Readout of Layer 0

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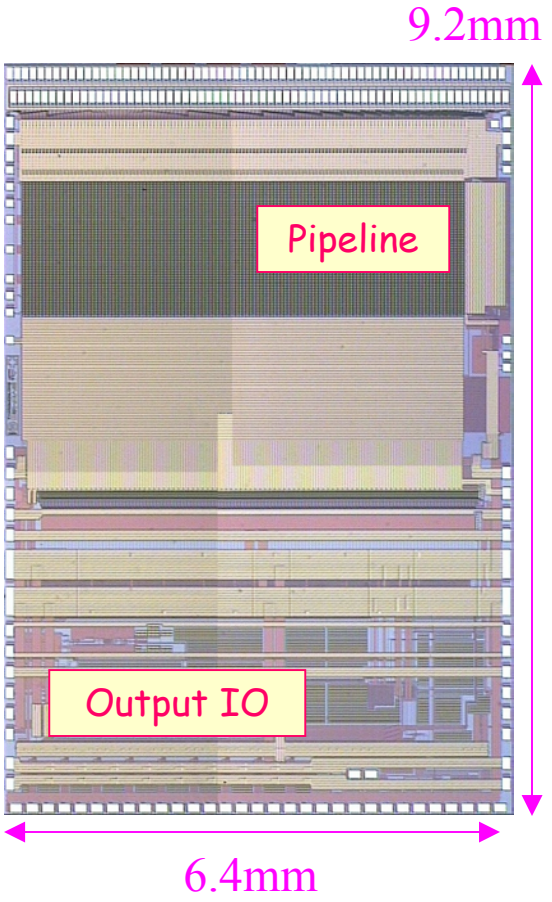
Outline

- Readout chip SVX4
- Analog cables
  - S/N, grounding issues
- Hybrids & digital cables
  - Recycling previous work
- Infrastructure
  - Need to co-exist with present SMT

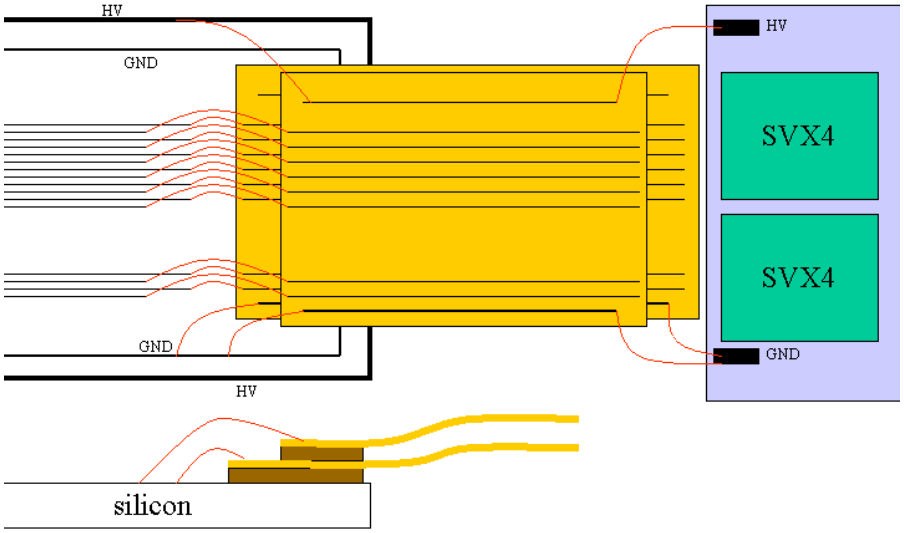
SVX4 Chip

- Fermilab and LBL developed new readout chip SVX4
  - Successor of SVX2 and SVX3 chip
  - 0.25 μm technology, intrinsically rad-hard (>30Mrad)
  - For fixed rise time (69ns): ENC ≅ 300 + 41 x C (pF)
- First version ready in June 2002
  - Fully functional chip, used for hybrid/module/full readout chain prototyping
- Second version ready in May 2003
  - Improved ADC design – good uniformity of pedestals
  - Test results all positive
  - Have enough chips for Layer 0



Analog Flex Cables

- Low mass, fine pitch cables
  - Trace width 16 um
  - Constant 91 um pitch without fan-out region
  - Two cables shifted by 45.5 um, effective pitch 45.5 um matches sensor pitch

