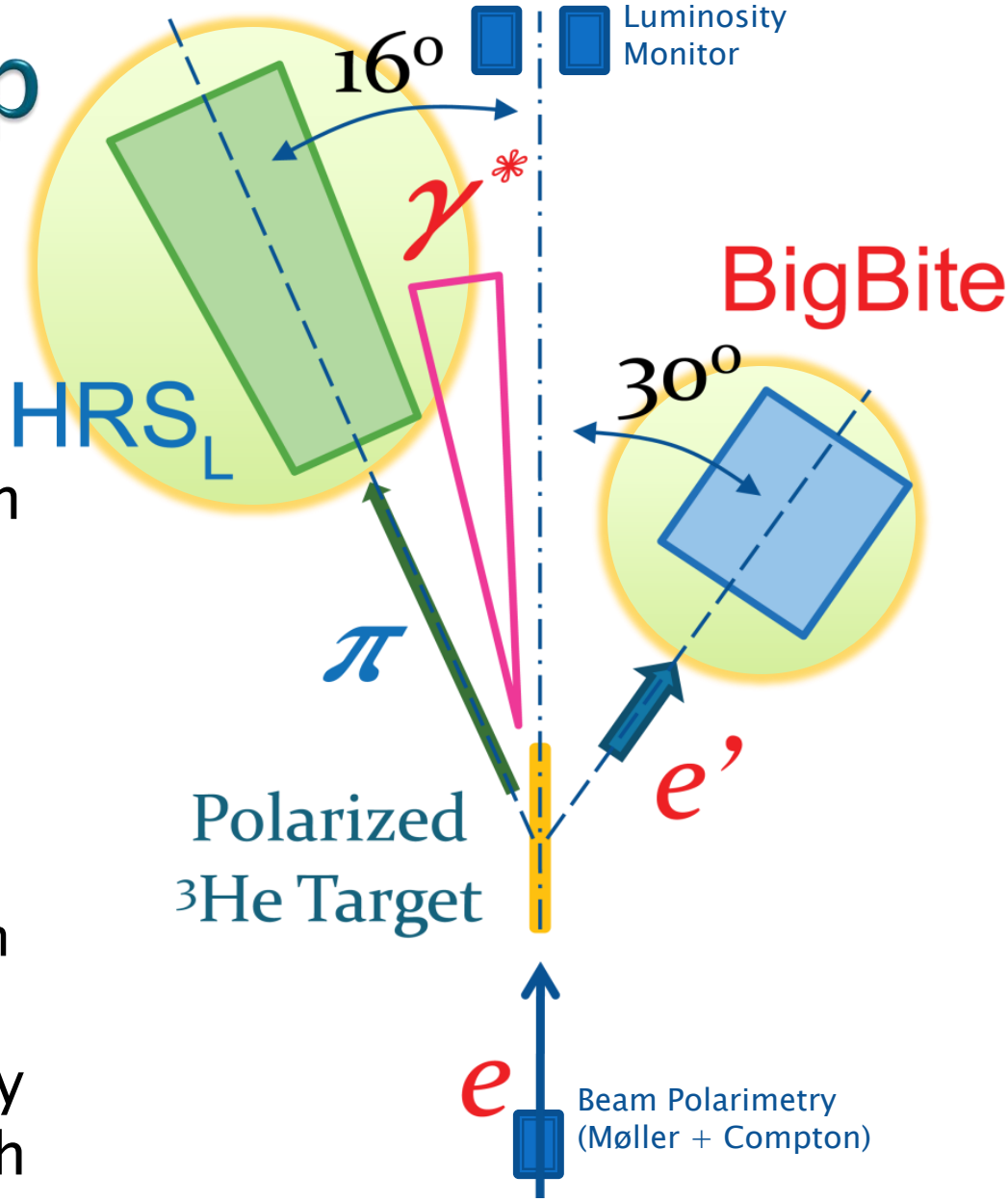
Coincidence TOF Calibration for E06010

- Introduction
- LHRS Timing
- BigBite Timing
- Coincidence Timing

E06-010 Setup

- E0-6010 Setup
  - Two arm coincidence
  - Each arm equipped with a high resolution timing detector
  - LHRS server as hadron arm
    - Detecting pion, kaon and proton
    - Total fly length ~27m
  - BigBite detector electron with short fly path



