

The Tracker Monte Carlo Description

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SiD Tracker Meeting

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The Beam Pipe

```
<detector id="0" name="BeamPipe" type="Polycone">  
  <position z = "-185*cm" inner_r = "185.*17./351*cm" outer_r = "inner_r+.1*cm"  
  material = "Beryllium" />  
  <position z = "-6.25*cm" inner_r = "1.2*cm" outer_r = "inner_r+.1*cm" material  
  = "Beryllium" />  
  <position z = "-6.25*cm" inner_r = "1.2*cm" outer_r = "inner_r+.0165*cm"  
  material = "Beryllium" />  
  <position z = "6.25*cm" inner_r = "1.2*cm" outer_r = "inner_r+.0165*cm"  
  material = "Beryllium" />  
  <position z = "-6.25*cm" inner_r = "1.2*cm" outer_r = "inner_r+.1*cm" material  
  = "Beryllium" />  
  <position z = "185*cm" inner_r = "185.*17./351*cm" outer_r = "inner_r+.1*cm"  
  material = "Beryllium" />  
</detector>
```

```
<detector id="0" name="BeamPipeLiner" type="Polycone">  
  <position z = "-6.25*cm" inner_r = "1.19*cm" outer_r = "inner_r+.01*cm"  
  material = "Titanium" />  
  <position z = "6.25*cm" inner_r = "1.19*cm" outer_r = "inner_r+.01*cm"  
  material = "Titanium" />  
</detector>
```

Vertex Detector Barrel

```
<detector id="0" name="BarrelVertex" type="MultiLayerTracker"
  readout="VtxBarrHits">
  <layer id="1" inner_r = "1.5*cm" outer_z = "6.25*cm">
    <slice material = "Silicon" width = "0.01*cm" sensitive = "yes" />
  </layer>
  <layer id="2" inner_r = "2.6*cm" outer_z = "6.25*cm">
    <slice material = "Silicon" width = "0.01*cm" sensitive = "yes" />
  </layer>
  <layer id="3" inner_r = "3.7*cm" outer_z = "6.25*cm">
    <slice material = "Silicon" width = "0.01*cm" sensitive = "yes" />
  </layer>
  <layer id="4" inner_r = "4.8*cm" outer_z = "6.25*cm" >
    <slice material = "Silicon" width = "0.01*cm" sensitive = "yes" />
  </layer>
  <layer id="5" inner_r = "6.0*cm" outer_z = "6.25*cm">
    <slice material = "Silicon" width = "0.01*cm" sensitive = "yes" />
  </layer>
</detector>
```

Vertex Detector Endcaps

```
<detector id="1" name="EndcapVertex" type="DiskTracker" reflect="true"
  readout="VtxEndcapHits">
  <layer id="1" inner_r = "1.5*cm" inner_z = "7.0*cm" outer_r = "7.0*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="2" inner_r = "1.8*cm" inner_z = "9.5*cm" outer_r = "7.0*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="3" inner_r = "2.0*cm" inner_z = "12.0*cm" outer_r = "7.0*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="4" inner_r = "2.5*cm" inner_z = "17.0*cm" outer_r = "7.0*cm" >
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
</detector>
```

Vertex Detector Supports

```
<detector id="0" name="BarrelVertexSupports" type="MultiLayerTracker">
  <layer id="1" inner_r = "7.0*cm" outer_z = "6.5*cm">
    <slice material = "Beryllium" width = "0.1*cm"/>
  </layer>
  <layer id="2" inner_r = "11.2*cm" outer_z = "23.0*cm">
    <slice material = "PolystyreneFoam" width = "1.5*cm"/>
  </layer>
</detector>
```

```
<detector id="1" name="BarrelVertexEndSupports" type="DiskTracker"
reflect="true">
  <layer id="1" inner_r = "1.5*cm" inner_z = "6.5*cm" outer_r = "7.0*cm">
    <slice material = "Beryllium" width = "0.5*cm" />
  </layer>
  <layer id="2" inner_r = "2.3*cm" inner_z = "20.0*cm" outer_r = "11.2*cm">
    <slice material = "PolystyreneFoam" width = "3.0*cm" />
  </layer>
</detector>
```

Missing Elements

- Have no wafer supports in barrel region.
- Have do disk supports in forward region.
- Have no readout elements for either.

