

CLAS Collaboration meeting

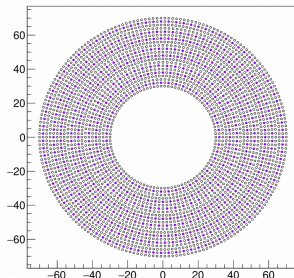
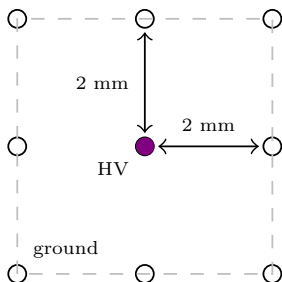
ALERT AHDC tracking
and alignment

Felix Touchte Codjo

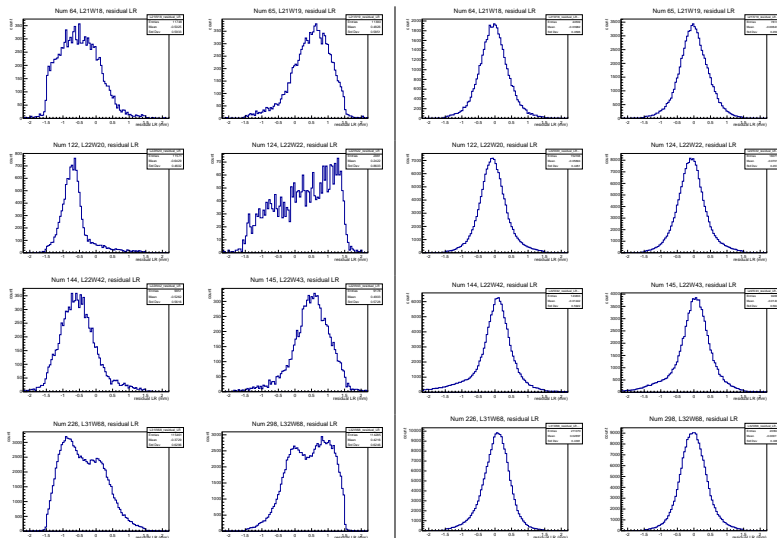
IJCLab

June 30, 2026

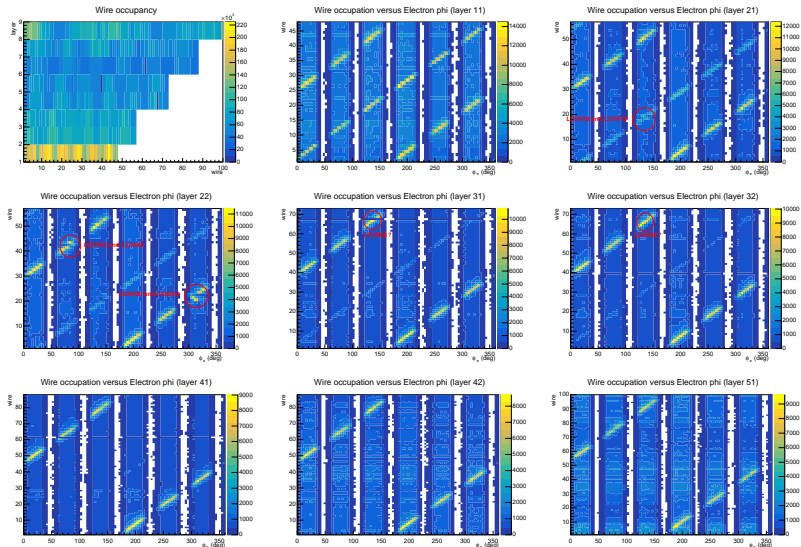
- ▶ Cylindrical wire chamber filled with He/CO₂ (80/20%)
- ▶ Novelty :
 - All wires have the same \varnothing , 30 μm , and AlMg5 material
 - Total of 3026 wires, 576 are readouts with positive charge
 - Sense wires are distributed over 5 superlayers containing 1 or 2 layers (11, 21, 22, 31, 32, 41, 42, 51)
 - It has stereo angles varying from 3.8° to 7.4° between superlayers for the v_z reconstruction



