

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

UNITED STATES PATENT AND TRADEMARK OFFICE

---

BEFORE THE PATENT TRIAL AND APPEAL BOARD

---

VARIAN MEDICAL SYSTEMS, INC.  
Petitioner

v.

WILLIAM BEAUMONT HOSPITAL  
Patent Owner

U.S. Patent No. 6,842,502  
Filing Date: February 16, 2001  
Issue Date: January 11, 2005

Title: CONE BEAM COMPUTED TOMOGRAPHY WITH A FLAT PANEL IMAGER

---

**PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT NO. 6,842,502**

*Inter Partes* Review No. 2015-\_\_\_\_

## Table of Contents

	Page
I. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(a)(1).....	1
A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1) .....	1
B. Related Matters Under 37 C.F.R. § 42.8(b)(2) .....	1
C. Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3) .....	1
D. Service Information.....	2
II. PAYMENT OF FEES - 37 C.F.R. § 42.103 .....	2
III. REQUIREMENTS FOR <i>INTER PARTES</i> REVIEW UNDER 37 C.F.R. §§ 42.104 AND 42.108 .....	2
A. Grounds for Standing Under 37 C.F.R. § 42.104(a).....	2
B. Identification of Challenge Under 37 C.F.R. § 42.104(b) and Statement of Precise Relief Requested .....	3
C. Requirements for <i>Inter Partes</i> Review 37 C.F.R. § 42.108(c) .....	4
IV. BRIEF BACKGROUND OF THE UNDERLYING TECHNOLOGY.....	4
A. Radiotherapy and Image Guidance .....	4
B. 3-D Computed Tomography with Flat Panel Imagers .....	5
C. The '502 Patent Did Not Advance the Art.....	7
V. SUMMARY OF THE '502 PATENT .....	8
A. The Specification and File History of the '502 Patent.....	8
B. The Challenged Claims of the '502 Patent .....	10
VI. CLAIM CONSTRUCTION UNDER 37 C.F.R. § 42.104(b)(3) .....	11
A. “based on one rotation” .....	12
B. “three dimensional information” .....	13
C. “a computer connected to said radiation source and said cone beam computed tomography system, wherein said computer receives said image of said object and based on said image sends a signal to said radiation source that controls said path of said radiation source” .....	14

**Table of Contents**  
(continued)

	<b>Page</b>
VII. THE CLAIMS OF THE '502 PATENT HAVE A PRIORITY DATE OF NO EARLIER THAN FEBRUARY 16, 2001 .....	16
VIII. GROUND 1 – CLAIMS 1-14, 16-29, 33, AND 35-38 ARE OBVIOUS OVER JAFFRAY 1999 SPIE, JAFFRAY 1999 JRO, AND ADLER/DEPP UNDER 35 U.S.C. § 103(a) .....	18
A. Prior Art and Date Qualification for Ground 1 .....	18
B. Brief Description of Jaffray 1999 SPIE, Jaffray 1999 JRO, and Adler/Depp .....	20
C. Jaffray 1999 SPIE, Jaffray 1999 JRO, Adler, and Depp Disclose Each Limitation of Claims 1-14, 16-29, 33, and 35-38 and Were Obvious to Combine .....	26
1. Challenged Independent Claim 1 .....	26
a. “a radiation source that moves about a path and directs a beam of radiation towards an object” .....	28
b. “a cone-beam computed tomography system comprising: an x-ray source that emits an x-ray beam in a cone-beam form towards said object” .....	29
c. “a flat-panel imager receiving x-rays after they pass through the object, said imager providing an image of said object” .....	30
d. “wherein said image contains at least three dimensional information of said object based on one rotation of said x-ray source around said object” .....	31
e. “and a computer connected to said radiation source and said cone beam computed tomography system, wherein said computer receives said image of said object and based on said image sends a signal to said radiation source that controls said path of said radiation source” .....	33
2. Motivation to Combine Jaffray 1999 SPIE, Jaffray 1999 JRO, and Adler/Depp .....	35

**Table of Contents**  
(continued)

	<b>Page</b>
3. Dependent Claims – kV X-rays .....	40
a. Claim 2.....	40
b. Claim 5.....	41
4. Dependent Claims – Object Stage and Rotation.....	41
a. Claims 3, 7, and 10 .....	41
b. Claims 4, 8 and 11 .....	42
c. Claim 13.....	44
d. Claim 14.....	45
5. Dependent Claims – Flat Panel Imagers.....	46
a. Claim 17.....	46
b. Claim 18.....	47
c. Claim 19.....	47
d. Claim 20.....	48
e. Claim 38.....	48
6. Dependent Claims – Object Imaging.....	49
a. Claims 12 and 16 .....	49
b. Claim 21.....	50
c. Claim 22.....	51
d. Claim 23.....	51
7. Dependent Claims – Gantry Limitations .....	52
a. Claim 24.....	52
b. Claim 25.....	53
c. Claims 26 and 27 .....	54
8. Dependent Claims – Structural Additions .....	54
a. Claim 6.....	54
b. Claim 9.....	55
c. Claim 28.....	55

**Table of Contents**  
(continued)

	<b>Page</b>
d. Claim 29.....	56
e. Claim 33.....	56
f. Claims 35, 36, and 37 .....	57
IX. CONCLUSION.....	59

**List of Exhibits**

<b>Ex. No.</b>	<b>Description of Document</b>
<b>1001</b>	U.S. Patent No. 6,842,502 issued to David A. Jaffray, <i>et al.</i> (“’502 patent”)
<b>1002</b>	Declaration of Dr. James Balter (“Balter Decl.”)
<b>1003</b>	U.S. Patent No. 5,207,223 issued to Adler <i>et al.</i> (“Adler”)
<b>1004</b>	U.S. Patent No. 5,427,097 issued to Depp (“Depp”)
<b>1005</b>	D.A. Jaffray <i>et al.</i> , <i>Performance of a Volumetric CT Scanner Based Upon a Flat-Panel Imager</i> , SPIE, 3659:204-14 (Feb. 1999) (“Jaffray 1999 SPIE”)
<b>1006</b>	D.A. Jaffray <i>et al.</i> , <i>A Radiographic and Tomographic Imaging System Integrated into a Medical Linear Accelerator for Localization of Bone and Soft-Tissue Targets</i> , Int. J. Radiation Oncology Biol. Phys., 45:773-89 (Oct. 1999) (“Jaffray 1999 JRO”)
<b>1007</b>	Apr. 20, 2004, Office Action
<b>1008</b>	Jan. 23, 2004 Applicant’s Remarks
<b>1009</b>	Provisional Application No. 60/183,590 filed by David A. Jaffray <i>et al.</i> (“’590 Provisional”)
<b>1010</b>	Highlighted copy of the ’502 Patent showing matter not disclosed in the ’590 Provisional Application
<b>1011</b>	P. Munro, <i>Portal Imaging Technology: Past, Present, and Future</i> , Seminars in Radiation Oncology, 5:115-33 (Apr. 1995) (“Munro 1995”)
<b>1012</b>	Feb. 16, 2001 Application
<b>1013</b>	P.J. Biggs <i>et al.</i> , <i>A Diagnostic X Ray Field Verification Device For A 10 MV Linear Accelerator</i> , Int’l J. Radiation Oncology Biol. Phys., 11:635-43 (1985) (“Biggs 1985”)

**List of Exhibits**

<b>Ex. No.</b>	<b>Description of Document</b>
<b>1014</b>	<i>A. Ezz et al., Daily Monitoring and Correction of Radiation Field Placement Using a Video-Based Portal Imaging System: A Pilot Study</i> , Int’l J. Radiation Oncology Biol. Phys., 22:159-65 (1991) (“Ezz 1991”)
<b>1015</b>	<i>W. De Neve et al., Routine clinical on-line portal imaging followed by immediate field adjustment using a tele-controlled patient couch</i> , Radiotherapy & Oncology, 24:45-54 (1992) (“De Neve 1992”)
<b>1016</b>	<i>T.R. Mackie et al., Tomotherapy: A new concept for the delivery of dynamic conformal radiotherapy</i> , Med. Phys., 20:1709-19 (Nov./Dec. 1993) (“Mackie 1993”)
<b>1017</b>	<i>L.E. Antonuk et al., Thin-Film, Flat-Panel, Composite Imagers for Projection and Tomographic Imaging</i> , IEEE Transactions on Medical Imaging, 13:482-90 (Sept. 1994) (“Antonuk 1994”)
<b>1018</b>	<i>R. Sephton et al., A diagnostic-quality electronic portal imaging system</i> , Radiotherapy & Oncology, 35:204-47 (1995) (“Sephton 1995”)
<b>1019</b>	<i>M.C. Kirby et al., Clinical Applications of Composite and Realtime Megavoltage Imaging</i> , Clinical Oncology, 7:308-16 (1995) (“Kirby 1995”)
<b>1020</b>	<i>J.M. Michalski et al., Prospective Clinical Evaluation of an Electronic Portal Imaging Device</i> , Int’l J. Radiation Oncology Biol. Phys., 34:943-51 (1996) (“Michalski 1996”)
<b>1021</b>	<i>D.A. Jaffray et al., Exploring “Target Of The Day” Strategies for A Medical Linear Accelerator With Conebeam-CT Scanning Capability</i> , Proceedings of the 12th International Conference on the Use of Computers in Radiation Therapy, Medical Physics Publishing, pp. 172-75 (1997) (“Jaffray 1997”)
<b>1022</b>	<i>D. Yan et al., Adaptive radiation therapy</i> , Phys. Med. Biol., 42:123-32 (1997) (“Yan 1997”)

**List of Exhibits**

Ex. No.	Description of Document
1023	D. Yan <i>et al.</i> , <i>The Use of Adaptive Radiation Therapy to Reduce Setup Error: A Prospective Clinical Study</i> , Int’l J. Radiation Oncology Biol. Phys., 41:715-20 (1998) (“Yan”)
1024	M.A. Mosleh-Shirazi <i>et al.</i> , <i>A cone-beam megavoltage CT scanner for treatment verification in conformal radiotherapy</i> , Radiotherapy & Oncology, 48:319-28 (1998) (“Mosleh-Shirazi 1998”)
1025	S. Webb <i>et al.</i> , <i>Tomographic Reconstruction from Experimentally Obtained Cone-Beam Projections</i> , IEEE Transactions on Medical Imaging, MI-6:67-73 (Mar. 1987) (“Webb 1987”)
1026	P.S. Cho <i>et al.</i> , <i>Cone-beam CT for radiotherapy applications</i> , Phys. Med. Biol., 40:1863-83 (1995) (“Cho 1995”)
1027	D.A. Jaffray <i>et al.</i> , <i>Dual-Beam Imaging for Online Verification of Radiotherapy Field Placement</i> , Int’l J. Radiation Oncology Biol. Phys., 33:1273-80 (1995) (“Jaffray 1995”)
1028	S.M. Midgley <i>et al.</i> , <i>A Feasibility Study For The Use Of Megavoltage Photons And A Commercial Electronic Portal Imaging Area Detector For Beam Geometry CT Scanning To Obtain 3D Tomographic Data Sets Of Radiotherapy Patients In The Treatment Position</i> , Proceedings of the 4th Int’l Workshop of Electronic Portal Imaging, Amsterdam, 1996, Abstract No. 60 (2 pages) (1996) (“Midgley 1996”)
1029	J. Wong <i>et al.</i> , <i>Initial clinical experience with a gantry mounted dual beam imaging system for setup error localization</i> , Int’l J. Radiation Oncology Biol. Phys., 42(Suppl. 1):138 (Abstract 28) (1998) (“Wong 1998”)
1030	L.E. Antonuk <i>et al.</i> , <i>Demonstration of megavoltage and diagnostic x-ray imaging with hydrogenated amorphous silicon arrays</i> , Med. Phys., 19:1455-66 (Nov./Dec. 1992) (“Antonuk 1992”)
1031	L.E. Antonuk <i>et al.</i> , <i>A Real-Time, Flat-Panel, Amorphous Silicon, Digital X-ray Imager</i> , RadioGraphics, 15:993-1000 (1995)



**List of Exhibits**

<b>Ex. No.</b>	<b>Description of Document</b>
	("Antonuk 1995")
<b>1032</b>	J. Chabbal <i>et al.</i> , <i>Amorphous Silicon X-ray Image Sensor</i> , Proceedings of SPIE (Society of Photographic Instrumentation Engineers), 2708:499-510 (1996) ("Chabbal 1996")
<b>1033</b>	R. Ning <i>et al.</i> , <i>Selenium Flat Panel Detector-Based Volume Tomographic Angiography Imaging: Phantom Studies</i> , Proceedings of SPIE (Society of Photographic Instrumentation Engineers), 3336:316-24 (Feb. 1998) ("Ning 1998")
<b>1034</b>	R. Ning <i>et al.</i> , <i>Flat panel detector-based cone beam volume CT imaging: detector evaluation</i> , Proceedings of SPIE (Society of Photographic Instrumentation Engineers), 3659:192-203 (Feb. 1999) ("Ning 1999")
<b>1035</b>	U.S. Patent No. 6,041,097 issued to Roos <i>et al.</i> ("Roos 1998")
<b>1036</b>	J.H. Siewerdsen <i>et al.</i> , <i>Signal, noise power spectrum, and detective quantum efficiency of indirect-detection flat-panel imagers for diagnostic radiology</i> , Med. Phys., 25:614-28 (May 1998) ("Siewerdsen 1998")
<b>1037</b>	A.T. Redpath <i>et al.</i> , <i>Chapter 6: Simulator Computed Tomography</i> , pp. 169-89, in <i>The Modern Technology of Radiation Oncology</i> , J. Van Dyk (ed.) (1999) ("Redpath 1999")

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

Petitioner Varian Medical Systems, Inc. (“Petitioner”) respectfully submits this Petition for *Inter Partes* Review of claims 1-14, 16-29, 33, and 35-38 of U.S. Patent No. 6,842,502 [Ex. 1001] (“the ’502 patent”).