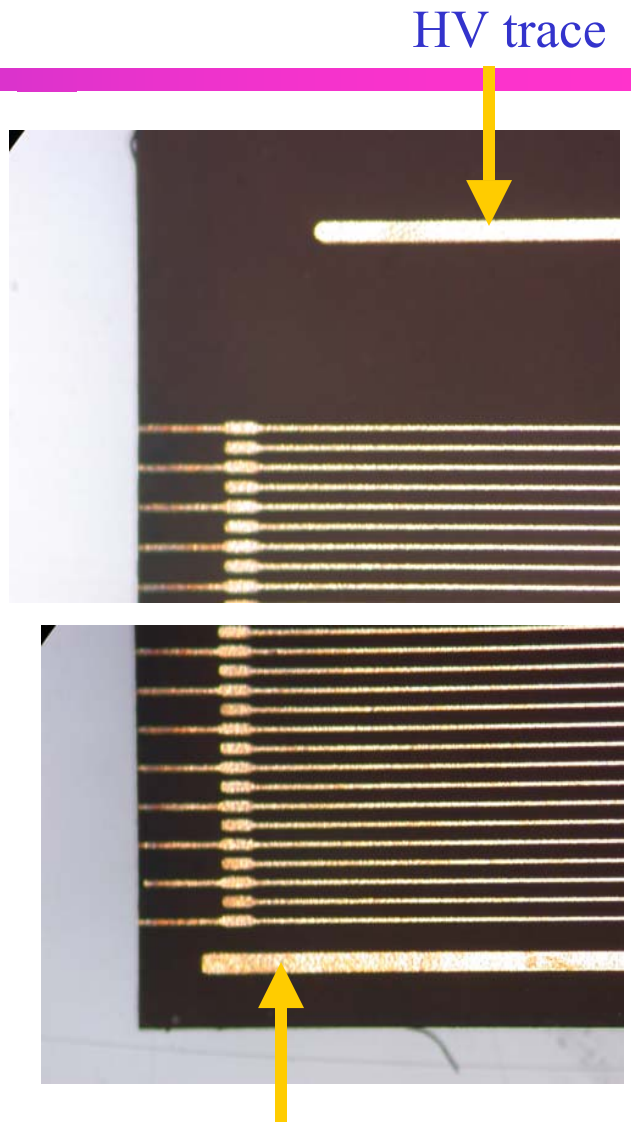


  - Fine tuning of layout needed because of different Si strip pitch
  - Going to smaller pitch on a single cable will require new prototyping phase

Analog Flex Cables

- Had several prototype runs with Dyconex (Switzerland)
  - pitch 91 um, trace width 16 um
  - Used regular etching technology
  - March 2002 : 15 mechanical grade cables + 12 good cables
  - July 2002 : 27 good cables

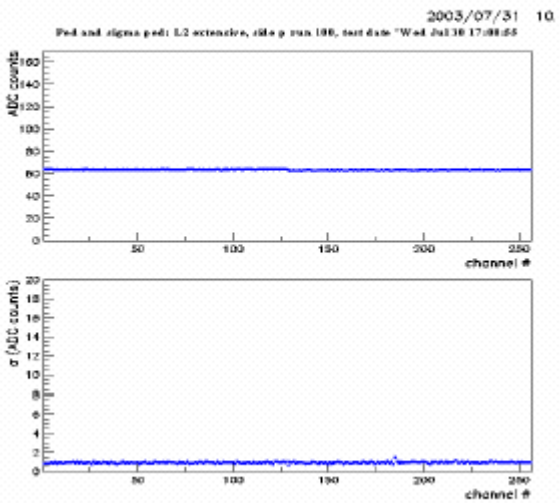
- Last run : in March 2003 received 40 cables – all good
  - C=0.35 pF/cm – in agreement with calculations



L0 hybrids

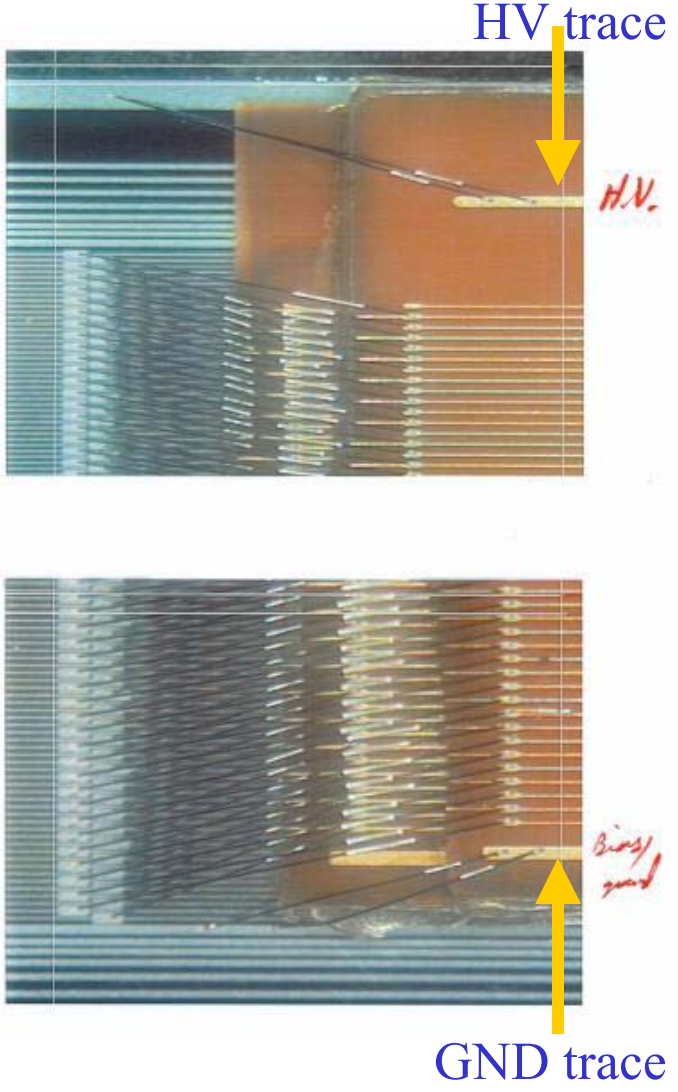
- Received 50 hybrids from Amitron in May 2003
  - Stuffed 10 hybrids
  - Used for L0 prototypes
  - Hybrids had a micro-crack in the corner – caught by vendor
- 25 Rev.2 L0 hybrids are due next week

