Our first look at the LAC threshold calibration Method

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- Aim : to understand and to eventually optimize the LAC calibration method presented during the C&A Workshop (Bari)
- Technique : we use TVAC runs 077016907, 0770169078, 077016910 and 077016911, and add a gaussian noise to the LAC threshold fit (if necessary)
- Result : we characterize a 'bad channel' and propose some options to improve the fit.

Presentation at Bari :

https ://confluence.slac.stanford.edu/download/attachments/4096462/

CAL+LAC+thresholds+calibration+using+Observatory+TVAC+data.pdf ?version=1

Standard Method

- Pedestal histogram (from periodic trigger events) is fitted with a gaussian and pedestal drift *dped* is determined.
- LEX8 ADC signal is fitted with

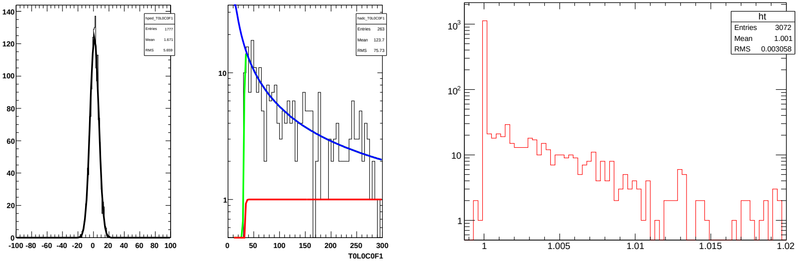
  $$f(x) = f_{signal}(x) f_{eff}(x) = p2/(x+p3)/(1+\exp((p0+x)/p1)$$

  $f_{signal}(x) = p2/(x+p3)$ is the assumed signal
  $f_{eff}(x) = 1./(1+\exp((p0+x)/p1)$ (a sigmoid) describes the threshold efficiency
- LAC threshold is computed $LAC = p0 - dped$

We used LEX8 histograms computed by Zach and wrote a local script to :

- understand and reproduce the LAC values
- try to improve the fit if necessary

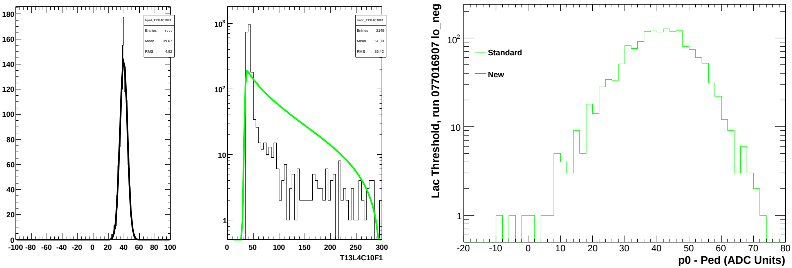
Left panel : pedestal histogram ; Middle panel : LEX8 ADC histogram (good channel) fitted with function f (green), blue is $f_{signal}(x)$, red is $f_{eff}(x)$;
Right panel is the ratio of LAC values obtained with my own code and those obtained by Zach.



$\Longrightarrow$ Agreement is excellent within 2%

What can go wrong ?

Run 077016907 : "Cold" run and LAC threshold = 2 MeV at positive end of each crystal ("LoNeg" run)



Left panel : pedestal histogra, $dped \approx 40$ ADC

Middle panel : LEX8 histogram fitted with function f

- nominally expect first LAC bin $\approx dped + 3sigma_{ped} \approx 50$ADC
- effectively at ≈ 30ADC

LAC is too low. Only LoNeg and LoPos runs seem to be affected.

Right panel : histogram of LAC values

Once the pedestal is characterized, there can be 4 different situations :

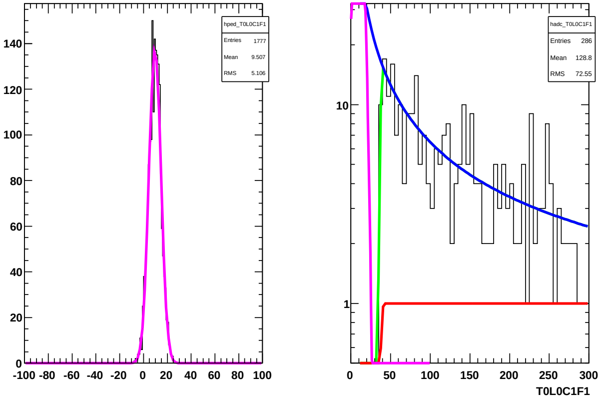
"Good crystal"

- x_{fb} (First non-empty ADC bin in LEX8) is greater than $dped + 3\sigma_{ped}$: we can fit the histogram by $f_{signal}(x) \times f_{eff}(x)$. This is true for 98% of the crystals of run 077016907.

