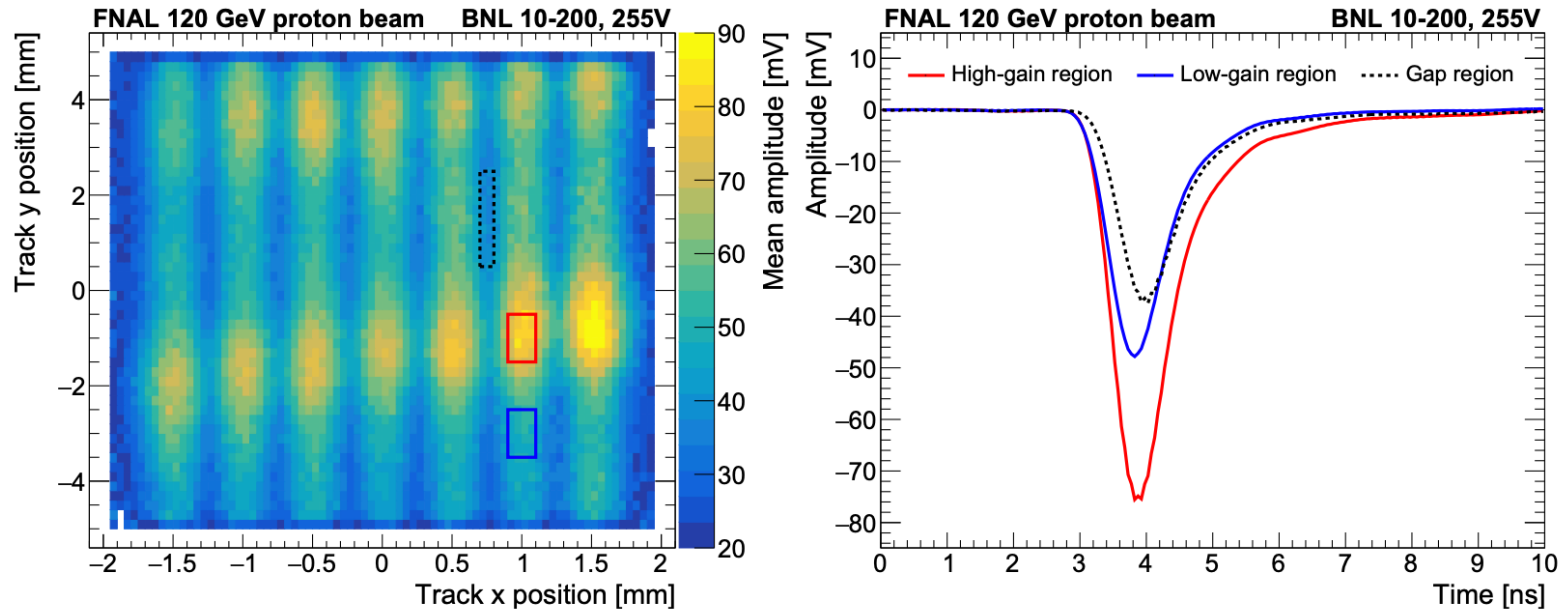


- Introduction:

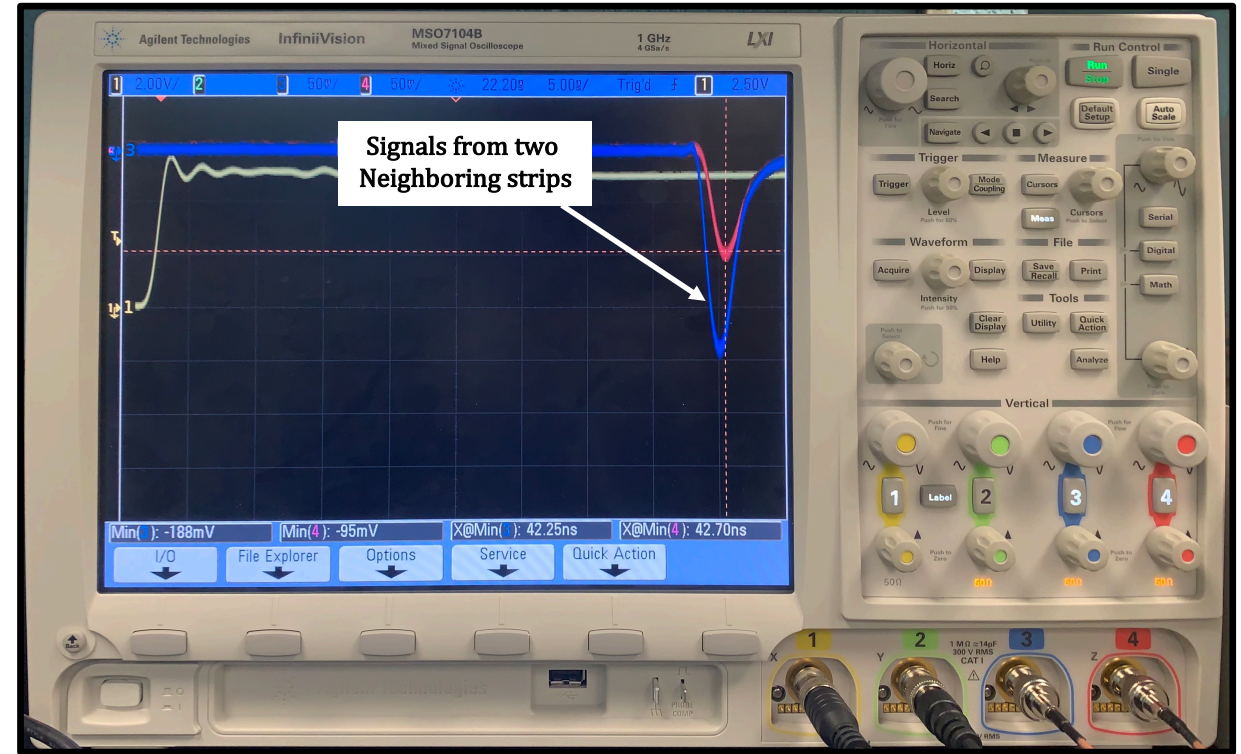
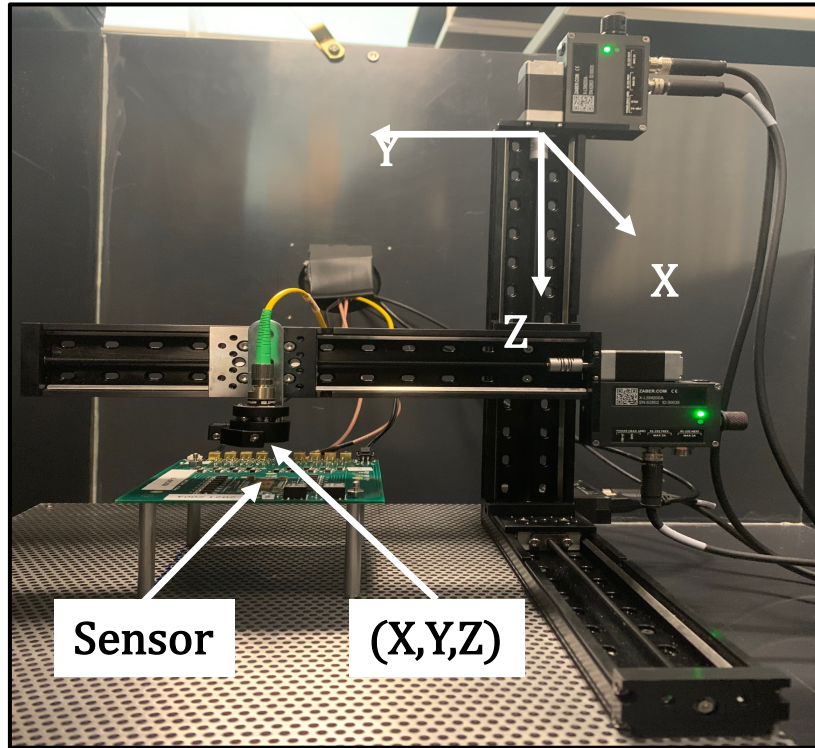
- Gain non-uniformity in the previous BNL production of AC-LGAD sensors
- Expecting to have sensors with more uniform gain in this BNL production for the upcoming beam test in January 2023



