

# Intermediate Silicon Tracker (INTT) Specifications

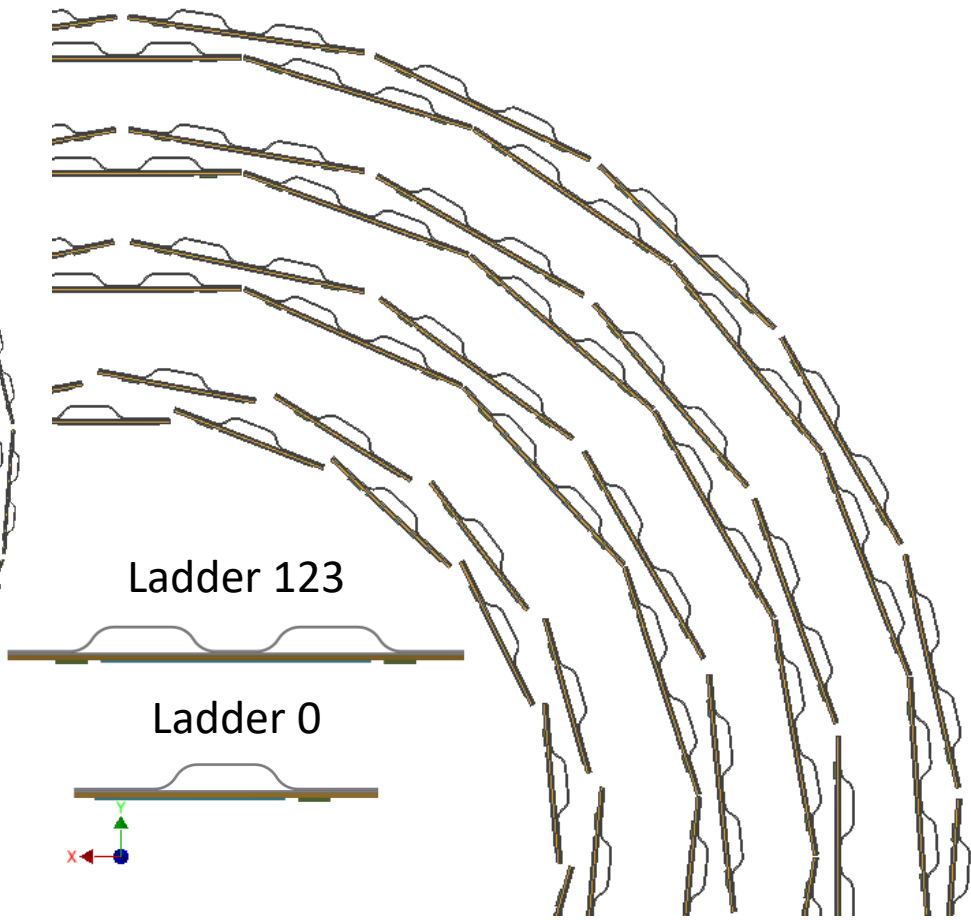
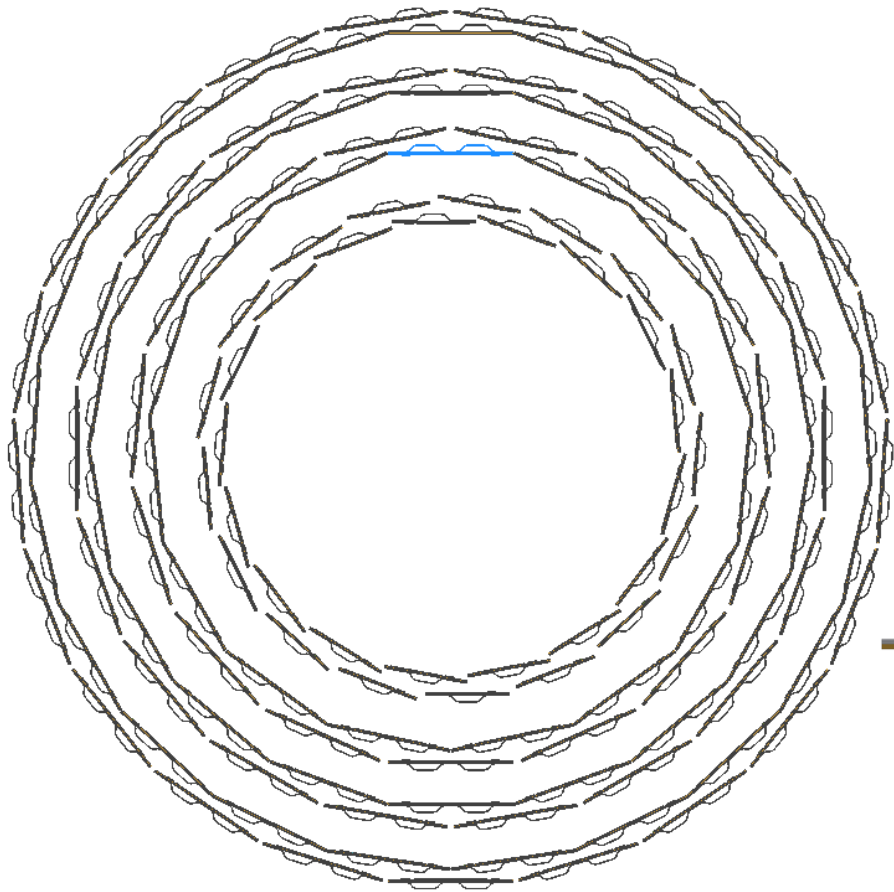
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Brookhaven National Laboratory

