The status of the FROST experiment

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on behalf of the FROST run group

Florida State University

Hadron Spectroscopy Group Meeting
October 31, 2008

Outline

FROST Overview
Calibration Overview
Sample analysis

Motivation
g9a run summary
The manpower list of cooking and calibration

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The motivation for the FROST

The g1 experiment

- E_γ = 0.5 - 2.9 GeV Circularly polarized beam
- Polarization Observables:σ_0, P, $C_{\hat{x}} / C_{\hat{z}}$

The g8 experiment

- E_γ = 0.9 - 2.1 GeV Linearly polarized beam
- Polarization Observables:Σ, P, T, $O_{\hat{x}} / O_{\hat{z}}$

The g13 experiment

- E_γ = 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)
- Linearly polarized beam, Transversely polarized target (LT)

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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

10.5 Billion events

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 $\sim 85\,\%$

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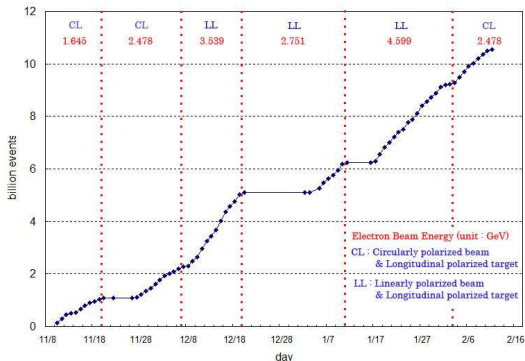
Targets

Jo McAndrew

1. Polarized Butanol (C_4H_9OH) (L 5.0 cm, ϕ 1.5 cm) ~ 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

Evan McClellan (from the CEU poster)

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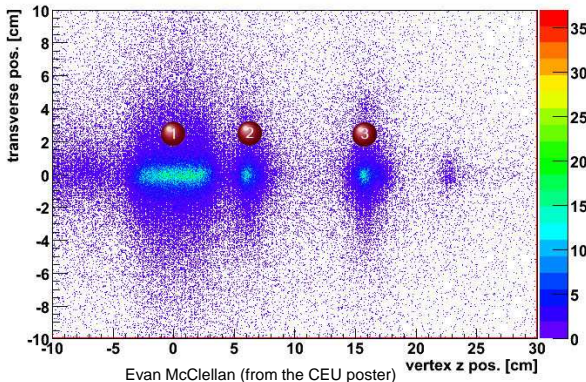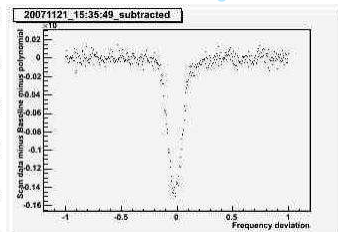
The manpower list of cooking and calibration

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 (UMASS)	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

Outline

Tagger Calibration

The RF-Tcounter alignment

Liam Casey   Franz Klein

- ⬤ dt = (Time reconstructed in the tagger at the target center) - (RF time identified nearest bucket at the target center)
- ⬤ T counter is matched to the RF bucket.
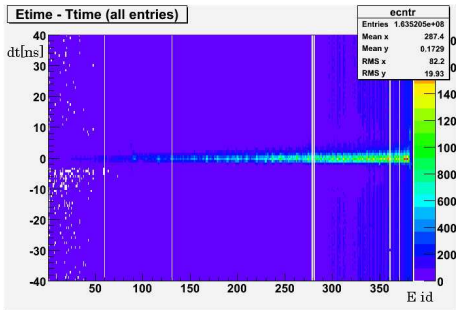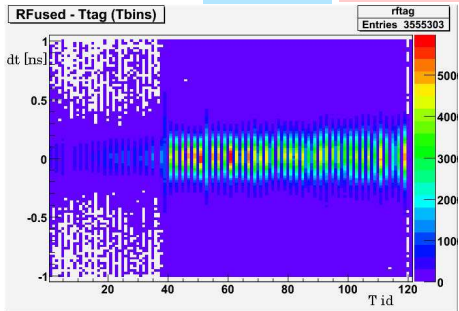
E/T counter timing alignment

- ⬤ dt = (E-counter time) - (T-counter time)
- ⬤ The E-counter and T-counter are near in time.

