Layer0 Module PRR

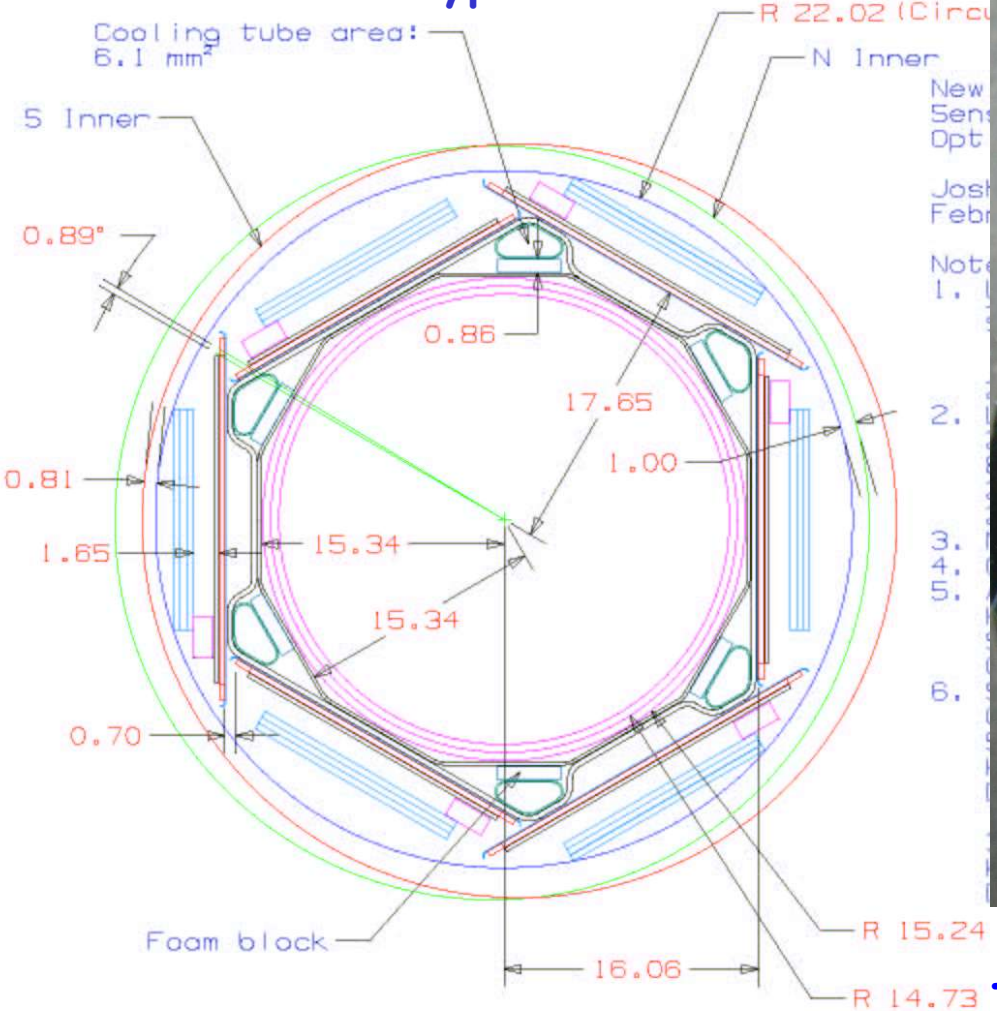
Andrei Nomerotski 11/24/2004

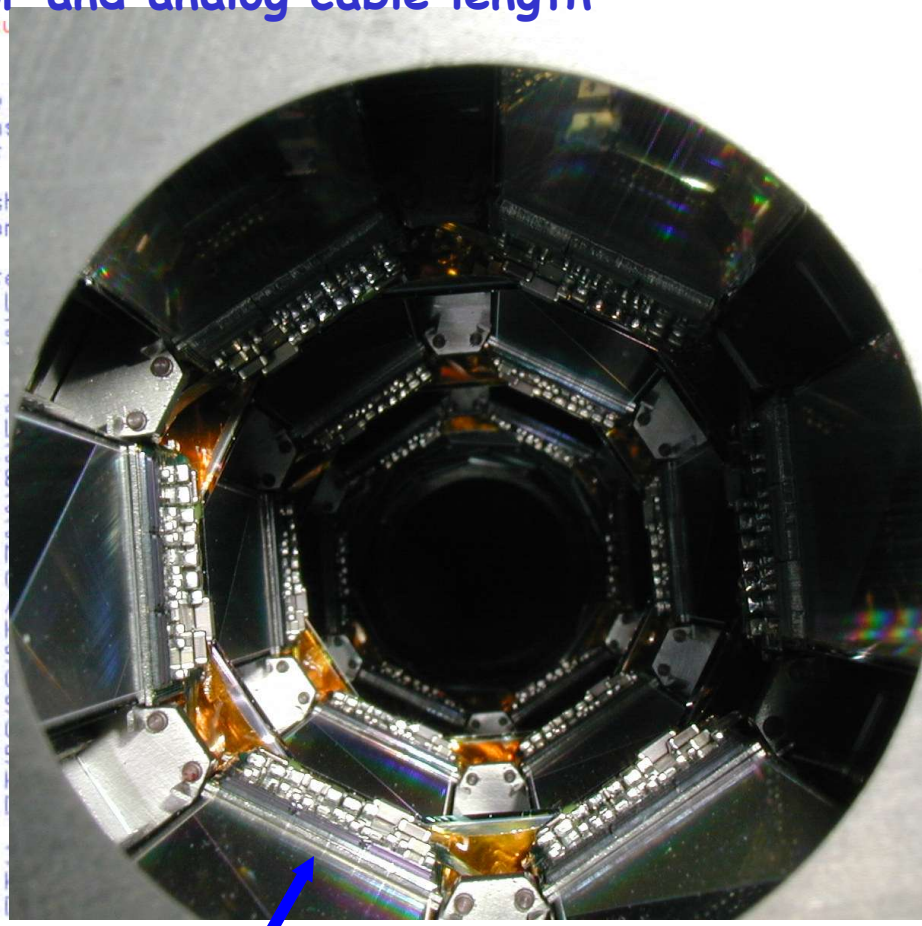
Outline

- L0 modules
  - History
  - Design
  - Prototypes
- Production Parts
  - Sensors
  - Pitch Adapters
  - Analog Cables/Spacers
  - Hybrids
- Schedule
- Summary

Layout of Layer0

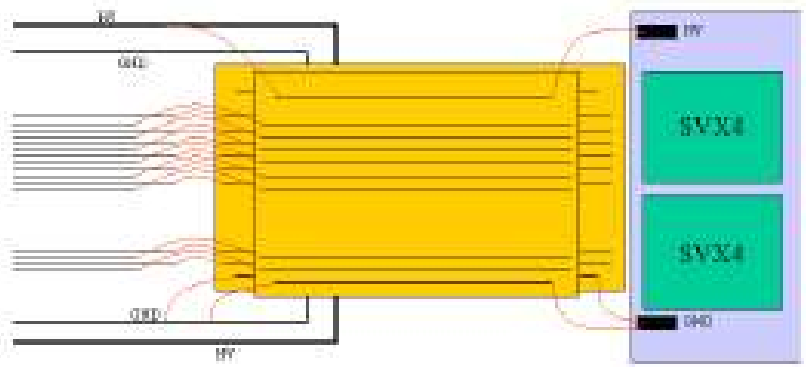
- 6-fold symmetry, total 48 modules, 96 SVX4 readout chips
- 8 module types different in sensor and analog cable length



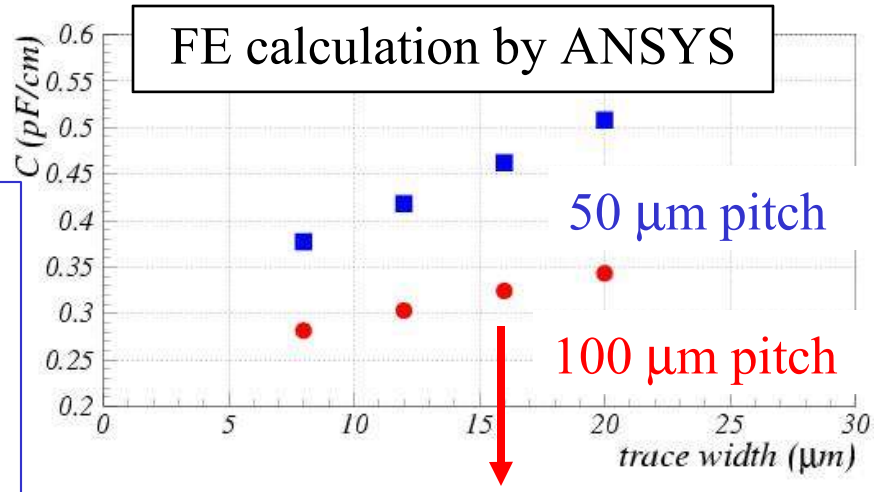


Inside SMT

Concept of Module with Analog Cable



- 91μm trace pitch.
- 16μm trace width.
- Two cables laminated with 45μm offset.
- 50 μm thick Kapton substrate.



