Status report on SiD global parameters study and PFA activities at MIT

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18 August 2009

Goals and plans

- ## Short tem: Revisit SiD global parameters
  - Especially those relating to the HCAL
  - Follow up Marcel's "SiDish" study
  - Have some things to say by Albuquerque ALPCG meeting
  - Keep in mind physics performance vs. cost as well as jet energy resolution vs. global parameters
- ## Longer term: Contribute to PFA development
  - Provide additional effort on existing SiD PFAs
  - And/or investigate PandoraPFA
    - What would be needed to run a Pandora-like PFA in org.lcsim?
    - Identify the important differences between SiD PFAs and PandoraPFA
- ## Feedback is welcome
  - What are the highest priorities?
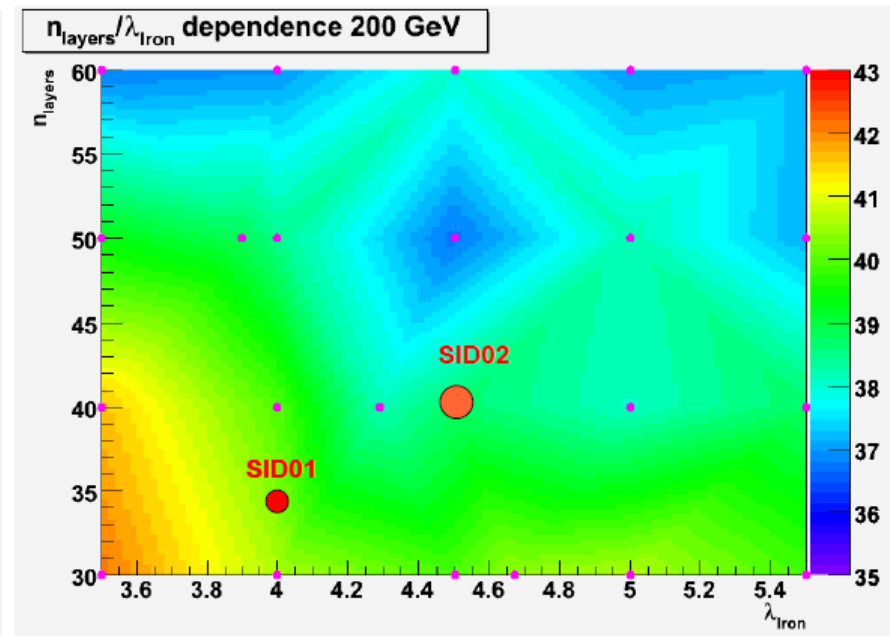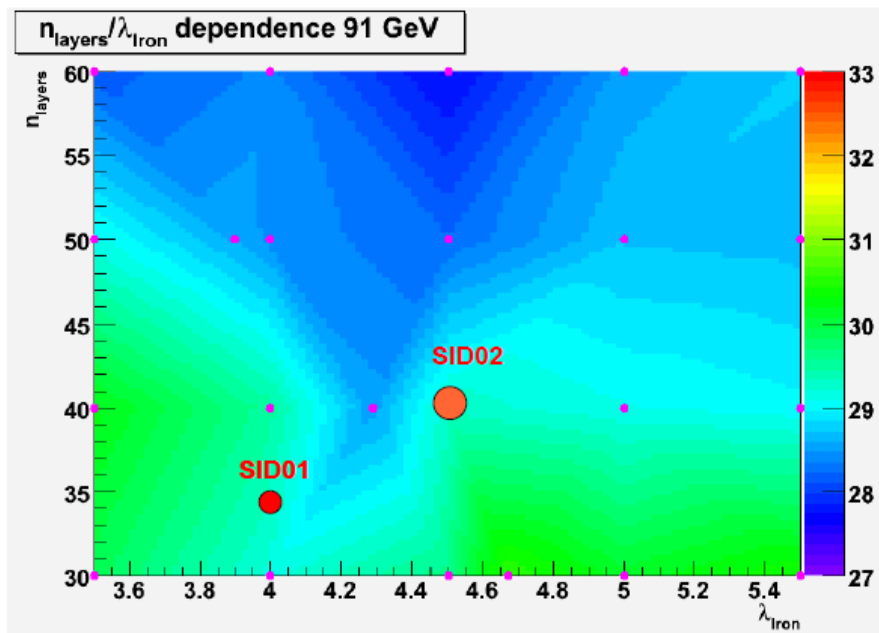
Where SiDish studies got us

