



# Timing Measurements

## SiPM Hamamatsu 3x3 mm<sup>2</sup>

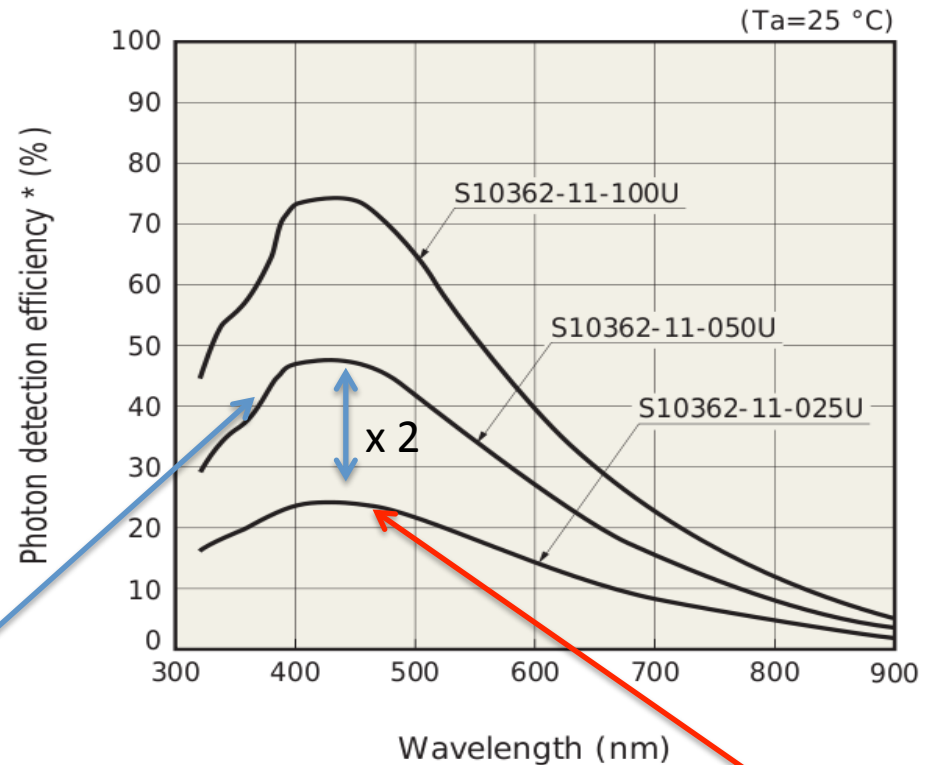
### 25 $\mu\text{m}$ vs. 50 $\mu\text{m}$

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# SiPM Hamamatsu 3x3 mm<sup>2</sup>

## Motivation:

- SiPM will be used for the timing measurements in the microscope detector and start counter
- Check timing resolution for high rate performance
- Measure pixel recovery time
- Decide of the sensor type to use: 25  $\mu\text{m}$  or 50  $\mu\text{m}$  pixel size



