

# The status of the FROST experiment

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on behalf of the FROST run group

Florida State University

Hadron Spectroscopy Group Meeting  
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# Outline

- 1 **FROST Overview**
  - Motivation
  - g9a run summary
  - The manpower list of cooking and calibration
- 2 **Calibration Overview**
  - Tagger/TOF
  - ST/DC/EC
- 3 **Sample analysis**
  - Sample analysis  $\gamma p \rightarrow \pi^+ n$
  - Summary

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# The motivation for the FROST

## The g1 experiment

- $E_\gamma = 0.5 - 2.9$  GeV **Circularly** polarized beam
- Polarization Observables:  $\sigma_0$ , P,  $C_x/C_z$

## The g8 experiment

- $E_\gamma = 0.9 - 2.1$  GeV **Linearly** polarized beam
- Polarization Observables:  $\Sigma$ , P, T,  $O_x/O_z$

## The g13 experiment

- $E_\gamma = 1.1 - 2.3$  GeV **Linearly/Circularly** polarized beam
- Target: unpolarized deuterium

The experiment using the polarized target is needed to find Observables related to the target.

The FROST satisfies this condition for "Complete" experiment.

$$\pi N \rightarrow \pi N, \eta N, \pi\pi N, \Lambda K, \text{ etc.}$$

Four possible combinations of beam-target polarization:

### g9a (Nov. 3, 2007 - Feb. 12, 2008)

- Circularly polarized beam, Longitudinally polarized target (CL)
- Linearly polarized beam, Longitudinally polarized target (LL)

### g9b (Scheduled in 2009)

- Circularly polarized beam, Transversely polarized target (CT)
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# g9a run summary

g9a run period: Nov. 3, 2007 - Feb. 12, 2008

Data set: 603 Runs, 17,676 files, 35 TBytes

The current calibration: pass 0, version 3

## Production Data

Beam current: 15 nA

Torus current: 1920 A

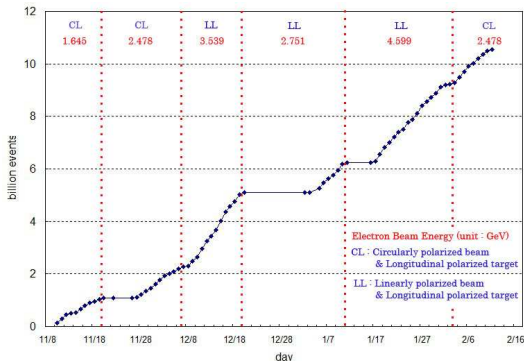
Target:

- Longitudinal polarized target
- Average target polarization  $\sim 80\%$

Photon beam:

- Circularly and linearly polarized photon beam  
0.5 - 2.4 GeV
- Electron beam polarization  $\sim 85\%$

## 10.5 Billion events



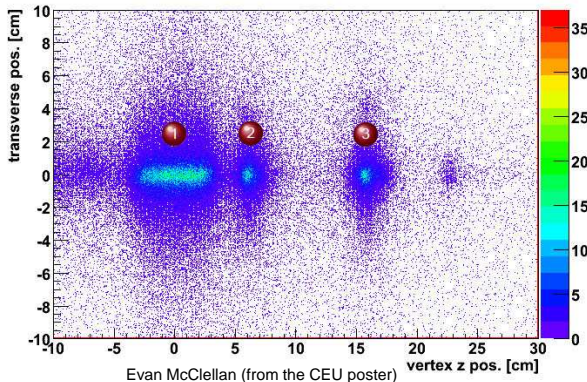


# Targets

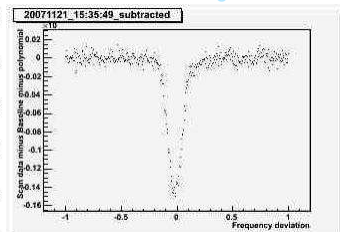
Jo McAndrew

- 1 Polarized Butanol ( $C_4H_9OH$ ) (L 5.0 cm,  $\phi$  1.5 cm)  $\sim$  5 g
- 2 Carbon ( $^{12}C$ ) (L 0.15 cm) (6 cm from CLAS center)
- 3 Polyethylene ( $CH_2$ ) (L 0.35 cm) (16 cm from CLAS center)

vertex cut



Polarization Signal



# The manpower list of cooking and calibration

Item	Contact	Prerequisite
Cooking	Sungkyun Park (FSU)	all calibrated
Tagger Calibration	Liam Casey (CUA), Franz Klein (CUA)	none
TOF Calibration	Robert Coyne (UMASS), Hideko Iwamoto (GWU), Arthur Sabintsev (GWU)	TAG
ST Calibration	Mukesh Saini (FSU)	TAG
DC Calibration	Sean Kuvin (FSU), Evan McClellan (FSU) Sungkyun Park (FSU), Volker Crede (FSU)	TOF
EC Calibration	Simona Malace (USC)	TOF
Beam Polarization (Lin.)	Stuart Fegan (Uof Glasgow)	none
Target Polarization	Jo McAndrew (Uof Edinburgh)	none
DC Alignment	Sungkyun Park (FSU)	DC
Energy loss corrections	Jo McAndrew (Uof Edinburgh)	none