- Explored a considerable region of detector parameter space
  - B-field (4T, 5T (sid02), 6T)
  - ECAL inner radius (1.0 m, 1.25 m (sid02), 1.5 m)
  - ECAL inner Z (lenght of SiD) (1.5 m, 1.7 m (sid02), 1.9 m, 2.1 m)
  - HCAL depth (3.5 - 5.5 lambda)
  - HCAL longitudinal segmentation (30 - 60 layers)
  - See Marcel's talk and paper: "Detector Optimization for SiD"
    - http://ilcagenda.linearcollider.org/contributionDisplay.py?contribId=147&sessionId=23&confId=2628
    - arXiv:0902.3205
- Used qqbar events
  - at 91 and 200 GeV CMS
  - $|\cos(\theta)| < 0.7$
  - Also studied forward endcap region using u jets
- Performance measured in terms of alpha in %:
  - $\sigma(E)/E = alpha/\sqrt{E}$
- Provided essential input for the LoI

Marcel's SiDish variants

TAG	Layers	total thickness	Iron thickness	Scintillator thickness	HCAL thickness	λ_{tot}
SIDish_v2_hcal30	30	32.7	26.2	6.5	980	4.92
SIDish_v2_hcal40	40	24.5	18.0	6.5	980	4.61
SIDish_v2_hcal50	50	19.6	13.1	6.5	980	4.45
SIDish_v2_hcal30_l45	30	31.7	25.2	6.5	951	4.75
SIDish_v2_hcal40_l45	40	25.4	18.9	6.5	1016	4.83
SIDish_v2_hcal50_l45	50	21.6	15.1	6.5	1081	4.91
SIDish_v2_hcal60_l45	60	21.6	15.1	6.5	1081	4.91
SIDish_v2_hcal30_l50	30	34.5	28.0	6.5	1035	5.25
SIDish_v2_hcal40_l50	40	27.5	21.0	6.5	1100	5.33
SIDish_v2_hcal50_l50	50	23.3	16.8	6.5	1165	5.41
SIDish_v2_hcal60_l50	60	20.5	14.0	6.5	1230	5.49
SIDish_v2_hcal30_l55	30	37.3	30.8	6.5	1119	5.75
SIDish_v2_hcal40_l55	40	29.6	23.1	6.5	1184	5.83
SIDish_v2_hcal50_l55	50	25.0	18.5	6.5	1249	5.91
SIDish_v2_hcal60_l55	60	21.9	15.4	6.5	1314	5.99
SIDish_v2_hcal30_l40	30	28.9	22.4	6.5	867	4.25
SIDish_v2_hcal40_l40	40	23.3	16.8	6.5	932	4.33
SIDish_v2_hcal50_l40	50	19.9	13.4	6.5	997	4.41
SIDish_v2_hcal60_l40	60	17.7	11.2	6.5	1062	4.49
SIDish_v2_hcal30_l35	30	26.1	19.6	6.5	783	3.75
SIDish_v2_hcal40_l35	40	21.2	14.7	6.5	848	3.83
SIDish_v2_hcal50_l35	50	18.3	11.8	6.5	913	3.91
SIDish_v2_hcal60_l35	60	16.3	9.8	6.5	978	3.99

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2

Marcel Stanitzki

SiDish HCAL parameter results

- ## For barrel region
  - – Over 20 (depth, layer) combinations per plot

What we're working on

- Revisit HCAL parameter studies in SiD framework
  - Extend to higher energies (500 and 1000 GeV)
  - Determine alpha vs. energy for each variant
  - Check for any differences with SiDish
  - Changes include
    - `Simulation:        Mokka → SLIC`
    - `Reconstruction:  Marlin → org.lcsim`
    - `PFA:                 PandoraPFA → Iowa PFA`
    - `Tracking:           TPC → All silicon`
    - `                         Track cheaters → real tracking`
    - `HCAL readout     Scint/analog → RPC/digital`
    - `HCAL segm.        3x3 cm → 1x1 cm`
  - Study single particles too
    - Check linearity and resolution for gammas, n's, KL's
    - Similar to Norm's studies in sid02_scint
      - http://ilcagenda.linearcollider.org/materialDisplay.py?contribId=1&materialId=slides&confId=3378

