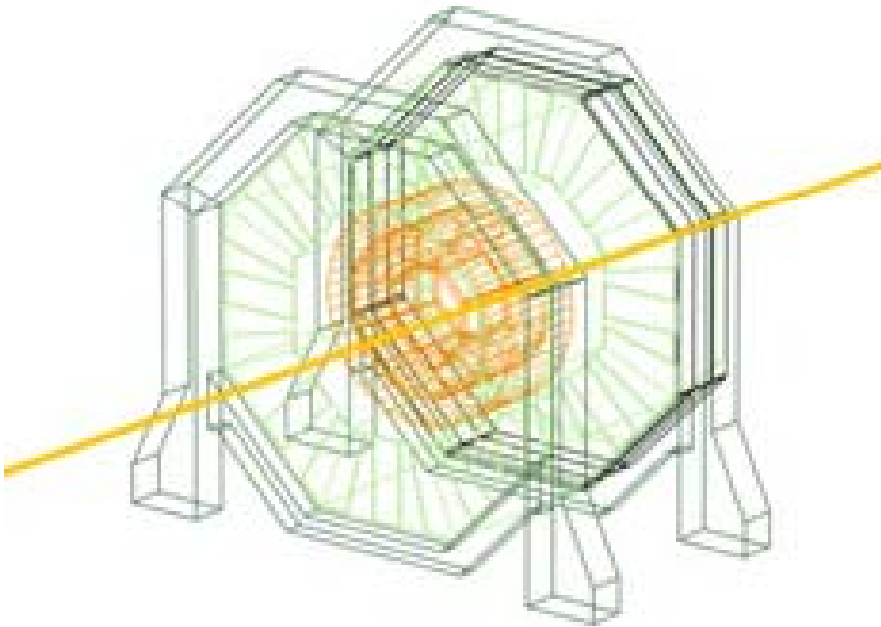

SiD Vertexing and Tracking Contribution to the LOI



Bill Cooper
Marcel Demarteau
Ron Lipton
Rich Partridge
Dong Su

For the SiD Vertex/Tracking Group

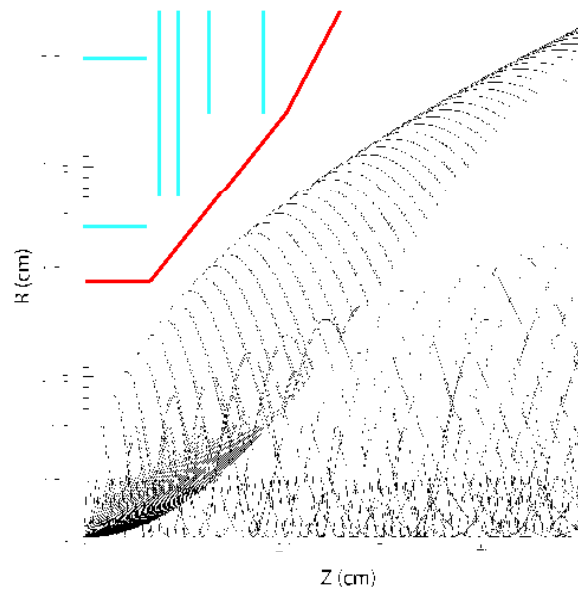
SiD Workshop
SLAC, March 2-4, 2009

- Latest version of section on Vertex and Track detector dated February 25
 - <http://home.fnal.gov/~marcel/sidloi.pdf>
 - <http://home.fnal.gov/~marcel/sidloi.zip>
 - Contains driver, all source LaTeX files and all eps figures
- Total of 35 pages, with 21 figures
- Received but yet to be incorporated:
 - Sensor testing results from Bruce and Sally
 - Module description and tracker hit digitization from Tim
- Promised:
 - Results on calorimeter assisted tracking (Dima)
 - Write-up on track fitter (Rob)
 - More text on frequency interferometry alignment (Keith)
 - More performance results (Rich)
 - Nominal hit multiplicity as function of angle (Sudong)
 - Figure of sensor test results (Bruce)
- A big thank you to all those who have contributed to the loi and have proofread the write-up so far.

Figures



- Beam profile plot included (Maruyama)
- Need a quantitative description of background
 - Number of background hits per layer for various machine options



Figures

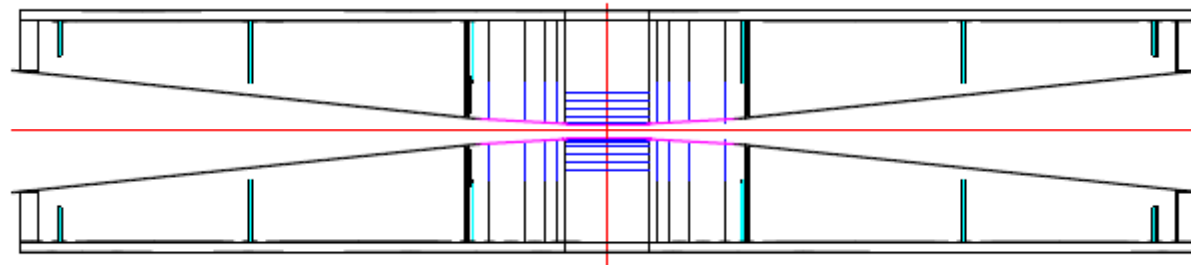


Figure 1.2: R-z view of the vertex detector and its support structure.

