Systematics for The n-^{3}He Experiment

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Outline

1. **M1 Asymmetry**
2. **Detector Asymmetry**
3. **Instrumental Asymmetry**
4. **Systematics associated with GF calculation**

M1 Asymmetry & Detector Asymmetry

$$\text{M1 Asymmetry: } A_b = \frac{M_1^{\uparrow} - M_1^{\downarrow}}{M_1^{\uparrow} + M_1^{\downarrow}} \tag{1}$$

$$\text{Detector Asymmetry: } A_d^i = \frac{Y_i - Y_{i*}}{Y_i + Y_{i*}} \tag{2}$$

Where, i and i* are conjugate wire index.

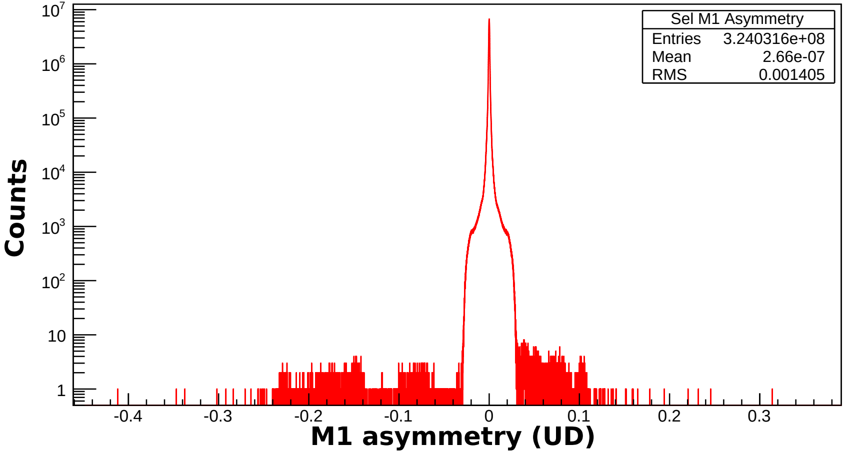
$$A_d = \frac{\sum_i w_i A_d^i}{\sum_i w_i} \tag{3}$$

$$w_i = \delta^{-2} A_{phy}^i \tag{4}$$

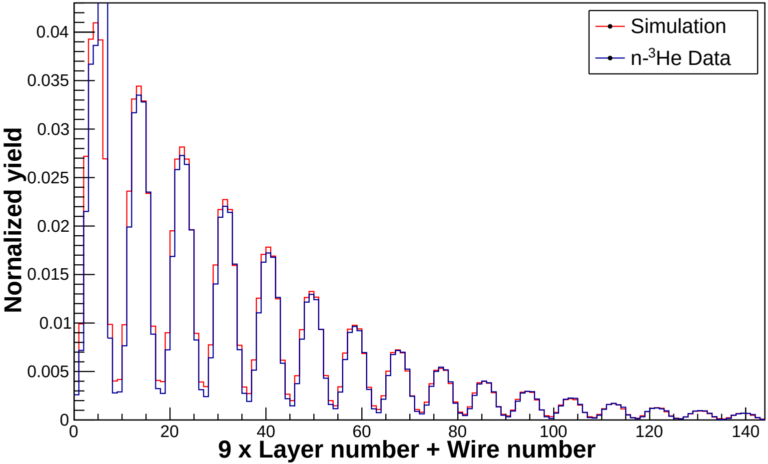
$\delta^{-2} A_{phy}^i$ is the error from the wire physics asymmetry considering all the runs in a single batch.

— $A_b A_d$?

