Thesis Topics of E03-004 and E05-015

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- Single-spin asymmetries in semi-inclusive $n^{\uparrow}(e, e'\pi^{-})$.
  Two independent analysis as crosscheck:
  Collins moment: $\sin(\phi_h + \phi_S)$. Sivers moment: $\sin(\phi_h - \phi_S)$.
  K^{-} single-spin asymmetry can also be a thesis topic. (Need RICH to work at 2.4 GeV/c).
- Double-spin asymmetries in semi-inclusive $n^{\uparrow}(\vec{e}, e'\pi^{-})$.
  The $\cos(\phi_S)$ moment, ratio of $g_{1T}(x)/g_1(x)$.
  $g_{1T}(x)$ is transverse momentum dependent PDF, linked with quark angular momentum.
  Need $\phi_S = 0°$, better run three target spin orientations $(0°, 45°, 90°)$.
- Double-spin asymmetries of DIS inclusive $n^{\uparrow}(\vec{e}, e')$.

Parity-allowed asymmetry, related to higher-twist.
Single-spin asymmetries of DIS inclusive $n^{\uparrow}(e, e')$.
Two-photon exchange on the parton level. Last experiment done in 1968 at SLAC setting upper limit (Steve Rock's thesis).
Need BigBite singles trigger, and careful luminosity corrections to beat down the false asymmetries.

- E05-015: single-spin asymmetries A_y in quasi-elastic ${}^3He^{\uparrow}(e, e')$. Approved for 8 days ($Q^2 = 0.5$ and 1.0 GeV^2). Will extend to $Q^2 = 2.2$ in the next stage.

- Add π^+ for A_{UT}, flavor decomposition of transversity.

Decisions to Make for E03-004

- Two target spin direction or three target spin direction ?
  A larger ϕ_S coverage helps in separation of $\sin(\phi_h + \phi_S)$ from $\sin(\phi_h - \phi_S)$.
  Collins asymmetry $A_{UT}^{Collins} = 0$ at $\phi_h + \phi_S = 0°$. A good check on systematics.

- Major target design decisions:
  Installation of the third pair of target coils, laser optics.

- BigBite single-arm trigger.
  Add a Cherenkov in BigBite for extra π^-/e separation ?

- Luminosity monitors to beat down systematics in SSA.

One Option for BigBite Cherenkov

Follow the Hall B gas Cherenkov example, we can chose:

- Heavy gas C_4F_{10} (perfluorobutane) at 1 atm (n=1.00153, threshold $p_\pi = 2.5$ GeV/c). Copy Hall B the gas system.
- Average of 2.3 cm path length per-γ. 46 cm path gives 20γ.
- One mirror reflection efficiency 85$\%$. QE of PMT average to 25%. $\Rightarrow$ 4 photo-electrons per event.
- Hall B gas Cherenkov: path length 60$\sim$100 cm, double-mirror reflection, Winston cones help light collection. Average PID efficiency 99$\%$.
- All simulation and design tools exist. Alex Vlassov will help.

Can we fi t in a 60 cm Cherenkov between BigBite chambers ?

Hall B Gas Cherenkov