

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.,
Petitioner,

v.

OUSTER, INC.,
Patent Owner.

IPR2023-01457
Patent 11,190,750 B2

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

JURGOVAN, *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 44–48 and 50 (“the challenged claims”) of U.S. Patent 11,190,750 B2 (Ex. 1001, “the ’750 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. 82. 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. 82; Paper 5, 1.

C. The '750 Patent (Ex. 1001)

The '750 patent is titled “Optical Imaging System with a Plurality of Sense Channels.” Ex. 1001, code (54). The '750 patent discloses “a new and useful optical system for collecting distance information in the field of optical sensors.” *Id.* at 1:22–25.

Figure 1 of the '750 patent is shown below.

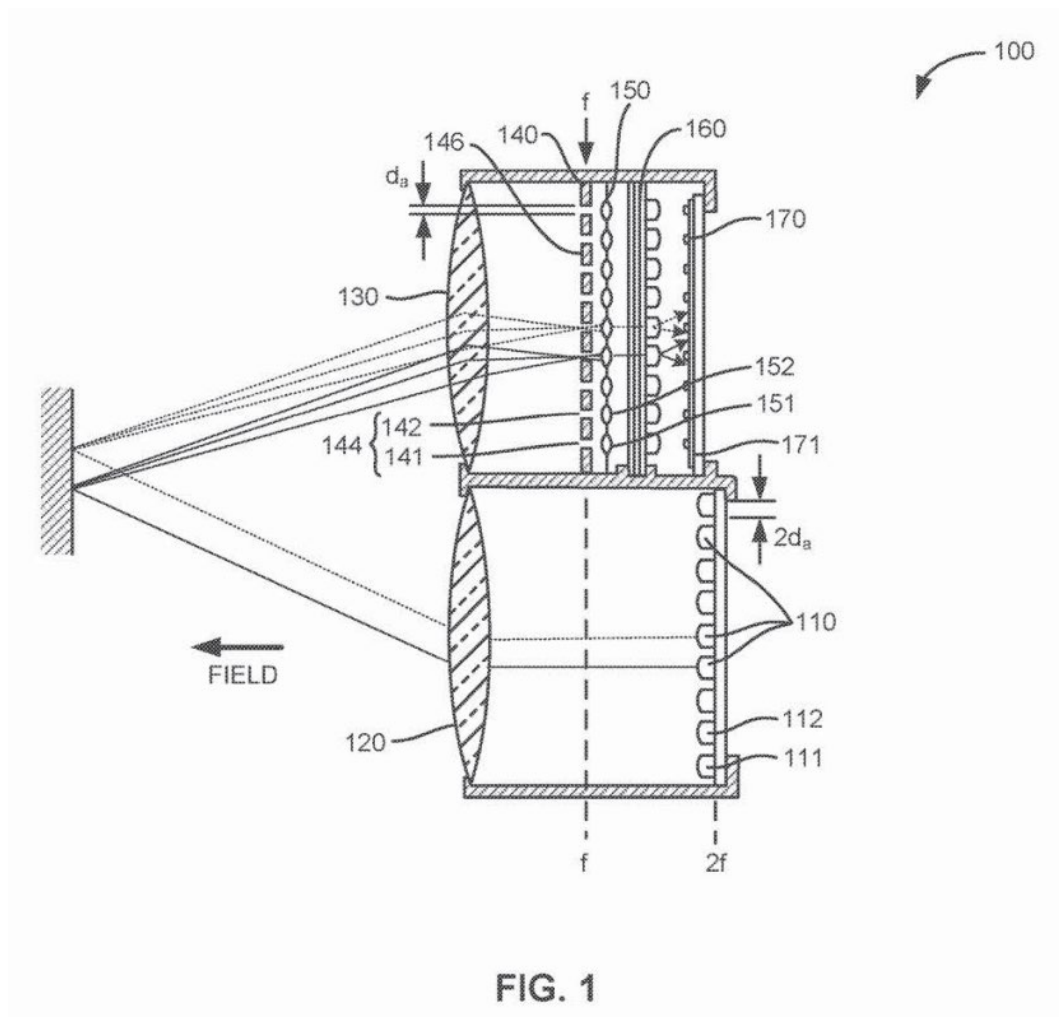


Figure 1 shows optical system 100 including illumination sources 110, bulk transmitter optic 120, bulk imaging optic 130, aperture layer 140, lenses 150, optical filter 160, and pixels 170. *Id.* at 1:63–2:25. Illumination sources 110 are configured to output an illuminating beam with an operating wavelength. *Id.* at 1:66–2:3. Illumination sources 110 include an array of laser diodes or light-emitting diodes (LEDs). *Id.* at 1:66–2:3, 11:7–11, 12:19–23. The beam from illumination sources 110 passes through bulk transmitter object 120 into the field where the photons may reflect off objects. *Id.* at 2:48–51, Figs. 1, 2. Reflected photons pass through bulk imaging optic 130 and through apertures 140 which define non-overlapping fields of view. *Id.* at 2:48–51. Photons passing through apertures 140 reach lenses 150 which perform collimation. *Id.* at 2:14–19, Figs. 1, 2. Optical filter 160 passes a narrow band of light wavelengths including the operating wavelength. *Id.* at 2:53–55. Pixels 170 correspond to each lens 150, and each includes a set of sub-pixels. *Id.* at 2:23–26. A diffuser 180 (not shown) between optical filter 160 and pixels 170 spreads collimated light from the lenses 150 across a set of subpixels. *Id.* at 2:26–29.

D. Claims

Of the challenged claims, only claim 44 is independent, and the remaining claims depend therefrom. Claim 44 is shown below with Petitioner's identifiers in brackets and disputed language shown in emphasis.

[44(a)] An optical imaging system comprising:

[44(b)] a bulk imaging optic;

[44(c)] a plurality of pixels arranged behind the bulk imaging optic, wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs)

and has a field of view that is non-overlapping beyond a ***threshold distance*** in a field external to the optical imaging system with fields of view of all other pixels in the plurality of pixels, and wherein the plurality of pixels includes at least a first pixel and a second pixel;

[44(d)] an aperture layer disposed between the bulk imaging optic and the plurality of pixels, the aperture layer comprising a plurality of apertures separated from each other by a stop region, the plurality of apertures including a first aperture disposed in a first optical path extending between the bulk imaging optic and the first pixel and a second aperture disposed in a second optical path extending between the bulk imaging optic and the second pixel;

[44(e)] a bulk transmitting optic disposed ***adjacent to*** the bulk imaging optic; and

[44(f)] a plurality of emitters arranged to project electromagnetic radiation through the bulk transmitting optic and into the field according to an illumination pattern where electromagnetic radiation output from each emitter in the illumination pattern is ***coincident with*** a field of view of a corresponding pixel in the plurality of pixels.

Ex. 1001, 21:40–22:20.

E. Prior Art and Asserted Challenges to Patentability

Petitioner asserts that claims 44–48 and 50 are unpatentable on the following challenges (Pet. 1–2):

Ground	Claim(s) Challenged	35 U.S.C. §¹	Basis/Reference(s)
1A	44, 45, 48, 50	103	Retterath ² , Borowski ³
1B	44–48, 50	103	Retterath, Borowski, Weimer ⁴
1C	44, 45, 48, 50	103	Retterath, Borowski, Hipp ⁵
1D	44–48, 50	103	Retterath, Borowski, Weimer, Hipp
2	44–48, 50	103	Imai ⁶ , Higashi ⁷ , Grzesik ⁸
3	44–48, 50	103	Weimer, Borowski, Hipp

¹ Because the '750 patent issued from a patent application that was filed after March 16, 2013, patentability is governed by the version of 35 U.S.C. § 103 set forth in the Leahy-Smith America Invents Act (“AIA”), Pub L. No. 112–29, 125 Stat. 284 (2011).

