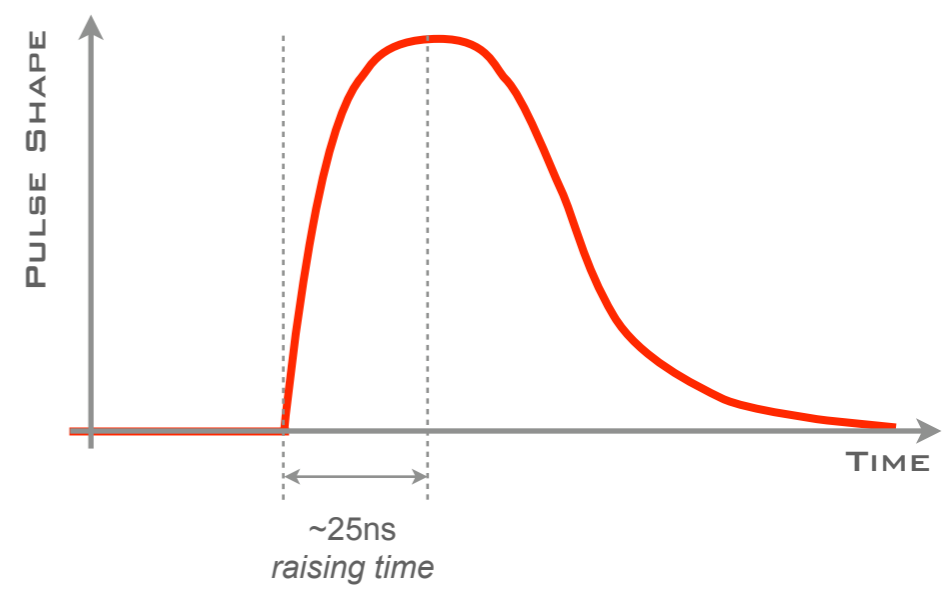


# PULSE SHAPE

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

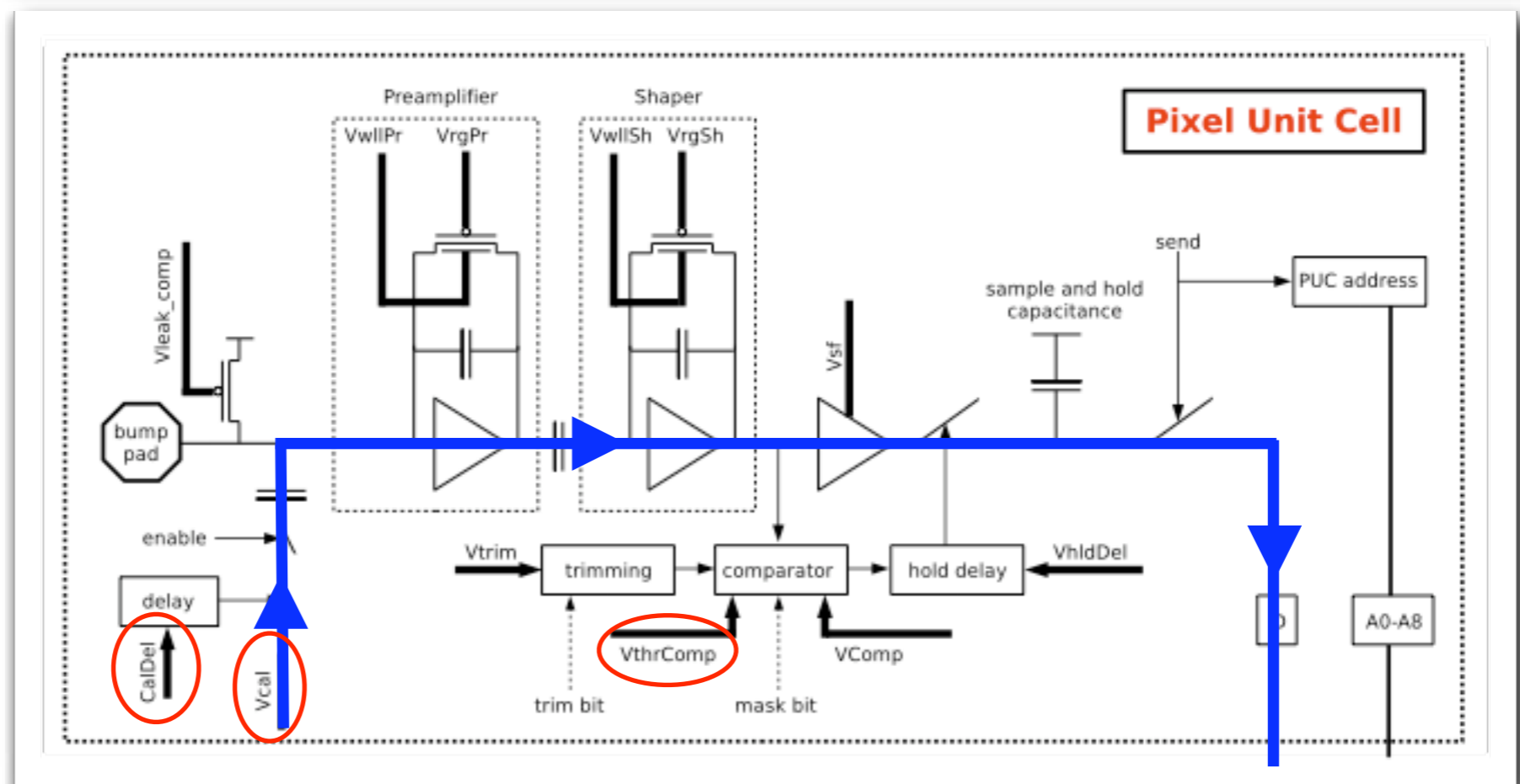
**WANT TO SEE**

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



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

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

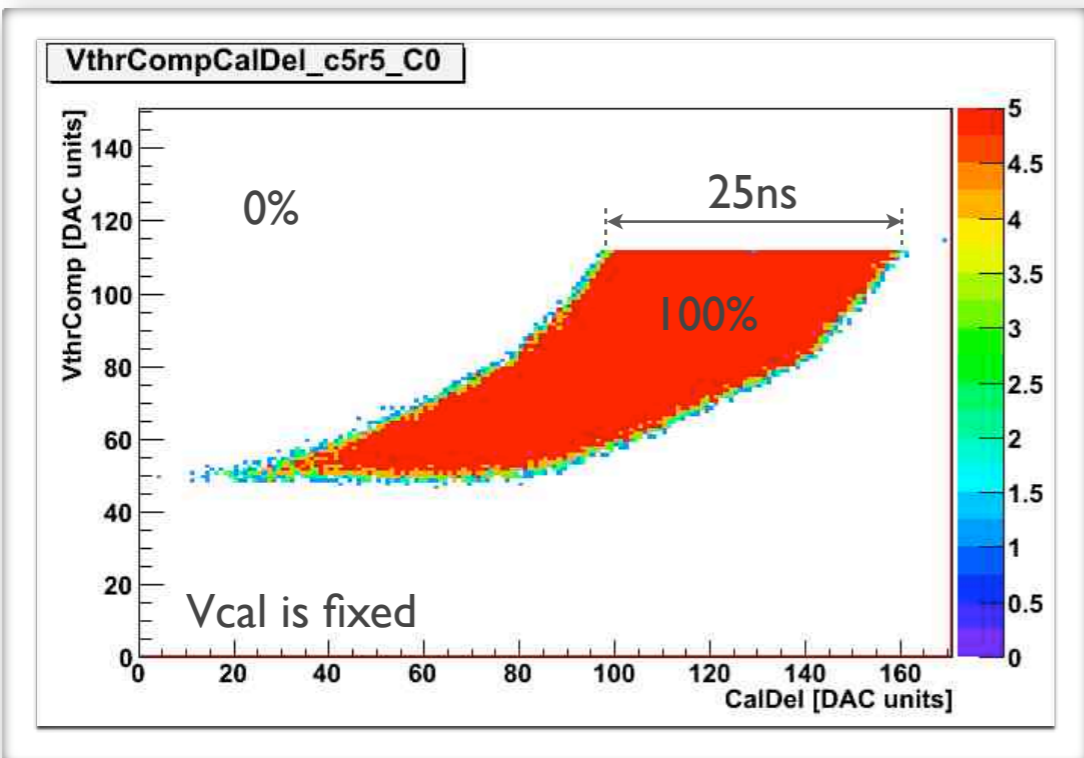


Pulse Shape gets altered as signal propagates through electronics and we'd like to understand how it changes, then modify correspondingly Inputs so that original shape is restored (the same as for non-radiated chips).  $V_{cal}$  was assumed to remain the same with fluence.

