

# PROGRESS ON G4 SIMULATION

JOE S, SEP 7, 2006

A brief history of PMT slot positions

The PMT positions in the Geant 4 DIRC simulation were implemented by Ivan in December 2005 to match Jerry's spreadsheet of the CMM data obtained in November after the run

We then compared the occupancy in data and G4 and **adjusted the angle of the focusing mirror** by a few  $0.1^\circ$  to bring G4 into better agreement.

However, we were not able to match occupancy in all slots simultaneously with simple angle tweaks.

We seemed to need an **additional rotation** that we did not pursue at the time.

Analysis using G4 angle so far were all done with this set of positions.

In July Jerry measured those numbers again and produced latest table of slot centers.

Today: discuss study to establish better PMT slot positions

Worked out new G4 slot positions from Jerry's table and the previous G4 values (based on Dec 2005 numbers) – differences at the 1-2mm level

		Ivan	nominal	Jerry 7/28	diff to Ivan	corr. diff.	Jerry Dec 1, 2005	corr. diff to Ivan	Jerry diff 12/1 - 7/28	new G4 values	Change to G4
1	x	18.500	-18.500	-18.371	0.130	0.130	-18.500	0.000	0.130	18.371	-0.130
	y	2.500	2.500	2.992	-0.492	0.000	2.992	0.000	0.000	2.500	0.000
2	x	11.970	-11.970	-11.841	0.130	0.130	-11.97	0.000	0.130	11.841	-0.130
	y	0.524	0.500	1.107	-0.583	-0.091	1.016	0.000	0.091	0.614	0.091
3	x	6.500	-6.500	-6.370	0.130	0.130	-6.5	0.000	0.130	6.370	-0.130
	y	-0.040	0.000	0.543	-0.583	-0.091	0.452	0.000	0.091	0.051	0.091
4	x	0.000	0.000	0.130	0.130	0.130	0	0.000	0.130	-0.130	-0.130
	y	0.000	0.000	0.492	-0.492	0.000	0.492	0.000	0.000	0.000	0.000
5	x	-7.430	7.480	7.618	0.188	0.188	7.43	0.000	0.188	-7.618	-0.188
	y	0.494	0.500	0.992	-0.498	-0.005	0.986	0.000	0.006	0.499	0.005
6	x	-14.930	14.930	15.151	0.221	0.221	14.93	0.000	0.221	-15.151	-0.221
	y	2.038	2.000	2.530	-0.492	0.000	2.53	0.000	0.000	2.038	0.000

*all numbers in cm*

Added those numbers to G4 and ran comparison of G4 to run 12b (Nov 2005 run)

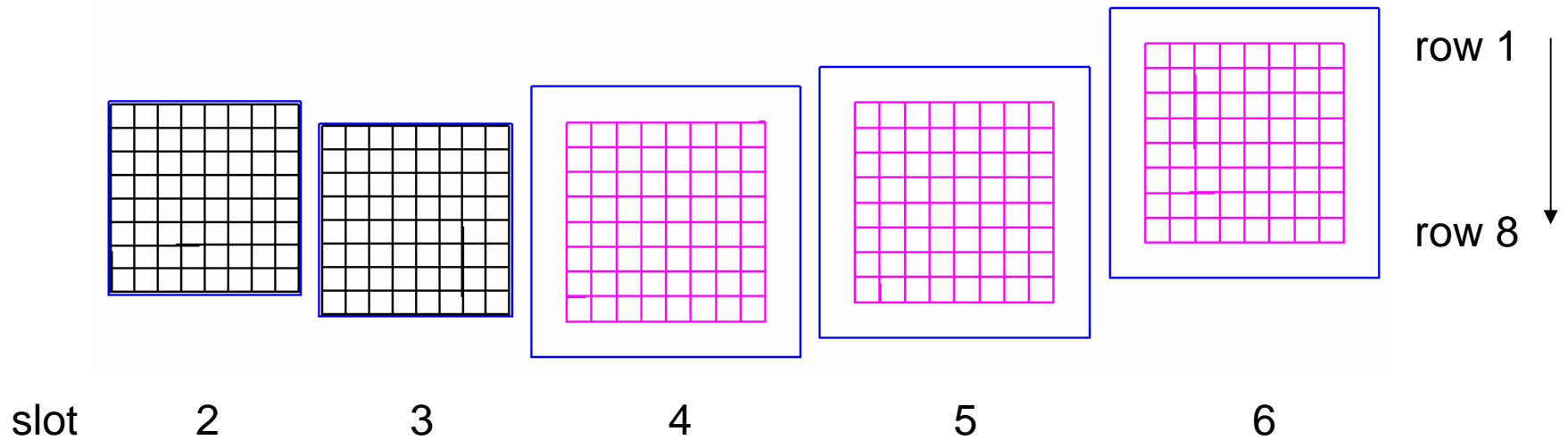
Observed need for additional slot-dependent shifts at the -3...+1mm level.

Do not want to tune G4 values to explicitly improve  $\theta_c$  resolution – goal is better description of data.

→ part 1 of talk

Modified some of Ivan's code for 2006 geometry, ran same study as for 2005

→ part 2 of talk



PMT layout for Aug 18, 2006 G4 variable lambda run with 2005 conditions

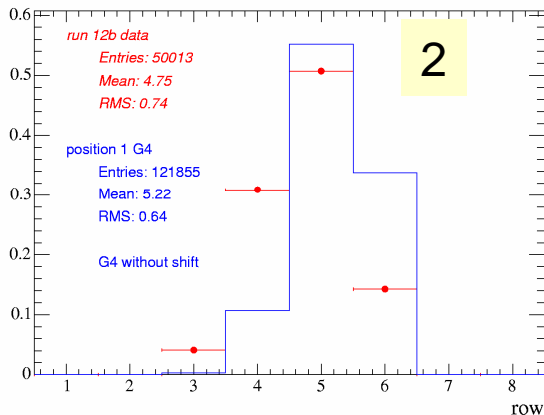
(Plot produced using Geant 4 and jas3.)

plot occupancy as function of row number in each slot for selected events (*normalized to 1*)

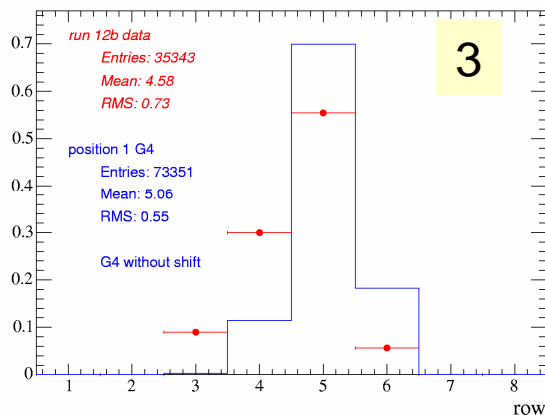
compare run12b to 50k G4 events

(*use latest positions; remember that G4 does not describe the background hits in data*)

row {slot>0&&status==7&&status==7&&slot==2}



row {slot>0&&status==7&&status==7&&slot==3}

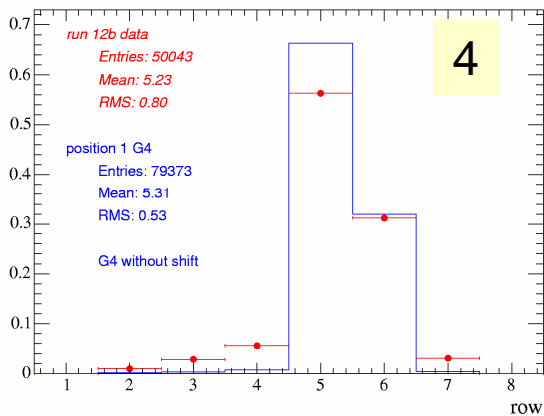


data: red points  
G4: blue histo

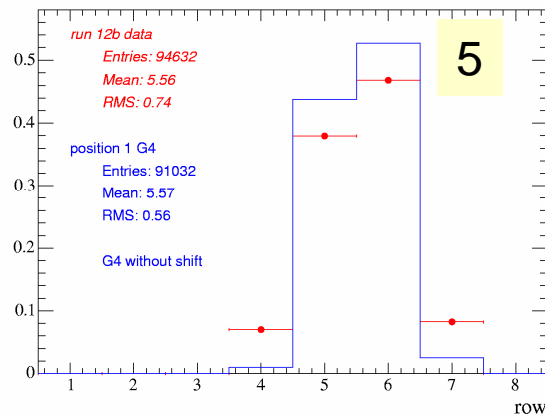
OK agreement for 4, 5  
(tuned mirror angle)