- Eugene Pasyuk (ASU)
- Steffen Strauch (USC): Official Analysis Coordinator

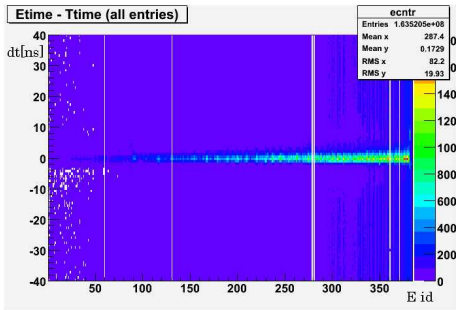
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# Tagger Calibration

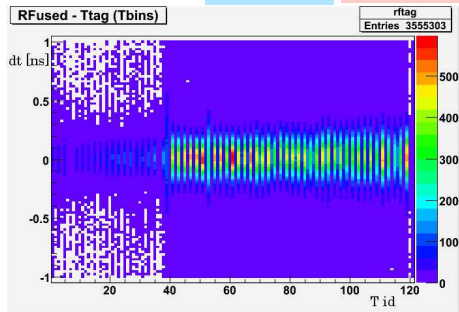
## The RF-Tcounter alignment

- $dt = (\text{Time reconstructed in the tagger at the target center}) - (\text{RF time identified nearest bucket at the target center})$
- T counter is matched to the RF bucket.



Liam Casey

Franz Klein



## E/T counter timing alignment

- $dt = (\text{E-counter time}) - (\text{T-counter time})$
- The E-counter and T-counter are near in time.

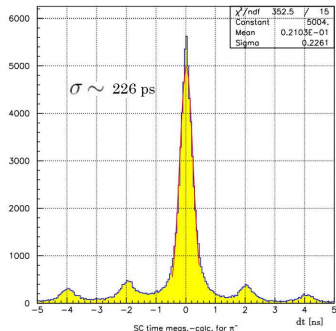
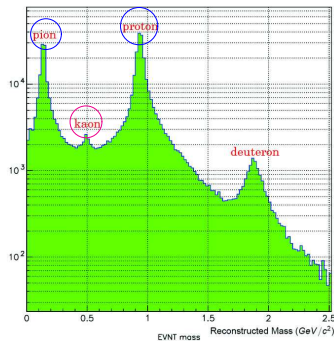
# TOF Calibration

Hideko Iwamoto

Eugene Pasyuk

## $\pi^-$ resolution for run 55739

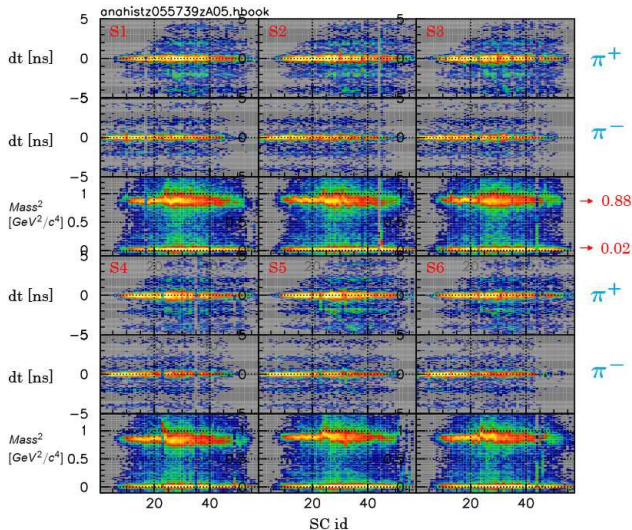
- The time-of-flight times are corrected for the flight time back to the target.
- $dt = RF\_vtime - TOF\_vtime$



## Particle identification

- Particle identification in CLAS relies on the combination of measured charged-particle momenta (from DC) and the flight time from the target to the respective TOF counters.
- TOF mass shows the distribution of masses for all reconstructed hadrons.
- A small kaon peak is visible between the two.

# TOF Calibration



## TOF alignment

- dt = RF\_vtime - TOF\_vtime
- All paddles in each sector have the pion resolution peak centered on zero.
- Mass peak values flat over all paddles in each sector.
- All sectors show similar results.

