

D-Egg Bare PMT gain measurement Summary

Jun 15, 2022

Morii

Data acquisition of Gain Measurement

Gain measurement for bare PMT at room temperature

Measurement set up

Laser: Hamamatsu c10196 : 400nm pulse width 60ps

Filter: fix 1% + rotation 0.1%

Oscilloscope: R&S: RTO-1044

Power Supply: KEYSIGHT E3631A + HV board

Data acquisition

laser repetition rate : 100Hz

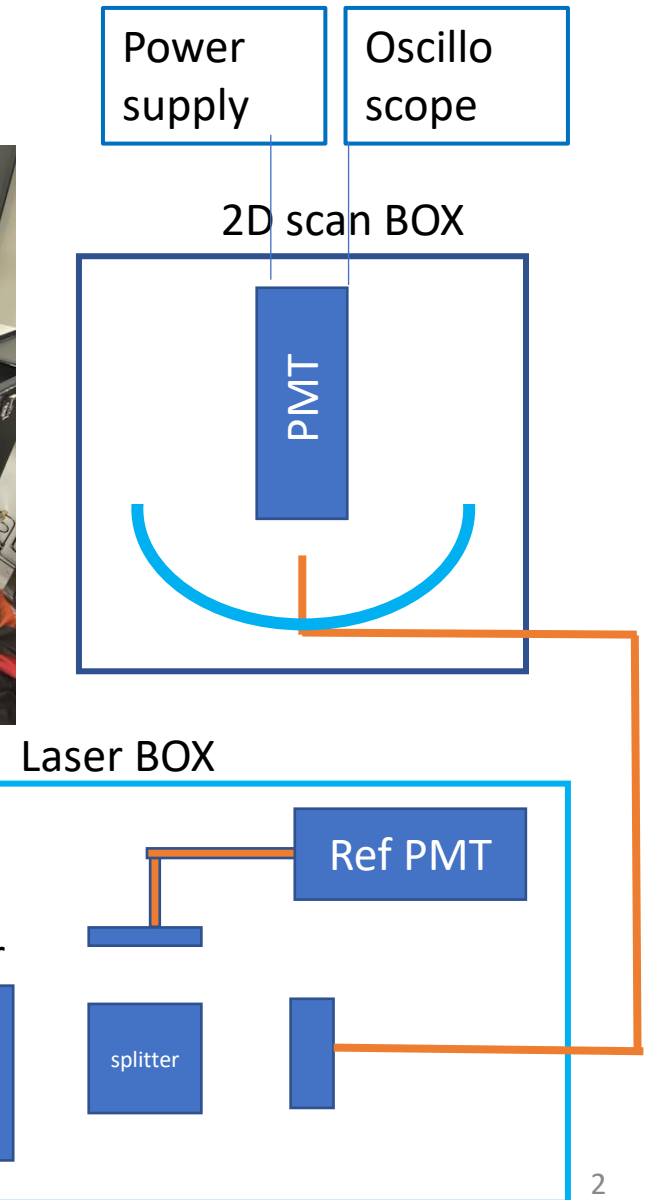
data: 5000 shot/ one HV point

pre-test to know approximately HV for 1×10^7 gain

Control voltage V_c : 3.5, 3.9, 4.2

Then set 4~5 point near 1×10^7 point

code: gain_calibration.ipynb

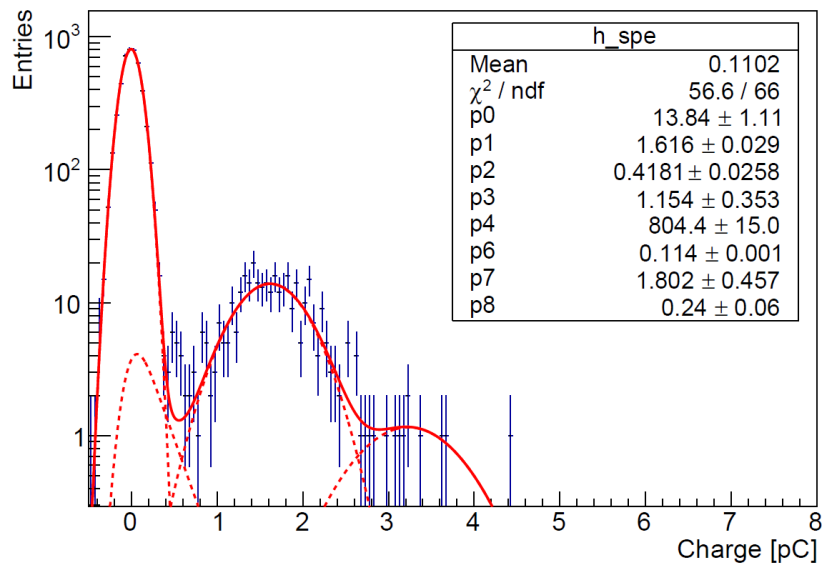


Gain measurement (analysis)

1) Calculate charge from each waveform, then get charge histogram at each HV
code: run_rev5.py (auto_charge_calc.py, auto_make_charge_dist.py, spe_fitting.py)

2) Draw HV vs Gain curve, then get HV at 1×10^7 gain
code: get_gain_curve.py

Ex: sq0975 spe histogram HV=1600V

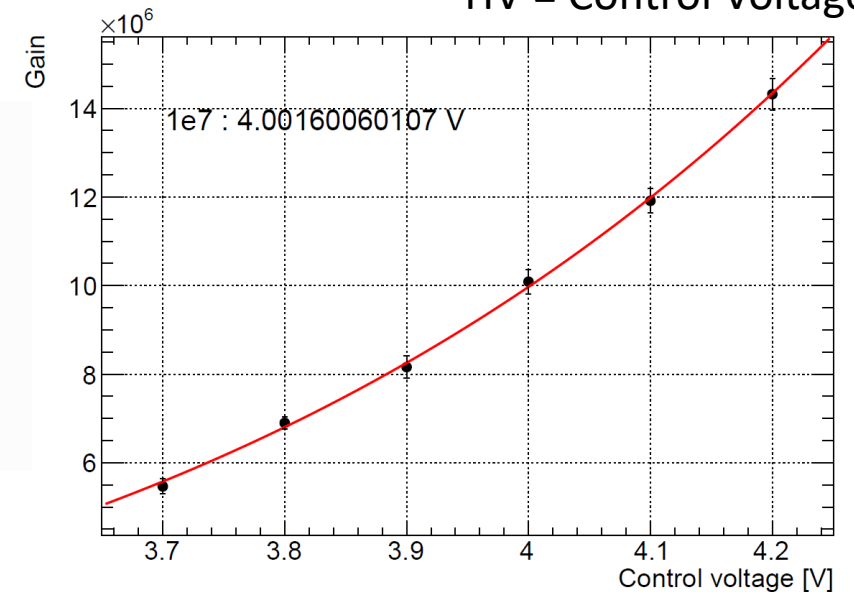


fit function

$$\begin{aligned} SPE_{fit} = & A_{pdc} \exp\left(-\frac{(x-0)^2}{2\sigma_{ped}^2}\right) \\ & + A_{exp} \text{erf}(x) \exp(-x/\tau) \\ & + A_{SPE} \exp\left(-\frac{(x-\mu_{SPE})^2}{2\sigma_{SPE}^2}\right) \\ & + A_{2PE} \exp\left(-\frac{(x-\mu_{2PE})^2}{2\sigma_{2PE}^2}\right) \end{aligned}$$

