Channel inter-calibration with cosmic rays

Cosmic rays

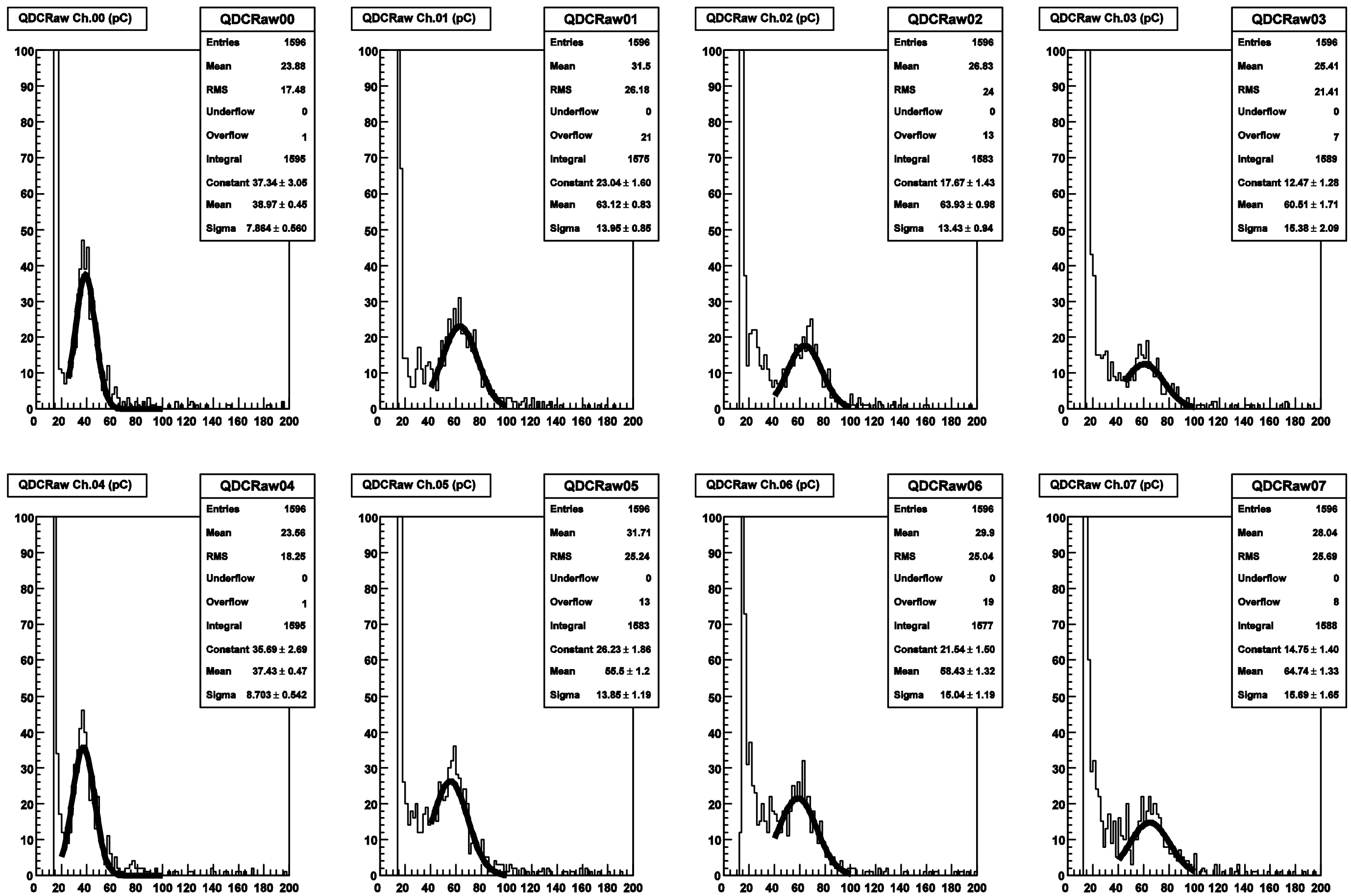
- 2 types of data taking: integrated charge (QDC CAEN V792N) and lineshape (Flash ADC CAEN V1721). Timing information is also present (TDC CAEN V1190)
- Calorimeter rotated 90 degrees, a cosmic trigger with an “up” scintillator (11x5x50) mm^3 and a “down” one () select vertical, “passing” tracks, with some fakes due to over-coverage