² Retterath et al., U.S. Patent 10,203,399 B2, issued Feb. 12, 2019 (Ex. 1005). Petitioner contends that Retterath is prior art under § 102(a)(2). Pet. 2.

³ Borowski et al., U.S. Patent Pub. 2013/0300838 A1, published Nov. 14, 2013 (Ex. 1006). Petitioner contends that Borowski is prior art under § 102(a)(1). Pet. 2.

⁴ Weimer et al., U.S. Patent 8,736,818 B2, issued May 27, 2014 (Ex. 1008). Petitioner contends that Weimer is prior art under § 102(a)(1). Pet. 2.

⁵ Hipp, U.S. Patent 7,787,105 B2, issued Aug. 31, 2010 (Ex. 1007). Petitioner contends that Hipp is prior art under § 102(a)(1). Pet. 2.

⁶ Imai, U.S. Patent Pub. 2016/0274223 A1, published Sep. 22, 2016 (Ex. 1009). Petitioner contends that Imai is prior art under § 102(a)(2). Pet. 2.

⁷ Azuma et al., JP2015-078953, published Apr. 23, 2015 (Ex. 1010 - Japanese version; Ex. 1011 - English version). Petitioner contends that this document is prior art under § 102(a)(1). Pet. 2. Consistent with the parties’ references in the Petition and Preliminary Response, we will refer to this document as “Higashi” although we note it does not appear to be the name of the applicant or any inventor. We refer to the English version herein only (Ex. 1011).

⁸ Grzesik, U.S. Patent Pub. 2017/0040368 A1, published Feb. 9, 2017 (Ex. 1012). Petitioner contends that Grzesik is prior art under § 102(a)(2). Pet. 2.

In support of its proposed challenges, Petitioner relies on the Declarations of Dr. James Shanley. Ex. 1003; Ex. 1040. Patent Owner relies on the Declaration of Dr. Jason Janét. Ex. 2009. The Declarants were deposed during the trial, and the transcripts from those depositions are included in the record. Ex. 1041 (Janét); Ex. 2010 (Shanley).

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. We determine that Petitioner has shown by a preponderance of the evidence that claims 44–48 and 50 would have been obvious over one of Petitioner’s prior art combinations (Ground 2).

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 ’750 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)).

I. “Stop Region”

Claim 44’s limitation 44(d) recites “the aperture layer comprising a plurality of apertures separated from each other by a **stop region**.” Ex. 1001, 22:5–7.

In relation to Grounds 1A to 1D, Petitioner and Patent Owner dispute whether the claimed “stop region” can encompass a partially transparent material as disclosed by Retterath. PO Resp. 21; Pet. Reply 7–8; PO Sur-Reply 10.

Because we do not reach Grounds 1A to 1D in this decision (see § III.D, *infra*), we need not and do not decide whether a “stop region” may include a partially transparent material. *See Realtime*, 912 F.3d at 1375, *supra*.

2. “Coincident With”

Limitation 44(f) of claim 44 recites “electromagnetic radiation output from each emitter in the illumination pattern is *coincident with* a field of view of a corresponding pixel in the plurality of pixels.” Ex. 1001, 22:18–20.

As explained in § II.C, the ’750 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, 1:63–2:29.

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 44(f) such as “field of view,” they are not related to the dispute over claim terminology that the parties raise before us. Ex. 1026, 2⁹.

In its Response, Patent Owner argued that

the term “electromagnetic radiation output from each emitter in the illumination pattern is coincident with a field of view of a corresponding pixel” should be construed to mean that the electromagnetic radiation output from each emitter in the illumination pattern and the field of view of a corresponding pixel cover substantially the same area in the field.

PO Resp. 25–26.

⁹ For Exhibit 1026, we use the numbering of the “Joint Claim Construction Chart” rather than the Exhibit numbering herein.

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 near perfect” which “improperly excludes example embodiments in the ’750 patent, defies normal usage by others, and injects ambiguity.” *Id.* at 2–7 (citing Ex. 1001, 3:52–63, 6:3–11, 11:11–19, Figs. 1–2; Ex. 1040 ¶¶ 11–22).

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 “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 ’750 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, 2:44–3:11, 2:58–3:3, 3:16–20, 6:3–11, 6:25–28, 10:65–11:19, Fig. 1; Ex. 1041, 41:7–24; Ex. 2009 ¶¶ 105–119).

The parties’ dispute over this claim language thus centers on the meaning of “*coincident with*” in limitation 44(f). To determine what this means in the context of the ’750 patent, we consider the intrinsic evidence.

The '750 patent's specification mirrors the claim language in limitation 44(f) 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, 2:8–11, 3:56–59, 10:61–64, 14:20–23, 18:41–44 (claim 16),
21:33–39 (claim 43).

The term “coincident with” as used in the '750 patent does not require perfect coincidence. To explain why, we provide an annotated version of Figure 2 of the '750 patent below.

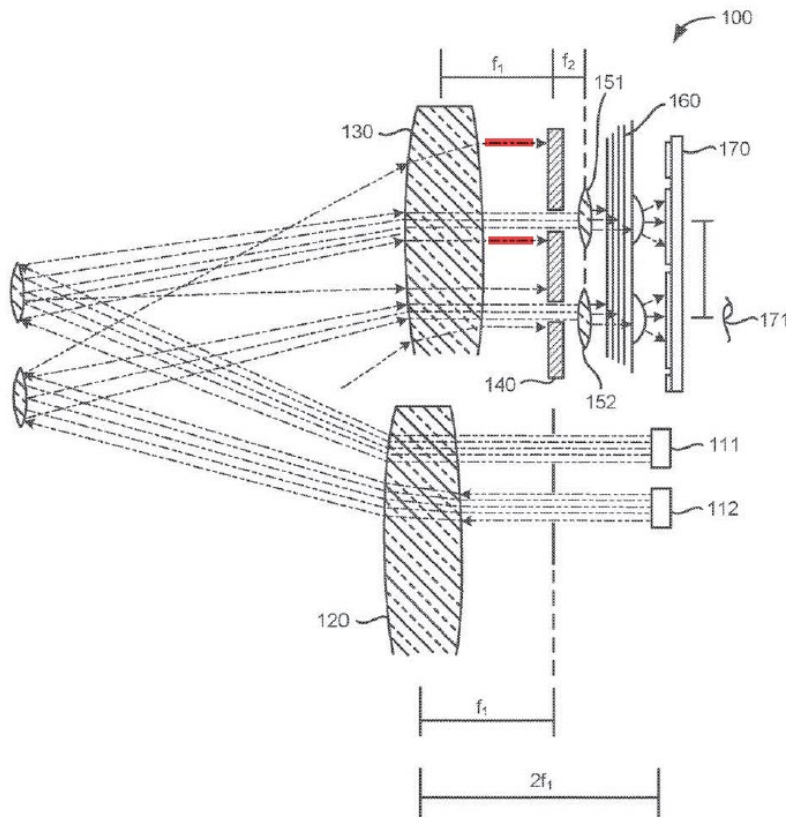


FIG. 2

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, 3:51–63. 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 '750 patent's Figure 4, which is reproduced below.

