

# Data analysis for the detection efficiency

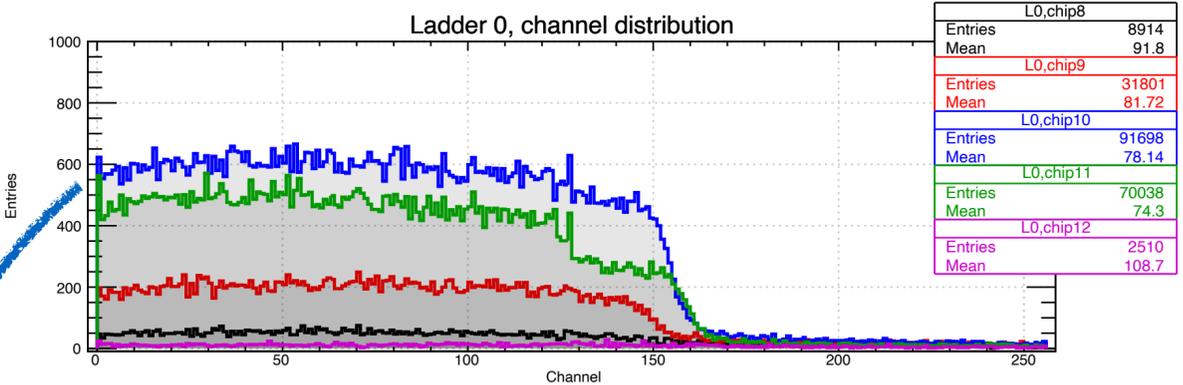
G. Nukazuka (RBRC)

Past reports:

- I. [Jan/27/2022](#) (clone hits)
- II. [Feb/24/2022](#) (BCO grouping, clustering)
- III. [Mar/17/2022](#) (alignment)

# Homework: Beam stability

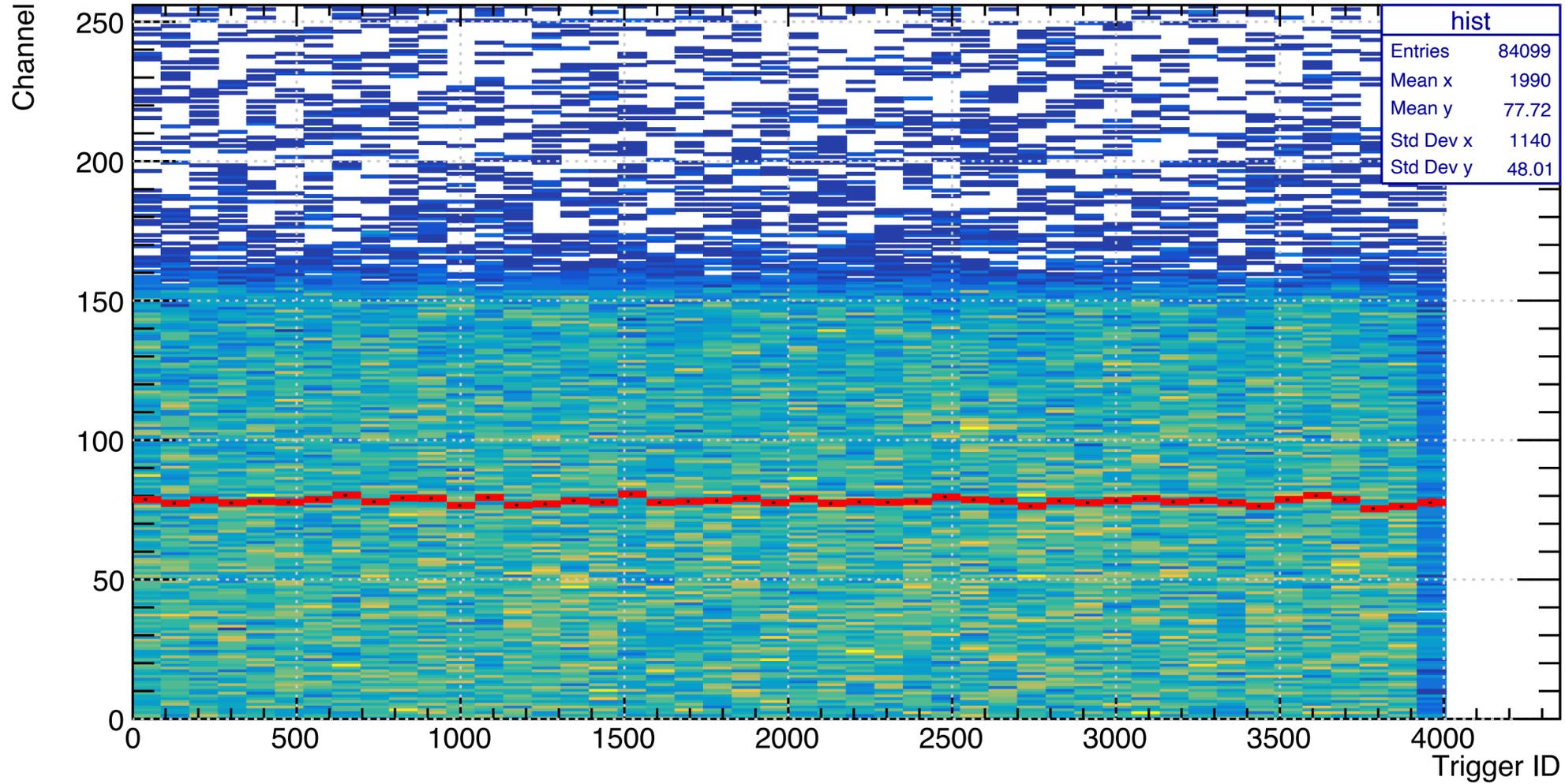
Run89, channel distributions,  
The hottest chip (chip10 for run89)  
after clustering



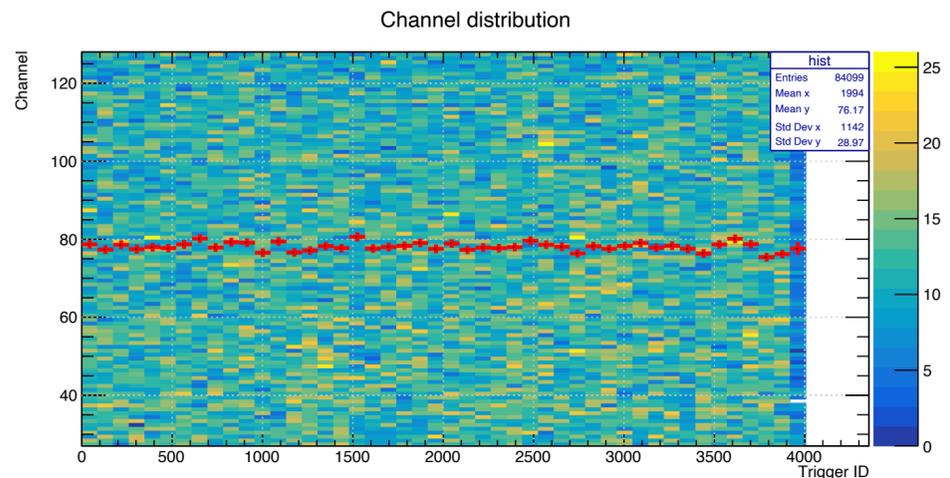
Hits only on the hottest chip of the upstream ladder (ladder0) are used.

Channel distribution

Channel of the chip column 10 (chip10&23)



x-axis: trigger ID ~ time  
since data was written to a file chronologically.

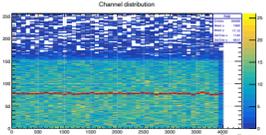
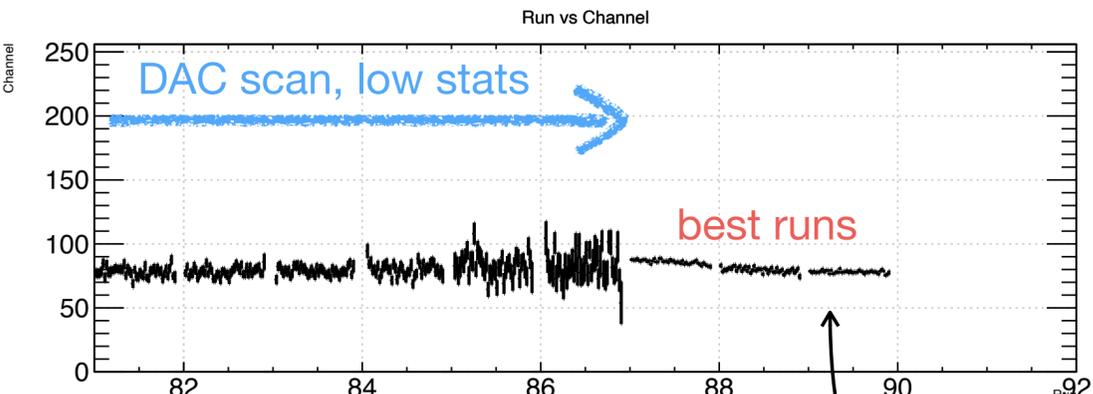
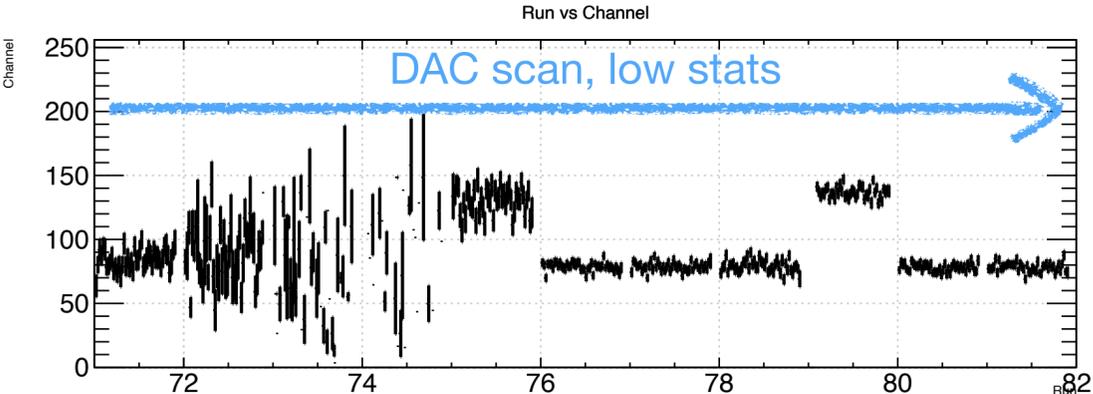
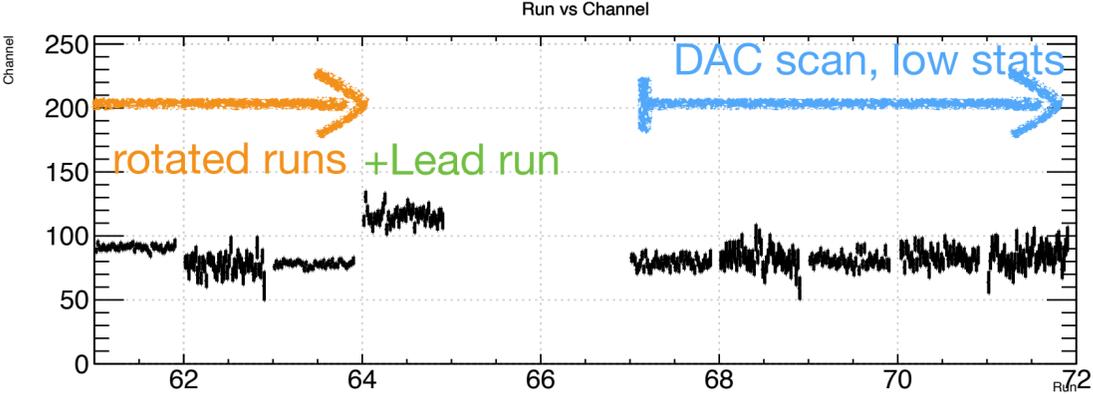
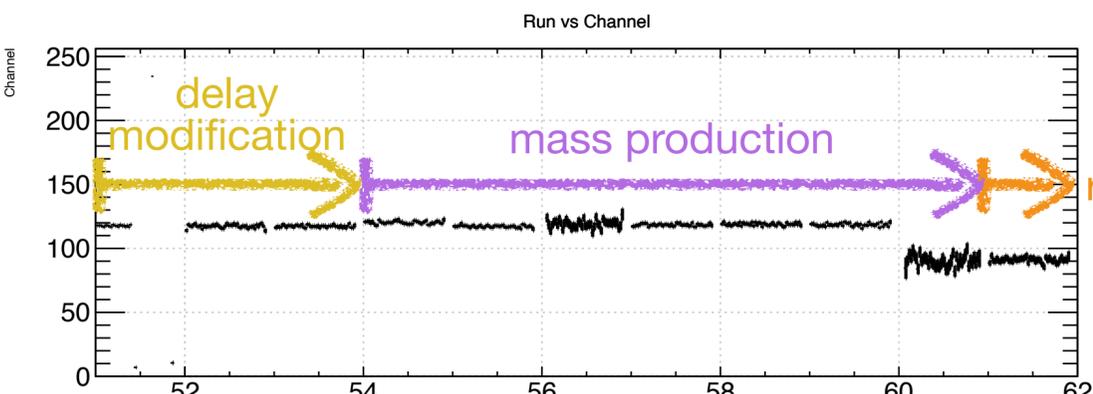
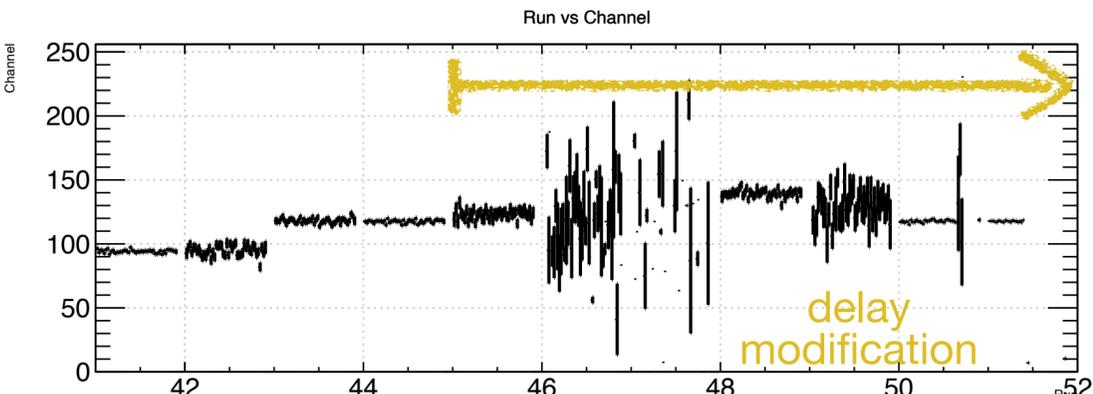
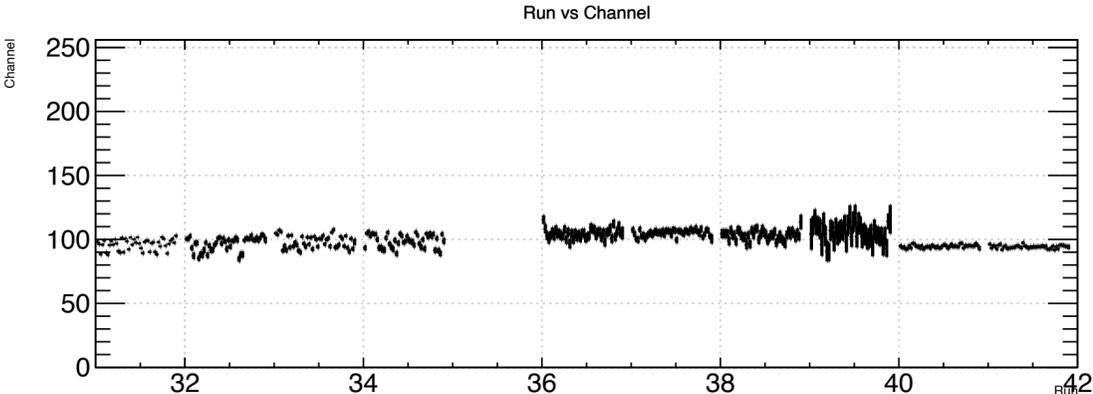
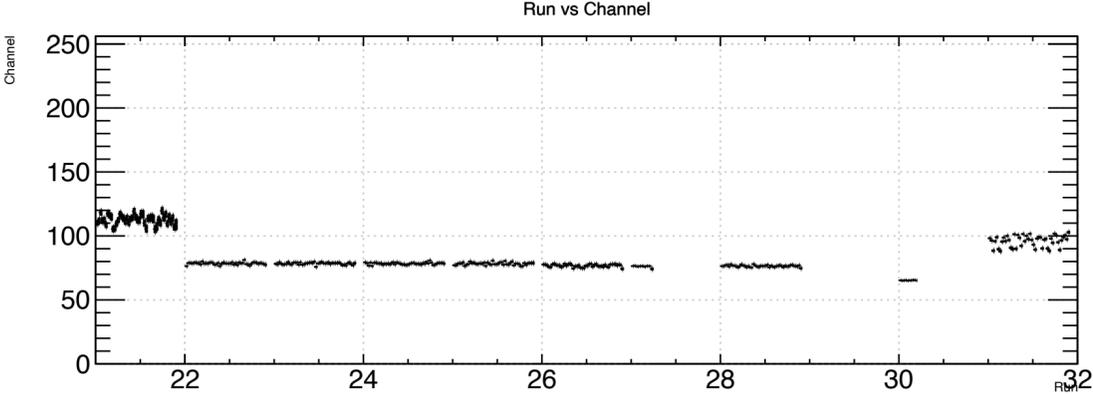


