

A report on optical contact tests

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on behalf of

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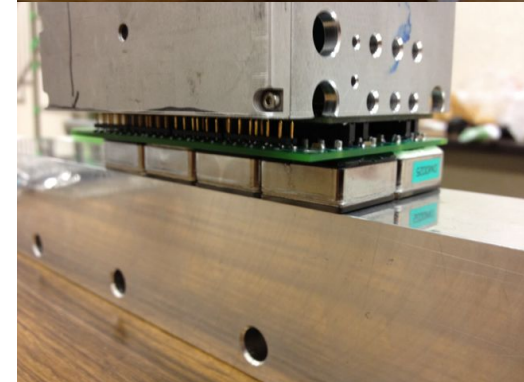
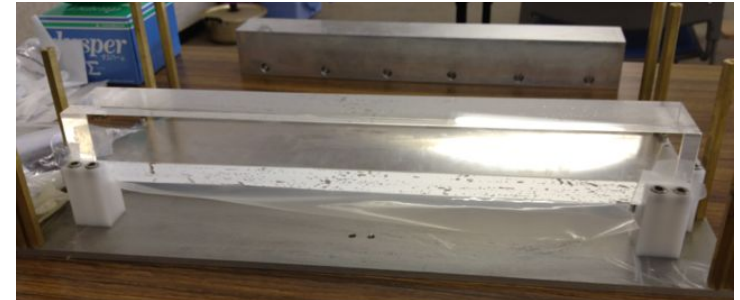
Question

- *How do we ensure the good and stable optical coupling between a prism end and PMT surfaces?*
 - *“Cragille Fused Silica Matching Liquid Code 06350”*
 - <http://www.cargille.com/FS06350.pdf>
 - *“ELJEN Technology EJ-550 Optical Grade Silicon Grease”*
 - <http://www.eljentechnology.com/index.php/joomla-overview/accessories/94-ej-550>
 - *Optical cookie*
 - *R&D on the ones custom-made by Inami-san.*
- *From the FNAL beam test experiences, “Code 06350” seems difficult to use for 2x4 PMT unit.*
 - *Due to the low viscosity and imperfect surface alignment.*

<i>Product</i>	<i>Material</i>	<i>Viscosity</i>	<i>Radiation tolerance</i>	<i>Pros</i>	<i>Cons</i>
<i>Code 06350</i>	<i>Hydrocarbon liquid (aliphatic and alicyclic)</i>	<i>Low</i>	<i>Fine</i>	<i>Seems to be the best for the optical matching to a fused silica.</i>	<i>PMT surfaces have to be aligned precisely and would be evaporated.</i>
<i>EJ-550</i>	<i>Silicon grease (methyl-phenyl-polysiloxane)</i>	<i>High</i>	<i>Fine</i>	<i>High-viscosity enough to fill the imperfect alignment of PMT surfaces.</i>	<i>Bubble elimination is necessary.</i>
<i>Cookie</i>	<i>Silicon rubber</i>	<i>n/a</i>	<i>(Fine)</i>	<i>Convenient to deal with handling and the alignment.</i>	<i>Bubble elimination is necessary.</i>

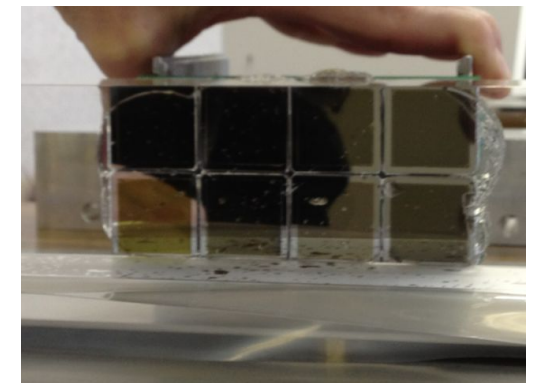
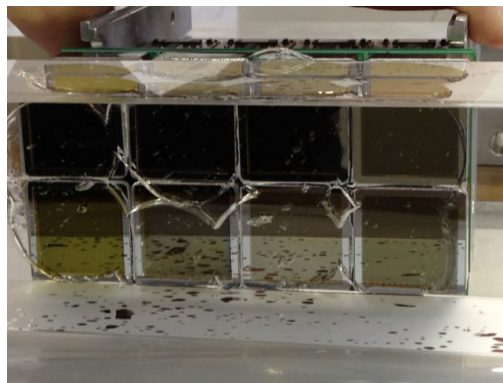
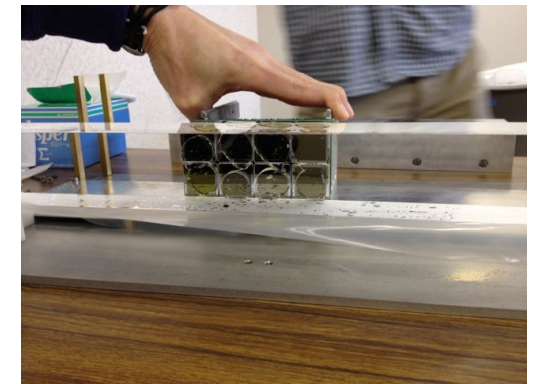
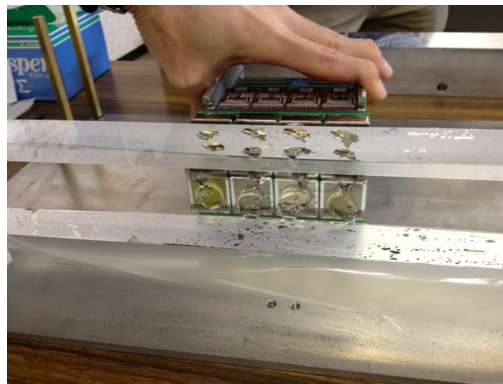
EJ-550 on a 2x4 front-end module (1)