arXiv:2211.09698

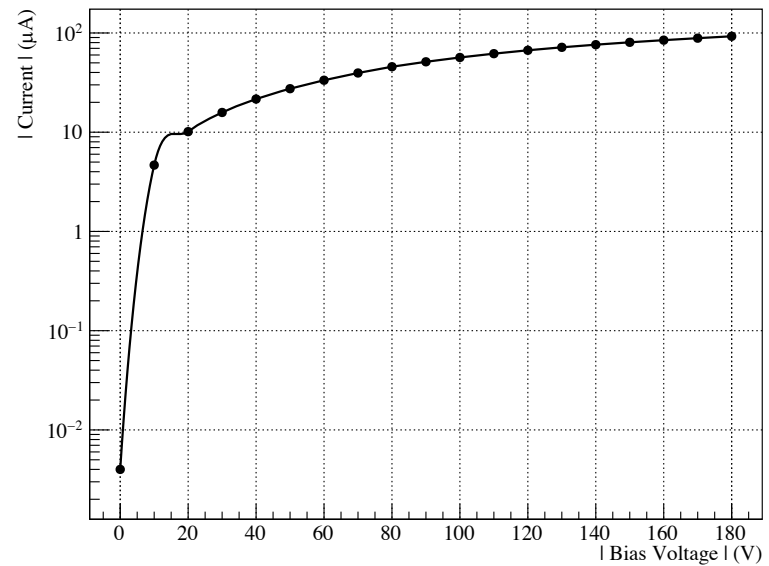
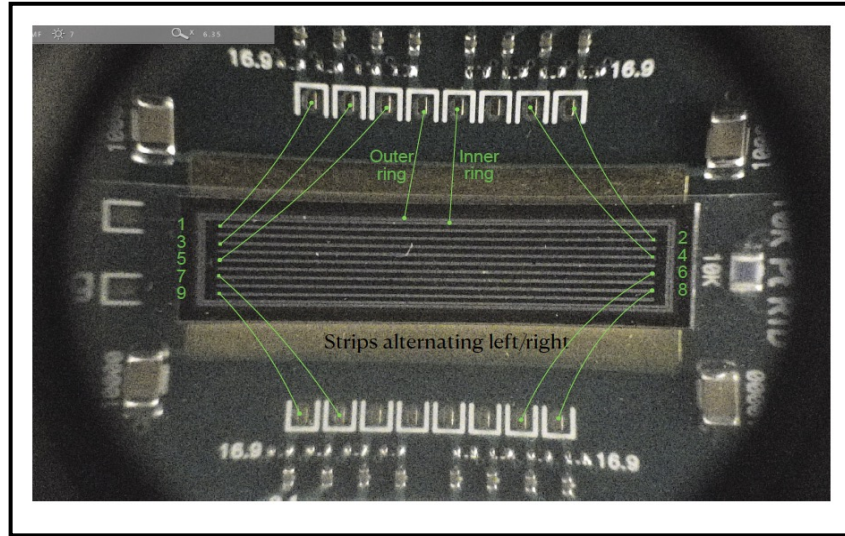
- Performed laser test to check the uniformity of the sensors in this production
- Preliminary results for the sensors with length of 1.0 cm and 2.5 cm are presented

- AC-LGAD Sensor Test Setup using Infrared (IR) Laser at UIC:

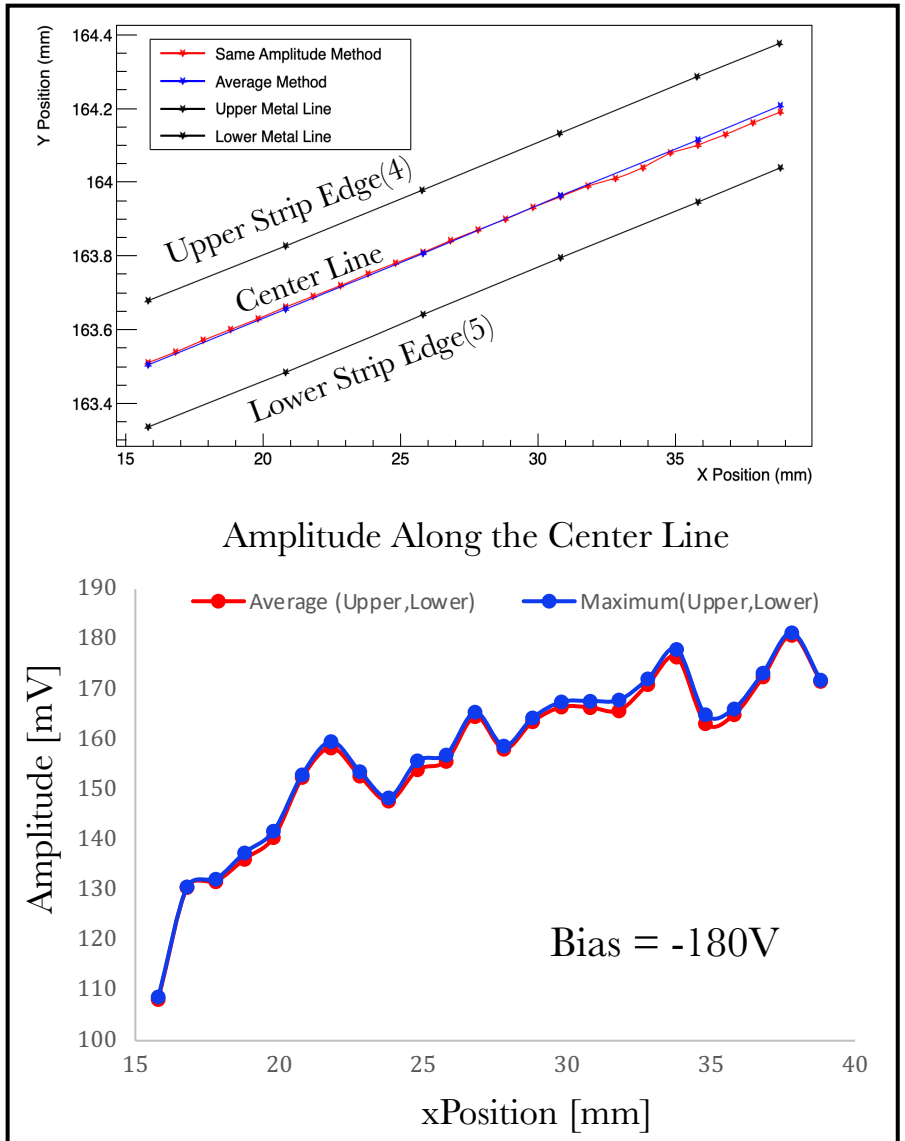


- Wavelength of IR Laser ~ 1060 nm with ultra low timing jitter (< 3 ps rms)
- Laser is mounted on a motor which has a microstep size ~ 0.047625 μm and is being controlled using LabView. The Z position of the motor is chosen such that sensor is at the focal plane of laser beam.
- To record the signals from the sensor strips we used an Agilent InfiniiVision MSO7104B Mixed Signal Oscilloscope with 1GHz bandwidth and sampling rate 4GSa/s.

- Previous BNL Production: Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 300 μm

