Silicon Analysis Update

Catherine Fry

Imperial College London

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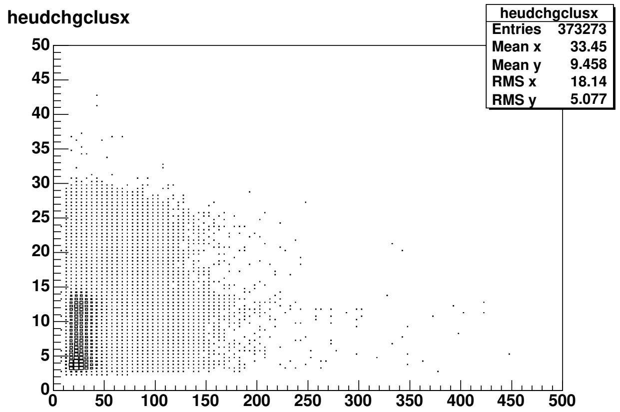
- Reminder
- Energy and silicon cluster charge
- Effect of calorimeter energy range on x_0 and y_0
- Effect of laser on/off and Pockels cell 0/1 on x_0 and y_0
- Subtracting laser off from laser on to leave just the Compton beam
- x_0 and y_0 from Compton and Bremsstrahlung beams
- Fitting η(y) from the silicon data
- Summary and future plans

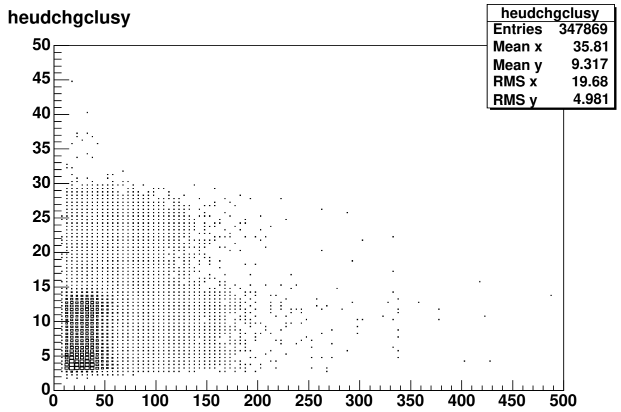
Reminder

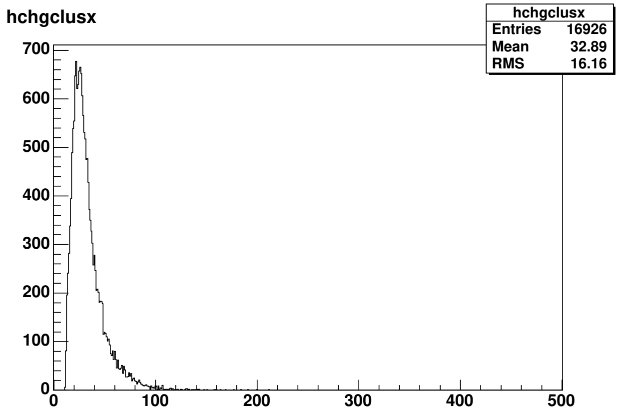
- Previously had started to look for differences in x_0 and y_0 and η-y parameters with laser on and off and Pockels cell 0 and 1
- No clear effects were seen
- Needed more statistics

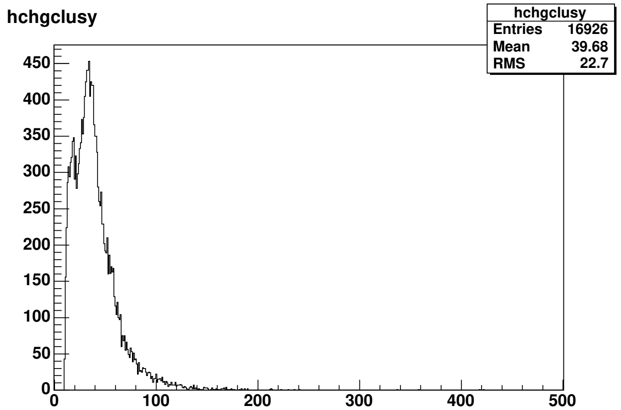
- On 8^{th} July took six consecutive runs of 20k events, all in same fill $\longrightarrow$ 1.2M events
- Online polarisation value during these runs was 32$\%$

Energy and silicon cluster charge









- Wanted to see if a cut could be made on energy or cluster charge to improve η-y distribution
- Distributions from energy vs. clusters in both x and y strips are quite even - no obvious cut can be made here
- Second peak in y cluster charge distribution...

