Parity Violating Deep Inelastic Scattering at JLab 6GeV

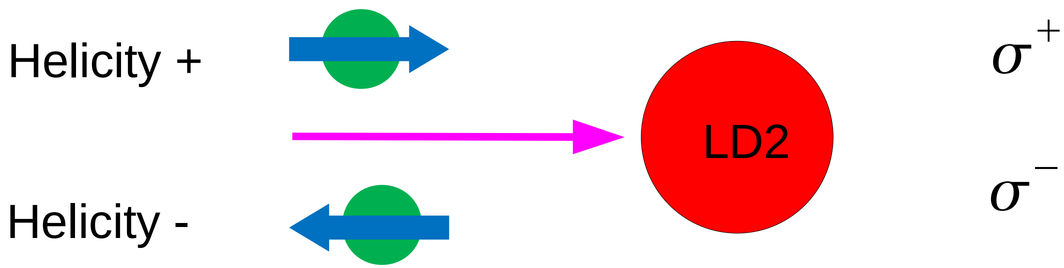
Diancheng Wang

Research Committee Review Meeting

Apr. 26th, 2012

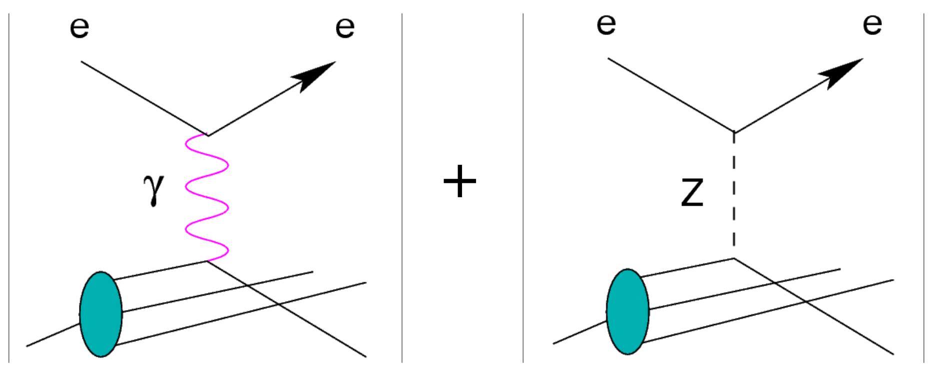
- Introduction of Physics
- Experiment Setup and Overview
- Data Analysis / Systematic Uncertainties
- Preliminary Results and Physics Interpretations

PVDIS Asymmetry



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

$A_{PV} =$



Deuterium (Simplified Formula) :

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

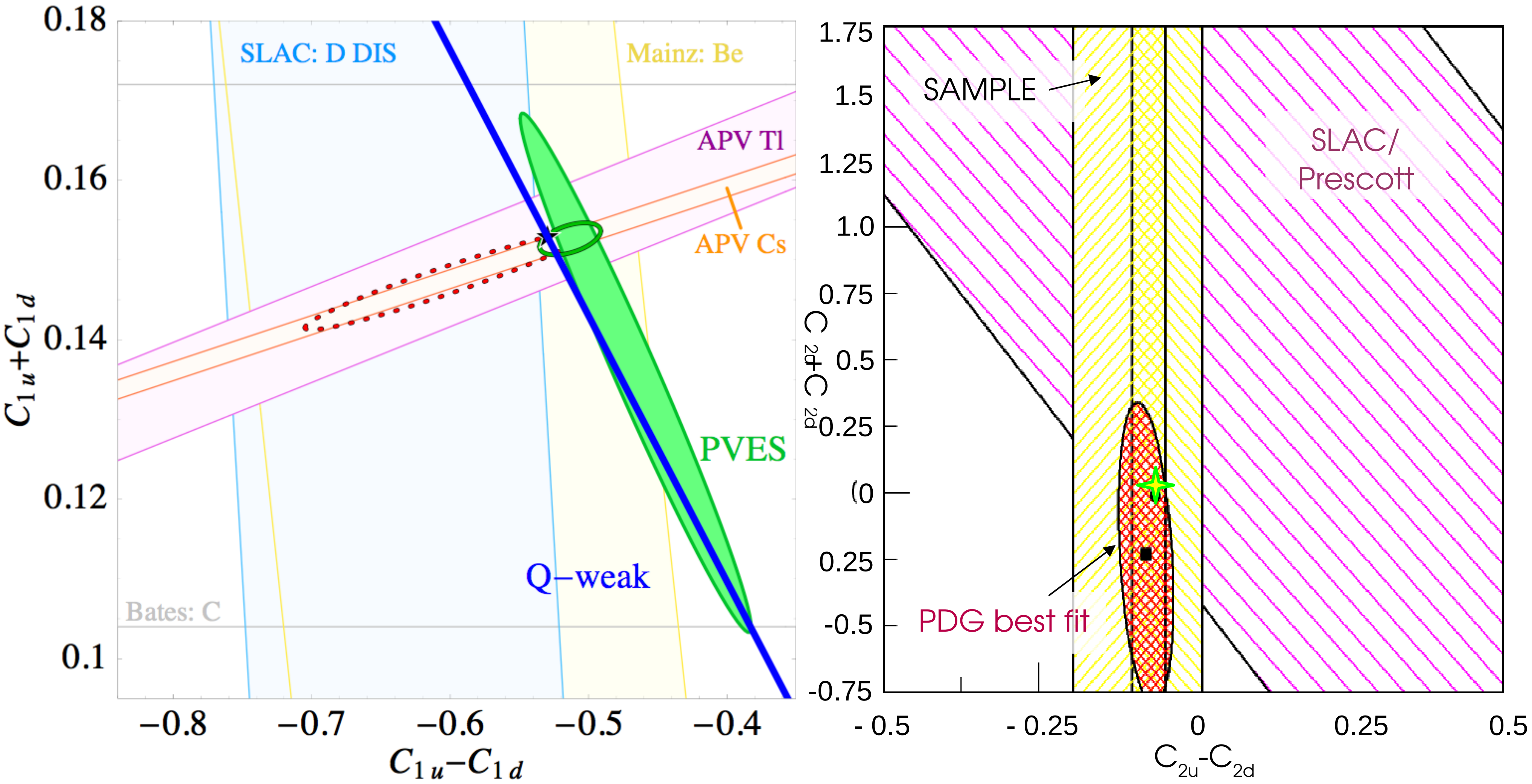
$$C_{1u} = g_A^e g_V^u = -\frac{1}{2} + \frac{4}{3}\sin^2(\theta_W) \qquad C_{2u} = g_V^e g_A^u = -\frac{1}{2} + 2\sin^2(\theta_W)$$

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

PVDIS: Only way to measure C_{2q} among current EW experiments

Quark Weak Neutral Couplings $C_{1,2q}$

all are 1 σ limit



Testing the EW Standard Model – Running of $\sin^2\theta_W$

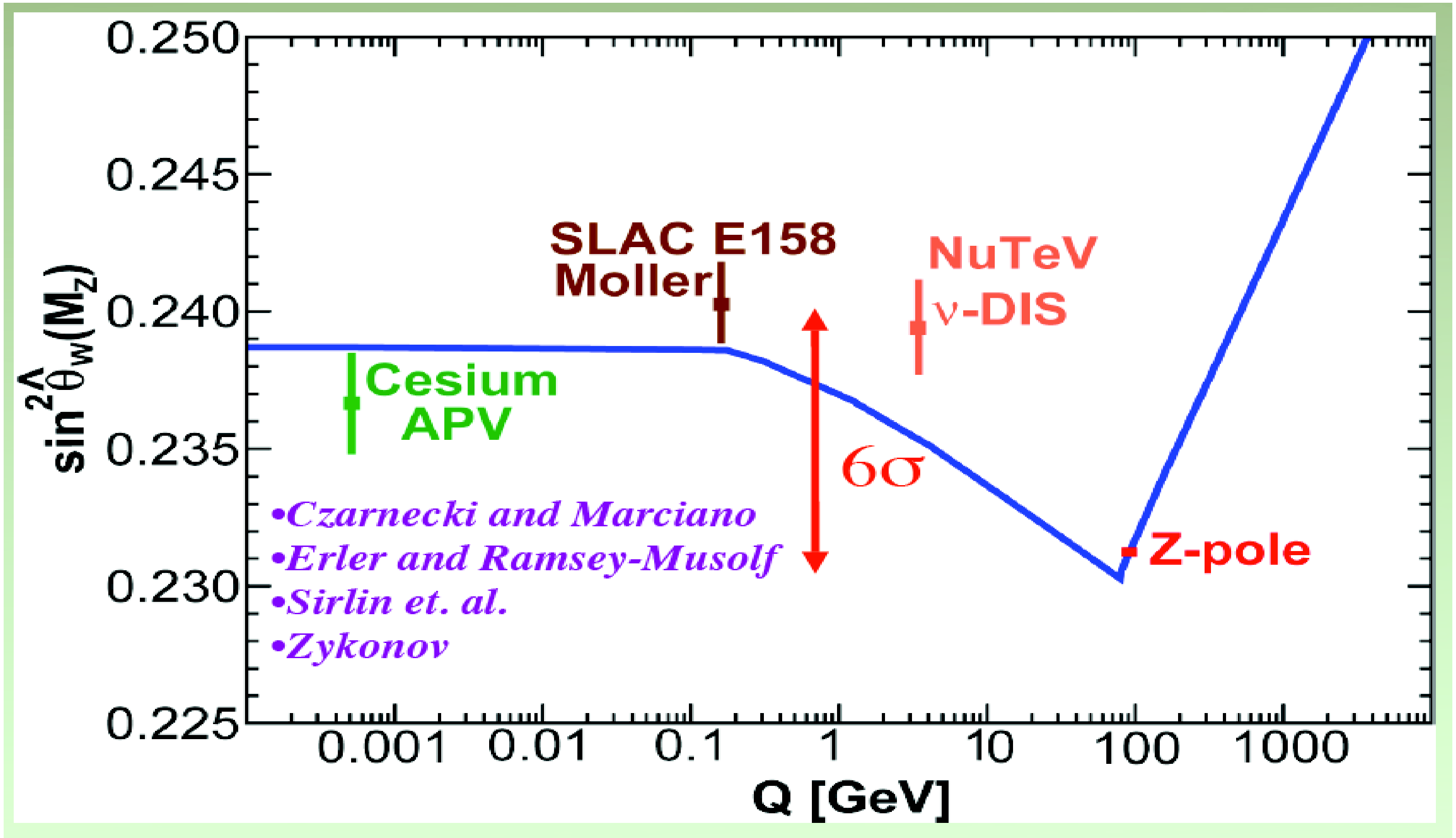


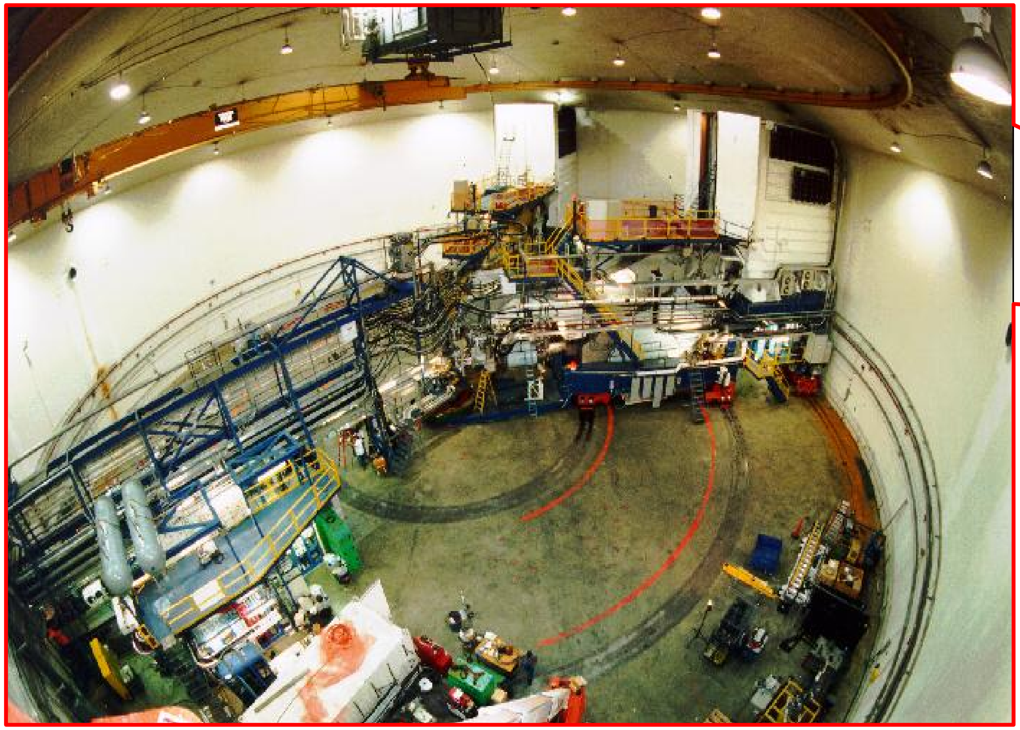
figure from K. Kumar, Seattle 2009 EIC Workshop EW talks

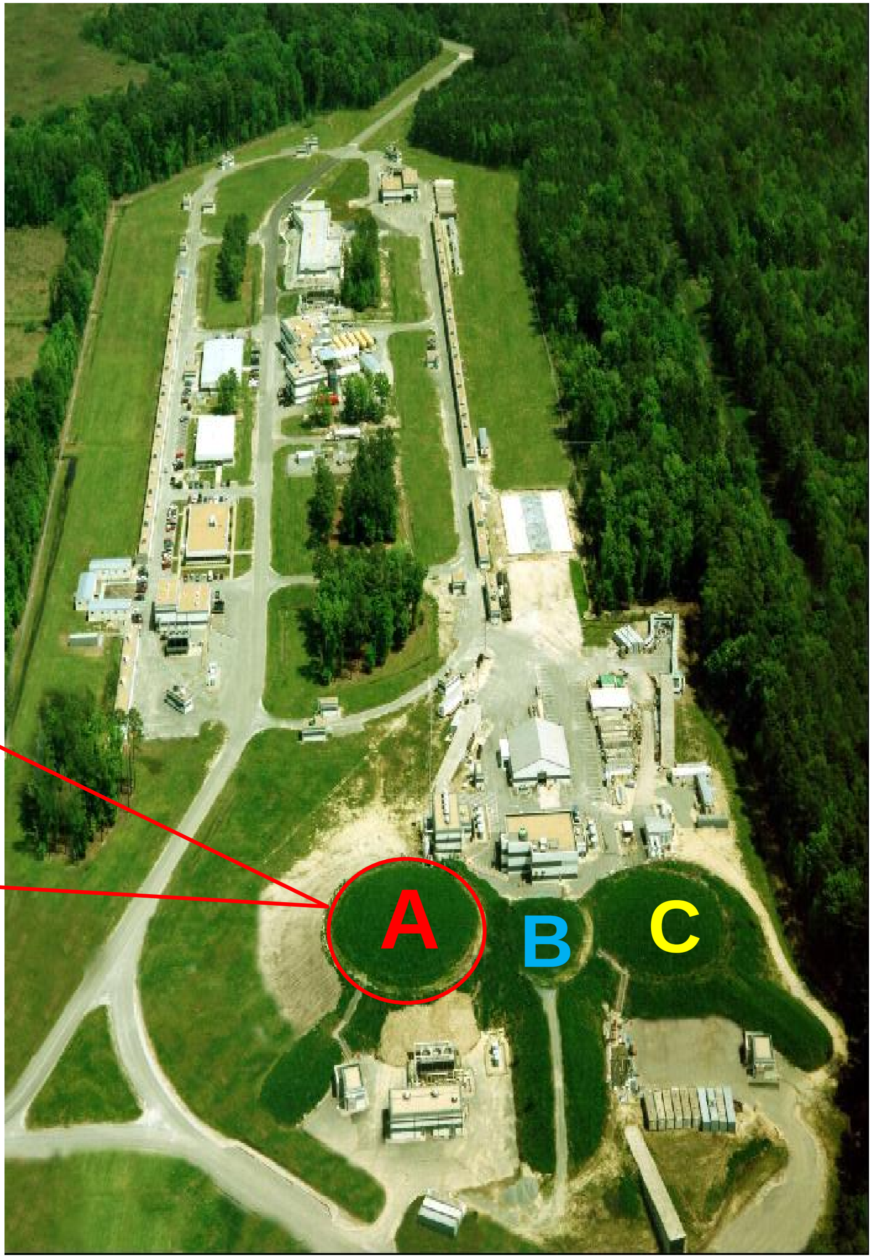
Also:
- Qweak (ongoing)
- PVDIS 12 GeV (planned)
- Moller 12 GeV (planned)

- Due to limited precision, PVDIS 6GeV DOES NOT aim to measure $\sin^2\theta_W$
- Will provide important experience / support for PVDIS 12GeV.

