Update on H8500 test in Bari

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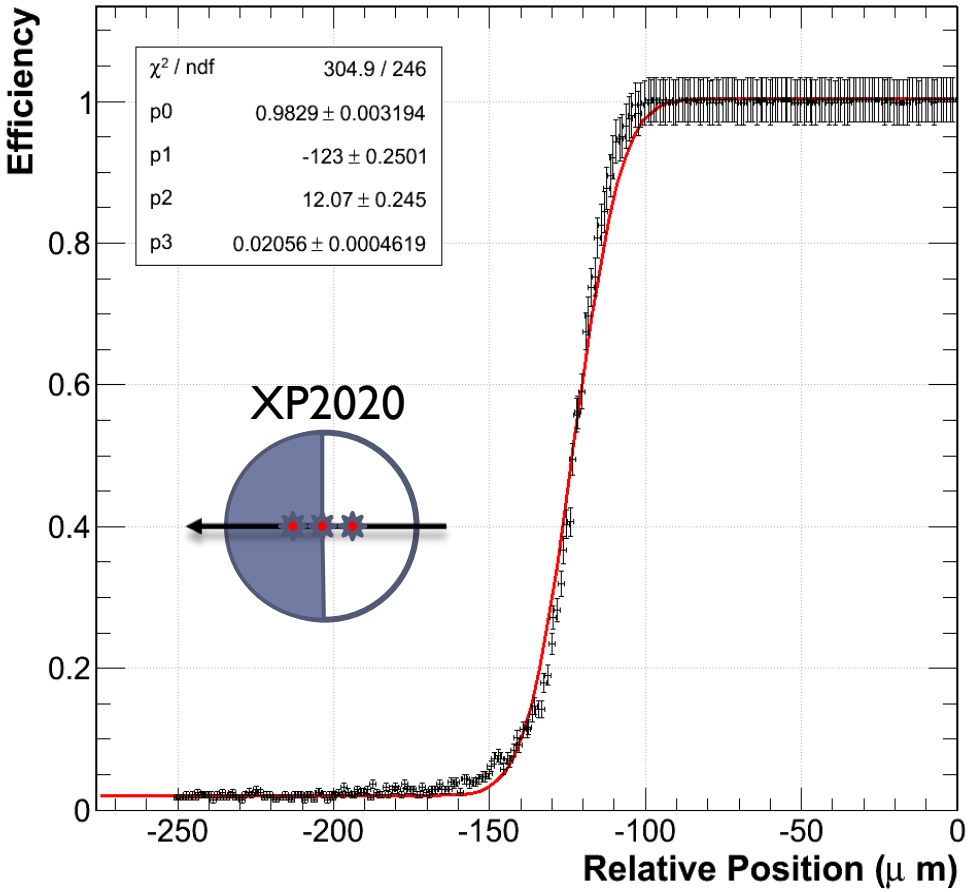
Outlook

- Laser Beam Profile
- H8500 studies w/o amplification
  - Fine step scan in a row on two pixel
    - Charge
    - Sharing
    - Time
  - Fine step pixel map
- Summary

Laser Beam Profile

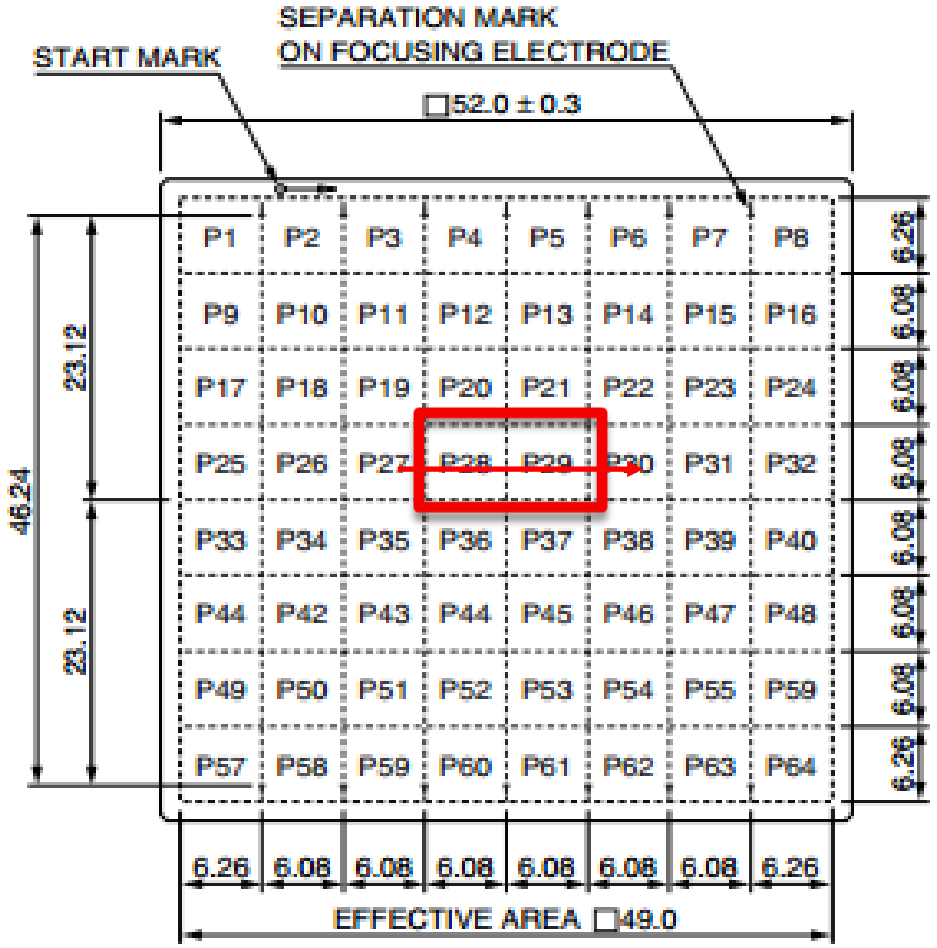
- I have reduced the beam diameter playing a little bit more with the focusing distance
- Scan Step = 1 μm
- Light Source @ 10 p.e. level
- Detector: XP2020 @ HV 2000V
- Fit with Gauss error function + off
- σ of the beam = 12 μm
- Beam size = 4 × σ = **50 μm**
- Offset: 2% of triggers due to environmental light noise



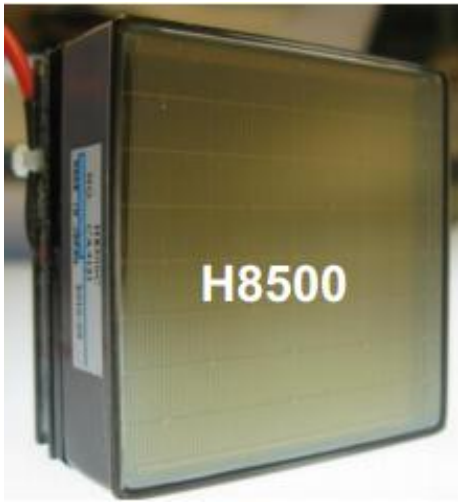
H8500 studies w/o amplification

- Direct connection between the MaPMT and the ADC and TDC modules
- No amplification chain
- Light level @ 20-25 p.e.
- H8500 @ 1000V

- Scan along horizontal direction across two pixels (P28 & P29) @ the center of the pixel
- Scan step = 50μm
- Signal threshold for TDC @ 5mV

