

MAPM Testing

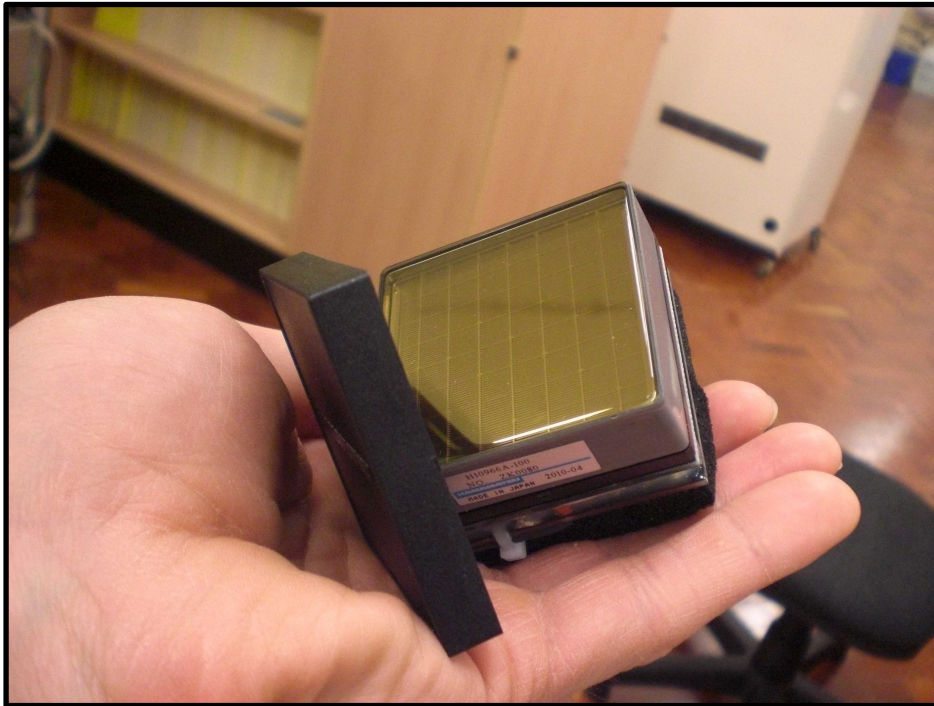
Mark Bryan

CTA-UK, Liverpool, September 2012

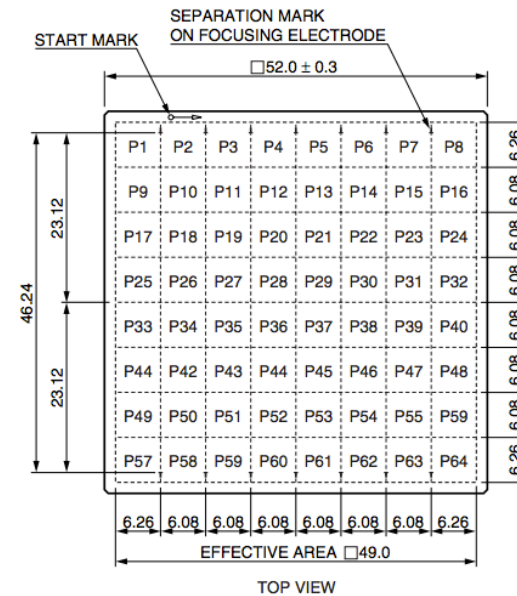


University of
Leicester

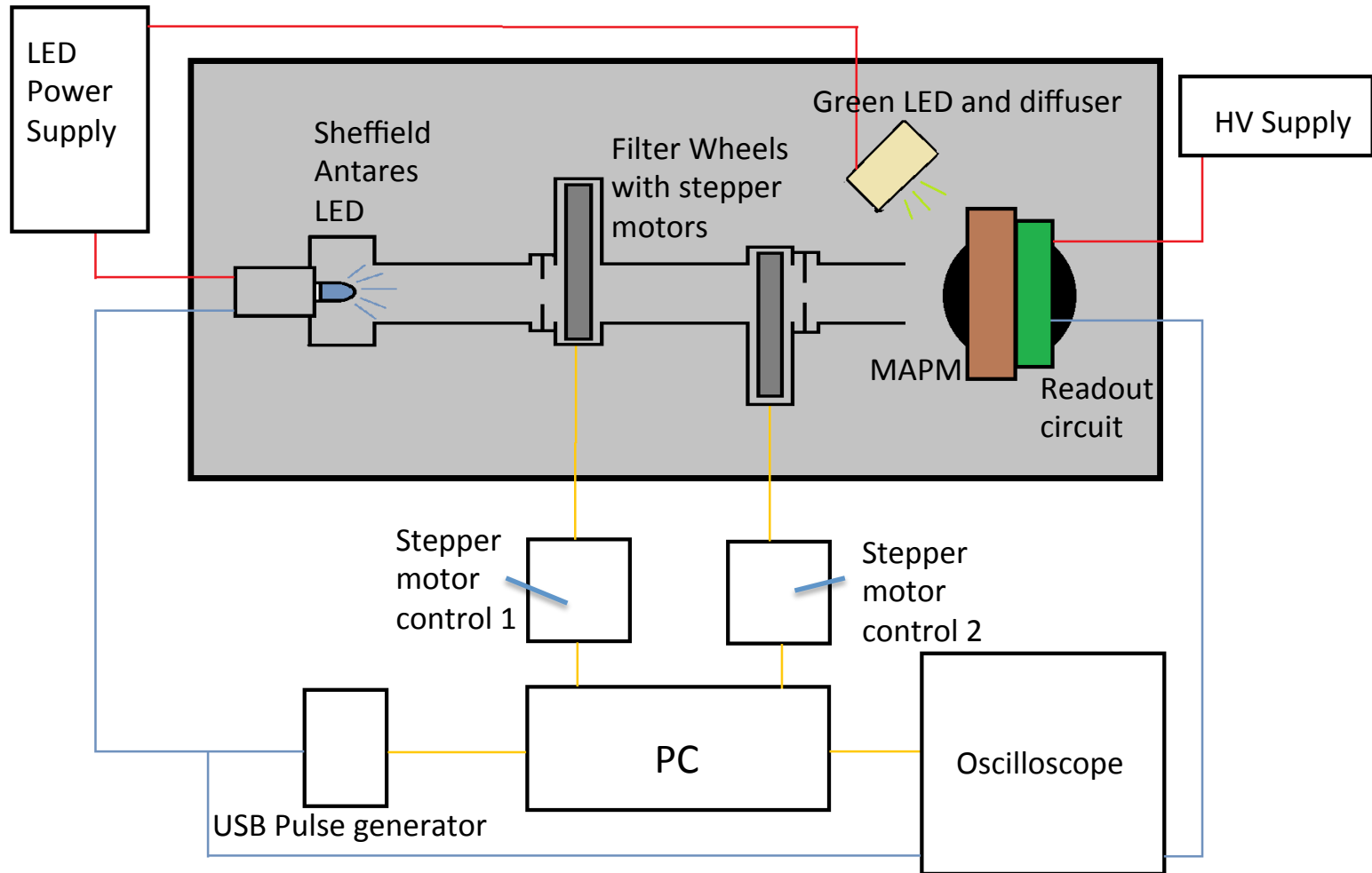
MAPMs



- 2 Hamamatsu H10966 MAPMs: ZK0125 and ZK0080
- 6x6mm pixel size
- Super-Bialkali Photocathode
- 8 Dynodes
- Maximum input voltage of -1100V
- Gain $\sim 10^5$ at 1000 V



Experimental Setup (I)

