

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.,
Petitioner,

v.

OUSTER, INC.,
Patent Owner.

IPR2023-01456
Patent 11,178,381 B2

Before MEREDITH C. PETRAVICK, KEVIN W. CHERRY, and
JON M. JURGOVAN, *Administrative Patent Judges*.

CHERRY, *Administrative Patent Judge*.

DECISION
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Hesai Technology Co., Ltd. (“Petitioner”) filed a Petition (Paper 2, “Pet.”) to institute an *inter partes* review of claims 1–3, 5–8, and 10–17 (“the challenged claims”) of U.S. Patent 11,178,381 B2 (Ex. 1001, “the ’381 patent”). Ouster, Inc. (“Patent Owner”) filed a Preliminary Response (Paper 6, “Prelim. Resp.”). We instituted *inter partes* review under 35 U.S.C. § 314(a). Paper 8 (“Inst. Dec.”).

During the trial, Patent Owner filed a Response (Paper 19, “PO Resp.”), Petitioner filed a Reply (Paper 21, “Pet. Reply”), and Patent Owner filed a Sur-Reply (Paper 25, “PO Sur-Reply”).

Petitioner and Patent Owner (“the parties”) requested oral argument (Papers 27 and 28). A hearing was conducted on January 13, 2025. Paper 33 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a). Having reviewed the complete trial record, we determine that Petitioner has shown, by a preponderance of the evidence, that the challenged claims are unpatentable.

II. BACKGROUND

A. *Real Parties in Interest*

Petitioner identifies itself, Hesai Group, and Hesai Inc. as real parties in interest. Pet. 85. Patent Owner identifies itself as the real party in interest. Paper 5, 1.

B. *Related Matters*

Petitioner and Patent Owner identify the following related matters:

- *Ouster, Inc. v. Hesai Group et al.*, No. 23-cv-00406 (D. Del.).

- *Certain LiDAR (Light Detection and Ranging) Systems and Components Thereof*, Inv. No. 337-TA-1363 (USITC) (“the ITC litigation”).

Pet. 85; Paper 5, 1.

C. *The ’381 Patent (Ex. 1001)*

The ’381 patent is titled “Optical System for Collecting Distance Information within a Field.” Ex. 1001, code (54). The ’381 patent is a continuation of Application No. 15/880,491, filed on Jan. 25, 2018 and issued as U.S. Patent No. 11,025,885, which is a continuation of Application No. 15/276,532, filed on Sept. 26, 2016 and issued as U.S. Patent No. 9,992,477. *Id.* at code (63). The ’381 patent claims priority to Provisional Application No. 62/232,222 filed on Sept. 24, 2015. *Id.* at code (60).

The ’381 patent relates to optical systems “for collecting distance information in the field of optical sensors.” *Id.* at 1:29–31. The optical systems of the ’381 patent may include “lenses for collecting photons from a field,” “optical filters that reject normally incident light outside of the operating wavelength, and pixels that detect incident photons.” *Id.* at code (57).

Figure 1 of the '381 patent is shown below.

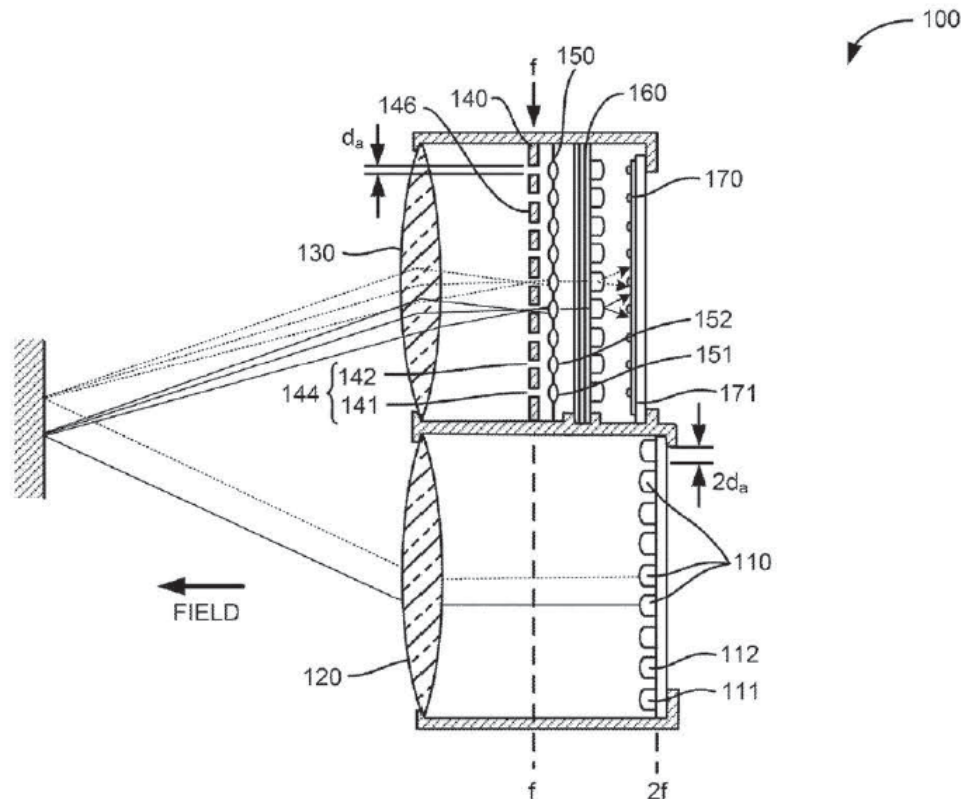


FIG. 1

Figure 1, above, is a schematic representation of a one-dimensional optical system for collecting distance information within a field. *Id.* at 2:5–7.

Figure 1 contains “a set of illumination sources 110,” each configured to output a beam “toward a discrete spot in the field.” *Id.* at 2:7–11. Figure 1 also contains a “bulk imaging optic 130” and “bulk transmitting optic.” *Id.* at 2:11–12, 5:34–36.

The optical system includes an “aperture layer 140,” which contains “a set of apertures 144” and a “stop region 146 around the set of apertures 144.” *Id.* at 2:12–17. Each aperture defines discrete fields of view ahead of the bulk imaging optic 130, which are described by the '381 patent as “non-

overlapping fields of view beyond a threshold distance from the system.”

Id. at 2:54–57. The illumination sources “project discrete illuminating beams at an operating wavelength into (and substantially only into) the fields of view defined by the apertures.” *Id.* at 2:57–60.

The ’381 patent further describes an “optical filter 160,” a “set of pixels 170” adjacent to the filter, and “a diffuser 180 interposed between the optical filter 160 and the set of pixels 170.” *Id.* at 2:27–35. The optical filter is “configured to pass light rays at the operating wavelength.” *Id.* at 2:27–29. The diffuser is “configured to spread collimated light” across a set of subpixels of a “pixel in the set of pixels 170.” *Id.* at 2:35–38. The ’381 patent explains that the pixels may include “an array of single-photon avalanche diode detectors” (“SPADs”). *Id.* at 9:7–9.

The ’381 patent’s optical system “collects three-dimensional distance data.” *Id.* at 2:40–44. The system reconstructs a virtual three-dimensional volume “based on recorded times between transmission of illuminating beams” and “detection of photons.” *Id.* at 2:44–49.

D. *Challenged Claims*

Petitioner challenges claims 1–3, 5–8, and 10–17. Pet. 1. Of the challenged claims, claims 1 and 14 are independent. Claim 1, reproduced below with Petitioner’s identifiers for the claim limitations, is illustrative of the claimed subject matter.

[1(a)] An optical system for collecting distance information, the optical system comprising:

[1(b)] a bulk transmitting optic;

[1(c)] a plurality of optical emitters arranged behind the bulk transmitting optic and configured to output electromagnetic radiation of an operating

wavelength through the bulk transmitting optic into a field external to the optical system according to an illumination pattern that comprises a plurality of non-overlapping emission regions;

[1(d)] a bulk imaging optic disposed adjacent to the bulk transmitting optic;

[1(e)] a plurality of pixels arranged behind the bulk imaging optic, wherein each pixel in the plurality of pixels has a field of view coincident with an emission region of a corresponding optical emitter in the plurality of optical emitters and each pixel comprises a plurality of single photon avalanche diodes (SPADs) operable to detect photons emitted from its corresponding optical emitter and received through the bulk imaging optic after being reflected from surfaces within the field; and

[1(f)] an optical filter disposed in an optical path of the plurality of pixels, the optical filter configured to allow a set of wavelengths of electromagnetic radiation, including the operating wavelength, to pass through the optical filter while blocking electromagnetic radiation outside the set of wavelengths from reaching the plurality of pixels.

Ex. 1001, 16:61–17:21.

E. *Evidence*

Petitioner submits the following evidence:

Evidence	Exhibit No.
Declaration of James F. Shanley, Ph.D.	1003
Retterath et al., US 10,203,399 B2 (issued Feb. 12, 2019, filed Nov. 12, 2013) (“Retterath”)	1005
Borowski, US 2013/0300838 A1 (published Nov. 14, 2013, filed Dec. 21, 2011) (“Borowski”)	1006
Hipp, US 7,787,105 B2 (issued Aug. 31, 2010, filed Sept. 13, 2007) (“Hipp”)	1007
Weimer et al., US 8,736,818 B2 (issued May 27, 2014,	1008

Evidence	Exhibit No.
filed Aug. 16, 2010) (“Weimer”)	
Imai, US 2016/0274223 A1 (published Sept. 22, 2016, filed Mar. 14, 2016) (“Imai”)	1009
Azuma et al., JP 2015-78953 (published Apr. 23, 2015, filed Oct. 18, 2013) (certified translation of Ex. 1010) (“Higashi”)	1011
Grzesik, US 2017/0040368 A1 (published Feb. 9, 2017, filed Apr. 14, 2015) (“Grzesik”)	1012
Pacala et al., US 2014/0211194 A1 (published July 31, 2014, filed Jan. 27, 2014) (“Pacala”)	1013
Second Declaration of Dr. James Shanley	1040
Deposition of Jason A. Janét	1041
Pacala et al., US 11,422,236 B2 (issued Aug. 23, 2022, filed Aug. 24, 2017)	1042
Campbell et al., US 9,841,495 B2 (issued Dec. 12, 2017, filed Nov. 3, 2016)	1043
Villeneuve et al., US 9,804,264 B2 (issued Oct. 31, 2017, filed Nov. 29, 2016)	1044
D. Bonzi, et al., “Figure of Merit for CMOS SPADs and arrays,” Proceedings of SPIE – The International Society for Optical Engineering (May 2013)	1045
H. Matsubara, et al., “Development of Next Generation LIDAR,” R&D Review of Toyota CRDL, vol. 43, no. 1 (2012) 7–12	1046
Villa et al., “CMOS imager with 1024 SPADs and TDCs for single-photon timing and 3D time-of-flight,” IEEE Journal of Selected Topics in Quantum Electronics (Sept. 2014)	1047

Patent Owner submits the following evidence.

Evidence	Exhibit No.
Declaration of Jason A. Janét, Ph.D.	2009
Deposition Transcript of James F. Shanley, Ph.D.	2010
Excerpts from The Oxford English Dictionary (2d Ed., Vol. III), Cham-Creeky (1989)	2011

Evidence	Exhibit No.
Sergey L. Vinogradov, “Evaluation of performance of silicon photomultipliers in LIDAR applications” (2017)	2012
Edoardo Charbon, et al., “SPAD-Based Sensors” (2013)	2013
Cristiano Niclass, et al., “A Single Photon Avalanche Diode Array Fabricated in Deep-Submicron CMOS Technology” (2006)	2014
Deposition Transcript of James F. Shanely, Ph.D., deposition in IPR2023-01421, dated June 6, 2024	2015
Deposition Transcript of Michael Stephen Lebby, Ph.D., deposition in IPR2023-01422, dated May 23, 2024	2016
Corrections to the July 10, 2024 Declaration of Jason A. Janét, Ph.D.	2018
Deposition Transcript of Jason A. Janét, Ph.D., taken Aug. 30, 2024 in IPR2023-01421	2019
Deposition Transcript of James F. Shanley, Ph.D., taken Nov. 6, 2024	2020

F. *Asserted Grounds*

Petitioner asserts the following grounds of unpatentability:

Claim(s) Challenged	35 U.S.C. §¹	Reference(s)/Basis
1–3, 6–8, 10, 11, 14–17	103	Retterath, Borowski
6–8, 17	103	Retterath, Borowski, Hipp
1–3, 5–8, 10–13	103	Retterath, Borowski, Pacala
1–3, 6–8, 10–17	103	Retterath, Borowski, Weimer
1–3, 5–8, 10–13	103	Retterath, Borowski, Weimer, Pacala

¹ The Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (“AIA”), amended 35 U.S.C. §§ 102, 103. Because the ’381 patent has an effective filing date after the effective date of the applicable AIA amendment, we refer to the AIA version of § 103.