The idea

- coincidence time (CT) between this two spectrometers are defined as the time difference between when two particles are created in the reaction
  - Sharp peak @ 0ns for perfect system
  - Multiple peaks for multi-final state
- Useful for
  - Reducing random coincidence background
  - Help hadron arm PID

General Calibration

- 3 independent piece for calibration

$$\mathrm{CT} = \mathrm{RF\ Time}_{\mathrm{LHRS}} - \mathrm{RF\ Time}_{\mathrm{Bigbite}} - \mathrm{Trigger\ Time\ Difference}$$

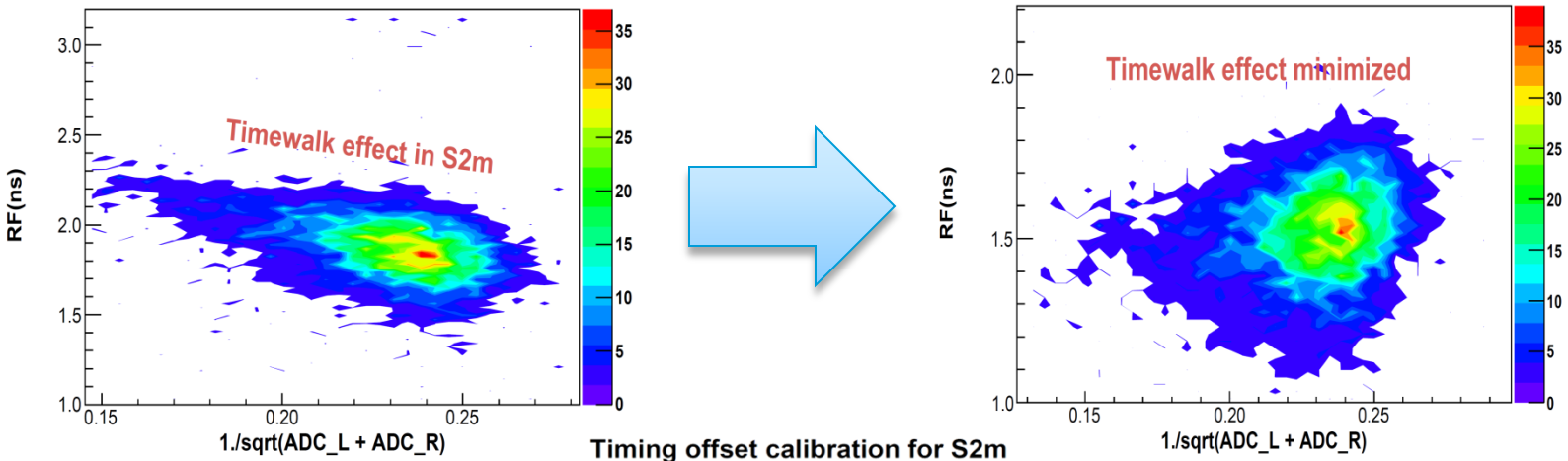
- RF $\mathrm{Time}_{\mathrm{Spectrometer}}$ is
  - time cost between
    a vertex reaction and single arm trigger
  - Consist of
    - Time of flight
    - Respond time of timing detector
    - timing detector TDC
- Calibrated VS RF signal
- Only relative timing counts

