



APD Status

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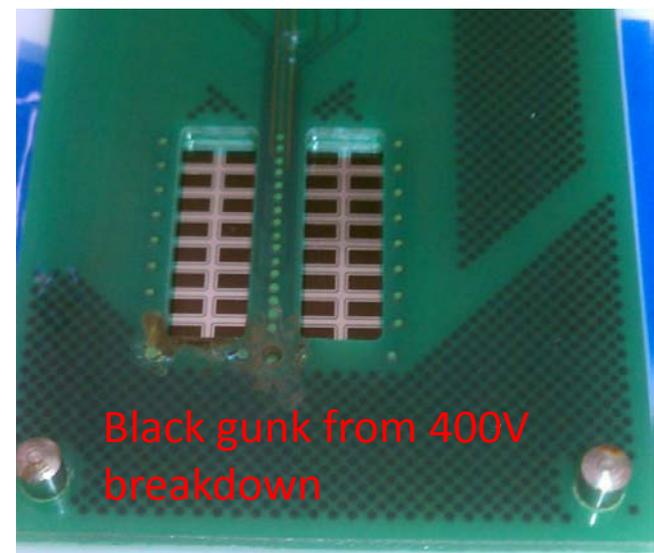
APD Status/Plans

- Installation of new prototype coated parts on prototype detector – completed
- Installation of old parts that were coated
 - Nearly complete
- Production beginning
 - First install on production module ends at Near Detector Surface Building
- Deliveries continuing at rate of 100/wk increasing to 150/week.
- Parts are coated and tested before installation
 - First large batch in production now
 - Testing station can test >50/day
- Beginning installation at Ash River when other outfitting completed, Late-January



Silicone failures investigation

- Several showed water
 - Failures due to blocked carrier board hole
 - Blockage prevents water vapor removal
 - Water in “face volume” conducted HV to signal vias producing black gunk from circuit board and via material
- Several have evidence of mechanical interaction of window frame and optical connector





Autopsy Report

- **25 Silicone coated and 1 parylene coated APD were removed after exhibiting noise on the detector for several weeks.**
- 11 of these were noisy from installation, 1 was parylene coated
 - 4 tested ok, available for installation
 - 4 fail breakdown scan, low breakdown voltage
 - 3 failed "soak" test, unstable current over scale of hours
 - 2 were not in gas system due to installation problems such as broken gas purge elbows
 - 4 were identified as "snug" on removal, showing contact between PCB window and optical connector, or some resistance on removal
- 9 became noisy over time
 - 3 appear tested out okay, available for installation
 - 3 were not in gas system, or cooled
 - 1 identified as "snug" on removal
- 6 had water on face and became noisy over time
 - separate category as we believe QC can prevent this
 - 16% recovery rate, one appears okay now (large error bar)



Autopsy conclusions

- Initial failures account for 40% of the attrition
 - 40% of initial failures reported as "snug"
 - Less precise prototype optical connectors may be the limit of usefulness of prototype detector.
- Initial failures should be replaced.
- Water failures (25%) due to blocked carrier board holes should be prevented
 - QA test checks for gas flow through hole now.
- Far higher fraction of "not in gas system" units failed over time
 - **Don't run APDs without gas system.**



Prototype Detector Status

- Many channels now running
 - 140 Silicone coated
 - 92 Parylene coated
- HUNDREDS of APDs operating COOLED
- Gain 15 years of cooling experience each month of operation

