Reconstruction of muon tracks on Muon Monitor in LSC

Maria Nelyubina, MIPT

August 2016

Project members

CUPP (Finland)

T. Enqvist
J. Joutsenvaara
P. Kuusiniemi
M. Slupecki (Poland)
W. Trzaska

LSC (Spain)

I. Bandac
A. Bayo
A. Bettini (Italy)
A. Iann (Italy)

INR (Russia)

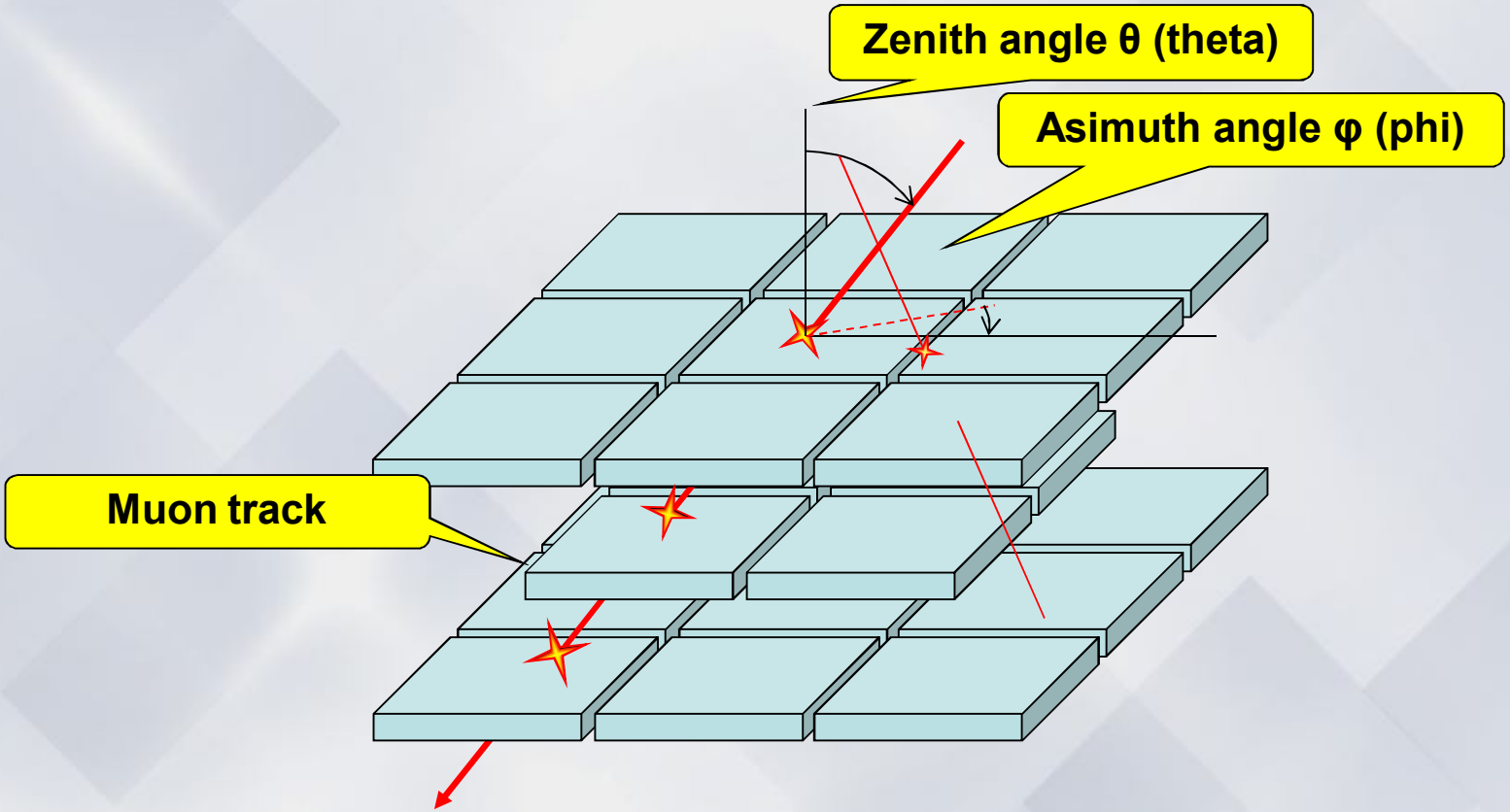
L. Bezrukov
A. Nozik

MIPT (Russia)

L. Inzhechik
T. Glukhikh
G. Koroteev
O. Matveeva
M. Nelyubina
A. Nozik
A. Fazliakhmetov

Task

To create an algorithm of reconstruction of muon tracks, only by triple sets of pixels.



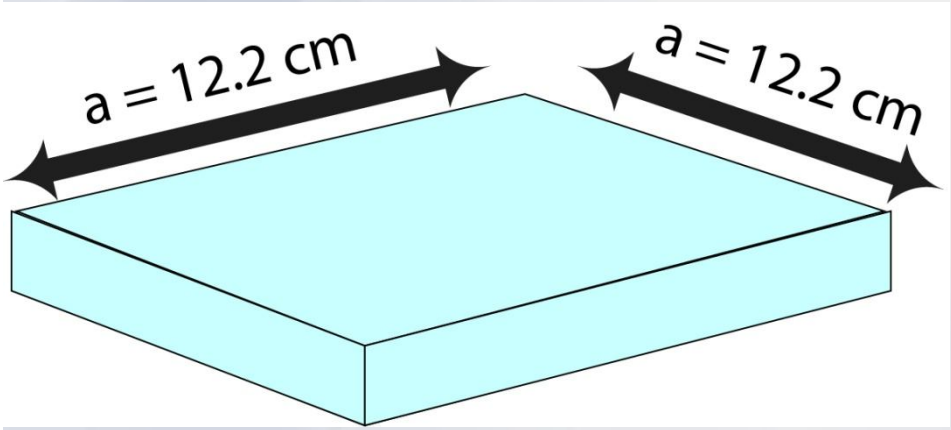
Method

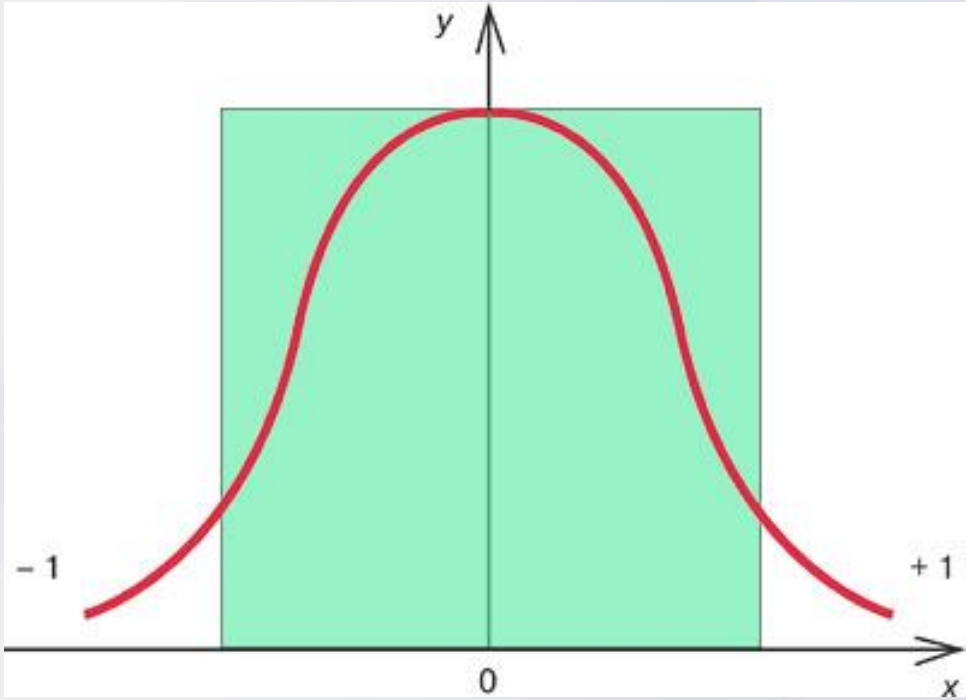
- Implementing of two algorithms
- Comparison of results of two algorithms
- Getting a previous angular distribution

