

# INTT Status

T. Hachiya

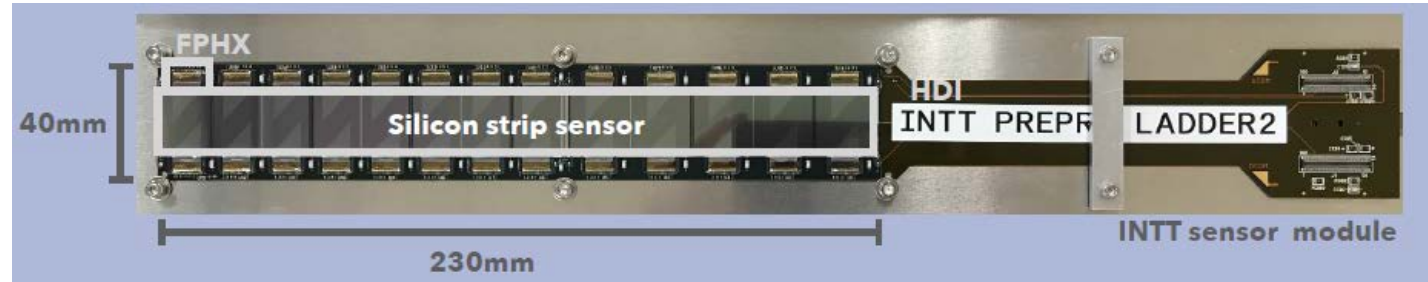
RBRC and Nara Women's Univ.

# Current status

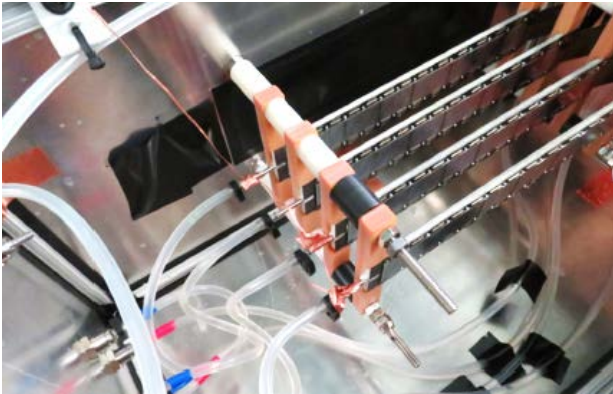
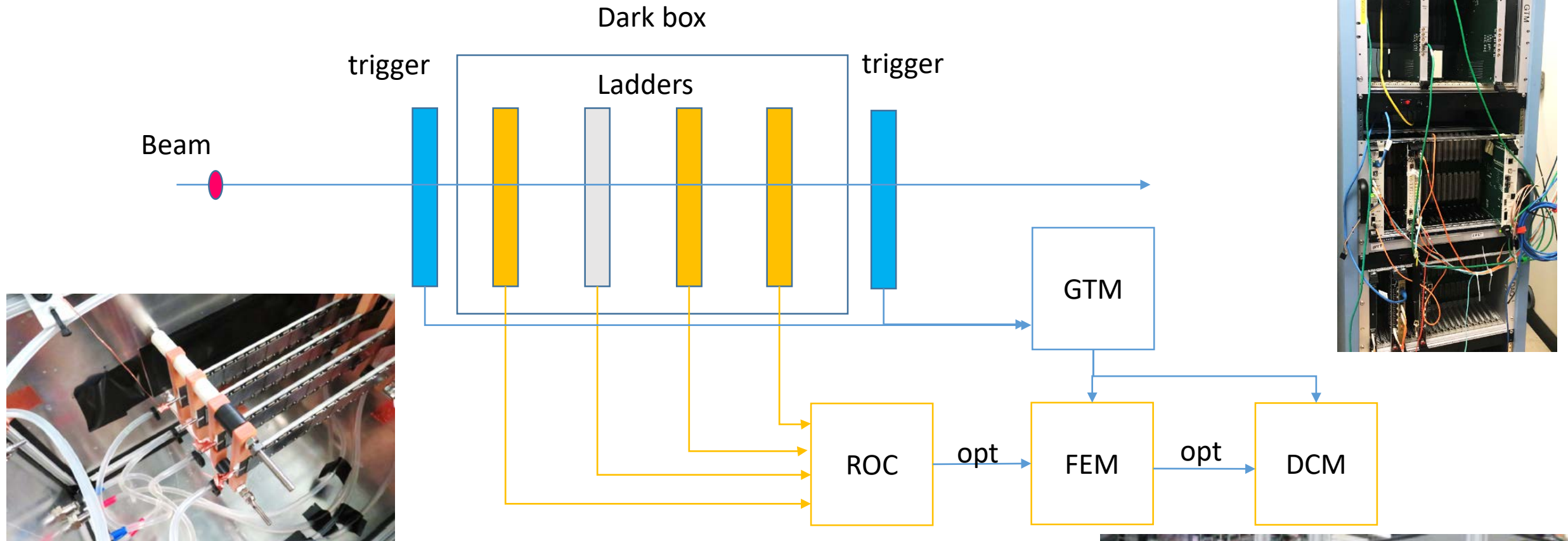
- Analysis on Beam test 2019
  - MIP and efficiency
- Bus extender status
- Production status (preparation)
- Streaming readout

# Beam Test at FNAL (June -)

- Ladders
  - New ladders with Si=320um
  - Liquid cooling system
- 4 ladders are installed
  - 3 ladders are successfully readout
- Purposes
  - Readout multiple ladders simultaneously w/ full readout chain (GTM – FEM – DCM)
  - Measure MIP peak
  - Study the efficiency
  - Test very long cables
- Short summary
  - Beam test was successful
  - We did and found some issues



# Beam Test setup



- We successfully readout 3 ladders (out of 4)
  - No data come out from that ladder
  - Problems about knowledge how the system works
  - Readout system is different with the standalone test bench at lab.



