SiD Calorimeter R&D Collaboration

R&D Report

Introduction and Overview

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SiD Calorimeter system R&D: CONTEXT

Our Calorimeter R&D has been carried out with the goal of providing the optimum calorimeter system for the ILC Physics program using the SiD Concept:

This involves a coherent approach with several aspects:

→ Understanding the required physics performance.

→ A cost-constrained concept for the detector.

→ Ideas for and development of technology options.

→ Simulation to understand effect of basic parameter variations.

→ Check of performance and optimization using PFA(s).

Calorimeter system: physics goals

- Separate W's, Z's in hadronic decay modes.

-> Need $(\sigma/E)_{jet}$ ~3-4% for required dijet mass resolution.

-> Use PFA approach.

+ have excellent performance for electrons, photons (direct from IP and off-angle), and taus.

The PFA approach requires a very integrated view of the detector, in which calorimetry plays a critical role in concert with the tracking system, and drives calorimeter design issues.

The Detector Concept

SiD: a compact detector – reduced inner calorimeter radius.

Use Si/W for the ECal -> excellent resolution/separation of γ/charged. Constrain the cost by limiting the size of the calorimeter (and muon) system.

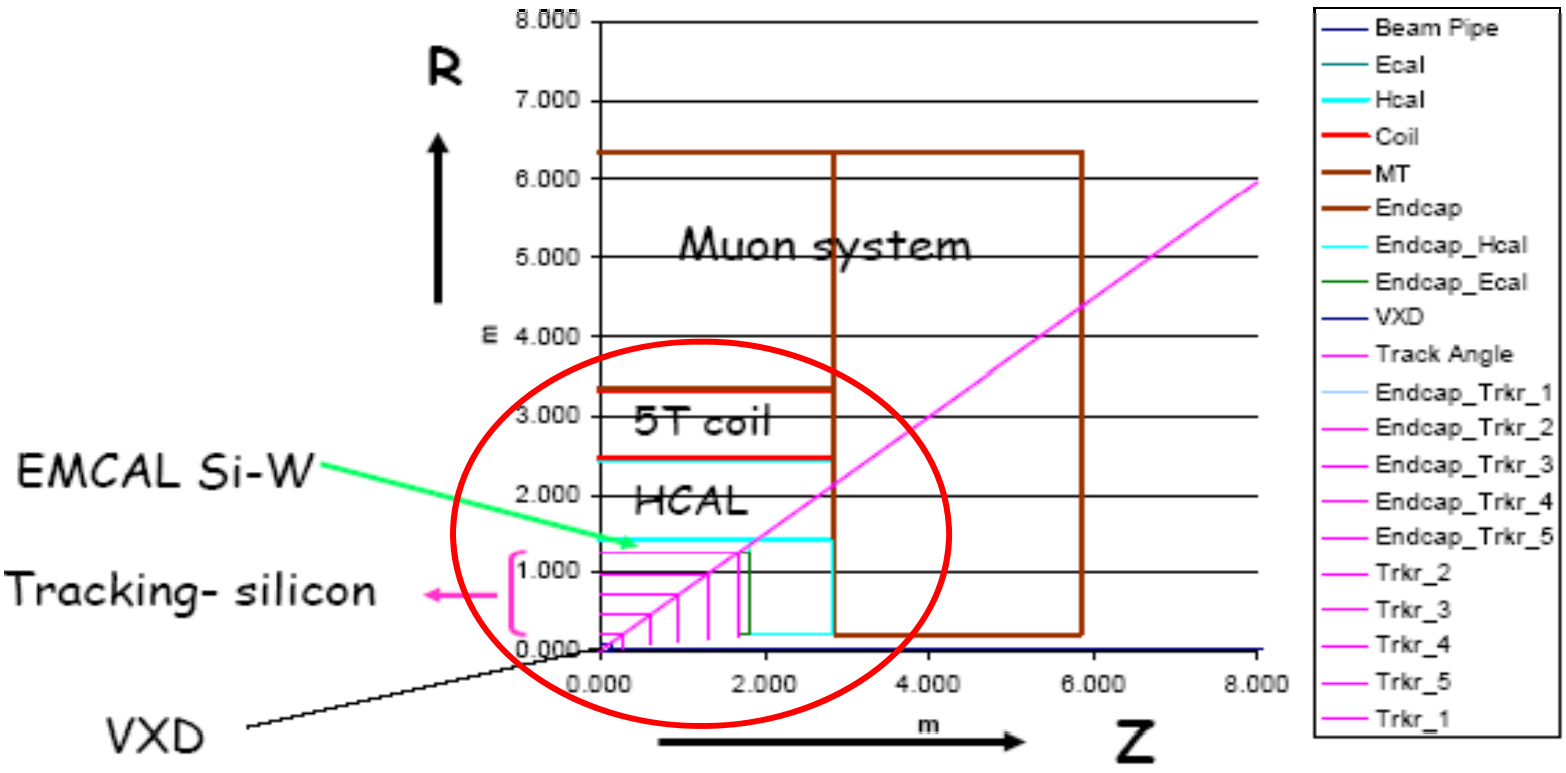
This then requires a compact tracking system -> Silicon only with very precise (~10μm) point measurements.