**I. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(a)(1)**

**A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)**

In addition to petitioner Varian Medical Systems, Inc., VMS International AG and its two Dutch parent companies, VMS Nederland Holdings BV and VMS Nederland BV, are real parties-in-interest.

**B. Related Matters Under 37 C.F.R. § 42.8(b)(2)**

The ’502 patent is the subject of one pending litigation involving the Petitioner: *Elekta Ltd. v. Varian Medical Systems, Inc.*, Case No. 2:15-cv-12169-AC-MKM (E.D. Mich. June 15, 2015), in which the patent owner contends that the Petitioner infringes the ’502 patent. The Petitioner was served with a complaint in that action on September 3, 2015.

Petitioner is concurrently filing an additional petition for *inter partes* review of claims 1-14, 16-29, 33, and 35-38, based on unique legal grounds and prior art. Petitioner is also seeking *inter partes* review of method claims 43-46, 48-55, 57, 59, 60-66, and 68 of the ’502 patent through two additional concurrently filed petitions.

**C. Lead and Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)**

Heidi L. Keefe (Reg. No. 40,673) (lead) hkeefe@cooley.com zpatdcdocting@cooley.com COOLEY LLP ATTN: Patent Group 1299 Pennsylvania Ave., NW, Suite 700 Washington, DC 20004 Tel: (650) 843-5001 Fax: (650) 849-7400	Daniel J. Knauss (Reg. No. 56,393) dknauss@cooley.com zpatdcdocting@cooley.com COOLEY LLP ATTN: Patent Group 1299 Pennsylvania Ave., NW, Suite 700 Washington, DC 20004 Tel: (650) 843-5287 Fax: (650) 849-7400
---	---

**D. Service Information**

The Petitioner may be served at the address provided above in Part I.C for lead and back-up counsel, and consents to electronic service at those addresses.

**II. PAYMENT OF FEES - 37 C.F.R. § 42.103**

This Petition requests review of 33 claims of the '502 patent, therefore excess claim fees are required. A payment of \$32,800 is submitted herewith, which comprises a \$11,600 request fee and a post-institution fee of \$21,200. *See* 37 C.F.R. § 42.15(a). This Petition meets the requirements of 35 U.S.C. § 312(a)(1).

**III. REQUIREMENTS FOR *INTER PARTES* REVIEW UNDER 37 C.F.R. §§ 42.104 AND 42.108**

**A. Grounds for Standing Under 37 C.F.R. § 42.104(a)**

The Petitioner certifies that the '502 patent is available for *inter partes* review, and that the Petitioner is not barred or otherwise estopped from requesting *inter partes* review on the grounds identified in the present Petition. The Petitioner is unaware of any previous petition for *inter partes* review of the '502 patent.

**B. Identification of Challenge Under 37 C.F.R. § 42.104(b) and Statement of Precise Relief Requested**

The Petitioner respectfully requests that the Board initiate *inter partes* review of claims 1-14, 16-29, 33, and 35-38. This Petition cites the following prior art references, submitted as Exhibits **1003** through **1006**:

<b>Ex. No.</b>	<b>Description of Document</b>
<b>1003</b>	U.S. Patent No. 5,207,223 issued to Adler <i>et al.</i> (“Adler”)
<b>1004</b>	U.S. Patent No. 5,427,097 issued to Depp (“Depp”)
<b>1005</b>	D.A. Jaffray <i>et al.</i> , <i>Performance of a Volumetric CT Scanner Based Upon a Flat-Panel Imager</i> , SPIE, 3659:204-14 (Feb. 1999) (“Jaffray 1999 SPIE”)
<b>1006</b>	D.A. Jaffray <i>et al.</i> , <i>A Radiographic and Tomographic Imaging System Integrated into a Medical Linear Accelerator for Localization of Bone and Soft-Tissue Targets</i> , Int. J. Radiation Oncology Biol. Phys., 45:773-89 (Oct. 1999) (“Jaffray 1999 JRO”)

The grounds on which this Petition is based are listed in the table below.

<b>Ground</b>	<b>Claims</b>	<b>Basis for Challenge</b>
1	1-14, 16-29, 33, and 35-38	Obvious over Jaffray 1999 SPIE, Jaffray 1999 JRO, and Adler/Depp (§ 103(a))

Section **VIII-C** below provides a detailed explanation as to why the challenged claims are unpatentable based on this ground.

This Petition also submits the accompanying Declaration of Dr. James Balter, an expert with over 20 years of experience in the fields of radiation

oncology and medical physics. (See Balter Decl., [Ex. 1002], ¶¶ 2-5.) Dr. Balter's declaration includes additional exhibits ([Exs. 1011-1037]), relied on by Dr. Balter as providing further information regarding the relevant technology and the state of the art at the relevant time.

**C. Requirements for *Inter Partes* Review 37 C.F.R. § 42.108(c)**

The Board should institute *inter partes* review of claims 1-14, 16-29, 33, and 35-38 because this Petition establishes a reasonable likelihood of prevailing with respect to each challenged claim. See 35 U.S.C. § 314(a). Each limitation of each challenged claim is disclosed and/or suggested by the prior art, as explained in detail below.

**IV. BRIEF BACKGROUND OF THE UNDERLYING TECHNOLOGY**

**A. Radiotherapy and Image Guidance**

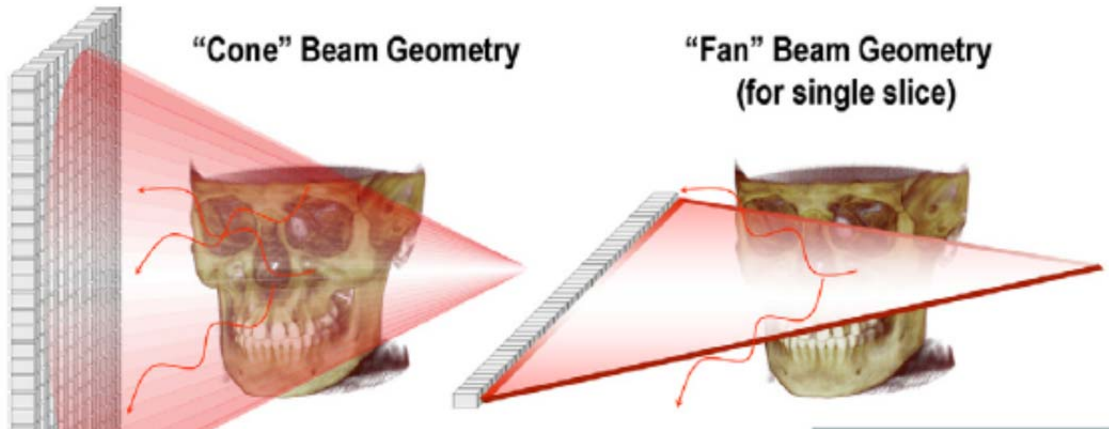
Radiation therapy or "radiotherapy" is the use of beams of radiation for the treatment of disease. Radiation therapy of internal patient lesions, such as cancerous tumors, is very old – dating back over 100 years. For decades, practitioners have known that the effectiveness of radiation therapy is increased when imaging is used to ensure that the radiation therapy beam is applied as narrowly as possible to a tumor while minimizing exposure to surrounding healthy tissues. (See Ex. 1002, ¶ 14.) Indeed, the first known instance of using x-ray imaging to improve the accuracy of radiation therapy dates back to the 1940s. (*Id.*,

¶¶ 15-16.) The corollary concept that imaging should be done close in time to when the radiation is delivered is likewise very old. As explained by Dr. Balter, the field of radiation therapy has consistently maintained its focus on combining imaging with radiation therapy, and the '502 patent did nothing to shift the direction of the field. (*Id.*, ¶¶ 14-17.)

### **B. 3-D Computed Tomography with Flat Panel Imagers**

The field of 3-D computed tomography (“CT”) imaging using x-rays was fully developed well in advance of the earliest possible priority date listed on the face of the '502 patent. By this time it was already well known that high quality 3-D images of patient internal structures could be obtained using x-ray technology and computer imaging systems. (*Id.*, ¶¶ 18-20.) In brief, these prior art systems used an x-ray source and imager to collect a multitude of x-ray projection images at different angles around the patient. Initially, these CT systems worked through a “stack-of-slices” approach in which several 2-D images were stacked on top of each other to form a 3-D image. The underlying 2-D CT images were obtained one at a time by rotating an x-ray source emitting a “fan” shaped beam around a patient and then progressively translating the patient through the scanner. By the mid-1990s, however, systems were available that obtained 3-D images in a single rotation using a technology called “cone-beam” CT (“CBCT”). As the name suggests, CBCT works by using a large x-ray field shaped in a cone rather than a

thin “fan-beam.” The figure below contrasts the fan-beam and cone-beam approaches to CT that were well established by 1999:



Central to the utility of this cone-beam approach were detectors that could receive x-ray cone-beam projection data. By the mid 1990s, the field of large flat-panel detector arrays had developed to meet this need. The art was unequivocal that such flat panel imagers were an obvious choice for large field x-ray imaging, stating in 1994 that “[t]he recent development of large-area, flat-panel a-Si:H imaging arrays is generally expected to lead to realtime diagnostic and megavoltage x-ray projection imagers . . . .” (See Ex. 1002, ¶ 150.) Thus before the ’502 applicants began their work, it was already known that CBCT imaging could be improved by the use of a large flat panel image detector to facilitate rapid acquisition of 3-D CT image data obtained from a single rotation of the imaging system around the patient.

**C. The '502 Patent Did Not Advance the Art**

The '502 patent generally relates to a cone-beam computed tomography (“CBCT”) imaging system that employs x-rays detected by a flat-panel imager (“FPI”) on a radiotherapy system. In the systems described by the '502 patent, the patient is imaged while in position for treatment with a beam of radiation. ('502, 1:12-18.) As described by the applicants, CBCT (as opposed to other forms of medical imaging such as traditional x-ray or magnetic resonance) is used to obtain three-dimensional patient information which can be used to better guide therapeutic radiation to a target lesion such as a tumor. (*Id.*, 1:20-22; 3:40-4:2.)

The systems claimed in the '502 patent were nothing more than the combination of known elements, with each element performing its well-known function. The applicants' assembly of old elements provided results just as would be expected by one of skill in the art. As described fully herein, it was known in the field of radiotherapy to use diagnostic (kV) x-rays on a radiotherapy gantry to obtain images for real-time control of a radiation source. It was also known to use kV x-rays for cone beam imaging on a linear accelerator gantry because of its superior image quality. A combined CBCT/FPI system was also known, and indeed it was known to use the exact type of flat panel imager used in this prior art CBCT system on a radiotherapy system. Because of the known benefits of CBCT, the known benefits of image-guided radiotherapy, and the express teaching in the



prior art to use the same flat panel imager of the prior art CBCT system on a radiotherapy gantry, it was obvious to apply the prior art CBCT/FPI system to control the prior art radiotherapy system because of the known benefits of improved imaging. (*See also* Ex. 1002, ¶¶ 21-22.)

In fact, the '502 patent does not claim any inventive elements in assembling these old components. The claims merely recite systems employing a CBCT-FPI in combination with a radiotherapy device, but the '502 applicants did not invent the use of CBCT with an FPI to obtain 3-D images of a patient. Nor did they invent the use of x-ray images as a means for guiding a radiation source. Instead, the applicants claimed the concept of performing image guided radiotherapy “based on one rotation” of the x-ray source around the object, and seek to exclude others from using it. This concept has also long been known in the field of computed tomography and radiation oncology. The '502 patent does nothing more than assemble known components to achieve an expected result. Thus the assembly (and the claimed methods of using it) were obvious, and the claims of the '502 patent should not have been issued.