# INTT workfest

- Oct. 7-11 2019 in Nara
  - Dec. 9-13 2019 in NCU (Taiwan)
  - Mar. 9-13 2020 in Nara
- 
- Speed up the beam test analysis
  - Setup the test bench at NCU

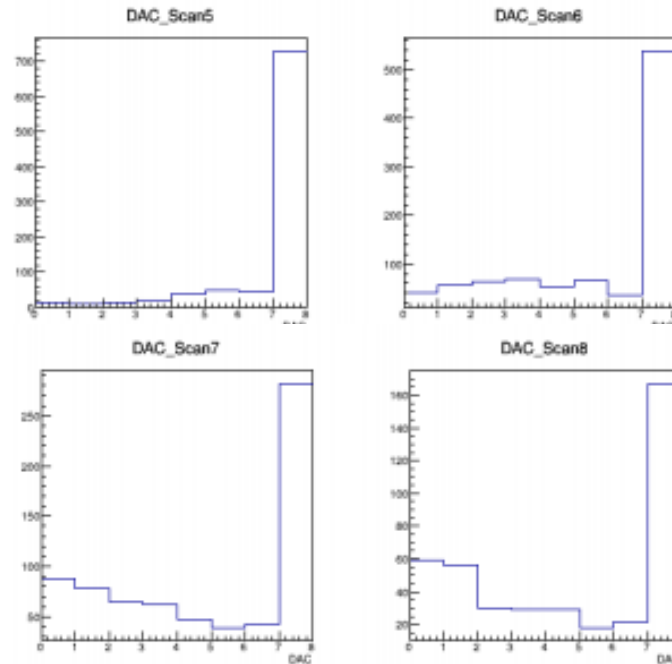
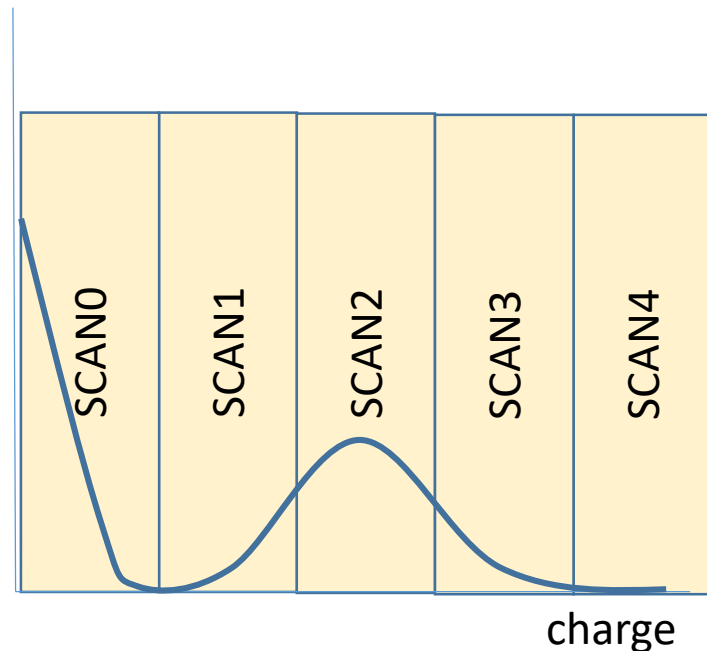


RBRC-xj group meeting



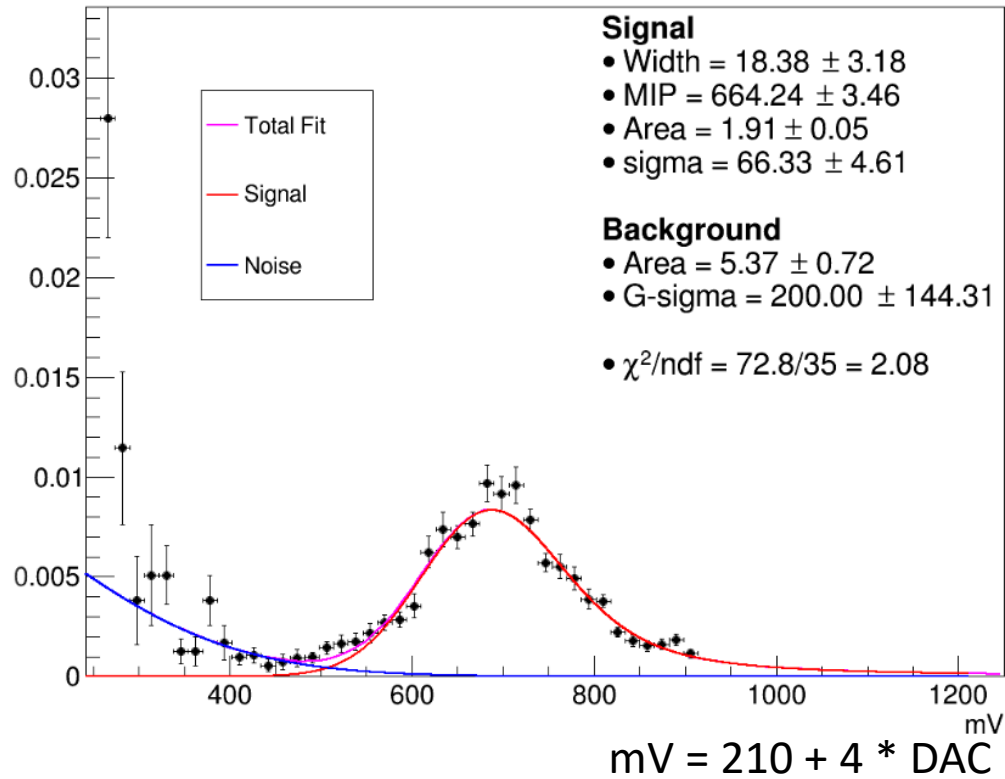
# MIP measurement with FPHX chip

- FPHX has 3 bit ADC range but these threshold can be set 8 bit DAC width.
  - ADC measurement is
- DAC Scan
  - Took data with changing DAC value to cover the full MIP range

