Calorimeter elastic calibrations and coincidence time corrections

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DVCS Collaboration Meeting
JLab

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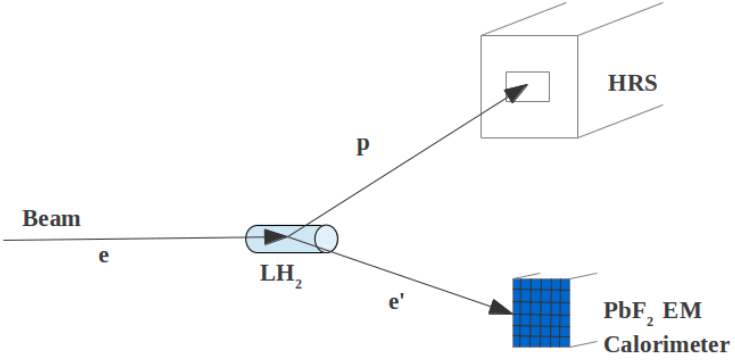
Outline

- Elastic calibrations - a summary
- Reference shapes - summary and outlook
- Calorimeter time corrections - summary and outlook

Calorimeter elastic calibrations - Setup



Calorimeter elastic calibrations - Procedure

- The goal is to extract the coefficients that convert ARS channels to energy and adjust the HV accordingly.
- We define a χ^2 and minimize it to get the 208 linear equations corresponding to 208 blocks.
- $\chi^2 = \Sigma_{j=0}^{events}(E_j - \Sigma_{i=0}^{208}(C_i A_i^j))$
- We invert the 208 by 208 matrix and solve it to get the coefficients
- $\Sigma_i^{208}(\Sigma_{j=1}^{events}(A_j^k A_j^i))C_i = \Sigma_{j=1}^{events} E_j A_j^k$

- E_j - electron energy for event j, according to High Resolution Spectrometer,
- A_i^j - amplitude of signal for block i,
- C_i - calibration coefficient for block i.

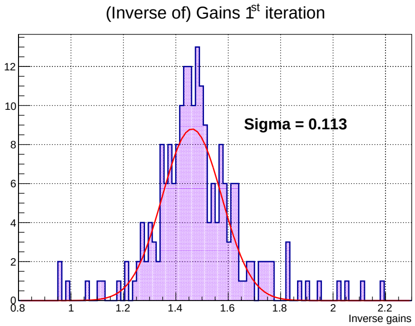
2 elastic calibrations were done in Fall 2016, October 28 and November 12.

Calorimeter elastic calibrations - Fall 2016 kinematics

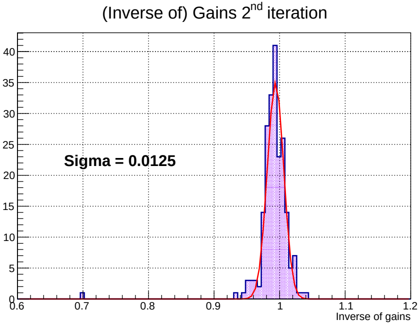
- HRS;
  - Angle - 32.5^0
  - Central Momentum - 3.0 GeV
- Calorimeter;
  - Angles - 21.4^0, 22.7^0,24^0
  - Distance - 6.18m
- Beam;
  - Energy - 6.45 GeV
  - Current - $5\mu A$
  - Raster - NONE

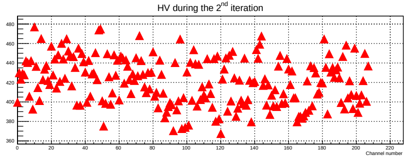
Calorimeter elastic calibrations - 28 October calibration

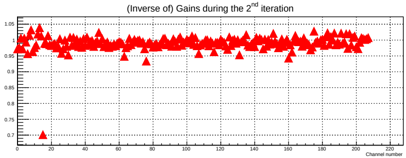
Before HV adjustment.



After HV adjustment.

