

Quality Assurance –Factory Machines (2.5.3.3)

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For University of Minnesota

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Review

NOvA

Outline

Inspection&Measurement
Reflectivity
Bonding

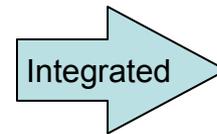
- Extrusions

Sample Light Transmission
Stringing

- Fiber

Inspection&Measurement

- Manifold/Seal
Components



Leak tested

Light transmission checked

Sample Testing

- Glue

Fiber Facing

- Optical Connector

Extrusion Checkout

- Purpose to validate quality of extrusions upon arrival at Fermilab factory
 - Inspection: discover damage during shipping
 - Measurement: cell/extrusion width and height, web thickness
 - *eg end plate design tolerates +/- 3mm variation in extrusion width*
 - Web integrity (successful kneed) See Dave Pushka's talk in commodities session
 - Reflectivity: (>90% at 426 nm) shown to predict cell performance.
 - **NOvA-doc2025 Bower**

16-cell extrusions are bonded in pairs along length to produce 32-cell extrusion assemblies

QA must insure bond quality (adhering and glue thickness).

Glue samples are drawn from lots for standardized stress tests (**NOvA-doc1027 Nitti**)



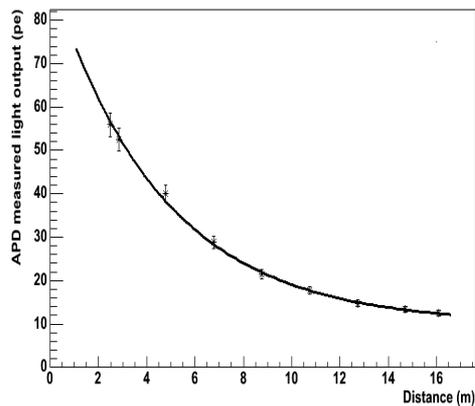
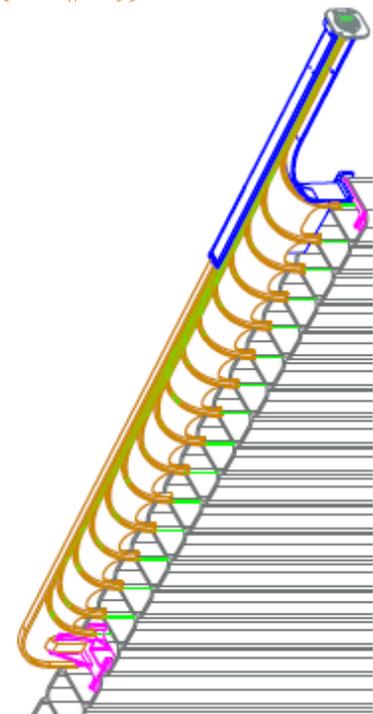
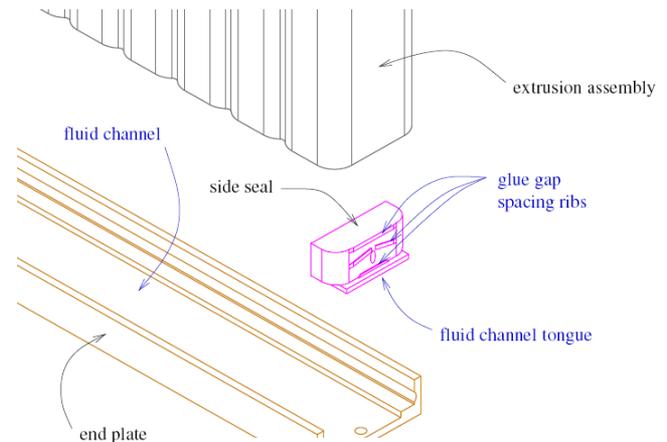
Manifold/End Seal Components & Fiber

QA components:

Inspection of manifold and end plate assembly components
Manifold cover, racetrack, side/center seals, optical connector
Front/back covers ...

