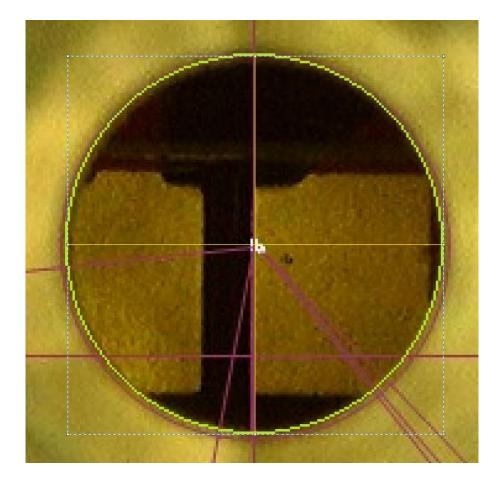
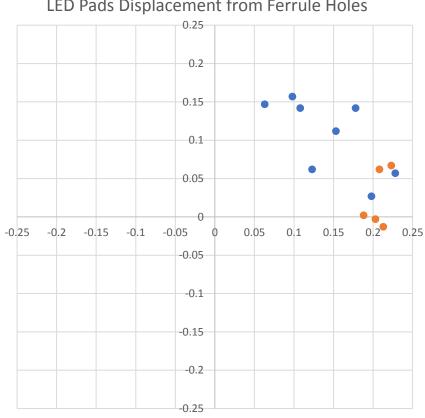


Pad height: 60mil = 1.524mm Package height: 170 mm Distance optical center to top of package: .63mm => Top of pads should be .542mm from center line of hole

Space between pads: 12mil = .31mm => Either pad should be .155 mm from center line of hole

## New Measurements





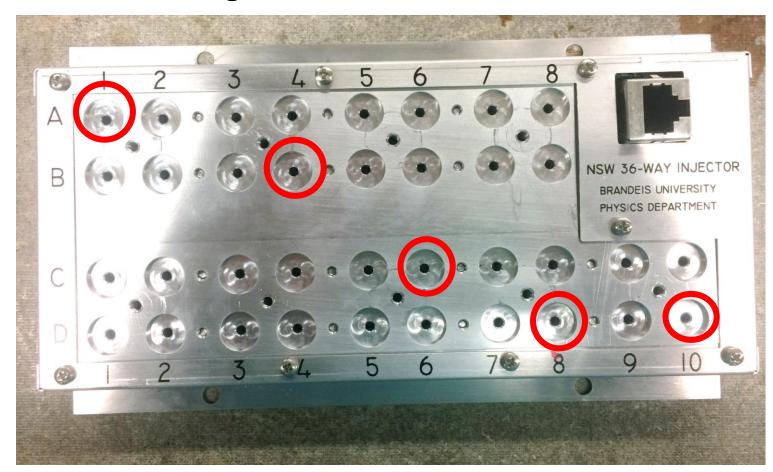
• First Board • Spot Check Across Four Boards

Average Horizontal Distance From Center: 169 um Average Vertical Distance From Center:

74 um

LED Pads Displacement from Ferrule Holes

On the previous board, differences in horizontal position due to pitch error. Not seen on new board – error is consistent on all points taken from different regions.



Holes measured on first board.

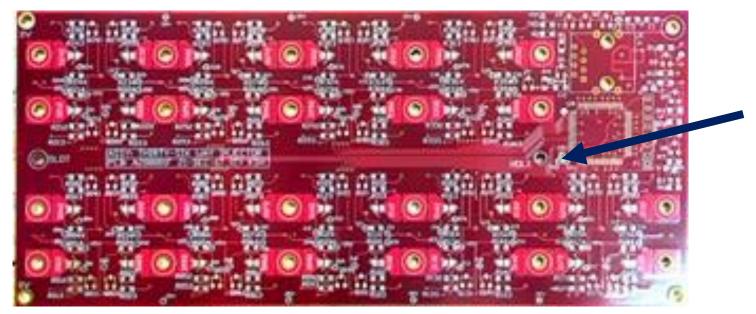
2 holes randomly chosen on each of 4 other boards for spot check.

