Track Reconstruction with Backgrounds: Vertex Detector

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SiD Tracking Meeting

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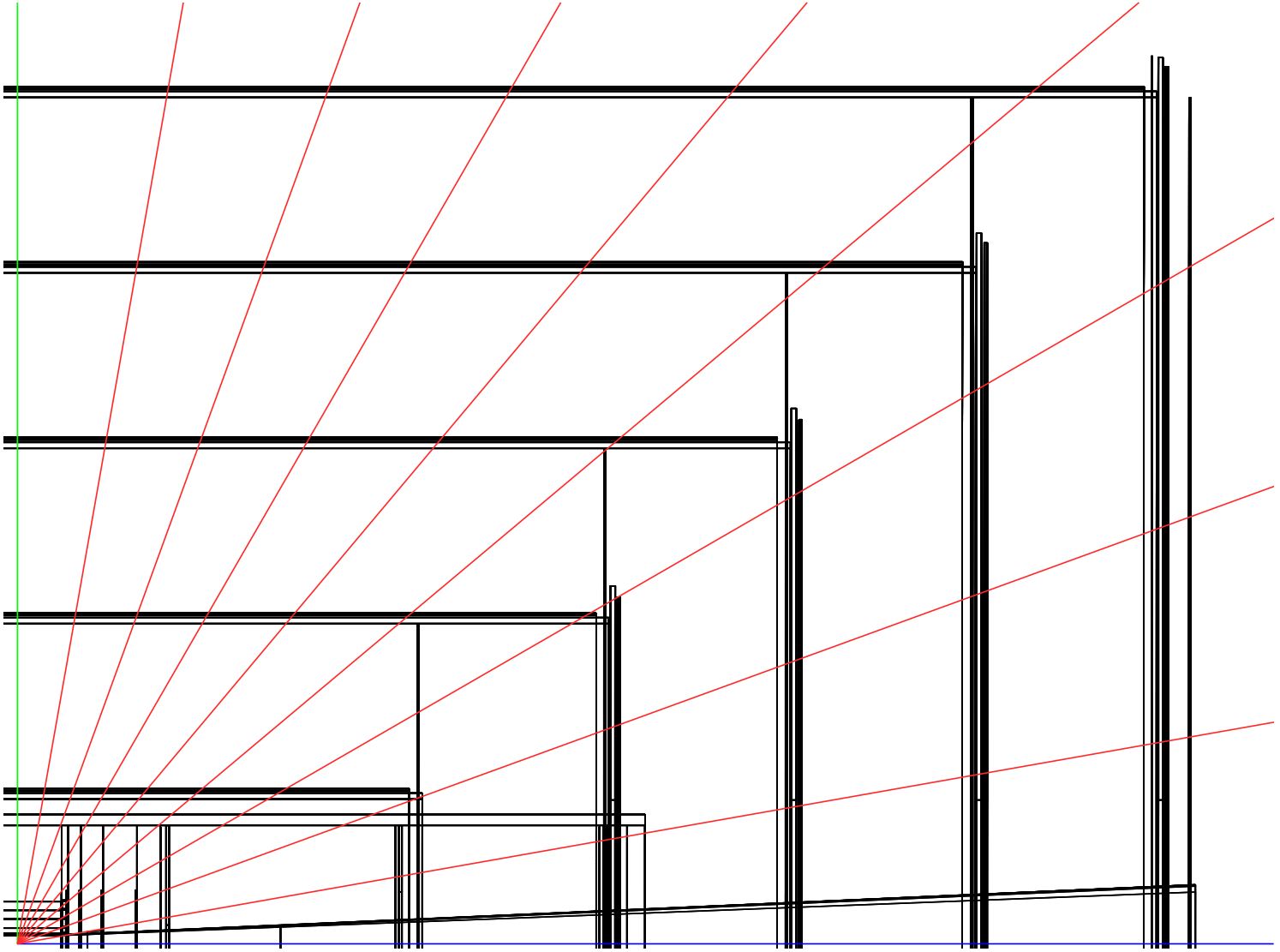
LOI Simulation Requirements

- Characterize subdetector performance.
  - Single particle response can be used to demonstrate energy and position resolution, etc.
  - Very detailed geometric description and detector response can be modeled.
- Demonstrate physics capabilities of the combined detector.
  - Canonical Benchmark physics reactions defined.
  - Large statistics for both signal and background drive alternate, simplified detector response approach.

