SoLID-SIDIS: Future Study of Transversity, TMDs and more

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Duke University, on behave of SoLID Collaboration
DIS Workshop @ SMU, Dallas, TX
04/30/2015
Outline

- Transversity and TMDs (quarks)
- Probe TMDs with SIDIS
- 6GeV SIDIS Results
- SoLID-SIDIS @ 11GeV
- GPD Study via DVCS with SoLID
- Summary
Unified View of Nucleon Structure

Wigner distributions (Belitsky, Ji, Yuan) (or GTMDs)

5D

\[ W(x, b_T, k_T) \]

Wigner Distributions

\[ \int d^2 b_T \]

\[ \int d^2 k_T \]

transverse momentum distributions (TMDs)
impact parameter distributions

semi-inclusive processes

3D

\[ f(x, k_T) \leftrightarrow f(x, b_T) \]

Fourier trf.

\[ b_T \leftrightarrow \Delta \]

\[ \xi = 0 \]

\[ H(x, 0, t) \]

\[ t = -\Delta^2 \]

generalized parton distributions (GPDs)
exclusive processes

1D

\[ \int d^2 k_T \]

\[ \int d^2 b_T \]

\[ \int dx \]

\[ \int dx x^{n-1} \]

\[ f(x) \]

\[ F_1(t) \]

\[ A_{n,0}(t) + 4\xi A_{n,2}(t) + \ldots \]

parton densities
form factors
generalized form factors
elastic scattering
lattice calculations

(X. Ji, D. Mueller, A. Radyushkin)

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**Transversity**

- **Difference between $\Delta q$ and $h_1(x)$**
  - **Non-relativistic**
    \[ h_1(x) = q^-(x) - q^+(x), \text{ Transversity} \]
  - **Relativistic:** Lorentz boost and rotation don’t commute
    - ✓ Implies the relativistic nature of the nucleon spin structure
    - ✓ Exist of orbital angular momentum of quarks

- **Hard to access in Inclusive DIS process:** \[ g_2 \sim (m_q/M)h_1(x) + \ldots \text{ OPE} \]
  Can be accessed in semi-inclusive DIS (SIDIS)

- **Interesting features:**
  - Valence-like behavior
  - Soffer’s inequality: \[ |h_1(x)| < \frac{1}{2}(f(x) + \Delta q(x)) \]
  - Link to tensor charge.

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## TMDs

### Leading-Twist TMDs

8 TMDs with different polarization direction of nucleons and quarks

<table>
<thead>
<tr>
<th>Nucleon Polarization</th>
<th>Quark Polarization</th>
<th>Unpolarized (U)</th>
<th>Longitudinally Polarized (L)</th>
<th>Transversely Polarized (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$f_1(x, k_T^2)$</td>
<td>$g_1(x, k_T^2)$</td>
<td>$h_1(x, k_T^2)$</td>
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<tr>
<td>U</td>
<td></td>
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<td></td>
<td>$h_1^1(x, k_T^2)$</td>
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<td></td>
<td></td>
<td></td>
<td>$h_{1L}^1(x, k_T^2)$</td>
<td>Boer-Mulders</td>
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<tr>
<td>L</td>
<td></td>
<td></td>
<td>Helicity</td>
<td>Long-Transversity</td>
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<td></td>
<td></td>
<td></td>
<td>$g_{1T}(x, k_T^2)$</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td>$f_1^\perp(x, k_T^2)$</td>
<td></td>
<td>$h_1^\perp(x, k_T^2)$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sivers</td>
<td></td>
<td>Transversity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$g_{1T}(x, k_T^2)$</td>
<td>Pretzelosity</td>
</tr>
</tbody>
</table>

