E08-011 Analysis Status Update

Parity Violating Deep Inelastic Scattering (6GeV)

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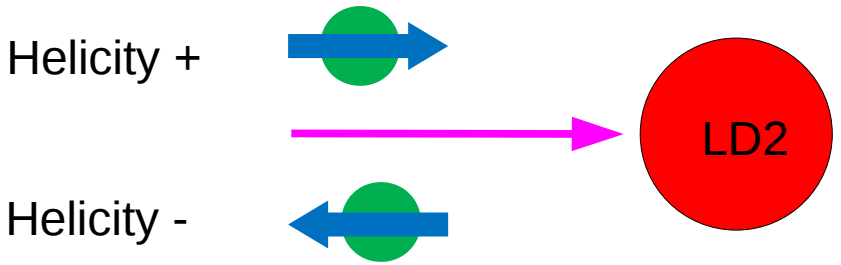
for the E08-011 collaboration

Hall A Collaboration Meeting, Dec. 15th, 2011

- Physics
- Completed Analysis Tasks:
  - Electron DIS Asymmetry Analysis
  - Beam Polarization (Compton/Moller)
  - Q^2 Measurement
  - Particle Identification Performance
- Updates since last meeting:
  - Deadtime Correction
  - Radiation Correction
  - Raw Pion Asymmetry

PVDIS Asymmetries

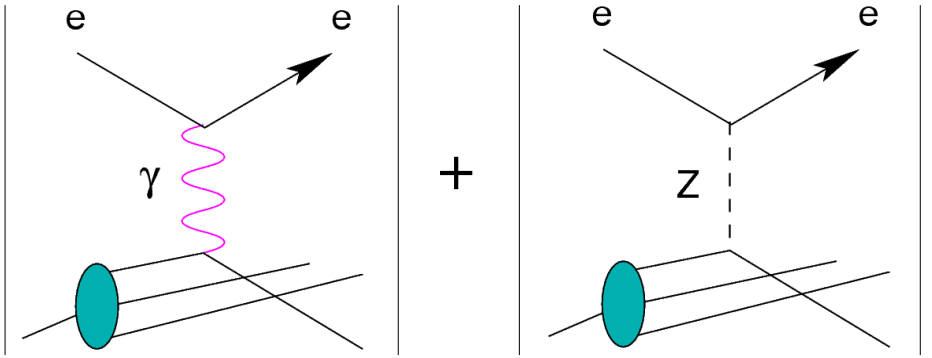


$$\sigma^+$$

$$\sigma^-$$

$$A_{pv} = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-}$$

$$A_{PV} =$$



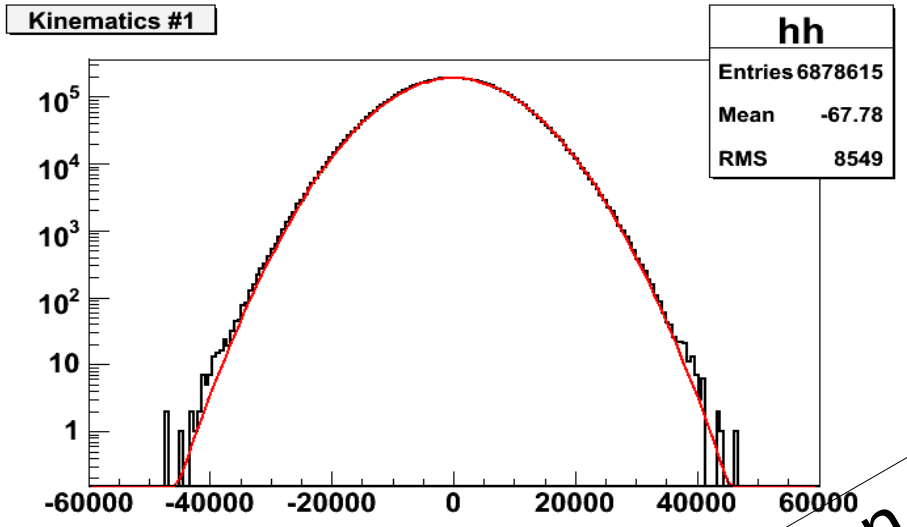
Deuterium:

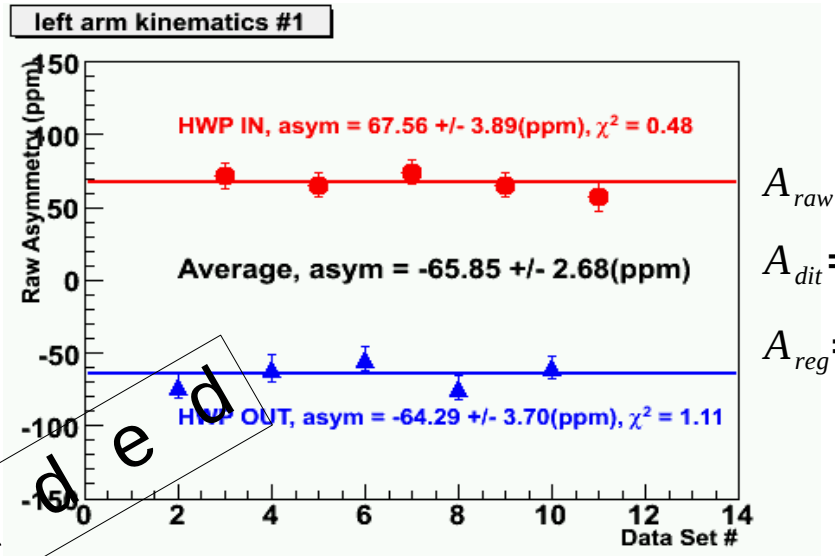
$$A_d = (540\ ppm) Q^2 \frac{2C_{1u}[1+R_C(x)] - C_{1d}[1+R_S(x)] + Y(2C_{2u} - C_{2d}) R_V(x)}{5 + R_S(x) + 4R_C(x)}$$

$$C_{1u} = g_A^e g_V^u = -\frac{1}{2} + \frac{4}{3}\sin^2(\theta_W) \qquad C_{2u} = g_V^e g_A^u = -\frac{1}{2} + 2\sin^2(\theta_W)$$

$$C_{1d} = g_A^e g_V^d = \frac{1}{2} - \frac{2}{3}\sin^2(\theta_W) \qquad C_{2d} = g_V^e g_A^d = \frac{1}{2} - 2\sin^2(\theta_W)$$