Resources – at MIT

- Scripts set up for relatively easy job submission at MIT
- Given stdhep and compact.xml files
  - Run SLIC
  - Calibrate detector variant using Ron's and Mat's/Taejong's code:
    - Use LCDetectors/detectors/sid02/ calibration files as starting point
    - Sampling fractions
      - Use qqbar at all energies of interest (100 to 1000 GeV)
      - Use QSFCalibrationFromData.java
      - Save AIDA file for inspection
      - Save last set of SF values printed in log files
        » Replace values in ./SamplingFractions/{EM,HAD}{Barrel,Endcap}.properties files
    - Photon and neutral hadron calibration
      - Use ZZnunubaruds events at 500 GeV
      - Use QuickCalibrationFromData.java
      - Save photon and nh values printed in log file
        » Replace values in ./{photon,hadron}Calibration/{photon,nh}Qcal-v2r3p10.properties files
    - PFA calibration
      - Use ZZnunubaruds events at 500 GeV
      - Run Mat's likelihood.sh script
      - Produces a binary likelihood.bin file
        » Place this file in the ./structuralPFA/ calibration directory
    - Assume we can use existing sid02 LongitudinalHmatrix.hmx file
      - What sorts of detector variations will require a new version?
        » Major ECAL changes, presumably
  - Run reconstruction/PFA
  - Determine jet energy resolution, other numbers
    - As in Ron's Summary.table (next slide)

Resources – at SLAC

- A number of existing detector variants already exist at SLAC
  - Leverage these where appropriate, noting simulation and recon versions
  - Ron's summary file lists many of these: /nfs/slac/g/lcd/mc/prj/users/cassell/Summary.table

E.g., sid01

Produce
same
numbers for
variants
under study

```
Detector info    Data    Anal      #evts Emean90 Erms90 jEres% alpha% Mmea90 Mrms90 dM/M %
s_127_S_rpc_dig: qq200:PPR    : 7275:  -0.72:  2.77:  1.96:  19.6: -0.74:  2.77:  1.39
               :        :DT>2   : 7275:  -2.16:  3.71:  2.65:  26.5: -2.17:  3.72:  1.88
               :        :DT>5   : 7275:  -2.94:  3.84:  2.76:  27.6: -2.96:  3.87:  1.96
               :        :MatPFA: 7275: 195.14:   6.6:  4.78:  47.8: -4.98:  6.66:  3.42
               :        :FastMC: 7275:  -1.59:  7.74:  5.52:  55.2: -1.76:  7.85:  3.96
               :        :PPRGen: 7275:   -0.7:  2.68:  1.91:  19.1: -0.71:  2.68:  1.35
               : qq500:PPR    : 5506:  -1.63:  5.81:  1.65:  26.0: -1.67:  5.83:  1.17
               :        :DT>2   : 5506:  -6.52: 20.25:   5.8:  91.8: -6.52: 20.43:  4.14
               :        :DT>5   : 5506:   -7.3: 20.36:  5.84:  92.4: -7.33: 20.57:  4.17
               :        :MatPFA: 6582: 486.76: 21.18:  6.15:  97.3:-13.36: 21.39:   4.4
               :        :FastMC: 7332:   -8.6: 26.36:  7.59: 119.9:  -9.5: 27.84:  5.68
               :        :PPRGen: 7332:  -1.78:  5.76:  1.64:  25.9:  -1.8:   5.8:  1.16
               :qq1000:PPR    : 7246: -11.86: 18.41:  2.63:  58.9:-12.06:  18.8:   1.9
               :        :DT>2   : 7246: -19.38: 51.57:  7.44: 166.3:-19.17: 52.44:  5.35
               :        :DT>5   : 7246: -20.28: 51.65:  7.46: 166.7:-20.08: 52.53:  5.36
               :        :FastMC: 7246: -24.82: 59.46:  8.62: 192.8:-27.19: 63.86:  6.56
               :        :PPRGen: 7246: -11.86: 18.38:  2.63:  58.8:-12.06: 18.77:   1.9
               : ZZ500:PPR    : 2639:  -0.29:   3.2:  1.97:  21.2:  0.08:  2.33:  2.55
               :        :DT>2   : 2639:  -2.19:   6.1:  3.78:  40.6: -0.86:  2.91:  3.22
               :        :DT>5   : 2639:  -2.89:  6.18:  3.85:  41.3: -1.34:  2.97:  3.31
               :        :MatPFA: 2639: 223.12: 28.32: 17.95: 192.5: -1.89:   4.4:  4.93
               :        :FastMC: 2639:  -2.33: 10.16:  6.31:  67.7: -1.28:  4.67:  5.19
               :        :PPRGen: 2639:  -0.38:  3.14:  1.93:  20.7: -0.66:  1.81:   2.0
```