LHRS Timing
by Chiranjib Dutta

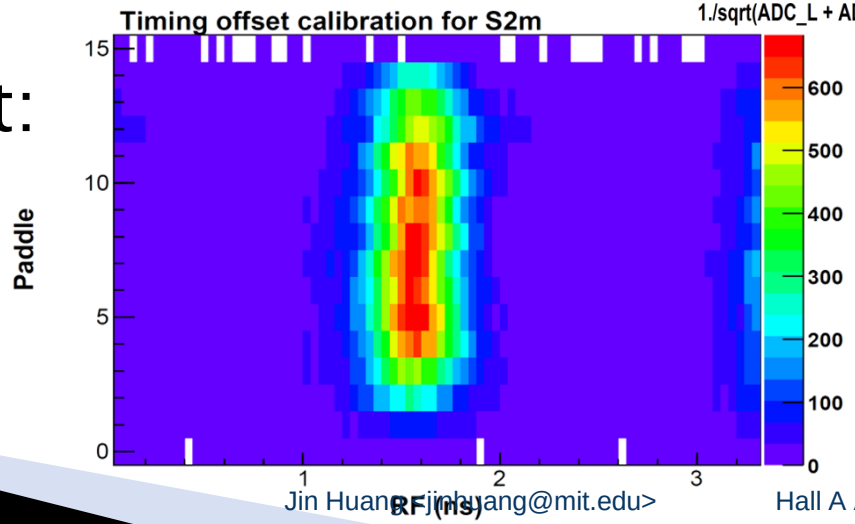
- Timing detector : s2m
- Optimal Calibration Order
  1. Rough offset alignment by looking into two-bar-hit events, with tight ADC cut
     - To precision below 1ns, so possible for next step
  2. Fit for matrix elements for fly path length using RF structure, with tight ADC cut
     - fly path length matrix is similar as optics matrix but independent
     - Up to 2^{nd} order of x_{pf} and th_{pf} is fine for us
  3. Fine bar offset and time walk correction using RF structure

LHRS Timing Calibrations
by Chiranjib Dutta

- Time walk effect contribute to a ~0.5ns long tail, corrected

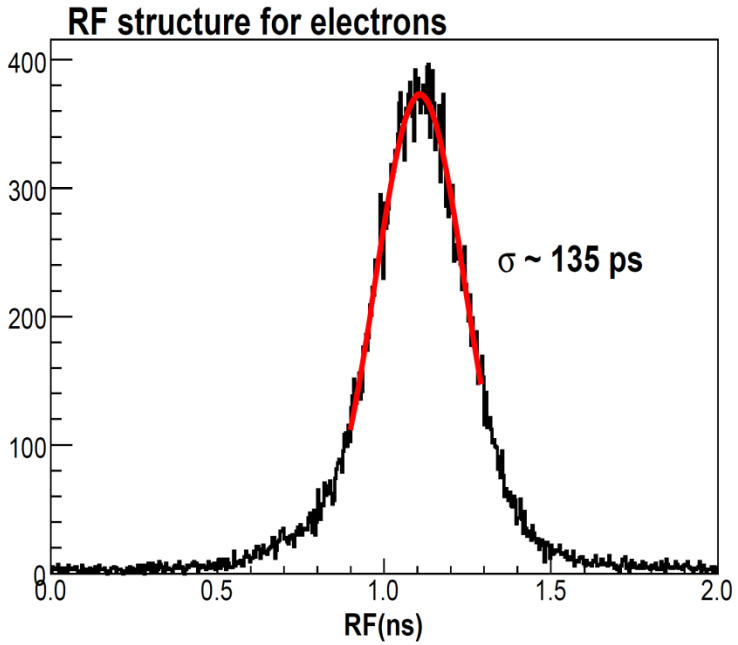


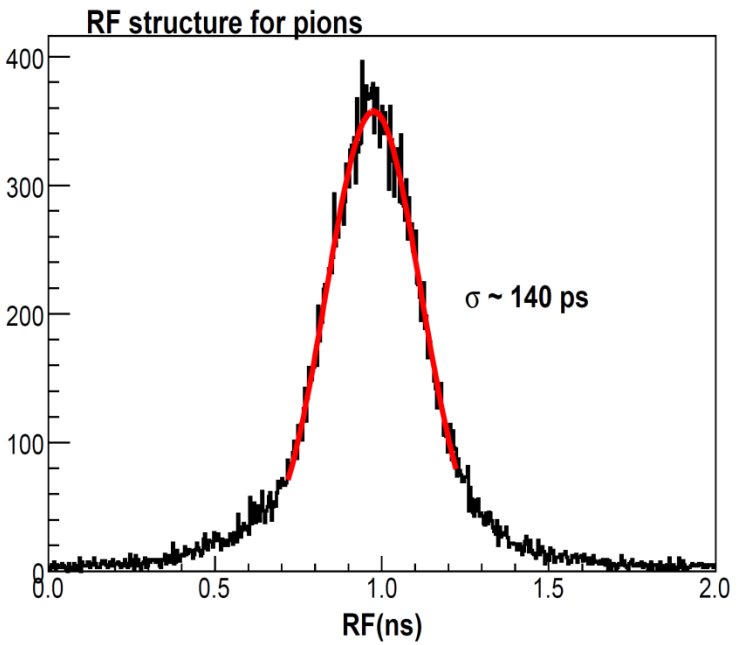
- Bar alignment:



LHRS single arm final
by Chiranjib Dutta

- Reached a 1σ resolution ≤140ps
- Checked with RF Structure $\mathrm{RF\ Time}_{\mathrm{Spectrometer}} - t_{\mathrm{RF}}$



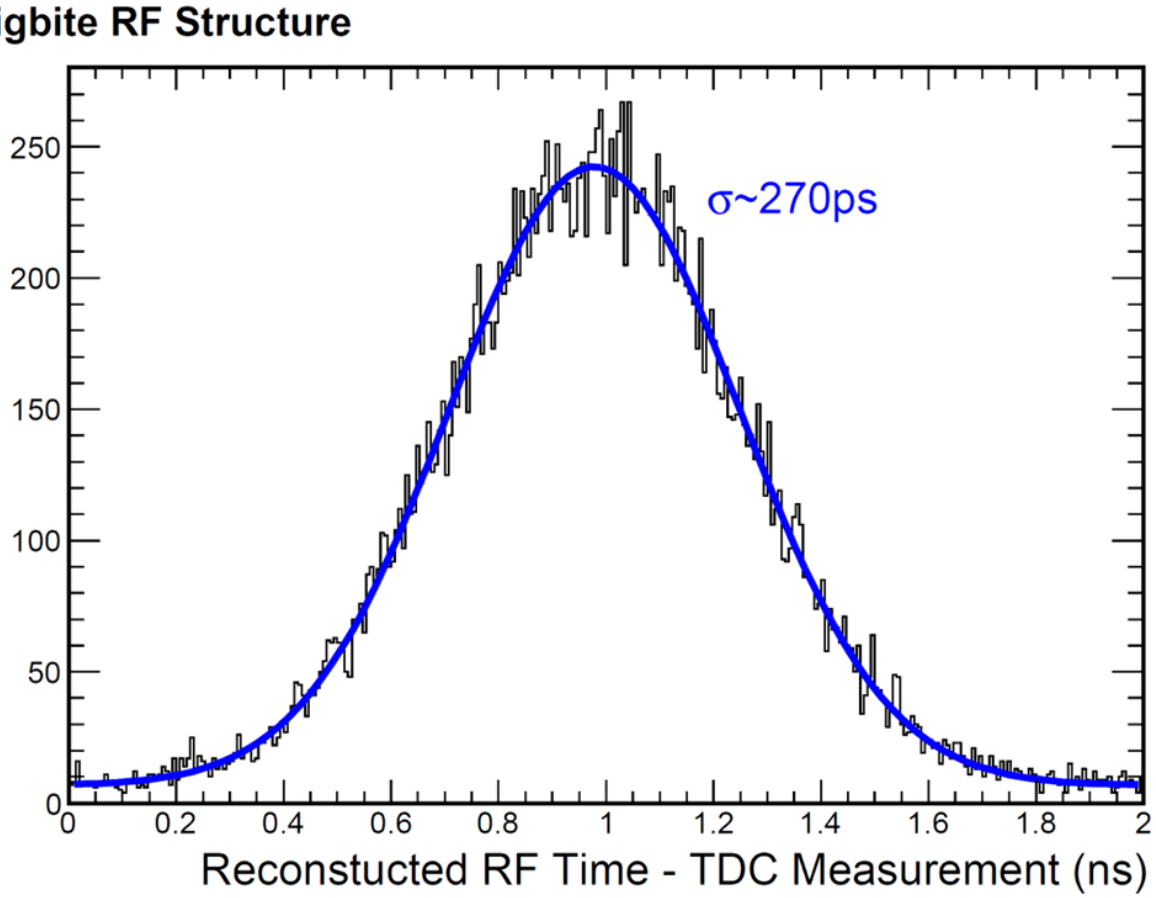


BigBite Timing

- Simpler due to
  - Short flight path, simple described by
    $\Delta L_{\text{time walk}}/c = 1.4 * \theta_{\text{MWDC}}$
  - Similarity of particle speed (e & γ)
- Timing detector : BigBite Timing Plane
  - 13 scintillator bar behind shower detector
  - Resolution ~230ps
  - Larger but similar time walk effect for all PMTs
    $\Delta t_{\text{time walk}} = -17.9(\text{ADC} - \text{pedstal})^{-0.140}\text{ns}$
  - Calibrated by minimizing timing difference between timing of neighbor bars when both hit