Example of input data

```
counts: 1
77_9 562.5 937.5 346.0
81_12 437.5 812.5 180.0
86_9 62.5 937.5 0.0
##########
counts: 1
75_13 562.5 62.5 346.0
84_3 562.5 62.5 180.0
93_11 687.5 -187.5 0.0
##########
```

Algorithm

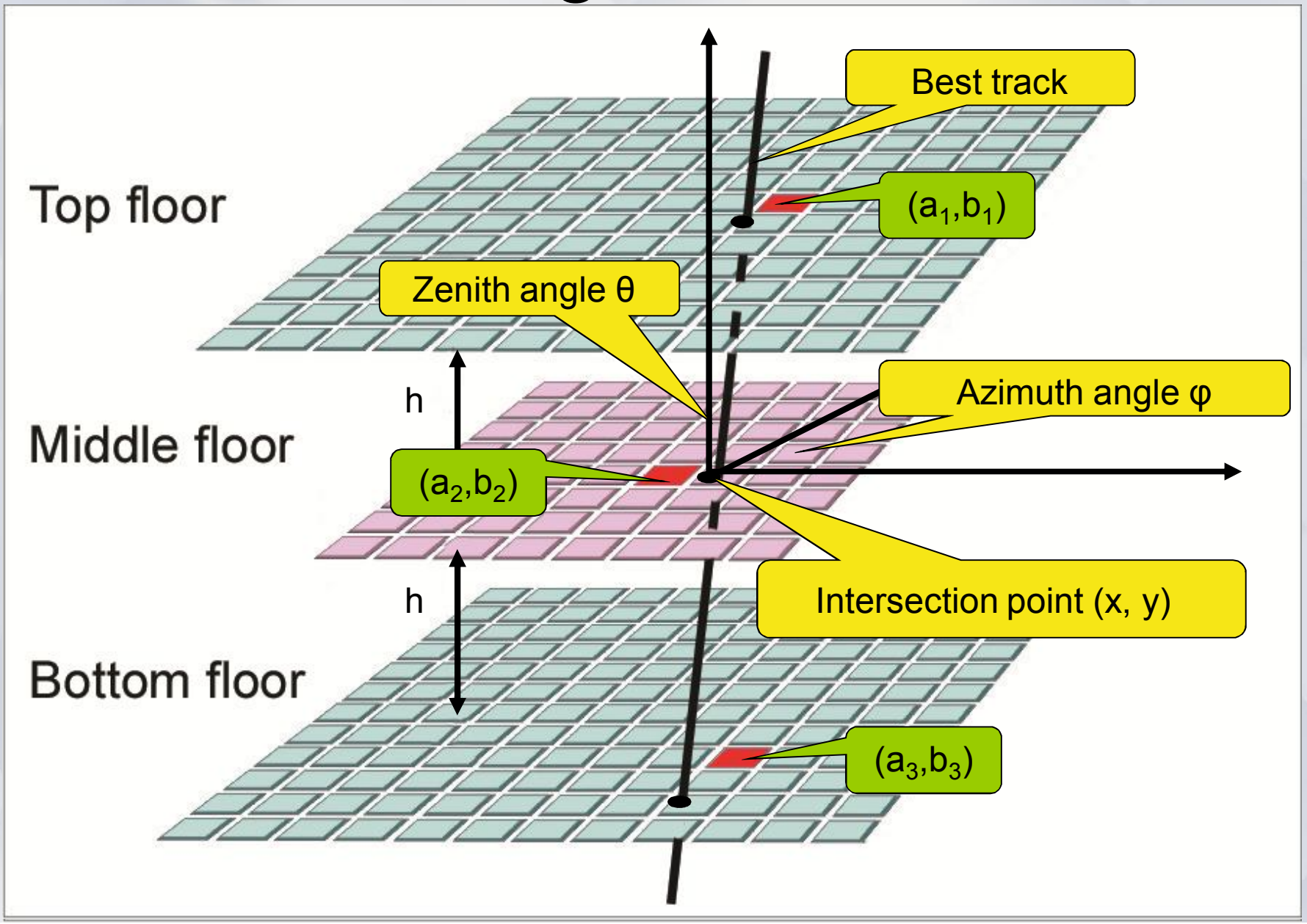




Triggered pixel defines track coordinate, with

uncertainty: $\sigma = \frac{a}{\sqrt{12}}$

Algorithm



Algorithm

Coordinates of intersection point of track and top and bottom floor:

$$x_1 = x + h\,tg\theta\cos\varphi$$
$$y_1 = y + h\,tg\theta\sin\varphi$$
$$x_3 = x - h\,tg\theta\cos\varphi$$
$$y_3 = y - h\,tg\theta\sin\varphi$$

Equation for χ2 criterion:

$$\chi^2 = \sum_i \frac{(a_i - x_i)^2}{\sigma^2} + \sum_i \frac{(b_i - y_i)^2}{\sigma^2}$$