- *EJ-550 has tested on a 2x4 front-end module to see if it works.*
 - *Using a test bench, the “FNAL expansion block”, a mock-up of a 2x4 front-end module and SL10 mock-ups.*
 - *The test bench was made by K.S. with the great help of Kohriki-san, Saitoh-san (KEK) and Kawai-san (Nagoya).*
 - *The front-end module mock-up was made by customizing a bad module used at the FNAL beam test.*
 - *The surface alignment of eight SL10 mock-ups were done by pressing the unit against an aluminum dummy block; the alignment looks reasonably good (within $\sim 100 \mu\text{m}$).*



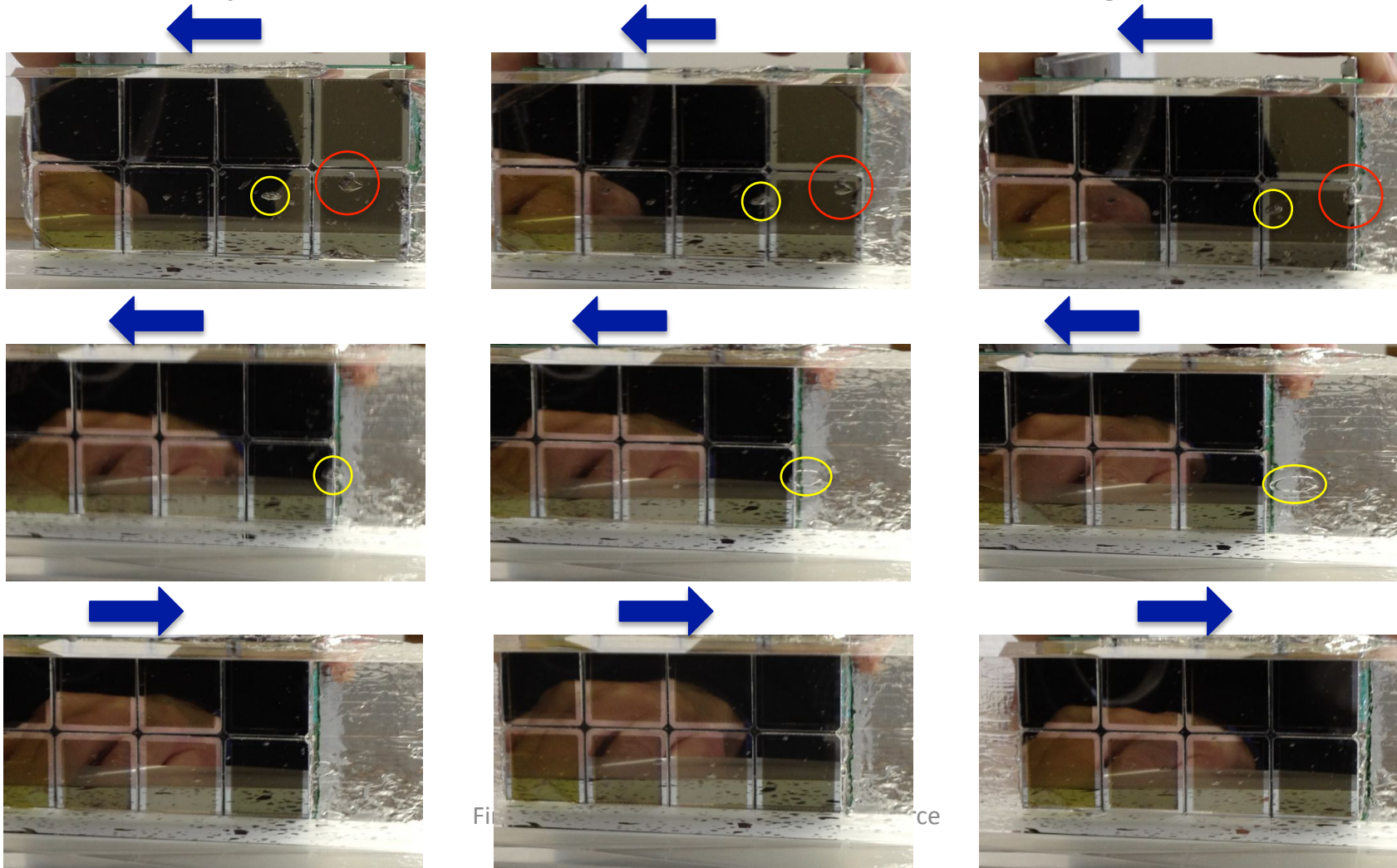
EJ-550 on a 2x4 front-end module (2)

- *Coupling procedure*
 - *Put EJ-550 enough at around the center region of a PMT surface.*
 - *On individual PMTs.*
 - *Pressed the module mock-up to a block end gradually.*
 - *EJ-550 spread over the PMT surfaces eliminating air gaps.*



