Dr. Franco Canestri
C-RAD GmbH

C-RAD Patientenlagerungsüberwachung und Atem Gating während der Strahlentherapie :

→ die Erfahrungen aus Gelsenkirchen, Dresden, Weiden, Lund, Seattle und Stockholm

Für :

Treffen von AK IMRT und AK Klinische Festkörperdosimetrie

03. + 04.04.2017 - Münster

Agenda

Background

C-RAD methods used in optical triangulation

Workflow CT → RT

Clinical Benefits and Published Results : Videos.

New Products !

Discussion

Background of the Presenter

- Ph.D in Medical Physics from University of Genoa and National Cancer Institute of Milan - Italy („Lasers in Surgery and Oncology“)
- Since 33 Years in Germany
- Professional Experiences with Hewlett-Packard Medical and Agilent Technologies Optical Division in Böblingen (Product Design). With C-RAD since beginning 2013.
- Scientific Publications : www.franco-canestri.de

Background of the Company

- Product ideas based on specific studies about patient positioning and monitoring during radiation therapy at the :

Karolinska Institutet, Stockholm

- Research and first developments by Anders Brahme started back in 1997

- C-RAD company was founded in 2003, now with Main Subsidiaries in USA, Germany, France and China plus 20+ Distributors world-wide.

→ C-RAD GmbH in Germany : 3 Offices in Berlin, Karlsruhe and Landau (Pfalz).

End-to-end treatment solution

Sentinel 4DCT
in CT room

For all CT Manufacturers

Catalyst/HD/PT in
RT room

SETUP AND POSITIONING OF PATIENTS

INTRA-FRACTION MOTION DETECTION

RESPIRATORY GATING

Multi Vendor
Support

ELEKTA

TomoTherapy

iba

VARIAN
medical systems

Siemens

„Installed base“ C-RAD Systeme in DACH :

„Sentinel“ (CT Raum) : **18**

„Catalysts“ (Behandl. Raum) : **35** **alle (1-Kamera + 3-Kamera HD (*))**

(„Catalysts HD“ (Behandl. Raum) : **18 (*))**

C-RAD „HIT“ Raum Lasers : **12**

Gesamt : **65** **C-RAD Systeme - Deutschsprachige Länder**

(Status ende März 2017) in 29 Kliniken.

Publikationen : aus LMU, UMM, Uni Mainz, Gelsenkirchen, etc.

Uni Kliniken mit C-RAD : Aachen, Mainz, LMU x 2, UMM, Bonn, Köln, Essen.

(*) : Catalyst HD 3-Kamera Version

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NEW ! C-RAD SGSRT solution

Stereotactic radiation therapy including frameless SRS and SBRT workflow

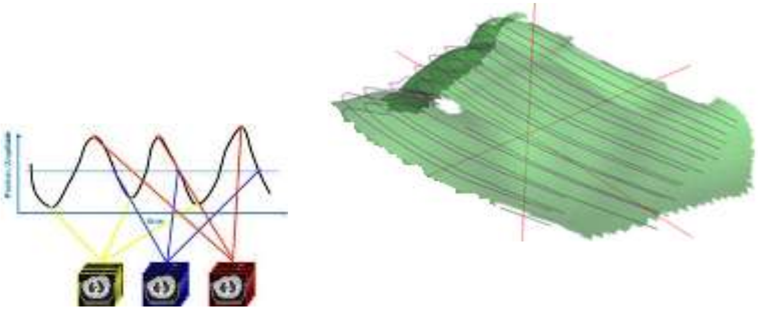
Visit our Stand at ESTRO in Vienna 2017

All-in-one solution for SRS and SBRT!

Workflow : Step 2 – RT (first Fraction)

from CT Room

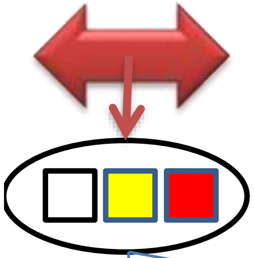
SENTINEL



in RT Room

catalyst

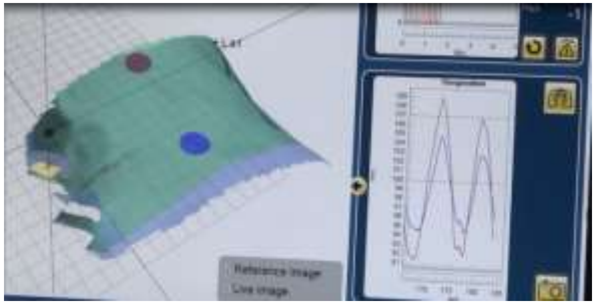
- **Again : Patient's Surface (now, first fraktion at the Linac)**
  + local Gating



