CLAS12 Collaboration Meeting

ALERT Simulation, Reconstruction and Calibration

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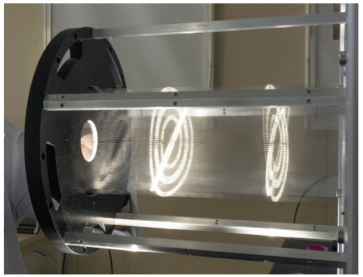
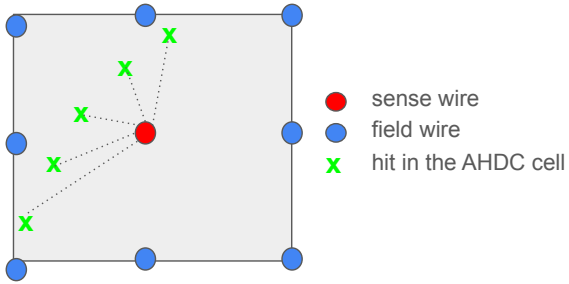
-- PhD student --

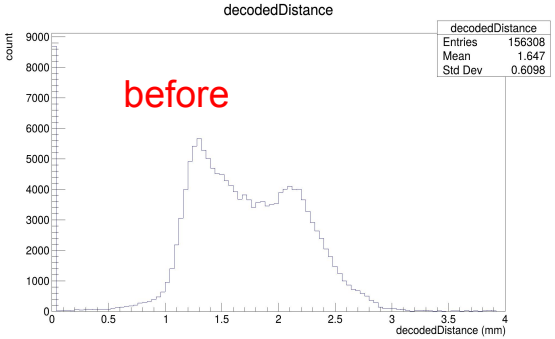
Simulation – AHDC waveform digitization

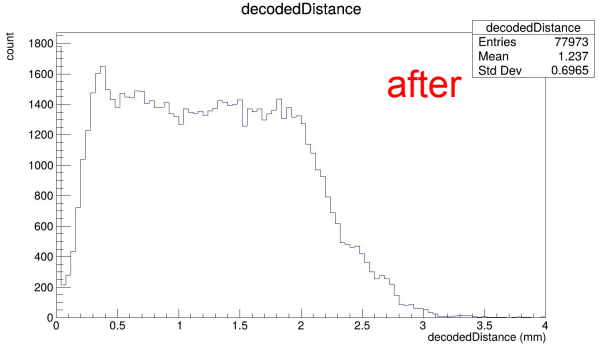
- **We had an issue** with the tracking in simulation
- Before, we used the drift time of all the hits in a AHDC detection cell
  - we reconstructed a mean of all distances
  - having nothing below 1 mm was the main source of our issue
- **To fix it**, we decided to only use the drift time of the closest hit
  - the distance is now well distributed over the cell size
  - we observe an improvement in the tracking



AHDC detection cell in Geant4

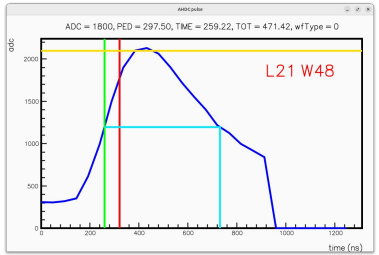


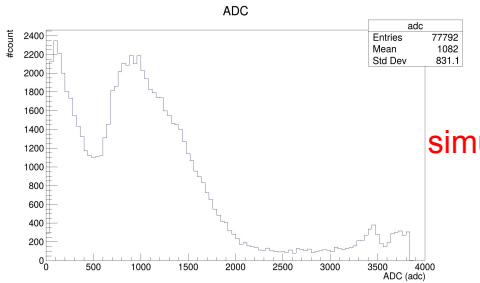




Simulation – Comparison with data

- We compared deuteron signals from elastics data (run 22712, 2 GeV, D2) with simulation
- The distributions look very similar
  - The ADC distribution presents two peaks
  - The first one is noise, so bad reconstructed waveform
  - The second one is characteristic of the detected particle
  - The separation between the two peaks is more clear in simulation
  - We have overestimated the noise in simulation
  - But we have not been able to spread the distributions as in real data (cf. ToT and the time distributions)
  - We should point that an ADC calibration for real data is being done by **Churamani Paudel**, but it has not been included in this analysis.