Improve 2, 3, 6 by shifting  
each slot separately in y

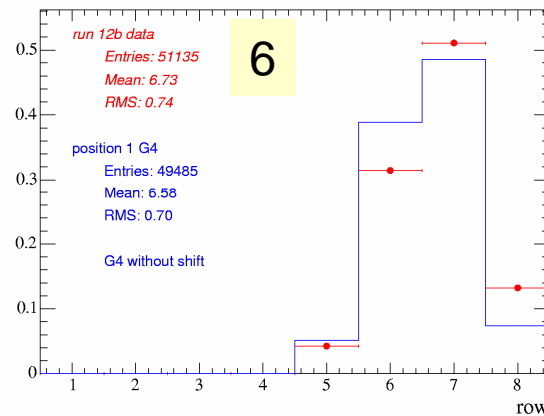
row {slot>0&&status==7&&status==7&&slot==4}



row {slot>0&&status==7&&status==7&&slot==5}

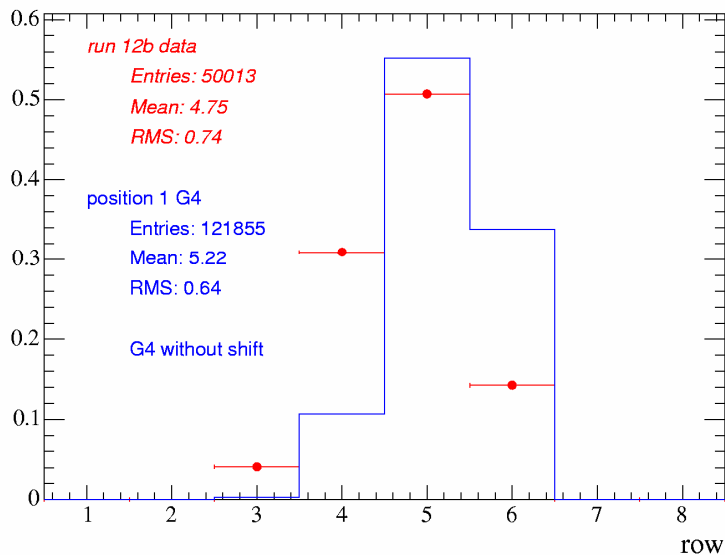


row {slot>0&&status==7&&status==7&&slot==6}



generate 50k G4 events each for detection plane y shifts between -5mm and +5mm

row {slot>0&&status==7&&status==7&&slot==2}



before



y shift by +3mm

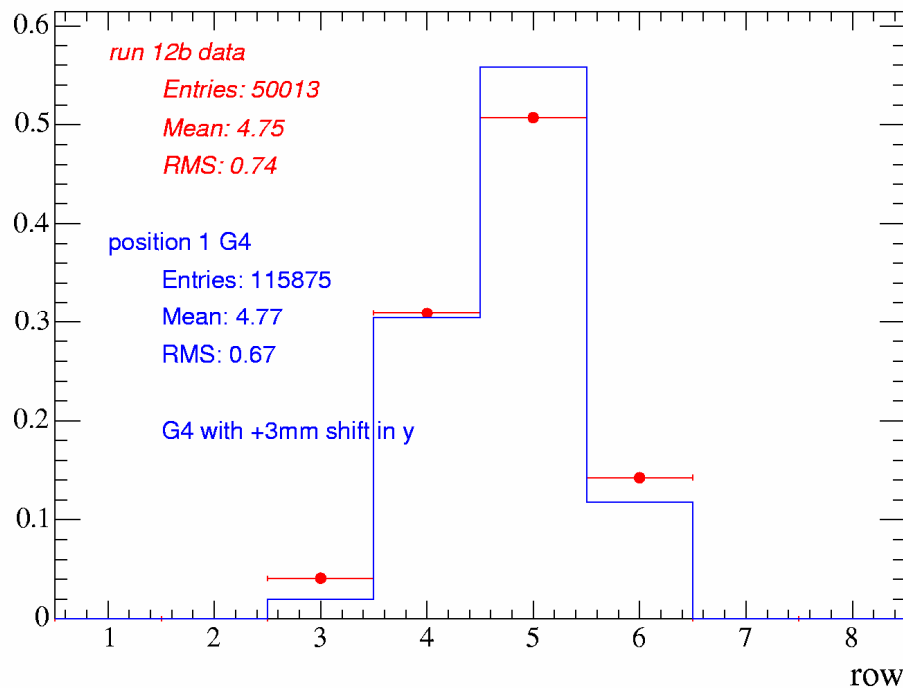
slot 2 improvement

Note that this is a large shift – half of one pixel row

Will result in large thetaC shift of slot 2 pixels by approx 10mrad!

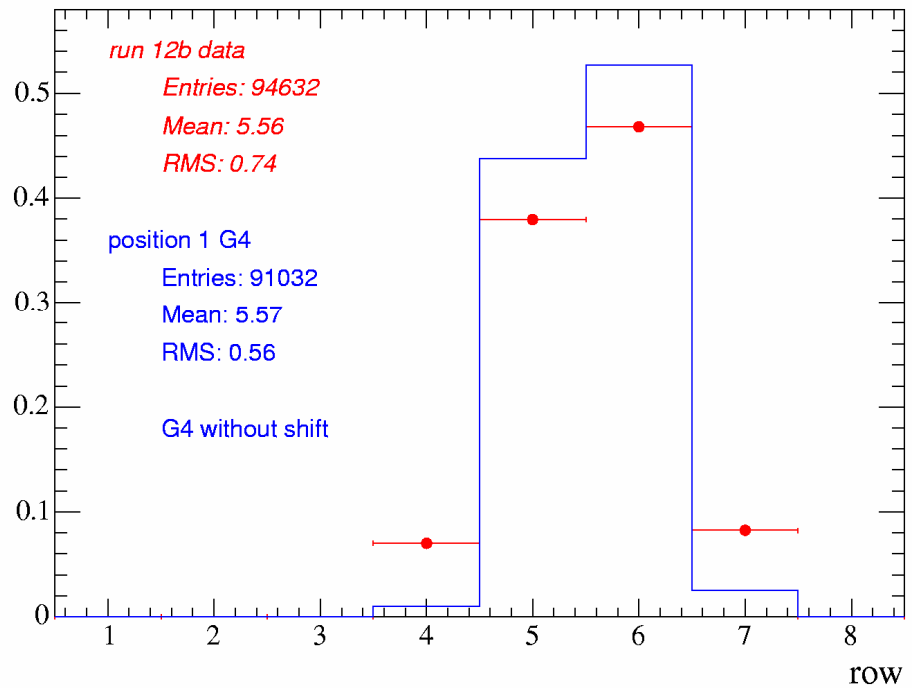
after

row {slot>0&&status==7&&status==7&&slot==2}

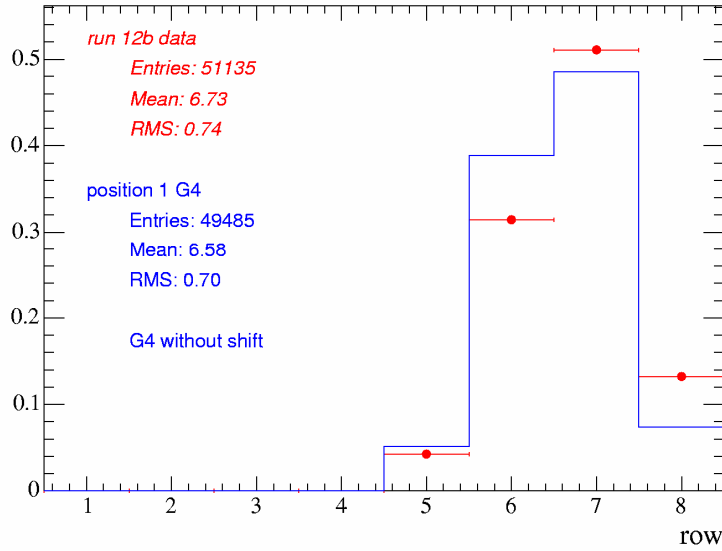


slot 5 does not need a shift.