Pedestals and Total noise

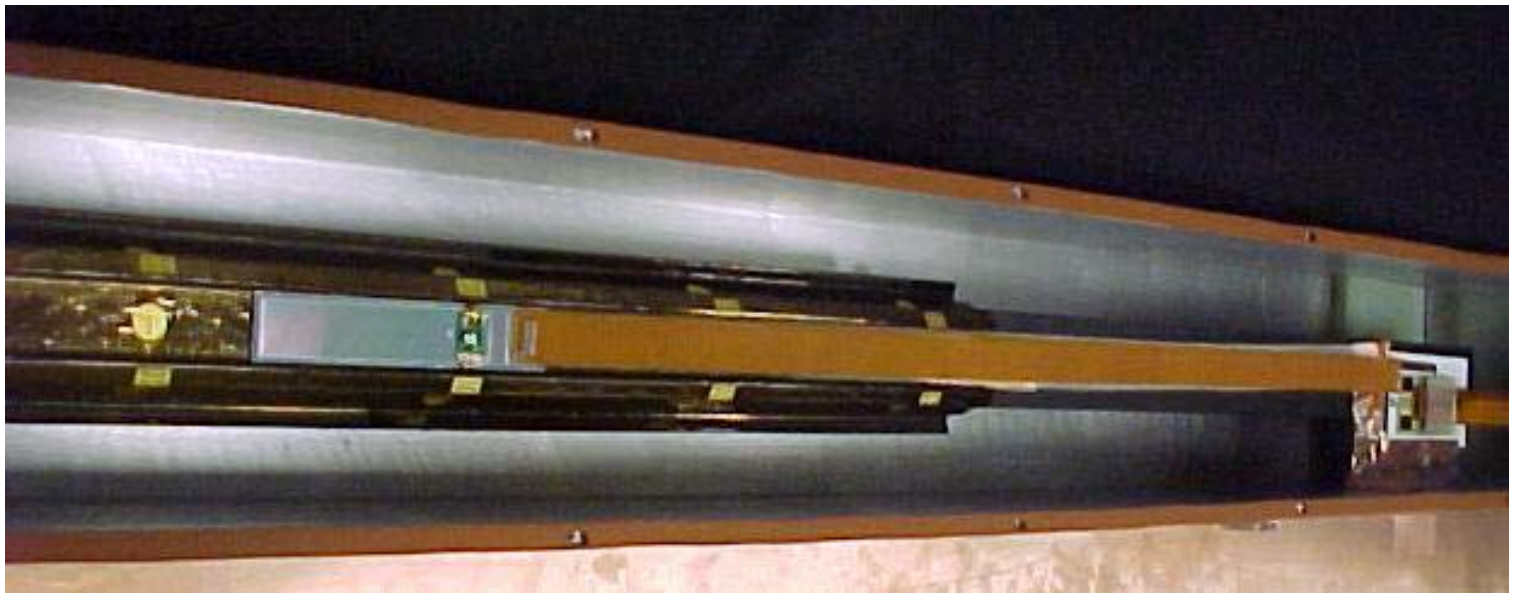


L0 module prototype

- Built 8 L0 module prototypes in 2001-2003
  - Dyconex cables
  - ELMA L0 sensors
  - Used various HDI/hybrids
- Proof of principle
  - Simpler approach works
  - Developed handling & assembly procedures
- Built L0 support structure with one L0 module
  - Grounding studies
- Plan to have several L0 modules installed on another support prototype



