
BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.
Petitioner

v.

OUSTER, INC.,
Patent Owner

Patent No. 11,422,236
Inter Partes Review No. 2023-01458

PATENT OWNER PRELIMINARY RESPONSE

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Statement of Material Facts in Dispute

Petitioner did not submit a statement of material facts in its Petition.
Accordingly, no response is due pursuant to 37 C.F.R. § 42.23(a), and no facts are admitted.

I. Introduction

Ouster, Inc. (“Ouster” or “Patent Owner”) respectfully submits this Preliminary Response in response to the Petition for *Inter Partes* Review filed by Hesai Technology Co., Ltd. (“Hesai” or “Petitioner”) challenging Claims 1-2 and 7-27 of U.S. Patent No. 11,422,236 (“the ’236 Patent” or “the challenged patent”). The ’236 Patent relates to a rotating LIDAR system for obtaining distance information in a field 360 degrees around the subject. 360-degree rotating LIDAR systems were known in the art, but prior art systems such as the one described in the Hall patent used fundamentally different lasers and detectors from the ’236 Patent. The ’236 Patent embodies Ouster’s core innovation, a rotating LIDAR system using vertical cavity surface emitting lasers (VCSELs) for emitters and a staggered array of single photon avalanche diodes (SPADs) as receptors, resulting in a digital sensor with high resolution. Each of Petitioner’s grounds for challenging Ouster’s novel invention is legally deficient for the reasons identified below. Accordingly, institution should be denied.

Hesai focuses on the prior art references that, at first glance, look visually similar to the devices described in the ’236 Patent. But Hesai wholly ignores what these references explicitly teach. Prior to Ouster’s invention, the unique combination of VCSELs and SPADs was a configuration that the prior art expressly taught away from and that presented clear technical challenges that

would have dissuaded a POSITA. The Hall reference, for example, leveraged the analog nature of its traditional avalanche photodiodes (APDs) to ignore early reflections caused by fog – an important function that would not have worked with highly sensitive SPAD arrays, which operate in a digital manner. Likewise, the Matsui reference considered the kinds of modifications that Hesai proposes, such as using multiple emitters in place of a single laser, and concluded that any benefits to such improvements were not worth the increased cost and complexity. Ouster’s invention was something the industry viewed as impossible; something Ouster only achieved with the unconventional combination of VCSELs and SPAD arrays. Hesai has not demonstrated that a skilled artisan would have reached the claimed combinations; it has merely used the claim language itself in an attempt to reconstruct the claimed invention using impermissible hindsight, ignoring the explicit teachings of the prior art, and improperly assuming a reasonable expectation of success.

Hesai’s obviousness positions are legally deficient because the prior art fails to disclose or suggest features required by the four challenged independent claims (1, 10, 16, and 23) including, at least:

- “a plurality of pixels arranged behind the bulk receiving optic, wherein each pixel in the plurality of pixels comprises a plurality of single photon avalanche diodes (SPADs) and wherein the plurality of

pixels includes a first set of pixels arranged in a first column and a second set of pixels arranged in a second column horizontally and vertically offset from the first column” (*see* Sections VII.A.i.b and VII.B.i.b *infra*);

- “each pixel in the plurality of pixels traverses a unique circular path parallel to and vertically offset from a unique circular path traversed by every other pixel in the optical system” (*see* Sections VII.A.i.c and VII.B.i.c *infra*);

Finally, as explained in Section VII.C below, the Petition also fails to meet its burden to show a POSITA would have had a reasonable expectation of success in combining the references to meet the limitations of the claimed invention. The Petition does not address the readily apparent difficulties in combining the references arising from their contradictory teachings and merely makes conclusory statements about a POSITA’s “reasonable expectation of success in combining these references using basic engineering principles.” *E.g.*, Petition at 16, 35-36, 43-4, 57, 74-75, 80.

In view of the foregoing, the Petition fails to demonstrate that there is a reasonable likelihood that at least 1 of challenged claims 1-2 and 7-27 of the ’236 Patent is unpatentable. Institution should be denied.

II. Background

Ouster is a pioneer and market leader in the digital LIDAR industry providing powerful and cost-effective digital LIDAR remote sensing solutions. Ouster's LIDAR provides real time "camera like" mapping of the external environment flexible enough to serve a wide variety of automotive, industrial, smart infrastructure, and robotics applications. Founded in 2015, Ouster set out in an entirely different direction from the then fledgling LIDAR industry. At the time, the LIDAR industry relied on slow, analog sensors such as avalanche photodiodes (APDs) that were low resolution, costly, and difficult to manufacture. Ouster's goal was to produce a LIDAR system that would be cost effective, high resolution, and ubiquitous in the industry. After years of research at its San Francisco headquarters, Ouster created a revolutionary LIDAR system that transformed LIDAR from an analog device with thousands of components to an elegant digital device powered by one chip-scale laser array and one CMOS sensor array. The result of this system is a full range of high-resolution LIDAR sensors that create first-of-their-kind "camera like" images at a dramatically lower price and with a simplified manufacturing process. Ex. 1021 at 2-5.

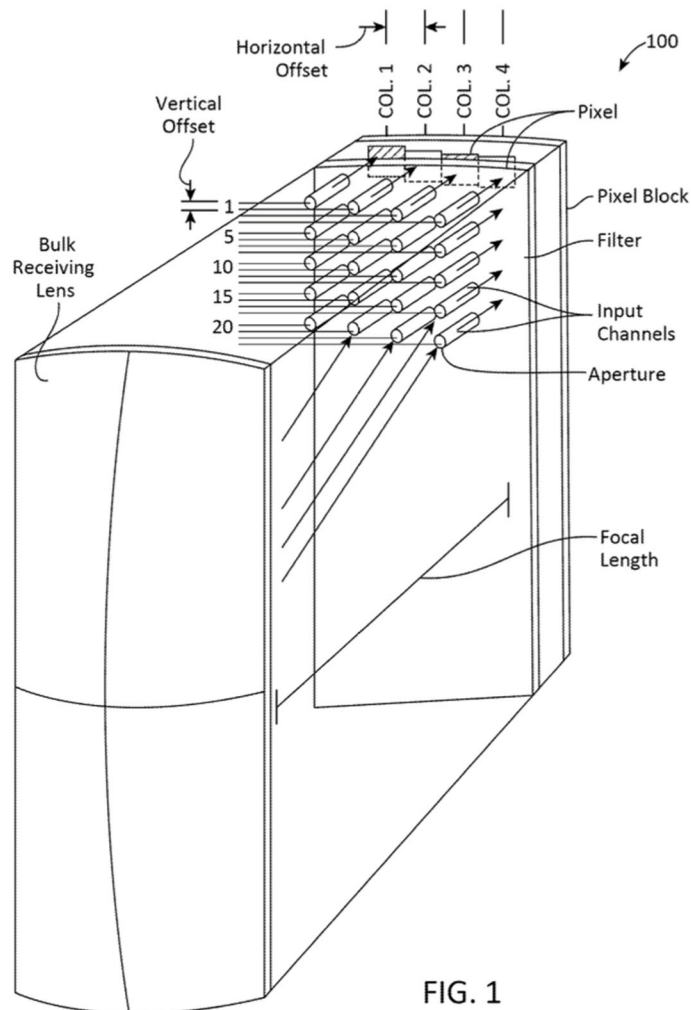
Ouster was able to achieve this remarkable success by employing the unique laser-detector combination that the industry viewed as impossible: employing vertical cavity surface emitting lasers (VCSELs) for emitters and single photon

avalanche diodes (SPADs) as receptors. After years of development, Ouster was able to solve the complex technical issues of using VCSELs and SPADs together by utilizing a simplified architecture based on two silicon chips. This allowed for more emitters and receptors in the product and resulted in a digital sensor with higher resolution. The digital architecture also greatly increased scalability, allowing Ouster to continually take advantage of ongoing advancements in semiconductor processing technology (often referred to as Moore's Law) to deliver cheaper and higher performing products. While analog LIDAR companies undertook engineering efforts to produce next generation products, Ouster's technology transformed the industry by allowing the integration of new chip sets into the same hardware platform. This resulted in both higher performance and lower costs. *Id.*

The invention of the '236 Patent embodies Ouster's innovative architecture, using VCSELs and SPADs together. Titled "Optical System for Collecting Distance Information Within a Field," the '236 Patent claims priority to a provisional application filed on August 24, 2016. Ex. 1001 at 1:8-15.

The '236 Patent describes an embodiment that uses arrays of VCSELs and SPADs arranged behind bulk transmitting and receiving optics respectively. The representative LIDAR system is comprised of a bulk transmitting optic and illumination sources, "a bulk receiving optic configured to collect illumination

beams of a plurality of illumination sources reflected from a field outside the optical system,” a staggered matrix pixel array, “and a set of input channels interposed between the first transmitting bulk receiving optic and the pixel array.”
Ex. 1001 at Fig. 1; 1:42-55, 11:8-14. The illumination source is a VCSEL array arranged behind a bulk transmitting optic. *Id.* at 11:15-17. Figure 1 below shows the input module or circuit of the LIDAR system.



Ex. 1001 at Fig. 1.

“[T]he bulk receiving optic functions to collect light (i.e., electromagnetic radiation) from outside the system; and each input channel functions to collect light from the bulk receiving optic, to filter this light, and to pass light over a relatively narrow wavelength band to a corresponding pixel in the pixel block.” Ex. 1001 at 9:11-16. *See e.g. id* at 2:21-26, 9:17-43, 10:10-27.

The pixel block includes pixels comprised of one or more detectors (including SPADs) where the pixels are configured in a skewed grid array. Ex. 1001 at Abstract; Fig. 2; 4:66-5:22, 5:52-54, 6:8-15, 11:15-17. Further, “[t]he system can also include an actuator that rotates the pixel block, the input channels, and the bulk receiving optic about a vertical axis such that each pixel (and each corresponding input channel) traverses a unique circular path parallel to and vertically offset from a unique circular path traversed by each other pixel in the system during a single rotation of the rotary actuator (hereinafter a ‘scan cycle’).” *Id.* at 4:66-5:5. Additionally, the ’236 Patent explains that by using “multiple vertically- and horizontally-offset columns of pixels, each pixel in the system can ...include a greater number of detectors and exhibit a greater dynamic range” than existing systems with “only a single column of pixels” with the same effective pixel pitch. *Id.* at 5:12-22. This results in a skewed grid that assists with distortion correction. *Id.* at 12:42-14:24.