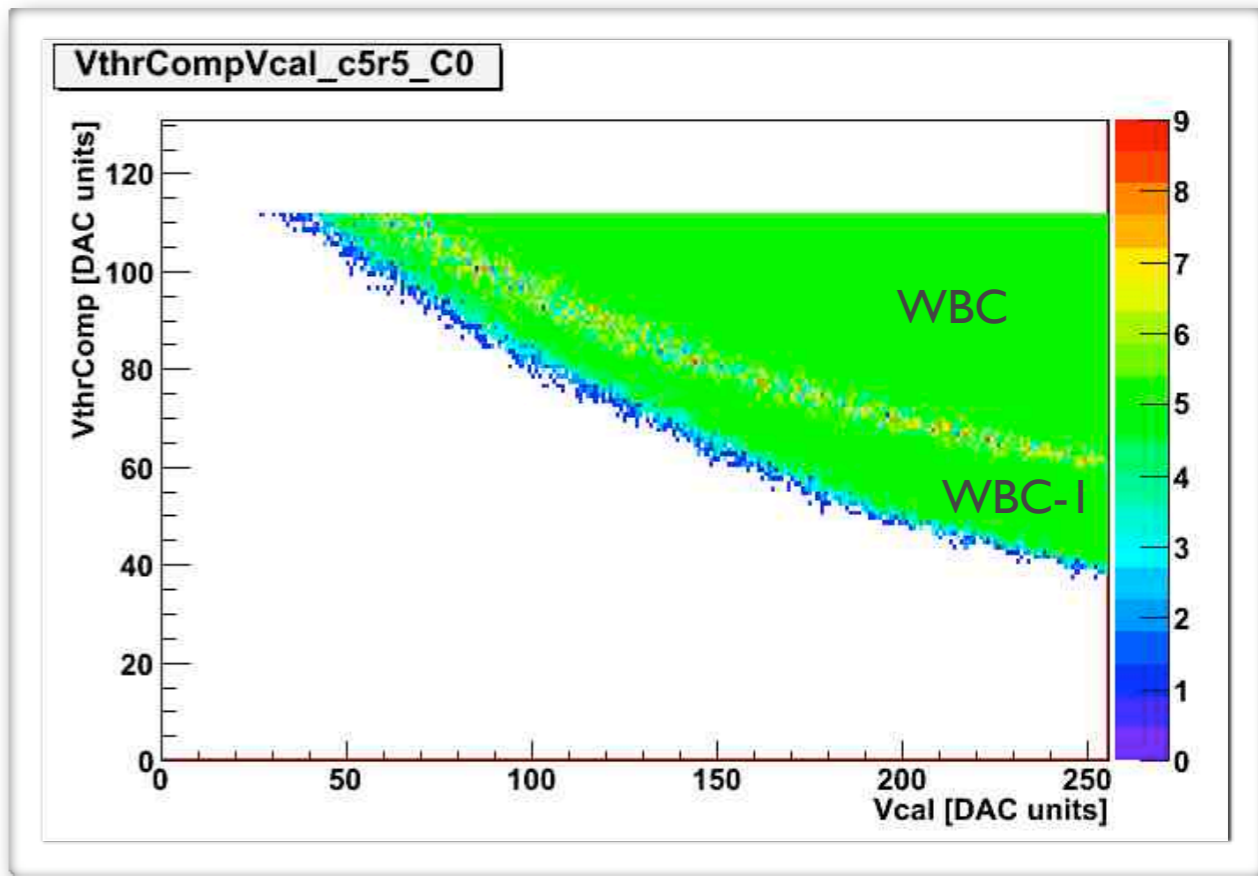


Inner part of “tornado” is contents of Time Window frame (25 ns).  
Edge is a Pulse Shape raising side.

“TORNADO”



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



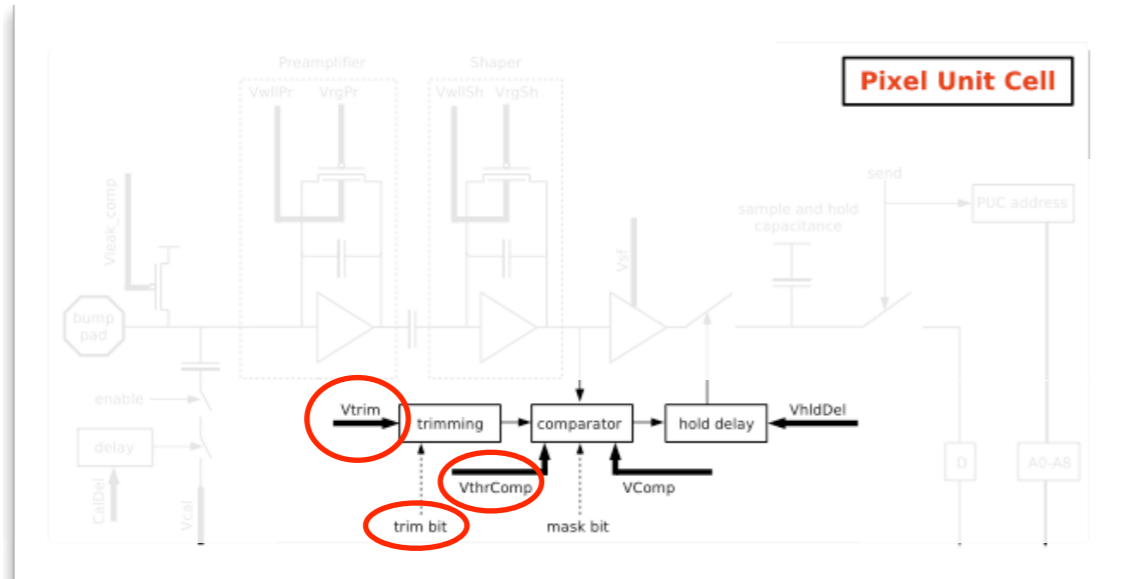
PulseShape is a signal development in time. Next conversions are needed:  
1. from CalDel DAC units to ns  
*can be extracted from “tornado”*  
2.  $V_{thrComp}$  to  $V_{cal}$   
*separate plot is necessary*

Threshold measurement to get value of injected signal in electrons.



# EFFICIENCY PLOTS

## DACs AFFECTING THRESHOLD



## Threshold

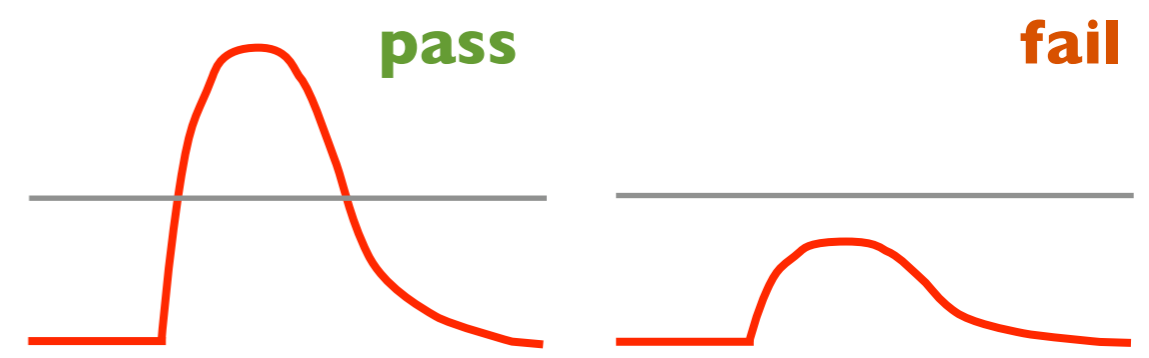
$$V_{thrComp} - \alpha \cdot V_{trim}$$

↑  
trim bits  
(individual per pixel)

