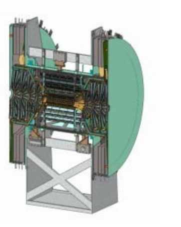


FVTX Wedge Assembly

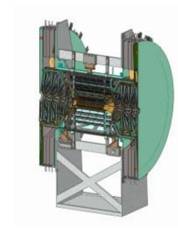
WBS 1.4.1.3.3 to 1.4.1.3.12

David Winter

Columbia University

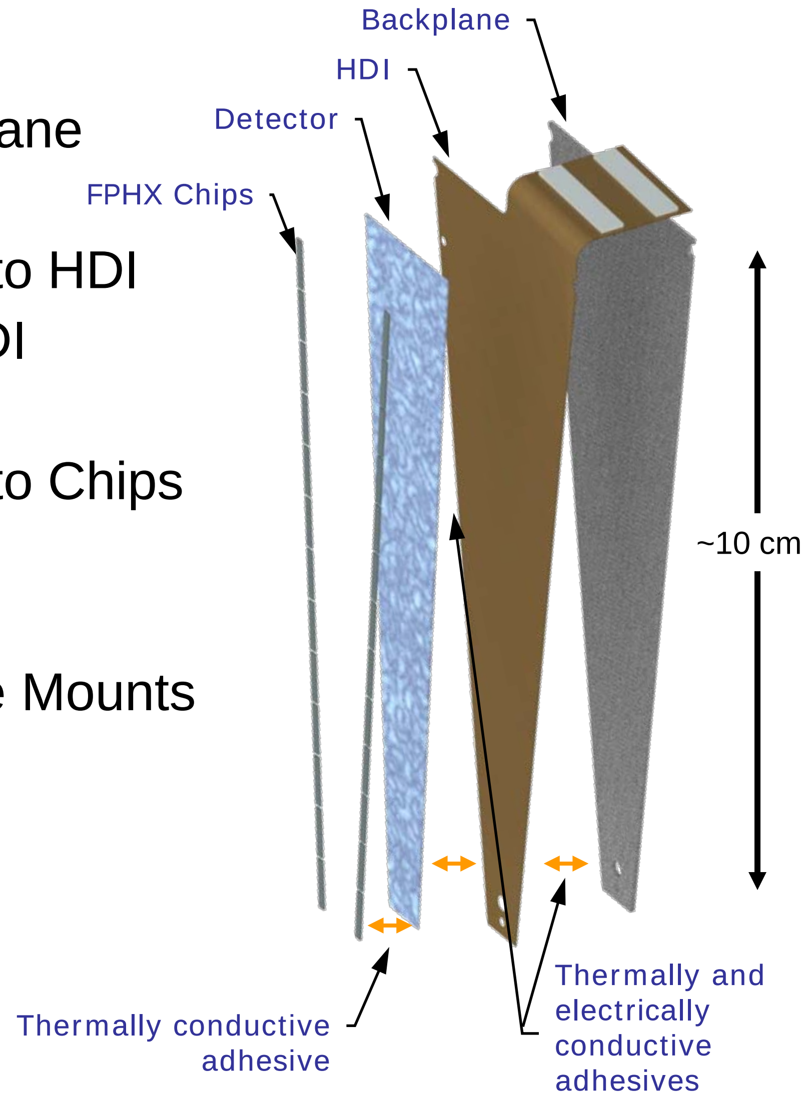
FVTX Wedge Manager

PHENIX

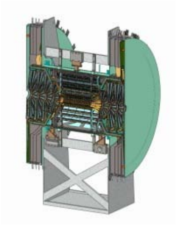


Talk Outline

- Scope
  - WBS 1.4.1.3.3 Attach HDI/Backplane
  - WBS 1.4.1.3.7 Bond Chips to HDI
  - WBS 1.4.1.3.12 Wirebond chips to HDI
  - WBS 1.4.1.3.8 Test Chips and HDI
  - WBS 1.4.1.3.4 Attach Sensor
  - WBS 1.4.1.3.5 Wirebond Sensor to Chips
  - WBS 1.4.1.3.6 Test Assembly
  - WBS 1.4.1.3.9 Encapsulation
  - WBS 1.4.1.3.11 Attach Backplane Mounts
- Wedge Schedule
- Status of prototypes, fixtures
- Procedure and Manpower
- Summary