## New Problem: Mounting Holes

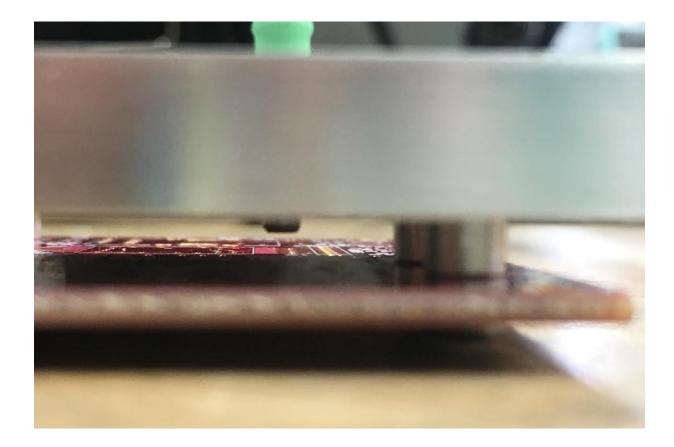
Mounting hole on previous board drilled 140um too far left

Previous hole precision: +/-125um

New precision: +/- 25 um



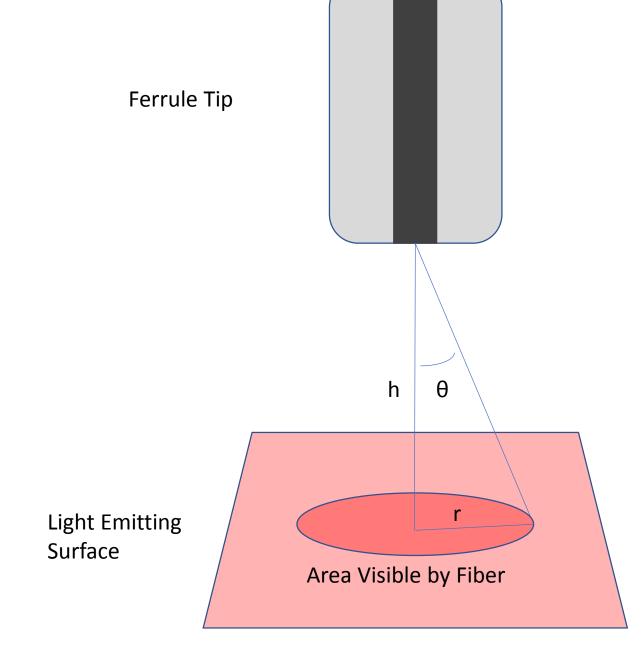
## LED to Ferrule Tip Distance Calculation



Full width of ferrule plate mounted to injector board = 12.83 mm Thickness of ferrule plate = 8.04 mm Thickness of circuit board = 1.64 mm Protrusion of ferrule from plate = 1.45 mm Thickness of Luxeon Z, as given in product brief = .69 mm Industry standard height of package mounted off circuit board =

~.100 mm

Subtract all others from 12.83 mm to find distance ferrule tip to light emitting surface = ~.890 mm