Silicon also chosen for robustness against backgrounds.

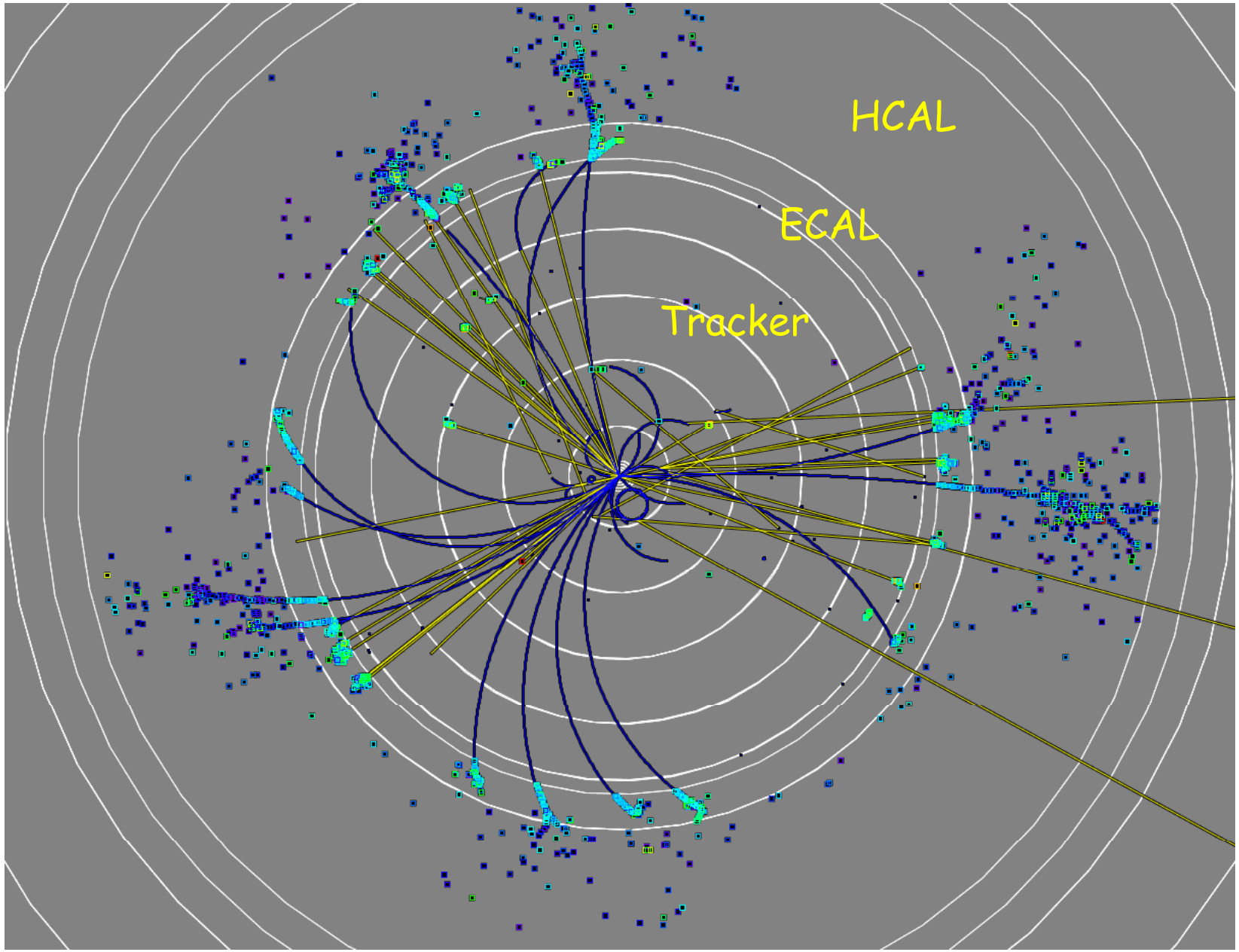
Also demands a calorimeter technology offering fine granularity -> potential impact on choice of technology.