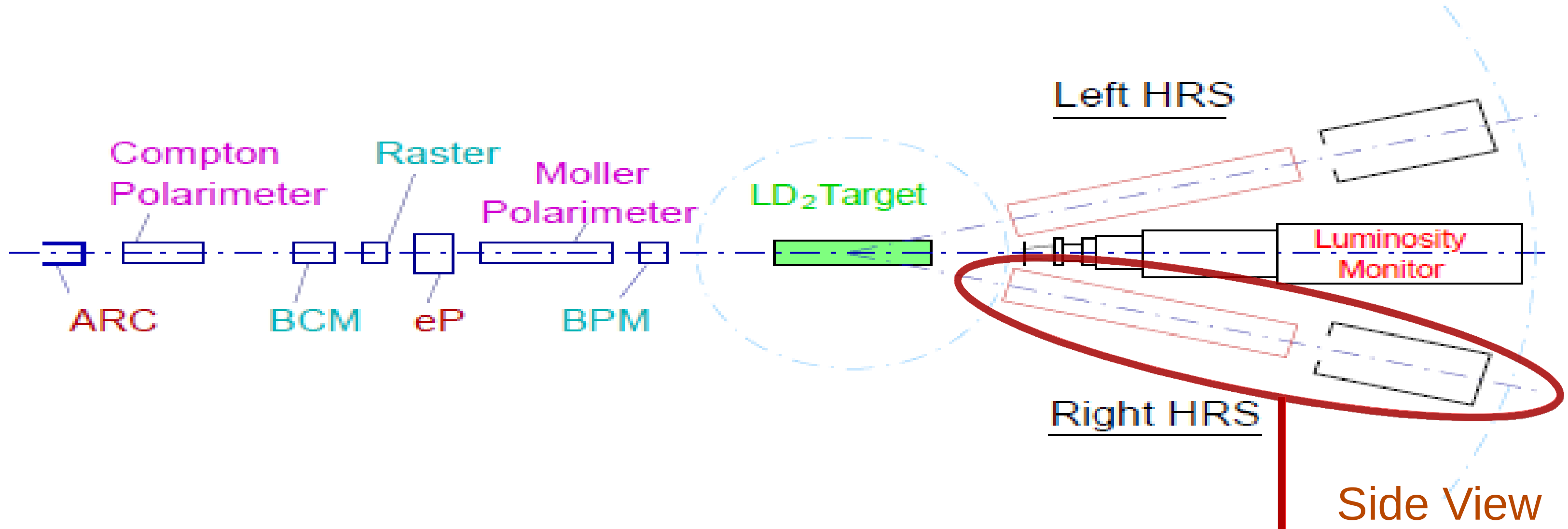
Jefferson Lab Hall A

- JLab: Linear accelerator provides continuous polarized electron beam
  - High Luminorsity
  - *E*beam = 6 GeV
  - *P*beam = 90%
- 3 experimental halls (Hall A, B, C)

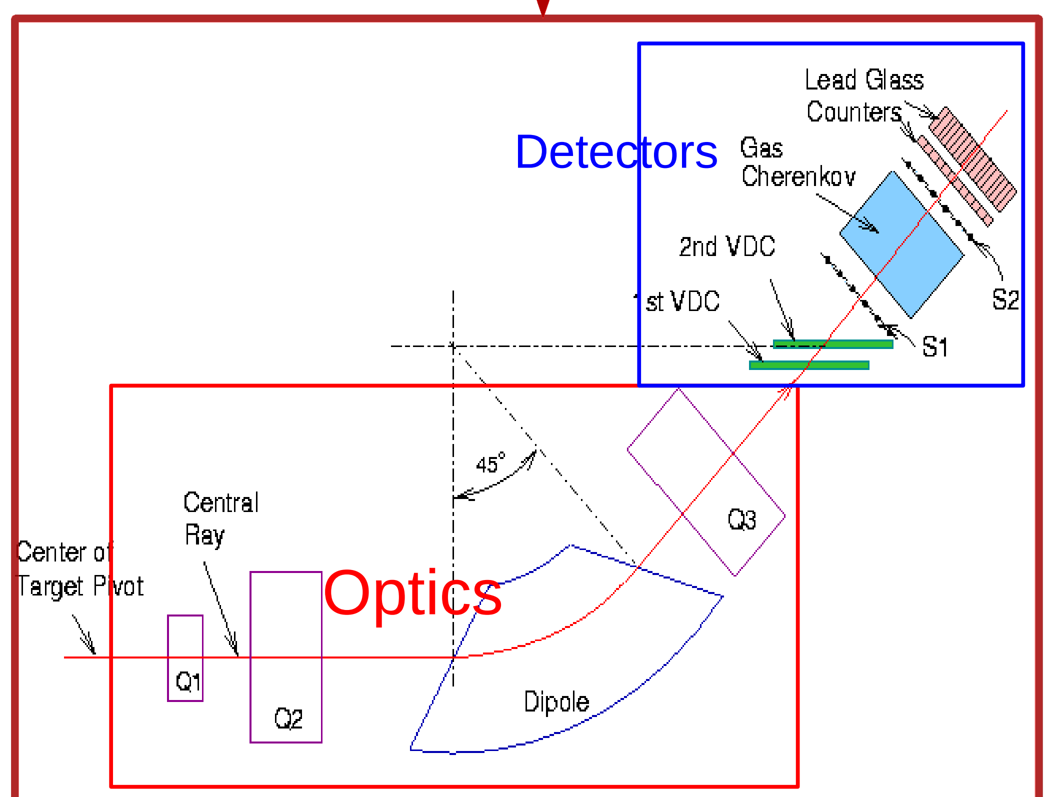




Hall A Experimental Setup

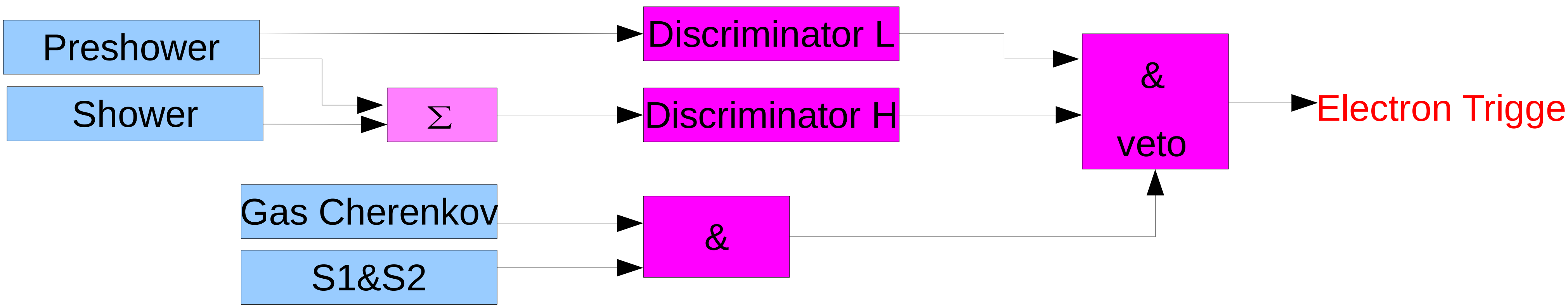


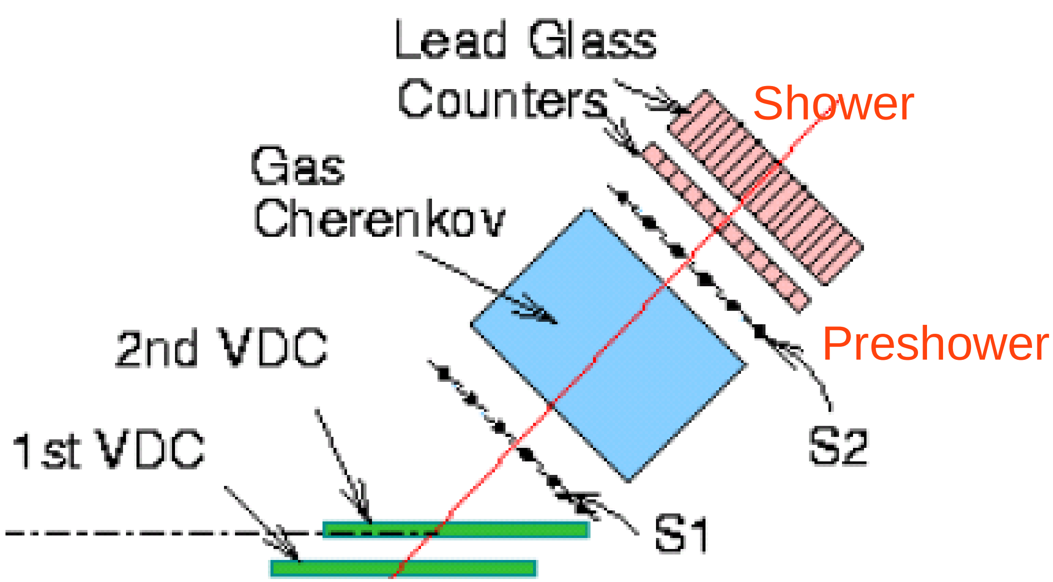
- High Resolution Spectrometer (HRS)
- Beam Energy 6.067 GeV
- 20 cm long liquid deuterium (LD_2) target
- 100 uA polarized beam with 90% beam polarization
- Two kinematics
  Q2=1.1(GeV)2 ; 12.90 ; P0 = 3.66 GeV
  Q2=1.9(GeV)2 ; 20.00 ; P0 = 2.63 GeV
- X = 0.25 ~ 0.3

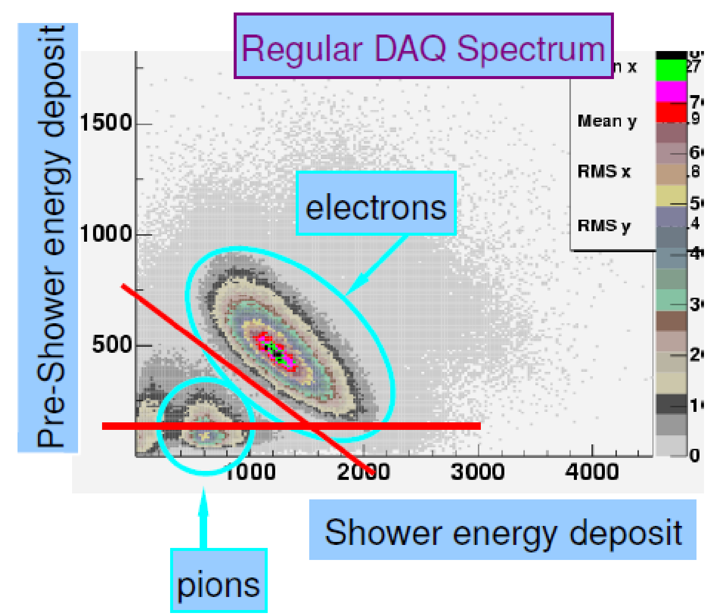


Online (Hardware) Particle Identification
Scaler Based Counting DAQ

- DIS region, pions contaminate, can't use integrating DAQ.
- High event rate (~500KHz), exceeds Hall A regular DAQ's Limit.
- Systematics: Deadtime and PID Efficiency







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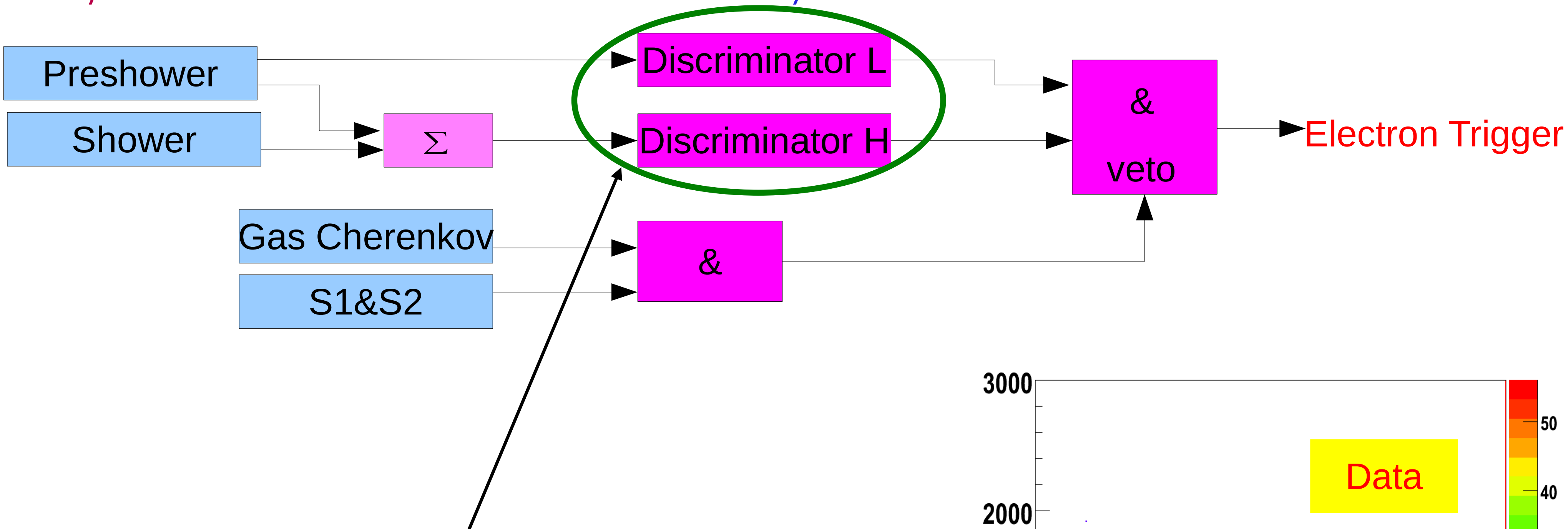
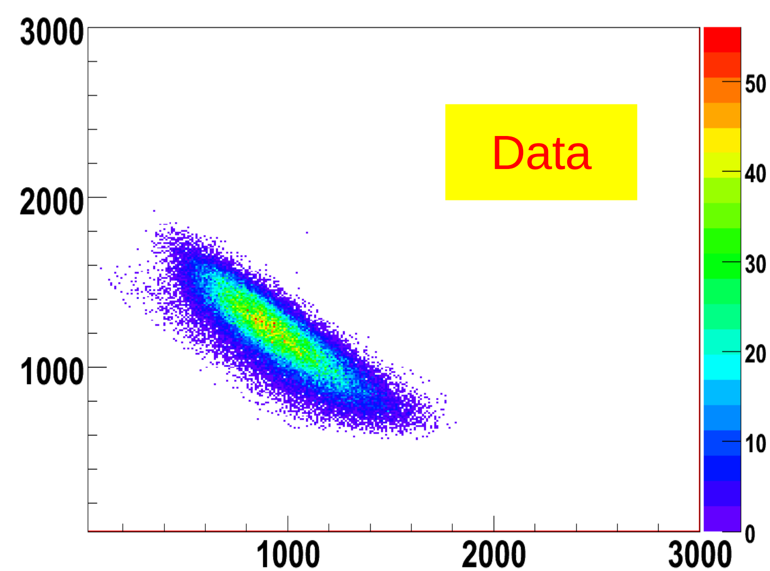
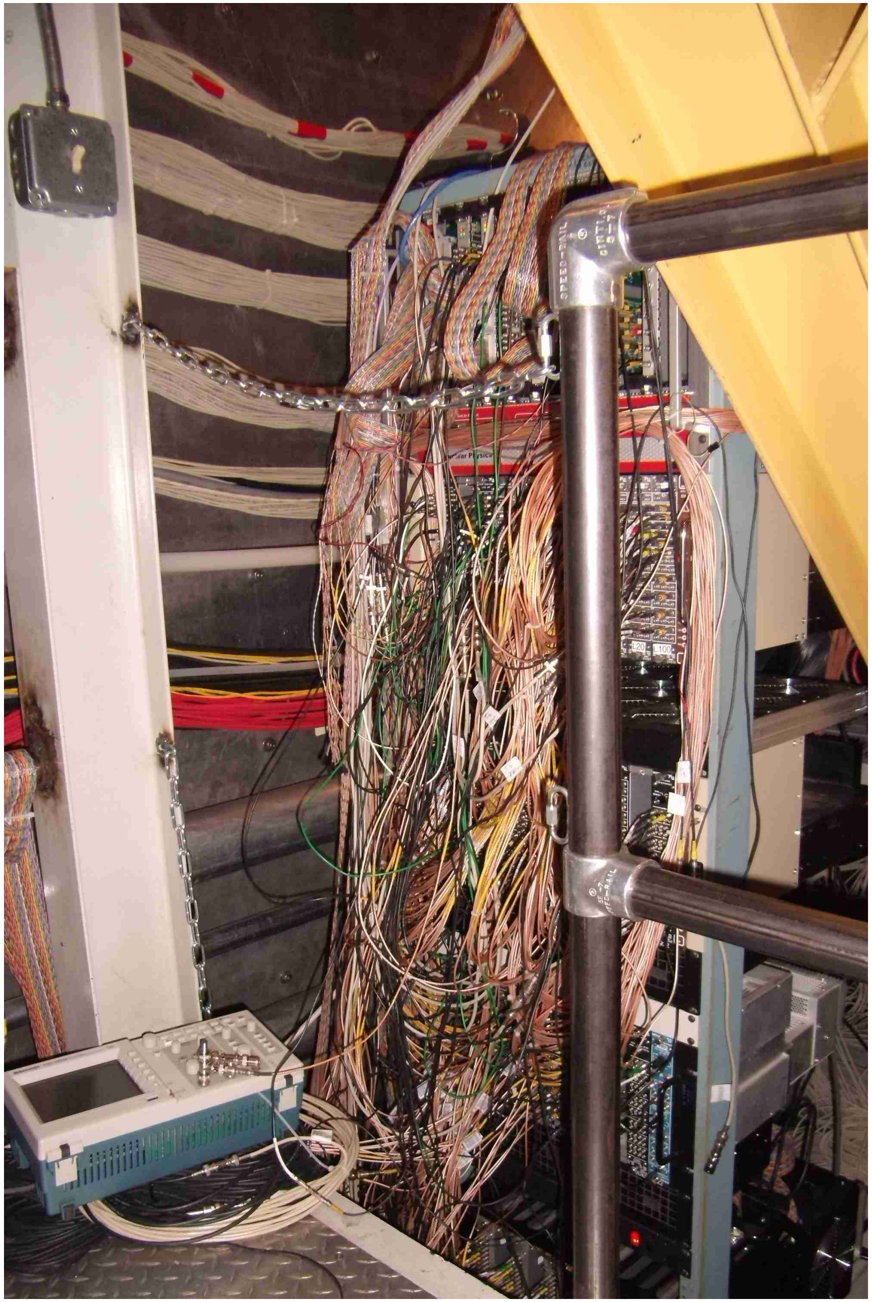
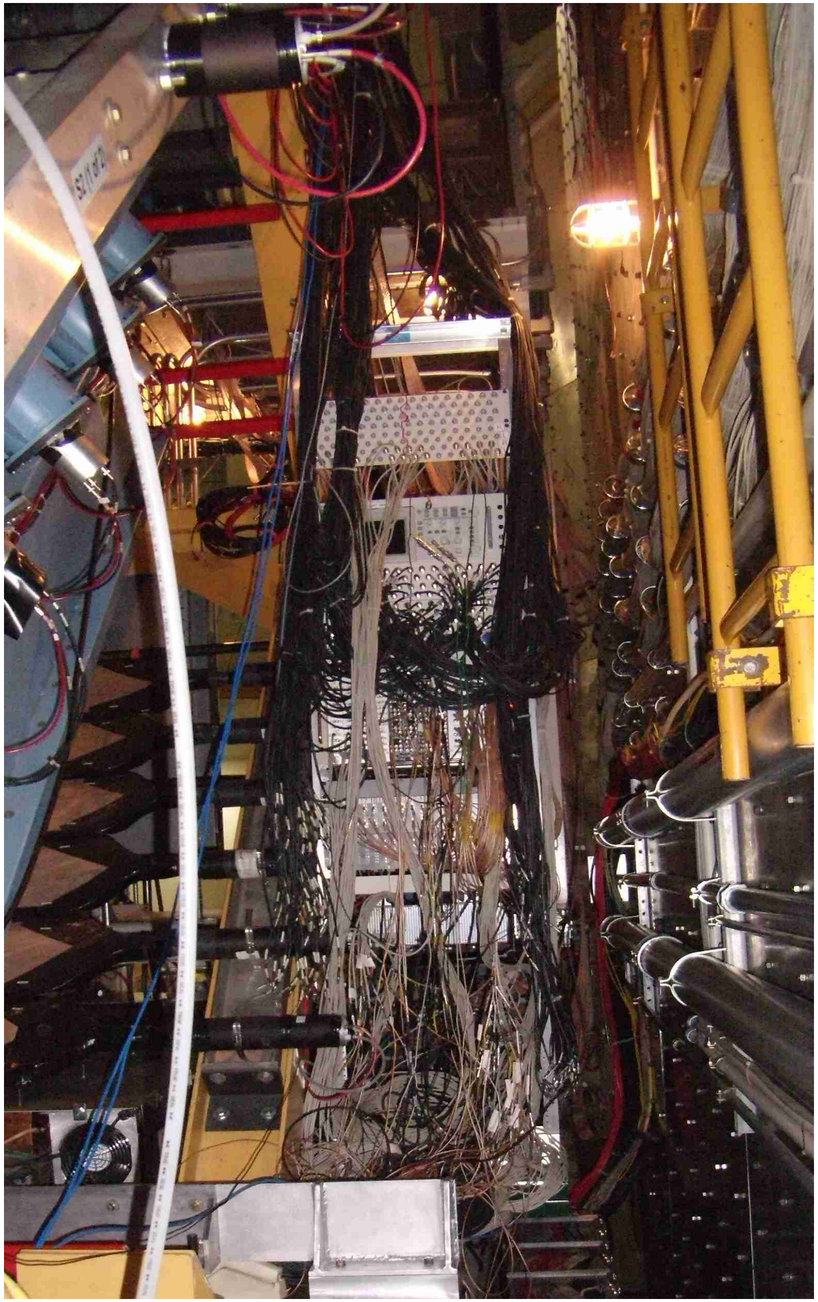