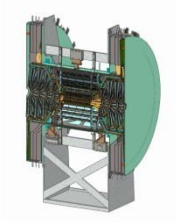


Scope



- Work with vendor to:
  - Prepare assembly lab(s)
  - Develop assembly procedure
- Receive backplanes, high-density interconnects (HDIs), sensors
  - All components arrive tested and qualified
  - HDIs populated with passive components
- Assemble received components into wedges
- Execute QA and testing procedures
- Enter QA/Test results into database
- Store assembled units
- Deliver assembled wedges to detector assembly facility at BNL

Wedge Schedule



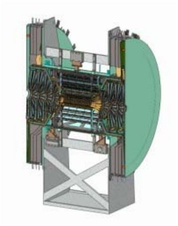
Highlights of Dates Important to Assembly

• 2nd Prototyping/design of components, fixtures:	In progress	
• Procure and Q/A sensors:	11/4/09	4/20/10
• Procure HDI:	10/27/09	2/9/10
• Fabrication of backplanes:	12/8/09	3/29/10
• Procure Wedge Assembly fixtures:	11/6/09	12/31/09
• FNAL testing of production run of FPHX:	12/25/09	2/4/10
• Wedge assembly:	2/2/10	1/13/11
– WBS 1.4.1.3.3 Attach HDI to Backplane:	2/2/10	3/8/10
– WBS 1.4.1.3.12 Wirebond FPHX to HDI	2/16/10	7/12/10
– WBS 1.4.1.3.5 Wirebond sensor to FPHX	3/9/10	10/14/10
– WBS 1.4.1.3.9 Encapsulation	4/6/10	11/11/10
– WBS 1.4.1.3.11 Attach BP mounts	6/8/10	1/13/11
• Endcap assembly (wedges onto disks):	6/22/10	1/24/11

Important dependencies

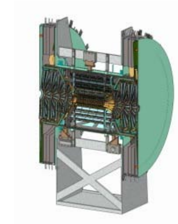
- Critical path components: FPHX, HDI 2nd prototype, Backplanes
- Sensor development and production, assembly fixtures

Main Highlights from Last Review



- Sidet at FNAL was contracted to do prototype assembly
  - Develop and evaluate procedures and fixtures
  - Develop Cost & Schedule estimate for production
  - Assemble prototypes for noise, cosmics, and test beam data
- Assembly fixtures designed and awaiting fabrication

Status of Prototype Assembly

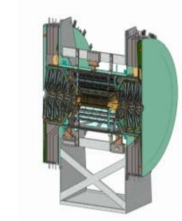


- Sidet has performed prototype assembly
  - In-line with previous experience, only technical challenge is size of FPHX chips (but they feel comfortable with them now)
  - Developed procedures
  - Evaluated assembly fixtures
  - R&D on adhesives (lamination tests, shapes, procedures)
  - Assembled prototype units for testing
  - Finished as of August 2009
- Prototypes produced to date (all 26-chip size):
  - Kapton HDI with sensor + 1 chip
  - Kapton HDI with sensor + 15 chips ★ ★
  - PCB HDI with 1 chip
  - PCB HDI with sensor + 26 chips ★ ★
  - PCB HDI with sensor + 8 chips (x2) ★ ★
  - PCB HDI with sensor + 8 chips (with FPHX2) ★

★ Used to take test beam data

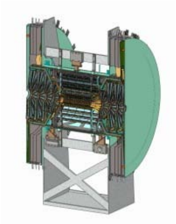
★ Used to take cosmic ray data

Assembly Fixtures

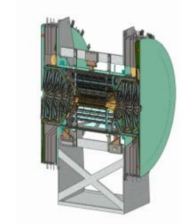


- Prototypes delivered to FNAL 12/9/09
  - 2 Sets; one used extensively, 1 held in reserve
- Initial evaluation by Sidet very positive
  - Fit well together
  - Allowed significant work to take place on procedure development
  - Enabled prototype modules to be built
  - Some issues identified (see next slides)

Assembly Fixture Issues and Solutions



Issue		Solution
BP without pedestals can't be precisely placed		Designed BP positioning fixture similar to sensor positioning fixture
Scribe lines for chip placement hard to use		• Glued 160 um wires as chip stops • Investigating machined stops
Chip spacing too narrow for Kapton HDI design		Fixture design changed to match Kapton
Acrylic sensor transfer fixture cracked		Design changed to use Al



