

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.
Petitioner

v.

OUSTER, INC.
Patent Owner

IPR2023-01421
U.S. Patent No. 11,175,405

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

TABLE OF CONTENTS

	<u>Page</u>
I. INTRODUCTION	1
II. GROUNDS 1-2: DROZ RENDERS OBVIOUS AN APERTURE LAYER WITH A STOP REGION.....	2
III. GROUNDS 1-2: A POSITA WOULD COMBINE PACALA AND DROZ.....	9
IV. GROUNDS 3-4: A POSITA WOULD COMBINE HALL, SPECTOR, AND BOROWSKI	15
A. Hall and Spector	15
B. Borowski and Spector	18
C. Hall and Borowski.....	21
V. SECONDARY CONSIDERATIONS.....	27
A. Industry Skepticism.....	27
B. Failure by Others.....	28

TABLE OF AUTHORITIES

<i>Allied Erecting & Dismantling Co. v. Genesis Attachments</i> , 825 F.3d 1373 (Fed. Cir. 2016)	10, 11, 12, 15
<i>Axonics, Inc. v. Medtronic, Inc.</i> , 75 F.4th 1374 (Fed. Cir. 2023)	5
<i>Elbrus Int’l Ltd. v. Samsung Elecs. Co.</i> , 738 F. App’x 694 (Fed. Cir. 2018)	17
<i>In re Etter</i> , 756 F.2d 852 (Fed. Cir. 1985)	10
<i>In re Fulton</i> , 391 F.3d 1195 (Fed. Cir. 2004)	22
<i>In re Keller</i> , 642 F.2d 413 (CCPA 1981)	10
<i>In re Mouttet</i> , 686 F.3d 1322 (Fed. Cir. 2012)	10, 22
<i>In re Sneed</i> , 710 F.2d 1544 (Fed. Cir. 1983)	11
<i>KSR Int’l Co. v. Teleflex Inc.</i> , 550 U.S. 398 (2007).....	16, 22, 23
<i>Medichem, S.A. v. Rolabo, S.L.</i> , 437 F.3d 1157 (Fed. Cir. 2006)	20, 26
<i>Pfizer, Inc. v. Apotex, Inc.</i> , 480 F.3d 1348 (Fed. Cir. 2007)	12
<i>Thorner v. Sony Comp. Entm’t Am. LLC</i> , 669 F.3d 1362 (Fed. Cir. 2012)	3
<i>Uber Techs., Inc. v. X One, Inc.</i> , 957 F.3d 1334 (Fed. Cir. 2020)	10, 17

LIST OF EXHIBITS

No.	Short Name	Exhibit
1001	‘405 Patent	U.S. Patent No. 11,175,405 to Pacala <i>et al.</i>
1002	‘405 Prosecution History	Prosecution history for U.S. Patent No. 11,175,405
1003	Shanley Declaration	Expert Declaration of Dr. James F. Shanley.
1004	Pacala	U.S. Patent Pub. No. 2014/0211194 to Pacala <i>et al.</i>
1005	Spector	U.S. Patent No. 10,473,766 to Spector
1006	Droz	U.S. Patent No. 10,605,984 to Droz <i>et al.</i>
1007	Villeneuve	U.S. Patent No. 10,520,602 to Villeneuve <i>et al.</i>
1008	Hall	U.S. Patent No. 9,983,297 to Hall <i>et al.</i>
1009	Borowski	U.S. Patent Pub. No. 2013/0300840 to Borowski
1010	Spector Provisional	U.S. Provisional Appl. No. 62/470,706 to Spector
1011	NIST	<i>Performance Analysis of Next-Generation LADAR for Manufacturing, Construction, and Mobility</i> , National Institute of Standards and Technology (2004)
1012	NOAA	Younkin <i>et al.</i> , <i>Velodyne VLP-16 Laser Scanner Acceptance</i> , NOAA Report, May 2016

No.	Short Name	Exhibit
1013	Pacala-2016	U.S. Patent Pub. No. 2016/0047901 to Pacala <i>et al.</i>
1014	Pacala-803	U.S. Patent No. 10,036,803 to Pacala <i>et al.</i>
1015	Hall-672	U.S. Patent No. RE46,672 to Hall
1016	ITC Complaint	Complaint in ITC Inv. No. 337-TA-1363
1017	Delaware Complaint	Complaint in <i>Ouster, Inc. v. Hesai Group et al.</i> , No. 23-cv-00406 (D. Del.)
1018	Stay Order	Order Granting Stay in <i>Ouster, Inc. v. Hesai Group et al.</i> , No. 23-cv-00406 (D. Del.)
1019	Joint Claim Construction Chart	Joint Claim Construction Chart in ITC Inv. No. 337-TA-1363 (July 7, 2023)
1020	Termination ID	ITC Inv. No. 337-TA-1363, EDIS Document Detail for Docket Entry: “Initial Determination Granting Respondents’ Motion for Termination of Investigation...”
1021	Shanley CV	<i>Curriculum Vitae</i> of James F. Shanley
1022	Sensors 2020	Lee <i>et al.</i> , “Accuracy-Power Controllable LiDAR Sensor System with 3D Object Recognition for Autonomous Vehicle,” in <i>Sensors</i> , Vol. 20, Iss. 19 (Oct. 2020)
1023	Hipp-747	U.S. Patent No. 6,747,747 to Hipp
1024	Weimer	U.S. Patent No. 8,736,818 to Weimer <i>et al.</i>

No.	Short Name	Exhibit
1025	Borowski-838	U.S. Patent Pub. No. 2013/0300838 to Borowski
1026	DGC	<i>Report to Congress: DARPA Prize Authority (2006)</i>
1027	Team DAD	Hall <i>et al.</i> , <i>Team DAD Technical Paper</i> , DARPA Grand Challenge (2005)
1028	Marino	Marino <i>et al.</i> , <i>A compact 3D imaging laser radar system using Geiger-mode APD arrays: system and measurements</i> , MIT Lincoln Lab (2003)
1029	Matsubara	Matsubara <i>et al.</i> , <i>Development of Next Generation LiDAR</i> , R&D Review of Toyota CRDL (2012)
1030	Hall-877	U.S. Patent No. 10,393,877 to Hall <i>et al.</i>
1031	Hagiz PHV Dec.	Declaration of Ron Hagiz in Support of Petitioner's Motion for <i>Pro Hac Vice</i> Admission
1032	Takai	Takai <i>et al.</i> , <i>Single-Photon Avalanche Diode with Enhanced NIR-Sensitivity for Automotive LIDAR Systems</i> , Sensors (2016)
1033	Shanley Reply Dec.	Reply Expert Declaration of Dr. James F. Shanley.
1034	Janét Tr.	Deposition Transcript of Jason A. Janét, Ph.D.

