

Filed on behalf of Metall Zug AG, Haag-Streit AG, and Haag-Streit USA Inc.

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**UNITED STATES PATENT AND TRADEMARK OFFICE**

**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

**PETITIONERS' REPLY TO PATENT OWNER RESPONSE**

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**EXHIBIT LIST**

<b>Exhibit No.</b>	<b>Description</b>
<b>1001</b>	<b>U.S. Patent No. 8,690,330 to Hacker <i>et al.</i></b>
<b>1002</b>	<b>File History of U.S. Patent No. 8,690,330 (including Certificate of Correction, dated July 29, 2014 and Certificate of Correction, dated February 28, 2017)</b>
<b>1003</b>	<b>File History from <i>Ex parte</i> reexamination request filed on July 6, 2015 as Reexamination Request No. 90/013,544 (including <i>Ex parte</i> Reexamination Certificate)</b>
<b>1004</b>	<b>B.E.A. Saleh and M.C. Teich, "Fundamentals of Photonics." John Wiley &amp; Sons Inc., 1991. pp. 399-400</b>
<b>1005</b>	<b>Choma, Michael A., et al., "Sensitivity advantage of swept source and Fourier domain optical coherence tomography," Optics Express, vol. 11, No. 18, Sep. 8, 2003, pp. 2183-2189.</b>
<b>1006</b>	<b>Lexer, F., et al., "Wavelength-tuning interferometry of intraocular distances," Applied Optics, vol. 36, No. 25, Sep. 1, 1997, pp. 6548-6553. ("Lexer")</b>
<b>1007</b>	<b>Lee et al., "In vivo optical frequency domain imaging of human retina and choroid," Optics Express, May 15, 2006, vol. 14, No. 10., pp. 4407-4408. ("Lee")</b>
<b>1008</b>	<b>U.S. Patent No. 7,414,779 to Huber <i>et al.</i> ("Huber")</b>
<b>1009</b>	<b>U.S. Patent No. 7,365,856 to Everett <i>et al.</i> ("Everett")</b>

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<p><b>1010</b></p>	<p><b>Drexler/Fujimoto, Optical Coherence Tomography – Technology and Applications, ISBN 978-3-540-77549-2, Springer Verlag Berlin Heidelberg 2008. (“Drexler”)</b></p>
<p><b>1011</b></p>	<p><b>Curriculum Vitae of Dr. James F. Brennan</b></p>
<p><b>1012</b></p>	<p><b>Declaration of Dr. James F. Brennan</b></p>
<p><b>1013</b></p>	<p><b>R. Huber, et al., European Conference on Biomedical Optics, June 12, 2005 – June 16, 2005, Munich (ECBO 2005), Optical Society of America, “Fourier Domain Mode Locked Lasers for OCT imaging at up to 290 kHz sweep rates”, PDA3.</b></p>
<p><b>1014</b></p>	<p><b>R. Huber, K. Taira, M. Wojtkowski, J. G. Fujimoto, "Fourier domain mode locked lasers for OCT imaging at up to 290 kHz sweep rates," Proc. SPIE 5861, Optical Coherence Tomography and Coherence Techniques II, 58611B (7 October 2005); doi: 10.1117/12.641732.</b></p>
<p><b>1015</b></p>	<p><b>R. Huber, K. Taira, M. Wojtkowski, J. G. Fujimoto, "Fourier domain modelocked lasers for swept source OCT imaging at up to 290 kHz scan rates," Proc. SPIE 6079, Coherence Domain Optical Methods and Optical Coherence Tomography in Biomedicine X, 60790U (20 February 2006); doi: 10.1117/12.648880.</b></p>
<p><b>1016</b></p>	<p><b>RESERVED</b></p>
<p><b>1017</b></p>	<p><b>U.S. Pat. No. 5,321,501 (“the ‘501 patent”)</b></p>
<p><b>1018</b></p>	<p><b>DE 103 23 920 (“the DE ‘920 patent”)</b></p>

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<b>1019</b>	<b>U.S. Patent No. 7,380,939 to Barth <i>et al.</i><sup>1</sup> ("the '939 patent")</b>
<b>1020</b>	<b>Curriculum Vitae of Dr. Sylvia Hall-Ellis</b>
<b>1021</b>	<b>Declaration of Dr. Sylvia Hall-Ellis</b>
<b>1022</b>	<b>Declaration of Siddhesh V. Pandit In Support of Motion to Correct</b>
<b>1023</b>	<b>Declaration of Andrew L. Ramos In Support of Motion to Correct</b>
<b>1024</b>	<b>Petitioners' Email to Patent Owner Counsel</b>
<b>1025</b>	<b>Huber, R., Wojtkowski, M., Fujimoto, J.G., "Fourier Domain Mode Locking (FDML): A new laser operating regime and applications for optical coherence tomography," <i>Optics Express</i>, April 17, 2006, Vol. 14, No. 8, pp. 3225-3237.</b>
<b>1026</b>	<b>RESERVED</b>
<b>1027</b>	<b>Declaration of Dr. James F. Brennan</b>
<b>1028</b>	<b>T. Pfeiffer et al, "Analysis of FDML lasers with meter range coherence," <i>Proc. SPIE 10053, Optical Coherence Tomography and Coherence Domain Optical Methods in Biomedicine XXI</i>,</b>

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<sup>1</sup> The '939 patent is a U.S. Patent that claims priority to Ex. 1018, the DE '920 patent.

