UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ELEKTA INC.,
Petitioner

v.

BEST MEDICAL INTERNATIONAL, INC.,
Patent Owner.

Case No.: IPR2020-00067

U.S. Patent No. 7,015,490

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 7,015,490

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LIST OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 7,015,490. **("'490 patent")**
1002	Prosecution History of U.S. Patent Application No. 10/915,968, which matured into U.S. Patent No. 7,015,490.
1003	Declaration of Arthur L. Boyer, PhD.
1004	US Patent No. 5,596,619. **("'619 patent")**
1005	US Patent No. 5,802,136. **("'136 patent")**
1006	Brahme, A. (1988). Optimal setting of multileaf collimators in stationary beam radiation therapy. *Strahlentherapie und Onkologie: Organ der Deutschen Rontgengesellschaft...[et al]*, *164*(6), 343-350. **("Brahme 1988b")**
1007	Chang, S. X., Cullip, T. J., & Deschesne, K. M. (2000). Intensity modulation delivery techniques:"Step & shoot" MLC auto-sequence versus the use of a modulator. *Medical physics*, *27*(5), 948-959. **("Chang 2000")**
1008	AAPM Online Publication History of Chang 2000, https://aapm.onlinelibrary.wiley.com/toc/24734209/2000/27/5.
1009	Chang, S. X., & Potter, L. D. (2001). An iterative "Step & Shoot" MLC-IMRT segmentation algorithm for continuous intensity maps. *International Journal of Radiation Oncology• Biology• Physics*, *51*(3), 408. **("Chang 2001")**
1010	International Journal of Radiation Oncology•Biology•Physics Online publication history of Chang 2001, https://www.redjournal.org/article/S0360-3016(01)02575-5/abstract.
1011	Siochi, R. A. C. (1999). Minimizing static intensity modulation delivery time using an intensity solid paradigm. *International Journal of Radiation Oncology* Biology* Physics*, *43*(3), 671-680. **("Siochi 1999")**
1012	International Journal of Radiation Oncology* Biology* Physics Online Publication History of Siochi 1999. https://www.sciencedirect.com/science/article/pii/S0360301698004301
1013	Boyer, A., Biggs, P., Galvin, J., Klein, E., LoSasso, T., Low, D., ... & Yu, C. (2001). Basic applications of multileaf collimators: report of Task Group No 50, Radiation Therapy Committee. *American Institute of Physics for the AAPM, New York, NY*. **("Boyer 2001")**
1014	Online Publication History of Boyer 2001.
1015	US Patent No. 6,757,355. **("Siochi '355")**

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1016	Webb, S. (2001). A simple method to control aspects of fluence modulation in IMRT planning. *Physics in Medicine & Biology*, *46*(7), N187. **(“Webb 2001”)**
1017	Physics in Medicine and Biology Online Publication History of Webb 2001, https://iopscience.iop.org/article/10.1088/0031-9155/46/7/403/meta.
1018	Webb, S. (1993). *The physics of three dimensional radiation therapy: Conformal radiotherapy, radiosurgery and treatment planning*. CRC Press. **(“Webb 1993”)**
1019	CRC Press. Publication information for Webb 1993. https://www.crcpress.com/The-Physics-of-Three-Dimensional-Radiation-Therapy-Conformal-Radiotherapy/Webb/p/book/9780750302548.
1020	Karzmark, C. J., & Morton, R. J. (1981). *Primer on theory and operation of linear accelerators in radiation therapy* (No. FDA--82-8181). Bureau of Radiological Health. **(“Karzmark 1981”)**
1021	1990s State of the Art Declaration – Arthur L. Boyer.
1022	CV of Arthur L. Boyer.
1023	Declaration of Marla Hirth
1024	Google Scholar Report for Chang 2000 (date limited: -2002).
1025	Google Scholar Report for Boyer 2001 (date limited: -2002).
1026	Google Scholar Report for Siochi 1999 (date limited: -2002).
1027	Google Scholar Report for Webb 1993 (date limited: -2002).
1028	Google Scholar Report for Webb 2001 (date limited: -2002).
1029	US Patent No. 6,314,159 (“Siochi ’159 2001”).

I. INTRODUCTION

Elekta Inc. ("Elekta" or "Petitioner") requests that the Board institute *inter partes* review ("IPR") of and cancel claims 1, 4, 10-12, 17-19 ("Challenged Claims") of U.S. Patent No. 7,015,490 ("the '490 patent") (Ex. 1001), assigned to Best Medical International, Inc. ("BMI" or "Patent Owner"), in accordance with 35 U.S.C. §§311-319 and 37 C.F.R. §42.100 *et seq*.

A. Declaration Evidence

This Petition is supported by declaration testimony of Dr. Arthur L. Boyer ("Boyer Declaration," Ex. 1003, "Boyer SOA Declaration," Ex. 1021 and "Hirth Declaration," Ex. 1023). Boyer Declaration describes the '490 patent, the person of ordinary skill in the art in the relevant time frame, interpretation of certain terms in the '490 patent, the state of the art of the '490 patent, the scope and content of the prior art compared to the claims of the '490 patent, and the rationales for combining prior art elements. Boyer SOA Declaration describes the state of the art of radiotherapy in the 1990s. Hirth Declaration describes the public availability and authenticity of the cited references.

II. MANDATORY NOTICES UNDER 37 C.F.R. §42.8(A)(1)

A. Real Parties-in-Interest (37 C.F.R. §42.8(b)(1))

Petitioner identifies Elekta Limited (UK), Elekta Holdings U.S., Inc. and Elekta AB as real parties in interest without admitting that they are in fact real parties in interest. Elekta Limited (UK), Elekta Holdings U.S., Inc. and Elekta AB have agreed to be bound by the estoppel provisions of 35 U.S.C. 315(e) to the same extent as Petitioners.

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

Patent Owner asserted the ’490 Patent in *Best Medical International*, *Inc*. v. *Elekta Inc. and Elekta Limited*, Civil Action 1:19-cv-03409-MLB (currently pending in the Northern District of Georgia, and previously pending in the District of Delaware as Civil Action No. 1:18-cv-01600-MN) and *Best Medical International*, *Inc*. v. *Varian Medical Systems*, *Inc. et al*, Civil Action 1:18-cv-01599 (currently pending in the District of Delaware).

C. Counsel (37 C.F.R. §42.8(b)(3)) and Service Information (37 C.F.R. §42.8(b)(3)-(4))

Petitioner designates Tamara D. Fraizer (Reg. No. 51,699) as lead counsel for this matter. Petitioner designates Christopher W. Adams (Reg. No. 62,550) and Vid R. Bhakar (Reg. No. 42,323) as back-up counsel for this matter.

Postal mailings and hand-deliveries for lead and back-up counsel should be addressed to: Tamara D. Fraizer, Squire Patton Boggs (US) LLP, 1801 Page Mill Road, Suite 110, Palo Alto, CA 94304-1043 (Telephone: (650) 843-3201; Fax: (650) 843-8777).

Pursuant to 37 C.F.R. §42.8(b)(4), Petitioner consents to e-mail service at: tamara.fraizer@squirepb.com; sfripdocket@squirepb.com.

For compliance with 37 C.F.R. §42.10(b), a Power of Attorney is also filed Concurrently herewith.

III. CERTIFICATION (37 C.F.R. §42.104(A)) AND PAYMENT OF FEES (37 C.F.R. §42.10)

Petitioner certifies that the ’490 patent is available for IPR, and Petitioner and the real parties-in-interest are not barred or estopped from requesting IPR on the grounds identified herein.

The complaint referenced in Section II.B was served within the last 12 months. Neither the Petitioner nor its real parties-in-interest (or privies) have been served with any other complaint alleging infringement of the ’490 patent.

The undersigned authorizes the USPTO to charge any fees due during this proceeding to Deposit Account No. 07-1850.

IV. IDENTIFICATION OF CLAIMS AND GROUNDS (37 C.F.R. §42.104(A),(B))

The application for the ’490 patent was filed on August 11, 2004 by Nomos Corporation, the Patent Owner’s predecessor-in-interest. The application claimed priority to U.S. Provisional Application No. 60/494,222, filed on August 11, 2003. Ex. 1002 at 6.

Because the filing date of the ’490 patent (and all applications to which it claims priority) is before the effective date of the AIA (March 16, 2013), the pre-AIA statute applies.

For purposes of this IPR, Petitioner treats August 11, 2003, the effective filing date of the cited provisional applications, as the “Alleged Priority Date” for all Challenged Claims. To the extent that the Patent Owner demonstrates a date of conception earlier than this, the Petitioner reserves the right to adjust the “Alleged Priority Date” accordingly.

Petitioner relies on the following references.

A. Patents and Patent Applications

Siochi ’355 (Ex. 1015). Issued as US Patent No. 6,757,355 on June 29, 2004. Siochi ’355 is prior art under §102(e).

B. Non-Patent Literature

Whether a reference constitutes a printed publication under §102(b) is a legal conclusion based on underlying factual determinations. *GoPro, Inc.* v. *Contour IP Holding LLC*, 898 F.3d 1170, 1173-74 (Fed. Cir. 2018) (opinion modified on other grounds). The Federal Circuit has "interpreted §102 broadly, finding that even relatively obscure documents qualify as prior art so long as the relevant public has a means of accessing them." *Id*. at 1174. A reference is "publicly accessible if it was disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence, can locate it." *Id*.

Chang 2000, Chang 2001, Siochi 1999, Webb 1993 and Webb 2001 are authentic copies of the references from their respective publications or books located at either the National Library of Medicine or the Library of Congress. Exs. 1007, 1009, 1011, 1018 and 1016. Each of the aforementioned references also bears a sticker and/or stamp from each of these institutions indicating the institutions name and the date the reference was received at the library. *Id*.; *see also* Ex. 1023 at ¶¶17-37 and 44-110. Each of the aforementioned dates were prior to the Alleged Priority Date. *Id*. Courts have held that papers that are catalogued and available to the public in libraries, including the Library of Congress, are sufficiently "publicly available" or "publicly accessible" to serve as prior art. *See, e.g.*, *In re Hall*, 781 F.2d 897 (Fed. Cir. 1986); *In re Cronyn*, 890 F.2d 1158, 1161 (Fed. Cir. 1989).

1. Chang 2000 **(Ex. 1007)**

Chang 2000 is a printed publication bearing a copyright date of 2000, first published by the American Association of Physicists in Medicine ("AAPM") in the International Journal of Medical Physics Research and Practice ("Medical Physics"). Ex. 1007 at cover page; *LG Elec., Inc.* v. *Advanced Micro Devices, Inc.*, IPR2015-00329, Paper 13 at 12 (PTAB Jul. 10, 2015) (copyright date is prima facie evidence of publication).

Chang 2000 includes other indicia of its public accessibility, including National Library of Medicine (NLM) and Library of Congress (LOC) publication data (Ex. 1023 at ¶¶22-23) and publisher information, showing this article was available for online download on "May 5, 2000." Ex. 1008 ("Issue Online: 05 May 2000"); *Voter Verified, Inc.* v. *Premier Election Solutions, Inc.*, 698 F.3d 1374, 1380 (Fed. Cir. 2012) (online article qualified as a §102(b) "printed publication" because interested and skilled persons could have located it).

Chang 2000 was cited by other references prior to the Alleged Priority Date. Ex. 1023 at ¶24. *See also Spitzer* v. *Aljoe*, No. 13-cv-05442-MEJ, 2016 WL 3275148 at *3 (N.D. Cal. Jun. 15, 2016) (taking judicial notice of the publicly availability of a document located on Google Scholar).

Thus, Chang 2000 is §102(b) prior art, publically accessible at least a year before the Alleged Priority Date.

2. Chang 2001 **(Ex. 1009)**

Chang 2001 is a printed abstract first published by the American Society for Radiation Oncology ("ASTRO") in "Volume 51, Number 3, Supplement 1, 2001" of the International Journal of Radiation Oncology·Biology·Physics ("Astro Journal"). Chang 2001 has a copyright date of 2001 on its publisher's website. Ex. 1009 at cover page; *see also LG Elec., Inc.*, IPR2015-00329, Paper 13 at 12 (PTAB Jul. 10, 2015).

