

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SIGRAY, INC.,
Petitioner,

v.

CARL ZEISS X-RAY MICROSCOPY, INC.,
Patent Owner.

IPR2022-00218
Patent 7,400,704 B1

Before GRACE KARAFFA OBERMANN, GEORGIANNA W. BRADEN,
and ELIZABETH M. ROESEL, *Administrative Patent Judges*.

ROESEL, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining No Claims Unpatentable
Dismissing Patent Owner's Revised Motion to Amend
35 U.S.C. § 318(a)

I. INTRODUCTION

A. Background and Summary

Sigray, Inc. (“Petitioner”) filed a Petition (Paper 2, “Pet.”) seeking an *inter partes* review of claims 1–15 (the “challenged claims”) of U.S. Patent No. 7,400,704 (Ex. 1001, “the ’704 Patent”). Carl Zeiss X-Ray Microscopy, Inc. (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). We instituted an *inter partes* review. Paper 7 (“Institution Decision” or “Inst. Dec.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 12, “PO Resp.”), Petitioner filed a Reply (Paper 19, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 23, “PO Sur-reply”). Patent Owner also filed a contingent motion to amend (Paper 11) and, following the Board’s issuance of Preliminary Guidance (Paper 20), a revised contingent motion to amend (Paper 24). We held an oral hearing on March 28, 2023, and a transcript is in the record. Paper 34 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a). We determine that Petitioner has not shown by a preponderance of the evidence that the challenged claims of the ’704 Patent are unpatentable. Briefly, in summary, Petitioner’s challenges based on Jorgensen, Deckman, and Flannery do not succeed because Petitioner fails to show that these references disclose projection magnification, as recited in independent claims 1 and 7, or that modification of these references to include projection magnification would have been obvious. Petitioner’s challenges based on Sasov do not succeed because Petitioner fails to show that Sasov discloses a scintillator, as recited in independent claim 7, or that modification of Sasov to include a scintillator would have been obvious. Because Petitioner has not shown unpatentability

of any of the challenged claims, we dismiss Patent Owner's revised contingent motion to amend as moot.

B. Related Matters

The parties identify the following district court litigation as a related matter: *Carl Zeiss X-Ray Microscopy, Inc. v. Sigray, Inc.*, No. 5-21-cv-01129 (N.D. Cal.). Pet. 89; Paper 4, 1 (Patent Owner's mandatory notices).

C. The '704 Patent (Ex. 1001)

The '704 Patent is directed to an X-ray imaging system that combines projection magnification and optical magnification. Ex. 1001, code (57), 2:47–51. An embodiment is shown in Figure 1, which is reproduced below.

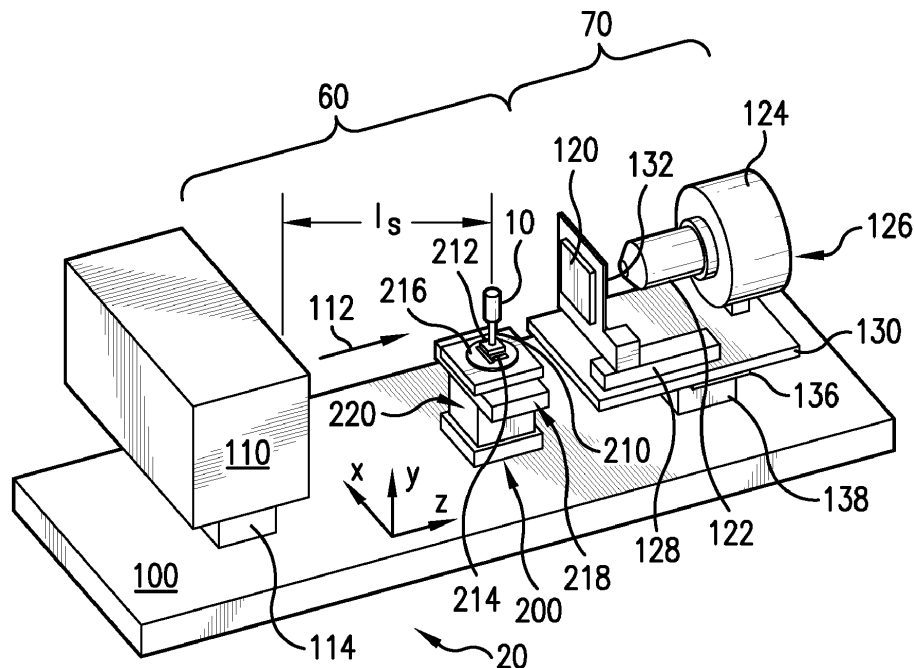


FIG. 1

Figure 1 is a diagram showing X-ray imaging system 20, including projection X-ray stage 60 and optical stage 70. Ex. 1001, 3:66–67, 4:19–23, 4:47–50, 5:13–16, Fig. 1.

The X-ray stage includes X-ray source 110 for generating X-ray beam 112, x-axis source motion stage 114 for adjusting the position of the X-ray source, and sample holder 200 for positioning sample 10 in the X-ray beam. *Id.* at 4:25–28, 4:35–40, 4:51–53, Fig. 1. The sample holder includes sample mount 210, mount base 212, x-z sample motion stage 214, sample rotation stage 216, x-axis sample motion stage 218, and y-axis sample motion stage 220. *Id.* at 4:53–5:10.¹ The X-ray stage also includes scintillator 120, which converts the X-ray beam, after interacting with a sample, into an optical signal. *Id.* at 5:11–13, 5:17–19.

The optical stage includes visible light magnification lens system 122, CCD detector 124, and z-axis scintillator motion stage 128 for adjusting the distance between the scintillation screen and the magnification lens system. *Id.* at 5:20–27. These optical stage components are secured to optical stage sub assembly bench 130, which can be aligned in the x- and y-directions using x-axis optical motion stage 136 and y-axis optical motion stage 138, respectively. *Id.* at 5:27–41.

D. Illustrative Claims 1 and 7

Petitioner challenges claims 1–15 (all claims) of the '704 Patent. Pet. 1. Claims 1 and 7 are independent, illustrative of the claimed subject matter, and reproduced below.

1. An x ray imaging system, comprising:
a projection x ray stage including:
an x ray source generating a diverging x ray beam; and

¹ Figure 1 shows the x-, y-, and z-axes, with the z-axis parallel to the x-ray beam, and the x- and y-axes perpendicular to the x-ray beam. The y-axis is vertical to optical bench 100 on which the x-ray system is mounted. *Id.* at 5:39–42, Fig. 1.

a scintillator for converting the x ray beam, after interacting with a sample, into an optical signal;

an optical stage including:

a detector; and

a magnification lens for imaging the optical signal of the scintillator onto the detector;

wherein a magnification of the projection x ray stage is between 1 and 10 times and a magnification of the optical stage is 5 or greater.

Ex. 1001, 9:63–10:7.

7. An x ray imaging system, comprising:

a projection x ray stage including

an x ray source generating a diverging x ray beam; and

a scintillator for converting the diverging x ray beam, after interacting with a sample, into an optical signal, wherein a magnification of the projection x ray stage is between 1 and 10 times; and

a sample holder for holding and positioning the sample in proximity to the scintillator, the sample holder comprising:

a rotation motion stage for rotating the sample in the x ray beam;

x-y-z axis motion stages to center the sample's region of interest at the rotation axis of the rotation stage; and

at least one z-axis motion stage for adjusting a source-to-sample distance and a sample-to-detector distance with respect to the rotation motion stage and the x-y-z axis motion stages.

Id. at 10:22–39.

E. Asserted Challenges to Patentability

Petitioner asserts the following challenges to patentability.

Claims Challenged	35 U.S.C. §²	Reference(s)/Basis
1, 3, 4	102(b)	Jorgensen ³
7, 8	102(b)	Sasov ⁴
1–15	103(a)	Jorgensen
1, 2	103(a)	Jorgensen, Hayashi ⁵
1, 3–6	103(a)	Deckman, ⁶ Flannery ⁷
1, 3–6	103(a)	Jorgensen, Deckman
1, 2	103(a)	Deckman, Flannery, Hayashi
7–10, 14	103(a)	Sasov
7, 8, 10–15	103(a)	Jorgensen, Mancini
7, 9	103(a)	Jorgensen, Donnelly ⁸
7, 9	103(a)	Sasov, Donnelly

² The Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102, 103, effective March 16, 2013. Because the ’704 Patent was filed before this date, we refer to the pre-AIA versions of §§ 102, 103. Ex. 1001, code (22).

³ Ex. 1007, S. Jorgensen, et al., *Three-Dimensional Imaging of Vasculature and Parenchyma in Intact Rodent Organs with X-ray Micro-CT*, Am. J. Physiol. (Sept. 1998) (“Jorgensen”).

⁴ Ex. 1008, A. Sasov, *X-ray Nanotomography*, Proc. SPIE 5535, Developments in X-Ray Tomography IV, (Oct. 26, 2004) (“Sasov”).

⁵ Ex. 1012, US 6,249,566 B1, issued June 19, 2001 (“Hayashi”).

⁶ Ex. 1010, US 4,891,829, issued January 2, 1990 (“Deckman”).

⁷ Ex. 1011, B. Flannery, et al., *Three-Dimensional X-ray Microtomography*, et al., Science, Vol. 237, Issue 4821 (Sept. 18, 1987) (“Flannery”).

⁸ Ex. 1013, WO 03/040712 A1, published May 15, 2003 (“Donnelly”).

Claims Challenged	35 U.S.C. § ²	Reference(s)/Basis
7–15	103(a)	Jorgensen, Sasov
7, 8, 12–14	103(a)	Sasov, Deckman

Pet. 14.

F. Testimonial Evidence

The record includes three declarations of Omid Ebrahimi Kia, Ph.D., submitted by Petitioner (Exs. 1005, 1023, and 1025) and Dr. Kia’s deposition testimony submitted by Patent Owner (Exs. 2013, 2029). The record also includes the declaration of Julie Bentley, Ph.D., submitted by Patent Owner (Ex. 2005); the declaration of Gonzalo Arce, Ph.D., submitted by Patent Owner (Ex. 2032);⁹ and Dr. Bentley’s deposition testimony submitted by Petitioner (Ex. 1024).¹⁰

II. ANALYSIS

A. Legal Standards

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the

⁹ Dr. Arce was not deposed by Petitioner. Tr. 36:24–26.

¹⁰ The record also includes declaration and deposition testimony of Patent Owner’s employee, Bruce Johnson, which Patent Owner relies upon to show objective indicia of nonobviousness. Exs. 1026, 2012, 2033. For the reasons discussed below, we determine that Petitioner has not proven its obviousness challenges without reaching objective indicia of nonobviousness.

grounds for the challenge to each claim”)); *see also* 37 C.F.R. § 42.104(b) (requiring a petition for *inter partes* review to identify how the challenged claim is to be construed and where each element of the claim is found in the prior art patents or printed publications relied upon).

A claim is anticipated under 35 U.S.C. § 102 only if “each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. Inc. v. Union Oil Co. of Cal.*, 814 F.2d 628, 631 (Fed. Cir. 1987). “[A]nticipation by inherent disclosure is appropriate only when the reference discloses prior art that must *necessarily* include the unstated limitation.” *Transclean Corp. v. Bridgewood Servs., Inc.*, 290 F.3d 1364, 1373 (Fed. Cir. 2002).

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

Additionally, the obviousness inquiry typically requires an analysis of “whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue.” *KSR*, 550 U.S. at 418 (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) (requiring “articulated reasoning with some rational underpinning to support the legal conclusion of

obviousness’’)). Petitioner cannot satisfy its burden of proving obviousness by employing “mere conclusory statements,” but “must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

B. Level of Ordinary Skill in the Art

Petitioner contends that a person of ordinary skill in the art (“POSITA”)

would have had a Ph.D. in physics, electrical engineering, or a similar field, with course work or industry experience in control theory, x-ray optics, laboratory experience, and applied mathematics; or a master’s degree with a subset of that course work and 3–4 years of x-ray and computing imaging experience.

Pet. 16 (citing Ex. 1005 ¶¶ 36–40). Patent Owner contends that a POSITA “would have had a master’s degree in physics, optics, electrical engineering or a similar field and 3–4 years of x-ray microtomography experience.” PO Resp. 5 (citing Ex. 2005 ¶ 33). The parties agree that additional industry experience may compensate for less formal educational experience, and Patent Owner contends that the reverse also is true. Pet. 16; PO Resp. 5.

We determine that the level of ordinary skill in the art, as articulated by Patent Owner, more accurately reflects the subject matter of the ’704 Patent and the asserted prior art than does Petitioner’s articulation. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001) (“the prior art itself reflects an appropriate level” as evidence of the ordinary level of skill in the art) (quoting *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 163 (Fed. Cir. 1985)). Petitioner does not explain how “control theory” and “applied mathematics” (Pet. 16) relate to the subject matter of the ’704 Patent and the asserted prior art, and Petitioner’s reference to

“laboratory experience” (*id.*) is too general to be useful in defining the requisite level of skill. Furthermore, whereas Petitioner requires a POSITA to have “x-ray and computing imaging experience” (*id.*), Patent Owner more particularly specifies “x-ray microtomography experience” (PO Resp. 5), which is the field of art for the ’704 Patent, as well as many of the asserted prior art references. Ex. 1001, code (54) (“High resolution direct-projection type x-ray microtomography system using synchrotron or laboratory-based x-ray source”); Ex. 1007 (discussing X-ray microcomputed tomography); Ex. 1008 (discussing X-ray nanotomography and microtomography); Ex. 1010, code (54) (“Method and apparatus for utilizing an electro-optic detector in a microtomography system”); Ex. 1011 (title: “Three-dimensional X-ray Microtomography”). For these reasons, we apply Patent Owner’s definition of a POSITA. Even if we applied Petitioner’s definition of a POSITA, however, the outcome would be the same because our resolution of the controversy does not turn on the differences between the parties’ contentions about level of ordinary skill in the art.

