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EVALUATION OF PMT SYSTEM PERFORMANCE

— Francesco I. and Davide P.

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TIME RESOLUTION: TEST SETUP

- In order to have a good capability in reconstructing the inclination of tracks with respect to the GEM plane (X, Y) , it is crucial to have the possibility of measuring the width of the PMT pulse which is directly proportional to the total length of the track in the Z plane.
- DAQ issues do not easily allow the acquisition of waveforms with a very high sampling rate (1GS/s or more);
- The resolution on the signal width (Time Over Threshold) for fast light signals (6ns-16ns) was evaluated for different sampling rates;
- Test was performed by simply sending light pulses provided by a fast laser source on a R7378A PMT (1” diameter);
- V_{drift} is between 40 μm/ns and 60 μm/ns (0.5 kV/cm - 1.0 kV/cm);

SETUP

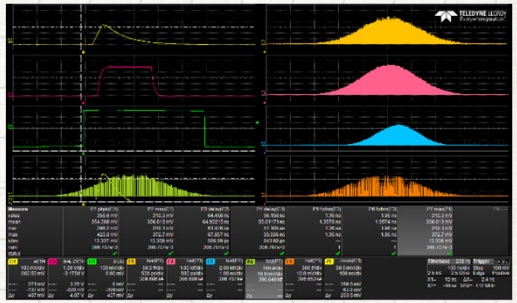
Dark box

Laser Pulse module

1" PMT R7378A

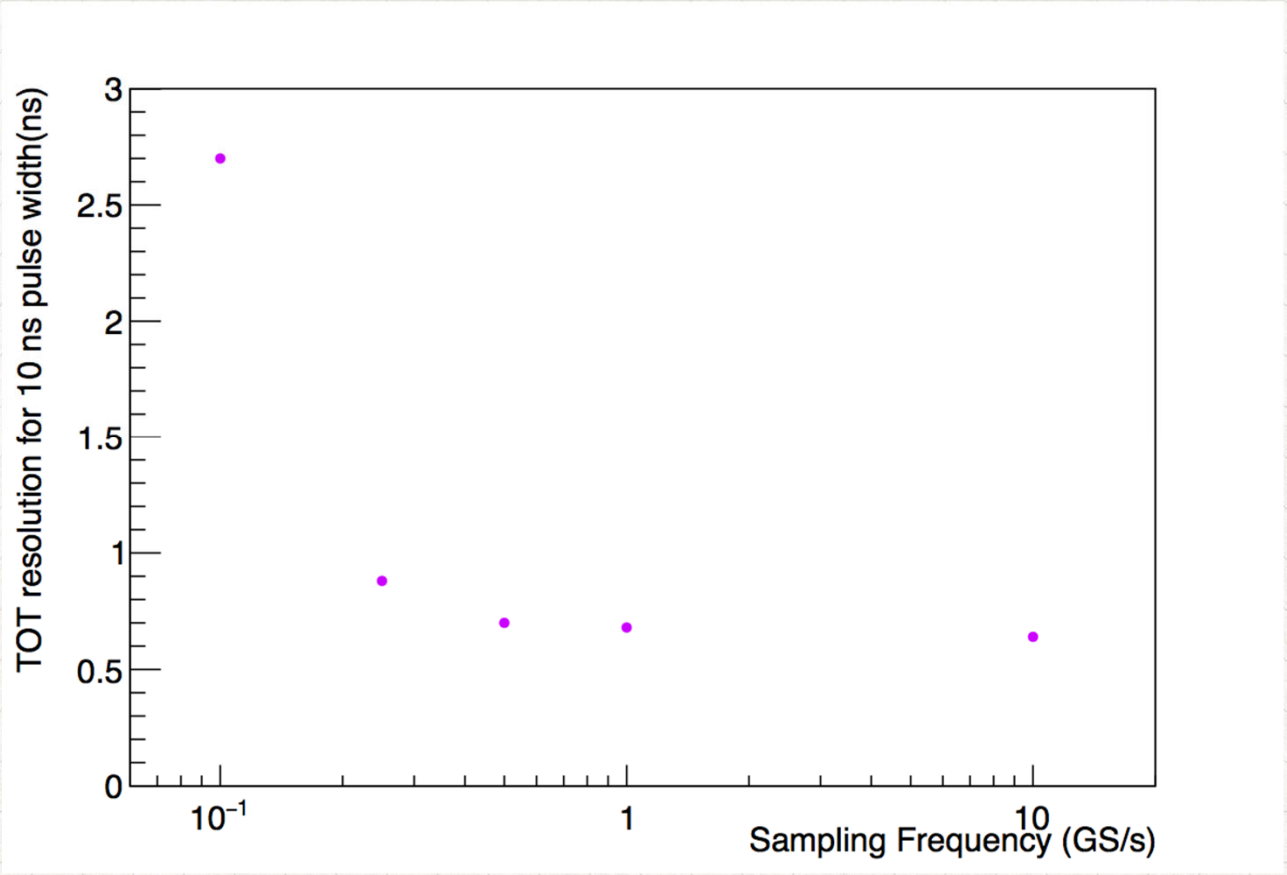
Analog output

Lecroy oscilloscope



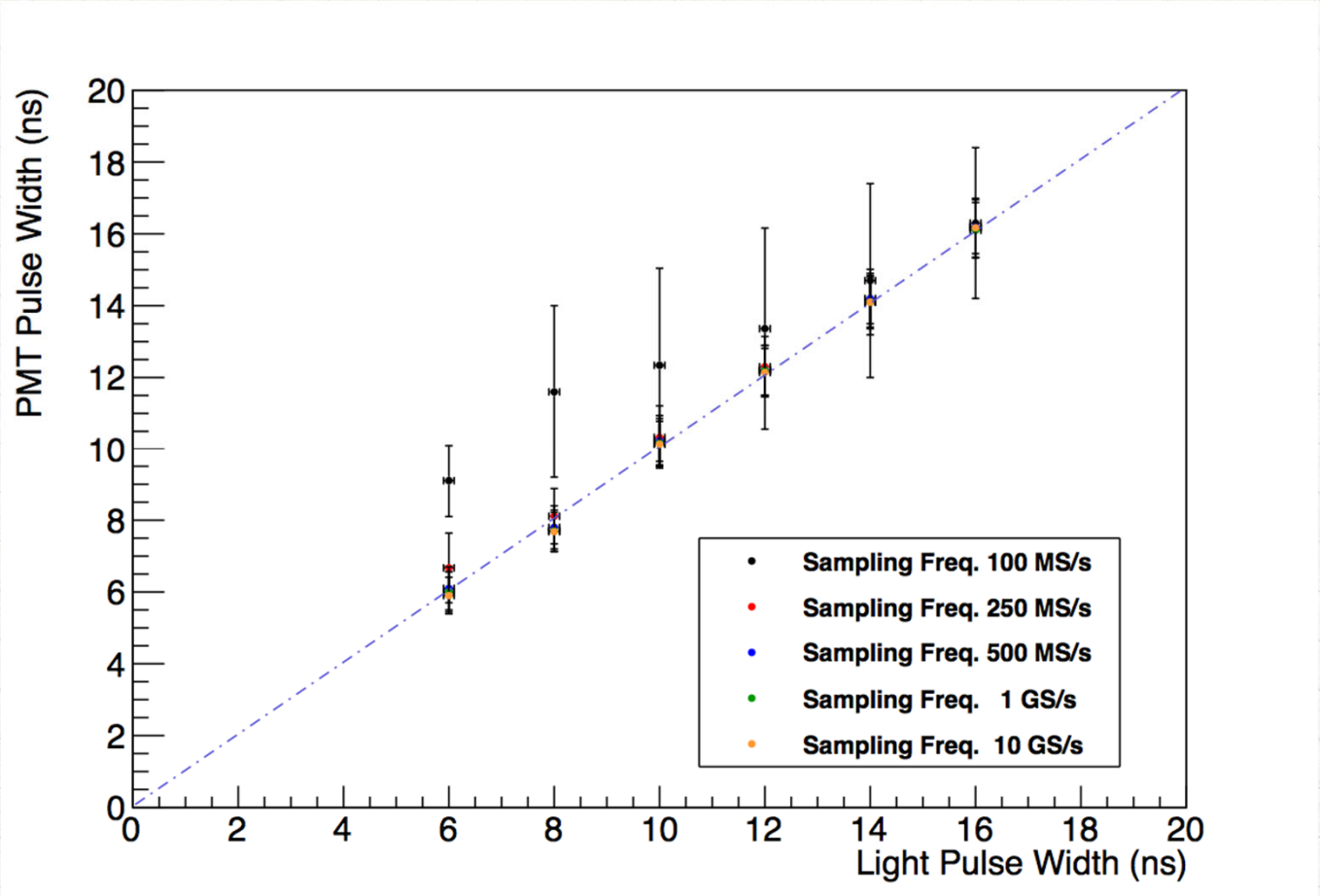
- Fast PMT pulse (1.5 ns rise time, TTS 0.9 ns)
- Large bandwidth oscilloscope (1Ghz, 10GSample/s, adjustable up to 100MS/s)
- Large light pulse amplitude (many p.e.)