QA Fiber:

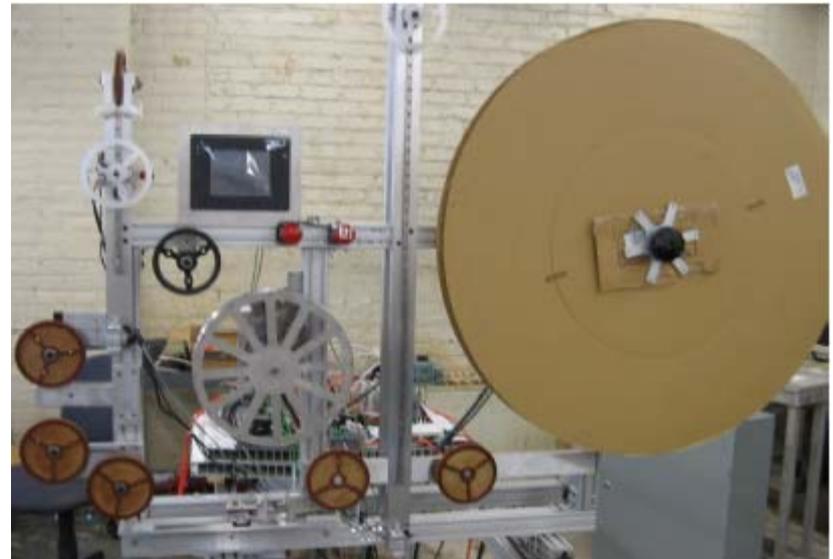
Fiber attenuation measured for each spool upon arrival.
First 10 meters taken from each spool.
Results stored in database.
Results used in fiber continuity check at later time.



Fiber Stringing Machine

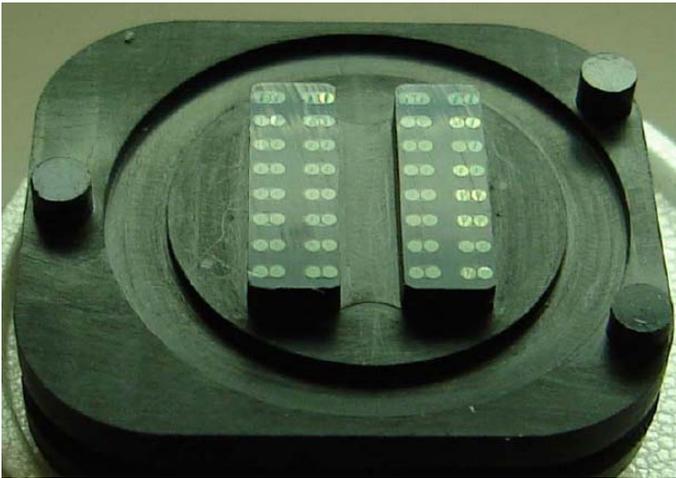
- Key assembly machine
 - Reels out extrusion length of fiber on to take-up reel
 - Vacuum “puck” pulls fiber through the extrusion.
 - Use of vacuum proof of principle demonstrated at UMN
 - Active tension control during routing
 - String pot for position sensing
- Machine in use.
- Details given in separate talk.

- *Automatic fiber/cell tracking
- *String pot allows cell tracking
- *Operator enters fiber registration
- *Data stored in database
 - Allows comparison of spool calibration from Michigan state with light transmission tests at factory



Fiber Facing Machine

- Provides flush cut of fiber at the optical connector.
- Based on MINOS machine.
 - Dumore tool post grinder
 - Coupled to Thomson movement
 - &Linear table
 - Duo diamond tips on drum
- Design allows 2/3 additional cuts.
- Fixturing needs some improvement.



QA: Fiber Continuity

Fiber Continuity:

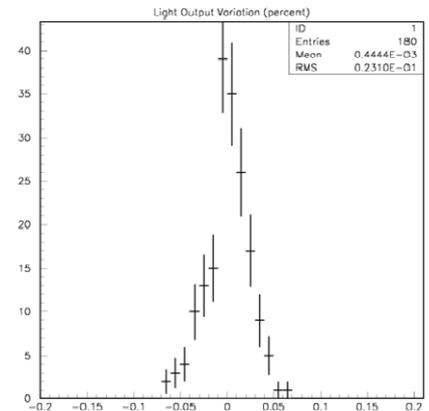
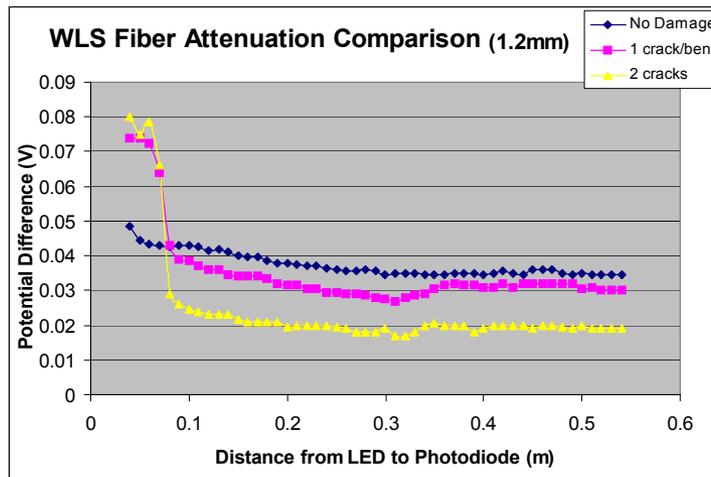
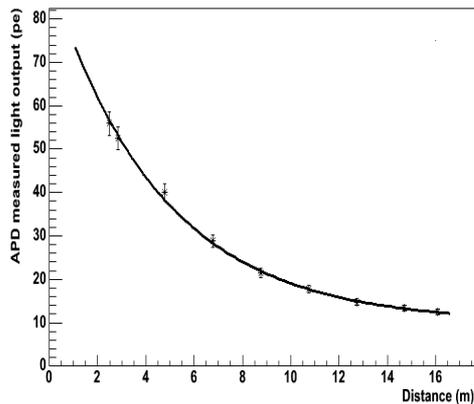
Check light output after module is complete (after fiber facing).

Compare to spool calibration.

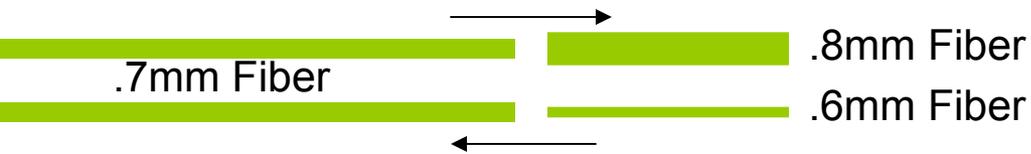
Determines whether any damage to fiber occurred to during module assembly.

Must interface to 64 fiber ends of completed module.

“Typical” loss for kinked fiber → 25%.