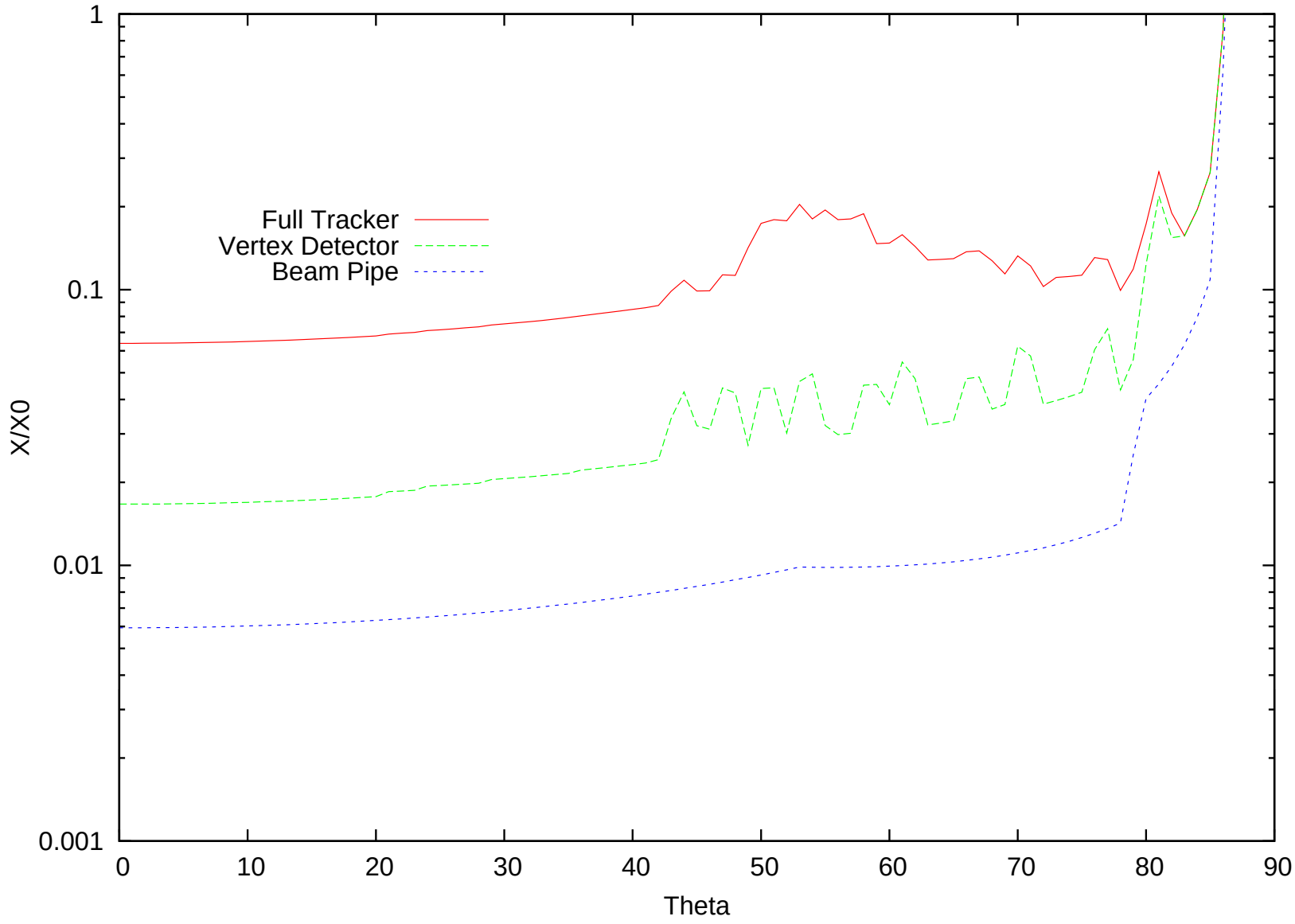
Detector Response Simulation

- The detector being modeled is sid02.
- Using slic version v2r5p3.
- Geant4 9.1 patch 2.
- LCPhys physics list.

sid02 Tracker Geometry



sid02 Tracker Material Scan



Expected LOI contents: final wording of IDAG additional requests

(1) Detector optimization: identification of the major parameters which drive the total detector cost and its sensitivity to variations of these parameters.

