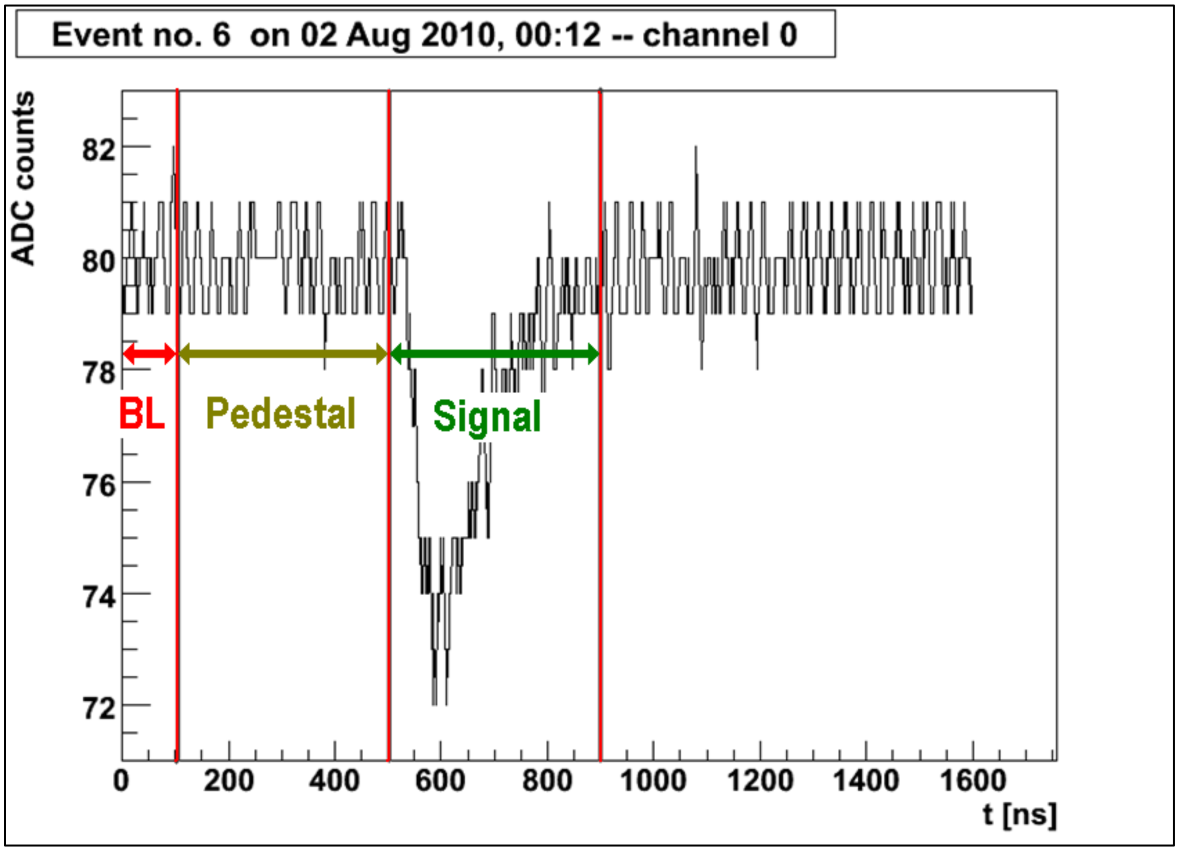
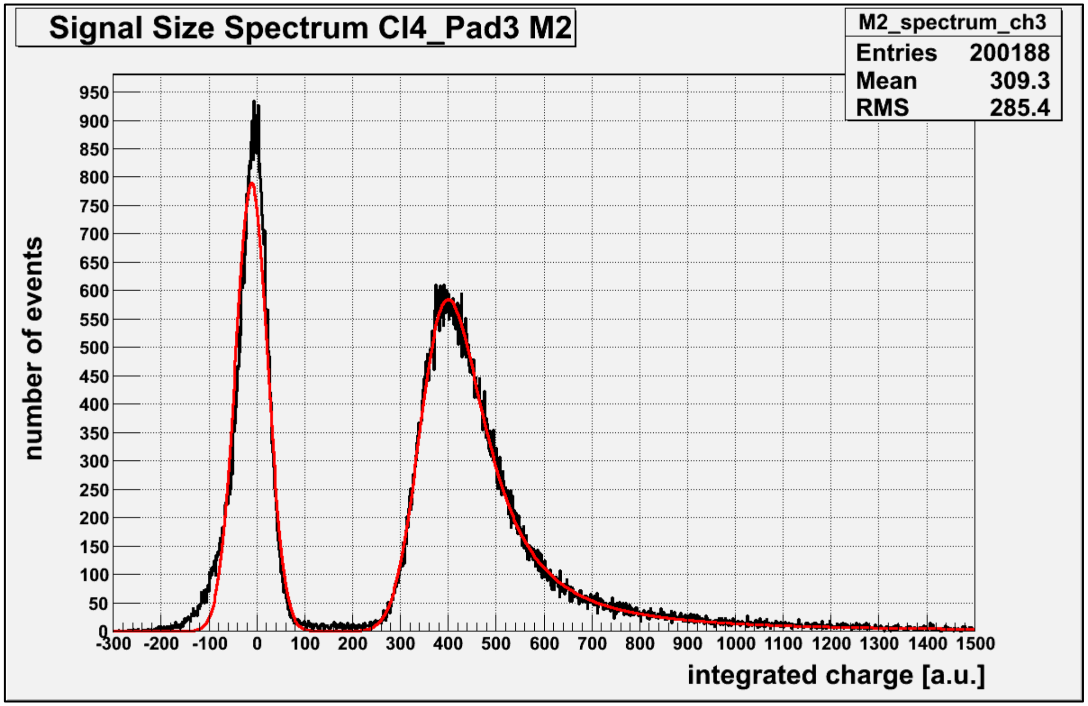
Post-thesis results

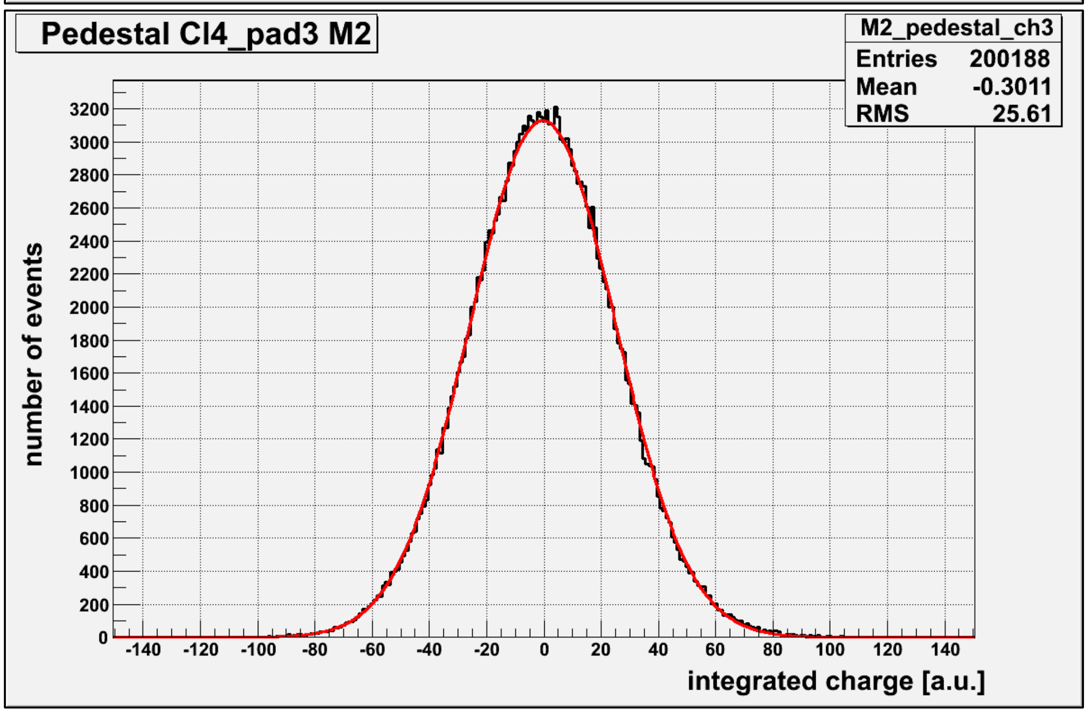
Improved method to obtain signal size spectra from 2010 testbeam data

Method used in my thesis



- samples {0, … ,49} for baseline
- samples {50, … ,249} for pedestal
- samples {250, … ,449} for signal size
- integration over signal size window and pedestal window with respect to baseline