zoomed view

Time dependence of the beam profile  
in a run is negligible.

# Homework: Beam stability

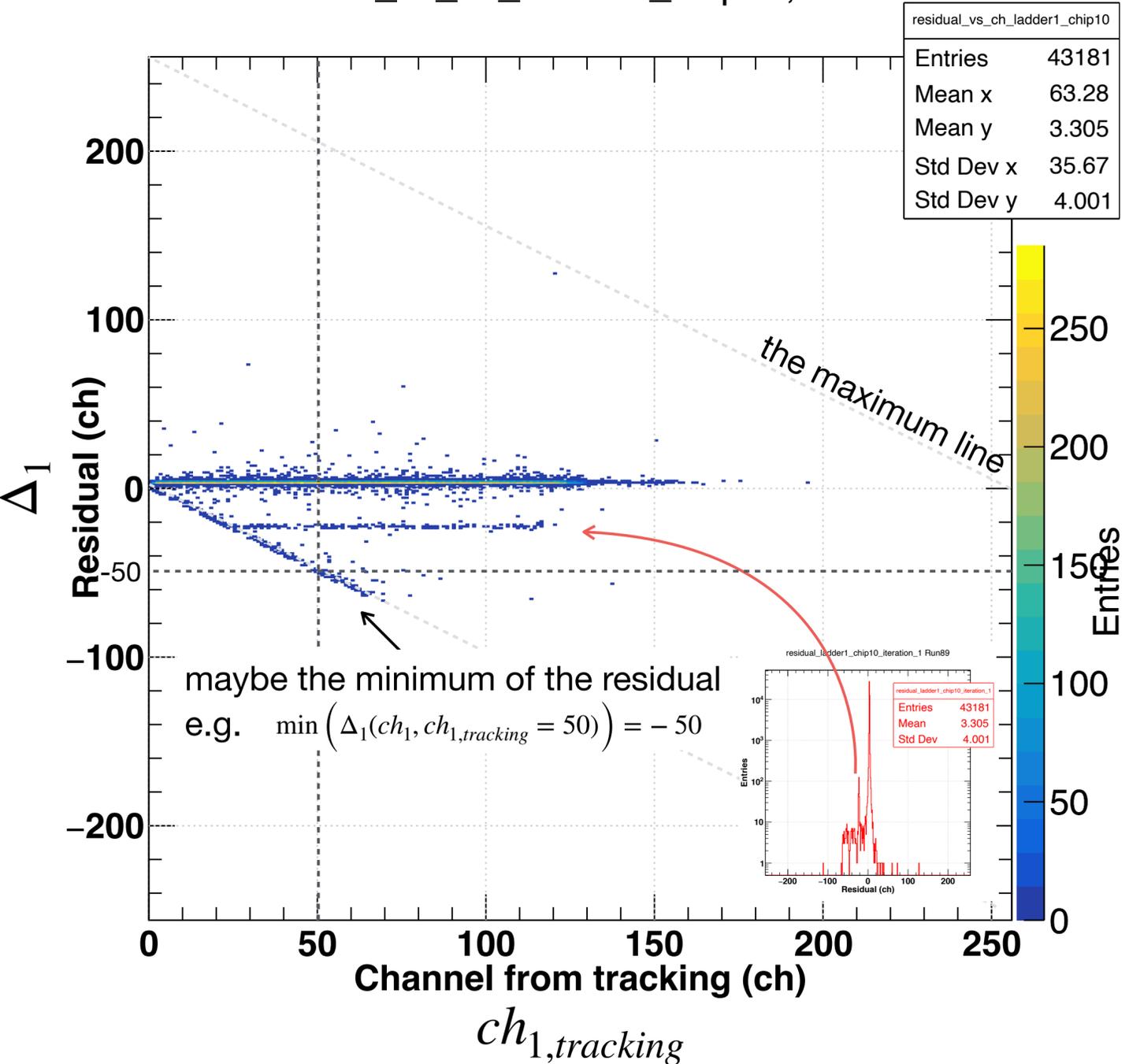
x-axis: #run + trigger ID  
y-axis: channel dists. of  
the hottest chip column



Channel distribution was affected  
by our activity.  
The beam was more or less stable.

# Homework: Can I remove the lines ?

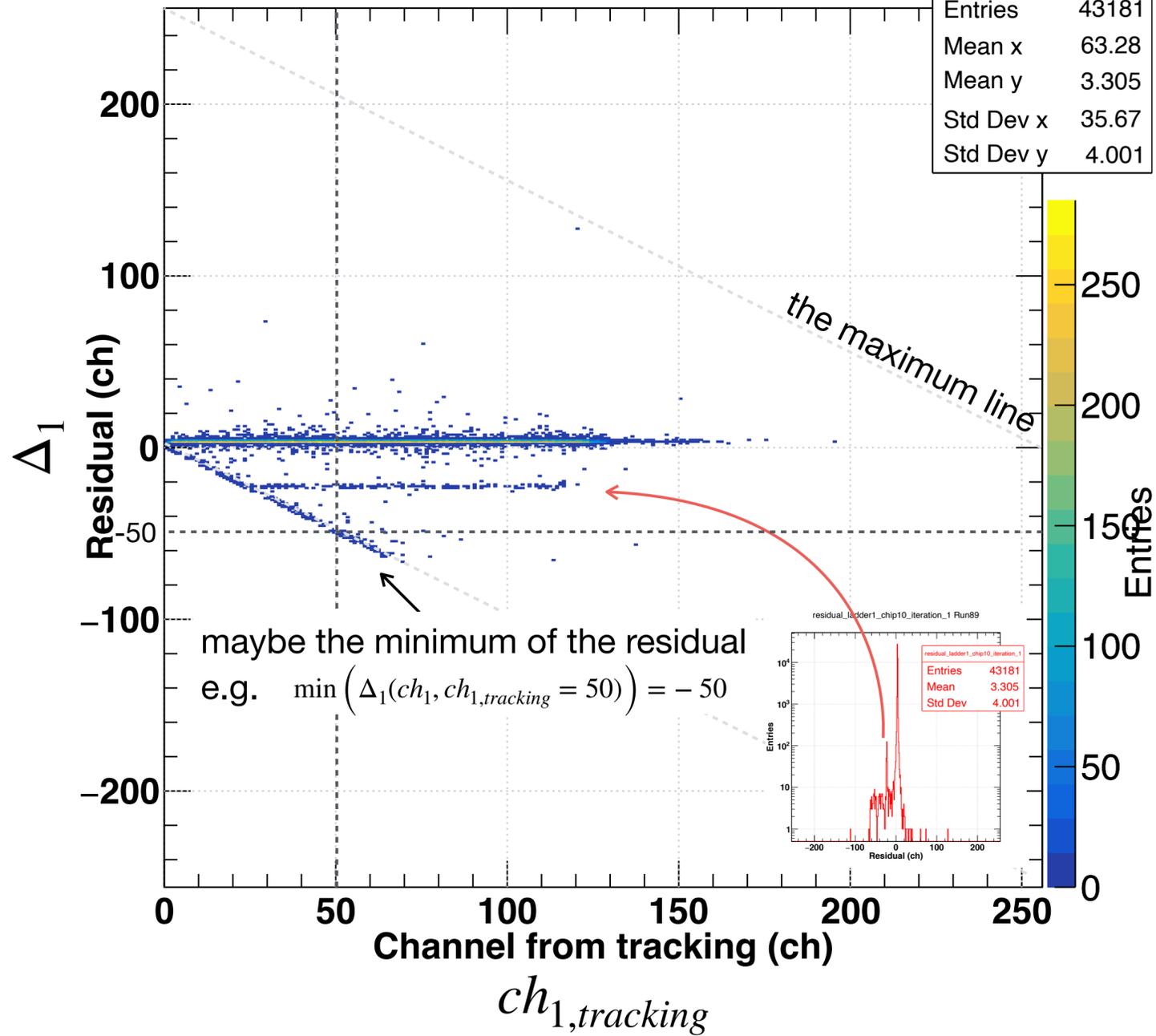
residual\_vs\_ch\_ladder1\_chip10, Run89



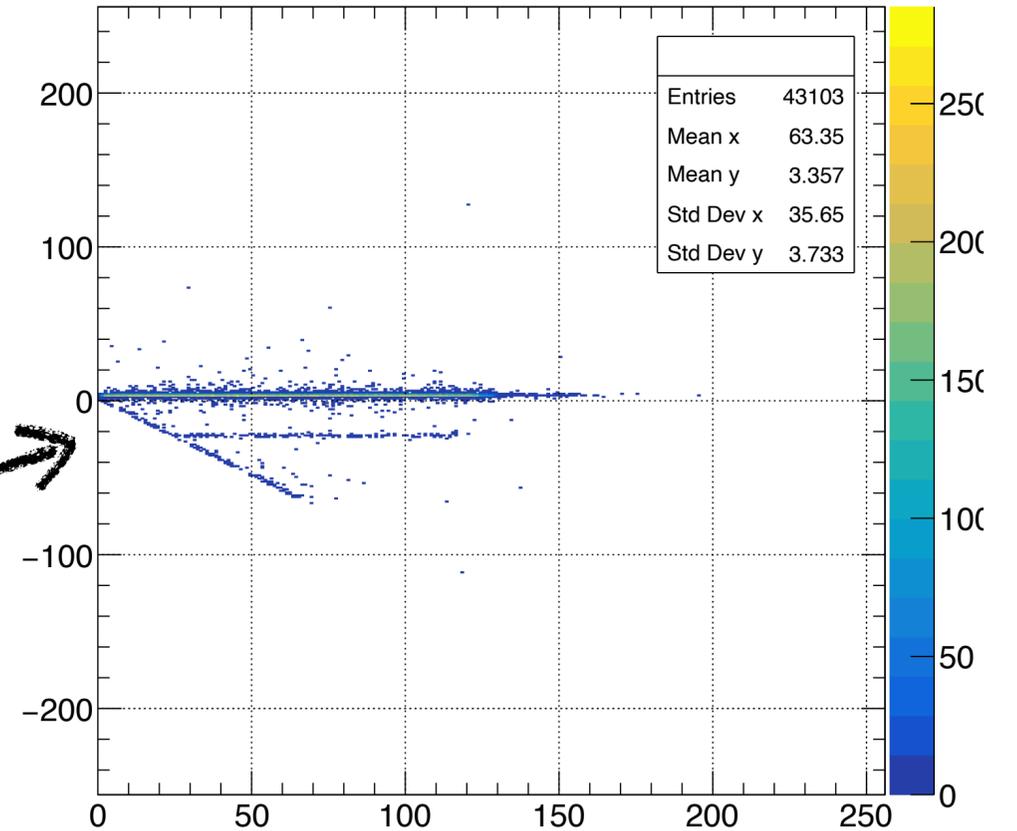
# Homework: Can I remove the lines ?

residual\_vs\_ch\_ladder1\_chip10, Run89

residual_vs_ch_ladder1_chip10	
Entries	43181
Mean x	63.28
Mean y	3.305
Std Dev x	35.67
Std Dev y	4.001



masking  $ch_0$  of the ladder1  
 ( $1 \leq ch_1$ )

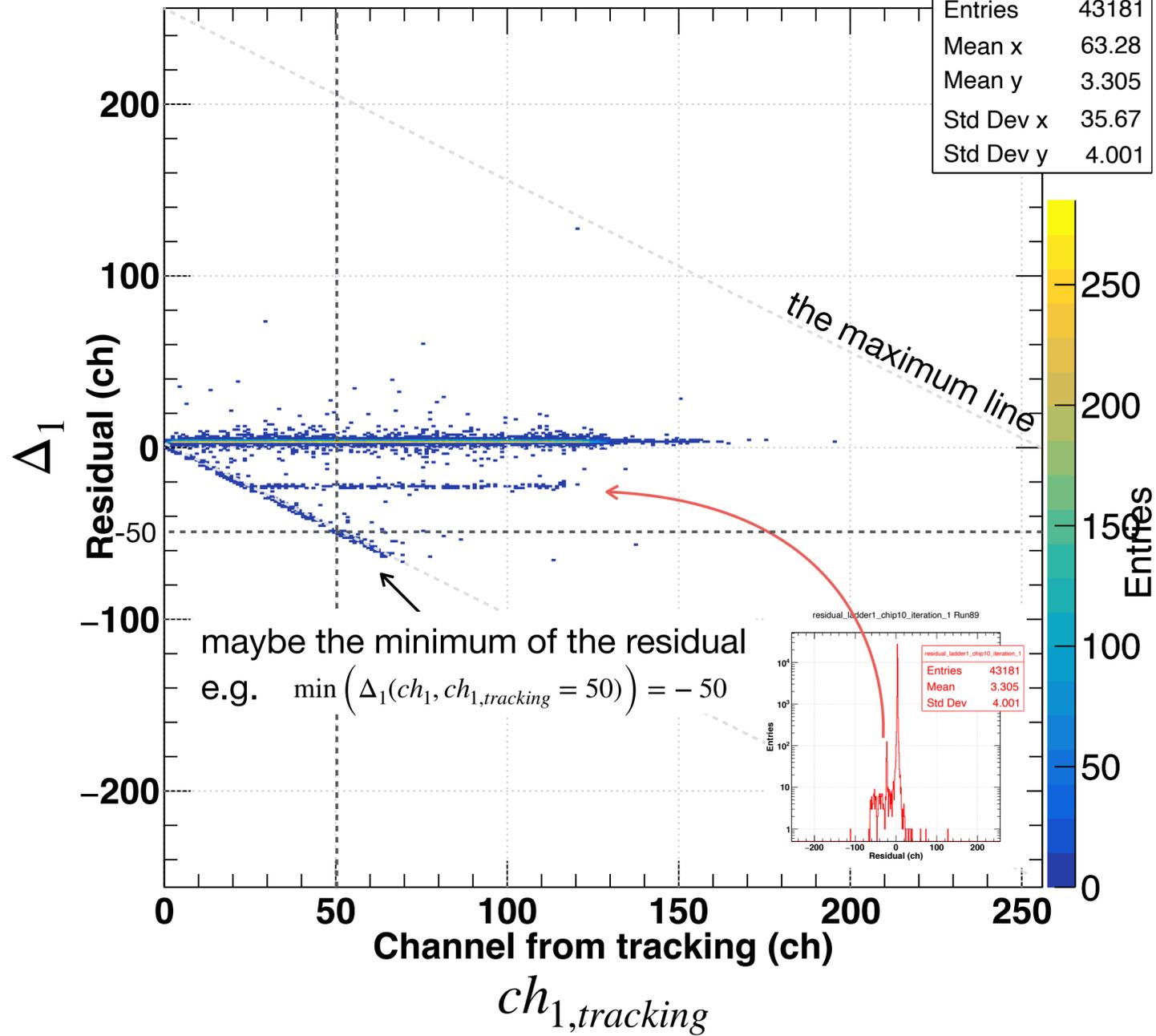


The minimum line gets slightly narrower but exists clearly.

