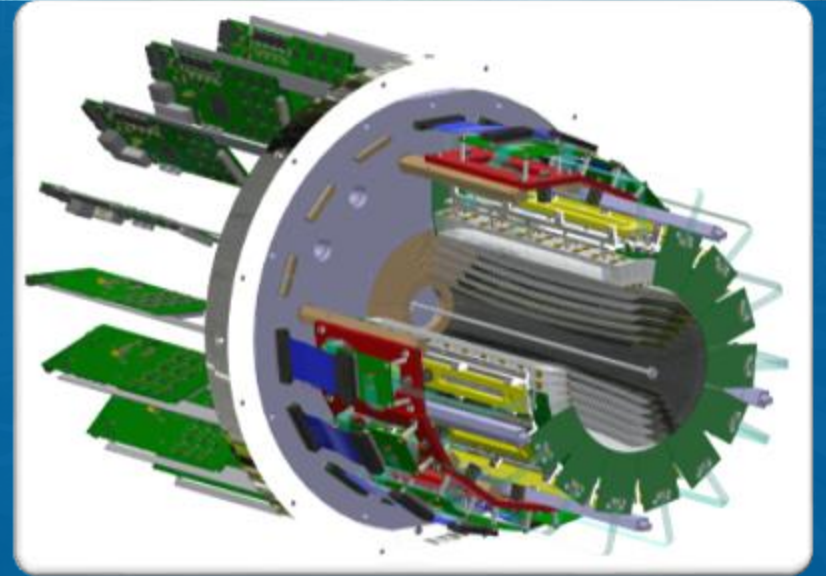


ALERT ATOF Calibration



Zhiwan Xu for ALERT/Run Group L

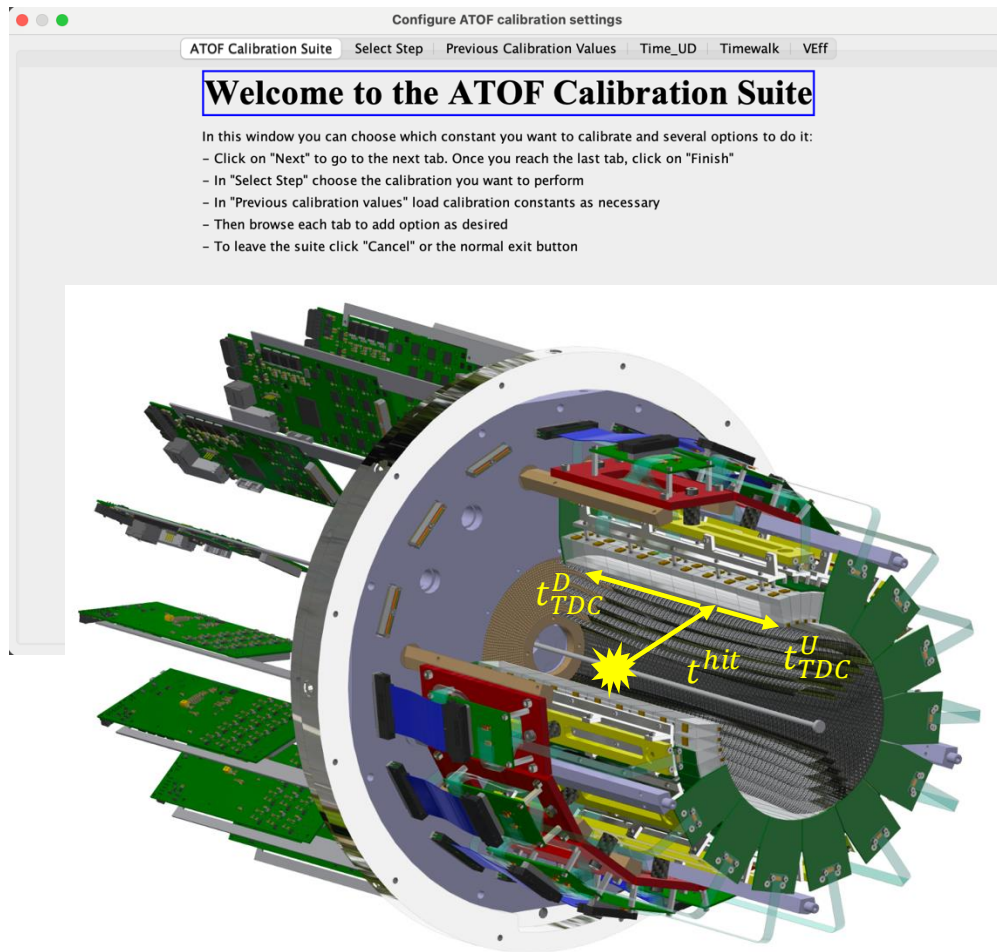
zhiwan.xu@anl.gov

Argonne National Laboratory

11/19/2025

ATOF Calibration

Ready in calcode: <https://code.jlab.org/hallb/clas12/calibration/calcode/-/tree/main>



- Bar hit time (t^{hit}) from Up/Downstream end (✓):

- $t^{D(U)} = t_{TDC}^{D(U)} - t_{vertex} - t_{TW}^{D(U)} \mp t_{U2D} - \frac{L-z}{v_{eff}}$

- $t^{hit} = \frac{1}{2}(t^U + t^D) + c_{b2b}$

- Wedge hit time (t^{hit}) has better resolution (✓)

- $t^{hit} = t_{TDC}^w - t_{vertex} - t_{TW}^w - \frac{h}{v_{eff}} + c_{w2w}$

ATOF Calibration

Bar

- Event selection on t^{sum}
- Bar Phi Alignment:
 - $t_{U2D} = \frac{\Delta t}{2}$, $c_{b2b} = \frac{t^{sum} - t_{S0L0}^{sum}}{2}$

Wedge

- Clean wedge selection (2 options)
- Wedge Phi Alignment
 - $c_{w2w} = t - t_{S0L0}$

Effective velocity

- Bar hit z position (2 options)
 - $v^{eff} = \frac{2}{slope}$

Time Walk

- TDC vs TOT [ns]: $f = a + be^{cx}$
- $t_{TW}^{w/U/D} = f(x) - f(x = 30ns)$

Configure ATOF calibration settings

ATOF Calibration Suite | Select Step | Previous Calibration Values | Time_UD | Time_Wedge | Timewalk | VEff

☒ Time_UD
☐ Time_Wedge
☐ Timewalk
☐ VEff

CCDB variation: default

☐ Use FD electron information (status < -2000)