"Bad crystal"

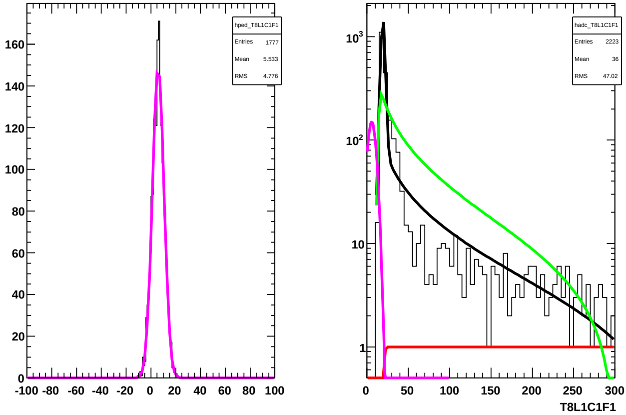
- $dped \leq x_{fb} \leq dped + 3\sigma_{ped}$, we have to take the Gaussian from the pedestal into account to correctly derive the LAC value : $f(x) = (f_{signal}(x) + Gauss) \times f_{eff}(x)$. This can lead to a difference of $20\% - 30\%$ in the LAC value
- $dped - [1,2]\sigma_{ped} \leq x_{fb} \leq dped$: we can neglect the signal and try to fit with $f(x) = Gauss \times f_{eff}(x)$
- $x_{fb} \leq dped - [1,2]\sigma_{ped}$, we probably can not say more than assume that its value is close to x_{fb}

Here $x_{fb} \geq dped + 3\sigma_{ped}$, so we fit with $f(x) = f_{signal}(x) \times f_{eff}(x)$
Left Panel : pedestal histogram.
Right Panel : LEX8 signal, purple is the gaussian pedestal, green curve is the standard method, blue is the signal (f_{signal}) and red is f_{eff}



Result : run 077016907 $dped \leq x_{fb} \leq dped + 3\sigma_{ped}$

Here $dped \leq x_{fb} \leq dped + 3\sigma_{ped}$, so we fit with
$f(x) = (f_{signal}(x) + Gauss) \times f_{eff}(x)$ (17 crystals)
Left Panel : pedestal histogram.
Right Panel : LEX8 signal, purple is gaussian pedestal, green curve is the standard method,black is the new method and red is f_{eff}



Results

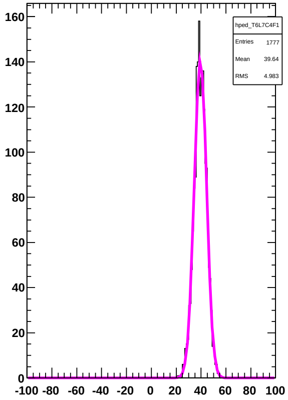
dped = 5.9 ADC
LAC_{std} = 14.3 ADC
LAC_{new} = 19.7 ADC
$\chi^2_{std}/\mathrm{dof} = 1556$
$\chi^2_{new}/\mathrm{dof} = 155$

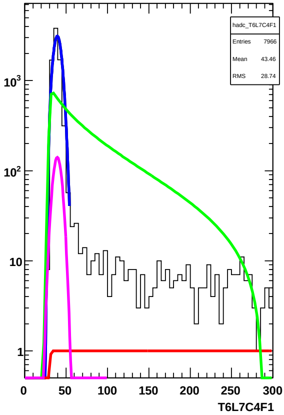
Result : run 077016907 $dped \leq x_{fb} \leq dped + 3\sigma_{ped}$

$\Delta = x_{fb} - dped - 3 \times \sigma_{ped}$

Xtal	χ^2/dof std	χ^2/dof new	Δ
T0L6C0F1	69.6315775503	20.6131580543	-4.75019393495
T1L7C8F1	83.5287467186	36.5473207055	-3.37600875458
T3L0C2F1	1904.13033303	98.4454979464	-11.8773614895
T3L0C5F1	629.610742521	82.1854578701	-9.15848717796
T3L1C3F1	372.907225155	30.8973574619	-10.4495847757
T3L2C9F1	55.868319614	16.6253901287	-4.57058752213
T3L4C5F1	114.018503122	59.3649886928	-4.59366724708
T3L5C8F1	403.213531082	19.9949248228	-9.93125560719
T3L6C4F1	33.7920330474	21.9132139187	-3.64588675364
T3L7C4F1	77.1373643313	33.2947581787	-5.66216711021
T4L2C8F1	151.434192807	70.8212494171	-3.54439986526
T7L3C1F1	117.064138628	36.1964732049	-9.06907242065
T8L1C1F1	1556.84054992	155.774545728	-9.93473722451
T11L3C1F1	16.1789363225	16.0782311145	-8.93160032456
T11L3C2F1	249.406717574	77.4841025686	-4.83868526216
T11L6C5F1	67.1874499805	31.4545980119	-4.40320017298
T14L6C10F1	37.4890962774	16.5488586541	-11.360349216

Here $x_{fb} \leq dped$, so we fit with $f(x) = Gauss \times f_{eff}$ (4 crystals)
Left Panel : pedestal histogram.
Right Panel : LEX8 signal, purple is gaussian pedestal, green curve is the standard method, blue is the gaussian and red is f_{eff}



