The low-energy electron/positron beam

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**Collaboration Meeting, September 2015**
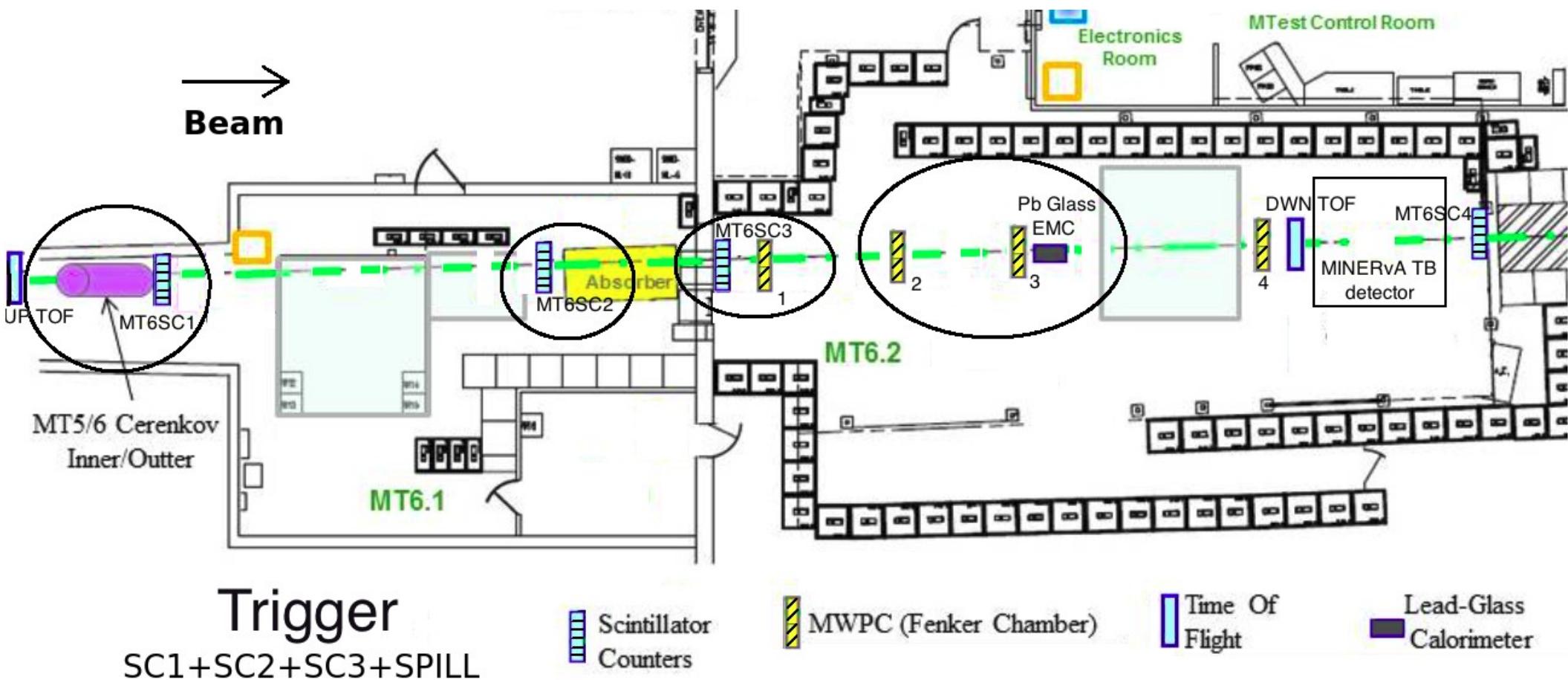
Test Beam Parallel Session

Laboratorio de Partículas Elementales

Universidad de Guanajuato ®
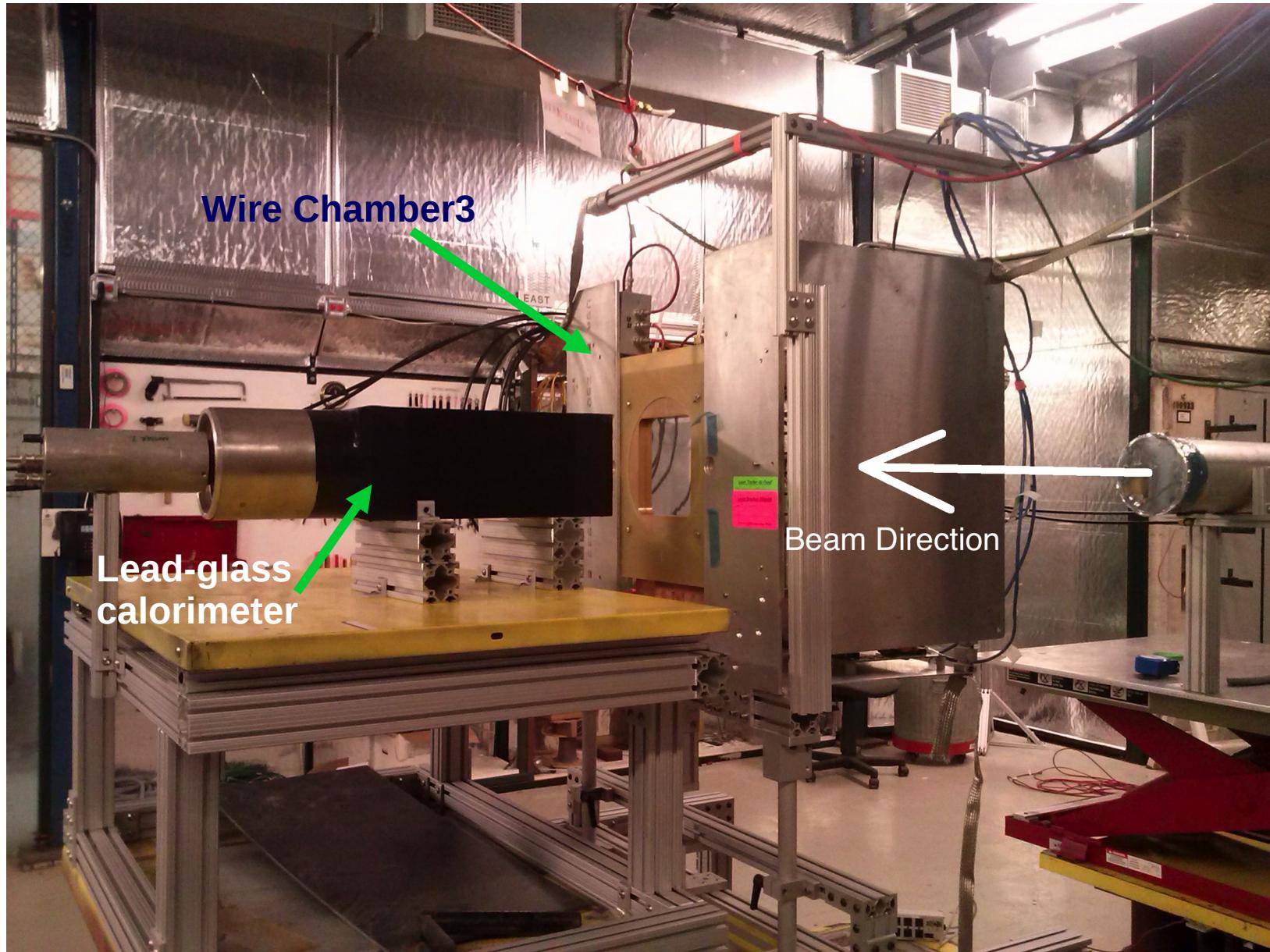
The same old diagram

What we did

- Basically, getting a relative energy scale for positrons and electrons, comparing both polarities.