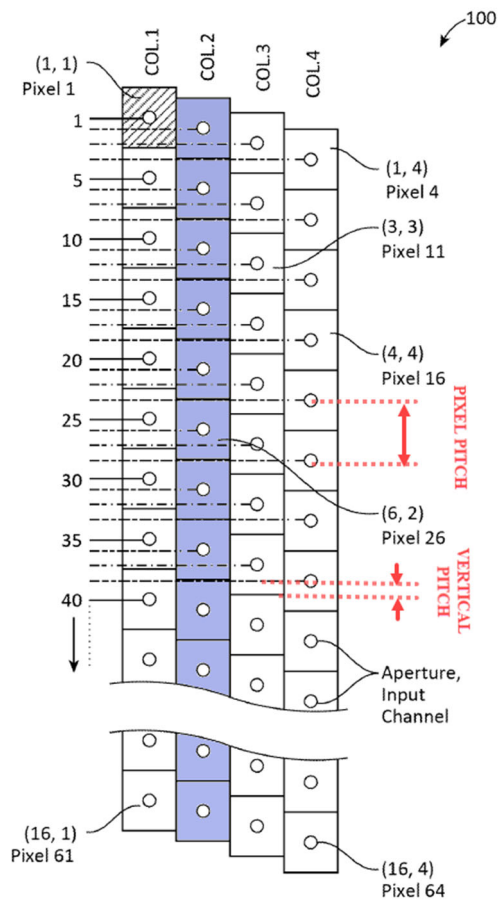


FIG. 2

Ex. 1001 at Fig. 2 (modified).

The many advantages and benefits of the claimed LIDAR system demonstrate that the USPTO's decision to grant the '236 Patent is consistent with the primary goal of the patent system: rewarding innovation for the benefit of society.

III. Person of Ordinary Skill in the Art

A person of ordinary skill in the art (POSITA) is a hypothetical person presumed to be aware of all pertinent art, to think along with conventional wisdom in the art, and to have ordinary creativity. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 407-09, 420-21 (2007). For the limited purpose of this Preliminary Response, Patent Owner does not dispute Petitioner's definition of a POSITA as having an undergraduate degree in mechanical engineering, electrical engineering, or physics, and two to three years of experience in LIDAR design. Petition at 9.

IV. Claim Construction

A. Applicable Law

Claims are ordinarily given their “ordinary and customary meaning,” which is “the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-13, 1315 (Fed. Cir. 2005) (citation omitted). To construe a claim term, the PTAB should look to “the words of the claims themselves, the remainder of the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art.” *Id.* at 1314 (citation omitted). “A patent’s specification, together with its prosecution history, constitutes intrinsic evidence to which the PTAB gives priority when it construes claims.” *Knowles Elecs. LLC v. Cirrus Logic, Inc.*, 883 F.3d 1358, 1361-

62 (Fed. Cir. 2018) (footnote omitted).

For purposes of this preliminary response, Patent Owner agrees with Petitioner that no formal constructions are necessary.

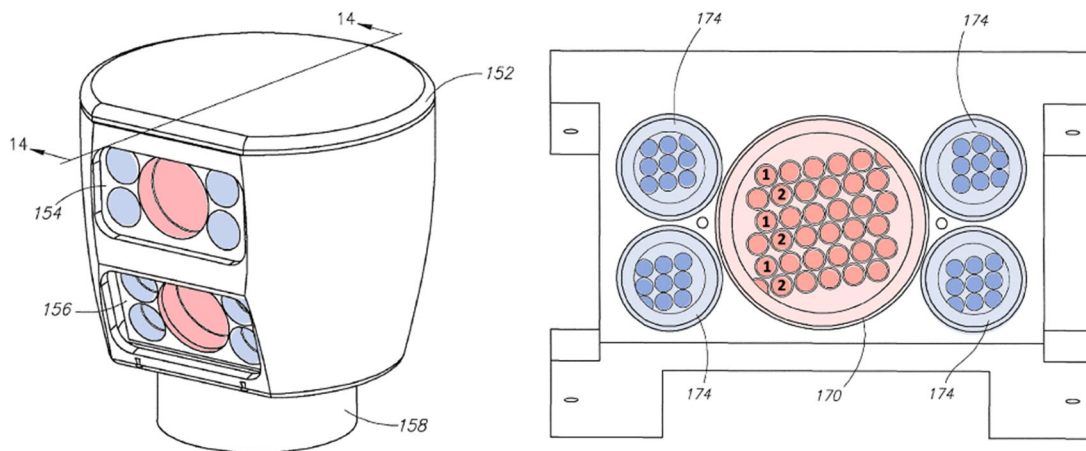
V. The Prior Art

A. Hall (Ex. 1004)

U.S. Patent No. 7,969,558 to Hall (Ex. 1004) is directed to a rotating LIDAR-based “3-D point cloud measuring system” with a plurality of emitters and a plurality of detectors. Ex. 1004 at Abstract. Hall explains that in a LIDAR system, “each distance measurement can be considered a pixel, and a collection of pixels emitted and captured in rapid succession (called a ‘point cloud’) can be rendered as an image or analyzed for other reasons such as detecting obstacles.” *Id.* at 1:21-24. Hall explains that some LIDAR systems using a single laser emitter and detector with a moving mirror to “render a 2-D (i.e., single plane) point cloud” consisting of distance measurements along a straight line. *Id.* at 1:32-39; Figs. 1-2. Hall further explains that such a single emitter/detector device “can be employed to capture an entire 3-D array of distance points” by rotating the entire device on a gimbal, or by using optics to divide the laser beam. *Id.* at 1:45-2:9. The first approach, however, can only capture “one point at a time,” whereas the latter approach lacks resolution because splitting the laser beam “causes the point cloud to be less dense, but cover a broader area.” *Id.* Hall stresses that none of these

systems are adequate for the task of autonomous vehicle navigation, where “it is necessary to see everywhere around the vehicle, almost a full 360 degrees, in order to safely navigate today’s highways,” while also “hav[ing] a minimum of delay between the actions happening in the real world and the imaging/reaction to it.” *Id.* at 2:35-60. Hall also explains that because “human response time is in the several tenths of a second,” a navigation computer must receive imaging updates at least 5 to 10 times per second. *Id.* at 2:49-54.

To achieve the demands of autonomous vehicle navigation, Hall discloses the rotating housing shown in the Figures 13 and 22 annotated by Petitioner below, with multiple transmitters behind lenses shown in blue, and multiple detectors behind a receive lens in red. Hall’s system is mounted on top of a vehicle and rotated at a rate of up to 200 Hz, thereby providing “the unique combination of 360 degree FOV, high point cloud density, and high refresh rate.” Ex. 1004 at 4:5-13.



Id. at Figs. 13, 22 (annotated by Petitioner). To accomplish this goal, the emitters and detectors are held in a fixed relationship to each other, and each emitter/detector pair is controlled by circuitry that controls the timing and intensity of the laser, records time-of-flight, and calculates the height of the measured point. *Id.* at 3:15-17, 5:11-15. The emitter/detector pairs are aligned to measure ranges between 500 feet and 20 feet. *Id.* at 5:8-11. Hall further explains that the device has the additional advantages of being compact, rugged, and having relatively simple embedded circuitry. *Id.* at 3:28-31, 5:26-31 (explaining that by firing only a few lasers at a time, expensive detection circuitry can be minimized by sharing it among several detectors), 6:21-25 (“A small footprint is achieved through the use of embedded DSP technology.”).

Hall is unconcerned with the number and physical arrangement of the emitters and detector arrays, so long as each emitter is aligned with at least one detector, and vice versa. Hall explains that the precise number of emitters and detectors can vary, as a single laser beam can be divided into several smaller beams, with each smaller beam focused on its own detector, and conversely a single detector can be shared by multiple lasers so long as only one laser fires at a time to avoid ambiguity as to which laser is firing. Ex. 1004 at 3:18-24, 4:63-67. As such, Hall never correlates pixels to any individual detector in the device. Likewise, Hall provides little explanation for how the emitters and detectors are

arranged in Figure 22, and his description does not match what Figure 22 shows. For example, Hall describes Figure 22 as showing emitters “organized relatively horizontally” within cavity 174; Hall says nothing about whether the emitters are offset from each other in any way. *Id.* at 6:67-7:3. Likewise, Hall does not explain whether each of the smaller circles within cavities 174 and 170 in Figure 22 corresponds to an emitter or detector respectively. Thus, whereas Figure 22 as annotated by the Petitioner shows nine dark blue circles within each emitter cavity 174, and 36 dark blue circles in Figure 22, Hall explains that “behind each of the lenses in the cavity 174, *are 16 laser emitters* organized relatively horizontally, thereby combining *for 32 total emitters.*” *Id.* at 6:67-7:3 (emphasis added). Moreover, although Figure 22 shows 36 small dark red circles within receiver cavity 170, Hall states that “[b]ehind the lens of the cavity 170 *are 32 detectors.*” *Id.* at 7:3-5 (emphasis added).

Hall does not disclose the use of VCSEL emitters or a plurality of SPADs as detectors. Instead, Hall only discloses the use of conventional laser diode emitters (“preferably an OSRAM 905 nm emitter”) and APD detectors. Ex. 1004 at 5:5-7; *see also* Ex. 1026. Hall’s device is configured for the use of conventional high-powered lasers and analog APDs. Hall explains that a key feature of his device is that it “works well under all lighting and most weather conditions” by dynamically varying the intensity of the laser based on the strength of the reflection signal

detected by the APDs. Ex. 1004 at 4:19-29. “A direct benefit of this feature is that the Lidar system is capable of seeing through fog and heavy rain by *increasing laser power dynamically and ignoring early reflections.*” *Id.* (emphasis added).

Hall further explains that the use of analog APDs confers the “capability to receive and decipher multiple returns from a single laser emission through digitization and analysis of the waveform generated by the detector as the signal generated from the emitter returns.” *Id.* at 4:30-33.

B. Borowski (Ex. 1005)

U.S. Publication No. 2013/0300840 to Borowski (Ex. 1005) discloses a 3D landscape imaging system that includes an “illuminating part” which generates very short pulses of laser light, and a “receiving part” that detects the returned laser light. Ex. 1005 at Abstract; [0001]-[0002]. Borowski uses arrays of SPADs arranged in a vertical direction to obtain high-resolution images of the surrounding landscape. *Id.* at [0007], [0008], [0046], [0050]. Borowski describes extensive circuitry that is required to use highly sensitive SPAD arrays in an imaging system, including local DSPs associated with “macro-cell” clusters of SPADs that “perform various operations mainly for multiplexing and averaging the detected events of the SPAD detector cells” so that clusters of SPADs can operate as the equivalent of “a single ‘perfect’ SPAD having no recovery time.” *Id.* at [0053]. Because individual SPADs are highly sensitive and could be triggered by

unwanted light, Borowski discloses that “[a]n important operation of the local DSP is the blanking (suppression) of some received light pulses” such as “other illuminating pulses” aimed “at a different focus on the illuminated landscape.” *Id.* at [0051]-[0052]. The entire SPAD array also requires an additional global DSP to “combine data from multiple sensors in a complete 3D representation.” *Id.* at [0054].

All of Borowski’s 360-degree long-range imaging embodiments are intended to produce high-resolution imagery in static applications, not for use on moving vehicles. Moving objects in the frame are undesirable nuisances that Borowski’s device attempts to remove from subsequent frames via compensation. For example, Borowski discloses a high-resolution landscape imager used to “continuously captur[e] 3D data” around the device that can be used for “tele-monitoring of a site.” *Id.* at [0045]. Although this system can detect “movement of at least some objects in the landscape,” Borowski explains that such movement is undesirable, and uses detected movement to remove movement from subsequent captured frames. *Id.* at 45 (“A movement *estimation and compensation means* is associated to the 3D real-time imager to allow the imaging of a real world with moving objects”) (emphasis added), [0055], [0073] (disclosing firing the emitter only once per ten rotations “to limit effects of the movements of the targets”). Borowski further notes that such a compensation operation is “data intensive and

best done locally on board of the integrated circuit containing a SPAD detector array.” *Id.* at [0055]. Likewise, Borowski never discloses that these landscape imagers could be used on moving vehicles or other objects.