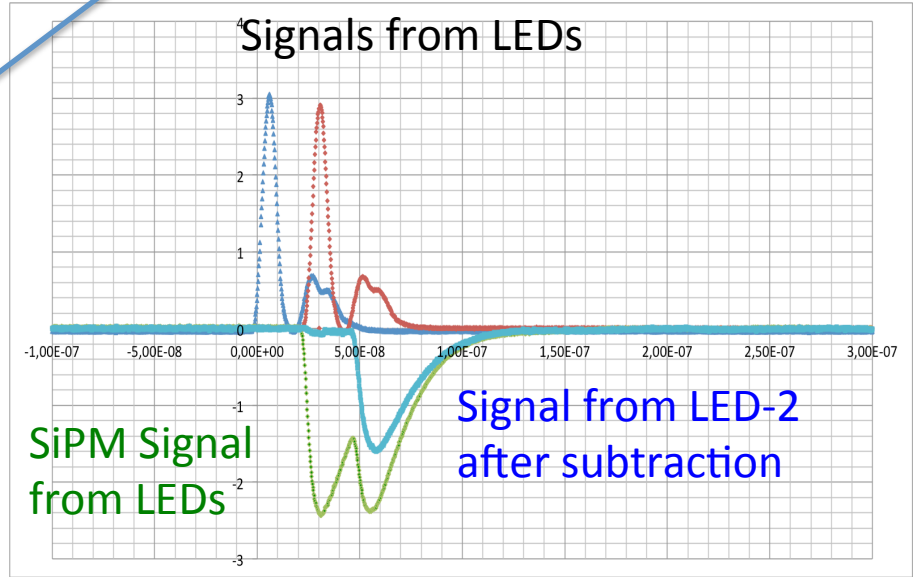
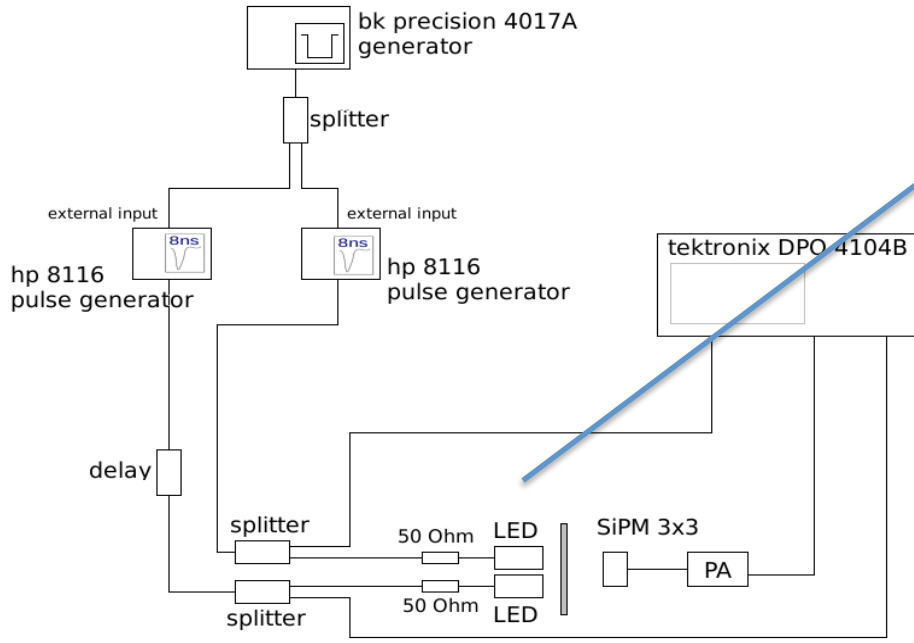
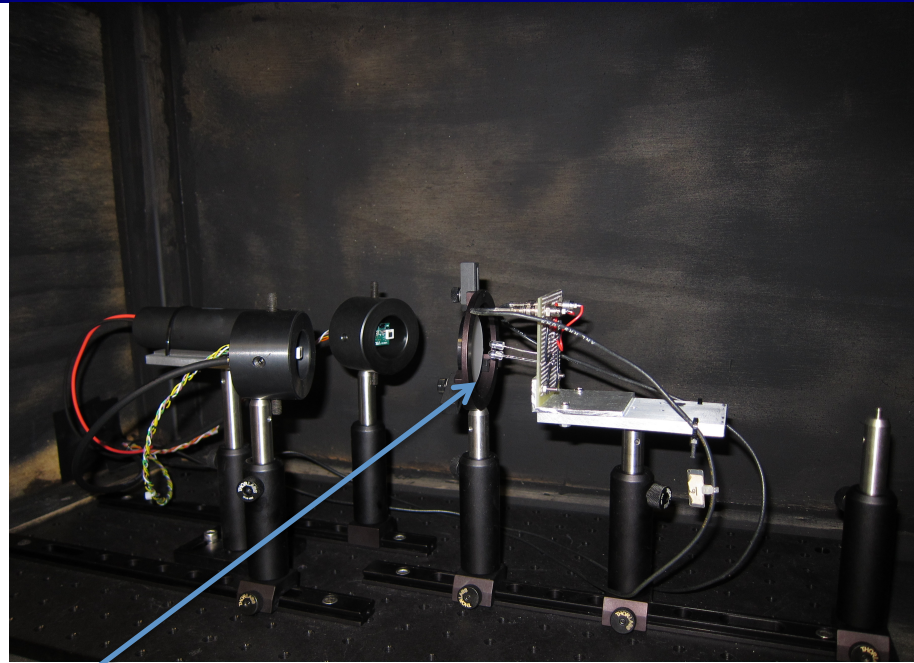
Pixel Size **50 x 50  $\mu\text{m}$**   
Peak Wavelength 440 nm  
**Number of pixels 3600**  
Terminal Capacitance 320 pF  
**Gain 750000**

Pixel Size **25 x 25  $\mu\text{m}$**   
Peak Wavelength 440 nm  
**Number of pixels 14400**  
Terminal Capacitance 320 pF  
**Gain 275000**

# Pixel Recovery Time

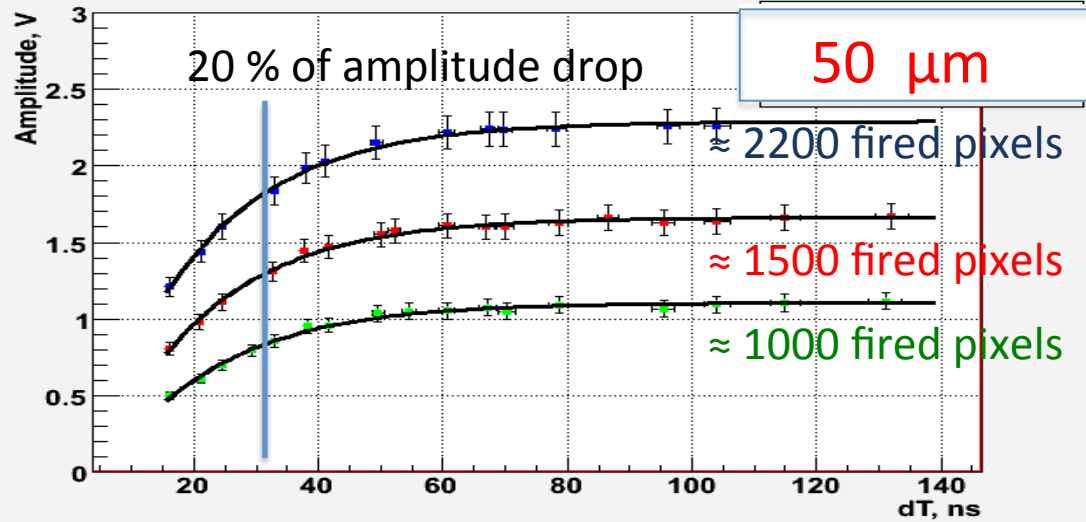
# Experimental Setup

- Estimate pixel recovery time using two-LEDs setup
  - “Blind” SiPM using the first LED pulse
  - Measure SiPM amplitude from the second LED
  - Very delay between the 1<sup>st</sup> and 2<sup>nd</sup> LED pulses from 10 to 800 ns
  - Very LED amplitudes of the 1<sup>st</sup> and 2<sup>nd</sup> pulses

