E08-010 (N$\rightarrow\Delta$) Analysis Update

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Spokespersons and analysis group

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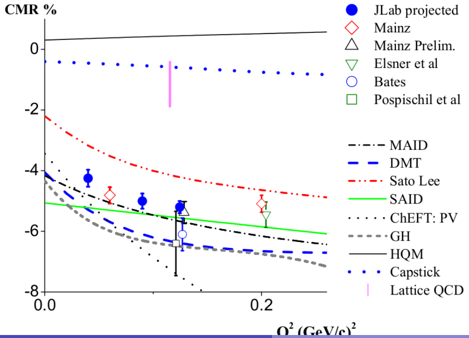
Outline

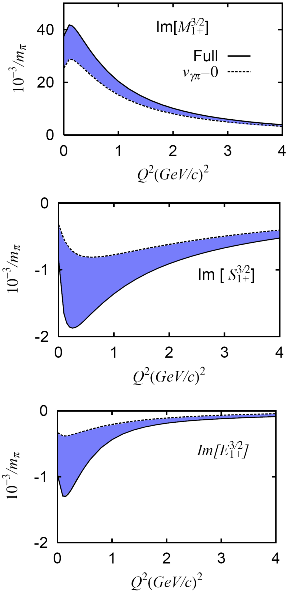
- Motivation
- Methodology
- Experimental Overview
- Completed Work
- Preliminary Results
- Future Work

Motivation

- Δ Resonance $\rightarrow$ H(e,e'p)π^0
- Nucleon Dynamics
- Quadrupole transition
  $\rightarrow$ non-spherical components
- Quark-gluon and Mesonic DOF
- Low Q^2 $\rightarrow$ Pion cloud dominates

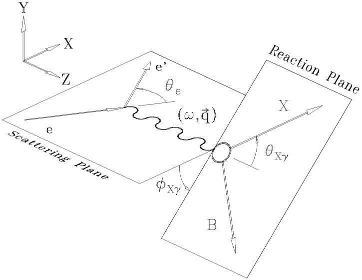


Sato Lee   Pion Cloud



Methodology

N $\rightarrow \Delta$
H(e,e'p)π^0



$$\sigma = J_\Omega \Gamma_\nu \frac{p_{cm}}{k_{cm}} (R_T + \epsilon_L R_L + \epsilon R_{TT} \cos 2\phi_{X_\gamma} + \nu_{LT} R_{LT} \cos \phi_{X_\gamma})$$

measure multiple azimuthal angles ϕ for fixed θ to extract
R_T, R_L, R_{TT}, R_{LT} = f(amplitudes(W,Q^2),g(θ))

Fit R_i vs. θ to get amplitudes(W,Q^2)

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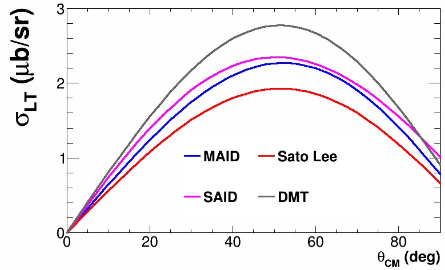
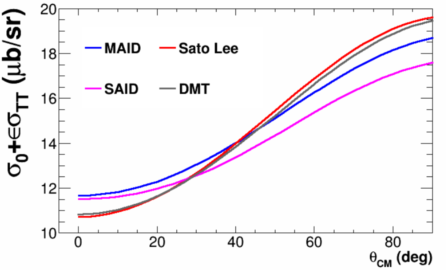
Methodology





$$\sigma = J_\Omega \Gamma_\nu \frac{p_{cm}}{k_{cm}} (R_T + \epsilon_L R_L + \epsilon R_{TT} \cos 2\phi_{X_\gamma} + \nu_{LT} R_{LT} \cos \phi_{X_\gamma})$$