SiD Barrel Tracker

```
<detector id="1" name="BarrelTracker" type="MultiLayerTracker">
  <layer id="1" inner_r = "18.635*cm" outer_z = "26.67*cm">
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Rohacell31" width = "1.3*cm" />
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="2" inner_r = "44.885*cm" outer_z = "61.67*cm">
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Rohacell31" width = "1.3*cm" />
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="3" inner_r = "71.135*cm" outer_z = "96.67*cm">
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Rohacell31" width = "1.3*cm" />
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="4" inner_r = "97.385*cm" outer_z = "131.67*cm" >
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Rohacell31" width = "1.3*cm" />
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="5" inner_r = "123.635*cm" outer_z = "166.67*cm">
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Rohacell31" width = "1.3*cm" />
    <slice material = "CarbonFiber" width = "0.025*cm" />
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
</detector>
```

SiD Disk Tracker

```
<detector id="3" name="EndcapTracker" type="DiskTracker" reflect="true" readout="TkrEndcapHits">
  <layer id="1" inner_r = "4.0*cm" inner_z = "27.1*cm" outer_r = "20.50*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="2" inner_r = "4.0*cm" inner_z = "27.13*cm" outer_r = "20.50*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="3" inner_r = "7.9*cm" inner_z = "62.1*cm" outer_r = "46.75*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="4" inner_r = "7.9*cm" inner_z = "62.13*cm" outer_r = "46.75*cm" >
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="5" inner_r = "11.7*cm" inner_z = "97.1*cm" outer_r = "73.0*cm" >
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="6" inner_r = "11.7*cm" inner_z = "97.13*cm" outer_r = "73.0*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="7" inner_r = "15.6*cm" inner_z = "132.1*cm" outer_r = "99.25*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="8" inner_r = "15.6*cm" inner_z = "132.13*cm" outer_r = "99.25*cm">
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="9" inner_r = "19.5*cm" inner_z = "164.94*cm" outer_r = "125.50*cm" >
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
  <layer id="10" inner_r = "19.5*cm" inner_z = "164.97*cm" outer_r = "125.50*cm" >
    <slice material = "Silicon" width = "0.03*cm" sensitive = "yes" />
  </layer>
</detector>
```

SiD Disk Tracker Supports

```
<detector id="4" name="EndcapTrackerSupports" type="DiskTracker" reflect="true">
  <layer id="1" inner_r = "4.0*cm" inner_z = "27.16*cm" outer_r = "20.50*cm">
    <slice material = "CarbonFiber" width = "0.039*cm" />
    <slice material = "Rohacell31" width = "2.5*cm" />
    <slice material = "CarbonFiber" width = "0.039*cm" />
  </layer>
  <layer id="2" inner_r = "7.9*cm" inner_z = "62.16*cm" outer_r = "46.75*cm">
    <slice material = "CarbonFiber" width = "0.039*cm" />
    <slice material = "Rohacell31" width = "2.5*cm" />
    <slice material = "CarbonFiber" width = "0.039*cm" />
  </layer>
  <layer id="3" inner_r = "11.7*cm" inner_z = "97.16*cm" outer_r = "73.0*cm">
    <slice material = "CarbonFiber" width = "0.039*cm" />
    <slice material = "Rohacell31" width = "2.5*cm" />
    <slice material = "CarbonFiber" width = "0.039*cm" />
  </layer>
  <layer id="4" inner_r = "15.6*cm" inner_z = "132.16*cm" outer_r = "99.25*cm">
    <slice material = "CarbonFiber" width = "0.039*cm" />
    <slice material = "Rohacell31" width = "2.5*cm" />
    <slice material = "CarbonFiber" width = "0.039*cm" />
  </layer>
  <layer id="5" inner_r = "19.5*cm" inner_z = "165.0*cm" outer_r = "125.5*cm">
    <slice material = "CarbonFiber" width = "0.039*cm" />
    <slice material = "Rohacell31" width = "2.5*cm" />
    <slice material = "CarbonFiber" width = "0.039*cm" />
  </layer>
</detector>
```