Delta < 0

Delta = 0

Delta > 0



Gating at Linac

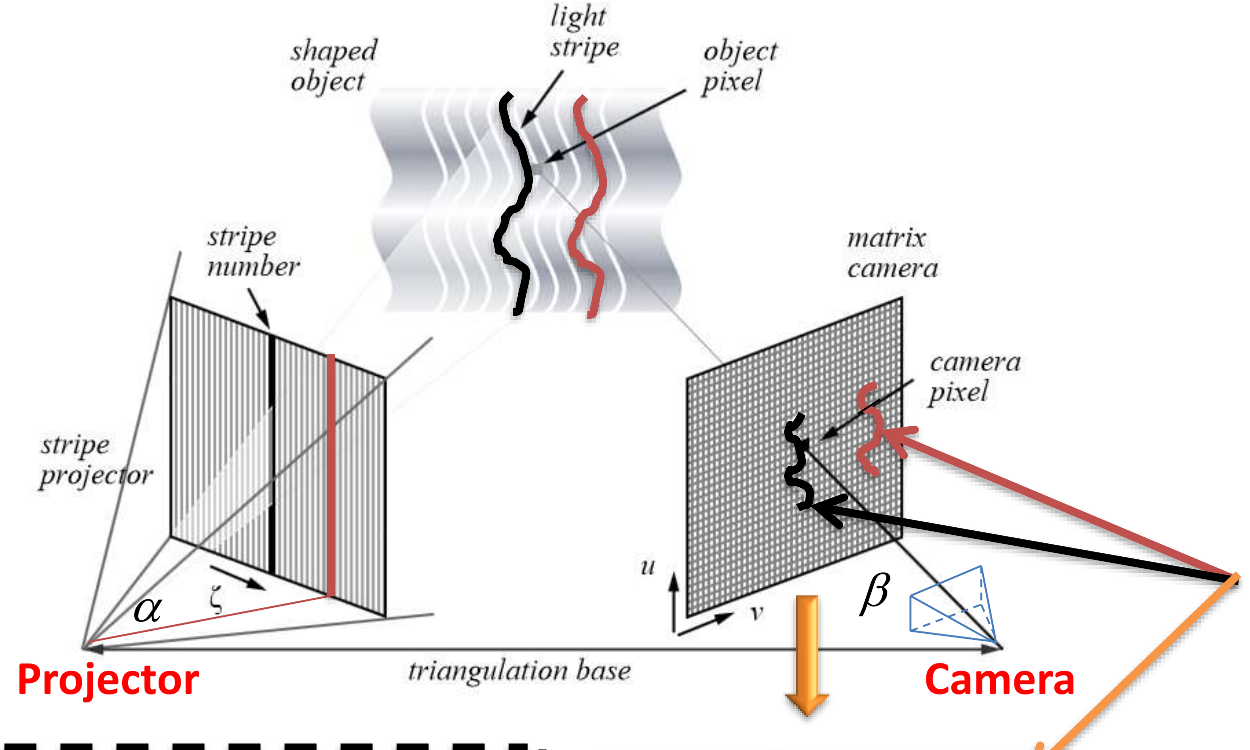
Back-projection,
Patient Vicinity & Safety

Isocenter

C-RAD

catalyst

Workflow : RT (first Fraction)