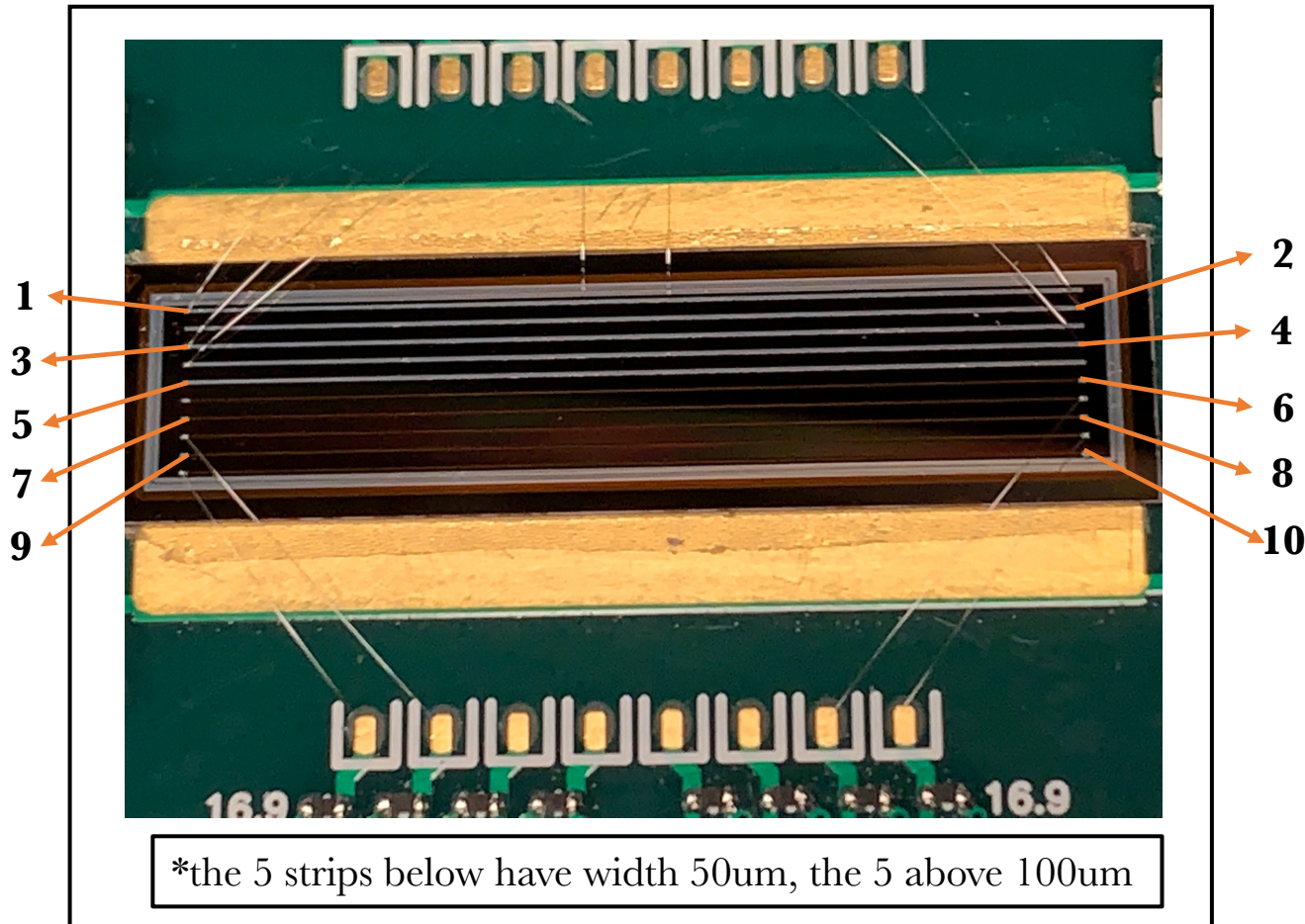


Laser Test at UIC

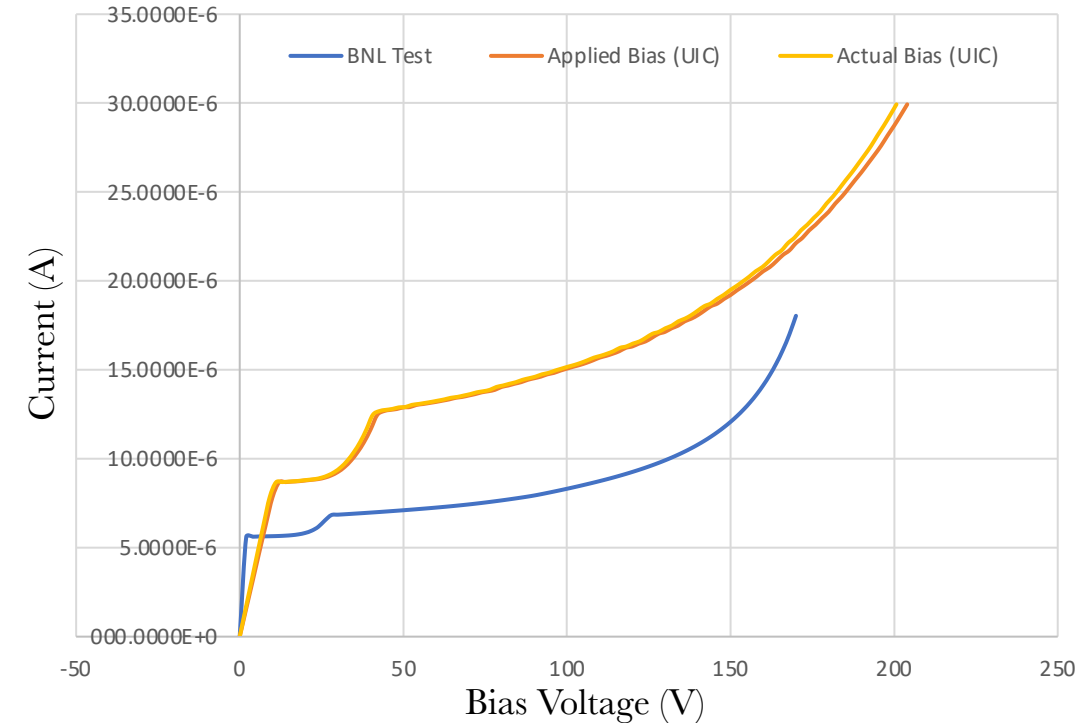


- Amplitude along the center line shows a non-uniform gain along the strip direction.

- W3051(1,4) : Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 400/450 μm



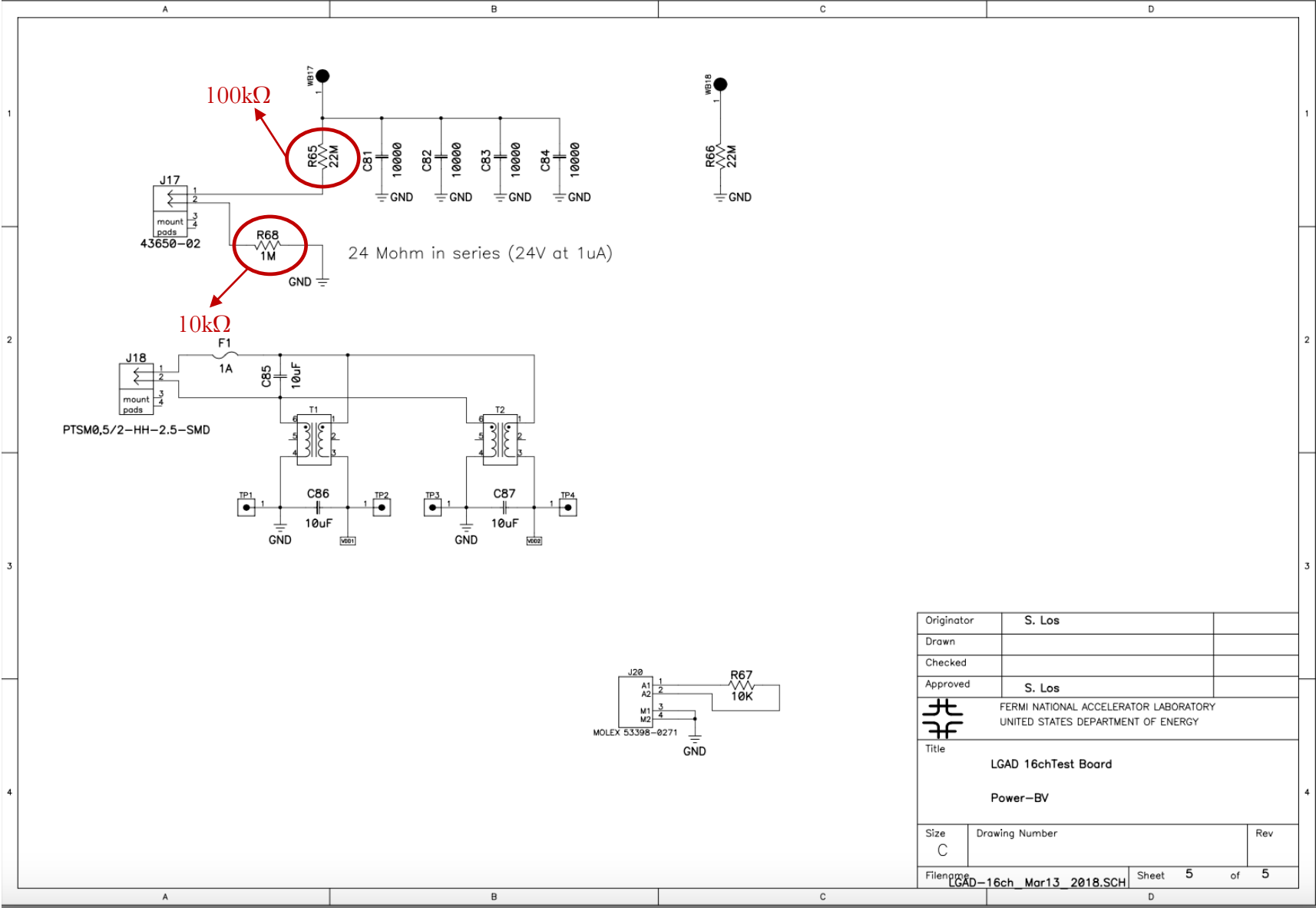
- 110 k Ω Resistor in the Bias line on FNAL16-Ch board (UIC Test)
- Actual Voltage = Applied Voltage - (Current * Resistance)



Parameters for 2D Scan in the Sensor Plane

- Applied Bias Voltage = -190V, Current = -26.11 μA , Actual Bias Voltage = -187.12V
- Internal Trigger, Trigger Level = 0.20V, Frequency = 5.0kHz, Attenuation = 40% (Manual)
- xPosition BinWidth = 200 μm , yPosition BinWidth = 20 μm

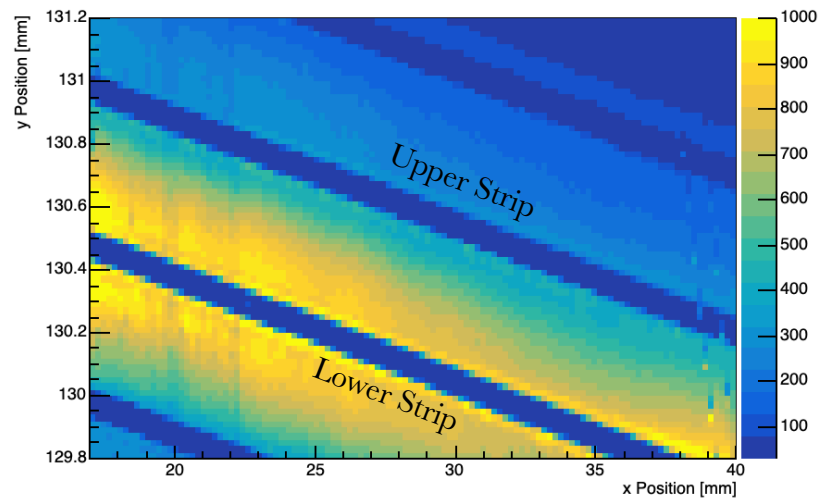
• Schematics of the FNAL16-ch board:



