1 GPD Program

In response to the Director's Review recommendation that "the SoLID Collaboration should investigate the feasibility of carrying out a competitive GPD program. Such a program would seem particularly well suited to their open geometry and high luminosity...", for different GPD experiments are in different stages of study/approval.

As has been remarked elsewhere, a variety of hard exclusive measurements are needed to disentangle the contributions of the different GPDs, with the general Compton processes (DVCS, TCS, DDVCS) sensitive to various real and imaginary combinations of all four leading twist GPDs (Fig. 1), vector-meson DEMP sensitive to the spin-average H, E GPDs and pseudoscalar-meson DEMP sensitive to the spin-difference $\tilde{H}$, $\tilde{E}$. The SoLID GPD program under investigation includes many of these reactions, and has the potential to greatly improve our understanding.

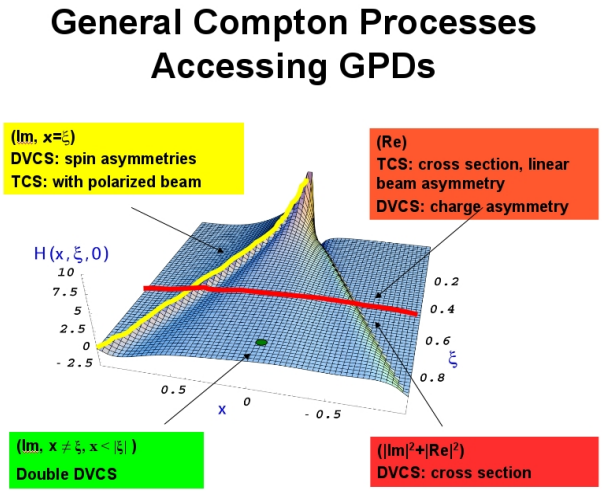

Figure 1: General Compton processes accessing GPDs.

Timelike Compton Scattering (TCS) from an unpolarized LH_2 target can provide information on the real (imaginary) parts of the Compton amplitude using unpolarized (circularly polarized) photons. In this case, the produced lepton pair sets the hard scale ($Q^2 > 4$ GeV^2) and the azimuthal asymmetry of the $\ell^+\ell^-$ plane with respect to the q-vector allows the separation of the GPD and Bethe-Heitler contributions. This has been approved as a run group experiment with the J/ψ experiment (E12-12-006A).

Double Deeply Virtual Compton Scattering (DDVCS) in the di-lepton channel on an unpolarized LH_2 target has been reviewed by PAC43 as LOI12-12-005. The solenoidal configuration is ideal for high luminosity, with a fully parasitic proposal (as part of the J/ψ run group) for the e^+e^- channel under preparation. Once this experiment has run, a later phase of measurements might include the $\mu^+\mu^-$ channel. A workshop at ECT Trento to refine the DDVCS physics program is planned for October 24-28, 2016.

A possible Deeply Virtual Compton Scattering (DVCS) experiment on polarized ^{3}He is also under study. The 12 GeV polarized DVCS experiments to date utilize longitudinally (E12-06-119) and transversely (C12-12-010) polarized proton targets. No polarized neutron-DVCS experiment has been proposed at JLab to date, and SoLID could make a unique contribution here once the reaction exclusivity requirements and

possible backgrounds are better understood. A complete set of SoLID DVCS data with both proton and neutron targets at varied polarization would be essential to control systematic uncertainties, perform flavor decomposition, and disentangle the different GPDs.

Deep Exclusive Meson (π^-) Production (DEMP) using a transversely polarized ^{3}He (neutron) target looks very promising. The transverse single-spin asymmetry in exclusive charged π production has been identified as the most sensitive observable to probe $\tilde{E}$. In this case, one fits the $\sin(\phi - \phi_S)$ dependence, where $(\phi - \phi_S)$ is the azimuthal difference between the π^- reaction plane and the polarized target. Theoretical calculations suggest higher twist corrections likely cancel in the asymmetry, allowing access to to GPDs at much lower value of Q^2 than typically required in DEMP reactions. This measurement has been proposed as a run group experiment with the transversely polarized ^{3}He SIDIS experiment (PR12-10-006B), and detailed studies on the expected uncertainties are underway.

This summary makes clear that the SoLID-SIDIS setup is indeed very attractive in terms of acceptance and luminosity, and will allow a Phase 1 GPD program to be initiated with minimal impact on the approved SoLID program. Once this has been executed, one could envision a later Phase 2 suite of GPD experiments with additional recoil detectors near the target (such as low momentum proton tagging for DEMP), dedicated configurations (for DDVCS), or improved EC resolution (to allow exclusive vector meson and π^0 measurements). These would require much more study, and are clearly beyond the scope of the present proposals.