GROUND OF CHALLENGE (37 C.F.R. § 42.204(b)(2))

No.	Ground for Challenge
1	Pacala and Droz Render Obvious Claims 21, 23, 26-31, and 34 Of The '405 Patent
2	Pacala, Droz, and Villeneuve Render Obvious Claims 24-25 and 32-33 Of The '405 Patent
3	Hall, Borowski, and Spector Render Obvious Claims 21 and 23-33 Of The '405 Patent
4	Hall, Borowski, Spector, and Droz Render Obvious Claim 34 Of The '405 Patent

LIST OF CHALLENGED CLAIMS

Claim 21	
21(a)	An optical system for performing distance measurements, the optical system comprising:
21(b)	a stationary housing having a base, a top and an optically transparent window disposed between the base and the top and extending fully around a periphery of the stationary housing;
21(c)	a light ranging device disposed within the housing and comprising:
21(d)	a platform;
21(e)	a light transmission module coupled to the platform and comprising a bulk transmitter optic and a plurality of optical emitters, each optical emitter in the plurality of optical emitters configured to generate and transmit pulses of radiation through the bulk transmitter optic and through the optically transparent window into a field external to the optical system; and
21(f)	a light sensing module coupled to the platform and comprising a bulk receiver optic, an aperture layer comprising a plurality of apertures separated by a stop region, a plurality of photosensors operable to detect photons emitted from the plurality of optical emitters and received through the bulk receiver optic after being reflected from surfaces within the field, and an optical filter disposed between the bulk receiver optic and the plurality of photosensors and configured to allow a band of radiation, including an operating wavelength of the plurality of optical emitters, to pass through the filter to the plurality of photosensors while blocking radiation outside the band from reaching the plurality of photosensors; and
21(g)	a motor disposed within the housing and operatively coupled to spin the platform and the light ranging device within the housing;
21(h)	wherein: each photosensor in the plurality of photosensors comprises a plurality of single photon avalanche diodes (SPADs);
21(i)	the plurality of apertures comprises at least first, second, third and fourth apertures;

21(j)	the plurality of photosensors comprises at least first, second, third and fourth photosensors; and the light sensing module includes a first optical path to the first photosensor through the first aperture, a second optical path to the second photosensor through the second aperture, a third optical path to the third photosensor through the third aperture, and a fourth optical path to the fourth photosensor through the fourth aperture.
Claim 23	
23	The optical system for performing distance measurements according to claim 21 wherein the system generates distance data based on times between transmission of pulses of light from the plurality of optical emitters and detection of photons from the pulses of light by the plurality of photosensors.
Claim 24	
24	The optical system for performing distance measurements according to claim 21 wherein the plurality of optical emitters are arranged to form a plurality of emitter channels having non-overlapping fields of view, and the plurality of photosensors are arranged to form a plurality of receiver channels having non-overlapping the fields of view and having a one-to-one relationship with the plurality of emitter channels such that the field of view for each receiver channel is coincident with the field of view of a corresponding emitter channel.
Claim 25	
25	The optical system for performing distance measurements according to claim 21 wherein the plurality of emitters are configured to project a plurality of illuminating beams in the field external to the optical system according to an illumination pattern that substantially matches, in size and geometry across a range of distances from the system, a plurality of non-overlapping fields of view of the plurality of photosensors.
Claim 26	
26(a)	An optical system for performing distance measurements, the optical system comprising:

26(b)	a stationary housing having a base, a top and an optically transparent window disposed between the base and the top and extending fully around a periphery of the stationary housing;
26(c)	a light ranging device disposed within the housing and comprising:
26(d)	a platform;
26(e)	a light transmission module coupled to the platform and comprising a bulk transmitter optic and a plurality of optical emitters, each optical emitter in the plurality of optical emitters configured to generate and transmit pulses of radiation through the bulk transmitter optic and through the optically transparent window into a field external to the optical system; and
26(f)	a light sensing module coupled to the platform and comprising a bulk receiver optic, an aperture layer comprising a plurality of apertures separated by a stop region, a plurality of photosensors operable to detect photons emitted from the plurality of optical emitters and received through the bulk receiver optic after being reflected from surfaces within the field, and one or more optical filters disposed between the bulk receiver optic and the plurality of photosensors, each of the one or more optical filters configured to allow a set of wavelengths of radiation, including an operating wavelength of the plurality of optical emitters, to pass through the one or more optical filters while blocking radiation outside that set; and
26(g)	a motor disposed within the housing and operatively coupled to spin the platform and the light ranging device within the housing;
26(h)	wherein: each photosensor in the plurality of photosensors comprises a plurality of single photon avalanche diodes (SPADs);
26(i)	the plurality of apertures comprises at least first, second, third and fourth apertures;

26(j)	the plurality of photosensors comprises at least first, second, third and fourth photosensors; and the light sensing module includes a first optical path to the first photosensor through the first aperture, a second optical path to the second photosensor through the second aperture, a third optical path to the third photosensor through the third aperture, and a fourth optical path to the fourth photosensor through the fourth aperture.
Claim 27	
27	The optical system for performing distance measurements set forth in claim 26 wherein the one or more optical filters comprise a bandpass filter.
Claim 28	
28	The optical system for performing distance measurements set forth in claim 26 wherein the one or more optical filters comprise a plurality of optical filters.
Claim 29	
29	The optical system for performing distance measurements set forth in claim 28 wherein each of the plurality of optical filters is supported by an optically transparent substrate.
Claim 30	
30	The optical system for performing distance measurements set forth in claim 29 wherein the plurality of optical filters are disposed in the first optical path.
Claim 31	
31	The optical system for performing distance measurements according to claim 26 wherein the system generates distance data based on times between transmission of pulses of light from the plurality of optical emitters and detection of photons from the pulses of light by the plurality of photosensors.
Claim 32	