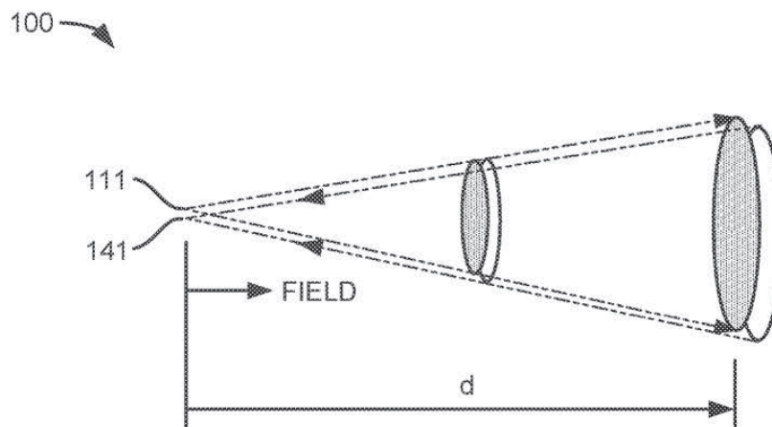


FIG. 4

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 '750 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, 11:11–19 (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 ’750 patent does not lend any insight into proper construction of “coincident with.” Ex. 1002, 1346 (part 8) (amendment adding claim 44). Claim 44 was allowed without any rejection requiring the applicant to explain why the claim distinguished over the prior art cited during examination. Ex. 1002, 1707–1708 (part 10) (examiner’s statement of reasons for allowance).

Turning to the extrinsic evidence, Patent Owner relies on a dictionary which defines “coincidence” as “occupies the same portion of space as.” See Ex. 2011, 8 (definition of “coincidence”). This definition is generally consistent with a POSITA’s understanding of the term, but as explained “coincident with” as used in the ’750 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);

Sequoia Tech., LLC v. Dell, Inc., 66 F.4th 1317, 1324 (Court of Appeals stating that its “decision rests solely on the intrinsic evidence”).

The ’750 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 illumination source’s “discrete spot” and the aperture’s field of view. As used in the ’750 patent, the “discrete spot” of illumination can be “substantially identical or slightly greater” than its corresponding aperture’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.

D. Grounds 1A–1D: Obviousness Over Retterath-Borowski Combinations

We do not reach Grounds 1A–1D (Pet. 9–44) in this Decision because we decide that all challenged claims would have been obvious under Ground 2 (§ II.E), as discussed below.

E. Ground 2: Obviousness Over Imai, Higashi, and Grzesik

Petitioner contends that claims 44–48 and 50 would have been obvious over the combination of Imai, Higashi, and Grzesik. Pet. 44–69; Pet. Reply 19–23. Patent Owner disputes that the challenged claims would have been obvious over this combination. PO Resp. 41–50; PO Sur-Reply 18–20.

In this section, we discuss the disclosures of Imai, Higashi, and Grzesik, and address the parties’ contentions whether the claim limitations are met by the combination. For the reasons that follow, we determine that claims 44–48 and 50 would have been obvious over the combination.

1. Imai (Ex. 1009)

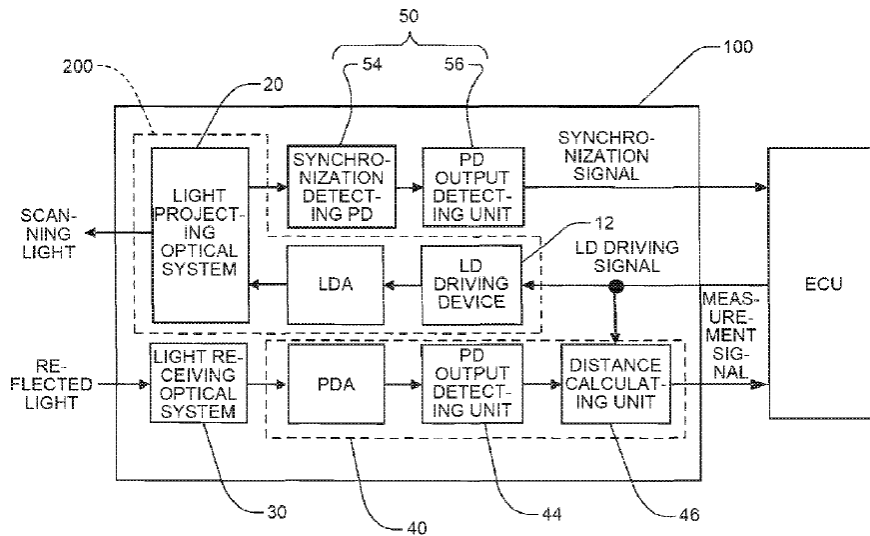
Imai discloses a laser radar as follows:

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



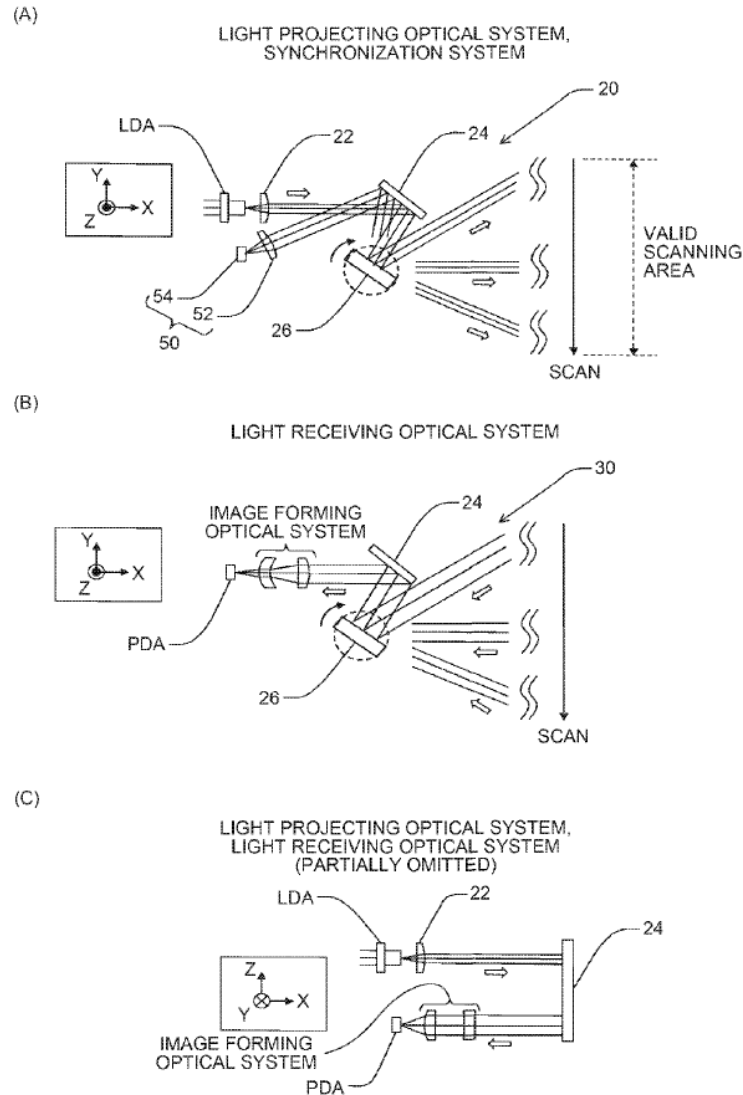
Imai's Figure 1 above shows a laser radar described as follows:

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.