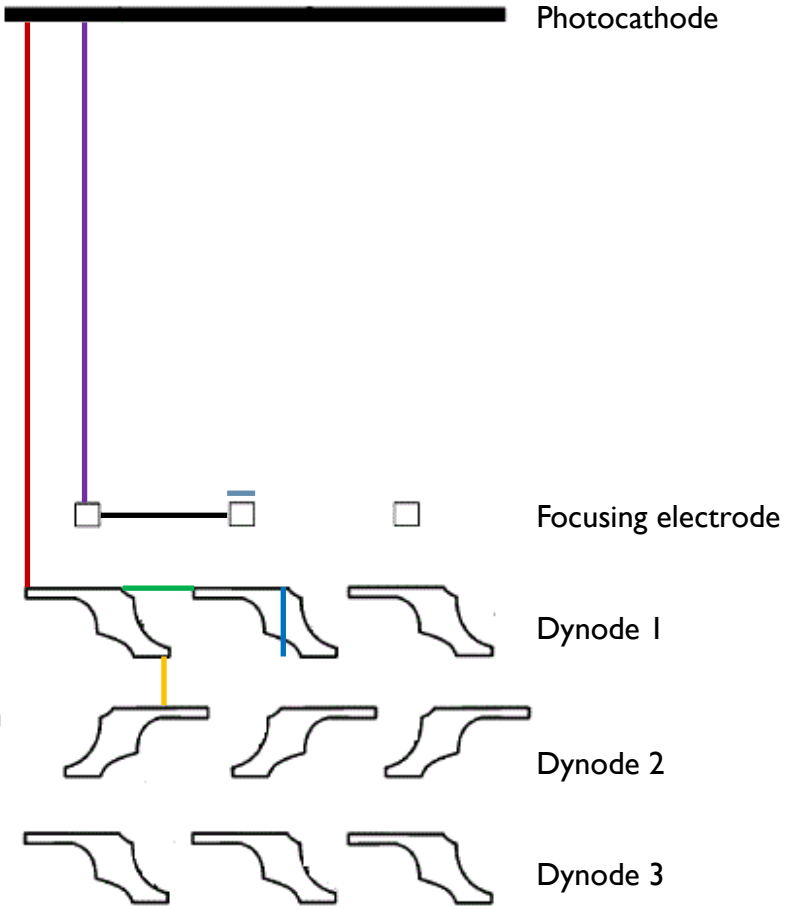


H8500 Structure



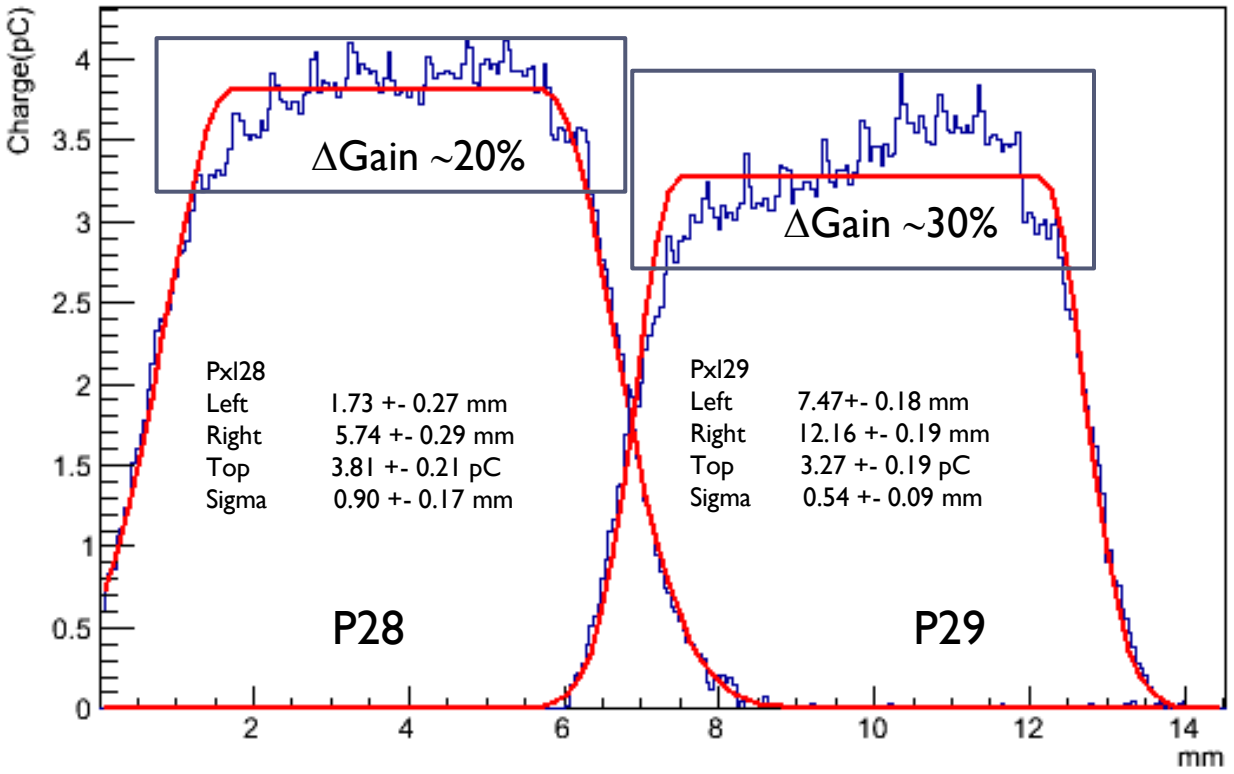
1) **red** line (distance between photocathode and first dynode): **3 mm**
2) **black** line (distance between two adjacent focusing electrode): **0.5 mm**
3) **green** line (distance between two adjacent dynodes): **0.2 mm**
4) **blue** line (dynode thickness): **0.2 mm**
5) **orange** line (distance between first dynode and second dynode): **0.2 mm**
6) **purple** line (distance between photocathode and focusing electrode): **2.75 mm**
7) **light blue** line (focusing electrode thickness): **0.05 mm**