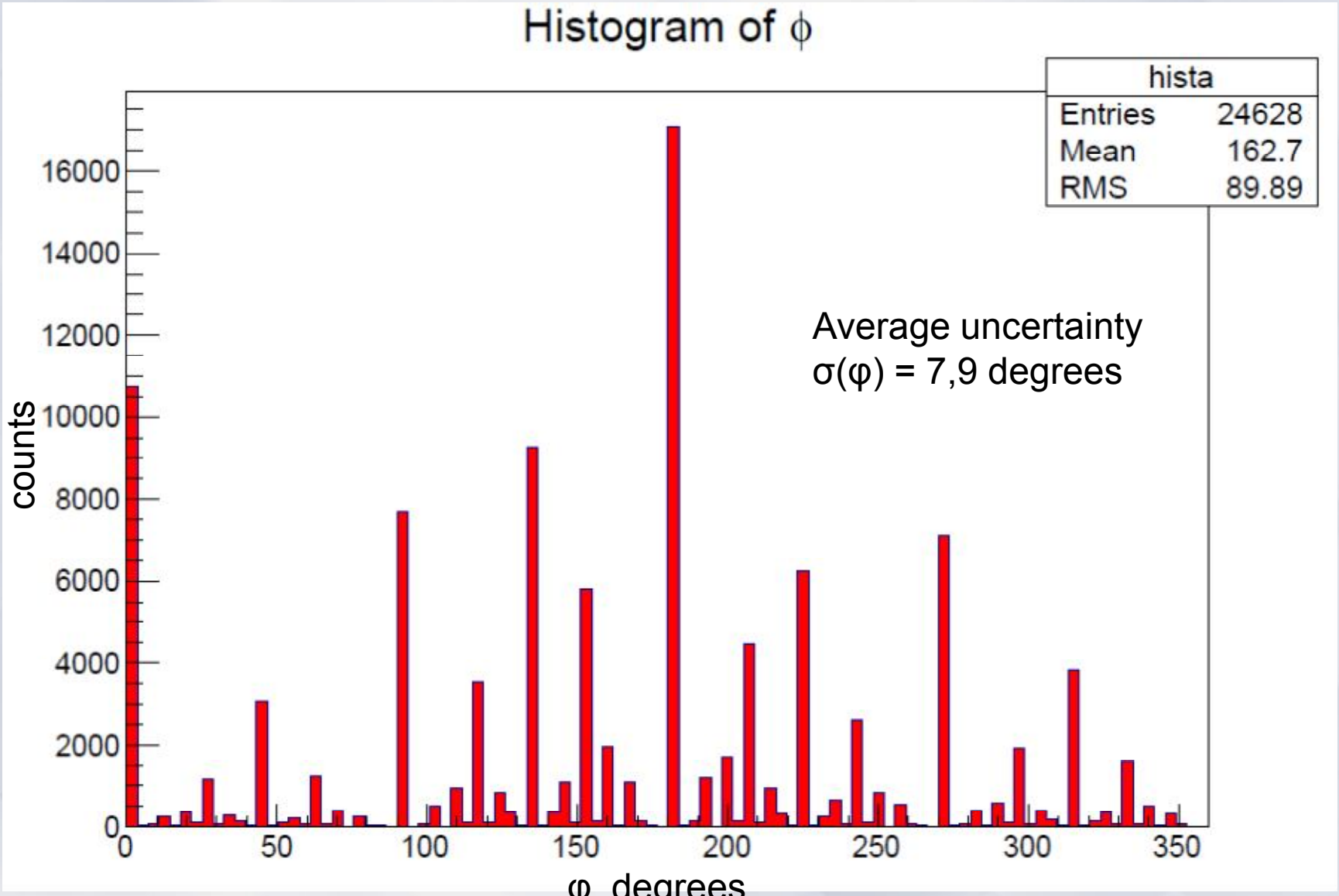
Solved equation for χ^2:

$$x = \frac{a_1 + a_2 + a_3}{3}$$
$$y = \frac{b_1 + b_2 + b_3}{3}$$
$$2htg\theta - \cos\varphi(a_1 - a_3) - \sin\varphi(b_1 - b_3) = 0$$
$$tg\varphi = \frac{b_1 - b_3}{a_1 - a_3}$$

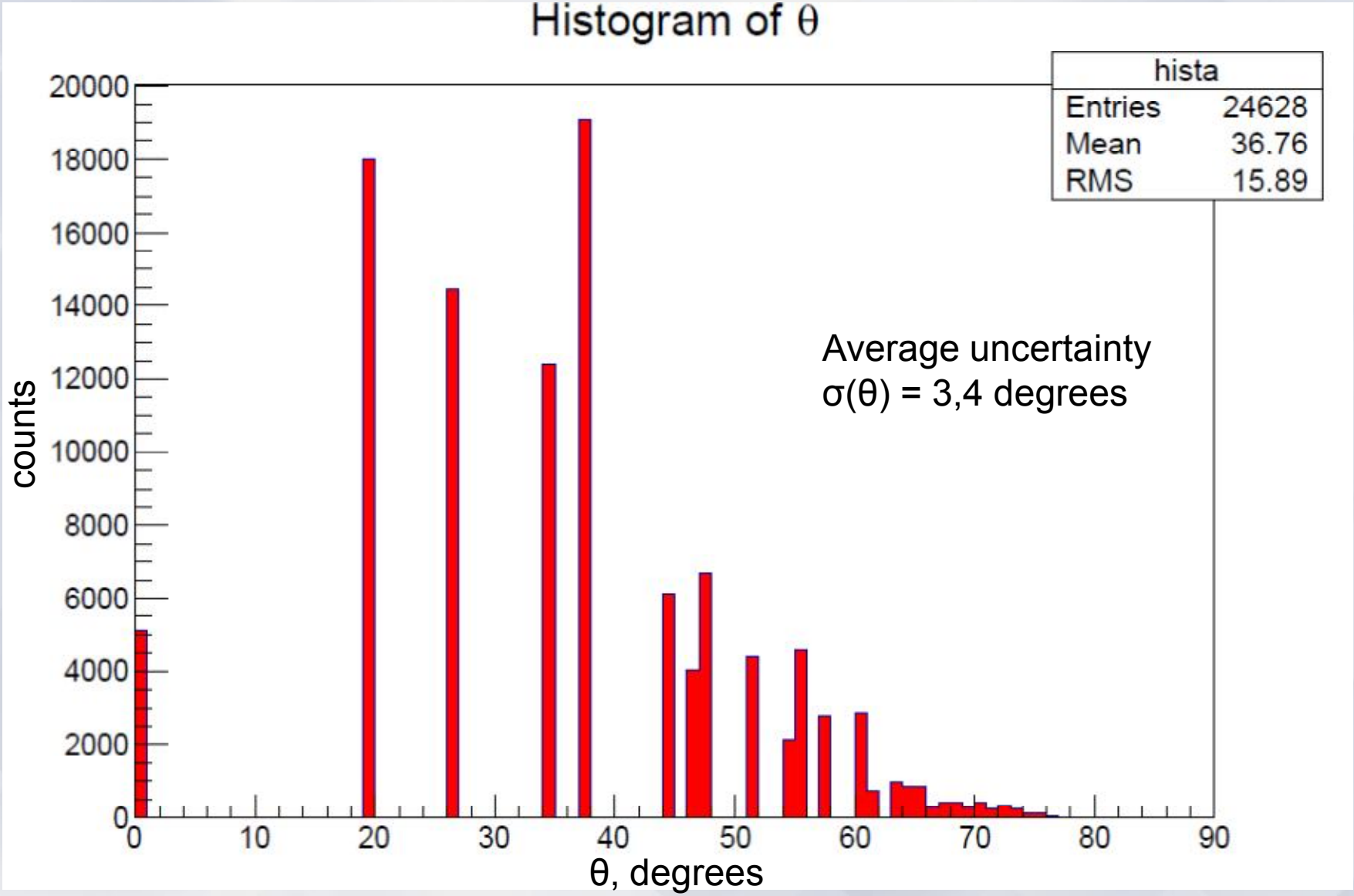
Angles uncertainties:

$$\Delta\varphi = \frac{\sigma}{\sqrt{2}htg\theta}$$
$$\Delta\theta = \frac{\sigma\cos^2\theta}{\sqrt{2}h}$$

