Progress of SiD Towards the DBD

Tim Barklow
SLAC
for the SiD Concept

Overview

Introduction - Detector design
- Design Study Organization

Areas of SiD to be included in DBD

Area-by-area summary for detector components

Simulation/reconstruction, PFA

Benchmarking

Costs

DBD Editors

Collaboration with CLIC on DBD

The SiD Design

A compact, cost-constrained detector designed to make precision measurements and be sensitive to a wide range of new phenomena.

-> Compact design with 5T field.

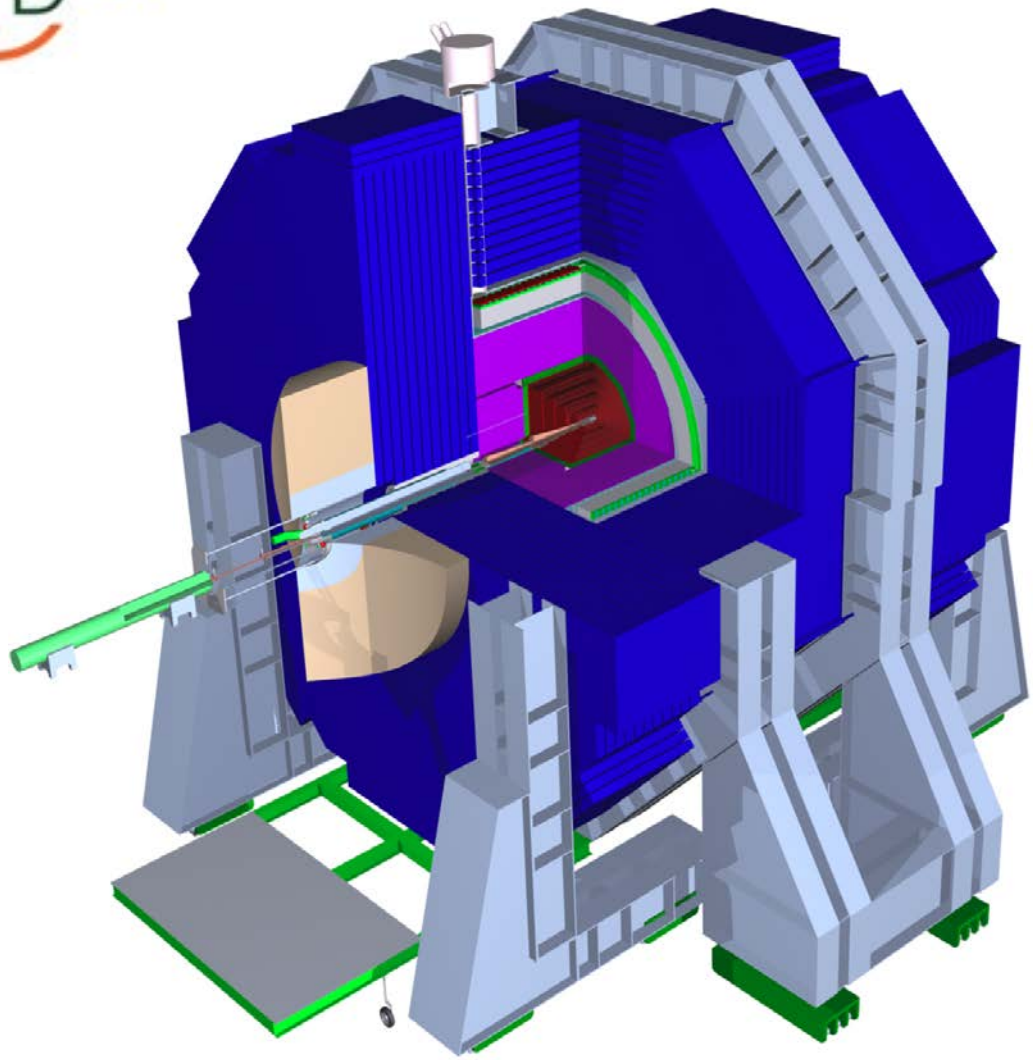
-> Robust silicon vertexing and tracking system – excellent momentum resolution, live for single bunch crossings.

-> Calorimetry optimized for jet energy resolution, based on a Particle Flow approach, “tracking calorimeters”, compact showers in ECal, highly segmented (longitudinally and transversely) ECal and HCal.

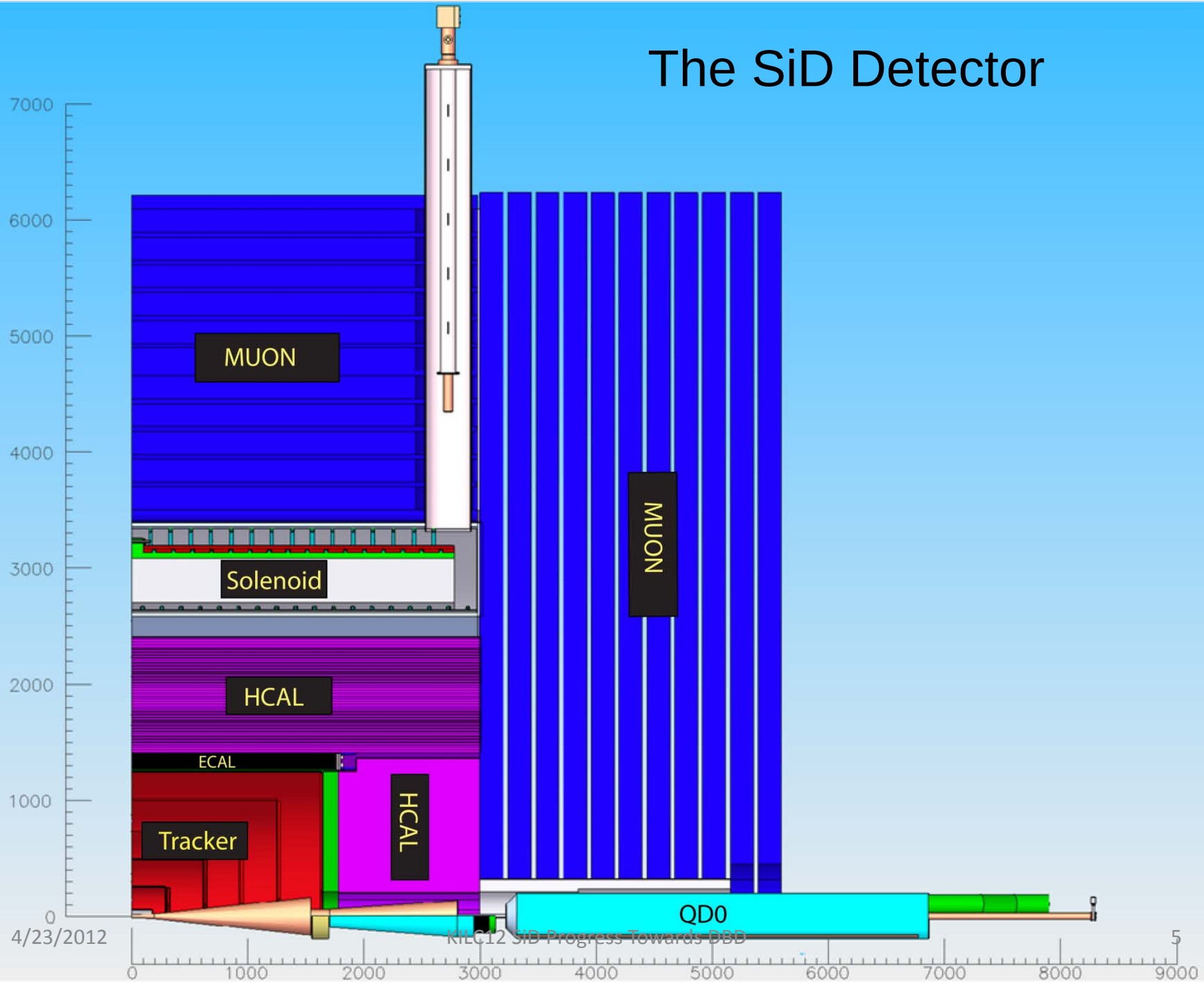
-> Iron flux return/muon identifier – component of SiD self-shielding.

-> Detector is designed for rapid push-pull operation.