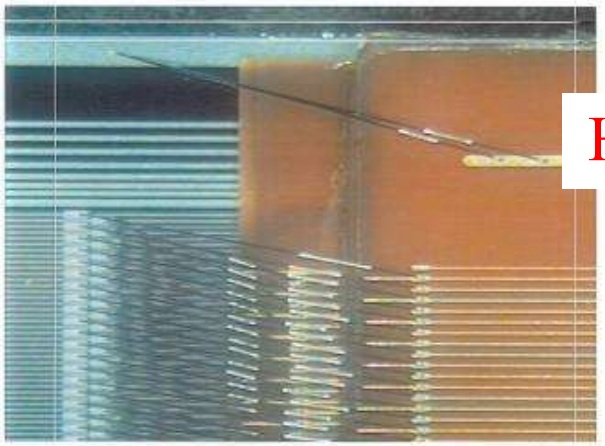
16 μm wide trace with ~100μm pitch gives adequate capacitance

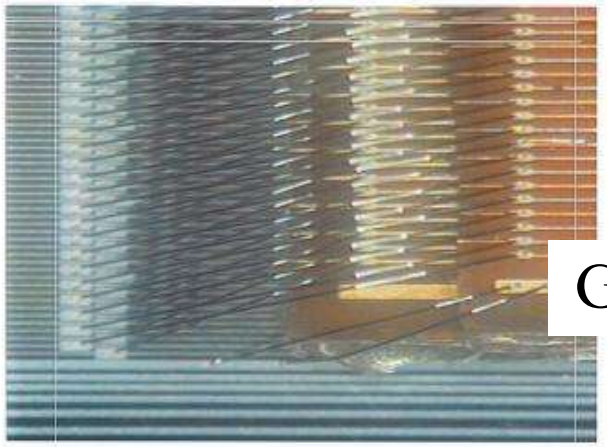
Adopted design with double-deck analog cable

History

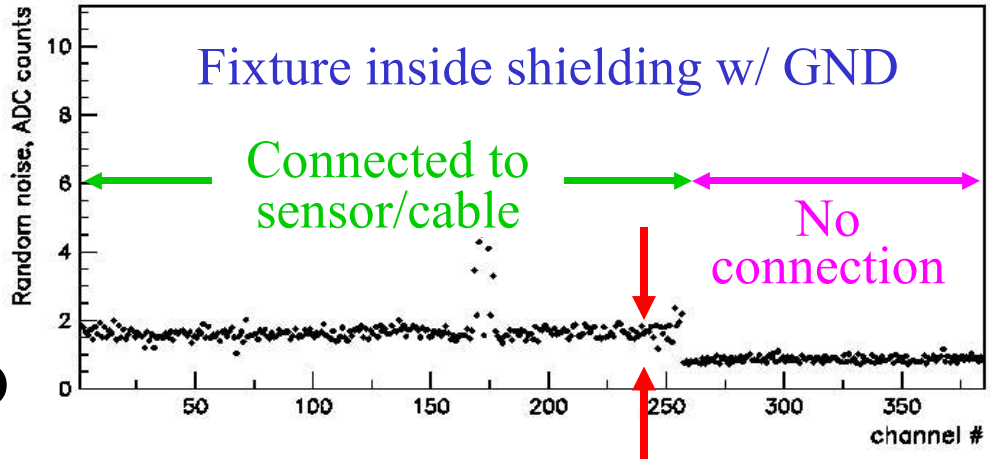
- Milestones of module prototyping
  - April 2002, 1st prototype
    - CDF L00 sensor + CDF L00 analog cable + SVX2 HDI
    - Learnt about importance of grounding..
  - June 2002, 2nd prototype
    - ELMA sensor + double analog cable + SVX2 HDI
    - Tested double-deck analog cable design
  - Sept 2002, 4th prototype
    - L1 hybrid with 4 SVX4 chips
    - Tested SVX4 performance with analog cable
    - Developed grounding procedure
  - June 2003, 7th prototype
    - 2-chip L0 hybrid
  - April 2004, tested four L0 modules at Run2B support structure
    - Validated grounding scheme with laminated meshes

L0 Prototype with SVX2





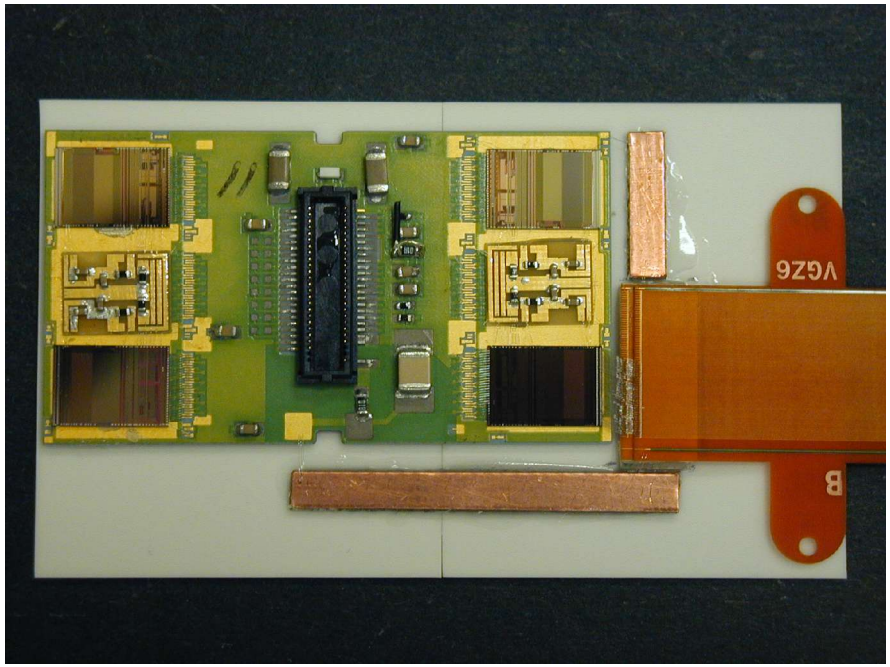
- Dyconex analog cable + ELMA prototype sensor + SVX2 chip
- Noise increase ~ 1000 e ← consistent with

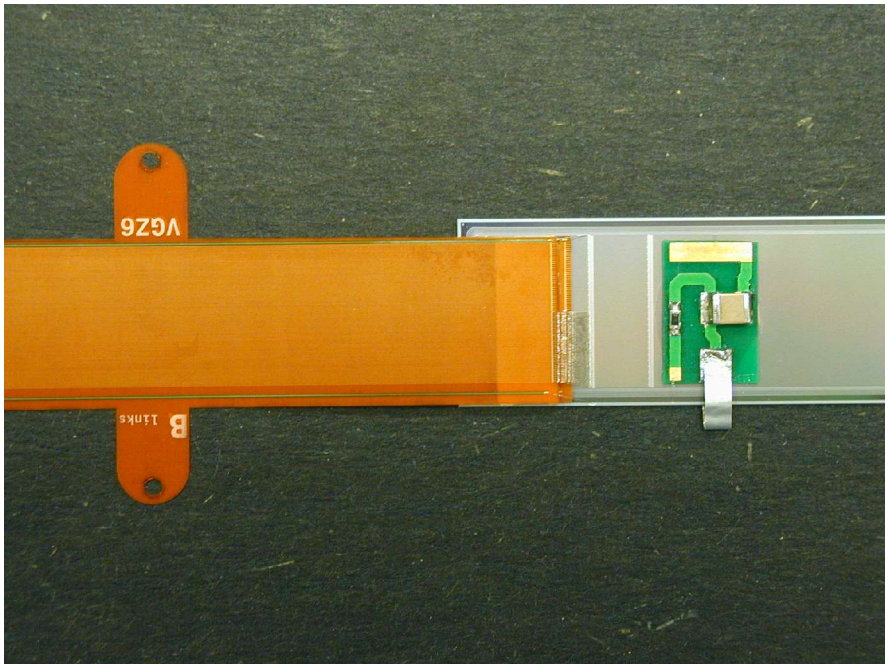


Noise increase due to capacitive load

L0 Prototype with SVX4

- First prototype using new SVX4 chip.
  - Large capacitive load
  - Long analog cable ← signal transmission
- L1 prototype hybrid with SVX4.