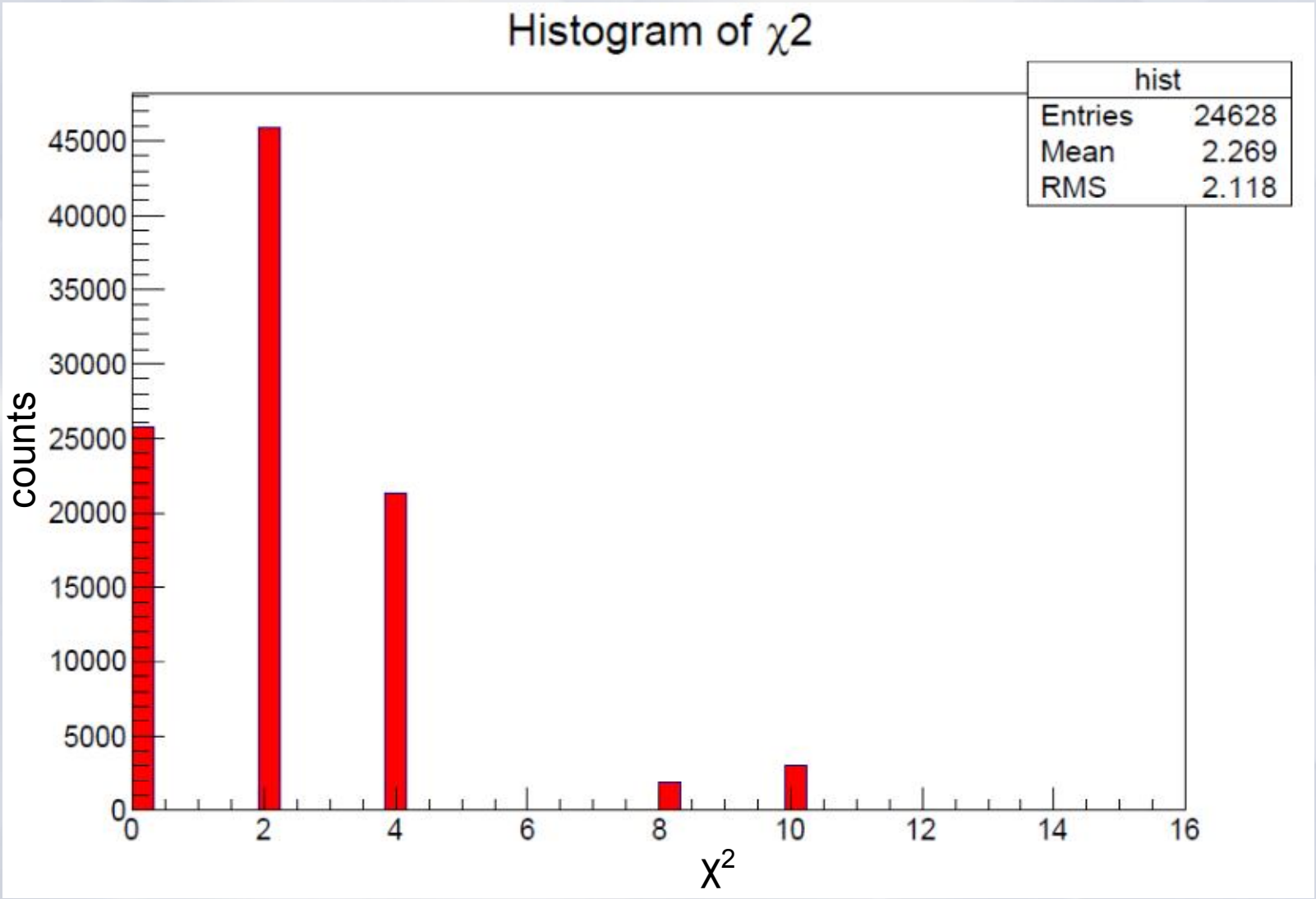
Results: histogram for azimuth angle φ



Results: histogram for zenith angle θ

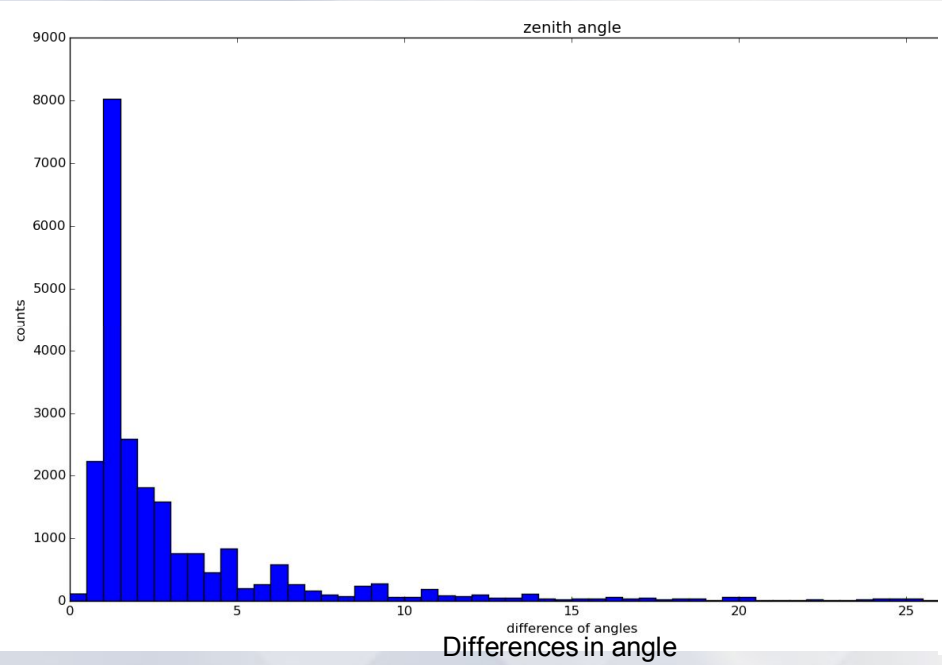


Histogram for chi-squared quantity χ^2

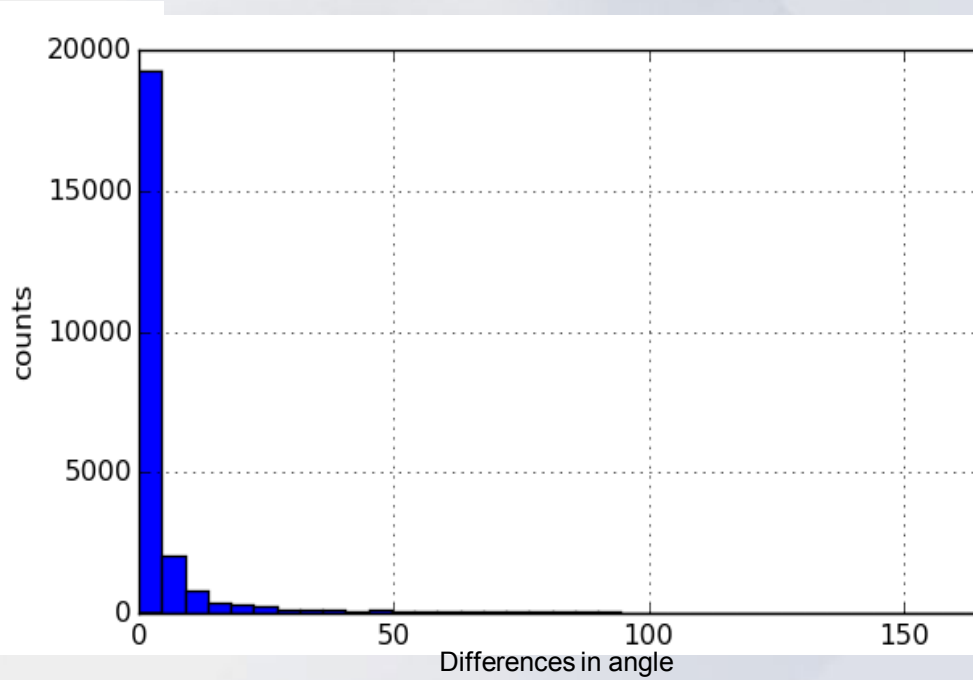


Maximum of chi-squared is at 2, that means a good work and reasonableness of the method.