Missing Elements

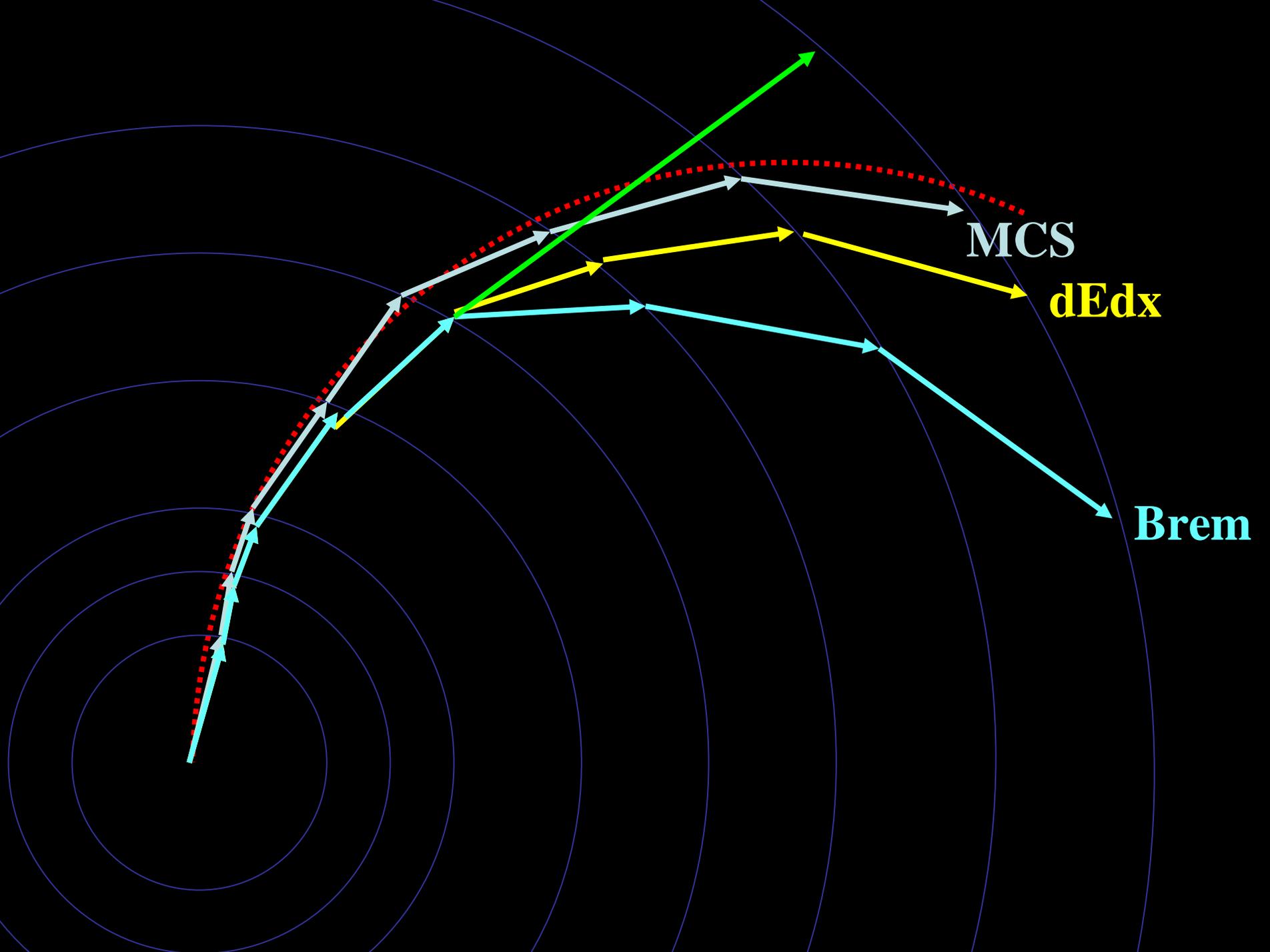
- Need effective amounts of Kapton, copper and silicon to model the readout cables and chips.
- Plan is to model this as evenly distributed over the area of the barrels and disks, unless objections.
- Do not have the end stiffener hoops.
- Do not have the inter-barrel disks.

