
Silicon Detector: Simulation & Reconstruction

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The LOI Physics Benchmarks Process

- The Letter of Intent (LOI) process required a number of physics analyses to be conducted with full-detector simulation, *ab initio* event reconstruction, and analysis.
- The benchmark processes were deliberately chosen to highlight the intrinsic detector performance, to facilitate comparisons between the concept designs.
- Although still far from “real”, the physics benchmarking requirements presented us with a large-scale, end-to-end exercise which stressed most aspects of the software systems.
 - Event Generation
 - Detector Simulation
 - Event Reconstruction
 - Physics Analysis

Work Plan for 2012

1. Demonstrate proof of principle on critical components.
2. Define a feasible baseline design.
3. Complete basic mechanical integration of the baseline design...
4. Develop a realistic simulation model of the baseline design, including the identified faults and limitations.
5. Develop a push-pull mechanism, ...
6. Develop a realistic concept of integration with the accelerator ...
7. Simulate and analyze updated benchmark reactions with the realistic detector model.

Include the impact of detector dead zones and updated background conditions.

8. Simulate and study some reactions at 1 TeV, including realistic higher energy backgrounds, demonstrating the detector performance.

For 7 and 8, Specific physics channels will be investigated and defined by the Physics Common Task Group and supported by the Software Common Task Group.

9. Develop an improved cost estimate.

Detector Design

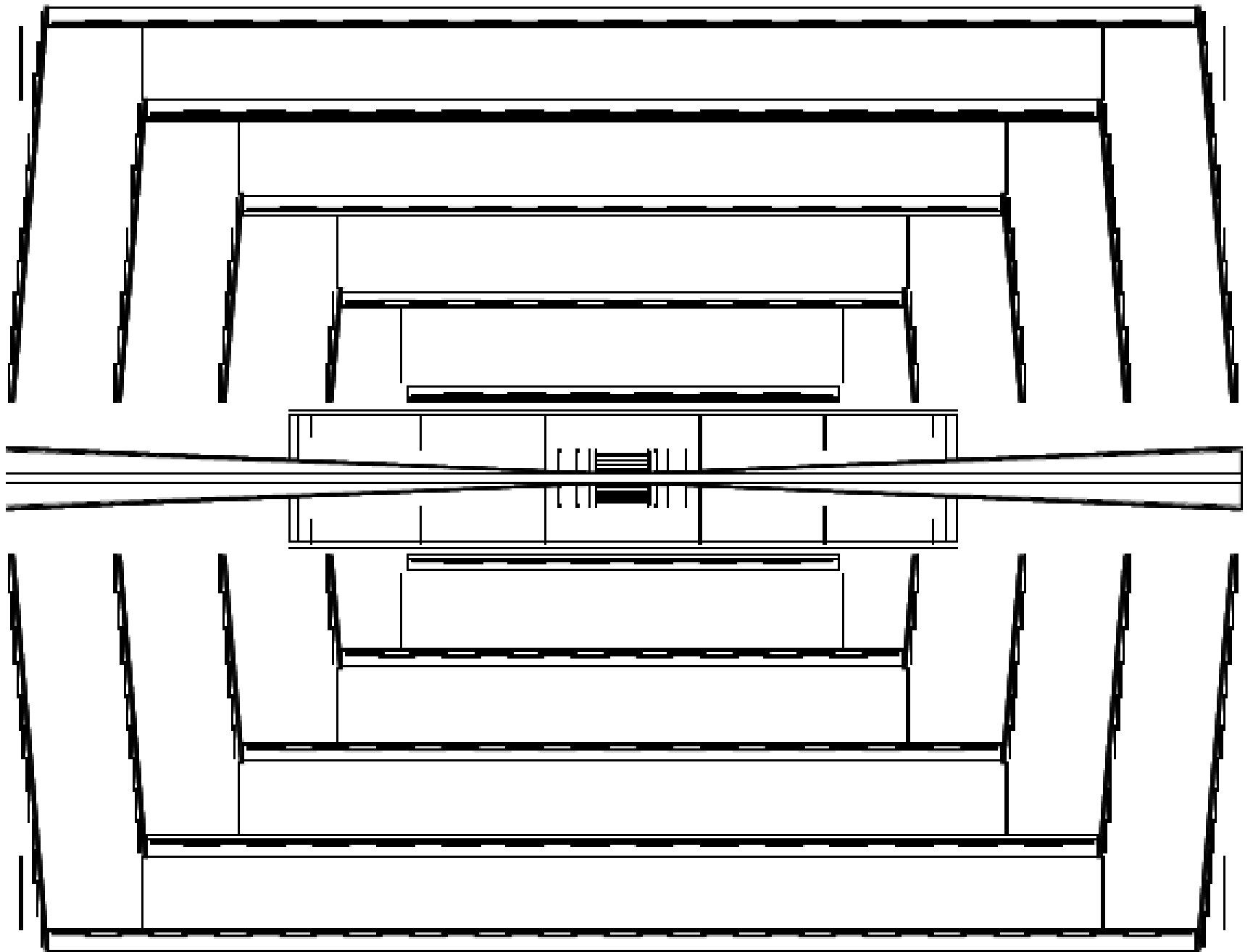
- Develop a realistic simulation model of the baseline design, including the identified faults and limitations.
- LOI studies were conducted with the sid02 geometry, using simplified geometries.

