

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

Ladders Evaluation and Classification

WBS: 3.01

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March 2nd, 2021

❑ Evolution

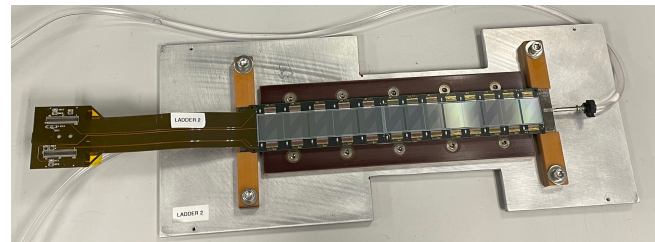
- ❖ 2017 – Half-ladders Prototype 1
- ❖ 2019 – Half-ladders Prototype 2

❑ 2021 – Ladder Pre-Production

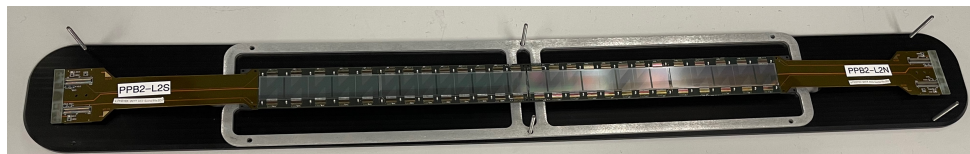
❑ Ladder testing & performance

- ❖ Monitoring

- Half-ladder
- 1 HDI
 - 26 chips
 - 2 Sensors



- Ladder
- 2 HDIs
 - 52 chips
 - 4 Sensors



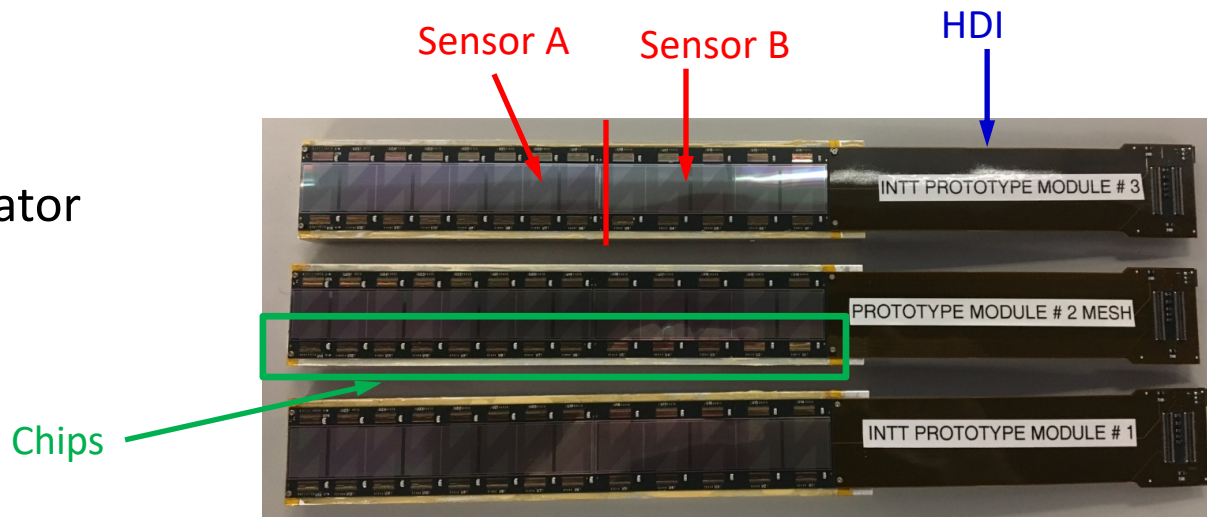
- ❖ 3 Half-ladders built at BNL
- ❖ Stave is aluminum plate

Sensors Table

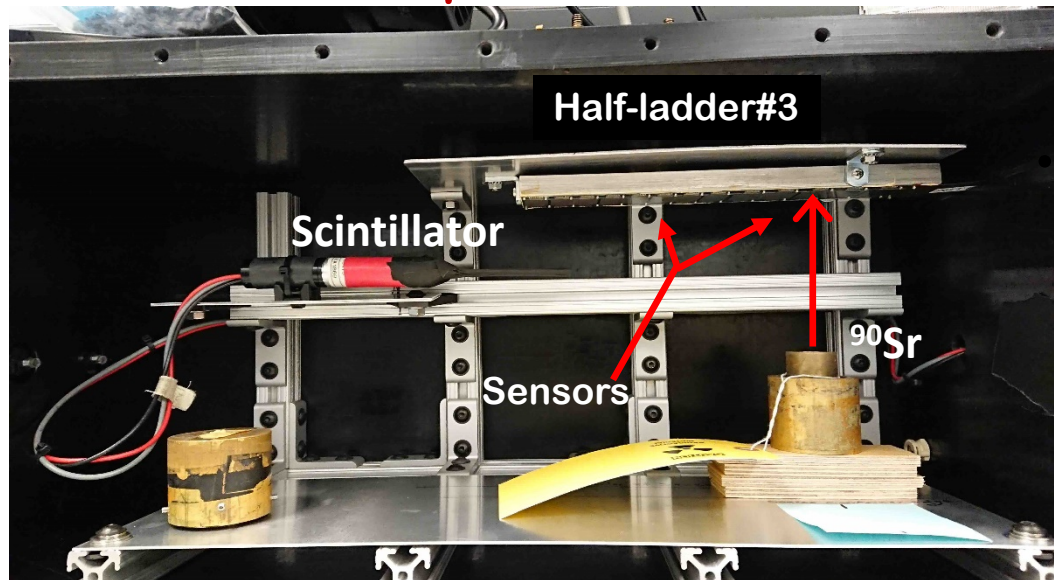
Type	number of blocks	active area dimension	strip pitch
A	8	128 mm × 19.96 mm	78 μm
B	5	100 mm × 19.96 mm	78 μm

Testing achieved:

- Source test
- External Trigger Scintillator
- Beam test



Source Test Setup at BNL



^{90}Sr illumination focuses on Chip16.

