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

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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 (length 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

Partial list of Marcel's SiDish variants

From HCAL depth and segmentation study

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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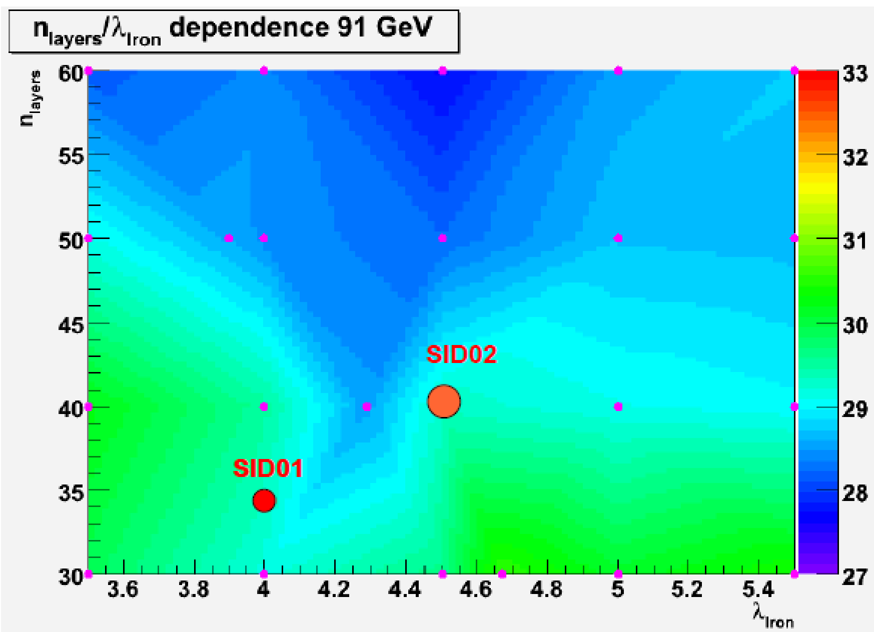
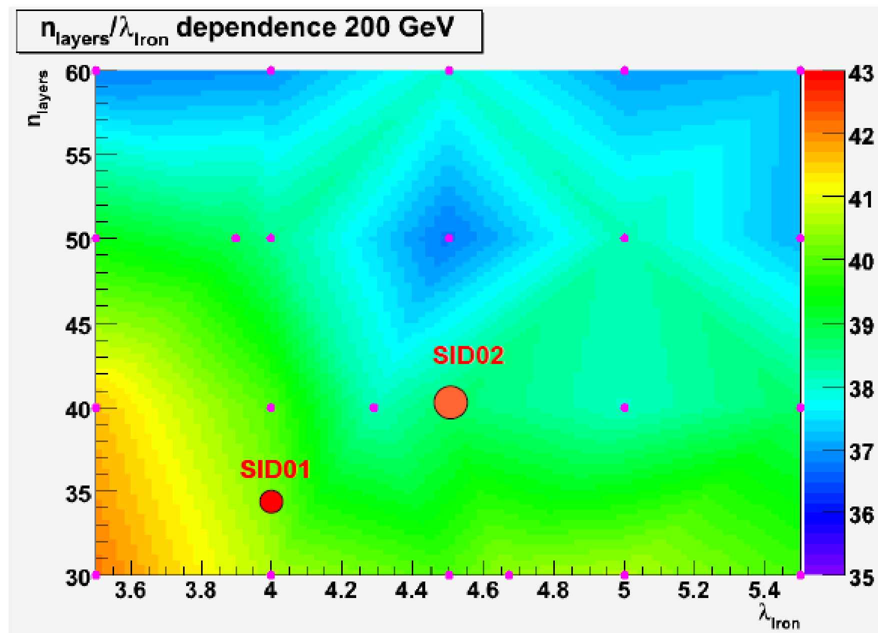
Marcel Stanitzki

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
    - Add other "enhancements"
      - HCAL crosstalk and noise via digisim

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
    - Some variants may benefit from re-running simulation and/or recon/PFA with current org.lcsim code
  - Ron's summary file lists many of these: /nfs/slac/g/lcd/mc/prj/users/cassell/Summary.table

