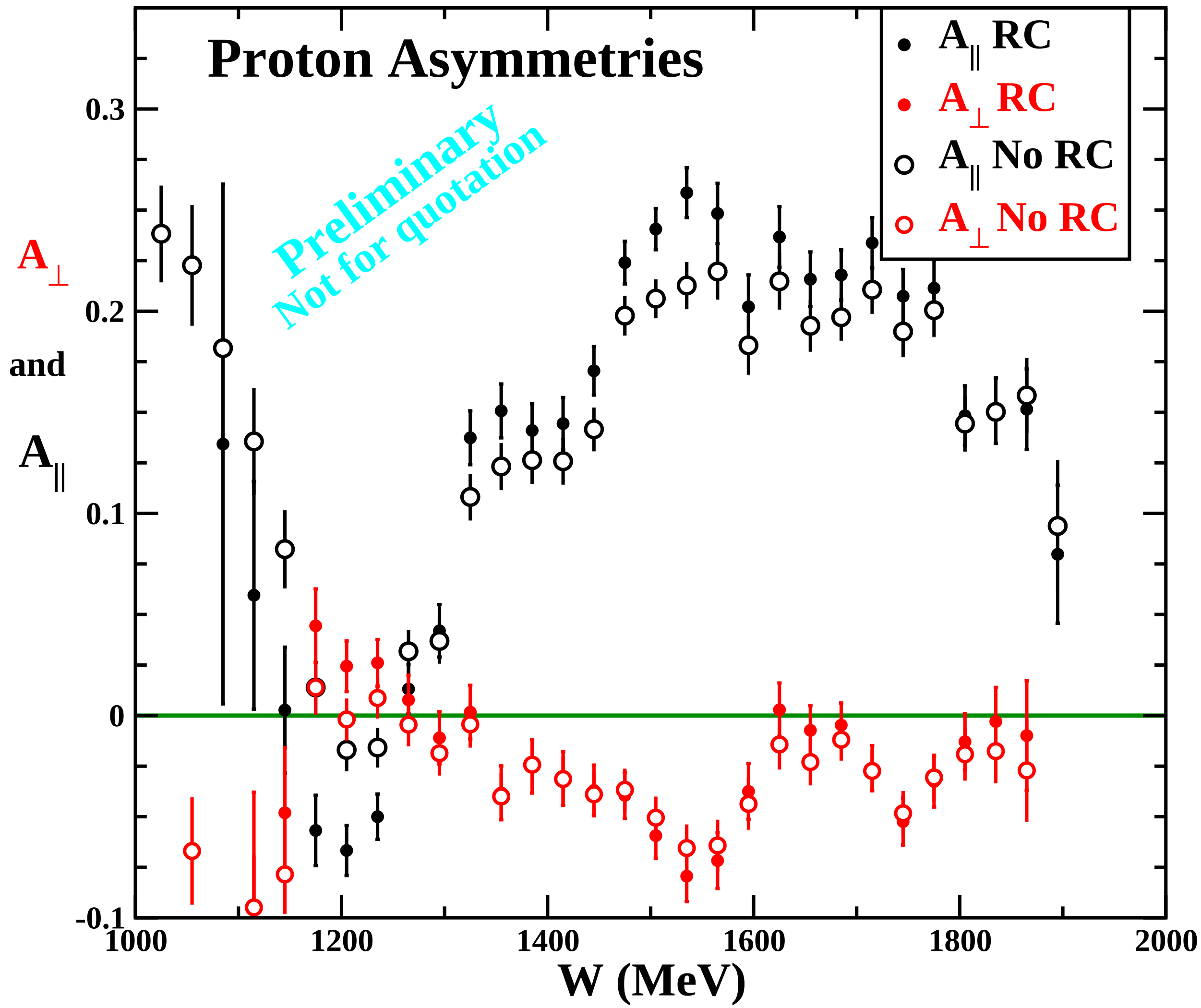
# Backup slides

# Compare proton $A_{\parallel}$ and $A_{\perp}$ w/o RC



# Structure functions in DIS and resonances

- Polarized and unpolarized structure functions share common interpretation:
  - DIS: Parton model and Operator Product Expansion (OPE)
    $A_1(x) \approx \frac{g_1(x)}{F_1(x)} = \frac{\sum e_i^2 \Delta q_i}{\sum e_i^2 q_i}$
  - Resonances: forward virtual Compton scattering
    $A_1(Q^2,\nu) = \frac{\sigma^T_{1/2} - \sigma^T_{3/2}}{\sigma^T_{1/2} + \sigma^T_{3/2}} = \frac{M\nu G_1(Q^2,\nu) - Q^2 G_2(Q^2,\nu)}{W_1(Q^2,\nu)}$
  - Connection: scaling limit

$$\lim_{Q^2,\nu\to\infty} M\nu G_1(Q^2,\nu) = g_1(x)$$
$$\lim_{Q^2,\nu\to\infty} MW_1(Q^2,\nu) = F_1(x)$$