Preliminary case: sid02_plus10

HCAL+10% Based on sid02 geometry

	sid02	sid02_plus10
SolenoidBarrelInnerRadius	255	266.2
SolenoidBarrelOuterZ	288	299.3
HADBarrel, HADEndcal layer repeat	40	44
MuonEndcap inner r	20	20
MuonEndcap inner z	303.3	314.5
MuonEndcap outer r	608.2	619.2
MuonBarrel	Computed	Computed

Sim

Z mass: comparison with sid02
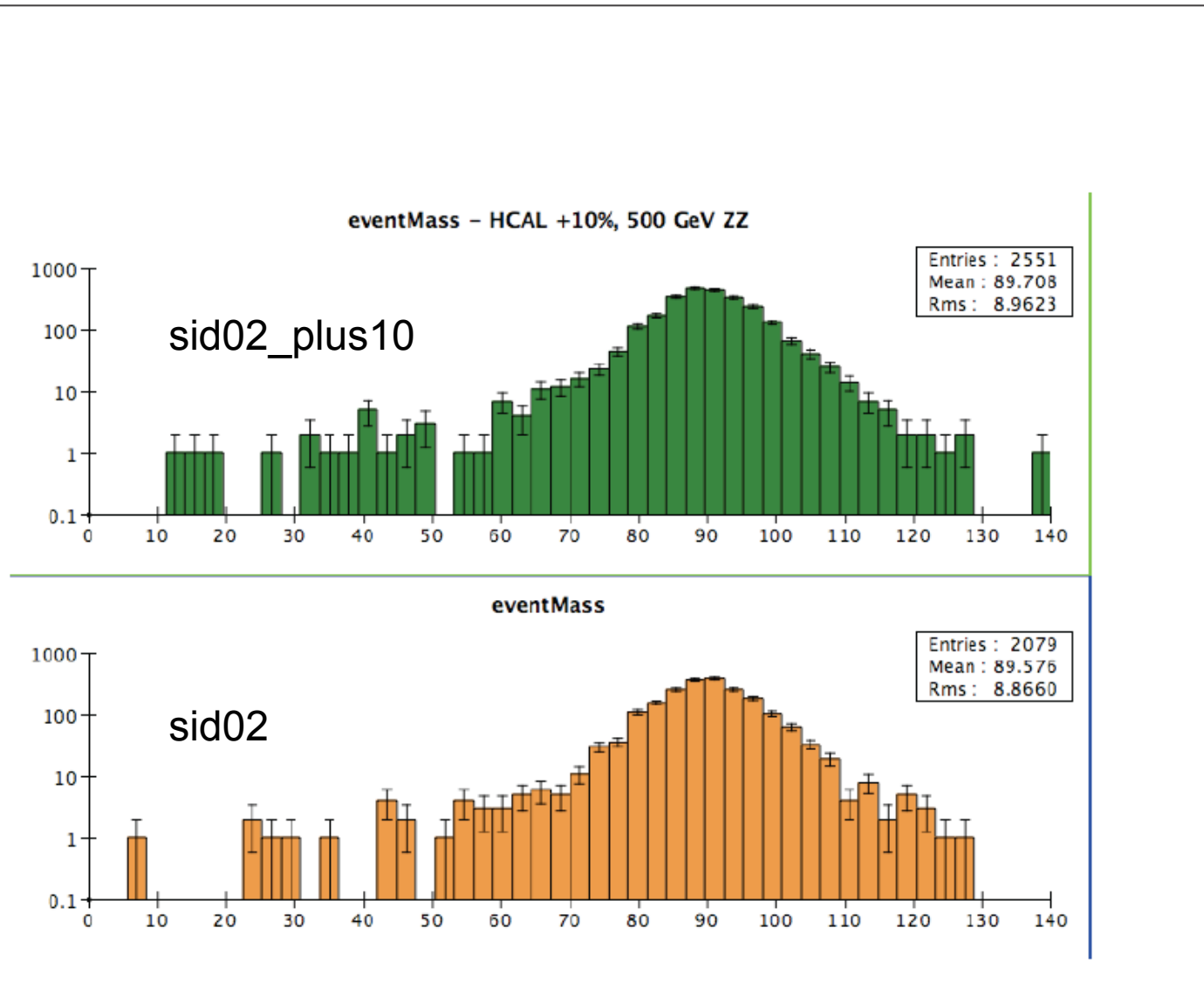
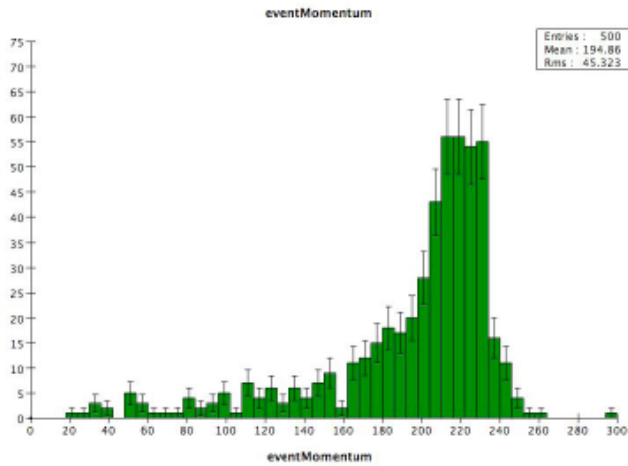# Calibration comparison: Z mass
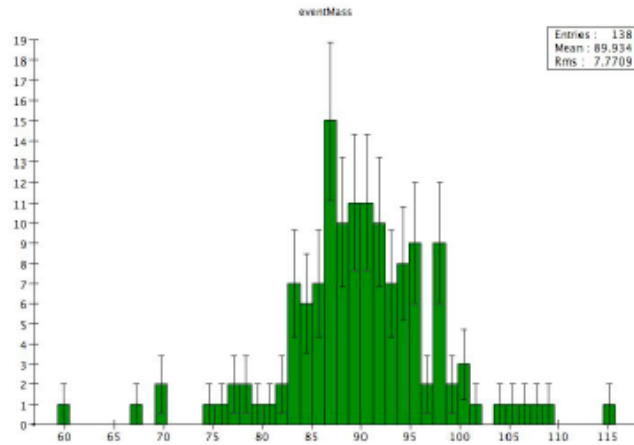
calibration constants
for sid02_plus10
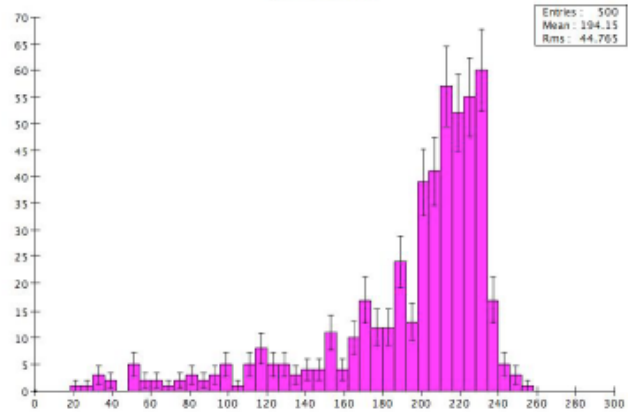computed from scratch

