# PIONEER FLEX studies

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For the SCIPP group

Flex production for PIONEER

- Flex used in PIONEER to transmit signal from sensor to readout (analog signal)
  - Length ~5 cm
- Need very low material budget to reduce the impact on the exiting positron energy
  - Around 10 flexes on each side in the positron's way
- Very thin flex with 2 layers (ground and channels)
  - Total thickness ~150um
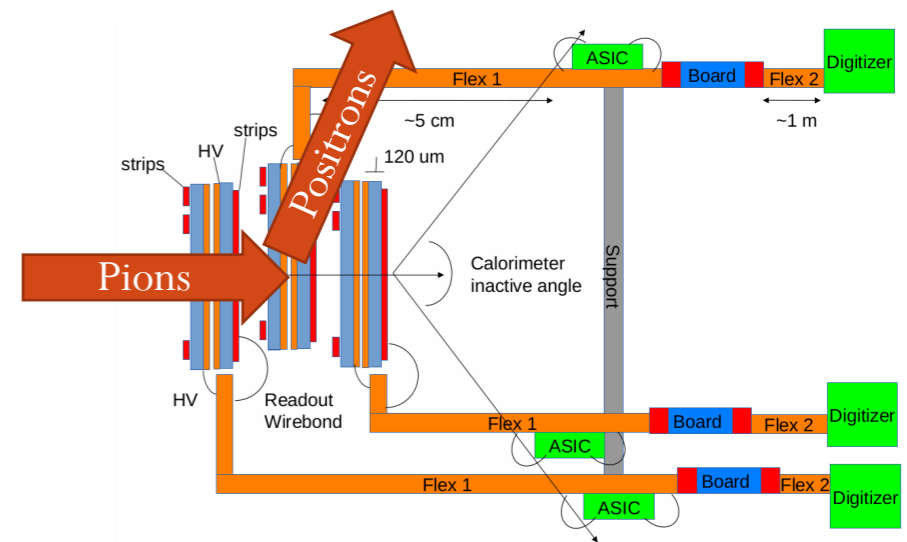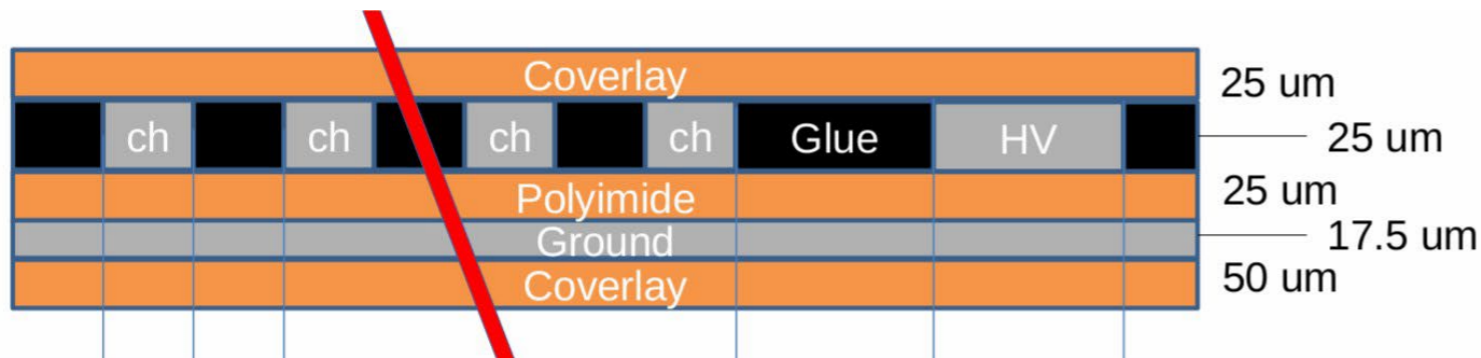
Flex production for PIONEER

