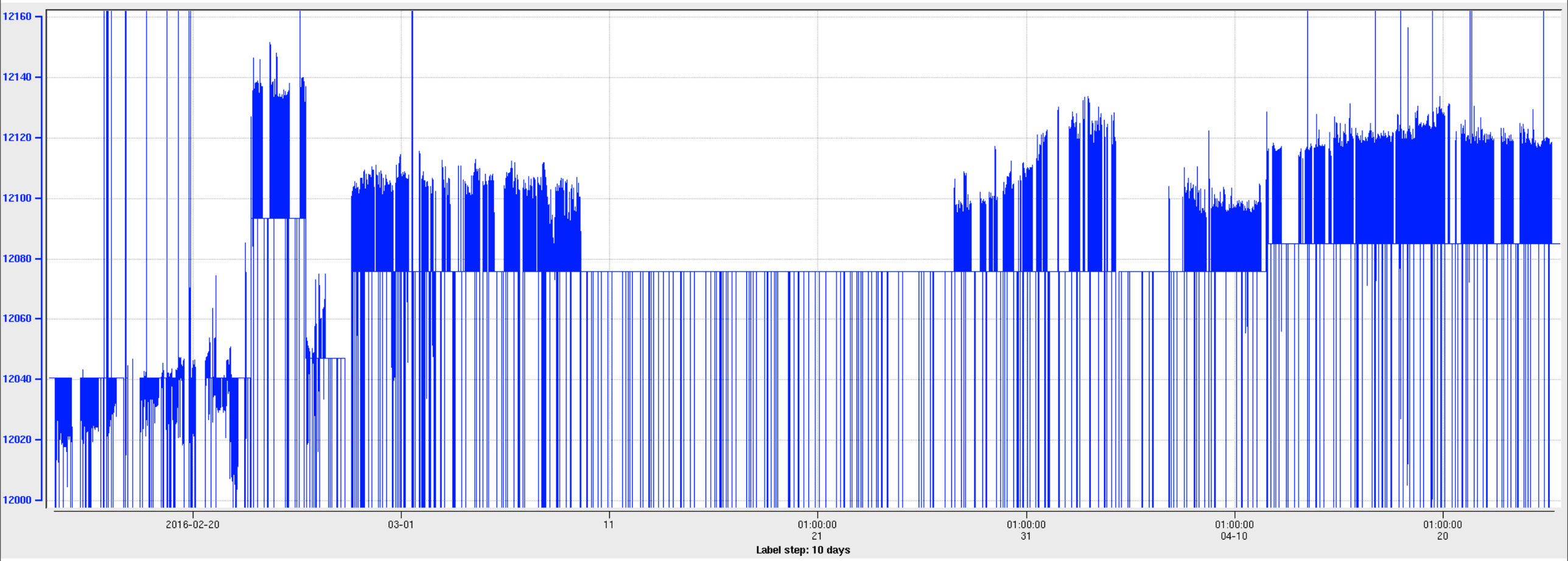
Hall D beam energy during the spring 2016 run

A. Deur

Beam energy stability



Uncorrected Hall D beam energy (from MyaViewer).

Obtained via beam displacement in Hall D ramp (epics name: HALLD:p).

$$\text{Energy} = P_0(1+\delta_{\text{steering}})(1+\delta_{\text{orbit}})$$

Baseline energy calculated from nominal dipole magnetic field settings in Hall D ramp. Assumes a perfectly centered beam.

Correction due to quads and changes in beam transport in the ramp.

Correction for $y \neq 0$ (or $x \neq 0$).

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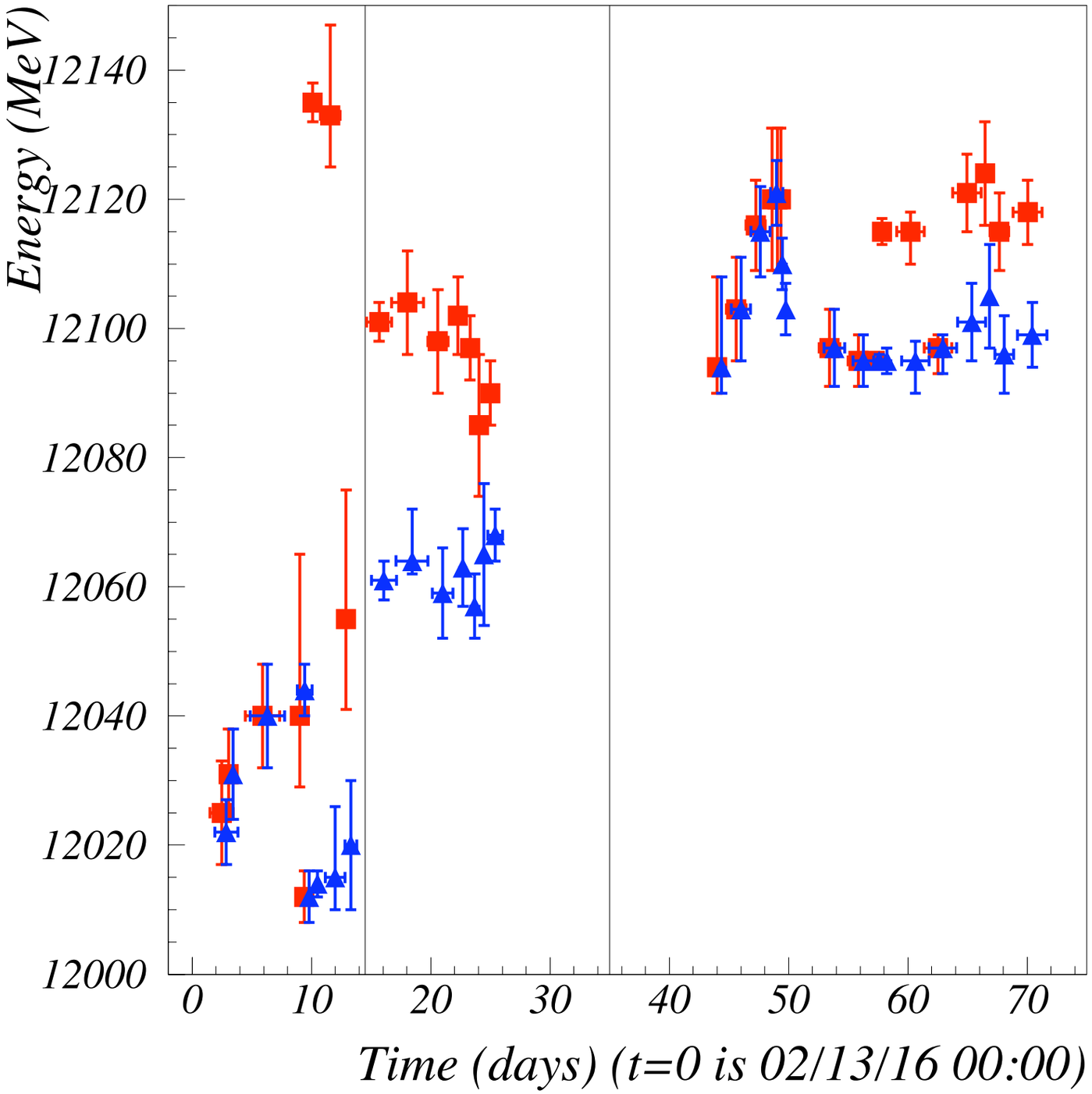
Problems with HALLD:p output

HALLD:p varied over a ~1% range during Spring 2016 run. Some variations are genuine, some are artifacts of measurement method.

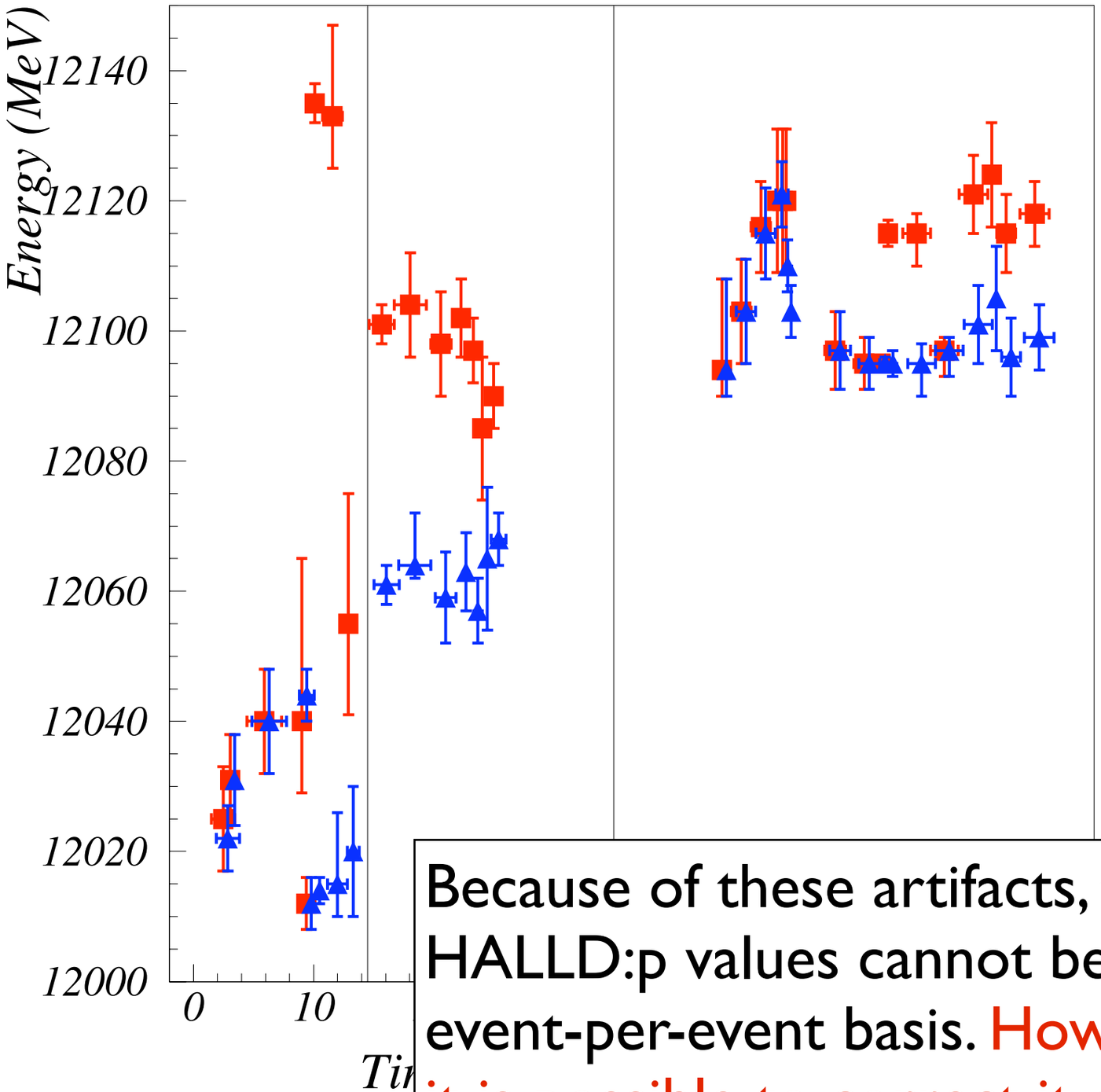


Rough energy time-dependence for the full run, binned in periods of approximate stability:

- Uncorrected Hall D beam energy
- First attempted correction for artificial drifts (See July 20th report).

error bars bracket the time range or energy drift range. (They are not uncertainties.)

HALLD:p varied over a ~1% range during Spring 2016 run. Some variations are genuine, some are artifacts of measurement method.



Rough energy time-dependence for the full run, binned in periods of approximate stability:

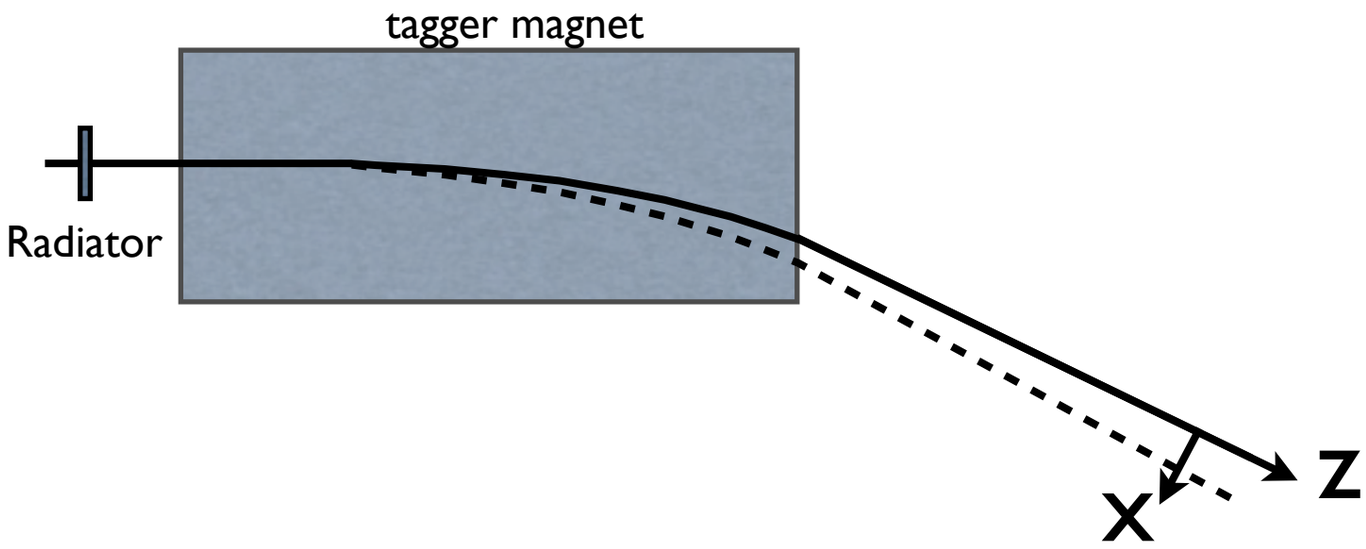
- Uncorrected Hall D beam energy
- First attempted correction for artificial drifts (See July 20th report).

error bars bracket the time range or energy drift range. (They are not uncertainties.)