HV vs Gain curve

HV = Control Voltage X 400



Result summary table

PMT	Vc[V]@G=1E7	HV[V]@G=1E7	measurement date	Comment	D-Egg	PMT	Vc[V]@G=1E7	HV[V]@G=1E7	measurement date	Comment	D-Egg
SQ0241	3.776	1510.4	2021/9/29		0	SQ0551	3.724	1489.6	2021/4/5	Golden PMT	0
SQ0244	3.312	1324.8	2021/9/27		0	SQ0553	4.061	1624.4	2021/4/22	socket removed	0
SQ0245	3.499	1399.6	2021/9/30		0	SQ0582	4.007	1602.8	2021/4/21	socket removed	0
SQ0252	3.876	1550.4	2021/9/29		0	SQ0598	3.893	1557.2	2021/9/2		0
SQ0253	4.195	1678	2021/9/30		0	SQ0609	3.749	1499.6	2021/10/12	One pin short, extend	X
SQ0255	3.566	1426.4	2021/10/1		0	SQ0644	3.479	1391.6	2021/10/14	One pin short, extend	X
SQ0256	3.553	1421.2	2021/9/29		0	SQ0655	4.039	1615.6	2021/4/21	socket removed	0
SQ0259	3.927	1570.8	2021/9/28		0	SQ0657	3.51	1404	2021/4/19	Golden PMT	0
SQ0266	4.197	1678.8	2021/9/27		0	SQ0687	3.835	1534	2021/8/30		0
SQ0271	3.983	1593.2	2021/10/1		0	SQ0723	3.984	1593.6	2021/9/1		0
SQ0328	3.699	1479.6	2021/10/1	flood damaged, check & OK	0	SQ0770	3.827	1530.8	2021/4/20	socket removed	0
SQ0331	3.961	1584.4	2021/10/5		0	SQ0775	3.835	1534	2021/1/7	Golden PMT	0
SQ0336	3.556	1422.4	2021/9/27	flood damaged, check & OK	0	SQ0797	3.703	1481.2	2021/5/20	Golden PMT	0
SQ0340	4.124	1649.6	2021/10/4	flood damaged, check & OK	0	SQ0817	4.205	1682	2021/5/27	Golden PMT	0
SQ0343	3.544	1417.6	2021/9/24	flood damaged, check & OK	0	SQ0846	3.75	1500	2021/4/22	socket removed	0
SQ0344	3.895	1558	2021/9/24	flood damaged, check & OK	0	SQ0866	3.871	1548.4	2021/3/17	Golden PMT	0
SQ0345	3.911	1564.4	2021/9/15		0	SQ0871	4.169	1667.6	2021/10/15	One pin short, extend	X
SQ0425	3.483	1393.2	2021/10/6	gel study PMT	0	SQ0884	3.973	1589.2	2021/4/22	socket removed	0
SQ0428	3.593	1437.2	2021/2/17	Golden PMT	0	SQ0894	4.145	1658	2021/4/20	socket removed	0
SQ0450	3.98	1592	2021/9/24	flood damaged, check & OK	0	SQ0953	4.185	1674	2021/4/23	Golden PMT	0
SQ0451	4.239	1695.6	2021/10/4		0	SQ0967	3.823	1529.2	2021/4/14	Golden PMT	0
SQ0456	3.772	1508.8	2021/10/7	gel study PMT	0	SQ0975	4.002	1600.8	2020/12/8	Golden PMT	0
SQ0459	3.904	1561.6	2021/10/7	Pressure test	0	SQ0987	4.163	1665.2	2021/5/17	Golden PMT => Broken	X
SQ0460	3.249	1299.6	2021/9/28	Pressure test	0	SQ0991	3.779	1511.6	2021/1/27	Golden PMT	0
SQ0516	3.397	1358.8	2021/10/6	gel study PMT	0	SQ1018	3.867	1546.8	2021/9/2		0
SQ0526	4.033	1613.2	2021/10/6	gel study PMT	0	SQ1071	3.625	1450	2021/10/5	new golden	0
SQ0527	4.017	1606.8	2021/10/14	One pin short, extend	X						

Golden PMT

Result plot

- HV(Control voltage) VS gain
- SPE distribution histogram at Gain $\sim 1 \times 10^7$

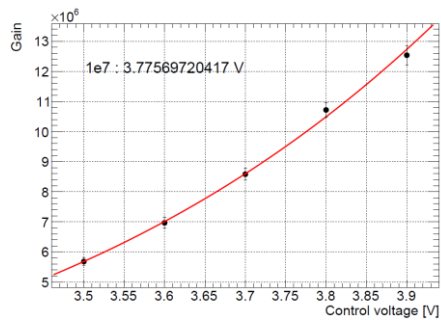
more detail plot figure

Latafa PC

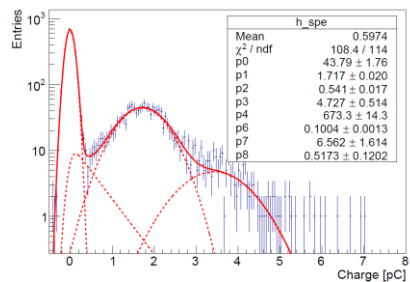
`/home/icecube/measurement/analysis/workspace/gain/figs`

figures in each PMT name directory

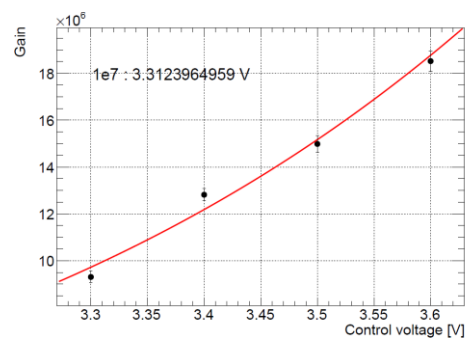
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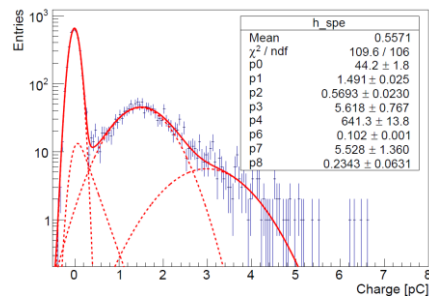
Vc=3.8V



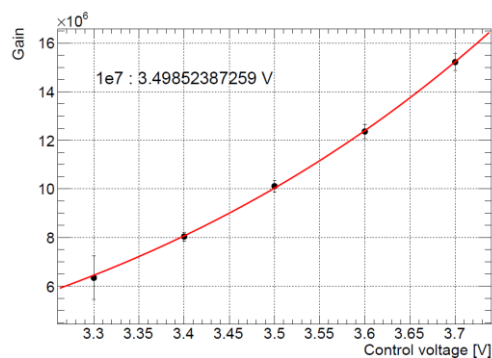
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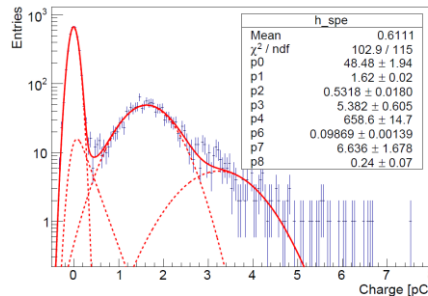
Vc=3.3V



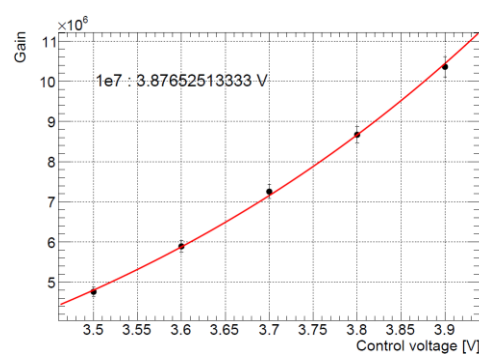
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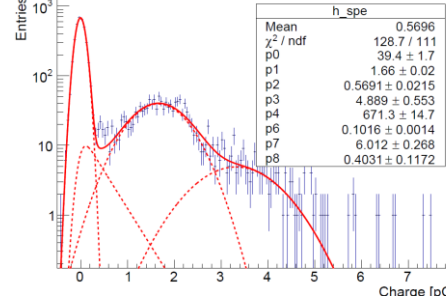
Vc=3.5V