- 3mm-thick scintillator was put in front of half-ladder.

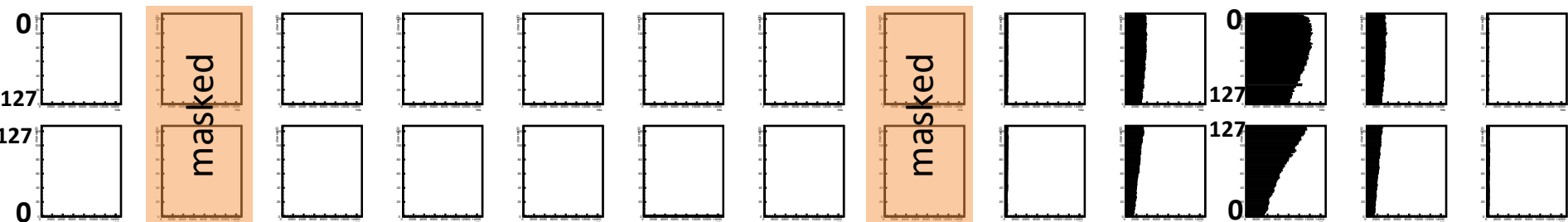
2017 – Prototype: Source test

^{90}Sr Source

Chip26 Chip25 Chip24 Chip23 Chip22 Chip21 Chip20 Chip19 Chip18 Chip17 Chip16 Chip15 Chip14



Chip13 Chip12 Chip11 Chip10 Chip9 Chip8 Chip7 Chip6 Chip5 Chip4 Chip3 Chip2 Chip1



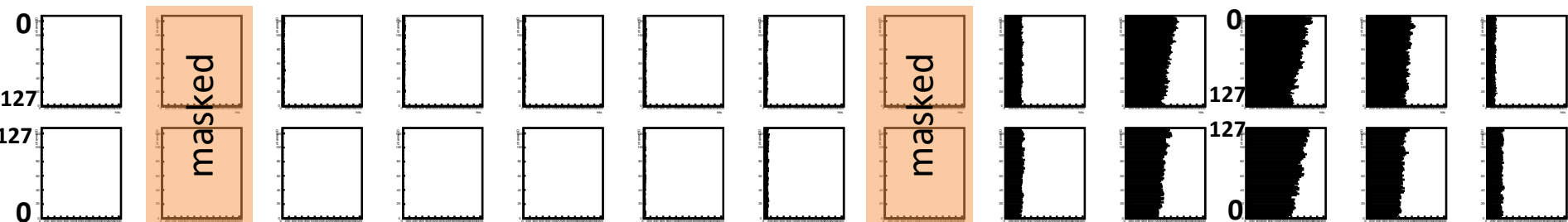
hits versus channel id for each strip

^{90}Sr Source + Scintillator

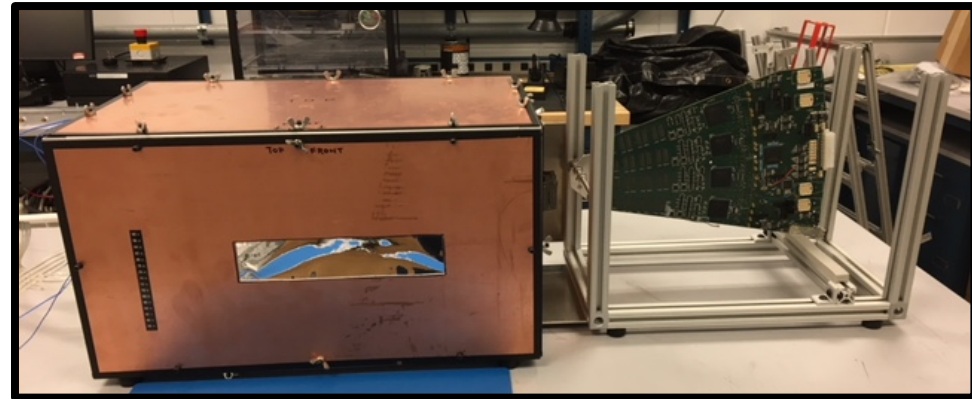
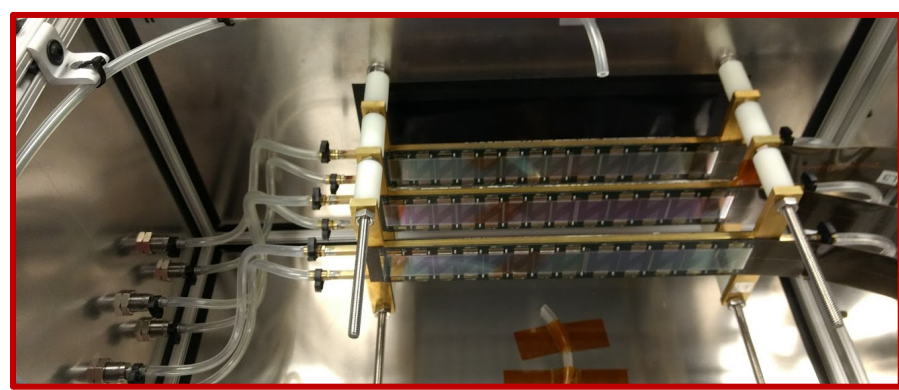
Chip26 Chip25 Chip24 Chip23 Chip22 Chip21 Chip20 Chip19 Chip18 Chip17 Chip16 Chip15 Chip14



Chip13 Chip12 Chip11 Chip10 Chip9 Chip8 Chip7 Chip6 Chip5 Chip4 Chip3 Chip2 Chip1



hits versus channel id for each strip



First prototypes built on aluminum plates.