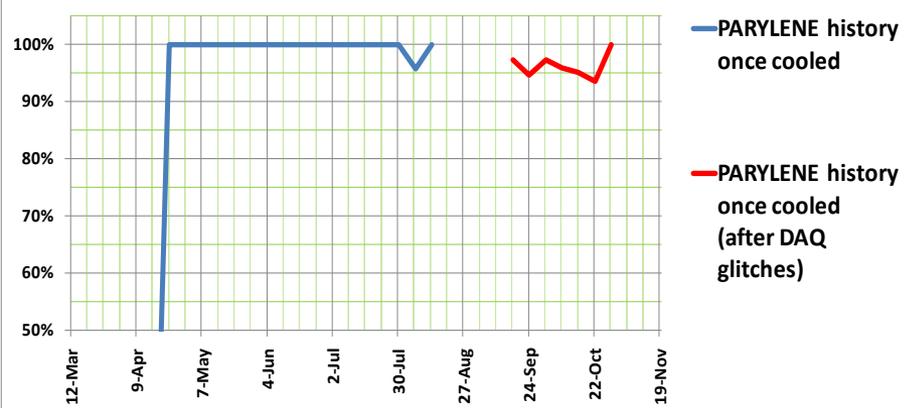


On Detector Coating Performance

SILICONE history once cooled



PARYLENE history once cooled



- **Silicone**

- 178 installed
- 162 work cold after installation
 - 91%
- 140 continue to work cold today
 - Some after 26 weeks
 - 86% of those which initially worked cold
- 79% of the 178 installed

- **Parylene**

- 107 installed
- 92 work cold after installation
 - 86%
- 92 continue to work cold today
 - Some after 33 weeks
 - 100% of those which initially worked cold
 - But not necessarily the same ones
 - 86% of the 107 installed



Final installation test

- Perform final installation test using final components (recommendation at Aug 14 review)
 - Green Ready, Amber in progress
 - Production Snouts from UMN
 - Production OC/fiber
 - Final (first production delivery) APDs
 - Parylene coated
 - Production Ash River heat sinks
 - Production mounting hardware
 - Final electronics box and electronics
 - Production DCM/DAQ
 - Install/cool monitor APDs in several batches to test ~100 parts to understand expected AR installation success rate



Final Installation test progress

- Mechanical parts have been assembled
- Plan for DAQ, power, water, and dry gas supplies in place
- Electronics and APD Parts shipped week of Nov 5
- Installation beginning week of Nov. 12
- Initial results ...





Production Schedule

DATE	Shipment	Coating	Assembly	Testing
10/29/2012	25			
11/5/2012	86 (delayed by Sandy)	25	25	25
11/12/2012	100			
11/19/2012	100			
11/26/2012	150			
....	150/wk			

- After arrival parts are coated – 1-2 wks/batch
- After coating, parts are assembled to spacer frames and tested – 1 wk/batch
- Parts available for installation 2-3 weeks after arrival
- Cascading through production/QA steps in table



