Final Design of the INTT Ladder and Production Readiness Review (PRR)

Ladders Evaluation and Classification

WBS: 3.01

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Overview

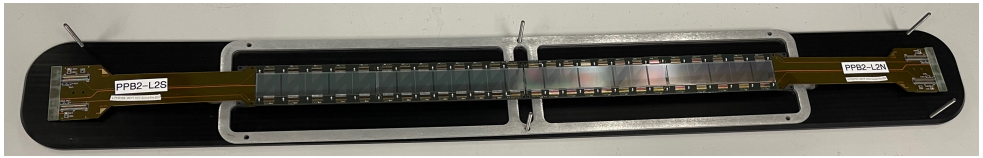
- Evolution
  - 2017 – Half-ladders Prototype 1
  - 2019 – Half-ladders Prototype 2
- 2021 – Ladder Pre-Production
- Ladder testing & performance
  - Monitoring

Half-ladder

- 1 HDI
- 26 chips
- 2 Sensors

Ladder

- 2 HDIs
- 52 chips
- 4 Sensors



2017 – Prototype Half-ladder

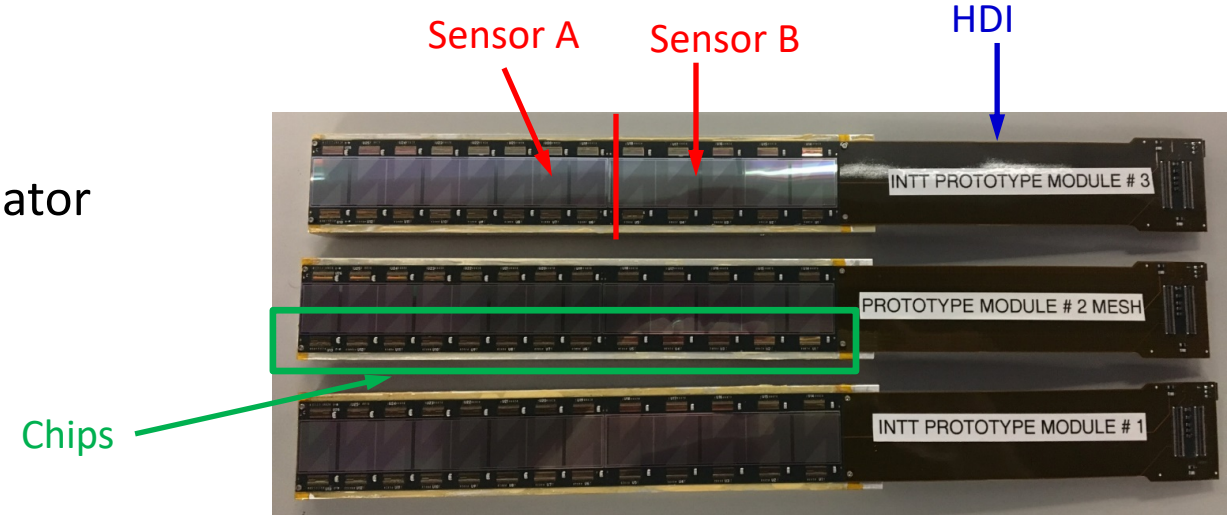
- 3 Half-ladders built at BNL
- Stave is aluminum plate

Sensors Table

Type	number of blocks	active area dimension	strip pitch
A	8	128 mm × 19.96 mm	78 μm
B	5	100 mm × 19.96 mm	78 μm

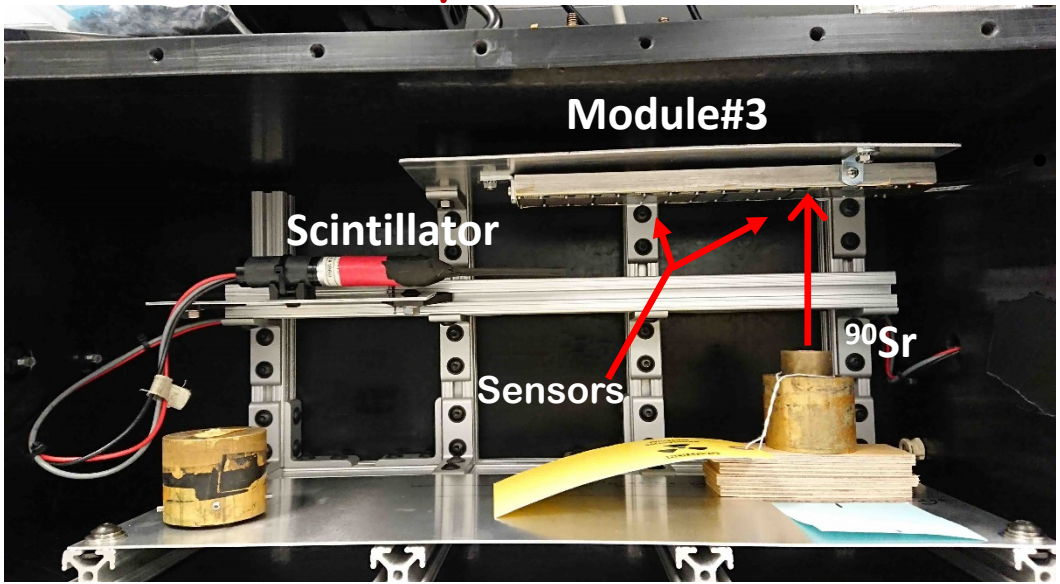
Testing achieved:

