Young-Kee Kim (ykkim@fnal.gov)
Chair of the Steering Group
Deputy Director of Fermilab
Professor of Physics, Univ. of Chicago

Dear Young-Kee,

I think that there are many interesting and important fixed target experiments -- especially at forward x_F -- that can and should be done at Fermilab. Examples:

1) Measurement of the proton's fundamental three-quark structure from diffractive tri-jet production $p A \to Jet Jet Jet A$. This is the natural extension of the pioneering diffractive dijet experiment done at FermiLab which measured the pion wavefunction and established QCD color transparency. Highly interesting AdS/QCD predictions for hadron light-front wavefunctions can be tested.

Direct measurement of the pion valence quark momentum distribution, the pion light cone wave function squared.
By E791 Collaboration (E.M. Aitala et al.). FERMILAB-PUB-00-221-E, Oct 2000. 13pp.
Published in Phys.Rev.Lett.86:4768-4772,2001.
e-Print: hep-ex/0010043

Measurement of light-cone wave functions by diffractive dissociation.
Daniel Ashery (Tel Aviv U.) . Nov 2005. 6pp.
Talk given at 11th International Conference on Elastic and Diffractive Scattering: Towards High Energy Frontiers: The 20th Anniversary of the Blois Workshops, Chateau de Blois, Blois, France, 15-20 May 2005.
Published in Nucl.Phys.Proc.Suppl.161:8-14,2006. Also in *Cairns 2005, Light-cone QCD and nonperturbative hadron physics* 8-14
e-Print: hep-ex/0511052

Hadronic spectra and light-front wavefunctions in holographic QCD.
Stanley J. Brodsky (SLAC) , Guy F. de Teramond (Costa Rica U.) . SLAC-PUB-11716, Feb 2006. 11pp.
Published in Phys.Rev.Lett.96:201601,2006.
e-Print: hep-ph/0602252

2) Fermilab should study the forward hadroproduction of exotic doubly heavy quark states such as the bottom-charm heavy baryon $b c q$ system. As shown in the FermiLab SELEX experiment, doubly heavy charm states are hadroproduced at high x_F. This physics also shows the importance of intrinsic heavy quark Fock states in the proton -- rigorous first principle predictions of QCD. The need for measuring the charm and bottom structure functions at high x_{bj} has been re-emphasized by Pumplin and Tung.

The Charm Parton Content of the Nucleon.
J. Pumplin (Michigan State U.) , H.L. Lai (Michigan State U. & Washington U., Seattle & Taipei Municipal Coll.) , W.K. Tung (Michigan State U. & Washington U., Seattle) . MSU-HEP-070101, Jan 2007. 15pp.
Published in Phys.Rev.D75:054029,2007.
e-Print: hep-ph/0701220

Heavy quark mass expansion and intrinsic charm in light hadrons.
M. Franz (Ruhr U., Bochum) , Maxim V. Polyakov (Ruhr U., Bochum & St. Petersburg, INP) , K. Goeke (Ruhr U., Bochum) . RUB-TP2-03-00, RUB-TPII-03-00, Feb 2000. 20pp.
Published in Phys.Rev.D62:074024,2000.
e-Print: hep-ph/0002240

QCD and intrinsic heavy quark predictions for leading charm and beauty hadroproduction.
R. Vogt (LBL, Berkeley) , S.J. Brodsky (SLAC) . SLAC-PUB-6468, LBL-35380, Apr 1994. 22pp.
Published in Nucl.Phys.B438:261-277,1995.
e-Print: hep-ph/9405236

3) The mechanisms which produce the very large Sivers effect (transverse polarization correlation) observed in inclusive high x_F hadroproduction processes are not understood. Many types of experimental studies are possible, such as the measurement of the final state polarization of the charmed baryon in $p p \to \Lambda_c X$ at high x_F.

4) Many studies at RHIC are based on the assumed scale invariance of high p_T inclusive reactions. In fact there are huge deviations from $1/p_T^4$ scaling, as seen in plots of $ p p \to p X$ at fixed x_T and \theta_{CM}$. This points to the presence of new types of direct QCD processes where the hadron is produced directly within the subprocess. Understanding this is crucial for interpreting anomalies seen in heavy ion collisions, such as the growing proton to pion ratio.