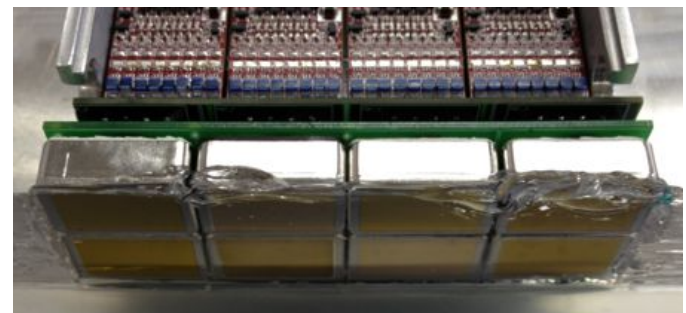
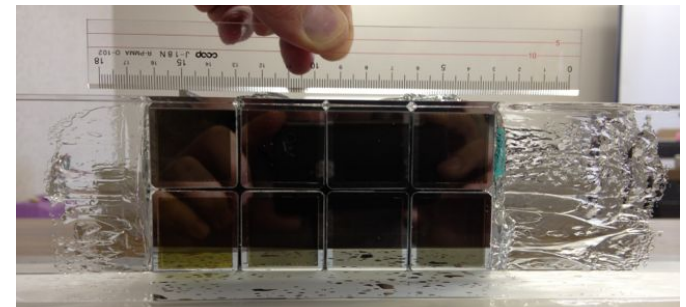
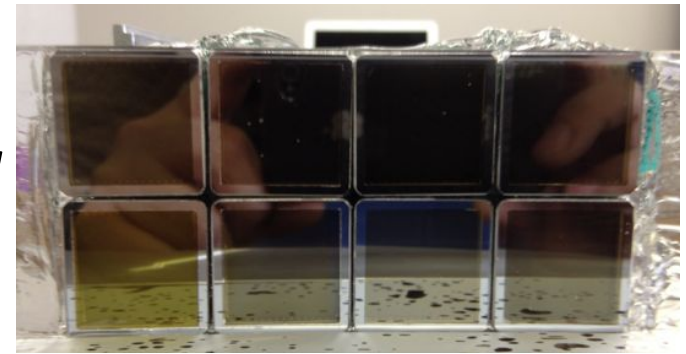
EJ-550 on a 2x4 front-end module (3)

- *Coupling procedure (cont'd)*
 - *Translated the module mock-up horizontally (mostly) and vertically (a little bit) to eliminate remaining bubbles.*



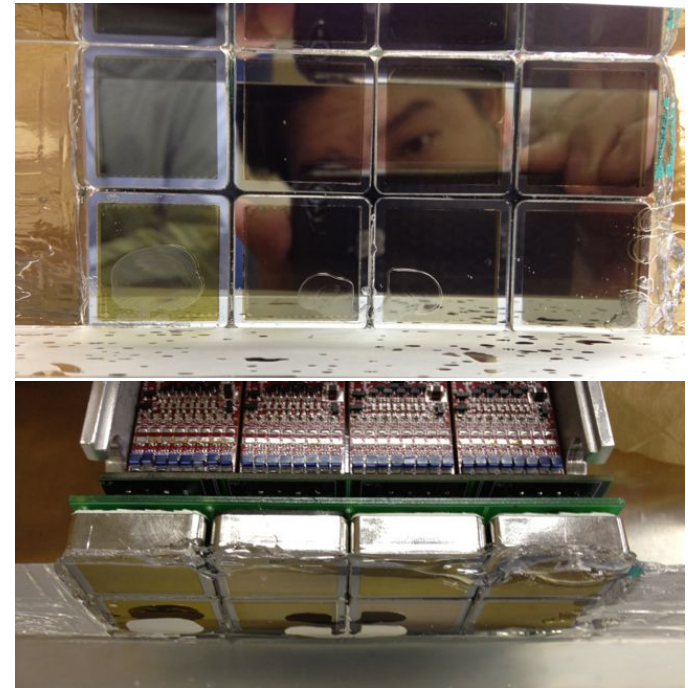
EJ-550 on a 2x4 front-end module (4)

- *Finally air gaps and large bubbles were eliminated.*
 - *Remaining bubbles seemed too small and few to be harmful.*
 - *The module mock-up was translated horizontally by ~ 90 mm in total.*
 - *Less than naïve expectation, which is \pm half of the module width ($\pm \sim 60$ mm).*
 - *For the FNAL prototype module, at least one side plate of the readout chassis would need to be removed to translate the last front-end module.*
 - *What do we do for the real detector where the side plate cannot be removed?*
- *Is the grease thin enough regarding the transmittance?*
 - *Need to confirm it.*

