



A NEW INNER LAYER SILICON STRIP DETECTOR FOR D0

LINDA BAGBY
FOR THE
D0 COLLABORATION
Fermilab



Run IIb Layer 0 Detector

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- Mechanical Specifications
- Electronics
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- Summary

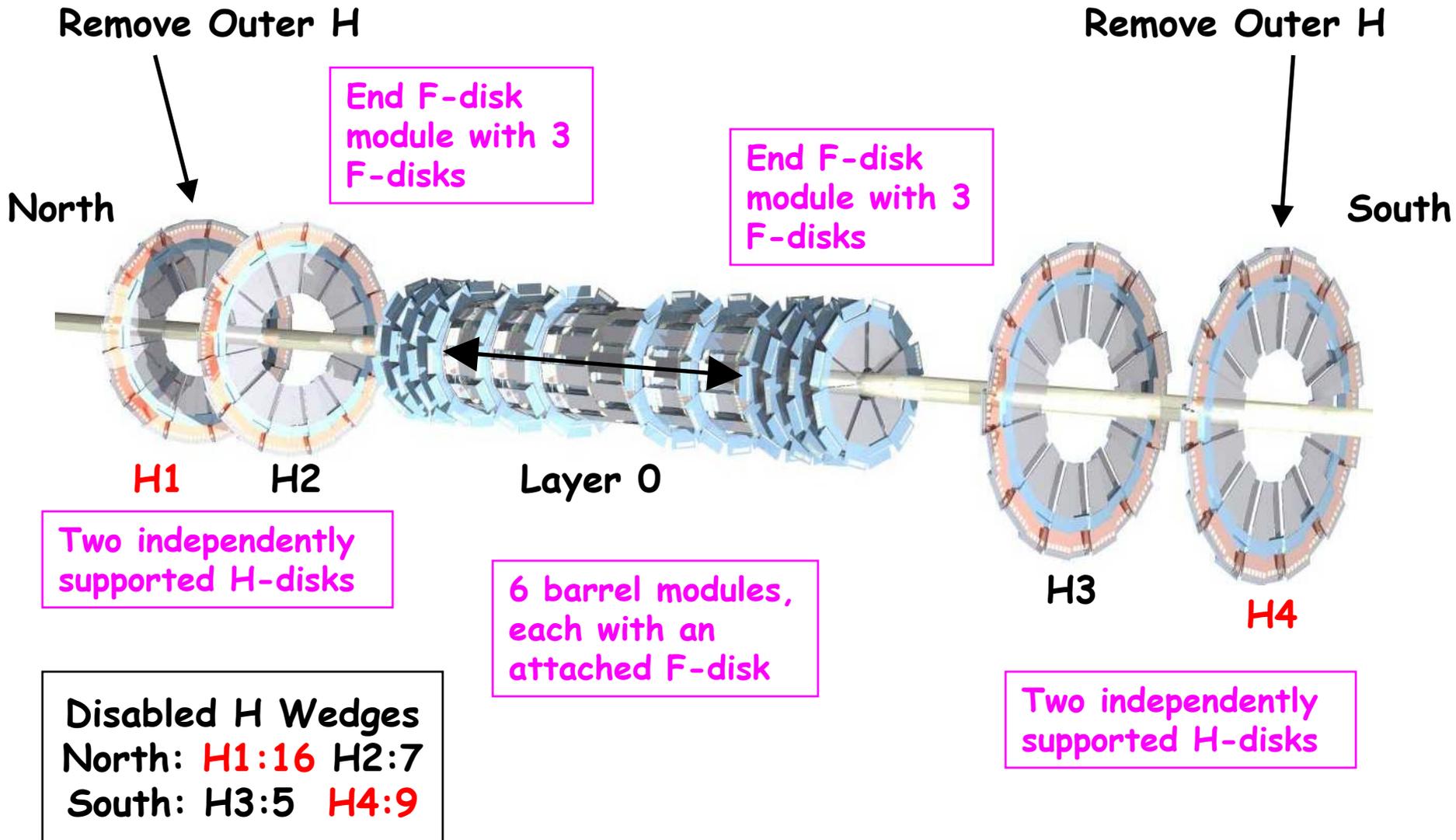


Introduction

- 15 Collaborative Institutions
 - ◆ Brown
 - ◆ California State University at Fresno
 - ◆ Fermilab
 - ◆ Kansas
 - ◆ Kansas State
 - ◆ Louisiana Tech
 - ◆ Michigan State
 - ◆ Mississippi
 - ◆ Moscow State
 - ◆ Northwestern University
 - ◆ Rice
 - ◆ StonyBrook
 - ◆ University of Illinois-Chicago
 - ◆ Washington
 - ◆ Zurich



RunIIa Silicon Geometry





Physics Motivation

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

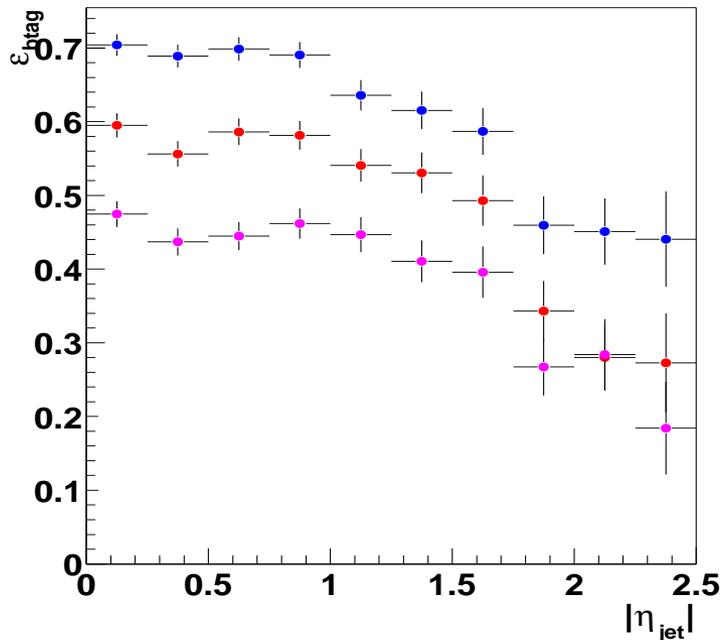
- Mitigate tracking losses due to detector failure.
 - ◆ Currently we have 86% of the detector hybrids enabled.
- Provide more robust tracking and pattern recognition for higher luminosities.
- Improve impact parameter resolution by a factor of 2 for low transverse momentum particles.
 - ◆ Increase b-tagging efficiency by 20%.
 - ◆ Possibly resolve B_s meson flavor oscillations.



Eff. and IP Resolution

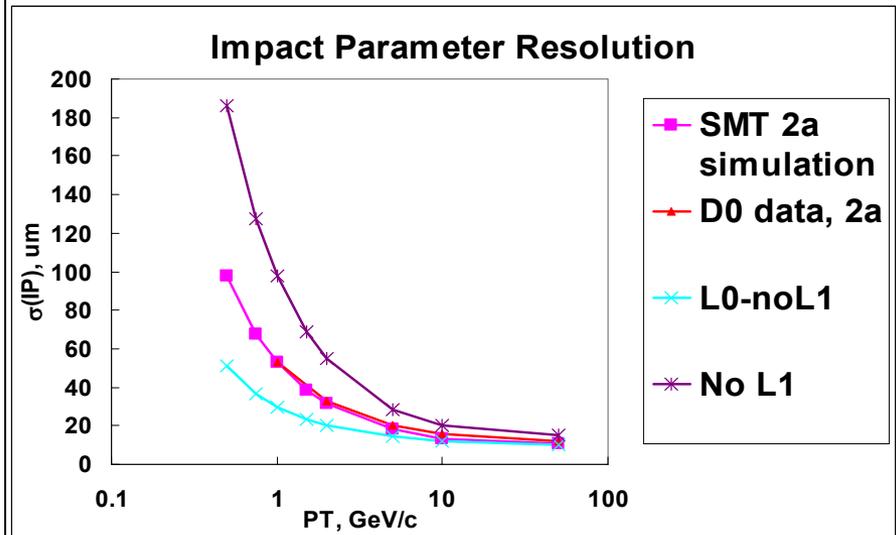
Efficiency studies:

- 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.

