OPPORTUNITIES WITH JLAB ENERGY AND LUMINOSITY UPGRADE

26 September 2022 — 30 September 2022

ECT* - Villa Tambosi

Strada delle Tabarelle, 286

Trento - Italy

Opportunities with JLab energy upgrade

Energy upgrade of JLab will provide access to

- **full range of kinematics where the non-perturbative sea is expected to be significant**
- **open up the phase space to access large momentum transfer**
- **and large transverse momenta of final state particles.**
- **near-threshold charmonium photoproduction will enable studies of the gluonic properties of the proton**
- **an extensive program at the intensity frontier will cover light and heavy quark hadron spectroscopy**
- **QCD in medium**

Theory-Lattice-Experiment coordination is critical

To understand/describe an observable, requires clear understanding of detector and physics backgrounds, and transparent validation procedure for extraction of underlying structure and distribution functions.
Involvement of advanced tools in physics analysis (ML,AI,..), require even more sophisticated validation procedures, which can only be done with proper simulation of the observable, including all detector (GEANT) and physics backgrounds

Close collaboration of phenomenology, lattice and experiment critical for understanding of QCD dynamics, and required for proper validation of different QCD based formalisms

Resolution: (Town Meeting Sep 23-25)

"We recommend the establishment of a national EIC theory alliance to enhance and broaden the theory community needed to advance EIC physics goals and the experimental program. This theory alliance will develop a diverse workforce through a competitive national EIC theory fellow program and tenure-track bridge positions, including appointments at minority serving institutions."

Summary

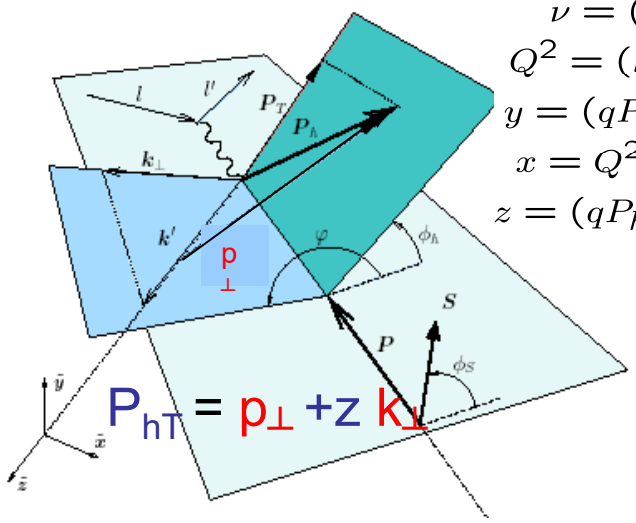
To produce a realistic and convincing physics program we should be able to simulate the observables, their physics and detector backgrounds, to claim understanding of observables and validate the interpretation

We need the analysis frameworks with controlled systematics HERE and NOW

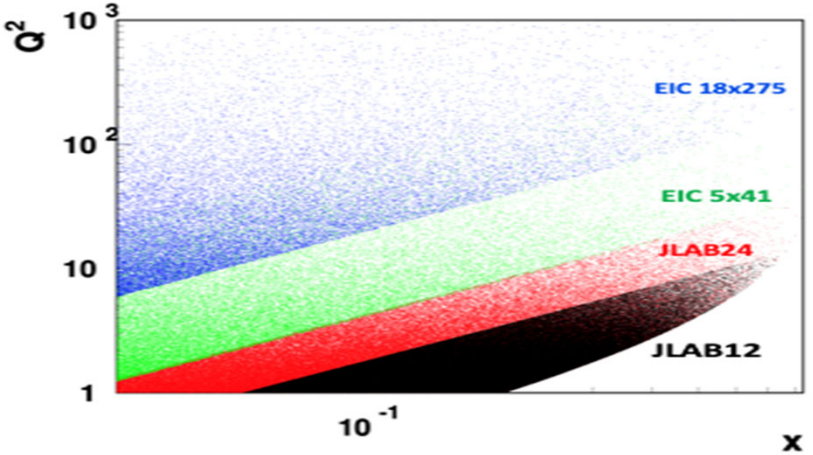
HAVE A VERY PRODUCTIVE WEEK!