Raw Electron Asymmetries



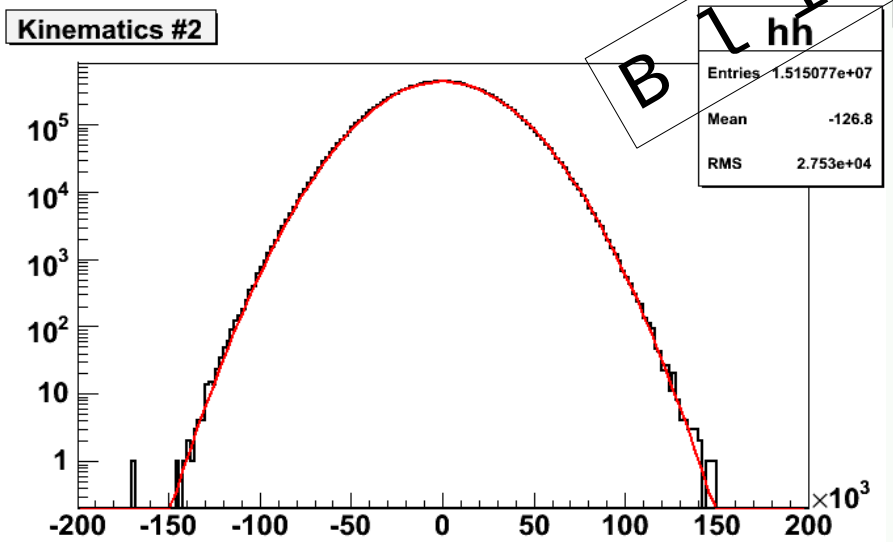


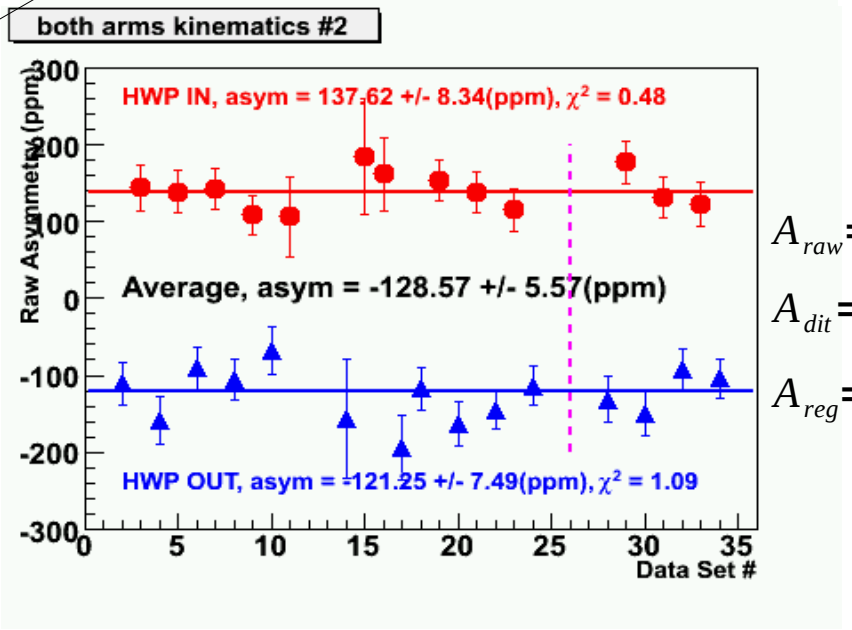
$A_{raw} = -65.85\text{ppm}$

$A_{dit} = -65.85\text{ppm}$

$A_{reg} = -65.93\text{ppm}$

Blinded





$A_{raw} = -128.57\text{ppm}$

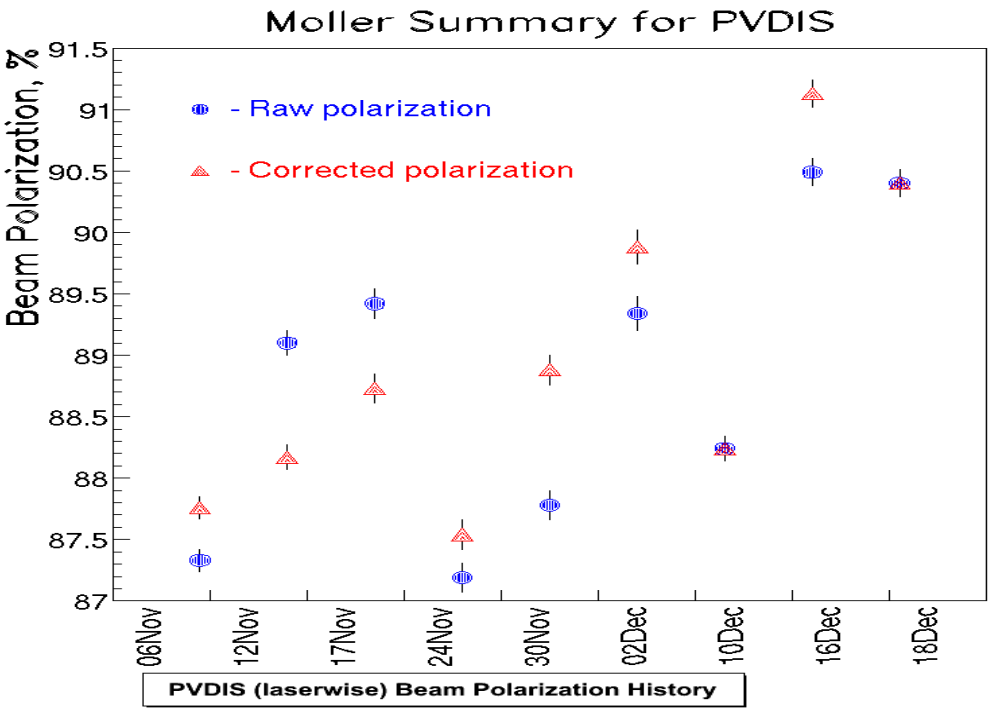
$A_{dit} = -128.52\text{ppm}$

$A_{reg} = -128.87\text{ppm}$

Doing two independent analyses, difference between the two is ~0.3ppm

Beam Polarization (Compton/Moller)

$$A' = A_{measure} / Polarization$$



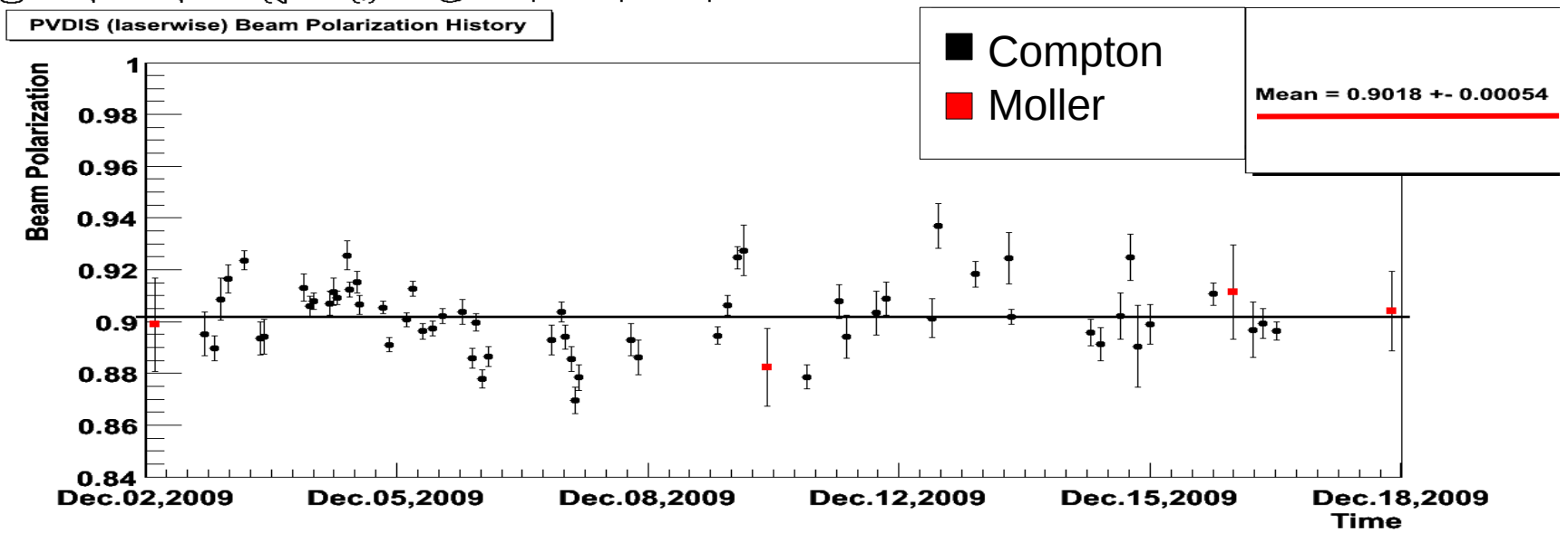
Moller: 88.47% +/- 2.0% (syst, relative) (6.0GeV)

90.4% +/- 1.7% (syst, relative) (4.8GeV)

Compton: 90.2% +/- 2.0% (syst, relative)

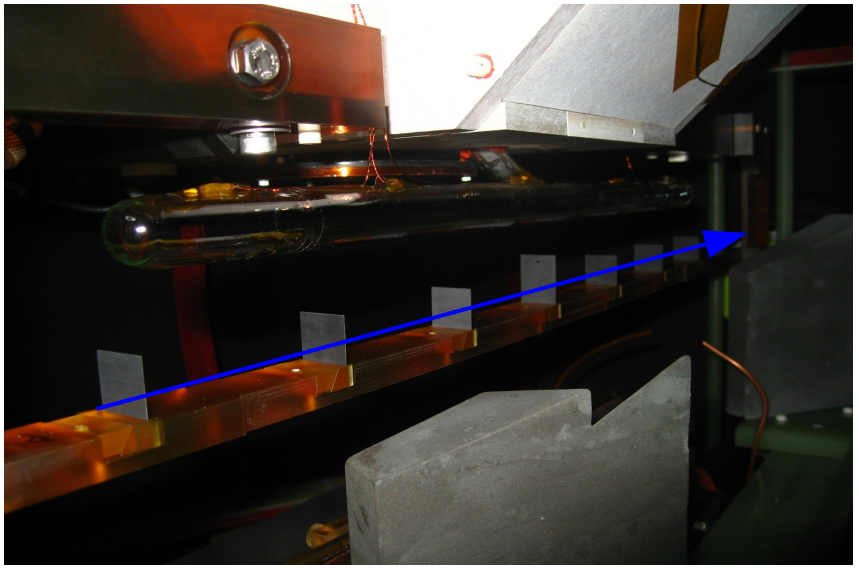
Systematic mainly from A_{th}

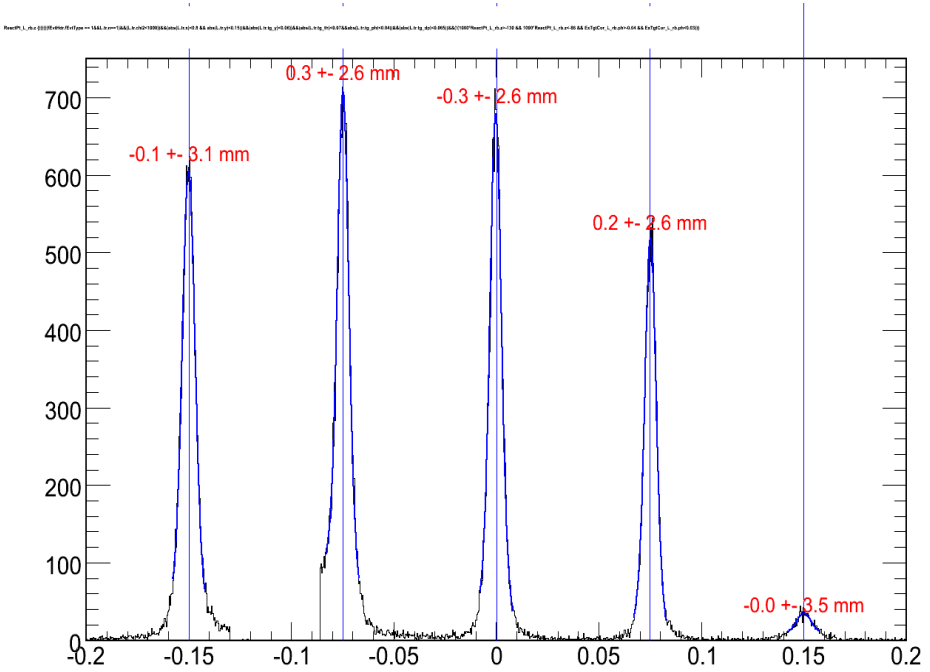
$(A_{\exp} = P_\gamma \times P_e \times A_{th})$