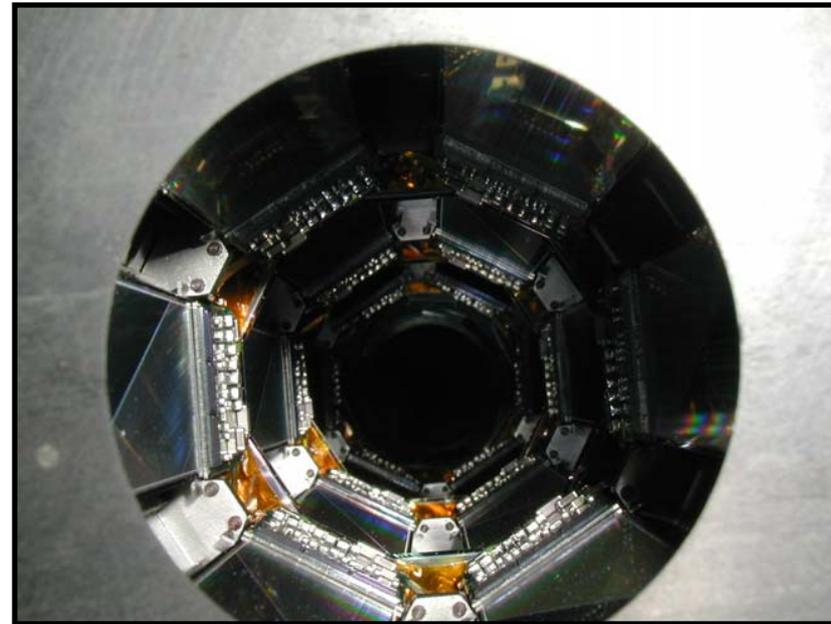




Mechanical Specifications

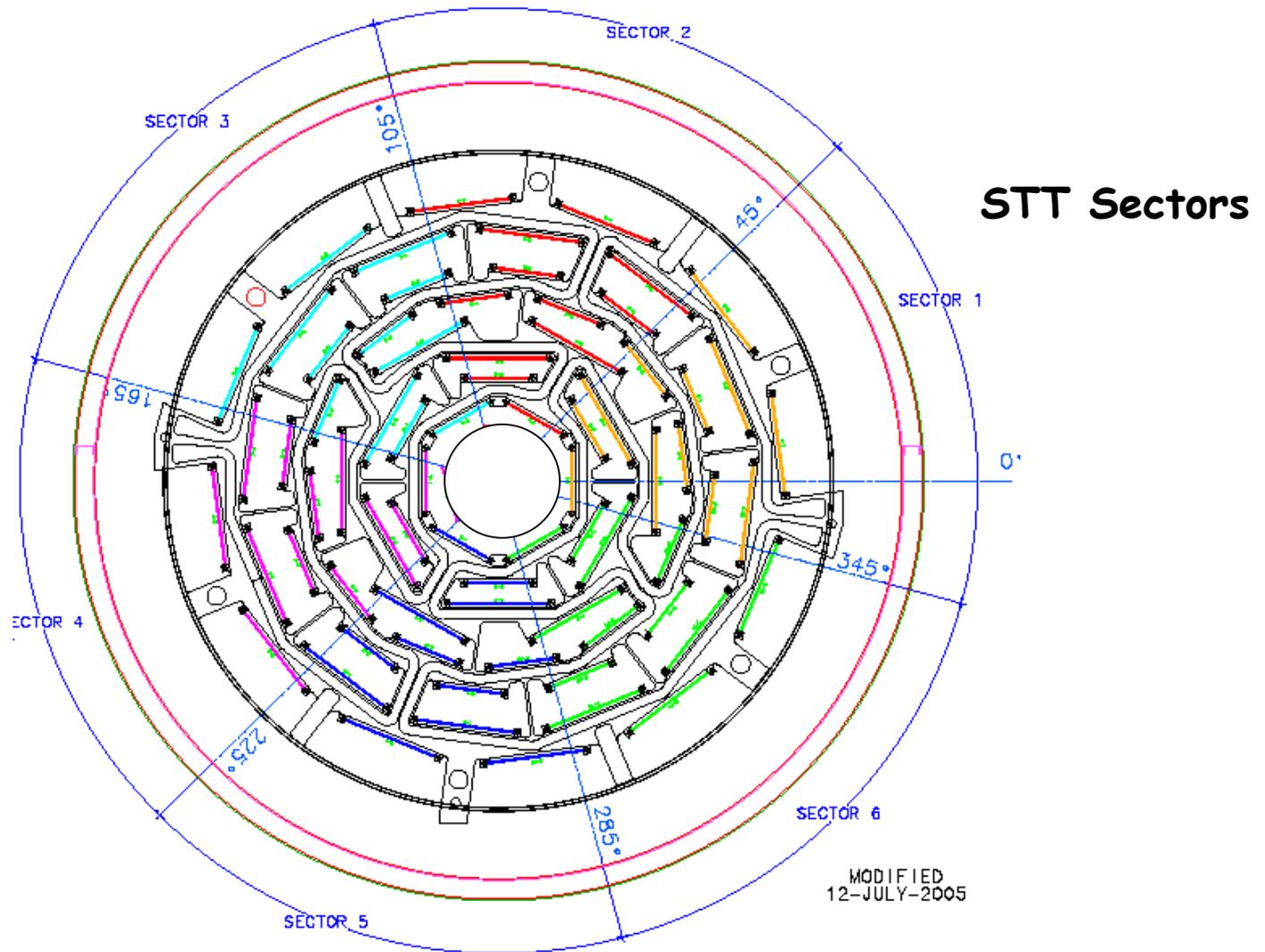
- Detector must fit between radii of 16mm - beam pipe flange and 22.8mm - SMT support structure openings.
- 6 fold geometry due to mechanical constraints.
- Four sensor types provide 98.4% ϕ acceptance. (71 μ m pitch for both = 93.1%)
- 48 sensor/low mass analog cable modules. (12,288 chs.)
- Analog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