Two identical DAQ paths with known discriminator width (30ns, 100ns), for deadtime study



Online (Hardware) PID Scaler Based Counting DAQ

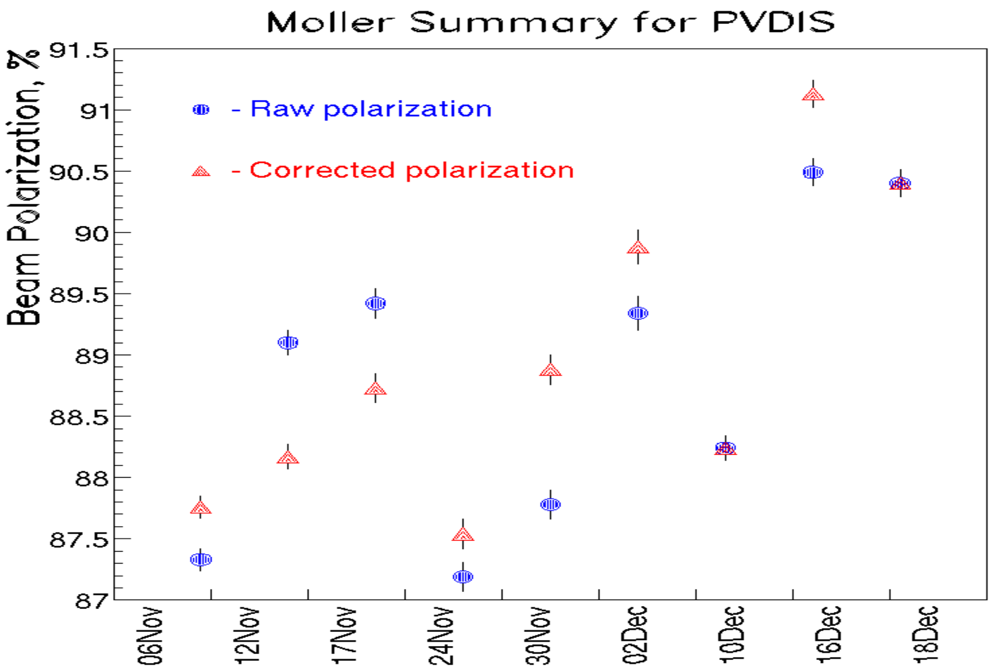




Data Analysis / Systematic Uncertainties:

- Beam Polarization
- Deadtime Correction
- PID Efficiency
- Pair Production Background
- Transverse Asymmetry Background
- Q^2 Measurement / Optics Calibration
- Electro-Magnetic Radiative Correction
- False Asymmetries

Beam Polarization (Compton/Moller)



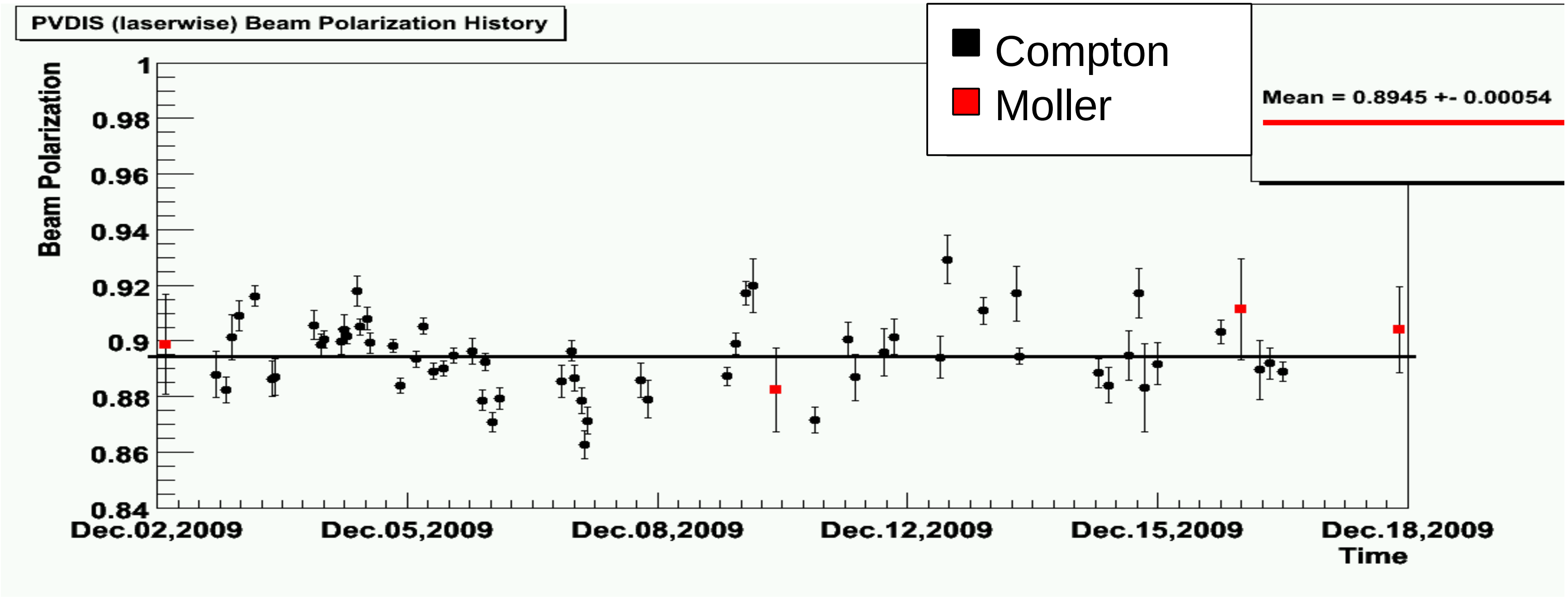
Moller: 88.47% +/- 2.0% (syst, relative) (6.0GeV)

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

Compton: 89.45% +/- 1.92% (syst, relative)

Systematic mainly from A_{th}

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



Deadtime Correction

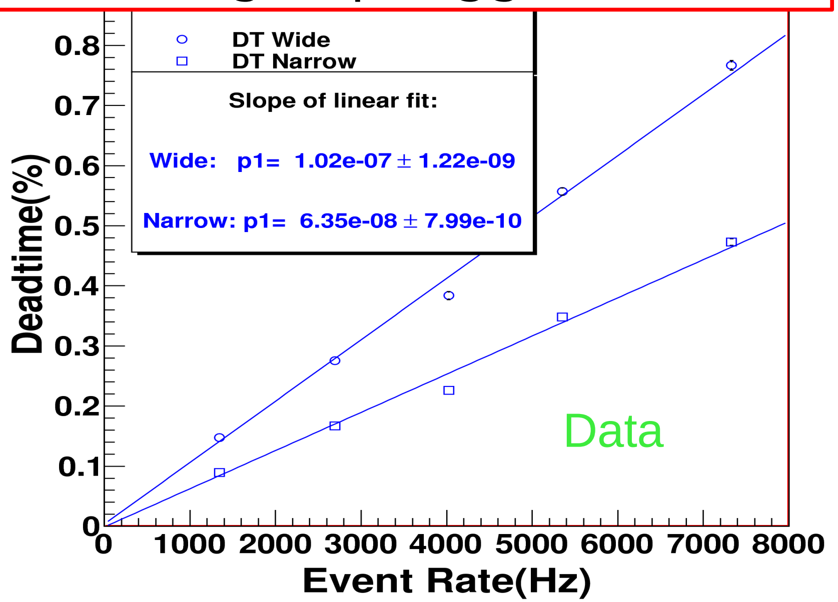
Deadtime correction to asymmetry: $A' = A_{measure} / (1 - Deadtime)$

Methods to study Deadtime:

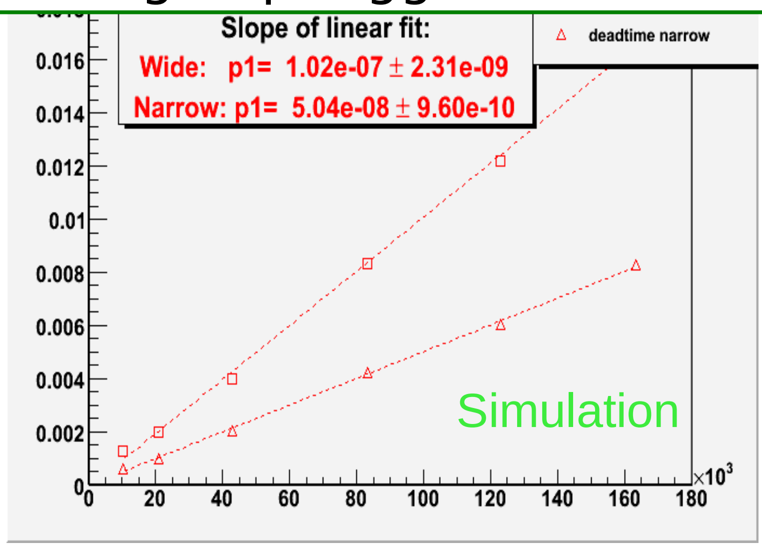
- Theoretically, $Deadtime \propto Event\ Rate$
- FADC data: direct way to study deadtime, but low statistics.
- Tagger method: use a tagger signal to mimic physics signal.
- Software simulation: simulating all the signals and electronics.

The Tagger method:

HRS group tagger data

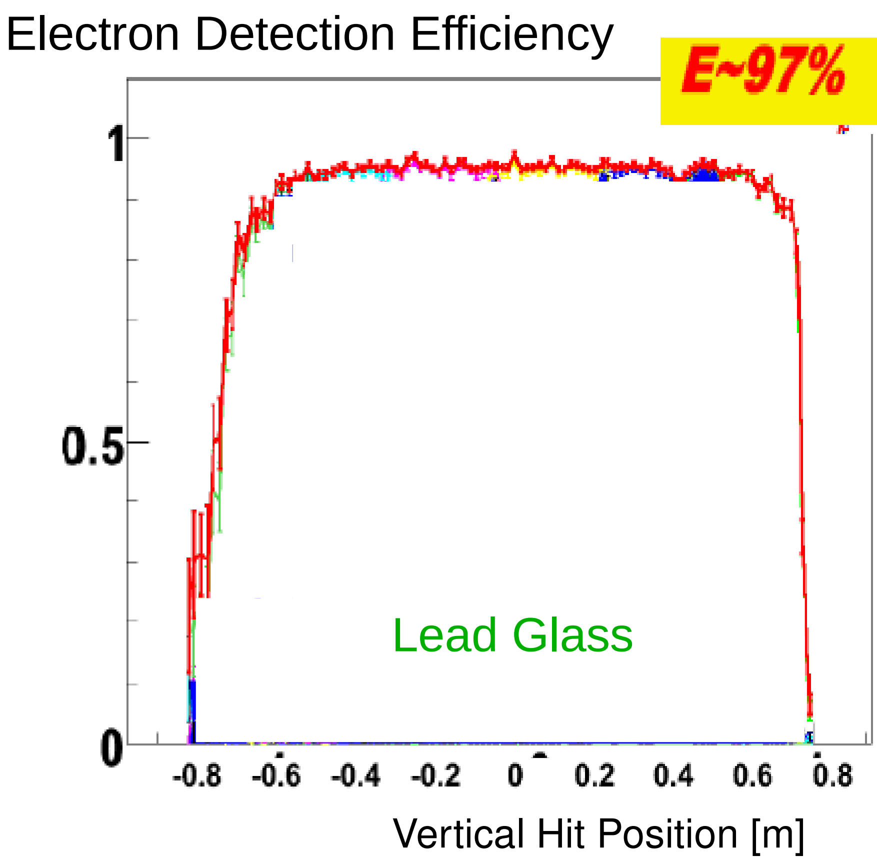


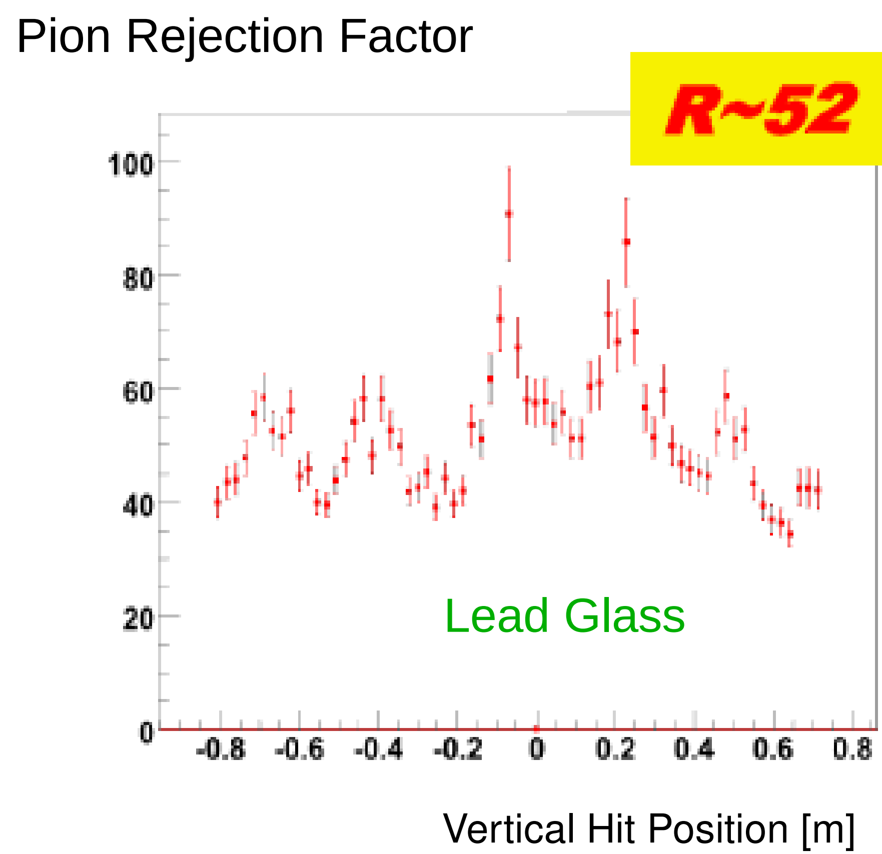
HRS group tagger simulation



Deadtime corrections to asymmetry is: 1.49% +/- 0.44% (Kinematics #1)
0.86% +/- 0.25% (Kinematics #2)

Particle Identification Performance





Affects measured asymmetry (Q^2) if it varies over the acceptance or if there are “holes”

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

Asymmetry correction due to electron efficiency: <0.2%

Correction Due to Pion Contamination

Pion asymmetry is observed to be non-zero:

	Left Kine#1	Left Kine#2	Right Kine#2
Aπ narrow (ppm)	-48.01(7.54)	-14.00(14.89)	-9.51(4.22)
electron fraction	0.56 (0.16)	0.04(0.04)	0.011(0.001)
Aπ corrected (ppm)	-30.85(12.84)	-8.91(16.31)	-8.04(4.27)

Pion correction uncertainty is the combination of:

$$\frac{\Delta A_e}{A_e} = \Delta f \oplus f \frac{\Delta A_\pi}{A_e}$$

	Kine#1	Kine#2
Correction to Ae	1.00019(0.00014)	1.00024(0.00003)

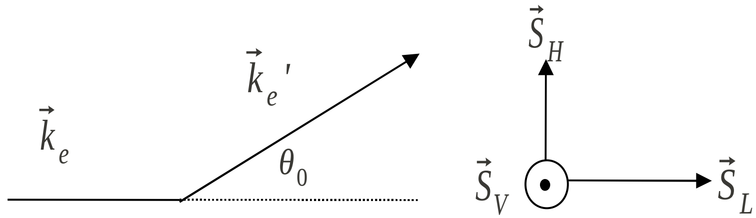
Pair Production Background (Dilution)

Positron asymmetry measured, consistent with zero:

	Left Kine#1	Left Kine#2	Right Kine#2
Ae+ narrow (ppm)	723.2(1154.7)	N/A	1216(1304.5)
π+ fraction	0.58 (0.01)	N/A	0.19(0.01)
Correction to Ae	1.00025	1.0048	1.0048
Uncertainty	10% of correction	10% of correction	10% of correction

Transverse Asymmetry Background

- Transverse Asymmetry:



$$\vec{S}_e \cdot \left[\vec{k}_e \times \vec{k}_e{}' \right]$$

Correction to Ad: $A_T^{pure \quad transverse}$

$$\frac{A_T}{\sin\theta_0} \cdot \left[S_H \cdot \sin\theta_{tr} - S_v \cdot \sin\theta_0 \cdot \cos\theta_{tr} \right]$$