32	The optical system for performing distance measurements according to claim 26 wherein the plurality of optical emitters are arranged to form a plurality of emitter channels having non-overlapping fields of view, and the plurality of photosensors are arranged to form a plurality of receiver channels having non-overlapping fields of view and having a one-to-one relationship with the plurality of emitter channels such that the field of view for each receiver channel is coincident with the field of view of a corresponding emitter channel.
Claim 33	
33	The optical system for performing distance measurements according to claim 26 wherein the plurality of emitters are configured to project a plurality of illuminating beams in the field external to the optical system according to an illumination pattern that substantially matches, in size and geometry across a range of distances from the system, a plurality of non-overlapping fields of view of the plurality of photosensors.
Claim 34	
34	The optical system for performing distance measurements according to claim 26 wherein the one or more optical filters comprises a first optical filter disposed in the first optical path between the first photosensor and the first aperture, a second optical filter disposed in the second optical path between the second photosensor and the second aperture, a third optical filter disposed in the third optical path between the third photosensor and the third aperture, and a fourth optical filter disposed in the fourth optical path between the fourth photosensor and the fourth aperture.

I. INTRODUCTION

Patent Owner's Response fails to raise any persuasive reason to preserve the validity of the challenged claims of the '405 patent.

With respect to Grounds 1 and 2, based primarily on Pacala and Droz, PO only disputes a single limitation, based on a claim construction for the term "stop region," raised for the first time in PO's Response. However, as discussed below, PO's proposed construction is not supported by the intrinsic evidence. Further, even under PO's proposed construction, Droz discloses a "stop region." PO's arguments regarding motivation to combine fail because they rely on improper "bodily incorporation" arguments that have been repeatedly rejected by the Federal Circuit.

With respect to Grounds 3 and 4, based primarily on Hall, Spector, and Borowski, PO does not dispute that every limitation of the challenged claims is disclosed in the prior art. PO only argues that a POSITA would not be motivated to combine the references. However, PO again relies on improper "bodily incorporation" arguments, and PO's arguments are not otherwise supported by the evidence. To the extent PO argues that there may be disadvantages associated with the proposed combination, the possibility of

unquantified disadvantages does not in itself rebut motivation to combine, and PO's arguments are thus insufficient as a matter of law.

Finally, PO asserts secondary considerations of obviousness based on industry skepticism and failure of others. However, PO does not offer any evidence of widespread skepticism or failure relating to the alleged invention. Instead, PO relies solely on the fact that Petitioner's expert did not use SPADs in a LiDAR device nearly a decade before the '405 patent, and on a single paper by a lone researcher in Russia, who asserts that he is not aware of any attempts to use SPADs in LiDAR devices. By contrast, extensive evidence exists demonstrating successful research in the field by others in the years leading up to the '405 patent.

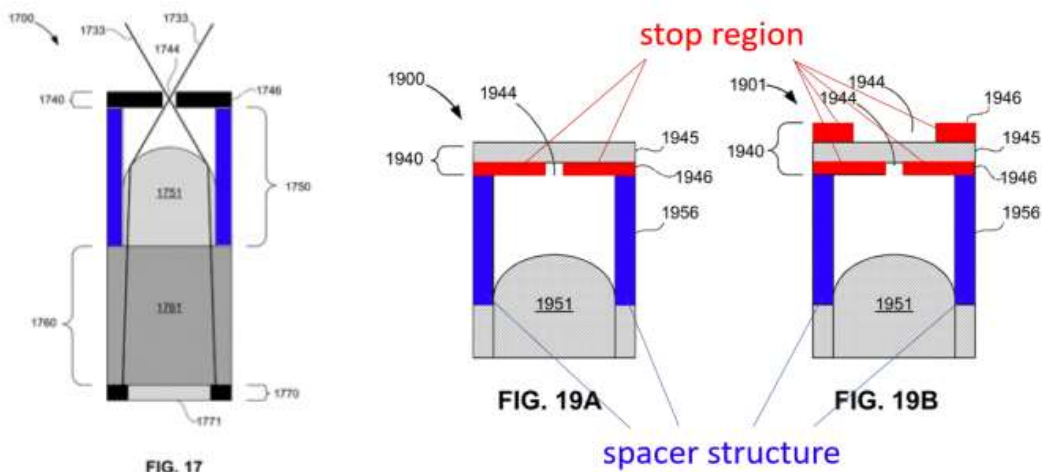
II. GROUNDS 1-2: DROZ RENDERS OBVIOUS AN APERTURE LAYER WITH A STOP REGION

PO argues that Droz does not disclose a stop region based on an incorrect, newly proposed construction of "stop region" as "an optically non-transparent region that defines a field of view for a photosensor." POR 26. PO does not dispute that under the interpretation of "stop region" relied upon in the Petition, Droz's light-absorbing material layers are stop regions as set forth in the Petition. Pet. 28; EX1003 ¶¶150-151; EX1006, 13:39-43, 14:47-60.

As an initial matter, PO's proposed construction is incorrect. PO relies on a sentence from a single embodiment to limit the scope of the claim term, which is improper. POR 26; *Thorner v. Sony Comp. Entm't Am. LLC*, 669 F.3d 1362, 1365-66 (Fed. Cir. 2012). PO also points to exemplary embodiments that purportedly use a stop region to define a field of view, but does not identify any disclaimer or definition that limits the term "stop region" in this manner. *See* POR 26-27. PO also misinterprets the specification: the specification describes the *aperture layer* as defining a field of view in certain embodiments; it does not purport to define the term "stop region" to require defining a field of view. EX1033, ¶15; EX1001, 37:17-23.

PO argues that a stop region must define a field of view because the specification discloses non-transparent regions that are not described as "stop regions." POR 28-29. However, these examples do not support PO's construction; they merely show that the term "stop region" refers to non-transparent regions *in the aperture layer*. EX1033, ¶16. For example, PO relies on the examples below, where the blue annotated regions are not described as "stop regions." POR 28-29. However, the blue annotated regions are also not part of the aperture layer. EX1033, ¶16. The claims expressly state that the stop regions are part of the aperture layer. *See*

EX1001, Cl. 21 (“an *aperture layer comprising* a plurality of apertures *separated by a stop region*”). The specification also consistently describes the stop region as the optically non-transparent region of the aperture layer, without separately requiring it to define a field of view. EX1033, ¶17; EX1001, 38:44-47, 38:55-58, 38:66-39:2, 39:9-12, 40:56-63, 41:13-25. Thus, non-transparent regions outside of the aperture layer would not be “stop regions” for that reason alone.