- GLG-fit for signal size spectrum
- gauss-fit for pedestal

- definition signal to noise:

$$S / N = \frac{Signal}{\sigma_{Pedestal}}$$

$$= \frac{MPV_{Spectrum} - mean_{Pedestal}}{\sigma_{Pedestal}}$$

results – S/N

signal to noise, Cluster 4				
Pad	feedback	signal (M2) [au]	sigma (M2) [au]	**S/N**
0	active	382.7	30.7	**12.5**
1	active	372.1	27.9	**13.3**
2	active	372.7	27.0	**13.8**
3	active	386.6	25.5	**15.2**
4	passive	182.9	16.0	**11.4**
5	passive	174.3	16.6	**10.5**
6	passive	175.2	18.2	**9.6**
7	passive	177.5	17.8	**10.0**

- 10 to 11 for passive feedback
- 13 to 15 for active feedback

results – corr. coeff.

correlation coefficients, cluster 4			
combination of channels	**feedback**	**correlation coeff. (mean)**	**standard deviation**
0 and 1	activ	**0.54**	0.02
0 and 2	activ	**0.55**	0.02
0 and 3	activ	**0.51**	0.02
1 and 2	activ	**0.54**	0.02
1 and 3	activ	**0.52**	0.02
2 and 3	activ	**0.52**	0.01
4 and 5	passiv	**0.29**	0.02
4 and 6	passiv	**0.36**	0.02
4 and 7	passiv	**0.35**	0.02
5 and 6	passiv	**0.32**	0.03
5 and 7	passiv	**0.26**	0.05
6 and 7	passiv	**0.33**	0.09

- small for passive feedback (0.26 to 0.36)
- moderate for active feedback (0.51 to 0.55)

pros and cons of that method

pros:

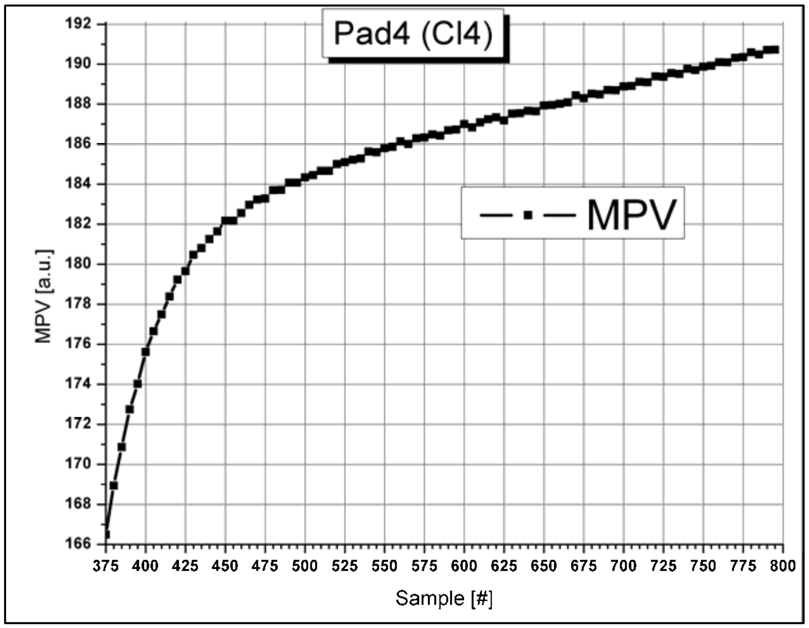
- integrating with respect to baseline (necessary because of temp. dependence of BL)
- pedestals are built independently from integration window for signals (no additional influences apart from noise)

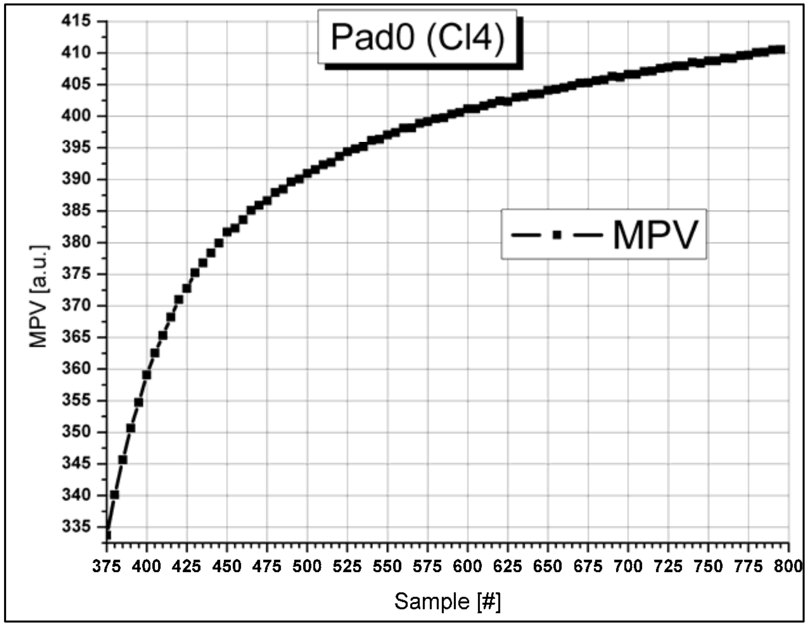
cons:

- number of samples for baseline calculation less than for pedestal
  - noise distribution widened by the error of the baselines
- sizes of integration windows were fixed “by eye”
  - windows too small -> signal sizes too small
  - windows too large -> noise distribution too wide

fixing integration window sizes

- built spectra with different integration window sizes
- fitted with GLG -> plotted MPV(Landau) vs. window size





- no saturation in signal size

fixing integration window sizes

- fitting signals with signal shape function:

$$s(t) = V_{out}(t) = -V_0 \frac{t}{\tau} \exp(-t/\tau)$$

- getting sizes of integration windows from fitting parameters
  - Maximum:

$$t = \tau$$

  - Amplitude:

$$A = s(t = \tau) = -V_0 \exp(-1)$$

  - Area under the curve:

$$F(a) = V_0 \left(\exp(-a/\tau)(a + \tau) - \tau \right)$$

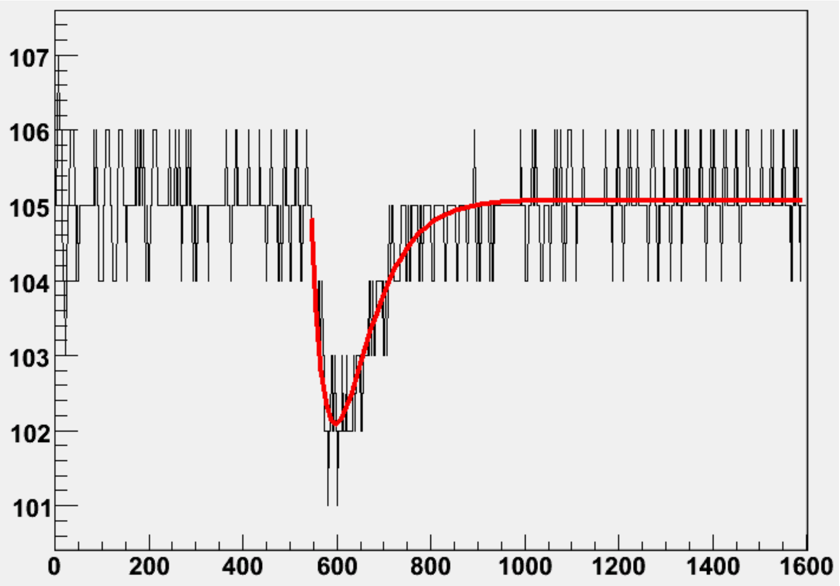
$$F_{Ges} = F(a \to \infty) = V_0 \left(\lim_{a \to \infty} [\exp(-a/\tau)(a + \tau)] - \tau \right) = -V_0 \tau$$

fixing integration window sizes

- parameterized function for ROOT:

$$p[0] - p[1]*(x - p[2])/p[3]*TMath::Exp(-(x - p[2])/p[3])$$

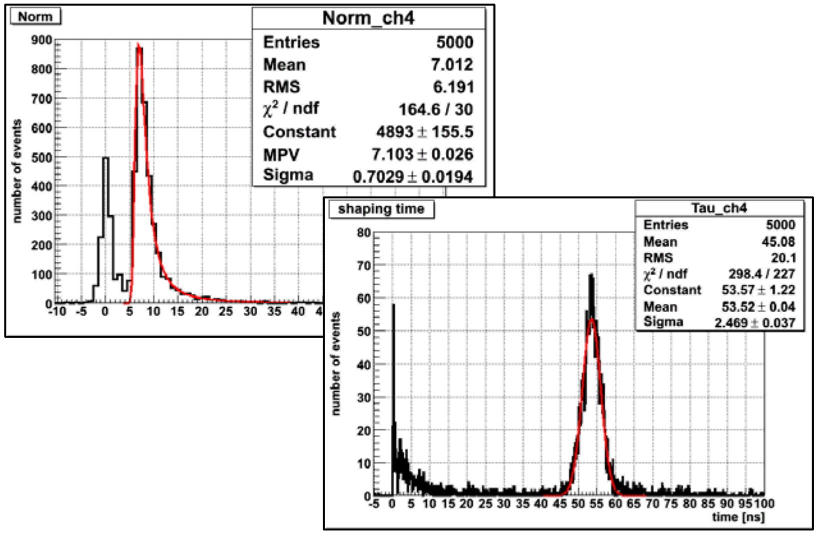
- p[0]   : y-offset   -> baseline
- p[1]   : norm   -> $-V_0$* amplification
- x-p[2]: relative time -> p[2] = time when signal (fit) starts
- p[3]   : time constant (τ), shaping time

