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

INTermediate Tracker (INTT) Overview

WBS: 3.01

Rachid Nouicer, BNL

March 2nd , 2021

INTT Collaboration (Manpower)

sPHENIX

BNL
- Rachid Nouicer
- Dan Cacace
- Connor Miraval
- Robert Pisani
- Steven Andrade
- Donald Pinelli
- Antonio Vederosa

Perdue University
- Wei Xie
- Milan Stojanovic
- Han-Sheng Li

Rikkyo University
- Hikaru Imai
- Daisuke Imagawa

RIKEN
- Itaru Nakagawa
- Yasuyuki Akiba
- Genki Nukazuka

Nara Women's University
- Takashi Hachiya
- Maya Shimomura
- Miu Morita
- Mika Shibata
- Yumika Namimoto
- Sakiko Nishimori
- Runa Takahama
- Natsuki Kuroda

National Central University
- Chia-Ming Kuo
- Kai-Yu Cheng
- Cheng-Wei Shih
- Wei-Che Tang

National Taiwan University
- Ron—Shyang Lu
- Lien-Sheng Tsai
- Jenny Huang

Japan Atomic Energy Agency
- Shoichi Hasegawa

Tokyo Metropolitan Industrial Technology Research Institute
- Takashi Kondo

Hayashi-REPIC co.
- Daisuke Yanagawa

Strong Commitments of RIKEN/RBRC for sPHENIX/INTT

Letter from H. Enyo (Director, RNC)

From: Hideto En'yo [mailto:enyo@riken.jp]
Sent: Friday, August 26, 2016 5:07 AM
To: Edward O'Brien <eobrien@bnl.gov>
Cc: Yasuyuki Akiba <akiba@rcf.rhic.bnl.gov>
Subject: sPHENIX inner tracker

Dear Ed,

RIKEN and RBRC Experiment group is working to develop a silicon detector for sPHENIX. In the present plan, the detector is made of 4 layers of silicon strip detector barrels, placed at R=6, 8, 10, and 12 cm from the beam pipe and covering +/−12 cm along the beam. This project is led by Dr. Itaru Nakagawa of RIKEN and supported by Dr. Yasuyuki Akiba, the group leader of RBRC experiment group. Our intention is to provide this detector as an in-kind contribution to sPHENIX, as a part of continuing collaboration of RIKEN and BNL on the RHIC spin physics program. We heard that there is possibility that part of the sPHENIX detector can be de-scoped due to limited budget. We hope our in-kind contribution can help to avoid or to reduce the chance of de-scoping.

Best regards,

Hideto En'yo,

Director, RIKEN Nishina Center

Letter from the other side of the Pacific Ocean (Japan)

INTT Many Successful Reviews – Technical Review 2018

sPHENIX

Department of Physics

BROOKHAVEN NATIONAL LABORATORY

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P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344-2286
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haggerty@bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

www.phenix.bnl.gov/~haggerty

Memo

Date: January 17, 2018

To: Jim Mills, Don Lynch, xxx

From: John Haggerty

Subject: sPHENIX INTT Technical Review

Thank you for agreeing to serve on the technical review of the sPHENIX Intermediate Tracker on Wednesday, February 7, 2018 at 1pm in room 2-219 of the Physics building.

The agenda and Blue Jeans connection information is here:

https://indico.bnl.gov/conferenceDisplay.py?confId=4087

A few words about logistics: I would like to keep the presentations as brief as possible and complete the oral part of the review in about three hours, The conceptual design is described in the draft CDR which is available from the Indico page.

The purpose of the review is to review the current state of technical development of the project. There will be no cost and schedule information presented or reviewed. The goal of the review is to work toward a positive answer to the question posed to an eventual CD-1 review committee:

- Is the conceptual design technically sound and likely to meet the objectives of its scientific case?

Let's parse that question. The question is about a "conceptual" design. That means that not every design will be in its final form and ready to construct, but that one can reasonably imagine that between CD-1 and CD-2 that one could complete a full, detailed, baseline design. It must be "technically sound," which means that once the design is complete, it is unlikely that flaws in the design will prevent it from achieving its physics goals. It is "likely to meet the objectives of the scientific case" means that the right tools have been used to assess whether the detector we propose will be able to make the measurements we propose to make.

I would like to emphasize that this is by DOE order 413.3b and custom a serious assessment of a project, but by no means a final design review or a collaboration meeting. We do not expect to see final drawings or calculations (although many of the concepts are in an advanced sate of engineering). This design has now been reviewed in a number of reviews of various types (from the DOE Science Review in 2014 through the BNL Director's review

INTT Pre-CD-1 Conceptual Design Review

Wednesday, February 7, 2018 from **13:00** to **16:15** (US/Eastern)
at **Building 510 (2-219)**

Description To join the Meeting:
https://bluejeans.com/256960760

To join via Room System:
Video Conferencing System: bjn.vc -or-199.48.152.152
Meeting ID : 256960760

To join via phone :
1) Dial:
+1.408.740.7256 (United States)
+1.888.240.2560 (US Toll Free)
+1.408.317.9253 (Alternate number)
(see all numbers - http://bluejeans.com/numbers)
2) Enter Conference ID : 256960760

In the physical world, we will be in Room 2-219 of the Physics Building

Material Charge

Wednesday, February 7, 2018

13:00 - 13:45	Detector Overview *45'*	Speaker: Dr. Rachid Nouicer (Brookhaven National Laboratory)
13:45 - 14:30	Electronics and Readout *45'*	Speaker: Dr. Nakagawa Itaru (RIKEN)
14:30 - 15:15	Tracking and Simulation Software *45'*	Speaker: Gaku Mitsuka (RIKEN)

Suggestions were followed and recommendations were implemented successfully.

INTT Many Successful Reviews – Directorate Review 2019

11:15 AM **INTT Overview/Management(20+10)** 30m
Speaker: Rachid Nouicer (Brookhaven National Laboratory)
3.01_INTT_ESH.pptx F_INTT_Overview_D...

11:45 AM **INTT Ladder/Det Assembly(20+10)** 30m
Speaker: Connor Miraval (Brookhaven National Laboratory)
sPHENIX_Directors_...

12:15 PM Lunch 1h

1:15 PM **INTT Electronics(20+10)** 30m
Speaker: Nakagawa Itaru (RIKEN)
Directorsreview201...

1:45 PM **INTT Mechanics, Integration & Infrastructure(20+10)**
Speaker: Dan Cacace (BNL)
sPHENIX_Directors_...

2:15 PM **INTT Cost and Schedule(20+10)**
Speaker: Rachid Nouicer (Brookhaven National Laboratory)
F_INTT_Cost_and_S...

Costs/Schedule/Management

Director's Review
Apr 9, 2019, 8:00 AM → Apr 11, 2019, 3:50 PM US/Eastern
Berkner B

Description Plenary and Project Management Breakout in Berkner B

Meeting URL: https://bluejeans.com/991617325

Meeting ID
991 617 325

To join via phone :

1) Dial: +1.408.740.7256

+1.888.240.2560

+1.408.317.9253 (see all numbers - http://bluejeans.com/numbers?ll=en)

Statements from the Review Committee

Draft April 13, 2019

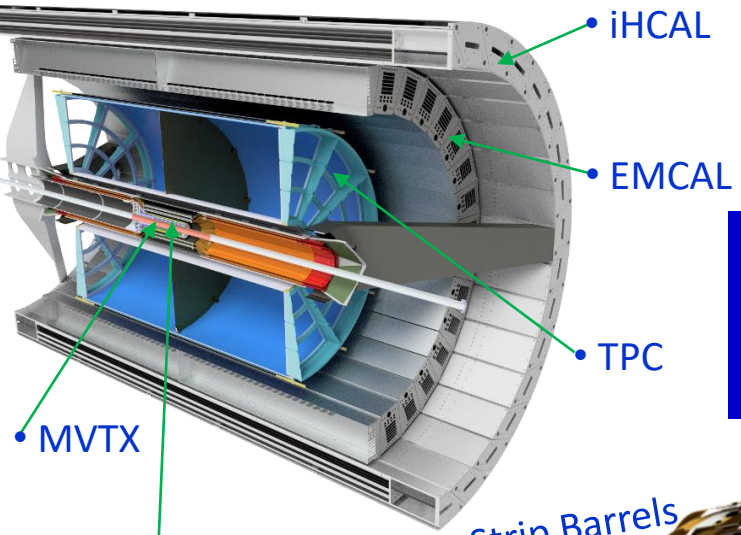
Silicon Detectors & Mechanical Integration - Bill Wahl (BNL), Paul O'Connor (BNL), Sven Herrmann (BNL)

Acknowledgements

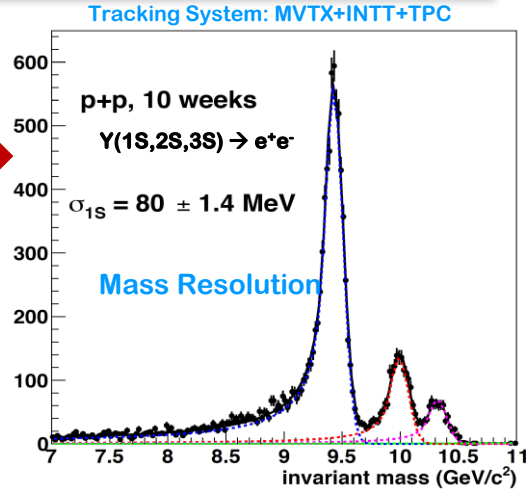
The sub-committee commends the INTT & MVTX detector projects for their state of technical readiness. The designs are very mature for a project at pre-PD1 and the decision to leverage experience from past projects will likely result in cost savings and significant risk reduction.