Results comparison of two algorithms



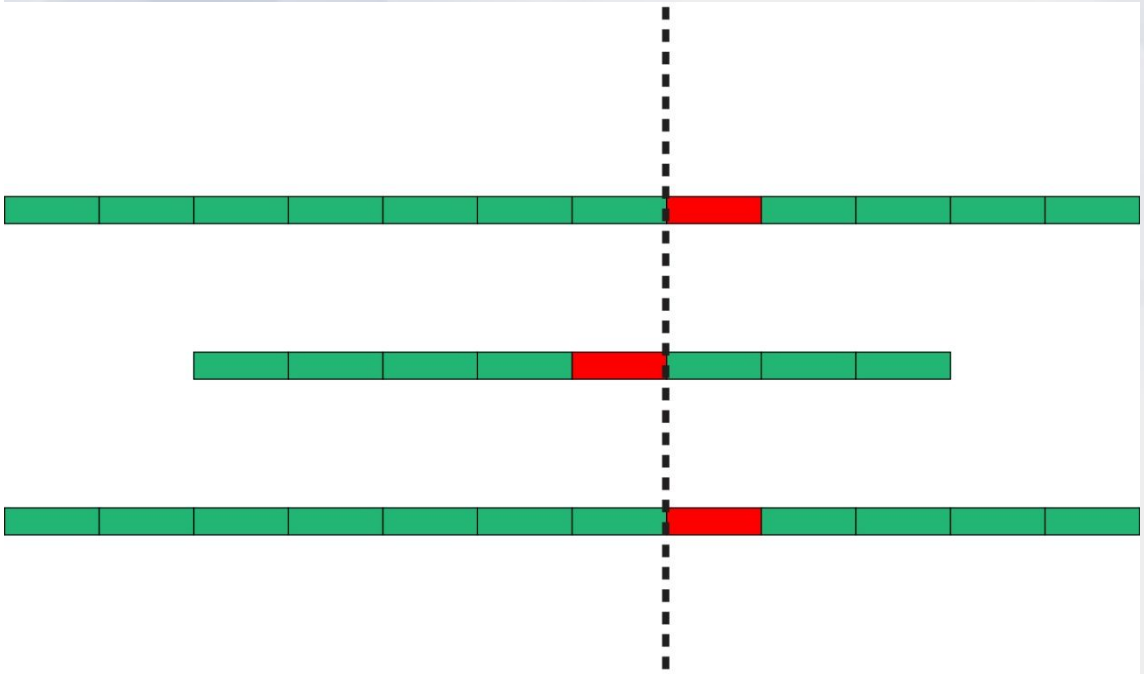
Zenith angle

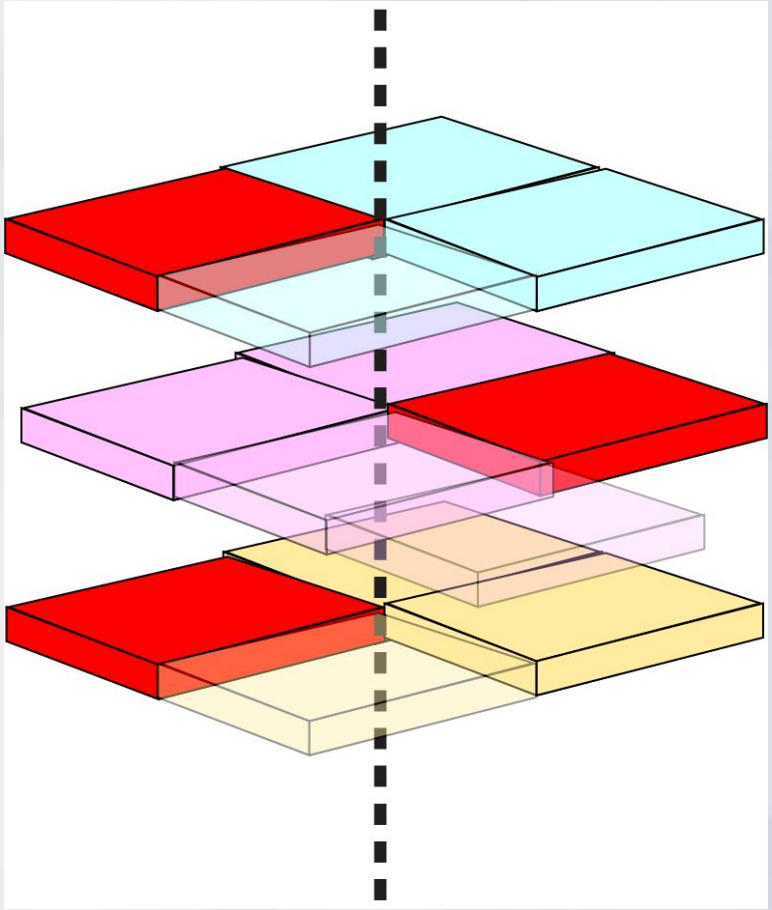


Azimuth angle

Therefore, these two methods are similar to each other with systematic error of 1-2 degrees.

