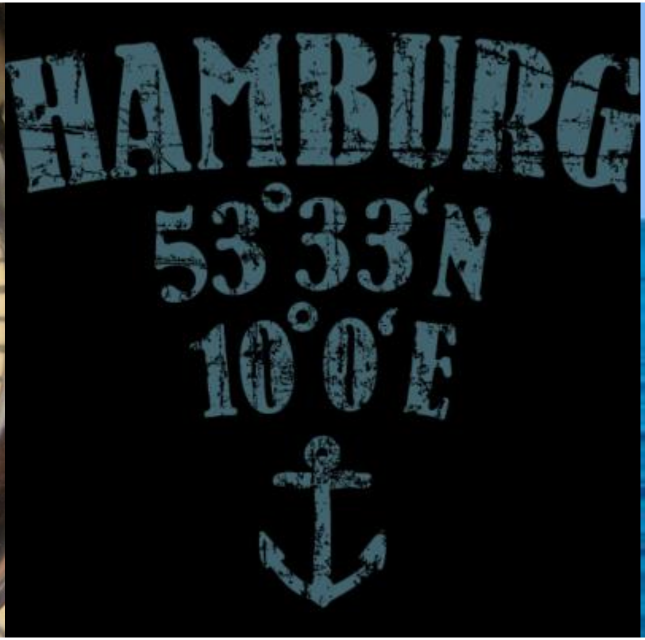


Maritimes an der Waterkant:
Neues von Dolphin & COMPASS

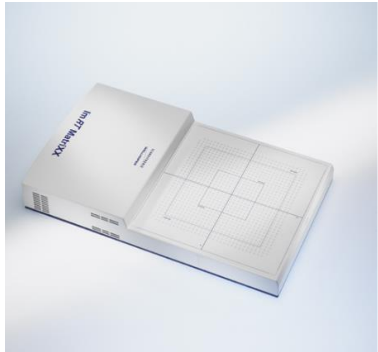
Hamburg, Mai 2018

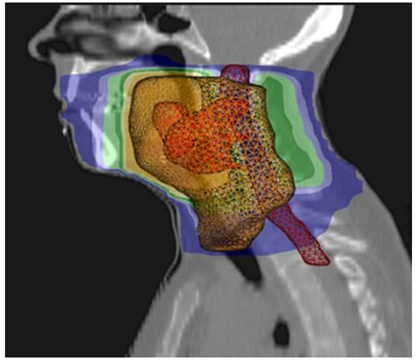
Dr. Lutz Müller |

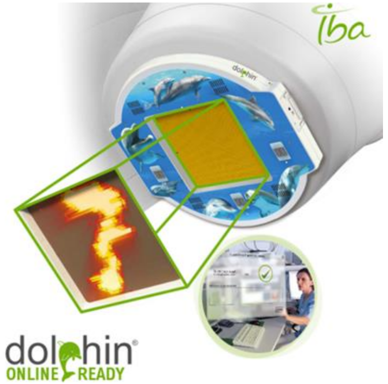
Lutz.Mueller@iba-group.com

DOSIMETRY

…a short History of Intensity Modulated Treatments







2000-2005
Studies

2005-2010
Mature
IMRT

2010-2015
Vmat

2015-2020
Hypofract.
SBR
ART

Technology	Film	Electronic Arrays	3D Dose Reconstruction	Online Ready
% Patients	<1	10	80	Close to 100

Early IMRT Adaptor from Germany

Courtesy

Th Wieczorek

Fulda 2002

…a Modern Implementation

Requirements for a State-of-the-Art Patient Plan QA System

- Efficient: easy set-up, no hybrid plan
- Precise: high error-detection capability. Avoid false positives
- Meaningful: potential consequences for the patient shall be evaluated
- Redundant: verification chain shall encompass many components
- Adaptable: customer shall be able to tailor results of verification to his needs

The solution:

Advanced online-capable detector: dolphin®

Advanced software, rendering results in 3D patient anatomy: COMPASS

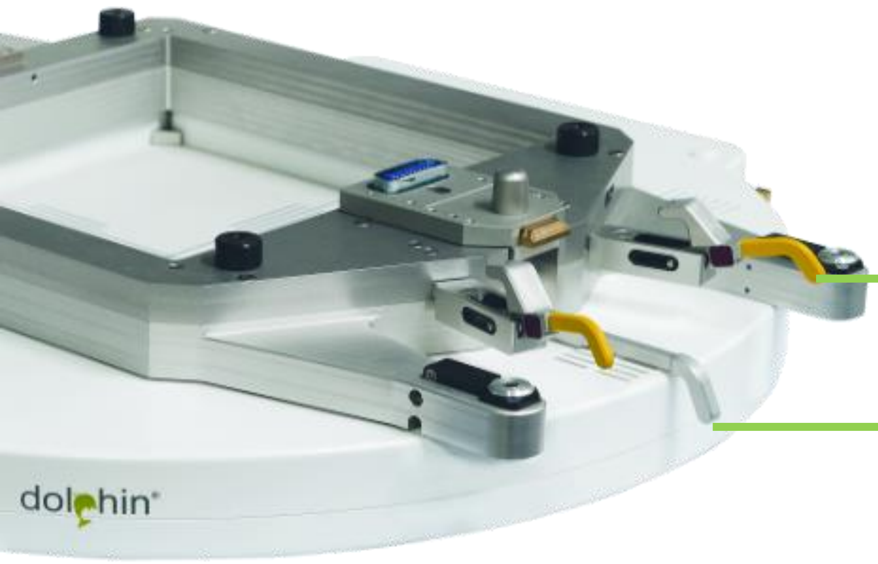
Dolphin®

Advanced Technology

dolphin® Advanced Detector Design

Slim design
- ➤ Maximum clearance
- ➤ Supports SRS / SBRT cases with non-coplanar beams
  - Independent from the couch orientation
  - Non-coplanar beams can be verified without collapsing the beam to zero

Cable-free design
- ➤ Wireless data connection
- ➤ Battery powered
- ➤ Integrated Gantry angle sensor calibrated in factory



Easy attachment
- ➤ Linac head accessory mounts supported
- ➤ Accessory coding
- ➤ Double lock for maximum security

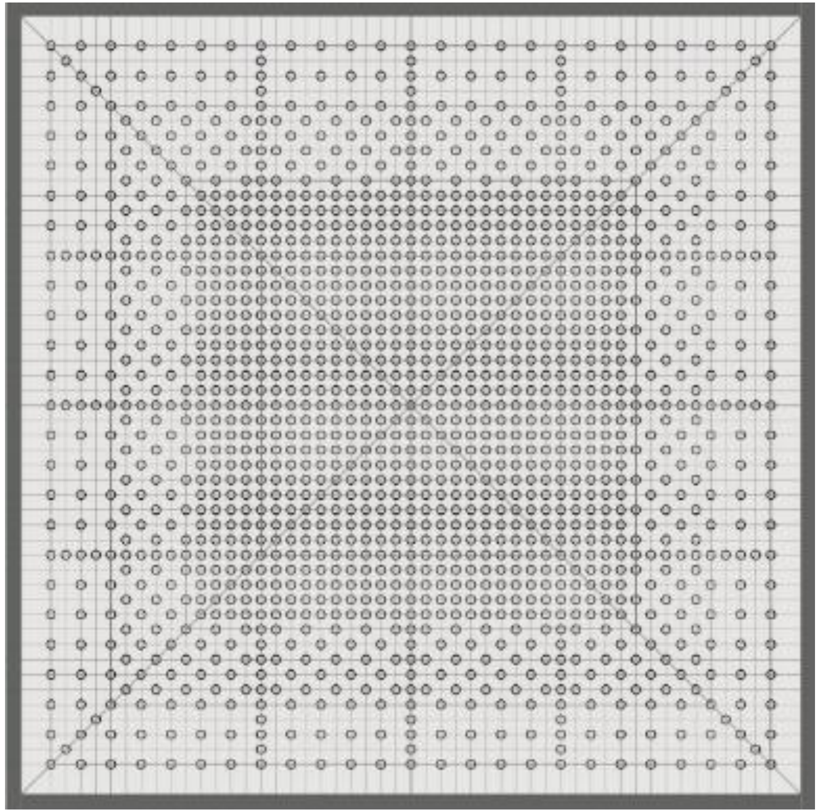
Setup: Ready in 1 Minute!

Advanced Detector Design

- 1513 air-vented plain parallel ionization chambers
- 5 mm high resolution spacing (15 x 15 cm² inner area)
- **Full 40 x 40 cm² treatment field size coverage**
- Small chamber volume
  - 3.2 mm diameter, 2 mm electrodes gap

- Device is based on the same physical principle as the MatriXX with Compass
  - It can be used for Pre-treatment QA

- Chambers and detector design with reduced attenuation
  - Once the device is attached the beam is still fully usable for patient treatment
  - The system is ready for online verification



* Dolphin is released for pre-treatment QA. Approval for online use during patient treatment is pending by Linac manufacturers.

Requirements for a State-of-the-Art Patient Plan QA System

- Efficient: easy set-up, no hybrid plan
- Precise: high error-detection capability. Avoid false positives
- Meaningful: potential consequences for the patient shall be evaluated
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- Adaptable: customer shall be able to tailor results of verification to his needs

The solution:

Advanced online-capable detector: dolphin®

Advanced software, rendering results in 3D patient anatomy: COMPASS

Limitations of Phantom-based QA

Is the 2D γ approach telling us really the truth ?

Which Criteria to be used?

- 3% δ dose in accordance with other QA procedures
- 3mm DTA is already quite high, specially for SBRT etc.
- 100% passing rate should be required, but cannot achieved in practice. 98%, 95% or even less are common choices
- γ local or global?
- Threshold for relevant field signals?

- Additional criteria?
  - No hot/cold spot cluster?
  - Correlation to critical anatomical structures

Is 2D QA really *clinically* sufficient ?

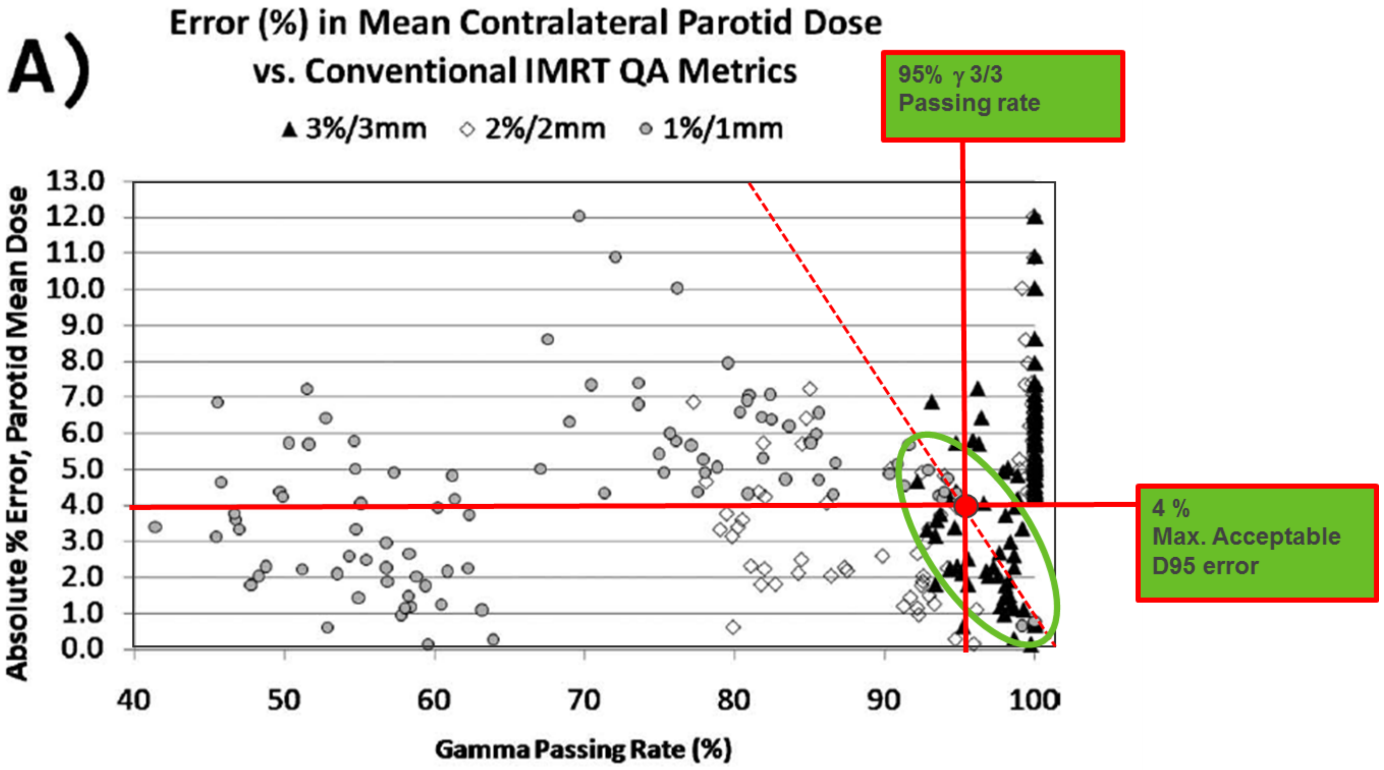
Per-beam, planar IMRT QA passing rates do not predict clinically relevant patient dose errors[a)]

Benjamin E. Nelms[b)]
Canis Lupus LLC and Department of Human Oncology, University of Wisconsin, Merrimac, Wisconsin 53561

Heming Zhen
Department of Medical Physics, University of Wisconsin, Madison, Wisconsin 53705

Wolfgang A. Tomé
Departments of Human Oncology, Medical Physics, and Biomedical Engineering, University of Wisconsin, Madison, Wisconsin 53792

Medical Physics, Vol. 38, No. 2, February 2011



Results for H&N case, 3%/3mm, N=83

ROI	Metric	Mean Error [%]	Range [%]	
			min	max
Spinal Cord	D1cc	3.2	-11.1	15.7
Contralateral Parotis	Mean Dose	4.5	-10.9	12.0
Ipsilateral Parotis	Mean Dose	1.5	-3.7	4.1
Larynx	Mean Dose	5.7	-15.9	9.2
CTV	D95	1.3	-3.7	2.6
Gamma Passing Rate : $\gamma<1$ for 95% of Pixels				

V. CONCLUSIONS

There is a lack of correlation between conventional IMRT QA performance metrics (Gamma passing rates) and dose differences in critical anatomic regions-of-interest. The most common acceptance criteria and published actions levels therefore have insufficient, or at least unproven, predictive power for per-patient IMRT QA. Moreover, the methodology of basing action levels on prior performance achievements using these conventional methods is unwarranted because meeting these criteria does not ensure that clinically acceptable dose errors.

γ method for pre-treatment QA:

Unsufficient predictive power for patient outcome

Is Gamma analysis sufficient?

3D DVH-based metric analysis *versus* per-beam planar analysis in IMRT pretreatment verification

Pablo Carrasco,[a] Núria Jornet, Artur Latorre, Teresa Eudaldo, Agustí Ruiz, and Montserrat Ribas
Servei de Radiofísica i Radioprotecció, Hospital de la Santa Creu i Sant Pau, Sant Antoni Maria Claret, 167, 08025 Barcelona, Spain

(Received 16 February 2012; revised 22 June 2012; accepted for publication 25 June 2012; published 26 July 2012)

Conclusion

V. CONCLUSIONS

None of the approaches tested to verify IMRT plans by means of gamma analysis using 3%/3 mm or 2%/2 mm criteria solve the problem of evaluating treatment plans. Neither is it clear whether global 3D gamma analysis is superior to local 3D gamma analysis.