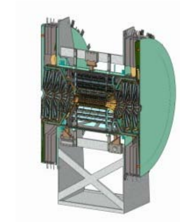
Current Assembly Procedure

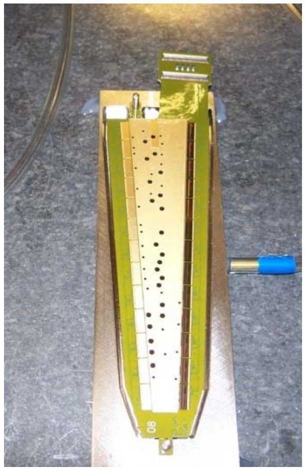
1. Bond HDI to backplane ★
2. Bond FPHX readout chips to HDI ★
3. Wire bond FPHX output pads to HDI ★
4. Test HDI + FPHXs
5. Bond sensor to HDI ★
6. Wire bond sensor output pads to FPHX input pads ★
7. Test assembly
8. Encapsulate wire bonds ★
9. Final Testing of assembly
10. Pedestal attachment/HDI bending ★

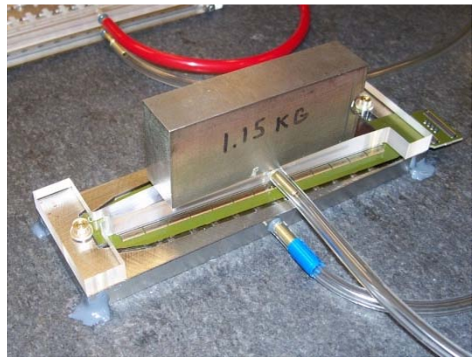
RED: performed by FVTX
BLACK: performed by Sidet
★ Developed procedure
★ Done manually
★ Work in progress

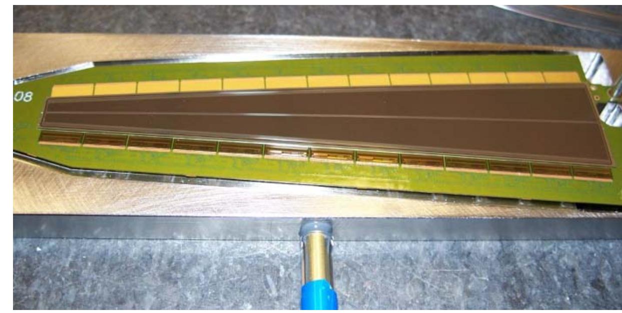
- Additional details
  - Strips of Arclad 7876 (2 mil) adhesive tape for:
    - Bonding chips to HDI
    - Bonding side edges of sensor to HDI
  - Ag epoxy in center area of sensor for bias
  - Encapsulant is Sylgard 186
  - Assembly (Sidet) time includes inspection and QA
  - Traveler documents for each module