C. Claim Construction

In an *inter partes* review, we apply the same claim construction standard as would be used by a district court to construe a claim in a civil action involving the validity or infringement of a patent. 37 C.F.R. § 42.100(b). Under that standard, claim terms are given their ordinary and customary meaning, as would have been understood by a person of ordinary skill in the art at the time of the invention, in light of the language of the claims, the specification, and the prosecution history of record. *Id.*; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–19 (Fed. Cir. 2005) (en banc); *Thorner v. Sony Comput. Entm’t Am. LLC*, 669 F.3d 1362, 1365–66 (Fed. Cir. 2012).

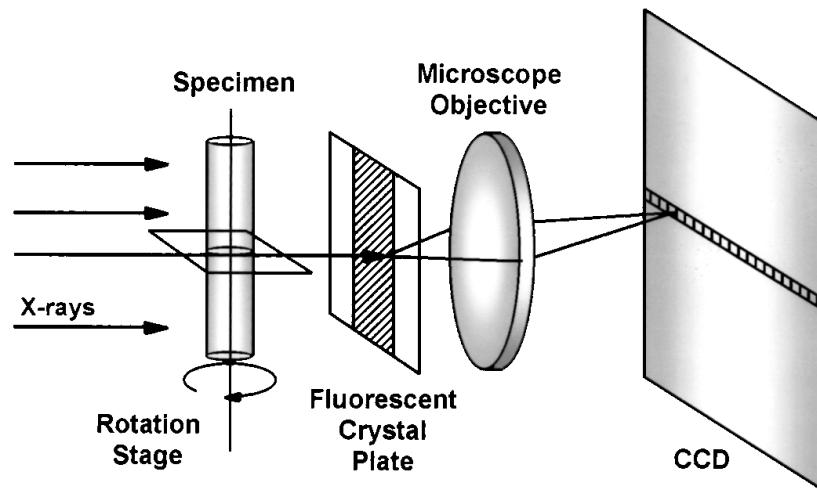
Neither party proposes any express claim constructions. *See* Pet. 17 (“all claim terms should receive their plain and ordinary meaning”); PO Resp. 5 (applying the same constructions as Petitioner). We determine that no claim term requires express construction for purposes of resolving any controversy between the parties. *Realtime Data LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

D. Petitioner’s Jorgensen-led Challenges

Petitioner challenges claims 1, 3, and 4 as anticipated by Jorgensen and claims 1–15 as obvious based on Jorgensen. Pet. 14. Petitioner also combines Jorgensen with various other references. *Id.* Our analysis of these challenges focuses on the limitation of independent claims 1 and 7 that recites “a magnification of the projection x ray stage” (hereinafter, “projection magnification”) “is between 1 and 10 times.” Ex. 1001, 10:5–6, 10:27–28. Petitioner contends that Jorgensen inherently discloses projection magnification within the claimed range or that it would have been obvious to use such a range. Pet. 3, 20–23. Patent Owner disputes these contentions. PO Resp. 13–21. We provide an overview of Jorgensen before turning to our analysis of the parties’ contentions.

1. Jorgensen (Ex. 1007)

Jorgensen describes a microtomography X-ray scanner for generating three-dimensional images. Ex. 1007, H1103. Jorgensen Figure 1 is reproduced below.



Jorgensen Figure 1 (above) is a schematic diagram of a microtomographic system that includes a source of X-rays, a rotation stage for holding the specimen, a fluorescent crystal plate (scintillator), a microscopic objective lens, and a charge-coupled device (CCD). *Id.* at H1104, Fig. 1.

Jorgensen provides the following description of the X-ray source:

Our scanner uses a Philips spectroscopy X-ray tube (PW2275/20 molybdenum anode, long line focus) with a 12×0.4 -mm focal spot that is projected at a 4° angle to provide an effective spot size of 0.8×0.4 mm. We use an angulated line source rather than a microfocus source because a line source generates the desired X-ray flux at 50 kW/cm^2 , whereas a same size, conventional focal spot would generate the desired flux at 625 kW/cm^2 The geometry and intensity distribution of the X-ray focal spot are of concern if the X-ray beam geometry is used to achieve magnification, but in our system the long X-ray focal spot-to-specimen distance and the close proximity of the specimen to the X-ray-to-light conversion crystal greatly reduce this concern.

Ex. 1007, H1104 (reference number omitted). Jorgensen's Figure 2 includes photographs of a microtomography scanner, and its caption states, in part, "The collimated X-ray beam is shielded by a lead-wrapped brass tube as the beam passes from the source into the shielded cover of the scanner." *Id.* at H1105.

Jorgensen discloses that the scintillator converts transmitted X-rays to visible light, which is “transferred by a lens onto the surface of a CCD-based imaging camera.” Ex. 1007, H1104. According to Jorgensen, the lens provides selectable magnification of 1- to 10-fold. *Id.* at H1103, H1104. Jorgensen states that, “if the magnification is twofold, a 1-cm² X-ray image is imaged by a 2-cm² area on the CCD chip, effectively making the CCD pixels 12 μm on a side (referenced to specimen).” *Id.* at H1104. Jorgensen describes the CCD as having an 1,024 × 1,024 array of 24 μm on-a-side square pixels. *Id.*

Jorgensen discloses acquiring X-ray projection data for numerous angles of view, as the specimen is rotated 360 degrees. Ex. 1007, H1104, H1106, H1108. According to Jorgensen, the X-ray projection data are submitted to a reconstruction program for computing a tomographic image. *Id.* at H1106. Jorgensen provides the following description of the reconstruction program.

Backprojection. Because we use an X-ray focal spot that subtends ≤ 0.8 mrad at the scintillator, we have reasonably pure cone-beam geometry. In addition, when the scanned volume within the specimen subtends an angle at the X-ray focal spot that is less than the angle subtended by the CCD pixel height divided by the diameter of the scanned volume, we can reasonably assume that the cone-beam geometry is well represented by a stack of contiguous, parallel, transverse fans that ignore the axial divergence of the X-ray beam. This greatly simplifies the backprojection process. In general, however, we use a cone-beam backprojection, modified Feldkamp reconstruction algorithm (12).

*Id.*¹¹

Jorgensen evaluated the effective resolution of the scanner using a plastic cylinder containing glass beads of known diameters as a specimen and comparing the “true” volume of the beads with the volume determined from the computed tomographic (“CT”) image. Ex. 1007, H1107–H1108, Table 1 (summarizing the accuracy of the estimates of microsphere volume and the role of the axial and radial locations of the microspheres in the scanned volume). Jorgensen provides several explanations for the inaccuracy of these volume determinations.

We expect there to be increased distortion of the microsphere in the axial direction the further the sphere is away from the central plane of symmetry of the X-ray cone-beam. Similarly, the radial distance from the axis of rotation also has an impact on the accuracy because the peripheral zone of the CT image suffers from reduction of the number of transmitted rays passing through each voxel; hence, a “noisier” image is to be expected.

Id. at H1108.

As indicated in Table 1, the error with which we can estimate the volume of the glass beads (as a fraction of the true volume) decreases with increased diameter. This error is attributable to a number of factors such as the fact that the 3-D image is made up of discrete voxels . . . , that there is noise in the gray scale values due to X-ray photon statistics, and other imaging factors . . . due to blurring of the original X-ray projection image recorded by the CCD imaging array, due to the X-ray focal spot’s finite size, the thickness of the fluorescent crystal, and the optical limitations of the lens that projects the image onto the CCD array. In addition, the CT image reconstruction algorithm (12) also distorts the image, especially

¹¹ Jorgensen’s reference (12) is Feldkamp, et al., *Practical cone-beam algorithm*, J. Opt. Soc. Am. A/Vol. 1, No. 6, 612–619, June 1984 (Ex. 2006, “Feldkamp”).

in the axial direction due to the cone-beam geometry of the X-ray beam. These factors are all interrelated.

Id. at H1110–1111 (reference numbers omitted).

Jorgensen includes the following discussion of the performance of its imaging method:

Scanner design. Our approach uses high-resolution electro-optical imaging of the X-ray image of a specimen held close to the imager. This approach has several advantages over the more traditional use of X-ray magnification in which the specimen is held close to the X-ray focal spot so that a large X-ray image is projected onto a large area-imaging device such as an image intensifier. Advantages include reduced blurring due to the size and shape of the X-ray focal spot and reduced cone-beam angle and therefore reduced artifacts associated with cone-beam reconstruction algorithms.

Id. at H1111.

2. *Anticipation*

Petitioner concedes that Jorgensen does not explicitly disclose projection magnification between 1 and 10 times. Pet. 3; Ex. 1005 ¶ 53. Petitioner asserts that “Jorgensen inherently discloses a projection magnification between 1 and 2 based on the specific dimensions that it teaches.” Pet. 3; Ex. 1005 ¶ 53. Relying on a formula provided in the background section of the ’704 Patent,¹² Petitioner contends that, “[b]ecause

¹² The ’704 Patent states that, with “a relatively simple projection geometry, in which the radiation produced by an x-ray source is allowed to penetrate the sample, and the transmitted radiation is collected by the detector . . . , the geometrical magnification of the system is” given by the formula:

$$M = \frac{L_s + L_d}{L_s}$$

“where, L_s is the source to sample distance and the L_d is the sample to detector distance.” Ex. 1001, 1:40–52.

the sample in Jorgensen is placed closer to the detector than the source, the x-ray projection magnification is between 1x and 2x.” Pet. 21–23 (citing Ex. 1001, 1:40–52; Ex. 1005 ¶¶ 83–85; Ex. 1007, H1104, H1111, Figs. 2A, 2B).

The dispute about whether Jorgensen inherently discloses projection magnification is really a dispute about the nature of Jorgensen’s X-rays: whether or not the X-ray beam is diverging. *See, e.g.*, PO Resp. 14–16 (arguing that Jorgensen does not disclose projection stage magnification because the X-ray beam is collimated (parallel), not diverging).¹³ In the subsections below, we first address the requirement for a diverging X-ray beam. Then we address the parties’ contentions relating to Jorgensen’s disclosures, “projected at a 4° angle,” “X-ray beam geometry,” “collimated X-ray beam,” and “cone-beam geometry.” Ex. 1007, H1104–H1106. Lastly, we address Patent Owner’s argument about CCD pixel size and Petitioner’s reply argument about filling the CCD before summarizing our determination regarding inherent disclosure.

a) Requirement for a Diverging X-Ray Beam

Petitioner’s contention that Jorgensen inherently discloses X-ray projection stage magnification and Petitioner’s calculation of projection magnification based on the source-to-sample and sample-to-detector distances are premised on Petitioner’s argument that Jorgensen’s X-ray beam is diverging. Pet. 3, 18–19, 21–23.

¹³ At the hearing, Petitioner argued, “I don’t believe that there’s any dispute that each of the x-ray sources at issue here do in fact generate a diverging x-ray beam.” Tr. 6:10–12. That is incorrect, at least for Jorgensen, Deckman, and Flannery. Patent Owner argues that these references do not teach a diverging X-ray beam. PO Resp. 14–16, 21; PO Sur-reply 4.

It is undisputed that a diverging X-ray beam is what enables magnification at the projection X-ray stage. Ex. 1001, 2:61–64 (“This diverging x-ray beam is characteristic of projection systems since the diverging beam enables magnification in the system’s x-ray stage.”). Patent Owner presents the undisputed testimony of Dr. Bentley that magnification occurs at the projection stage when the X-ray beam is diverging, and the formula for calculating projection magnification based on the source-to-sample and sample-to-detector distances, as provided in the background section of the ’704 Patent, applies when the X-ray beam is diverging. Ex. 2005 ¶¶ 22, 23. Dr. Kia provides two examples of projection magnification with diverging light sources: a slide projector and shadow puppets using a flashlight. Ex. 1005 ¶ 43; *see* Ex. 2005 ¶ 22 (discussing Dr. Kia’s testimony).

Patent Owner presents Dr. Bentley’s undisputed testimony that parallel X-rays do not produce projection magnification, regardless of the source-to-sample and sample-to-detector distances. Ex. 2005 ¶ 41. Dr. Bentley testifies, “when the x-ray beam projected through a sample has been collimated, such that the x-rays are parallel when they reach the sample, no magnification results from geometric projection.” *Id.* ¶ 53; *see also* Ex. 2032 ¶ 49 (similar testimony from Dr. Arce).

Petitioner and Dr. Kia do not dispute that parallel X-rays do not give rise to projection magnification. *See* Pet. Reply 1–2; Ex. 1025 ¶¶ 5, 6 (arguing that X-ray beams in Jorgensen, Deckman, and Flannery are not perfectly parallel, but not disputing the premise that parallel beams do not result in projection magnification). For example, Dr. Kia testifies that, when the sample is “very close” to the detector, as shown in Jorgensen Figure 2B, the projection magnification is “slightly greater than 1x” and “can never be

reduced to exactly 1x.” Ex. 1023 ¶ 6. Importantly, however, that statement “assumes that the X-ray beam is diverging.” Ex. 2029, 11:9–17. Thus, the parties’ dispute hinges on whether or not Petitioner has shown that Jorgensen’s X-rays are diverging.

b) “Projected at a 4° Angle”

Jorgensen discloses: “Our scanner uses a Philips spectroscopy X-ray tube (PW2275/20 molybdenum anode, long line focus) with a 12×0.4 -mm focal spot that is projected at a 4° angle to provide an effective spot size of 0.8×0.4 mm.” Ex. 1007, H1104.