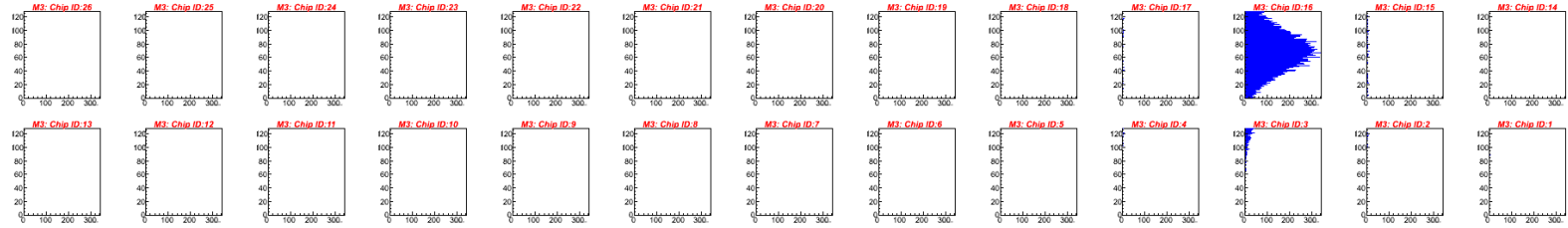


Proton beam – 120 GeV

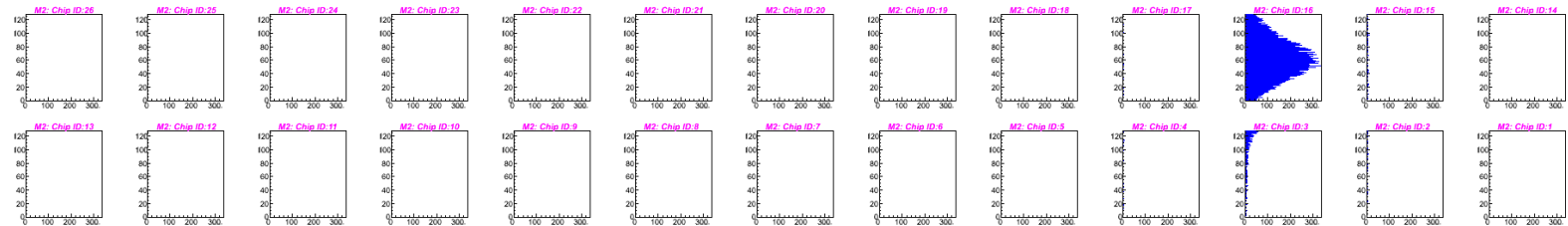
X-axis: # of hits
Y-axis: channel number