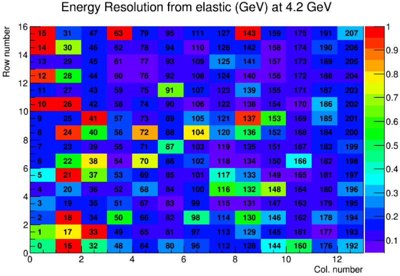






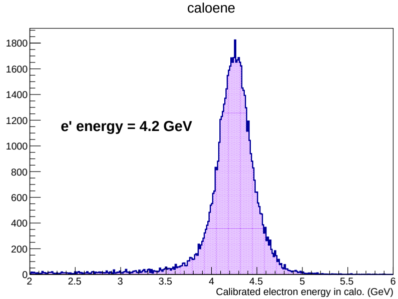
- Ch. 15 demanding higher HV.
- Average 170 ADC channels/GeV.

Edge blocks suffer from lack of statistics.

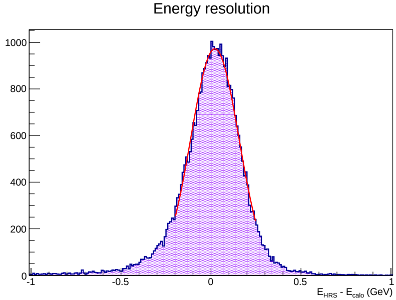


Calorimeter elastic calibrations - 28 October calibration

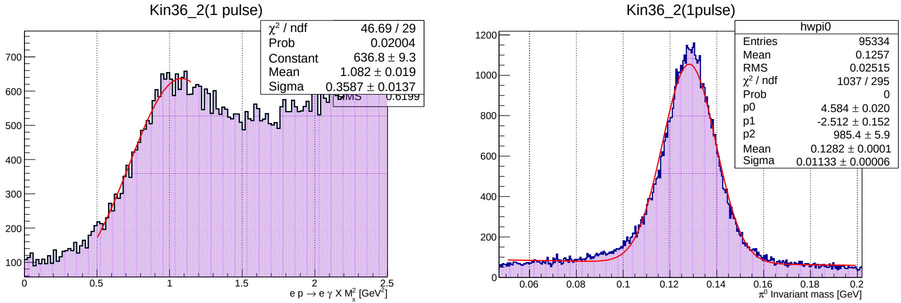
Calibrated elastic electron energy measured by the calorimeter.



Calorimeter energy resolution relative to HRS, $\sigma = 133$ MeV.



Calorimeter elastic calibrations - 28 October calibration - DVCS observables



- No background subtraction yet.
- Optimization to be done by π^0 calibration - see next talk(F.Georges).

Calorimeter elastic calibrations - Summary and outlook

Date	Electron(GeV)	Resolution(MeV)	E_{beam}(GeV)
Dec. 2014	5.2	167	7.3
Feb. 2016	3.1	144	4.4
Apr. 2016	3.1	144	4.4
Oct. 2016	4.2	133	6.5
Dec. 2016	4.2	154	6.5

- Apr. 2016 - we loaded the wrong HV for the second iteration.
- Calibration coefficients ready for all these data but at this point you still need to talk to people and personally implement them in your code(s).
- **To do: Copy these coefficients to the SQL database.**

Calorimeter Reference shapes

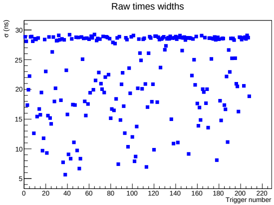
- Reference pulses were extracted from elastic data.
- For each block, a reference shape is done,
- Signals with a high response from the PMTs were selected, iterative averaging both in time and amplitude is done for all selected signals per block,
- Reference shapes were extracted from each of the following elastic data sets;
  - Fall 2014
  - Spring 2015
  - Spring 2016
  - Fall 2016

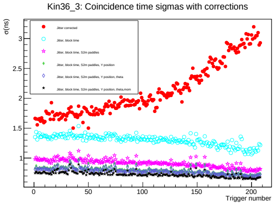
Calorimeter Reference shapes - Conclusion and outlook