TIME RESOLUTION: RESULTS



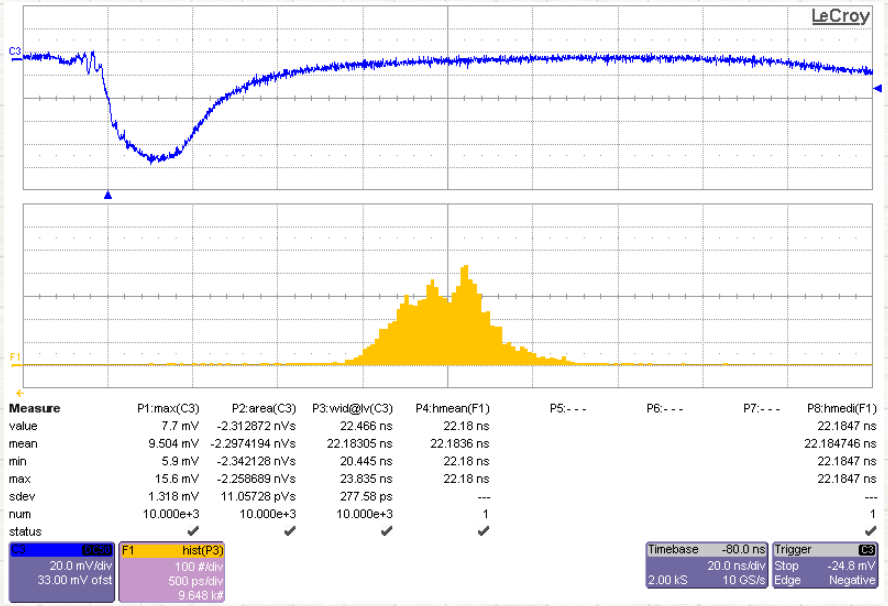
- Except the acquisition with 100 MS/s, in all other cases TOT (Time Over Threshold) resolutions (stdev) better than 1 ns were found;

TIME RESOLUTION: RESULTS

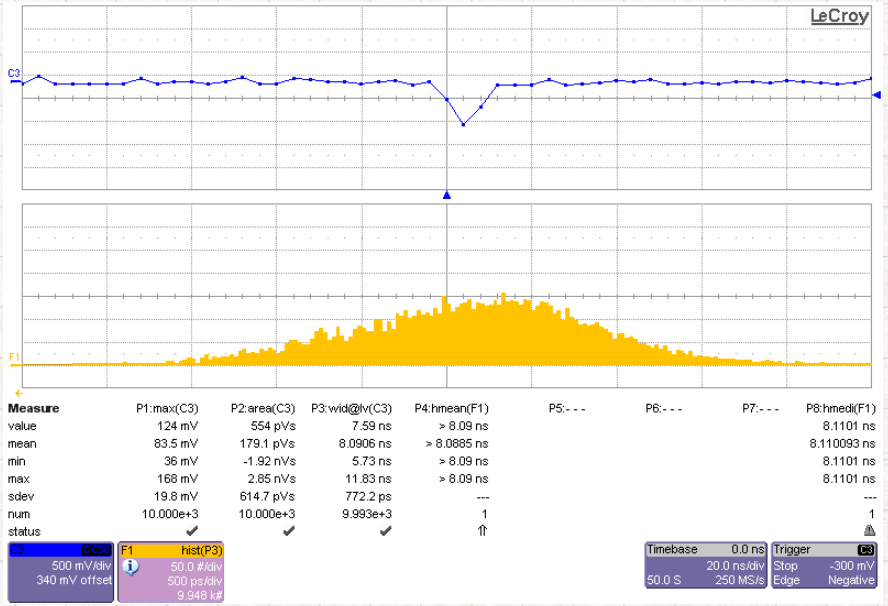


- Except the acquisition with 100 MS/s, in all other cases reconstructed values are in very good agreement with the light pulse width expectations;

SIGNAL EXAMPLES



10 Gsample/s



250 Msample/s

- Test to be repeated with a faster pulser and ligth pulse with varius amplitude

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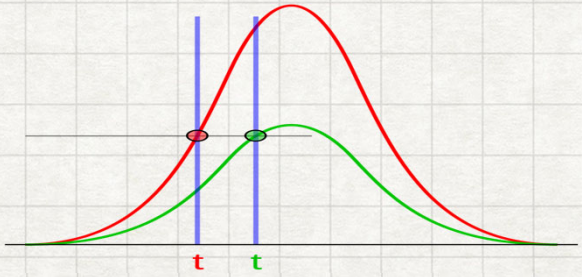


PMTS STATUS

H3695-10

Anode Characteristics

Luminous Typ. (A/lm)	Gain Typ.	Dark Current Typ. (nA)	Dark Current Max. (nA)	Time Response Rise Time Typ. (ns)	Time Response Transit Time Typ. (ns)	Time Response Transit Time Spread Typ. (ns)	Pulse Linearity 2 % Typ. (mA)	Pulse Linearity 5 % Typ. (mA)	Notes	Type No.
100	1.0×10^6	1	50	0.8	9.0	0.5	3	7	H3164-12: SHV, BNC connector type H3164-14: SHV, LEMO connector type	H3164-10
100	1.0×10^6	2	50	0.7	9.0	0.5	3	7	H3695-12: SHV, BNC connector type H3695-14: SHV, LEMO connector type	H3695-10

