Correlations Calculation

The Recipe

1. Calculate covariance of yields :

The covariance between the yields by two wires is given by -

$$Cov(Y^i, Y^j) = \frac{1}{N}\sum_{k=1}^{N}(Y_k^i - \bar{Y}^i)(Y_k^j - \bar{Y}^j) \tag{11}$$

Where i and j are wire the number indices and N is the number of samples. So $Cov(Y^i, Y^j)$ is a 144x144 matrix.

2. Calculate covariance of raw and physics asymmetry:

Since raw asymmetry A_i^r is related to the yield by the relation,

$$A_i^r = \frac{Y_i^\uparrow - Y_i^\downarrow}{Y_i^\uparrow + Y_i^\downarrow} \tag{12}$$

So we can relate the covariance in yields to the raw asymmetry as

$$Cov(A_i^r, A_j^r) = \frac{Cov(Y_i, Y_j)}{\bar{Y_i}\bar{Y_j}} \tag{13}$$

Any the physics covariance is

$$Cov(A_i^p, A_j^p) = \frac{Cov(A_i^r, A_j^r)}{G_i G_j} \tag{14}$$

superscript "r" indicates raw asymmetry and "p" for physics asymmetry. Indices i and j again for wire number. G indicates the geometry factor.

3. Calculate total (overall) physics asymmetry:

Now the total (global) physics asymmetry is related to individual wire physics asymmetry by –

$$A_p^{tot} = \frac{\sum_i w_i A_i^p}{\sum_i w_i} \tag{15}$$

where the weight w_i is given by—

$$w_i = \sum_j InvCov(A_i^p, A_j^p) = \sum_j G_i G_j InvCov(A_i^r, A_j^r) = \sum_j G_i G_j \bar{Y_i} \bar{Y_j} InvCov(Y_i, Y_j) \tag{16}$$

Where InvCov is the inverse of the covariance matrix.

4. Calculate error in total(overall) physics asymmetry :

The error in the total(overall) physics asymmetry –

$$\Delta A_p^{tot} = \frac{1}{\sqrt{\sum_i w_i}} \tag{17}$$

where w_i is given by equation (16).