Differences between the planned dose and the measured dose are obtained when verifying real patient plans. However, their interpretation in clinical terms based on a common gamma analysis is not straightforward and remains unclear.

All in all, a suitable alternative for evaluating and reporting the measured planar differences is to transfer their impact to the plan DVH and then to compare the resulting DVHs with the clinical tolerances of the PTV and OAR.

DVH
Needed for
Clinical
Assessment of
PTV
And
OAR

JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 15, NUMBER 5, 2014

A six-year review of more than 13,000 patient-specific IMRT QA results from 13 different treatment sites

Kiley B. Pulliam,[1] David Followill,[2] Laurence Court,[2] Lei Dong,[1,3] Michael Gillin,[2] Karl Prado,[4] and Stephen F. Kry[2a]

The University of Texas Graduate School of Biomedical Sciences at Houston,[1] Houston, TX; Department of Radiation Physics,[2] The University of Texas MD Anderson Cancer Center, Houston, TX; Department of Radiation Oncology,[3] Scripps Proton Therapy Center, San Diego, CA.,[4] University of Maryland School of Medicine, Baltimore, MD, USA

sfkry@mdanderson.org

Received 10 February, 2014; accepted 27 May, 2014

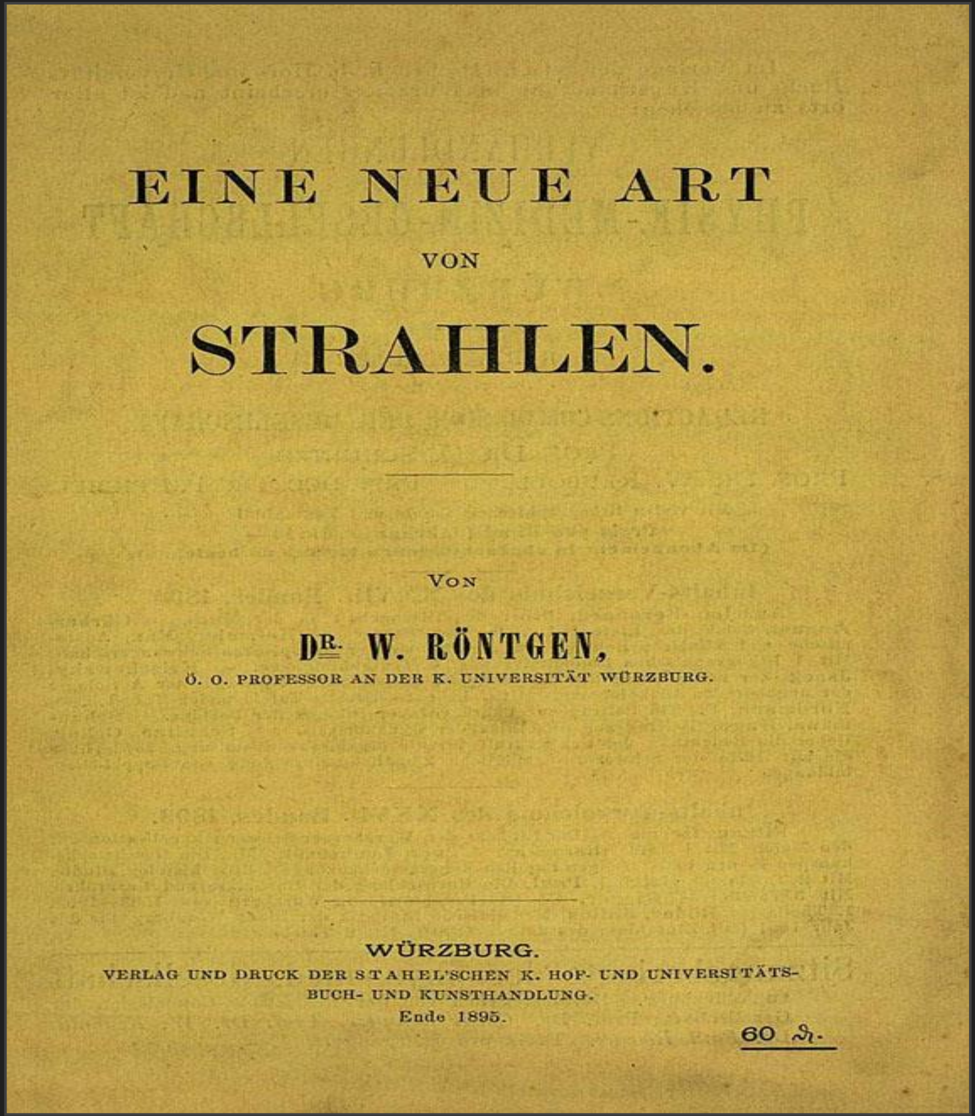
Conclusions

V. CONCLUSIONS

Our review of 13,003 patient-specific IMRT QA plans found a large difference in sensitivity to dosimetric errors between point dose and planar gamma analysis, specifically that using our gamma criteria did not result in appreciable plan error detection. Additionally, we found that, despite improvement in dosimetric agreement over time, plan failure rates remained nearly constant and at a nontrivial rate (2.3%); therefore, QA programs with no plan failures may have QA techniques and/or action levels that are not sensitive to plan errors. We also found that there were significant and substantial differences in the QA agreement between different treatment sites.

COMPASS Software

C.W. Röntgen, Würzburg 1895 (just ~100 km from IBA)



EINE NEUE ART

VON

STRAHLEN.

Von

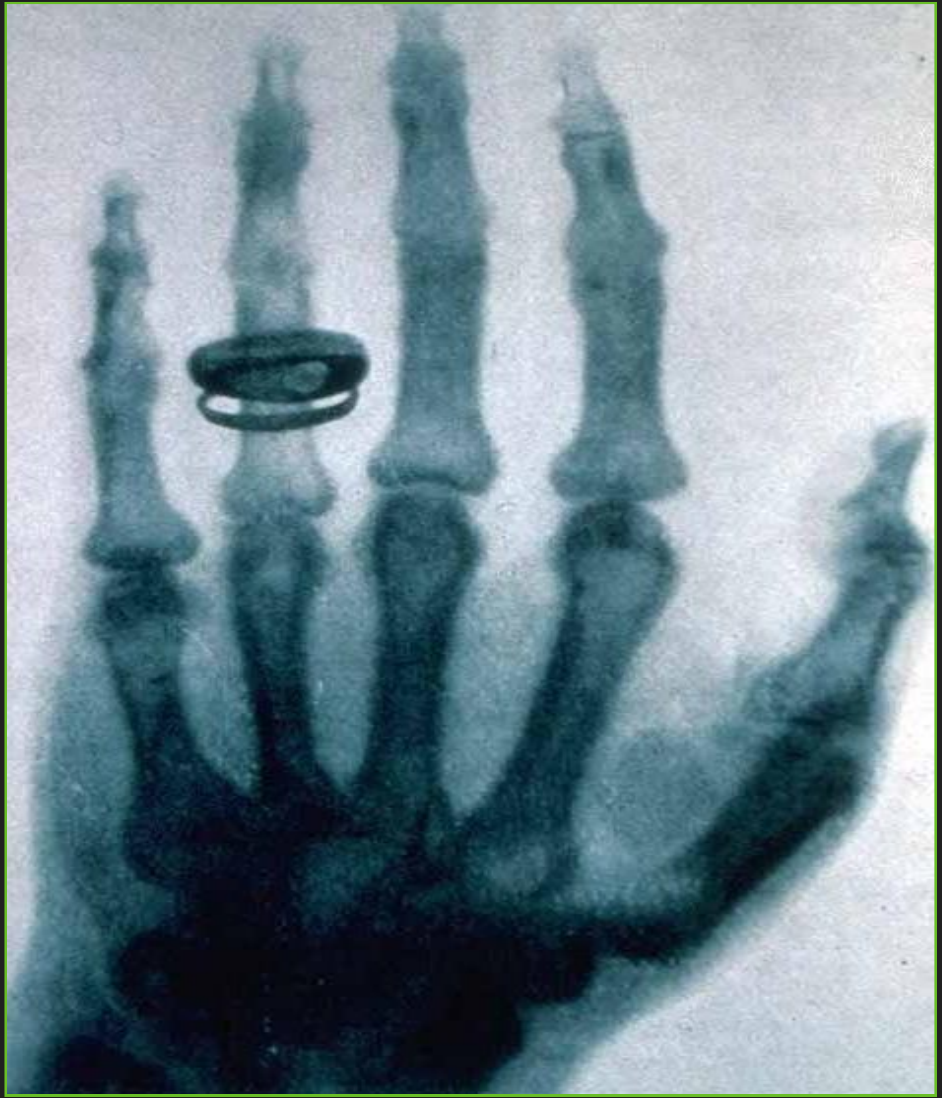
DR. W. RÖNTGEN,

Ö. O. PROFESSOR AN DER K. UNIVERSITÄT WÜRZBURG.

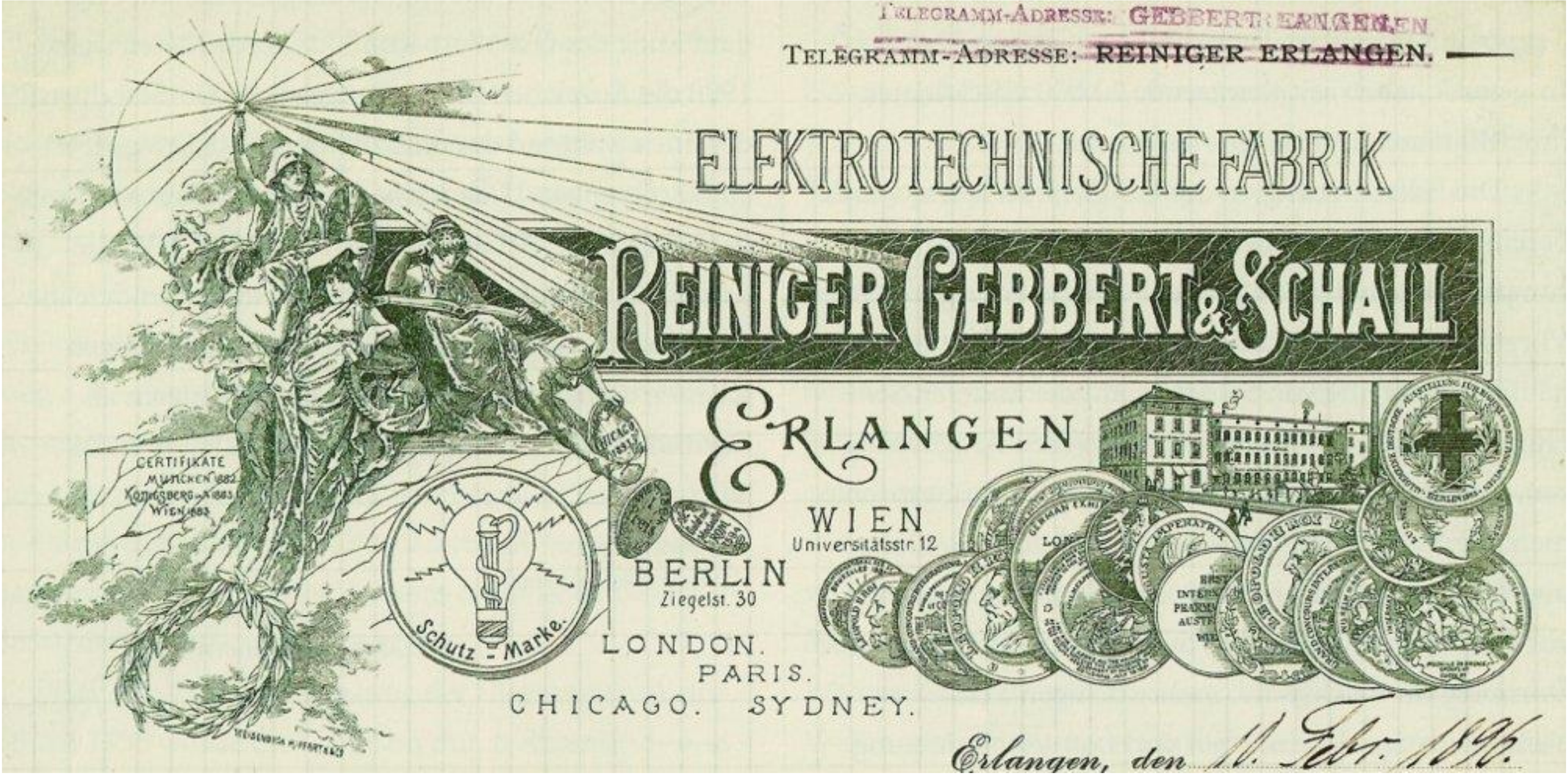
WÜRZBURG.

VERLAG UND DRUCK DER STAHEL'SCHEN K. HOF- UND UNIVERSITÄTS-
BUCH- UND KUNSTHANDLUNG.
Ende 1895.

60 ₰.