Claim(s) Challenged	35 U.S.C. §¹	Reference(s)/Basis
6–8, 17	103	Retterath, Borowski, Weimer, Hipp
6–8, 17	103	Retterath, Borowski, Weimer, Hipp, Pacala
1–3, 10–16	103	Imai, Higashi
6–8, 17	103	Imai, Higashi, Grzesik
5	103	Imai, Higashi, Pacala

III. ANALYSIS

A. *Legal Standards*

A claim is unpatentable under 35 U.S.C. § 103 if “the differences between the [claimed invention] and the prior art are such that the [claimed invention] as a whole would have been obvious [before the effective filing date of the claimed invention] to a person having ordinary skill in the art to which [the claimed invention] pertains.” *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

In conducting an obviousness analysis, one must determine whether the claimed elements are present in the prior art. *PAR Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1194–1198 (Fed. Cir. 2014) (citing *Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1164 (Fed. Cir. 2006)). However, a patent claim “is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR*,

550 U.S. at 418. An obviousness determination requires finding “both ‘that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.’”

Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd., 821 F.3d 1359, 1367–68 (Fed. Cir. 2016) (citation omitted); *see KSR*, 550 U.S. at 418.

Further, an assertion of obviousness “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *KSR*, 550 U.S. at 418; *In re NuVasive, Inc.*, 842 F.3d 1376, 1383 (Fed. Cir. 2016) (a finding of a motivation to combine “must be supported by a ‘reasoned explanation’”).

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3)); *see also Intelligent Bio-Sys.*, 821 F.3d at 1369. Therefore, to prevail in an *inter partes* review, Petitioner must explain how the proposed combinations of prior art would have rendered the challenged claims unpatentable.

B. *Level of Ordinary Skill in the Art*

The person of ordinary skill in the art is a hypothetical person who is presumed to know the relevant prior art. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citing *Custom Accessories, Inc. v. Jeffrey–Allan Indus., Inc.*, 807 F.2d 955, 962 (Fed. Cir. 1986)). In determining the skill level, the Board may consider various factors including “the type of problems encountered in the prior art; prior art solutions to those problems;

rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *Id.* In a given case, every factor may not be present, and one or more factors may predominate. *Id.*

Petitioner asserts that a person of ordinary skill in the art would have had an undergraduate degree in mechanical or electrical engineering or physics, plus 2–3 years of experience in LiDAR design.

Pet. 3 (citing Ex. 1003 ¶¶ 72–77).

Patent Owner argues that

a POSITA would have had an undergraduate degree in mechanical or electrical engineering and two to three years of work experience with electro-optical and electro-mechanical devices or systems, with, at a minimum, at least one year of work experience was with LIDAR designs, where less work experience may be compensated by a higher level of education or vice versa.

PO Resp. 4 (citing Ex. 2009 ¶ 60).

We agree with and will apply Patent Owner’s statement of the level of ordinary skill in the art. This level of ordinary skill is reflective of the education and experience that would have been required to understand the problems and solutions identified in the ’381 patent and the prior art.

Okajima v. Bourdeau, 261 F.3d 1350 (Fed. Cir. 2001).

C. *Claim Construction*

In an *inter partes* review, claims are construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b). 37 C.F.R. § 42.100(b); *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). This standard includes “construing

the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b). “Any prior claim construction determination concerning a term of the claim in a civil action, or a proceeding before the International Trade Commission, that is timely made of record in the *inter partes* review proceeding will be considered.” *Id.*

“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

1. “Coincident With”

Limitation 1(e) of claim 1 recites “a field of view ***coincident with*** an emission region of a corresponding optical emitter in the plurality of optical emitters.” Ex. 1001, 19:18–20.

The ’381 patent’s optical system includes illumination sources 110 that generate discrete spots of light coincident with the fields of view of apertures 144 which pass light received from respective illumination sources to respective pixels 170. *See, e.g.*, Ex. 1001, 2:5–38.

In its Petition, Petitioner contended that “the challenged claims should receive their ordinary and customary meaning.” Pet. 3. Petitioner also indicated that preliminary constructions were exchanged in the ITC litigation prior to its termination. *Id.* Although those constructions touched upon the meaning of certain terms in limitation 1(e) such as “field of view,” they are

not related to the dispute over claim terminology that the parties raise before us. Ex. 1026, 2².

In its Response, Patent Owner argued that

the term “each pixel in the plurality of pixels has a field of view coincident with an emission region of [a corresponding/its paired] optical emitter” should be construed to mean that the field of view of each pixel and emission region of a corresponding [or paired] optical emitter cover substantially the same area in the field.

PO Resp. 23–24 (citing Ex. 2009 ¶¶ 108–122).

In its Reply, Petitioner reiterated that “no constructions that substitute language for the original claim terms are necessary.” Pet. Reply 1.

Petitioner argued that “coincident with” is a common phrase that would have been understood by a POSITA. *Id.* at 2. Petitioner asserted that Patent Owner’s proposal improperly narrows “coincident with” to mean “cover substantially the same area in the field,” mandating that the field of view “matches” the “discrete spot” of an illumination source “to a degree of near perfection” which “improperly excludes example embodiments in the ’381 patent, defies normal usage by others, and injects ambiguity.” *Id.* at 2–8 (citing Ex. 1001, 3:60–4:5, 6:12–20, 11:17–25, Figs. 1–2; Ex. 1040 ¶¶ 9–22).

In its Sur-Reply, Patent Owner repeated that the “limitation should be construed to require that the field of view of each pixel and the emission region of a corresponding optical emitter cover substantially the same area in the field.” PO Sur-Reply 5. Patent Owner argued that Petitioner takes an

² For Exhibit 1026, we use the numbering of the “Joint Claim Construction Chart” rather than the Exhibit numbering herein.

“overbroad view” of the claim language as satisfied “by *any* overlap between emission and detection regions.” *Id.* (emphasis Patent Owner’s). Patent Owner asserts that its construction of “coincident” is consistent with its plain and ordinary meaning, and that the ’381 patent indicates that fields of view of optical emitters and corresponding detector pixels are to be “substantially *matched*.” *Id.* at 5–10 (citing Ex. 1001, 2:53–3:20, 3:25–30, 6:34–37, 11:4–25, Fig. 1; Ex. 1041, 41:7–24; Ex. 2009 ¶¶ 108–122).

The parties’ dispute over this claim language thus centers on the meaning of “*coincident with*” in limitations 1(e) and 14(e). To determine what this means in the context of the ’381 patent, we consider the intrinsic evidence.

The ’381 patent’s specification mirrors the claim language in limitations 1(e) and 14(e) and repeatedly mentions that its optical system has an aperture array wherein each aperture defines “a field of view coincident with a discrete spot output by a corresponding illumination source.” Ex. 1001, 2:16–19, 3:65–4:1, 10:67–11:3, 14:25–28.

The term “coincident with” as used in the ’381 patent does not require perfect coincidence. To explain why, we provide an annotated version of Figure 2 of the ’381 patent below.

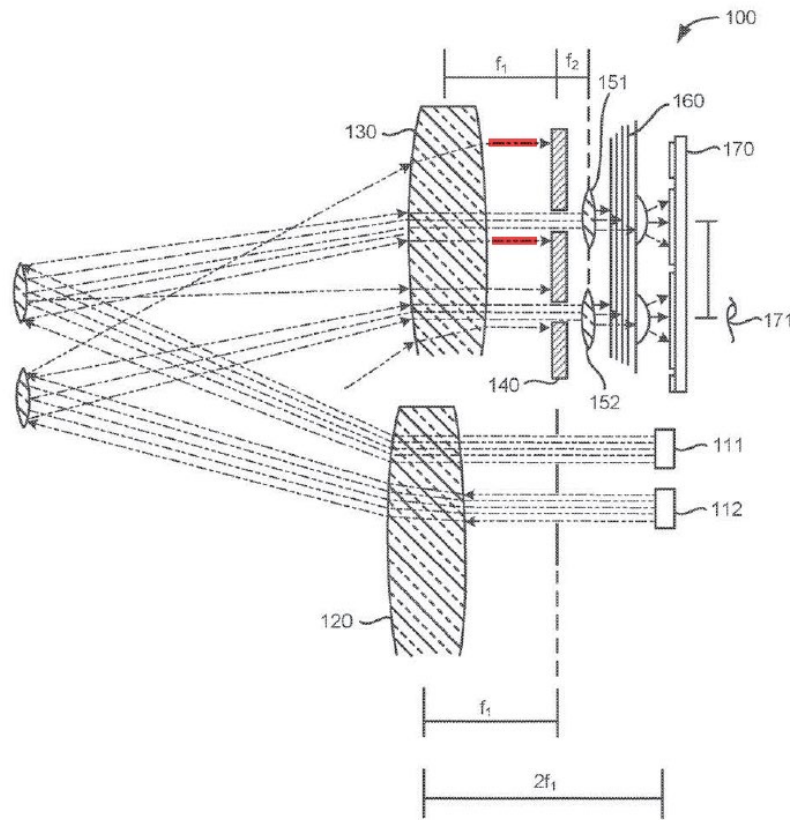


FIG. 2

In Figure 2 above, the rays of electromagnetic radiation indicated in red originate from illumination source 111, but they are not coincident with the corresponding aperture's field of view, and instead they are absorbed or blocked by the aperture layer's stop region. Ex. 1001, 3:61–4:5. As Figure 2 shows, out of five ray lines emitted by illumination source 111, only three are within its corresponding aperture's field of view. This conveys an understanding that “coincident with” does not require perfect matching of the discrete spot of radiation from the illumination source and the aperture's field of view.

A similar understanding can be gleaned from the '381 patent's Figure 4, which is reproduced below.

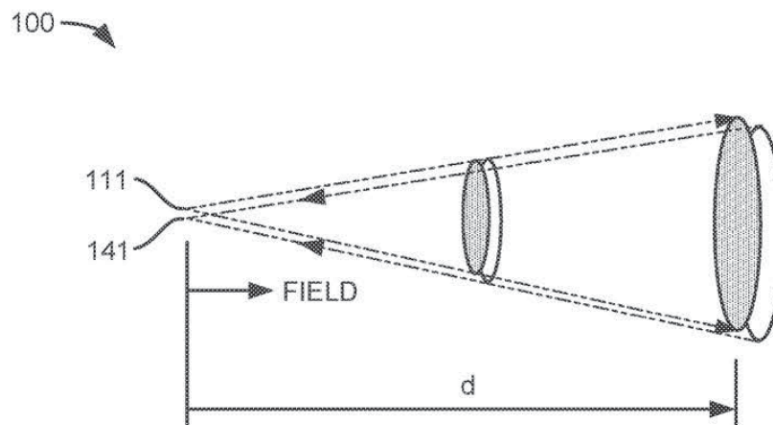


FIG. 4

As shown in Figure 4 above, the radiation from illumination source 111 does not exactly match the field of view of aperture 141. Furthermore, the '381 patent states:

each emitter outputs an illuminating beam of diameter *substantially identical to or slightly greater than* the diameter of a corresponding aperture in the apertures layer, and the column of emitters is arranged along the focal plane of the bulk transmitter optic such that each illuminating beam projected from the bulk transmitter optic into the field intersects and is of *substantially the same size and geometry* as the field of view of the corresponding sense channel, as shown in FIG. 4.

Ex. 1001, 11:17–25 (emphases added). Hence, because the illuminating beam's diameter is “substantially identical or slightly greater than” the aperture's diameter and the beam is of “substantially the same size and geometry” of the aperture's field of view, it follows that the illuminating beam's “discrete spot” may be substantially identical to or slightly greater than the aperture's field of view.

The prosecution history of the '381 patent does not lend any insight into proper construction of “coincident with.” Ex. 1002. Claims 1 and 14 were allowed without any rejection requiring the applicant to explain why

the claim distinguished over any prior art cited during examination.

Ex. 1002, 509 (examiner's statement of reasons for allowance).

Turning to the extrinsic evidence, Patent Owner relies on a dictionary which defines "coincident" as "occupies the same portion of space as." *See* Ex. 2011, 8 (definition of "coincident"). This definition is generally consistent with a POSITA's understanding of the term, but as explained "coincident with" as used in the '381 patent does not require perfect coincidence.

As the intrinsic evidence is sufficient to determine the meaning of "coincident with," we do not resort to extrinsic evidence such as the declarations and deposition testimony of the parties' experts. *See Phillips*, 415 F.3d at 1317 (explaining that extrinsic evidence is less significant than intrinsic evidence); *Seabed Geosolutions (US) Inc. v. Magseis FF LLC*, 8 F.4th 1285, 1287 (Court of Appeals gives primacy to intrinsic evidence and resorts to extrinsic evidence only if consistent with intrinsic evidence).

The '381 patent makes clear that "coincident with" is used in its ordinary and customary sense to mean "occupies the same portion of space as" but this does not require perfect coincidence between the optical emitter's "emission region" and the pixel's field of view. As used in the '381 patent, the "emission region" of the optical emitter can be "substantially identical or slightly greater" than its corresponding pixel's "field of view." We need not construe the term any further to resolve the parties' dispute over this claim language. *See Realtime*, 912 F.3d at 1375.

2. "Proportional to"

Claim 3 depends from claim 1 and further recites "wherein the plurality of optical emitters are arranged in a first arrangement and the

plurality of pixels are arranged in a second arrangement, *proportional to* the first arrangement.” Ex. 1001, 17:28–31 (emphasis added). Patent Owner contends that “[a] POSITA would have considered proportional arrangements to be arrangements that are related by a scaling factor.” PO Resp. 41 (citing Ex. 2009 ¶ 142). Patent Owner argues that, for example, “a POSITA would have considered [certain] arrangements proportional” because “the elements have the same basic pattern, but the elements in [one of the arrangements] are twice as far apart from each other as compared to the elements [in the second arrangement].” *Id.* In contrast, Patent Owner argues that “two arrangements [can] have the same number of elements, but a POSITA would not have considered them to be ‘proportional,’ because they have a different pattern.” *Id.* at 42–43 (citing Ex. 2009 ¶ 144); *see also id.* at 59–60 (making the same argument in the context of the Imai grounds).