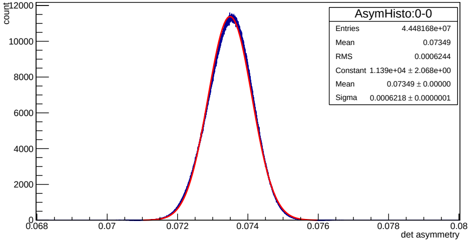
M1 Asymmetry

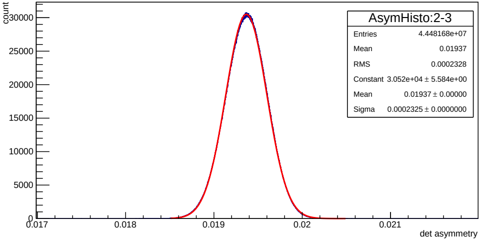


Detector Asymmetry

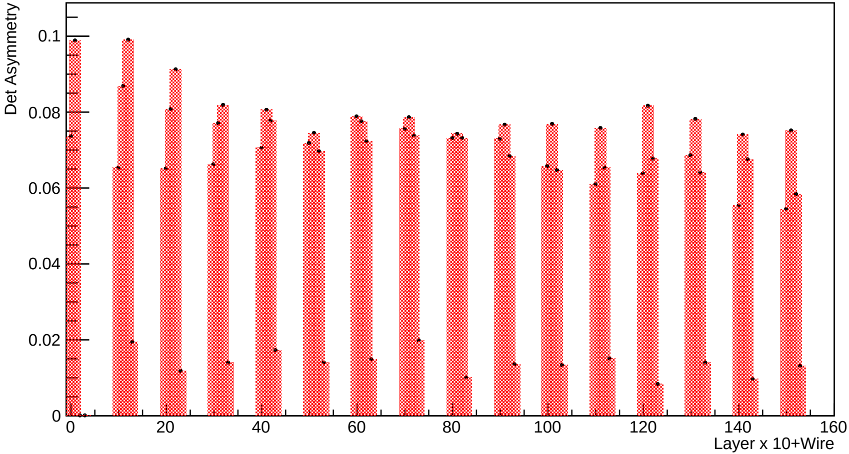


Detector Asymmetry

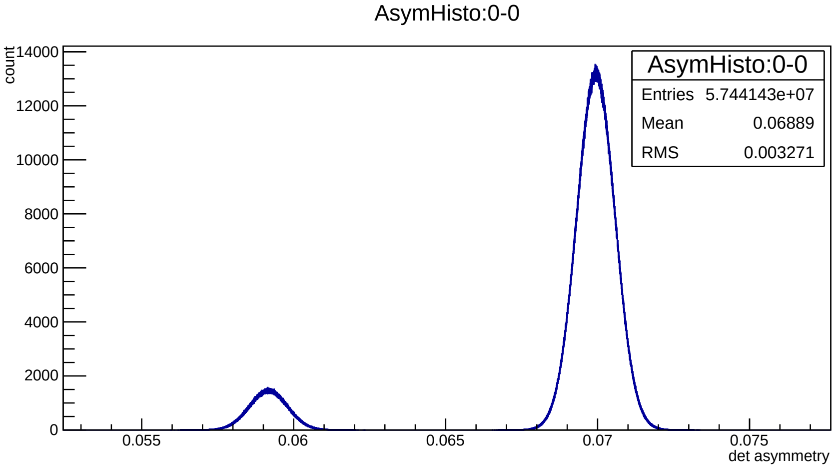




Detector Asymmetry



Detector Asymmetry



Instrumental Asymmetry

$$A_i = \frac{Y_i^{\uparrow} - Y_i^{\downarrow}}{Y_i^{\uparrow} + Y_i^{\downarrow}} = \frac{(S_i^{\uparrow} + b_i^{\uparrow}) - (S_i^{\downarrow} + b_i^{\downarrow})}{(S_i^{\uparrow} + b_i^{\uparrow}) + (S_i^{\downarrow} + b_i^{\downarrow})} \approx \frac{S_i^{\uparrow} - S_i^{\downarrow}}{S_i^{\uparrow} + S_i^{\downarrow}} + \frac{b_i^{\uparrow} - b_i^{\downarrow}}{S_i^{\uparrow} + S_i^{\downarrow}} \quad (5)$$

where $b_i^{\uparrow\downarrow}$ is the contribution from pedestal.

$$A_{inst}^{i} = \frac{1}{G_i}\frac{b_i^{\uparrow} - b_i^{\downarrow}}{2S^i} \quad (6)$$

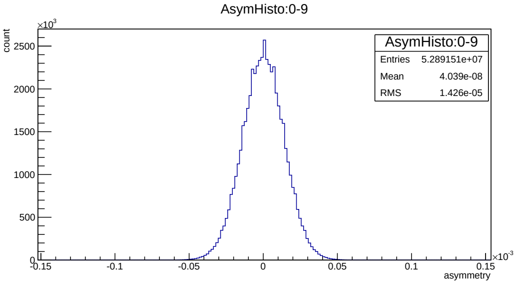
$$A_{inst} = \frac{\sum_i w_i A_{inst}^{i}}{\sum_i w_i} \quad (7)$$