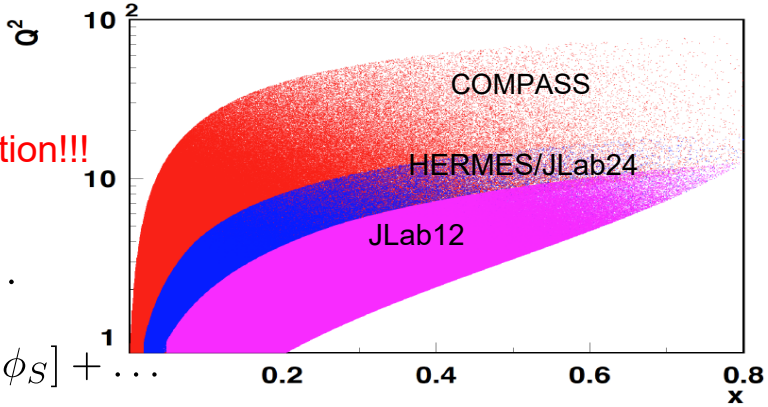
Support slides…

SIDIS kinematical coverage and observables



$$\nu = (qP)/M$$
$$Q^2 = (k - k')^2$$
$$y = (qP)/(kP)$$
$$x = Q^2/2(qP)$$
$$z = (qP_h)/(qP)$$

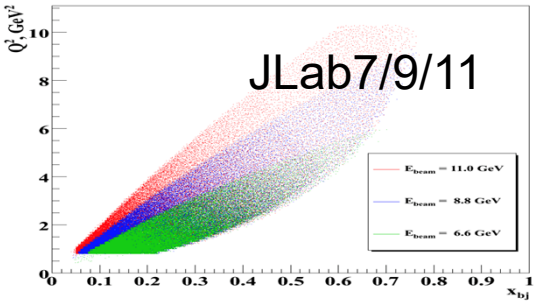




SIDIS experiments measure azimuthal dependence of the cross section!!!

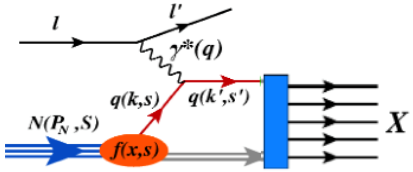
$$\sigma \propto F_{UU} + P_b\sqrt{2\epsilon(1-\epsilon)}F_{LU}^{\sin\phi}\sin\phi + P_t\epsilon F_{UL}^{\sin 2\phi}\sin 2\phi + \ldots$$
$$+\epsilon F_{UU,L} + |S_\perp|[F_{UT}^{\sin(\phi-\phi_S)}\sin(\phi-\phi_S) + \sqrt{2\epsilon(1+\epsilon)}F_{UT}^{\sin\phi_S}\sin\phi_S] + \ldots$$

- Studies of azimuthal modulations give access to underlying 3D partonic distributions
- All assumptions involved in description of SFs, should be tested!
- QCD predicts only the Q^2-dependence of 3D PDFs



QCD: from testing to understanding

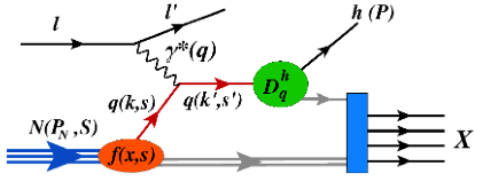
0h DIS



Testing stage:

pQCD predictions, observables in the kinematics where theory predictions are easier to get (higher energies, 1D picture, leading twist, IMF)

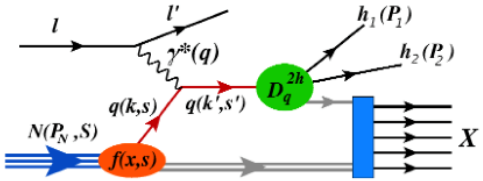
1h SIDIS/DVMP



Understanding stage:

non-perturbative QCD, strong interactions, observables in the kinematics where most of the data is available (all energies, quark-gluon correlations, orbital motion)

2h SIDIS/DVMP



production in SIDIS provides access to correlations inaccessible in simple SIDIS (dihadron fragmentation, correlations of target and current regions, entanglement....)