

Precision Physics With MOLLER Workshop

Outlook

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Thought Provoking Talks!

- **Thanks to Wally and Jianwei!**
- **Thanks to all the speakers!**
  - **Greatly appreciate every speaker's efforts to think about the important issues specifically relevant for MOLLER measurements and systematic control**
- **Thanks to all the participants!**
- **It has been stimulating and exciting to pivot towards MOLLER Physics!**
  - **Reminder of our approach to systematic control of physics interpretation**
  - **Articulation of what we can do with the first high power beam, especially with transverse polarization. Originally conceived as way to check our understanding of the apparatus!**
  - **Important insight from experts on relevant phenomenology**
- **Clearly aspects that need further investigation and theoretical engagement**

Discussion topics (I)

- **Electron Proton Inelastic Scattering**
  - **Xiachao's toy model gets the right ballpark for E158: next make MOLLER predictions**
  - **How robust is the denominator for APV in inelastic scattering: new measurements?**
  - **Perhaps more interesting, is an explicit low Q2 high W APV measurement motivated?**
  - **MOLLER should try fitting more W bins in the deconvolution analysis**
  - **New MOLLER data can be fed back into proton weak charge box diagram contributions**
  - **Is there any insight to be gained from neutrino scattering data?**
  - **Are there theory synergies with the latest development in precision beta decay? Misha pointed out lattice QCD connections**
  - **New insights from higher twist effects analysis perhaps interpolating into Regge region**
  - **Accuracy of kinematic extrapolation: new combined QED-QCD factorization approach**

Discussion Topics (II)

- **Single spin asymmetries in inelastic e-p scattering**
  - **When there is a hard scale, AT is estimated to be smaller than 1 ppm**
  - **Perhaps some followup to get estimates as you evolve to lower Q2 is warranted**
  - **Delta and other resonance AT could be large at small angle! A followup with experts such as Wally, Peter et al, and Barbara, Marc V et al is required for MOLLER-specific insights**
- **Hyperon Asymmetry**
  - **The kinematics and sensitivities are now identified; preliminary estimates show that it is a a small correction but important to get a better handle for MOLLER's ultimate precision**
  - **Very exciting that there is synergies with ongoing and potentially future GlueX campaigns and collaboration should be pursued**

Discussion topics (III)

- **Radiative Corrections**
  - **Great progress with two complete 2-loop calculations! Uncertainty now robustly below MOLLER precision goals**
  - **Exact estimates for MOLLER apparatus including detector cutoffs will require further collaboration (EFT, McMule…)**
  - **Running of the weak mixing angle: uncertainty well below MOLLER uncertainty**
  - **must continue to monitor developments in running of alpha, both new data and Lattice QCD**
- **MOLLER physics extraction**
  - **Discussion on Yury's slide**

What we need from theory

- SM prediction for A_{PV} and A_T, ideally to order $O(\alpha^2)$, on the timescale of the final publications
  - $O(\alpha)$ calculations for both A_{PV} and A_T done circa 2004; $O(\alpha^2)$ for A_{PV} is partially done
- Which means
  - Running of $\sin^2\theta_W$ (c.f. S Kuberski's talk, this talk)
  - Electroweak or EM corrections (boxes, vertices) to order $O(\alpha^2)$
  - Internal brem and corresponding counter-terms to order $O(\alpha^2)$
  - Kinematic distributions, i.e. double-differential cross sections $\frac{d^2\sigma}{dE'd\Omega}$
  - Ideally kinematic distributions for the backgrounds
  - The rest (i.e. external radiation, backgrounds) are handled in Geant4