D0 Layer 0 Design and Testing

Daekwang Kau: Florida State University

1. Motivation

Layer 0 is a new silicon detector to be located inside the current inner layer.This detector is designed to:

- Mitigate tracking losses due to radiation damage and detector failure.
  - We expect Layer 1 Micron sensors to begin to fail at exposures of ~ 3.5-5 fb-1 due to radiation damage.
  - Currently we have 86% of HDIs enabled.
- Provide more robust tracking and pattern recognition for higher luminosities.
- Improve impact parameter resolution by a factor of 2.
  - Increase b-tagging efficiency by 20%.
  - Possibly resolve B_s meson flavor oscillations.

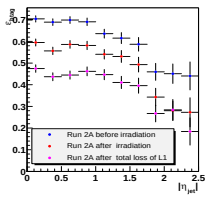
2. Radiation and IP Resolution

"After Irradiation" effect studies:

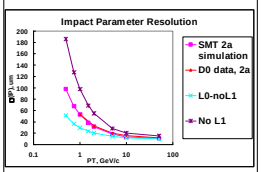
a) 10% hits are lost in outer layers

b) 50% hit loss in L1 and F-disks

c) "total loss" : a) + 100% hit loss in L1 and 50% in F-disks

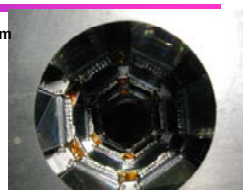


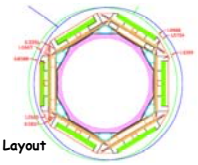
- Improve IP resolution
  - Low mass analog cables
    - ? No room for hybrid on sensor.
    - ? No room to cool hybrid.



3. Layer 0 Design Specifications

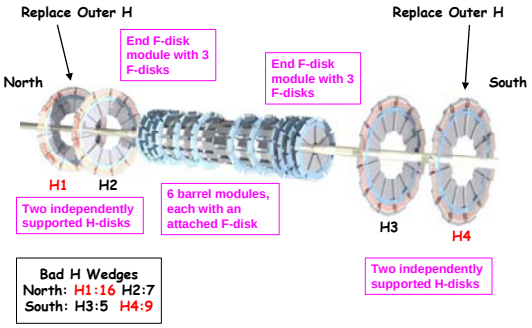
- Detector must fit between radii of 16mm – beam pipe flange and 22.8mm - SMT support structure openings.
- 6 fold geometry due to mechanical constraints.
- Four sensor types provide 98.4% f acceptance. (71mm pitch for both = 93.1%)
- 48 sensor/low mass analog cable modules. (12,288 chs.)
- Analog cable between sensor and hybrid, max ~35 cm long.
- SVX4 readout chip (96).
- Six phi segments – match STT.
- Replace Outer H-disk.