How to calibrate

- Initial 8-channel equalization done on the basis of Hamamatsu individual datasheets
- Select passing tracks, identify pedestals and peaks, one passing tracks deposits 90 MeV in all and 16 MeV in the plastic+glue
- Find correction factors, assuming individual gain laws for PM "n" (V in kV)

$$\log(G_n) = \log(G_n^0) + \alpha \cdot \log(V_n / V_n^0)$$

Run 224: “Hamamatsu” working points for “up” calorimeter (1.45 kV)



HV correction table for “up” calorimeter (newV=1.45 kV)

Ch	Ped	Peak	Qfit	fact	oldV	newV
0	15.962	38.968	46.011	0.978	1.434	1.427
1	15.611	63.125	47.514	0.947	1.442	1.426
2	13.941	63.929	49.988	0.900	1.432	1.401
3	15.491	60.51	45.019	1.000	1.349	1.349
4	15.059	37.434	44.75	1.006	1.399	1.401
5	15.793	55.505	39.712	1.133	1.405	1.443
6	14.558	58.434	43.876	1.026	1.451	1.459
7	13.895	64.744	50.85	0.885	1.427	1.391

The HV correction

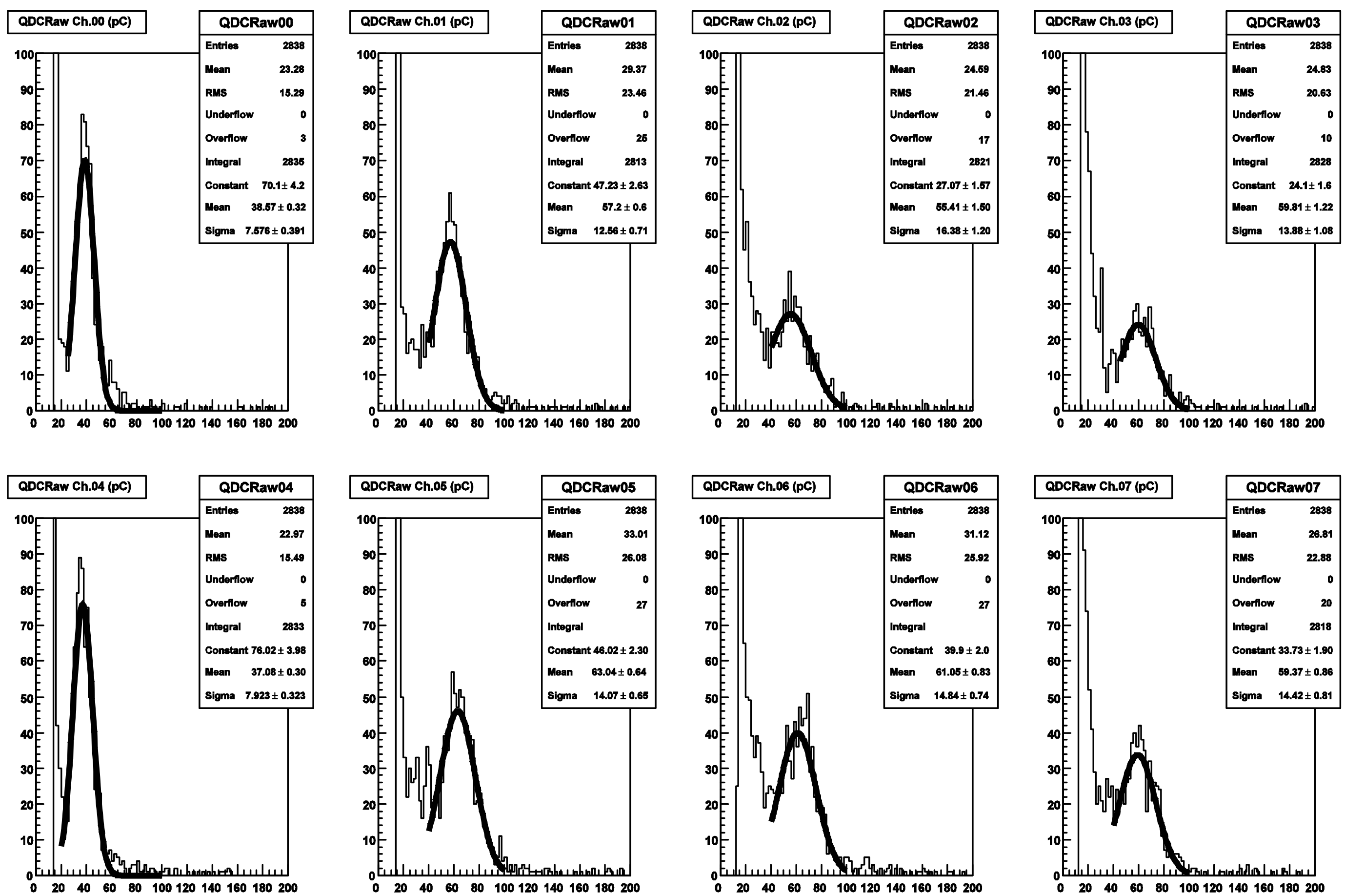
- Let's choose a "target" amplification (45 pC)
- In column 5 we find the factor to correct for
- According to