Target type (H2/D2/He4): H2

Beam Energy [GeV]: 2.2

☐ Elastic peak or ☐ Quasi-Elastic Events (Do not select both)

Additional option for elastic events

Back Next Cancel

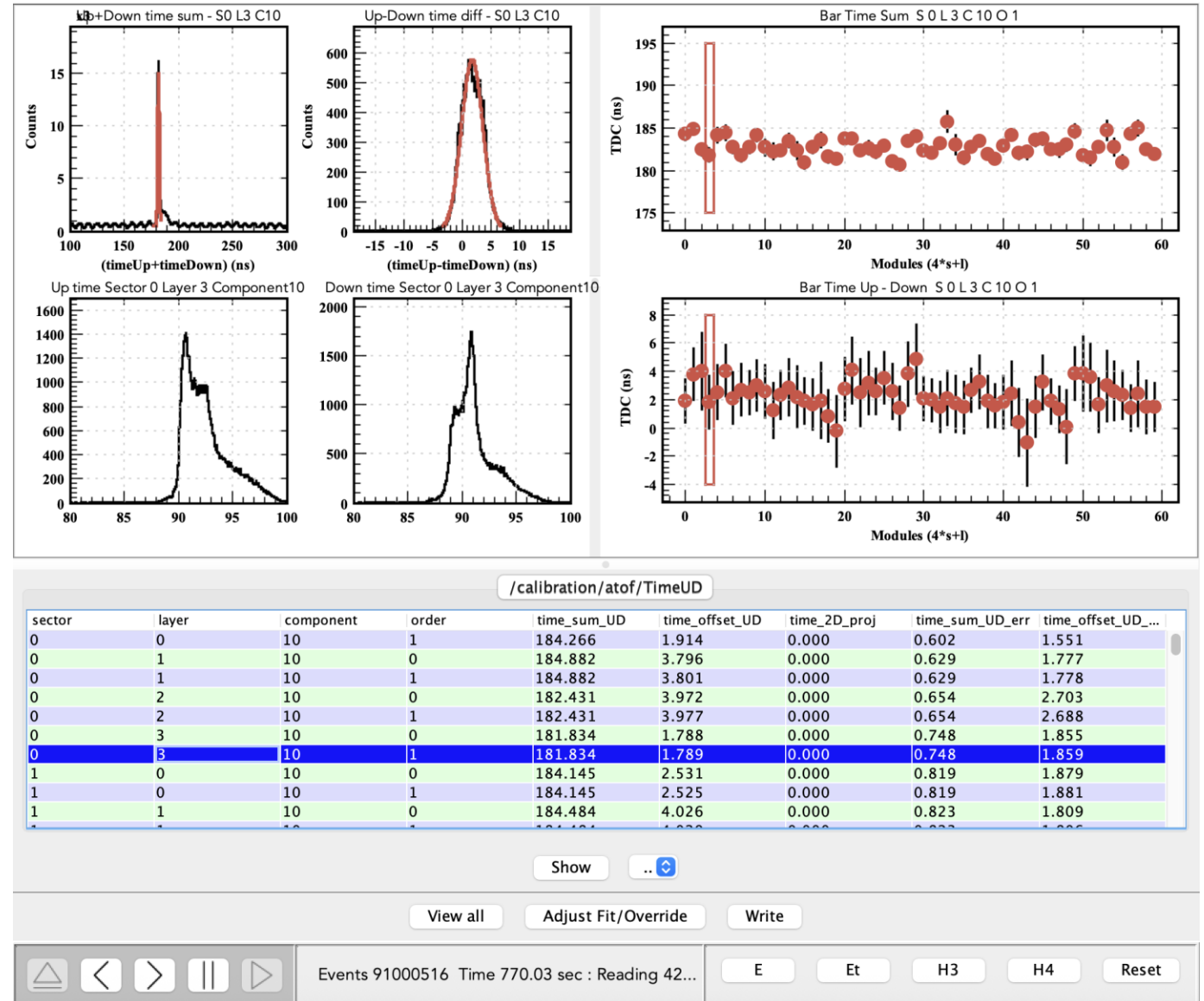
ATOF Calibration

Bar timing

- Bar $t^{sum} = t^U + t^D$
- Bar $\Delta t = t^U - t^D$ with hits on central wedges.
- RF time (periodic 4ns) observed in t^{sum} - also provide event selections $\pm 5\sigma$.

$$t_{U2D} = \frac{\Delta t}{2}$$

$$c_{b2b} = \frac{t^{sum} - t_{SOLO}^{sum}}{2}$$



ATOF Calibration

Bar timing

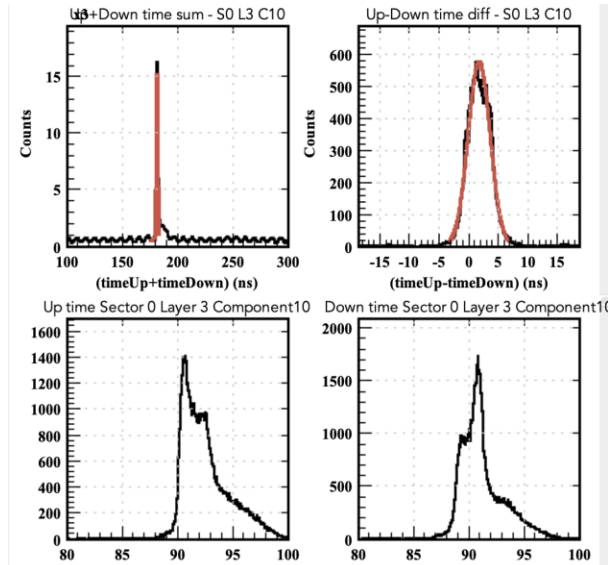
– 2.2 GeV H2 run

Bar Phi Alignment:

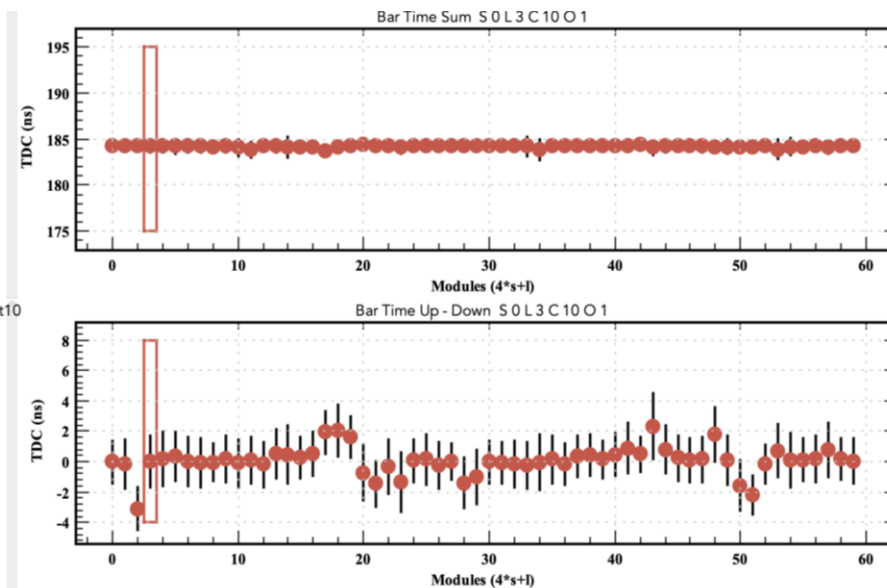
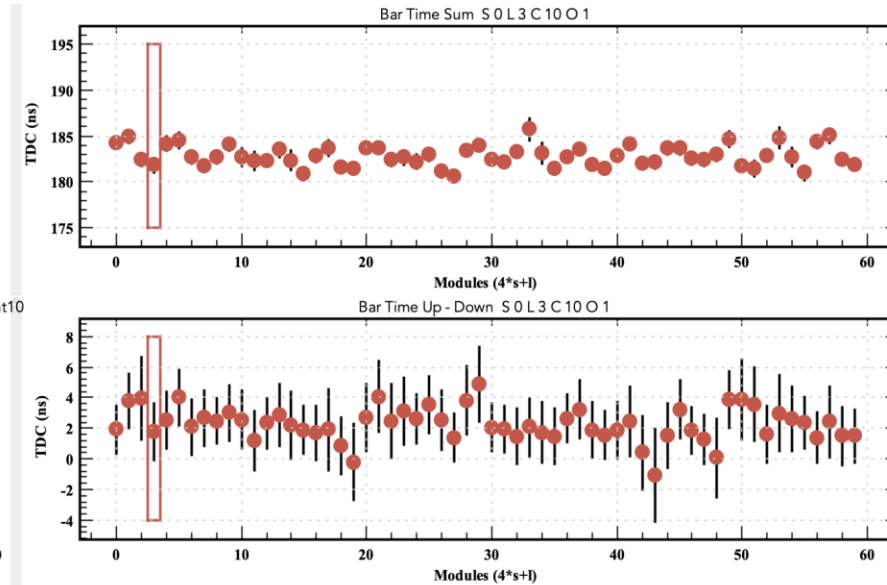
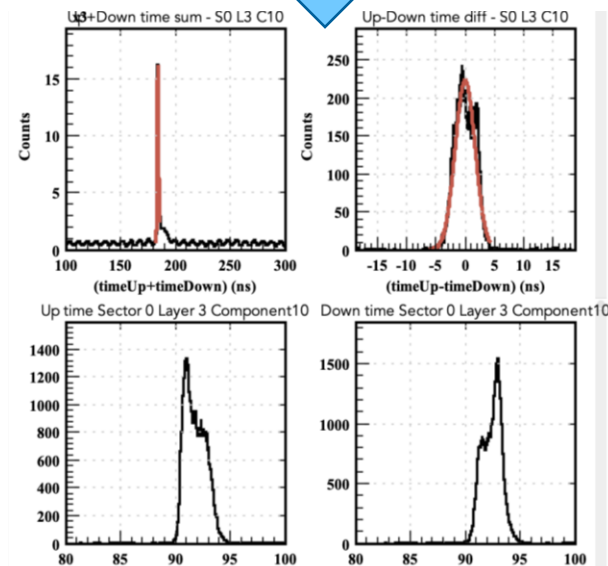
$$\blacksquare t^{UD} = \frac{\Delta t}{2}, c_{b2b} = \frac{t^{sum} - t_{S0L0}^{sum}}{2}$$

- Bar sum is aligned well
- Few modules' bar time difference is offset - will be absorbed in the effective velocity fitting