- Measured: -24.15 +/- 15.05 ppm (Kine #1)
  23.49 +/- 44.91 ppm (Kine #2)

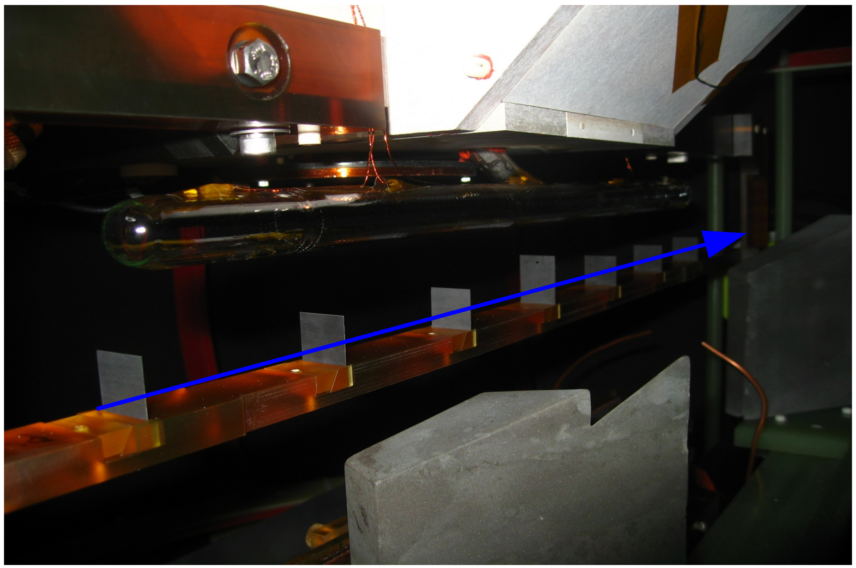
θ_{tr} very small, $S_V < 2\%$, $S_H < 20\%$

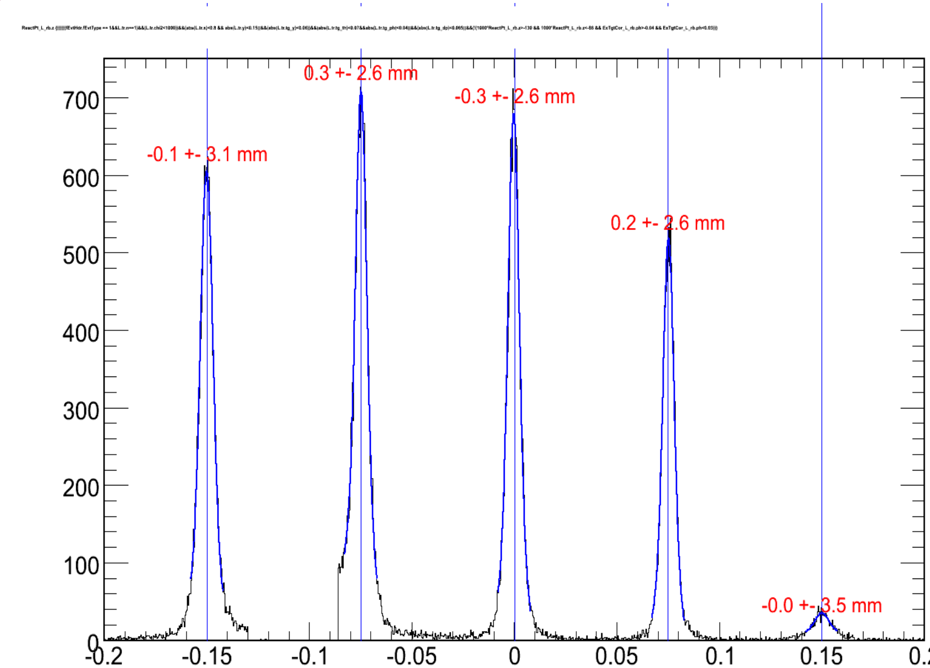
Systematic Error due to Transverse Asymmetry:

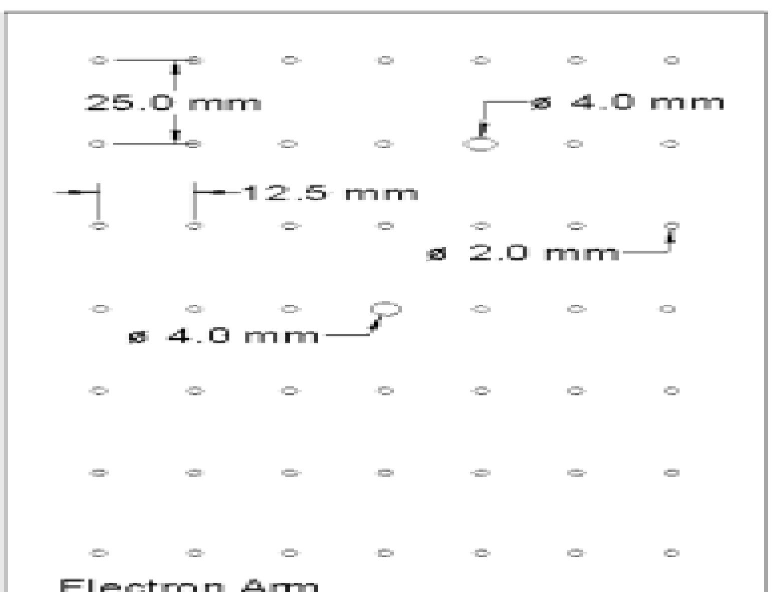
0.55% (Kine #1)
0.56% (Kine #2)

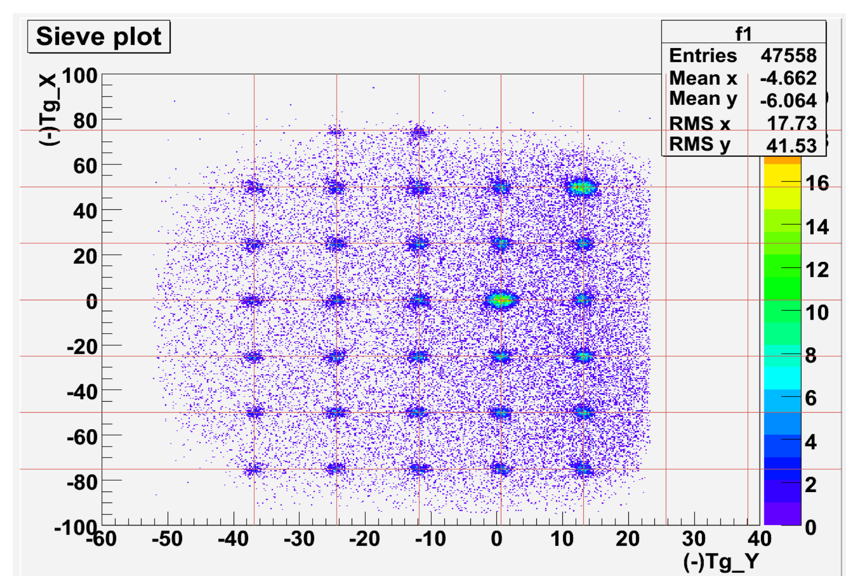
Tracking Reconstruction / Q^2 Measurement

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

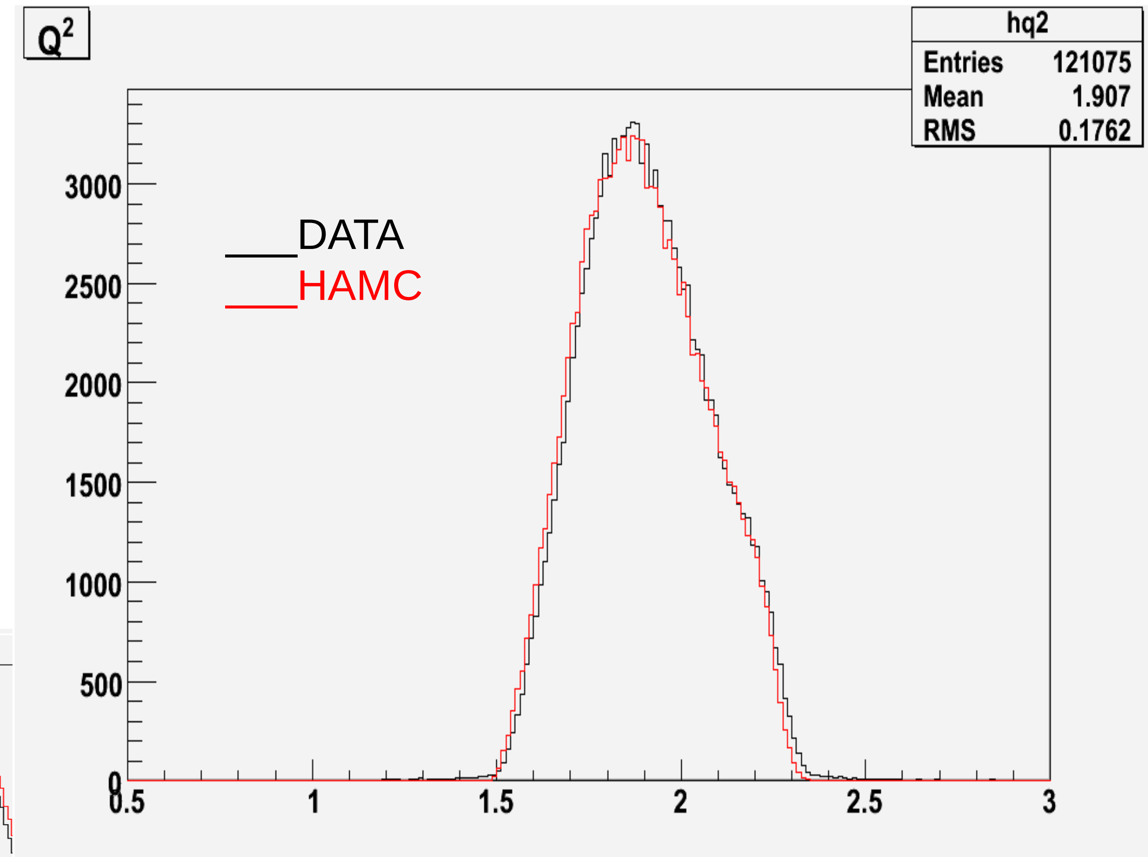




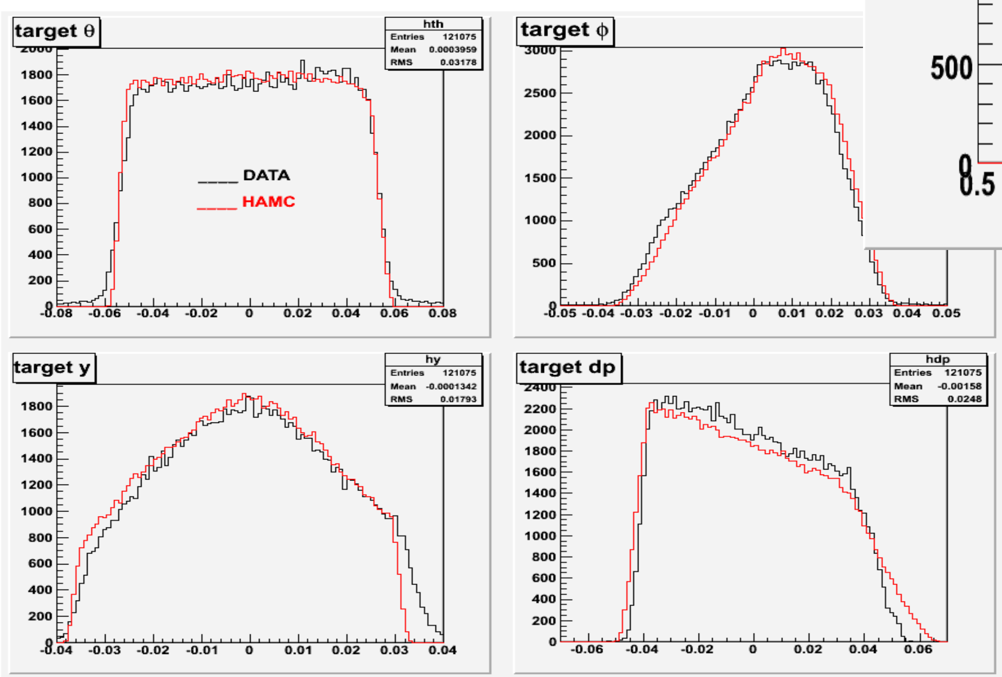




Hall A Monte Carlo



Basic checks of HAMC:

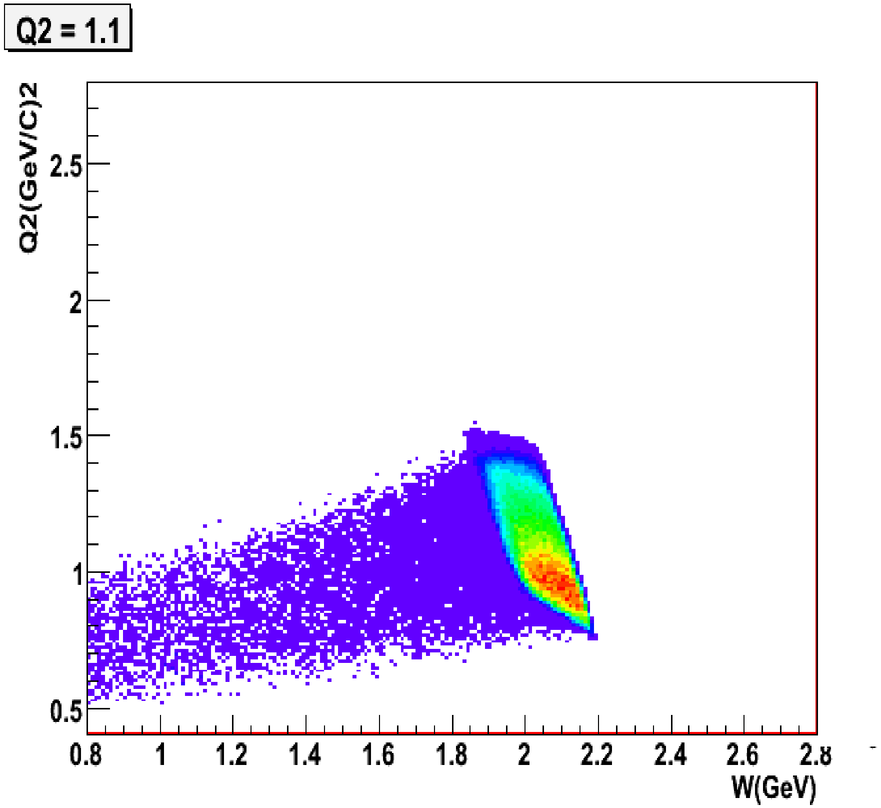


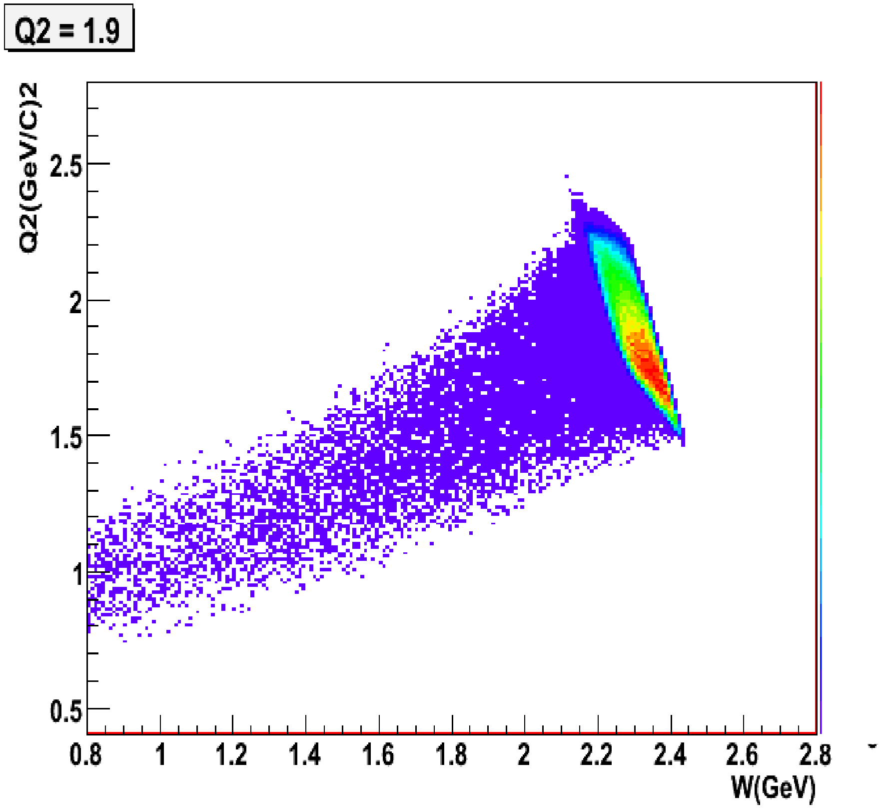
$$Q^2_{data} = 1.907$$

$$Q^2_{hamc} = 1.896$$

EM Radiative Corrections

Monte Carlo Simulation

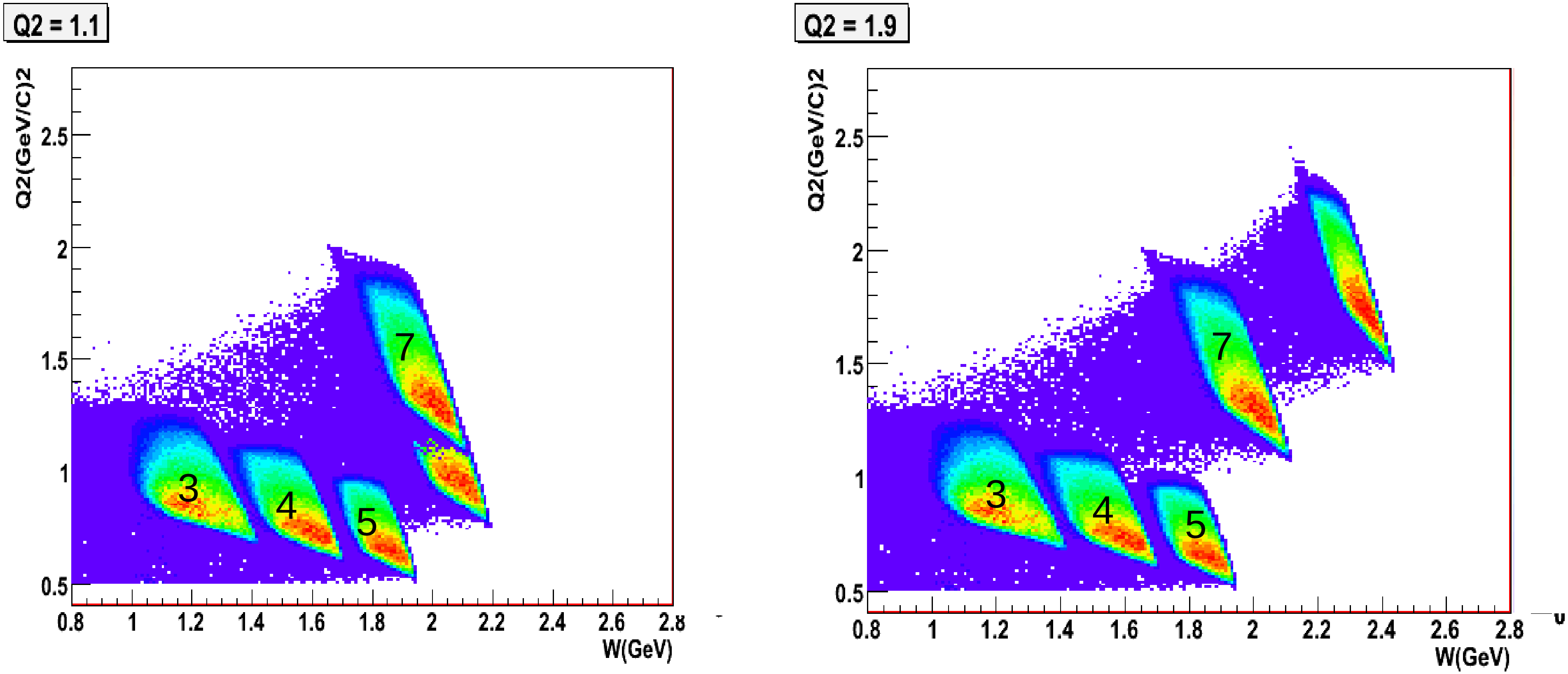




- No previous measurements of Apv in the resonance region
- Two Theory Calculations for Apv in the resonance, and "Toy Model"
- Measured resonance Apv (10-15% stat.) to constrain inputs of resonance PV models