(2) Plans for getting the necessary R&D results to transform the design concept into a well-defined detector proposal.

(3) Conceptual design and implementation of the support structures and the dead zones in the detector simulation.

(4) Sensitivity of different detector components to machine background in the context of the beam parameter space considered in the RDR.

(5) Calibration and alignment schemes.

(6) Estimates of overall size, weight, and requirements for crane coverage and shielding.

(7) Push-pull ability with respect to technical aspects (assembly areas needed, detector transport and connections, time scale) and maintaining the detector performance for a stable and time-efficient operation.

(8) A statement about energy coverage, identifying the deterioration of the performance at energies up to 1 TeV and the consequent detector upgrades.

Detector Optimization

- Although IDAG.1 targets total detector cost, to which the vertex detector contributes ~ nothing, some optimization studies should nevertheless be done to study:
  - Improvements in physics performance
  - Robustness to backgrounds
  - Performance at higher energies
- Possibilities:
  - Pixel size
  - Integration time

  } Fairly straightforward
  - Number and placement of layers

Conceptual Design

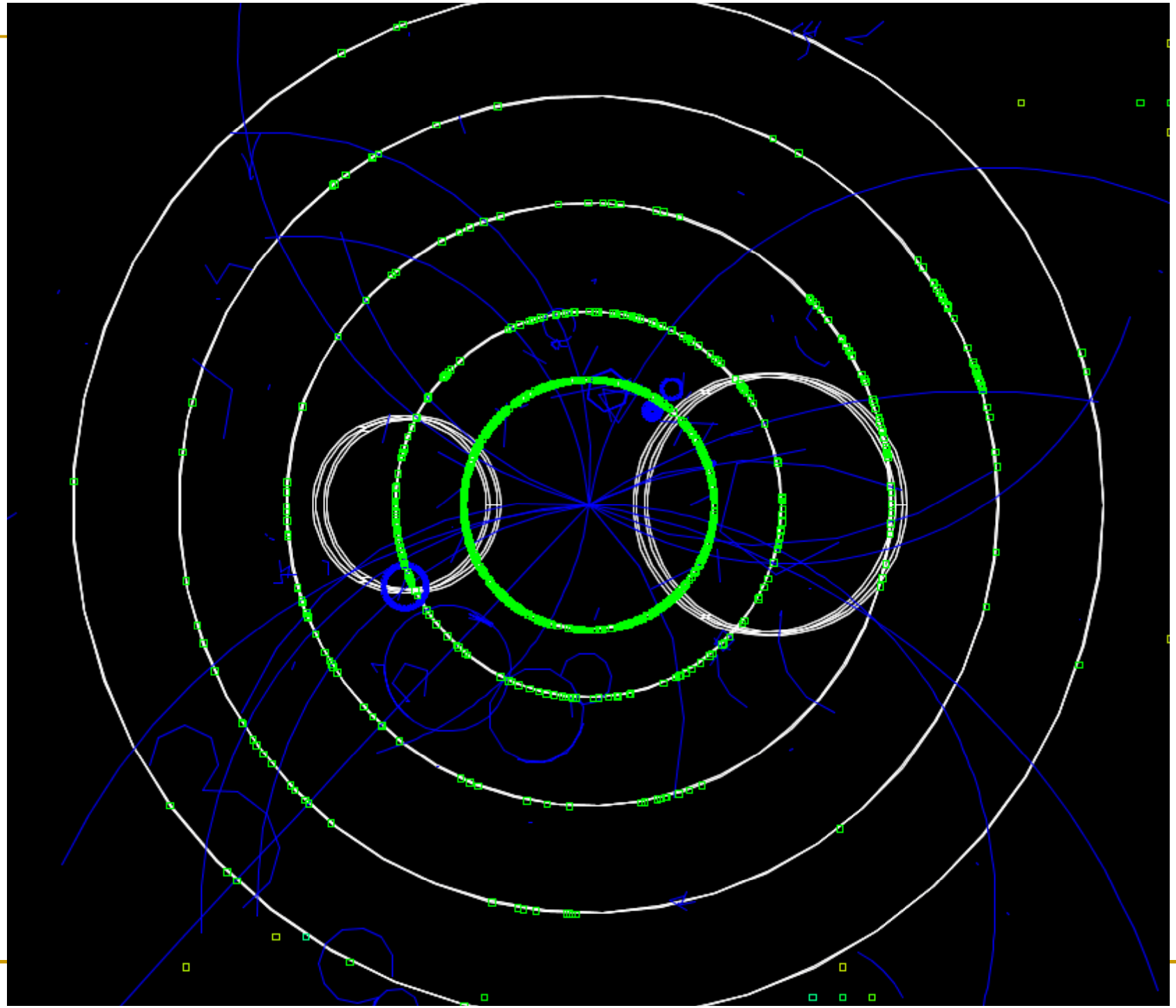
- IDAG.3 requires the implementation of the support structures and the dead zones in the detector simulation.
- Simplified geometry (sid02), and simplified MC hit digitization is being used for the full set of physics benchmarks.
- Have the ability to model much more detailed geometries to characterize the subdetector performance.
  - But we need a design!

