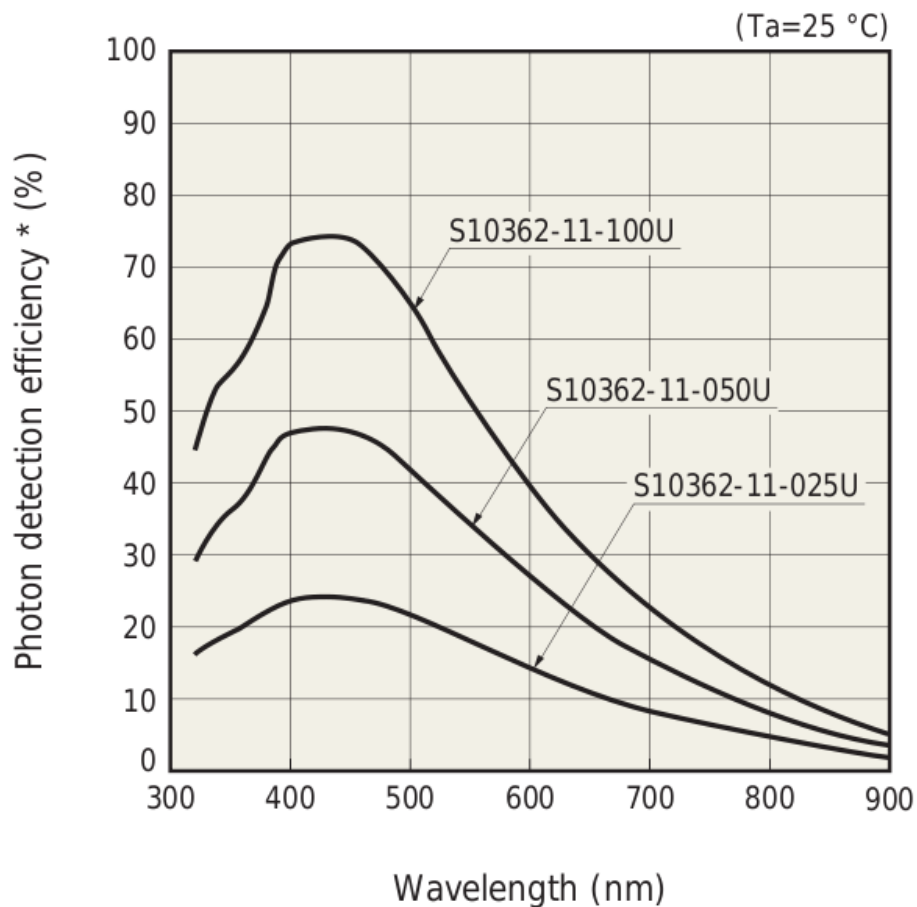




Timing measurements
SiPM Hamamatsu 3x3 mm²
25 μm vs. 50 μm

Alex Somov
Ivan Tolstukhin
5/1/2012

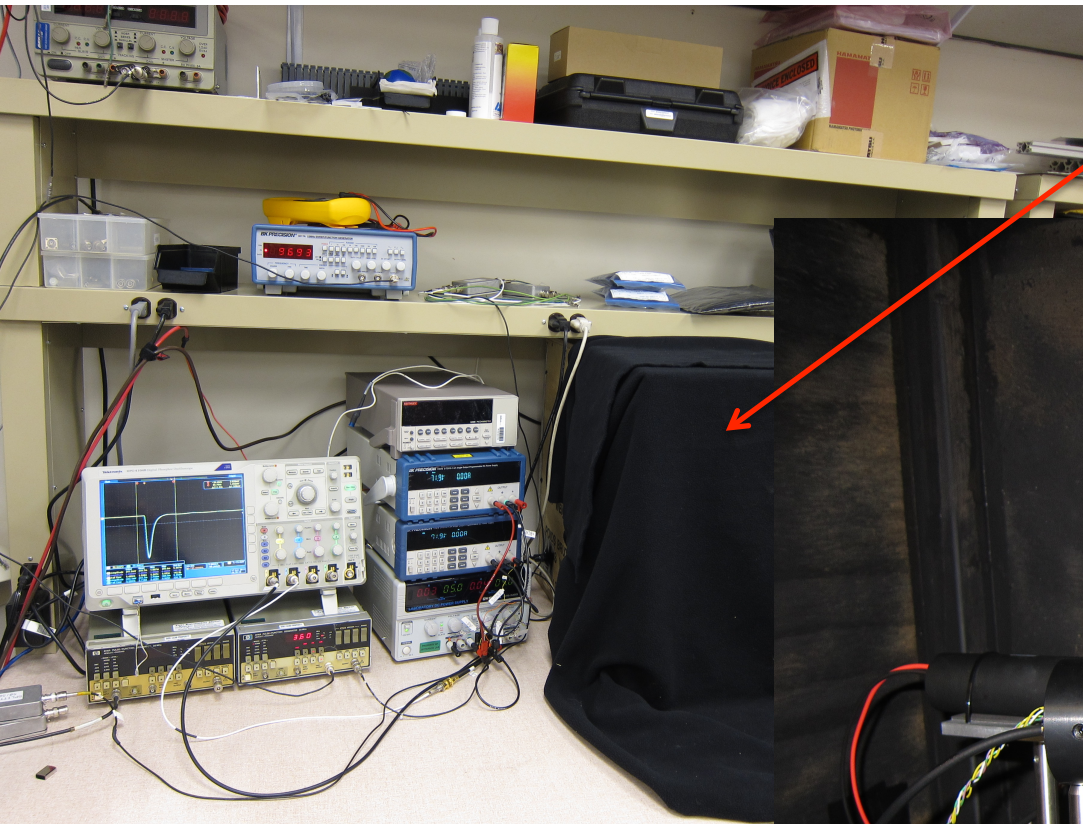
SiPM Hamamatsu 3x3 mm²



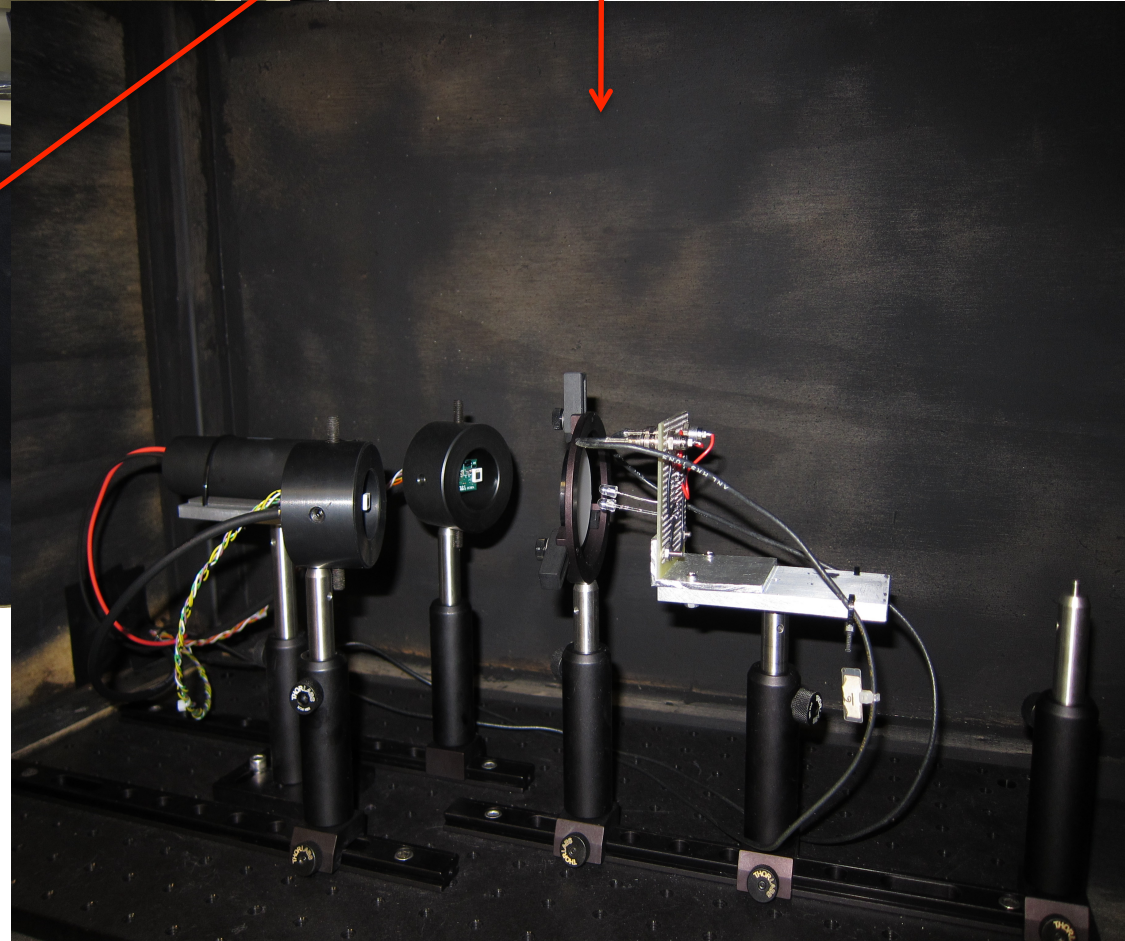
Pixel Size	50 x 50 μm
Peak Wavelength	440 nm
Number of pixels	3600
Terminal Capacitance	320 pF
Gain	750000

Pixel Size	25 x 25 μm
Peak Wavelength	440 nm
Number of pixels	14400
Terminal Capacitance	320 pF
Gain	275000