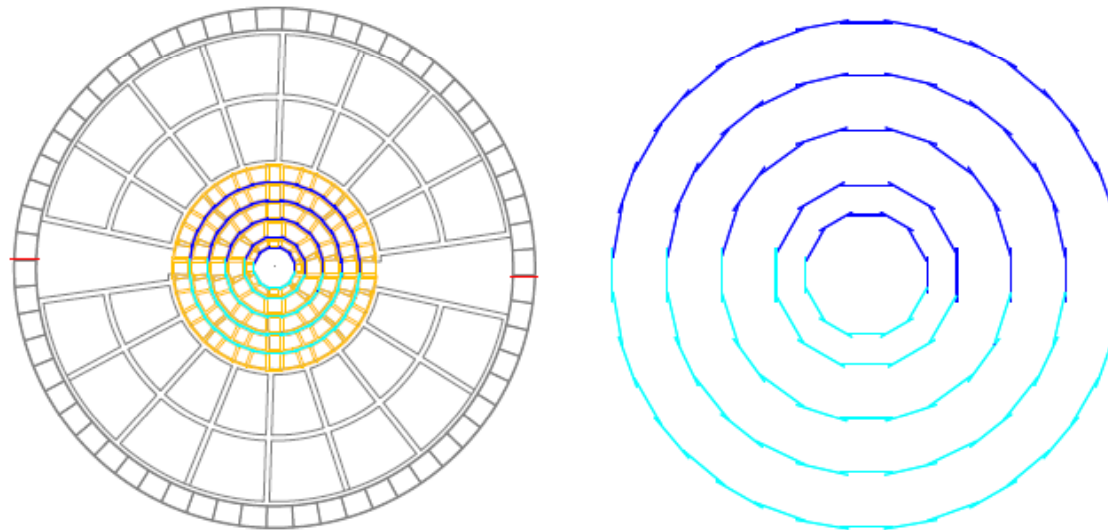


Figure 1.3: Barrel end view of the vertex detector (left) and layer arrangement of the silicon sensors only (right).

Figures

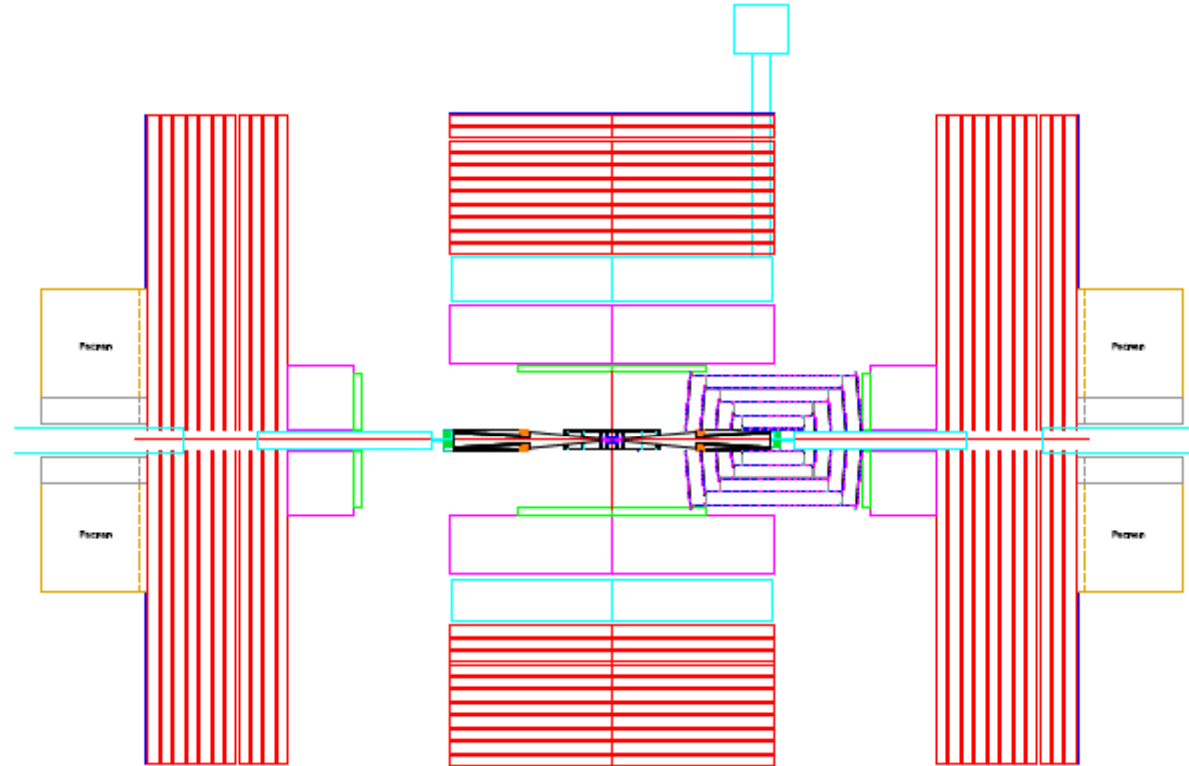


Figure 1.4: Tracker in the open position for servicing of the vertex detector.

Figures



- Lampshade geometry mentioned as baseline, but Monte Carlo simulation carried out with disk geometry