Again; Suggestions were followed and recommendations were implemented successfully (many thanks to the reviewers).

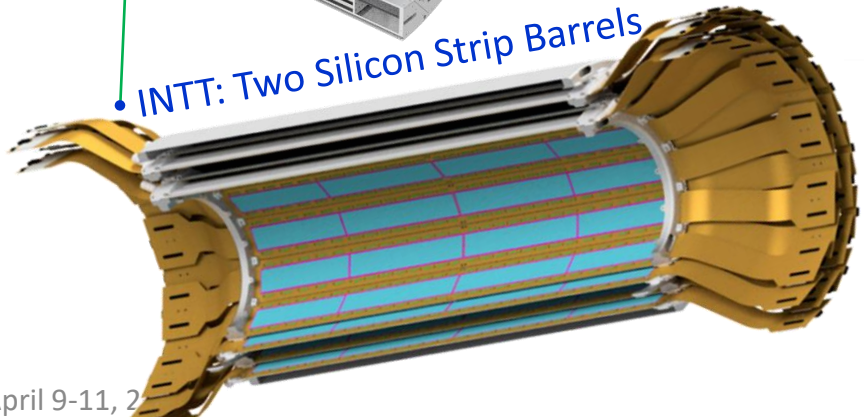
3.01 The sPHENIX INTT WAS SET



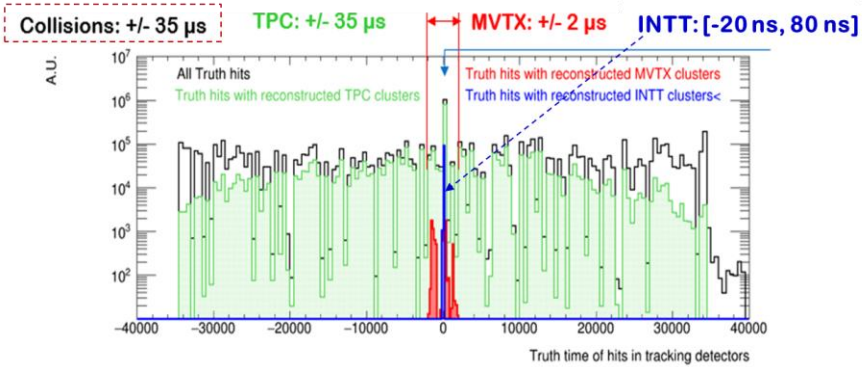
- Charged Tracking in sPHENIX:
  - MVTX provides vertexing
  - TPC provides p-resolution
  - INTT provides matching



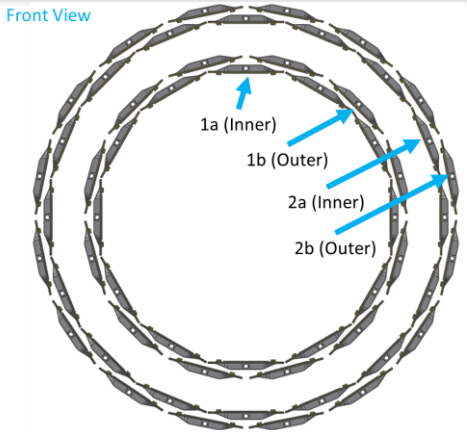
- INTT has a unique role in the sPHENIX tracking system being the only detector with sufficiently fast time response to be able to associate individual tracks and events.

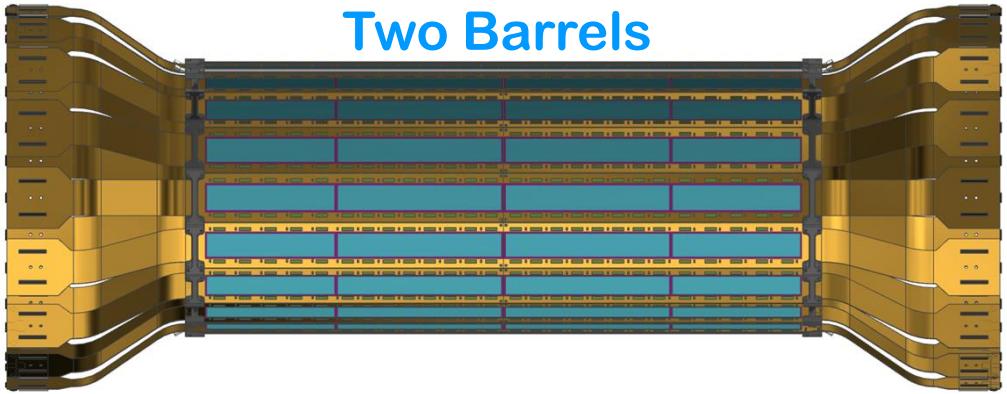


Event generator (simulated data): event pile up



3.01: INTT Two Barrels Specification





Barrel	Center of Sensor Tangent Radius (mm)	Pseudo rapidity	QTY of Ladders	Angle (deg)	Coverage (PHI) (%)	Overlap (%)	Clearance (mm)	Chip Power Dissipation (W)	Stave Rad Length (%)	Barrel Rad Length (%)
1	-	-	24	-	100	2	2.00	62.30	0.80	2.20
1a (Inner)	71.88	1.37	12	0	53	0	0.60	31.15	0.40	1.10
1b (Outer)	77.32	1.31	12	0	49	0	3.80	31.15	0.40	1.10
2	-	-	32	-	100	2	2.22	83.07	0.80	2.20
2a (Inner)	96.80	1.12	16	0	53	0	0.60	41.53	0.40	1.10
2b (Outer)	102.62	1.07	16	0	49	0	3.12	41.53	0.40	1.10
Total	-	-	56	-	-	100	11.22	145.37	1.60	4.40

Today

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

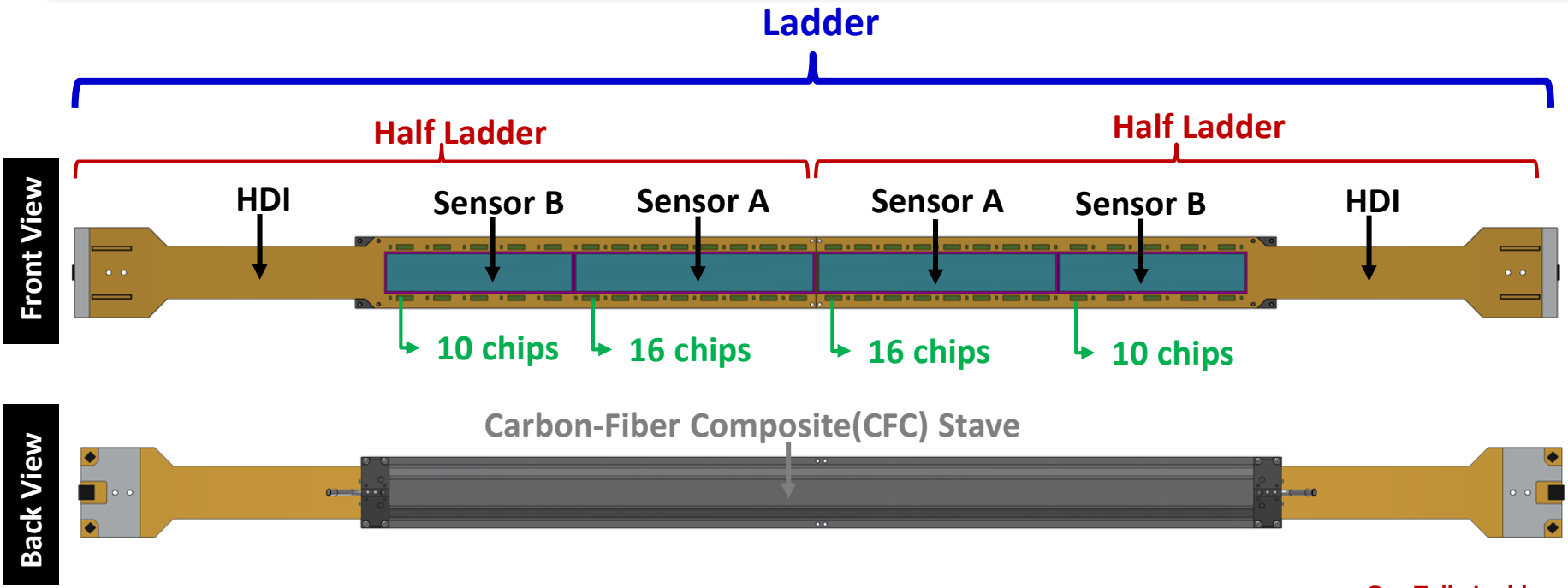
Tuesday Mar 2, 2021, 9:00 AM → 12:25 PM US/Eastern