$$\log(G_n) = \log(G_n^0) + \alpha \cdot \log(V_n / V_n^0)$$

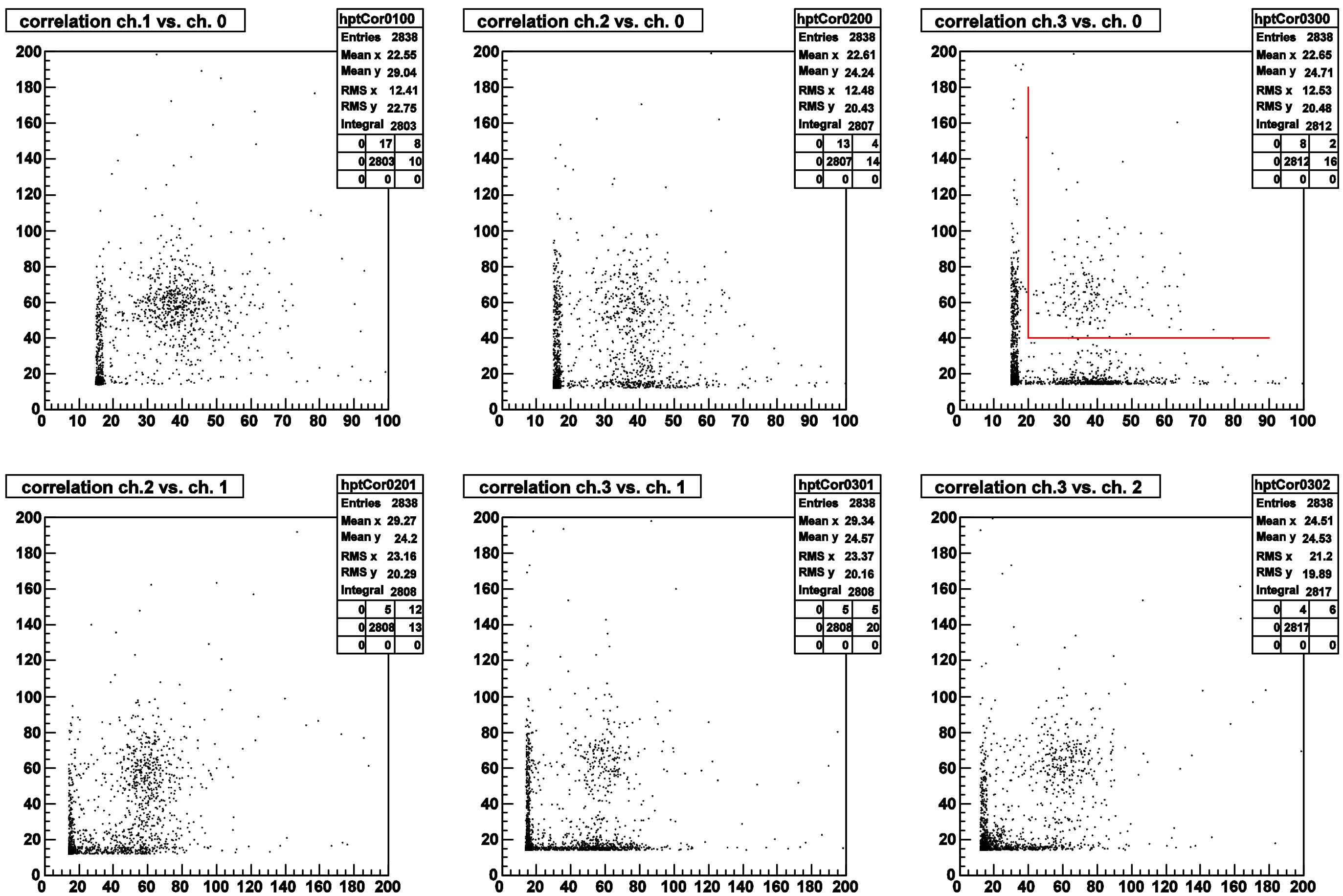