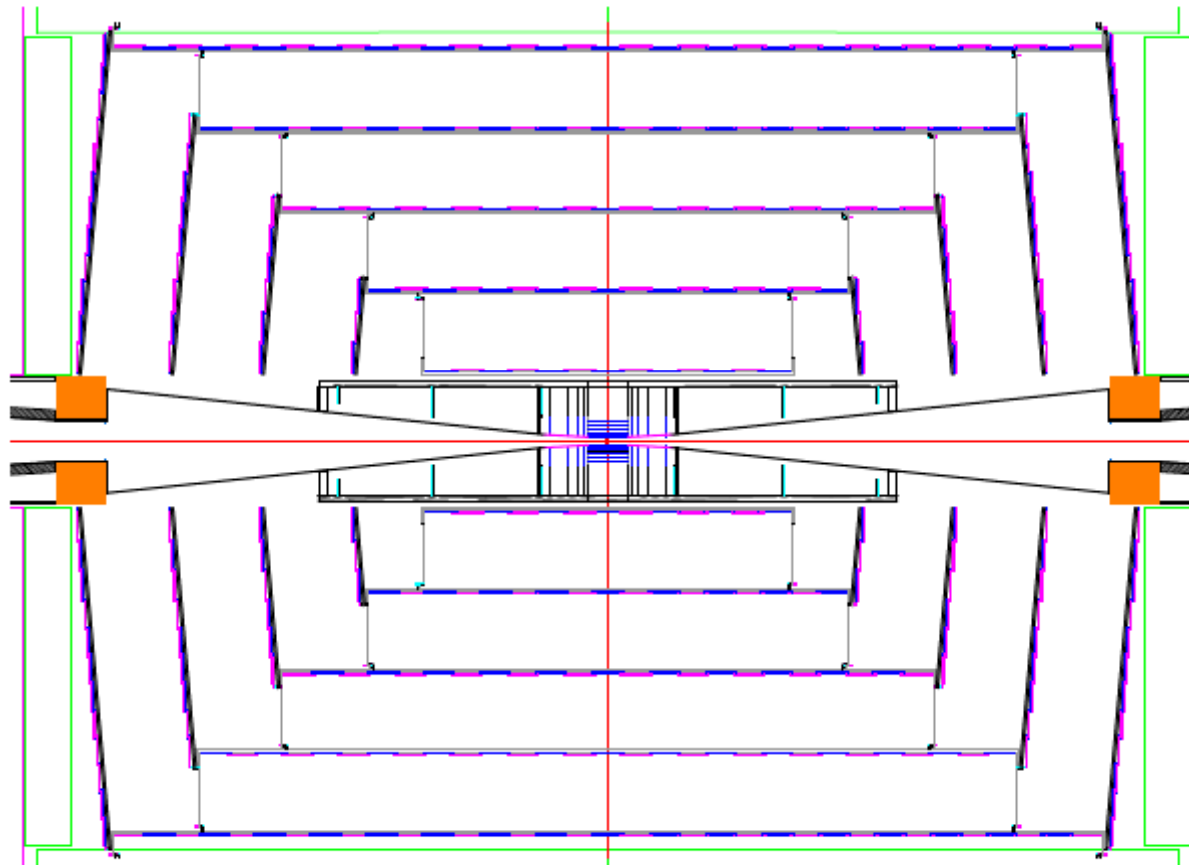


Figure 1.6: R-z view of the whole tracking system.

Figures

- Tracker details
- Detail of support of cylinders from barrels is still missing

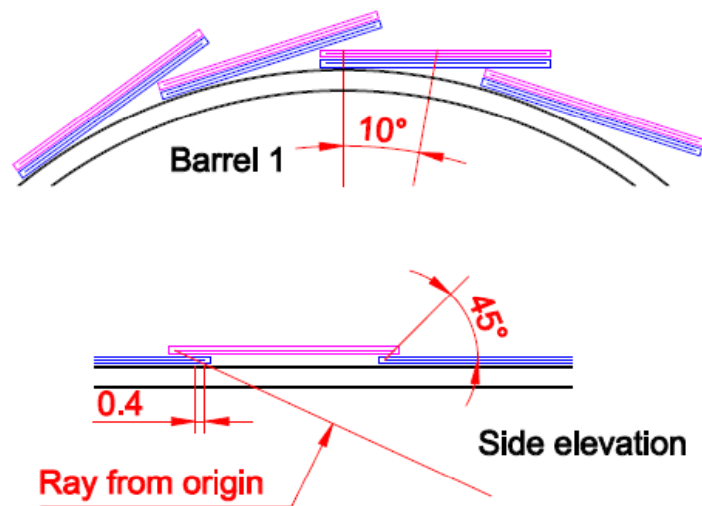


Figure 1.7: Detail of the sensor overlap in the barrel region in the z and $R\phi$ projection.

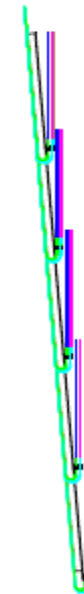


Figure 1.9: Detail of the sensor overlap and cable routing for the tracker disks.