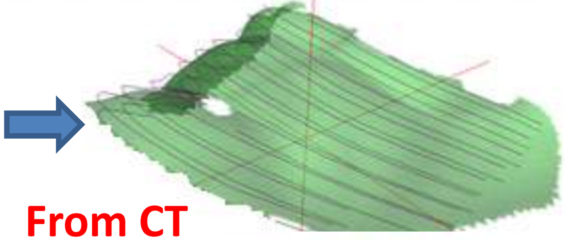


Projector

Camera

Patient‘s „signature“

3D surface capturing with one unit, up to 80 times per second



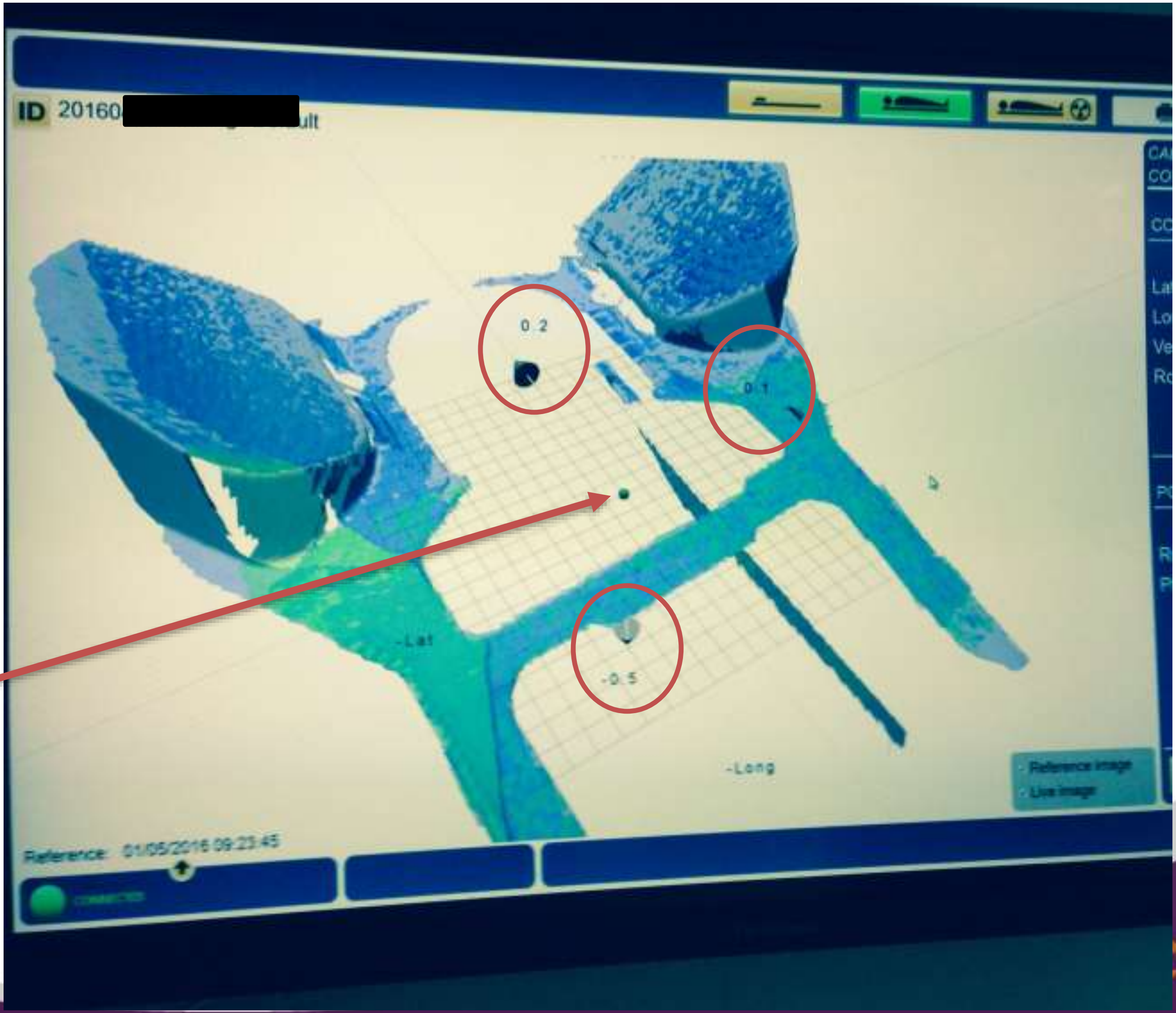
From CT

SENTINEL

catalyst

C-RAD

Workflow in RT : Lagerungshilfe Check am Linac (Genauigkeit < 1 mm. – konfigurierbar)



Isozentrum

Respiratory gating / coaching for ”Deep Inspiration Breath Hold” (DIBH)