$V_{thrComp}^1$	0..255
$V_{trim}^1$	0..255
trim bits <sup>2</sup>	0..15

<sup>1</sup> per ROC  
<sup>2</sup> per pixel

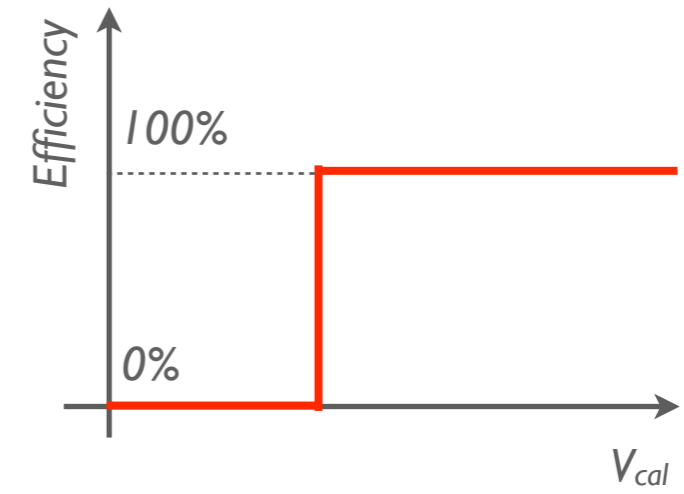
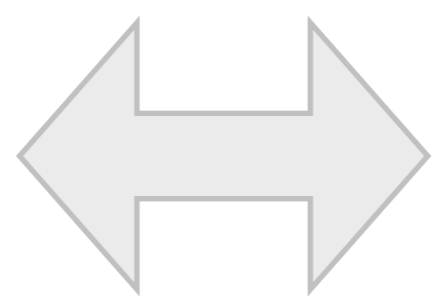
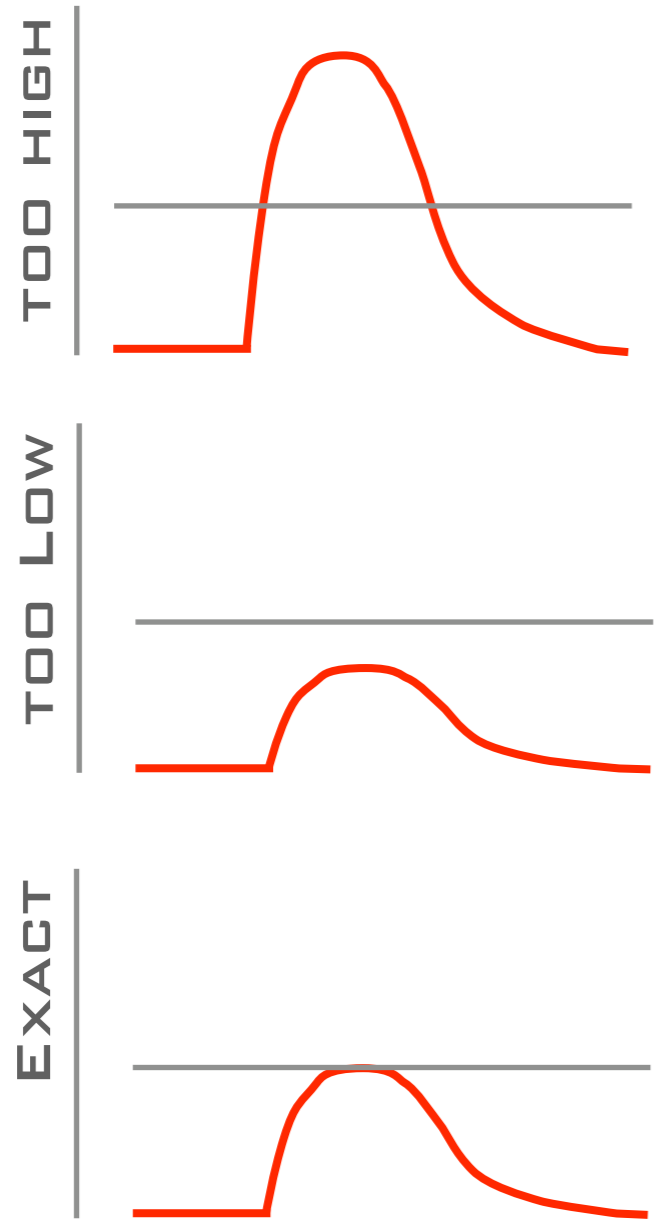
Threshold is used to check whether signal is above some level to mainly reduce noise.



# Threshold

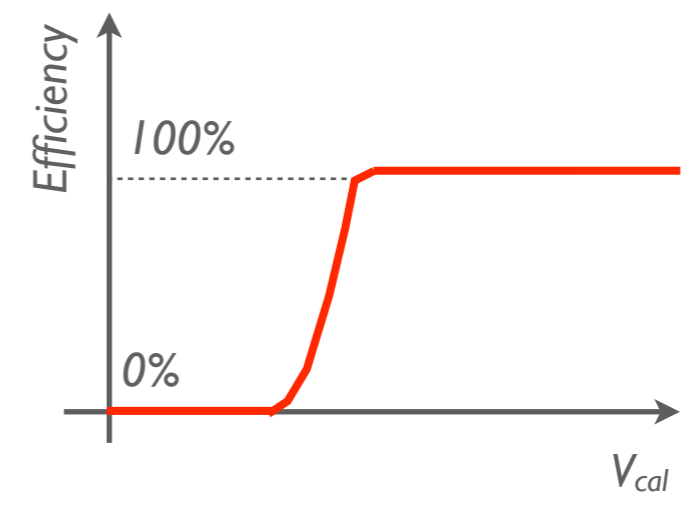
Measurement

Fix threshold and vary  $V_{cal}$ .



IDEALLY

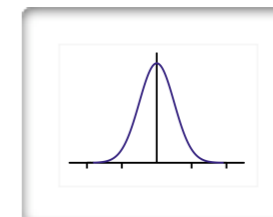
Unfortunately noise spoils threshold measurement. It is added to  $V_{cal}$ .



IN REALITY

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

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

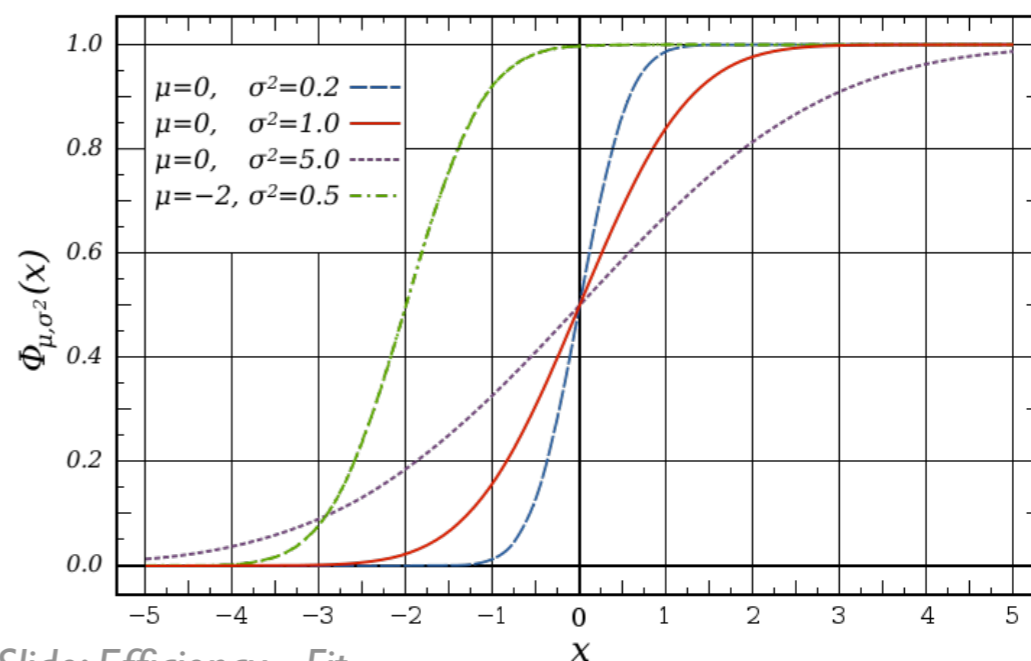
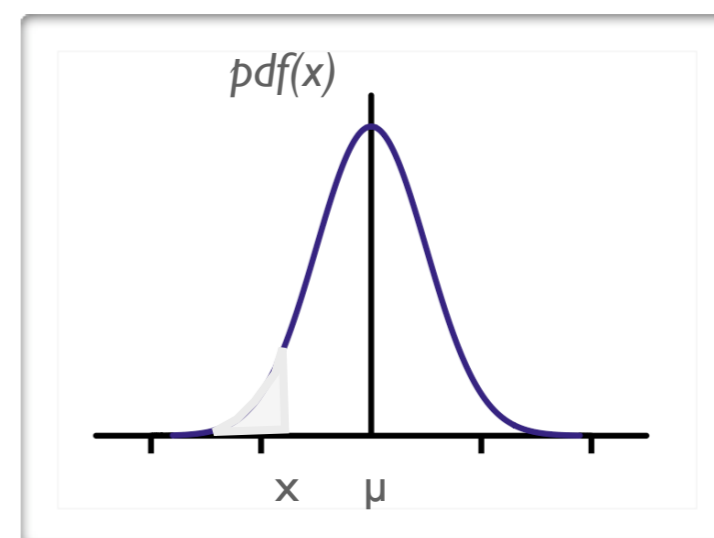
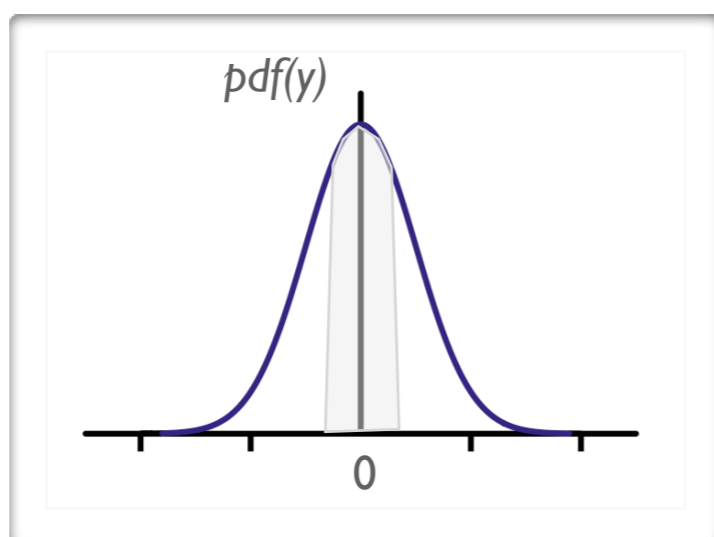
Transform variable and get normal distribution (Gaussian with mean at zero):