- ❑ Source test
- ❑ External Trigger Scintillator
- ❑ Beam test



2017 – Prototype Half-ladder

Source Test Setup at BNL

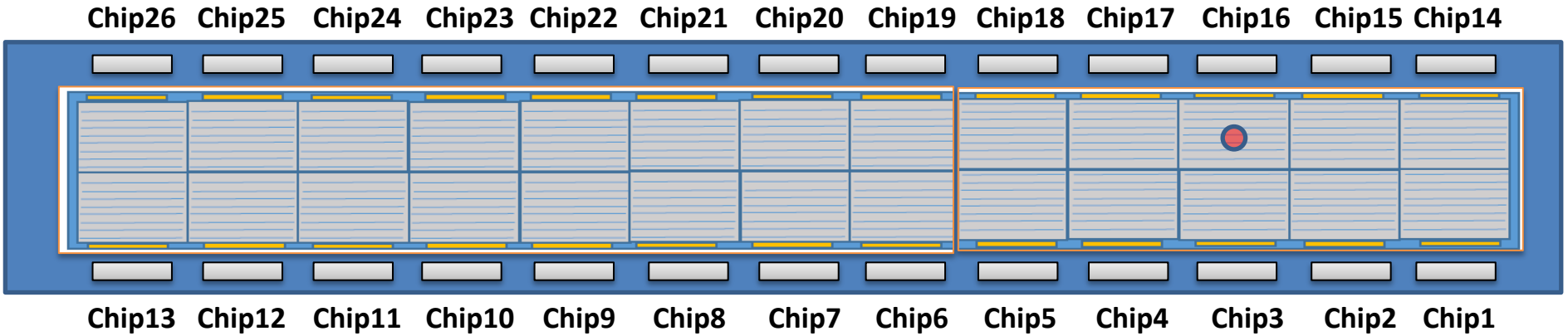


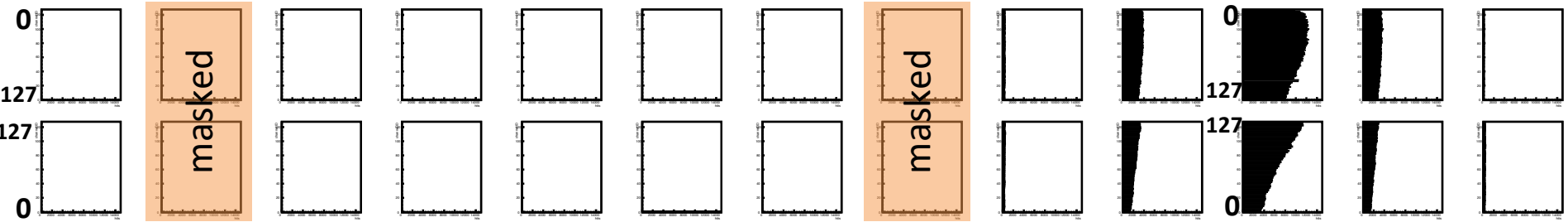
^{90}**Sr** illumination focuses on Chip16.

- 3mm-thick scintillator was put in front of Module.

2017 – Prototype: Source test

^{90}Sr Source

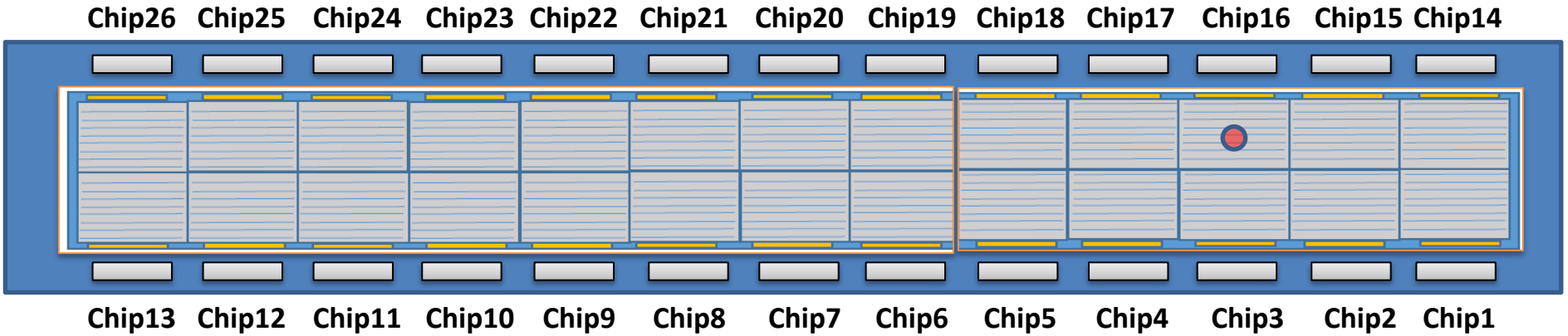


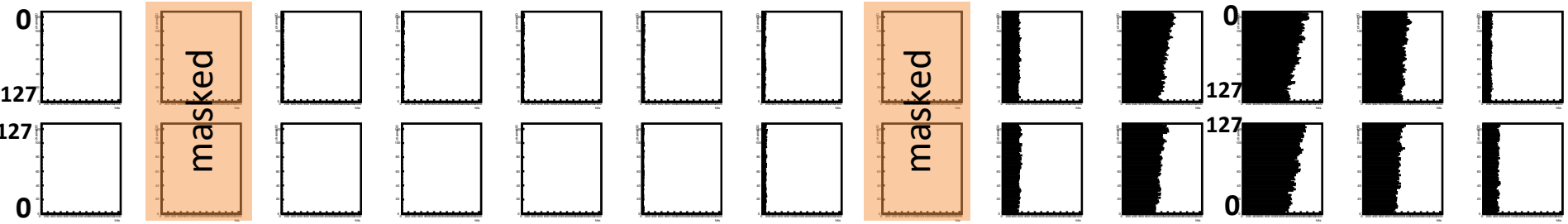


hits versus channel id for each strip

2017 – Prototype: External Trigger Scintillator

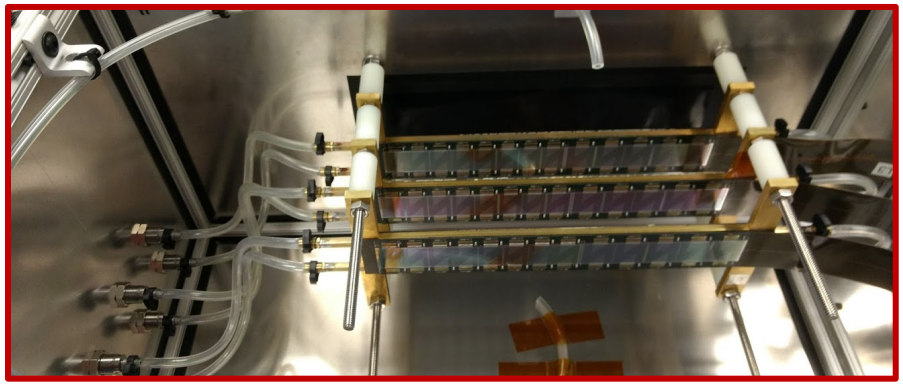
^{90}Sr Source + Scintillator

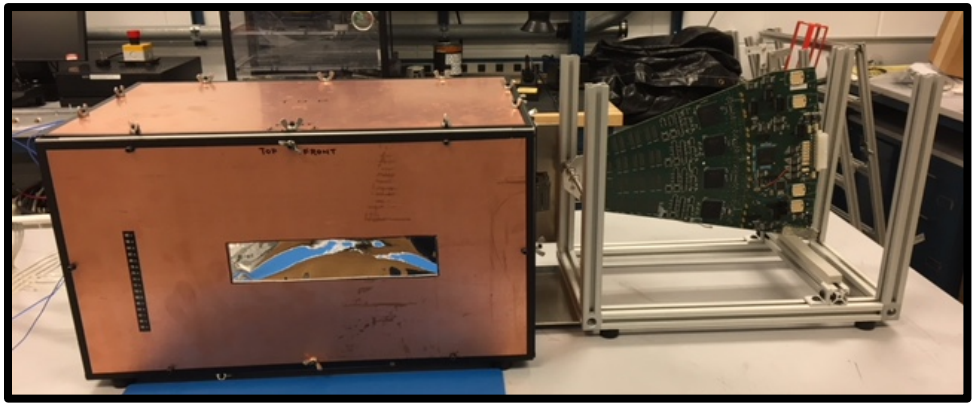




hits versus channel id for each strip

Beam Test 2018





First prototypes built on aluminum plates.