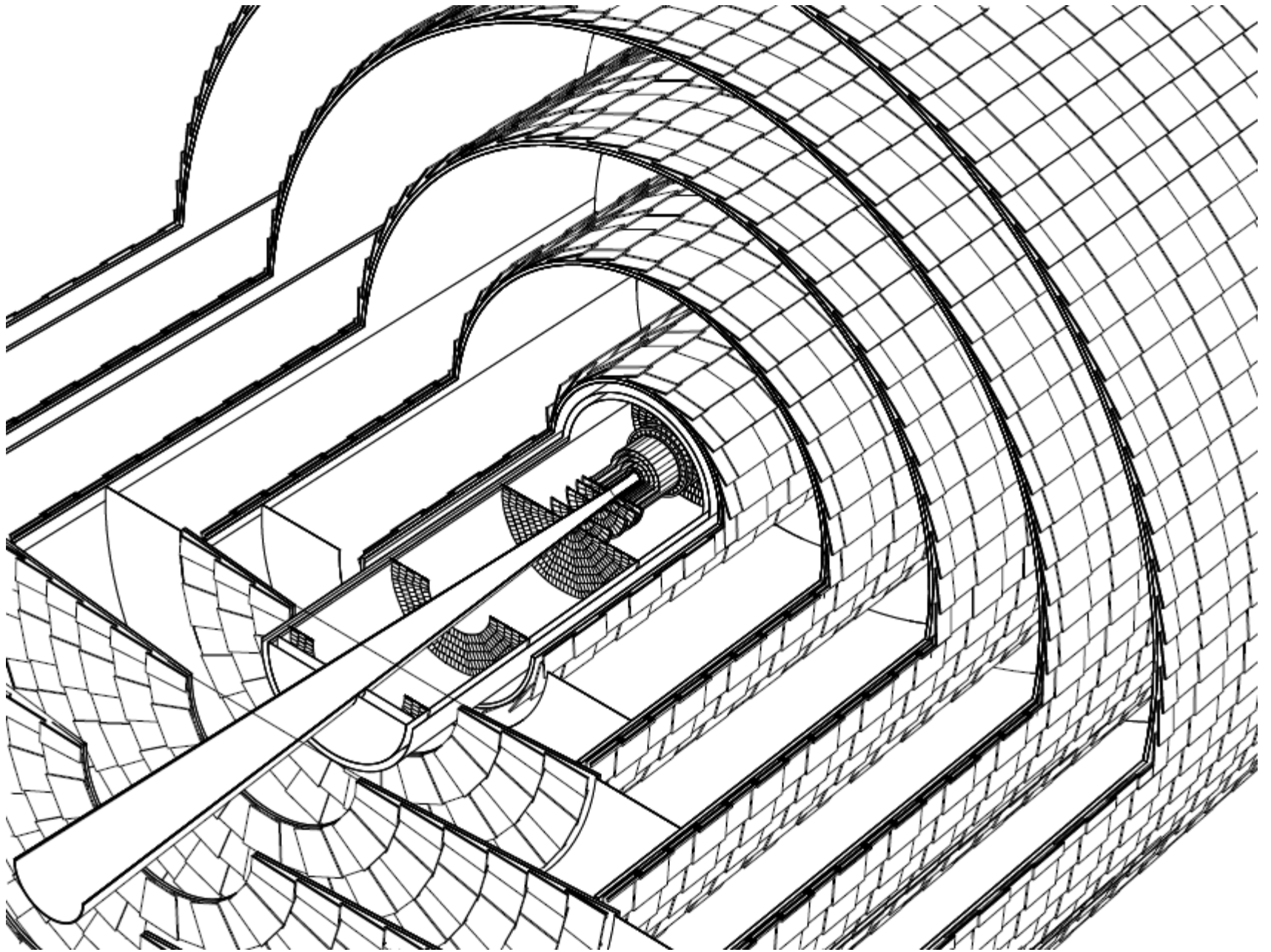
Beyond sid02

- The detector model sid02 was a necessary compromise between the desire to include all the details of the engineering designs and the need to complete the large-scale physics benchmarking simulations in a timely fashion.
- Since then have developed a detector model which includes more realistic detectors.
 - Benefits from engineering work done for the LOI.
 - Allows much more realistic subdetector performance studies to be undertaken.

sidloi

- This model attempts to incorporate the detector as described in the LOI in as much detail as possible.
- Trackers composed of silicon wafers with support structures and readout.
- More realistic modular calorimeters, but much more detail needs to be incorporated.
- Still a work in progress, as many of the details remain to be documented.