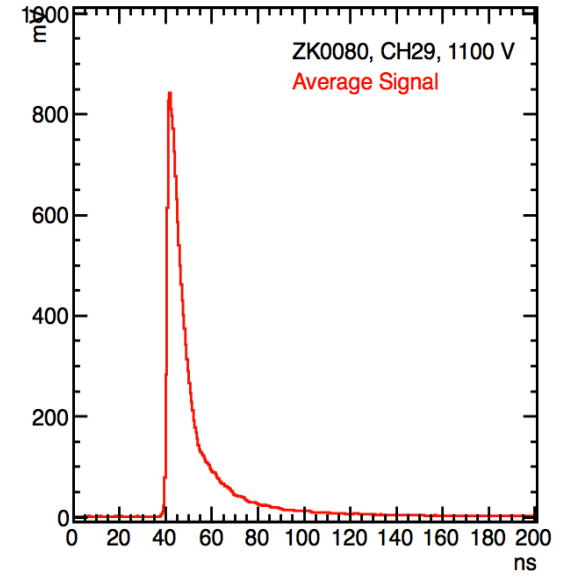
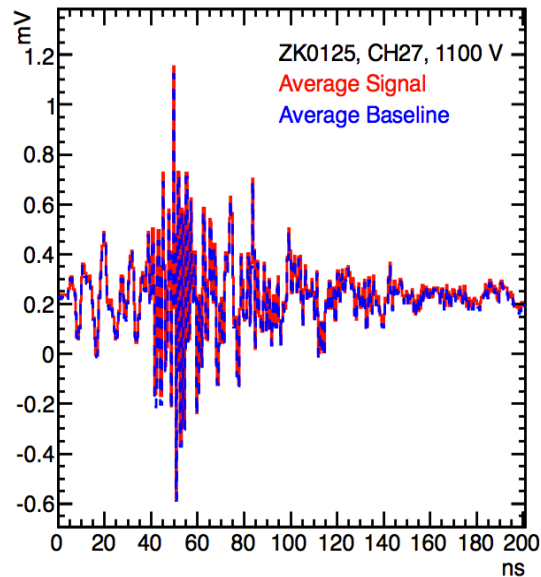
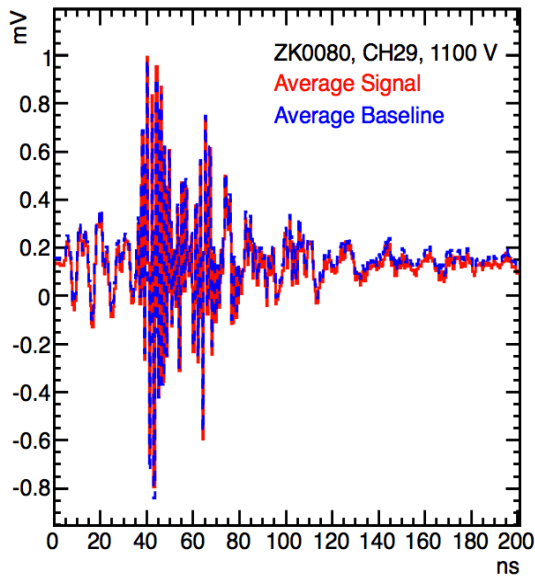


Experimental Setup (II)

- ⦿ Combined Control and Acquisition software written in C++
- ⦿ LeCroy WaveRunner HRO 64Zi
 - ❑ 2GS/s, 12 bit
 - ❑ USB interface
 - ❑ Triggered by the LED input pulse
 - ❑ One waveform: 500 samples over 200ns
 - ❑ Acquisition rate ~300 waveforms a second
 - ❑ Costs the equivalent of 1 year's student loan (or a brand new Volkswagon Golf)
- ⦿ Stored as a binary file and analysed in Root

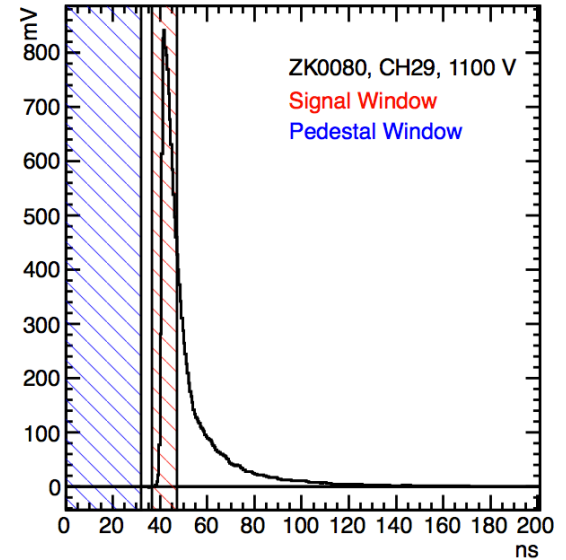
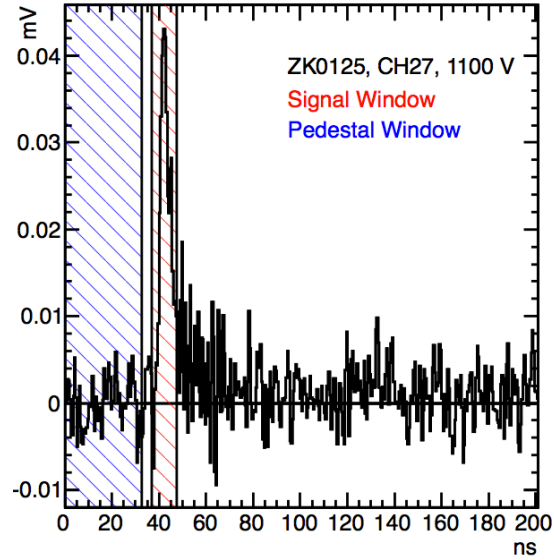
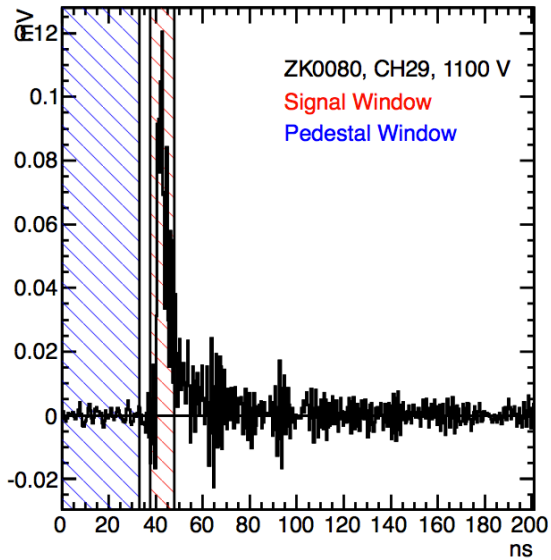


Waveform Analysis (I)