5. Calculate the chi-square of the weighted average :
The chi-square in our weighted asymmetry calculation is given by –

$$\chi^2 = \sum_{ij}(A_i^p - A_p^{tot})w_{ij}(A_j^p - A_p^{tot}) \tag{18}$$

6. Quote the Result:
Then the final result is :

$$A_p^{tot} \pm \Delta A_p^{tot} \tag{19}$$

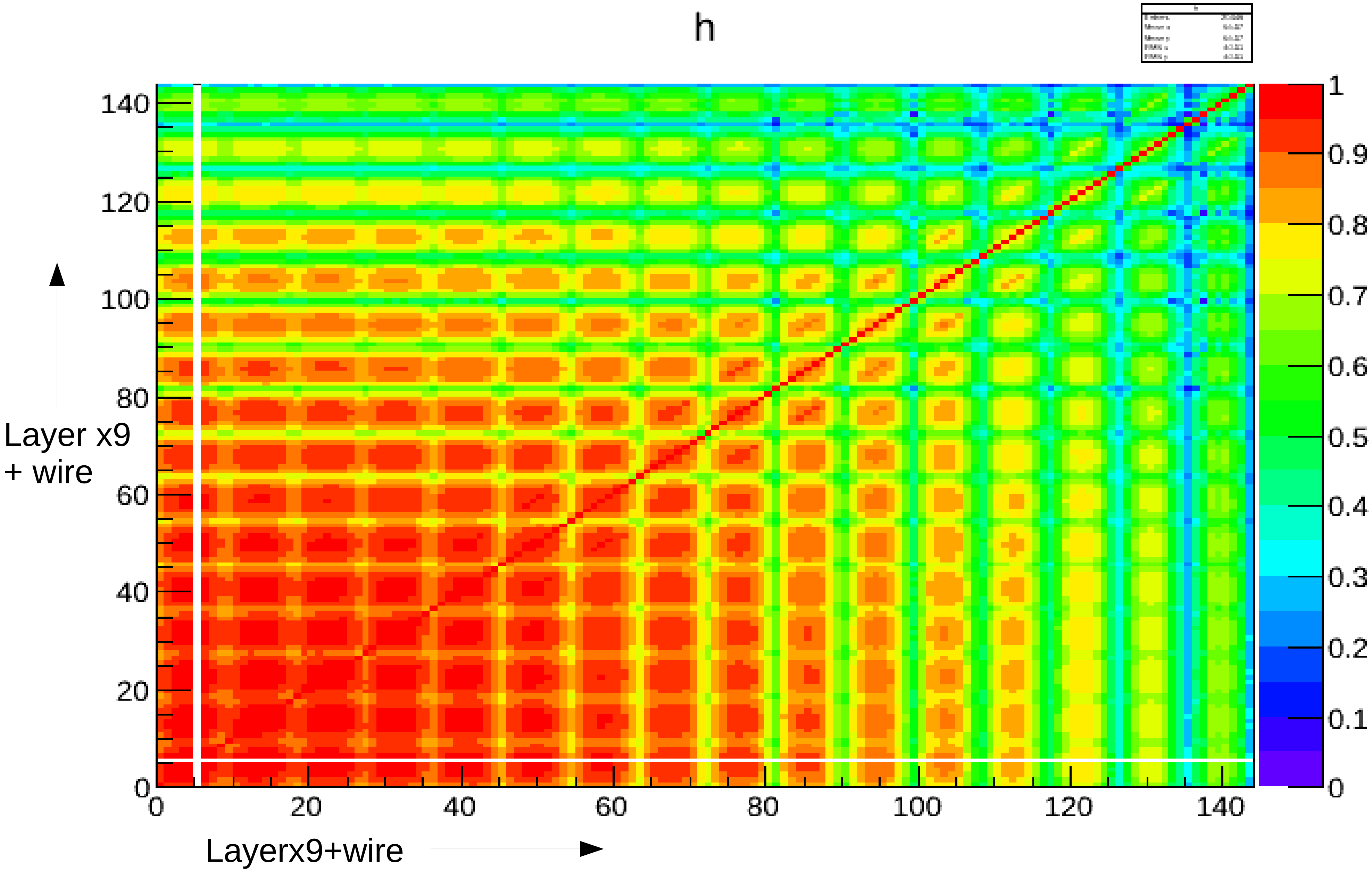
And the goodness of the result is given by χ^2/ndf

Now the measure of covariance is often expressed as the correlation coefficient (which is just the normalized covariance) as :