Data from Hamamatsu engineers



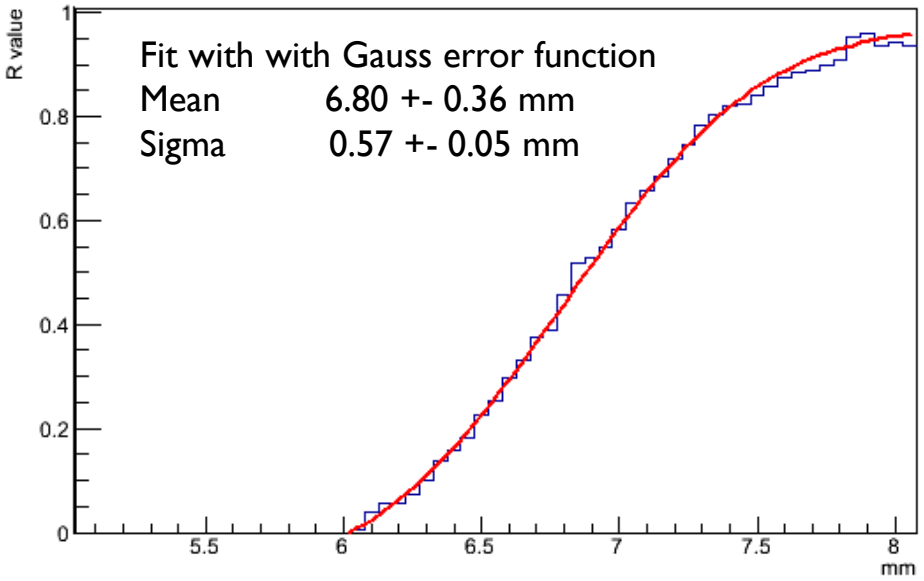
H8500 studies w/o amplification Charge

- Fit done with a Gaussian with flat top



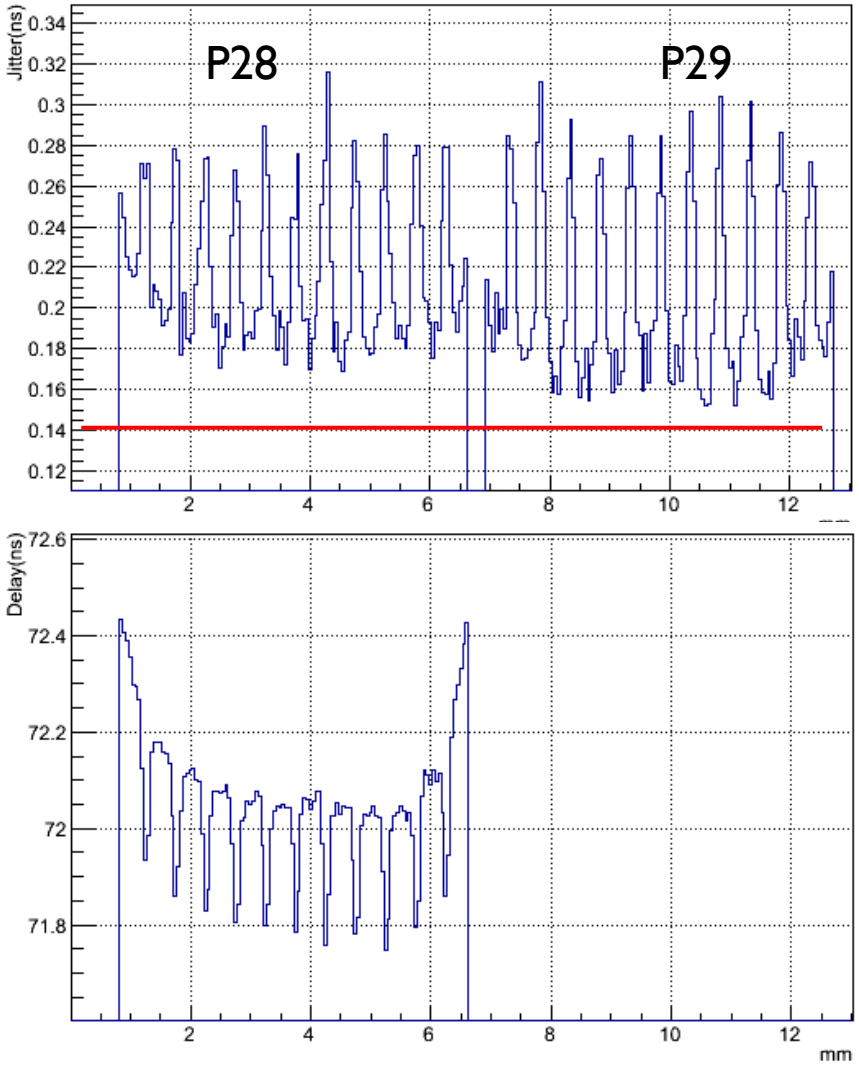
- For both pixels it is evident the effect of the focusing electrodes on the collected charge
- When the beam hits the photocathode near one of the electrodes the collected charge increases (+5%)
- The gain ratio between the two pixels (from fit result) is: p29/p28 = 0.86 +- 0.07
- Pixel Size from fit:
  - (Right –Left)+ 2.355*Sigma
  - P28 = 6.13 +- 0.47 mm
  - P29 = 5.96 +- 0.30 mm

H8500 studies w/o amplification
Charge Sharing



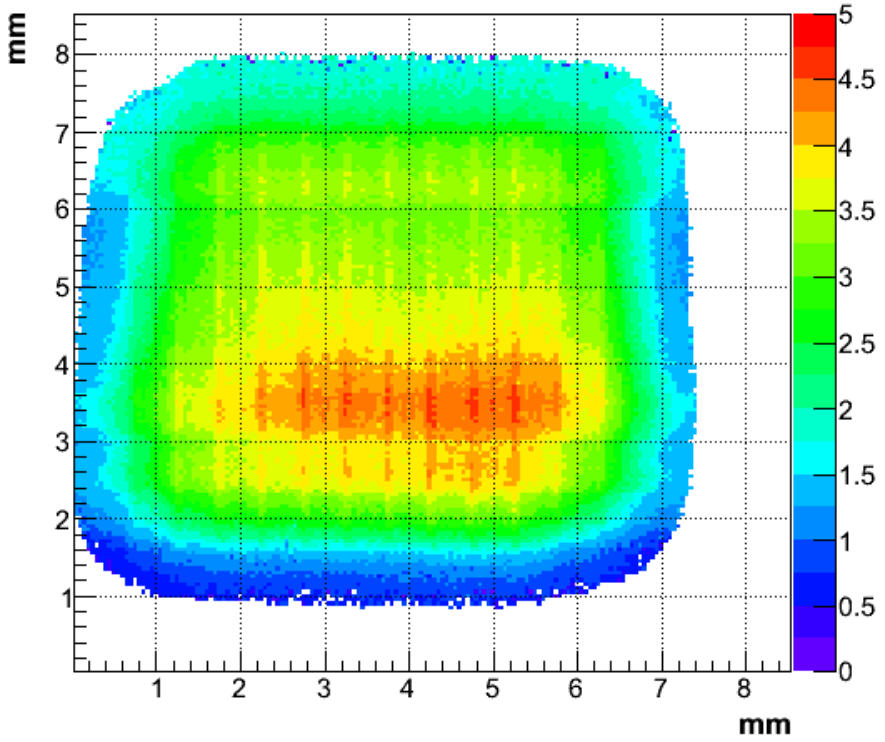
- In order to evaluate the charge sharing I have evaluated the sharing ratio R defined as:
  - R=Charge(P29)/**(**Charge(P28)+Charge(P29)**)**
- According to the fit results the sharing region has a sigma of 600 μm
- Since we are working at the level of 20-25 p.e. this kind of sharing could be due the optical sharing of the photons at the photocathode entrance and to the spread of photoelectrons in the region between the photocathode and the first dynode.
- We know from Doug measurement that when we reduce the light at 1 p.e. level the sharing is null