Thus, Chang 2001 is §102(b) prior art, publically accessible a year before the Alleged Priority Date.

3. Siochi 1999 **(Ex. 1011)**

Siochi 1999 is a printed publication bearing a copyright date of 1999 and first published by Elsevier Inc.in "Volume 43, Issue 3…1999" of the Astro Journal. Ex. 1011 at cover page; *see also LG Elec., Inc.*, IPR2015-00329, Paper 13 at 12 (PTAB Jul. 10, 2015).

Siochi 1999 includes other indicia of its public accessibility, including NLM and LOC publication data (Ex. 1023 at ¶¶35-36) and publisher information, which shows that this article was available for online download on "19 February 1999."

Ex. 1012 ("Available online 19 February 1999"; *see also Voter Verified, Inc.*, at 698 F.3d 1380.

Siochi 1999 was cited by other references prior to the Alleged Priority Date. Ex. 1023 at ¶37. *See also Spitzer* at *3.

Thus, Siochi 1999 is §102(b) prior art, publically accessible a year before the Alleged Priority Date.

4. Boyer 2001 (Ex. 1013)

Boyer 2001 is a book bearing a copyright date of 2001 that was first published by Medical Physics Publishing in "July 2001" for AAPM. Ex. 1013 at cover page, page 2; *see also LG Elec., Inc.*, IPR2015-00329, Paper 13 at 12 (PTAB Jul. 10, 2015).

Boyer 2001 includes other indicia of its public accessibility and publisher information, which shows that this book was published in July 2001. Ex. 1014.

Boyer 2001 was cited by other references prior to the Alleged Priority Date. Ex. 1023 at 43. *See also Spitzer* at *3.

Thus, Boyer 2001 is §102(b) prior art, publically accessible a year before the Alleged Priority Date.

5. Webb 1993 (Ex. 1018)

Webb 1993 is a book bearing a copyright date of 1993 that was first published by IOP Publishing Ltd. Ex. 1018 at page 2;*see also LG Elec., Inc.*, IPR2015-00329, Paper 13 at 12 (PTAB Jul. 10, 2015).Webb 1993 includes other indicia of its public accessibility, including NLM and LOC publication data (Ex. 1023 at ¶¶58-59) and publisher information, which shows that this book was "published" as an "eBook" on "1 January 1993" and was thus available for online download on or around that date. Ex. 1019; *see also Voter Verified, Inc.*, at 698 F.3d 1380.

Webb 1993 was cited by other references prior to the Alleged Priority Date. *Id*. Ex. 1023 at ¶60. *See also Spitzer* at *3. Petitioner's expert, Arthur L. Boyer, was one of the co-authors of the latter article and recalls reviewing Webb 1993 in advance of the Alleged Priority Date.

Thus, Webb 1993 is §102(b) prior art, publically accessible a year before the Alleged Priority Date.

6. Webb 2001 **(Ex. 1016)**

Webb 2001 is a printed publication bearing a copyright date of 2001 and first published by IOP Publishing Ltd. in the United Kingdom in "July 2001." Ex. 1016 at cover page ("July 2001"); *see also LG Elec., Inc.*, IPR2015-00329, Paper 13 at 12 (PTAB Jul. 10, 2015).

Webb 2001 includes other indicia of its public accessibility, including LOC publication data (Ex. 1023 at ¶48) and publisher information, which shows that this article was received for publication on "9 April 2001" Ex. 1017.

Webb 2001 was cited by other references prior to the Alleged Priority Date. Ex. 1023 at ¶49. *See also Spitzer* at *3.

Thus, Webb 2001 is §102(b) prior art, publically accessible a year before the Alleged Priority Date.

Petitioner submits the Challenged Claims are unpatentable on the following grounds:

Ground	Statutory Basis and Art Cited	Claims
I	§103 – obvious over Chang 2000 in view of Chang 2001, in further view of Boyer 2001.	1, 10, 11, 17
II	§103 – obvious over Chang 2000 in view of Chang 2001, in further view of Siochi 1999, and Boyer 2001.	4, 12, 18, 19
III	§103 – obvious over Siochi ’355 in view of Webb 2001, in further view of Siochi 1999	1, 4, 10, 11, 17, 18
VI	§103 – obvious over Siochi ’355 in view of Webb 2001 and Siochi 1999, in further view of Webb 1993.	12, 19

V. TECHNOLOGY BACKGROUND

The Challenged Claims relate to optimization of radiotherapy treatment plans delivered by a medical linear accelerator (“LINAC”). Ex. 1021 at ¶¶10-88.

A radiotherapy treatment machine includes a LINAC and a multi-leaf collimator (“MLC”). *Id*. at 15-24. The MLC is affixed to the LINAC and has several pairs of metallic leaves that can be moved to create an opening that shapes the beam of radiation as it exits the treatment machine. *Id*. at ¶¶34-39. Shaped beams can be precisely delivered to a patient on a treatment couch from various directions. *Id*. at ¶15, Figure B. LINACs have been used to treat patients with radiation in this manner since at least the early 1990s. *Id*. at ¶15.

Such conformal radiation treatment requires developing a detailed treatment plan based on three-dimensional images of the patient. *Id.* at ¶¶26-33, 76-80; Ex. 1003 at ¶¶144-154. IMRT is a type of conformal radiation therapy that not only conforms the beam to the shape of a tumor, but also modulates the intensity of radiation delivered to the patient on a scale that is smaller than the radiation beam itself (it converts a single beam into multiple sub-beams, called beamlets), usually by delivering several differently shaped beams from each of several angles. Ex. 1021 at ¶¶57-64; Ex. 1003 at ¶¶126-132, 146.

IMRT treatment planning is complex, and requires use of iterative optimization to find the “best” plan, where “best” depends on the goal of the optimization. Ex. 1021, ¶71-72; Ex. 1003, ¶143-144. The goal is defined by a “cost” function, and the computer algorithms search for a solution that minimize the value of the cost function. Ex. 1021, ¶¶72, 79. Traditionally, IMRT treatment planning optimized the dose, using one cost function for the tumor and others for healthy tissues. *Id.*, ¶¶75-76. By the late-1990s, algorithms were developed to also optimize the delivery efficiency, for example, by sequencing the MLC shapes used in the treatment. Ex. 1003 at ¶¶159-166.

Delivery efficiency is important because patients won't tolerate laying on the treatment table for a long time. *Id.*, ¶158. It was understood that (all else equal) the time required to deliver an IMRT treatment plan correlated with the number of segments in the treatment plan as well as the complexity of the intensity maps. Ex. 1003, ¶162. It was also understood that to improve IMRT delivery efficiency, "the total leaf movement [associated with set-up of the MLC] should be minimized." *Id.*, ¶163. This was because the time required for the leaves to move from one shape to the next was a potential limiting factor for treatment delivery. Ex. 1003 at ¶¶158-163.

The '490 patent relates to one potential aspect of IMRT treatment planning: "optimization of collimator angles for [MLCs] used in intensity modulated radiation therapy treatment." Ex. 1001 at 1:26-31. The '490 patent presents a "cost function obtained by combining the prior algorithm based upon Brahme's orientation theory" with a supposedly "new" second function. Ex. 1001 at 5:65 to 6:1, 6:53-56. Despite the previous statement, the '490 patent does not identify or fully characterize the paper in which Brahme presented this theory. (Ex. 1006) ("Brahme 1988b").

Brahme 1988b considered the mismatch between the MLC leaves and the outline of a tumor, as shown by the hatched areas in the figure below. Ex. 1003, ¶¶191-192; Ex. 1006 at 346, Figure 3.

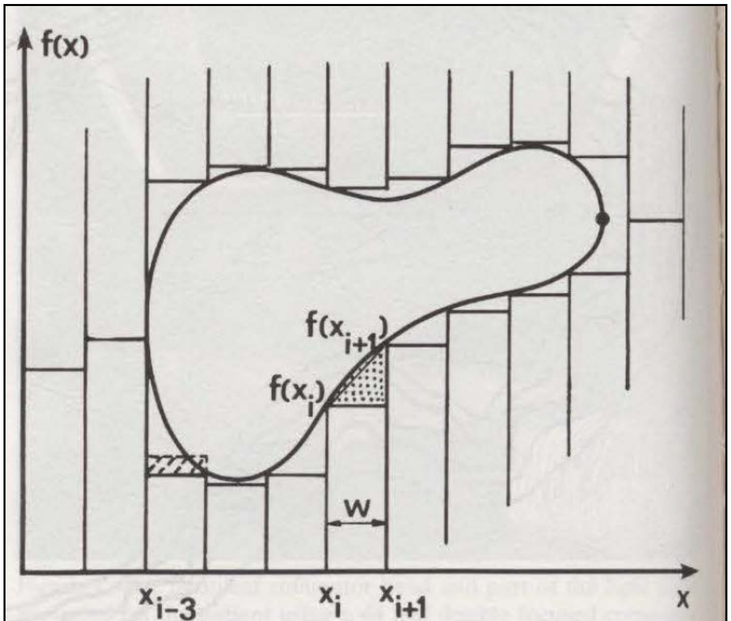


Figure 3. Illustration of the setting of a multileaf collimator and the coordinate system used in the mathematical analysis. The dotted area corresponds to the quantity ΔA_i in equation (1).

For different orientations of an MLC against a target, Brahme 1988b determined the "area difference" between the edges of the MLC leaves and the tumor, and the "treated area" and the "relative mean energy imparted." Ex. 1006 at 348. Orienting the MLC leaves to align with the smallest cross-section reduced the treated area and relative mean energy imparted. *Id*. For simple shapes, Brahme concluded "the best rotation angle . . . is obtained by aligning the direction of motion of the leaves with the direction in which the target volume has its smallest cross-section." *Id.* at 347.

In the early 1990s, Brahme's "area difference" metric was incorporated into conformal treatment planning systems to find collimator angles that provided the best match and the lowest monitor units. Ex. 1003 at ¶¶139-141. By 2002, Brahme's orientation theory was also incorporated into IMRT optimization programs that had mechanisms to enhance delivery efficiency by reducing the number of segments and MUs. *Id.* For example, (Xia 1998) discloses a sequencing algorithm that minimizes treatment segments with minor increases to monitor units based on leaf motion constraints and collimator angles. *Id.* at ¶141.

Also by 2002, it was known to include delivery considerations in the optimization of conformity in IMRT treatment plans, for example, with a "hybrid" cost function. Webb 2001 characterized conformity as an issue in "dose-space" and characterized delivery efficiency as an issue in "beam-space." Ex. 1016 at Abstract. Webb 2001 taught to use a hybrid function having a dose-space portion and a beam-space portion, with weighting factors to determine the relative emphasis to be placed on conformity vs. efficiency. *Id.* at N189.

VI. BACKGROUND

A. Overview of the '490 Patent

The '490 patent relates generally to "intensity modulated radiation therapy treatment," and in particular to "optimization of collimator angles for multi[-]leaf collimators ("MLC") used in intensity modulated radiation therapy treatment." Ex. 1001 at 1:26-31. The '490 patent discloses "a new algorithm" with "a cost function, to determine an optimum collimator angle of the multi-leaf collimator." *Id.* at 2:34-35. This cost function is "obtained by combining the prior algorithm based upon

Brahme's orientation theory with the algorithm utilized in the present invention." *Id.* at 2:8-10.

Use of this cost function allegedly "enhances the delivery efficiency . . . by reduc[ing] the number of segments and MUs" and/or "enhance[s] conformity of the radiation beam arrangement to a target shape." *Id.* at 1:58-60; 2:40-42. The delivery efficiency part of the cost function "minimizes the maximum leaf travel distance" that a leaf pair must move. *Id.* at 9:50-60. The conformity part of the cost function minimizes the area difference, as explained by Brahme 1988b. The relative importance of delivery efficiency and conformity is specified by "weights… assigned to the maximum effective length and area difference" and "[b]y applying a first weight value to the maximum effective length and a second weight value to the area difference prior to determining the minimum sum value, a different collimator angle can be deemed the optimum angle." *Id.* at 3:18-23.