Very good signal observed

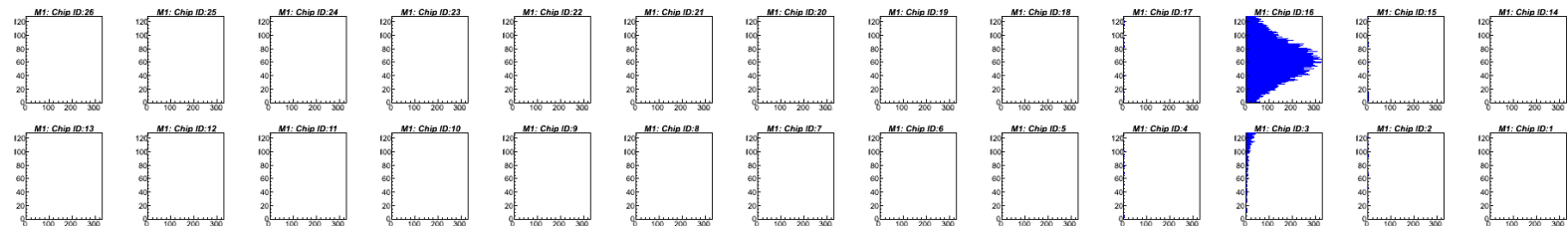
Half-ladder #3



Half-lader #2



Half-ladder #1



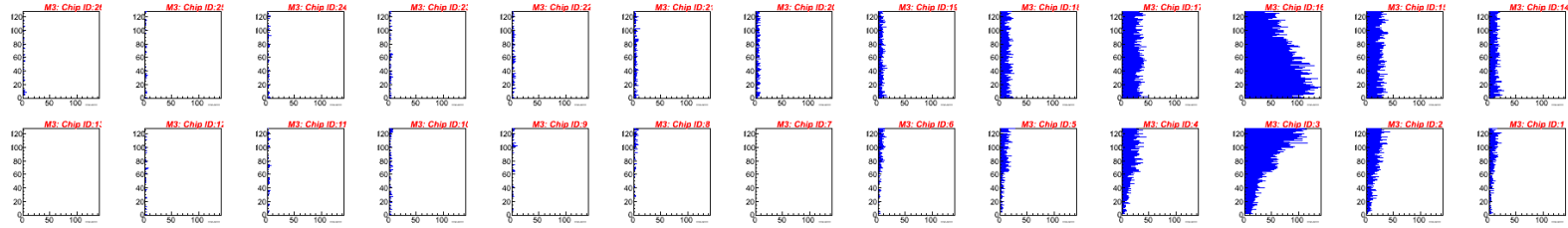
Proton beam – 120 GeV

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

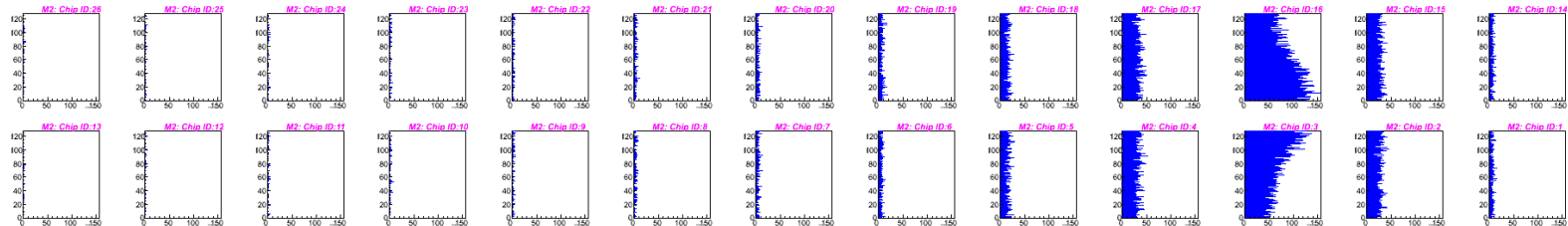
Very good signal observed

With bricks

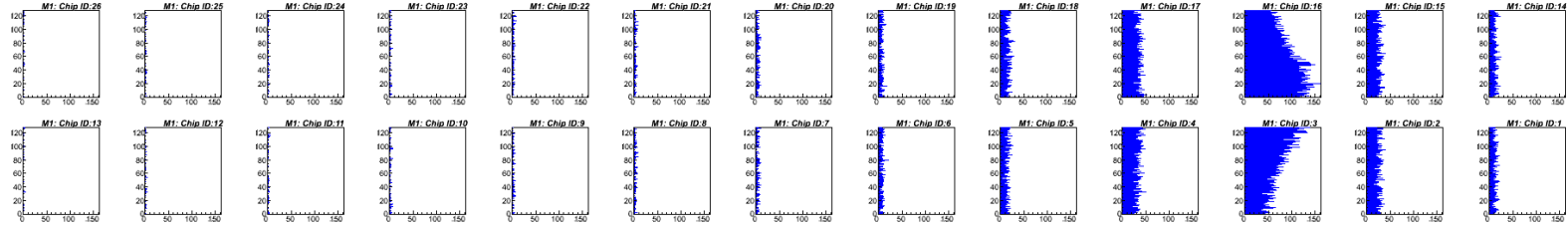
Half-ladder #3



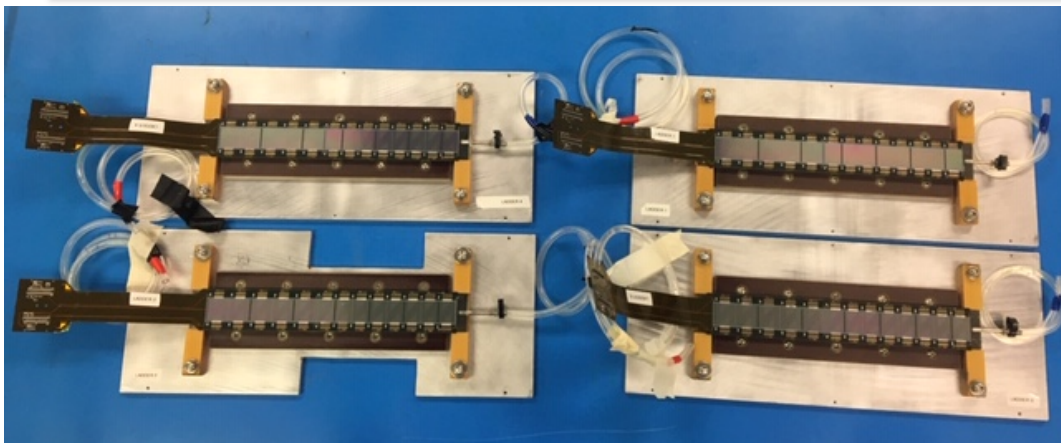
Half-lader #2



Half-ladder #1



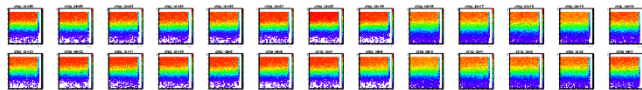
2019 – Prototype Half-ladders



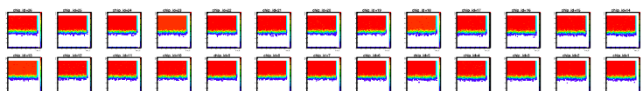
4 half-ladders built on carbon fiber plates.

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

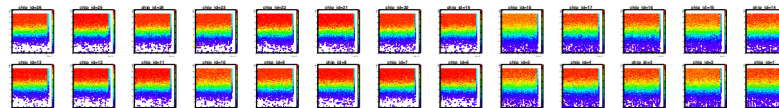
Bias voltage = 0 V



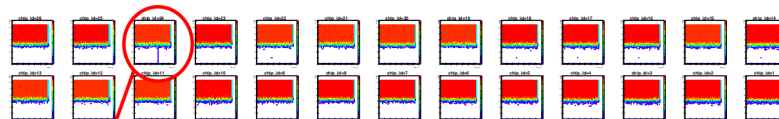
Bias voltage = 100 V, leakage current = 0.43 uA



Bias voltage = 0 V



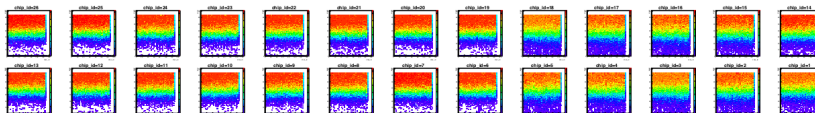
Bias voltage = 100 V, leakage current = 0.26 uA



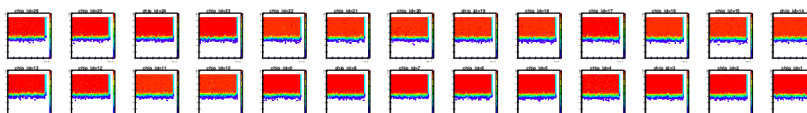
Id 24, channel ID range [80,85]: maybe noisy.

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

Bias voltage = 0 V



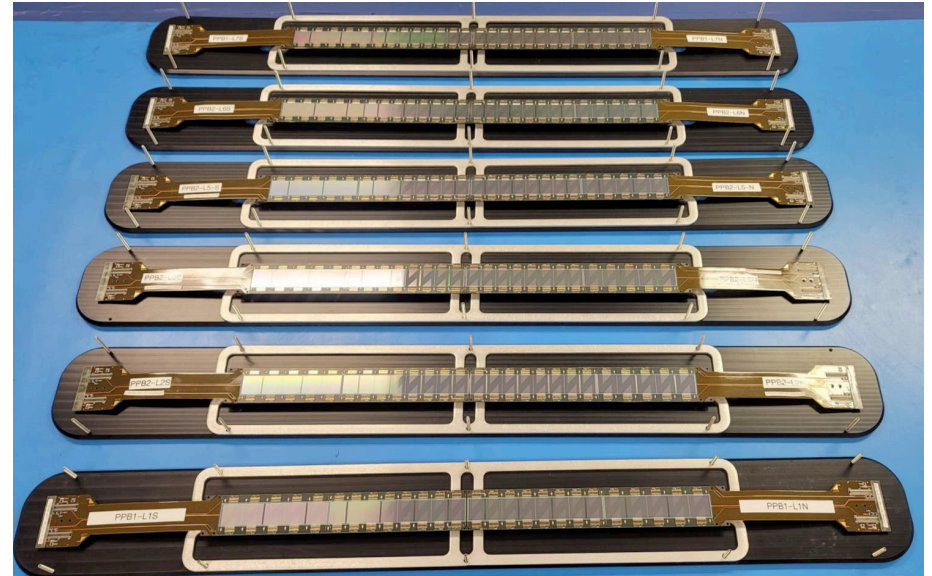
Bias voltage = 100 V, leakage current = 0.48 uA



