SuperB FastSim Status

David Brown, LBNL
on behalf of the Fast Simulation Group

SuperB Computing Workshop
Frascati
16 December 2008

SuperB FastSim Goals

- Detector optimization studies
  - beampipe, tracker layout, Z=0?, ...
  - forward PID, forwards+backwards EMC, ...
  - Coordinated by the Geometry Task Force
    - first meeting on Wednesday afternoon
- Physics reach studies
  - performance on benchmark channels
    - feedback to detector design
  - high-statistics studies of rare channels
- Really Fast (~100Hz)

Fastsim is an important tool for the TDR

SuperB FastSim Design

- Simplify detector element description
  - cylinders, rings, cones, ...
- Fully model particle passage through detector
  - Energy loss, multiple scattering, interactions, showering...
- Parameterize detector response
  - track hit resolution, cluster shape, Cherenkov photon resolution, ...
- 'Reconstruct' tracks, clusters, rings, ...
  - Model hit overlaps, cluster splitting, ...(eventually)
- Result compatible with BaBar analysis tools
  - Vertexing, tagging, PID, BtuTuple, ...

Progress since Elba

- Simulation of neutral particles
- Simulation of outer detector (coil+IFR)
- Add ring and cone geometries
- Tuning of energy loss, discrete interactions
- EM and hadronic shower modeling prototypes
- Tuning and refinement of detector response
  - Dirc, Emc, Svt, Dch, ...
- 3-D Event Display
- XML-based configuration description
- Release System prototype
- Code cleanup and restructuring

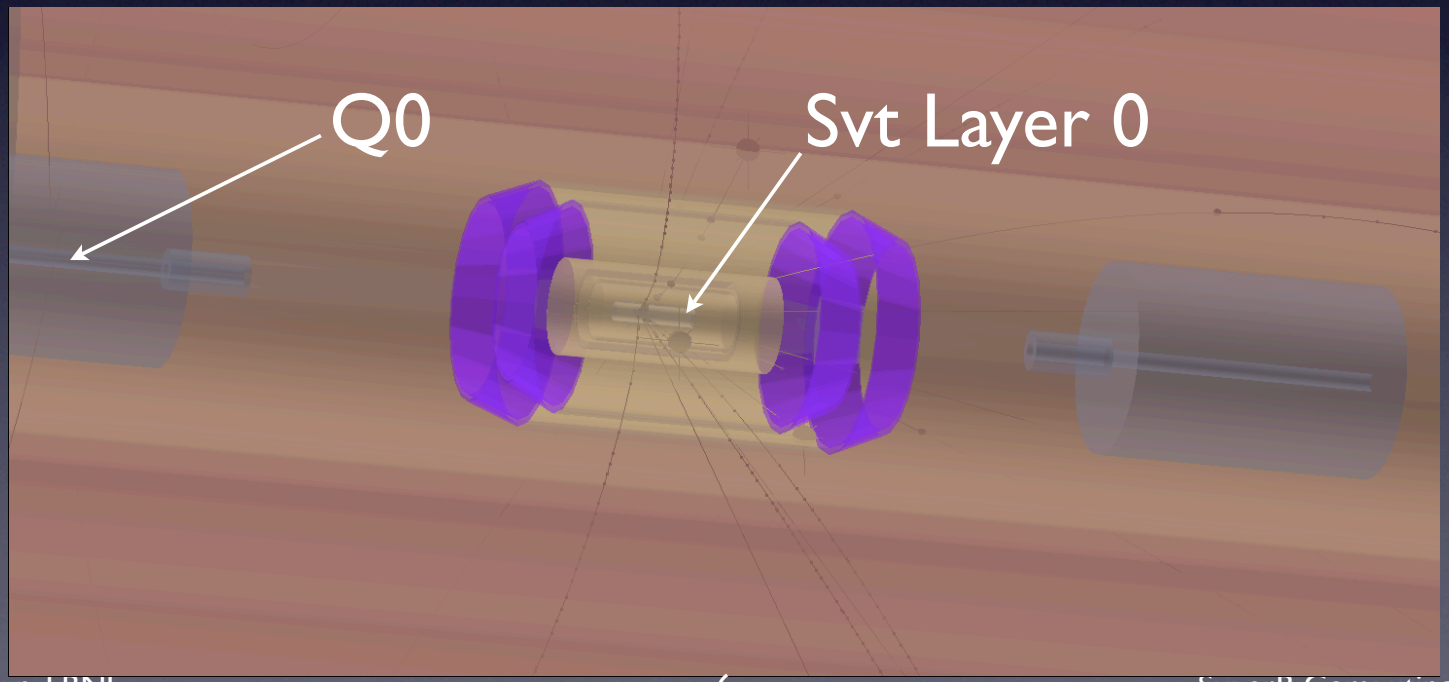
Under Rapid Development!