In contrast, Borowski discloses only one device that may be used with moving vehicles, a “3D Short Distance Landscape Imager” shown in Figure 7 below. Ex. 1005 at [0177]-[178].

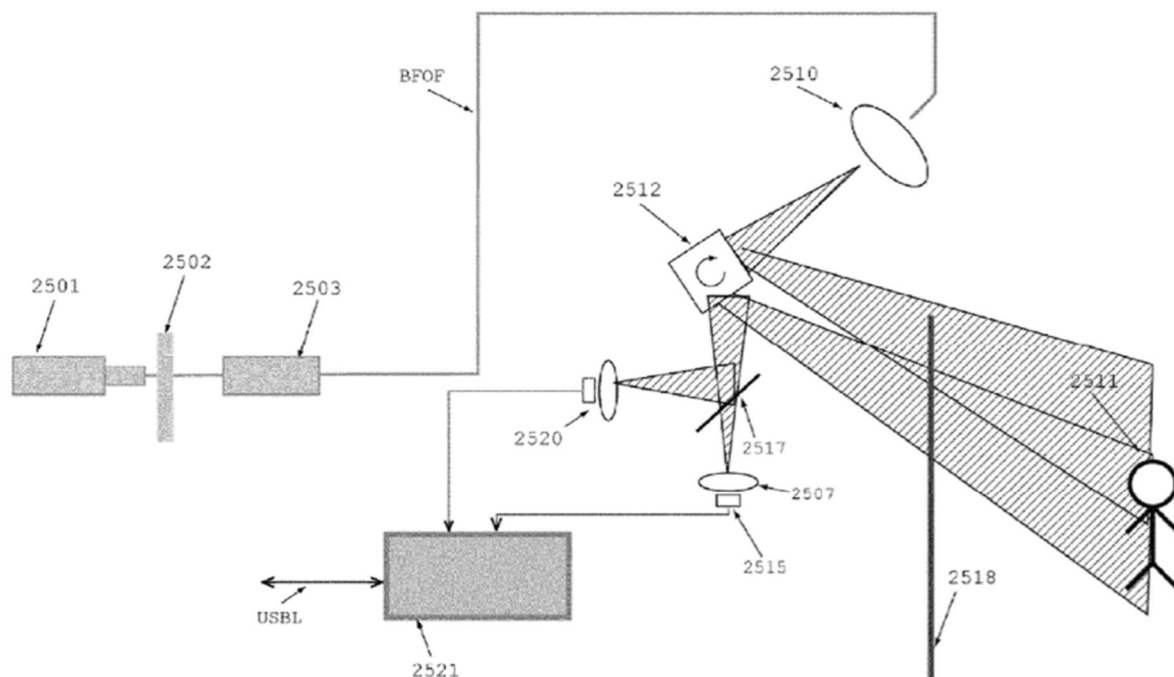


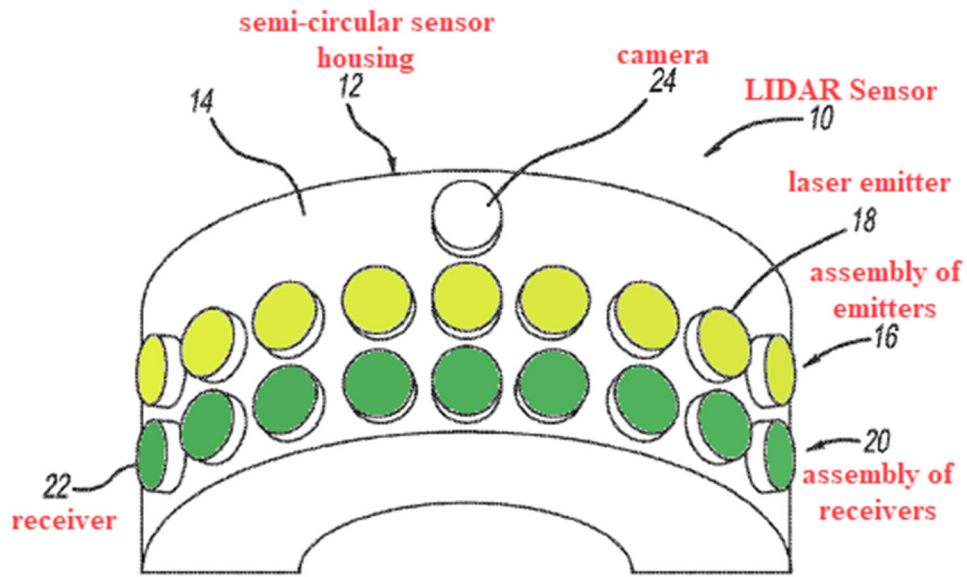
Fig. 7

This device is dramatically different from Borowski’s 360-degree landscape imagers, as it only covers an “angular range of 90° horizontally and 30° vertically.” *Id.* at [0178]. Borowski does not disclose using this device for vehicle navigation, perhaps because even though it has “a precision of relief in the millimeter range”

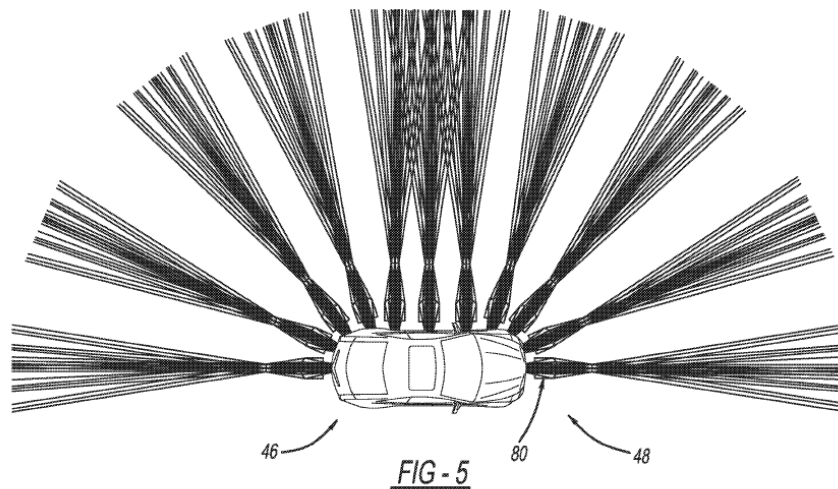
and an acquisition time “in the millisecond range,” it has an imaging range of only “a few meters around the imager.” *Id.* Moreover, even with the faster capture speed of this device, Borowski explains that “[m]ovement estimation and compensation will [still] be needed.” *Id.* Like its long-distance landscape imager, Borowski’s short-range imager also requires extensive circuitry to support the SPAD arrays, including local DSPs associated with each SPAD array and an additional global DSP to synthesize a 3D image of the landscape. *Id.* at [0191], [0192], [0201], [0202].

C. Lipson (Ex. 1006)

U.S. Patent No. 9,831,630 to Lipson (Ex. 1006) discloses a 180° field of view LIDAR system with VCSEL emitters where the sensors, which may include a SPAD detector, are arranged in a non-rotating linear configuration. Ex. 1006 at Claims 3, 13, and 16; 3:51-4:13; 7:12-15. *See e.g.*, Figs. 1, 4, and 5.



Ex. 1006 at Fig. 1 (modified).

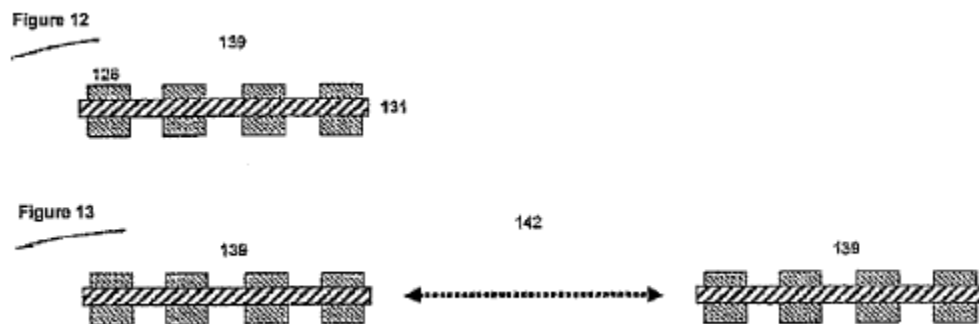


Id. at Fig. 5. According to Lipson, prior art rotating LIDAR systems “typically suffer from being bulky and typically lack robustness” in addition to being “generally too costly to be implemented in mass produced vehicles.” *Id.* at 2:1-5,

2:32-34. Lipson further explains that the fixed linear configuration lacks these “drawbacks in the prior art...by not having any moving parts.” *Id.* at 4:39-43.

D. Hipp (Ex. 1007)

U.S. Patent No. 7,787,105 to Hipp (Ex. 1007) discloses “taking of a large number of distance images having distance picture elements [where] [e]lectromagnetic radiation is transmitted in the form of transmission pulses at objects, and reflected echo pulses are detected.” Ex. 1007 at Abstract. Hipp explains that sensors working with the pulse TOF method return distance measurements faster than if CCD cameras were used. *Id.* at 6:1-7:13. Hipp further discusses the use of masking the active zones of APD sensors (*see* Fig. 12) arranged in a one-dimensional array (*see* Fig. 13). Ex. 1007 at 19:17-23. Hipp recognizes that employing a mask only reduces – but does not eliminate – interference signals to the APD sensors. *Id.* at 22:1-17.



Ex. 1007 at Figs. 12-13.

E. Tan (Ex. 1008)

U.S. Patent No. 7,544,945 to Tan (Ex. 1008) discloses a Vertical Cavity Surface Emitting Laser (VCSEL) array laser scanner for vehicle-based LIDAR systems. Ex. 1008 at Abstract. Tan discloses that existing rotating LIDAR systems have disadvantages for use in vehicle navigation because the rotation motors “can require significant power, and the presence of moving parts can increase the likelihood of device failure,” and because “for many vehicles, particularly automobiles, it is desirable to locate lidar devices in perimeter positions that consume as little space as possible” rather than on the roof of the vehicle. *Id.* at 1:46-62.

