Full Detector Simulation with Gismo

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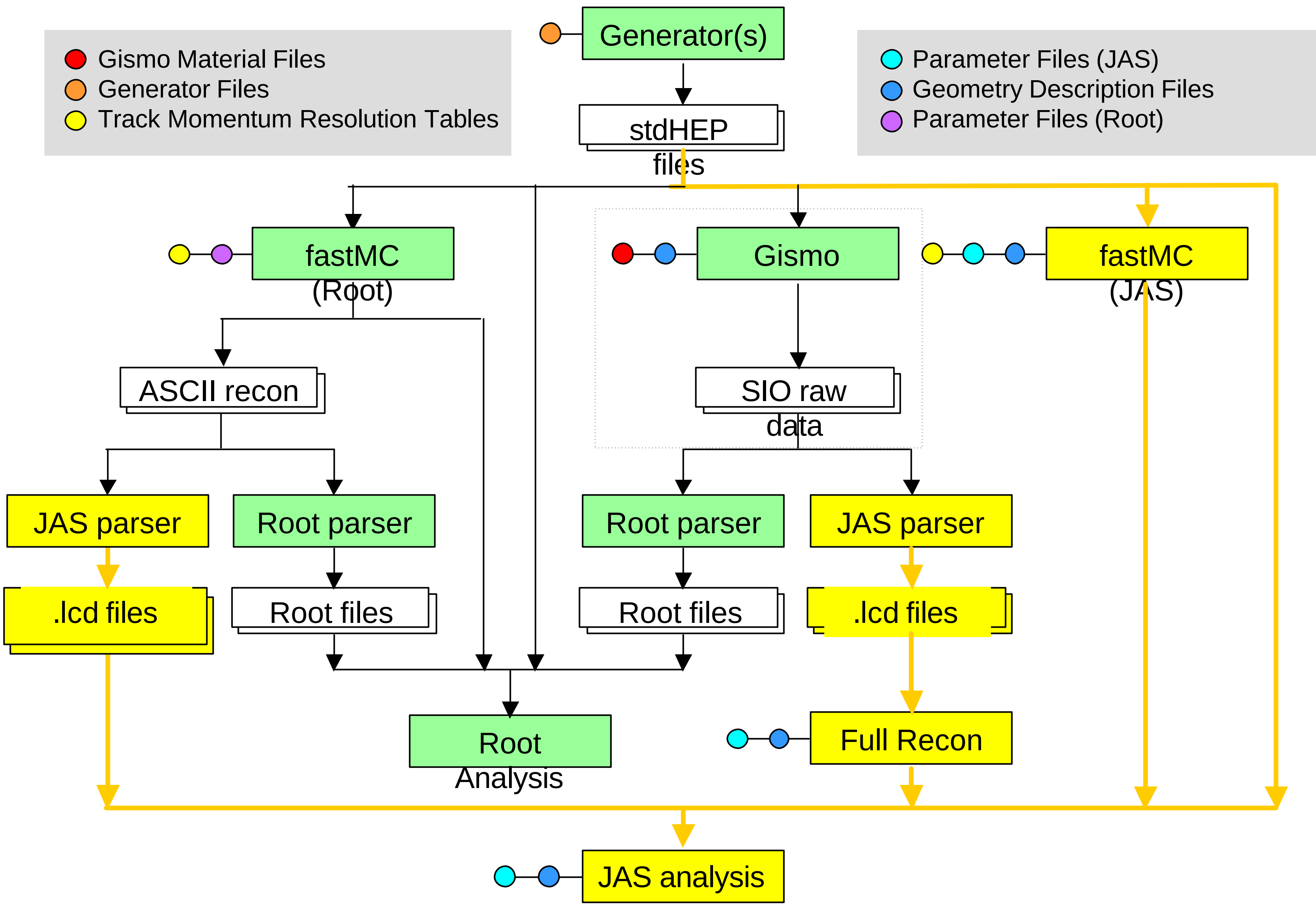
LCWS2000 at FNAL