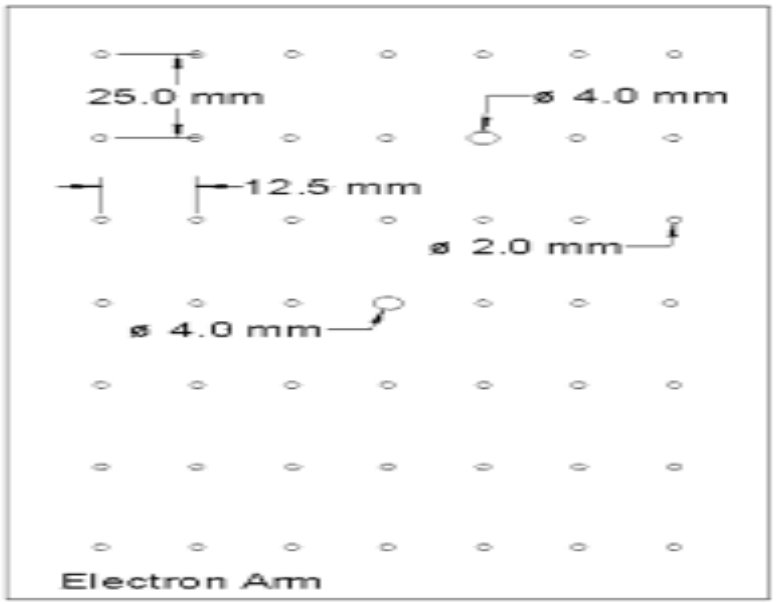


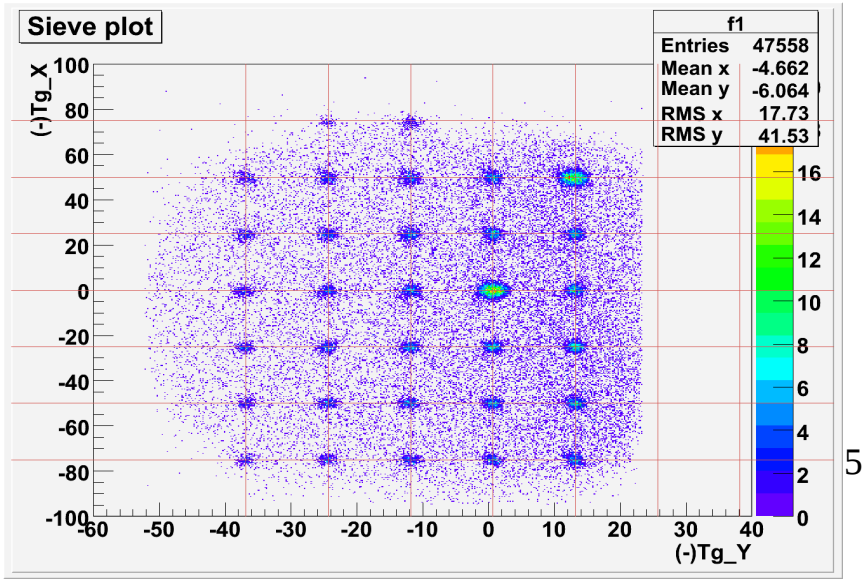
Tracking Reconstruction / Q^2 Measurement

- DIS asymmetry is sensitive to Q^2, thus tracking reconstruction
- After calibration, asymmetry uncertainty due to Q^2 reconstruction is <1%







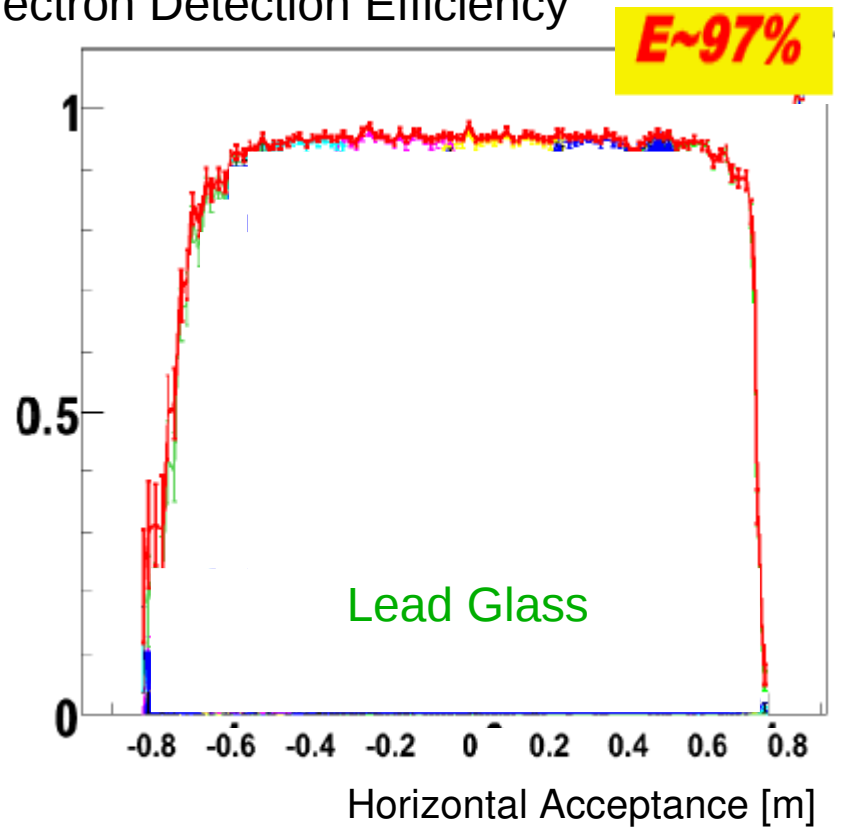


PVDIS Q^2 Uncertainties

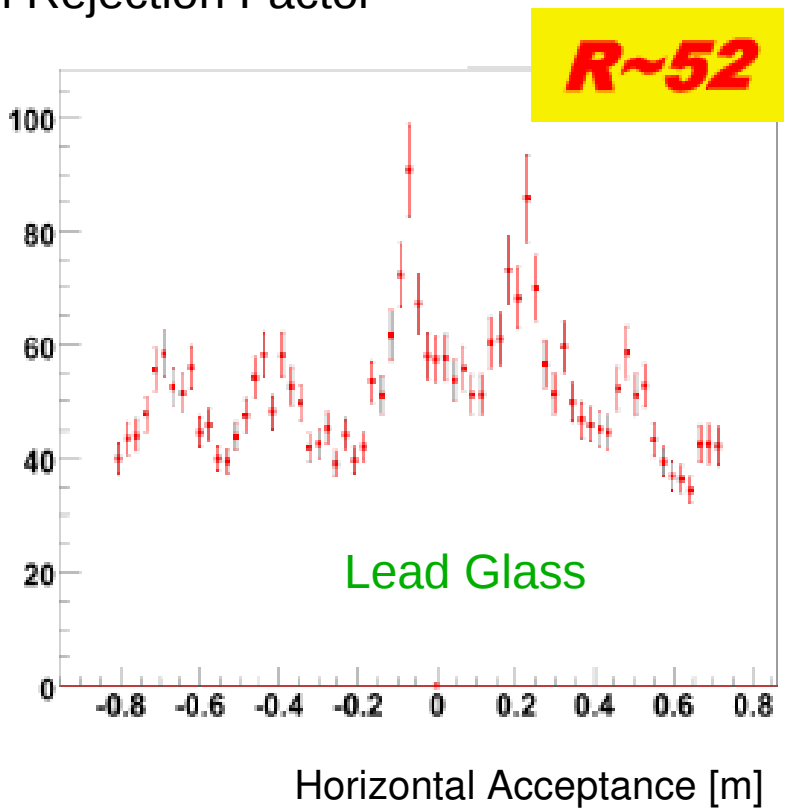
	LHRS						RHRS	
Kinematics	DIS#1	DIS#2	Res#3		Res#4	Res#5	DIS#2	Res#5
Angle θ	12.90	20.00	12.90	12.90	12.90	12.90	20.00	12.90
E'	3.66	2.63	4.0,3.66, 4.0,3.66	3.66	3.55	3.1	2.63	3.1
HRS angle survey?	Y	Y	N	N	N	N	Y	N
Carbon multi foil data?	Y	Y	Y	Y	N	N	Y	Y
D (from survey) (mm)	0.5	0.5					0.5	
D (from data) (mm)			0.5		0.5	0.5		0.5
D (no survey, no data) (5mm)								
reactZ from ytarg optimization (mm)	0.3	0.3	0.3		0.3	0.3	0.3	0.3
reactZ from target position (mm)	**2.5**	**2.5**	**2.5**		**2.5**	**2.5**	**2.5**	**2.5**
sin(θ) term, to be used for reactZ	0.22	0.34	0.22		0.22	0.22	0.34	0.22
sieve survey?	N	N	N	N	N	N	N	N
sieve data?			Y	Y				
sieve horizontal position, absolute (mm)	**0.51**	**0.51**	**0.51**		**0.51**	**0.51**	**0.50**	**0.50**
sieve horizontal position, calibration (mm)	0.1	0.1	0.1		0.1	0.1	0.1	0.1
horizontal angle using HAPPEX database (mrad)							**0.5**	**0.5**
Total angle uncertainty (mrad), using 1.12m d.d.	0.816	1.003	0.816		0.816	0.816	1.117	0.953
Total angle uncertainty, relative (%)	0.363	0.287	0.363		0.363	0.363	0.320	0.423
Total Q2 uncertainty (%)	**0.725**	**0.575**	0.725		0.725	0.725	**0.640**	0.847