To address these disadvantages, Tan discloses a fixed array of VCSEL emitters intended to “*replace* lidar laser systems that employ mechanically rotated...optics.” Ex. 1008 at 3:6-8 (emphasis added). Tan further describes an array of low divergence angle lasers that can be activated one at a time, instead of mechanically moving reflective optics for a single laser. Each addressable laser produces a collimated light beam in a different direction, covering a wider area than a single laser. These beams then bounce off objects in the vehicle’s surroundings, and the reflected light is detected via a photodetector. *Id.* at 6:15-43. Tan does not specifically mention SPADs among the kinds of photodetectors that

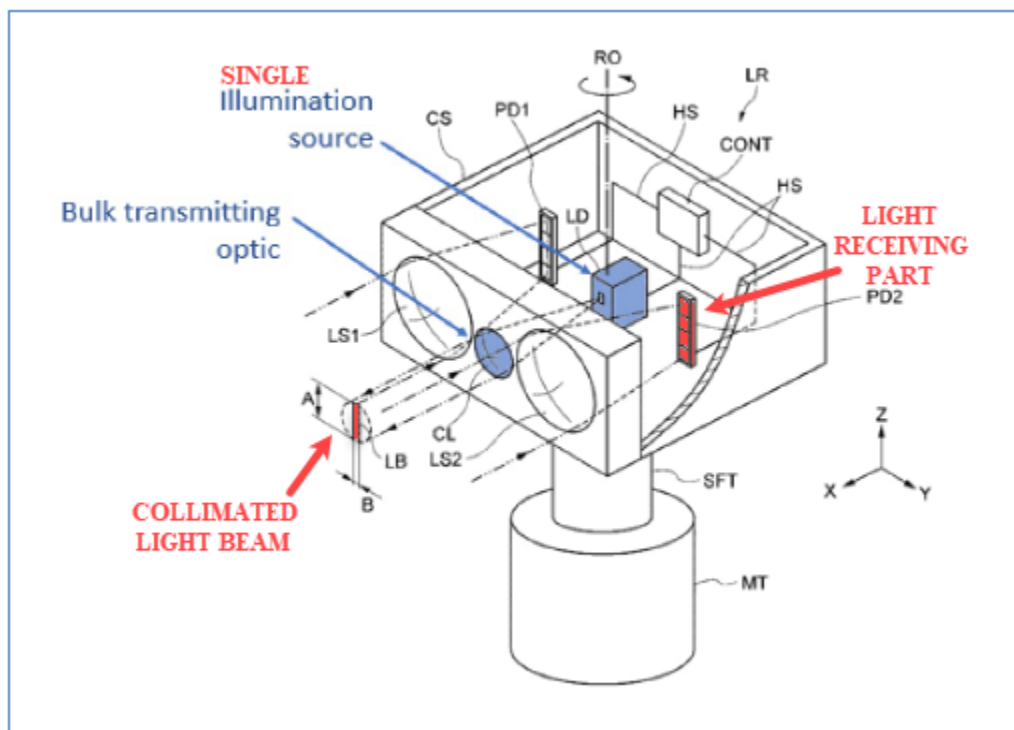
may be used with the laser array. Instead it generically refers to “avalanche photodiodes.” *Id.* at 9:23-28.

F. Weimer (Ex. 1029)

U.S. Patent No. 8,736,818 to Weimer (Ex. 1029) discloses “electronically steered flash LIDAR systems and methods in which illumination within a scene is adaptively controlled.” Ex. 1029 at 1:5-8. Weimer generally notes various spot light sources may be applicable, including a laser, pulsed laser, array of multiple lasers, VCSEL, laser array. *Id.* at 1:56-59, 9:34-37; Petition at 40-42. Weimer, focusing on the illumination signal, does not mention SPADs while generally discussing a multiple pixel detector where pixels may be arranged in a 2-D array. Ex. 1029 at 8:48-9:6.

G. Matsui (Ex. 1031)

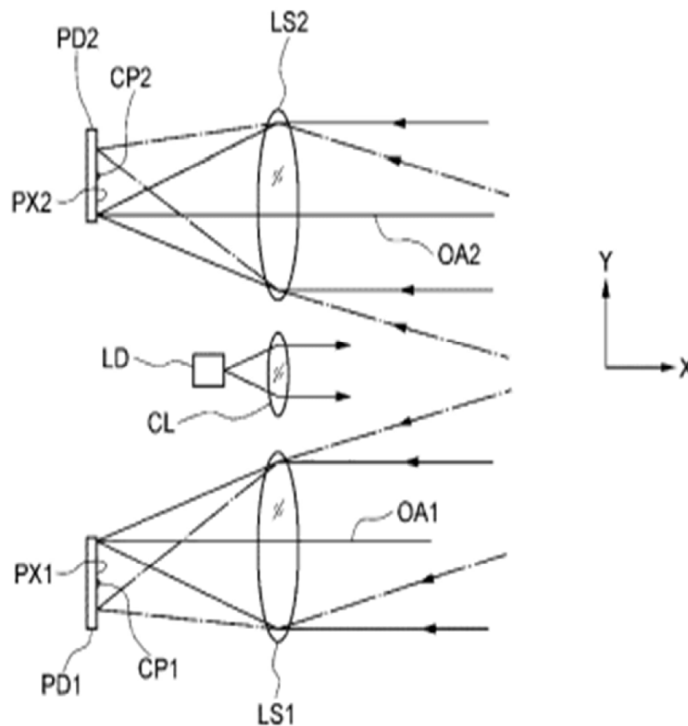
WO Publication 2017/110573 to Matsui (Ex. 1031) discloses a laser radar LR system with a single illumination source, semiconductor laser LD, which emits divergent light in a pulsed fashion. Ex. 1031 at [0016]-[0017]. The light is then vertically elongated by “conver[sion] into a collimated light beam LB by the collimating lens CL and [then] irradiated toward the object” of interest. *Id.* at [0024]-[0025].



Petition at 58 (modified with annotations in red); *see also* Ex. 1031 at Fig. 2; [0016]-[0017]. Matsui also teaches two receiving lenses (LS1, LS2), separated by a collimating lens, where a stand-alone light receiving part (PD1, PD2) is behind each lens. *Id.* at Fig. 4; [0017] (“first lens (first light reception optical system) LS1 that focuses the reflected light beam (first reflected light beam) from the object OBJ onto which light was projected and scanned; a first light receiving part PD1 that receives the light focused by the first lens LS1; a second lens (second light reception optical system) LS2 that is arranged on the side opposite to the first lens LS1 across the collimating lens CL and focuses another reflected light beam

(second reflected light beam) from the object OBJ; a second light receiving part PD2 that receives the light focused by the second lens LS2”), [0019]-[0022].

[FIG. 4]

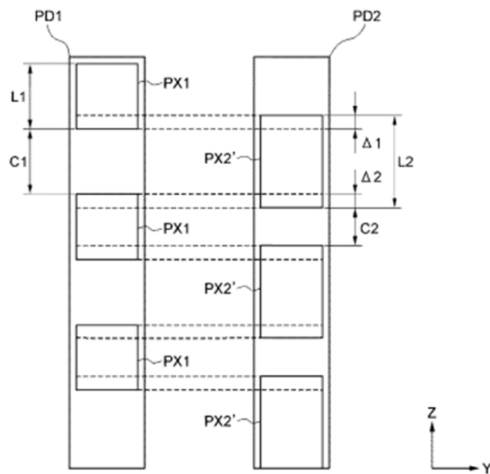


Id. at Fig. 4. Matsui further discloses two distinct and spaced apart one-dimensional arrays, light receiving parts (PD1, PD2), each comprised of light receiving elements (respectively PX1, PX2), that receive reflected light beams. *Id.* at Figs. 2, 14; Abstract, [0011], [0016]-[0020].

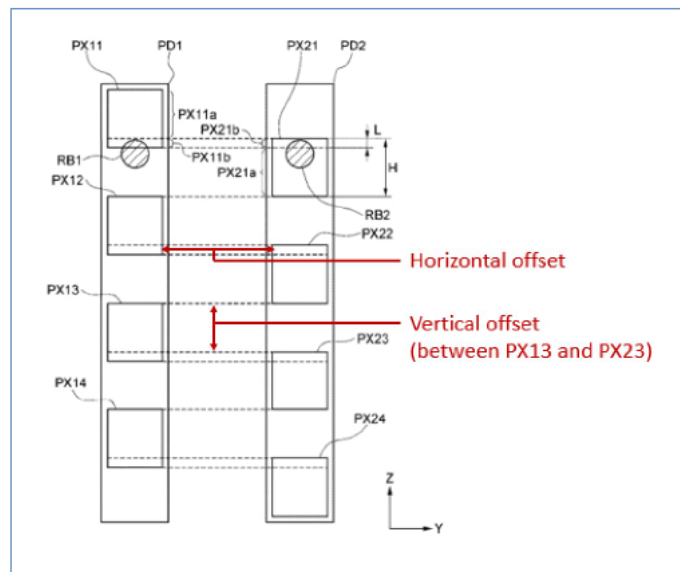
The one-dimensional light receiving parts (PD1, PD2) are arranged “such that at least two adjacent first light receiving elements PX1 would come into gapless contact with a second light receiving element PX2 interposed therebetween

when the first light receiving elements PX1 are shifted relative to the second light receiving elements PX2 in the second direction, thus providing high resolution with a simple configuration and making it possible to detect faint reflected light beams from an object while suppressing the input of ambient stray light.” Ex. 1031 at Abstract. And, shifting the light receiving elements (PX1, PX2) outward in the Y-direction achieves a “cost reduction and effective utilization of the light receiving parts PD1 and PD2 can be achieved.” *Id.* at [0023].

Additionally, the light receiving elements have unequal spacing, both between the light receiving elements as well as between the separate one-dimensional light receiving parts (PD1, PD2). Petition at 60; Ex. 1031 at Figs. 11, 14; [0036] (“the length in the Z direction of the first light receiving elements PX1 is L1, while the length in the Z direction of the second light receiving elements PX2’ is L2 (>L1). Furthermore, the interval between adjacent first light receiving elements PX1 is C1, while the interval between adjacent second light receiving elements PX2’ is C2, where the relationship $(L1+C1) = (L2+C2)$ obtains.”), [0037]-[0038].



Ex. 1031 at Fig. 11; [0036]-[0038].



Petition at 60; *see also* Ex. 1031 at Fig. 14; [0036]-[0038].

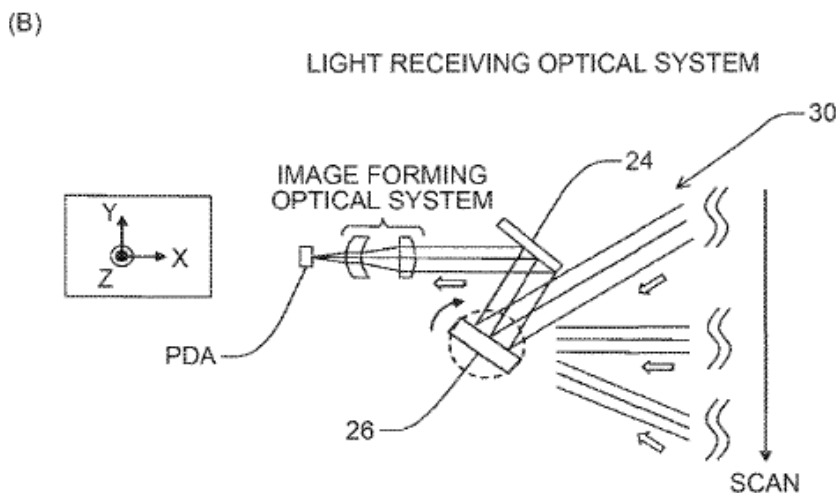
Matsui also discloses analog APDs as light receiving elements, noting that “in order to increase the resolution of the object to be detected, multiple light receiving elements that receive reflected light may be arrayed to ensure high resolution.” Ex. 1031 at [0003].