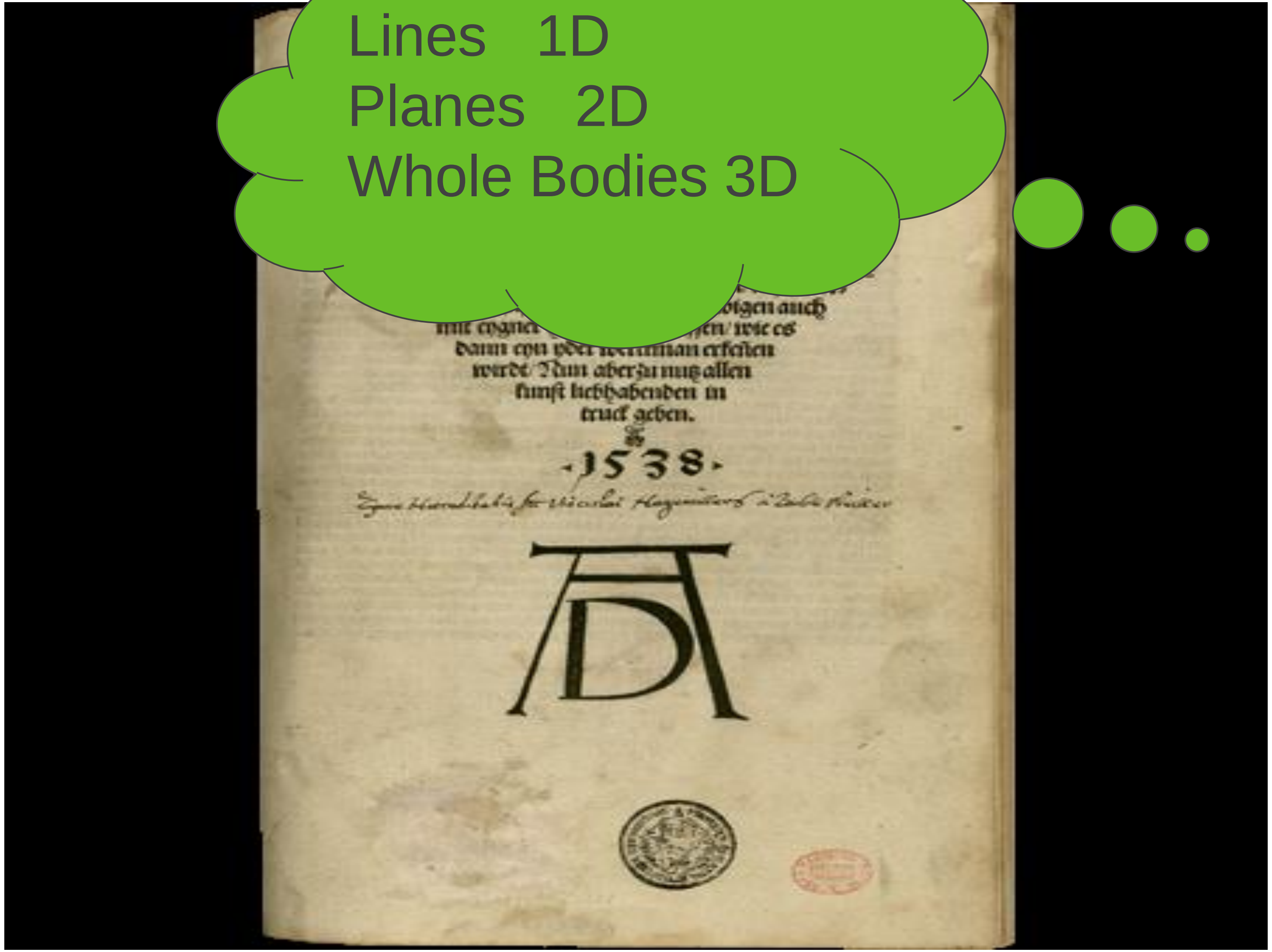


Origin of the Medical Valley
(Siemens)-Reiniger (now: Siemens Healthineers)



Historic Siemens-Reiniger x-ray tube

Welcome to Nuremberg



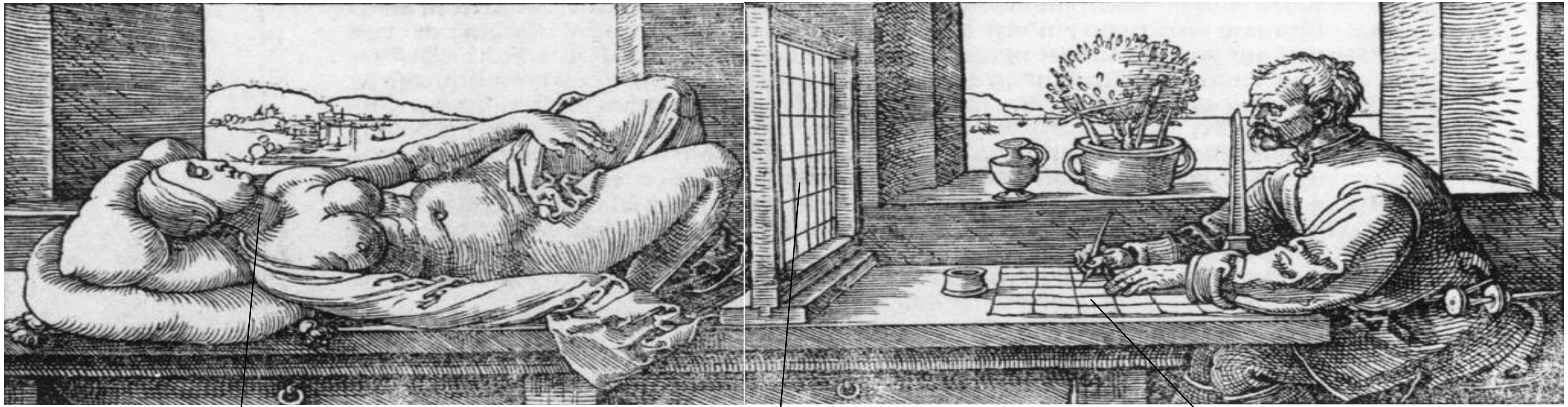
Lines 1D
Planes 2D
Whole Bodies 3D

Instructions how to measure with COMPASS and ruler lines, planes and whole bodies

Linien, Ebenen unnd gantzen corporen

durch Albrecht Dürer zů sammen getzogen / vnd zů nutz allen kunstlieb habenden mit zů gehörigen figuren / in truck gebracht / im jar. M. D. X X v.

Albrecht Dürer, wood engrave



3D Anatomy

Beamlets

2D plot

US008160204B2

(12) **United States Patent**
Müller et al.

(10) **Patent No.: US 8,160,204 B2**
(45) **Date of Patent: Apr. 17, 2012**

(54) **METHOD AND DEVICE FOR IMRT VERIFICATION**

(75) Inventors: **Lutz Müller**, Nürnberg (DE); **Caterina Brusasco**, Bossiere (BE); **Björn Hårdemark**, Stockholm (SE); **Johan Löf**, Djursholm (SE); **Anders Murman**, Uppsala (SE)

(73) Assignees: **Ion Beam Applications S.A.**, Louvain-la-Neuve (BE); **Raysearch Laboratories AB**, Stockholm (SE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 210 days.

(21) Appl. No.: **12/513,139**

(22) PCT Filed: **Oct. 31, 2007**

(86) PCT No.: **PCT/EP2007/061787**
§ 371 (c)(1),
(2), (4) Date: **Mar. 18, 2010**

(87) PCT Pub. No.: **WO2008/053026**
PCT Pub. Date: **May 8, 2008**

(65) **Prior Publication Data**
US 2010/0215147 A1 Aug. 26, 2010

(30) **Foreign Application Priority Data**
Nov. 3, 2006 (EP) 06123486

(51) **Int. Cl.**
A61N 5/10 (2006.01)

(52) **U.S. Cl.** **378/65**

(58) **Field of Classification Search** 378/65
See application file for complete search history.

(56) **References Cited**

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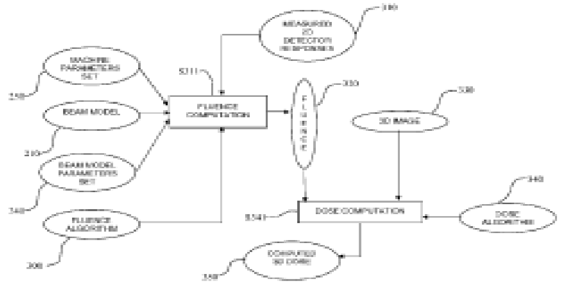
J.M. Kapatoes et al., "Delivery Verification in Sequential and Helical Tomotherapy," Physics in Medical and Biology, (1999) vol. 44, pp. 1815-1841.
J.M. Kapatoes et al., "A Feasible Method for Clinical Delivery Verification and Dose Reconstruction in Tomotherapy," Medical Physics, Apr. 2001, vol. 28, Issue 4, pp. 528-542.
J.M. Kapatoes et al., "On the Accuracy and Effectiveness of Dose Reconstruction for Tomotherapy," Physics in Medical and Biology, (2001) vol. 46, pp. 943-966.
International Search Report, International Application No. PCT/EP2007/061787; date of completion Feb. 19, 2008, 4 pages.
International Search Report, International Application No. PCT/EP2007/061836; date of completion Mar. 20, 2008, 4 pages.

Primary Examiner — Courtney Thomas
(74) *Attorney, Agent, or Firm* — Fitch, Even, Tabin & Flannery, LLP

(57) **ABSTRACT**

The present invention relates to a method and device for verification of the quality of a radiation beam in conformal radiation therapy, and in particular for IMRT (Intensity Modulated Radiation Therapy) applications.

16 Claims, 6 Drawing Sheets



特　許　証
(CERTIFICATE OF PATENT)

特許第５０８５６６０号
(PATENT NUMBER)

発明の名称
(TITLE OF THE INVENTION)
オンラインＩＭＲＴ検証の方法および装置

特許権者
(PATENTEE)
ベルギー・Ｂ－１３４８・ルヴァンーラーヌーヴ・シュマン・デュ・サイクロトロン・３
国籍　ベルギー王国
イオン・ビーム・アプリケーションズ・エス・アー

その他別紙記載

発明者
(INVENTOR)
ルッツ・ミュラー
カテリーナ・ブルサスコ
ビュルン・ホルデマルク

その他別紙記載

出願番号
(APPLICATION NUMBER)
特願２００９－５３５０８６

出願日
(FILING DATE)
平成１９年１１月　２日(November 2, 2007)

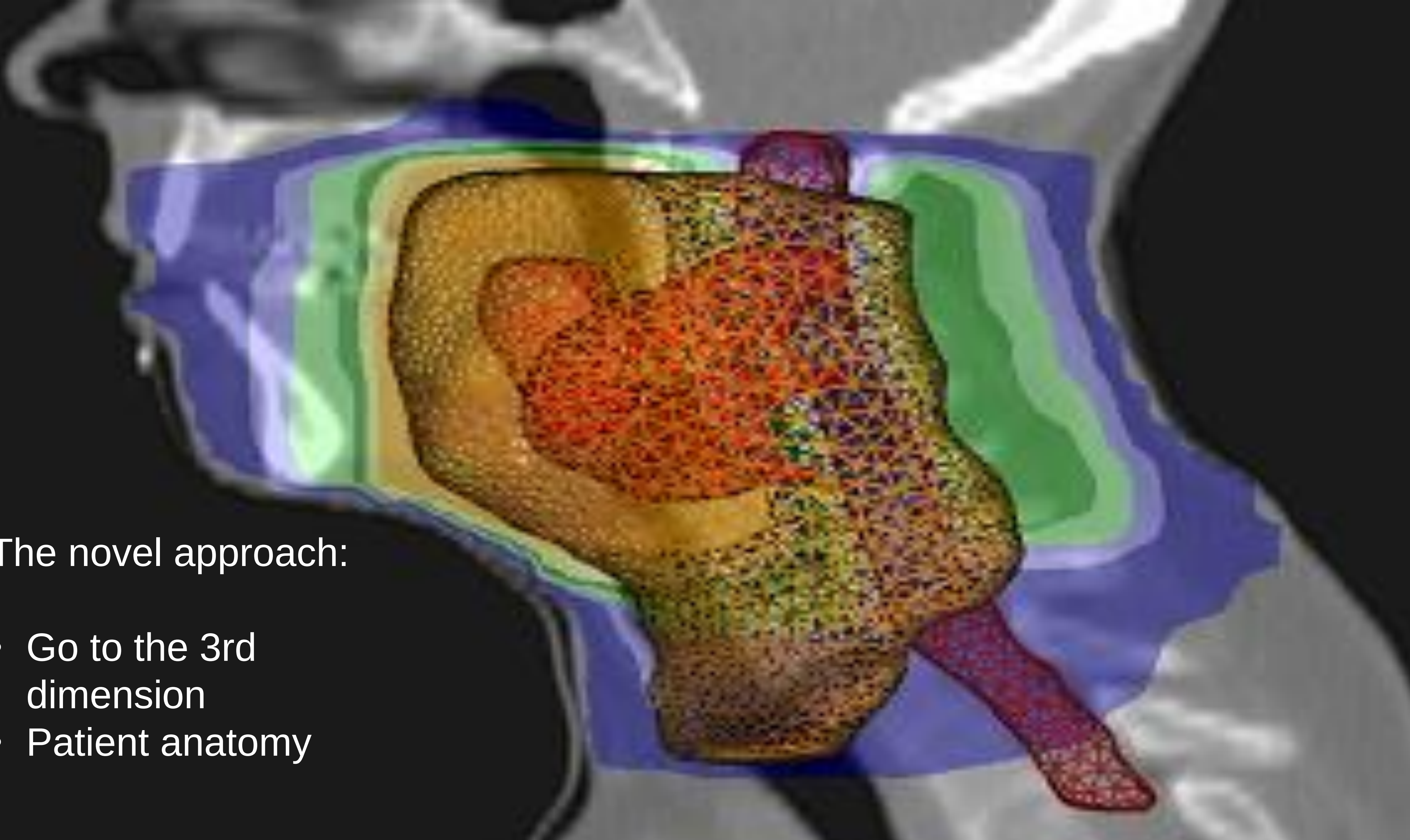
登録日
(REGISTRATION DATE)
平成２４年　９月１４日(September 14, 2012)

この発明は、特許するものと確定し、特許原簿に登録されたことを証する。
(THIS IS TO CERTIFY THAT THE PATENT IS REGISTERED ON THE REGISTER OF THE JAPAN PATENT OFFICE.)

平成２４年　９月１４日(September 14, 2012)

特許庁長官
(COMMISSIONER, JAPAN PATENT OFFICE)

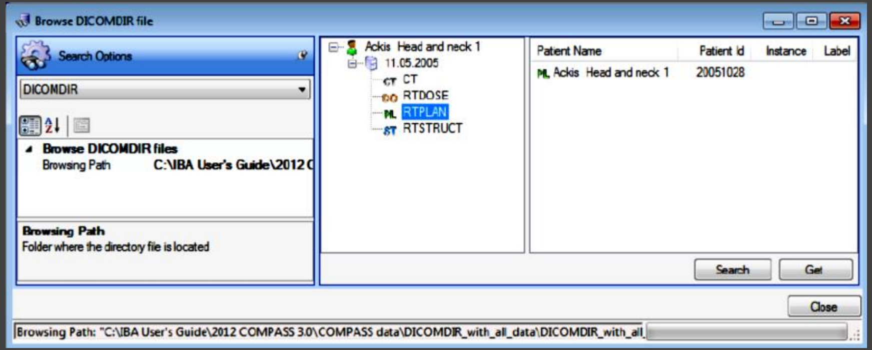
岩井良行

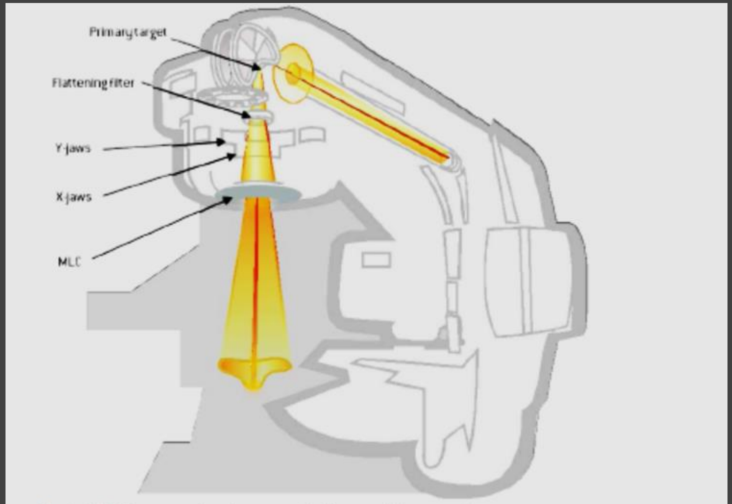


The novel approach:

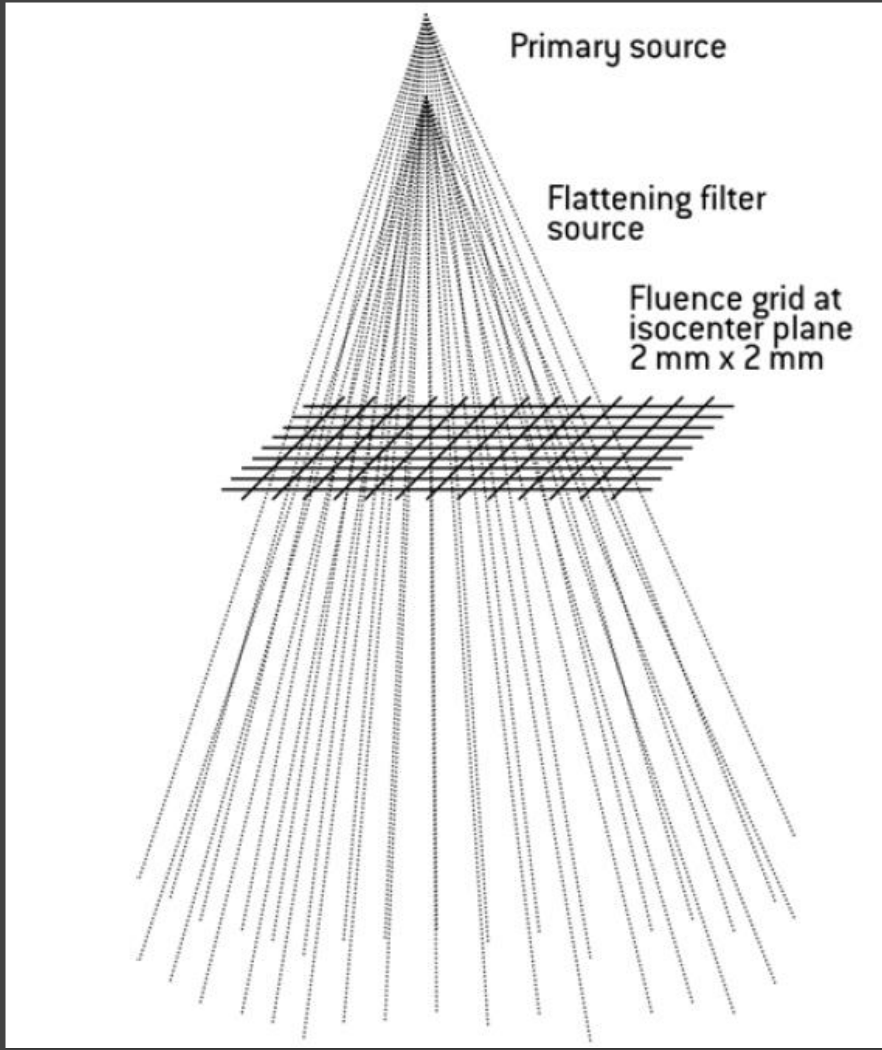
- Go to the 3rd dimension
- Patient anatomy

From Plan to (ideal) Fluence

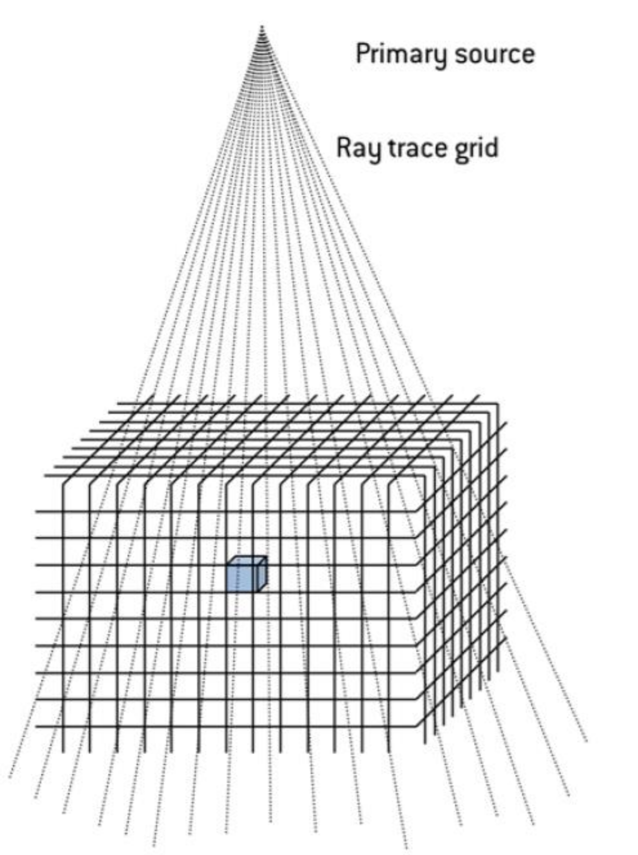


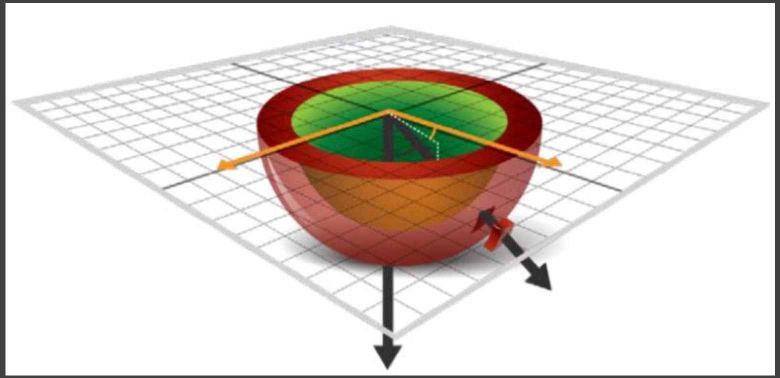


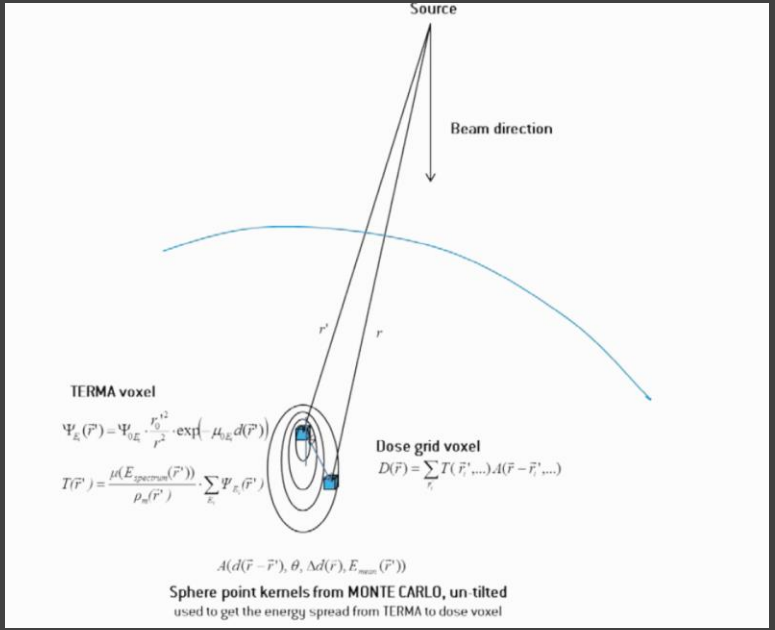
Physical LINAC components and corresponding beam model components.



Dose Computation

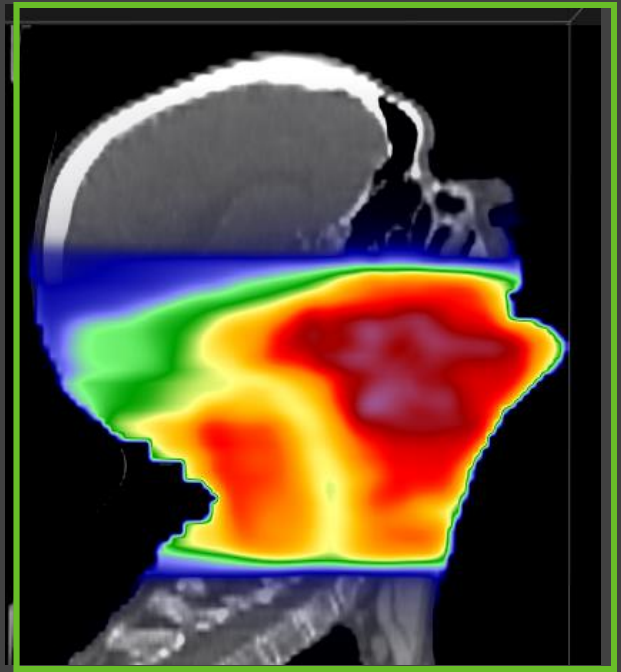


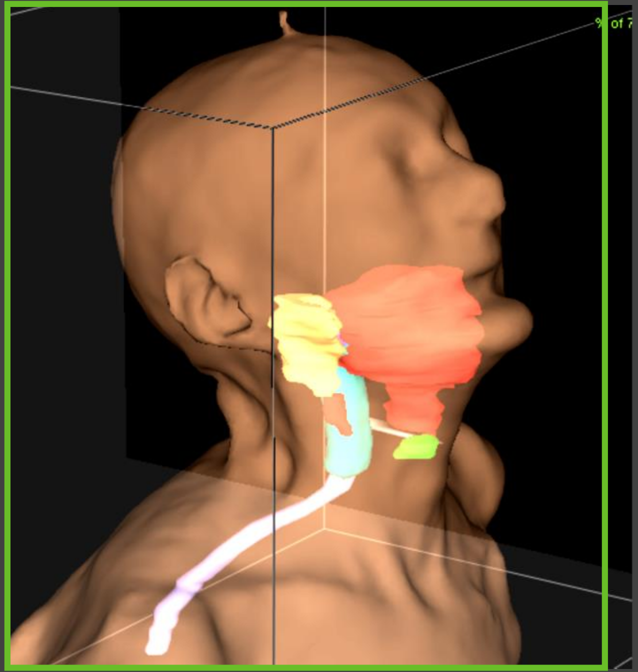


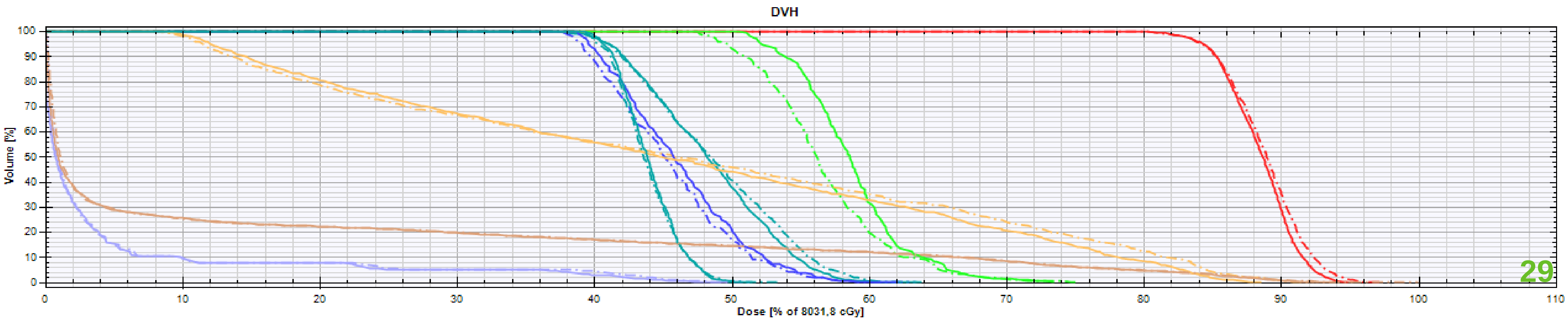


- Fluence backprojection + ‚collapsed cones‘ out of MC kernel + dose superposition