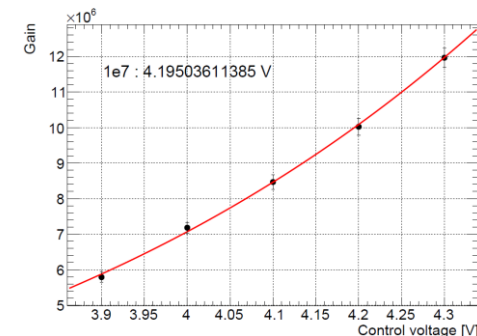
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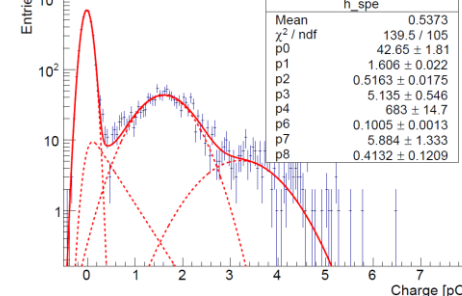
Vc=3.9V



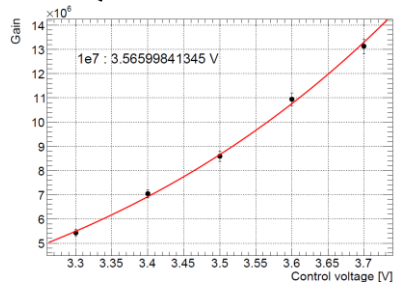
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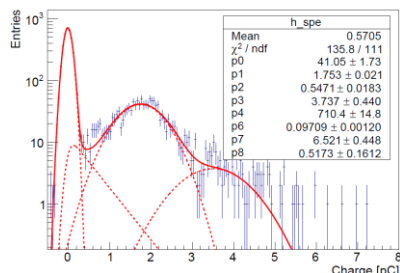
Vc=4.2V