1. Barrels Global Specification
2. Ladder L0 Specifications
3. Ladder L1 (2,3) Specifications
4. Stave Specifications
5. Summary

# Barrels Global Specifications

# Barrels Global Configuration



# Ladders and Barrels Global Specifications

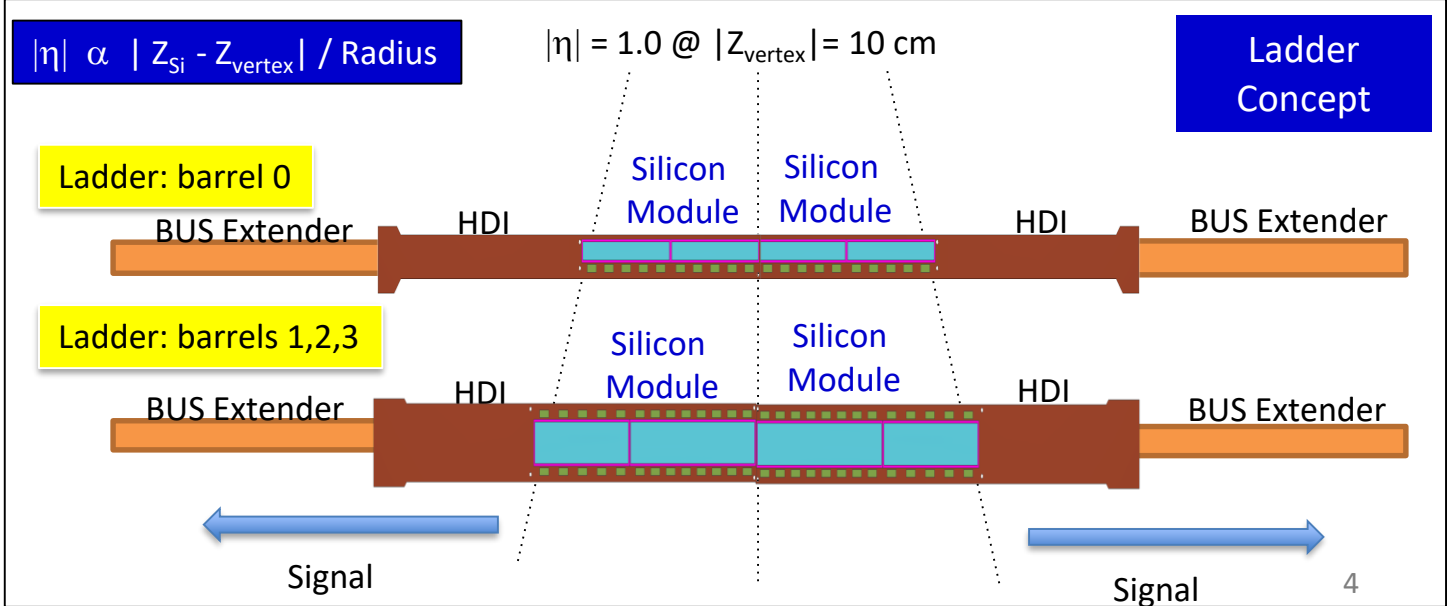
Barrel	Center of Sensor Radius (mm)	Pseudo rapidity	Quantity ladder	Angle (deg)	Coverage ( $\phi$ ) (%)	Overlap (%)	Clearance (mm)	Chips Power dissipation (W)
0	68.76/74.62	1.03/0.97	34	0	100	2.5	0.25/1.5	56.56
1	89.87/95.45	1.18/1.13	30	0	100	2.5	0.25/1.5	99.84
2	108.35/113.61	1.03/0.99	36	0	100	2.5	0.25/1.5	119.81
3	126.76/131.79	0.91/0.88	42	0	100	2.5	0.25/1.5	139.77

**Note:** ←  
 INTT barrels positions move out radially preventing interference and providing more clearance to MVTX/INTT

→ Number of ladders increased and it has been adjusted to maintain 100 % coverage and full hermeticities.

Total Quantity: 142 Ladders:

Total: 416 Watts



# Radiation Length of INTT Ladder

Material	Thickness [ $\mu\text{m}$ ]	$X/X_0$
Silicon	320	0.34%
HDI	473	0.49%
Stave	500	0.25%
<b>Total</b>	<b>1293</b>	<b>1.08%</b>

HDI Material	Thickness [ $\mu\text{m}$ ]	$X/X_0$
Copper*	52	0.36
Polymide	380	0.13
<b>Total**</b>	<b>432</b>	<b>0.49</b>

\*Copper thickness is not physical thickness, but effective material thickness.