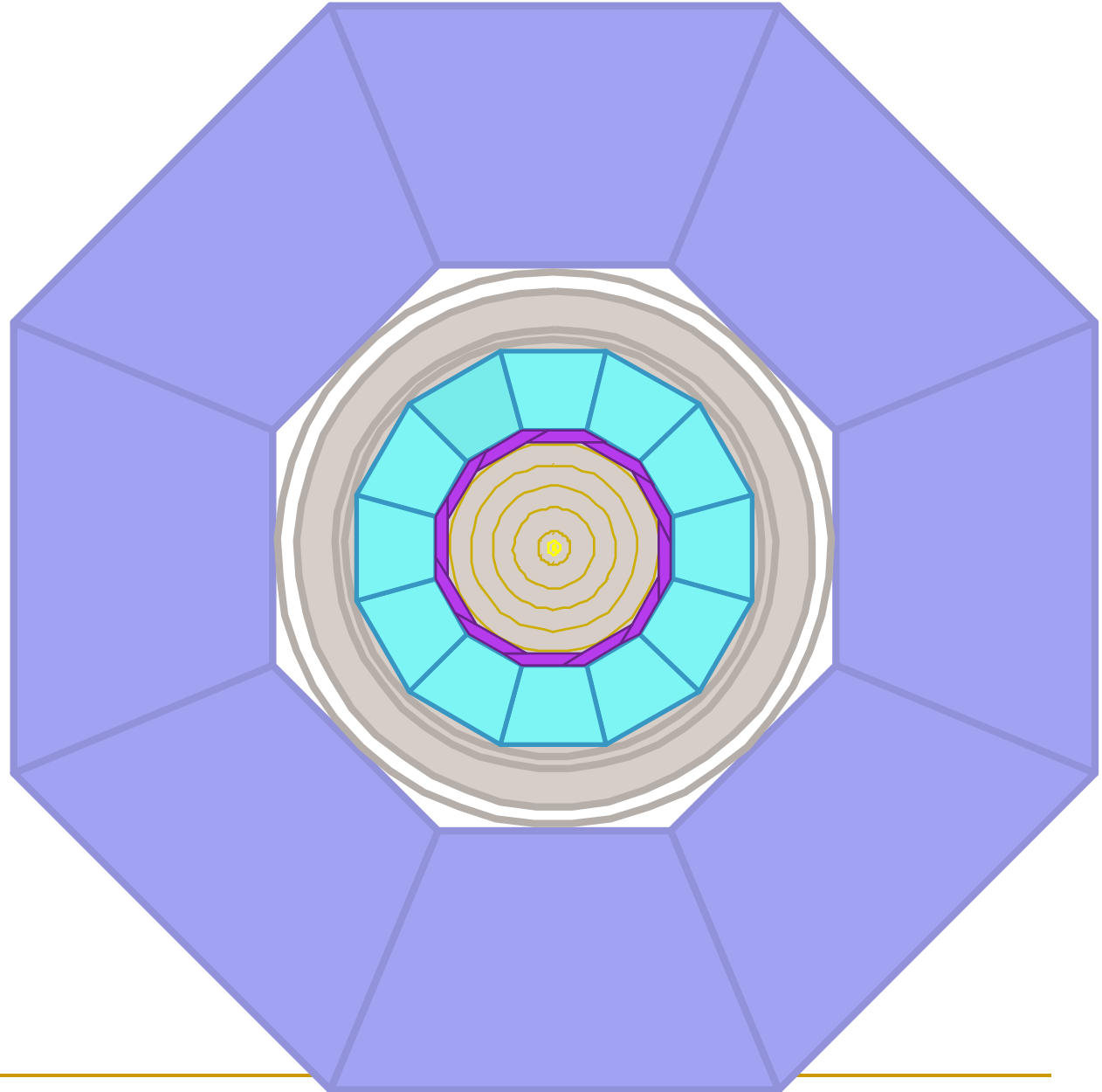
sidloi

Dodecagonal,
overlapping
stave EMCal

Dodecagonal,
wedge HCal

Cylindrical
Solenoid with
substructure

Octagonal,
wedge Muon



Silicon Detector Definition

- Expect that the detector design will change going forward.
- Need to implement some form of Change Control Board to ensure that the modifications motivated by physics studies or engineering constraints are formally communicated to the subdetector, simulation and reconstruction groups.
- Optimization of SiD is an area where new groups could profitably contribute.

Physics Benchmarking

- Simulate and analyze updated benchmark reactions with the realistic detector model.
 - Include the impact of detector dead zones and updated background conditions
- Physics Common Working Group has first draft proposal. See plenary talk by M. Peskin.
- New machine configuration, SB2009 means starting from scratch.
 - Running GuineaPig to calculate e^+ , e^- , γ spectra
 - Generating SM Backgrounds
 - Generating Signal

Event Generation Details

- Whizard was used for all LOI processes.
 - Need to get latest version, e.g.
 - Include all top decay modes
 - tau polarization in decay other than tau-pair process
- Should we include other, dedicated generators for some processes such as Bhabha or SUSY production?
- Should we change the Pythia fragmentation from its default to the LEP-tuned values?
- Arrange some load sharing with ILD when generating these events.

Processing Strategy

- Successfully completing the LOI exercise required the use of all available resources.
- The 500 GeV events were primarily processed using the LCG.
 - Analysis groups were at RAL & Oxford.
- The 250GeV sample was primarily processed at SLAC, on the FermiGrid and the OSG.
 - Analysis groups primarily at SLAC.
- Use of SLAC Isf batch system by far the easiest.
 - Borrowed “fair shares” from BaBar and ATLAS
- Will we have Grid access when LHC starts?