EM Radiative Corrections

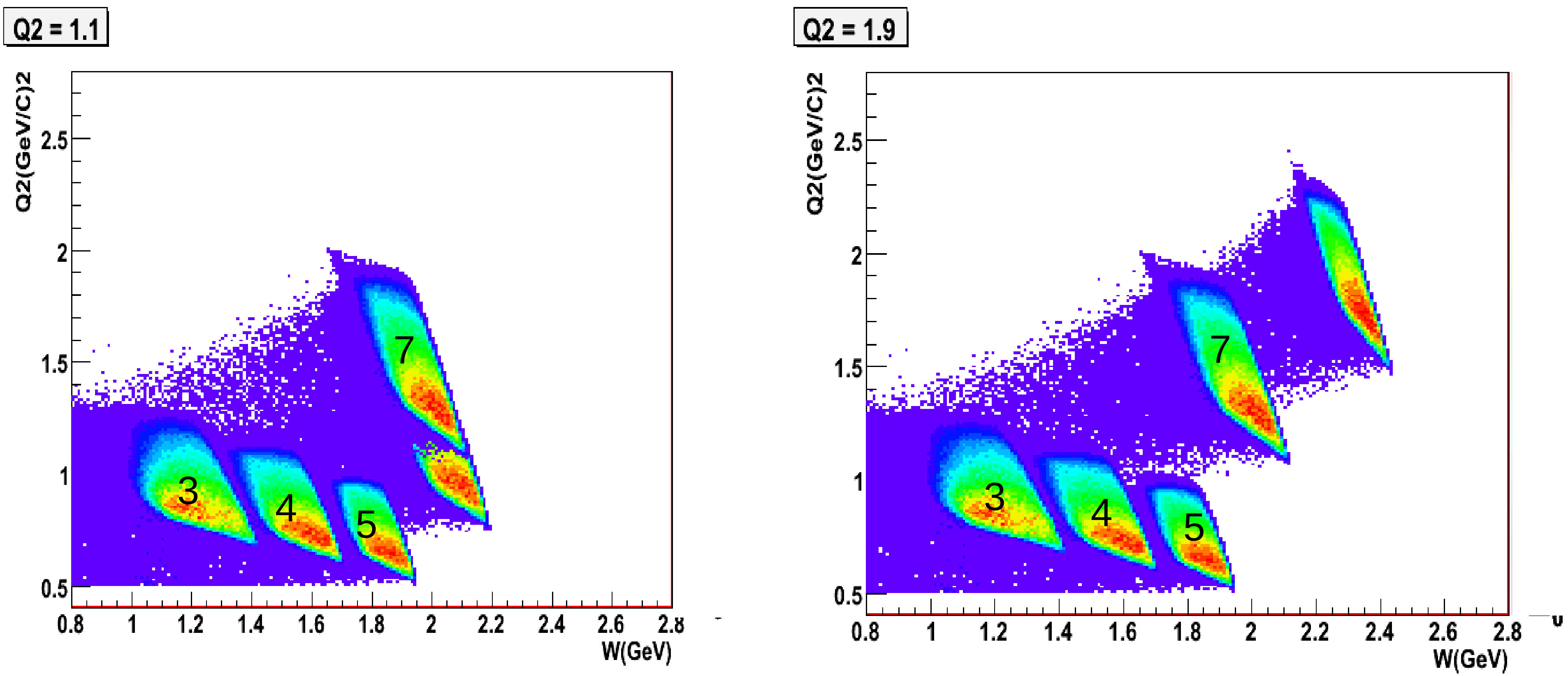
Monte Carlo Simulation



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

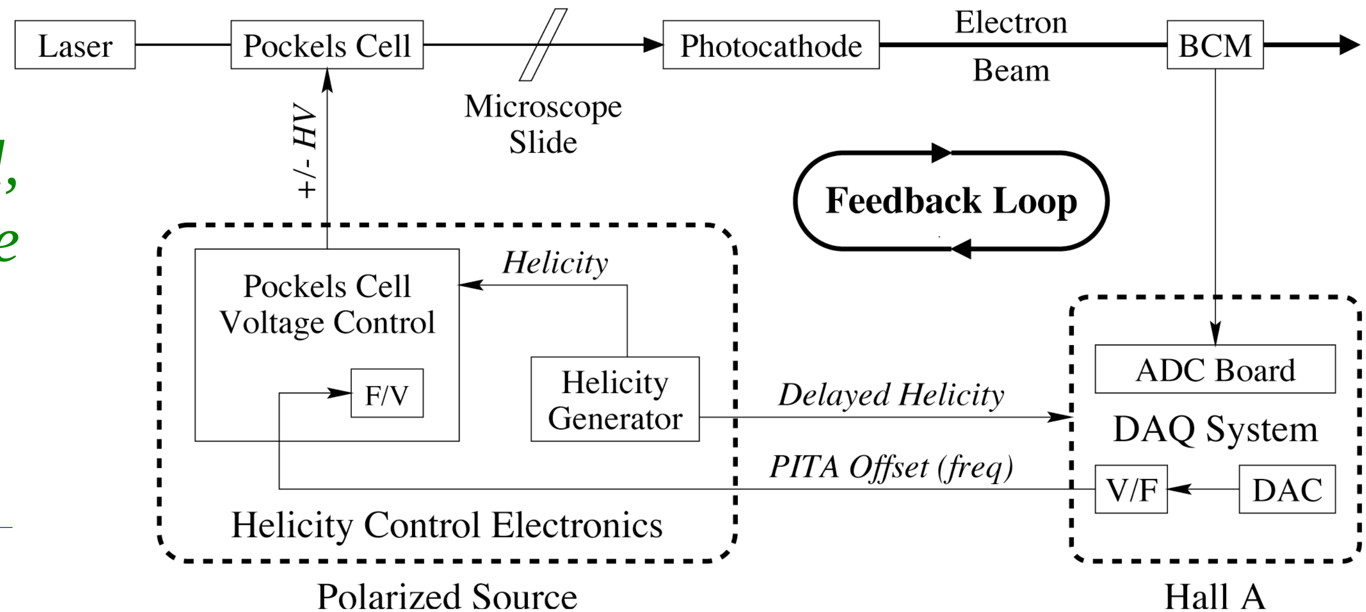
Monte Carlo Simulation

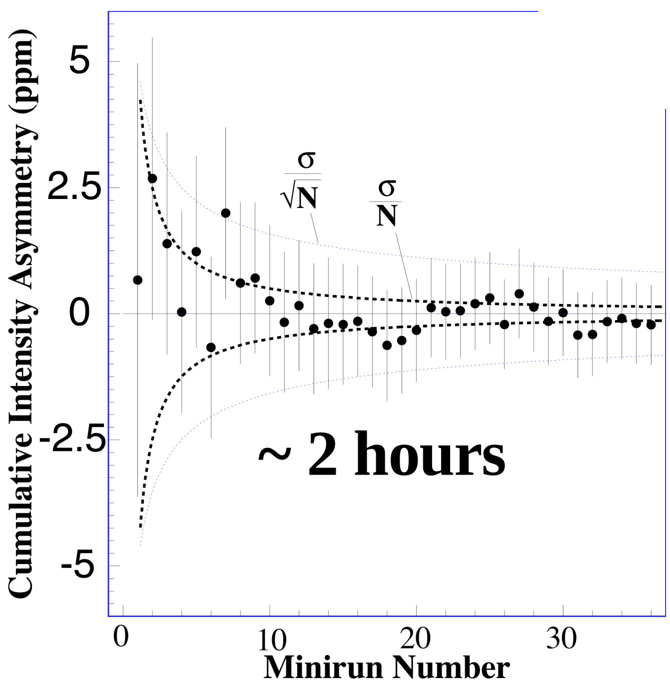


- No previous measurements of Apv in the resonance region
- Two Theory Calculations for Apv in the resonance, and "Toy Model"
- Measured resonance Apv (10-15% stat.) to constrain inputs of resonance PV models
- Radiative Corrections: 2.1%+/-2.0% (Kine #1); 1.9%+/-0.43% (Kine #2)
- Radiative correction related to γ-γ box still not done, should be smaller than 1%

False Asymmetry: Charge Asymmetry / Intensity Feedback

With passive measures optimized, Feedback zeroes the helicity-correlated effects even further





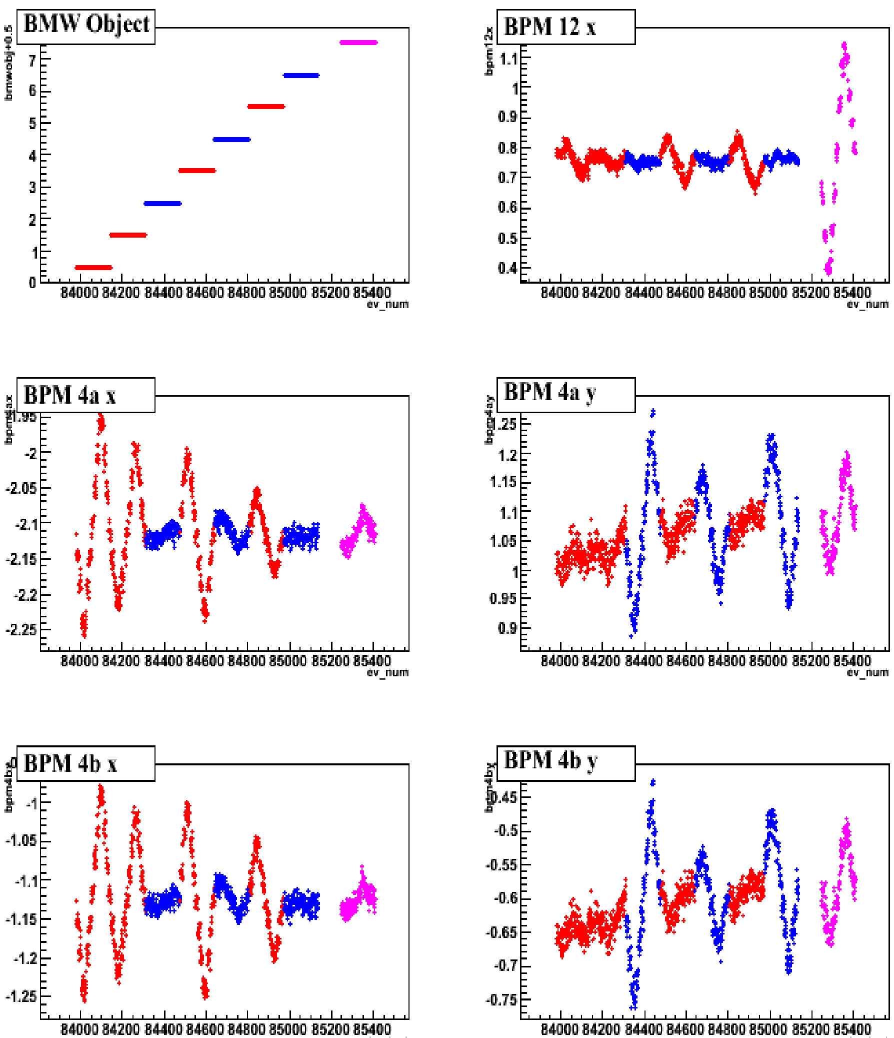
Low jitter and high accuracy allows sub-ppm Cumulative charge asymmetry in ~ 1 hour

False Asymmetry: Beam Modulation

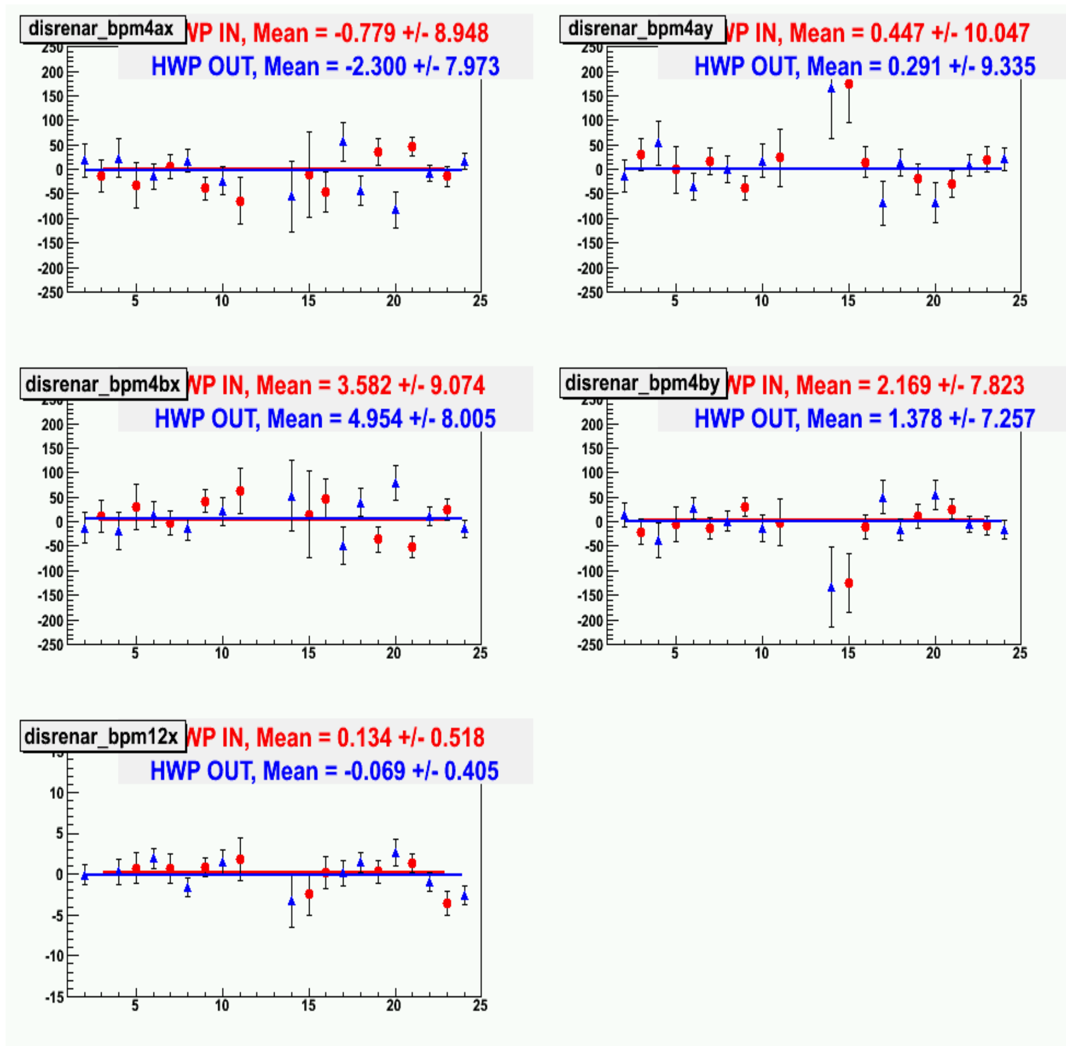
$$A_{mes} = A_{raw} - A_{beam} - \boxed{\sum \beta_i \Delta x_i}$$

Two independent methods:

- Dithering: intentionally vary the beam parameters
- Regression: use the natural motion of the beam



Dithering plots



Dithering slopes (β_i's) history:

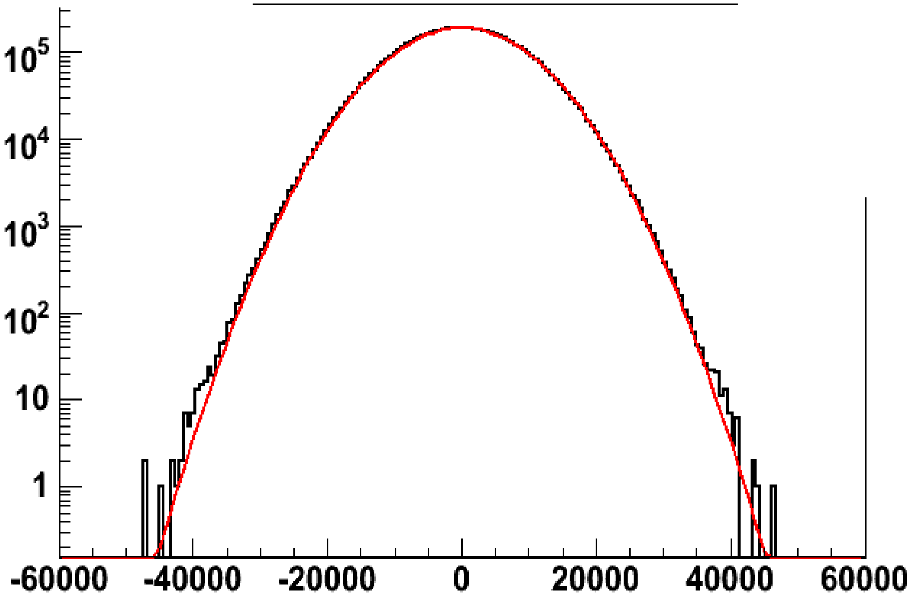
Asymmetry Results

Asymmetry Analysis

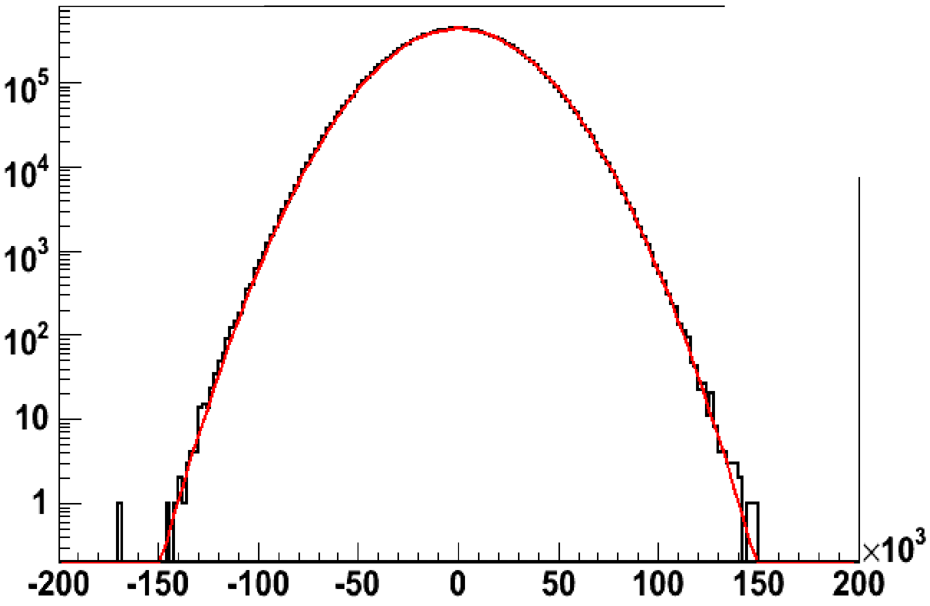
- Blinded Analysis. Unblind after all systematics were finalized.
- Two independent analysis as cross check.