sid02 Calibration constants
applied to sid02_plus10

Sim
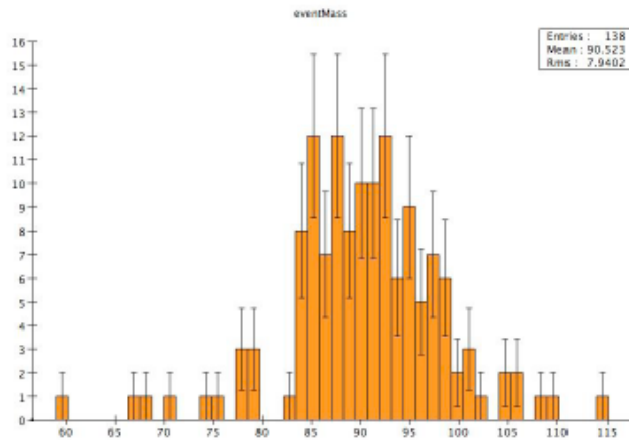
Calibration comparison: event mom.

calibration constants
for sid02_plus10
computed from scratch

sid02 Calibration constants
applied to sid02_plus10

Other Ideas

- Remember that the PFA approach is being used outside the context of ILC detectors
  - Example: CMS
    - Joe Incandela: *"Particle–Flow Event Reconstruction in CMS and Performance for Jets, Taus, and Emiss_T"* http://cms-physics.web.cern.ch/cms-physics/public/PFT-09-001-pas.pdf
- It may be useful to keep in touch with folks outside the ILC PFA community as well
  - We wonder if it might make sense at some point to hold a PFA workshop addressing both the ILC and non-ILC PFA community
- What about the effect of leading particles in showers?
  - Can consideration of lateral vs. longitudinal spread provide information?