SiD Response to Benchmarking List

The reduced benchmarking list of 7+1 processes described in section IV of http://arxiv.org/pdf/hep-ex/0603010 (page 9) has been proposed as the starting point for the list of common LOI benchmarks. The SiD proposes that the list be pared down a little, and that physics observables be defined explicitly for each process. The SiD recommends the following for the common LOI physics benchmarks:

0. Single $e^{\pm}$, $\mu^{\pm}$, $\pi^{\pm}$, π^0, $K^{\pm}$, K_s^0, γ, W, Z; $0 < |\cos\theta| < 1$, $0 < p < 500$ GeV

Measure identification efficiency, misidentification efficiency, and energy resolution as a function of $|\cos\theta|$ and particle energy. Note that the W and Z bosons have been added to the list; only light quark decays of the W and Z bosons should be considered. These processes are not so much physics benchmarks as they are lepton id, flavor id, V0 reconstruction, and PFA performance benchmarks.

1. $e^+e^- \to f\bar{f}$, $f = \mu$, c, b at $\sqrt{s}$=1.0 TeV;

The muon pair final state is used to measure the luminosity-weighted center-of-mass energy. This will challenge the momentum measurement of very high energy charged particles in both the central and forward regions. The $c\bar{c}$ and $b\bar{b}$ final states are used to examine the coupling of charm and bottom quarks to a 7 TeV Z' boson through the measurement of the left-right forward-backward asymmetry A_{FB}^{LR} for charm and bottom. This measurement requires good vertex detector performance to isolate heavy flavor jets and to measure the quark charge.

2. $e^+e^- \to Zh$, $\to \ell^+\ell^- X$, $l = e, \mu$, $m_h = 120$ GeV at $\sqrt{s}$=0.25 TeV;

Classic measurement of Higgs mass and $\sigma(e^+e^- \to Zh)$. Note the center-of-mass energy.

3. $e^+e^- \to Zh$, $h \to b\bar{b}$, $c\bar{c}$, gg, $\tau^+\tau^-$, WW^*, $\gamma\gamma$, $\mu^+\mu^-$, $m_h = 120$ GeV at $\sqrt{s}$=0.25 TeV;

Measure a variety of Higgs branching fractions. The decays $b\bar{b}$, $c\bar{c}$, gg test the vertex detector, the decays $\tau^+\tau^-$, WW^*, $\gamma\gamma$ challenge the calorimeter, while the rare Higgs decay $H \to \mu^+\mu^-$ provides a benchmark for the measurement of charged particle momentum.

4. $e^+e^- \to Zhh$, $m_h = 120$ GeV at $\sqrt{s}$=0.5 TeV;

Measure the triple Higgs coupling. Excellent benchmark for integrated detector performance. Tests ability of detector to measure jet-jet masses and separate b and c jets. A measurement of the b quark charge may also come into play.

6. $e^+e^- \to \tilde{\tau}_1\tilde{\tau}_1$, at Point 3 at $\sqrt{s}$=0.5 TeV;

Measure the mass of the stau lepton and $\sigma(e^+e^- \to \tilde{\tau}_1\tilde{\tau}_1)$. Classic low visible energy benchmark which challenges the far forward detector and many other detector components.

7. $e^+e^- \to \tilde{\chi}_1^+\tilde{\chi}_1^-/\tilde{\chi}_2^0\tilde{\chi}_2^0$ at Point 5 at $\sqrt{s}$=0.5 TeV;

Measure the mass of the second lightest neutralino χ_2^0 and $\sigma(e^+e^- \to \chi_2^0\chi_2^0)$. In this scenario the lightest chargino and second lightest neutralino decay to on-shell W and Z bosons, respectively. This is primarily a W/Z separation benchmark that is used to test calorimeter and PFA performance.