Detector Material Simulation

- Material effects are computed per-element
  - double-Gaussian scattering and energy loss
  - tuned by comparing with G4 (BaBar full sim)
- Interaction probabilities computed per-element
  - EM (Had) showers for e, γ (K_L, ...) in 'thick' materials
  - γ conversion, e brems, etc. in 'thin' materials
- True particle trajectory in detector recorded
- Interactions recorded as discrete SimHits
  - Energy loss, direction change, effect, daughters, ...

PacDisplay (Aritoki Suzuki)

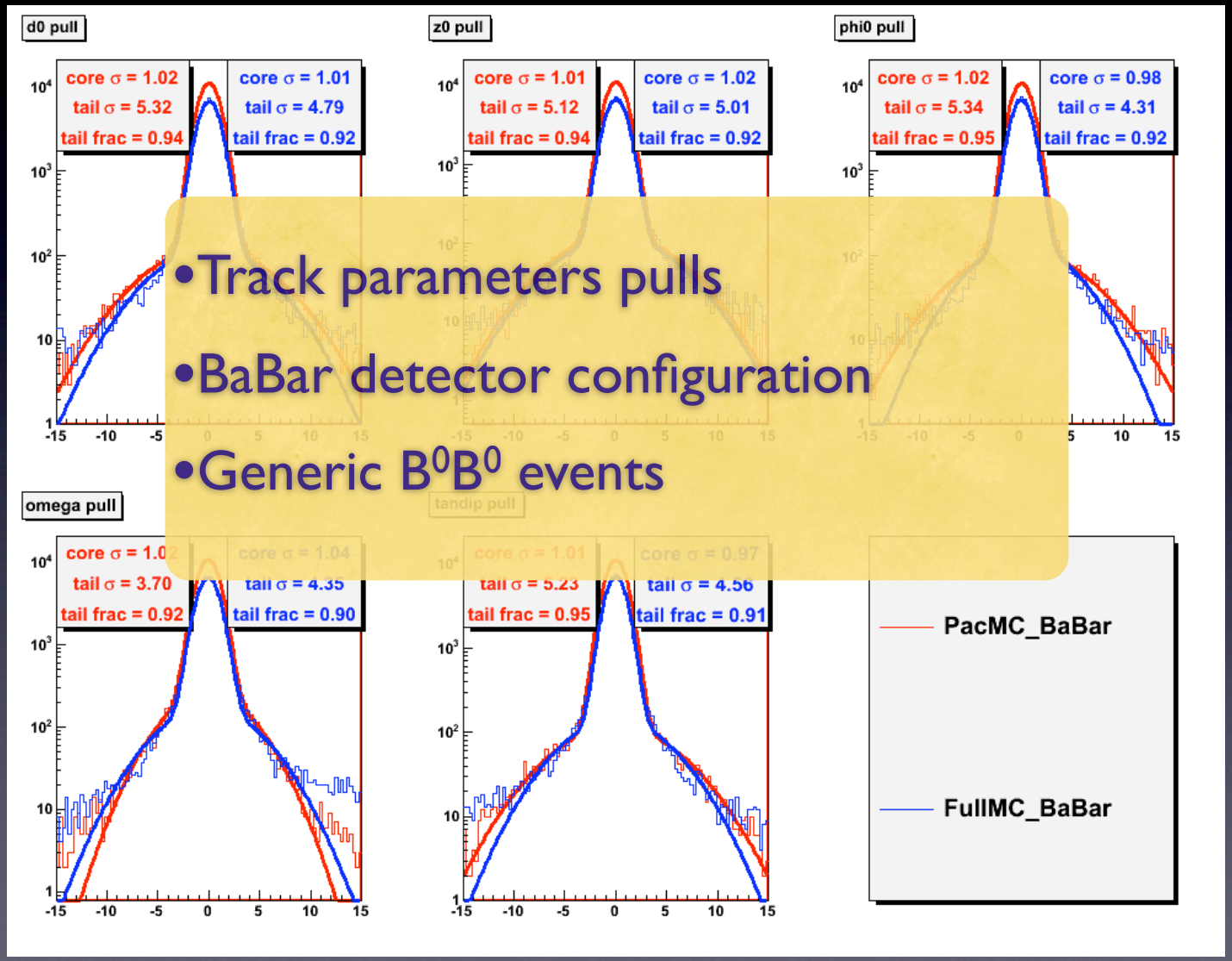
- Module in PacMC produces output root file
- Viewer macro runs in a root (5.20) session
- OpenGL graphics (zoom+move, transparency, cutouts, camera+lighting control, selection,...)