Experimental setup

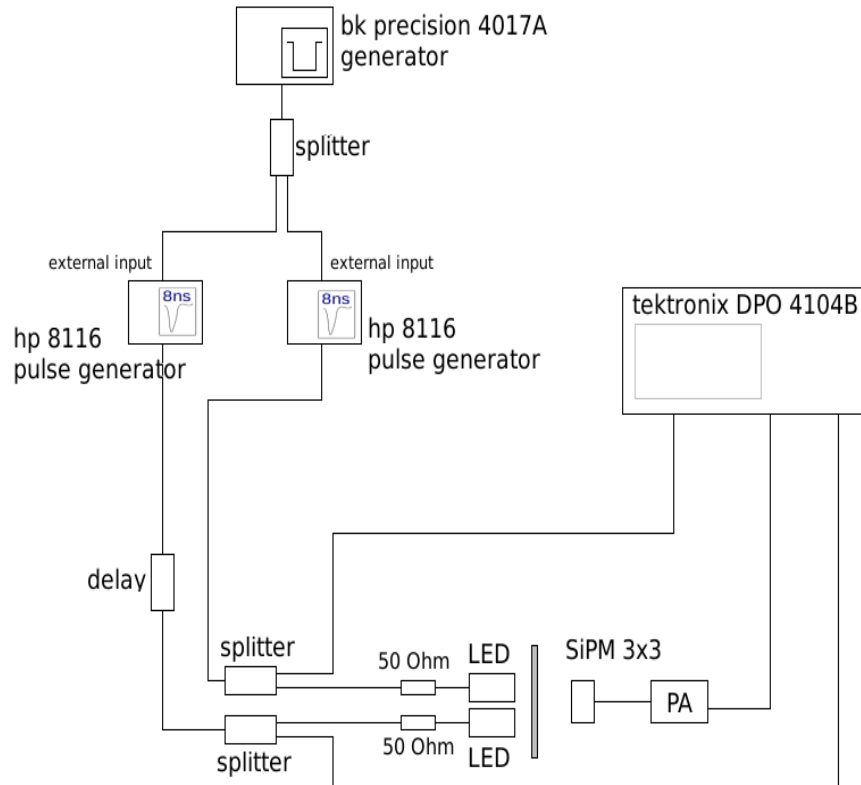


Dark box

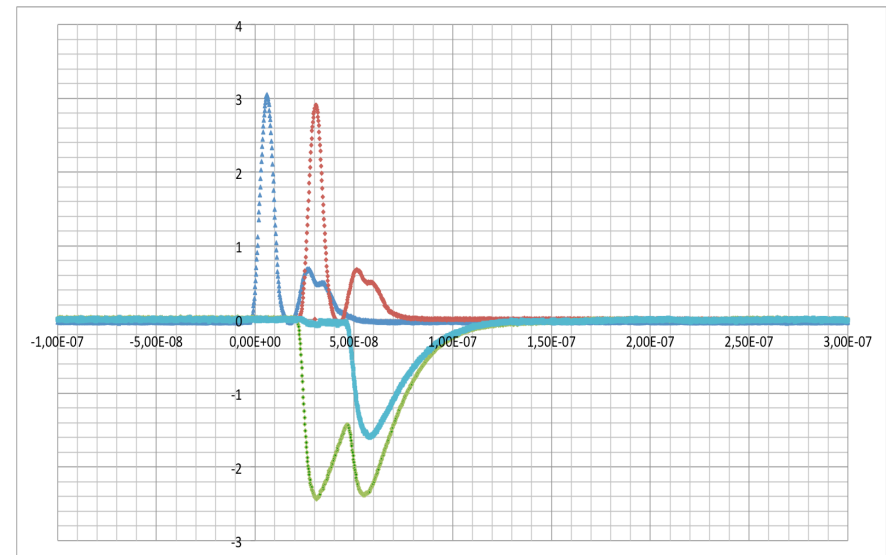
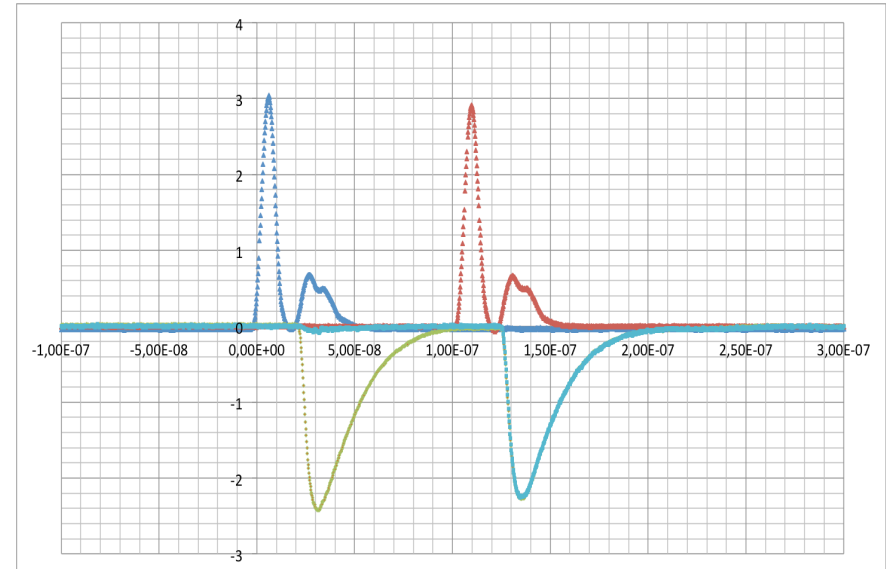


Pixel recovery time

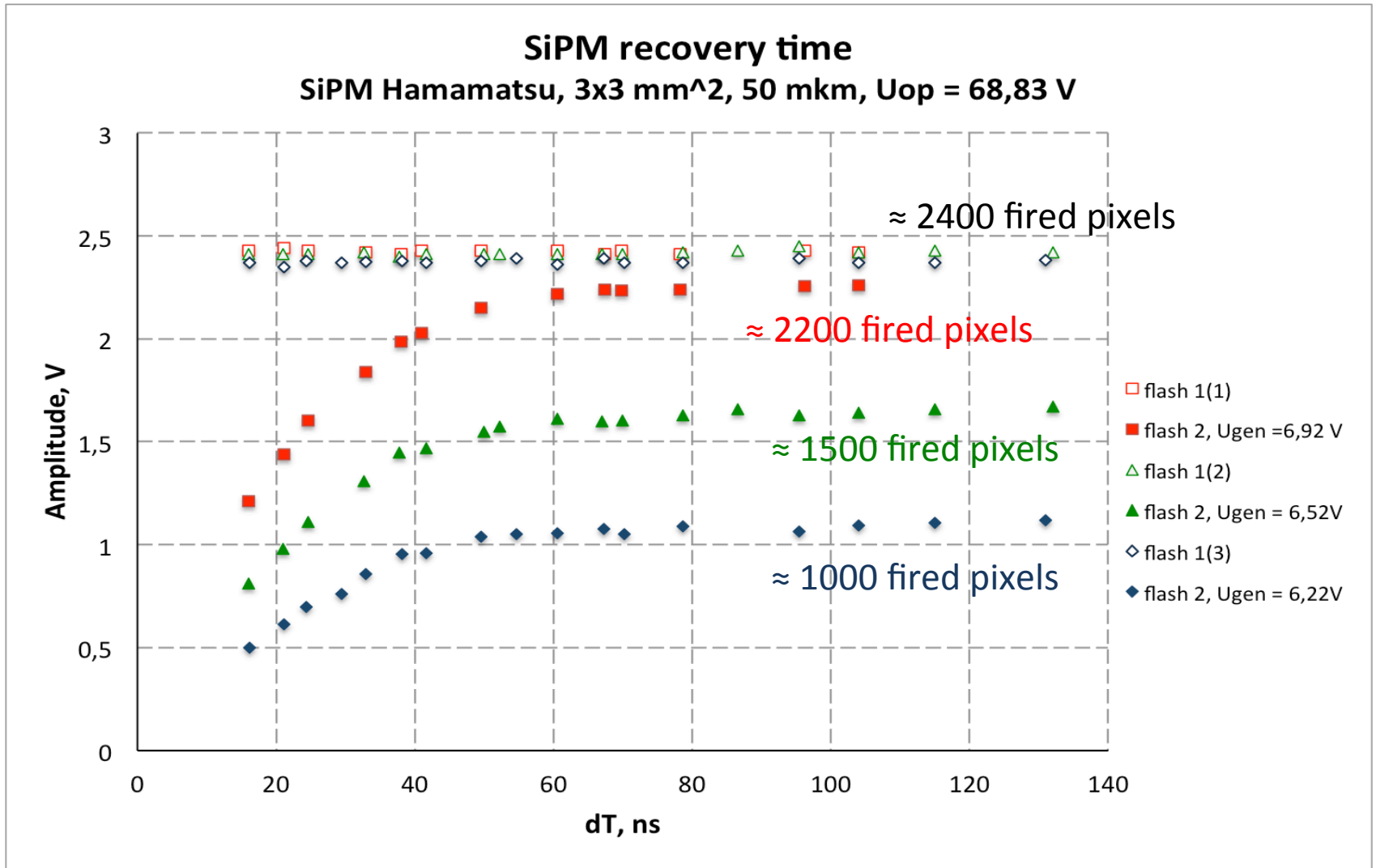
Experimental setup



- Two LED's
 - 1st – stable high pulse
 - 2nd – different amounts of light
- Delay line from 16 to 140 ns
- Observing signals on oscilloscope