The '490 patent further discloses that its delivery cost term is based on "the number of segments in a pair of MLC leaves[, which] is proportional to an **effective leaf travel distance."** This quantity is defined by the equation:

$$le = \left(1 + \frac{n-1}{k}\right)\sum_{i-1}^{n} m_i$$

where "n is the number of separated target regions in the path of the MLC leaf pair, or leaf travel distance of an individual MLC leaf pair; m_i is the leaf travel distance in the ith isolated target region for the MLC leaf pair; and k is the weight factor to account for multi isolated regions [e.g. subtargets, as noted by Brahme 1988b] in the path over which the MLC leaf pair sweeps." *Id*. at 6:18-34; Ex. 1003, ¶¶135-137, Figs. 3-4.

The delivery cost term disclosed in the '490 patent requires identifying, for each possible collimator angle, the pair of MLC leaves that has the largest effective leaf travel distance, and then choosing the collimator angle for which that distance is the smallest.

B. Relevant Prosecution History

U.S. Patent Application No. 10/915,968 ("the '968 application"), which resulted in the '490 Patent, was filed on August 11, 2004. *See* Ex. 1002 at 1. Other than a Notice to File Missing parts that cited informalities with the '968 applications drawings and a missing inventor oath or declaration, there were no intervening office actions from the Office. *Id*. at 43-69. The Examiner allowed the claims of the '968 application on October 4, 2005. *Id*. at 78. The Examiner did not consider the references in this Petition.

In the Notice of Allowance on October 4, 2005, the Examiner indicated that the prior art did not disclose:

> adjust[ing] a collimator angle of a multi-leaf collimator in accordance with a function having both a term related to delivery efficiency, which is related to the number of radiation beam segments and monitor units and may be related to the maximum effective length for a multi-leaf collimator leaf pair determined for each of a plurality of discrete collimator angles, and a term related to conformity of the radiation beam arrangement to a target shape, as indicated by a difference between the area of the opening of the multi-leaf collimator and that of a target shape in a beam's eye view.

Id. at 82.

Contrary to this conclusion, each of the prior art references (individually or in combination) relied upon in this Petition discloses or suggests adjusting a collimator angle of a multi-leaf collimator in accordance with a function having both a term related to delivery efficiency, such as one related to number of segments and monitor units, which may be based on maximum effective length of a leaf pair, and a term related to conformity of the radiation beam arrangement to a target shape, which may be indicated by an area difference.

C. Cited References

1. Chang 2000

Chang 2000 discloses radiation therapy treatment planning using an in-house 3D treatment planning system, PLanUNC (PLUNC). Ex. 1007 at 949. This treatment planning system was used to study two intensity modulation radiotherapy (IMRT) delivery systems. *Id.* at 948. For one of these, the sequence of the MLC segments was optimized using the IMFAST software system, the details of which are said to be reported in Siochi 1999. *Id.* at 952-53 (citing reference #31). *See* Ex. 1003 at ¶216.

Chang 2000 discloses that "[t]he orientation of MLC leaves (the collimator angle) should be considered as a variable in the MLC-IM [(intensity modulation)] treatment delivery optimization process." Ex. 1007 at 957. The "collimator angle" can have "significant influence on the discrepancy between the discrete 'sky-scraper' IM map created for (and delivered by) the MLC technique and its corresponding original smooth map." *Id.* An "optimal collimator angle can minimize the field edge jaggedness; an optimal collimator angle can also reduce the difference between the discrete IM map and its original smooth map." *Id.* Chang 2000 further discloses "[w]e are currently in the process of incorporating such a concept into PLUNC for the MLC-IM treatment delivery technique." *Id.*

2. Chang 2001

Chang 2001 discloses radiation therapy treatment planning using the same in-house 3D treatment planning system as was used in Chang 2000, namely, PLanUNC (PLUNC). Ex. 1009 at Purpose.

Chang 2001, discloses a "new MLC-IM segmentation algorithm" intended "to improve the quality and efficiency" of treatment, that selects a collimator angle for a segment based on a weighted cost function having two parts, one of which is the area difference between the MLC and the treatment region. *Id.* As explained in

Chang 2001, "[t]he preferable collimator angle for the segment field is chosen based on two weighted criteria: 1) preservation of the steep gradient portion of the intensity map slice and 2) minimization of the difference between the shape of the slice and that of the MLC segment field." *Id.* Materials and Methods.

Chang 2001 explains that the new algorithm "is able to focus on the regions of the [intensity] map that are likely to play an important role in the achieving the optimization objectives." *Id.* at Conclusion. Chang 2001 compared the "dose optimization quality" and the "treatment efficiency" of the new algorithm with other methods. *Id.* Chang 2001 concluded that the algorithm "has the potential to increase the quality of the 'step & shoot' IMRT treatment and may also increase the treatment efficiency." *Id.*

3. Siochi 1999

Siochi 1999 discloses a sequencing optimization algorithm that reduces IMRT treatment times. Ex. 1011 at 671. It "determines the best segmentation possible for delivering an intensity map using multiple static fields that are automatically delivered in sequence." *Id.* at 679. The algorithm evaluates each set of segments in terms of leaf travel, beam on time, verify and record (V&R) overhead, and chooses the set [of segments] having the minimum delivery time. *Id.* at 671. Importantly, Siochi 1999 discloses a delivery cost function that is an expression of the time required for delivery based on delivery time, and the leaf travel time component is defined as the maximum leaf distance that a pair of leaves must move from one segment to the next.

4. Boyer 2001

Boyer 2001 explains that its aim was "to provide basic information and to state fundamental concepts needed to implement the use of a multileaf collimator (MLC) in the conventional clinical setting." Ex. 1013 at 1. Boyer 2001 notes that "[r]otation of the direction of leaf travel can optimize the fit of the leaf shape to treatment target volumes." *Id.* at 40. Boyer 2001 further notes that "Brahme's work (1988) considers the optimal choices of the collimator angle in order to optimize the leaf direction . . . [and] [t]he one conclusion drawn by Brahme is that the optimal direction for the leaf motion is in the direction along the narrower axis." *Id.* Boyer 2001 discloses that "[o]ne group (Du et al. 1994) has developed a method for determining optimal leaf positioning in concert with optimal collimator angulation." *Id.*

5. Siochi '355

Siochi '355 discloses methods "for delivering radiation to a treatment area with a multi-leaf collimator operable to rotate about axis R of the radiation beam." Ex. 1015 at 5:65–6:3. Siochi '355 provides a method to "reduce the stair-step effect created by the width of the leaves" by using a combination of collimator angles, the first of which is selected "according to procedures used ... for conventional [MLC] radiation delivery." *Id.* at 6:7-19. The process entails decomposing a desired intensity map into multiple fields to be delivered from the different collimator angles, using an optimization method that "yields the shortest treatment delivery time." *Id.* at 10:21-26.

6. Webb 1993

Webb 1993 is section 5.3 of a book authored by Steve Webb. The section is entitled "Brahme's theory of orientation"—the same phrase that is used in the '490 patent. Webb 1993 discloses that Brahme 1988b (discussed) provided the "optimal angulation of the MLC leaves . . . at some particular static orientation relative to the target volume." Ex. 1018 at 233. Webb 1993 provides a summary and explanation of the equations provided in Brahme 1988b. *Id.* at 233-35. Webb 1993 also notes Brahme's conclusion that "the leaves should be aligned to minimize the opening of the collimator from the fully closed position." *Id*. at 234.

7. Webb 2001

Webb 2001 notes that many treatment planning systems produced plans with "high dose-space conformality," but notes that their "monitor-unit efficiency" could be "quite small." Ex. 1016 at Abstract. Webb 2001 addresses this "tradeoff between obtaining desirable features in beam-space and high conformality in dose-space." *Id.* Webb 2001 provided a mechanism by which "this can be under the control of the user." *Id.* at N188. Webb 2001's "*new development* [wa]s to compute two extra parameters at each iteration[,] which characterize beam-space and then make use of them in a hybrid cost function," as shown in the annotated equation below. *Id.* at N189.

$$\chi = \underset{\text{Dose Space}}{\left\{\sum_i \sum_j I_w(i,j)\left(D(i,j) - D^p(i,j)\right)^2\right\}} + \underbrace{w_3[w_1 S_+ - w_2 F_{\min}]}_{\text{Beam Space}}$$

Webb's 2001 hybrid cost function includes weighting parameter w_3, which controls the relative contribution of the beam-space term relative to the dose-space term. *Id.* at N190. The weight can be set by a user to permit "the desireable features of beam-space [to] be traded off with the degree of conformality of dose-space by allow[ing] the user to choose between the degree of conformality and the degree of smoothness and size of field components in the constituent beams." *Id.* at N194. By minimizing this hybrid function, one would consider both dosimetric and delivery aspects of radiation treatment.

VII. PERSON OF ORDINARY SKILL IN THE ART ("POSITA")

The level of skill in the art is generally evidenced by the prior art references. *See Chore-Time Equip., Inc. v. Cumberland Corp.*, 713 F.2d 774, (Fed. Cir. 1983); *see also Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). A POSITA would have an undergraduate degree in science, computer science, engineering or math, and have additional training in radiation dosimetry, medical physics, medicine, or an equivalent field of study, with at least 2-3 years of computer programming experience and some clinical experience in radiation therapy or radiation therapy treatment planning. Ex. 1003 at ¶¶77-117.

VIII. CLAIM CONSTRUCTION (37 C.F.R. §42.104(B)(3))

Claim terms are to be construed "in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 37 C.F.R. 42.100(b).

Claim Limitation	***Proposed Construction***	***Claims***
"radiation beam segment" or "segment"	"a portion (of a plurality of portions) of a radiation beam arrangement"	1, 10, 17
"radiation beam arrangement"	"an arrangement of radiation beam segments at a given radiation delivery angle (gantry angle) of a multi-leaf collimator (MLC)"	1, 4, 10, 17, 19

Petitioner submits that the constructions provided above should be adopted, as they are supported by the language of the patent and the testimony of Dr. Boyer. Ex. 1003 at ¶¶202-213.

The interpretation of "radiation beam segment" or "segment" to mean "a portion of a radiation beam arrangement" is supported by the specification. Ex. 1003 at ¶¶206-208. It discloses that the leaves of the multi-leaf collimator form the radiation beam segments with reference to FIG. 17. Ex. 1001 at 5:48-49. Also, one of ordinary skill in the art would understand that "radiation beam segments" and "segments" are used interchangeably in the '490 patent. Ex. 1003 at ¶¶207-209. Indeed, according to Dr. Boyer, the way the specification uses "segments" (alone) only makes sense if this term is referring to "radiation beam segments." Ex. 1003 at ¶210.

The interpretation of "radiation beam arrangement" to mean "an arrangement of radiation beam segments at a given radiation delivery angle (gantry angle) of a multi-leaf collimator (MLC)" is also consistent with the use of this term in the specification. The Summary of the Invention explains that "[b]ecause a target is typically treated utilizing multiple radiation beam delivery angles (gantry angles of rotation on a linear accelerator), this process of determining an optimum collimator angle can be repeated for *each selected* radiation beam delivery angle" (emphasis added). *Id*. Subsequently, the '490 Specification that its "discussion primarily focused [on] determining a rotational angle of the multi-leaf collimator for a beam delivery iteration at a single radiation beam delivery angle (gantry angle of rotation for a linear accelerator)," but in practice, calculation of the optimal collimator angle would be required for each radiation beam delivery angle (gantry angle) used in the radiation treatment session. *Id*. 10:2-9; Ex. 1003, ¶¶212-213.

ARGUMENTS

The Challenged Claims are unpatentable in view of the references cited for each ground below.