Assembling the Prototypes

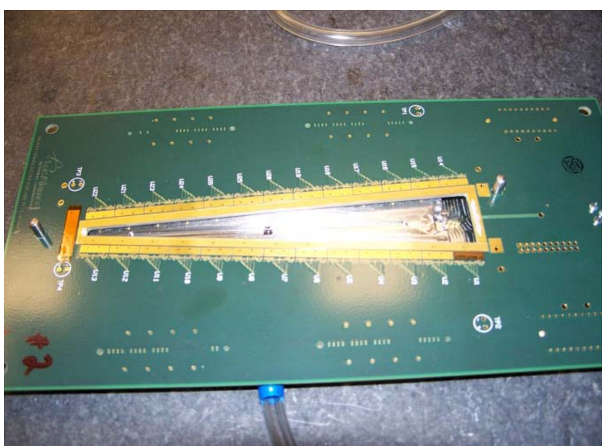


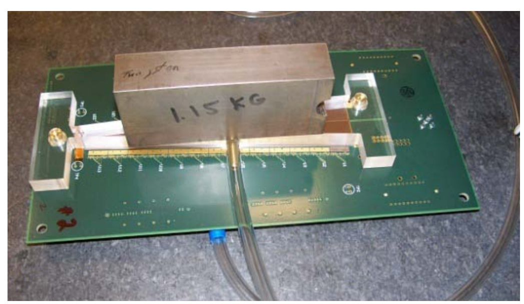


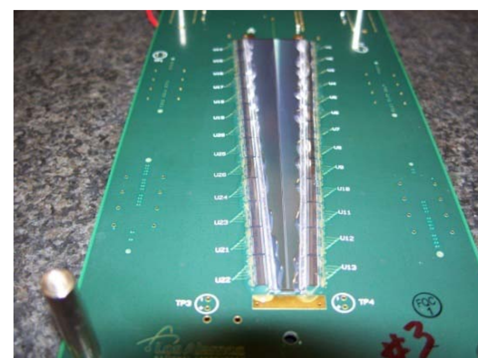




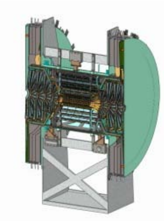
Chips → Sensor → (Ready for) Encapsulation

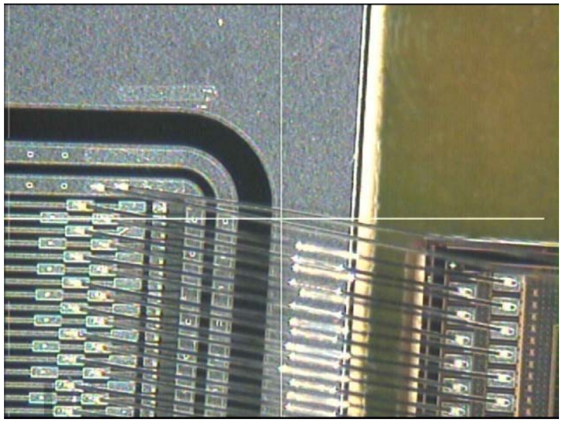


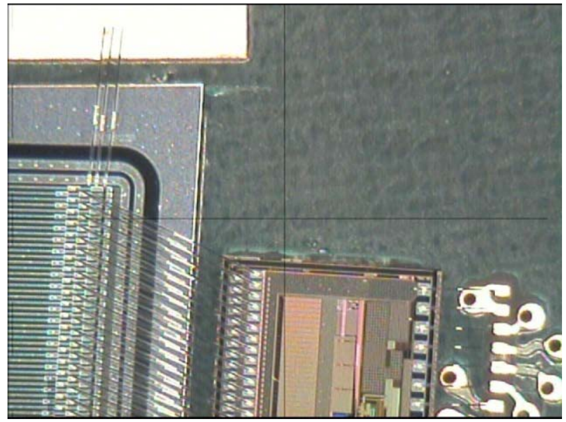




Assembling the Prototypes (2)