Petitioner cites to the '939 patent, rather than the DE '920 patent, because it is in English.

	<b>100531T (21 February 2017); <a href="https://doi.org/10.1117/12.2254792">https://doi.org/10.1117/12.2254792</a>.</b>
<b>1029</b>	<b>Agrawal, Fiber-optic Communication Systems, ISBN 0-471-21571-6 John Wiley &amp; Sons, Inc. (2002).</b>
<b>1030</b>	<b>Siegman, Lasers, ISBN 0-935702-11-5 University Science Books 1986.</b>
<b>1031</b>	<b>H. Lim, F. Ö. Ilday, and F. W. Wise, "Femtosecond ytterbium fiber laser with photonic crystal fiber for dispersion control," Optics Express, December 16, 2002, Vol. 10, No. 25., pp. 1497-1502.</b>
<b>1032</b>	<b>A. Efimov and D.H. Reitze, "Programmable dispersion compensation and pulse shaping in a 26-fs chirped-pulse amplifier," Optics Letters, October 15, 1998, Vol. 23, No. 20., pp. 1612-1614.</b>
<b>1033</b>	<b>U. Keller, "Materials and new approaches for ultrashort pulse lasers," Current Opinion in Solid State and Materials Science, Vol. 1, Issue 2, pp. 218-224 (April 1996); <a href="https://doi.org/10.1117/12.2254792">https://doi.org/10.1117/12.2254792</a>.</b>
<b>1034</b>	<b>Chong, Changho, et al., "Large coherence length swept source for axial length measurement of the eye," Applied Optics, Vol. 48, No. 10, April 1, 2009, pp. D144-D150.</b>
<b>1035</b>	<b>Biedermann, B., Wieser, W., Eigenwillig, C., Klein, T. and Huber, R., "Dispersion, coherence and noise of Fourier domain mode locked lasers," Optics Express, June 8, 2009, Vol. 17, No. 12., pp. 9947-9961.</b>

1036	<b>Kraetschmer, T. and Sanders, S., "Ultrastable Fourier Domain Mode Locking Observed in a Laser Sweeping 1363.8 – 1367.3 nm," Conference on Lasers and Electro-Optics and 2009 Conference on Quantum electronics and Laser Science Conference, Baltimore, MD, 2009, pp. 1-2, 2009.</b>
1037	<b>Klein, T., Wieser, W., Reznicek, L., Neubauer, A., Kampik, A., and Huber, R., "Multi-MHz retinal OCT," Biomedical Optics Express, October 1, 2013, Vol. 4, No. 10., pp. 1890-1908.</b>
1038	<b>Blatter, C., Klein, T., Grajciar, B., Schmoll, T., Wieser, W., Andre, R., Huber, R., and Leitgeb, R. A., "Ultrahigh-speed non-invasive widefield angiography," J. Biomedical Optics, July 2012, Vol. 17, No. 7., pp. 1-2.</b>
1039	<b>Kolb, J. P., Klein, T., Eibl, M., Pfeiffer, T., Wieser, W., and Huber, R., "Megahertz FDML laser with up to 143nm sweep range for ultrahigh resolution OCT at 1050nm" (2016).</b>
1040	<b>Srinivasan, V. J., Huber, R., Gorczynska, I., and Fujimoto, J. G., "High-speed, high-resolution optical coherence tomography retinal imaging with a frequency-swept laser at 850 nm," Optics Letters, February 15, 2007, Vol. 32, No. 4., pp. 361-363.</b>
1041	<b>Kent, Christopher, "Any Way You Slice It: A Better AC View A forthcoming," Review of Ophthalmology, February 16, 2005, available at <a href="https://www.reviewofophthalmology.com/article/any-way-you-slice-it-a-better-ac-view">https://www.reviewofophthalmology.com/article/any-way-you-slice-it-a-better-ac-view</a>.</b>
1042	<b>Yasuno, Y., Hong, Y., Makita, S., Yamanari, M., Akiba, M., Miura, M., and Yatagai, T., "In vivo high-contrast imaging of deep posterior eye by 1-<math>\mu</math>m swept source optical coherence tomography and scattering optical coherence angiography" Optics Express, May 14, 2007, Vol. 15, No. 10., pp. 6121-6139.</b>

## **I. INTRODUCTION**

In its Response to the Petition, PO contended that the “linewidth” and “moveable sample” limitations are missing from the art combinations set forth in the Petition. PO must rely on an improperly narrowed interpretation of the term “moveable sample” for these arguments. Specifically, against the ordinary and customary meaning of “moveable sample,” PO adds additional limitations via its claim construction that “movable sample” is “characterized by significant, hard-to-control motion during an A scan measurement of its entire depth.” Paper 17 at 9-20. This claim construction is improper, and the challenged claims are unpatentable.

For the claims that explicitly recite the eye, *e.g.*, claim 2, PO argues that one of the wavelengths disclosed by Huber would cause various problems, such as dispersion, “water absorption,” and scattering. PO’s arguments related to Huber’s wavelengths are refuted by devices that were available for ophthalmic imaging operating at the same wavelengths prior to the ‘330 patent. PO’s contentions also fail because they ignore Huber’s disclosure of dispersion management techniques. Finally, although PO devotes a significant portion of its Reply to discussing alleged “water absorption” issues that would affect Huber’s tunable laser source, it conveniently ignores the fact that the ‘330 patent itself never mentions or accounts for these supposedly important complications.