Citing this disclosure, Petitioner asserts that “Jorgensen discloses a diverging, cone-beam x-ray source projected at a 4° angle.” Pet. 18–19 (citing Ex. 1005 ¶¶ 68–70; Ex. 1007, H1104, H1106). Dr. Kia’s declaration includes the identical assertion. Ex. 1005 ¶ 69. At his deposition, Dr. Kia reiterated his understanding of Jorgensen’s x-ray source as “fanning out” at a 4-degree angle.

Q. Okay. . . . Is it your opinion that the 4-degree projection angle collimates the beam [by beam limiting]?

A. Whatever it is, as he’s disclosing, the X-ray, the description of the X-rays that are interacting with the specimen as the specimen is rotated is that those are at 4-degree angle. So regardless of how[, he] is beam limiting to get to that.

So the Figure 2A -- actually 2B, where you see the rotation stage and there’s a specimen at the tip where it’s rotating, as the X-ray is hitting that, it’s fanning out at 4 degrees. The cone beam covers 4 degrees by 4 degrees.

Ex. 2013, 65:14–66:1; *see also id.* at 60:12–17 (Jorgensen “provides a 4-degree pure cone beam and it radiates the specimen to be imaged.”); *id.* at 61:6–9 (Jorgensen’s X-ray beam is “collimated with a 4-degree dispersion angle.”); *id.* at 61:25–62:9 (same).

Furthermore, Dr. Kia confirmed that his opinions are based on his understanding that Jorgensen's X-rays intersect the sample at a 4-degree angle.

Q. . . . So when you were forming your opinions, you assumed that the X-ray beams in Jorgensen are at a 4-degree angle when they intersect the sample; is that right?

A. The extent of the beam that is forming the image on the scintillator. Yes.

Id. at 66:2–8.

After Dr. Kia's deposition, Patent Owner submitted the declaration of Dr. Bentley explaining the significance of the 4-degree angle in Jorgensen. Dr. Bentley testifies that "Jorgensen's X-ray source . . . is a 12 mm by 0.4 mm molybdenum anode" and "[t]his line source is tilted at a 4° angle so that, from the perspective of the sample, it appears as a 0.8 mm by 0.4 mm rectangle." Ex. 2005 ¶ 58 (citing Ex. 1007, H1104); *see also id.* ¶ 42 ("Jorgensen discloses that the system generates x-rays from a line source tilted at an angle."). Dr. Bentley explains why Dr. Kia's understanding of Jorgensen's x-ray beam is incorrect.

I understand that Petitioner's expert testified that the x-ray beam generated by this line source interacts with the sample at a 4° angle. I disagree. . . . Jorgensen's beam is collimated and passes through a long lead-wrapped tube before interacting with the sample. Accordingly, any x-ray diverging at a 4° angle would never reach the sample. Instead, they would run into the lead-wrapped tube, which would extinguish the x-ray.

Id. ¶ 59. Neither Petitioner nor Dr. Kia disputes Dr. Bentley's testimony quoted above, which we find credible, persuasive, and supported by Jorgensen's description of a line source that generates X-rays. Ex. 1007, H1104, H1105.

At the hearing, Petitioner conceded that the characterization of Jorgensen's X-ray beam as diverging at a 4-degree angle is incorrect. Tr. 6:13–8:2 (discussing the Petition at page 18). Below is an excerpt of that discussion.

JUDGE ROESEL: So the four degrees is the angle at which the line source is tilted. It is not the angle at which the cone beam fans out. Is that right?

MR. YOUNGBLOOD: Correct, Your Honor.

JUDGE ROESEL: So did Petitioner correct the record on that point? Because the Board relied on that statement as being undisputed in the DI, and so if it's not true, did Petitioner correct that statement?

MR. YOUNGBLOOD: I thought that we had corrected that, but I don't have a citation for you. It's not that the x-ray source is not projecting at 4 degrees. It's just that that -- so that is the angle that the x-rays hit the anode. So I guess you're correct, that this is not written correctly on page 18 of the petition. I apologize for that.

JUDGE ROESEL: And so, how about your expert's testimony at -- in his deposition, he characterized the x-ray beam as fanning out at an angle of 4 degrees. So that's not true either, is it?

MR. YOUNGBLOOD: That's correct. He actually raised that issue with us after the deposition, when he went back to look at it. And that's when I thought that in a subsequent deposition, he had made a correction there, but I don't have that citation. I don't know. Maybe during patent owner's time I can try to find that. . . .

Tr. 7:6–25.

We relied on Petitioner's incorrect interpretation of Jorgensen in our Institution Decision. Dec. Inst. 12 (citing Pet. 18; Ex. 1007, H1104). Yet, prior to the hearing, neither Petitioner nor Dr. Kia corrected the record. *See* Tr. 46:5–8 ("JUDGE ROESEL: Counsel, were you able to find where

Dr. Kia corrected his testimony about the meaning of a 4-degree angle in Jorgensen? MR. YOUNGBLOOD: Sorry. I did not look for that. I'm sorry. Apologies.'"). Petitioner's and Dr. Kia's admittedly incorrect characterization of Jorgensen's X-ray beam, and their failure to correct the record, negatively impact the credibility of Petitioner's contentions and Dr. Kia's testimony about projection magnification in Jorgensen.

c) *"X-ray Beam Geometry"*

Jorgensen discloses: "The geometry and intensity distribution of the X-ray focal spot are of concern if the X-ray beam geometry is used to achieve magnification, but in our system the long X-ray focal spot-to-specimen distance and the close proximity of the specimen to the X-ray-to-light conversion crystal greatly reduce this concern." Ex. 1007, H1104.

Based on this disclosure, Petitioner asserts: "Jorgen[sen] uses 'long X-ray focal spot-to-specimen distance and [] close proximity of the specimen to the X-ray-to-light conversion crystal' and explains that 'X-ray beam geometry is used achieve magnification[.]'" Pet. 3. Dr. Kia's declaration includes the identical assertion. Ex. 1005 ¶ 53.

Petitioner and Dr. Kia misstate the disclosure of Jorgensen. Contrary to their assertions, the reference does *not* "explain[] that 'X-ray beam geometry is used achieve magnification[.]'" Pet. 3; Ex. 1005 ¶ 53. Rather, Jorgensen states, "[t]he geometry and intensity distribution of the X-ray focal spot are of concern *if* the X-ray beam geometry is used to achieve magnification." Ex. 1007, H1104 (emphasis added). Petitioner and Dr. Kia ignore the "if," which again negatively impacts their credibility on the issue of whether Jorgensen inherently discloses projection magnification.

Moreover, the remainder of the sentence demonstrates that Jorgensen does *not* use the X-ray beam geometry to achieve magnification. Jorgensen goes on to say, “but in our system the long X-ray focal spot-to-specimen distance and the close proximity of the specimen to the X-ray-to-light conversion crystal ***greatly reduce this concern.***” *Id.* (emphasis added). We credit Dr. Bentley’s explanation of this passage.

Jorgensen contrasts its system with systems that use “the X-ray beam geometry . . . to achieve magnification.” Jorgensen explains that attempting to use geometric magnification with its disclosed source would result in problems due to the source’s geometry and intensity distribution. . . . Jorgensen thus explicitly teaches that the asserted projection stage should not be used to achieve geometric magnification.

Ex. 2005 ¶ 72 (citation omitted); *see also* Ex. 2032 ¶ 35 (similar testimony by Dr. Arce). In contrast to Dr. Kia’s testimony (Ex. 1005 ¶ 53), the testimony of Drs. Bentley and Arce is credible, persuasive, and supported by Jorgensen’s discussion of x-ray beam geometry. Ex. 1007, H1104. Their testimony is reinforced by Dr. Kia’s admission that a “drawback” of Jorgensen’s arrangement in which the specimen is positioned close to the scintillator is that “it does not enjoy magnification of the X-ray stage.” Ex. 2029, 18:24–19:10.

In the Institution Decision, we stated: “the quoted passage appears to support that projection magnification is reduced, but not eliminated, by Jorgensen’s system.” Inst. Dec. 11 (citing Ex. 1007, H1104). On the record now before us, however, we determine that Petitioner has not met its burden to show that Jorgensen discloses a diverging x-ray beam that inherently produces projection magnification within the claimed range.

d) “*Collimated X-ray Beam*”

Jorgensen provides the following description of the X-ray beam: “The collimated X-ray beam is shielded by a lead-wrapped brass tube as the beam passes from the source into the shielded cover of the scanner.” *Id.* at H1105.

Petitioner and Dr. Kia ignore this description in their opening submissions. Neither the Petition, nor Dr. Kia’s initial declaration, even mention collimation or a collimated X-ray beam. *See* Ex. 2013, 64:13–17 (Dr. Kia: “I’ve explained the X-ray source of Jorgensen in a number of ways. It has a 4-degree projection angle . . . and whether it discloses collimation or not is irrelevant.”).

Dr. Bentley explains that a “collimated x-ray beam is a beam where the rays have been made to be parallel.” Ex. 2005 ¶ 40 (citing Ex. 1010, 13:35–14:18). At her deposition, Dr. Bentley explained that “collimated” means “parallel beams” and “[t]hose terms are used often interchangeably.” Ex. 1024, 15:18–16:3. Similarly, Dr. Arce explains, a “collimated X-ray beam is a beam where the X-rays have been made to be parallel such that no meaningful divergence is present.” Ex. 2032 ¶ 47 (citing Ex. 1010, 13:35–14:18).

The testimony of Drs. Bentley and Arce is supported by Deckman’s teachings that, when using an X-ray tube for microtomotography, the X-ray beam “must be conditioned so that it is plane parallel” and that “[d]ifferent collimation techniques can be used to achieve [the required] degree of parallelism.” Ex. 1010, 13:35–41, 14:1–3. Deckman thus confirms that collimation is technique for minimizing beam divergence so as to provide a nearly parallel X-ray beam. *Id.*

Dr. Bentley testifies that “Jorgensen’s x-ray beam is ‘collimated’” and “the x-rays have been made to be parallel.” Ex. 2005 ¶ 52 (quoting

Ex. 1007, H1105). According to Dr. Bentley, “when the x-ray beam projected through a sample has been collimated, such that the x-rays are parallel when they reach the sample, no magnification results from geometric projection. Thus, Jorgensen does not disclose a magnification of the projection x-ray stage.” *Id.* ¶ 53. Similarly, Dr. Arce testifies that “Jorgensen expressly discloses that the beam is collimated. Thus, the X-rays that reach Jorgensen’s sample are essentially parallel (*i.e.*, not diverging) and there is no projection stage magnification.” Ex. 2032 ¶ 51. Furthermore, Dr. Bentley testifies, without dispute by Petitioner and Dr. Kia, that “Jorgensen’s beam is collimated and passes through a long lead-wrapped tube before interacting with the sample. Accordingly, any x-ray diverging at a 4° angle would never reach the sample. Instead, they would run into the lead-wrapped tube, which would extinguish the x-ray.” Ex. 2005 ¶ 59. We find that the foregoing testimony of Drs. Bentley and Arce is credible and that Petitioner and Dr. Kia have no persuasive response, as discussed below.

At her deposition, Dr. Bentley summarized the bases for her conclusion that the Jorgensen’s X-rays are parallel.

Q. And it’s your opinion that the system described here in Jorgensen that he shows pictures of, photographs, it’s your opinion that the X-rays from that source have no cone-beam angle? They are parallel?

A. Based on what I’ve read, so Figure 1 shows the X-rays coming in parallel to the specimen.

Figure 2 shows the X-ray source, and it also shows a very long, lead-wrapped brass pipe that the source goes through. That would limit the amount of angles that actually make it to the specimen off the source. And then I believe we were looking at this somewhere in here where he talks about the less than .8 milliradians at the scintillator. That’s a very small angle

and is small enough to be considered [a] parallel source at infinity, however you want to describe that.

Ex. 1024, 142:16–143:12.

Dr. Bentley explained that an essentially collimated, parallel beam results when the source is viewed from far away. Ex. 1024, 16:10–17:3 (“The further [*sic*, farther] away you are, the angle that you see off the source becomes shallower and shallower until it approaches, essentially, a collimated beam.”). Dr. Bentley’s testimony is supported by Deckman, which identifies various collimation techniques, including “distance” as one way “to limit the angular beam spread through the sample.” Ex. 1010, 14:1–6. Deckman explains that “[c]ollimation increases as the distance between sample and source is increased.” *Id.* at 14:6–7.

Petitioner and Dr. Kia did not address Jorgensen’s disclosure of a “collimated X-ray beam” until the reply stage. Petitioner argues that Jorgensen’s collimator does not create “perfectly parallel x-rays” and that “Deckman describes collimation as reducing—not eliminating—beam divergence.” Pet. Reply 1. Citing Dr. Kia’s testimony, Petitioner argues, “a POSITA would understand collimation to mean reducing—not eliminating—beam divergence.” *Id.* at 2 (citing Ex. 1025 ¶¶ 5, 6).

Dr. Kia testifies:

To my knowledge, no x-ray sources currently available can generate a perfectly parallel x-ray beam.

In the context of x-ray microtomography, collimation refers to limiting or reducing the x-ray beam divergence using, for example, adjustable lead shutters or “leaves.” The lead material blocks x-rays, leaving a smaller opening or window that the x-rays can pass through. In this way, the x-ray beam can be shaped into, for example, a fan or cone shape. Both fan beams and cone beams are diverging and result in a projection

magnification of $>1x$. The prior art references I previously analyzed for the Petition are consistent with this understanding.

Ex. 1025 ¶¶ 5, 6.