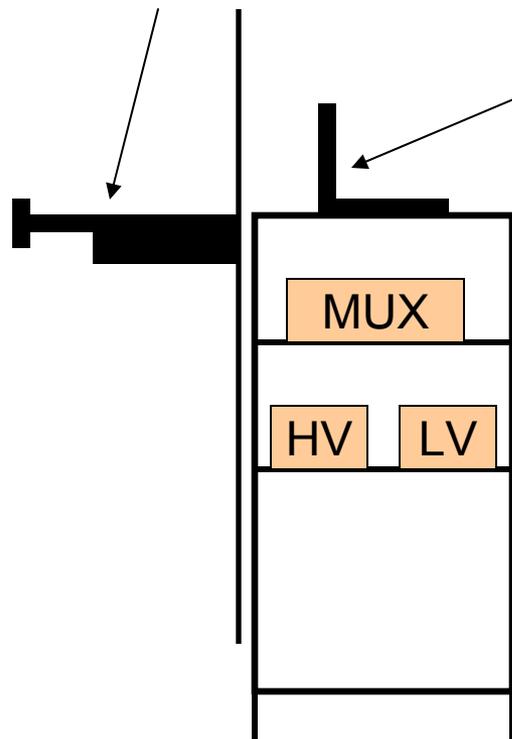


QA: Fiber Continuity Device



Optical Connector

Vertical movement
For placement at module

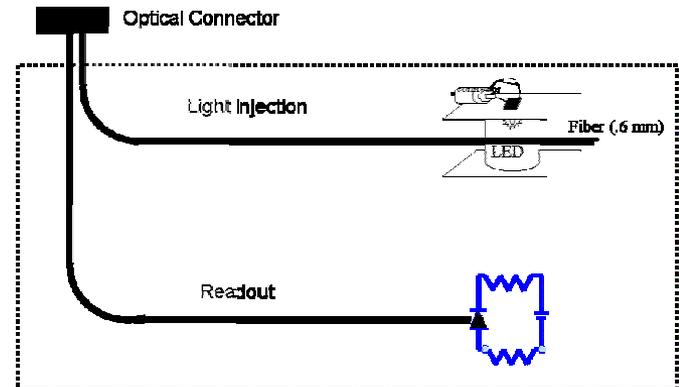


Results display (Labview)

Hamamatsu S8550
(APD array)
Agilent 34970A
(MUX)



Layout for single channel



QA: Leak Test

Leak Test: (NOvA-doc1031)

Designed to identify 3 micron leaks during module production.

Executed after the glue cure.

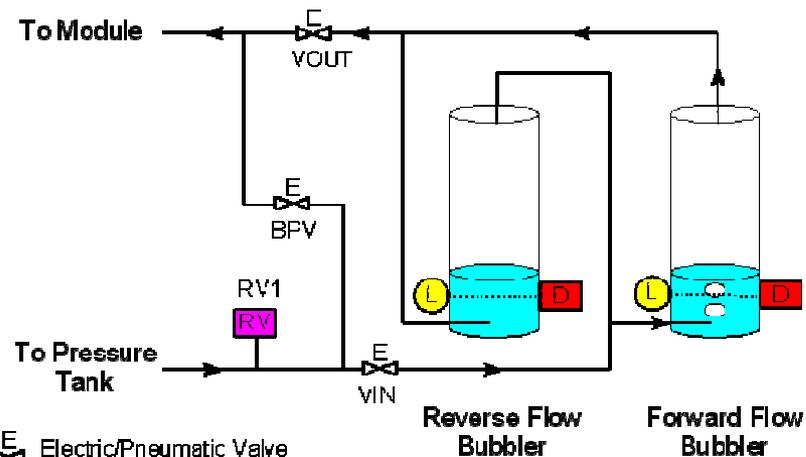
Duration 12 hours.

All modules required to pass leak test.

Leak test machine:

Bubble bottle

Developed by Tom Chase, Ben Nitti, Nathaniel Pearson, and Alex Smith



 Electric/Pneumatic Valve

 Relief Valve

 IR Photodiode/LED
Bubble Counter

Module Fill: VIN, VOUT closed, BPV open
Module Test: VIN, VOUT open, BPV closed

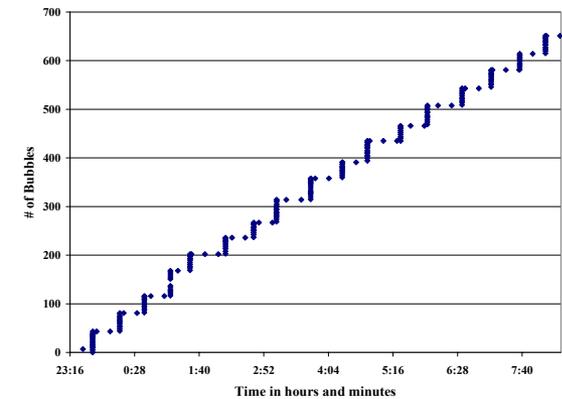
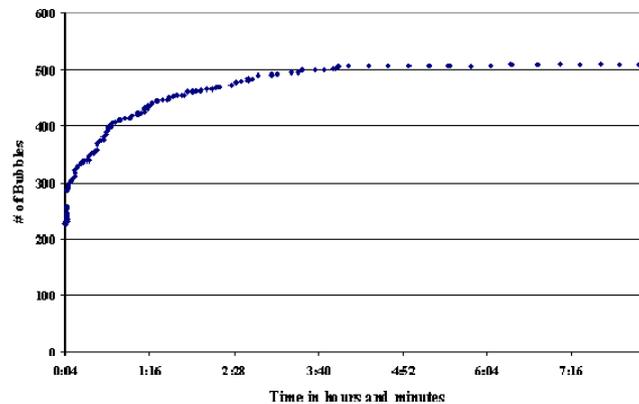
QA: Leak Test

Leak test machine:

Leak detection (3 micron holes) demonstrated in a factory setting.
Optical counter for bubbles.