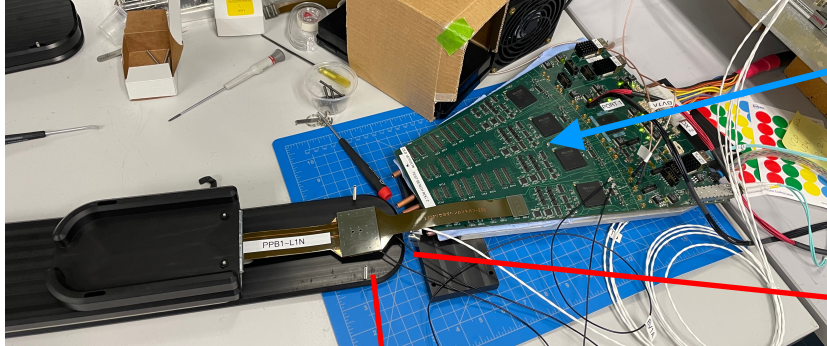
- INTT ladder 1
- 20 cm conversion cable 1
- Roc 9
- P400-P401

2021 Ladder Pre-production

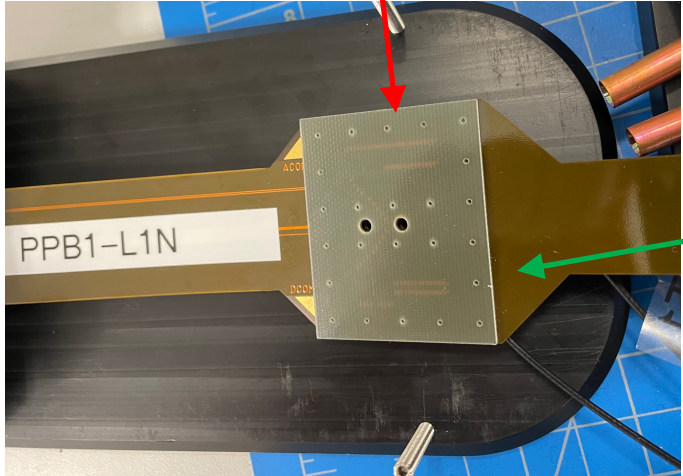
- ❑ 7 Ladders were built at BNL
- ❑ Three stages of measurement:
 - ❑ HDIs-Chips (regulator 2.5V)
 - ❑ HDIs-Chips-Sensors (regulator 2.5V)
 - ❑ Encapsulated (regulator 3.0V)