row {slot>0&&status==7&&status==7&&slot==5}



row {slot>0&&status==7&&status==7&&slot==6}



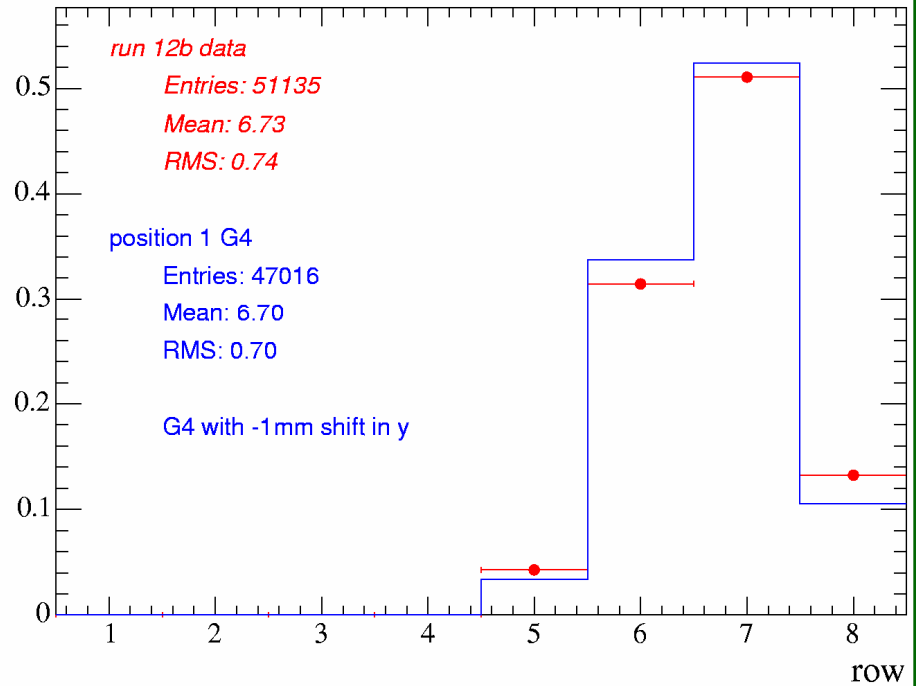
before



y shift by -1mm

slot 6 improvement

row {slot>0&&status==7&&status==7&&slot==6}



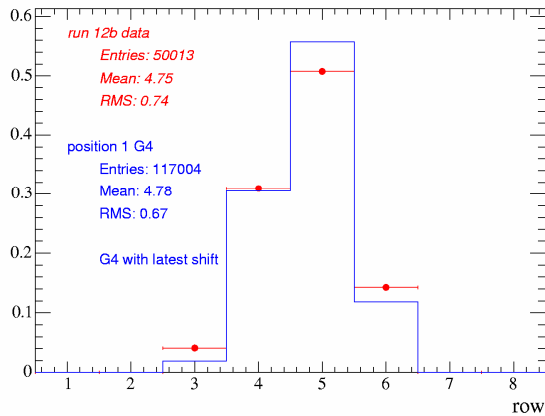
after

occupancy as function of row for selected events in each slot **after the shifts**

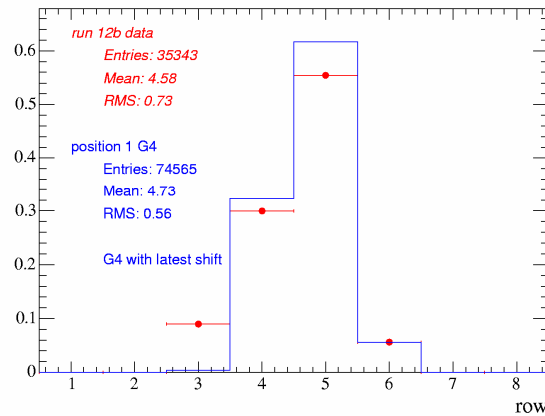
needed to shift G4 up for slot 2/3 and down for slot 6 – similar to “rotation” but simpler

next step: same study for 2006 detector geometry.

row {slot>0&&status==7&&status==7&&slot==2}



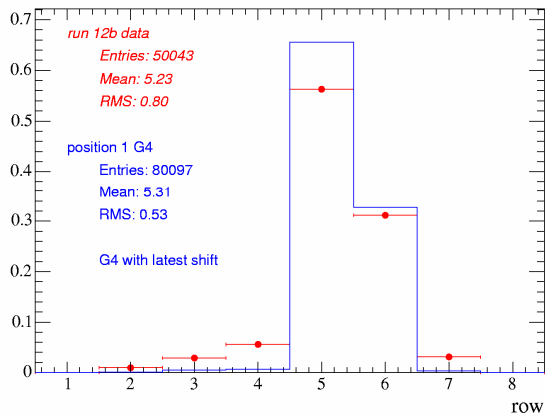
row {slot>0&&status==7&&status==7&&slot==3}



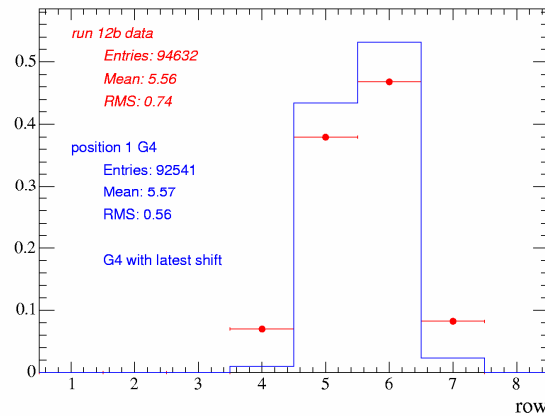
*Final shifts for 2005:*

- slot 2: **+3.0mm**
- slot 3: **+2.1mm**
- slot 4: **-0.1mm**
- slot 5: **0.0mm**
- slot 6: **-1.1mm**

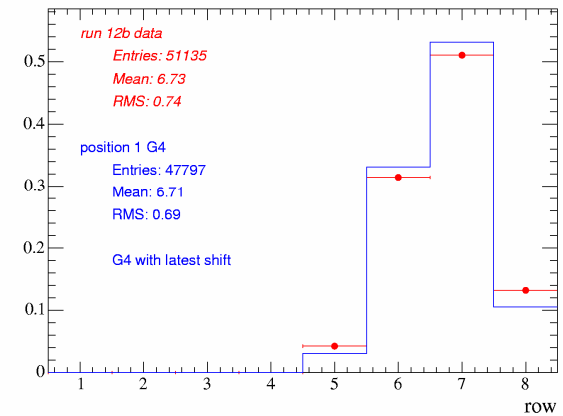
row {slot>0&&status==7&&status==7&&slot==4}