## **V. SUMMARY OF THE '502 PATENT**

### **A. The Specification and File History of the '502 Patent**

The '502 patent is entitled “Cone Beam Computed Tomography with a Flat Panel Imager.” It describes a radiotherapy system with a cone-beam x-ray source

coupled to an FPI for providing 3-D images of a patient, all under computer control, and methods of using the same for patient radiotherapy. The specification describes embodiments of this basic system employing aspects such as a motorized table for movement of the patient, the use of kV x-rays, and the use of amorphous silicon imagers as an FPI. The specification also describes a benefit of CBCT in the ability to obtain 3-D images from a single rotation of the x-ray gantry around the patient. Finally, the specification describes an embodiment in which the radiotherapy source is controlled based on the CBCT scan of the patient.

During prosecution, applicants originally sought broad claims to radiotherapy systems with a radiation source, cone-beam x-ray source and FPI, and computerized control of the radiation source based on the CBCT image. But as Examiner Ho noted, every one of these limitations were already known in the prior art “Swerdloff,” “Hu,” and “Roos” references:

[T]he prior art discloses a radiation therapy system comprising a radiation source, a con-beam [sic] computed tomography system comprising an x-ray source and a flat-panel imager receiving x-rays after they pass through the object, the imager providing an image of the object, and a computer controls the path of the radiation source based on the image . . . .

(Ex. 1007, Apr. 20, 2004 Office Action, at 6.)

In response to rejections based on these prior art image-guided radiotherapy systems combined with CBCT-FPI systems, the applicants amended their claims to specify that the image “contains at least three dimensional information of said object based on one rotation of said x-ray source around said object.” This amendment was the sole basis for Examiner Ho’s allowance of the claims:

[T]he prior art fails to teach or fairly suggest that the image contains at least three-dimensional information of the object based on one rotation of the x-ray source around the object as claimed.

(*Id.*) As explained below, the prior art Jaffray 1999 SPIE reference did in fact disclose the element the Examiner believed was missing from the prior art.

**B. The Challenged Claims of the ’502 Patent**

This Petition addresses claims 1-14, 16-29, 33, and 35-38. The challenged claims include one independent claim and 32 dependent claims directly or indirectly depending from claim 1. Claim 1 is reproduced below:

<b>Claim 1</b>
A radiation therapy system comprising:
a radiation source that moves about a path and directs a beam of radiation towards an object;
a cone-beam computed tomography system comprising: an x-ray source that emits an x-ray beam in a cone-beam form towards said object,
a flat-panel imager receiving x-rays after they pass through the object, said imager providing an image of said object,
wherein said image contains at least three dimensional information of said object based on one rotation of said x-ray source around said object;
and a computer connected to said radiation source and said cone beam computed

<b>Claim 1</b>
tomography system, wherein said computer receives said image of said object and based on said image sends a signal to said radiation source that controls said path of said radiation source.

(’502, 28:21-37, claim 1.)

The remaining challenged claims are all dependent claims that incorporate the above limitations by reference, but add nothing of patentable significance. The specific arguments of invalidity of all challenged claims are set forth in detail in the specific grounds below.

**VI. CLAIM CONSTRUCTION UNDER 37 C.F.R. § 42.104(b)(3)**

A claim subject to *inter partes* review must be given its “broadest reasonable construction in light of the specification of the patent in which it appears.” 37 C.F.R. § 42.100(b). As the Federal Circuit has recognized, the “broadest reasonable” construction standard is fundamentally different from the manner in which the scope of a claim is determined in litigation. *See In re Swanson*, 540 F.3d 1368, 1377-78 (Fed. Cir. 2008). Accordingly, the constructions proposed in this Petition represent the broadest reasonable interpretation that one of ordinary skill in the art would assign to the terms below, and not necessarily the construction that

would be appropriate in litigation.<sup>1</sup> For claim terms not addressed below, Petitioner has applied the plain and ordinary meaning of those terms.

**A. “based on one rotation”**

This term appears in independent claim 1. The proper construction of this term is “based on a single complete, 360° degree rotation.” The term was added during prosecution to differentiate the prior art references. Specifically, the ’502 applicants argued that the prior art cited by the Examiner did not render the claims obvious because they could not form a usable 3-D image based on a single complete rotation of the CBCT-FPI system around the object. Instead, applicants argued, these prior art systems required multiple rotations around the object in a helical or spiral scan approach in order to generate a 3-D image. For example, the applicants stated that the prior art x-ray device “could not form a usable image based on just one rotation of the x-ray source . . . .” (*See* Ex. 1008, Jan. 23, 2004 Applicant Remarks, at 37 (emphasis added).)

The claims of the patent reciting this element, therefore, should be construed such that a single full rotation (through 360°) around the object being imaged is required. This construction comports with the express teachings of the

---

<sup>1</sup> Petitioner reserves the right to seek different constructions for terms of the ’502 patent claims, as appropriate, in district court litigation.

specification. For example, in the “Preferred Embodiments,” the specification refers to the CBCT system of Figure 3 and states:

The flat plane [sic] imager **326** is positioned such that the piercing point (i.e., the intersection of the central ray and the image plane) is centered on the imaging array (i.e., between columns #**256** and #**257**,  $\pm 0.01$  mm), with a quarter-pixel offset applied to give improved view sampling for cone beam computerized tomography acquisitions in which the object **316** is rotated through 360°.

(’502, 7:64-8:4 (emphasis added).) Thus, one of skill in the art would understand that the “based on one rotation” element of the claims means that the CBCT system necessarily requires a single complete, 360° rotation around the object to obtain its 3-D image (*See* Ex. 1002, ¶¶ 35-36.)

**B. “three dimensional information”**

This term appears in independent claim 1. The term should be construed as “information concerning three dimensions of an object (such as length, width, and depth).” This construction is confirmed by the specification, which states that three-dimensional information is obtained from a plurality of 2-D images obtained from different angles. (’502, 3:40-43 (“a cone beam computerized tomography system reconstructs three-dimensional (3-D) images from a plurality of two-dimensional (2-D) projection images acquired at various angles about the subject.”).) One of ordinary skill in the art would understand “three-dimensional

information” as “information concerning three dimensions of an object (such as length, width, and depth).” (*See* Ex. 1002, ¶ 37.)

- C. “a computer connected to said radiation source and said cone beam computed tomography system, wherein said computer receives said image of said object and based on said image sends a signal to said radiation source that controls said path of said radiation source”**

This term appears in independent claim 1. The element generically recites a computer and the function it performs: receiving 3-D information and based on that 3-D information sending a signal that controls the path of the radiation source. This purely functional computer term is not a description of structure, and no structure for performing the claimed function is recited elsewhere in the claim. Accordingly, the term is governed by the means-plus-function limitations of 35 U.S.C. § 112(6).<sup>2</sup> *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1349 (Fed. Cir. 2015) (en banc).

There is no structure disclosed in the specification for programming the general-purpose computer to perform the recited function. *WMS Gaming Inc. v.*

---

<sup>2</sup> Section 112 was amended and subsections were renamed by the America Invents Act (“AIA”), Pub. L. No. 112-29, § 4(c), 125 Stat. 284, 296 (2011). Because the application that led to the ’502 patent was filed before September 16, 2012, the pre-AIA version of § 112(6) (now referred to as § 112(f)) applies.

*Int'l Game Tech.*, 184 F.3d 1339, 1349 (Fed. Cir. 1999) (“In a means-plus-function claim in which the disclosed structure is a computer, or microprocessor, programmed to carry out an algorithm, the disclosed structure is not the general purpose computer, but rather the special purpose computer programmed to perform the disclosed algorithm.”). What meager structural description is linked to the recited function in the specification is not a sufficient algorithm to comply with the requirements of § 112(6) for computer-implemented claims. The specification states broadly that the control function can be performed by “[a] computer ... connected to the radiation source and the [CBCT] system, wherein the computer receives the image of the object and based on the image sends a signal to the radiation source that controls the path of the radiation source.” (’502, 4:57-62.) The flow charts (and accompanying text) likewise merely restate the claimed function of controlling the radiation path based on the 3-D image. (’502, 27:15-23, 27:40-28:19, Figs. 24 & 26.) This disclosure is insufficient to comply with the algorithm requirements of § 112(6). *Noah Sys., Inc. v. Intuit Inc.*, 675 F.3d 1302, 1317 (Fed. Cir. 2012) (“purely functional language, which simply restates the function associated with the means-plus-function limitation, is insufficient to provide the required corresponding structure.”).

As explained by Dr. Balter, the specification’s disclosure is insufficient algorithm structure because it contains no description of *how* to reposition the



object based on the 3-D information obtained from the CBCT system to obtain the claimed control. (*See* Ex. 1002, ¶¶ 38-40.) The absence of corresponding structure for performing the claimed function, as required by § 112(6), renders the claims of the '502 patent that include this element invalid for indefiniteness.

Nevertheless, should the Board conclude that the term is not indefinite under § 112(6), then this claim element should be construed as a means-plus-function element, whose structure includes an algorithm based on the meager functional restatements provided in the specification (and equivalents thereof) as required by § 112(6). ('502, 4:57-62, 27:15-23, 27:40-28:19, Figs. 24 & 26.) Under this view, the claims are obvious because structure for performing the claimed function, at least at the level of detail of the '502 specification, was taught in the prior art. (*See* Ex. 1002, ¶ 41.)

#### **VII. THE CLAIMS OF THE '502 PATENT HAVE A PRIORITY DATE OF NO EARLIER THAN FEBRUARY 16, 2001**

The '502 patent seeks the benefit of provisional application 60/183,590 (“the '590 application”), filed on February 18, 2000. ('502, 1:4-8; the '590 provisional is submitted as Ex. 1009.) The claims of the '502 patent, however, are not entitled to this priority date because they are wholly unsupported by the '590 provisional.

As noted above, the challenged claims require the claim element of controlling the path of a radiation source based on a three-dimensional image

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

obtained through a single CBCT rotation. Independent claim 1, recites a control element: “said computer receives said image of said object and based on said image sends a signal to said radiation source that controls said path of said radiation source.” Every other challenged claim is a dependent claim that incorporates one of these independent claims.

None of the claims that were ultimately allowed are supported by the '590 provisional. This is most clearly evidenced by the fact that the '590 provisional contains only a fraction of the disclosure contained in the nonprovisional on which the '502 application is based. The provisional application discloses a benchtop CBCT-FPI system, and focuses on the features of the imager and image quality. The provisional has no discussion of using the benchtop system to control a path of a radiotherapy beam, as the claims of the '502 patent purport to cover.

The nonprovisional application filed a year later contained disclosure that is nowhere found in the provisional, including an additional 16 pages of new text, 48 new figures, and 92 new claims. The focus of these new disclosures is the installation of a CBCT-FPI system on a medical linear accelerator for use in image-guided radiotherapy. For example, every word in the specification from Column 19, line 59 to the end of the patent – over eight columns of text – is new matter that was not disclosed in the '590 provisional. This new disclosure is shown in Exhibit **1010**. Exhibit **1010**, is a copy of the '502 patent that shows the

new matter in yellow highlight that was added to the '502 specification and absent from the '590 provisional.

As confirmed by Dr. Balter, the '590 provisional has no support for methods of controlling a radiation source beam based on 3-D CBCT-FPI image information. (*See* Ex. **1002**, ¶¶ 48-50.) None of the teachings in the patent describing guidance of radiotherapy based on a CBCT-FPI system found in columns 19-28 of the '502 patent were presented in the '590 provisional. One of ordinary skill in the art, reviewing the '590 provisional, would not have recognized that the applicants possessed the invention they claimed. (*See* Ex. **1002**, ¶ 51.)

Because all of the claims of the '502 patent must rely on new matter added to the February 16, 2001 nonprovisional, the earliest effective filing date for the claims can be no earlier than February 16, 2001. *See, e.g., PowerOasis, Inc. v. T-Mobile USA, Inc.*, 522 F.3d 1299, 1306 (Fed. Cir. 2008); *see also Butamax Advanced Biofuels LLC v. Gevo, Inc.*, IPR2014-00402, Paper No. 11 at 5 (P.T.A.B. Aug. 8, 2014).