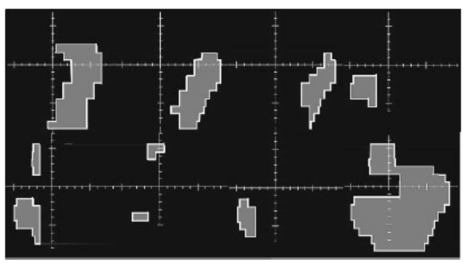
IX. GROUND #1: CHANG 2000 IN VIEW OF CHANG 2001, IN FURTHER VIEW OF BOYER 2001

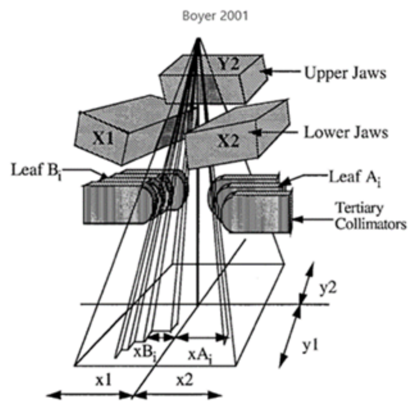
A. Claim 1. "A computer-implemented method of determining a collimator angle of a multi-leaf collimator having an opening and a plurality of multi-leaf collimator leaf pairs for closing portions of the opening to form a radiation beam arrangement having a plurality of radiation beam segments to apply radiation to a tumor target, the method comprising the steps of..."

Chang 2000 discloses "[a]n in-house 3D treatment planning system, PLanUNC (PLUNC) . . . was used for the study . . . . Pencil beams of different intensities are used to assemble the intensity modulation of a field. . . ." Ex. 1007 at 949 ¶¶3-6. "To deliver the IM [intensity modulation] fields via the MLC technique, each of the original IM maps . . . was converted into the corresponding ''skyscraper''-like discrete map. . . . The discrete IM maps were then input to a stand-alone MLC sequence optimization software system IMFAST . . . . , which generated an optimal sequence of MLC segments . . . ." Ex. 1007 at 952 ¶5 to 953 ¶1.

Chang 2001 discloses "[t]he continuous intensity maps produced by the in-house TPS PlanUNC . . . are used for the MLC segmentation." Ex. 1009 at Materials and Methods. "The MLC segments are generated iteratively based on the residual intensity map to be delivered….” *Id*. Chang 2001 further discloses, “[t]he preferable collimator angle…is chosen…” *Id*.

Figure 7 of Chang 2000 (reproduced below) shows MLC segments openings and Figure 2 of Boyer 2001 (reproduced below) shows leaf pairs. Ex. 1007 at Fig. 7; Ex. 1009. at Fig. 2.





See also Ex. 1003 at ¶¶293-296.

Claim 1[a]: “calculating an initial radiation beam arrangement according to a desired prescription; and”

Chang 2000 discloses, “[t]o deliver the IM [intensity modulation] fields via the MLC technique, each of the original IM maps . . . was converted into the corresponding ‘‘skyscraper’’-like discrete map. . . . The discrete IM maps were then input to a stand-alone MLC sequence optimization software system IMFAST . . . . , which generated an optimal sequence of MLC segments . . . .” Ex. 1007 at 952 ¶5 to 953 ¶1.).

Chang 2001 similarly discloses that “[t]he continuous intensity maps produced by the in-house TPS PlanUNC . . . are used for MLC segmentation. The

MLC segments are generated iteratively . . . . A base portion (slab) of the map with the optimal height is "sliced" from the map and the appropriate MLC segment field to deliver the intensity slab is calculated." Ex. 1009 at Materials and Methods. *See also* Ex. 1003 at ¶¶297-98.

Claim 1[b]: "changing the radiation beam arrangement by incorporating a first cost function to determine the collimator angle of the multi-leaf collimator,"

Chang 2000 discloses "[t]he collimator angle, or the orientation of the MLC leaves, can have significant influence on the discrepancy between the discrete 'sky-scraper' IM map . . . and its corresponding original smooth map. . . . An optimal collimator angle can minimize the field edge jaggedness; an optimal collimator angle can also reduce the difference between the discrete IM map and its original smooth map. The orientation of MLC leaves (the collimator angle) should be considered as a variable in the MLC-IM treatment delivery optimization process." Ex. 1007 at 957 ¶3.

Chang 2001 further discloses that "[t]he preferable collimator angle for the segment field is chosen based on two weighted criteria: 1) preservation of the steep gradient portion of the intensity map slice and 2) minimization of the difference between the shape of the slice and that of the MLC segment field." Ex. 1009 at Materials and Methods.

Boyer 2001 discloses this limitation. Ex. 1013 at 36 ¶2-3; *see also id.* at 40 at ¶4-5.

See also Ex. 1003 ¶¶299-301.

Claim 1[c]: "the first cost function including both a second cost function to enhance delivery efficiency by reducing a number of radiation beam segments and reducing a number of radiation beam monitor units required for delivery of the desired prescription and a third cost function to enhance conformity of the radiation beam arrangement to a target shape."

Chang 2001 discloses "present[ing] a software approach to improve the quality and efficiency of the "step & shoot" treatment delivered by the conventional MLC accelerators. . . . The preferable collimator angle for the segment field is chosen based on two weighted criteria: 1) preservation of the steep gradient portion of the intensity map slice and 2) minimization of the difference between the shape of the slice and that of the MLC segment field. The software approach is able to focus on the regions of the map that are likely to play an important role in achieving the optimization objectives." Ex. 1009, Purpose.

Delivery efficiency is defined by "number of radiation beam segments" and/or "number of radiation beam monitor units," in Chang 2000. Ex. 1007 at 949 ¶2; 955 ¶4; Fig 9; Fig 12). The "minimization of the difference" (#2 above) enhances conformity of the radiation beam to a target shape. The other term (#1 above) may enhance delivery efficiency, consistent with the stated goal to "improve the quality and efficiency. Ex. 1009, Purpose.

See also Ex. 1003¶¶302-04.

The combination of Chang 2000, Chang 2001 and Boyer 2001 renders claim 1 obvious.

B. Claim 10. "A method of determining a collimator angle of a multi-leaf collimator having an opening and a plurality of multi-leaf collimator leaf pairs for closing portions of the opening to form a radiation beam arrangement having a plurality of radiation beam segments to apply radiation to a tumor target, the method comprising the steps of:"

The preamble of claim 10 is the same as that of claim 1. Chang 2000 in combination with Chang 2001, optionally in combination with Boyer 2001 disclose this limitation.

See also Ex. 1003 at ¶308.

Claim 10[a]: "providing a cost function having a first delivery efficiency portion providing for enhanced radiation delivery efficiency and a second target conformity portion providing for enhanced target conformity;"

As noted in Section IX.A[c], Chang 2001 discloses this limitation.

Claim 10[b]: "determining a type of radiation delivery system carrying the multi-leaf collimator;"

As indicated in Boyer 2001, "the variations in design are significant" for MLC configurations, and configurations must be known. Ex. 1013 at 19, Table 2. Specifying the type of radiation delivery system is an obvious way to identify the necessary machine parameters needed for treatment planning.

Siochi 1999 discloses "optimization algorithm…for a Siemens multi-leaf collimator…" *Id.* at 672.

See also Ex. 1003 at ¶¶311-12.

Claim 10[a]: "determining a size and a shape of the target;"

In Fig. 1 (reproduced below), Chang 2000 shows "[a] sinus tumor treated with a standard three-field setup" with the outline of the MLC around the sinus tumor. Ex. 1007 at 950.

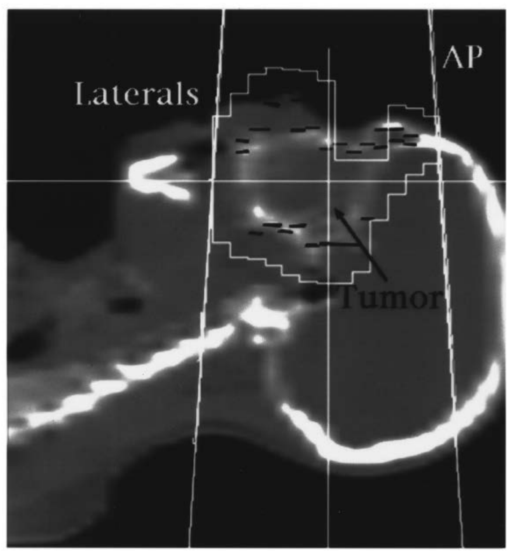


FIG. 1. A sinus tumor treated with a standard three-field setup. The globes were blocked via MLC in all three beams. The same beam setup and ports were used in all IMRT and conventional treatment techniques studied.

Boyer 2001 discloses "[g]eometric methods align each leaf with the continuous contour of the portal aperture or with the projection of the PTV (ICRU 1993) as indicated on a simulation film or DRR by a radiation oncologist. The determination of the target volume is, of course, critical to the success of the therapy. . . . The target area is defined based on the prescription image. For conventional radiation therapy, the prescription image is the simulation film and the physicians draw field prescriptions directly on films." Ex. 1013 at 36, Sec. (a).

See also Ex. 1003 at ¶313-14.

Claim 10[a]: "selecting a preference between delivery efficiency and target conformity responsive to the determination of the type of radiation delivery system and the size and the shape of the target;"

Chang 2001 discloses "[w]e present a software approach to improve the quality and efficiency of the "step & shoot" treatment . . . ." Ex. 1009 at Purpose. Chang 2000 discloses "[w]e found an [inensit moduoation] (IM) level of five to be a good compromise between irradiation time and dosimetric quality…" Ex. 1007 at 958 ¶¶2-3. In addition, this paper notes that one would have to know the "finite width of the MLC leaf," which indicates "determination of the type of radiation delivery system." *Id*. at 948 ¶3 to 949 ¶1.

Boyer 2001 discloses that the MLC configuration depends on the type of machine being using via Table 2, which provides a "summary of MLC configurations" for treatment machines by five different companies. Ex. 1013 at p. 19, Table 2.

The disclosure of Boyer 2001 together with Chang 2000, including Fig. 9 showing how the number of segments decreases with IM level, and Fig. 11 showing how the [dose volume histogram] (DVH) curves improve at higher IM level, which indicates a tradeoff between delivery efficiency and target conformity that is controlled by selection of an IM level and dependent on the type of radiation delivery system, considering the size and shape of the tumor.

See also Ex. 1003 at ¶¶315-16.

Claim 10 [e]: "determining a value for the cost function at a selected radiation beam delivery angle incorporating the selected preference; and"

Chang 2001 discloses "[t]he number of fields and the geometry of each field including its port must be defined by the user prior to dose optimization." Ex. 1007, 949, ¶3. Chang 2000 also describes "a nasopharynx tumor treated with a six-field (co-planar) setup," which indicates two beam delivery angles were used. *Id.* at 951.

Chang 2000 also describes the use of "[p]encil beams of different intensities…to assemble the intensity modulation field…The iterative process continues until every pencil beam in the IM fields has the same pencil beam-averaged target dose unless it is limited by the normal structure dose tolerance." *Id*. at 949 ¶¶3-6.

Chang 2001 and Chang 2000 showed that the geometry of the tumor is defined where at least two selected angles to deliver the radiation beam at multiple fields.

See also Ex. 1003 at ¶¶317-18.

Claim 10 [f] "responsive to the value of the cost function, determining the collimator angle."

As noted in Section IX.A[b], Chang 2000, Chang 2001, and Boyer 2001 disclose this limitation.

See also Ex. 1003 at ¶319-21.

C. Claim 11. "A method as defined in claim 10, wherein…"

As discussed in Section IX.B, Chang 2000 in combination with Chang 2001, optionally in view of Boyer 2001 disclose all the limitations of claim 10.

See also Ex. 1003 at ¶322.

Claim 11[a]: "the step of selecting a preference includes the step of assigning separate weight values to the first delivery efficiency portion of the cost function and to the second target conformity portion of the cost function."

As discussed in Section IX.B[d], Chang 2001, Chang 2000 and Boyer 2001 disclose this limitation.

See also Ex. 1003 at ¶¶323-25.

The combination of Chang 2000, Chang 2001 and Boyer 2001 render claim 11 obvious.