Tracking Simulation

- Multiple measurement types supported
  - double-sided Si strips, Si pixels, wires, ...
  - Measurements can be associated to any geometry
    - cylinder, cone, ring, ...
- Hit positions smeared by an analytic function
  - double-Gaussian for Svt, 'T2D' function for Dch,...
- Electronic Inefficiency, geometric overlaps and gaps modeled statistically
  - EG Svt ribs modeled as thick CF with large gaps

Tracking Response

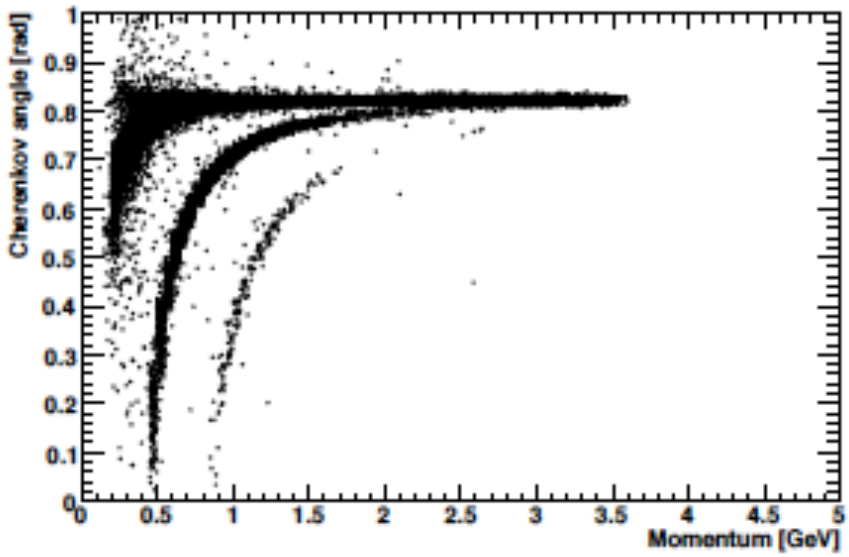