To restore BR^2, boost B -> 5T

Calorimeter system



PFA development – a challenge!



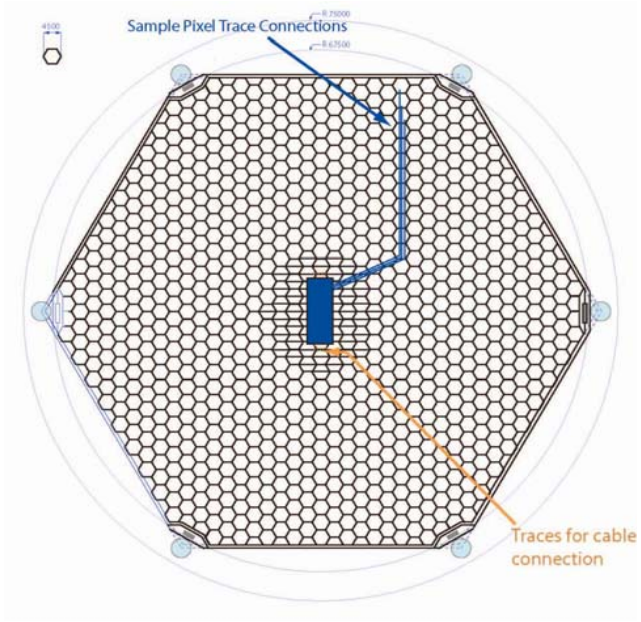
Calorimeter system: design issues for SiD

ECAL: Granularity must be sufficient to allow efficient charged particle/γ separation at limited radii. Need to limit shower spread – start with small Moliere radius and limit effective radius with small active gaps. Ensure reasonable energy resolution -> no impact on jet energy resolution.

HCAL: small transverse cell size to meet PFA imaging requirements: tracking charged particles, matching energy clusters. Measure neutral hadron energy via ~linear hits vs. energy relation. Sufficient depth to contain hadron showers, while limiting radial extent/coil size.

Calorimeter system: technology choices

- ECAL: Silicon-Tungsten was a basic choice in the original SiD design. It is dense, compact and easily segmented