**VIII. GROUND 1 – CLAIMS 1-14, 16-29, 33, AND 35-38 ARE OBVIOUS OVER JAFFRAY 1999 SPIE, JAFFRAY 1999 JRO, AND ADLER/DEPP UNDER 35 U.S.C. § 103(a)**

**A. Prior Art and Date Qualification for Ground 1**

Each limitation of claims 1-14, 16-29, 33, and 35-38 is disclosed or suggested by D.A. Jaffray *et al.*, *Performance of a Volumetric CT Scanner Based*

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

*Upon a Flat-Panel Imager*, SPIE, 3659:204-14 (February 1999) [**Ex. 1005**]  
 (“**Jaffray 1999 SPIE**”), D.A. Jaffray *et al.*, *A Radiographic and Tomographic  
Imaging System Integrated into a Medical Linear Accelerator for Localization of  
Bone and Soft-Tissue Targets*, Int. J. Radiation Oncology Biol. Phys., Vol. 45:773-  
89 (October 1999) [**Ex. 1006**] (“**Jaffray 1999 JRO**”), U.S. Patent No. 5,207,223  
issued to Adler *et al.*, published on May 4, 1993 [**Ex. 1003**] (“**Adler**”), and U.S.  
Patent No. 5,427,097 issued to Depp, published on June 27, 1995 [**Ex. 1004**]  
 (“**Depp**”).<sup>3</sup>

The Jaffray 1999 references are § 102(b) (pre-AIA) prior art because, as noted above, the '502 patent is not entitled to seek the priority date of its provisional application, and the references published more than one year before February 16, 2001, the earliest nonprovisional date of the '502 patent. And at a minimum, the Jaffray 1999 references are prior art under § 102(a) (pre-AIA) because each published before February 18, 2000, the filing date of the earliest application appearing on the face of the '502 patent. Adler/Depp qualifies as prior

---

<sup>3</sup> As discussed below, Adler and Depp are treated as a single reference for this petition because Depp expressly incorporates Adler by reference and describes itself as an improvement of Adler's disclosure. The disclosures are collectively referred to herein as “Adler/Depp.”

art under at least § 102(b) (pre-AIA) because they were published more than one year before February 18, 2000, the filing date of the earliest application appearing on the face of the '502 patent. Adler/Depp was not before the Office during examination or considered by the Examiner prior to issuance of the patent.

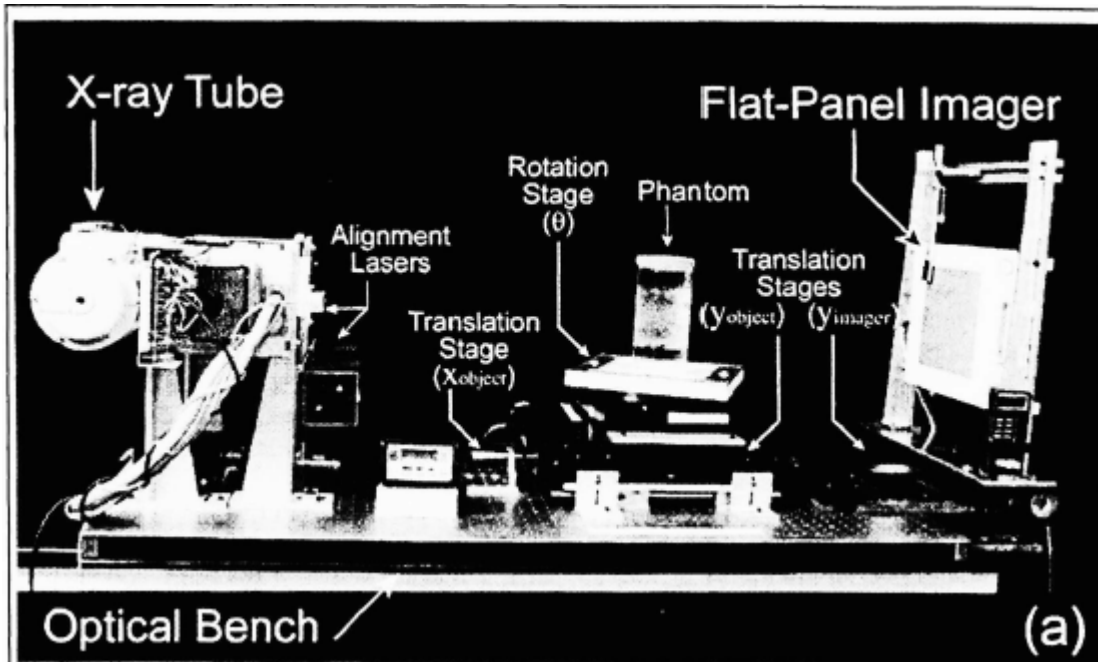
**B. Brief Description of Jaffray 1999 SPIE, Jaffray 1999 JRO, and Adler/Depp**

**Jaffray 1999 SPIE [Ex. 1005]**, entitled “Performance of a Volumetric CT Scanner Based Upon a Flat-Panel Imager,” discloses a system for CBCT scanning to create 3-D (“volumetric”) images with flat panel imagers as detectors. As Jaffray 1999 SPIE explained:

A table-top CBCT scanner based upon an a-Si:H FPI has been constructed, and a system for CBCT image acquisition, processing, and reconstruction has been implemented. This system is capable of producing high quality volumetric images. Reconstructions were generated from 300 radiographs (100 kVp; 1 mAs per projection) obtained at 1.2° increments through 360°.

(Jaffray 1999 SPIE, at 16.) Jaffray 1999 SPIE reported the efforts as a success, concluding “The imaging performance of the prototype supports the hypothesis that FPIs can be employed in computed tomography applications.” (*Id.*)

Jaffray provided a figure summarizing the components of his system, including a CBCT system, and FPI, and a rotation stage for rotation of the x-ray beam relative to the object being imaged:



(Jaffray 1999 SPIE, at 18.) Jaffray 1999 SPIE expressly taught mounting the system on a medical linear accelerator for rotation around the patient for the purpose of image-guided radiotherapy: “The CBCT system described in this report will be adapted for implementation in our clinic for image-guidance of external beam radiotherapy. Specifically, the flat-panel imager will be mounted on a treatment gantry opposite a kilovoltage x-ray tube in a manner previously accomplished with a CCD-based imager.” (*Id.*, at 25.)

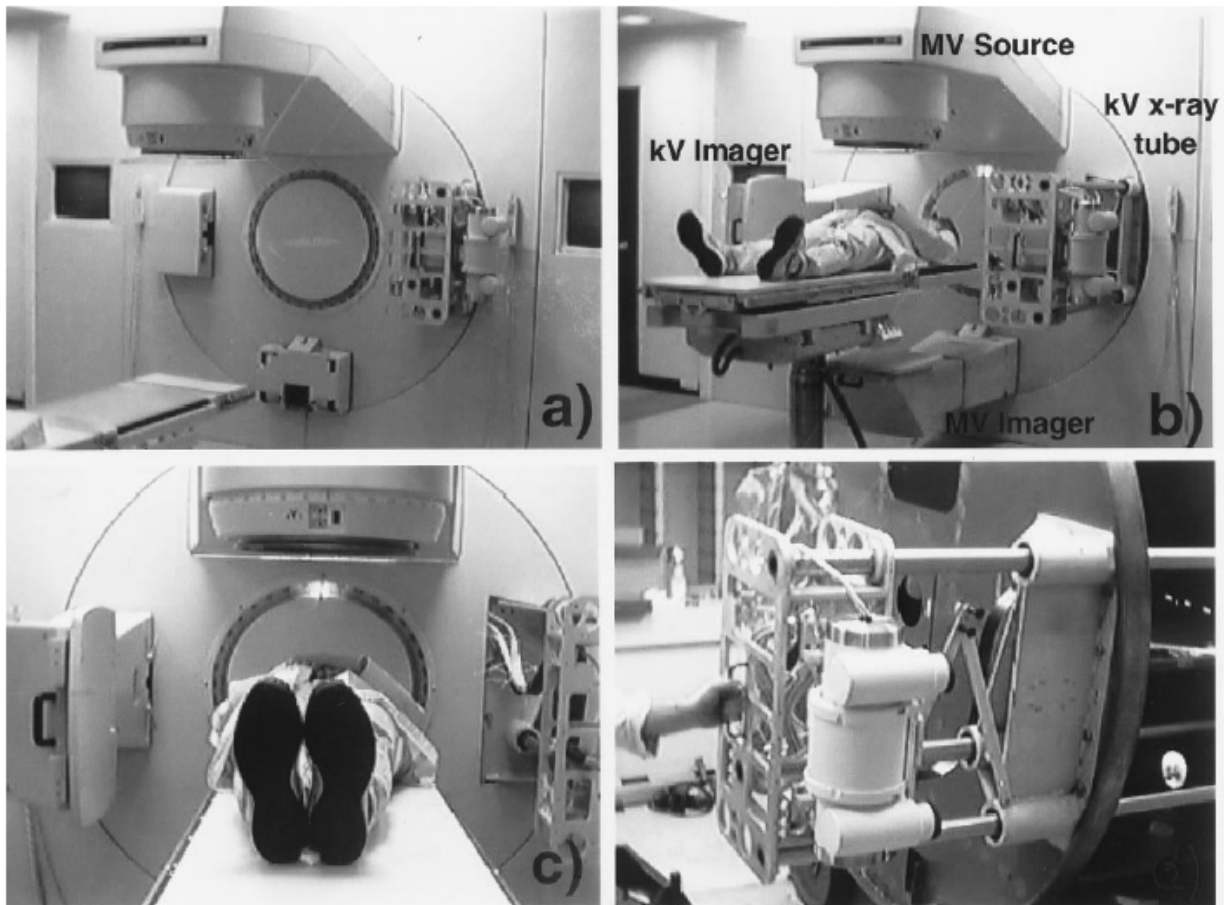
**Jaffray 1999 JRO [Ex. 1006]**, entitled “A Radiographic and Tomographic Imaging System Integrated into a Medical Linear Accelerator for Localization of Bone and Soft-Tissue Targets,” provides a detailed description of the realization of Jaffray’s plan to install a CBCT system onto a radiotherapy device. (Jaffray 1999

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

JRO, at 9.) As Jaffray explained, the system employed 120 kVp x-rays through a single complete rotation of the gantry around 360°. (*Id.*)

The dual-beam linear accelerator device of Jaffray 1999 JRO employs a CCD camera for image detection, but expressly suggests the use of a FPI in place of the CCD: “There is significant room for additional optimization of the system: investigating the impact of x-ray scatter, reducing veiling glare in the optical housing, and exploring the use of flat-panel imagers for increased detective quantum efficiency.” (Jaffray 1999 JRO, at 15 (emphasis added).)

Jaffray 1999 JRO provides a figure showing his CBCT system installed on a linear accelerator device for rotation around the patient:



(*Id.*, at 5, stating “The dual-beam system was constructed on a Elekta SL-20 medical linear accelerator.”)

**Adler [Ex. 1003]**, entitled “Apparatus for and Method of Performing Stereotaxic Surgery,” discloses systems for selectively irradiating a target within a patient. Adler discloses use of diagnostic x-ray imaging, 3-D image mapping of target lesions, and adjustment of the radiotherapy source if needed to ensure targeted delivery of the radiation dose. Like the ’502 applicants, Adler recognized the benefit of accurately targeting high doses of radiation to a tumor while

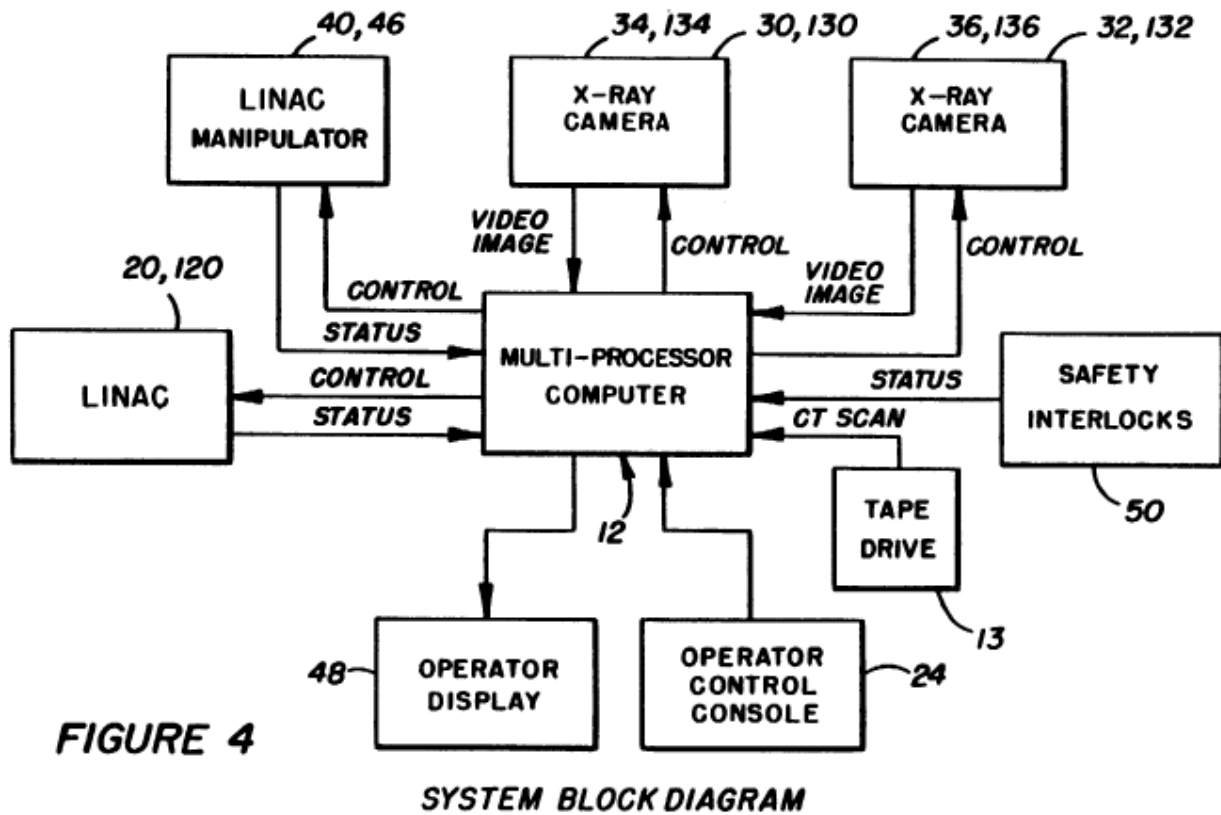


Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

avoiding unnecessary irradiation of surrounding healthy tissues. (Adler, 3:34-52.)