Figures

- Tracker

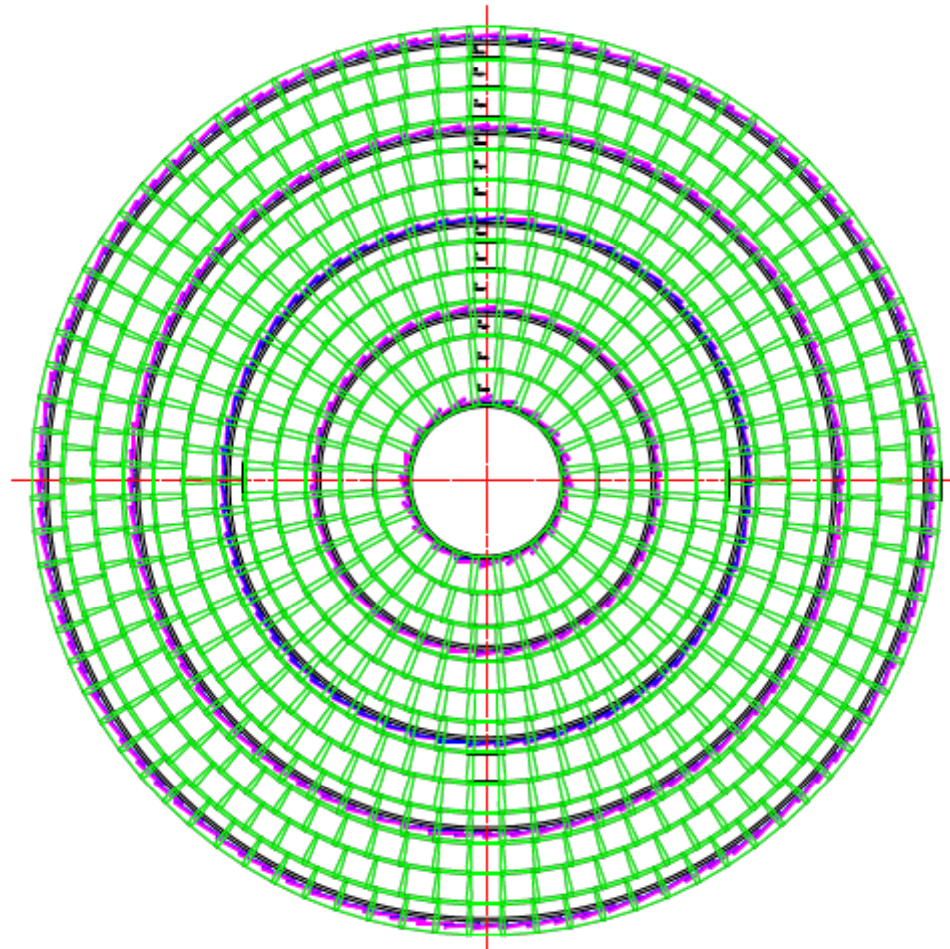


Figure 1.8: $R\phi$ projection view of the tracker barrels and disks.

Figures



- Material budget as modeled in the Monte Carlo

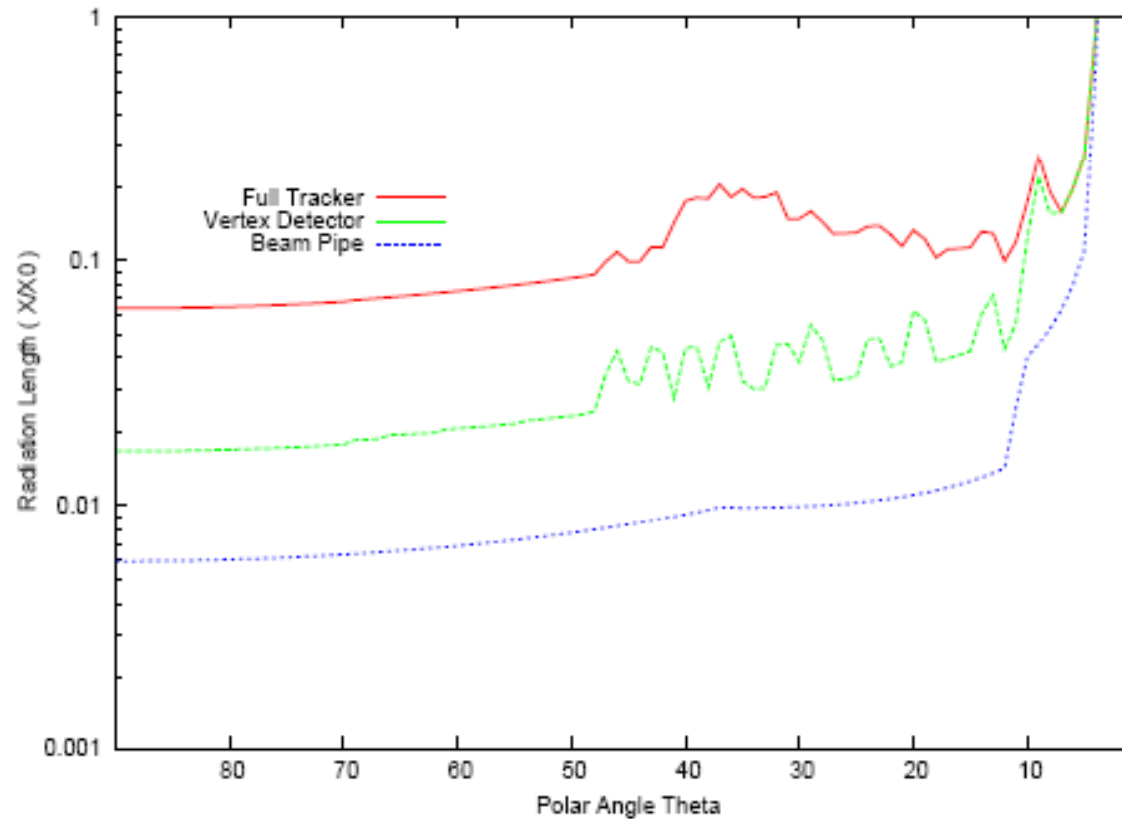


Figure 1.10: Material budget of the tracking system.

Figures

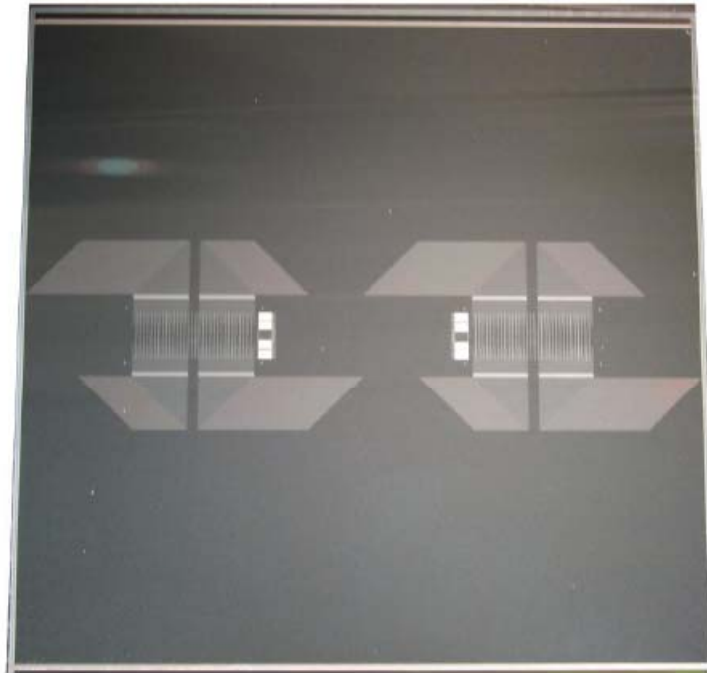


Figure 1.11: Photograph of a prototype SiD tracker sensor.