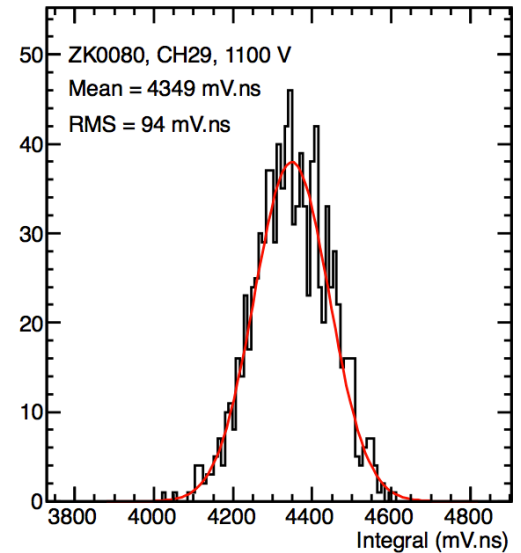
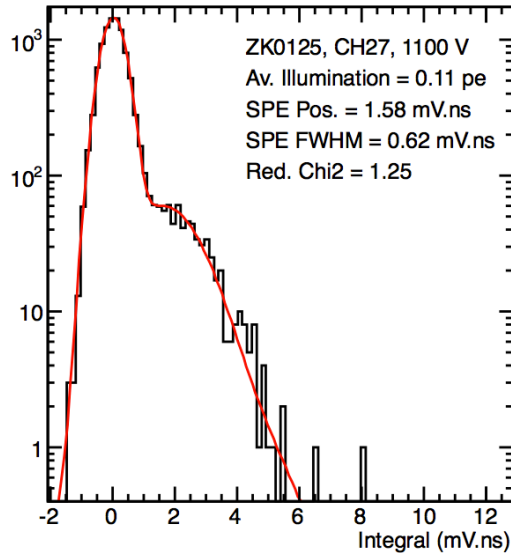
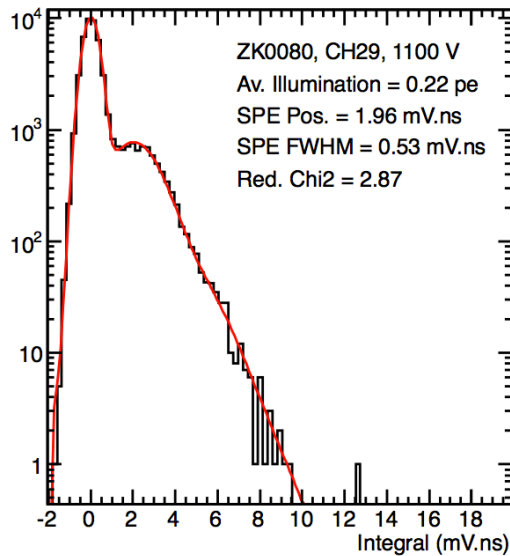
- Systematic Noise great enough to make low illumination measurements difficult
- Darkwave subtraction for each measurement

Waveform Analysis (II)



- Determination of integration region
- Pedestal removal

Waveform Analysis (III)



- Pulse integral distribution histogram
- Fitted with Poisson convoluted with a Gaussian
- Free parameters: electronic noise amplitude and RMS, signal per photon, signal RMS & illumination level
- Simultaneous fits with shared Gain and Signal RMS

Pulse Shape

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help

Zoom Undo



Measure	P1:ampl(C1)	P2:width(C1)	P3:rise(C1)	P4:fall(C1)	P5:ampl(C2)	P6:width(C2)	P7:rise(C2)	P8:fall(C2)
value	33.11 mV	4.163 ns	9.226 ns	1.252 ns	2.839 mV	5.987 ns	23.199 ns	6.071 ns
status								

C1	ACTM	C3	ACTM
20.0 mV	2.00 V/div		
42.000 mV	5.9200 V		

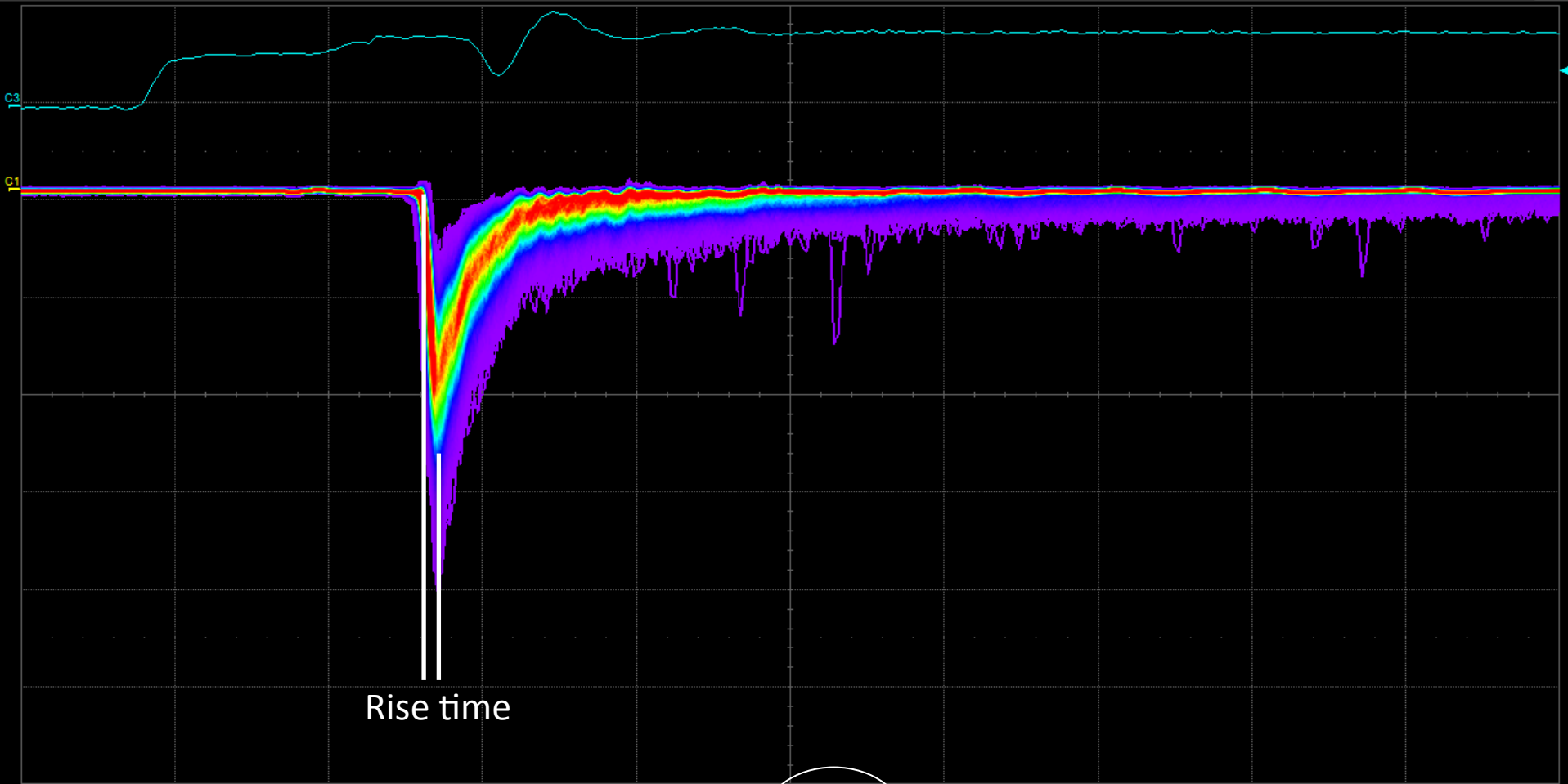
Tbase	-80.8 ns	Trigger	CS
	20.0 ns/div	Stop	720 mV
400 S	2 GS/s	Edge	Positive

LeCroy 9/5/2012 10:46:09 AM

Pulse Shape

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help

Zoom Undo



Rise time

Measure	P1:ampl(C1)	P2:width(C1)	P3:rise(C1)	P4:fall(C1)	P5:ampl(C2)	P6:width(C2)	P7:rise(C2)	P8:fall(C2)
value	33.11 mV	4.163 ns	9.226 ns	1.252 ns	2.839 mV	5.987 ns	23.199 ns	6.071 ns
status								

C1	ACTM	C3	ACTM
20.0 mV	2.00 V/div		
42.000 mV	5.9200 V		

Tbase	-80.8 ns	Trigger	CS
	20.0 ns/div	Stop	720 mV
400 S	2 GS/s	Edge	Positive

LeCroy

9/5/2012 10:46:09 AM

Pulse Shape

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help

Zoom Undo



Measure	P1:ampl(C1)	P2:width(C1)	P3:rise(C1)	P4:fall(C1)	P5:ampl(C2)	P6:width(C2)	P7:rise(C2)	P8:fall(C2)
value	33.11 mV	4.163 ns	9.226 ns	1.252 ns	2.839 mV	5.987 ns	23.199 ns	6.071 ns
status								