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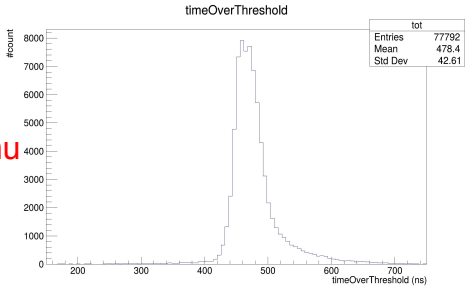
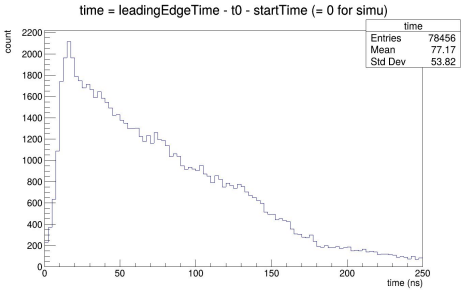
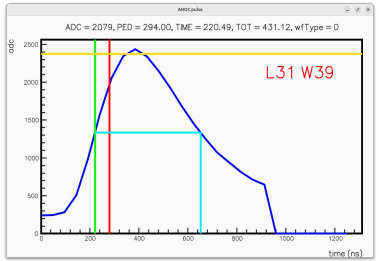
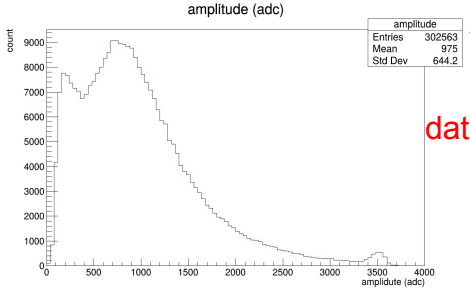
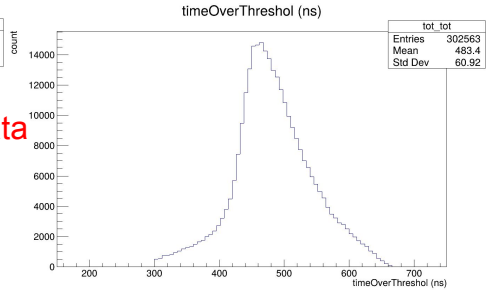