Before

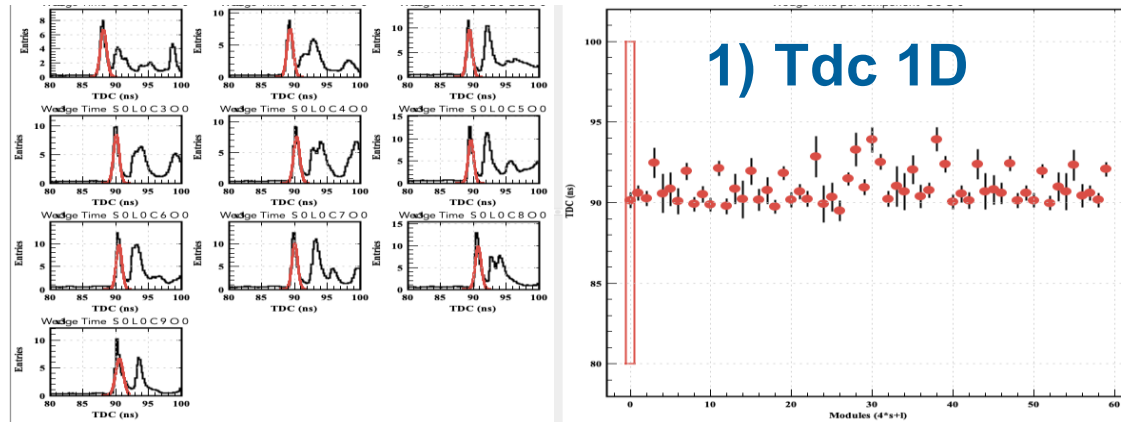


After

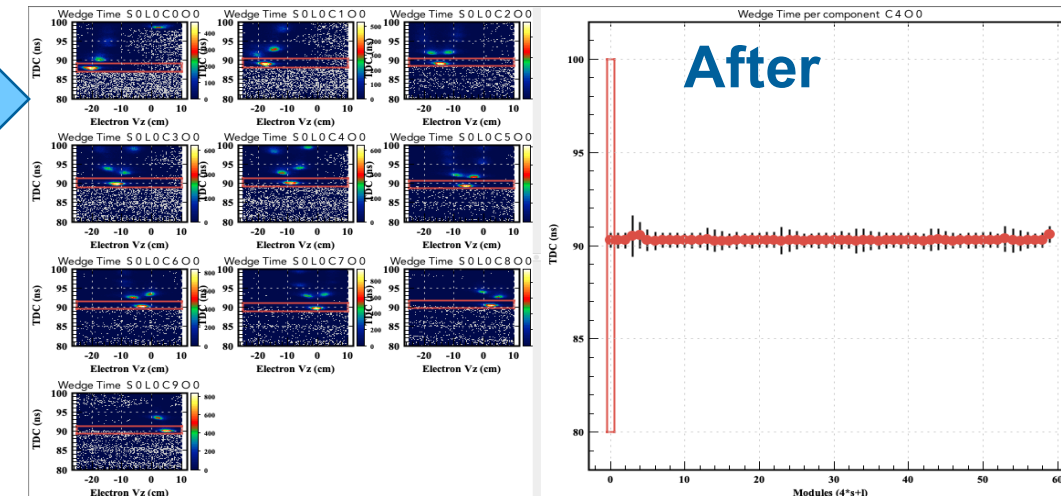
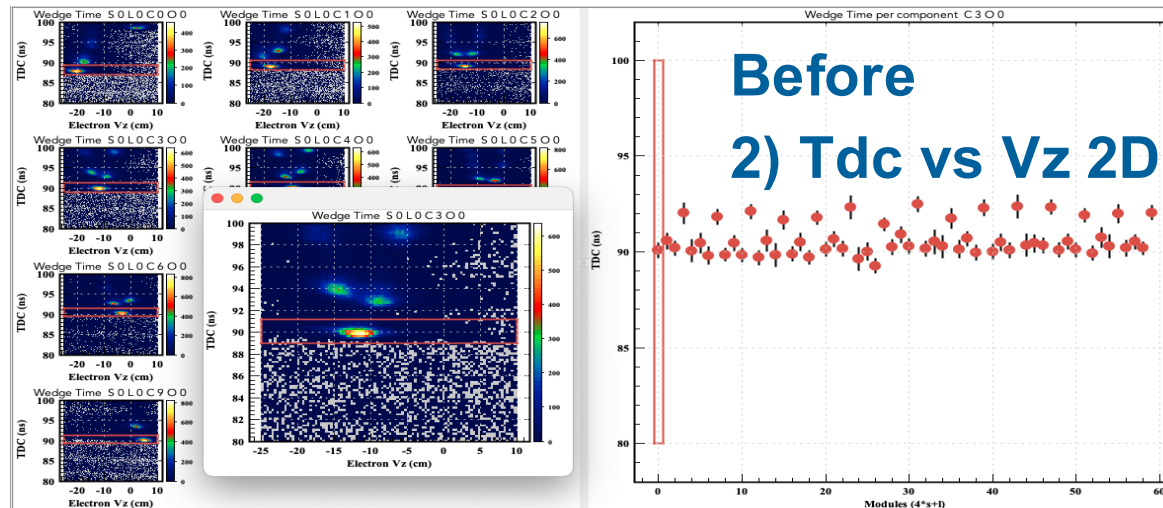


ATOF Calibration

Wedge timing – elastic data 2.2 GeV H2



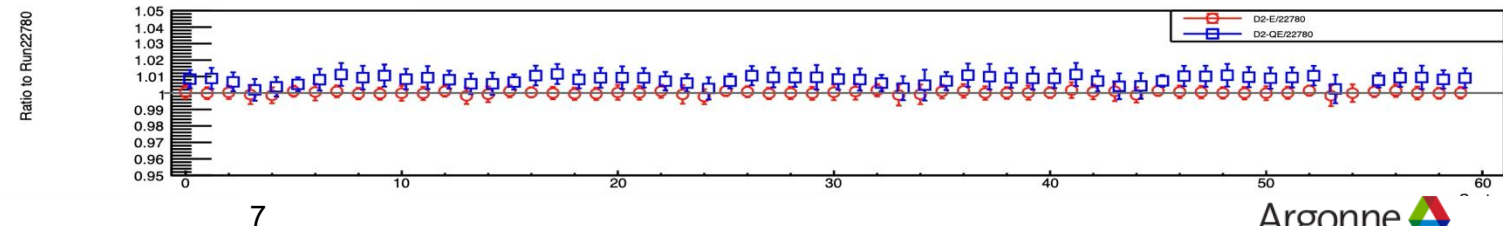
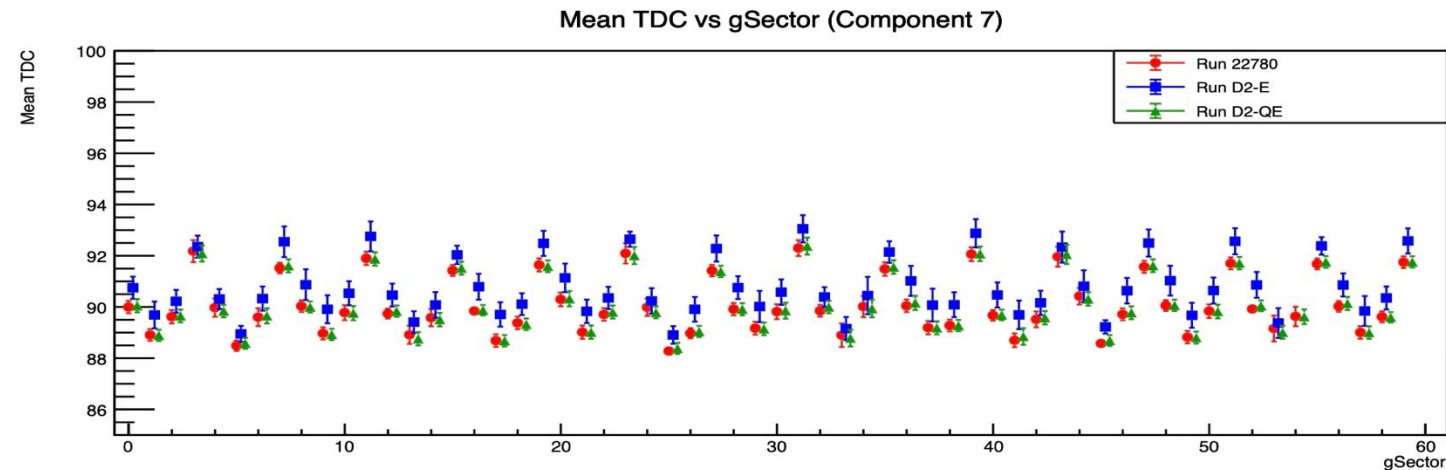
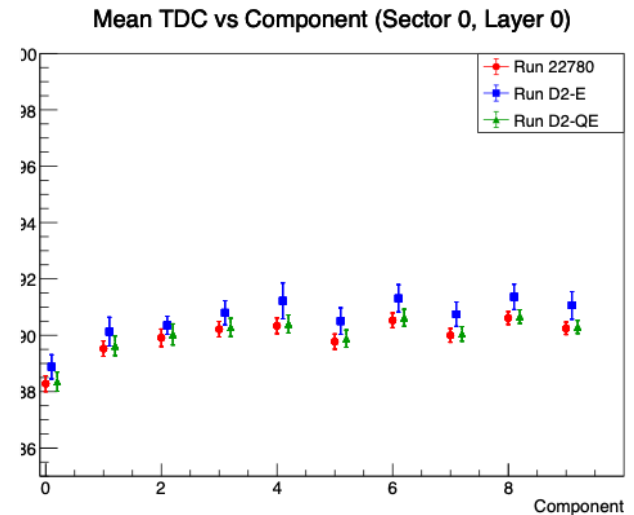
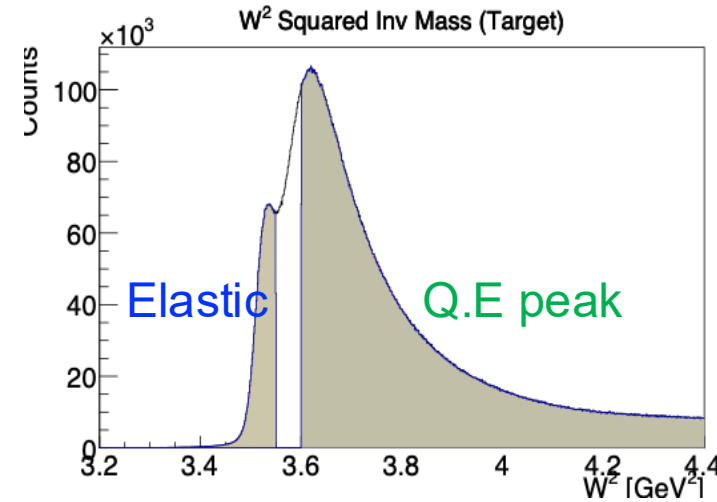
- Clean wedge selection with Vz from scattering electron
- Wedge Phi Alignment for each component
 - $c_{w2w} = t - t_{SOLO}$