Finally, Matsui discloses that a key feature of his invention is its low cost and low complexity. Ex. 1031 at [0010] (“It is an ***objective*** of the present invention to provide a radar, and a light projection/reception unit for use therein, which makes it possible to achieve high resolution and ***reduce detection failure while keeping costs down.***”) (emphasis added); *see also, e.g., id.* at Abstract, [0009], [0013], [0023], [0038]. In particular, Matsui stresses the importance of using only one laser, explaining that “providing numerous light sources and light receiving elements causes the cost to increase greatly.” *Id.* at [0009].

H. Imai (Ex. 1033)

U.S. Patent No. 10,114,110 to Imai (Ex. 1033) relates to an object detecting device, sensing device, and mobile object device designed to detect the presence of objects and their distance. Ex. 1033 at 1:15-21. Imai explains an object detecting device includes a light source with multiple light emitting units arranged in a sub-scanning direction, a deflector, and an optical detector with multiple light receiving units. *Id.* at Abstract. Imai aimed to improve detection resolution in a sub-scanning direction without increasing data acquisition time or decreasing detection range. *Id.* at 16:22-25. Imai focuses on the arrangement of multiple light emitting units (including VCSELs) and a corresponding array of light receiving units, with provisions for specific electrical connections and timing control of light emission. *Id.* at 14:40-54. Imai mentions that a substitution of “an APD (avalanche

photodiode) or a SPAD (single photon avalanche diode)” for the photodiode (PD) that is detailed throughout the text because APDs and SPADs have “higher sensitivity.” *Id.* at 5:1-8. Additionally, Imai’s system explained that in conjunction with the PDs, additional optics and mechanical considerations, such as a rotary mirror 26 and a light reflecting mirror 24 are required. *Id.* at Fig. 2; 3:15-37, 4:13-59.



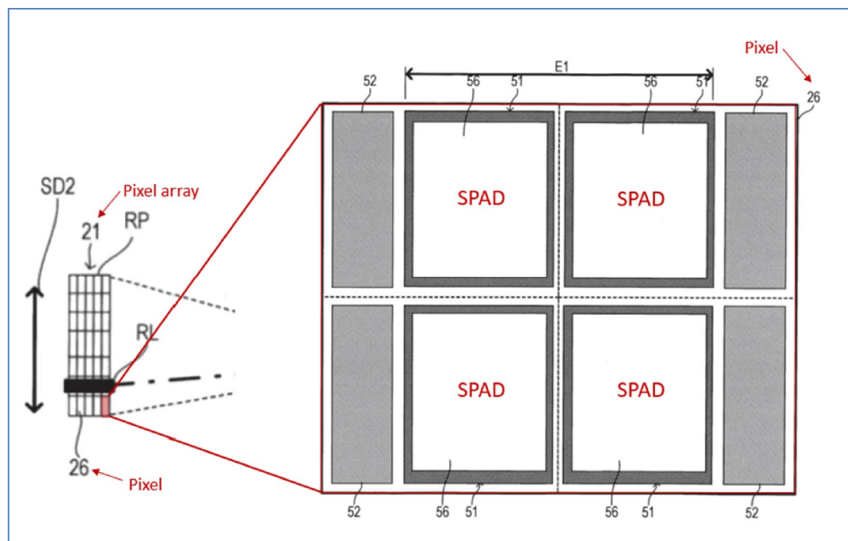
Id. at Fig. 2. The purpose of the light reflecting mirror 24 is to redirect light on the optical path between the coupling lens 22 and the rotary mirror 26. *Id.* at 4:13-59.

Imai explains that this redirection allows for a more compact device design and facilitates the deflection of the light around the Z-axis by the rotary mirror, which in turn projects a beam across a target area. *Id.* Further, the reflecting mirror directs light towards the PDs to assist with timing the light emissions. *Id.*

I. Higashi (Ex. 1034)

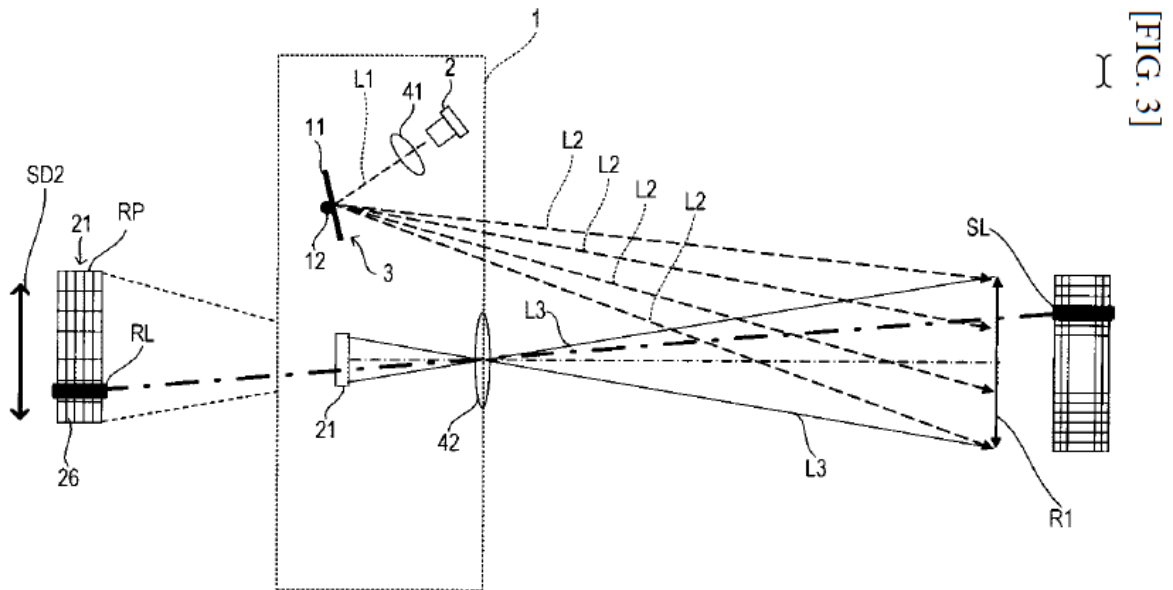
JP Publication No. 2015-78953 to Higashi (Ex. 1034) discloses a radar device 1 applied to vehicles, encompassing a light source 2, a one-dimensional scanner 3, a scan control unit 4, a light detection unit 5, and a processing unit 6. Ex. 1034 at Abstract; Claims 1, 15, 16; [0015]. The light source – a semiconductor laser diode – emits pulsed laser light; a one-dimensional scan directing the emitted light at a predetermined scanning angle is achieved with a rotating mirror 11. *Id.* at [0016]-[0017].

Higashi discloses the use of SPAD detectors in a pixel. Ex. 1034 at [0027].



Petition at 71-72 (showing “Figure 3 (excerpted) and Figure 4”). Additionally, Higashi teaches a single light source that uses a collimating lens and mirror scan a predetermined scanning angle range which varies depending upon vehicle speed. Ex. 1034 at Figs. 2, 3; [0023] –[0024], [0062]. The “laser light is shaped into a

rectangular shape.” *Id.* at [0025]. Thus, the geometry of the light receiving surface is defined “such that the longitudinal length of the reflected light shaped into a rectangular shape is longer than the short direction length of the light receiving surface RP formed into the rectangular shape.” *Id.* at [0025]-[0026].



Id. at Fig. 3.

The detection unit, a pixel array arranged in a two-dimensional matrix, detects the reflected light. Ex. 1034 at [0018], [0065]. Additionally, depending on the vehicle speed, both the light intensity and the predetermined scanning angle of the one-dimensional scanner change. *Id.* at [0078]-[0080].

VI. Overview of Arguments

The Board may institute an *Inter Partes* Review (IPR) proceeding only if Petitioner demonstrates that there is “a reasonable likelihood that the petitioner

would prevail with respect to at least 1 of the claims challenged in the petition.” 35 U.S.C. § 314 (2018). Petitioner has failed to meet that burden, and institution should be denied.

Ground 1 relies on a combination of Hall as the primary reference and at least Borowski as a secondary reference. Ground 2 relies on a combination of Matsui as the primary reference and at least Imai as a secondary reference. However, each of Hall and Borowski and Matsui and Imai fail to disclose or suggest elements of the four independent claims (1, 10, 16, and 23) for which the Petition relies upon them. Moreover, the Petition’s purported motivations to combine Hall and Borowski and Matsui and Imai are inconsistent and conclusory. Hall and Borowski, and Matsui and Imai teach away from combination with one another and teach away from the claimed invention. Yet Petitioner and its expert fail to acknowledge or address the readily apparent difficulties in combining the references to achieve the claimed invention. In addition, to the extent these references disclose select features of the claimed invention, Petitioner simply cherry picks features from each reference and argues for the combination of these particular features with no motivation beyond that of reconstructing the claimed invention with the benefit of hindsight, while ignoring how the references teach away from the purported combinations. For purposes of this preliminary response,

Ouster has selected and addressed only a small subset of example issues sufficient to show the Petition should not be instituted.¹

A summary of Patent Owner's arguments and Petitioner's deficiencies is provided below.

Ground	Deficiencies of the Ground
1A: Hall in view of Borowski	• Hall <i>teaches away</i> from using SPAD arrays in place of APDs • Borowski also teaches away from using SPAD arrays in the vehicle of Hall • Hall does not teach the claimed arrangement of pixels and also shows only detectors, not pixels
1B through 1G	• The claims challenged in these grounds depend from independent claims in Ground 1A or recite the same limitations, and therefore these grounds are deficient for the same reasons as Ground 1A • The additional references do not teach the missing pixel limitations and teach away from Hall
2A	• Matsui <i>teaches away</i> from using multiple emitters or SPAD arrays as detectors • Imai does not teach replacing each detector with an array of SPADs • Matsui does not teach the claimed arrangement of pixels
2B through 2G	• The claims challenged in these grounds depend from independent claims in Ground 2A, and therefore these grounds are deficient for the same reasons as Ground 2A

¹ By making certain arguments in this Preliminary Response under 35 U.S.C. § 314, Patent Owner does not waive the right to present additional arguments should the Board institute *inter partes* review proceedings, including arguments that one or more references relied on in the Petition are not prior art to the '236 Patent.

VII. Petitioner has not demonstrated that there is a reasonable likelihood that it would prevail with respect to at least one of the challenged claims.