C1	ACTM	C3	ACTM
20.0 mV	2.00 V/div		
42.000 mV	5.9200 V		

Tbase	-80.8 ns	Trigger	CS
	20.0 ns/div	Stop	720 mV
400 S	2 GS/s	Edge	Positive

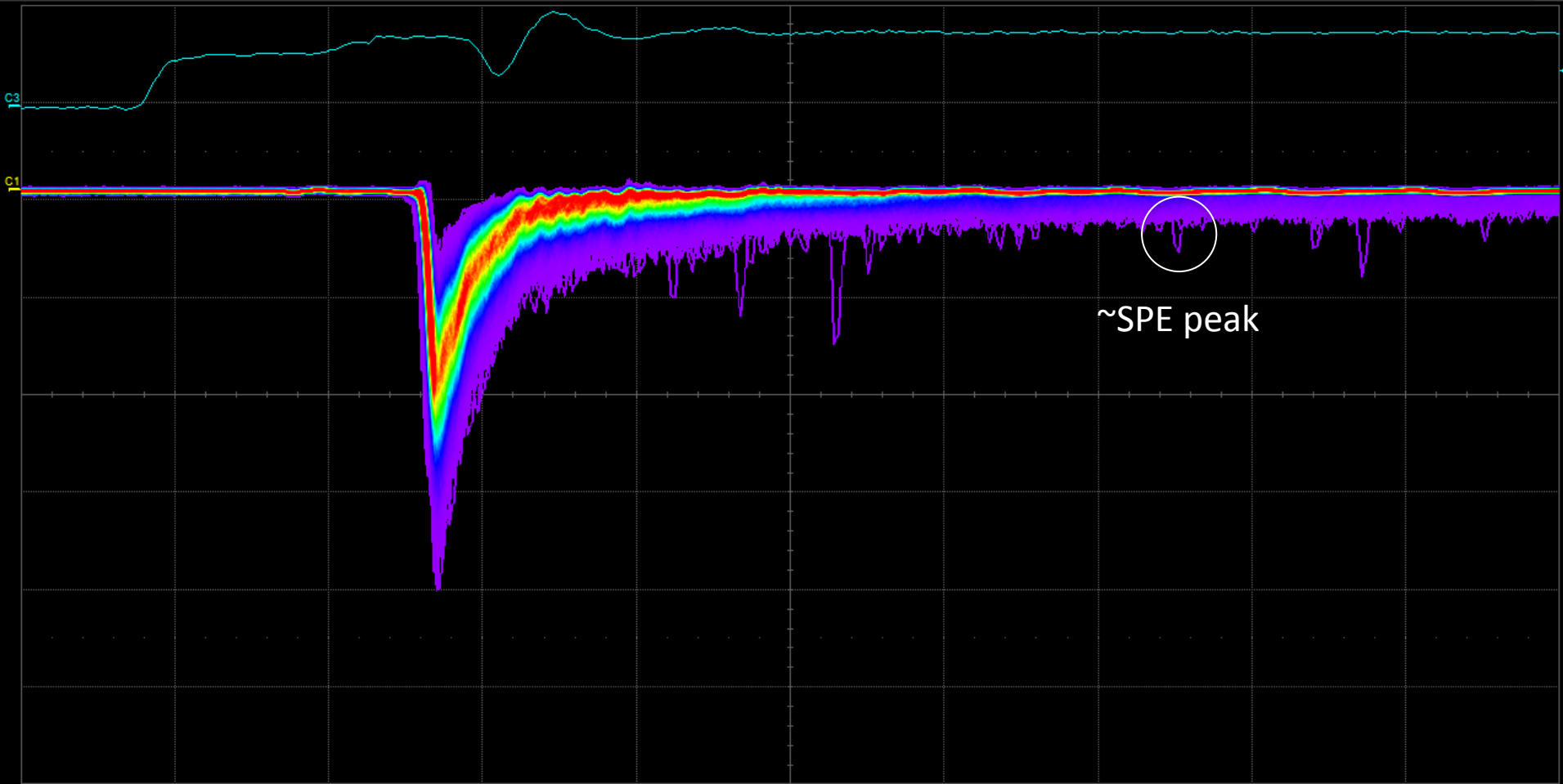
LeCroy

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Pulse Shape

File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help

Zoom Undo



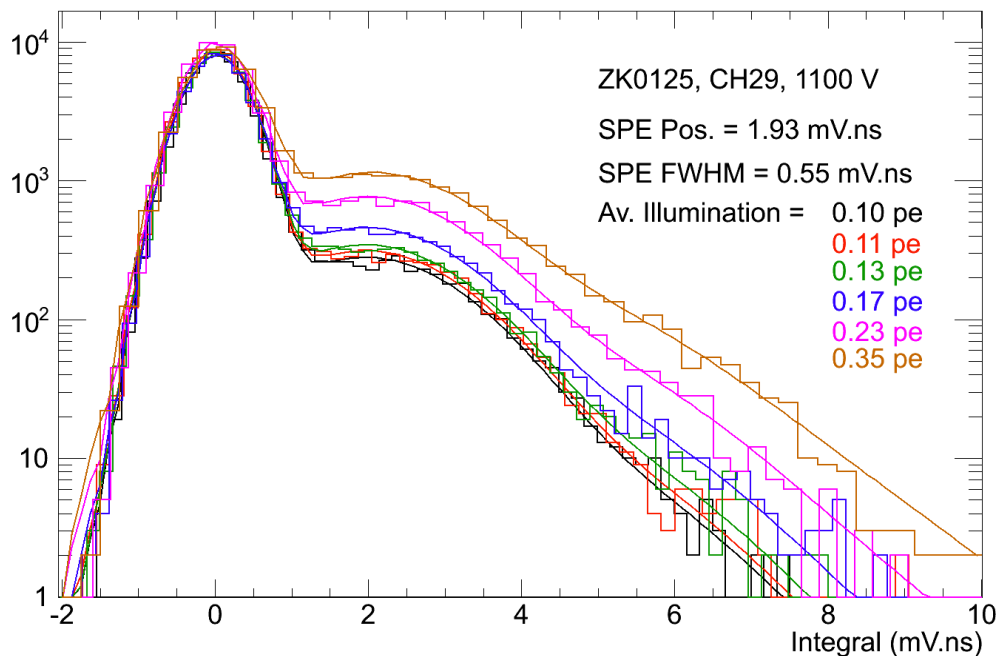
Measure	P1:ampl(C1)	P2:width(C1)	P3:rise(C1)	P4:fall(C1)	P5:ampl(C2)	P6:width(C2)	P7:rise(C2)	P8:fall(C2)
value	33.11 mV	4.163 ns	9.226 ns	1.252 ns	2.839 mV	5.987 ns	23.199 ns	6.071 ns
status								
C1	ACTM	C3	ACTM					
20.0 mV	2.00 V/div							
42.000 mV	5.9200 V							