To solve the problem of prior localization of tumor targets within a patient, Adler provides a system in which a 3-D “map” of the patient is compared against diagnostic x-ray scans, to obtain “the real time location of the target region” within the patient. (*Id.*, 5:10-39.) Based on this real-time information, the relative position of the radiosurgical apparatus and the patient can be adjusted to ensure proper aim at the target region. (*Id.*)

As shown in Figure 4 of Adler, the process is under computer control, in which x-ray image information is processed and control signals are sent to the “linac manipulator” which controls the therapeutic beam:



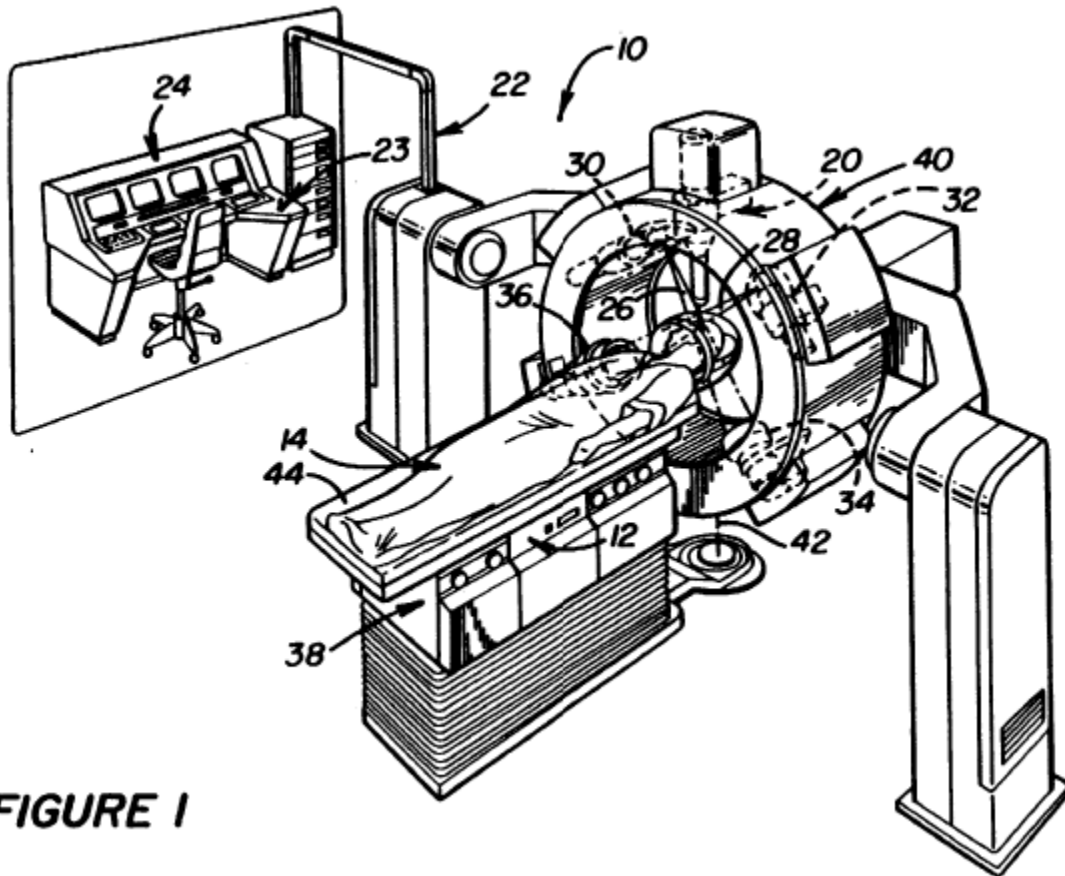
(*Id.*, Fig. 4.)

**Depp [Ex. 1004]** shares a similar title and the same assignee as Adler and describes itself as describing improvements to the method and apparatus disclosed in Adler, which Depp incorporates by reference. (Depp, 1:12-17.) Among other improvements, Depp describes “a unique temporal procedure for operating the radiosurgical beam and the diagnostic target locating beams in order to continuously locate the target region in substantially real time.” (*Id.*, 7:42-45.) Thus, Depp expressly teaches a device in which diagnostic images are used to ensure proper targeting of the treatment beam in real time.

**C. Jaffray 1999 SPIE, Jaffray 1999 JRO, Adler, and Depp Disclose Each Limitation of Claims 1-14, 16-29, 33, and 35-38 and Were Obvious to Combine**

**1. Challenged Independent Claim 1**

The preamble of claim 1 recites: “A radiation therapy system comprising.” Although the preamble may not be limiting under its broadest reasonable construction, Adler/Depp and Jaffray 1999 JRO disclose it. Adler/Depp discloses a radiotherapy system configured for selectively irradiating a target within a patient. (*See* Adler, Abstract, 3:62-68; Depp, Abstract, 1:6-12, 1:18-26; *see also* Ex. 1002, ¶¶ 61-63.) As shown in Figure 1 of Adler, for example, Adler/Depp disclose a system for delivering radiotherapy to a patient:



(Adler, Fig. 1; *see also* Depp, Fig. 1.)

Adler/Depp also teaches an alternative embodiment in which the radiation source is contained in a mechanism having six degrees of movement freedom (as opposed to being within the gantry **40** shown in Adler's Figure 1). (*See* Adler, Fig. 3; *see also* Depp, Fig. 3.) Finally, as discussed in Section VIII-B above, Jaffray 1999 JRO expressly discloses a radiotherapy system using a medical linear accelerator device.

**a. “a radiation source that moves about a path and directs a beam of radiation towards an object”**

As discussed with respect to the claim preamble, Adler/Depp teaches systems with a radiation source that moves with respect to the patient (the “object”) and directs a beam of radiation toward that object: “A beaming apparatus **20** is provided which, when activated, emits a collimated surgical ionizing beam of a strength sufficient to cause the target region **18** to become necrotic.” (Adler, 6:44-47; *see also* Depp, 4:19-22.) As explained by Adler/Depp, their radiation source moves:

The broad range of adjustment of the relative positions of the gantry **40** and the patient **14** allows the collimated beam to be continuously focused on the target region while the healthy tissue through which the collimated beam passes is changed, as by rotating the beaming apparatus **20** through as much as 360° about the patient. (Adler, 7:52-58; *see also* Depp, 5:25-31.) Accordingly, this claim element is taught by both Adler/Depp. (*See* Ex. 1002, ¶ 64.)

Jaffray 1999 SPIE also suggests this limitation: “Ultimately, this imaging system will be installed on a conventional radiotherapy linear accelerator in our clinic.” (Jaffray 1999 SPIE, at 17.) Such a device contains a radiation source that directs a beam of radiation at an object that it moves around. (*See* Ex. 1002, ¶ 65.) Jaffray 1999 JRO also expressly discloses this limitation, because the CBCT system of this reference was installed on a conventional linear accelerator, which

satisfies this claim limitation: “An Elekta SL-20 ... linear accelerator forms the basis of the system. This accelerator is computer controlled and produces 6 and 18 MV photon beams.” (Jaffray 1999 JRO, at 4; *see also* Ex. 1002, ¶ 66.)

**b. “a cone-beam computed tomography system comprising: an x-ray source that emits an x-ray beam in a cone-beam form towards said object”**

Jaffray 1999 SPIE expressly discloses a CBCT x-ray system that moves around the object, emitting multiple x-ray beams in cone-beam form: “The CBCT system is illustrated in Figure 1. The main components of the system are the x-ray tube, the rotation stage, and the flat-panel imager.” (Jaffray 1999 SPIE, at 17.) Jaffray explained: “A single CBCT scan is obtained by acquiring projection images at 1.2° increment rotations of the object across 360°.” (*Id.*, at 25.) As explained by Dr. Balter, this disclosure is an express disclosure of passing multiple x-ray beams in cone beam (“CB”) form through said object from different angles. (*See* Ex. 1002, ¶¶ 67-68.)

Jaffray 1999 JRO also expressly discloses this element:

To generate a CB-CT dataset, a series of radiographic exposures are acquired at regular angular intervals as the accelerator gantry is rotated through a specified range (typically 180° or 360°). The control system operates the camera’s shutter and read-out mechanisms in synchrony with the firing of the x-ray generator ....

(Jaffray 1999 JRO, at 9.) Thus, like Jaffray 1999 SPIE, this reference expressly teaches passing multiple cone-beam x-rays through an object from multiple angles. As confirmed by Dr. Balter, one of skill in the art would recognize in these teachings an express disclosure of this claim element. (*See* Ex. 1002, ¶¶ 67-68.)

**c. “a flat-panel imager receiving x-rays after they pass through the object, said imager providing an image of said object”**

Jaffray 1999 SPIE expressly teaches this element:

The CBCT system is illustrated in Figure 1. The main components of the system are the x-ray tube, the rotation stage, and the flat-panel imager.... We propose the construction of a CBCT system for radiotherapy guidance on a treatment-by-treatment basis using CT data obtained with a kV x-ray source and a large area, indirect detection flat-panel imager (FPI).

(Jaffray 1999 SPIE, at 17.) Jaffray 1999 SPIE further explained:

A single CBCT scan is obtained by acquiring projection images at 1.2° increment rotations of the object across 360°. The acquisition process – object rotation, x-ray exposure, and image acquisition — is synchronized by the host computer. Volume data sets were obtained from the projection data using the Feldkamp algorithm for CBCT reconstruction.

(*Id.*, at 25.) Jaffray 1999 SPIE thus taught the use of an FPI to obtain 3-D image information (“volume data sets”) based on a plurality of 2-D projection images. (*See* Ex. 1002, ¶ 69.)

Jaffray 1999 JRO also expressly suggests the use of FPI:

There is significant room for additional optimization of the system: investigating the impact of x-ray scatter, reducing veiling glare in the optical housing, and exploring the use of flat-panel imagers for increased detective quantum efficiency.

(Jaffray 1999 JRO, at 15 (emphasis added).) As explained by Dr. Balter, these FPI devices function as x-ray detectors by detecting multiple x-ray beams that pass through the object being imaged. Thus, this element is expressly taught by both Jaffray 1999 references. (*See* Ex. 1002, ¶¶ 69-70.)

**d. “wherein said image contains at least three dimensional information of said object based on one rotation of said x-ray source around said object”**

This limitation was expressly taught by Jaffray 1999 SPIE: “an entire volumetric image is acquired through a single rotation of the source and detector.” (Jaffray 1999 SPIE, at 17.) Specifically, in Jaffray 1999 SPIE, “all scans reported in this study involved 300 projections over 360 degrees of rotation.” (*Id.*, at 19.) Jaffray 1999 SPIE reported “full 3-dimensionality of the data acquired in a single rotation.” (*Id.*, at 24.) Jaffray 1999 SPIE thus taught the use of an FPI to obtain 3-D image information (“volume data sets”) from a single rotation of the CBCT



around the patient. Indeed, as explained by Dr. Balter, one of ordinary skill in the art would have been aware from the teachings of the prior art that a benefit of CBCT is the ability to obtain a 3-D image of a patient from a single rotation of the CT gantry around the patient. (*See* Ex. 1002, ¶ 71; *see also id.*, ¶ 136.) Accordingly, this element was expressly taught in the prior art.

Adler/Depp teaches the use of three-dimensional information about the object based on a plurality of 2-D projection images, because Adler/Depp (as noted above) teaches obtaining two x-ray images (“diagnostic beams **26** and **28**”) at a “known non-zero angle relative to one another.” (Adler, 7:6-12.) These beams are received by “[i]mage receivers **34** and **36**” and the resulting signals are passed to the “microprocessor **12**.” (*Id.*, 7:17-23.) As confirmed by Dr. Balter, these images provide three-dimensional information. (*See* Ex. 1002, ¶ 72.)