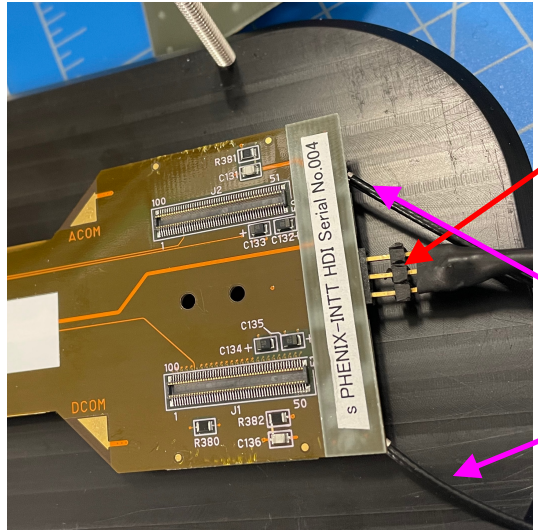
2021 Ladder testing



ROC



Conversion cable

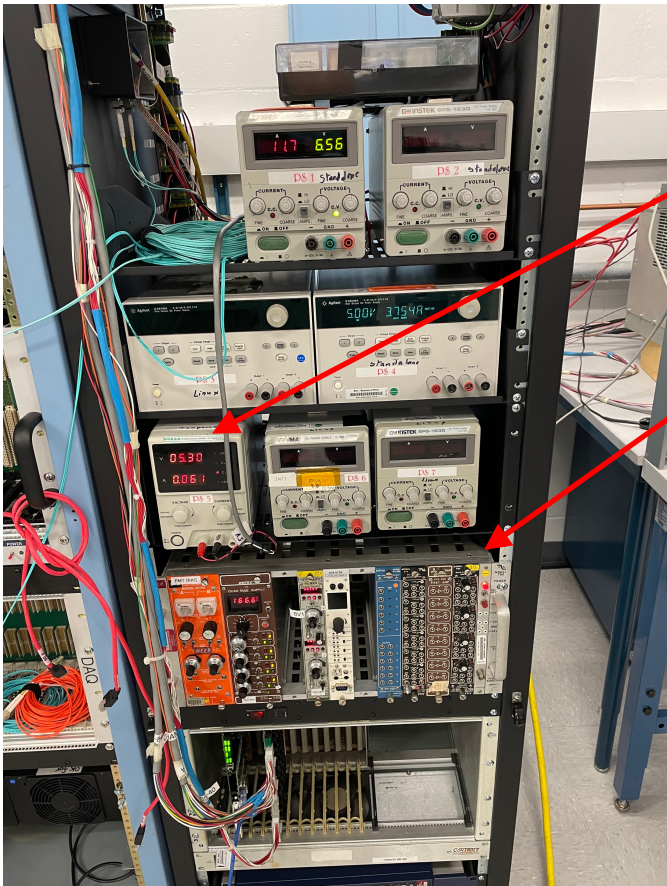


Temperature

BV1B

BV1A

2021 Ladder testing

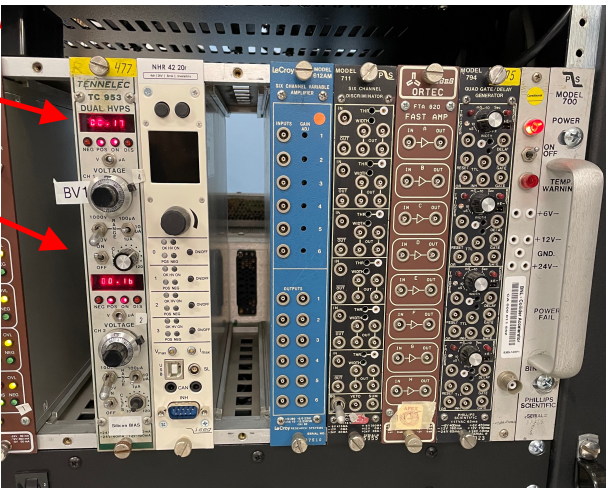


Temperature

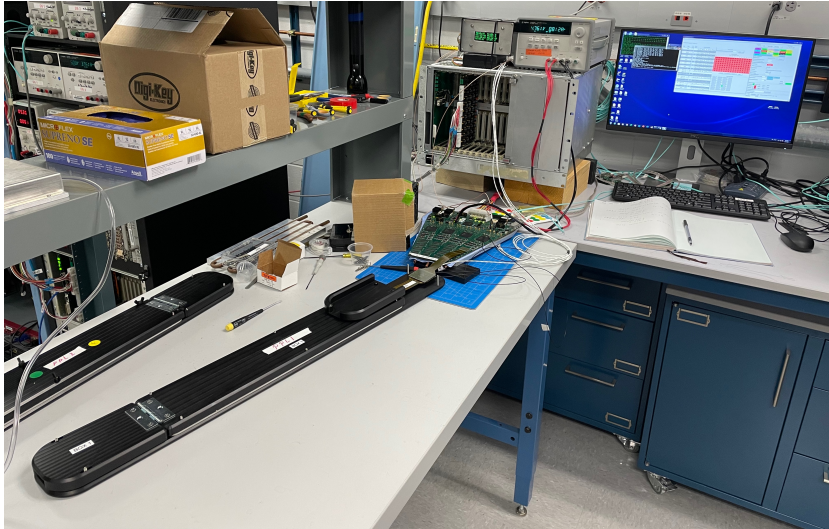
Silicon Bias

❖ BV1A

❖ BV1B



2021 Ladder testing



2021 Pre-production Status of the Ladder



Ladder				HDIs/Chips																				Queue										
				0	Chip is BAD																0	7 Days												
				1	Chip is Mounted																1	11 Days												
				2	Chip is Good																2	14 Days												
NEW				South Chips/HDI Status										North Chips/HDI Status																				
Count	TEMP	Barrel Type	Built	Wire Bonding	U26	U25	U24	U23	U22	U21	U20	U19	U18	U17	U16	U15	U14	Data File	U26	U25	U24	U23	U22	U21	U20	U19	U18	U17	U16	U15	U14	File	Wire Bonding	
	New Name		At	Delivered Date	U13	U12	U11	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1	Name	U13	U12	U11	U10	U9	U8	U7	U6	U5	U4	U3	U2	U1	Name	Days in Queue	Date Completed
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	PPB2_L2	2	BNL	11/4/2020	2	2	2	0	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		
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		
4	PPB2_L4	2	BNL	11/9/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	2021130-1021_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1102_0,2		
5	PPB2_L5	2	BNL	11/11/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	2021130-1251_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1242_0,2		
6	PPB2_L6	2	BNL	11/13/2020	2	2	2	2	2	2	2	2	2	2	2	2	2	2021130-1315_0,2	2	2	2	2	2	2	2	2	2	2	2	2	2	20201130-1320_0,2		
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		

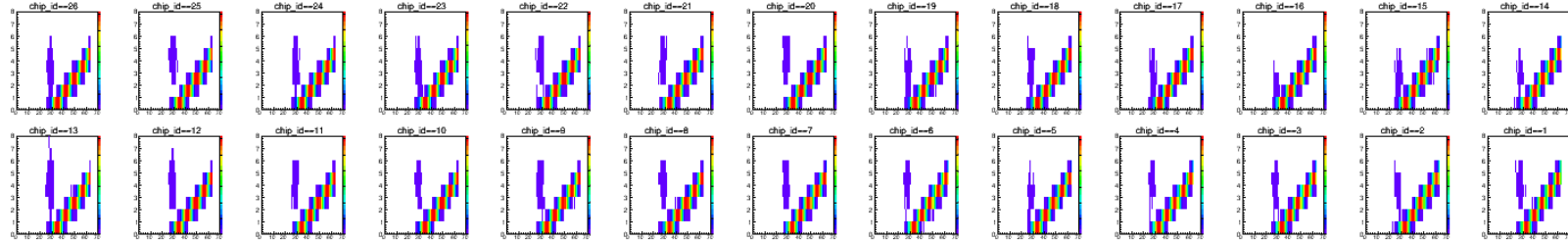
Ladder				Sensors										Queue		Ladder				Ladder Class	Location							
				Sensor is BAD																0	Bad							
				Sensor is Mounted																1	Ready For Enc							
				Sensor is Good																2	At Inst							
																				3	Encapsulated							
																				4	Tested Good							
NEW				South Sensor Status					North Chips/HDI Status					Encapsulation					Ladder Class	Location								
Count	TEMP	Barrel Type	Built	Wire Bonding	Sensor A	Sensor B	File	Sensor A	Sensor B	File	Wire Bonding	South	File	North	File	Date	1 to 5	Of										
	New Name		At	Delivered Date	Name	Name	Name	Name	Name	Vb=100V	Days in Queue	Date Completed	Name	Name	Name	Complete		Ladder										
1	PPB1_L1	1	BNL	01/14/2021	2	2	20210128-1111_0,2	2	2	20210128-1059_0,2	8	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	8	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	8	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	8	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	13	12/23/2020	4	20210222-1549_0,2	4	20210122-1519_0,2	02/22/2021		BNL									