Particle Identification Performance

Electron Detection Efficiency



Pion Rejection Factor



	Lead Glass	Gas Cherenkov	Overall
Electron Efficiency	97%	96%	95%
Pion Rejection Factor	52	200	10e4

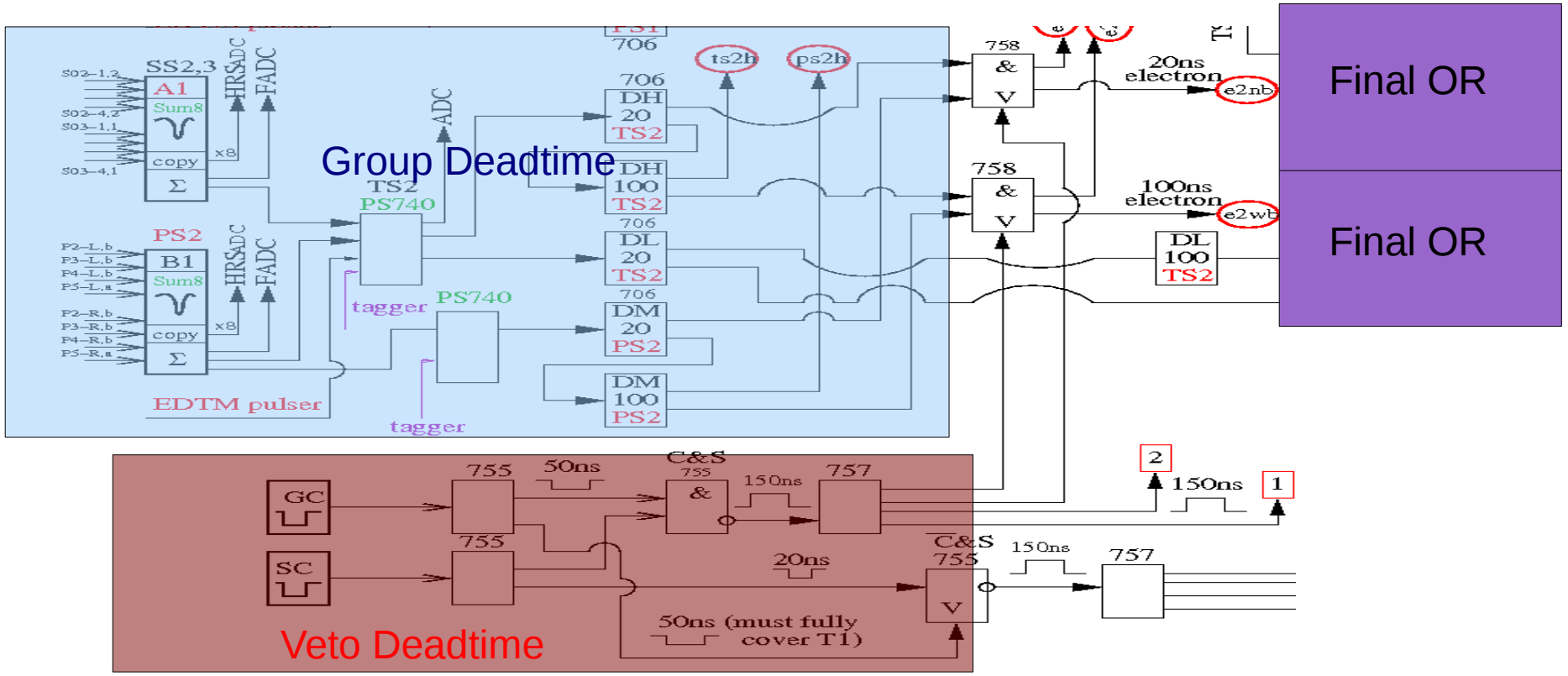
Asymmetry correction due to **electron efficiency <0.5%**
pion contamination <0.1%

Deadtime Correction

Deadtime correction to asymmetry: $A' = A_{measure}(1 - Deadtime)$

Deadtime Decomposition:

- Group Deadtime: proportional to group rate; narrow/wide path.
- Veto Deadtime: T1/GC rate; the same for all groups.
- Final OR: individual group triggers are ORed together to form final global trigger.
- Overall Deadtime: Veto DT (+) Group DT (+) Final OR DT



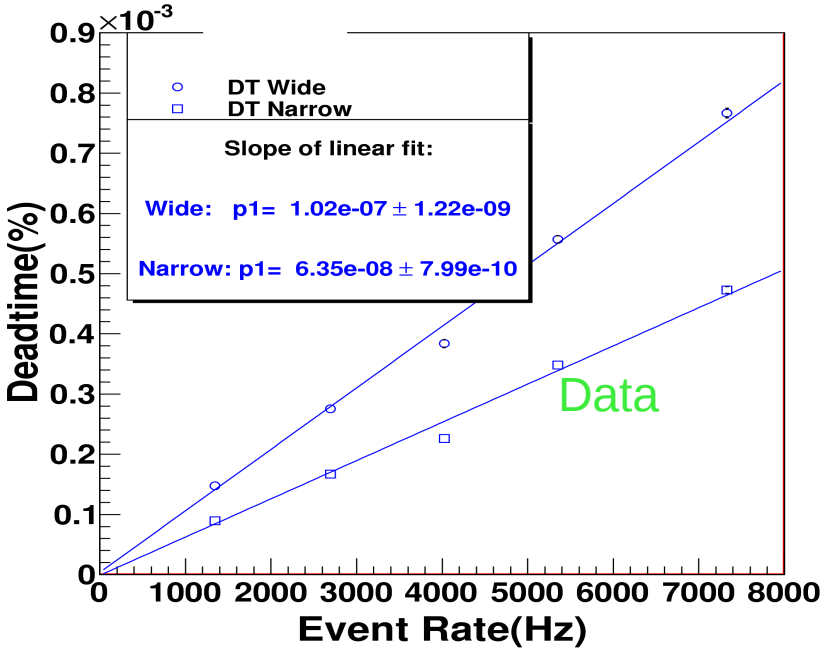
Deadtime Correction

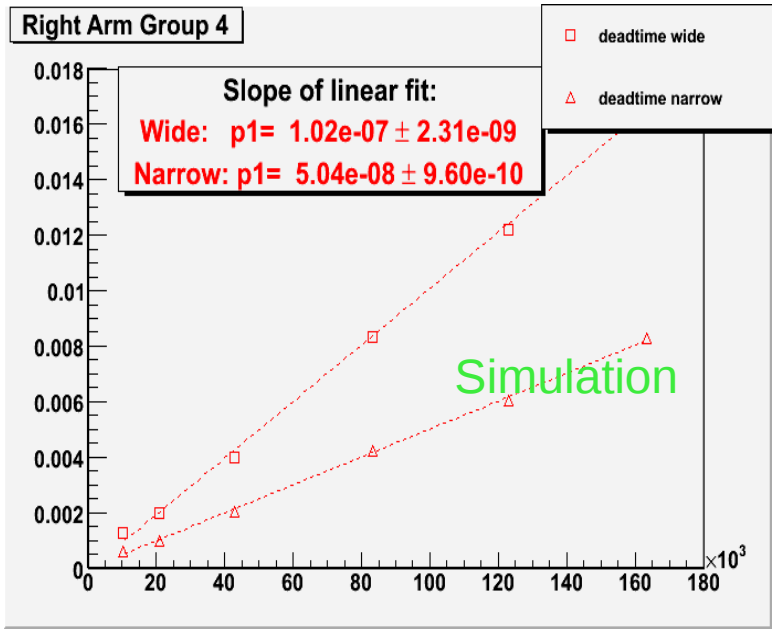
Deadtime correction to asymmetry: $A' = A_{measure}(1 - Deadtime)$

Methods to study Deadtime:

- Theoretically, $Deadtime \propto Event\ Rate$
- FADC data: direct way to study veto deadtime, but low statistics.
- Tagger method: study group deadtime, compare with simulation.
- Software simulation: simulating all the signals and electronics, so everything. only way to get overall deadtime.