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

# Error Function

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

↑  
normal distribution

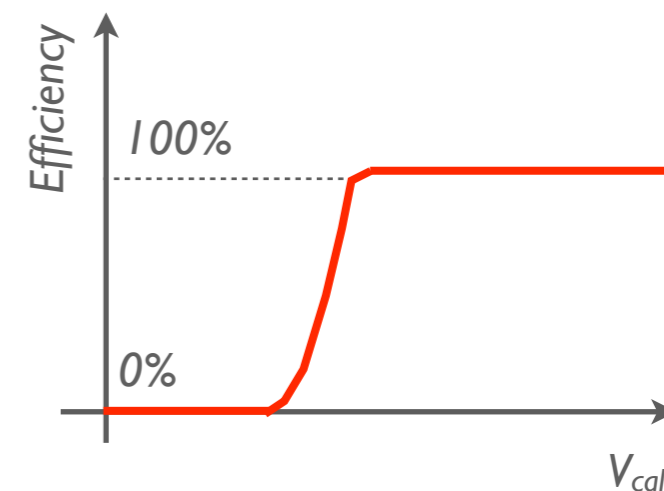


## FITTING FUNCTION

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

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

$$\mu$$



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

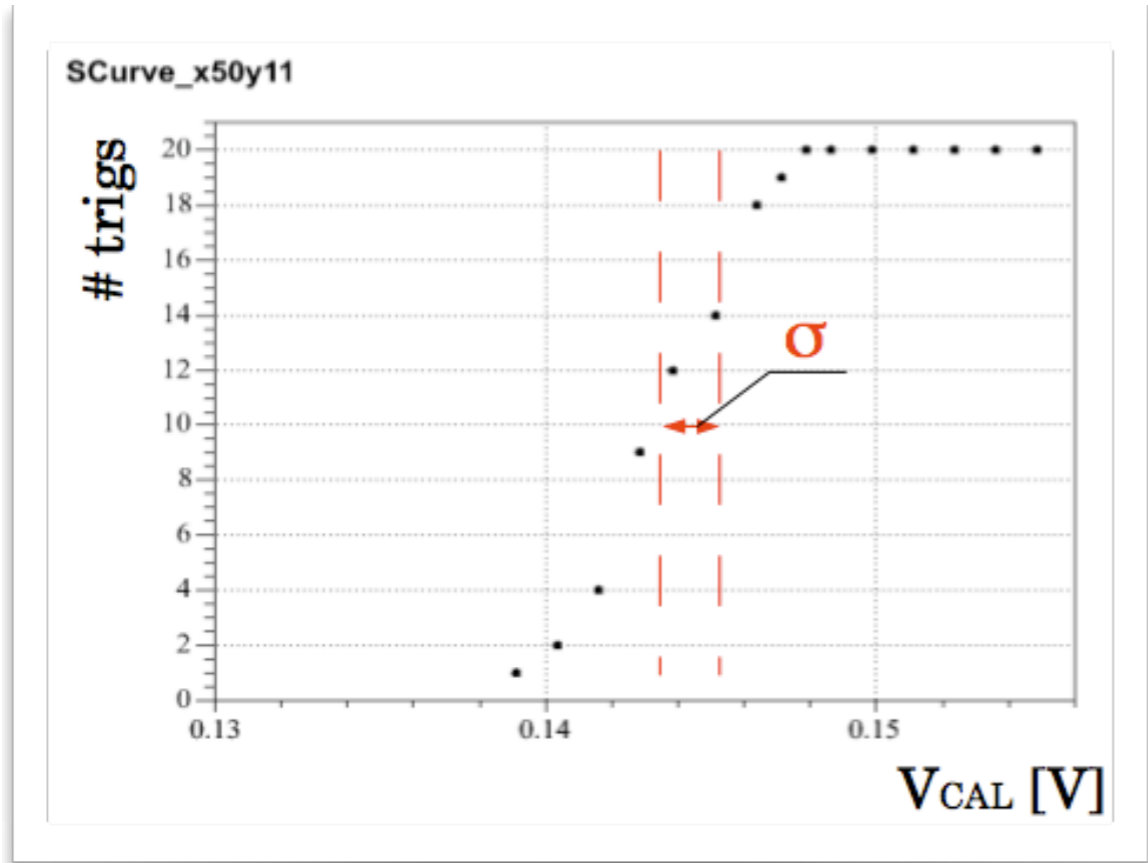
Thus for In-time Threshold measurement Efficiency plot should be fitted with Error Function.

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

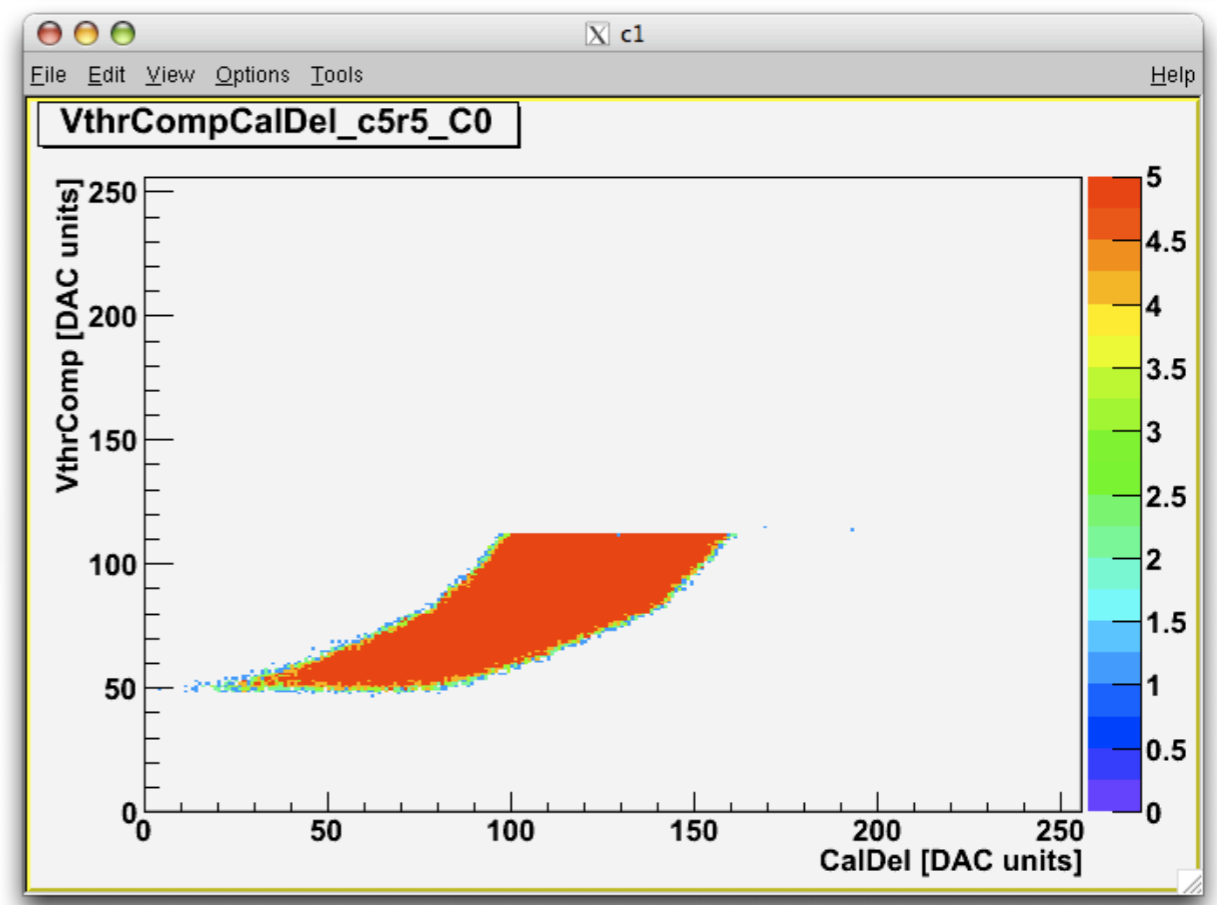
**“Tornado”**  
 Efficiency is 100% inside and 0% outside.  
 Vcal is injected 5 times into pixel for given value of  $V_{thrComp}$  and CalDel.