- Track parameters pulls
- BaBar detector configuration
- Generic B^0B^0 events

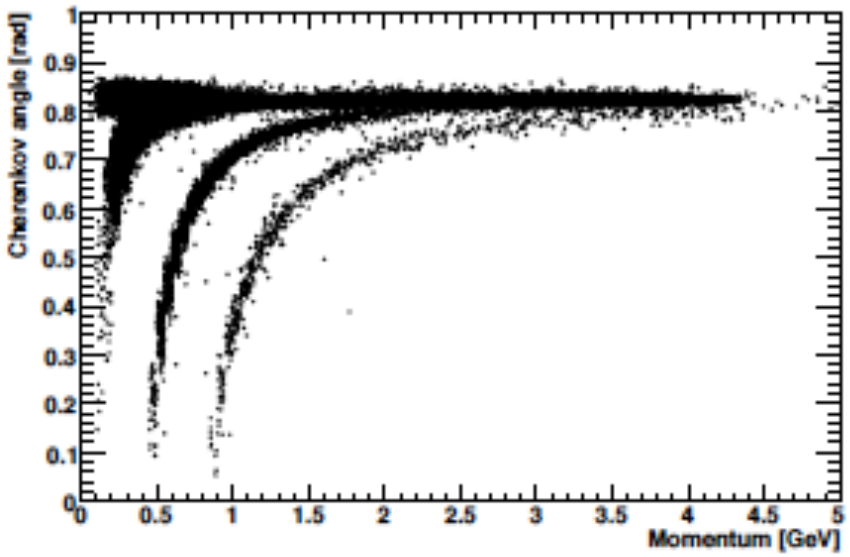
Dirc Simulation (Rolf Andreassen)

- Seed rings on true position, direction
- Generate photons according to ring dictionary
- Smear Θ_C with reconstructed track angle error
- Dispersion, QE configurable

Dirc response



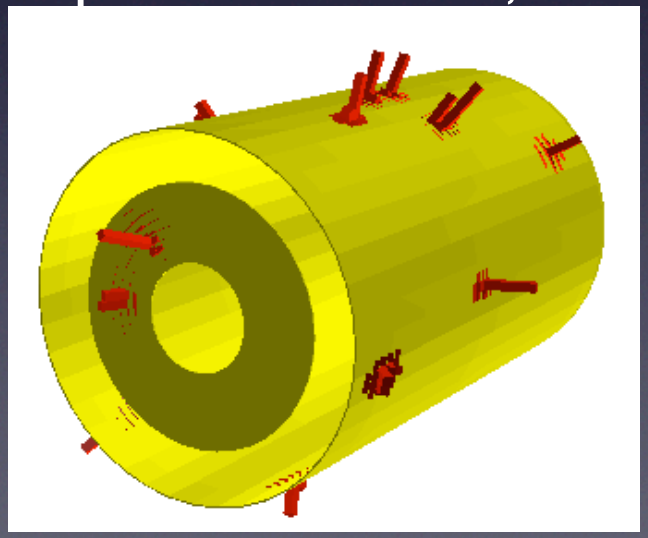
Fast simulation

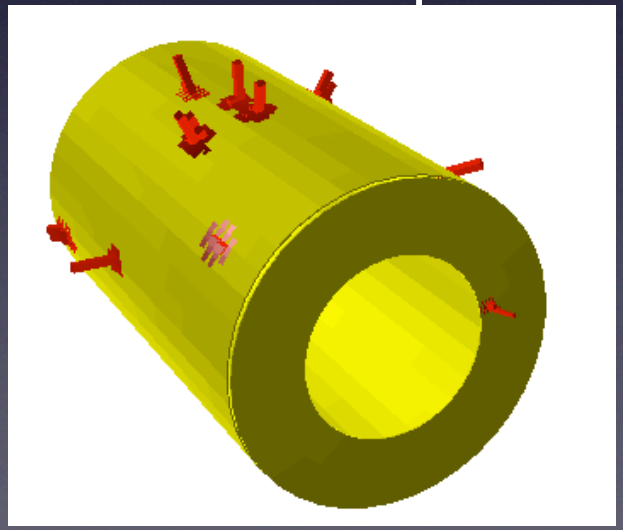


Full simulation

Emc Simulation (Chih-hsiang Cheng)