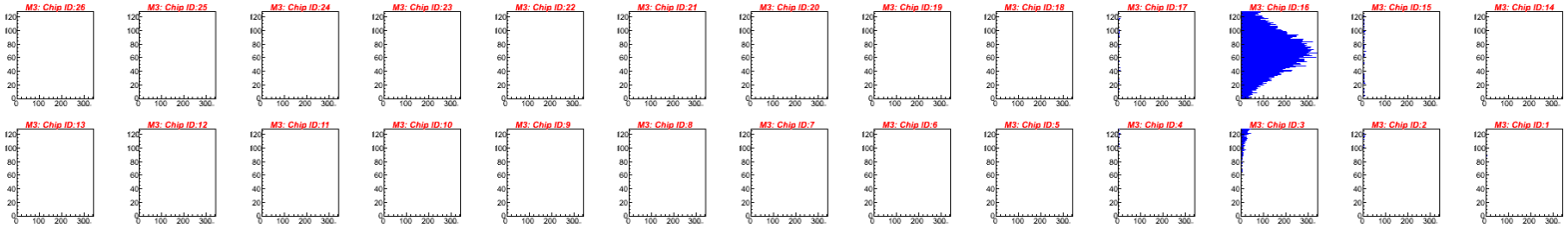
Beam Test 2018

Proton beam – 120 GeV

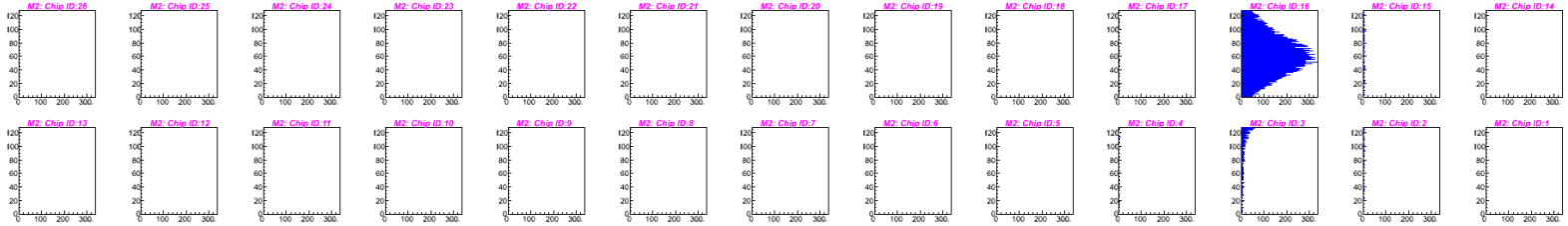
X-axis: # of hits
Y-axis: channel number

