



Analysis of Jan 2020 Test beam Runs

Jim Freeman - Fermilab

Sergey Uzunyan - Northern Illinois University,

Michael Krohn, **Garett Reichenbach** - University of Minnesota

Sandeep Gill - Panjab University,

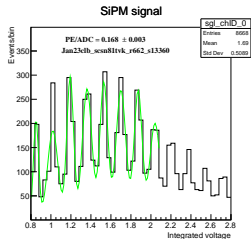
Chandigarh Chris Papageorgakis, Tim Edberg - University of Maryland

Martin Kwok - Brown University

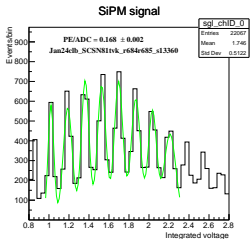
Fermilab

July 8, 2020

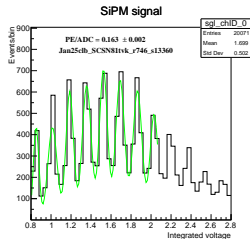
Calibration Runs for Each Day, SiPM 14160 & 13360-1350, Tile: SCSN81 Calibration Tile



Jan 23, **SiPM: 13360**

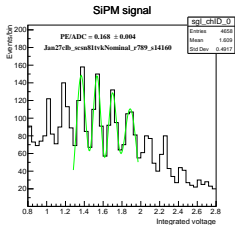


Jan 24, **SiPM: 13360**

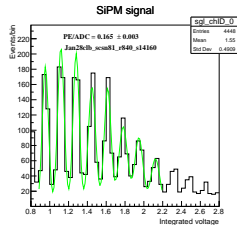


Jan 25, **SiPM: 13360**

Day	PE/adc
Jan 23	0.168 ± 0.003
Jan 24	0.168 ± 0.002
Jan 25	0.163 ± 0.002
Jan 27	0.168 ± 0.004
Jan 28	0.165 ± 0.003

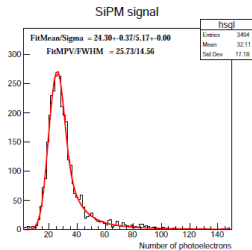


Jan 27, **SiPM: 14160**

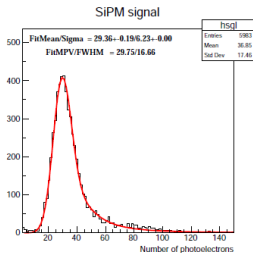


Jan 28, **SiPM: 14160**

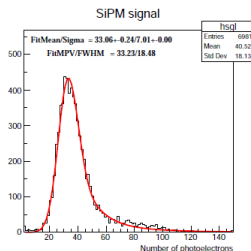
Investigation of Bias Voltage effect on Light Yield, SiPM 14160-1350, Tile: EJ200 Reference Tile



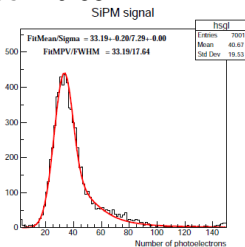
Bias: 40.83V



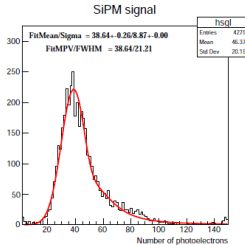
Bias: 41.33V



Bias: 41.83V



Bias: 42.33V



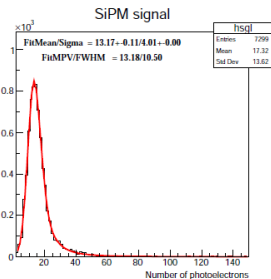
Bias: 42.83V

Investigation of Bias Voltage effect on Light Yield, SiPM 14160-1350, Tile: **EJ200 Reference Tile**

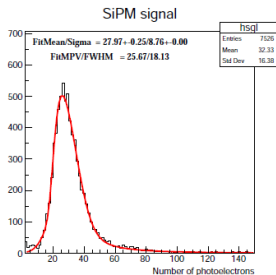
Bias	MPV	FWHM	Mean	σ
40.83	25.73	14.56	24.30 ± 0.37	5.17
41.33	29.75	16.66	29.36 ± 0.19	6.23
41.83	33.23	18.48	33.06 ± 0.24	7.01
42.33	33.19	17.64	33.19 ± 0.20	7.29
42.83	38.64	21.21	38.64 ± 0.26	8.07

Table: Fitting information on Light Yield from EJ200 Tile with varying SiPM 14160-1350 Bias Voltage.