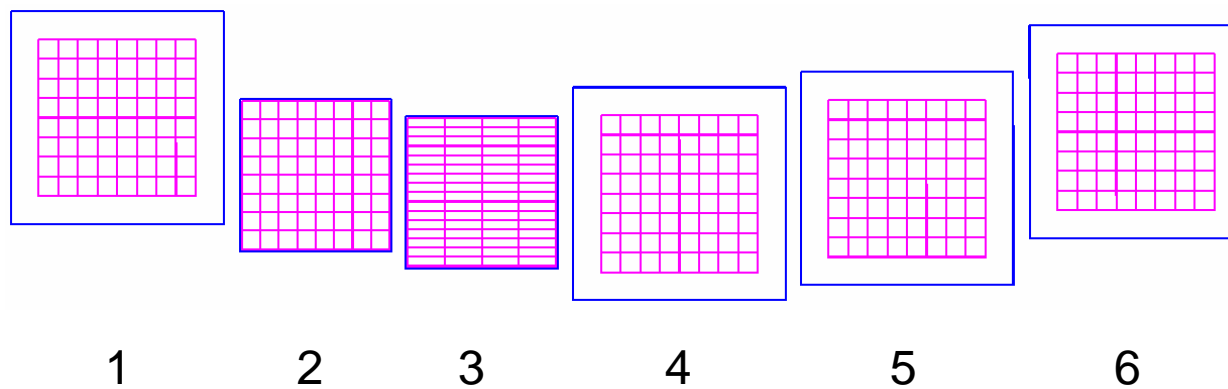
row {slot>0&&status==7&&status==7&&slot==5}



row {slot>0&&status==7&&status==7&&slot==6}







PMT layout for Aug 19, 2006 G4 fixed lambda run with 2006 conditions

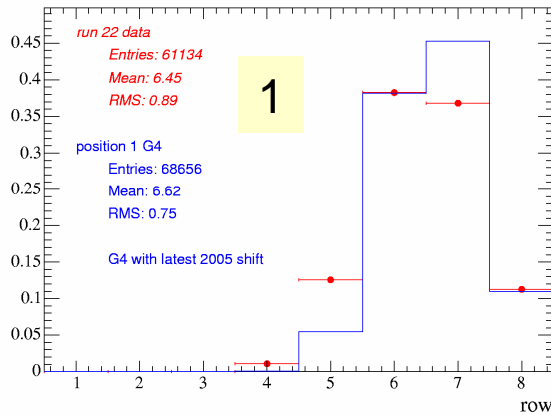
# Ran G4 with 2006 detector arrangement using shifts determined from 2005 data

Compare 50k G4 events to 52k good events from run 22 (position 1)

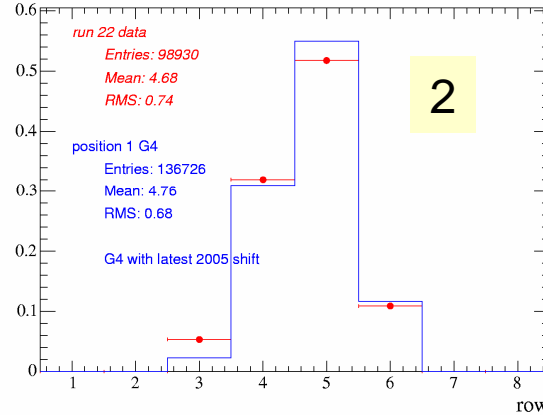
data: red points  
G4: blue histo

pretty good agreement, some fine tuning needed

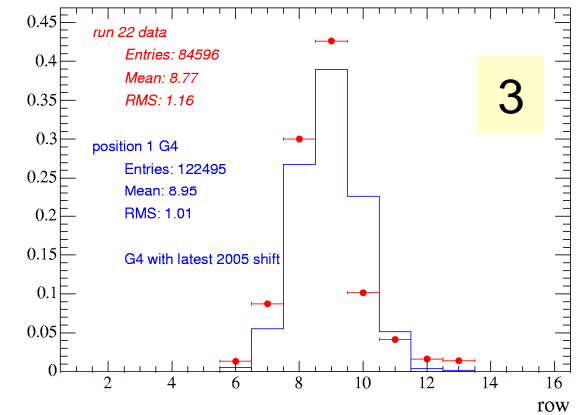
row {slot>0&&status==7&&status==7&&slot==1}



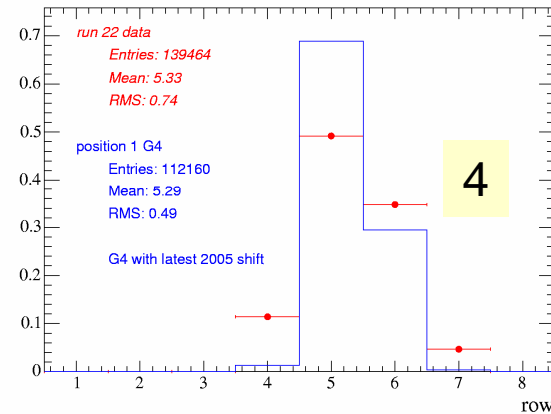
row {slot>0&&status==7&&status==7&&slot==2}



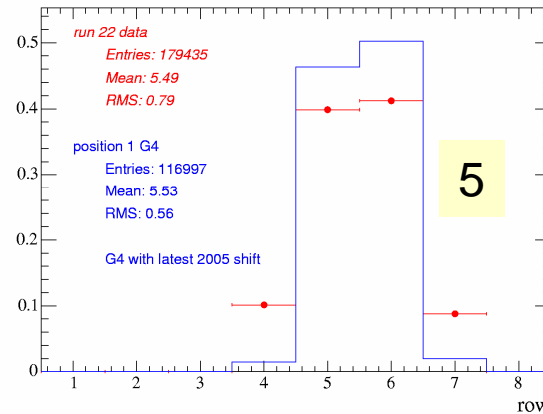
row {slot>0&&status==7&&status==7&&slot==3}



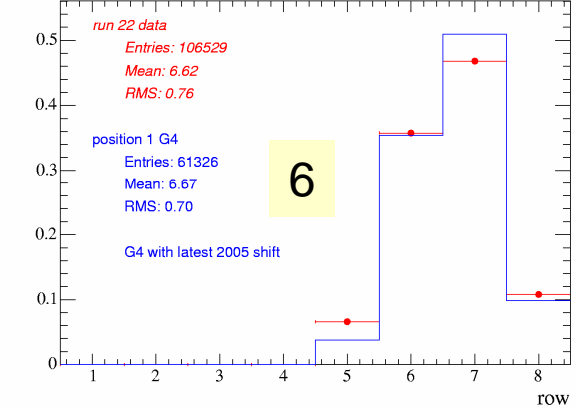
row {slot>0&&status==7&&status==7&&slot==4}