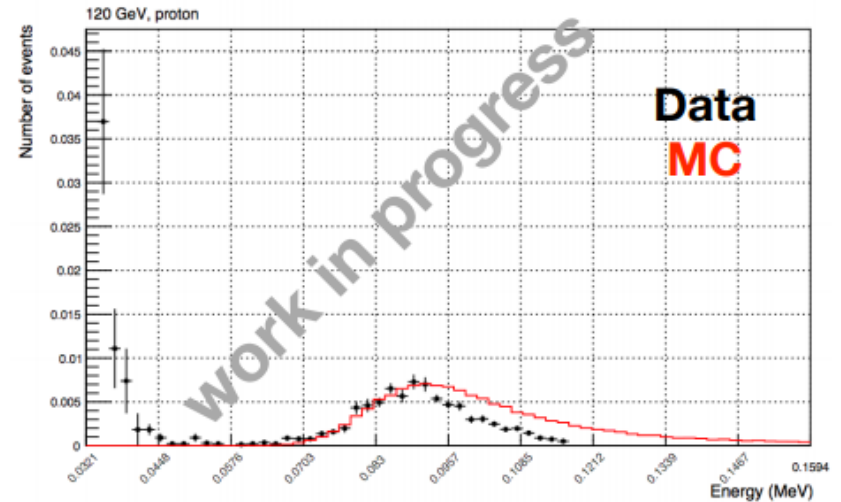
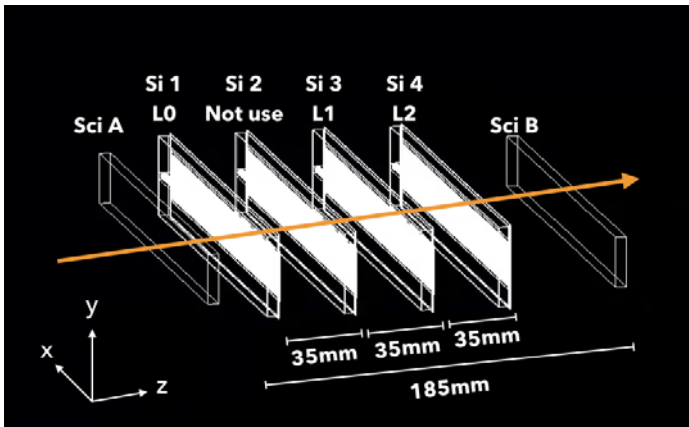


ADC (3bit)	DAC (8bit)
0	20
1	25
2	48
3	98
4	148
5	172
6	223
7	248

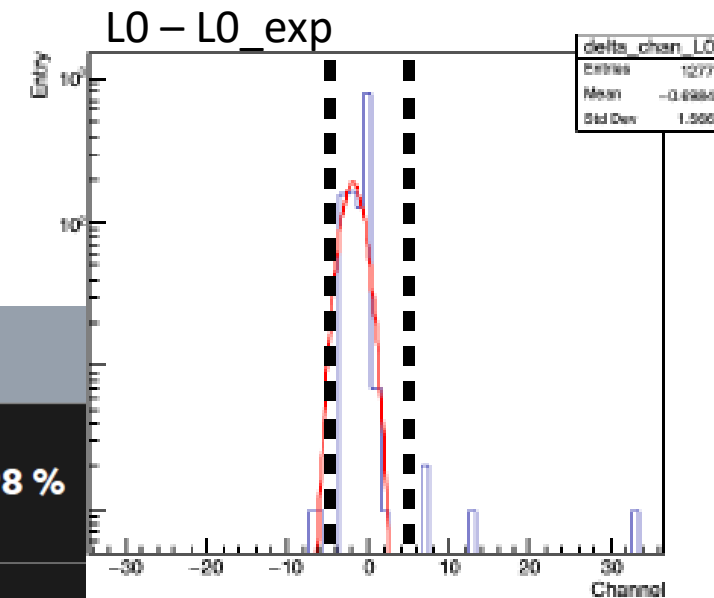
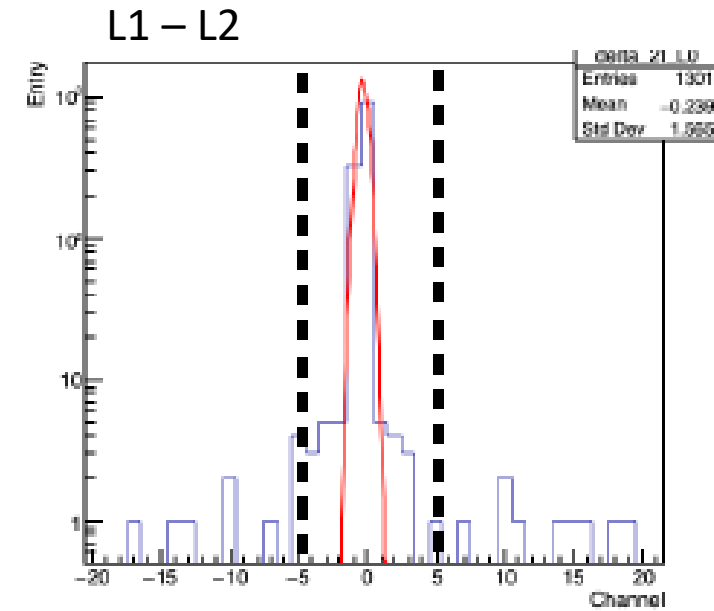
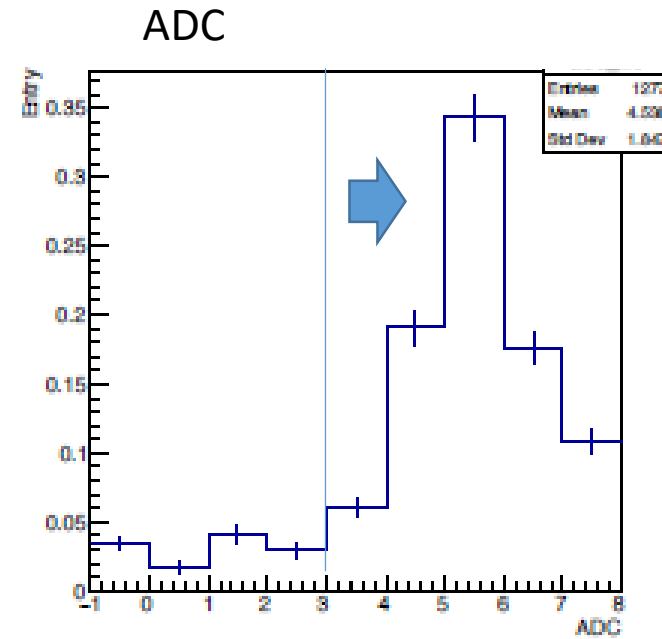
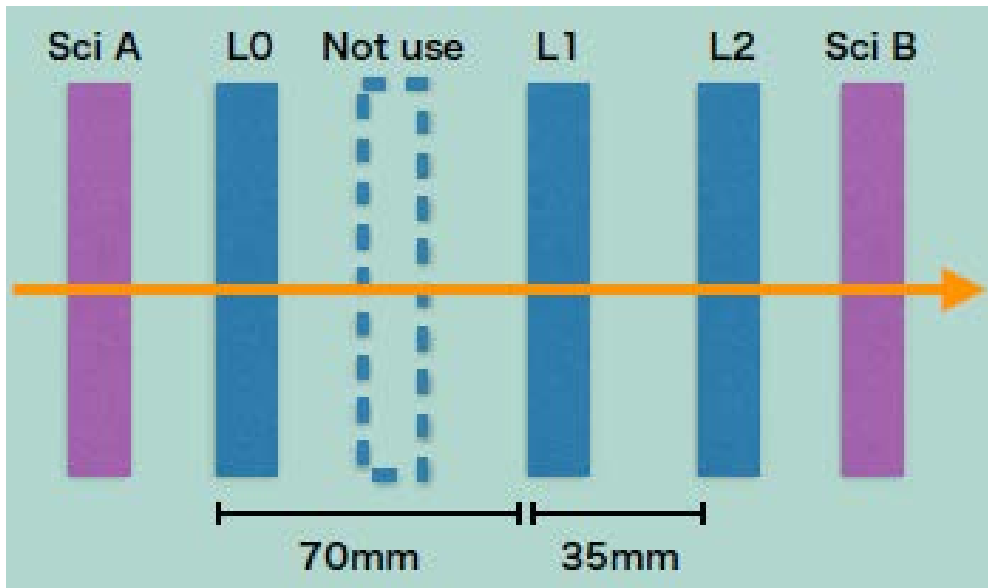
# MIP peak Layer=0 chip=6