Petitioner argues that no construction of this term is necessary, and that Patent Owner’s arguments are “premised on an implicit attempt to narrowly construe claim 3 as excluding emitter/detector arrangements that ‘cannot be reduced to a scaling factor.’” Pet. Reply 8–9 (citing PO Resp. 42). Petitioner asserts that Patent Owner’s proposal imports limitations (“a scaling factor”) that are simply not mentioned in the claim. *Id.* at 9 (citing Ex. 1040 ¶¶ 23–24).

Patent Owner responds contending that these are “untimely arguments” and that it “did not propose a claim construction” for this term. PO Sur-Reply 11. Patent Owner argues that the ’381 patent Specification’s use of the word “proportional” indicates that it relates to spatial—not numeric—considerations. *Id.* (citing Ex. 1001, 11:48–60, 14:21–24).

We agree with Petitioner that Patent Owner has offered an implicit claim construction of “proportional to” seeking to limit the term. Thus, we disagree with Patent Owner’s attempt to have us ignore Petitioner’s contentions as improper new arguments. *See* PO Sur-Reply 10. Instead, we find that Petitioner’s arguments on the term “proportional to” are proper reply arguments to Patent Owner’s contentions.

We begin with the language of the claims. The claims merely require that the “plurality of pixels are arranged in a second arrangement, proportional to the first arrangement.” Ex. 1001, 17:30–31. There are no other specific requirements about “first arrangement” or the “second arrangement” and no specific requirement about what kind of “proportional[ity]” is required. Thus, the language of the claims does not provide a basis for Patent Owner’s narrow reading, nor does it necessarily preclude it.

As for the Specification, Patent Owner points us to two portions of the disclosure. First, Patent Owner directs us to column 11, lines 48 to 60, which states:

The system can therefore include a set of emitter arranged according to an emitter pitch distance, configured to output illuminating beams of diameter, and offset behind the bulk transmitter optic by an offset distance as a function of a scale factor (e.g., 2.0 or 3.0) and 1) the aperture pitch distance in the aperture layer, 2) the diameter of apertures in the aperture layer, and 3) the focal length of bulk transmitter optic, respectively. The system can therefore include an illuminating subsystem that is proportionally larger than a corresponding receiver subsystem to achieve greater total output illumination power within the same beam angles and fields of view of corresponding channels in the receiver subsystem.

Ex. 1001, 11:48–60. This portion of the Specification does mention “a scale factor” and “proportional[,]” but it deals with offset of the emitters from the bulk transmitter optic, not the arrangement of either the emitters or the pixels. We do not agree with Patent Owner that this shows any particular usage for the term “proportional” that requires a scale factor or ties “proportional” only to the “spatial relationship” between components.

Second, Patent Owner directs us to column 14, lines 21 to 24, which states “an aperture layer coincident the focal plane, defining a set of apertures 144 in a second rectilinear grid array proportional to the first rectilinear grid array. . . .” Ex. 1001, 14:21–24. This description goes on to describe the nature of the pixels as either a 24-by-24 grid array of 300- μ m-square pixels or a 12-by-12 grid array of 600- μ m-square pixels. *Id.* at 15:2–10. However, there is no description of the number or size of the emitters in this discussion (and Patent Owner does not direct us to any such description). Moreover, there is nothing in this discussion that indicates that it is the only type of proportionality contemplated in the patent or that it is intended to limit the claims in any way. Accordingly, we find that the Specification does not support limiting the claims in the manner proposed by the Patent Owner.

As we discussed above with respect to “coincident with,” the prosecution history contains no relevant discussion of the claims. Thus, we find that the intrinsic evidence does not support limiting the claims in the manner proposed by Patent Owner and decline to adopt the implicit claim construction offered by Patent Owner. We need not construe the term any further to resolve the parties’ dispute over this claim language. *See Realtime*, 912 F.3d at 1375.

D. *Obviousness Grounds Based on Imai*

Petitioner contends that claims 1–3, 5–8, and 10–17 would have been obvious over the combinations of Imai and Higashi; Imai, Higashi, and Grzesik; and Imai, Higashi, and Pacala. Pet. 55–83; Pet. Reply 21–24. Patent Owner disputes that the challenged claims would have been obvious over these combinations. PO Resp. 51–59; PO Sur-Reply 18–20.

1. *The Prior Art*

In this section, we discuss the disclosures of Imai, Higashi, Grzesik, and Pacala and address the parties’ contentions whether the claim limitations are met by the combination. For the reasons that follow, we determine that claims 1–3, 5–8, and 10–17 would have been obvious over the combinations of these references set forth below.

a) *Imai (Ex. 1009)*

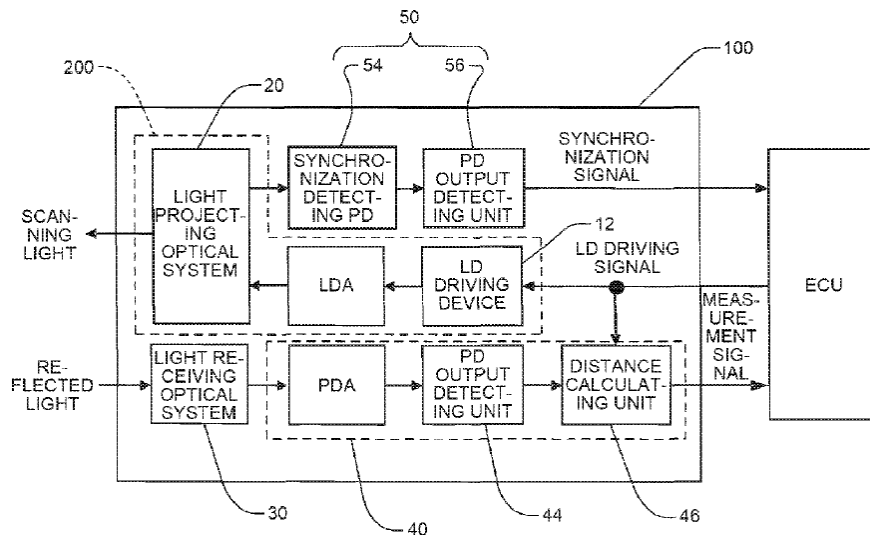
Imai discloses a laser radar as follows:

The laser radar 100 is a scanning laser radar mounted on an automobile as a mobile object for detecting whether there is an object (for example, a preceding vehicle, a stopping vehicle, an obstacle, a pedestrian and the like) by emitting light and detecting a distance to the object and the like by receiving reflected light (scattered light) from the object.

Ex. 1009 ¶ 27.

Imai's Figure 1 is reproduced below.

FIG.1



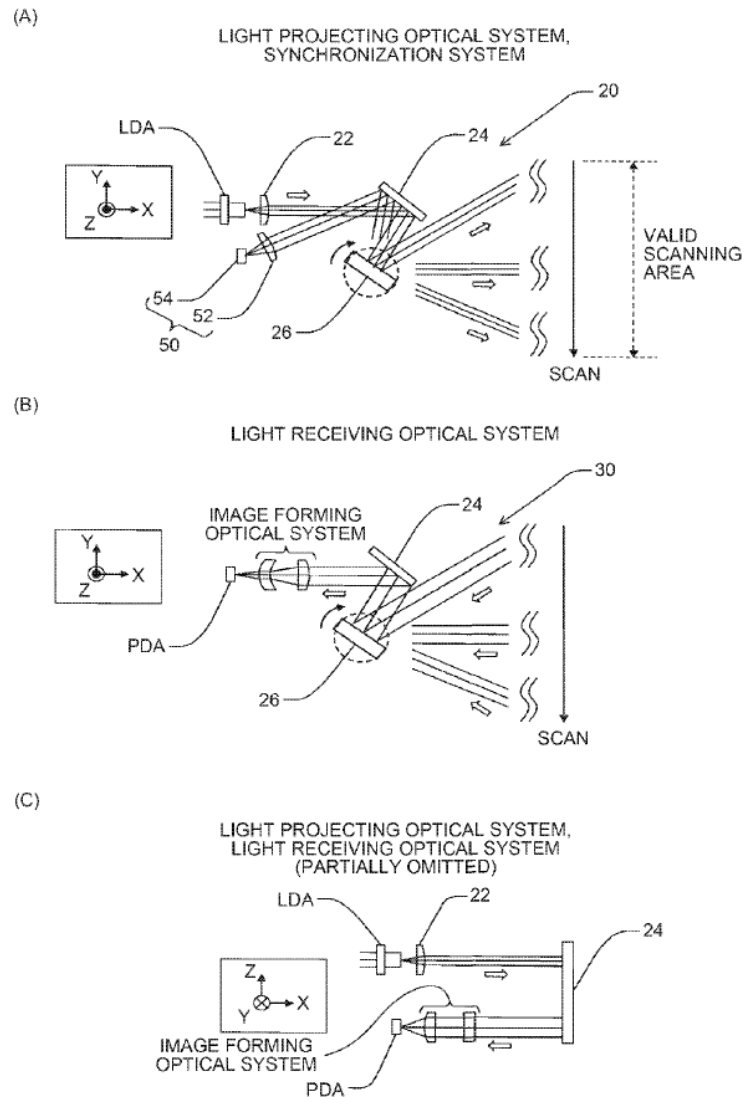
Imai's Figure 1 above shows a laser radar described as follows:

The laser radar 100 is provided with an LDA (laser diode array) including a plurality of LDs (laser diodes) as a light source, an LD driving device 12, a light projecting optical system 20, a light receiving optical system 30, a detection system 40, a synchronization system 50 and the like as illustrated in FIG. 1.

Id. ¶ 29.

Imai's Figures 2A, 2B, and 2C are reproduced below.

FIG.2



Imai's Figure 2A above depicts a light projection system and synchronization system; Figure 2B depicts a light receiving optical system; and Figure 2C depicts an optical path of light from an LDA to a reflecting mirror and from the reflecting mirror to a PDA. *Id.* ¶ 11. Imai discloses that

The light receiving optical system 30 includes the rotary mirror 26 which reflects the light projected from the light projecting optical system 20 to be reflected (scattered) by the object located

in the valid scanning area, the reflecting mirror 24 which reflects the light from the rotary mirror 26, and an image forming optical system arranged on the optical path of the light from the reflecting mirror 24 to form an image of the light on a PDA (photo diode array) as an optical detector.

Id. ¶ 37.

Furthermore, Imai discloses the following:

The laser radar 100 of this embodiment described above is provided with the LDA (light source) including a plurality of LDs (light emitting units) arranged in the Z-axis direction (direction corresponding to the sub-scanning direction), the rotary mirror 26 (deflector) which deflects the light from the LDA, and the PDA (optical detector) including a plurality of PDs (light receiving units) arranged in the direction corresponding to the sub-scanning direction so as to correspond to a plurality of LDs to receive the light deflected by the rotary mirror 26 to be reflected by the object.

Id. ¶ 85.

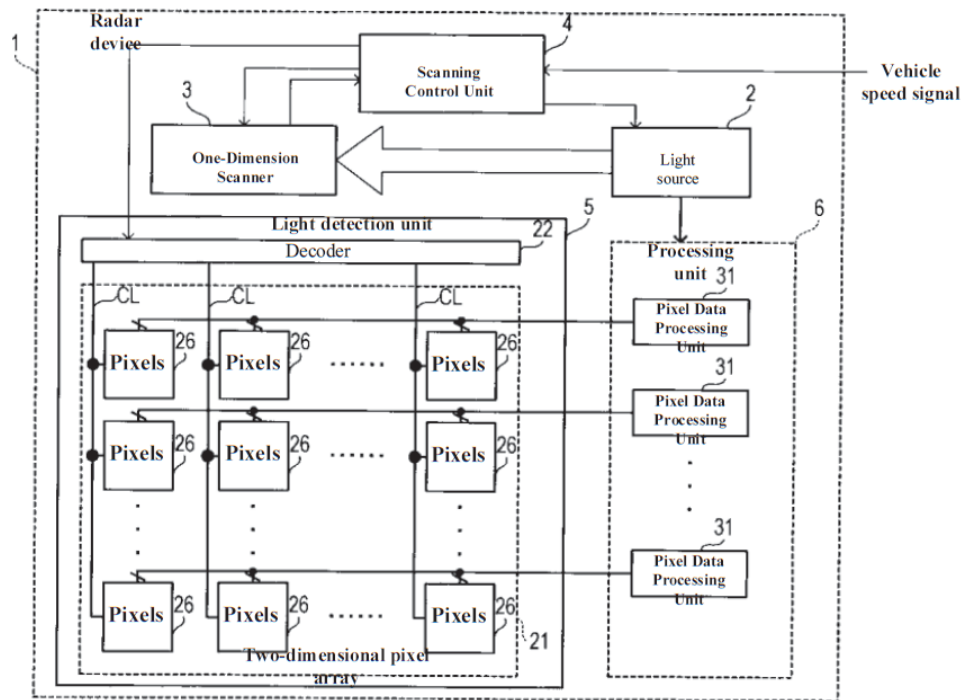
In addition, Imai discloses that a SPAD (single photon avalanche diode) may be used as a light receiving element due its higher sensitivity, detection accuracy, and detection distance compared to a PD (photo diode).