H10721P-04

Parameter			H10720 / H10721 series				Unit
Suffix			-110, -113	-210	-01, -04	-20	—
Input voltage			+2.8 to +5.5				V
Max. input voltage			+5.5				V
Max. input current *1			2.7				mA
Max. average output signal current *2			100				µA
Max. control voltage			+1.1 (Input impedance 1 MΩ)				V
Recommended control voltage adjustment range			+0.5 to +1.1 (Input impedance 1 MΩ)				V
Effective area			φ8				mm
Peak sensitivity wavelength			400	400	400	630	nm
Cathode	Luminous sensitivity	Min.	80	100	100	350	µA/lm
		Typ.	105	135	200	500	
	Blue sensitivity index (CS 5-58)	Typ.	13.5	15.5	—	—	—
	Red / White ratio	Typ.	—	—	0.2	0.45	—
	Radiant sensitivity *3	Typ.	110	130	77	78	mA/W
Anode	Standard type: Luminous sensitivity *2	Min.	80	100	100	350	A/lm
		Typ.	210	270	400	1000	
	Standard type: Radiant sensitivity *2 *3	Typ.	2.2×10^5	2.6×10^5	1.5×10^5	1.5×10^5	A/W
	Standard type: Dark current *2 *4	Typ.	1	1	1	10	nA
		Max.	10	10	10	100	
	P type dark count *2 *4	Typ.	50	50	600	—	s^{-1}
		Max.	100	100	1000	—	
Rise time *2			0.57				ns
Ripple noise *2 *5 (peak to peak)		Max.	0.1				mV
Settling time *6		Max.	10				s
Operating ambient temperature *7			+5 to +50				°C
Storage temperature *7			-20 to +50				°C
Weight		Typ.	45 (H10720 series), 80 (H10721 series)				g

- The 4 PMTs (2 x type) bougth for this task are in the works at LABE (some problems about connectors)

Test MPPC Hamamatsu

Francesco Iacoangeli

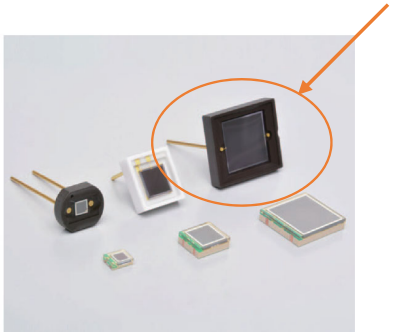
Hamamtsu MMPC

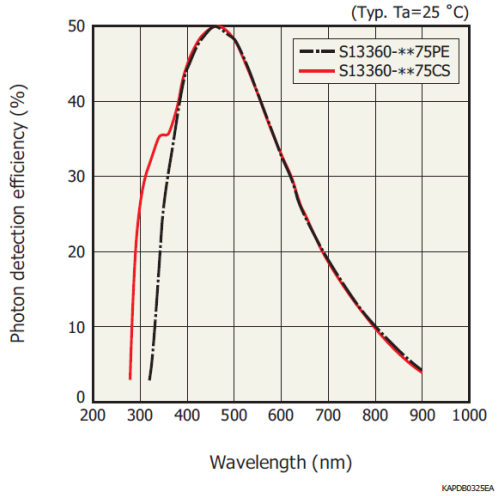
Type:

2 x S13360-6075CS

2 x S13360-6050CS

2 x S13360-6025CS





Type no.	Pixel pitch (μm)	Effective photosensitive area (mm)	Number of pixels	Package	Fill factor (%)
S13360-1325CS	25	1.3 × 1.3	2668	Ceramic	47
S13360-1325PE				Surface mount type	
S13360-3025CS		3.0 × 3.0	14400	Ceramic	
S13360-3025PE				Surface mount type	
S13360-6025CS		6.0 × 6.0	57600	Ceramic	
S13360-6025PE				Surface mount type	
S13360-1350CS	50	1.3 × 1.3	667	Ceramic	74
S13360-1350PE				Surface mount type	
S13360-3050CS		3.0 × 3.0	3600	Ceramic	
S13360-3050PE				Surface mount type	
S13360-6050CS		6.0 × 6.0	14400	Ceramic	
S13360-6050PE				Surface mount type	
S13360-1375CS	75	1.3 × 1.3	285	Ceramic	82
S13360-1375PE				Surface mount type	
S13360-3075CS		3.0 × 3.0	1600	Ceramic	
S13360-3075PE				Surface mount type	
S13360-6075CS		6.0 × 6.0	6400	Ceramic	
S13360-6075PE				Surface mount type	