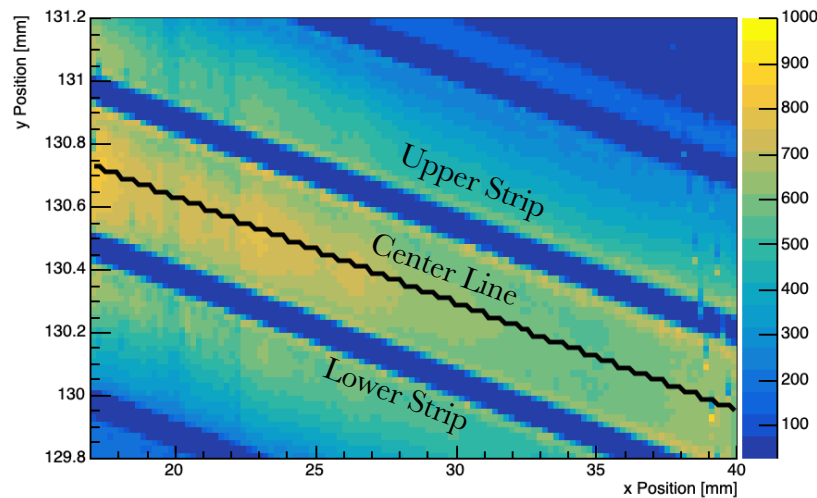
Originator	S. Los	
Drawn		
Checked		
Approved	S. Los	
FERMI NATIONAL ACCELERATOR LABORATORY UNITED STATES DEPARTMENT OF ENERGY		
Title LGAD 16chTest Board Power-BV		
Size C	Drawing Number	Rev
Filename LGAD-16ch_Mar13_2018.SCH	Sheet 5	of 5

- W3051(1,4) : Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 400 μm

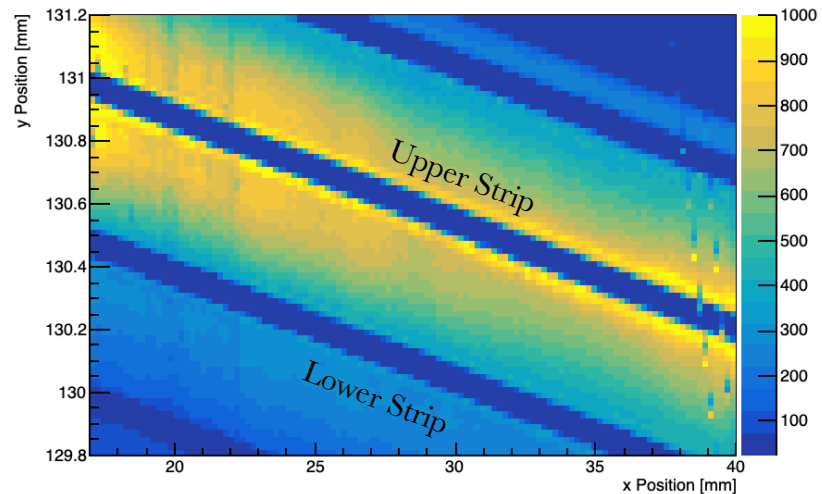
Amplitude (Lower Strip)



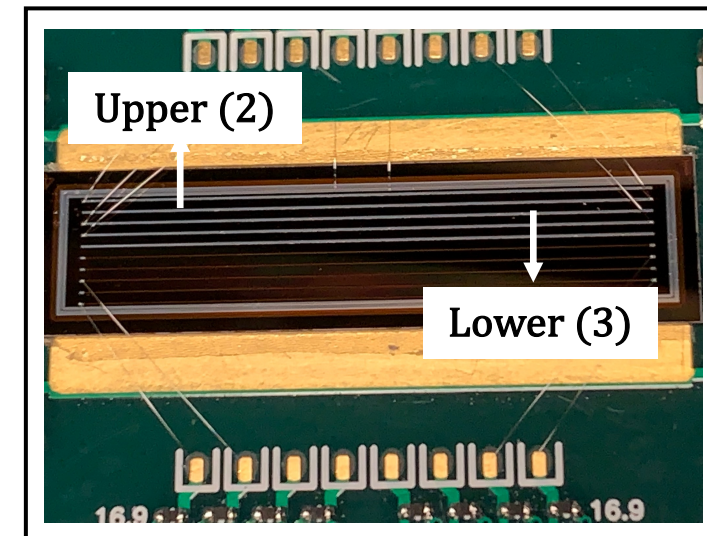
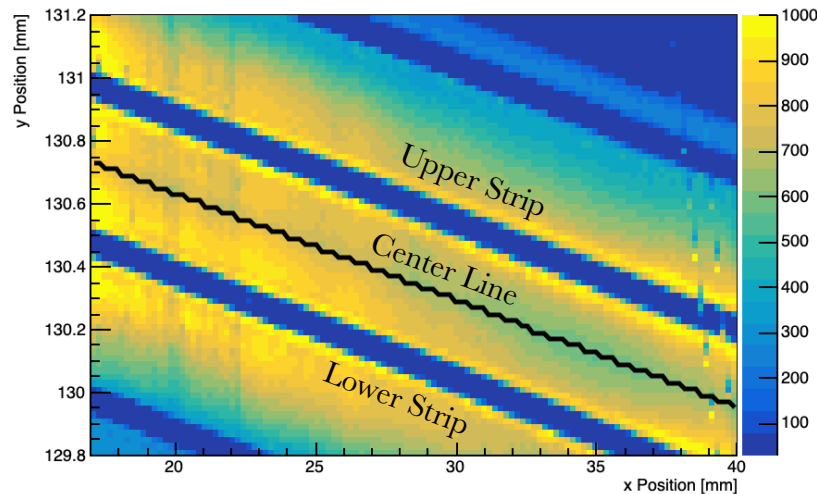
Average Amplitude (Lower, Upper)



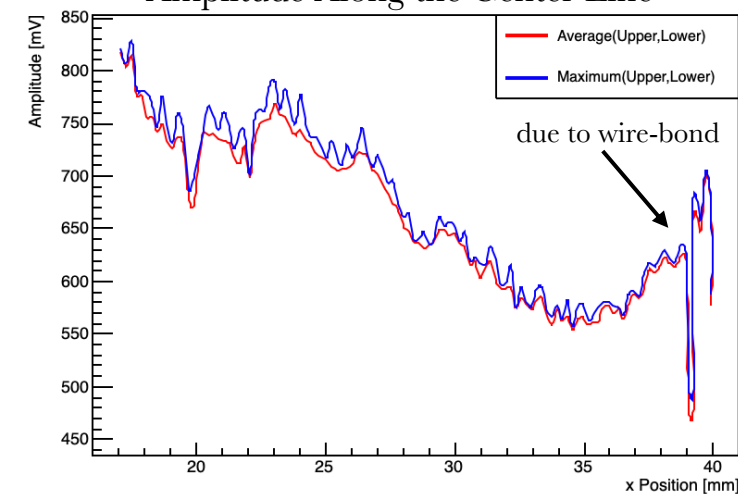
Amplitude (Upper Strip)



Maximum Amplitude (Lower, Upper)