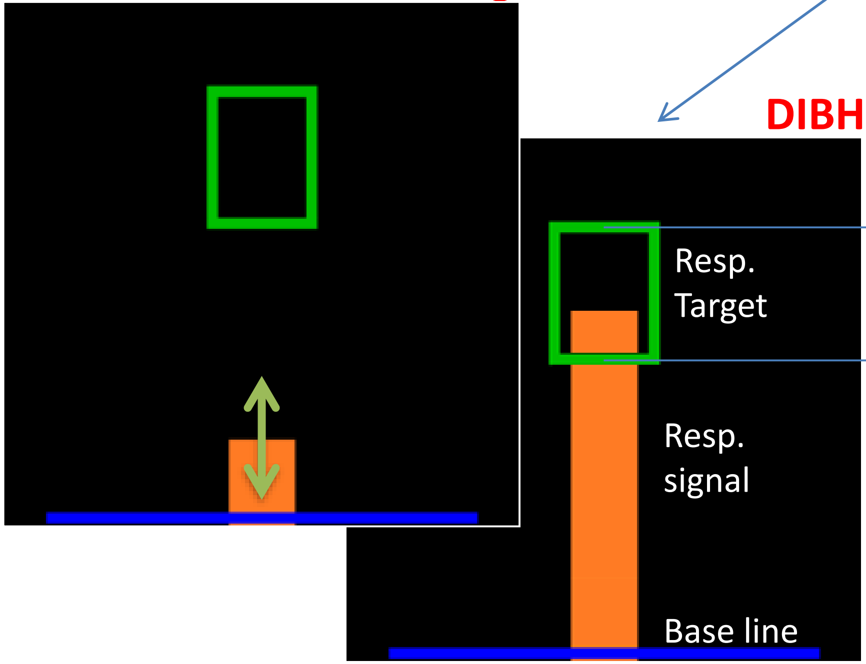
„Catalyst“ „Sentinel“

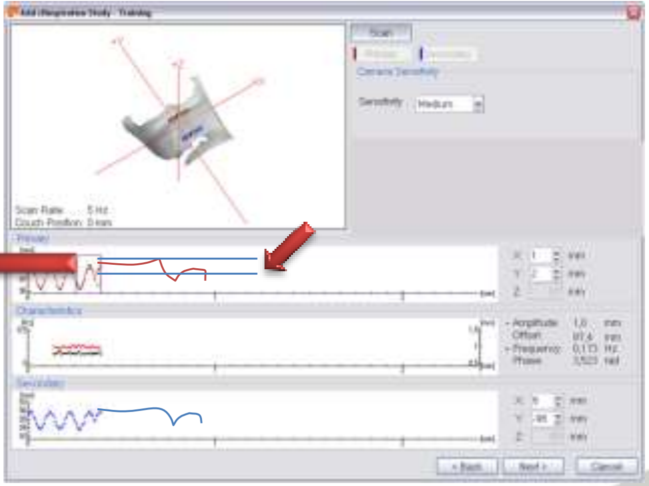
RT ← CT

Patient’s Visual feedback

Exported via DICOM

from 4DCT „Sentinel“



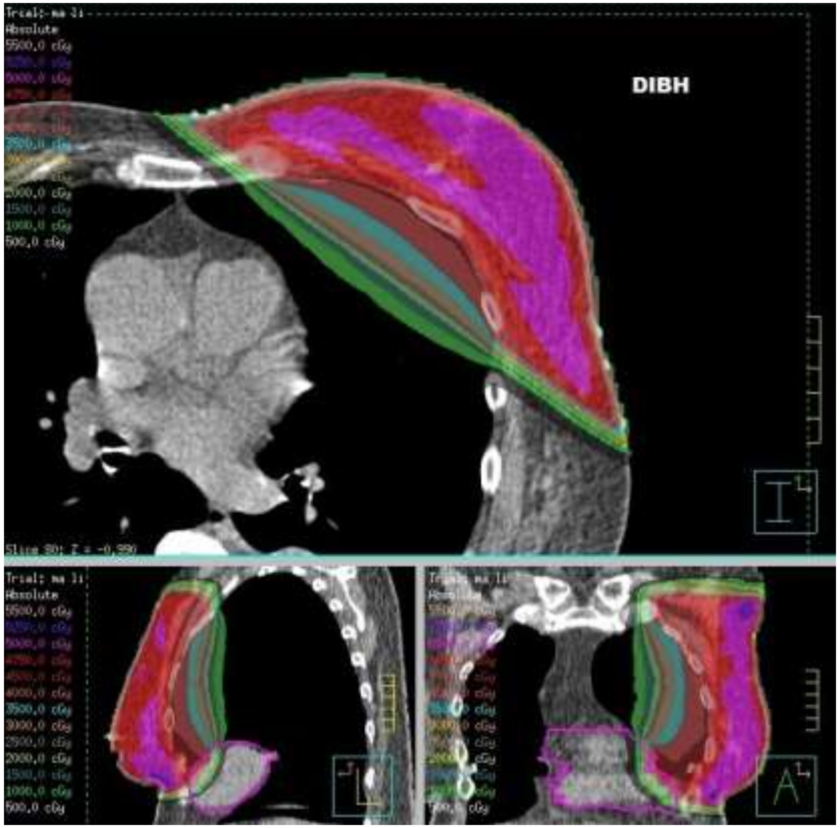


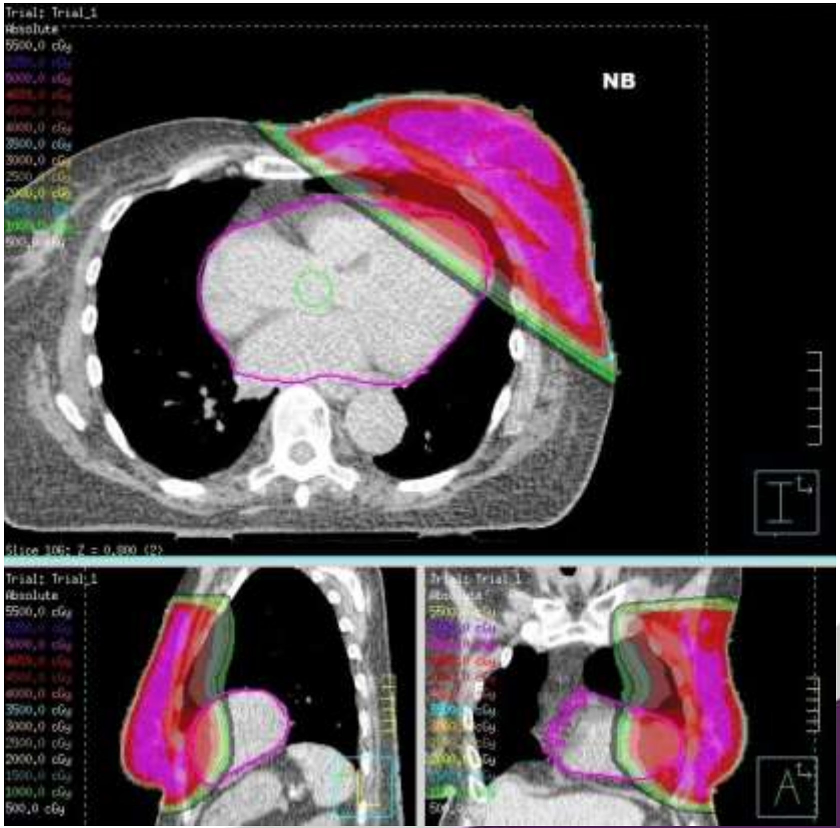
Scan Rate: 5 Hz
Couch Position: 0 mm
Sensitivity: Medium
Amplitude 1,0 mm

Neue C-RAD Bluethoot Patientenbrille

- **4DCT im CT Raum (Sentinel)**
- **Gating im Linac Raum (Catalyst)**

Dosimetrical comparison between Plans in DIBH and free breathing via C-RAD Goggles.





Results (Hepp, R. – Galalae, R. - 2015)

- **Lung** (DIBH vs. Free Breathing) :
  - V_{20Gy} : 12% vs. 17% (p:0.0003)

  - Reduction of lung complication probability >20%*