- We compute

$$\log(V_n) = \log(V_n^0) + \log(G_n / G_n^0) / \alpha$$

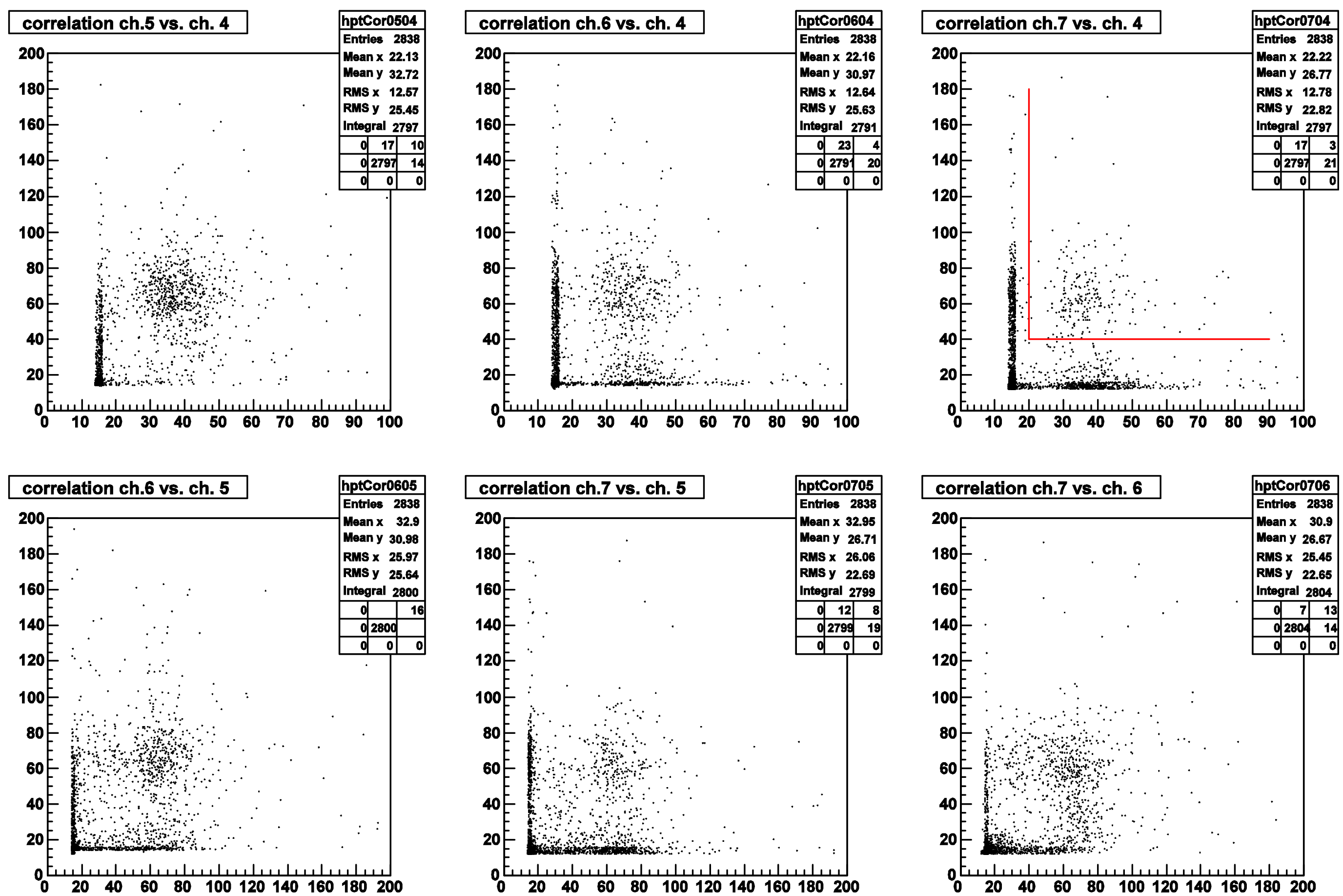