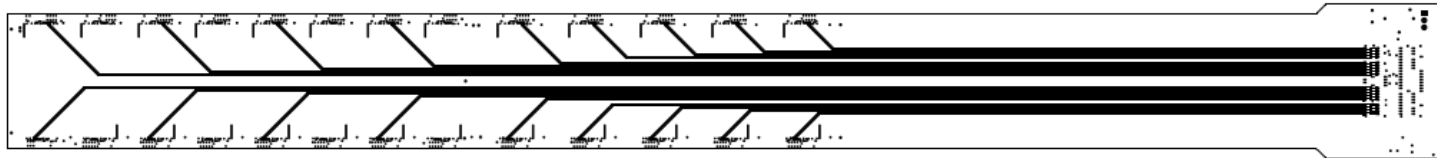
\*\*Total thickness won't become 473 $\mu\text{m}$ , because of the effective thickness.

# Physical and Effective Thickness of Copper Layer



HDI composed of total 7 copper layers. 4 layers are ground or power layers, so they are solid copper, so it's 9um thickness is fully occupied by copper. On the other hand, the rest 3 layers are signal line layers where the amount of copper is a lot less than ground and power layers. Here I introduce “effective thickness” to give the correct amount of copper material for the signal layers.

One of signal layer



The copper area is only a few % of solid copper case.

The effective copper thickness is calculated by  $9\mu\text{m} * \text{a few\%}$ .

# Layer Structure of HDI



Regist	20 $\mu\text{m}$
Copper plated	15 $\mu\text{m}$
L1 Electrolytic copper foil	9 $\mu\text{m}$
Base Polyimide	50 $\mu\text{m}$
L2 Electrolytic copper foil	9 $\mu\text{m}$
Glue	25 $\mu\text{m}$
Base Polyimide	12.5 $\mu\text{m}$
Glue	15 $\mu\text{m}$
L3 Electrolytic copper foil	9 $\mu\text{m}$
Base Polyimide	50 $\mu\text{m}$
L4 Electrolytic copper foil	9 $\mu\text{m}$
Glue	25 $\mu\text{m}$
Base Polyimide	12.5 $\mu\text{m}$
Glue	15 $\mu\text{m}$
L5 Electrolytic copper foil	9 $\mu\text{m}$
Base Polyimide	50 $\mu\text{m}$
L6 Electrolytic copper foil	9 $\mu\text{m}$
Glue	25 $\mu\text{m}$
Base Polyimide	25 $\mu\text{m}$
L7 Electrolytic copper foil	9 $\mu\text{m}$
Copper plated	15 $\mu\text{m}$
Regist	20 $\mu\text{m}$
	$\mu\text{m}$
	438 $\mu\text{m}$
TOTAL厚	438 $\mu\text{m}$



Coverlay Polyide	12.5 $\mu\text{m}$
Coverlay Glue	25 $\mu\text{m}$
Copper plated	15 $\mu\text{m}$
L1 Electrolytic copper foil	9 $\mu\text{m}$
Base Polyimide	50 $\mu\text{m}$
L2 Electrolytic copper foil	9 $\mu\text{m}$
Glue	25 $\mu\text{m}$
Base Polyimide	12.5 $\mu\text{m}$
Glue	15 $\mu\text{m}$
L3 Electrolytic copper foil	9 $\mu\text{m}$
Base Polyimide	50 $\mu\text{m}$
L4 Electrolytic copper foil	9 $\mu\text{m}$
Glue	25 $\mu\text{m}$
Base Polyimide	12.5 $\mu\text{m}$
Glue	15 $\mu\text{m}$
L5 Electrolytic copper foil	9 $\mu\text{m}$
Base Polyimide	50 $\mu\text{m}$
L6 Electrolytic copper foil	9 $\mu\text{m}$
Glue	25 $\mu\text{m}$
Base Polyimide	25 $\mu\text{m}$
L7 Electrolytic copper foil	9 $\mu\text{m}$
Copper plated	15 $\mu\text{m}$
Coverlay Glue	25 $\mu\text{m}$
Coverlay Polyimide	12.5 $\mu\text{m}$
Glue for support plate	40 $\mu\text{m}$
Support Plate FR-4 1.0t	1000 $\mu\text{m}$
TOTAL厚	473 $\mu\text{m}$

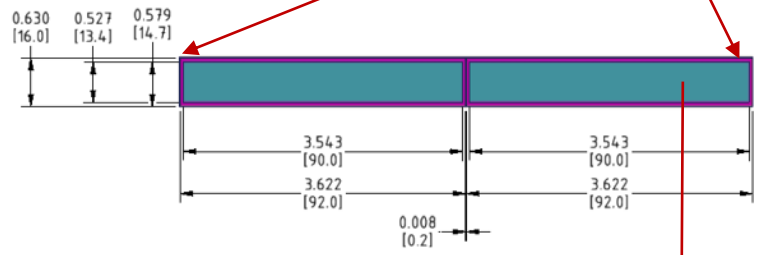
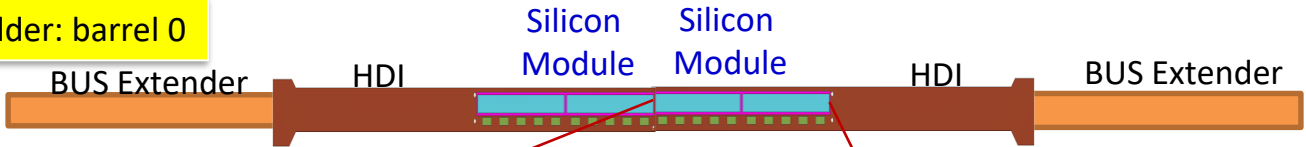
Occupancy	Sub Component Thickness		Real [ $\mu\text{m}$ ]	Else [ $\mu\text{m}$ ]
	Copper Layers	Effective [ $\mu\text{m}$ ]		
				12.5
				25
	100%	15.00	15	
	100%	9.00	9	
				50
	100%	9.00	9	
				25
				12.5
				15
	8.2%	0.74	9	
				50
	100%	9.00	9	
				25
				12.5
				15
	3.2%	0.29	9	
				50
	100%	9.00	9	
				25
				25
	0.5%	0.05	9	
	1%	0.08	15	
				25
				12.5
Total		52.146	93	380
Radiation Length [cm]		1.435		28.6
X-/Xrad [%]		0.36339		0.132867
				0.496254