Because of these artifacts, the current HALLD:p values cannot be used on (epics) event-per-event basis. However, we will see that it is possible to correct it on event-per-event basis.

Other problem

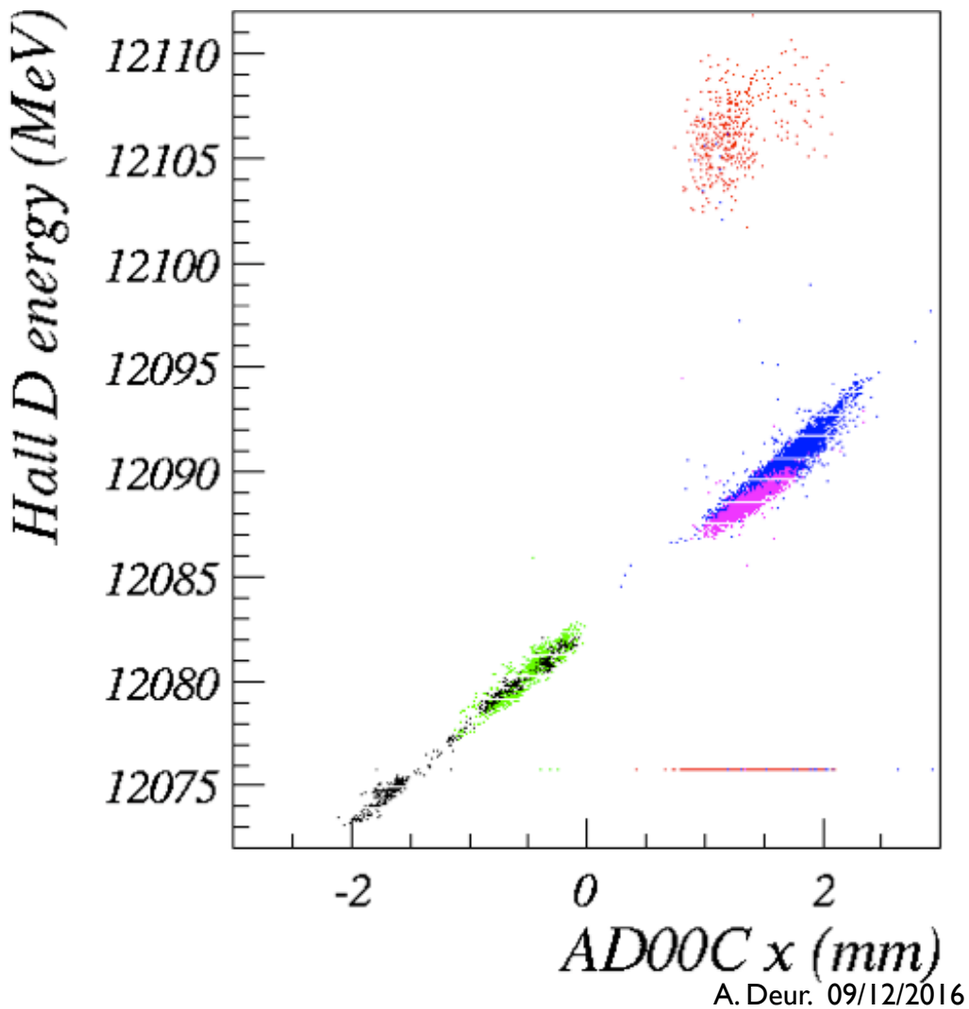
Using tagger magnet as analyzer:



Accelerator systems use left handed convention.

⇒Expect smaller energy at larger x,

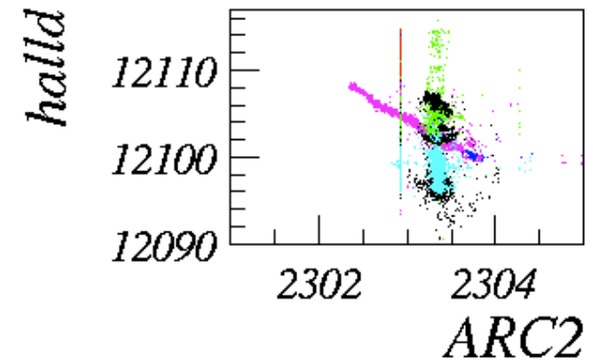
Opposite to what we see in AD00c-x vs HALLD:p.

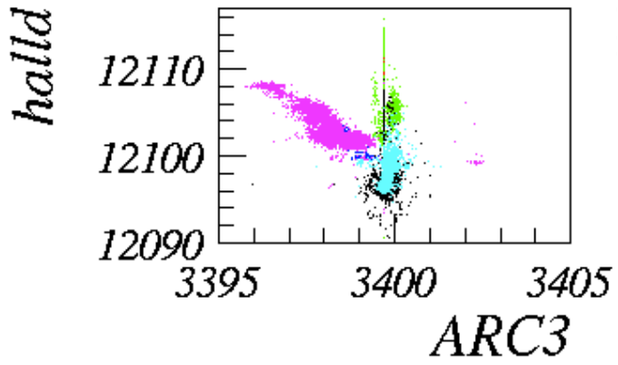


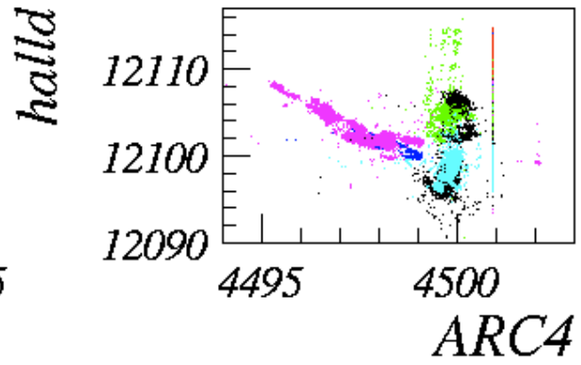
Negative correlations with Hall A energy and ARCs

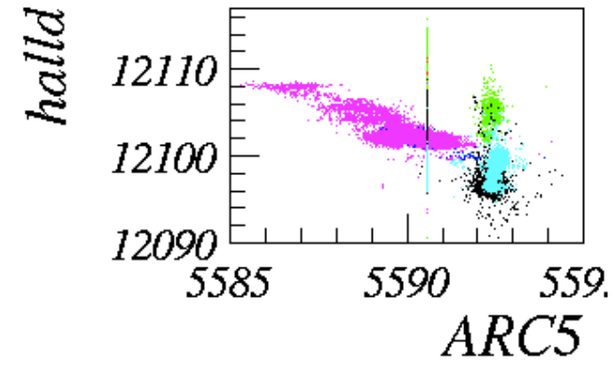
Hall D energy variation is negatively correlated with Hall A and ARCs:

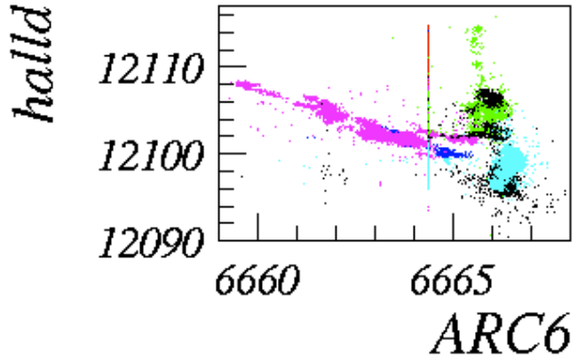
Expect a positive correlation.

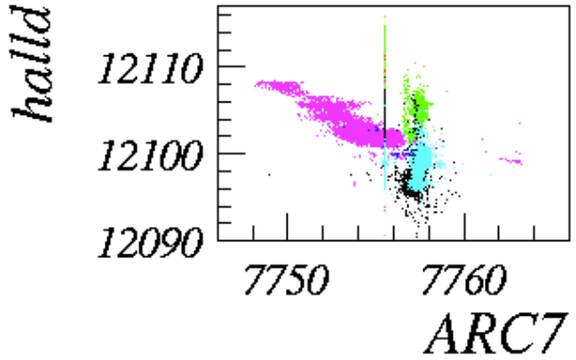


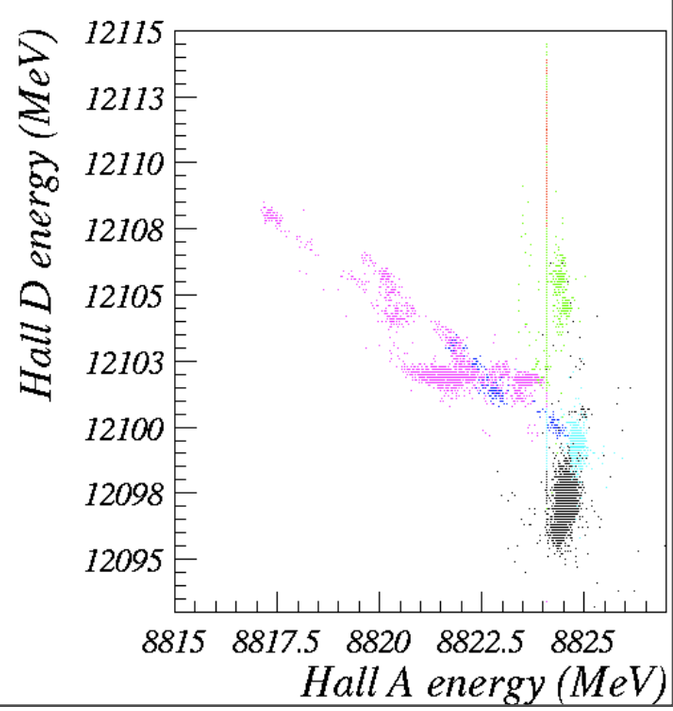












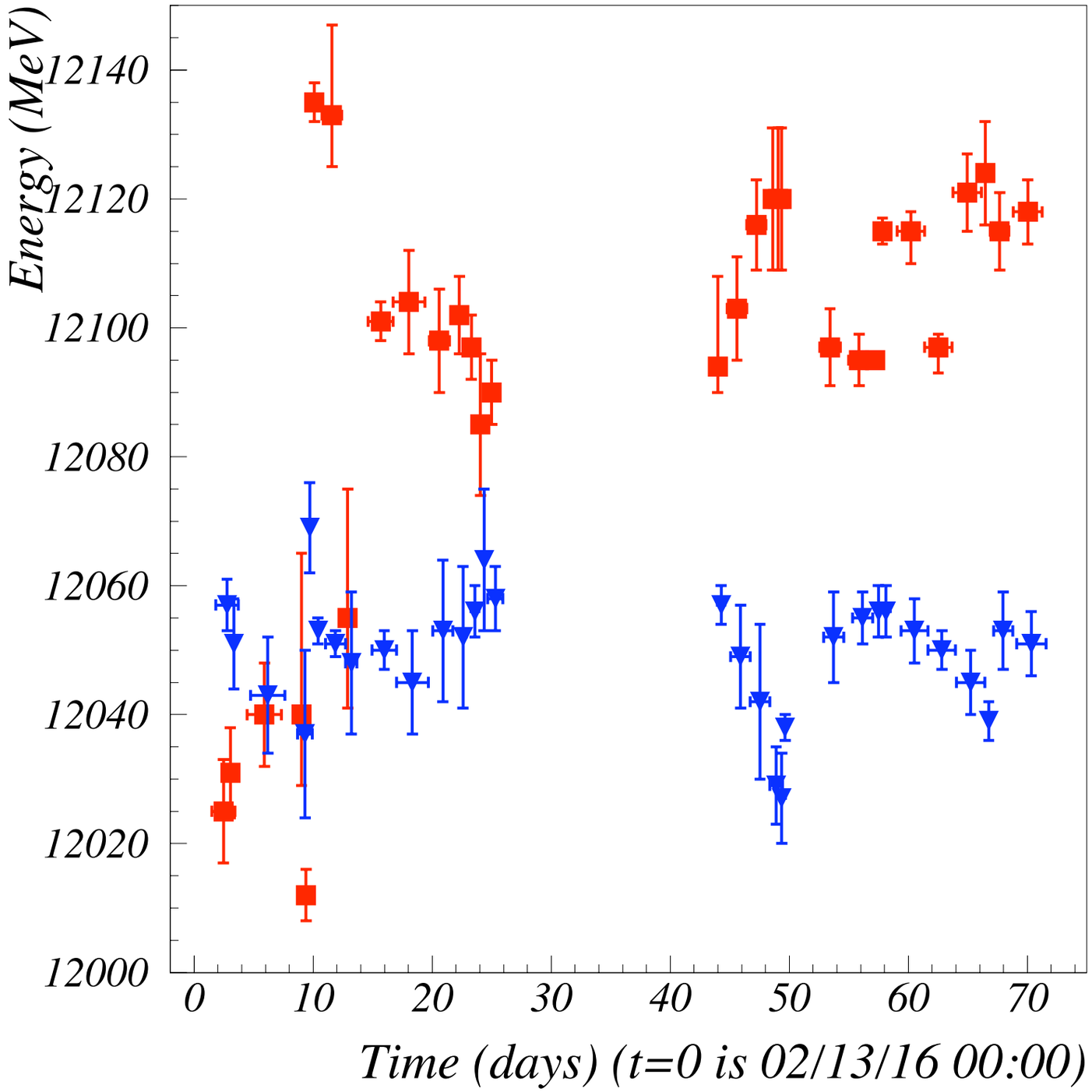
Discussion with accelerator (Mike McCaughan, Yves Roblin, Todd Satogata, Mike Tiefenback)

- Bug found in code to get Hall D energy.
  - Energy=$P_0(1+\delta_{steering})(1+\delta_{orbit})$ but δ_{orbit} had the wrong sign (Accelerator has left-handed convention and model has right-handed. When accounting for the difference ($x \rightarrow -x$), mistakingly did $y \rightarrow -y$ too and since the Hall D ramp bends vertically, δ_{orbit} had the wrong sign.)