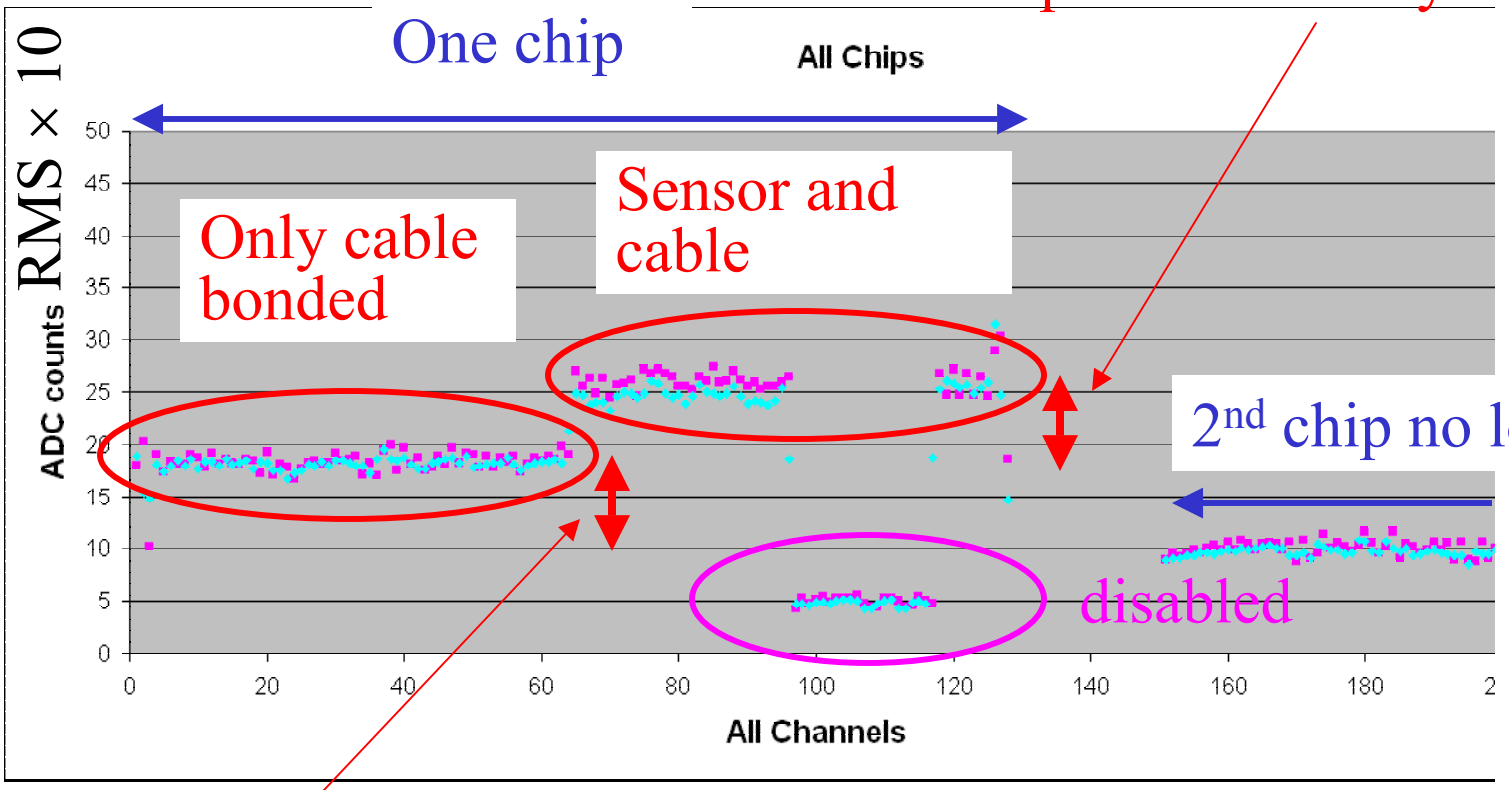
L0 module prototype



L0 module mounted on the sensor support structure

- Noise studies with L0 structure
  - Noise vs. two cables separation
  - Shielding/Grounding effects
  - Noise vs. distance to shielding