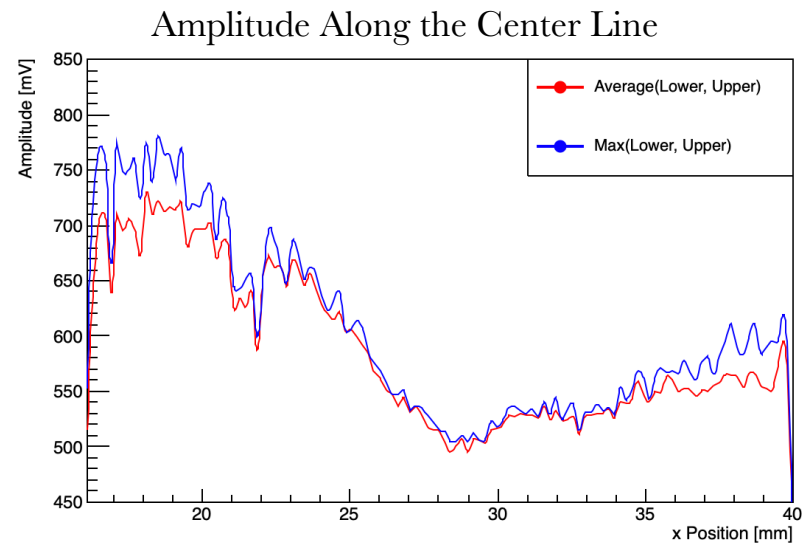
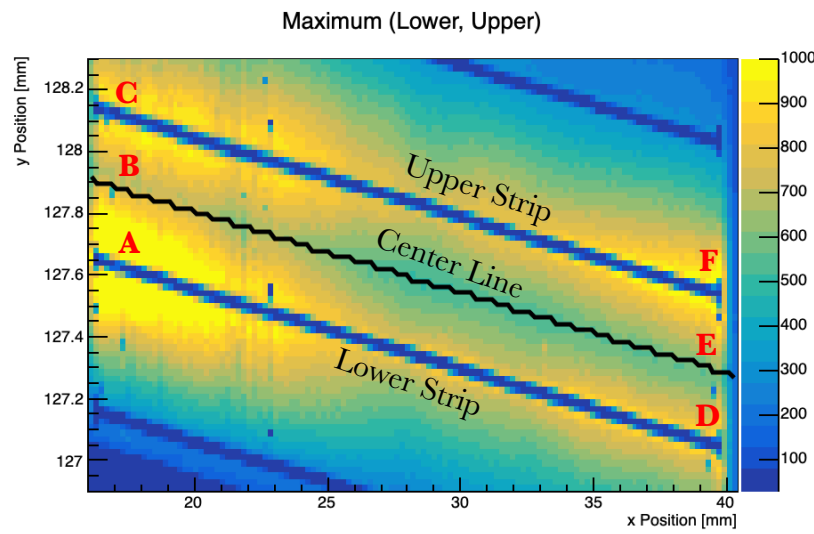
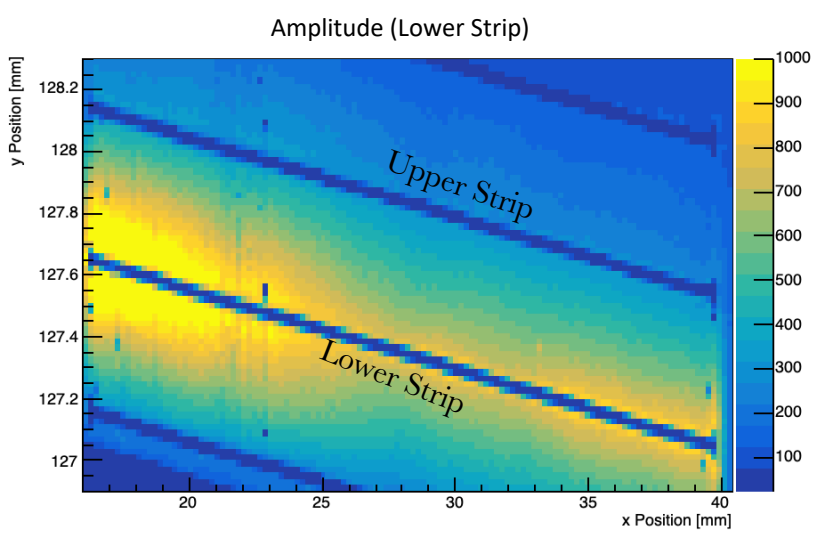
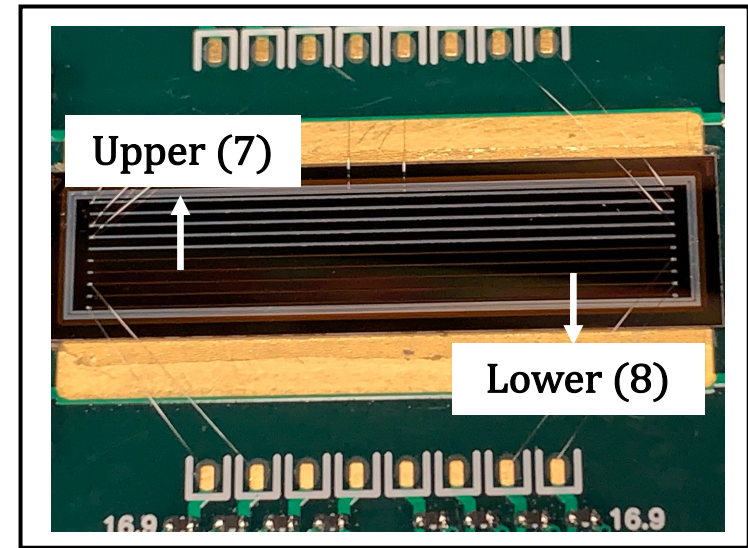
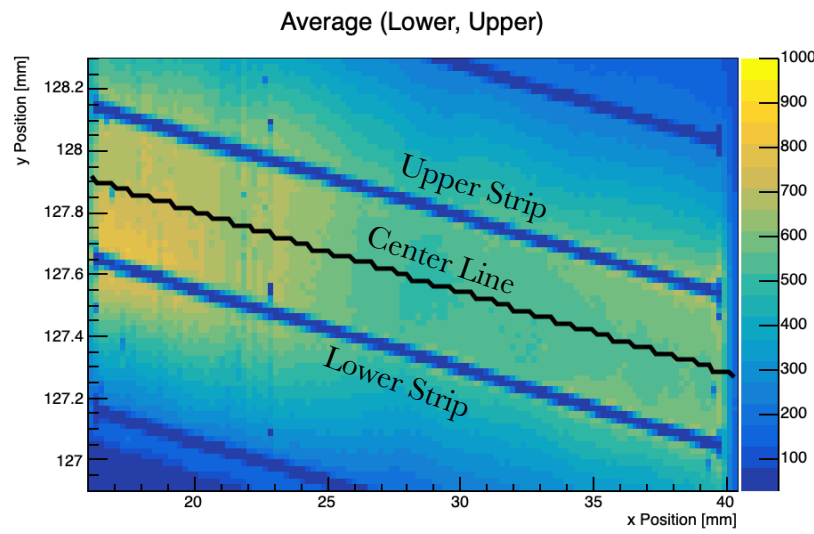
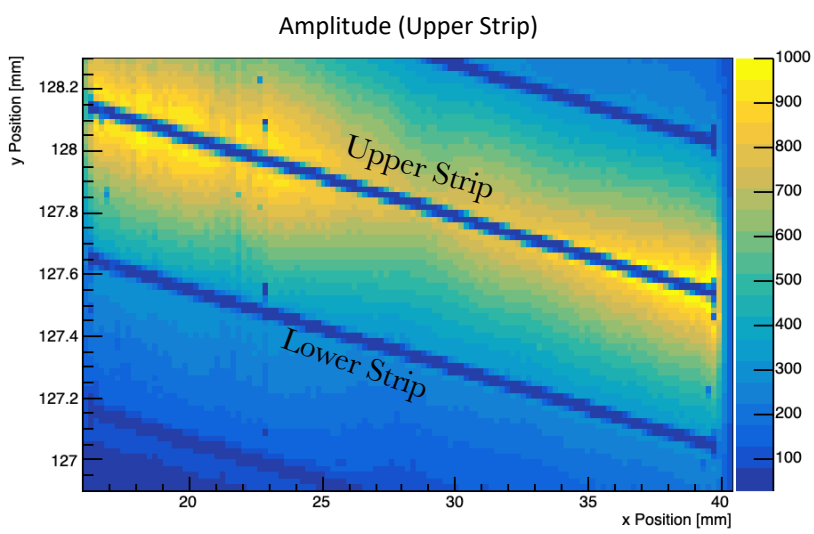


Amplitude Along the Center Line



- Center line passes through the bins corresponds to center between the two strips
- Amplitude along the center line shows a non-uniform gain along the strip direction

• W3051(1,4) : Thickness = 50 μ m, Length = 25 mm, Pitch = 500 μ m, Gap = 450 μ m



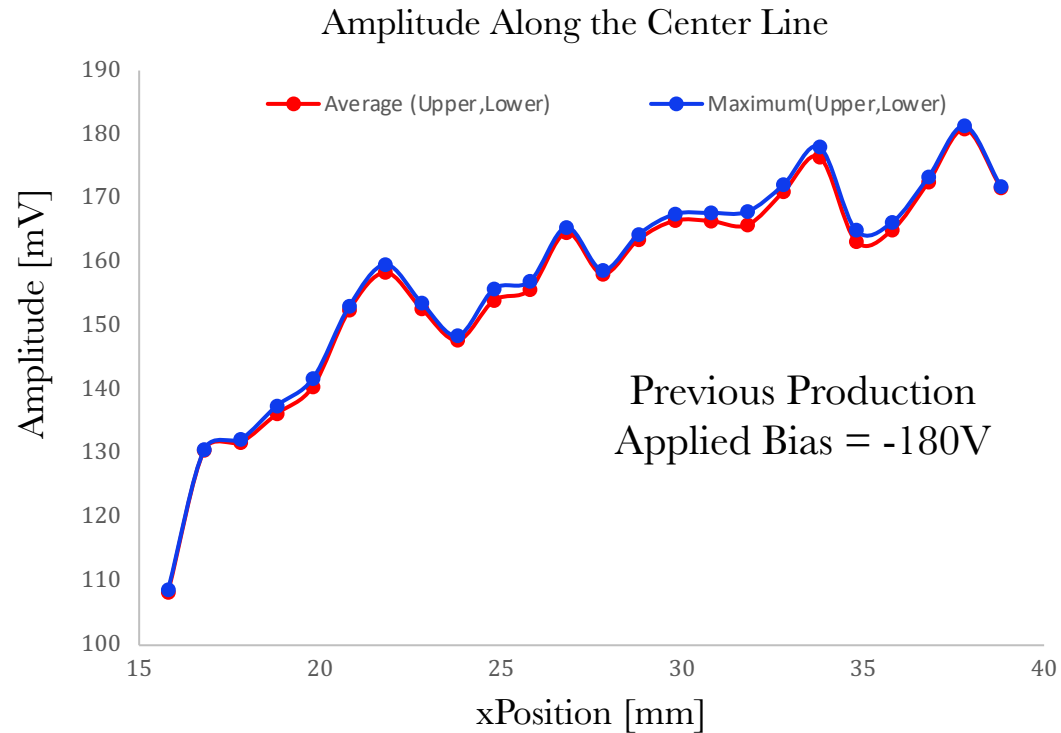
- Center line passes through the bins corresponds to center between the two strips.
- Amplitude along the center line shows a non-uniform gain along the strip direction.