Petitioner's reply arguments are unconvincing and insufficient to carry its burden. Petitioner contends that collimation reduces beam divergence (Pet Reply 2), but fails to show that the collimated X-ray beam in Jorgensen diverges enough to result in projection magnification "between 1 and 10 times," as claimed. Dr. Kia provides no objective evidence or analysis to support his assertion that "[b]oth fan beams and cone beams are diverging and result in a projection magnification of $>1x$." Ex. 1025 ¶ 6. Dr. Kia discusses the meaning of collimation generally (*id.* ¶¶ 5, 6), and he admits that Jorgensen's X-ray beam is collimated by a tube and possibly other collimators (Ex. 2029, 58:23–59:25), but he fails to address how Jorgensen's disclosure of a "collimated X-ray beam" impacts his opinion about projection magnification. For example, Dr. Kia testifies that an "x-ray beam can be shaped into . . . a fan or cone shape" (Ex. 1025 ¶ 6), but tellingly, he does not say that Jorgensen's X-ray beam is shaped into a fan or cone shape. In fact, Dr. Kia's reply testimony about collimation does not even mention Jorgensen by name. *Id.*

Both Petitioner and Dr. Kia ignore Jorgensen's disclosure that the "X-ray beam is shielded by a lead-wrapped brass tube as the beam passes from the source into the shielded cover of the scanner." Ex. 1007, H1105. Petitioner estimates that, in Jorgensen, the X-ray source is spaced "several feet" or as much as "one meter" from the sample. Pet. 22; Ex. 1024, 22:2–5 (Petitioner's question to Dr. Bentley); Tr. 10:8–9 (Petitioner: "we know that the source is approximately one meter from the scintillator"). Yet Petitioner and Dr. Kia fail to address how the long lead-wrapped brass tube affects

beam divergence. Dr. Bentley's testimony on that topic is unrebutted.
Ex. 2005 ¶ 59.

e) “Cone-beam Geometry”

In a section titled “Tomographic Image Reconstruction,” Jorgensen discloses: “*Backprojection*. Because we use an X-ray focal spot that subtends ≤ 0.8 mrad at the scintillator, we have reasonably pure cone-beam geometry.” Ex. 1007, H1106.

Petitioner and Dr. Kia rely on this statement as support for their assertion that “Jorgensen discloses a diverging, cone-beam x-ray source projected at a 4° angle.” Pet. 18–19; Ex. 1005 ¶ 69 (quoting Ex. 1007, 1106). Despite the highly technical nature of Jorgensen's disclosure, Dr. Kia does not explain how or why it leads him to conclude that it describes a “diverging, cone-beam x-ray source.” Ex. 1005 ¶ 69. Dr. Kia merely states his conclusion and then includes selected quotes from Jorgensen. *Id.* Furthermore, Dr. Kia focuses on the second half of the sentence (“we have reasonably pure cone-beam geometry”), while ignoring the subheading “backprojection” and the prefatory clause, “[b]ecause we use an X-ray focal spot that subtends ≤ 0.8 mrad at the scintillator.” Ex. 1007, H1106.

Dr. Bentley, on the other hand, provides a persuasive explanation for why Jorgensen's statement about “reasonably pure cone-beam geometry” does not support Petitioner's argument that Jorgensen's x-ray source inherently produces projection magnification. Ex. 2005 ¶¶ 57–61. According to Dr. Bentley, “Jorgensen ‘use[s] a cone-beam backprojection, modified Feldkamp reconstruction algorithm (12),’ which assumes that all of the x-rays can be traced back to a single point.” *Id.* ¶ 58 (citing Ex. 1007,

H1106; Ex. 2006, Fig. 4). Dr. Bentley explains that Jorgensen's X-ray source, however, is a "line source," which, "from the perspective of the sample, . . . appears as a 0.8 mm by 0.4 mm rectangle." *Id.* (citing Ex. 1007, H1104). According to Dr. Bentley, Jorgensen's line source "suffers from rectangular geometry and non-ideal intensity distribution, which can lead to a distorted image . . . because all of the x-rays cannot be traced back to a single point." *Id.* ¶ 60 (citing Ex. 1007, H1104); *see also* Ex. 2032 ¶ 50 (similar testimony from Dr. Arce).

Dr. Bentley explains that, "by using 'an X-ray focal spot that subtends <0.8 mrad at the scintillator' (*i.e.*, by placing the x-ray focal spot far away from the scintillator), the authors were able to reasonably assume that the x-rays could be traced back to a single point and thus use their desired cone-beam reconstruction algorithm." Ex. 2005 ¶ 61.¹⁴ Based on the foregoing explanation, Dr. Bentley opines that "a POSITA would have understood that Jorgensen describes the system as having 'reasonably pure cone-beam geometry' to justify their use of a cone-beam reconstruction algorithm; not because the system has a diverging x-ray beam at the sample." *Id.*; *see also* Ex. 2032 ¶ 51 (similar testimony from Dr. Arce).

¹⁴ In her declaration, Dr. Bentley testifies that "Jorgensen's disclosure that the X-ray focal spot 'subtends <0.8 mrad at the scintillator' confirms that the maximum divergence of the beam would be less than 0.023 degrees (0.4 mrad)." Ex. 2005 ¶ 62. At her deposition, however, Dr. Bentley clarified her testimony, explaining that "less than [0].8 milliradians" is not describing the divergence, but rather "the angle that the focal spot subtends at the sin [*sic*, scintillator]." Ex. 1024, 117:6–22, 118:14–21, 167:14–21; *see also id.* at 118:2–13 (explaining angular subtense). Petitioner agrees with Dr. Bentley's clarification. Tr. 8:3–24. For this reason, we do not rely on paragraph 62 of Dr. Bentley's declaration.

At her deposition, Dr. Bentley testified that Feldkamp's cone-beam reconstruction algorithm "could be applied whether or not it was a perfect point source close to the object or a collimated source far away from the object." Ex. 1024, 77:21–78:10 (discussing Ex. 2006). Dr. Bentley supported that testimony by referencing Feldkamp's discussion of "the limit as d goes to infinity, which shows that the algorithm works for the parallel-projection case." *Id.* at 78:11–19 (referencing Ex. 2006, 615). Similarly, Dr. Bentley testified that the Feldkamp algorithm "will work with both large and small [cone angles] and even parallel rays when there isn't a cone angle." *Id.* at 85:21–86:7; *see also id.* at 126:13–20 (similar testimony).

At her deposition, Dr. Bentley reiterated:

Jorgensen has expressly disclosed that their beam is collimated, and they're using this pure cone-beam geometry to justify their use of a cone-beam reconstruction algorithm. It's not because the source was diverging at the sample. It was far enough [a]way, and/or with the collimator they put in there, it makes it look like it's far enough way that those rays are essentially parallel. As I mentioned, this algorithm in [Feldkamp] works for when d goes to infinity. There's nothing about it that says that it can't be used [for rays that are essentially parallel].

Ex. 1024, 93:4–22.

When questioned about Jorgensen's disclosure, "[b]ecause we use an X-ray focal spot that subtends 0.8 mrad at the scintillator, we have reasonably pure cone-beam geometry," (Ex. 1007, H1106), Dr. Bentley testified:

I think the "we have reasonably pure cone-beam geometry" alone, it could -- it could be either collimated rays or rays like the line segments drawn in Feldkamp.

But when you couple it with the first part of the sentence, which is something that subtends less than .8 milliradians, that's

the part that is leading towards the parallel rays statement in my declaration.

Ex. 1024, 117:7–15 (referencing Ex. 2005 ¶ 61).

In sum, we are persuaded by Dr. Bentley’s testimony that Jorgensen’s reference to “cone-beam geometry” (Ex. 1007, H1106) relates to the reconstruction algorithm and does not support Petitioner’s argument that Jorgensen discloses a diverging x-ray source that necessarily produces projection magnification within the claimed range. *Compare* Pet. 18, 21, 23, *with* Ex. 2005 ¶ 61. Dr. Bentley’s testimony shows that the cone beam reconstruction algorithm works with either diverging or parallel rays. *See, e.g.,* Ex. 1024, 85:21–86:7. Therefore, Jorgensen’s references to “cone-beam geometry” or a “cone angle” in the context of discussing image reconstruction (*e.g.,* Ex. 1007, H1106, H1108, H1111) are insufficient to show that Jorgensen’s “collimated X-ray beam . . . shielded by a lead-wrapped brass tube” is a diverging beam that necessarily produces projection magnification.

In the Reply, Petitioner argues that “Jorgensen’s collimated x-ray beam is also expressly disclosed as a diverging ‘cone beam.’” Pet. Reply 2. Contrary to Petitioner’s contention, Jorgensen’s collimated x-ray beam is *not* “expressly disclosed as . . . diverging.” *Id.* Petitioner attempts to support its contention by quoting small, out-of-context snippets from Jorgensen without explaining how they support Petitioner’s contention. *Id.* (citing Ex. 1007, H1106 (“we have reasonably pure cone-beam geometry”); H1108 (“the X-ray cone beam”); H1111 (“the cone-beam geometry of the X-ray beam”).) Because Petitioner provides no citation to expert testimony, we rely on Dr. Bentley’s explanation of these snippets.

Petitioner's first snippet concerning "cone-beam geometry" (Ex. 1007, H1106) is discussed above.

Petitioner's second snippet is excerpted from Jorgensen's disclosure, "We expect there to be increased distortion of the microsphere in the axial direction the further the sphere is away from the central plane of symmetry of the X-ray cone-beam." Ex. 1007, H1108. When asked about this portion of Jorgensen at her deposition, Dr. Bentley testified:

Q. Why is there increased distortion away from the central plane of symmetry of the X-ray cone beam?

A. I believe this goes back to what I was talking about earlier with Feldkamp and this concept of a perfect point source, which doesn't exist. So the point source has some extent.

Q. And so it's your opinion that it's the finite size of the point of the X-ray source that is creating the increased distortion in the axial direction the further the sphere is away from the central plane of the X-ray cone beam?

A. So in Jorgensen the assumption is that we have a perfect point source at infinity, so we have collimated rays coming in. Jorgensen talks about the fact that he's got an X-ray focal spot that subtends less than .8 milliradians at the scintillator. So there is some small deviation from that perfect-point-source-at-infinity assumption, and I believe the error analysis that he's referring to here is due to that.

Ex. 1024, 165:14–166:13. Dr. Bentley's explanation is credible and undermines Petitioner's argument that Jorgensen discloses a diverging x-ray beam that necessarily produces projection magnification within the claimed range.

Petitioner's third snippet is excerpted from Jorgensen's disclosure that "the CT image reconstruction algorithm (12) also distorts the image, especially in the axial direction due to the cone-beam geometry of the X-ray beam." Ex. 1007, H1111. Although Dr. Bentley did not opine on this

particular excerpt (*see* Ex. 1026, 137:11–140:22), she did respond to Petitioner’s questions about axial distortion, as quoted above (Ex. 1024, 165:14–166:13), and that testimony does not support Petitioner’s argument.

Turning again to the Reply, Petitioner argues that “Jorgensen’s reconstruction algorithm assumes a diverging beam.” Pet. Reply 2–8. This is a new argument based on new evidence (Feldkamp, Ex. 2006) presented for the first time in the Reply. Under our rules, such new arguments and evidence are procedurally improper. 37 C.F.R. § 42.23(b); CTPG 73–74. Additionally, Petitioner’s new argument is unsupported by any citation to expert testimony. *Impax Laboratories v. Lannett Holdings, Inc.*, 893 F.3d 1372, 1380 (Fed. Cir. 2018) (rejecting patent challenger’s arguments discounting the significance of a particular aspect of the prior art, where challenger’s expert did not dispute its relevance and the arguments “are without any evidentiary support beyond its attorney arguments concerning factual issues”). Even if it were procedurally proper, Petitioner’s new argument is refuted by Dr. Bentley’s testimony that the Feldkamp reconstruction algorithm works with parallel rays. Ex. 1024, 77:21–78:19, 85:21–86:7, 93:4–22, 126:13–20.

Next, Petitioner interprets Jorgensen as teaching that, for small scan volumes, a fan-beam method can be used and axial divergence can be ignored, and “for larger scan volumes, Jorgensen uses cone-beam backprojection, which assumes both axial and radial divergence.” Pet. Reply 8 (citing Ex. 1007, H1106). Again, this argument is unsupported by any citation to expert testimony. *See Impax*, 893 F.3d at 1380. In any event, Petitioner’s unsupported attorney argument relates to reconstruction algorithms and is insufficient to show that Jorgensen discloses a diverging

x-ray beam that necessarily produces projection magnification within the claimed range.

f) CCD Pixel Size

Although Petitioner, not Patent Owner, bears the burden of proof, Patent Owner and Dr. Bentley present an un rebutted analysis of Jorgensen's disclosures relating to CCD pixel size that persuasively supports the absence of projection magnification. PO Resp. 16–17; Ex. 2005 ¶¶ 54–56.

Jorgensen discloses that, when the lens that transfers a light image to the CCD is set to twofold magnification, the CCD pixels are effectively “12 μm on a side (referenced to specimen).” Ex. 1107, H1104. Jorgensen describes the CCD as having “square pixels” that are “24 μm on-a-side.” *Id.* Based on these disclosures, Dr. Bentley testifies:

Jorgensen explains that when magnification of the lens is set to 2x, the specimen size is doubled by the lens (such that a 12 μm on a side square at the sample corresponds to a 24 μm on a side pixel at the detector). That can be true **only if** there is no additional magnification in the projection stage.

Ex. 2005 ¶ 54. Dr. Bentley provides an example showing that, “even if the projection stage magnification were only 1.1x, then a 24 μm pixel at the detector would correspond to a 10.9 μm pixel referenced to the sample,” not 12 μm , as stated by Jorgensen. *Id.* ¶ 55. Dr. Bentley concludes that “Jorgensen's disclosure of ‘CCD pixels 12 μm on a side (referenced to specimen)’ when the optical stage is set to 2x magnification is thus inconsistent with geometric magnification in the projection stage.” *Id.* Dr. Bentley reinforces her conclusion with the observation that “Jorgensen only describes obtaining magnification from its optical stage.” *Id.* ¶ 56 (quoting Jorgensen's description of magnification lens, Ex. 1007, H1104).