Noise perfomance

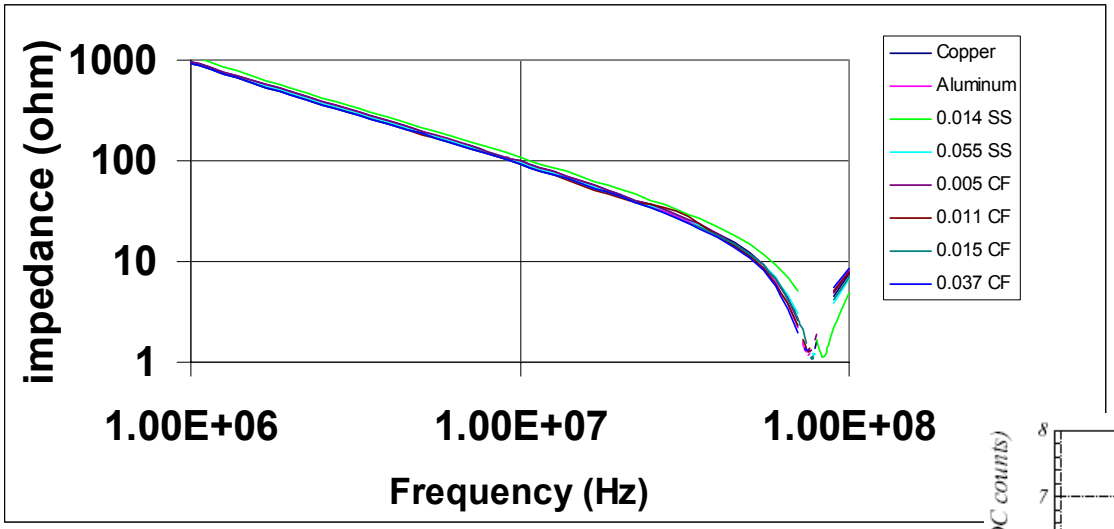


SVX4 ENC: const+41C ➔ 600e indicates C = 15pF for ~45cm

Measured S/N = 11:1, expect 14:1 with shorter cables

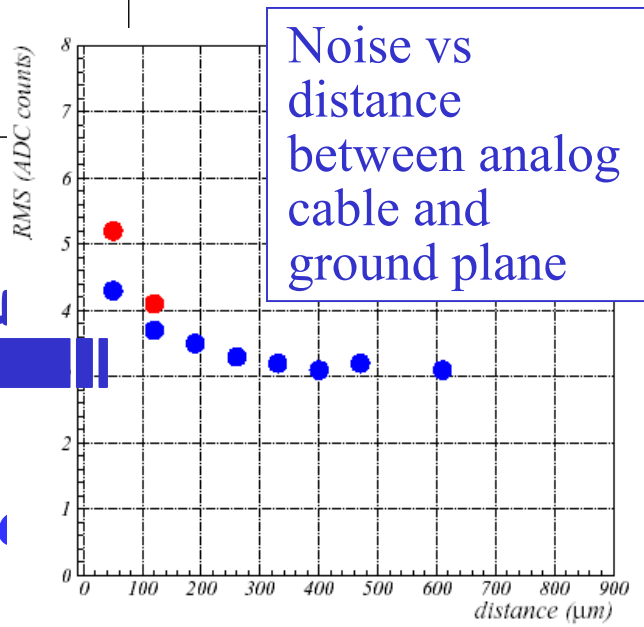
Carbon Fiber

- Carbon fiber has high conductivity



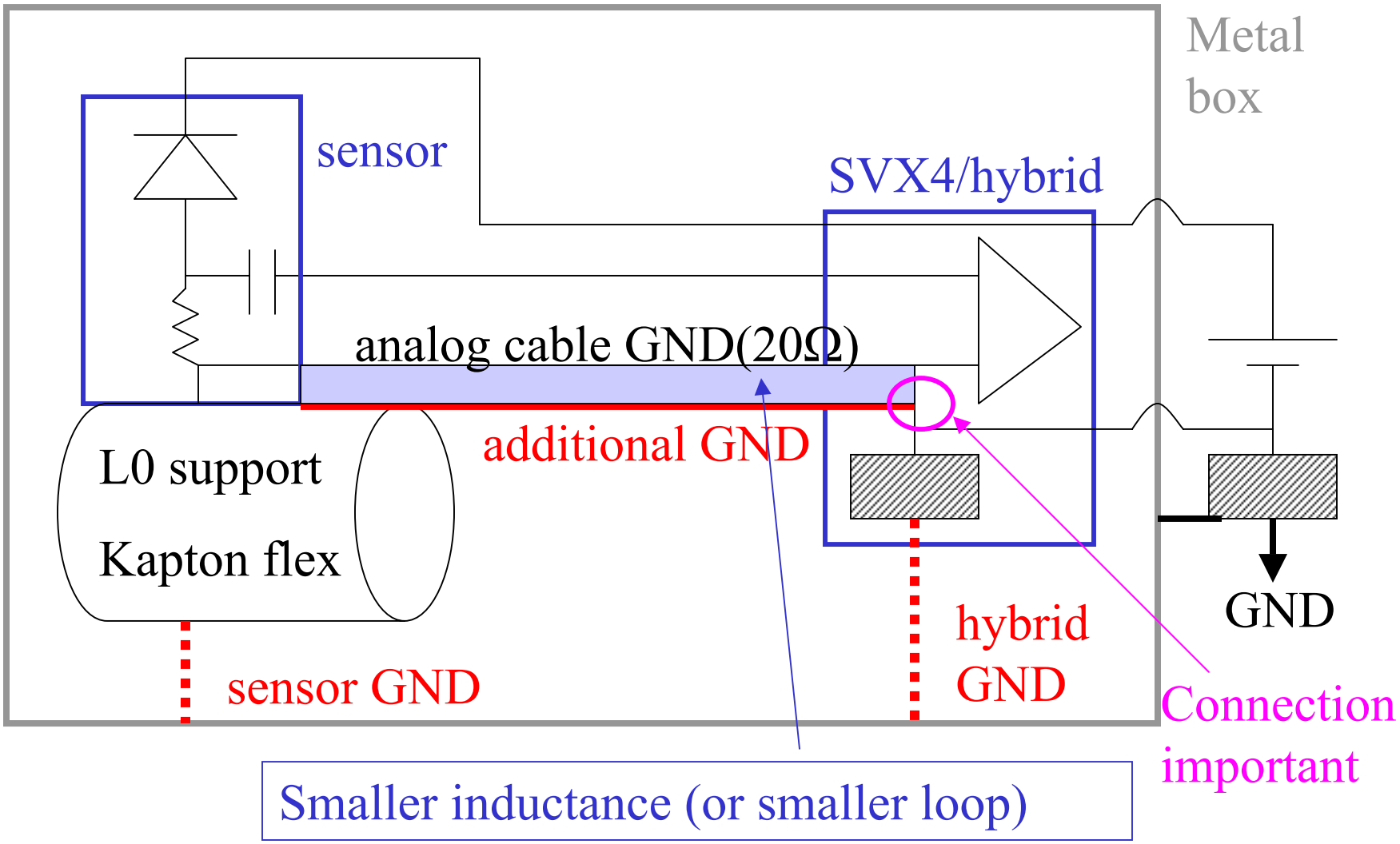
➔ Special caution needed in grounding scheme