- This still does not produce correct baseline changes.
  - To make the several baseline change corrections consistent, the sign of $\delta_{steering}$ needs also to be flipped. Assuming this correction as well yields:

$$\text{Corrected Energy}=P_0 \frac{(1-\delta_{steering})(1-\delta_{orbit})}{(1+\delta_{steering})(1+\delta_{orbit})}$$

Before and after corrections



Bins in periods of approximate stability:

- Uncorrected Hall D beam energy
- Proper correction for artificial drifts

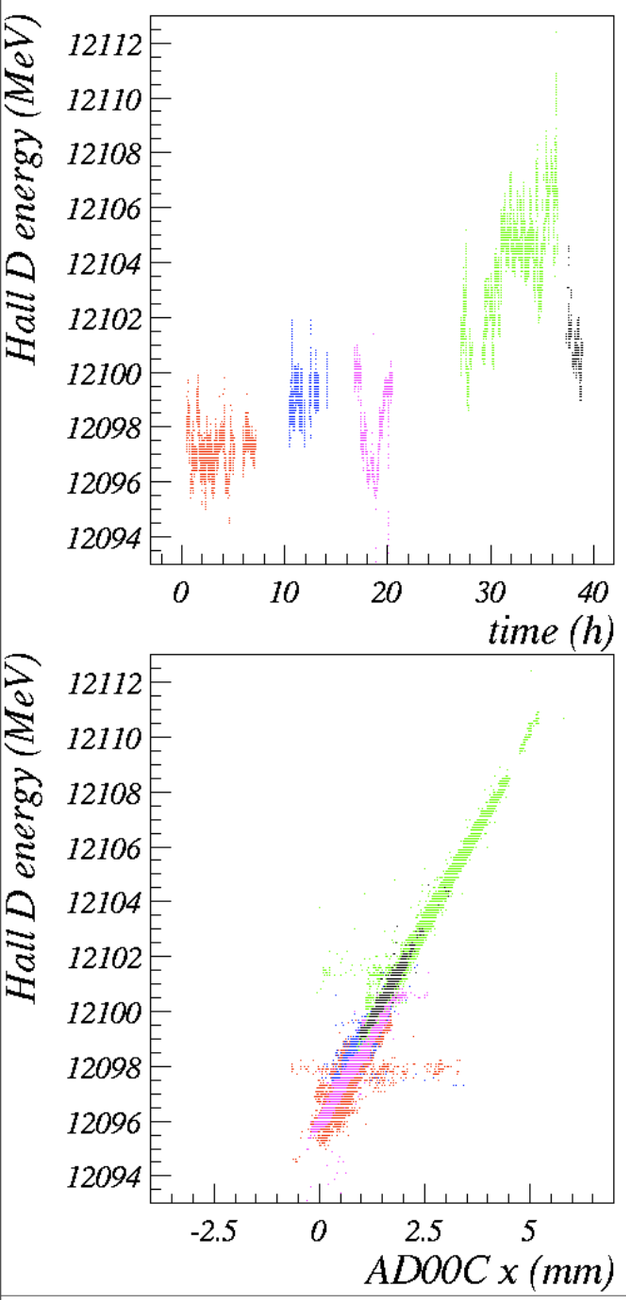
error bars bracket the time range or energy drift range. (They are not uncertainties.)

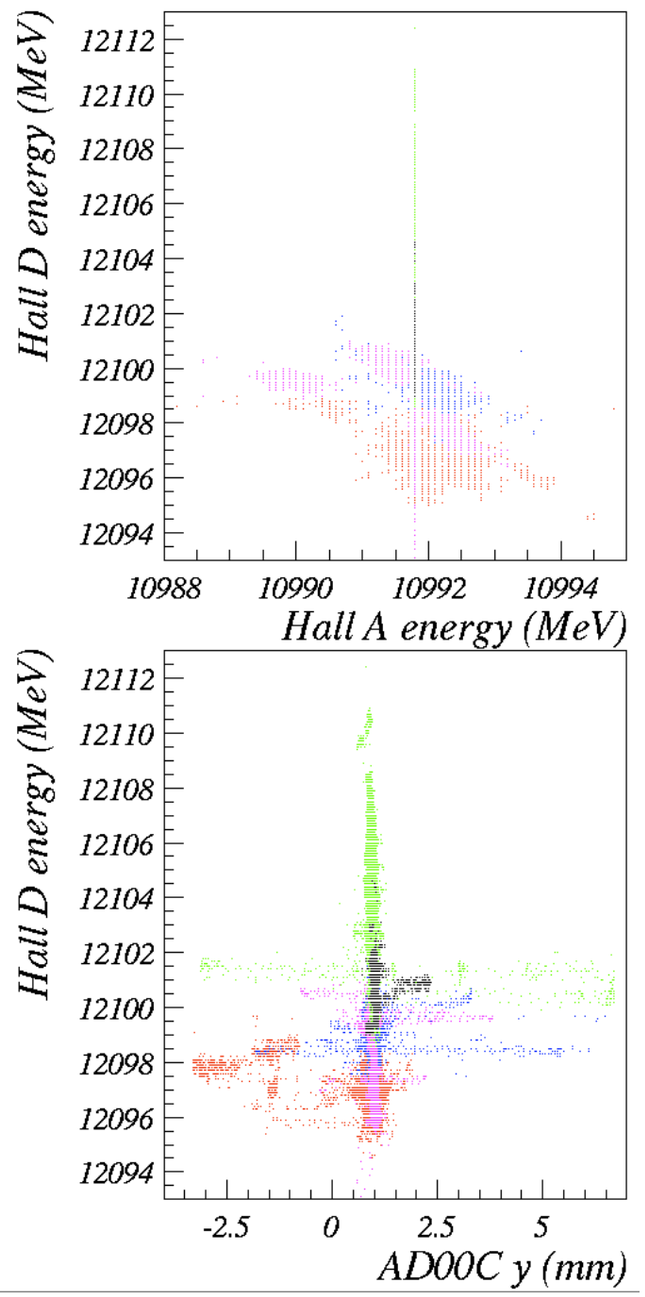
Beam energy now varies within 50 MeV.

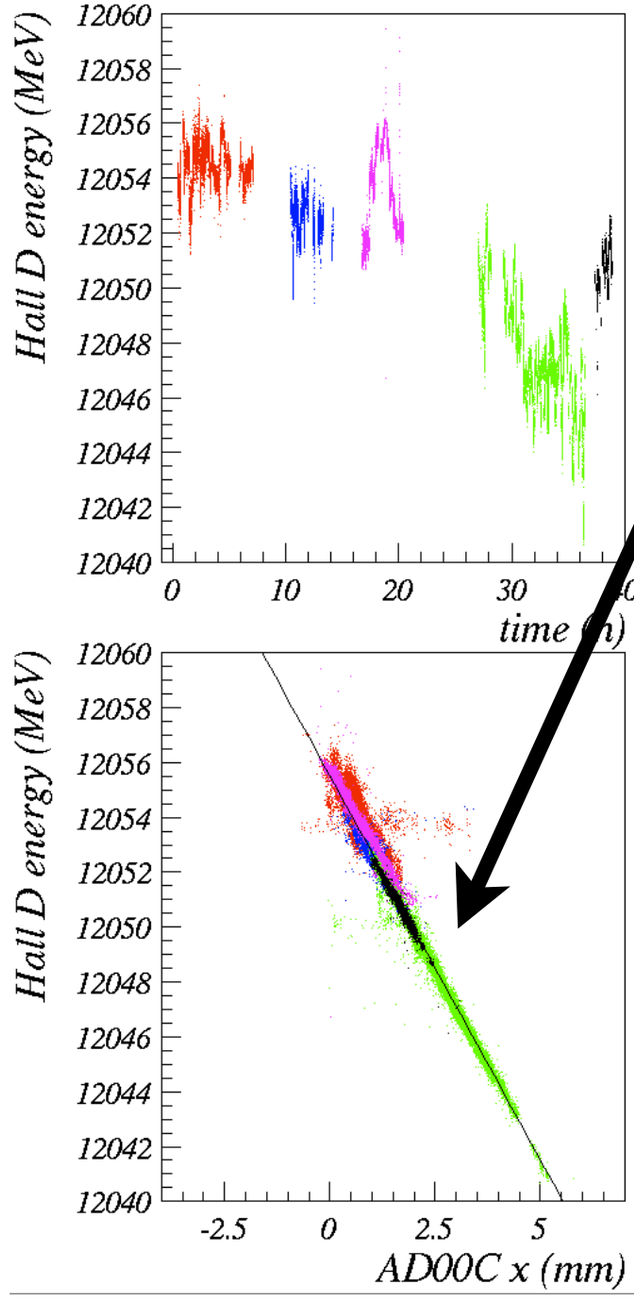
Before and after corrections

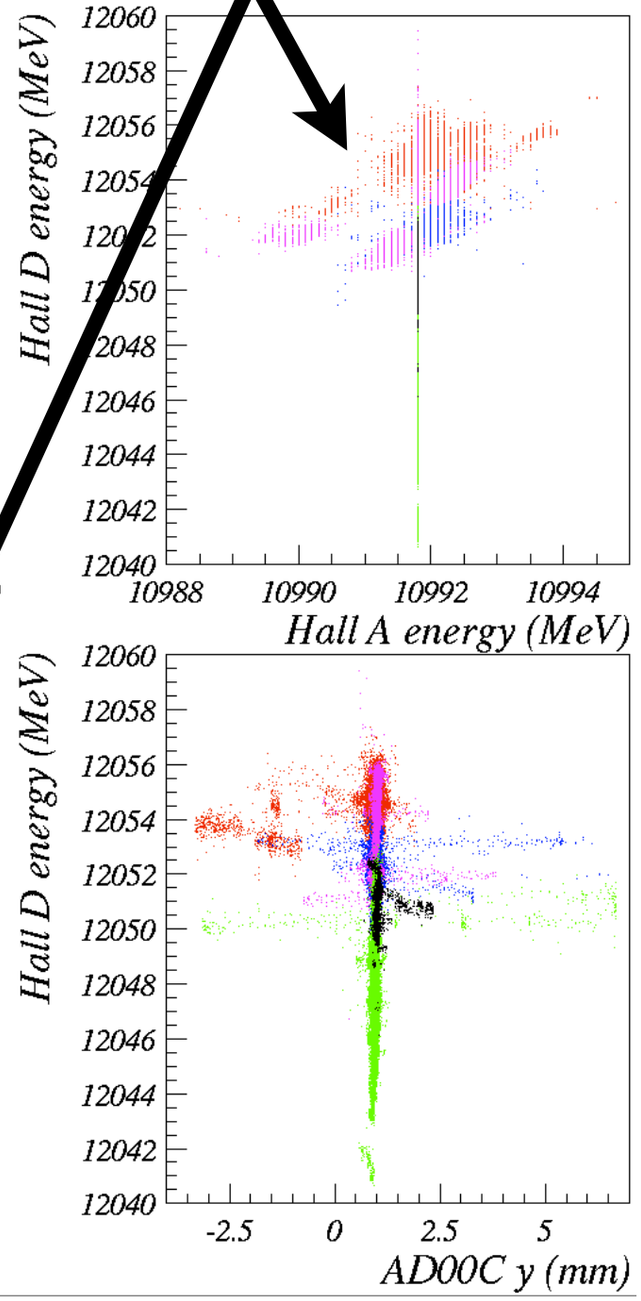
Ex: Mar. 28-30:

Right correlations signs









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Most serious problems are solved

Variation of beam position at tagger dump with radiator thickness:

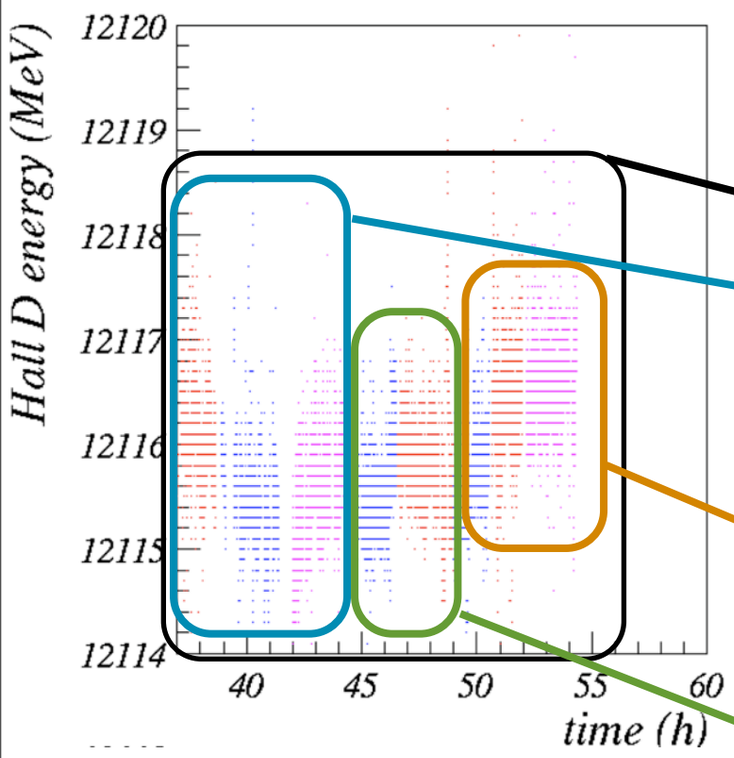
From July 20th report:

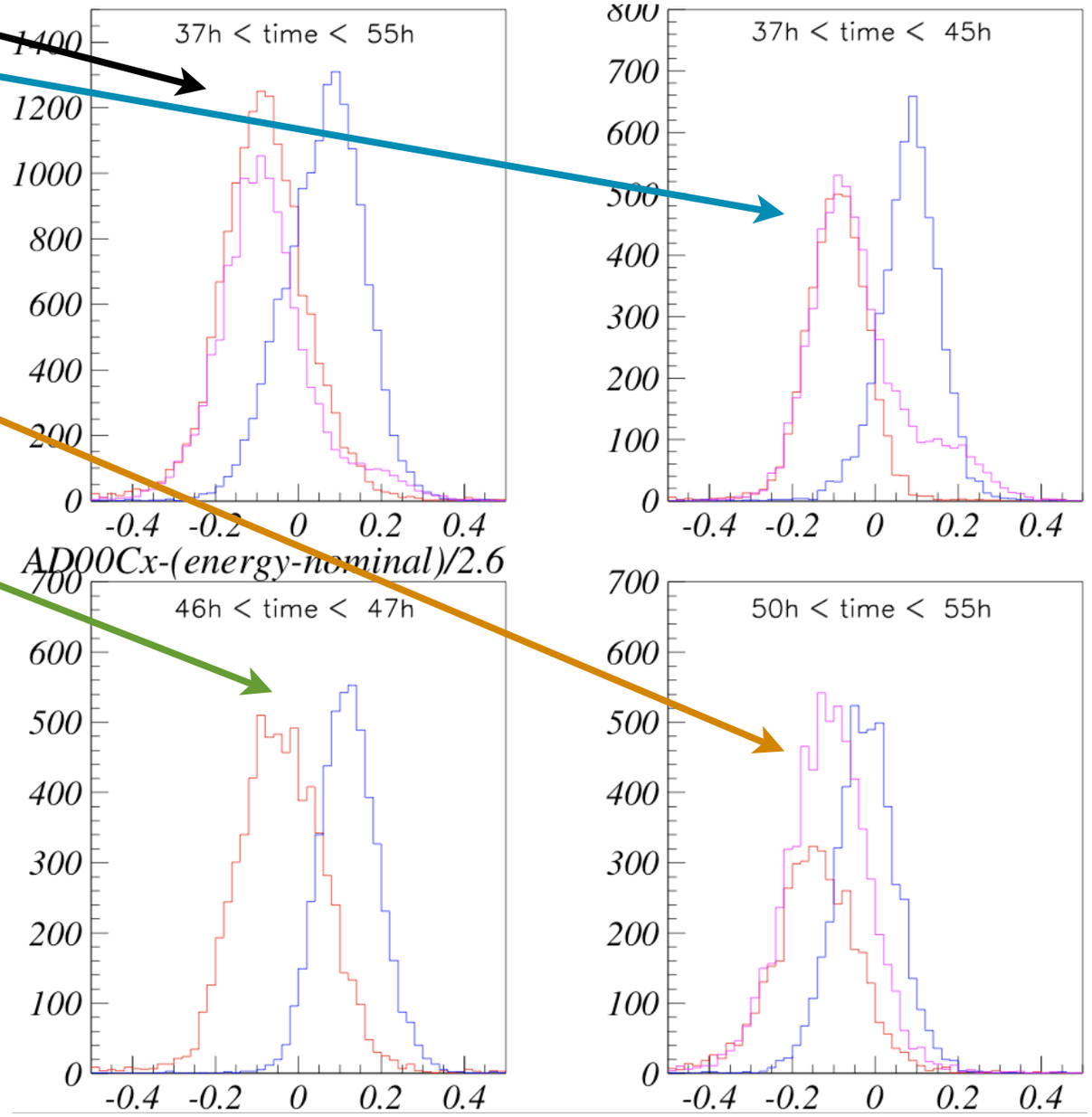
Data from Apr. 24th - 25th

Al. (RL=3.4 10^{-4})

50 μm diamond, perp (RL=3.4 10^{-4})

50 μm diamond, perp (RL=2.7 10^{-4})





- Blue data (higher energy) shifted each time toward positive x.
- Red and purple overlap.

Variation of beam position at tagger dump with radiator thickness:

From July 20th report:

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Al. (RL=3.4 10^{-4})

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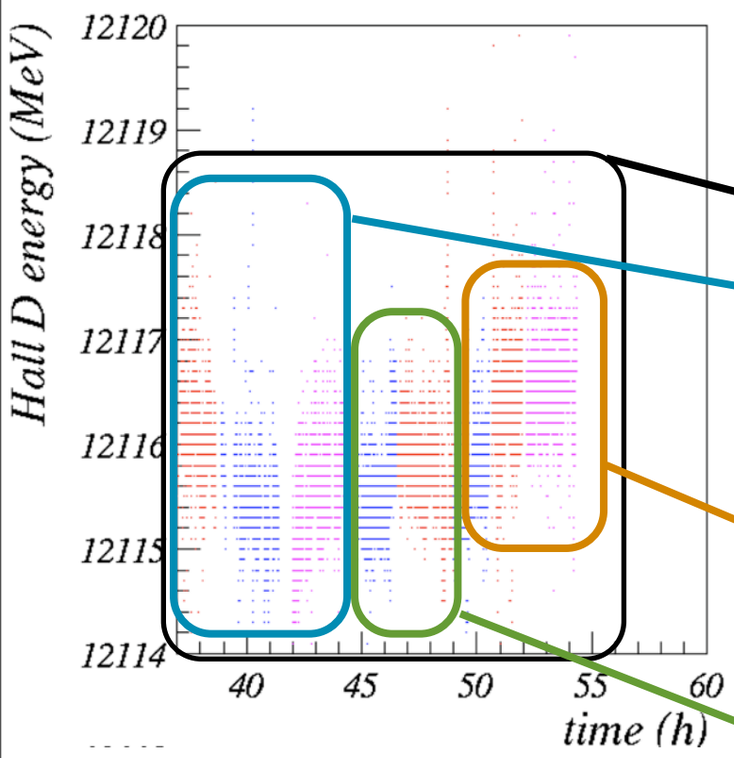
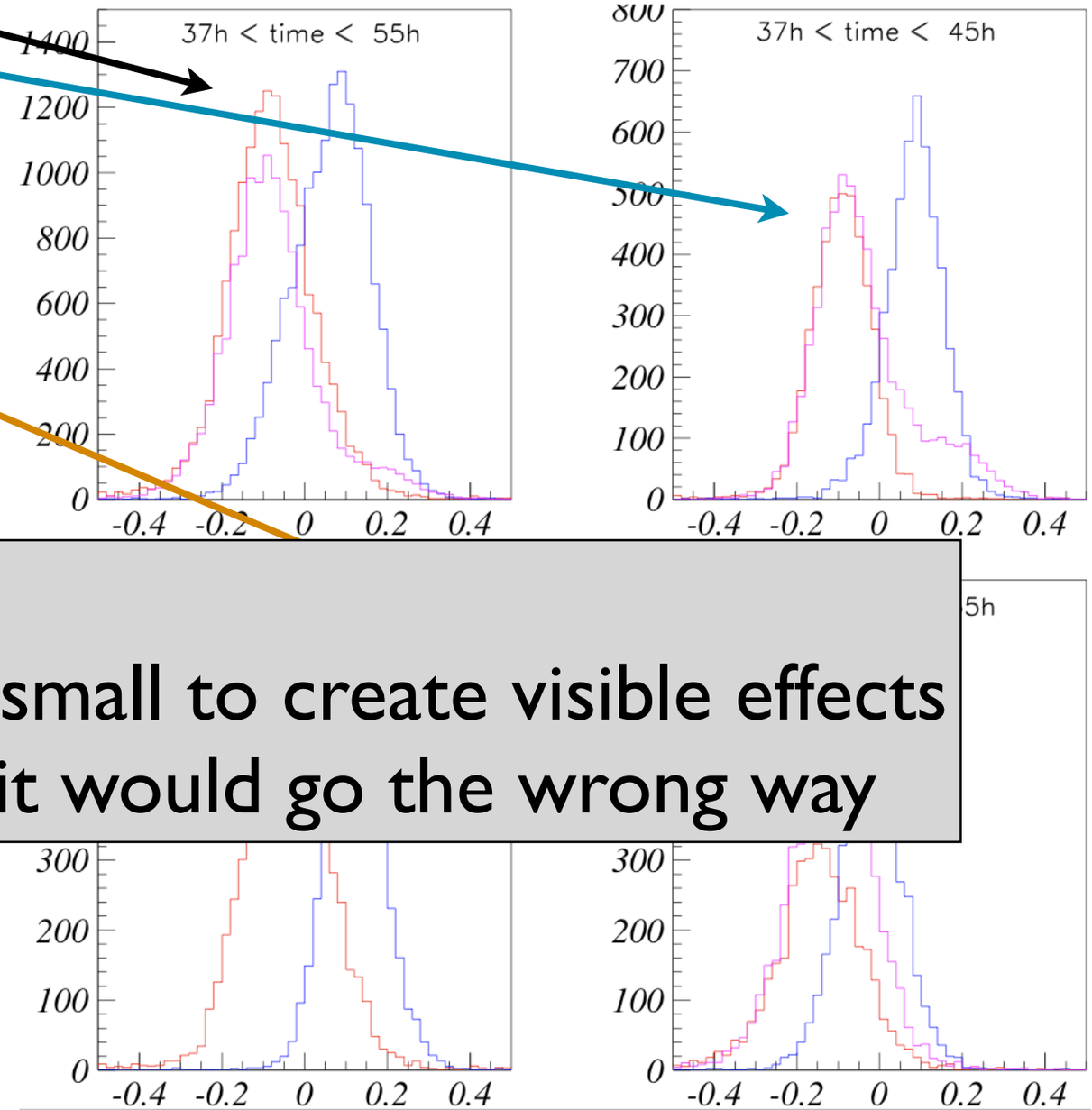


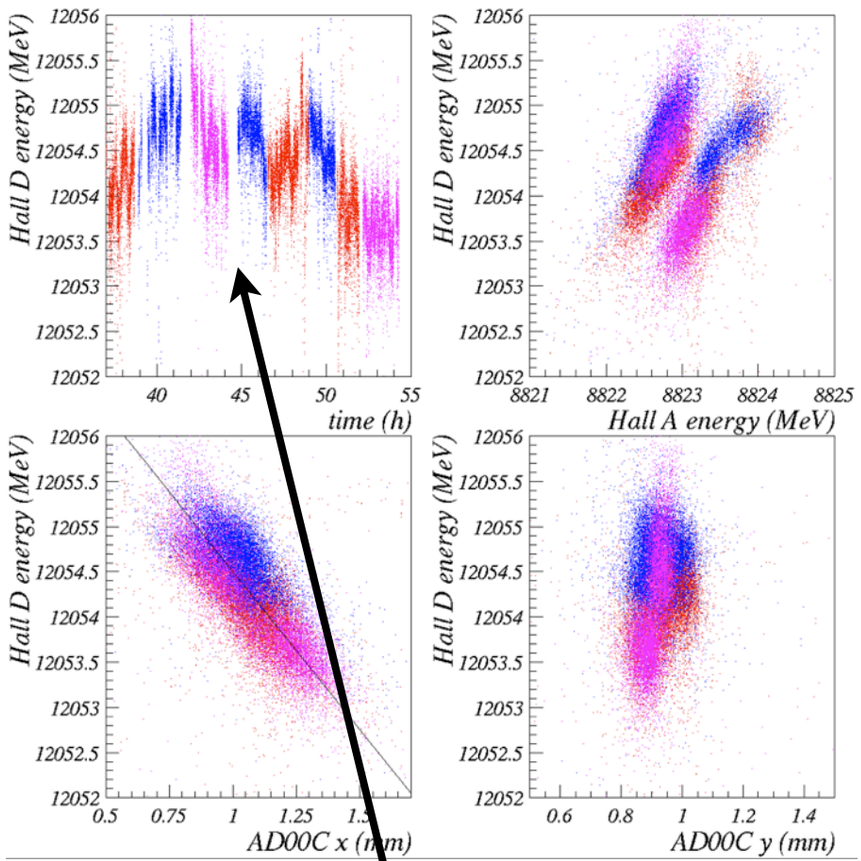


- Blue data (higher energy) shifte… posit…
- Red…

Problems:

- Radiator thickness are too small to create visible effects
- With sign bug corrections, it would go the wrong way

Variation of beam position at tagger dump with radiator thickness:

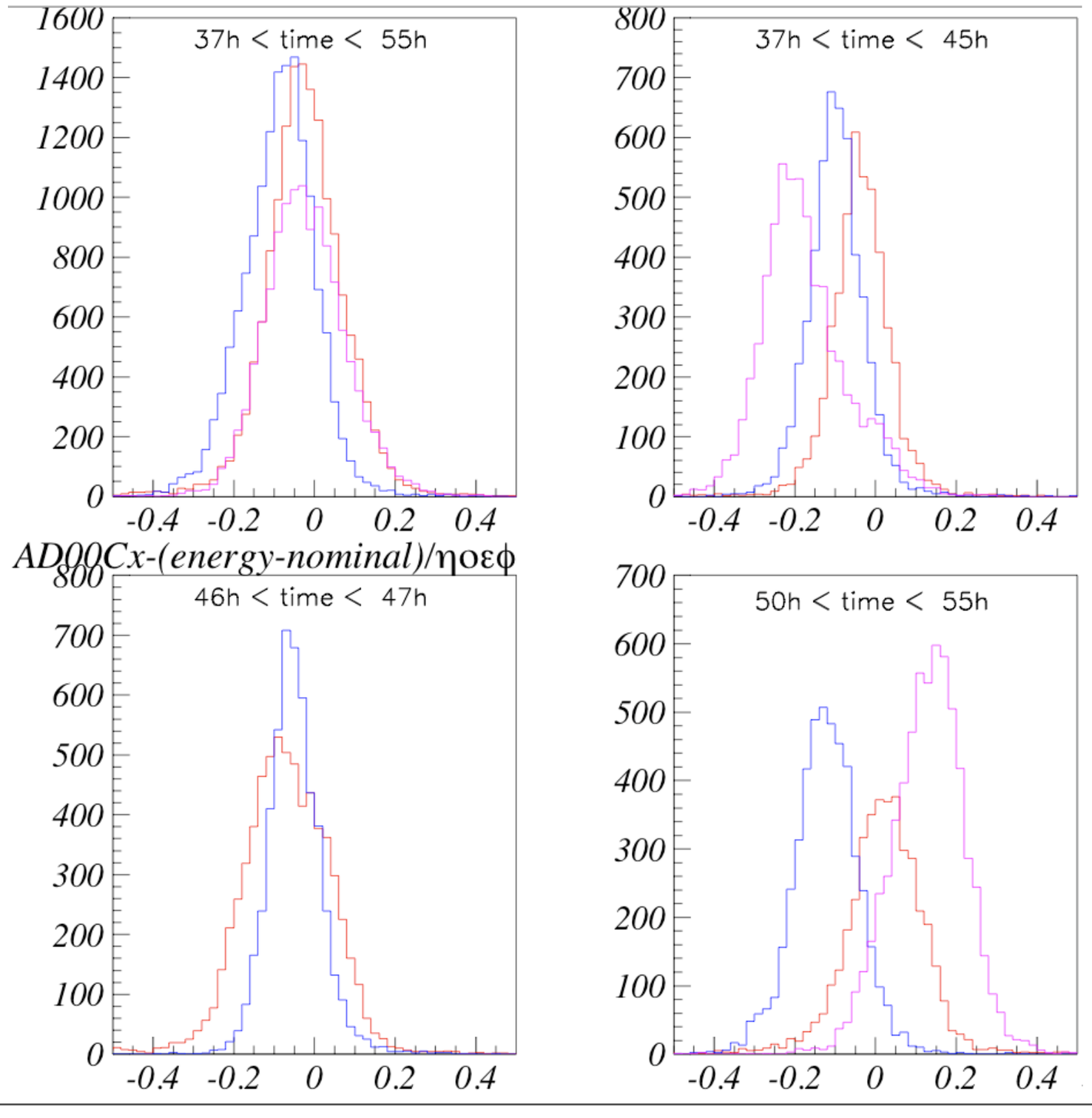


Correcting for time dependence

Al. (RL=3.4 10^{-4})

50 μm diamond, perp (RL=3.4 10^{-4})

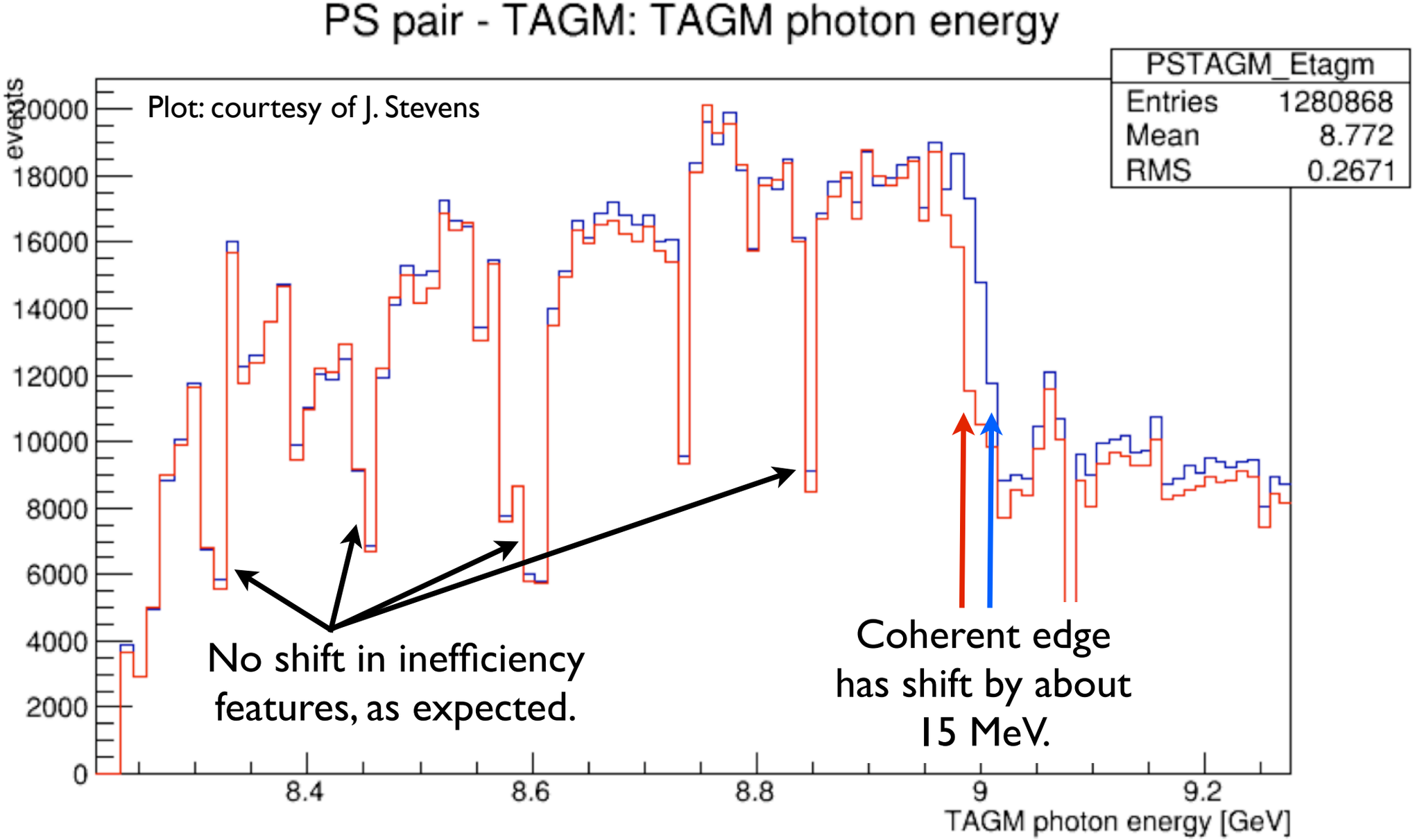
50 μm diamond, perp (RL=2.7 10^{-4})



Energy sign variation using coherent edge

Blue: Run 10857. HALLD:p read about 12091 MeV (before sign bug corrections).

Red: Run 10867. HALLD:p read about 12074 MeV (before sign bug corrections).



Run 10857 after proper baseline correction: 12064.5 MeV

Run 10867 after correction: 12064.7 MeV

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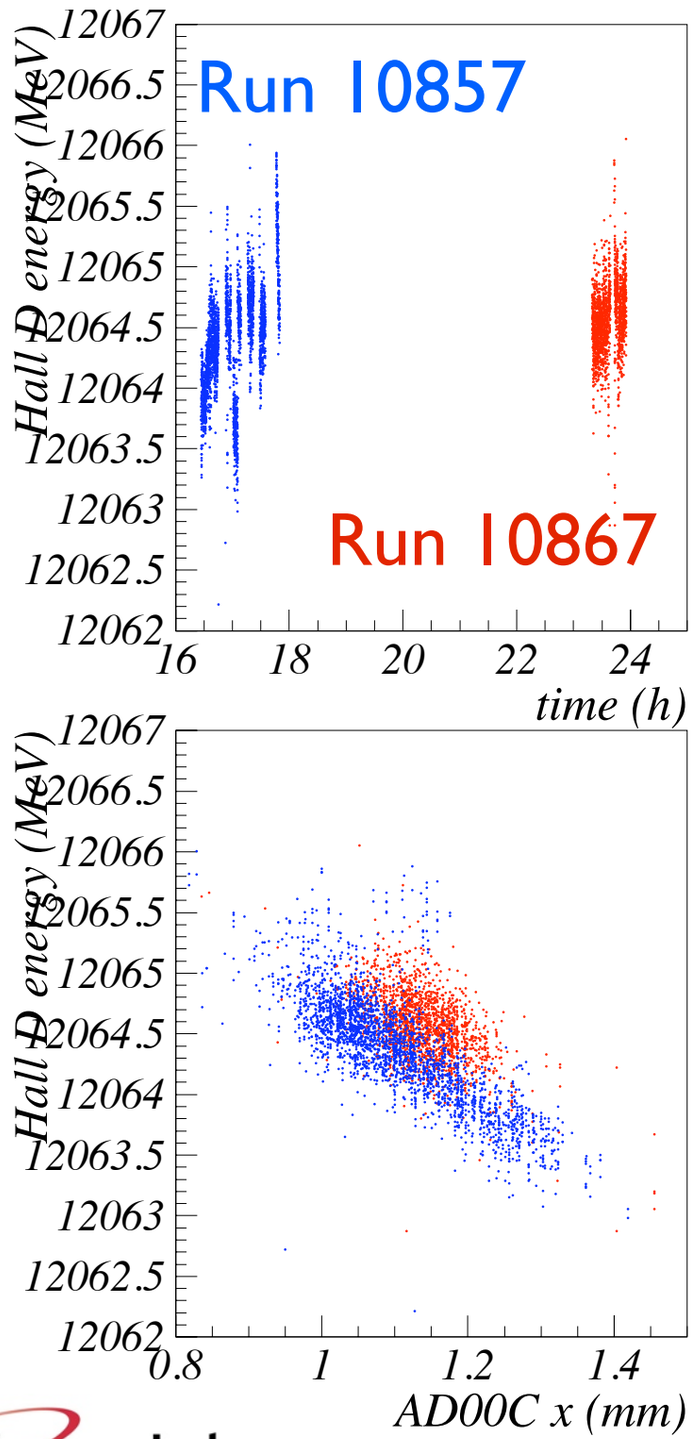
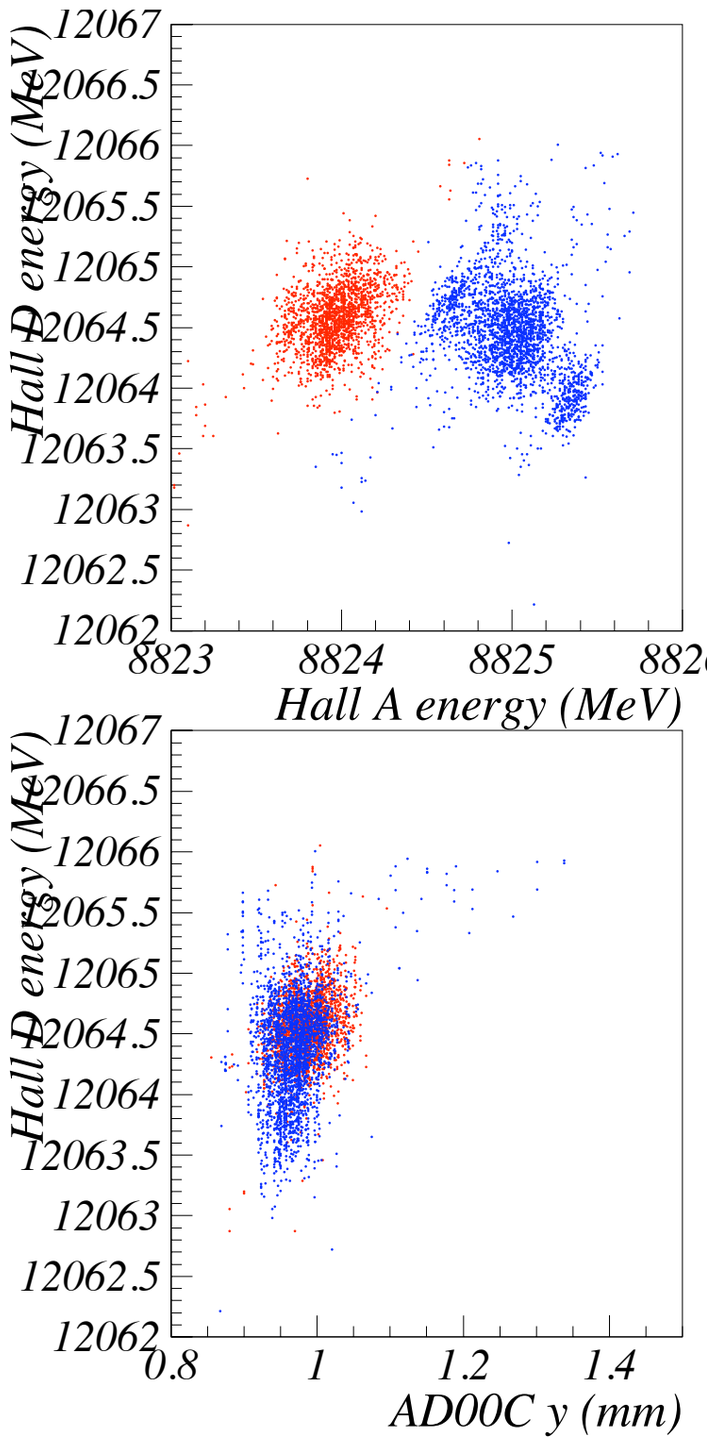
Energy sign variation using coherent edge