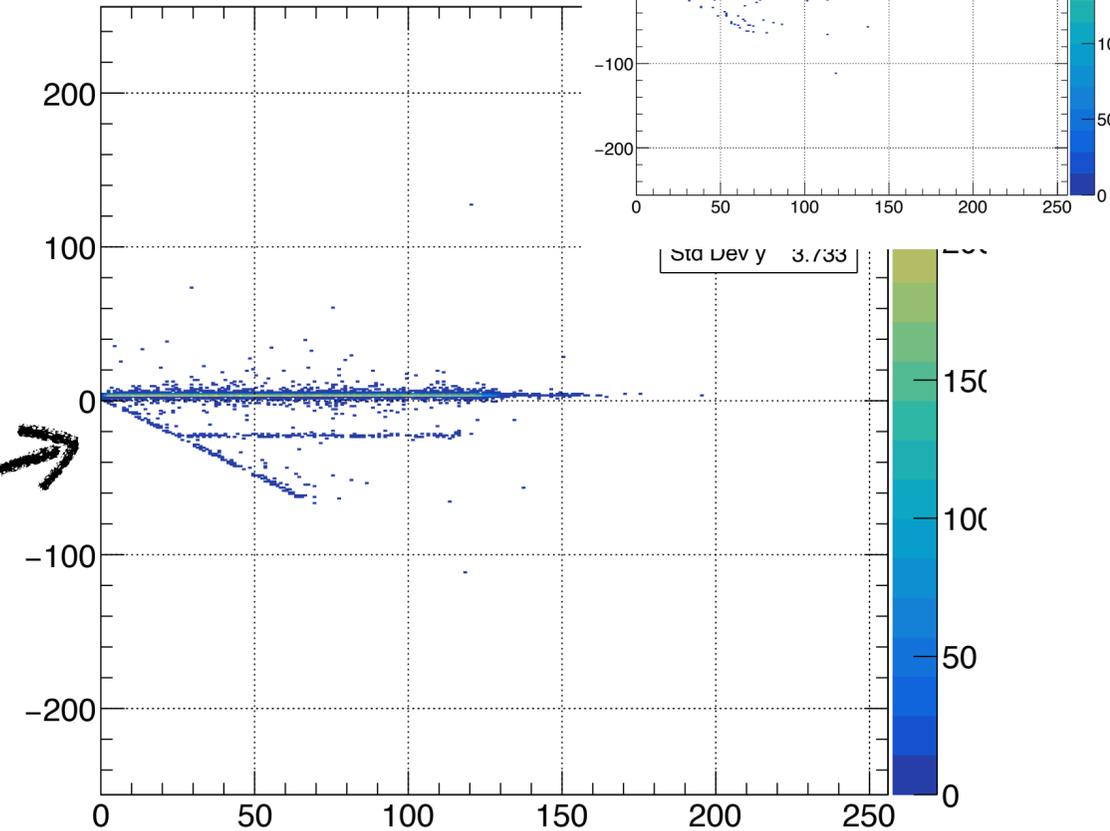
# Homework: Can I remove the lines ?

residual\_vs\_ch\_ladder1\_chip10, Run89

residual_vs_ch_ladder1_chip10	
Entries	43181
Mean x	63.28
Mean y	3.305
Std Dev x	35.67
Std Dev y	4.001



masking ch0 of the ladder1  
( $1 \leq ch_1$ )

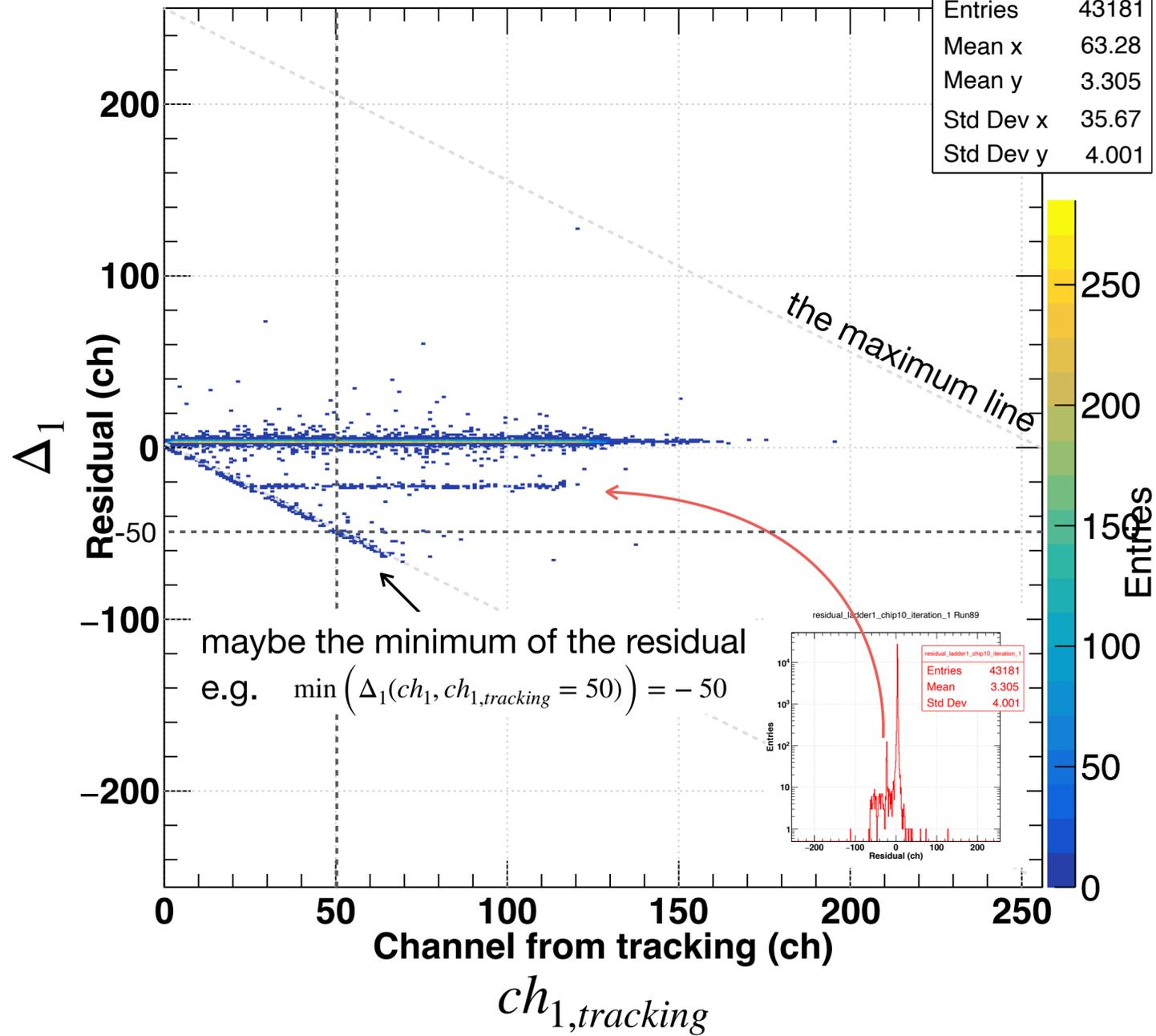


The minimum line gets slightly narrower but exists clearly.

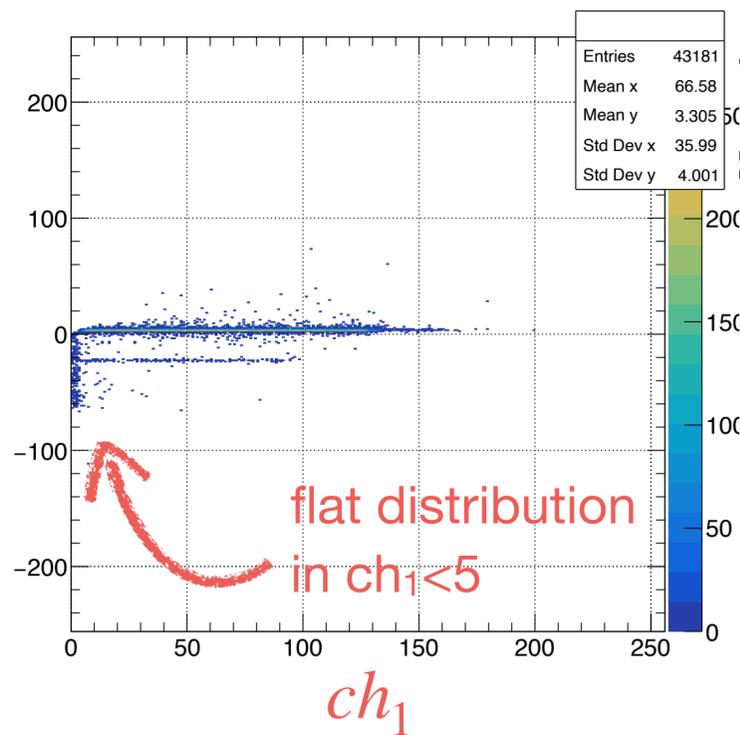
# Homework: Can I remove the lines ?

residual\_vs\_ch\_ladder1\_chip10, Run89

residual_vs_ch_ladder1_chip10	
Entries	43181
Mean x	63.28
Mean y	3.305
Std Dev x	35.67
Std Dev y	4.001

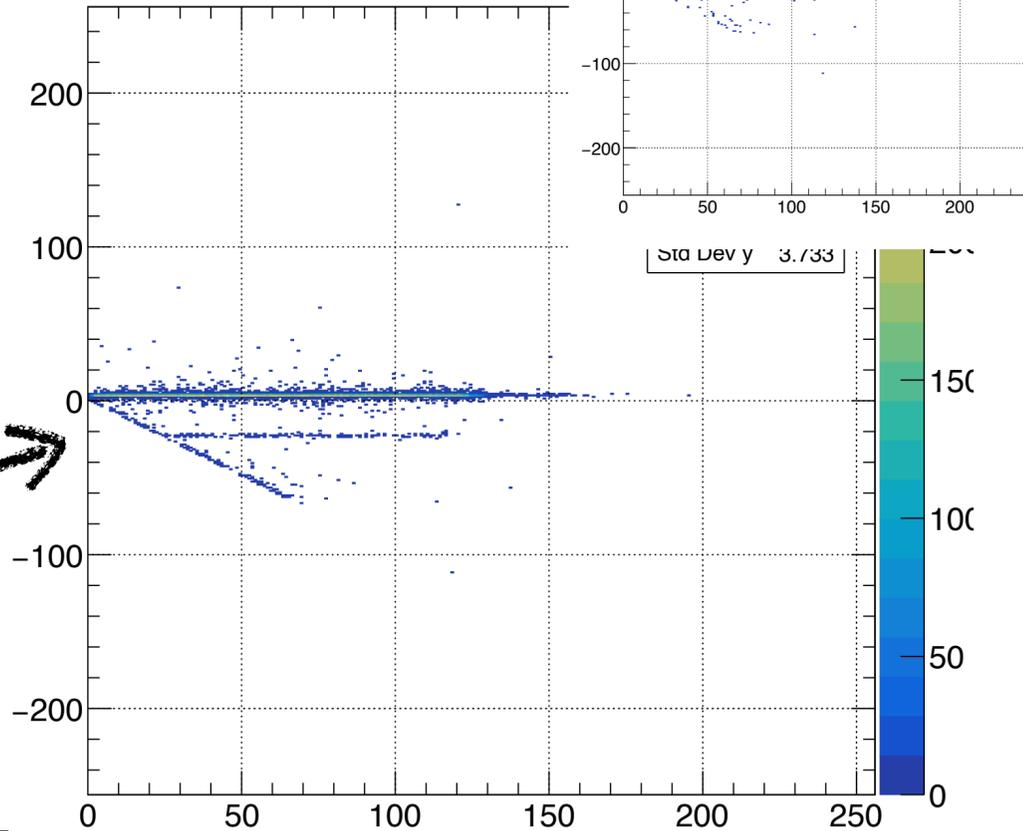
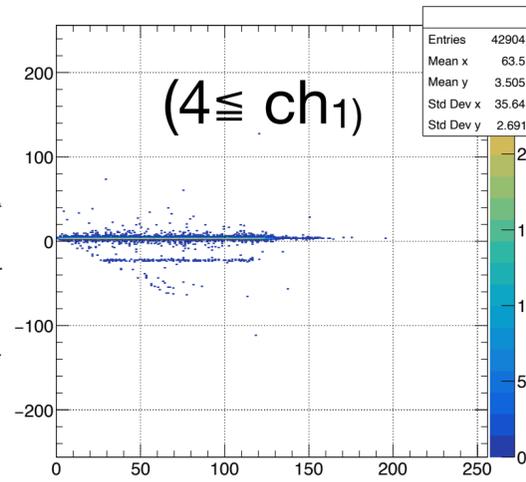


masking  $ch_0$  of the ladder1  
( $1 \leq ch_1$ )



The minimum line gets slightly narrower  
but exists clearly.

The origin of the flat distribution  
found in the residual  
distributions are not clear...