- Reference shapes were copied to the SQL DB for 2014, 2015 and Spring 2016 data, however the EDTM wasn't suppressed for those. EDTM-suppressed reference shapes have been done and are ready to be copied to the DB for 2014,2015 and Spring 2016.
- A few channels still need to be checked for Fall 2016 reference shapes and once this is done, they will also be copied to the DB.
- Once shapes are in the DB, the right set can be reached by the command: gdvcs $\rightarrow$ SetRun(runnumber); in your working macro. A wrong runnumber may take you to the wrong set of shapes where some of them are different and the timing is different.
- **Once everything is finalized and implemented, a note will be written and submitted to the ELOG.**

HRS-Calorimeter coincidence time corrections

- The goal was to reduce the dispersion of the coincidence time For each calorimeter block to less than 1 ns standard deviation
- A narrow coincidence window will close out many accidentals and improve the energy resolution of the calorimeter
- Corrections were applied to consider different calorimeter block positions, cable lengths, electron and light propagation distances in HRS. These include;
  - ARS stop trigger jitter
  - Time per calorimeter block
  - S2m scintillator paddle centering
  - Light propagation in S2m scintillators
  - Electron angle (theta) in HRS
  - Electron momentum in HRS

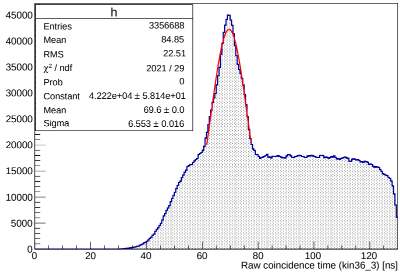




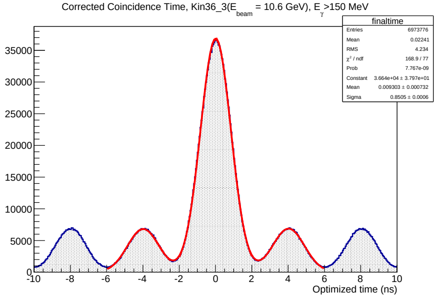
HRS-Calorimeter coincidence time corrections

Example of "raw" and final time for Fall 2016 data, kin36_3.

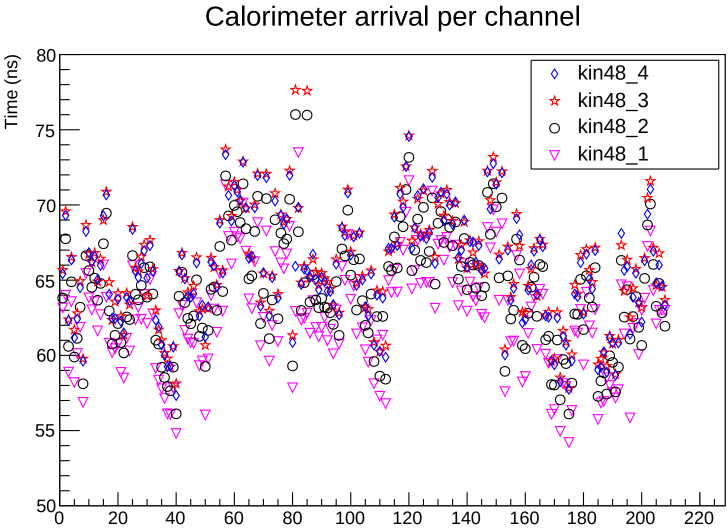
Time spectrum with just corrections for jitter, $\sigma = 6.5$ ns.



Time spectrum after all corrections, σ=0.85 ns.