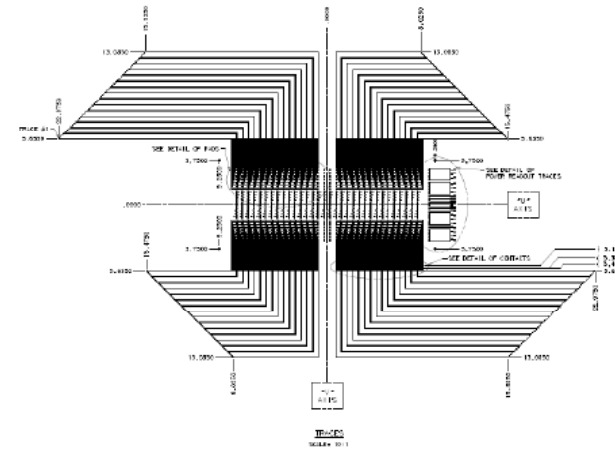


Figure 1.12: Detail of the double-metal routing of the traces to the readout chip and the connections to the readout cable, visible to the right of the bump-bond array.

Figures

- Module plus cable plus readout. Good figure is missing

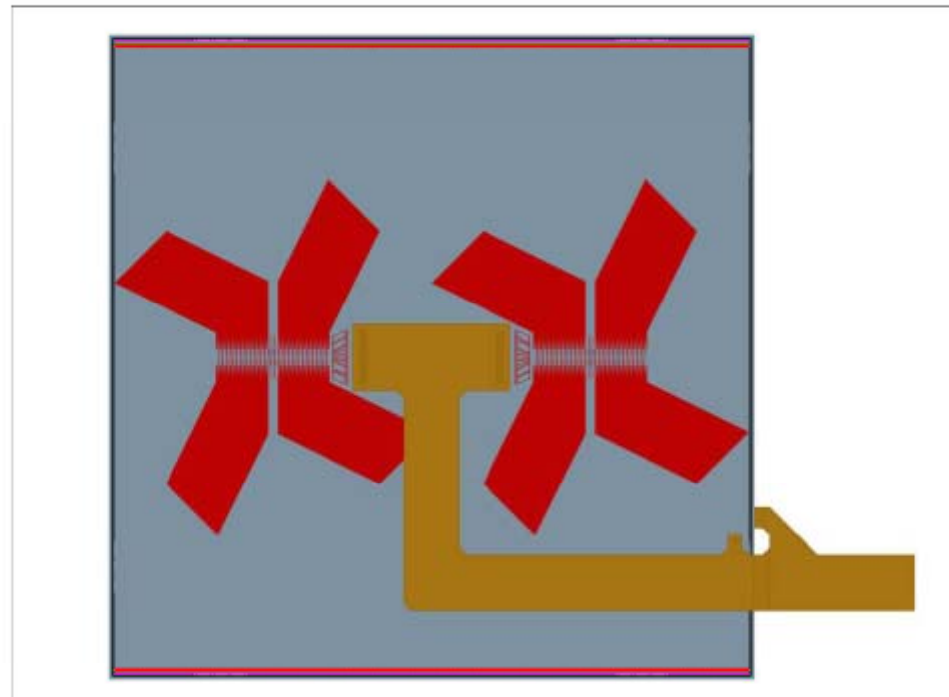
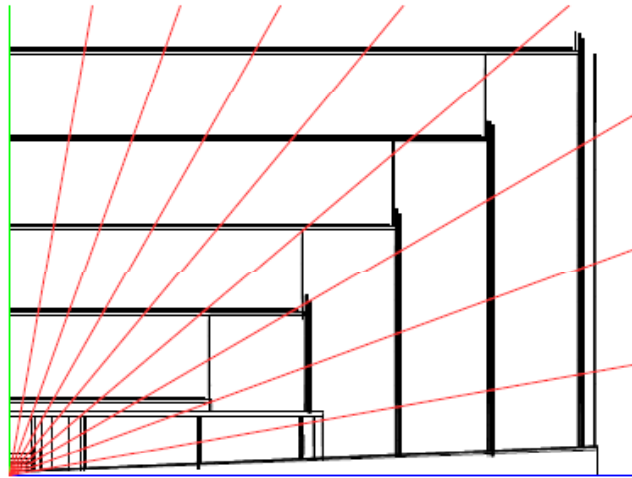


Figure 1.13: Sketch of a module to the tracker barrel. This figure should be replaced.