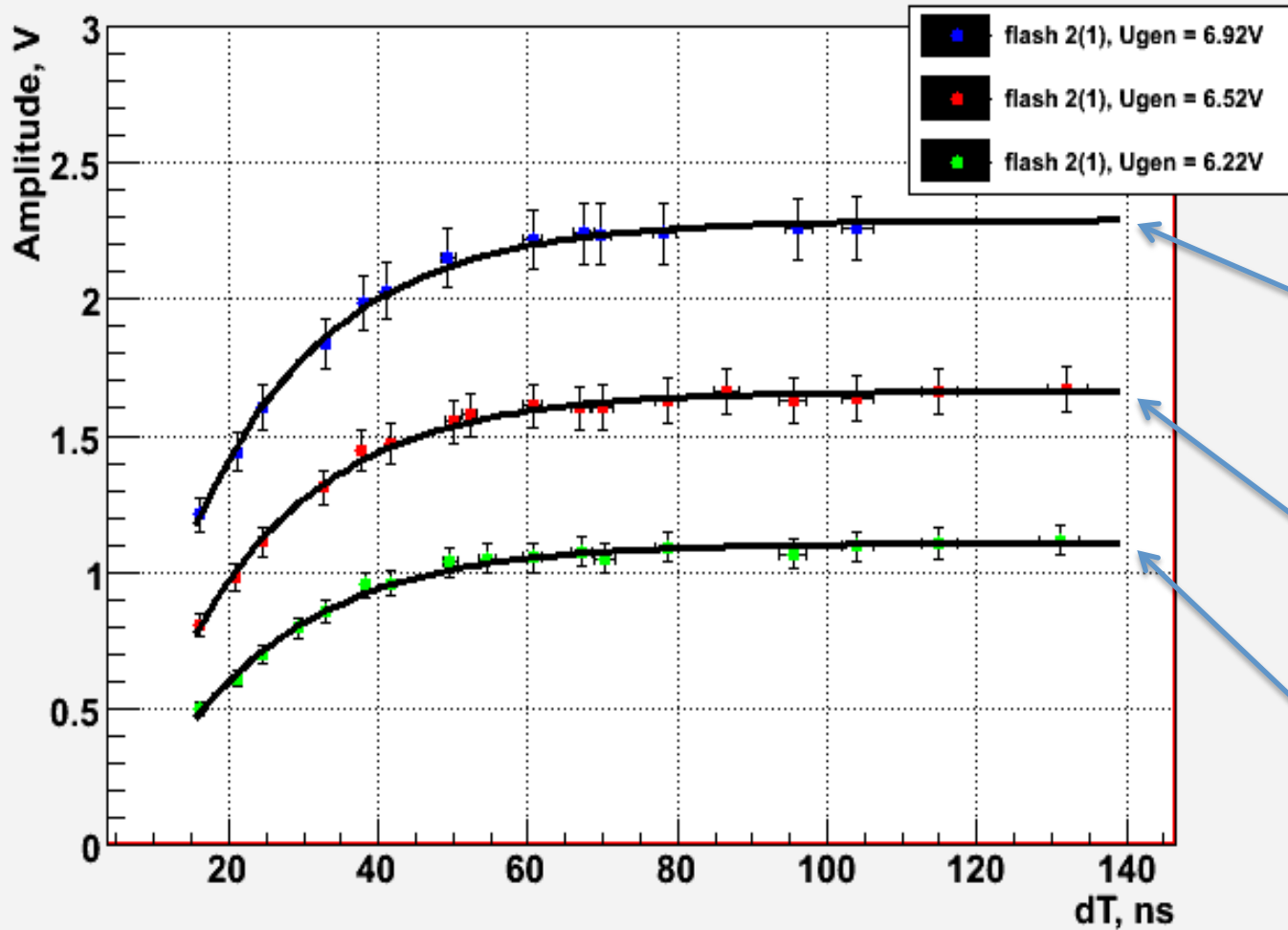


SiPM Hamamatsu, 3x3 mm², 50 μm



SiPM Hamamatsu, 3x3 mm², 50 μm

SiPM recovery time. SiPM Hamamatsu 3x3 mm², 50 mkm



Fit function:
 $y = A - B \cdot \exp(-x/\tau)$

$A = 2.28 \pm 6.1 \cdot 10^{-2}$
 $B = 2.65 \pm 0.42$
 $\tau = 18.05 \pm 3.3$

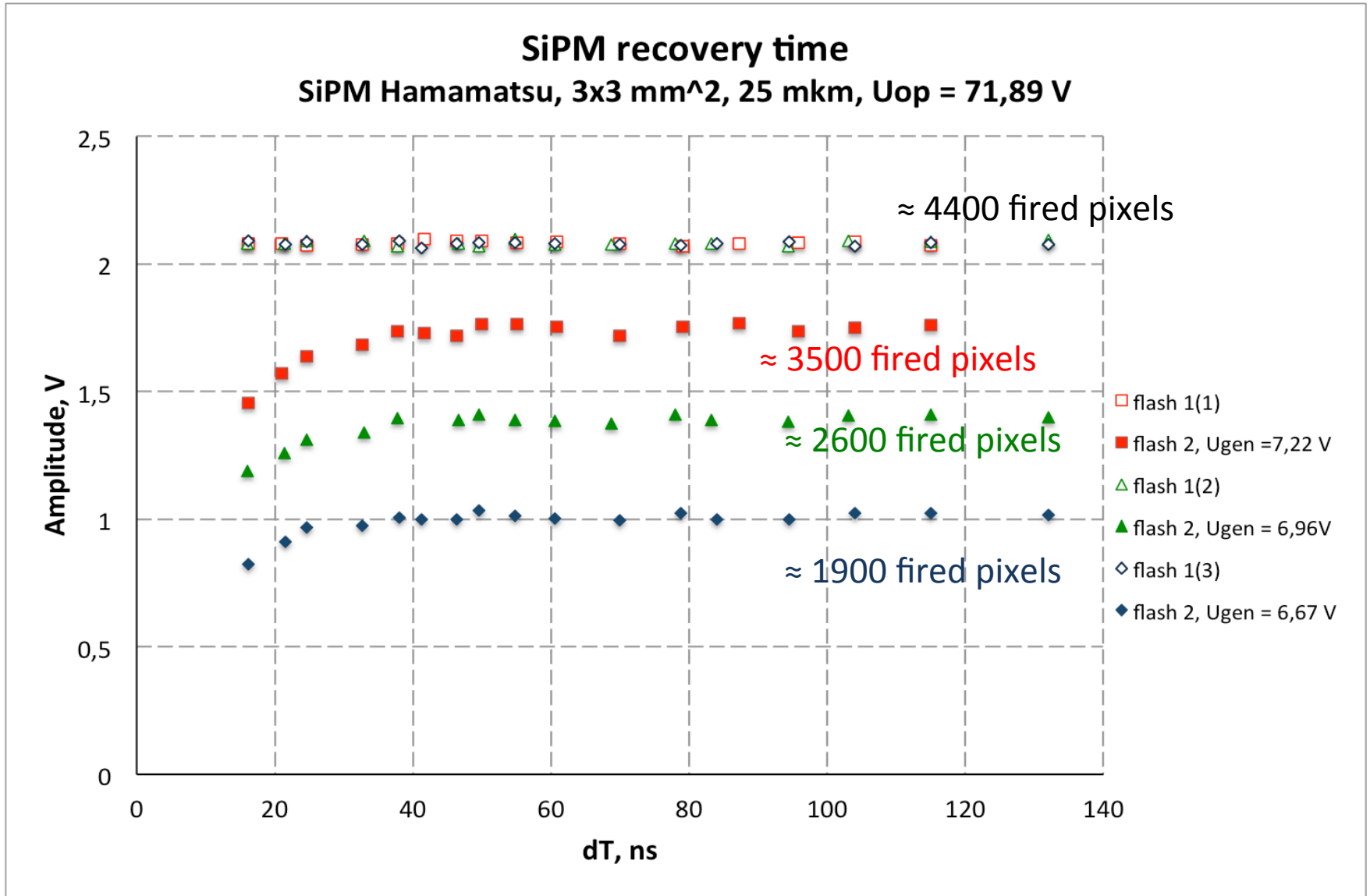
$A = 1.66 \pm 3.3 \cdot 10^{-2}$
 $B = 2.14 \pm 0.3$
 $\tau = 17.74 \pm 2.6$

$A = 1.11 \pm 2.34 \cdot 10^{-2}$
 $B = 1.51 \pm 0.18$
 $\tau = 18.25 \pm 2.35$

<Fit>: $y = 1.68 - 2.1 \cdot \exp(-dT/18.01)$

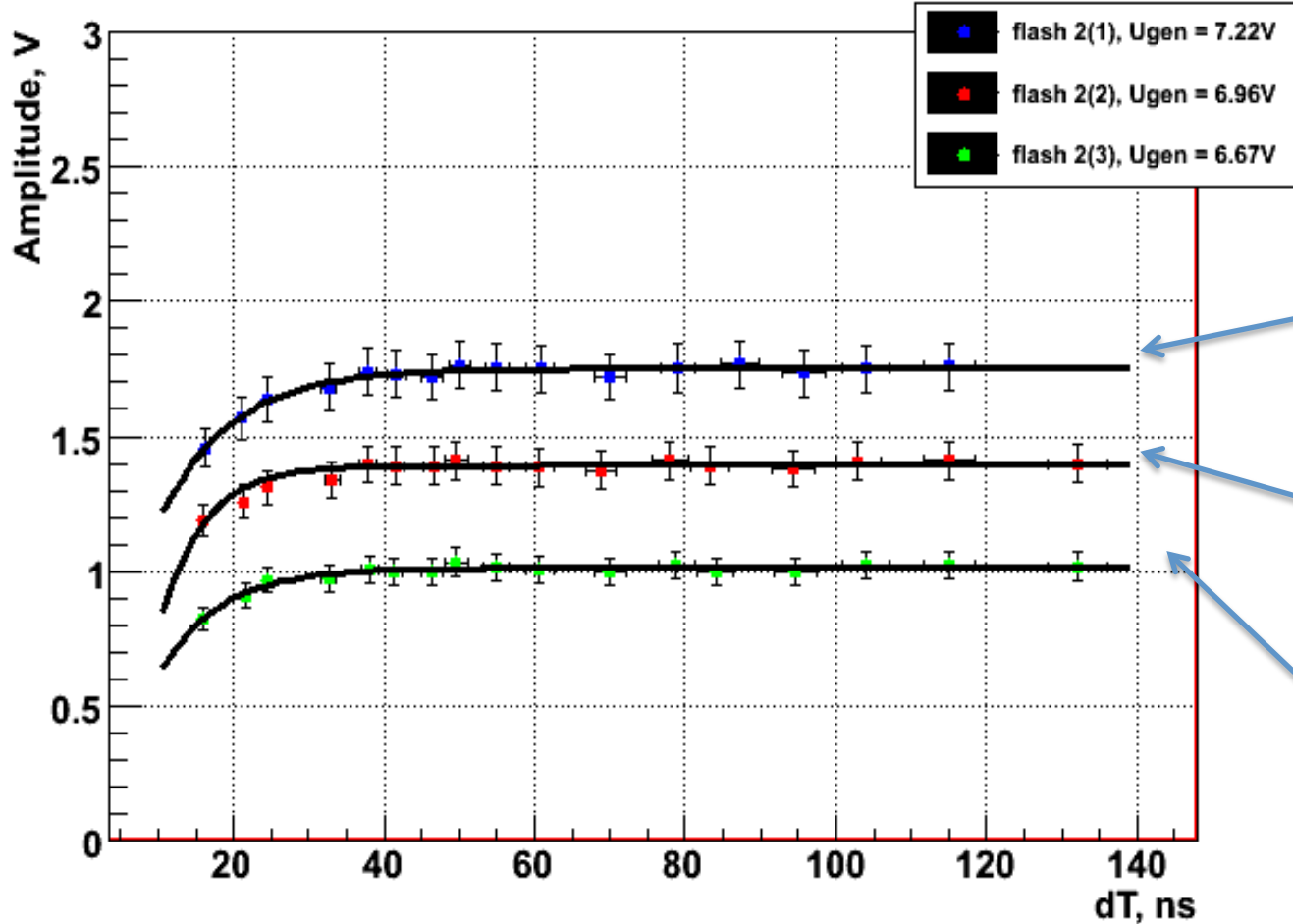
$\langle \tau_{50} \rangle = 18.01 \text{ ns}$

SiPM Hamamatsu, 3x3 mm², 25 μm



SiPM Hamamatsu, 3x3 mm², 25 μm

SiPM recovery time. SiPM Hamamatsu 3x3 mm², 25 mkm



Fit function:
 $y = A - B \cdot \exp(-x/\tau)$

$A = 1.39 \pm 1.9 \cdot 10^{-2}$
 $B = 3.43 \pm 2.28$
 $\tau = 5.76 \pm 1.5$

$A = 1.75 \pm 3.0 \cdot 10^{-2}$
 $B = 1.62 \pm 1.8$
 $\tau = 9.48 \pm 5.57$

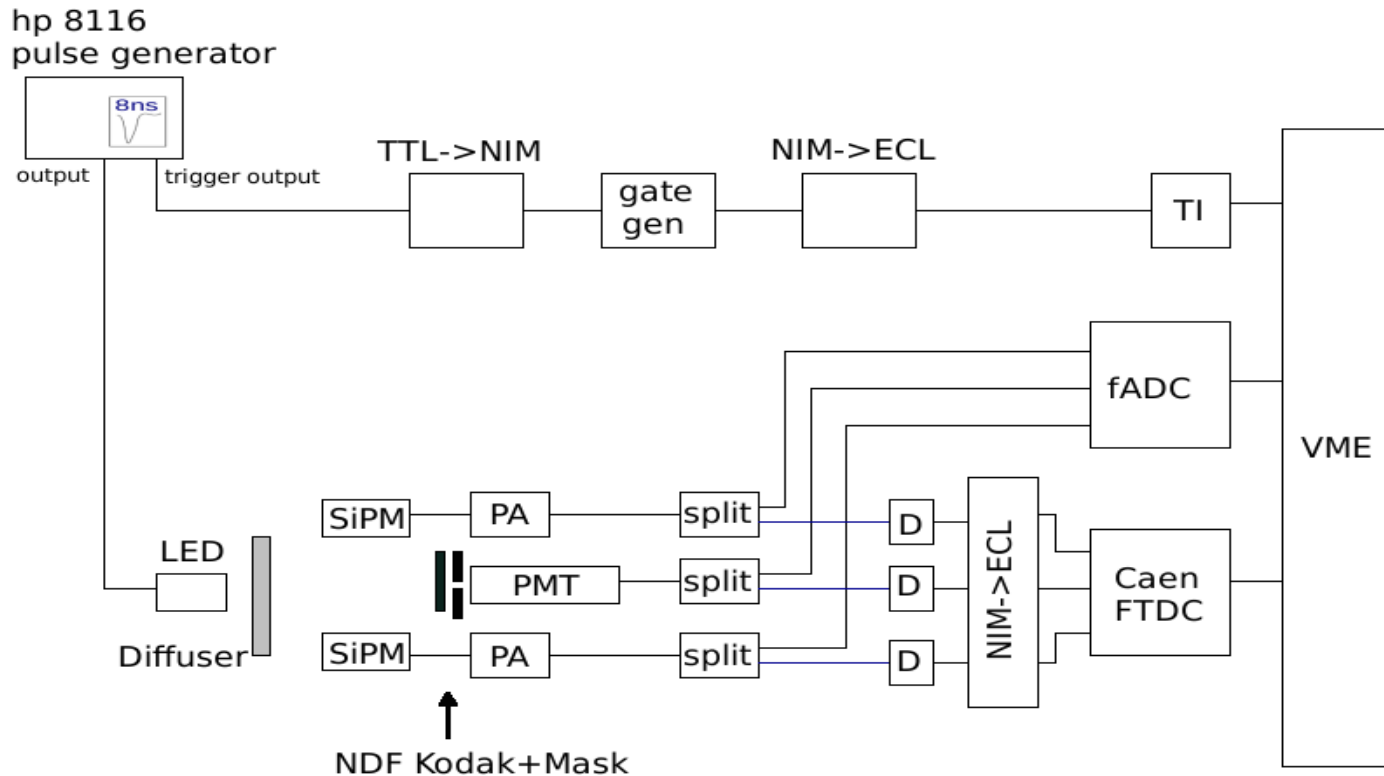
$A = 1.01 \pm 1.55 \cdot 10^{-2}$
 $B = 1.41 \pm 1.65$
 $\tau = 7.91 \pm 4.26$