# Ladder L0 Specifications

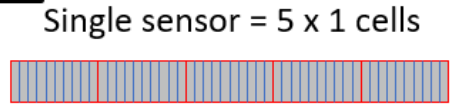
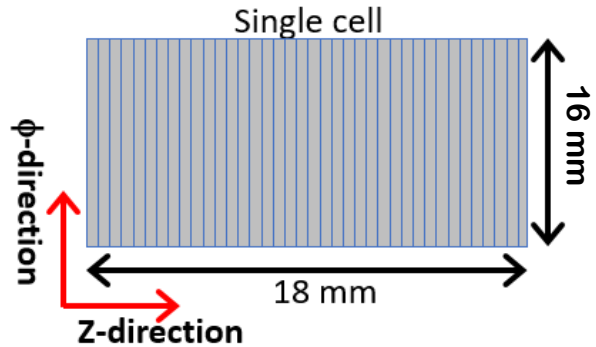


# Ladder L0: Sensor Specifications

Ladder: barrel 0



**L0: Sensor design for L0: better seg. in z: 140.6 um**



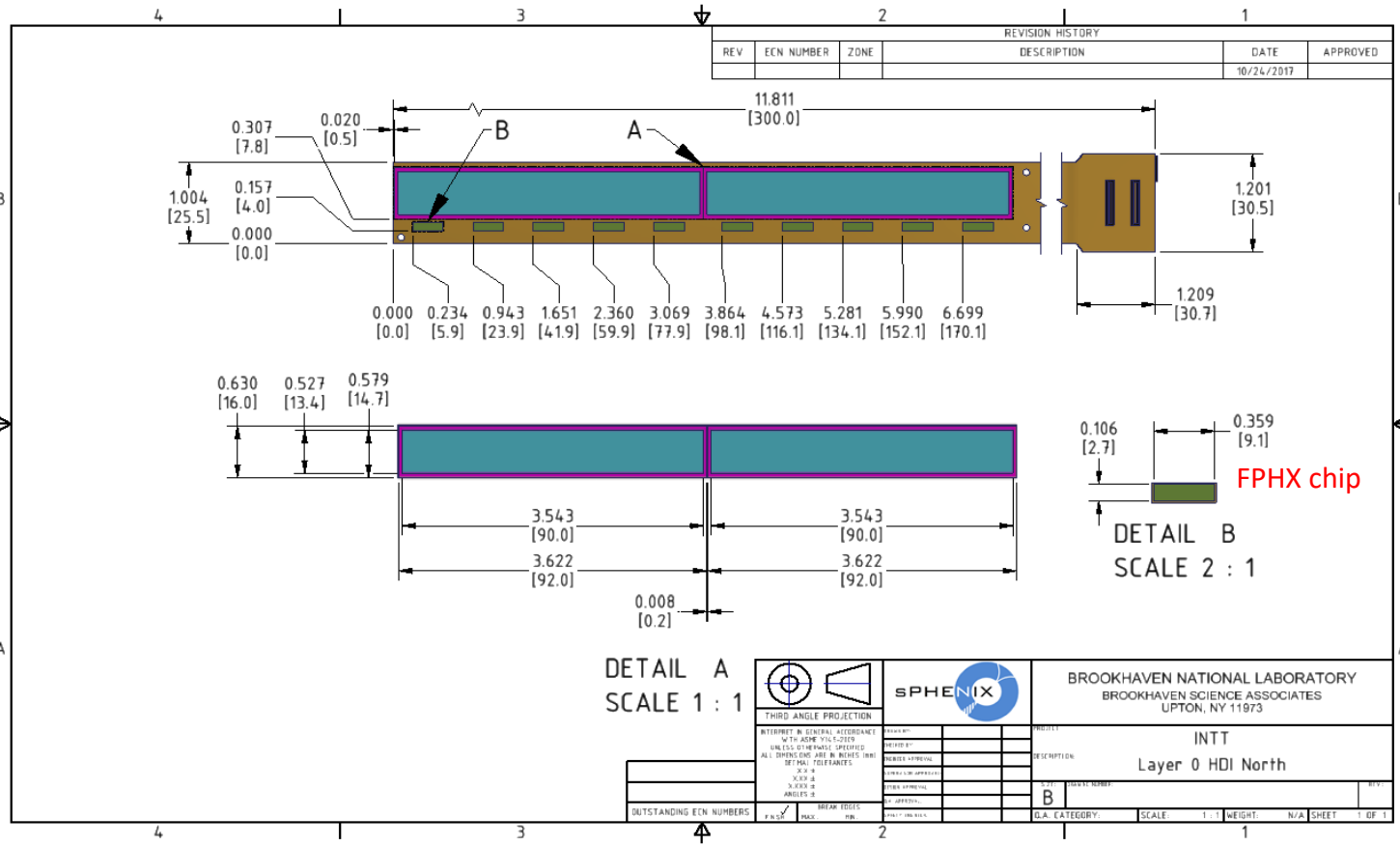
- Thickness: 320 um
- Pitch: 18 mm/128 = 140.625 um
- Φ-length (single sensor) = 16 mm
- F-length (active area) = 13.4 mm
- Z-length (single sensor) = 92 mm
- Z-length (active area) = 18 mm x 5 cells = 90 mm