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



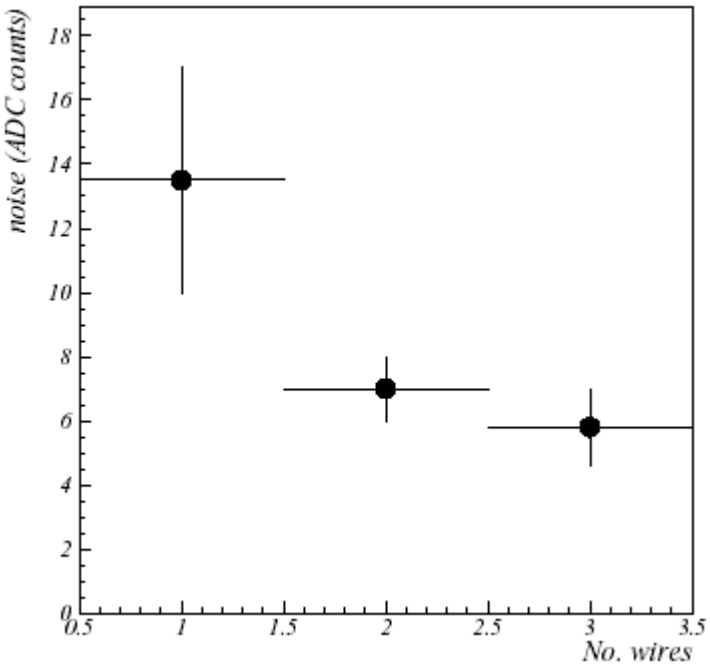
Noise vs distance between analog cable and ground plane

Grounding Study

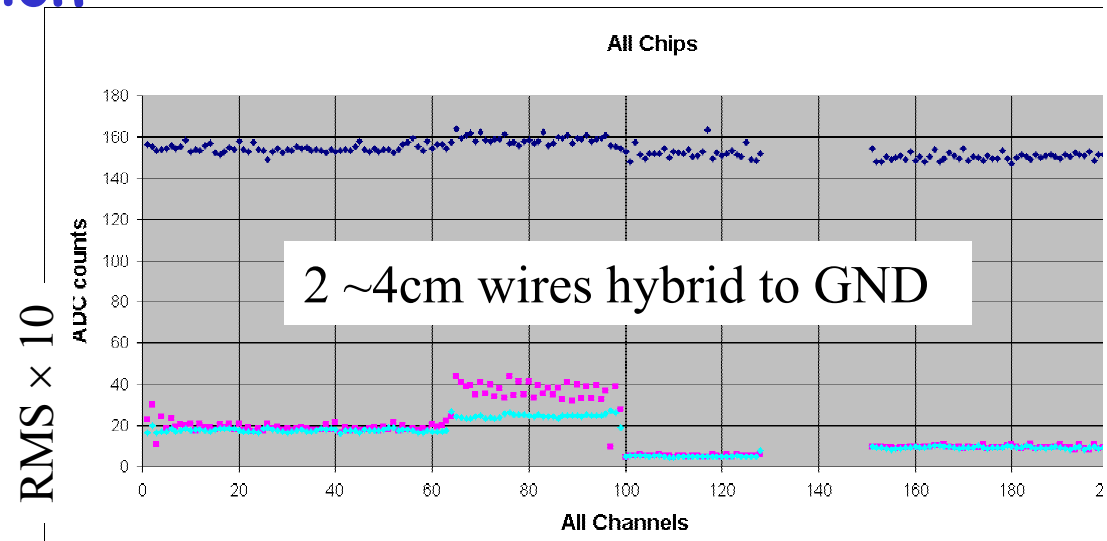


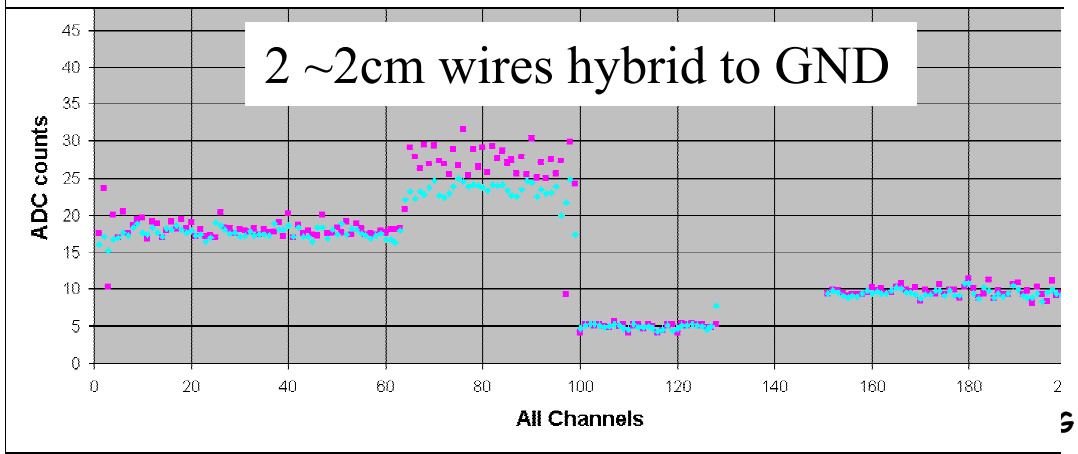
Importance of Low Inductance Connection

- In frequency range of our interests, low impedance connection is equivalent to low inductance connection