<Fit>: $y = 1.38 - 2.15 \cdot \exp(-dT/7.72)$

$\langle \tau_{25} \rangle = 7.72 \text{ ns}$

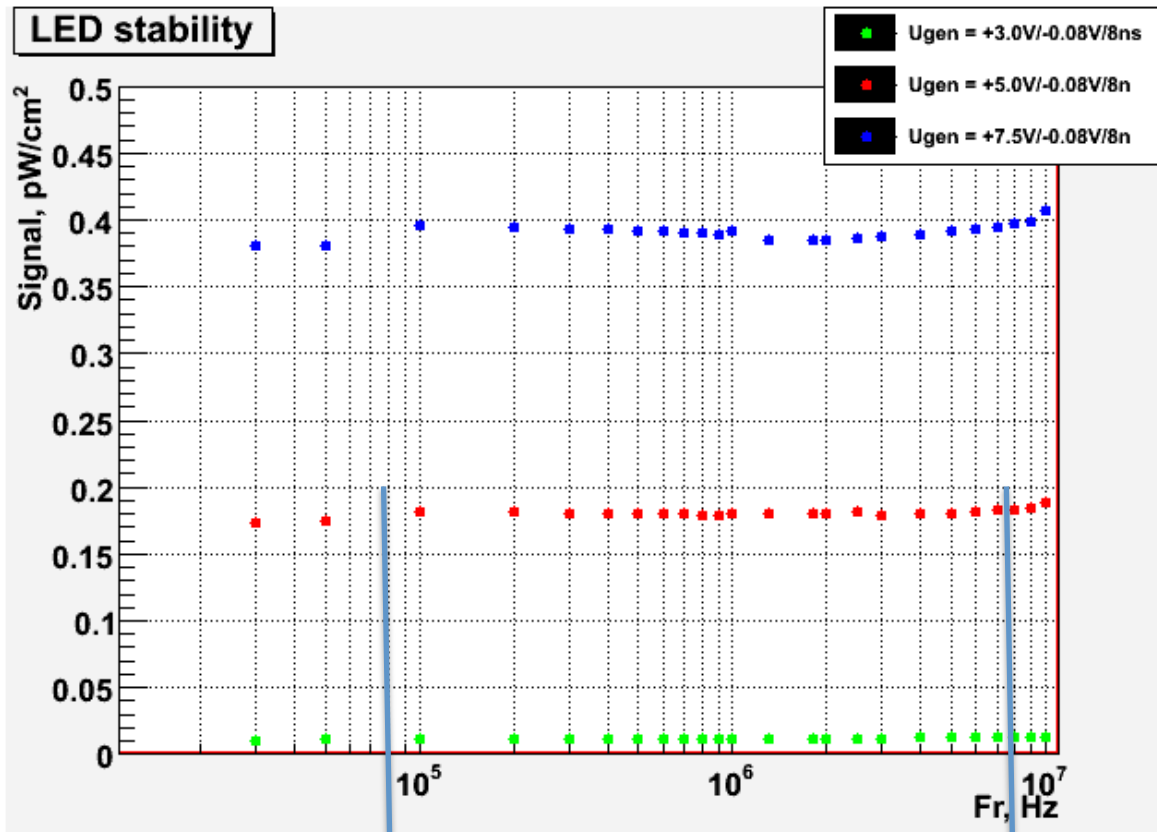
Time resolution

Experimental setup



Translator TTL->NIM: Philips 726
Gate-delay generator: Philips 794
NIM->ECL: LeCroy 4617
Discriminator: CFD Philips 715 / CFD ORTEC 935
PMT: Hamamatsu H6533
SiPM: Hamamatsu 3x3 mm², 25 or 50 mkm
Splitter: 50/50 (JLab)
PA: JLab
Caen FTDC: VX 1290A
fADC-250: JLab

LED stability



Radiometer/Photometer
ILT 1400-A

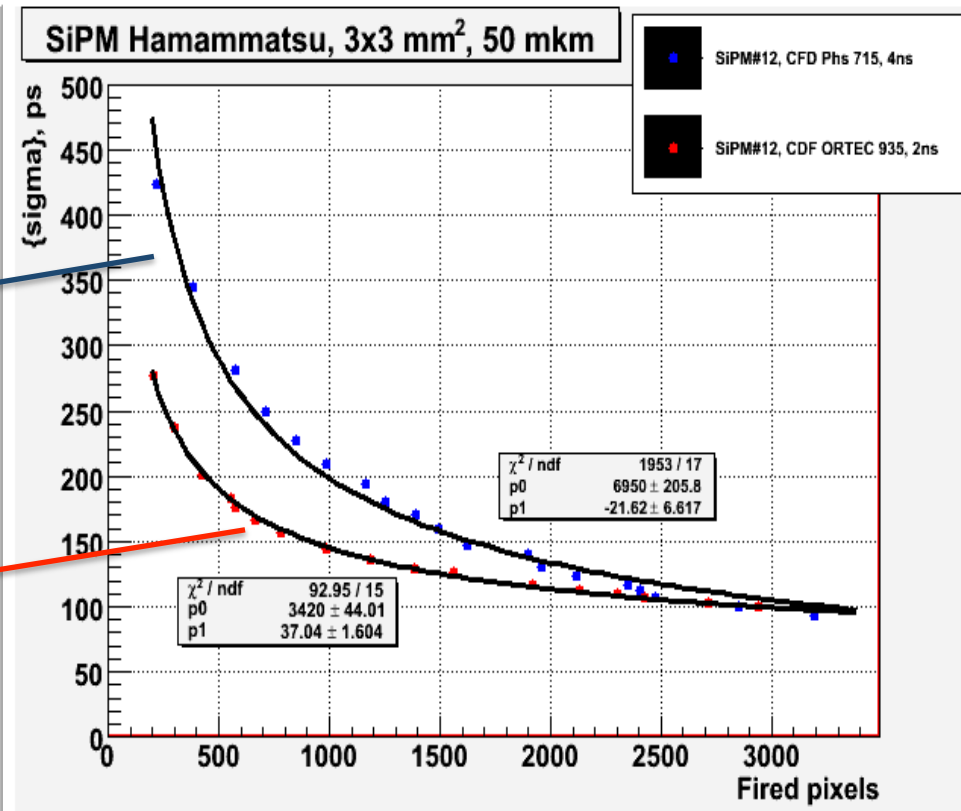
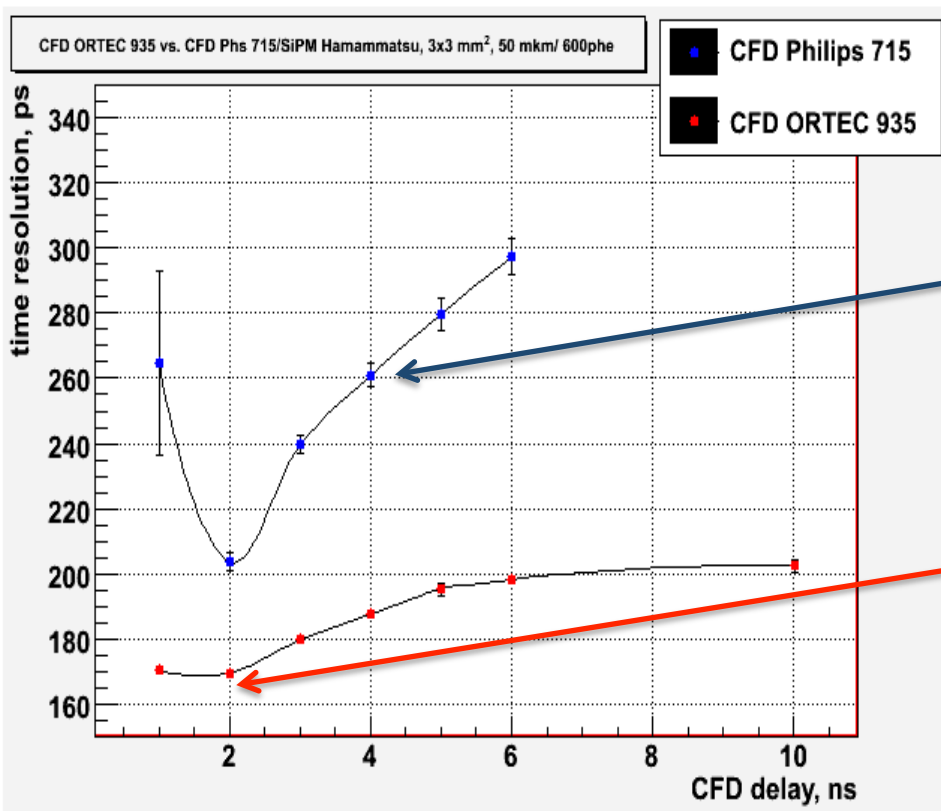
LED

- Panasonic
- LNG992CFB
- Blue
- 5.0 mm²

Working region

LED is rather stable
in this region

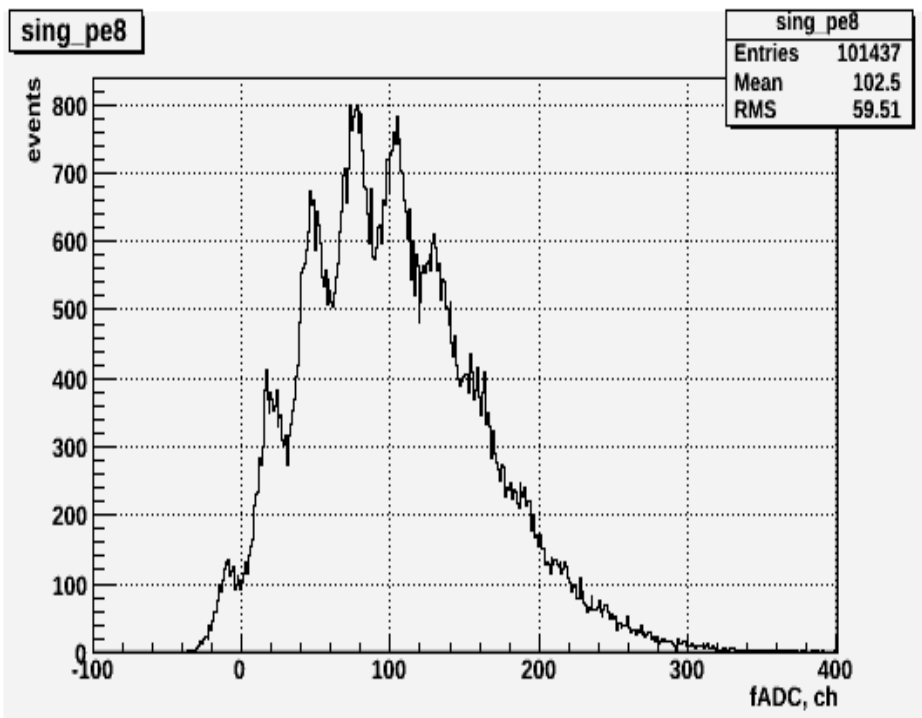
CFD investigation



The time resolution as function of CFD delay for CFD Philips 715 (blue) and CFD ORTEC 935 (red)