Monte Carlo Description



Vertex detector

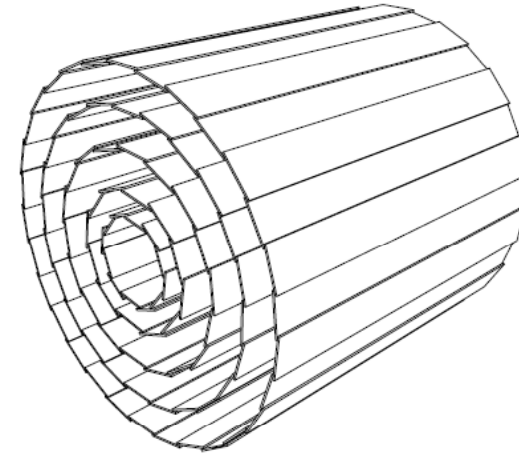
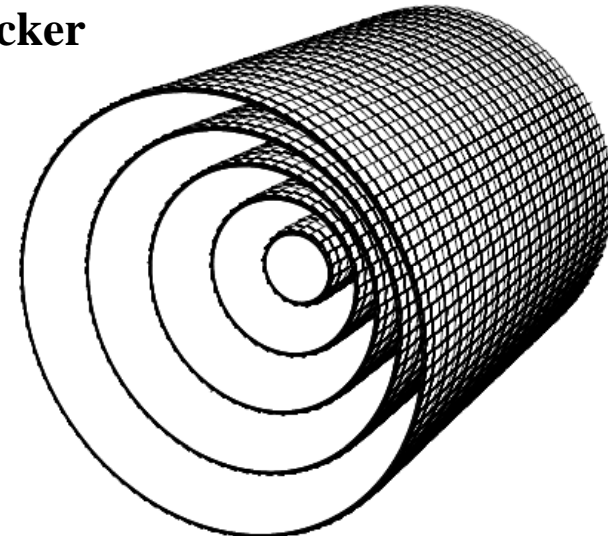
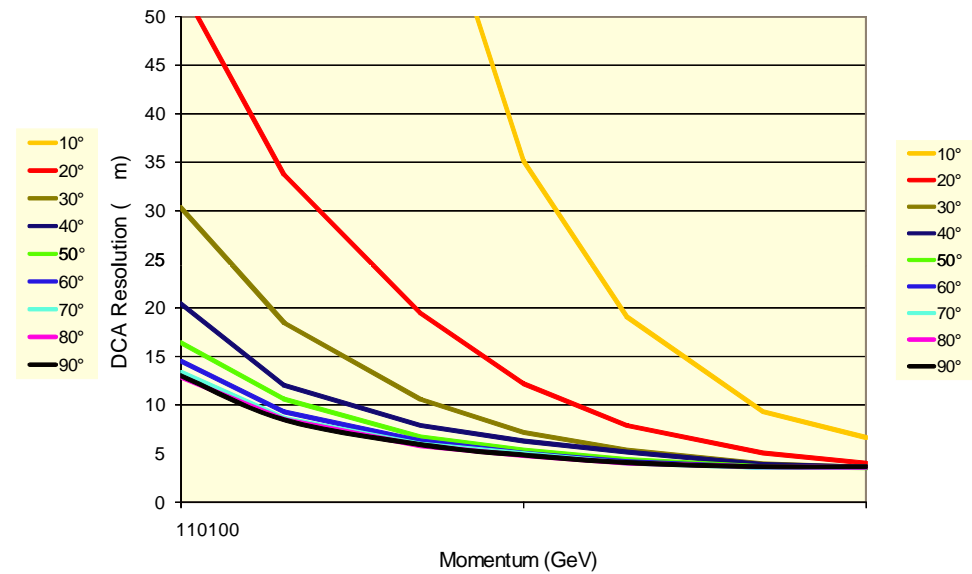
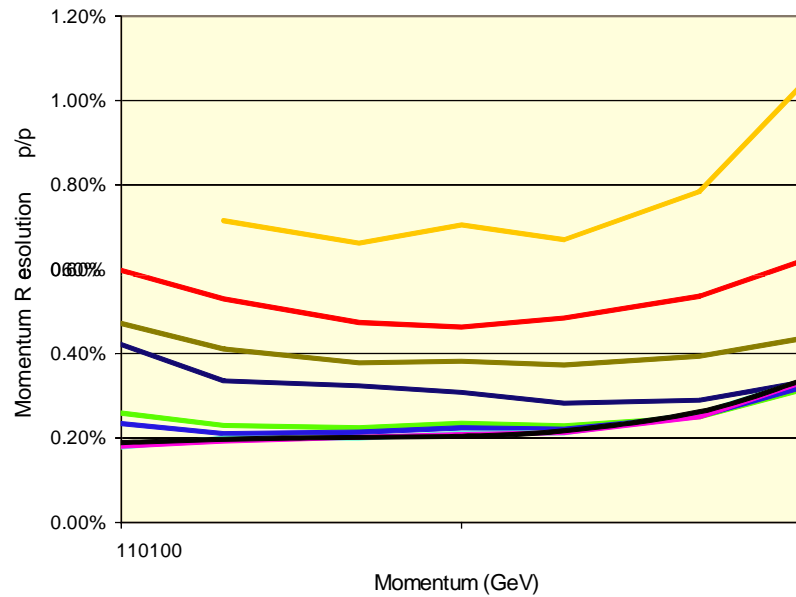


Figure 1.14: R-z view of the simplified tracking system as implemented in sid02.**Tracker**