# Relation between $A_1, A_2$ and $A_\parallel, A_\perp$

- Clean extraction of $A_1, A_2$ for protons and deuterons is crucial.
- Solution: measure $A_\parallel, A_\perp$ on polarized ammonia

$$
\begin{aligned}
A_1 &= \frac{C}{D}(A_\parallel - dA_\perp) \\
A_2 &= \frac{C}{D}(c'A_\parallel - d'A_\perp)
\end{aligned}
$$

- Kinematic variables $C, c', d, d'(E, E', \theta), D(E, E', \theta, R)(R = \sigma_L/\sigma_T)$
- $d' \approx 1, c' \approx d \leq 1$ ( at RSS kinematics)
- Comparable systematic errors for both $A_\parallel, A_\perp$ is important.

# SSF $g_1, g_2$ and Spin Asymmetries $A_1, A_2$

- $g_1, g_2$ can be extracted directly from $A_{||}, A_{\perp}$ or $A_1, A_2$

$$
\begin{aligned}
g_1 &= \frac{F_1}{1+\gamma^2}(A_1 + \gamma A_2) \\
g_2 &= \frac{F_1}{1+\gamma^2}(\frac{A_2}{\gamma} - A_1) \;;\; \gamma^2 = \frac{Q^2}{\nu^2}
\end{aligned}
$$

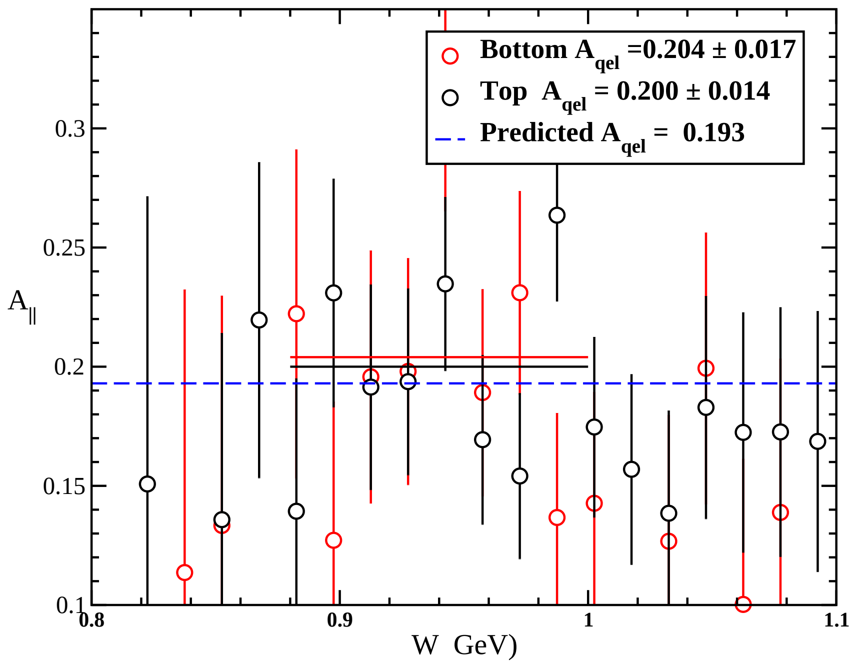
  - Need $F_1 = F_2(1+\gamma^2)/2x/(1+R)$ in the resonance region. Measurement of F2 and R in resonance region

- Also can get $g_1, g_2$ directly from cross section differences: $F_2$ and $R$ not needed