## II. PO'S CLAIM CONSTRUCTION IS INCORRECT

### A. **The Term "movable sample" Should Not Be Afforded Patentable Weight**

As noted in the Institution Decision, the preamble is not ordinarily treated as limiting the scope of the claim. Paper 15 at 11-12. Petitioners agree that the record does not support "movable sample" having patentable weight under the circumstances.

*Id.*

PO appears to argue that the preamble is a claim limitation because it is "necessary to give life, meaning, and vitality" to the claim. Paper 17 at 18-20. However, the preamble of claim 1 does not "recite additional structure or steps underscored as important by the specification." *Catalina Mktg. Int'l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002). Instead, as noted by the Board, the body of claim 1 itself refers to the "sample" that is subject to being measured by the claimed apparatus. Paper 15 at 13. The claimed apparatus is no different if the sample is movable or immovable.

PO argues that the preamble is limiting because it further its goal of limiting the claimed invention to preferred embodiments in order to facilitate its arguments against the cited prior art. The Federal Circuit "has repeatedly 'cautioned against limiting the claimed invention to preferred embodiments or specific examples in the

specification.” *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1346–47 (Fed. Cir. 2015) (quoting *Teleflex, Inc. v. Ficoso N. Am. Corp.*, 299 F.3d 1313, 1328 (Fed. Cir. 2002)). “[I]t is the claims, not the written description, which define the scope of the patent right.” *Id.* at 1346; *see also Phillips v. AWH Corp.*, 415 F.3d at 1323 (Fed. Cir. 2005) (“[W]e have expressly rejected the contention that if a patent describes only a single embodiment, the claims of the patent must be construed as being limited to that embodiment.”).

**B. PO’s Construction of “movable sample” Is Incorrect**

PO initially proffered a construction of “moveable sample” that was limited to “a sample that is subject to involuntary movement including, but not limited to, a human eye.” Paper 10 at 8. The Institution Decision rejected this construction as “an attempt to limit the claim’s scope to the preferred embodiments.” Paper 15 at 14-15. Similarly, the Board rejected PO’s attempt to construe “sample” as limited to a human eye. *Id.* at 17.

Now, PO claims that “movable sample” means “a live ocular sample, including an eye, but not limited to a human eye, characterized by significant, hard-to-control motion during an A scan measurement of its entire depth.” Despite proposing two different constructions, PO curiously contends that the new “proposed construction is

the only plausible construction compelled by the claims and the specification of the '330 patent." Paper 17 at 12.

Besides the nonrestrictive nature of the ordinary meaning of "movable sample," the doctrine of claim differentiation provides a powerful argument against construing the term "movable sample" to be "a live ocular sample," *e.g.*, an eye.<sup>2</sup> The doctrine of claim differentiation is at its strongest in this type of case, "where the limitation that is sought to be 'read into' an independent claim already appears in a dependent claim." *Liebel– Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 910 (Fed.Cir.2004); see *Wenger Mfg., Inc. v. Coating Mach. Sys., Inc.*, 239 F.3d 1225, 1233 (Fed.Cir.2001) ("Claim differentiation ... is clearly applicable when there is a dispute over whether a limitation found in a dependent claim should be read into an independent claim, and that limitation is the only meaningful difference between the two claims."). *Interdigital Commc 'ns, LLC v. Int'l Trade Comm 'n*, 690 F.3d 1318 (Fed. Cir. 2012).

PO's construction is further strained by the inclusion of limitations that have no relevance to the term "movable sample":

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<sup>2</sup> Each of the citations PO provides as support for the term "ocular sample" only refer to the eye. Paper 15 at 10-11.

a live ocular sample, including an eye, but not limited to a human eye, characterized by significant, hard-to-control motion **during an A scan measurement of its entire depth.** (emphasis added).

Even if PO's assertion that the '330 patent solves the problem of "the hard-to-control motion of the movable sample during an A-scan measurement along its entire depth" was correct, PO provides no support for importing a reference to "A scan measurement of its entire depth" (highlighted in bold above) into the construction of "movable sample." Paper 15 at 13.

PO's new construction is nothing but a verbose attempt to read the term "eye" into the claim term under the guise of not explicitly importing the limitation from claim 2 into claim 1. The new construction also adds limitations into the term are unrelated to the ordinary and customary meaning of "movable sample." PO's proposed construction should be rejected for at least these reasons.

### **III. THE ASSERTED PRIOR ART DISCLOSES THE CLAIMED LINEWIDTH**

As a threshold matter, PO's argument (Paper 17 at 20-38) is based on its flawed construction of "movable sample," which is unsupported for the reasons set forth above. For the purposes of institution, the Board construed the term as "encompassing

a sample, including, but not limited to, a human eye, that is subject to voluntary or involuntary movement relative to the SS OCDR measurement device.” Paper 15 at 16. Petitioners agree with the Board's construction.

PO's arguments that Huber needs to be modified for use in SS OCDR on a human eye are not relevant to claim 1, as noted by the Board. Paper 15 at 24. Nevertheless, since the Board was of the opinion that PO's arguments regarding the eye are relevant to claims 2, 40, and 42, Petitioners address these arguments below. *Id.* at 24.

**A. Using A Wavelength of 1305 nm for Ophthalmic Imaging Was Known**

PO's contention that 1305 nm was not suitable for ophthalmic imaging and measurement of eye length is based on the argument that “water absorption increases dramatically between 1100 nm and 1200 nm and upward.” Paper 17 at 21-22. This reasoning is flawed for three reasons. Ex. 1027, ¶27; 47-54.