Run 225: working points from 224



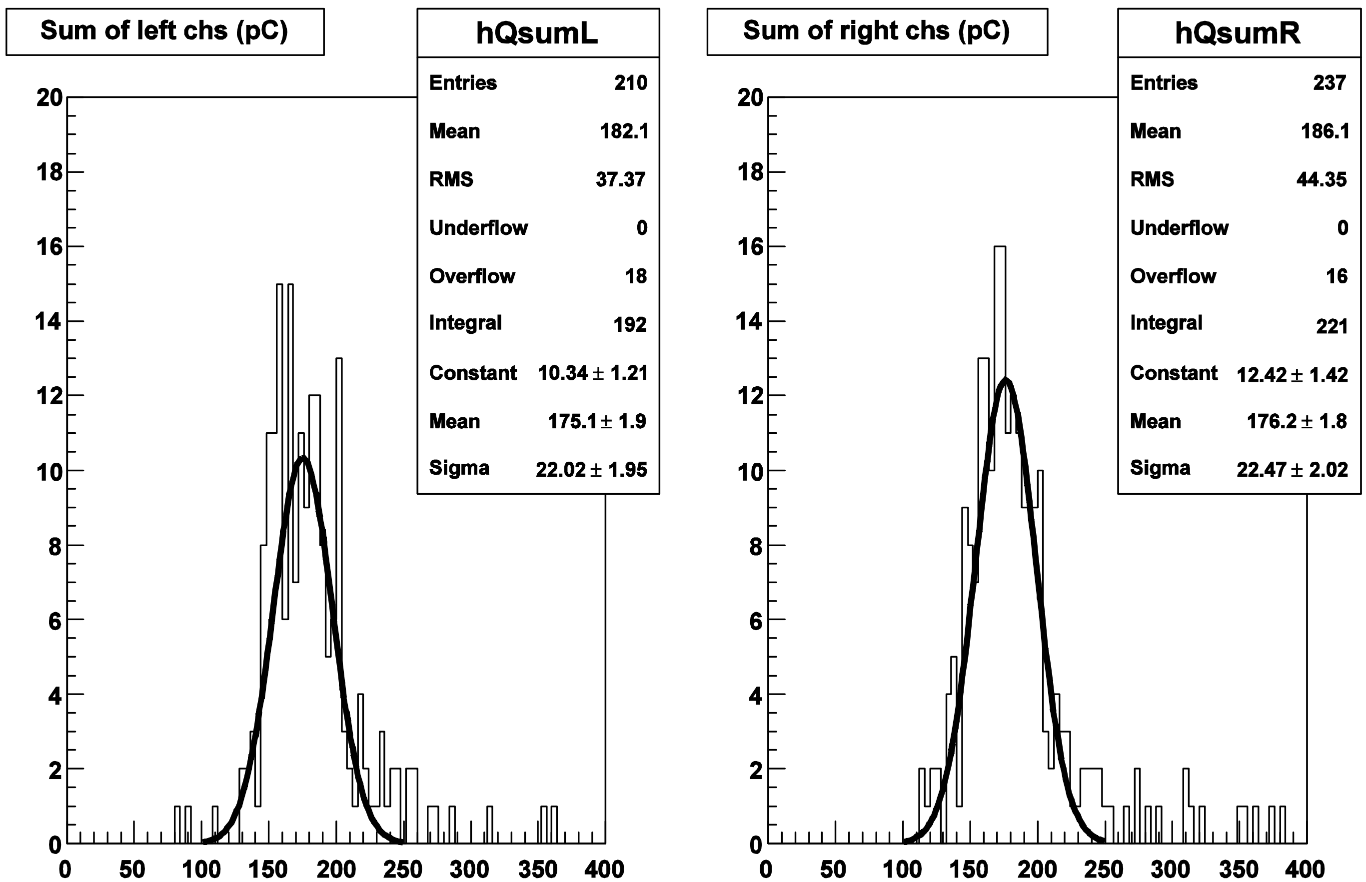
Find passing tracks (left side)