Overview

- Why do full simulation
- Gismo features
- Current detectors
- Data availability
- Summary

LCD Software Road Map



Full Simulation: Tool for

- **Detector design and comparisons**
- **Reconstruction development**
- **Realistic parameters for fast simulation**
- **Beam background studies and overlays**

Full Simulation

- **Although many analyses can be performed with fast, parameterized simulations, these cannot be the final word.**
  - **Most often, complications due to pattern recognition (e.g. clustering and track finding in complex events) are completely ignored.**
  - **Detector effects (cracks, edges, inefficiencies, field inhomogeneities) and physics effects (dE/dx, production of secondaries, decays in flight, etc.) are not simulated.**
- **Essential for development of realistic reconstruction algorithms and physics analyses!**

GISMO/GISMOAPPS

- **Full featured simulation**
  - Object-Oriented C++
  - AIX, Linux, OSF1, SunOS, NT platform support
  - CVS storage
  - Prod/Dev/Test of individual facilities with DEC
  - Complex geometries, XML definitions
  - EGS(EM) + Gheisha(hadronic) (1 MEV cutoff)

GISMO/GISMOAPPS

- **Digitization**
  - **Tracking: actual position at active layer**
  - **Calorimeters: total energy per channel**
  - **Full MC record for each digitization**

    Each particle's contribution is separately included for each calorimeter hit
- **Generator input from /HEPEVT/ via FNAL STDHEP I/O package**
- **SIO output**

Beam Background Overlays

- **Take output from full beam simulation (from IR/backgrounds group)**
- **Feed into full Gismo simulation**
- **Build library of simulated background bunches**
- **Overlay backgrounds on signal events at start of reconstruction**
  - Adjust timing of hits (for TPC e.g.)
  - Add energy in calorimeter cells