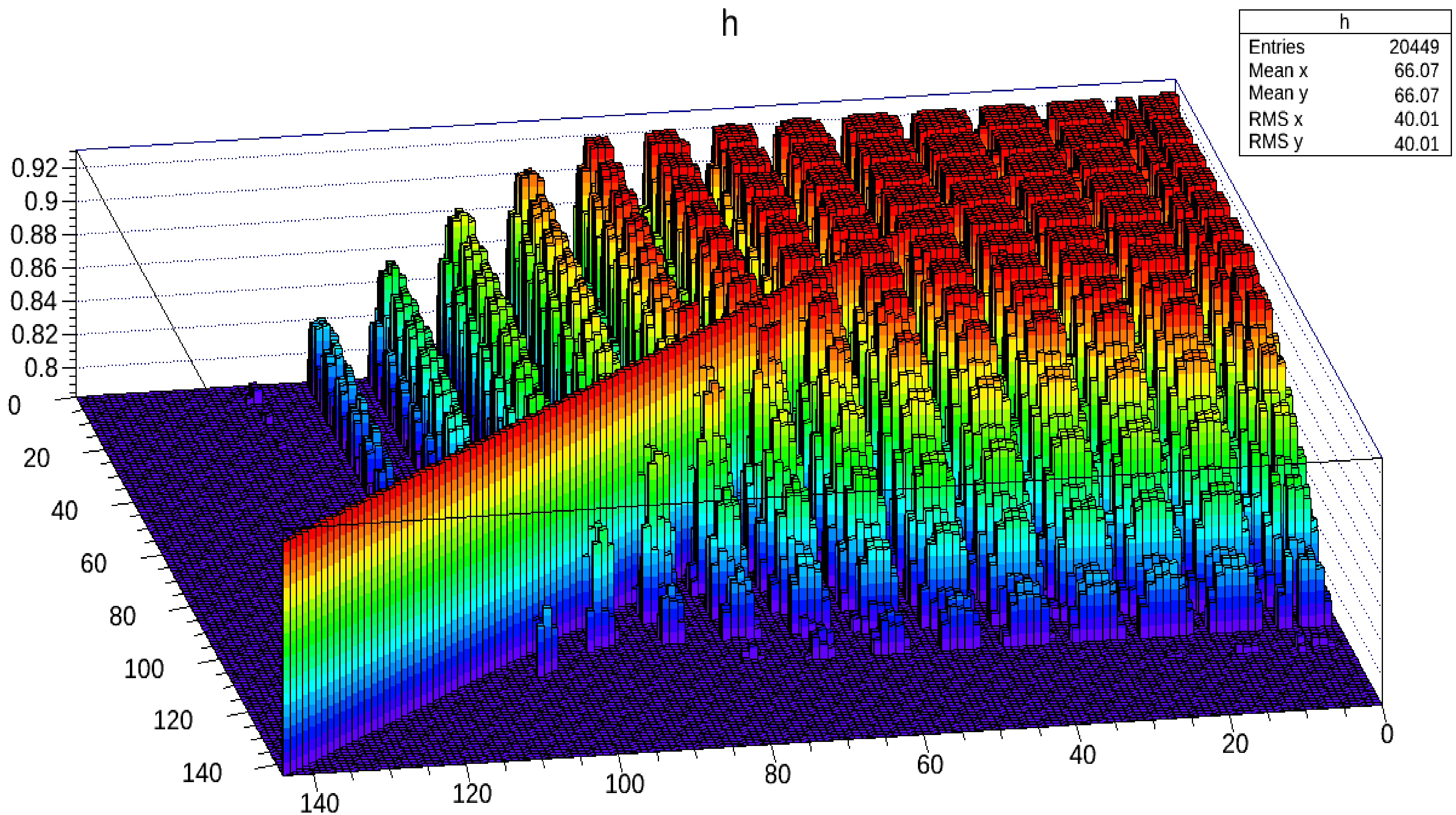
$$\rho = \frac{Cov(Y_i, Y_j)}{\sigma_i \sigma_j} \tag{20}$$

where σ_i and σ_j are standard deviations (square root of variance). The correlation coefficient varies between -1 and +1 where the sign indicates the sense of correlation. If the variables are perfectly correlated linearly , then $|\rho| = 1$, if the variables are independent then $\rho = 0$(care should be taken