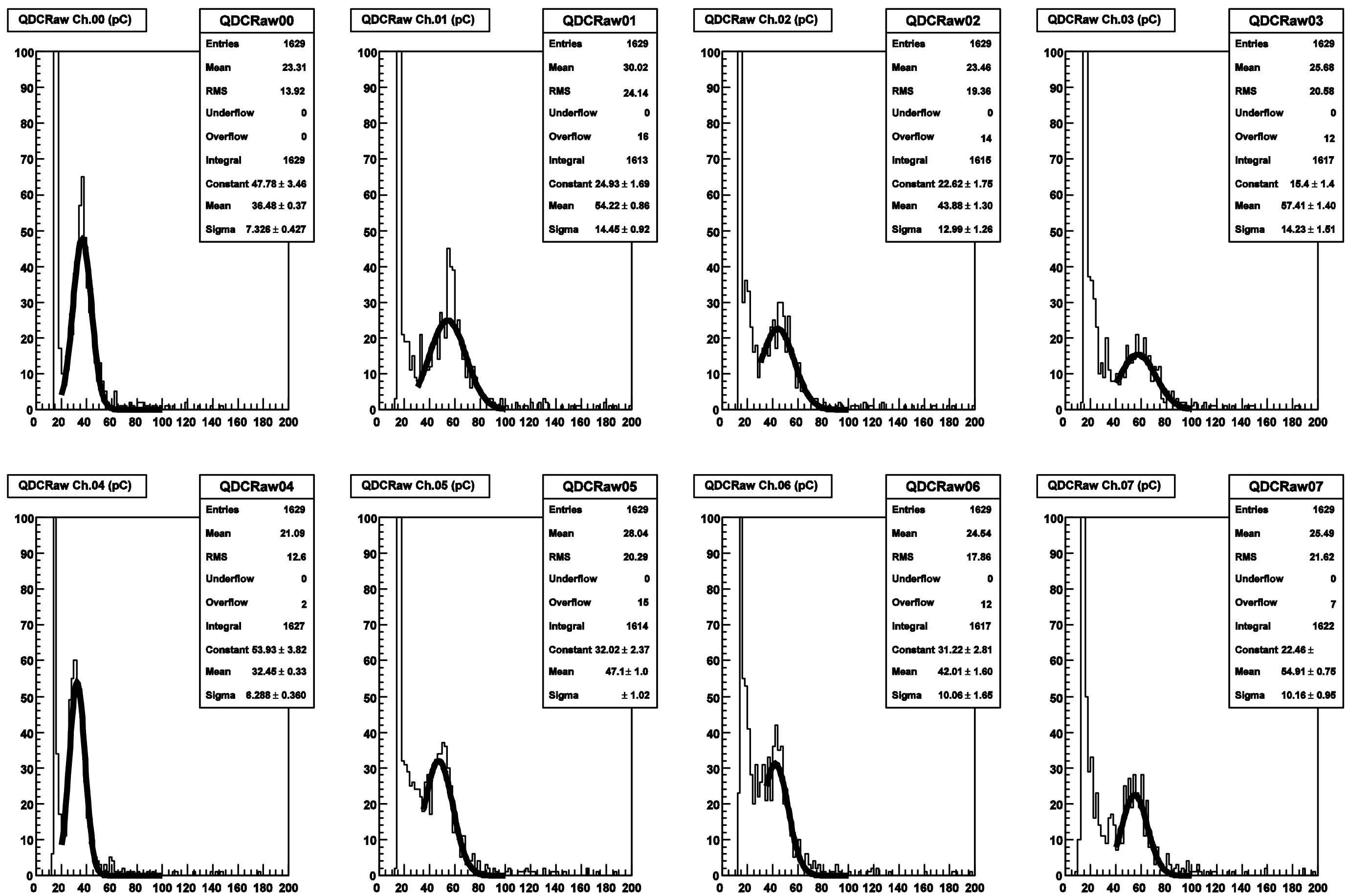
Find passing tracks (right side)