Id. ¶ 48.

b) Higashi (Ex. 1011)

Higashi discloses “a radar device that acquires information about an object that reflects light by irradiating light and receiving the reflected light.” Ex. 1011 ¶ 1.

Higashi's Figure 1 is reproduced below.



As shown in Figure 1 above, Higashi discloses that the “radar device 1 is mounted in a vehicle and comprises of a light source 2, a one-dimensional scanner 3, a scanning control unit 4, a light detection unit 5 and a processing unit 6.” *Id.* ¶ 15. Light source 2 is a semiconductor laser diode, and emits pulsed laser light as a radar wave. *Id.* ¶ 16. One-dimensional scanner 3 is driven to rotate by a drive source, and scans one-dimensional laser light over a predetermined angle range. *Id.* Scanning controller 4 controls light source 2 and one-dimensional scanner 3 according to scanning angle and vehicle speed. *Id.* ¶ 17.

Light detection unit 5 comprises a two-dimensional pixel array 21 and decoder 22. *Id.* ¶ 18. Pixel array 21 includes pixels 26 arranged in a two-dimensional matrix. *Id.* Each pixel outputs a detection signal when

receiving laser light. *Id.* Decoder 22 selects pixels 26 in columns by application a selective voltage control. *Id.*

Processing unit 6 measures the distance to the object that reflected the laser beam based on the difference between the time when the light source 2 irradiated the pulsed laser beam and the time when the reflected laser beam was detected by the light detection unit 5. *Id.* ¶ 20. Processing unit 6 includes pixel data processing units 31 for each row of pixels. *Id.* ¶ 21.

Higashi's Figure 4 is reproduced below.

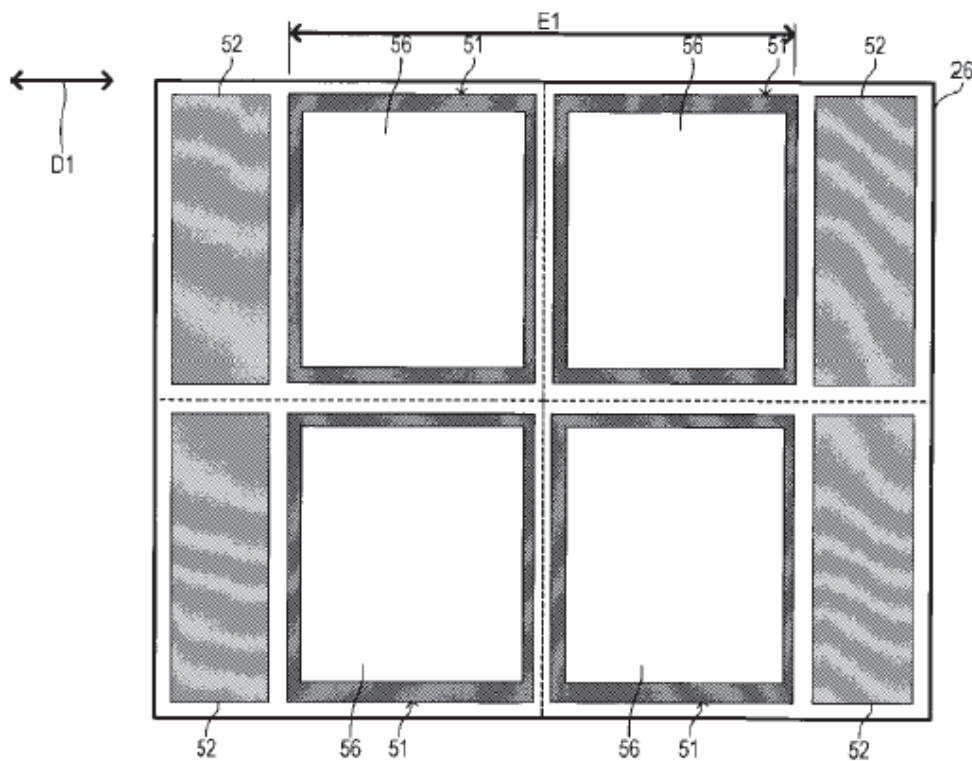


Figure 4 above shows that pixel 26 comprises four light receiving elements 51 which may each be “a single photon avalanche diode (SPAD) operating in Geiger mode, capable of detecting single photon incidence.” *Id.* ¶ 27.

c) *Grzesik (Ex. 1012)*

Grzesik is titled “Photodiode Placement for Cross Talk Suppression.” Ex. 1012, code (54). Grzesik discloses that “[e]lectronic avalanche photodiodes (APDs) operating in Geiger-mode (GM) can be employed to detect single infrared photon arrival with sub-nanosecond accuracy” and that “Geiger-mode avalanche photodiode arrays are important for a wide range of applications, including . . . three-dimensional laser radar (LADAR).” *Id.*

¶ 3. Grzesik seeks to reduce “optical cross talk” where avalanche photodiodes generate highly energetic charge carriers which may lose energy by emitting a spectrum of photons which are absorbed and detected by other photodiodes in the array. ¶ 6.

Grzesik's Figure 3 is reproduced below.

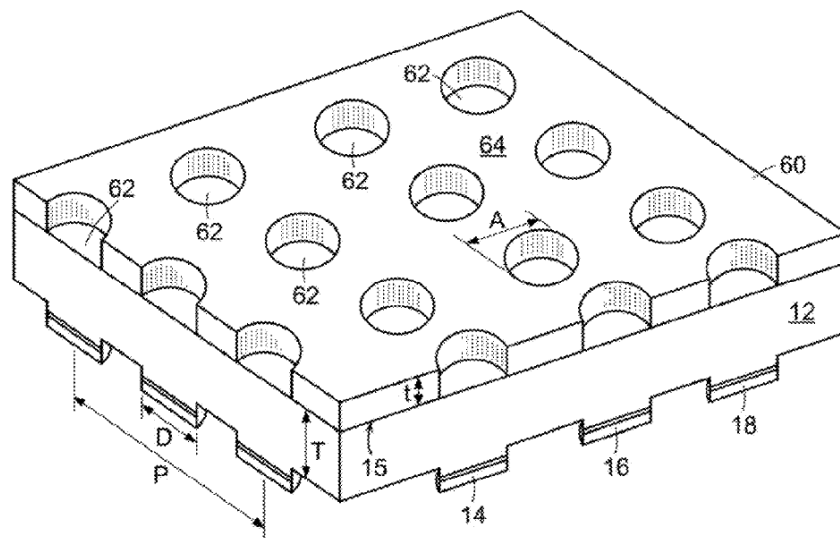


FIG. 3

Figure 3 above shows photodiode array with one or more cross talk absorption layers 60 with apertures 62 allowing input radiation to enter substrate 12 and reach photodiodes 14, 16, 18. *Id.* ¶ 33. Cross talk

absorption layer 60 includes surface regions 64 covered with absorption material. *Id.*

d) *Pacala*

Pacala is titled “Cost-Effective LIDAR Sensor for Multi-Signal Detection, Weak Signal Detection and Signal Disambiguation and Method of Using Same.” Ex. 1013, code (54). *Pacala* relates to “the use of cost-effective robust time-of-flight (ToF) lidar sensors for real-time wide-field-of-view three-dimensional mapping and object detection.” *Id.* ¶ 3. *Pacala* describes a “lidar-based apparatus” that is “used for multi-signal detection, weak signal detection and signal disambiguation.” *Id.* ¶ 10.

Figure 1 of *Pacala* is show below.

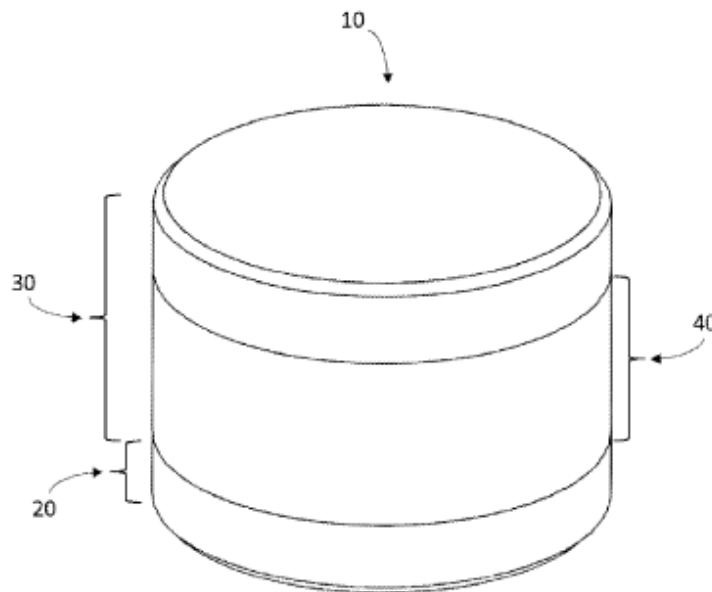


Fig. 1

Figure 1, above, is a schematic diagram of an external view of a lidar sensor. *Id.* ¶ 12. *Pacala*’s lidar sensor 10 contains static base 20, static head assembly 30, and window 40. *Id.*

Figure 2 of Pacala is shown below.

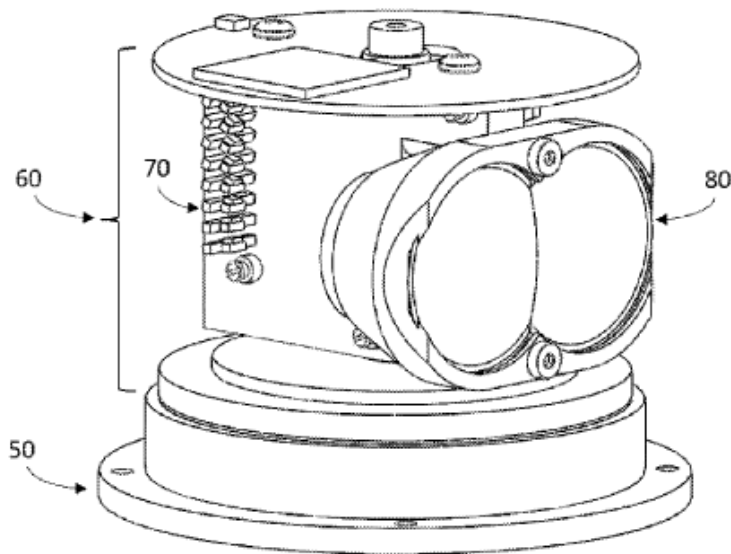


Fig. 2

Figure 2, above, is a schematic diagram of an internal view of a lidar sensor. *Id.* ¶ 13. Figure 2 of Pacala depicts a motor and “spinning turret 60 that contains optoelectronic components 70 (including optical transmitters and receivers).” *Id.* ¶ 13.

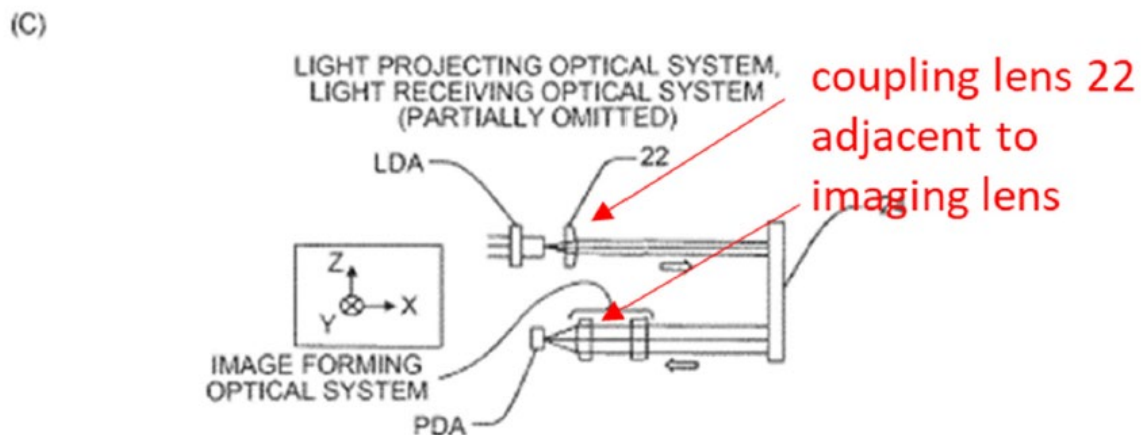
*2. Obviousness of Claims 1–3 and 10–16 over
Imai and Higashi*

a) Analysis of Independent Claims 1 and 14

In this section, we analyze Petitioner’s and Patent Owner’s contentions concerning disputed limitations of independent claims 1 and 14 below. We then address the undisputed limitations. Throughout, we use Petitioner’s identifiers to indicate the limitations under discussion. For the reasons that follow, we determine that claims 1 and 14 would have been obvious over the combination of Imai and Higashi.