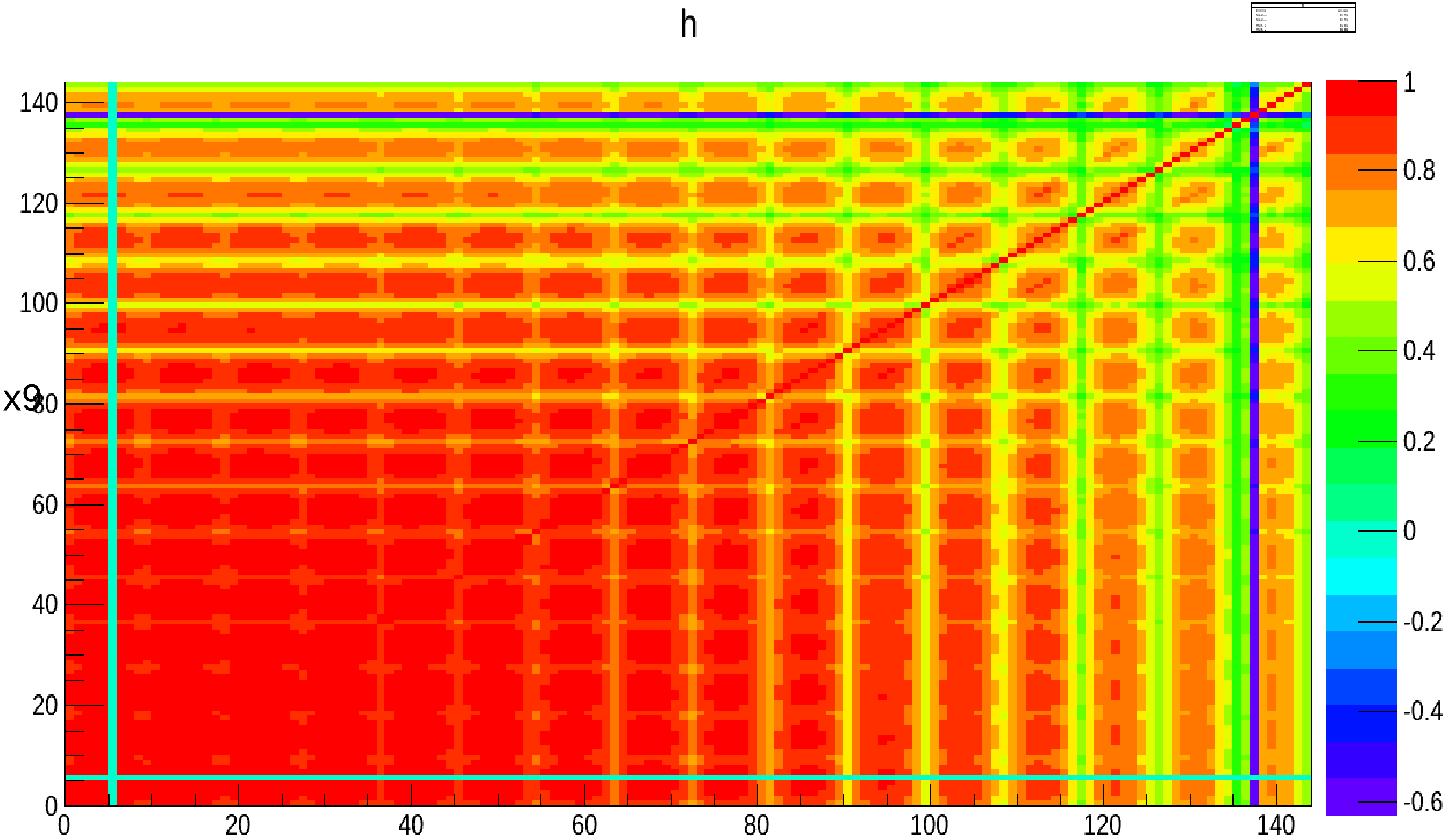
Yield Correlations: Typical UD run: run# 26230 at 0.5 atm



Yield Correlations:Typical UD run: run# 26230 at 0.5 atm (Alternative plotting)