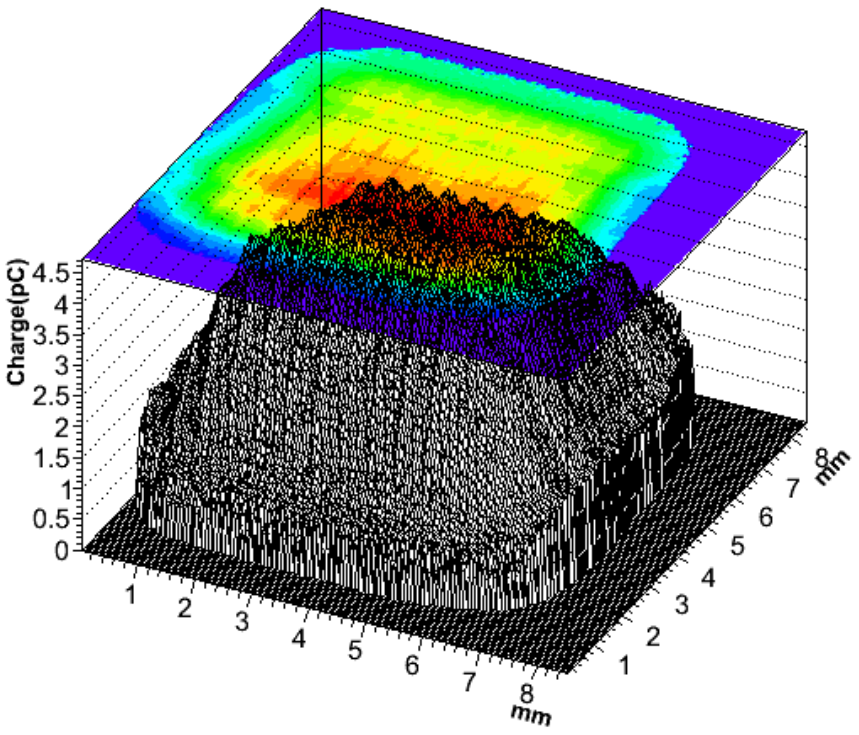
H8500 studies w/o amplification
Timing



- The jitter is evaluated from the σ of the Gaussian fit of the time distribution.
- The intrinsic jitter of the readout chain is 140ps.
- From the scan is clearly visible the effect of the focusing electrodes on the jitter.
- There are 11 electrodes for each pixel.
- When the light beam hits the region between the electrodes the jitter is lower (180ps for P28 and 160ps for P29).
- When the light beam hits the electrode the jitter increases of almost 100ps.
- The parabolic shape of the delay distribution reflects the effect of the focusing field inside. The p.e. emitted near the border of the pixel takes more time to reach the first dynode ($\Delta t \sim 100$ps)
- When the light beam hits the electrode the signal is faster with respect to the region between the electrodes ($\Delta t \sim 250$ps)

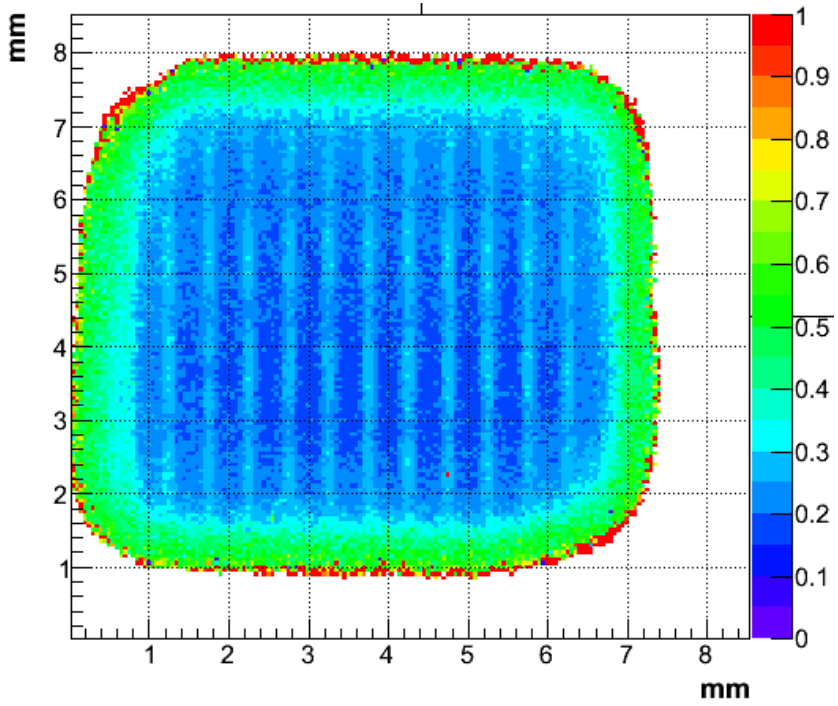
H8500 studies w/o amplification
Charge Map

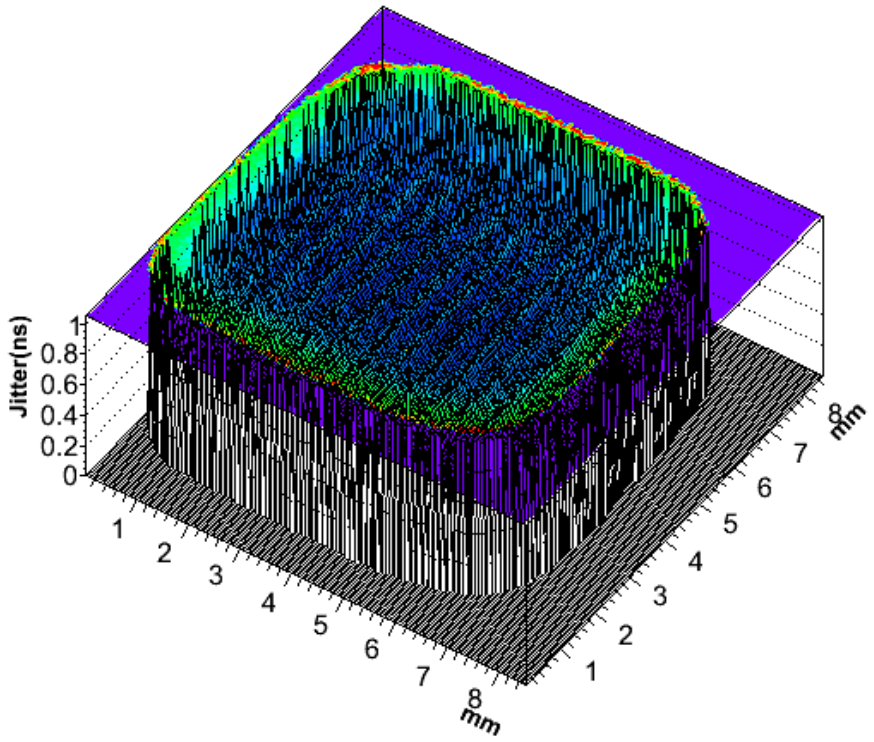




- Map of pixel 28 build with 50μm steps
- The focusing electrodes are visible
- There is a great disuniformity along the y-direction