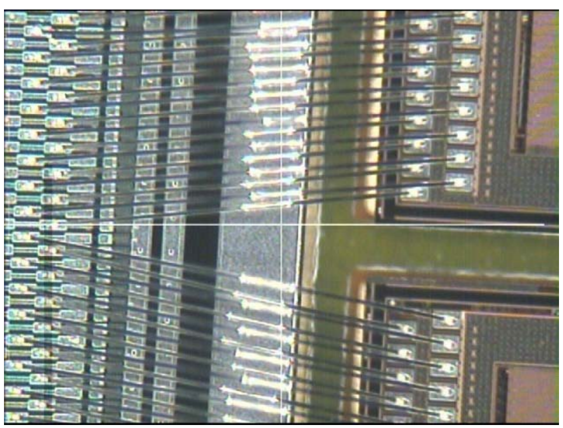


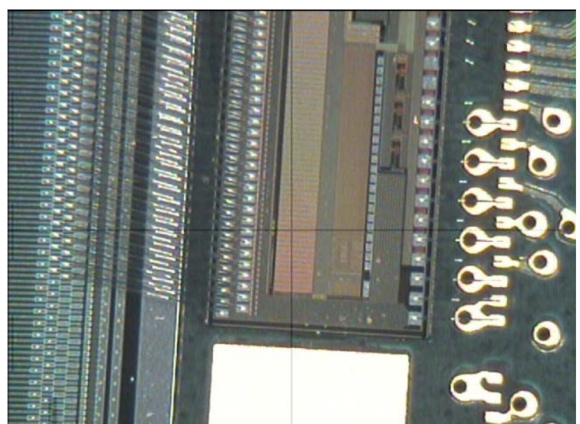


Kapton HDI missing bond pad for guard ring
Bonded to FPHX pad

Kapton HDI

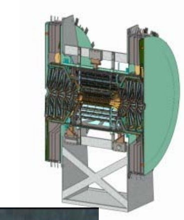
PCB HDI



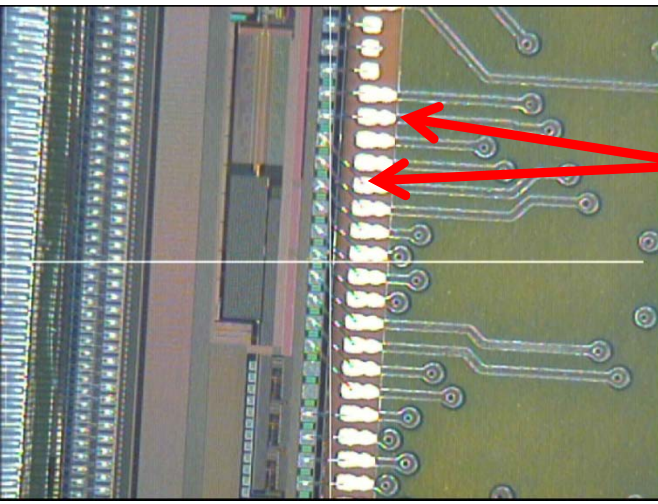


Kapton and PCB HDIs have different chip spacing
Hand-mounted and wirebonded without problem

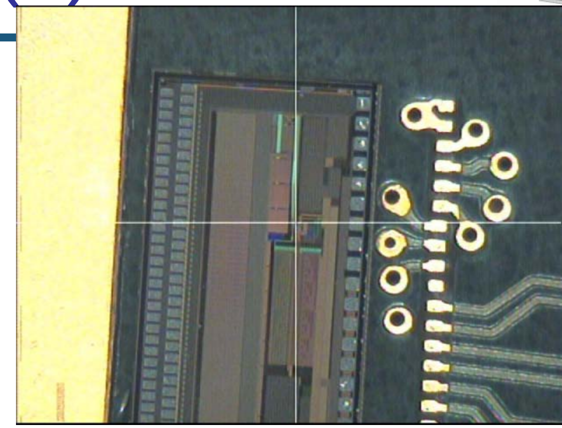
Assembling the Prototypes (3)



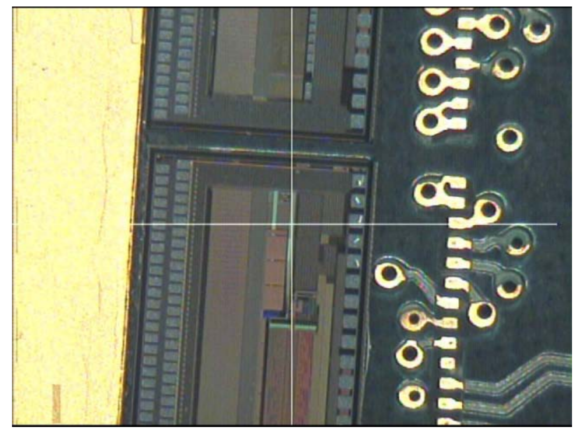
Some challenges allowed Sidet to demonstrate their technical prowess…



Mismatch between FPHX and HDI pads
Wirebonded with no trouble

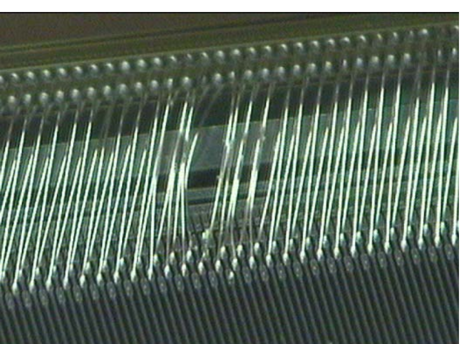


Chip 1



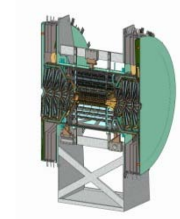
Chip 12

Chip 13



Discovered just how easy it is to bump the wirebonds
Bonds separated by hand (none broken)