(1) *Dispute Over “Adjacent To”*

Petitioner contends that the combination of Imai and Higashi discloses claim 1’s limitation 1(d) reciting “a bulk imaging optic disposed *adjacent to* the bulk transmitting optic.” Pet. 65–66; Pet. Reply 23–24. To explain its contention, Petitioner provides the following annotated version of Imai’s Figure 2C:



Pet. 66. Petitioner’s annotated version of Imai’s Figure 2 above shows in red that coupling lens 22 of the projection optical system 20 and imaging lens (unnumbered) on the light receiving optical system 30 are “adjacent to” each other along the “Z-axis” direction” similar to the ’381 patent’s embodiment. *Id.* at 65–66 (citing Ex. 1009 ¶¶ 38–39, 41, Fig. 2C; Ex. 1001, 11:11–13; Ex. 1003 ¶ 268; Ex. 1027 ¶¶ 19–22).

Patent Owner argues that “Petitioner’s expert testified that Figure 2C is nothing more than a ‘sketch’ from which ‘a lot’ is omitted” and therefore “Figure 2C does not indicate that any element is adjacent to any other element, because elements have been omitted.” PO Resp. 55 (citing Ex. 2010, 88:7–90:21; Ex. 2009 ¶¶ 213–216). As evidence for its assertion, Patent Owner points to Imai’s Figure 2C’s caption as “partially omitted” and alleges that Imai’s Figure 2A and 2B “do not show lenses in the receive and

transmit paths anywhere near each other.” *Id.* at 55–56 (citing Ex. 2009 ¶¶ 213–214). Patent Owner states that Petitioner’s declarant, Dr. Shanley, confirmed that Figure 2C is not an accurate representation of spatial relationships in the depicted system and is “just a sketch basically” and that “a lot” is omitted from Figure 2C. *Id.* at 57–58 (citing Ex. 2010, 89:7–90:21; Ex. 2009 ¶ 214).

We agree with Petitioner, however, that Imai discloses that its coupling lens 22 and imaging lens (unnumbered) are “adjacent to” each other in Imai’s Figure 2C, and thus satisfies claim 1’s limitation 1(d). Pet. 65–66; Pet. Reply 23–24; Ex. 1003 ¶ 268. That the figure may be regarded a “sketch” that omits certain elements does not diminish what it discloses nor how a POSITA would have understood it. Even if, as Patent Owner asserts, the exact spatial relationship between the lenses could not be ascertained from the figure, the fact that they are shown next to each other in the figure would have at least suggested the “adjacent to” limitation to a POSITA.

Furthermore, Dr. Shanley testifies that the “adjacent to” configuration was “conventional and commonly used in LiDAR systems.” Ex. 1003 ¶ 268 (citing Ex. 1005, Fig. 11b, 6:8–15; Ex. 1013, Fig. 2). Patent Owner does not dispute this statement.

Patent Owner argues that Petitioner raises untimely new arguments in its Reply “related to omitted elements and an ‘X-Z plane’ that it never previously discussed.” PO Sur-Reply 20–21 (citing Pet. Reply 23–24). However, Petitioner’s contentions had nexus and were responsive to Patent Owner’s assertion in its Response that Imai’s Figure 2C “partially omitted” elements such that it could not be determined whether the “coupling lens 22”

and imaging lens were “adjacent to” one another in Imai’s system. PO Resp. 54–59. Specifically, Petitioner’s Reply stated that Imai explains exactly what is “partially omitted” from Imai’s Figure 2C and that the lenses are shown “adjacent to” one another in the X-Z plane in the figure.

Pet. Reply 23 (citing Ex. 1009 ¶ 38). The Petition also expressly mentioned Imai’s Paragraph 38 which Petitioner asserts discloses what is “partially omitted” from Imai’s Figure 2C, and reproduced Imai’s Figure 2C showing the lenses “adjacent to” one another in the X-Z plane. Pet. 65–66. Hence, Petitioner’s Reply arguments properly expand on and are a fair extension of its Petition contentions. Under these circumstances, Petitioner’s Reply arguments are not improper new arguments. *See Rembrandt Diagnostics v. Alere, Inc.*, 76 F.4th 1376, 1385 (Fed. Cir. 2023).

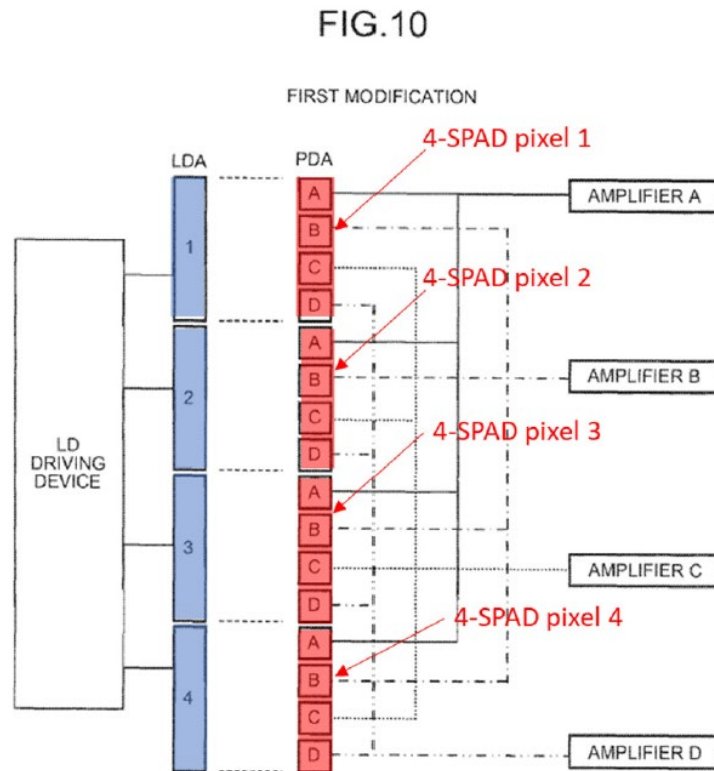
Accordingly, Petitioner shows by a preponderance of the evidence that Imai discloses the “adjacent to” language of claim 1’s limitation 1(d) notwithstanding Patent Owner’s arguments.

(2) *Dispute Over “Coincident With”*

Petitioner contends that the combination of Imai and Higashi discloses the part of claim 1’s limitation 1(e) reciting “electromagnetic radiation output from each emitter in the illumination pattern is ***coincident with*** a field of view of a corresponding pixel.” Pet. 66–70; Pet. Reply 21–22. Specifically, Petitioner contends that two different embodiments of Imai

shown in respective Figures 10³ and 11⁴ disclose the “coincident with” limitation.

Petitioner’s annotated version of Imai’s Figure 10 is shown below:



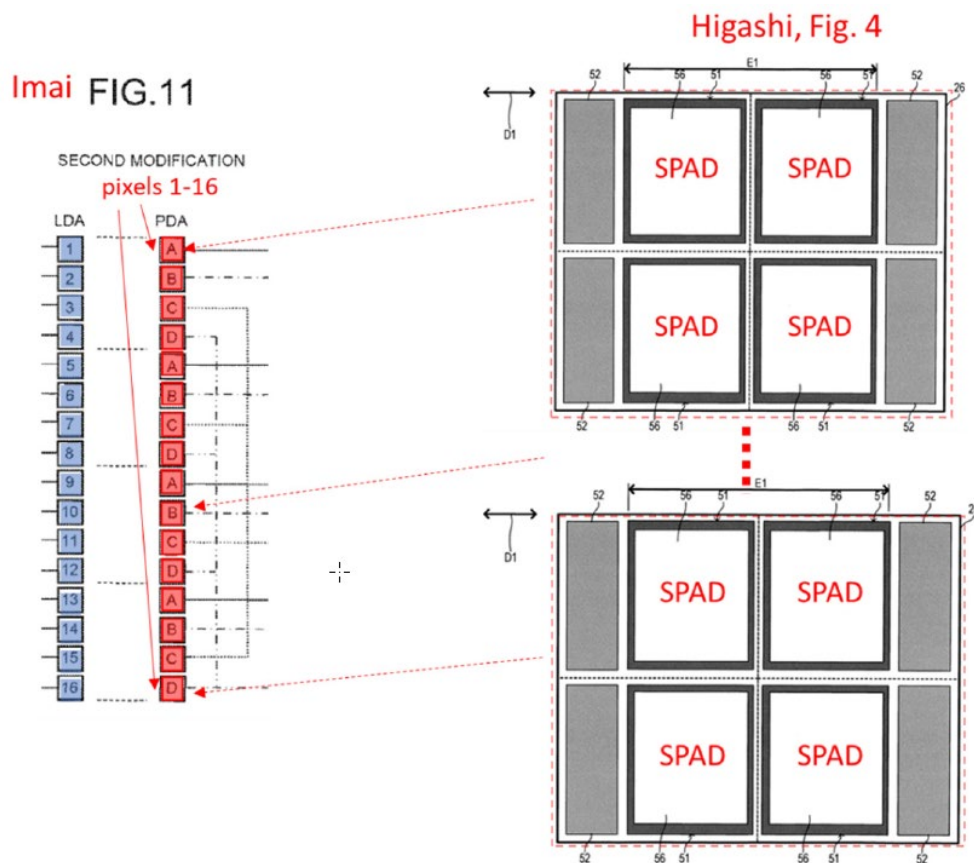
Pet. 66. Petitioner’s version of Imai’s Figure 10 above shows that Imai discloses four pixels, with each pixel including four SPADs. *Id.* at 66–67 (citing Ex. 1009 ¶¶ 37–41, 48, 61, 77, 96, 99–101, 109–112, Figs. 2B–2C, 4B, 10; Ex. 1027 ¶¶ 18–22, 41–42, 77–82; Ex. 1003 ¶¶ 271–273). Petitioner states that Imai discloses that the irradiation range of laser diode (LD) 1 (blue) corresponds to the light receivables ranges of four-SPAD photodiodes

³ Petitioner refers to the Figure 10 embodiment as the “first manner” that Imai accounts for this limitation.

⁴ The Figure 11 embodiment in combination with Higashi. Petitioner refers to this as the “second manner” that the combination accounts for this limitation.

(PDs) of pixel 1 (red), the irradiation range of laser diode (LD) 2 (blue) corresponds to the light receivables ranges of four-SPAD photodiodes (PDs) of pixel 2 (red), and so forth. Pet. 66–67 (citing Ex. 1009 ¶¶ 99–101; Ex. 1003 ¶ 273).

Imai's Figure 11 embodiment combined with Higashi's suggested improvement for using multiple SPADs at each detector pixel is similar to its Figure 10 embodiment. Pet. 68 (citing Ex. 1009, Fig. 11; Ex. 1011, Fig. 4; Ex. 1003 ¶ 274). Petitioner's illustration of the proposed combination using annotated figures from Imai and Higashi is reproduced below.



The annotated versions of Figure 11 of Imai and Figure 4 from Higashi are reproduced above showing four SPADs at each of Imai's pixels. Pet. 68.

Petitioner contends that “[e]ach pixel (pixels 1-16) has a field of view coincident with an emission region of a corresponding LD in the LDA (LD1 to LD16).” *Id.* (citing Ex. 1003 ¶ 275). Petitioner submits that “Imai explicitly states that, not only are ‘the number’ of LDs and that of PDs in FIG. 11 the same, but also that ‘the LDs and PDs *one-to-one correspond to each other.*” *Id.* at 68–69 (citing Ex. 1009 ¶ 125).

Petitioner argues that a POSITA would have been motivated to implement the 16 pixels to each have a field of view coincident with an emission region of a corresponding LD. *Id.* (citing Ex. 1009 ¶¶ 62–64, 67–70, Figs. 5, 7A–7B). Petitioner contends that “[a] POSITA would have been motivated to implement the LDs and the pixels 1-16 to achieve a one-to-one correspondence (such that each of pixels 1-16 was coincident with a corresponding one of the LDs) in order to provide a balanced tradeoff of detection time and detection distance.” *Id.* (citing Ex. 1009 ¶¶ 67-70; Ex. 1003 ¶¶ 274–276).

Patent Owner argues that the claimed limitation should be construed to mean that “the field of view of each pixel and the emission region of a corresponding [or paired] optical emitter cover substantially the same area in the field” and that “Imai only discloses emission regions that are significantly larger or smaller than the detection regions of the corresponding or paired detectors.” PO Resp. 51–54 (citing Ex. 2009 ¶¶ 192–201).

We have already explained that the ordinary and customary meaning of “coincident with” is “occupies the same portion of space as” and, as the term is used in the ’381 patent, does not require perfect coincidence and allows for the illumination source’s “discrete spot” to be “substantially

identical or slightly greater than” the corresponding aperture’s field of view. *See* § III.C.1. Under this construction, the ’381 patent’s “slightly greater” illumination spot is indistinguishable from Imai’s disclosure that the laser diodes’ irradiation ranges are “slightly larger” than the receiving ranges of the corresponding SPAD photodiodes relative to their corresponding apertures’ fields of view.

Accordingly, we do not adopt Patent Owner’s construction of “coincident with.” But even if we did, we would determine that there is no material difference between the ’381 patent’s discrete spot of illumination “covering substantially the same area” as an aperture’s field of view, as compared to Imai’s laser diode having “slightly larger” illumination pattern than its corresponding SPAD photodiode’s “receiving range.” Furthermore, even if there was a difference between Patent Owner’s “substantially the same area” and Imai’s “slightly larger,” we would consider “coincident with” to have been obvious to a POSITA in light of Imai’s “slightly larger” disclosure. *See* Ex. 1040 ¶¶ 53–54.

Patent Owner criticizes Petitioner’s alleged position that “*any* overlap between emission and detection regions is sufficient.” *Id.* at 52. We find no such statement by Petitioner in the briefs, so we will not consider this argument further.