2021 Bench Test Performance

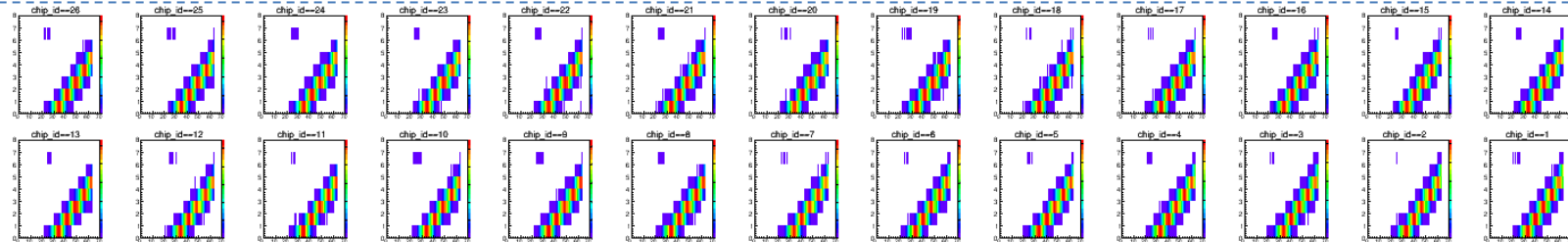
PPB2-L5 South - Calibration plots

x – amplitude; y – ADC

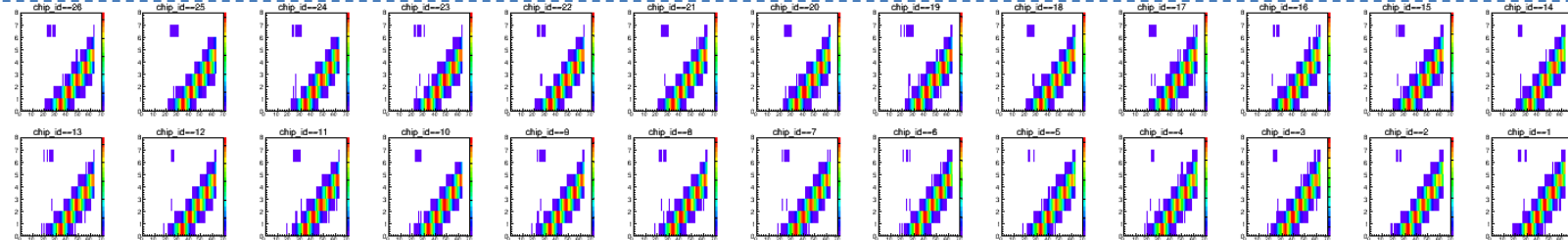
HDI-Chips



HDI-Chips-Sensors



Encapsulated

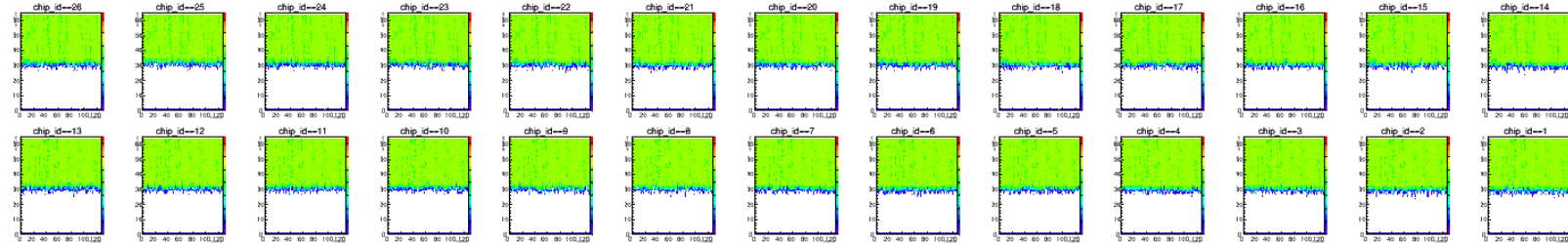


2021 Bench Test Performance

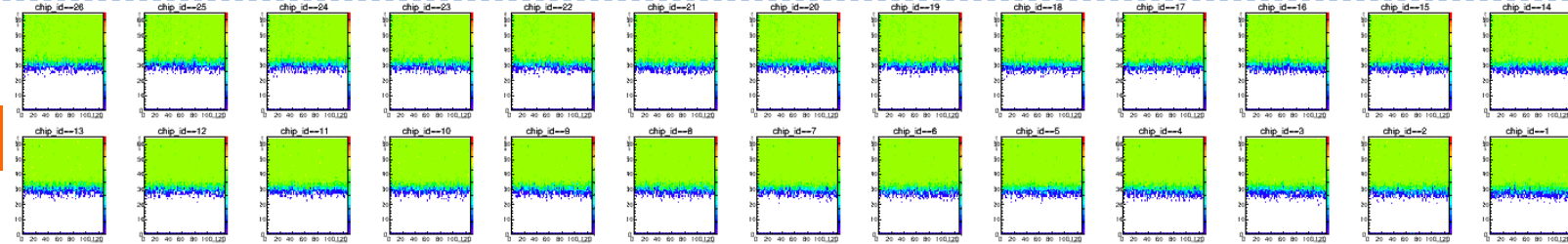
PPB2-L5 South - Calibration plots

x – Channel; y – amplitude

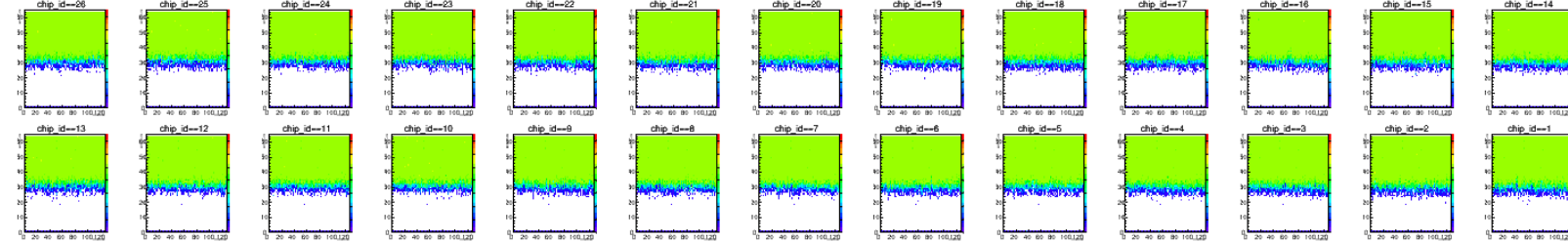
HDIs-Chips



HDIs-Chips-Sensors



Encapsulated



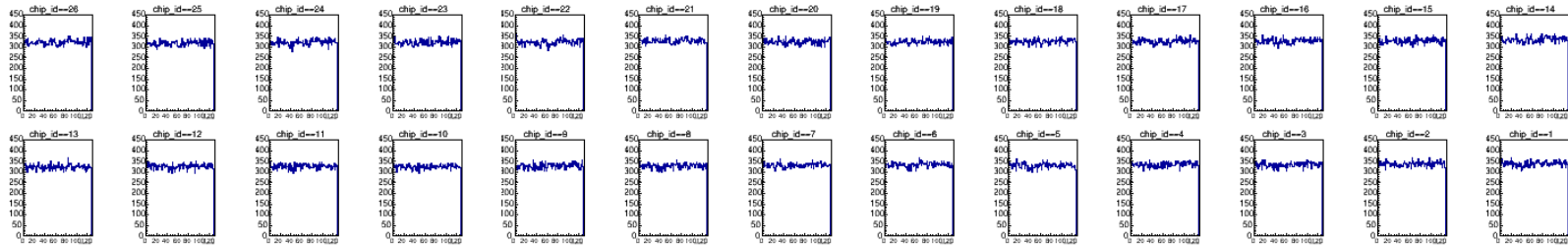