First, ophthalmic OCT at 1.3 $\mu$ m was well known at the time. Time-domain systems were already commercially available (Zeiss Visante), and Swept-source systems had been presented as prototypes (Tomey 3-D CAS-OCT, later commercially distributed as SS-1000). Ex. 1010, 964-65; 1026; Ex. 1027, ¶¶24-25.

Second, PO implies that only measurements in absence of absorption were possible or feasible. This ignores the large sensitivity of interferometric measurements, in particular of Fourier-domain methods like Swept-source OCT: In Exhibit 1005, a SNR of 121 dB at 1308nm was reported for SS-OCT at a power level of 500 $\mu$ W, which is considered safe for the eye (Visante uses "<6.5 mW"). Ex. 1027, ¶25-26. It was also demonstrated that swept-source systems in general have a significant sensitivity advantage over time-domain systems (here, 19dB). This advantage compensates a large part of the attenuation due to absorption: a "relative intensity loss" of 0.12% at 1310nm results in -29dB, and 0.8% at 1150nm in -21dB. So compared to Zeiss Visante, a Swept-source eye length measurement at 1.3 $\mu$ m could be realized at only 10 dB SNR penalty, and at 1150nm with only 2dB SNR penalty due to absorption.

Third, PO omits that the higher absorption at 1.3 $\mu$ m results in a 21-fold higher permissible power on the eye compared to 780nm (Ex. 1010, 962), allowing for a SNR-increase of 13 dB.

A POSITA had a reasonable expectation of success measuring the eye length at 1.3 $\mu$ m by OCT, since it was known to measure the eye by OCT at 1.3 $\mu$ m (Zeiss, Tomey), that OCT had a large sensitivity (Ex. 1005), that the eye length could be measured by Swept-source OCT (Ex. 1006), and that the additional attenuation could

be compensated by implementing Swept-source OCT (Ex. 1005) or increasing laser power. Ex. 1010, 962; Ex. 1027, ¶¶26-27.

**B. The '330 Patent Does Not Discuss Water Absorption**

The use of interferometry to measure distances between various parts of the eye was well-known prior to the '330 patent. Ex. 1012 at 50-57. A wide range of wavelengths could be used for ophthalmic measurements, including “between 600 and 1150 nm” as disclosed by the '330 patent. Ex. 1001, 5:13-15. Despite the broad range of disclosed wavelengths, PO attempts to disavow the specification of the '330 patent by arguing that wavelengths higher than 800 nm were disfavored (“Because of water absorption, a wavelength around 800 nm was the preferred central wavelength for retinal OCT around the time of the claimed invention”). Paper 17 at 22; Ex. 1027, ¶¶48-54, 60. PO appears to be emphasizing the 800 nm wavelength even though the '330 patent itself is not limited as such.

According to PO and its expert, “because of water absorption, a wavelength around 800 nm was the preferred central wavelength for retinal OCT around the time of the invention.” Paper 17 at 22. In light of this alleged problem, PO argues that using Huber at a wavelength of 1305 nm would not have been suitable because “water absorption increases dramatically between 1100 nm and 1200 nm and upwards.” Paper 17 at 22. Yet, **this argument ignores the fact that the '330 patent itself describes**

**using wavelengths of up to 1150 nm, which is within the alleged wavelength range that allegedly causes water absorption problems.** Ex. 1001, 8:37-41.

PO's contention that 800 nm was preferred is further undermined by its cited references. Exhibit 2016 (*cited by PO*) itself discloses a FDML laser in the **1050 nm** wavelength region for use in *in vivo* ophthalmic imaging. Ex. 2016 at 2049. This wavelength is higher than the allegedly preferred 800 nm and is close to the range which PO alleges has "water absorption" problems. Notably, Ex. 2016 is prior art to the '330 patent under 35 U.S.C. §102(b) and lists Huber as its first named author (the same Huber as the prior art cited by Petitioners (Ex. 1008)).

### **C. Petitioner's Reply to the POPR**

PO argued that when Huber's wavelength is reduced to a much shorter wavelength of around 780 nm, purportedly suitable for eye length measurement, that  $\delta k = 309.82 \text{ m}^{-1}$ . Paper 10 at 24. In response, Petitioners pointed out that this argument was meritless because another wavelength, which the '330 patent disclosed as being acceptable for measuring the eye (1150 nm), would result in  $\delta k = 142.52 \text{ m}^{-1}$ , which still met the linewidth limitation of claim 1. Paper 13 at 4; Paper 17 at 25. Contrary to PO's assertion, Petitioners did not raise a new combination of Huber and Lexer. Instead, Petitioners were simply responding to PO's argument regarding reducing Huber's wavelength to that disclosed by Lexer.

The purpose of this example was to demonstrate that PO was cherry-picking a wavelength, in this case 780 nm, to improperly suggest that Huber did not disclose the claimed linewidth. When a wavelength of 1150 nm (on the upper limit of what the '330 patent disclosed) was used, however, the linewidth disclosed by Huber still met the claim limitation. It would have been obvious to use a wavelength such as 1150 nm because a wide range of 600 nm to 2000 nm was disclosed by Huber. Ex. 1027, ¶¶14-19. Moreover, Huber disclosed the use of lower wavelengths than those discussed in Exhibit 1008, such as 1050 nm, **for 3D *in vivo* ophthalmic imaging**. Ex. 2016 at 2014.