- Compare voltages (just for positrons).

- Efficiency for the FTBF Cherenkov counter.

- Compare the tunning or reproducibility (just for electrons).

- An approximate electron/positron content of the beam.
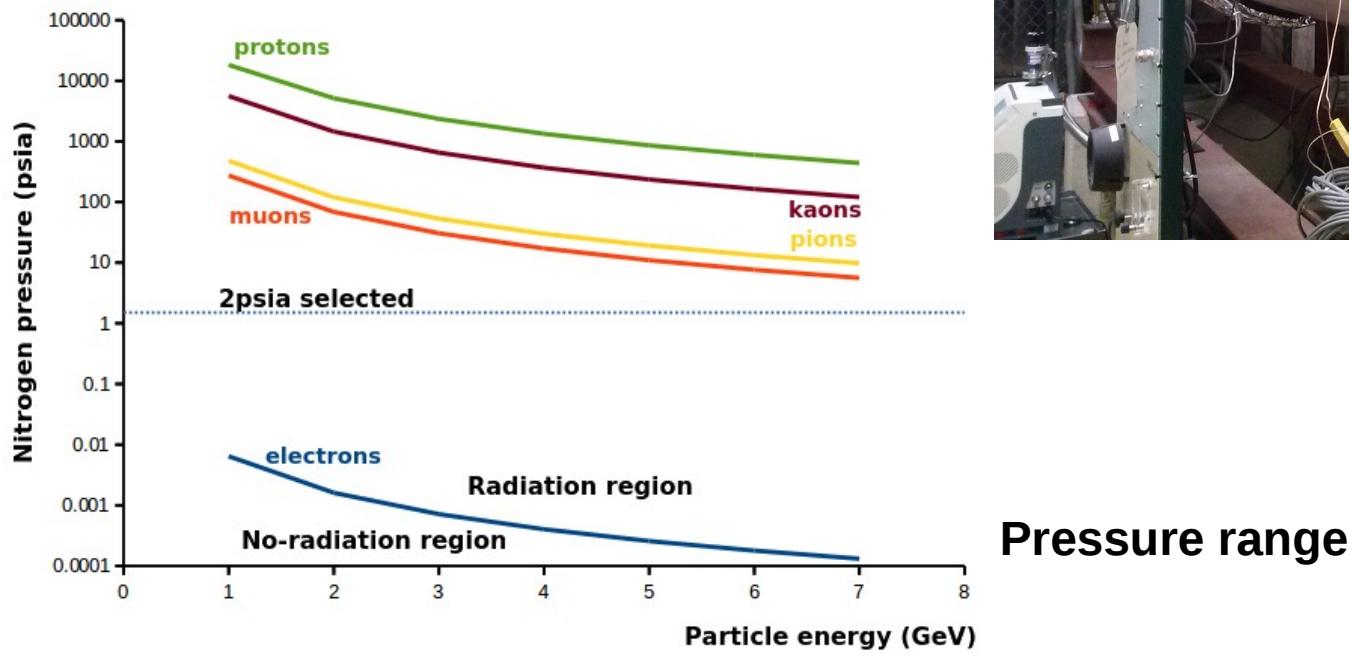
Remembering what we used

Wire Chamber3

Lead-glass calorimeter

Beam Direction

... And how we used it
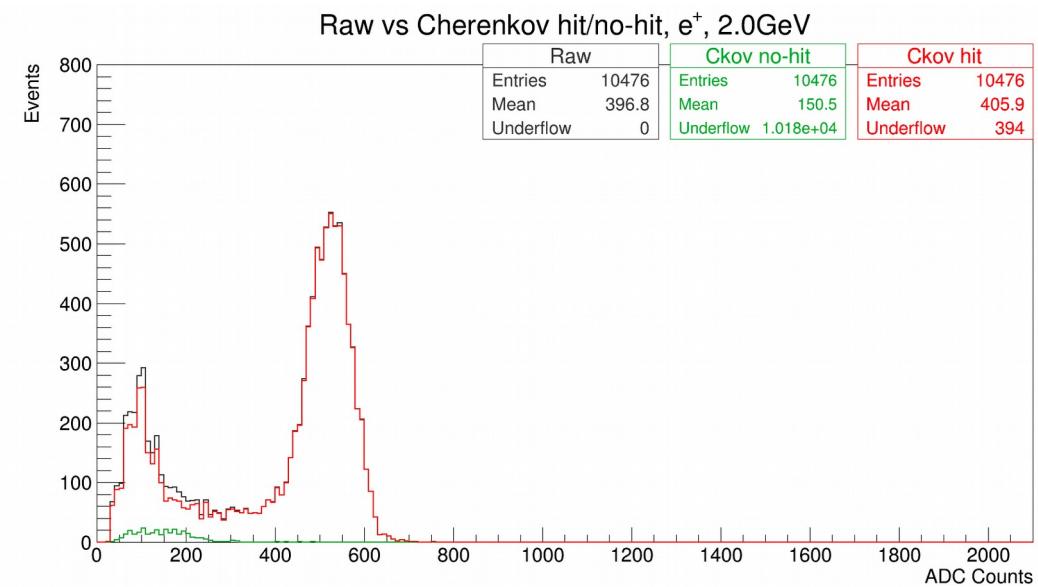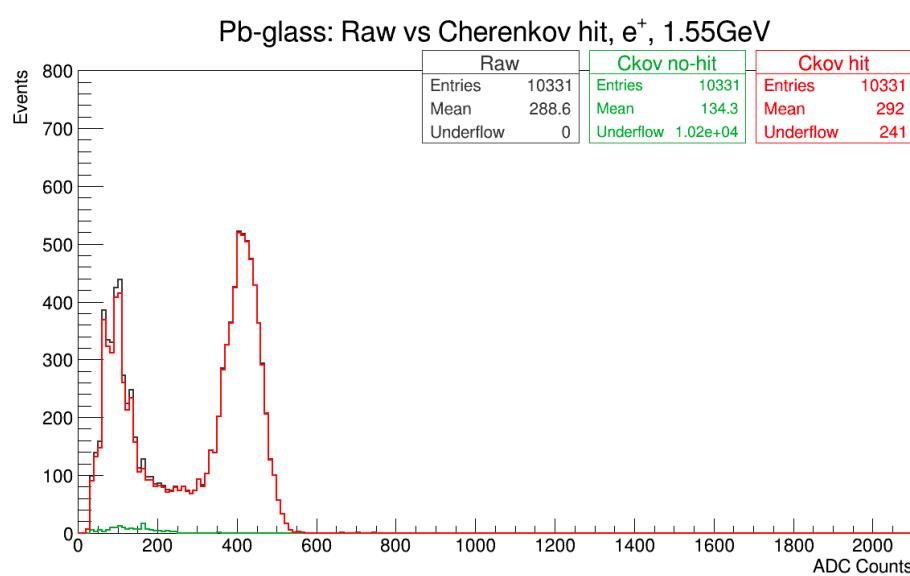
$$p_T = \frac{\frac{1}{\sqrt{1 - \frac{m^2}{E^2}}} - 1}{\delta}$$