See P. Mulders’ talk on Monday
Probe TMDs with SIDIS

\[
\frac{d\sigma}{dx dy d\phi_S dz d\phi_h dP_{h \perp}^2} = \frac{\alpha^2}{x y Q^2 \sqrt{2(1-\varepsilon)}} \cdot \left\{ F_{UU,T} + \ldots + \varepsilon \cos(2\phi_h) \cdot F_{UU}^{\cos(2\phi_h)} + \ldots \right. \\
+ S_T \left[ \varepsilon \sin(2\phi_h) \cdot F_{UT}^{\sin(2\phi_h)} + \ldots \right] \\
+ S_T \left[ \varepsilon \sin(\phi_h + \phi_S) \cdot F_{UT}^{\sin(\phi_h + \phi_S)} + \sin(\phi_h - \phi_S) \cdot (F_{UL}^{\sin(\phi_h - \phi_S)} + \ldots) \\
+ \varepsilon \sin(3\phi_h - \phi_S) \cdot F_{UT}^{\sin(3\phi_h - \phi_S)} + \ldots \right] \\
+ S_L \lambda_e [\sqrt{1-\varepsilon^2} \cdot F_{LL} + \ldots] \\
+ S_T \lambda_e [\sqrt{1-\varepsilon^2} \cos(\phi_h - \phi_S) \cdot F_{LT}^{\cos(\phi_h - \phi_S)} + \ldots] \right\}
\]

\( S_U, S_T \): Target Polarization; \( \lambda_e \): Beam Polarization

✓ TMDs can be assessed SSA/DSA in SIDIS process
Transversely polarized target Single Spin Asymmetry (SSA):
Separation of Collins, Sivers and pretzelosity effects
through azimuthal angular dependence:

\[ A_{UT}(\phi_h^l, \phi_s^l) = \frac{1}{P} \frac{N^\uparrow - N^\downarrow}{N^\uparrow + N^\downarrow} \]

\[ = A_{UT}^{Collins} \sin(\phi_h + \phi_s) + A_{UT}^{Sivers} \sin(\phi_h - \phi_s) \]

\[ + A_{UT}^{Pretzelosity} \sin(3\phi_h - \phi_s) \]

**UT:** Unpolarized beam + Transversely polarized target

**Collins:**
\[ A_{UT}^{Collins} \propto \langle \sin(\phi_h + \phi_s) \rangle_{UT} \propto h_1 \otimes H_1^\perp \]

**Sivers:**
\[ A_{UT}^{Sivers} \propto \langle \sin(\phi_h - \phi_s) \rangle_{UT} \propto f_{1T}^\perp \otimes D_1 \]

**Pretzelosity:**
\[ A_{UT}^{Pretzelosity} \propto \langle \sin(3\phi_h - \phi_s) \rangle_{UT} \propto h_{1T}^\perp \otimes H_1^\perp \]

**Transversity**
**Sivers**
**Prezelosity**

Double-Spin Asymmetry (DSA). e.g.:

**Worm-Gear**
\[ A_{LT}^{Worm-Gear} \propto \langle \cos(\phi_h - \phi_s) \rangle_{LT} \propto g_{1T} \otimes D_1 \]

**Worm-Gear**

Fragmentation functions can be obtained from (e+,e-) data.
TMDs with SIDIS @ Hall-A 6-GeV

- Sizable Collins $\pi^+$ asymmetries at $x=0.34$?
  - Hints of violation of Soffer's inequality?
  - Data are limited by stat. Needs more precise data!

- Negative Sivers $\pi^+$ Asymmetry
  - Consistent with HERMES/COMPASS
  - Independent demonstration of negative $d$ quark Sivers function.

(See K. Allada’s talk in WG6)

X. Qian et al. (Hall A Collaboration) *PRL* 107 072003 (2011)

Blue band: model (fitting) uncertainties
Red band: other systematic uncertainties
TMDs with SIDIS @ Hall-A 6-GeV

- **Worm-Gear** $g_{1T}$ Access:
  
  $$g_{1T} = \begin{array}{c}
\end{array}$$

  $$A_{LT}^{\cos(\phi_h-\phi_s)} \propto F_{LT}^{\cos(\phi_h-\phi_s)} \propto g_{1T}^q \otimes D_{1q}^h$$

- Dominated by real part of interference between $L=0$ (S) and $L=1$ (P) states
  
  Imaginary part → Sivers effect

- (Measured by COMPASS and HERMES on p and D targets)

- E06-010 - First data on effectively neutron target
- Consistent with models in signs
- Suggest larger asymmetry, possible interpretations:
  - Larger quark spin-orbital interference
  - different $P_T$ dependence
  - larger subleading-twist effects

*(See K. Allada’s talk in WG6)*

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Precision Study of TMDs with SoLID+11 GeV

- Explorations:
  HERMES, COMPASS, RHIC-spin, Jlab-6GeV,…

- From exploration to precision study
  JLab12: valence region; EIC: sea and gluons