- Clearly indicates low inductance connection reduces noise

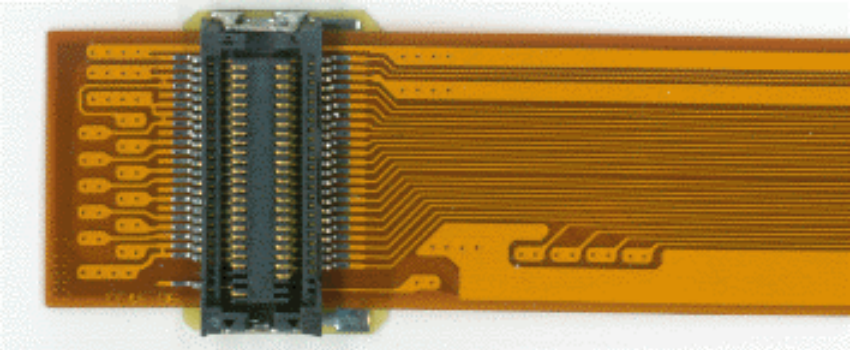




Digital Jumper Cable

Hybrid - **Jumper Cable** - Junction Card - Twisted Pair Cable – Adapter Card

- AVX connector on both sides
- Received 450 test station cables (50 cm long) and 30 longer cables (100 cm) from 3 vendors

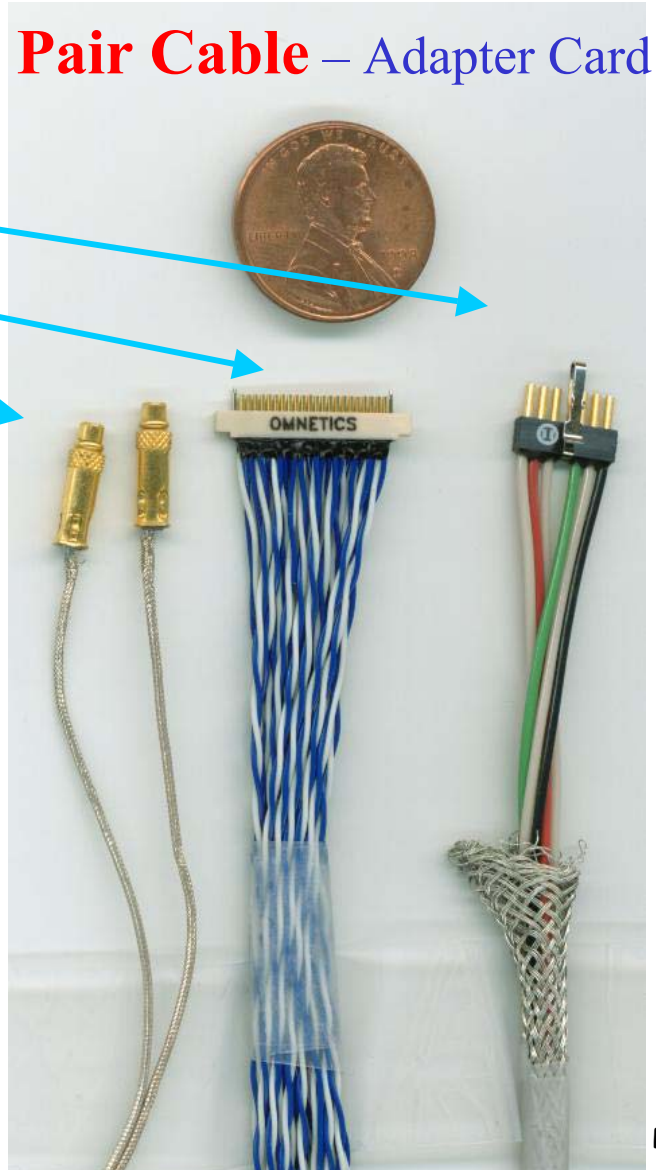


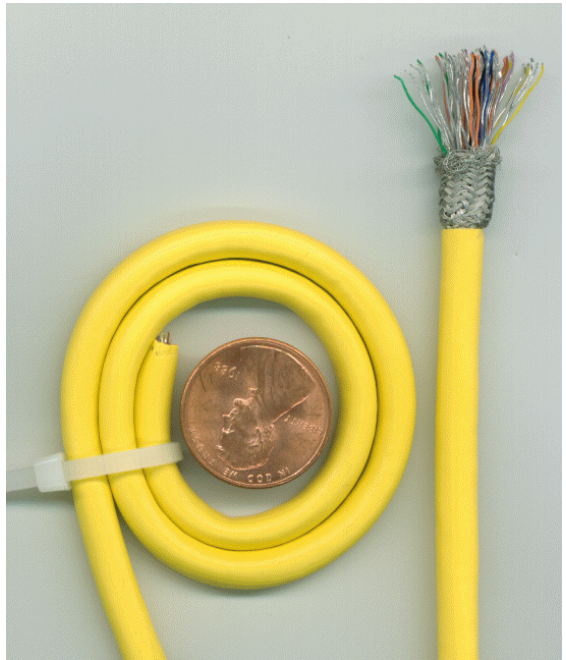
- Preferably keep same design – allows for 2 mm connector
  - Smaller connector or soldering of the cable will require changes in the design