- First prototype with copper as conductor with gold phoenix pcb (https://www.goldphoenixpcb.com/)
  - It was extraordinary cheap 250$ for 75 flexes (Sierra quote was 1000+$)
- Once design is finalized we plan to switch to Al traces to reduce material budget
  - Omni Circuit boards (https://www.omnicircuitboards.com/)
- Pitch of 200 um and 500 um, larger trace for HV and one ground plane
  - First electrical tests shows 1-10 pF of inter capacitances
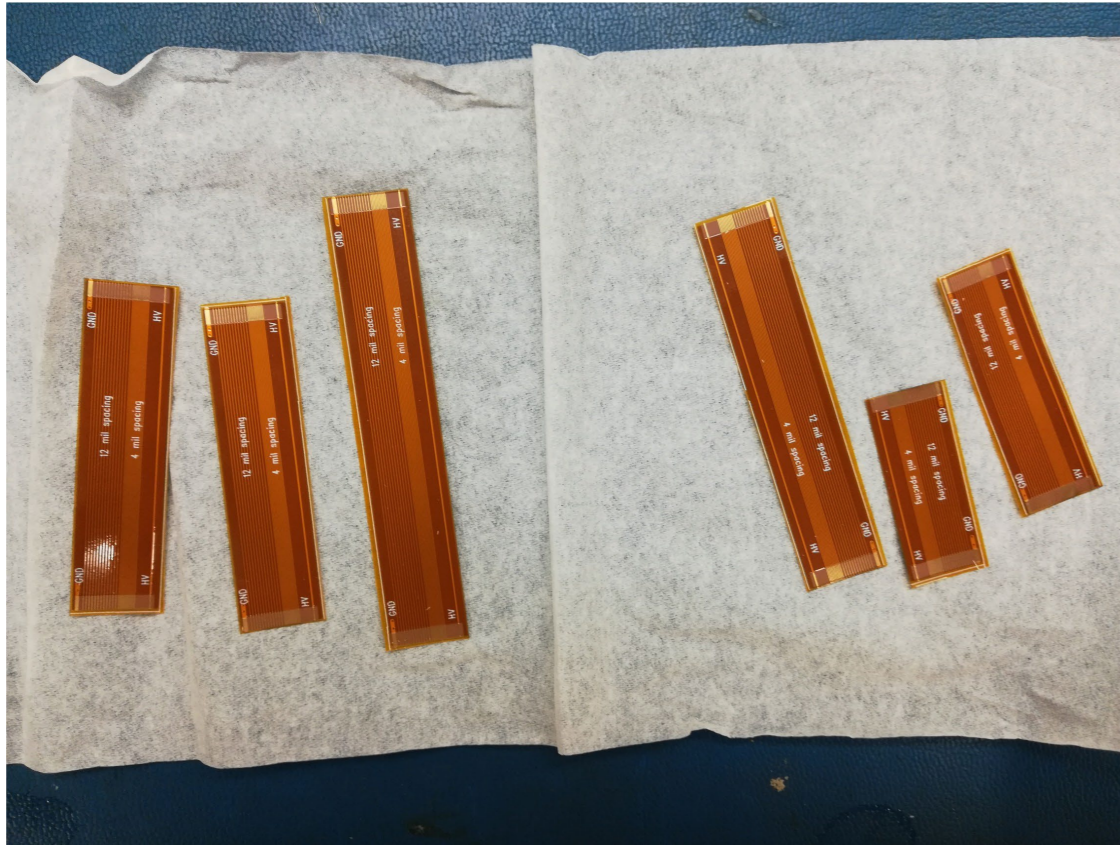
|	3 cm	5 cm	7 cm
HV-CH (ground)	0.9	1.7	2.85
HV-CH (float)	4.2	6.4	9.1
CH-CH (ground)	0.7	1.2	1.8
CH-CH (float)	3.2	4.8	6.8
HV-ground	12	19.7	27
CH-ground	7	10.8	15.7

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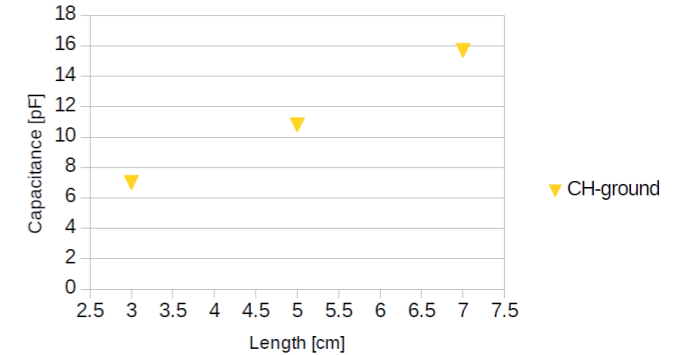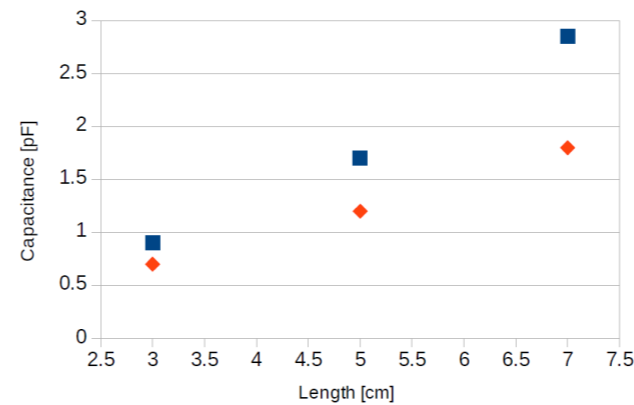
Flex testing