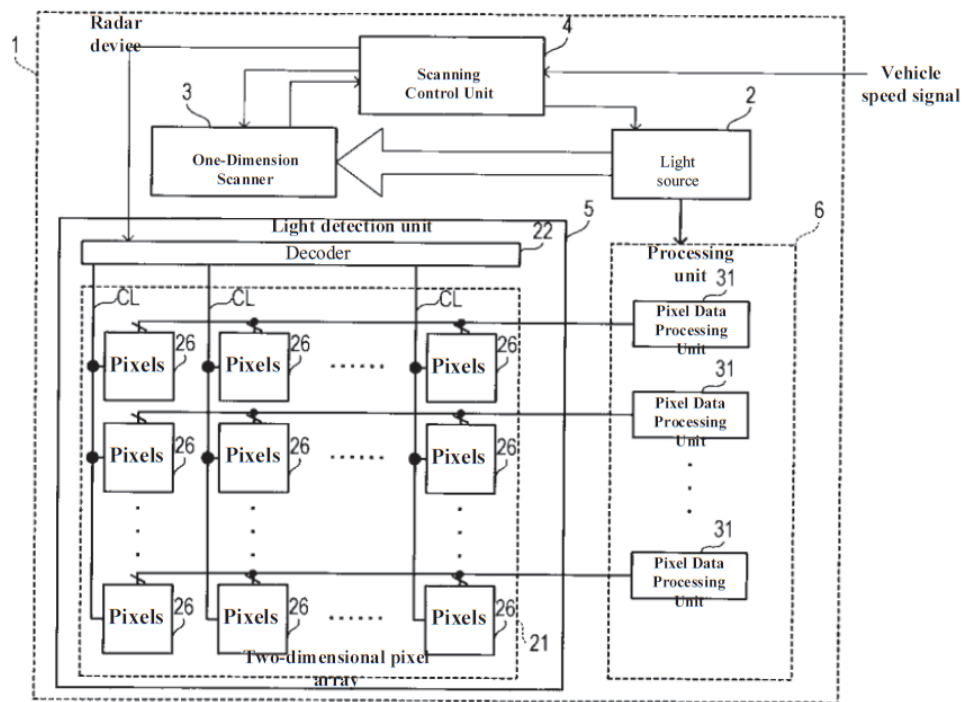
In addition, Imai discloses that a SPAD (single photon avalanche diode) may be used as a light receiving element due its higher sensitivity, detection accuracy, and detection distance compared to a PD (photodiode).

Id. ¶ 48.

2. *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.*

“[P]rocessing 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.

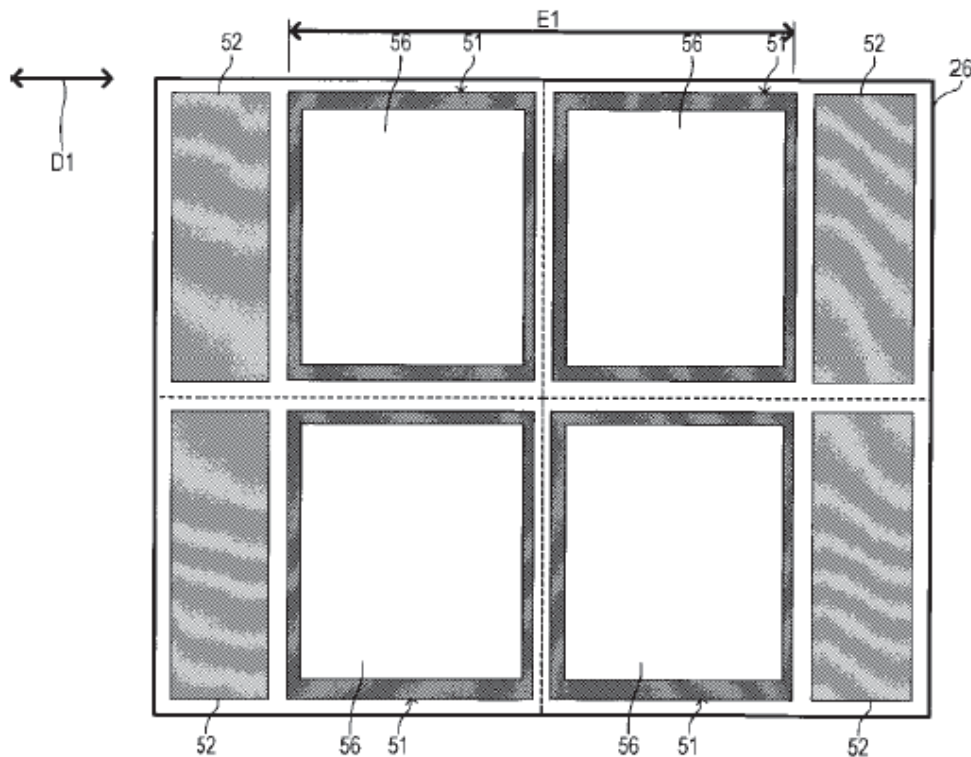


Figure 4 above shows that pixel 26 comprises four light receiving elements 51 which may each be “a single photon avalanche diode (SPAD)” “operating in Geiger mode, capable of detecting single photon incidence.” *Id.* ¶ 27.

3. *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. *Id.* ¶ 6.

Grzesik’s Figure 3 is reproduced below.

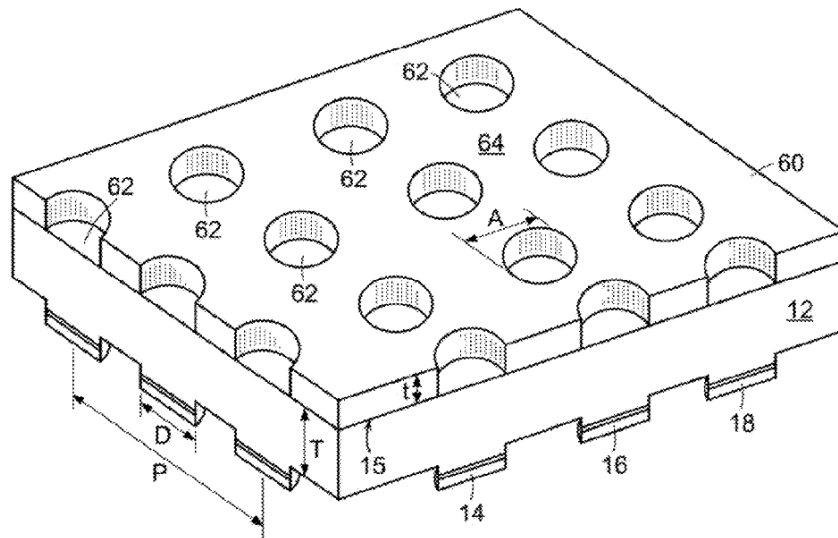


FIG. 3

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.*

4. Analysis of Independent Claim 44

In this section, we analyze Petitioner’s and Patent Owner’s contentions concerning disputed limitations of independent claim 44 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 claim 44 would have been obvious over the combination of Imai, Higashi, and Grzesik.

a) Dispute Over “Threshold Distance”

Petitioner contends that the combination of Imai, Higashi, and Grzesik discloses claim 44’s limitation 44(c) reciting “wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs) and has a field of view that is non-overlapping beyond a ***threshold distance*** in a field external to the optical imaging system with fields of view of all other pixels in the plurality of pixels.” Pet. 51–52, 55–59 (citing Ex. 1003 ¶¶ 222–223); Pet. Reply 22–23.

Patent Owner states that Petitioner relied on Imai for this limitation but argues that it does not disclose any “threshold distance.” PO Resp. 50 (citing Ex. 2009 ¶¶ 180–183); PO Sur-Reply 18. Patent Owner asserts that this was confirmed by Petitioner’s expert who stated that the threshold distance in Imai was “not a quantifiable number.” *Id.* (citing Ex. 2010, 99:4–100:2).