Statistical quality of data (blinded pair-wise asymmetry):

Q^2=1.1



Q^2=1.9



Corrections and Uncertainties, Kine #1

blinding factor = -12.00665ppm

		Correction	Uncertainty
Run-by-Run	Raw (Dithering A_d) (ppm)	-66.43	2.68
	$\Delta P_b/P_b$	13.4%	2.0%
	Deadtime correction	1.49%	0.44%
	PID efficiency	0.048%	0.008%
Global	Radiative Correction	2.1%	2.0%
	Q^2	N/A	0.725%
	Transverse Asymmetry	N/A	0.55%
	Target Endcap	0.017%	0.003%
	False Asymmetry	N/A	0.16%
	Pair Production	0.025%	0.005%
	Pion Dilution	0.019%	0.014%
	Statistical (ppm)	3.15	
	Systematics	3.01%	

Corrections and Uncertainties, Left Kine #2

blinding factor = -12.00665ppm

		Correction	Uncertainty
Run-by-Run	Raw (Dithering) A_d (ppm)	-128.48	10.43
	$\Delta P_b/P_b$	12.0%	1.33%
	Deadtime correction	0.84%	0.25%
	PID efficiency	0.091%	0.013%
Global	Radiative Correction	1.9%	0.43%
	Q^2	N/A	0.575%
	Transverse Asymmetry	N/A	0.56%
	Target Endcap	0.023%	0.005%
	False Asymmetry	N/A	0.1%
	Pair Production	0.52%	0.052%
	Pion Dilution	0.025%	0.004%
	Statistical (ppm)	12.08	
	Systematics	1.64%	

Corrections and Uncertainties, Right Kine #2

blinding factor = -12.00665ppm

		Correction	Uncertainty
	Raw (Dithering) A_d (ppm)	-128.56	6.58
Run-by-Run	$\Delta P_b/P_b$	12.7%	1.69%
	Deadtime correction	0.86%	0.25%
	PID efficiency	0.161%	0.018%
Global	Radiative Correction	1.9%	0.43%
	Q^2	N/A	0.640%
	Transverse Asymmetry	N/A	0.56%
	Target Endcap	0.023%	0.005%
	False Asymmetry	N/A	0.03%
	Pair Production	0.48%	0.048%
	Pion Dilution	0.024%	0.002%
	Statistical (ppm)	7.67	
	Systematics	1.96%	

Asymmetry Results as of Today

x_{bj}=0.241, Q^2=1.085 GeV^2:

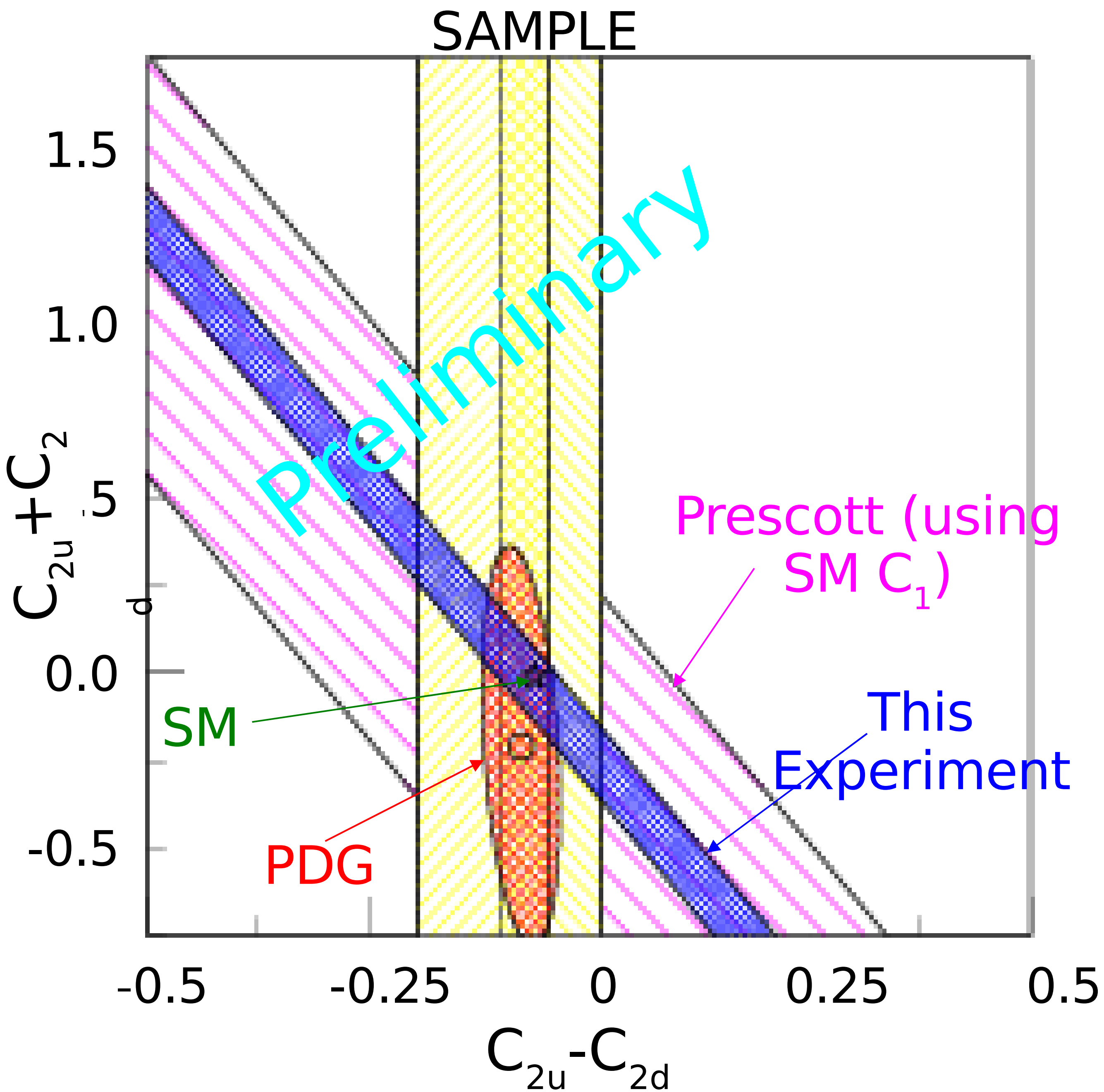
Ad=-92.27 ±3.15 (stat.) ± 2.77 (syst) ppm

Preliminary

x_{bj}=0.295, Q^2=1.901 GeV^2:

Ad=-163.60 ± 6.48 (stat.) ± 3.05 (syst) ppm

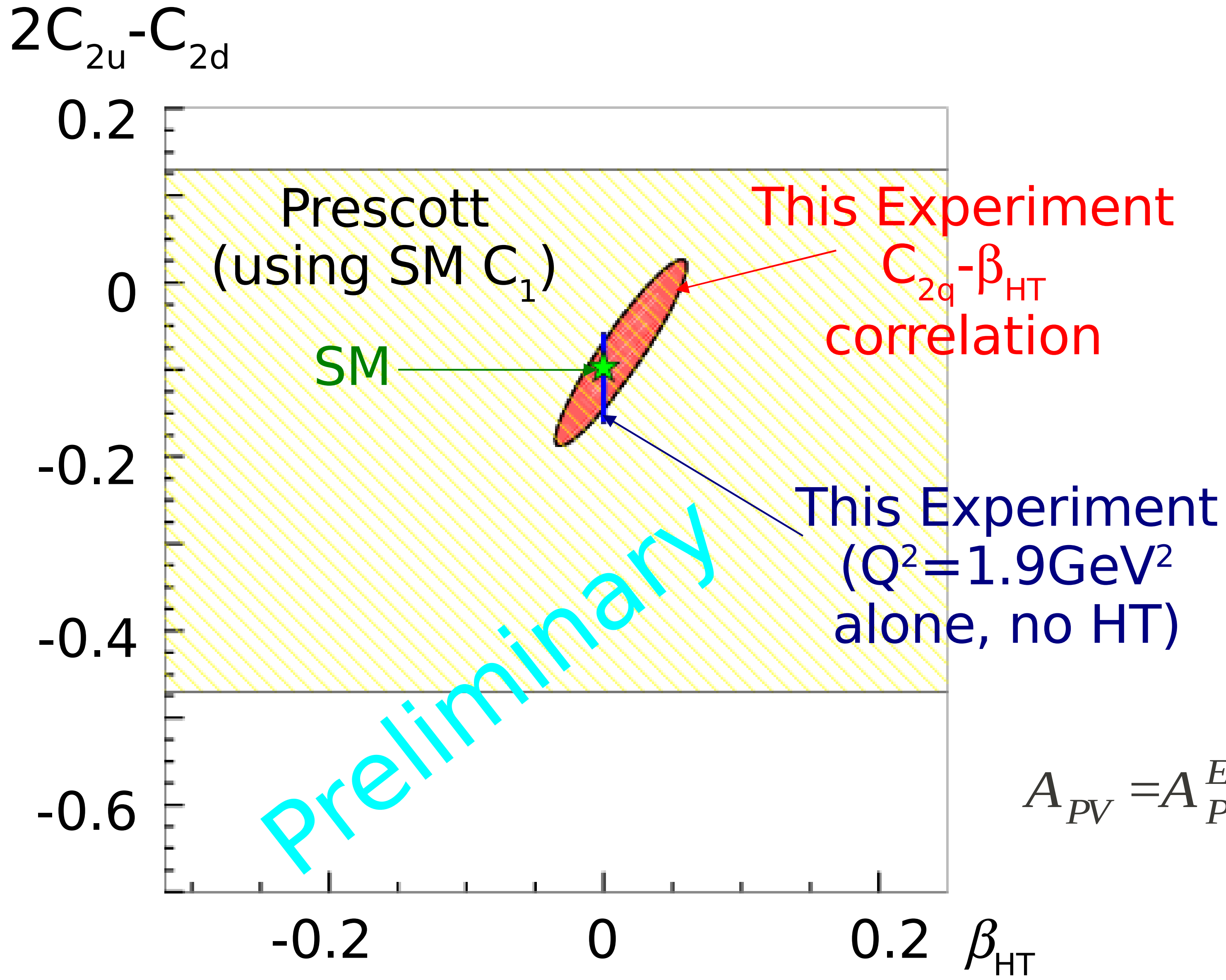
Preliminary C_{2q} from Q^2=1.9 GeV^2 Point



Assuming no HT

Preliminary
$\Delta(2C_{2u}-C_{2d})=0.052$
(experimental error only)

Preliminary C_{2q}- β_{HT} Correlation from Q^2=1.1 and 1.9 GeV^2 Combined



$$A_{PV} = A_{PV}^{EW}\left(1+\frac{\beta_{HT}}{(1-x)^3 Q^2}\right)$$

Summary and To Do

- We have finalized our asymmetry analysis;
- Extraction of C_{2q} is not final, but preliminary results
  - from Q^2=1.9 GeV^2 point assuming no higher twist is consistent with the Standard Model value and factor of five improvement over previous data;
  - simultaneous fit to both Q^2=1.1 and 1.9 GeV^2 points indicate the HT to be small;
- Radiative correction related to γ-γ box still not done;
- Publications in preparation (PRL paper, NIM paper on DAQ, separate publication on resonance Apv results possible, PRC long archival paper).

Backup Slides

"Exact formula"

- PVDIS asymmetry in full generality:

$$A_{PV}=\frac{\sigma_R-\sigma_L}{\sigma_R+\sigma_L}=\left(\frac{G_F Q^2}{2\sqrt{2}\pi\alpha}\right)\left[g_A^e Y_1\frac{F_1^{\gamma Z}}{F_1^{\gamma}}+\frac{g_V^e}{2}Y_3\frac{F_3^{\gamma Z}}{F_1^{\gamma}}\right]=\left(\frac{G_F Q^2}{4\sqrt{2}\pi\alpha}\right)\left[a_1 Y_1+a_3 Y_3\right]$$

A_{PV}, $g_{A,V}$ follow PDG

$$C_{1u}=2g_A^e g_V^u=-\frac{1}{2}+\frac{4}{3}\sin^2(\theta_W)+\delta C_{1u}\approx\ 0.19$$

$$C_{1d}=2g_A^e g_V^d=+\frac{1}{2}-\frac{2}{3}\sin^2(\theta_W)+\delta C_{1d}\approx\ 0.35$$

$$C_{2u}=2g_V^e g_A^u=-\frac{1}{2}+2\sin^2(\theta_W)+\delta C_{2u}\approx-0.030$$

$$C_{2d}=2g_V^e g_A^d=+\frac{1}{2}-2\sin^2(\theta_W)+\delta C_{2d}\approx\ 0.025$$

$$g_A^e=-\frac{1}{2},\quad g_V^e=-\frac{1}{2}+2\sin^2\theta_W$$

$$g_V^u=\frac{1}{2}-\frac{4}{3}\sin^2\theta_W,\quad g_A^u=\frac{1}{2}$$

$$g_V^d=-\frac{1}{2}+\frac{2}{3}\sin^2\theta_W,\quad g_A^d=-\frac{1}{2}$$

Note the factor 2

In the QPM:

$$F_1^{\gamma}=\frac{1}{2}\sum Q_q^2\left[q(x)+\bar{q}(x)\right]$$

$$F_1^{\gamma Z}=\sum Q_q g_V^q\left[q(x)+\bar{q}(x)\right]$$

$$F_3^{\gamma Z}=2\sum Q_q g_A^q\left[q(x)-\bar{q}(x)\right]$$

(if neglecting R)

$$F_2^{\gamma}=2xF_1^{\gamma}$$

$$F_2^{\gamma Z}=2xF_1^{\gamma Z}$$

"Exact formula"

$$Y_1=\left(\frac{1+(1-y)^2-y^2\left[1-\frac{r^2}{(1+R^{\gamma Z})}\right]-xy\frac{M}{E}}{1+(1-y)^2-y^2\left[1-\frac{r^2}{(1+R^{\gamma})}\right]-xy\frac{M}{E}}\right)\left(\frac{1+R^{\gamma Z}}{1+R^{\gamma}}\right)$$

$$Y_3=\left(\frac{1-(1-y)^2}{1+(1-y)^2-y^2\left[1-\frac{r^2}{(1+R^{\gamma})}\right]-xy\frac{M}{E}}\right)\left(\frac{r^2}{1+R^{\gamma}}\right)$$

$$r^2=1+\frac{Q^2}{\nu}=1+\frac{4M^2x^2}{Q^2}$$

Note 0801.4791 has an extra "2" for this term for both Y1 and Y3. That was a typo of this paper.

$$a_1=2g_A^e\frac{F_1^{\gamma Z}}{F_1^{\gamma}}=2\frac{\sum C_{1q}Q_q[q(x)+\bar{q}(x)]}{\sum Q_q^2[q(x)+\bar{q}(x)]}$$

$$a_3=2\frac{g_V^e}{2}\frac{F_3^{\gamma Z}}{F_1^{\gamma}}=2\frac{\sum C_{2q}Q_q[q(x)-\bar{q}(x)]}{\sum Q_q^2[q(x)+\bar{q}(x)]}$$

for deuteron:

$$a_1=\frac{6\left[2C_{1u}(1+R_c)-C_{1d}(1+R_s)\right]}{5+R_s+4R_c}$$

$$a_3=\frac{6\left[(2C_{2u}-C_{2d})R_V\right]}{5+R_s+4R_c}$$

in the limit M/Q<<1

$$r^2 = 1 + \frac{Q^2}{\nu} = 1 + \frac{4M^2x^2}{Q^2} \approx 1$$

if in addition $R^{\gamma Z} = R^{\gamma}$

$$Y_1 = 1$$

$$Y_3 = \left(\frac{1-(1-y)^2}{1+(1-y)^2 - y^2 \left[\frac{1}{(1+R^{\gamma})} \right]} \right) \left(\frac{1}{1+R^{\gamma}} \right)$$

if in addition $R^{\gamma Z} = R^{\gamma} \approx 0$

$$Y_1 = 1 \qquad Y_3 = \left(\frac{1-(1-y)^2}{1+(1-y)^2 - y^2 \left[\frac{1}{(1+R^{\gamma})} \right]} \right)$$

$$A_d = \left(\frac{3 G_F Q^2}{2\sqrt{2}\pi\alpha} \right) \frac{2 C_{1u} \left[1 + R_C(x) \right] - C_{1d} \left[1 + R_S(x) \right] + Y \left(2 C_{2u} - C_{2d} \right) R_V(x)}{5 + R_S(x) + 4 R_C(x)}$$