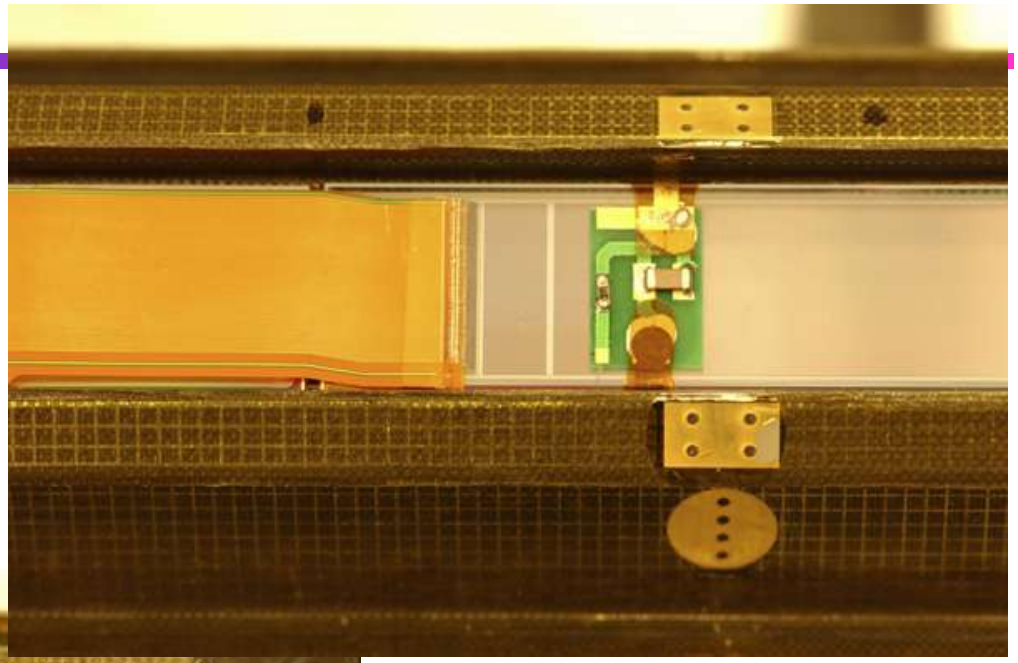


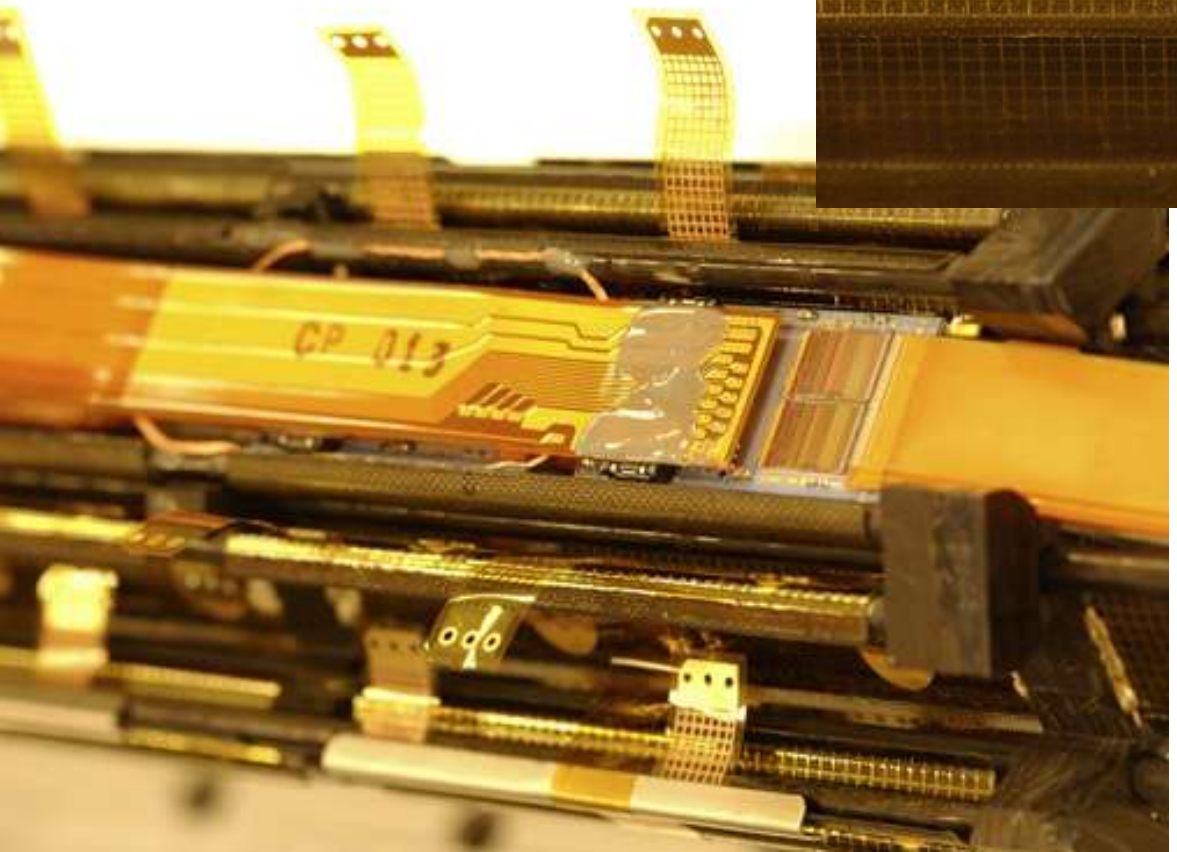
L0 Run2B Support Structure

Implements new grounding approach : laminated ground mesh covering all surface – crucial design feature ensuring low inductance path for GND and hence low noise

L0 Module on Support Structure

Sensor region →



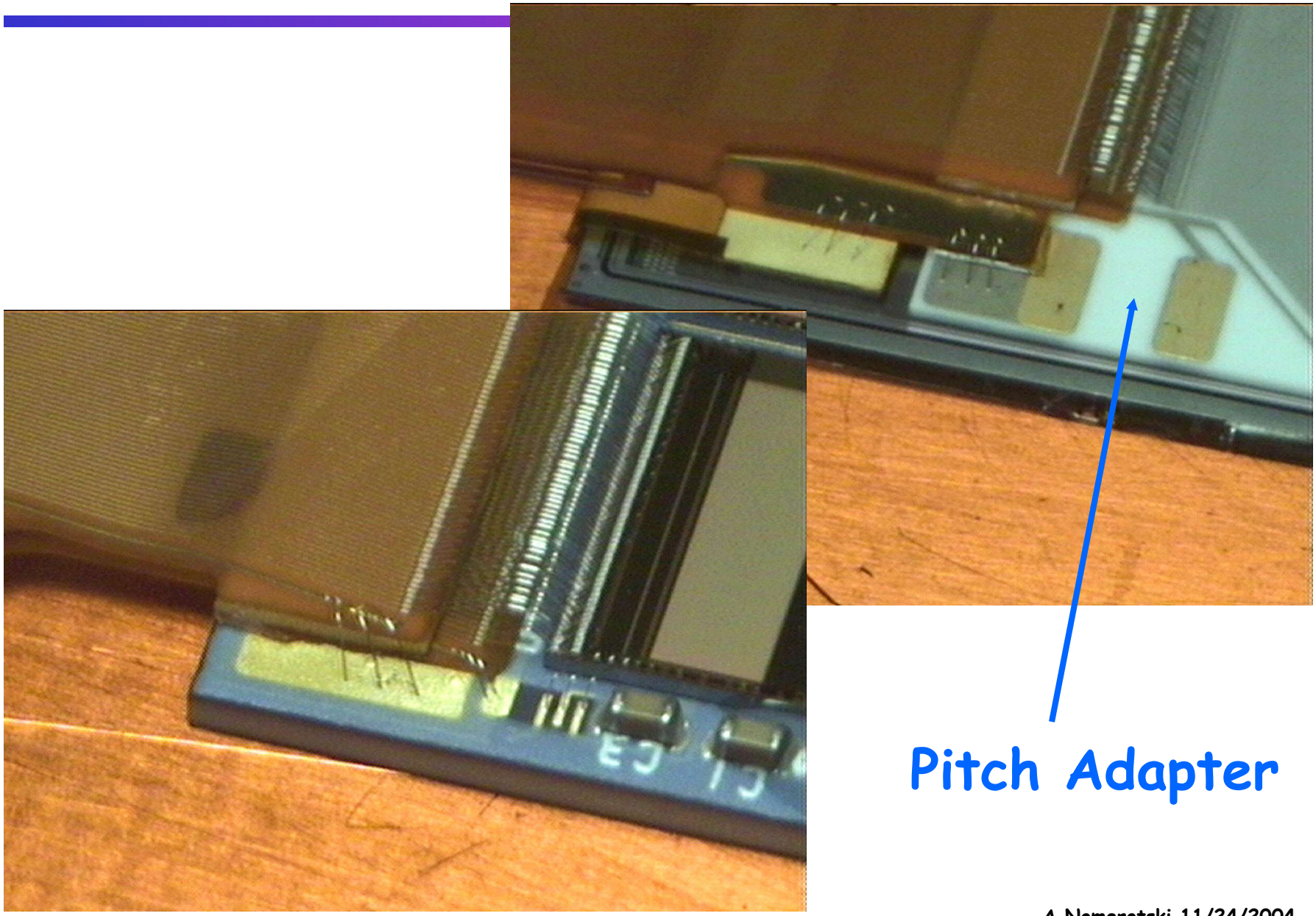


← Hybrid region

Towards Layer0 Production

- Nov 2003 : Run2B project → Layer0 project
- Kept the same concept but
- Adapted design to new L0 mechanical constraints
  - Larger sensor strip pitch : 71 and 81 um
  - Added Pitch Adapter between sensor and analog cable
    - Also replaces filtering board
  - Fan-out region on analog cable, hybrid side
- All changes were not significant and we had full confidence that previous results apply to new design
- Skipped prototyping (except pitch adapter) to order production parts
  - Sensor, Hybrid and Analog cable PRRs in beginning of 2004
- Built and tested more prototypes with production parts
  - By now have 10 new style prototypes