Inside of Layer 1



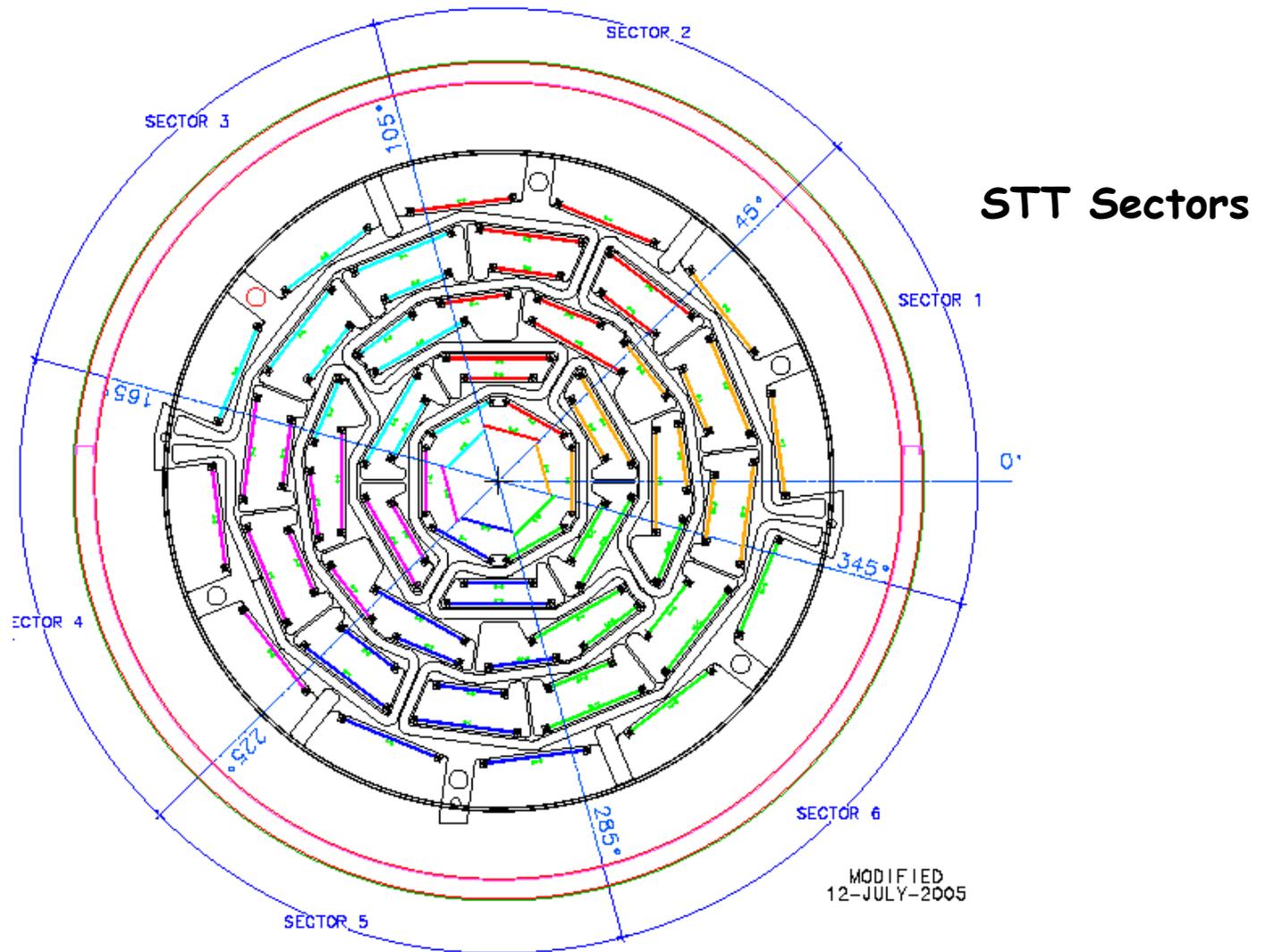


Layer 0 Position



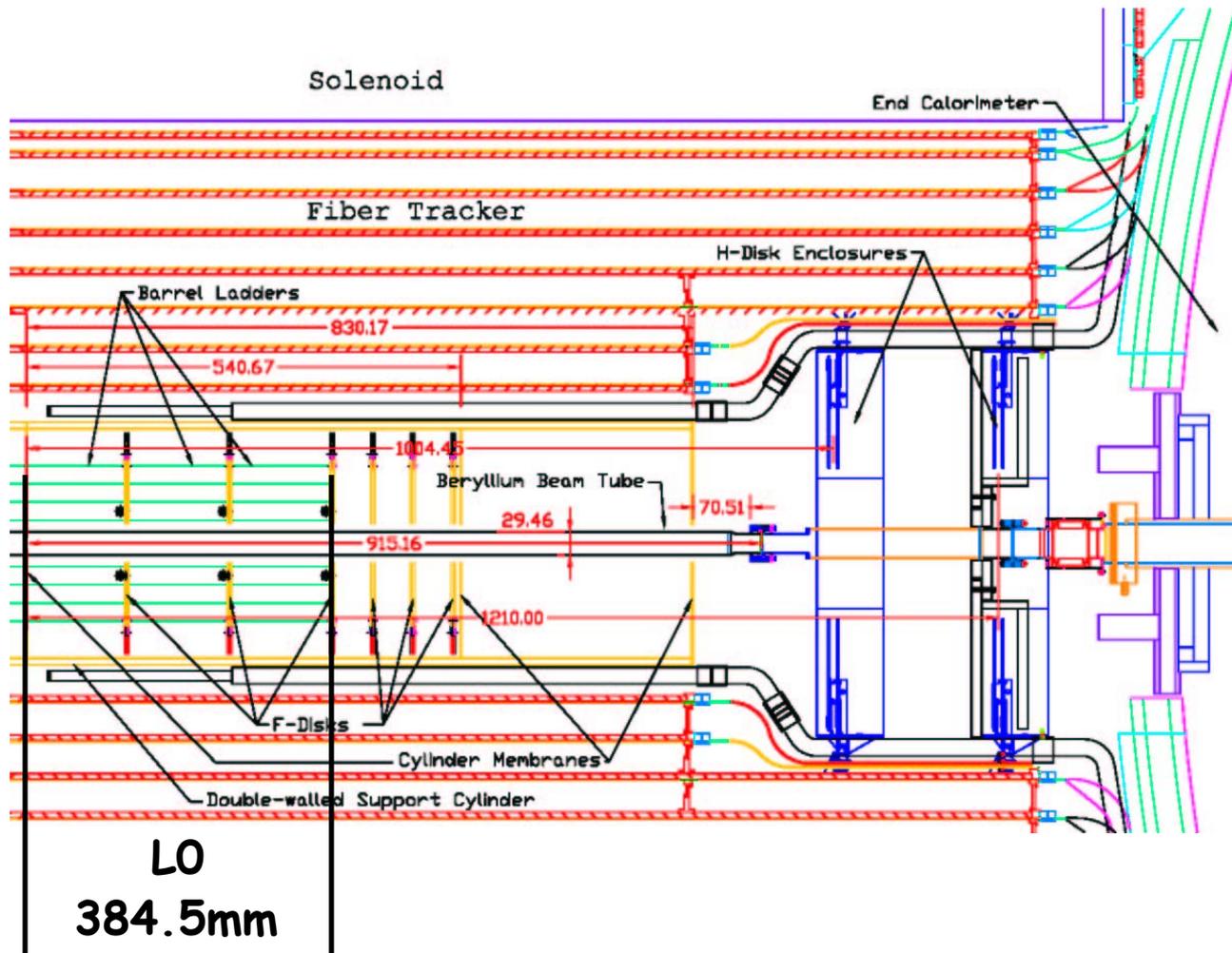


Layer 0 Position





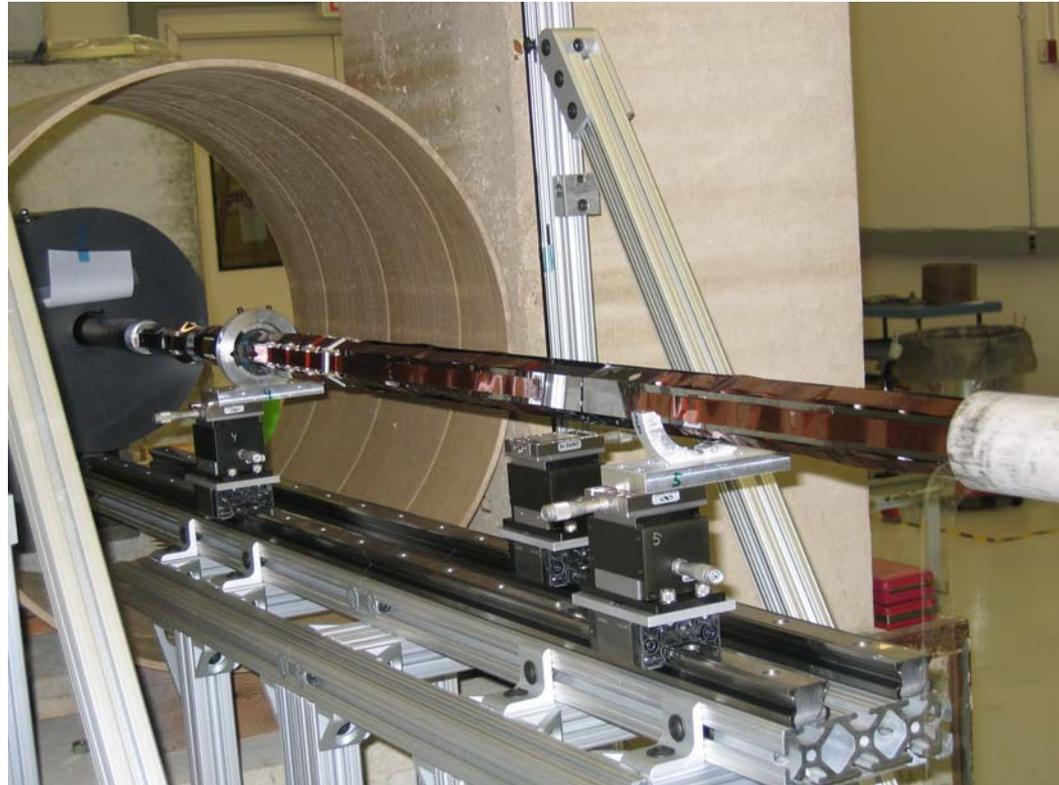
Run IIb Beam Pipe in Run IIa Silicon



- Outer diameter of the beryllium beam pipe: 29.464 mm.
- Length of the beryllium beam pipe 1828.8 mm.