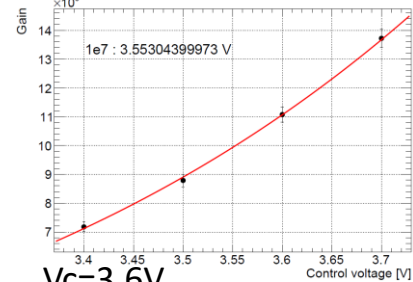
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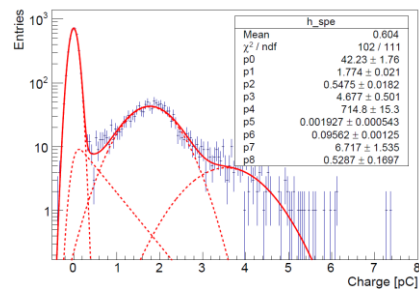
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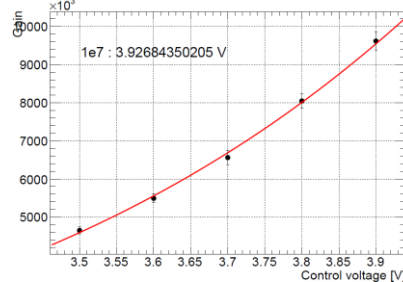
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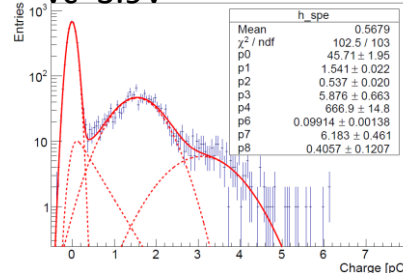
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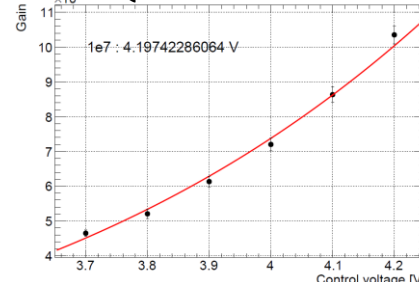
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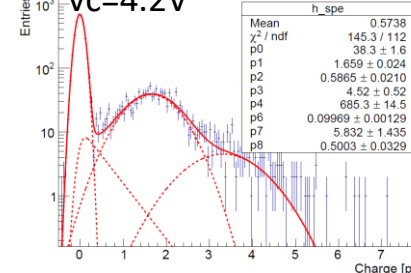
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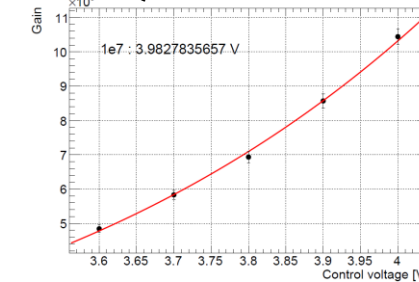
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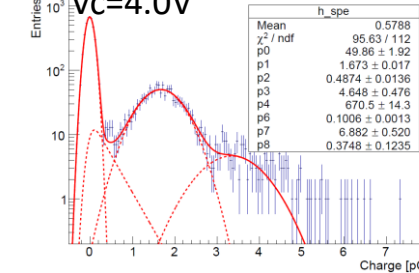
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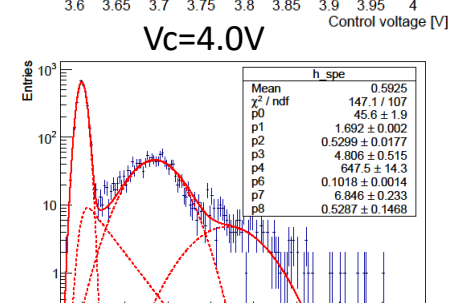
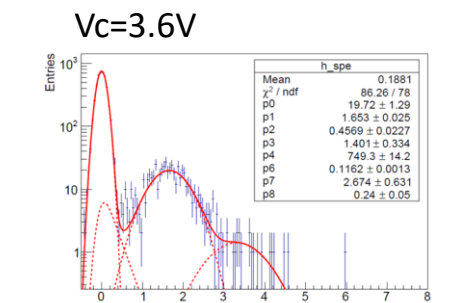
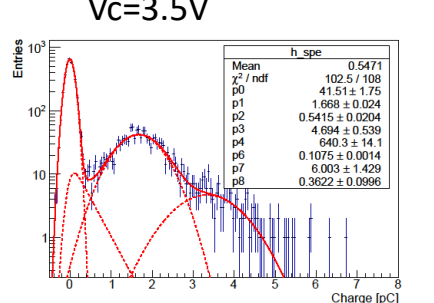