New Layer0 Prototype

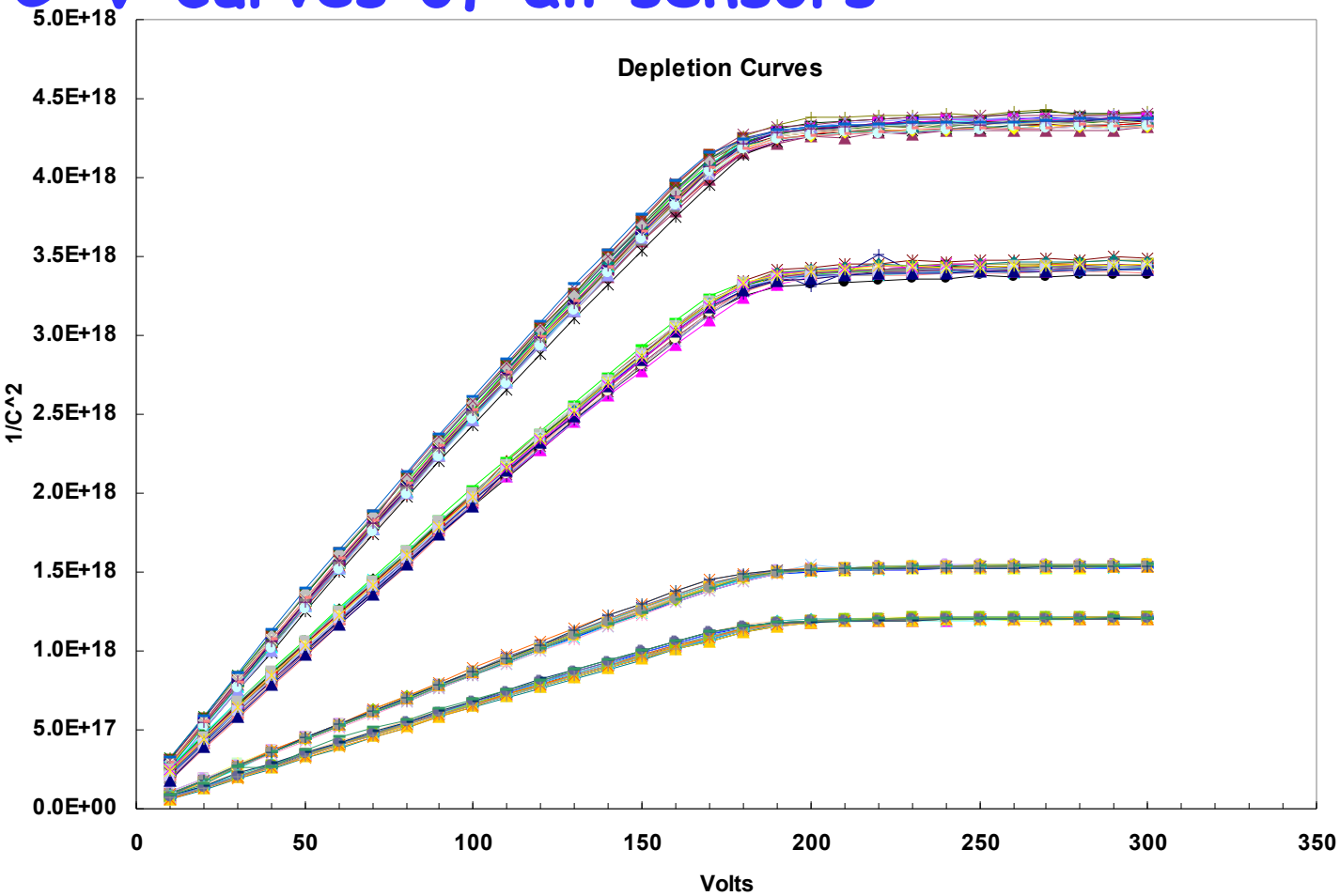


Sensors

- Pitch 71/81 micron, intermediate strip, 70/120 mm long: four types
- Ordered from HM 120 sensors (4 x 30) in March 2004
- Received 112 in July and 8 in November 2004
- All IV, CV tested at Fermilab
  - 3 out of spec due to large $\Delta I/\Delta V$ - used for prototypes
- Only one(!) bad strip – pinhole on one of last 8 sensors
  - Out of 120 x 256 = 30720 strips
  - spec 1%
- Four sensors fully probed at Stony Brook
  - Results consistent with HM
- One sensor and some test structures irradiated at KSU
  - Currently being tested at Stony Brook, have done it before for Run2B sensors