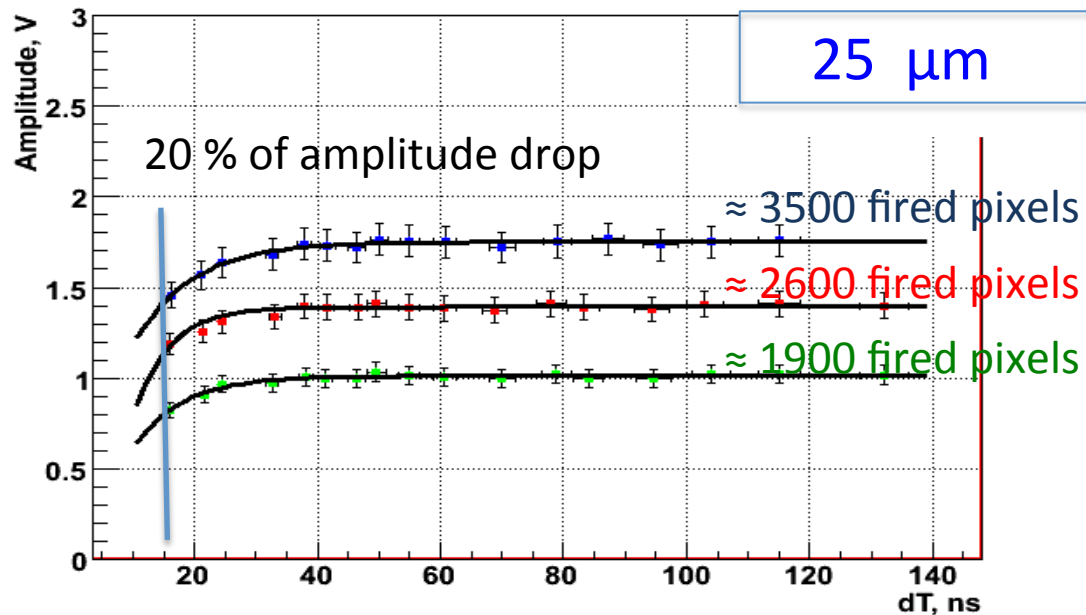


# Pixel Recovery Time

SiPM recovery time. SiPM Hamamatsu 3x3 mm<sup>2</sup>, 50 mkm



SiPM recovery time. SiPM Hamamatsu 3x3 mm<sup>2</sup>, 25 mkm

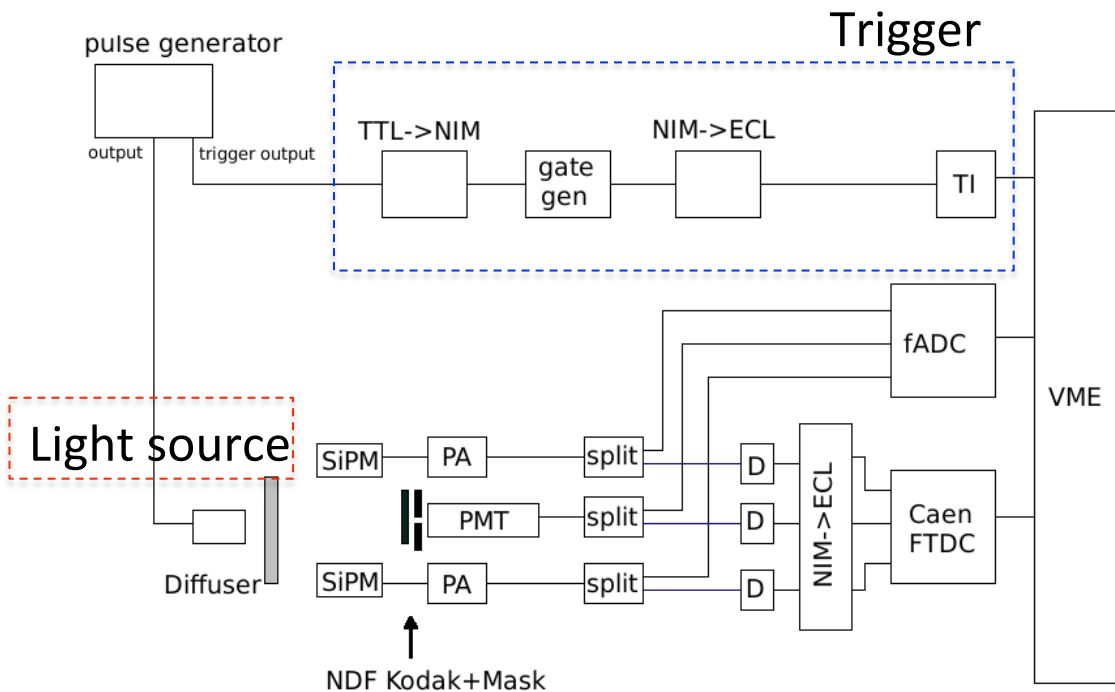


- SiPM amplitude of the 2<sup>nd</sup> LED pulse as a function of the pulses delay
- First pulse use a large
- Pixel recovery time for 50  $\mu\text{m}$  pixel size SiPM is about 30 ÷ 35 ns and for 25  $\mu\text{m}$  – 15 ÷ 20 ns