Two in-plane measurements at $\phi = 0^\circ$ and $\phi = 180^\circ$ allows extraction of resonant amplitudes

$$\sigma_{LT} = f(R_{LT}, \theta_{CM})$$

$$\sigma_0 + \epsilon\sigma_{TT} = g(R_T, R_L, R_{TT}, \theta_{CM})$$

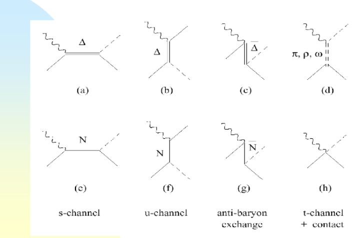
Signal and BG Sensitivities

$$R_{TT} = 3\,\sin^2\theta \;\; (\;\; E2 \cdot M1 + (M1)^2 + \ldots \sum(\text{background}) \;\;)$$
$$R_{LT} = \text{-}6\,\cos\theta \sin\theta \;\; (\;\; C2 \cdot M1 + \ldots \sum(\text{background}) \;\;)$$
$$R_T + R_L = (M1)^2 + \ldots \sum(\text{background})$$

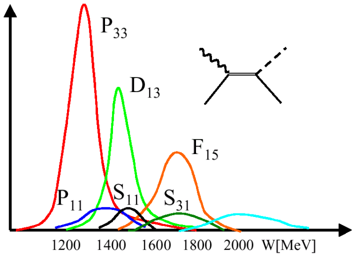
$R_{TT} \rightarrow$ sensitivity to EMR
$R_{LT} \rightarrow$ sensitivity to CMR
$R_T + R_L \rightarrow$ sensitivity to M1

$$CMR = \frac{C2}{M1}$$

Background !



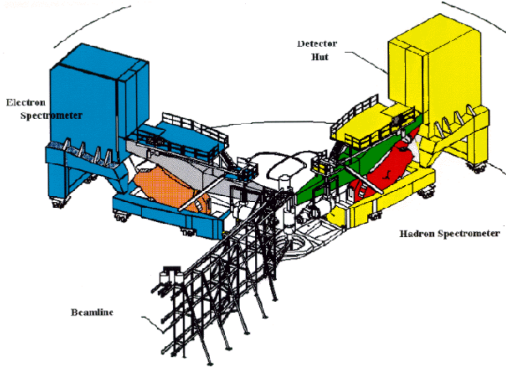
Tails of higher resonances



The experiment

- Data taken Feb-Mar 2011
- H(e,e'p)π^0
  - N$\rightarrow$ Δ
  - π^0 channel
- Two HRSs in coincidence
- 4 and 15 cm LH_2 targets
- Beam energy = 1.16 GeV
- 14 Kinematics
- Q^2 = 0.04 - 0.125 $(GeV/c)^2$
- W = 1.17 - 1.232 GeV

Hall A Schematic



The Detectors

Vertical Drift Chamber (VDC)

Define Particle Tracks

Particle Momentum $\vec{p}$

Scintillators

DAQ Trigger

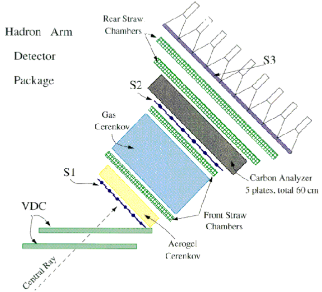
Coincident Timing

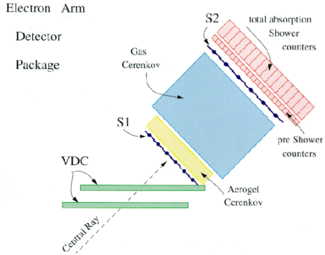
Particle Identification

Cherenkov

Lead Glass Showers

Scintillators





Completed Work

Calibrations

BCM
BPM and Raster
VDCs
Mispointing
cTOF
PID

Efficiencies

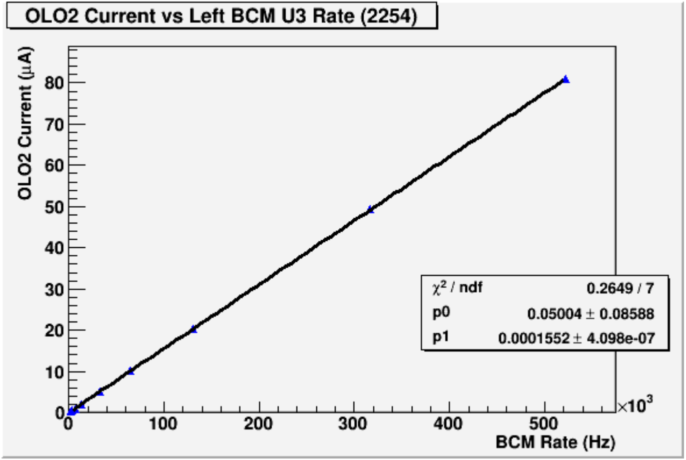
Live time
Multi-hit Events

Target Corrections

Thermal Contraction
Window Thickness
Beam Offset + End Cap
Curvature
Target Boiling