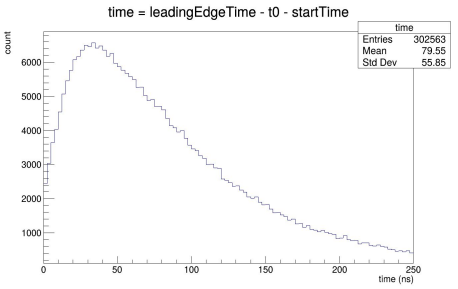






data

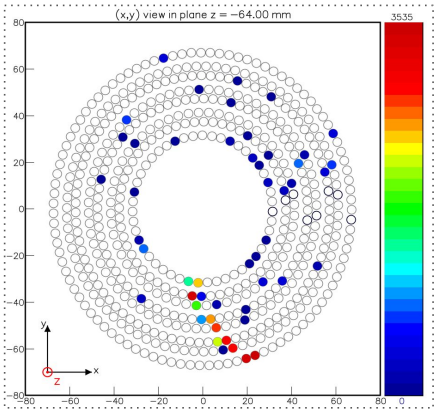


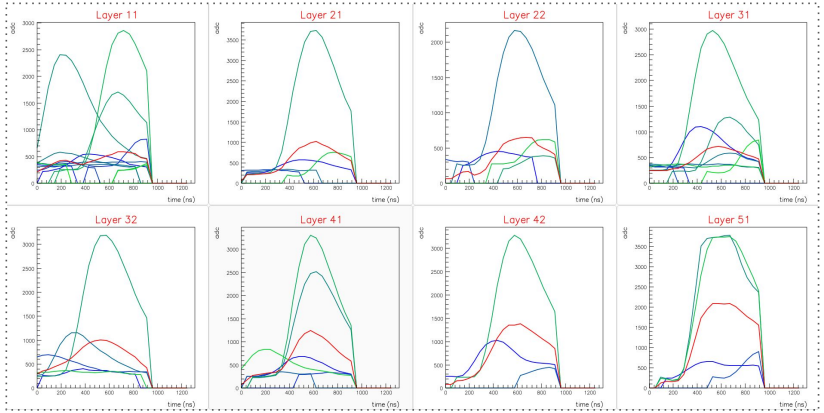


Reconstruction – Hit selection for real data

- We have a lot of hits in the AHDC (> 20 % occupancy in the first layer)
- Most of them are noise and make the tracking difficult
- However, we identified clear patterns that can be used to get rid of them
  - At first, we extracted various informations from the signals: leadingEdgeTime, timeOverThreshold, amplitude, pedestal
  - Then we applied raw cuts, loaded from a CCDB, based on these informations (occupancy ~ 4 %)
  - However, we had a low ADC cut
    - it resulted to a low detection efficiency of the protons
  - Finally, when **Noémie Pilleux** initiated a waveform classification (next slide) we have been able to prevent this low ADC cut

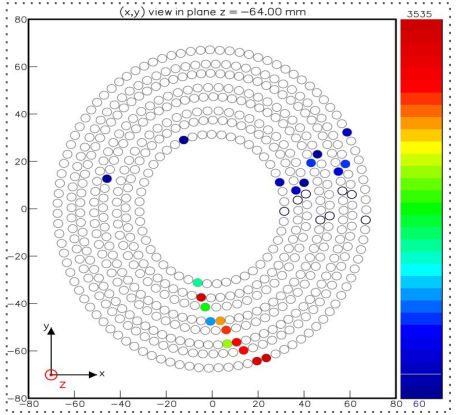
before





after

wfType <= 2 & non ADC cuts

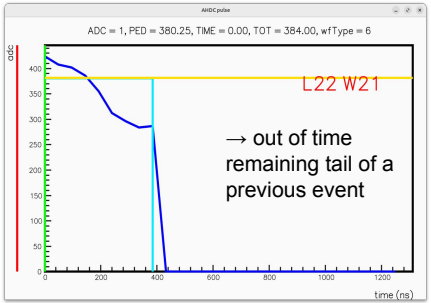


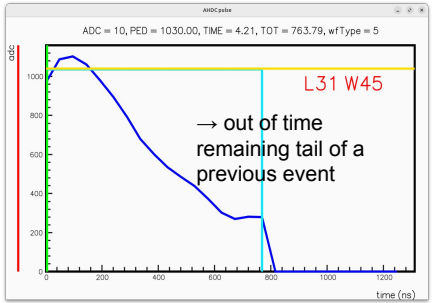
-- run 22712, current 50 nA --

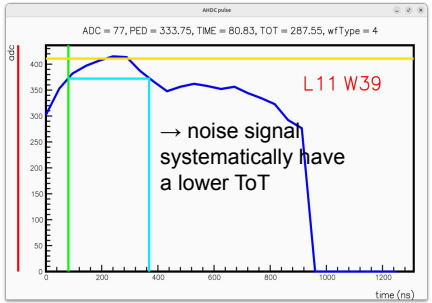
Simulation – Waveform classification

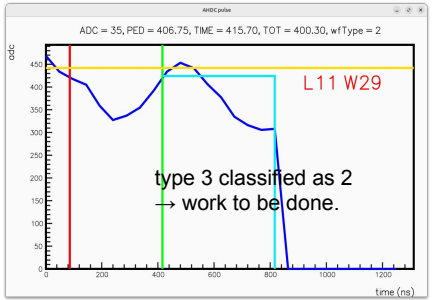
- Description
  - wfType 6 ⇒ too short (nsamples <= 10)
  - wfType 5 ⇒ decreasing baseline
  - wfType 4 ⇒ bad ToT (ToT < 300)
  - wfType 3 ⇒ pileUp (not done yet)
  - wfType 2 ⇒ bad trailingEdgeTime
  - wfType 1 ⇒ saturating
  - wfType 0 ⇒ OK

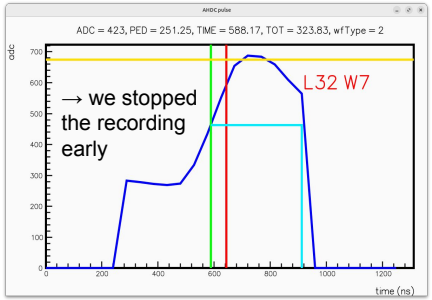
- We only use wfType <= 2 (and later wfType <= 3) because they have a good time reconstruction.