# Ladder L0: HDI and Chips Specifications



Thickness: 473 um  
 Width: 25.5 mm  
 z-length total: 300 mm  
 (radiation length = 0.49%)

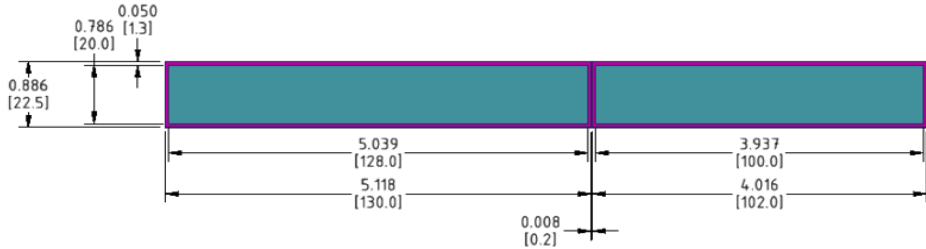
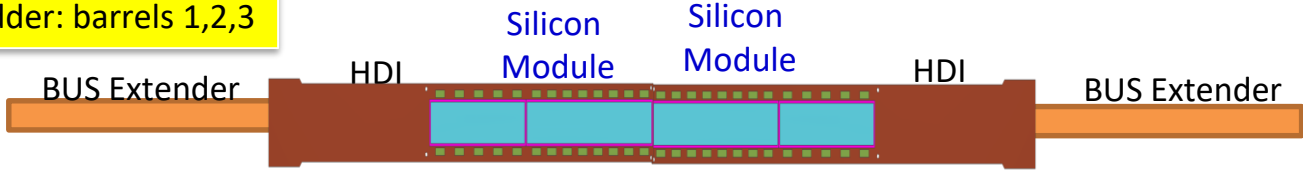
Sensor thickness: 320 um  
 FPHX chip thickness: 320 um