Machine Backgrounds

- IDAG.4 requests a study of the sensitivity to machine backgrounds.
- Have generated large samples of beam backgrounds using GuineaPig and whizard.
  - Pairs files have ~80k particles per bunch crossing
    - large files, take a long time to generate & overlay
  - Only ~150 particles pass through the beampipe
    - Create events containing only these “prompt” tracks.
- Have the ability to overlay these events at the MC hit level, i.e. before digitization.

ILC500 Backgrounds

- $\gamma\gamma \rightarrow$ hadrons
  - 241232 events
  - ftp://ftp-lcd.slac.stanford.edu/ilc/ILC500/backgrounds/gghad/stdhep/whizard/
- $\gamma\gamma \rightarrow \mu\mu$ ($p_T > 115$ MeV)
  - 433931 events
  - ftp://ftp-lcd.slac.stanford.edu/ilc/ILC500/backgrounds/ggmumu/stdhep/whizard/
- GuineaPig pairs
  - ~25000 bunch crossings
  - ftp://ftp-lcd.slac.stanford.edu/lcd/ILC/ILC500/backgrounds/pairs/stdhep/



Track Finding with Backgrounds

- Machinery is in place, but doing this without detailed geometry and pixel simulation will not tell us much.
  - The devil is in the details of hit merging, cluster size effects, differing hit measurement resolutions, etc.
- Had hoped to do this with the full geometry.
  - Can we settle on something today?
- Will do this using production reconstruction release, but do not expect much impact.
- Can use simplified geometry, but detailed pixel digitization. Will at least address the issue of hit merging.

Energy Coverage

- IDAG.8 requests a statement on the deterioration of the performance up to 1TeV.
- Have generated some event samples, but have not yet started any dedicated studies.
- Not clear what performance metrics should be studied here.
  - Suggestions?

Plan for sid02

1. Run production reconstruction over just the beam pair backgrounds to determine what, if any, tracks are reconstructed.
2. Run production reconstruction over single muons to determine efficiency and resolution.
3. Merge single muons with varying numbers of pairs files and rerun reconstruction.
   - Expect 3 to be simple sum of 1 & 2

- Repeat using Nick's detailed pixel digitization package.

Moving forward

- If we want to study the more detailed geometry of a ~engineered design, we need to act NOW!
- Designs will continue to evolve, but we need something better than sid02 for the LOI.