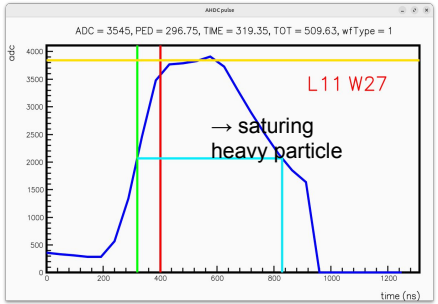


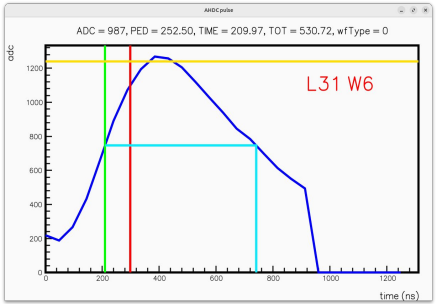












Simulation – Hit selection efficiency

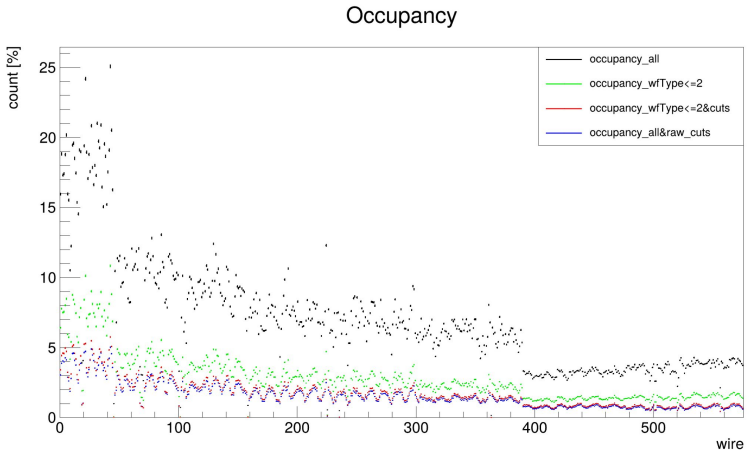
- The table below resumes the performance of hit selection efficiency over the coatjava version.
  - Of course, the occupancy statistics depend on the beam current
  - We looked at the number of reconstructed elastic events to estimate the quality of our hit selection
  - We see that the raw cuts were very restrictive
  - The elastic detection efficiency increases almost by a factor 2
  - *This increase also benefits from the time calibration made by **Michael Paolone**.

→ run 23003, beam current 200 nA

	ALL	rawCuts 13.0.1	wfTye <= 1 coat 13.3.0	wfTye <= 2 coat dev	wfTye <= 2 & cuts coat 13.4.0	wfType <= 2 & cuts (strong) coat dev
		time >= 200 time <= 500			time >= 0 time <= 340 *t0 substractred	time >= 0 time <= 340 *t0 substractred
		tot >= 350 tot <= 650			tot >= 300 tot <= 750	tot >= 340 tot <= 620
		ped >= 180 ped <= 360			ped >= 120 ped <= 350	ped >= 120 ped <= 350
					samples > 10	samples > 14
Occupancy on the 1st layer	40 %	6 %	4 %	15 %	8 %	5.5 %
nb elastics nb protons nb deuterons	–	9472 2485 3662	5725 921 3020	-	17882 4394 6757	12650 2343 5502