SiPM calibration

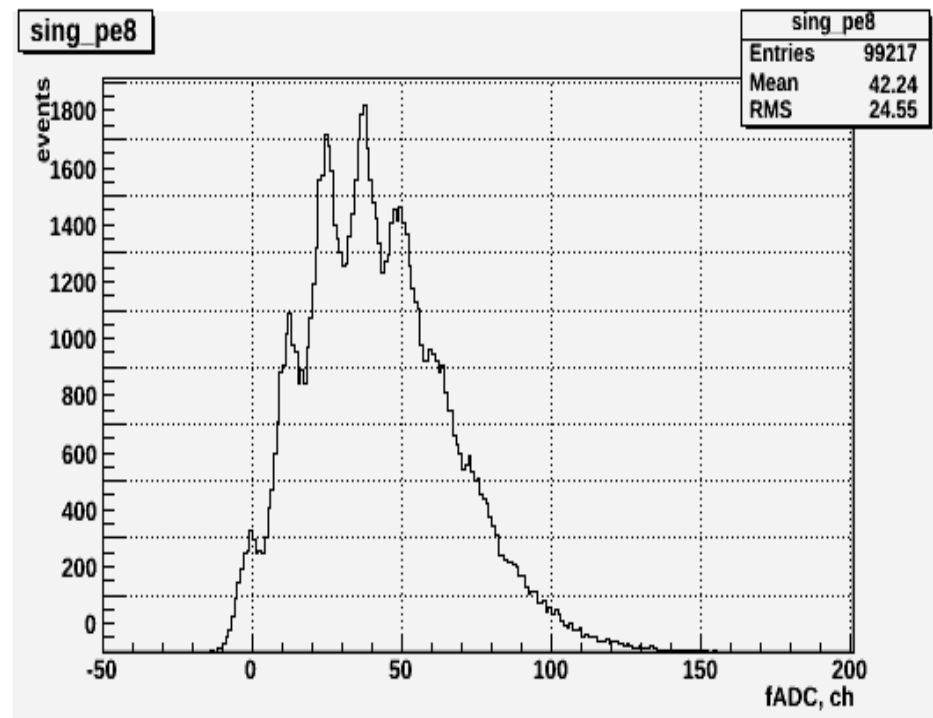
SiPM Hamamatsu, 3x3 mm², 50 μm



1 fired pixel \approx 27 channels

SiPM signal: $A = 6.7 \text{ mV}$
 $I = 1.06 \mu\text{A}$

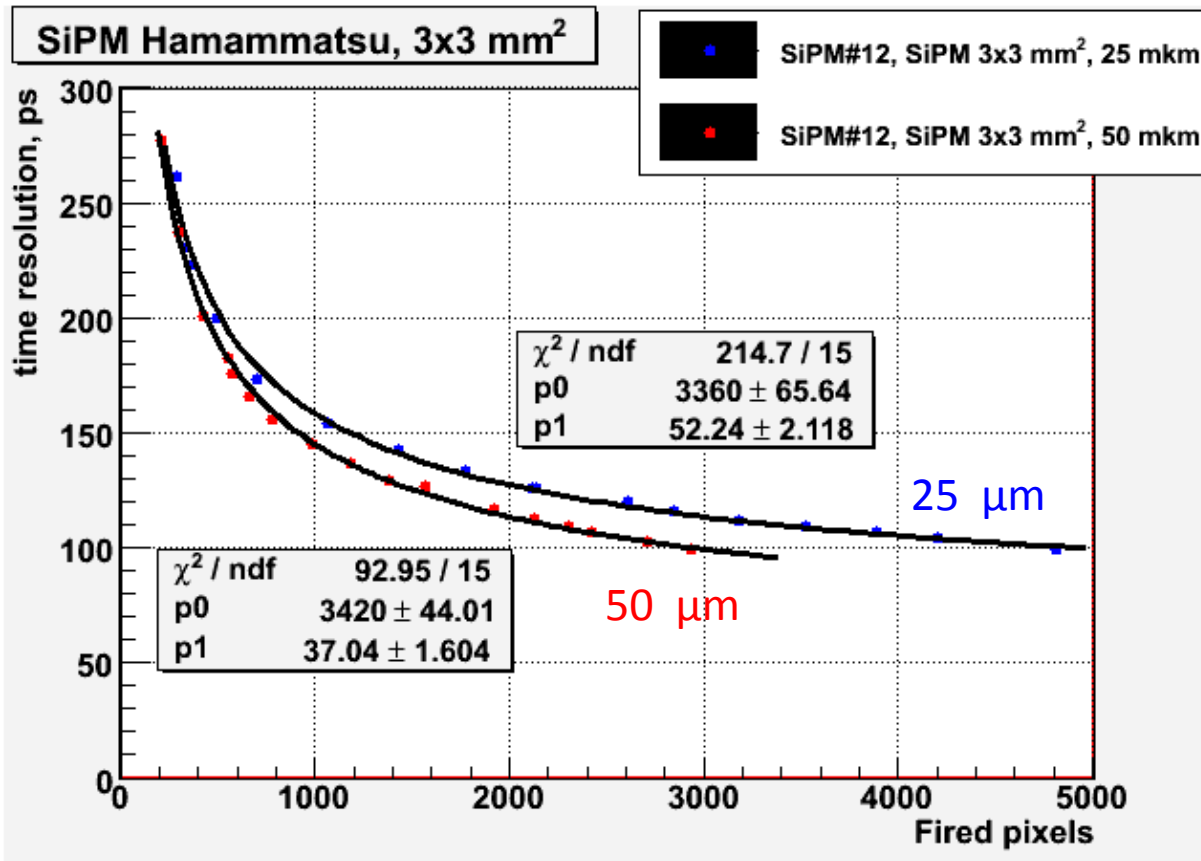
SiPM Hamamatsu, 3x3 mm², 25 μm



1 fired pixel \approx 12 channels

SiPM signal: $A = 3.7 \text{ mV}$
 $I = 0.157 \mu\text{A}$

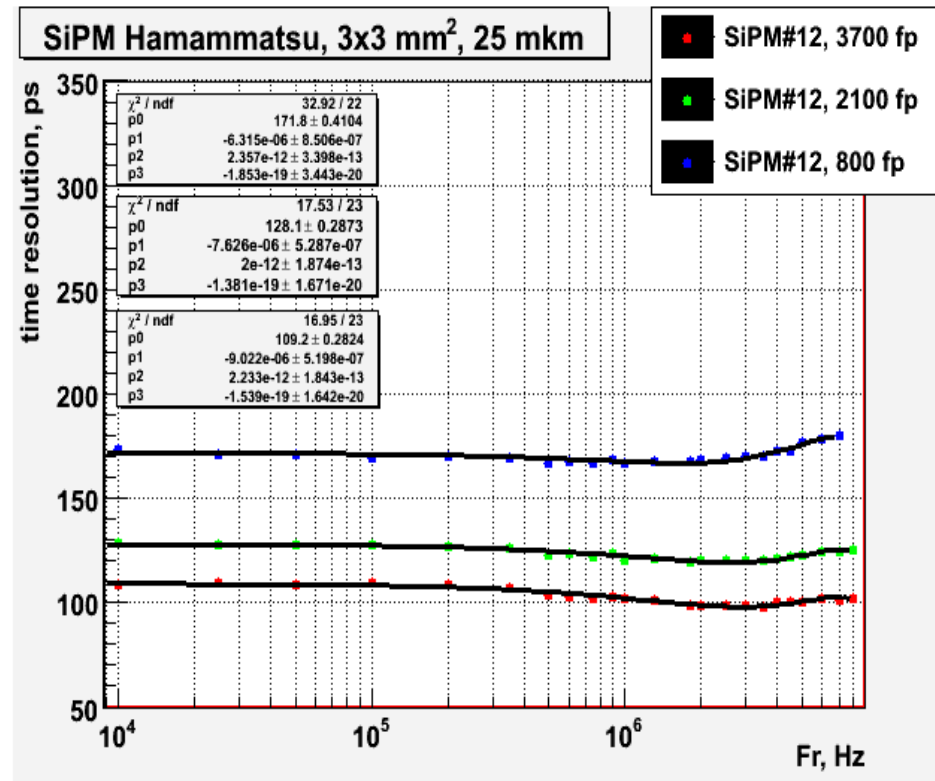
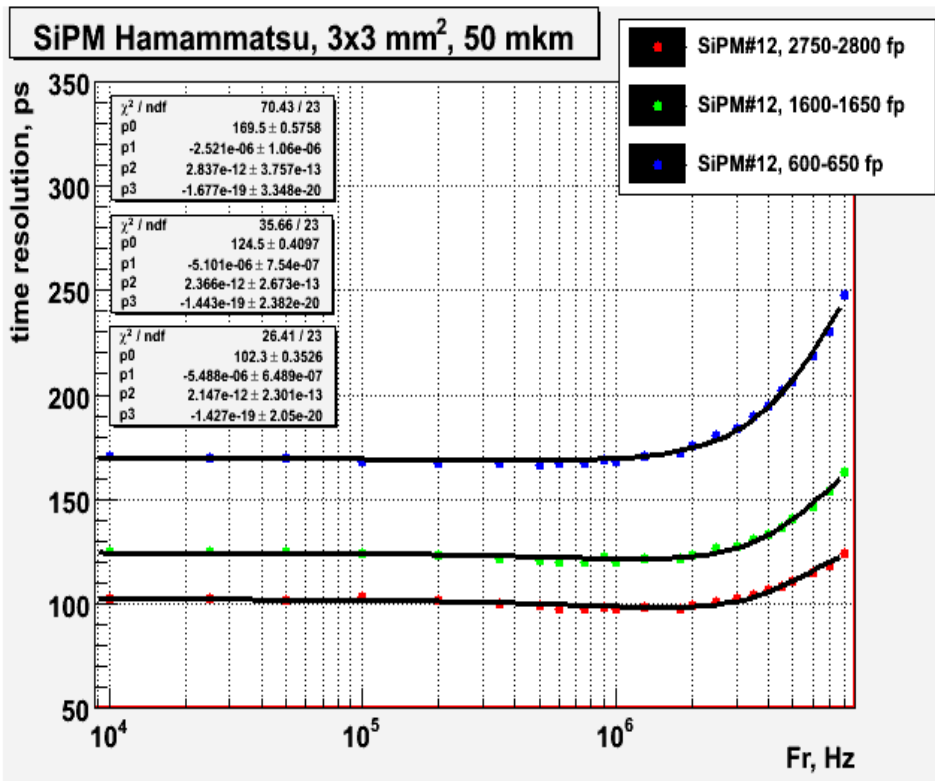
Time Resolution vs. Number of Fired Pixels



Fit function:

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

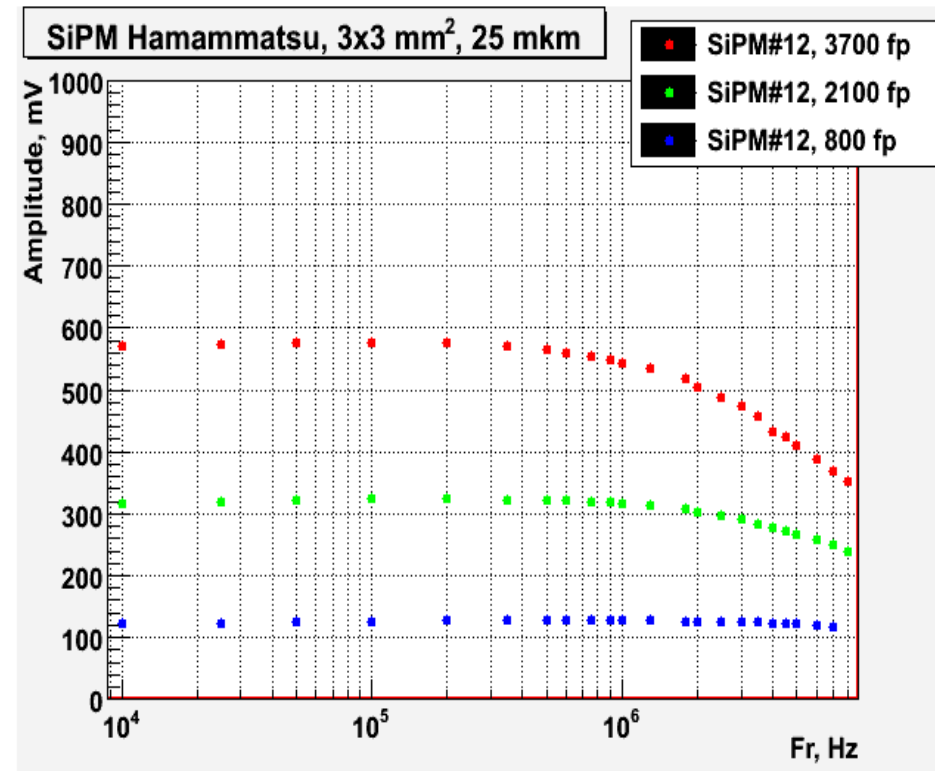
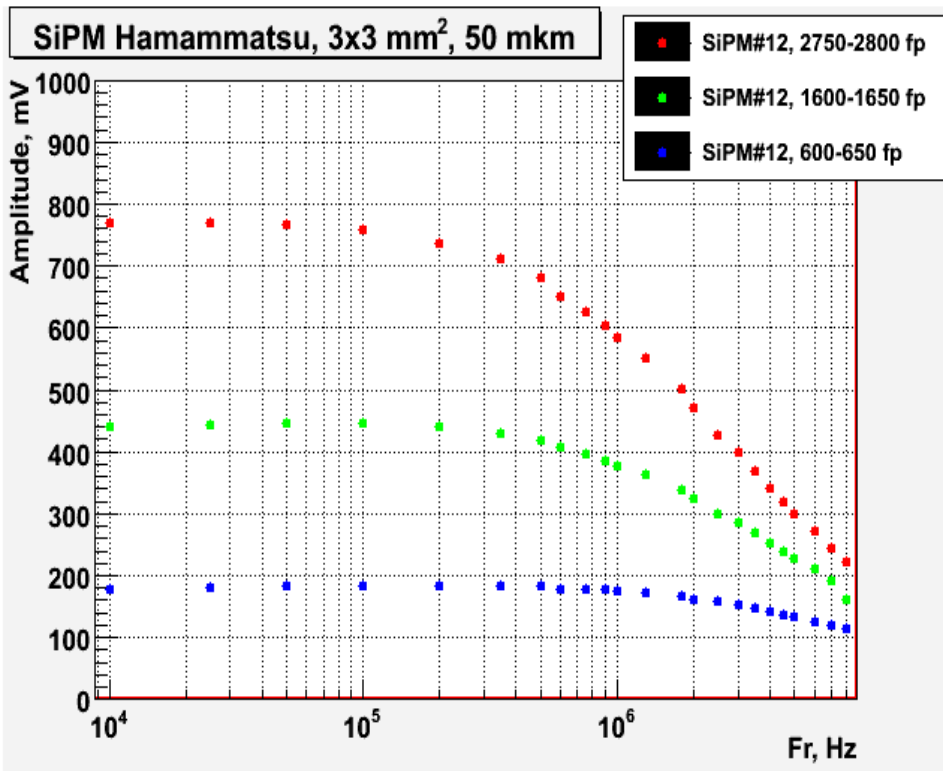
Time Resolution vs. Rate



SiPM Hamamatsu 3x3 mm², 50 μm
Different light intensity

SiPM Hamamatsu 3x3 mm², 25 μm
Different light intensity

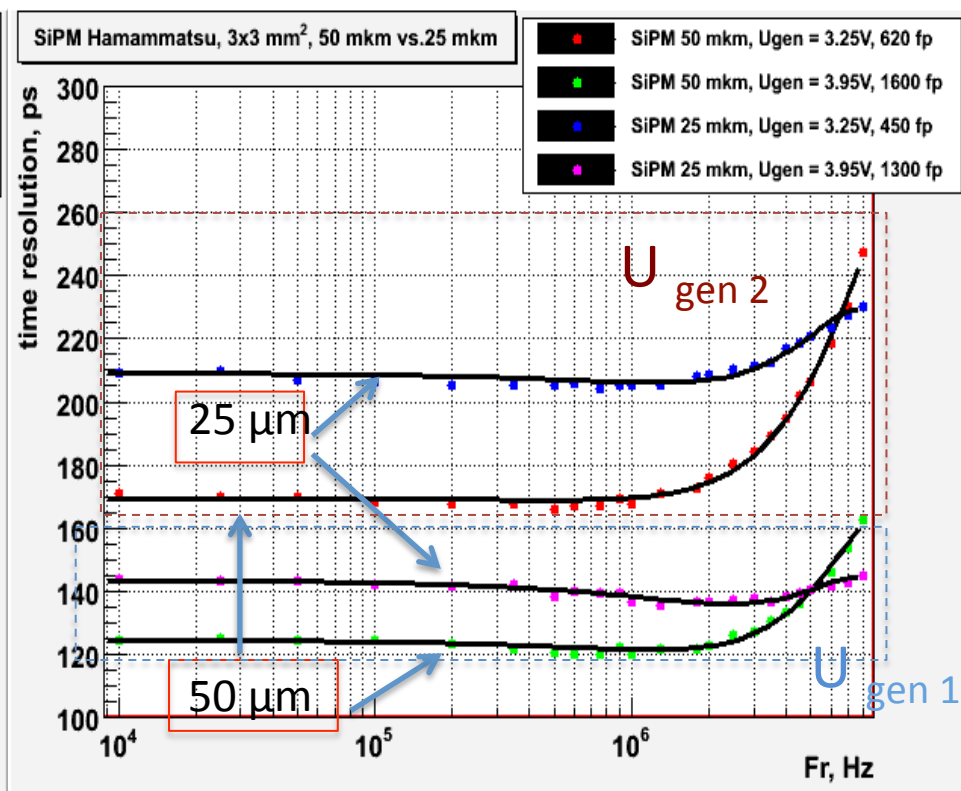
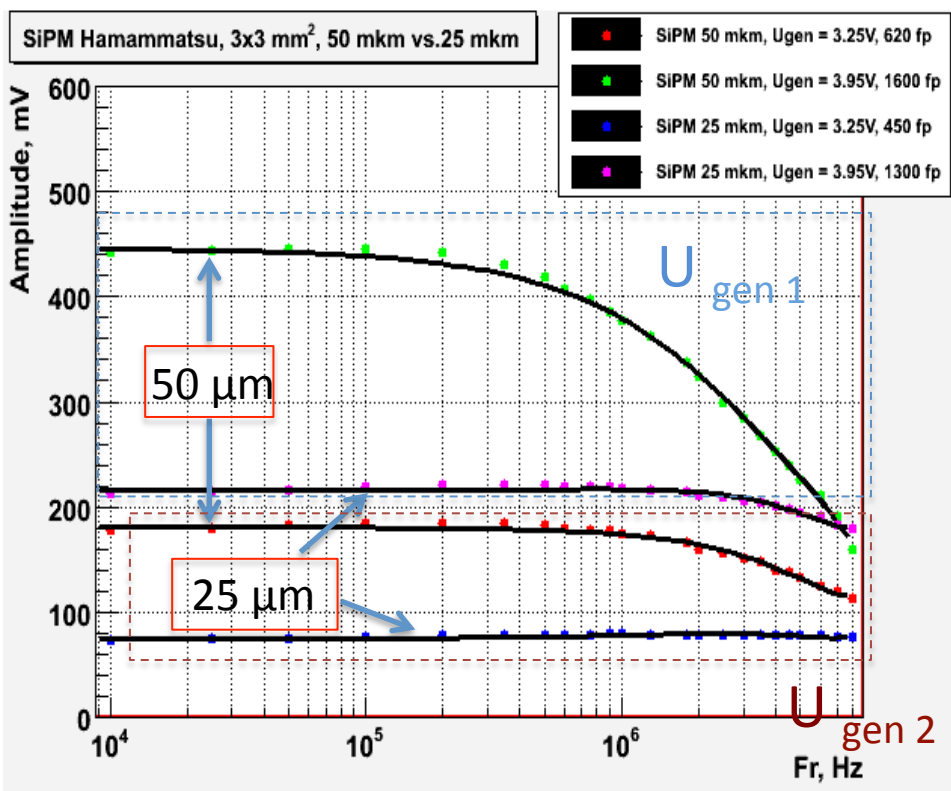
Amplitude vs. Rate



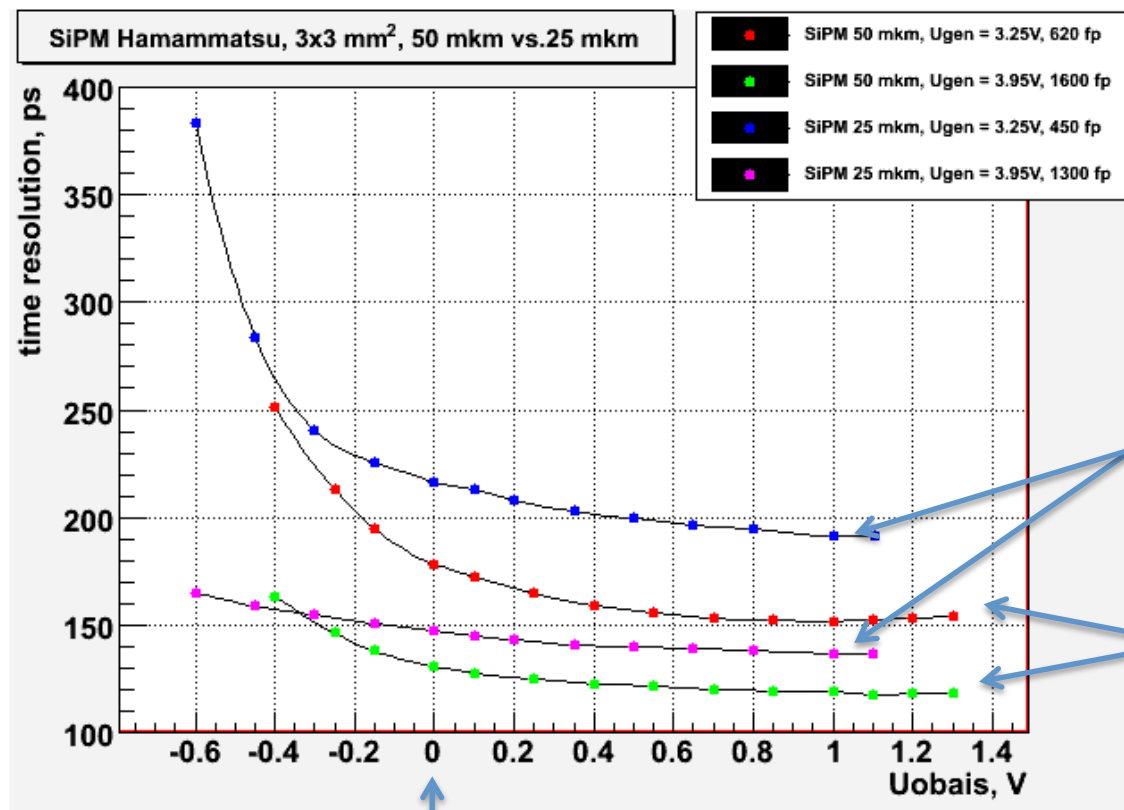
SiPM Hamamatsu 3x3 mm², 50 μ m
Different light intensity