  ✓ Transversity: fundamental PDFs, tensor charge
  ✓ TMDs: 3-d momentum structure of the nucleon
    → information on quark orbital angular momentum
    → information on QCD dynamics
  ✓ Multi-dimensional mapping of TMDs

- Precision → high statistics
  - high luminosity and large acceptance → SoLID+11GeV
About SoLID

- **SoLID: Solenoidal Large Intensity Device**
  - High Intensity \((10^{37} \sim 10^{39} \text{ cm}^{-2}\text{s}^{-1})\) and,
  - Large Acceptance \((7.5<\theta<25, 0<\Phi<360, 1<Pe<7\text{GeV}/c \text{ for SIDIS})\)

- **Approved SIDIS Programs:**
  - → E12-10-006 (A), SIDIS with Transversely Polarized He3, 90 days
  - → E12-11-007 (A), SIDIS with Longitudinally Polarized He3, 35 days
  - → E12-11-108 (A), SIDIS with Polarized Proton, 120 days
  - → and bonus runs ...

- **Other Physics Programs:**
  - Parity Violation Deep Inelastic Scattering (PVDIS): **E12-10-007** (169 days, A)
  - J/ψ: Near Threshold Electroproduction of J/ψ at 11 GeV: **E12-12-006** (60 days, A-)
  - *(new LOIs & Proposals)* Generalized Parton Distributions (GPDs):
    - polarized-proton/neutron DVCS, Doubly DVCS, DVMP, TCS, etc
  - more
SoLID-SIDIS Configuration
**Coverage:**
- **Forward Acceptance:** $\Phi: 2\pi$, $\Theta: 8^\circ-14.8^\circ$, $P: 1.0 - 7.0 \text{ GeV}/c$
- **Large Acceptance:** $\Phi: 2\pi$, $\Theta: 16^\circ-24^\circ$, $P: 3.5 - 7.0 \text{ GeV}/c$

**Resolution:**
- $\delta P/P \sim 2\%$, $\Theta \sim 0.6\text{mrad}$, $\Phi \sim 5\text{mrad}$

**Coincidence Trigger:**
- Electron Trigger + Hardron Trigger (pions, and maybe kaons)
SoLID-SIDIS Configuration

CLEO

MRPC

HGC

LGC

GEM

EC

IHEP, COMPASS Shashlik, 2010

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SoLID-SIDIS Phase Space Coverage

- Natural extension of E06-010
- Much wider phase space
- Both transversely and longitudinally polarized target
SoLID-SIDIS

- SIDIS: 4-D (x, pt, Q2, z) probe of nucleon transverse momentum distributions (TMDs)
- SoLID-SIDIS studies TMDs with extensive coverage and resolutions (48 Q-z bins)

One Typical Bin to show the good statistics
Transversity to Tensor Charge

Tensor Change: Lowest moment of transversity
- Fundamental quantity
- Beyond Standard model searches:
  parameters depend on precision of tensor charge

\[ \delta q = \int_0^1 dx (h_1^q(x) - h_1^q(x)) \]

Global model fits to experiments (SIDIS and e+e-)

1 - 12 GeV SoLID (projection)

Extractions from experiments:
2,3 - Anselmino et al, Phys.Rev. D87 (2011)
4 - Anselmino et al, Nucl. Phys. Proc. Sup;
5 - Bacchetta, Courtoy, Radici, JHEP 130;

Lattice QCD:
6 - Alexandrou et al, PoS(LATTICE 2014)

DSE:
8 - Pitschmann et al, (2014)
9 - Hecht, Roberts and Schmidt, Phys. Re;

Models:
10 - Cloet, Bentz and Thomas, Phys. Lett.
13 - Gamberg and Goldstein, Phys. Rev. I
Sivers Function

- The distribution of unpolarised parton in a transversely polarized neutron
- Sign change between SIDIS and Drell-Yan
- Significant Improvement in the valence quark (high-\(x\)) region

Illustrated in a model fit (from A. Prokudin)

Future EIC

With future SoLID-SIDIS data

Multi Dimensional Probe

\[ f_{1\perp} \]

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Access the orbital angular momentum (OAM) of quarks and gluons with transverse n/p

**Pretzelocity:** L=0 and L=2 interference (S-D int.)
L=1 and L=-1 interference (P-P Int)

**Worm-Gear:** L=0 and L=1 Interference.
Quick Summary

**SIDIS Summary:**
- TMDs provide plentiful 3D information of the nuclear structure.
- TMDs can be probed via SIDIS on polarized targets.
- Hall-A 6GeV results showed the power of SIDIS on TMD study.
- New SoLID-SIDIS experiments aims to perform 4-D precise measurements of TMDs.