Tbase	-80.8 ns	Trigger	CS
	20.0 ns/div	Stop	720 mV
400 S	2 GS/s	Edge	Positive

LeCroy
9/5/2012 10:46:09 AM

Filter Calibration

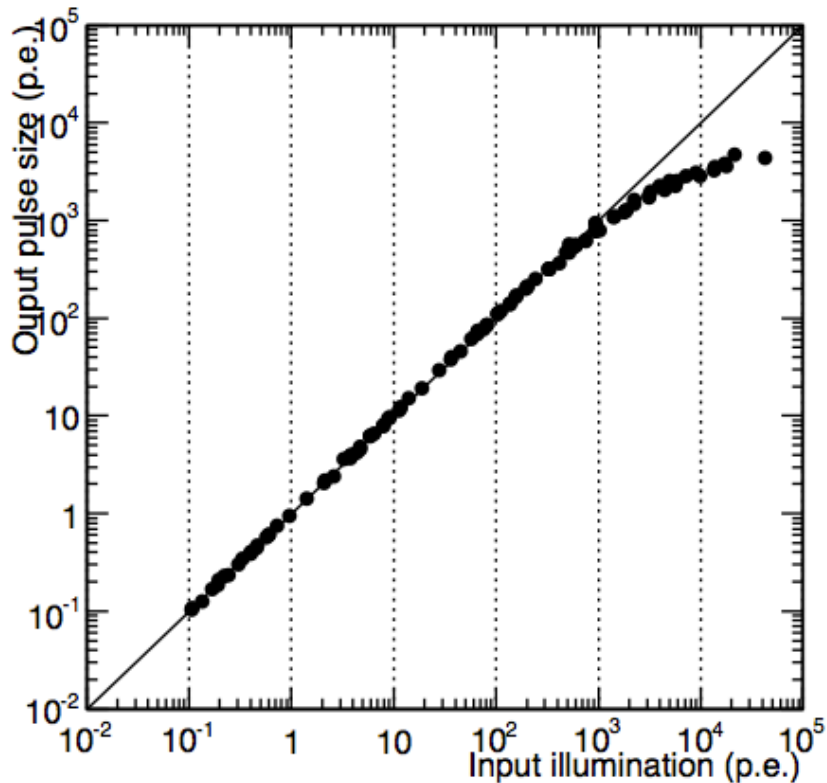
- ⊙ Filters needed calibration.
- ⊙ Calibration was done by comparing two filters' measured illumination levels with the LED tuned to produce a measurable SPE spectrum in both.
- ⊙ The fitting for the two filters' waveform sets was done simultaneously with shared signal per photon and signal RMS.



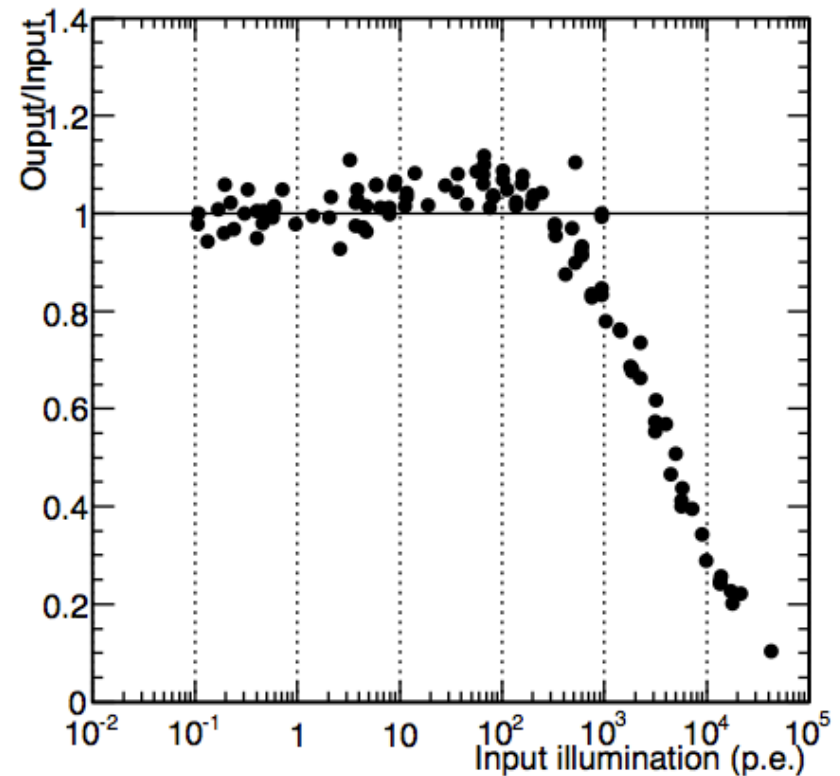
Dynamic Range: CH29, Device ZK0125

- ⊙ Compared calibrated filters to measured illumination level
- ⊙ Multiple dynamic range runs with varying initial illumination.

Linearity (CH=29 HV=1100)



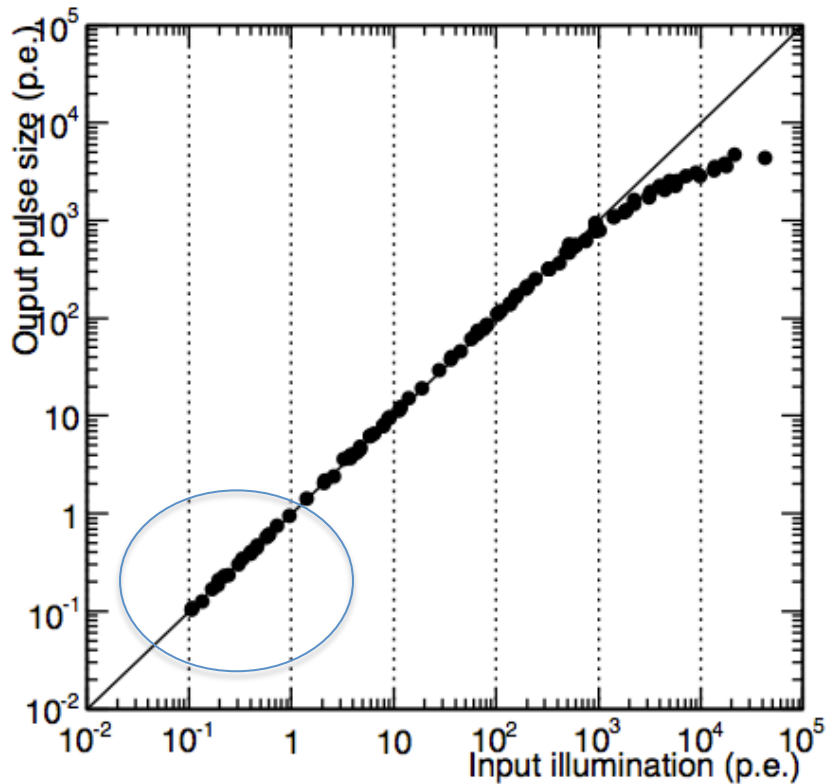
Linearity (CH=29 HV=1100)



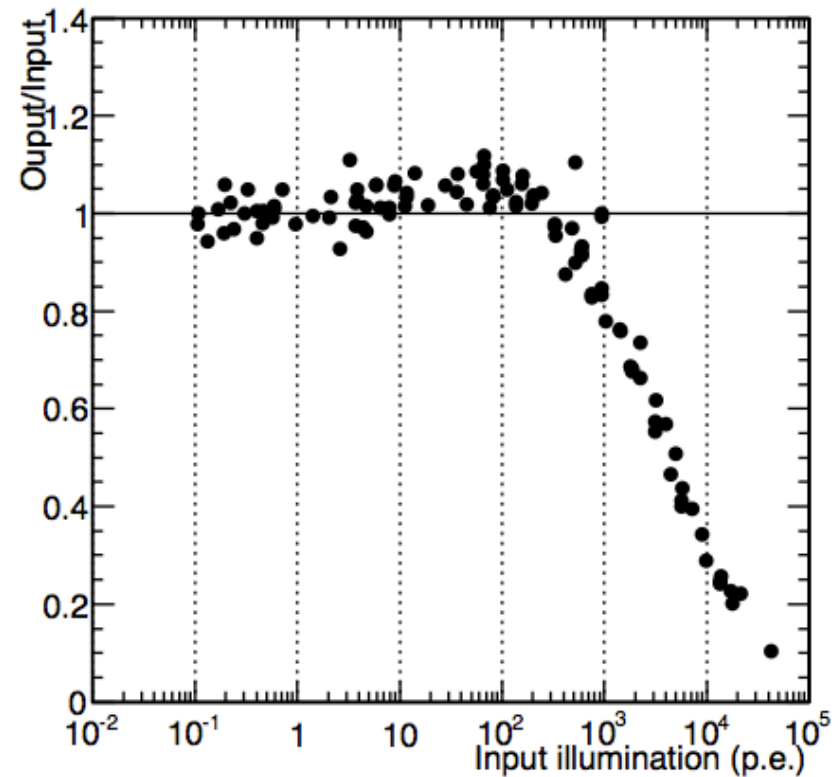
Dynamic Range: CH29, Device ZK0125

- ⊙ Low illumination: Illumination level determined by simultaneous fit

Linearity (CH=29 HV=1100)