In addition, contrary to PO’s arguments, in at least one embodiment, the ’405 patent describes the aperture layer and its stop regions as preventing light “from travelling into ... an adjacent receiver channel.” EX1033, ¶18; EX1001, 41:7-29.

PO’s extrinsic evidence (POR 30-31) also does not support its construction. The cited definitions describe an “aperture stop” and do not

define the term “stop region.” EX1033, ¶19. Further, they explain that the field of view is determined by a diameter, such as of the “clear aperture of the lens”—not by an optically non-transparent region. EX2013, 49.

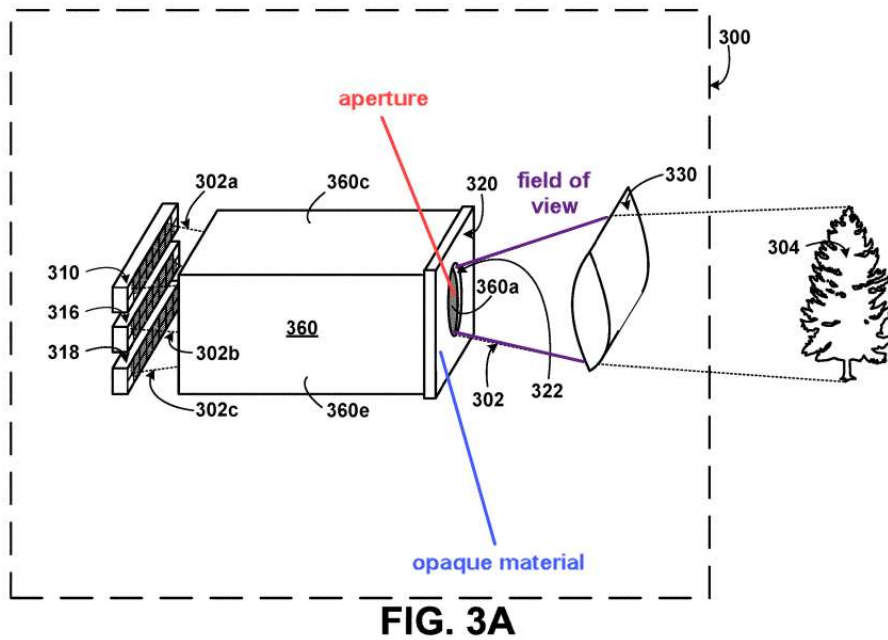
Even under PO’s erroneous construction, Droz discloses a “stop region.”¹ EX1033, ¶¶20-26. PO admits that Droz “rel[ies] on the size of the input ends of the waveguides” to “define the field of view for the light detectors.” POR 35 (citing EX1006, 16:59-67). However, PO is incorrect in arguing that this technique is “entirely different” and “does not involve the use of stop regions.” POR 35-36.

Droz explains that the “input ends” of the waveguides can be “limiting apertures.” EX1006, 15:35-43. The input ends of the waveguides further “extend[] between cladding layers,” which are separated by light-absorbing

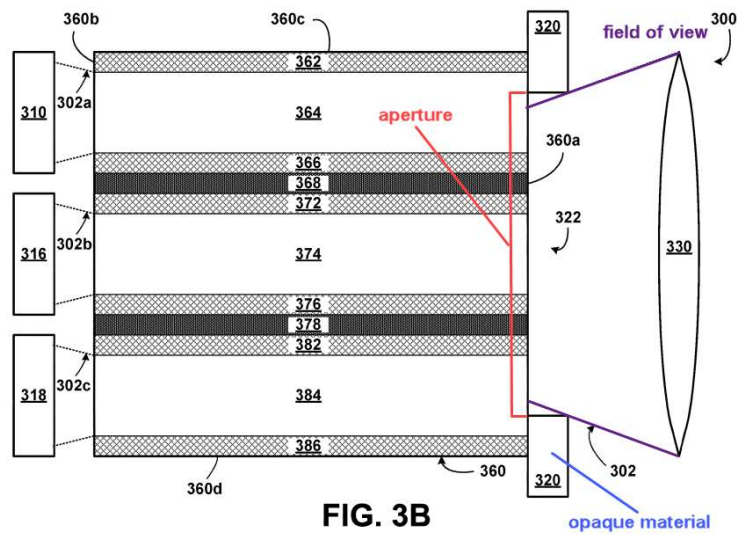
¹ PO raised this construction for the first time in its Patent Owner Response. Accordingly, Petitioner “must be given the opportunity in its reply to argue and present evidence of anticipation or obviousness under the new construction, at least where it relies on the same embodiments for each invalidity ground as were relied on in the petition.” *Axonics, Inc. v. Medtronic, Inc.*, 75 F.4th 1374, 1384 (Fed. Cir. 2023).

layers. EX1006, 16:59-62. In particular, the light-absorbing layers absorb light that directly strikes the portion of the layer at the input end of the waveguide, as well as light that “propagate[s] inside a cladding layer of a waveguide.” EX1033, ¶22; EX1006, 4:43-48. The light-absorbing layers thus determine the field of view of the input ends of the waveguides. EX1033, ¶¶21-22. That is consistent with PO’s extrinsic evidence defining an “aperture stop” as a “*diameter*” that “limits the size” of light passing through the system. EX1033, ¶22.

For example, in one embodiment, Droz includes an “opaque material” that defines an “aperture.” The opaque material and aperture “spatially filter light ... from the scene,” thus behaving “like an optical pinhole.” EX1006, 6:6-9, 6:23-29. The opaque material surrounding the aperture defines the “portion of the focused light to be transmitted to” the detectors (*i.e.*, the field of view). *Id.*, 6:25-28. This embodiment is illustrated in Figure 3A, annotated below, which shows the aperture and opaque material defining a field of view corresponding to the dotted line. *Id.*, 13:14-17; EX1033, ¶23.



The field of view of the aperture is shown in more detail in Figure 3B, where the opaque material 320 surrounds aperture 322 and defines a field of view shown by lines 302. EX1006, 13:61-66; EX1033, ¶24.