Effect of calorimeter energy range on x_0 and y_0

- Originally calorimeter energy range was 10—16 GeV
- Measure x_0 and y_0 by fitting double Gaussian to clusters in silicon x and y strips
- Look at data with laser on and Pockels cell = 1

E_{min} / GeV	E_{max} / GeV	x_0 / mm	y_0 / mm
0	40	26.03 ± 0.01	32.37 ± 2.59
0	5	25.60 ± 0.03	32.13 ± 0.01
0	10	25.87 ± 0.01	31.94 ± 0.00
0	16	26.12 ± 0.01	31.89 ± 0.00
10	16	26.28 ± 0.01	31.82 ± 0.00
10	40	26.12 ± 0.01	31.84 ± 0.00
16	40	24.76 ± 0.05	32.51 ± 0.00

- x_0 may increase slightly as energy range covers higher energies
- No particular trend observed with y_0
- Should look at laser off data and Compton-only (laser on — laser off)

Effect of laser on/off and Pockels cell 0/1 on x_0 and y_0

Laser	Pockels cell	x_0 / mm	y_0 / mm
0	0	25.55 ± 0.04	32.27 ± 0.01
0	1	25.32 ± 0.04	32.36 ± 0.01
1	0	25.80 ± 0.08	31.77 ± 0.00
1	1	26.28 ± 0.01	31.82 ± 0.00

y_0(laser on) $<$ y_0(laser off)

$\longrightarrow$ possible difference in the y-positions of the Compton and Bremsstrahlung beams

y_0(pc 0) $<$ y_0(pc 1)

$\longrightarrow$ expected asymmetry between the two laser helicities

No particular difference observed in x.

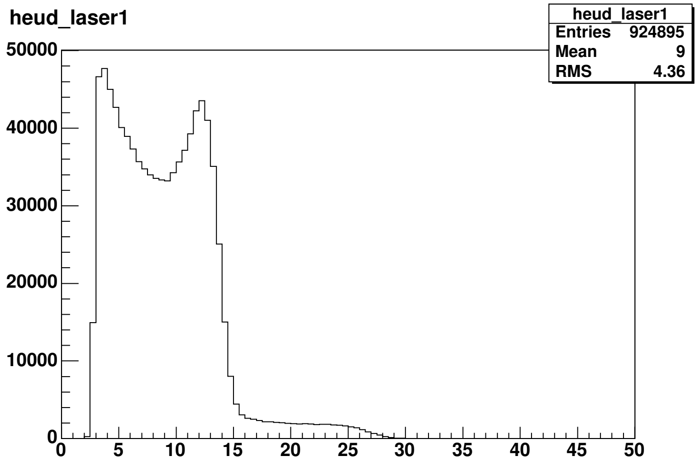
Need to subtract laser off from laser on to leave just the Compton beam...

Subtracting laser off from laser on to leave just the Compton beam - I

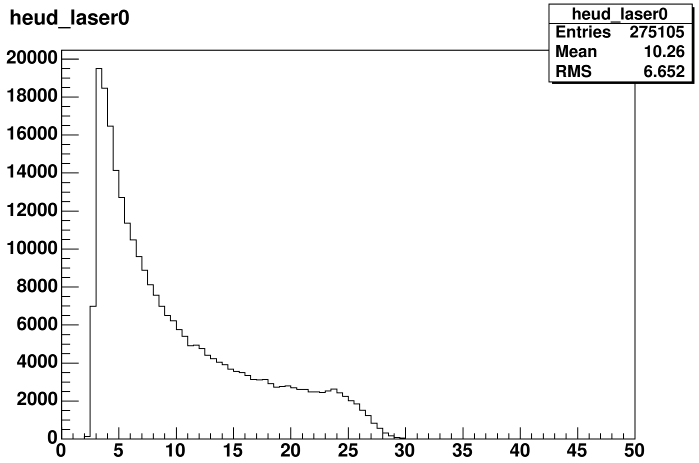
- Normalise tail of laser off (Bremsstrahlung) energy distribution to tail of laser on (Compton + Bremsstrahlung) energy distribution