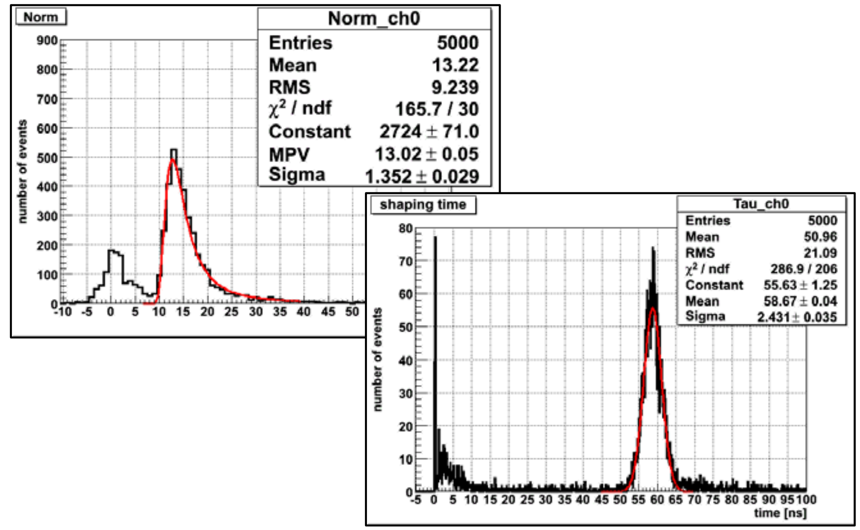


consistency checks

- ran signal fitting over 5000 events in channel 3 (active feedback) and channel 4 (passive feedback) of cluster 4
- all four parameters were free (no restrictions)
  - only signal starting time (p[2]) was restricted to X-axis range of an ADC-spectrum
- checked if resulting values for fitting parameters are consistent with previous obtained results

consistency checks -“Norm”-Spectra

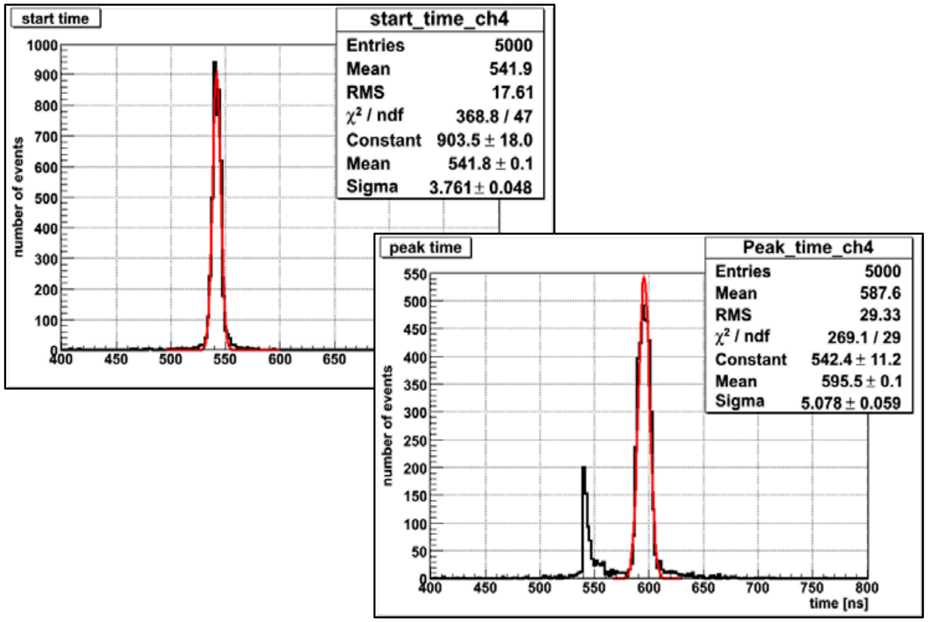


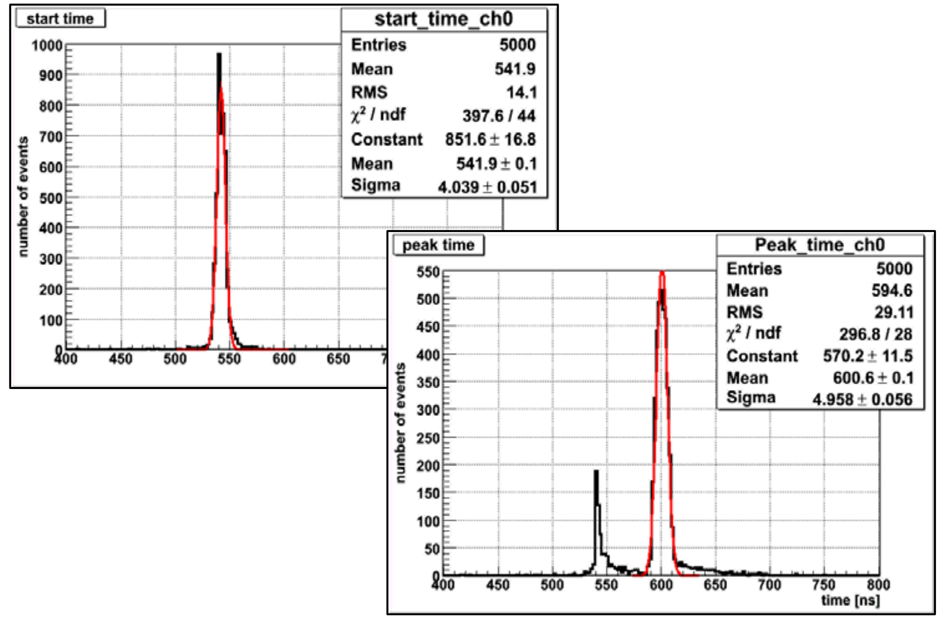


- MPV: 7.1 a.u.
- Tau: 53.5 ns
- MPV_Signal_Size (Area)
- = MPV_Norm*Tau
- = 379.9 ADC-counts*ns
- = **190.0** ADC-counts*sample
- for “old” method **182.9** ADC-counts*smaple

- MPV: 13.0 a.u.
- Tau: 58.7 ns
- MPV_Signal_Size (Area)
- = MPV_Norm*Tau
- = 764.3 ADC-counts*ns
- = **382.2** ADC-counts*sample
- for “old” method **382.7** ADC-counts*smaple

consistency checks - timing





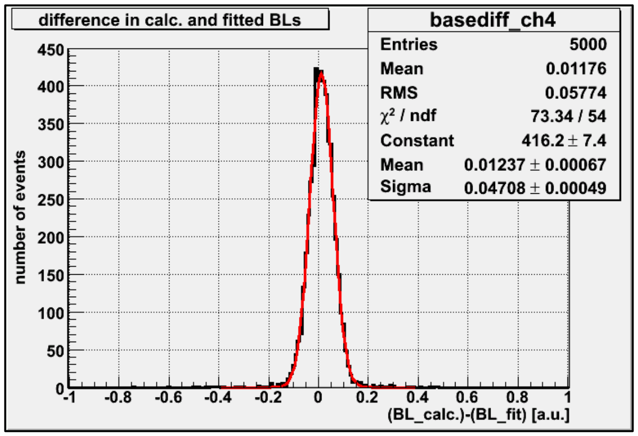
- “peak_time” = “start_time” + tau
- mean(peak_time) = 596 ns