Allows to change #bunches/train, bunch timing

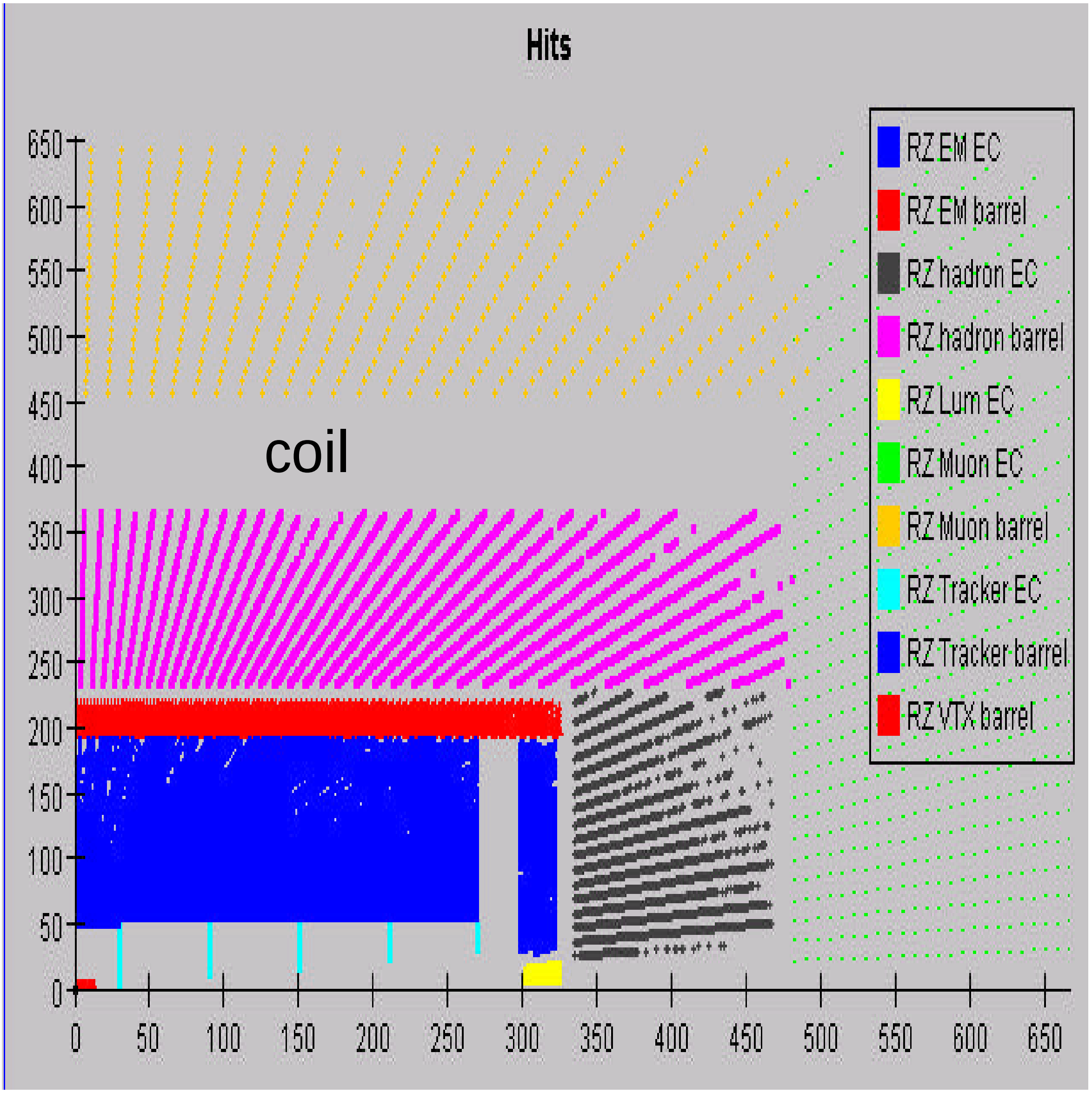
Current detector designs

	S2	L2
Beam pipe	.075 cm Be + .01 cm Ti shield 1 cm inner radius	.075 cm Be + .01 cm Ti shield 1 cm inner radius
Vertex	5 layers .01 cm Si r = 1.2 – 6.0 cm	5 layers .01 cm Si r = 1.2 – 6.0 cm
Tracker	3 doublets Si, r = 14,15 42,43 70,71 5 Si discs z = 31, 61, 91, 121, 149 cm	144 layer TPC, r = 52-190 cm 5 Si discs z = 30-270 cm 1 layer Si, r = 48 cm
EM Calorimeter	50 layers W/Si, barrel r = 78-103 cm EC z = 152-178 cm, mean cell width = 1.5 cm, #channels = 4X10**6	40 layers Pb/Scint, barrel r = 196-220 cm, EC z = 297-322 cm, mean cell width = 3.4 cm, #chans = 3.4X10**6
Had Calorimeter	38 layers Cu/Scint, barrel r = 188-287 cm, EC z = 189-388 cm, mean cell width = 3.5 cm, #chans = 3X10**6	120 layers Pb/Scint, barrel r = 233-365 cm, EC z = 334-446 cm, mean cell width = 13 cm, #chans = 1.1X10**6
Muon Calorimeter	10 layers Fe, barrel r = 300-420 cm, EC z = 298-318 cm	24 layers Fe, barrel r = 453-645 cm, EC z = 447-669 cm
Luminosity Monitor	50 layers W/Si, z = 151-176 cm	50 layers W/Si, z = 300-325 cm
Coil	29 cm Al, r = 113-182 cm B = 6T	29 cm Al, r = 378-448 cm B = 3T