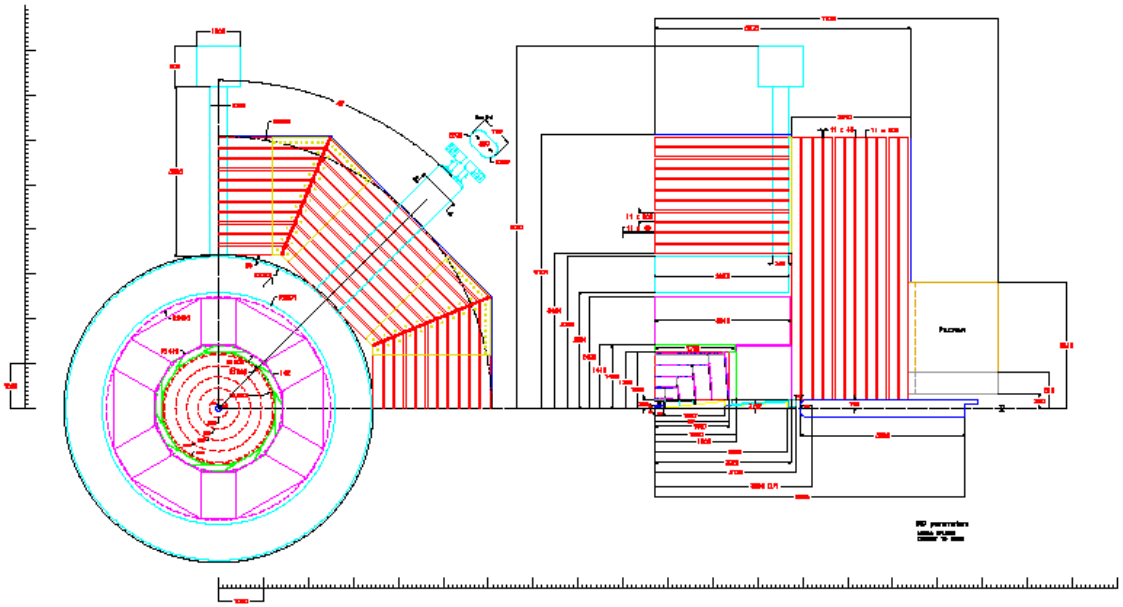
The Silicon Detector Concept



The SiD Detector



SiD Global Parameters

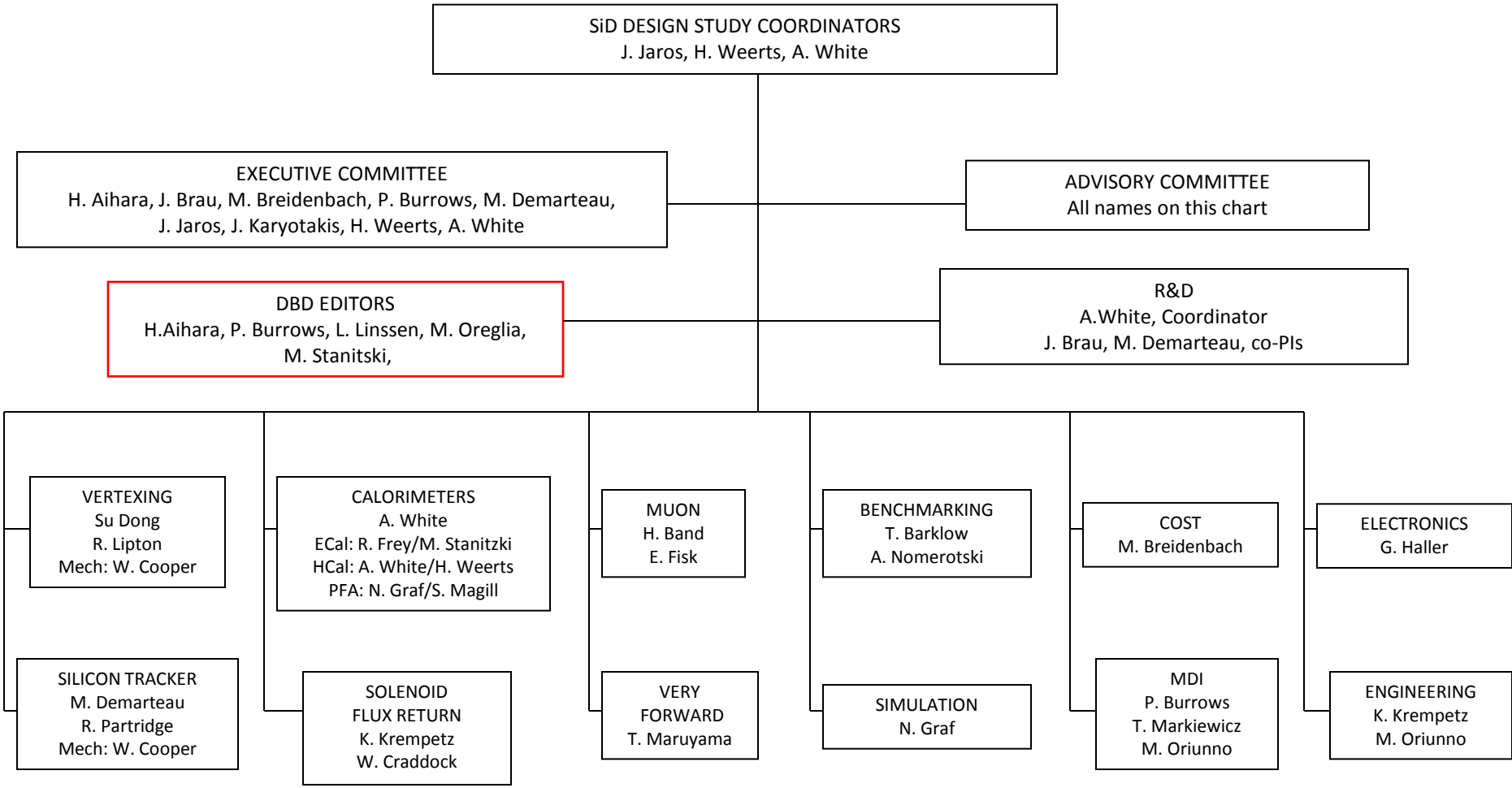


Detector	Technology	Radius (m)		Axial (z) (m)	
		Min	*Max*	*Min*	*Max*
Vertex Detector	Pixels	0.014	0.06		0.18
Central Tracking	Strips	0.206	1.25		1.607
Endcap Tracker	Strips	0.207	0.492	0.85	1.637
Barrel Ecal	Silicon-W	1.265	1.409		1.765
Endcap Ecal	Silicon-W	0.206	1.25	1.657	1.8
Barrel Hcal	RPCs	1.419	2.493		3.018
Endcap Hcal	RPCs	0.206	1.404	1.806	3.028
Coil	5 tesla	2.591	3.392		3.028
Barrel Iron	RPCs	3.442	6.082		3.033
Endcap Iron	RPCs	0.206	6.082	3.033	5.673

Combining barrel and endcaps these trackers and calorimeters cover $|\cos\theta| \leq 0.99$

LumiCal and BeamCal (described later) are used for $|\cos\theta| > 0.99$

SiD Design Study Organization



-> Current focus on preparation/organization/writing for DBD .

-> Next SiD Workshop: August 21-23@SLAC

DBD - Areas of SiD

Introduction and Philosophy of the SiD Detector Concept
Vertex detector
Tracking detector
E.M. calorimeter
Hadron calorimeter
Muon system
Forward calorimeters
Solenoid
MDI
Simulation/reconstruction/PFA
Benchmarking
Costs

DBD – Summary by Area

Groups/collaborators
System description
Critical R&D and Goals

Key R&D results to date
(not an exhaustive R&D report)

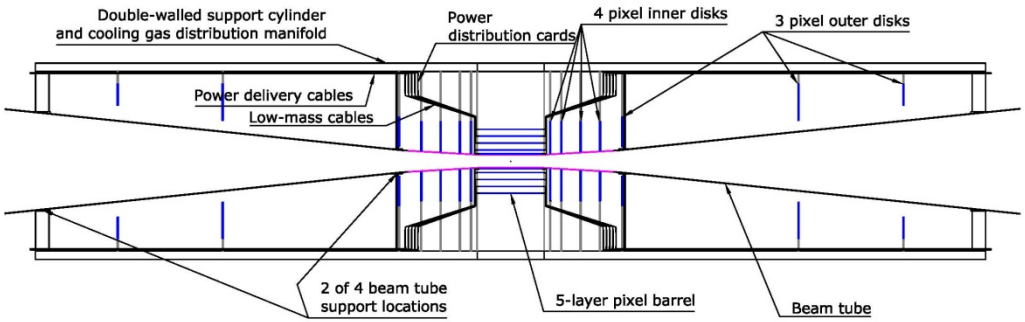
Timeline for R&D
Results anticipated for DBD
Issues and concerns

Vertex Detector

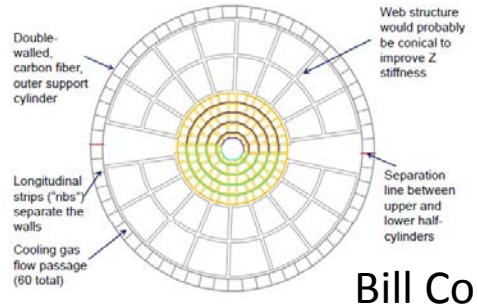
Participating Institutions: PLUME, SiLC, Fermilab, SLAC, Cornell U., U. of New Mexico, U. of Oregon, Yale U.

Baseline: Silicon pixels, all-silicon barrel, carbon fiber end rings & support cylinder
Option 1: Silicon on foam sensor support
Option 2: Silicon on carbon fiber sensor support
Option 3: Silicon micro-strip outer disks (vs. pixels)

Vertex Detector Side Elevation



End view



Bill Cooper (FNAL)

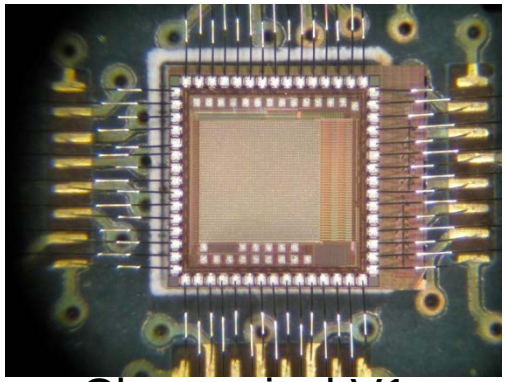
Area of critical R&D/goals

Sensor technology R&D: Incorporate latest developments
Low-mass structures: Demonstrate all-silicon, silicon on carbon fiber, & silicon on foam structures
Power delivery: Develop DC-DC conversion & serial power
Cooling/cabling/vibrations: Fabricate & test R&D structures for vibrations due to air cooling & pulsed power

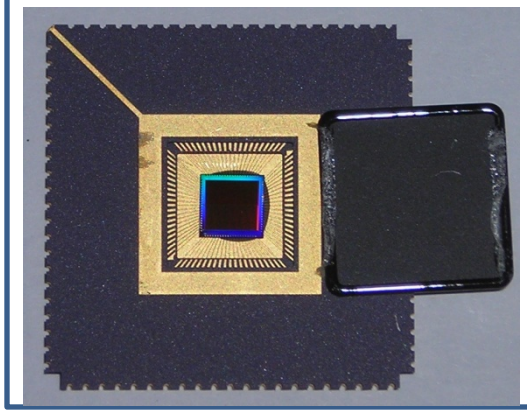
Vertex Detector

Sensor R&D and results to date for 3D and Chronopixel

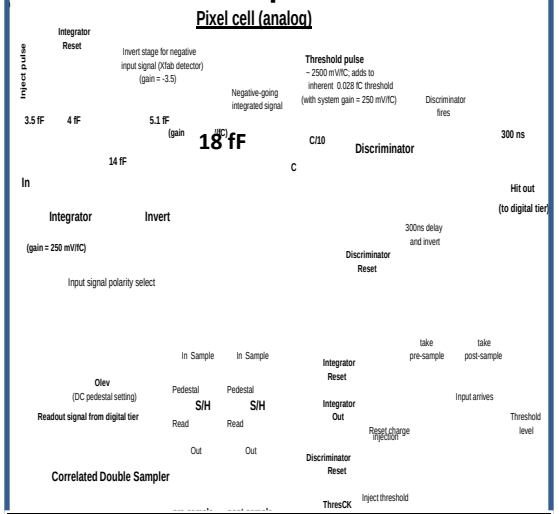
VIP 2a – 3 tier MIT-LL

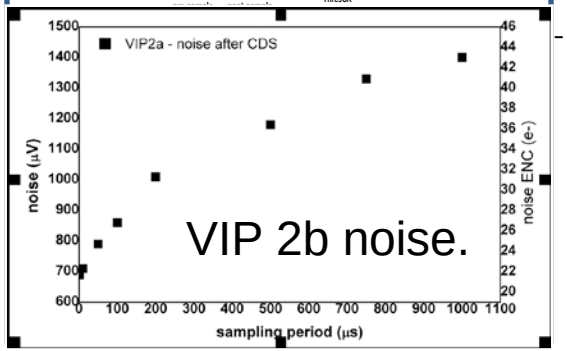


Chronopixel V1



VIP 3D chip





VIP

- VIP2a (3-tier MIT-LL chip) is produced and tested
- Both analog and digital sections work well, solving problems found in VIP1
- VIP2b (2-Tier Tezzaron/Global foundries) is in process.
- Initial tests of 2D test devices shows good analog performance.
  noise = 8e + 0.5 e/ fF
- Sensors for 3D integration of VIP2b produced and tested.

Chronopixel

- Measured noise of 24 e, specification is 25 e.
- Sensitivity measured to be 35.7µV/e, exceeding design spec of 10µV/e.
- Comparator accuracy 3 times worse then spec, need to improve this in prototype 2.
- Sensors leakage currents ($1.8 \cdot 10^{-8}$ A/cm^2) is not a problem.
- Readout time satisfactory
- Prototype 2 late 2011, 65nm TSMC

Vertex Detector

Timeline for R&D
- Sensor technology R&D: On-going Chronopixel, 3D prototypes produced
- Low-mass structures: Silicon structures of each type have been made; R&D is paused on all structures except silicon on foam, which is progressing well.
- Power delivery: R&D is expected to resume in FY2012.
- Cooling/cabling/vibrations: R&D awaits power delivery results. B field studies? (Yale)

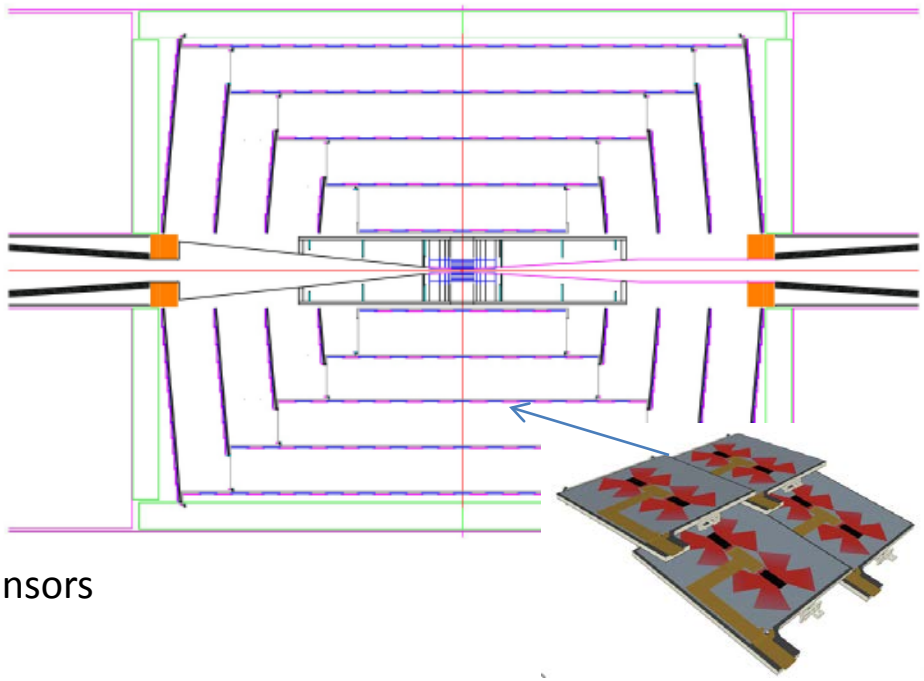
Results expected for inclusion in DBD
- Conceptual VTX+beam pipe design
- Plume low mass ladder results
- 3D sensor integration with readout (VIP2b chip), Chronopixel tests v2.
- CMOS MAPS and DepFET experience in STAR and BELLE
- Benefit from parallel work on e.g. CMS Track Trigger Upgrade

Issues/concerns for DBD and beyond
- No funding to proceed on support R&D. Expertise, mandrels,…available
- Limited ability to consider system aspects of designs
- No ability to demonstrate low mass ladder/sensor concepts outside of PLUME work