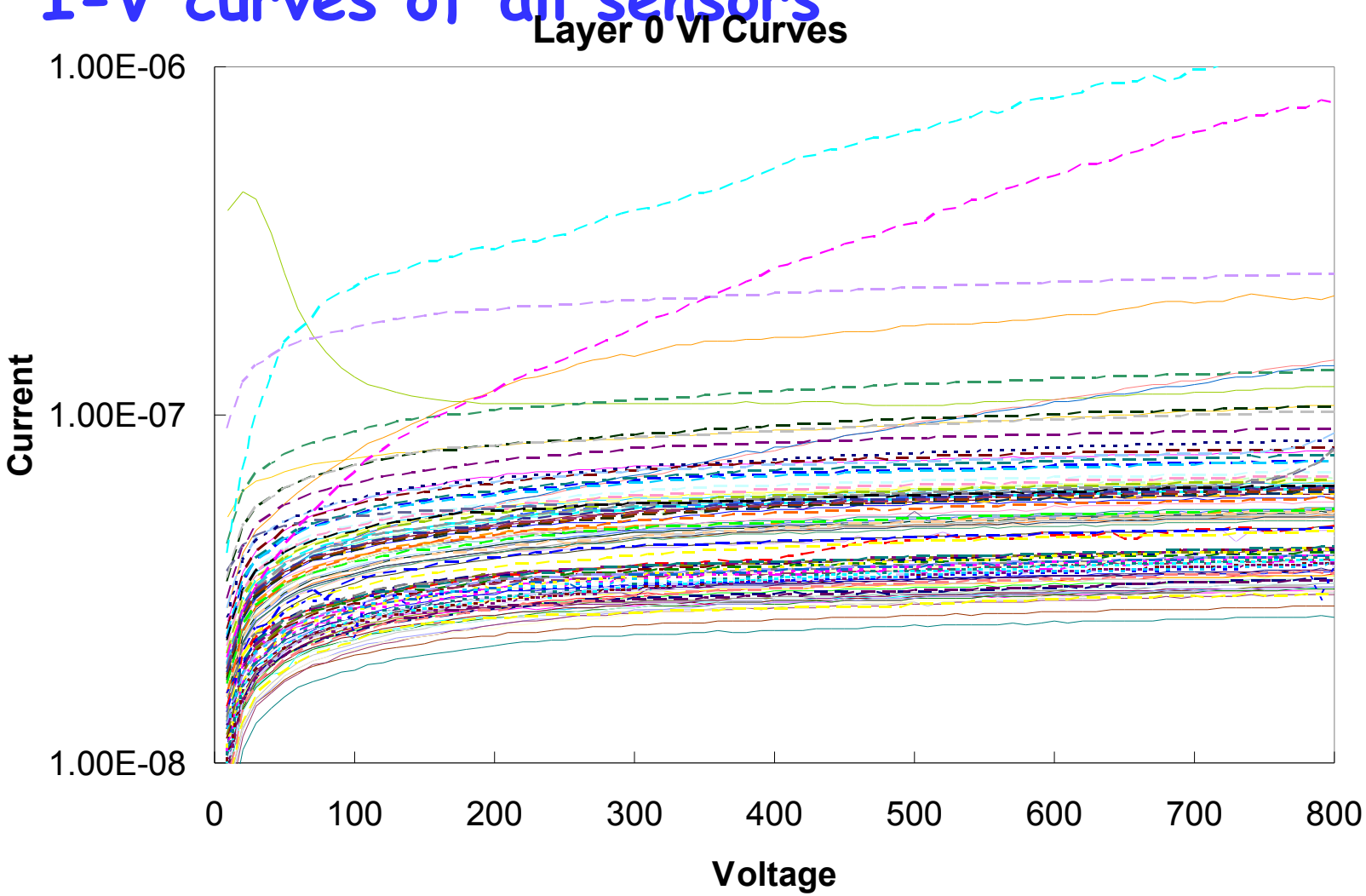
Sensors

- Sensors look remarkably good
- C-V curves of all sensors



Sensors

I-V curves of all sensors

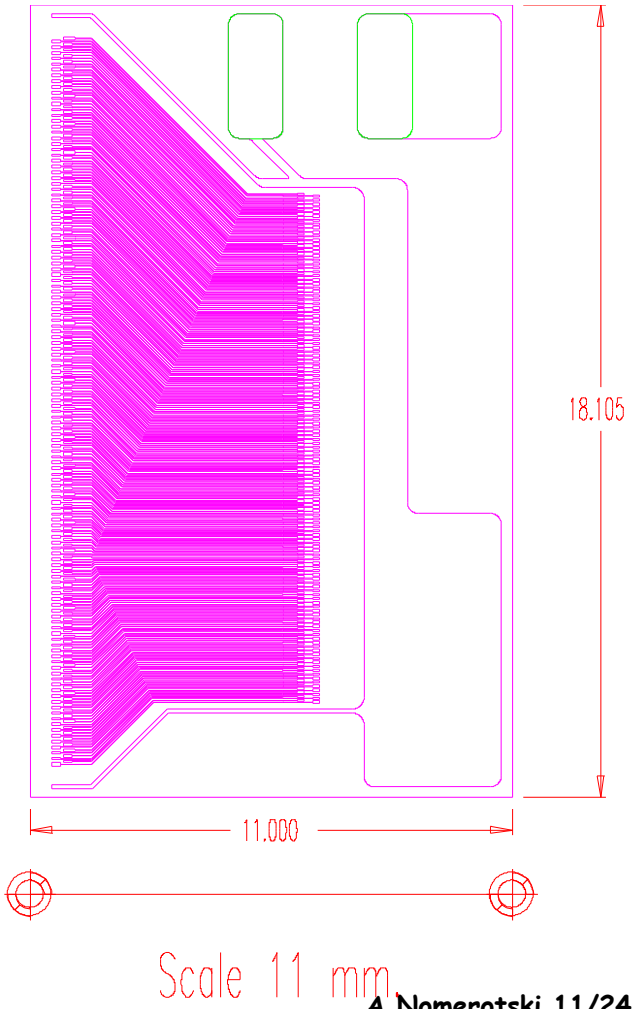


Pitch Adapter

- Pitch Adapter was a new feature on modules
  - Two types, typically ordered 2 x 50 parts
- February 2004, ordered from Thin Film Concepts
  - Used previously by CDF
  - Poor pulls strengths (2-3 grams and many no-sticks)
- May 2004, ordered from Thin Film Technology
  - Better initial bondability, but had uneven etching quality and a number of open or shorted traces
- June 2004, ordered parts from TFT Seigert
  - Used by LHC-b
  - Satisfactory bond strength (6.8+/- 0.8 g) and etching quality
  - Received in October 2004
  - Will be used for production

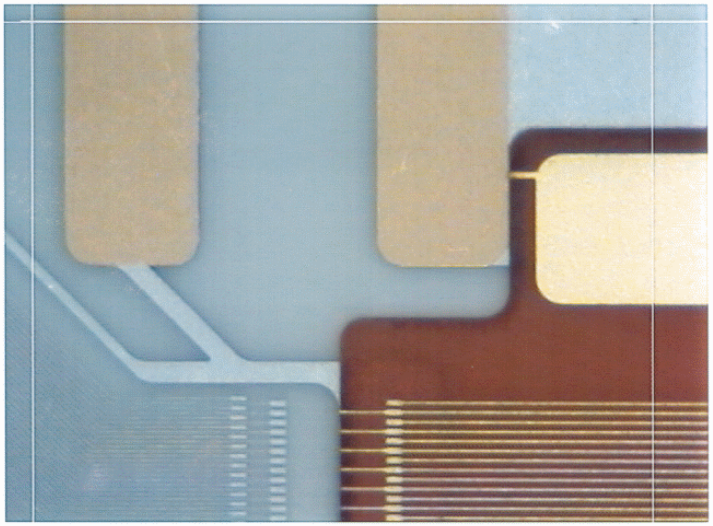
Pitch Adapter

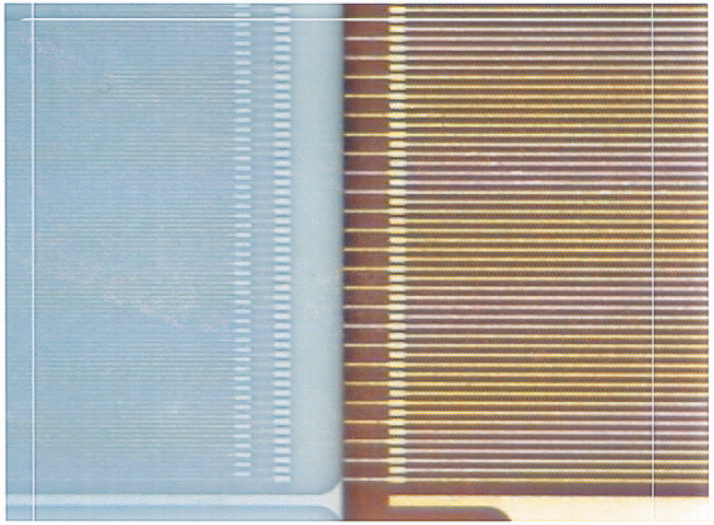
- Another vendor (Advanced Thin Film Products) provided samples with very good pull strengths
  - ordering some as R&D
- Testing
  - Visual inspection
  - Mechanical measurement at KU



Pitch Adapter

- Bottom analog cable glued to pitch adapter



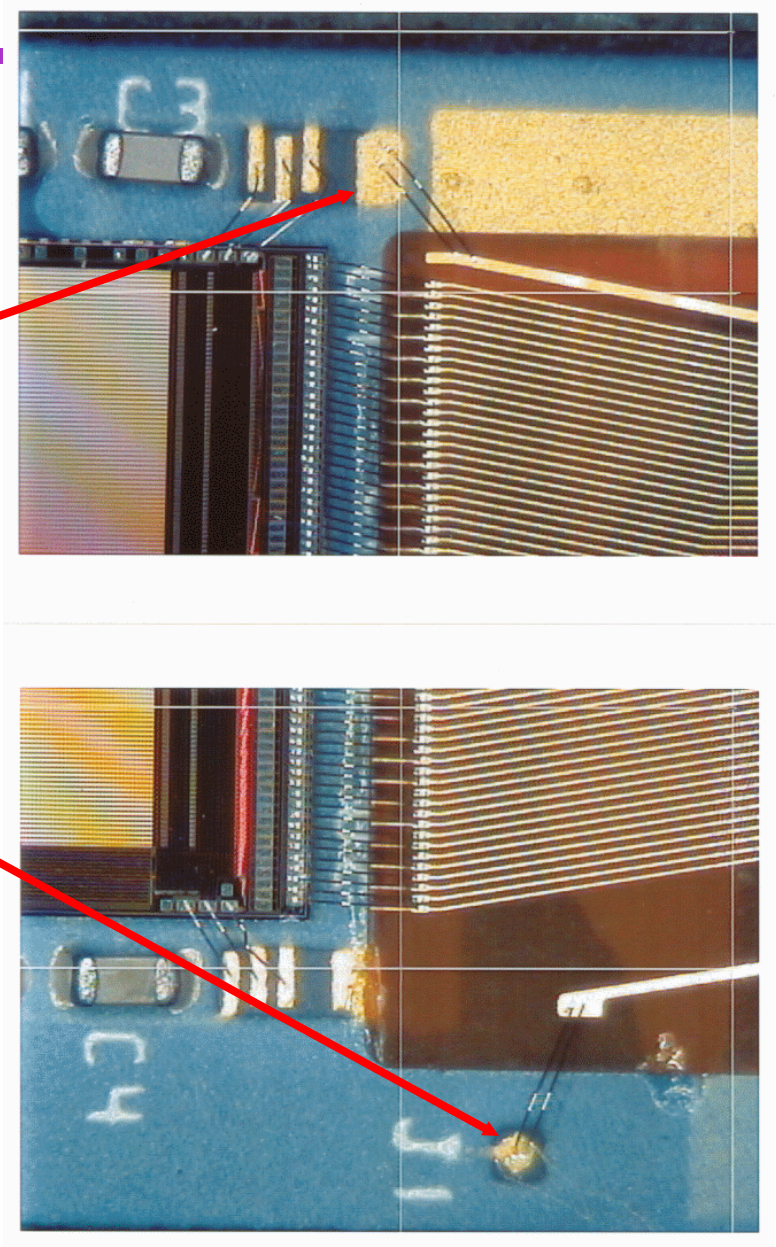


Analog Cable

- Considered high risk item – was ordered in March 2004
  - Total 200 cables
- Produced at Dyconex (Switzerland), delivered in July 2004
- Testing : visual inspection – no bad channels
- Have 8 types of cables (4 pairs different in length), 128 lines per cable