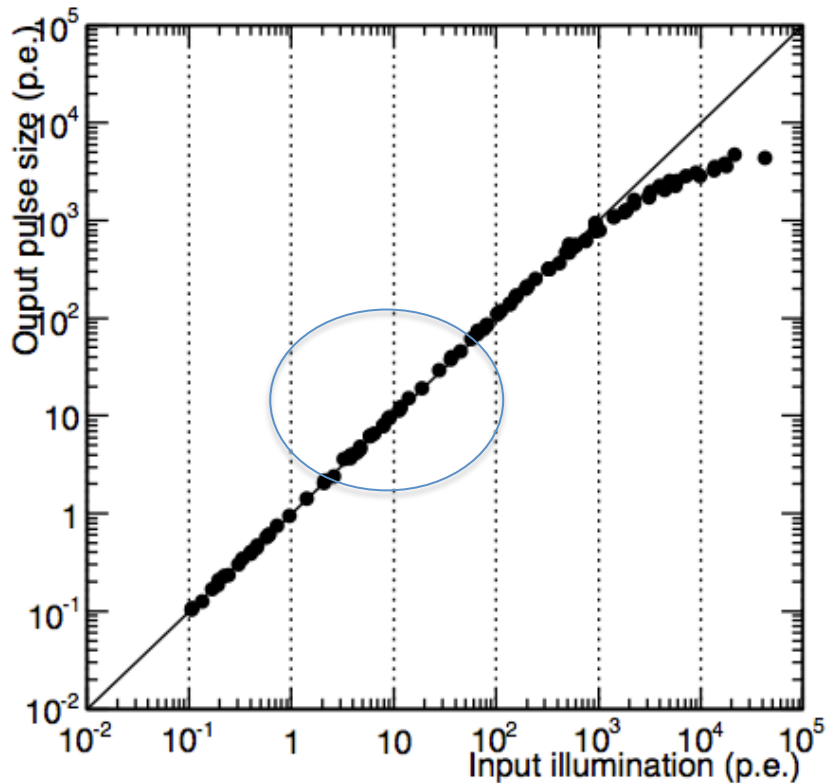
Linearity (CH=29 HV=1100)



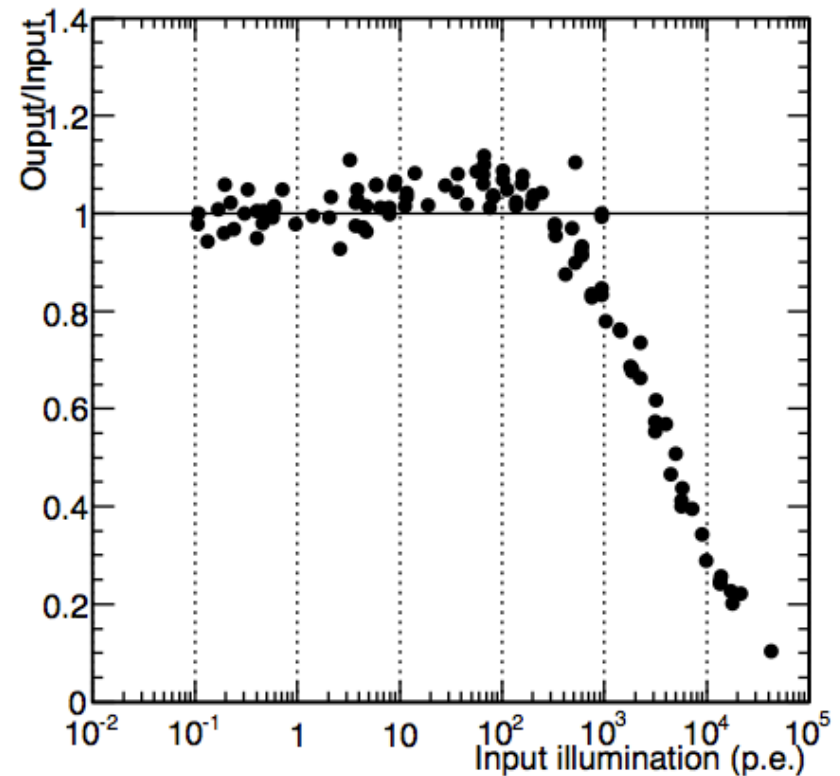
Dynamic Range: CH29, Device ZK0125

- ⊙ Medium illumination: Illumination level determined by a fit of the single histogram

Linearity (CH=29 HV=1100)



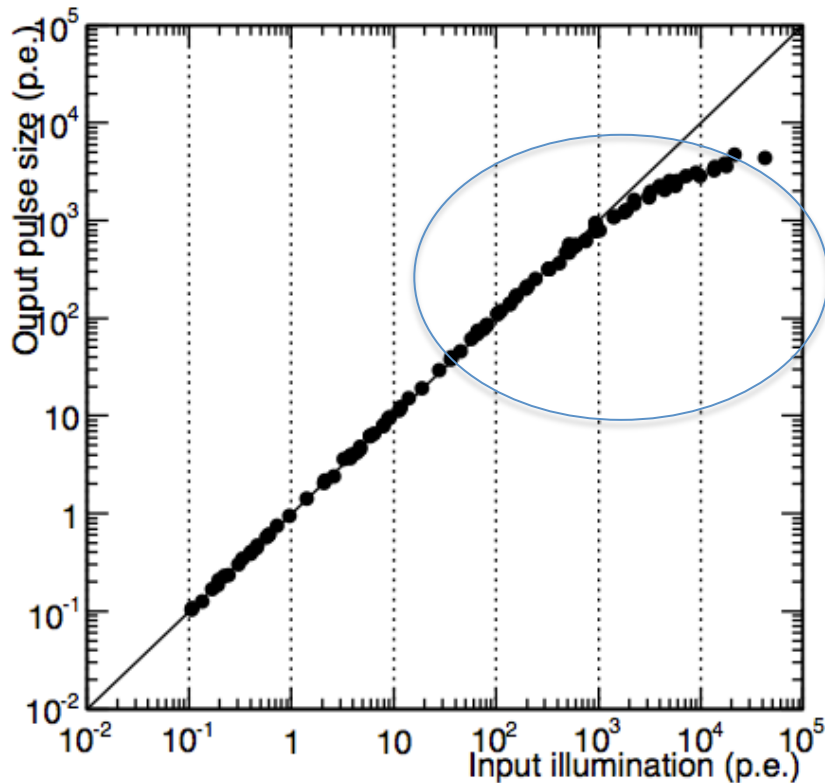
Linearity (CH=29 HV=1100)