Silicon Tracker

Participating Institutions:
ANL, FNAL, Michigan, New Mexico, Oregon, UC Davis, UCSC

Baseline: silicon tracking; no alternatives considered



First priority R&D:

- Development of KPIX chips and associated sensors
- Studies of signal to noise and crosstalk
- Development of sensors, modules and overall support structures for the barrels and disks
- Studies of pulsed power, power delivery, and associated vibrations
- Studies of heat removal, particularly from the disks
- Studies of alignment precision and monitoring

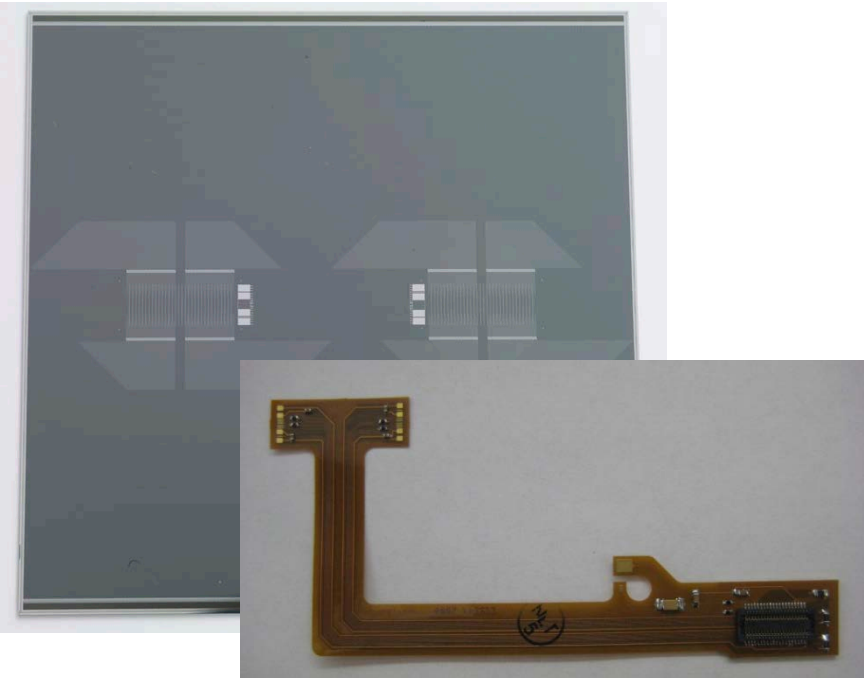
Second priority R&D:

- Studies of alternative sensors and readout to provide z information
- Development of cabling
- Development of module fabrication techniques

Silicon Tracker: Status

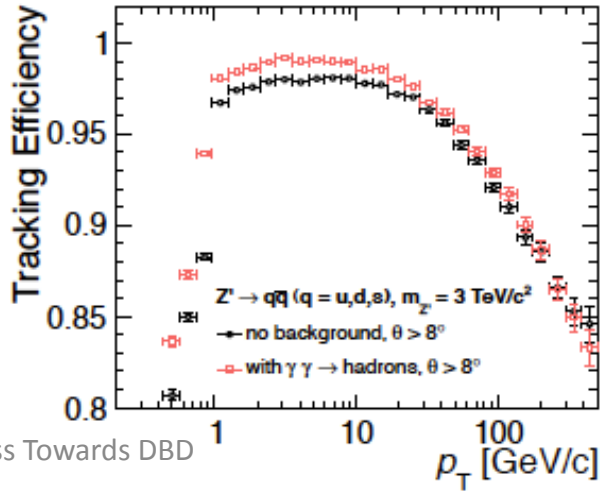
Module

- All components in hand
  - 1024 channel KPiX chip
  - Sensor
  - Cable
- Had difficulties in past bump bonding KPiX to sensors; IZM vendor appears to have solved the problem



Software

- Optimized tracking algorithms for CLIC_SiD and studies at 3 TeV
  - Silicon tracking performs very well under severe conditions: Z' → qqbar @ 3 TeV



Silicon Tracker: Timeline

Modules:

- Complete full Si module this year
- Bench test (noise, crosstalk, …) and, if time permits, beam tests at SLAC in 2012

Alignment:

- Resume laser scanned interferometry (U. Michigan/K. Riles) 2012

Reconstruction:

- A robust system has been tested for CDR – fine for DBD
- $\Rightarrow$ Study tracking algorithms and optimize the layout and segmentation if effort available

Concerns:

- Personnel to construct/test Si module
- People to study pulse powering and associated vibration tests

ECal

SLAC National Accelerator Lab

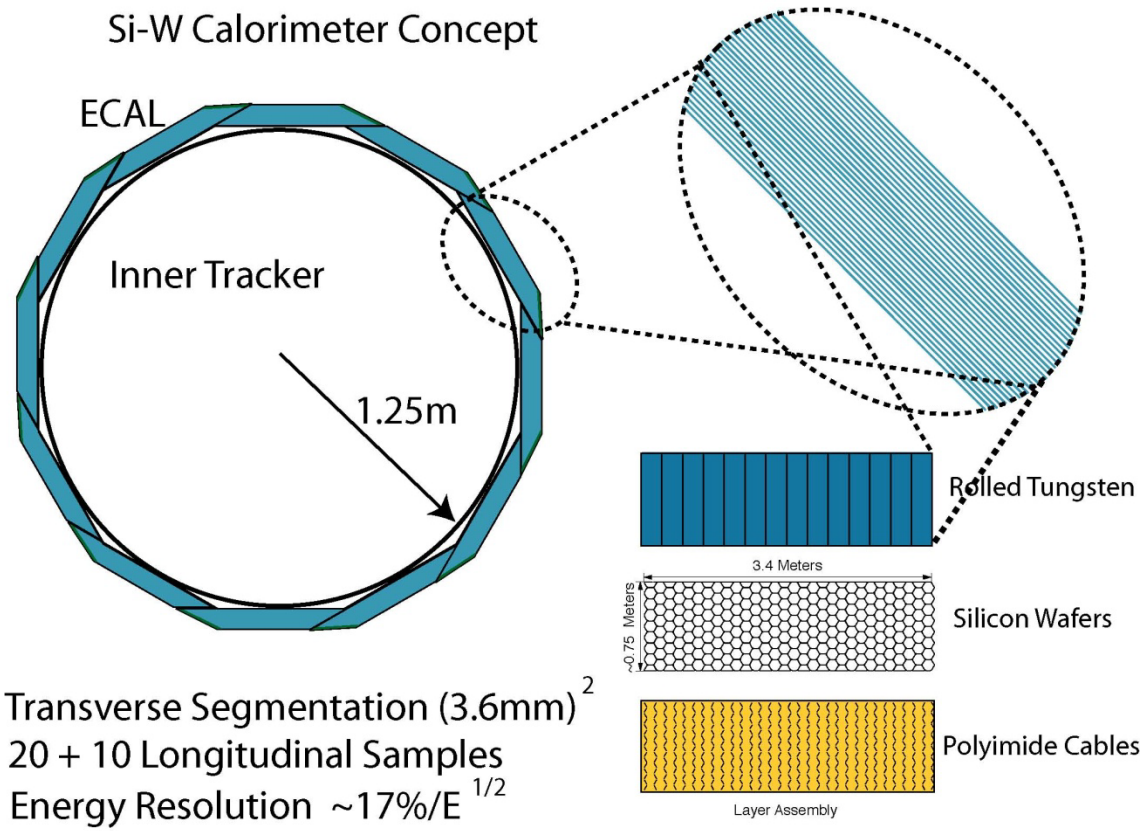
UC Davis

University of Oregon

Brookhaven National Lab

Baseline: Silicon-tungsten (13 mm^2 pixels) with highly integrated readout (KPiX chip)

Option: MAPS – uses same tungsten and mechanical structure



Critical R&D: Build test beam prototype module using components of final SiD ECal:

- 1024-channel integrated readout chip (KPiX)
- 1024-pixel silicon sensors
- interconnects

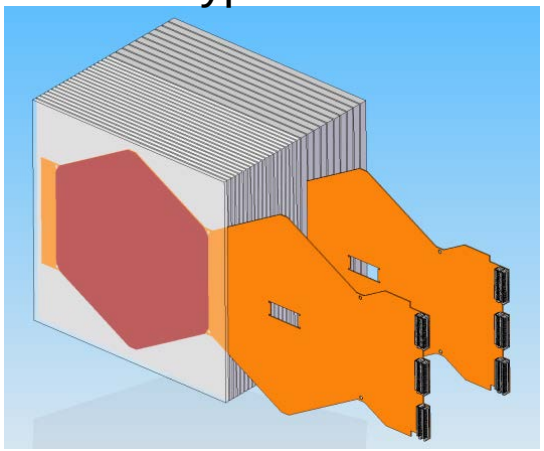
ECal (contd)

<u>Silicon sensors</u>: Meet specs. for SiD ECal
- Hamamatsu
- low leakage current; DC coupled
- sufficient number for prototype (30 layers)

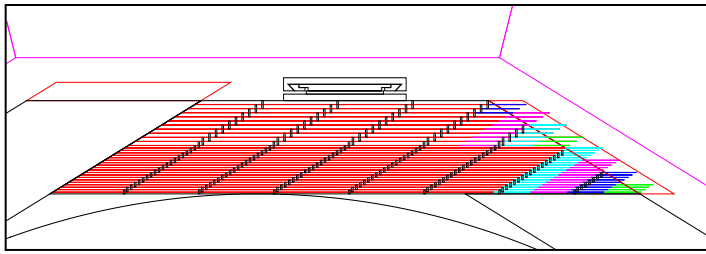
<u>Integrated readout chip (KPiX)</u>: prototypes meet SiD specs.:
- low noise (10% of MIP)
- large dynamic range: ~10^4
- full digitization and muliplexed output
- passive cooling (power pulsing)

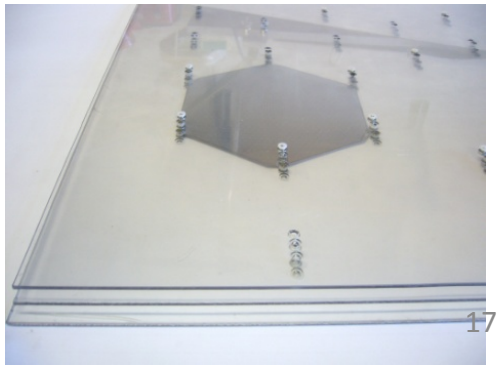
<u>Interconnects</u>:
- Flex cable R&D ok so far – successful attachment to dummy sensors
- Main focus of recent R&D is the KPIX – sensor interconnect. Problem recently solved using IZM:

Prototype module



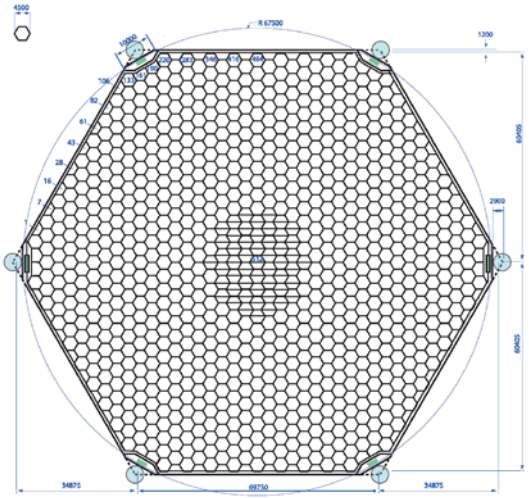
Development of ECal mechanics



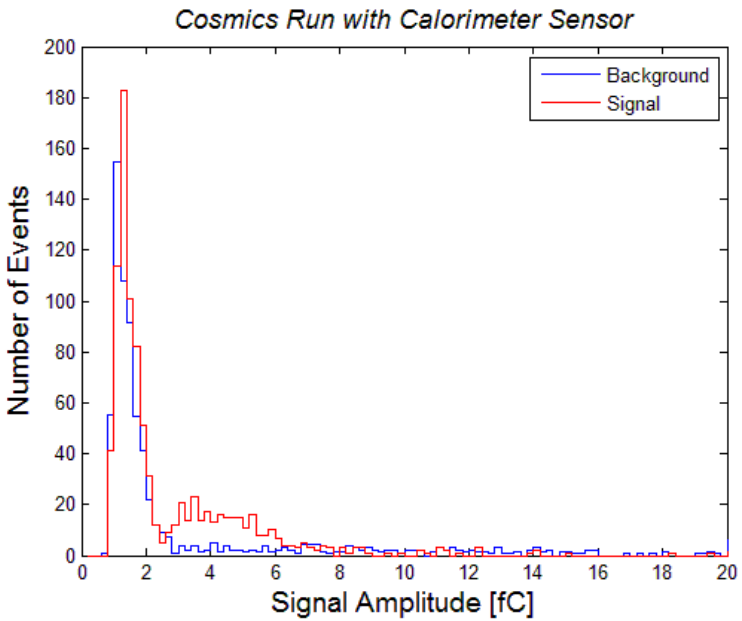


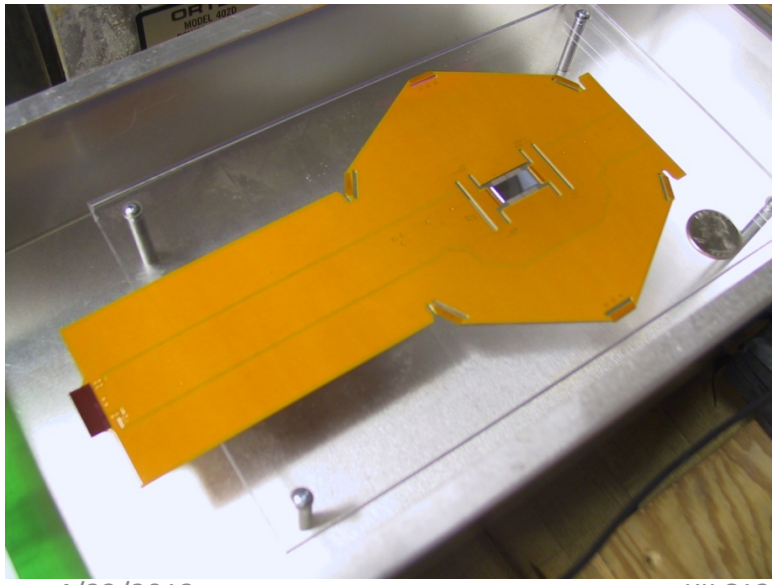
ECal (contd)

SiD EmCal Sensors

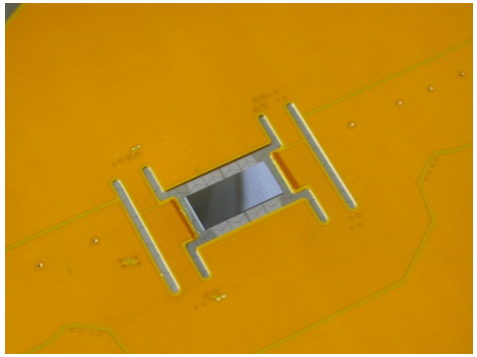


1024 Pixel Si Sensor
12 cm across flats





KPiX bump bonded by IZM to sensor
Cable bump bonded to sensor
Assembly 1 mm high



ECal (contd)

Timeline for R&D
- Assemble test module now that bonding problem has been solved
- Target is revived End Station test beam at SLAC sometime in 2012

Results expected for inclusion in DBD
- Technical results on components – updates to LOI
- Successful assembly of fully functional prototype will demonstrate feasibility of the design
- First test beam results, if available in time

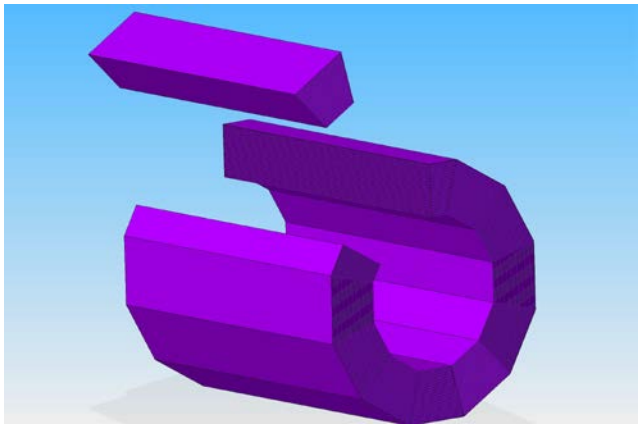
Issues/concerns for DBD and beyond
- Personnel also engaged in other experiments
- The MAPS option (UK based) needs resources to continue

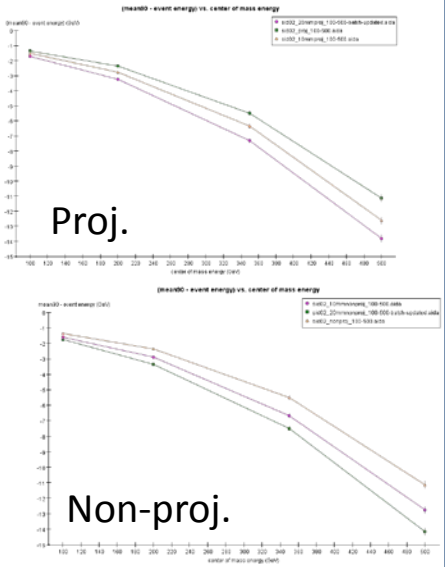
Hadron Calorimeter

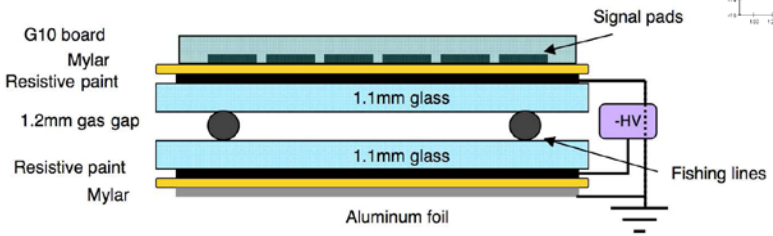
Calorimeter for ILC

Argonne National Laboratory
Boston University
Fermi National Accelerator Laboratory
IHEP Beijing
Illinois Institute of Technology
University of Iowa
McGill University
Northwestern University
University of Texas at Arlington
NIU
SLAC

Baseline – 4.5 λ RPC/Steel
Option 1 – GEM/μmegas/Steel
Option 2 – Scint/Steel







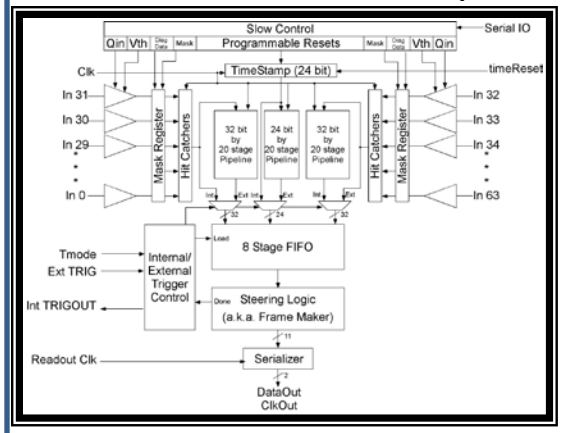
Areas of critical R&D/goals - baseline

Large area glass chambers
Module design (projective/non-projective)
Gas (re-)circulation/routing
Improved readout boards
HV/LV distribution
Data transmission

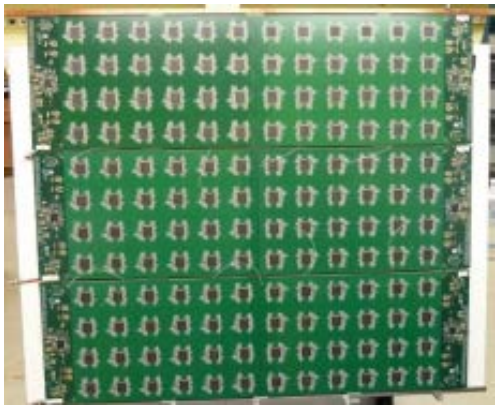
Hadron Calorimeter

R&D and results to date

Readout – DCAL chip



Detector layer w/ Front-end boards

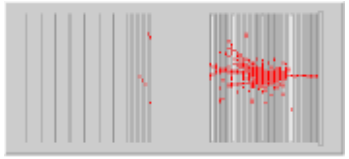


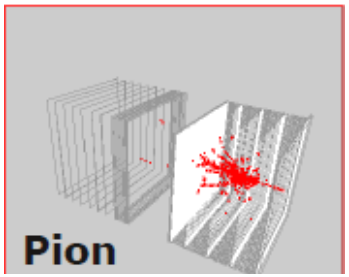
DHCAL:

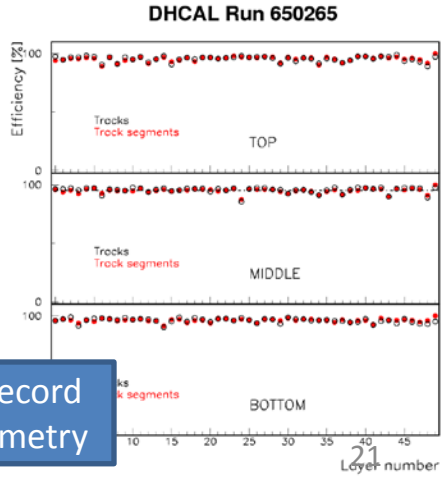
480,000 readout channels

Had **5 test beam runs** so far

- 10/2010: 38 layers
- 1/2011: completed 38+14 during run
- 4/2011: SiW ECAL + RPC DHCAL
- 6/2011: RPC DHCAL (high energies)
- 11/2011: Minimal absorber: 50 layers
- 2012: Tests with W absorbers at CERN