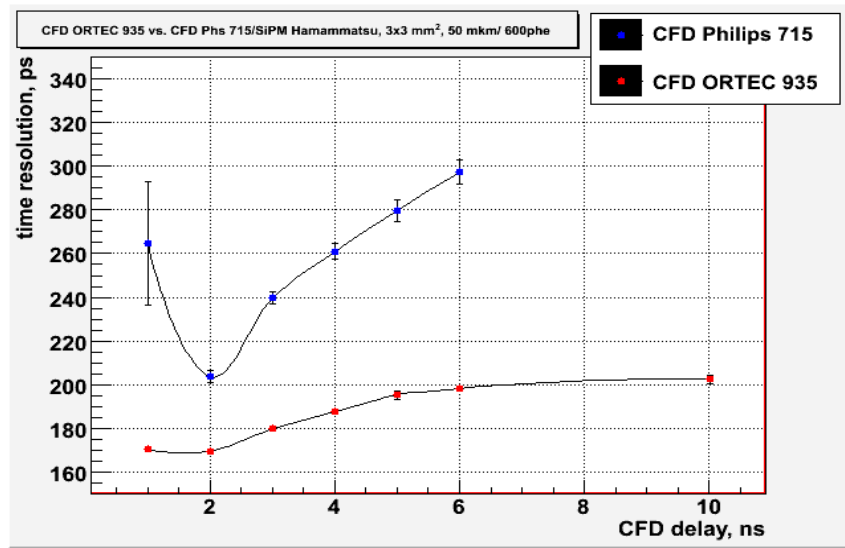
About two times better pixel resolution for 25  $\mu\text{m}$  pixel size SiPM.

# Timing Resolution

# Experimental Setup



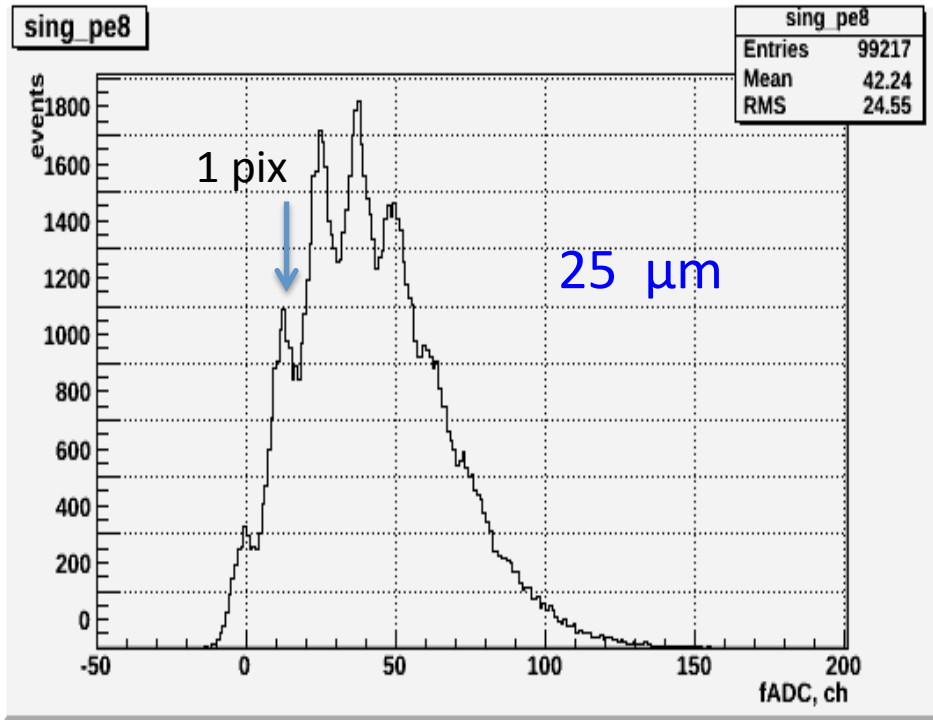
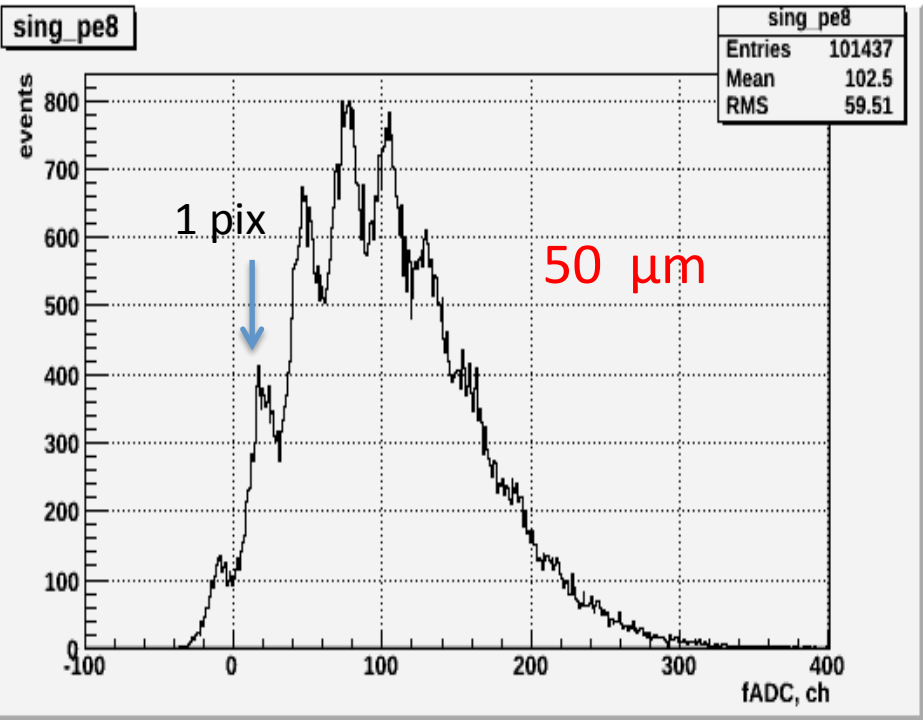
- Measure timing resolution using two identical SiPMs
  - $\Delta t = t_{SiPM1} - t_{SiPM1}$
- Two different types of light sources:
  - Picosecond light pulser Hamamatsu PLP-10 (100 ps pulse width)
  - Blue LED (8 ns pulse width)