row {slot>0&&status==7&&status==7&&slot==5}

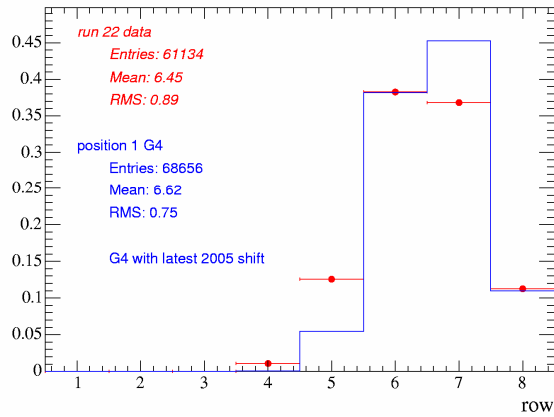


row {slot>0&&status==7&&status==7&&slot==6}

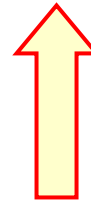


generated 50k G4 events each with 1mm shifts between -5mm and +10mm

row {slot>0&&status==7&&status==7&&slot==1}



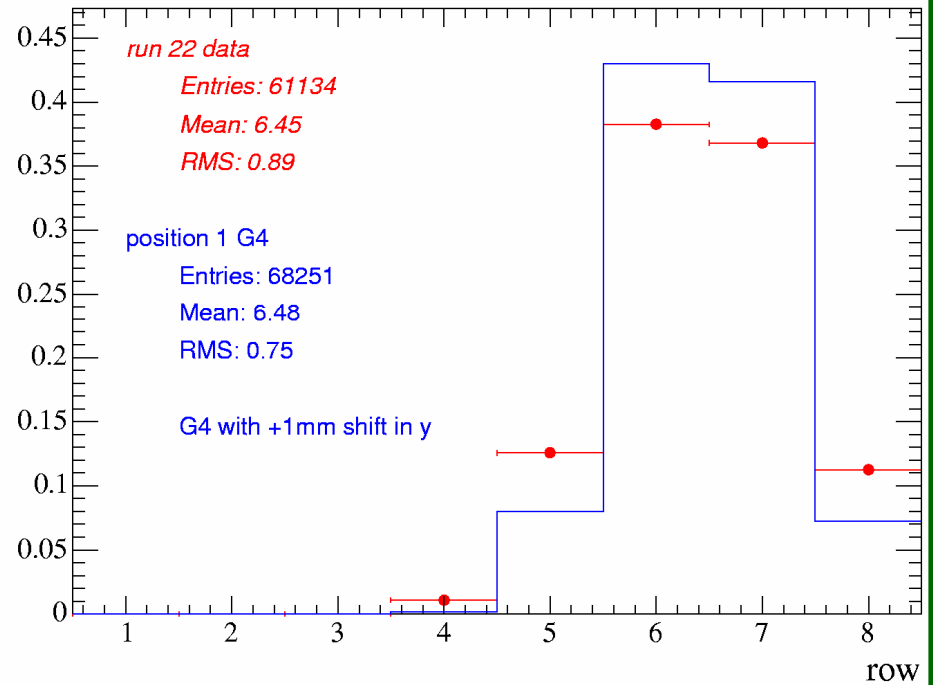
before



y shift by +1mm

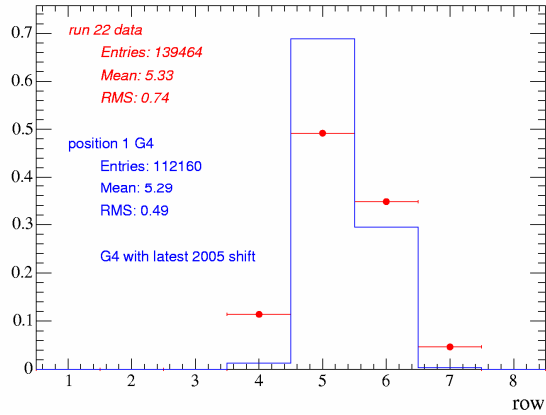
slot 1 improvement

row {slot>0&&status==7&&status==7&&slot==1}

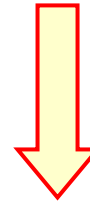


after

row {slot>0&&status==7&&status==7&&slot==4}



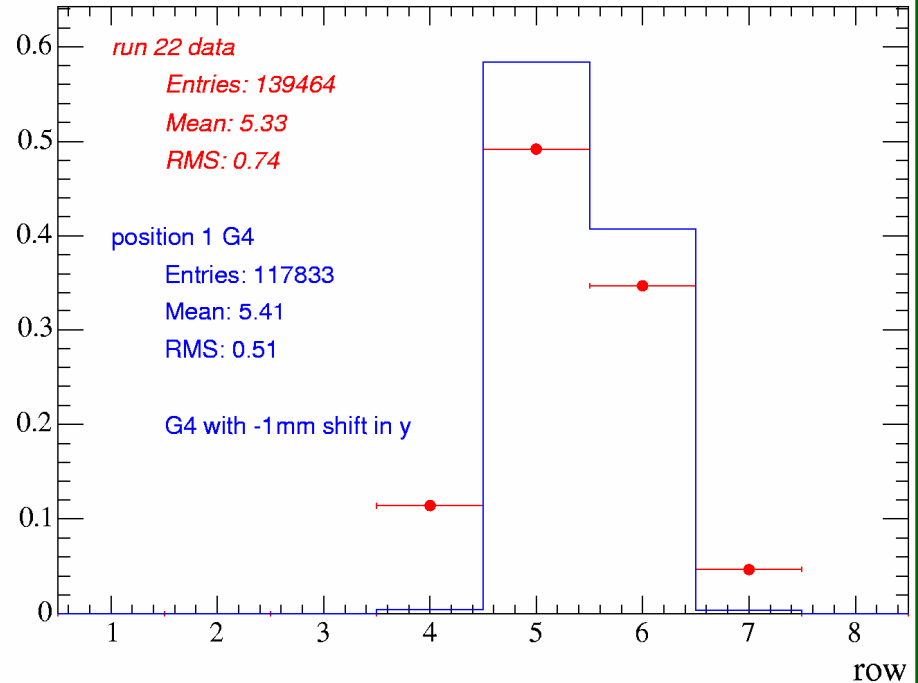
before



y shift by -1mm

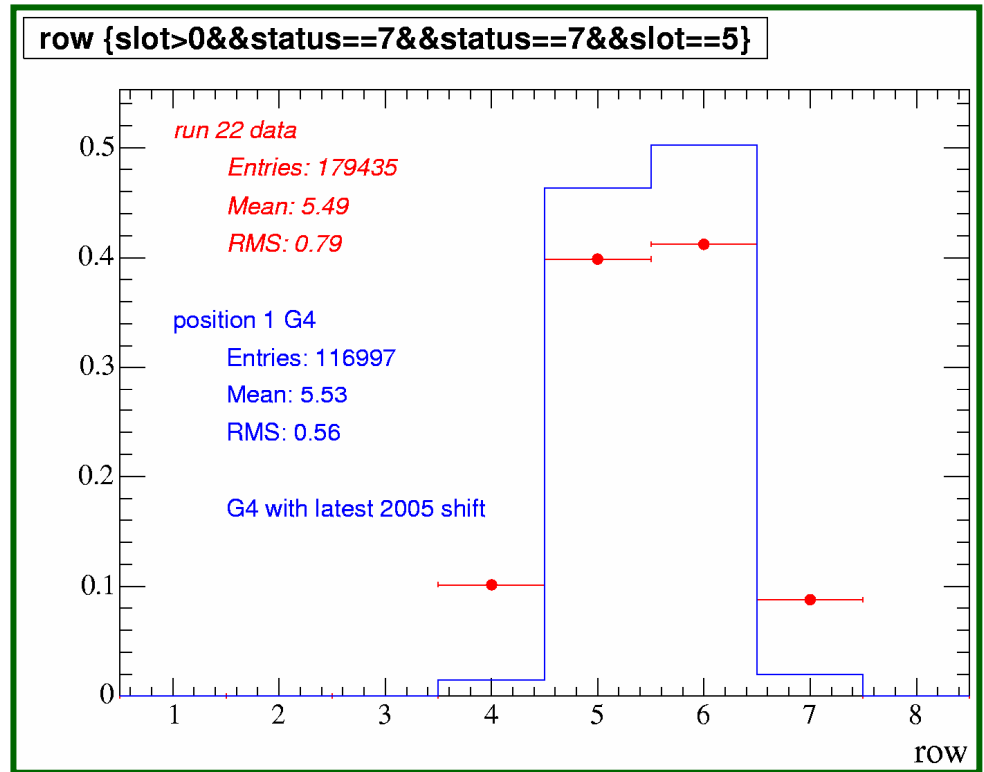
slot 4 improvement

row {slot>0&&status==7&&status==7&&slot==4}



after

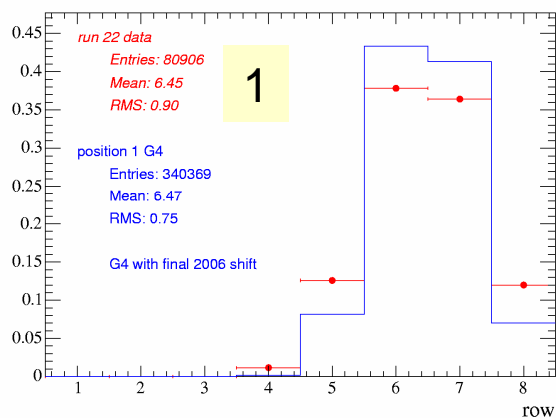
slot 5 does not need a shift.