- Outer diameter of stainless steel beam pipe flanges 30.48 mm.
- Layer 0 extends to end of barrels.



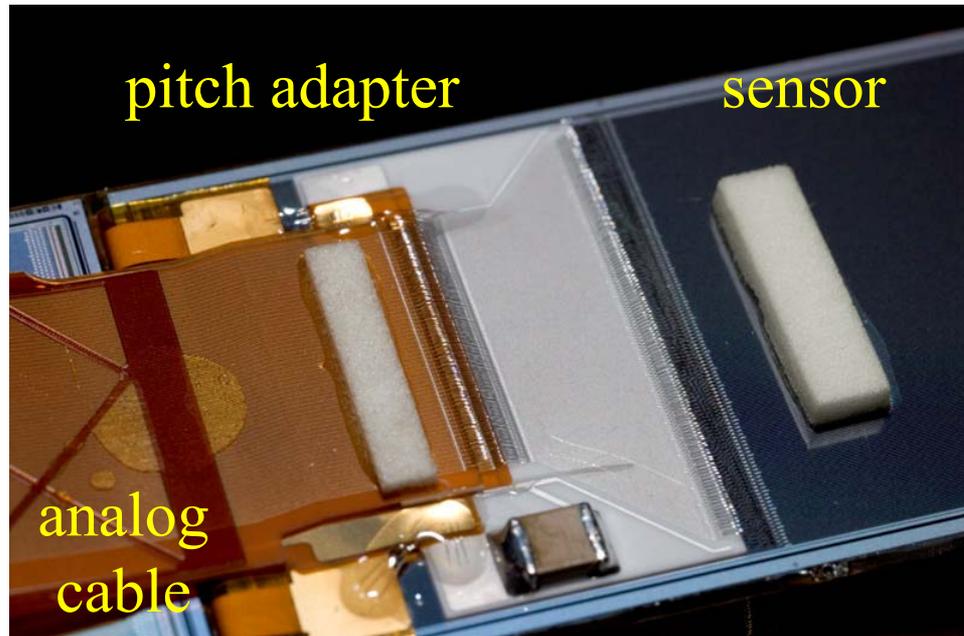
Installation Mock-Up



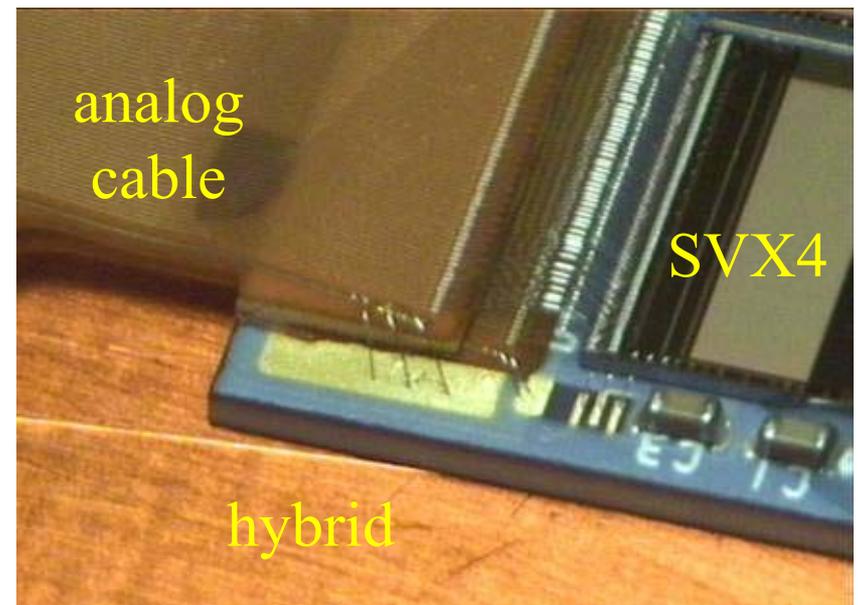
- Installation tool made by University of Washington.
- Tool is cantilevered from one end as it is inserted.
- Multiple stages allow support through RunIIa aperture.