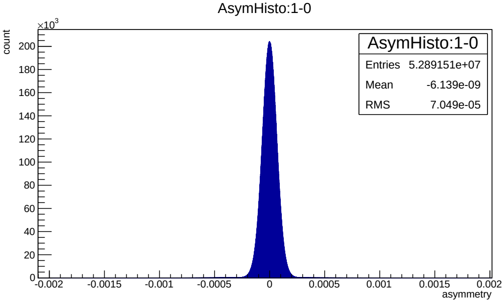
$$(\delta A_{inst})^2 = \frac{\sum_i w_i^2 (\delta A_{inst}^{i})^2}{(\sum_i w_i)^2} \quad (8)$$

where,

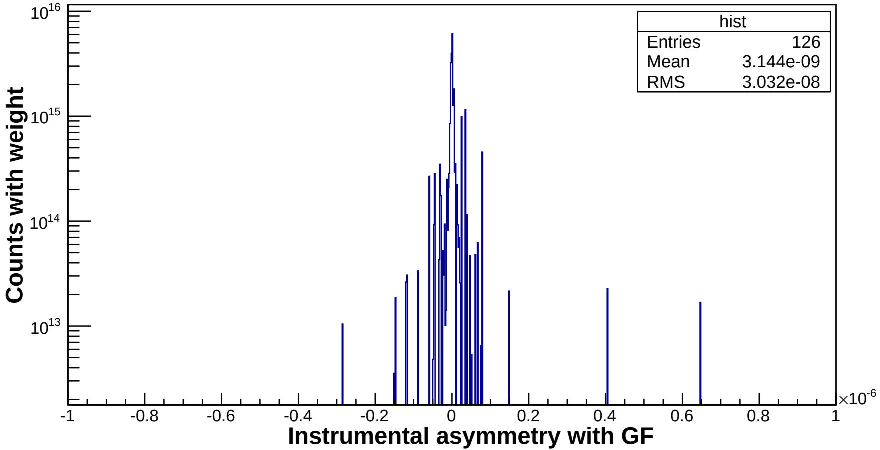
$$w_i = \delta^{-2} A_{phy}^{i} \quad (9)$$

Instrumental Asymmetry





Instrumental Asymmetry



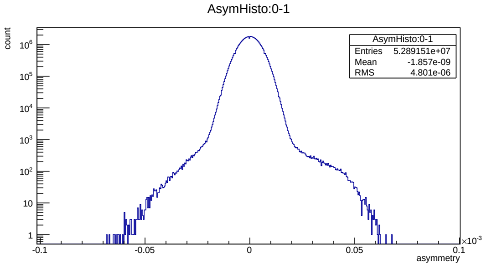
Instrumental Asymmetry

Analysis of all the no-beam data using Eq. 7 and Eq. 8 gives,

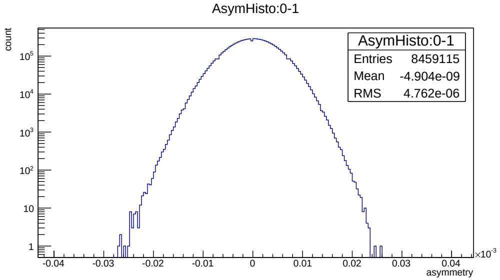
$$A_{inst} = (3.14 \pm 0.60) \times 10^{-9}. \tag{10}$$

This includes three types of no-beam runs —
— Maintenance day runs
— Long time accelerator down runs
— Accidental no beam runs during normal operations

Instrumental Asymmetry: Summer runs vs all runs



(c) All runs



(d) Summer runs

Instrumental Asymmetry: Tuesday runs vs Summer runs vs all runs

Summer runs(Total 677 runs):

$$A_{inst} = (13.12 \pm 1.14) \times 10^{-9}. \tag{11}$$

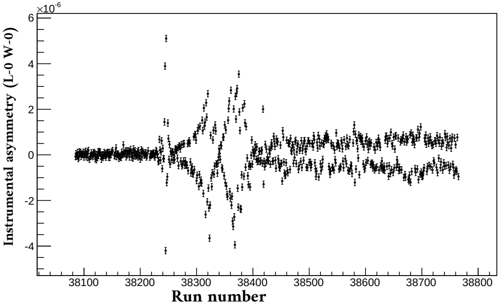
Tuesday runs (Total 620 runs):

$$A_{inst} = (6.918 \pm 1.15) \times 10^{-9}. \tag{12}$$

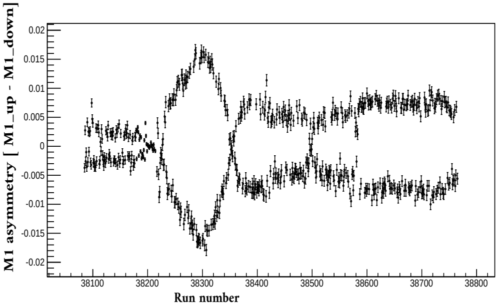
All runs (Total 4383 runs):