**SoLID Summary:**
- Take advantage of latest detector and electronics techniques.
- Active MC simulation, software developments and Pre-CDR & Prototyping.

**SoLID Timeline:**
- CLEO-II magnet has been requested and will be transported in 2017.
- Pre-conceptual Design Report has been submitted in 2014.
- Director review in Feb. 2015.
- Planning to move forward (DOE Science Review).
Explore GPDs in SoLID:

- DVCS with transverse and longitudinal polarized proton and neutrons
- Doubly-DVCS, DVMP, Timelike DVCS...
**GPD Study @ SoLID**

- DVCS with polarized electron beam and targets:
  - NH3: Transversely polarized (proton)
  - He3: Transversely & Longitudinally polarized (neutron)

<table>
<thead>
<tr>
<th>Polarization</th>
<th>Asymmetries</th>
<th>CFFs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal Beam</td>
<td>$A_{LU}$</td>
<td>$\text{Im}{\mathcal{H}_p, \mathcal{H}_p, \mathcal{E}_p}$&lt;br&gt;$\text{Im}{\mathcal{H}_n, \mathcal{H}_n, \mathcal{E}_n}$</td>
</tr>
<tr>
<td>Longitudinal Target</td>
<td>$A_{UL}$</td>
<td>$\text{Im}{\mathcal{H}_p, \mathcal{H}_p}$&lt;br&gt;$\text{Im}{\mathcal{H}_n, \mathcal{E}_n, \mathcal{E}_n}$</td>
</tr>
<tr>
<td>Long. Beam + Long. Target</td>
<td>$A_{LL}$</td>
<td>$\text{Re}{\mathcal{H}_p, \mathcal{H}_p}$&lt;br&gt;$\text{Re}{\mathcal{H}_n, \mathcal{E}_n, \mathcal{E}_n}$</td>
</tr>
<tr>
<td>Transverse Target</td>
<td>$A_{UT}$</td>
<td>$\text{Im}{\mathcal{H}_p, \mathcal{E}_p}$&lt;br&gt;$\text{Im}{\mathcal{H}_n}$</td>
</tr>
<tr>
<td>Long. Beam + Trans. Target</td>
<td>$A_{LT}$</td>
<td>$\text{Re}{\mathcal{H}_p, \mathcal{E}_p}$&lt;br&gt;$\text{Re}{\mathcal{H}_n}$</td>
</tr>
</tbody>
</table>
GPD Study @ SoLID

- Double-DVCS: $e + p/ n \rightarrow e' + p/ n + l^+ + l^-$
  - A lepton pair in the final state instead of a real photon
  - Can access GPDs beyond the $x = \xi$ limit
  - New LOI submitted to 2015-PAC and aimed for a proposal to 2016-PAC

- Timelike-DVCS:
  - Inverse of the space-like DVCS
  - Extract the real part of CFFs
  - New proposal, run with SoLID-J/Psi

- Deep Virtual Meson Production:
  - One meson in the final state ($\pi^0, \rho^0, \omega^0$, etc.)
  - Quantum numbers probe individual GPD components more selectively than DVCS:
    \[ \rho^0/\rho + /K^* \rightarrow H^', \xi \quad (u/d), \pi, \eta, K \rightarrow H, \bar{H} \]
  - Aimed for a new proposal, run with SoLID-SIDIS
Summary

- Understanding the nucleon structure from 1D (PDFs&FF) to 3D (TMDs & GPDs)
- SIDIS provides a powerful tool to study TMDs
  - 8 leading twist TMDs to access quark spin & OAM, tensor change, and so on
- SoLID-SIDIS programs will perform 4D precise measurements of TMDs
  - Three A rated experiments, two newly approved “bonus” experiments, and more ...
- With the features of high luminosity and large acceptance, SoLID can explore a wide range of physics topics:
  - SIDIS, PVDIS, J/Psi, GPD, and more ...
- With the similar SoLID-SIDIS setup, we can also study GPDs via DVCS and etc.
  - Three Letter-of-Intents and one proposal will be submitted in this PAC.
- SoLID - A strong and still expending collaboration:
  - 200+ physicists, 50+ institutions and significant international contributions ...
- Welcome to join the SoLID collaboration and explore more physics programs
Backup Slides
GPD Study @ SoLID