During deposition, Dr. Kia testified that Jorgensen's disclosure, "12 μm on a side (referenced to specimen)," refers to "the image plane on the scintillator," rather than a side of the sample. Ex. 2013, 72:25–73:7. Petitioner does not rely on Dr. Kia's testimony in the Reply. *See* Pet. Reply (no discussion about Jorgensen's disclosure of "referenced to specimen"). We agree with Patent Owner's argument that Dr. Kia's interpretation of "referenced to specimen" is incorrect. PO Resp. 17 n.2 (citing Ex. 2005 ¶ 54 n.1). Patent Owner presents the un rebutted testimony of Dr. Bentley explaining why Dr. Kia's interpretation is incorrect.

In the field of optics, a reference to a pixel on the imaged specimen is a reference to the specimen. It is also referred to as the equivalent pixel size on the specimen and describes how big the pixel looks at the specimen. I note also that Jorgensen expressly distinguishes between the specimen and the scintillator. *See* Jorgensen [Ex. 1007] at H1104 (referring to "in the long X-ray focal spot-to-specimen distance and the close proximity of the specimen to the X-ray-to-light conversion crystal"). Accordingly, a POSITA would not have understood "referenced to the specimen" to mean the image plane on the scintillator.

Ex. 2005 ¶ 54 n.1. Petitioner did not cross-examine Dr. Bentley on this testimony. *See* Ex. 1024. We also observe that Jorgensen's parenthetical states, "referenced to specimen" (Ex. 1007, H1104), not "referenced to scintillator," as Dr. Kia's interpretation would imply. Ex. 2013, 72:25–73:7; *see* Tr. 30:15–21 (Patent Owner: Petitioner's position that "referenced to specimen" should be understood as "referenced to scintillator" is "just not what the reference says.")).

In the Institution Decision, we rejected a similar argument by Patent Owner, stating that Jorgensen's disclosure about CCD pixel size "is an example of the magnification that can be achieved by the lens, i.e., optical

stage magnification, and does not exclude the possibility of additional magnification at the x-ray projection stage.” Inst. Dec. 12. Petitioner asserts this preliminary finding was correct, but does not explain why. Pet. Reply 9. At the institution stage, we did not have Dr. Bentley’s testimony about the meaning of “referenced to specimen” in Jorgensen. Ex. 2005 ¶¶ 54 n.1. On the record now before us, Patent Owner’s argument is unrebutted and supported by the credible testimony of Dr. Bentley and the disclosure of Jorgensen. Ex. 2005 ¶¶ 54–56; Ex. 1007, H1104. Moreover, the mere “possibility of additional magnification at the x-ray projection stage” (Inst. Dec. 12.) is not enough to show inherent disclosure. *In re Oelrich*, 666 F.2d 578, 581 (CCPA 1981) (“Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.”).

g) Filling the CCD

For the first time in the Reply, Petitioner argues that “Jorgensen requires a diverging beam to fill its CCD.” Pet. Reply 9–10. Although Petitioner tries to present this argument as a rebuttal to Patent Owner’s analysis of CCD pixel size (*id.* at 9 (citing PO Resp. 16–17)), the argument is, in our view, a new theory of inherent disclosure that should have been presented in the Petition. The Reply presents new calculations of how many pixels would be filled with a non-diverging beam and how much the X-ray beam increases in size based on Jorgensen’s disclosures of effective spot size of the X-ray source and the size of the pixels and the CCD array. Pet. Reply 9–10. In contrast, the Petition asserts that Jorgensen’s X-ray beam is diverging and presents a calculation of projection magnification based on Jorgensen’s source-to-sample and source-to-detector distances (Pet. 18, 21,

23), with no mention of filling the CCD. There is no reason Petitioner's CCD-filing argument could not have been presented in the Petition. It is therefore improper. 37 C.F.R. § 42.23(b); CTPG 73–74.

Petitioner's new reply argument is not persuasive in any event. The argument presumes that Jorgensen's scanner produces an image that fills the entire CCD. Petitioner relies on Dr. Kia's testimony that a "POSITA would know to use the entire CCD to maximize image quality." Ex. 1025 ¶ 7. Petitioner also relies on Dr. Bentley's testimony that "[m]ost of the time when you're using a sensor, you'd like to use the entire sensor" and "in general you try to maximize the amount of pixels you get." Ex. 1024, 188:6–17; *see* Pet. Reply 9 (cropped quotes from this testimony).

Patent Owner, on the other hand, directs us to testimony from both experts that, in some circumstances, a POSITA would not want to fill the entire CCD. PO Sur-reply 11 (citing Ex. 1024, 189:17–191:1; Ex. 2029, 67:21–68:7). Dr. Bentley testifies that sometimes, "you don't want to image that over the entire CCD, because you need a navigation area to navigate around and find out where [the small area being imaged] is [located]." Ex. 1024, 189:17–190:10. Dr. Kia testifies that "Jorgensen's system is *capable of* configuring it to fill the entire CCD. If he doesn't want to fill up the CCD, he also has the option, but it would need to be configured with the right tradeoffs." Ex. 2029, 67:21–68:7 (emphasis added).

At most, the evidence shows that a POSITA would have usually wanted to fill the entire CCD and Jorgensen is capable of being configured to do that. But that is an argument about obviousness, not inherent disclosure. The evidence is insufficient to show that Jorgensen *requires* a diverging beam or that the disclosed scanner *necessarily* produces projection magnification.

Furthermore, Petitioner’s CCD-filling argument is based on Dr. Kia’s assumption that **all** of the magnification needed to fill the CCD occurs at the projection stage, and none occurs at the optical stage. Ex. 1025 ¶ 7 (“Jorgensen uses an x-ray beam that diverges sufficiently to fully utilize the CCD **at the lowest optical magnification setting**.” (emphasis added)); Pet. Reply 10 (citing this testimony); *see also* Ex. 1007, H1104 (Jorgensen’s lens provides “1- to 10-fold magnification”). Dr. Kia provides no support for that assumption.

For all of these reasons, Petitioner’s reply argument about filling the CCD is not persuasive and is insufficient to carry its burden.

h) Summary of Findings on Inherent Disclosure

“Demonstrating inherent disclosure requires meeting a stringent standard.” *Amgen Inc. v. Sandoz Inc.*, No. 2022-1147, 2023 WL 2994166, at *10 (Fed. Cir. Apr. 19, 2023). “Inherency . . . may not be established by probabilities or possibilities.” *Oelrich*, 666 F.2d at 581. “The mere fact that a certain thing **may** result from a given set of circumstances is not sufficient.” *Id.* (emphasis added). Rather, the patent challenger must “show that the **natural result flowing** from the operation as taught would result in the performance of the questioned function.” *Id.*; *see PersonalWeb Technologies, LLC v. Apple, Inc.*, 917 F.3d 1376, 1382–83 (Fed. Cir. 2019) (determining that the Board’s reliance on inherency was improper because the structure relied upon to meet a claim element “does not necessarily exist” in the reference).

As discussed above, it is undisputed that there can be no projection magnification unless the X-ray beam is diverging, and there is a vigorous dispute about whether Jorgensen teaches a diverging X-ray beam. *See*

II.D.2.a., *supra*. The credibility of Petitioner’s position on this issue is negatively impacted by Petitioner’s and Dr. Kia’s admittedly incorrect interpretations of Jorgensen’s disclosures concerning “projected at a 4° angle” and “the X-ray beam geometry is used to achieve magnification.” Ex. 1007, H1104; *see* II.D.2.b. and c., *supra*.

On balance, we find that the testimony of Drs. Bentley and Arce about Jorgensen is more credible than Dr. Kia’s testimony, which is often conclusory and insufficiently supported by the evidence. Drs. Bentley and Arce do a better job of explaining and reconciling Jorgensen’s varying descriptions of the X-ray beam than does Dr. Kia. For example, although Dr. Kia relies on Jorgensen’s repeated references to a “cone-beam,” we find that Petitioner’s evidence does not outweigh the explanations provided by Drs. Bentley and Arce, particularly in view of Jorgensen’s description of the X-ray beam as “collimated” and “shielded by a lead-wrapped brass tube.” *See* II.D.2.d. and e., *supra*. Even if we consider Petitioner’s improper new reply argument about filling the CCD, we find that argument insufficient and does not outweigh Patent Owner’s un rebutted evidence about CCD pixel size. *See* II.D.2.f. and g., *supra*.

In sum, viewing the record as a whole, we find that Petitioner has not shown persuasively that Jorgensen inherently discloses projection magnification within the claimed range.

3. *Obviousness*

The Petition asserts that, “even if the claimed magnification range was not inherent in Jorgensen, it would have been obvious to use such a range.” Pet. 3. That argument is wholly undeveloped and unsupported. In the sections of the Petition that address alleged obviousness of claims 1 and 7

based on Jorgensen, alone or in combination with another reference, Petitioner relies on the same arguments and evidence for obviousness as it presents for anticipation. Pet. 33, 36, 59–60, 66, 72, 78. Petitioner presents no rationale for modifying Jorgensen to include projection magnification within the claimed range.

Patent Owner argues persuasively that a POSITA would not have had reason to add projection magnification to Jorgensen. PO Resp. 25. Patent Owner’s argument is supported by Jorgensen’s teaching that “[t]he geometry and intensity distribution of the X-ray focal spot are of concern if the X-ray beam geometry is used to achieve magnification.” Ex. 1007, H1104. Patent Owner’s argument is further supported by Dr. Kia’s deposition testimony. When asked about the above-quoted statement in Jorgensen, he responded, “they cannot -- they don’t want to implement a system where they’re going to rely on the magnification because their focal spot and their geometry cannot support their resolution -- their resolution need.” Ex. 2013, 76:11–77:12. Still further support is provided by Dr. Bentley’s testimony that “the Jorgensen system’s design depends on avoiding geometric magnification” and “Jorgensen explains that attempting to use geometric magnification with its disclosed source would result in problems due to the source’s geometry and intensity distribution.” Ex. 2005 ¶¶ 70, 72 (discussing Ex. 1007, H1104).

In the Reply, Petitioner argues that “Jorgensen teaches the trade-offs of using different amounts of projection stage magnification.” Pet. Reply 11 (citing Ex. 1023 ¶ 8; Ex. 1007, H1111, H1113). Petitioner’s argument is not supported by the cited portions of Jorgensen, which discuss the advantages of holding the sample close to the imager (Ex. 1007, H1111) and the trade-offs, if the x-ray source were positioned closer to the sample (*id.* at H1113).

Projection magnification is not discussed. Because Petitioner does not show that Jorgensen's collimated X-ray beam is diverging, Petitioner fails to establish that positioning the X-ray source closer to the sample would result in projection magnification. And Petitioner makes no argument that it would have been obvious to an ordinarily skill artisan at the critical time to replace Jorgensen's collimated X-ray source with a diverging one.

4. Conclusion for Jorgensen-led Challenges

Petitioner's challenges based on Jorgensen, alone or in combination with another reference, rely on Petitioner's unproven contention that Jorgensen inherently discloses projection stage magnification within the claimed range or that it would have been obvious to modify Jorgensen to include this limitation. Pet. 3, 20–23, 33, 36, 45, 59–60, 72, 78. For all of the foregoing reasons, Petitioner has not proven those contentions by a preponderance of the evidence, and its Jorgensen-led challenges do not succeed.

E. Petitioner's Deckman and Flannery-led Challenges

Petitioner challenges claims 1 and 3–6 as obvious based on Deckman and Flannery. Pet. 14. Petitioner also combines Deckman and Flannery with various other references. *Id.* Our analysis of these challenges focuses on the projection magnification limitation of claim 1. Petitioner contends that Deckman and Flannery disclose projection magnification within the claimed range. Pet. 51–53. Patent Owner disputes that contention. PO Resp. 21–25. We provide an overview of the references before turning to our analysis of the parties' contentions.

1. *Deckman (Ex. 1010)*

Deckman is titled, “Method and apparatus for utilizing an electro-optic detector in a microtomography system,” and discloses “an apparatus and a method for producing tomographic images of an object irradiated by a beam of collimated radiation transmitted in a plurality of rays through a set of coplanar sections of an object as viewed from a plurality of angles about a rotation axis.” Ex. 1010, codes (54), (57), 2:8–13; *see also id.* at 23:50–55 (claim 1). Deckman describes a computerized x-ray tomography detector that achieves spatial resolution below 10 microns in reconstructed images. *Id.* at 3:28–31, 3:35–37. According to Deckman, “the detector can be used to acquire data in multiple stacked planes, allowing the internal structure of a sample to be reconstructed on a three[-]dimensional network of points.” *Id.* at 3:32–35.

With reference to Figures 3 and 4, Deckman discloses two modes for data acquisition: fan beam mode and plane parallel mode. Ex. 1010, 5:47–6:25. Deckman Figure 3 is reproduced below, with the upper and lower panels arranged side-by-side.