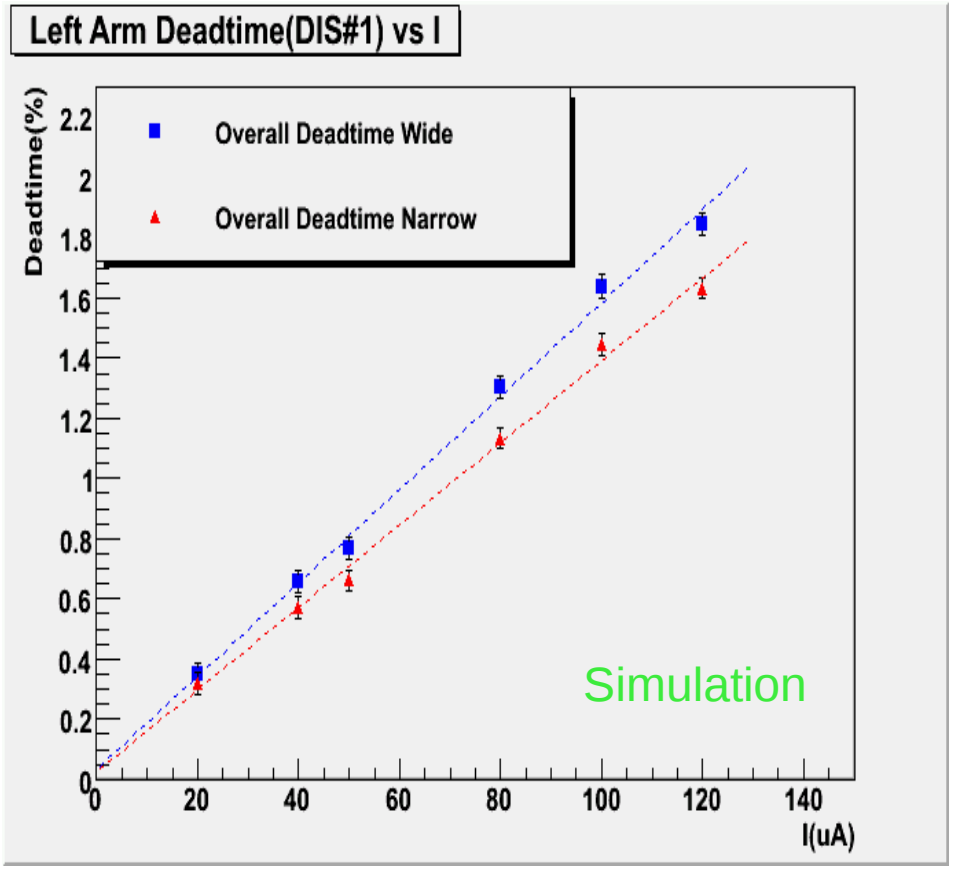
The Tagger method:
(Group Deadtime)

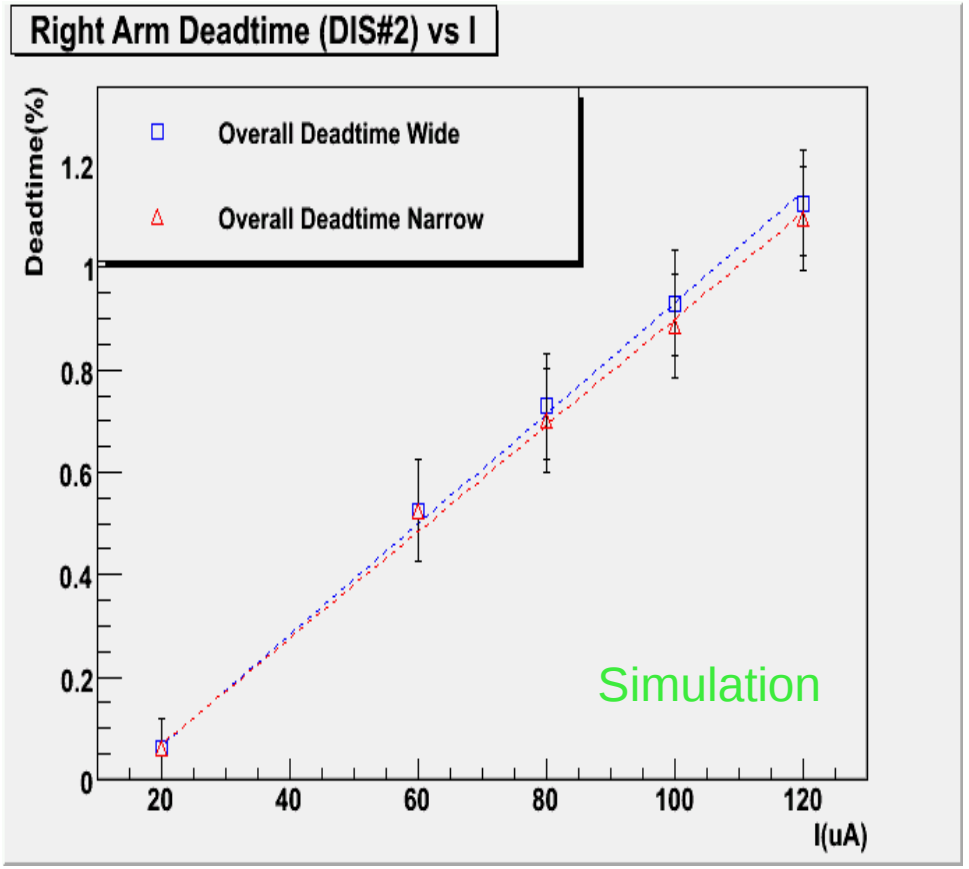




Deadtime Correction

Overall Deadtime:

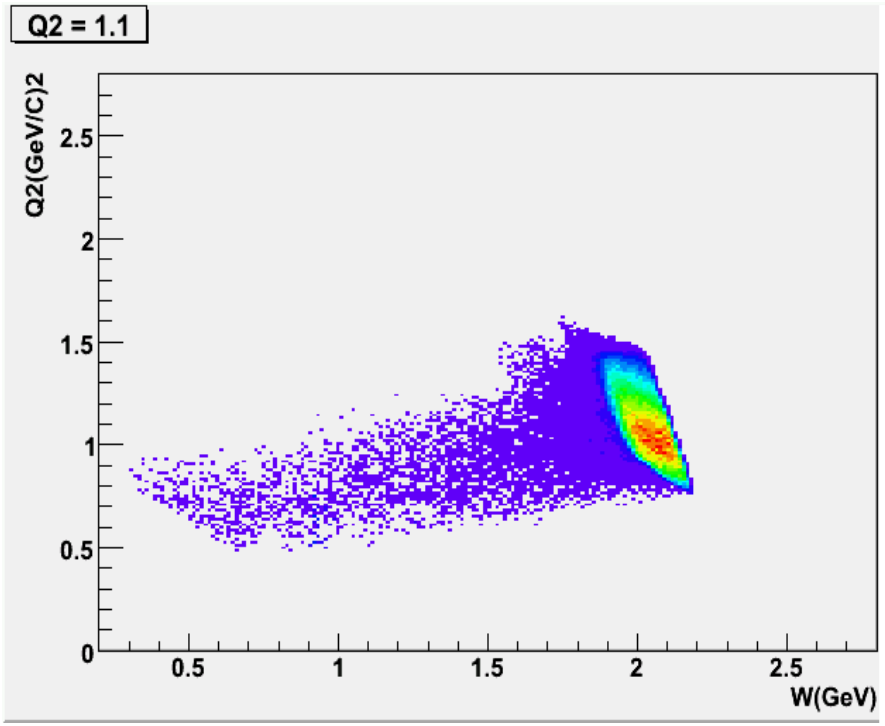


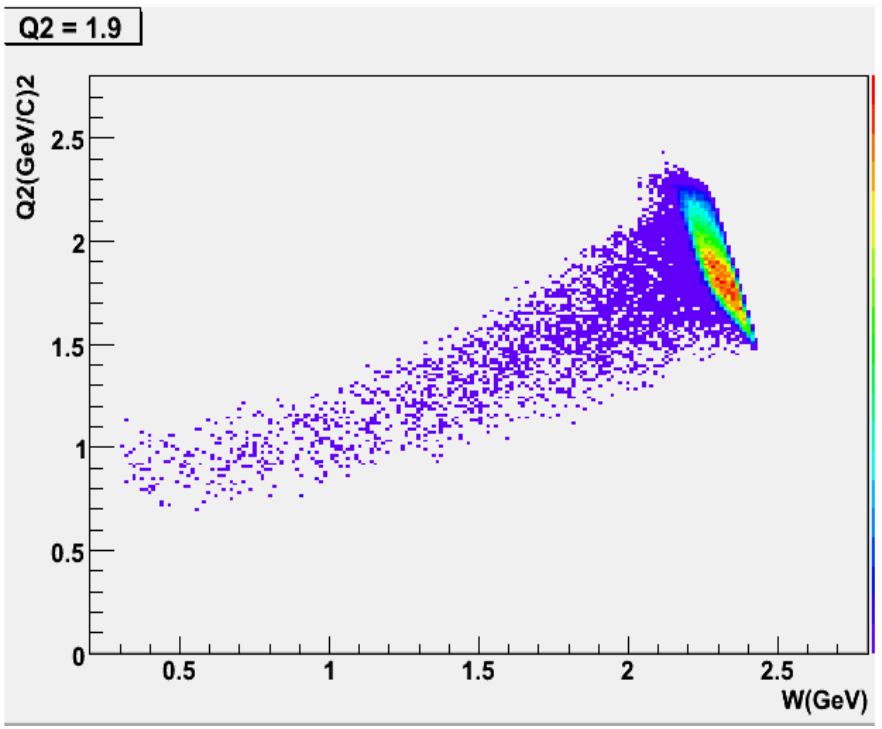


- Veto Deadtime dominates.
- Deadtime corrections to asymmetry is: ~1.6% +/- 0.5% (Kinematics #1)
  ~1% +/- 0.3% (Kinematics #2)