TOF Calibration

Hideko Iwamoto   Eugene Pasyuk

π^- resolution for run 55739

- The time-of-flight times are corrected for the flight time back to the target.

- dt = RF_vtime - TOF_vtime

$\sigma \sim 226$ ps

SC time meas.-calc. for π^-

dt [ns]

Reconstructed Mass (GeV/c^2)

EVNT mass
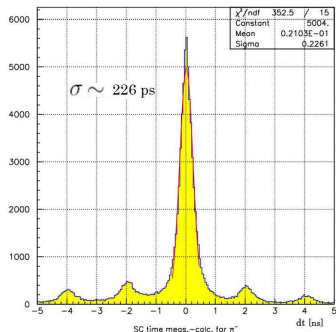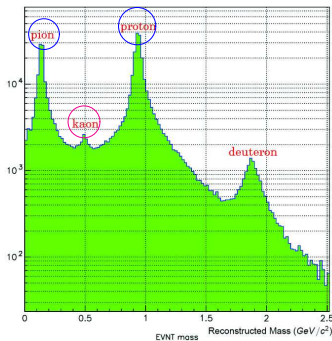
Particle identification

- 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
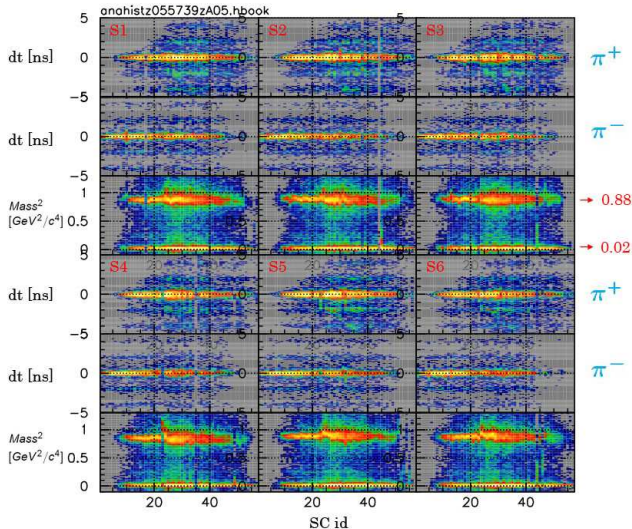
TOF alignment

- $dt = RF\_vtime - TOF\_vtime$
- 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

The time-delay calibration for each paddle

Mukesh Saini

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

$t_{ST} - t_{TAG}$ vs ST position, sector 1, segment 1

	Entries 93148
Delta_t_pd2pd...	-0.18296
veff_leg...	14.44623
veff_nose...	27.00000
veff_nose2...	-0.00687

quadratic polynomial

linear function

sttag_pion	
Entries	3047892
Mean x	11.52
Mean y	0.005791
RMS x	6.884
RMS y	1.099
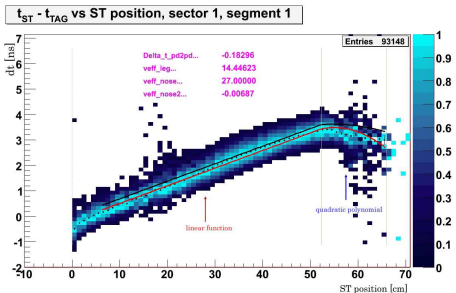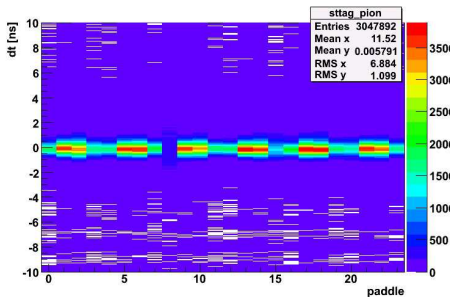
The st-tag histogram for run 55605

- dt = (RF vertex time) - (ST vertex time)
- offsets are around zero.

