Spin observable measurements in pseudo scalar-meson polarized photo-production using polarized neutrons in solid HD

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(On behalf of CLAS collaboration)

1. Physics motivation: for missing resonances issue, measure 16 spin observables for neutron (little known)

Sandorfi –CIPANP'12

Polarization observables in γn (p) → photo-production :

Photon beam		Target			Recoil			Target - Recoil								
					x'	y'	z'	x'	x'	x'	y'	y'	y'	z'	z'	z'
		x	y	z				x	y	z	x	y	z	x	y	z
unpolarized	σ_0		T			P		$T_{x'}$		$L_{x'}$		Σ		$T_{z'}$		$L_{z'}$
$P_L^\gamma \sin(2\phi_\gamma)$		H		G	$O_{x'}$		$O_{z'}$		$C_{z'}$		E		F		$-C_{x'}$	
$P_L^\gamma \cos(2\phi_\gamma)$	$-\Sigma$		$-P$			$-T$		$-L_{z'}$		$T_{z'}$		$-\sigma_0$		$L_{x'}$		$-T_{x'}$
circular P_c^γ		F		$-E$	$C_{x'}$		$C_{z'}$		$-O_{z'}$		G		$-H$		$O_{x'}$	

This talk

Full set of 16

status	CLAS run period	beam	target
complete	g13	$\vec{\gamma}_L$, $\vec{\gamma}_c$	LD_2
complete	g14	$\vec{\gamma}_L$, $\vec{\gamma}_c$	$H\vec{D}$ice

(Longitudinally polarized)

Sandorfi, Hoblit, Kumano, Lee, J.PHYS, G38 (2011)053001

Pseudoscalar meson reactions and observables measured in this experiment

reaction	*observable*
$\gamma + n\,(p) \rightarrow \pi^- p\,(p)$	σ_0, Σ, E, G
$\gamma + n\,(p) \rightarrow \pi^+ \pi^- n\,(p)$	$\sigma_0, I^c\,(\Sigma), I^s, I^o, P_z,$ $P^o{}_z\,(E), P^s{}_z\,(G), P^c{}_z$
$\gamma + n\,(p) \rightarrow K^0 \Lambda\,(p)$	σ_0, Σ, E, G $O_{x'}, O_{z'}, C_{x'}, C_{z'}, P, T=(-O_{y'})$ $L_{x'}, L_{z'}, T_{x'}, T_{z'}$
$\gamma + n\,(p) \rightarrow K^0 \Sigma^0\,(p)$	$\sigma_0, \Sigma, P, E, G$
$\gamma + n\,(p) \rightarrow K^+ \Sigma^-\,(p)$	σ_0, Σ, E, G

From proposal E06-101

2. Experimental apparatus

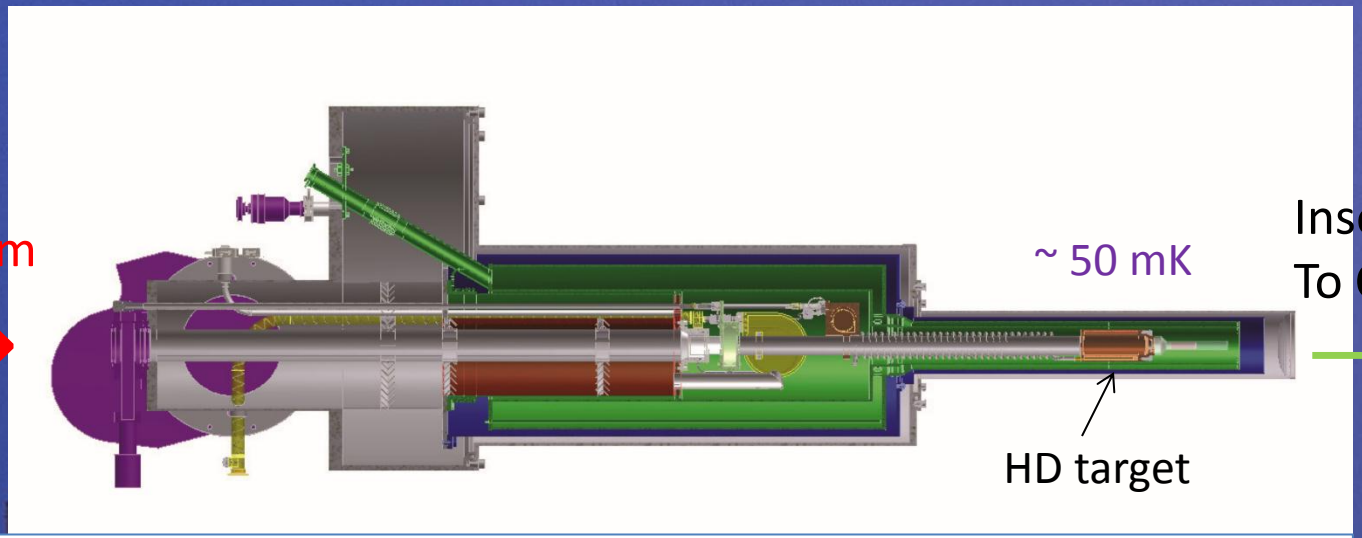
Circularly and linearly polarized photon beams