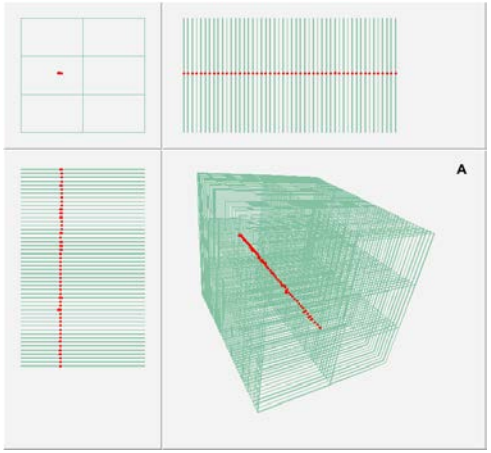


World record in calorimetry

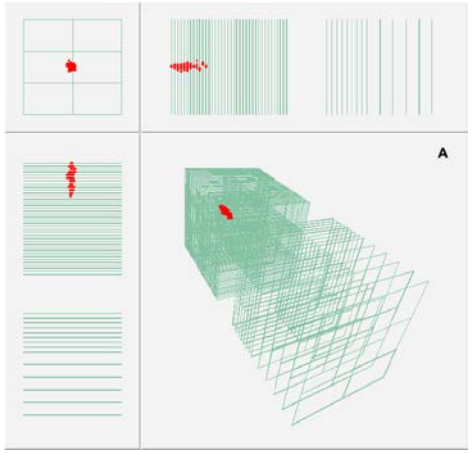
Hadron Calorimeter

Selection of nice events from the test beam

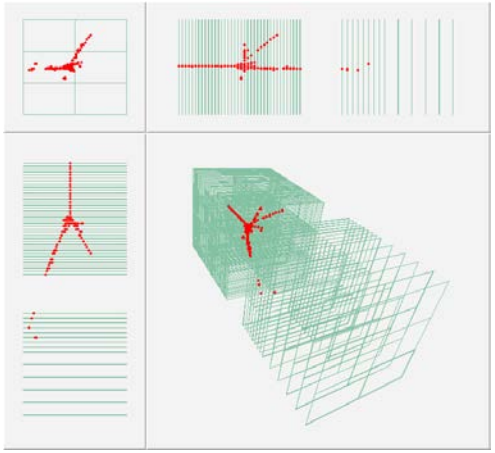
Muon in the minimal absorber structure



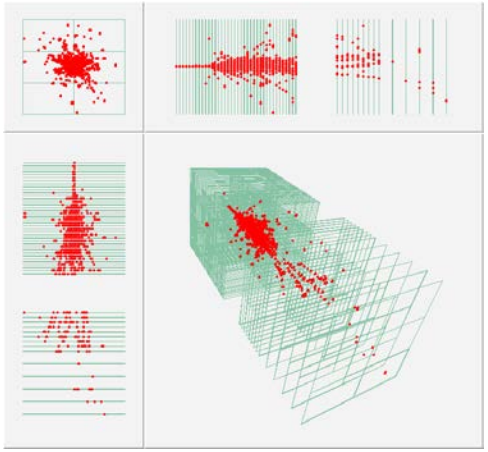
8 GeV e^+ in the DHCAL



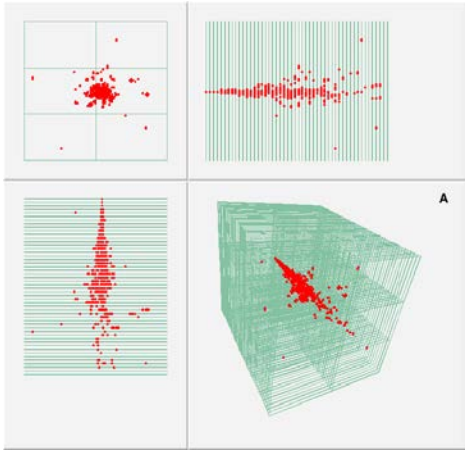
8 GeV/c π^+ in the DHCAL and TCMT



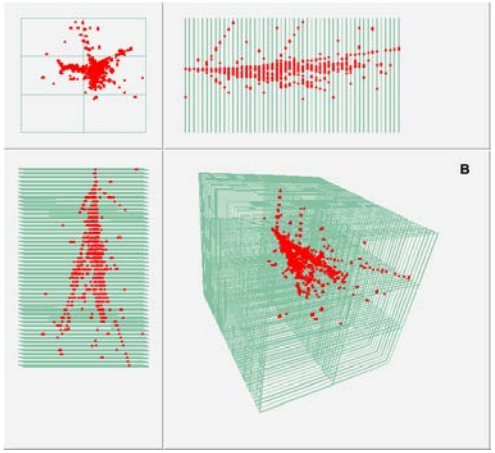
120 GeV/c p in the DHCAL and TCMT



10 GeV e^+ in the minimal absorber structure



10 GeV π^+ in the minimal absorber structure



Hadron Calorimeter

Timeline for R&D
- Completed prototype construction in Dec 2010
- 5 successful test beam campaigns at FNAL in 2010/2011
- Beam tests at CERN in 2012 (DHCAL with Tungsten absorber)
- R&D on HV distribution system, high-rate RPCs, 1-glass RPCs, gas … ongoing
- Gas re-circulation systems being developed and tested at CERN

Results expected for inclusion in DBD
- Description of DHCAL/RPCs/Readout system (instrumentation paper)
- Detailed measurement of noise in the DHCAL (noise paper)
- Calibration of the DHCAL with Muons
- DHCAL response to positrons and pions
- Measurements with large 1-glass RPCs (viability of design)
- Conceptual engineering design (if resources permit)

DHCAL concept will be validated

Issues/concerns for DBD and beyond
- Conceptual engineered design
- Analysis of DHCAL data not yet complete

SOLENOID/DID

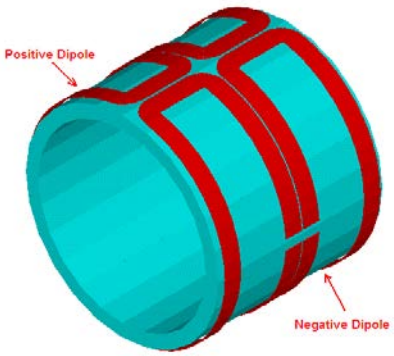
Participating Institutions
SLAC (Wes Craddock)
FNAL
BNL
LLNL
(CERN & KEK informal)

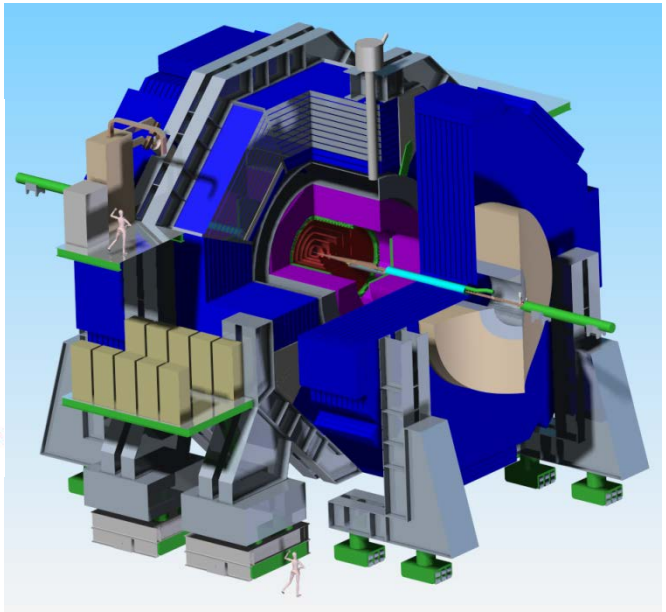
Baseline
Modified CMS Conductor

Option 1
Al-0.1% Ni (ATLAS) Stabilizer

Option 2
Advanced Next Generation Stabilizer

Note: The only significant option choices based on technological advancements are with the conductor.





Areas of Critical R&D / Goals

1. 3 D Magnet Field FEM Analysis
2. Integration of DID Coil into Cryostat
3. Assembly and Installation Procedures
4. Structural and Thermal Design (real world)
5. Cryogenic Systems Integration with QD0

SOLENOID/DID

RESULTS TO DATE

Magnetic Field Calculations

1) 2D to minimize stray fields – Sufficient for DBD
2) Iron Barrel HCAL option – Completed: Complexity not worth improved uniformity
3) 3D (with DID): ANSYS modeling at least ½ completed. Need to solve and study.
4) BNL Opera 3D simplified solenoid/DID analysis. Need ANSYS/Opera comparison

Structural and Thermal Design

1) Vacuum shell analysis completed. Need attachment integration with Fe and detector.
2) Need coil support, thermal shield and current lead design.
3) Practical but not detailed DID winding and solenoid attachment schemes.

Conductor: CMS conductor with 40 strand Rutherford cable. Need DID conductor.

Electrical: Sufficient for DBD except for DID coil and instrumentation list.

Cryogenics: Detector layout completed but needs integration with QDO

Conductor R&D: Identified many potential paths for higher strength high conductivity aluminum such as carbon nanotubes reinforcement and scandium.

SOLENOID/DID

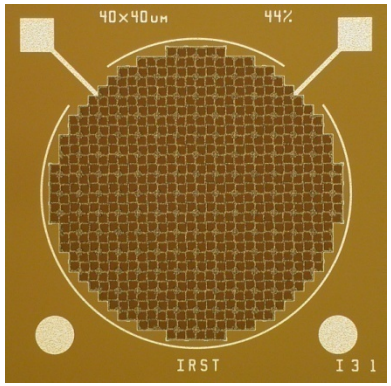
Results expected for inclusion in DBD

- 3 D Magnetic Field, Force & Stress including DID Coil and Vacuum Shell
- Structural and Thermal Design including Integration with Iron and Detector
- Assembly and Construction Procedure
- Size and Tolerances for Major Components
- Cryogenic Scheme integrated with QD0
- Power Supply/Dump Circuit/Grounding/Instrumentation

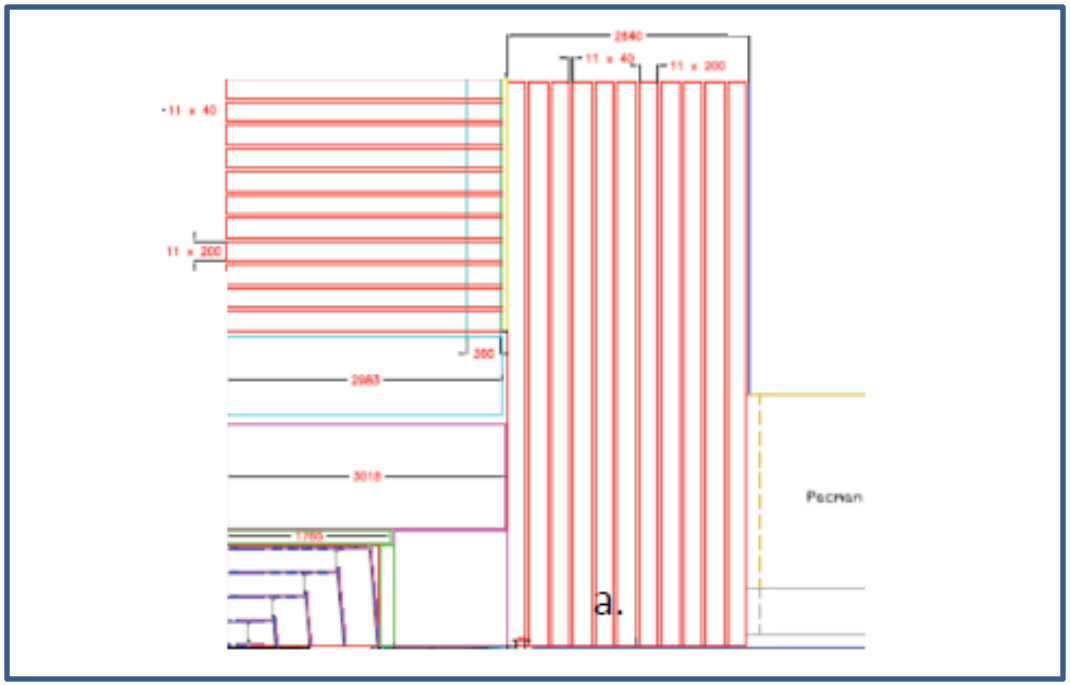
Issues/concerns for DBD and beyond

- The main concern is SLAC manpower committed to other projects.
- Potential cost savings exist using advanced high purity Al stabilizers and conductor fabrication techniques. There will be negligible time to pursue this before the DBD.

Strip-scintillator/Si avalanche photo-diode Muon System



APD's
1.2 mm ϕ
660 pix
40μ^2



Fermilab Test beam + Inst
INFN Udine APDs
Notre Dame Scint /WLS

Baseline:
Strip-scintillator/WLS fiber
& Avalanche Photo-Diodes

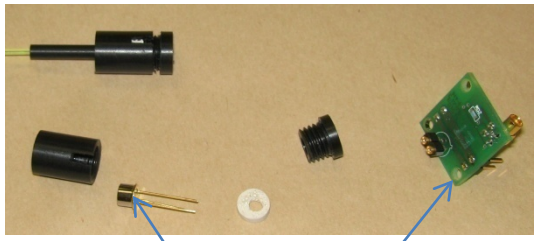
(replaces old baseline of
double layer
resistive plate chambers)

Areas of critical R&D/goals
Need to build and test strips with robust techniques.
We need enough tests to validate the technology.
We need HEP Laboratories to back an LC.

Strip-scintillator/Si avalanche photo-diode Muon System

R&D and results to date

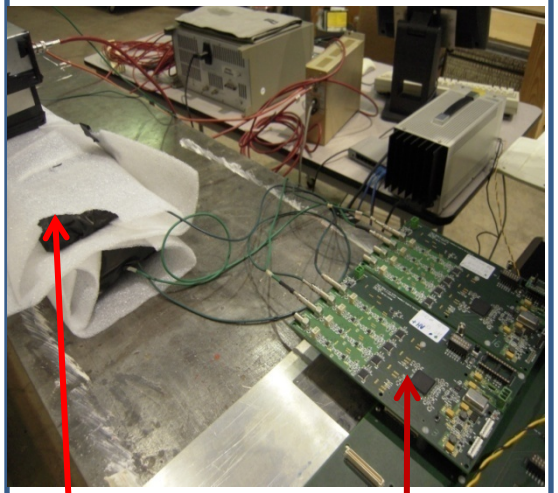
Prototype construction



SiAPD

Pre-amp

Test Setup



Strip-Scint.