Distance between vias on left & right led to interference between chips, sensor and vias
Thin bead of epoxy to protect vias allowed 26 chips to be placed



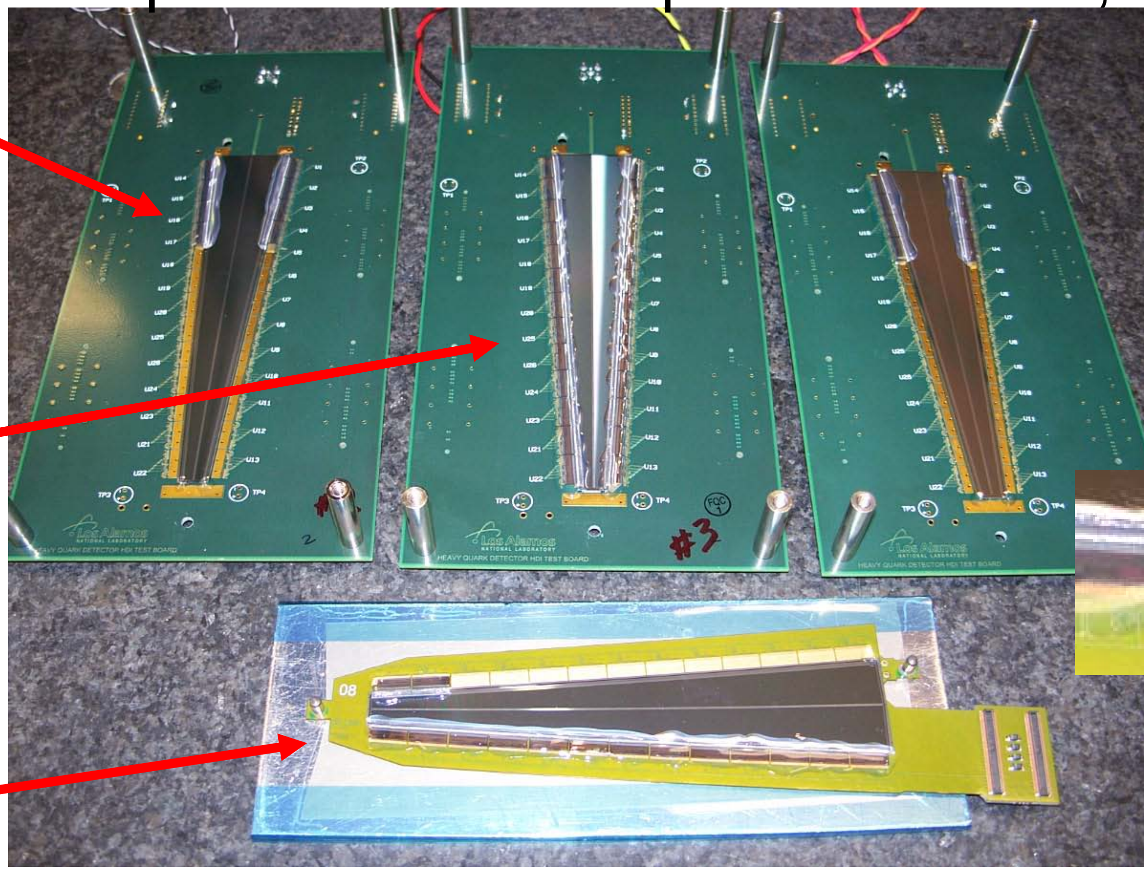
Prototype Results

3 PCB and 1 Kapton HDIs with chips and sensors, encapsulated

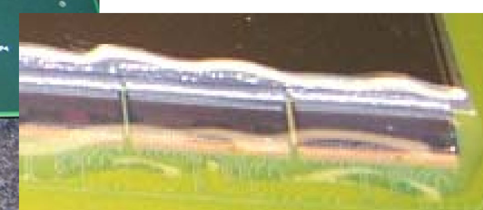
8 chips

26 chips

13+2 chips

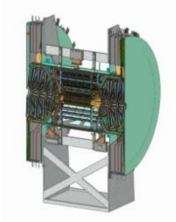


encapsulant



No assembly issues with the prototyping!