No hindsight reasoning is required because Huber himself disclosed using such lower wavelengths for measurements of the eye. The motivation to use a different, *e.g.*, lower wavelength, was well-known to a POSITA before the priority date of the '330 patent. That is, "the largest clinical application of OCT is ophthalmology, where OCT can visualize cross-sectional structure of retinal pathologies" provided sufficient motivation to adapt Huber's laser accordingly. Ex. 2016 at 2049.

In addition, the premise of PO's argument is flawed. There is no physical reason that a linewidth  $\delta\lambda$  should be a property of a certain FDML laser design. In laser physics, a POSITA would assume that the coherence length is given by the laser geometry and sweep dynamics, not by the laser wavelength. Coherence length, as well

as linewidth  $\delta k$  should be assumed constant when converting wavelengths, and  $\delta \lambda$  converted accordingly.

#### **D. Dispersion**

The first implementations of FDML lasers was at 1300 nm, which was near the zero dispersion point of standard optical fibers which were easy to cheaply obtain by research institutions. Ex. 2016 at 2049; Ex. 1027, ¶¶5 & 25-26. To account for dispersion due to changes in wavelength, Huber disclosed that “dispersion management can also be performed” to compensate for or introduce the desired amount of dispersion. Ex. 1008, 12:64 – 13:15; Ex. 1027, ¶¶6-8 & 20-23. As noted below, the specific fiber referenced in Huber (Ex. 1008) has a zero dispersion point at 1300 nm. Ex. 1027, ¶5.

The Huber article cited by PO states “In conclusion, an FDML laser operating at a new wavelength in a nonzero dispersion regime is discussed, design rules are derived, **and operation at 1050 nm without additional dispersion compensating elements** is presented.” (emphasis added). As explained by Dr. Brennan, Huber, Ex. 1008, discloses SSOCT systems having an FDML laser as the swept source with multiple mechanisms for dispersion management within the laser system, including a feedback element or fiber delay line which contains dispersion compensation. Ex. 1008, 2:29-34 & 12:53-63; Ex. 1027, ¶¶20-23.

Huber further discloses that the dispersion management can be accomplished by “an optical fiber, a free space element, a telescope element, a multi-pass cavity element and combinations thereof” which may incorporate “dispersion compensation fiber, chirped fiber Bragg grating, and grating pair, prism compressors, acousto-optic or liquid crystal based shaper devices.” Ex. 1008, 2:29-34, 12:64-13:15, & 22:59-23:9; Ex. 1027, ¶¶20-21.

As also explained by Dr. Brennan, dispersion management and dispersion compensation were well-known before 2006. Ex. 1027, ¶21. Agrawal, Ex. 1029, is a textbook about the state of optical fiber communications at the time it was published, in 2002. *Id.* Agrawal discloses numerous examples of dispersion management such as dispersion compensated fiber and chirped fiber gratings and discusses broadband dispersion management. *Id.*; Ex. 1029 at 279–99 & 311-17. Further, these dispersion management techniques have been widely used since the 1990's to enable long-haul high-speed telecommunications links. *Id.*

Dr. Brennan explains that a chirped grating can be used to compensate for dispersion at the range of wavelengths claimed in Huber. Ex. 1027, ¶¶21-23. Thus, a POSITA would have clearly understood the concept of using dispersion compensating components to manage and limit distortion in a laser system at wavelengths shorter than 1300 nm. Ex. 1027, ¶23.

PO argues that implementing Huber's FDML at wavelengths other than  $1.3\mu\text{m}$  is not feasible due to dispersion in the optical fiber. On the other hand, the '330 patent specification states that "The inventive device is particularly suitable when the line width  $\delta k$  of the light source lies between 22 and  $50\text{ m}^{-1}$ . Such line widths can be implemented, for example, with tunable fiber ring lasers, and offer acceptable drops in sensitivity over the measurement depth." Ex. 1001, 3:54-58. If this statement were true in the preferred wavelength range, then a POSITA would expect that the '330 patent would disclose how to tackle dispersion in fiber ring lasers or an explanation of what a fiber ring laser is supposed to be. Since the '330 patent does not discuss the important aspect of fiber dispersion, PO's arguments regarding dispersion are further undermined. Ex. 1027, ¶46.

#### **IV. THE ASSERTED PRIOR ART MEETS THE MEASURING RANGE LIMITATION**

The '330 patent does not specify the meaning of "measuring range" or "depth of a sample," as used in claim 1. Paper 1 at 51. PO argues that relying on Huber's disclosure of coherence length to meet the "measuring range" limitation is allegedly fraught with errors for two reasons: (i) this is purportedly an inherency argument; (ii) it is impermissible hindsight. Paper 17 at 40-45.

**A. PO Confuses Water Absorption and Coherence Length**

PO's allegations are incorrect because it mixes together two separate technical issues: (i) signal power reduction due to water absorption; and (ii) decrease in sensitivity of the measurement due to low coherence. These issues are generally independent from each other – if the coherence length is long enough, a POSITA can increase the optical power of a source to overcome power lost to water absorption. Ex. 1027, ¶47. Fourier-domain interferometry can tolerate a significant amount of attenuation (absorption or coherence loss) before the signal disappears in the noise. Ex. 1027, ¶¶46-47.