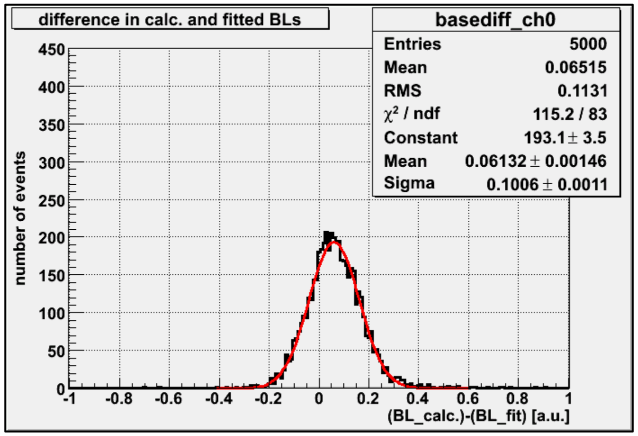
- mean(peak_time) = 601 ns

- both close to 600 ns

consistency checks - baselines

- “BL_calc.”: average of first 200 sample in an event
- “BL_fit”: parameter p[0] from fit
- plots: distribution of (“BL_calc.”-”BL_fit”)





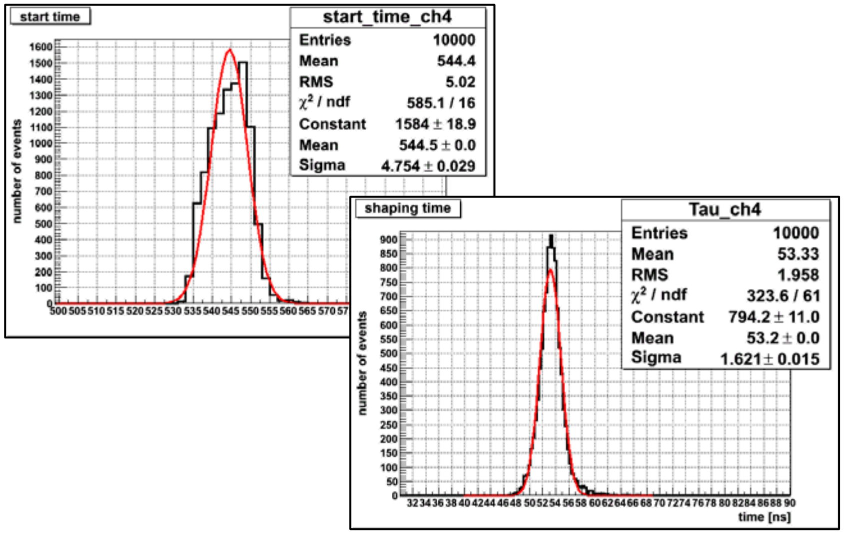
- mean: 0.012 ADC-counts
- mean: 0.061 ADC-counts

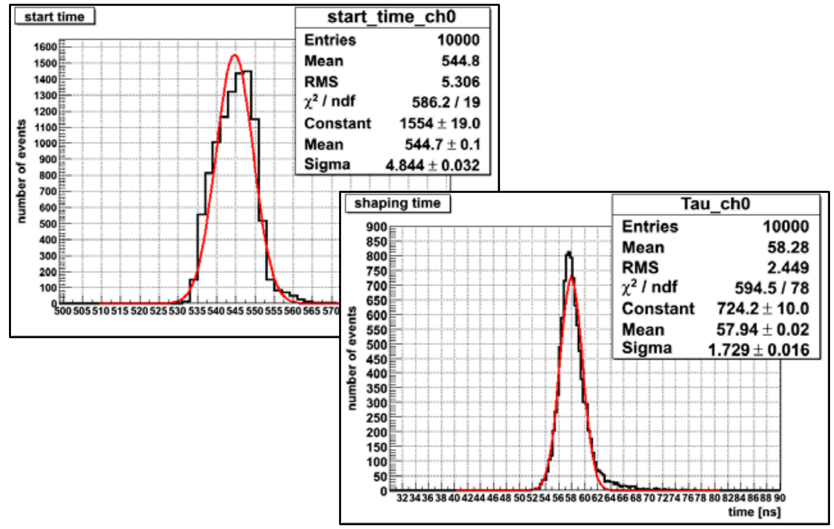
- both show positive difference
  - > consistent with the observed fact that signal size does not saturate (but differences too small to explain it fully)

fixing integration window sizes

- fitting with selected events (for more precise parameters):
  - only events with signals (“Norm” >= 0.9 MPV)
  - events with no “peaks” in baseline (hopefully low noise events)
  - took only fits with error less than 3% for all four parameters into account
  - 10 000 events

fixing integration window sizes





- start_time = 545 ns
- = sample # 272
- tau = 53.2 ns

- start_time = 545 ns
- = sample # 272
- tau = 57.9 ns

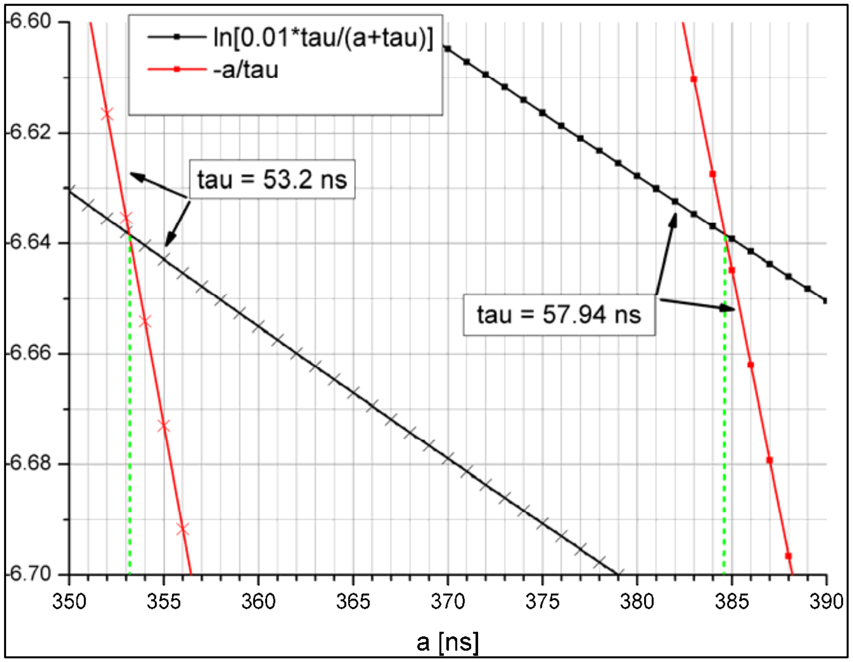
- end of int. window: when area under the curve reaches 99% of it's (theoretical) maximum
- have to solve:

$$\ln\left(\frac{0.01\tau}{(a+\tau)}\right) = -\frac{a}{\tau}$$

"a" = relative time when area reaches 99%

fixing integration window sizes

- graphical solution:

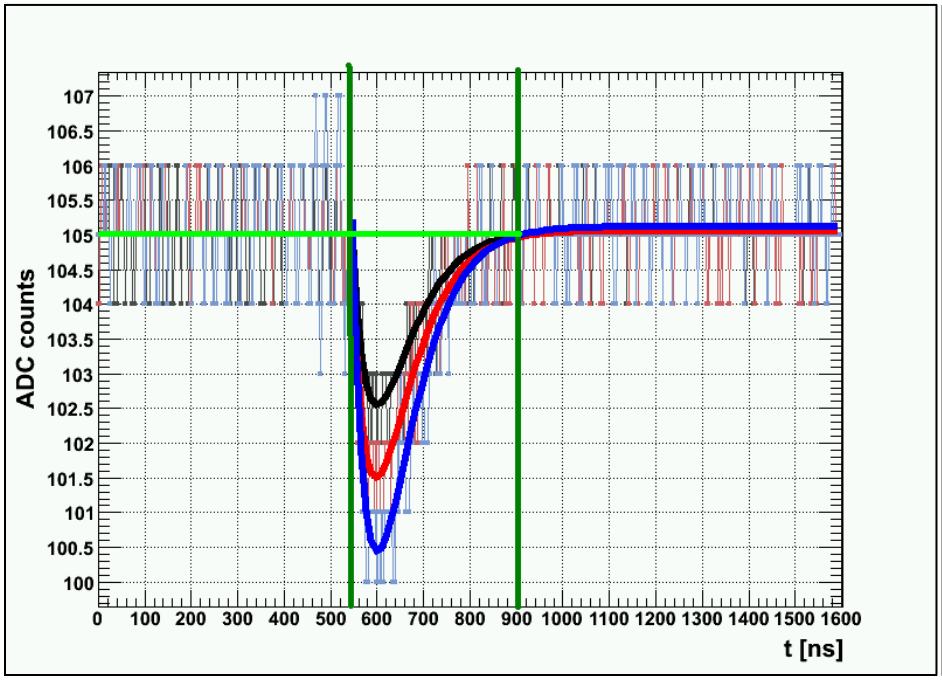


- a = 353 ns = 177 samples ("passive")
- a = 385 ns = 193 samples ("active")
- int. window sizes:
  - "passive" ch.: (272 – 449) sample#
  - "active" ch.: (272 – 465) sample#