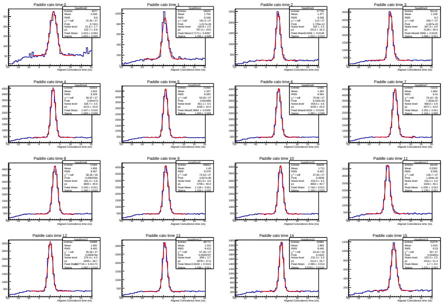


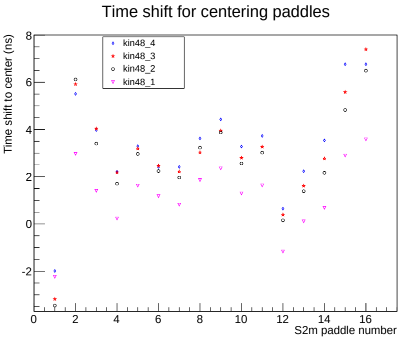
Calorimeter Time corrections - Kin48_1,2,3,4 - calo channels



Calorimeter Time corrections - Kin48_1,2,3,4 - S2m centering

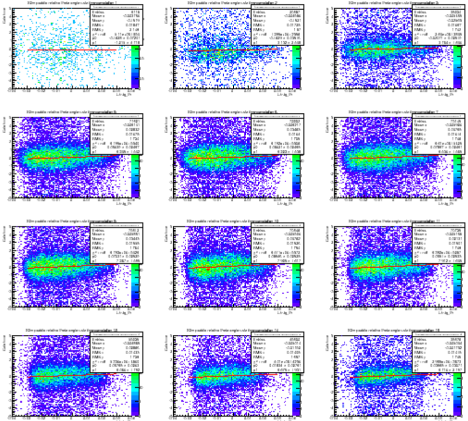
Time distribution as a function of scintillator paddles.

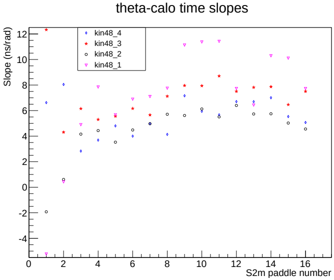


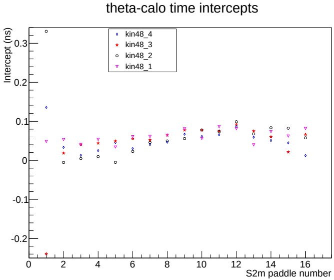


Calorimeter Time corrections - Kin48_1,2,3,4 - S2m θ correction

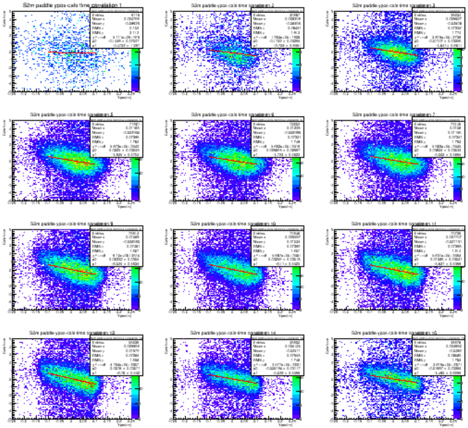
Statistical effects at the far end of S2M.

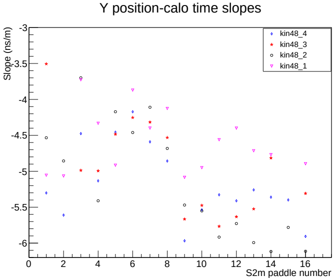


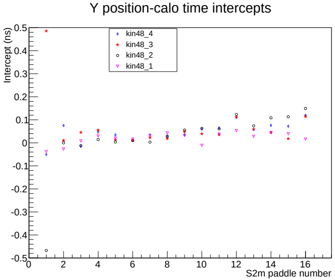




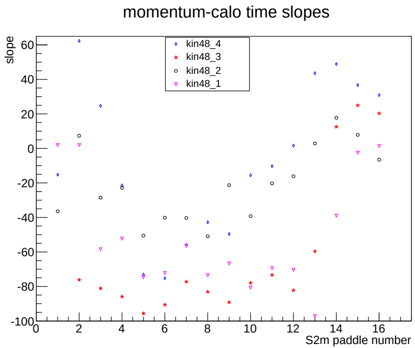
Calorimeter Time corrections - Kin48_1,2,3,4 - S2m Y correction