ST Calibration

The π^- ST offset for all runs

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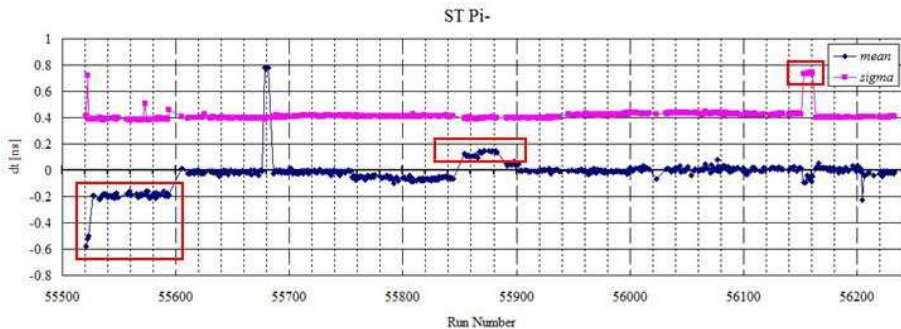
- Values of mean and sigma are stable.
- We need to adjust means in some ranges.

DC Calibration

Residuals for all runs

Sungkyun Park   Evan McClellan

Sean Kuvin   Volker Crede

DC Residuals Ave.(9/5 ~9/16)
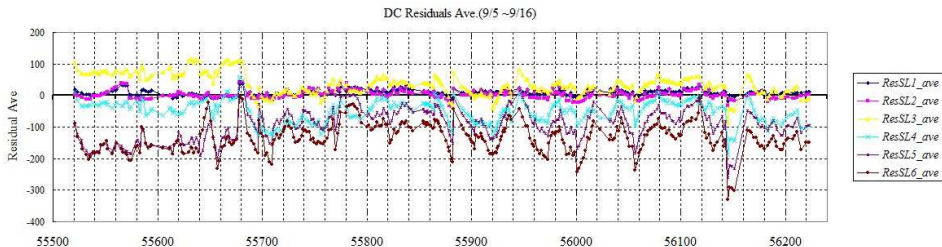
- Residual = calculated DOCA - fitted DOCA
- The region 3 of DC need to be improved.
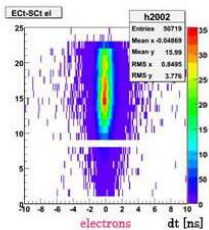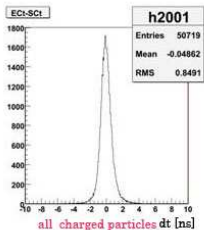
DC Calibration

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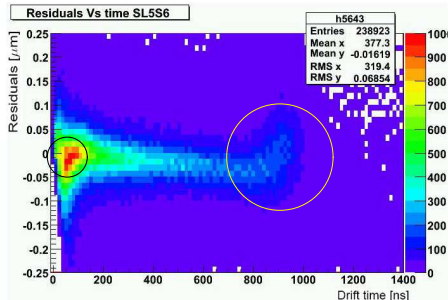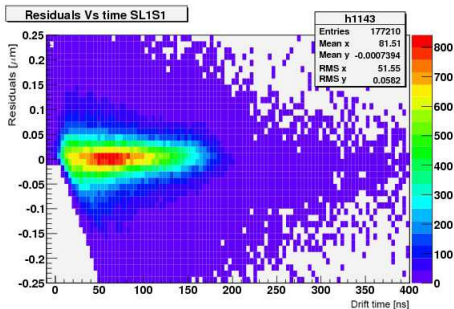
- The suggested solution is to adjust the value of Tzero and Tmax in SL5 and SL6.
- In the superlayer 5, there are residuals in the larger drift times and residual peaks that are not centered around zero.
- There are big problems with the calibration software, trk_mon for DC calibration.