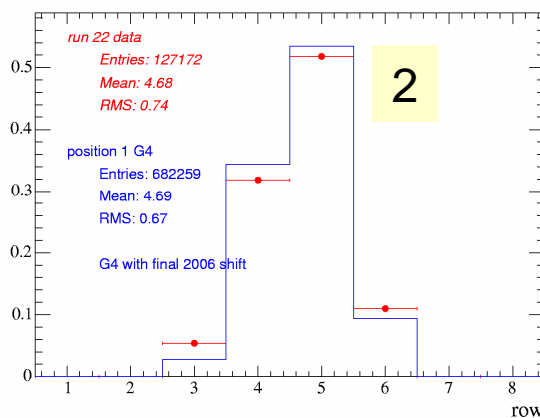
After the 2005 shift optimization  
all slots were within 1mm in 2006.

Final shifts for 2006:  
 slot 1: +1.0mm  
 slot 2: +0.4mm  
 slot 3: +0.1mm  
 slot 4: -1.0mm  
 slot 5: 0mm  
 slot 6: +0.4mm

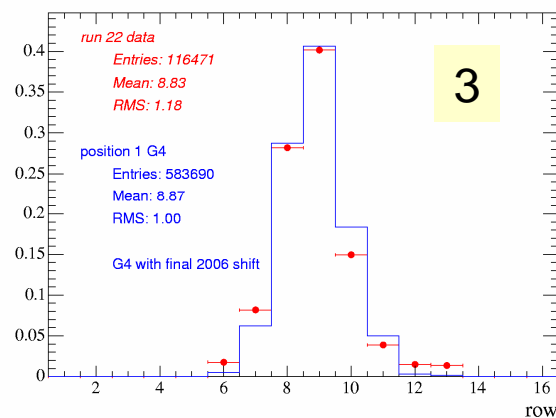
row {slot>0&&status==7&&status==7&&slot==1}



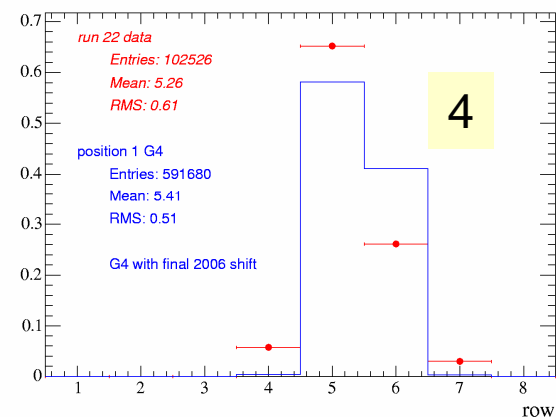
row {slot>0&&status==7&&status==7&&slot==2}



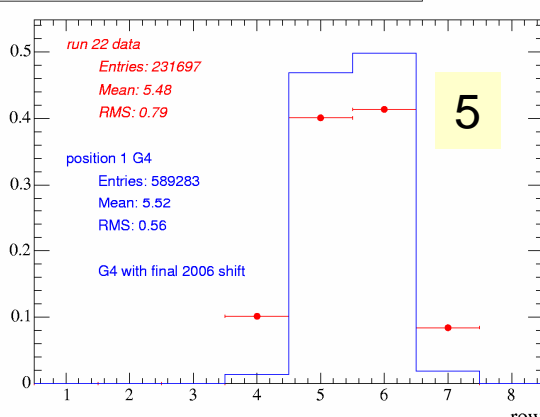
row {slot>0&&status==7&&status==7&&slot==3}



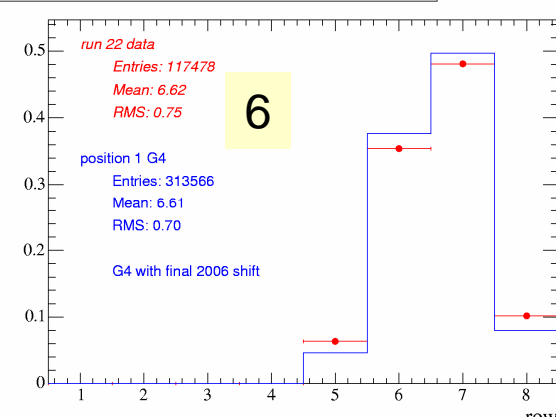
row {slot>0&&status==7&&status==7&&slot==4}



row {slot>0&&status==7&&status==7&&slot==5}



row {slot>0&&status==7&&status==7&&slot==6}



# Cherenkov ring images in good agreement after tuning of slot positions

run 22 data (2006)

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 1  
Burle 5

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 2  
Hamamatsu 4

64	48	32	16
63	47	31	15
62	46	30	14
61	45	29	13
60	44	28	12
59	43	27	11
58	42	26	10
57	41	25	9
56	40	24	8
55	39	23	7
54	38	22	6
53	37	21	5
52	36	20	4
51	35	19	3
50	34	18	2
49	33	17	1

Slot 3  
Hamamatsu 2

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 4  
Burle 4

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 5  
Burle 15

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 6  
Burle 14

Geant4

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 1  
Burle 5

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 2  
Hamamatsu 4

64	48	32	16
63	47	31	15
62	46	30	14
61	45	29	13
60	44	28	12
59	43	27	11
58	42	26	10
57	41	25	9
56	40	24	8
55	39	23	7
54	38	22	6
53	37	21	5
52	36	20	4
51	35	19	3
50	34	18	2
49	33	17	1

Slot 3  
Hamamatsu 2

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 4  
Burle 4

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 5  
Burle 15

1	2	17	18	33	34	49	50
3	4	19	20	35	36	51	52
5	6	21	22	37	38	53	54
7	8	23	24	39	40	55	56
9	10	25	26	41	42	57	58
11	12	27	28	43	44	59	60
13	14	29	30	45	46	61	62
15	16	31	32	47	48	63	64

Slot 6  
Burle 14

Next (after vacation): determine Cherenkov angles for all slots and pads, apply to data.

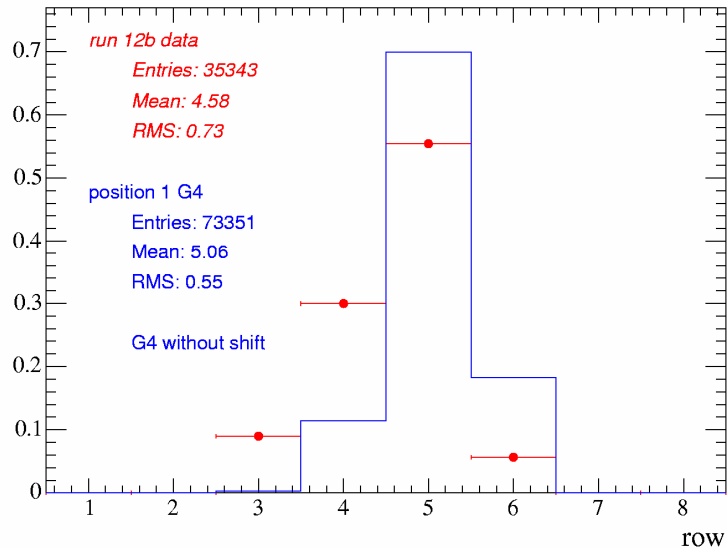
# ADDITIONAL SLIDES

(SLOTS SKIPPED PREVIOUSLY)