# Detection efficiency, Beam track definition

For example:

The tested ladder: ladder1 (middle)

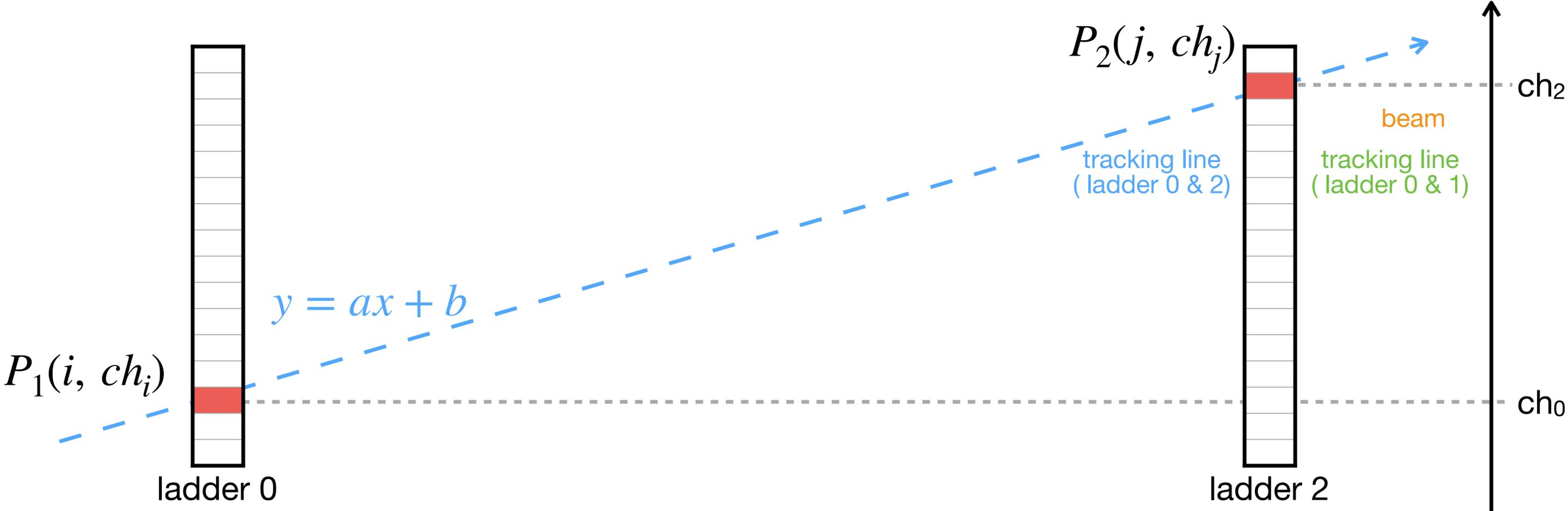
The testing ladders: ladder0 and ladder2

## Beam track definition

Data selection: The testing ladders can only have **a cluster on the testing chip column.**

More selections are possible:

- single/multiple hit cluster
- DAC value
- Hit channel(s)
- the predicted hit position
- #ADC0, 1, ... in the clusters
- the slope and/or the intercept of the beam track



# Detection efficiency, Hit search and distance to the predicted point

For example:

The tested ladder: ladder1 (middle)

The testing ladders: ladder0 and ladder2

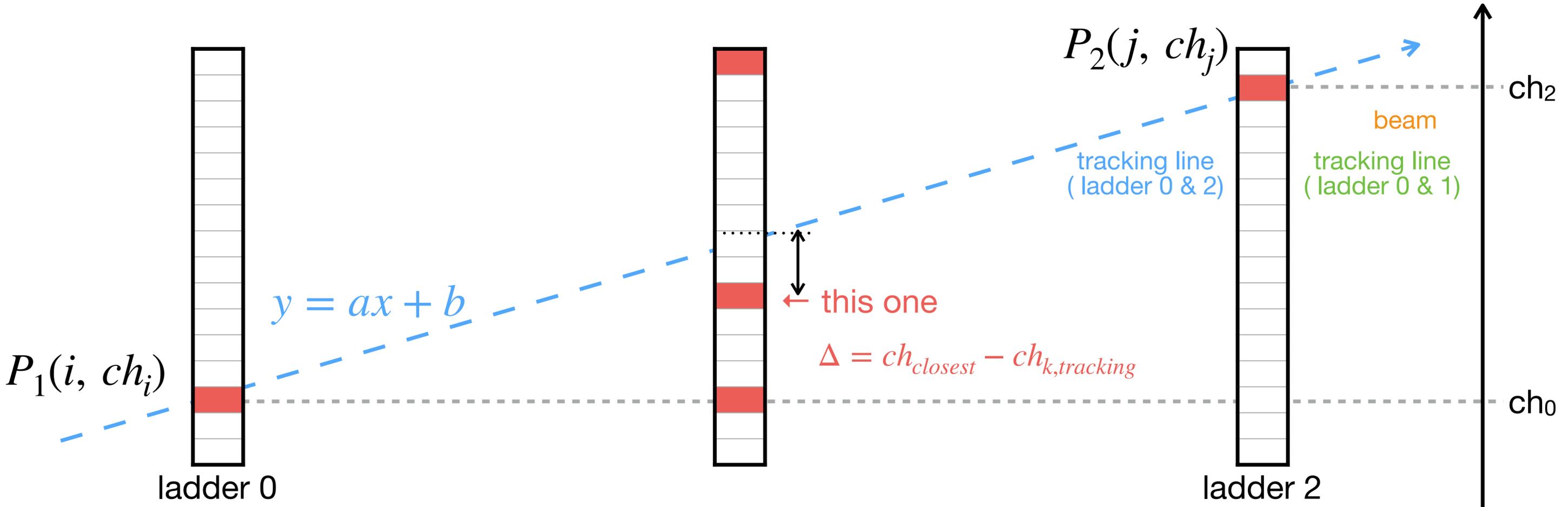
## Beam track definition

Data selection: The testing ladders can only have a **cluster on the testing chip column**.

## Hit search

Data selection: The tested ladder can only have clusters on the tested chip column otherwise this test is skipped.

The closest hit to the predicted position is hired.



# Detection efficiency, Run89 ladder1 chip10

$$\varepsilon \equiv \frac{N(h_i \cap h_j \cap h_k)}{N(h_i \cap h_j)}, (i \neq j \neq k)$$

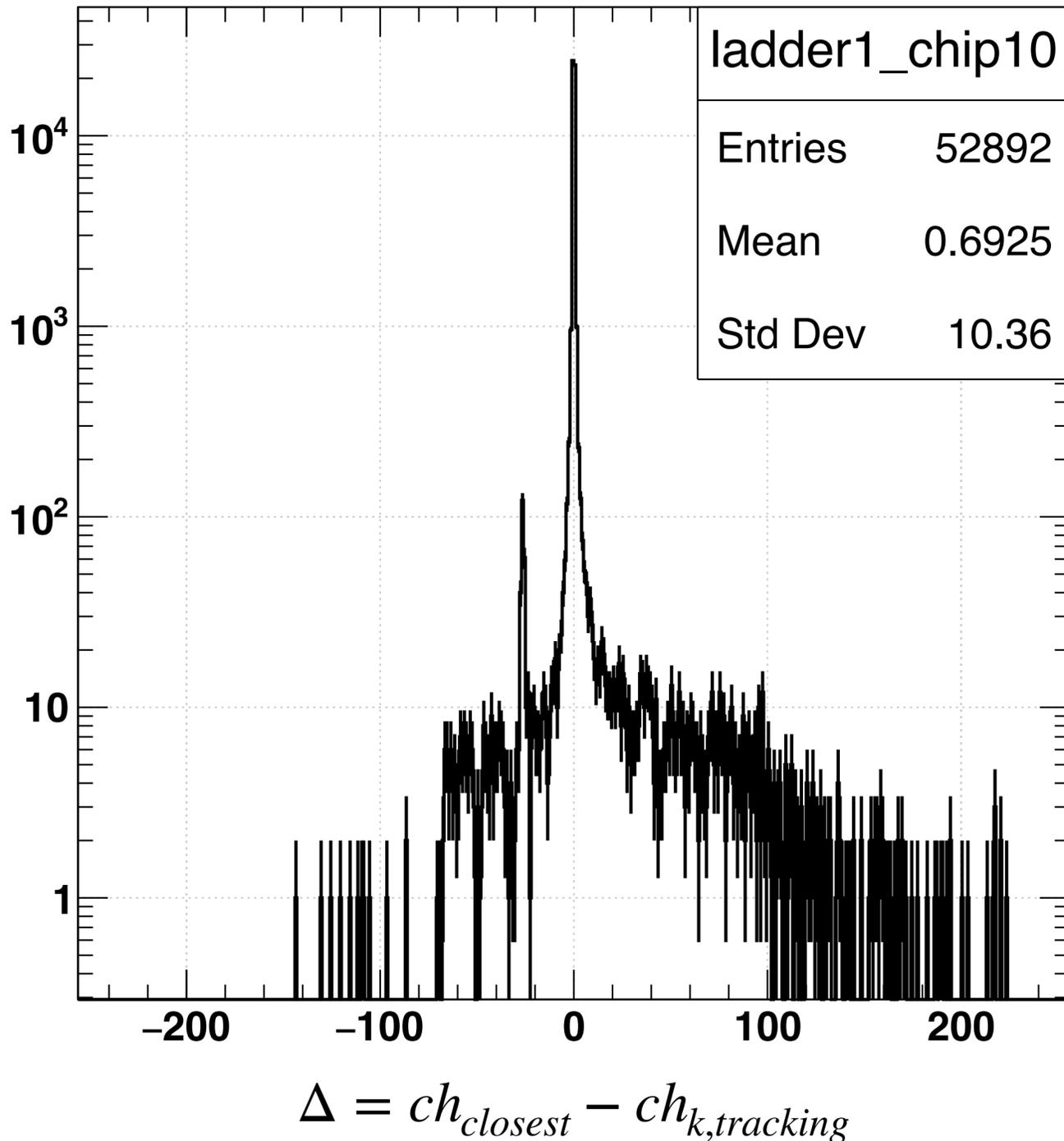
Numerator

#successful tracking = 53235

Difference of the closest hit and the predicted hit position

53235 - 52892 = 343 cases: Hit was not found on ladder 1 chip col. 10

ladder1\_chip10

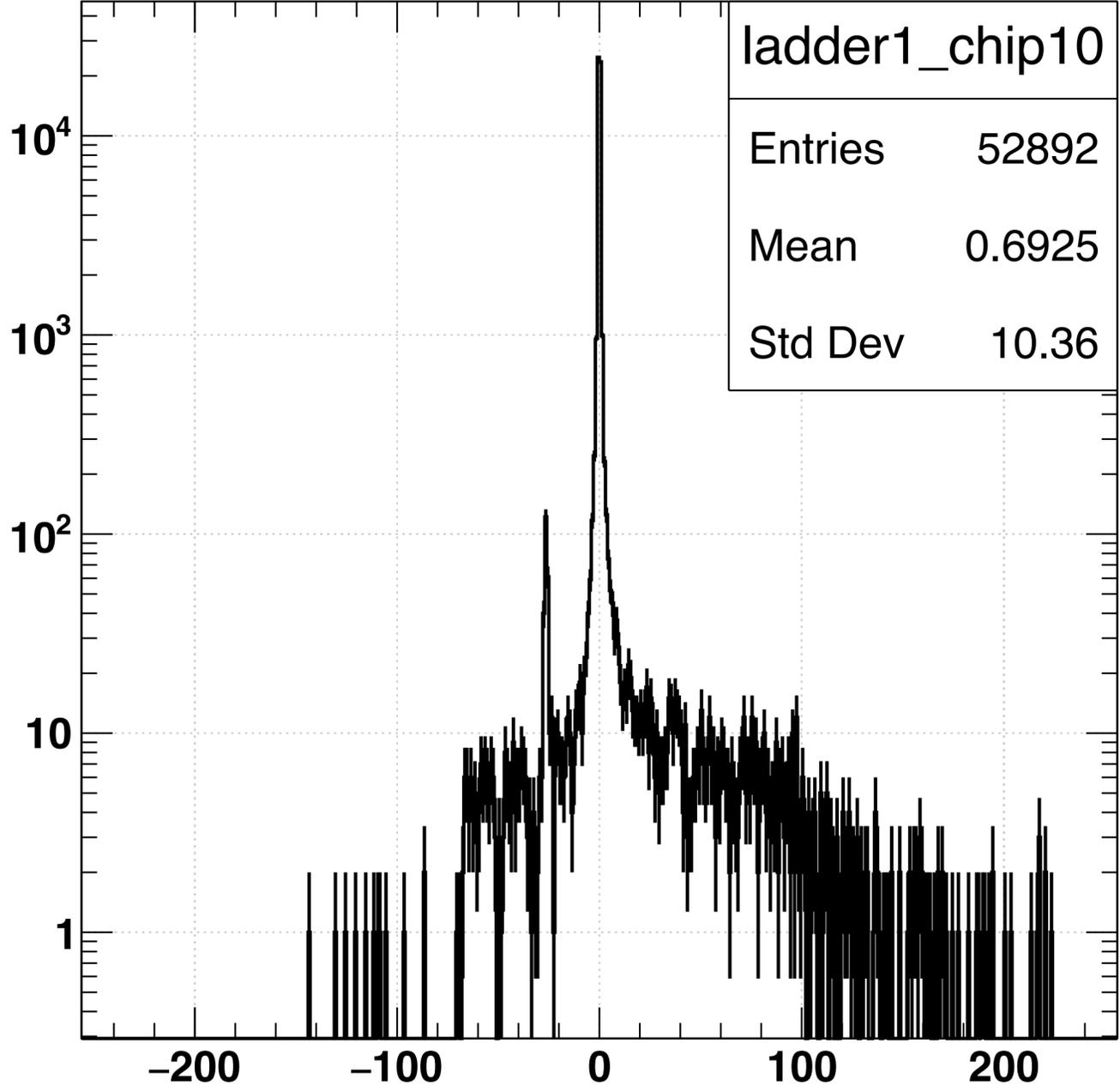


**! no additional cut applied !**

# Detection efficiency, Run89 ladder1 chip10

$$\varepsilon \equiv \frac{N(h_i \cap h_j \cap h_k)}{N(h_i \cap h_j)}, (i \neq j \neq k)$$

ladder1\_chip10



$$\Delta = ch_{closest} - ch_{k,tracking}$$

Numerator

#successful tracking = 53235

Difference of the closest hit and the predicted hit position

53235 - 52892 = 343 cases: Hit was not found on ladder 1 chip col. 10

Mean and std dev are estimated by fitting with 2 gaussians (need to be done in better way)