A. Ground 1 is unlikely to prevail because it fails to satisfy the legal requirements for obviousness.

In Ground 1, Petitioner asserts that the combination of Hall and Borowski renders the claims obvious. (Petition at 10). Petitioner bears the burden of demonstrating that subject matter was obvious in view of (i) the scope and content of the prior art, (ii) the differences between the claimed invention and the prior art, and (iii) the level of ordinary skill in the art. *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17-18 (1966). In *KSR Int’l Co. v. Teleflex Inc.*, the Supreme Court reinforced that any rationale for combining references for obviousness must be “made explicit.” 550 U.S. at 418 (2007). According to the Court, “[r]ejections on obviousness grounds 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.” *Id.* (quoting *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

i. Ground 1A: Petitioner has not met its burden of demonstrating that Hall and Borowski render claims 1, 7, 9-10, and 23 unpatentable

The Petition has failed to establish that the skilled artisan would be motivated to combine Hall and Borowski or even that such a combination would meet each and every limitation of claims 1, 7, 9-10, and 23.

a. Petitioner has not met its burden of demonstrating a motivation to combine Hall with Borowski

The Petition contends that a POSITA would have been motivated to apply Borowski's teaching of multiple SPADs to Hall's rotating LIDAR device. Petition at 14. This assertion, however, is refuted by the express teachings of Hall and Borowski, as a POSITA would have understood Hall and Borowski to teach that SPAD arrays are uniquely unsuited to use in place of the standard APDs of Hall's moving apparatus.

First, by teaching a LIDAR system able see through rain and fog, Hall expressly teaches away from the use of SPADs in place of APDs. *AstraZeneca AB v. Mylan Pharms. Inc.*, 19 F.4th 1325, 1337-38 (Fed. Cir. 2021) (explaining that a reference teaches away "if a skilled artisan 'upon reading the reference . . . would be led in a direction divergent from the path that was taken' in the claim") (citations omitted). As Petitioner concedes, Hall's device had a "wide horizontal and vertical field-of-view, and is designed for long-range detection in all weather conditions." Petition at 14. Hall's device is able to operate in severe weather conditions *because* it uses APDs, not SPADs, as it is capable of "seeing through fog and heavy rain by increasing laser power dynamically and *ignoring early reflections*." Ex. 1004 at 4:26-29 (emphasis added). In contrast, it was well known in the art that an array of SPADs would be useless in heavy rain or fog because the

SPADs would be prematurely triggered by – and thus unable to see through – early reflections caused by fog and rain as required by Hall.

For example, Petitioner filed the 2015 Field Guide to Lidar as Ex. 1016, which Petitioner’s expert, Dr. Hesselink relied on in his background discussion. Ex. 1003 at ¶42. This Field Guide explains that SPADs can be triggered by “the detection of a desired target photon” *or* by “the detection of an undesired foreground clutter photon (such as from *backscatter from fog*).” Ex. 1016 at 47 (emphasis added); *see also id.* (“If the fog or clouds are close enough to the target when an avalanche occurs, the dead time will prevent avalanching on a return from the target.”). Petitioner fails to acknowledge this fundamental limitation of SPADs, and likewise fails to identify any teaching in Hall or Borowski explaining how SPADs could be used to see through rain and fog. Nor is there any such teaching. At most, Borowski teaches the use of a blanking function to prevent a SPAD array from being inadvertently activated by light reflected from a *different* emitter (*see* Ex. 1005 at [0052]), not unwanted reflections from the paired emitter due to fog. Thus, a POSITA, armed with the knowledge of Ex. 1016, would understand Hall to expressly teach away from using a SPAD array because it would be uniquely unsuited to see through fog and heavy rain.

Second, Petitioner contends that Borowski “teaches the electronics and associated circuitry necessary to integrate multi-SPAD arrays or pixels into a

LiDAR device like Hall.” Petition at 16. As discussed above, Borowski does in fact specify a substantial amount of circuitry necessary to operate the SPAD array, such as local DSPs for each SPAD array, and a global DSP to combine signals from the arrays. Ex. 1005 at [0050]-[0055]. Hall expressly teaches away from adding electronic components that needlessly increase cost, complexity, power consumption, and heat generation, which is exactly what Borowski’s SPAD array would do. Ex. 1004 at 5:26-31 (teaching that by sharing “the detection circuitry among several detectors,” “considerable cost savings can be had by minimizing the use of these expensive components”), 5:35-38 (“An additional benefit of power-cycling the detectors is that total system power consumption is reduced, and the detectors therefore run cooler and are therefore more sensitive”). For example, Hall explains that similar to the ability to ignore early rain reflections, the “unit also has the capability to receive and decipher multiple returns from a single laser emission through *digitization* and analysis of the *waveform* generated by the detector as the signal generated by the emitter returns.” *Id.* at 4:29-33 (emphases added). Hall’s reference to digitizing the “waveform” emphasizes that this capability depends on the analog nature of APDs. *See* Ex. 1016 at 130 (explaining that an APD can “generate a complete image with a single frame” whereas a SPAD would require “[a]s many as [] 50 images” to acquire an equivalent image). Assuming there was no obstructing fog, Borowski’s SPAD array could also receive and decipher

multiple returns, but it would only be able to do so by using 1) multiple SPADs in place of a single APD, and 2) a local DSP to control the SPAD array so it could essentially act like an APD. Ex. 1005 at [0053]. Hall plainly teaches away from this exercise of adding complexity to achieve the same result. Ex. 1004 at 5:26-31, 5:35-38.

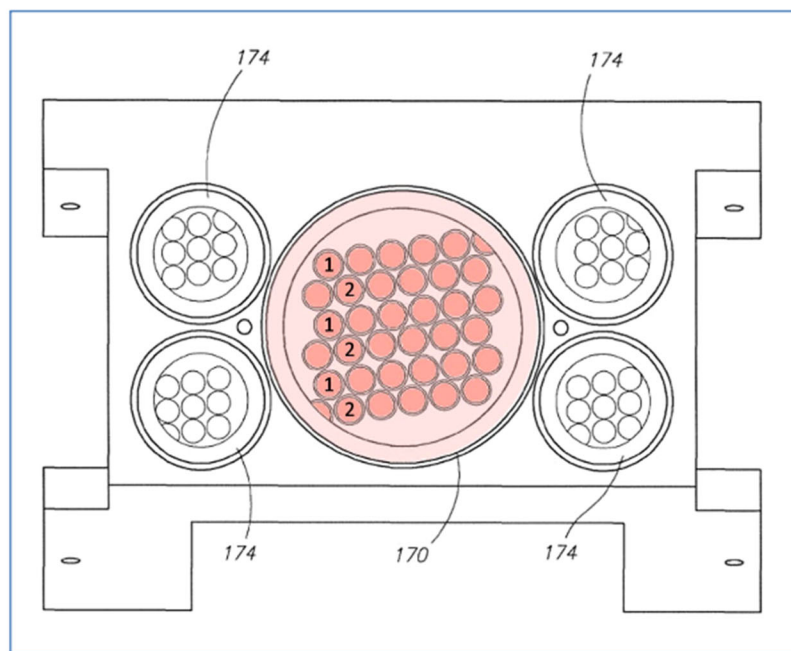
Third, Borowski also teaches away from using his SPAD array with Hall. As discussed above, all of Borowski's long-distance imaging devices using SPADs are intended for static use capturing landscapes. Ex. 1005 at [0004]-[0007], [[0134]. The only embodiment Borowski discloses for use with a moving vehicle is a very short-ranged imager that only covers a 90-degree field of view out to a few meters in front of the vehicle. *Id.* at [0178]. And all of Borowski's embodiments try to *eliminate* movement from any captured frame. *Id.* at [0045], [0055], [0073]. Thus, Borowski's teachings would dissuade a POSITA from trying to use a SPAD array in Hall's device, as a range of a few meters would be woefully insufficient "in order to safely navigate today's highways." Ex. 1004 at 2:45-47.

b. *Limitations 1 include, 10(c), and 23(c):* Hall and Borowski fail to disclose "a plurality of pixels includ[ing] a first set of pixels arranged in a first column and a second set of pixels arranged in a second column horizontally and vertically offset from the first column"

All challenged claims of the '236 Patent require a "plurality of pixels" arranged in columns "horizontally and vertically offset" from each other. The

Petition contends that Hall teaches this limitation in Figure 22, arguing that each dark red circle within cavity 170 of Figure 22 of Hall is a detector, and because a detector “collects incident light for a specific location in the array,” then the dark red circles show pixels arranged in horizontally and vertically offset columns.²

Petition at 20. Petitioner’s theory is based on flawed conclusory assumptions that are refuted by Hall itself.



First, Petitioner incorrectly assumes that each dark red circle in Figure 22 represents a detector. Tellingly, the Petition cites only Figure 22 of Hall to support

² Petitioner does not contend that Borowski teaches the claimed pixel arrangement.

this assertion.³ As set forth above in Section VII.A, Hall provides no explanation for why the detector array is arranged as shown in Figure 22, and Hall's specification directly contradicts Figure 22 in describing 1) 32 emitters in Figure 22 "organized relatively horizontally" within two cavities 174 versus 36 circles within 4 cavities 174 in Figure 22, and 2) 32 detectors within cavity 170 versus the 36 shown in Figure 22. Ex. 1004 at 6:67-7:5. These facially contradictory descriptions make it improper for Petitioner to assume that each dark red circle is a

³ The Petition also cites Dr. Hesselink, who offers only conclusory testimony based on his interpretation of Figure 22 that should be disregarded. *Verlander v. Garner*, 348 F.3d 1359, 1371 (Fed. Cir. 2003). *See also* 37 C.F.R. § 42.65(a) ("Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight."); *Rohm & Haas Co. v. Brotech Corp.*, 127 F.3d 1089, 1092 (Fed. Cir. 1997) (nothing in the Federal Rules of Evidence or Federal Circuit jurisprudence requires the fact finder to credit unsupported assertions of an expert witness). Furthermore, Petitioner may not incorporate by reference Dr. Hesselink's testimony to circumvent the word limit. Any testimony that Petitioner fails to explain in the Petition itself should be disregarded. *See Cisco Sys., Inc. v. C-Cation Techs., LLC*, No. IPR2014-00454, Paper 12 at 7-10 (P.T.A.B. Aug. 29, 2014).

detector. Furthermore, because Figure 22 contains “an obvious error of a typographical or similar nature that would be apparent to one of ordinary skill in the art,” under well-settled law, Figure 22 “cannot be said to disclose [prior art] subject matter.” *LG Elecs. Inc. v. ImmerVision, Inc.*, 39 F.4th 1364, 1372-73 (Fed. Cir. 2022) (holding errors in a table in a reference disqualified it as prior art) (citing *In re Yale*, 434 F.2d 666 (C.C.P.A. 1970)); *see also In re Yale*, 434 F.2d at 669 (reversing obviousness finding due to obvious error in prior art because “an error obvious to one of ordinary skill in the art [] cannot be said to describe or suggest that [claimed feature] to those in the art.”). Accordingly, given its facial errors, Petitioner has failed to demonstrate that Figure 22 of Hall is prior art at all, let alone that the dark red circles in Figure 22 each represent a detector.