CLAS detectors and electron tagging system

Polarized neutron target (Solid HD) : newly installed

New longitudinally polarized target for this experiment

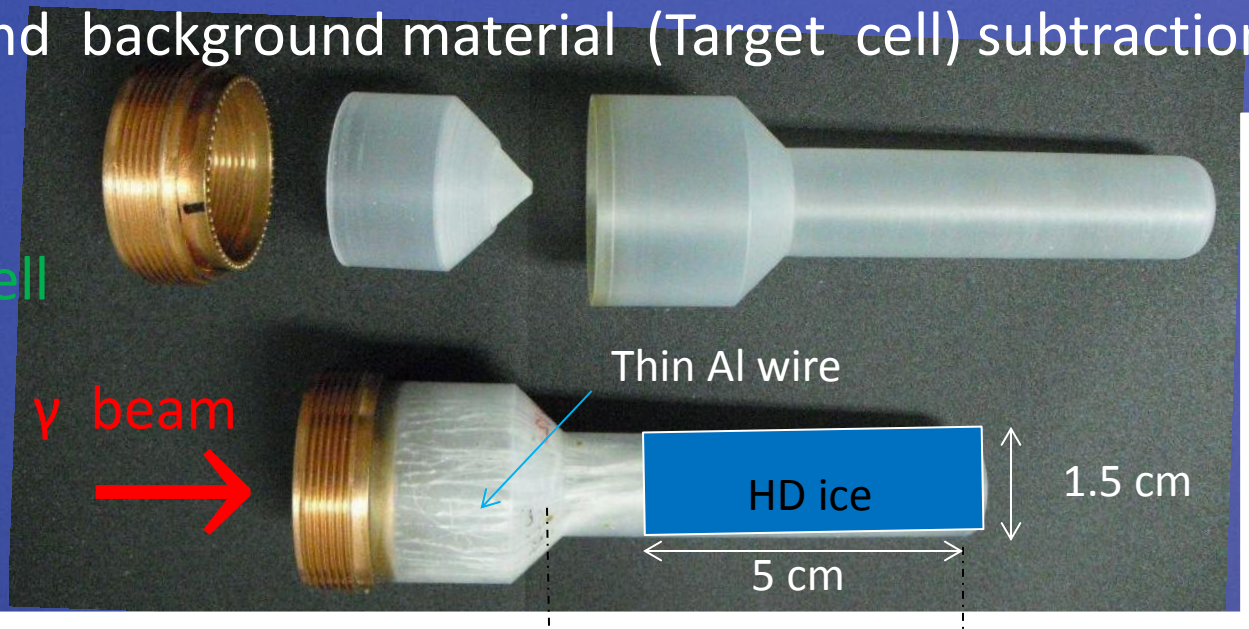
Frozen Spin Polarized solid HD target
Relaxation time > 1 year @ ~ 50 mK and 0.9 Tesla



* Horizontal Dilution Fridge (designed and constructed by HDice group at Jlab)
* 1 Tesla main Solenoid for longitudinal holding field
* Transverse field of 750 Gauss for field rotation (spin flip)
* NMR coil: polarization monitor during the run and spin transfer and H-spin flip, Birdcage coil

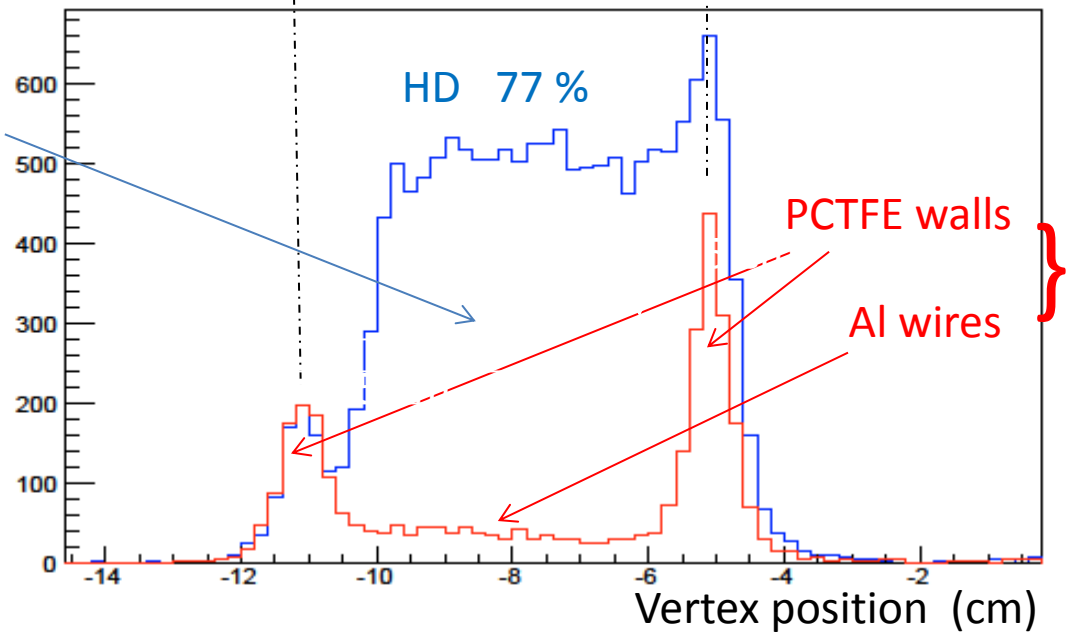
Target and background material (Target cell) subtraction