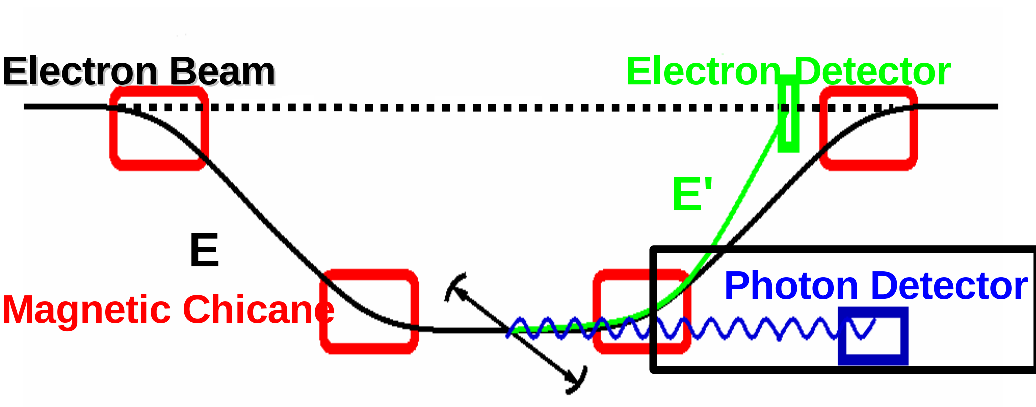
(a_1, a_3 stay the same)

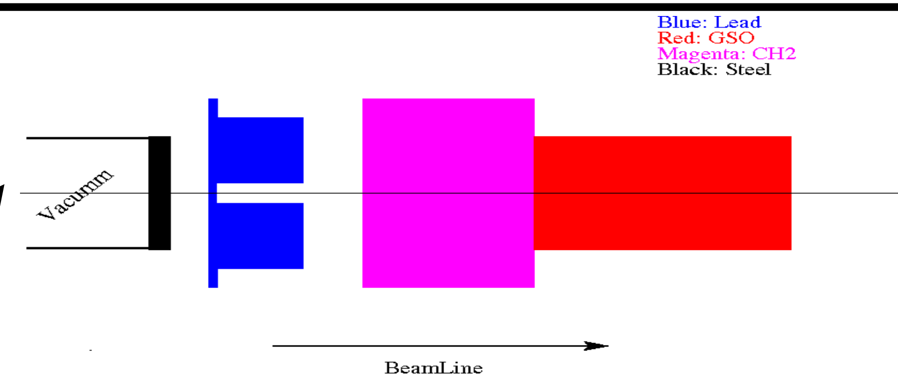
"PR08-011 formula"

Current Extraction Method

- Use MSTW2008 NLO, 3-flavor PDF to construct F_2^{γ} and $F_{1,3}^{\gamma Z}$ in the quark-parton model. Different methods differ by no more than 0.5% in the a_1 term and 2% in the a_3 term.
- Use $C_{1,2}$ from J. Erler: evaluated at measured Q^2, preliminary γ-Z box correction included.
- run α(EM) to measured Q^2 to account for vacuum pol.
- HT correction to a_3 is estimated but not applied.
- Corrections not done: γ-γ box (denominator), interference between Z and γ-γ box (numerator). This correction is about 1% for E158. Using 1% for PVDIS for now.
- Subtract the calculated a_1 term from the measured asymmetry, and compare the rest with the calculate a_3 term.

Compton Analyzing Power



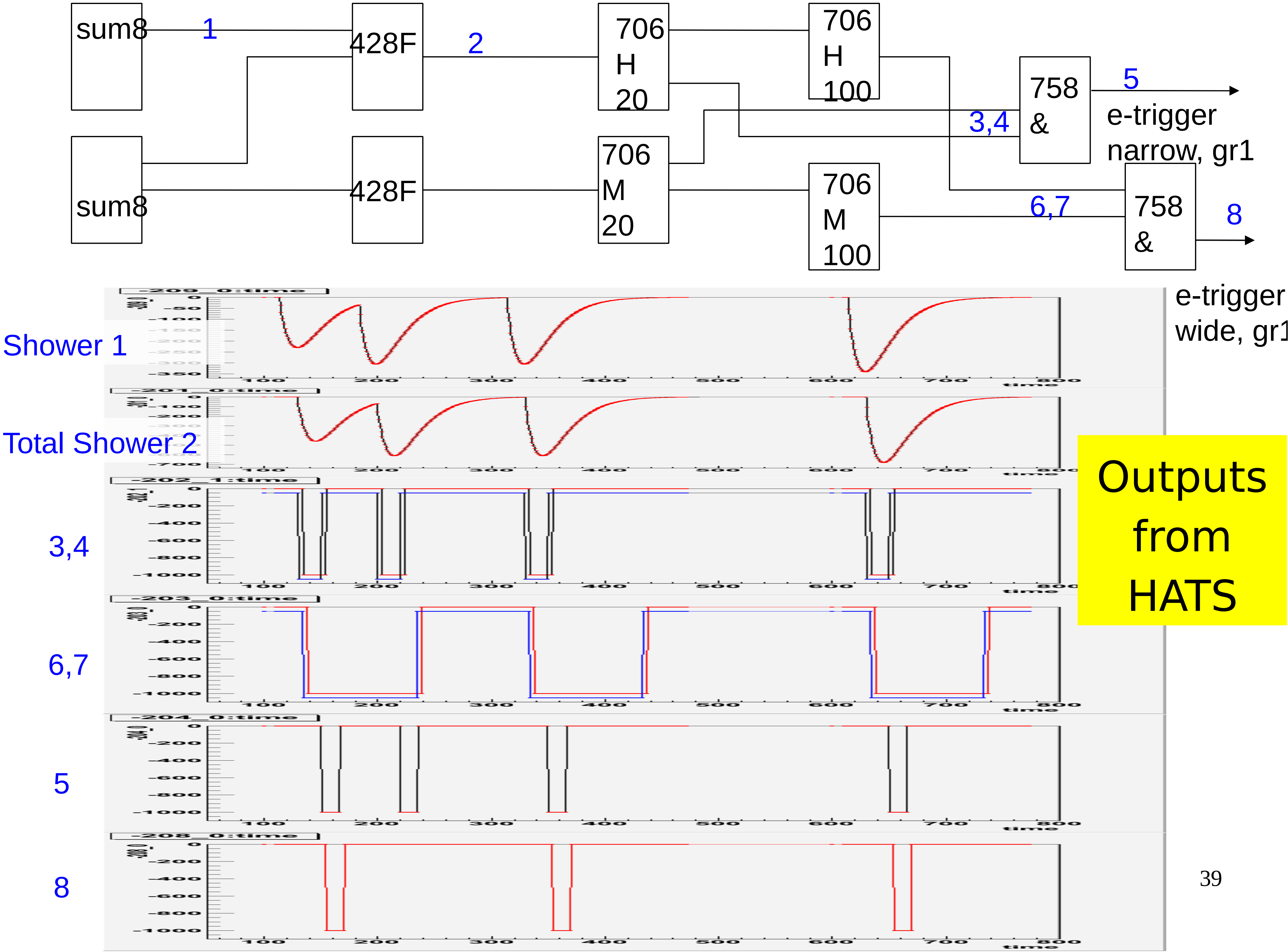


Vacuum End Cap(steel): 0.05cm
Lead shielding thickness: 0.3 cm
Collimator: inner radius 0.5cm
outer radius 4.0 cm, length 5.0 cm
CH2: radius 5.0 cm, length 10.2 cm
GSO: radius 3.0 cm, length 15.0 cm

GEANT4 MC to calculate A_{th}

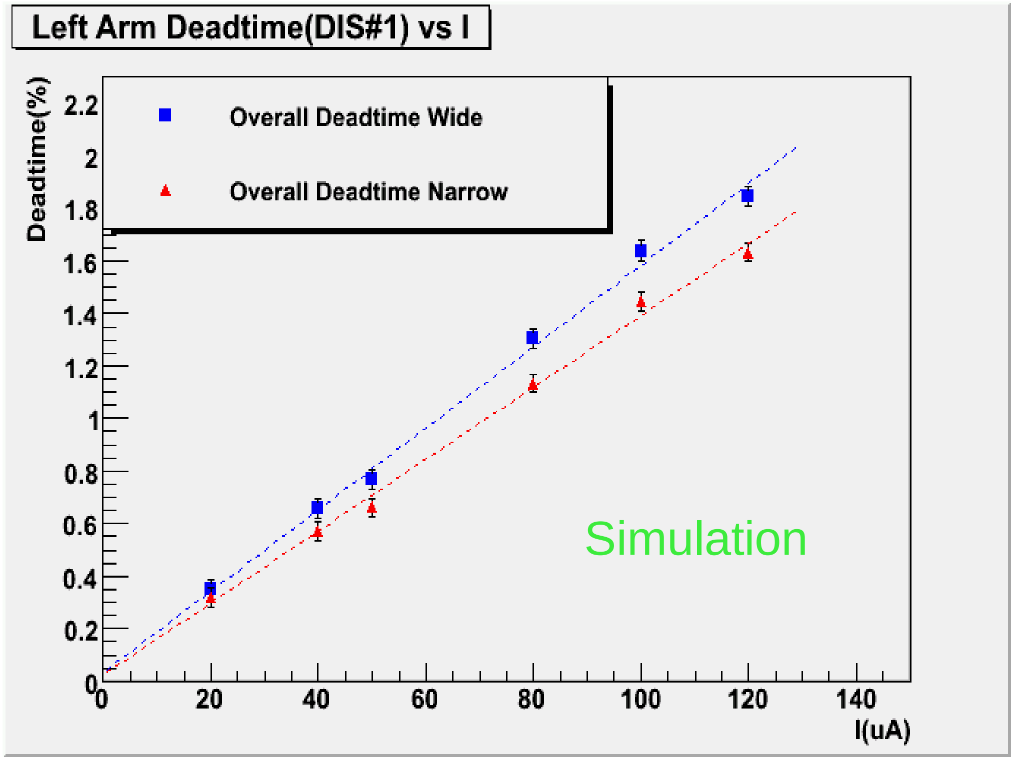
Inputs to the simulation:

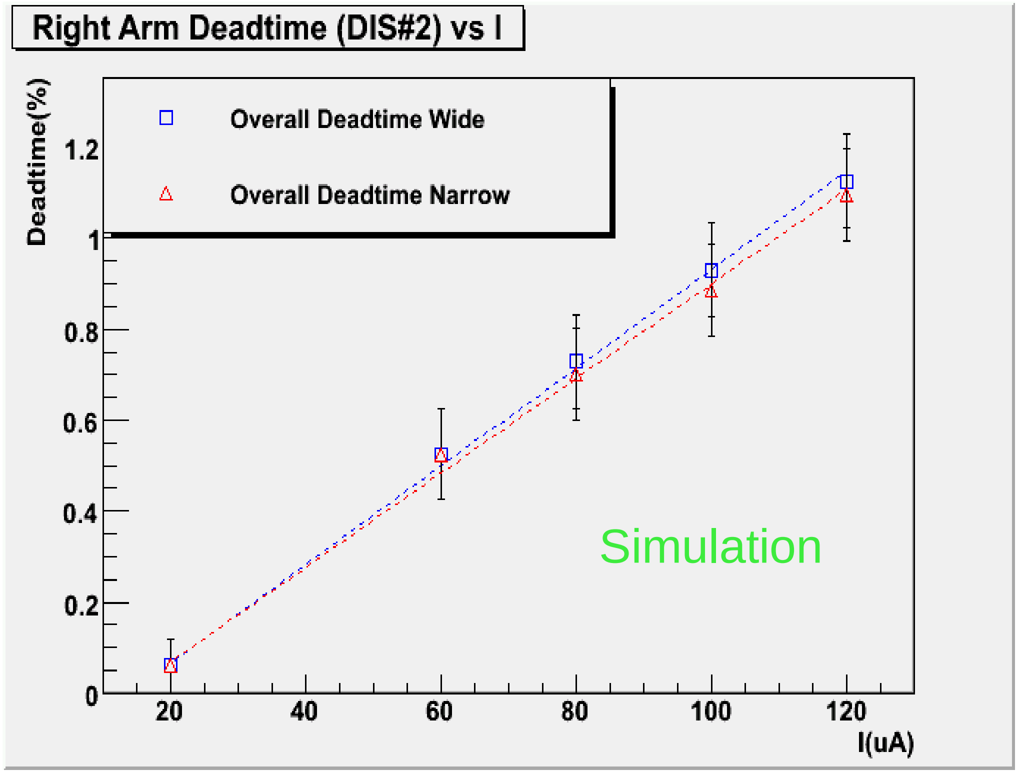
- The experimental setup:
  - →Shielding, alignment.....
  - →Thickness of the lead shielding
  - → Radius of the hole of the collimator
- Detector resolution, smearing
- Pileup Effect
- PMT nonlinearity



sum8
1
428F
2
706
H
20
706
H
100
758
&
5
e-trigger
narrow, gr1
3,4
sum8
428F
706
M
20
706
M
100
6,7
758
&
8
e-trigger
wide, gr1
Shower 1
Total Shower 2
3,4
6,7
5
8
Outputs from HATS

Deadtime Correction Results





@100uA	RES #3	RES #4	RES #5	RES #7	DIS #1	DIS #2
Narrow	1.48%	2.22%	2.06%	0.73%	1.45%	0.89%
Wide	1.68%	2.62%	2.36%	0.80%	1.64%	0.93%

Uncertainty: take 30% relative

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

EM Radiative Corrections

Two theory calculations for Apv in the resonance:

- Lee/Sato: Delta(1232) only
  - Current: D=n+p
  - On-going: with wavefunctions – for separate publication

- M. Gorshteyn (Indiana)
  - whole resonance
  - isospin rotation p -> n

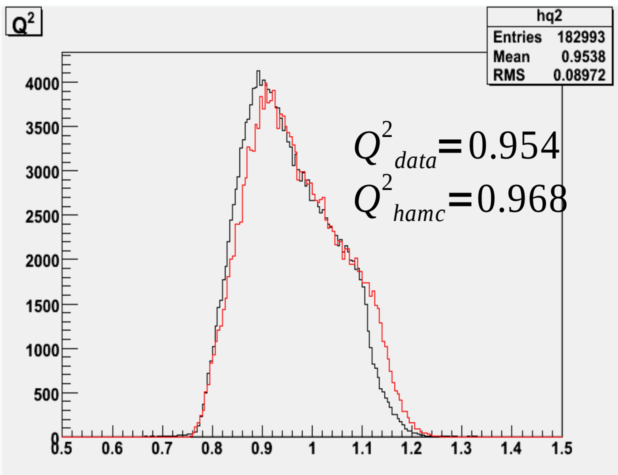
- Toy Model:

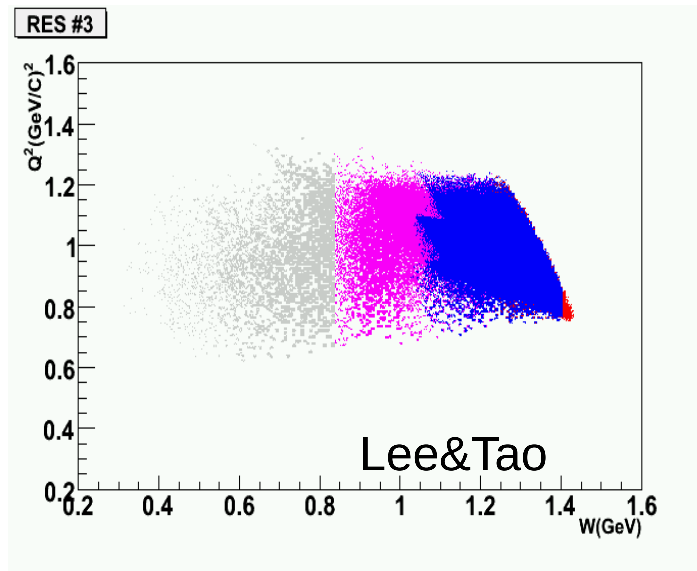
Latest Hall C RES fit

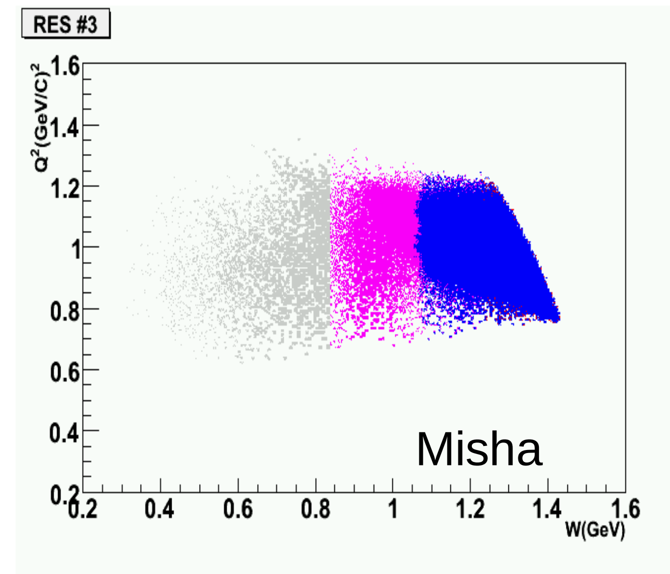
$$A^{RES} = A^{DIS\ \ formula} \frac{\sigma^{RES}}{\sigma^{DIS\ \ formula}}$$

Res #3 / Delta Resonance

(Magnets Mistuned)