Electronics

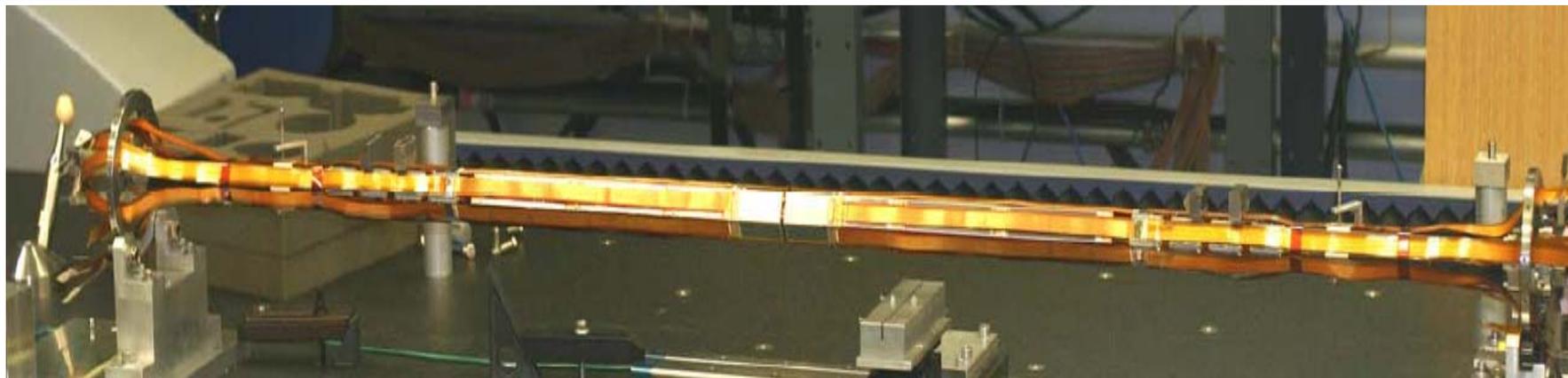


- sensor
- pitch adapter
- analog cable
- hybrid
- SVX4





Layer 0 Specifications



Layer	Radius	Z Segmentation	Readout/(Strip) pitch	Sensor Length	Analog Cable Length
OA	16.0 mm	inner	71 (35.5) μm	70 mm	32.0, 34.6 cm
OA	16.0 mm	outer	71 (35.5) μm	120 mm	16.7, 24.4 cm
OB	17.6 mm	inner	81 (40.5) μm	70 mm	32.0, 34.6 cm
OB	17.6 mm	outer	81 (40.5) μm	120 mm	16.7, 24.4 cm

Overall length

769 mm

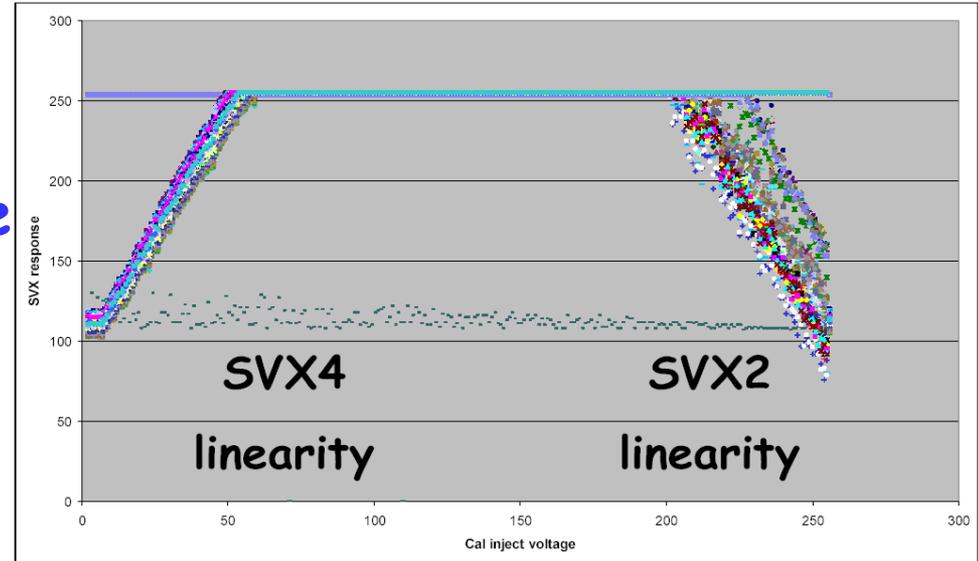
Sensor build up in Z

12-12-7-7-7-7-12-12

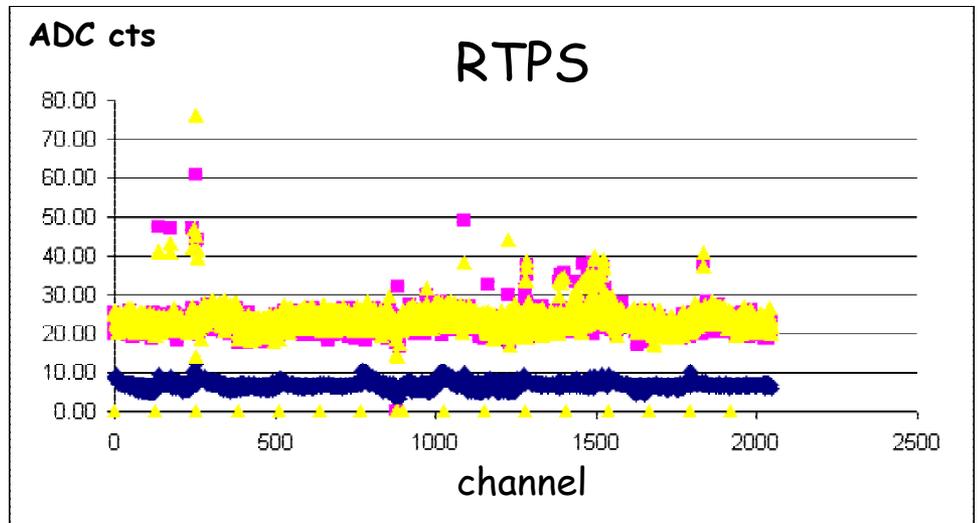


SVX4 VS SVX2

- Much of the electronics designed for the cancelled RunIIB upgrade was used for Layer 0.
- SVX4 features include
 - ◆ Better linear response
 - ◆ RTPS



- pedestal
- total noise $\times 10$
- diff. noise $\times 10$





The Big Challenge - Noise

- The most difficult electronics challenge in Layer 0 is noise reduction.

- ◆ Analog cable works as a "good" antenna.