Pressure threshold
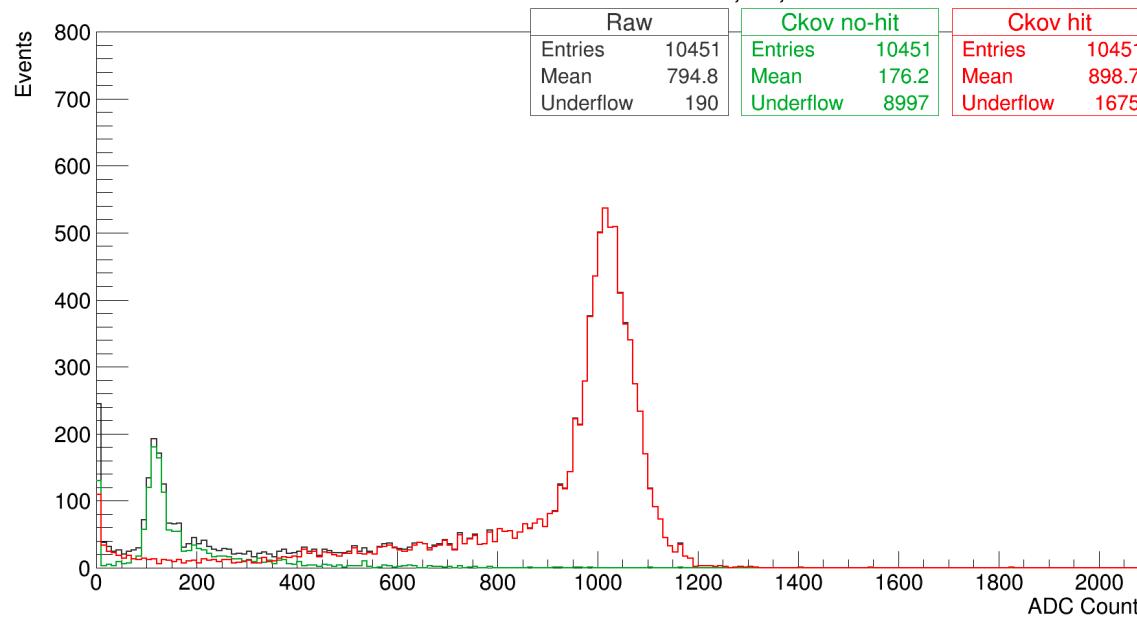
Pressure range

The spectra

Pb-glass: Raw vs Cherenkov hit, e$^+$, 1.55GeV

	Raw	Ckov no-hit	Ckov hit
Entries	10331	10331	10331
Mean	288.6	134.3	292
Underflow	0	1.02e+04	241

Raw vs Cherenkov hit/no-hit, e$^+$, 2.0GeV

	Raw	Ckov no-hit	Ckov hit
Entries	10476	10476	10476
Mean	396.8	150.5	405.9
Underflow	0	1.018e+04	394
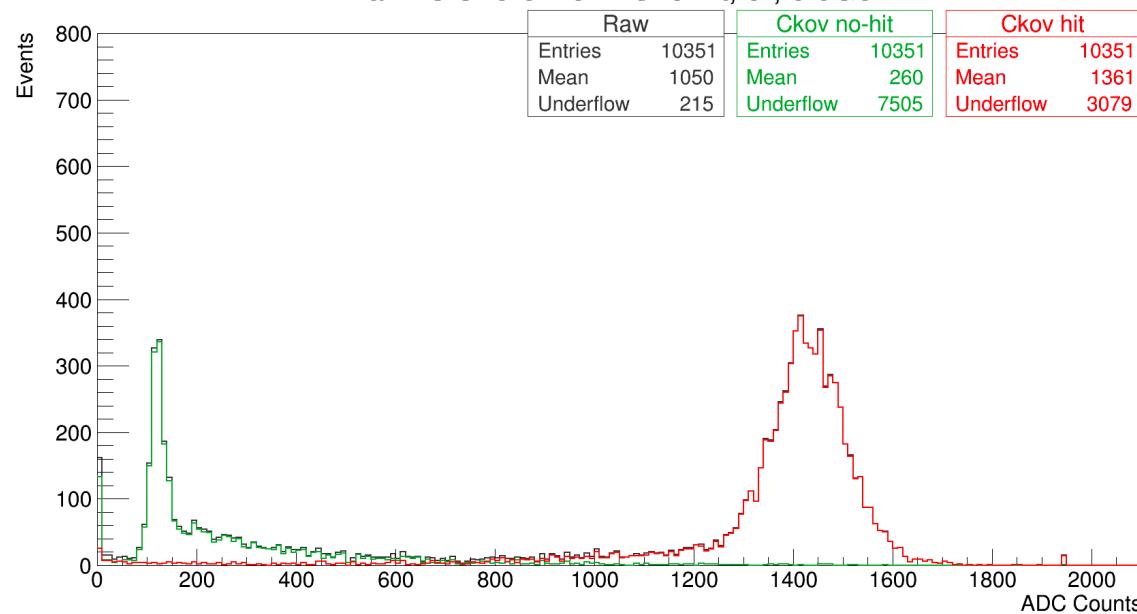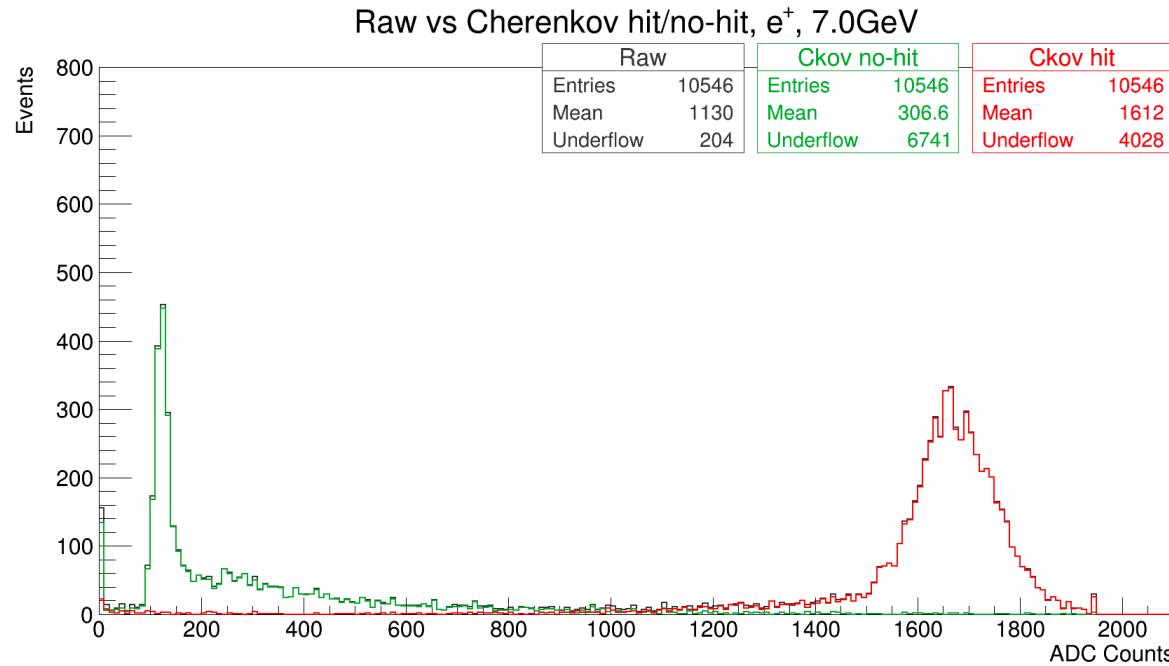
Raw, Cherenkov hit, and Cherenkov no-hit