Target Cell



Reconstructed vertex (beam direction) for π^- and proton

HD and target cell



3. Running conditions and Preliminary results

Triggers

*** 1 charged:** $\gamma + p \rightarrow \pi^{+} + X$

$\gamma + n\,(p) \rightarrow \pi^{-} + X$

*** 2 charged:** $\gamma + n\,(p) \rightarrow \pi^{-} + p + X\,(0, \pi^{0}, .)$

g14 experiments: Dec. 2011 – May. 2012

* Circularly polarized photon beams: $0.85 < E_\gamma < 2.4$ GeV

$\overrightarrow{D}$: 27 days → 4.5 B events

$\overleftarrow{D}$: 37 days → 6.1 B events

* Linearly polarized photon beams: $1.6 < E_\gamma < 2.2$ GeV

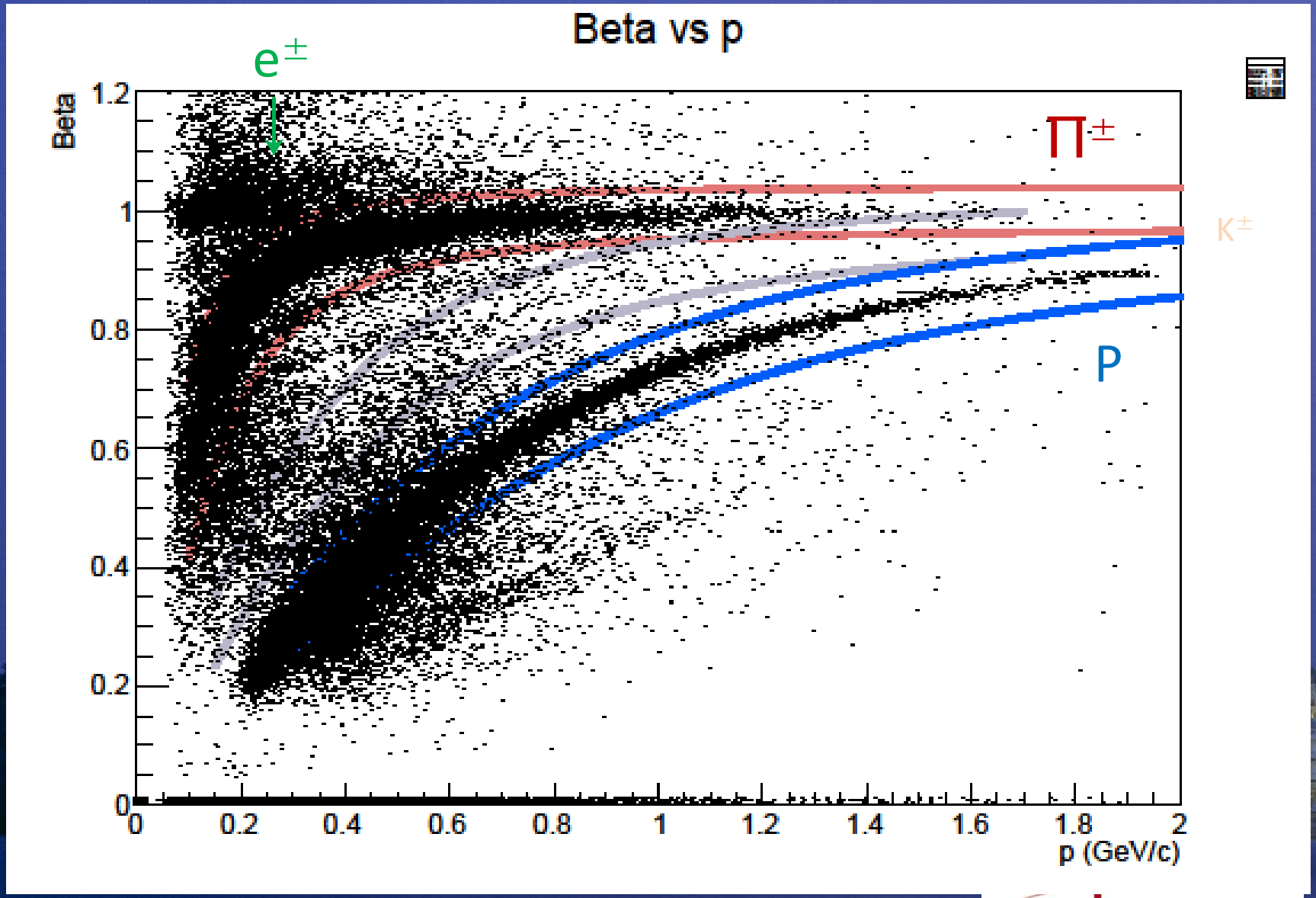
$\overrightarrow{D}$: 21 days → 2.5 B events