Droz teaches that “opaque material 320 can be omitted,” and “each respective input end of the waveguides in array 360 may correspond to a respective aperture.” EX1006, 16:18-21. Droz further discloses that each waveguide “receive[s] *a portion of light* 302 projected on side 360a and extending between cladding layers 362 and 366 (i.e., input end of the first waveguide). The portions of the light-absorbing layers aligned with the input ends of the waveguides (in red below) act as stop regions between the input ends of the waveguides (apertures), and define a field of view (in green below) by absorbing light that arrives at the front end of the light-absorbing layer and light that propagates in the cladding layers. EX1033, ¶25.

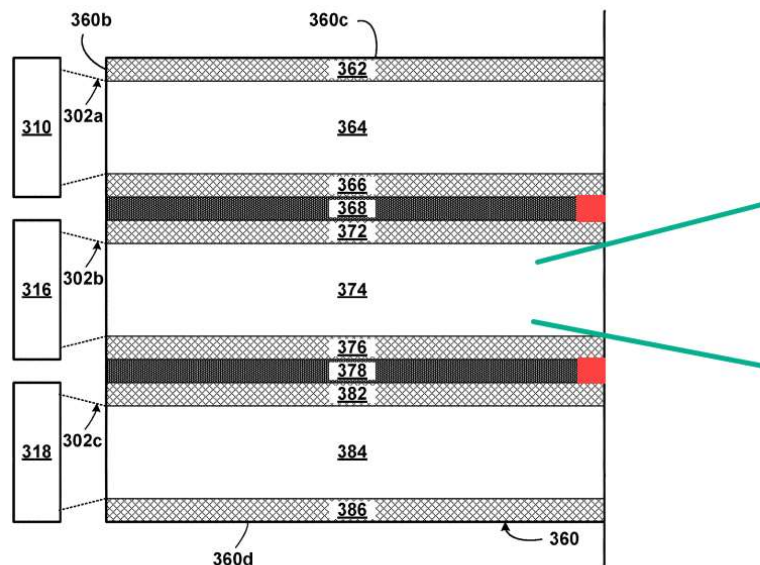


FIG. 3B

PO argues that the light-absorbing layer also prevents light from leaking between adjacent waveguides. *See* POR 33-34. The fact that the light-absorbing layer serves this additional function does not change the fact that it is *also* a stop region, as shown above. Indeed, as noted above, in one embodiment of the '405 patent the stop regions also prevent light “from travelling into ... an adjacent receiver channel.” EX1001, 41:7-29.

PO also argues that the light-absorbing layers do not define a field of view because the outer waveguides in Figure 3B only have a single light-absorbing layer. POR 36-37. PO is incorrect. The light-absorbing layers still define a field of view for the outer waveguides, at least with respect to the side of each waveguide adjacent to the light-absorbing layer. EX1033, ¶26. In addition, a POSITA would have understood that Figure 3B shows one portion of Droz’s system, and that other structures and components not illustrated would typically prevent light from entering the waveguides along the outer sides. *Id.*

III. GROUNDS 1-2: A POSITA WOULD COMBINE PACALA AND DROZ

PO’s argument against combining Pacala and Droz is the quintessential example of an improper “bodily incorporation” argument. Indeed, PO expressly states that it disputes motivation to combine because of purported

“challenge[s]” associated with “attempting to *incorporate* the waveguides of Droz into the Pacala system.” POR 38.

As the Federal Circuit has repeatedly explained, “[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference.” *Allied Erecting & Dismantling Co. v. Genesis Attachments*, 825 F.3d 1373, 1381 (Fed. Cir. 2016) (quoting *In re Keller*, 642 F.2d 413, 425 (CCPA 1981)). To the contrary, “whether one prior art reference can be incorporated into another is ‘basically irrelevant.’” *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1341 (Fed. Cir. 2020) (quoting *In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985)). More specifically, “a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements.” *In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012). Instead, the inquiry “focuses on what the combined teachings would have suggested.” *Id.* at 1330. Yet an “actual, physical substitution of elements” is precisely what PO insists is required. POR 39-44. These arguments fail as a matter of law, and cannot undermine the undisputed benefits of the proposed combination described in the Petition. *See* Pet. 18-20.

Allied Erecting is particularly instructive on this point. The Petitioner in that case relied on a prior art reference disclosing demolition tools with replaceable “jaws.” *Id.* at 1377. However, in order to arrive at the claims at issue, Petitioner combined that reference with a second reference that suggested making the jaws movable. *Id.* at 1380. The Patent Owner argued that the combination “involves a massive, nonobvious reconstruction of the device that not only changes its principle of operation, but renders the device inoperable as a result.” *Id.* The Federal Circuit rejected this argument, explaining that “it is not necessary that [the references] be physically combinable to render obvious the [challenged patent].” *Id.* at 1381 (quoting *In re Sneed*, 710 F.2d 1544, 1550 (Fed. Cir. 1983)). Yet PO makes the equivalent argument here by arguing that the proposed combination might require Pacala to be redesigned to an unspecified extent based on the size or weight of Droz’s waveguides.

PO’s argument is also not supported by any evidence. PO primarily criticizes Dr. Shanley for not investigating the weights, dimensions, materials, and forces associated with the systems in Pacala and Droz, and for opining that designing a real-world system that accounts for all of these details would normally involve a team of engineers. POR 41-44. However, Petitioner is

not required to describe how to design a complete, functional, real-world system in order to establish that the challenged claims are obvious. Petitioner need only establish that a POSITA “*would have been motivated* to combine the teachings of the prior art references to achieve the claimed invention.” *Allied Erecting*, 825 F.3d at 1381 (quoting *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1361 (Fed. Cir. 2007)). The Petition provides that motivation by identifying specific reasons, based on express disclosures in Droz and the understanding of a POSITA, to combine the references. Pet. 18-20. PO does not dispute these reasons in its Response.

Nor does PO offer any argument or evidence that the proposed combination would be outside the capability of a POSITA or would otherwise require undue experimentation. Indeed, Dr. Shanley’s deposition testimony confirms otherwise. PO selectively quotes from Dr. Shanley’s deposition to incorrectly suggest that he admitted combining Pacala and Droz would be difficult. POR 42-44. In fact, however, Dr. Shanley expressly opined that a POSITA would be capable of combining the references. For example, when interrogated regarding how to determine the size and weight of the components in the combined system, Dr. Shanley explained that a “mechanical engineer out of school” (with less experience than a POSITA)

could use CAD software to determine the “form, fit, and function, including weight” to determine these details. EX2011, 56:1-20. Similarly, while Dr. Shanley opined that a team would normally be involved in designing a real-world system, “there are certain members of the team who could run *all* of those programs and do *all* of that analysis.” *Id.*, 58:6-21. Dr. Shanley also explained that modifying Pacala’s system in view of Droz’s waveguides would have “no effect” on rotational forces when properly designed. *Id.*, 61:2-11.