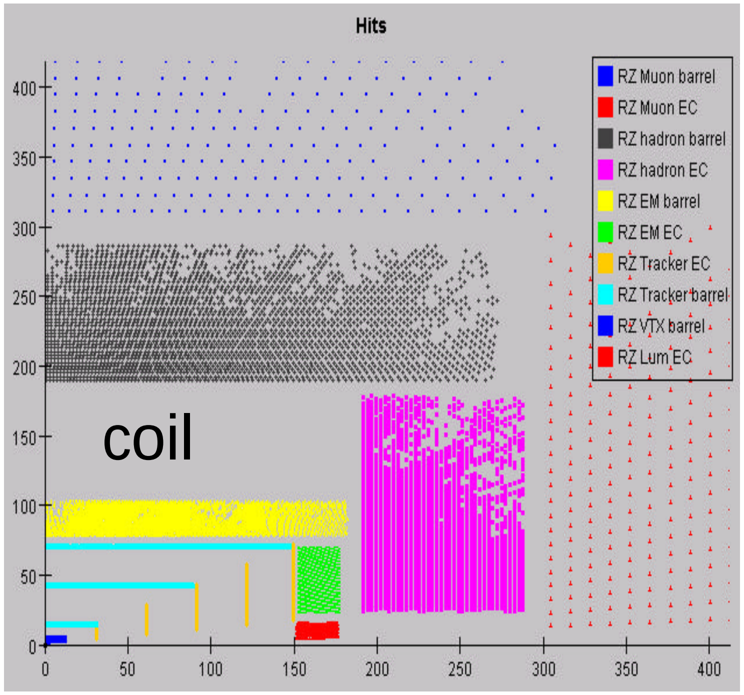
Current detector coverage

		coverage theta (mr)	coverage cos(theta)	Theta segment*	Phi segment*
S2	EM	135	.991	10mr	20mr
	HAD	67	.998	10mr	20mr
	LUM	34	.999	10mr	20mr
	VTX	192	.982		
	Tracking	119	.993		
L2	EM	90	.996	10mr	20mr
	HAD	66	.998	30mr	60mr
	LUM	15	.9999	10mr	20mr
	VTX	192	.982		
	Tracking	114	.994		