Very good signal observed

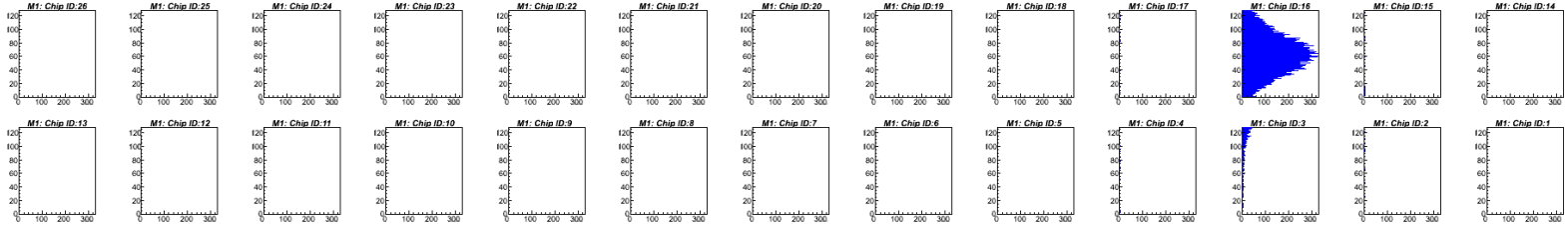
Half-ladder #3



Half-lader #2



Half-ladder #1



Beam Test 2018

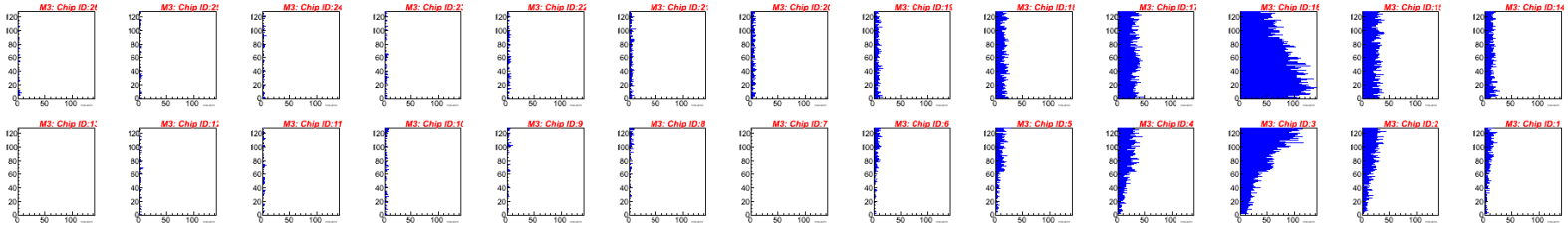
Proton beam – 120 GeV

X-axis: # of hits
Y-axis: channel number

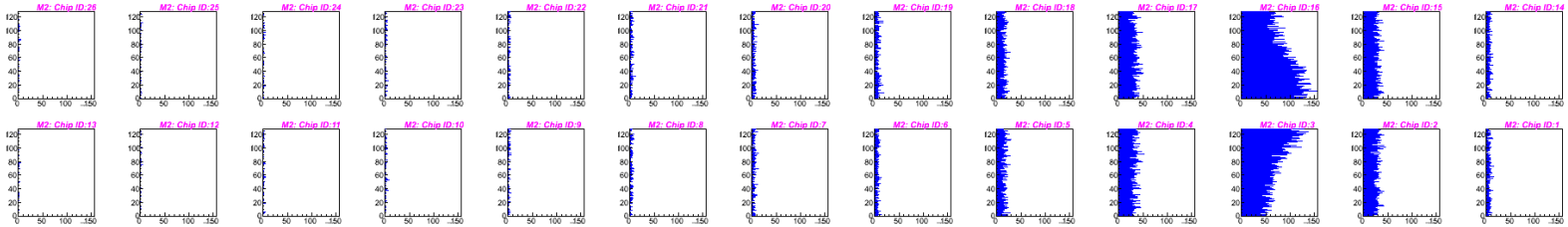
Very good signal observed

With bricks

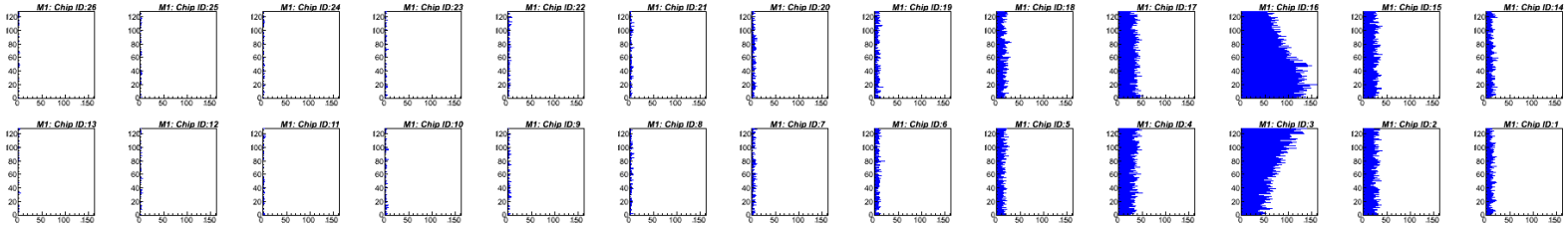
Half-ladder #3



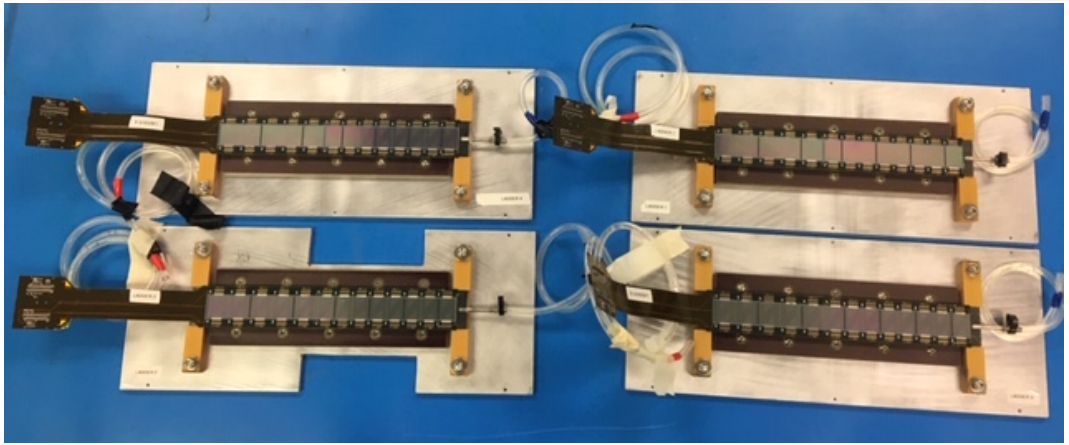
Half-lader #2



Half-ladder #1

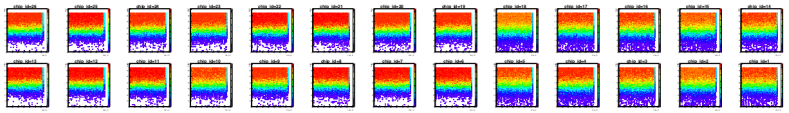


2019 – Prototype Half-ladders

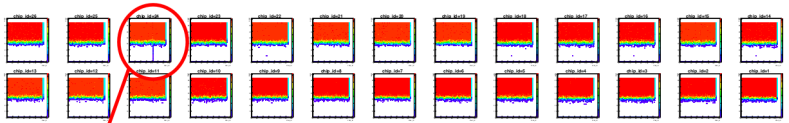


4 half-ladders built on carbon fiber plates.

Bias voltage = 0 V



Bias voltage = 100 V, leakage current = 0.26 uA

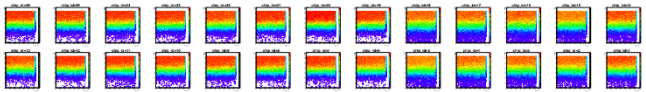


Id 24, channel ID range [80,85]: maybe noisy.

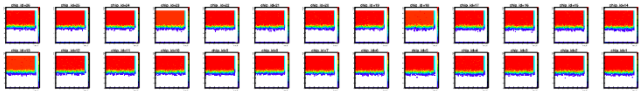
- INTT ladder 4
- 20 cm conversion cable 1
- Roc 9
- P400-P401

- INTT ladder 3
- 20 cm conversion cable 1
- Roc 9
- P400-P401

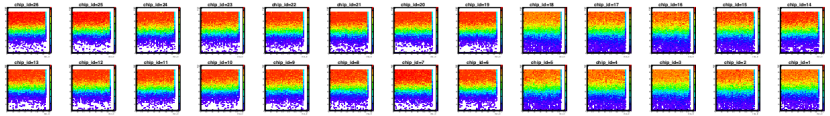
Bias voltage = 0 V



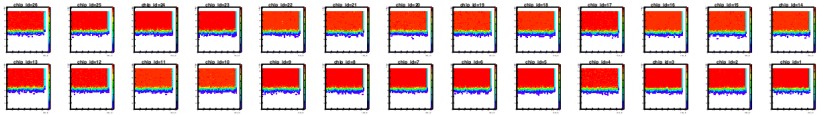
Bias voltage = 100 V, leakage current = 0.43 uA



Bias voltage = 0 V



Bias voltage = 100 V, leakage current = 0.48 uA



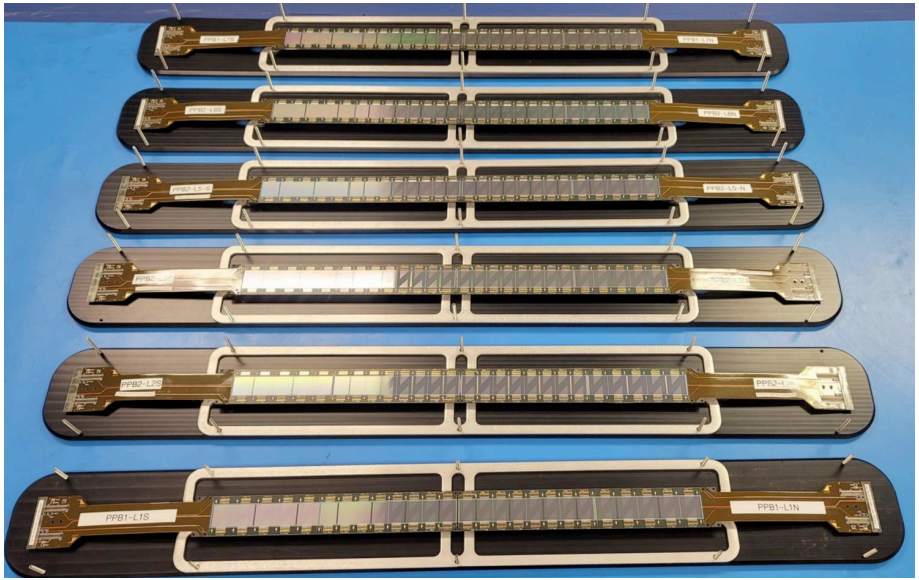
- INTT ladder 1
- 20 cm conversion cable 1
- Roc 9
- P400-P401