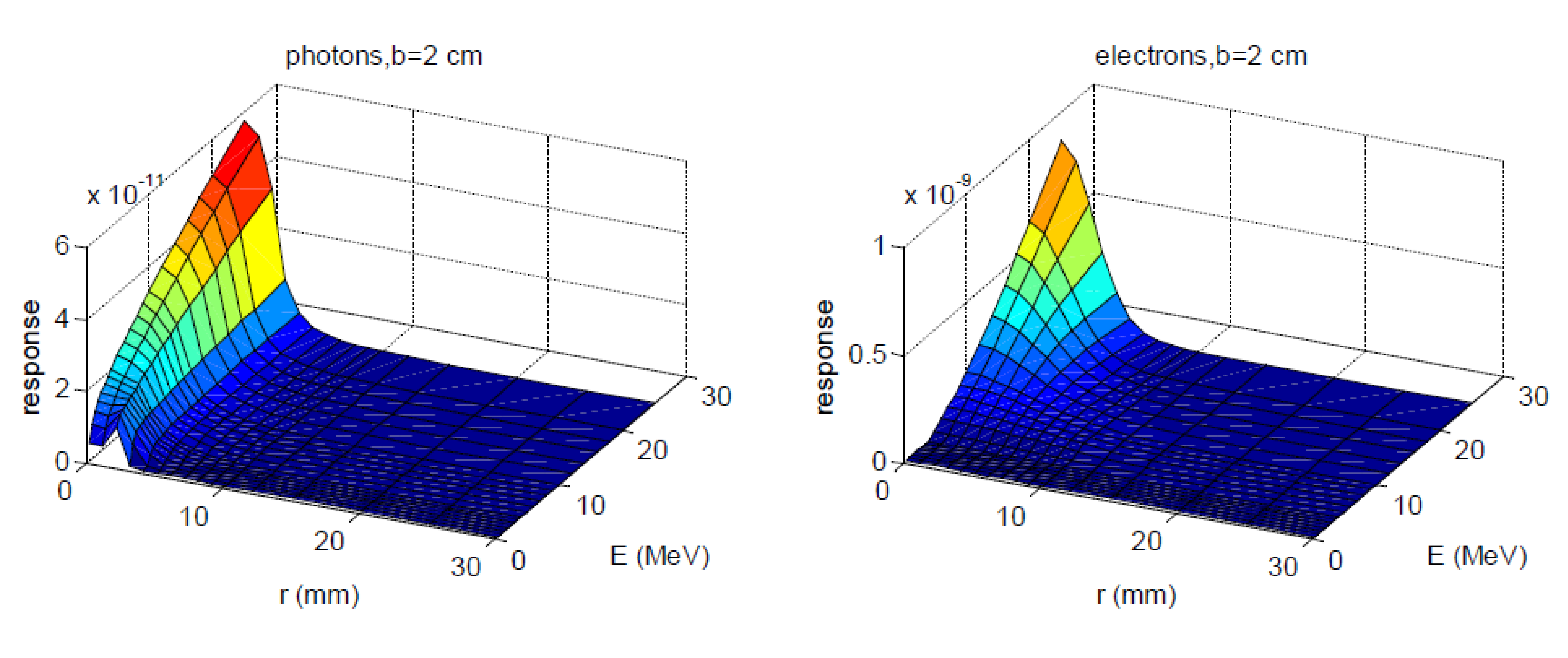
Dose in Patient Anatomy -> DVHs



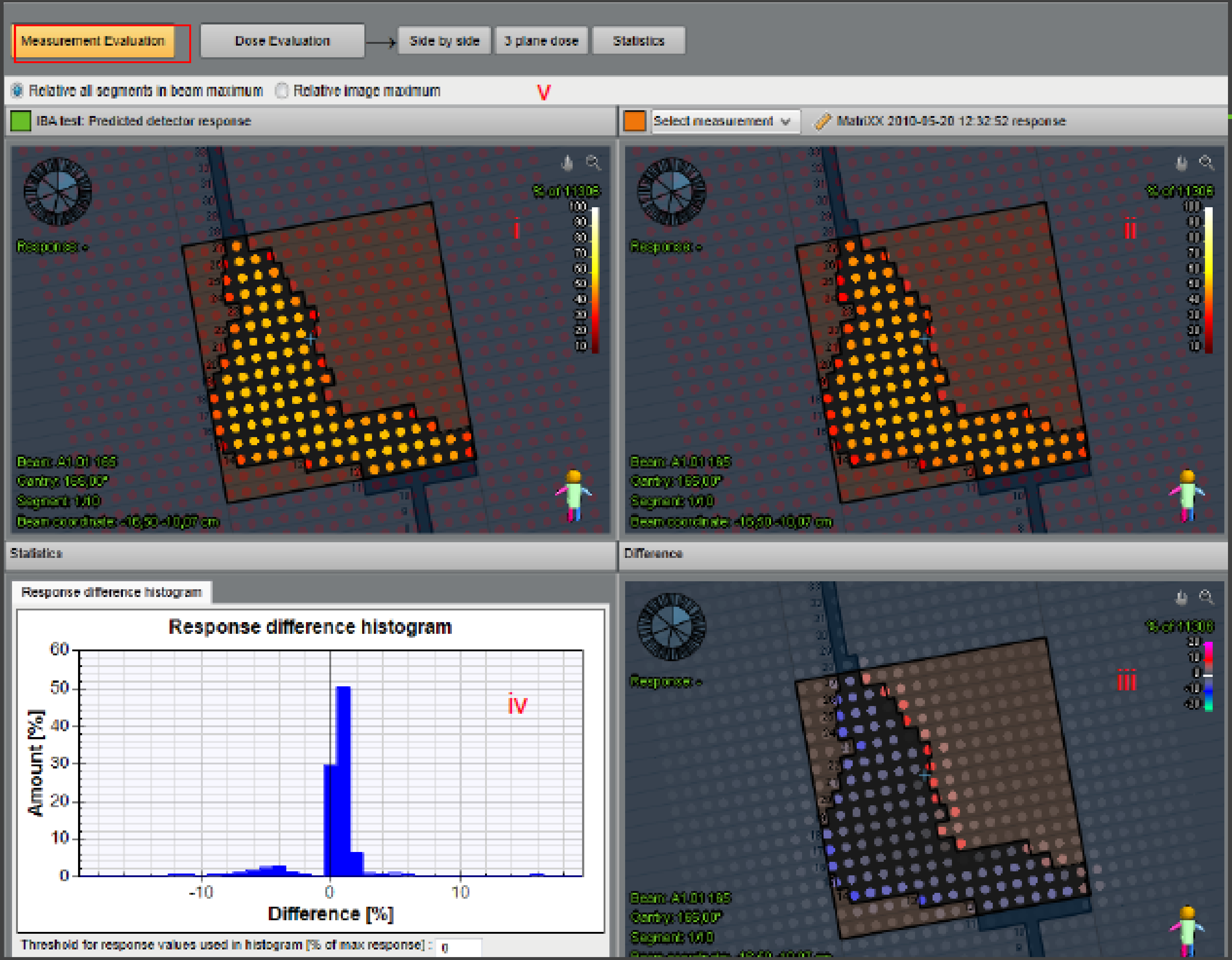




Detector Response Kernels (for MatriXX, BU=2cm)



Probability of creating a signal, depending on energy and radial distance

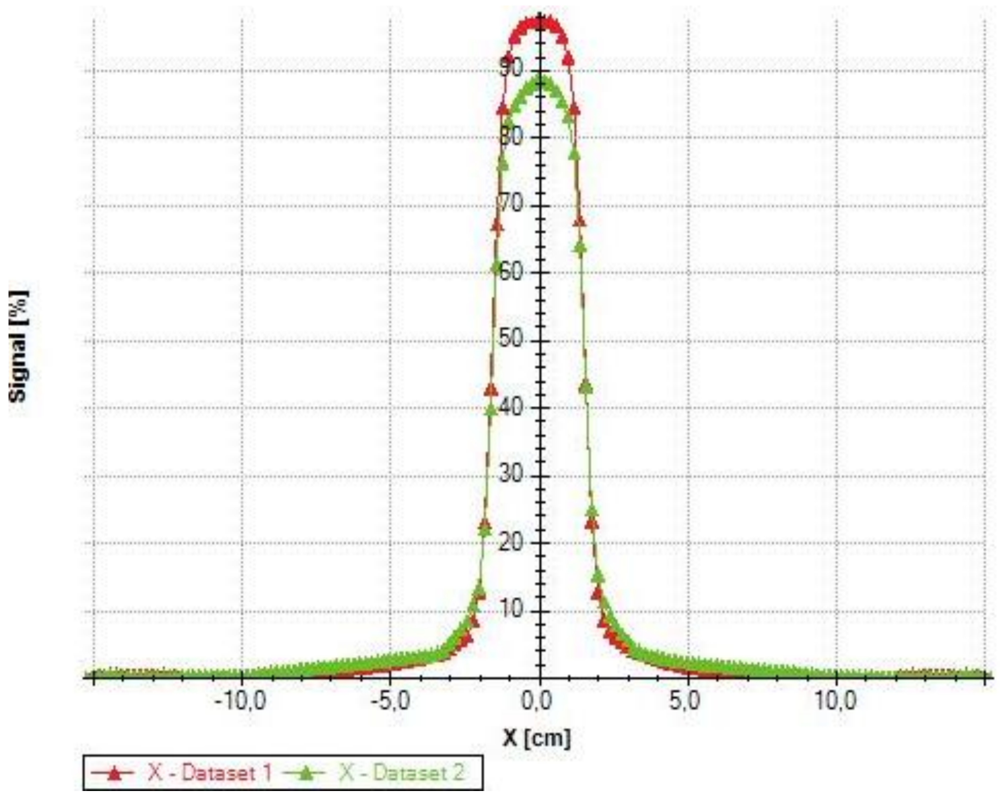


- Comparison between predicted and measured responses gives input for perturbative effective fluence determination

COMPASS 2018 – new DOLPHIN kernels

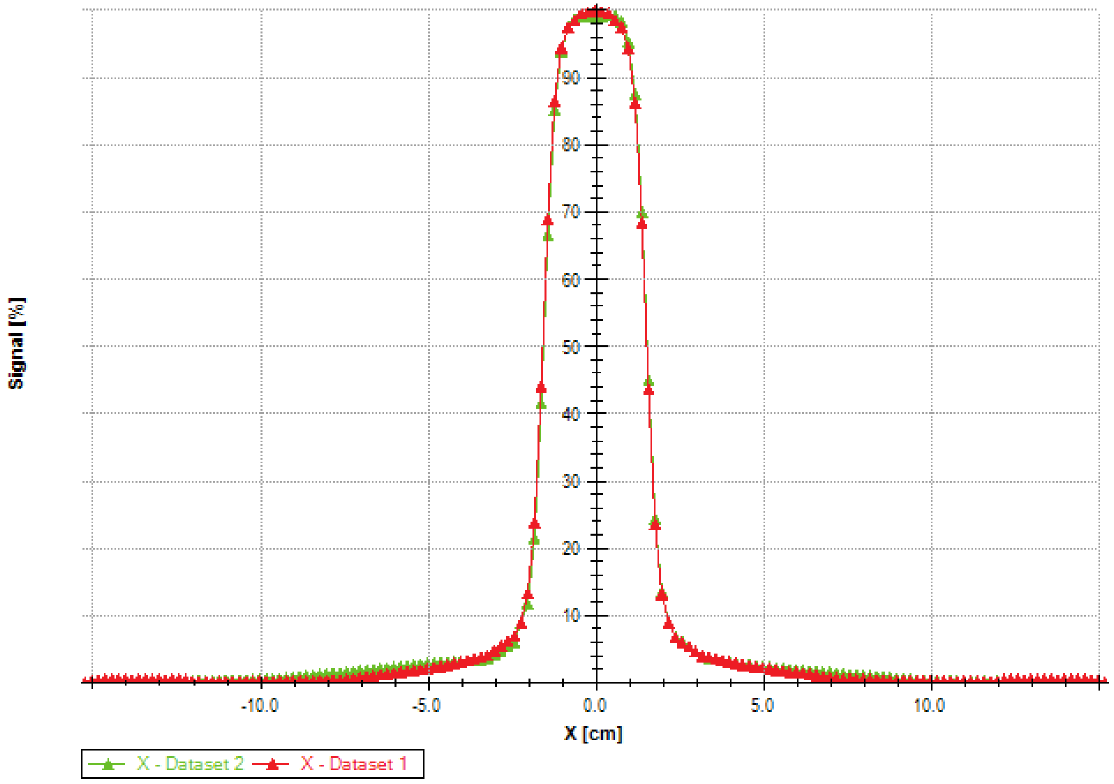
COMPASS 4.0

10 MV Mannheim report from 2016



COMPASS 2018

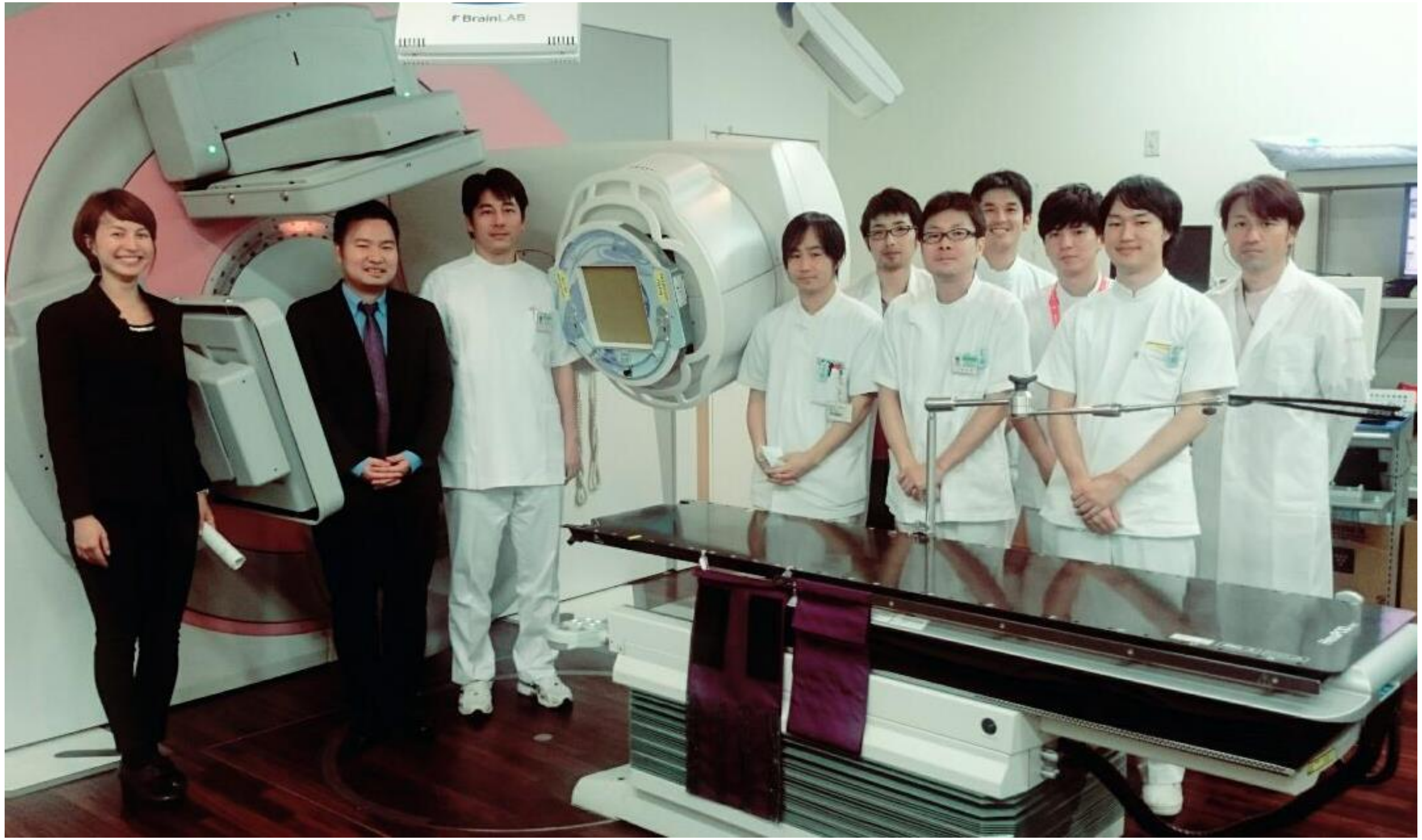
same data, new kernels

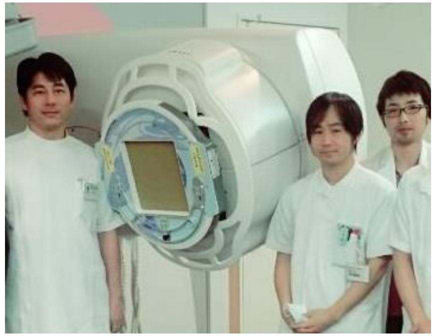


DOLPHIN & COMPASS

Clinical experience

Trial Report on Dolphin

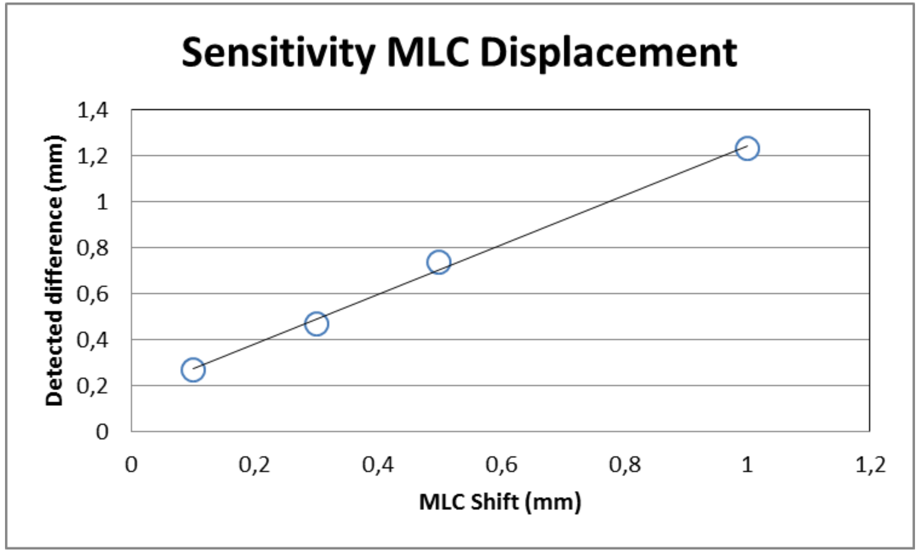




Kumamoto University Hospital

Yuji Nakaguchi et al. Preliminary Data to be Published

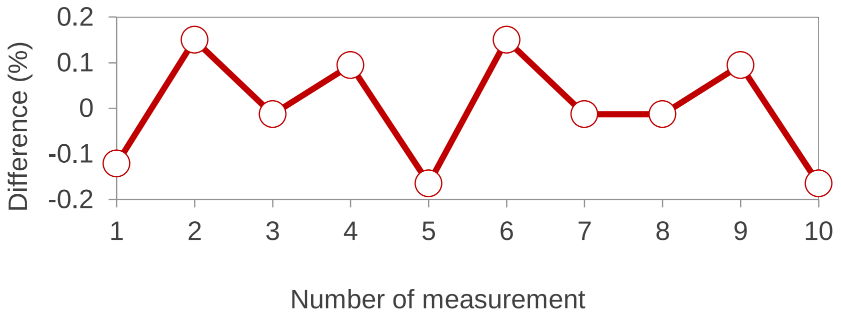
Kumamoto Evaluation - Reproducibility



熊本大学
Kumamoto University

Number of measurement	Field (mm)		offset (mm)		Angle (°)
	X	Y	X	Y	
1	0,00	0,00	-0,600	0,500	0,00
2	0,00	0,00	0,700	-0,400	0,10
3	0,00	0,00	0,400	-0,400	0,00
4	1,00	0,00	0,900	-0,500	0,00
5	1,00	0,00	1,000	-0,500	0,00
6	1,00	0,00	0,900	-0,400	0,00
7	0,00	0,00	0,800	-0,400	0,10
8	0,00	0,00	0,700	-0,400	0,00
9	0,00	0,00	0,400	-0,400	0,00
10	1,00	0,00	0,900	-0,500	0,10
Mean	**0,40**	**0,00**	**0,610**	**-0,340**	**0,03**
St. Dev	**0,52**	**0,00**	**0,47**	**0,30**	**0,05**