SimTrackerHit

- Tracker hits are written out for each step in Geant4.
 - $x, y, z, t, E, \text{MCParticle}$
 - Step is determined by physics processes.
 - If only ionization, then start and end are at sensitive detector boundaries \rightarrow create hit at midpoint
 - If other process occurs (e.g. δ -ray), then this is recorded as a separate hit.
 - Could artificially subdivide Si thickness to improve sampling, and therefore make digitization easier (see later discussion)
 - Need to investigate effects of varying range cut.

Improved Track Definition

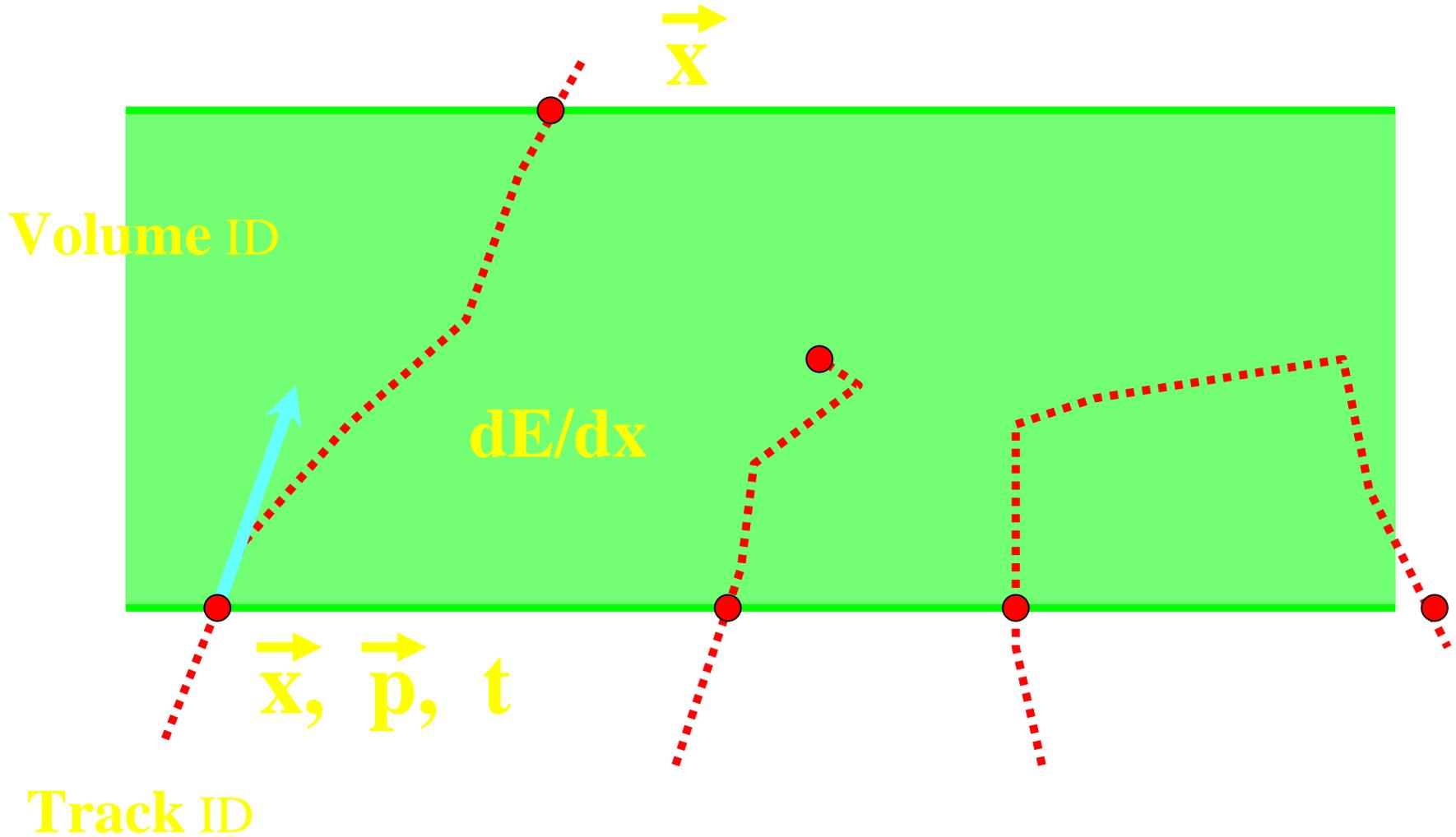
- Particles suffer various indignities while traversing the detector.
- Knowing track parameters at a single point (*e.g.* the point of generation) is insufficient for precision fits due to material effects (dE/dx , MCS, bremsstrahlung) and field inhomogeneities.
 - No global functional form for the fit.
- Store track information at each volume.