- MIP peak clearly seen in all plots
  - PEAK = 664@L0
  - X-axis is changed to mV ( same with N electrons)
- Single strip hit is requested.
- MIP peak is confirmed by GEANT



# Efficiency



- Analysis cut
  - Hit in denominator : single hit + ADC>3
  - Correlated hits in 3 layers

$$eff = \frac{L1 + L2 + L0}{L1 + L2}$$

- Efficiency
  - A few % loss by the timing
  - Noise can saturate the band width

	L0	L1	L2
2019	<b>96.0 ± 0.55%</b>	<b>65.6 ± 1.1 %</b>	<b>85.9 ± 0.98 %</b>
2018	<b>95.8 ± 0.17%</b>	<b>97.7 ± 0.13 %</b>	<b>97.8 ± 0.13 %</b>

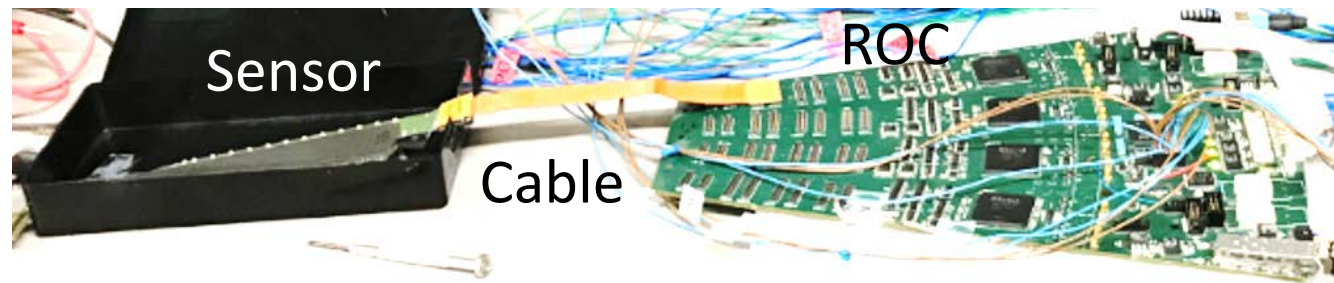


# Next beam test in May 2020

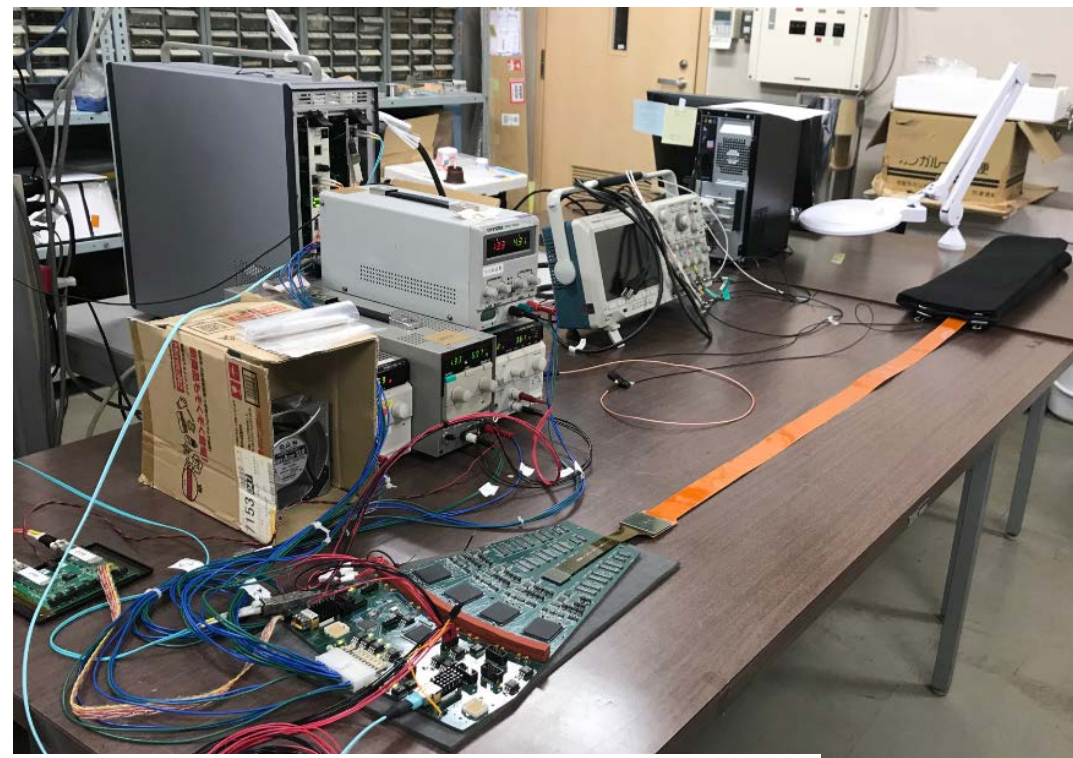
- Take more data with full readout chain
  - Work with full readout chain
- Study the efficiency loss by timing
  
- Plan
  - March 23rd - April 10th Ladder assembly and test
  - April 1st - 14th GTM based DAQ test. (Should be prepared even earlier)
  - April 15th - 21st Packing and shipping equipments
  - April 22nd - 29th install at FTBF
  