Geometric calibration and reproducibility



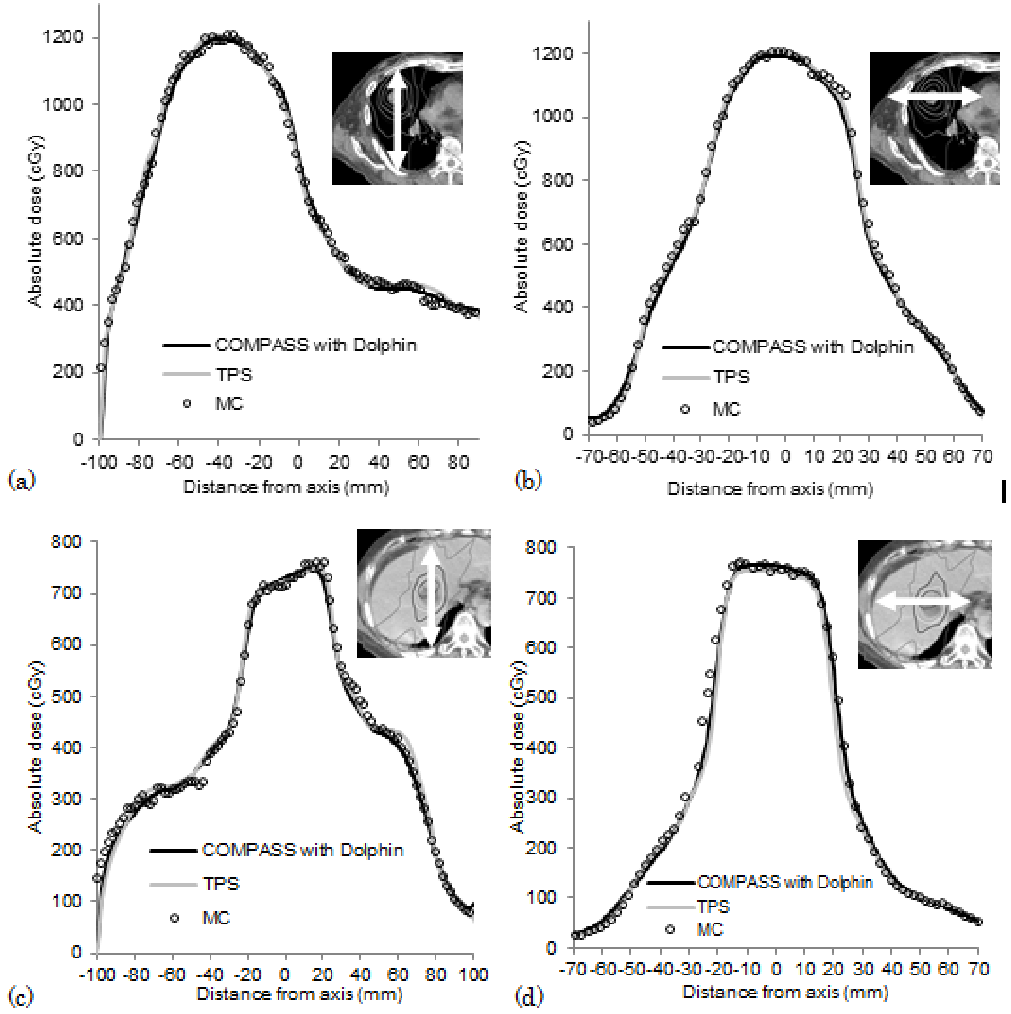
Absolute dose calibration initially measured with Farmer type ion chamber. Calibration difference for following measurements was within 0.2%.

There's no need of absolute calibration every time.

Kumamoto SBRT Lung & Liver cases - DOLPHIN

Lung

Liver



AP

LR

CONCLUSION

…For clinical cases, COMPASS can detect small changes for dose profiles and DVH. COMPASS system also showed good agreement with MC. Finally, we confirmed the feasibility of using the new COMPASS system with the new transmission detector for SBRT…

Experience from a customer in Germany

- **2 Sites**, ca. 30km apart from each other
- **highest** level of supply outside a university (level IV)
- **3 Linacs**
- **approx 1400 pat/year. 110-140 pat/d**
- **8 physicians, (5+2) physicists, 10 radiographers**
- **Pinnacle 9.10**
- **IMRT since 2007, VMAT since 2010 (~ 100% now)**
- SBRT (Body and Head)
- **Patient Plan QA (100%): Compass with MatriXX, since 8/2016: Dolphin (Pre-T)**
- Rating by state-council: „**AA**“

Bayreuth

Kulmbach

WHY ARE WE USING THE DOLPHIN

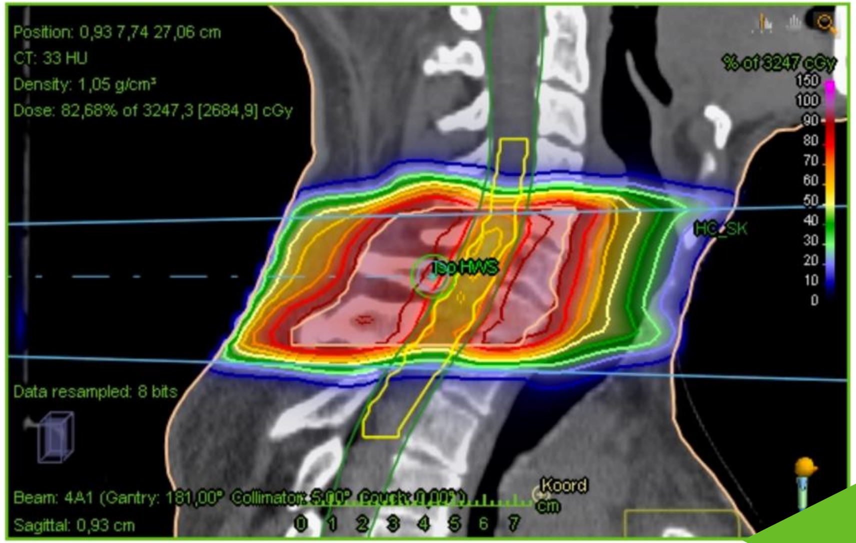
1. faster measurements
    1. faster setup: no wiring
    2. highly reproducible positio
2. high resolution (at the central a
3. 40x40 scm field size

TIME CONSUMPTION IN THE EVENINGS/WEEKENDS FOR THE PHYSICIST

	MatriXX Gantrymount	Dolphin pretreatment
Setup	10 min	2 min
Pre Measurement Checks	10 min	none
Measurement time per patient plan	2 min	2 min
Calculation time per patient	5 min	5 min
sum for 10 plans	90 min	72 min

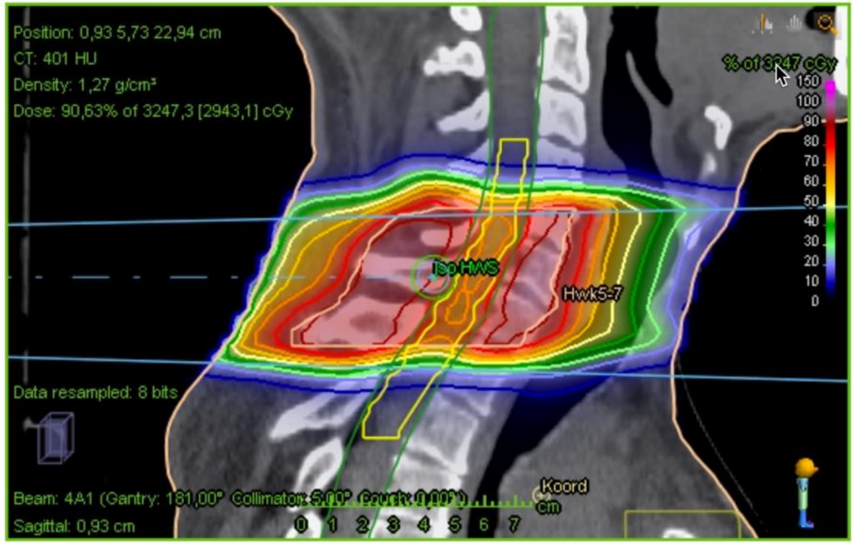
WHY ARE

HWK5-7 BWK7.0: TPS dose



Dose grid resolution [cm]: [0,4 0,4 0,4]

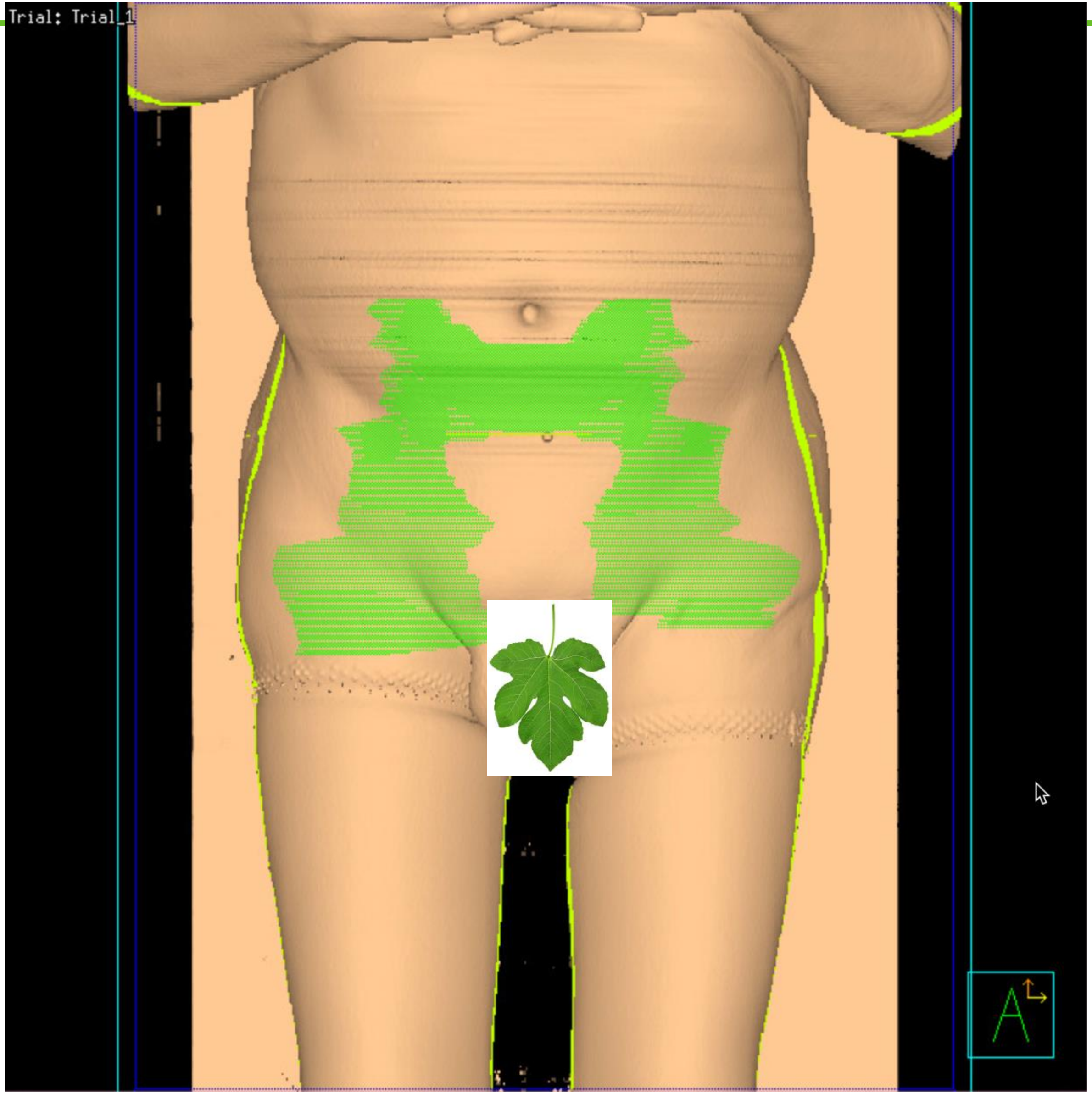
HWK5-7 BWK7.0: Reconstructed with 12.01.2017 18:08:53, Machine: Versa26jul16



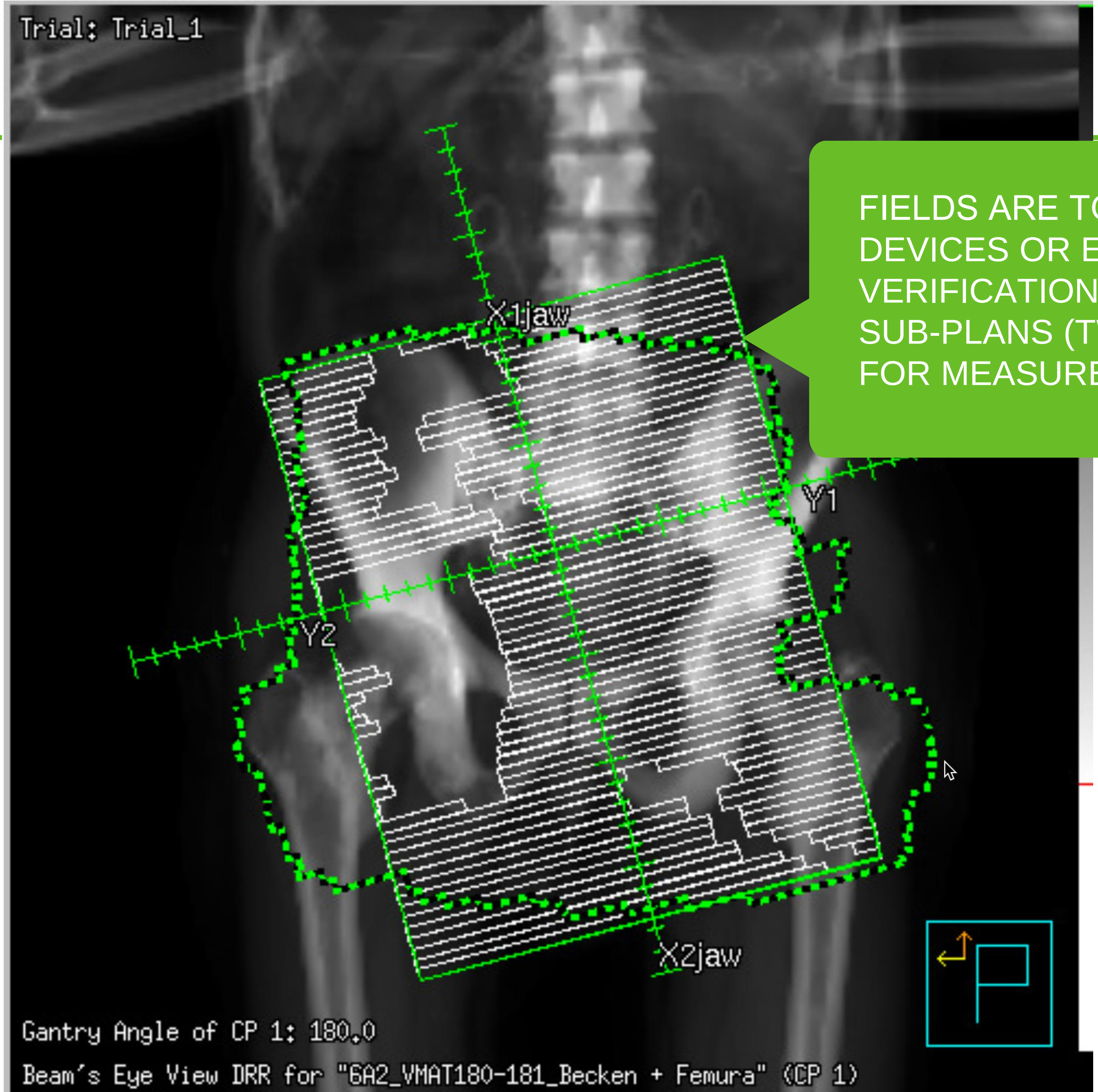
Imaging system: AS Open20, Outline: HC_Mensch, Dose grid resolution [cm]: [0,4 0,4 0,4]