2-219

Russell Feder (sPHENIX)

9:00 AM	→ 9:25 AM	**INTT Overview** **Speaker**: Rachid Nouicer (Brookhaven National Laboratory)	25m
9:25 AM	→ 9:50 AM	**Ladder Performance** **Speaker**: Takashi Hachiya (RIKEN)	25m
9:50 AM	→ 10:15 AM	**Ladder Electronic Components** **Speaker**: Nakagawa Itaru (RIKEN)	25m
10:15 AM	→ 10:50 AM	**Stave and Barrel Design** **Speaker**: Dan Cacace (BNL)	35m
10:50 AM	→ 11:15 AM	**Stave Quality Assurance Tests** **Speaker**: Robert Pisani (BNL, sPhenix)	25m
11:15 AM	→ 11:40 AM	**Ladder Assembly at NTU** ¶	25m
11:40 AM	→ 12:05 PM	**Ladder Assembly at BNL** **Speaker**: Connor Miraval (Brookhaven National Laboratory)	25m
12:05 PM	→ 12:30 PM	**Ladders Evaluations and Classification** **Speaker**: Milan Stojanovic (Purdue University)	25m

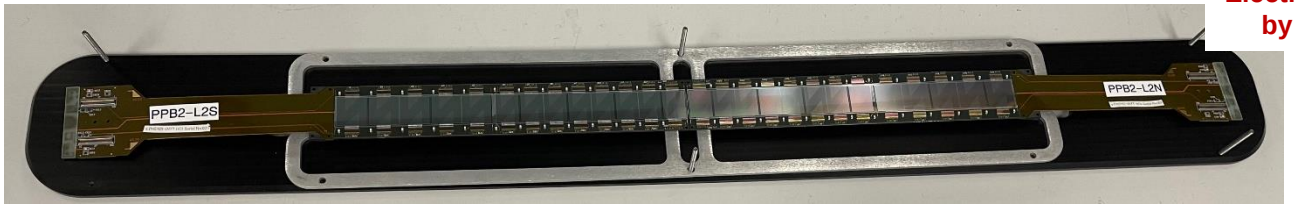
What is INTT Ladder?



See Talk: Ladder Electronic Components by Itaru Nakagaya

Ladder

- 1 Stave
- 2 HDIs
- 52 chips
- 4 Sensors



What is INTT Ladder?

Ladder

Half Ladder | **Half Ladder**

Front View

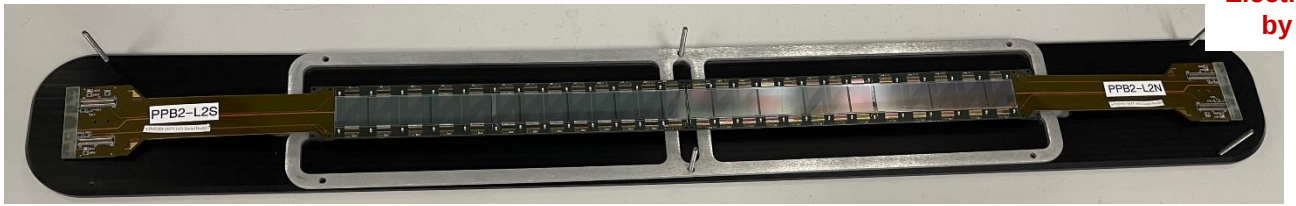
Back View

- FPHX: used successfully in FVTX/PHENIX tracker
- Strip sensor: AC-coupled silicon sensor, standard HPK silicon sensor design (78 um)
- HDI: conservative copy of FVTX/PHENIX
- CFC-Stave: NEW design

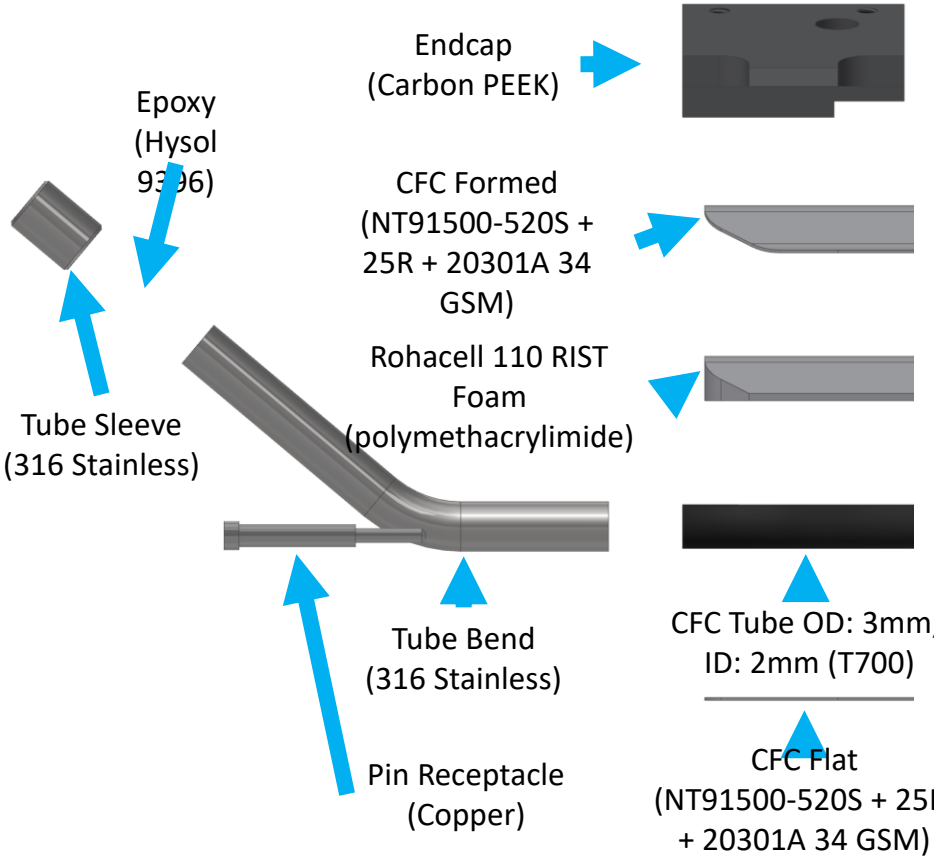
Electronic Components by Itaru Nakagaya

Ladder

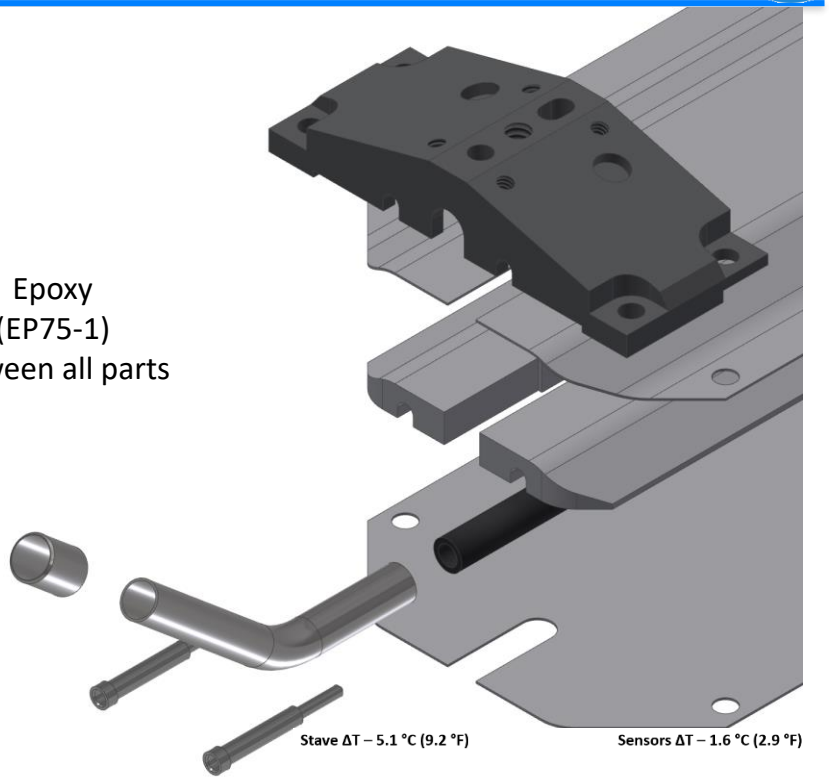
- 1 Stave
- 2 HDIs
- 52 chips
- 4 Sensors