Second, even if Figure 22 were prior art, and each dark red circle in Figure 22 represented a single detector, Petitioner’s theory still fails because Hall does not teach any arrangement of *pixels* at all. Petitioner does not contend that the term “pixel” requires any construction. Instead, the Petition assumes that “[e]ach detector is a pixel because it collects incident light for a specific location in the array.” Petition at 20 (citing Ex. 1004 at 5:5-7, Fig. 22). This assumption, however, is directly at odds with the ’236 Patent specification, which provides that “each pixel can include *one or more detectors*.” Ex. 1001 at 5:52-54 (emphasis added). Furthermore, Hall directly refutes Petitioner’s assertion that each detector must

correspond to a pixel. In Hall's lexicon, a "pixel" is a distance measurement such that a collection of pixels "captured in rapid succession...can be rendered as an image or analyzed for other reasons such as detecting obstacles." Ex. 1004 at 1:19-24 ("[E]ach distance measurement can be considered a pixel."). Hall further explains that a single detector can represent *multiple* pixels because in some configurations, "a single detector is 'shared' among several lasers by focusing several detection regions onto a single detector." *Id.* at 3:18-21, 4:63-67. Thus, Figure 22 of Hall does not show an arrangement of "pixels," and likewise does not show columns of horizontally and vertically offset pixels as required by this claim limitation.⁴ Accordingly, Petitioner has not shown that the combination of Hall and Borowski teaches this limitation.

⁴ In fact, because Hall teaches that a "point cloud" is a "collection of pixels" that "can be rendered as an image," the only arrangement of "pixels" that Hall expressly teaches is columns of pixels that have *no* horizontal or vertical offset from each other, such as the pixels on a computer monitor or in a digital JPEG image. Ex. 1004 at 1:19-24.

c. *Limitations 1(d), 10(d), and 23(d): “each pixel in the plurality of pixels traverses a unique circular path”*

All challenged claims of the '236 Patent require that each pixel traverse a “unique circular path” during each scan cycle. Petitioner contends that Hall teaches this limitation based on the ostensible arrangement of detectors in Figure 22.

Petition at 23-24. As set forth above in Section VII.A.i.b, however, the detectors in Hall’s device are not pixels, and Petitioner has failed to show that the combination of Hall and Borowski discloses *any* arrangement of pixels whatsoever. Thus, the Petition also fails to show that each pixel in a plurality of pixels traverses a unique circular path. Moreover, Hall’s description of the laser emitters in Figure 22 being “organized relatively horizontally” suggests that the detectors may be so arranged as well, such that even if they were pixels, they would not traverse a unique circular path in the manner that Petitioner suggests. Ex. 1004 at 6:67-7:5.

ii. Grounds 1B to 1D: Petitioner has not met its burden of demonstrating that any of the dependent claims are unpatentable

Grounds 1B through 1D use the same combination of Hall and Borowski of Ground 1A with further modifications from additional references addressing certain dependent claims. *See* Petition at 27-40. These grounds challenge claims depending from independent claims 1, 10, and 23. Because Patent Owner’s arguments in Sections VII.A.i *supra* show that each of independent claims 1, 10, and 23 are non-obvious, these dependent claims are also nonobvious. *See e.g., In*

re Fritch, 972 F.2d 1260, 1266 (Fed. Cir. 1992) (“[D]ependent claims are nonobvious if the . . . claims from which they depend are nonobvious.”).

Additionally, Grounds 1B through 1D further fail because of a lack of motivation to combine the additional references with the combination of Ground 1 and because those references do not teach or suggest the limitations the Petition contends these references supply. As one non-limiting example, the Petition does not demonstrate that any of the additional references teach or suggest the limitations missing from the combination of Hall and Borowski as discussed above in Section VII.A, namely:

- “a plurality of pixels ... includ[ing] a first set of pixels arranged in a first column and a second set of pixels arranged in a second column horizontally and vertically offset from the first column” (limitations 1(c), 10(c), 23(c)); and
- “each pixel in the plurality of pixels traverses a unique circular path” (limitations 1(d), 10(d), 23(d)).

As a further non-limiting example, several of Petitioner’s additional references teach away from using their inventions with rotating sensor systems like Hall in LIDAR, and a POSITA would not have been motivated to combine these references with Hall and Borowski. Lipson, for example, expressly teaches away from using rotating sensor systems in LIDAR, teaching that such systems are

bulky, not robust, and too costly when compared to Lipson’s fixed LIDAR system. Ex. 1006 at 2:1-5, 2:32-34, 4:39-43. Similarly, Tan expressly teaches away from using his invention with centrally-located rotating LIDAR systems, explaining that rotating devices like Hall “can require significant power, and the presence of moving parts can increase the likelihood of device failure.” Ex. 1008 at 1:46-62 (“[F]or many vehicles, particularly automobiles, it is desirable to locate lidar devices in perimeter positions that consume as little space as possible”). Instead, Tan teaches the use of a fixed emitter array to completely “*replace* lidar laser systems that employ mechanically rotated...optics.” *Id.* at 3:6-8 (emphasis added). Thus, a POSITA aware of the teachings of Tan would have been expressly dissuaded from combining Tan with a mechanically rotated system such as Hall.

iii. Ground 1E: Petitioner has not met its burden of demonstrating that Hall, Borowski, and Weimer render claims 11-13, 16-17, and 22 unpatentable

Ground 1E uses the same combination of Hall and Borowski of Ground 1A but adds the Weimer reference to address independent claim 16 and dependent claims 11-13, 17, and 22. Claims 11-13 depend from independent claim 10, and claims 17 and 22 depend from independent claim 16. Claim 16, limitation 16(b) corresponds to limitations 1(c), 10(c), and 23(c), addressed to a “plurality of pixels” arranged in columns horizontally and vertically offset from each other. As discussed above, neither Hall nor Borowski teaches such a configuration and the

Petition does not contend that Weimer teaches this limitation. Accordingly, Ground 1E fails for the same reasons described in Section VII.A.i above for Ground 1A.

iv. Grounds 1F and 1G: Petitioner has not met its burden of demonstrating that any of the dependent claims are unpatentable

Grounds 1F and 1G use the same combination of Hall, Borowski, and Weimer of Ground 1E with further modifications from additional references addressing certain dependent claims. *See* Petition at 48-50. Grounds 1F and 1G challenge claims 14 and 18-21 which depend from claims 10 or 16. Because Patent Owner's arguments in Sections VII.A.i. and VII.A.iii show that independent claims 10 and 16 are non-obvious, dependent claims 14 and 18-21 are also non-obvious. *In re Fritch*, 972 F.2d at 1266 n.17.

B. Ground 2 is unlikely to prevail because it fails to satisfy the legal requirements for obviousness.

In Ground 2, Petitioner asserts that the primary combination of Matsui and Imai renders the claims obvious. Petition at 50. Petitioner fails to make the requisite showing to establish a reasonable likelihood of obviousness of any challenged claim in this Ground.

i. Ground 2A: Petitioner has not met its burden of demonstrating that Matsui and Imai render claims 1, 7, 9-13, 16-17, 22-23, and 26-27 unpatentable

The Petition fails to establish that the combination of Matsui and Imai teach each and every limitation of claims 1, 7, 9-13, 16-17, 22-23, and 26-27. As discussed below, Matsui discloses a radically different system than that envisioned in the '236 Patent, and explicitly teaches that using a single laser collimated into a slit is preferable to using multiple emitters. Ex. 1031 at [0007] -[0010].

a. Petitioner has not met its burden of demonstrating a motivation to combine Matsui with Imai

Petitioner alleges that Matsui meets each and every limitation of independent claims 1, 10, 16, and 23 except for a plurality of optical emitters and plurality of pixels wherein each pixel comprises a plurality of SPADs. The Petition contends that a POSITA would have been motivated to modify the emitter and detector portions of Matsui to have multiple VCSEL emitters and a plurality of SPADs respectively, as taught by Imai. Petition at 54. The references, however, provide nothing that would motivate such a combination and, to the contrary, expressly disfavor Petitioner's clip-art approach.

First, Matsui explicitly teaches away from using multiple emitters as employed in the Imai device. Notably, Matsui was well aware of embodiments with multiple emitters and their purported benefits, explaining that a "rotating [] unit in which numerous light sources and the same number of light receiving

elements are arrayed two-dimensionally” would have “the advantage of not being prone to receiving other ambient stray light.” Ex. 1031 at [0008]. Nevertheless, Matsui concludes that such benefits are not worth the increased cost and potential detection gaps. *Id.* at [0009] (“However...providing numerous light sources and light receiving elements causes the cost to increase greatly, and since it is physically impossible to completely fill the space between the multiple light sources, there is a high risk that localized gaps will occur in the laser light irradiated onto the object, leading to the problem of detection failure occurring.”). In view of Matsui’s emphatic teaching of a single laser, Petitioner fails to present any reason – much less a sufficient reason – that one of ordinary skill in the art would have modified Matsui to add plurality of optical emitters to project light to a scan area.

Second, there is no indication that the combination of Matsui and Imai could achieve Matsui's stated objective of low cost. Petition at 55. Imai is mostly unconcerned with cost, and only references cost in association with reducing the number of amplifiers associated with “above-described PD (photo diode) as a light receiving element” and simply notes that SPADs have a “higher sensitivity than that of the PD [and] are advantageous in detection accuracy and detection distance.” Ex. 1033 at 5:1-7, 12:40-43 (“When the amplifier commonly connected to at least two (for example, four) PDs which are electrically connected to each

other is further provided, the number of amplifiers may be decreased and a small size and a low cost may be realized.”), 12:44-48. Moreover, even Petitioner and its expert concede that modifying Matsui with Imai *would* increase the cost and complexity of Matsui’s device. Euphemisms like “not overly cost prohibitive” and “only a minor increase in cost” (*see* Petition at 55) do not change the fact that the proposed modification would be more expensive than Matsui’s existing device, a consequence that Matsui expressly teaches away from.

Third, even if a skilled artisan would have elected to modify Matsui, there would be no rational reason to combine it with Imai. Matsui and Imai address entirely different problems. While Matsui is directed to “achiev[ing] high resolution and reduc[ing] detection failure while keeping costs down” (Ex. 1031 at [0010]), Imai is directed to “improv[ing] resolution in a detection range in a sub-scanning direction while inhibiting the increase in detection data obtaining time and the decrease of a detection distance.” Ex. 1033 at 1:31-35, *see e.g. id.* at 1:39-40.

In sum, in view of Matsui’s consistent teaching away from using multiple emitters and avoiding increased cost and complexity, a POSITA would have had no motivation to combine Matsui with Imai.

b. *Limitations 1(c), 10(c), and 23(c): Matsui and Imai fail to disclose “a plurality of pixels arranged behind the bulk receiving optic, wherein each pixel in the plurality of*

pixels comprises a plurality of single photon avalanche diodes (SPADs) and wherein the plurality of pixels includes a first set of pixels arranged in a first column and a second set of pixels arranged in a second column horizontally and vertically offset from the first column”

Neither Matsui nor Imai teach this limitation, which is required by all challenged claims of the '236 Patent.