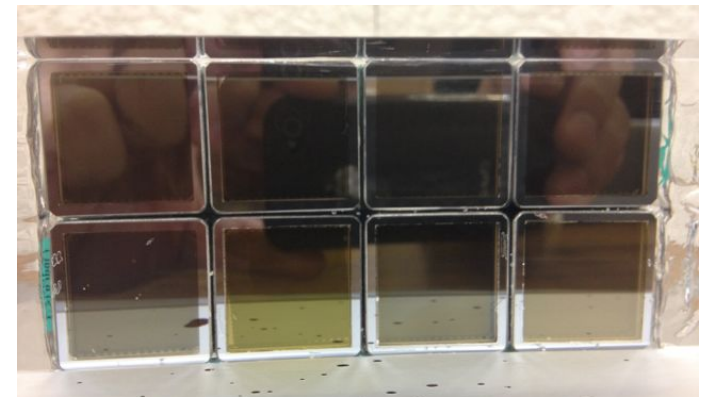


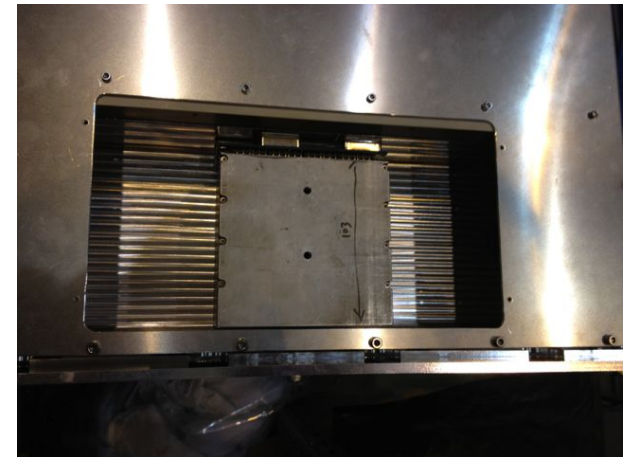
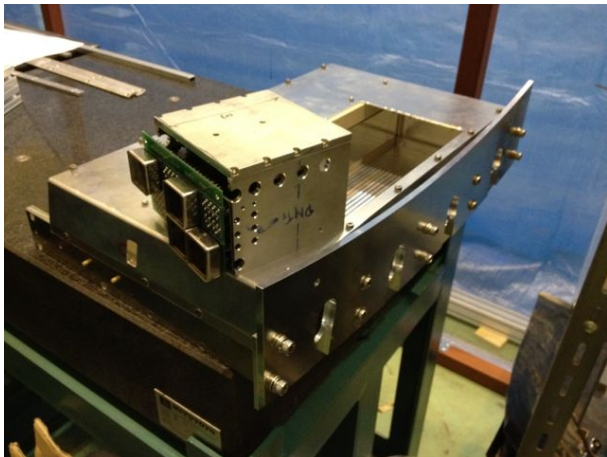
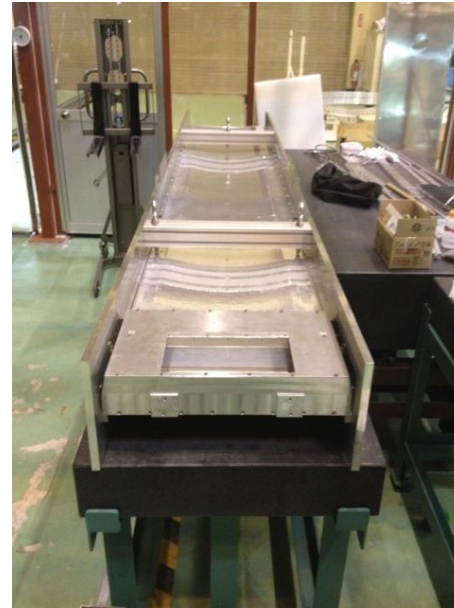
EJ-550 on a 2x4 front-end module (5)

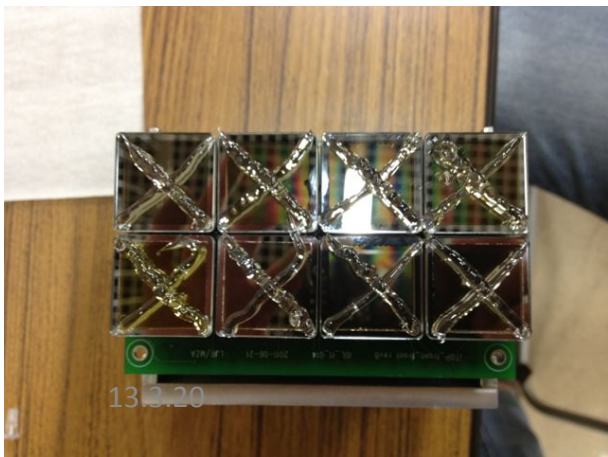
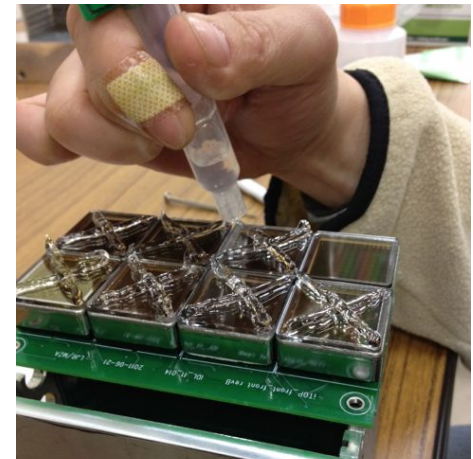
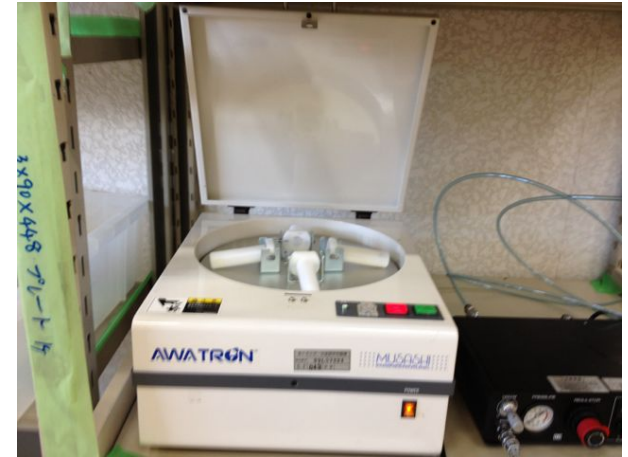
- *After around an hour, large bubbles appeared.*
 - *Probably because the pressure at the contact was relaxed.*
 - *The module mock-up was kept as it was without any supports.*
 - *Hope this would not happen in a front-end chassis.*
 - *Positioning screws and/or plungers at the backward end (to keep pressing PMTs) would solve this issue.*
- *After putting the grease twice, the contact stays (at least) for a few days.*
 - *Enough amount of grease seems helpful.*
- *Visual inspection through the top face of the block works well.*
 - *Expected to work through the tilted face (17.2°) of a prism, too.*