EC Calibration

Sector 2, Plane U

Simona Malace
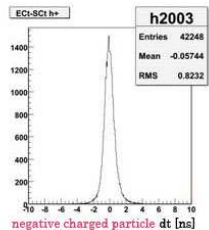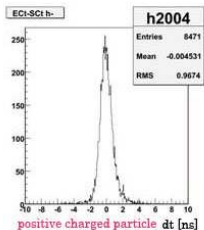
EC time calibration

- EC time is calibrated against SC time.
- dt = (EC time) - (SC time) for charged particles.

Identifing the neutron

- neutrals → photon and neutron
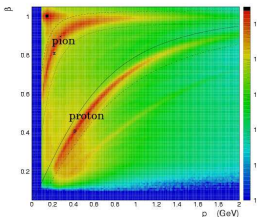- neutrals with $\beta < 0.9$ are neutrons and photons otherwise.
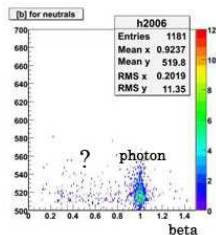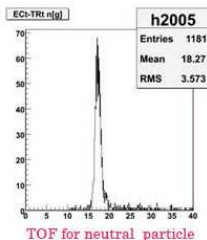
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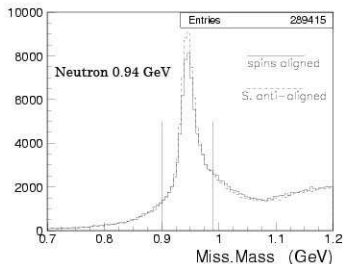# Sample analysis $\gamma p \rightarrow \pi^+ n$
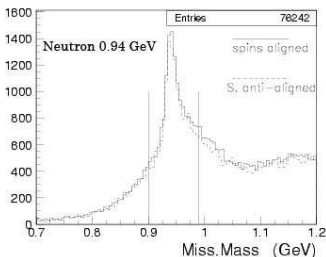
Franz Klein

β 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.

γp->π⁺X (for target)

γp->π⁺X (for C,CH2)

Sungkyun Park   The status of the FROST experiment

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

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

$E_{raw} = \frac{N^+ - N^-}{N^+ + N^-}$ (N^+ is positive photon helicity, N^- 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.(γp->π^+n)

hel.asym.(π^+n) on C,CH2

hel.asym.(π^+n) on target
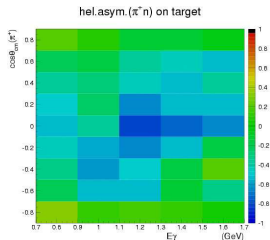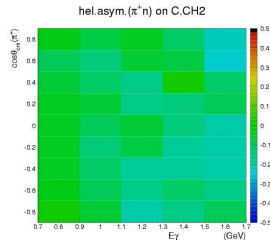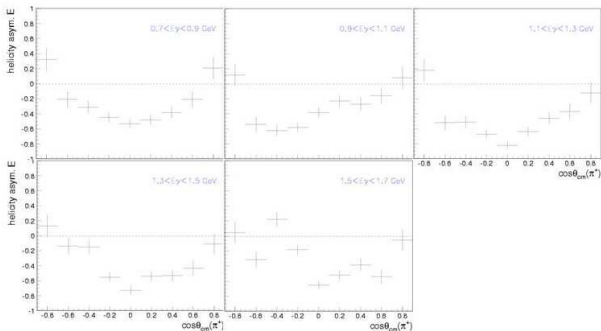
Summary

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.