Comparator Threshold Voltage →

**S-CURVE: THRESHOLD MEASUREMENT**



**DAC-DAC SCAN: TORNADO**



↑ Calibration Signal injection Delay

← Calibration Signal



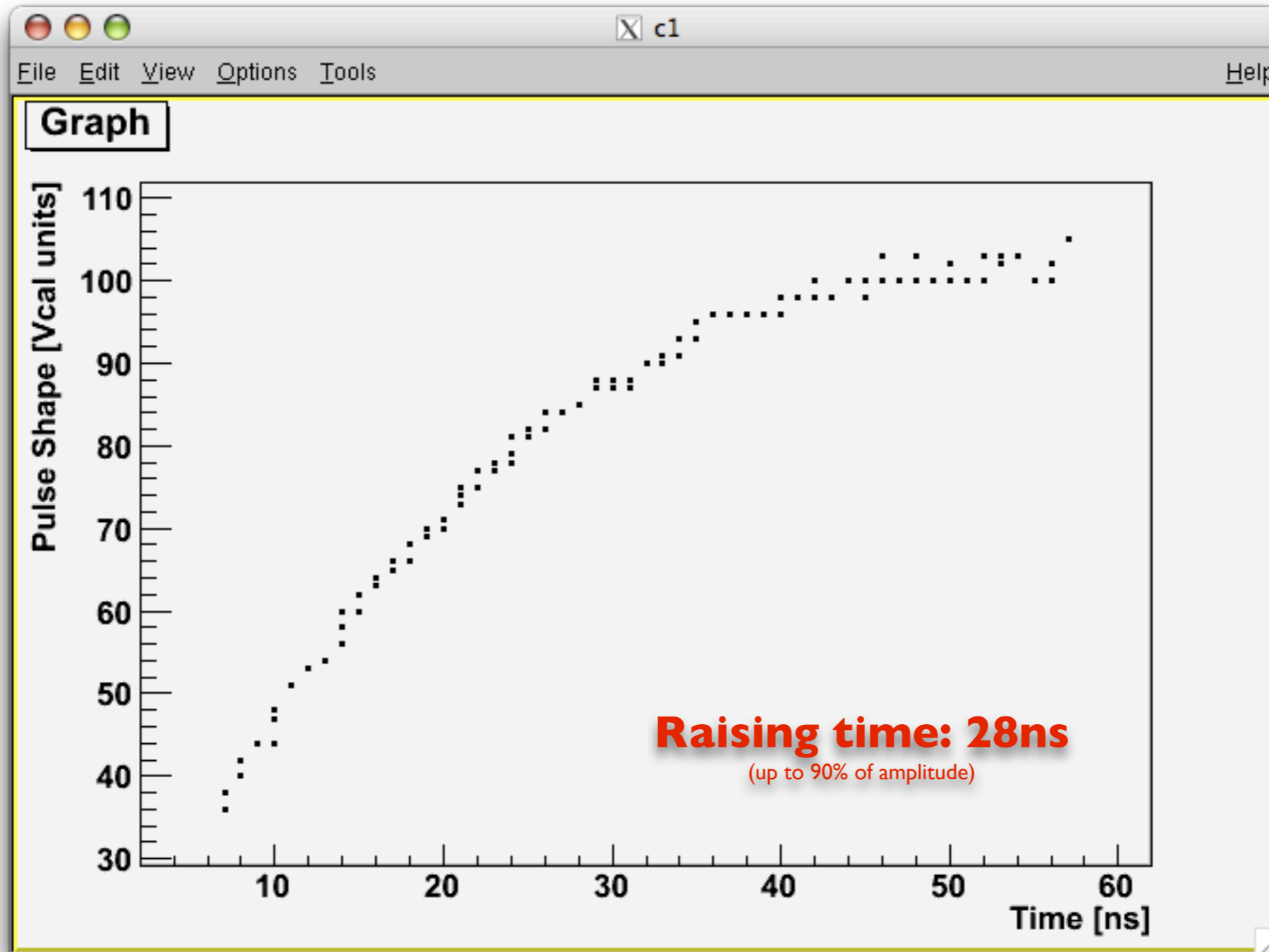


# PROCEDURE

BY ERIC STACHURA