H8500 studies w/o amplification
Jitter Map





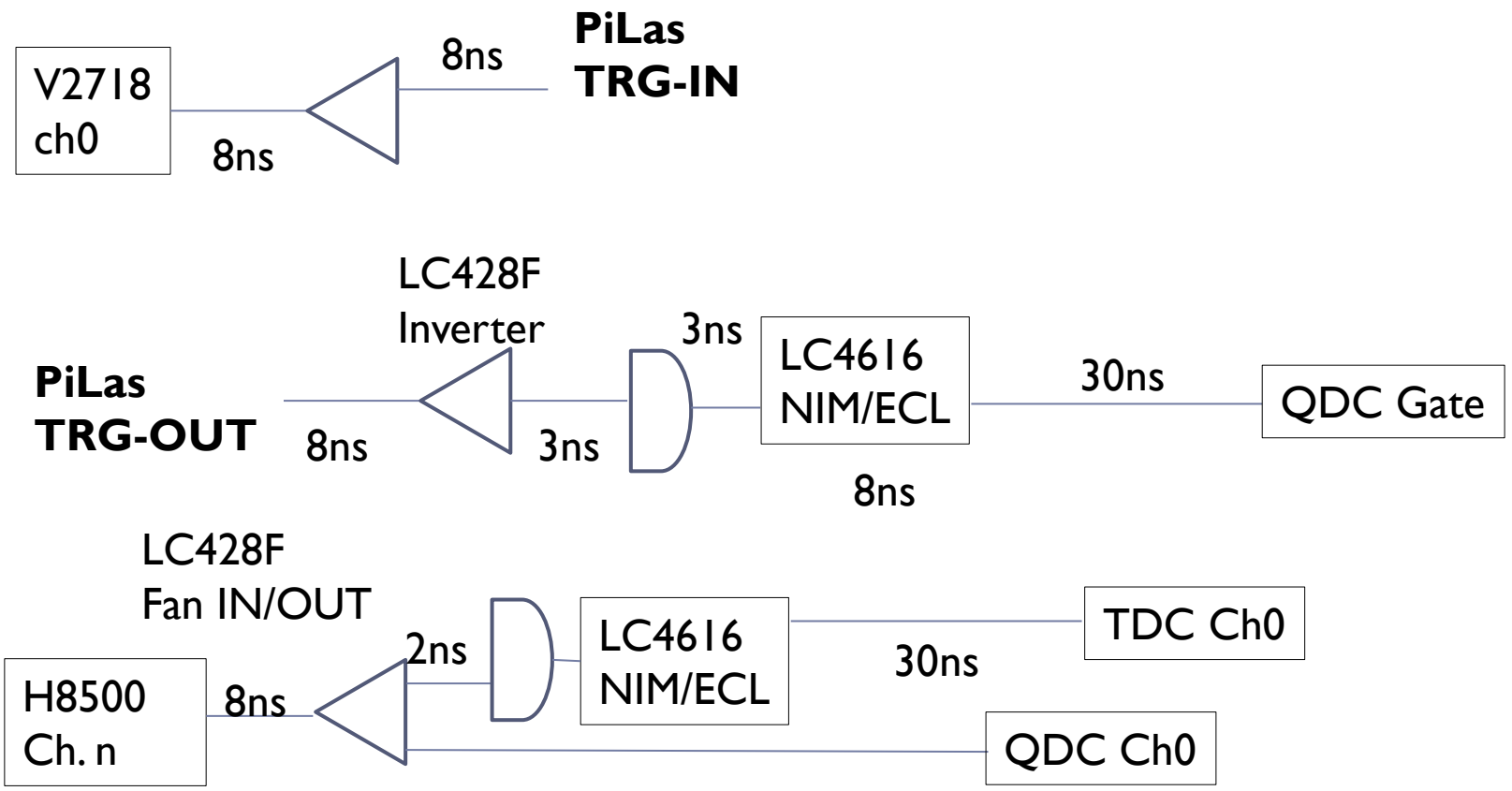
- Map of pixel 28 build with 50μm steps
- The 11 focusing electrodes are all clearly visible
- The distance between the electrodes is 500μm and the width 50μm

Summary

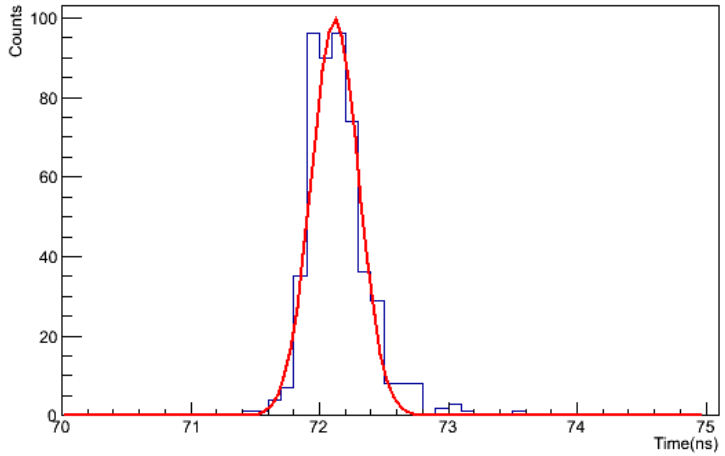
- We have performed a detailed scan of the MaPMT pixels to study the effect of the focusing electrodes on the performances
- We have found, as expected, that the there is an effect in gain that seems to increase a little bit (+5%) near the focusing electrode
- We have also found that there is an effect on timing performance of the device. Near the focusing electrode the jitter increase of almost 100ps and the transit time is 250ps shorter
- We are still working to fix some bugs in our electronics. We plan to use it for our measurements in order to study in detail the performance at single p.e. level

Back-up Slides

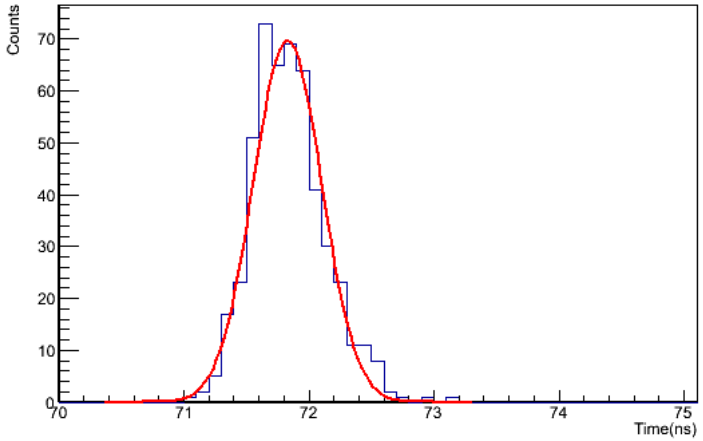
Trigger system for H8500 w/o amplification