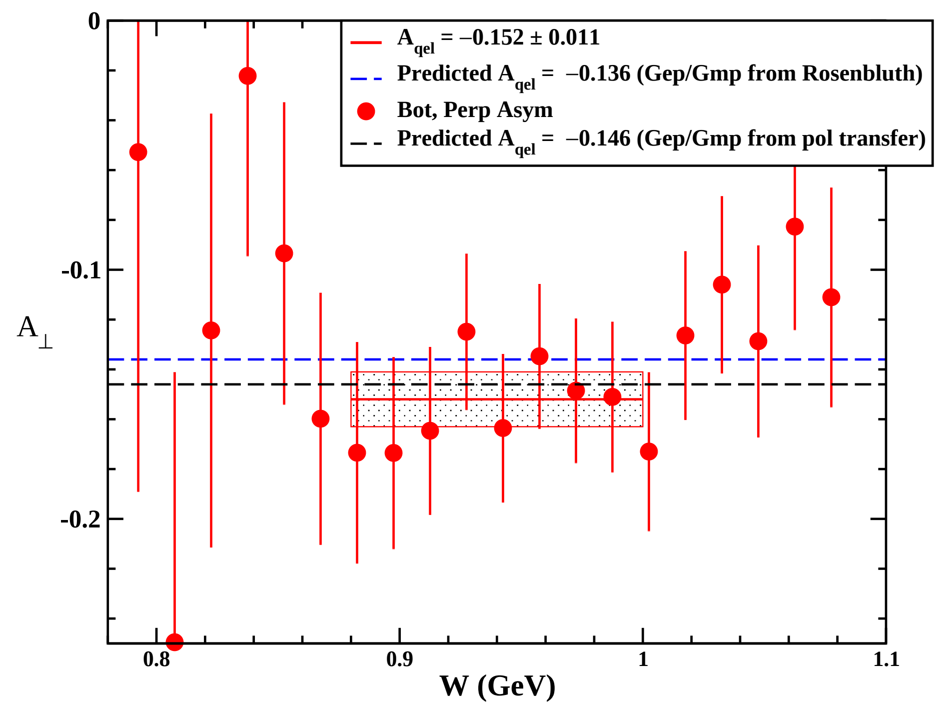
- $g_1$ can be extracted from $A_{||}$ and SSF model for $g_2$

# Measured deuteron $A_{qel}$

- $A_{qel}$ for $B_{||}$
- Average $A_{qel}$ for $0.88 < W < 1.0$
- Top and bottom agree!




- $A_{qel}$ for $B_{\perp}$
- Average $A_{qel}$ for $0.88 < W < 1.0$
- Better agreement with $\frac{G_{Ep}}{G_{Mp}}$ from recoil pol., but both within $2\sigma$



# Elastic and Quasi-elastic Asymmetry

## Proton elastic

$$A_{el} = \frac{K_1 \cos\theta^\star + K_2 \frac{G_E}{G_M} \sin\theta^\star \cos\phi^\star}{G_E^2/G_M^2 + \tau/\epsilon}$$

$\theta^\star, \phi^\star$ = polar and azimuthal angles between $\vec{q}$ and target spin

$K_1, K_2$ = kinematic factors

| | B$_\parallel$ | B$_\perp$ |
|---|---|---|
| $\theta^\star, \phi^\star$ | $129^\circ, 180^\circ$ | $41^\circ, 162^\circ$ |
| $\frac{\Delta A_{el}/A_{el}}{\Delta \frac{G_E}{G_M} / \frac{G_E}{G_M}}$ | 0.02 | 1 |

- A$_\parallel$ used to determine $P_b P_t$
- A$_\perp$ measure $\frac{G_E}{G_M}$

## Deuteron quasi-elastic

- At quasi-free peak in PWIA:

$$A_{qel} = \frac{\sigma_p A_{el}^p + \sigma_n A_{el}^n}{\sigma_p + \sigma_n}$$

- Sensitivity to nucleon form factors

| | B$_\parallel$ | B$_\perp$ |
|---|---|---|
| $\frac{\Delta A_{qel}/A_{qel}}{\Delta \frac{G_{Ep}}{G_{Mp}} / \frac{G_{Ep}}{G_{Mp}}}$ | 0.01 | 0.6 |
| $\frac{\Delta A_{qel}/A_{qel}}{\Delta \frac{G_{En}}{G_{Mn}} / \frac{G_{En}}{G_{Mn}}}$ | 0.08 | 0.01 |

- Given statistical error, quasi-elastic A$_\parallel$,A$_\perp$ used to check $P_b P_t$ for deuteron asymmetries

# Motivation and Goals

- Motivation
  - For $Q^2 < 5$ GeV$^2$ , inclusive $(e, e')$ dominated by W $<$ 2 GeV (resonances)
  - Limited proton and deuteron $A_\perp$ in this $Q^2$, $W$ region.
  - Need good W resolution ( $\Delta W < 30$ MeV)
- Goals
  - Measure proton and deuteron spin asymmetries $A_1(W, Q^2)$ and $A_2(W, Q^2)$ at $Q^2 \approx 1.3$ GeV$^2$ and 0.8$< W <$ 2 GeV.
  - Extract $g_1$ and $g_2$ structure functions and study:
    - W dependence
    - Onset of polarized local duality
    - twist-3 effects in $d_2$ matrix element