$\overleftarrow{D}$: 9 days → 1.2 B events

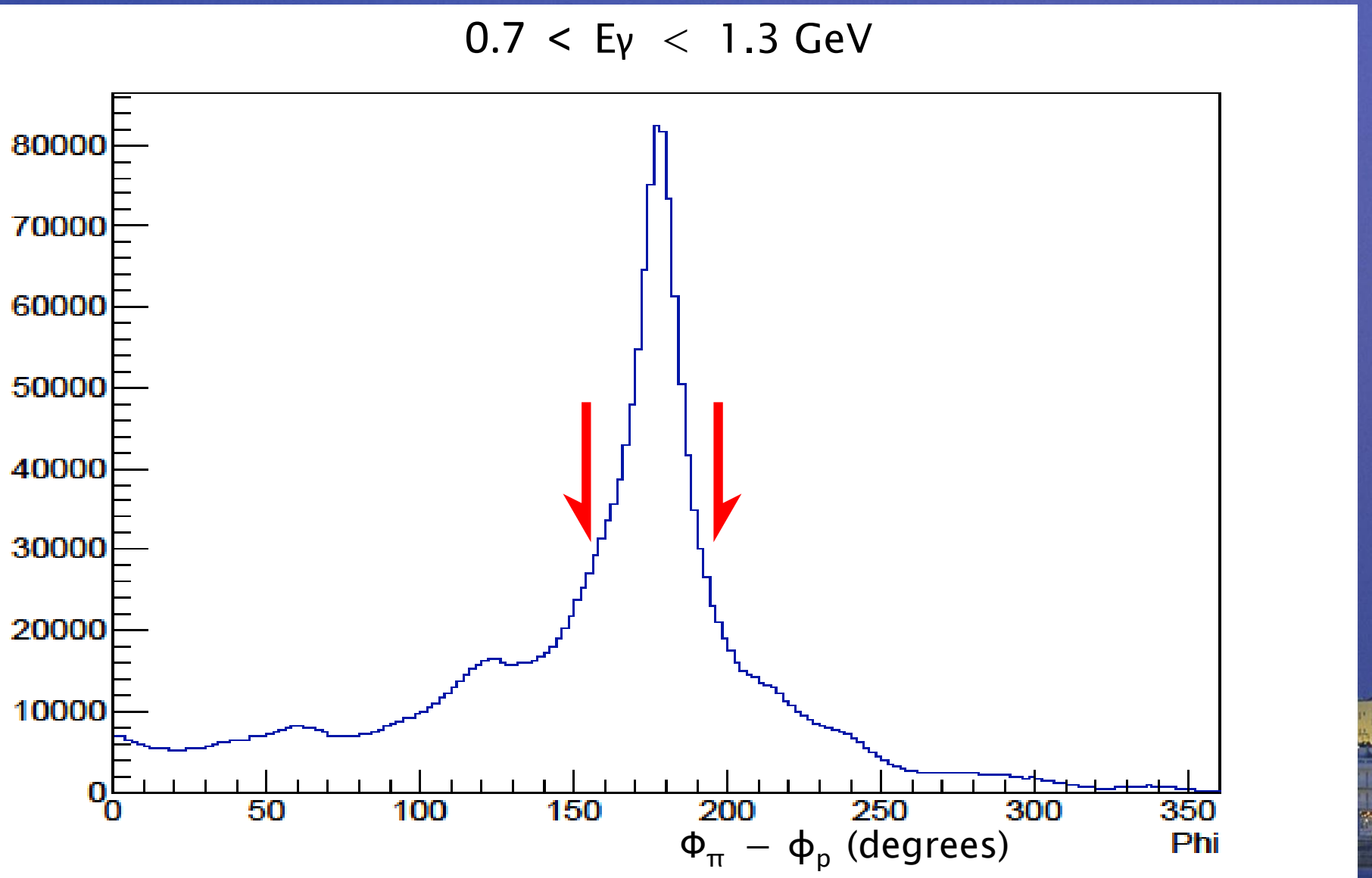
Data reductions for $\gamma + n(p) \rightarrow \pi^- + p\,(p)$

(a) Only π^- and Proton detected in CLAS
(b) Coplanarity cut
(c) Cut for Missing mass squared
(d) Missing momentum cut
(e) Target Cell subtraction and vertex cut

