Assembling the Nova Far Detector

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A reminder – the Nova Far Detector is located near International Falls, Minn.
- About 810 km from Fermilab, 2° off the NUMI line.
Far Detector Hall

- The detector hall is complete
  - Photo from May 2012
Nova Detector Concept

- The detector will be ~15 ktons of PVC and liquid scintillator
- Approximately 65% of the mass is “live”.
The PVC Extrusion

• The Nova detector module is formed from a special PVC formula, designed for high reflectivity
• The PVC is extruded at Extrutech in Manitowoc, Wis.
• Then shipped to our module factory in Minneapolis, Minn.
The PVC Extrusion

• 15.7 m pieces of this PVC are extruded for the basic detector unit
  – Each extrusion contains 16 separate volumes
• 48 of these pieces fill a truck
  – 0.3% of Nova in each shipment

Arrival at the Minneapolis Module Factory
Nova Module Production

- The module factory employs ~270 UM undergraduates
  - Large factory space just off campus
- Extrusions are glued together to form 32 volume units
Extrusion become Modules

- Optical fibers are placed into each volume
  - Both ends brought to an optical connector
  - Opposite end is sealed with a cap
Delivered to the Ash River Site

• Finally, the detector modules are shipped to the Ash River site
  – 24 modules fill a truck
The Nova Plan

- Final assembly
  - 12 modules in each layer (15.7 x 15.7 m)
  - 32 layers assembled into a single block (2.5 m thick, ~200 tons)
  - 30 blocks stood in a row
Block Pivoter Construction

• Final assembly of the block pivoter occurred in the spring
  – Thee assembly table and installation tool
Block Pivoter Assembly

- Table top full assembled
  - 3300 bolts make up the connections
  - Viewed from the back (north) side.
  - Approximately 750 tons
Block Pivoter in Assembly Position

- Towers have been installed
  - These take the table load when horizontal, hydraulics deenergized.
- First set of pallets installed
  - These are consumed, a new set for each block
Table Top Leveling

- The table surface was shimmed, based on the flatness survey
• The shims were then covered with plywood and the surface was painted.
• Second survey showed at ±8 mm range
Pivoter Commissioning Plans

• We held a “Pseudo-block” exercise the week of 4 June
  – Similar one was done on the prototype
  – Define block volume with something simple.
  – Test clearances and positioning against the south wall.

Unistrut mockups on the table
Block Pivoter Test Drive

- The table top, with “mock block” was rotated to vertical
- Then traveled to the south end of the hall
- Clearances checked to catwalks
  - West – 6”
  - East assembly area – 2”
Block Pivoter Test Drive

- The plywood optical connectors did their job on the south wall
  - Interferences with piping, cable trays is now fixed
Other Assembly Equipment

- Two lifting fixtures are at Ash river
  - The third is a spare
Assembly Area

- Assembly area, viewed from the south
Adhesive Dispenser

- The lifting fixture is lowered into the adhesive dispenser
- The fixture and module are then rotated, exposing the module underside
  - Process takes ~ 1 min.
- Module being rotated within the dispenser
Adhesive Dispenser

• The adhesive dispenser then passes over the module 4 times
  – 8 simultaneous beads laid down
  – Each subsequent pass translates the nozzles over
  – Process takes ~ 5min.

• Typical installation module installation time is 15 min.
  from first adhesive
  – Open time is 20 min.

• No ESH issues from vapors
Bringing it all Together

• The pivoter is ready for assembly to begin
  – Surface flattened to specifications (±1 cm)
  – Fall protection in place, pallets and alignment posts set
  – Installation operation has been practiced
• Adhesive dispenser has been commissioned
• Lifting fixtures commissioned
• Dry stack assembly has occurred
  – Trained the crew, found some issues and fixed them
• Six layers of tested, good modules are at Ash River
Layer Quality

• Typical flatness check from the dry stack.
• Laser scanner gives a height of channel 0 (blue) for one module, channel 31 (red) for the adjacent one.
  – We look at the difference
  – Green lines are ±1 mm
Layer 31, Block 0

• The first layer went in last week.
• No adhesive is needed
  – Just grout on the bottom surfaces
Assembly Alignment Check

• These are the dimensions found for the first layer
  – Diagonals imply 89.97°
  – Widths demonstrate cumulative affect of module curves
  – Widths imply modules are slightly undersized (~0.03”, maybe more)

• A laser scan provides our final record of the alignment.
Assembling the Second Layer

• First glued module being positioned
• These “horizontal” modules have a slight tilt (1.25 mr).
  – Set by the alignment stops

Compression Plates
Assembly Conclusions

• Assembly of the Far Detector has begun.
  – We worked on the third layer today.
• We still have things to learn, issues to settle
• We are currently doing surface preparation on the modules
  – Improves adhesive bond
  – Takes a lot of time and adds risk
• Too early to make a conclusion about our ultimate rate.
  – Goal is 3-4 layers/day (without surface preparations)
• We hope to place the first block in one month