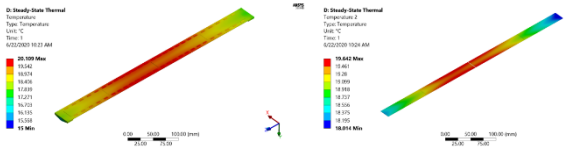
Stave Design – Parts and FEA Analysis



Epoxy
(EP75-1)
Between all parts



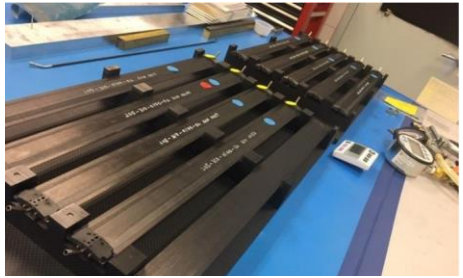
See Talk: Stave and Barrel Design and FEA Analysis by Daniel Cacace



Production Stave Quality Assurance

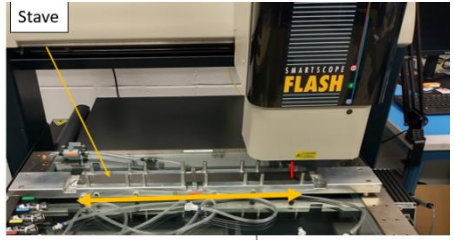
1) Staves are being fabricated by Asuka Co. in Japan to specification on previous drawings.

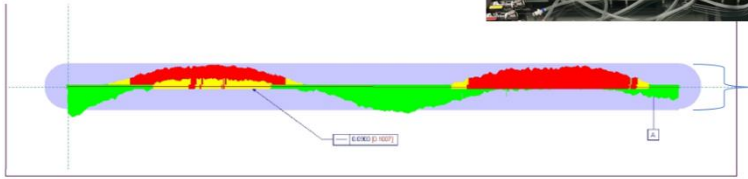
2) BNL and Si-Taiwan labs receive the completed staves and we retest them before ladder assembly.



Flatness measurement at BNL

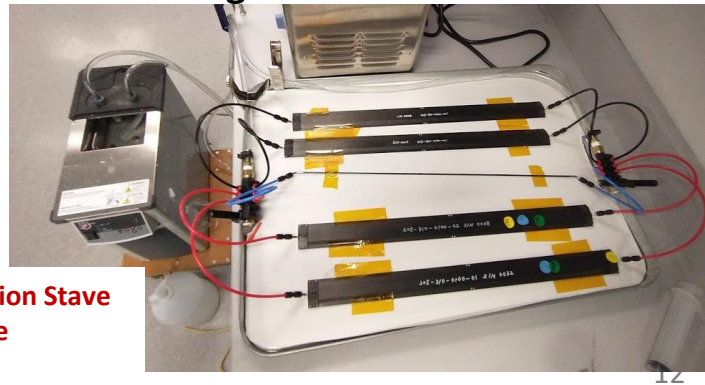
- At BNL, we use a no contact **OGP** SmartScope Multisensor Measurement Systems to measure stave flatness. Fully Automated
- OGP takes measurements at several points across the whole stave.
- Measurement taken relative to plan made by mounting holes. Report gives us average deviation from the points made by the plan.
- Sample of a report below.





Dim	Dimension Label	Nominal	USL	LSL	Actual	Deviation	Status
1	Flatness	0.0000	0.0900		0.1007	0.1007	+ 0.0107

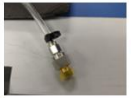
Long Term Flow Test



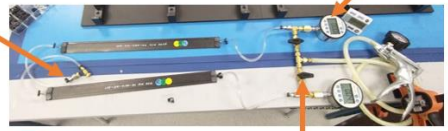
Stave is pressurized to 20psi and tested for 20 minutes. The pressure drop between 10 and 20 minutes is recorded.

Pressure Test

Tygon tube with metal Plug



Tygon connected directly to SS tube and clamped (0.25" OD 1/8" ID)



0.05% Gauge

Isolation Valve

Hardware:
Ashcroft digital High Precision Gauge
3032089SD02L30
30 psi 0.05%
2 isolated channels that are used indep

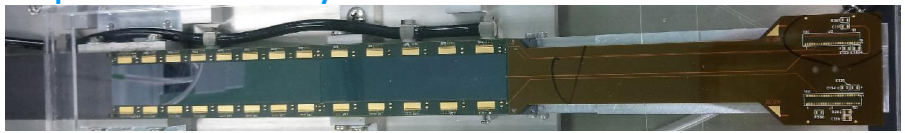
Single ladder is tested at at a time to ke
simple and accurate.

See Talk: Production Stave Quality Assurance by Robert Pisani

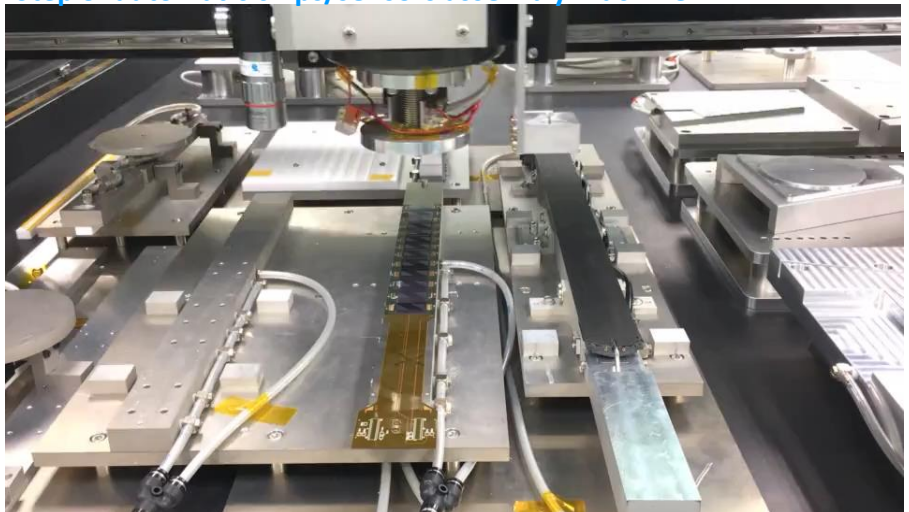
Ladder Assembly and Quality Assurance at NCU/NTU (Taiwan)

Step 1: Module assembly

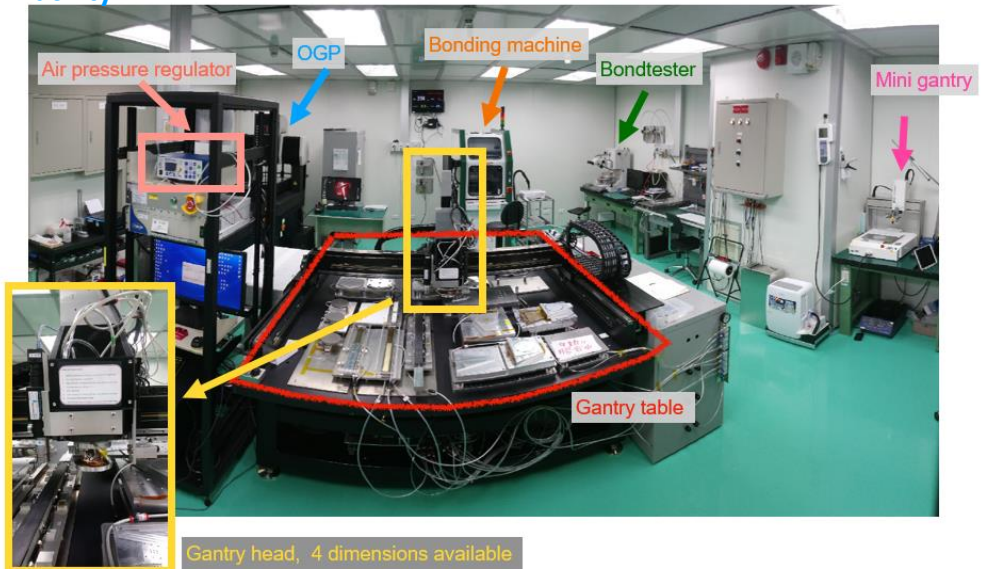
Step 2: Ladder assembly



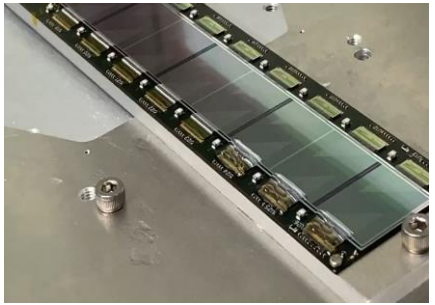
Step 3: automatic chips/sensors assembly machine