Denominator

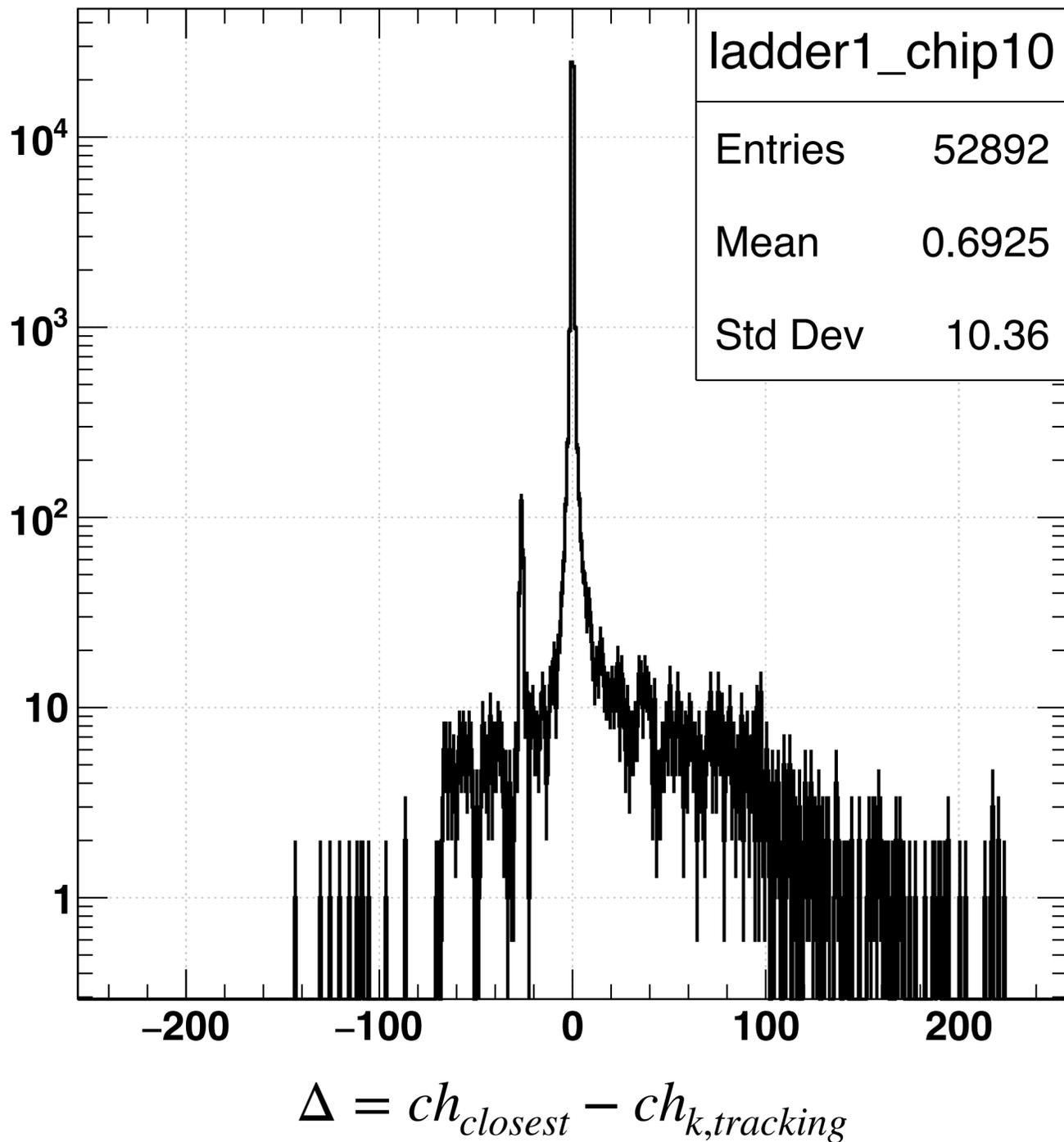
If all accepted: 52892 → 0.994

**! no additional cut applied !**

# Detection efficiency, Run89 ladder1 chip10

$$\varepsilon \equiv \frac{N(h_i \cap h_j \cap h_k)}{N(h_i \cap h_j)}, (i \neq j \neq k)$$

ladder1\_chip10



Numerator

#successful tracking = 53235

Difference of the closest hit and the predicted hit position

53235 - 52892 = 343 cases: Hit was not found on ladder 1 chip col. 10

Mean and std dev are estimated by fitting with 2 gaussians (need to be done in better way)

Denominator

If all accepted: 52892  $\rightarrow$  0.994

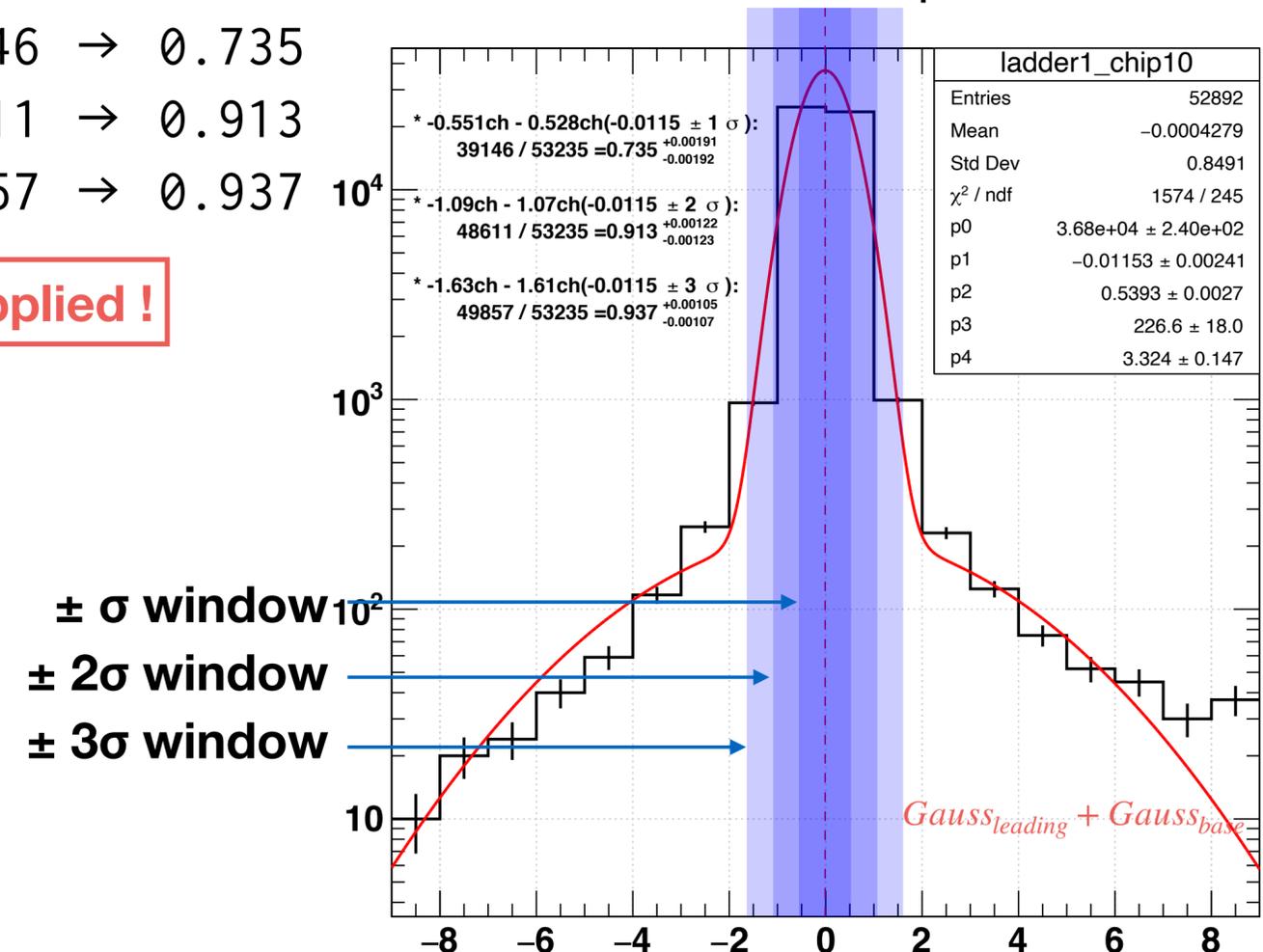
Mean  $\pm \sigma$  : 39146  $\rightarrow$  0.735

Mean  $\pm 2\sigma$  : 48611  $\rightarrow$  0.913

Mean  $\pm 3\sigma$  : 49857  $\rightarrow$  0.937

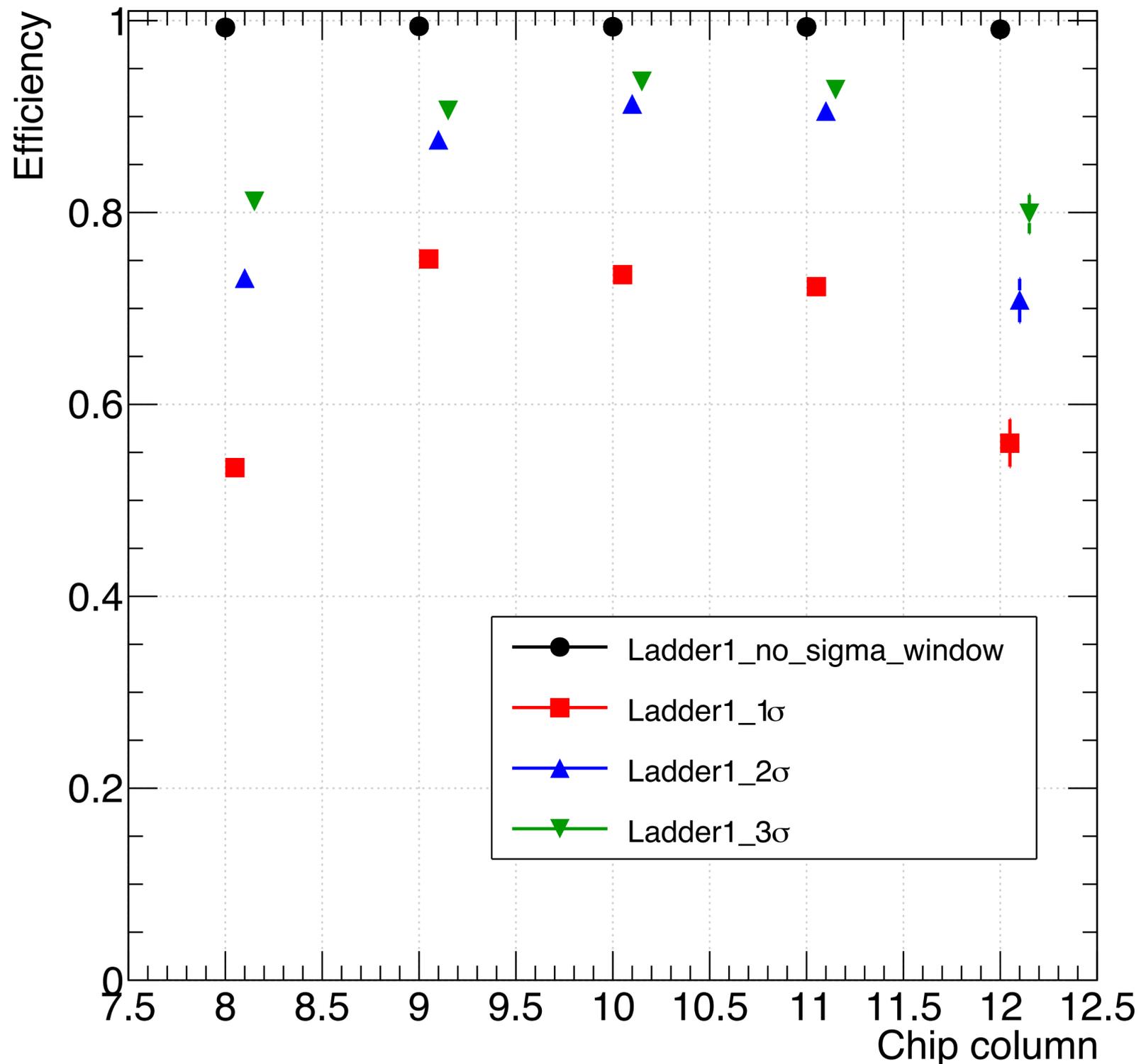
**! no additional cut applied !**

ladder1\_chip10



# Detection efficiency, Run89 ladder1 chip8, 9, 10, 11, 12

**! no additional cut applied !** Ladder1



chip	$\sigma$	denominator	numerator	$\epsilon$	error
<b>8</b>	<b>-1</b>	<b>3056</b>	<b>3078</b>	<b>0.993</b>	<b>2E-03</b>
8	1	1644	3078	0.534	9E-03
8	2	2252	3078	0.732	8E-03
<b>8</b>	<b>3</b>	<b>2498</b>	<b>3078</b>	<b>0.812</b>	<b>7E-03</b>
<b>9</b>	<b>-1</b>	<b>16781</b>	<b>16881</b>	<b>0.994</b>	<b>6E-04</b>
9	1	12686	16881	0.751	3E-03
9	2	14783	16881	0.876	3E-03
<b>9</b>	<b>3</b>	<b>15300</b>	<b>16881</b>	<b>0.906</b>	<b>2E-03</b>
<b>10</b>	<b>-1</b>	<b>52892</b>	<b>53235</b>	<b>0.994</b>	<b>4E-04</b>
10	1	39146	53235	0.735	2E-03
10	2	48611	53235	0.913	1E-03
<b>10</b>	<b>3</b>	<b>49857</b>	<b>53235</b>	<b>0.937</b>	<b>1E-03</b>
<b>11</b>	<b>-1</b>	<b>39111</b>	<b>39371</b>	<b>0.993</b>	<b>4E-04</b>
11	1	28453	39371	0.723	2E-03
11	2	35659	39371	0.906	1E-03
<b>11</b>	<b>3</b>	<b>36544</b>	<b>39371</b>	<b>0.928</b>	<b>1E-03</b>
<b>12</b>	<b>-1</b>	<b>439</b>	<b>443</b>	<b>0.991</b>	<b>6E-03</b>
12	1	248	443	0.560	2E-02
12	2	314	443	0.709	2E-02
<b>12</b>	<b>3</b>	<b>354</b>	<b>443</b>	<b>0.799</b>	<b>2E-02</b>

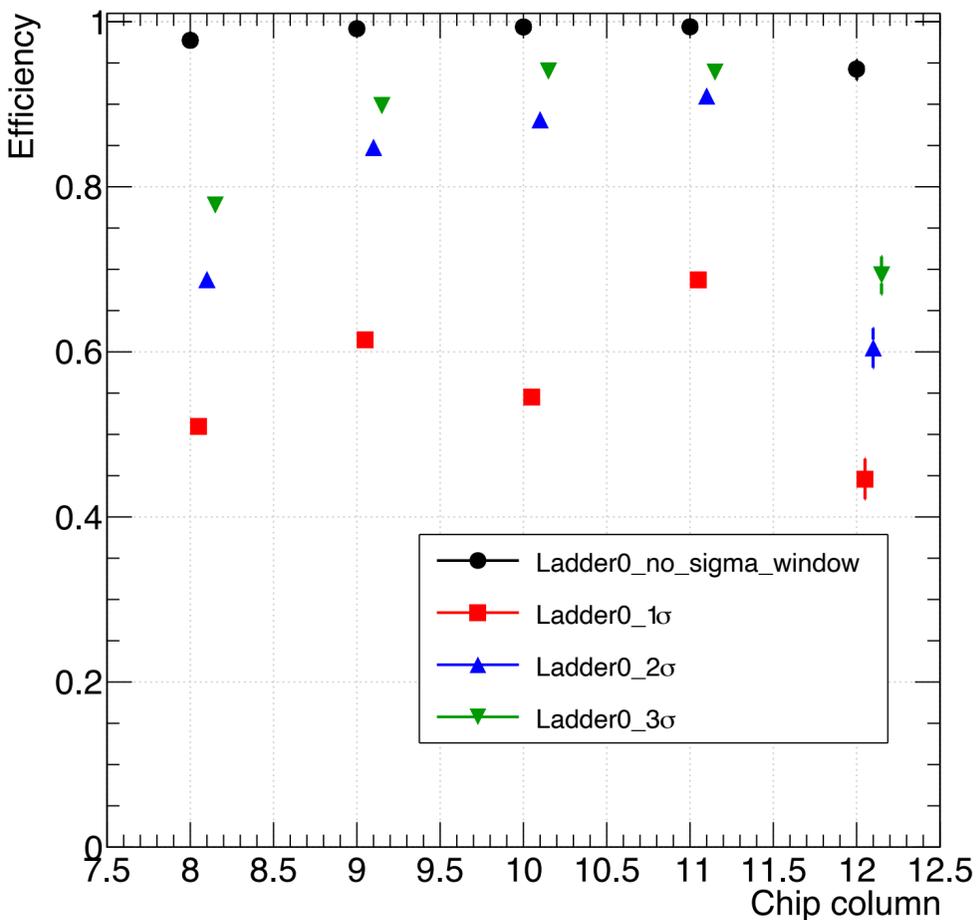
n.b. The same alignment correction obtained from chip col. 10 was applied.