We agree with Petitioner that Imai discloses the claimed non-overlapping “threshold distance” even though it does not specifically mention or show it. For example, Imai discloses that the “irradiation

ranges” of its laser diodes correspond to the “light receivable ranges” of corresponding groups of four SPADs constituting pixels. Pet. 54–57 (citing Ex. 1009 ¶¶ 48, 99–101, Fig. 10; Ex. 1003 ¶¶ 222–223). In other words, the fields of view of Imai’s pixels are non-overlapping with those of other pixels in the array. Ex. 1009, Figs. 5, 7; Ex. 1003 ¶ 222. Hence, it was obvious that there must be a “threshold distance” in Imai’s system beyond which the pixels’ fields of view are non-overlapping because the “irradiation ranges” are in fact non-overlapping when they arrive at the pixels.

Furthermore, we agree with Petitioner that the claimed “threshold distance” would have been obvious in light of Grzesik’s teachings. Pet. 55–56, n.3 (citing Ex. 1012, Fig. 3; Ex. 1003 ¶ 223). Grzesik’s absorption layer 60 defines apertures 62 which define the fields of view of corresponding photodiodes. *See, e.g.*, Ex. 1012 ¶¶ 33, 37. Although Grzesik does not mention “pixels” per se, a POSITA would have understood that Grzesik’s photodiodes would have been associated with corresponding pixels, and those photodiodes would be replaced with SPADs, as, for example, Imai discloses. Ex. 1009 ¶¶ 48, 99–101. Thus, a POSITA would have understood Grzesik to disclose that its pixels have fields of view defined by their corresponding apertures which are non-overlapping beyond a “threshold distance” because the received light is non-overlapping when it reaches the pixels. Ex. 1003 ¶ 223.

Patent Owner criticizes Petitioner’s expert, Dr. Shanley, for stating that the “threshold distance” in Imai was “not a quantifiable number.” PO Resp. 50 (citing Ex. 2010, 99:4–100:2). We understand Dr. Shanley to have meant that he could not quantify Imai’s “threshold distance” without first knowing geometries, properties, and spatial relationships of the optical

elements in Imai's system. Petitioner further points out that the '750 patent likewise does not mention or require quantification of its "threshold distance." Pet. Reply 22–23 (citing *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994); *In re Paulsen*, 30 F.3d 1475, 1481 n.9 (Fed. Cir. 1994)); Ex. 1001, 2:44–48.

Patent Owner argues that Petitioner's assertion that the '750 patent does not provide details concerning its "threshold distance" is an improper new argument in Petitioner's Reply that was not raised in its Petition. PO Sur-Reply 18. We do not agree. Petitioner's observation has a nexus, and is responsive, to Patent Owner's argument that Imai must quantify a "threshold distance" to disclose it. PO Resp. 50. In addition, Petitioner's contention properly expands on, and is a fair extension of, its Petition argument that Imai discloses the claimed "threshold distance." Pet. 55–59. Under the circumstances presented here, Petitioner's contention in its Reply was not an improper new argument. *See Rembrandt Diagnostics, LP v. Alere, Inc.*, 76 F.4th 1376, 1385 (Fed. Cir. 2023).

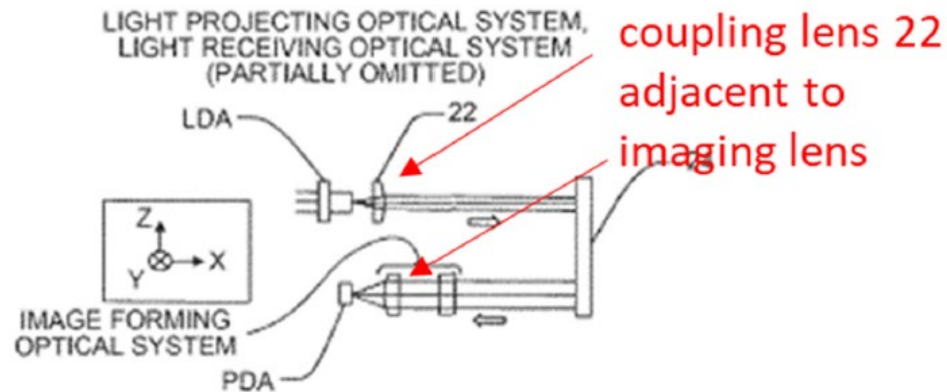
Accordingly, Petitioner shows by a preponderance of the evidence that a POSITA would have considered the claimed "threshold distance" of claim 44's limitation 44(c) obvious in light of Imai's and Grzesik's teachings notwithstanding Patent Owner's arguments.

b) Dispute Over "Adjacent To"

Petitioner contends that the combination of Imai, Higashi, and Grzesik discloses claim 44's limitation 44(e) reciting a bulk transmitting optic disposed ***adjacent to*** the bulk imaging optic. Pet. 59–61; Pet. Reply 21–22.

To explain its contention, Petitioner provides the following annotated version of Imai's Figure 2C:

(C)



Pet. 61. 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 '750 patent's embodiment. *Id.* at 60–61 (citing Ex. 1009 ¶¶ 38–39, 41, Fig. 2C; Ex. 1001, 11:5–7; Ex. 1003 ¶ 233; Ex. 1027 ¶¶ 13–22).

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 due to the omission of elements from the figure. PO Resp. 44–45 (citing Ex. 2010, 88:7–90:21; Ex. 2009 ¶ 186). 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 46–47 (citing Ex. 2009 ¶ 188). 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 47–49 (citing Ex. 2010, 89:7–90:21; Ex. 2009 ¶ 187).

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 44’s limitation 44(e). Pet. 59–61; Pet. Reply 21–22; Ex. 1003 ¶ 233. 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 ubiquitous in such LiDAR devices before September 2015.” Ex. 1003 ¶ 234. 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 (citing Pet. Reply 21–22). 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. 44–49. 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 21 (citing Ex. 1009 ¶ 38). The Petition also expressly mentioned

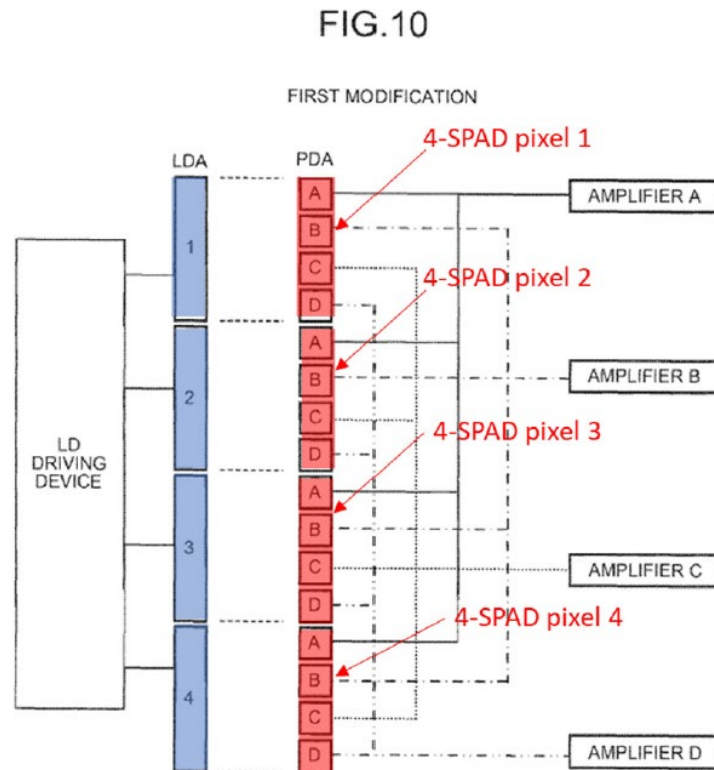
Imai's Paragraph 38 which Petitioner asserts discloses what is "partially omitted" from Imai's Figure 2C, and reproduced Imai's Figure 2C showing the lenses "adjacent to" one another in the X-Z plane. Pet. 60–61. Hence, Petitioner's Reply arguments properly expand on and are a fair extension of its Petition contentions. Under these circumstances, Petitioner's Reply arguments are not improper new arguments. *See Rembrandt*, 76 F.4th at 1385 (Fed. Cir. 2023).