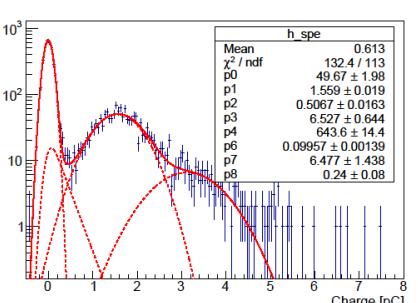
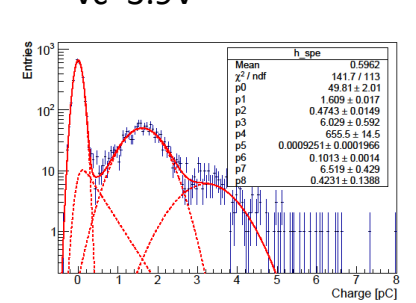
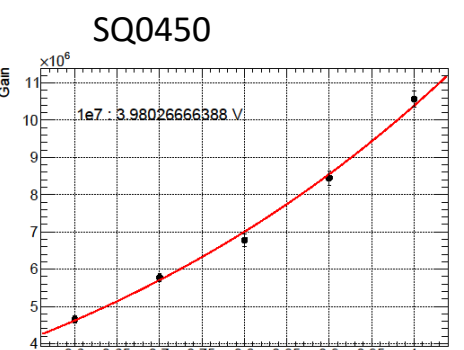
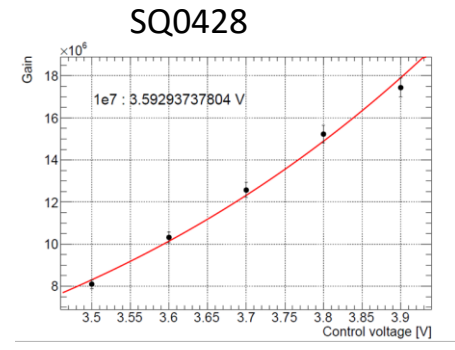
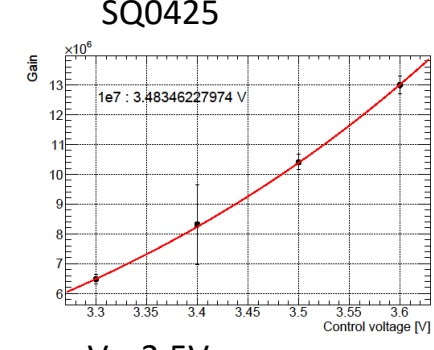
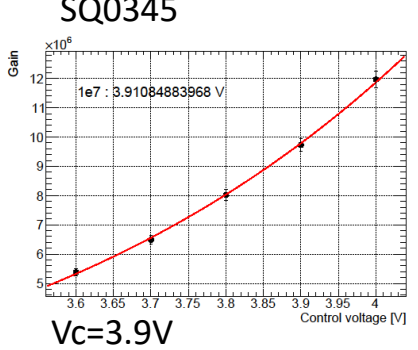
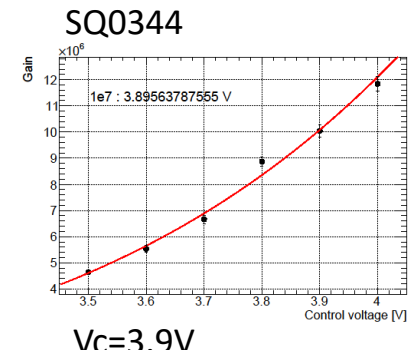
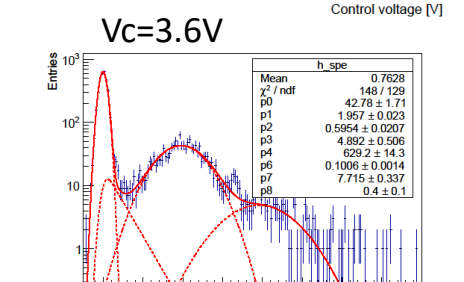
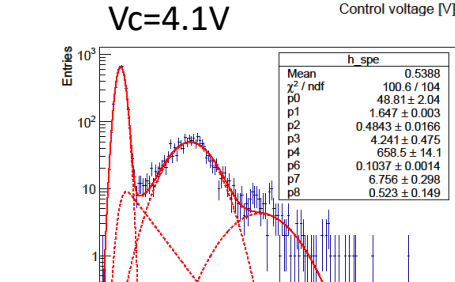
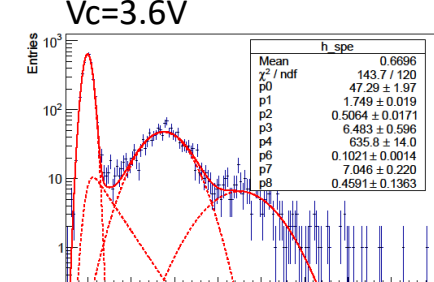
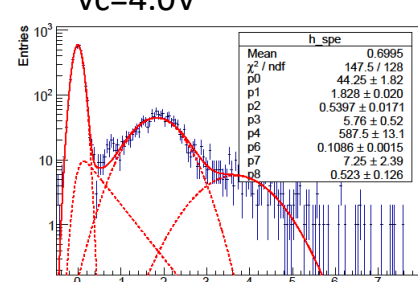
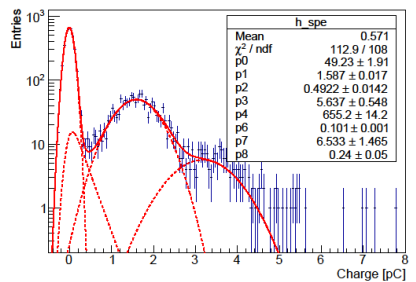
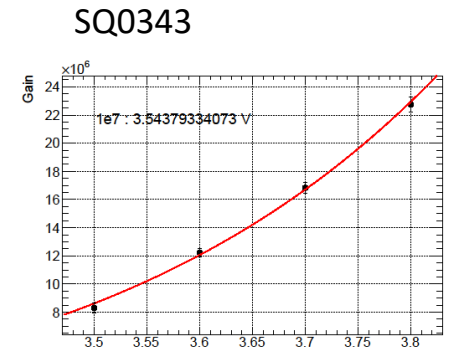
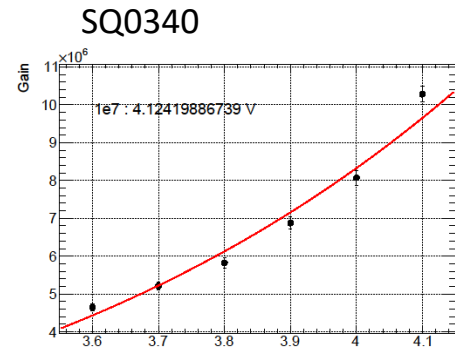
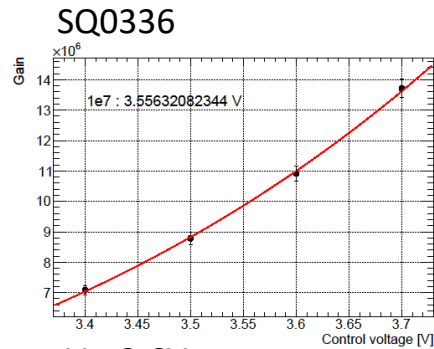
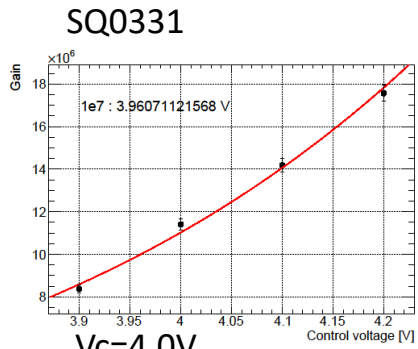
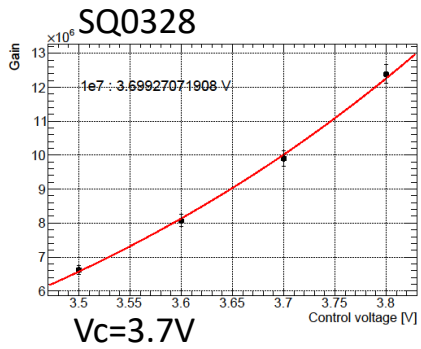


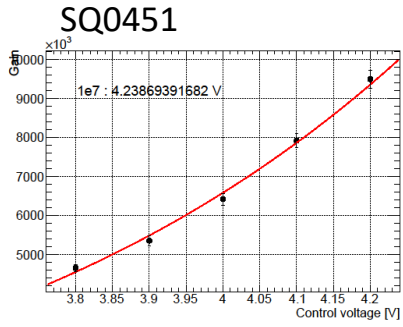
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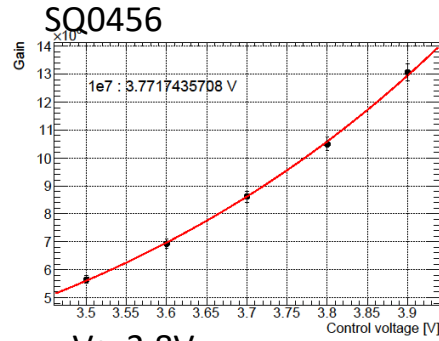
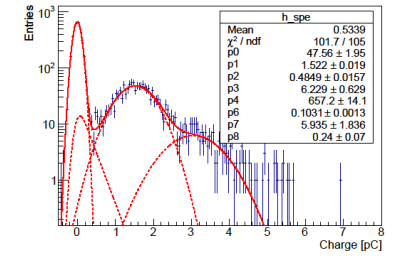
Vc=4.0V