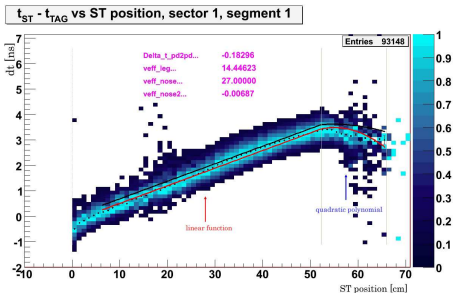
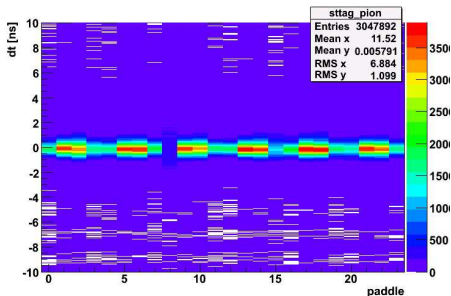
we need fine tuning of some counters.

# ST Calibration

Mukesh Saini

## The time-delay calibration for each paddle

- $dt = (\text{ST hit time}) - (\text{RF hit time})$
- The fit comes as linear function in the leg, but in the nose, it behaves as quadratic polynomial.

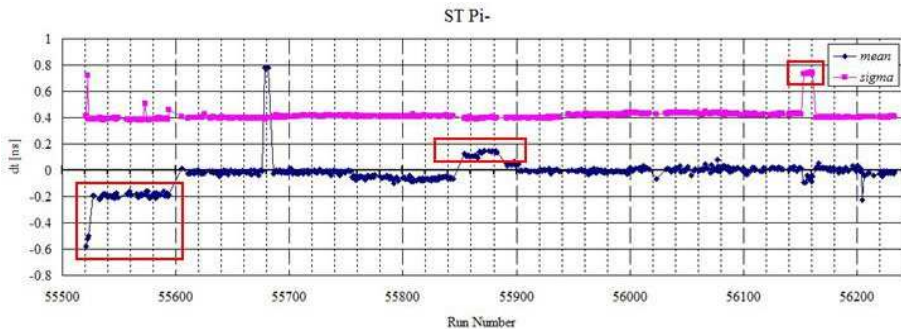


## The st-tag histogram for run 55605

- $dt = (\text{RF vertex time}) - (\text{ST vertex time})$
- offsets are around zero.

# ST Calibration

The  $\pi^-$  ST offset for all runs



- Values of mean and sigma are stable.
- We need to adjust means in some ranges.



# DC Calibration

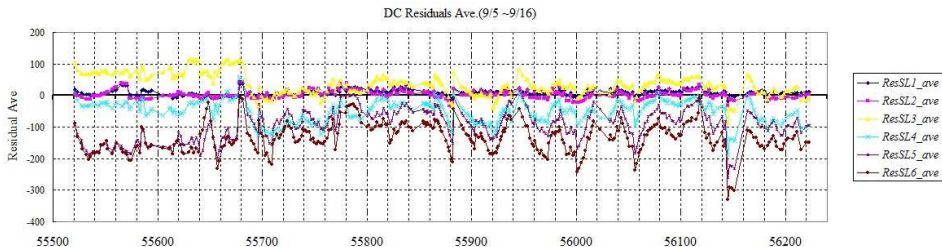
## Residuals for all runs

Sungkyun Park

Evan McClellan

Sean Kuvin

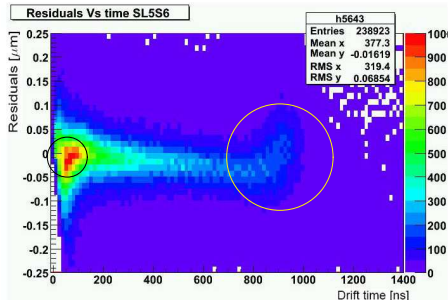
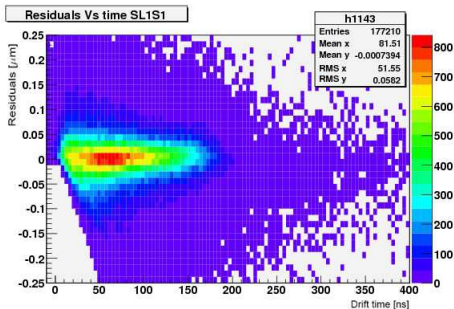
Volker Crede



- Residual = calculated DOCA - fitted DOCA
- The region 3 of DC need to be improved.

# DC Calibration

## Residuals vs The drift time

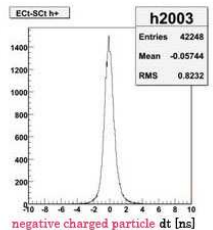
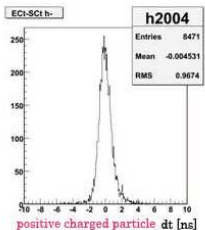
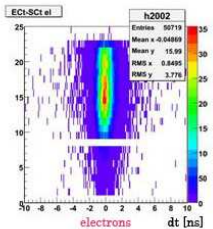
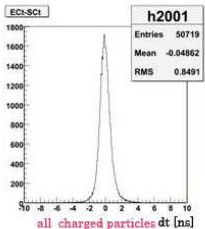


- The suggested solution is to adjust the value of Tzero and Tmax in SL5 and SL6.
- In the superlayer 5, there are residuals in the larger drift times and residual peaks that are not centered around zero.
- There are big problems with the calibration software, trk\_mon for DC calibration.