The '330 patent itself does not include water absorption in its discussion of measuring range. Ex. 1027, ¶48. Dr. Brennan explains that the 330's own definition of measuring range in their discussion of Fig. 3 conforms to a water-absorption-independent definition of the measuring range. Ex. 1012, ¶¶71-72; Ex. 1027, ¶¶48-54. That is, Petitioners' equation for measuring range provides the same value of measuring range (e.g., their value of 54 mm) when you plug in the '330 patent's values of signal drop (20 dB) and linewidth ( $47 \text{ m}^{-1}$ ). And, importantly, the signal drop in Petitioners' equation only accounts for signal drop due to finite linewidth (*i.e.*, non-infinite coherence length). Ex. 1012, ¶67.

PO disparages Petitioners' "theoretic calculations" of measuring range's dependence on linewidth as not considering water absorption. Ex. 1027, ¶¶45-48. However, there is no explicit definition of "measuring range" in the '330 patent. Petitioners were forced to reverse engineer the meaning of this term based on the '330 patent's discussion of Fig. 4. The explanation in the '330 patent regarding "measuring range" does not consider water absorption, but rather only depends on linewidth as discussed above. Ex. 1027, ¶¶48-52.

**B. Huber Explicitly Discloses the Claimed Measuring Range**

Petitioners did not make an inherency argument, and one was not necessary. Huber *explicitly discloses* a coherence length of between 1 cm and 40 cm. Paper 1 at 51-53; Ex. 1027, ¶63. Claim 1 recites that "the A scan measuring range corresponds to the depth of the sample." Even if the sample is a human eye, the A-scan measuring range corresponding to the optical path length of the human eye is between 19 and 54 mm. Paper 1 at 51-52. A coherence length of 40 cm (400 mm), disclosed by Huber, easily meets this limitation. *Id.* at 52-53.

PO contends that "Petitioner has never addressed the significant absorption and scattering of light inside a sample when inferring measurement range solely based on a purported coherence length of Huber's laser." Paper 17 at 42; Ex. 1027, ¶¶45-46. PO's argument is incorrect for four reasons. *First*, the Petition notes that the '330 patent

discloses a depth of human eyes of between 14 mm and 40 mm. Paper 1 at 51. Due to the index of refraction within the eye (disclosed by the '330 patent, Ex. 1008 at 42-45), Petitioners then note that the optical path length of the human eye would be between 19 mm and 54 mm. *Id.* at 51-52. Thus, Petitioners **do** account for the physical realities of light inside a sample when determining measurement range. Ex. 1027, ¶¶46-47.

**Second**, the coherence length of 40 cm (400 mm) far exceeds either the physical depth of a human eye (between 14 mm and 40 mm) or the optical path length of the human eye (between 19 mm and 54 mm). Although PO tries to confuse the issue by invoking its “water absorption” argument, it never claims that the higher end of the coherence length disclosed by Huber would not be sufficient to measure the depth of the eye. Ex. 1027, ¶¶48-54.

**Third**, although PO now attempts to argue that “water absorption” is an important issue that must be accounted for, its contention is undermined by the fact that the '330 patent itself does not mention this issue even a single time in its entire disclosure. Ex. 1027, ¶¶48, 54. And, as discussed above, if Dr. Leitgeb's Declaration is true, the alleged issue with water absorption is present in at least part of the wavelength range disclosed by the '330 patent. Ex. 1001, 5:13-15. PO's argument asks the Board to believe that, despite such water absorption problems, the '330 patent's disclosure is

enabled even though there is no discussion of this complication or any explanation of how the '330 patent accounts for this factor. Ex. 1027, ¶46.

*Fourth*, PO argument ignores the relationship between coherence length and linewidth. Ex. 1027, ¶¶55-56. The measuring range is a function of the properties of the laser source, whether expressed as linewidth or coherence length. Ex. 1027, ¶¶60-63. Huber discloses various embodiments, some of which are described in terms of coherence length  $l_c$ . Paper 1 at 65-66; Ex. 1008, 10:22-26 & 24:5-9; Ex. 1012, ¶¶61-62. The coherence lengths convert to linewidths of  $69 \text{ m}^{-1}$  and  $6.9 \text{ m}^{-1}$ , which both meet the linewidth limitation recited by claim 1 ( $\delta k < 168 \text{ m}^{-1}$ ), further underscoring that the measuring range limitation is also met by the coherence lengths disclosed by Huber.

Contrary to PO's conclusion, Petitioners do not ignore the physical changes of light propagating inside a sample. Paper 17 at 42. In fact, the difference between physical depth of the eye and optical path length, which accounts for these physical changes, was explicitly addressed in the Petition. Paper 1 at 51-53; Ex. 1027, ¶¶45-54.

**C. Huber's Explicit Disclosure of the Claimed Measuring Range Does Not Use Hindsight Reasoning**

PO argues that using Huber's explicitly disclosed coherence length, which a POSITA would understand can be converted to a laser linewidth, somehow employs hindsight reasoning. Ex. 1012, ¶¶60-65. As support, PO points to Dr. Leitgeb's

Declaration, which states that conventional laser sources possess long coherence lengths. Paper 17 at 43-44. PO alleges that "Petitioner has failed to demonstrate a particular reason to apply Huber's broad coherence length in the alleged combination to achieve the claimed measuring range." Paper 17 at 45. This contention ignores the explicit arguments in the Petition.

The Petition explains that Huber recognized that precise and high-speed measurements were important to OCT and other interferometric approaches to imaging. Paper 1 at 42; Ex. 1027, ¶1. Everett disclosed an OCT system that allows for correction of effects caused by movement of the eye. Paper 1 at 43; Ex. 1027, ¶¶64-68. Lexer disclosed the application of WTI to ophthalmology to perform depth imaging of various structures of the eye. Paper 1 at 44. The coherence lengths disclosed by Huber would be more than sufficient to measure the depths of the eye, even accounting for the physical properties of the eye. Ex. 1012, ¶127; Paper 1 at 44.