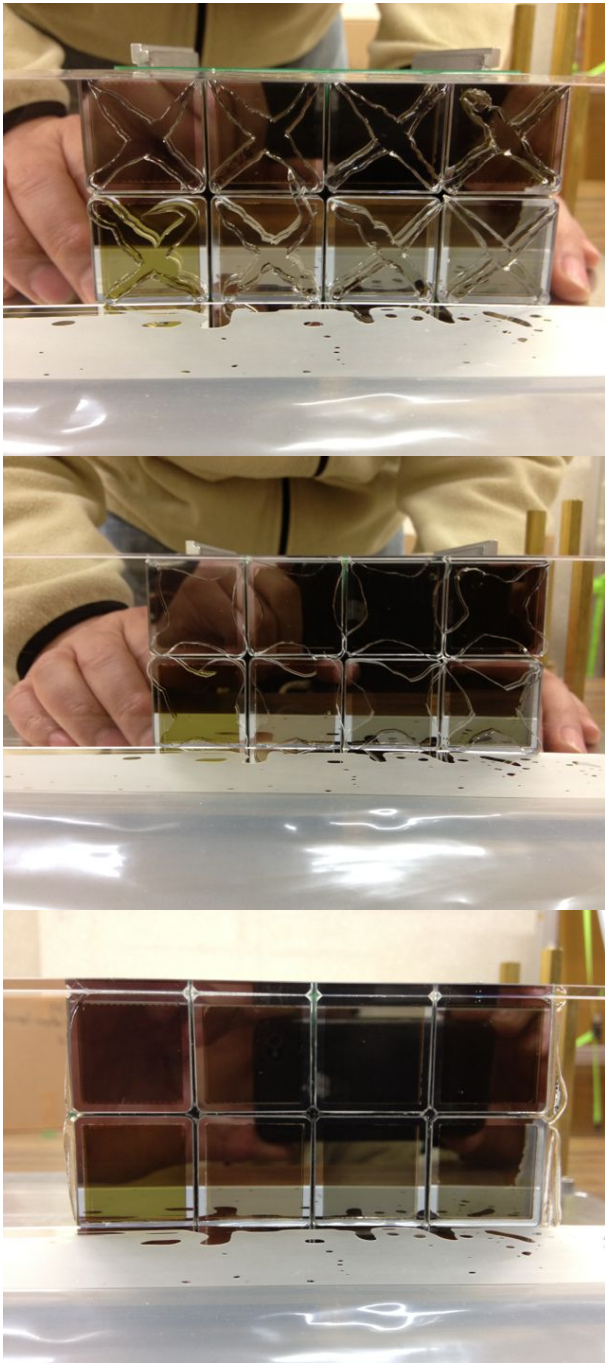


After putting the grease twice.