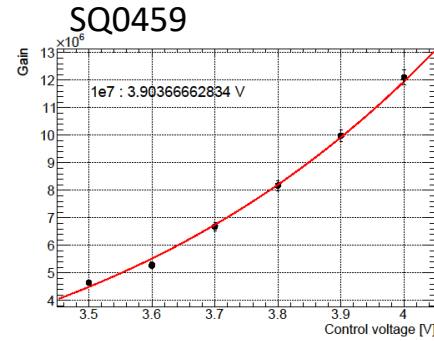
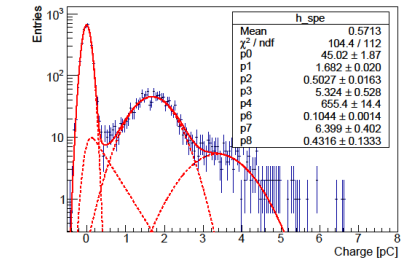




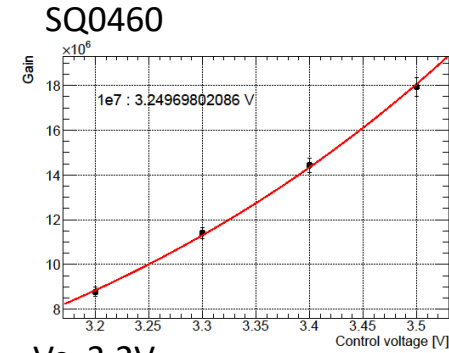
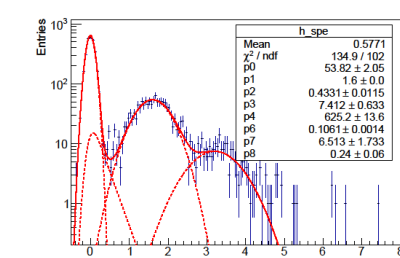
Vc=4.2V



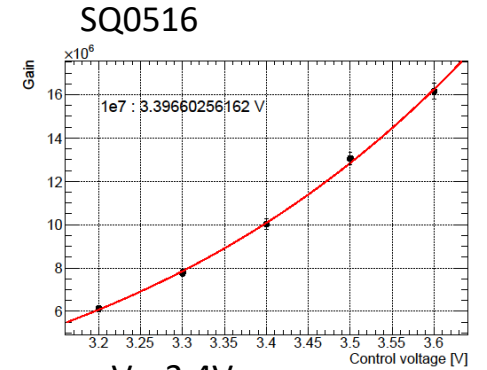
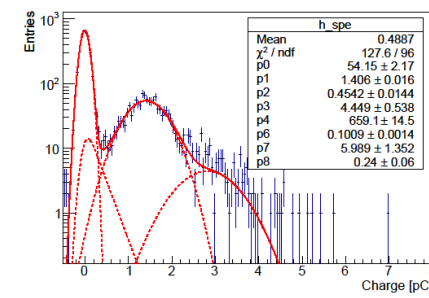
Vc=3.8V



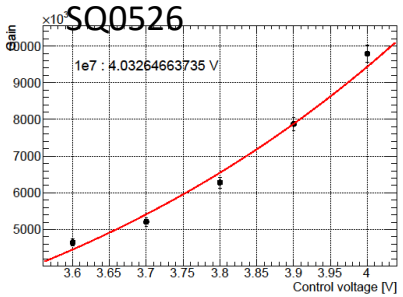
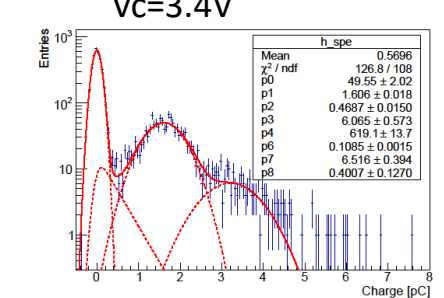
Vc=3.9V



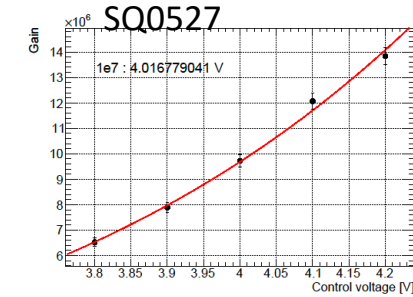
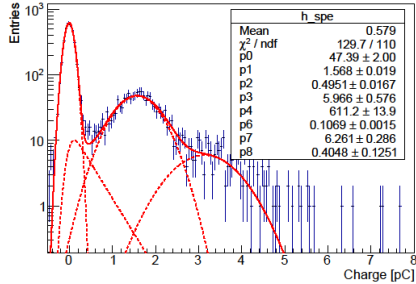
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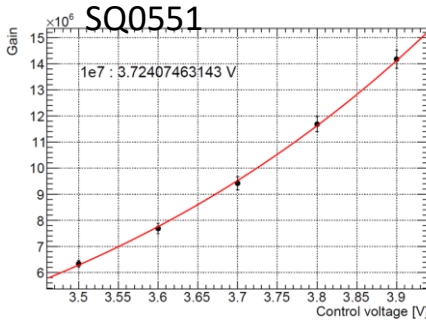
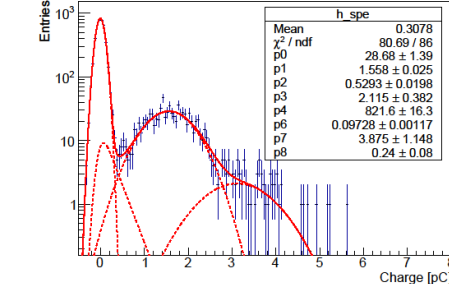
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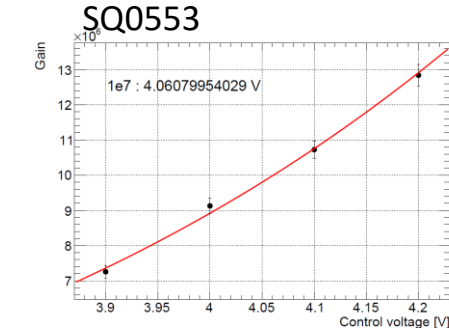
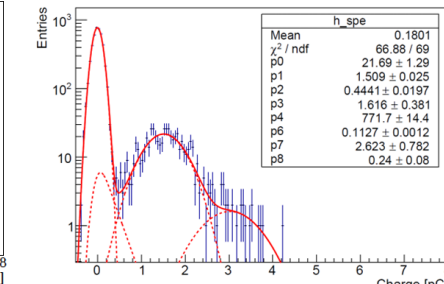
Vc=4.0V