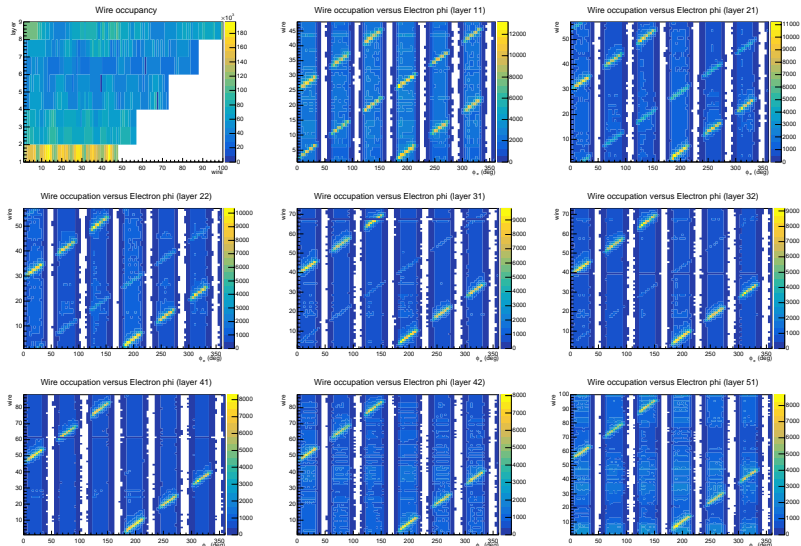
- ▶ Analyzing wire by wire distributions, we found 4 couples of wire swaps
- ▶ Distributions before (on the left) and after fix (on the right)



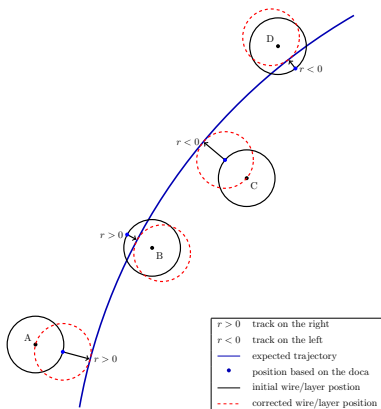
- Swaps were also visible in the wire occupancy versus electron ϕ_e distributions for elastic events



- Wire occupancy versus electron ϕ_e distributions for elastic events after fixing the translation table



- ▶ Context: limitations in the AHDC track reconstruction
 - need to improve the overall tracking resolution
 - need to improve the resolution of the reconstructed θ
 - need to extract the relative position of the AHDC with respect to CLAS
- ▶ Principle:
 - Select elastic events : electron + track (collection of hits)
 - Compute the expected track kinematics from the electron ones
 - Propagate the expected track
 - Estimate how far it deviates from the measured collection of hits
- ▶ Our observable : **residual_LR**
 - It indicates whether the track is on right or on the left of the measurement
- ▶ Correction angles (rotZ)



$$\alpha_i = \alpha_{i-1} - \frac{r_i}{R} \cdot \frac{1}{2}$$

- ▶ The phi alignment is so much dependent on the precision of the vertex determination

$$(\text{AHDC } v_z) = (\text{CLAS electron } v_z) - (v_z \text{ shift})$$

- ▶ Limitations

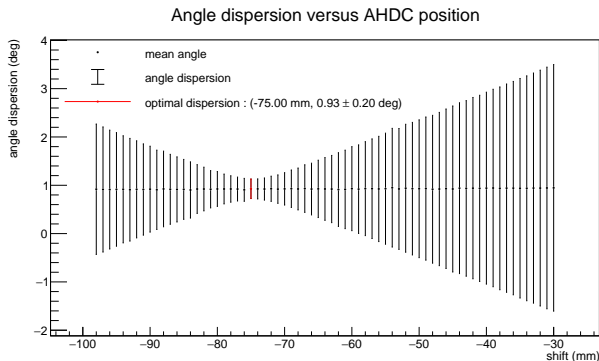
- (CLAS electron v_z) has a limited resolution for elastic events, $\theta_e \sim 6^\circ$
- (v_z shift) relative position of the AHDC relative to the center of CLAS

- ▶ Solutions/Observations

- Doing a fit can release the constraint on (CLAS electron v_z)
- Using the exact (v_z shift) value make the correction angles smaller (so more physical)

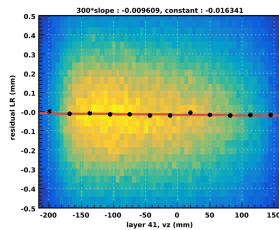
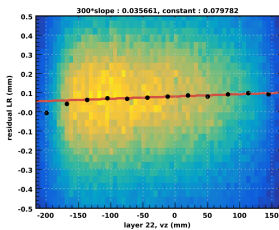
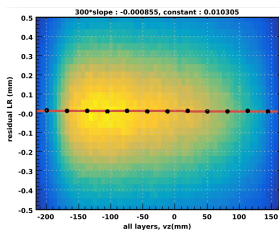
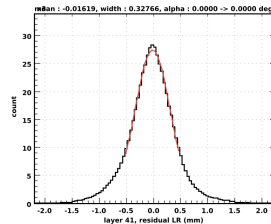
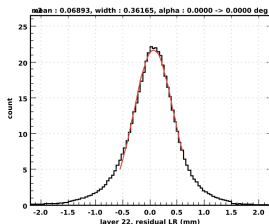
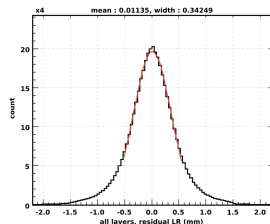
layer \ shift	-54 mm	-30 mm	-70 mm
11	0 deg	-1.49	+0.756
21	+2.55	+3.82	+1.517
22	+2.11	+3.24	+0.984
31	0	-1.54	+0.807
32	-0.32	-1.96	+0.382
41	+3.0	+3.73	+1.305
42	+2.13	+3.3	+0.975
51	-0.21	-1.61	+0.679