H8500 studies w/o amplification
Timing - backup

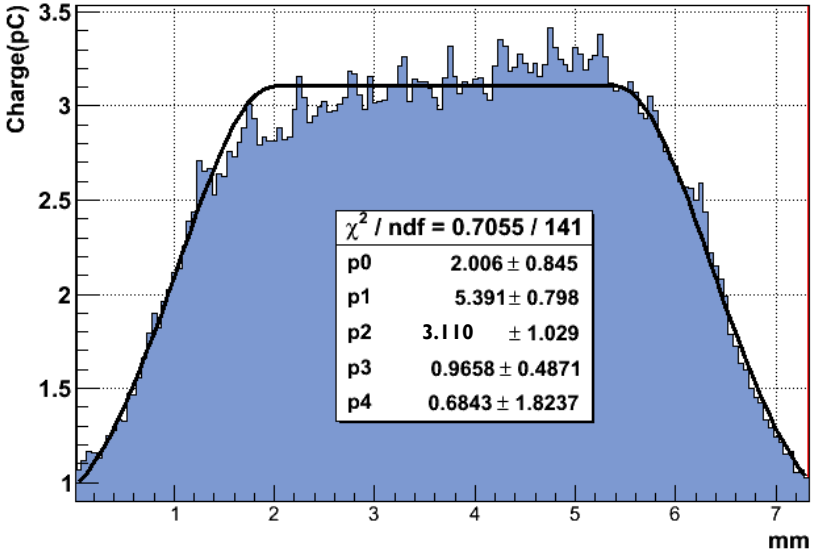


Minimum of jitter
Mean 72.12 +- 0.01 ns
Sigma 0.18 +-0.01 ns

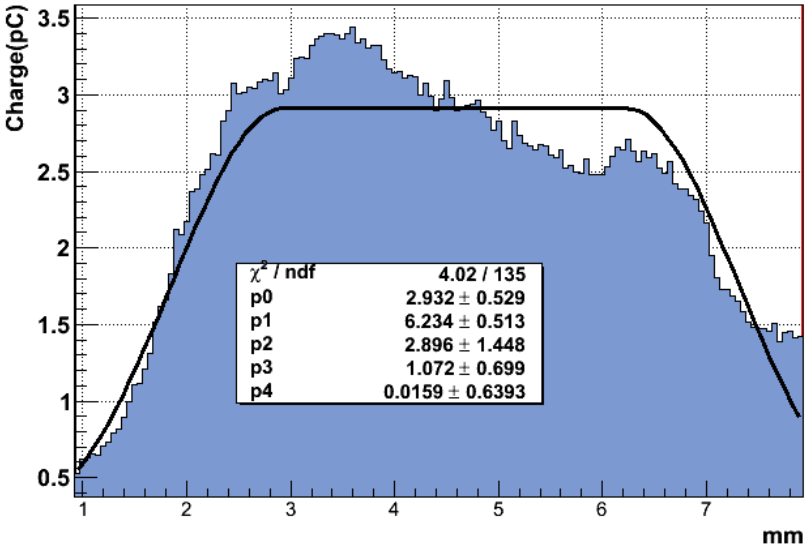


Maximum of jitter
Mean 71.83 +- 0.01 ns
Sigma 0.27 +- 0.01 ns

H8500 studies w/o amplification
Charge Map – backup

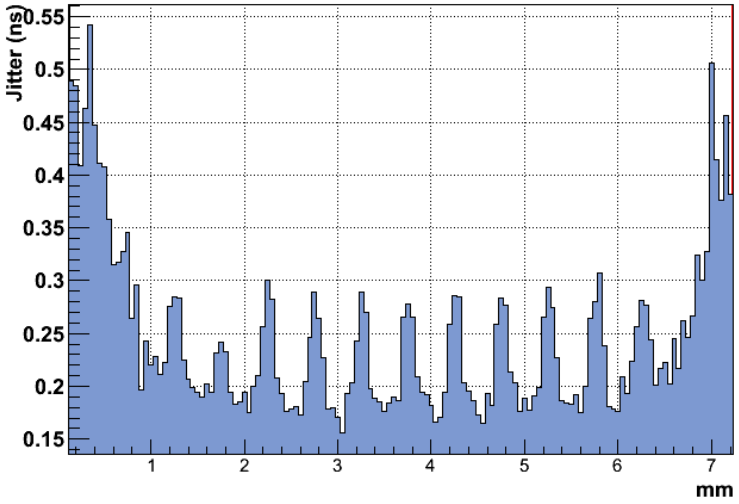


X – projection
ΔGain ~ 20%

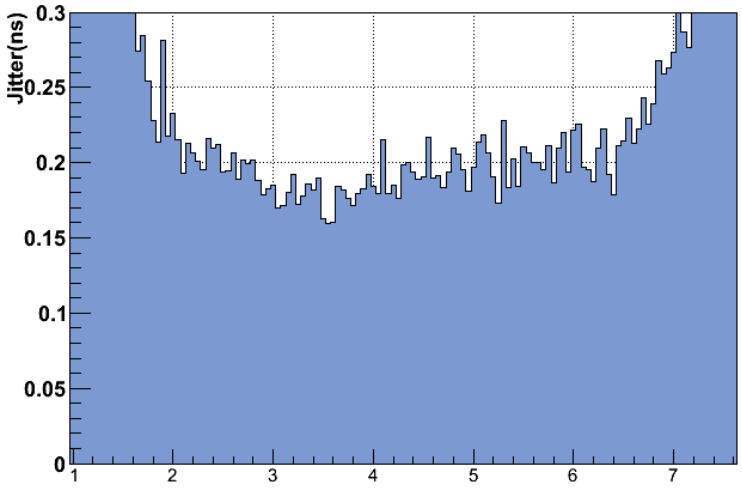


Y – projection
ΔGain ~ 30%

H8500 studies w/o amplification
Jitter Map - backup

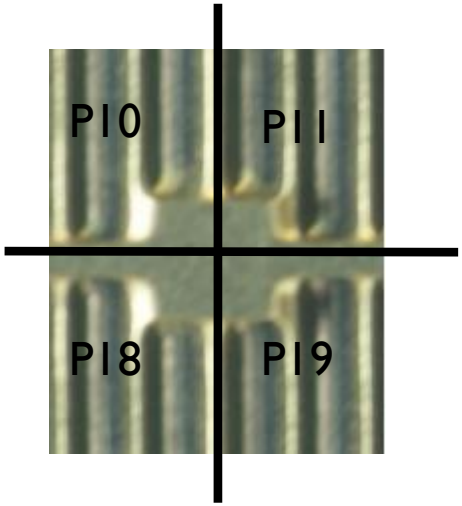


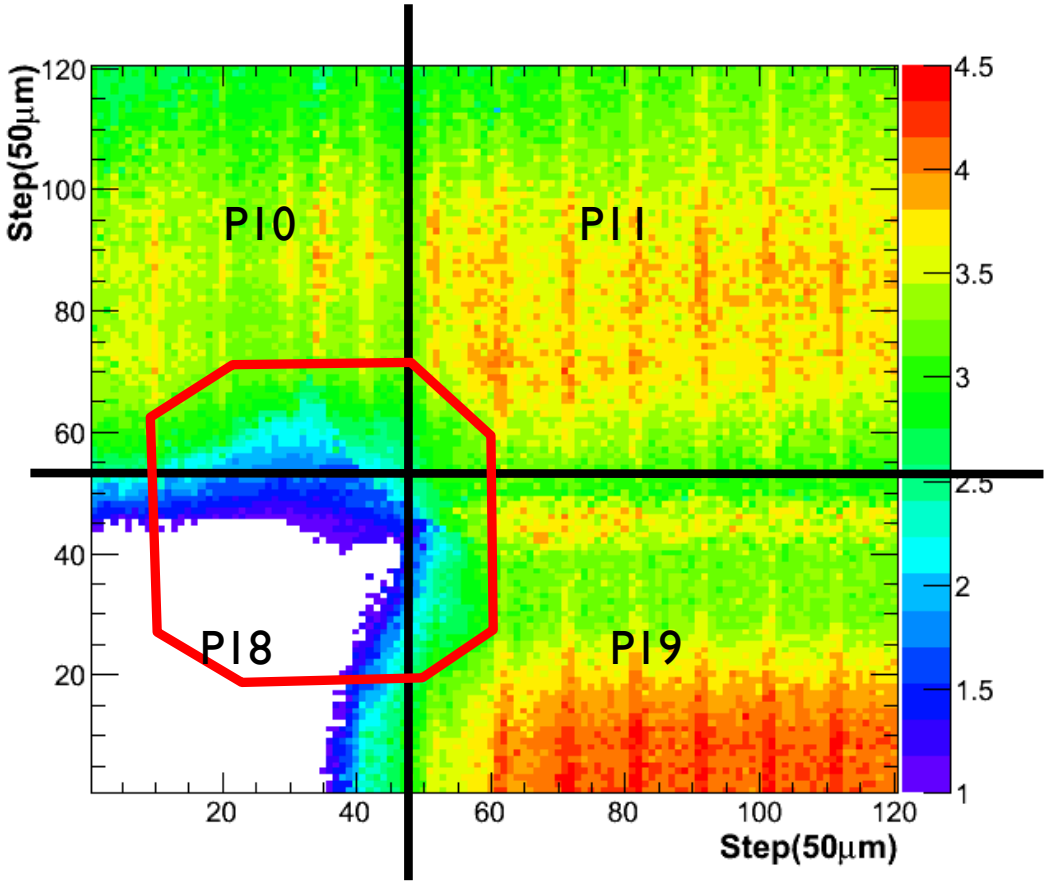
X – projection



Y – projection

Effect of the constructional support structure

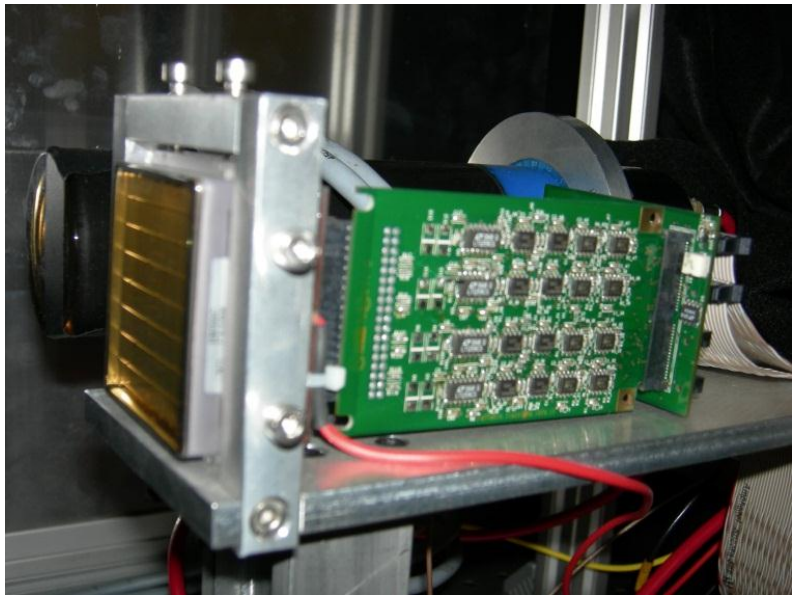




- Unfortunately the readout chain of P18 was off
- The red counter marks the region where it is possible to observe the effect of the constructional support structure

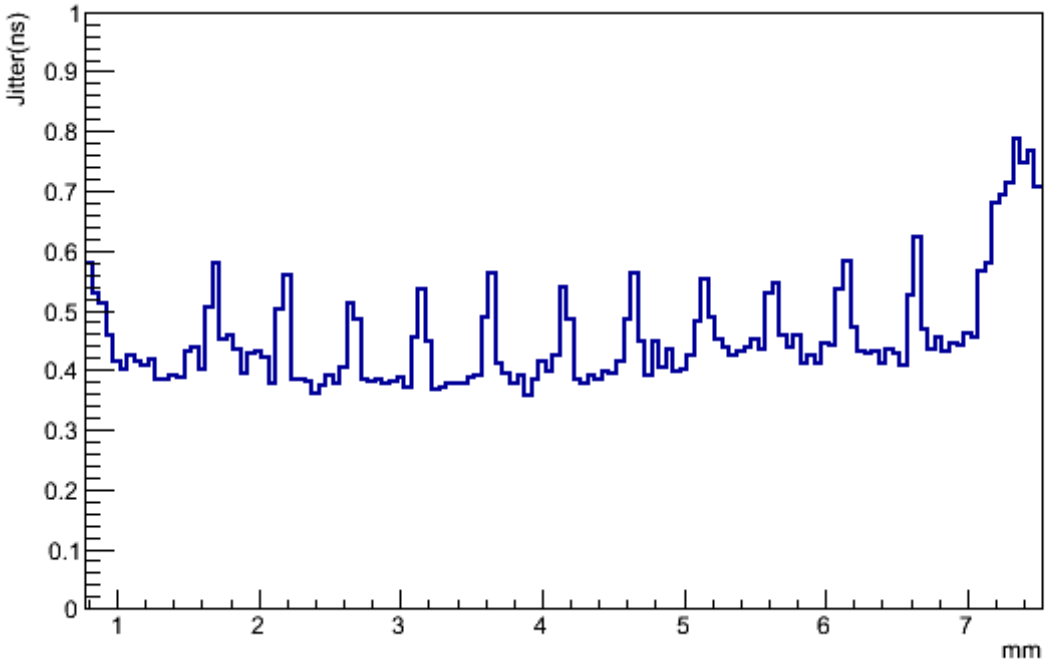
Bari Electronics

- Tran-resistance preamplifier