Twisted Pair Cable

Hybrid - Jumper Cable - Junction Card - **Twisted Pair Cable** – Adapter Card

- **Consists of**
  - Power & HV lines : 6-pin Omnetics connector
  - Signal pairs : 44-pin Omnetics connector
  - Clock coaxes
- **Have 25 prototype cables in hand**

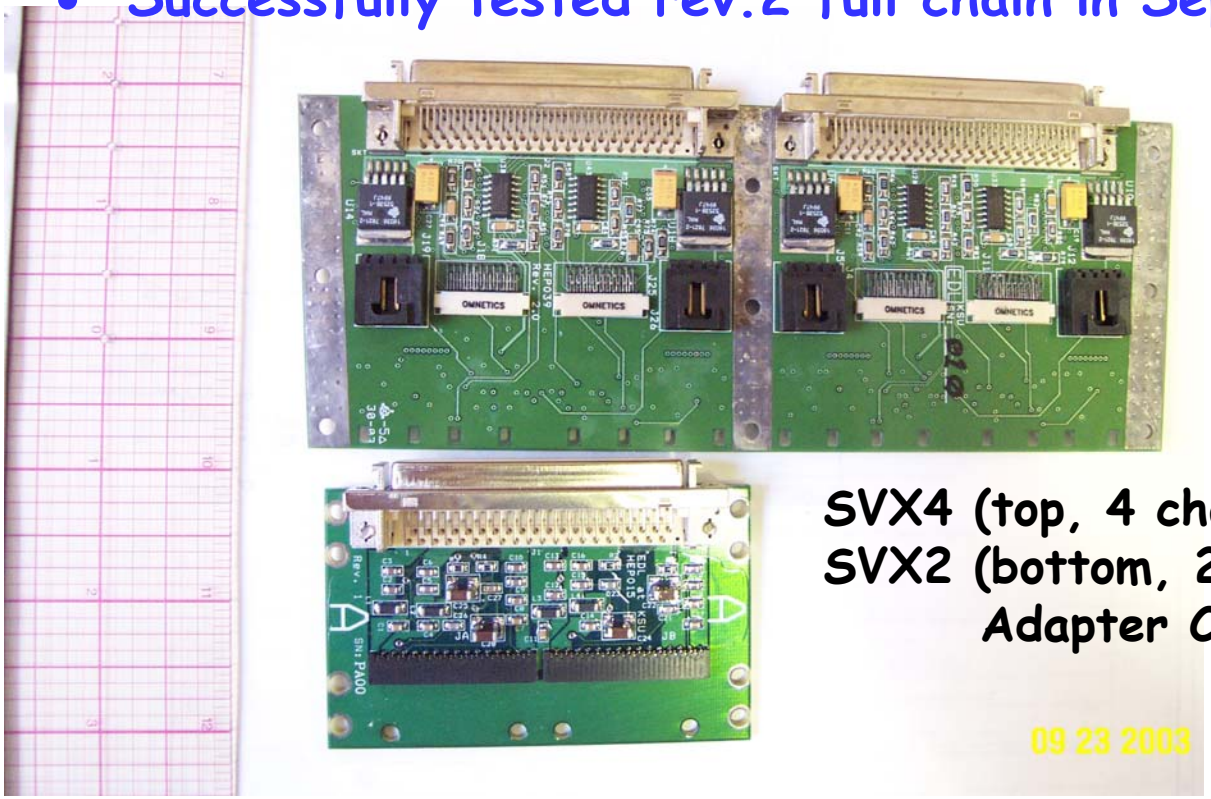




PMG

Adapter Cards

- Rev.2 Adapter Card received in August 2003
- Successfully tested rev.2 full chain in Sept 2003



SVX4 (top, 4 channels) vs
SVX2 (bottom, 2 channels)
Adapter Card

- Discussing option to float ground of AC to prevent South-North ground loops
  - Considerable redesign of AC and infrastructure

Test Stands

- Production test stands with Purple Card and SASEQ
  - Setup completed
  - Enough for Layer 0
- Full chain tests with SASEQ
  - Done lots of measurements for rev.2 prototypes
  - Error free readout of 5 M events achieved
- 1% test stand : full copy of the real readout chain
  - Infrastructure up and running
  - Firmware changes completed
  - Error free readout of ~100k
  - Can be extended to test full Layer 0 at Sidet

Infrastructure

- Logistics of mixed (SVX2+SVX4) readout
  - Remove H-disks to create free readout chains
  - SVX4 and SVX2 will need to co-exist in one Sequencer crate
    - Handled by Sequencer Controller firmware
- Low Voltage
  - New Adapter Card
    - Receives 3 voltages via 80-conductor cable using the same lines as old AC
    - Has voltage regulation
  - Currents are small
  - => can use SVX2 voltages for SVX4 and new AC : possibly no mods are needed – being investigated
- High Voltage
  - If HV expectations are below 300 V can use the same HV path as for H disks – no mods are needed – being investigated
- In any scenario small number of channels gives flexibility – can be implemented different ways

Summary

- Taken decision to use SVX4
- Developed working prototypes of modules with analog cables
  - Manufacturable
  - Good S/N
- Trying to use existing parts and experience as much as possible
  - Almost no time for new prototypes
- Readout infrastructure can be handled in different ways
  - Keep it simple