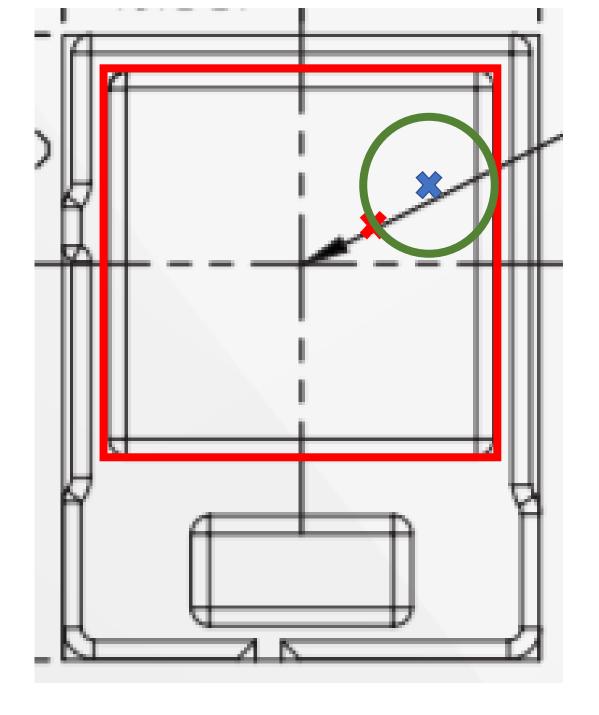


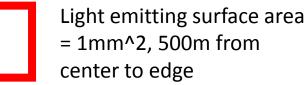
## Field of View

 $\theta$  for our 62.5um fibers = .22rad (12.7°)

h in our setup = 890um

 $\Rightarrow$ r = h\*sin( $\theta$ ) = 195 um





um up





Error in Horizontal Distance of LEDs to center of pads when placed by machines: up to 135 um horizontal, up to 105 um vertical

Average error from mounting

hole accuracy: 169um right, 74

- Field of view of ferrule: 195um radius when .890mm from ferrule to LED
- ⇒ Total maximum horizontal distance from center seen by ferrule: 499um.
- ⇒ Total maximum vertical distance from center seen: 374um.

