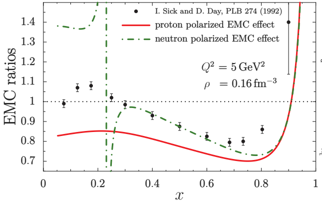
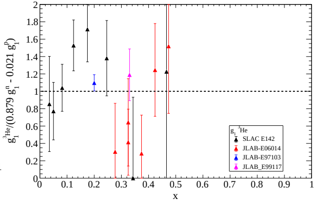
Polarized EMC Effect in the Neutron

- The EMC effect is observed in light nuclei and a significant pEMC effect is predicted for the proton[1]
- Quasi-free neutron from ^{2}H should be best for extracting g_1^n with minimal nuclear effects
  $\rightarrow$ is experimentally challenging due to large dilution and low polarization
- ^{3}He is most common polarized neutron target – better polarization from technology advances
- First neutron pEMC-like ratio is $^3\text{He}/n^*$ – no enhanced pEMC predicted (?)
  $\rightarrow$ Need quasi-free g_1^{n*} to form meaningful pEMC ratios when P_n > few percent.



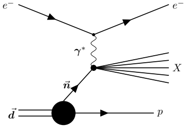
$$R_{As}^{^3\text{He}} = \frac{g_1^{^3\text{He}}}{P_n g_1^n + P_p g_1^p}$$



$\vec{D}$ target with spectator proton tagging

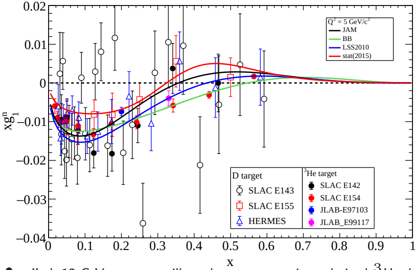
- Scattered electron / proton coincidence **eliminates target dilution**
- ND_3 target **figure-of-merit improves by factor a of 100!**

$$f.o.m. \propto P_T^2 \boldsymbol{f}^2$$



Polarized EMC effect with ^{3}He needs better ^{2}H data

- Tag spectator proton: $\vec{e} + \vec{D} \rightarrow e' + p + X$
- Improve g_1^n to better constrain zero-crossing region
- g_1^n from ^{3}He poorly constrained due to P_p/P_n uncertainties
- $g_1^{^3\text{He}}$ sensitive to non-nucleonic degrees of freedom [2]
- Low moments more sensitive to Δ contributions to WF [3]

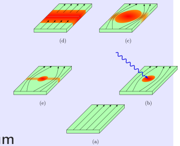


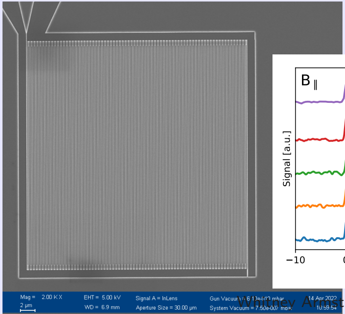
- JLab 12 GeV program will produce more precise polarized ^{3}He data.
- EIC will have spectator tagging with $\vec{D}$, however, new technology enables opportunities at JLab for active $\vec{D}$ targets.
- **Support active target R&D leveraging technology advancements and existing facilities to enhance US nuclear science over next 5-10 years**

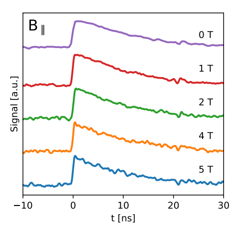
Superconducting Nanowire Active Polarized Target

Superconducting nanowire detectors

- Quantum sensor operates at $T < 5$K
- 10 nm NbN thin film, $T_c \simeq 14K$[4]
- Meandering geometry 100nm wide wire
- Current biased at roughly 20 μA
- Nearly zero dark count rate
- SNSPD pixels 10×10 μm to 100×100 μm
- Detect photons at high rate in strong magnetic field > 5 T [5]
- Microelectronics R&D underway to develop high-channel count cryogenic readout ASIC for SNSPDs[6]

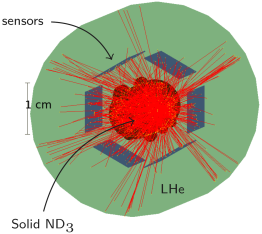






Active Polarized Target Concept

- Polarized material (*e.g.* ND_3) surrounded by SNSPDs in LHe
- 5 T magnetic field traps recoil in target material
- Recoiling proton generates photons in polarized material and scint. in LHe



- Cryogenic photon detector solves problem of efficient photon detection in $< 1K$ cryostat
- R&D needed to pick best material and design integrated superconducting nanowire sensor
- A range telescope of nanowire detectors could directly measure energy of higher momentum recoils – much higher channel count.
- Other nuclei such as ^{6}Li could also be explored and would complement polarized light ions at the EIC (see C. Peng's slides)

Will enhance JLAb 12 GeV physics with high luminosity (SOLID) and large acceptance (CLAS12) detectors

Other opportunities with SNSPD Polarized Active Target

Active $\vec{n}$ target with proton tagging

- $\vec{n}$DVCS $\Delta\sigma_{UT}, \Delta\sigma_{LT} \to \mathcal{E}$
- $\vec{n}$SIDIS $\to$ Sivers TMD flavor separation (complementary to ^{3}He data)
- pEMC effect in g_2^n

Active $\vec{p}$ target with recoil tagging

- $\vec{p}$DVCS measure A_{UT} $\Im\mathfrak{m}\,\mathcal{E}$
- Nucleon Spin Polarizabilities with polarized active proton/deuteron target (See C. Howell's and H. Griesshammer's slides)

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