- Use
  - Jlab fADC-250
  - 25 ps CAEN TDC
  - ORTEC 935 constant fraction discriminator

# SiPM Calibration

## Typical calibrations spectrum



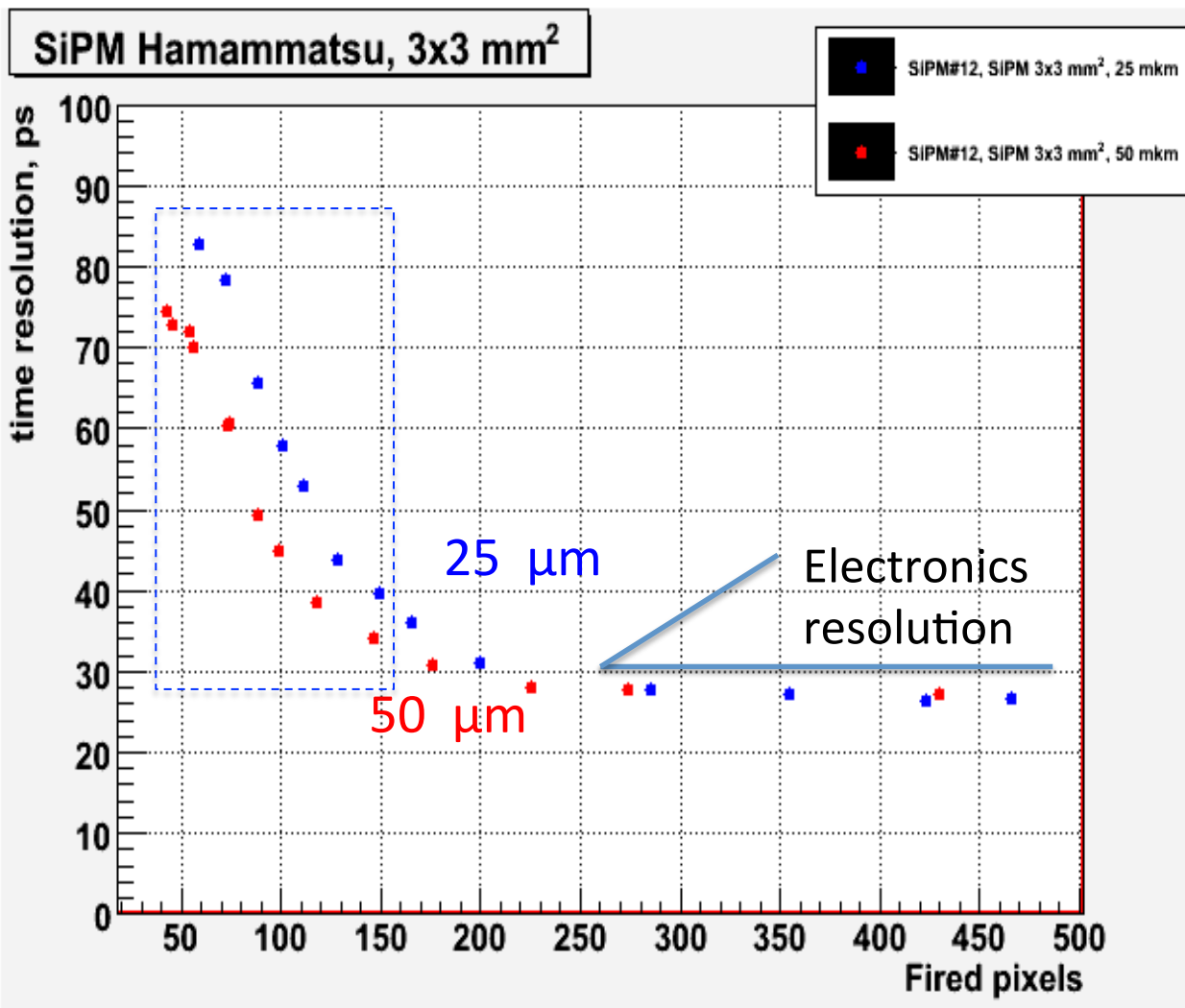
1 fired pixel  $\approx$  27 channels