- Parameterized clusters based on energy deposition on a grid
- Resolution and transverse shape parameterized by standard functions
  - configurable parameters
  - separate forward, barrel and backward responses

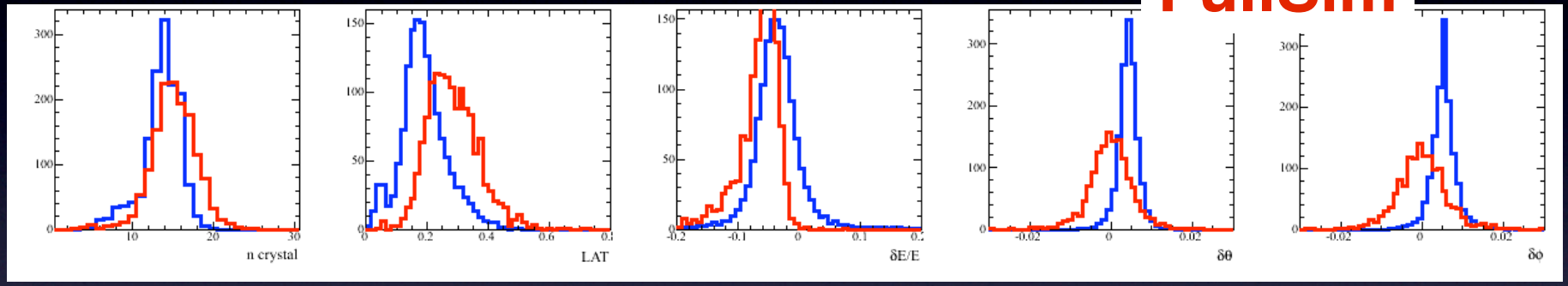