- Find normalisation factor and then can subtract laser off from laser on data for other histograms, using this weighting

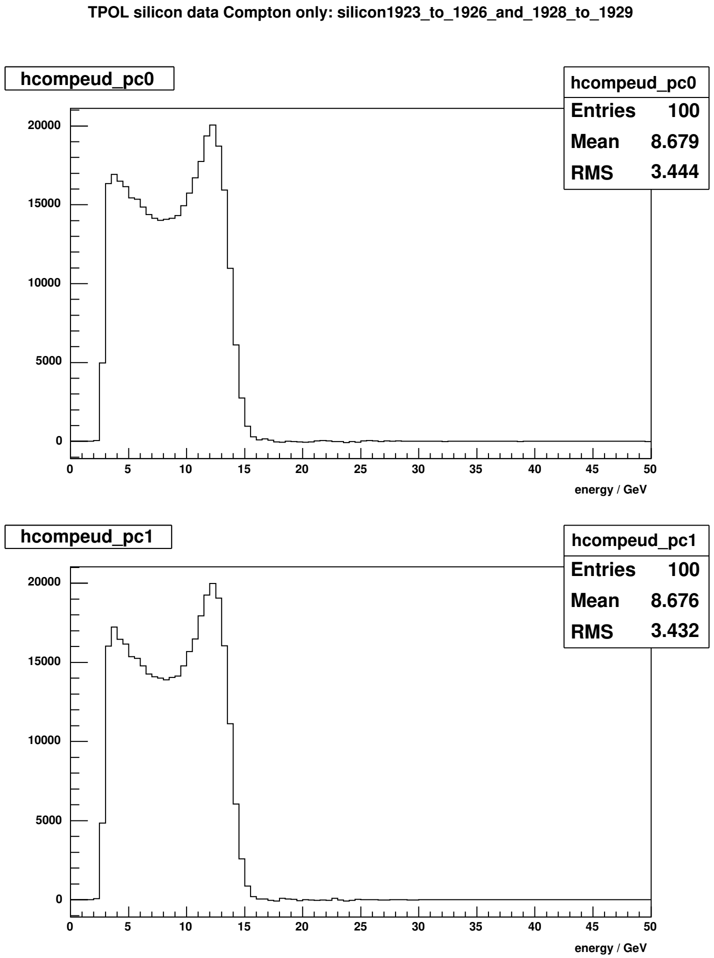
- Laser on - Compton + Bremsstrahlung



- Laser off - Bremsstrahlung only



Subtracting laser off from laser on to leave just the Compton beam - II



- Laser on — normalised laser off for each Pockels cell setting - Compton only
- Get a separate normalisation factor for Pockels cell 0 and 1 so can look at these data separately

x_0 and y_0 from Compton and Bremsstrahlung beams

Beam	Pockels cell	x_0 / mm	y_0 / mm
Compton	0	26.30 ± 0.00	31.76 ± 0.00
Compton	1	26.35 ± 0.01	31.79 ± 0.00
Bremsstrahlung	0	25.55 ± 0.04	32.27 ± 0.01
Bremsstrahlung	1	25.32 ± 0.04	32.36 ± 0.01

x_0(bremsstrahlung) $<$ x_0(Compton)

y_0(bremsstrahlung) $>$ y_0(Compton)

$\longrightarrow$ bremsstrahlung beam shifted w.r.t. Compton beam?

No obvious difference between Pockels cell 0 and 1 for bremsstrahlung beam, as expected

Also no great difference between Pockels cell 0 and 1 for Compton beam, surprising?

Should see a difference in y...