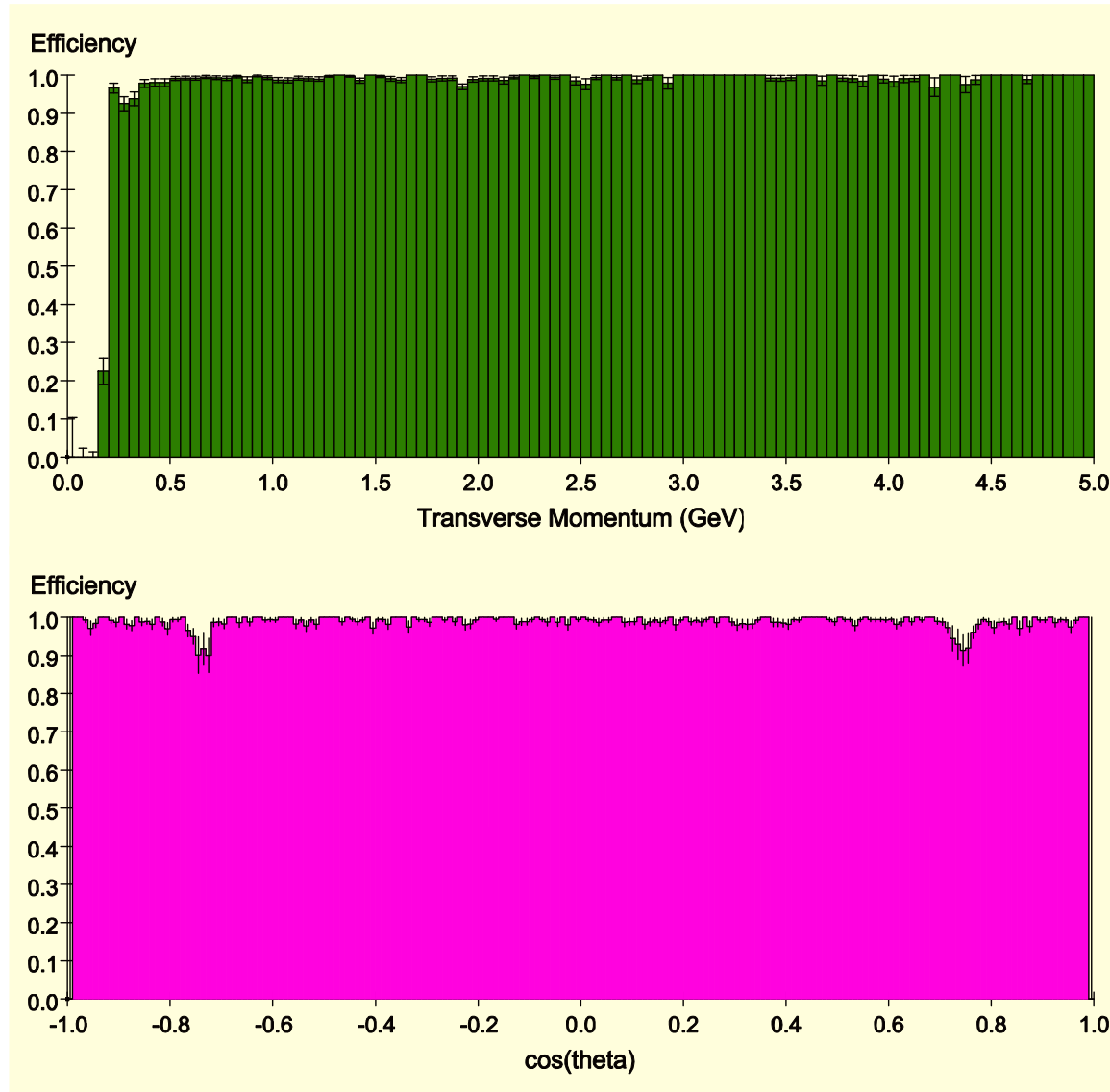


Figures



- Cast the momentum resolution in a more standard format
- Also plot as function of angle

Figures



Figures

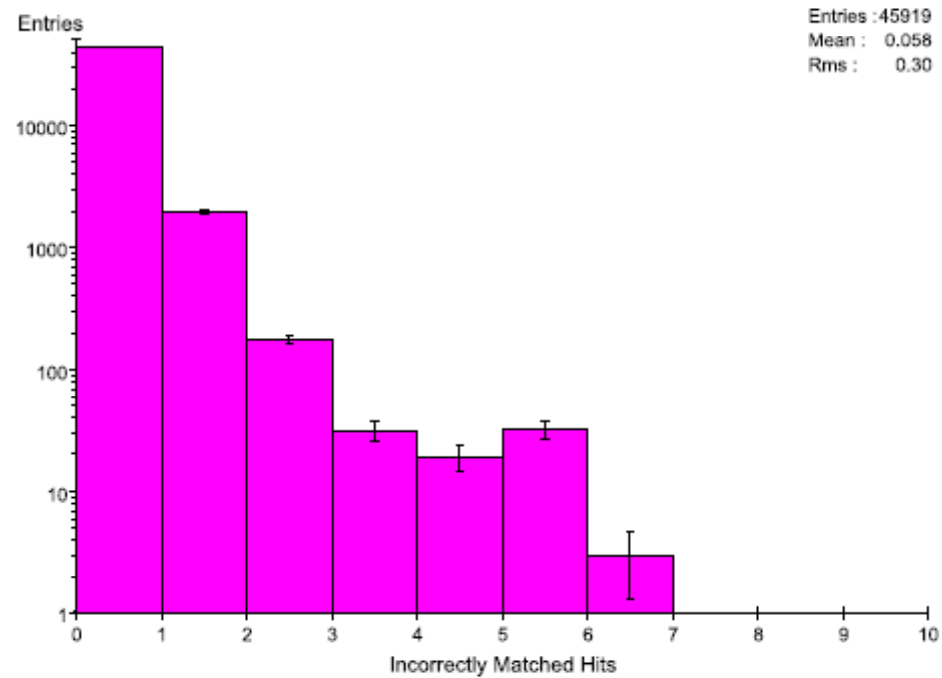


Figure 1.19: Number of mis-assigned hits on a track.