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Raw vs Cherenkov hit/no-hit, e$^+$, 4.0GeV

Raw		Ckov no-hit		Ckov hit	
Entries	10451	Entries	10451	Entries	10451
Mean	794.8	Mean	176.2	Mean	898.7
Underflow	190	Underflow	8997	Underflow	1675

Raw vs Cherenkov hit/no-hit, e$^+$, 6.0GeV

Raw		Ckov no-hit		Ckov hit	
Entries	10351	Entries	10351	Entries	10351
Mean	1050	Mean	260	Mean	1361
Underflow	215	Underflow	7505	Underflow	3079

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Raw vs Cherenkov hit/no-hit, e$^+$, 7.0GeV

Raw		Ckov no-hit		Ckov hit	
Entries	10546	Entries	10546	Entries	10546
Mean	1130	Mean	306.6	Mean	1612
Underflow	204	Underflow	6741	Underflow	4028

positrons at 7.0GeV

Raw vs Cherenkov hit/no-hit, e$^-$, 7.0GeV, run_54

| Raw		Ckov no-hit		Ckov hit	
Entries	10518	Entries	10518	Entries	10518
Mean	1081	Mean	289.2	Mean	1442
Underflow	167	Underflow	7282	Underflow	3420

electrons at 7.0GeV

Pretty much the same for the negative polarities (at the backup)

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Doing fits

Pb glass, positron fit, pedestal subtracted, 2.0GeV

Pb_Spec	
Entries	10476
Underflow	394
χ^2 / ndf	26.08 / 16
Prob	0.05293
Constant	545.4 ± 9.1
Mean	521.7 ± 0.7
Sigma	49.67 ± 0.74

Pb glass, electron fit, pedestal subtracted, 2.0GeV, run_47

Pb_Spec	
Entries	10543
Underflow	859
χ^2 / ndf	20.49 / 13
Prob	0.08375
Constant	694.6 ± 13.2
Mean	376.6 ± 0.6
Sigma	26.93 ± 0.47

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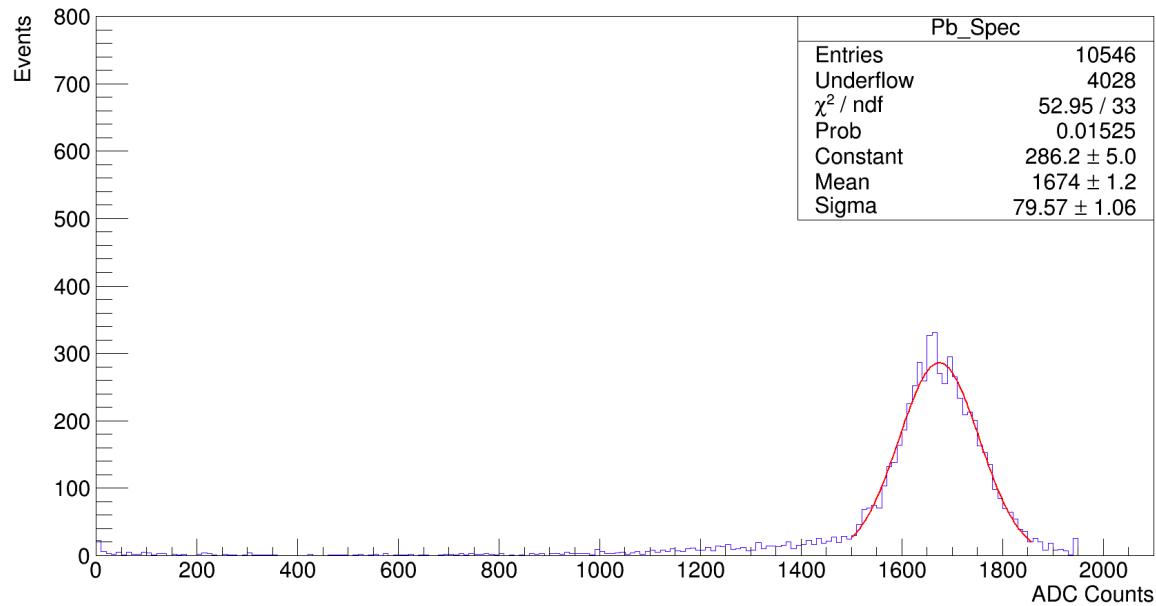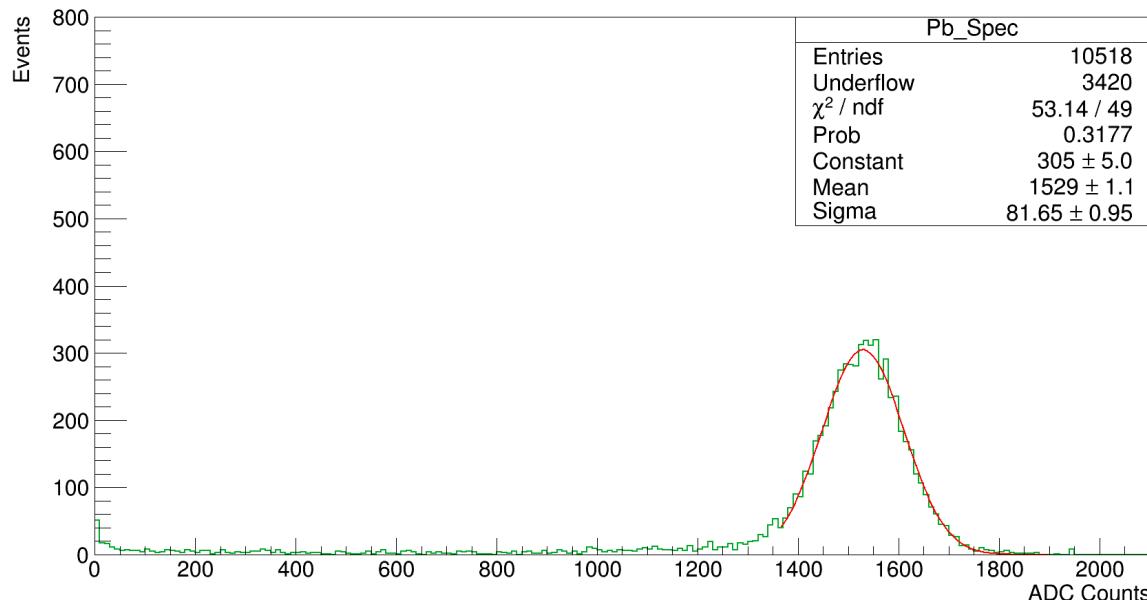
Two more

Pb glass, positron fit, pedestal subtracted, 7.0GeV

Pb_Spec	
Entries	10546
Underflow	4028
χ^2 / ndf	52.95 / 33
Prob	0.01525
Constant	286.2 ± 5.0
Mean	1674 ± 1.2
Sigma	79.57 ± 1.06

Events

ADC Counts

Pb glass, electron fit, pedestal subtracted, 7.0GeV, run_54

Pb_Spec	
Entries	10518
Underflow	3420
χ^2 / ndf	53.14 / 49
Prob	0.3177
Constant	305 ± 5.0
Mean	1529 ± 1.1
Sigma	81.65 ± 0.95