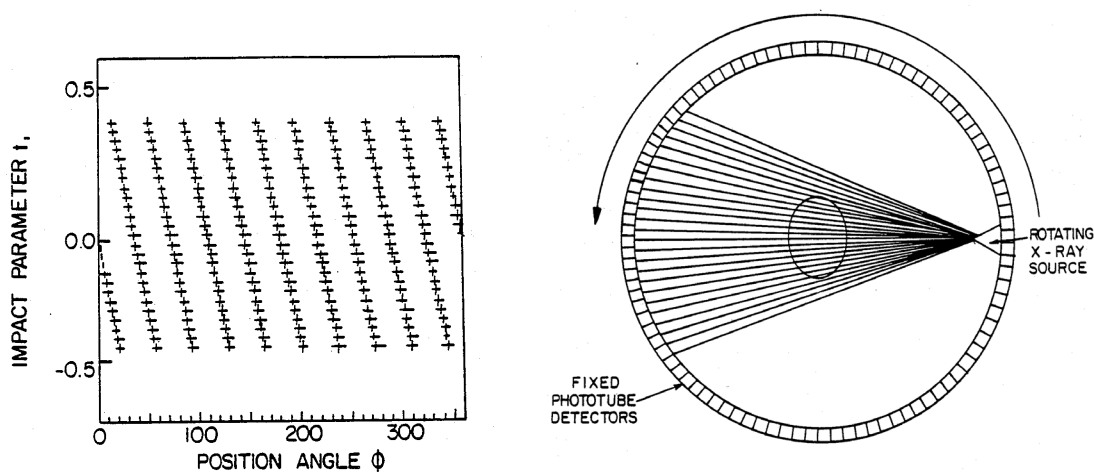


FIG. 3

Deckman Figure 3 (above) shows observational paths in a typical medical CT scanner using the “fan beam” observational mode, with discrete observational paths occurring at points (t_1, Φ) shown in the left panel.

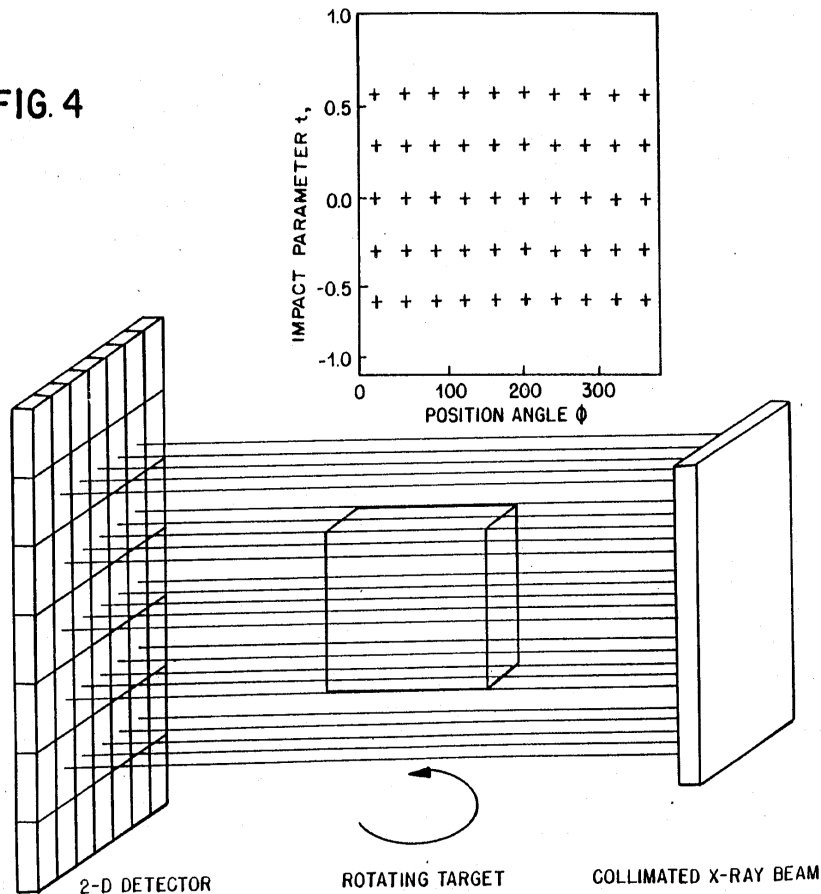
Ex. 1010, 2:39–42. Deckman describes the Figure 3 embodiment as follows:

In medical tomography measurements are typically obtained with a fixed set of detectors located along a ring surrounding the patient, as shown in FIG. 3. The X-ray source rotates about the ring, illuminating a series of detectors opposite the source with a collimated fan beam of radiation. The opening angle of the collimated X-ray beam is broad enough so that the fan of paths from source to detector completely encompasses the target. For accurate reconstruction of the entire target, the range of impact parameters must span the diameter of the target and the angular rotations must span at least one half of a complete rotation. We refer to the mode of operation shown in FIG. 3 as fan beam collimation.

Ex. 1010, 5:57–6:2.

Deckman Figure 4 is reproduced below.

FIG. 4



Deckman Figure 4 (above) shows observational paths in a scanner using the “parallel beam” observational mode, with discrete observational paths in one of the planes occurring at points (t_1, Φ) shown in the upper panel. Ex. 1010, 2:43–50. As shown in Figure 4, “a parallel, collimated beam of radiation irradiates the target in multiple stacked planes and multiple impact parameters simultaneously” and “[t]he target is rotated for observations at different view angles Φ .” *Id.* Deckman describes the Figure 4 embodiment as follows:

Another mode of operation for a tomographic scanner is shown in FIG. 4. Collimated X-rays, or other penetrating radiation, illuminate the target along two dimensional sets of plane parallel paths that are recorded by a panoramic detector. If a two dimensional imaging electro-optic detector is used, data in

multiple stacked planes is measured simultaneously. Views from different angles are achieved by rotating the target (as shown in FIG. 4) or by rotating both source and detector around a stationary sample. Data taken in this geometry are said to be taken in plane parallel mode. The plane parallel mode of data acquisition is clearly preferred when high spatial resolution between 0.5 and 25 microns is selected. For high spatial resolution data acquisition, X-ray beams can be readily collimated for the plane parallel mode shown in FIG. 4, whereas appropriate collimation for the fan beam geometry is difficult. Throughout this application, we will illustrate the use of electro-optic detectors with the plane parallel mode of data acquisition. However, the invention is also applicable to the fan beam mode of data acquisition. Also, the application will be illustrated for the case in which the sample is physically rotated.

Ex. 1010, 6:3–25.

Deckman describes the x-ray source requirements for its microtomography detector. Ex. 1010, 12:63–14:36. Deckman discloses:

Sources of X-rays . . . include synchrotrons, rotating anodes, X-ray generators and X-ray tubes. To use these sources of radiation in a preferred embodiment for which the device acts as a microtomography system, the X-ray beam generated must be conditioned so that it is plane parallel with a predetermined spectral distribution. Parallelism of the rays is required due to the nature of the reconstruction algorithms which require that rays pass through only a single column of pixels in the sample.

Id. at 13:35–44. Deckman discloses equations 13 and 14 for calculating the maximum angular divergence of rays passing through a sample as a function of the minimum resolution element in the image, the sample diameter, and the sample-to-detector distance. *Id.* at 13:44–68. Deckman discloses that various collimation techniques can be used to achieve the required degree of parallelism and beam divergence. *Id.* at 14:1–22.

Deckman Example 1 references Figure 10, reproduced below.

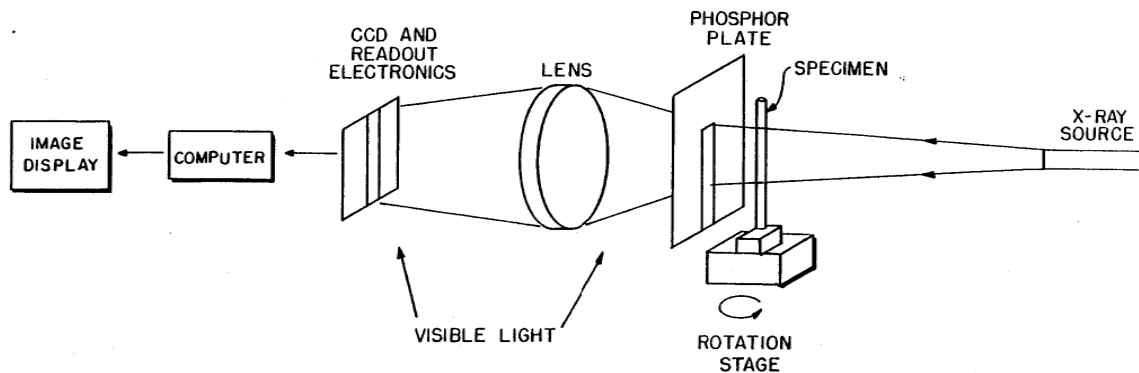


FIG.10

Deckman Figure 10 (above) shows an X-ray microtomography apparatus. Ex. 1010, 3:7–9. Deckman Example 1 describes use of the Figure 10 apparatus to examine a glass tube packed with silica beads and evaluate various detector attributes, including spatial resolution. *Id.* at 21:35–23:48, Fig. 12 (reconstructed images of bead-packed glass tube).

2. *Flannery (Ex. 1011)*

Flannery is titled “Three-Dimensional X-ray Microtomography” and discloses “a high resolution imaging x-ray detector and high-speed tomographic image reconstruction procedures together with a collimated monochromatic area-filling x-ray beam.” Ex. 1011, 1439.¹⁵ According to Flannery, the detector is “capable of submicrometer resolution” and “makes efficient use of the area-filling collimated x-ray beam to record data simultaneously in multiple stacked planes suitable for reconstruction of three-dimensional images.” *Id.*

¹⁵ Two of Flannery’s co-authors are the co-inventors of Deckman and affiliated with Exxon Research and Engineering Company, the assignee of Deckman. *Compare* Ex. 1011, 1439, *with* Ex. 1010, codes (73), (75).

Flannery Figure 2 is similar to Deckman Figures 3 and 4 (reproduced above). The caption to Flannery Figure 2 states:

A schematic comparison of the source-detector configuration in conventional medical CI scanners (top) and the x-ray microtomography device (bottom). Not that the set of projection measurements occurs in a fan-beam pattern with the medical scanner, and in a plane-parallel pattern in the microtomography system. The medical scanner acquires data in a single plane by rotating the source along the rim containing detectors. The microtomography configuration uses a fixed source producing a large beam of collimated radiation and a panoramic detector to record data simultaneously in multiple stacked planes from which a complete three-dimensional image can be reconstructed.

Ex. 1011, 1440 (Figure 2 caption). Flannery describes the microtomography system as follows:

[B]y using a collimated beam of large size compared with the sample, and by using a panoramic detector, the microtomography system acquires data simultaneously in a large number of stacked coplanar sections. Thus, the data from one set of M two-dimensional projection measurements allow us to reconstruct several hundred sequential planes of the sample to form a three-dimensional map.

Id. at 1440 (M is the number of view angles at which projection data is acquired.).

Flannery Figure 6 is similar to Deckman Figure 10 (reproduced above). The caption to Flannery Figure 6 states:

Schematic of the x-ray microtomography device. A collimated beam of monochromatic x-rays illuminates a sample mounted on a rotatable stage. The intensity of the transmitted x-ray beam is recorded in a digital, panoramic, electro-optic detector. At the heart of the device is a phosphor face plate that converts x-rays to optical radiation with high resolution.

Ex. 1011, 1442 (Figure 6 caption).

Flannery discloses that “synchrotron x-ray sources produce an intense, well-collimated beam of x-rays that is ideal for high-resolution tomography.” Ex. 1011, 1442. Flannery includes the following discussion of the x-ray source:

Principal attributes desired in the radiation source are (i) high intensity levels in a narrow energy range, (ii) nearly parallel collimation, and (iii) beam stability in position and intensity. To achieve resolution Δt in a cross-sectional map of an object of maximum diameter D , penumbral shadowing from the apparent source size and beam divergence cannot exceed an angle $\alpha \approx \Delta t/D$ in passing through the target into the detector. Items (i) and (ii) especially place stringent limits on design because loss of flux usually accompanies high collimation.

Id. at 1443. Flannery discloses reconstructed images obtained using a laboratory x-ray source (Figures 8 and 9) and with a synchrotron source (Figures 10 and 11). *Id.* at 1442–1443. Flannery states that the disclosed technique achieves $\sim 10 \mu\text{m}$ resolution with a laboratory source and “images at $2.8 \mu\text{m}$ per pixel” with a synchrotron source. *Id.* at 1444.

3. Obviousness

Relying on the '704 Patent's formula (*see* page 15 n.12, *supra*) and the sample-to-source and sample-to-detector distances in Deckman, Petitioner calculates a projection magnification of 1.01 for Deckman. Pet. 52 (citing Ex. 1001, 1:40–52; Ex. 1005 ¶ 186; Ex. 1010, 21:48–66). Petitioner contends that a “POSITA would understand that Flannery places the sample closer to the scintillator than to the source and therefore has projection magnification between 1 and 2.” *Id.* (citing Ex. 1005 ¶ 187; Ex. 1011, Figs. 2, 6). In addition, Petitioner asserts that the references are “based on the same research by both Flannery and Deckman as co-authors/co-inventors at Exxon” and disclose “the same overall design

architecture,” and thus a “POSITA would understand that Flannery has a similar magnification to Deckman.” Pet. 53 (citing Ex. 1005 ¶ 188).

Patent Owner argues that Deckman and Flannery do not disclose projection stage magnification because both references disclose a collimated, parallel x-ray beam. PO Resp. 21–25.

At the institution stage, we did not find a reasonable likelihood that Petitioner would prevail on its challenges based on Deckman and Flannery. Our Institution Decision states: “Petitioner does not address Deckman’s disclosures relating to a plane parallel X-ray beam and maximum angular divergence. On this record, these disclosures appear to undermine Petitioner’s contention that Deckman discloses a diverging x-ray beam.” Inst. Dec. 25 (citing Pet. 48). Similarly, we stated that “Petitioner does not address . . . disclosures in Flannery [relating to a plane parallel x-ray beam], which appear to undermine Petitioner’s contention that Flannery discloses a diverging x-ray beam.” Inst. Dec. 26 (citing Pet. 48). We concluded: “On this record, it is unclear whether Petitioner’s calculation of a projection magnification of 1.01 for Deckman and assertion that ‘Flannery has a similar magnification to Deckman’ (Pet. 52–53) adequately take into account plane parallel collimation and the small degree of angular divergence disclosed by these references.” Inst. Dec. 26. For the reasons discussed below, the evidence overwhelmingly demonstrates Petitioner fails to carry its burden.