Yield Correlations :LR run 0.5 atm : run#57631



Layer x9 + wire

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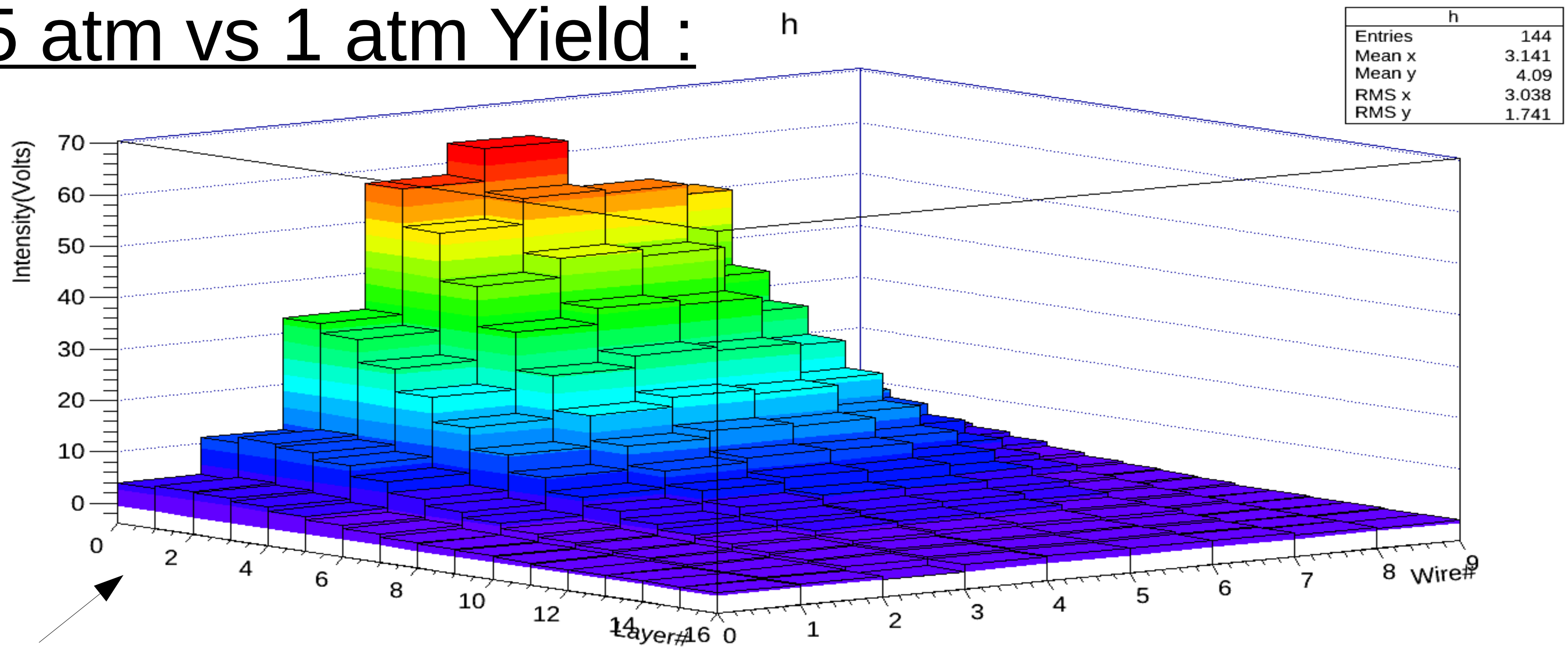
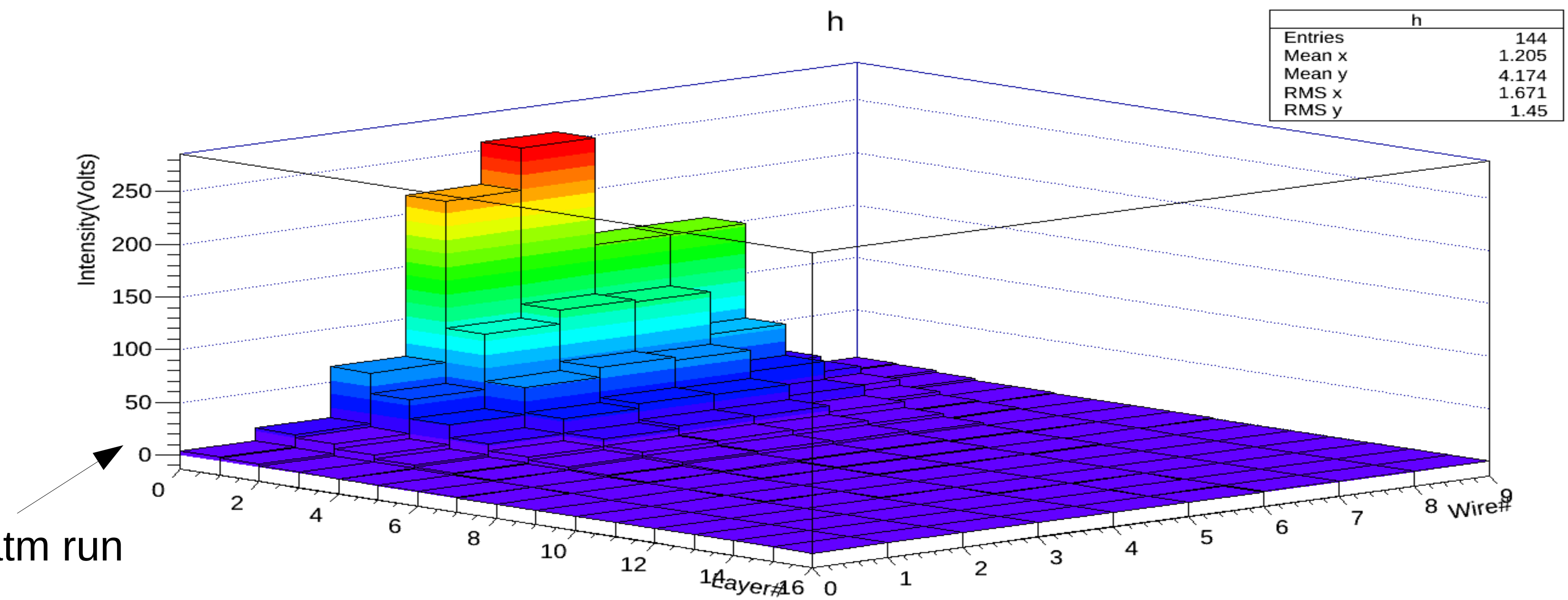
0.5 atm vs 1 atm Yield :

