Simulation Status for Pixels

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Where to find info

- **B-tau Web Page** (I. Tomalin, F. Palla)

- **Tracker Simulation and Geometry**
  - Coordinators: Filippo Ambroglini (University of Perugia, Italy)
    Neeti Parashar (Purdue University Calumet, USA)

- **Tasks:**
  - TIB + TOB + TEC+ TID = Filippo
  - Barrels + Disks = NP

- **Pixel offline group** (chair. V. Chiochia/Uni.Zurich)
  - https://uimon.cern.ch/twiki/bin/view/CMS/PixelOfflineSoftware
The forward pixels detector consists of two end-caps, with two disks for now.

Each disk contains 24 blades, made of an aluminum base.

Cooling channels of adjacent blades are connected by nipples.

Each panel has a beryllium base plus HDI and three or four plaquettes.
Status

- Detector Description Database used for simulation (OSCAR), reconstruction (ORCA), visualization, analysis..
- Files are written in XML
- Design of some of the components is not final

- Each file describes a subsystem
- Subsystems are positioned using coordinates of the anchor point

Each subsystem can be visualized and tested independently
Some basic checks

- Position and orientation of active detector areas have been checked for the Tracker - Complete!!!
- The pixel positioning comparison between engineers’ drawings and simulation has already been done, both for barrel and forward pixel subdetectors
- The forward pixel plaquette local axis orientation has been revisited and updated
Material Budget

- Extensive work
- No source files found for FPIX
- Mixture program written
- Output implemented in XML
- Produce such a plot for the FPIX

This is the actual integrated radiation length of the whole simulated Tracker as a function of pseudorapidity $\eta$

Geometry/TrackerCommonData/data/pixfwdMaterials.xml
Geometry/CMSCommonData/data/materials.xml
More FPIX Geometry changes

“Geometry/TrackerSimData/data/trackerProductsCut.xml"

- Energy loss of SimHits of one-pixel events
- Energy loss of SimHits of two-pixel events
Visualization using IGUANA

Committed in CVS
Forward Pixel Test at FNAL

- Non-CMSSW software was used to do physics analysis on the beam test
  - Efficiency after radiation
  - Charge cure for one-pixel events and two-pixel events
  - Resolution in x and y direction

- Comparison between Simulation in CMSSW and Beam test showed some differences

- The following changes in CMSSW were made:
  - Put product cuts for FPIX (missed earlier)
  - Implemented Mis-calibration (by Danek)
  - Some changes on the charge width in the reconstruction codes for simulation fpixel beam test special case.
    - No 20 degree rotation.
    - No magnetic field.

GOOD AGREEMENT
The diagram shows a comparison between simulation and test beam data for the charge of a single cluster. The MPV (Mean Peak Value) and FWHM (Full Width at Half Maximum) are calculated for both conditions.

- **Simulation**
  - MPV: 22.48
  - FWHM: 11

- **Test Beam**
  - MPV: 23.18
  - FWHM: 10

The table includes key statistics for the charge of 1 cluster:

<table>
<thead>
<tr>
<th></th>
<th>Simulation (k electrons)</th>
<th>Test Beam (k electrons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPV</td>
<td>22.48</td>
<td>23.18</td>
</tr>
<tr>
<td>FWHM</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

One pixel events:
- Landau curve peaked at ~23k electrons, Γ~10k (scale factor: 1 adc units = 60 electrons)
Charge of 2 clusters

<table>
<thead>
<tr>
<th>Charge of Cluster, size_x * size_y=2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>charge_2</strong></td>
</tr>
<tr>
<td>Entries: 3217</td>
</tr>
<tr>
<td>Mean: 29.19</td>
</tr>
<tr>
<td>RMS: 12.27</td>
</tr>
<tr>
<td>$\chi^2$/ndf: 0.04780/74</td>
</tr>
<tr>
<td>Prob: &lt; 1</td>
</tr>
<tr>
<td>Constant: 0.2689 ± 0.4286</td>
</tr>
<tr>
<td>MPV: 21.68 ± 0.68</td>
</tr>
<tr>
<td>Sigma: 3.844 ± 0.322</td>
</tr>
</tbody>
</table>

| **charge_2**                         |
| Entries: 3061                        |
| Mean: 26.31                          |
| RMS: 8.591                           |
| $\chi^2$/ndf: 0.0786/66             |
| Prob: < 1                            |
| Constant: 0.4252 ± 0.6696           |
| MPV: 23.7 ± 4.3                     |
| Sigma: 1.825 ± 2.255                |

Two pixel events:
After using calibration we sum the charge of the 2 pixel.