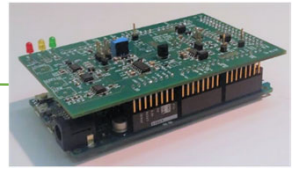
Timing measurements

Dark box

Laser Pulse module

SiPM
13360-6050CS

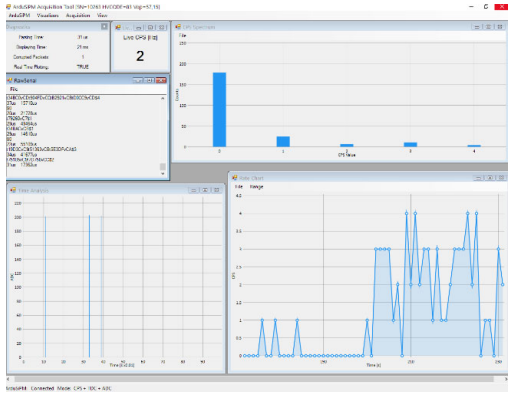
ArduSiPM



Analog output

Digital Output

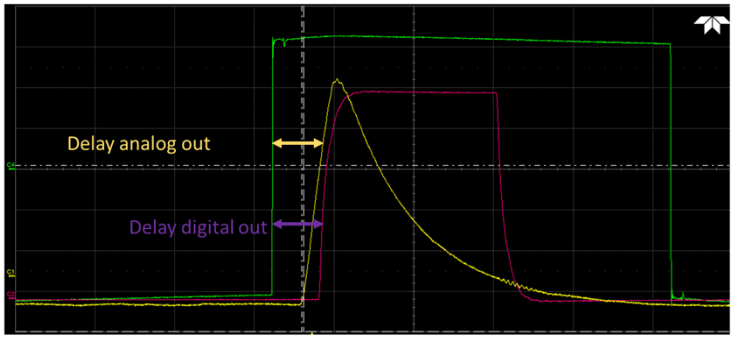
USB Readout
(count per second)



Pulsed laser trigger

ArduSiPM analog

ArduSiPM digital
(th =8 mV)