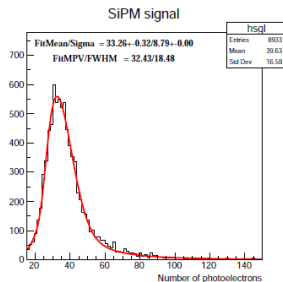
Investigation of Stacked Tiles effect on Light Yield, **ESR Wrap**, SiPM 14160-1350, Tile: SCSN81 Tile, Run 798 814 & 845, 30x30mm



x1 Tile, **ESR Wrap**



x2 Tiles, **ESR Wrap**

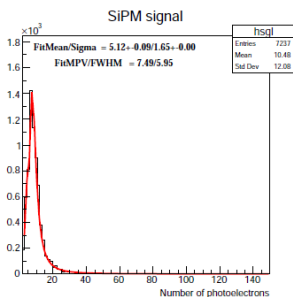


x3 Tiles, **ESR Wrap**

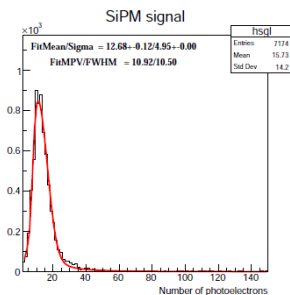
Thickness	MPV	FWHM	Mean	σ
x1	13.18	10.50	13.17 ± 0.11	4.01
x2	25.67	18.13	27.97 ± 0.25	8.76
x3	32.43	18.48	33.26 ± 0.32	8.79

Table: Fitting information on Light Yield from SCSN81 Tile with varying thickness.

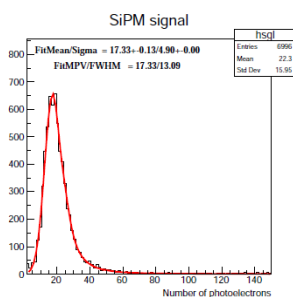
Investigation of Stacked Tiles effect on Light Yield, **Tyvek Wrap**, SiPM 14160-1350, Tile: SCSN81 Tile, Run 838 814 & 845, 30x30mm



x1 Tile, **Tyvek Wrap**



x2 Tiles, **Tyvek Wrap**

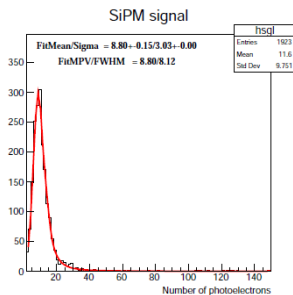


x3 Tiles, **Tyvek Wrap**

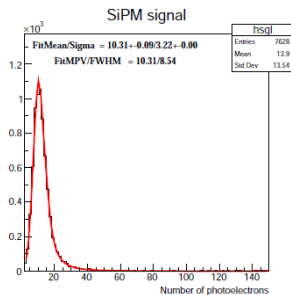
Thickness	MPV	FWHM	Mean	σ
x1	7.49	5.95	5.12 ± 0.09	1.65
x2	10.92	10.50	12.68 ± 0.12	4.95
x3	17.33	13.09	17.33 ± 0.13	4.90

Table: Fitting information on Light Yield from SCSN81 Tile with varying thickness

Investigation of Stacked Tiles effect on Light Yield, SiPM 14160-1350, Tile: SCSN81 Tile, Run 843 & 859, 50x50mm



x1 Tile, ESR Wrap

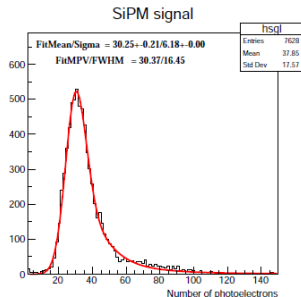
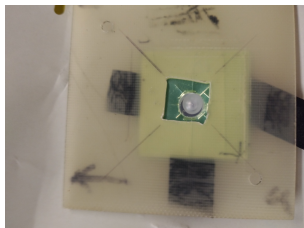
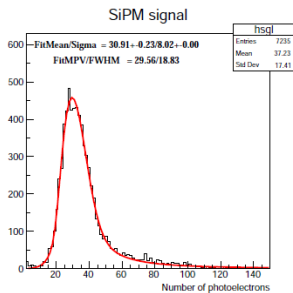


x2 Tiles, ESR Wrap

Thickness	MPV	FWHM	Mean	σ
x1	8.80	8.12	8.80 ± 0.15	3.03
x2	10.31	8.54	10.31 ± 0.09	3.22

Table: Fitting information on Light Yield from SCSN81 5x5cm Tile with varying thickness.