- Crucial part
  - GTM based DAQ well prepared
    - We have new engineer from the BNL instrumentation division.
      - Work for the DAQ and upgrade the DAQ with the streaming readout

# Very long data cable (Bus extender) R & D

- Follow the FVTX tech -- FPC
- Status
  - Design completed
  - Prototype tested at FNAL beam test
  - Performance looks OK
- Issues
  - Remain in the production



	FVTX	INTT
Length	10~30 cm	<b>120cm</b>
Layer	7	4
Signal	62 pairs (LVDS)	62 pairs
Power	V-a, V-d, GND	V-a, V-d, GND
Substrate	Polyimide	<b>LCP</b>
Impedance	50	50

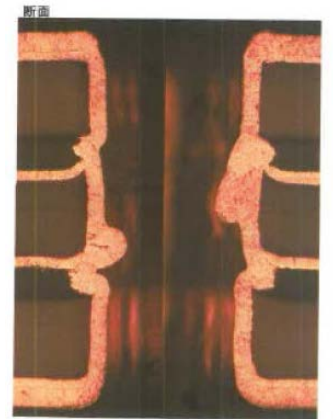
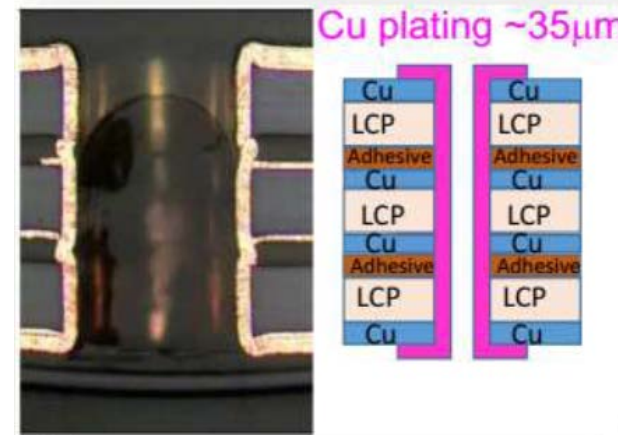


**Long FPC with high density is technically challenging**

# Current Bus Extender status

- Production issue

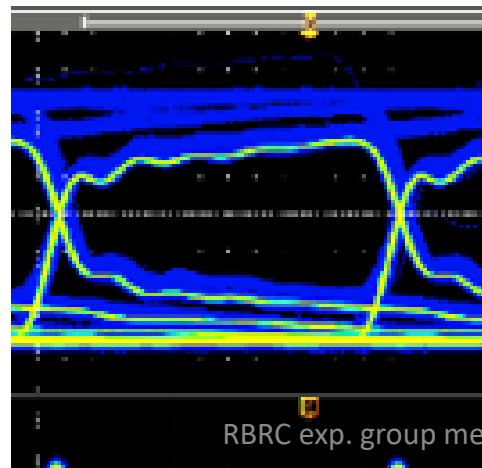
- Making the through hole on FPC has problem
  - Some nodules by residue of the glue
  - Changing the drill and washing the hole by chemical doesn't work very much
  - Testing new glue sheets
    - works nicely



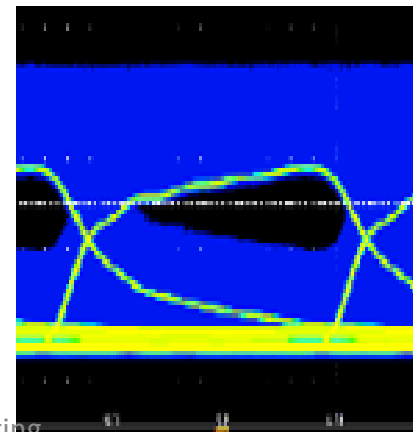
- Pulse heights issue

- Smaller pulse from sensor
  - Eye is small
- Use larger LVDS current to get higher pulse
  - HDI modification is needed

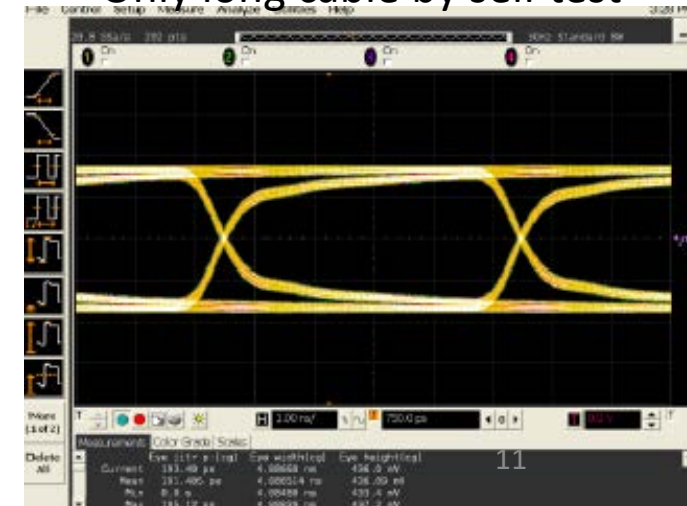
w/o BE



w/ BE



Only long cable by self test

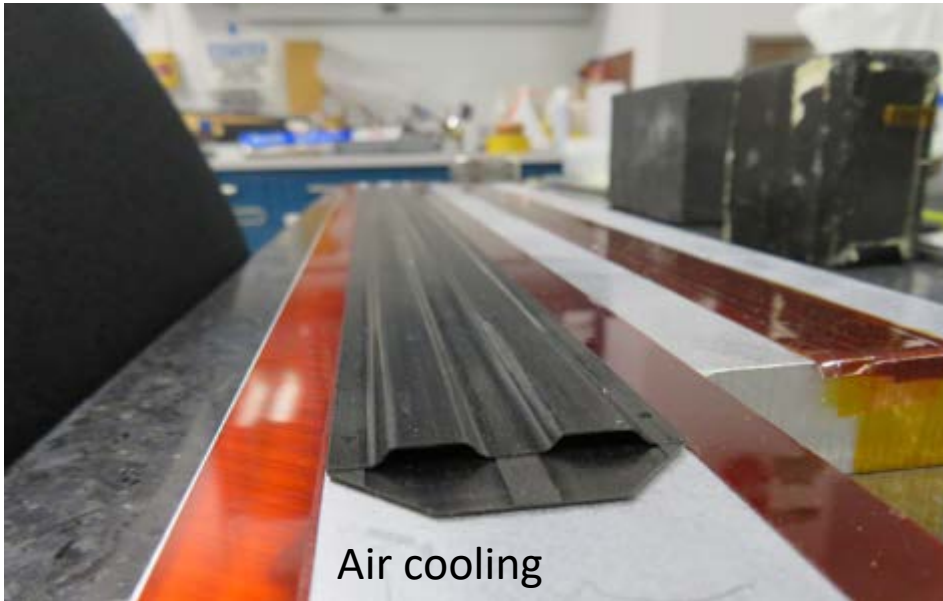


# Stave design updated

- Cooling system from air to liquid (water)
- Thickness 400  $\rightarrow$  600  $\mu\text{m}$  for stiffness
  - the effect on mass resolution is under investigation