Patent Owner asserts that “Imai makes clear that using irradiation regions that are significantly *larger* than receiving ranges for its system is important to the proper functioning of its system.” *Id.* at 52–53 (citing Ex. 2009 ¶ 223). Imai, however, states “*slightly* larger”—not “*significantly* larger”—contrary to Patent Owner’s assertion. Ex. 1009 ¶ 101. As explained, the ’381 patent makes clear that “coincident with” does not

require perfect alignment of the illuminated discrete spot and the aperture's field of view, and we agree with Petitioner that "[t]here is no meaningful distinction between the area described by Imai and the '381 [p]atent." Pet. Reply 22 (citing Pet. 66–70; Ex. 1009 ¶¶ 99–101; Ex. 1040 ¶ 54).

Accordingly, Petitioner shows by a preponderance of the evidence that Imai discloses the “coincident with” language of claim 1’s and 14’s limitations 1(e) and 14(e) notwithstanding Patent Owner’s arguments.

(3) Preamble – Optical System for collecting distance information (1(a)/14(a))

The preamble limitation 1(a) of claim 1 recites “An optical imaging system, comprising.” Ex. 1001, 16:61–62. Claim 14 contains a similar recitation. *Id.* at 18:8–9.

Petitioner contends that Imai discloses the preamble because “Imai describes a ‘scanning laser radar’ for ‘emitting light and detecting a distance to the object by ... receiving reflected light (scattered light) from the object.’” Pet. 63–64 (citing Ex. 1009 ¶¶ 27, 29–30, 32–47, 51–54, 86, 101, 115; Ex. 1011 ¶ 15, Fig. 1; Ex. 1027 ¶¶ 17, 28, 53, 41–48, Figs. 4A, 5, 7; Ex. 1003 ¶¶ 260–261).

Patent Owner does not dispute Petitioner’s contentions regarding preamble limitations 1(a) and 14(a).

After reviewing the evidence, we find that Petitioner has shown by a preponderance of the evidence that Imai discloses a scanning laser radar that is an “optical imaging system” as recited in preamble limitation 1(a) (and 14(a)). For example, Imai’s laser radar includes an “image forming optical system.” Ex. 1009 ¶ 37. Therefore, we need not, and do not, decide whether the preamble is limiting. *See, e.g., Catalina Mktg. Int’l v.*

Coolsavings.com, Inc., 289 F.3d 801, 808 (Fed. Cir. 2002).

(4) *Bulk Transmitting Optic (1(b)/14(b))*

Claim 1’s limitation 1(b) recites “a bulk transmitting optic.”

Ex. 1001, 16:63. Claim 14 contains a similar limitation. *Id.* at 18:10.

Petitioner contends that Imai discloses a “coupling lens 22” which discloses the claimed “bulk transmitting optic” and an “imaging lens” (unnumbered) which discloses the claimed “bulk imaging optic.” Pet. 63 (citing Ex. 1009 ¶¶ 32–34, Figs. 2A (annotated); Ex. 1003 ¶¶ 262, 263; Ex. 1027 ¶¶ 13–15).

Patent Owner does not dispute that Imai discloses the claimed “bulk transmitting optic.”

Consequently, we determine that Petitioner has shown by a preponderance of the evidence that Imai discloses limitations 1(b) and 14(b).

(5) *Optical Emitters (1(c)/14(c))*

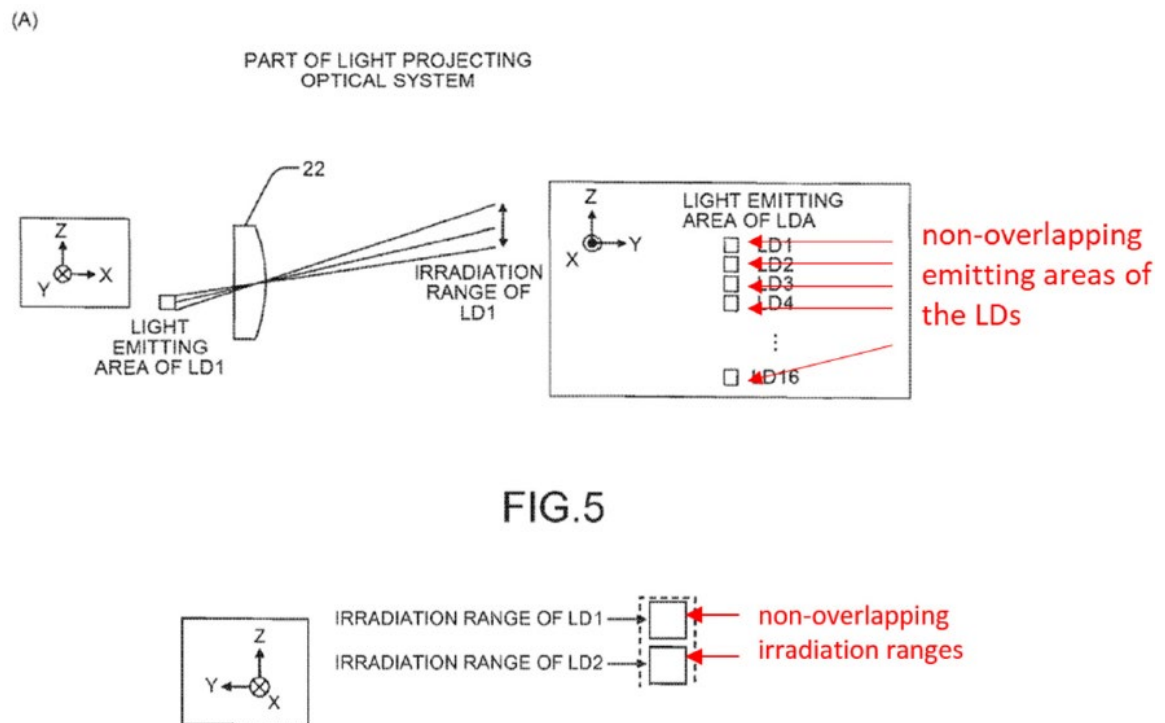
Claim 1’s limitation 1(c) recites

a plurality of optical emitters arranged behind the bulk transmitting optic and configured to output electromagnetic radiation of an operating wavelength through the bulk transmitting optic into a field external to the optical system according to an illumination pattern that comprises a plurality of non-overlapping emission regions.

Ex. 1001, 16:64–17:3.

Petitioner contends that Imai discloses “a plurality of optical emitters arranged behind the bulk transmitting optic” as recited in limitation 1(c). Pet. 64 (citing Ex. 1009 ¶¶ 29, 32–34, 36, 47, 60, 66–83, 85, Figs. 2A, 4A, 5–6, 7A, 7B; Ex. 1003 ¶ 265). We agree with Petitioner’s contention, which Patent Owner does not dispute.

Petitioner further contends that Imai discloses “configured to output electromagnetic radiation of an operating wavelength through the bulk transmitting optic into a field external to the optical system according to an illumination pattern that comprises a plurality of non-overlapping emission regions.” Pet. 64–65 (citing Ex. 1009 ¶¶ 29, 60, Figs. 5 (nonoverlapping irradiation ranges of each LD in the LDA), 7A, 8, 10, 11, 13, 14; Ex. 1003 ¶ 266; Ex. 1027 ¶¶ 13–20, 28, 29, 41–48, 53, 66). Petitioner illustrates this in these annotated versions of Figure 4A and a portion of Figure 5.



Annotated versions of Figure 4A and a portion of Figure 5 of Imai showing the non-overlapping emitting areas of the laser diodes (“LDs”). Pet. 65 (citing Ex. 1003 ¶ 266).

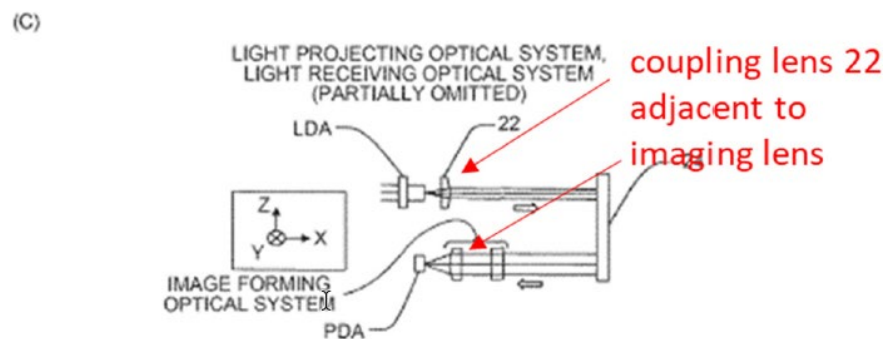
Patent Owner does not dispute that Imai accounts for this portion of limitations 1(c) and 14(c). We agree with Petitioner that Imai discloses this part of limitations 1(c) and 14(c).

Accordingly, Petitioner shows by a preponderance of the evidence that Imai discloses claim 1's limitation 1(c) and claim 14's limitation 14(c).

(6) *Bulk Imaging Optic (1(d)/14(d))*

Claim 1's limitation 1(d) recites "a bulk imaging optic disposed adjacent to the bulk transmitting optic." Ex. 1001, 17:4–5. Claim 14 recites only that there is a "bulk imaging optic." *Id.* at 18:17.

To show that Imai discloses this limitation, Petitioner provides the following annotated version of Imai's Figure 2C:



Pet. 66. In Imai's Figure 2C above, Petitioner indicates in red an imaging lens (unnumbered) which it considers to be equivalent to the claimed "bulk imaging optic" and coupling lens 22, which it considers to be the "bulk transmitting optic." *Id.* at 65–66 (citing Ex. 1009, ¶¶ 38–39; Ex. 1027 ¶¶ 19–22; Ex. 1003 ¶ 268). As discussed above, Petitioner contends that the two lenses are "adjacent to each other along the 'Z-axis' direction." *Id.* at 65.

Patent Owner does not dispute Petitioner's contentions concerning the disclosure of a "bulk imaging optic," but does dispute, as discussed above whether the "bulk imaging optic" is "adjacent to" the "bulk transmitting optic" as recited in claim 1. *See* PO Resp. 54–59.

Reviewing the evidence and in view of the discussion of "adjacent to"

above, we find that Petitioner has shown by a preponderance of the evidence that Imai discloses the “bulk imaging optic adjacent to” of claim 1’s limitation 1(d) and the “bulk imaging optic” of claim 14’s limitation 14(d).

(7) *Plurality of Pixels (1(e)/14(e))*

Claim 1’s limitation 1(e) recites

a plurality of pixels arranged behind the bulk imaging optic, wherein each pixel in the plurality of pixels has *a field of view coincident with an emission region of a corresponding optical emitter* in the plurality of optical emitters and each pixel comprises a plurality of single photon avalanche diodes (SPADs) operable to detect photons emitted from its corresponding optical emitter and received through the bulk imaging optic after being reflected from surfaces within the field.

Ex. 1001, 17:6–14 (emphasis added). Claim 14 recites a similar limitation. *Id.* at 18:18–28.

Petitioner contends that Imai discloses “a plurality of pixels arranged behind the bulk imaging optic” as recited in limitation 1(e) (and limitation 14(e)). Pet. 66–67 (citing Ex. 1009 ¶¶ 37–41, 61, 96–99, Fig. 10; Ex. 1003 ¶ 271). In particular, Petitioner argues that Imai teaches that each photo diode (PD) can be in the form of “a SPAD” (Ex. 1009 ¶ 48), and Imai’s embodiment shown in FIG. 10 “plainly depicts that each detector pixel includes four such PD elements: Pixel 1 (PD1-PD4), Pixel 2 (PD5-PD8), Pixel 3 (PD9-PD12), and Pixel 4 (PD13-PD16).” *Id.* at 66. Petitioner submits that “[t]he four pixels (including all of the detector elements PD1-PD16 in the array (PDA)) are arranged behind the lens of the image forming system.” *Id.* at 67 (citing Ex. 1009 ¶¶ 37–41, 61, Figs. 4B, 2B–C). We agree with Petitioner’s contention, which Patent Owner does not dispute.

Petitioner correctly contends that Imai alone and in combination with Higashi discloses the remainder of limitation 1(e)—the “coincident with” requirement discussed above—notwithstanding Patent Owner’s arguments. Pet. 67 (citing Ex. 1009 ¶¶ 29, 32–34, 36–41, 47, 60–61, 62–64, 66–83, 85, 99–101, 109–112, 125, Figs. 2A–2C (annotated), 4A–4B, 5–6, 7A–7B, 10, 11; Ex. 1027 ¶¶ 13–20, 28–29, 41–48, 53, 66; Ex. 1003 ¶¶ 272–277). Specifically, Petitioner contends that Imai’s laser diodes are emitters arranged behind coupling lens 22 to project light (electromagnetic radiation) through coupling lens 22 into a field external to the optical system. *Id.* at 64–67. Petitioner contends that Imai teaches that electromagnetic radiation output from each emitter in the illumination pattern is coincident with a field of view of a corresponding pixel in two manners. *Id.* at 66–70. The first manner is Imai’s Figure 10 embodiment wherein radiation ranges of laser diodes LD1–LD4 correspond to light receivable ranges pixels of groups of four SPAD photodiodes PD1–PD4, PD5–PD8, PD9–PD12, and PD13–PD16 (PDs), respectively. *Id.* at 66–67. The second manner is Imai’s Figure 11 embodiment in which the irradiation ranges of the laser diodes coincide with the light receivable ranges of the SPAD photodiodes with a one-to-one correspondence when combined with Higashi’s teachings of using multiple SPADs at each detector pixel. *Id.* at 68–70.