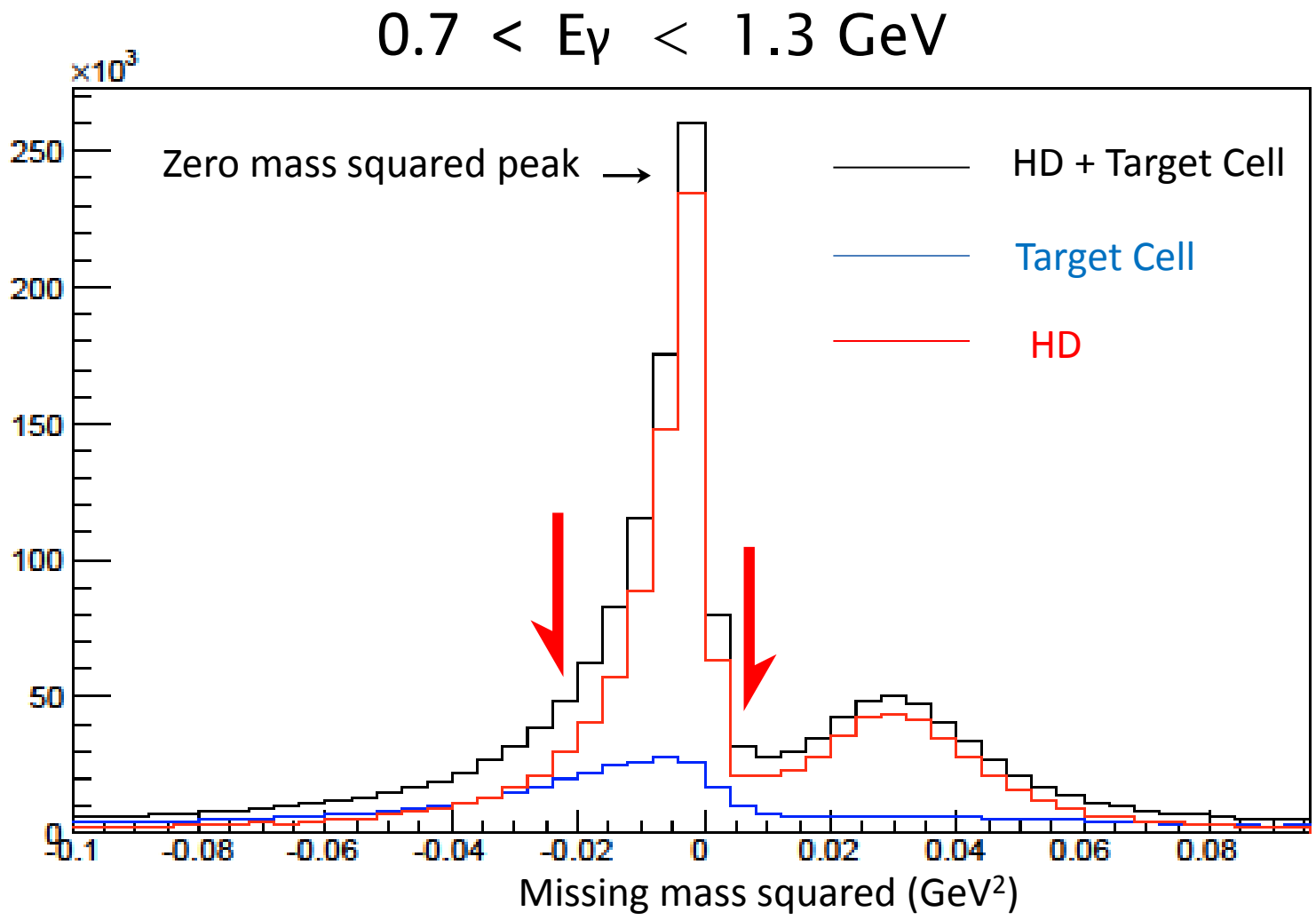
(a) Particle Identification using $\beta = v/c$ vs P (v: from TOF)



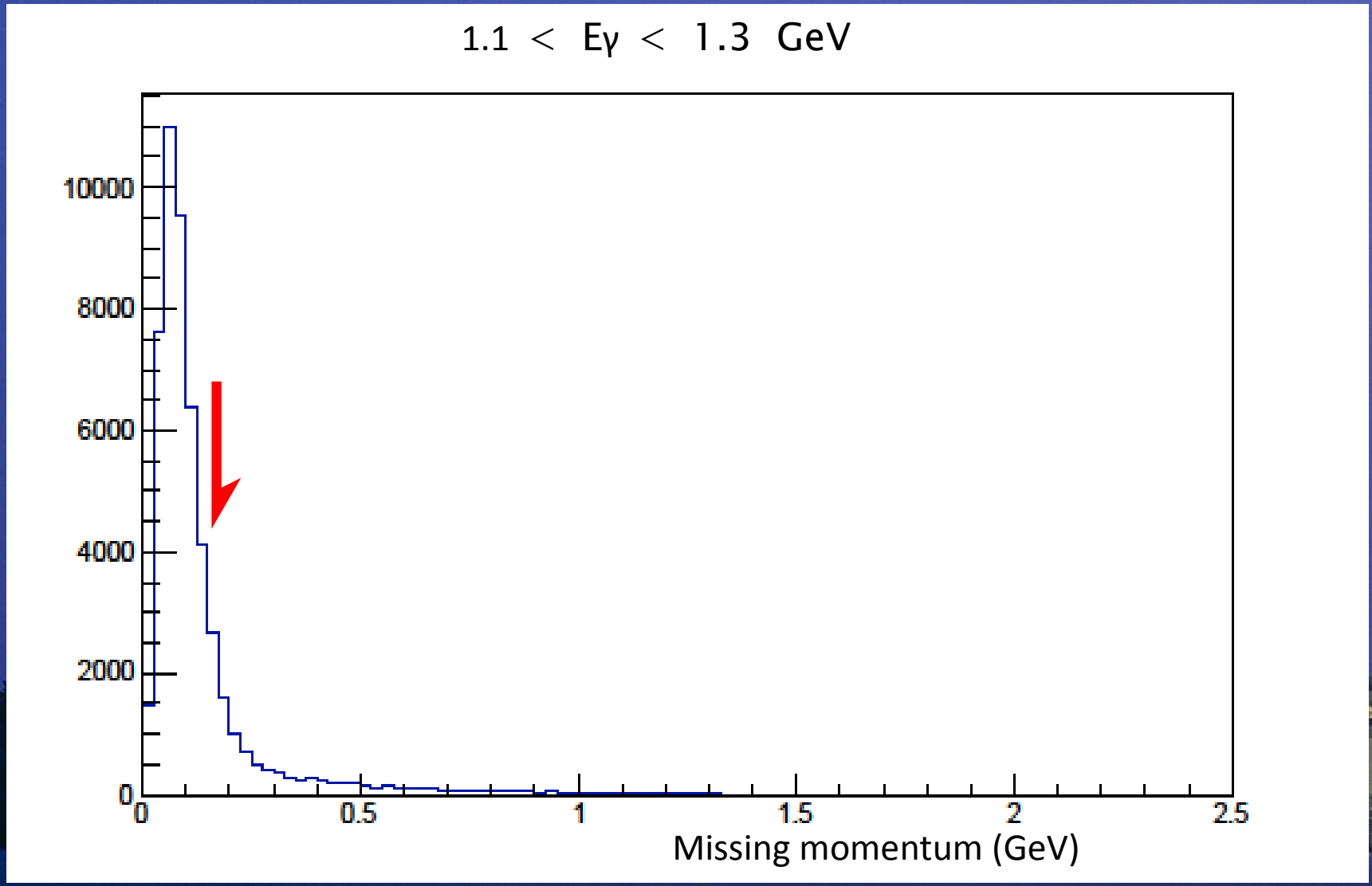
(b) $\Phi_{\pi^-} - \phi_p$ distribution and coplanarity cut for π^- and proton