Prototype-III

(April, 2019)



Air cooling

Prototype-IV

(Feb. 2020)



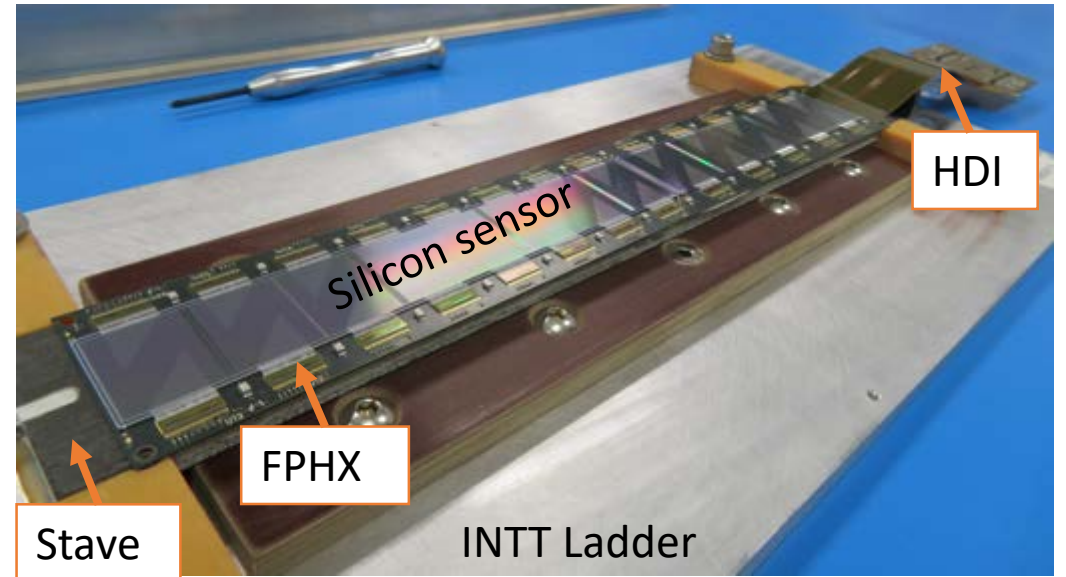
Thickness: 0.38 mm  
Height: 3.5 mm  
Width: 38.00 mm  
Length: 497 mm

Liquid cooling



# Towards Production

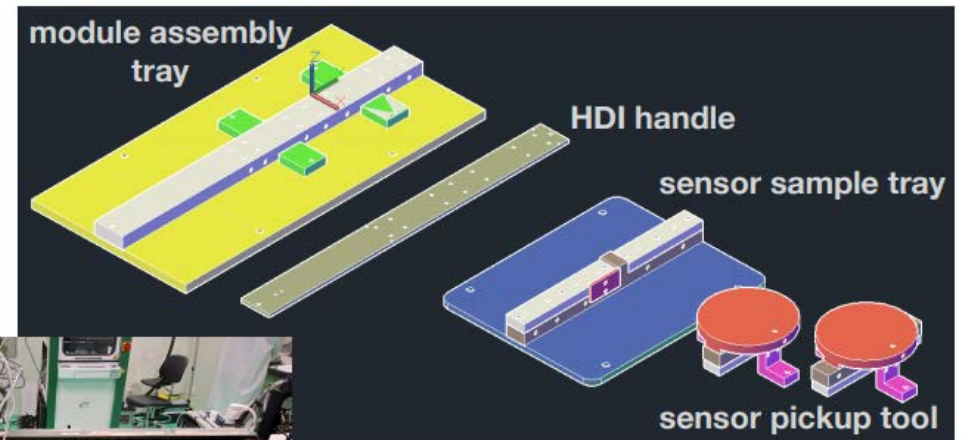
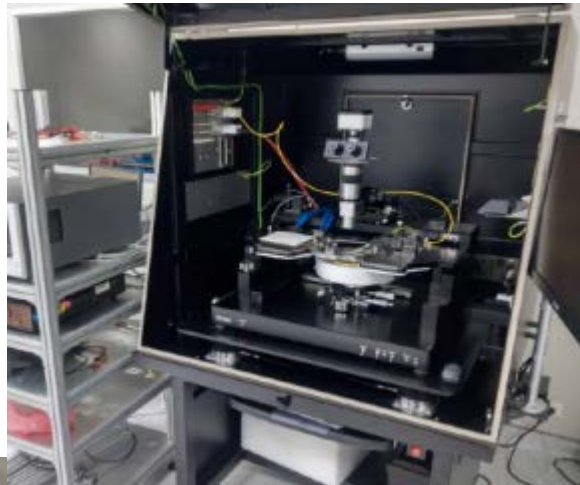
Component	Make	Status
Silicon Sensors	Hamamatsu Co.	Ready
FPHX Chip	FNAL	Ready
HDI	REPIC Co.	Ready
Stave	LBNL -> ASUKA Co.	Prototype-4
Bus Extender	REPIC Co.	Prototype-4



Moving to the production phase

# INTT Production

- Production at BNL (2/3) and NCU (1/3)
- Test bench for pre-production check is in preparation

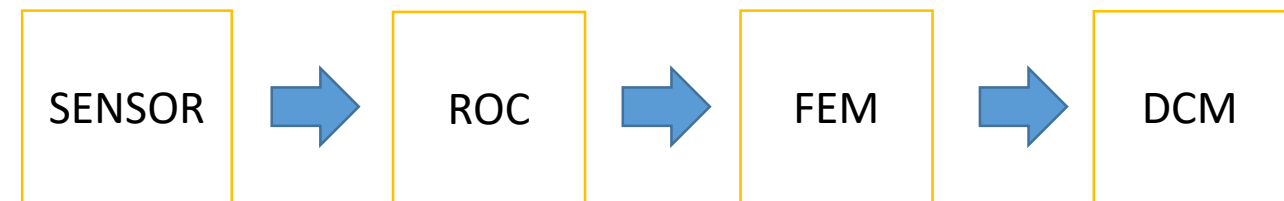


- first design of the assembly tools was done and tested on the gantry @ NTU
- the concept is good, some minor changes are needed
- will discuss whether it's possible to start with stave → need larger oven
- aim for assembling the first ladder in Taiwan for next beam test!