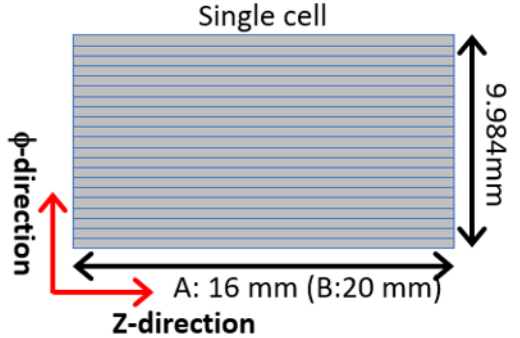
# Ladder L1 (2, 3) Specifications

# Ladder L1 (2,3): Sensor Specifications

Ladder: barrels 1,2,3



**L1, L2, L3 Sensor design: better seg in  $\phi$**



Type A: Single sensor = 8x 2 cells  
 Type B: Single sensor = 5x 2 cells

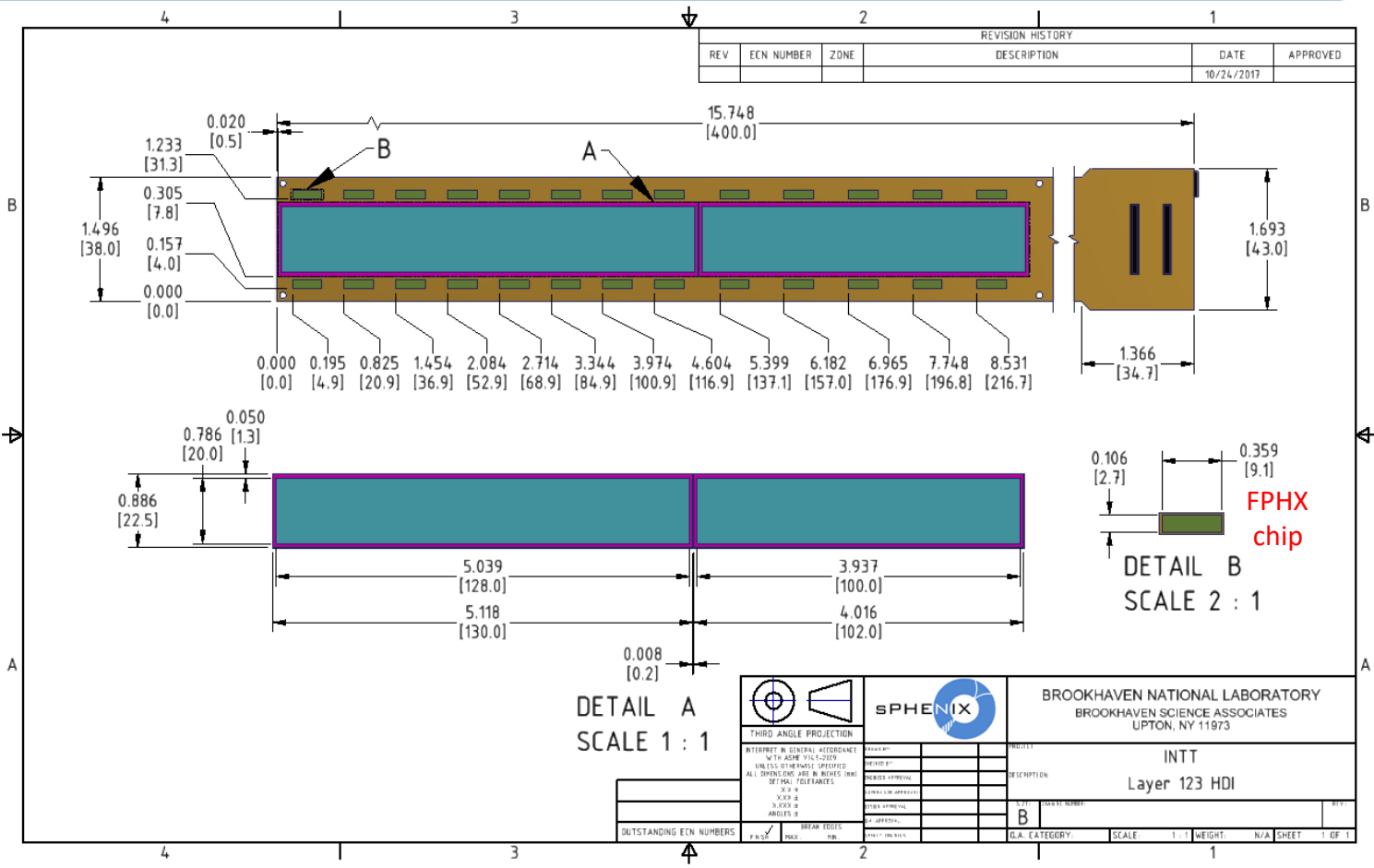


Thickness: 320  $\mu$ m  
 Pitch: 9.984 mm/128 = 78  $\mu$ m  
 $\Phi$ -length (single sensor) = 22.5 mm  
 $\Phi$ -length (active area) = 20.0 mm  
 Z-length type-A (single sensor) = 130.0 mm  
 Z-length type-A (active area) = 128.0 mm  
 Z-length type-B (single sensor) = 102.0 mm  
 Z-length type-B (active area) = 100.0 mm

# Ladder L1 (2,3): HDI Specifications

Thickness: 473 um  
 Width: 38.0 mm  
 z-length total: 400 mm  
 (radiation length = 0.49%)

Sensor thickness: 320 um  
 FPHX chip thickness: 320 um



		BROOKHAVEN NATIONAL LABORATORY BROOKHAVEN SCIENCE ASSOCIATES UPTON, NY 11973	
THIRD ANGLE PROJECTION		PROJECT: INTT DESCRIPTION: Layer 123 HDI	
INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.5-2018 UNLESS OTHERWISE SPECIFIED. ALL DIMENSIONS ARE IN UNITS INDICATED BY TOLERANCES.		DATE: 10/24/2017 DRAWN BY: B	
OUTSTANDING ECN NUMBERS:		Q.A. CATEGORY: SCALE: 1:1 WEIGHT: N/A SHEET: 1 OF 1	