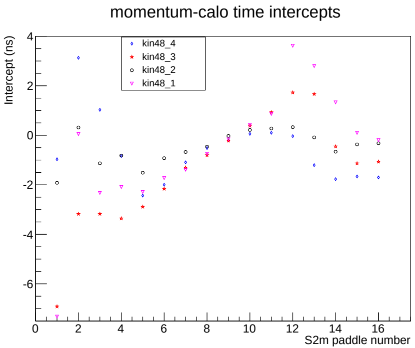




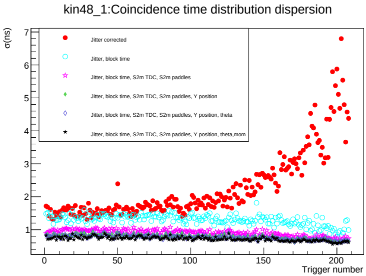


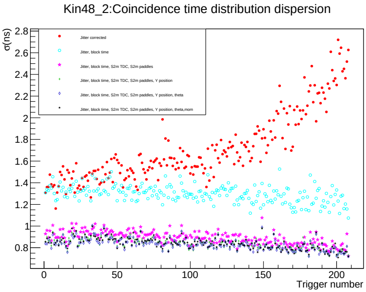
Calorimeter Time corrections - Kin48_1,2,3,4 - S2m momentum correction

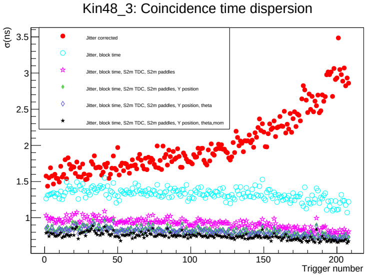


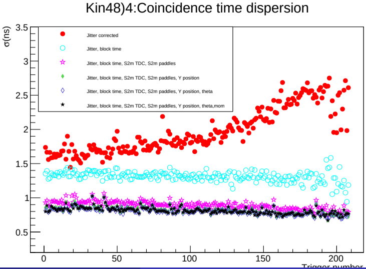


Calorimeter Time corrections - Kin48_1,2,3,4 - Summary of σs from fit



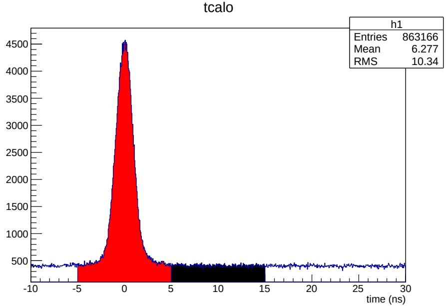




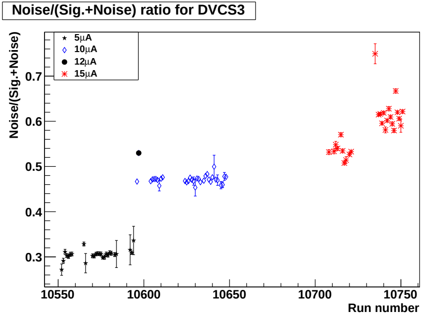


Calorimeter Time corrections - $\frac{Noise}{Signal+Noise}$ ratio

Only single pulse waveform analysis was done for this result.



Increase with beam current - 2 pulse analysis?



Calorimeter Time corrections - Conclusions and outlook

- Time corrections have been done for all kinematics (0.36, 0.48 and 0.60) based on the current state of the SQL DB(ref. shapes).
- Up to now, these have not been copied to the SQL DB, you still need to talk to people and do some hard-coding in your analysis code in order to implement the corrections.
- To Do;
  - Conclude work on reference shapes and copy them to SQL DB.
  - Re-do the calorimeter arrival times with updated DB.
  - Collect all corrections and copy them to the DB.
  - Look at $\frac{noise}{signal+noise}$ across all the kinematics.

The End, Thank you