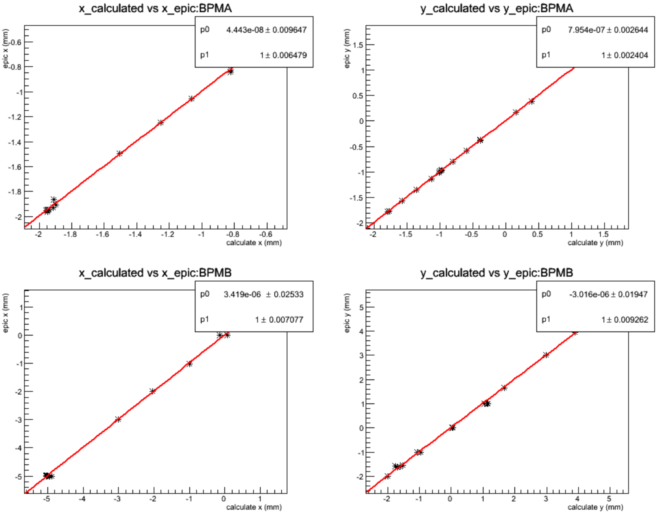
Calibrations

- BCM



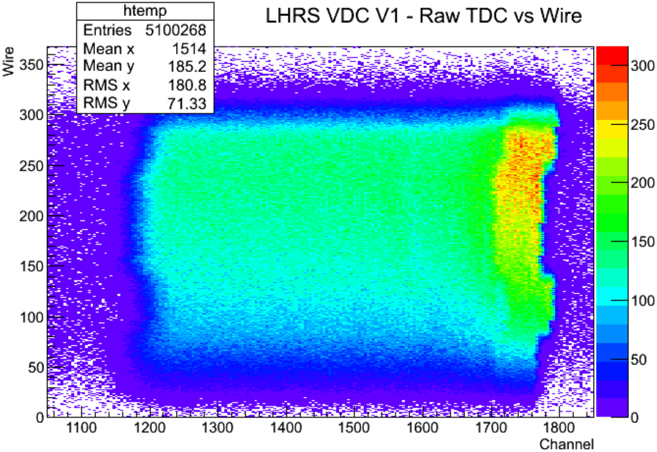
Calibrations

- BPM,Raster



Calibrations

- VDCs Before



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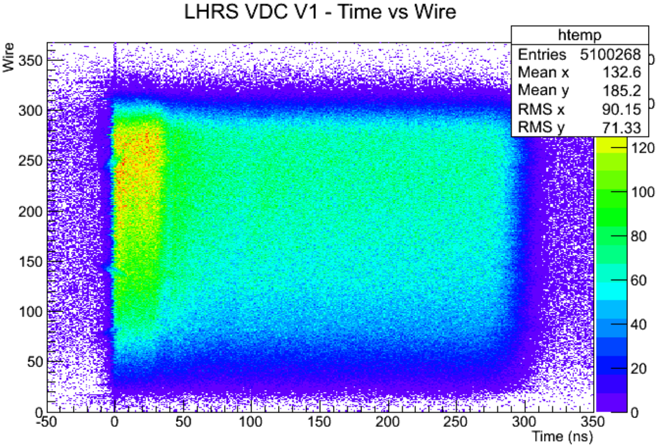
Calibrations