Accordingly, Petitioner shows by a preponderance of the evidence that Imai discloses the "adjacent to" language of claim 44's limitation 44(e) notwithstanding Patent Owner's arguments.

c) Dispute Over "Coincident With"

Petitioner contends that the combination of Imai, Higashi, and Grzesik discloses the part of claim 44's limitation 44(f) reciting "electromagnetic radiation output from each emitter in the illumination pattern is ***coincident with*** a field of view of a corresponding pixel." Pet. 61–64; Pet. Reply 19–20. Specifically, Petitioner contends that two different embodiments of Imai shown in respective Figures 10 and 11 disclose the "coincident with" limitation.

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



Pet. 54. Petitioner's version of Imai's Figure 10 above shows that Imai discloses four pixels, with each pixel including four SPADs. *Id.* at 54–56 (citing Ex. 1009 ¶¶ 37–41, 48, 61–64, 67–70, 77, 96–101, 109–112, Figs. 2B–2C, 4B, 7A–7B, 10; Ex. 1027 ¶¶ 18–22, 41–42, 77–82; Ex. 1003 ¶¶ 219–228). 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 (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. 62–63 (citing Ex. 1009 ¶¶ 99–101; Ex. 1003 ¶ 237).

Imai's Figure 11 embodiment is similar to its Figure 10 embodiment but Petitioner states that it has a one-to-one correspondence of laser diodes

to respective SPAD photodiodes. Pet. 63 (citing Ex. 1009 ¶ 125; Ex. 1003 ¶ 238).

Petitioner further states that the irradiation range of each laser diode (LD) is “slightly larger” than corresponding “light receiving ranges” of respective SPAD photodiode (PD) pixels. Pet. 62 (citing Ex. 1009 ¶ 101).

Patent Owner argues that the claimed limitation should be construed to mean that “the electromagnetic radiation output from each emitter in the illumination pattern and the field of view of a corresponding pixel 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 detectors.” PO Resp. 41–44 (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 ’750 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.2. Under this construction, the ’750 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 ’750 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.

Patent Owner criticizes Petitioner's alleged position that "*any* overlap between emitter radiation outputs and corresponding detector fields of view is sufficient." *Id.* at 43. 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 43–44 (citing Ex. 2009 ¶ 196). Imai, however, states "*slightly* larger"—not "*significantly* larger"—contrary to Patent Owner's assertion. Ex.1009 ¶ 101. As explained, the '750 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 '750 [p]atent." Pet. Reply 20 (citing Pet. 54–58, 61–64; Ex. 1009 ¶¶ 99–101; Ex. 1040 ¶¶ 51–52).

Accordingly, Petitioner shows by a preponderance of the evidence that Imai discloses the "coincident with" language of claim 44's limitation 44(f) notwithstanding Patent Owner's arguments.

d) Preamble – Optical Imaging System (44(a))

The preamble limitation 44(a) of claim 44 recites “An optical imaging system, comprising:” Ex. 1001, 21:40.

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. 53 (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 ¶¶ 215–216).

Patent Owner does not dispute Petitioner’s contentions regarding preamble limitation 44(a).

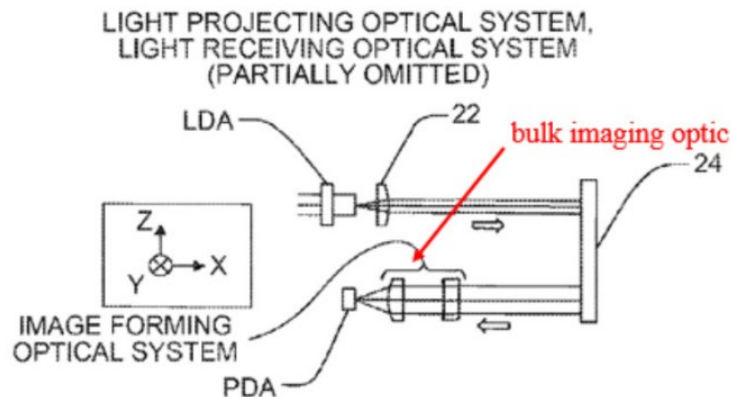
After reviewing the evidence, we find that Petitioner has shown by a preponderance of the evidence that Imai discloses a scanning laser radar that is an “optical imaging system” as recited in preamble limitation 44(a). For example, Imai’s laser radar includes an “image forming optical system.” Ex. 1009 ¶ 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).

e) Bulk Imaging Optic (44(b))

Claim 44’s limitation 44(b) recites “a bulk imaging optic.” Ex. 1001, 21:41.

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

(C)



Pet. 53. 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.” *Id.* at 53–54 (citing Ex. 1009, code (57), ¶¶ 39–41; Ex. 1027 ¶¶ 19–22; Ex. 1003 ¶¶ 217–218).

Patent Owner does not dispute Petitioner’s contentions concerning limitation 44(b).

Reviewing the evidence, we find that Petitioner has shown by a preponderance of the evidence that Imai discloses the “bulk imaging optic” of claim 44’s limitation 44(b).

f) Plurality of Pixels (44(c))

Claim 44’s limitation 44(c) recites

a plurality of pixels arranged behind the bulk imaging optic, wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs) and has a field of view that is non-overlapping beyond a **threshold distance** in a field external to the optical imaging system with fields of view of all other pixels in the plurality of pixels, and wherein the plurality of pixels includes at least a first pixel and a second pixel;

Ex. 1001, 21:42–22:3.

Petitioner contends that Imai discloses “a plurality of pixels arranged behind the bulk imaging optic” as recited in limitation 44(c). Pet. 54–55 (citing Ex. 1009 ¶¶ 37–41, 61; Ex. 1003 ¶ 221). We agree with Petitioner’s contention, which Patent Owner does not dispute.

Petitioner further contends that Imai and Grzesik each disclose “wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs) and has a field of view that is non-overlapping beyond a *threshold distance* in a field external to the optical imaging system with fields of view of all other pixels in the plurality of pixels.” Pet. 54–57 (citing Ex. 1009 ¶¶ 77, 96–101, 109–112, 125, Figs. 10, 11; Ex. 1011, Fig. 4; Ex. 1027 ¶¶ 18–22, 41–42, 77–82; Ex. 1012, Fig. 3; Ex. 1003 ¶¶ 221–226). We have already discussed the parties’ dispute concerning this limitation and decided that Petitioner has shown that Imai and Grzesik disclose this part of limitation 44(c). See § III.E.4.a.

Petitioner further contends that Imai discloses “wherein the plurality of pixels includes at least a first pixel and a second pixel.” Pet. 54 (citing Ex. 1009 ¶¶ 96–99, Fig. 10 (Pixel 1 (PD1–PD4), Pixel 2 (PD5–PD8), Pixel 3 (PD9–PD12), and Pixel 4 (PD13–PD16)), 57 (citing Ex. 1009 ¶ 125, Fig. 11 (LDs and SPAD PDs with one-to-one correspondence)). We agree with Petitioner that Imai discloses this part of limitation 44(c).

Accordingly, after reviewing the evidence, we find that Petitioner has shown by a preponderance of the evidence that Imai and Grzesik disclose claim 44’s limitation 44(c).

g) Aperture Layer (44(d))

Claim 44's limitation 44(d) recites

an aperture layer disposed between the bulk imaging optic and the plurality of pixels, the aperture layer comprising a plurality of apertures separated from each other by a stop region, the plurality of apertures including a first aperture disposed in a first optical path extending between the bulk imaging optic and the first pixel and a second aperture disposed in a second optical path extending between the bulk imaging optic and the second pixel.