2021 Bench Test Performance



PPB2-L5 South - Calibration plots

x – channel; y – # of entries

HDIs-Chips



2021 Test Web Monitoring

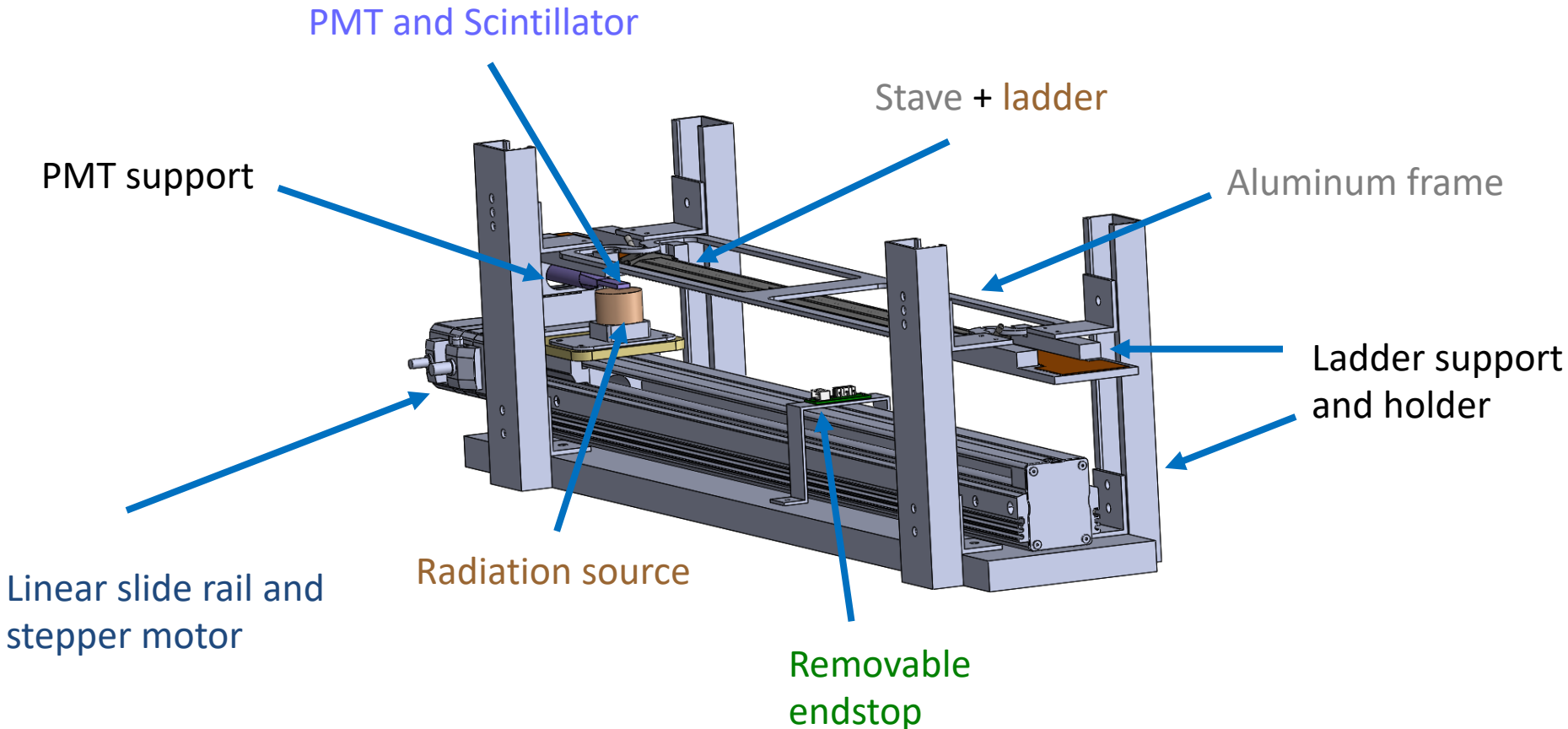


Wiki page for test monitoring: https://wiki.bnl.gov/sPHENIX/index.php/Assembly_at_BNL
 Assembly at BNL

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 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

- ✓ 7 ladders produced
- ✓ All tests showed 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 ladder mass-production