- e. **“and a computer<sup>4</sup> connected to said radiation source and said cone beam computed tomography system, wherein said computer receives said image of said object and based on said image sends a signal to said radiation source that controls said path of said radiation source”**

Adler teaches a computer (“the processor **12**”) that is coupled to the x-ray imaging system, receives image information, and based on the image information, sends a signal to the radiation source to control its path. Adler teaches obtaining two x-rays (“diagnostic beams **26** and **28**”) at a “known non-zero angle relative to one another.” (Adler, 7:6-12.) These beams are received by “[i]mage receivers **34** and **36**” and the resulting signals are passed to the “microprocessor **12**.” (*Id.*, 7:17-23.) Adler/Depp then teaches control of positioning based on this image: “[m]eans are provided for adjusting the relative position of the beaming apparatus **20** and the patient **14** as needed in response to data which is representative of the real time location of the target region **18** ....” (*Id.*, 7:37-40.) Adler/Depp teaches that this adjusting may be done by moving the radiation source in the gantry or by moving the patient table:

---

<sup>4</sup> As discussed above in Section VI-C, this means-plus-function claim element is invalid for indefiniteness. Nevertheless, to the extent that its scope can be understood, Petitioner has shown it is disclosed in the prior art.

In the particular embodiment illustrated in FIG. 1 the means for adjusting the relative positions of the beaming apparatus and the patient comprises a gantry **40** to which the beaming apparatus **20**, the diagnostic x-ray generators **30** and **32** and the image receivers **34** and **36** are mounted along with conventional apparatus for lowering and raising the operating table **38** and for rotating it about an axis **42** and for tilting the top **44** of the operating table **38** about a longitudinally extending axis, all as illustrated by arrows in FIG. 2. The broad range of adjustment of the relative positions of the gantry **40** and the patient **14** allows the collimated beam to be continuously focused on the target region while the healthy tissue through which the collimated beam passes is changed, as by rotating the beaming apparatus **20** through as much as 360° about the patient.

(Adler, 7:42-58.) Finally, Adler/Depp notes that “FIG. 4 illustrates, in system block diagram form, operation of the logic by which the apparatus of FIG. 1 ... can be controlled.” (Adler, 8:32-34.) As Adler/Depp explains, “[s]ignals from the image receivers **34,134** and **36,136** are passed to the processor **12**.” (Adler, 8:36-38.) Then, “[s]ignals from the processor **12** are passed to ... the gimbal **40** thus controlling its positioning ....” (*Id.*, 8:43-47.) As confirmed by Dr. Balter, these teachings would have been recognized by one of ordinary skill in the art as an express disclosure of a system comprising a computer connected to a moveable radiation source and a diagnostic x-ray imaging system, controlling the position of the radiation source based on multiple x-rays images. (*See* Ex. 1002, ¶¶ 73-74.)

Depp also teaches this element. Depp contains similar disclosures as Adler.

(Depp, 6:13-40.) Depp further teaches that:

The apparatus also utilizes a pair of [] diagnostic beams of radiation or target locating beams.... These beams are passed through the surrounding area containing the target region and reference points and, after passing through the surrounding area, contain data indicating the positions of the reference points within the surrounding area. This position data is collected by cooperating detectors, as described previously, and delivered to the multiprocessor computer where the latter compares it with previously obtained reference data for determining the position of the target region with respect to each of the reference points during each such comparison. The radiosurgical beam is accurately directed into the target region in substantially real time based on this information.

(Depp, 11:46-61.) Accordingly, this element was taught by the prior art. (*See Ex. 1002, ¶ 75.*)

## **2. Motivation to Combine Jaffray 1999 SPIE, Jaffray 1999 JRO, and Adler/Depp**

Claim 1 is obvious because all elements of the claim were taught by the prior art, as explained above, and because one of ordinary skill in the art would have been motivated to combine them. As discussed above, during prosecution the Examiner was readily able to combine a prior art radiation therapy system (Swerdloff) with a prior art CBCT-FPI system (Hu and Roos), but believed the

only element of the claims missing from the prior art was obtaining a 3-D image based on one rotation of the x-ray source around the object. However, as shown above, this element was shown expressly in the Jaffray 1999 SPIE reference.

Adler/Depp does not disclose the use of a CBCT-FPI system for performing x-ray imaging, but it would have been obvious to obtain these elements from the Jaffray 1999 references to improve the accuracy of Adler/Depp's imaging during radiotherapy. By 1999, it was well-known that CBCT was useful for providing rapid 3-D image information about a patient in the treatment position as shown by Jaffray 1999 SPIE and Jaffray 1999 JRO, as well as other background prior art cited by Dr. Balter. (*See* Ex. 1002, ¶¶ 76-77.) As explained by Dr. Balter, CBCT-FPI was one of only a finite number of choices the artisan had in order to provide an obvious improvement on the radiation therapy control systems of Adler/Depp, and indeed the art specifically suggested this assembly. (*See id.*)

As an example of the express suggestions contained in the prior art, Jaffray 1999 SPIE explains the benefit of image-guided radiotherapy:

Unfortunately, delivery of increased dose is limited by (i) the presence of adjacent normal structures and (ii) the precision of beam delivery. In some sites, the diseased target is directly adjacent to radiosensitive normal structures.... Due to uncertainties in patient positioning..., it is necessary to irradiate a larger volume to guarantee that the prostate always receives the prescribed dose. It can be demonstrated that

significant dose escalation may be possible if these uncertainties could be reduced from current levels (~10 mm) to the level of 2-3 mm. This reduction can only be achieved through an on-line imaging and guidance system capable of detecting the prostate and surrounding structures with high spatial accuracy.

(Jaffray 1999 SPIE, at 16-17 (emphasis added).) Jaffray 1999 SPIE nominates CBCT-FPI as a prime candidate for this imaging system: “[a] strong candidate technology to satisfy these requirements is cone-beam computed tomography (CBCT).” (*Id.*, at 17.) Jaffray 1999 SPIE also expressly suggests use of the CBCT-FPI system for image-guided radiotherapy “The CBCT system described in this report will be adapted for implementation in our clinic for image-guidance of external beam radiotherapy.” (*Id.*, at 25.)

One of skill in the art would have been motivated to combine the CBCT and FPI teachings of Jaffray 1999 SPIE with the linear accelerator radiation therapy teachings of Jaffray 1999 JRO. First, two of the three authors of Jaffray 1999 SPIE were authors of Jaffray 1999 JRO. Second, both articles teach a system to address problems in administering radiotherapy. Specifically, both articles disclose a need to confirm the precise location of the area targeted for radiation. (Jaffray 1999 SPIE, at 16-17; Jaffray 1999 JRO, at 3-4.) Third, both articles teach implementing a CBCT system with a linear accelerator for image guidance of radiotherapy. (Jaffray 1999 SPIE, at 17, 25; Jaffray 1999 JRO, at 3-7, 18.) The primary

difference between the articles is that Jaffray 1999 SPIE uses and evaluates incorporating an FPI into the CBCT system used for imaging guidance while Jaffray 1999 JRO uses a CCD-based imager mounted to a linear accelerator. Jaffray 1999 JRO teaches use of flat panel imagers as a possible substitution for the CCD-based imager, however. (Jaffray 1999 JRO, at 15.) Further, Jaffray 1999 SPIE cites directly to Jaffray 1999 JRO, teaching that a flat panel imager can be substituted for the CCD-based imager of Jaffray 1999 JRO. (Jaffray 1999 SPIE, at 25-26 (endnote 8).) As explained by Dr. Balter, one of ordinary skill in the art would have viewed this as an express suggestion to combine the teachings of these references. (*See* Ex. 1002, ¶¶ 78-79.)

It was also obvious to combine the Jaffray 1999 references with the radiotherapy system teachings of Adler/Depp. For example, Jaffray 1999 JRO expressly suggests the usefulness of its disclosure in obtaining image-guided radiotherapy. “An on-line kV imaging system has been integrated with a medical linear accelerator for the purpose of localizing the patient and verifying beam placement.” (Jaffray 1999 JRO, at 18.) Adler/Depp likewise teaches that improved x-ray image based targeting, in real-time, of internal lesions such as tumors is desirable to avoid irradiation of healthy surrounding tissues, and Jaffray 1999 SPIE provides an improved method for acquiring volumetric (3-D) CT image data using CBCT and an FPI. (*See* Adler, 2:49-53, 3:34-42, 5:40-54; Depp,

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

Abstract, 1:55-65, 2:48-53, 11:54-61; Jaffray 1999 SPIE, at 16-17.) As explained by Dr. Balter, one of ordinary skill in the art would have viewed this as an express suggestion to combine the teachings of these references. (*See* Ex. 1002, ¶ 80.)

Adler and Depp should be treated as a single reference because Depp states that it is an improvement of Adler, and incorporates it by reference. (*See* Depp, 5:35-55, 7:31-47.) One of skill in the art would be motivated to combine the Jaffray 1999 references with Adler/Depp because all three references are in the same field of medical imaging in conjunction with radiation therapy and all three are concerned with the problem of obtaining accurate 3-D information about the internal structure of objects like patients. (*See* Adler, 1:6-18; Depp, 1:6-18; Jaffray SPIE 1999, at 16-17; *see also* Ex. 1002, ¶ 81.) As explained by Dr. Balter, the combination of the CBCT-FPI methodology of the Jaffray 1999 references with the radiotherapy control apparatus of Adler and Depp, as done by the '502 applicants, was also obvious because it combined the known methods of CBCT with an FPI to improve the diagnostic imaging and real-time adjustment of radiotherapy described in Adler and Depp. (*See* Ex. 1002, ¶ 81.) In this field, the results obtained by the inventors (obtaining 3-D image information concerning target lesions in patients for the purpose of targeting the radiation source) were the predictable work of combining the CBCT-FPI system of the Jaffray 1999 references with the radiotherapy systems of Adler and Depp. (*See id.*) Accordingly, the claimed



combination was obvious. *See* MPEP § 2141 (III); *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 419-20 (2007); *see also Toshiba Samsung Storage Tech. Korea Corp. v. LG Elecs., Inc.*, IPR2014-00204, Paper No. 31 at 29 (P.T.A.B. Mar. 31, 2015).

### **3. Dependent Claims – kV X-rays**

#### **a. Claim 2**

Claim 2 depends from claim 1 and adds the further limitation to claim 1 of “wherein said x-ray source comprises a kV x-ray source.” Jaffray 1999 SPIE provides express disclosure of this limitation: “We propose the construction of a CBCT system for radiotherapy guidance on a treatment-by-treatment basis using CT data obtained with a kV x-ray source and a large area, indirect detection flat-panel imager (FPI).” (Jaffray 1999 SPIE, at 17 (emphasis added).)

One of skill in the art would have been further motivated to combine Adler/Depp with Jaffray 1999 SPIE because it was well-known by those of ordinary skill in the art that kV energy x-ray beams are superior to megavolt energy beams for imaging. Indeed, as Jaffray 1999 JRO admits, “[u]sing a kV x-ray source to determine field placement is not a novel concept.” (Jaffray 1999 JRO, at 4.)

As explained by Dr. Balter, the published work in the field clearly disclosed the superiority of kV beams over MV beams for imaging. (*See* Ex. 1002, ¶¶ 83-

85.) For example, Jaffray 1999 JRO stated: “The primary reason for the poor quality of the megavoltage portal images is the intrinsically low subject contrast of bony anatomy at megavoltage energies .... [W]e have taken a more direct approach: to increase the subject contrast by using a kilovoltage (kV) x-ray source to localize the placement of the field.” ( Jaffray 1999 JRO, at 4.)

**b. Claim 5**

Claim 5 depends from claim 1 and recites the additional limitation “wherein said x-ray source emits x-rays with energies of approximately 100 kV.” Jaffray 1999 SPIE expressly discloses this element: “[V]olumetric imaging is accomplished by rotating the object incrementally over 360 degrees, delivering a radiographic x-ray pulse (e.g., 100-130 kVp, ~0.1-10 mAs), and acquiring a projection image at each increment.” (Jaffray 1999 SPIE, at 16 (emphasis added).) One of skill in the art would have been motivated to combine Adler/Depp with Jaffray 1999 SPIE to obtain the method of claim 5 for the same reasons set forth for claim 2. (*See also* Ex. 1002, ¶ 86.)

**4. Dependent Claims – Object Stage and Rotation**

**a. Claims 3, 7, and 10**

Claim 3 depends from claim 2 and adds the limitation “further comprising a stage that moves said object relative to said x-ray source and said flat-panel imager.” This limitation adds nothing of patentable significance. This element

was expressly taught by Adler/ Depp:

[M]eans for adjusting the relative positions of the beaming apparatus and the patient comprises a gantry **40** to which the beaming apparatus **20**, the diagnostic x-ray generators **30** and **32** and the image receivers **34** and **36** are mounted along with conventional apparatus for lowering and raising the operating table **38** and for rotating it about an axis **42** and for tilting the top **44** of the operating table 38 about a longitudinally extending axis, all as illustrated by arrows in FIG. 2.

(Adler, 7:42-58 (emphasis added).) Depp contains the same express teaching.

(Depp, 5:15-31.)

It would have been obvious to combine the teachings of Adler/Depp of controlling the radiation source by moving the “operating table **38**,” with the CBCT-FPI system of the Jaffray 1999 references. (*See* Ex. 1002, ¶¶ 87-88.) As Adler/Depp makes clear, such support tables can move and be used to position a patient with respect to a radiotherapy source. One of ordinary skill in the art would have been motivated to use the support table for this purpose.