As we explained in detail above, we find that Petitioner has shown by a preponderance of the evidence that both Imai and Imai and Higashi account for “coincident with” and remaining requirements of limitations 1(e) and 14(e).

Accordingly, after reviewing the evidence, we find that Petitioner has shown by a preponderance of the evidence that Imai and Higashi disclose claim 1's limitation 1(e) and claim 14's limitation 14(e).

(8) *Optical Filter (1(f)/14(f))*

Claim 1's limitation 1(f) recites

an optical filter disposed in an optical path of the plurality of pixels, the optical filter configured to allow a set of wavelengths of electromagnetic radiation, including the operating wavelength, to pass through the optical filter while blocking electromagnetic radiation outside the set of wavelengths from reaching the plurality of pixels.

Ex. 1001, 17:15–21. Claim 14 recites a similar limitation. *Id.* at 18:29–35.

Petitioner asserts that the combination of Imai and Higashi accounts for this limitation. Pet. 70 (citing Ex. 1003 ¶¶ 278–279; Ex. 1011 ¶ 86; Ex. 1003 ¶ 279). Petitioner asserts that “Higashi’s suggested bandpass filter would predictably operate as an optical filter disposed in an optical path of the pixels of the Imai-Higashi combination to effectuate its purpose of allowing a set of wavelengths of electromagnetic radiation, including the operating wavelength, to pass through while blocking electromagnetic radiation outside the set of wavelengths from reaching the pixels.” *Id.* We agree with Petitioner that the combination of Imai and Higashi discloses limitations 1(f) and 14(f).

Patent Owner does not dispute Petitioner’s contentions regarding limitations 1(f) and 14(f).

Accordingly, after review of the evidence, we determine that Petitioner has shown by a preponderance of the evidence that the combination of Imai and Higashi teaches or suggests limitations 1(f) and 14(f).

(9) *Claim 14 “wherein” clause (14(g))*

The “wherein” clause of claim 14 (limitation 14(g)) recites:

wherein, the optical system is configured to collect distance data based on times between transmission of beams of electromagnetic radiation from the plurality of optical emitters and detection of photons from the beams by the plurality of pixels.

Ex. 1001, 18:36–40.

Petitioner contends that Imai teaches “‘a scanning laser radar . . . for detecting whether there is an object . . . by emitting light and detecting a distance to the object and . . . by receiving reflected light (scattered light) from the object,’ providing three-dimensional distance data.” Pet. 70–71 (citing Ex. 1009 ¶¶ 27, 40, 48, 51–54, 78–81; Ex. 1011 ¶ 20; Ex. 1003 ¶¶ 280–281; Ex. 1027 ¶¶ 9, 21, 29).

Patent Owner does not contest Petitioner’s contentions regarding this limitation.

We have reviewed Petitioner’s contentions and evidence and find that Petitioner has shown by a preponderance of the evidence that the combination of Imai and Higashi teaches or suggests this limitation.

(10) *Motivation to Combine and Reasonable Expectation of Success*

Petitioner contends that a POSITA would have been motivated to implement the teachings of Higashi in Imai’s system in at least two ways. Pet. 58–62. First, a POSITA would have been “prompted to utilize a bandpass ‘filter’ (as suggested by Higashi) in Imai’s system,” where “[i]n the resulting combination, the received light along the optical path of the pixels would pass through the bandpass filter to advantageously pass through the operational wavelength of the laser light and filter out other

interference.” *Id.* at 59 (citing Ex. 1003 ¶¶ 253–55). Second, Petitioner contends that, to the extent Imai did not disclose multiple SPAD cells for each detector pixel, a POSITA would have been prompted to implement Higashi’s conventional multi-SPAD pixel to achieve a number of known advantages. *Id.* (citing Ex. 1003 ¶ 255)

Petitioner identifies multiple reasons to make this combination. First, with respect to Higashi’s bandpass filter, Petitioner argues that “a POSITA would have been prompted to implement Imai’s system to include a bandpass filter for the received light (as suggested by Higashi) so as to advantageously pass through only light of the operational wavelength of the corresponding laser emitter and ‘eliminate the effect of background light.’” *Id.* at 60 (citing Ex. 1011 ¶ 86; Ex. 1003 ¶ 256). Petitioner contends that “the resulting combination would advantageously filter out interfering light sources along the optical path of each of the detector pixels, thereby improving accuracy, improving the signal-to-noise ratio, and reducing the likelihood of false detections at the detector pixel.” *Id.* at 61.

Second, Petitioner argues that “a POSITA would have been motivated to arrange multiple SPADs in each of Imai’s detector pixels (e.g., pixels 1–16 in Imai’s FIG. 11) so that “erroneous detection of pixels[] can be reduced” and improved accuracy is achieved.” *Id.* (citing Ex. 1011 ¶ 71–72; Ex. 1003 ¶ 257; Ex. 1009 ¶ 48).

Third, Petitioner contends that using Higashi’s multi-SPADs in Imai’s detector pixels would have led to uninterrupted performance when an individual diode is quenched, and would have furthered Imai’s objective of “inhibiting the increase of detection obtaining time” because multi-SPADs facilitate high speed data processing as they can take turns to receive the

incoming photons. *Id.* (Ex. 1009 ¶¶ 6–7; Ex. 1011 ¶¶ 71, 72; Ex. 1027 ¶¶ 3–4; Ex. 1003 ¶ 258).

Fourth, Petitioner asserts that the combination “was simply the application of known techniques (e.g., use of multi-SPAD pixels and bandpass filters in a LiDAR system) to a known system (Imai’s LiDAR system that utilized SPAD detectors) ready for improvement to yield predictable results (benefits articulated above).” Pet. 62 (citing *KSR*, 550 U.S. at 417). Petitioner contends

Given the predictable and analogous nature of these two LiDAR references, a POSITA would have had a reasonable expectation of success in making the proposed combination, especially where: (1) both Imai and Higashi contemplate multiple subpixel elements for each detector pixel, (2) Higashi provided the added detail of a readout circuit for each multi-SPAD pixel, and (3) Higashi describes the performance benefits of a bandpass filter.

Id. (citing Ex. 1011 ¶¶ 31–40, 86; Ex. 1003 ¶ 259). Petitioner further asserts that “implementing bandpass filters and multi-SPAD detector pixels was commonly suggested for a variety of LiDAR systems at the time; it was ubiquitous.” *Id.* (citing Ex. 1006, code (57), ¶¶ 3, 14, 154; Ex. 1029 ¶ 62; Ex. 1003 ¶ 259).

Patent Owner does not dispute Petitioner’s contentions concerning the motivation to combine Imai and Higashi, or the reasonable expectation of success a POSITA would have had in making the combination.

Petitioner shows by a preponderance of the evidence that a POSITA would have been motivated to combine Imai and Higashi with a reasonable expectation of success.

b) Secondary Considerations

Patent Owner contends that “there was significant industry skepticism of the use of SPADs in LIDAR systems prior to the ’381 patent.”

PO Resp. 61 (citing Ex. 2009 ¶¶ 245–51). Specifically, Patent Owner contends that Petitioner’s expert, Dr. Shanley, considered using SPADs in LIDAR systems he worked on but chose instead to use photodiodes instead of SPADs⁵ due to size requirements, power requirements, complexity, cost, lack of ease of use, lack of reliability, and lack of availability. *Id.* at 61–62 (citing Ex. 2015, 122:15–126:18; Ex. 2015, 12:18–22, 14:13–15:4, 16:20–17:1, 18:10–15). Patent Owner further asserts that Dr. Shanley testified that his own team never used SPADs and that he was not aware of any system that used SPADs before the priority date of the ’381 patent. *Id.* at 62–63 (citing Ex. 2009 ¶¶ 245–251; Ex. 2015, 79:2–80:16).

Patent Owner also argues there was a “failure of others” to develop arrays of SPADs for use in LIDAR systems. PO Resp. 63–64. Specifically, Patent Owner asserts that Sergey L. Vinogradov discussed repeated failure of researchers to develop practical SPAD arrays due to various issues such as low fill factor, high dark count rate in backside illuminated SPAD technology, and expense and inflexible scaling in Digital Silicon Photomultiplier (dSiPM) technology. *Id.* at 63–64 (citing Ex. 2009 ¶¶ 252–254; Ex. 2014, 3–4).

Petitioner asserts that Patent Owner did not demonstrate “nexus” between any unique features of the challenged claims and the purported

⁵ Technically, a SPAD is a species of photodiode. *See, e.g.*, Ex. 1003 ¶ 51. We understand Patent Owner to be arguing that Dr. Shanley elected to use a photodiode that was not a SPAD in his 2008 project.

“skepticism” to use SPADs in LIDAR systems, and never asserted that the claimed element was novel. Pet. Reply 25–28 (citing *Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR 2018-00129, Paper 33, 34–35 (PTAB Jan. 24, 2020) (precedential) (“must be a nexus to some aspect of the claim not already in the prior art”); *In re Kao*, 639 F.3d 1057, 1068–1069 (Fed. Cir. 2011); Ex. 1040 ¶ 68).

Petitioner also argues that Patent Owner ignores the widespread teaching of SPADs in LiDAR systems at the relevant time. Pet. Reply 26–27. Petitioner asserts that Imai and Higashi (as well as Borowski) disclose using SPADs in LiDAR systems to achieve known benefits before the ’381 patent’s priority date. *Id.* at 26 (citing Pet. 7, 12–18, 57–62; Ex. 1003 ¶¶ 51–62). Petitioner contends that, by 2015, SPADs were “embraced by the industry as some of the best photodetectors to use in LiDAR system, depending on the needs of the design.” *Id.* at 25–26 (citing Ex. 1003 ¶¶ 51–62, 89–95, 112, 118–122; Ex. 1040 ¶¶ 69–71).

Petitioner further alleges that various publications stated that SPADs were the most suitable photodetectors for single-photon timing LIDAR applications (*id.* at 27 (citing Ex. 1045, 2–5)); that combining a SPAD array with an optical scanning system improves performance (*id.* (citing Ex. 1046, 1–11)); and that SPADs “are the best candidates” for LiDAR system (*id.* (citing Ex. 1047, 1–8)). Petitioner contends that these publications demonstrate that “SPADs were often a preferred option in LiDAR systems” and that the recited SPAD claim element in the ’381 patent was not novel in 2015. *Id.* at 27–28 (citing *Kao*, 639 F.3d at 1068–1069).

In its Sur-Reply responding to Petitioner’s contentions, Patent Owner argues that Petitioner did not identify the claim element that allegedly lacks

nexus. PO Sur-Reply 23. Patent Owner further argues that while an isolated feature may be present in the prior art, this does not render irrelevant objective evidence of that feature in the claimed combination. *Id.* (citing *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1330–1331 (Fed. Cir. 2016)).

Patent Owner reasserts, in response to Petitioner’s contention that SPADs in LIDAR systems were ubiquitous or well-known, that Dr. Shanley testified he was unaware of any commercial or noncommercial LIDAR devices that used SPADs prior to the ’381 patent. PO Sur-Reply 23–24 (citing Ex. 2015, 23:20–22, 79:2–80:13). Patent Owner argues that this evidence indicates that SPADs in LIDAR systems were not obvious to a POSITA in 2017. *Id.* at 24.

“For objective evidence of secondary considerations to be relevant, there must be a nexus between the claimed invention and the objective evidence.” *Volvo Penta of the Americas, LLC v. Brunswick Corp.*, 81 F.4th 1202, 1211 (Fed. Cir. 2023) (citing *In re GPAC*, 57 F.3d 1573, 1580 (Fed. Cir. 1995)). As Patent Owner did not assert nor demonstrate that a presumption of nexus applies in this case due to claimed invention being coextensive with a commercial product, to succeed in its assertion, Patent Owner must demonstrate that the evidence is a direct result of the unique characteristics of the claimed invention. *Id.*

However, Patent Owner has not established that the claimed invention has unique characteristics to which the evidence of secondary considerations would be applicable. *See* §§ III.D.2.a. Accordingly, Patent Owner’s evidence of secondary considerations does not demonstrate nonobviousness. *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1246 (Fed. Cir. 2010) (citing *KSR*, 550 U.S. at 417 (“[W]here the inventions represented no more than

‘the predictable use of prior art elements according to their established functions,’ the secondary considerations are inadequate to establish obviousness as a matter of law’’)).⁶

Patent Owner’s alleged evidence of industry skepticism relies on Dr. Shanley’s testimony concerning the reasons that he decided not to use SPADs in a project that he worked on in 2008. PO Resp. 61–62 (citing Ex. 2015, 122:15–126:18; Ex. 2015, 12:18–22, 14:10–15:4, 16:20–17:12, 18:10–15). Dr. Shanley’s decision not to use SPADs in the 2008 project, however, does not reflect how an entire industry viewed the use of SPADs in LIDAR devices before the ’381 patent’s priority date. Furthermore, Dr. Shanley testified that, by 2015, SPADs were used in LIDAR system because of the known benefits they provided. Ex. 1040 ¶ 67 (citing Ex. 1003 ¶¶ 51–62, 89–95, 112, 118–122). Hence, even if there was industry skepticism in 2008, Dr. Shanley’s testimony establishes that that skepticism had dissipated by 2015. *Id.*

⁶ Furthermore, Patent Owner alleged in its Response that the use of SPADs in LIDAR devices was the unique characteristic of the ’381 patent’s claims. PO Resp. 62–64. In its Sur-Reply, however, Patent Owner seemed to shift its position by asserting that the combination of claimed features was the unique characteristic of the invention. PO Sur-Reply 23.