(c) Missing mass squared distribution for $\gamma + n(p) \rightarrow \pi^- + p + X$ and cut

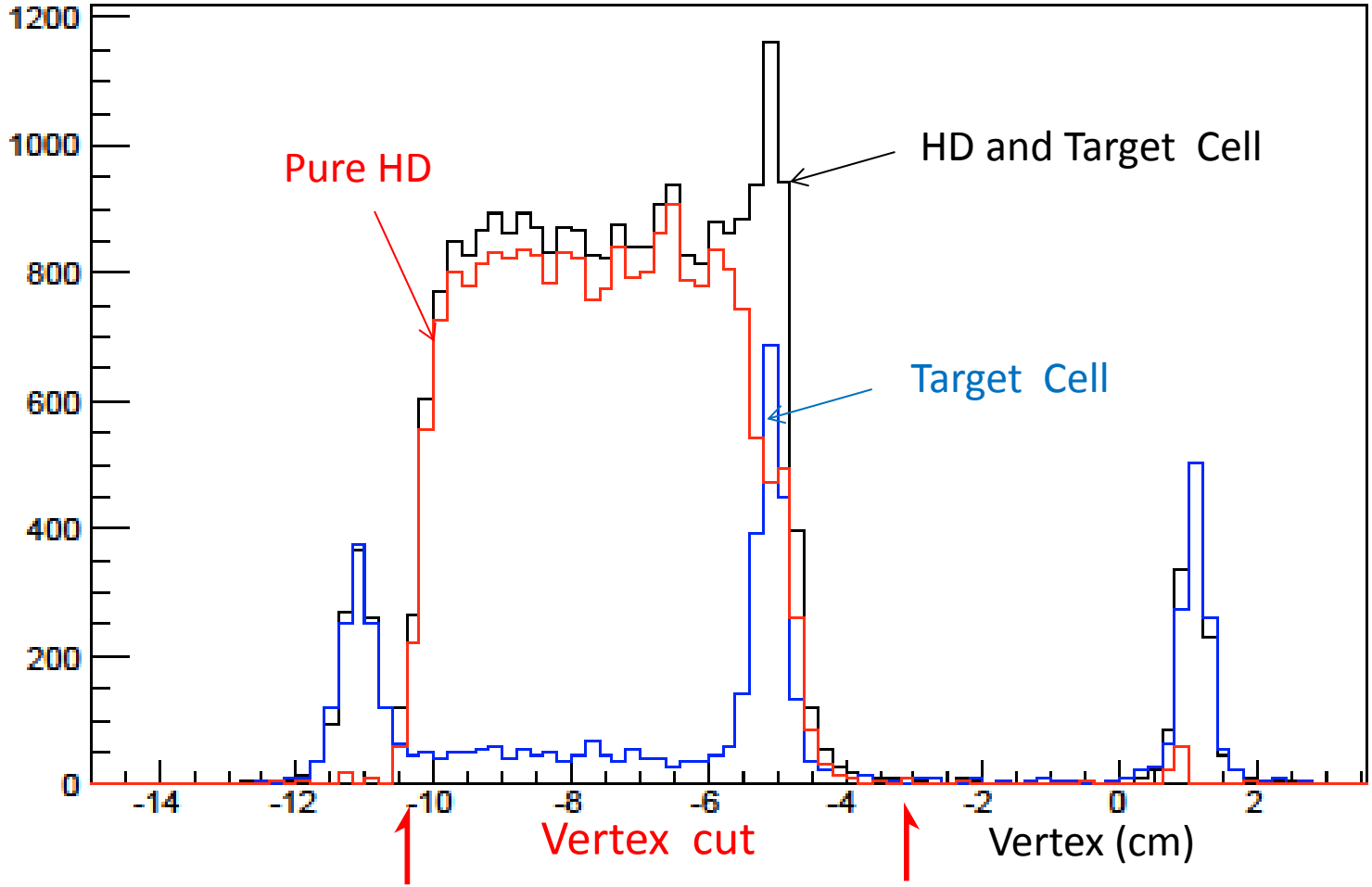


(d) Missing momentum distribution for $\gamma + n(p) \rightarrow \pi^- + p + X$; excludes bound neutrons