Analog Cable

- Bottom cable bonded to SVX4 chips
- Ground connection
- HV connection



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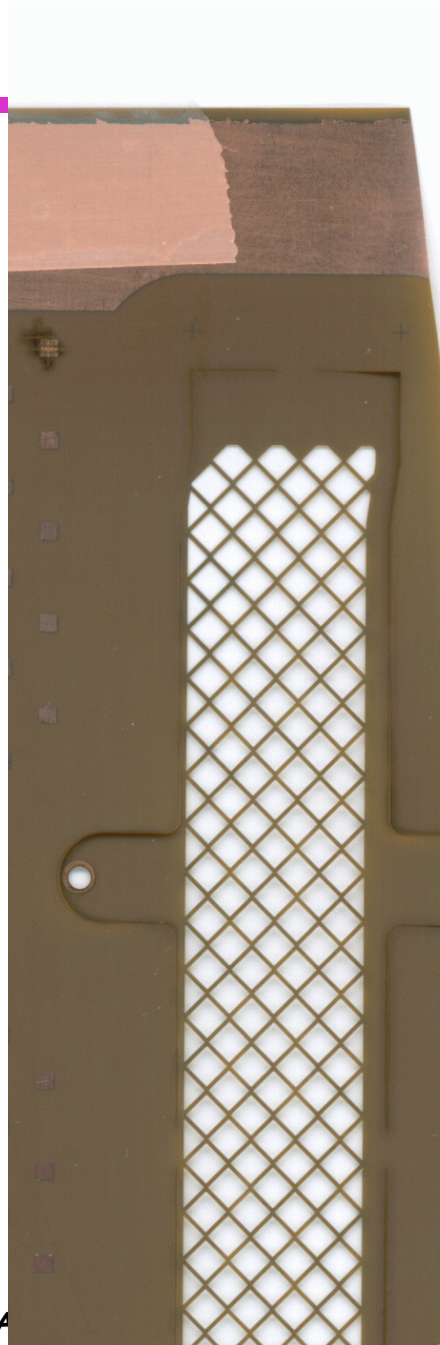
Spacers

- 75 micron thick kapton spacer between two cables to reduce capacitive coupling
- Initially ordered from Compunetics (as shown) then found a cheaper vendor
- Have enough for production



Hybrid

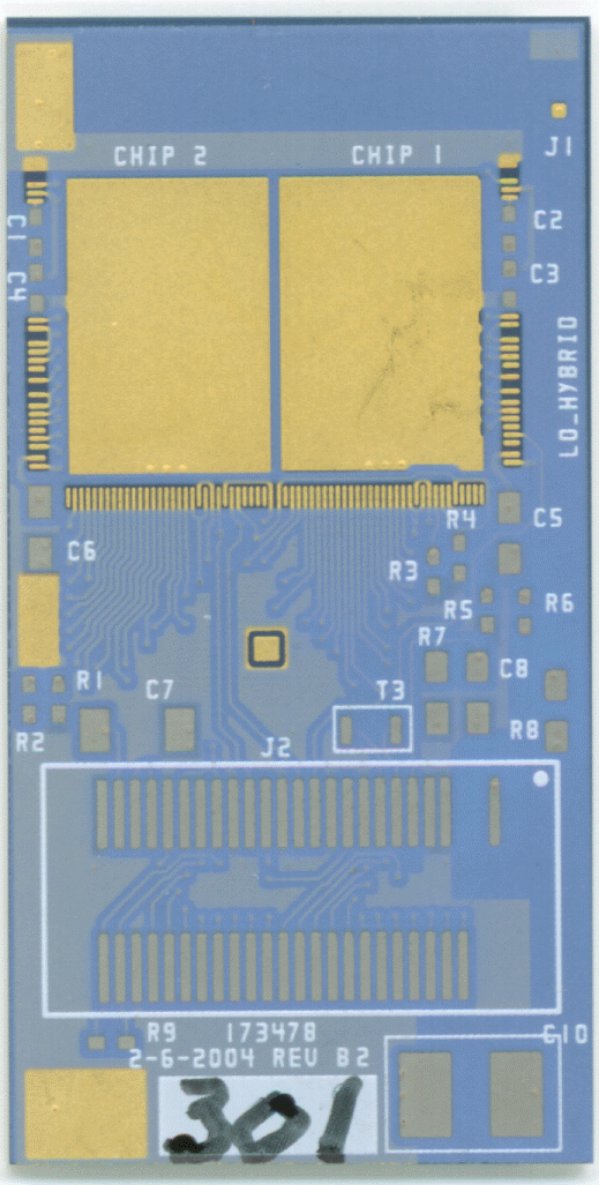
- Revision 3 hybrid
- Ordered 125 in April 2004 from Amitron
- Received 119 in September 2004
  - 70 "in spec"
  - 49 "out of spec"
    - Cutoff edge off by 200 micron
    - Could be used with modified fixtures
- Mechanical tests at Fermilab and KU
  - Dimensions OK (apart from misplaced cut line at 49 "out of spec" hybrids)
  - Flatness < 80 micron (spec 150 um)
  - Thickness < 800 micron (spec 850 um)
- Electrically all hybrids are OK

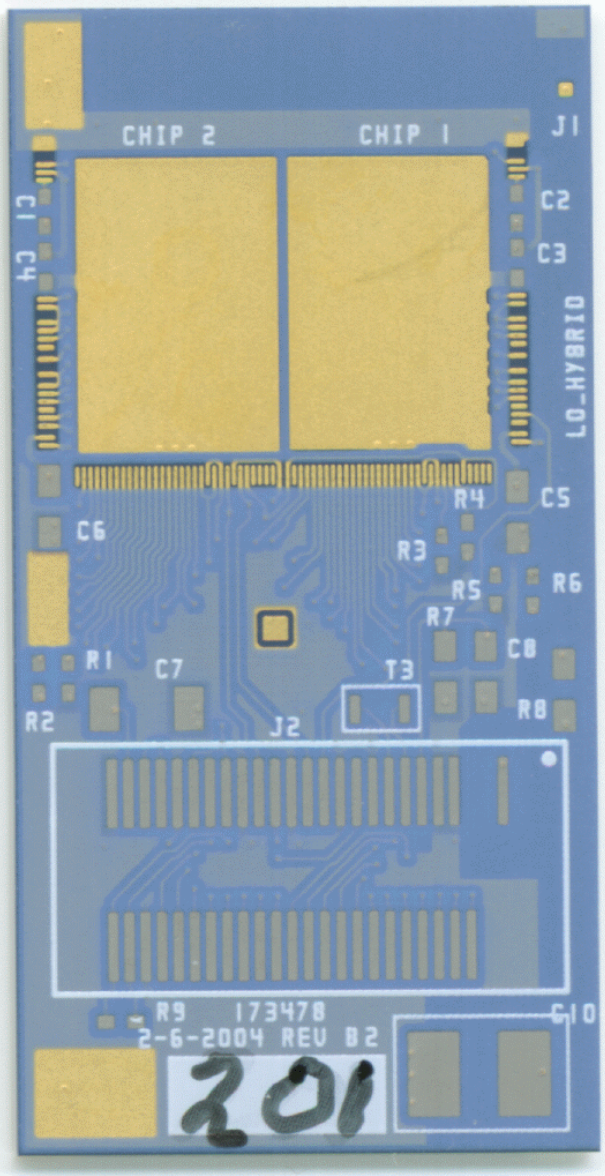
Hybrid

- So far assembled and tested 20 hybrids
  - 10 at Fermilab
  - 10 at NXGen
    - Two batches 5 hybrids each to verify procedures
      - Ordered second small batch because first batch had two wrong resistors per hybrid
    - Shipped around without any issues
  - Good performance
  - 100% yield (is expected) after resoldering of resistors at 6 NXGen hybrids
- First large batch of 36 has been assembled at NXGen and currently is at Fresno
  - First 5 hybrids tested ok
- Remaining hybrids will be assembled shortly after tests of this batch