σ_E for passing tracks ("up" calorimeter)



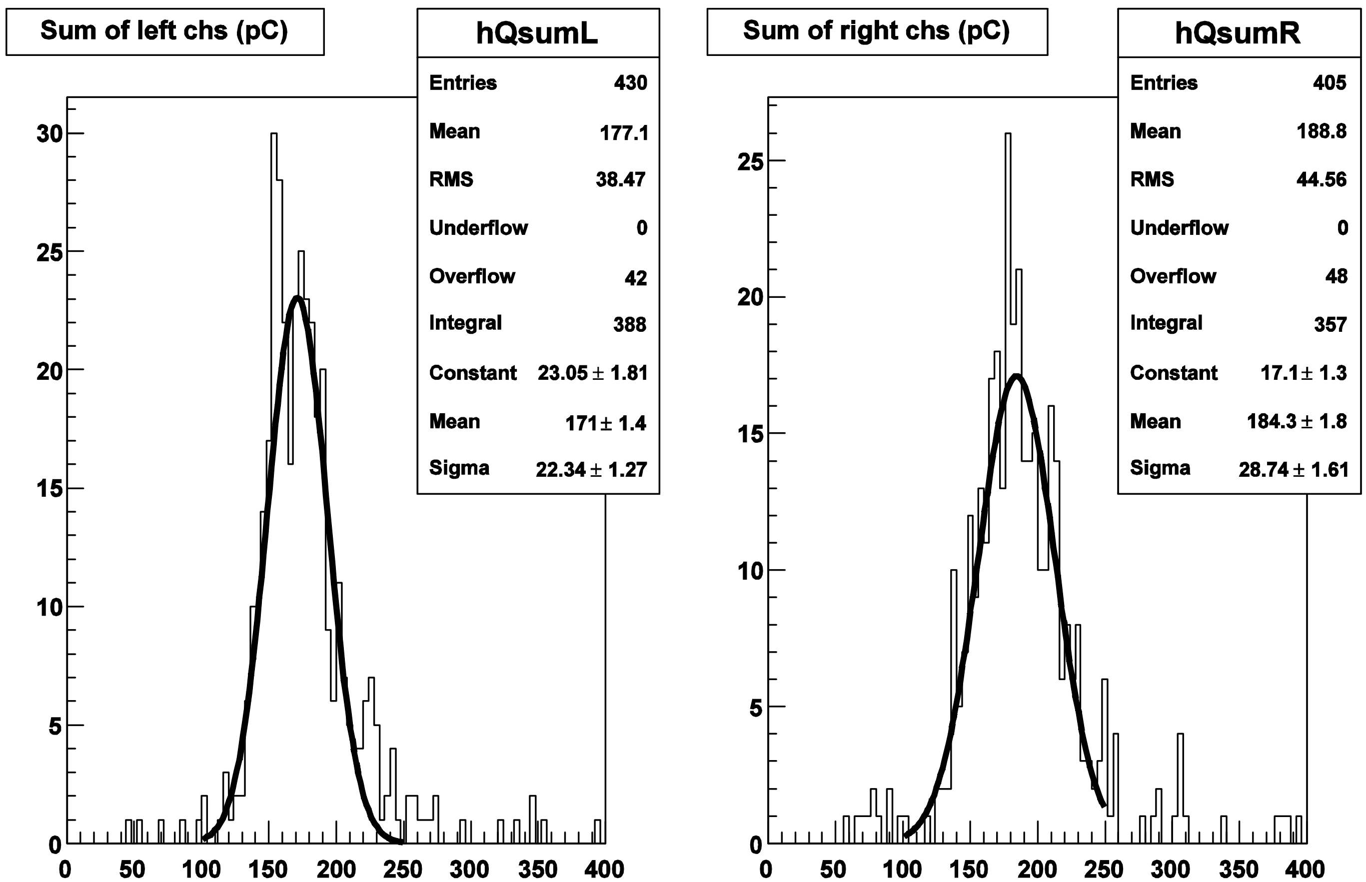
Run 230: “Hamamatsu” working points for “down” calorimeter (1.40 kV)