D. Claim 17. "An apparatus for use in conformal radiation therapy of a target tumor, the apparatus comprising:"

Chang 2000 discloses that "[t]here are several different techniques available for routine clinical treatment delivery of intensity modulation radiation therapy (IMRT) designed by dose optimization algorithms. . . . Multileaf collimator (MLC) techniques utilize a built-in or added-on functionality of modern medical accelerators . . . . The MLC techniques deliver an intensity modulated photon field by either moving the collimator leaves during irradiation or by irradiating a sequence of static MLC ports." Ex. 1007 at 948 ¶1. The modern medical accelerator with an MLC is used to deliver an intensity modulated photon field is equivalent to the apparatus of claim 17. Ex. 1003 at ¶318.

See also Id. at ¶334.

Claim 17[a]: " a multi-leaf collimator having a plurality of selectable discrete collimator angles, an opening to pass a radiation beam and a plurality of multi-leaf collimator leaf pairs to close portions of the opening to form a radiation beam arrangement having a plurality of radiation beam segments;"

As discussed in Section IX.A[preamble], Chang 2001, Chang 2000 and Boyer 2001 disclose this limitation.

See also Ex. 1003 at ¶¶335-37.

Claim 17[b]: "and a computer in communication with the multi-leaf collimator to form the radiation beam arrangement incorporating a cost function to determine a collimator angle of the multi-leaf collimator to thereby enhance the radiation beam arrangement,"

Boyer 2001 discloses that "when MLC field-shape files are saved and retrieved from an information management system…computer-controlled MLCs can be used…The accelerator manufacturers are offering networking systems to integrate the planning, delivery, verification, and record keeping…" Ex. 1013 at p. 44 ¶¶3-4. Ex. 1003 at ¶338.

Chang 2000 discloses that "[t]he collimator angle, or the orientation of the MLC leaves, can have significant influence on the discrepancy between the discrete 'sky-scraper' IM map created for (and delivered by) the MLC technique and its corresponding original smooth map. . . . An optimal collimator angle can minimize the field edge jaggedness; an optimal collimator angle can also reduce the difference between the discrete IM map and its original smooth map. The orientation of MLC leaves (the collimator angle) should be considered as a variable in the MLC-IM treatment delivery optimization process." Ex. 1007 at 957 ¶3.

Chang 2001 discloses that "[t]he preferable collimator angle for the segment field is chosen based on two weighted criteria: 1) preservation of the steep gradient portion of the intensity map slice and 2) minimization of the difference between the shape of the slice and that of the MLC segment field. … Once the segment field is determined the intensity map it delivers is calculated using the PlanUNC TPS photon source model."). Ex. 1009 at Materials and Methods.

Boyer 2001 discloses this limitation.

See also Ex. 1003 at ¶339-41.

Claim 17[c]: "the cost function including both parameters to enhance conformity of the radiation beam arrangement to a shape of the target, and parameters to enhance delivery efficiency by reducing a number of segments and reducing a number of monitor units required for delivery of a desired radiation prescription."

As noted in Section IX.A[c], Chang 2001 and Chang 2000 discloses this limitation. Siochi 1999 discloses that the function used in calculating delivery time as part of treatment time optimization includes a variable M_i that "is the number of monitor units for the ith segment." Ex 1011 at 673 ¶ 1. In addition, because "[t]he relative beam-on coefficients are directly proportional to the number of monitor units to be delivered," minimizing treatment time may include minimization of the number of monitor units. *Id.* at 672 ¶ 4.

See also Ex. 1003 at ¶¶342-47.

The combination of Chang 2000, Chang 2001, and Boyer 2001 render claim 17 obvious.

X. GROUND #2: CHANG 2000 IN VIEW OF CHANG 2001, IN FURTHER VIEW OF SIOCHI 1999, IN FURTHER VIEW OF BOYER 2001

A. Claim 4. "A method as defined in claim 1, further comprising the step of…"

Claim 4 depends from claim 1. As discussed in Section IX.A, Chang 2000 in combination with Chang 2001, optionally in further view of Boyer 2001, discloses all the limitations of claim 1.

Claim 4[a]: "rejecting the change in the radiation beam arrangement if the change of the radiation beam arrangement significantly leads to a lesser correspondence to the desired prescription and accepting the change of the radiation beam arrangement if the change of the radiation beam arrangement both leads to more radiation delivery efficiency and does not lead to significantly less correspondence to the desired prescription."

Siochi 1999 discloses a "recently patented (14) optimization algorithm that minimizes the total delivery time . . .," where reference (14), US Patent 5,663,999, noting at 7:29-33, with reference to step 276 in Figure 6, "One example of an optimization routine is simulated annealing. Simulated annealing is a known optimization routine that is described in 'Numerical Recipes in C'". Ex. 1011 at 672. It would be known to a POSITA that simulated annealing operates by "rejecting [a] change . . . if the change . . . leads to a lesser correspondence to the desired [goal] and accepting the change . . . if the change . . . leads to [greater correspondence with the goal]," as recited in claim 4.

Boyer 2001 discloses this limitation. Ex. 1003 at ¶294.

See also Ex. 1003 at ¶¶306-07.

The combination of Chang 2000, Chang 2001, Siochi 1999 and Boyer 2001 render claim 4 obvious.

B. Claim 12. "A method as defined in claim 11, wherein…"

Claim 12 depends from claim 11. As discussed in Section IX.B and IX.C, Chang 2000 in combination with Chang 2001, and optionally in view of Boyer 2001 disclose all the limitations of claim 11.

See also Ex. 1003 at ¶326.

Claim 12[a] "wherein the first delivery efficiency portion of the cost function includes a delivery efficiency cost function that determines at each of a plurality of discrete collimator angles a weighted value of a maximum effective length for a multi-leaf collimator leaf pair of the plurality of multi-leaf collimator leaf pairs having the maximum effective length,"

Siochi1999 describes a "figure of merit" calculated for each possible segment configuration called "delivery time," and "total delivery time is the sum of the total beam on time, the total [verify & record] (V&R) overhead, and the total time for leaf travel" (equation 2 below)". Ex. 1011 at 673 ¶1.

$$\tau = \sum_{i=1}^{n} \frac{M_i}{\dot{D}} + \sum_{i=2}^{n} \mathrm{Max}\left(V_1, \frac{\mathrm{Max}\left(\left|x_i^j - x_{i-1}^j\right|\right)}{v}\right) \quad (2)$$

The maximum leaf distance is the term $Max(|x_i^j - x_{i-1}^j|)$, where x_i^j is the position of the jth leaf in the ith segment. The term $Max(|x_i^j - x_{i-1}^j|)$ takes the maximum value of the difference between positions of two leafs in different segments. *Id.* Taking the maximum leaf travel time is equivalent to determining "a weighted value of a maximum effective length for a multi-leaf collimator leaf pair of the plurality of multi-leaf collimator leaf pairs having the maximum effective length," as recited in claim 12. The distance between leaf positions and therefore leaf travel is directly related to delivery efficiency . . . , the leaf travel is minimized. Therefore by optimizing collimator angles, delivery efficiency is improved by minimizing leaf travel.

Siochi 1999 does not disclose determining this cost function "at each of a plurality of discrete collimator angles." However, it would have been obvious to a POSITA to use the "weighted value of a maximum effective length for a multi-leaf collimator leaf pair of the plurality of multi-leaf collimator leaf pairs having the maximum effective length" as recited in claim 12, to consider the efficiency of other aspects of IMRT involving the MLC, such as the determination of the collimator angle.

In addition, Boyer 2001 discloses that "[r]otation and translation of the collimator are often required for the best conformation. The best collimator angle can be set automatically by an algorithmic search through all the possible angles…" Ex. 1013 at p. 36. This discloses that optimization includes target conformity optimization at each of a plurality of discrete collimator angles.

See also Ex. 1003 at ¶¶327-30.

Claim 12[b] "and wherein the second target conformity portion of the cost function includes a target conformity cost function that determines at each of a plurality of discrete collimator angles a weighted value of an area difference between an area of the opening in the multi-leaf collimator which the multi-leaf collimator can define when approaching correspondence with the target shape in the beams eye view of the multi-leaf collimator and an area of the target shape in the same beams eye view of the multi-leaf collimator."

Chang 2001 discloses "[t]he preferable collimator angle for the segment field is chosen based on .... minimization of the difference between the shape of the slice and that of the MLC segment field." Ex. 1009, Materials and Methods.

Boyer 2001 discloses that "Rotation and translation of the collimator are often required for the best conformation. The best collimator angle can be set automatically by an algorithmic search through all the possible angles…" Ex. 1013 at p. 36. Ex. 1003 at ¶316.

Boyer 2001 discloses the "[t]hree leaf coverage strategies that have been used are illustrated in Figure 12 (reproduced below). . . . Each strategy uses the intersections of the effective field contour with the projections of the trajectories of the sides of the ith leaf." Ex. 1013 at p. 37. Figure 12 shows, through the three presented strategies, that a weighted value of an area difference between an area of the opening in the multi-leaf collimator in the beams eye view and an area of the target shape in the same beams eye view is considered for target conformity.

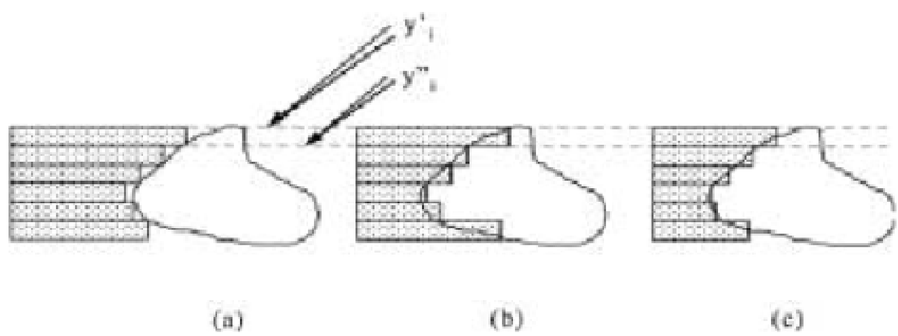


Figure 12. Illustration of three strategies for positioning MLC leaves at the nominal field boundary. (a) "out-of-field placement," (b) "in-field" placement, (c) "cross-boundary" placement.

See also Ex. 1003 at ¶¶331-33.

The combination of Chang 2000, Chang 2001 and Siochi 1999, in further view of Boyer 2001, render claim 12 obvious.

C. Claim 18. "An apparatus as defined in claim 17, wherein…"

Claim 18 depends from claim 17. As discussed in Section IX.D, Chang 2000 in view of Chang 2001, in further view of Boyer 2001, disclose all the limitations of claim 17.

See also Ex. 1003 at ¶348.

Claim 18[a]: "wherein the parameters to enhance delivery efficiency include a value of a maximum effective length for a multi-leaf collimator leaf pair of the plurality of multi-leaf collimator leaf pairs having the maximum effective length."

As discussed in Section X.B[a], Siochi 1999 discloses this limitation.

See also Ex. 1003 at ¶¶349-52.

The combination of Chang 2000, Chang 2001, and Siochi 1999, in further view of Boyer 2001, render claim 18 obvious.

D. Claim 19. "An apparatus as defined in claim 18, wherein…"

Claim 19 depends from Claim 18. As noted in Section IX.D and X.B, Chang 2000 in view of Chang 2001, in view of Siochi 1999, in further view of Boyer 2001, disclose all the limitations of claim 18.

See also Ex. 1003 at ¶353.

a. **Claim 19[a]: "wherein the parameters to enhance conformity of the radiation beam arrangement include an area difference between an area of an opening in the multi-leaf collimator which the multi-leaf collimator can define when approaching correspondence with a target shape in a beams eye view of the multi-leaf collimator and an area of the target shape in the same beams eye view of the multi-leaf collimator, a view from the perspective of the opening in the multi-leaf collimator along an axis of the radiation beam defining the beams eye view of the multi-leaf collimator"**

As discussed in Section X.B[b], Chang 2001 and Boyer 2001 disclose these limitations.

See also Ex. 1003 at ¶¶354-56.

The combination of Chang 2000, Chang 2001 and Siochi 1999, in further view of Boyer 2001, render claim 19 obvious.