Hybrid

- Top side





Hybrid

- Back side

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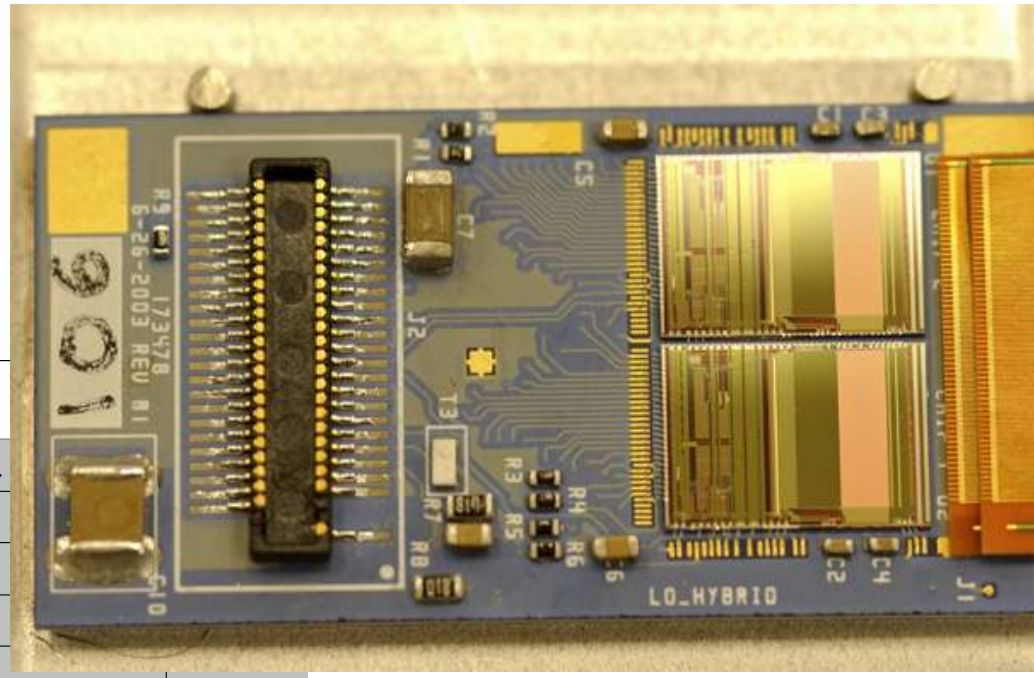
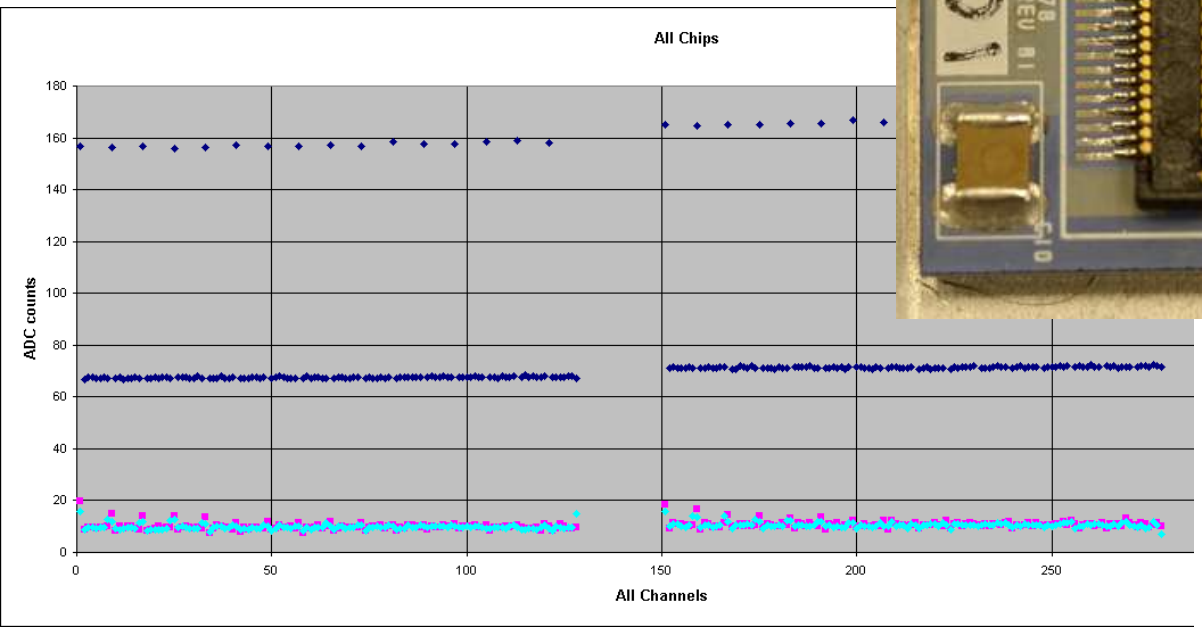
Hybrid

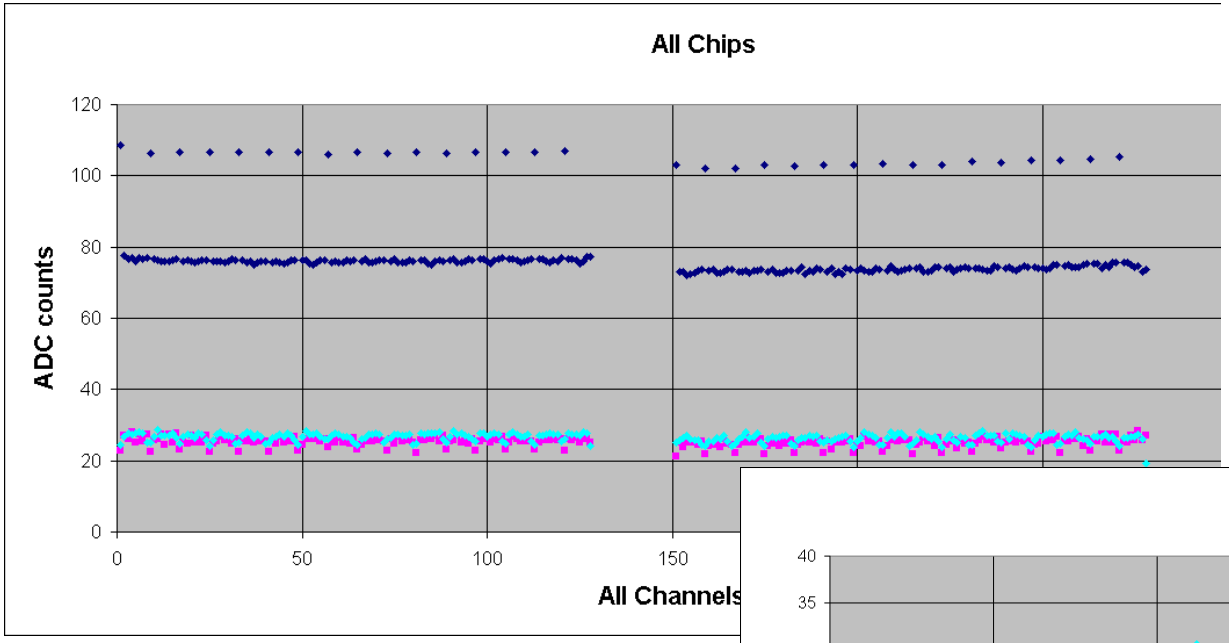
- Test results are good
  - Noise 1 ADC count
  - Flat pedestals
  - Plot below shows
    - Calinjects
    - Total & differential noise