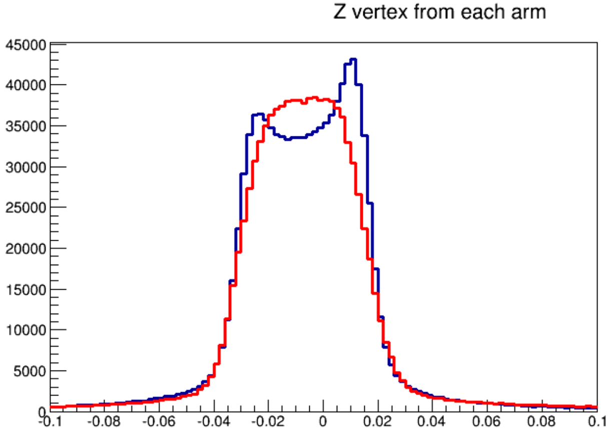
- VDCs After



Calibrations

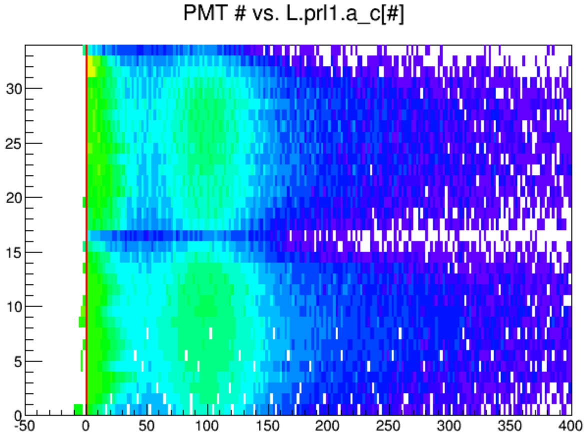
LHRS: 48° RHRS: 22°

- Mispointing



Calibrations

- Pion Rejection Layers



Efficiencies

Live time

LT $\approx$ 90%

Multi-hit Events

Single Track cut $\approx$ 70-80%
Correlate VDC Tracks to s2 hits
Multi-track analysis $\approx$ 90-95%
15% boost to statistics

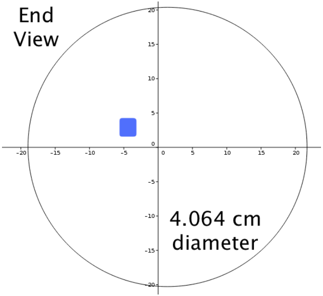
Target Length

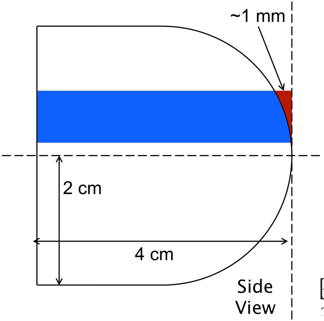
Corrections

Thermal Contraction
Window Thickness
Beam offset and End cap curvature

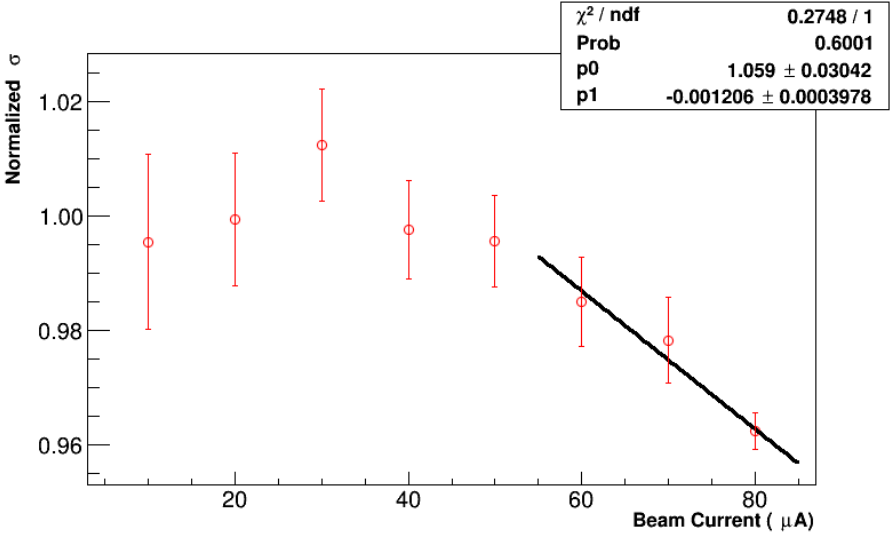
Overall Effect

15 cm $\rightarrow$ 14.8 $\pm$ 0.02 cm (1.3% effect)
4 cm $\rightarrow$ 3.86 $\pm$ 0.004 cm (3.5% effect)