E.g., sid01

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

Produce same numbers for variants under study

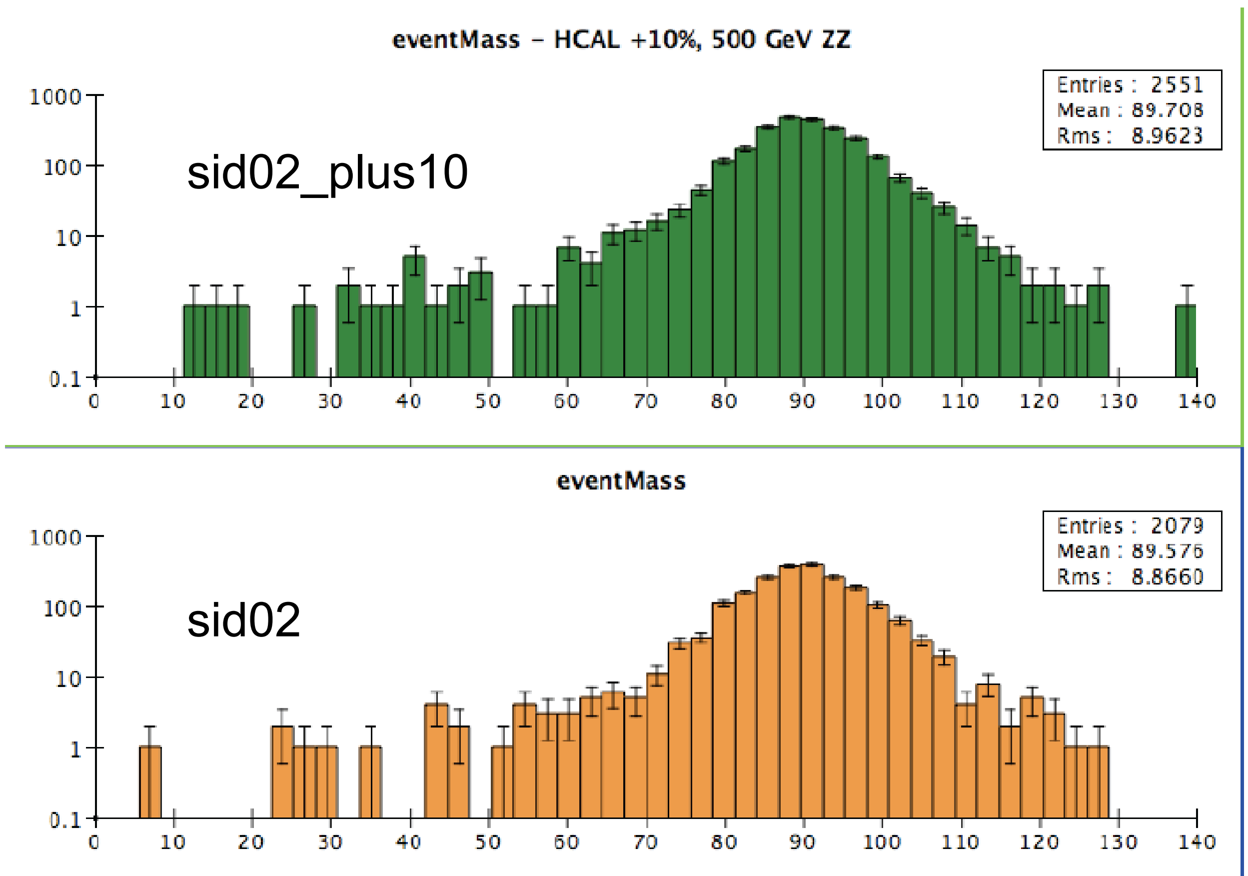
Preliminary case: sid02_plus10

HCAL+10% Based on sid02 geometry

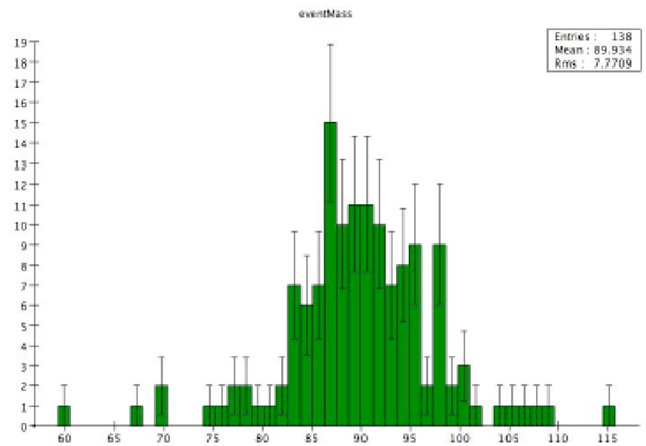
	sid02	sid02_plus10
SolenoidBarrelInnerRadius	255	266.2
SolenoidBarrelOuterZ	288	299.3
HADBarrel, HADEndcal layer repeat	40	44
MuonEndcap inner r	20	20
MuonEndcap inner z	303.3	314.5
MuonEndcap outer r	608.2	619.2
MuonBarrel	Computed	Computed

Add 4 layers

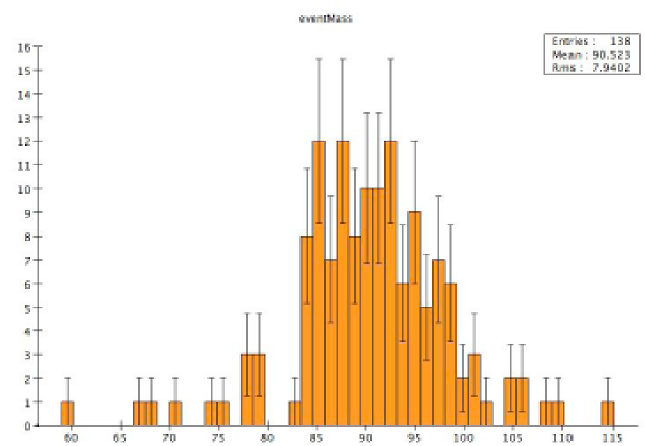
Z mass: comparison with sid02



Calibration comparison: Z mass

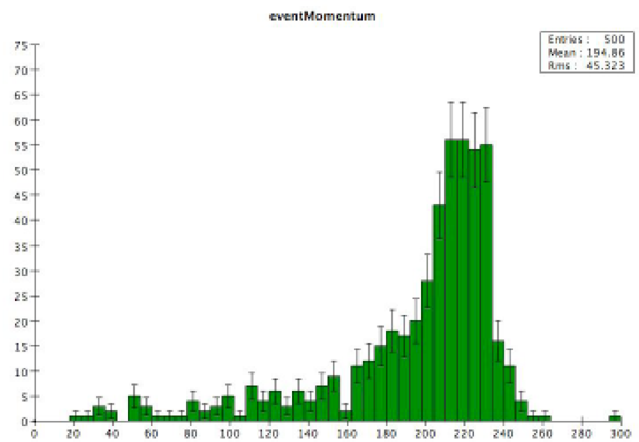


calibration constants