PO offers no evidence to the contrary. PO does not identify any disclosure in Pacala or Droz that requires any particular size, weight, or material, and the challenged claims do not impose any such requirement. For example, PO characterizes Pacala’s system as “compact” and “tightly packed,” but Pacala does not use these terms to describe its system, and does not otherwise disclose the size or weight of its system. *See generally* EX1004. Similarly, PO asserts that Droz’s waveguides are large because they have multiple “layers” that are “stacked” together (POR 40-41), but Droz does not require a particular size, thickness, weight, or density for these “layers.” *See generally* EX1006. Further, in one exemplary embodiment, each waveguide has a length of 200 μm —*i.e.*, a fraction of a millimeter. EX1006, 3:49-58.

PO does not explain why a POSITA would be incapable of adding a component fractions of a millimeter in size to Pacala's system without undue experimentation.

PO's expert similarly offers no support for the opinion that any physical characteristics of Droz or Pacala would prevent their combination.² He merely provides the same vague assertions as PO about Droz's "layers" and criticizes Dr. Shanley for not computing the dimensions and weights of the hypothetical combined system—despite the fact that such computations are not required in an obviousness analysis. *See* EX2010, ¶¶111-120. Yet PO's expert does not dispute the benefits of the combination identified by Dr. Shanley, or Dr. Shanley's testimony that a POSITA (or even a mechanical

² Even if PO's expert had offered any such opinion, it should be given little weight. While Dr. Shanley has extensive experience designing and building LiDAR systems, PO's expert identified only isolated projects he worked on involving LiDAR, which typically failed to result in even a rudimentary functional LiDAR system, or merely involved analyzing an existing LiDAR device or integrating it into a larger system. EX1034, 21:9-22, 23:4-10, 33:3-34:5, 37:5-11.

engineer out of school) would be capable determining the appropriate dimensions and weights in a real world system, and could do so without undue experimentation—which is all that is required to establish motivation to combine and reasonable expectation of success.

IV. GROUNDS 3-4: A POSITA WOULD COMBINE HALL, SPECTOR, AND BOROWSKI

PO does not dispute that Hall, Spector, and Borowski collectively disclose each and every limitation of claims 21 and 23-34 of the '405 patent. PO only challenges the motivation to combine these references. PO's arguments are not supported by the evidence and contrary to law.

A. Hall and Spector

PO's argument against combining Hall and Spector again relies on an improper "bodily incorporation" argument. *See, e.g., Allied Erecting*, 823 F.3d at 1381. PO's argument rests on the premise that if the particular aperture array from Spector's system were bodily incorporated into Hall's system, the resulting system would have a low resolution. POR 45-50. However, obviousness does not require Petitioner to establish that Spector's exemplary aperture array may be bodily incorporated directly into Hall's system, as discussed above. Indeed, the Petition relies more generally on Spector's

teaching of “adding an aperture array to detectors to improve a conventional LiDAR system.” Pet. 56.

As PO acknowledges, in Spector’s particular system, the apertures in the aperture array are spaced relatively far from one another because Spector “caus[es] the microoptics and aperture arrays to *move* in order to fill in the gaps between the discrete detection points.” POR 47 (citing EX1005, 4:55-65; EX1010, 13). Petitioner does not propose including Spector’s scanning system into Hall. POR 50. Contrary to PO’s argument, any purported problem with Spector’s aperture array is easily solved by spacing adjacent apertures more closely together in the combined system. As the Supreme Court has recognized, “[a] person of ordinary skill is also a person of ordinary creativity, not an automaton.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007). Plainly, a POSITA with ordinary creativity would have understood that if the aperture array does not move, then the apertures must be closer together in order to capture sufficient detail in a scene.

PO does not contend that a POSITA would not have been capable of implementing Spector’s aperture array using a finer resolution for the apertures. Indeed, Dr. Shanley testified that “a mechanical engineer out of school or an optical engineer or an electrical engineer” would all have been

capable of using CAD programs to determine “the form, fit, and function” of the individual components in a LiDAR system. EX2011, 56:4-20. A POSITA—who has more experience than an engineer out of school under either party’s definition³—would have been capable of implementing the spacing of the apertures in a manner suitable for Hall’s system. Even if applying Spector’s aperture array to Hall’s system would have required a different implementation or additional design work, the proposed combination would nevertheless render obvious the challenged claims. *See Uber*, 957 F.3d at 1341 (“Even if the two proposed solutions would have required different implementation, ... two known, finite, predictable solutions for solving the same problem ... render[] obvious the challenged limitation.”); *Elbrus Int’l Ltd. v. Samsung Elecs. Co.*, 738 F. App’x 694, 698 (Fed. Cir. 2018) (rejecting a similar bodily incorporation argument).

³ PO disputes the level of skill in the art presented in the Petition. EX1033, ¶¶9-13. However, both parties agree that a POSITA would have experience working with LiDAR devices. Petitioner’s arguments apply under either party’s definition. *Id.*, ¶12.

For the reasons above, PO's arguments that bodily incorporating Spector's aperture array into Hall's system would render the combination "inoperative" is flawed as a matter of law, and cannot defeat the motivations to combine presented in the Petition. PO does not otherwise dispute the advantages of the combination articulated in the Petition, including avoiding cross-talk and improving accuracy. Pet. 56-58. PO only argues that these benefits would have been "outweighed" by its legally improper bodily incorporation argument. POR 52.

B. Borowski and Spector

PO incorrectly argues that a POSITA "would not have had a reasonable expectation of success of using Borowski's SPAD arrays with Spector's apertures" because Spector discloses that an aperture array is "beneficial" for "detectors with a large fill factor" (*i.e.*, 10% or more). POR 56; EX1005, 3:49-54. Even accepting PO's characterization of Spector, however, Spector does not indicate that an aperture array *could not be used* for detectors with a smaller fill factor, or would be *disadvantageous*. Thus, PO's argument has no bearing on whether a POSITA would reasonably expect to be successful in combining the references—regardless of fill factor.