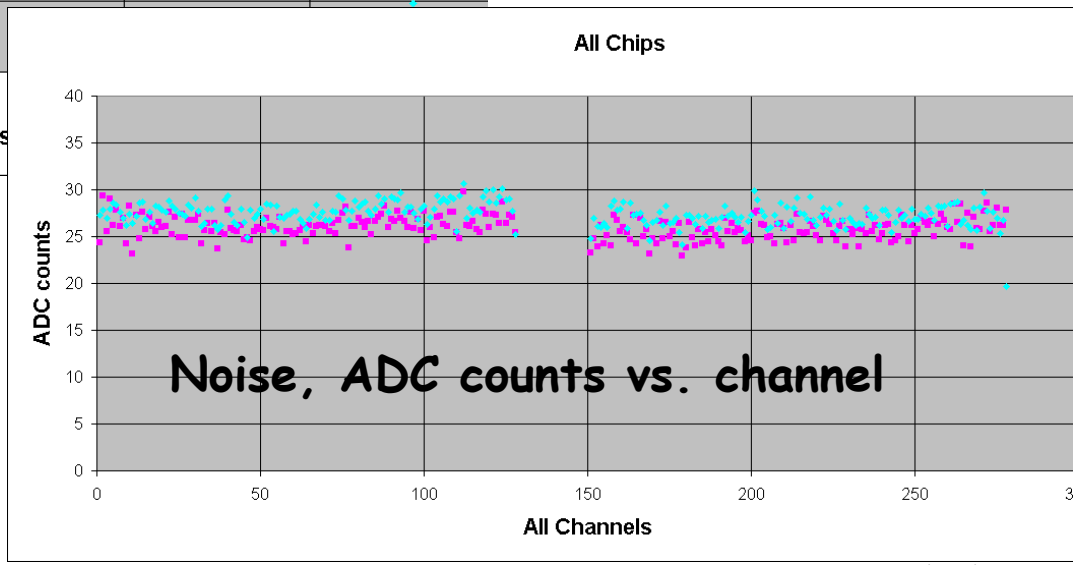




L0 module

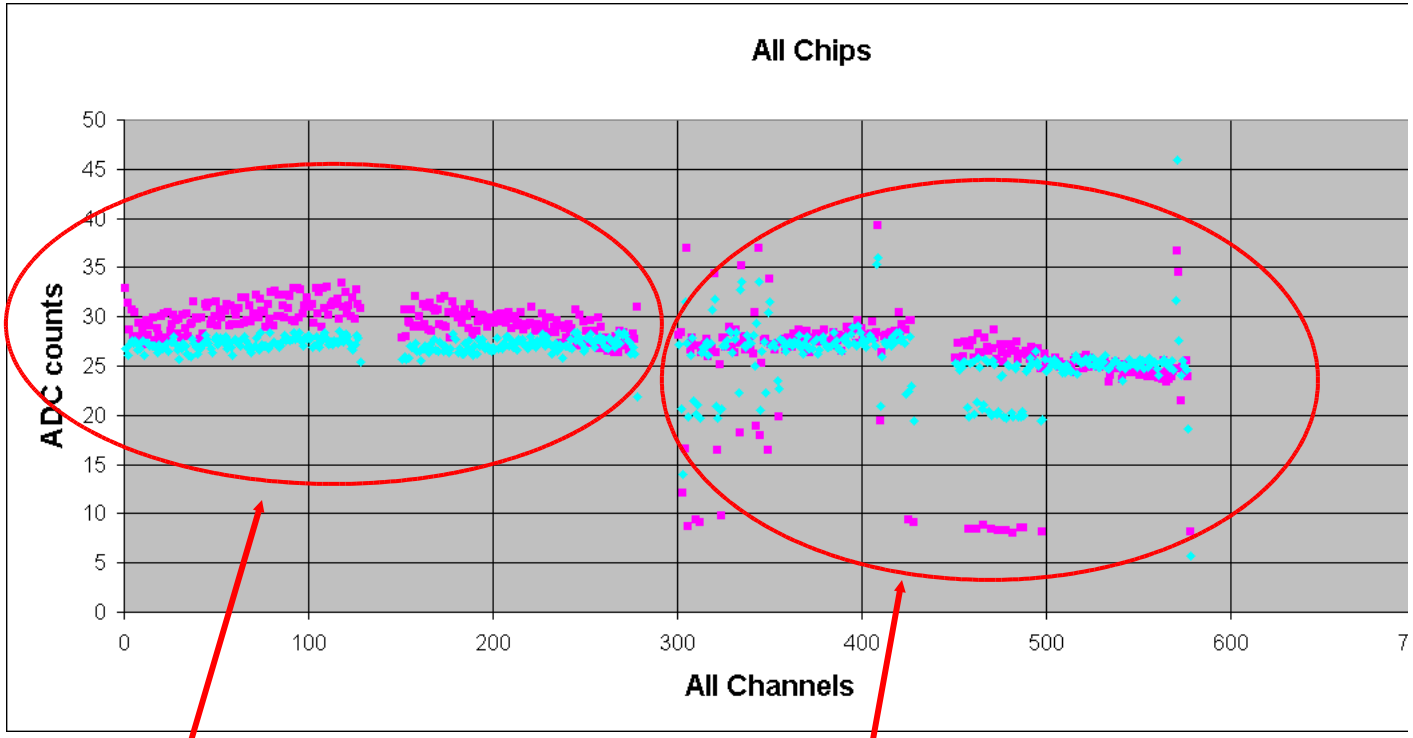
- Note that module is not in the Faraday cage





L0 Modules on Support Structure

- Noise practically the same as before – proof of principle for the new grounding approach
  - No Faraday cage – in fact no shield at all (!)



Almost perfect module from previous page

Module has two regions with failed bonding

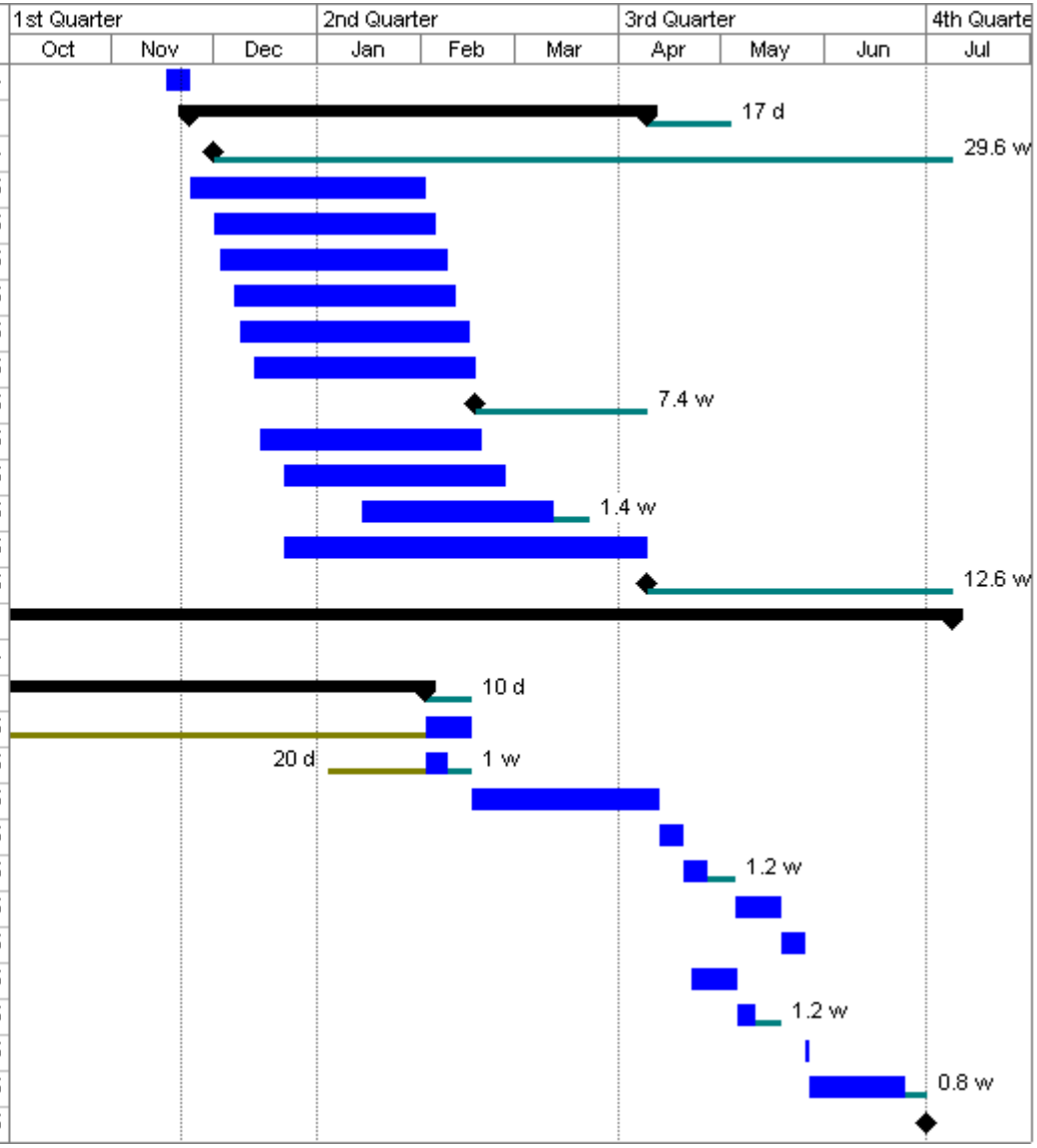
Schedule

- Original (internal) schedule calls for module production to start in November 2004 and finish in April 2005
- Currently plan to start production in December and finish in March 2005

- Schedule has enough slack to accommodate some unexpected delays
- See more in Dmitri's talk

Schedule

ID	Task Name	Finish
163	Conduct L0 module production readiness review	Tue 11/23/04
164	**Module Production**	**Fri 4/8/05**
165	Silicon L0 Module Production Begun	Wed 12/1/04
166	Prepare sensors for module production	Tue 2/1/05
167	Align and glue pair of flex cables	Fri 2/4/05
168	Align and glue sensor to flex cable	Tue 2/8/05
169	Perform sensor-to-flex cable wirebonds	Thu 2/10/05
170	Attach end hybrids to flex cable	Mon 2/14/05
171	Wirebond end hybrid to flex cable	Wed 2/16/05
172	Silicon L0 Module Production Complete	Wed 2/16/05
173	Debug sensor modules	Fri 2/18/05
174	Burn-in sensor modules	Fri 2/25/05
175	Evaluate and repair sensor modules	Fri 3/11/05
176	Perform quality assurance tests	Fri 4/8/05
177	Silicon L0 Module Production and Testing Co	Fri 4/8/05
178	**Final Detector Integration and Assembly**	**Fri 7/8/05**
179	**Layer 0 Support Structure Holding Fixtures**	**Fri 6/11/04**
183	**Layer 0 Module Installation Fixtures**	**Tue 2/1/05**
187	Design and fabricate detector garage	Tue 2/15/05
188	Certify module mounting procedures	Tue 2/8/05
189	Mount layer 0 sensor modules	Tue 4/12/05
190	Verify sensor alignment	Tue 4/19/05
191	Install temperature sensors	Tue 4/26/05
192	Perform initial electrical test of readout	Wed 5/18/05
193	Install outer shell	Wed 5/25/05
194	Beams Div bakeout and leak check of beam pipe	Thu 5/5/05
195	SiDet leak check of beam pipe	Tue 5/10/05
196	Install beam pipe	Thu 5/26/05
197	Test final system	Fri 6/24/05
198	Layer 0 Silicon Detector Assembly and Testing C	Thu 6/30/05



Summary

- L0 modules have long history of successful prototyping
- Almost all production parts are available and within specs
- Next two talks will cover in detail procedures on
  - Module Production (Dmitry)
  - Module Testing (Andrzej)