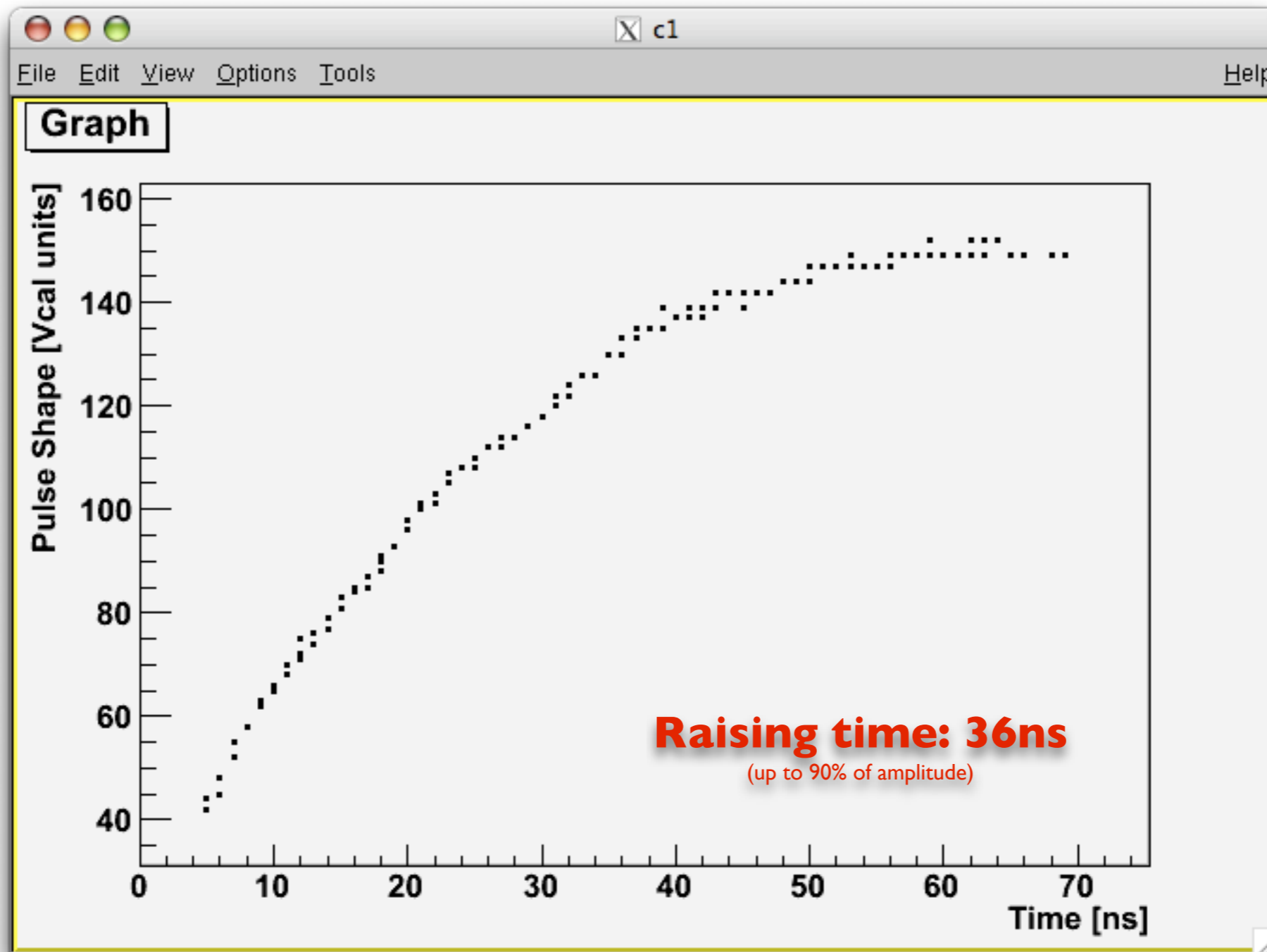


# RESULTS



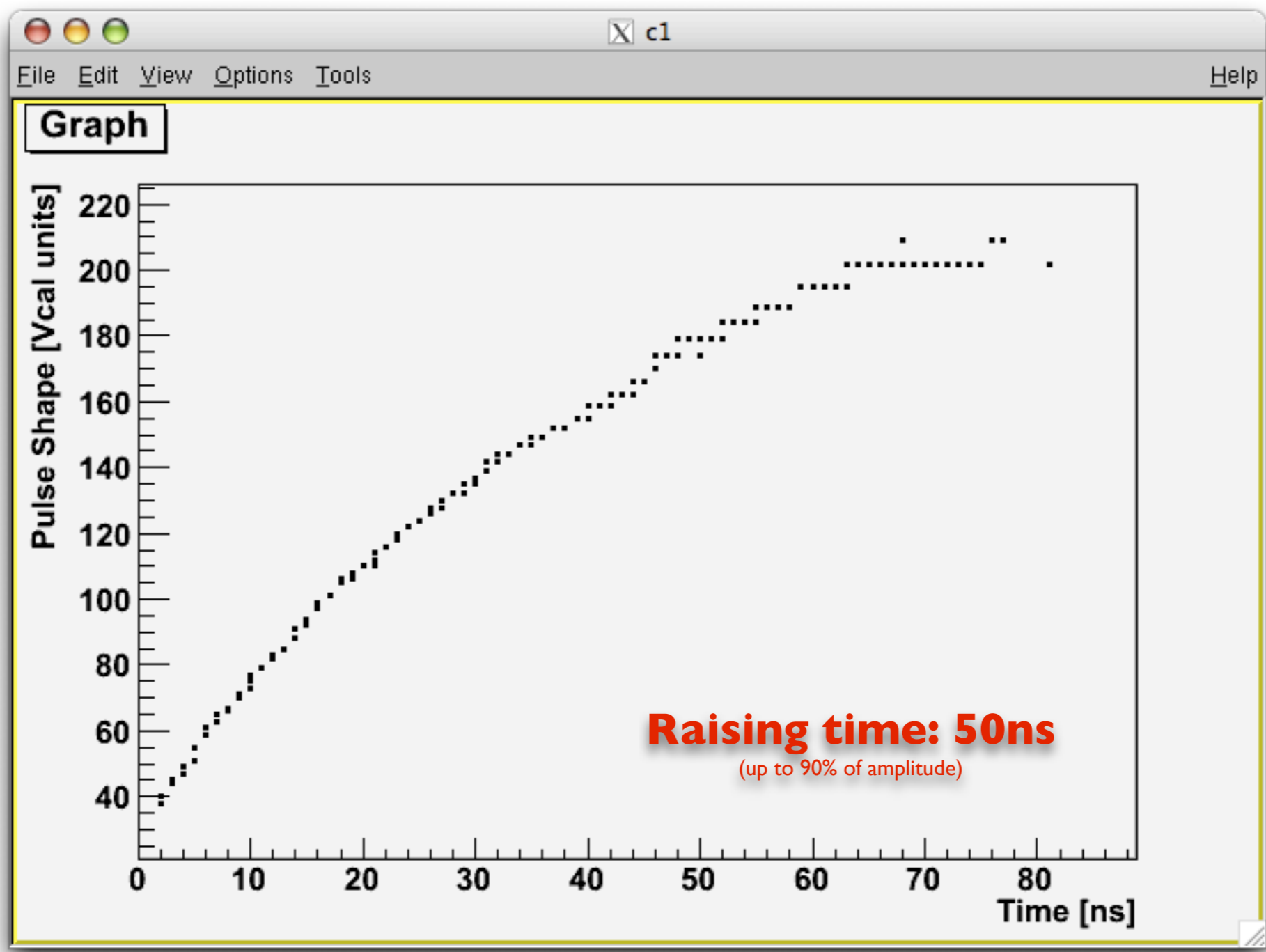
ROC 260962-11-06

Fluence: 4.2E+14

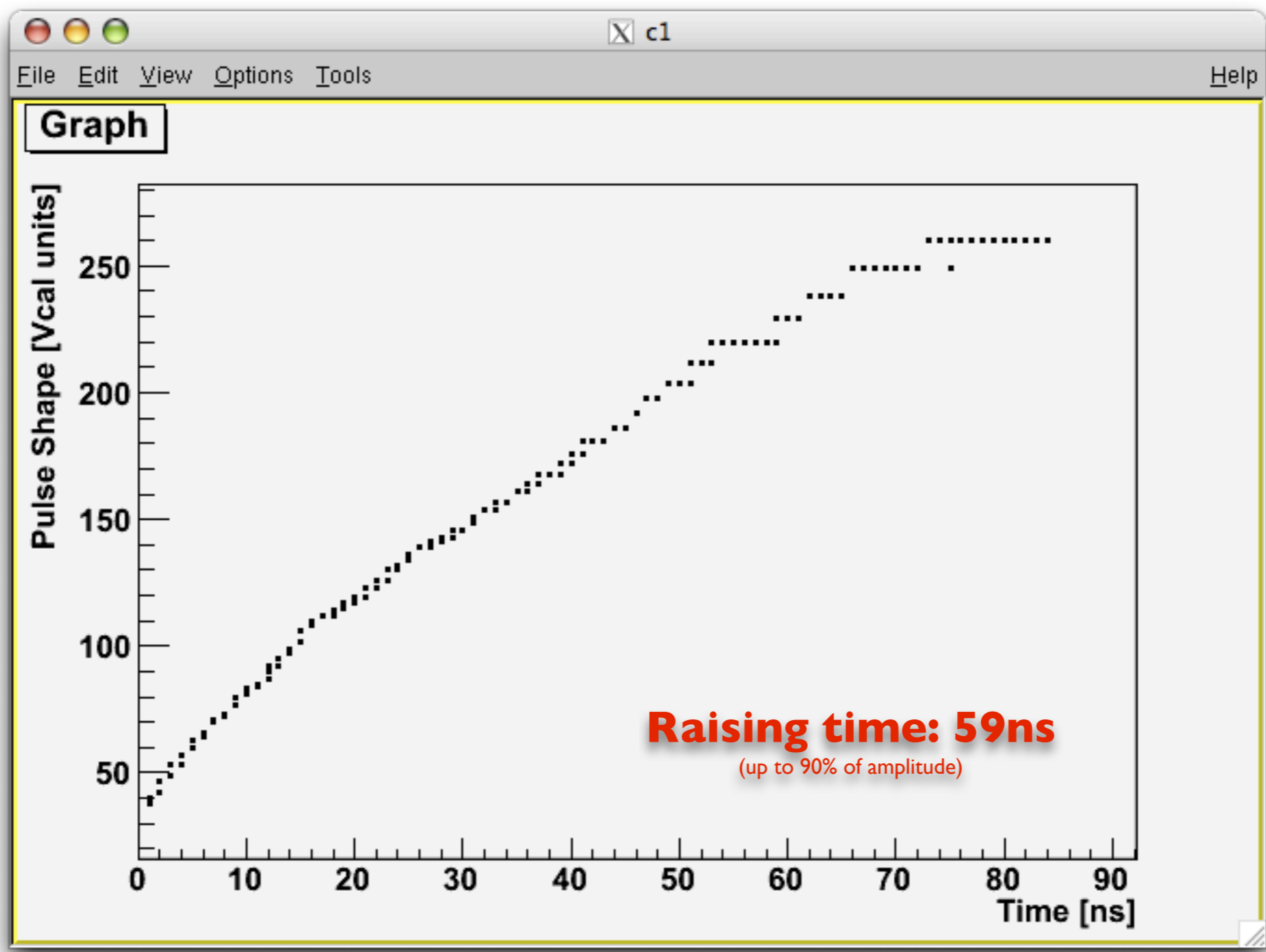


ROC 260962-11-06

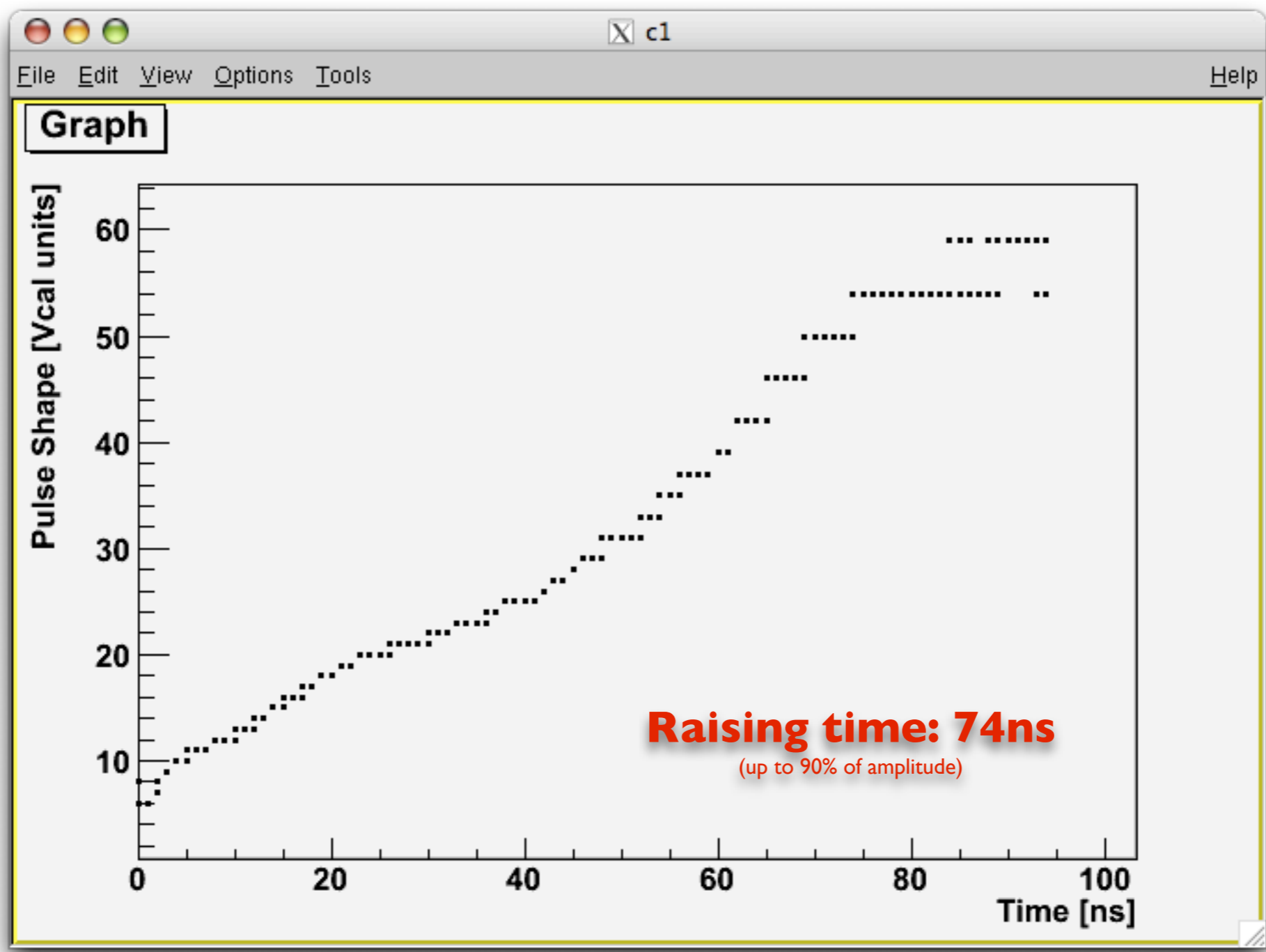
Fluence: 4.2E+14