ATOF Calibration

Wedge timing – constants from H2 / D2 target

- To understand the 1st peak, we compared the H2 run, coherent D2, and incoherent protons from D2 run.
- Same phi pattern.
- Same tdc value for the H2 and incoherent protons in D2
- Observe coherent D2 slower than incoherent protons ~ 1ns

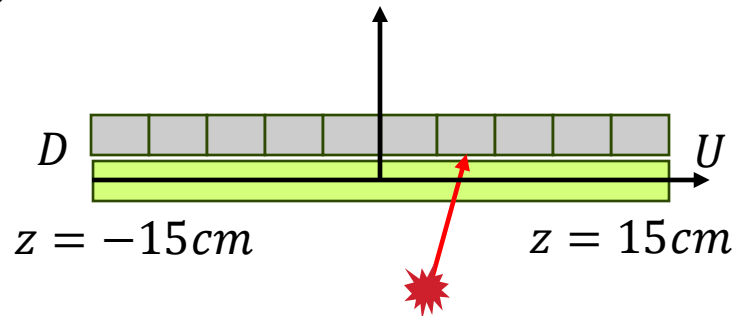


ATOF Calibration

- Bar effective velocity

1) Tdc 1D

- ✦ Bar time difference t^{UD} with hits on each wedge component (from 1st peak). Fit the 10 cases by Gaussian
- ✦ Fit linearly on the 10 peaks vs z (wedge)
- ✦ $v^{eff} = \frac{2}{slope}$



2) Tdc vs Vz 2D

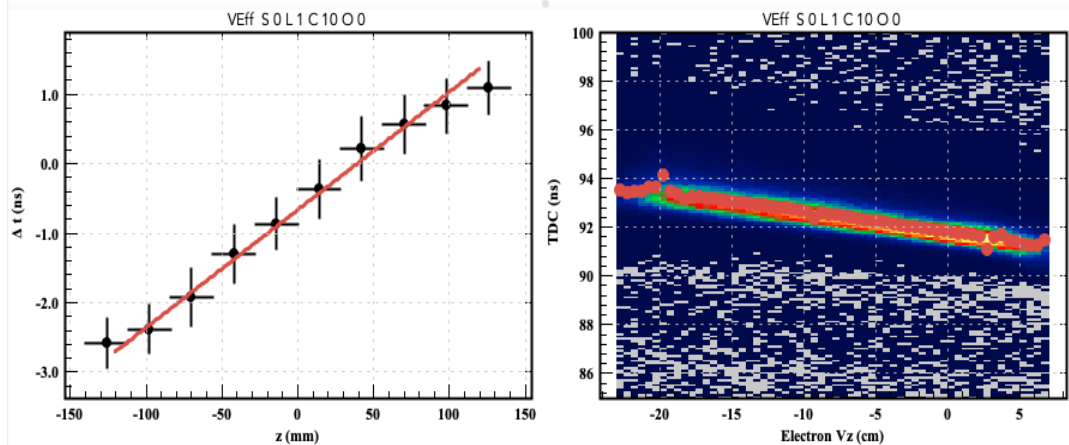
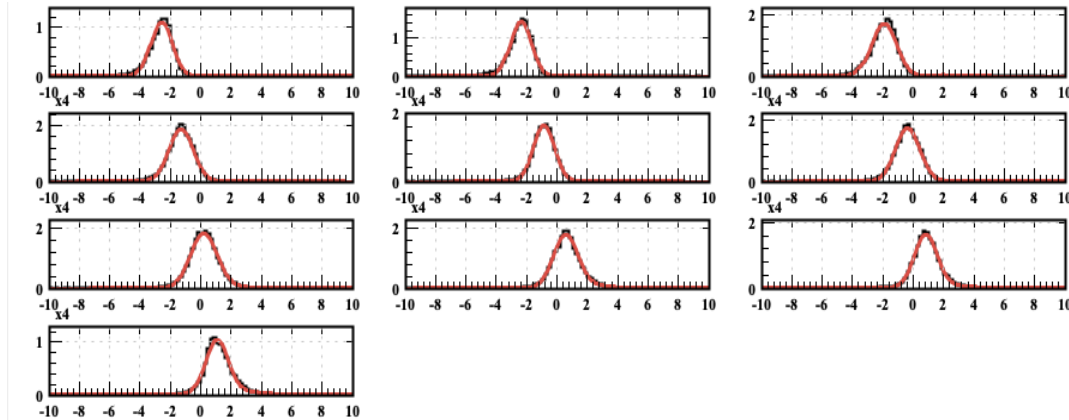
- ✦ Individual bar time vs vertex (Vz) from scattered electron
- ✦ Notice: the vertex would be different from geometry z
- ✦ Fit the 2D histo linearly
- ✦ $v^{eff} = \frac{1}{slope}$