Investigation of off-center SiPM by 1.7mm on Light Yield, SiPM 14160-1350, Tile: EJ200 Tile, Run 848 & 850, 30x30mm



Offset, ESR Wrap

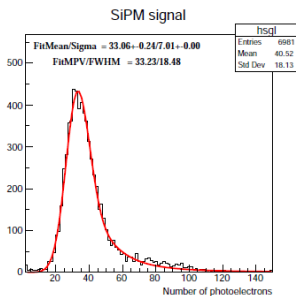
Aligned, ESR Wrap

Thickness	MPV	FWHM	Mean	σ
offset	29.56	18.83	30.91 ± 0.23	8.02
aligned	30.37	16.45	30.25 ± 0.21	6.18

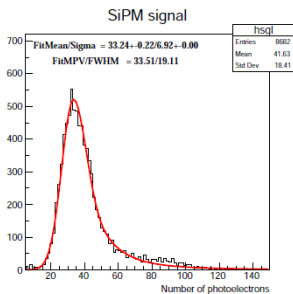
Table: Fitting information on Light Yield from EJ200 Reference Tile with offset SiPM position.

Investigation of Hole-size on Light Yield, SiPM

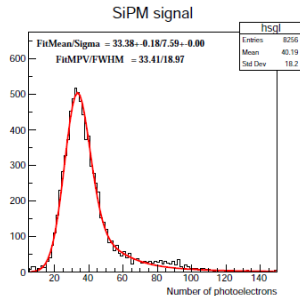
14160-1350, Tile: EJ200 Tile, Run 797 796 & 784,
30x30mm



Hole Size: $\frac{1}{4}$ "



Hole Size: $\frac{3}{16}$ "

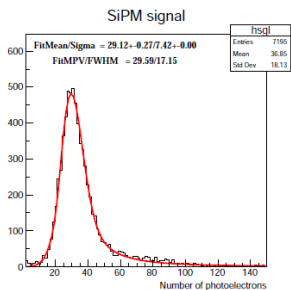
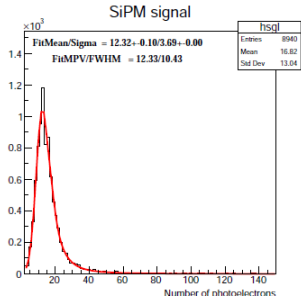
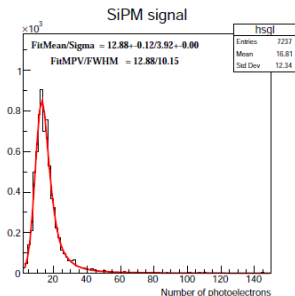


Hole Size: $\frac{1}{8}$ "

Hole-size	MPV	FWHM	Mean	σ
$\frac{1}{4}$ "	33.23	18.48	33.06 ± 0.24	7.01
$\frac{3}{16}$ "	33.51	19.11	33.24 ± 0.22	6.92
$\frac{1}{8}$ "	33.41	18.97	33.38 ± 0.18	7.59

Table: Fitting information on Light Yield from EJ200 Tile with Varying Hole Sizes

Investigation of Radiation on Light Yield, SiPM 14160-1350, Tile: Irradiated Tiles, Run 799 802 & 839



Tile: DESY PS5, 29x29

Tile: NIU-PS-H, 30x30

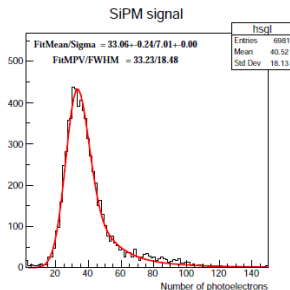
Tile: UPS923A, 30x30

Tile	MPV	FWHM	Mean	σ
DESY PS5	12.88	10.15	12.88 ± 0.12	3.92
NIU-PS-H	12.33	10.43	12.32 ± 0.10	3.69
UPS923A - Rad amount Unsure	29.59	17.15	29.12 ± 0.27	7.42

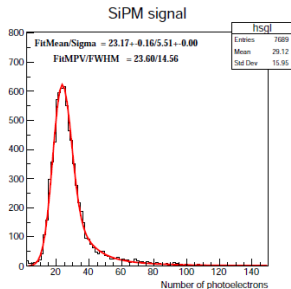
Table: Fitting information on Light Yield from Each Irradiated Tile. (irradiated 1.16 Mrad , 0.030 kRad/hour, Co60, t=-30 deg C - all irradiated with esr wrapping)