XI. GROUND # 3: SIOCHI ′355 IN VIEW OF WEBB 2001, IN FURTHER VIEW OF SIOCHI 1999

A. Claim 1. "A computer-implemented method of determining a collimator angle of a multi-leaf collimator having an opening and a plurality of multi-leaf collimator leaf pairs for closing portions of the opening to form a radiation beam arrangement having a plurality of radiation beam segments to apply radiation to a tumor target, the method comprising the steps of…"

Siochi '355 discloses "a beam shielding device, such as a . . . collimator, is typically provided . . . ." Ex. 1015 at 1:23-27. "The collimator is a beam shielding device which may include multiple leaves . . . typically arranged as opposing leaf pairs. . . . The beam shielding device defines a field on the zone of the patient for which a prescribed amount of radiation is to be delivered." *Id.* at 1:29-37. "The radiation emitting device is programmed to deliver the specific treatment prescribed by the oncologist." *Id.* at 1:52-53.

Siochi '355 discloses "[t]he radiation emitting device is programmed to deliver the specific treatment prescribed by the oncologist. . . . ." *Id.* at 1:52-58. "The leaves of the multi-leaf collimator . . . are positioned to define a first treatment field…delivering radiation to the first treatment field and rotating the multi-leaf collimator about a central axis …to define a second treatment field and radiation is delivered to the second treatment field." *Id*. at 1:58-65. "The collimator is . . . rotated about central axis R to its optimum . . . position." *Id.* at 10:51-53. "Software products such as Beamshaper may be used to determine the optimum collimator orientation, as is well known by those skilled in the art." *Id.* at 6:16-19.

See also Ex. 1003 at ¶¶358-59.

Claim 1[a]: "calculating an initial radiation beam arrangement according to a desired prescription; and"

Siochi '355 discloses "[t]he radiation emitting device is programmed to deliver the specific treatment prescribed by the oncologist." *Id.* at 1:52-53. "The outputs of the optimization engines are intensity maps. . . ." *Id.* at 2:1-2. "The intensity map is decomposed to define two orthogonal maps, ..." *Id.* at 9:52-55. (See Figures 5 and 6 below).

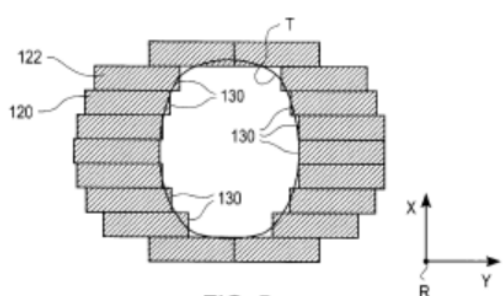


FIG. 5

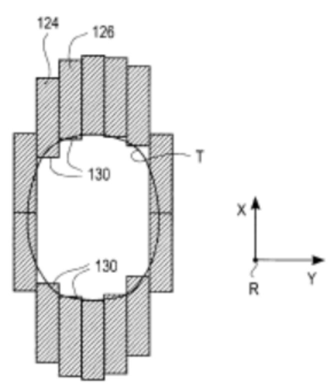


FIG. 6

Siochi '355 further discloses that "the accumulated dosage at each cell, . . . should correspond to the prescription as closely as possible." *Id.* at 2:7-11. A prescription is "a particular volume and level of radiation permitted to be delivered to that volume." *Id.* at 1:48-49. In Figure 11 from Siochi '355 (below), "T" represents "tumor" or "target," and "1" identifies radiation. *Id.* at 8:46-49; 8:58-62.

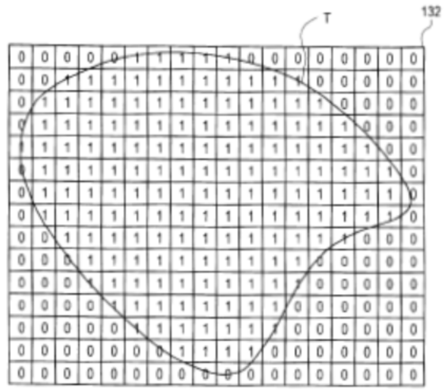


FIG. 11

See also Ex. 1003 at ¶¶360-61.

Claim 1[b]: "changing the radiation beam arrangement by incorporating a first cost function to determine the collimator angle of the multi-leaf collimator,"

Siochi '355 discloses that "[s]everal decompositions of an intensity map are possible to create the two orthogonal maps. An optimization method . . . may be used to find a decomposition which yields the shortest treatment delivery time to minimize overall treatment time and increase the life of the radiation treatment device, for example." Ex. 1015 at 10:19-27. "Methods for making the treatment volume correspond more closely with a tumor include . . . using a multi-leaf collimator to create an irregularly shaped field corresponding generally to the shape of the tumor." *Id.* at 2:12-18. "Software products such as Beamshaper may be used to determine the optimum collimator orientation, as is well known by those skilled in the art." *Id.* at 6:16-19.

To the extent Siochi ’355 does not disclose “changing the radiation beam arrangement by incorporating a first cost function to determine the collimator angle of the multi-leaf collimator,” this would have been known to one of skill in the art, as methods for optimization of radiation therapy treatment plans using a cost function have been known since at least 1990.

See also Ex. 1003 at ¶¶362-63.

Claim 1[c]: “the first cost function including both a second cost function to enhance delivery efficiency by reducing a number of radiation beam segments and reducing a number of radiation beam monitor units required for delivery of the desired prescription and a third cost function to enhance conformity of the radiation beam arrangement to a target shape.”

Siochi ’355 states “resolution at the border of the target area can be increased by applying the radiation in two different collimator orientations.” Ex. 1015 at 6:42-45.

Siochi ’355 discloses that “[a]n optimization method such as described in U.S. patent application Ser. No. 09/457,602, now U.S. Pat. No. 6,314,159 . . . may be used to find a decomposition which yields the shortest treatment delivery time to minimize overall treatment time.” *Id.* at 10:21-26.) A POSITA would know of particular cost functions that could be used to enhance delivery efficiency, including by reducing a number of radiation beam segments and reducing a number of radiation beam monitor units required for delivery of the desired prescription.

Also, it would have been obvious to one of skill in the art to combine the second cost function to enhance delivery efficiency (as noted) and the third cost function to enhance conformity (as noted) into a single objective function, for example, in view of Webb 2001. Ex. 1016 at N189. (Webb 2001 discloses "a hybrid cost function χ" that "combines features from dose-space and . . . beam-space.") By minimizing this hybrid function, one would consider both dosimetric and delivery aspects of radiation treatment, as disclosed in Siochi '355, and provide the advantages of controlling the trade-off as described in Webb 2001.

Siochi 1999 discloses "a cost function" and an optimization algorithm that "determines the best segmentation possible for delivering an intensity map." Ex. 1011 at 679, para. 5. "Different sets of segments will also have different total beam on times and different amounts of leaf travel… [and in minimizing total treatment time], minimizing the number of segments may produce the minimum treatment time." *Id.* at 671, ¶3 - 672, ¶1. Siochi 1999 discloses that the function that is used in calculating delivery time, as part of treatment time optimization includes the variable M_i that "is the number of monitor units for the ith segment." *Id.* at 673 ¶1. In addition, "[t]he relative beam-on coefficients are directly proportional to the number of monitor units to be delivered." *Id.* at 672, ¶4. Thus, minimization of treatment time may include minimization of a number of monitor units.).

See also Ex. 1003 at ¶¶364-67.

The combination of Siochi ’355 in view of Webb 2001 and Siochi 1999 renders claim 1 obvious.

B. Claim 4. “A method as defined in claim 1, further comprising the step of…”

Claim 4 depends from claim 1. As discussed in Section XI.A, Siochi ’355 2000 and Siochi 1999 disclose all the limitations of claim 1.

See also Ex. 1003 at ¶368.

Claim 4[a]: “rejecting the change in the radiation beam arrangement if the change of the radiation beam arrangement significantly leads to a lesser correspondence to the desired prescription and accepting the change of the radiation beam arrangement if the change of the radiation beam arrangement both leads to more radiation delivery efficiency and does not lead to significantly less correspondence to the desired prescription.”

As discussed in Section X.A[a], Siochi 1999 discloses this limitation.

Ex. 1029, incorporated by reference into Siochi ’355, discloses that “The parameters zi,j may be chosen by using standard optimization algorithms such as simulated annealing. . .” Ex. 1029 at 8:21-27. It would be known to a POSITA that simulated annealing operates by “rejecting [a] change . . . if the change . . . leads to a lesser correspondence to the desired [goal] and accepting the change . . . if the change . . . leads to [greater correspondence with the goal],” as recited in claim 4.

In addition, this limitation would have been known to one of skill in the art, as methods for optimization of radiation therapy treatment plans using a cost function and stochastic methods of optimization have been known since at least 1990.

See also Ex. 1003 at ¶¶369-71.

The combination of Siochi ’355 in view of Webb 2001 and Siochi 1999 renders claim 4 obvious.

C. Claim 10. “A method of determining a collimator angle of a multi-leaf collimator having an opening and a plurality of multi-leaf collimator leaf pairs for closing portions of the opening to form a radiation beam arrangement having a plurality of radiation beam segments to apply radiation to a tumor target, the method comprising the steps of”

As discussed in Section XI.A, Siochi ’355 2000 and Webb 2001 disclose this limitation.

See also Ex. 1003 at ¶372.

Claim 10[a]: “ providing a cost function having a first delivery efficiency portion providing for enhanced radiation delivery efficiency and a second target conformity portion providing for enhanced target conformity;”

As noted in Section XI.A[c], Siochi ’355 discloses this limitation.

See also Ex. 1003 at ¶¶373-76.

Claim 10[b]:“ determining a type of radiation delivery system carrying the multi-leaf collimator;”

A POSITA would know to “determin[e] a type of radiation delivery system carrying the multi-leaf collimator,” because it is necessary to know the MLC configurations in order to plan for and deliver treatment using one of them.

Also, as noted in Section IX.B[c], Siochi 1999 discloses this limitation.

See also Ex. 1003 at ¶¶ 377-78.

Claim 10[c]: "determining a size and a shape of the target;"

Siochi '355 discloses a 'partial plan view of a treatment area T and a portion of the leaves of the multi-leaf collimator positioned in two different orientations to define a border of the treatment area. . ." Ex. 1015 at 6:34-37; Figure 4.

See also Ex. 1003 at ¶379.

Claim 10[d]: "selecting a preference between delivery efficiency and target conformity responsive to the determination of the type of radiation delivery system and the size and the shape of the target;"

Webb 2001 discloses that Equation 2 "combines features from dose-space and…features from beam-space…The three weights…control the relative contributions to the overall cost which is to be minimized…[I]f w_3 is set to zero the iterations ignore beam-space constraints and proceed to minimize only the cost in dose-space." Ex. 1016 at N189 ¶4-N190 ¶1. In addition, the cost function described in Webb 2001 "allows the user to choose between the degree of conformality and the degree of smoothness and size of field components in the constituent beams." *Id.* at N194 ¶2. This discloses that setting values for weights in a cost function can be used to select a preference between delivery efficiency and target conformity

Webb 2001 discloses that the optimization method described "is very transportable provided a treatment-planning system manufacturer provides access to the specification of the cost function." *Id.* at N194. Thus, determining specifics of operation of a treatment planning system is important for implementing optimization.

See also Ex. 1003 at ¶¶380-82.

Claim 10[a] "determining a value for the cost function at a selected radiation beam delivery angle incorporating the selected preference; and"

Siochi '355 discloses "…the two collimator positions maybe spaced at an angular rotation other than ninety degrees, or the radiation may be applied with the collimator positioned in more than two angular orientations, without departing from the scope of the invention." *Id.* at 6:21-25. Siochi '355 further discloses that "[s]oftware products such as Beamshaper may be used to determine the optimum collimator orientation, as is well known by those skilled in the art." *Id*. at 6:16-19.