1 fired pixel  $\approx$  12 channels

- Determine single pixel in ADC counts



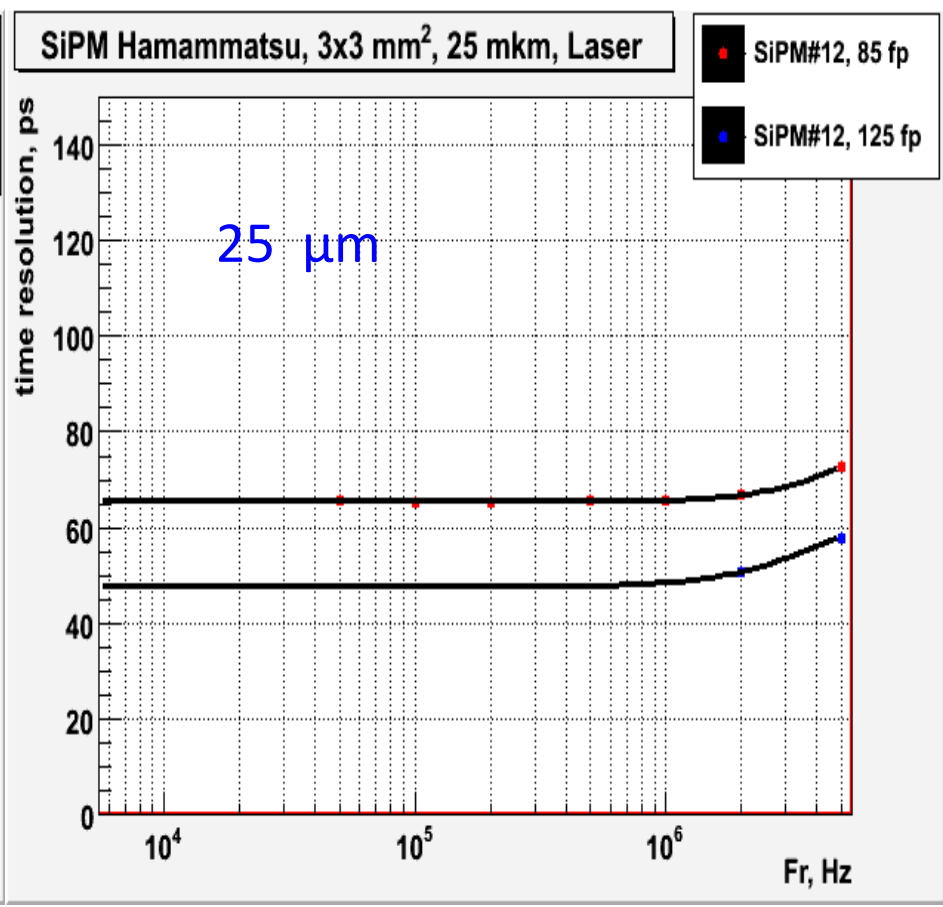
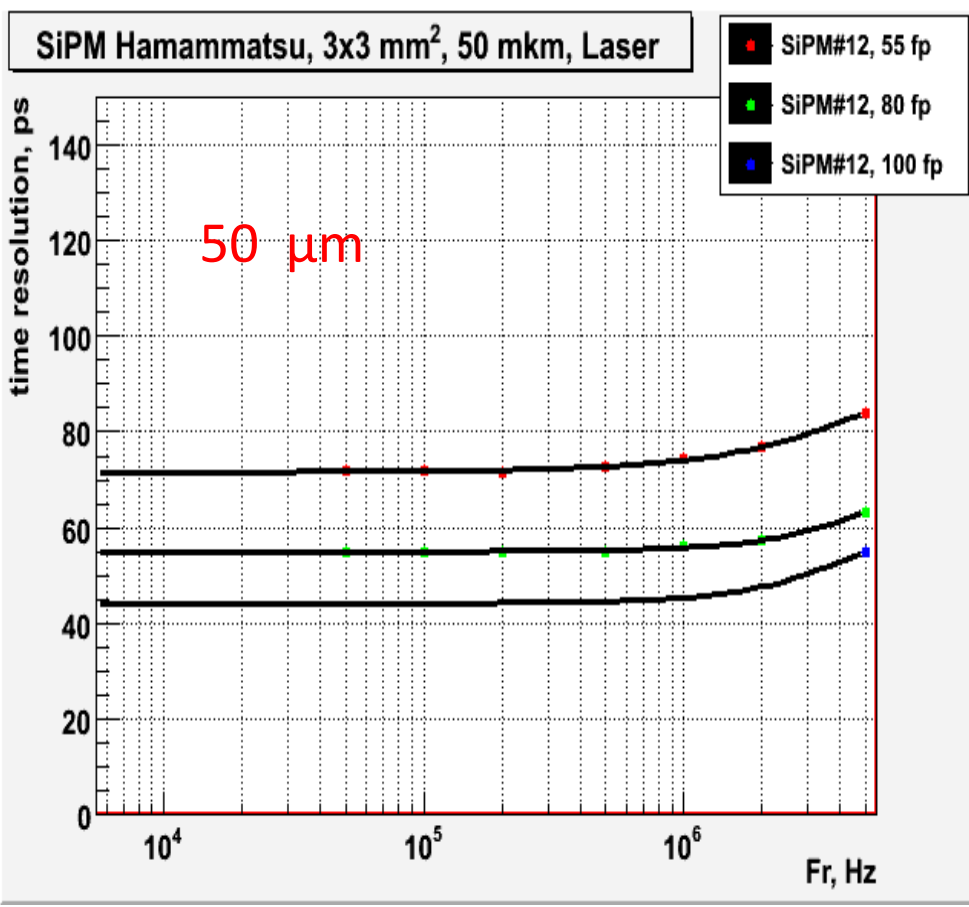
# Time Resolution vs. Number of Fired Pixels: Laser