Ex. 1001, 22:4–12.

Petitioner asserts that Grzesik's "cross talk absorption layer" is equivalent to the claimed "aperture layer." Pet. 59 (citing Ex. 1003 ¶ 229). Regarding the part of the limitation reciting "an aperture layer disposed between the bulk imaging optic and the plurality of pixels," Petitioner asserts that Grzesik's absorption "layer would have been predictably positioned between the imaging forming optical system and the SPAD pixels" in the combination of Imai, Higashi, and Grzesik. *Id.* We agree with Petitioner that Grzesik discloses this part of limitation 44(d).

For the part of the limitation reciting "the aperture layer comprising a plurality of apertures separated from each other by a stop region," Petitioner asserts that Grzesik's absorption layer comprises "a plurality of apertures formed over pixels in a detector array and separated by a stop region ("surfaces 64") where photons are blocked." *Id.* (citing Ex. 1012, 4:53–5:6, 5:11–32, Fig. 3; Ex. 1003 ¶ 229). We agree that Grzesik discloses this part of limitation 44(d).

Regarding the remaining part of limitation 44(d), Petitioner contends that "the plurality of apertures include a first aperture disposed in a first optical path extending between the imaging lens and the first pixel and a

second aperture disposed in a second optical path extending between the imaging lens and the second pixel.” *Id.* (citing Ex. 1012, 4:53–5:32, Fig. 3). We agree with Petitioner’s contention.

Patent Owner does not dispute Petitioner’s contentions regarding limitation 44(d).

Accordingly, after review of the evidence, we find that Petitioner has shown by a preponderance of the evidence that Grzesik discloses limitation 44(d).

h) Bulk Transmitting Optic (44(e))

Claim 44’s limitation 44(e) recites “a bulk transmitting optic disposed ***adjacent to*** the bulk imaging optic. Ex. 1001, 22:13–14.

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. 59–61 (citing Ex. 1009 ¶¶ 32–34, Figs. 2A, 2C (annotated); Ex. 1003 ¶¶ 231–234).

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

We already discussed the parties’ dispute concerning the “adjacent to” limitation and determined that Petitioner is correct that Imai discloses this limitation. *See* § III.E.4.b; Pet. 60–61 (citing Ex. 1009 ¶¶ 38–39, 41, Figs. 2A, 2C (annotated); Ex. 1027 ¶¶ 13–22; Ex. 1003 ¶ 233).

Consequently, we find that Petitioner has shown by a preponderance of the evidence that Imai discloses limitation 44(e).

i) Optical Emitters (44(f))

Claim 44's limitation 44(f) recites

a plurality of emitters arranged to project electromagnetic radiation through the bulk transmitting optic and into the field according to an illumination pattern where electromagnetic radiation output from each emitter in the illumination pattern is ***coincident with*** a field of view of a corresponding pixel in the plurality of pixels.

Ex. 1001, 22:15–20.

As already discussed in § III.E.4.c, Petitioner correctly contends that Imai discloses limitation 44(f) notwithstanding Patent Owner's arguments. Pet. 61–64 (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 ¶¶ 235–239). 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 61. 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 61–62. 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 62–63. 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. *Id.* at 63–64.

Accordingly, Petitioner shows by a preponderance of the evidence that Imai discloses claim 44's limitation 44(f) notwithstanding Patent Owner's arguments concerning the "coincident with" language.

j) Motivation to Combine and Reasonable Expectation of Success

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. Pet. 47.

First, Petitioner contends that combining Higashi's multi-SPAD pixel predictably would have reduced erroneous detection and improved accuracy consistent with Imai's objective of achieving higher sensitivity. *Id.* at 48–49 (citing Ex. 1009 ¶ 48; Ex. 1011 ¶¶ 71–72, 75, Fig. 4; Ex. 1003 ¶ 209).

Second, 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.* at 49 (Ex. 1009 ¶¶ 6–7; Ex. 1011 ¶ 71; Ex. 1027 ¶¶ 3–4; Ex. 1003 ¶ 210).

Third, 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. 49–50 (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.

Pet. 50 (citing Ex. 1011 ¶¶ 31–40, 86; Ex. 1003 ¶ 211). 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 ¶ 211).

Petitioner contends that multiple reasons would have prompted a POSITA to combine Grzesik’s cross talk absorption layer (corresponding to the claimed “aperture layer”) in the Imai-Higashi combination. Pet. 51–53.

First, Petitioner contends that implementing Grzesik’s absorption layer in the Imai-Higashi combination would reduce cross talk consistent with Imai’s objective of improving resolution by allowing for more pixels to be used in a specified detection area. *Id.* at 51–52 (citing Ex. 1012, 4:65–5:6, 5:11–32; Ex. 1009 ¶¶ 6–7; Ex. 1003 ¶¶ 212–213).

Second, Petitioner asserts that the combination would have been prompted as “the application of known techniques (Grzesik’s suggested improvement for a cross talk absorption layer to reduce secondary detection) to a known system (the primary Imai LiDAR system) ready for improvement to yield predictable results (benefits articulated above).” *Id.* at 52 (citing *KSR*, 550 U.S. at 417).

Petitioner asserts that “a POSITA would have had a reasonable expectation of success at adapting Grzesik’s cross talk absorption layer to the scanning laser radar of the Imai-Higashi combination.” Pet. 52 (citing Ex. 1003 ¶ 214). Specifically, Petitioner contends that “Grzesik demonstrates the known benefits of implementing a cross talk absorption layer disposed on the detector array, with apertures of the cross talk absorption layer aligned with individual detectors, and describes using its cross talk absorption layer on Geiger-mode APDs (e.g., SPADs) as used by the Imai-Higashi combination.” *Id.* at 52–53 (citing Ex. 1003 ¶ 214).

Patent Owner does not dispute Petitioner’s contentions concerning the motivation to combine Imai, Higashi, and Grzesik, 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, Higashi, and Grzesik with a reasonable expectation of success.

k) Secondary Considerations

Patent Owner contends that “there was significant industry skepticism of the use of SPADs in LIDAR systems prior to the ’750 patent.” PO Resp. 55 (citing Ex. 2009 ¶¶ 221–227). 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 SPADs¹⁰ due to size requirements, power requirements, complexity, cost,

¹⁰ Technically, a SPAD is a species of photodiode. *See, e.g.*, Ex. 1003 ¶ 38. We understand Patent Owner to be arguing that Dr. Shanley elected to use a photodiode that was not a SPAD in his 2008 project.

lack of ease of use, lack of reliability, and lack of availability. *Id.* at 55–56 (citing Ex. 2010, 122:15–126:18; Ex. 2015, 12:18–22, 14:10–15:4, 16:20–17:12, 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 ’750 patent. *Id.* at 56 (citing Ex. 2009 ¶¶ 221–227; 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. 56–58. 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 56–58 (citing Ex. 2009 ¶¶ 228–230; Ex. 2012, 3–4).

Petitioner asserts that Patent Owner did not demonstrate “nexus” between any unique features of the challenged claims and the purported “skepticism” to use SPADs in LIDAR systems, and never asserted that the claimed element was novel. Pet. Reply 25–26 (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 '750 patent's priority date. *Id.* at 26 (citing Pet. 46–50; Ex. 1003 ¶¶ 51–62). Petitioner contends that, by 2015, SPADs were “embraced by the industry as some of the best LiDAR system photodetectors.” *Id.* at 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 26 (citing Ex. 1045, 2–5)); that combining a SPAD array with an optical scanning system improves performance (*id.* at 26–27 (citing Ex. 1046, 1–11)); and that SPADs “are the best candidates” for LiDAR system (*id.* at 27 (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 '750 patent was not novel in 2015. *Id.* at 27 (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 '750 patent. PO Sur-Reply 23 (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.E.4.a–j. 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”)).¹¹

¹¹ Furthermore, Patent Owner alleged in its Response that the use of SPADs in LIDAR devices was the unique characteristic of the ’750 patent’s claims. PO Resp. 55–58. 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 44’s preamble recites an “optical imaging system” (Ex. 1001, 21:40) 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.