Facility



Step 4: Wire bonding and Encapsulation

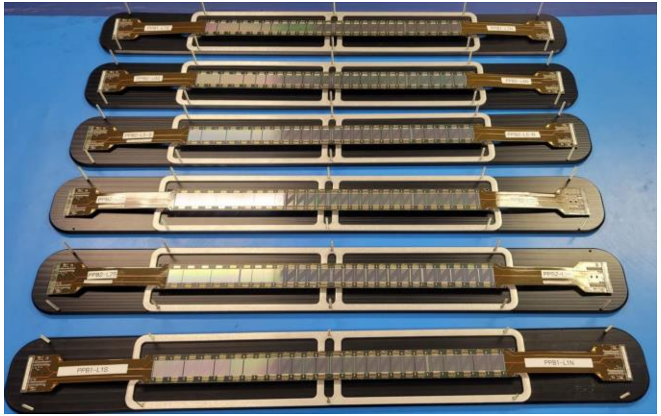


See Talk: Ladder Assembly at NCU/NTU by Cheng-Wei Shih

Ladder Assembly and Quality Assurance at BNL

sPHENIX

7 Pre-production ladders assembled successfully



Draft INTT Ladder Assembly Steps (ver. 12/16/2020)

A. Carbon Fiber Flatness Inspection Steps

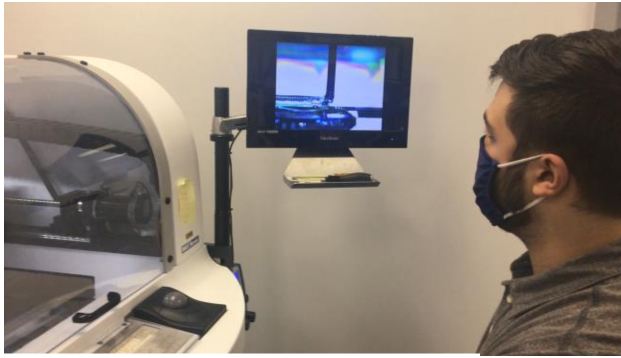
1. Remove all fixtures from the OGP platen, except for the Base Fixtures and the Pickup Base Fixture.
2. Clean all debris from the OGP platen and base fixtures.
3. Power on the OGP system and open MeasureMind 3D Multisensor.
   a. Go through the OGP initialization process.
   b. File->Open: C:\INTT\Prod Routines\INTT-CF-Flatness.RTN
   c. Navigate to System - > Configuration -> Safe Zones and enable Safe Zones 1 and 2.
4. Open MeasureFit
5. Open SmartReport
   a. File->Open: C:\Prolink\QC-CALC 3.2\Data\INTT-CFStave-Flatness.mfp, INTT-CF-Flatness_Report.Qcc
   b. This file should already be open upon SmartReport startup. Check the top border to verify this.
6. Place Carbon Fiber Stave on Base Fixture (top fixture meaning located towards the wall) and remove the lower left (towards you), and lower right (towards you), pins to expose the small thru-holes in the fixture. (Pins closest to the operator when standing in front of the OGP machine).
7. Engage the vacuum pump.
8. Run the routine on the OGP.
   a. When prompted, save the output as C:\INTT\Prod Data\INTT-CF-Flatness.DAT
   b. After the OGP routine is completed, go to C:\INTT\Prod Data\ and save a time stamped copy of the DAT file in the Archive subfolder. (MeasureFit will delete the original when it generates the report).
9. In MeasureFit, play the INTT CF Flatness Inspection under the Macros tab.
10. Once the report file is generated, save the file under C:\INTT\Prod Reports\
    a. Save the file with the following timestamp format:
       INTT_SNXXXX_205-310-0100-XX_Report.pdf
       &
       INTT_SNXXXX_205-310-0100-XX_VAC_Report.pdf
11. Repeat these steps. Once with the Vacuum on and once with the vacuum off.

B. High Density Interconnect (HDI) Gluing Steps

1. Install the Carbon Fiber Stave on the Base Fixture (mounted to the OGP platen located towards the wall) in the same fashion as [Section A | Step 6].
2. Verify that all 2mm locating pins are installed in the Base Fixture and are captured by the Carbon Fiber Stave.

Ladder Assembly

Wire bonding and Encapsulation



See Talk: Ladder Assembly at BNL
by Connor Miraval

Ladder QA in every assembly steps: HDI, chips/HDI, and Sensors/chips/HDI

Ladder | **HDIs/Chips**

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

Queue Colors: 7 Days, 11 Days, 14 Days

South Chips/HDI Status

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

North Chips/HDI Status

Count	U26 U13	U25 U12	U24 U11	U23 U10	U22 U9	U21 U8	U20 U7	U19 U6	U18 U5	U17 U4	U16 U3	U15 U2	U14 U1	File Name	Wire Bonding Days in Queue	Wire Bonding Date Completed
1	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 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	2 2	2 2	20201207-1613_0,2		
3	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	20210106-1653-0,2		
4	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	20201130-1102_0,2		
5	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	20201130-1242_0,2		
6	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	20201130-1320_0,2		
7	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	20201202-1047_0,2		

Sensors

Sensor is BAD
Sensor is Mounted
Sensor is Good

Queue Colors: 7 Days, 11 Days, 14 Days

Count	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	Wire Bonding Date Completed
1	01/14/2021	2	2	20210128-1111_0,2	2	2	20210128-1059_0,2	5	01/19/2021
2	01/06/2021	2	2	20210127-1558_0,2	2	2	20210127-1545_0,2	9	01/15/2021
3	01/14/2021	2	2	20210128-1021_0,2	2	2	20210128-1012_0,2	5	01/19/2021
4	01/13/2021	2	2	20210127-1622_0,2	2	2	20210127-1641_0,2	8	01/21/2021
5	12/10/2020	2	2	20210127-1519_0,2	2	2	20210127-1506_0,2	29	1/8/2021
6	12/07/2020	2	2	20210127_1438_0,2	2	2	20210127_1419_0,2	21	12/28/2020
7	12/04/2020	2	2	20210127_1159_0,2	2	2	20210127_1133_0,2	19	12/23/2020

Ladder

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

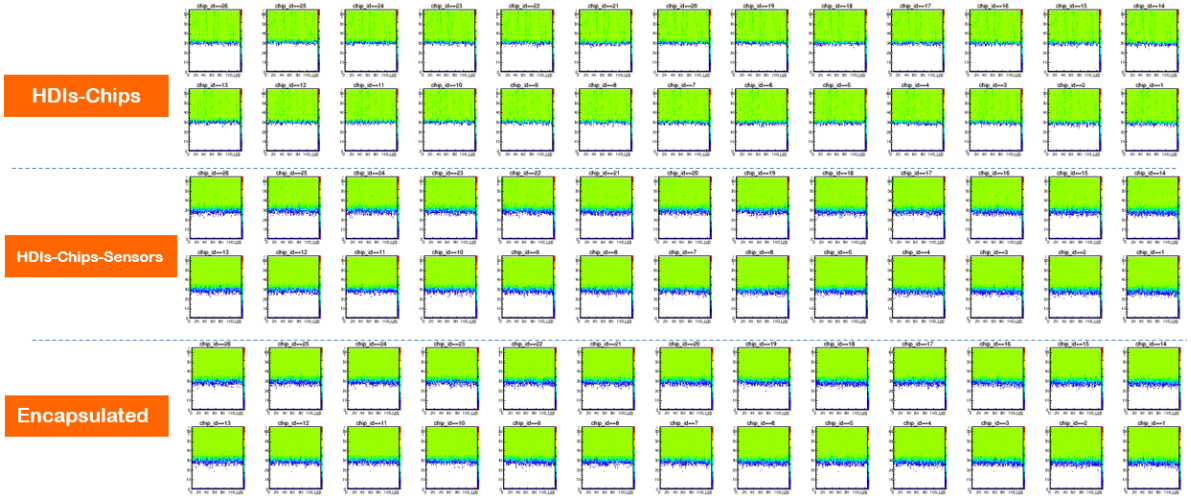
Count	Encapsulation: South	File Name	North	File Name	Date Complete	Ladder Class 1 to 5	Location Of Ladder
1	2		2				BNL
2	2		2				BNL
3	4	20210222-0905_0,2	4	20210222-1040_0,2	02/19/2021		BNL
4	4	20210222-1206_0,2	4	20210222-1113-0,2	02/22/2021		NWU
5	4	20210222-	4	20210222-	02/22/2021		NWU
6	4	20210224-1220_0,2	4	20210224-1203_0,2	02/24/2021		NWU
7	4	20210222-1549_0,2	4	20210122-1519_0,2	02/22/2021		BNL