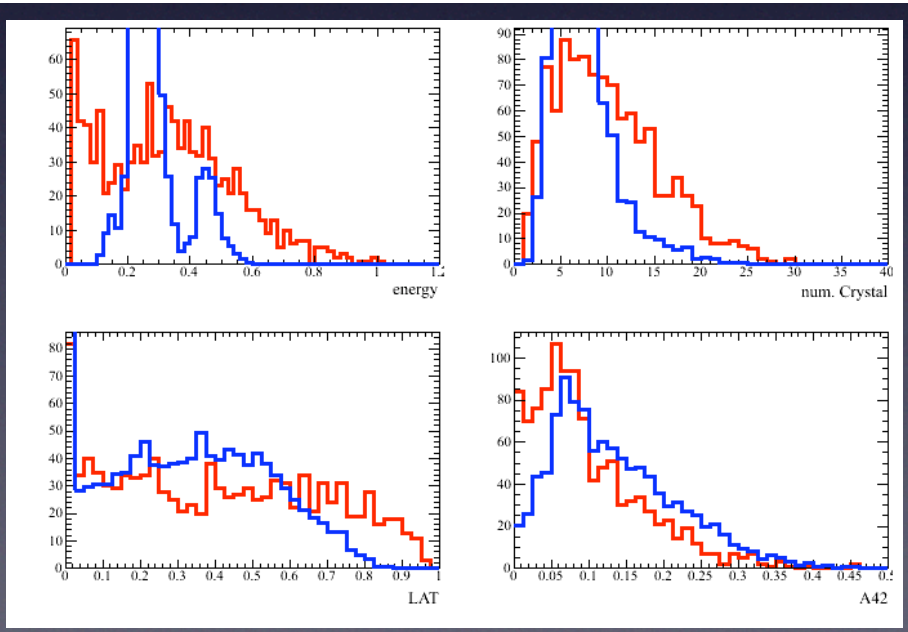
EMC Response

1 GeV photons

FastSim
FullSim



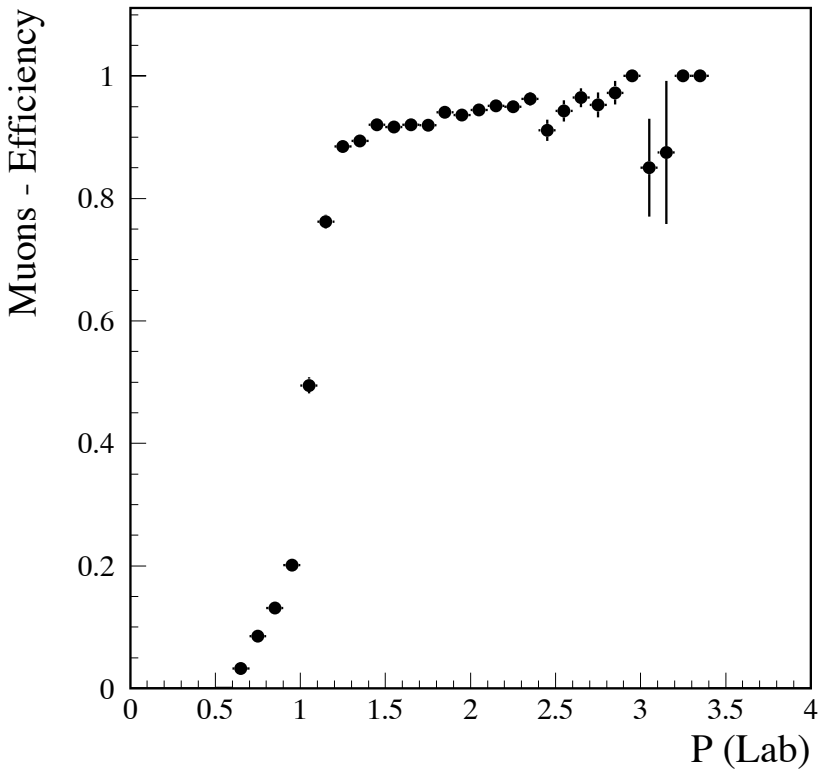
1 GeV K_L

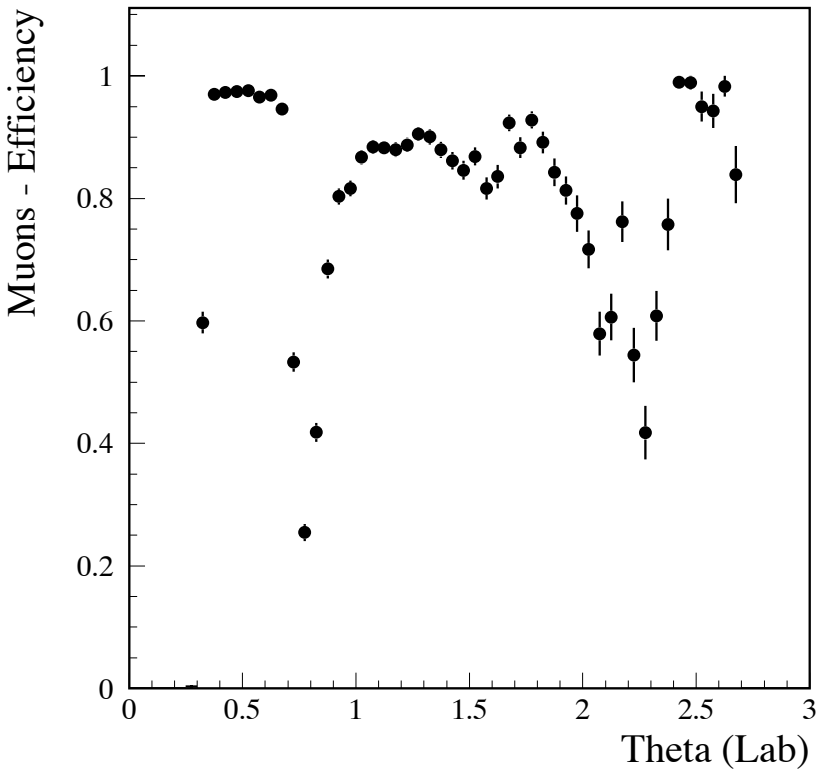


Ifr Simulation (Marcello Rotondo, Giuliano Castelli)