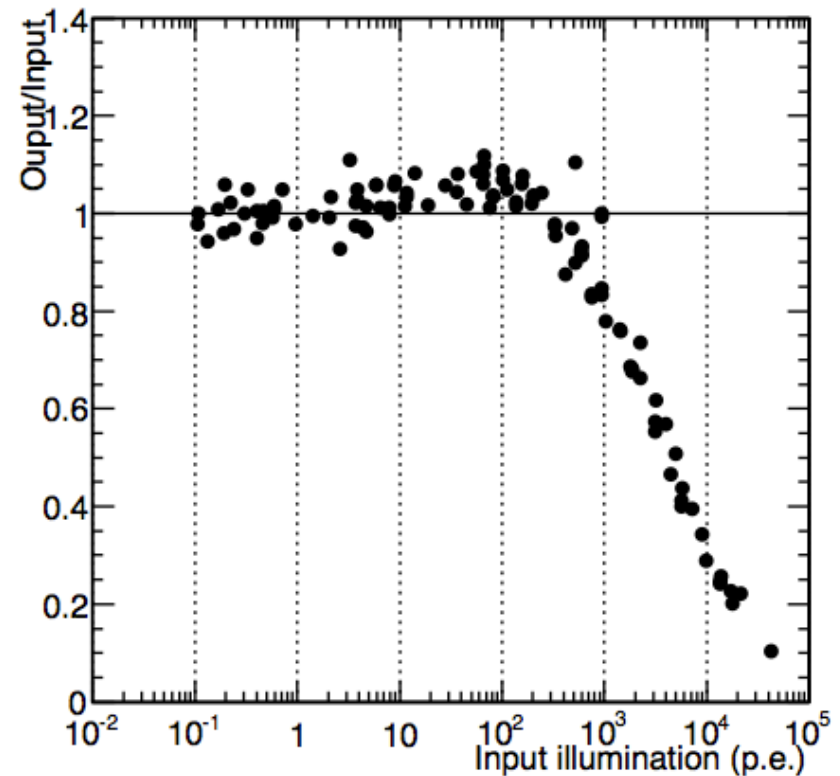
Dynamic Range: CH29, Device ZK0125

- ⊙ High Illumination: Illumination level determined by Gaussian mean (divided by signal per photon).

Linearity (CH=29 HV=1100)



Linearity (CH=29 HV=1100)

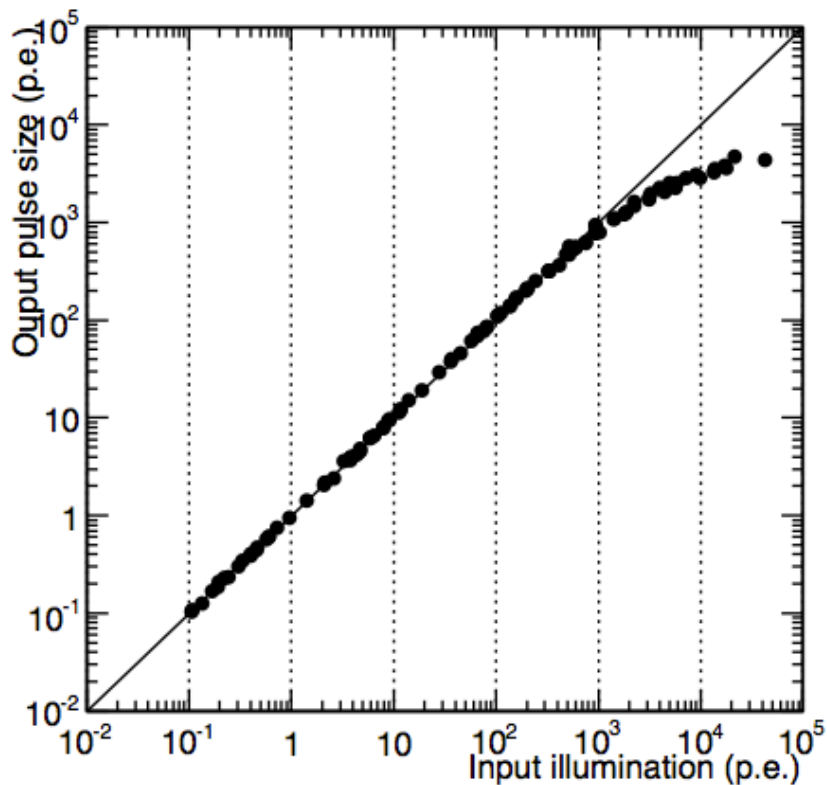


Dynamic Range: CH29, Device ZK0125

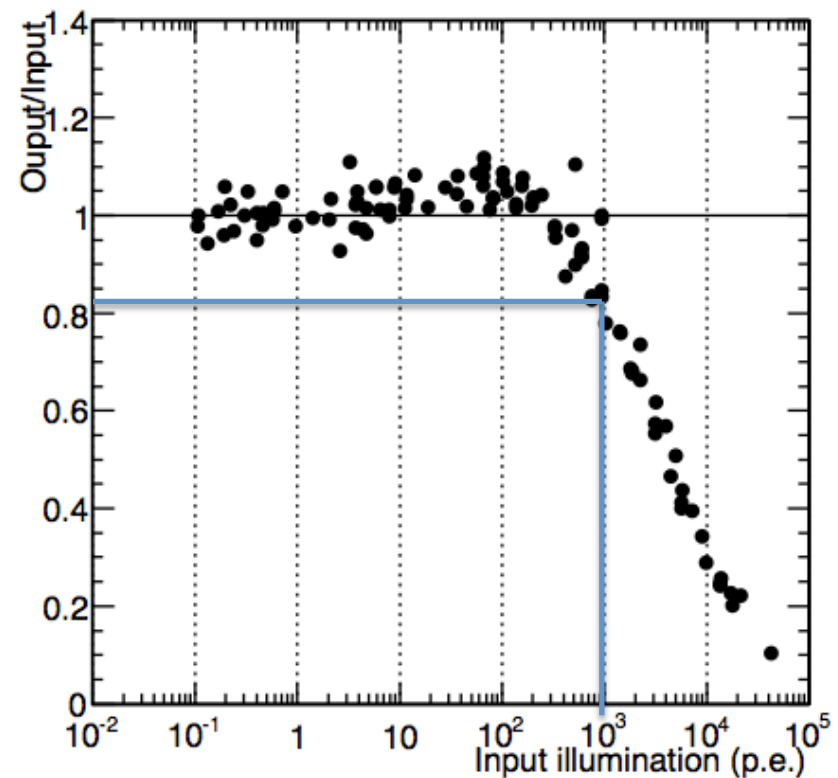
⊙ Results?

- $\sim \pm 5\%$ spread around out=in
- $\sim 20\%$ deviation from linearity by 1000 pe.

Linearity (CH=29 HV=1100)