- Generalized Parton Distributions (GPD):
  - Encode Information of the parton distribution in both the transverse plane and longitudinal direction.
  - Four GPDs for quarks or gluons:
    \( H^{q/g}, E^{q/g}, \tilde{H}^{q/g}, \tilde{E}^{q/g} \)
  - Connect to FF & PDFs: e.g.

\[
\begin{align*}
\int_0^1 dx H^q(x, \xi, t) &= F_1^q(t) \\
\int_0^1 dx E^q(x, \xi, t) &= F_2^q(t) \\
\int_0^1 dx \tilde{H}^q(x, \xi, t) &= g_A^q(t) \\
\int_0^1 dx \tilde{E}^q(x, \xi, t) &= g_P^q(t)
\end{align*}
\]

- \( X \to \) Longitudinal quark momentum fraction (not experimental accessible)
- \( \xi \to \) Longitudinal momentum transfer. In Bjorken limit:
  \(~x_B/(2-x_B)\)
- \( t \to \) Total squared momentum transfer to the nucleon:
  \( t = (P-P')^2 \)

- Angular Momentum Sum Rule (Ji’s Sum Rule):
  \( (X. \ Ji, \ PRL \ 78, \ 610 \ (1997)) \)

\[
J_{q/g} = \frac{1}{2} \int_{-1}^{+1} dx \cdot x [H^{q/g}(x, \xi, 0) + E^{q/g}(x, \xi, 0)]
\]
Deeply Virtual Compton Scattering (DVCS):

\[ \frac{d\sigma}{dQ^2 dx_B dt d\phi} \propto |\tau_{DVCS}|^2 + I + |\tau_{BH}|^2 \]

Interference-Term

\[ I = |\tau_{DVCS}^* \tau_{BH}^* + \tau_{DVCS}^* \tau_{BH}|^2 \]

Compton Form Factor (CFF):

\[ \tau_{DVCS} \propto \int_{-1}^{+1} H(x, \xi, t) dx = P \int_{-1}^{+1} H(x, \xi, t) dx - i \pi H(\pm \xi, \xi, t), \]

\[ \tau_{BH} \propto \text{from Nucleon FF, } F_1 \text{ & } F_2 \]

Can access GPDs via DVCS by measuring the \( \Phi \) dependence of DVCS & Interference Terms

CFFs access GPDs at \( x=\xi \)

In the asymmetry:

\[ A = \frac{I}{|\tau_{DVCS}|^2 + I + |\tau_{BH}|^2} \]

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GPD Study @ SoLID

- DVCS with polarized electron beam and targets:
  - Beam-Spin Asymmetry (ALU):
    \[ \Delta \sigma_{LU} \propto \sin \phi \text{Im}\{F_1 \mathcal{H} + \xi (F_1 + F_2) \tilde{\mathcal{H}} + kF_2 \mathcal{E}\}d\phi \]
  - Longitudinal Target-Spin Asymmetry (AUL):
    \[ \Delta \sigma_{UL} \propto \sin \phi \text{Im}\{F_1 \tilde{\mathcal{H}} + \xi (F_1 + F_2) \mathcal{H} + kF_2 \mathcal{E}\}d\phi \]
  - Longitudinal Double-Spin Asymmetry (ALL):
    \[ \Delta \sigma_{LL} \propto (A + B \cos \phi) \text{Re}\left\{F_1 \tilde{\mathcal{H}} + \xi (F_1 + F_2) \left(\mathcal{H} + \frac{x_B}{2} \mathcal{E}\right)\right\}d\phi \]
  - Transverse Target-Spin Asymmetry (AUT):
    \[ \Delta \sigma_{UT} \propto \sin \phi \text{Im}\{k (F_2 \mathcal{H} - F_1 \mathcal{E}) + \ldots\}d\phi \]
  - Transverse Double-Spin Asymmetry (ALT):
    \[ \text{Im}\{\mathcal{H}_p, \mathcal{H}_n, \mathcal{E}_p, \mathcal{E}_n\} \]
    \[ \text{Re}\{\mathcal{H}_p, \mathcal{H}_n, \mathcal{E}_p, \mathcal{E}_n\} \]

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Magnet

◆ CLEO-II Solenoid Magnet: from Cornell Univ.