- With poor grounding scheme, the noise can be high as ADC overflow

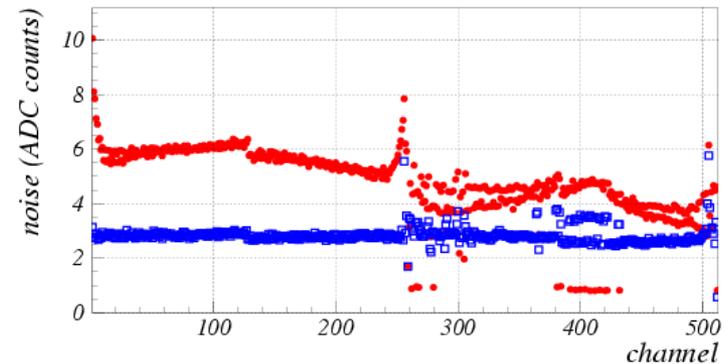
255 ADC counts

1MIP ~ 30 ADC counts

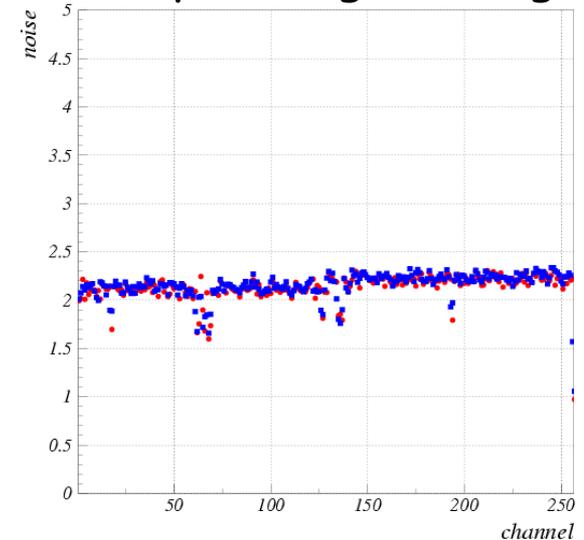
● total noise

■ diff. noise

Poor grounding

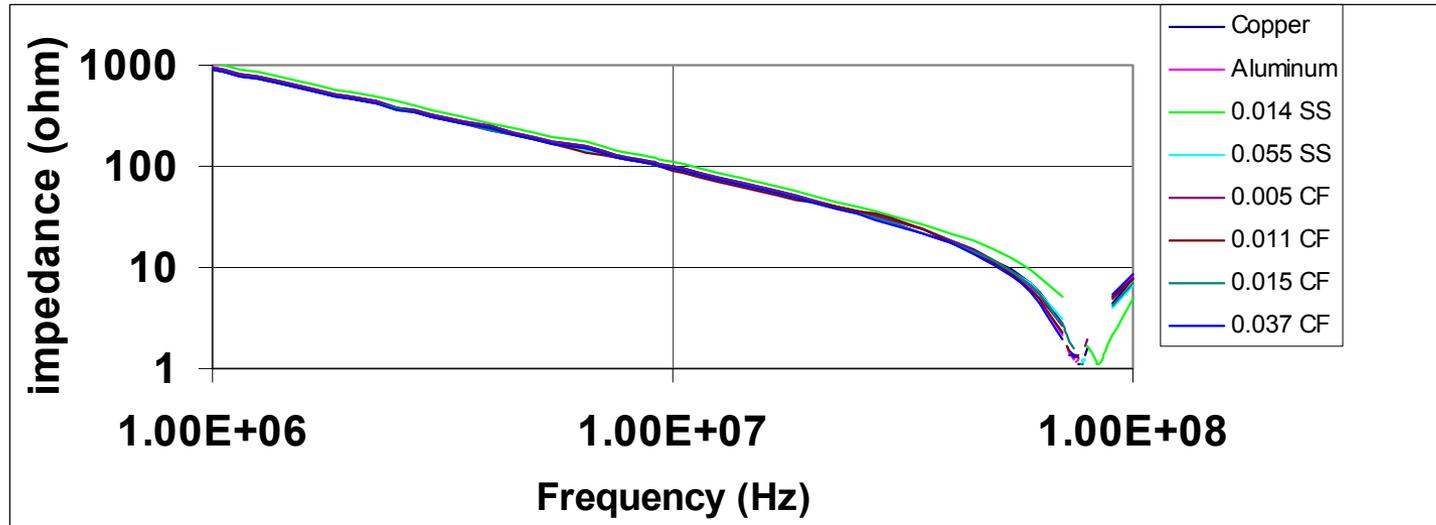


Improved grounding





Carbon Fiber as a support structure

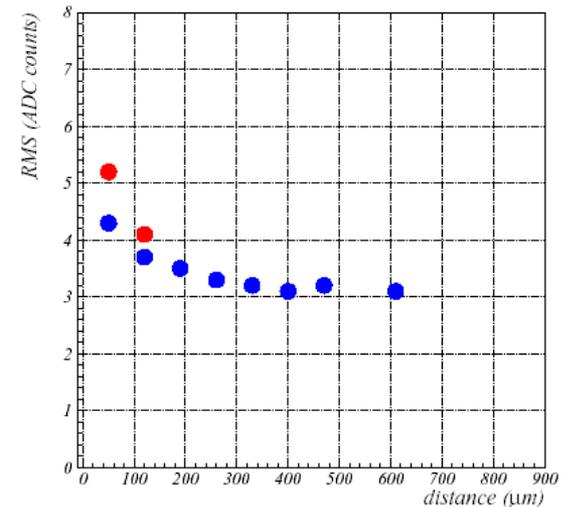
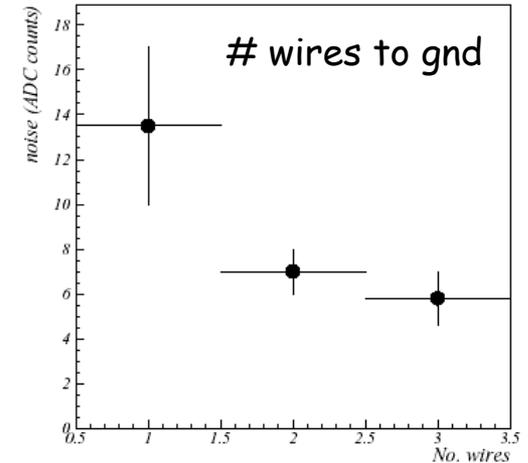
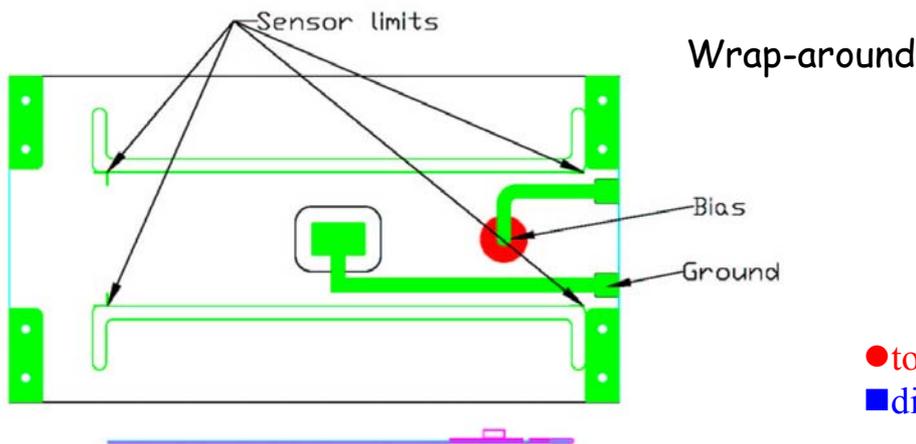


- Carbon Fiber has to be treated as a conductor.
- No difference between Cu, Al, SS, and Carbon Fiber
- Proper grounding is crucial!