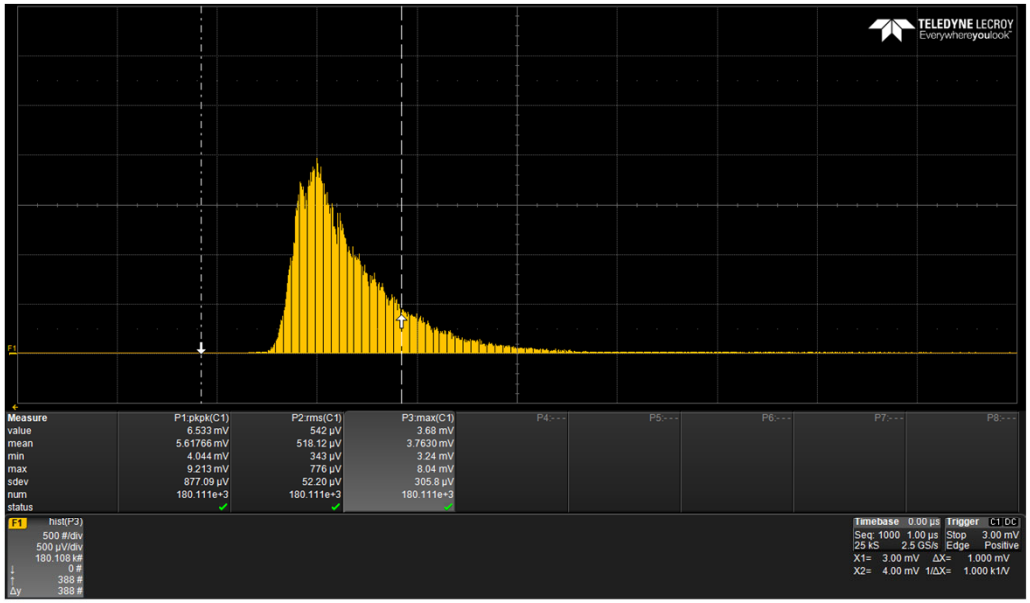


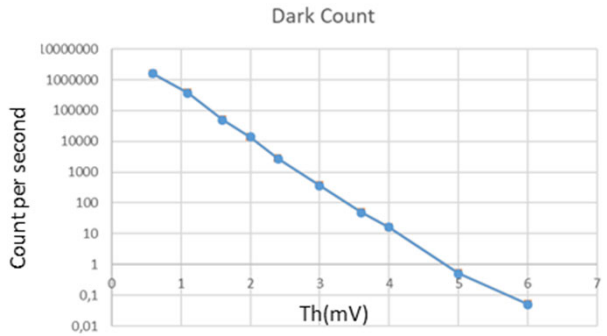
Dark Count

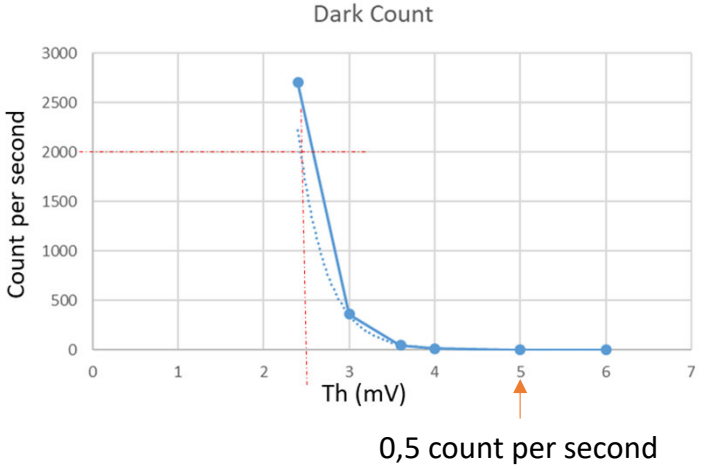
Electrical and optical characteristics (Typ. Ta=25 °C, unless otherwise noted)

Type no.	Measure-ment conditions	Spectral response range λ (nm)	Peak sensitivity wavelength λp (nm)	Photon detection efficiency PDE*4 λ=λp (%)	Dark count*5 Typ. (kcps)	Dark count*5 Max. (kcps)	Terminal capaci-tance Ct (pF)	Gain M	Break-down voltage VBR (V)	Crosstalk probability (%)	Recom-mended operating voltage Vop (V)	Tem-perature coefficient at recom-mended operating voltage ΔTVop (mV/°C)
S13360-1325CS	Vover =5 V	270 to 900	450	25	70	210	60	7.0×10^5	53 ± 5	1	VBR + 5	54
S13360-1325PE		320 to 900			400	1200	320					
S13360-3025CS		270 to 900										
S13360-3025PE		320 to 900			1600	5000	1280					
S13360-6025CS		270 to 900										
S13360-6025PE		320 to 900										
S13360-1350CS	Vover =3 V	270 to 900		40	90	270	60	1.7×10^6		3	VBR + 3	
S13360-1350PE		320 to 900			500	1500	320					
S13360-3050CS		270 to 900										
S13360-3050PE		320 to 900			2000	6000	1280					
S13360-6050CS		270 to 900										
S13360-6050PE		320 to 900										
S13360-1375CS	Vover =3 V	270 to 900		50	90	270	60	4.0×10^6		7	VBR + 3	
S13360-1375PE		320 to 900			500	1500	320					
S13360-3075CS		270 to 900										
S13360-3075PE		320 to 900			2000	6000	1280					
S13360-6075CS		270 to 900										
S13360-6075PE		320 to 900										

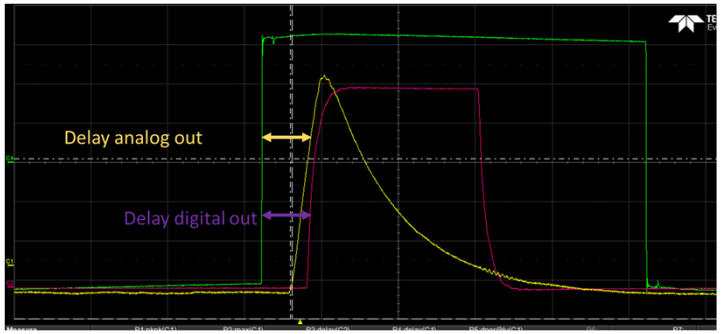
*4: Photon detection efficiency does not include crosstalk or afterpulses.
*5: Threshold=0.5 p.e.
Note: The above characteristics were measured at the operating voltage that yields the listed gain. (See the data attached to each product.)