2021 Ladder Pre-production

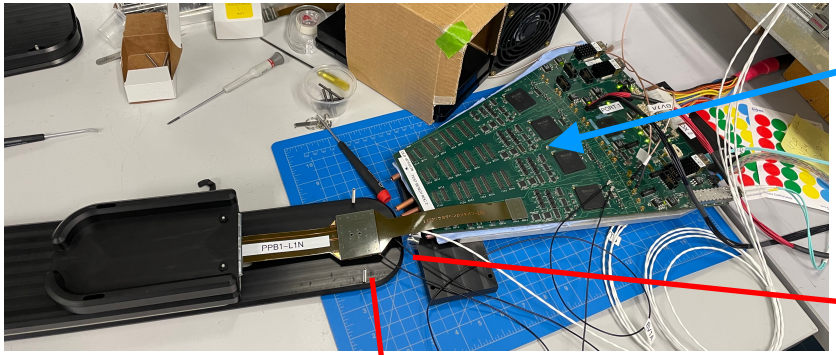
2021 Pre-production

- 7 Ladders were built at BNL

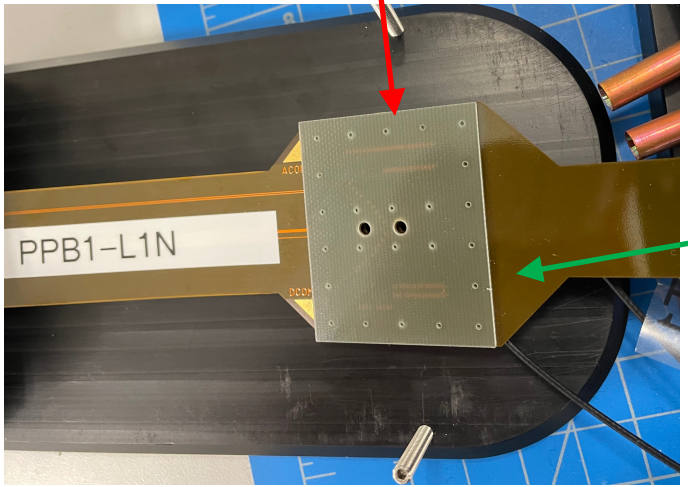
- Three stages of measurement:
  - HDIs-Chips (regulator 2.5V)
  - HDIs-Chips-Sensors (regulator 2.5V)
  - Encapsulated (regulator 3.0V)