Grounding variables

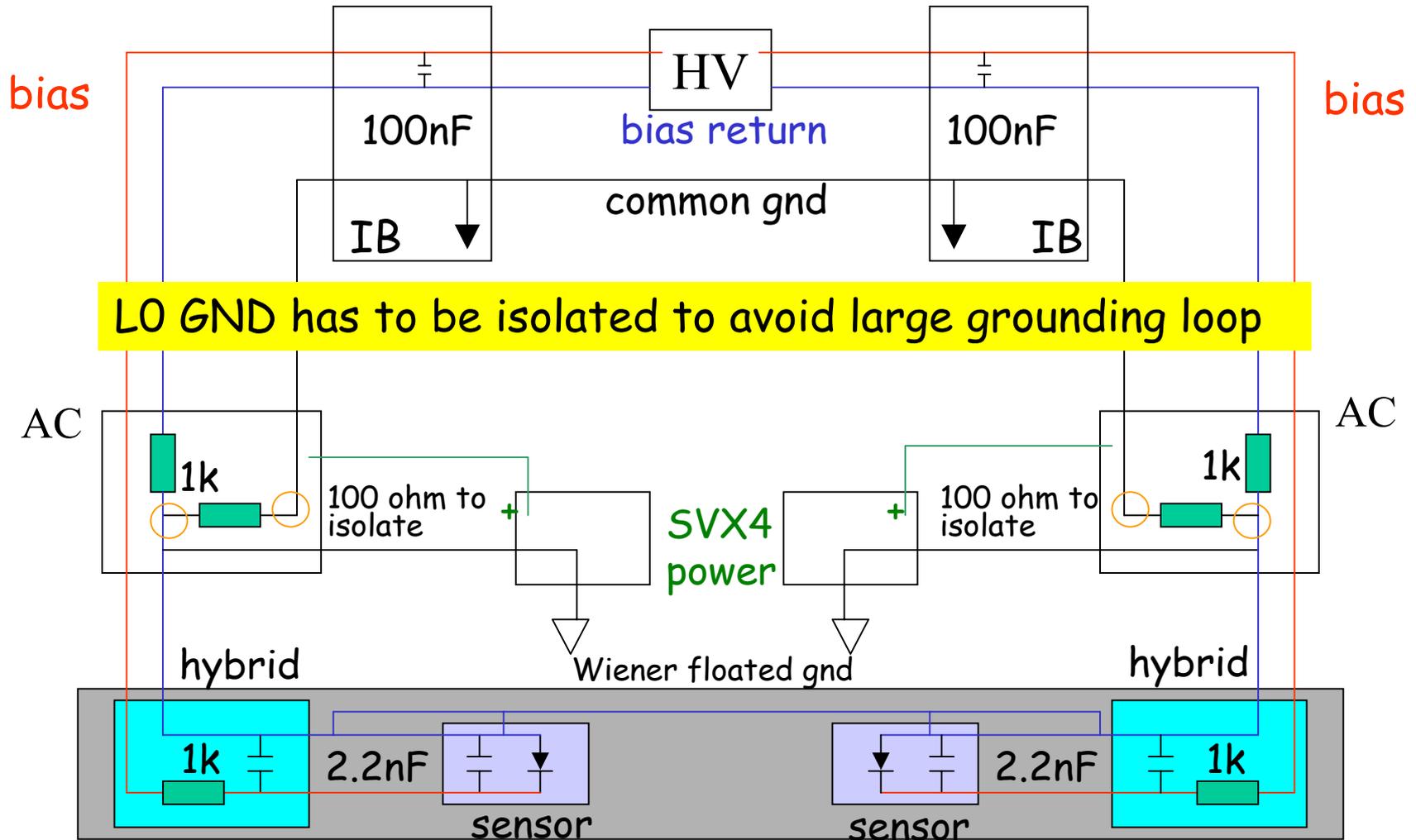
- Low inductance connection important. The more connections the better.
- Proximity of analog cable to support structure has to be controlled.