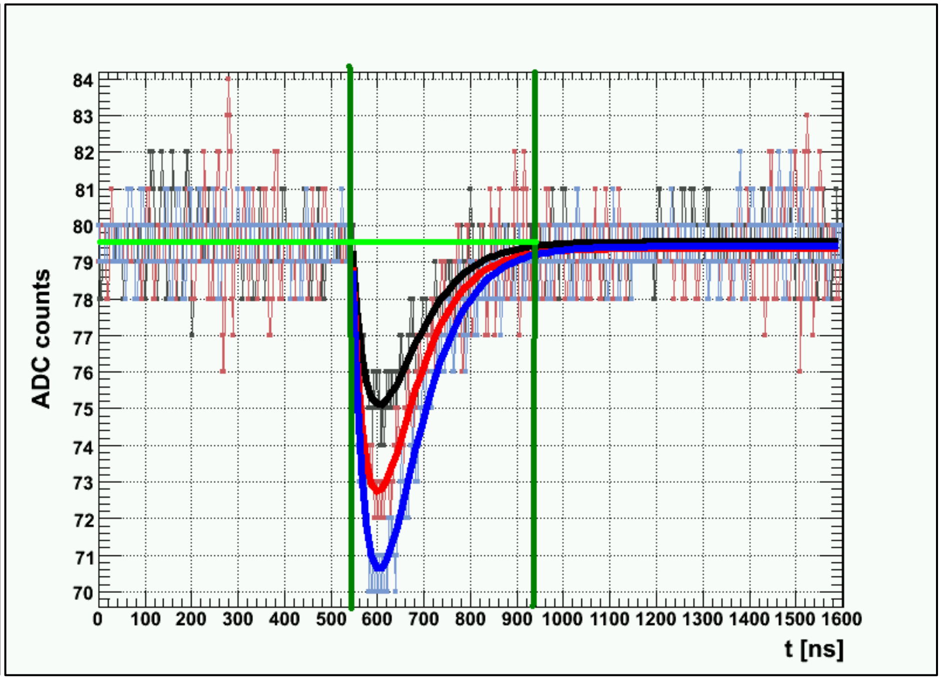
- took:
  - "passive" ch.: (271 – 451) sample#
  - "active" ch.: (271 – 467) sample#

fixing integration window sizes

“passive” channel:

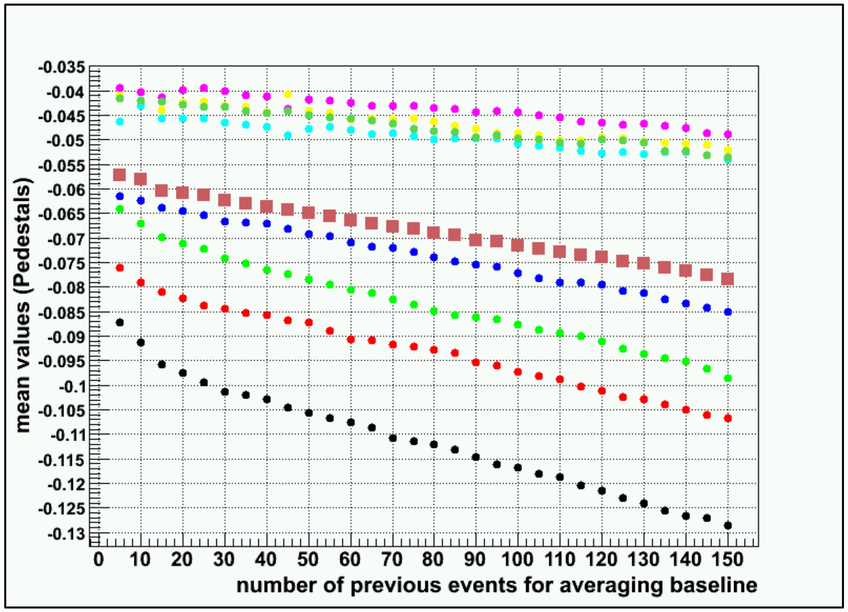


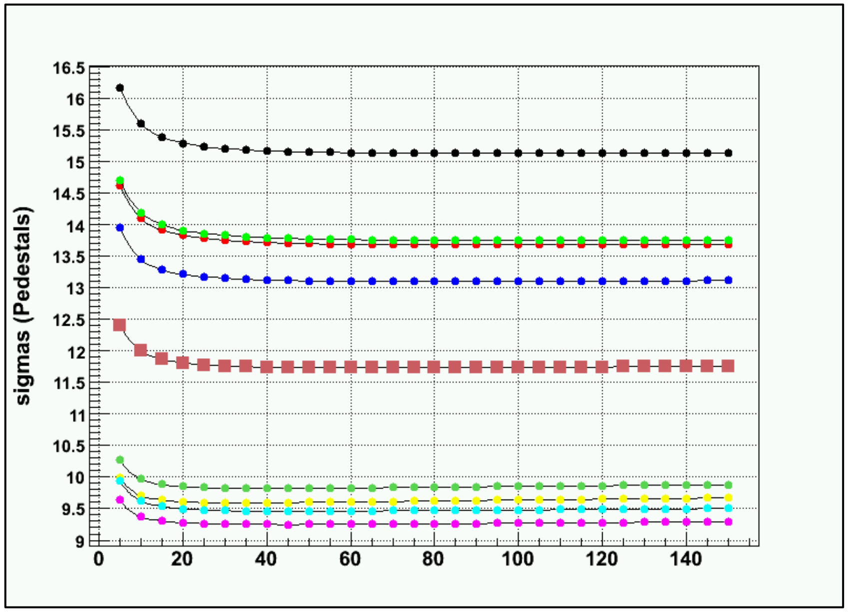
“active” channel:



averaging baseline

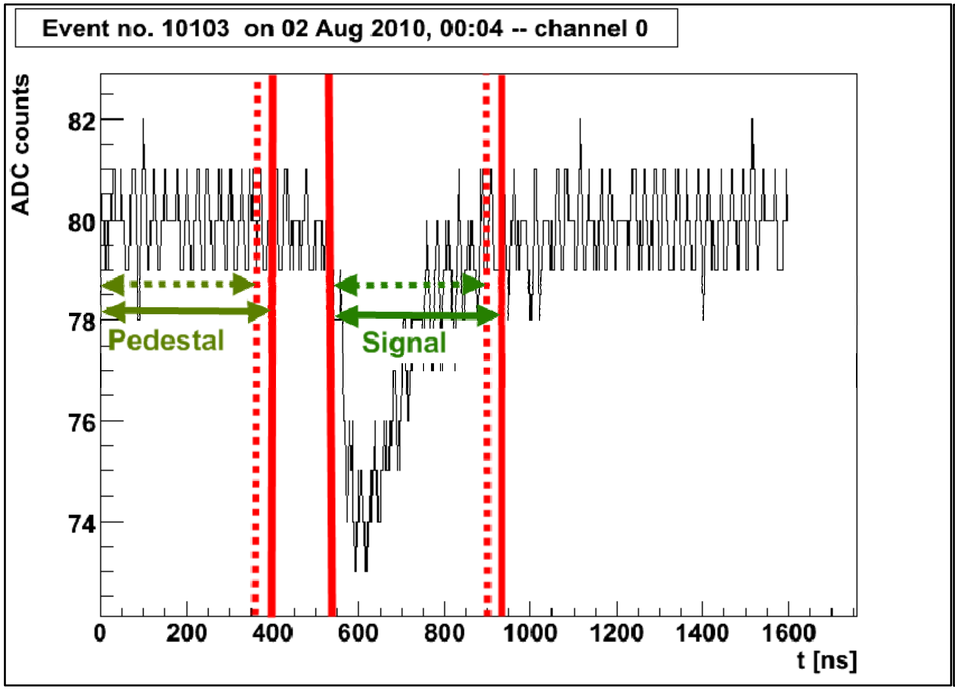
- baseline as average of baselines from previous events
- be aware of changing baseline with temperature