If a sigma window is not required, the efficiency reaches to 0.994.  $\pm \sigma$ ,  $2\sigma$  windows are too narrow

# Detection efficiency, Run89 ladder0, 1 2, chip8, 9, 10, 11, 12

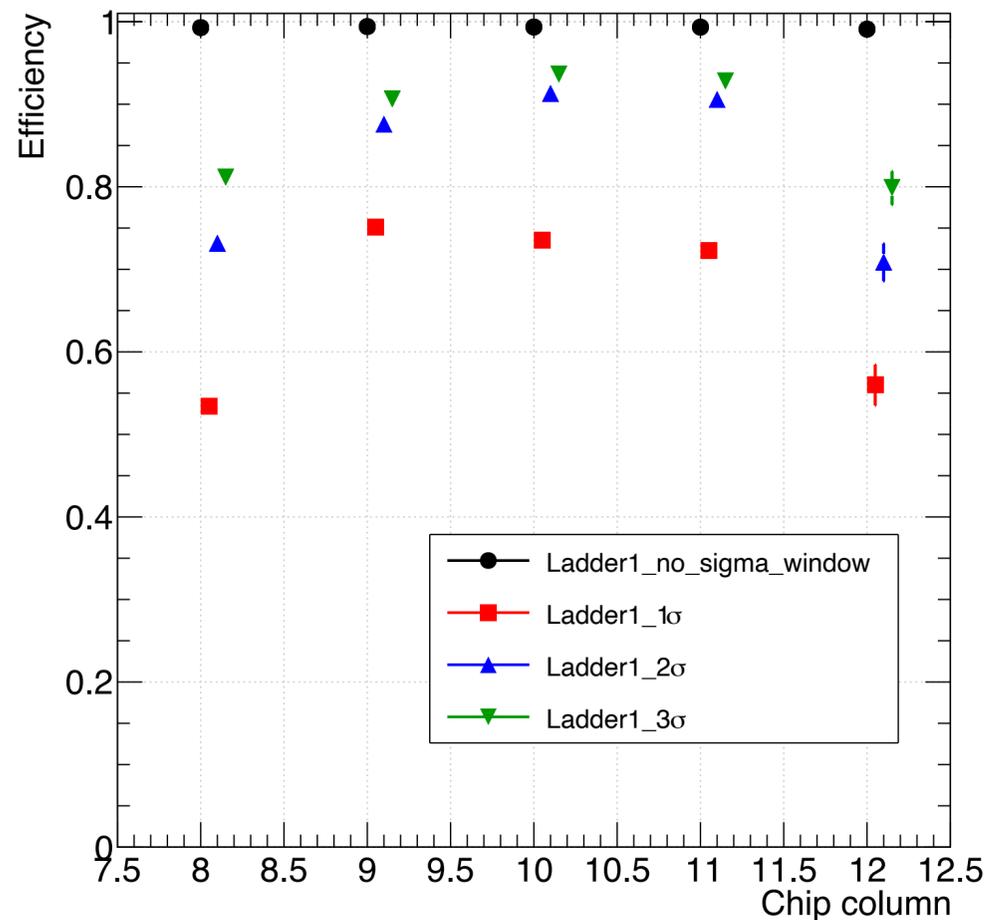
**! no additional cut applied !**

Ladder0



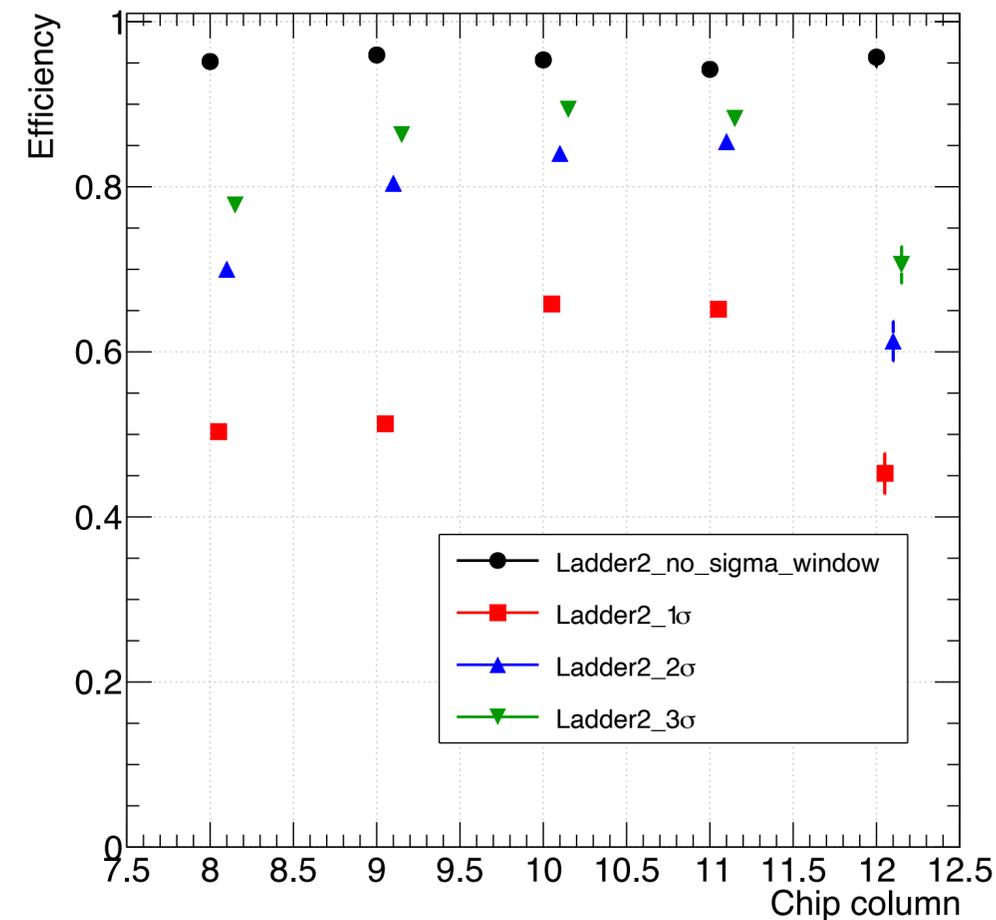
no sigma:0.977, 0.992, 0.994, 0.994, 0.943  
 3 σ :0.778, 0.898, 0.940, 0.939, 0.693

Ladder1



no sigma:0.993, 0.994, 0.994, 0.993, 0.991  
 3 σ :0.812, 0.906, 0.937, 0.928, 0.799

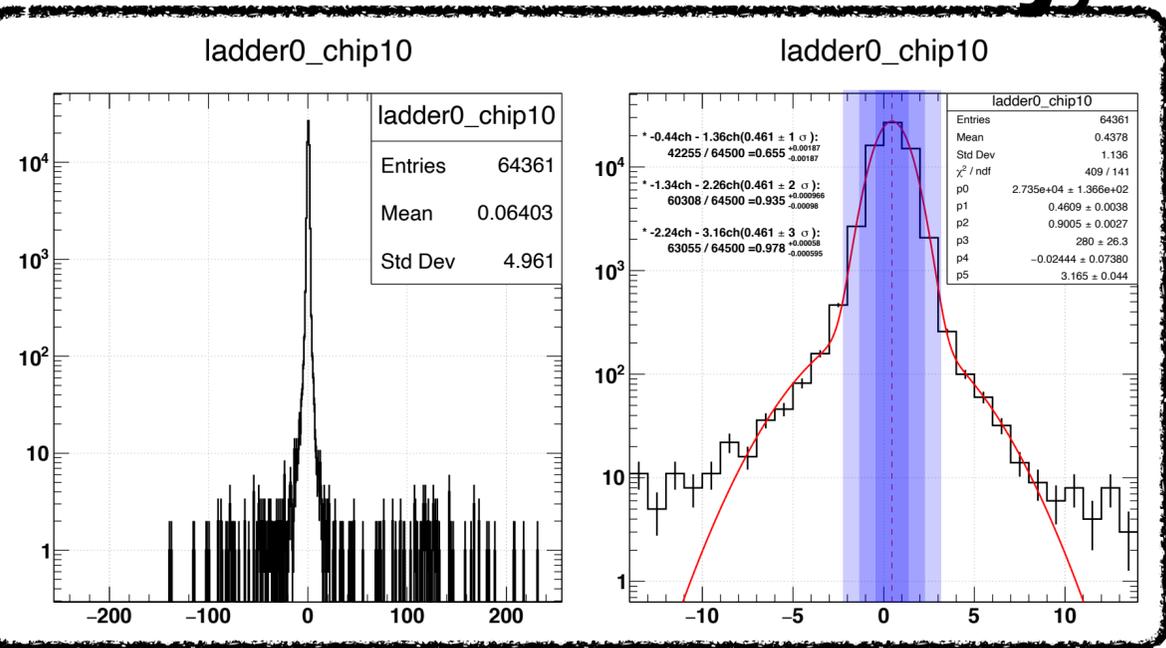
Ladder2



no sigma:0.952, 0.960, 0.954, 0.942, 0.957  
 3 σ :0.778, 0.863, 0.894, 0.883, 0.706

# Detection efficiency, MC for Run89

**! no additional cut applied !**

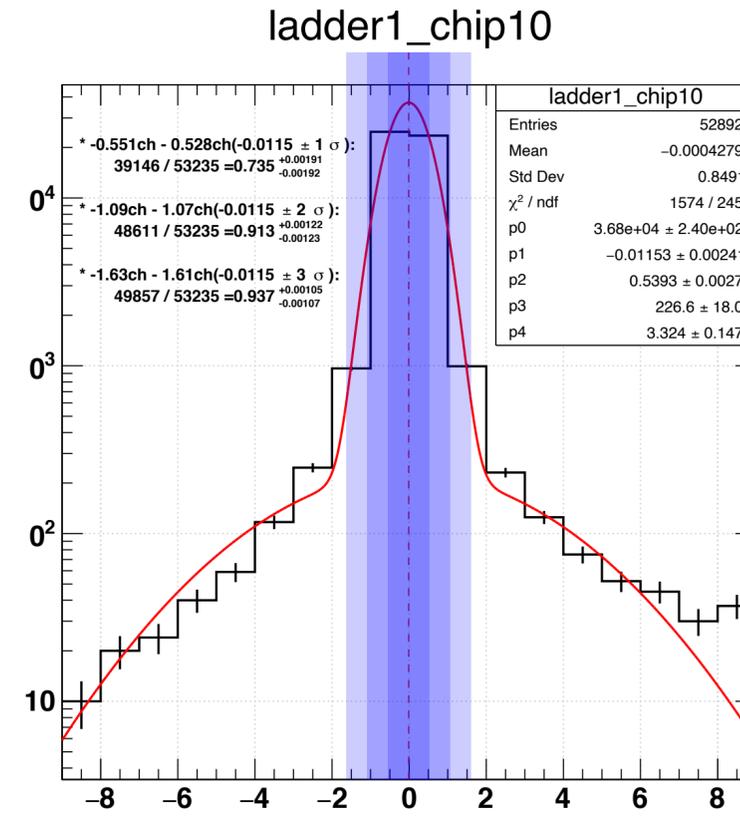
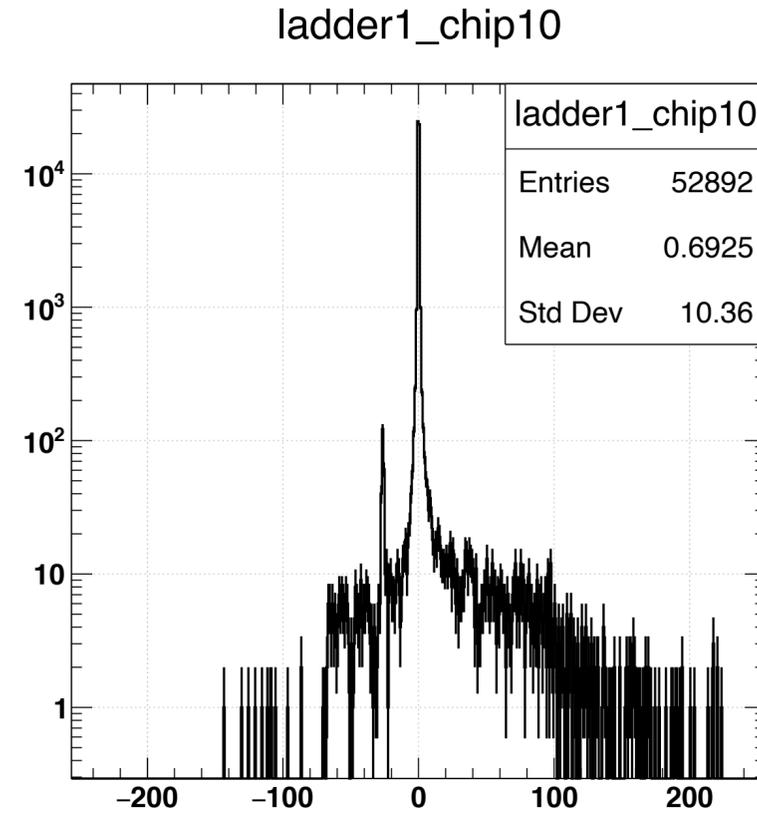


The same analysis was performed to MC data (latest version). Alignment correction was not applied because it's not needed. Contribution of largely scattered beam is clearly seen in the  $\Delta$  distribution.  
→ Even  $3 \sigma$  window may be too narrow if gaussian width is used.

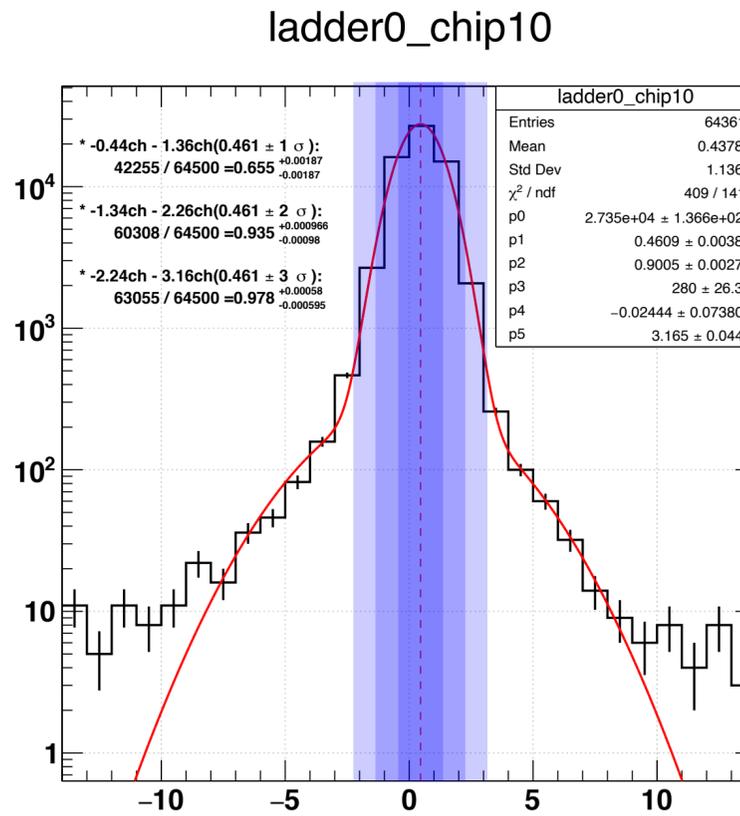
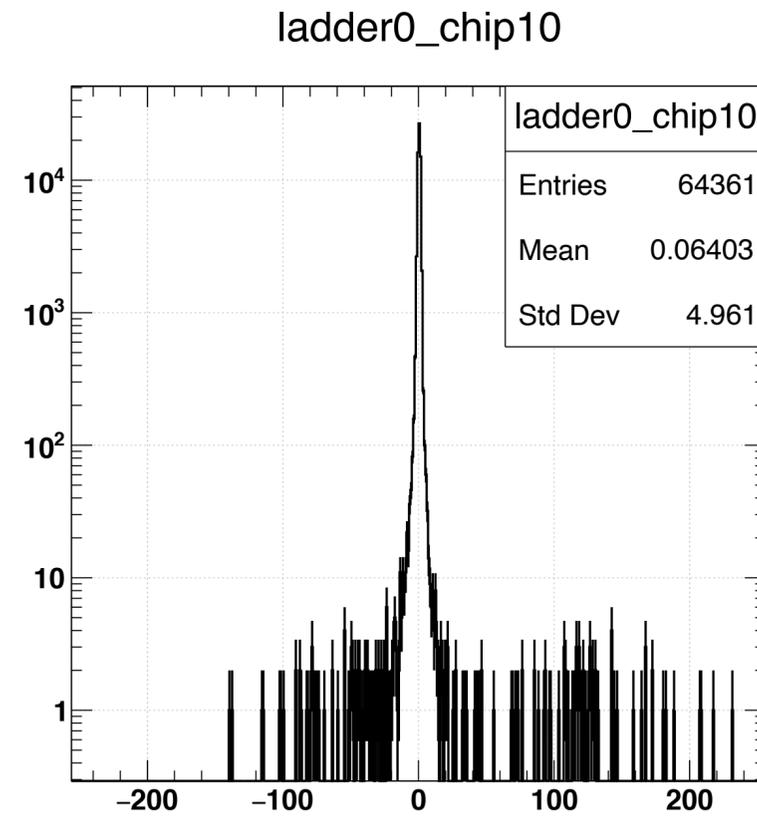
# Detection efficiency, MC for Run89