Events

ADC Counts

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Summary for fits, positrons

positrons				
Energy (GeV)	Mean	σ (standard deviation)	χ^2/ndf	Probability
1.55	416$\pm$0.7	42.9$\pm$0.58	18.22/16=1.14	0.31
2.0	521.7$\pm$0.7	49.7$\pm$0.74	26.08/16=1.63	0.05
4.0	1023$\pm$0.8	48.7$\pm$0.83	30.31/15=2.02	0.01
6.0	1429$\pm$1.1	73.9$\pm$1.09	35.49.16/27=1.82	0.01
7.0	1674$\pm$1.2	79.6$\pm$1.06	52.95/33=1.60	0.02

Table 1. Parameters from the fits, for positrons

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Summary for fits, electrons

electrons				
Energy (GeV)	Mean	σ (standard deviation)	χ^2/ndf	Probability
1.55	269.9±0.5	23.9±0.38	12.32/10=1.23	0.26
1.77	320.1±0.5	25.9±0.42	22.35/13=1.72	0.05
2.0	372.3±0.6	28.6±0.4	16.99/13=1.31	0.20
3.0	597±0.7	38.7±0.67	17.11/12=1.43	0.15
4.0	817.9±0.9	51.38±0.8	29.91/19=1.57	0.05
5.0	1017±1.1	63.82±0.95	47.5/35=1.36	0.07
6.0	1341±1.1	71.6±1.0	48.67/30=1.62	0.02
7.0	1569±1.1	76.56±0.94	58.68/45=1.30	0.08
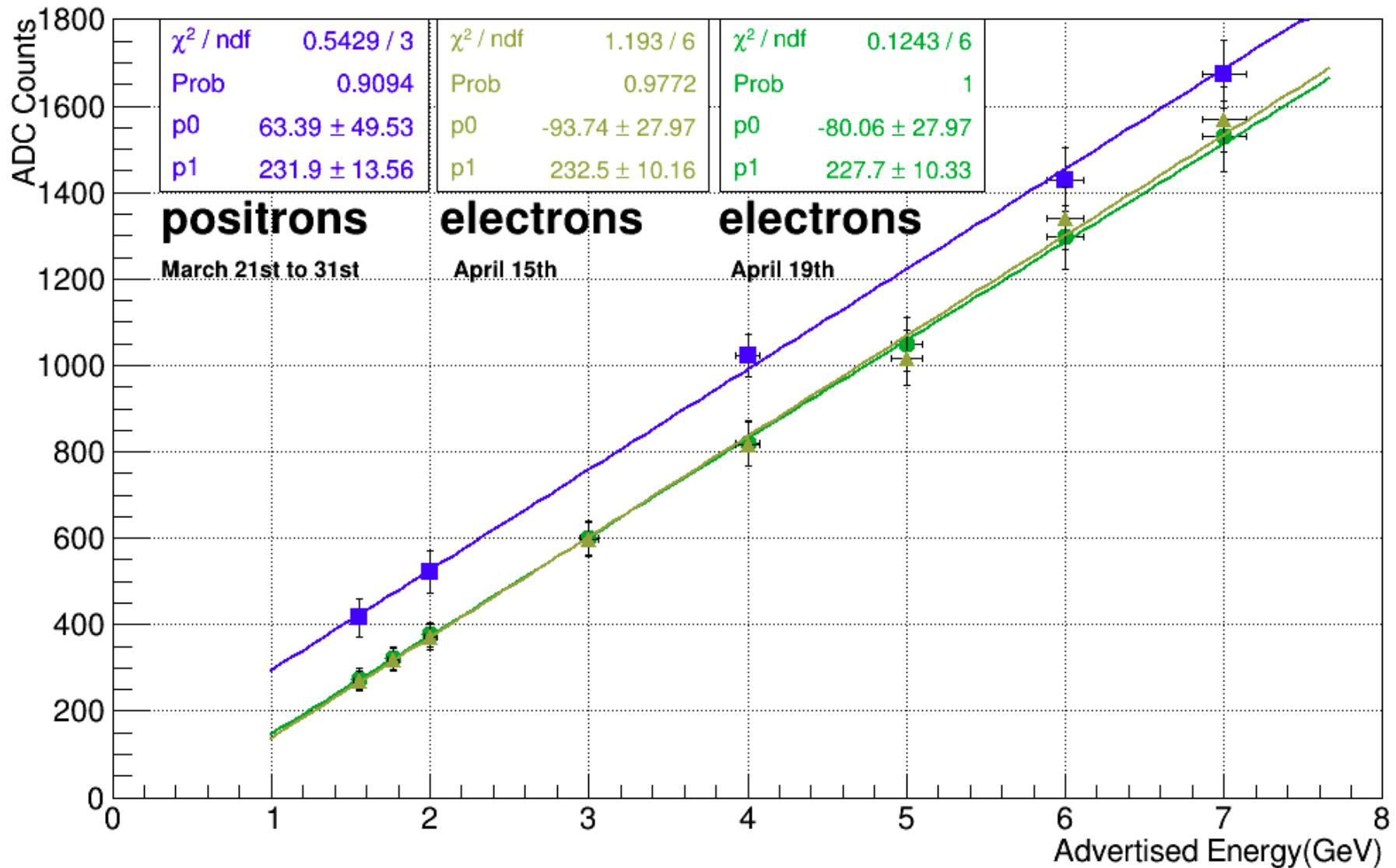
Table 2. Parameters from the fits, for electrons, April 15th