Run 10857 after sign bug corrections: 12064.5 MeV

Run 10867 after sign bug corrections: 12064.7 MeV

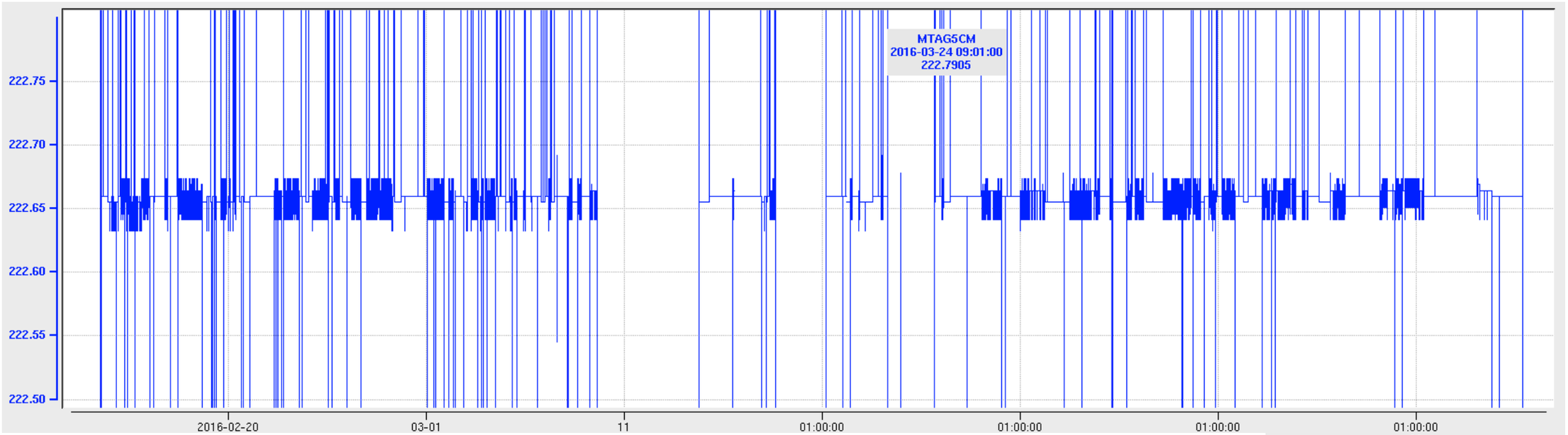




Why is the coherent edge offset between the two runs?

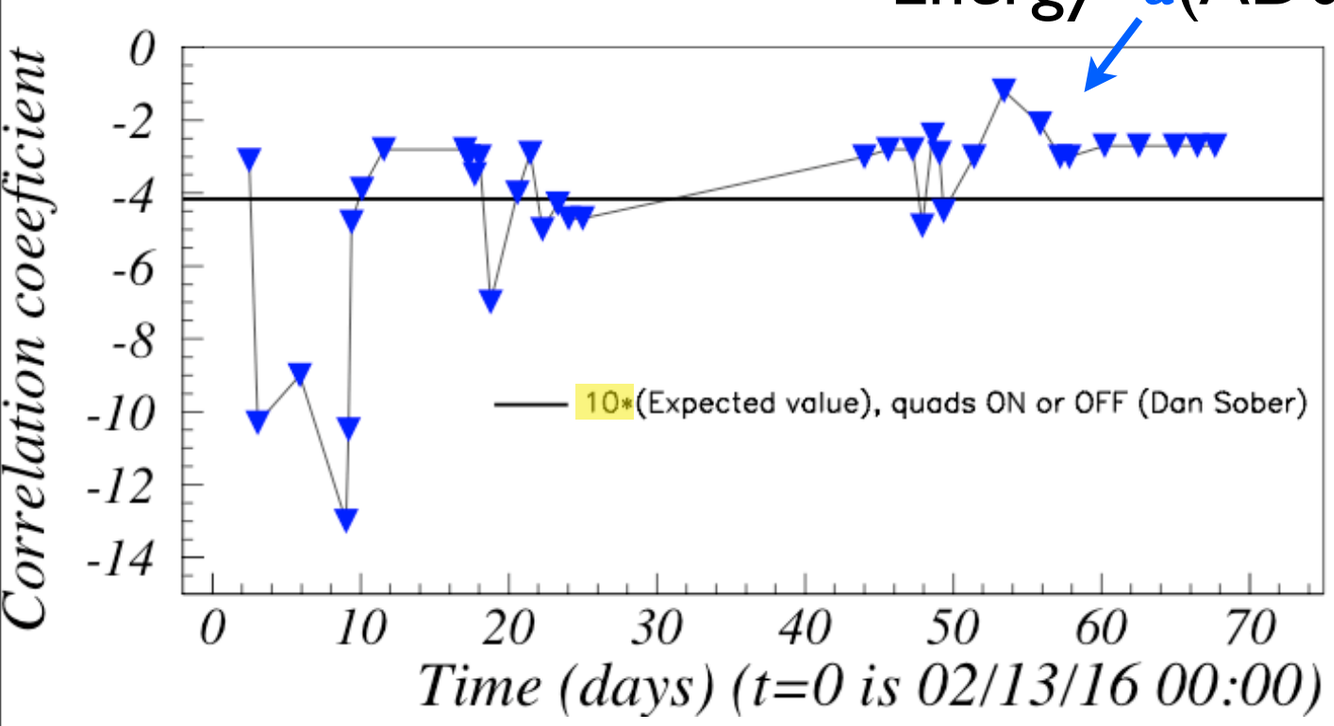
Monitoring using tagger magnet

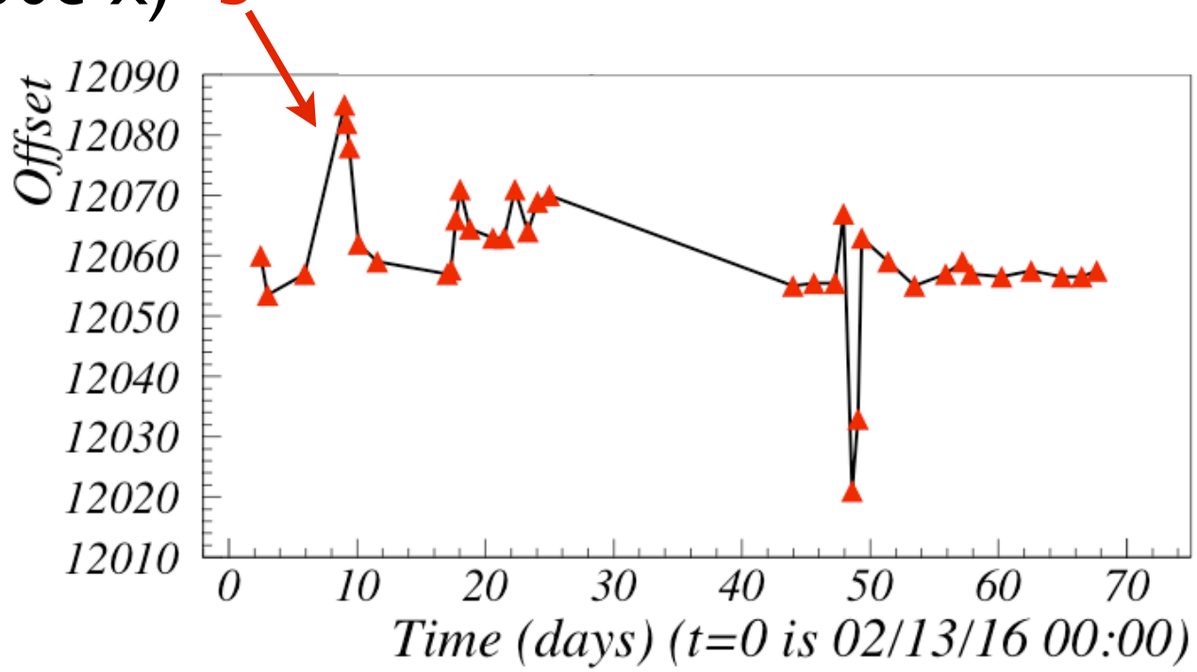
Tagger field was very stable during entire run:



Correlation between energy and position at beam dump:

Energy=a(AD00c-x)+b





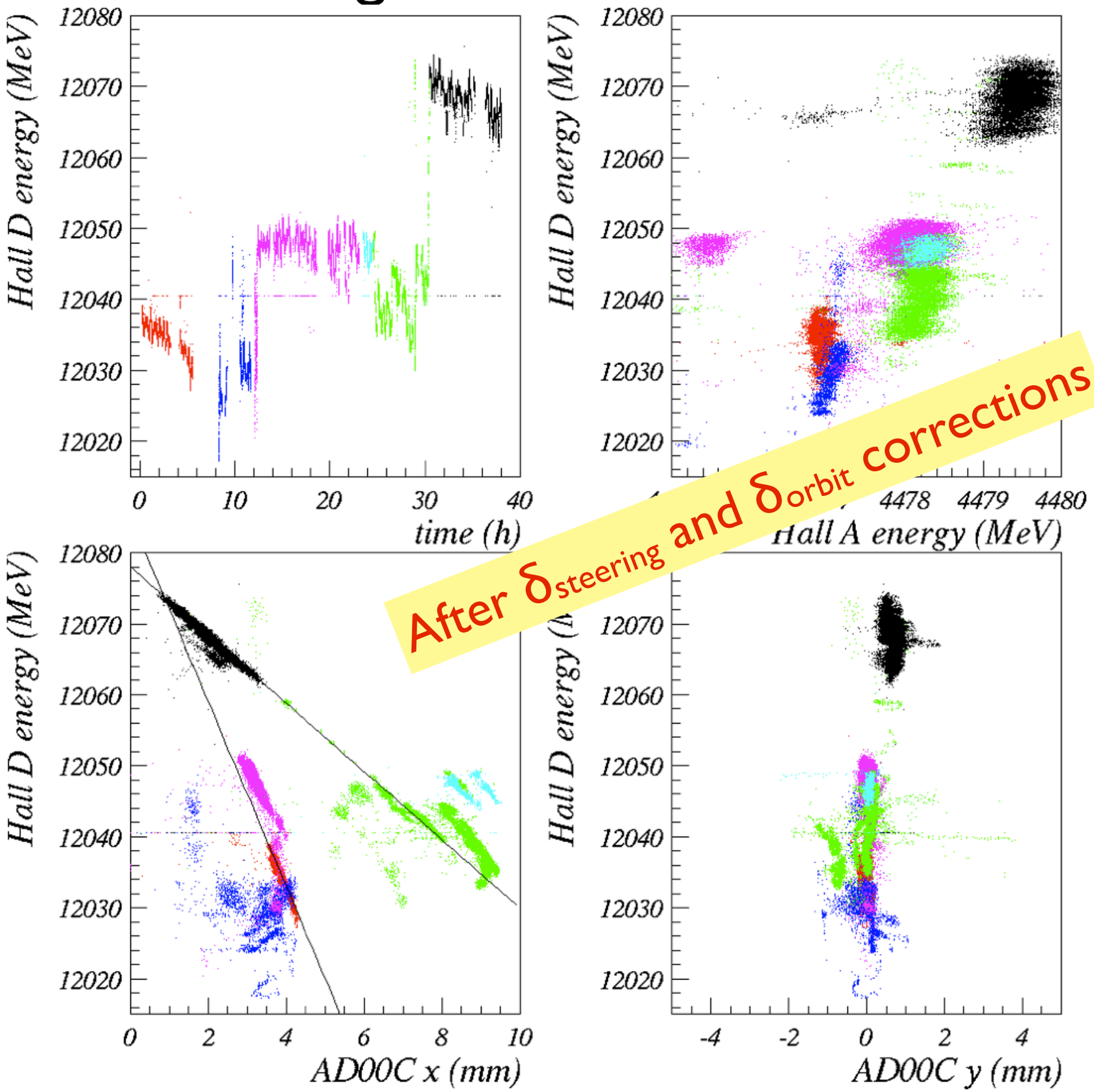
Position corrections are problematic so far (BPM calibration issues?)