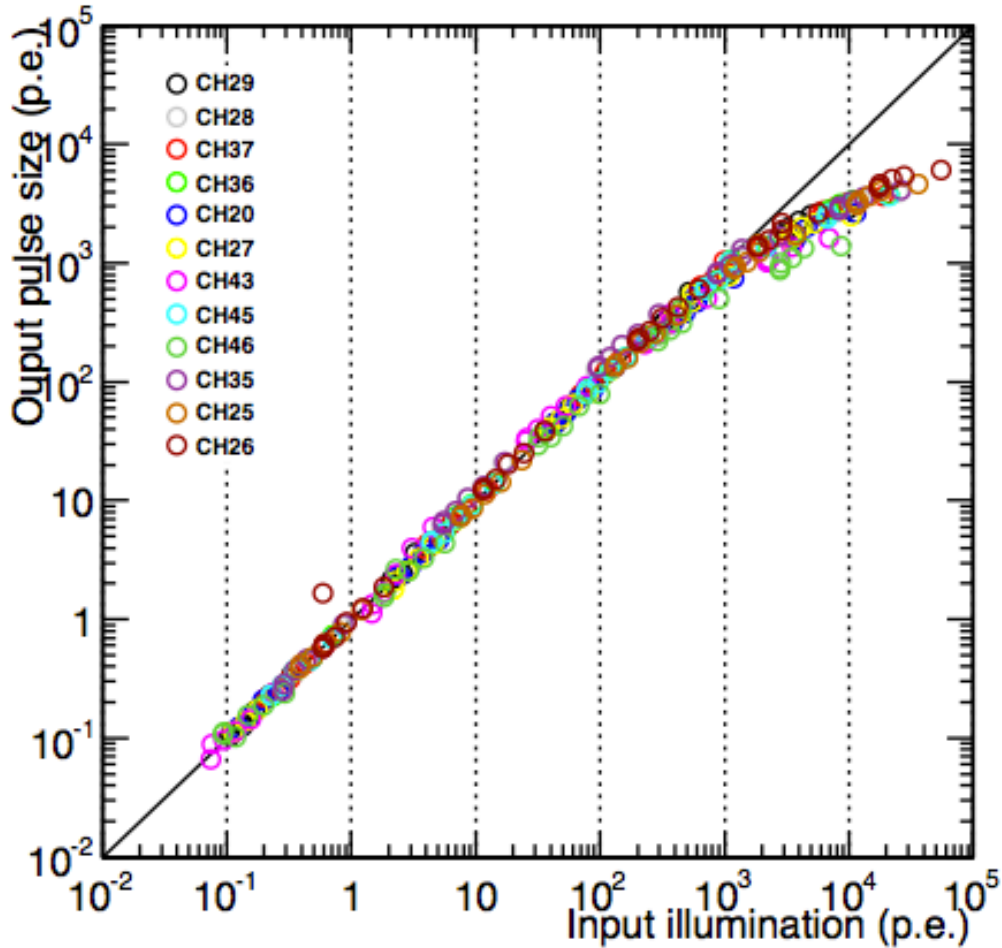


Linearity (CH=29 HV=1100)



Dynamic Range: Device ZK0125

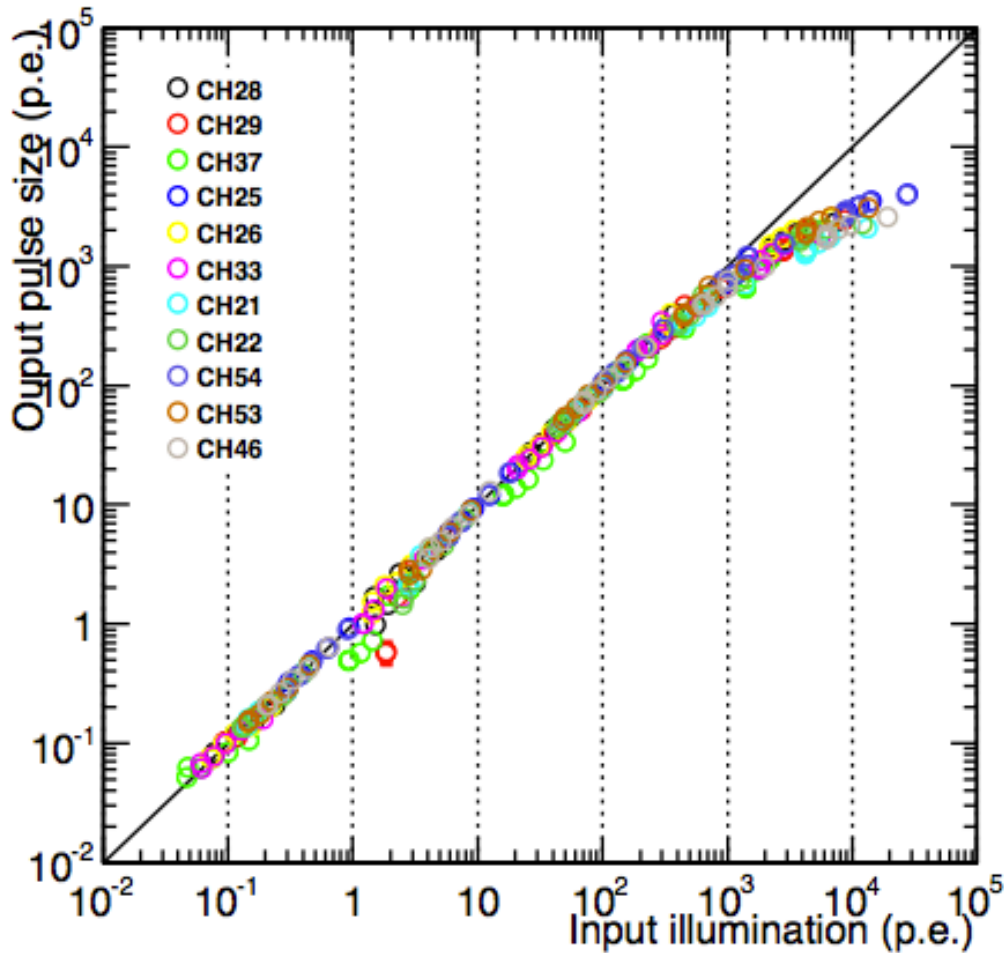
Linearity (ZK0125)



1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

Dynamic Range: Device ZK0080

Linearity (ZK0080)



1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64

Measurements taken but not in this presentation

- ⊙ Angular Dependence: MAPMs must be able to measure at up to $\sim 70^\circ$ for optical telescope design.
- ⊙ Gain: Gain must be within some limits and its dependence on HV needs to be characterised. Additionally gain sag due to background illumination needs to be accounted for in measurements.
- ⊙ Afterpulse Spectrum: Afterpulses interfere with triggering and devices need to be checked.

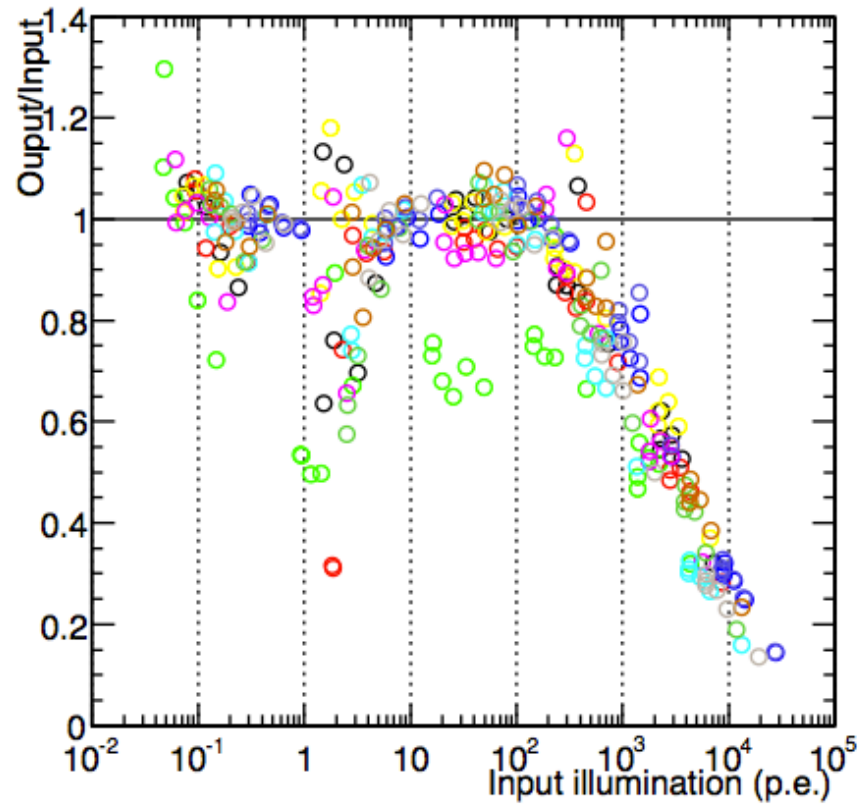
In Conclusion

- ⊙ Most MAPM measurements are finished and awaiting analysis
- ⊙ Dynamic range for a multiple channels and devices has been measured and analysed.
 - Both devices performed roughly as expected
 - No considerable difference between central and edge pixels

Any Questions?

Backup Slides

Linearity (ZK0080)



Linearity (ZK0125)