ATOF Calibration

Bar effective velocity

$$t^{D/U} = t_{TDC}^{D/U} - t_{vertex} - t_{TW}^{D/U} \mp t^{UD} - \frac{L - z}{v_{eff}}$$

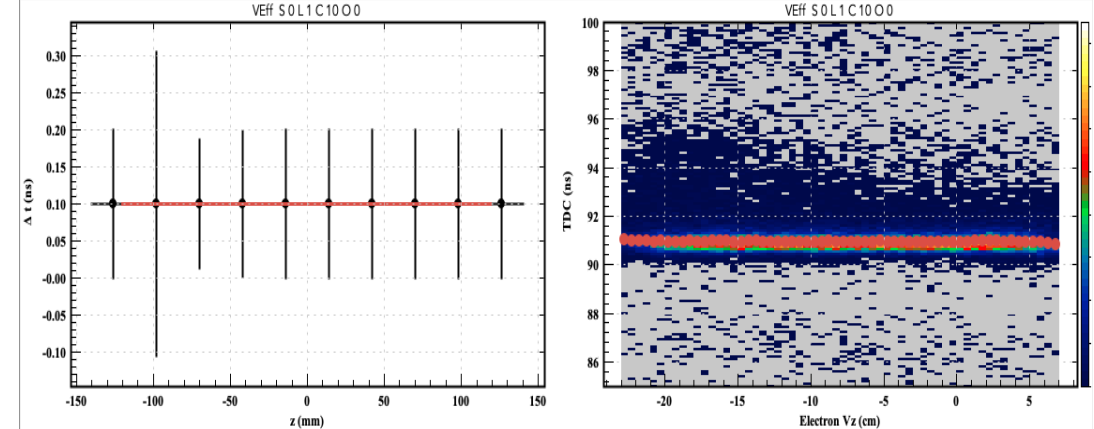
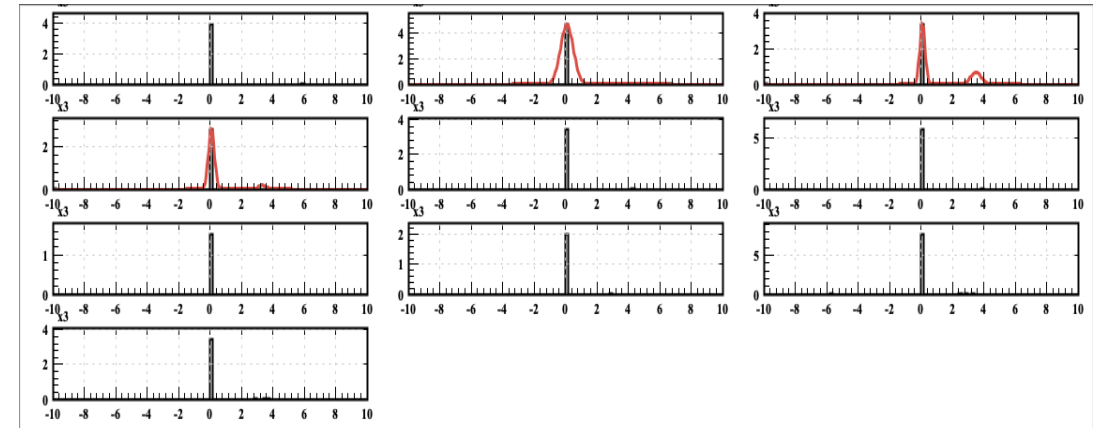
Before



1) Tdc 1D

2) Tdc vs Vz 2D

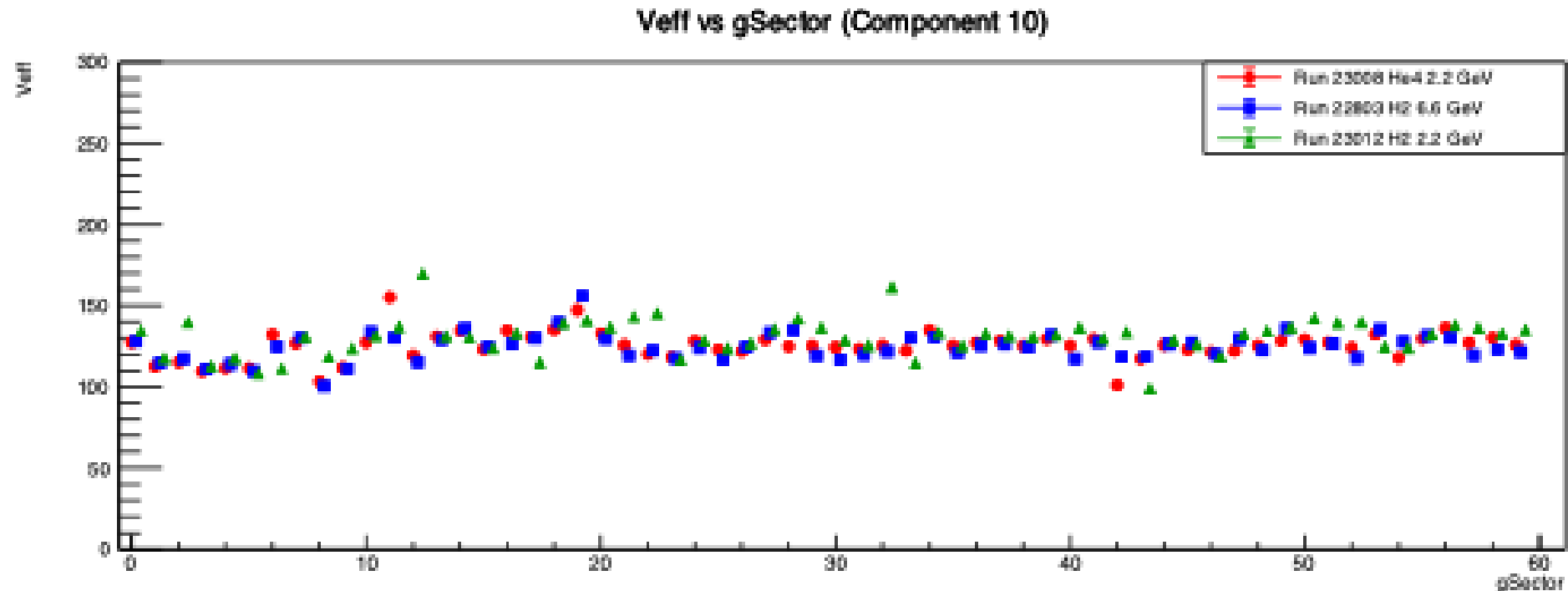
After



ATOF Calibration

Bar effective velocity – constants from H2/He4 target

- We compared V_{eff} calculated from H2 runs at 6.6 GeV, 2.2 GeV, and incoherent protons from He4 run at 2.2 GeV.
- Bar wedge alignment required.
- Similar phi pattern.