The Grid

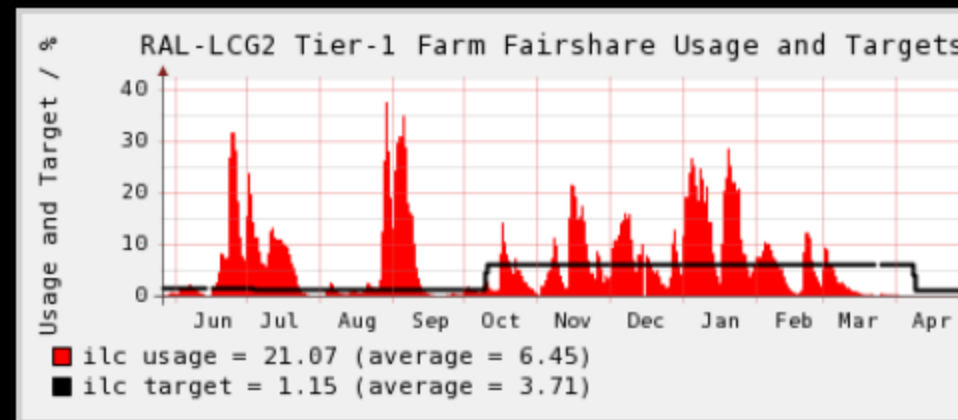
- Made extensive use of both the LCG and OSG grids.
 - LCG: DESY, RAL Tier 1, in2p3, ...
 - OSG running opportunistically on the CMS grid
- In general, no problems with the concept software
 - SiD software (slic & org.lcsim) just worked (also ran MarlinReco on LCG where it was installed).
- Number of issues with Grid job submission, monitoring and file transfers.
- Grid is still high-maintenance & very LHC-centric.
- This process can no longer rely on individuals, it has to be institutionalized, automated and coordinated with ILD. New groups could contribute.
- See talk by Jan Strube for details.



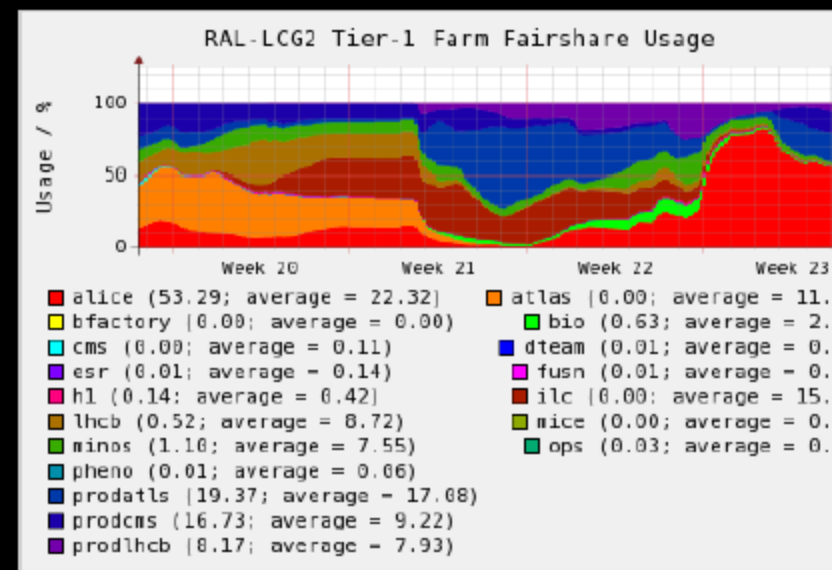
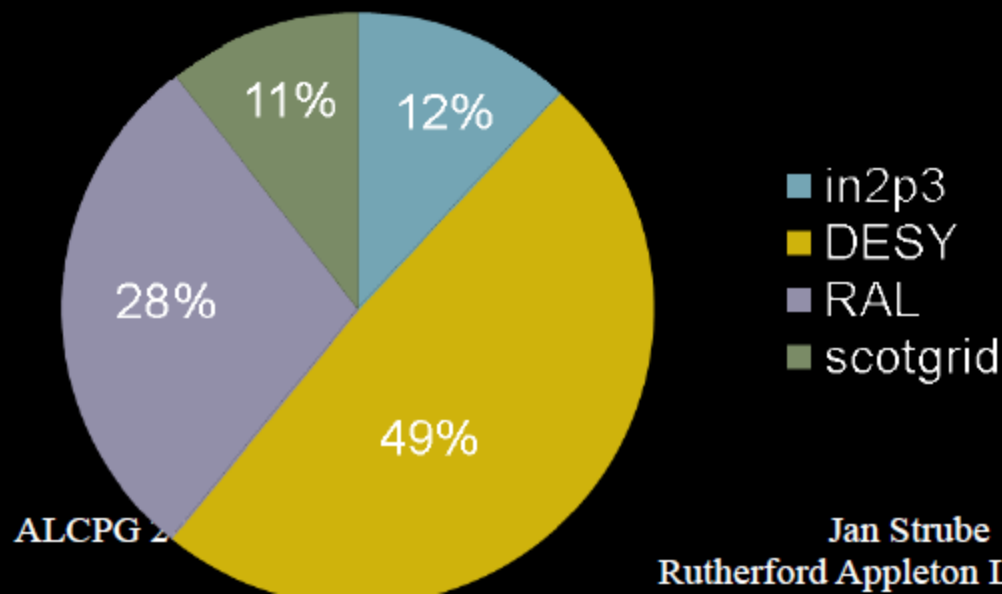
Production Stats