Tracker Hit

- **MC Track Number**
- Encoded **detector ID** (detector dependent)
- Global **hit position at entrance** to sensitive volume
- Global **hit position at exit** of sensitive volume
- **Track momentum** at entrance to sensitive volume
- **Energy deposited** by track in sensitive volume
- **Time** of track's crossing

Digitization



Long Strip Digitization

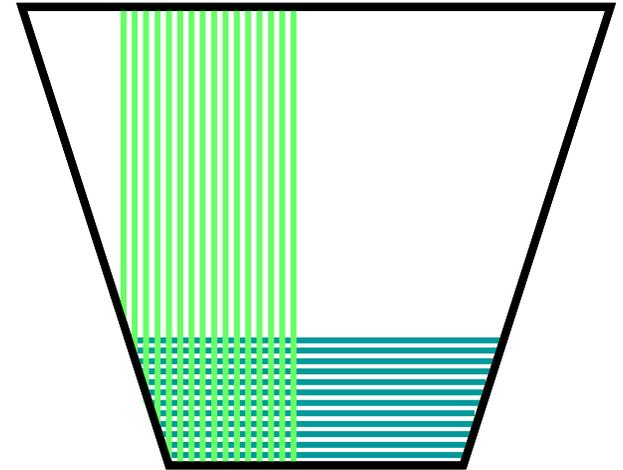
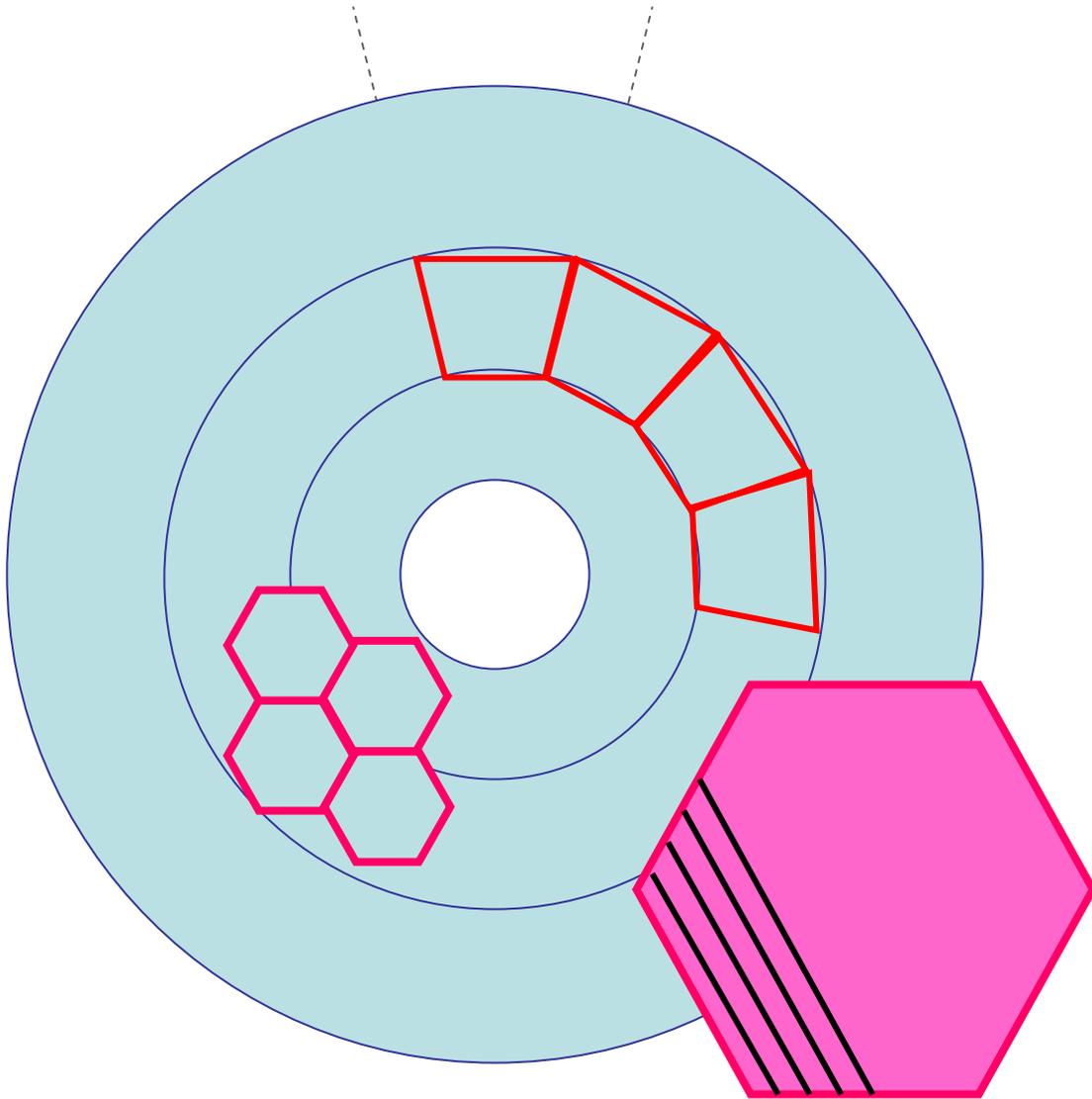
- UCSC group has developed package to produce strip hits with pulse heights from track trajectories.
 - Bruce Schumm, Christian Flacco, Michael Young
- C++ implementation of simside
- [Presentation at ALCPG04](#)
- Waiting on me to provide the interface to LCD simulation environment.