Ladder Assembly and Quality Assurance

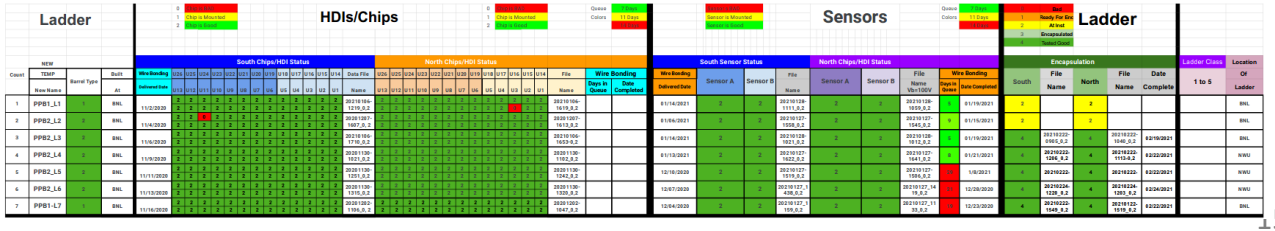
See Talk Ladders Evaluation and Classification by Milan Stojanovic

Ladder assembly steps and QA steps are coupled

PPB2-L5 South - Calibration plots x – Channel; y – amplitude

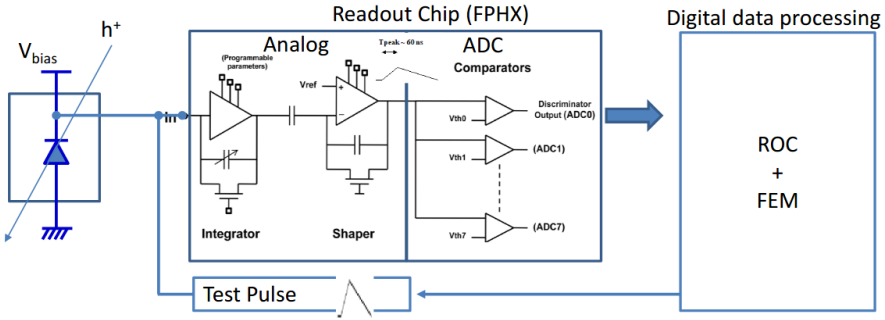


Ladder QA in every assembly steps: HDI, chips/HDI, and Sensors/chips/HDI

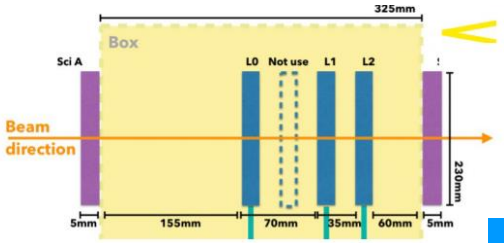


Ladder Performance: Beam Tests 2018 and 2019

Readout Schematic: beam test 2019

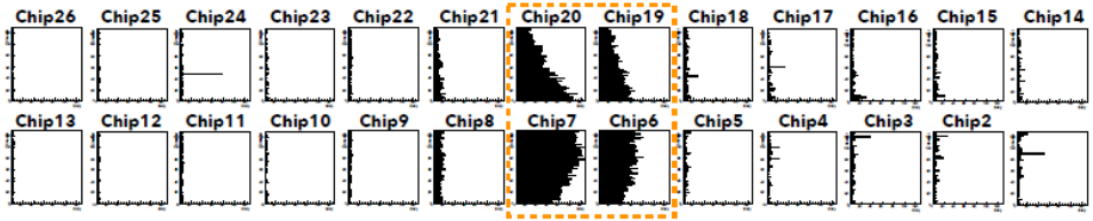


Setup: beam test 2019

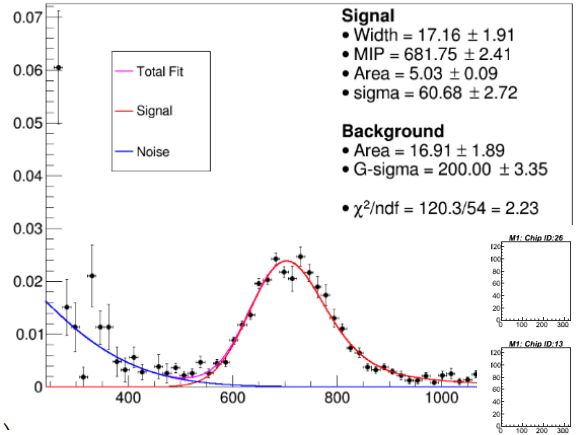


See Talk Ladder Performance by Takashi Hachiya

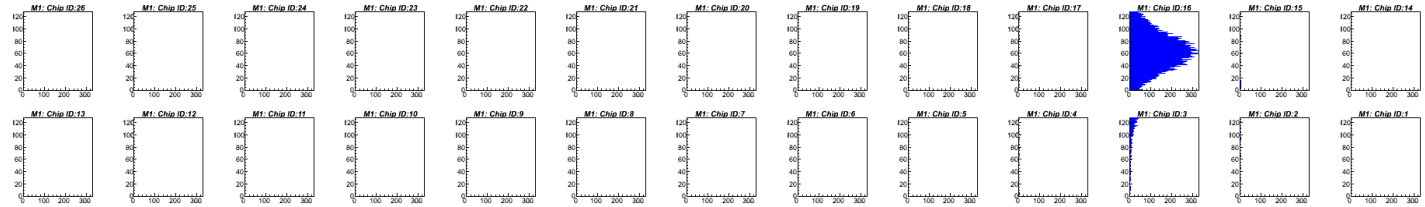
Half-ladder #1: **Beam Test 2019**



MIP Peak: beam test 2019



Half-ladder #1: **Beam Test 2018** with proton beam 120 GeV



Today

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

Tuesda
2-219
Russel

Subject: INTT Production Readiness Review

A Production Readiness Review (PRR) for INTT components will be held March 2nd, 2021 as a virtual meeting. The purpose of the PRR is to address design updates and actions items from the FDR and approve readiness for fabrication of the INTT stave and ladder parts and assemblies.