Investigation of Radiation on Light Yield, SiPM

14160-1350, Tile: **EJ200 Ref Tile**, SiPM: 14160-1350,
ESR, Run 848 & 808, 30x30, 30x30



Non-irradiated

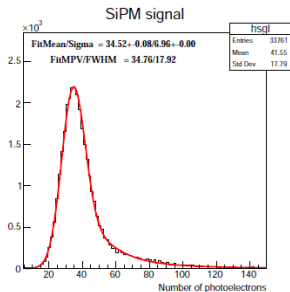


Irradiated

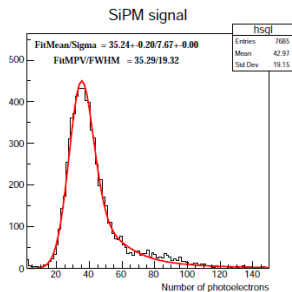
	MPV	FWHM	Mean	σ
non-Irrad	33.23	18.48	33.06 ± 0.24	7.01
Irrad	23.60	14.56	23.17 ± 0.16	5.51

Table: Fitting information on Light Yield EJ200 Tile Before and after radiation. (irradiated 1.16 Mrad , 0.030 kRad/hour, Co60, t=-30 deg C - all irradiated with esr wrapping)

Investigation of SiPM change on Light Yield, Tile: **EJ208 Tile**, ESR, Run 651-658 & 801, 30x30



SiPM: 13360-1350

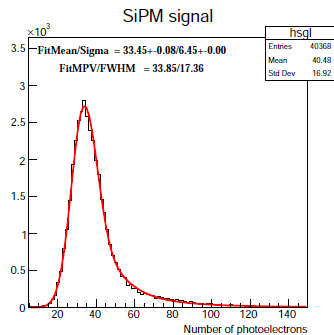


SiPM: 14160-1350

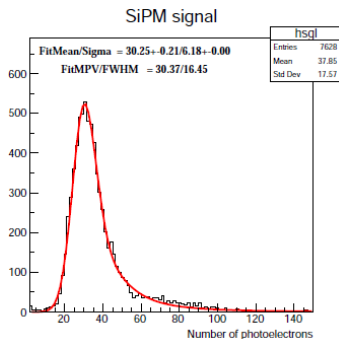
SiPM	MPV	FWHM	Mean	σ
13360 - No Silk Screen	34.76	17.92	34.52 ± 0.08	6.96
14160	35.29	19.32	35.24 ± 0.20	7.67

Table: Fitting information on Light Yield EJ208 Tile with SiPM: 13360 and SiPM: 14160.

Investigation of SiPM change on Light Yield, Tile: **EJ200 Ref Tile, ESR, Run 663-664 & 848**



SiPM: 13360-1350

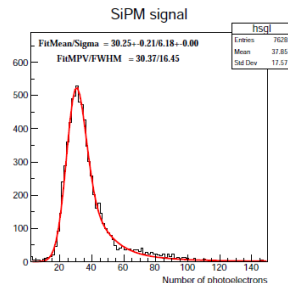
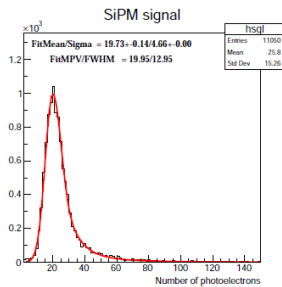


SiPM: 14160-1350

SiPM	MPV	FWHM	Mean	σ
13360 - No Silk Screen	33.85	17.36	33.45 ± 0.08	6.45
14160	30.37	16.45	30.25 ± 0.21	6.18

Table: Fitting information on Light Yield EJ200 Reference Tile with SiPM: 13360 and SiPM: 14160.

Investigation of Black Tape around SiPM on Light Yield, SiPM 14160-1350, Tile: **EJ200 Ref Tile**, ESR, Run 848 & 852-853, 30x30



Black Tape

Control

SiPM	MPV	FWHM	Mean	σ
tape	19.95	12.95	19.73 ± 0.14	4.66
no tape	30.73	16.45	30.25 ± 0.21	6.81

Table: Fitting information on Light Yield EJ200 Tile with Black tape around SiPM.