## Preliminary results

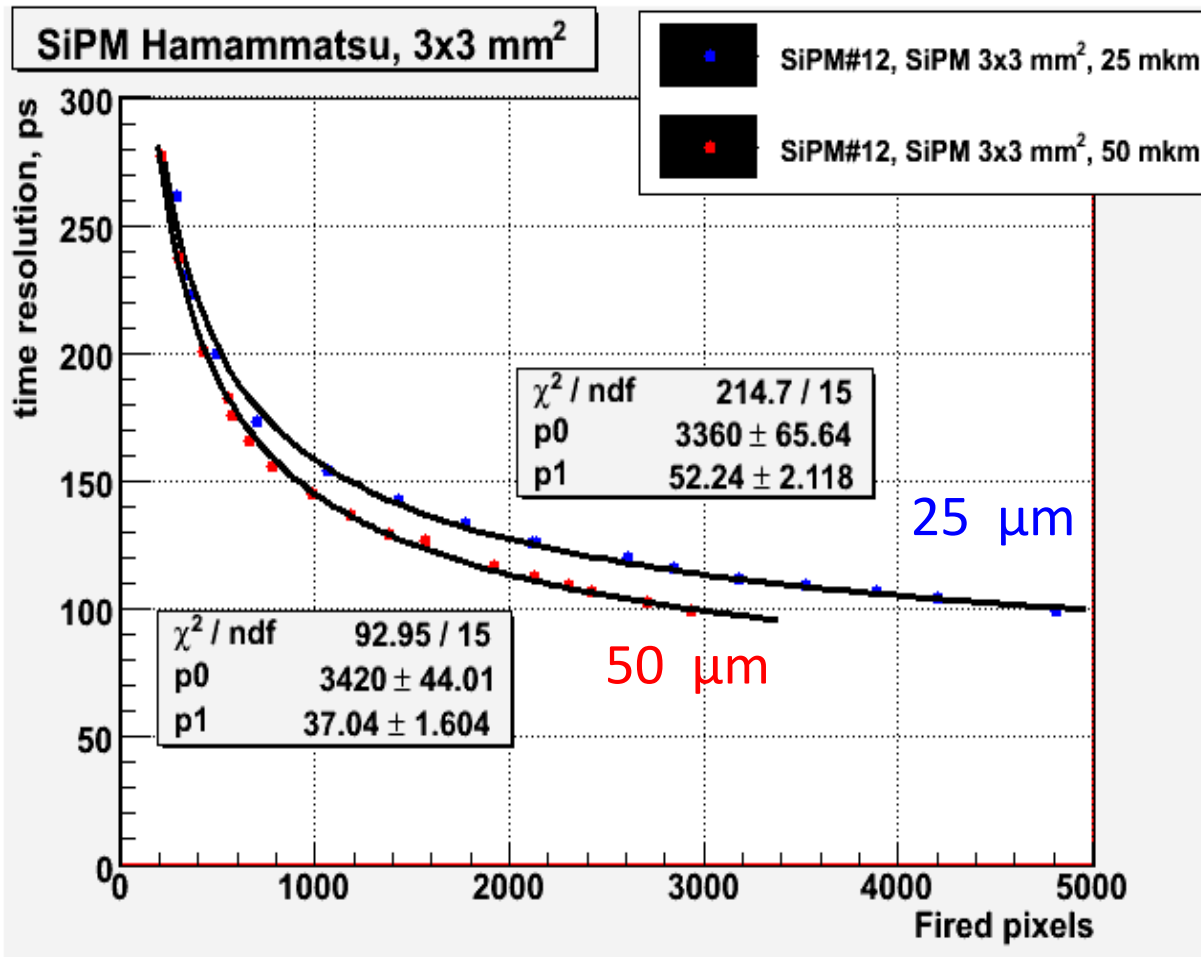
- Measure  $(\sigma(t_1 - t_2))/\sqrt{2}$
- Intrinsic resolution of CAEN 1290 is about 30 ps
- Uncertainties in timing resolution for low-pixel region are under study
- Timing resolution seems to be slightly worse for 25 μm sensor
  - NOTE: the PDE is two times smaller!!!