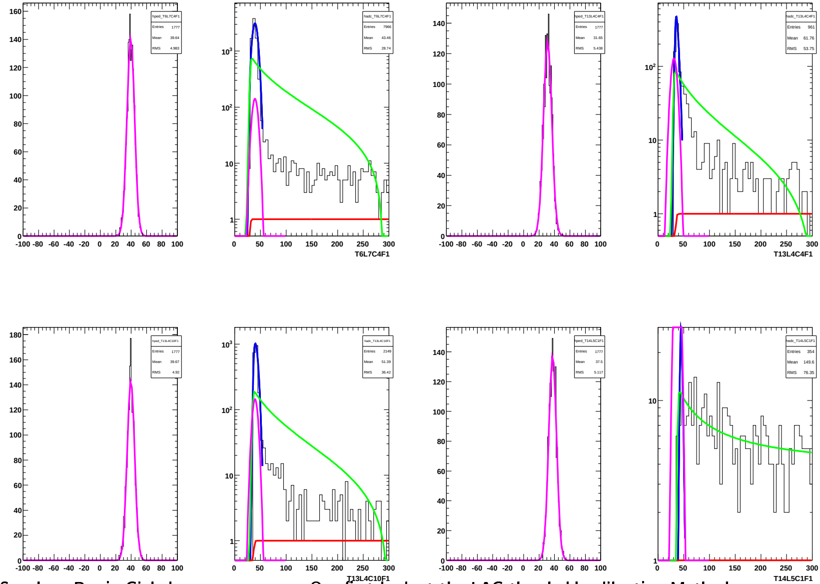


Results

dped = 39.5 ACD
LAC_{std} = 29.8 ACD
LAC_{new} = 29. ACD
$\chi^2_{std}/\mathrm{dof} = 24531$
$\chi^2_{new}/\mathrm{dof} = 919$

Result : run 077016907 $x_{fb} \leq dped$

Plots for the 4 crystals with $x_{fb} \leq dped$



Result : run 077016907 $x_{fb} \leq dped$

$x_{fb} \leq dped$

Xtal	LAC std	χ^2/dof std	LAC new	χ^2/dof new
T6L7C4F1	-9.6	24531.0220939	-10.4	919.019412359
T13L4C4F1	-0.9	467.567879387	2.7	0.608600976207
T13L4C10F1	-5.2	3501.52821136	3.2	54.7008069556
T14L5C1F1	0.1	13.6168952645	6.19	9.62331816444

For this cases, results might not be meaningful.

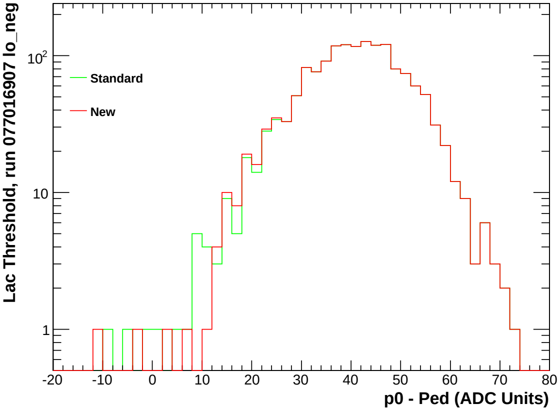
run 077016907

LAC threshold distribution for run 07016907.

Green is the standard method.

Red is the new method.

We improve the fit when $dped \leq x_{fb} \leq dped + 3\sigma_{ped}$



Simulation

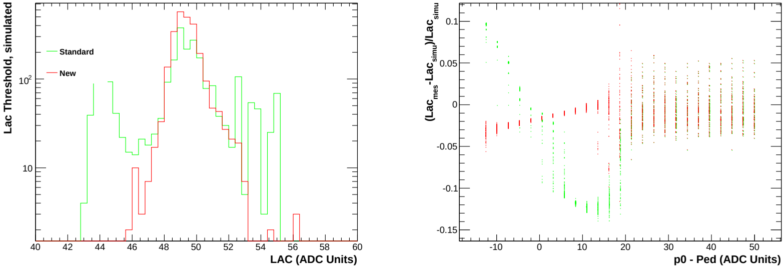
The aim is to validate by simulations the new method.
We simulate pedestal distribution by drawing a gaussian distribued variable $N(dped, \sigma_{ped} = 5ACD)$.
We also simulate LEX8 distribution with a LAC value of 50 ACD by the following method :

- the signal $S(x)$ is assume to be a power law of index 1.01
- the signal is convolued with the pedestal $S'(x) = S(x) * N(x, \sigma_{ped})$
- we multiply S' by the sigmoide

We change the value of *dped* (from 0 to LAC$+3 \times \sigma_{ped} = 65$ ACD) to simulate the 4 possible configurations.
σ_{ped} is keep constant.

Left panel : LAC distribution. Green is the standard method, red is the new method

Right panel : residual distribution versus the simulated value of the pedestal- $\mathrm{LAC}_{\mathrm{theo}}$, green is the standard method, red is the new method



We better find the 'true' LAC value with the new method (error is less than 5%).

Conclusion

- We are able to reproduce the results of Zach
- We propose an option to improve the fit and made simulations to validate them. Should this be implemented in the package ?
- Next : use the CVS code to generate the LAC values
- Next : study the effectiveness of the option from slide 6 with true data