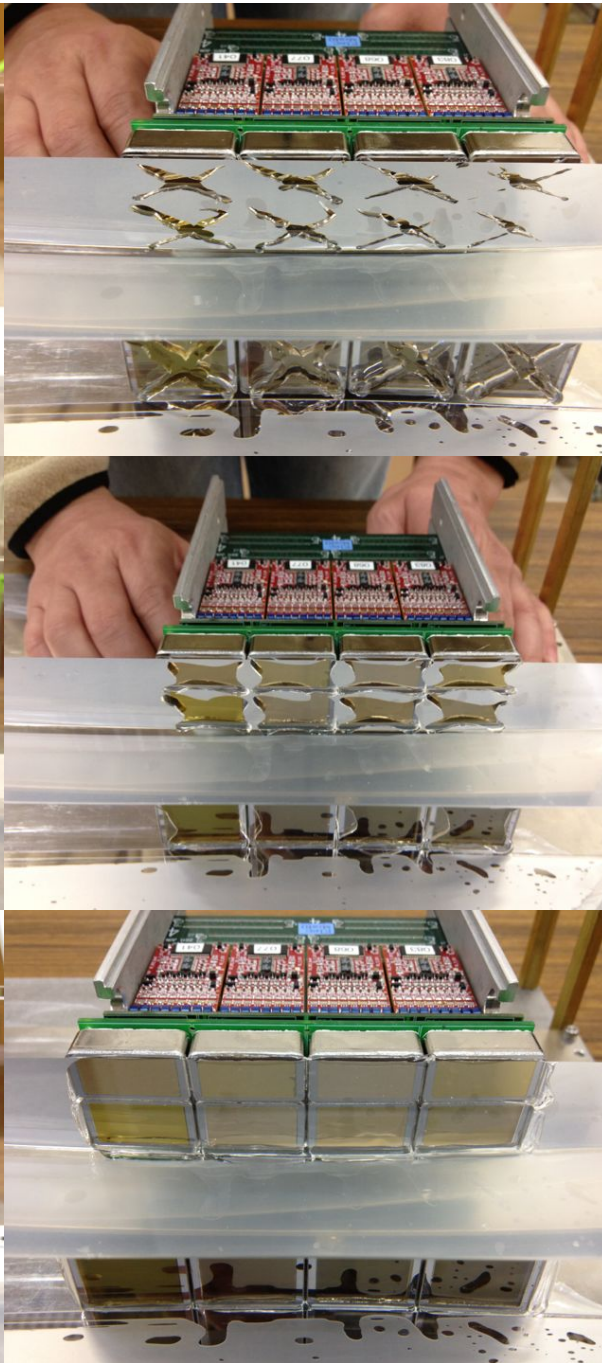








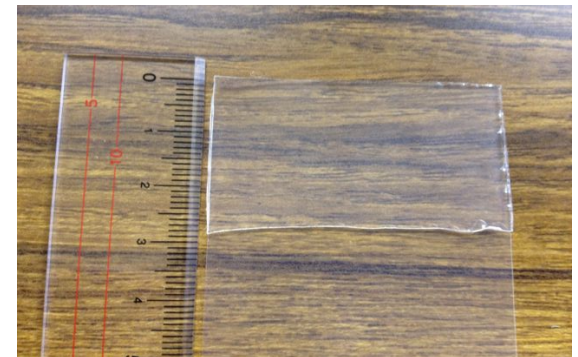
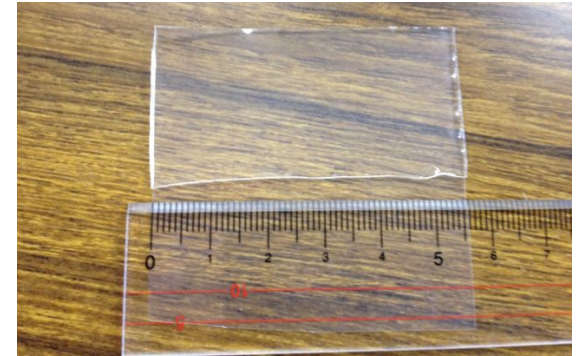
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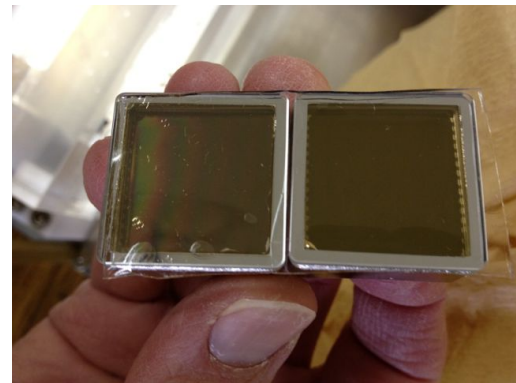
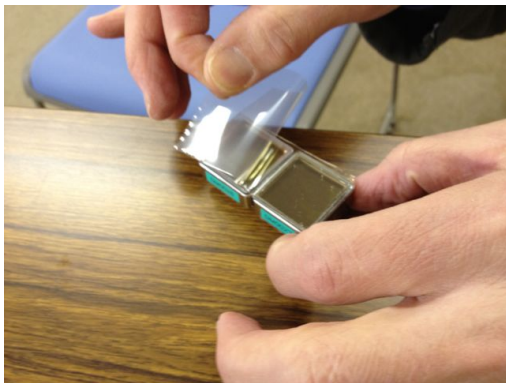
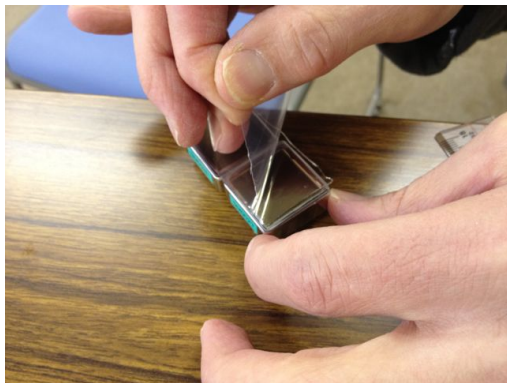
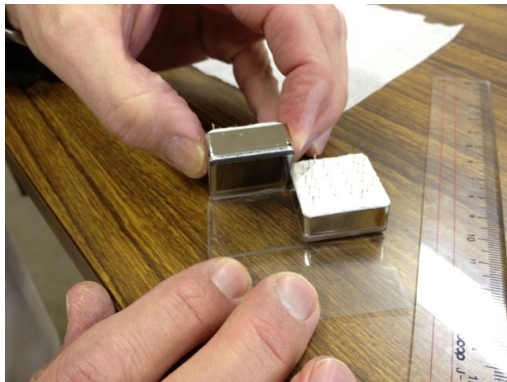
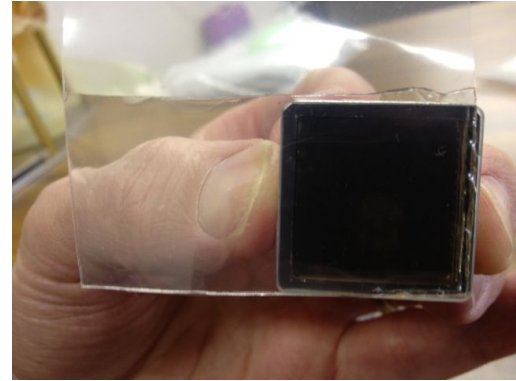
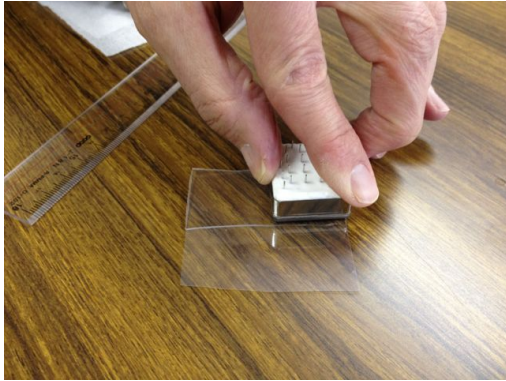
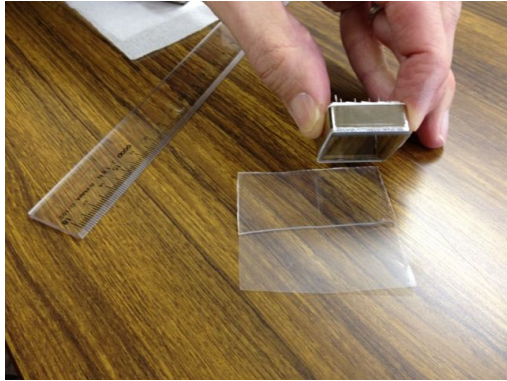