# EC Calibration

Simona Malace

Sector 2, Plane U

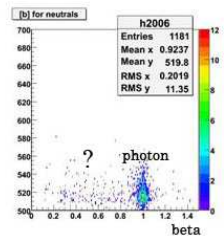
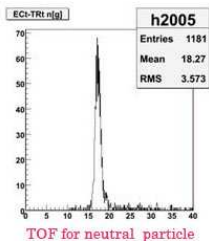


## EC time calibration

- EC time is calibrated against SC time.
- $dt = (\text{EC time}) - (\text{SC time})$  for charged particles.

## Identifying the neutron

- neutrals  $\rightarrow$  photon and neutron
- neutrals with  $\beta < 0.9$  are neutrons and photons otherwise.



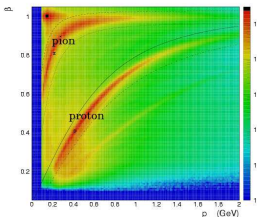
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# Sample analysis $\gamma p \rightarrow \pi^+ n$

Franz Klein

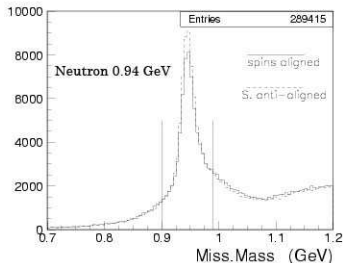
$\beta$  vs. p cut



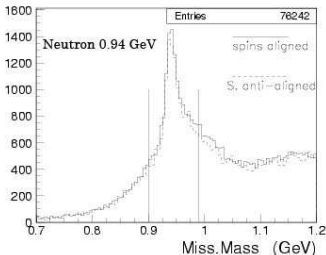
## The data used

- All runs with circularly polarized beam (A05) from pass0/v2 + runs 55521 - 55676 (A01, A10, and A15) from pass0/v1 (for enough statistics)
- using 5 % of the total statistics with circularly polarized beam.

$\gamma p \rightarrow \pi^+ X$  (for target)



$\gamma p \rightarrow \pi^+ X$  (for C, CH2)



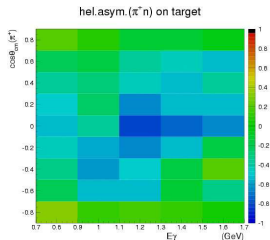
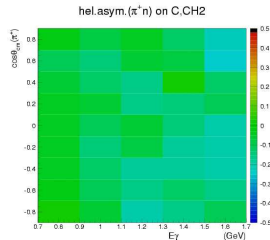
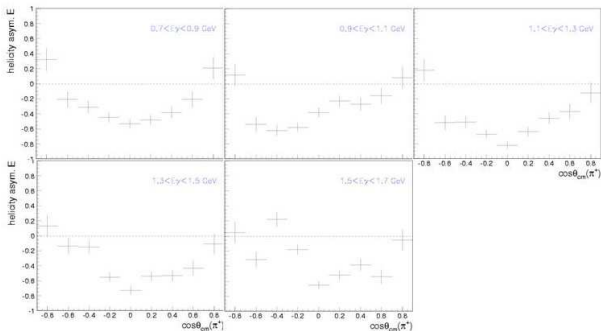
# Sample analysis $\gamma p \rightarrow \pi^+ n$

## Helicity asymmetry for $\gamma p \rightarrow \pi^+ n$

$$E_{raw} = \frac{N^+ - N^-}{N^+ + N^-} \quad (N^+ \text{ is positive photon helicity, } N^- \text{ is negative photon helicity})$$

- $E_{raw}$  is scale with  $\frac{1}{0.85}$  for average target polarization
- $\frac{1}{P_g}$  ( $P_g$  = photon polarization calculated from helicity transfer assuming the electron beam polarization was 80%)

hel. asym. ( $\gamma p \rightarrow \pi^+ n$ )



# Summary

- Tagger calibration** It is in good condition.
- TOF calibration** It is good overall but still needs some more fine tuning.
- ST calibration** We need to adjust values of mean in some ranges.
- DC calibration** After fixing the software, trk\_mon,  
the residual averages of the region 3 need to be improved.
- EC calibration** EC time calibration is good.  
EC part needs to investigate the existence of the neutron.

We anticipate to be ready for pass1 cooking in December.