Whether SPADs in LIDAR devices or a combination involving them is what Patent Owner asserts to be the unique characteristic, claim 1’s preamble recites an “optical system for collecting distance information” (Ex. 1001, 16:61–62) not a “LIDAR device” and this term appears nowhere in any of the challenged claims. Also, Patent Owner did not allege that the preamble was limiting. Consequently, Patent Owner’s assertion of secondary conditions is unavailing for lack of nexus between what Patent Owner asserts to be the unique characteristic and the alleged evidence of secondary considerations.

Moreover, Dr. Shanley pointed to several patents and papers that proposed use of SPADs in LIDAR applications before the '381 patent's priority date, including Borowski (Ex. 1006), Imai (Ex. 1009), Higashi (Ex. 1011), Droz (Ex. 1036), Marino (Ex. 1019), and Matsubara (Ex. 1023). Ex. 1003 ¶¶ 37 (Droz), 51 (Matsubara), 88–96 (Borowski), 108–116 (Imai), 117–122 (Higashi), 139 (Marino); Ex. 1045, 2–5; Ex. 1046, 7–12; Ex. 1047, 1–8. Ex. 1040 ¶¶ 66–68 (citing Pet. 7, 12–18, 57–62; Ex. 1003 ¶¶ 51–62, 89–95, 112, 118–122).

Patent Owner's evidence of failure of others depends largely on the Vinogradov paper. PO Resp. 63–64 (citing Ex. 2014, 3–4). We agree with Petitioner that Vinogradov's failure by 2015 to achieve a commercial product does not mean that no others disclosed the solution of how to do so, as the patents and papers identified above demonstrate. Ex. 1040 ¶ 69. Even if we considered the Vinogradov paper to be evidence of a failure to achieve the claimed invention, this failure is outweighed by the many successes represented by the patents and papers that Petitioner identifies.

Accordingly, we find Patent Owner's evidence of skepticism and failure of others to be unavailing in attempting to establish nonobviousness of the claimed invention.

c) Conclusion for Independent Claims 1 and 14

Petitioner has shown by a preponderance of the evidence that a POSITA would have been motivated to combine Imai and Higashi with a reasonable expectation of success in arriving at claims 1 and 14, and that each limitation of claims 1 and 14 is disclosed, or at least suggested, by the combination. We further determine that Patent Owner's evidence of secondary considerations is unavailing. Accordingly, Petitioner has shown

by a preponderance of the evidence that claims 1 and 14 would have been obvious over the combination of Imai and Higashi.

d) Analysis of Claim 3

Claim 3 depends from claim 1 and recites

wherein the plurality of optical emitters are arranged in a first arrangement and the plurality of pixels are arranged in a second arrangement, proportional to the first arrangement.

Ex. 1001, 17:28–31.

Petitioner contends that the combination of Imai and Higashi discloses claim 3 by providing a plurality of optical emitter in a first arrangement and a plurality of pixels in a second arrangement that is proportional to the first arrangement. Pet. 71. Specifically, Petitioner contends that Imai demonstrates its optical emitters (e.g., LDs) are arranged in a first arrangement and its pixels (e.g., PDs) are arranged in a second arrangement, proportional to the first arrangement. *Id.* Petitioner argues that Imai, for example, provides 4 LDs in a first arrangement and 4 pixels (each including 4 SPADs) in a second arrangement proportional to the first arrangement. *Id.* (citing Ex. 1009, Fig. 10). Petitioner also argues that the combination of Imai and Higashi, in the modification of Figure 11 discussed above, provide 16 LDs in a first arrangement and 16 pixels (each including 4 SPADs) in a second arrangement, proportional to the first arrangement. *Id.*

Patent Owner argues that Petitioner merely shows that Imai teaches using the same number of emitters and detectors, but that “having the same *number* of emitters and detectors does not indicate that the arrangement of emitters and detectors are proportional.” PO Resp. 59–60. Patent Owner argues that Petitioner has failed to show that claim 3 is unpatentable because they rely solely on correspondence between the number of emitters and

detectors without showing that the arrangement of emitters and detectors is “proportional.” *Id.* at 60 (citing Ex. 2009 ¶¶ 229–231).

As we explained above, we do not agree with Patent Owner’s implicit claim construction. We find that Petitioner has shown by a preponderance of the evidence Imai alone and Imai in combination with Higashi teaches the limitations of claim 3. *See* Pet. 71; Ex. 1003 ¶¶ 282–283. We further agree with Petitioner that, even applying Patent Owner’s narrower construction, that Imai describes and illustrates configurations in which the LDs and pixels exhibit the same spatial arrangement, as illustrated in Figure 11, which Petitioner relies on for its “second manner” of accounting for limitation 1(e) (in combination with Higashi) discussed above.⁷ *See* Pet. Reply 24–25 (citing Ex. 1009, Fig. 11; Ex. 1040 ¶¶ 62, 63).

After reviewing the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 3 would have been obvious over the combination of Imai and Higashi.

e) Claims 2, 10–13, 15, and 16

Claims 2, 10, 12, and 13 depend from claim 1. Claim 11 depends from claim 10. Claims 15 and 16 depend from claim 14. Petitioner provides a detailed mapping of how the combination of Imai and Higashi accounts for the limitations of claims 2, 10–13, 15, and 16. Pet. 70–76. Patent Owner

⁷ We disagree with Patent Owner that the reference to Figure 11 is a new argument on reply. *See* PO Sur-Reply 22. The Petition expressly referred back to the analysis of the “second manner” discussed for limitation 1(e). *See* Pet. 71. The “second manner” exclusively relies on Figure 11 of Imai. *See* Pet. 68–71 (discussing the “second manner” in detail). Thus, we find that Patent Owner had adequate notice of this argument in the Petition.

does not raise any arguments beyond those considered above with respect to claims 1 and 14.

We have reviewed Petitioner’s evidence and contentions and find that Petitioner has shown by a preponderance of the evidence that claims 2, 10–13, 15, and 16 would have been obvious over the combination of Imai and Higashi.

3. Obviousness of Claims 6–8 and 17 over Imai, Higashi, and Grzesik

Claim 6 depends from claim 1, and claims 7 and 8 depend from claim 6. Claim 17 depends from independent claim 14. All of these dependent claims add limitations related to an “aperture layer.” *See* Ex. 1001, Petitioner contends that the combination of Imai, Higashi, and Grzesik discloses claims 6–8 and 17. Pet. 76–80. Specifically, Petitioner argues that Grzesik describes an aperture layer (“cross talk absorption layer”) comprising a plurality of apertures formed over pixels in a detector array and separated by a stop region (“surfaces 64”) where photons are blocked. *Id.* at 79 (citing Ex. 1012, FIG. 3, 4:53–5:6, 5:11–32; Ex. 1003 ¶ 309). Petitioner submits that Grzesik’s “cross talk absorption layer” includes an opaque structure. *Id.* (citing Ex. 1012, 4:53–5:6, 5:11–32; Ex. 1003 ¶¶ 310–311). Petitioner further submits that the aperture layer suggested by Grzesik comprises at least four instances connoted as “apertures 62,” each formed over a respective pixel of the SPAD array such that a respective optical path extends between the bulk imaging optic (i.e., image forming optical system) and the respective pixel (e.g., SPAD macro-cell) through the respective instance of aperture. *Id.* at 80 (citing Ex. 1003 ¶¶ 312–13). Petitioner asserts that a person of ordinary skill in the art would have been motivated to

combine Grzesik with Imai and Higashi with a reasonable expectation of success. In particular, Petitioner argues that a person of ordinary skill in the art would have been motivated to combine the references to reduce optical cross talk. *Id.* at 77–78 (citing Ex. 1012, 4:65–5:6, 5:11–32; Ex. 1003 ¶¶ 305–07; Ex. 1009 ¶¶ 6, 7).

Patent Owner does not dispute Petitioner’s contentions for claims 6–8 and 17 besides the arguments considered above with respect to claim 1.

After review of the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claims 6–8 and 17 would have been obvious over the combination of Imai, Higashi, and Grzesik.

4. Obviousness of Claim 5 over Imai, Higashi, and Pacala

Claim 5 depends from claim 1 and further recites “a rotation mechanism configured to rotate the optical system about a rotational axis.” Ex. 1001, 17:35–37. Petitioner relies on Imai and Higashi, as explained above for the limitations of claim 1, and on Pacala for the recited “rotational mechanism.” Pet. 82–83 (citing Ex. 1013 ¶ 13, Fig. 2; Ex. 1003 ¶¶ 321–22). Petitioner contends that a person of ordinary skill in the art would have been motivated to combine Pacala with Imai and Higashi with a reasonable expectation of success. *Id.* at 80–82. In particular, Petitioner argues that a POSITA would have been motivated to combine Imai-Higashi with Pacala’s rotational mechanism to capture an overall wider field of view. *Id.* at 81 (citing Ex. 1003 ¶¶ 317–18). Petitioner also asserts that the combination of Imai-Higashi with Pacala’s rotational mechanism was simply a known technique, applied to a known system ready for improvement to yield predictable results with a reasonable expectation of success. *Id.* at 81–82

(citing *KSR*, 550 U.S. at 417; Ex. 1003 ¶ 319; Ex. 1009 ¶ 3; Ex. 1013 ¶¶ 13–14, Fig. 2).

Patent Owner does not raise any separate arguments regarding claim 5 besides those considered above with respect to claim 1. We have reviewed Petitioner’s arguments and evidence, and find that Petitioner has shown by a preponderance of the evidence that claim 5 would have been obvious over the combination of Imai, Higashi, and Pacala.

E. *Obviousness Based on Retterath*

We do not reach the remaining grounds, based on Retterath, in this Decision because we have already decided that all challenged claims would have been obvious under the various grounds based on Imai (§ II.D), as discussed above.

F. *Remaining Arguments by Patent Owner*

Patent Owner also raises two overarching arguments that we wish to address. First, Patent Owner argues that Petitioner’s arguments in the Reply exceed the proper scope of a reply. PO Sur-reply 2–3. With respect to the Imai-based grounds⁸, we disagree. As we have explained above, we find that the specific arguments we discussed above properly respond to Patent Owner’s arguments. Second, Patent Owner argues that we should give no weight to either of Dr. Shanley’s declarations due to “his obstructive and nonresponsive conduct at his November 6 deposition.” *Id.* at 3. We have reviewed Dr. Shanley’s November 6 deposition and do not agree with Patent Owner’s characterization of his deposition. Dr. Shanley responded to the questions put to him and, while Patent Owner may not agree with some of

⁸ We express no opinion on the arguments raised with respect to the Retterath-based grounds.

the answers, that is not a sufficient basis to give no weight to the entirety of his opinions.

IV. CONCLUSION

After considering the evidence and arguments presented in the Petition, we determine that Petitioner has established by a preponderance of the evidence that the challenged claims of the '381 patent are unpatentable as obvious over the combinations of Imai, Higashi; Imai, Higashi, and Grzesik; and Imai, Higashi, and Pacala, notwithstanding Patent Owner's arguments. Therefore, we do not reach the remaining grounds.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 318(a), claims 1–3, 5–8, and 10–17 of the '381 patent have been shown to be unpatentable; and

FURTHER ORDERED that any party seeking judicial review must comply with the notice and service requirements of 37 C.F.R. § 90.2.⁹

⁹ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this Decision, we draw Patent Owner's attention to the April 2019 Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not shown Unpatentable
1–3, 6–8, 10, 11, 14–17	103	Retterath, Borowski ¹⁰		
6–8, 17	103	Retterath, Borowski, Hipp		
1–3, 5–8, 10–13	103	Retterath, Borowski, Pacala		
1–3, 6–8, 10–17	103	Retterath, Borowski, Weimer		
1–3, 5–8, 10–13	103	Retterath, Borowski, Weimer, Pacala		
6–8, 17	103	Retterath, Borowski, Weimer, Hipp		
6–8, 17	103	Retterath, Borowski, Weimer, Hipp, Pacala		
1–3, 10– 16	103	Imai, Higashi	1–3, 10–16	
6–8, 17	103	Imai, Higashi, Grzesik	6–8, 17	
5	103	Imai, Higashi, Pacala	5	
Overall Outcome			1–3, 5–8, 10– 17	

¹⁰ Because we determine that claims 1–3, 5–8, and 10–17 are unpatentable on the Imai-based grounds, we do not reach the remaining grounds.

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PETITIONER:

Michael Hawkins
Craig Deutsch
Yao Wang
Fish & Richardson PC
hawkins@fr.com
deutsch@fr.com
ywang@fr.com

PATENT OWNER:

Nicoletta Kennedy
Megan Bussey
Kilpatrick Townsend & Stockton LLP
nkennedy@kilpatricktownsend.com
mbussey@kilpatricktownsend.com

Phillip Morton
Eamonn Gardner
Patrick Lauppe
Cooley LLP
pmorton@cooley.com
egardner@cooley.com
plauppe@cooley.com