The agenda for the INTT review and web meeting link information is posted on INDICO here: *https://indico.bnl.gov/event/10800/*

This ***Production Readiness Review (PRR)*** for the INTT stave and ladder components addresses the following questions and topics:

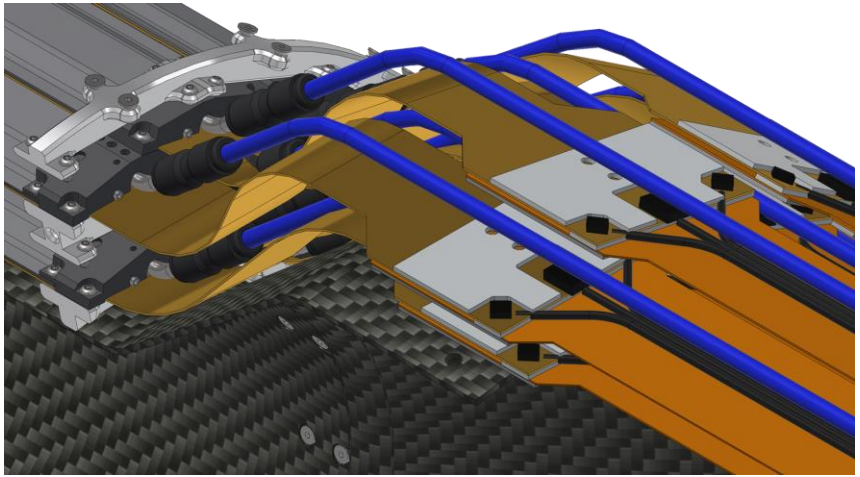
1. **Engineering and Design** – For the items under consideration for fabrication approval are all requirements and interfaces locked and documented? Has the integration of the parts been carefully checked with other INTT components and surrounding sPHENIX components? Is the design complete, and documented in detailed assembly and parts drawings? Have the drawings been checked?
2. **Management** - Has the schedule for procurement, including internal signatures and approvals, bid duration, material procurement, and fabrication been correctly estimated? Is the schedule in-line with the sPHENIX construction schedule?
3. **Fabrication** – Have potential vendors been identified? Will assembly be required? Who will perform the assembly? What are the acceptance criteria for parts? Is this documented and part of the procurement package? Who will do the acceptance inspection and testing? Is shipping included in the procurement? Where will equipment be stored upon arrival at BNL?
4. **Quality** - What are the quality assurance requirements for this procurement? Are material certifications required? Are there intermediate inspection steps required during fabrication that will require BNL team involvement?
5. **Safety** – Have all safety requirements for assembly and testing work at BNL been satisfied and closed out? Is there an ESR approval for the INTT assembly and testing areas in building 510?

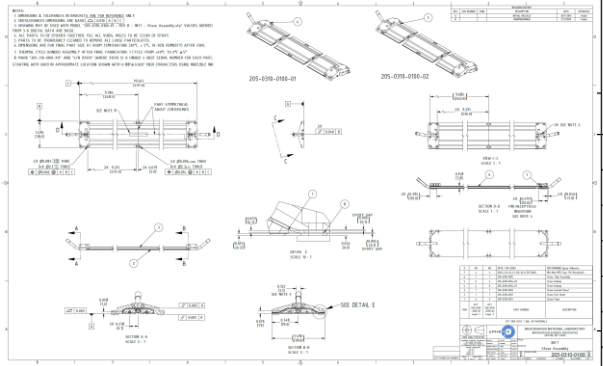
General conduct of sPHENIX PRR's is described in

https://docdb.sphenix.bnl.gov/cgi-bin/private/ShowDocument?docid=207

1. Engineering and Design –

- For the items under consideration for fabrication approval are all requirements and interfaces locked and documented? Has the integration of the parts been carefully checked with other INTT components and surrounding sPHENIX components?
  - **Yes, all direct interfaces to the ladders are internal to the INTT. Indirect interfaces between the INTT and MVTX/TPC have been accounted for in the design (see Dan's Talk for detail).**
- Is the design complete, and documented in detailed assembly and parts drawings? Have the drawings been checked?
  - **Yes, all parts have been designed and have drawings that are signed and approved (see Dan's Talk for detail).**





DRAWN BY:	D. CACACE	5/22/2019
CHECKED BY:	R. RUGGIERO	5/22/2019
ENGINEER APPROVAL:	R. FEDER	5/22/2019
SUPERVISOR APPROVAL:	J. MILLS	5/22/2019
DESIGN APPROVAL:	R. NOUICER	5/22/2019
Q.A. APPROVAL:	C. GORTAKOWSKI	5/22/2019
SAFETY ENGINEER:	L. STIEGLER	5/22/2019

2. Management –

- Has the schedule for procurement, including internal signatures and approvals, bid duration, material procurement, and fabrication been correctly estimated?
  - **Yes, RIKEN INTT management and procurements service at RIKEN in direct contact with Japanese companies**
  - **HPK (sensors), Yamashita (HDI), and Asuka co. (CFC-staves), they did:**
    - **prototype (done)**
    - **pre-production (done)**
    - **production procurements in place**

Component	Prototype	Pre-Production	Production
FPHX Chips (FNAL)	✔ + beam tests	✔ + beam test	✔ 12000 (52x56 needed)
Silicon Strip Sensors (HPK)	✔ + beam tests	✔ + beam test	✔ x (4x56 needed)
HDI (Yamashita)	✔ + beam tests	✔ + beam test	✔ x (2x56 needed)
CFC-Stave (Asuka)	✔	✔ 7 ladders	- (56 needed)
Ladder	✔ + beam test half ladders	✔ 7 ladders	- (56 needed)

- FPHX: used successfully in FVTX/PHENIX
- Strip sensor: AC-coupled silicon sensors standard HPK design (78 um)
- HDI: conservative copy of FVTX/PHENIX
- CFC-Stave: NEW design (low risk)

2. Management –

- Is the schedule in-line with the sPHENIX construction schedule?
  - **Yes.**

Pre- COVID-19 Schedule of INTT WBS Input to P6

	WBS	Task Name	Text10	Duration	Constraint Type	Co Da	Type	Start	Finish	Predec
0	03.01.	sPHENIX_INTT		1490 days	As Soon As Possible	NA	Fixed Duration	Wed 2/1/17	Tue 1/24/23	
1	03.01.01	INTT Construction	L3 Manager	808 days	As Soon As Possible	NA	Fixed Duration	Mon 3/4/19	Thu 5/26/22	
2	03.01.01.1	Ladder Assembly	R. Nouicer	481 days	As Soon As Possible	NA	Fixed Duration	Tue 3/19/19	Mon 2/22/21	
18	03.01.01.2	Stave CFC	D. CACACE	262 days	As Soon As Possible	NA	Fixed Duration	Mon 3/4/19	Thu 3/19/20	
29	03.01.01.3	EndRings	D. CACACE	153 days	As Soon As Possible	NA	Fixed Duration	Tue 10/22/19	Wed 6/3/20	
34	03.01.01.4	Barrel Assembly	C. Miraval	30 days	As Soon As Possible	NA	Fixed Duration	Tue 2/23/21	Mon 4/5/21	
42	03.01.01.5	Support Rails	D. CACACE	173 days	As Soon As Possible	NA	Fixed Duration	Tue 10/22/19	Wed 7/1/20	
50	03.01.01.6	INTT Assembly	C. Miraval	573 days	As Soon As Possible	NA	Fixed Duration	Tue 2/11/20	Thu 5/26/22	
58	03.01.02	INTT Electronics		931 days	As Soon As Possible	NA	Fixed Duration	Mon 4/3/17	Mon 12/28/20	
59	03.01.02.1	Silicon Sensor	I. Nakagawa	397 days	As Soon As Possible	NA	Fixed Duration	Wed 9/12/18	Thu 4/16/20	
66	03.01.02.2	Silicon Sensor QA	C.M. Kuo	110 days	As Soon As Possible	NA	Fixed Duration	Fri 4/17/20	Wed 9/23/20	
72	03.01.02.3	HDI Cable	I. Nakagawa	421 days	As Soon As Possible	NA	Fixed Duration	Wed 8/1/18	Thu 4/9/20	
82	03.01.02.4	Extension Cable and Conversion Cable	T. Hachiya	461 days	As Soon As Possible	NA	Fixed Duration	Fri 2/22/19	Mon 12/28/20	
95	03.01.02.5	FPHX Chips	Y. Akiba	240 days	As Soon As Possible	NA	Fixed Duration	Mon 4/3/17	Tue 3/20/18	
101	03.01.02.6	ROC FVTX	I. Nakagawa	124 days	As Soon As Possible	NA	Fixed Duration	Thu 8/1/19	Fri 1/31/20	
106	03.01.3	INTT Integration in sPHENIX		430 days	As Soon As Possible	NA	Fixed Duration	Tue 5/4/21	Tue 1/24/23	
107	03.01.3.1	Detector Monitoring	W. Xie	362 days	As Soon As Possible	NA	Fixed Duration	Tue 5/4/21	Thu 10/13/22	
111	03.01.3.2	Electronic Services and Detector Commissioning	W. Xie	430 days	As Soon As Possible	NA	Fixed Duration	Tue 5/4/21	Tue 1/24/23	
119	03.01.4	Project Management		0 days	As Soon As Possible	NA	Fixed Duration	Wed 2/1/17	Wed 2/1/17	

INTT end of construction 5/26/2022

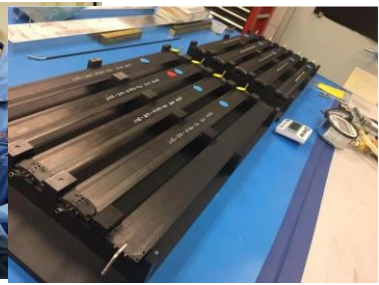
- Ladder Assembly
  - 02/22/2021 (schedule)
  - 05/22/2021 (new)