before (hidden ADC cut) *after

→ run 22712, current 50 nA

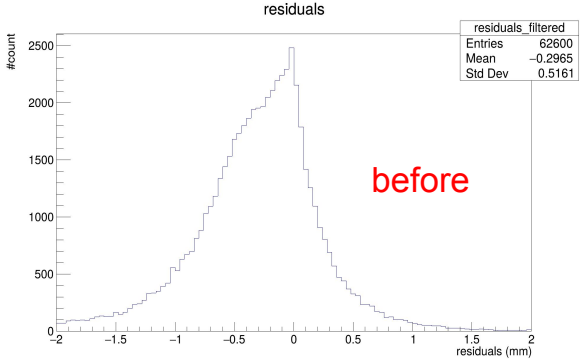


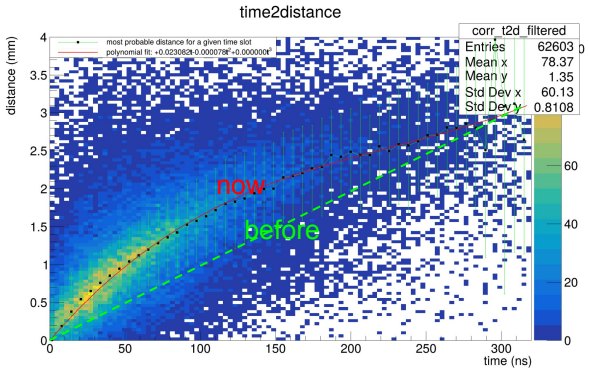
Calibration – time2distance

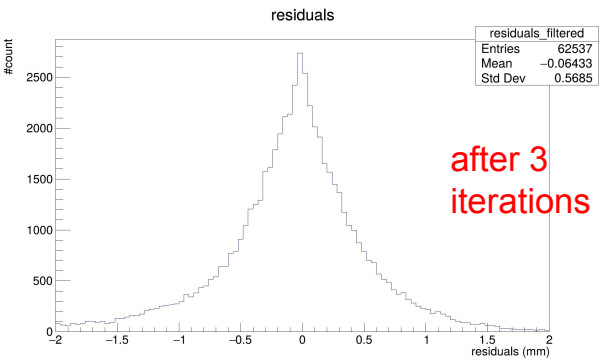
- We didn't have a calibration of the time2distance in real data
- The net result was that the residual distribution was systematically shift to one side
  - The distance in the ***time versus distance*** plot is the distance between the wire and the Kalman Filter track
  - The dashed green line represents the (non calibrated) time2distance used before the tracking
  - The smooth red line shows the real tendency of the time2distance
    - The polynomial coefficients of this fit is stored in a CCDB
    - When we re-run the reconstruction with this estimation of the time2distance, we obtained a better residual distribution
  - Additional, AHDC waveform simulation now use the same time2distance as real data

$$\text{residual} = \text{distance}_{\text{from time calibration}} - \text{distance}_{\text{from track fitting}}$$