! no additional cut applied !

real data



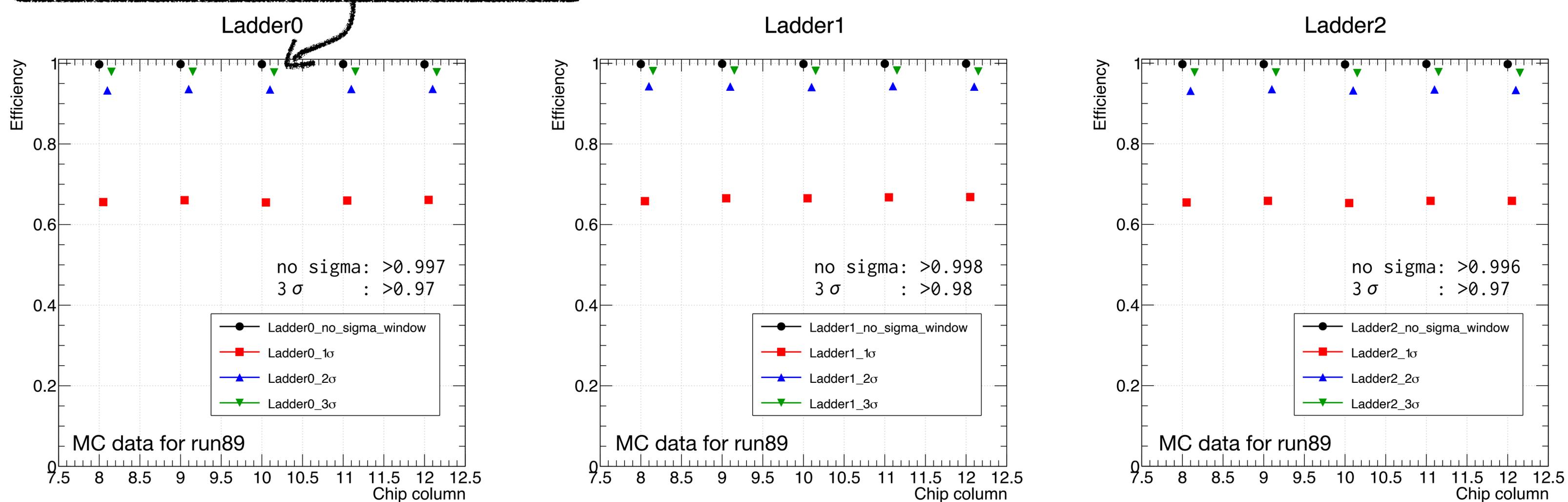
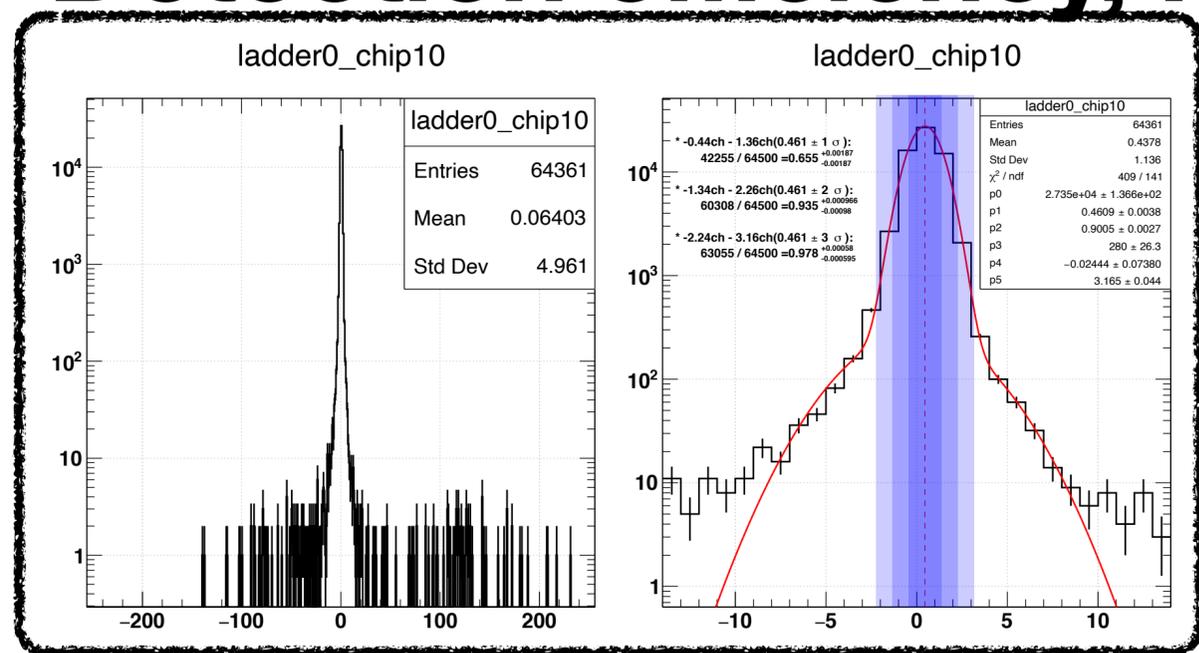
MC data



# Detection efficiency, MC for Run89

**! no additional cut applied !**

The same analysis was performed to MC data (latest version).  
 Alignment correction was not applied because it's not needed.  
 Contribution of largely scattered beam is clearly seen in the  $\Delta$  distribution.  
 → Even  $3\sigma$  window may be too narrow if gaussian width is used.  
 Detection efficiency without the sigma window is  $\sim 99.7\%$ .  
 Detection efficiency without  $3\sigma$  window is  $\sim 97\%$ .  
 No chip dependence was found, of course.



# Detection efficiency, additional cut(s) for Run89 ladder1 chip10

No sigma window cut

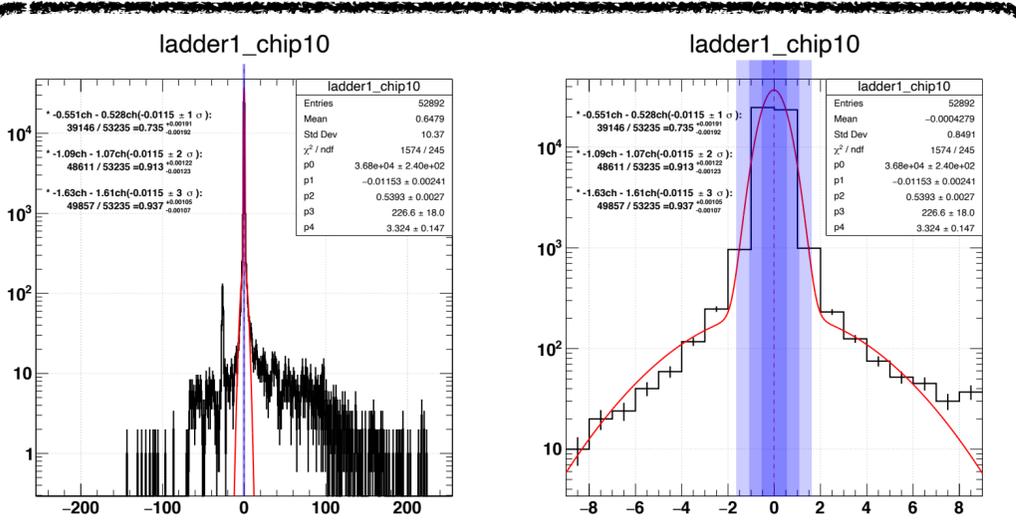
3  $\sigma$  window

	chip	$\sigma$	denominator	numerator	$\epsilon$	error (upper)	error (lower)		chip	$\sigma$	denominator	numerator	$\epsilon$	error (upper)	error (lower)
no additional cut	10	-1	52892	53235	0.994	0.000	0.000		10	3	49857	53235	0.937	0.001	0.001
only single hit clusters	10	-1	31511	31749	0.993	0.000	0.001		10	3	29822	31749	0.939	0.001	0.001
multi hit clusters	10	-1	2711	2723	0.996	0.001	0.002		10	-1		2723			
central area	10	-1	33658	33918	0.992	0.000	0.001		10	3	32016	33918	0.944	0.001	0.001
no ADC0	10	-1	39630	39821	0.995	0.000	0.000		10	3	37479	39821	0.941	0.001	0.001
straight beam track	10	-1	14731	14816	0.994	0.001	0.001		10	3	14232	14816	0.961	0.002	0.002

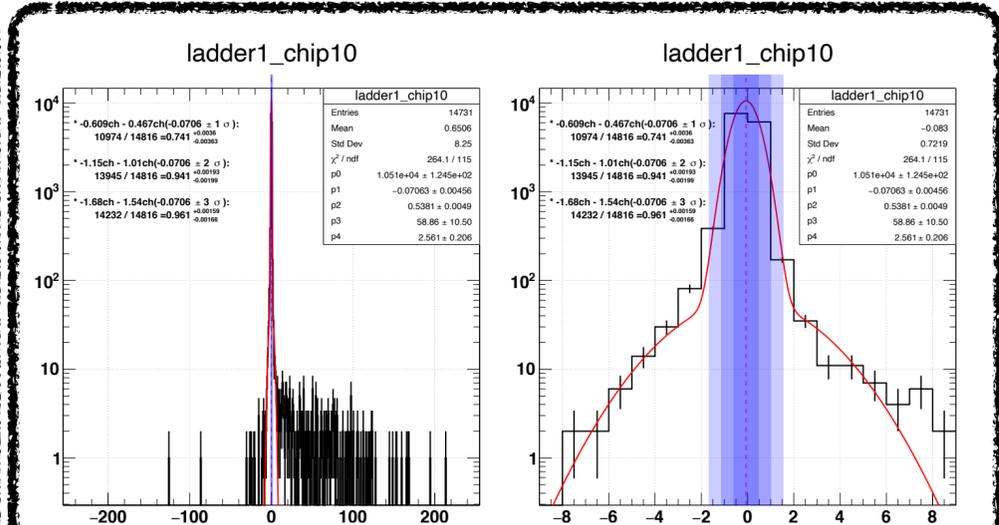
• **central area:**  $20 < ch_{\text{testing}} < 120, 20 < ch_{\text{tracking}} < 120$

• **no ADC0:** clusters don't have a hit with ADC0 on the testing ladders

• **straight beam track:**  $|ch_{\text{testing}, 1} - ch_{\text{testing}, 2}| < 3 \text{ ch}$



no additional cut



straight beam track

Cuts increase efficiency a little bit. Correlation of parameters to  $\Delta$  need to be checked.

# Detection efficiency, comparison

Analysis	Run	$\epsilon$ (%) Ladder 0	$\epsilon$ (%) Ladder 1	$\epsilon$ (%) Ladder 2
Cheng-Wei	89	$99.3^{+0.2}_{-0.2}$	$99.5^{+0.1}_{-0.2}$	$97.1^{+0.3}_{-0.4}$
Miu	87	99.53	99.39	99.56
	88	$\pm 0.02$	$\pm 0.03$	$\pm 0.02$
	89			
FNAL in 2019		$96.0 \pm 0.5$		
Cosmic ray by Genki		$98.2^{+1.2}_{-2.4}$		