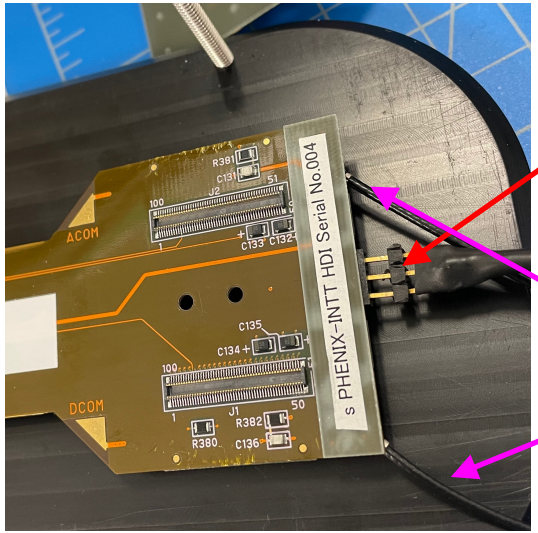
2021 Ladder testing



ROC



Conversion cable

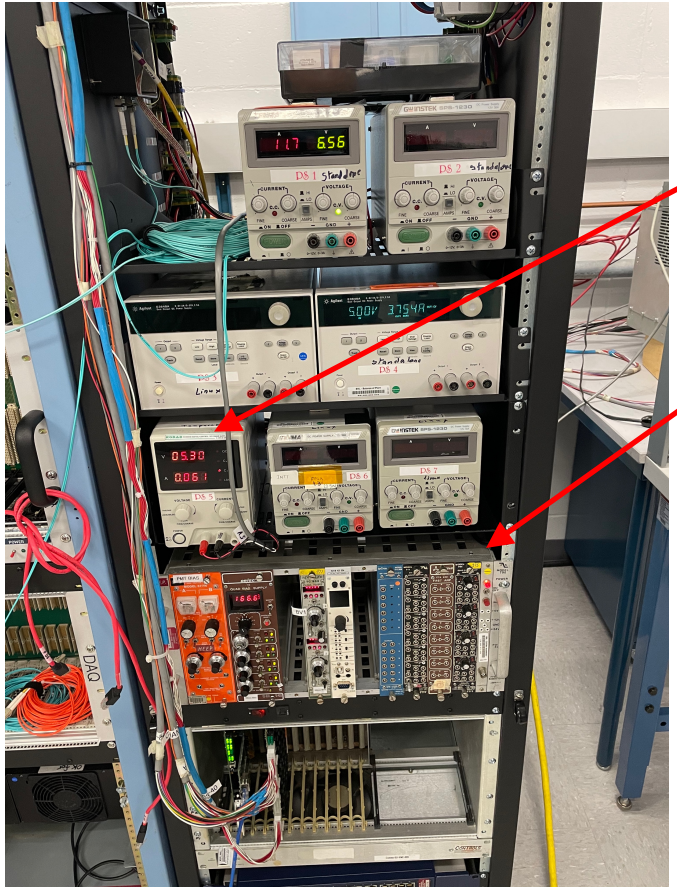


Temperature

BV1B

BV1A

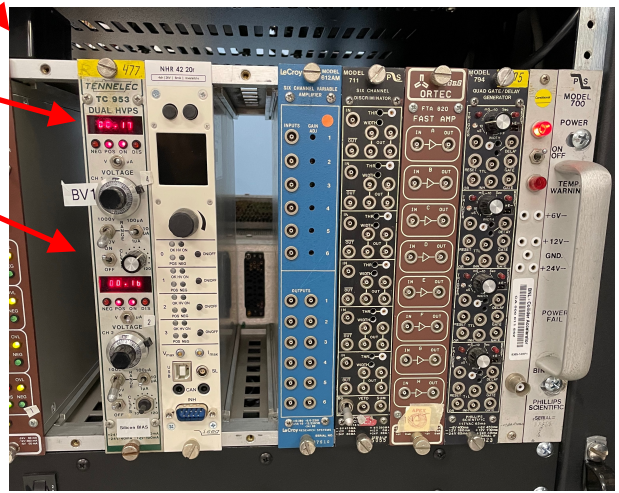
2021 Ladder testing



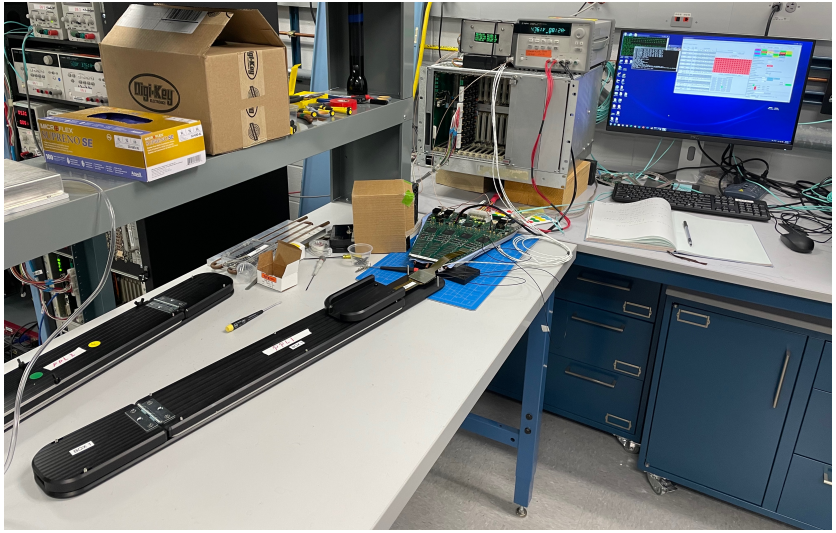
Temperature

Silicon Bias

- ❖ BV1A
- ❖ BV1B



2021 Ladder testing



2021 Pre-production Status of the Ladder

Ladder

HDIs/Chips

0 Chip is BAD
1 Chip is Mounted
2 Chip is Good

Queue Colors: 7 Days, 11 Days, 14 Days

Count	NEW TEMP New Name	Barrel Type	Built At	South Chips/HDI Status: Wire Bonding Delivered Date	U26	U25	U24	U23	U22	U21	U20	U19	U18	U17	U16	U15	U14	Data File Name	North Chips/HDI Status: U26	U25	U24	U23	U22	U21	U20	U19	U18	U17	U16	U15	U14	File Name	Wire Bonding: Days in Queue	Date Completed
					U13	U12	U11	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1		U13	U12	U11	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1			
1	PPB1_L1	1	BNL	11/2/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	20210106-1219_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20210106-1619_0,2		
					2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	0	2	2			
2	PPB2_L2	2	BNL	11/4/2020	2	2	0	2	2	2	2	2	2	2	2	2	2	20201207-1607_0, 2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201207-1613_0,2		
					2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2			
3	PPB2_L3	2	BNL	11/6/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	20210106-1710_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20210106-1653-0,2		
					2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2			
4	PPB2_L4	2	BNL	11/9/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1021_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1102_0,2		
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5	PPB2_L5	2	BNL	11/11/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1251_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1242_0,2		
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6	PPB2_L6	2	BNL	11/13/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1315_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1320_0,2		
					2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2			
7	PPB1-L7	1	BNL	11/16/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	20201202-1106_0, 2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201202-1047_0,2		
					2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2			

Ladder

Sensors

Sensor s BAD
Sensor is Mounted
Sensor is Good

Queue Colors: 7 Days, 11 Days, 14 Days

0 Bad
1 Ready For Enc
2 At Inst
3 Encapsulated
4 Tested Good

Ladder

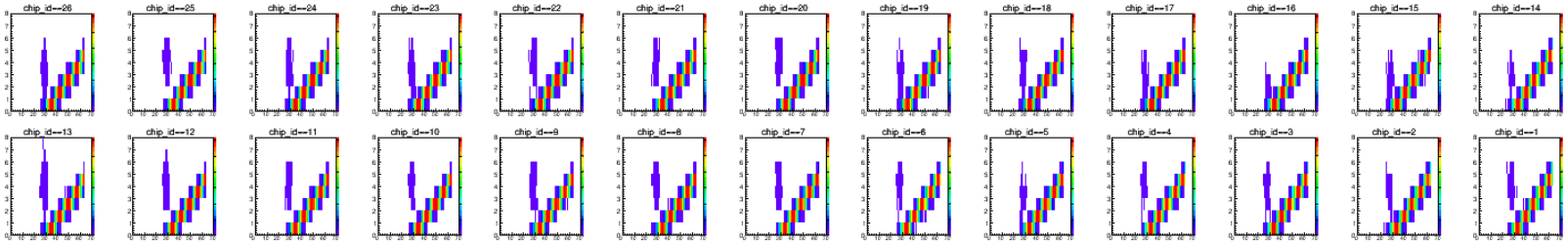
Count	NEW TEMP New Name	Barrel Type	Built At	South Sensor Status: Wire Bonding Delivered Date	Sensor A	Sensor B	File Name	North Chips/HDI Status: Sensor A	Sensor B	File Name Vb=100V	Wire Bonding: Days in Queue	Date Completed	Encapsulation: South	File Name	North	File Name	Date Complete	Ladder Class 1 to 5	Location Of Ladder
1	PPB1_L1	1	BNL	01/14/2021	2	2	20210128-1111_0,2	2	2	20210128-1059_0,2	5	01/19/2021	2		2				BNL
2	PPB2_L2	2	BNL	01/06/2021	2	2	20210127-1558_0,2	2	2	20210127-1545_0,2	9	01/15/2021	2		2				BNL
3	PPB2_L3	2	BNL	01/14/2021	2	2	20210128-1021_0,2	2	2	20210128-1012_0,2	5	01/19/2021	4	20210222-0905_0,2	4	20210222-1040_0,2	02/19/2021		BNL
4	PPB2_L4	2	BNL	01/13/2021	2	2	20210127-1622_0,2	2	2	20210127-1641_0,2	8	01/21/2021	4	20210222-1206_0,2	4	20210222-1113-0,2	02/22/2021		NWU
5	PPB2_L5	2	BNL	12/10/2020	2	2	20210127-1519_0,2	2	2	20210127-1506_0,2	29	1/8/2021	4	20210222-	4	20210222-	02/22/2021		NWU
6	PPB2_L6	2	BNL	12/07/2020	2	2	20210127_1438_0,2	2	2	20210127_1419_0,2	21	12/28/2020	4	20210224-1220_0,2	4	20210224-1203_0,2	02/24/2021		NWU
7	PPB1-L7	1	BNL	12/04/2020	2	2	20210127_1159_0,2	2	2	20210127_1133_0,2	19	12/23/2020	4	20210222-1549_0,2	4	20210122-1519_0,2	02/22/2021		BNL