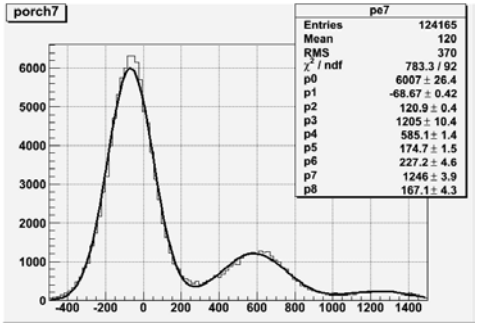
TB4 Boards: 8 channels

180 digitizations * 4.708ns = 847ns

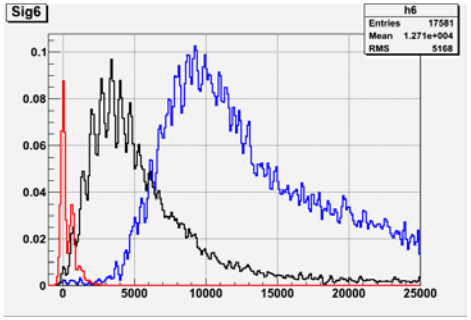
212 MHz

Results: FTBF beam

Calibration w/Noise



Resolution: Single p.e.s



Strip-scintillator/Si APD Muon System

Timeline for R&D
- New design of mechanical /optical coupling scheme using tooling.
  Jan 31, 2012. Try with short strips. Feb. 2012
- Refine drawings of coupling scheme with specifications. March 2012
- Start work on new test stand. Manpower needed.
- Set-up tests with 4 strips and new optical/mechanical coupling. June 2012
-

Results expected for inclusion in DBD
- First results from cosmic ray tests of new coupling scheme.
- Write a paper if there is sufficient data.
- …

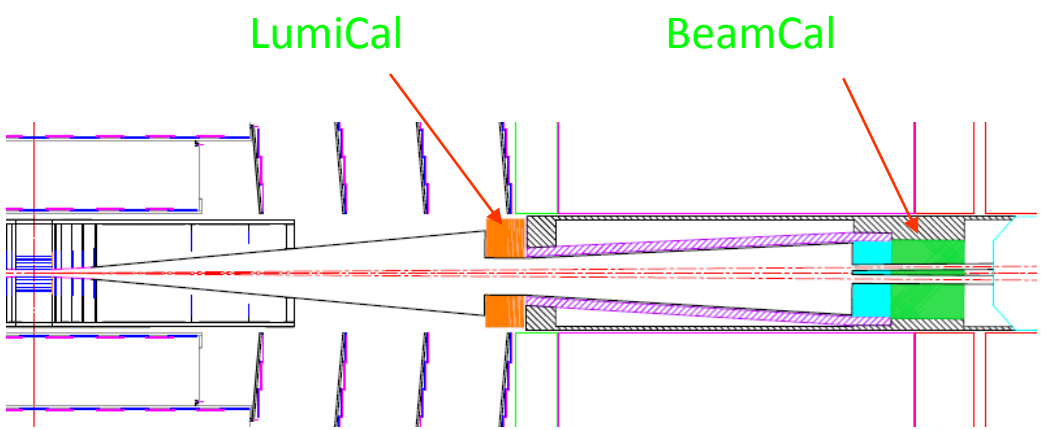
Issues/concerns for DBD and beyond
- No money; Need a few km of WLS fiber at a cost of $2 or $3 per foot.
- No people; Universities have dropped out.
- Funds are needed and does anyone think we will get them?
- Need Lab directors and DOE HQ to help us. Universities too.

Forward Detector

Participating Institutions:
UC Santa Cruz (SCIPP),
Pontificia Universidad Catslica de Chile, U. of Colorado, SLAC

Baseline:
Silicon-Tungsten sampling calorimeter

SiD Forward Region



Areas of critical R&D/goals

Radiation hard Silicon sensor R&D
FCAL chip development
Simulation study of BeamCal tagging

Forward Detector

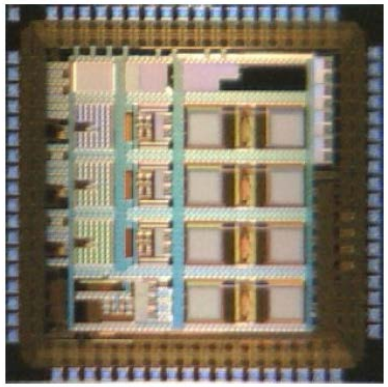
Radiation hard sensor R&D (SCIPP/SLAC)

- Micron sensors from ATLAS R&D
- Runs of up to 100 Mrad (Spring 2012)
- Will assess the bulk damage effects and charge collection efficiency degradation.
- Charge collection apparatus being upgraded at SCIPP to process many samples quickly.

FCAL chip development (Santiago/SCIPP)

- 180 nm TSMC process
- 72 pads, 2.4 mm × 2.4 mm
- 7306 nodes, 35789 circuit elements
- 3 channels
- No digital memory

Bean v1.0 prototype

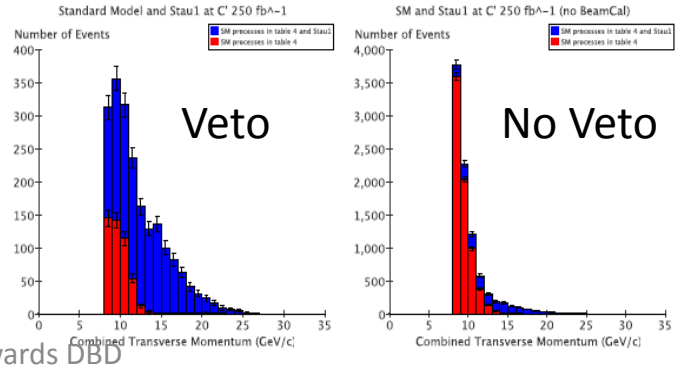


Study of stau production (Colorado)

- Stau production in co-annihilation points: M. Battaglia et al hep-ph/0306219 $\sigma \sim 10$ fb
- Background

  $\gamma\gamma \rightarrow \tau\tau$, $\sigma \sim 10^6$ fb

  BeamCal veto is essential.



Forward Detector

Timeline for R&D
- Summer 2012: Initial (100 MRad) study completed
- Summer 2012: Submission of second BEAN prototype
- BeamCal simulation study has been completed.

Results expected for inclusion in DBD
- 100 MRad study with Czochralski/FloatZone n-on-p/p-on-n sensors
- Submission of second prototype BEAN readout chip
- BeamCal simulation study.

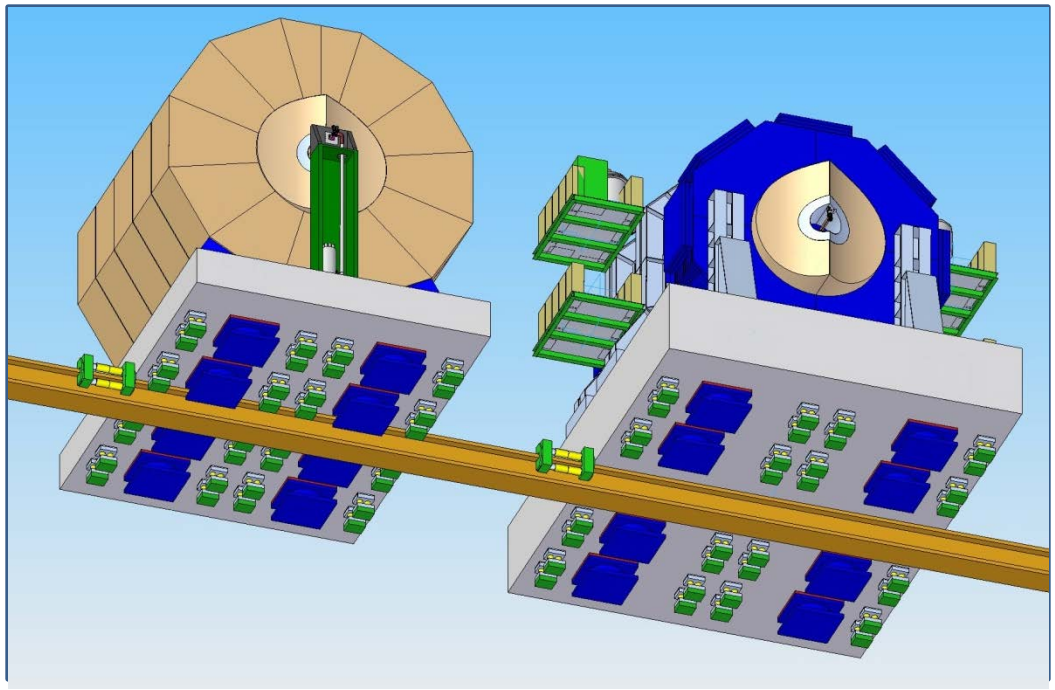
Issues/concerns for DBD and beyond
- Availability of SLAC 13.6 GeV test beam
- Chilean support for BEAN chip development (and continue US support for digital components)

Machine Detector Interface

Participating Institutions
SLAC
Fermilab
BNL
Oxford U.
U. Of Michigan
ILC CFS
ILC MDI CTG

Push-Pull Baseline : Platform on rollers with gripper jacks

Ex. Area Baseline: 3 Shafts access with single Gantry



Areas of critical R&D/goals

1. Motion System for Push-Pull
2. Platform & QD0/FCAL Alignment
3. QD0 Adjustment System
4. Intra-train Fast Feedback System
5. Beam Pipe Design
6. IR Hall Design
7. QD0 Prototype

Machine Detector Interface

Timeline for R&D

	Options Review	Final Design
Motion System for Push-Pull	Apr. 2012	Sept.2012
Platform @ QD0/FCAL Alignment	Apr. 2012	Sept.2012
QD0 Adjustement	Apr. 2012	Sept.2012
Intratrain Fast feedback System	Mar. 2012	Mar.2012
Beam Pipe & Forward Cal	Mar 2012	Jun.2012
IR Hall Design	Apr. 2012	July.2012
QD0 Prototype	Apr. 2012	Nov.2012

Results expected for inclusion in DBD

- Motion System for Push-Pull
- IR Hall Design
- Beam Pipe & Forward Cal
- Results from QD0 Prototype
- Performance of FONT prototypes of Intra-train Feedback System at ATF2

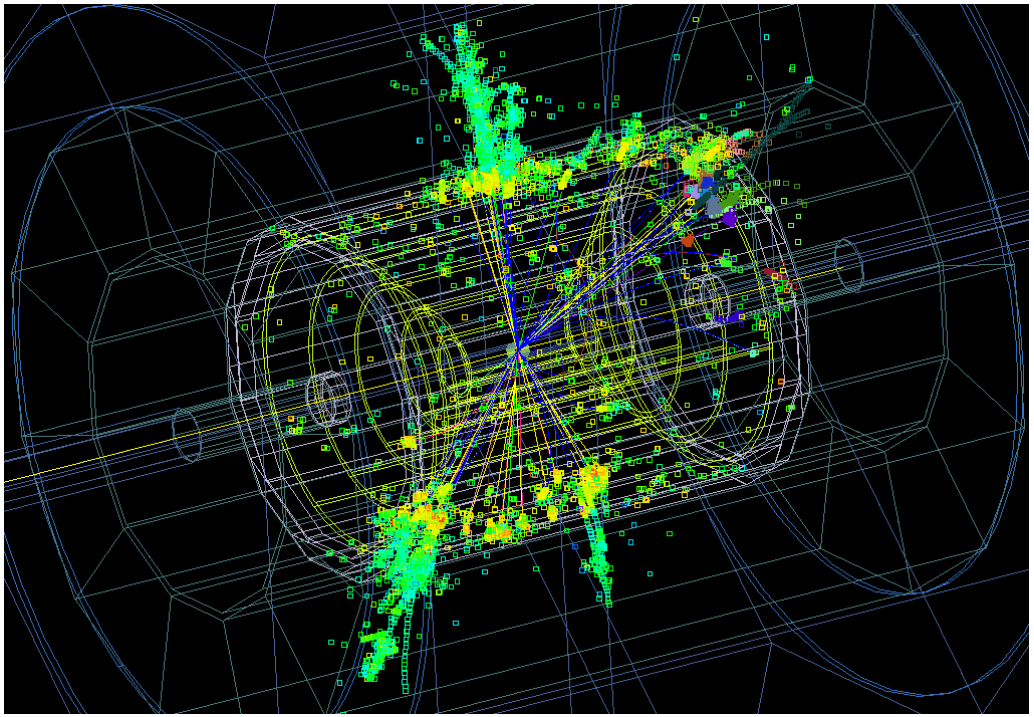
Issues/concerns for DBD and beyond

- Timeline for QD0 Prototype Completion very tight given scope of work
- Keep or increase Manpower available after DBD
- M&S for prototype construction

Simulation and Reconstruction

SLAC: slic
org.lcsim

Baseline:
sid_dbd : LOI geometry with more realistic detector descriptions.
Option 1:
sid_dbdopt: Detector optimized for 1TeV operations.
Option 2
sid_dbdspt: Silicon Pixel Tracker option.
Option 3
sid_dbdsci: Analog scintillator HCal



Areas of critical R&D/goals

Finalize global system design via detector performance optimization using physics analyses.
Incorporate latest detector R&D results
Improve tracking and PFA reconstruction
Automate & streamline production sim/reco

Simulation and Reconstruction

R&D and results to date

CLiC CDR provided stress test of the DBD simulation, reconstruction and analysis exercise.

Required improvements to the functionality such as event overlay, track-finding in dense environments and use of PandoraPFA.

DBD will benefit from these improvements.

Most significant difference wrt LOI will be the use of Grid resources (CPU & SE).
Dirac tried and proved in CLiC CDR. Will coordinate with ILD on common solution.

Event overlay to be incorporated into the reconstruction.