O(1000 m^2) silicon

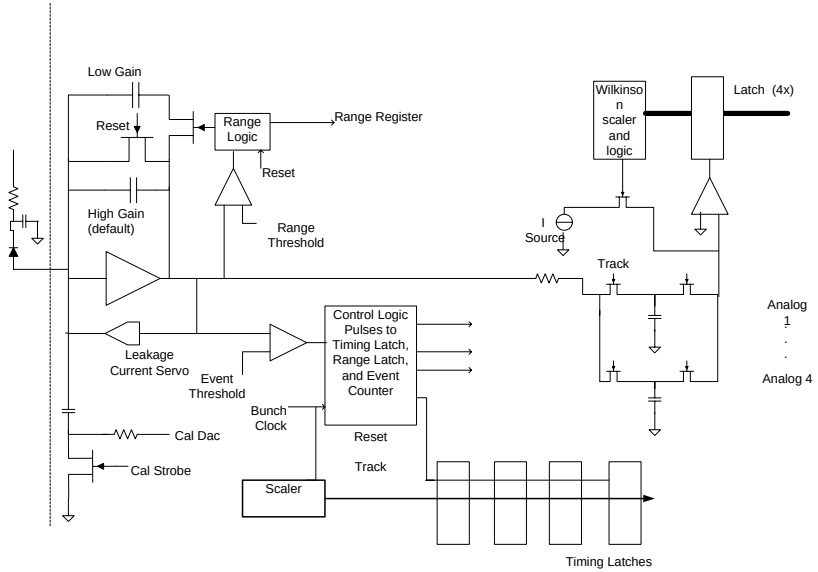
80 million channels

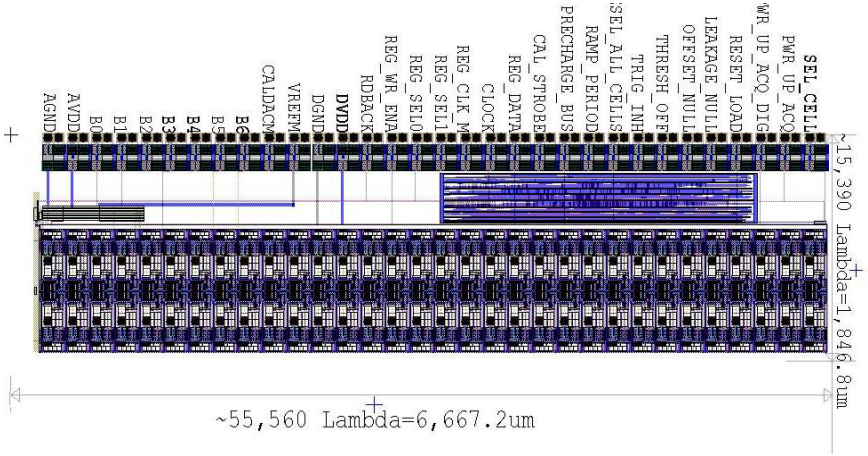
Pixel size ~ 13mm^2

Major issue: the integration of the readout with the sensor.

Calorimeter system: technology choices

- Readout Electronics: KPiX ASIC being developed for ECAL and Silicon Tracker, and is being applied to option for the HCAL.

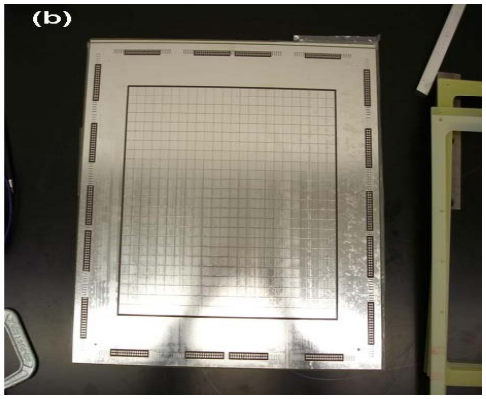


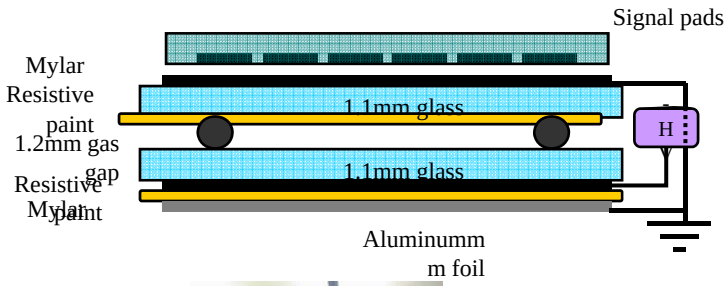


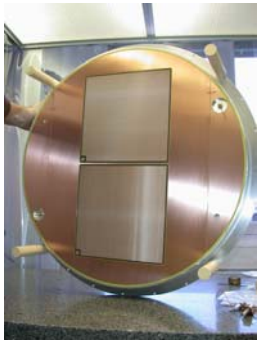
Several KPiX versions made, tested – about to be applied to GEM-DHCAL; integration with ECAL sensor soon.

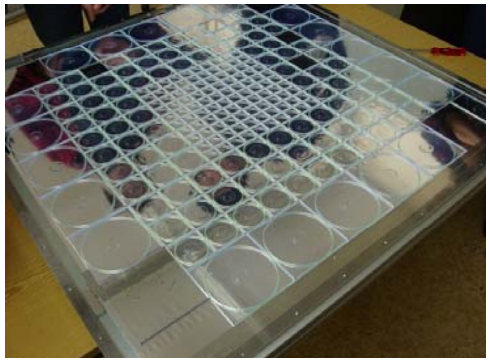
Calorimeter system: technology choices

- HCAL: imaging requirements impose small cell size. Several possible ways to achieve this -> competing technologies:









Technology selection requires prototype tests, simulated physics performance comparisons, evaluation of risks, estimation of costs -> framework for a selection plan.