Proposed QA and Testing of Wedge Units

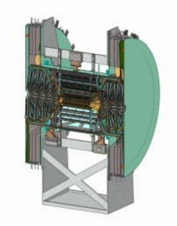


Basic Procedure includes:

- Power up to verify low voltage and bias channels are operational
- Download of configuration to the FPHX chips
- Read back of configuration from the FPHX chips
- Threshold and noise measurements of the FPHX chips
- Readout of strips in response to external source (for example, LEDs)
- Record results in database

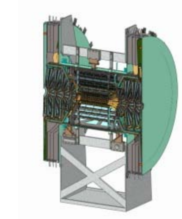
- In-line with testing FVTX has done with prototype modules
- Plan calls for testing at various stages of assembly
- Test multiple units at once (for example, current ROC can easily read out four wedges at once)
- Final qualification to be performed after assembly completed and before shipping

Status of Production Estimate



- Important goal of the prototype SOW was to develop a production (cost and schedule) estimate
- Estimate produced in Spring/Summer
- SOW finalized this Fall.
- In current estimate, production spans ~40 weeks
  - Primary bottleneck is wirebonding (31.5 weeks)
  - Testing can take place in parallel
  - Does not include attaching of pedestals
- Quoted cost is $248k. Includes:
  - Labor
  - Materials and Services
  - Indirect

Basis for Schedule Estimates



Step	Rate per week	Responsibility
HDI to BP	100	Senior, Junior Tech
FPHX Chips to HDI	40	Senior, Junior Tech
Wirebond FPHX-HDI	40-60	Tech Specialist, Sr. Technician
Sensor to HDI	120	Senior, Junior Tech
Wirebond Sensor-FPHX	20	Tech Specialist, Sr. Technician
Encapsulate	40-50	Junior Tech

Assumptions

- Sidet technicians in charge of assembly steps; FVTX personnel for QA testing
- At least 4 sets of assembly fixtures + enough bases for transport between steps
- QA System testing done in parallel and keeps up with production

Schedule will need to be optimized:

- Steps are done in series, and more than one step handled by each tech
- Individual throughput is not the same from step to step
- Functional balance to be established to prevent techs from being idle waiting for predecessors

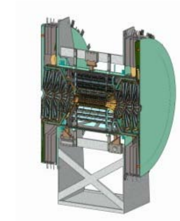
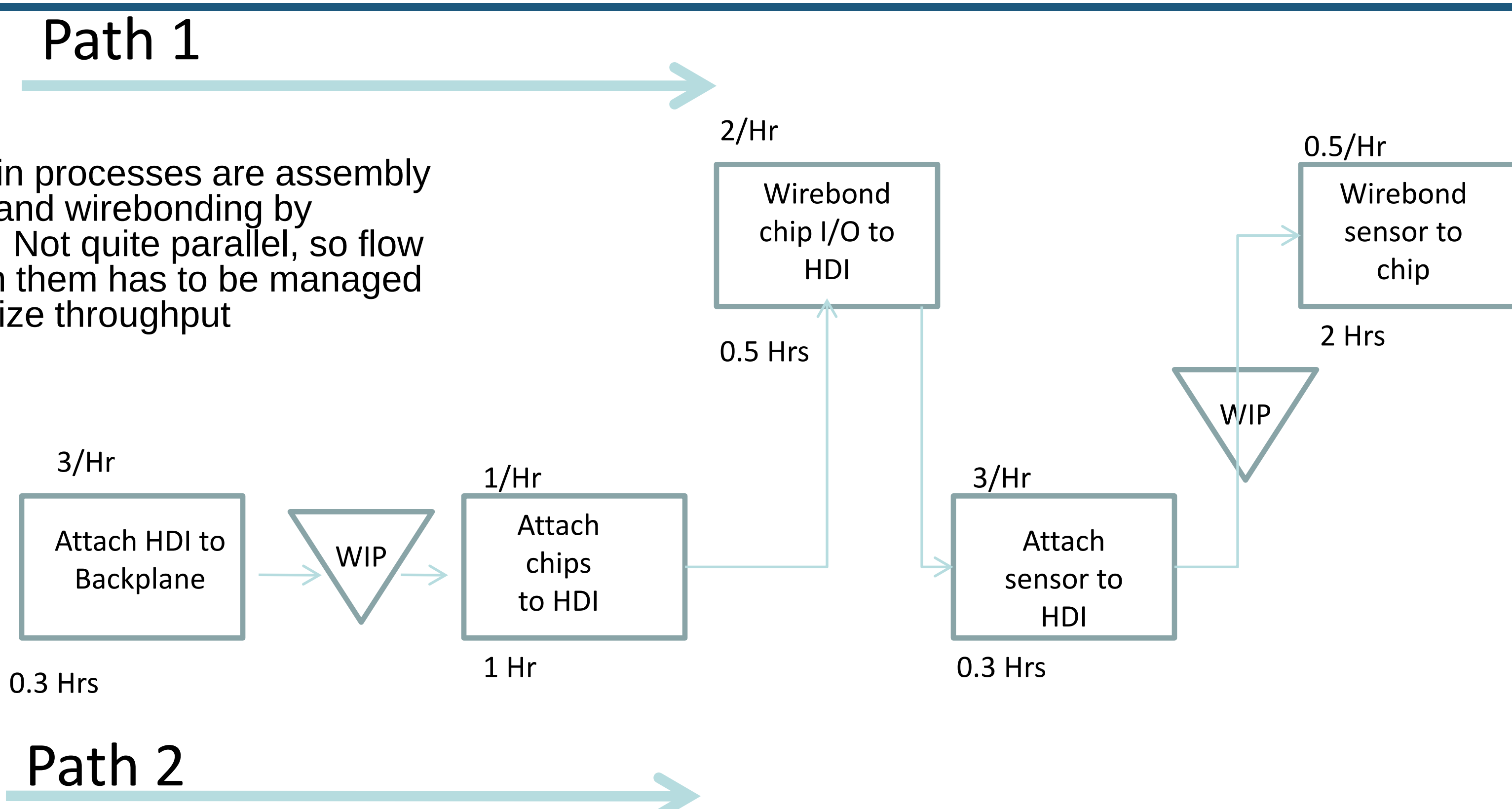