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. 54–58 (citing Ex. 2010, 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 '750 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 ¶ 71 (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 skepticism had dissipated by 2015. *Id.*

Moreover, Dr. Shanley pointed to several patents and papers that proposed use of SPADs in LIDAR applications before the '750 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, 1–11; Ex. 1047, 1–8. Ex. 1040 ¶¶ 70–72 (citing Pet. 12–13, 46–46; 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. 56–57 (citing Ex. 2012, 3–4). We agree with Petitioner that Vinogradov's failure by 2015 to achieve a commercial

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.

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 ¶ 73.

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.

l) Conclusion for Independent Claim 44

On this record, Petitioner has shown by a preponderance of the evidence that a POSITA would have been motivated to combine Imai, Higashi, and Grzesik with a reasonable expectation of success in arriving at claim 44, and that each limitation of claim 44 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 claim 44 would have been obvious over the combination of Imai, Higashi, and Grzesik.

5. Analysis of Claim 45

Claim 45 depends from claim 44 and recites

wherein the plurality of pixels further includes third and fourth pixels, and the plurality apertures further includes a third aperture disposed in a third optical path extending between the bulk imaging optic and the third pixel and a fourth aperture disposed in a fourth optical path extending between the bulk imaging optic and the fourth pixel.

Ex. 1001, 22:21–27.

Petitioner contends that the combination of Imai, Higashi, and Grzesik discloses claim 45 by providing a plurality of pixels, including third and

fourth pixels. Pet. 64. Specifically, Petitioner contends that Grzesik's absorption layer includes at least four instances of 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.* (citing Ex. 1012, 4:53–5:32, Fig. 3; Ex. 1003 ¶¶ 240–241).

Patent Owner does not dispute Petitioner's contention for claim 45.

After reviewing the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 45 would have been obvious over the combination of Imai, Higashi, and Grzesik.

6. Analysis of Claim 46

Claim 46 depends from claim 44 and recites "wherein the plurality of emitters comprises a plurality of vertical-cavity surface-emitting lasers (VCSELs)." Ex. 1001, 22:28–30.

Petitioner contends that the combination of Imai, Higashi, and Grzesik renders obvious claim 46. Pet. 65. Specifically, Petitioner contends that Imai discloses a plurality of emitters comprising a plurality of VCSELs. *Id.* (citing Ex. 1009 ¶¶ 138–139; Ex. 1027 ¶¶ 119–120; Ex. 1003 ¶¶ 241–243).

Patent Owner does not dispute Petitioner's contentions concerning claim 46.

After review of the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 46 would have been obvious over the combination of Imai, Higashi, and Grzesik.

7. Analysis of Claim 47

Claim 47 depends from claim 44 and recites “wherein each emitter in the plurality of emitters comprises a single VCSEL.” Ex. 1001, 22:31–33.

Petitioner contends that the combination of Imai, Higashi, and Grzesik renders obvious claim 47. Pet. 65 (citing Ex. 1003 ¶¶ 244–245).

Specifically, Petitioner asserts that Imai teaches that “a plurality of VCSELs (surface emission lasers) is one-dimensionally arranged in the sub-scanning direction [Z-axis on Fig. 6].” *Id.* (citing Ex. 1009 ¶ 138). Petitioner asserts that a POSITA would have recognized from Imai’s one-dimensional arrangement in the Z-axis in Figure 5 that each laser diode (LD) comprises a single VCSEL. *Id.* (citing Ex. 1003 ¶ 245; Ex. 1025).

Patent Owner does not dispute Petitioner’s contentions for claim 47.

After review of the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 47 would have been obvious over the combination of Imai, Higashi, and Grzesik.

8. Analysis of Claim 48

Claim 48 depends from claim 44 and recites “wherein each pixel in the plurality of pixels is operable to output a signal corresponding to a count of photons incident on the pixel within one sample period.” Ex. 1001, 22:34–37.

Petitioner asserts that “[i]n the Imai-Higashi-Grzesik combination, each pixel is operable to output a signal corresponding to a count of photons incident on the pixel within one sampling.” Pet. 65–66 (citing Ex. 1003 ¶¶ 246–250). Specifically, Petitioner contends that Higashi discloses that when photons enter SPADs, they generate an output signal indicating that the photon has been detected. *Id.* at 66 (citing Ex. 1011 ¶ 27). Petitioner

asserts that Higashi discloses a pixel processing unit 31 and a readout circuit 52 which count photons within a sampling period for the pixels of the prior art combination. *Id.* at 66–68 (citing Ex. 1011 ¶¶ 27–28, 31–53, 55–56, 76, Figs. 4–7; Ex. 1003 ¶¶ 248–250).

Patent Owner does not dispute Petitioner’s contentions for claim 48.

After reviewing the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 48 would have been obvious over the combination of Imai, Higashi, and Grzesik.

9. Analysis of Claim 50

Claim 50 depends from claim 44 and recites “wherein the optical imaging system is configured to collect distance data based on recorded times between transmission of beams of electromagnetic radiation emitted from the plurality of emitters and detection of photons originating from the beams of electromagnetic radiation.” Ex. 1001, 22:41–46.

Petitioner contends that the combination of Imai, Higashi, and Grzesik discloses claim 50. Pet. 68–69. Specifically, Petitioner states 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.” Pet. 69 (citing Ex. 1009 ¶¶ 27, 40, 48, 51–54, 78–81; Ex. 1011 ¶ 20; Ex. 1003 ¶¶ 251–252). Petitioner further states that Imai teaches that a “distance calculating unit 46 . . . calculates the distance to the object from time difference between rise timing of the LD driving signal and detection timing of the light reception signal by the PD output detecting unit 44.” *Id.* (quoting Ex. 1009 ¶ 40). According to Petitioner, the times are recorded in Imai in order to effectuate the calculations. *Id.*

Patent Owner does not dispute Petitioner's contentions for claim 50.

After review of the evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 50 would have been obvious over the combination of Imai, Higashi, and Grzesik.

F. Ground 3: Obviousness Over Weimer, Borowski, and Hipp

We do not reach Ground 3 in this Decision because we have already decided that all challenged claims would have been obvious under Ground 2 (§ II.E), as discussed above.

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 '750 patent are unpatentable as obvious in Ground 2 over the combination of Imai, Higashi, and Grzesik notwithstanding Patent Owner's arguments. Therefore, we do not reach Grounds 1 and 3.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, pursuant to 35 U.S.C. § 318(a), claims 44–48 and 50 of the '750 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. § 90.2.¹²

¹² 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
44, 45, 48, 50	103	Retterath, Borowski ¹³		
~~44–48,~~ 50	103	Retterath, Borowski, Weimer		
44, 45, 48, 50	103	Retterath, Borowski, Hipp		
~~44–48,~~ 50	103	Retterath, Borowski, Weimer, Hipp		
~~44–48,~~ 50	103	Imai, Higashi, Grzesik	44–48, 50	
~~44–48,~~ 50	103	Weimer, Borowski, Hipp		
Overall Outcome			44–48, 50	

¹³ Because we determine that claims 44–48 and 50 are unpatentable on the Imai, Higashi, and Grzesik ground, we do not reach the remaining grounds.

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