SiPM Hamamatsu 3x3 mm², 25 μ m
Different light intensity

25 μm vs 50 μm : same light intensity



Time Resolution vs. Bias



The optimal SiPM bias for timing measurements is 0.3-0.4 V larger than nominal

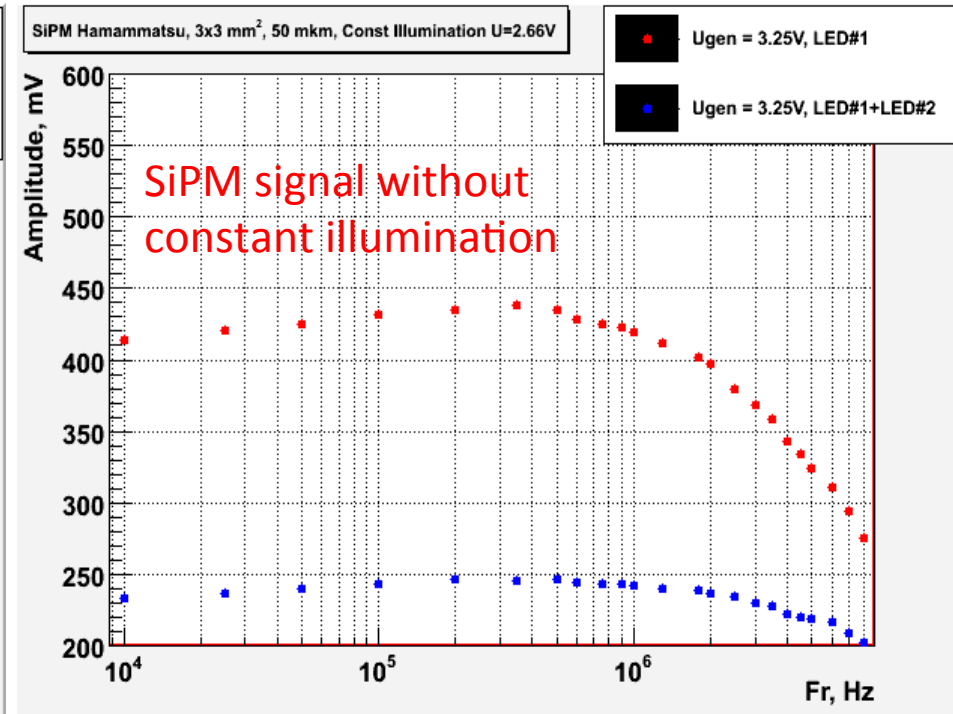
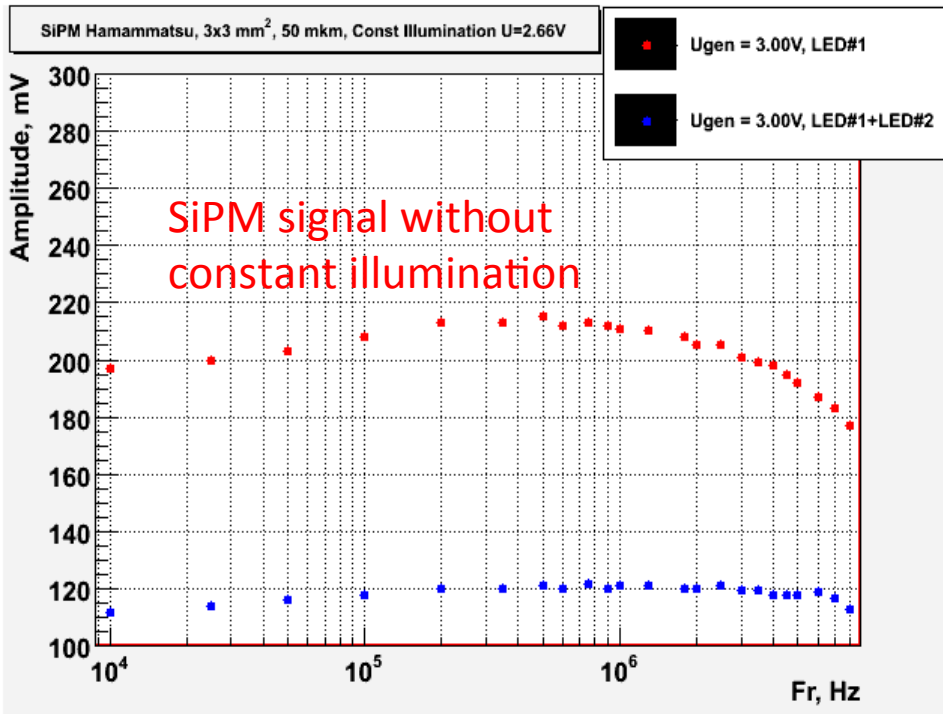
25 μm

50 μm

Nominal bias from Hamamatsu

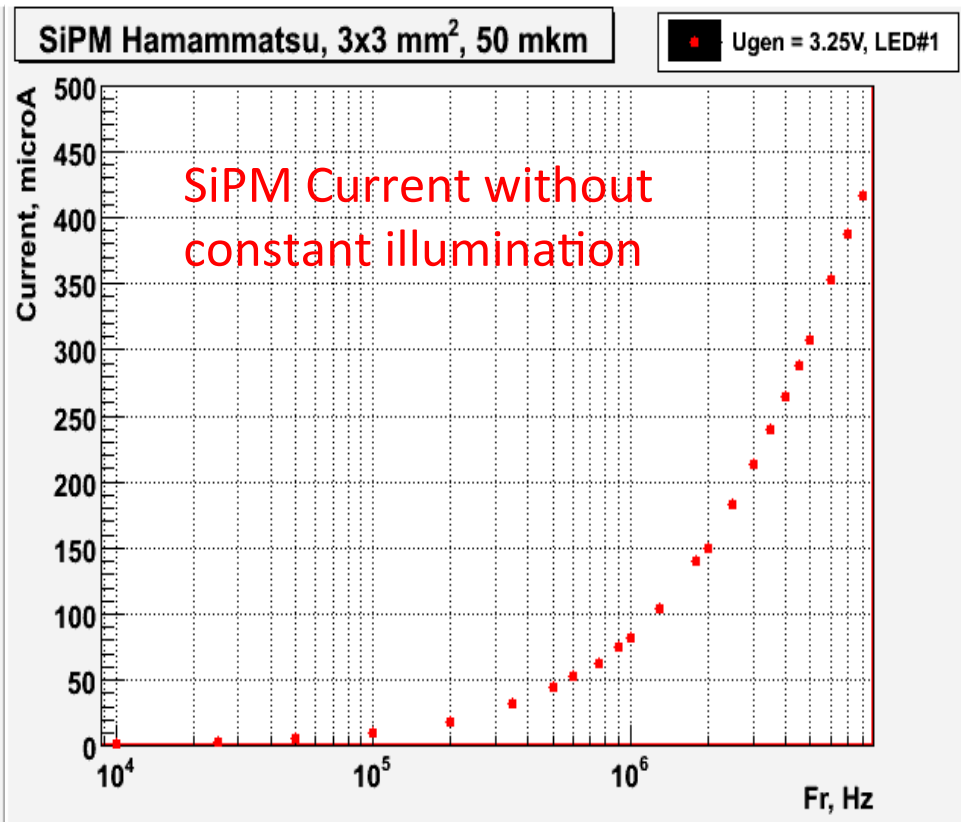
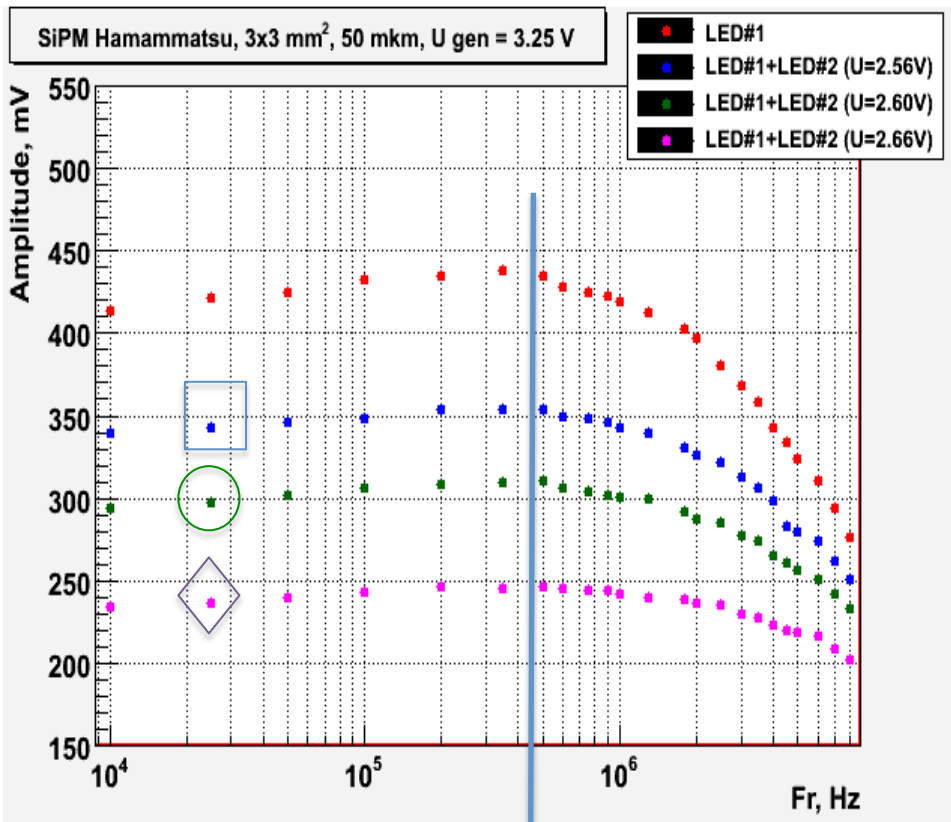
Amplitude investigation with Constant Illumination




SiPM Hamamatsu, 3x3 mm², 50 μm



The same constant illumination, U = 2.66 V

SiPM Hamamatsu, 3x3 mm², 50 μm

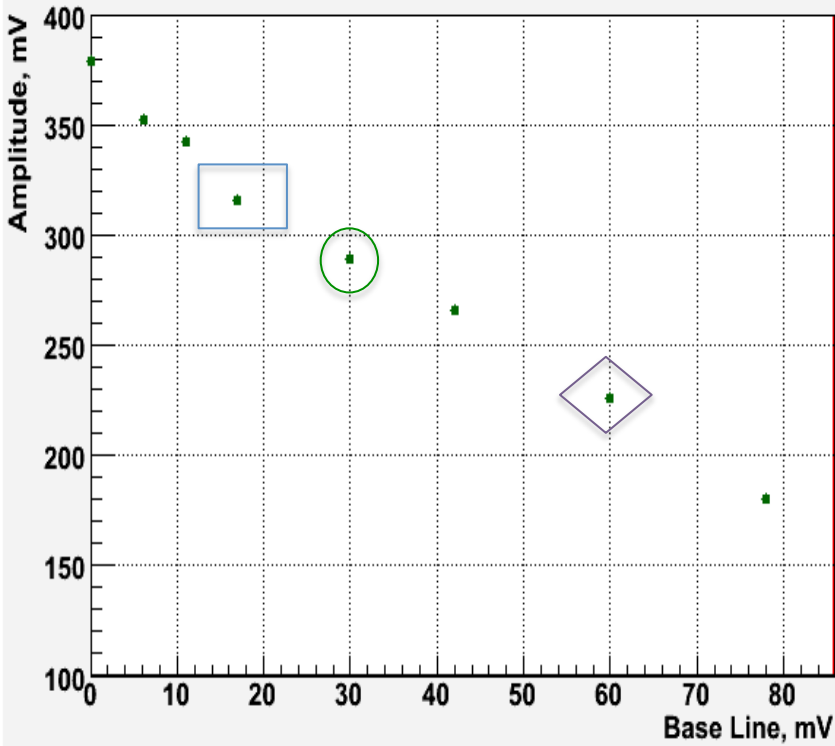


-  $I_{SiPM} = 0.12 \text{ mA}$
-  $I_{SiPM} = 0.21 \text{ mA}$
-  $I_{SiPM} = 0.357 \text{ mA}$