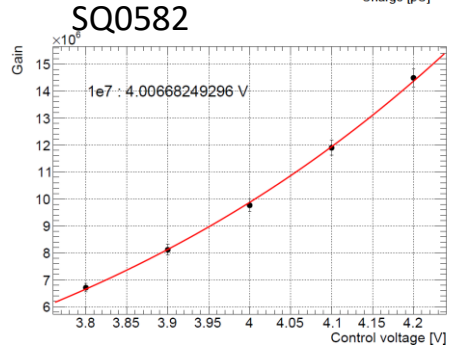
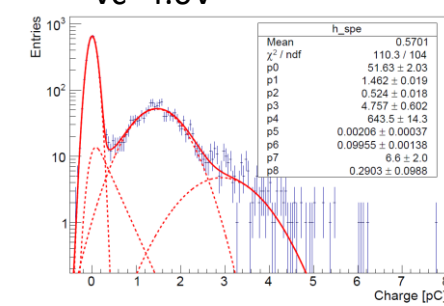
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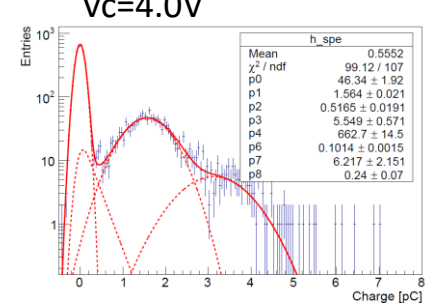
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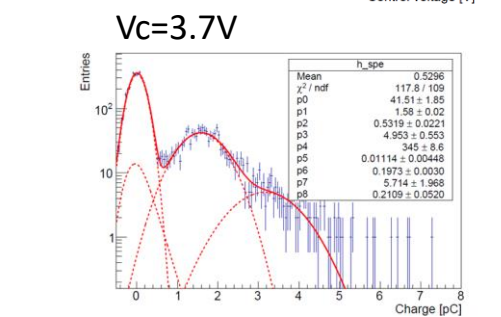
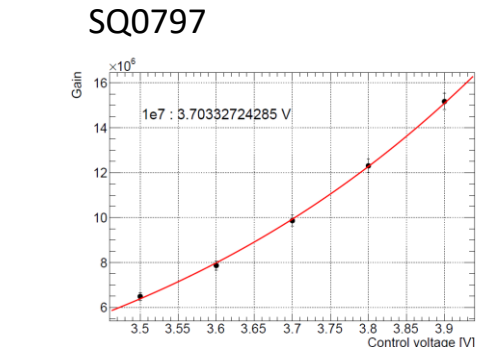
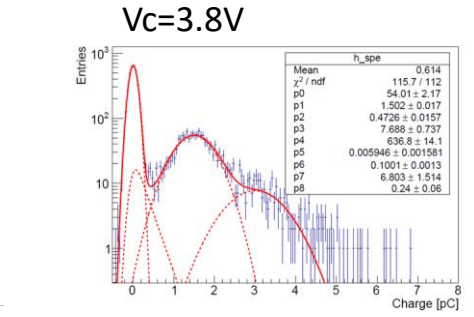
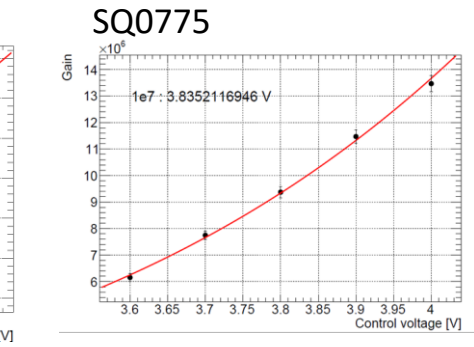
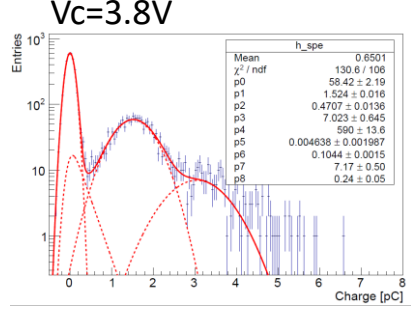
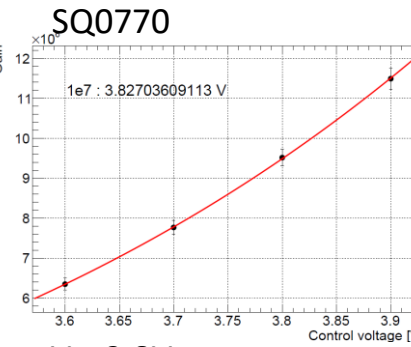
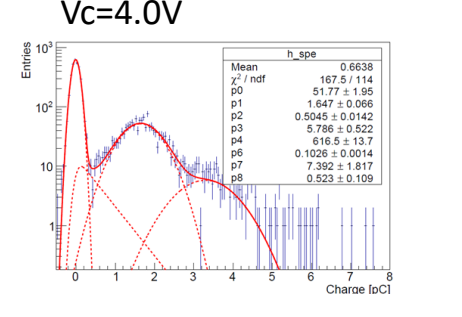
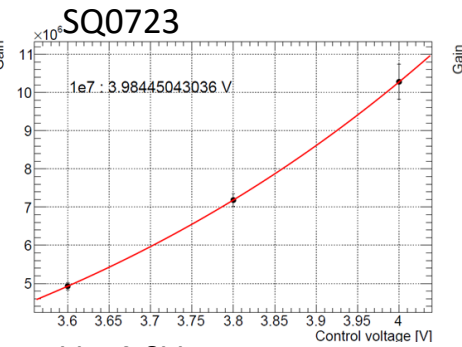
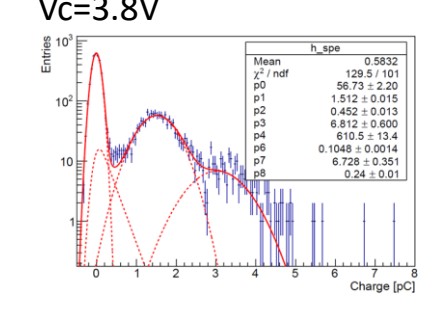
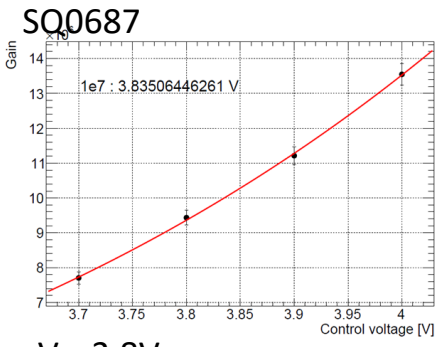
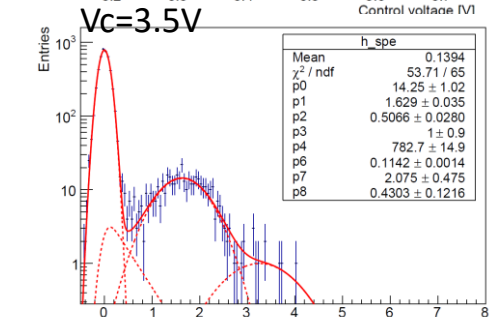
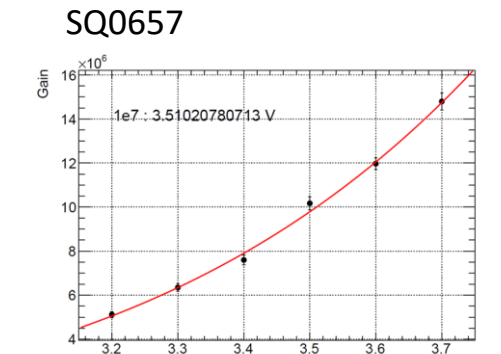
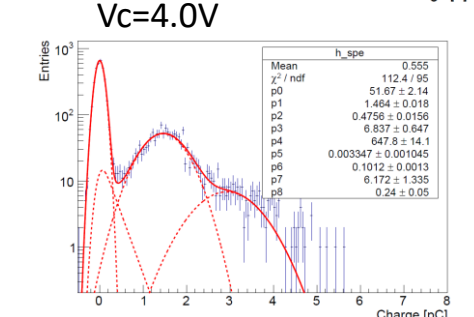
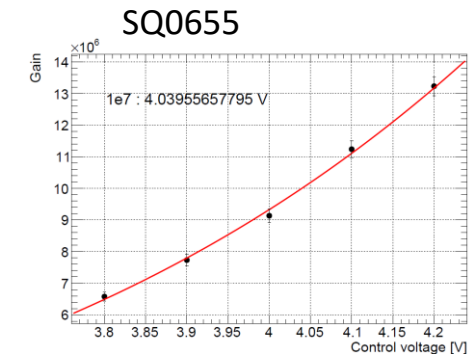
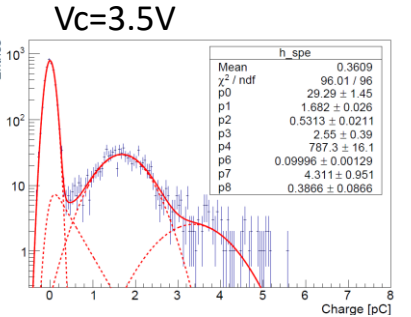
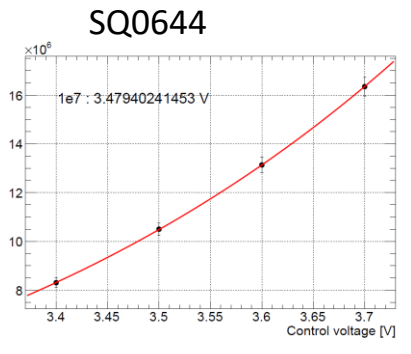
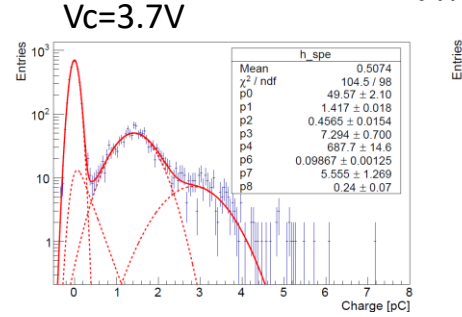
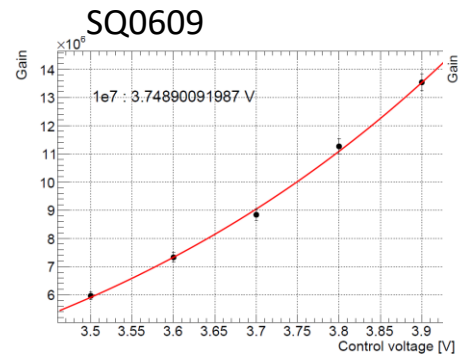
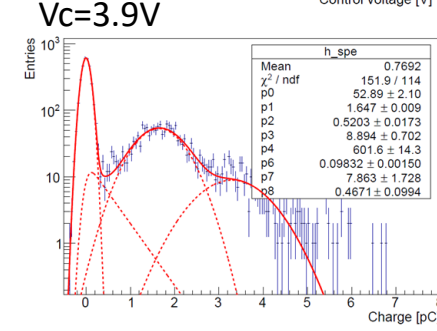
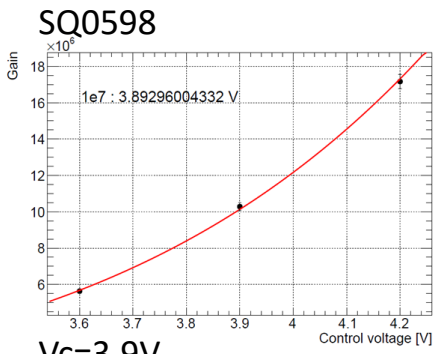