Effect of detector noise and electronic inefficiency will be studied

Full detector response simulation will use slic, plus detailed SiD design.

Reconstruction will use detailed silicon strip and pixel response, RPC response, plus track finding and fitting using org.lcsim.

slicPandora and LCFI for individual particle reconstruction and jet flavor tagging.

Simulation and Reconstruction

Timeline
- Learn from and preserve functionality developed for CLiC CDR
- Adapt tracking code to LCIO2.0 event data model
- Implement Kalman fitting for final track states
- Develop full digital HCal response simulation
- Upgrade to latest PandoraPFA & LCFIPlus

Results expected for inclusion in DBD
- Full simulation of realistic detector design including support structures
- Full tracker hit digitization and ab initio track finding and fitting.
- Digital RPC signal simulation, including cross-talk , noise & inefficiencies
- Full reconstruction using slicPandora & LCFIPlus

Issues/concerns for DBD and beyond
- Loss of key individuals in reconstruction efforts.
- Lack of manpower to conduct detector optimization studies.
- Aging software infrastructure.

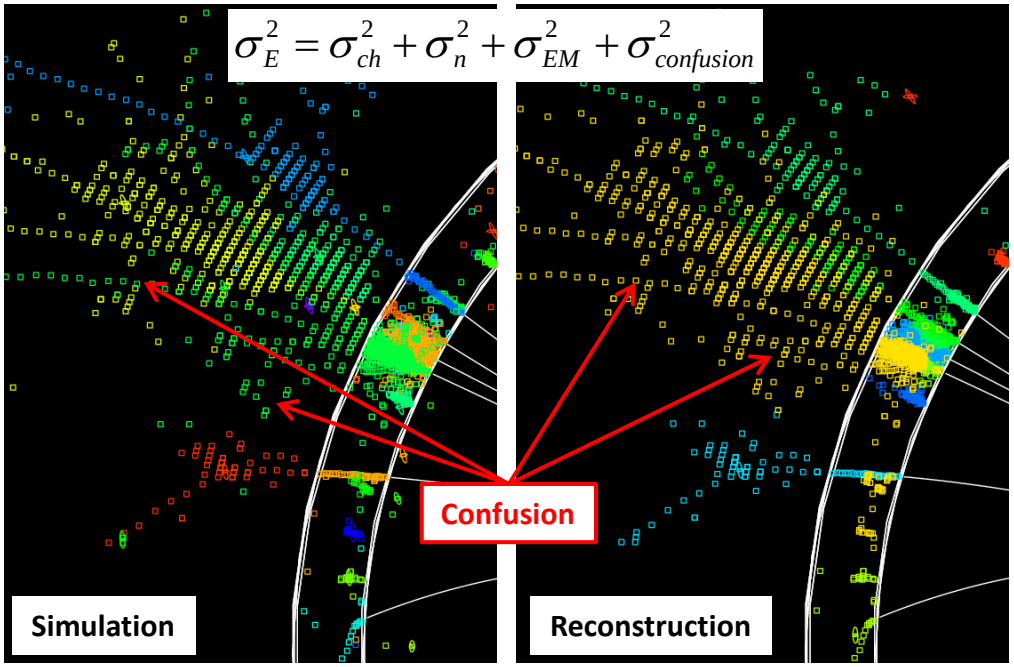
Iowa Particle Flow Algorithm

Pandora/PFA already used with CLIC_SiD for CDR.

This section describes work on alternative Iowa PFA.

Participating Institutions

The University of Iowa
and
SLAC National Laboratory



Areas of critical R&D/goals

The ILC physics goals require a jet-jet reconstructed mass resolution at most 3%.
The current implementation, a work in progress, now achieves 3.1% for

$$e^+e^- \to q\bar{q}(q = u, d, s) \text{ at } \sqrt{s} = 500\,\text{GeV}$$

When ideal photon detection is used, this improves to 2.6%.
Work is ongoing in the area of pattern recognition to improve the shower reconstruction as well as the neutral hadron identification.

Iowa Particle Flow Algorithm

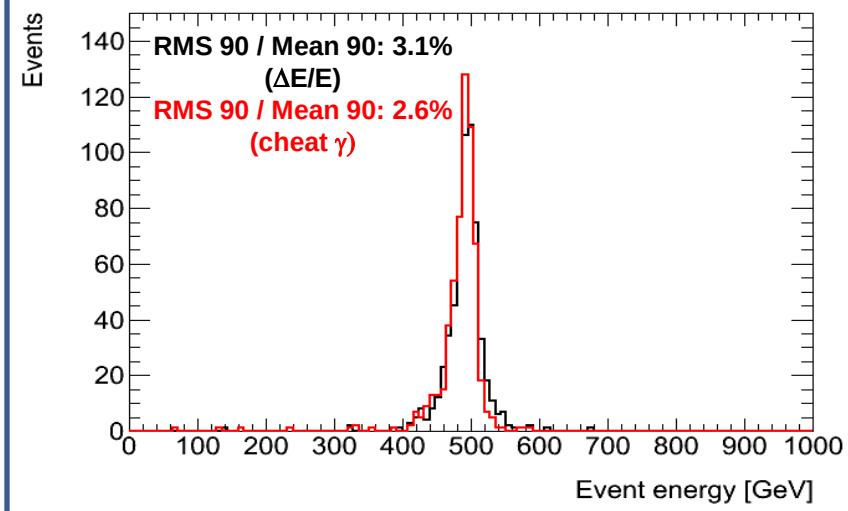
Iowa PFA R&D and results to date

$$e^+e^- \rightarrow q\bar{q}(q = u, d, s) \text{ at } \sqrt{s} = 500\,\text{GeV}$$

Improvements achieved in:
- photon/hadron confusion
- purity of subclusters
- track-seed matching
- likelihood for link scoring

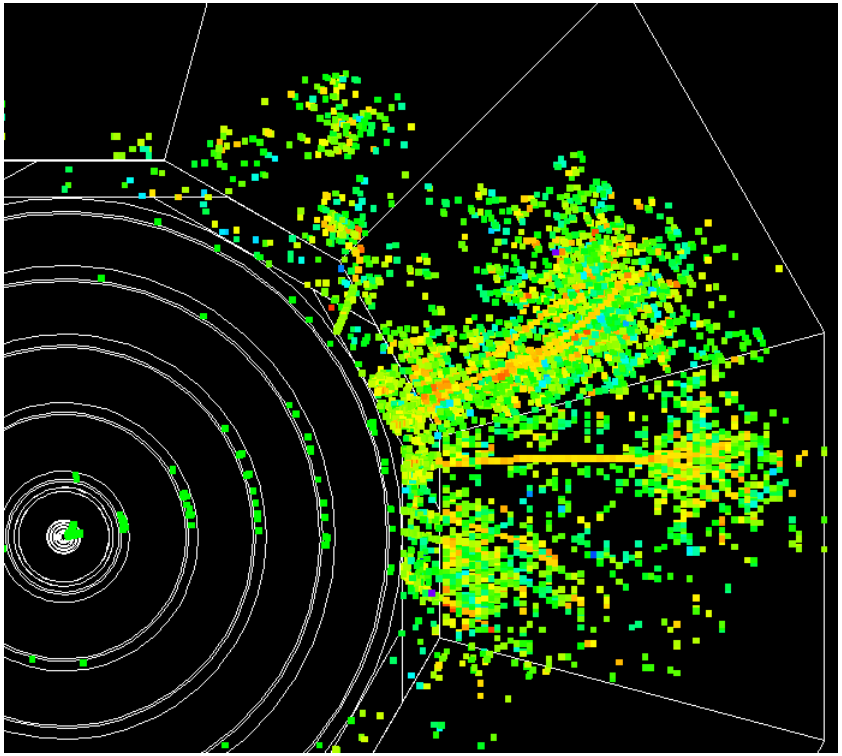
Current status:
- Improved resolution
  3.5% (LOI) → 3.1%
- 2.6% with perfect photon reconstruction

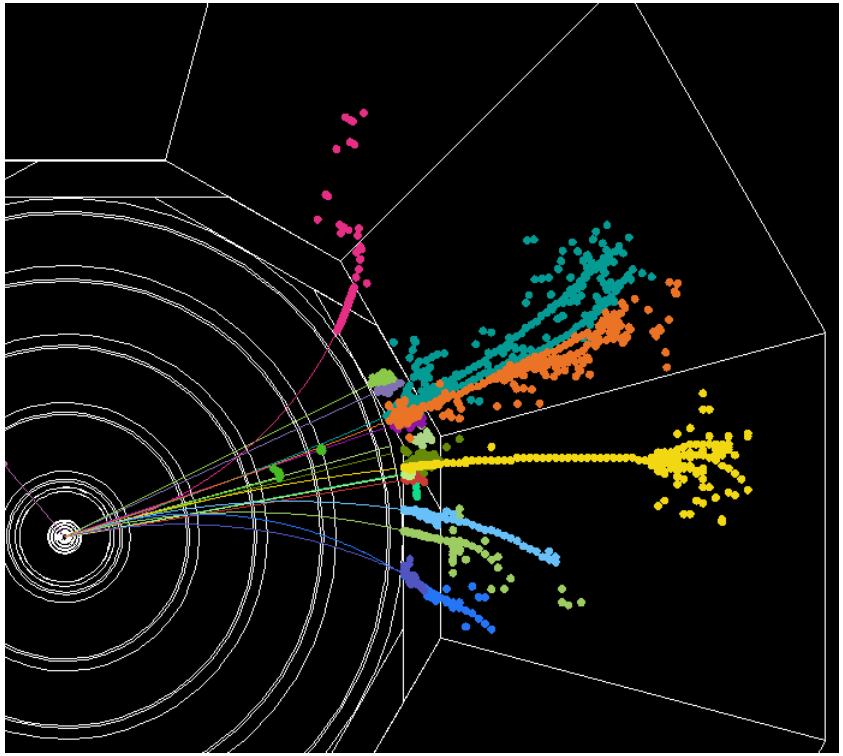
In progress rewriting shower building:
- First iteration : charged shower cores (**Done**)
- Second iteration : primary and secondary neutral showers (**Done**)
- Third iteration : overall event E/p balance (**Ongoing**)



	Charged	Neutral	Photons	Purity
Reco as Charged	51.76	4.47	1.54	0.90
Reco as Neutral	6.60	8.11	1.97	0.49
Reco as Photons	3.11	0.86	21.58	0.84
Efficiency	0.84	0.60	0.86	