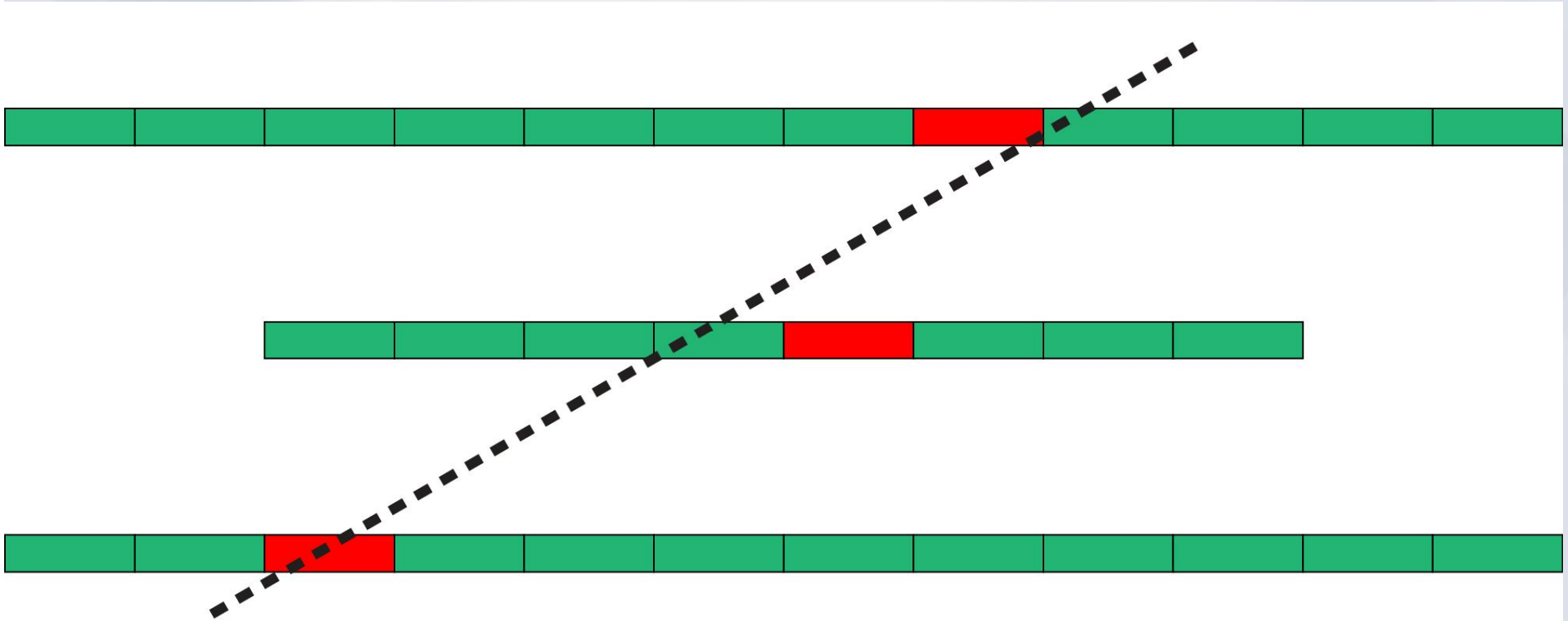
Select by χ^2: choose a criterion





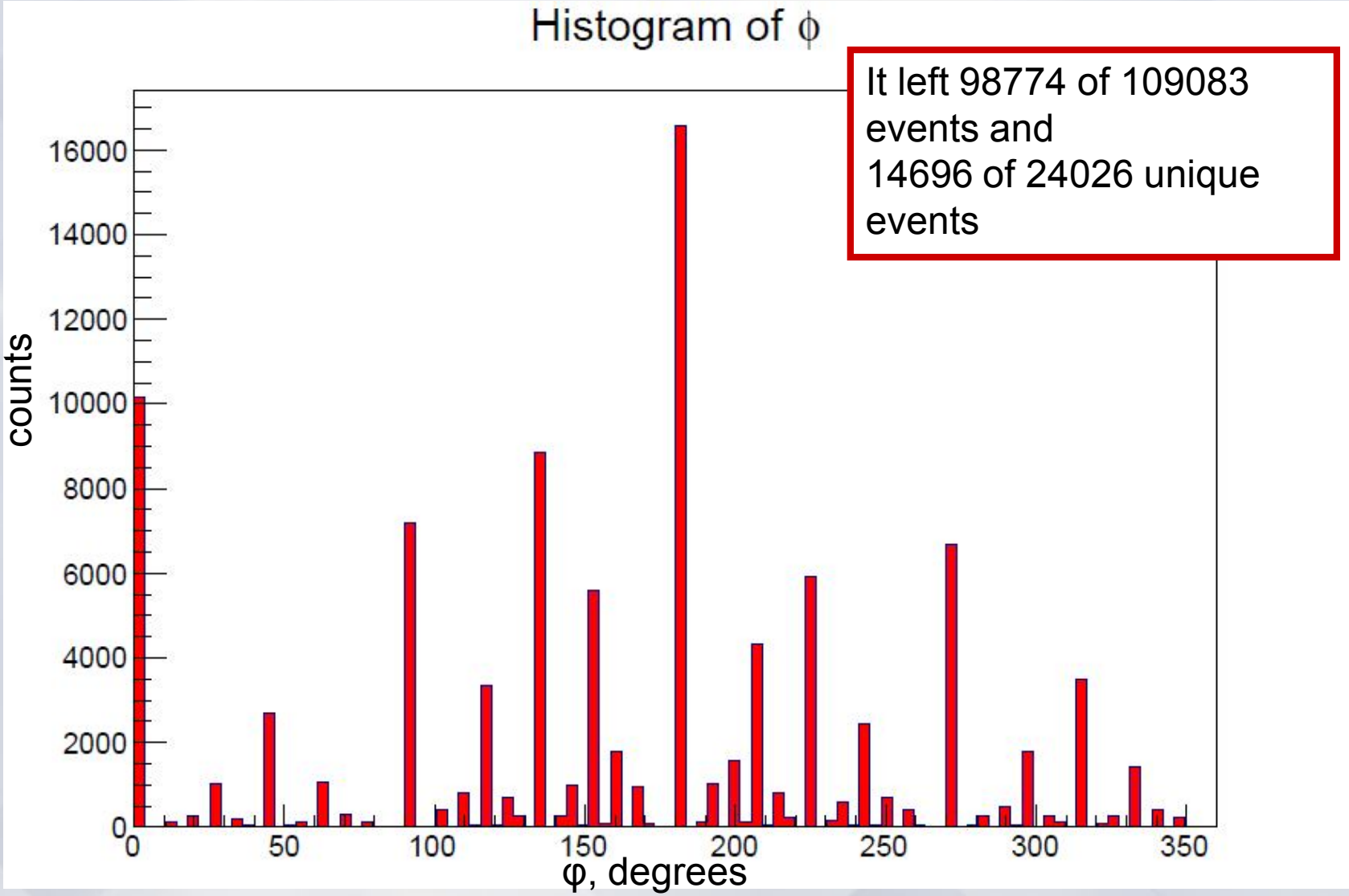
The line intersects triggered pixels, but only in corners. Such event has $\chi^2 = 16$