25 different data sets

Production Step	# events
Simulation (SLiC)	42,611,000
Reconstruction	31,991,000
Flavor Tagging	20,446,000



CPU times (for the jobs for which I have this info)



Reconstruction

- Much of the reconstruction software will have to be modified or rewritten to accommodate the new geometries.
 - New neighboring definitions and clustering code for the calorimeter.
 - New tracking code for digitization in planar silicon detectors, finding and fitting.
 - New extrapolation and track-cluster association code.
 - Loss of key individuals and lack of infrastructure support at the labs makes this very challenging.
-

Tracking

- Digitization improves from the virtual segmentation used in the LOI to full digitization of SimTrackerHits into ADC counts in pixels and strips, using detailed drift, diffusion, readout, ...
- Full clustering of neighboring hits, giving cluster-dependent measurement position and uncertainties.
- Much testing remains to be done.
- Need to implement full fitting accounting for multiple scattering and energy loss.

Calorimeter Clustering & PFA

- Code has been developed to provide full functionality for modular calorimeters
 - Return list of neighboring cells within module
 - Given position, return ID
 - Given ID, return position
- Testing that clustering code works with new geometries, modifying or augmenting as necessary.
- Need to develop cross-module clustering.
- Will need to check that existing PFA works with new geometries, modify or replace as necessary.

LCIO

- Access to a common event data model and a common persistence format played a large part in the successful use of cross-concept software packages, e.g. LCFIVertex.
- Events from SiD Java-based reconstruction were further processed using MarlinReco.
 - No need for a single monolithic framework.
 - Functionality of the tools themselves and common event data model more important than the framework into which they plug.
- Discussions initiated on LCIO2.0 in response to user experiences to-date. Requires manpower to implement.

1 TeV analyses

- Simulate and study new 1 TeV benchmarks.
- First draft proposal presented at this workshop (see talk by M. Peskin).
- Need to provide feedback to Physics group to ensure that SiD's strengths are represented.
- Need to obtain machine parameters appropriate for this energy.
- Arrange some load sharing with ILD when generating these events.
- Overlap with CLIC?

Testbeams?

- “Demonstrate proof of principle for critical components”
- Will require SiD-specific testing of detector components.
- Simulation and reconstruction demands for a testbeam effort are different, and in some cases much more demanding, than what was done for the LOI.
- Excellent opportunity for new groups to contribute.

Summary

- Much was done for the LOI, but much more will need to be done for this exercise.
- In many cases “starting from scratch.”
- Effort is severely resource-limited.
- Many areas in which new groups or individuals can contribute.
- Even if “2012” is not three years away, time is short.
- Volunteers?