HV correction table for "down" calorimeter (newV=1.45 kV)

Ch	Ped	Peak	Qfit	fact	oldV	newV
0	16.110	36.462	40.745	1.104	1.395	1.425
1	15.783	54.222	38.439	1.171	1.365	1.411
2	14.099	43.876	29.776	1.511	1.393	1.520
3	15.660	57.405	41.745	1.078	1.395	1.417
4	15.132	32.453	34.643	1.299	1.405	1.485
5	15.863	47.102	31.239	1.441	1.387	1.498
6	14.579	42.013	27.434	1.640	1.396	1.550
7	13.965	54.913	40.948	1.099	1.401	1.429

σ_E for passing tracks ("down" calorimeter, run 232)



Device scale (at 1.45 kV)

- According to Montecarlo a passing cosmic track leaves 16 MeV of energy in the scintillator
- Scale of the device (when “Happy Box” is used) is approximately 170 pC / 16 MeV = 11 pC / MeV
- BTF-equivalent scale (no “Happy Box” there) is 5.5 pC / MeV

Number of photoelectrons

- Assuming a PM gain ≈ $1.4 \cdot 10^6$, the number of photoelectrons per cosmic track is:

$$N_{pe} = \frac{170 \cdot 10^{-12}}{2 \cdot 1.6 \cdot 10^{-19} \cdot 1.4 \cdot 10^{6}} = 380$$

- The factor 2 in the denominator is due to the "Happy Box"
- Approximately 1/7th of these 380 p.e. develop in the first PM, 2/7th in each of the other 3 PMs

Photoelectrons/MeV

- According to Montecarlo 16 MeV are deposited in the scintillator by cosmic track, 50 MeV in all. This means:
- 24 photoelectrons/MeV in the fibers (14 cm)
- 8 photoelectrons/MeV in the whole calorimeter

Expected resolution

- In absence of other fluctuations (shower development or PM gain fluctuations) we would expect $\sigma_E/E = 1/\sqrt{N_{pe}}$ = 13% in the first PM, 10% in the others, in total 5.3% for the energy sum. They are bigger (see slide 7)
- For the sum we find 20/180 = 11%, consistent with simulation (no shower fluctuations).
- We can't determine from widths how many photoelectrons we have, must rely on PM gain