Although Petitioner asserts that “Deckman explicitly discloses every limitation” of claim 1 except for optical magnification (Pet. 55), that is plainly not true. Petitioner points to no explicit disclosure of projection magnification in either Deckman or Flannery. In both instances, Petitioner’s contention rests on inherency. *See* Pet. 53 (asserting that Flannery inherently discloses the projection magnification limitation); *see also PAR*

Pharmaceutical, Inc. v TWI Pharmaceuticals, Inc., 773 F.3d 1186, 1194–95 (Fed. Cir. 2014) (“[I]nherency may supply a missing claim limitation in an obviousness analysis[;] . . . however, . . . the use of inherency . . . must be carefully circumscribed in the context of obviousness.”).

As discussed above, there can be no projection magnification unless the X-ray beam is diverging. *See* II.D.2.a., *supra*. Petitioner and Dr. Kia assert that “[b]oth Deckman and Flannery disclose an x-ray source generating a diverging x-ray beam.” Pet. 48; Ex. 1005 ¶ 174. As support, they quote the following excerpt from Deckman Example 1: “X-rays were generated from a Cu fine focus X-ray tube manufactured by Phillips Electronic Instruments. . . . Take-off angle of the experiment with respect to the anode shadow projected by the tube was approximately 5° yielding an effective X-ray source size of approximately 750 microns by 500 microns.” Pet. 48; Ex. 1005 ¶ 174 (quoting Ex. 1010, 21:44–56). The quoted excerpt does not say the X-ray beam is diverging. It appears that Petitioner and Dr. Kia misinterpret Deckman’s disclosure of a take-off angle as a disclosure of an angle of beam divergence—the same mistake they made for Jorgensen. As discussed above, Petitioner and Dr. Kia are admittedly incorrect in asserting that Jorgensen’s disclosure of “projected at a 4° angle” means the X-ray beam is diverging at a 4-degree angle. *See* II.D.2.b., *supra*. Here, it appears Petitioner and Dr. Kia are similarly incorrectly asserting that Deckman’s disclosure of a 5-degree take-off angle means the X-ray beam is diverging at a 5-degree angle.

Petitioner and Dr. Kia also quote the following excerpt from Flannery: “To achieve resolution Δt in a cross-sectional map of an object of maximum diameter D , penumbral shadowing from the apparent source size and beam divergence cannot exceed an angle $\alpha \approx \Delta t/D$ in passing through the target

into the detector.” Pet. 48–49; Ex. 1005 ¶ 174 (quoting Ex. 1011, 1443). The quoted excerpt provides an equation for calculating the maximum angular divergence of an x-ray beam passing through a sample. Ex. 1011, 1443. Flannery’s equation is similar to Deckman’s equation 13, which Deckman describes as follows:

[A] principal ray passing through the sample . . . must be parallel with any other ray through another point in the sample with an accuracy given by

$$\alpha < \frac{\Delta t}{D} \times 2 \quad (\text{Eq. 13})$$

where α is the maximum angular deviation of two principal rays through different points in the sample, Δt is the minimum resolution element in the image and D is the distance the X-ray beam travels through the sample.

Ex. 1010, 13:44–55. When read in light of Deckman, the excerpt from Flannery relied upon by Petitioner and Dr. Kia (Ex. 1011, 1443) demonstrates that the X-rays passing through the sample “must be parallel” within a certain limit. Ex. 1010, 13:44–55. Citing this disclosure, Petitioner concedes that “Deckman discloses a ‘plane parallel mode of data acquisition,’ which requires that the x-ray beam divergence be reduced below a certain threshold to maintain resolution.” Pet. Reply 14 (citing Ex. 1010, 6:3–25; 13:35–68). But neither Petitioner nor Dr. Kia attempt to show that this threshold encompasses angular divergence sufficient to result in projection magnification within the claimed range.

Petitioner and Dr. Kia also cite Deckman Figure 10 (reproduced above) and Flannery Figure 6, which is similar. Pet. 48–49; Ex. 1005 ¶ 174 (citing Ex. 1010, Fig. 10; Ex. 1011, Fig. 6). Both figures are described as “schematic” diagrams of an X-ray microtomography apparatus. Ex. 1010,

3:7–9; Ex. 1011, 1442. Both figures show two lines representing rays emanating from an X-ray source and traveling through a specimen to a phosphor plate, where the two lines diverge along that path. Deckman Figure 10 and Flannery Figure 6 provide some support for a diverging X-ray beam. But these schematic figures are less persuasive than the text of Deckman and Flannery, which describe with overwhelming clarity that a collimated, plane parallel X-ray beam is required for the X-ray microtomography devices relied upon by Petitioner. *See, e.g.*, Ex. 1010, 13:37–41 (“[I]n a preferred embodiment for which the device acts as a microtomography system, the X-ray beam generated must be conditioned so that it is plane parallel.”); *id.* at 13:41–44 (“Parallelism of the rays is required due to the nature of the reconstruction algorithms which require that rays pass through only a single column of pixels in the sample.”); *id.* at 24:50–55, 25:15–21 (both independent claims of Deckman reciting a beam of plane parallel collimated x-ray radiation).

Petitioner and Dr. Kia rely on Deckman Example 1 to show a diverging X-ray beam and to calculate projection magnification. Pet. 48 (citing Ex. 1010, 21:44–56, Fig. 10); Pet. 52 (citing Ex. 1010, 21:48–66); Ex. 1005 ¶¶ 174, 186; Ex. 1010, 21:35–23:48 (Deckman Example 1). Deckman Example 1 describes the X-ray microtomography system shown in Figure 10, including the source-to-sample and sample-to-detector distances Petitioner relies on to calculate projection magnification. Pet. 52 (citing Ex. 1001, 1:40–52; Ex. 1010, 21:48–66). Petitioner and Dr. Kia rely on Deckman Example 1 and Figure 10 to show all of the remaining limitations of claim 1. Pet. 47–55; Ex. 1005 ¶¶ 169–192.

Critically, however, Petitioner and Dr. Kia ignore Deckman’s teaching that Example 1 uses a plane parallel x-ray beam.

With this geometric arrangement of the apparatus, the angular deviation, α , of 2 principle rays through different points in the sample was 2.5 times 10^{-2} radians, which as required by Equation 13 is significantly less than $2\Delta t/S = 4.26 \times 10^{-2}$ radians. Angular divergence, α' , of 2 rays through the same point in the sample is 3.75×10^{-3} radians which as required by Equation 14 is less than $\Delta t/S = 4 \times 10^{-3}$ radians. Thus, data is acquired in multiple stacked planes in the plane parallel mode.

Ex. 1010, 22:40–49. Deckman’s equations 13 and 14 specify the maximum angular divergence of rays passing through a sample necessary to ensure the degree of parallelism required for the reconstruction algorithms. *Id.* at 13:41–68. Deckman applies equations 13 and 14 to the geometric arrangement of the apparatus of Figure 10 and Example 1 and determines that the angular divergence of the X-rays is less than the maximums specified by equations 13 and 14 and thus have the requisite degree of parallelism. *Id.* at 22:40–49. Thus, the X-rays are parallel, not diverging, and the ’704 Patent’s equation for calculating projection magnification based on source-to-sample and sample-to-detector distances does not apply.

Ex. 2005 ¶¶ 41, 64, 67; *see also* II.D.2.b., *supra*.

Petitioner and Dr. Kia acknowledge that Flannery does not explicitly disclose sample-to-source or sample-to-detector distances and, for purposes of calculating projection magnification, they rely on estimated distances based on Flannery Figures 2 and 6. Pet. 52; Ex. 1005 ¶ 187. But Petitioner and Dr. Kia ignore the descriptions of these figures, including the labels within Figure 2 that identify a “Collimated x-ray beam” and “Plane parallel ray pattern.” Ex. 1011, Fig. 2; *id.* at 1440 (Figure 2 caption: “The microtomography configuration uses a fixed source producing a large beam of collimated radiation.”); *id.* at 1442 (Figure 6 caption: “A collimated beam of monochromatic x-rays illuminates a sample mounted on a rotatable

stage.”). Petitioner and Dr. Kia also disregard Flannery’s teaching that one of the “[p]rincipal attributes desired in the radiation source” is “nearly parallel collimation.” *Id.* at 1443.

We are persuaded by the unrebutted testimony of Dr. Bentley: “Projection stage magnification is inconsistent with the disclosures of Deckman and Flannery because the systems collimate the x-ray beam—that is, make the rays parallel—before irradiating the sample. Thus, neither Deckman nor Flannery discloses a magnification of the projection x-ray stage.” Ex. 2005 ¶ 64. Dr. Bentley supports her testimony with numerous quotes from the text and figures in Deckman and Flannery. *Id.* ¶¶ 65, 66, 68. Dr. Bentley concludes that “as with Jorgensen, Petitioner’s application of the magnification formula disclosed in the ’704 patent to the systems disclosed in Deckman and Flannery is improper.” *Id.* ¶ 67. Petitioner did not cross-examine Dr. Bentley on this testimony. *See, generally*, Ex. 1024 (deposition of Dr. Bentley).

In the Reply, Petitioner argues that Deckman’s collimation and plane parallel mode reduce, rather than eliminate, beam divergence. Pet. Reply 1–2, 14 (citing Ex. 1025 ¶¶ 5, 6). As discussed above, however, Petitioner and Dr. Kia fail to show that reducing beam divergence below the thresholds described in Deckman will necessarily produce projection magnification within the claimed range. Alternatively, Petitioner argues that “Deckman discloses a ‘collimated fan beam of radiation’” and a “‘fan beam’ is clearly diverging.” Pet. Reply 1, 14–16 (citing Ex. 1005 ¶ 6; Ex. 1010, 5:62–65, 6:1–2, 6:9–13, 6:20–24, 7:5–14; Fig. 3). This is a new argument raised for the first time in the Reply and is procedurally improper. 37 C.F.R. § 42.23(b); CTPG 73–74.

Petitioner's new reply argument is not persuasive in any event. Dr. Kia provides no objective evidence or analysis to support his assertion that "[b]oth fan beams and cone beams are diverging and result in a projection magnification of $>1x$." Ex. 1025 ¶ 6. Moreover, Petitioner's and Dr. Kia's analysis for claim 1 relies on Deckman Example 1 (Pet. 47–55; Ex. 1005 ¶¶ 169–192), which illustrates Deckman's plane parallel mode of data acquisition. Ex. 1010, 22:40–49. Petitioner and Dr. Kia present no alternative analysis based on Deckman's fan beam mode illustrated in Figure 3. For example, Petitioner and Dr. Kia make no attempt to identify a scintillator, magnification lens, or optical stage magnification in Deckman's Figure 3 embodiment.

The deficiencies in Petitioner's obviousness challenge based on Deckman and Flannery are not remedied by Petitioner's challenges based on Deckman and Flannery in combination with other references. *See* Pet. 59–60, 62. Therefore, for all of the foregoing reasons, Petitioner has not proven its obviousness challenges based on Deckman and Flannery, by themselves or in combination with other references.

F. Petitioner's Sasov-led Challenges

Petitioner challenges claims 7 and 8 as anticipated by Sasov and claims 7–10 and 14 as obvious based on Sasov. Pet. 14. Petitioner also combines Sasov with various other references. *Id.* Our analysis of these challenges focuses on the limitation of independent claim 7 that recites "a scintillator for converting the diverging x ray beam, after interacting with a sample, into an optical signal." Ex. 1001, 10:25–26. Petitioner contends that Sasov discloses this limitation or that it would have been an obvious design choice. Pet. 26–27, 83. Patent Owner disputes these contentions.

PO Resp. 32–37. We provide a brief overview of Sasov before turning to our analysis of the parties’ contentions.

1. Sasov (Ex. 1008)

Sasov discloses a “compact laboratory x-ray ‘nano-CT’ scanner . . . for 3D non-invasive imaging.” Ex. 1008, 201. According to Sasov, “[t]he x-ray detector is based on an intensified CCD with single-photon sensitivity.” *Id.*

Sasov states that the “X-Ray nano-CT instrument is based on the same general principles as clinical CT-scanners and all other micro-CT systems.” Ex. 1008, 202. According to Sasov, “[t]he object mechanically rotates inside the x-ray beam and an x-ray camera acquires the necessary number of angular projections (typically hundreds or thousands) for subsequent reconstruction of the object’s three-dimensional internal microarchitecture in the computer memory using back-projection algorithms.” *Id.*

Sasov discloses that “[t]he x-ray detector contains an intensified 1.3 Megapixel CCD (1280x1024 pixels) and camera electronics with 12-bit digital output through an IEEE-1394 (FireWire) port.” Ex. 1008, 205. According to Sasov, “[t]he intensified CCD with Be-window includes 18 mm format [microchannel plate] MCP-based image intensifiers, fiber-optically coupled to a Sony ICX285AL CCD-sensor.” *Id.*

2. Anticipation

Petitioner contends that “Sasov discloses an image intensifier” and a “POSITA would understand that an image intensifier includes a scintillator to convert the x-ray beam into an optical signal.” Pet. 27 (citing Ex. 1005 ¶ 102; Ex. 1008, 205).

Sasov does not expressly disclose a scintillator. Petitioner, therefore, relies on inherent disclosure for this claim limitation. *See Transclean*, 290 F.3d at 1373 (“[A]nticipation by inherent disclosure is appropriate only when the reference discloses prior art that must *necessarily* include the unstated limitation.”).

The parties dispute whether Sasov’s “MCP-based image intensifiers” (Ex. 1008, 205) necessarily include a scintillator. Pet. 27; PO Resp. 32–34; Pet. Reply 18–19. Petitioner relies on Dr. Kia’s testimony:

Sasov discloses an image intensifier. Ex. 1008 at 205 (“The intensified CCD with Be-window includes 18 mm format MCP-based image intensifiers, fiber-optically coupled to a Sony ICX285AL CCD-sensor.”). It is my opinion that a POSITA would understand that an image intensifier includes a scintillator to convert the x-ray beam into an optical signal.