- Dynamic test connecting to a sensor on one side and to a FNAL 16ch board on the other
  - AC-LGAD strip sensor from BNL
- Initial observation
  - Higher noise (caused by increased input capacitance)
  - Additional ringing after sensor pulse
  - Increased cross talk between strips
  - Long range cross talk
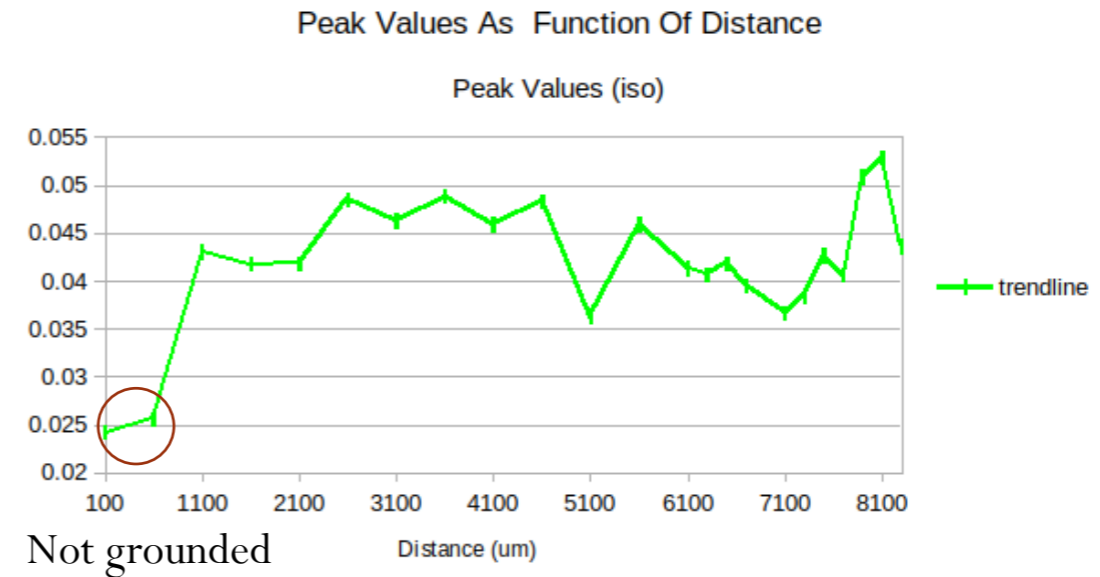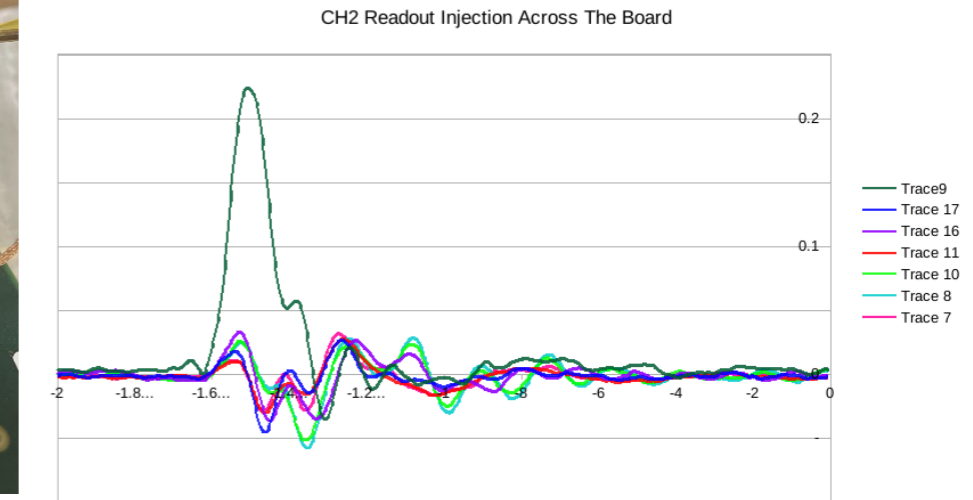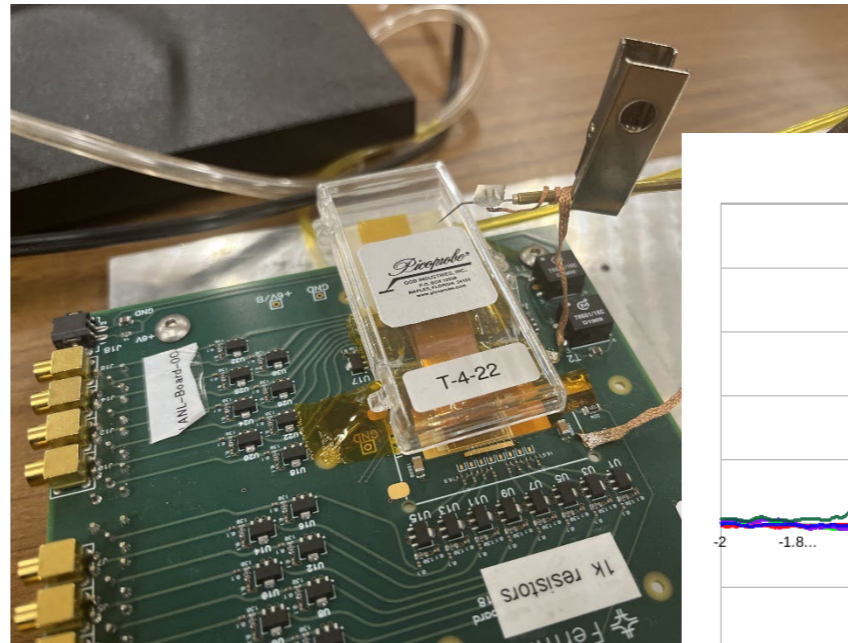- With all grounded traces in between the effect is reduced slightly