Even if PO's argument is understood to dispute motivation to combine, PO fails to establish that SPADs necessarily have a "small fill factor" by Spector's standards, *i.e.*, less than 10%. PO's sole evidence on this point is a single paper authored by a lone researcher in Russia ("Vinogradov"). POR 56-57, EX2014. Neither PO nor its expert provide any reasons why this singular paper reflects the universe of SPAD technology as of the priority date of the '405 patent in 2017, or the state of the industry more generally at that time. It does not. *See* EX1033, ¶¶35-38. Nor does the Vinogradov paper itself assert that SPAD technology cannot achieve a fill factor above 10%. Instead, the Vinogradov paper cites to a single project published in 2013 and 2014—three years before the '405 patent—where the researchers purportedly reported a fill factor less than 10%. EX2014, 3 (citing an MiSPIA project described in references 20 and 21), 11 (references 20 and 21 dated 2013 and 2014, respectively). In the same paragraph, however, Vinogradov notes that "the same team" was able to achieve a "better result" with a "fill factor of 20%" only "a year later" in 2015. *Id.*, 3. Vinogradov then discusses a "SPAD array design ... demonstrated by Philips" that achieved a **50%** fill factor initially, improving to **78%** in a "recent optimization." *Id.*, 3-4. The Philips design was initially published in **2009**, and the "recent optimization" in **2012**,

both years before the '405 patent. None of these examples demonstrate that in **2017**, a POSITA would have believed that SPADs cannot achieve a fill factor greater than 10%.

In order to discount the more recent results, PO argues that these “attempts at addressing the fill factor issue” are “associated with other significant issues.” POR 57. Here, again, PO relies entirely on Vinogradov, which states, without citation or analysis, that the technology used in the Philips design is “expensive and inflexible in scaling.” POR 56; EX2014, 4. Even if Vinogradov’s unsupported conclusions is accepted, however, the mere existence of potential disadvantages in a proposed combination does not necessarily obviate a motivation to combine. *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) (“[A] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine.”). For example, it is entirely plausible that a POSITA would be motivated to obtain the undisputed increased range of SPAD technology (*see* Pet. 57) even if the improved performance increases the cost of the system.

Further, Vinogradov’s conclusion, based solely on two data points well before the date of the '405 patent, is plainly refuted by other contemporaneous

references. For example, by early 2016, at least one team of researchers at Toyota had developed a “SPAD structure” that could be used “to achieve a higher-performance, e.g., longer-range, higher precision, and higher measurement rate, LIDAR system.” EX1032, 8. This SPAD structure enabled “a high [fill factor] of 33.1%.” *Id.* The same paper also acknowledges that “state-of-the-art” SPAD structures as early as 2012 had achieved “a fill factor of 21.6%.” *Id.*, 2 (citing reference 7, a 2012 paper). Neither PO nor Vinogradov even discusses these examples, which would have been available to a POSITA as of the date of the ’405 patent in 2017.

C. Hall and Borowski

PO initially argues that because Hall already discloses using APDs as detectors, Petitioner was required to establish that a POSITA would have been specifically motivated “to *replace* Hall’s APDs with Borowski’s SPAD arrays.” POR 58 (emphasis added). Tellingly, PO does not cite any case law in support of this argument—because that is not the law. However, PO is also incorrect—the Petition provides specific reasons why a POSITA would have been motivated to use SPADs instead of Hall’s APDs.

The Supreme Court has explained that where there are “a finite number of identified, predictable solutions” to a problem, “a [POSITA] has good

reason to pursue the known options within his or her technical grasp.” *KSR*, 550 U.S. at 402. Here, APDs and SPADs are two detection techniques among a finite number of photon detection techniques, both well known in the art by the time of the ‘405 patent. EX1003, ¶¶38, 44-46. Accordingly, a POSITA would have had good reason to consider SPADs for use in Hall’s system, notwithstanding Hall’s disclosure of APDs. Further, SPADs represent a “known technique” using the prior art according to its established function, which is sufficient to establish a motivation to combine. *KSR*, 550 U.S. at 417 (“If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond that person's skill.”). The Federal Circuit has expressly rejected PO’s argument—*i.e.*, that because Hall discloses an alternative design (using APDs), a POSITA would not be motivated to consider other options (such as SPADs). *Moultet*, 686 F.3d at 1334 (“[M]ere disclosure of alternative designs does not teach away.” (quoting *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004))). Indeed, even if “better alternatives exist in the prior art” compared to the proposed combination, that “does not mean that an inferior combination is inapt for obviousness purposes.” *Id.*

In addition, “[u]nder the correct analysis, *any need or problem* known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.” *KSR*, 550 U.S. at 420. The Petition identifies specific problems in existing LiDAR systems, as acknowledged by Hall (such as an increase in measurement noise at large distances and challenges balancing power management with high resolution and range). Pet. 57. The Petition then explains how Borowski discloses SPADs as a solution to those problems, thereby motivating a POSITA to use SPADs instead of APDs for detection in Hall’s system. *Id.* That is all that is required to establish a motivation to combine.

PO separately argues that a POSITA would not have been motivated to use SPADs in Hall’s system based on vague assertions that Hall’s system is “noisy” and that SPADs are “highly prone to noise,” creating an “incompatibility between Hall’s system and Borowski’s SPADs.” POR 59-60. PO’s characterization of Hall is exaggerated. Hall includes a single passage that refers generally to “measurement noise” in the “return signals” of existing LiDAR systems. EX1008, 2:27-33. PO merely argues that a “POSITA would have understood” that a LiDAR system in an autonomous

vehicle would “involve[] ample noise,” but offers no explanation or analysis as to how or why Hall’s system is subject to any more noise than a typical LiDAR system. POR 59. Nor does PO attempt to quantify the noise in Hall’s system or otherwise show that the levels of noise would render SPADs inoperable or would be outside the capabilities of a POSITA to address.