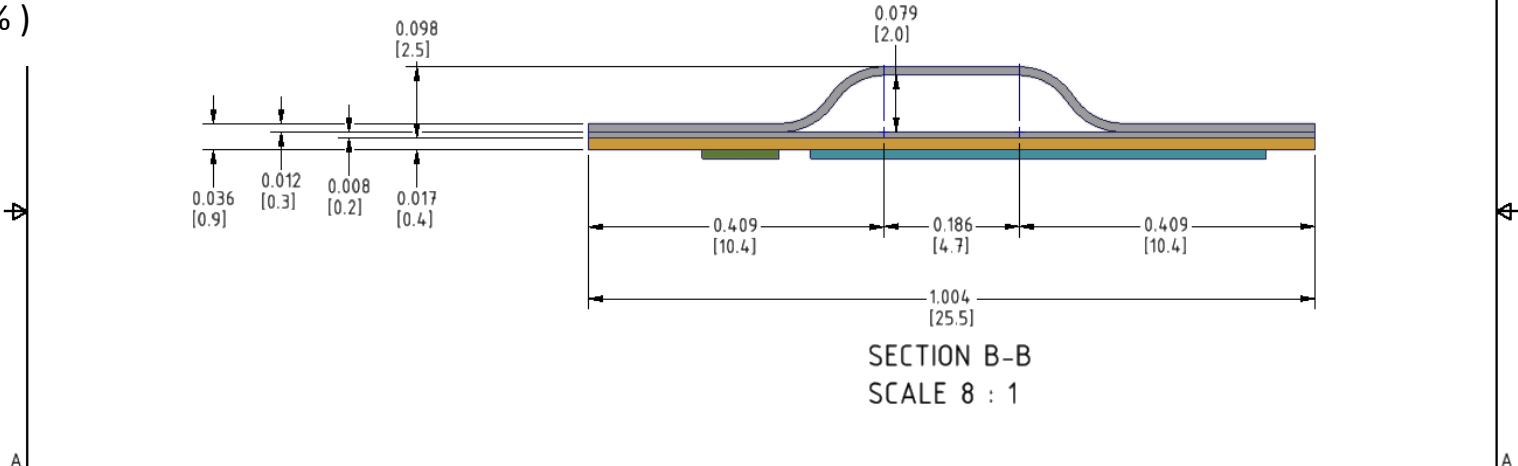
# Stave Specifications

# Ladder L0: Stave Specifications



Thickness: 0.5 mm, (2.5 mm tall)  
 Width: 25.5 mm  
 Z-length total: 480 mm  
 Material: Carbon Fiber and Epoxy  
 (radiation length = 0.25%)

REVISION HISTORY					
REV	ECN NUMBER	ZONE	DESCRIPTION	DATE	APPROVED
				1/4/2018	



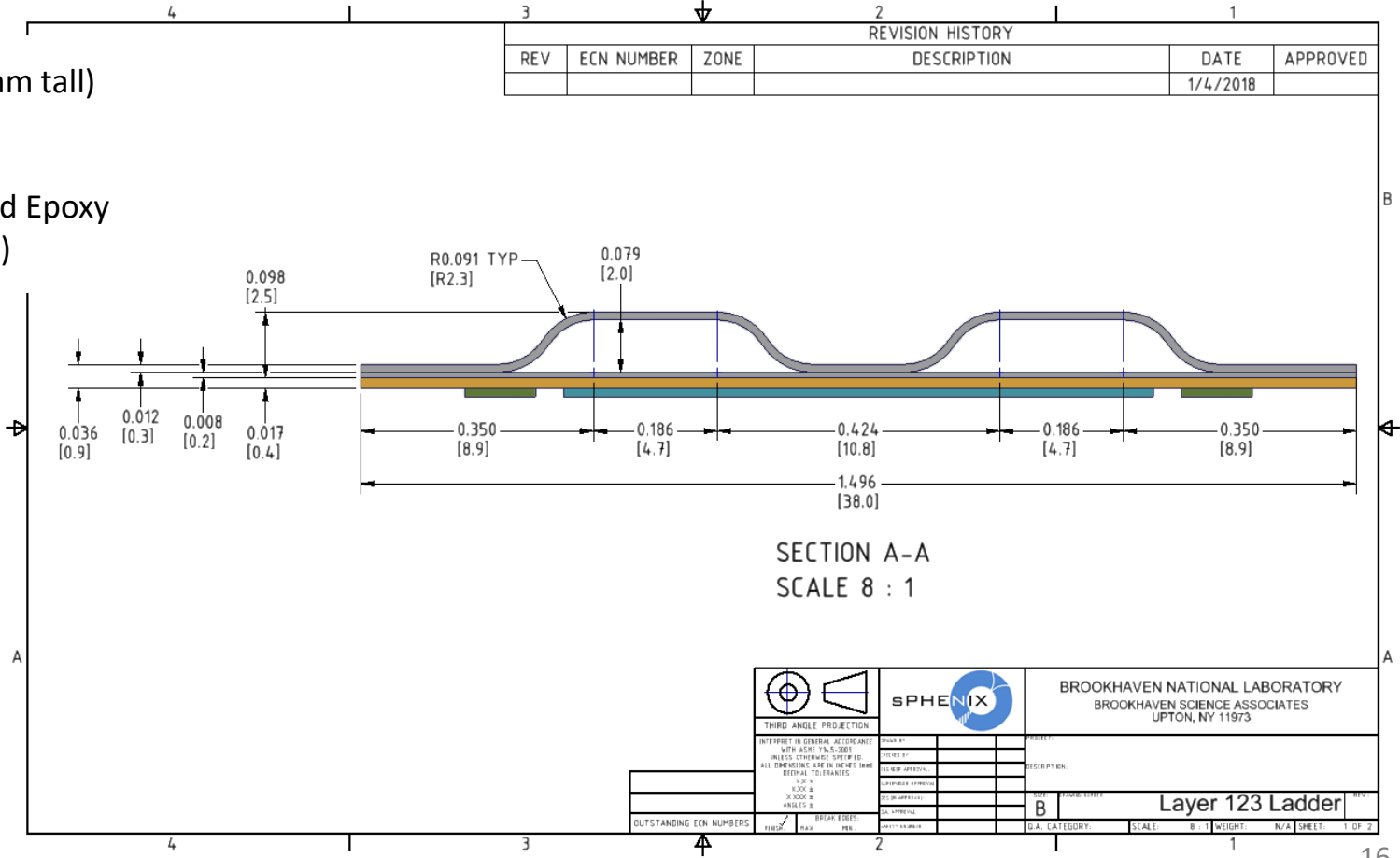
SECTION B-B  
 SCALE 8 : 1

				BROOKHAVEN NATIONAL LABORATORY BROOKHAVEN SCIENCE ASSOCIATES UPTON, NY 11973	
THIRD ANGLE PROJECTION INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.5, 2001 UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED DIMENSIONAL TOLERANCES FRACTIONS DECIMALS ANGLES		TITLE: Layer 0 Ladder DATE: 1/4/2018 DRAWN BY: [blank] CHECKED BY: [blank] DESIGNED BY: [blank]		PROJECT: [blank] DESCRIPTION: [blank] SHEET: 2 OF 2	
OUTSTANDING ECN NUMBERS: [blank]		DIMENSIONAL TOLERANCES: [blank]		D.A. CATEGORY: [blank] SCALE: 8 : 1 WEIGHT: N/A SHEET: 2 OF 2	