Far right: Number of bubbles counted versus time for 6 micron hole.

Middle: Some settling time required.



QA: Leak Test

Long term dye leak test. **NOVA-doc 1031Sword et. al.**

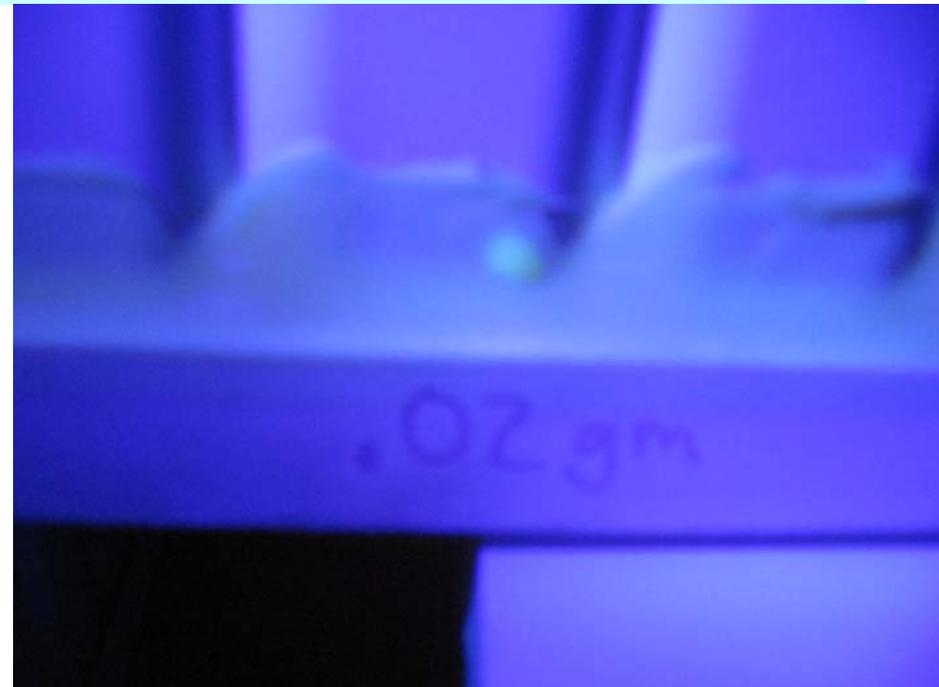
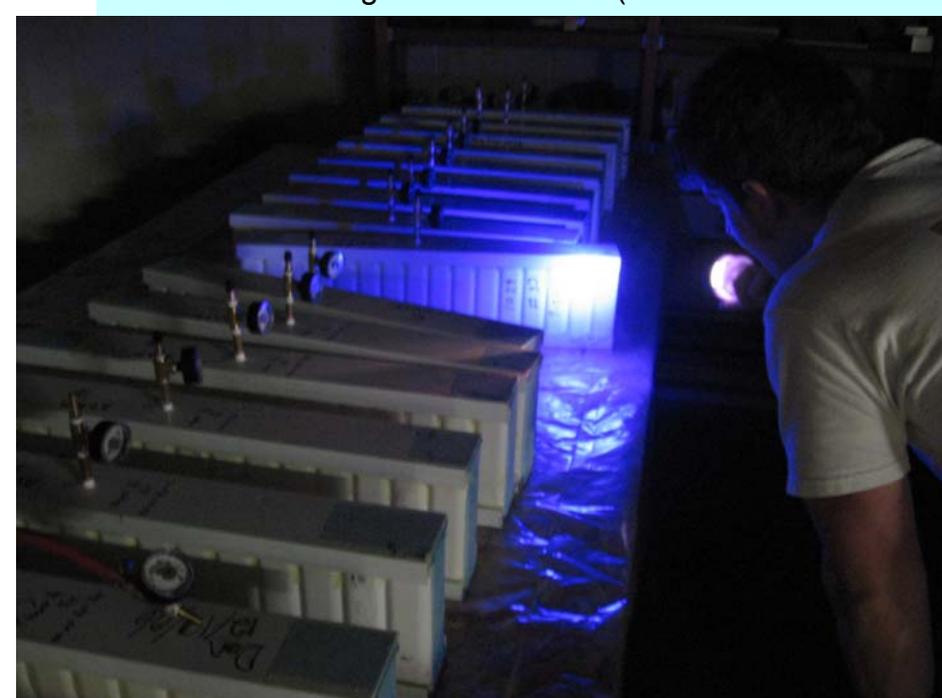
Fluorescent dye added to water in module.