MUCH HIGHER CONFIDENCE IN MEASUREMENT IN CRITICAL AREAS (STEEP GRADIENTS OR SMALL VOLUME AREAS)

WHY ARE WE USING THE DOLPHIN



WHY ARE



FIELDS ARE TOO WIDE FOR „NORMAL“ DEVICES OR EPIDS → SEPARATE VERIFICATION OF NEWLY GENERATED SUB-PLANS (TWICE THE TIME NEEDED FOR MEASUREMENT)

Dolphin® used in Turkey for SRS and SBRT treatment

Bora Tas, Asst. Prof. and Chief Medical Physicist at the Gaziosmanpasa Hospital in Istanbul, Turkey:

“We are now using Dolphin to perform patient QA for our advanced and challenging stereotactic cases and for our Head & Neck treatments. Compared to our previous table based QA solution we can now measure and verify our patient QA in significantly less time”.

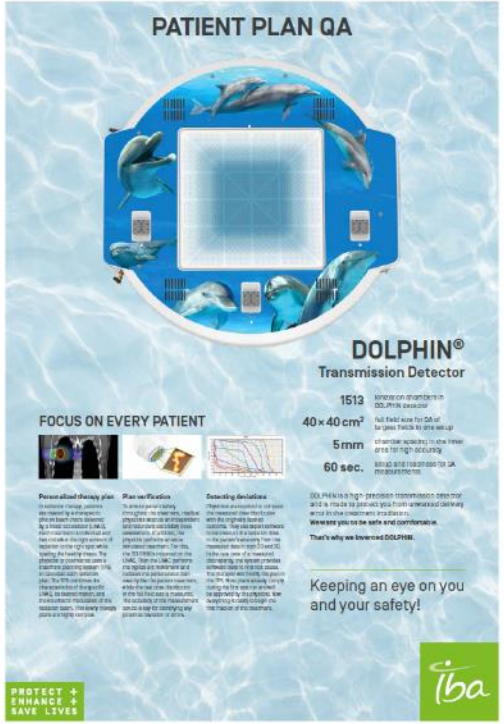
DOLPHIN & COMPASS 2018

Verification process streamlined with Dolphin

Osaka International Cancer Institute started clinical treatment on March 27, 2017, and 3 LINACs were installed with the VMAT technique. We aim to contribute to improve the patients QOL by increasing VMAT application and addressing various cases. However, higher frequency of VMAT application may lead to more time spent on patient verification. Therefore we chose the Dolphin transmission detector and COMPASS software from IBA to do patient verification efficiently. We established simultaneous measurements of dose distribution and point dose by utilizing the characteristics of transmission detector. In addition, the automatic verification helped us in enabling instant comparison of planned distribution vs measured distribution. With this verification system based on the Dolphin transmission detector, we were able to finish 11 cases with 3D plan verification within only 90 minutes.

Serbia is doing 3D verification with Dolphin in 2018

We are proud to let you know that with the great support of our KVARK D.O.O. we sold and shipped six new Dolphins to Serbia by the end of December 2017. The systems will be installed during 2018 in the hospitals of Niš, Kragujevac, Belgrade and Kladovo.



INTEROPERABILITY AGREEMENT

This Interoperability Agreement ("**Agreement**") is entered into between IBA Dosimetry GmbH, having its principal place of business at Bahnhofstrasse 5, 90592 Schwarzenbruck, Germany ("**Vendor**"), and Varian Medical Systems, Inc., having its principal place of business at 3100 Hansen Way, Palo Alto, California 94304, USA ("**Varian**") and is effective April 16, 2018 ("**Effective Date**").

Press Release

IBA Dosimetry to Showcase DOLPHIN Advancements Enabling Verification of the Complete RT Treatment Chain

High-dose cases cases can now be verified fast and efficiently with Patient QA and Machine QA constancy checks using DOLPHIN® transmission detector measurements

Barcelona, Spain, April 19, 2018 – IBA (Ion Beam Applications S.A.), the world's leading provider of proton therapy solutions and radiation therapy integrated quality assurance (QA) for the treatment of cancer, today announced it will be demonstrating the latest advancements of its DOLPHIN solution for advanced patient quality assurance, April 20-23 in Barcelona, Spain at ESTRO 37, booth 1500.

Modern radiation therapy has become highly specialized with increasing complexity in treatment planning and LINAC delivery. This in return requires new and comprehensive QA solutions that address the growing number of possible sources and impact of dose deviations, in particular for high-dose cases. To verify the accuracy of patient treatments IBA Dosimetry further enhanced the DOLPHIN solution with its COMPASS 3D verification software. As a result, DOLPHIN enables the radiation therapy team to verify the complete treatment chain and therefore provides the confidence and safety needed.

DOLPHIN includes the following five checks for verification of the complete treatment chain:

- **Verification of the real patient plan.** DOLPHIN enables to detect errors in the data transfer or the QA plan generation, no QA surrogate plan is required.
- **Real measurement of the plan delivery**. The DOLPHIN advanced high-resolution ionization chamber detector array enables to find errors in the treatment delivery such as beam line defects, MLC deviations, dose rate changes, flatness/symmetry drifts, gantry positioning errors, etc.
- **Secondary Dose Calculation** with TPS-class algorithm. The secondary verification of the TPS dose calculation enables to detect errors in the TPS algorithm, the TPS performance, or of the TPS export.
- **Machine constancy checks with myQA.** DOLPHIN's detector array is optimized to find deviations and trends in the LINAC constancy for profiles, output and wedge factors.
- **Independent verification of the Treatment Planning System** (TPS). The independent beam model of Dolphin's verification software enables detection of errors in the TPS configuration and performance, its beam model, commissioning, or the linac calibration.

With this comprehensive range of verification checkpoints, DOLPHIN integrates patient QA and machine QA in one unique holistic solution.

Today, DOLPHIN and IBA Dosimetry's 3D patient anatomy based patient QA software COMPASS is in clinical use at leading healthcare providers around the world:

Press release | 19/APR/2018

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Registration Court: Local Court (Amtsgericht) Nürnberg, HRB 4262
Managing Directors (Geschäftsführer): Olivier Legrain, Jean-Marc Bothy, Soumya Chandramouli
Dosimetry-info@iba-group.com | www.iba-dosimetry.com

PROTECT + ENHANCE + SAVE LIVES

Press Release

ICON CANCER CARE

Dolphin is a versatile 3-in-1 device, with its gantry-mounted design simple to set up and enabling the us to perform treatment planning dose verification, patient measurement based QA, and machine routine constancy QA checks.

It is simple to set up with very minimised set up uncertainties. For a with multiple machines' department is showing more in budget conveniences on routine QA equipment setup.

To the planning dose verification, compass software handles overshoot, tissue inhomogeneity's and irregular surface. Via 3D gamma-value analysis on dosimetry reconstruction, delivered 3D dose in patient geometry, allows us to evaluate the impact of delivery uncertainties and to make meaningful clinical decisions to give us a more accurate dose calculation result.

Matrix ionization detectors distributed with MyQA software enabling us to directly use the device for machine routine constancy QA by simply taking a field beam shot, we can analyse the output rate, field flatness and symmetry. Dolphin obtains profile characteristics and output in one single exposure, thus significantly reducing time required for routine QA combined for measurement, data process/analysis, save and create report etc. plus with device gantry mounted, the measurement technique can directly check the gantry and collimator angle dependence etc some routine machine QA items.

Dolphin clinical team:

Yang Wang, PhD, Professor, physicist

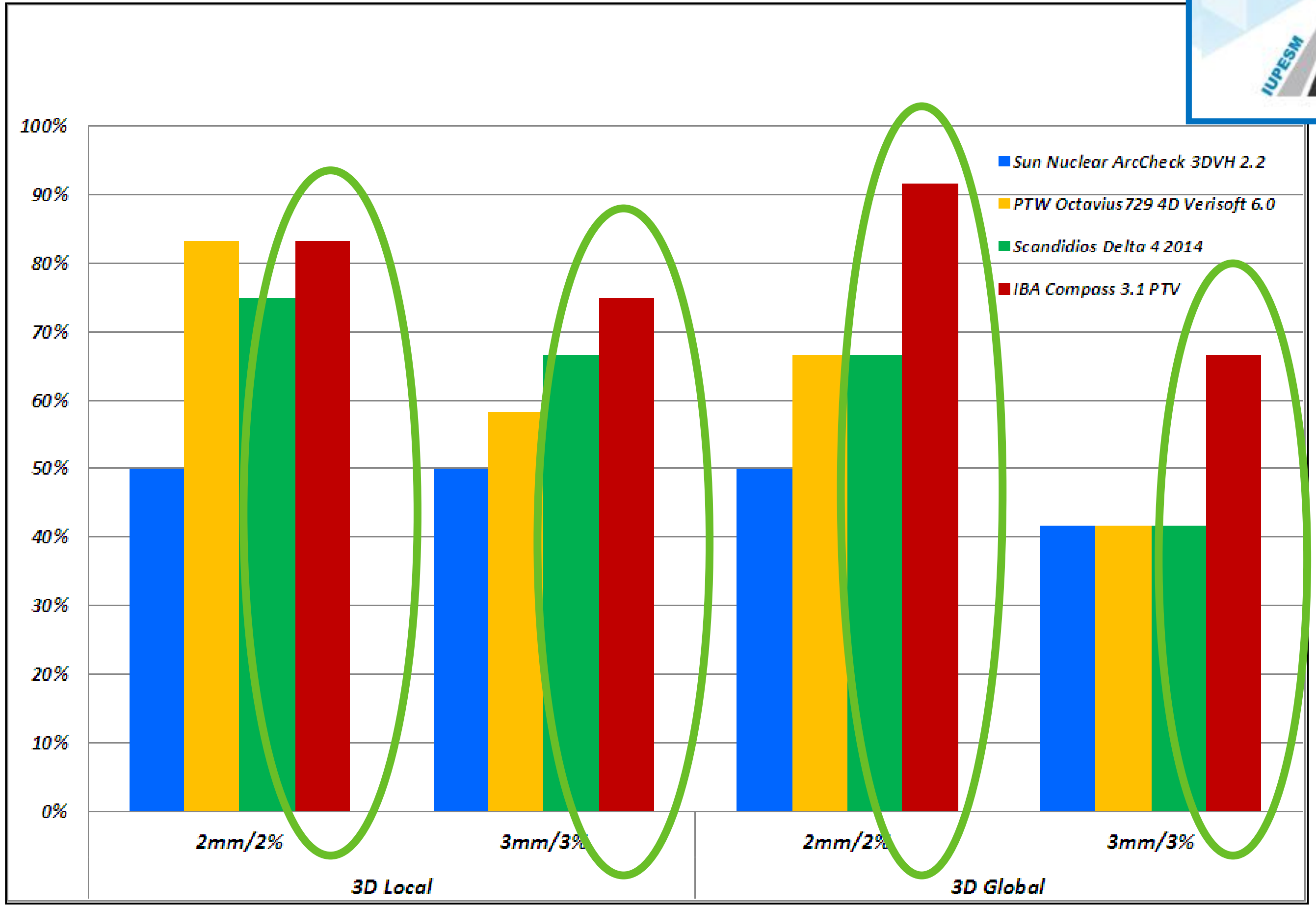
Emma Cai, MSc, physicist

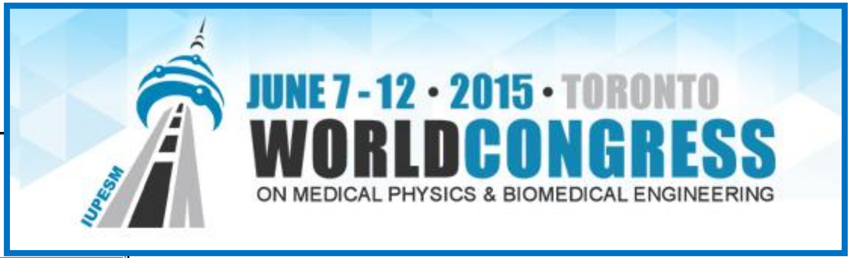
Ben Archibald- Heeren, MSc, physicist

Mikel Byrne, MSc, physicist

COMPASS – the best solution in the market

Error sensitivity study, Tallinn, NEMC, Estonia:





Sensitivity study, induced errors

- *Increased gap*
- *Shifted gap*
- *Underdose*
- *Overdose*

4 different anatomical locations

COMPASS best in class

Weakest System only finds 50% of the errors!