  3 months delay

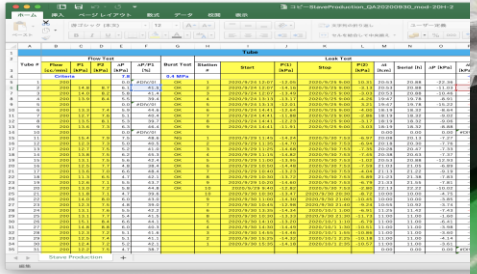
  (1.5 months delay because we have two sites for assembly)

3. Fabrication –

- Have potential vendors been identified?
  - Yes, Asuka company in japan produced the prototype and pre-production CFC-staves successfully



- Will assembly be required? Who will perform the assembly?
  - Yes, Asuka co. will assembled the CFC-staves
- What are the acceptance criteria for parts? Is this documented and part of the procurement package? Who will do the acceptance
  - Yes, the stave requirements criteria are part of stave design, and Asuka co. will do acceptance tests during fabrication process, see Rob's Pisani talk
- inspection and testing?
  - During fabrication steps, Asuka co. will do flow, pressure, and flatness tests of all staves. Only staves satisfied the criteria will be delivered



- Is shipping included in the procurement?
  -Yes, RIKEN includes shipping in the procurements
- Where will equipment be stored upon arrival at BNL?
  - At the silicon lab room 2-211, physics dept. BNL.

4. Quality –

- What are the quality assurance requirements for this procurement?
  - **BNL and Taiwan assembly teams will retest all staves prior to the ladder assembly, see Robert's Pisani talk.**

- Are material certifications required?
  - **Material certifications are not needed, see Dan's Cacace Talk about CFC stave material**

- Are there intermediate inspection steps required during fabrication that will require BNL team involvement?
  - **No.**

Each Stave goes through a multi-step testing and inspection process to ensure the staves are of high quality.

1. Visual inspection
2. Leak test
   a) Pressurized test
   b) Submersion test
3. Flow consistency test
4. Flatness measurement
5. Long Term flow testing

A	B	C	D	E	F	G	H	I	J	K	L	M	N
	Barrel 2		Barrel 2		Excellen	Class 1	X < 0.15		Barrel 2		X <0.09 psi Goo	Range Good	
	Lot # -01 Layer 1				Fair	Class 3	0.150 < X < 0.200				0.75 < X < 1.25		
	Lot # -02 Layer 2				Poor	Class 5	X > 0.201	No Vacuum			>0.10 Poor		
	Lot Number	Serial Number	Stave Type		Flatness Operator	Date	Flatness no Vacuum mm	Vendor Flatness	Flow/Leak Operator	Date	10 min leak in PSI start 20psi	Delta P of stave at 200 ccm (psi)	Vendor Flow #
Count					Name				Name			PSI	PSI
1	205-310-0100-02	0011	Batch 1	5	SA	12/16/2020	0.1037	0.0220	SA/RP	12/11/20	0.127	0.975	0.856
2	205-310-0100-02	0012	Batch 1	1	SA	1/27/2021	0.0799	0.1140	SA	1/15/21	0.055	0.97	0.856
3	205-310-0100-02	0014	Batch 1	1	SA	1/26/2021	0.1026	0.0670	SA	1/13/21	0.050	0.79	0.783
4	205-310-0100-02	0015	Batch 1	4	SA	01/27/2021	0.1087	0.0340	SA	01/15/21	0.093	0.99	0.827
5	205-310-0100-02	0017	Batch 1	1	RN	01/11/2021	0.1674	0.1450	SA	01/11/21	0.035	0.93	0.856
6	205-310-0100-02	0020	Batch 1	1	SA	1/27/2021	0.0689	0.2560	SA	1/15/21	0.049	0.8	0.957
7	205-310-0100-02	0021	Batch 1	5	SA	2/4/2021	0.0909	0.0660	SA	1/19/21	0.910	0.85	0.986
8	205-310-0100-02	0023	Batch 1	5	RN	12/21/2020	0.0941	0.0820	SA	1/22/21	2.00	0.76	0.870
9	205-310-0100-02	0024	Batch 1	4	RN	1/7/2021	0.1581	0.0980	SA/RP	12/23/20	0.103	1.18	0.812
10	205-310-0100-02	0026	Batch 1	2	SA	1/27/2021	0.1698	0.0910	SA	1/15/21	0.065	1.005	0.740
11	205-310-0100-02	0027	Batch 1	1	RN	1/11/2021	0.1584	0.2770	SA/RP	12/11/20	0.050	0.85	0.957
12	205-310-0100-02	0029	Batch 1	1	RN	1/11/2021	0.1248	0.1450	SA	1/12/21	0.055	1.09	0.943
13	205-310-0100-02	0030	Batch 1	1	RN	1/7/2021	0.0788	0.1330	SA/RP	12/23/20	0.043	1	1.044
14	205-310-0100-02	0032	Batch 1	2	SA	1/26/2021	0.2212	0.0940	SA	1/13/21	0.070	0.975	0.783
15	205-310-0100-02	0033	Batch 1	5	SA	2/4/2021	0.0679	0.1360	SA	1/28/21	0.190	0.59	0.841
16	205-310-0100-02	0035	Batch 1	1	SA	1/25/2021	0.1328	0.2270	SA	1/14/21	0.047	0.925	0.928
17	205-310-0100-02	0036	Batch 1	1	RN	12/21/2020	0.0906	0.1520	SA	02/04/21	0.055	0.575	0.812
18	205-310-0100-02	0037	Batch 1	1	SA	1/27/2021	0.1090	0.2390	SA	1/15/21	0.065	1.025	0.740
19	205-310-0100-02	0038	Batch 1	2	RN	1/7/2021	0.1768	0.0980	SA/SA	12/23/20	0.076	0.85	1.059
20	205-310-0100-02	0041	Batch 1	5	SA	2/4/2021	0.1592	0.1210	SA	1/14/21	0.450	0.72	0.798
21	205-310-0100-02	0042	Batch 1	1	SA	1/26/2021	0.1167	0.1450	SA	1/14/21	0.060	1.025	0.870
22	205-310-0100-02	0044	Batch 1	2	SA	1/27/2021	0.1796	0.2240		1/13/21	0.055	0.8	0.754
23	205-310-0100-02	0045	Batch 1	2	RN	1/7/2021	0.1838	0.2890	SA/SA	12/23/20	0.051	0.8	0.798
24	205-310-0100-02	0047	Batch 1	2	SA	1/26/2021	0.1882	0.1380	SA	1/14/21	0.045	0.855	0.957
25	205-310-0100-02	0048	Batch 1	1	RN	12/23/2020	0.1679	0.1720	SA	1/22/21	0.055	0.785	0.740
26	205-310-0100-02	0050	Batch 1	2	SA	1/26/2021	0.2211	0.0910	SA	1/13/21	0.070	0.98	0.885
27	205-310-0100-02	0051	Batch 1	5	RN	12/21/2020	0.1261	0.1760	SA	1/28/21	1.165	0.795	0.841
28	205-310-0100-02	0053	Batch 1	1	SA	1/26/2021	0.1986	0.196	SA/RP	12/23/20	0.055	0.895	0.870
29													

5. Safety – INTT Environmental, Safety and Health (ES&H)

- The INTT detector assembly (ladders, barrels and testing) work is carried in the silicon lab room 2-211 in the physics department at BNL.

- The INTT Environment, Safety, and Health (ES&H) at the silicon lab (room 2-211) is handled by Brookhaven National Laboratory Integrated Safety Management System (ISMS) through the Silicon Lab Experimental Safety Review (ESR) Form: PO-035-2016.

- The Silicon Lab ESR Form describes all the works carried out by the INTT team and trainings required from each individual. The INTT individuals working in the silicon lab are registered in the Brookhaven National Laboratory Integrated Safety Management System (ISMS). The individuals are notified in case their training is expired or new trainings are required.

- All work associated with the INTT silicon lab will be conducted in a manner that ensures protection of the people (required trainings to achieve the work safely and effectively, glasses,…) , and the environment. Implementing procedures and additional guidance to ensure accomplishment of these expectations will be established as necessary and communicated to members of INTT team.

- All INTT components needed to meet mission requirements are fully defined and are designed, assembled, and operated in accordance with applicable Federal (including DOE) requirements.

- The INTT Environment, Safety, and Health (ES&H) follow sPHENIX ES&H at BNL. The work of INTT at the silicon at BNL is under the supervision of Achim Franz as its Experiment Review Coordinator (ERC).