- Outer-detector is modeled as 0-Field
  - straight-line trajectories
- (muon) hits are reconstructed as 2-D clusters
- Fit to hits gives chisquared
- muon response in reasonable agreement with fullsim

IFR Response





FastSim configuration

- XML detector description (I. Gaponenko)
  - Describes element geometry, material, and measurement parameters
  - Elements live in Volumes which can have their own properties
  - Configuration files can be included in other configuration files
  - Multiple files can processed, overwriting previous parameters
- Material composition
  - Uses BaBar text-based structure

Si_SuperB.xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<edml>
  <included>
    <volume name="Si Tracking Region">
      <cyl name="Beampipe" id="0" zmin="-282" zmax="356" radius="1.05" thick="0.0911"
mat="SB-BPipe" />
      <cyl name="SvtMaps" id="0"  zmin="-3.5" zmax="6.5" radius="1.15" thick="0.005"
mat="svt-Silicon" meas="SiMaps" overlap="0.01" />
      <cyl name="SvtMapsSupport" id="0" zmin="-3.5" zmax="6.5" radius="1.21" thick="0.112"
mat="SB-MapsSupport" />
      <cyl name="SvtMaps" id="1"  zmin="-3.5" zmax="6.5" radius="1.27" thick="0.005"
mat="svt-Silicon" meas="SiMaps" overlap="0.01" />
.....
```

Materialslist.data