Ex. 1005 ¶ 102; *see also id.* ¶ 312 (similar testimony). We find that the above-quoted testimony is conclusory and unsupported by objective evidence or technical reasoning. Although Dr. Kia opines that “a POSITA would understand that an image intensifier includes a scintillator to convert the x-ray beam into an optical signal,” he does not explain why a scintillator would have been necessary to convert X-rays to an optical signal, either in Sasov’s instrument or more generally.

Patent Owner relies on Dr. Bentley’s directly contrary opinion that a “POSITA would have understood that Sasov’s MCP-based image intensifier does not necessarily include a scintillator to convert an x-ray beam into an optical signal.” Ex. 2005 ¶ 86; PO Resp. 32–33 (citing this testimony). Dr. Bentley provides detailed reasoning in support of her opinion.

In general, there are two techniques for converting X-ray’s to visible light—direct and indirect conversion techniques. . . . Direct conversion techniques convert X-rays to electrons that are

multiplied and strike a phosphor display screen to provide a visible image. There is no scintillator for converting the diverging x-ray beam, after interacting with a sample, into an optical signal. In contrast, indirect conversion techniques first convert X-rays to visible light (photons) in a scintillator. The photons are then converted to electrons, which are then multiplied, and then strike a phosphor display screen to provide a visible image.

Ex. 2005 ¶ 87 (citing Exs. 2007,¹⁶ 2008¹⁷). Dr. Bentley's testimony is supported by She, which discloses a direct conversion X-ray photo-electron cathode that is integrated with a micro channel plate and an output phosphor display screen to form a panel type X-ray intensifier. Ex. 2007, code (57). Dr. Bentley's testimony is also supported by Veaux, which discloses a hard X-ray detector with an MCP image intensifier, where the "photocathode set on the MCP input converts the x-ray emission into electrons that are multiplied in the MCP and proximity focused onto the P11 phosphor screen deposited on a fiber-optic plate." Ex. 2008, abstract.

Petitioner and Dr. Kia do not dispute Dr. Bentley's testimony that there are two techniques for converting X-ray's to visible light, one that uses a scintillator and one that does not. Ex. 2005 ¶ 87. Dr. Kia testified he is familiar with both techniques and characterized the use of a scintillator as "a large deviation" from direct conversion techniques that do not use a scintillator. Ex. 2013, 17:3–19:2; *see* PO Resp. 33 (citing this testimony). Dr. Kia agrees that a POSITA would have understood that "x-ray images may be captured by an image intensifier coupled with a camera, with a flat

¹⁶ US 5,285,061, issued February 8, 1994 ("She").

¹⁷ J. Veaux, et al., *Hard x-ray detector with an MCP image intensifier working in the 100 keV 1 MeV x-ray range*, Review of Scientific Instruments 62, 1562 (1991) ("Veaux").

panel detector, with a scintillator positioned in front of a camera *or a limited set of direct conversion detectors.*” Ex. 1025 ¶ 9 (emphasis added); *see* PO Sur-reply 16–17 (citing this testimony). Although Dr. Kia asserts that direct conversion detectors “were in their infancy at the time” of Sasov, he provides no objective support for that characterization and does not address *She* (Ex. 2007), which issued ten years before Sasov. Dr. Kia testifies that the high energy “[h]ard” X-rays of Veaux would not be used for x-ray microtomography (Ex. 1025 ¶ 11), but he does not dispute Dr. Bentley’s testimony that Veaux is an example of a direct conversion technique in which X-rays are converted to electrons that are multiplied and strike a phosphor display screen to provide a visible image. Ex. 2005 ¶ 87.

Dr. Bentley also explained why a POSITA may have understood Sasov as disclosing a direct conversion technique that does not use a scintillator.

A POSITA would have understood that there were reasons why Sasov’s MCP-based image intensifier may use a direct conversion technique (no scintillator) instead of an indirect conversion technique (with scintillator). . . . Indeed, the prior art identifies numerous disadvantages associated with indirect conversion techniques (*e.g.*, poor spatial resolution and sensitivity as well as scintillation noise, cost, and inefficiency). . . .

Sasov’s system, however, is intended to provide high-resolution images (*e.g.*, “150–200 nanometers 3D spatial resolution”). . . . Accordingly, a POSITA would have understood that Sasov’s MCP-based image intensifier may have used a direct conversion technique, which does not include a scintillator, to provide higher resolution images and to avoid the inefficiency of scintillator-based indirect conversion techniques. As explained in *She*, the benefits of using a direct conversion technique may have included faster response times, better spatial resolution and sensitivity, increased efficiency, and reduced costs.

Ex. 2005 ¶¶ 88, 89 (citing Ex. 1008, abstract; Ex. 2007, 1:13–34).

Dr. Bentley’s testimony is supported by She, which discusses problems associated with indirect conversion techniques that use a scintillator, stating “[t]here are numerous disadvantages in having to convert an X-ray image to a visible light image before generating and multiplying a corresponding electron image.” Ex. 2007, 1:13–22. Among the problems mentioned by She are limited response time, poor spatial resolution and sensitivity, cost, and scintillation noise. *Id.* at 1:26–34.

Dr. Kia testifies that these problems are confined to “older, large-format, direct-view, medical imaging systems” and do not apply to “more modern, small-format image intensifiers coupled to CCDs, as is disclosed in Sasov.” Ex. 1025 ¶ 12. We find that Dr. Kia’s testimony is not sufficiently supported by objective evidence or technical reasoning. Dr. Kia does not explain how or why the smaller size of Sasov’s image intensifier would avoid the problems exhibited by scintillators or negate the advantages of direct conversion, as described by She. Ex. 2007, 1:26–34, 1:37–43. None of the advantages of direct conversion without a scintillator, as described by She and identified by Dr. Bentley, appear to be tied to the size of the image intensifier. Ex. 2005 ¶ 89 (“the benefits of using a direct conversion technique may have included faster response times, better spatial resolution and sensitivity, increased efficiency, and reduced costs”); Ex. 2007, 1:37–43 (describing a photo-electron cathode that directly converts an X-ray image to an equivalent electron image and exhibits “high efficiency, low noise, high speed and a broad band x-ray photon detection capability”).

Furthermore, when comparing image intensifiers in quantitative terms, Dr. Kia exaggerates the size difference. Ex. 1025 ¶ 12 (comparing “17×17 inches” in U.S. Pat. No. 4,300,046 with 18 mm in Sasov). She’s

image intensifier is just “50 mm to 200 mm” in diameter. Ex. 2008, 3:43–45. Moreover, although Dr. Kia opines that the disadvantages of scintillator-based image intensifiers do not apply to “image intensifiers coupled to CCDs, as disclosed in Sasov” (Ex. 1025 ¶ 12), he does not assert that a direct conversion MCP-based image intensifier could not be coupled to a CCD. She, for example, describes an X-ray microscope having a direct conversion MCP-based image intensifier coupled to a video-camera. Ex. 2007, 3:29–36, 3:49–62, Figs. 2, 3.

For these reasons, we find that Dr. Kia’s opinion (Ex. 1005 ¶ 102) is persuasively rebutted by Dr. Bentley’s credible, evidence-supported testimony that a POSITA may have understood Sasov as disclosing a direct conversion technique that does not use a scintillator. Ex. 2005 ¶¶ 87–89 (citing Exs. 1008, 2007, 2008). Dr. Kia’s response to Dr. Bentley’s testimony (Ex. 1025 ¶¶ 11, 12) is inadequate and does not persuade us that a POSITA would have understood that Sasov’s MCP-based image intensifier necessarily includes a scintillator. Because Patent Owner has shown an equally plausible understanding of Sasov that does not include a scintillator, Petitioner does not meet the “stringent standard” required for inherency. *Amgen*, 2023 WL 2994166, at *10; *PersonalWeb*, 917 F.3d at 1382 (no inherency where there is “an equally plausible, if not more plausible, understanding of” the reference and “[n]either [the petitioner] nor its expert provided any adequate response to this reading of” the reference).

3. *Obviousness*

Petitioner contends that “Deckman discloses a scintillator (‘Phosphor Plate’),” that Sasov’s image intensifier and Deckman’s phosphor plate “perform the same function of converting the x-ray beam into an optical

signal,” and that “[t]he selection of whether to use a simple scintillator or a more expensive image intensifier is an obvious design choice for a POSITA based on imaging requirements and budget for the device.” Pet. 82–83 (citing Ex. 1005 ¶ 314; Ex. 1010, Figs. 7, 10).

Petitioner relies on Dr. Kia’s testimony:

It is my opinion that a POSITA would understand that the image intensifier from Sasov and the phosphor plate from Deckman perform the same function of converting the x-ray beam into an optical signal. It is also my opinion that a POSITA would also know that an image intensifier accelerates the electrons from the x-ray beam to provide additional photons from the scintillator. The selection of whether to use a simple scintillator or a more expensive image intensifier is an obvious design choice within the skill of the art based on imaging requirements and budget for the device.

Ex. 1005 ¶ 314.

We find that Dr. Kia’s testimony is persuasively rebutted by Dr. Bentley, who testifies that Sasov’s MCP-based image intensifier and Deckman’s phosphor screen do not perform the same function. Ex. 2005 ¶ 91. Dr. Bentley explains:

[I]f Sasov’s MCP-based image intensifier uses a direct conversion technique, then it converts x-rays to electrons, multiplies those electrons, and then converts the multiplied electrons to an optical signal. In contrast, Deckman’s phosphor screen converts the X-rays directly to an optical signal. As a result, Sasov’s MCP-based image intensifier typically produces a higher intensity optical signal than a phosphor screen.

Id. Dr. Bentley’s testimony demonstrates that Deckman’s phosphor screen lacks the image intensification function of Sasov’s MCP-based image intensifier. *Id.*

Furthermore, Dr. Bentley provides credible, evidence-supported testimony that “a POSITA would not have expected a scintillator to

necessarily be less expensive than Sasov’s MCP-based image intensifier.” Ex. 2005 ¶ 92 (emphasis omitted; citing Ex. 2007, 1:26–30). Dr. Bentley’s testimony is supported by She, which characterizes the cost of a scintillator as “prohibitive” “due to the complicated fabrication techniques and the attendant requirement to use light shielding.” Ex. 2007, 1:26–30. We also credit Dr. Bentley’s opinion that a POSITA would not have been motivated to sacrifice image intensity, which is critical in Sasov, “for an unknown and unlikely reduction in cost.” Ex. 2005 ¶ 92. The criticality of image intensity is supported by Sasov’s disclosure that the “limited flux from the x-ray source necessitates a very effective detection system.” Ex. 1008, 204; *see* Ex. 2005 ¶ 93 (quoting this disclosure). This same disclosure supports Dr. Bentley’s testimony that “a POSITA would have understood that Sasov’s detection system would have been less effective at converting x-rays to visible light if the MCP-based image intensifier was replaced with a ‘simple scintillator plate.’” Ex. 2005 ¶ 93.

Neither Petitioner nor Dr. Kia provides any rebuttal to Patent Owner’s evidence that a POSITA would not have been motivated to replace Sasov’s MCP-based image intensifier with a scintillator plate. *See* Pet. Reply (no discussion about replacing Sasov’s image intensifier with a scintillator); *see also* PO Sur-reply 16 n.8 (“Petitioner’s Reply does not address this issue.”).

4. Conclusion for Sasov-led Challenges

Petitioner’s challenges based on Sasov, alone or in combination with another reference, rely on Petitioner’s unproven contentions that Sasov inherently discloses a scintillator or that use of a scintillator in place of Sasov’s image intensifier would have been obvious. Pet. 26–27, 64, 75, 83. For all of the foregoing reasons, Petitioner has not proven those contentions

by a preponderance of the evidence, and its Sasov-led challenges do not succeed.

G. Patent Owner's Revised Contingent Motion to Amend

Patent Owner's motion to amend is contingent on the Board's finding one or more of the challenged claims unpatentable. Paper 24, 1. Because Petitioner has not shown by a preponderance of the evidence that any of the challenged claims is unpatentable, Patent Owner's revised contingent motion to amend is dismissed as moot.

III. CONCLUSION

In summary:

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 3, 4	102(b)	Jorgensen		1, 3, 4
7, 8	102(b)	Sasov		7, 8
1–15	103(a)	Jorgensen		1–15
1, 2	103(a)	Jorgensen, Hayashi		1, 2
1, 3–6	103(a)	Deckman, Flannery		1, 3–6
1, 3–6	103(a)	Jorgensen, Deckman		1, 3–6
1, 2	103(a)	Deckman, Flannery, Hayashi		1, 2
7–10, 14	103(a)	Sasov		7–10, 14

Claims	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
7, 8, 10–15	103(a)	Jorgensen, Mancini		7, 8, 10–15
7, 9	103(a)	Jorgensen, Donnelly		7, 9
7, 9	103(a)	Sasov, Donnelly		7, 9
7–15	103(a)	Jorgensen, Sasov		7–15
7, 8, 12–14	103(a)	Sasov, Deckman		7, 8, 12–14
Overall Outcome				1–15

Motion to Amend Outcome	Claim(s)
Original Claims Cancelled by Amendment	
Substitute Claims Proposed in the Amendment	16–23
Substitute Claims: Motion to Amend Granted	
Substitute Claims: Motion to Amend Denied	
Substitute Claims: Not Reached	16–23

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has not shown that claims 1–15 of the '704 Patent are unpatentable;

FURTHER ORDERED that Patent Owner's revised contingent motion to amend is *dismissed* as moot; and

FURTHER ORDERED that because this Decision is final, a party to the proceeding seeking judicial review of the Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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