Select by χ^2: choose a criterion

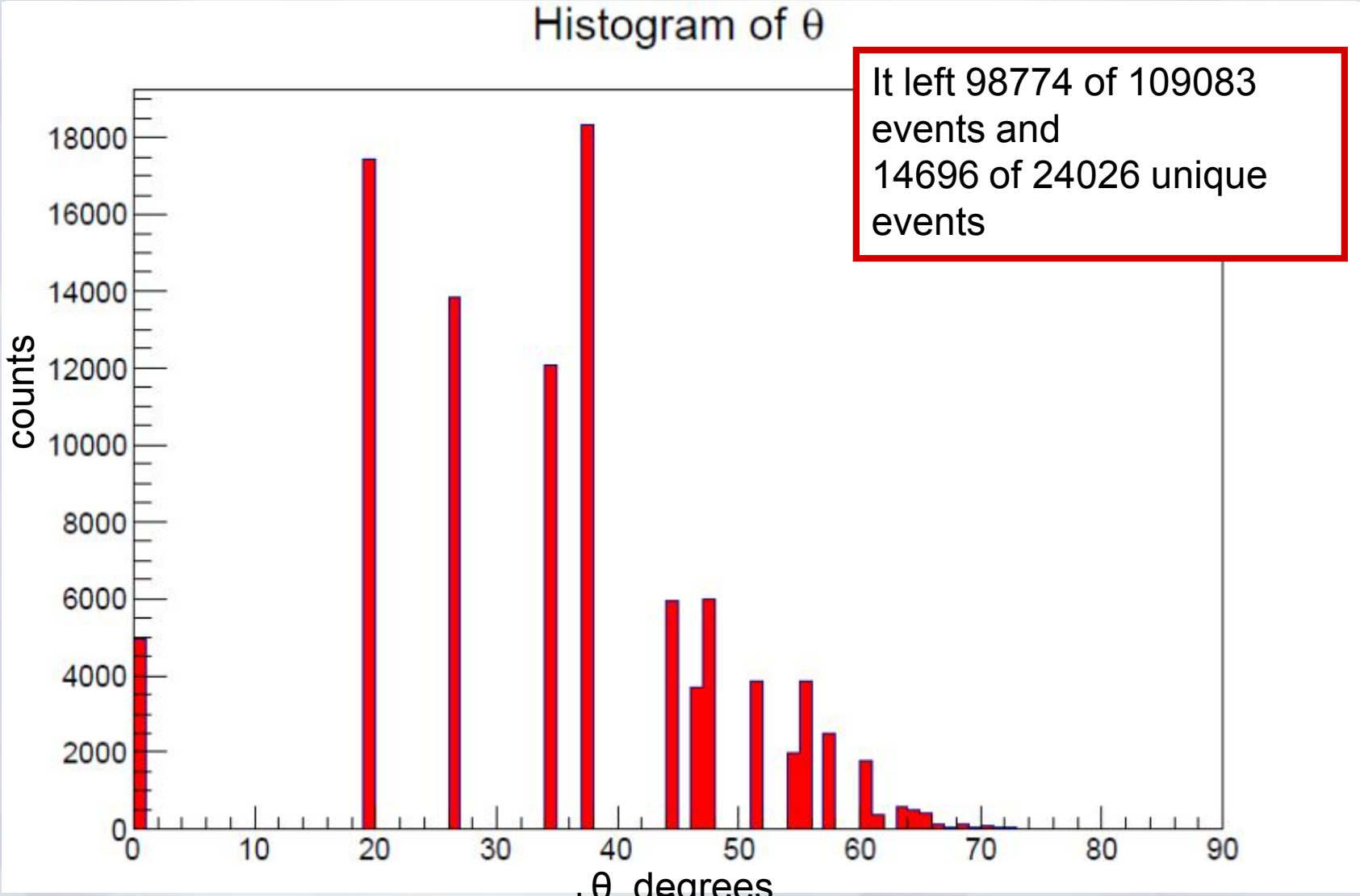


The line does not intersect one of triggered pixels. Such event has $\chi^2 = 18$.