L2



S2

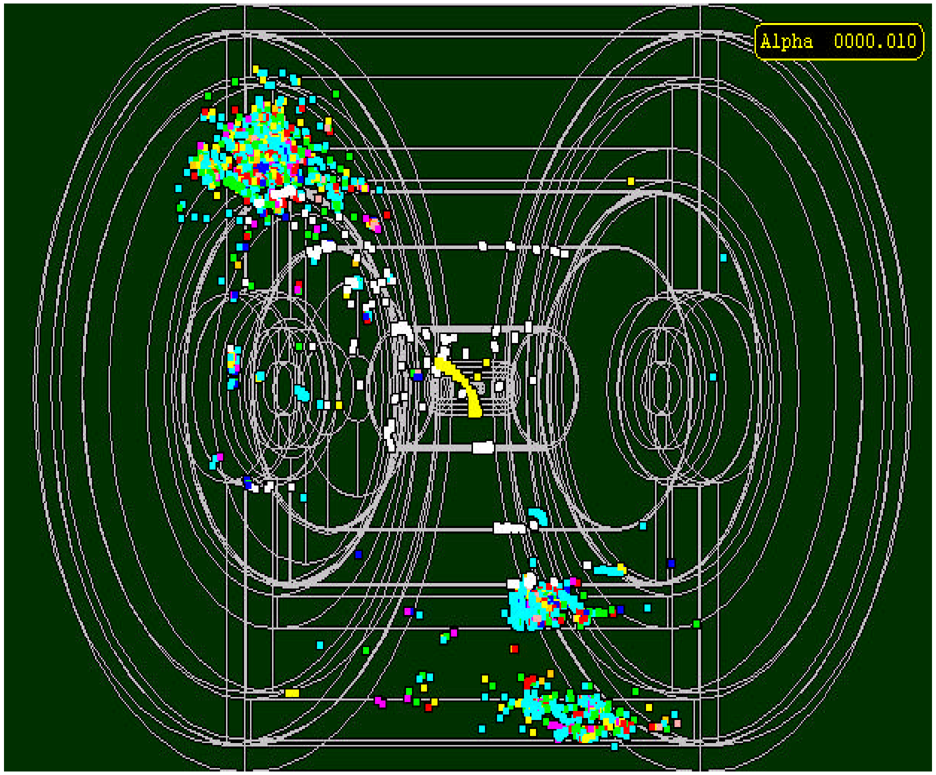


R-Z plots of hit positions from active elements of the two current designs

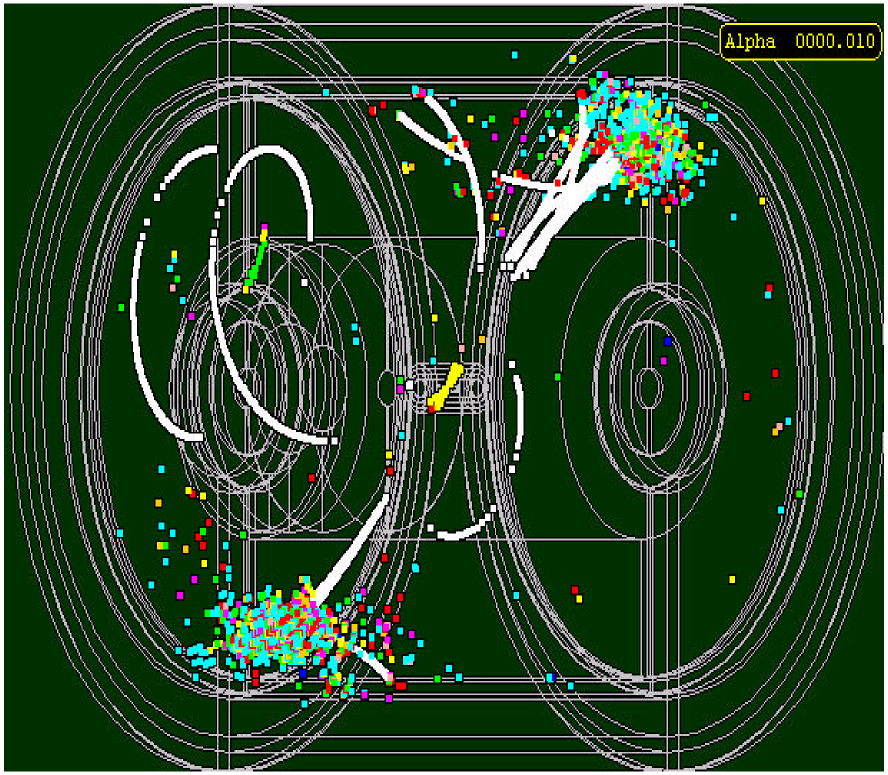
ee -> qq

fisheye view

S2



L2



```
<!DOCTYPE lcdparm SYSTEM "detParms.dtd" >

<!--   Following describes the standard large detector, version 2        -->
<!--

CVS $Header:
/afs/slac.stanford.edu/g/nld/cvsroot/lcd/dat/large/2/largeParms2.xml,v 1.0
2000/1/21 16:00:00 jrb Exp $

detector_ID:
type  L2
major 2
minor 0
end;
<lcdparm>
  <global file="largeParms2.xml" />
  <physical_detector topology="large" id = "L2" >
    <volume id="EM_BARREL" rad_len_cm="1.4" inter_len_cm="0.03" >
       <tube>
         <barrel_dimensions inner_r = "196.0" outer_z = "322.0" />
         <layering n="40">
           <slice material = "Pb" width = "0.4" />
           <slice material = "Tyvek" width = "0.05" />
           <slice material = "Polystyrene" width = "0.1" sensitive = "yes" />
           <slice material = "Tyvek" width = "0.05" />
         </layering>
<!-- Took out owall; has been replaced with EM_BARREL_ELECTRONICS below -->
         <segmentation theta = "300" phi = "300" />
      </tube>
      <calorimeter type = "em" />
    </volume>
<!-- electronics.  Slight gap (.15 cm) between it and EM barrel proper -->
    <volume id="EM_BARREL_ELECTRONICS">
       <tube>
         <barrel_dimensions inner_r = "220.15"     outer_z = "322"  />
         <layering>
           <slice  material = "G10" width = "6.85" />    <!-- ??? -->
         </layering>
       </tube>
       <support type = "electronics" />
    </volume>
<!-- Support structures for barrel: inner wall and endrings -->
    <volume id="EM_BARREL_INNER_WALL" >
       <tube>
         <barrel_dimensions inner_r = "193"     outer_z = "325"  />
         <layering>
           <slice  material = "Al" width = "3" />
         </layering>
       </tube>
```

```
       <support />
    </volume>
    <volume id="EM_BARREL_ENDRING">
       <disk>
         <disk_dimensions inner_r = "196" inner_z = "322" outer_r = "227" />
         <layering>
           <slice  material = "Al" width = "3" />
         </layering>
       </disk>
       <support />
    </volume>
    <volume id = "EM_ENDCAP" rad_len_cm = "1.4" inter_len_cm = "0.03">
       <disk reflected = "yes">
         <disk_dimensions inner_r = "29.0" inner_z = "297.5"