Fitting η(y) from the silicon data - I

Try fit functions with four and six parameters:

$$\eta(y) = -sign(y - y_0)\Big(1 - P_0 \exp(-\tfrac{|y-y_0|}{P_1}) - (1 - P_0) \exp(-\tfrac{|y-y_0|}{P_2})\Big)$$

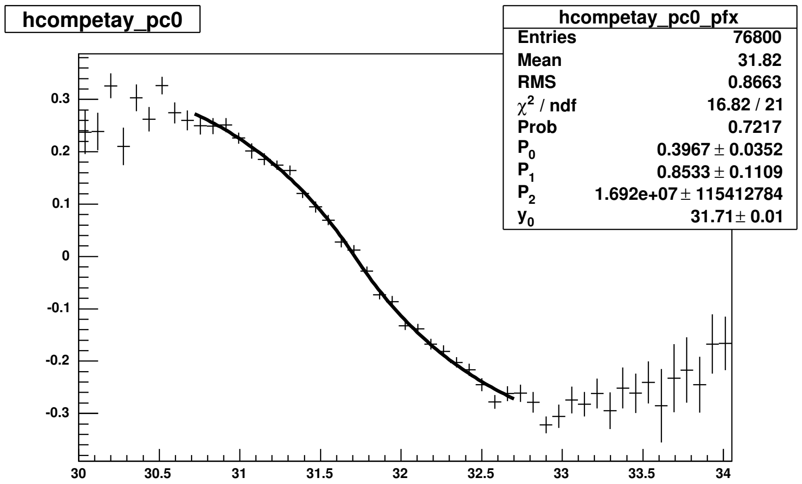
$$\eta(y) =$$
$$-sign(y-y_0)\Big(1-P_0 \exp(-\tfrac{|y-y_0|}{P_2})-(1-P_0-P_1) \exp(-\tfrac{|y-y_0|}{P_3})-P_1 \exp(-\tfrac{|y-y_0|}{P_4})\Big)$$

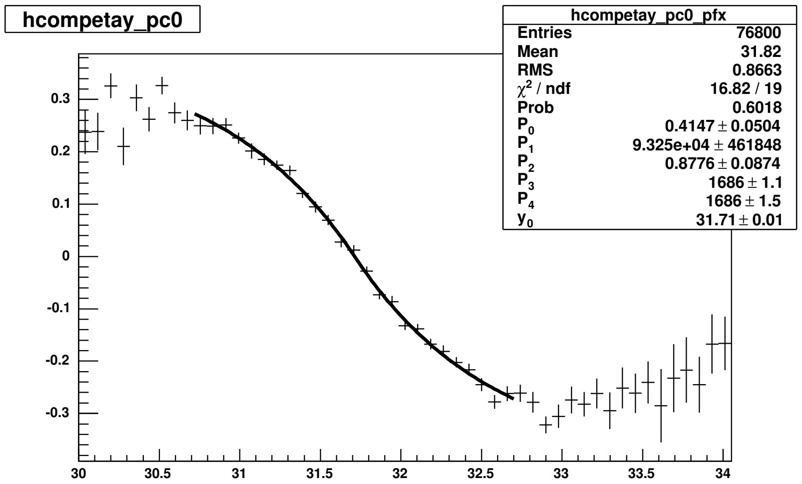
Fit Compton and bremsstrahlung data with Pockels cell 0 and 1