electrons				
Energy (GeV)	Mean	σ (standard deviation)	χ^2/ndf	Probability
1.55	275±0.5	23.4±0.47	13.74/7=1.96	0.06
1.77	321.8±0.5	26.6±0.42	20.47/13=1.57	0.08
2.0	376.6±0.6	26.9±0.47	20.49/13=1.58	0.08
3.0	600.6±0.7	39.6±0.58	20.56/18=1.14	0.30
4.0	819.1±0.9	52.6±0.71	34.88/24=1.45	0.07
5.0	1049±1.2	62.9±1.02	40.47/32=1.26	0.15
6.0	1296±1.0	72.9±0.86	43.27/32=1.35	0.09
7.0	1529±1.1	81.7±0.95	53.14/49=1.09	0.32
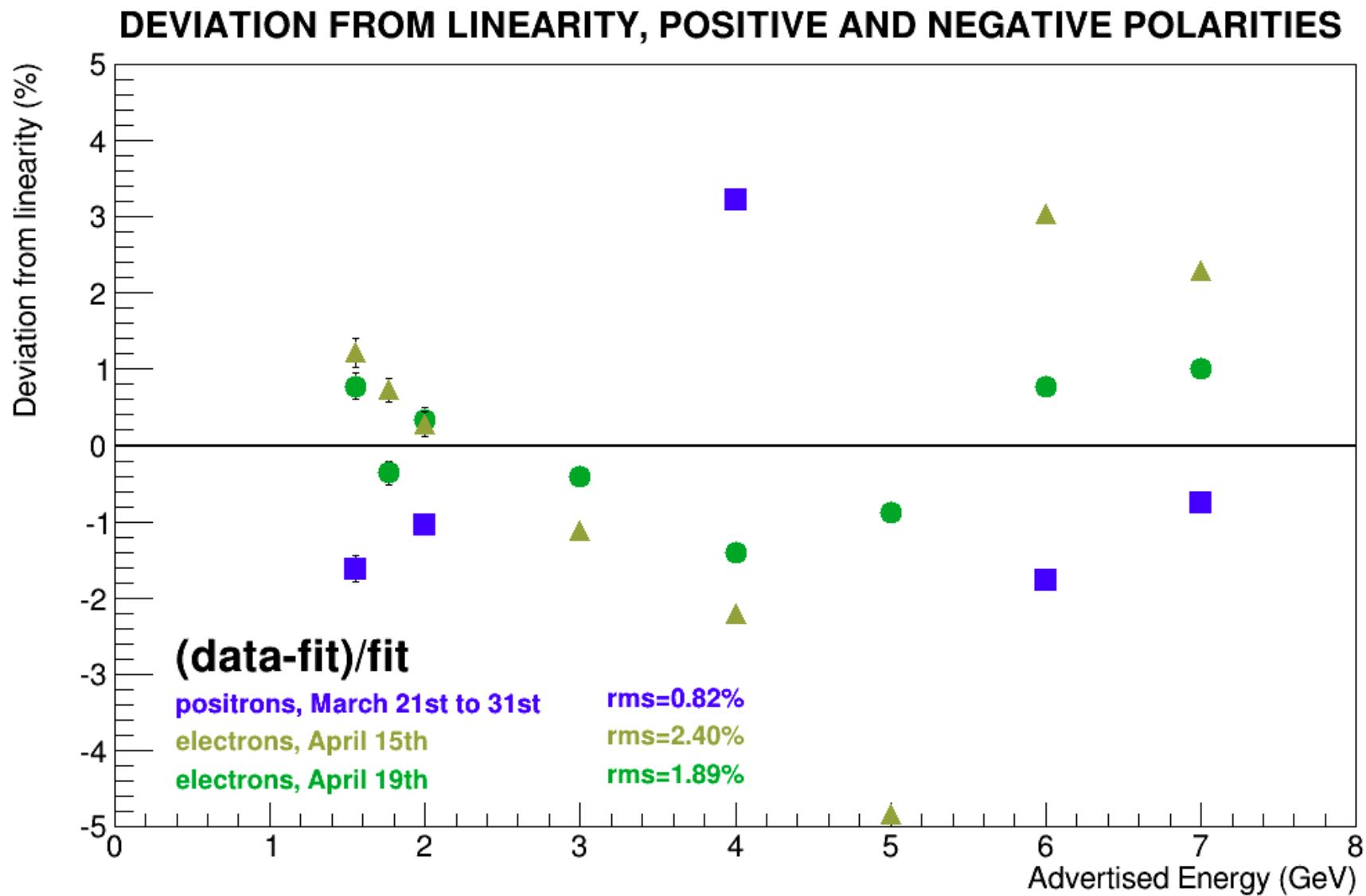
Table 3. Parameters from the fits, for electrons, April 19th

Linearity

LINEARITY, ALL RUNS

	positrons	electrons	electrons
	March 21st to 31st	April 15th	April 19th
χ^2 / ndf	0.5429 / 3	1.193 / 6	0.1243 / 6
Prob	0.9094	0.9772	1
p0	63.39 ± 49.53	-93.74 ± 27.97	-80.06 ± 27.97
p1	231.9 ± 13.56	232.5 ± 10.16	227.7 ± 10.33

Residuals

DEVIATION FROM LINEARITY, POSITIVE AND NEGATIVE POLARITIES

(data-fit)/fit

positrons, March 21st to 31st   rms=0.82%
electrons, April 15th   rms=2.40%
electrons, April 19th   rms=1.89%

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But remember that AD changed the "beam equation"

- From

$$MT4W(Gauss)=+10.96Gauss+(57.92Gauss/GeV)P_{Beam}$$

- To

$$MT4W(Gauss)=-11.75Gauss+(57.92Gauss/GeV)P_{Beam}$$
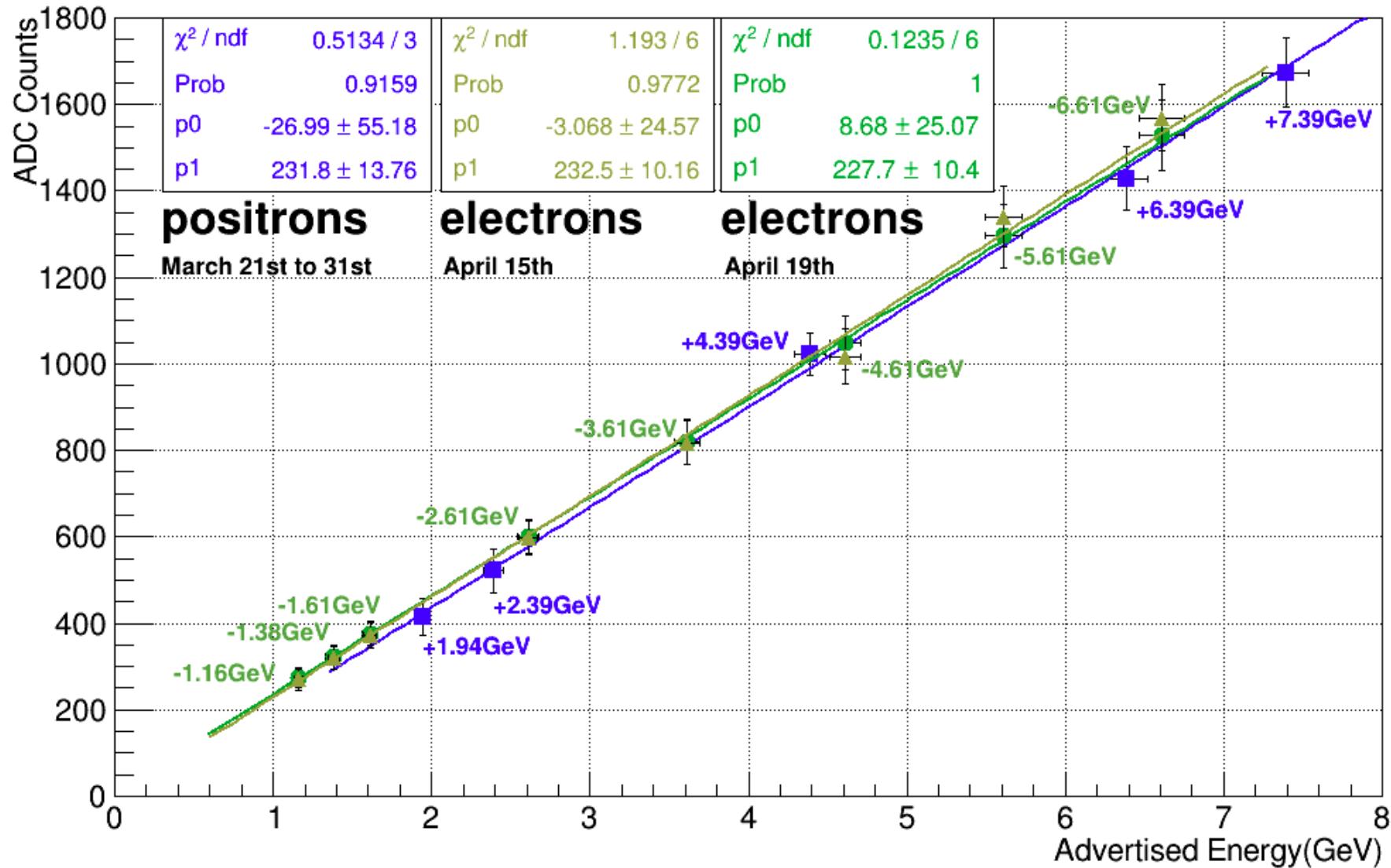
Actual energy points