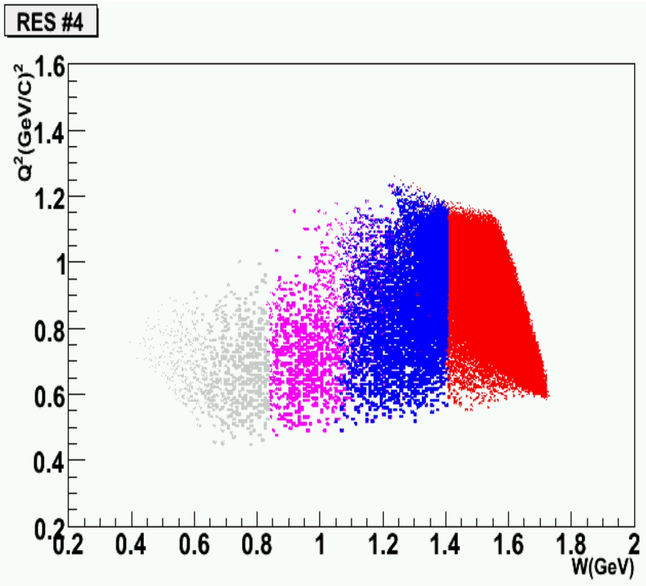


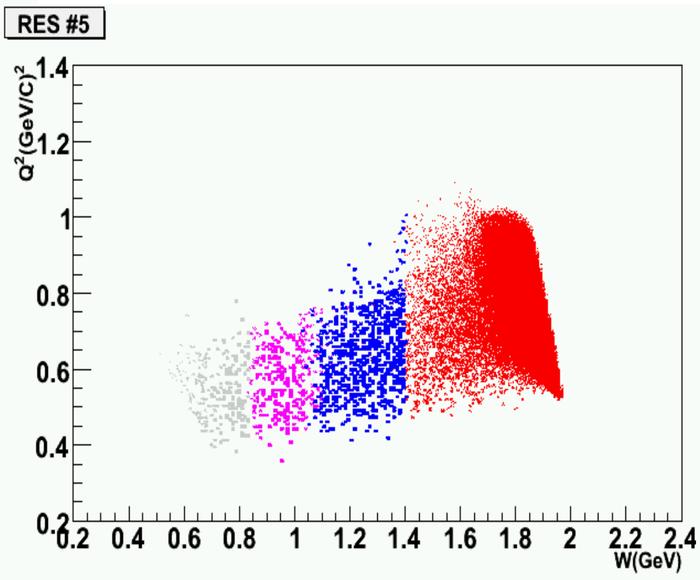


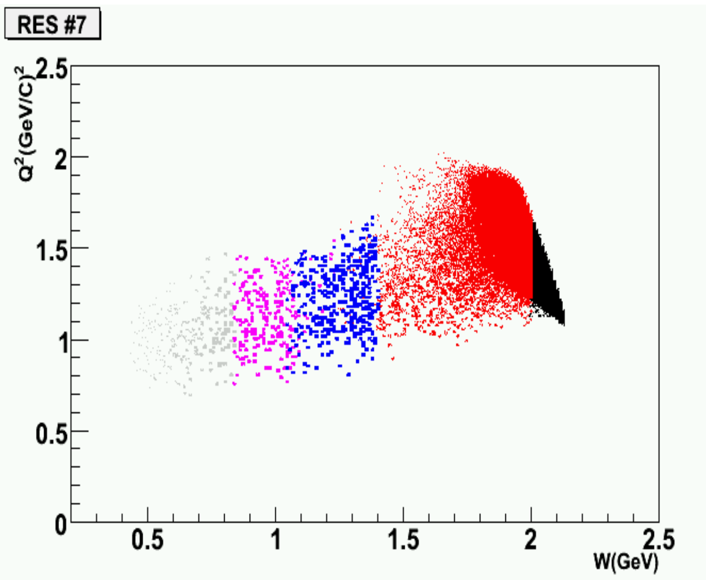


	Elastic	Quasi	Table	Dis	Toy	<Asym>	Data
Lee&Tao	79.2 (0.14%)	-45.5 (11.9%)	-88.5 (86.5%)	0	-49.7 (1.5%)	-82.61(ppm)	-66.258 +/-7.768 (ppm)
Misha	79.2 (0.14%)	-45.5 (11.2%)	-88.1 (88.7%)	0	0	-83.13(ppm)	

Resonance #4,5,7 / Lee&Tao

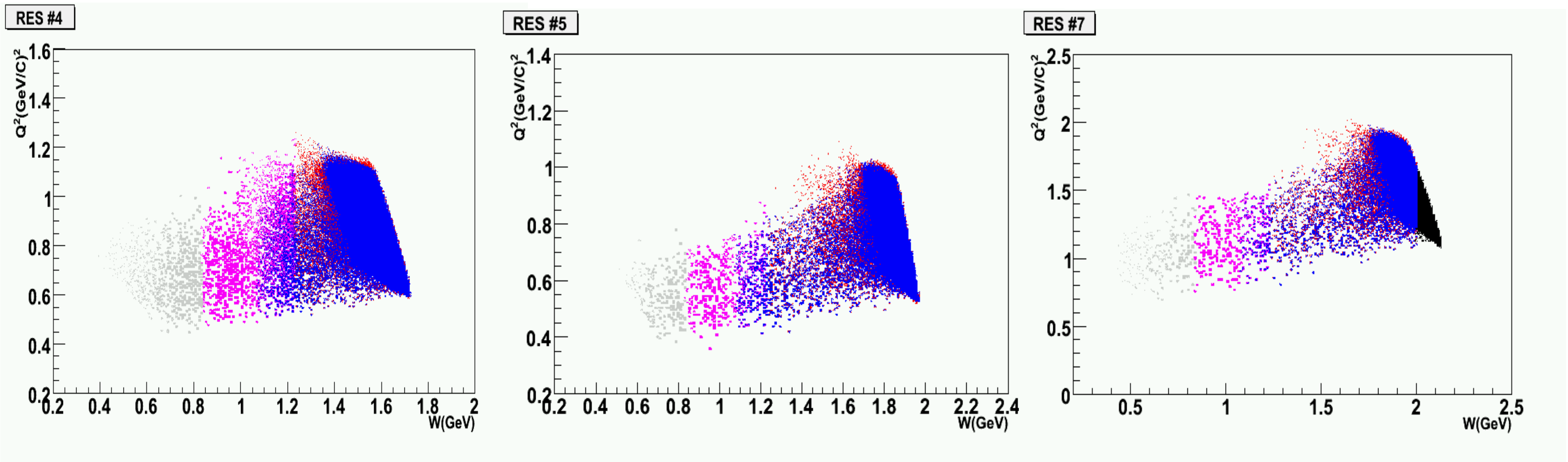






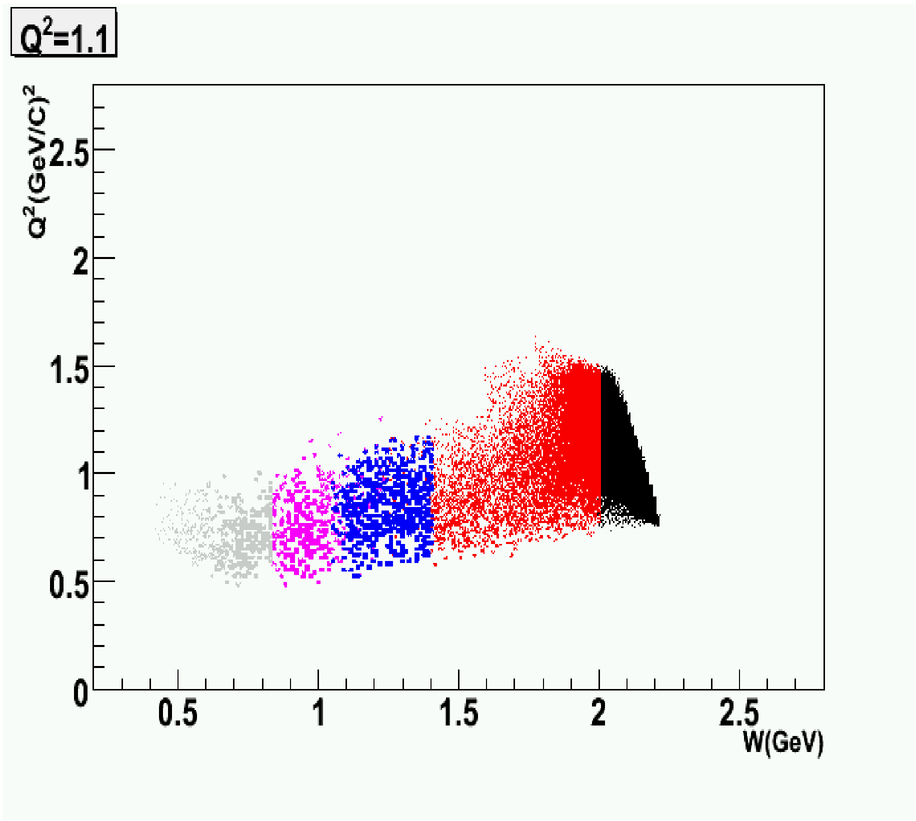
	Elastic	Quasi	Delta	Dis	Toy	<Asym>	Data
Res #4	53.9 (0.03%)	-25.4 (1.5%)	-75.9 (5.26%)	0	-65.0 (93.2%)	-65.0 (ppm)	-73.4+/-6.9 (ppm)
Res #5	42.8 (0.02%)	-18.0 (1.5%)	-55.3 (1.6%)	0	-59.9 (96.8%)	-59.1 (ppm)	-60.9 +/- 5.15 (ppm)
Res #7	81.4 (0.04%)	-44.1 (0.89%)	-98.5 (0.99%)	-108.8 (31.3%)	-122.4 (66.8%)	-117.1 (ppm)	-118.8 +/- 16.9 (ppm)

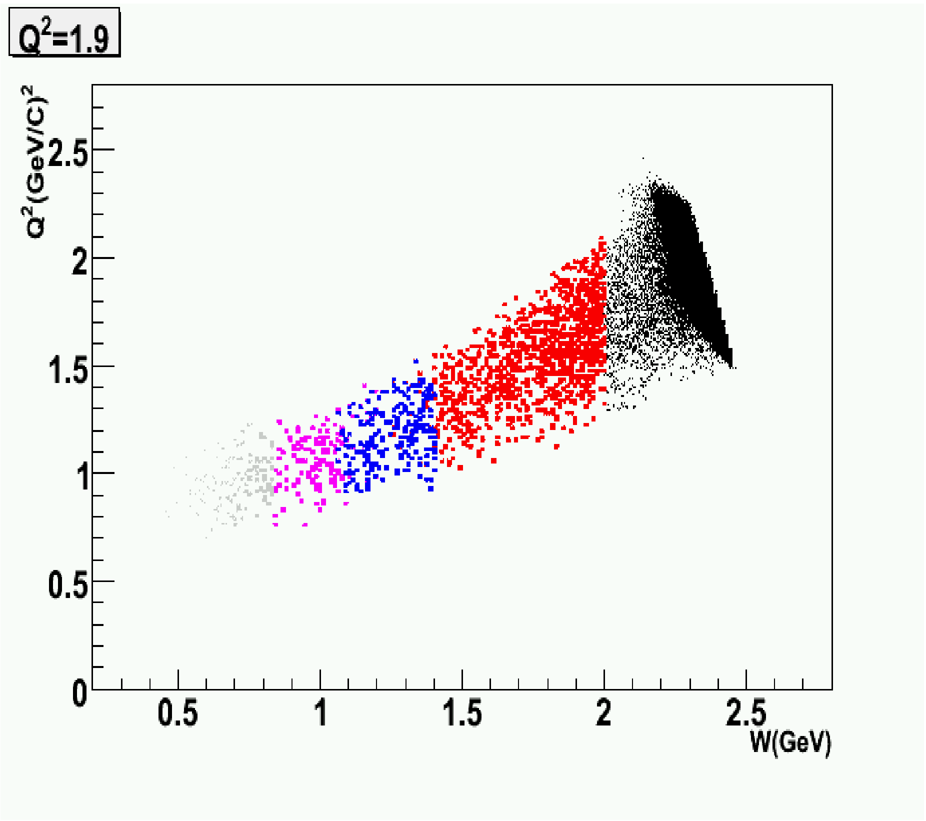
Resonance #4,5,7 (Misha)



	Elastic	Quasi	Table	Dis	Toy	<Asym>	Data
Res #4	53.9 (0.03%)	-27.1 (1.8%)	-69.5 (94.0%)	0	-57.7 (4.2%)	-68.2 (ppm)	-73.4+/-6.9 (ppm)
Res #5	42.8 (0.02%)	-18.2 (1.6%)	-62.4 (91.9%)	0	-65.6 (6.5%)	-61.9 (ppm)	-60.9 +/- 5.15 (ppm)
Res #7	81.4 (0.04%)	-44.2 (0.9%)	-127.6 (62.1%)	-108.8 (31.3%)	-125.9 (5.7%)	-120.8 (ppm)	-118.8 +/- 16.9 (ppm)

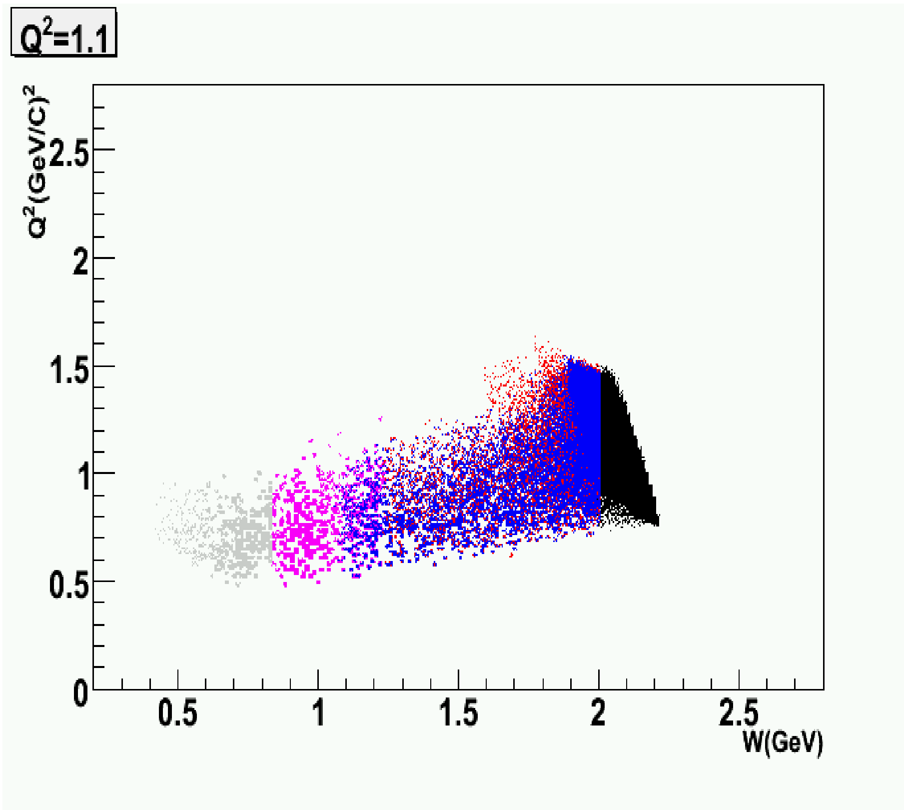
DIS Radiative Corrections (Lee&Tao)

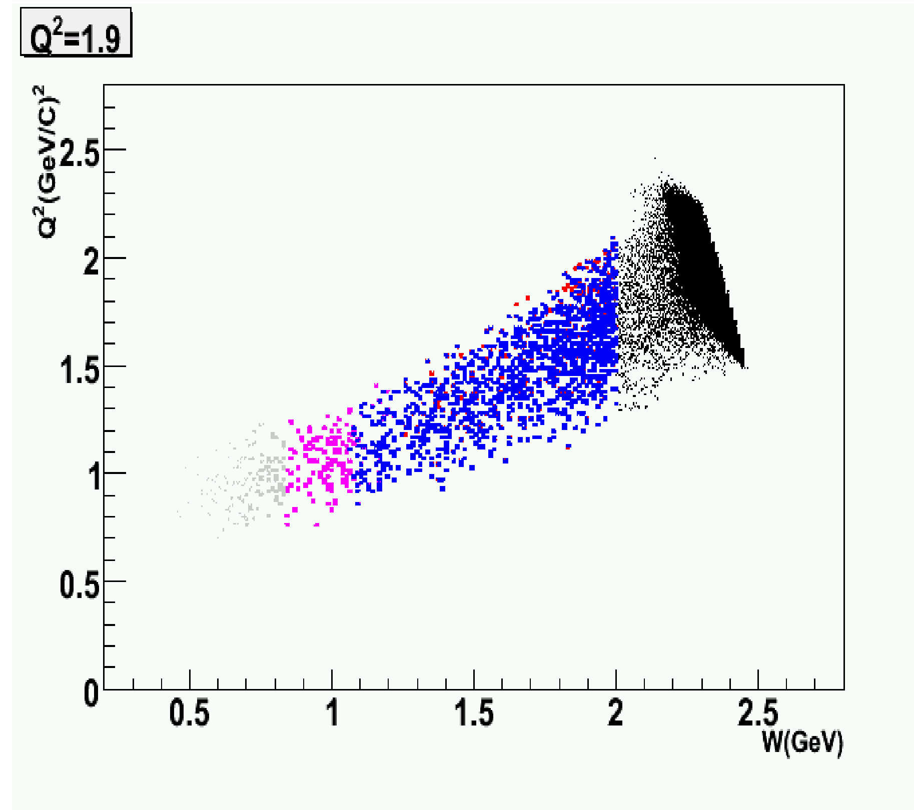




	Elastic	Quasi	Delta	Dis	Toy	<Asym>	A_<qsq_vrt>	Correction Factor
Dis #1	56.0 (0.03%)	-26.5 (1.3%)	-70.7 (1.2%)	-86.1 (74.4%)	-93.3 (23.2%)	-86.8 (ppm)	-88.6 (ppm)	1.021
Dis #2	79.7 (0.03%)	-45.8 (0.95%)	-107.7 (0.83%)	-159.3 (95.5%)	-118.1 (2.7%)	-156.6 (ppm)	-159.6 (ppm)	1.019

DIS Radiative Corrections (Misha)





	Elastic	Quasi	Table	Dis	Toy	<Asym>	A_<qsq_vrt>	Correction Factor
Dis #1	56.0 (0.03%)	-26.5 (1.3%)	-97.4 (19.1%)	-86.1 (74.4%)	-92.7 (5.3%)	-87.8 (ppm)	-88.6 (ppm)	1.009
Dis #2	79.7 (0.03%)	-45.8 (0.95%)	-117.7 (3.4%)	-159.3 (95.5%)	-147.8 (0.1%)	-156.7 (ppm)	-159.6 (ppm)	1.019