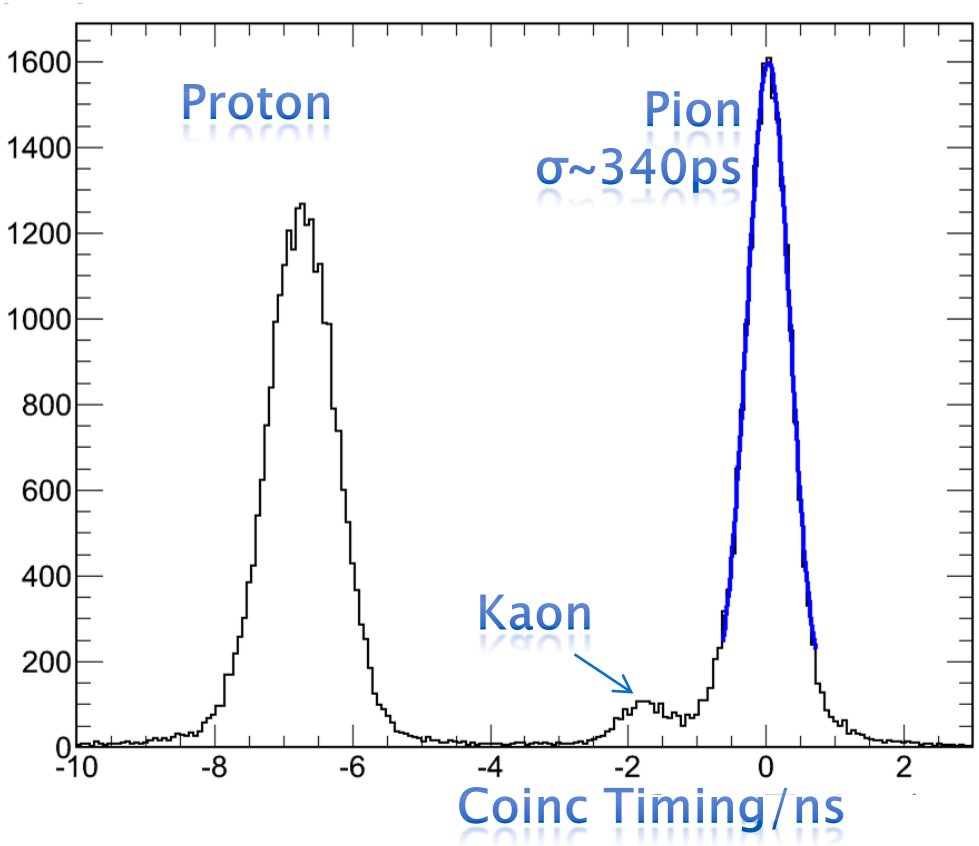
BigBite single arm final

- Final electron timing resolution reached σ~270ps

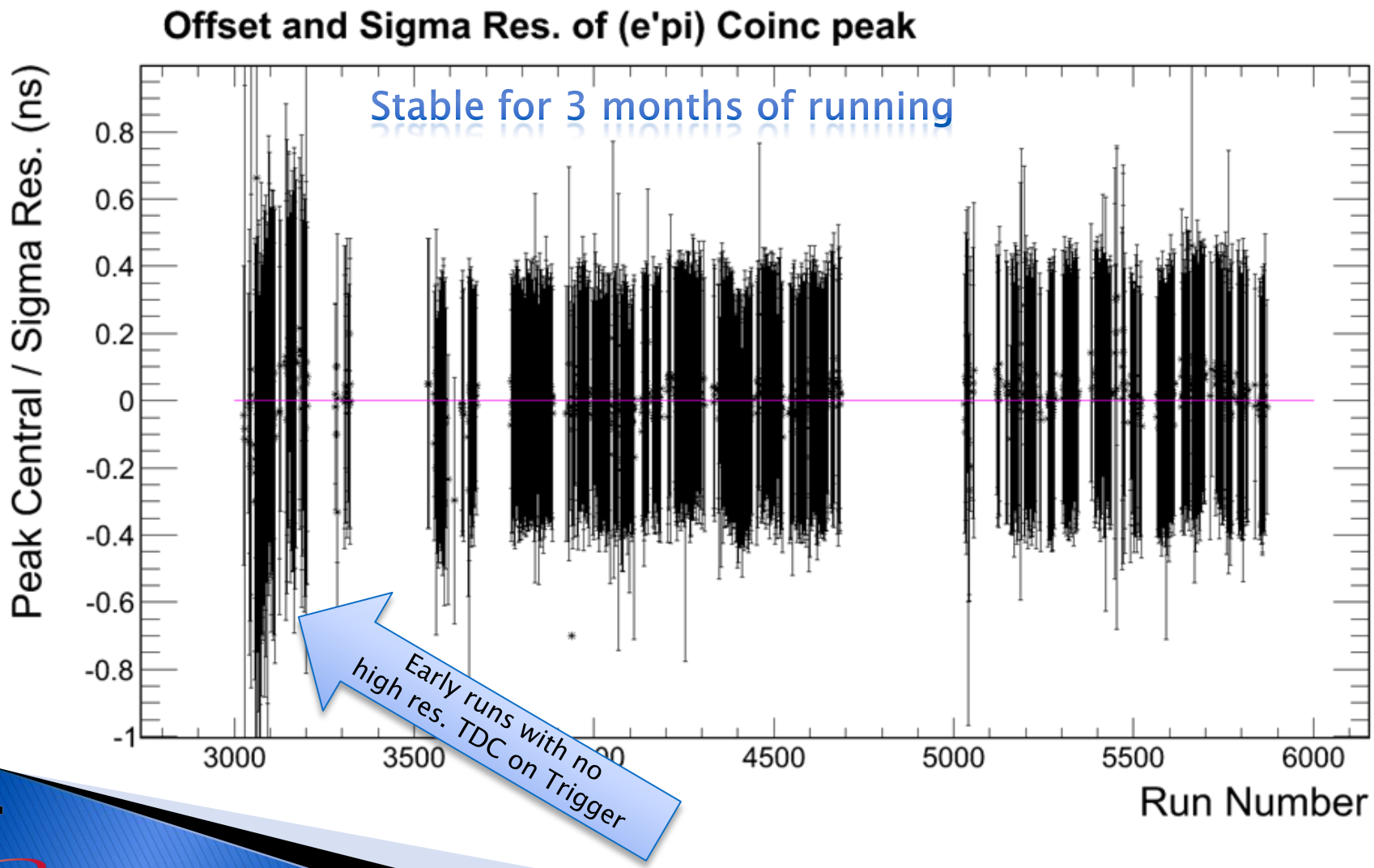


Combing -> CT

- Difference between two single arm trigger is measured by high res. TDC
- Compiling All Pieces:
  - σ~340ps
  - Random Coinc Rej. 100:1
  - Pion Rej. from Kaon >25:1
  - Also for (e,γhadron) σ~400ps