Role of possible TCMT under study (analog/hybrid case?)

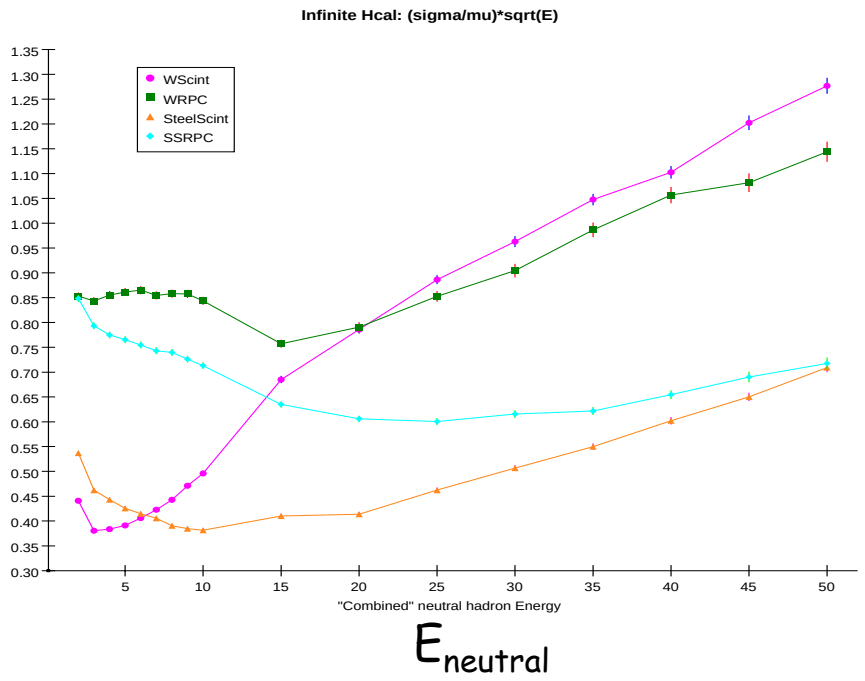
NOTE: coherence with CALICE for this area.

Calorimeter system: basic simulations

Many parameters to study:

- Absorber material
- Active layer technology, gap size
- Transverse, longitudinal segmentation
- Total thickness, thickness/layer
- Inner radius
- B-field central value

Many issues can be tackled without full PFA approach, but can help make informed choices in support of PFA-based calorimetry