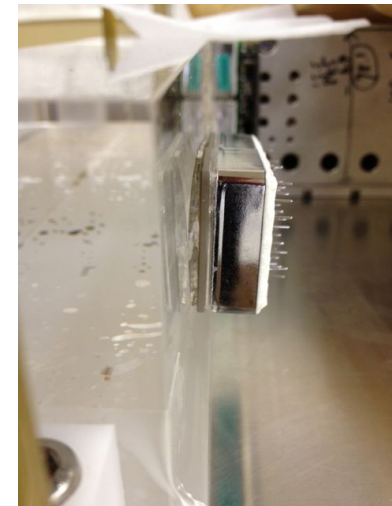
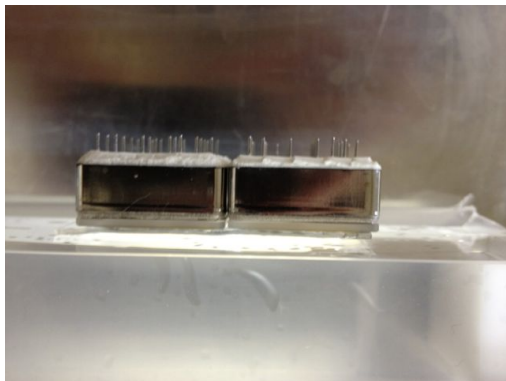
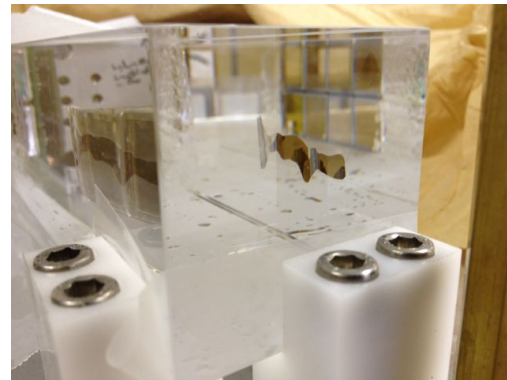
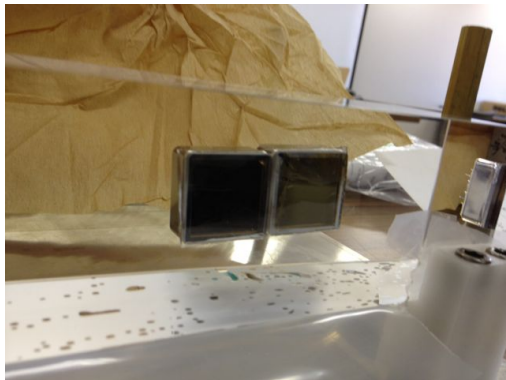
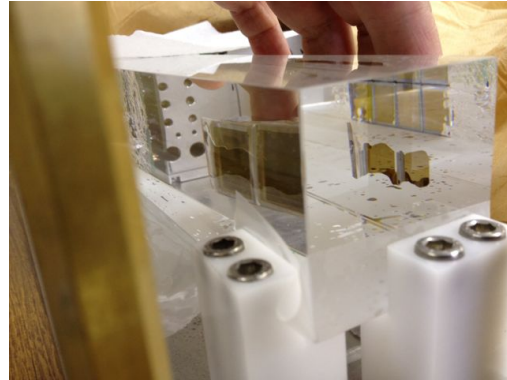
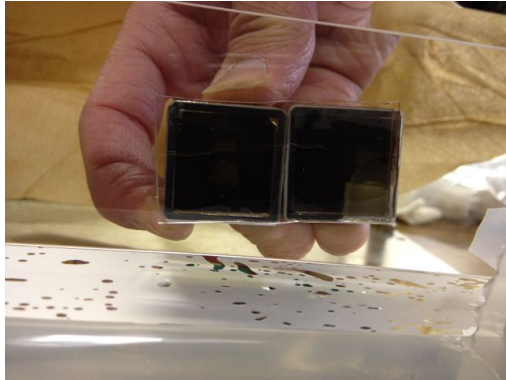
Final Electro-mechanical Packing Task Force