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



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



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

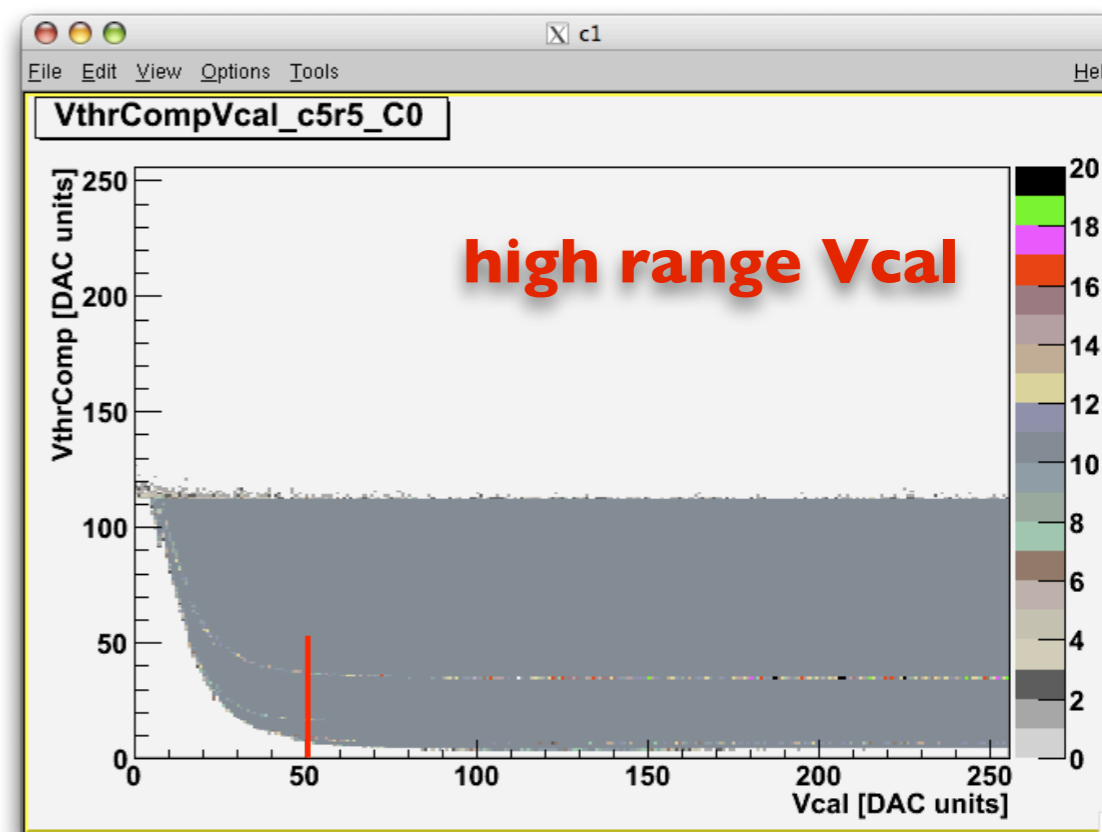
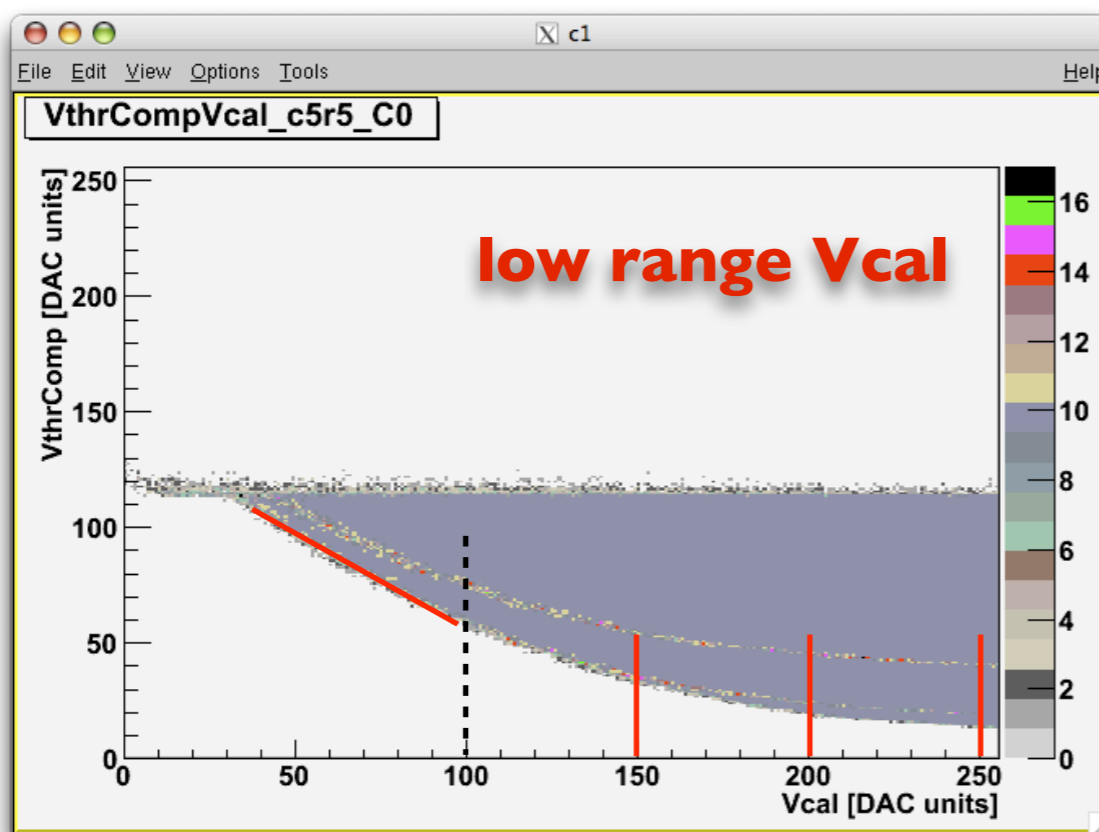