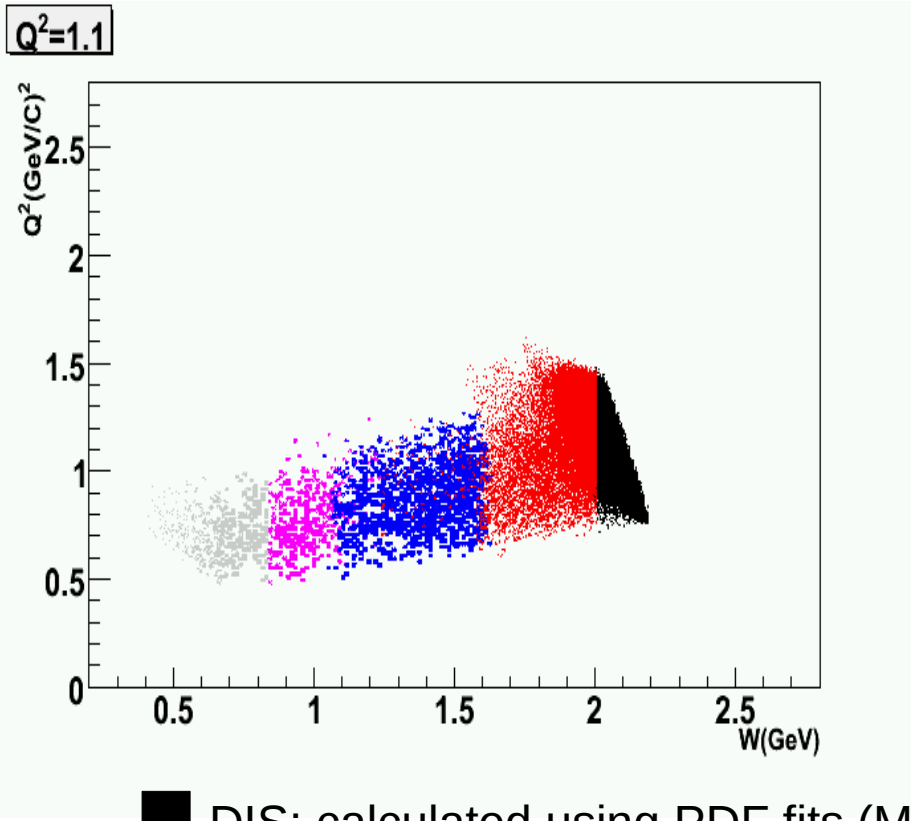
EM Radiative Corrections

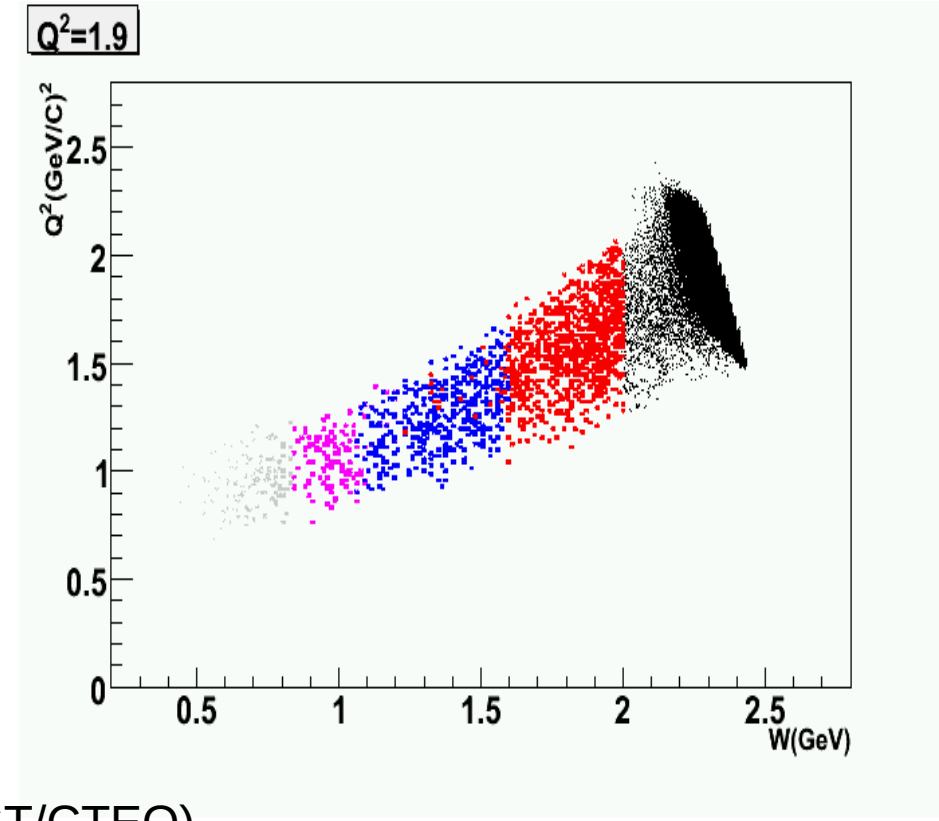
Monte Carlo Simulation (HAMC)





EM Radiative Corrections





DIS: calculated using PDF fits (MRST/CTEQ).

Elastic Quasi-Elastic : Data/Theoretical calculations

Resonance:

Some calculation (Misha Gorshteyn), which covers a large part of the resonance

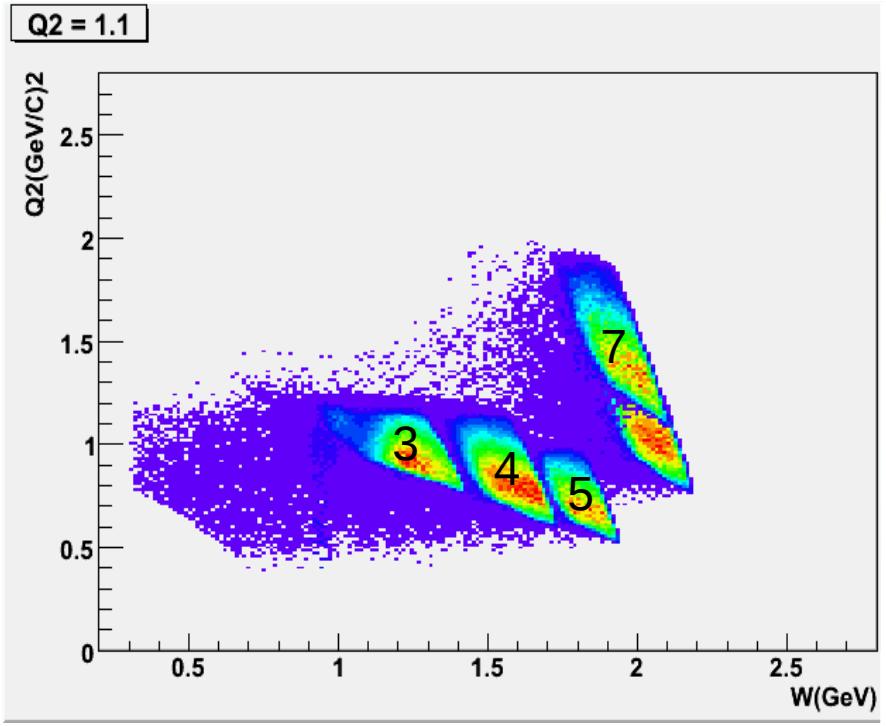
Delta Resonance: Theoretical calculation (Lee & Tao).