# Streaming readout

- FELIX is used for streaming read out at sPHENIX
  - Developed for ATLAS
  - sPHENIX TPC uses FELIX
  - sPHENIX management decided to use this for INTT (All tracking detectors)
- INTT needs to update readout chain
  - FELIX replace FEM and DCM-II
  - ROC FPGA code needs to be updated for FELIX
    - New engineer take care of this

Current readout chain

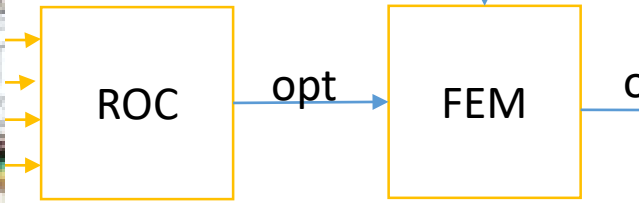
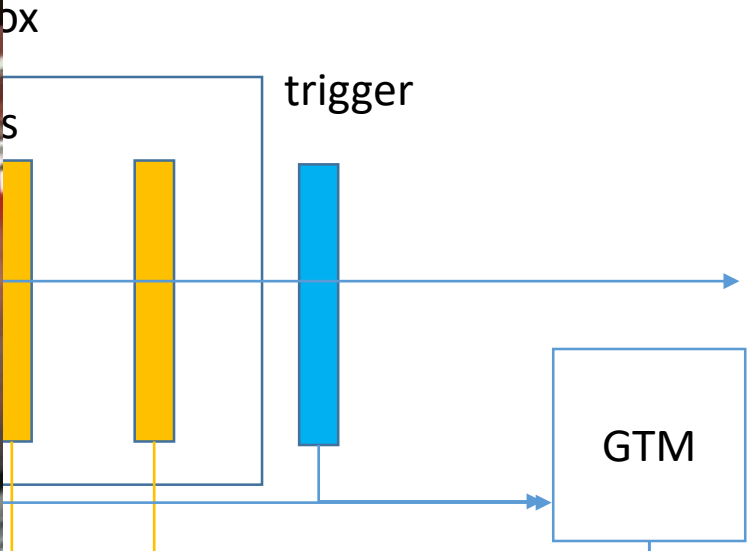
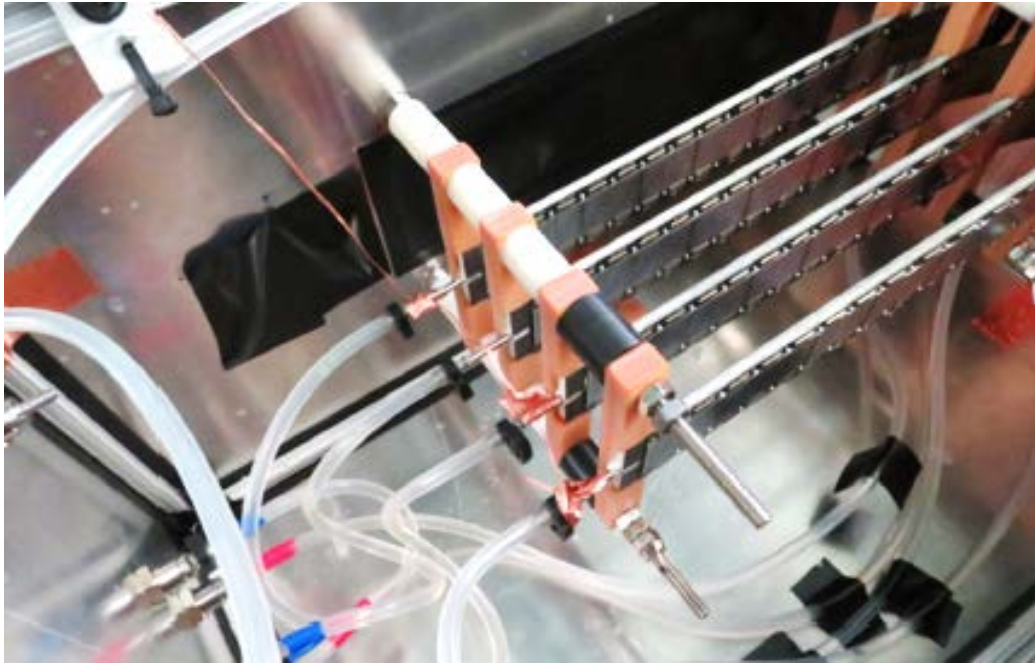


FELIX readout chain









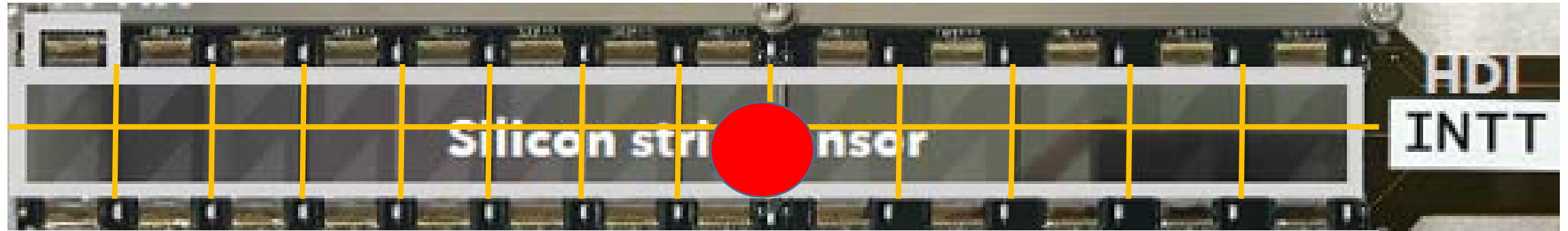
of 4)

works  
alone test bench at lab.

