SoLID EC Update

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for EC group
What’s new

- PVDIS
  - Using background produced with 1\textsuperscript{st} plane baffle inner radius at 4\text{cm} (change from 2\text{cm}) which reduces low energy photons to about half, thus we have lower radiation dose and better e- efficiency and pi rejection
  - Trigger study
- SIDIS
  - forward angle EC moves back 10\text{cm} to make room for HGCC which doesn’t affect EC performance.
- Layout
- Cost update
PVDIS
Updated radiation dose VS layers (High radiation $\phi$ slice)

- Photon (EM) <- dominant!
- Photon ($\pi^0$)
- Electron
- Pion- Pion+ Proton

Improve by two-fold

$3^{rd}$ Update

New: $4^{th}$ Update
PVDIS Update on PID
Mid radius, higher $\gamma$ $\phi$-band shown
Other configuration also simulated

Improvement

Pion Efficiency

Electron Efficiency

Update

8/19/2013
Figure 12: Calorimeter pion and electron efficiency for the PVDIS experiment, evaluated with the presence of background at eight typical regions on the calorimeter.
PVDIS EC Trigger Effect

Electron

Pion

Trigger Efficiency vs Momentum (GeV/c)

R = 33 cm, Trig = 2.5 GeV
R = 190 cm, Trig = 2.5 GeV
R = 190 cm, Trig = 2.0 GeV
R = 220 cm, Trig = 2.0 GeV
R = 247 cm, Trig = 2.0 GeV
PVDIS Rate on EC

before trigger

\( \gamma(EM) \ 5.4 \times 10^8 \text{ kHz} \)
\( e(EM) \ 4.4 \times 10^6 \text{ kHz} \)
\( e(DIS) \ 9.6 \times 10^2 \text{ kHz} \)
\( \pi^+(DIS) \ 1.5 \times 10^6 \text{ kHz} \)
\( \pi(DIS) \ 1.2 \times 10^6 \text{ kHz} \)
\( \gamma(\pi^0(DIS)) \ 1.1 \times 10^6 \text{ kHz} \)

after trigger at 2GeV

\( e(DIS) \ 5.9 \times 10^2 \text{ kHz} \)
\( \pi^+(DIS) \ 1.3 \times 10^4 \text{ kHz} \)
\( \pi(DIS) \ 4.7 \times 10^4 \text{ kHz} \)
SIDIS EC Performance

Figure 10: Calorimeter pion and electron efficiency before (blue) and after (red) the consideration background in the SIDIS experiment. As a bottom line for performance, worse background situation was evaluated here (inner radius region).
Layout: forward angle EC (FAEC) from ANL

Module Assembly 2, Tube Coordinates (Victor Guarino)

Center Set "B"
Center set "A"
Budget Estimate Update
IHEP (not including fibers) for 1700 PS+SH

- Preshower: $112k-$120k
- Shower: $549k-$651k
- Structure+assembly: $255k-$340k

IHEP total: ($1.22-$1.51)M + 24% overhead (2012 rate) = ($1.51-$1.87)M

Fiber connectors+tubing (Leoni+other): ~$300k

WLS+clear fibers with diamond-cutting: $777k+$448k (S.G.) - $1.66M (Kuraray)

PMTs: $640x2x(\sim1900)=$2.43M

Total from above (no contingency): ($5.3M-$5.7M) if using S.G.

Labor? Shipping? Contingency?
Cost @ May 2013 Meeting

- Based on 1700 modules
- No quote yet for SPD
- No quote yet for Shower fiber mirrors (IHEP)
- Updated fiber cost with diamond-tool cutting (do not know yet if IHEP can cut the fibers)
Cost Update

- Will be based on 1800 modules;

- SPD quote: $(40-70)k$ (IHEP very rough estimate)

- Quote for WLS fiber cutting, polishing, adding mirrors (IHEP): $50$/piece a few years ago, now $(20-30)$% higher $\rightarrow $(108-117)$k$

- Need to order all WLS fibers in spools and ship to IHEP, need $(10-15)$% longer length to allow cutting.

- We still need to cut the other end of WLS fibers and all clear fibers (CLAS12 cutters).
Cost Update

IHEP (not including fibers) for 1800 PS+SH

- Preshower: $113k-$122k
- Shower: $570k-$678k
- Structure+assembly: $540k-$720k
- Fiber cutting + mirrors: $108k-$117k
- IHEP total: ($1.38-$1.70)M + 30% overhead (changed from 24% for a conservative estimate) = ($1.80-$2.21)M

- Fiber connectors+tubing (Leoni+other): ~$300k
- WLS+clear fibers (S.G), rough ends: $234k+$564k
- PMTs: $640x2x(~1900)= $2.43M

Total from above (no contingency): ($5.33M-$5.74M)

- Labor ($0.75M)? Shipping ($0.5M)? Contingency (30%): → $8.6M - $9.2M
Plan for Budgeting