7

<u>yfx na</u> l	0	0.051	0.102	0.152	0.203	0.254	0.305	0.356	0.406	0.457	0.508	0.559	0.61	0.66	0.711	0.762	0.813	0.864	0.914	0.965	1.016	1.067	1.118	1.168	1.219	1.27	1.321	1.372	1.422
0	0	0	0	0	0.011	0.011	0.022	0.022	0.034	0.034	0.034	0.034	0.022	0.022	0.022	0.011	0.011	0.011	0.011	0	0	0	0	0	0	0	0	0	0
0.08	0	0	0.011	0.022	0.034	0.045	0.056	0.067	0.079	0.079	0.079	0.079	0.067	0.056	0.045	0.034	0.034	0.034	0.022	0.022	0.022	0.022	0.011	0.011	0	0	0	0	0
0.16	0	0.011	0.022	0.045	0.056	0.09	0.112	0.124	0.135	0.146	0.146	0.135	0.124	0.112	0.09	0.079	0.079	0.079	0.067	0.067	0.056	0.056	0.045	0.034	0.022	0.011	0.011	0	0
0.24	0	0.022	0.045	0.056	0.101	0.124	0.169	0.191	0.202	0.213	0.213	0.202	0.18	0.169	0.157	0.146	0.135	0.135	0.124	0.124	0.112	0.101	0.09	0.079	0.056	0.034	0.022	0	0
0.32	0	0.034	0.067	0.101	0.146	0.191	0.236	0.27	0.292	0.303	0.303	0.292	0.27	0.247	0.236	0.225	0.225	0.213	0.213	0.213	0.202	0.18	0.191	0.157	0.135	0.101	0.067	0.045	0
0.4	0	0.045	0.09	0.135	0.191	0.247	0.303	0.337	0.371	0.382	0.393	0.382	0.36	0.337	0.326	0.315	0.303	0.303	0.303	0.292	0.281	0.258	0.225	0.191	0.146	0.112	0.079	0.045	0
0.48	0	0.045	0.112	0.169	0.236	0.303	0.36	0.416	0.449	0.483	0.483	0.472	0.461	0.438	0.427	0.427	0.416	0.416	0.416	0.404	0.382	0.36	0.315	0.27	0.213	0.157	0.112	0.067	0
0.56	0	0.067	0.146	0.225	0.303	0.382	0.449	0.517	0.573	0.607	0.618	0.618	0.596	0.562	0.573	0.517	0.517	0.517	0.517	0.506	0.483	0.449	0.379	0.348	0.281	0.213	0.157	0.101	0.056
0.64	0	0.09	0.157	0.236	0.326	0.393	0.483	0.562	0.618	0.652	0.674	0.663	0.652	0.64	0.629	0.618	0.618	0.629	0.629	0.618	0.607	0.562	0.517	0.449	0.36	0.281	0.191	0.135	0.079
0.72	0	0.09	0.18	0.247	0.348	0.438	0.528	0.618	0.629	0.685	0.719	0.742	0.73	0.708	0.708	0.708	0.708	0.719	0.719	0.719	0.697	0.663	0.607	0.528	0.438	0.27	0.225	0.157	0.101
0.8	0	0.09	0.18	0.258	0.371	0.483	0.584	0.674	0.753	0.798	0.82	0.82	0.798	0.787	0.787	0.787	0.809	0.82	0.831	0.831	0.809	0.764	0.685	0.607	0.494	0.382	0.281	0.191	0.124
0.88	0	0.101	0.18	0.258	0.371	0.483	0.584	0.697	0.764	0.809	0.831	0.831	0.82	0.809	0.809	0.82	0.831	0.854	0.865	0.876	0.854	0.798	0.73	0.652	0.517	0.404	0.292	0.202	0.124
0.96	0	0.112	0.18	0.225	0.371	0.494	0.618	0.708	0.798	0.843	0.865	0.865	0.854	0.843	0.854	0.854	0.876	0.899	0.921	0.933	0.921	0.865	0.787	0.674	0.562	0.449	0.315	0.225	0.124
1.04	0.022	0.101	0.191	0.27	0.393	0.517	0.618	0.73	0.831	0.876	0.876	0.888	0.876	0.865	0.876	0.888	0.91	0.944	0.9	0.91	1.91	0.92	9,831	0.73	0.596	0.461	0.337	0.225	0.146