row {slot>0&&status==7&&status==7&&slot==3}

2005 geometry



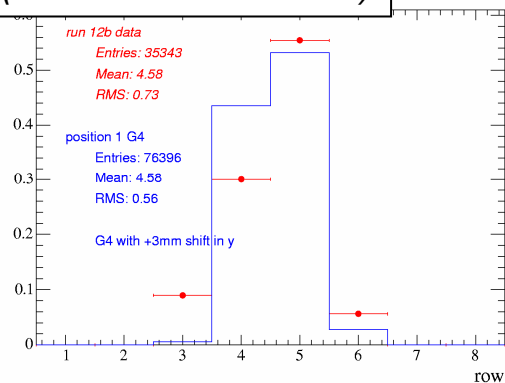
before



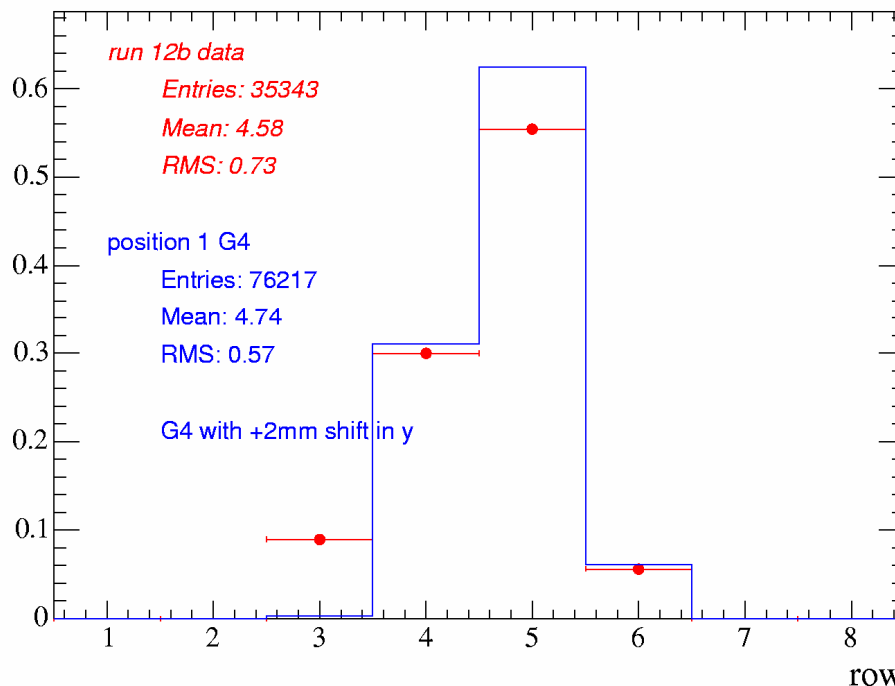
y shift by +2mm

slot 3 improvement

(+3mm shift too much)

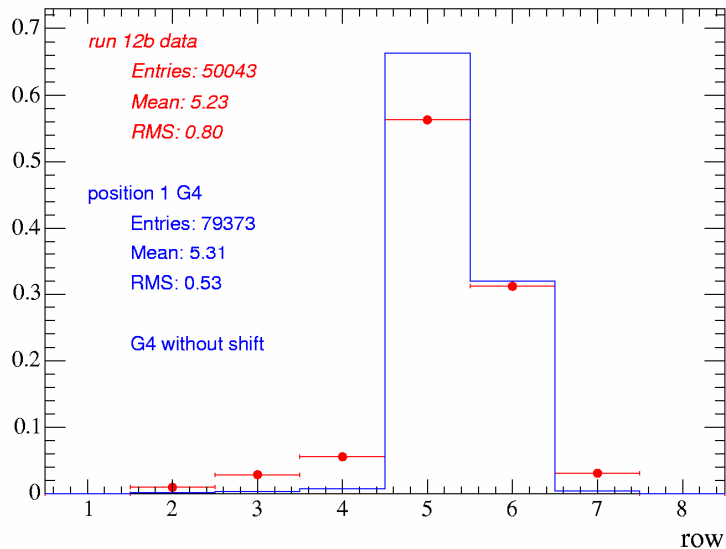


row {slot>0&&status==7&&status==7&&slot==3}



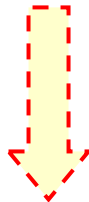
after

row {slot>0&&status==7&&status==7&&slot==4}



before

2005 geometry

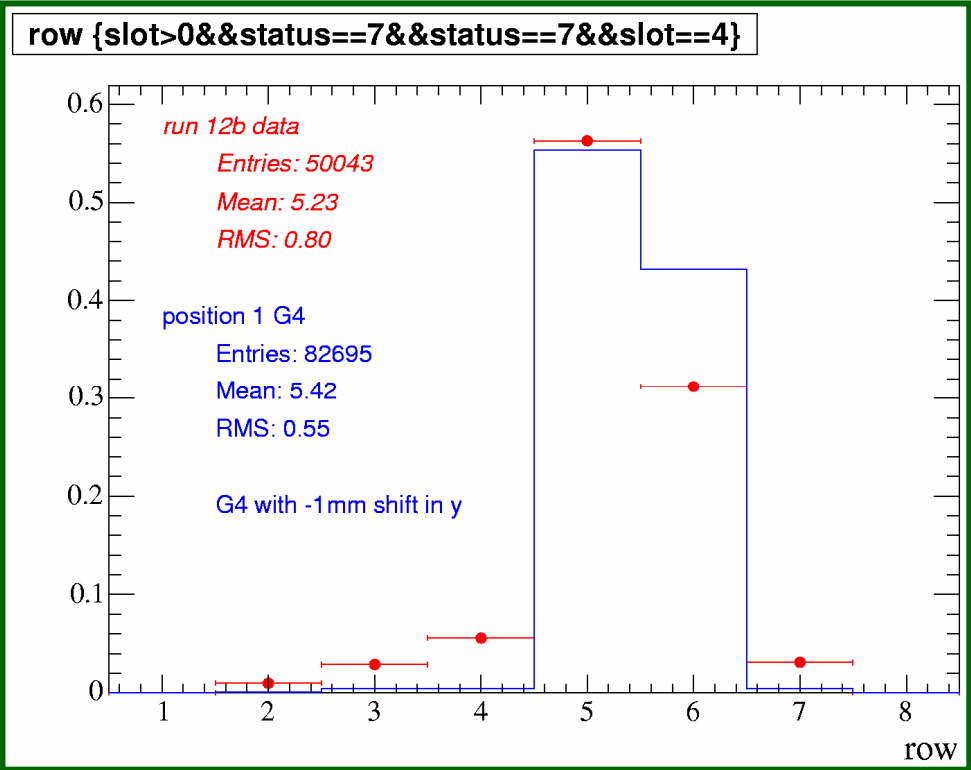


y shift by -1mm ?