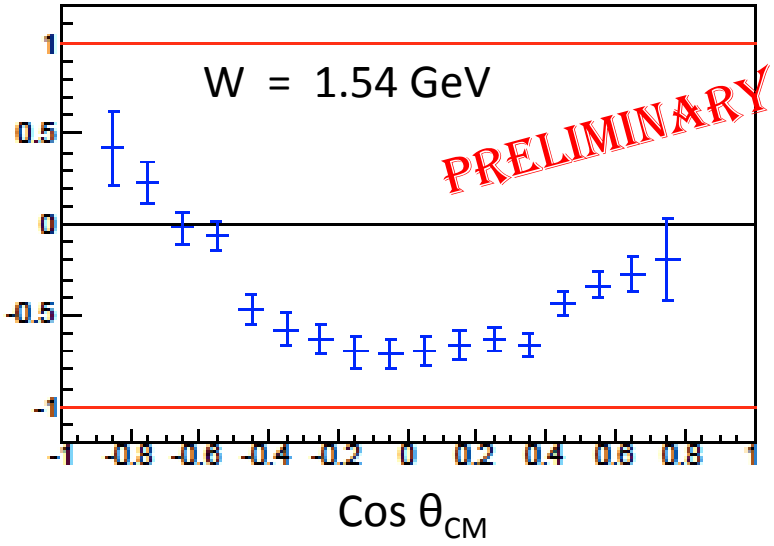
(e) Target Cell subtraction and vertex cut

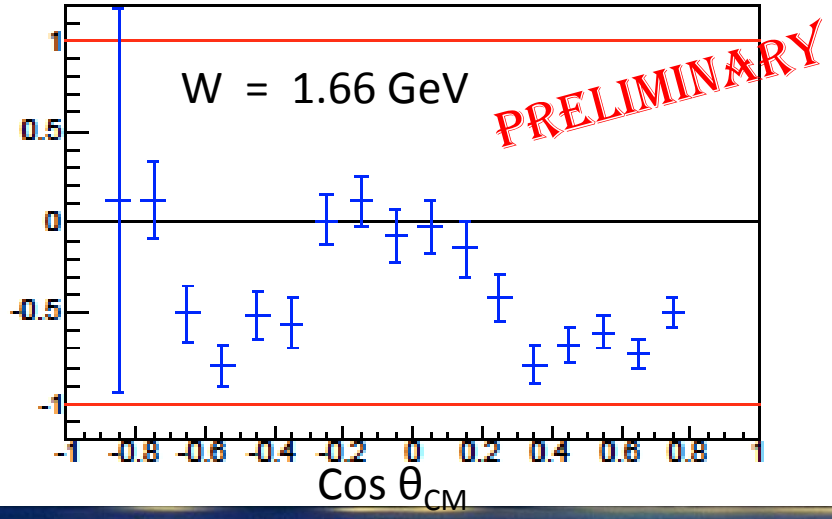
Reconstructed vertex along beam axis (1.1 < Eγ < 1.3 GeV) for spin parallel