```
...
SB-MapsSupport  1.738 0.0 0.0 +5 0.554 svt-CFiber 1 0.17 svt-Aluminum 1 0.128 svt-Epoxy 1
0.09 svt-Kapton 1 0.058 pep-H
20 1 -10 -20 -30 20.0 1.0 solid
...
```

DircConfig.xml

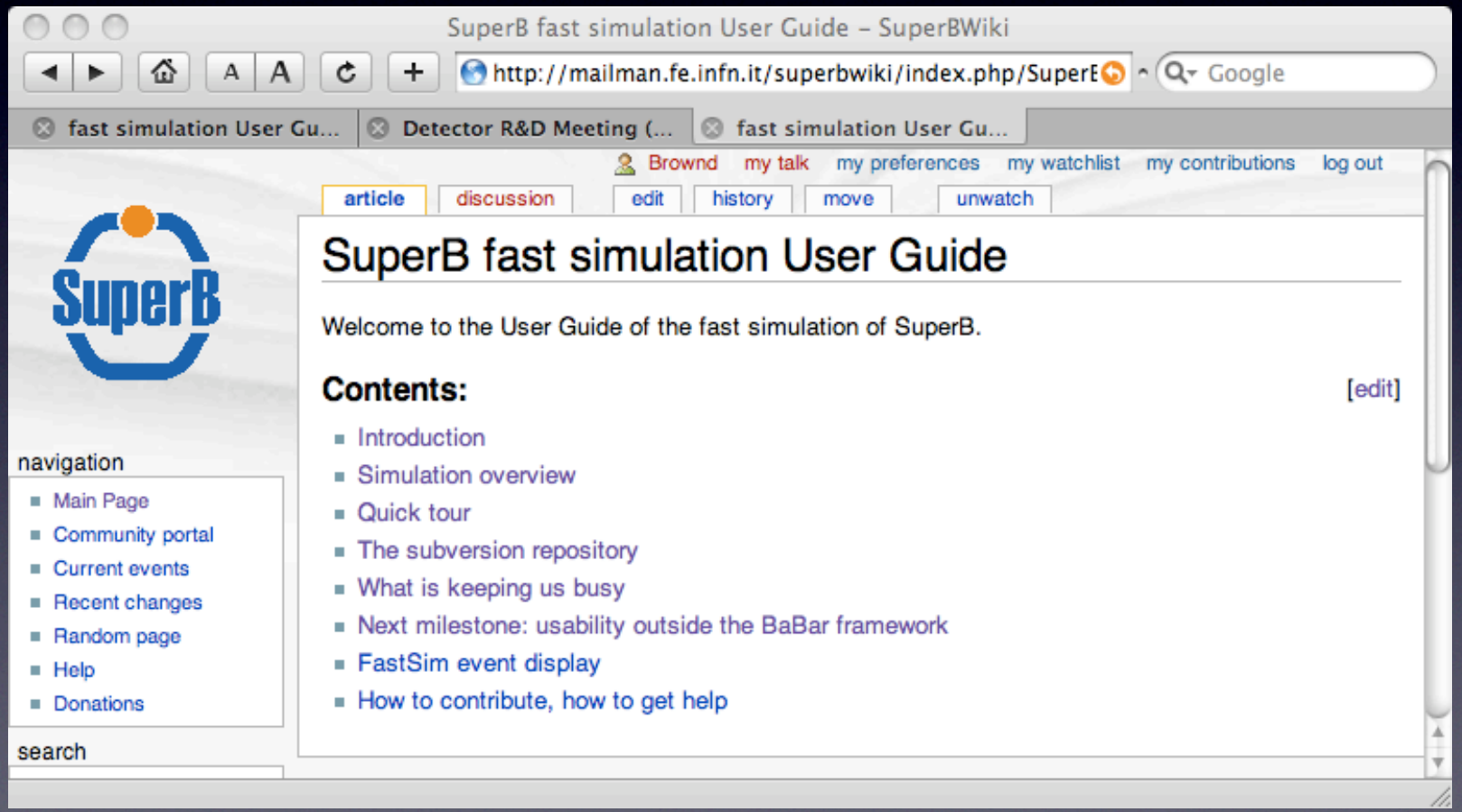
```
...
      <param name="WindowWidth" type="float"> 0.025 </param>
      <param name="BkgWindow" type="float"> 0.02 </param>
      <param name="QuantumEfficiency" type="float"> 1.000 </param>
      <param name="AchromConstant" type="float"> 0.0042 </param>
...
```

FastSim Release System

- Based on Subversion code repository
  - next-generation CVS
- Use BaBar build system (gmake)
  - SCONS-base build system under study
- Release defined as a directory in subversion
  - ie Releases/FastSim/V0.0.1
  - contains package tags, build logs, test results, ...
  - Subversion commit records are the log
- ReleaseTools scripts support release system

Documentation (Wiki)

- Actively support by developers and users is essential



Development in Progress

- Particle decays ($K^{\pm}$,$\pi^{\pm}$,$\mu^{\pm}$,...) (U. Cin., UMD)
  - Must follow through detector to find decay point
  - Neutral (K_s,Λ) are decayed by generator
- Hit overlap simulation (D. Roberts)
  - Changes track resolution, tails, hit assignment
  - Use same tool to model machine backgrounds?
  - Useful for calorimeter, PID too?
- Subsystem response tuning
- Code cleanup
  - Remove conditions access, ...

Workshop Goals

- Feedback from physics and users
  - What is needed to make fastsim more useful?
- Coordination with Full Sim
  - Geometry and material description
  - Background frame overlay
- Shower modeling improvements
  - Shower parameterization, fluctuation modeling
  - Detector response to shower
- Particle ID
  - Missing information (dE/dx, Ifr timing?)
  - Selectors for FastSim

Conclusions

- SuperB FastSim V0.0.1 is ready
  - Used in yesterday's tutorial
  - Interesting studies already possible
- Fastsim is under rapid development
  - Hope to make progress on key issues here
  - Aim for full functionality by April Physics Workshop
- Users contributions are welcome!
  - Your feedback is crucial
  - Contact Matteo or I if you want to participate