Figures

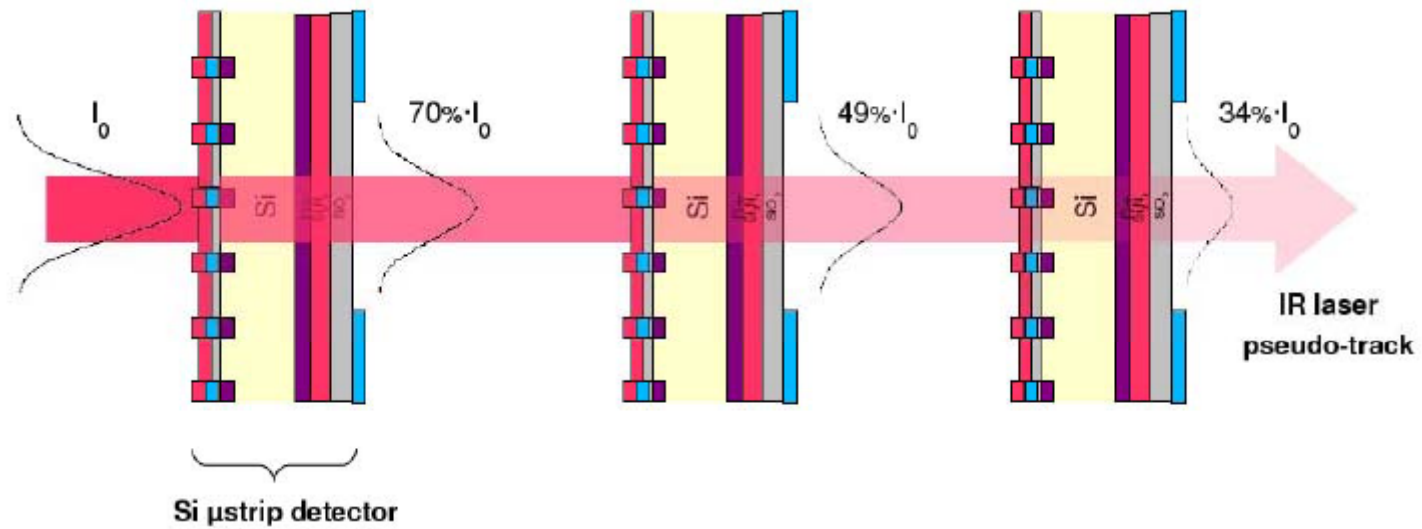


Figure 1.21: Sketch of the IR alignment method.

List of Figures for LOI



1. Elevation view of sub-detector; all silicon for vertex ✓
2. R-phi view of sub-detector, barrels, disks, forward disks ✓
3. Detail on vertex detector support from beam pipe and servicing ✓
4. Detail on barrel/disk support for tracker ---
5. Detail on module design ✓

6. Number of charged particles/cm² as function of radius for various z locations including beam backgrounds; occupancy as function of radius for barrels ---
7. Material budget as function of cos(theta) ✓
8. Double-metal sensor layout + a characteristic (CV-curve?) ---

9. Track reconstruction efficiency as function of integrated # bunch crossings ---
10. Impact parameter resolution as function of p_T and tan(lambda) ---
11. Track reconstruction efficiency as function of track p_T and cos(theta) ✓
12. Fitted track momentum resolution as function of p_T and cos(theta) ✓
13. Efficiency of V-reconstruction (K_s, Δ) with calorimeter assisted tracking ---

Figures Contributed to Benchmarking

Tracker contributions to benchmarking section

1. Higgs recoil mass measurement precision from ZH production (mandatory reaction)
2. Secondary vertex reconstruction efficiency from ZH, $H \rightarrow cc$ (mandatory reaction)
3. Heavy flavor tagging performance: b-tag efficiency versus purity ?

List of Tables for LOI



1. Main parameters of the vertex-tracker system: barrels / disks
Radii of layers, extend of layers, z-position of disks, number of channels, number of modules, stereo angle for disks ✓
2. Sensor technology options for vertex detector with pros and cons ---
3. Estimated power consumption and thermal budget description ✓

IDAG Questions



- Sensitivity of different detector components to machine background as characterized in the MDI panel
 - Addressed through different vertex sensor detector technologies
- Calibration and alignment schemes
 - University of Michigan system
- Status of an engineering model describing the support structures and the dead zones in the detector simulation
 - Described in the main text
- Plans for getting the necessary R&D results to transform the design concept into a well-defined detector proposal
 - Will be addressed in the description about sensor technologies and R&D
- Push-pull ability with respect to technical aspects
 - Defer to overall write-up on push-pull
- A short statement about the energy coverage, identifying the deterioration of the performances when going to energies higher than 500 GeV and the considered possible detector upgrades.
 - Background plot will include 1 TeV running
- How was the detector optimized: for example the identification of the major parameters which drive the total detector cost and its sensitivity to variations of these parameters
 - No optimization done as of yet

Missing Parts I



IDAG related

- Sensitivity of different detector components to machine background as characterized in the MDI panel
 - Background files exist with 1, 10 and 100 bunch crossings. No bunch crossing information, just cumulative hits.
Rich is running his track finder on these files. Expect results this week.
 - Different vertex sensor detector technologies not addressed.
Will be addressed in R&D section
- Calibration and alignment schemes
 - Text is thin on alignment, but maybe adequate. The text does not really address adequacy of alignment for push-pull.
 - What is missing is physics feedback on the alignment requirement.
- Energy coverage
 - Will run some track finding efficiency for a benchmark process at different centre of mass energies. Suggest ttbar events
- How was the detector optimized?
 - Not addressed in any quantitative way

Missing Parts II



Non-IDAG related

- Performance
 - **More quantitative characterization of the performance of the detector with the full simulation would be beneficial**
 - B-tagging efficiency
 - Tau-identification
 - ...
- R&D section; may be the most crucial piece, but is as of today completely missing.
 - **Vertex detector sensor technologies**
 - Have we excluded any technologies?
 - **Power delivery**
 - ...

Final Remarks



- We are finally in a position to quantitatively compare tracker designs. It would be good if we embarked on a systematic study of various tracker designs.
- R&D section could be a sensitive section. A proper balance needs to be found, especially in vertex detector sensor technology between the needs for SiD and R&D efforts world-wide.
- If everyone pulls together, the companion vertex and tracking section to the LOI should be publishable as a NIM paper. We hope each and everyone will help accomplishing this goal.