Because all three references deal with OCT and attempt to solve the problem of movement of an eye during acquisition of A-scans, a POSITA would have been motivated to combine these references with a reasonable expectation of success. Paper 1 at 45; Ex. 1012, ¶¶123-28; Ex. 1027, ¶¶65, 68. Contrary to PO's assertion, the reason to use the longer coherence lengths is derived directly from the prior art and

knowledge of a POSITA. No hindsight reasoning is used in the Petition, nor is any necessary.

V. **EVERETT DOES NOT TEACH AWAY FROM THE CLAIMED INVENTION**

PO argues that Everett teaches away from the claimed invention because it allegedly focuses on motion *between* A-scans. Paper 17 at 47. As recognized in the Institution Decision, Petitioners do not rely on Everett for the details of SS OCDR. Paper 15, 26. Moreover, PO's argument fails on its face because it does not point to anything that directs a POSITA not to use Everett with methods that address motion during *individual* A-scans.

The Petition notes that Everett seeks to avoid objectionable motion of the sample. Paper 1 at 45; Ex. 1009, 2:7-10; 4:14-31. PO also argues (with apparent support from Dr. Leitgeb) that "Everett does not contemplate *fast and hard-to-control motion* that occurs *during an individual A-scan* that covers an entire depth of a human eye. Paper 17 at 49.

Everett teaches avoiding motion-related corruption during A-scans when Everett teaches the use of "guidepost" A-scans that are acquired sufficiently fast to avoid motion-related corruption. Ex. 1027, ¶64. Everett focused on sample motion *between* multiple A-scans. PO asks the Board to find that because Everett does not focus on

every technical problem known to exist in the field of OCT, *e.g.*, objectionable motion during *individual* scans, that it necessarily teaches away from the claimed invention. Such a conclusion would require the Board to ignore the level of knowledge of a POSITA and common sense. PO has not pointed to anything in Everett that teaches away from its invention being used with methods for addressing motion during *individual* A-scans. Ex. 1027, ¶¶64-68. PO contends that Everett is focused on the retinal region alone with a depth range of about 1.5 mm. Paper 17 at 47.

PO's argument is irrelevant, however, because Petitioners rely on Everett for its disclosure of performing OCT on the eye. *See, e.g.*, Paper 1 at 47, 49-50, & 52-53. There is nothing in Everett that *teaches away* from using its method for images of the entire depth of the eye. As admitted in the '330 patent, Lexer disclosed measuring the entire depth of the eye in 1997. Ex. 1001, 2:15-21; Ex. 1012, ¶50-53. PO has not pointed to anything in Everett that directs a POSITA not to use its technique with SS OCSR methods that focus on motion during *individual* A-scans. To the contrary, by discussing the need to avoid objectionable movement during the acquisition of *individual* A-scans, Everett actually contemplates this type of motion as discussed above. Ex. 1009, 2:7-10 & 4:14-31; Ex. 1027, ¶¶64-68.

**VI. CLAIMS 2, 40, AND 42 ARE ALSO OBVIOUS<sup>3</sup>**

PO does not provide any new arguments regarding these dependent claims.

Paper 17 at 50. The entirety of PO's argument is based on the premise that only wavelengths of 780 nm or 800 nm can be used for ophthalmological imaging. Paper 17 at 22, 28, & 38. PO's position is undermined by the '330 patent itself, which discloses that various wavelengths between 600 nm and 1150 nm are suitable for imaging the depth of the eye. Ex. 1001, 5:13-15 & 8:37-41.

PO also undermines its argument by citing Exhibit 2016, which is also authored by Huber<sup>4</sup> and discloses an FDML laser that operates **in the 1050 nm wavelength region for 3D *in vivo* ophthalmic imaging**. Ex. 2016 at 2049. Ex. 2016 discloses that a POSITA knew at the time that "the largest clinical application of OCT is ophthalmology, where OCT can visualize cross-sectional structure of retinal pathologies." *Id.*; Ex. 1027, ¶1. Ex. 2016 also explains why Huber (Ex. 1008) provides

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<sup>3</sup> The Institution Decision erroneously states that claims 40 and 42 depend from claim 39. Paper 15 at 6. However, dependent claims 40 and 42 depend from claim 2, which depends from claim 1.

<sup>4</sup> Along with other authors.

an example of wavelengths with a zero dispersion point around 1300 nm – “the first implementations of FDML lasers were demonstrated at 1300 nm **near the zero dispersion point of standard optical fiber.**” *Id.*; Ex. 1027, ¶5. In other words, the reason that Huber (Ex. 1008) provides an example of wavelengths with a zero dispersion point around 1300 nm is that widely available and cheap fiber at the time, manufactured by Corning®, had a zero dispersion point around that wavelength. Ex. 1001, 10:12-26. *Id.* However, Huber described that a broad range of wavelengths could be used between 600 nm and 2000 nm. Ex. 1008, 2:17-19 & 9:50-52. *Id.*; Ex. 1027, ¶¶14-16.