By contrast, Dr. Shanley explains that noise and interference are common and well-known problems in optical systems, and identifies a number of well-known techniques for reducing noise in LiDAR systems. *See* EX1003, ¶¶50-56. The proposed combination of Hall, Spector, and Borowski also incorporate multiple techniques that would mitigate the impact of any noise before light is received at the photodetectors. For example, Hall discloses the use of “optical filters” that “absorb light outside of a predetermined wavelength range,” thus preventing ambient and stray light from reaching the detectors. EX1008, 7:13-27. Spector discloses an aperture array that “reduces cross-talk and background.” EX1005, 6:12-15; EX1010, 13. And Borowski discloses using an array of SPADs arranged in a “macro-cell” that “acts as the equivalent of a single ‘perfect’ SPAD having no recovery time,” thus overcoming problems associated with the sensitivity of individual SPADs. EX1009, [0053]; *see also id.*, [0019]-[0027] (describing

problems in the prior art). Dr. Shanley also discusses a related Borowski reference (Borowski-838) that describes additional benefits of SPADs and several noise mitigation techniques. EX1003, ¶189 (discussing Borowski-838); EX1025, [0205], [0321] (describing techniques to mitigate internal and external noise).

PO argues that there may be other sources of noise. POR 61-62. But PO does not even attempt to explain how and why these noise sources would be present in the proposed combination, how any such noise would impact the performance or operability of the combined system, or why the noise-mitigation techniques disclosed in Hall, Borowski, and Spector, and generally known to a POSITA, would not be adequate to mitigate the impact of any noise. Nor does PO offer any evidence that a POSITA would not otherwise be capable of implementing at least some noise mitigation techniques, or that the impact of any unmitigated noise would outweigh the clear benefits associated with SPADs, as taught by Borowski. *See* Pet. 57; EX1009, [0035]. Indeed, it is the very sensitivity of SPADs that make them apt for Hall's system, since Hall teaches that conventional systems increase range by disadvantageously "increasing laser pulse intensity." EX1008, 2:27-33; *see also id.*, 2:39-45 (discussing disadvantages of increasing pulse rate and pulse

intensity). Borowski's SPAD arrays, however, can detect lower intensity light from a LiDAR emitter because SPADs "provide[] significant carrier amplification." EX1009, [0035]. More recent literature that pre-dates the '405 patent confirms that those in the field viewed SPADs as promising candidates for automotive LiDAR systems, and were successful in incorporating SPADs into automotive LiDAR systems, notwithstanding their noise sensitivity. *See generally* EX1032 (2016 paper discussing SPAD-based automotive LiDAR system).

At best, PO's discussion of noise sources identifies speculative disadvantages that may exist in the combined system. However, the possibility of disadvantages alone does not establish no motivation to combine. *Medichem*, 437 F.3d at 1165 ("[A] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine."). PO has not shown that these disadvantages have a meaningful impact on the performance of the combined system, particularly in view of the noise mitigation techniques described above that are expressly included in the combined system. The clear benefits of SPADs, particularly in the context of Hall's system, would thus motivate a POSITA to combine the references, notwithstanding any potential noise sensitivity.

V. SECONDARY CONSIDERATIONS

A. Industry Skepticism

PO's allegation that there was "significant industry skepticism" regarding the use of SPADs in LiDAR is premised entirely on mischaracterized quotes from Dr. Shanley's deposition. *See* POR 62-64. Neither PO nor its expert cites to any other source to establish that there existed widespread skepticism in the industry regarding the use of SPADs in LiDAR. By contrast, numerous references that pre-date the '405 patent and are cited in the Petition demonstrate the industry had contemplated incorporating SPADs into LiDAR devices for years. *See, e.g.,* EX1028; EX1029; *see also* EX1032, 1 (2016 paper stating that "SPADs, their front-end circuits, and a complete digital signal processor (DSP) have been successfully and integrally designed as a low-cost system-on-a-chip implementation"); EX1033, ¶¶28-30.

Dr. Shanley merely testified that he did not use SPADs in LiDAR systems that he personally helped design and build years before the '405 patent. *See* EX2011, 13:19-19:3, 23:16-19. PO's Response focuses on a particular system designed by Dr. Shanley in **2008**, nearly a decade before the '405 patent. POR 63; EX2011, 17:2-20; EX1033, ¶32. Dr. Shanley

testified that it would have been “straightforward engineering” to use an array of SPADs to represent a pixel in a LiDAR device. EX2011, 16:1-19. The testimony fails to establish that there was *industry* skepticism about the use of SPADs in **2017**, particularly in light of the extensive evidence (including references cited in the preceding paragraph) demonstrate the industry was actively developing SPAD-based LiDAR systems.

PO also incorrectly asserts that Dr. Shanley “was not aware of any LIDAR system, commercial or otherwise, that used SPADs prior to the ’405 patent.” POR 63. In fact, Dr. Shanley identified several *non*-commercial LiDAR systems that used SPADs. EX2011, 74:6-20. In any event, whether or not Dr. Shanley could recall specific examples of commercial SPAD-based LiDAR devices at his deposition has no bearing on the question of whether there was *industry skepticism* regarding the use of SPADs in LiDAR devices. EX1033, ¶33.

B. Failure by Others

PO also argues that many others had “failed[]to develop arrays of SPADs for use in LIDAR systems,” based on the Vinogradov paper. POR 64-65, EX2014. As discussed above, PO does not explain why Vinogradov is reflective of the state of the art as of 2017; it is not. EX1033, ¶¶36-37. Nor

does the Vinogradov paper itself indicate that the author surveyed the industry before concluding that “there are no attempts” to implement SPAD arrays in LiDAR. EX2014, 4. To the contrary, the author states that “detailed analysis of the SPAD-based receivers is *out of the scope of this paper.*” *Id.* Indeed, Vinogradov only discusses two research projects involving SPADs—one of which dates back to the 2009-2012 time frame—before concluding that *all* such attempts have been unsuccessful. *Id.*, 3.

Numerous other papers and patents discuss the successful use of SPADs, including in LiDAR devices—none of which Vinogradov or PO address. EX1033, ¶38. For example, Droz, Borowski, Matsubara, Marino, and Takai all disclose SPADs in LiDAR systems. *See generally* EX1006; EX1009, [0003]-[0007]; EX1028; EX1029; EX1032, 8. These references confirm that others were successful in using SPADs in LiDAR’s system.

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CERTIFICATE OF LENGTH (37 C.F.R. §§ 42.24(D))

The undersigned hereby certifies that, according to the word-processing system used to prepare the foregoing document, this document has 5,505 words and thus complies with the applicable word limit.

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