for sid02_plus10
computed from scratch

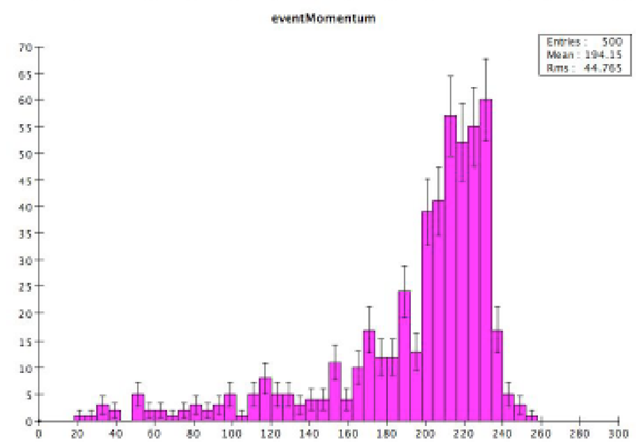


sid02 Calibration constants
applied to sid02_plus10

Calibration comparison: event mom.



calibration constants
for sid02_plus10
computed from scratch



sid02 Calibration constants
applied to sid02_plus10

Additional 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
- Can other shower characteristics be used to divide showers into categories with different statistical behavior?
  - What about the effect of leading particles in showers?
  - Can consideration of lateral vs. longitudinal spread provide information?
  - Some studies along this line have been done before
    - Is it useful to do so again?