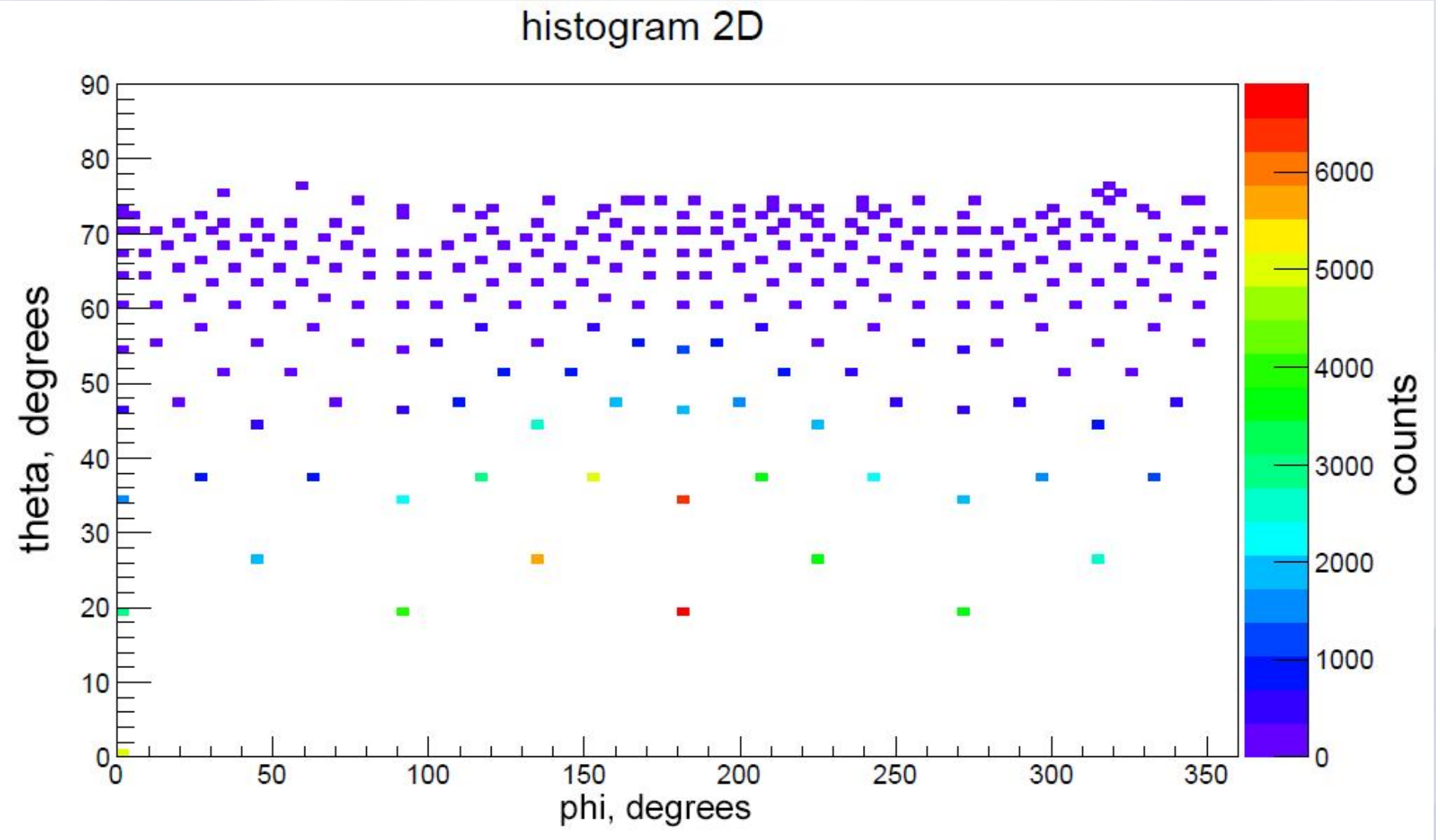
Selected events by $\chi^2 \leqq 16$



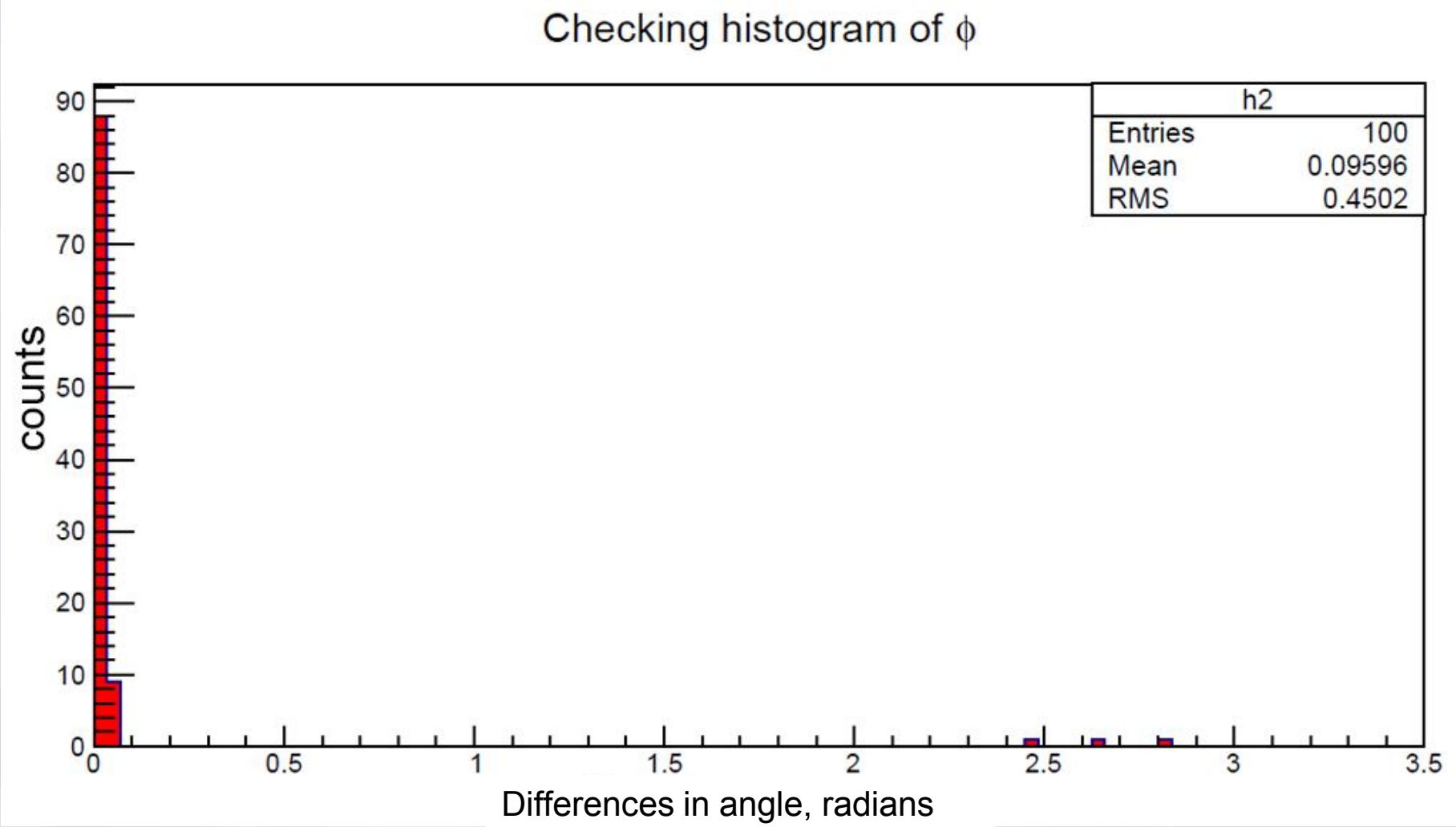
Selected events by $\chi^2 \leqq 16$



Angles after selection

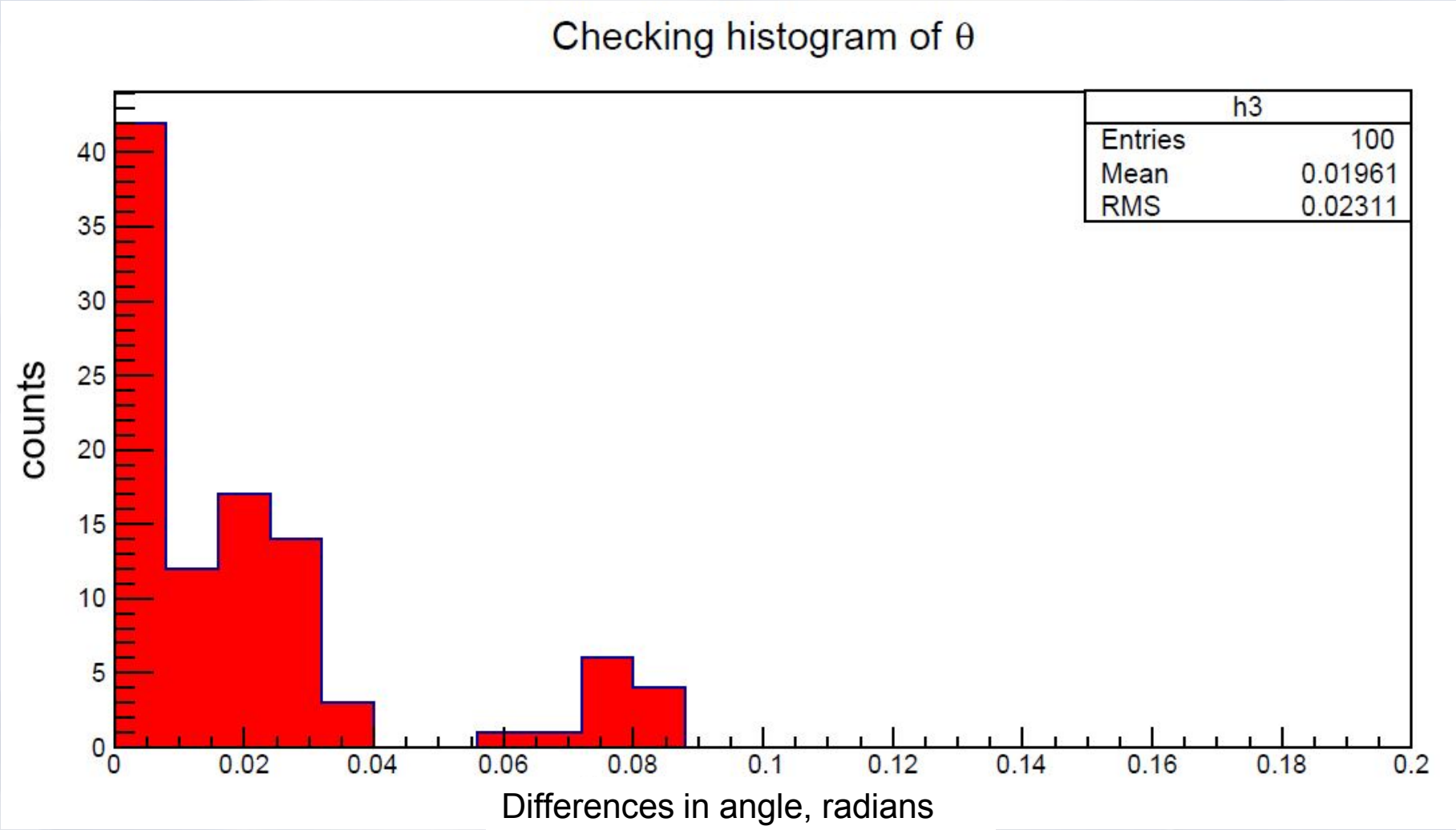


One more task: checking of simulation



Given algorithm has been used for checking results of muon simulation by Alexander Nozik. This is a histogram of differences between simulations angles and processed angles.

One more task: checking of simulation



Given algorithm has been used for checking results of muon simulation by Alexander Nozik. This is a histogram of differences between simulations angles and processed angles.

Conclusion

- the task of muon tracking analysis for triple-events was successfully solved
- the criterion to select “good” events from “bad” was created
- the previous results of angles was got