                          outer_r = "187.0" />
         <layering n="40">
           <slice material = "Pb" width = "0.4" />
           <slice material = "Tyvek" width = "0.05" />
           <slice material = "Polystyrene" width = "0.1" sensitive = "yes" />
           <slice material = "Tyvek" width = "0.05" />
         </layering>
         <segmentation theta = "300" phi = "300" />  <!-- ??? -->
       </disk>
       <calorimeter type = "em" />
    </volume>
<!-- electronics.  Slight gap (.15 cm) between it and EM endcap proper -->
    <volume id="EM_ENDCAP_ELECTRONICS">
       <disk>
         <disk_dimensions inner_r = "29.0"  inner_z = "321.65"
                           outer_r = "187"  />
         <layering>
           <slice  material = "G10" width = "6.35" />  <!-- ??? -->
         </layering>
       </disk>
       <support type = "electronics" />
    </volume>
    <!-- inner support disk for  EM_ENDCAP  -->
    <volume id="EM_ENDCAP_INNER_DISK">
       <disk>
         <disk_dimensions inner_r = "25" inner_z = "295" outer_r = "188" />
         <layering>
           <slice  material = "Al" width = "2.5" />
         </layering>
       </disk>
       <support />
    </volume>
    <volume id = "HAD_BARREL"  inter_len_cm = "0.05" >
      <tube>
        <barrel_dimensions inner_r = "233.0" outer_z = "466.0" />
        <layering n="120">
```

Data Availability

Latest data sets: October 2000

Archived at

SLAC (lcddata01.slac.stanford.edu)

S2 and L2 detectors

10000 events of udscb, tt, ZZ, WW, ZH

Diagnostic generator requested samples also available

Previous data sets:

Archived at

SLAC (lcddata01.slac.stanford.edu)

SLAC (sldnt0.slac.stanford.edu)

PENN (sp05.hep.upenn.edu)

All accessible through JAS or FTP

Summary

- A functional full simulation package exists
- Changing detector models is easy
  - Serious detector design studies are possible
- Realistic reconstruction/analysis is possible
- Generating realistic parameters for a fast MC is possible
- Data sets of 10000 events for several processes already available

Future Plans

We plan to maintain the current simulation framework which defines and creates the geometry and data structure and replace the physics simulation package GISMO with GEANT4.

We welcome collaboration with other groups making this transition.