2021 Bench Test Performance

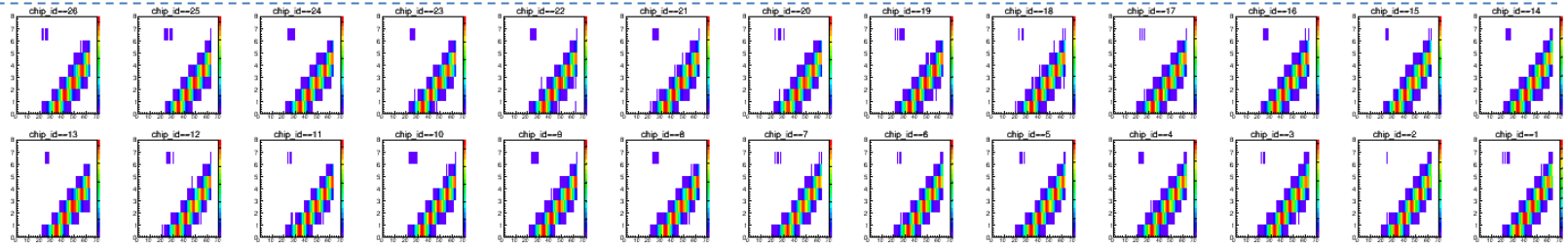
PPB2-L5 South - Calibration plots

x – amplitude; y – ADC

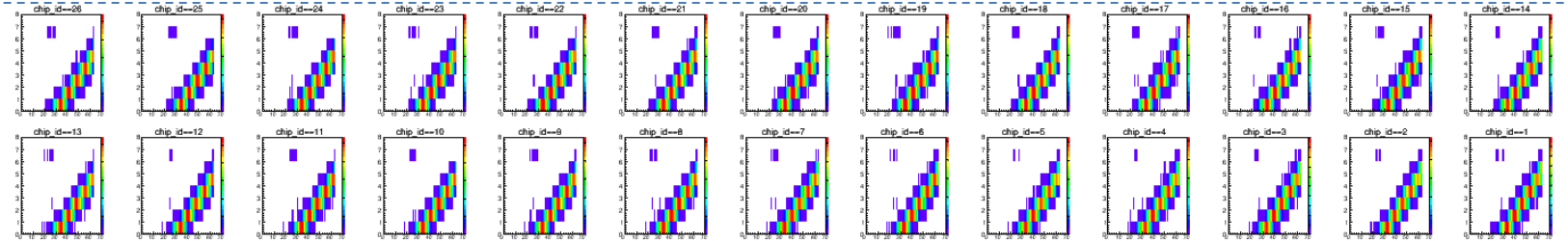
HDIs-Chips



HDIs-Chips-Sensors



Encapsulated

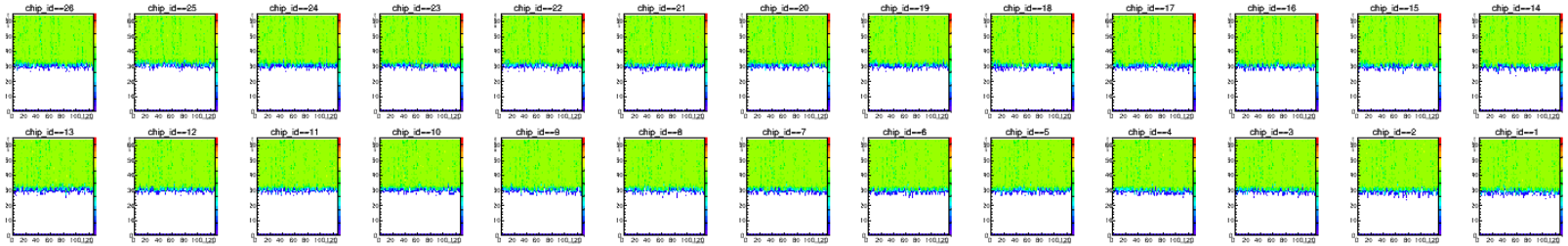


2021 Bench Test Performance

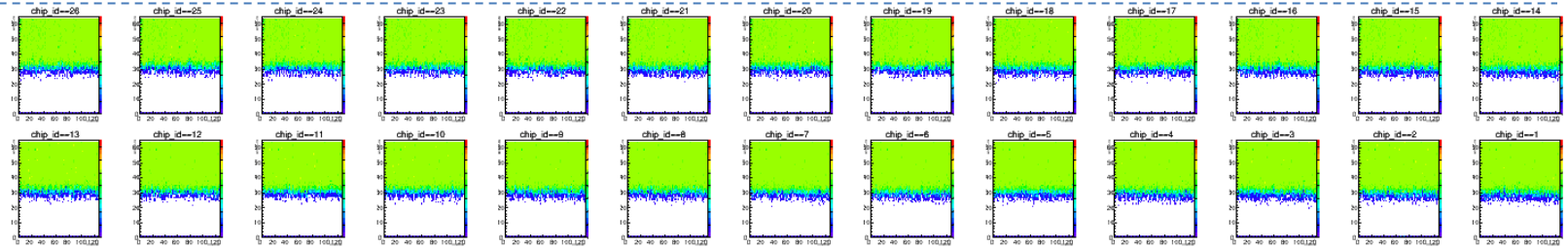
PPB2-L5 South - Calibration plots

x – Channel; y – amplitude

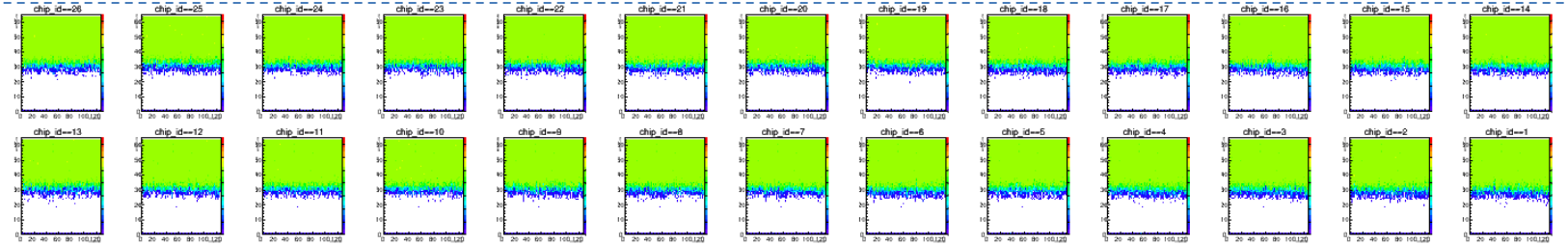
HDIs-Chips



HDIs-Chips-Sensors



Encapsulated

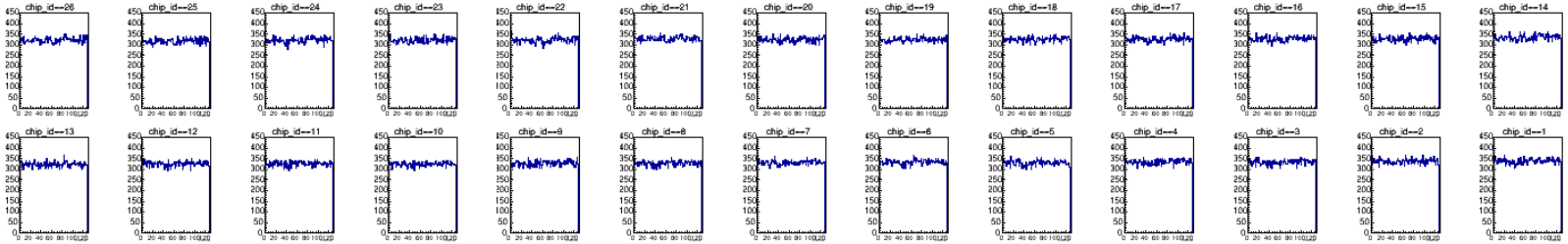


2021 Bench Test Performance

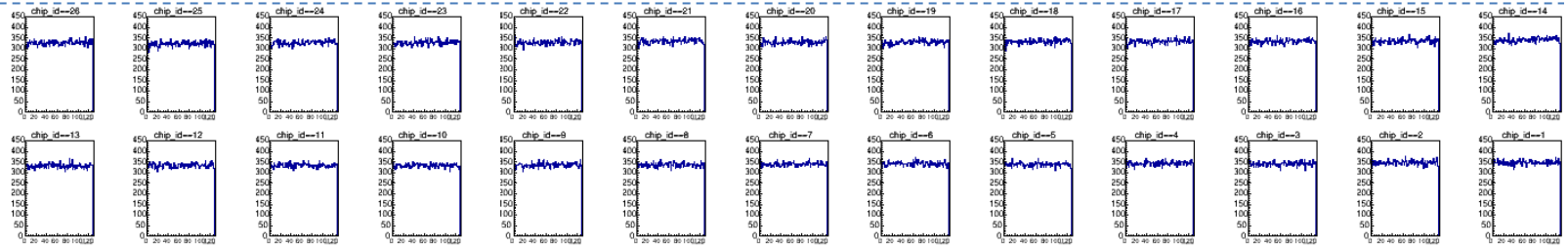
PPB2-L5 South - Calibration plots

x – channel; y – # of entries

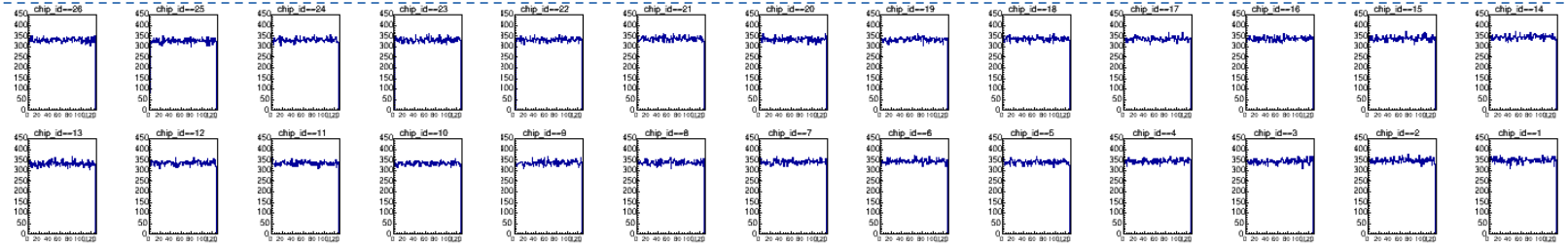
HDIs-Chips



HDIs-Chips-Sensors



Encapsulated



2021 Test Web Monitoring

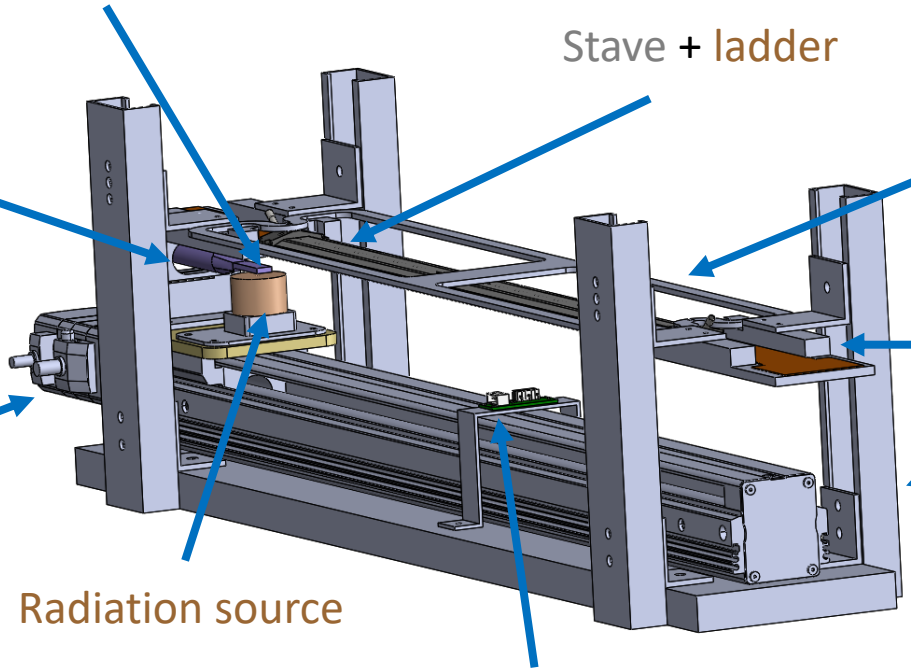
- Wiki page for test monitoring: https://wiki.bnl.gov/sPHENIX/index.php/Assembly_at_BNL

Assembly at BNL

Data and analysis macros can be found at: Click Here

	Ladder	HDIs-Chips: South	South Status	HDIs-Chips: North	North Status	Chips-Sensors South (100 V)	South Status	Chips-Sensors North (100 V)	North Status	Encapsulated: South	South Status	Encapsulated: North	North Status
1	PPB1-L1	- 20210106-1219_0,2 1) png, 2) png, 3) png	GOOD	- 20210106-1619_0,2 1) png, 2) png, 3) png	GOOD								