Claims 7 and 10 recite the identical limitation. Claim 7 depends from claim 6 and claim 10 depends from claim 1. Claims 1 and 6 are discussed in Sections VIII-C-1 and VIII-C-8-a, respectively.

**b. Claims 4, 8 and 11**

Claim 4 depends from claim 3 and adds the limitation “wherein said stage

rotates about an axis of rotation relative to said x-ray source and said flat-panel imager.” This element is expressly taught by Jaffray 1999 SPIE:

The main components of the system are the x-ray tube, the rotation stage, and the flat-panel imager. These three components are mounted rigidly to an optical bench (Fig. 1a).... A set of alignment lasers realize the axis of rotation (AOR) and the source plane (that which is perpendicular to the axis of rotation and intersects the x-ray source); furthermore, the AOR is positioned so that it intersects the perpendicular axis between the source and detector plane.

(Jaffray 1999 SPIE, at 17 (emphasis added).) This discloses that the stage AOR (“axis of rotation”) is relative to the x-ray source and the FPI. This reference also expressly discloses that the object rotates: “volumetric imaging is accomplished by rotating the object.” (*Id.*, at 16.) Furthermore, as explained by Dr. Balter, the claim recites rotation “relative” to the x-ray source and FPI, which under the broadest reasonable construction means that either the object or the x-ray source must rotate. Thus, from the point of view of the x-ray source, if the x-ray source are mounted on a rotating gantry as suggested by Jaffray 1999 JRO, the object will “rotate” relative to the x-ray source as the gantry rotates around the object.

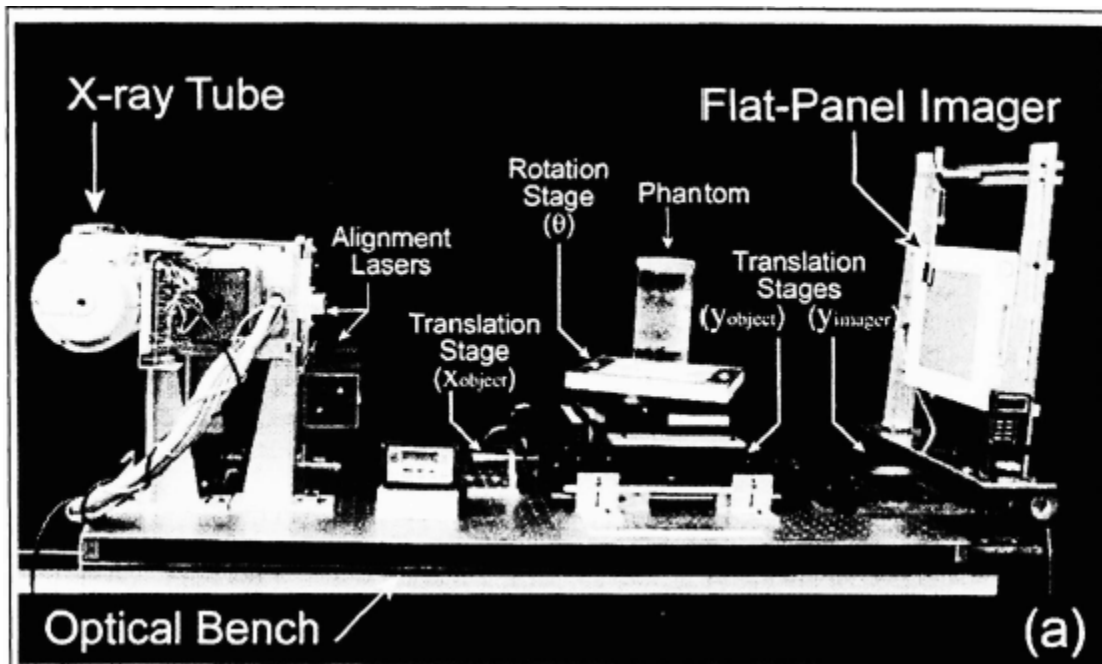
As explained by Dr. Balter, one of ordinary skill in the art would have been motivated to combine the Jaffray 1999 references and Adler/Depp to obtain the method of claim 4 because these references teach the advantages of a patient stage

or table that rotates relative to the axis of rotation of the x-ray source and FPI, and that one of the known benefits of cone-beam CT is the ability to obtain 3-D image information about an object based on a single rotation of the x-ray source relative to the object. (*See* Ex. 1002, ¶¶ 89-92.)

Claims 8 and 11 recite the identical limitation as claim 4. Claim 8 depends from claim 7, and claim 11 depends from claim 10. Claims 7 and 10 are discussed in Section VIII-C-4-a.

**c. Claim 13**

Claim 13 depends from claim 11 and adds the limitation “wherein said stage translates along said axis of rotation.” Jaffray 1999 SPIE expressly discloses this element. In defining the system as shown in Figure 1, Jaffray 1999 SPIE states: “The relative position of these components is controlled by means of three translation stages, which are used during initial setup to accurately determine and control the imaging geometry.” (Jaffray 1999 SPIE, at 17.) Figure 1 of Jaffray 1999 SPIE expressly depicts the translation stage, which translates along the axis of rotation of the rotation stage:



(*Id.*, at 18 (Fig. 1).) As explained by Dr. Balter, it was obvious to use a translating stage, common in CT scanners and linear accelerator devices, for the purpose of positioning the patient during scanning or radiation therapy beam delivery. (*See* Ex. 1002, ¶¶ 93-94.)

**d. Claim 14**

Claim 14 depends from claim 13 and adds the limitation “wherein said stage rotates about a second axis of rotation that is perpendicular to said axis of rotation.” This element is expressly disclosed by Adler/Depp’s teaching of a moveable table supporting the object being imaged. Adler discloses:

[T]he means for adjusting the relative positions of the beaming apparatus and the patient comprises a gantry **40** to which the beaming apparatus **20**, the diagnostic x-ray generators **30** and **32** and the image

receivers **34** and **36** are mounted along with conventional apparatus for lowering and raising the operating table **38** and for rotating it about an axis **42** and for tilting the top **44** of the operating table **38** about a longitudinally extending axis ....

(Adler, 7:43-52 (emphasis added).) Thus, Adler expressly discloses a stage (operating table 38) that rotates about an axis 42 that is perpendicular to the first axis of rotation. Depp contains the same express disclosure. (Depp, 5:16-24.) As explained by Dr. Balter, one of skill in the art would be motivated to use a table with additional flexibility in degrees of rotational freedom to better facilitate patient positioning. (*See* Ex. 1002, ¶¶ 95-96.)

## **5. Dependent Claims – Flat Panel Imagers**

### **a. Claim 17**

Claim 17 depends from claim 1 and adds the limitation “wherein said flat-panel imager comprises an array of individual detector elements.” This element is expressly disclosed by Jaffray 1999 SPIE: “The FPI incorporates a 512x512 active matrix array of a-Si:H thin-film transistors and photodiodes in combination with an overlying (133 mg/cm<sup>2</sup> Gd<sub>2</sub>O<sub>2</sub>S:Tb) phosphor.” (Jaffray 1999 SPIE, at 16 (emphasis added).) As explained by Dr. Balter, this statement is an express disclosure of the limitation of claim 17 because such a matrix array is made of a square of elements, 512 elements on a side. (*See also* Ex. 1002, ¶ 97.) Furthermore, one of skill in the art would have been motivated to obtain the

method of claim 17 because the prior art expressly taught the advantages of FPI imagers. As this arrangement is a standard characteristic of an FPI, one of ordinary skill in the art would have been motivated to employ it. (*See* Jaffray 1999 SPIE, at 16-17 section entitled “Introduction and Motivation”; *see also* Ex. 1002, ¶ 98.)

**b. Claim 18**

Claim 18 depends from claim 17 and adds the limitation “wherein said array is a two-dimensional array.” This element is also expressly taught by Jaffray 1999 SPIE because the flat panel imager array of that reference is a 2-D array, as Jaffray 1999 SPIE expressly states: “[t]his is made possible by the use of a two-dimensional (2-D) detector ....” (Jaffray 1999 SPIE, at 17.) As explained by Dr. Balter, an FPI array like the a-Si:H type taught in Jaffray 1999 SPIE is a 2-D array. Indeed, a key part of the motivation to use an FPI is its 2-D array status, which makes it appropriate for detection of the large 2-D projections obtained by using a cone-beam x-ray source. (*See* Ex. 1002, ¶ 99.)

**c. Claim 19**

Claim 19 depends from claim 17 and adds the limitation “wherein each of said individual detector elements further comprises a-Si:H photodiode.” This element is also expressly taught by Jaffray 1999 SPIE: “The FPI incorporates a 512x512 active matrix array of a-Si:H thin-film transistors and photodiodes ....”



(Jaffray 1999 SPIE, at 16 (emphasis added).) As explained by Dr. Balter, this limitation adds nothing of patentable significance, because the prior art expressly taught the use of FPIs comprising a-Si:H photodiodes, and one of ordinary skill in the art would have been motivated to employ this standard component. (*See* Ex. 1002, ¶ 100.)

**d. Claim 20**

Claim 20 depends from claim 19 and adds the limitation “wherein each of said individual detector elements further comprises a transistor coupled to said Si:H photodiode.” This element is also expressly taught by Jaffray 1999 SPIE: “The FPI incorporates a 512x512 active matrix array of a-Si:H thin-film transistors and photodiodes ....” (Jaffray 1999 SPIE, at 16 (emphasis added).) As explained by Dr. Balter, this teaching is an express disclosure of transistors coupled to photodiodes. This limitation adds nothing of patentable significance, because the prior art expressly taught the use of FPIs comprising transistors coupled to a-Si:H photodiodes, and one of ordinary skill in the art would have been motivated to use this standard format known for an FPI. (*See* Ex. 1002, ¶ 101.)

**e. Claim 38**

Claim 38 depends from claim 1 and adds the limitation of “wherein said flat-panel imager is an amorphous silicon flat-panel imager.” Jaffray 1999 SPIE expressly discloses this element. The purpose of the reference was to “characterize

the performance of a cone-beam computed tomography (CBCT) imaging system based upon an indirect-detection, amorphous silicon flat-panel imager (FPI).” (Jaffray 1999 SPIE, at 16.) As the authors explained, “[r]ecent advances in amorphous silicon (a-Si:H) flat-panel technology have made large-area, efficient x-ray detectors a reality. Such imagers are well-suited to CBCT ...” (*Id.*, at 19.) As explained by Dr. Balter, it would have been obvious to combine the radiotherapy systems of Adler/Depp with the CBCT-FPI apparatus, using an amorphous flat panel imager, as expressly taught by Jaffray 1999 SPIE. One of ordinary skill in the art would have been motivated by this express suggestion and by the known benefits of FPI detectors that were disclosed in the prior art. (*See* Ex. 1002, ¶ 102.)

## **6. Dependent Claims – Object Imaging**

### **a. Claims 12 and 16**

Claim 12 depends from claim 11 and adds the limitation “wherein said x-rays from said x-ray source are emitted along a source plane that is perpendicular to said axis of rotation.” Claim 16 adds the similar, broader limitation of “wherein said x-rays from said x-ray source are emitted along a source plane.” These limitations add nothing of patentable significance. Jaffray 1999 SPIE expressly discloses this limitation. As noted above for claim 9, the reference expressly discloses x-rays in a source plane and defines the x-ray source plane as “perpendicular to the axis of rotation.” (Jaffray 1999 SPIE, at 17.) As explained

by Dr. Balter, one of skill in the art would be motivated to provide x-rays along a source plane perpendicular to the relative axis of rotation of the object to obtain the obvious benefit of obtaining information about the entire object volume through a single rotation. (*See* Ex. 1002, ¶ 103.)

**b. Claim 21**

Claim 21 depends from claim 1 and adds the limitation “wherein said computer receives said image from said flat-panel imager and generates a computed tomography image of said object based on said received image.” This element is expressly taught by Jaffray 1999 SPIE: “The acquisition process – object rotation, x-ray exposure, and image acquisition — is synchronized by the host computer. Volume data sets were obtained from the projection data using the Feldkamp algorithm for CBCT reconstruction.” (Jaffray 1999 SPIE, at 25 (emphasis added).) Furthermore, the image reconstruction methodology employed by the reference, such as the Feldkamp algorithm, was well-known and in standard use for this purpose before 1999. (*See* Ex.1002, ¶ 104.)

This element is also expressly taught by Jaffray 1999 JRO: “The kV and MV imagers are controlled via a PC.... The same system is used to acquire the many projections used for the conebeam reconstructions.” (Jaffray 1999 JRO, at 6 (Fig. 3).) As explained by Dr. Balter, this limitation adds nothing of patentable significance because the prior art teaches the use of computers to perform storage

and processing of the 2-D projection images and image reconstruction using known algorithms for that purpose. (*See* Ex. 1002, ¶ 104.)