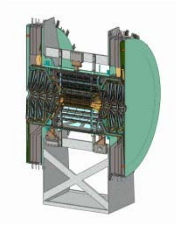
Illustration of Process Flow

Two main processes are assembly by Bert and wirebonding by Tammy. Not quite parallel, so flow between them has to be managed to optimize throughput



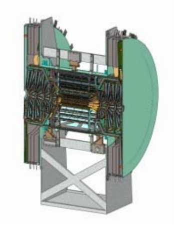
- Testing done in parallel and throughput can keep up with production
- Similar case for encapsulation
- Glue curing can happen overnight and not critical for process flow

Projected Manpower Requirements



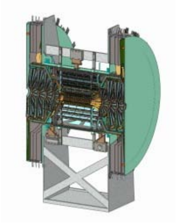
- Currently assembly itself calls for Sidet technicians
  - Steps that are manpower and time-intensive are also require technical skill (chip placement, wirebonding)
  - Handled by senior and junior techs, with load taken more by junior techs as experience is gained
    - Assembly: Tech Supervisor, Jr/Sr Technician
    - Wirebonding: Tech Specialist, Sr Technician
    - Encapsulation: Trechnician
- FVTX personnel in charge of wedge testing
  - Modest rate of 4-8 tested per day (easily reachable) more than keeps pace with production
  - Will require 1-2 people for span of production time (~30 weeks)
  - Graduate students and Postdocs available from several institutions to perform on-site testing
  - Subsystem manager stationed on-site to oversee production

Summary: WBS 1.4.1.3.3-12



- Specification Document — TDR, Management plan
- Prototype status — Complete
- Number of wedges — 104 small, 313 large
- Spares — 8 small, 25 large
- Institutions Involved — Columbia, NMSU, UNM, LANL
- QA procedures in place — Done
- Production schedule: — 2/2/10 to 1/13/11
- Assembly work completed:
  - Several prototype modules
  - Fixtures prototyped and in process of revision
  - Sidet established that assembly is well within their technical expertise
  - Sidet provided production estimate & SOW now in place

Summary



- Wedge assembly comprises WBS items 1.4.1.3.3 –1.4.1.3.12
- Production schedule: 2/2/10 to 1/13/11
- Prototyping assembly work complete
  - Several prototype modules
  - Fixtures prototyped and in process of revision
  - Sidet established that assembly is well within their technical expertise
  - Sidet provided production estimate
- Production SOW in place