

Correlations Calculation

The Recipe

1. Calculate covariance of yields :

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

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

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,

$$A_i^r = \frac{Y_i^\uparrow - Y_i^\downarrow}{Y_i^\uparrow + Y_i^\downarrow} \quad (12)$$

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

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

Any the physics covariance is

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

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 –

$$A_p^{tot} = \frac{\sum_i w_i A_i^p}{\sum_i w_i} \quad (15)$$

where the weight w_i is given by—

$$w_i = \sum_j InvCov(A_i^p, A_j^p) = \sum_j G_i G_j InvCov(A_i^r, A_j^r) = \sum_j G_i G_j Y_i Y_j InvCov(Y_i, Y_j) \quad (16)$$

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 –

$$\Delta A_p^{tot} = \frac{1}{\sqrt{\sum_i w_i}} \quad (17)$$

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 –

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

6. Quote the Result:

Then the final result is :

$$A_p^{tot} \pm \Delta A_p^{tot} \quad (19)$$

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