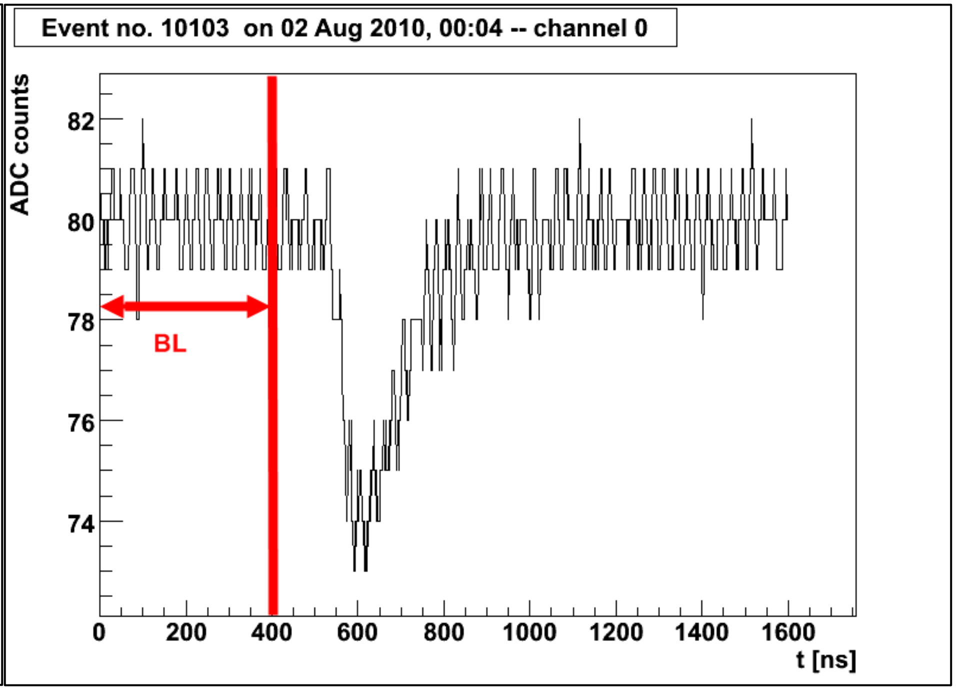




- took 40 previous events for averaging

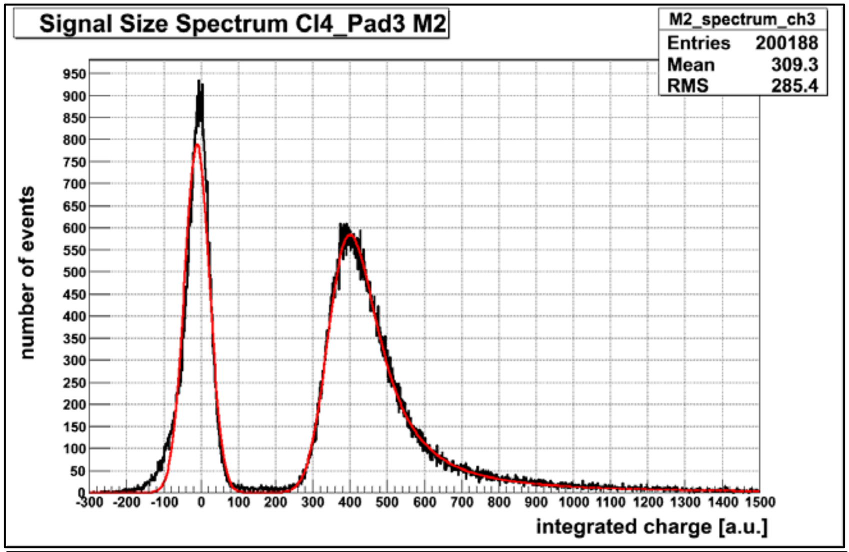
new windows

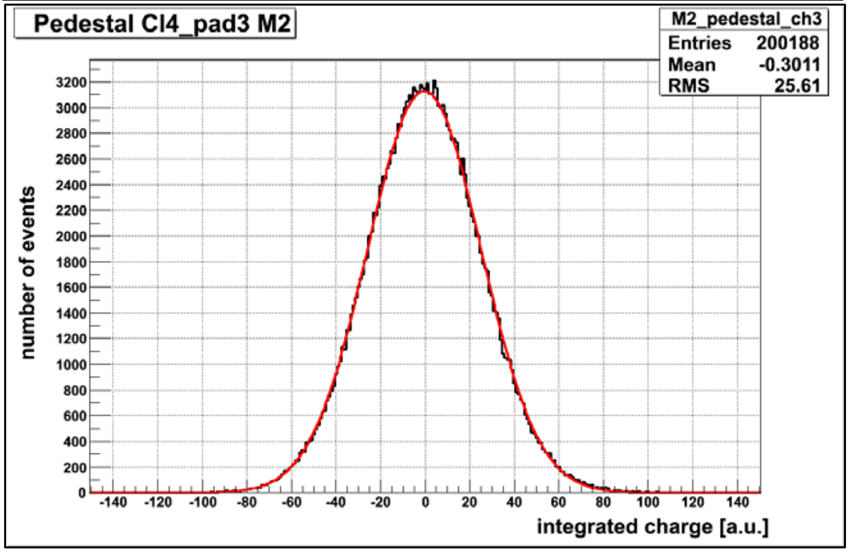

Event no. 10103 on 02 Aug 2010, 00:04 -- channel 0
ADC counts
82
80
78
76
74
Pedestal
Signal
0
200
400
600
800
1000
1200
1400
1600
t [ns]


Event no. 10103 on 02 Aug 2010, 00:04 -- channel 0
ADC counts
82
80
78
76
74
BL
0
200
400
600
800
1000
1200
1400
1600
t [ns]

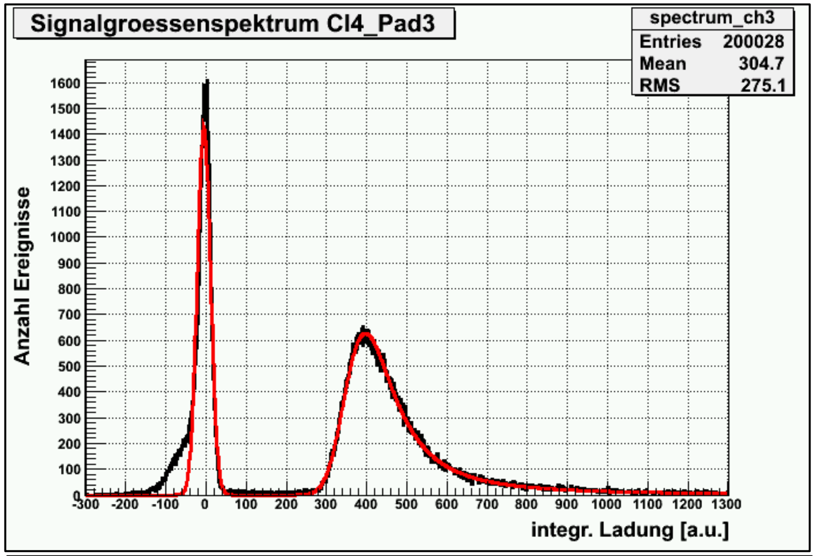
results – spectra

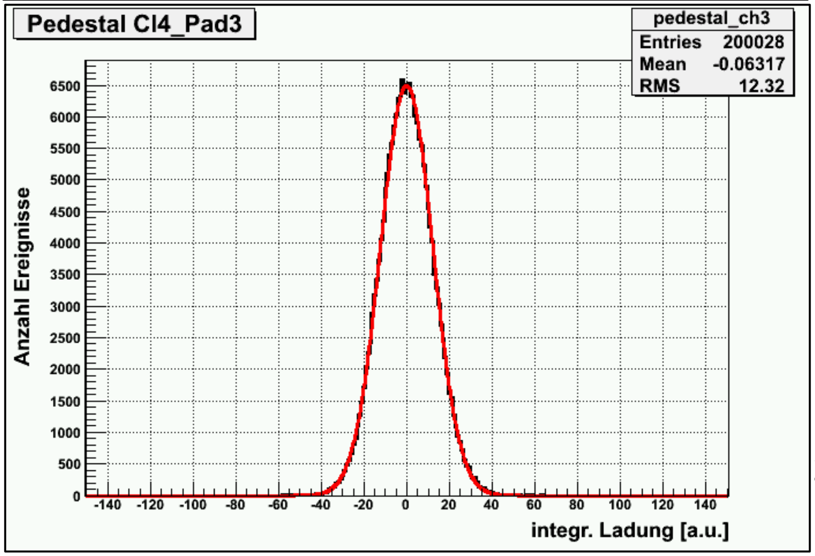
“old”:





“new”:





results – S/N

signal to noise, Cluster 4				
Pad	feedback	signal (M2) [au]	sigma (M2) [au]	**S/N**
0	active	382.7	30.7	**12.5**
1	active	372.1	27.9	**13.3**
2	active	372.7	27.0	**13.8**
3	active	386.6	25.5	**15.2**
4	passive	182.9	16.0	**11.4**
5	passive	174.3	16.6	**10.5**
6	passive	175.2	18.2	**9.6**
7	passive	177.5	17.8	**10.0**

- 10 to 11 for passive feedback
- 13 to 15 for active feedback

signal to noise, Cluster 4				
Pad	feedback	signal (new) [au]	sigma (new) [au]	**S/N**
0	active	384.7	15.9	**24.2**
1	active	373.0	14.2	**26.2**
2	active	373.7	13.5	**27.6**
3	active	386.3	12.3	**31.4**
4	passive	181.7	9.0	**20.3**
5	passive	172.7	9.3	**18.5**
6	passive	173.9	10.0	**17.5**
7	passive	176.0	9.9	**17.9**

- 18 to 20 for passive feedback
- 24 to 31 for active feedback

results – corr. coeff.