slicPandora

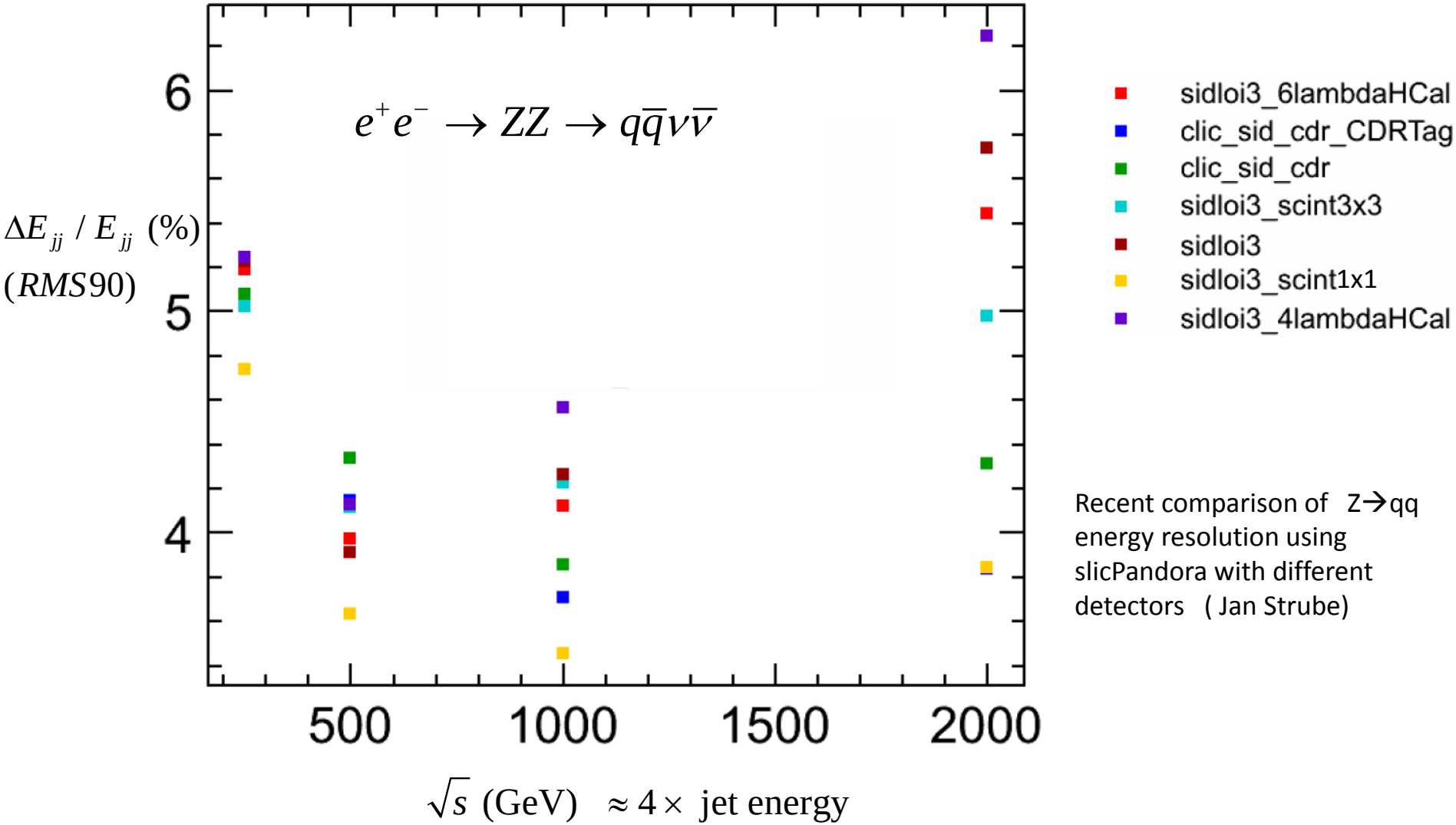




N. Graf & J. McCormick (SLAC)

It provides an interface between events reconstructed using org.lcsim (Java) and pandoraPFA (C++), demonstrating the interregional cooperation and collaboration enabled by the use of a common event data model and file format (LCIO). Successfully used to simulate the response of SiD' (clic_sid_cdr) at 3TeV for the CLiC CDR. Performs well at 1TeV using a digital RPC HCal. Number of improvements have been made recently to provide more flexibility in defining input LCIO collections and to accommodate changes to pandoraPFA itself.

slicPandora



Recent comparison of Z→qq energy resolution using slicPandora with different detectors (Jan Strube)

Benchmarking

- DBD Benchmark Event Generation (ILC Common Generation)
  - 2-4-6-8 fermion SM Background: MC event generation is complete. ee→2f and ee→4f were generated at DESY; ee→6f, high pT $\gamma\gamma$→2f, $\gamma\gamma$→4f, eγ→e+2f, eγ→e+4f were generated at SLAC; ee→ttbb & ttZ 8f backgrounds were generated at KEK.
  - low pT, high cross section $\gamma\gamma$→hadrons have been generated at SLAC
  - $\gamma\gamma$ mini-jet events (high pT subprocesses involving quark&gluon constituents of photons) will be generated at SLAC for the DBD -- they slipped through the cracks in the LOI generation.
  - vvH and ttH signals: DBD generation was completed at SLAC and KEK, respectively. The WW signal was generated when the ee→4f background was generated at DESY; alternate initial state polarizations and anomalous TGC's will be simulated through reweighting.
  - All MC event generation stdhep files are stored on the grid with an ftp accessible copy on SLAC NFS.

Benchmarking

- SiD Full Simulation and Reconstruction
  - The MC event generation stdhep files - each of which are generated with 100% initial state e-/e+ polarization and contain thousands of events - are mixed together at SLAC to produce smaller stdhep files with 500 events each and 80% /20% e-/e+ polarization. These smaller files serve as input to the SiD full simulation and reconstruction software which can be run either on the SLAC linux batch farm or on the grid.
  - 2-4-6-8 fermion SM Background: a little bit of everything is being fully simulated – just as was done for the LOI; more fully simulated background events can be produced at the request of the benchmarking group
  - low pT, high cross section $\gamma\gamma \rightarrow$ hadrons will be overlaid on all fully simulated events
  - SiD will use the LOI MC event generation stdhep files for the ttbar signal and background when it reanalyzes this benchmark with the DBD detector.

Benchmarking

- ttH Benchmark
  - Jan Strube (CERN) and Philipp Roloff (CERN) are doing the SiD ttH DBD benchmark and providing support for full simulation and reconstruction.
- vvH Benchmark
  - Homer Neal (SLAC) will analyze this benchmark. Homer is also doing validation of the particle flow object output from the SiD reconstruction software.
- WW Benchmark
  - SiD will do a simultaneous measurement of the initial state e-/e+ polarization and several triple gauge couplings. Tim Barklow will be responsible for this analysis.
- Reanalysis of ttbar at Ecm=500 GeV
  - Have yet to identify someone for this analysis.

Costs

SiD participates in the PEB Costing Working Group:

- Study of solenoid cost with CLIC
    - In-house (assume risk) vs. Industry contract
- Agreement of unit costs of common items:
    - Iron, stainless steel, tungsten, silicon

- A costing spreadsheet system exists (M. Breidenbach/SLAC) for SiD…will update with common costs/further output from Costing Group

Costs

SiD Interim Cost Estimate
M. Breidenbach
28 March 2012

- This cost estimate follows the structure of that used for the LOI.
- Units costs for silicon detectors, tungsten, iron, and stainless were agreed to with ILD and CLIC.
- No agreement was reached on a standardized cost for the superconducting solenoid. SiD is still using an industrial model of production, with at least some risk externalized.
- The unit cost for HCal detectors was increased.
- Since the ILD/CLIC agreement on tungsten costs, the price of Ammonium Paratungstate has continued to rise, and it is believed that the costs are significantly underestimated. See the sensitivity analysis below.
- A decision has been made to change the baseline option for the muon detectors from RPC's to scintillator. The cost effects of that change are not known, and the cost here is for RPC's.

	ILC Costs					
		M&S Base (M$)	M&S Contingency (M$)	Engineering (MY)	Technical (MY)	Administrative (MY)
1.1.1	Beamline Systems	3.7	1.4	4.0	10.0	0.0
1.1.2	VXD	2.8	2.0	8.0	17.7	0.0
1.1.3	Tracker	17.7	6.9	24.0	53.2	0.0
1.1.4	EMCal	99.9	39.9	13.0	287.8	0.0
1.1.5	Hcal	50.2	19.5	13.0	27.2	0.0
1.1.6	Muon Sys	5.3	1.6	5.0	19.8	0.0
1.1.7	Electronics	4.9	1.6	44.1	41.7	0.0
1.1.8	Magnet	112.5	38.7	29.2	25.0	0.0
1.1.9	Installation	4.1	1.1	4.5	46.0	0.0
1.1.10	Management	0.9	0.2	42.0	18.0	30.0
Totals		302.0	112.9	186.8	546.5	30.0

The above table is believed to be in ILC style accounting. To directly compare with others, it may be advisable to add the M&S base and contingency to get $415M.

SiD DBD Editors

Overall editors:

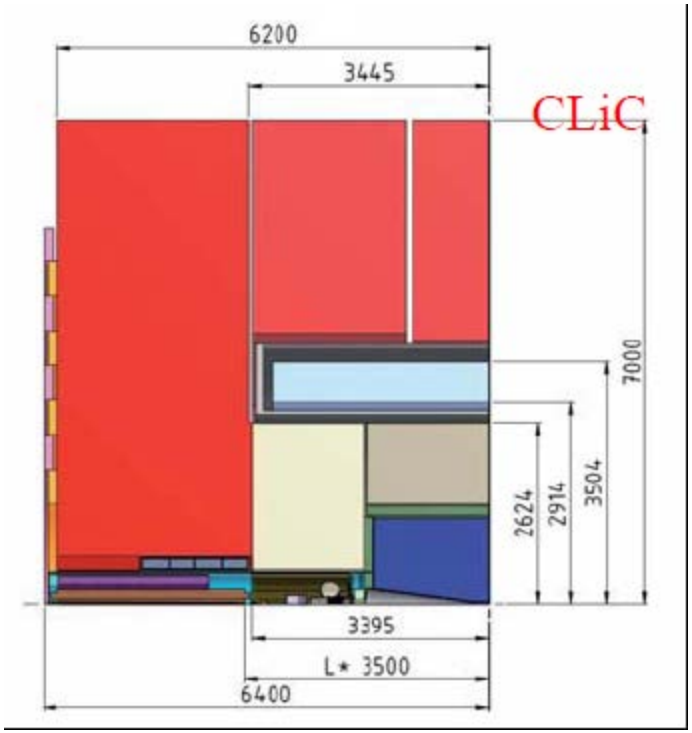
P. Burrows, M. Stanitzki, L. Linssen, M. Oreglia, H. Aihara

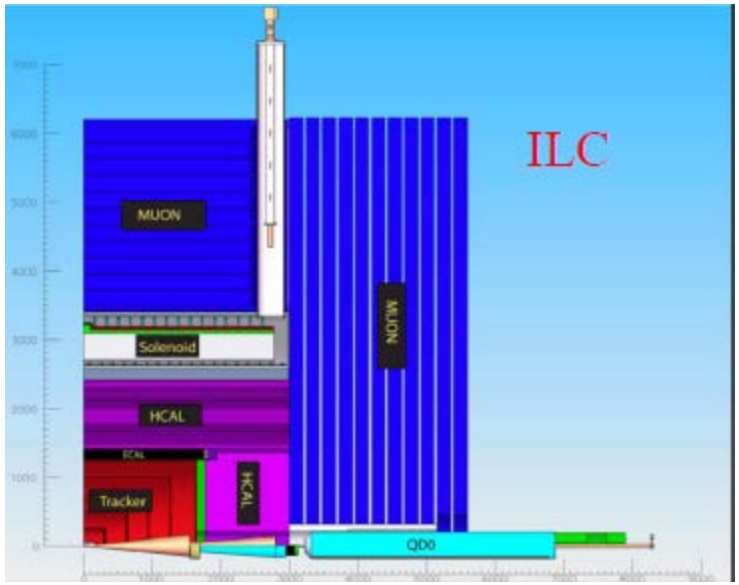
Section editors:

SiD Area	Section editors
VTX	R. Lipton, W. Cooper,
TRK	M. Demarteau, T. Nelson, W. Cooper
ECal	R. Frey, M. Stanitzki
HCal	A. White, L. Xia
Muon	G. Fisk, H. Band
FWD	B. Schumm, T. Maruyama
Magnet	W. Craddock, M. Oriunno
MDI	P. Burrows, T. Markiewicz
Sim/Reco/PFA/Perf.	N. Graf, J. Strube
Benchmarking	T. Barklow, P. Roloff
Cost	M. Breidenbach, K. Krempetz

CLIC contributions

Interworking with CLIC on DBD





Beneficial interworking with CLIC detector and physics group:
- Many SiD contributors/contributions to CDR
- Areas of contributions to DBD identified
- SiD simulation/reconstruction critically exercised during CDR work
- CDR tools (svn, job submission,…) will be used for DBD work

Areas of interworking with CLIC/DBD

- Participation in engineering and integration studies, in particular in the domain of:
  - Contribution to engineering studies on moveable service lines and on general infrastructure aspects for the experiment in the underground cavern
  - Vibration measurements
- Engineering calculations and design parameters of the SiD solenoid and its return yoke. Extrusion tests of a candidate reinforced conductor for the SiD solenoid
- Studies of tail catching and muon identification and layout proposal for the SiD yoke instrumentation at 500 GeV and at 1 TeV.
- Studies of the dependence of jet energy resolution and HCAL leakage as a function of HCAL depth at 1 TeV centre-of-mass (using SLiCPandora).
- Studies of particle identification for photons electrons and muons using particle flow objects at 1 TeV (using PFO's in SLiCPandora)
- Studies of occupancies and radiation levels in the vertex and tracking detectors due to beam-induced background at 1 TeV. This study includes a layout optimization of the forward region and beam-pipe liner.
- Participation in GRID production for the DBD using ILCDIRAC (within ILC common data sample subgroup)
- Participation in 1 or 2 detector benchmark studies at 1 TeV
- Participation in DBD editing tasks
- Setting up and hosting an SVN repository for the editing process of the SiD DBD document
- …and more …

Summary

✶ The SiD Concept remains a key element of future ILC/CLIC plans.

✶ R&D progress made as resources have allowed.

✶ Simulation/reconstruction well tested/robust for CDR – now being applied to DBD.

✶ Cooperation with CLIC colleagues worked well for CDR and continues to work well now on DBD

✶ DBD editors, outline in place; plans developing towards **SiD Workshop at SLAC, August 21-23, 2012**