Location of Center of the Strips
and the Center Line in both edges

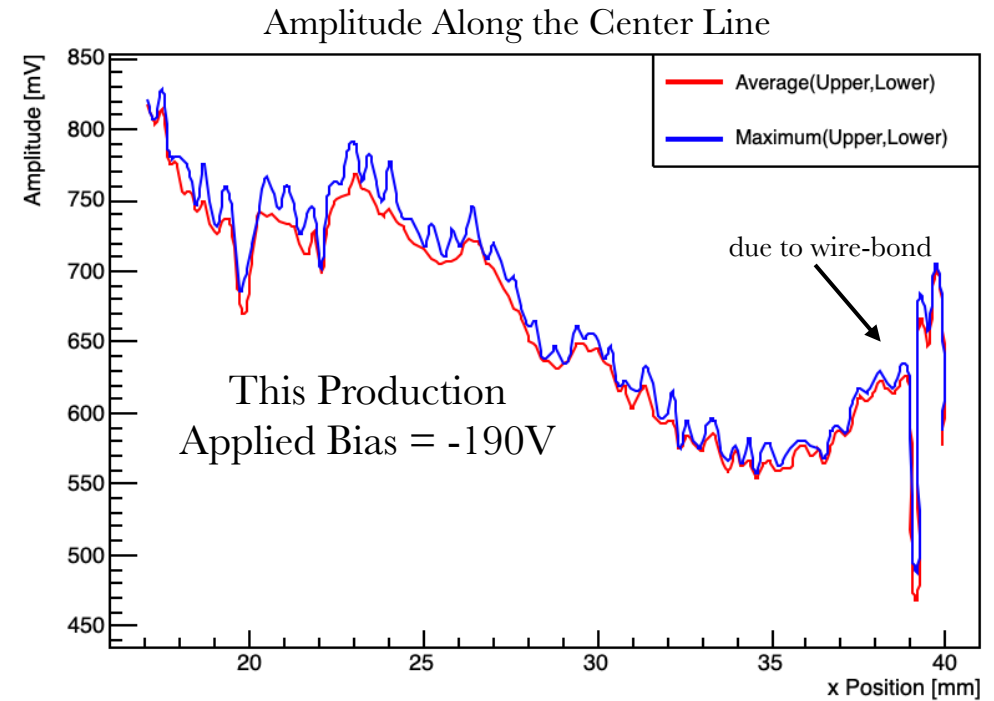
A(16.29,127.659) B(16.29,127.905) C(16.29,128.152)
D(39.70,127.048) E(39.70,127.294) F(39.70,127.541)

- Compare gain non-uniformity with previous BNL production: Laser Test at UIC

Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 300 μm

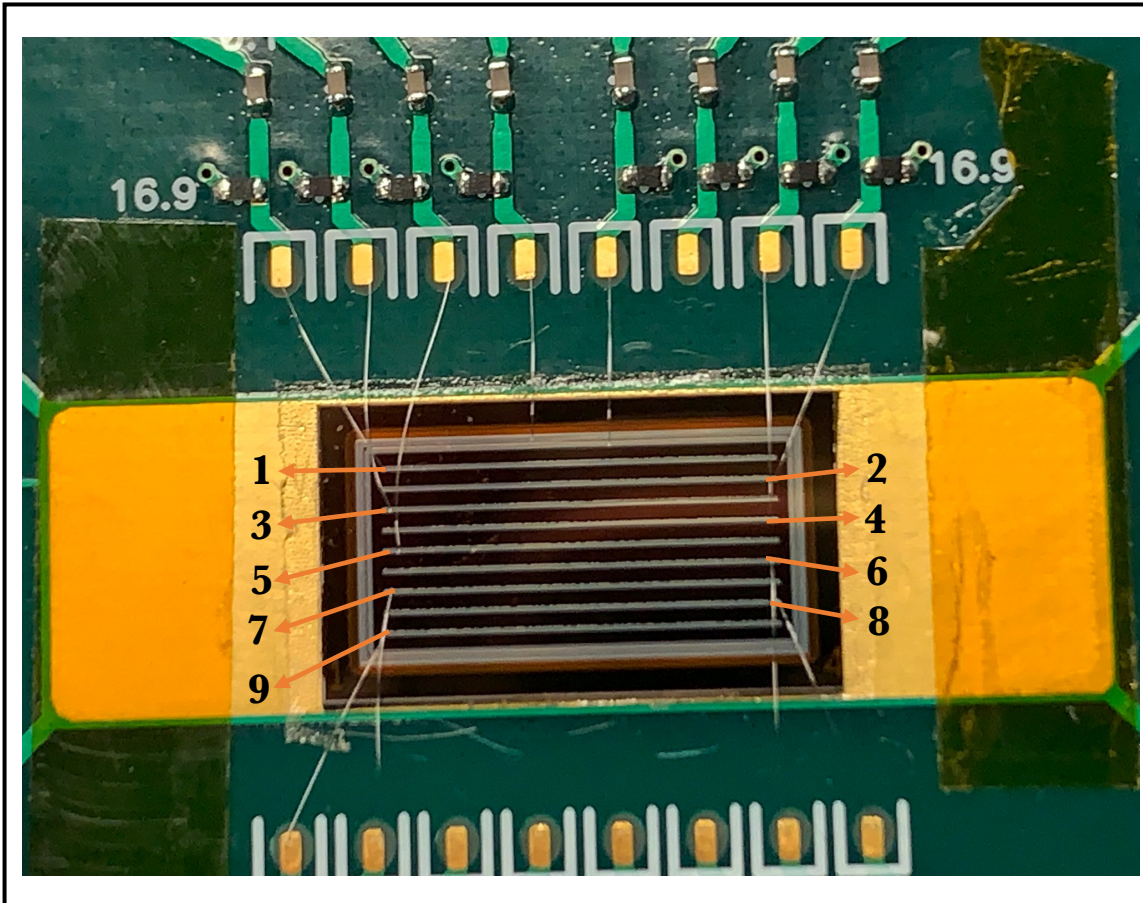


Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 400 μm

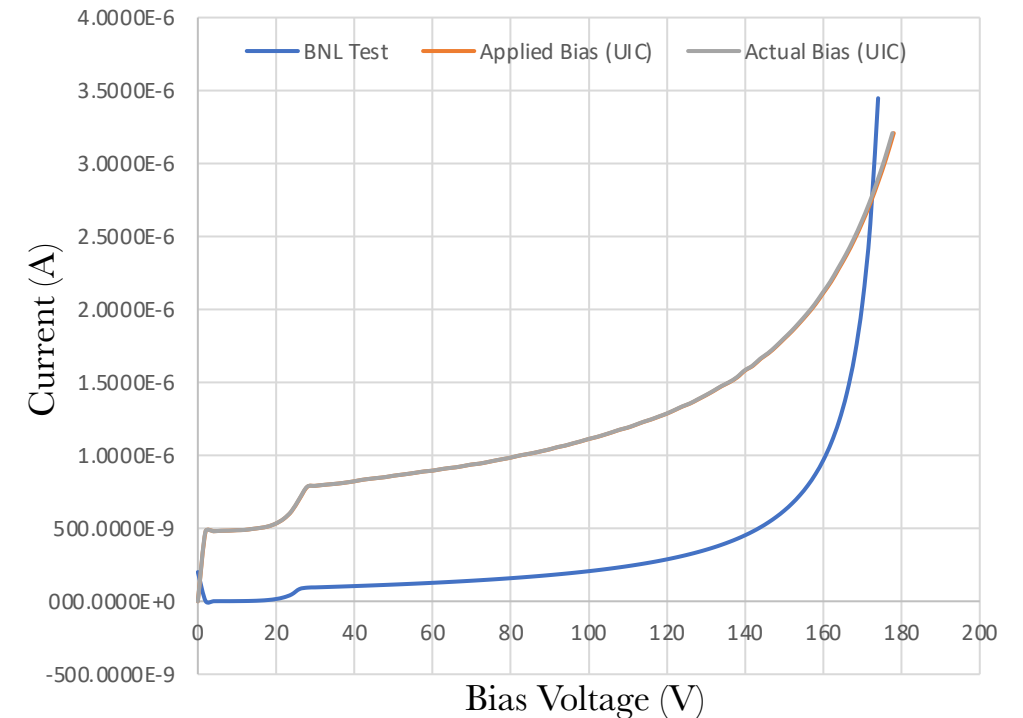


- Relatively less gain non-uniformity along the strip direction in the new production