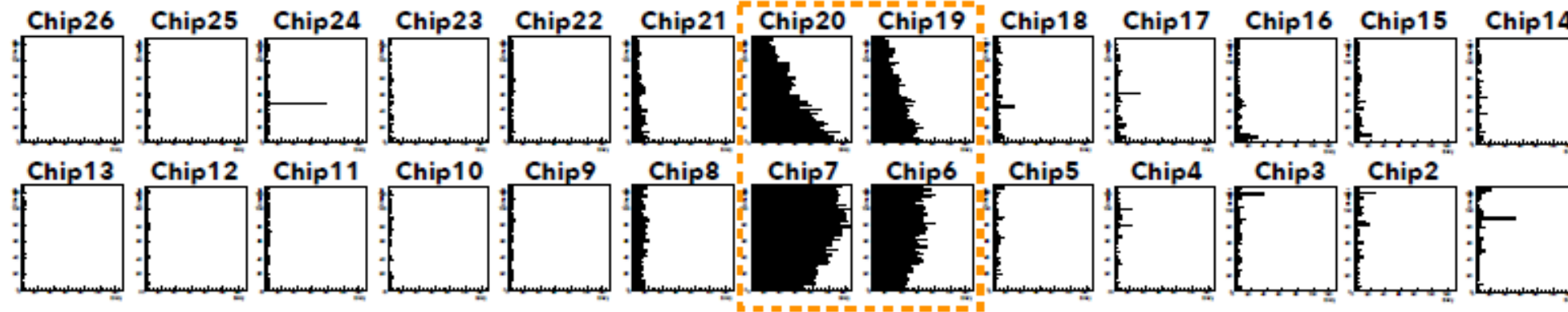


# Beam Signal

Beam position

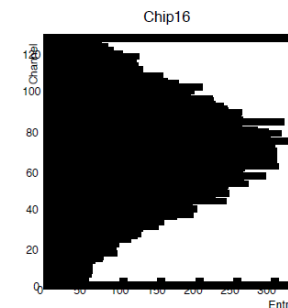


Beam spot = chip 6,7,19,20



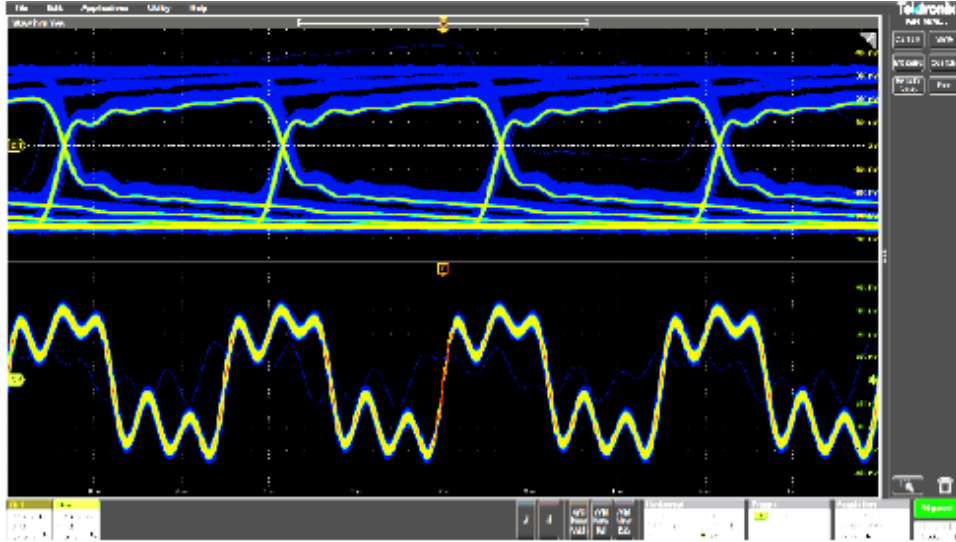
- Beam width in 2019 is wider than that in last year
- Analysis is in progress

Beam in 2018

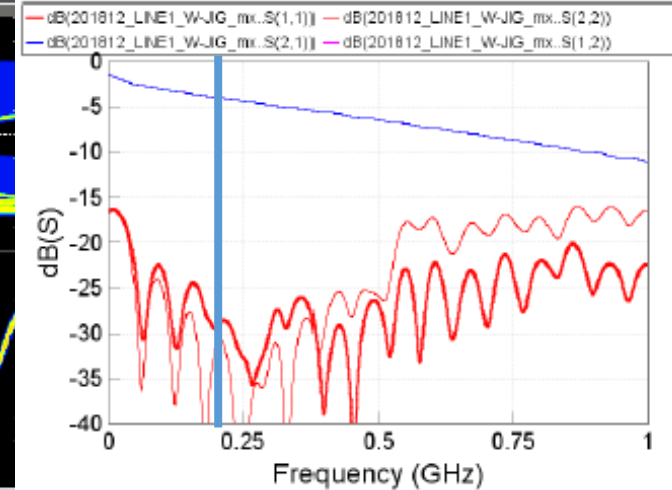
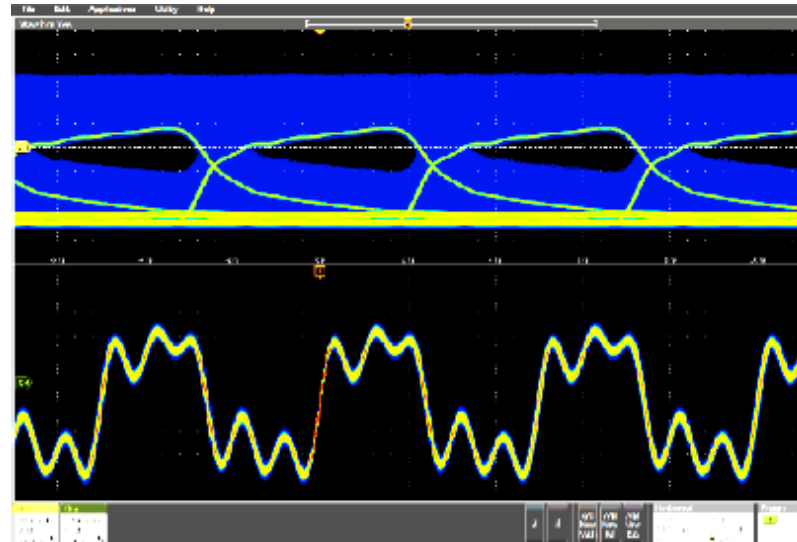


# LVDS Signal from FPHX w/ and w/o long cable

w/o cable



w/ cable



Only long cable by self test



- Signal height w/ the cable is 70% of that w/o the cable
  - Consistent with the expectation from EM simulation
- Eye is not enough open
- It is confirmed that the bus extender itself has a good performance on signal transfer
  - Bus Ext with FPHX shows bad