Still a necessary energy monitoring?

Remaining issues

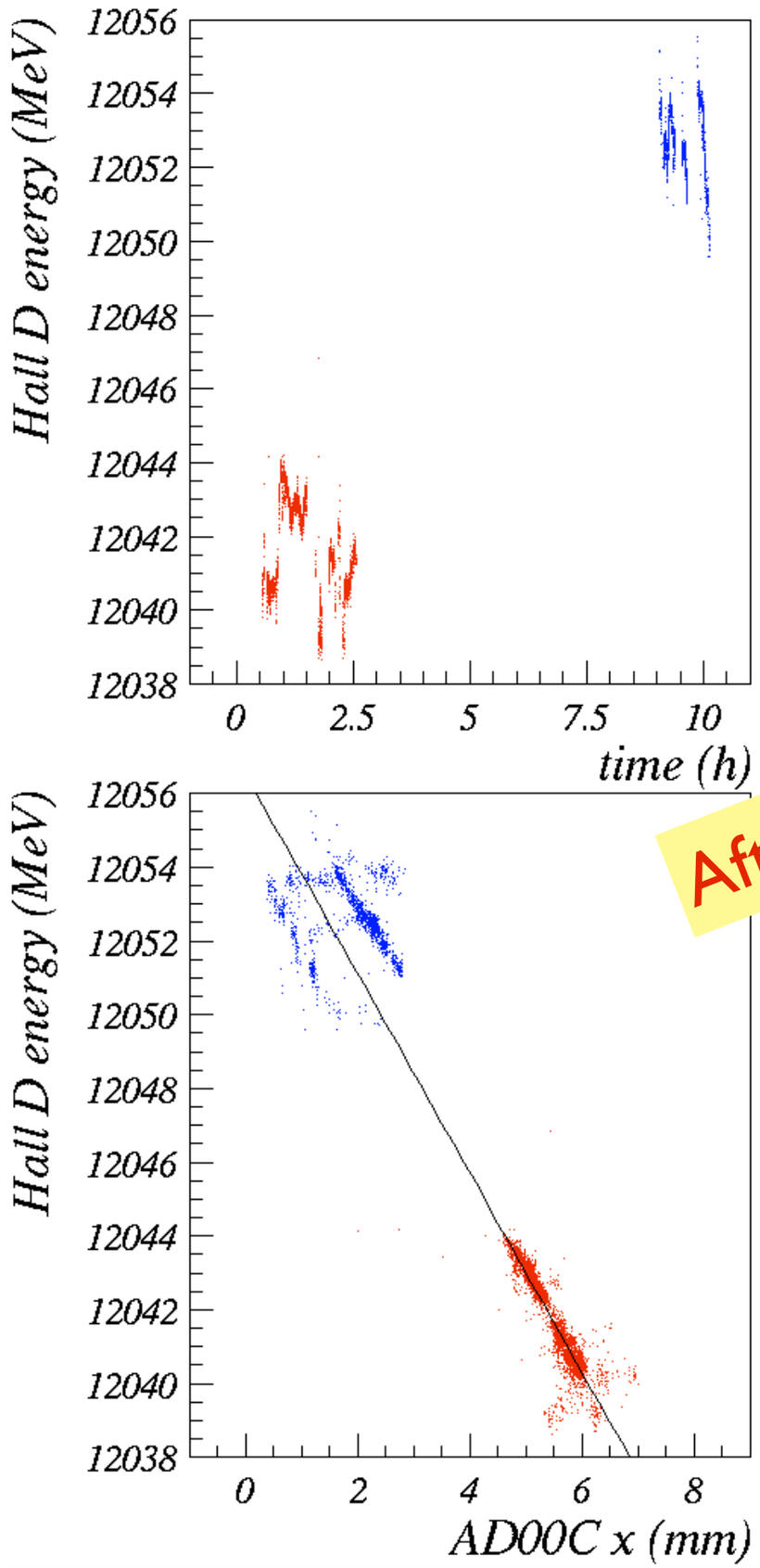
Sudden genuine energy changes.
Ex: Feb. 20-22:

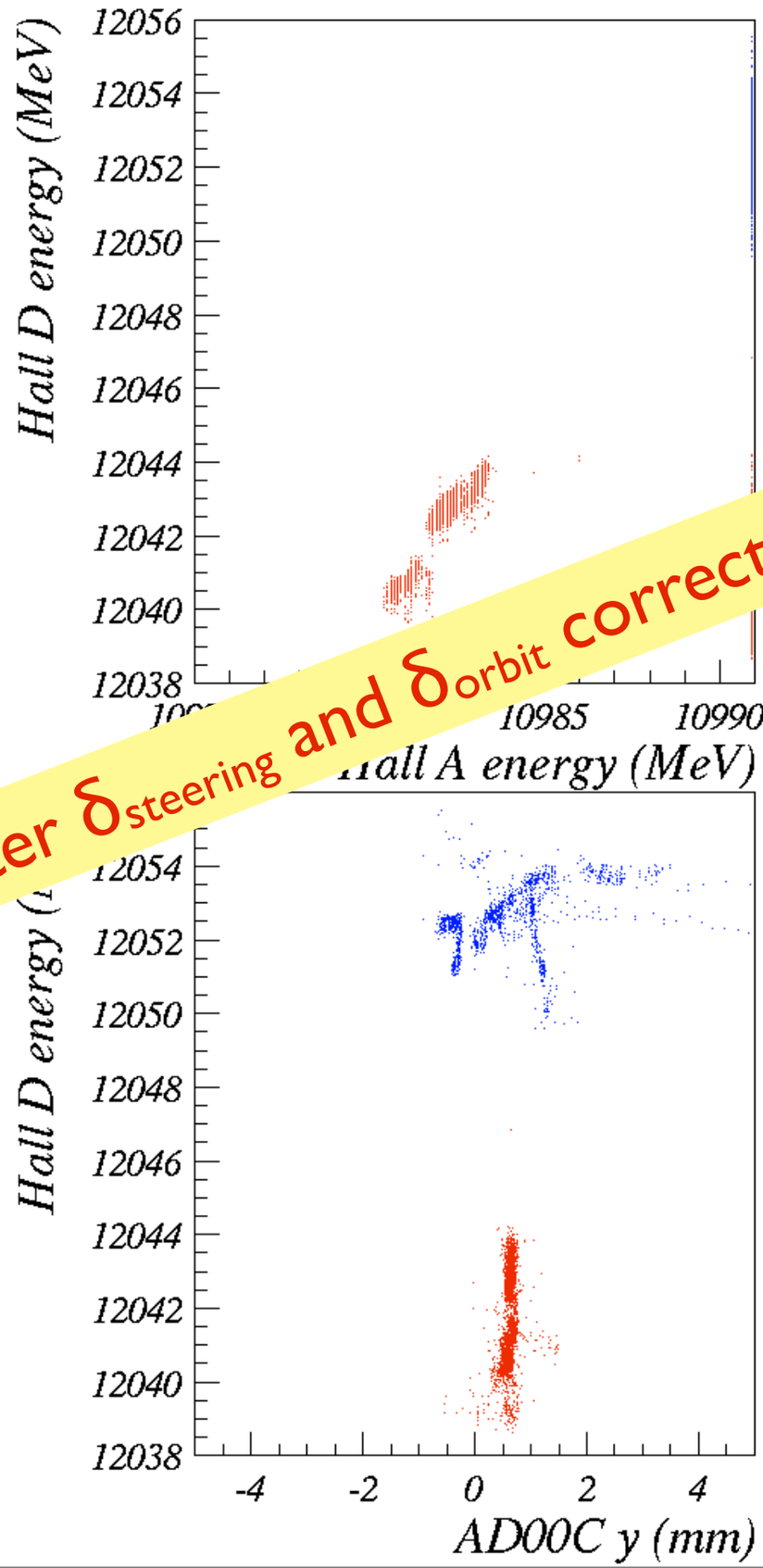
Also: why did the AD00Cx vs HALLD:p coef. changed?



Remaining issues

Sudden genuine energy changes.
Ex: Apr. 20:

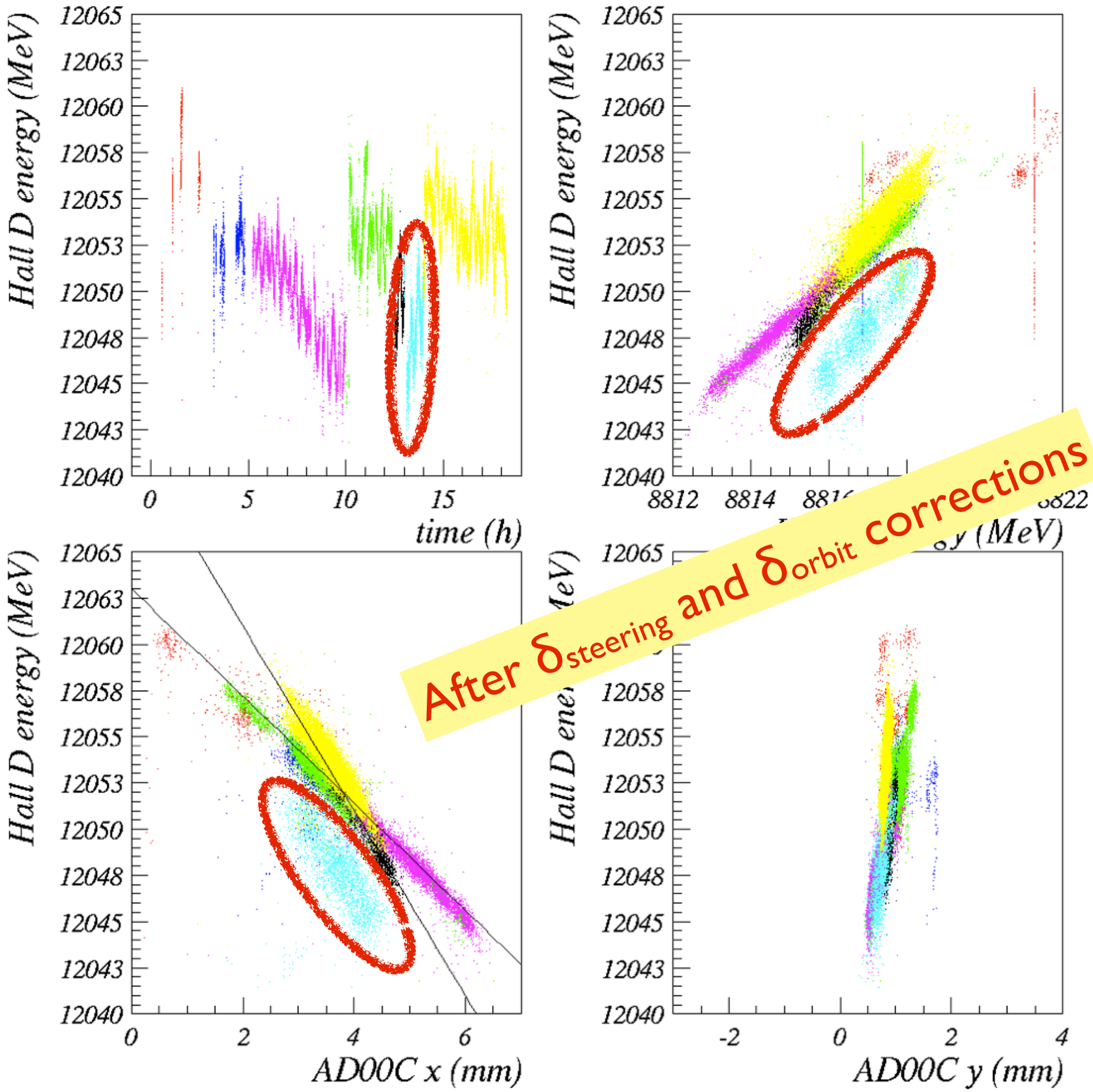




After $\delta_{steering}$ and δ_{orbit} corrections

Remaining issues

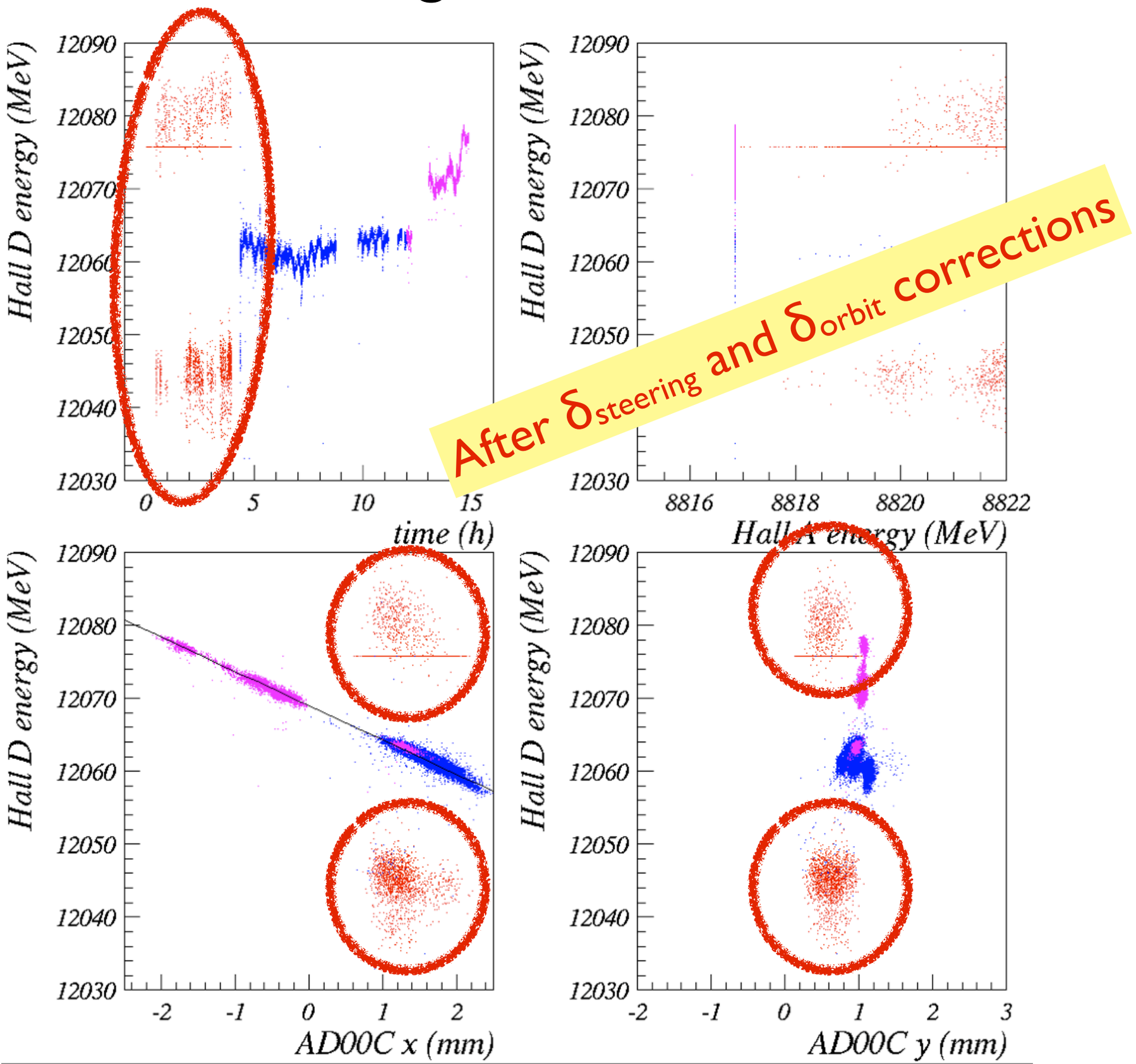
Sudden artificial energy changes.
Ex: March. 5-6:



Remaining issues

Incorrect energy readings:

March. 7th 18:00-22:30



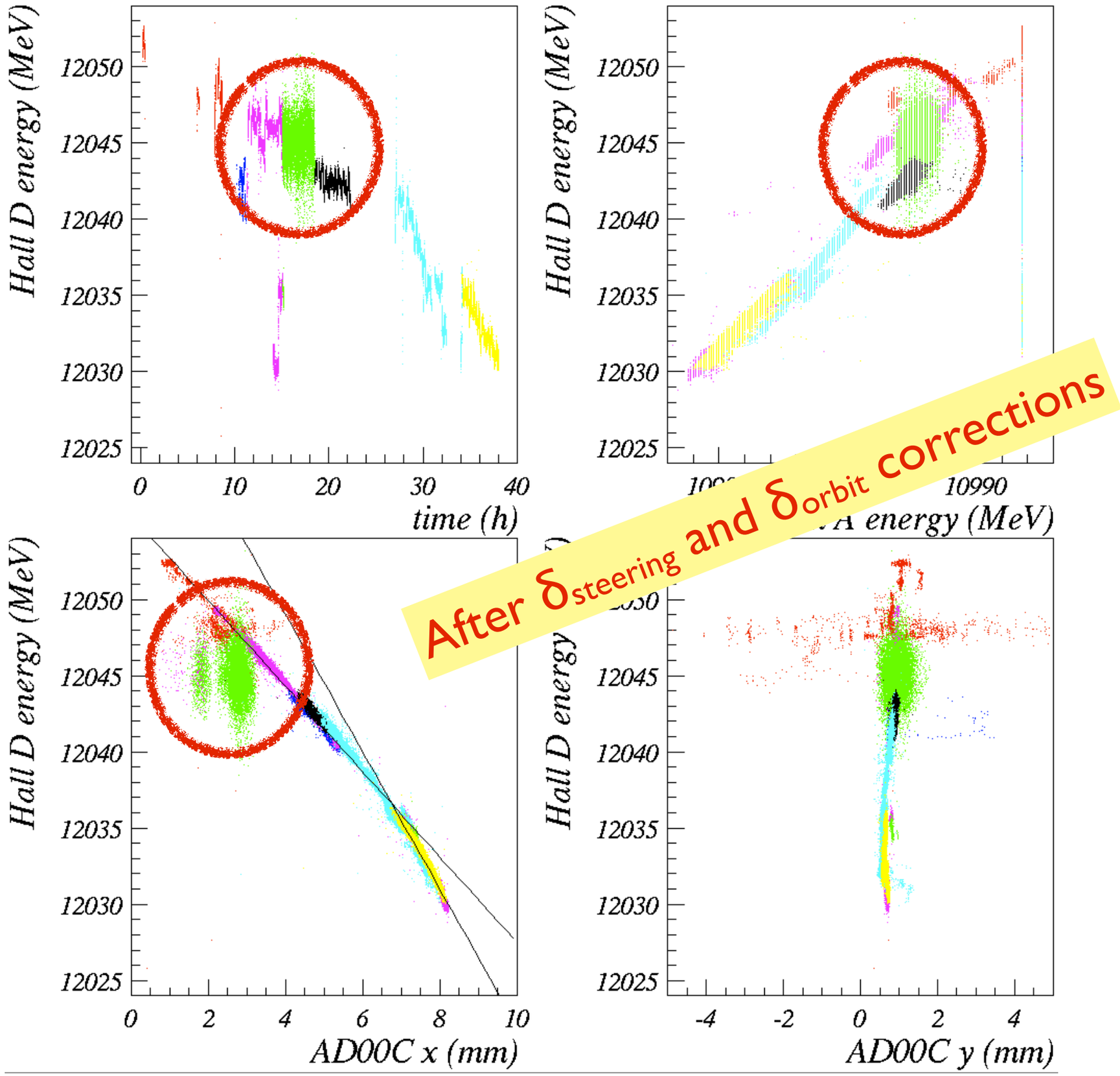
Remaining issues

Increased energy jitter:
Apr. 1st 00:25-04:25

(Other similar ex:
Apr 18th,
Apr 21st,
Apr 23rd)

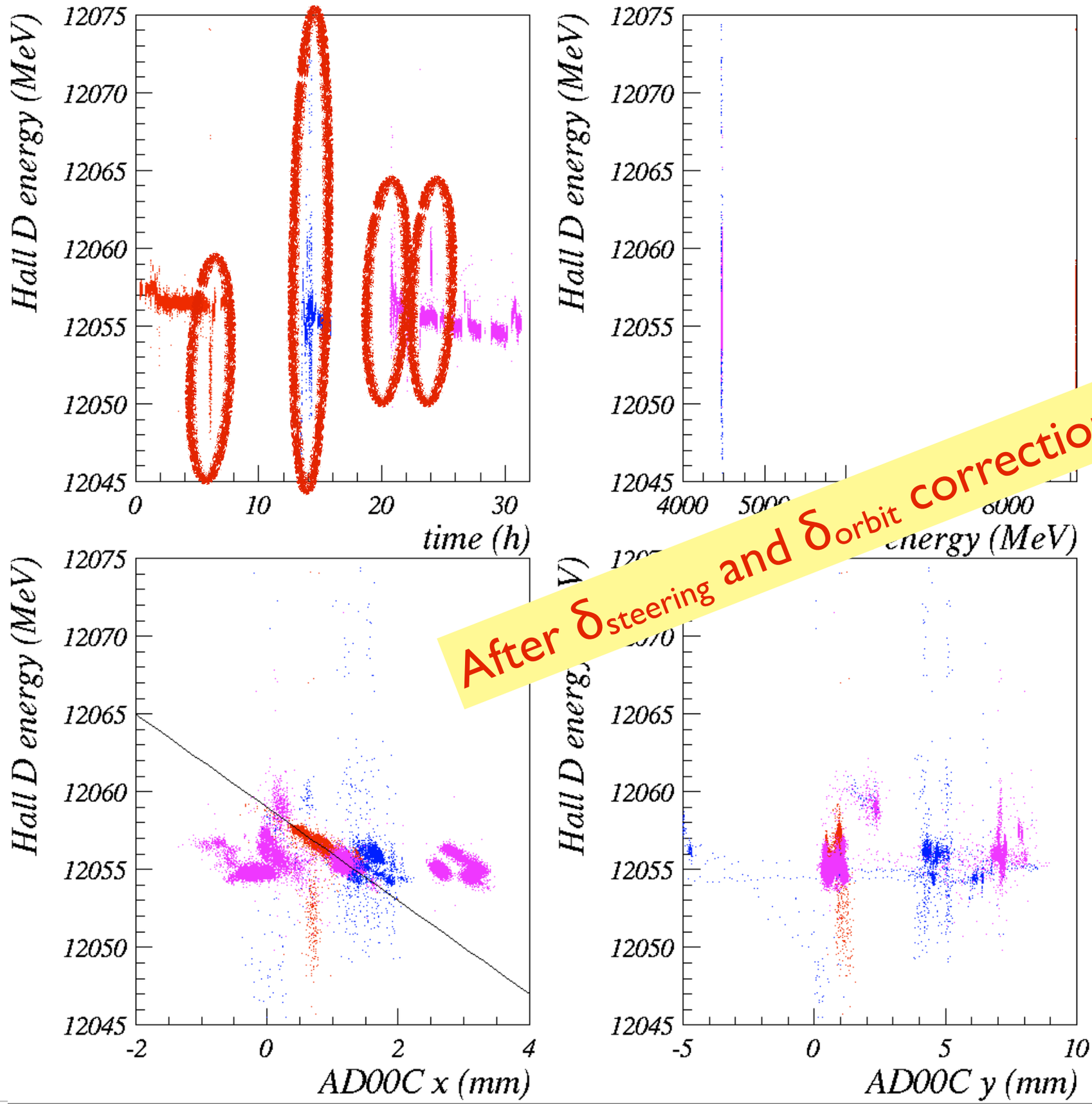
Also:
Large (genuine) energy drift:
25 MeV in 2 days

Also:
non-linear relation between AD00C-x and HALLD:p



Remaining issues

Artificial spikes are common: Ex. Apr. 11-12



Summary

- Sign bugs seems to explain most of the inconsistencies seen in the Hall D energy analysis.
- Overall, Hall D energy stayed stable within 50 MeV (0.4%). Accounting for slow energy drifts yields a monitoring (relative to initial energy value) with MeV accuracy (most of the time). Accuracy of absolute value?
- One sign mistake is now corrected in accelerator code for HALLD:p. Need confirmation for other bug and need to correct code before Fall run.
- With the assumed corrections, HALLD:p for the Spring 16 run, can be used on a event-per-event basis. Needs to be averaged over at least several minutes to be insensitive to random fluctuations).
- Minor problems remaining.
- Now updating the GlueX note detailing this work.
- Check HALLD:p vs AD00C-x corel. coef. unit with Dan Sober.
- Is there still a need for independent monitoring using tagger magnet and AD00C ?