# Ladder L1 (2,3): Stave Specifications



Thickness: 0.5 mm, (2.5 mm tall)  
 Width: 38.0 mm  
 Z-length total: 480 mm  
 Material: Carbon Fiber and Epoxy  
 (radiation length = 0.25%)





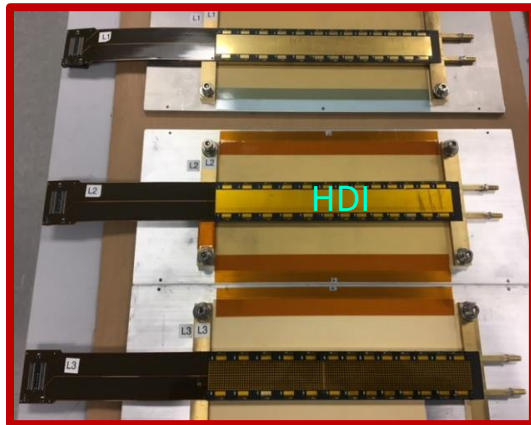
# Summary

# Summary: Silicon sensors and HDI are fabricated already

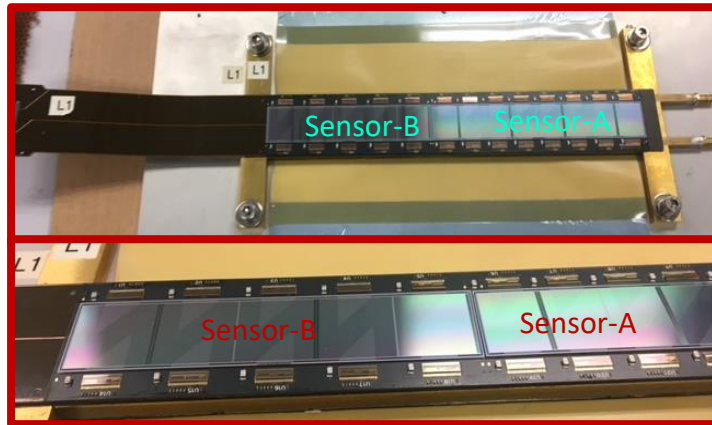
Mechanical support: CFC stave



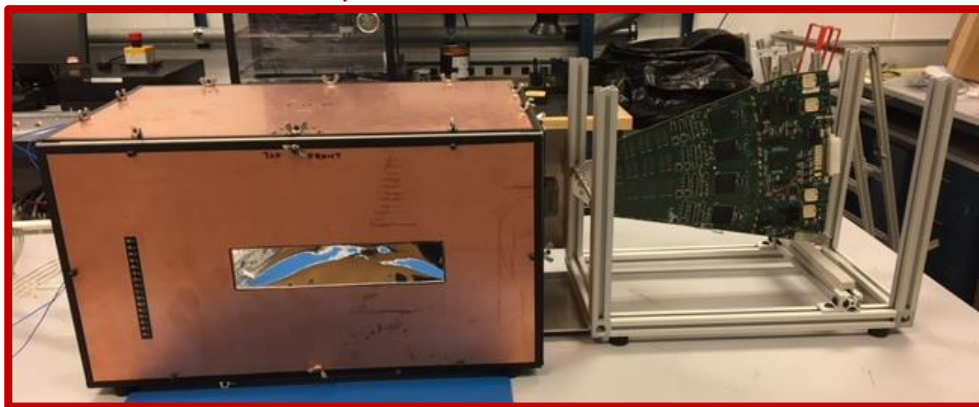
Gluing/wire-bonding HDI/Chips/Testing



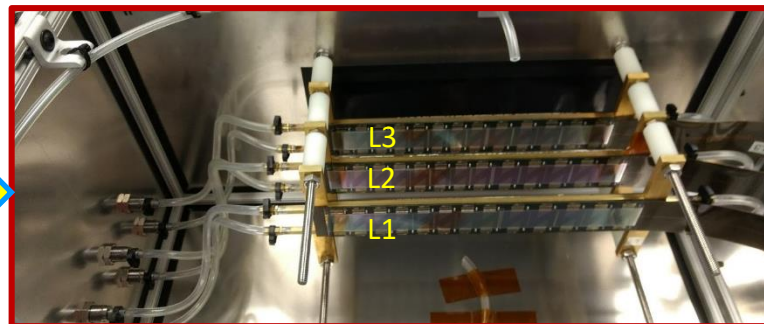
Gluing/wire-bonding Sensors/Chips



INTT telescope for the beam test: 120 GeV at FNAL



Three half ladders (barrels 1, 2 and 3)



End