See my talk

High-pT Physics at the LHC. Physics Department, University of Jyväskylä, Finland. "Novel QCD Phenomena - Part 1, Part 2, Part 3, Part 4". March 23 - 27, 2007.

Posted at:
http://www.slac.stanford.edu/grp/th/recentlectures.html#Stan_Brodsky

5) The Drell-Yan reaction is now understood to have unexpected leading-twist initial

state correction. This causes transverse spin asymmetries and violations of the Lam-Tung relations. There are also remarkable effects at large x_F where the incident hadron acts directly.

Initial state interactions in the unpolarized Drell-Yan process.
Daniel Boer (Vrije U., Amsterdam) , Stanley J. Brodsky (SLAC) , Dae Sung Hwang (Sejong U.) . SLAC-PUB-9561, Nov 2002. 23pp.
Published in Phys.Rev.D67:054003,2003.
e-Print: hep-ph/0211110

This is also related to the recent paper:

Factorization is violated in production of high-transverse-momentum particles in hadron-hadron collisions.
John Collins (Penn State U.) , Jian-Wei Qiu (Iowa State U. & Argonne) . ANL-HEP-PR-07-25, May 2007. 10pp.
e-Print: arXiv:0705.2141 [hep-ph]

6) The nuclear dependence of $p A \to J/\psi A$ production shows extraordinary deviations from PQCD predictions at high x_F. One expects even stronger nuclear suppression in forward production of the Λ_c. This is also relevant to Higgs hadroproduction at large x_F.

Measurement of J / psi and psi-prime suppression in p-A collisions at 800-GeV/c.
By FNAL E866/NuSea collaboration (M.J. Leitch et al.). LA-UR-99-5007, FERMILAB-PUB-99-394-E, Sep 1999. 5pp.
Published in Phys.Rev.Lett.84:3256-3260,2000.
e-Print: nucl-ex/9909007

Diffractive Higgs production from intrinsic heavy flavors in the proton.
Stanley J. Brodsky (SLAC) , Boris Kopeliovich, Ivan Schmidt (Santa Maria U., Valparaiso) , Jacques Soffer (Marseille, CPT) . SLAC-PUB-11784, USM-TH-181, CPT-2005-P-021, Mar 2006. 30pp.
Published in Phys.Rev.D73:113005,2006.
e-Print: hep-ph/0603238

6) Nuclear antishadowing is a novel effect in QCD. In fact it has been shown to non-universal, depending on a remarkable way on the flavor of the struck quark or antiquark. Fundamental understanding of this phenomenon is needed to understand the CTEQ anomaly. A number of experimental DY and DIS measurements are needed.

Nuclear antishadowing in neutrino deep inelastic scattering.

Stanley J. Brodsky (SLAC) , Ivan Schmidt (Santa Maria U., Valparaiso) , Jian-Jun Yang (Santa Maria U., Valparaiso & Regensburg U. & Nanjing Normal U.) . SLAC-PUB-9677, USM-TH-136, Aug 2004. 36pp.
Published in Phys.Rev.D70:116003,2004.
e-Print: hep-ph/0409279

7) Hard Diffraction is now understood to be a leading twist phenomenon. Fermilab could measure reactions such as the doubly-diffractive Drell-Yan process $ p p \to p p \ell^+ \ell^-$.

Hard diffraction from parton rescattering in QCD.
Stanley J. Brodsky (SLAC) , Rikard Enberg (Ecole Polytechnique) , Paul Hoyer (Helsinki Inst. of Phys.) , Gunnar Ingelman (Uppsala U. & DESY) . SLAC-PUB-10692, CPHT-RR-049-0804, HIP-2004-37-TH, TSL-ISV-2004-0281, Sep 2004. 10pp.
Published in Phys.Rev.D71:074020,2005.
e-Print: hep-ph/0409119

Structure functions are not parton probabilities.
Stanley J. Brodsky (SLAC) , Paul Hoyer (Nordita) , Nils Marchal (Nordita & Annecy, LAPTH) , Stephane Peigne (Annecy, LAPTH) , Francesco Sannino (Nordita) . SLAC-PUB-8818, LAPTH-842-01, NORDITA-2001-7-HE, Feb 2002. 30pp.
Published in Phys.Rev.D65:114025,2002.
e-Print: hep-ph/0104291

Best regards,

Stanley J. Brodsky
Professor, SLAC