**c. Claim 22**

Claim 22 depends from claim 1 and adds the limitation “wherein said image is a two dimensional projection image.” This element is expressly taught by Jaffray 1999 SPIE: “volumetric imaging is accomplished by rotating the object incrementally over 360 degrees, delivering a radiographic x-ray pulse ... and acquiring a projection image ....” (Jaffray 1999 SPIE, at 16.) Because this system employs 2-D FPI detectors in a CBCT system, the projection image is a 2-D projection image. (*See* Ex. 1002, ¶ 105.) As explained by Dr. Balter, a cone-beam x-ray image detected by a 2-D detector like an FPI is a 2-D projection image. (*See id.*)

**d. Claim 23**

Claim 23 depends from claim 22 and adds the limitation “wherein said computer receives said two dimensional projection image from said flat-panel imager and generates a computed tomography image of said object based on said two dimensional projection image.” This element is expressly taught by Jaffray 1999 SPIE: “The acquisition process – object rotation, x-ray exposure, and image acquisition — is synchronized by the host computer. Volume data sets were obtained from the projection data using the Feldkamp algorithm for CBCT

reconstruction.” (Jaffray 1999 SPIE, at 25 (emphasis added).) By definition, this image is a CT image based on the 2-D projection images. (*See* Ex. 1002, ¶ 106.)

This element is also expressly taught by Jaffray 1999 JRO: “The kV and MV imagers are controlled via a PC.... The same system is used to acquire the many projections used for the conebeam reconstructions.” (Jaffray 1999 JRO, at 6 (Fig. 3).) As explained by Dr. Balter, this claim is obvious for the same reason as claims 21 and 22. (*See* Ex. 1002, ¶ 107.)

## **7. Dependent Claims – Gantry Limitations**

### **a. Claim 24**

Claim 24 depends from claim 1 and adds the limitation “further comprising a gantry with a first arm and a second arm, wherein said x-ray source is attached to said first arm and said flat-panel imager is attached to said second arm.” This element is expressly taught by Jaffray 1999 SPIE:

Specifically, the flat-panel imager will be mounted on a treatment gantry opposite a kilovoltage x-ray tube in a manner previously accomplished with a CCD-based imager.

(Jaffray 1999 SPIE, at 25 (emphasis added).)

This element is also taught by Jaffray 1999 JRO, which discloses a two-arm gantry for the x-ray source and imager, respectively. This configuration is shown in Figure 1 of Jaffray 1999 JRO, which is reproduced in this petition at Section VIII-B above. As explained by Dr. Balter, this configuration is obvious because

one of ordinary skill in the art would be motivated to use the commonly known gantry arrangements of the prior art for placement of the x-ray source and FPI. (*See* Ex. 1002, ¶¶ 108-109.)

**b. Claim 25**

Claim 25 depends from claim 24 and adds the limitation “wherein said gantry rotates about an axis of rotation.” This element is taught by both Jaffray 1999 references, because in both cases the gantry is designed to rotate around an axis of rotation. For example, Jaffray 1999 SPIE discloses that “the flat-panel imager will be mounted on a treatment gantry opposite a kilovoltage x-ray tube ....” (Jaffray 1999 SPIE, at 25.) As explained by Dr. Balter, one of skill in the art would recognize that this teaches a rotating gantry on which the CBCT-FPI is mounted. (*See* Ex. 1002, ¶ 110.)

As another example, the gantry of the SL-20 linear accelerator system expressly disclosed in Jaffray 1999 JRO discloses a rotating gantry, comprising a kV source, and MV source, a kV imager, and an MV imager, and states that “measurements were made of the range of flex for each of the four components of the [dual-beam system] as the gantry was rotated through 360°.” (*See* Jaffray 1999 JRO, at 6.) As explained by Dr. Balter, it is obvious that the gantry supporting the x-ray system should rotate because such rotation is necessary to obtain the multiple 2-D projection images that are required for obtaining 3-D information about an

object. (*See* Ex. 1002, ¶ 111.)

**c. Claims 26 and 27**

Claim 26 depends from claim 24 and adds the limitation “wherein said radiation source operates at a power level higher than that of said x-ray source, wherein said radiation is of an intensity and energy that is effective for radiation treatment of an area of said object.” This limitation is expressly disclosed in Jaffray 1999 JRO, which discloses the dual-beam system comprising both a kV energy beam for imaging and an MV energy beam for treatment (and for additional imaging). Jaffray 1999 JRO discloses a system installed on an Elekta SL-20, an instrument design to deliver therapeutic radiation at MV levels: “An Elekta SL-20 ... linear accelerator forms the basis of the system. This accelerator is computer controlled and produces 6 and 18 MV photon beams.” (Jaffray 1999 JRO, at 4.) As explained by Dr. Balter, the use of MV energy was well known to be effective for radiation therapy. (*See* Ex. 1002, ¶¶ 112-113.)

Claim 27 depends from claim 1 and recites the identical limitation. The invalidity of claim 1 is explained in Section VIII-C-1.

**8. Dependent Claims – Structural Additions**

**a. Claim 6**

Claim 6 depends from claim 1 and adds the limitation “wherein said radiation source comprises a linear accelerator.” Jaffray 1999 JRO, the title of

which contains the phrase “imaging system integrated into a medical linear accelerator,” expressly discloses a linear accelerator as the radiation source: “A kilovoltage (kV) x-ray source is mounted on the drum assembly of an Elekta SL-20 medical linear accelerator ....” (Jaffray 1999 JRO, at 3.) One of skill in the art would have been motivated to use the common system of a linear accelerator as the radiation source for the system of claim 1. (*See* Ex. 1002, ¶ 114.)

**b. Claim 9**

Claim 9 depends from claim 8, and adds the limitation “further comprising an alignment laser that allows visualization of said axis of rotation.” Jaffray 1999 SPIE expressly discloses this element: “[a] set of alignment lasers realize the axis of rotation (AOR) and the source plane (that which is perpendicular to the axis of rotation and intersects the x-ray source) ....” (Jaffray 1999 SPIE, at 17.) One of ordinary skill in the art would have been motivated to employ a laser to help visualize rotation axes because, as confirmed by Dr. Balter, it was commonplace to employ lasers to assist in alignment and visualization of axes of rotation on a linear accelerator. (*See* Ex. 1002, ¶ 115.)

**c. Claim 28**

Claim 28 depends from claim 1 and adds the limitation “wherein said x-ray source rotates about an axis that is coincident with an axis of rotation of said radiation source.” This element is expressly taught by Jaffray 1999 JRO, which



disclosed that the “kilovoltage (kV) x-ray source is mounted on the drum assembly of an Elekta SL-20 medical linear accelerator, maintaining the same isocenter as the treatment beam with the central axis at 90° to the treatment beam axis.” (Jaffray 1999 JRO, at 3.) As explained by Dr. Balter, by maintenance of the same isocenter in an offset beam, the x-ray and radiation source axes are coincident as recited in the claim, and this configuration would provide the obvious benefit of performing a scanning geometry on the same axis as the radiation treatment source. (See Ex. 1002, ¶ 116.)

**d. Claim 29**

Claim 29 depends from claim 1 and adds the limitation “wherein said x-ray source is displaced relative to said radiation source.” This element is expressly taught by Jaffray 1999 JRO in the same teaching quoted above, which disclosed that the “kilovoltage (kV) x-ray source is mounted on the drum assembly of an Elekta SL-20 medical linear accelerator, maintaining the same isocenter as the treatment beam with the central axis at 90° to the treatment beam axis.” (Jaffray 1999 JRO, at 3.) As explained by Dr. Balter, being offset by 90°, the x-ray source is displaced relative to the radiation source. (See Ex. 1002, ¶ 117.)

**e. Claim 33**

Claim 33 depends from claim 1 and adds the limitation “further comprising an imaging device positioned opposite said radiation source and generating an

image of said object based on radiation from said radiation source that passes through said object.” This element is expressly disclosed by Jaffray 1999 JRO, which discloses a dual-beam, dual-imaging system for both the kV and MV beams. As shown in panel b) of Figure 1 of Jaffray 1999 JRO, reproduced in Section VIII-B above, the system comprises an imager opposite the MV radiation source labeled as “MV Imager” along the bottom of panel b). Claim 33 does not limit the type of imager positioned opposite the radiation source, thus the CCD-camera based MV imager disclosed by Jaffray 1999 JRO discloses this claim element. As explained by Dr. Balter, “portal imaging” using MV image detectors in radiation therapy was very well known before 1999, and one of skill in the art would have been motivated to add this known imaging capability to the system of claim 1. (*See Ex. 1002, ¶ 118.*)

**f. Claims 35, 36, and 37**

Claims 35, 36, and 37 are highly similar. All depend from claim 1 and add similar language about “no enclosed opening is formed from a structure that supports said radiation source and said cone-beam computed tomography system.”

For comparison, the claims are reproduced in the table below:

<b>Claim 35</b>	<b>Claim 36</b>	<b>Claim 37</b>
35. The radiation therapy system of claim 1, wherein no enclosed opening is formed from a	36. The radiation therapy system of claim 1, wherein no enclosed opening is formed from a	37. The radiation therapy system of claim 1, wherein no enclosed opening is formed from a

Petition for *Inter Partes* Review of  
 U.S. Patent No. 6,842,502

<p>structure that supports said radiation source and said cone-beam computed tomography system into which said object is inserted for the purpose of being treated by said radiation source or imaged by said cone-beam computed tomography system within such an enclosed opening.</p>	<p>structure that supports said radiation source into which said object is inserted for the purpose of being treated by said radiation source within such an enclosed opening.</p>	<p>structure that supports said cone-beam computed tomography system into which said object is inserted for the purpose of being imaged by said cone-beam computed tomography system within such an enclosed opening.</p>
---	--	---

The element of no enclosed opening is apparently meant to distinguish prior art “ring” or “donut” devices. But this limitation does not avoid the prior art. It is expressly disclosed in Jaffray 1999 JRO, which teaches a dual-beam kV and MV device with kV CBCT imaging installed on an Elekta SL-20 linear accelerator. This device has two gantry arms in a C configuration that are mounted on a rotating ring. This configuration is clearly shown in Figure 1 of Jaffray 1999 JRO, reproduced above in Section VIII-B. As can be seen in the figure, no enclosed opening around the object (patient) is formed by the CBCT or radiation source systems. As explained by Dr. Balter, this combination provides the apparent and obvious benefit of facilitating access to the patient on the radiation treatment table. (See Ex. 1002, ¶¶ 119-121.)

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

**IX. CONCLUSION**

Petitioner respectfully requests institution of *inter partes* review of claims 1-14, 16-29, 33, and 35-38 of the '502 patent, and a finding that those claims are unpatentable, based on the grounds presented in this Petition.

Dated: November 6, 2015

Respectfully submitted,

COOLEY LLP  
ATTN: Patent Group  
1299 Pennsylvania Ave., NW, Suite 700  
Washington, DC 20004  
Tel: (650) 843-5001  
Fax: (650) 849-7400

By: /Heidi L. Keefe/  
Heidi L. Keefe  
Reg. No. 40,673  
Counsel for Petitioner  
Varian Medical Systems, Inc.

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

**CERTIFICATE OF SERVICE**

I hereby certify, pursuant to 37 C.F.R. Sections 42.6 and 42.105, that a complete copy of the attached **PETITION FOR INTER PARTES REVIEW OF U.S. PATENT NO. 6,842,502**, including all exhibits (**Nos. 1001-1037**) and related documents, are being served via Federal Express on the 6th day of November, 2015, the same day as the filing of the above-identified document in the United States Patent and Trademark Office/Patent Trial and Appeal Board, upon the Patent Owner by serving the correspondence address of record with the USPTO as follows:

Jonathan P. O'Brien, Ph.D.  
Honigman Miller Schwartz & Cohn LLP  
350 East Michigan Avenue, Suite 300  
Kalamazoo, MI 49007

and upon counsel of record for the Patent Owner in the litigation pending before the U.S. District Court for the Eastern District of Michigan entitled *Elekta Ltd. and William Beaumont Hospital v. Varian Medical Systems, Inc.*, Case No. 2:15-cv-12169-AC-MKM, as follows:

J. Michael Huget  
Deborah J. Swedlow  
Sarah E. Waidelich  
Honigman Miller Schwartz & Cohn LLP  
315 East Eisenhower Parkway, Suite 100  
Ann Arbor, MI 48108

Theresa M. Gillis  
Brian A. Rosenthal  
B. Clayton McCraw  
Mayer Brown LLP  
1221 Avenue of the Americas  
New York, NY 10011

Petition for *Inter Partes* Review of  
U.S. Patent No. 6,842,502

Andrew S. Rosenman  
Amanda K. Streff  
Mayer Brown LLP  
71 South Wacker Drive  
Chicago, IL 60606

DATED: November 6, 2015

/ Heidi L. Keefe /  
Heidi L. Keefe  
Reg. No. 40,673

COOLEY LLP  
ATTN: Heidi L. Keefe  
Patent Docketing  
1299 Pennsylvania Ave. NW, Suite 700  
Washington, D.C. 20004  
Tel: (650) 843-5001  
Fax: (650) 849-7400