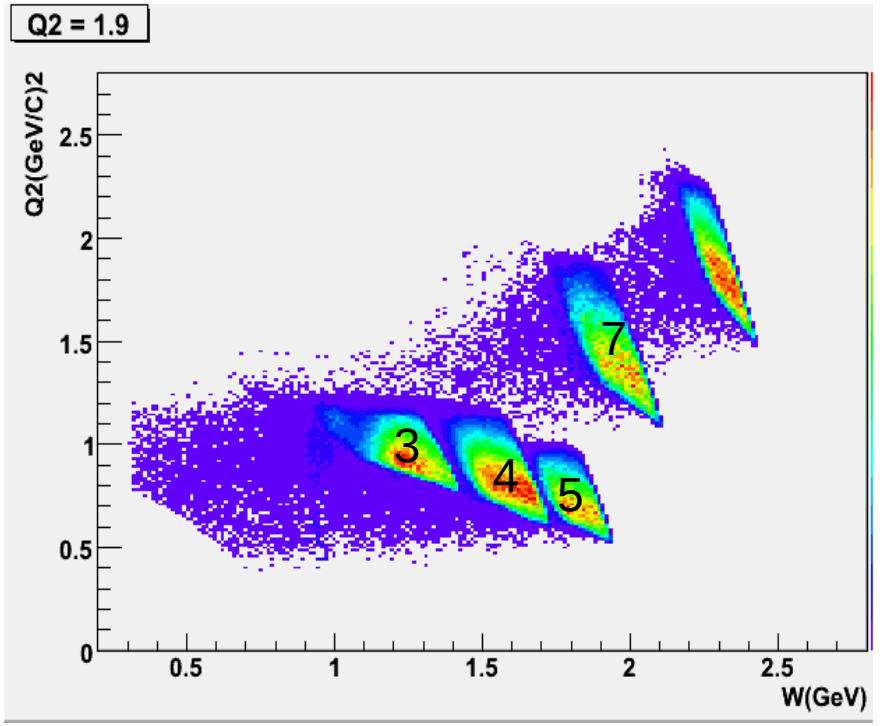
Other Resonance: No previous data

"Toy Model", eg. $A_{toy} = A_{dis} \times \frac{\sigma_{res}}{\sigma_{dis}}$

Use resonance data to constrain uncertainties.

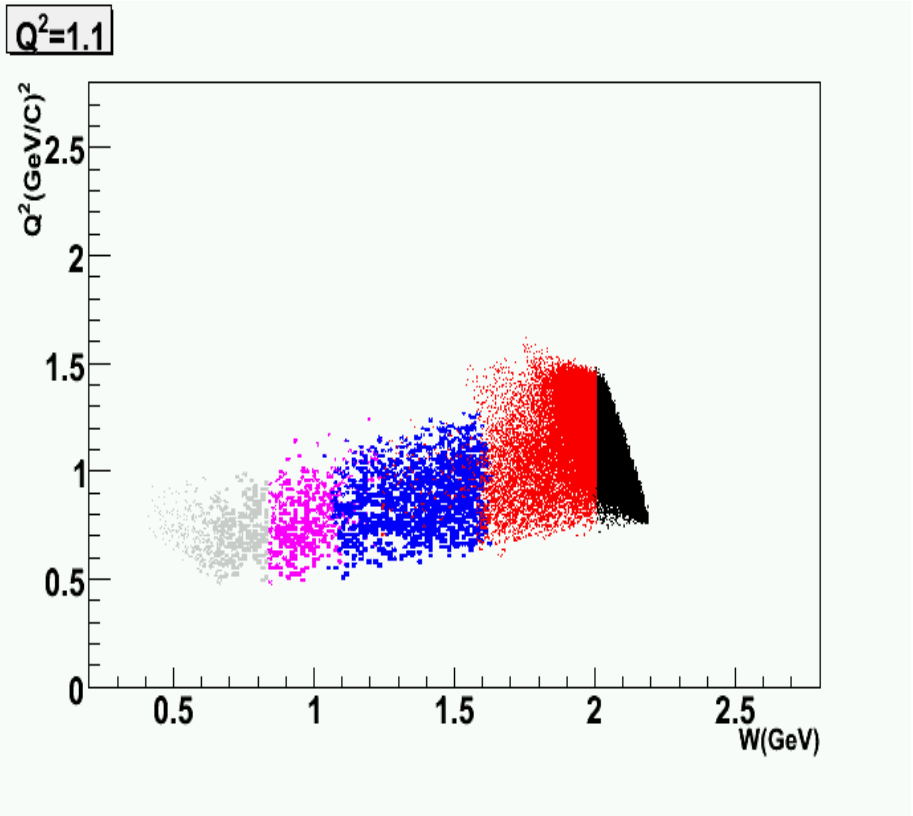
EM Radiative Corrections

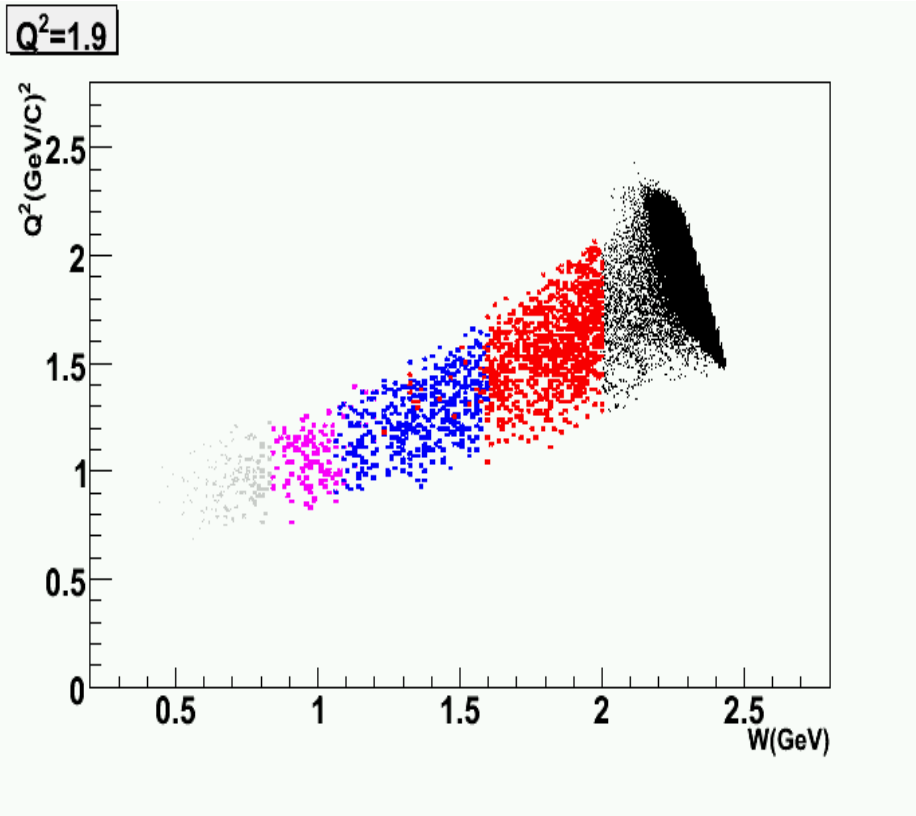




Kine#	E (GeV)	θ	E' (GeV)	e- rate (KHz)	A_d (ppm)	ΔA_d (ppm)
3 (Mistuned)	4.8	12.9	4.00(L)	1288	-66.3	7.8
4	4.8	12.9	3.55(L)	888	-73.4	6.9
5	4.8	12.9	3.10(R)	791	-60.9	5.15
7	6.0	15.0	3.66	280	-118.8	16.9

EM Radiative Corrections





	Elastic	Quasi	Delta	Dis	Toy	<Asym>	A_central	Correction Factor
Dis #1	58.4 (0.03%)	-26.9 (1.3%)	-68.3 (2.1%)	-85.2 (61.1%)	-94.6 (35.4%)	-87.4 (ppm)	-91.7 (ppm)	1.049
Dis #2	80.7 (0.05%)	-46.4 (0.897%)	-102.4 (1.46%)	-157.0 (95.5%)	-126.2 (2.03%)	-154.4 (ppm)	-161.7 (ppm)	1.047