*Zurl et al, Strahlenther Onkol 2010

Results (Hepp, R. – Galalae, R. - 2015)

- **Heart** (DIBH vs. NB):
  - V_{10Gy} : 0,3 % vs. 3 % (p:0.0002)
  - D_{2cm^3} : 21,4 Gy vs. 45,7 Gy (p<0.0001)

⇩

  - Mean Dose to the heart halved
  - In 80% long-term cardiac mortality risk below 1%*
    - In Free Breathing: 30% of the patients !!!

*Pili et al, Int J Radiat Oncol Biol Phys 2011

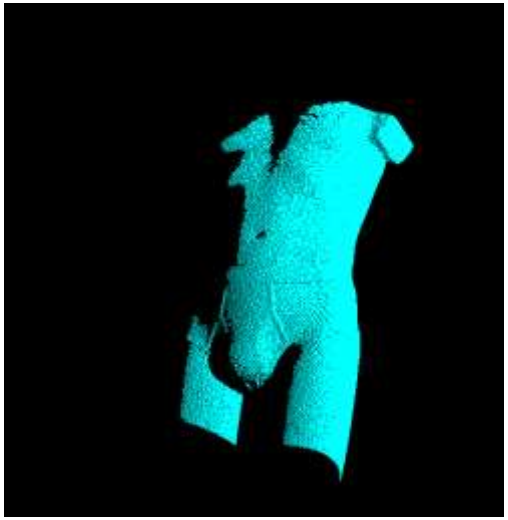
1-camera vs. 3-camera
Upgrade and final Installation

3-Camera Solution
KFJ Spital – Wien –

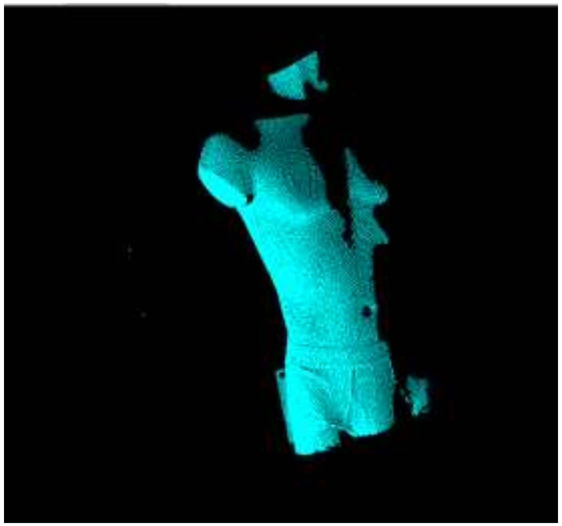
- Also for Stereotactic and PT Treatments
- Full Patient Surface coverage
- Monitoring independent from couch kicks