- Plan to reduce cost:
  - MAPMT study, now it's clear can do gain-matching at the FADC level. Any need for small-scale tests? – potential saving of up to $800k;
  - Get a MAPMT quote;
  - Customized PMT bases? (current base cost is $912k);
  - Smaller PMTs for Preshower?
Possible Design Update – Multi-Anode PMTs

- Current Preshower readout: 1 PMT ($600)/module, but each module is read out by only a couple of fibers so we are wasting cross-sectional area of the PMT;

- MAPMT: about $100/channel → potential saving of PS PMT from $1.02M to $200k;

- To be studied: gain-matching between channels of one MAPMT. LHCb used specialized front-end electronic modules to produce digital triggers. We could use FADC directly, no need for FE-electronics.
Backup
EC performance w/o background

- Cited from March collaboration Meeting

![Graph showing π⁻ rejection and e⁻ efficiency vs. Momentum (GeV) with a note: Preshower ID power drop significantly at this bin.](image)
Forth update of CLEO background

Cutting 2cm away on 1st baffle inner radius
Received background simulation from Zhiwen on May 24
Updated: Per-event pion rate for 1+6 hexagon cluster at Mid radius, high radiation $\phi$-slice

- Electron (mostly absorbed in Pb)
- Pion-
- Pion+

3rd Update

New 4th Update
Trigger turn on curve for 2 GeV electron
Shower Hex 1+6 trigger > 1.6 GeV

Outer radius, higher $\gamma \phi$-band, full bgd

100% pass for ~250 events/bin

Middle radius, higher $\gamma \phi$-band, full bgd

Pion Efficiency

Electron Efficiency

8/19/2013
Trigger turn on curve for 2.5 GeV electron Shower Hex 1+6 trigger > 2.1 GeV

Middle radius, higher γ ϕ-band, full bgd

Inner radius, higher γ ϕ-band, full bgd

Pion Efficiency

Electron Efficiency
Readout occupancy per shower channel for ~75MeV zero suppression

- High radiation phi slice
- Low radiation phi slice

Improved probability distribution.
(a) Stacked probability to find number of background $\pi^-$ (light blue), $\pi^+$ (dark blue) and electrons (green) at the front of preshower detector. The photons are significantly off scale at a rate of $\sim 3$ GHz.

(b) Stacked probability (count per 50k events) to find scintillator energy deposition for incoming background particle species of electrons (green), $\pi^-$ (light blue), $\pi^+$ (dark blue), protons (Yellow), EM process-originated photons (magenta) and $\pi^0$-originated photons (dark magenta). As comparison Energy deposition for high energy pion (red) and electrons (blue) are shown as non-filled curves.
Third update of CLEO background

- Received background simulation from Zhiwen on May 19
- Running background imbedding
Background imbedding and distribution
Mid-R, High Radiation phi slice

- Photon (6GHz/6+1 Hex cluster)
- Electron
- Pion- Pion+ Proton
Updated: Per-event pion rate
for 1+6 hexagon cluster at Mid radius, high radiation $\phi$-slice

Background particle per trigger

- Electron (mostly absorbed in Pb)
- Pion-
- Pion+

+ 6 GHz photon not shown (3GHz for lower $\phi$-radiation)
Update on PID with DC component removal (PS > MIP + Bgd + (2-3) σ)

Outer radius, higher γ φ-band

Due to Soft EM γ

Outer radius, lower γ φ-band

Pion Efficiency

Electron Efficiency
Update on PID with DC component removal (PS > MIP + Bgd + (2-3) σ)

Due to Hadron rate

Mid radius, higher γ φ-band

Pion Efficiency

Electron Efficiency
More detail in PID cut
Middle radius, lower γ φ-band, full bgd
Update on PID with DC component removal (PS > MIP + Bgd + (2-3) σ)

Inner radius, higher γ φ-band

Inner radius, lower γ φ-band

Pion Efficiency

Electron Efficiency
Trigger turn on curve for 2 GeV electron
Shower Hex 1+6 trigger > 1.6 GeV

Inner radius, higher $\gamma \phi$-band, full bgd

Middle radius, higher $\gamma \phi$-band, full bgd

Pion Efficiency

Electron Efficiency

100% pass for ~250 events/bin

Physics

8/19/2013
Trigger turn on curve for 2.5 GeV electron
Shower Hex 1+6 trigger > 2.1 GeV

Middle radius, higher γ φ-band, full bgd

Outer radius, higher γ φ-band, full bgd

Pion Efficiency

Electron Efficiency

8/19/2013
More detail in trigger cut

Middle radius, higher $\gamma \phi$-band, full bgd
Shower Hex 1+6 trigger > 2.1 GeV
Readout occupancy per shower channel for ~75MeV zero suppression

- High radiation phi slice
- Low radiation phi slice

![Graph showing probability as a function of radius with data points for high and low radiation slices.](image-url)