- ▶ According to the layer alignment without fit, the optimal AHDC position with respect to CLAS is **-75 mm**

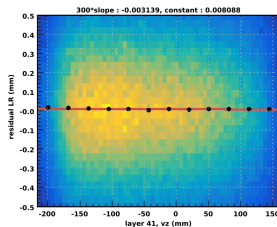
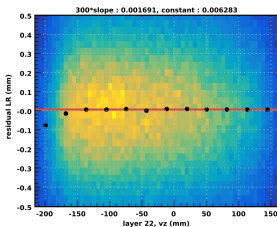
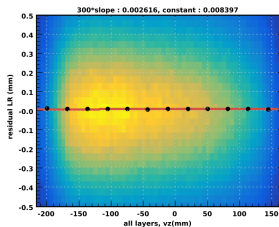
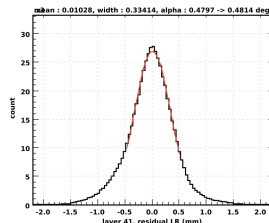
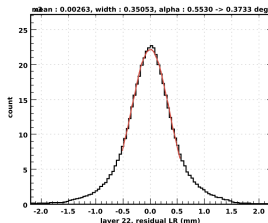
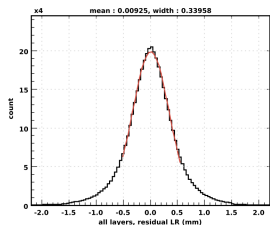


- ▶ The following alignment works have been done by performing a **fit** with a **-75 mm** shift

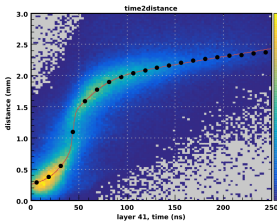
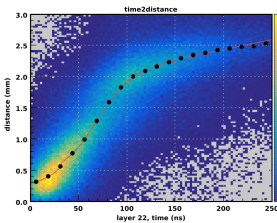
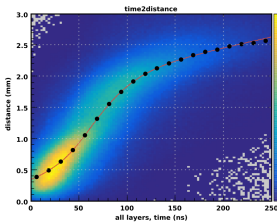
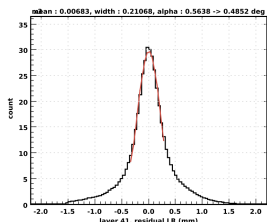
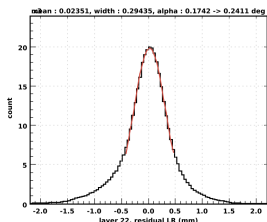
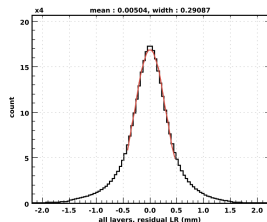
- ▶ We want the **residual_LR** to be well centered with $\langle r \rangle$ lower than $10 \mu\text{m}$
- ▶ The slope in **residual_LR** versus **vz** requires to apply different correction angles at the two ends of the detector



- ▶ Corresponding distributions after alignment (upstream_rotZ → downstream_rotZ)
- ▶ Next step: wire by wire alignment, only a rotZ relative to the layer alignment
- ▶ CCDB created and work already implemented in coatjava



- ▶ t_0 and T2D calibrations are ongoing, but we can already achieve good resolutions layer by layer
- ▶ E.g. after 25 iterations, the layer 41 reached a resolution of 210 μm !
- ▶ For now, I cannot really explain why this layer is so particular



- ▶ We are actively monitoring the quality of the tracking → wire swaps fixed
- ▶ To achieve our resolution goals, we developed an alignment software
 - alignment in v_z
 - layer alignment in ϕ
 - wire alignment in ϕ (code available, waiting to be run)
- ▶ The T2D calibration showed room for improvement → resolution of $210 \mu\text{m}$ in layer 41