- W3051(1,4) : Thickness = 50 μm , Length = 10 mm, Pitch = 500 μm , Gap = 400 μm



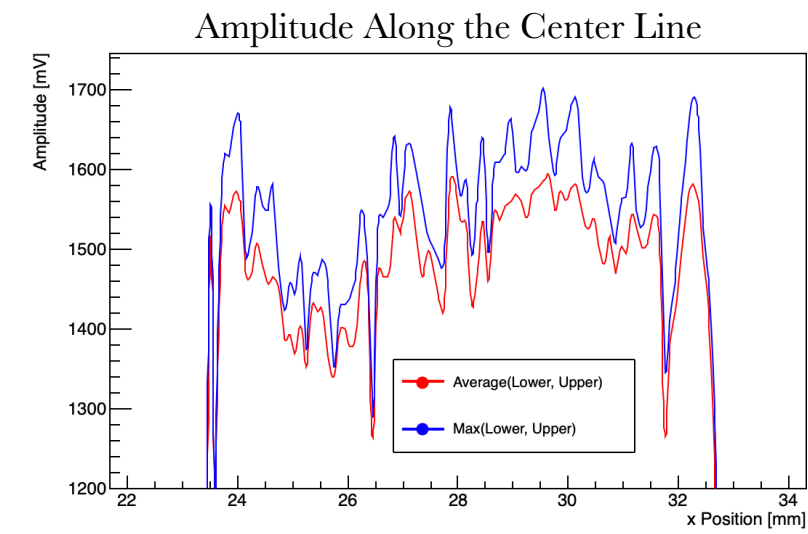
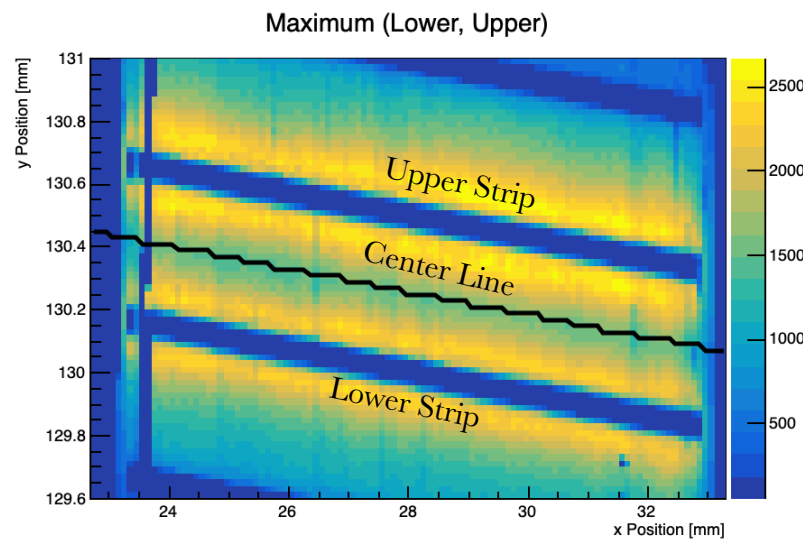
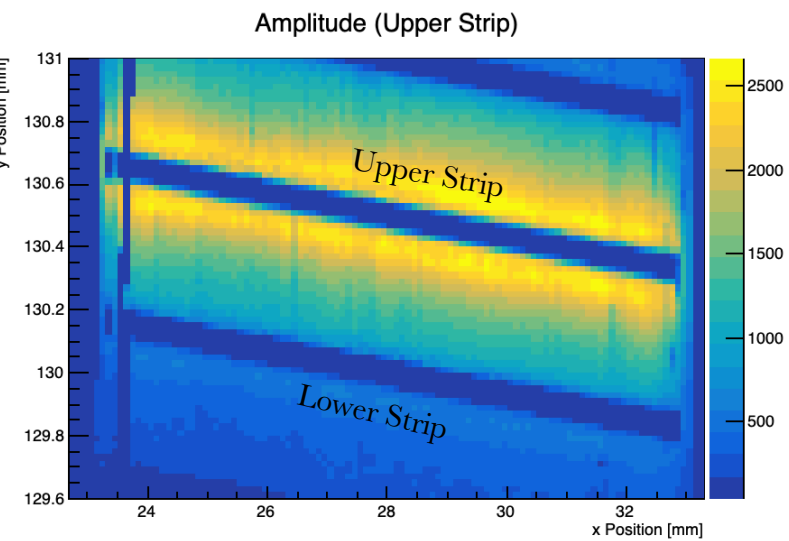
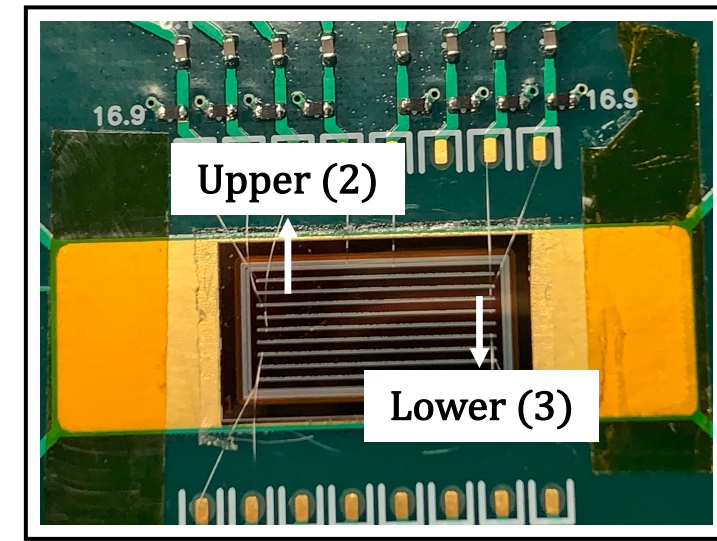
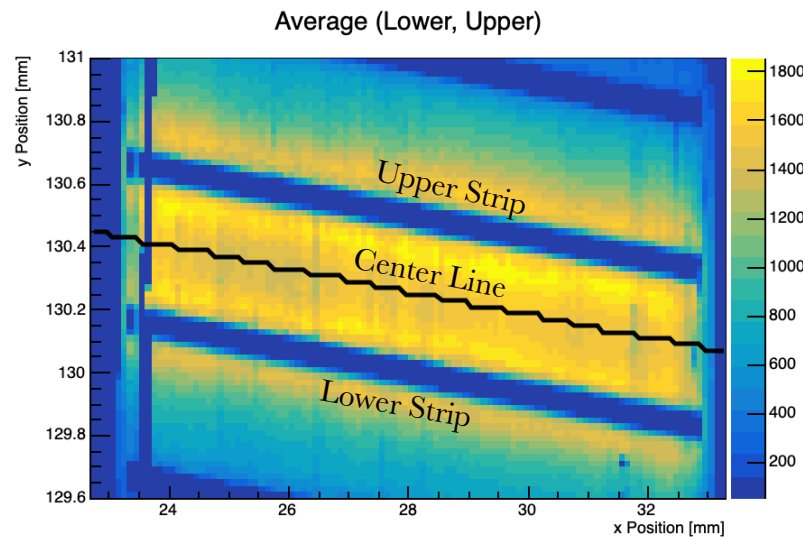
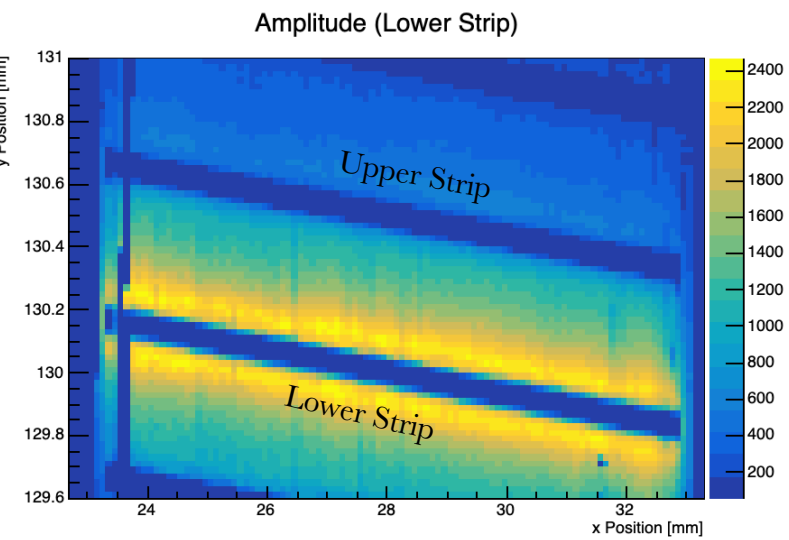
- 110 k Ω Resistor in the Bias line on FNAL16-Ch board (UIC Test)
- Actual Voltage = Applied Voltage - (Current * Resistance)