Camera Shots

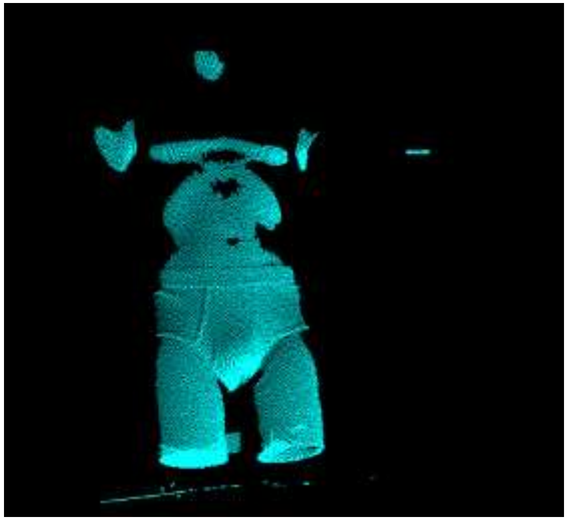
Right Camera 2



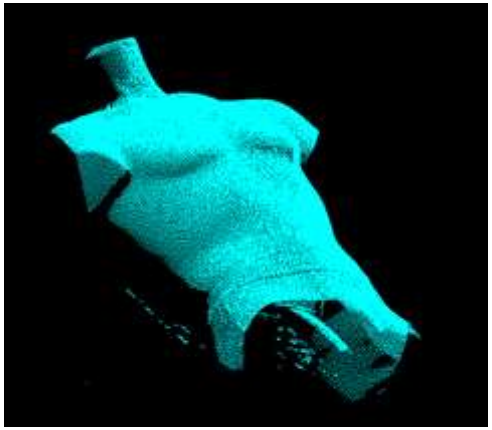
Left Camera 3



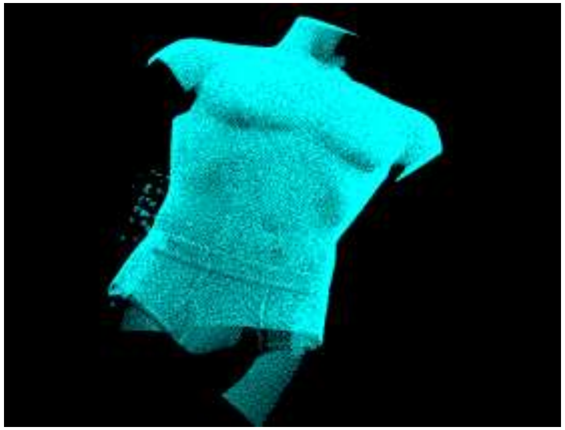
Central Camera 1



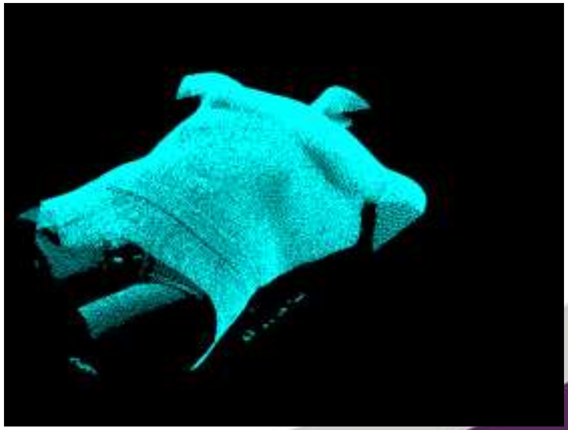
Composite Global Views (R2+L3+C1 Camera Shots Super-impositions)