As noted in Petitioners' Reply to the POPR, the result of using a wavelength of 1150 nm (disclosed by the '330 patent as being acceptable for depth imaging of the eye (Ex. 1001, 5:13-15 & 8:37-41), for example, in the equation at the bottom of page 24 of the POPR, is a linewidth of  $142.52 \text{ m}^{-1}$  for Huber, which meets the limitation of claim 1. The wavelength of 1150 nm is within the range disclosed the '330 patent as being acceptable for depth imaging of the eye, and it is also within the wavelength range disclosed by Huber. Ex. 1008, 2:17-19 & 9:50-52.

PO suggests that the use of 1150 nm in this equation is somehow the “epitome of hindsight reconstruction.” Paper 17 at 25. However, hindsight reconstruction is unnecessary when Huber itself discloses the use of such a wavelength. Huber himself disclosed the use of lower wavelengths, as cited by PO. Ex. 2016 at 2049. There is no

need for Petitioners to resort to hindsight reasoning when Huber himself considered lower wavelengths for imaging the depth of the eye and disclosed as much. *Id.*

**VII. THE NARROWED LINEWIDTHS OF CLAIMS 25, 40, AND 42 ARE DISCLOSED BY HUBER**

Dependent claims 25, 40, and 42 narrow the linewidth  $\delta k$ . Paper 17 at 50-51. Huber discloses a wide range of possible embodiments, for only one of which is  $\delta\lambda$  explicitly disclosed. For the other disclosures,  $\delta\lambda$  was not directly provided. Instead, Petitioners calculated  $\delta k$  based on what Huber disclosed: the coherence length  $L_c$ .<sup>5</sup> Ex. 1027, ¶¶16-19.

PO argues that the Petition is flawed for two reasons: (i) Petitioners apply hindsight reasoning; and (ii) Petitioners allegedly fail to show a reasonable expectation of success. With respect to PO's first argument, Petitioners' argument is that a

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<sup>5</sup> Dr. Brennan defines the relationship between  $\delta\lambda$ ,  $\delta k$ , and  $L_c$  (in which the relationship still holds:  $\delta k = 2\pi/\lambda^2 \delta\lambda$ ). Ex. 1012, ¶¶60-65. For these other disclosures, Petitioners calculated  $\delta k$  directly from  $L_c$ . Petitioner could have calculated  $\delta\lambda$  from  $L_c$  and then used  $\delta k = 2\pi/\lambda^2 \delta\lambda$  to determine  $\delta k$  and achieved the same result. However, a POSITA would have understood this relationship.

POSITA would not have had a reason to “combine different parts of Huber to arrive at the claimed line width.” Paper 17 at 53. This contention is refuted by the disclosure of Huber itself and asks the Board to ignore the considerable knowledge of a POSITA. Ex. 1027, ¶19.

Huber discloses that the coherence length can range from 1 cm to 40 cm and that it can be applied to various applications. Ex. 1008, 8:16-22 & 24:50 – 25:11; Paper 1 at 62; Ex. 1027, ¶14. Thus, a POSITA would have been motivated to use the longer coherence lengths disclosed by Huber with the disclosures of Everett and Lexer because it would allow for measurement of the entire depth of a sample or the eye. Paper 1 at 62; Ex. 1027, ¶¶14-19. Huber himself disclosed the use of its laser (Ex. 1008) for 3D *in vivo* ophthalmic imaging. Ex. 2016. Ex. 2016 predates the ‘330 patent’s priority date by over a year, underscoring the dubious nature of PO’s hindsight argument.

PO’s reasonable expectation of success argument similarly fails. Although PO alleges that “such a wavelength reduction would alter Huber’s operating principle of mode locking,” Ex. 2016 cited by PO directly contradicts this argument. Ex. 1027, ¶¶16-19.

**VIII. THE PRIOR ART DISCLOSES CLAIM 27**

The Petition states that it would have been obvious to choose the bandwidth of a receiver so that desired signals are collected and yet the effect of faster interference signals is minimized. Paper 1 at 64-65. Referencing Dr. Brennan's declaration, Petitioners point out that Analog Modules, Inc. sold photodetectors at the time of the '330 patent that had a maximum bandwidth of 80 MHz. Paper 1 at 64-65; Ex. 1012 at 180-81.

**IX. DR. LEITGEB'S DECLARATION (EX. 2013)**

In paragraph 4 of Dr. Leitgeb's declaration, he admits to a *previous and continuing collaboration with PO*. Ex. 2013 at ¶4. Although Dr. Leitgeb asserts that he is providing his "independent analysis," his previous and ongoing relationship with PO casts doubt on his objectivity and calls into question whether his opinions and conclusions that are favorable to PO are motivated by that collaboration. Ex. 1027, ¶12.

**X. CONCLUSION**

The Petition, supported by the expert declarations from Dr. James F. Brennan, has demonstrated a reasonable likelihood that the challenged claims are unpatentable.

Petitioners' Reply to Patent Owner's Response Regarding Claims 1-2, 21-27, 40 and 42 of U.S. Patent No. 8,690,330

Respectfully submitted,

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**XI. CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITATION**

Pursuant to 37 C.F.R. § 42.24 *et seq.*, the undersigned certifies that this Petitioners' Reply to Patent Owner's Response complies with the type-volume limitation of 5,600 words, comprising 5,488 words, excluding the parts exempted.

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**XII. CERTIFICATION OF SERVICE (37 C.F.R. §§42.6(e), 42.105(a))**

The undersigned hereby certifies that the above-captioned **PETITIONERS' REPLY TO PATENT OWNER RESPONSE** was served in its entirety on December 11, 2020, on the following correspondence address of record via email:

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