1.12	0	0.112	0.191	0.292	0.404	0.539	0.663	0.775	0.865	0.91	0.933	0.933	0.921	0.91	0.921	0.899	0.921	0.955	0.975	489	0.978	•	0.843	0.73	0.629	0.506	0.371	0.236	0.135
1.2	0.034	0.09	0.202	0.292	0.404	0.528	0.674	0.775	0.854	0.91	0.933	0.933	0.921	0.91	0.91	0.921	0.933	0.966	0.4	1	0.489	0.94	\$65	0.764	0.629	0.483	0.382	•	0
1.28	0.045	0.112	0.191	0.303	0.427	0.551	0.674	0.787	0.876	0.921	0.944	0.944	0.933	0.921	0.921	0.921	0.944	0.966	0.989	$\checkmark$	0.989		0.854	0.753	0.618	0.494	0.371	0.258	0
1.36	0.056	0.124	0.202	0.315	0.438	0.562	0.652	0.798	0.888	0.933	0.955	0.955	0.933	0.921	0.921	0.933	0.933	0.955	0.978	0.989	0.978	0.933	0.854	0.753	0.618	0.494	0.393	0.27	0
1.44	0.056	0.124	0.202	0.303	0.449	0.562	0.674	0.787	0.876	0.921	0.944	0.944	0.933	0.921	0.921	0.921	0.933	0.944	0.966	0.978	0.966	0.921	0.843	0.753	0.629	0.494	0.371	0.258	0
1.52	0.067	0.124	0.213	0.303	0.416	0.551	0.663	0.764	0.843	0.888	0.921	0.921	0.91	0.899	0.899	0.91	0.91	0.921	0.933	0.944	0.933	0.899	0.82	0.719	0.607	0.494	0.36	0.258	0
1.6	0.034	0.124	0.213	0.281	0.404	0.506	0.607	0.719	0.787	0.843	0.854	0.865	0.854	0.843	0.843	0.843	0.854	0.865	0.876	0.888	0.876	0.831	0.764	0.674	0.562	0.472	0.337	0.236	0
1.68	0.067	0.112	0.191	0.27	0.371	0.461	0.562	0.652	0.719	0.775	0.798	0.798	0.798	0.787	0.787	0.798	0.798	0.809	0.82	0.82	0.809	0.764	0.708	0.618	0.517	0.438	0.315	0.225	0
1.76	0.056	0.101	0.18	0.247	0.326	0.404	0.506	0.584	0.64	0.685	0.708	0.719	0.708	0.708	0.697	0.708	0.708	0.719	0.73	0.73	0.719	0.685	0.596	0.494	0.416	0.326	0.258	0.18	0
1.84	0.045	0.09	0.157	0.225	0.281	0.393	0.427	0.494	0.551	0.596	0.607	0.618	0.618	0.618	0.607	0.607	0.618	0.618	0.629	0.629	0.618	0.596	0.551	0.483	0.404	0.326	0.247	0.191	0
1.92	0.045	0.079	0.124	0.135	0.18	0.225	0.281	0.348	0.404	0.449	0.483	0.494	0.506	0.506	0.506	0.494	0.506	0.506	0.506	0.517	0.506	0.483	0.438	0.393	0.337	0.27	0.213	0.146	0
2	0.034	0.056	0.09	0.135	0.18	0.225	0.27	0.315	0.36	0.371	0.382	0.393	0.393	0.393	0.393	0.393	0.393	0.393	0.404	0.404	0.404	0.371	0.348	0.303	0.258	0.225	0.169	0.124	0
2.08	0.022	0.034	0.067	0.09	0.112	0.146	0.18	0.213	0.247	0.258	0.27	0.27	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.281	0.27	0.247	0.225	0.191	0.157	0.124	0.09	0
2.16	0.011	0.022	0.045	0.067	0.079	0.101	0.124	0.146	0.157	0.169	0.18	0.18	0.191	0.191	0.191	0.202	0.191	0.191	0.191	0.191	0.191	0.18	0.169	0.146	0.135	0.112	0.09	0.067	0
2.24	0.044	0.044	0.022	0.024	0.054	0.067	0.074	0.04	0.04	0.404	0.442	0.442	0.442	0.424	0.424	0.425	0.424	0.424	0.424	0.42.4	0.424	0.442	0.404	0.101	0.04	0.074	0.054	0.045	0