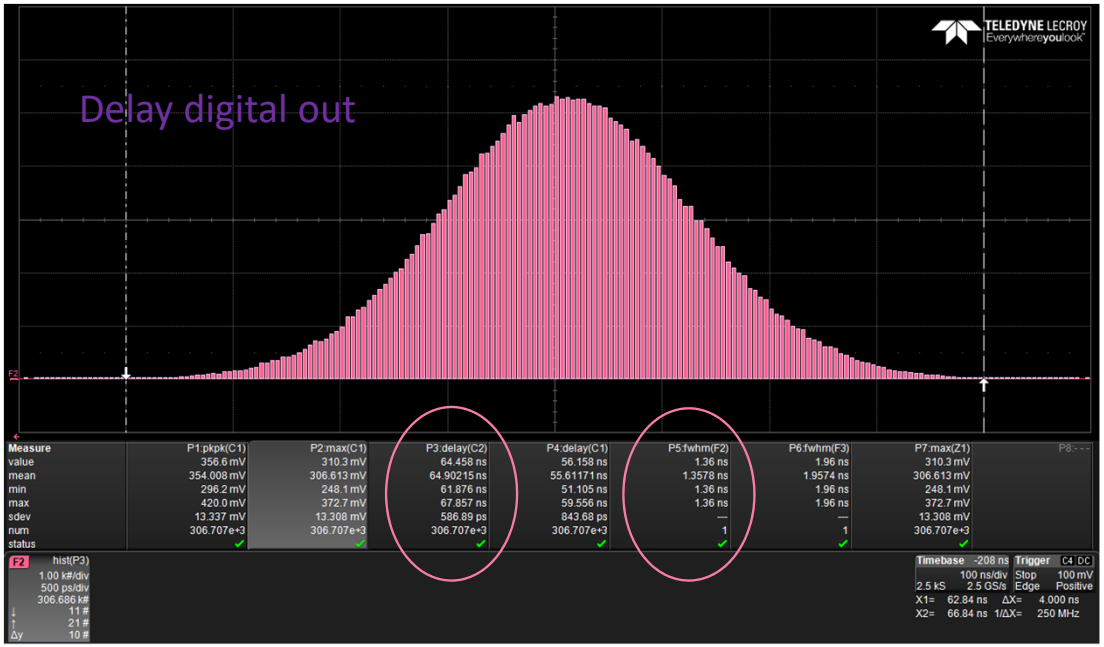


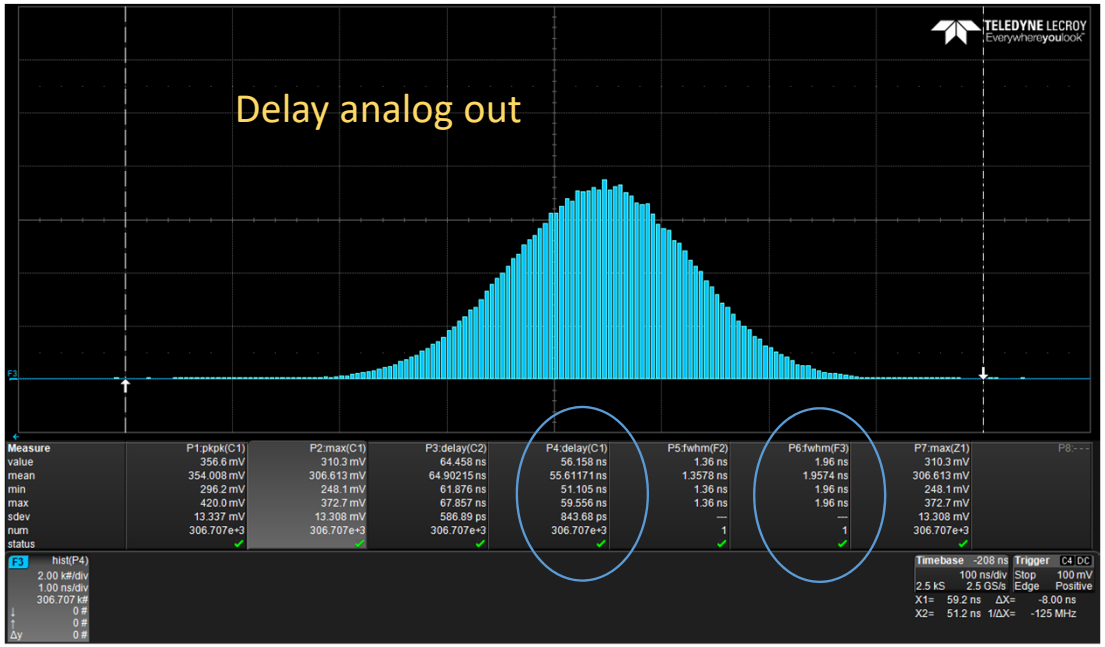




Jitter

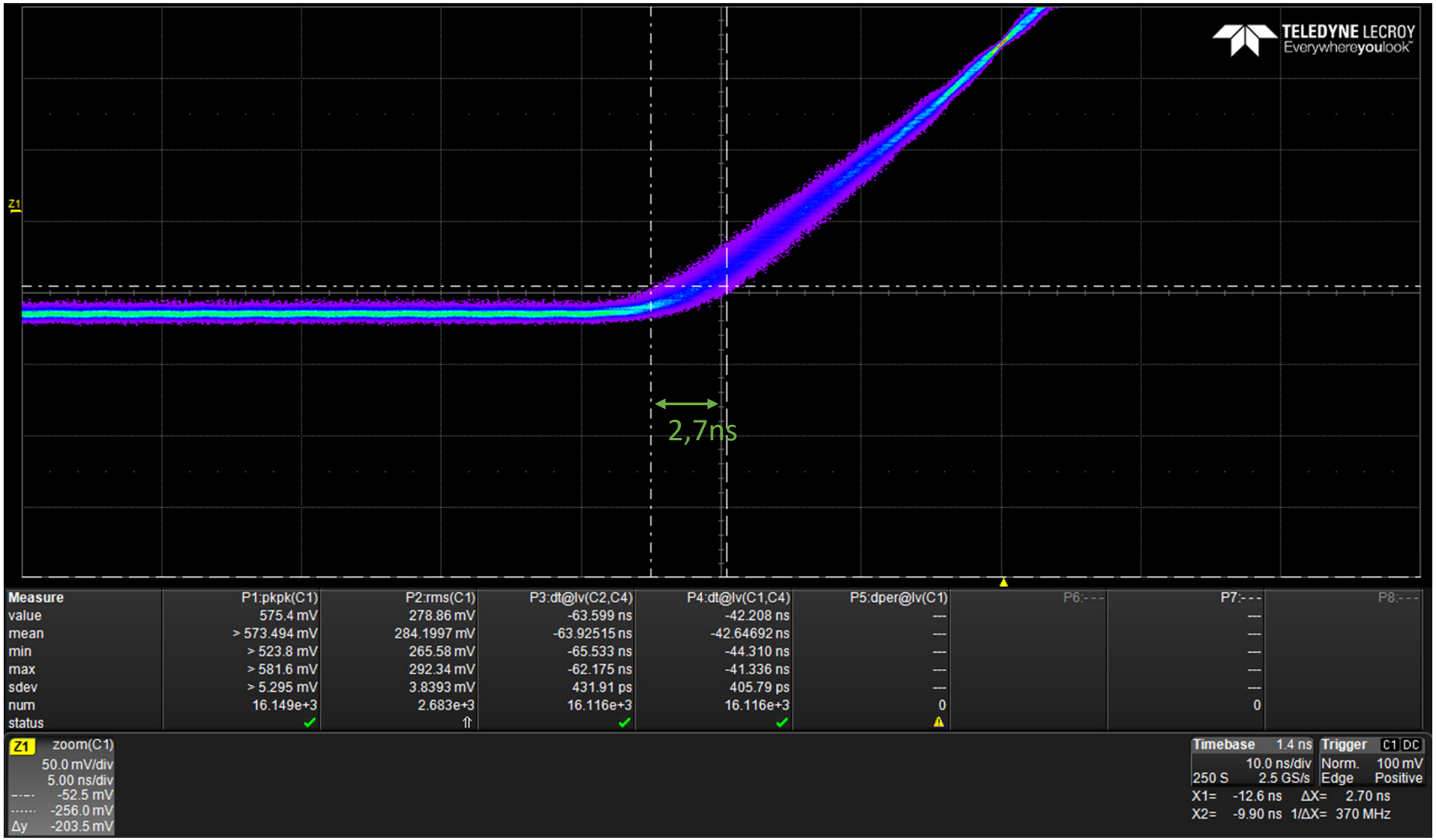






Sdev ~ 600 ps

Sdev ~ 800 ps


TELEDYNE LECROY
Everywhereyoulook
Z1
2,7ns
Measure | P1:pkpk(C1) | P2:rms(C1) | P3:dt@lv(C2,C4) | P4:dt@lv(C1,C4) | P5:dper@lv(C1) | P6:- - - | P7:- - - | P8:- - -
value | 575.4 mV | 278.86 mV | -63.599 ns | -42.208 ns | --- | | --- |
mean | > 573.494 mV | 284.1997 mV | -63.92515 ns | -42.64692 ns | --- | | --- |
min | > 523.8 mV | 265.58 mV | -65.533 ns | -44.310 ns | --- | | --- |
max | > 581.6 mV | 292.34 mV | -62.175 ns | -41.336 ns | --- | | --- |
sdev | > 5.295 mV | 3.8393 mV | 431.91 ps | 405.79 ps | --- | | --- |
num | 16.149e+3 | 2.683e+3 | 16.116e+3 | 16.116e+3 | 0 | | 0 |
status
Z1 zoom(C1)
50.0 mV/div
5.00 ns/div
-52.5 mV
-256.0 mV
Δy -203.5 mV
Timebase 1.4 ns
10.0 ns/div
250 S 2.5 GS/s
Trigger C1 DC
Norm. 100 mV
Edge Positive
X1= -12.6 ns ΔX= 2.70 ns
X2= -9.90 ns 1/ΔX= 370 MHz