distance between analog cable and support structure

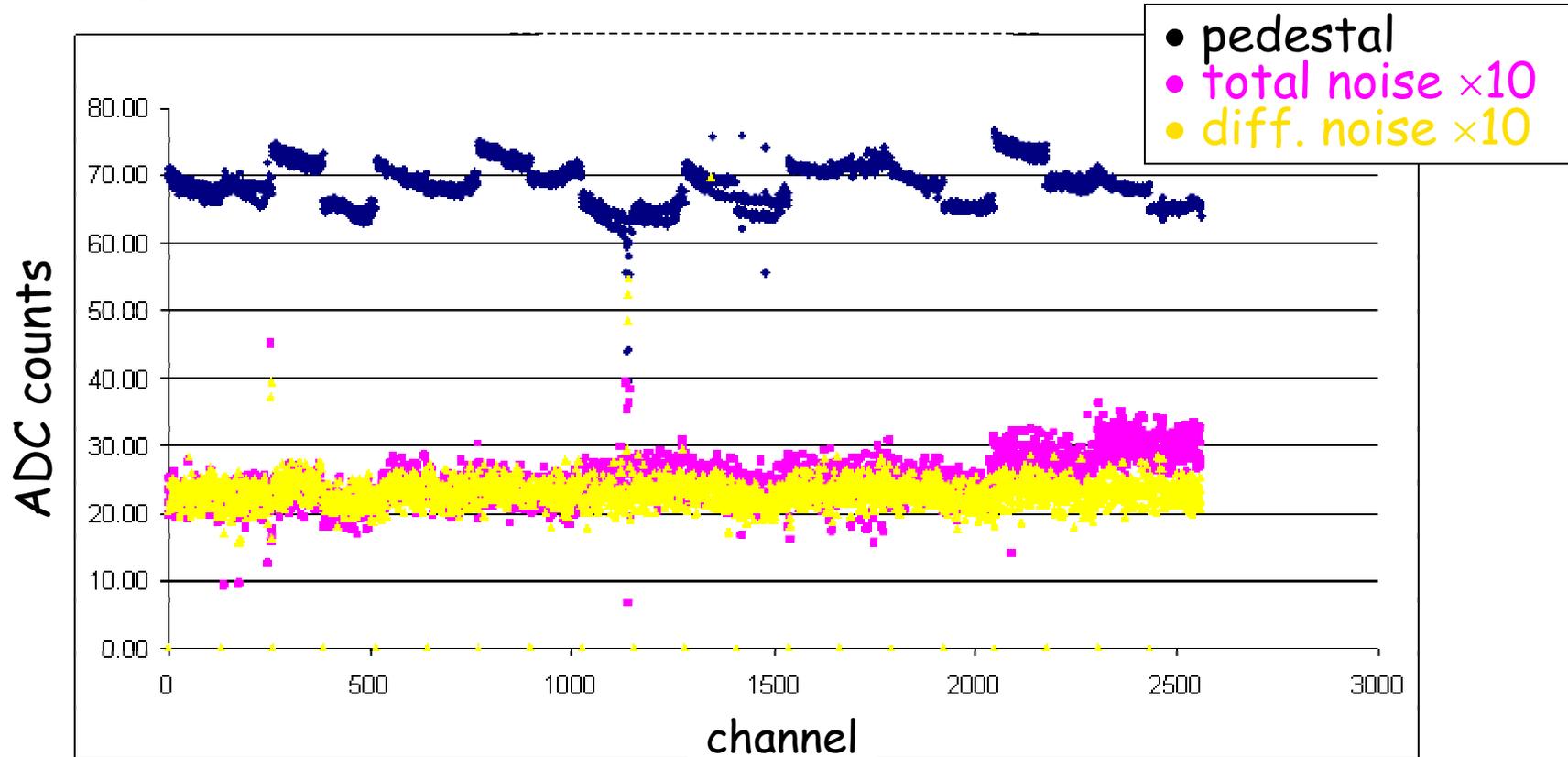


Isolated Ground





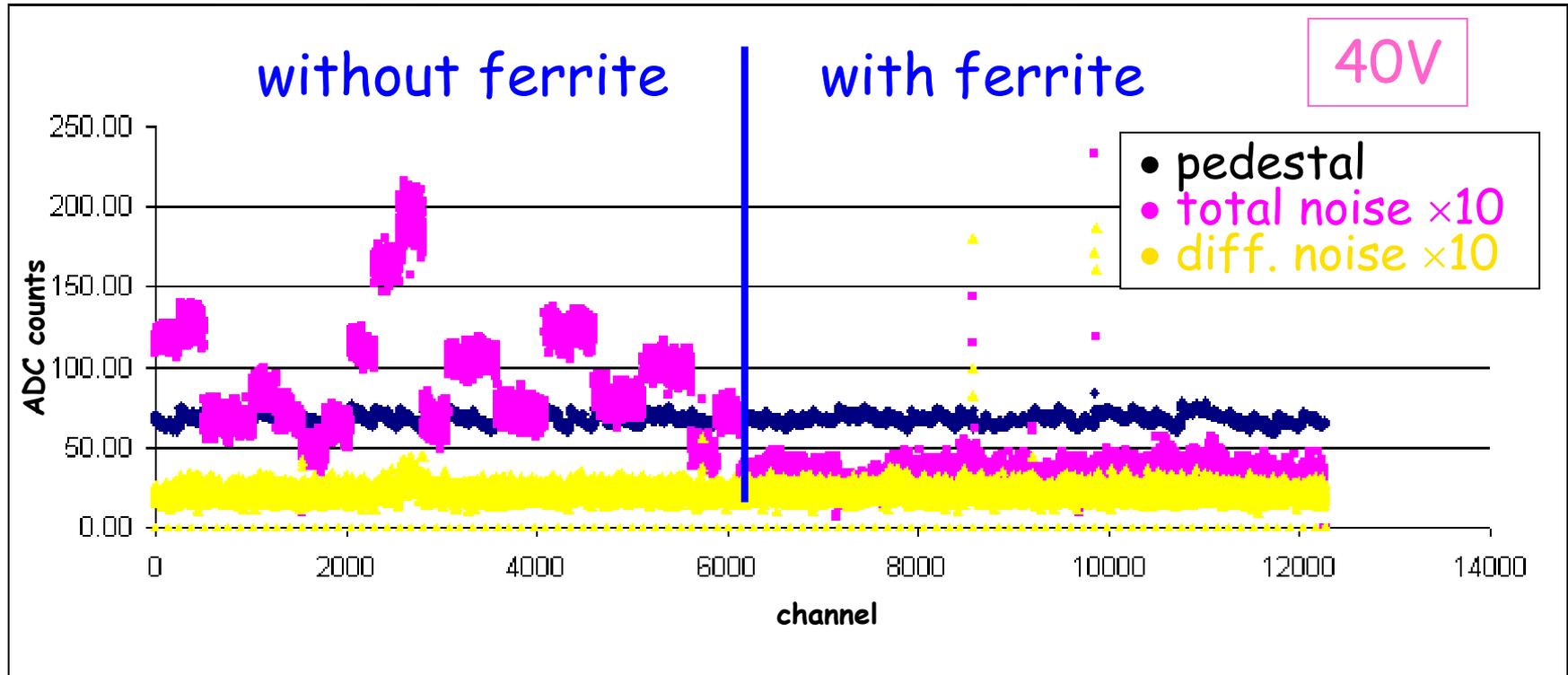
Isolated and Common ground shorted



- No significant pickup noise using common GND
- Cold (-10°C) running ok



LV Power Supply Filter response



- 5 turns on ferrite core of power cable reduced noise to 3-3.5 cts.
- Prototype filter design ready to test.
- Preliminary 200 gauss magnetic field tests show minimal effect on filter action.



Summary

- **Electronics**

- ◆ S/N 16:1 ADC counts w/RTPS or filters.
- ◆ Filtering required on isolated SVX4 power.
- ◆ Shield and filtering require for RTD system.
- ◆ Low inductance return path crucial for carbon fiber support structure.

- **Mechanical**

- ◆ Extreme geometrical constraints made mechanical design very interesting.
- ◆ Installation tooling required.
- ◆ Insertion experience acquired with mock up structure.



A Riddle.....

Diameter golf ball: 1.68" Diameter of Layer 0: 1.79"

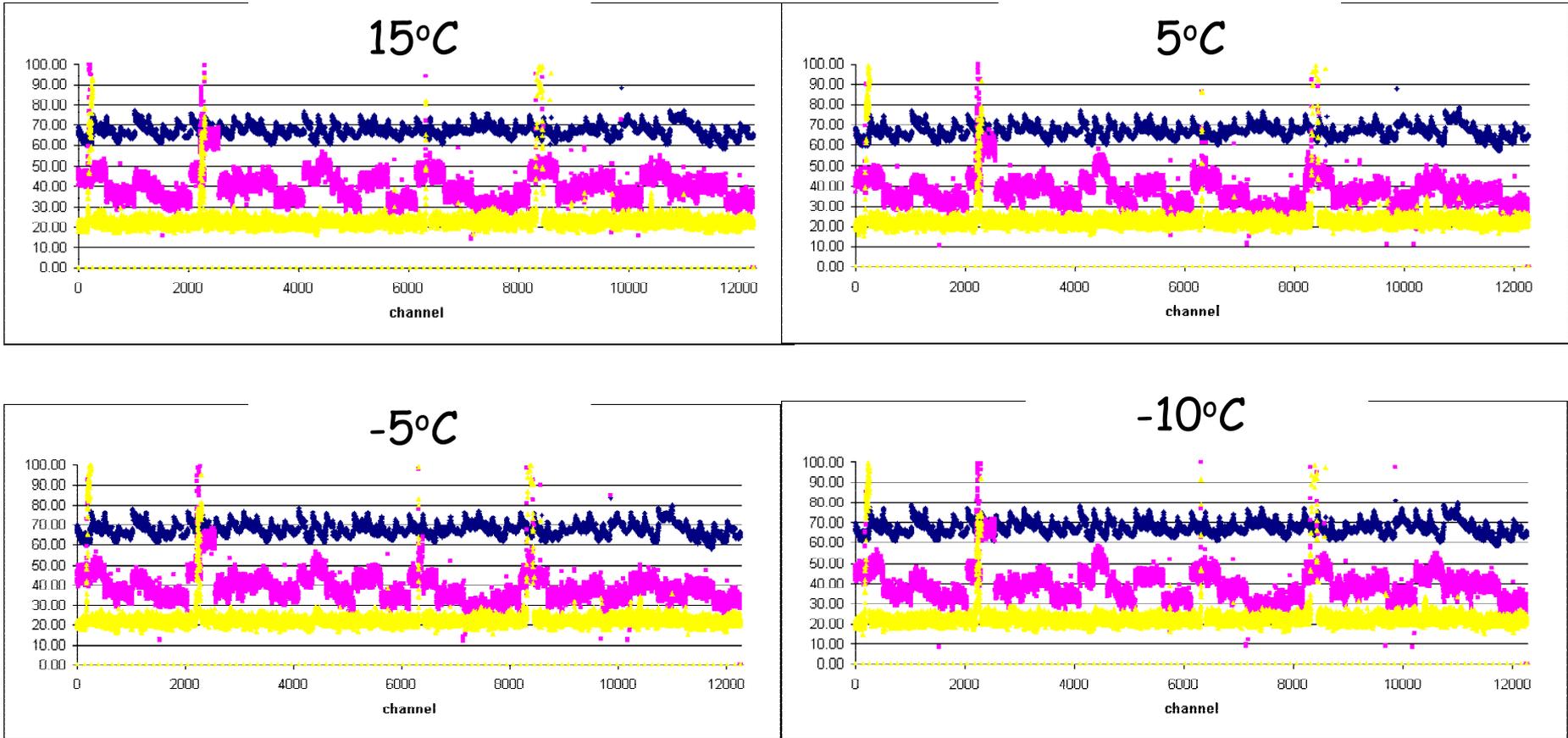




Back-ups



Cold Test



- Stable readout and noise level even under cold operation

- pedestal
- total noise $\times 10$
- diff. noise $\times 10$