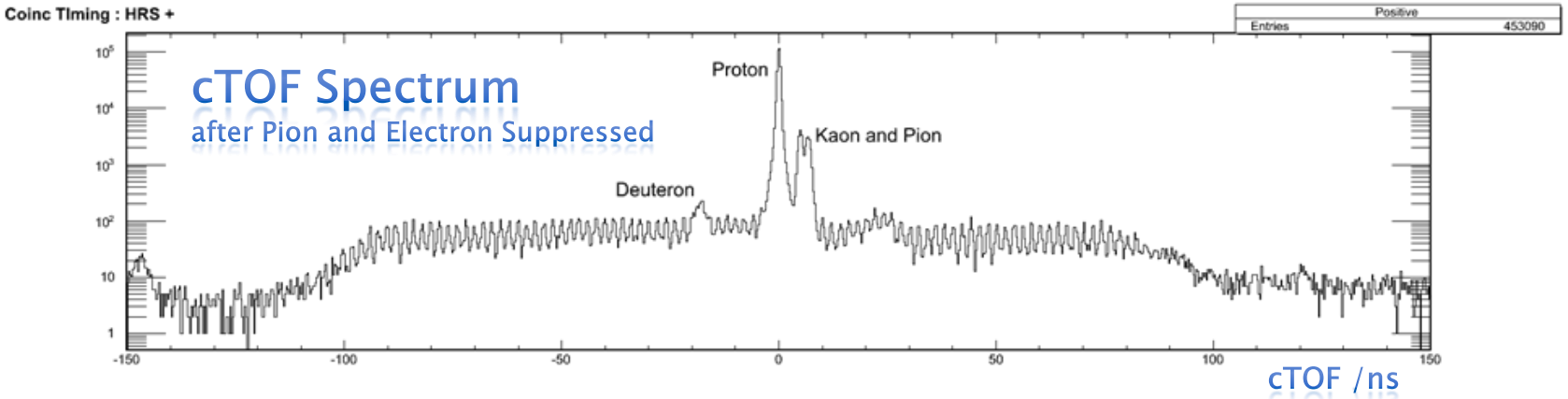


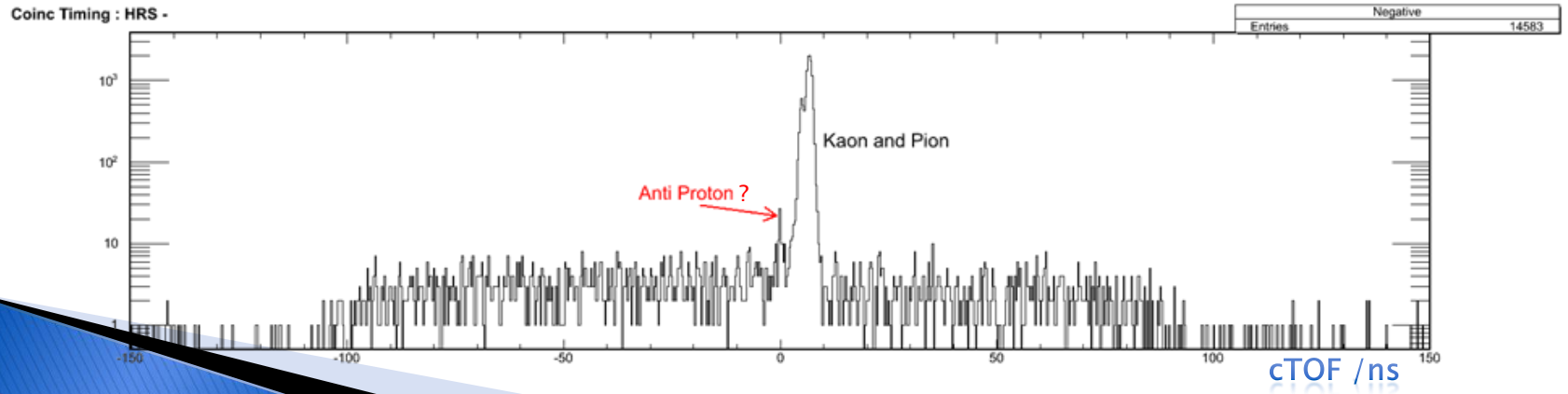
It's check run by run



Fun part: Identifying more particle with CT?

- We can also identify deuteron and possibly anti-proton? from the (e,e'hadron) CT





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