Parameters for 2D Scan in the Sensor Plane

- Applied Bias Voltage = -160V, Current = -2.11 μA , Actual Bias Voltage = -159.76V
- Internal Trigger, Trigger Level = 0.20V, Frequency = 5.0kHz, Attenuation = 40% (Manual)
- xPosition BinWidth = 100 μm , yPosition BinWidth = 20 μm

- W3051(1,4) : Thickness = 50 μm , Length = 10 mm, Pitch = 500 μm , Gap = 400 μm

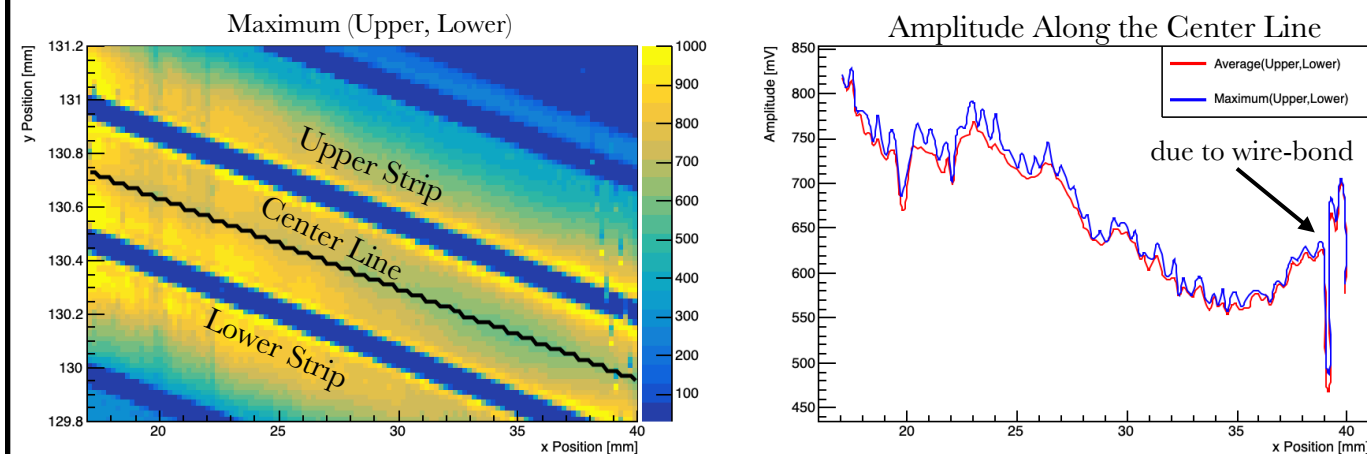


- Center line passes through the bins corresponds to center between the two strips.
- Amplitude along the center line shows relatively uniform gain along the strip direction.

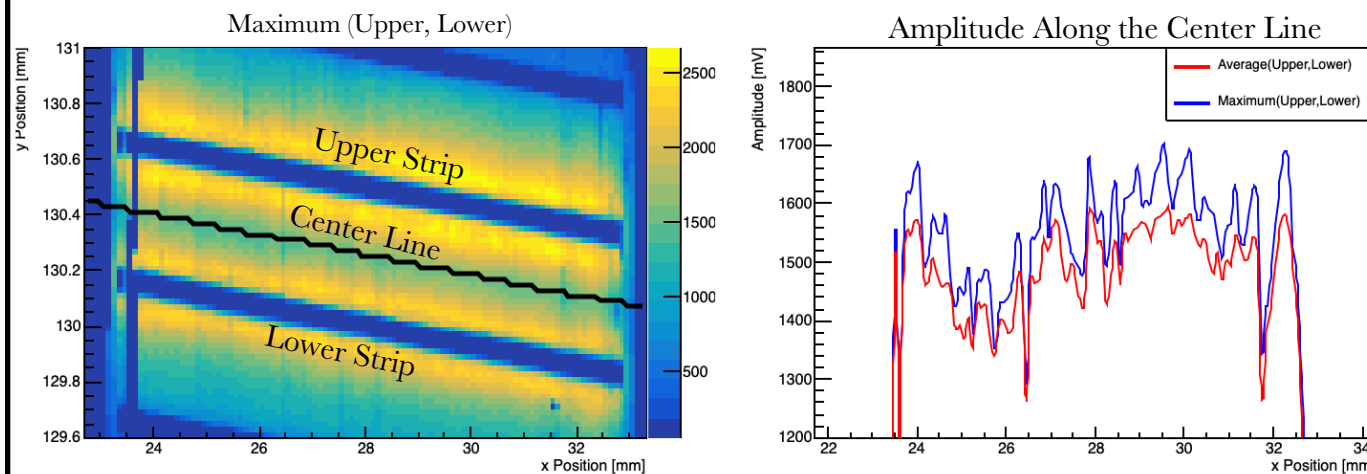
- Compare gain non-uniformity with Test Beam 2022 at FermiLab

Laser Test at UIC

Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 400 μm

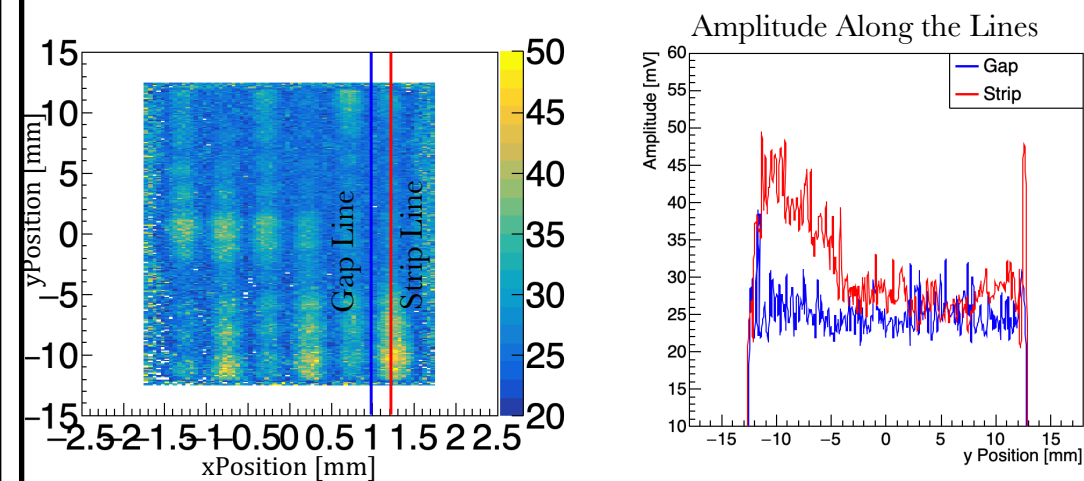


Thickness = 50 μm , Length = 10 mm, Pitch = 500 μm , Gap = 400 μm

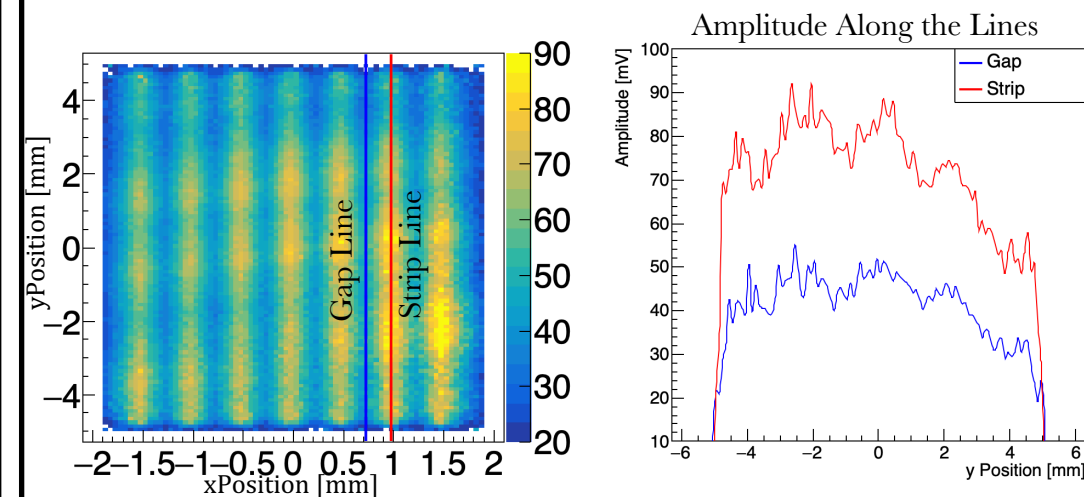


Beam Test at Fermilab

Thickness = 50 μm , Length = 25 mm, Pitch = 500 μm , Gap = 300 μm



Thickness = 50 μm , Length = 10 mm, Pitch = 500 μm , Gap = 400 μm



- Conclusion and Outlook:
 - Relatively less gain non-uniformity in the new BNL production
 - Larger gain non-uniformity in longer sensor (will cross-check with another 2.5 cm sensor)
 - Gain non-uniformity will be tested for other sensors (different gap width and length) using laser