MC Hits → Strips & PH → Clusters → Hits ($\varphi \pm \delta\varphi$)

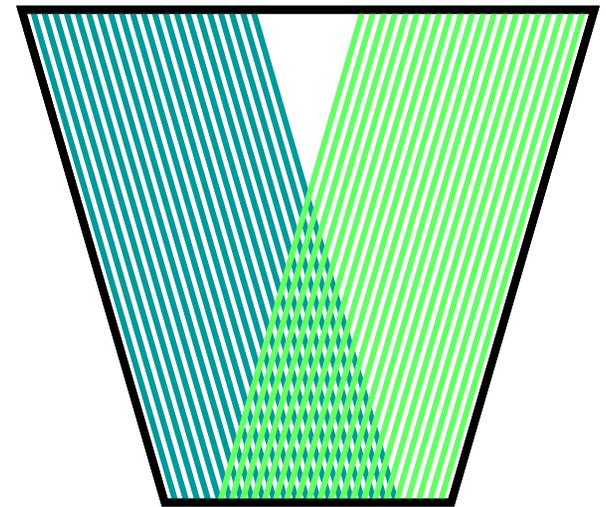
Disk Digitization

- Tiling still undecided
- Code exists to tile with wedges
 - Arbitrary number of radial segmentations
 - Arbitrary number of phi segmentations per annulus
- Hexagonal tiling (with Si wafers similar to the EM cal.) being worked on (?) by Rich Partridge.
- Working assumption is two close-by layers with stereo (x/y , u/v , or r/φ) to provide a 2D spacepoint @ fixed z for track finding.
- Fitting will use appropriate 1-D measurement.