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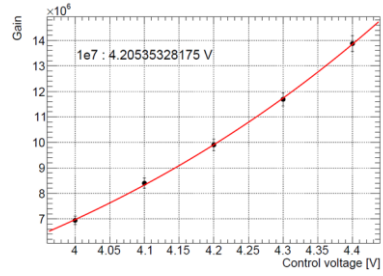


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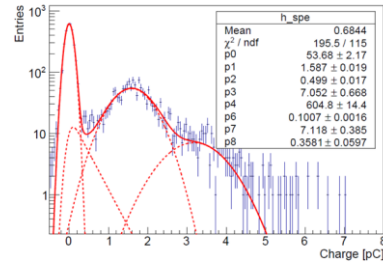




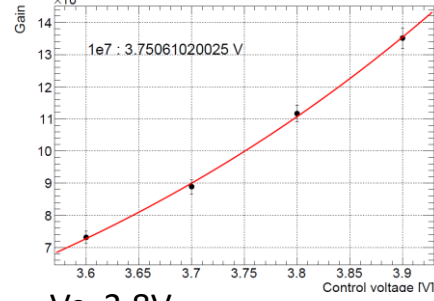
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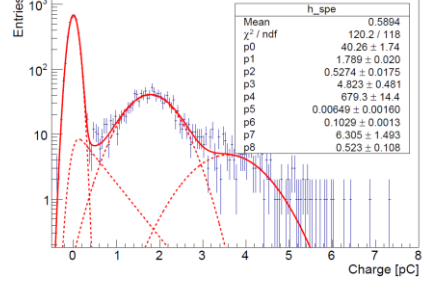
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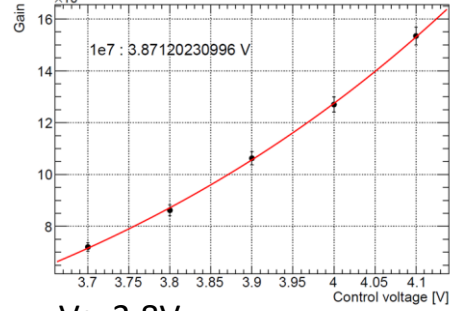
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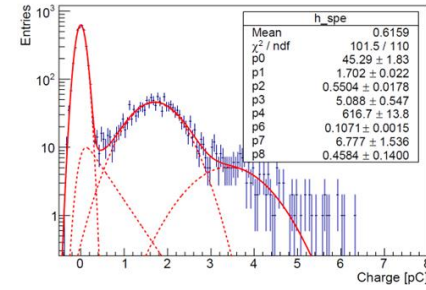
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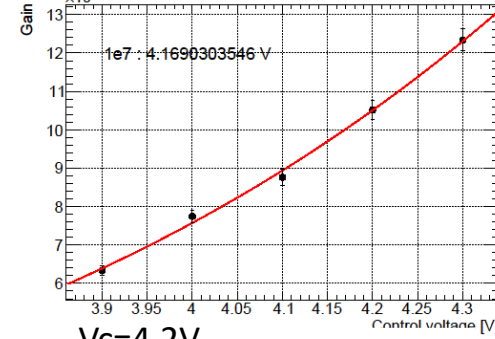
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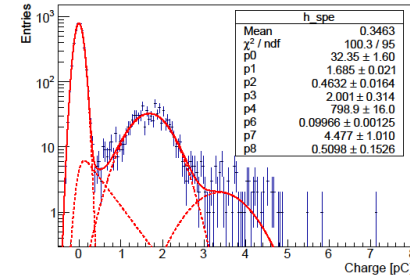
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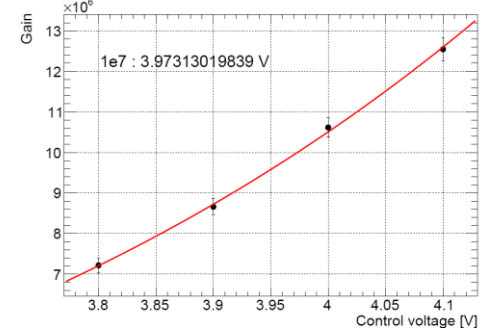
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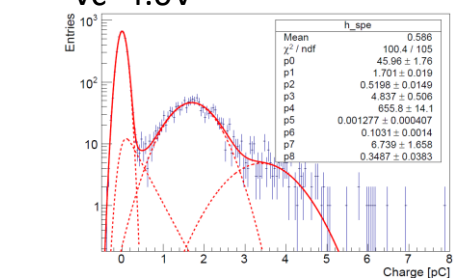
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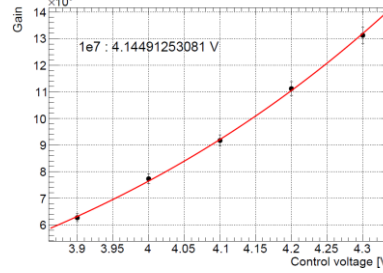
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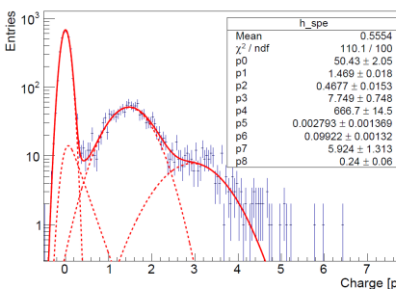
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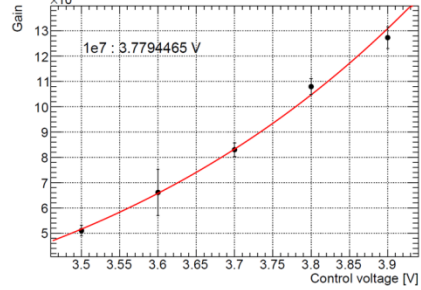
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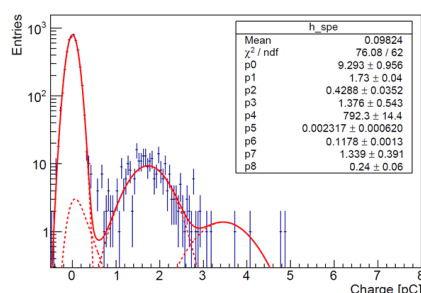
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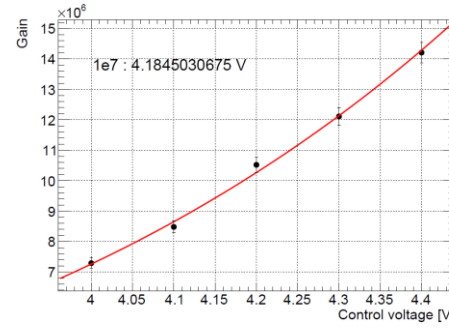
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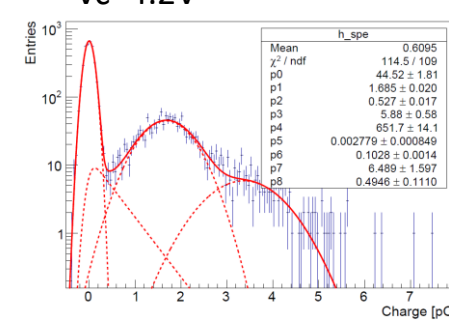
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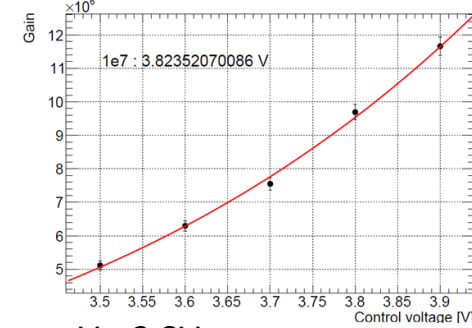
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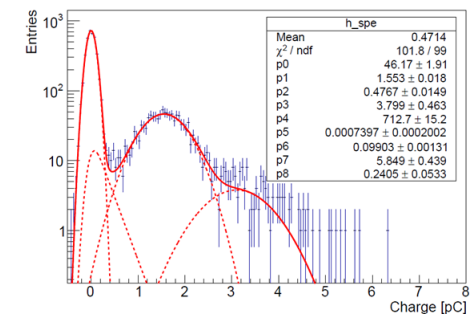
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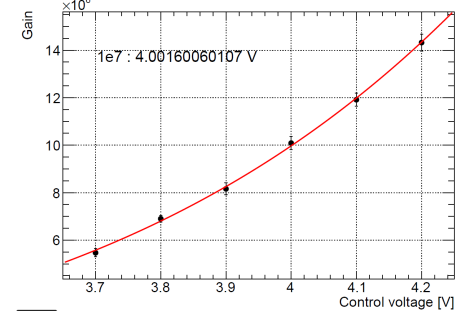
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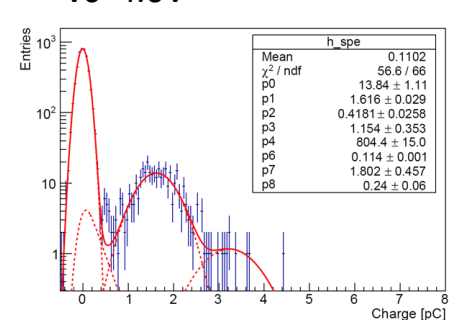
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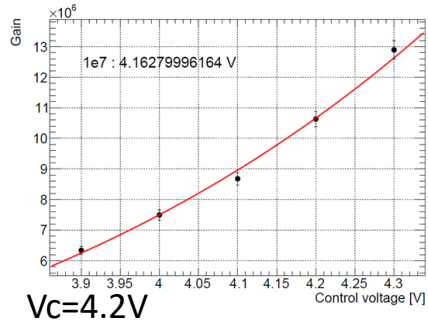
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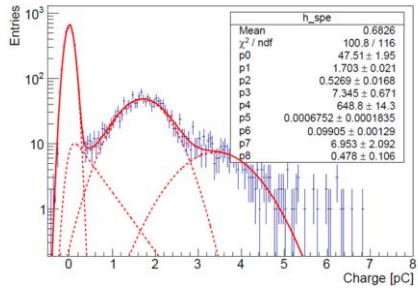
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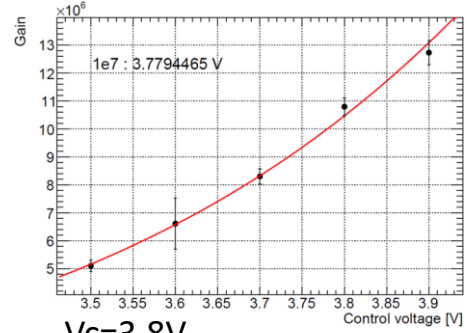
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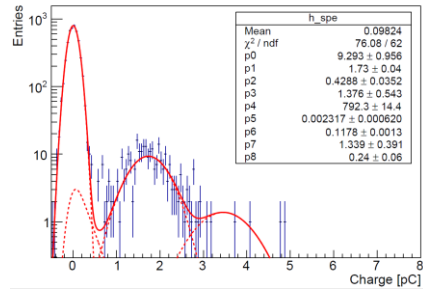
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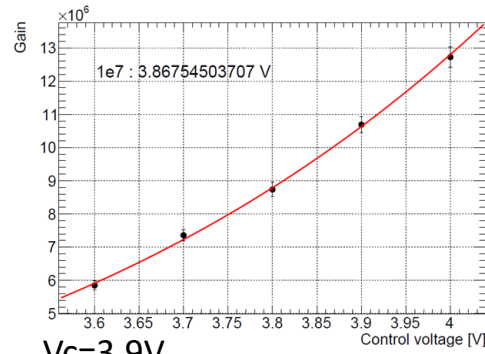
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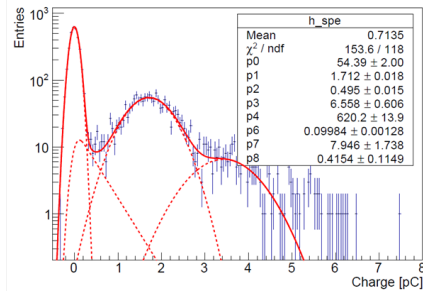
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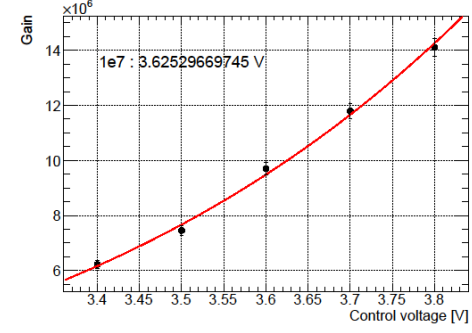
SQ1018



Vc=3.9V



SQ1071



Vc=3.6V