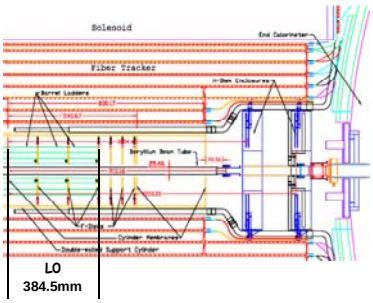


Layer 0: Hybrid Region Layout

4. Layer 0 Placement in RunIIa SMT



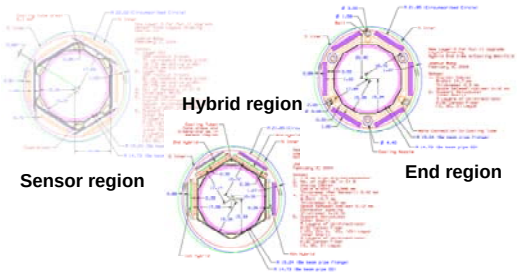
5. Run IIb Beam Pipe in Run IIa SMT



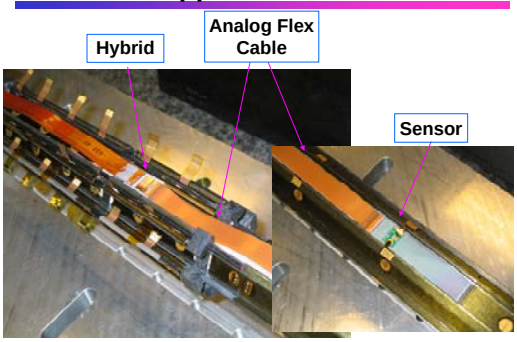
- Outer diameter of the beryllium portion of the beam pipe decreased from 38.1 mm to 29.464 mm. (<8.636mm)
- Overall length of the beryllium beam pipe decreased from 96" to 72". (<24")
- Outer diameter of the stainless steel beam pipe flanges decreased from 43.18 mm to 30.48 mm. (<12.7mm)
- L0 extends to end of barrels.

6. Support Structure

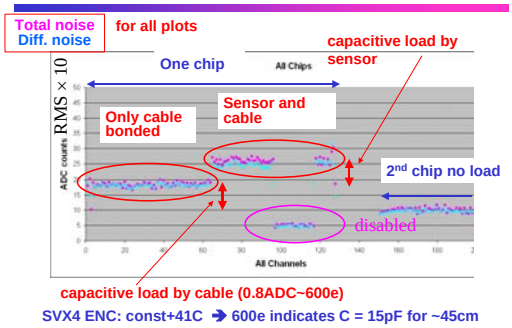
Design complete – now working on short prototypes and long mandrel designs



7. Layer 0 Module Mounted on the Support Structure



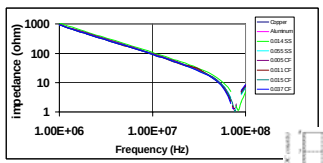
8. Noise Level before installation



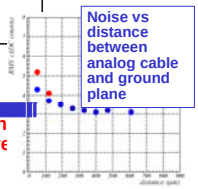
SVX4 ENC: const+41C ➔ 600e indicates C = 15pF for ~45cm

9. Application of Carbon Fiber

- Carbon fiber has high conductivity

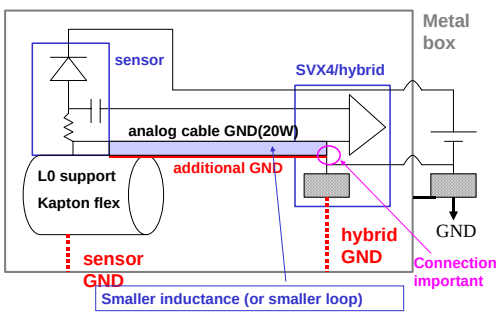


➔ Special caution needed in grounding scheme



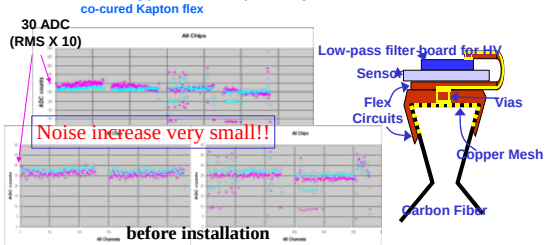
- Sensor/analog cable can be coupled to the support structure capacitively
- Controlling proximity between detector and support structure important

10. Grounding Study



11. Outcome of the Study

- Avoid grounding loop ➔ any conductor, i.e. carbon fiber support structure must be grounded with low inductance
- Particular importance of the ground connection at the hybrid
- Kapton flex with Cu mesh co-cured to the CF support structure
- Grounding pads at the backplane of hybrid allows connection to the co-cured Kapton flex



12. Status

Cancellation of RunIIb……09.03.03

Mechanical Design Workshop……09.25.03

Technical Design Report Submitted…… 10.15.03

DOE Project Approval……12.05.03

Electrical Isolation Scheme Workshop……12.17.03

Sensor Order RFQ……01.19.04

Hybrid and Analog Cable PRR……02.12.04

Ready to Move Layer 0 to DAB……

07.21.05 (~12:23AM)

- Several PRR coming soon. (Digital cable, Junction Card, Support Structure)
- Keeping pace with an aggressive schedule.
- Money—so far obligations are lower than base estimate in schedule.