No sigma window cut

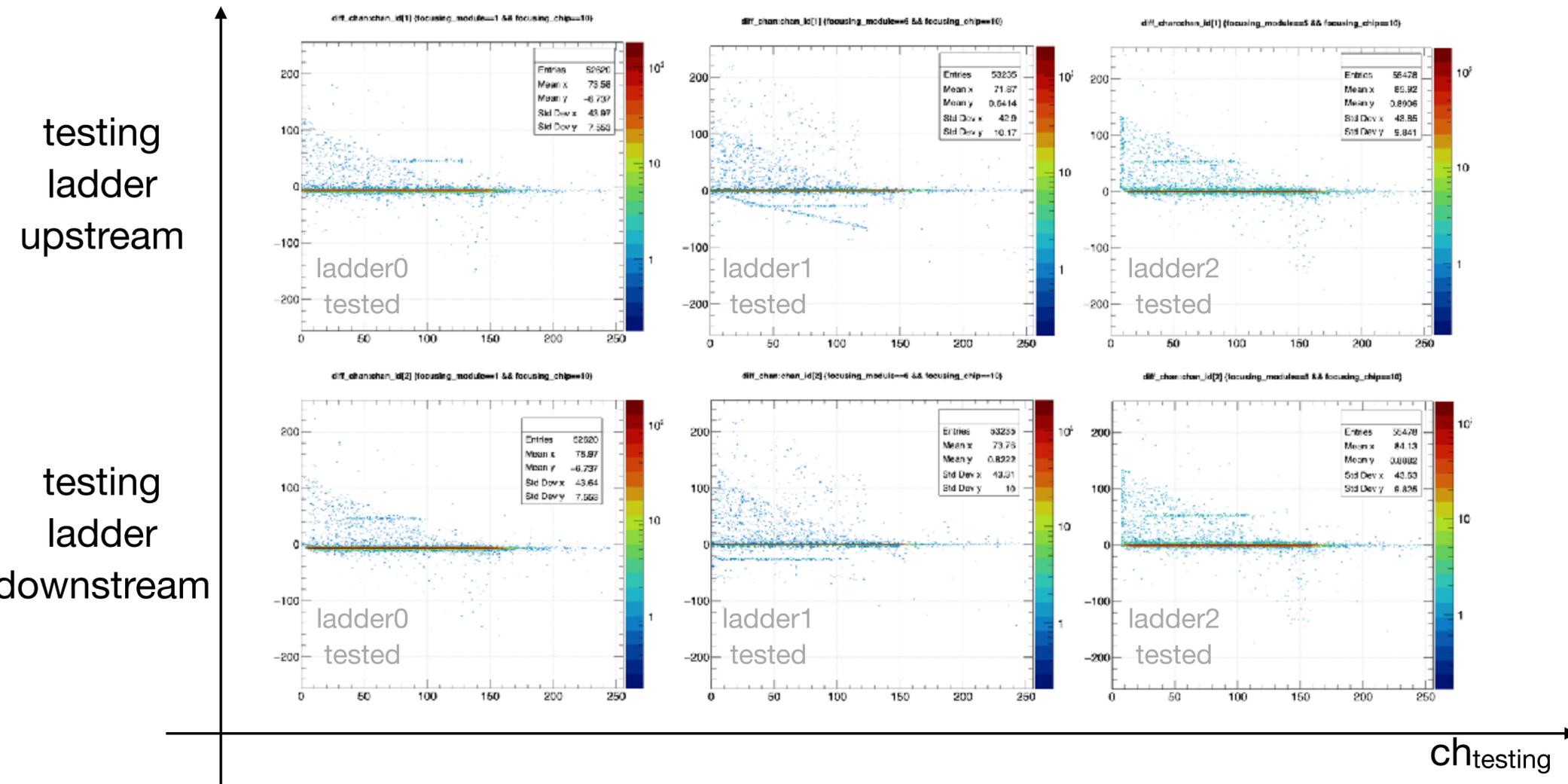
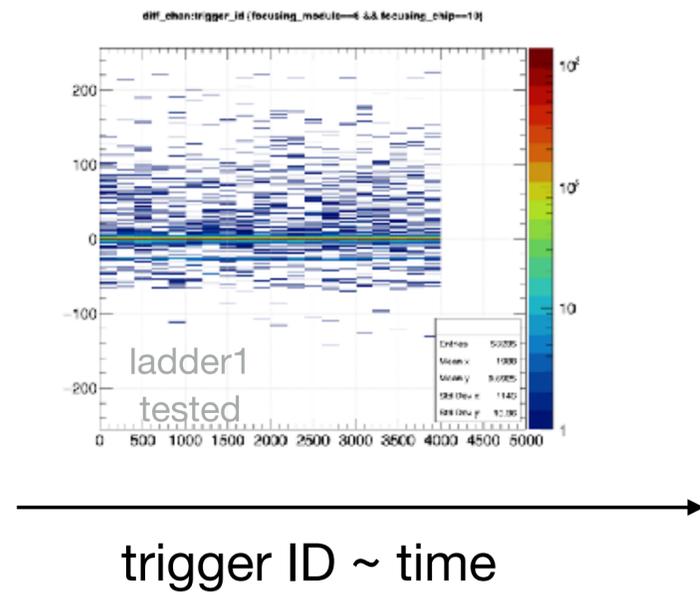
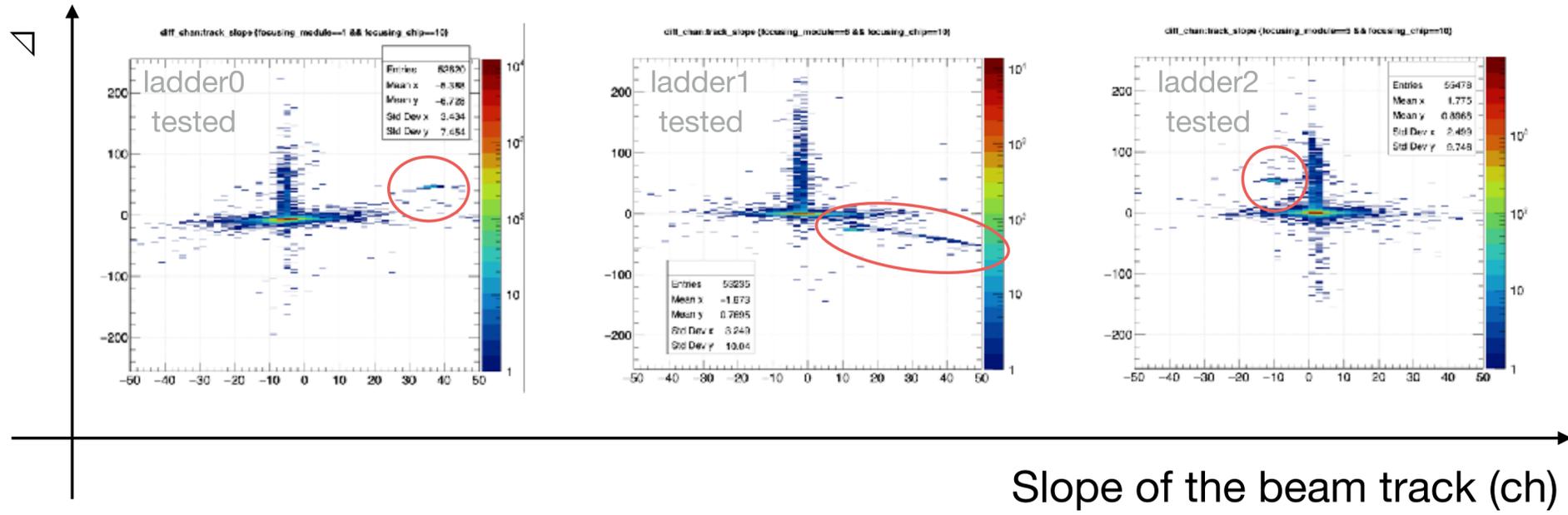
	chip	$\sigma$	$\epsilon$ Ladder 0	$\epsilon$ Ladder 1	$\epsilon$ Ladder 2
Genki, no additional cut	10	-1	0.994	0.994	0.954
Genki, straight beam track	10	-1	0.981	0.994	0.963

3  $\sigma$  window

chip	$\sigma$	$\epsilon$ Ladder 0	$\epsilon$ Ladder 1	$\epsilon$ Ladder 2
10	3	0.940	0.937	0.894
10	3	0.883	0.961	0.921

I have to do something more...

# Detection efficiency, for better results...



Correlation of  $\Delta$  to...

- beam track slope: small islands found
- time: no
- ch of the testing ladders: yes

# Plan for QuarkMatter2022



# Plan for QuarkMatter2022, current status

**Performance evaluation and mass production status for sPHENIX intermediate silicon tracker**  
G. Nukazuka (RBRC) for sPHENIX Collaboration

The sPHENIX collaboration will start data taking in 2023 at the Relativistic Heavy Ion Collider in BNL to study the Quark-Gluon Plasma and cold-QCD. A detector complex consisting of the solenoid magnet, a hadron calorimeter, an electromagnetic calorimeter, a time projection chamber, a MAPS-based vertex detector, and the intermediate silicon tracker (INTT) is under construction. A tracking system formed by the three latter detectors enables us to measure the heavy flavor jets and identify the three quark species. The INTT surrounding the collision point axially at about 10 cm away with two layers of silicon strip sensors detects hit points at the intermediate area of the tracking system to have better tracking precision. In addition to that, the INTT also provides timing information of the hits, which is possible only by INTT, thanks to its good timing resolution, to eliminate pile-up events by identifying bunch-crossing. This poster presentation will show the performance evaluation performed at laboratories and at a beam facility, and mass production status.

**SPHENIX**

performance evaluation (+QA?) /test beam

**INTT overview**

ladder mass production QA

Class	Criteria	Taiwan
Class 1	( 0% < bad ≤ 0.5%)	14
Class 2	( 0.5% < bad ≤ 1%)	2
Class 3	( 1% < bad ≤ 2%)	0
Class 4	( 2% < bad ≤ 3%)	0
Class 5	( 3% < bad ≤ 4%)	0
Class 6	( 4% < bad ≤ 5%)	0
Class 7	( 5% < bad ≤ 6%)	0
Class 8	( 6% < bad ≤ 7%)	0
Class 9	( 7% < bad ≤ 8%)	0
Class 10	( 8% < bad ≤ 9%)	0
Class 11	( 9% < bad ≤ 10%)	0
Class 12	( 10% < bad ≤ 11%)	0
Class 13	( 11% < bad ≤ 12%)	0
Class 14	( 12% < bad ≤ 13%)	0
Class 15	( 13% < bad ≤ 14%)	0
Class 16	( 14% < bad ≤ 15%)	0
Class 17	( 15% < bad ≤ 16%)	0
Class 18	( 16% < bad ≤ 17%)	0
Class 19	( 17% < bad ≤ 18%)	0
Class 20	( 18% < bad ≤ 19%)	0
Class 21	( 19% < bad ≤ 20%)	0
Class 22	( 20% < bad ≤ 21%)	0
Class 23	( 21% < bad ≤ 22%)	0
Class 24	( 22% < bad ≤ 23%)	0
Class 25	( 23% < bad ≤ 24%)	0
Class 26	( 24% < bad ≤ 25%)	0
Class 27	( 25% < bad ≤ 26%)	0
Class 28	( 26% < bad ≤ 27%)	0
Class 29	( 27% < bad ≤ 28%)	0
Class 30	( 28% < bad ≤ 29%)	0
Class 31	( 29% < bad ≤ 30%)	0
Class 32	( 30% < bad ≤ 31%)	0
Class 33	( 31% < bad ≤ 32%)	0
Class 34	( 32% < bad ≤ 33%)	0
Class 35	( 33% < bad ≤ 34%)	0
Class 36	( 34% < bad ≤ 35%)	0
Class 37	( 35% < bad ≤ 36%)	0
Class 38	( 36% < bad ≤ 37%)	0
Class 39	( 37% < bad ≤ 38%)	0
Class 40	( 38% < bad ≤ 39%)	0
Class 41	( 39% < bad ≤ 40%)	0
Class 42	( 40% < bad ≤ 41%)	0
Class 43	( 41% < bad ≤ 42%)	0
Class 44	( 42% < bad ≤ 43%)	0
Class 45	( 43% < bad ≤ 44%)	0
Class 46	( 44% < bad ≤ 45%)	0
Class 47	( 45% < bad ≤ 46%)	0
Class 48	( 46% < bad ≤ 47%)	0
Class 49	( 47% < bad ≤ 48%)	0
Class 50	( 48% < bad ≤ 49%)	0
Class 51	( 49% < bad ≤ 50%)	0
Class 52	( 50% < bad ≤ 51%)	0
Class 53	( 51% < bad ≤ 52%)	0
Class 54	( 52% < bad ≤ 53%)	0
Class 55	( 53% < bad ≤ 54%)	0
Class 56	( 54% < bad ≤ 55%)	0
Class 57	( 55% < bad ≤ 56%)	0
Class 58	( 56% < bad ≤ 57%)	0
Class 59	( 57% < bad ≤ 58%)	0
Class 60	( 58% < bad ≤ 59%)	0
Class 61	( 59% < bad ≤ 60%)	0
Class 62	( 60% < bad ≤ 61%)	0
Class 63	( 61% < bad ≤ 62%)	0
Class 64	( 62% < bad ≤ 63%)	0
Class 65	( 63% < bad ≤ 64%)	0
Class 66	( 64% < bad ≤ 65%)	0
Class 67	( 65% < bad ≤ 66%)	0
Class 68	( 66% < bad ≤ 67%)	0
Class 69	( 67% < bad ≤ 68%)	0
Class 70	( 68% < bad ≤ 69%)	0
Class 71	( 69% < bad ≤ 70%)	0
Class 72	( 70% < bad ≤ 71%)	0
Class 73	( 71% < bad ≤ 72%)	0
Class 74	( 72% < bad ≤ 73%)	0
Class 75	( 73% < bad ≤ 74%)	0
Class 76	( 74% < bad ≤ 75%)	0
Class 77	( 75% < bad ≤ 76%)	0
Class 78	( 76% < bad ≤ 77%)	0
Class 79	( 77% < bad ≤ 78%)	0
Class 80	( 78% < bad ≤ 79%)	0
Class 81	( 79% < bad ≤ 80%)	0
Class 82	( 80% < bad ≤ 81%)	0
Class 83	( 81% < bad ≤ 82%)	0
Class 84	( 82% < bad ≤ 83%)	0
Class 85	( 83% < bad ≤ 84%)	0
Class 86	( 84% < bad ≤ 85%)	0
Class 87	( 85% < bad ≤ 86%)	0
Class 88	( 86% < bad ≤ 87%)	0
Class 89	( 87% < bad ≤ 88%)	0
Class 90	( 88% < bad ≤ 89%)	0
Class 91	( 89% < bad ≤ 90%)	0
Class 92	( 90% < bad ≤ 91%)	0
Class 93	( 91% < bad ≤ 92%)	0
Class 94	( 92% < bad ≤ 93%)	0
Class 95	( 93% < bad ≤ 94%)	0
Class 96	( 94% < bad ≤ 95%)	0
Class 97	( 95% < bad ≤ 96%)	0
Class 98	( 96% < bad ≤ 97%)	0
Class 99	( 97% < bad ≤ 98%)	0
Class 100	( 98% < bad ≤ 99%)	0
Class 101	( 99% < bad ≤ 100%)	0

ladder mass production QA

bus extender

further upgrades (conv. cable, etc) prospect

summary

## HOW TO JOIN THE ONLINE PLATFORM OF THE QUARK MATTER 2022 CONFERENCE ?

The virtual conference will take place on the Zoom Events platform. The registered and confirmed attendees will receive an invitation from the platform (on March 29, 2022). **After receiving an invitation follow the instruction, which is available for download at the link below.** After signing in, you will get access to all conference sessions.

### Important:

- If you do have a *Zoom account*, please check whether your *Zoom username* matches the email address used for the conference registration. If not, please make a new Zoom registration with that email address.
- If you do not have a *Zoom account*, please register now using your email address (the one in the conference database) as the Zoom username.

Instructions on how to access the online conference can be found [here >>](#)

On 30, 31 March and 1 April between 14.00 and 16.00 CET, the zoom events platform will be open to presenters and attendees, where you will receive technical support and be able to practice your presentations live. In case of further problems, please contact technical support under [qm2022@symposium.pl](mailto:qm2022@symposium.pl)

### POSTER SESSIONS

It is planned to have three **one-hour long Poster Sessions**: **two on Wednesday (April 6)** and **one on Friday (April 8)**, They will be all **organised in an online mode**. Each poster session will be divided into 12 poster topical subsessions (rooms) that will be further divided into (up to) 15 breakout rooms. So each poster session will host about 180 separate poster presentations. The detailed (still preliminary) organization of poster sessions is displayed on [indico](https://indico.cern.ch/event/895086/timetable/#20220406)  
<https://indico.cern.ch/event/895086/timetable/#20220406>  
<https://indico.cern.ch/event/895086/timetable/#20220408>

Note that the indico list of poster presentations in a given room is divided into 4-minute slots, which serves only to arrange the presentations into a vertical list. In reality, each poster presentation is planned for one hour.

**For poster presenters:** It is required that the poster presentations are uploaded to the indico in advance, by Tuesday (April 5) afternoon at the latest. It will allow the interested participants to view the posters earlier. The recommended presentation format is similar to that of a standard oral presentation, with the main difference that the number of pages for a poster should be up to 5. The poster presenter should join first the topical subsession and then the breakout room assigned to a given poster. To do so, use the button to the right of the "share screen" button (marked as 4 white squares) and join the room assigned to your poster. Use "share screen" to present your poster (as well as some additional materials). Wait for participants who are interested in your presentation.

**For those who are going to view the posters:** Since the poster sessions will be organised online, it is recommended for the onsite participants to return to their hotels or other places with a good internet connection to take part in the poster sessions. We are also going to arrange some places in the conference lobby for this purpose. The first step is to select the topical subsession of your interest and join this track. Once there, you go to the breakout room where the poster you want to see is presented. To do so, use the button to the right of the "share screen" button (one marked as 4 white squares) and choose a poster. You can then switch from poster to poster by leaving one breakout room and joining the other one within this topical subsession. You can also leave this topical subsession and join another one of your further interest.

aaaaa