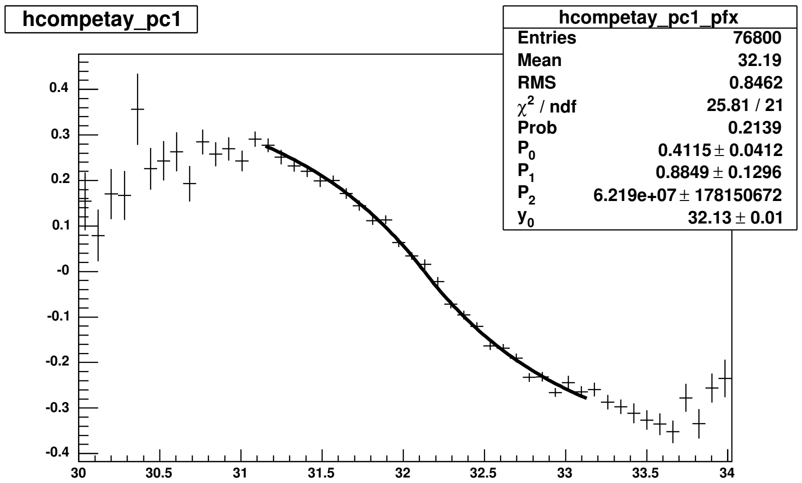
Fitting η(y) from the silicon data - II

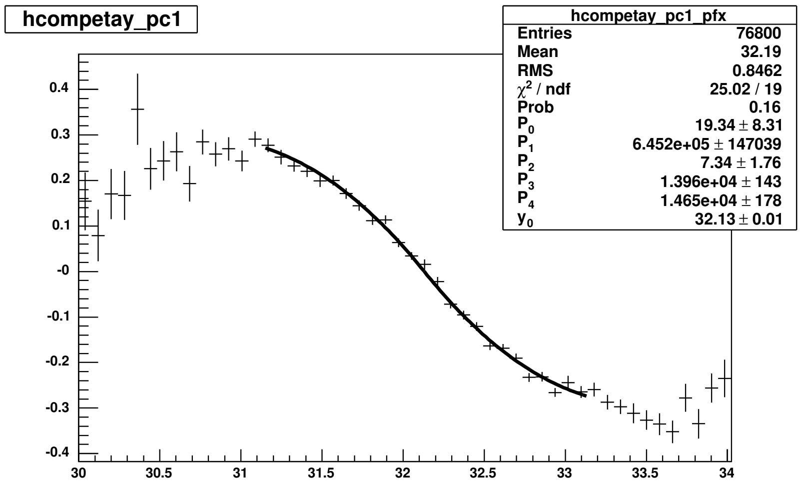
TPOL silicon data Compton only: silicon1923_to_1926_and_1928_to_1929

TPOL silicon data Compton only: silicon1923_to_1926_and_1928_to_1929



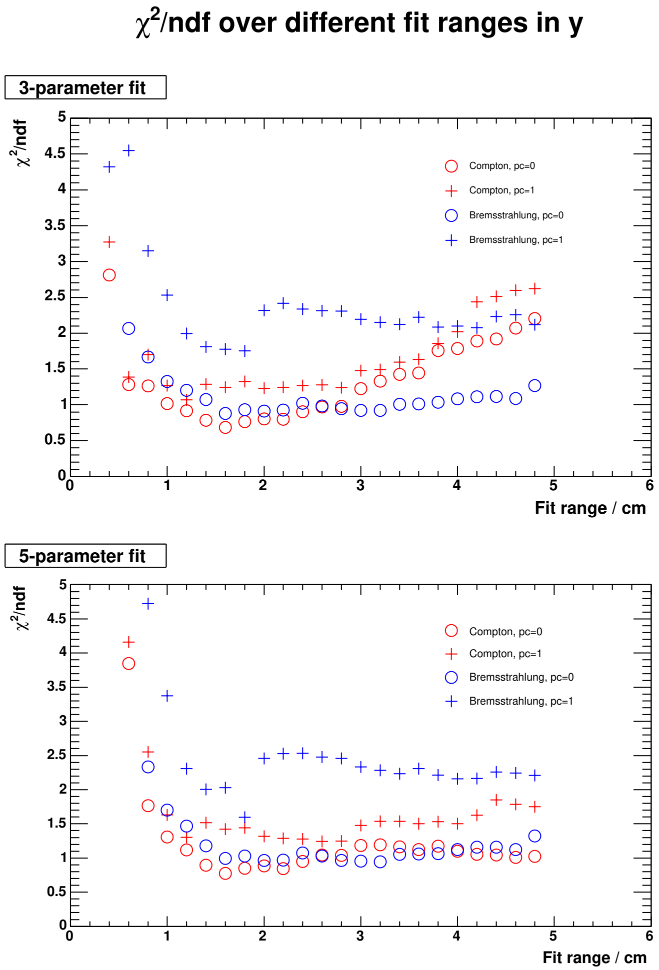






Fitting η(y) from the silicon data - III

Check χ^2/ndf against fit range:

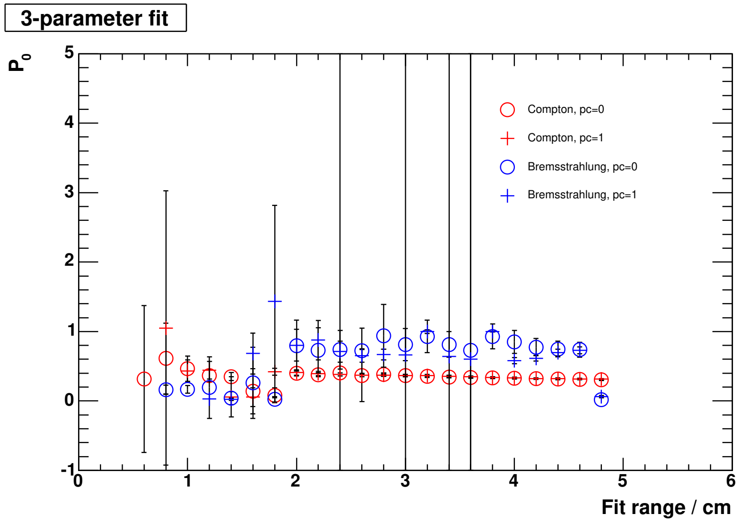


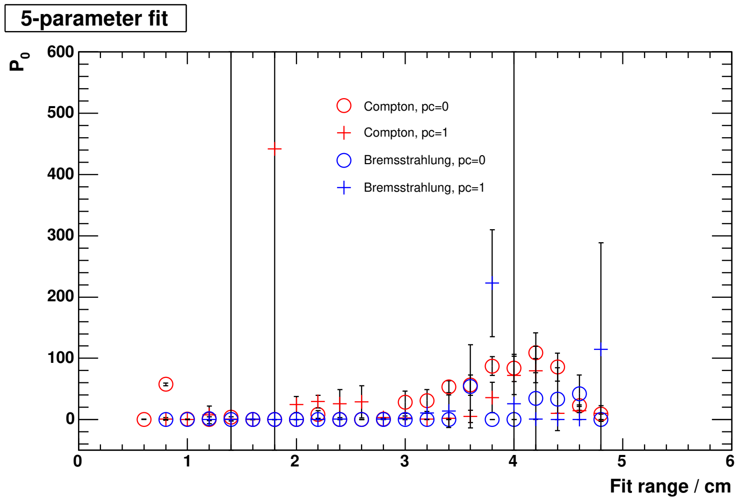
- Seems ranges greater than 1cm have reasonable χ^2/ndf
- Lowest χ^2/ndf with ranges between 1 and 2.5 cm

- red = Compton
- blue = bremsstrahlung
- circle = Pockels cell 0
- cross = Pockels cell 1