Compilation of all non-irradiated Tiles with **SiPM 13360**, Hole Size: $\frac{1}{4}$ " , ESR

Tile, Run, Size (mm)	MPV	FWHM	Mean	σ
EJ208, 651-658, 30x30	34.76	17.92	34.52 \pm 0.08	6.96
EJ200, 666-668, 30x30	33.85	17.36	33.45 \pm 0.08	6.45
NIU #19 EJ200, 672-674, 35x35	37.98	20.02	36.73 \pm 0.13	8.97
NIU "S" small, 688, 24x24	38.56	18.34	38.59 \pm 0.33	7.96
Ukr Tile, 690, 31x31	35.89	18.20	35.84 \pm 0.21	7.60
NIU IM # 19, 686-687, 39x39	19.24	12.46	19.17 \pm 0.11	4.58
EJ200 # 41, 694-713, 55x55	19.78	12.60	19.68 \pm 0.04	4.54
NIU # 25, 719-725, 39x39	17.71	11.76	17.68 \pm 0.05	4.28
NIU # 23. 726-732, 36x36	17.32	11.76	17.25 \pm 0.06	4.15
NIU # 21, 733-744, 36x36	21.17	13.16	21.08 \pm 0.06	4.75
Tile # 307, 757, 30x30	33.09	16.52	33.03 \pm 0.16	6.57
EJ262, 758, ???	23.74	13.93	23.68 \pm 0.10	5.21
Tile # 301, 759, 30x30	23.58	13.86	23.44 \pm 0.14	5.10

Compilation of all non-irradiated Tiles with **SiPM 14160**, Hole Size: $\frac{1}{4}$ " , ESR

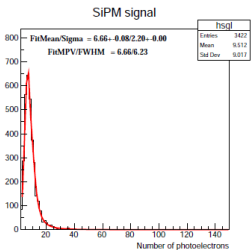
Tile, Run, Size (mm)	MPV	FWHM	Mean	σ
EJ200, 784, 30x30	33.23	18.48	33.06 ± 0.24	7.01
EJ208, 801, 30x30	35.29	19.32	35.24 ± 0.20	7.67
SCSN81 Baggy Wrap, 836, 30x30	13.18	10.50	13.17 ± 0.11	4.01
EJ262 Green Wrap, 837, 30x30	28.47	16.59	28.14 ± 0.19	6.32
SCSN81, 843, 50x50	8.80	8.12	8.80 ± 0.15	3.03
SCSN81, 845, 30x30	23.30	16.59	23.29 ± 0.14	6.79
EJ200, 848, 30x30	30.37	16.45	30.25 ± 0.21	6.18

Table: Fitting information on Light Yield from varying Tiles.

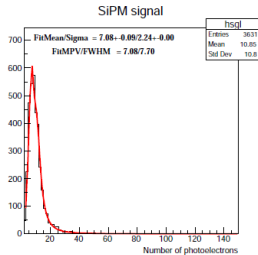


Extra Slides

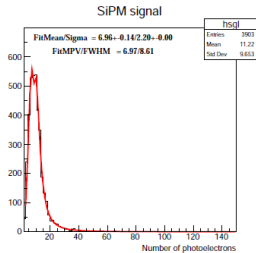
Investigation of Bias Voltage effect on Light Yield, SiPM 14160-1350, Tile: SCSN81 Calibration Tile



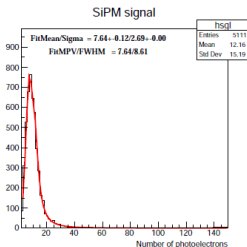
Bias: 40.83V



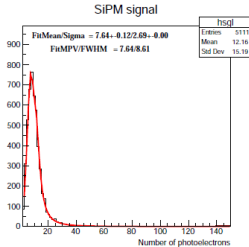
Bias: 41.33V



Bias: 41.83V



Bias: 42.33V



Bias: 42.83V

Investigation of Bias Voltage effect on Light Yield, SiPM 14160-1350, Tile: SCSN81 Calibration Tile

Bias	MPV	FWHM	Mean	σ
40.83	6.66	6.23	6.66 ± 0.08	2.20
41.33	7.08	7.70	7.08 ± 0.09	2.24
41.83	6.97	8.61	6.96 ± 0.14	2.20
42.33	7.64	8.61	7.64 ± 0.12	2.69
42.83	7.64	8.61	7.64 ± 0.12	2.69

Table: Fitting information on Light Yield from SCSN81 Calibration Tile with varying SiPM 14160-1350 Bias Voltage.