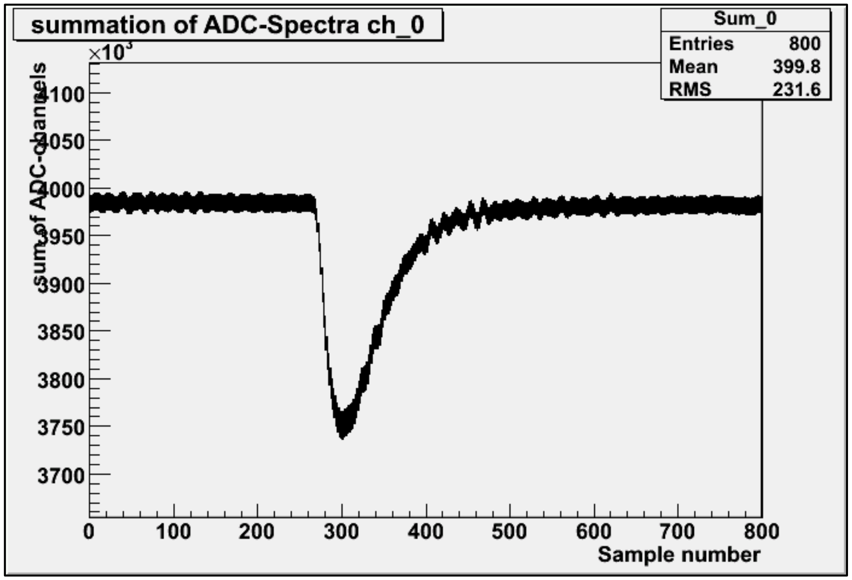
correlation coefficients, cluster 4			
combination of channels	feedback	correlation coeff. (mean)	standard deviation
0 and 1	activ	0.54	0.02
0 and 2	activ	0.55	0.02
0 and 3	activ	0.51	0.02
1 and 2	activ	0.54	0.02
1 and 3	activ	0.52	0.02
2 and 3	activ	0.52	0.01
4 and 5	passiv	0.29	0.02
4 and 6	passiv	0.36	0.02
4 and 7	passiv	0.35	0.02
5 and 6	passiv	0.32	0.03
5 and 7	passiv	0.26	0.05
6 and 7	passiv	0.33	0.09

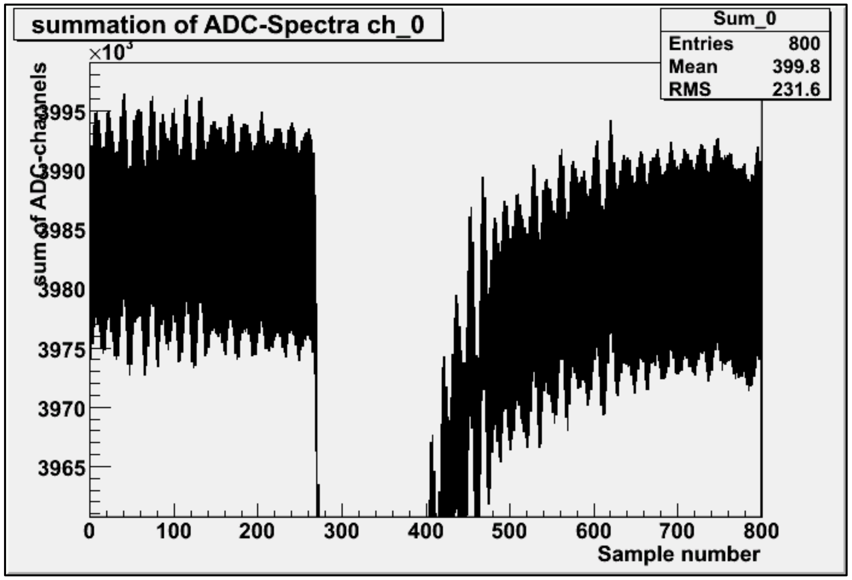
- small for passive feedback (0.26 to 0.36)
- moderate for active feedback (0.51 to 0.55)

correlation coefficients, cluster 4 (new)			
combination of channels	feedback	correlation coeff. (mean)	standard deviation
0 and 1	activ	0.30	0.02
0 and 2	activ	0.30	0.02
0 and 3	activ	0.27	0.02
1 and 2	activ	0.29	0.02
1 and 3	activ	0.28	0.02
2 and 3	activ	0.28	0.02
4 and 5	passiv	0.13	0.02
4 and 6	passiv	0.17	0.02
4 and 7	passiv	0.16	0.01
5 and 6	passiv	0.15	0.02
5 and 7	passiv	0.11	0.04
6 and 7	passiv	0.17	0.07

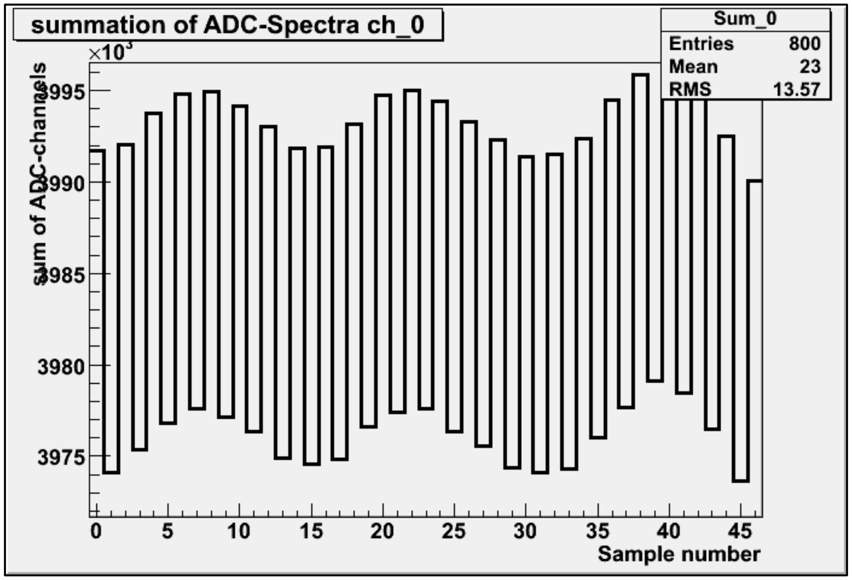
- very small for passive feedback (0.11 to 0.17)
- small for active feedback (0.27 to 0.30)