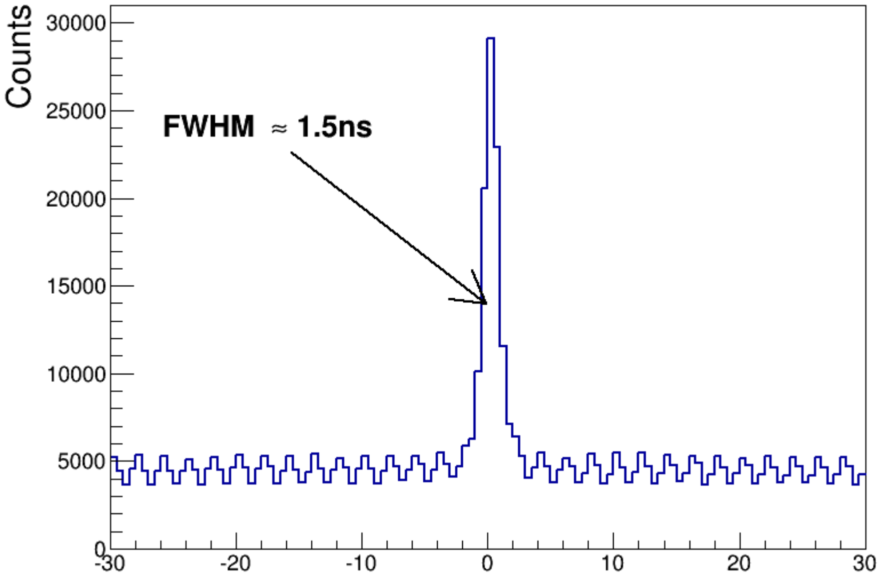




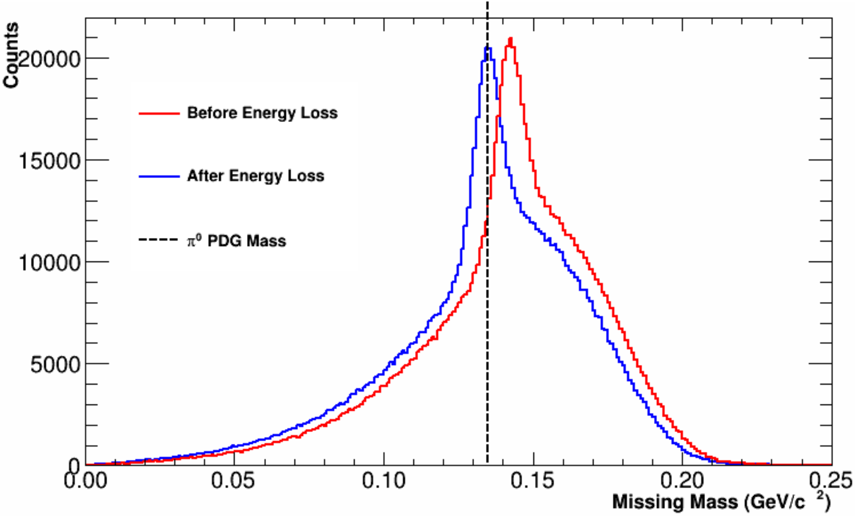
Target Boiling Test



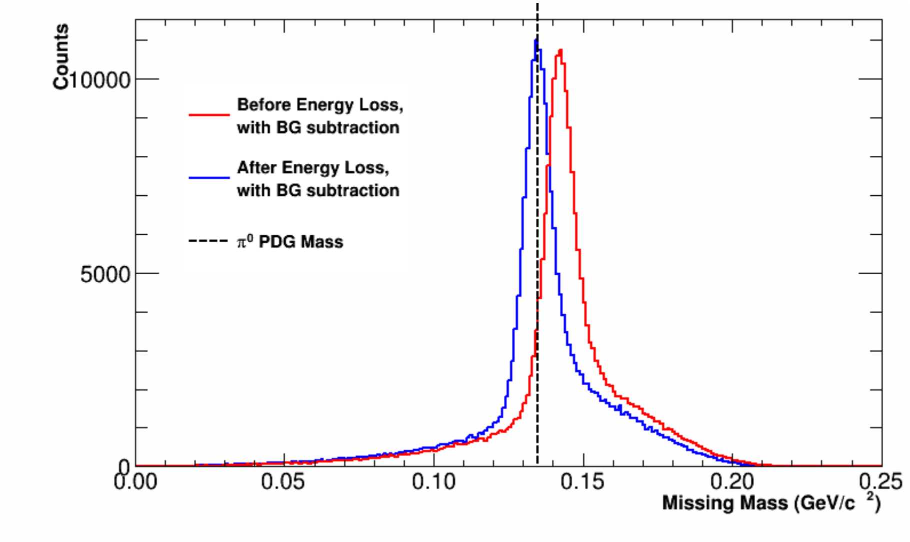
Coincidence Time of Flight



Missing Mass

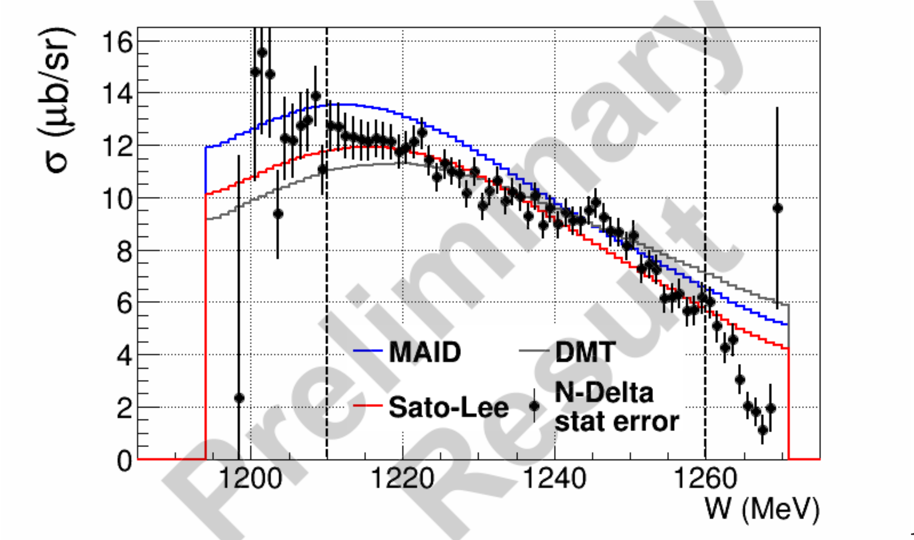


Missing Mass

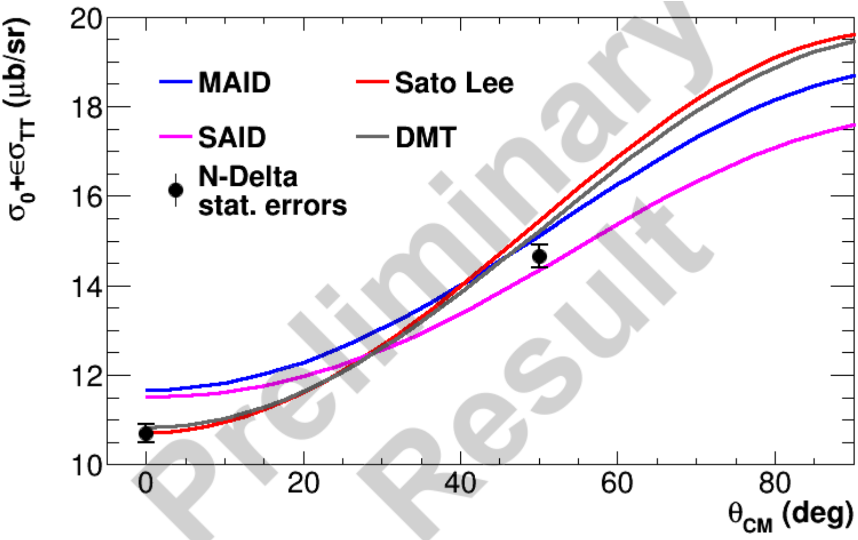


Preliminary Results

Central Q^2=0.125, $\theta_{CM} = 0$



Preliminary Results



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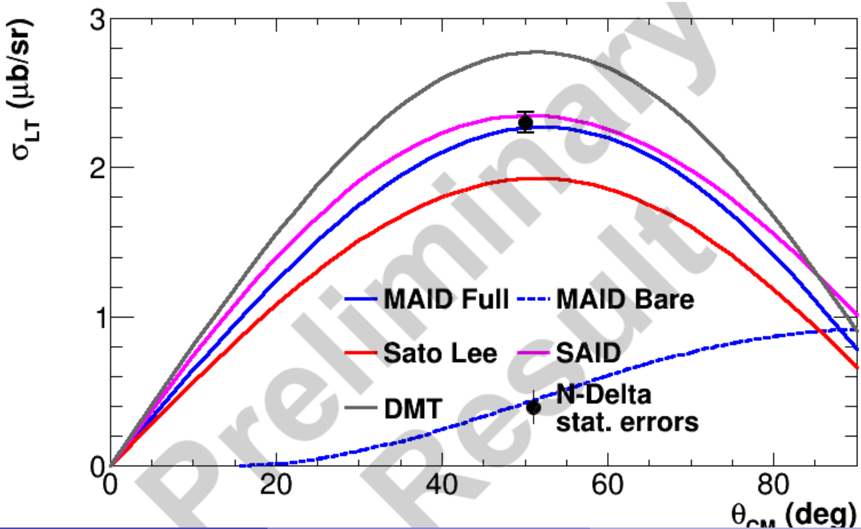
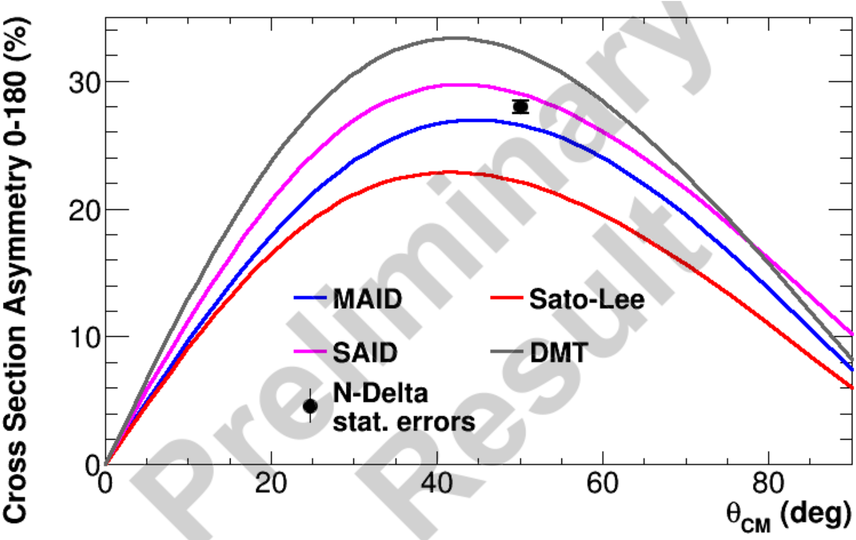
Preliminary Results

Full MAID ___
CMR: 5.5%

Bare MAID - - -