First issue: all wirebonds disconnected (except one) between sensor and flex (mechanical weakness)
2nd try with extra support between sensor and flex
All bonds remained connected

Pick up from strips connected to the flex
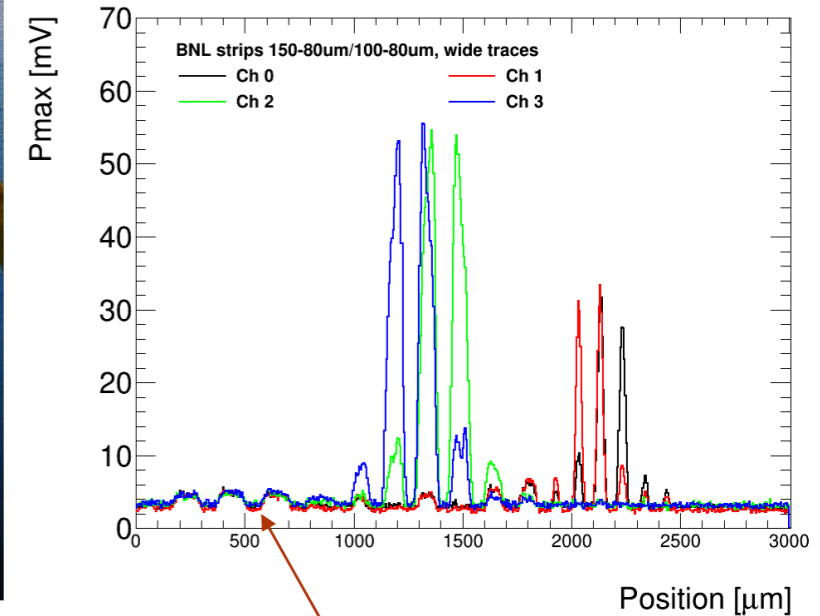
Flex testing

- Dynamic testing using a probe to inject an LGAD-like pulse
  - So to de-couple from AC-LGAD charge sharing
  - Fast square pulse and few pF capacitor in line
- Observed 'flat' cross talk across the entire flex
  - Less cross talk from traces that are not grounded

CH2 Readout Injection Across The Board

Trace9
Trace 17
Trace 16
Trace 11
Trace 10
Trace 8
Trace 7

Peak Values As Function Of Distance

Peak Values (iso)

Not grounded

Distance (um)

trendline

Conclusions

- 'light' flex production for the PIONEER experiment
  - Pitch of 200 um and 500 um, larger trace for HV and one ground plane
  - 3cm to 7cm lenght
- Cross talk of the order of 10% seen in between traces across the entire flex
  - Pretty bad for the analog use in PIONEER but should be good for digital signals
- We'll redesign the flex using simulation to reduce cross talk
- Eventually we will make an Al flex run

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