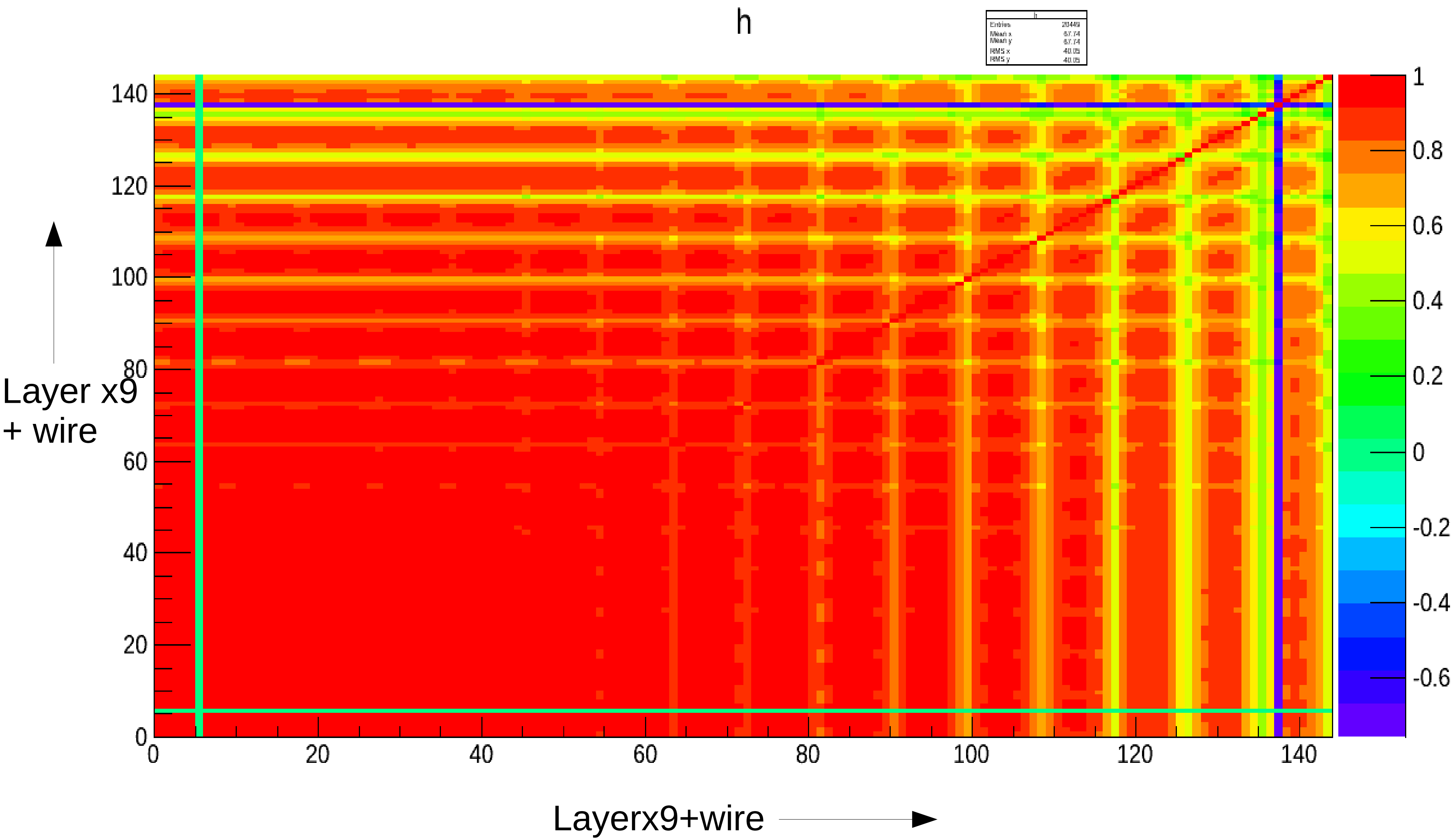


0.5 atm run



1 atm run

Yield Correlations : LR run #15010, 0.5 atm



Yield Correlations : LR run#60100 : 1 atm