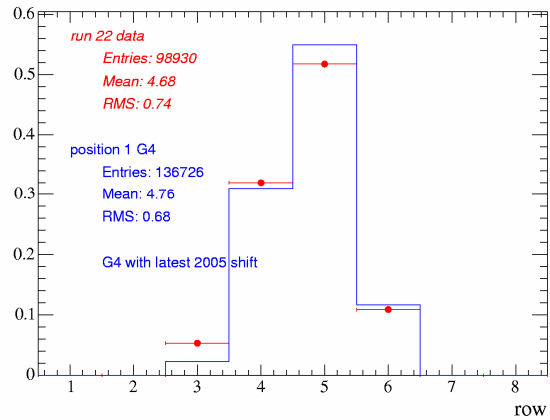
slot 4

marginal – OK without shift

after



row {slot>0&&status==7&&status==7&&slot==2}



before

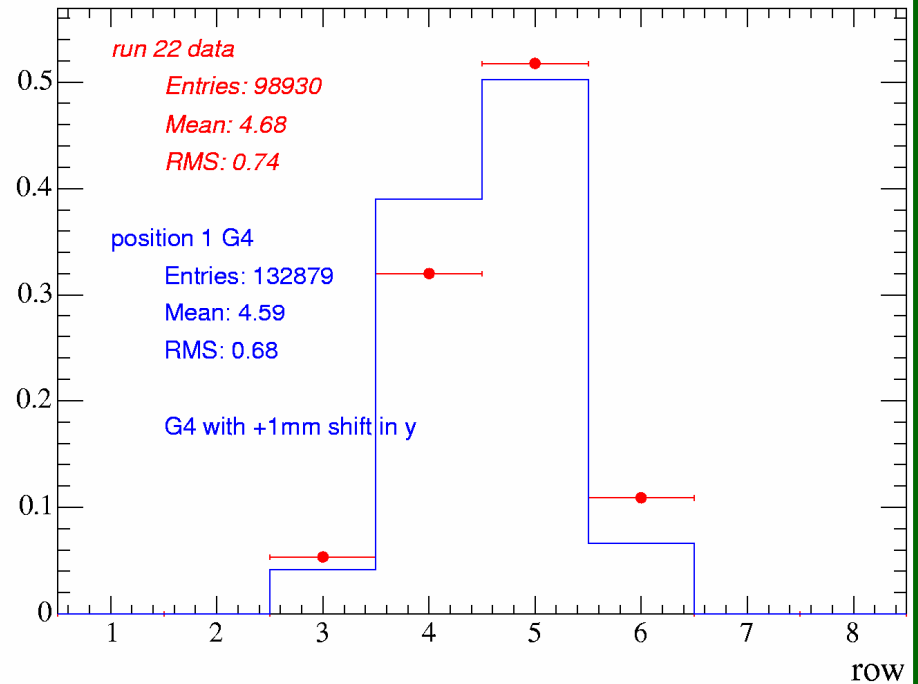


y shift by +1mm

slot 2

unshifted pretty good,  
+1mm too much

row {slot>0&&status==7&&status==7&&slot==2}

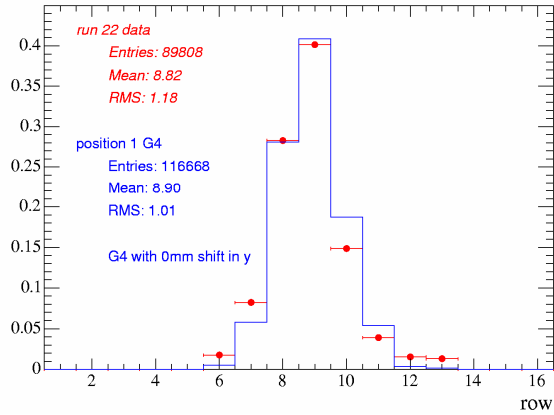


after

row {slot>0&&status==7&&status==7&&slot==3}

2006 geometry

before

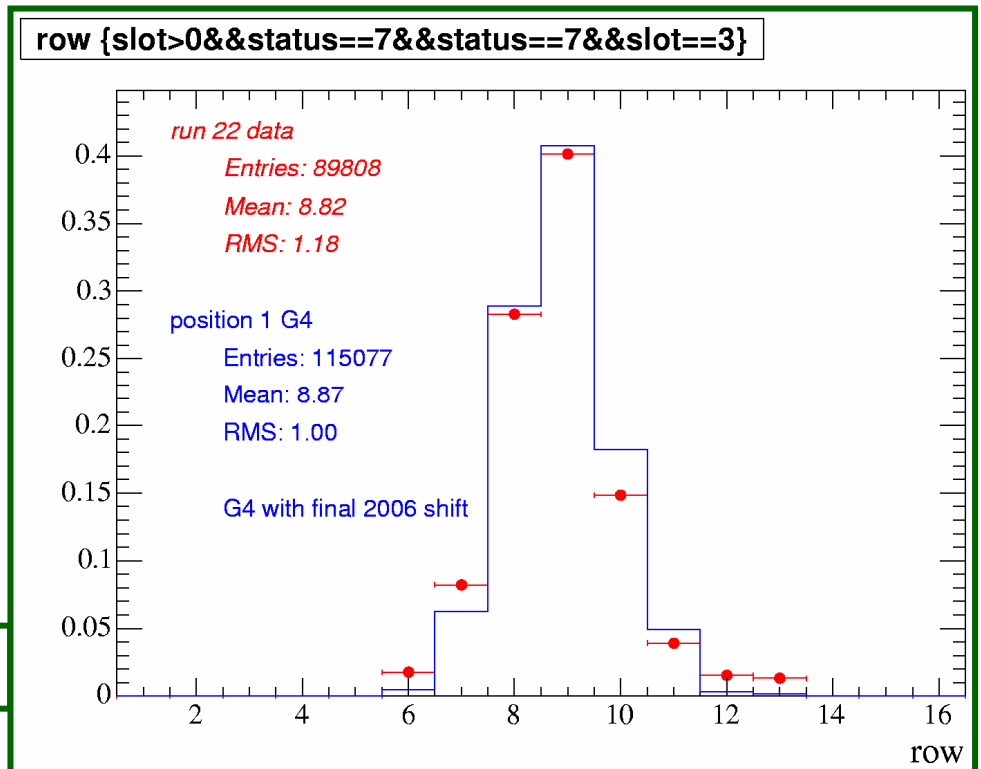


y shift by +1mm

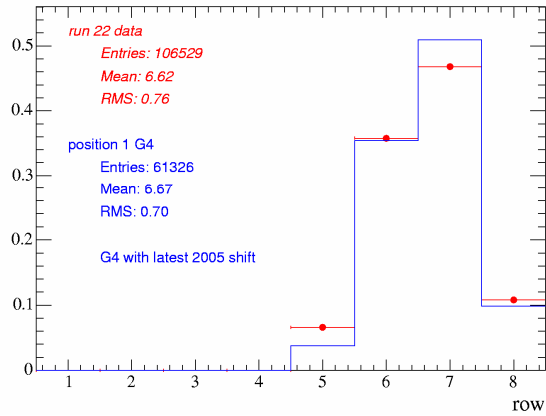
slot 3 improvement

+1mm is too much

after



row {slot>0&&status==7&&status==7&&slot==6}



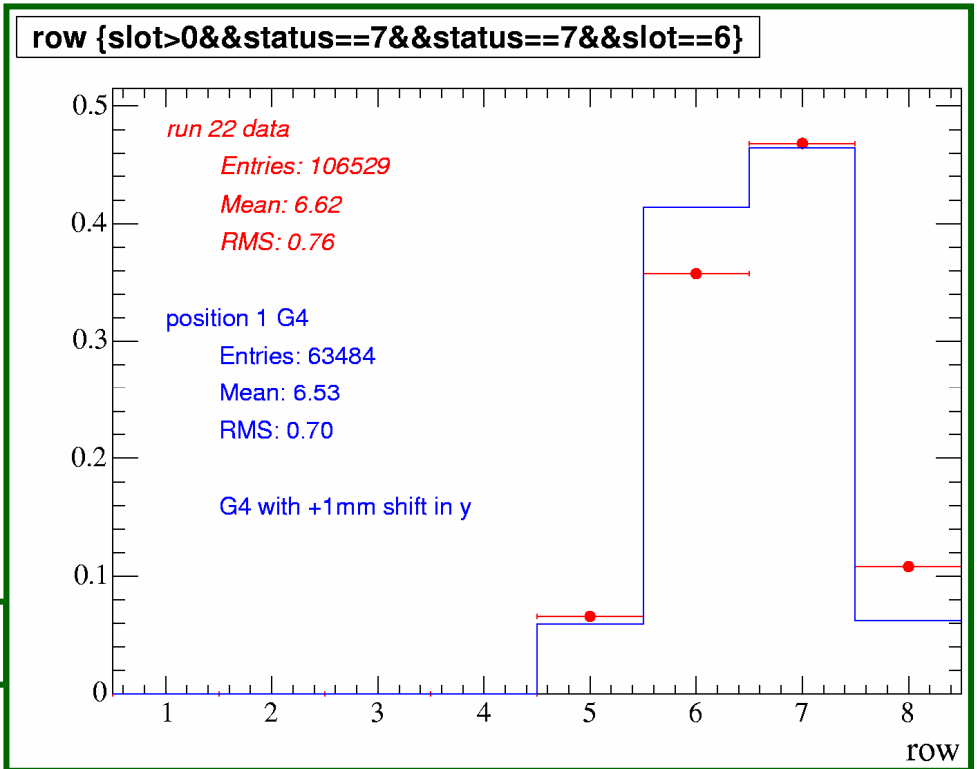
before



y shift by +1mm

slot 6 improvement

+1mm a bit much



after