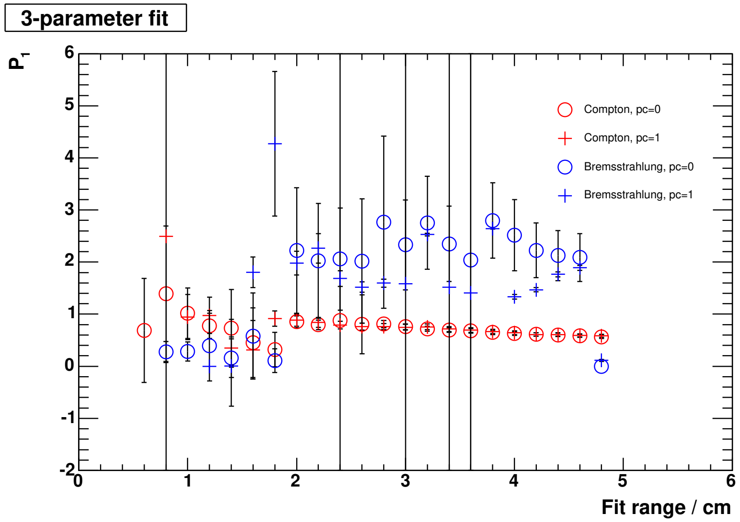
Fitting η(y) from the silicon data - IV

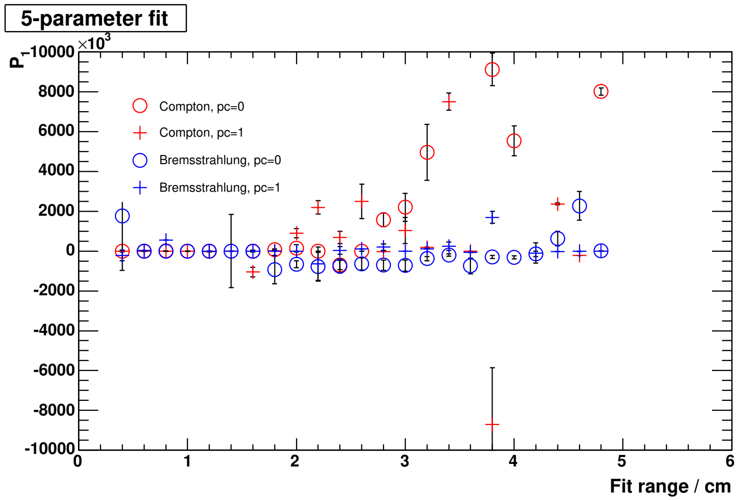
P_0 over different fit ranges in y





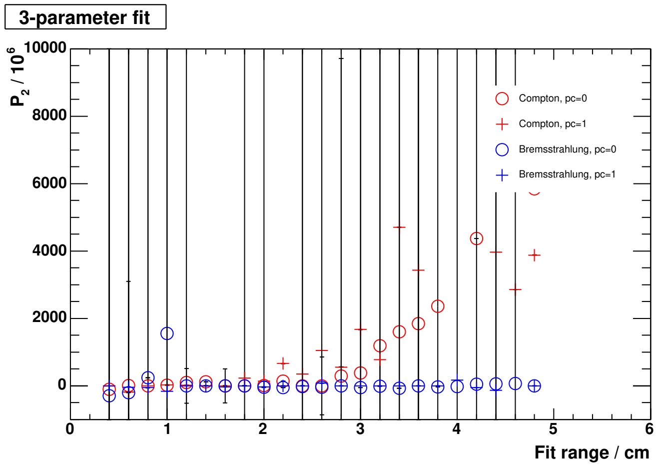
P_1 over different fit ranges in y

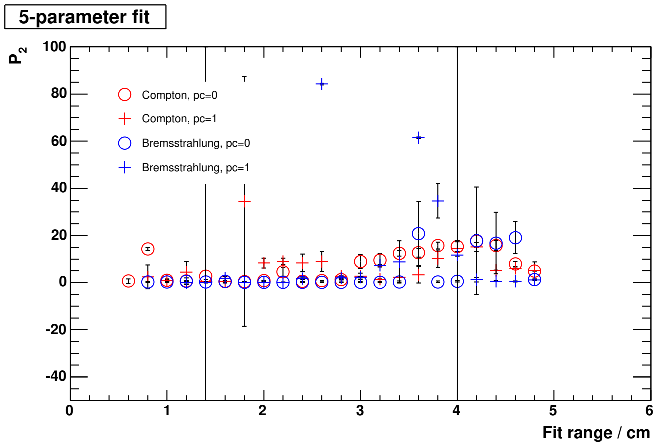




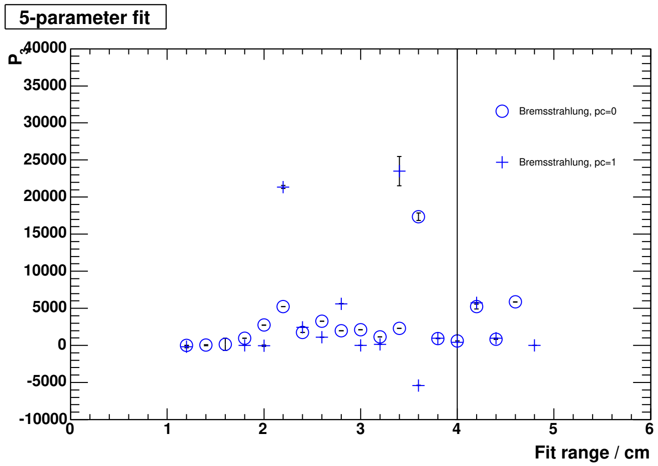
Fitting η(y) from the silicon data - V

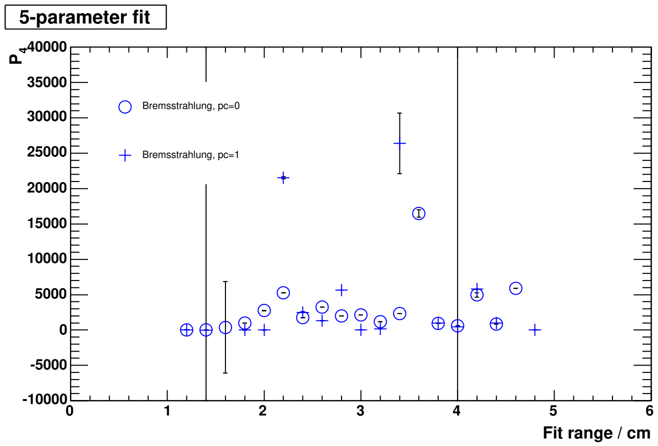
P_2 over different fit ranges in y





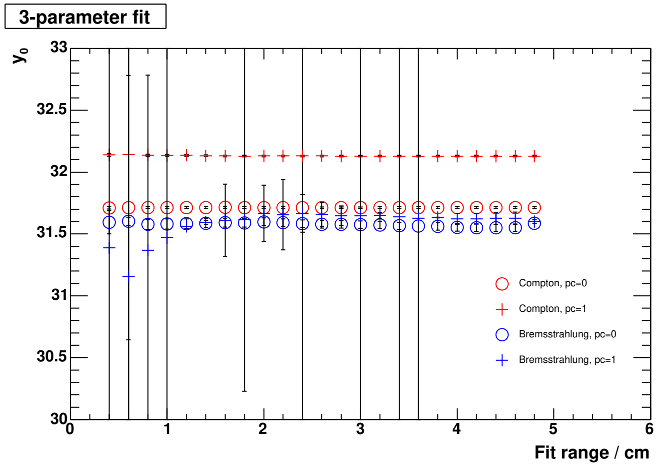
P_3 and P_4 over different fit ranges in y

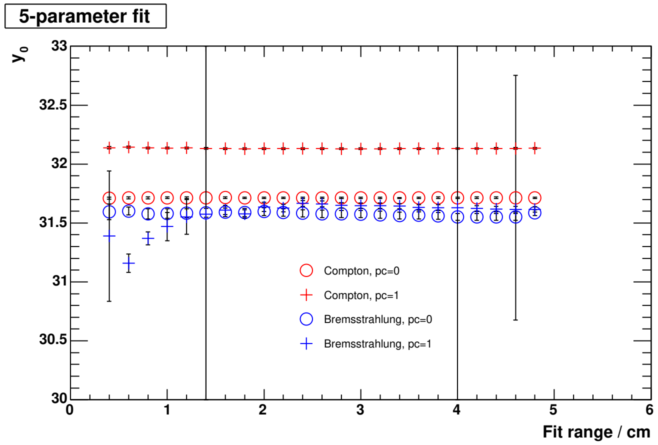




Fitting η(y) from the silicon data - VI

y_0 over different fit ranges in y





- See difference of about 0.5cm between y_0 for Compton Pockels cell 0 and Compton Pockels cell 1
- Negligeable difference between y_0 for bremsstrahlung Pockels cell 0 and bremsstrahlung Pockels cell 1
- Parameters not very stable although χ^2/ndf is OK
- Seems parameters can vary quite a lot and still describe the data quite well
- See small differences in parameters for Compton and bremsstrahlung data and Pockels cell 0 and 1

Summary and future plans

- No obvious cut on energy to be made - perhaps cut on y cluster charge, but would cut out quite a large fraction of the data
- No particular trend in y_0 as vary calorimeter energy
- Possible trend in x_0 as vary calorimeter energy
- Should re-check energy ranges with Compton-only data
- See shift in y-position between laser on and laser off
- For laser on see shift in y-position between Pockels cell 0 and 1 as expected
- Normalised bremmstrahlung (laser off) energy distribution to tail of laser on distribution and subtracted laser off data from laser on
- See difference in x and y positions for Compton and bremsstrahlung data
- No great difference in x and y positions for Compton and bremsstrahlung with Pockels cell 0 and 1 - as expected for bremsstrahlung, but should see difference in y for Compton data but it's only a very small change
- Fitted η(y) with 4 and 6 parameter fits and vary fit range
- χ^2/ndf is best with range 1 - 2.5 cm

- Fit parameters can vary quite a lot though, but have a small effect on χ^2/ndf
- See differences in parameters for Compton and bremsstrahlung data and Pockels cell 0 and 1

- Still want to check clustering - maybe use test beam data
- Want to find calorimeter alignment w.r.t. silicon detector - make profile of η vs x...
- During shutdown can use LED pulsar to check energy trigger level
- Put ellipse fit online