As disclosed in Webb 2001, Table 1 (reproduced below) shows values for the cost function in terms of dose space and beam space (rows labeled "Cost in dose space" and "Cost in beam space," respectively). In addition, the rows labeled "w_1," "w_2," and "w_3" show that different optimization runs utilize different combinations of values for three weights, thus incorporating a selected preference between beam-space and dose-space. Ex. 1016 at N191.

Table 1. The parameters applied during the optimization and the consequent outcomes in dose-space and beam-space for 11 separate optimizations. All symbols and the results are discussed in the text.

	9 beams equispaced at 40° intervals					5 beams equispaced at 72° intervals					
Run	4	1	8	10	9	12	13	14	15	16	17
Cost in dose space	4329	4861	5725	7029	8800	5497	6334	6656	6867	7235	8134
Cost in beam space	—	—	−7.0	−16.2	−24.2	—	—	1.1	−1.0	−1.9	−6.1
w_1	—	—	0.1	0.1	0.1	—	—	0.1	0.1	0.1	0.1
w_2	—	—	1	1	1	—	—	1	1	1	1
w_3	0	0	10	20	30	0	0	10	20	30	50
MWF included?	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
OAR_{mean}	0.285	0.312	0.418	0.493	0.560	0.365	0.402	0.435	0.453	0.475	0.523
σ_{OAR}	0.238	0.257	0.216	0.202	0.191	0.240	0.259	0.244	0.239	0.233	0.214
PTV_{mean}	0.996	0.996	0.995	0.993	0.993	0.995	0.992	0.993	0.992	0.991	0.988
σ_{PTV}	0.026	0.024	0.023	0.021	0.023	0.025	0.026	0.026	0.025	0.023	0.024
S_+	364	273	250	228	218	330	274	241	240	231	219
F_{min}	11	27	32	39	46	7	19	23	25	25	28
V_{80}	0.067	0.076	0.087	0.115	0.132	0.078	0.102	0.121	0.123	0.128	0.147
V_{70}	0.094	0.110	0.125	0.179	0.216	0.126	0.149	0.165	0.176	0.189	0.232
V_{60}	0.124	0.149	0.182	0.242	0.313	0.178	0.215	0.237	0.247	0.261	0.294

See also Ex. 1003 at ¶383.

Claim 10[f] "responsive to the value of the cost function, determining the collimator angle"

Siochi '355 discloses an optimization algorithm to determine an intensity matrix decomposition that yields the "shortest treatment delivery time to minimize overall treatment time." Ex. 1015 at 10:21-27 (incorporating by reference Ex. 1029). Then "[e]ach matrix is decomposed into orthogonal matrices [and]… [t]he collimator is then rotated about central axis R to its optimum zero degree offset position." *Id.* at 10:50-52. "Software products such as Beamshaper may be used to determine the optimum collimator orientation, as is well known by those skilled in the art." *Id.* at 6:16-19.

The collimator angle is determined as "known by those skilled in the art," e.g. using Brahme's orientation theory, as explained by Webb 1993, as part of the optimization using a delivery efficiency cost function, and the determination is therefore "responsive to the value of the cost function."

See also Ex. 1003 at ¶¶384-85.

The combination of Siochi ’355 in view of Webb 2001 and Siochi 1999 renders claim 10 obvious.

D. Claim 11. “A method as defined in claim 10, wherein…”

Claim 11 depends from claim 1. As discussed in Section XI.C, Siochi ’355 2000 and Webb 2001 and Siochi 1999 disclose all the limitations of claim 10.

See also Ex. 1003 at ¶386.

Claim 11[a]: “wherein the step of selecting a preference includes the step of assigning separate weight values to the first delivery efficiency portion of the cost function and to the second target conformity portion of the cost function.”

As noted in Section XI.C[d], Webb 2001 discloses this limitation.

See also Ex. 1003 at ¶¶387-88.

The combination of Siochi ’355 in view of Webb 2001 and Siochi 1999 renders claim 11 obvious.

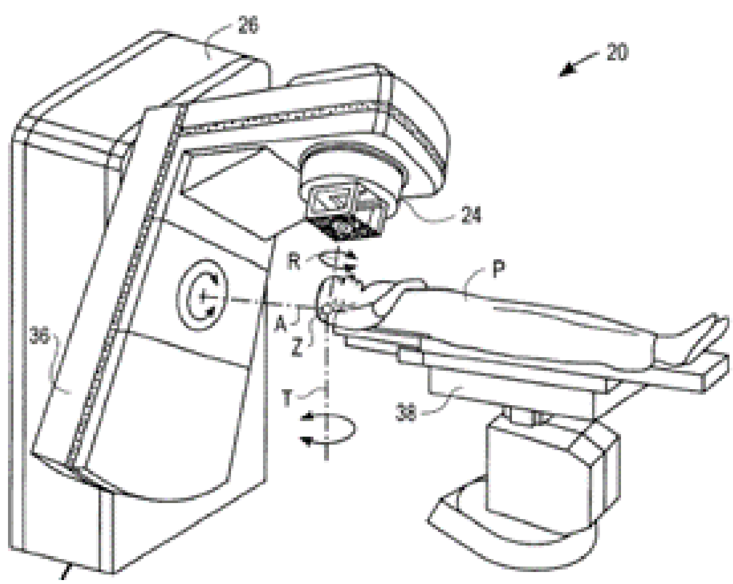
E. Claim 17. “An apparatus for use in conformal radiation therapy of a target tumor, the apparatus comprising…”

To the extent that the preamble is limiting, Siochi ’355 discloses, “[t]he radiation emitting device is programmed to deliver the specific treatment prescribed by the oncologist. When programming the device for treatment, the therapist has to take into account the actual radiation output and has to adjust the dose delivery based on the plate arrangement opening to achieve the prescribed radiation treatment at the desired depth in the target.” *Id.* at 1:52-58.

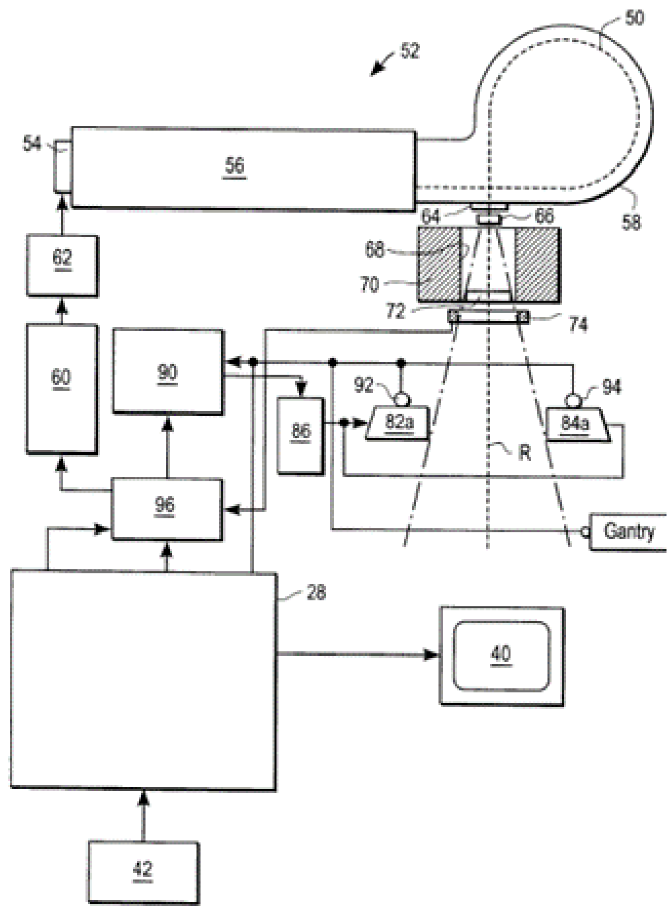
See also Ex. 1003 at ¶394.

Claim 17[a]: “a multi-leaf collimator having a plurality of selectable discrete collimator angles, an opening to pass a radiation beam, and a plurality of multi-leaf collimator leaf pairs to close portions of the opening to form a radiation beam arrangement having a plurality of radiation beam segments; and,”

Siochi ’355 describes “a multi-leaf collimator operable to rotate about axis R of the radiation beam, . . . (FIG. 1).” *Id.* at 5:66-6:3. In Fig. 1 of Siochi ’355 (reproduced below), element “A” illustrates a rotational axis of gantry 36 and element “R” illustrates a radiation beam axis. Ex. 1015 at 4:32-36.



“The multi-leaf collimator includes two opposing arrays of side-by-side elongated radiation blocking collimator leaves.” *Id.* at 2:18-20. “Each leaf can be moved longitudinally towards or away from the central axis of the beam, thus defining a desired shape through which the radiation beam will pass." *Id.* at 2:20-23. "[T]he beam 50 passes through a passage way 68…," also as shown in Fig. 2 (reproduced below). *Id.* at 5:7-13 and Fig. 2.



See also Ex. 1003 at 395-97.¶¶

Claim 17[b]:"a computer in communication with the multi-leaf collimator to form the radiation beam arrangement incorporating a cost function to determine a collimator angle of the multi-leaf collimator to thereby enhance the radiation beam arrangement,"

Siochi '355 discloses a "treatment processing unit 30 is used to input information, such as radiation intensity and location of treatment, into the radiation treatment device 20…" Ex. 1015 at 4:39-42. Fig. 1 (reproduced above) shows the processing unit 30, which is the computer, in communication with the radiation treatment device 20, which is the multi-leaf collimator.

Siochi '355 discloses that "[s]everal decompositions of an intensity map are possible to create the two orthogonal maps. An optimization method . . . may be used to find a decomposition which yields the shortest treatment delivery time to minimize overall treatment time and increase the life of the radiation treatment device, for example." *Id.* at 10:19-27. "Methods for making the treatment volume correspond more closely with a tumor include . . . using a multi-leaf collimator to create an irregularly shaped field corresponding generally to the shape of the tumor." *Id.* at 2:12-18. Siochi '355 discloses that "[s]oftware products such as Beamshaper may be used to determine the optimum collimator orientation, as is well known by those skilled in the art." *Id.* at 6:16-19.

See also Ex. 1003 at ¶¶398-400.

Claim [17c]: "the cost function including both parameters to enhance conformity of the radiation beam arrangement to a shape of the target, and parameters to enhance delivery efficiency by reducing a number of segments and reducing a number of monitor units required for delivery of a desired radiation prescription."

Fig. 5.17 of Webb 1993 (reproduced below) shows "the fitting of a planar target area with a multileaf collimator. The dotted area is the excess region treated by the *i*th leaf. The best orientation of the leaves relative to the area is that which minimizes the sum of such dotted areas of excess." Ex. 1018 at 233, Fig. 5.17. In addition, "[t]he problem reduces to finding the optimum way of arranging the leaves so as to minimize the volume (represented by an area 'seen' in the beam's-eye-view) of normal tissue outside the target volume." *Id*. at 234 ¶4.

Siochi 1999 discloses a cost function, Equation (2), that is used to calculate and minimize delivery time (τ), which is the "sum of the total beam on time, the total [verify and record] (V&R) overhead, and the total time for leaf travel." Ex. 1011 at 673, ¶1. Siochi 1999 discloses that an optimization algorithm "determines the best segmentation possible for delivering an intensity map." *Id.* at 679, ¶5. Siochi 1999 notes that "[d]ifferent sets of segments will also have different total beam on times and different amounts of leaf travel… [and in minimizing total treatment time], minimizing the number of segments may produce the minimum treatment time;" *Id.* at 671, ¶3-672, ¶1.

A POSITA would also commonly define delivery efficiency by "number of radiation beam monitor units," and would understand that reducing this number enhances delivery efficiency. In addition, Siochi 1999 discloses that the function that is used in calculating delivery time as part of treatment time optimization includes a variable M_i that "is the number of monitor units for the ith segment." *Id.* at 673 ¶1. In addition, because "[t]he relative beam-on time coefficients are directly proportional to the number of monitor units to be delivered," minimizing treatment time may include minimization of the number of monitor units. *Id.* at 672, ¶4.

See also Ex. 1003 at ¶¶401-07.

The combination of Siochi '355 in view of Webb 2001 and Siochi 1999 renders claim 17 obvious.