# Results

Summary for Vcal

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	<b>100</b>		
		Aug 6, 2009	<b>100</b>	<b>28</b>	
		Aug 6, 2009	150	<b>36</b>	
		Aug 6, 2009	200	<b>50</b>	<i>no plateau is seen on Pulse Shape plot</i>
		Aug 6, 2009	250	<b>59</b>	<i>no plateau is seen on Pulse Shape plot</i>
		Aug 6, 2009	50	<b>74</b>	<i>hight range, Pulse Shape is failed</i>







# Results

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  $\sim( 31.0+/-1.9)$  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.



# ONLINE LOGGER



- 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)



# Online Logger

Basic View

UIC University of Illinois at Chicago

The screenshot shows a web browser window titled 'KSLog' with the URL 'http://log.kshost.net/'. The page features a search bar and a login button. Below these is a list of log entries. Red arrows point to specific elements: 'Author' points to the author name 'Support Team' in the first entry; 'Date' points to the date 'Yesterday' in the first entry; 'Title' points to the entry title 'PIRE discussion'; and 'Number of Replies' points to the blue circle containing the number '3' next to the entry 'Reply System'.

Title	Number of Replies	Author	Date
Redesigned Control	2	Support Team	Yesterday
System Update		Support Team	16 Sep, 2009
MORE entries are visible		Support Team	15 Sep, 2009
PIRE discussion		Samvel Khalatyan	15 Sep, 2009
First testing message		Support Team	15 Sep, 2009
Reply is not visible on Login	2	Samvel Khalatyan	15 Sep, 2009
Reply System	3	Samvel Khalatyan	14 Sep, 2009
New post from iPod touch		Samvel Khalatyan	12 Sep, 2009
Send message		Samvel Khalatyan	12 Sep, 2009

Author

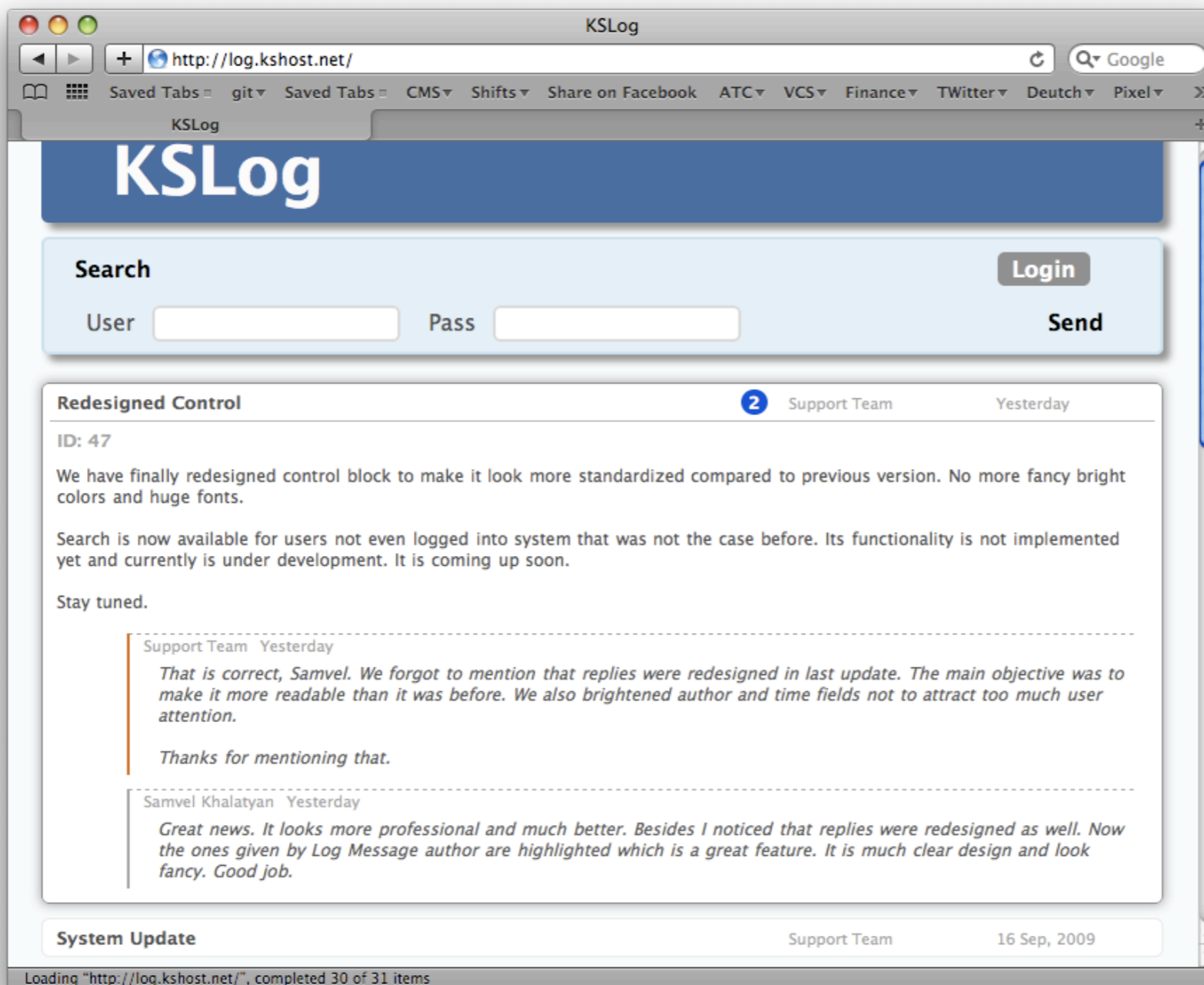
Date

Title

Number of Replies



# Expandable w/ Authentication



# Searchable



# Online Logger

Search

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at Chicago

The screenshot shows a browser window titled "KSLog" with the address bar containing "http://log.kshost.net/". The browser's menu bar includes "Saved Tabs", "git", "Saved Tabs", "CMS", "Shifts", "Share on Facebook", "ATC", "VCS", "Finance", "TWitter", "Deutch", and "Pixel". The main content area features a blue header with "KSLog" in white. Below the header is a search section with a "Search" button, radio buttons for "ID" (selected) and "Date", and input fields. The "ID" field contains "46". To the right of the search section are "Login", "Close", and "Send" buttons. A "System Update" section follows, dated "16 Sep, 2009" by the "Support Team". The update text reads: "ID: 46. The system was updated including a series of bugs fixes: - Compatibility with Firefox 2+ - Newly posted entry was showing up as empty row. - etc. Meanwhile a design was reviewed and slightly modified. It mainly affected replies shown that makes them less striking. Now it becomes much easier to read information presented. Any ideas are very welcome. Send them to email available on the bottom of the page. Stay tuned." At the bottom, a copyright notice states "Copyright © 2009 KSLog . All rights reserved."



# Online Logger

Add Entry

UIC  
University of Illinois  
at Chicago

The screenshot shows a web browser window titled "KSLog" with the URL "http://log.kshost.net/". The browser's address bar includes a search engine (Google) and several saved tabs: "git", "Saved Tabs", "CMS", "Shifts", "Share on Facebook", "ATC", "VCS", "Finance", "TWitter", "Deutch", and "Pixel".

The main content area of the browser displays the "KSLog" application. At the top, there is a blue header with the "KSLog" logo. Below the header, there is a navigation bar with "Search", "Add Entry" (highlighted), "Support Team", and "Logout".

The "Add Entry" form consists of a "Title" field, a "Message" text area, and a "Send" button. Below the form, there is a list of log entries:

Redesigned Control	2 Support Team	Yesterday
System Update	Support Team	16 Sep, 2009
MORE entries are visible	Support Team	15 Sep, 2009
PIRE discussion	Samvel Khalatyan	15 Sep, 2009
First testing message	Support Team	15 Sep, 2009
Reply is not visible on Login	2 Samvel Khalatyan	15 Sep, 2009