# Time Resolution vs. Rate: Laser



- Timing resolution degrades by about 20 % at 5 MHz

# Time Resolution vs. Number of Fired: LED

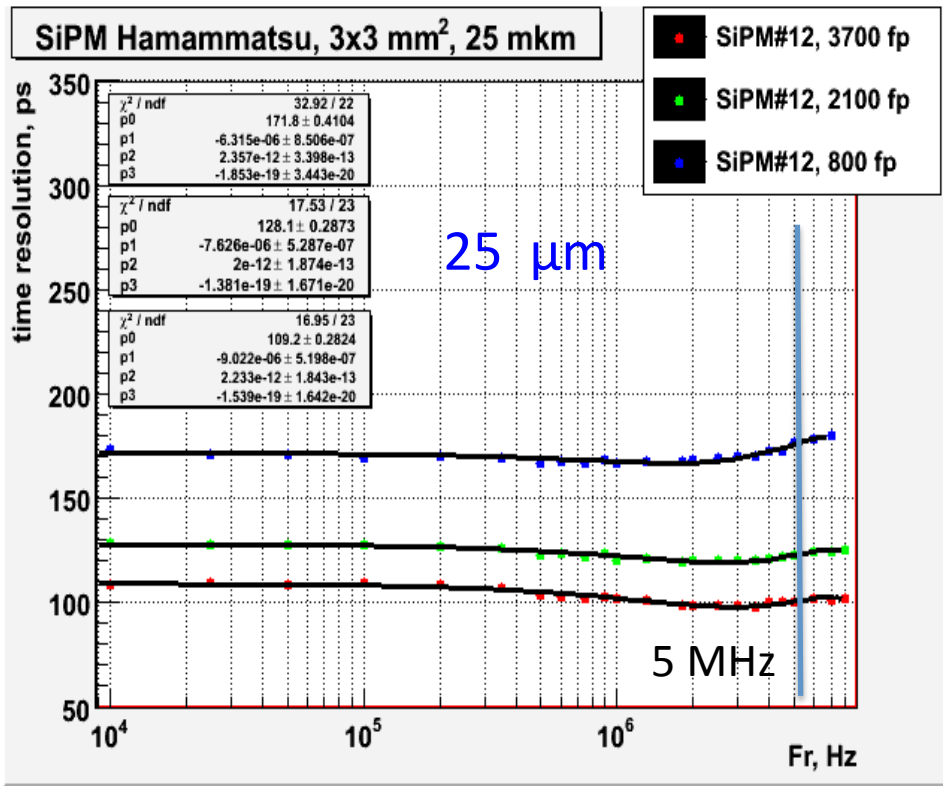
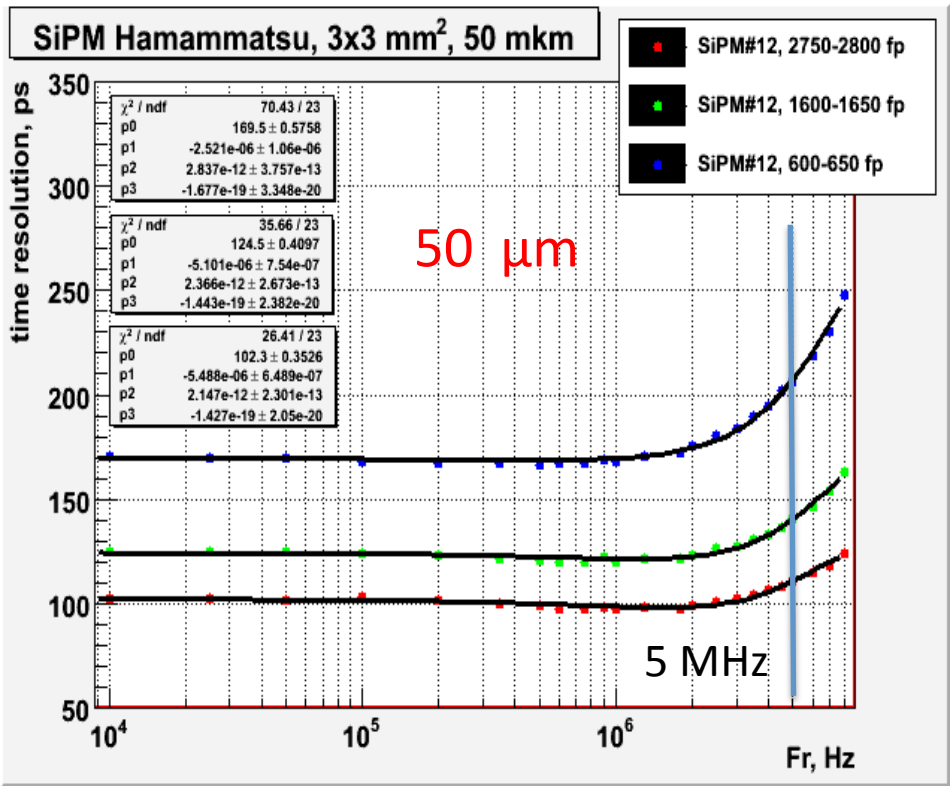


Fit function:

$$y(x) = p_0 / \sqrt{N_{fp}} + p_1$$

- Generator pulse width is 8 ns
- Slightly worse resolution was also observed for 25 μm SiPMs

# Time Resolution vs. Rate: LED



- Degradation of timing resolution at high rates was also observed for LED pulses
- LED stability at high rates has to be understood
- 25  $\mu\text{m}$  pixel size SiPM seem to have smaller timing resolution degradation at high rates

# Conclusion

- Compared the timing properties of 25  $\mu\text{m}$  and 50  $\mu\text{m}$  pixel size 3x3 mm<sup>2</sup> SiPMs Hamamatsu
- Was measured:
  - Pixel recovery time with LEDs
    - 35  $\div$  40 for 50  $\mu\text{m}$
    - 15  $\div$  20 for 25  $\mu\text{m}$
  - Timing resolution with laser and LED
    - Very good timing resolution was observed using laser pulse (30  $\div$  40 ps for about 100 fired pixels)
    - Timing resolution for 25  $\mu\text{m}$  sensor were found slightly worse then that of 50  $\mu\text{m}$  sensor
    - Small degradation of the timing resolution on the level of 20 – 30 % was observed at the rates above 5 MHz for both the laser and LED measurements