Intensity from LED as seen by ferrule 1mm away from surface

Intensity is still ~95% of maximum possible at this distance

Intensity loss minimized by ferrule distance from LED

40 - 40 0.051 0.102 0.152 0.203 0.254 0.305 0.356 0.406 0.457 0.508 0.559 0.61 0.66 0.711 0.762 0.813 0.864 0.914 0.965 1.016 1.067 1.118 1.168 0 0.008 0.032 0.024 0.032 0.024 0.016 0.016 0.008 0.008 0.008 0.002 0.002 0.002 0.002 0.002 0.002 0 0.129 0.508 0.605 0.653 0.669 0.653 0.613 0.589 0.524 0.476 0.282 0.113 0.04 0.048 0.105 0.323 0.056 0.024 0.016 0.051 NOBM 0.102 0.54 0.605 0.492 0.605 0.476 0.532 0.484 0.411 0.315 0.202 0.234 0.298 0.315 0.25 0.621 0.468 0.008 0.152 - Ú 0 0.218 0.492 0.661 0.532 0.645 0.516 0.516 0.315 0.306 0.339 0.202 0.355 0.427 0.565 0.315 0.581 0.581 0.484 0.202 0.105 0.016 0.203 0 0.258 0.524 0.694 0.548 0.637 0.46 0.387 0.323 0.444 0.46 0.242 0.435 0.484 0.254 0 0,008 0,185 0.597 0,782 0,621 0.524 0,444 0,605 0,452 0,565 0,581 0,282 0,524 0,589 0,2 4 0,694 0,895 0,766 0,831 0,839 669 0.452 0.01 0.305 0 0.008 0.315 0.621 0.79 0.581 0.435 0.637 0.476 0.516 0.621 0.605 0.306 0.556 0.601 0.879 0.694 0.903 0.806 0.863 0.879 0.669 0.524 0.01 0.356 0 0,008 0,387 0,621 0,782 0,508 0,629 0,806 0,75 0,726 0,637 0,589 0,306 0,548 0 53 0,895 0,726 0,919 0,855 0,839 0,871 0,742 0 0.406 0.008 0.008 0.234 0.629 0.75 0.435 0.815 0.911 0.895 0.935 0.758 0.677 0.339 0.613 621 0.879 0.75 0.911 0.831 0.831 0.879 0.79 0.5 8 0.024 0.457 0.008 0.008 0.323 0.613 0.661 0.492 0.815 0.903 0.879 0.944 0.726 0.661 0.347 0.637 71 0.96 0.782 0.96 0.823 0.935 0.968 0.782 0 32 0.508 0.008 0.008 0.524 0.734 0.815 0.613 0.71 0.879 0.79 0.944 0.742 0.621 0.331 0.597 0.64 0.984 0.863 1 0.927 0.895 0.968 0.694 1542 0.559 0.008 0.008 0.444 0.718 0.895 0.79 0.839 0.847 0.742 0.927 0.734 0.637 0.363 0.661 0.694 0. 2 0.823 0.992 0.919 0.903 0.944 0 45 0.306 0.00 0.61 0 0.452 0.742 0.927 0.847 0.895 0.976 0.831 0.944 0.694 0.605 0.347 0.613 0.718 0.968 0.82 952 0.734 0.218 0.010 0.66 0 0.016 0.75 0.718 0.96 0.758 0.831 1 0.815 0.968 0.702 0.581 0.355 0.653 0.702 0.976 0.855 0.96 0.911 0.887 0.952 0.758 0.218 0.02 0.711 0.008 0.048 0.702 0.806 0.911 0.976 0.871 0.968 0.847 0.919 0.645 0.621 0.379 0.669 0.702 0.968 0.839 0.952 0.855 0 0.048 0.702 0.887 0.879 0.984 0.847 0.992 0.831 0.895 0.613 0.621 0.379 0.694 0.726 0.968 0.863 0.968 0.944 0.762 0.782 0.75 0.758 0.5 0.00 0.813 0.008 0.105 0.589 0.653 0.798 0.96 0.863 0.992 0.855 0.911 0.677 0.629 0.379 0.669 0.685 0.968 0.798 0.935 0.903 0.831 0.968 0.766 0.524 0.0 0.864 0.008 0.089 0.718 0.879 0.903 0.806 0.774 0.895 0.79 0.952 0.71 0.621 0.379 0.718 0.669 0.952 0.782 0.935 0.879 0.863 0.952 0.758 0.427 0.00 0.718 0.331 0.395 0.734 0.914 0.008 0.113 0.726 0.863 0.79 0.774 0.468 0.742 0.75 0.992 0.702 0.621 0.355 0.669 0.742 1 0.782 0.54 0.00 0.965 0.008 0.089 0.726 0.798 0.637 0.395 0.024 0.177 0.589 0.903 0.661 0.581 0.347 0.694 0.742 0.935 0.242 0.032 0.032 0.46 0.919 0.742 0.008 0.097 0.597 0.742 0.589 0.274 0.024 0.024 0.411 0.742 0.589 0.468 0.315 0.516 0.581 0.702 0.097 0.024 0.032 0.452 0.661 0.556 0.323 1.016

Intensity map when ferrule pressed against LED surface