Goals:
→ Acceptance: $\Phi$: 2$\pi$, $\theta$: 8°-24° (SIDIS), 22°-35° (PVDIS),
  $P$: 1.0 - 7.0 GeV/c,
→ Resolution: $\delta P/P \sim 2\%$ (requires 0.1 mm tracking resolution)
→ Fringe field at the front end < 5 Gaus

Status:
→ CLEO-II magnet formally requested and agreed in 2013:
  Built in 1989 and operated until 2008, uniform central field at 1.5 T,
  Inner radius 2.9 m, coil radius 3.1 m and coil length 3.5 m
→ Site visit in 2014, disassembly in 2015 and plan transportation in 2017
→ Design of supporting structures and mounting system at JLab

CLEO at Cornell

CLEO in Hall–A
Detectors

◆ **GEM:**

- 6 planes (SIDIS/JPsi), area~37 m² (165K outputs),
- work in high rate and high radiation environment,
- tracking eff.>90%, radius resolution ~ 0.1 mm,

**Status:**

- **UVa:** First full size prototype assembled, and beam test at Fermi Lab Oct 2013

- **China:** CIAE/USTC/Tsinghua/LZU)
  - 30x30 cm prototype constructed and readout tested, and now moving to 100cmx50cm
  - Gem foil production facility under development at CIAE
  - Continue on read-out electronics design and test

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30cmx30cm GEM prototype

100cmx50cm GEM foil

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Detectors

◆ Multi-gap Resistive Plate Chamber:

**Goals:**
- 50 super-modules, each contains 3 modules, 1650 strips and 3300 output channels.
- Timing resolution < 100ps
- Works at high rate up to 10 KHz/cm2
- Photon suppression > 10:1
- $\pi/k$ separation up to 2.5GeV/c

**Status:**
- Prototype Developed at Tsinghua
- Beam test at Hall-A in 2012
- New facility for mass production
- Read-out electronics design
Detectors

**Electromagnetic Calorimeters (EC):**

**Goals:**
- Shashlyk sampling calorimeters
- 1800 modules (2 R.L.) for PreShower, 1800 modules (18 R.L) for Shower
- Electron eff. > 90%, E-Resolution ~ 10%/\sqrt{E}, 
  \pi suppression > 50:1
- Rad. Hard (<20% decreasing after 400K Rad)

**Status:**
- Sophisticated Geant Simulation
- Active Pre-R&D at UVa and Jlab
- Sample&PMT tests and Pre-Amp design

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Detectors

◆ Scintillating Pedal Detectors (SPD):

**Goals:**
- For SIDIS/JPsi only
- Two planes (in front of LAEC and FAEC):
  - LASPD: 60 modules, 5 mm or thicker, photon rej. 10:1
  - FASPD: 60 modules x 4 radius, photon rej. 5:1
- LASPD timing resolution < 150ps

**Status:**
- Design and Simulation
- Pre-R&D at UVa and JLab
Triggers & DAQ

- **Triggers:**
  - Estimation based on sophisticated Geant simulation and well-tune physics models
  - PVDIS: LGC+EC provide electron triggers, 27 KHz/sector, 30 sectors
  - SIDIS: Coincident trigger between electrons and hardrons within a 30 ns window:
    - LASPD+LAEC provide electron triggers, 25 KHz
    - LGC+FASPD+MRPC+FAEC provide electron trigger, 129 KHz
    - FASPD+MRPC+FAEC provide hardron trigger, 14 MHz
    - 66 KHz + 6 KHz (eDIS)

- **Read-Out and Data Acquisition System:**
  - Use fast electronics to handle the high rates (FADC, APV25, VETROC, etc.)
  - Read out EC clusters to reduce background
  - Current design can take the trigger rates
    - 60 KHz per sector for PVDIS, and 100 KHz overall for SIDIS
  - Use Level-3 to further reduce the events size
  - Learn new developments from others (e.g. Hall-D)