2	PPB2-L2	- 20201207-1607_0,2 1) png, 2) png, 3) png	GOOD	- 20201207-1613_0,2 1) png, 2) png, 3) png	Fewer entries for chip 13								
3	PPB2-L3	- 20210106-1710_0,2 1) png, 2) png, 3) png	GOOD	-20210106-1653-0,2 1) png, 2) png, 3) png	GOOD	20210128-1021_0,2 1) png, 2) png, 3) png	Chip 16 has more entries	20210128-1012_0,2 1) png, 2) png, 3) png	Chips 5 & 19 less entries for channels 32 & 25, respectively	20210222-0905,2 1) png, 2) png, 3) png		20210222-1040,2 1) png, 2) png, 3) png	
4	PPB2-L4	- 20201130-1021_0,2 1) png, 2) png, 3) png	Chips 14-26: No entries for channels > 105	- 20201130-1102_0,2 1) png, 2) png, 3) png	GOOD	20210127-1622_0,2 1) png, 2) png, 3) png	GOOD	20210127-1641_0,2 1) png, 2) png, 3) png	Chips 1-13: fewer entries for channels >80	20210222-1206_0,2 1) png, 2) png, 3) png		20210222-1113_0,2 1) png, 2) png, 3) png	

2021 Automatic Source Test Design



Ladder Evaluation

Ladder evaluation is based:

- Calibration
- Amplitude vs Channel ID
- # of entries for each Channel
- Automatic source test (not performed yet)

Classification is based on working live/dead channels from evaluation test

Summary

- ✓ 7 ladders produced
- ✓ All tests showed good ladder work properly
- ✓ Consistent performance in every assembly step
- ✓ Status and test monitoring available on-line
- ❑ For final evaluation we need automatic source test
- ❑ Ready for mass-production