$$A_{inst} = (3.14 \pm 0.60) \times 10^{-9}. \tag{13}$$

Summer runs: instrumental wire asymmetry vs M1 asymmetry

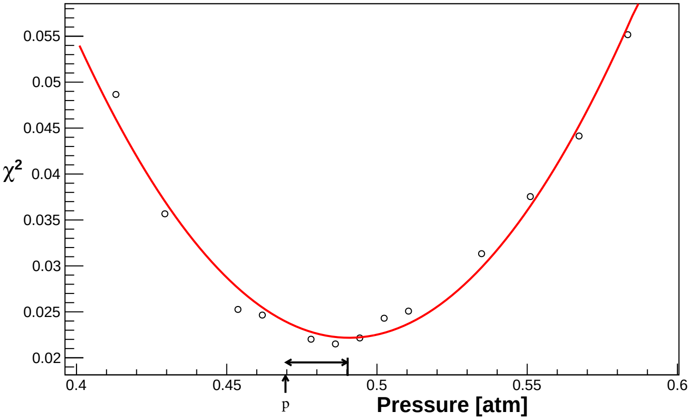


(e) Wire (instrumental) asymmetry



(f) M1 asymmetry (with no beam)

Systematics associated with GF calculation: Pressure optimization



Pressure optimization

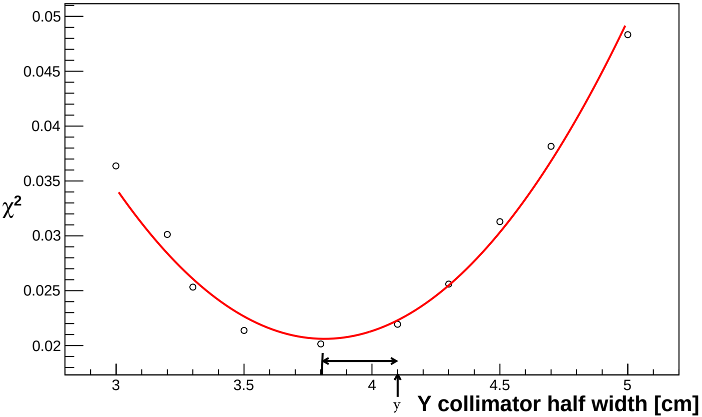
$$P = 0.47\ atm \qquad P_0 = 0.491\ atm \tag{14}$$

$$A_{UD}(P) = 1.02 \times 10^{-8} \qquad A_{UD}(P_0) = 1.0057 \times 10^{-8} \tag{15}$$

$$A_{LR}(P) = -4.41 \times 10^{-7} \qquad A_{LR}(P_0) = -4.343 \times 10^{-7} \tag{16}$$

From the two values $\delta A_{UD}(P)$ is calculated.

Half collimator width y optimization



Half collimator width y optimization

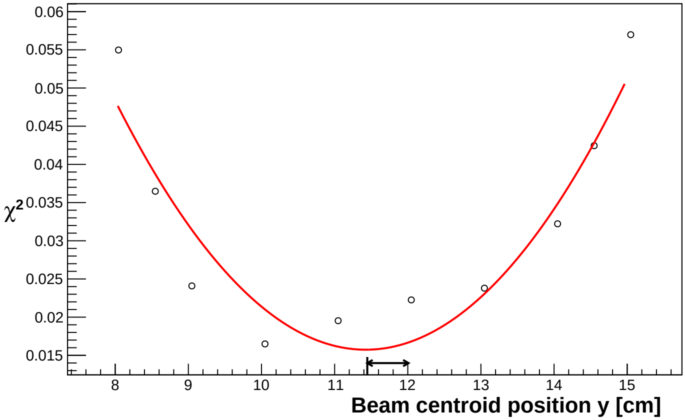
$$y = 4.1\ cm \qquad y_0 = 3.85\ cm \tag{17}$$

$$A_{UD}(y) = 1.02 \times 10^{-8} \qquad A_{UD}(y_0) = 1.00711 \times 10^{-8} \tag{18}$$

$$A_{LR}(y) = -4.41 \times 10^{-7} \qquad A_{LR}(y_0) = -4.1257 \times 10^{-7} \tag{19}$$

From the two values $\delta A_{UD}(y)$ is calculated.

Beam centroid position (y) optimization



Beam centroid position (y) optimization

$$y^{bc} = 12.04\ cm \qquad y_0^{bc} = 11.5\ cm \tag{20}$$

$$A_{UD}(y^{bc}) = 1.02 \times 10^{-8} \qquad A_{UD}(y_0^{bc}) = 1.00027 \times 10^{-8} \tag{21}$$

$$A_{LR}(y^{bc}) = -4.41 \times 10^{-7} \qquad A_{LR}(y_0^{bc}) = -4.2937 \times 10^{-7} \tag{22}$$

From the two values $\delta A_{UD}(y^{bc})$ is calculated.