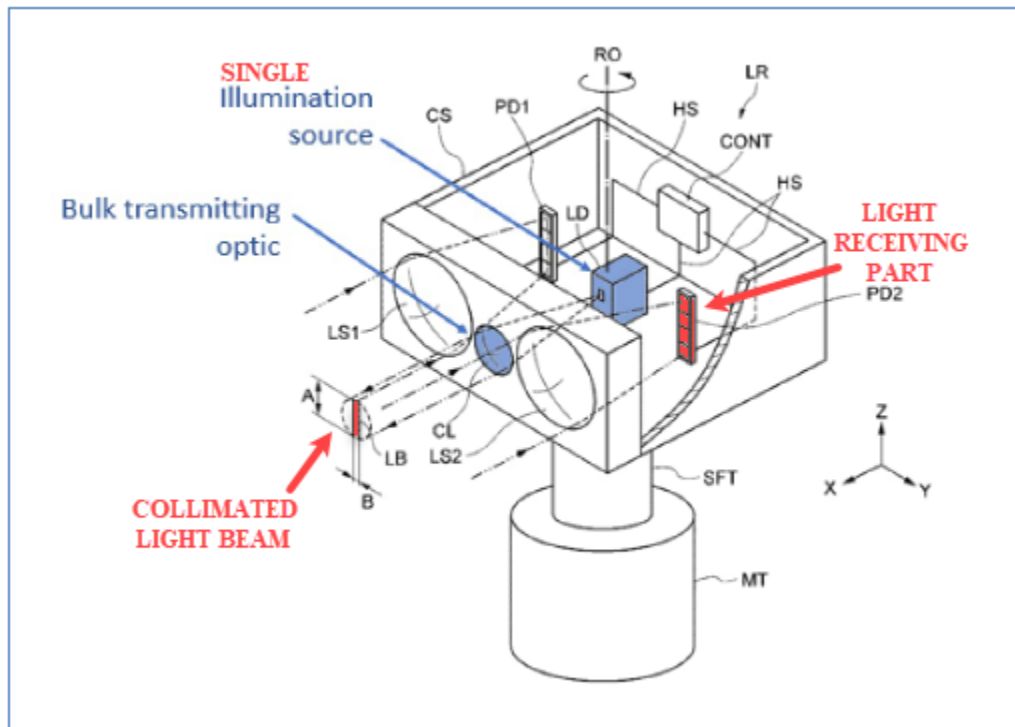
First, Petitioner has failed to prove that the combination of Matsui and Imai teach any arrangement of pixels whatsoever. Matsui discloses photodiodes as light receiving elements. Ex. 1031 at [0003] (“[L]aser radars that use the TOF scheme generally use light receiving elements with a high amplification factor, such as APDs (avalanche photodiodes).”). Petitioner assumes that each of Matsui’s light receiving elements PX is a pixel. Petition at 59. However, Matsui never describes light receiving elements PX as pixels, and Petitioner does not contend that the term “pixel” requires construction or otherwise explain why each light receiving element of Matsui is a “pixel.” Moreover, as discussed above, the '236 Patent specification expressly refutes Petitioner’s assumption that each detector must be a pixel, explaining that “*each pixel can include one or more detectors* configured to detect incident light.” Ex. 1001 at 5:52-54 (emphasis added). As such, light receiving elements are not pixels as described in the '236 Patent. Moreover, because Petitioner incorrectly equates each light receiving element PX with a pixel, Petitioner likewise fails to show that each light receiving part PD is a column

of pixels, nor does Petitioner show that Matsui and Imai disclose horizontally and vertically offset columns of pixels.

Second, even if each light receiving element PX were a pixel, the limitation “each pixel in a plurality of pixels comprises a plurality of single photon avalanche diodes” would still not be met because Petitioner only provides unsupported conclusory remarks suggesting a POSITA would replace one photodiode with an array of photodiodes, let alone an array of SPADs. Petition at 66, 79. Neither Matsui nor Imai teach using a plurality of SPADs in place of an individual light receiving element, and Petitioner provides no explanation of how a POSITA would modify Matsui to use an array of SPADs or have a reasonable expectation of success doing so.

Third, the combination of Matsui and Imai does not teach “a first set of pixels” and “a second set of pixels” behind the “bulk receiving optic” as required by this limitation. As seen below, Matsui teaches a one-dimensional vertical array of pixels behind *each* bulk optic LS1 and LS2, not two sets of pixels behind each

bulk optic as taught by the '236 Patent.



Petition at 58 (modified with annotations in red); *see also* Ex. 1031 at Fig. 2.

Petitioner attempts to sidestep this deficiency by contending that the *two* lenses LS1 and LS2 in Matsui “comprise a bulk receiving optic.” Petition at 59. Although it does not articulate its reasoning for this ground, Petitioner argues in Ground 1 that the “use of the indefinite article ‘a’” allows the term “bulk transmitting optic” to “encompass[] one or more optics.” *Id.* at 18 n.6. As Petitioner’s cited case makes clear, however, “the customary meaning of ‘a’ [is] *one or more*.” *KCJ Corp. v. Kinetic Concepts, Inc.*, 223 F.3d 1351, 1357 (Fed. Cir. 2000) (emphasis added); *see also id.* (holding “a continuous chamber covers one or

more continuous chambers”) (quotation omitted). In other words, the use of the indefinite article “a” simply means that the presence of one bulk receiving optic does not foreclose the presence of other bulk receiving optics. There is no basis, however, for Petitioner to do the opposite and try to combine multiple optics into a single one. Thus, the combination of Matsui and Imai fails to teach pixels arranged in two columns “behind the bulk receiving optic” as required by claims 1, 10, and 23.

c. *Limitations 1(d), 10(d), and 23(d): “each pixel in the plurality of pixels traverses a unique circular path”*

All challenged claims of the ’236 Patent require that each pixel traverse a “unique circular path” during each scan cycle. Petitioner contends that Matsui teaches this limitation based on the arrangement of Matsui’s light receiving elements PX. Petition at 60-62, 65-66, 70. As set forth above in Section VII.B.i.b, however, the light receiving elements in Matsui’s device do not correspond to pixels, and Petitioner has failed to show that the combination of Matsui and Imai discloses any arrangement of pixels whatsoever. Thus, the Petition also fails to show that each pixel in a plurality of pixels traverses a unique circular path.

ii. Ground 2B: Petitioner has not met its burden of demonstrating that Matsui, Imai, and Higashi render claims 1-2, 7, 9-13, 15-18, 22-24, 26-27 unpatentable

In Ground 2B, Petitioner adds Higashi as an additional reference to Matsui and Imai against many of the claims challenged in Ground 2A. Tellingly,

Petitioner adds Higashi primarily because “[t]o the extent...Matsui and Imai do not teach individual pixels each comprising a plurality of SPADs.” Petition at 76. As discussed above in Section VII.B.i, Petitioner has not shown a reasonable likelihood of prevailing that claims 1, 7, 9-13, 16- 17, 22-23, 26-27 are obvious over Matsui in view of Imai. Higashi does not cure any of the deficiencies in the combination of Matsui and Imai, particularly the Petition’s failure to demonstrate that Matsui teaches the required configuration of pixels. Thus, because all claims challenged in Ground 2B are the same as, or depend from claims in Ground 2A, Petitioner has failed to demonstrate a reasonable likelihood of prevailing on Ground 2B for at least the same reasons set forth for Ground 2A.

iii. Ground 2C and 2D: Petitioner has not met its burden of demonstrating that any of the dependent claims are unpatentable

Grounds 2C and 2D use the same combinations of Matsui and Imai, and Matsui, Imai, and Higashi respectively, and add Hipp as an additional reference addressing certain dependent claims. *See* Petition at 32-50, 79-81. These grounds challenge claims depending from independent claims 1, 10, and 23. Because Patent Owner’s arguments in Sections VII.B.i and VII.B.ii, *supra*, show that each of independent claims 1, 10, 16, and 23 are non-obvious, these dependent claims are also nonobvious. *In re Fritch*, 972 F.2d at 1266. Grounds 2C and 2D thus fail for, at least, the same reasons as Grounds 2A and 2B.

C. Petitioner Failed to Meet Its Burden to Show a Reasonable Expectation of Success

As explained above, the Petition asserts that the claimed invention would have been constructed by a POSITA from disparate prior art disclosures. The Petition fails to explain how a POSITA would have had a reasonable expectation of success in combining these references (and then further modifying them) to meet the limitations of the claimed invention despite the readily apparent difficulties stemming from their contradictory teachings. *Samsung Elecs. Co. v. Elm 3DS Innovations, LLC*, 925 F.3d 1373, 1380-83 (Fed. Cir. 2019) (finding Petitioner failed to establish a reasonable expectation of success in combining one reference’s semiconductor fabrication process with the incompatible dielectric material of another after “analyzing Petitioners’ obviousness grounds in the way presented in the Petition”); *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367 (Fed. Cir. 2016) (“The reasonable expectation of success requirement refers to the likelihood of success in combining references to meet the limitations of the claimed invention.”).

As explained above, the Petition’s Grounds attempt to combine incompatible references such as Hall, which teaches using increased laser power with analog APDs to see through rain and fog, and Borowski, which teaches the use of highly sensitive, digital SPAD arrays that were known to be unable to see in rain or fog,

and which would have required additional circuitry. *See* Section VII.A. Likewise, the Petition attempts to modify Matsui, which used an economical single emitter with APDs, to have multiple VCSEL emitters and a SPAD array in place of each existing APD. *See* Section VII.B. The Petition offers no evidence or argument addressing these incompatibilities. Rather, the Petition makes only conclusory contentions that a POSITA would have had a reasonable expectation of success in combining the references of the grounds using “[b]asic electrical engineering principles” or generically referring to “techniques for integrating SPAD arrays and VCSEL in laser-radar devices.” *See* Petition at 16, 57.

Petitioner thus failed to meet its burden to show a reasonable expectation of success for any of Grounds 1-2.

VIII. Conclusion

For the foregoing reasons, Petitioner is unlikely to prevail on any ground with respect to any of the challenged claims. Patent Owner respectfully requests that the Board institution of this Petition for *inter partes* review.

Respectfully submitted,

Dated: January 3, 2024

By: /s/ Nicoletta M. Kennedy
Nicoletta M. Kennedy
Reg. No. 68,161
Lead Attorney for Patent Owner
Ouster, Inc.

**KILPATRICK, TOWNSEND &
STOCKTON, LLP**
701 PENNSYLVANIA AVE, Ste. 200
Washington, DC 20002
Telephone: (202) 639-4711
nkennedy@kilpatricktownsend.com

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Patent Owner's Preliminary Response contains 10,984 words, as measured by the word-processing system used to prepare this paper. This word count does not include the items excluded by 37 C.F.R. § 42.24 as not counting towards the word limit.

Respectfully submitted,

Dated: January 3, 2024

By: /s/ Nicoletta M. Kennedy
Nicoletta M. Kennedy
Registration No. 68,161

CERTIFICATE OF SERVICE

I hereby certify that on January 3, 2024, I caused a true and correct copy of the foregoing Patent Owner's Preliminary Response to be served electronically on Petitioner at the following email addresses:

Jared W. Newton
James M. Glass
Nima Hefazi
QUINN EMANUEL URQUHART & SULLIVAN, LLP
jarednewton@quinnemanuel.com
jimglass@quinnemanuel.com
nimahefazi@quinnemanuel.com

By: /s/ Nicoletta M. Kennedy
Nicoletta M. Kennedy
Registration No. 68,161