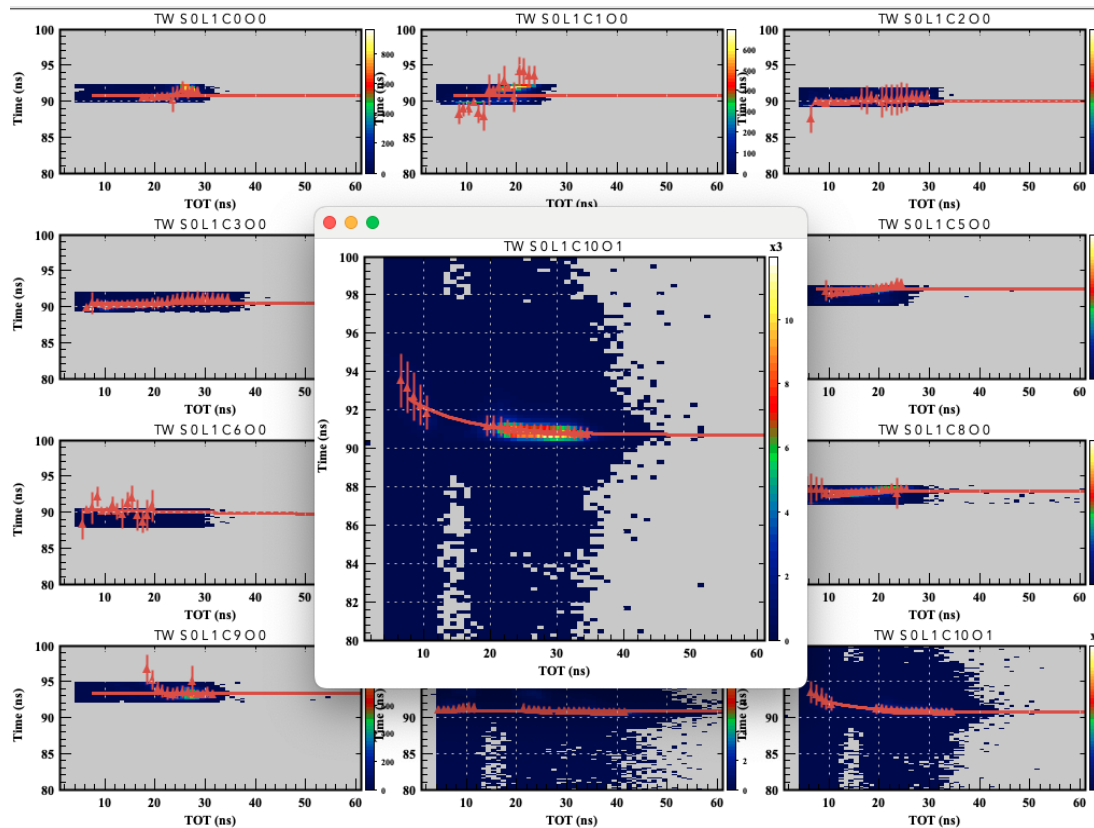


ATOF Calibration

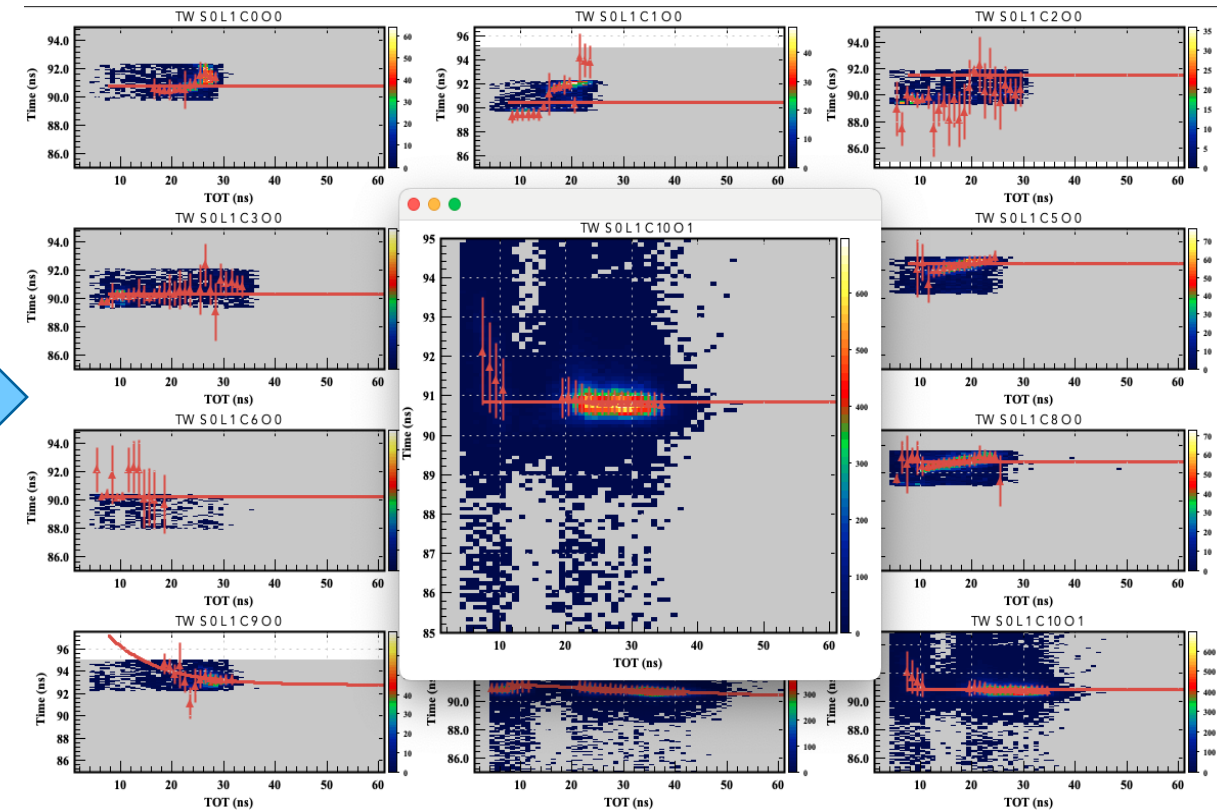
Time walk

- Bar or wedge (from the first peak) TDC vs TOT [ns]. Fit with $f = a + be^{cx}$
- Plan: only apply for ToT < 2000 (x~30) regions: $t_{TW}^{w/U/D} = f(x) - f(x = 30ns)$

