Future SiD ECal Projects

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This document records potential future projects related to the SiD ECal, and to the notes by A. Steinhebel published on Confluence (`https://confluence.slac.stanford.edu/pages/viewpage.action?pageId=227155228`). Currently planned future studies are indicated with a dagger (†). Estimates of study timelines are indicated as *long* (the type of project for a summer student), *medium* (a potential component of a larger study done by a longer-term contributor taking between one week and a few months), or *short* (doable in a day with the proper software background).

- Test Beam Studies
  1. Confirm measured MIP value [*short*]
     Use cosmics data from the SLAC test beam run to confirm the MIP value of 4 fC.
  2. Investigate late-forming showers [*medium*]
     Late-developing electron showers are likely classified as contamination in the current scheme. Investigate the late-developing shower hypothesis by, for example, comparing hits in early prototype layers of suspected late-developing events and compare to a standard shower shape.
  3. Leakage estimation [*medium*]
     Can the first few prototype layers be used to estimate the energy of the total shower? If so, this can be used as a potential leakage estimation tool for late-developing showers.
  4. Confirm cleaning with upstream layers [*medium*]
     Look at hits only in the upstream layers before cleaning out contamination. Can a clear distinction be made between true events and contamination?
- Shower Counting Algorithm
  1. Optimize algorithm [*medium*]
     Continue to optimize the efficiency with which the algorithm can count EM showers. The current efficiency of tagging two-electron events is around 85%.
- Leakage studies
  1. Add error bars to shower profile curves [*short*]
- ~~Software/Geometry Updates~~ - as of Nov. 2017
  1. ~~ECal module numbering [*short*]~~
     ~~Update ECal module numbering scheme so that ECal module 0 sits in front of HCal module 0 (currently, ECal module 2 is in front of HCal module 0).~~
  2. ~~Eliminate silicon layer0 tracking layer in module overlap region [*medium*]~~
     ~~Model ECal with shortened layer0 so that this tracking layer does not fall within the module overlap region and validate that the design does not decrease physics performance.~~
- Non-Linear Calibration Studies
  1. Test nonlinear calibration term with physics data [*long*]
     Incorporate the nonlinear calibration term into the current calibration protocol and test its effects on calibration. Should it be more permanently incorporated into the standard calibration scheme?
  2. Consider phi dependence on nonlinear term [*medium*]
     Determine calibration constants (both linear and nonlinear) as a function of phi, considering in particular the overlap region. How does the geometry affect the calibration?
  3. Calculate sampling fraction ratio [*short*]
     Calculate the true factor between thick and thin tungsten layers with which deposits behind thick tungsten layers are scaled by. All previous studies have assume this value to be identically 2.

4. Confirm relevant calibration range [*medium*]
   Find the energy distribution of τ-leptons from $\sqrt{s} = 250$ GeV e^+e^- events where $e^+ + e^- \to H + Z,\ H \to \tau^+ + \tau^-$ to confirm that calibration is being done in an appropriate energy range.

5. Reconcile simulation energy resolution with TDR [*medium*]
   Discover discrepancy between the simulation's ECal energy resolution value of $20\%/\sqrt{E}$ as compared to the TDR reported value of $17\%/\sqrt{E}$. Ensure that all reported values are consistent.

- Design Optimization Studies

  1. Active layer reduction [*long*] †
     Reduce number of active silicon layers to 25 and analyze physics effect, including energy resolution. Consider different configurations of tungsten absorber lengths and number of "thick" vs "thin" layers while holding the total depth of 26 X_0 of tungsten constant. For example, scan through incident π^0 energies and find the energy at which reconstruction breaks down therefore discovering at what energy information begins to get lost.

  2. Module design optimization [*long*]
     Optimize the bottom angle of each trapezoidal module from the current 30^o design. Analyze the effect on the size of the subsequent module overlap region and therefore the physics effect.