Shown are studies of the first 57 seals (6 inch)

Right plot is example of smallest dye amount detectable (conservative 0.02 gm)

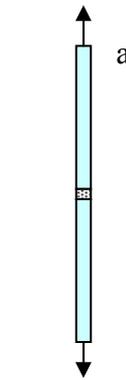
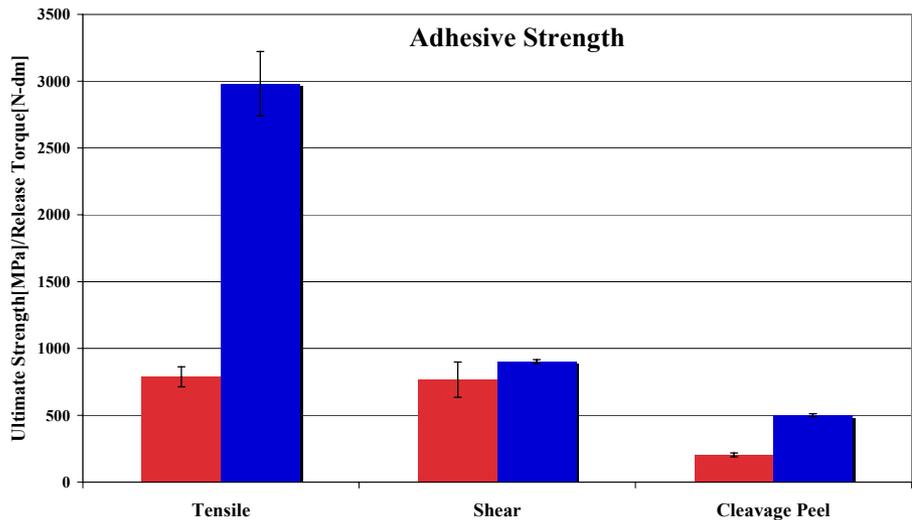
3 months with no leaks detected

Other work has calibrated the leak rate for mineral oil and determined that if all seals as good or better than these then a rate of less than 0.1 liter per year would be expected for entire detector. This does not account for single incident leaks (a module that is missed by QA).

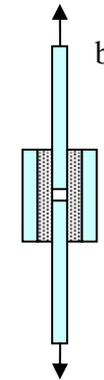


Glue

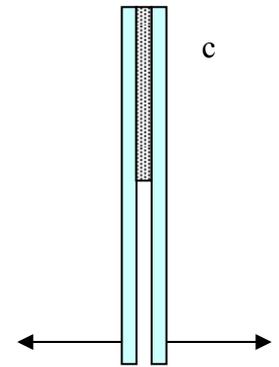
- Standard strength tests perform for each lot of glue.
- Shown are results from NOvA glue (Plastic Welder and 8216)



Tension



Peel



Cleavage peel

Summary

- Presented details on machines and plans to assure the production of high quality NOvA modules.
- Two critical components for assembly are the fiber stringing machine and the fiber facing machine.
- The quality of the fly cut and damage to fibers are probed with a fiber continuity test.
 - Both the facing machine and stringing machine have been in use during R&D
 - The continuity test uses a simple procedure of a light amplitude measurement from a standard candle. Control of various drift sources (LED) and fiber lot variation are understood. Transmission across the optical interface needs better control but manageable.
- Discovery of faulty glue seals is critical for the success of NOvA module fabrication. Long-term dye test demonstrate our ability to manufacture high quality seals. Bubble bottle leak detection will be employed to detect faulty seals.
- Glue quality will be monitored continuously throughout production.
- All components are inspected and critical dimensions are checked to be within specifications.