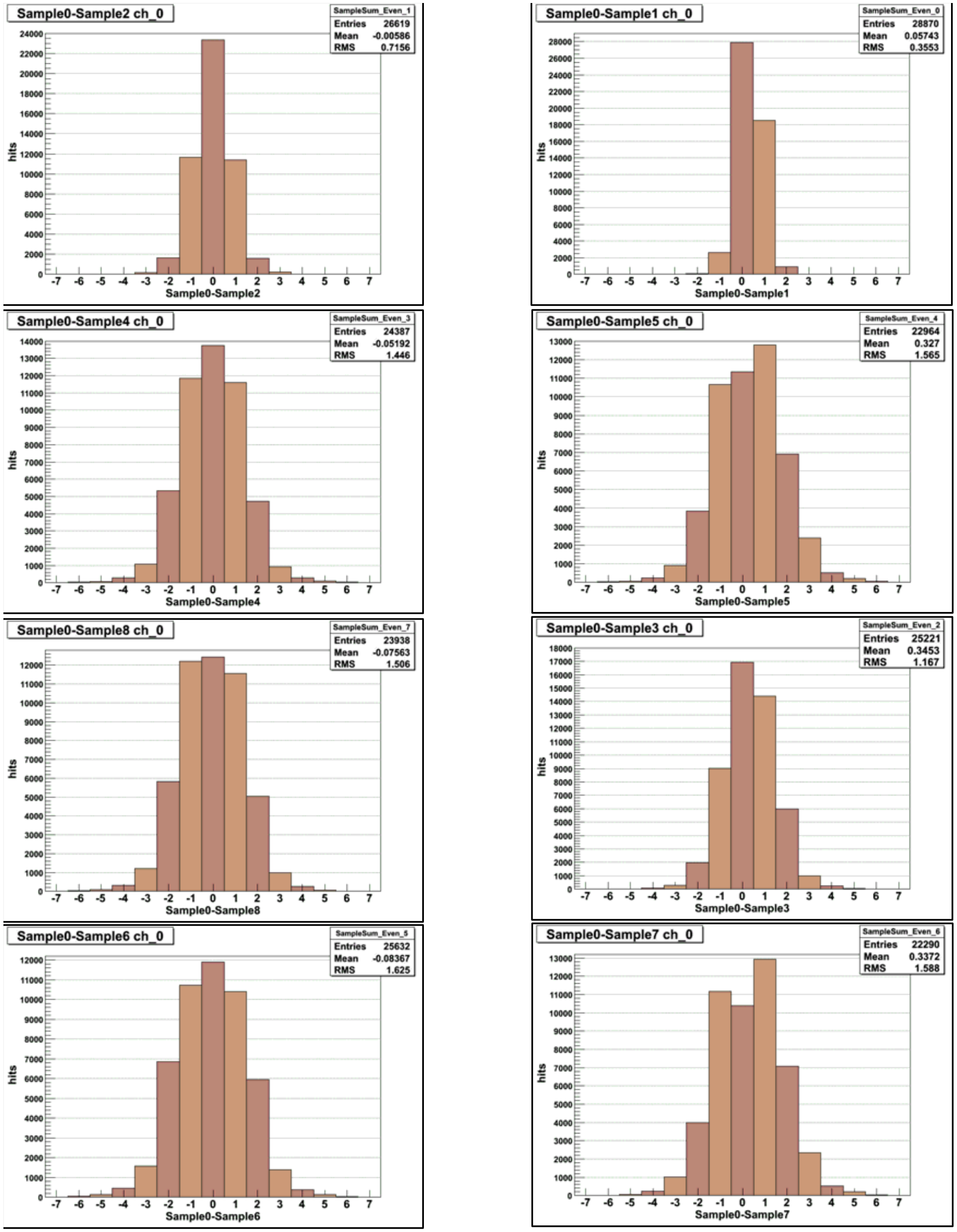
systematics in ADC?





- samplewise summation of 50k ADC-spectra
- systematic in samples?



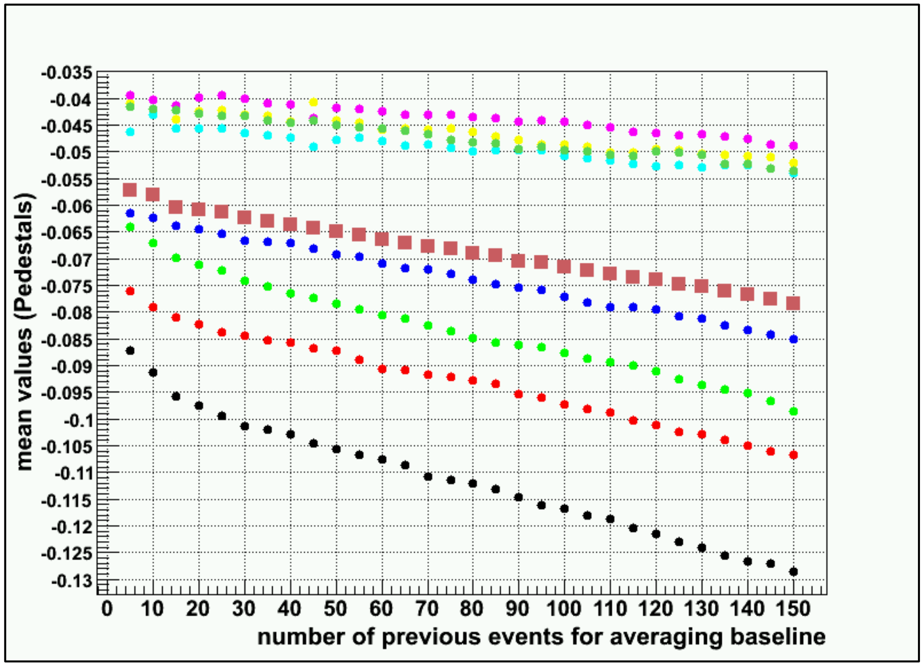


- sample0-sampleX
- X even -> gaussian
- X odd -> not gaus.

pedestals from samples:

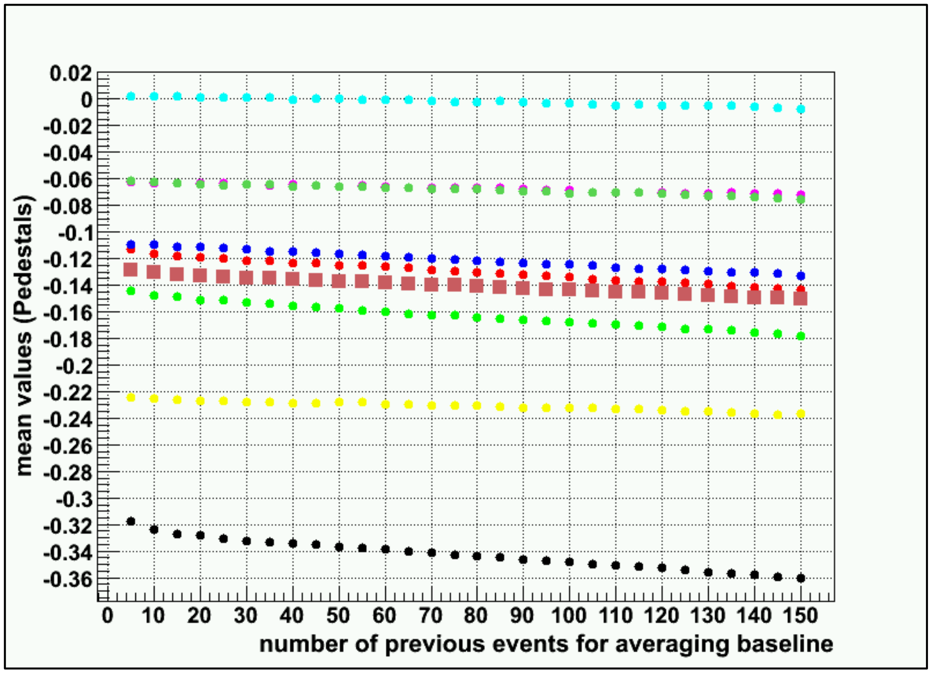
"active": {0…196}

"passive": {0…180}



"active": {0…197}

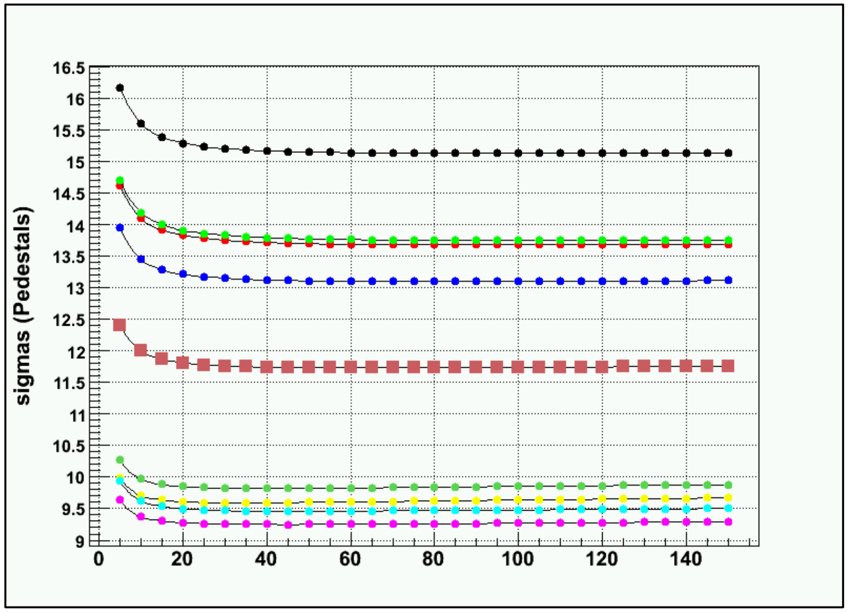
"passive": {0…181}



pedestals from samples:

“active”: {0…196}

“passive”: {0…180}



“active”: {0…197}

“passive”: {0…181}