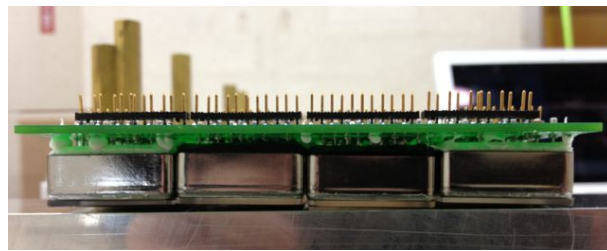
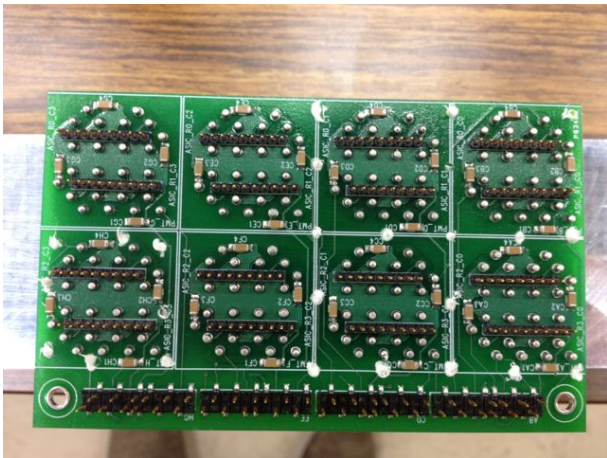
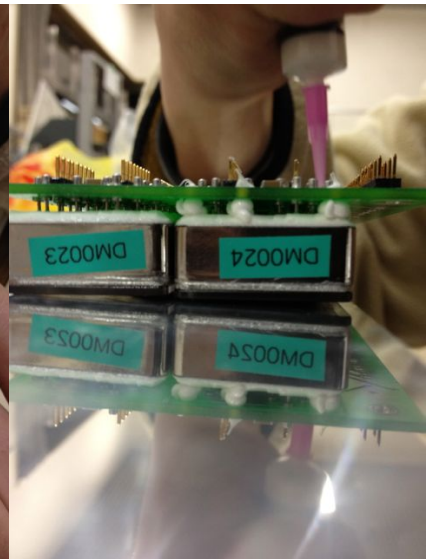
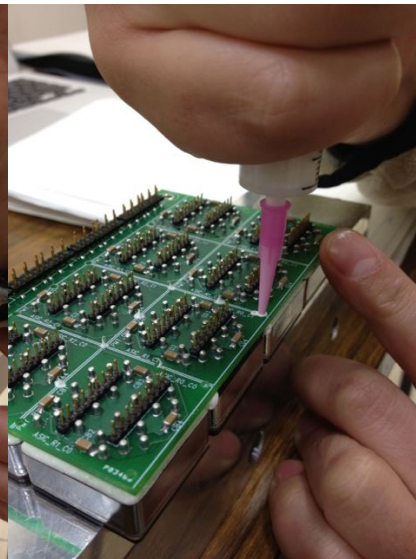
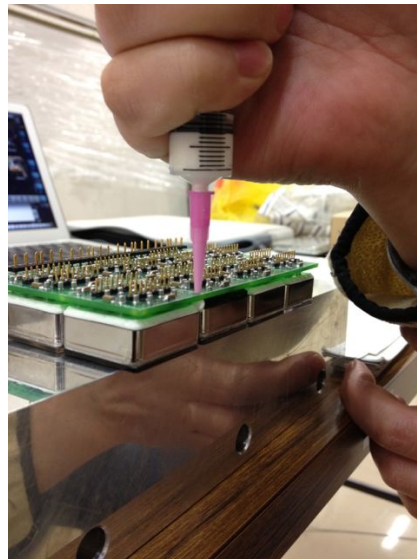
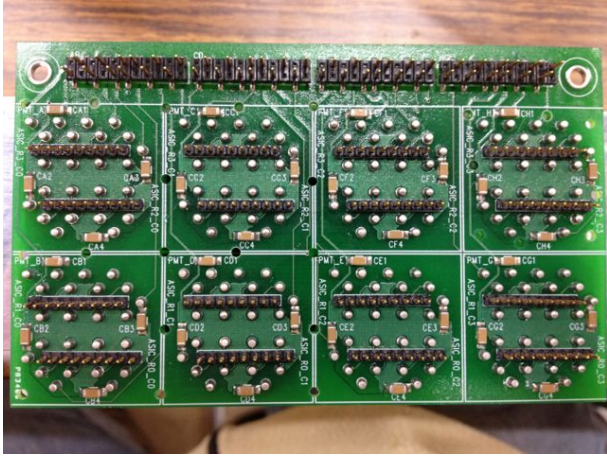
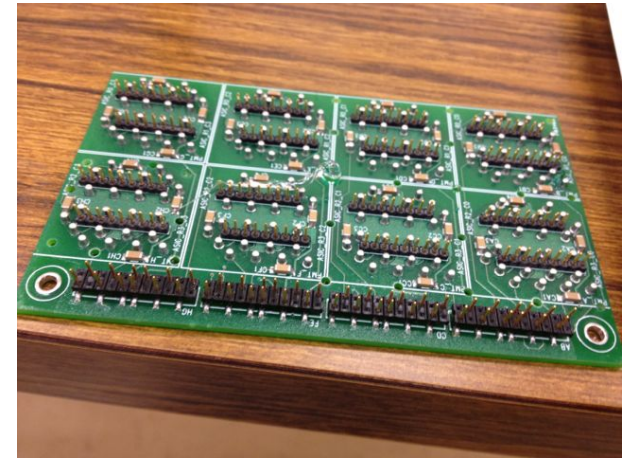
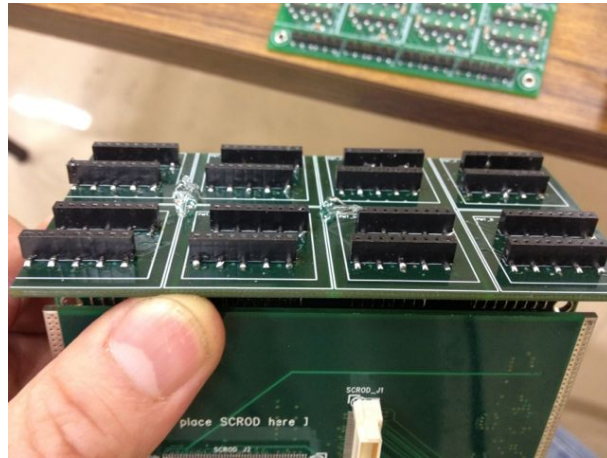
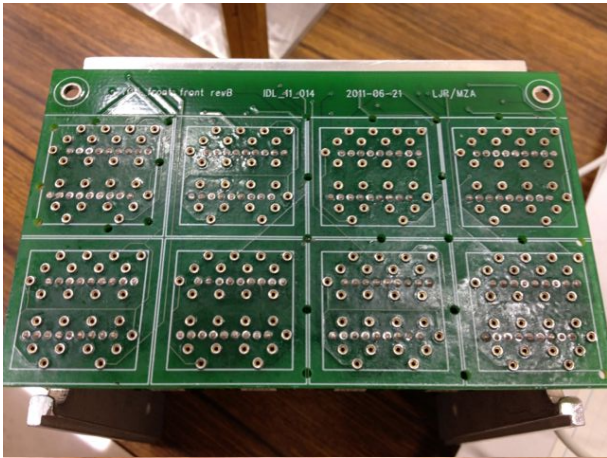
Convex-shaped optical cookie (1)

- *An optical cookie with a convex-shaped surface may be another solution for the optical contact.*
 - *A conventional optical cookie, which has flat surfaces, seems not applicable since it is very difficult to eliminate air gaps and bubbles when it is used.*









Final Electro-mechanical Packing Task Force