(S1+=0) CMR: 0%



Preliminary Results



Future Work

- Finalize σ for all kinematics
- Study systematic uncertainties
- Extract resonant amplitudes

- Publication in Fall

Back up Slides

Extra Slides Beyond this point

Multi Track Events

Percentage of events with specified tracks

Number of tracks in R arm	L arm 1	2	3	>3
1	72.24	7.68	1.99	0.22
2	10.54	1.11	0.28	0.03
3	4.38	0.44	0.09	0.01
>3	0.87	0.09	0.02	0.00

Totals: 72.24% 25.69% 2.07%

correlate VDC tracks with S2 TDC hits

Breaks when multiple VDC tracks hit the same S2 paddle

25.69% $\longrightarrow$ 18.25% + 7.44%

Final Multi Track scaling: 90.49%

Calculating Cross Sections

Average cross section per bin:

$$\frac{d\bar{\sigma}}{d\Omega} = \frac{(N_{det} - N_{bg}) \cdot \epsilon}{N_{PS}} \left(\frac{Y_N}{Y_R}\right)_{model}$$

Scale to central point using model:

$$\frac{d\sigma}{d\Omega} = \frac{d\bar{\sigma}}{d\Omega} \cdot \left(\frac{\sigma_{pt}}{\sigma_{avg}}\right)_{model}$$

ϵ includes efficiency scaling factors such as MT, LT, and cut efficiencies
N_{PS} is calculated using MCEEP, normalized for luminosity

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