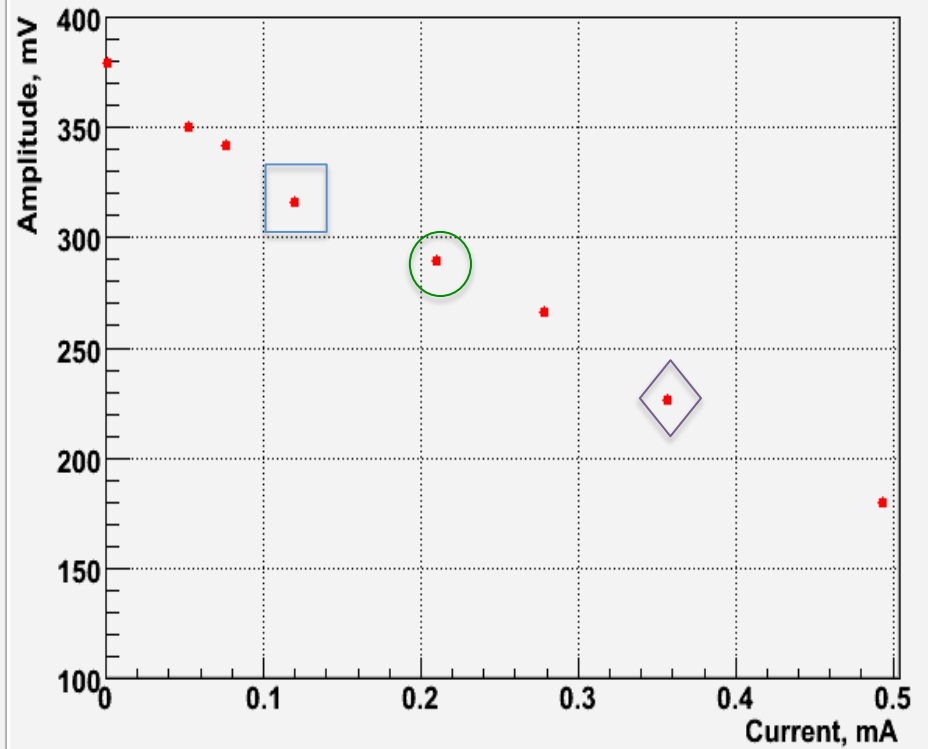
The fall point independent of the constant illumination

SiPM Hamamatsu, 3x3 mm², 50 μm

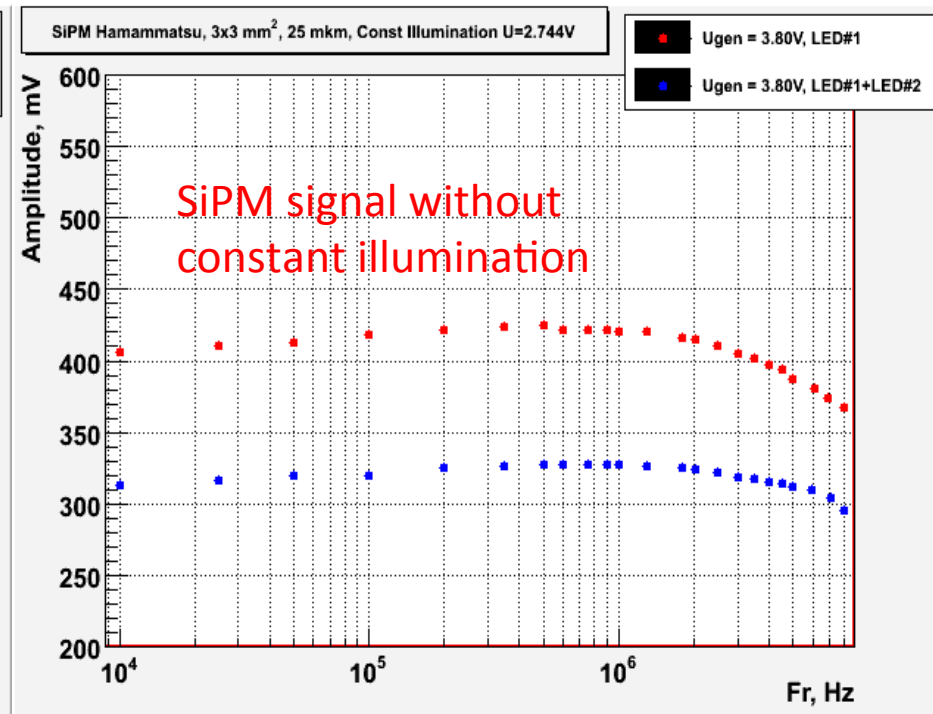
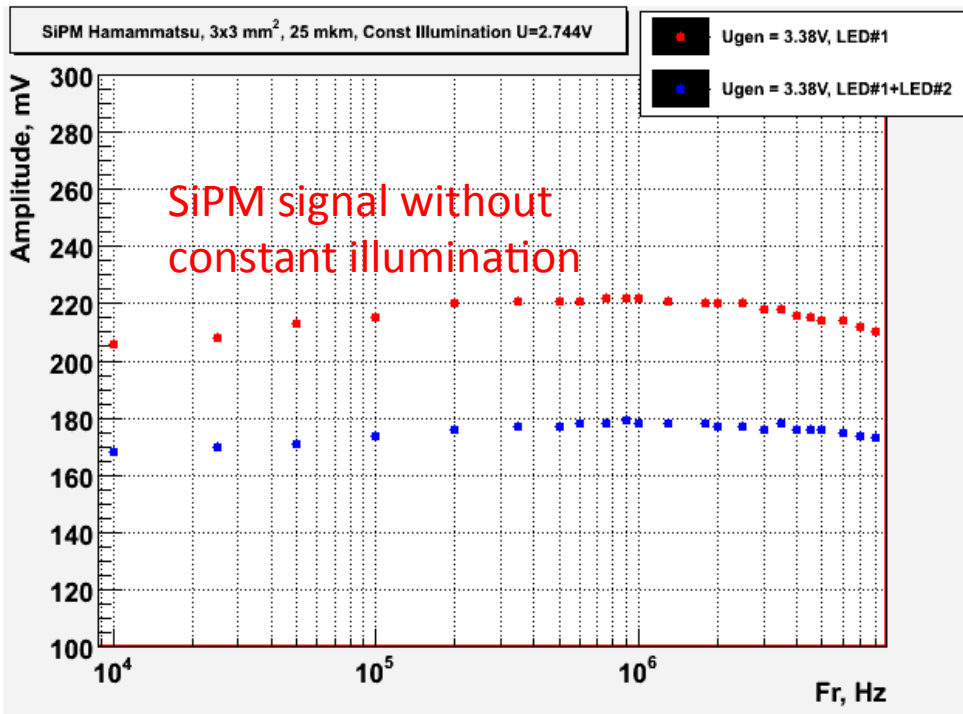
SiPM Hamamatsu, 3x3 mm², 50 mkm, U gen = 3.25 V



SiPM Hamamatsu, 3x3 mm², 50 mkm, U gen = 3.25 V

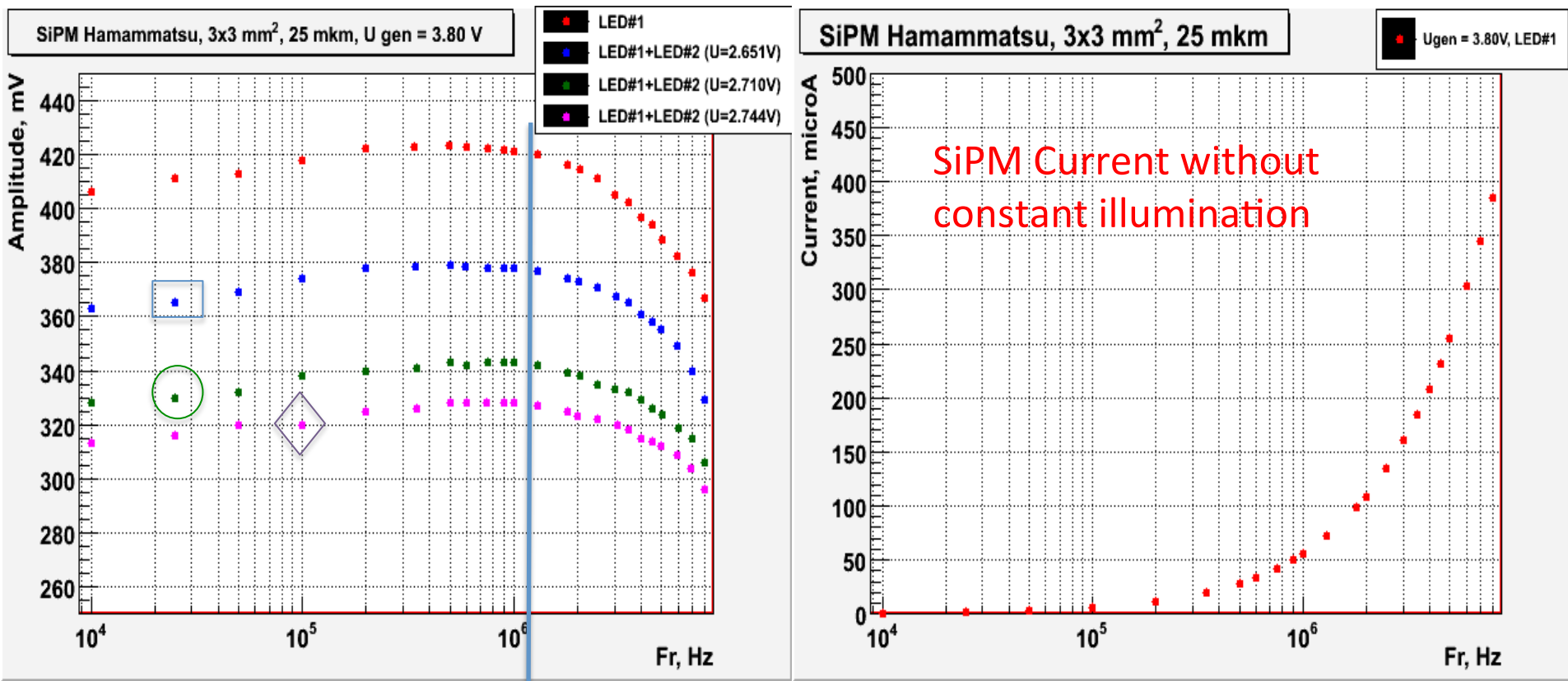


SiPM Hamamatsu, 3x3 mm², 25 μm



The same constant illumination, U = 2.74 V

SiPM Hamamatsu, 3x3 mm², 25 μm



□ $I_{SiPM} = 0.148 \text{ mA}$

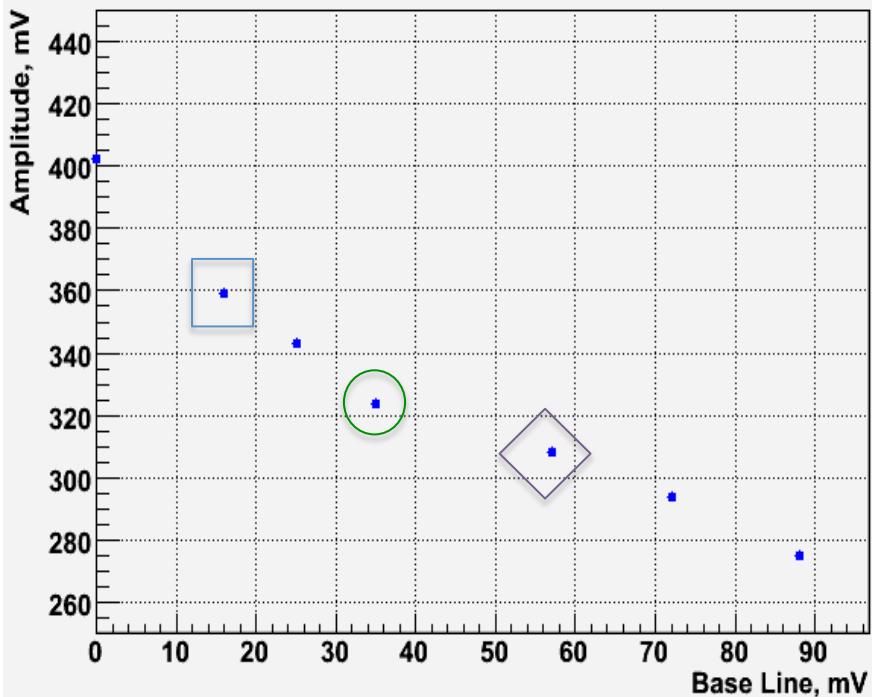
○ $I_{SiPM} = 0.352 \text{ mA}$

◇ $I_{SiPM} = 0.406 \text{ mA}$

The fall point independent of the constant illumination

SiPM Hamamatsu, 3x3 mm², 25 μm

SiPM Hamamatsu, 3x3 mm², 25 mkm, U gen = 3.80 V



SiPM Hamamatsu, 3x3 mm², 25 mkm, U gen = 3.80 V