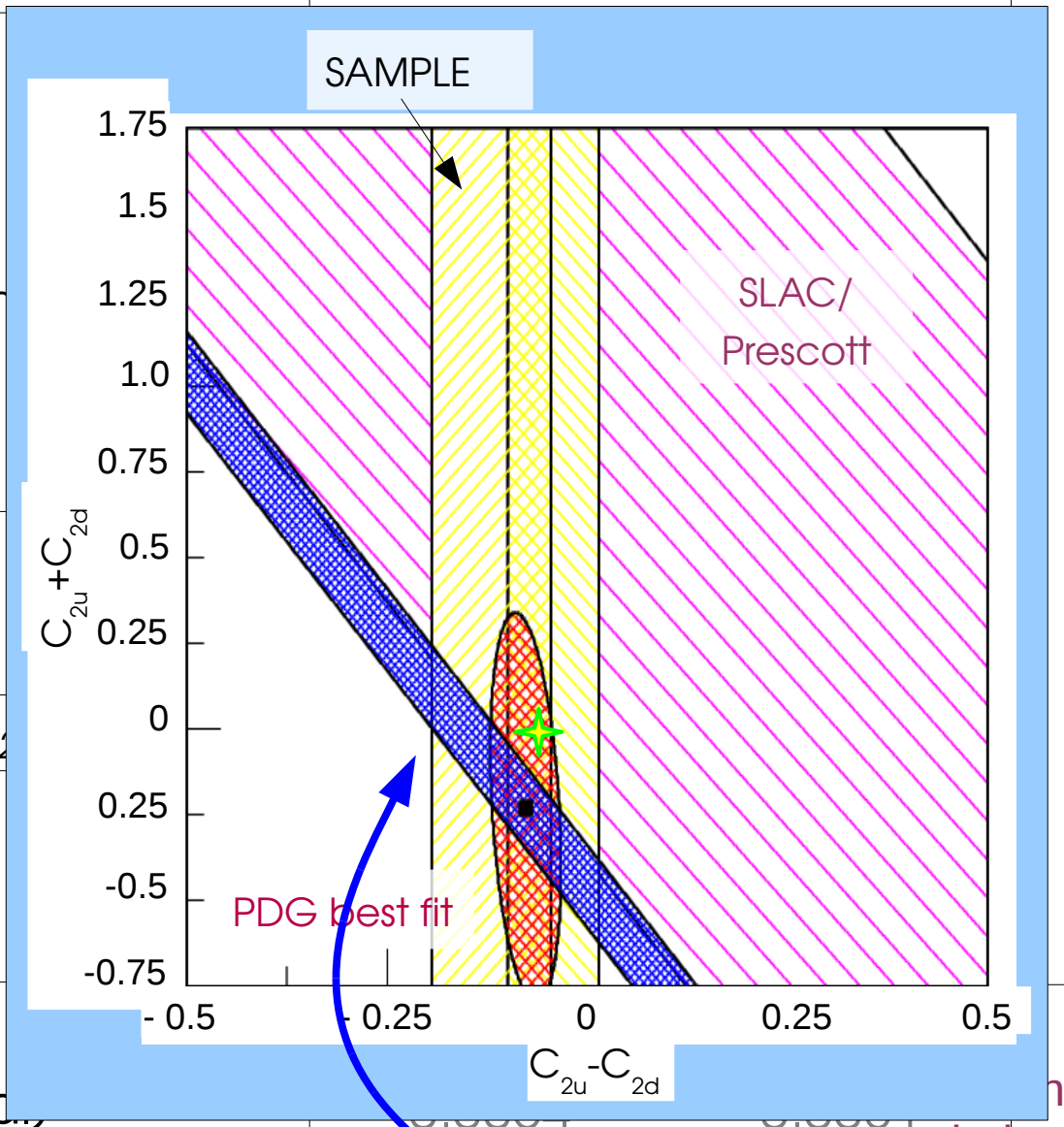
Error Budget

	Source \ $\Delta A_d/A_d$	Q^2=1.1 GeV^2	Q^2=1.9 GeV^2
ΔA_d	$\Delta P_b/P_b$	2.0%	2.0%
	Radiative Correction	1.0%	1.0%
	Q^2	0.7%	0.6%
	Deadtime correction	0.5%	0.3%
	Target endcap contamination	0.4%	0.4%
	Transverse Asymmetry	0.2%	0.4%
	PID efficiency	0.2%	0.2%
	False Asymmetry	0.2%	0.2%
	Systematics	2.48%	2.41%
	Statistical	3.00%	4.00%
	Total	3.89%	4.67%
$\Delta(2C_{2u}-C_{2d})$	Source \ $\Delta(2C_{2u}-C_{2d})$		
	A_d	0.0735	0.0565
	Parton distribution functions	0.0071	0.0031
	Electro-weak rad. cor.	0.0038	0.0024
	Higher Twist (using 1%/Q^2 on A_d)	0.0170	0.0064
	CSV (MRST nominal)	0.0054	0.0031
	CSV (MRST 90% C.L.)	0.0132	0.0085
	Total uncertainty	0.0739	0.0566

not included below

Error Budget

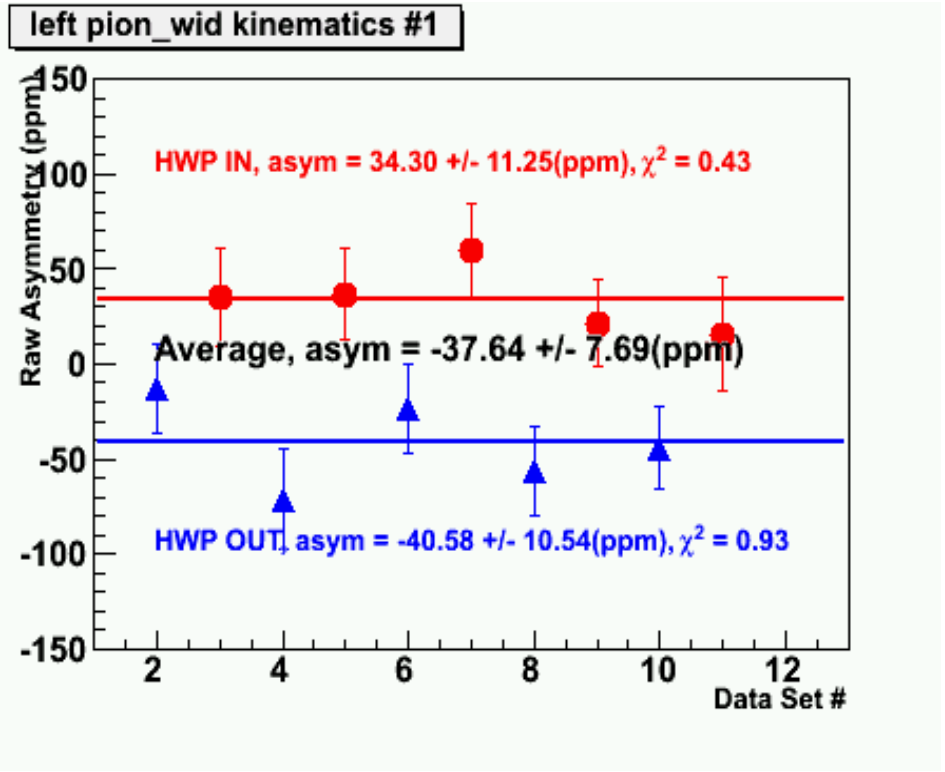
	Source \ $\Delta A_d/A_d$	Q^2=1.1 GeV^2	Q^2=1.9 GeV^2
ΔA_d	$\Delta P_b/P_b$		
	Radiative Correction		
	Q^2		
	Deadtime correction		
	Target endcap contam		
	Transverse Asymmetry		
	PID efficiency		
	False Asymmetry		
	Systematics		
	Statistical		
	Total		
$\Delta(2C_{2u}-C_{2d})$	Source \ $\Delta(2C_{2u}-C_{2}$		
	A_d		
	Parton distribution		
	Electro-weak rad.		
	Higher Twist (using		
	CSV (MRST nomina		
	CSV (MRST 90% C.L.)	0.0132	0.0085
	Total uncertainty	0.0739	0.0566

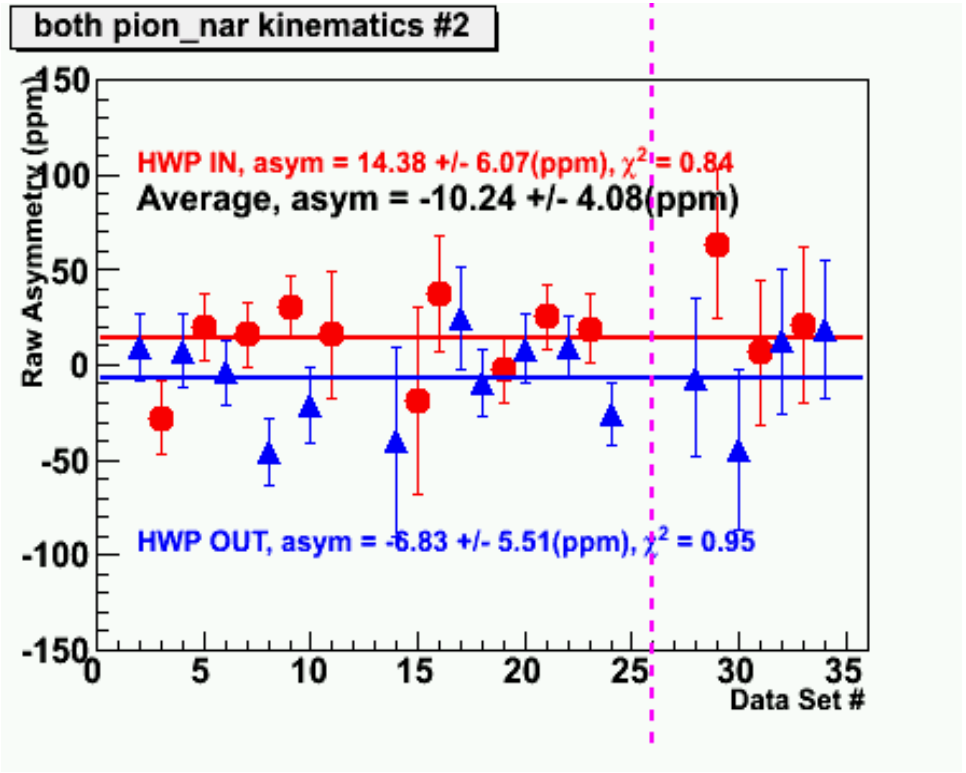


included below

Raw Pion Asymmetries

Very Preliminary!!





$\frac{e}{\pi} \sim 10$

$\frac{e}{\pi} \sim 0.42$

Need Electron Contamination Correction.

To Do

Finalize Everything and Unblind!