New information from the Prototype Near Detector

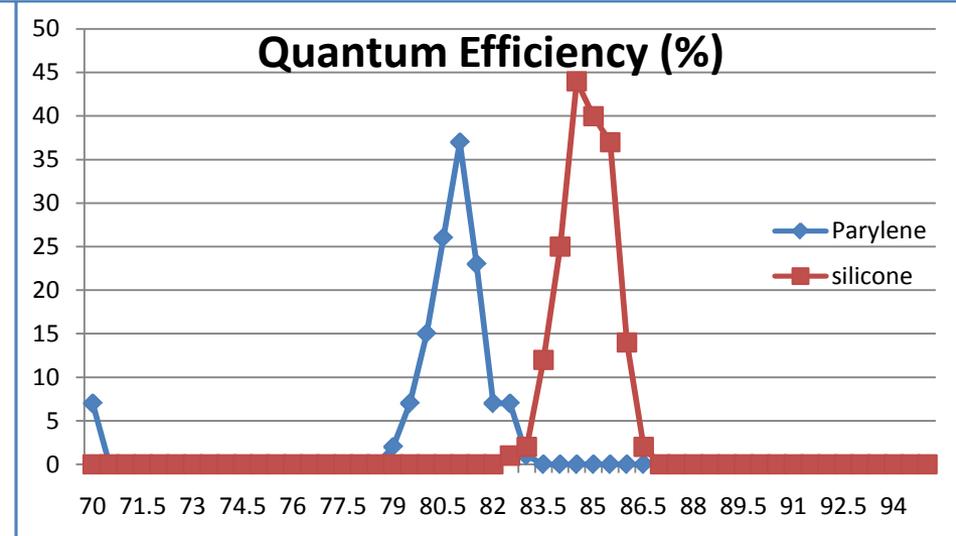
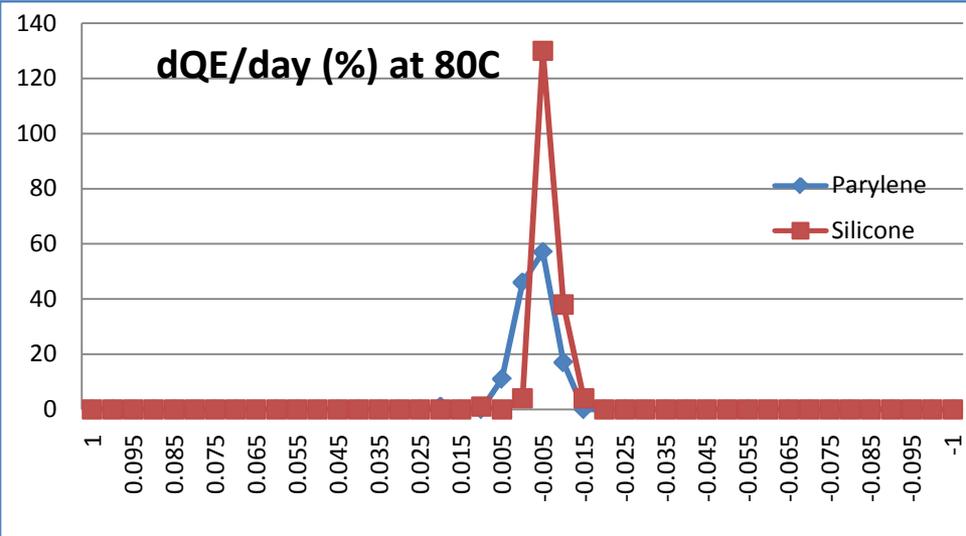
- Predicted TEC MTBF
200,000hrs, ~22yrs
 - Highly application dependent
- NDOS cooled operation of APDs give a measurement of TEC lifetime in our application
- So far 84 cooling-years with 0 failures
- expected ~4
- $MTBF > 84/2.3 > 36$ years at 90% confidence
- <1 failure/day

year	month	Cooling Hours	Total (hrs)	Total(years)
2011	6	3350	3350	0.4
2011	7	22034	25384	2.9
2011	8	28615	53999	6.2
2011	9	14233	68232	7.8
2011	10	11569	79801	9.1
2011	11	8699	88500	10.1
2011	12	7493	95993	11.0
2012	1	6305	102298	11.7
2012	2	6078	108376	12.4
2012	3	6251	114627	13.1
2012	4	6257	120884	13.8
2012	5	13480	134364	15.3
2012	6	53196	187560	21.4
2012	7	144679	332239	37.9
2012	8	126036	458275	52.3
2012	9	133908	592183	67.6
2012	10	140805	732988	83.6



APD Coating tests

- Tests of aging of coatings at 80C for parylene and silicone coated APDs.
- 6 APDs of each type of coating
 - Chemical aging processes typically go 2 times as fast for every 10°C increase in temperature.
 - We have completed an 112 day test (as of 11/2/2012)
 - Relative to room temperature, this is approximately 20 years of storage
 - Relative to operating temperature of -15 C, this is 220 years of operation
 - Test with 523 nm light, about the middle of our spectrum
 - Average change was -0.005% /day for silicone, and 0 for parylene
 - Total change in 10years would be 0.025% change in QE for silicone and 0 for parylene
 - Also no visible evidence of discoloration or yellowing seen
 - Test continues





Summary

- Production APDs are arriving, ~100/wk
 - First 100 part (86 shipped) delayed by hurricane
- Increasing shipment size to 150/wk after 4 weeks
- Parylene Coating is being commercially applied
- Parts are tested electrically before installation
- Final Installation tests have begun at Near Detector Building
- Final installation test will give us the data to understand the full plan for Ash River
- Ash River installation on the first block (384 APDs) will begin in Late January