| Old req. Energy (GeV)	Old MT4W probe (Gauss)	Corrected P_{BEAM}
1.55	100.74±1.0	1.94±0.05
2.0	126.80±1.0	2.39±0.06
4.0	242.64±1.0	4.39±0.10
6.0	358.48±1.0	6.39±0.13
7.0	416.40±1.0	7.39±0.15
-1.55	-78.81±1.0	-1.16±0.04
-1.77	-91.56±1.0	-1.38±0.05
-2.0	-104.88±1.0	-1.61±0.05
-3.0	-162.80±1.0	-2.61±0.07
-4.0	-220.72±1.0	-3.61±0.08
-5.0	-278.64±1.0	-4.61±0.10
-6.0	336.56±1.0	-5.61±0.12
-7.0	-394.48±1.0	-6.61±0.14
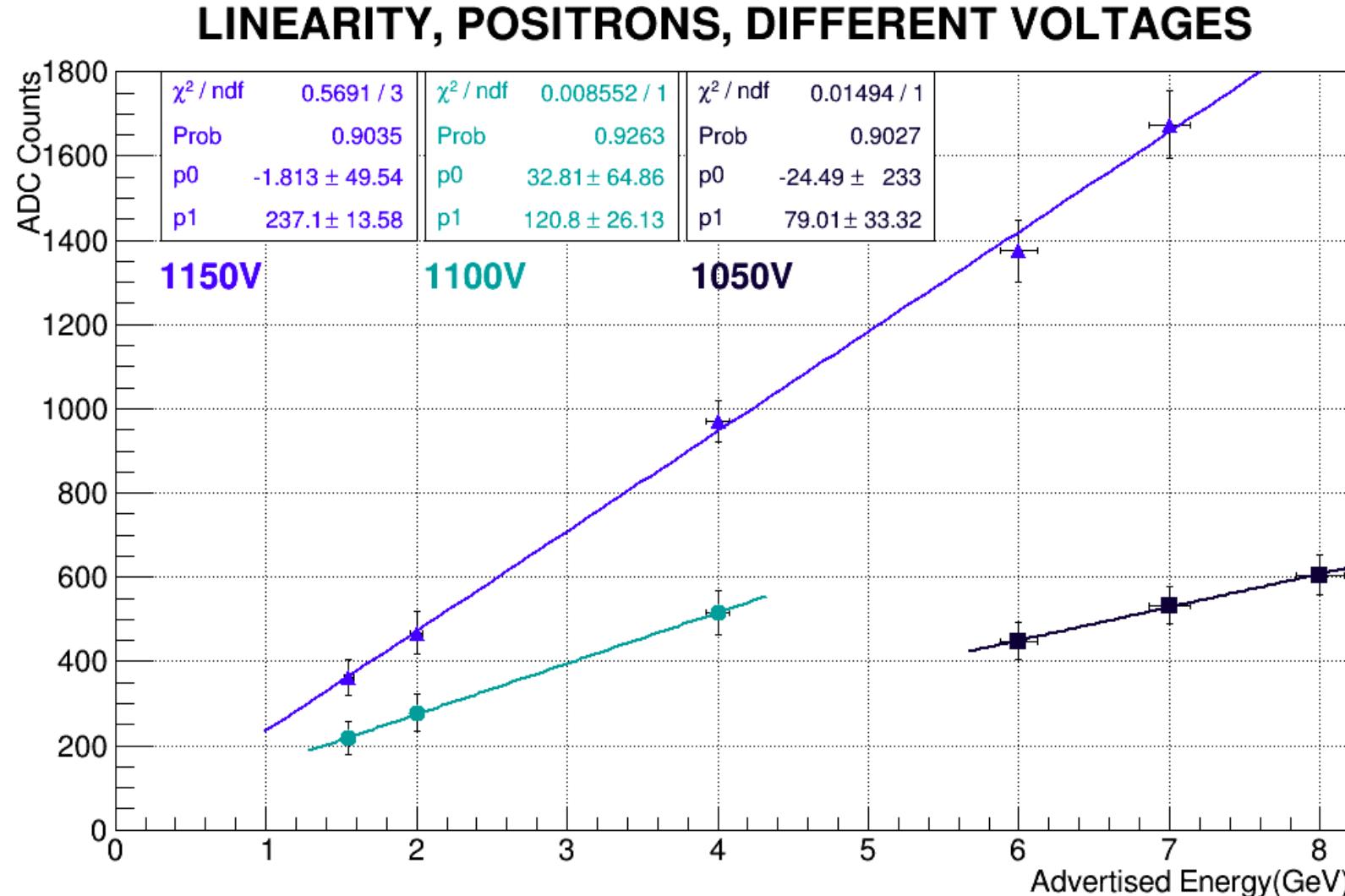
Table 4. Actual energy points at which data was taken.