F. Claim 18. "An apparatus as defined in claim 17, wherein…"

As noted in XI.E, Siochi '355 2000, Webb 2001 and Siochi 1999 disclose all of the limitations of claim 17.

See also Ex. 1003 at ¶408.

a. **Claim 18[a]: "wherein the parameters to enhance delivery efficiency include a value of a maximum effective length for a multi-leaf collimator leaf pair of the plurality of multi-leaf collimator leaf pairs having the maximum effective length."**

Claim 18 depends from claim 17. As discussed in Section X.A[a], Siochi 1999 discloses the limitation.

See also Ex. 1003 at ¶¶409-11.

The combination of Siochi '355 in view of Webb 2001 and Siochi 1999 renders claim 18 obvious.

XII. GROUND #4: SIOCHI ’355 IN VIEW OF WEBB 2001 AND SIOCHI 1999, IN FURTHER VIEW OF WEBB 1993

A. Claim 12. “A method as defined in claim 11, wherein…”

As discussed in Section XI.D, Siochi ’355 2000 in view of Webb 2001 and Siochi 1999 disclose all of the limitations of claim 11.

See also Ex. 1003 at ¶389.

Claim 12[a]: “wherein the first delivery efficiency portion of the cost function includes a delivery efficiency cost function that determines at each of a plurality of discrete collimator angles a weighted value of a maximum effective length for a multi-leaf collimator leaf pair of the plurality of multi-leaf collimator leaf pairs having the maximum effective length, and”

As discussed in Section X.B[a] with respect to Siochi 1999, Siochi 1999 discloses the limitation.

See also Ex. 1003 at ¶¶390-92.

Claim 12[b]: “wherein the second target conformity portion of the cost function includes a target conformity cost function that determines at each of a plurality of discrete collimator angles a weighted value of an area difference between an area of the opening in the multi-leaf collimator which the multi-leaf collimator can define when approaching correspondence with the target shape in the beams eye view of the multi-leaf collimator and an area of the target shape in the same beams eye view of the multi-leaf collimator.”

As shown in Webb 1993, Fig. 5.17 (reproduced below), shows “the fitting of a planar target area with a multi[-]leaf collimator. The dotted area is the excess region treated by the ith leaf. The best orientation of the leaves relative to the area is that which minimizes the sum of such dotted areas of excess.” Ex. 1018 at 233 Fig.

5.17. In addition, "[t]he problem reduces to finding the optimum way of arranging the leaves so as to minimize the volume (represented by an area 'seen' in the beam's-eye-view) of normal tissue outside the target volume.)" *Id.* at 234 ¶4. This is determining an area difference between an area of the opening of the multileaf collimator and an area of the target shape, at discrete collimator angles.

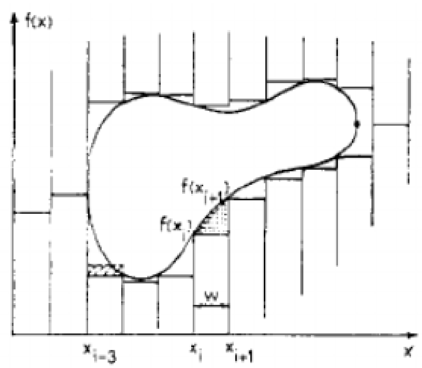


Figure 5.17. *Showing the fitting of a planar target area with a multileaf collimator. The dotted area is the excess region treated by the ith leaf. The best orientation of the leaves relative to the area is that which minimizes the sum of such dotted areas of excess. (From Brahme (1988).)*

See also Ex. 1003 at ¶393.

The combination of Siochi '355 and Webb 2001, in further view of Siochi 1999 and Webb 1993, renders claim 12 obvious.

B. Claim 19. "An apparatus as defined in claim 18, wherein…"

As discussed in Section XI.F, Siochi '355 2003 in view of Webb 2001 and Siochi 1999 disclose all of the limitations of claim 18.

See also Ex. 1003 at ¶412.

Claim 19[a]: "wherein the parameters to enhance conformity of the radiation beam arrangement include an area difference between
- **an area of an opening in the multi-leaf collimator which the multi-leaf collimator can define when approaching correspondence with a target shape in a beams eye view of the multi-leaf collimator and**
- **an area of the target shape in the same beams eye view of the multi-leaf collimator, a view from the perspective of the opening in the multi-leaf collimator along an axis of the radiation beam defining the beams eye view of the multi-leaf collimator."**

As discussed in Section XII.A[b], Webb 1993 discloses this limitation.

See also Ex. 1003 at ¶413.

The combination of Siochi '355 and Webb 2001, in further view of Siochi 1999 and Webb 1993, renders claim 19 obvious.

XIII. MOTIVATION TO COMBINE CITED REFERENCES

A. Grounds I and II

As discussed in the Boyer Decl., Chang 2000, Chang 2001, Siochi 1999 and Boyer 2001 all pertain to IMRT treatment, as well as the consideration of MLC constraints and capabilities in such treatments, as of the '490 patent's earliest effective date. Ex. 1003 at ¶267.

Chang 2000 discloses the use of in-house 3D treatment planning system, PLanUNC (PLUNC) . . . , one using an MLC to modulate intensity by movement of leaves, ... *Id.* at ¶268.

Chang 2000 discloses that Siochi 1999 (Ex. 1011) "has reported the details of the MLC sequencing optimization method used for this study." Ex. 1007. at 953.

Chang 2000 also acknowledged "Dr. Alfredo Siochi of Siemens Medical Systems for providing assistance with the IMFAST application." *Id.* at 958. Siochi 1999 confirms that intensity maps referenced in the article "were created on the PLUNC system from the University of North Carolina." Ex. 1011 at 671. Dr. Alfredo Siochi also "thank[ed]… Sha Chang, . . . of UNC" in Siochi 1999. *Id.* For at least these reasons, a POSITA would combine the teachings of Chang 2000 and Siochi 1999.

Also, Chang 2000 contemplates optimizing collimator angle in the PLUNC system used with Siochi 1999's MLC sequencing optimization method. *Id.* at 957. This is disclosed in Chang 2001. Sha X. Chang, the primary author of Chang 2000 is also the primary author of Chang 2001. Moreover, Chang 2000 acknowledges "Larry Potter [co-author of Chang 2001] for his valuable comments on the revised version [of this article]." *See* Ex. 1007 at 958. Further, Sha Chang, Larry Porter and Alfredo C. Siochi are co-authors on another article. *See* Ex. 1003 at ¶270.

In view of the similarities between the problems being addressed, the fact that the same software systems were being used, and the overlap in the researchers involved, a POSITA would have reason to combine the relevant disclosures of the above references. *See* Ex. 1003 at ¶¶267-71.

Further Chang 2000 references two articles by Arthur Boyer related to fundamental MLC techniques in its Introduction. Ex. 1007 at 948. Boyer 2001 is a report of an AAPM committee, and both Siochi and Chang had connections to

AAPM. *Id.* at 264. It also references MLC technology by Siemens. Ex. 1003 at ¶273. Accordingly, a POSITA searching for articles on Siemens MLCs and/or optimization of collimator angle, or looking for researchers through the AAPM network, would have considered Boyer 2001. For at least these reasons, a POSITA would have reason to combine Boyer 2001 with Chang 2000, Chang 2001, and/or Siochi 1999. *Id.*

A. Grounds III and IV

As also discussed in the Boyer Decl., Siochi ’355, Webb 2001, Siochi 1999, and Webb 1993 all pertain to methods of conformal radiation therapy (the first three all pertain to IMRT treatment specifically), as well as the consideration of MLC constraints and capabilities in such treatments, as of the ’490 patent’s earliest effective date. *See* Ex. 1003 ¶274.

Siochi ’355 discloses decomposition of an intensity map into segments delivered from multiple collimator angles, to improve resolution of the collimator edge, where the first angle is selected using standard conformational methods and the decomposition is optimized for shortest delivery time. *See* Ex. 1003 ¶275.

Siochi ’355 is a patent naming as its sole inventor Dr. R. Alfredo C. Siochi, and it incorporates by reference US Patent No. 5,663,999, which is a patent on the algorithm described in Siochi 1999. (Siochi ’355 at 9:10-15.) Siochi 1999 (also authored by Dr. Siochi) explains that “[i]n this paper, a recently patented (14) optimization algorithm that minimizes the total delivery time by taking all of the system parameters for a Siemens multi-leaf collimator (MLC) into account in a flexible way will be presented.” Ex. 1011 at 672. For at least these reasons, a POSITA would have reason to combine the teachings of Siochi ’355 and Siochi 1999. Siochi 1999 at 672, 680 (referencing US Patent No. 5,663,999). *See* Ex. 1003 ¶276.

Webb 2001 is directed to the general problem of controlling the trade-off between efficiency in beam-space and conformality in dose-space. Webb 2001 discloses a hybrid function that includes a beam space term and a dosimetric term. Webb 2001 also recognized that “inverse planning has started to include accounting for the... constraints imposed by the delivery apparatus.” *See Id.* at ¶277.

Thus, Webb 2001, Siochi ’355 and Siochi 1999 all contemplate the inclusion of delivery constraints in the treatment planning process, and all identify constraints based upon the time for MLC leaf movement. *See Id.* at ¶¶278-79.

For at least these reasons, a POSITA would have reason to combine Siochi ’355 and/or Siochi 1999 with Webb 2001. *See Id.* at ¶280.

XIV. SECONDARY CONSIDERATIONS OF NON-OBVIOUSNESS DO NOT NEGATE OBVIOUSNESS

Petitioner is not aware of any secondary considerations that would demonstrate non-obviousness in view of the art relied on in this Petition. Moreover, a strong showing of obviousness, as here, overcomes secondary considerations. *See*, e.g., *Leapfrog Enters, Inc*. v. *Fisher-Price, Inc*., 485 F.3d 1157, 1162 (Fed. Cir. 2007); *Dow Chemical Co.* v. *Halliburton Oil Well Cementing Co.*, 324 U.S. 320, 330 (1945) ("[Secondary] considerations are relevant only in a close case.").

Petitioner also is not aware of any nexus between any alleged commercial success and "the merits of the claimed invention." *Ohio Willow Wood Co*. v. *Alps South, LLC*, 735 F.3d 1333, 1344 (Fed. Cir. 2013); *Wyers* v. *Master Lock Co*., 616 F.3d 1231, 1246 (Fed. Cir. 2010) ("[f]or objective evidence of secondary considerations to be accorded substantial weight, its proponent must establish a nexus between the evidence and the merits of the claimed invention.").

It is Patent Owner's burden of production to provide evidence of secondary considerations. *Medtronic Inc*. v. *NuVasive Inc*., IPR2014-00087, Paper 44 at 21 (PTAB Apr. 3, 2015). Petitioner reserves the right to provide a full rebuttal to any secondary consideration evidence provided during this proceeding.

XV. SUMMARY CHARTS

A. Identification of Where Each Limitation of the Challenged Claims is Found in the Cited References

See Ex. 1003 at ¶414.

XVI. CONCLUSION

For the reasons set forth above, Elekta requests that the Board institute *IPR* of and cancel the Challenged Claims.

Dated: October 18, 2019

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CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. §42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 7,015,490 contains, as measured by the word-processing system used to prepare this paper, 13,333 words. This word count does not include the items excluded by 37 C.F.R. §42.24 as not counting towards the word limit.

Dated: October 18, 2019

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CERTIFICATE OF SERVICE

The undersigned certifies pursuant to 37 C.F.R. §42.6(e) and §42.105 that on October 18, 2019, a true and correct copy of the foregoing **PETITION FOR INTER PARTES REVIEW**, Petitioner's power of attorney, and all supporting exhibits will be served via USPS Express Mail on the Patent Owner at the following correspondence address of record as listed on PAIR:

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and was served via electronic mail upon counsel of record for the Patent Owner in the litigation pending before the U.S. District Court for the Northern District of Georgia entitled *Best Medical International, Inc., v. Elekta Inc. and Elekta Limited*, Case No. 1:19-cv-03409.

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