- Shaper w/ differential output
- ECL fast discriminator



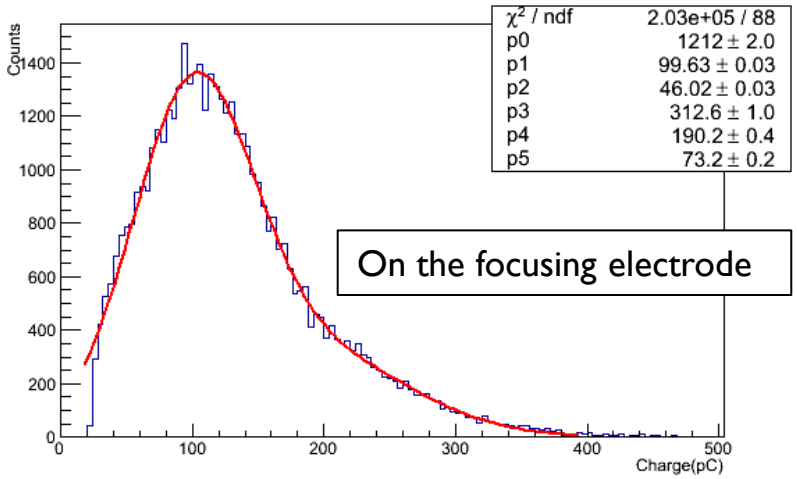
- We have equipped the MaPMT with 64 chains and …
- We have an issue on the digital lines when all the discriminators are connected: the signal does not keep the ECL levels
- We think there is a "feedback" on the threshold line, and we are investigating on it
- We switch back to single channel to perform some tests, but we are forced to set the threshold @ 15mV (may be too high for single p.e. studies)

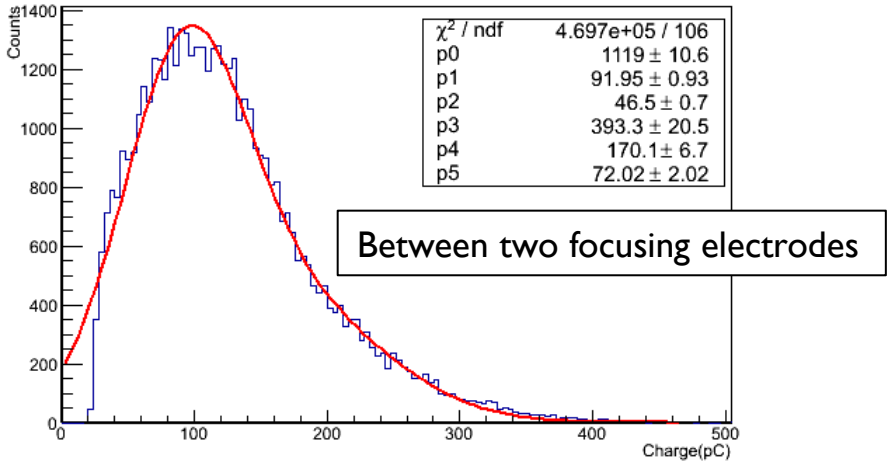
H8500 studies w/ amplification Time



- Intra pixel scan with 50μm step of pixel 1(6.26 x 6.26 mm)
- Light beam @ 1 p.e. level
- Jitter is evaluated with a Gaussian fit of the main peak in the time distribution (see next slides)
- Jitter scan shows clearly the position of the 11 focusing electrodes
- When the beam hits the photocathode in correspondence of a focusing electrode the jitter increase of 150ps