- Landau curve peak at ~22k, Γ~16k electrons
- Peak consistent with that of one pixel.
- Γ is obviously wider

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</thead>
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<tr>
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<td>21.68</td>
<td>21.79</td>
</tr>
<tr>
<td>FWHM</td>
<td>13</td>
<td>16</td>
</tr>
</tbody>
</table>

N. Parashar
Tracker Week at CERN
11 October 2006
Barrel Test Beam Analysis

- Barrel Pixel Beam Test at CERN
  - CMSSW to be used for physics analysis on the beam test data
  - Comparison between simulation and beam test will be more useful
  - Improve and tune pixel software at simulation, digitization and reconstruction levels
Implementation of E.B. Effect

- Digitization
- Reconstruction

EB Effect in Digitization

- Barrel Pixel
  - We know: $\vec{E} \cdot \vec{B} = EB \cos \theta = 0$
  - So the 2\textsuperscript{nd}-order Lorentz drift is not important

- Forward Pixel
  - With 20 degree rotation wrt magnetic field, $\vec{E} \cdot \vec{B} = EB \cos(20) \neq 0$
  - There should be shift in both x and y
    - $\sim - 2.8 \ \mu m$ in local x direction
    - $\sim +/- 6.9 \ \mu m$ in local y direction
Shifts in x and y

FPIX – z side

Mean shift along x
~ 2.7μm

Mean shift along y
~ 7.1μm
Correlation of Shift versus cluster size

- For the 2nd order Lorentz drift, the drift is more effective when the cluster size is greater than 1.

(X) and (Y) diagrams showing the correlation between shift and cluster size.
EB Effect in Reconstruction

Changes in SiPixelRechits Package

- Add the 2nd order Lorentz drift (E·B)
- Easily turn on/off via configuration file
- Add a boolean flag to switch to the EB correction
- Keep the current code unchanged
No effect on Barrel Pixel

1. X Coord. (SimHit.x - RecHit.x), Size = 1
   - Before E.B
   - After E.B

2. Y Coord. Res.(SimHit.y - RecHit.y), Size = 1
   - Before E.B
   - After E.B

3. X Coord. (SimHit.x - RecHit.x), Size = 2
   - Before E.B
   - After E.B

4. Y Coord. Res.(SimHit.y - RecHit.y), Size = 2
   - Before E.B
   - After E.B
ZMinus Side of FPix for Cluster Size = 2

- $\sigma_x = 5.97$ (Before E·B)
- $\sigma_x = 5.62$ (After E·B)
- 5.8% improvement

- $\sigma_y = 7.10$ (Before E·B)
- $\sigma_y = 6.18$ (After E·B)
- 12.9% improvement
Tracker_FAMOS vs Tracker_OSCAR

- Radiography of a quarter of the simulated tracker geometry
- (a): fast simulation (FAMOS)
- (b): full simulation (OSCAR)
- CMSSW version of FAMOS
- Proper tracker geometry – active layers
- Provides a more realistic track reconstruction performance simulation
CMSSW RecHits

- **Strips**
  - Done and tested, yet to be committed

- **Pixels**
  - Just started
  - Producing a macro file to read rootfile with the old data in FAMOS
  - Use the same macro to read the rootfile with CMSSW
Crew

- Vesna Cuplov – Purdue University Calumet
- Xingtao Huang – University of Puerto Rico
- Max Bunce – University of Colorado
- Vincenzo Chiochia – University of Zurich
- Danek Kotlisnki – PSI
- Riccardo Ranieri – CERN
- Patrick Janot – CERN

For suggestions/comments/volunteers
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