Elastics data from run 22712 on D2



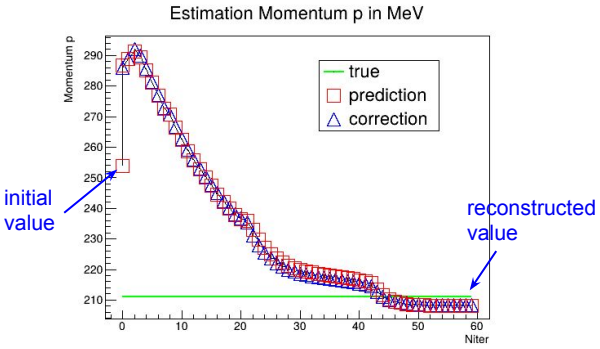


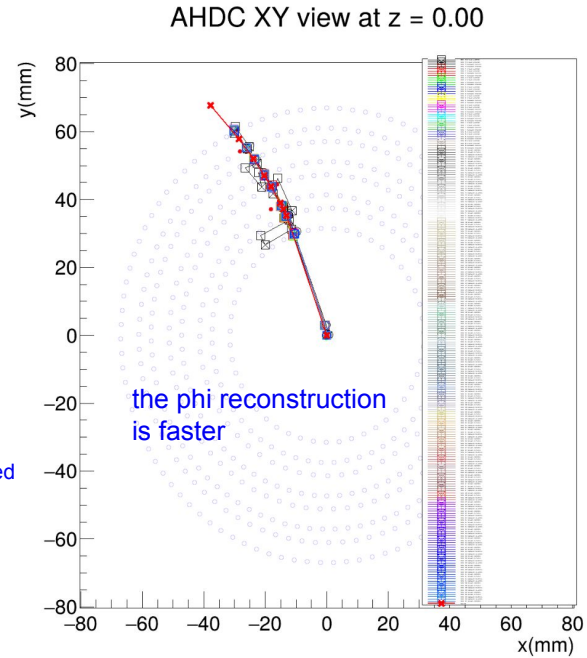


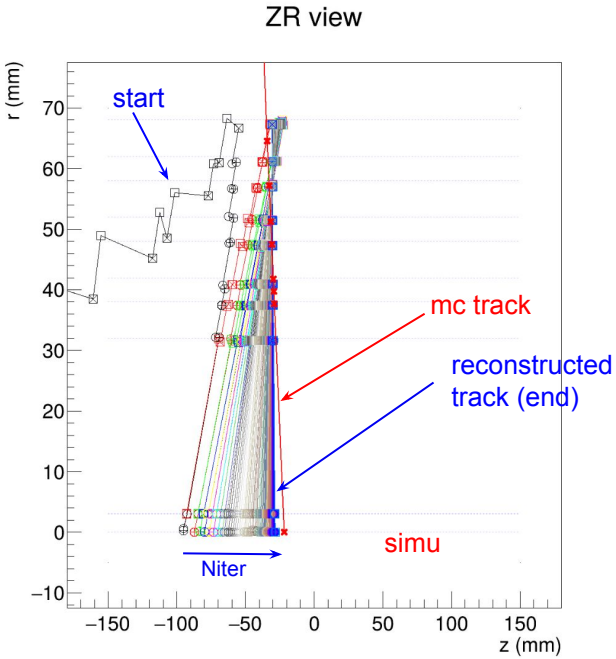
Calibration – Kalman Filter

- We use the Kalman Filter for the AHDC track reconstruction
- First implementation of the algorithm is due to **Mathieu Ouillon** and **Éric Fuchey**
  - I replace them on this task
- A lot of works remain to be done on the Kalman Filter but we can already see interesting things.

- Here is the evolution the fit over the number of iterations (Niter)
- This is simulation
- The goal is to converge faster to the right values



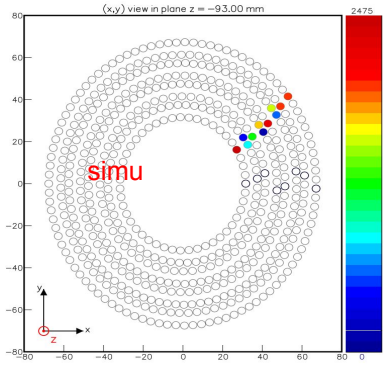


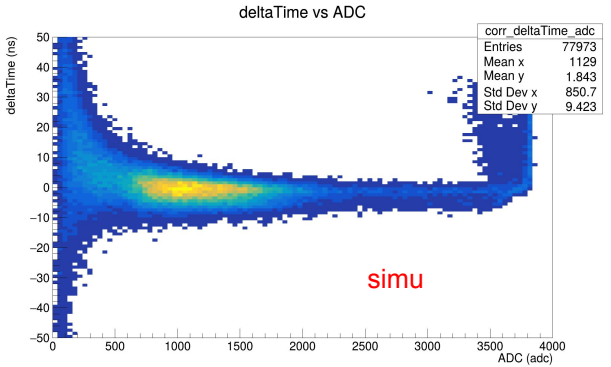


Calibration – Next steps for Kalman Filter

- Here is our plan for the Kalman Filter

1. Use all the hits for the Kalman Filter
2. Use the electron vertex
3. Use the ATOF information
4. Remove problematic hits
5. Improve the energy lost
6. Tune Kalman Filter parameters (measurement and process noises, initial error covariance matrix, number of iterations, and so on)
7. Take into account the deposited energy (time/distance resolution versus ADC)
8. Work on the computation time





Conclusion

- A lot of work have already been done on the simulation, the calibration or the reconstruction for the AHDC
  - Waveform digitization
  - Hit selection and waveform classification
  - time2distance implementation
  - Development of monitoring tools for the Kalman Filter
- But a lots remain to be done, especially on the Kalman Filter
  - We hope to present you a final version of the Filter during the next Collaboration meeting

-- Thank you for your time --