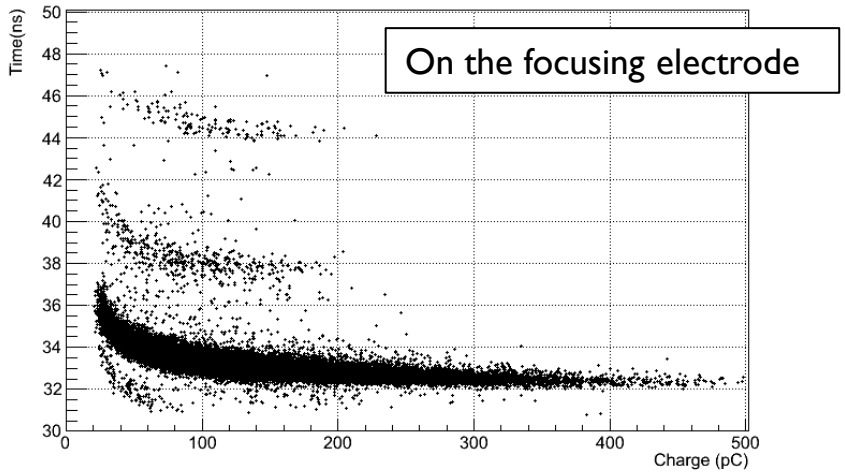
H8500 studies w/ amplification
Charge Comparison near/far focusing electrode

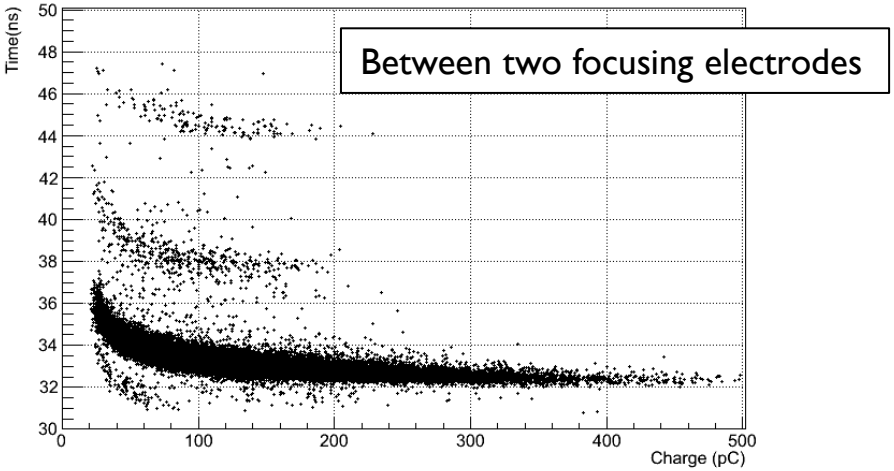




- Both distribution have been fit with two Gaussian function to take into account also the small chance of 2 p.e. emission
- On the focusing electrode the collected charge is
  - 1p.e. 100 +- 46 pC
  - 2p.e. 190 +- 73 pC
- In the region between two electrodes the collected charge is
  - 1p.e. 92 +- 46 pC
  - 2p.e. 170 +- 73 pC
- On the focusing electrode seems that the gain is higher as we have seen w/o amplification at an higher light level

H8500 studies w/ amplification
Charge-Time Comparison near/far focusing electrode

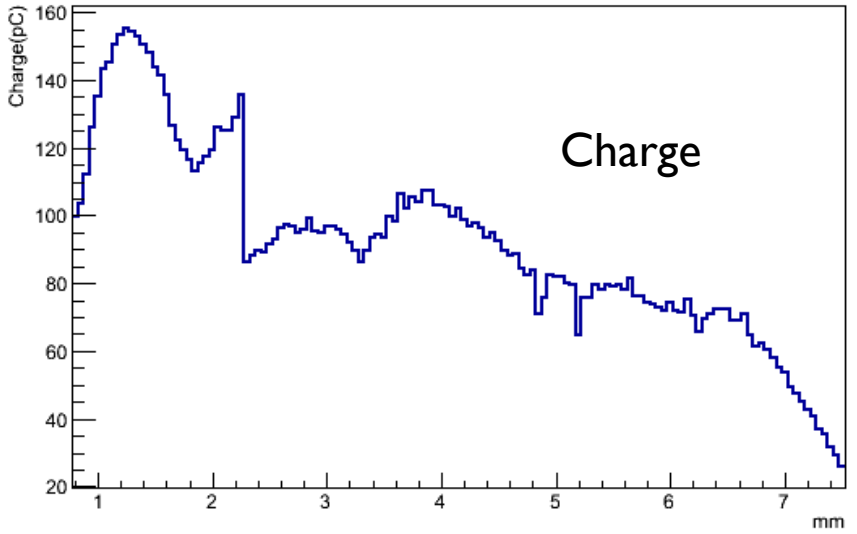


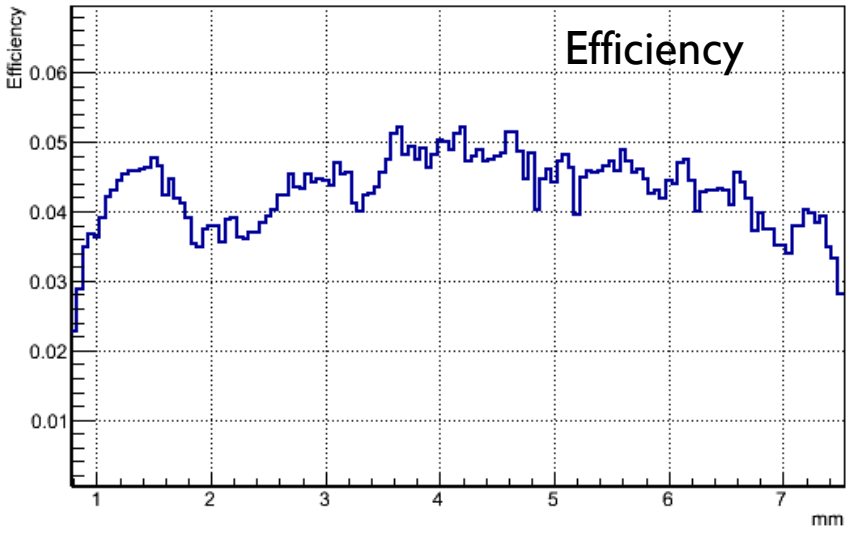


- The 15mV threshold is probably to high to study in detail the 1 p.e. effects
- The events related to the photons that convert on the first dynode and arrive ~2.0ns earlier are just a few percent of the total: this could be an effect of the threshold too high
- We observe two class of delayed events at +5ns and +12ns (back scattered photoelectrons)
- No major differences are observed near and far from the focusing electrode in these plots

H8500 studies w/ amplification Charge

- In the charge profile are visible some structures, but not directly correlated to the focusing electrode
- The gain variation is very high ~ 80%
- The efficiency has been measured with the threshold set at 15mv (a little it to high for 1 p.e. detection)
- Efficiency variation of ~ 35%





H8500 studies w/ amplification
Time Comparison near/far focusing electrode