Before



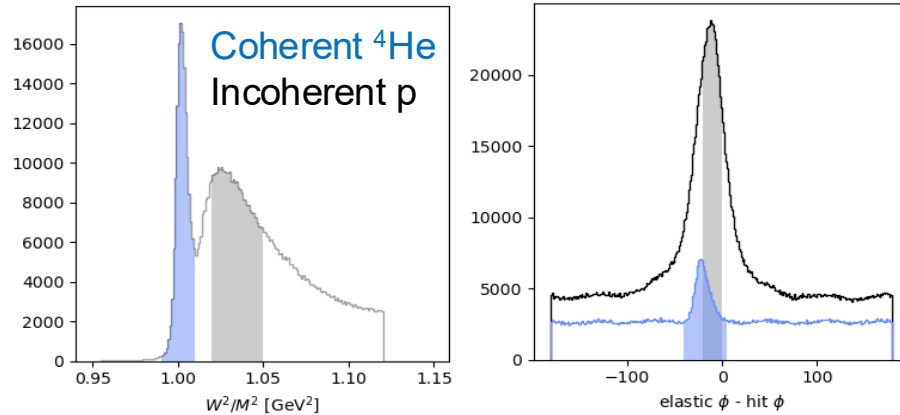
After



ATOF Calibration

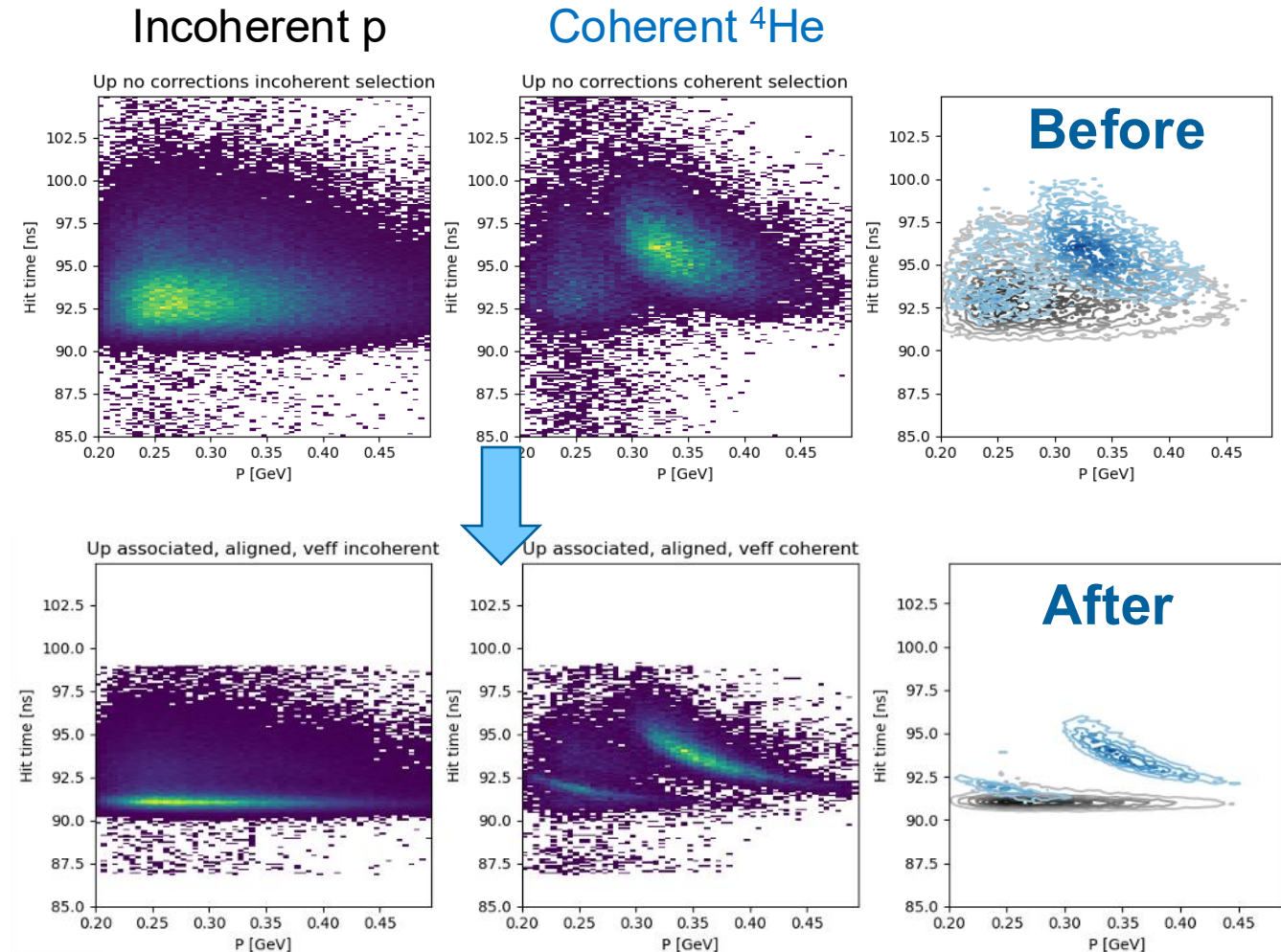
First glance PID (by Noémie Pilleux)

- elastic data, 2.2 GeV ^4He run



Showing upstream end of the double-sided bar readout

- **Associated** = selecting hits with a matching hit, in time, in the downstream end
- **Aligned**: all bars are time aligned against reference bar
- **Veff**: effective velocity correction



Conclusion

- We have developed the ATOF calibration suite and generate the first set of constants.
- First test of ^4He data at 2.2 GeV shows good results.
- Plan for future: 1) Head for the timeline calibrations, provide QA for different run period. 2) Require propagation time to better understand time-walk calibration.



THANK YOU



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of ENERGY

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