COMPASS as a Machine QA tool

Discussion

The TD, together with its application SW, has been validated for the following cases, as suggested in the AAPM TG-142 report:

- X-ray output constancy test, Daily/Monthly QA
- X-ray output constancy test vs. Dose rate, Monthly/Annual QA
- X-ray output constancy test vs. Gantry angle, Annual QA
- X-ray monitor unit linearity , Annual QA
- Photon beam profile constancy, Monthly QA

Repeatibility & Stability

N°	Penumbra Left [mm]	Penumbra Right [mm]	Symmetry [%]	Flatness [%]	Deviation [%]

Repeatibility: 10MV, 10x10 cm^2, Inline, IEC 60976 protocol

N°	Penumbra Left [mm]	Penumbra Right [mm]	Symmetry [%]	Flatness [%]	Deviation [%]
1	6,5	7	100,71	101,42	1,42
2	6,5	7	100,81	101,40	1,40
3	6,5	7	100,67	101,26	1,25
4	6,5	7	100,66	101,23	1,23
5	6,5	7	100,83	101,39	1,35
6	6,5	7	100,65	101,28	1,26
7	6,5	7	100,73	101,38	1,38
8	6,5	7	100,73	101,31	1,31
9	6,5	7	100,90	101,42	1,40
10	6,5	7	100,60	101,25	1,21
11	6,5	7	100,68	101,38	1,38
12	6,5	7	100,85	101,39	1,36
STD	0,00	0,00	0,09	0,07	0,07

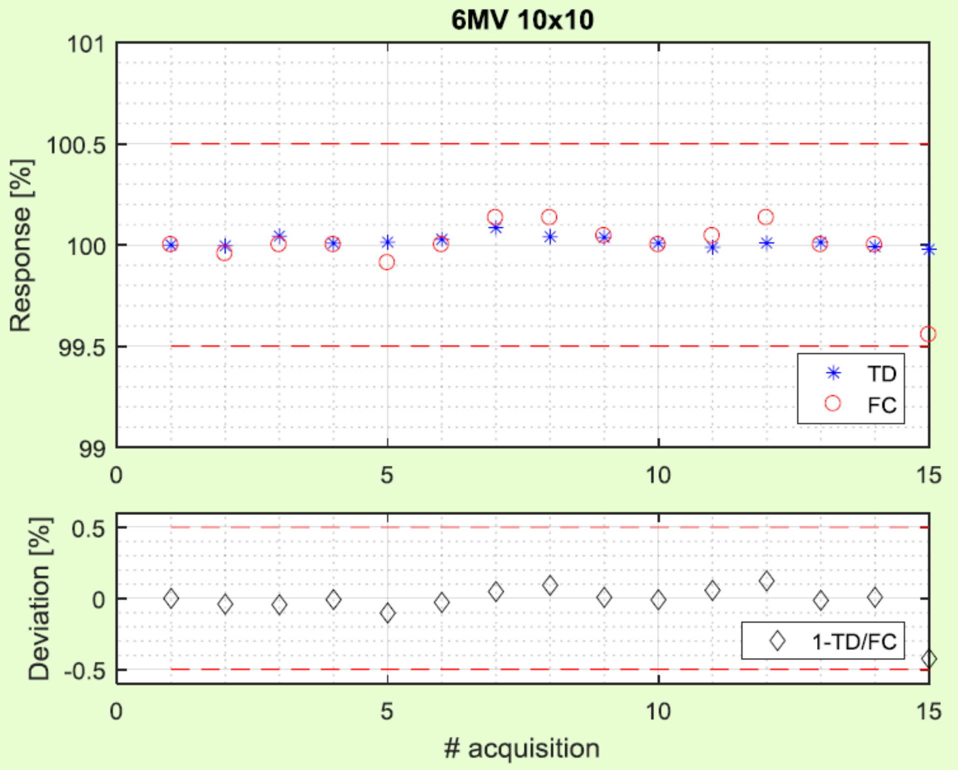
(g) Stability over time

Limits of variation of the TD response over one year do not exceed 1.5%.

In particular, stability of profile measurements with the TD over a period of 3 months shows an agreement with the refrence detector better than 0.5 % for flatness and symmetry, better than 1mm for penumbra width and field size.

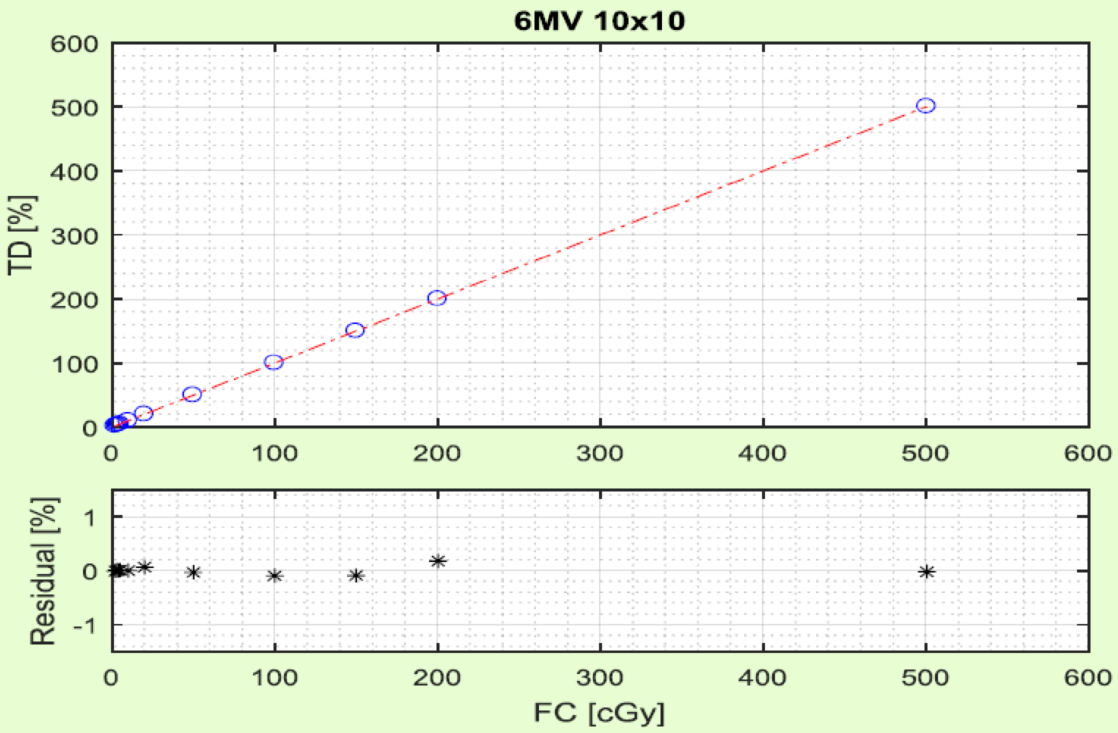
(a) Repeatibility of output

Repeatability of TD better than 0.5 %; deviation from FC output less than 0.5 %; for all beam qualities and field sizes.

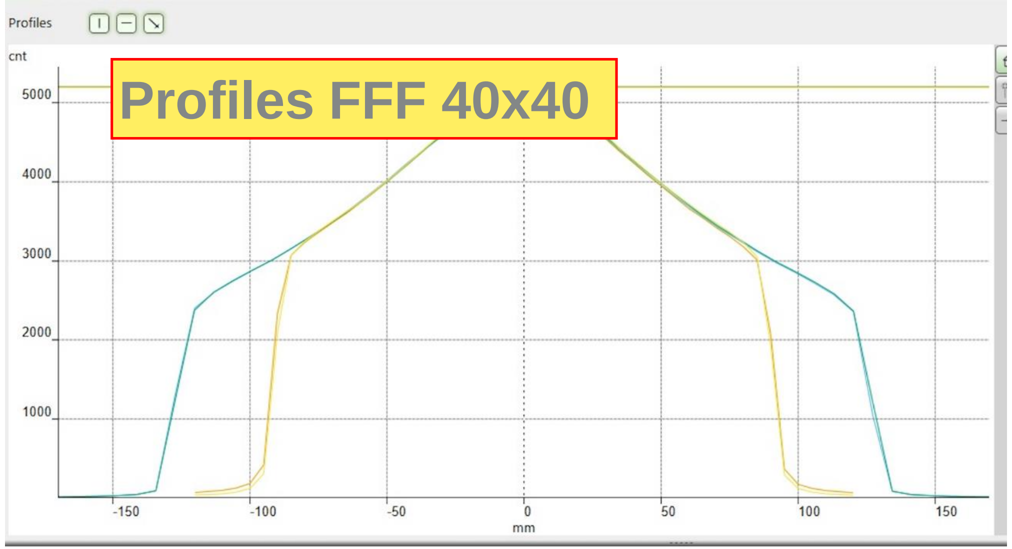


(b) Dose Linearity

The response of the TD has a linearity with the dose better than 1 % and comparable to the FC, for all beam qualities and field sizes.

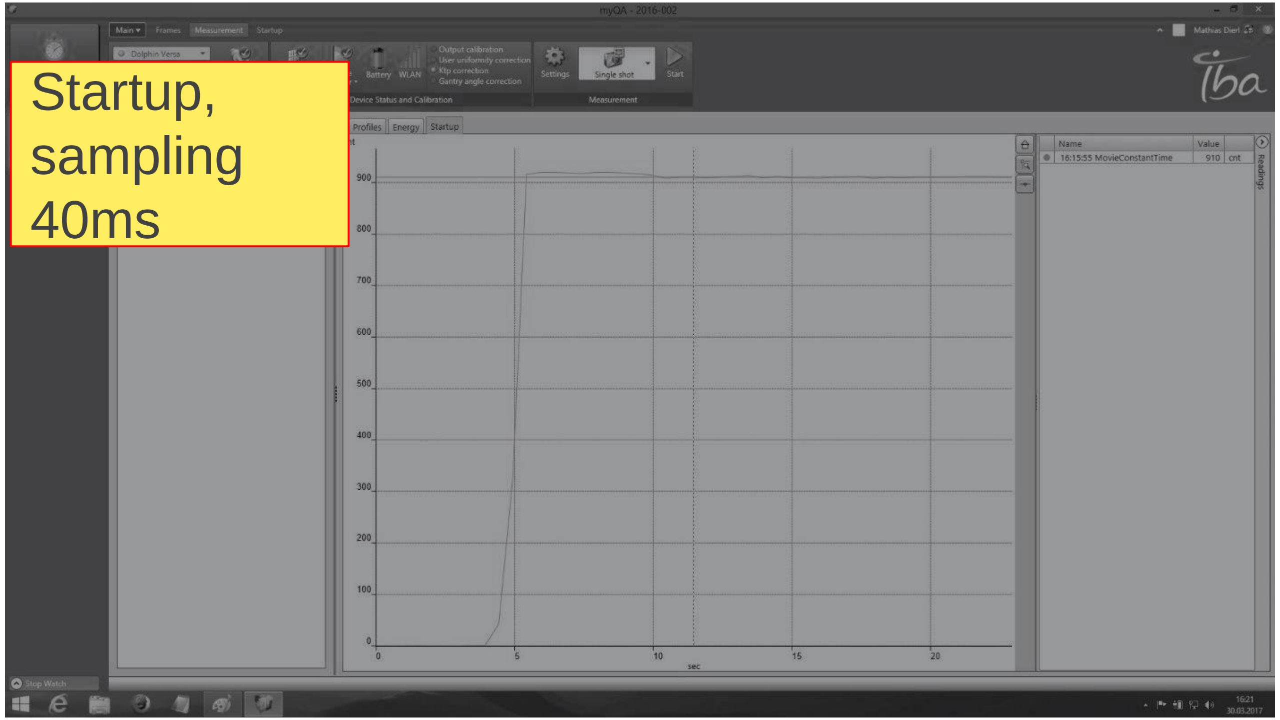


Is this Device limited to Patient-QA?



en Sie einen Spaltenkopf und legen Sie ihn hier ab, um nach dieser Spalte zu gruppieren

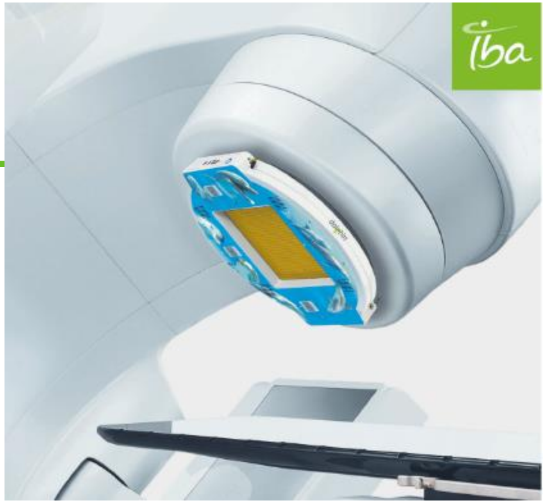
	Detector	Radiation Type	Direction	Gantry Angle	CAX	FW	Center	Pen L	Pen R	Sym
1	Dolphin	Photons	Diagonal --/++	359,9 °	5195 cnt	225,0 mm	-0,8 mm	83,6 mm	84,5 mm	101,74 %
1	Dolphin	Photons	Diagonal -+/+-	359,9 °	5195 cnt	225,9 mm	-0,5 mm	84,0 mm	84,6 mm	100,81 %
1	Dolphin	Photons	Crossline	359,9 °	5195 cnt	175,4 mm	-0,5 mm	48,6 mm	50,4 mm	101,83 %
1	Dolphin	Photons	Inline	359,9 °	5195 cnt	174,4 mm	-0,2 mm	48,1 mm	48,8 mm	100,90 %

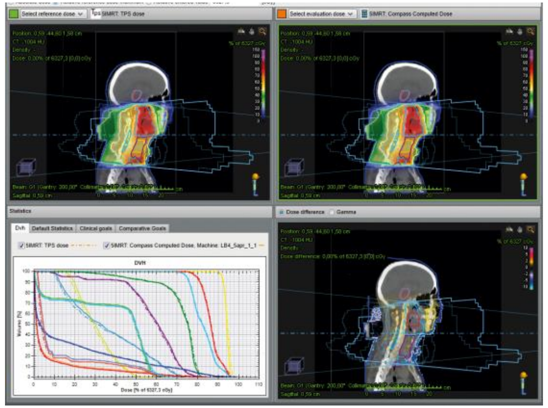


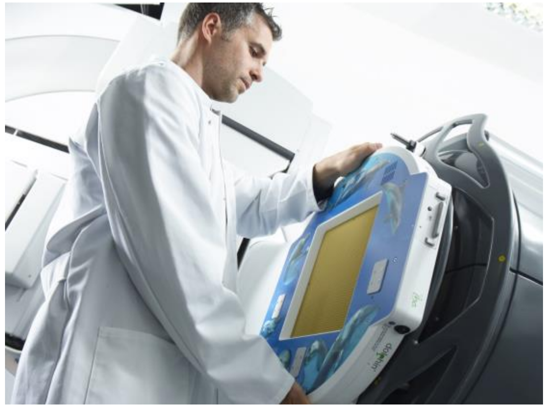
Conclusions

The dosimetric performances of the TD make it suitable for constancy checks of all photon-related dosimetric parameters in daily and monthly LINAC QA. Its use may increase efficiency and accuracy of QA, since it is quickly setup in a fixed position fixed at the LINAC's head, independent from beam quality, (flattened and unflattened in the range 6 - 15 MV) and field size (from 5x5 cm^2 to 40x40 cm^2 at isocenter).

Dolphin & COMPASS 2018 – News, details







Support of most relevant treatment energies

- 6 MV & 6 MV FFF photon beams
- 10 MV & 10 MV FFF photon beams

Enhanced precision

- Enhanced accuracy of the detector model for Dolphin (Dolphin kernels)
- Highest precision for error detection

Online ready

- Validation project progressing
- High energy activation tests passed

Further Functionality Enhancements

Increased TPS compatibility

- Import of beams with up to four arcs (e.g. for Monaco)
- Support of overlapping contours (e.g. for Monaco)
- Structure (ROI) Management for a flexible handling of density overrides

Simplified installation and licensing

- License manager for easier licensing
- More guidance for the SQL server installation
- Enabling of the network configurations with subnetworks

Flexibility of reporting

- Possibility to switch off the IBA and COMPASS logo in the report generation

Software legacies and regulatory updates

- E.g. Upside down display of some plans, Domain state error solved, gantry angle display problems fixed, counts per frame issue eliminated, Query and Retrieve for Eclipse
- Satisfy regulatory demands: fully compliant and updated documentation, detailed risk analysis review