Tiling Forward Disks

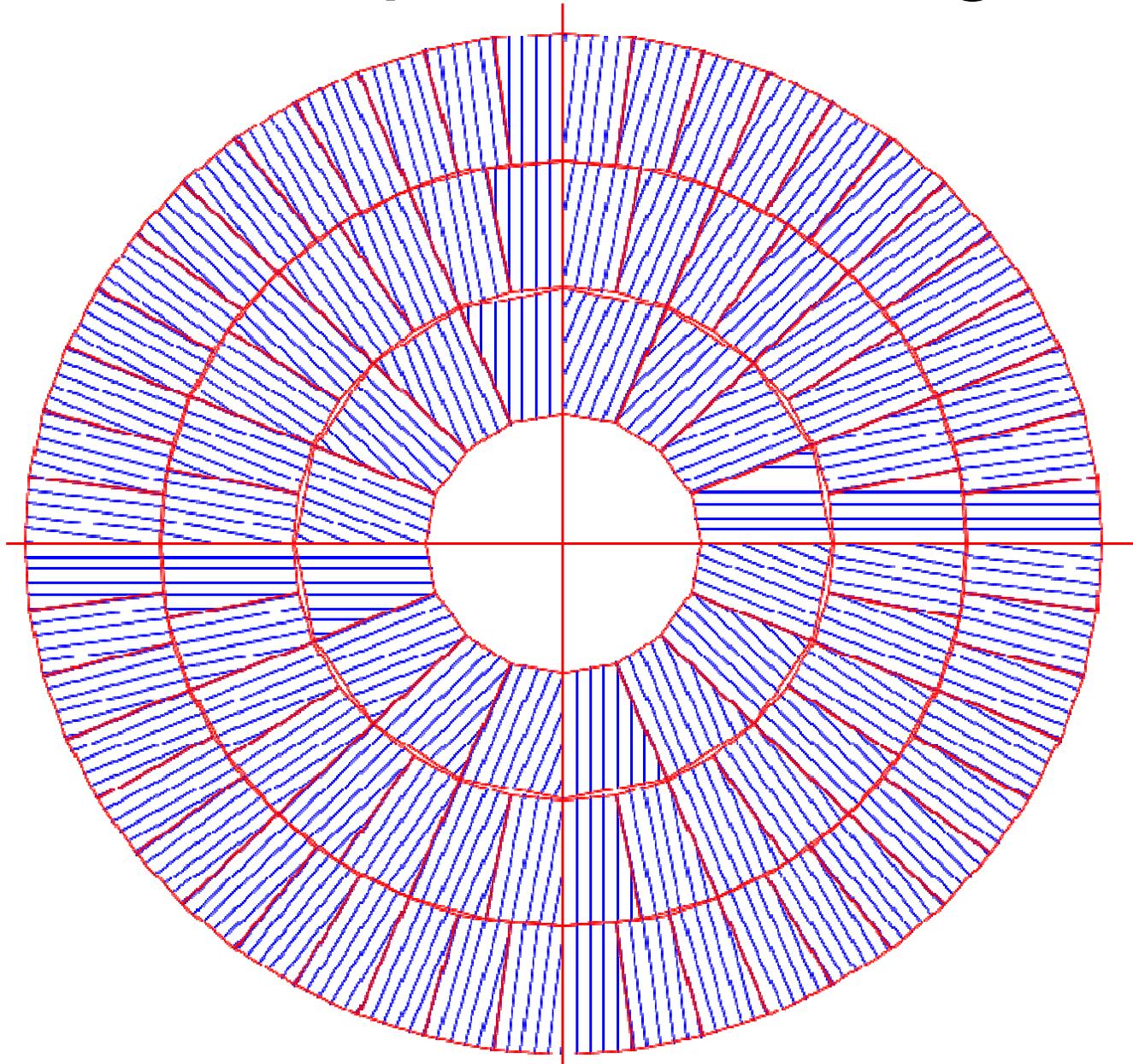


Large Angle Stereo



Shallow Angle Stereo

Example Disk Tiling



Variants

- Need to decide on canonical variants for the detector design.
 - Digitization not requiring any geometry changes
 - short vs long microstrips
 - alternate tiling in forward trackers
 - pixel regions in forward detectors
 - Different geometries
 - Vary location of barrels (currently evenly spaced)
 - Add layers (UCSC looking at 8 layers)
 - Change topology to have full disk end-caps.
 - ...