Linearity, actual energy
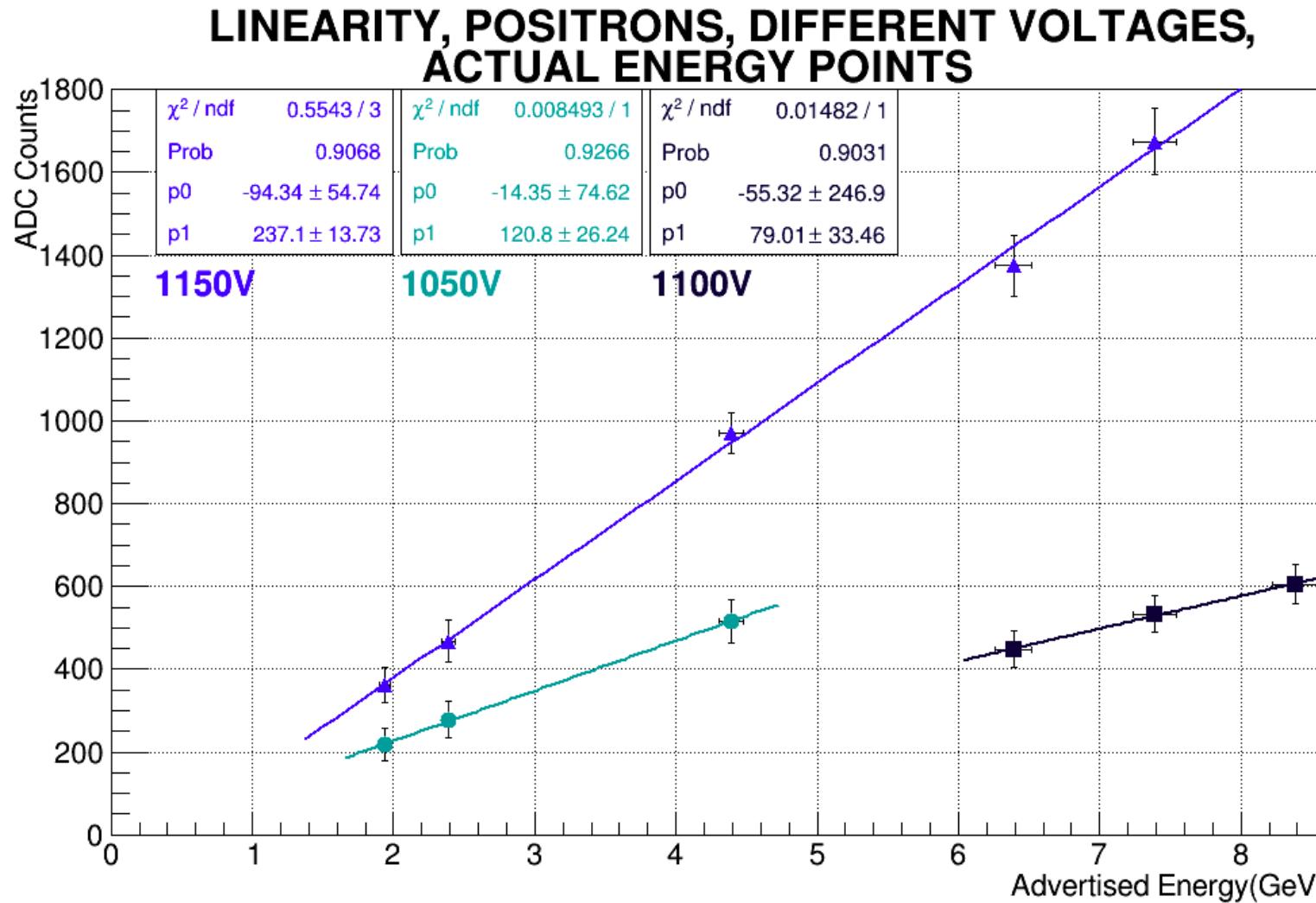

LINEARITY, ALL RUNS, ACTUAL ENERGY POINTS
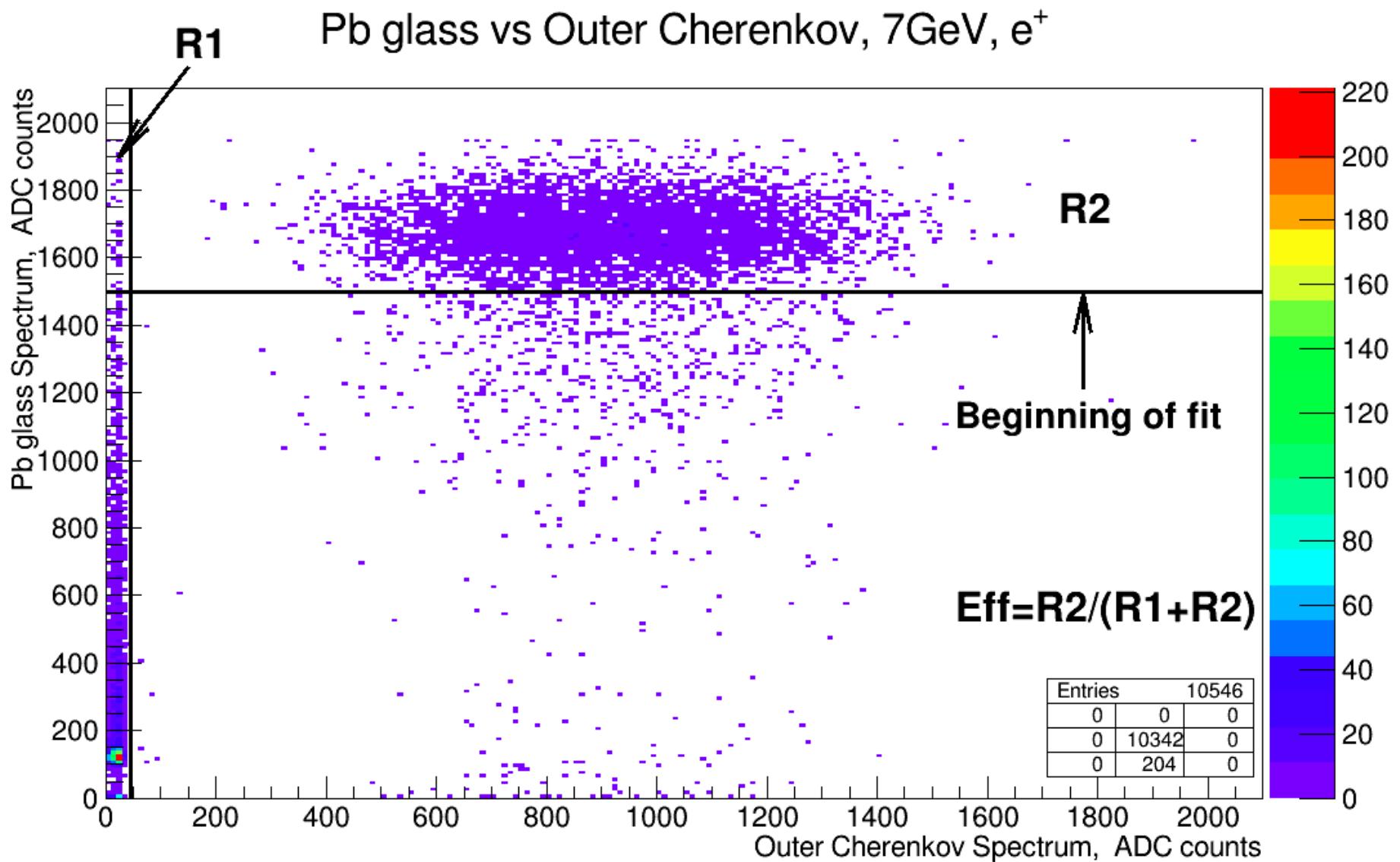
Now, with the measurements made at 1050V and 1100V (positrons)

Now with the actual energy points

LINEARITY, POSITRONS, DIFFERENT VOLTAGES, ACTUAL ENERGY POINTS

	1150V		1050V		1100V
χ^2 / ndf	0.5543 / 3	χ^2 / ndf	0.008493 / 1	χ^2 / ndf	0.01482 / 1
Prob	0.9068	Prob	0.9266	Prob	0.9031
p0	-94.34 ± 54.74	p0	-14.35 ± 74.62	p0	-55.32 ± 246.9
p1	237.1 ± 13.73	p1	120.8 ± 26.24	p1	79.01 ± 33.46

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Cherenkov efficiency

Pb glass vs Outer Cherenkov, 7GeV, e$^+$

Overall efficiency (positrons)

Energy (GeV)	positrons	
	Inner PMT eff.	Outer PMT eff.
1.55	99.56	99.98
2.0	99.56	99.95
4.0	99.75	99.92
6.0	99.57	99.62
7.0	99.56	99.40

Table 5. Overall efficiency for positrons.

*All uncertainties under 1%

For electrons

Energy (GeV)	electrons, April 15th		electrons, April 19th	
	Inner PMT eff.	Outer PMT eff.	Inner PMT eff.	Outer PMT eff.
1.55	99.76	99.90	98.14	99.76
1.77	99.67	99.98	99.52	99.93
2.0	99.74	99.99	99.50	99.96
3.0	99.76	99.94	99.82	99.95
4.0	99.72	99.87	99.61	99.85
5.0	99.66	99.82	99.64	99.82
6.0	99.39	99.52	99.49	99.60
7.0	99.30	99.48	99.26	99.44

Table 6. Overall efficiency for positrons.

*All uncertainties under 1%

Content

Energy	CC positrons	electrons, April 15th	electrons, April 19th
1.55GeV	52%	41%	36%
1.77GeV		43%	51%
2.0GeV	62%	46%	46%
3.0GeV		51%	53%
4.0GeV	58%	53%	53%
5.0GeV		55%	45%
6.0GeV	61%	59%	63%
7.0GeV	56%	54%	59%

Table 7. Approximate electron/positron content.

All uncertainties under 1%

Backup

- A bunch of extra plots in my thesis.

- Already sent to Leo

Thanks!