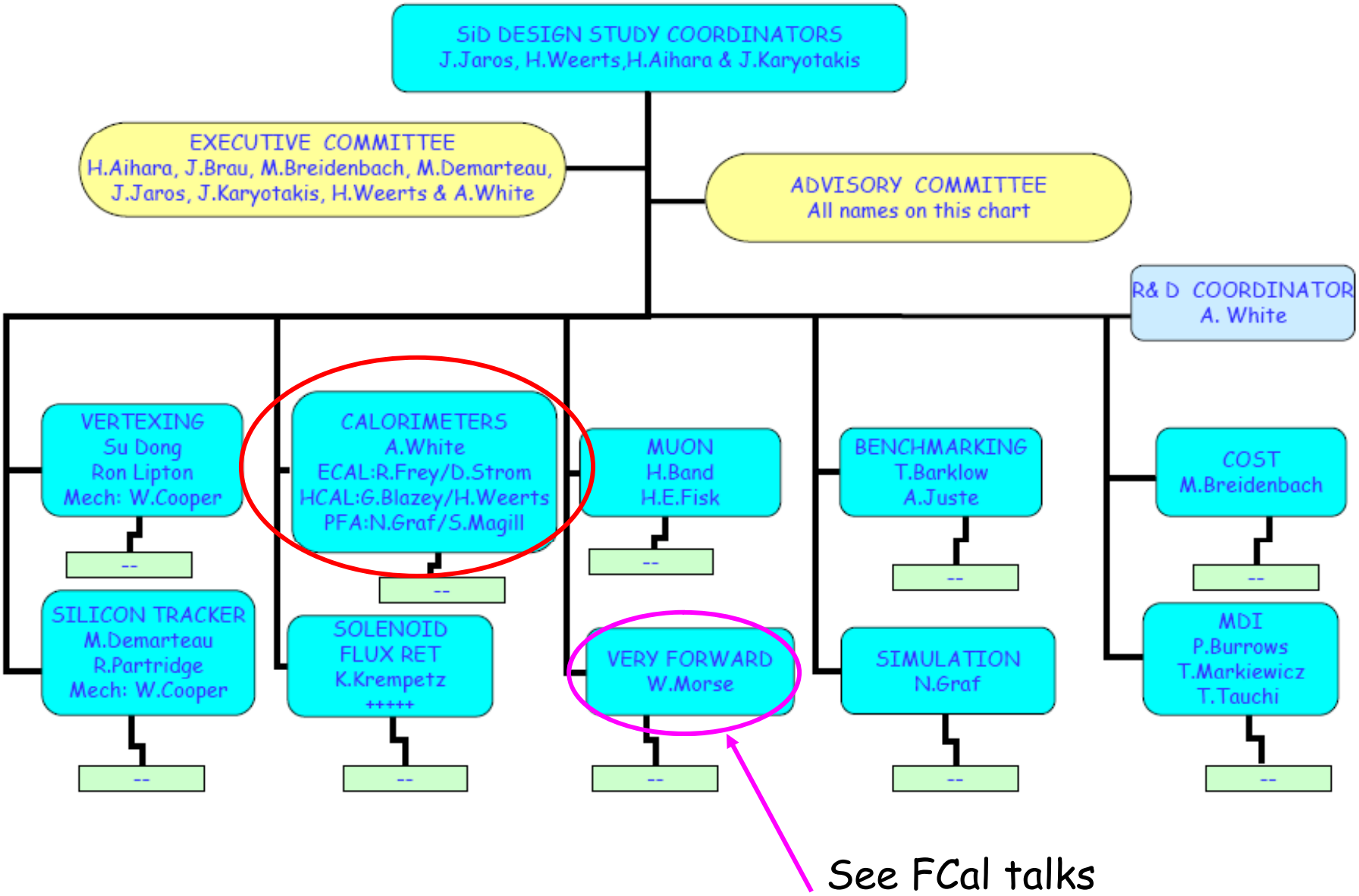
$(\sigma/\mu)\sqrt{E}$

$E_{neutral}$

Calorimeter system: other items

- Schedule – see individual talks and Summary Talk.
- Costs – Information and discussion in closed session.
- Organization – see chart…

SiD organization and subgroups



SiD Calorimeter R&D - Institutions

- University of California at Davis: ECal readout cables and bump bonding.
- University of Oregon: ECal sensors, KPiX testing, ECal mechanical design.
- SLAC: KPiX design and testing, PFA framework and simulations , ECal mechanical design.
- Argonne National Lab: RPC-DHCAL, DCAL digital readout for RPC's, HCal module design, PFA framework and simulations.
- Northern Illinois University: Scintillator HCal, TCMT, SiPM testing, PFA framework and simulations.
- University of Colorado: SiPM testing, ECal alternative design, simulations
- University of Texas at Arlington: GEM-DHCAL design, prototyping and testing, simulations.
- LAPP (Annecy): Micromegas-DHCAL, ECal mechanical design
- University of Washington: GEM-DHCAL prototype testing
- University of Iowa: PFA framework and simulations
- Kansas State University; Tracking from ECal
- MIT: GEM development, gas studies

SiD calorimeter R&D Review
Presentations and Speakers

Thursday, May 31, 2007
LCWS07, DESY

9.40 am SiD Calorimeter R&D Overview
Andy White – University of Texas at Arlington (15 min)

9.55 am Electromagnetic Calorimeter R&D
David Strom – University of Oregon (30 min)

10.30 am Coffee Break (30 min)

11.00 am Readout Electronics R&D
David Strom – University of Oregon (15 min)

11.15 am Basic Simulation Studies for SiD Calorimeter Design
John Jaros – SLAC (15 min)

11.30 am Hadron Calorimeter R&D
Jerry Blazey – Northern Illinois University (20 min)

11.50 am Summary of SiD Calorimeter R&D
Andy White – University of Texas at Arlington (5 min)

11.55 am Discussion