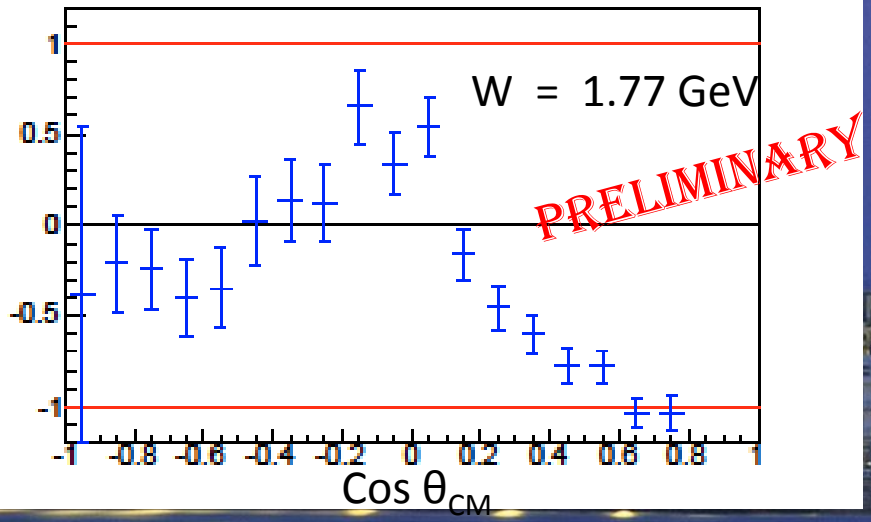


Preliminary E asymmetries for $\gamma + n(p) \rightarrow \pi^- + p$

- All cuts applied
- Use ~ 10 % of Data
- $P_D \sim 26.5\,\%$



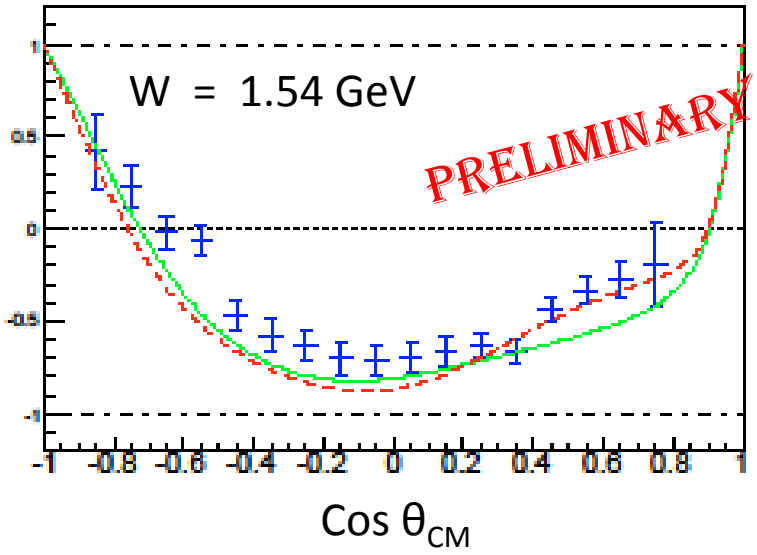


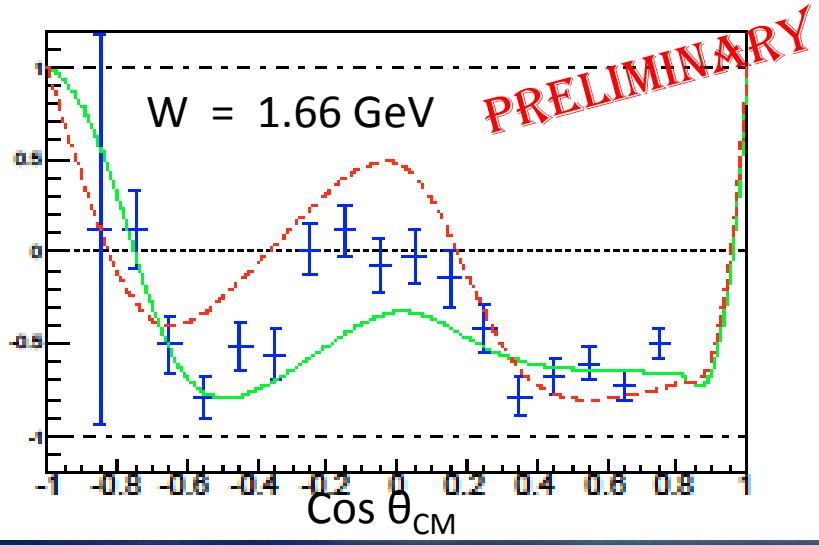


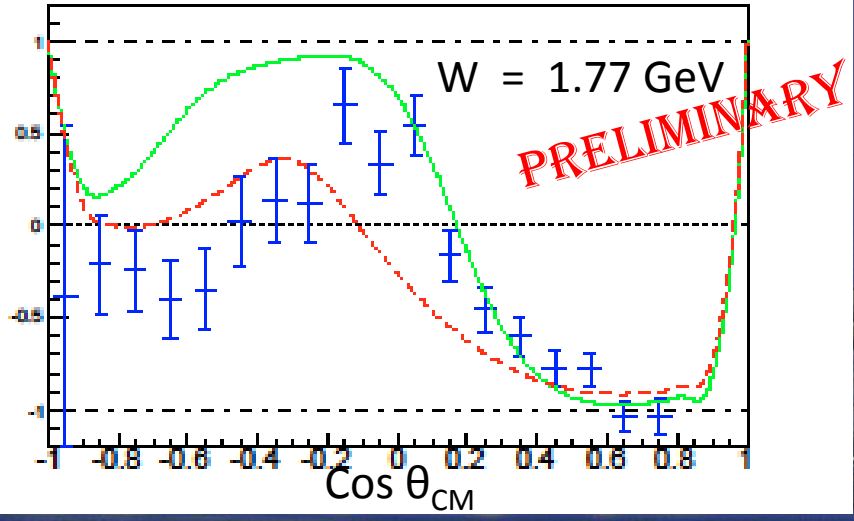
Preliminary E asymmetries for $\gamma + n(p) \rightarrow \pi^- + p$

SAID

MAID







4. Summary

a. Completed experiments for pseudoscalar-meson photo-production from longitudinally polarized HD at CLAS.

b. The experiment was done for 64 days of circularly and 30 days of linearly polarized photon beams.

c. Average target D polarization during the experiments have been estimated to be ~ 20 %.

d. Analyses for target polarizations has been going on.

e. Calibration for experimental data has been carried out.
Some preliminary asymmetries are shown.

f. Analysis for other channels, like $\gamma + n(p) \rightarrow n \pi^+ \pi^- (p)$ are ongoing