Right View



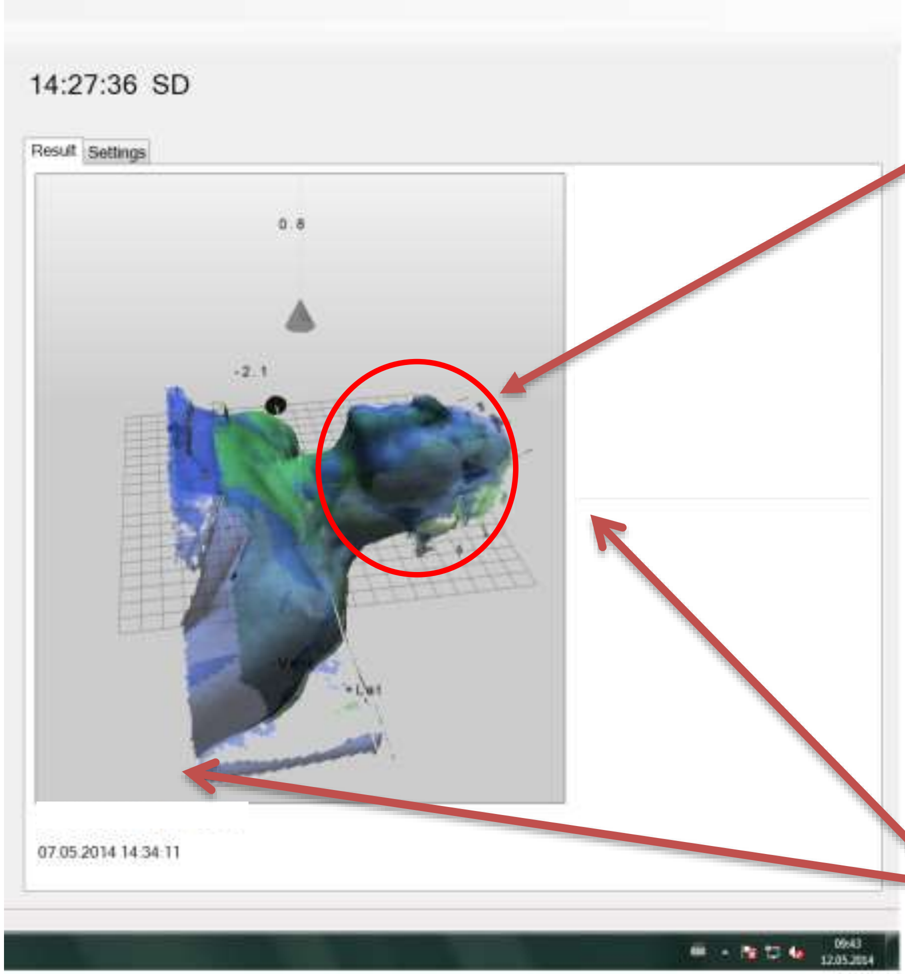
Central View



Left View

C-RAD

3-Camera Catalyst Stereotactic Report with Screen View



Patient Vicinity Recognition

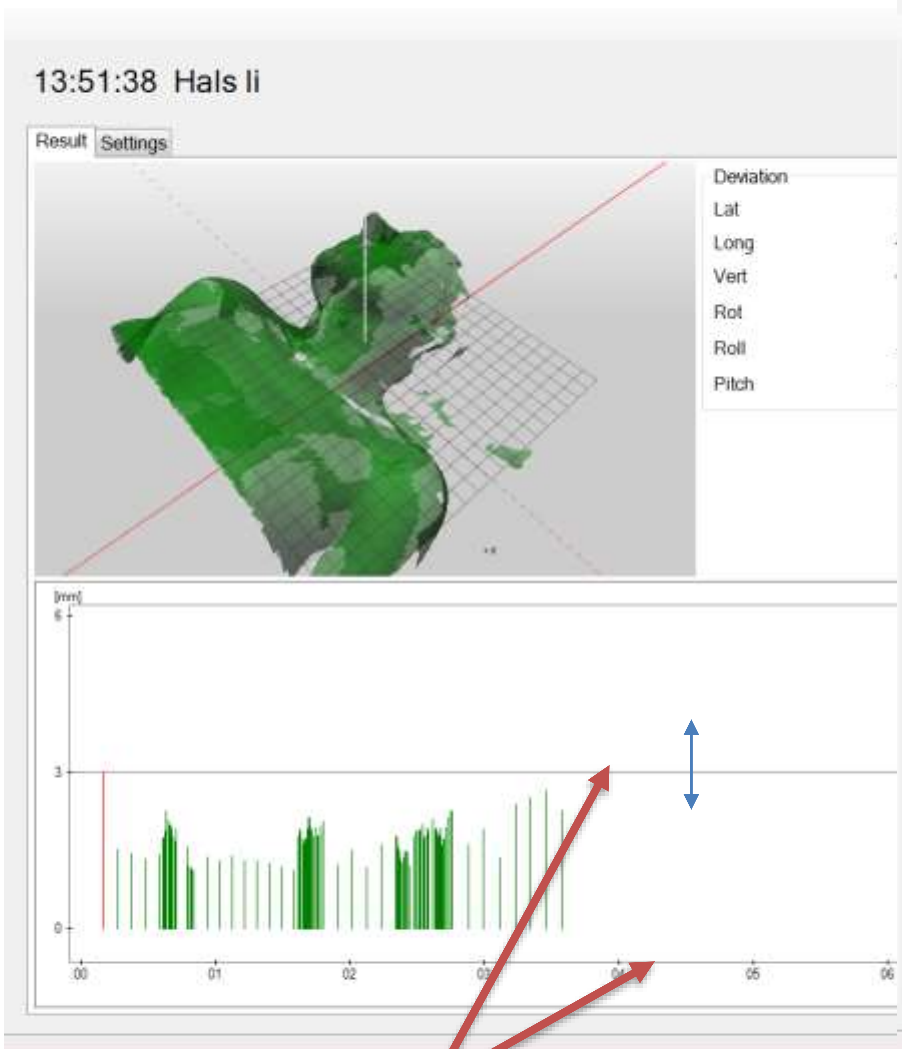
Critical Angles / Views

Benefits for Stereotactic Appications :

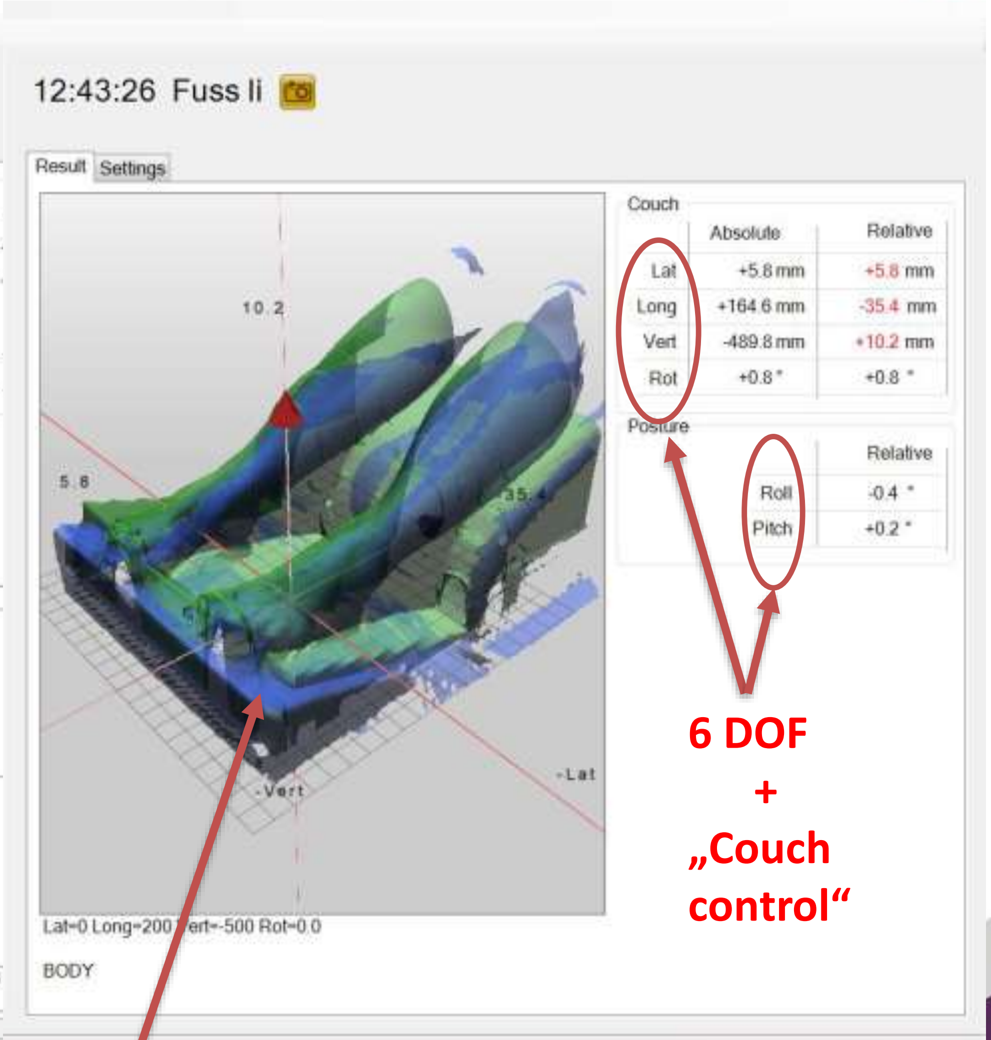
1) Full patient coverage indep. from couch kicks
2) Positioning, Patient Vicinity
3) Motion
4) Gating
5) Audio/Vidual (Googles)
6) Non-rigid Algorithm

→ Instant verification of postural errors (shoulder and head rotation)

„Patient Vicinity“ und Sicherheit :



13:51:38 Hals li



12:43:26 Fuss li

Couch

	Absolute	Relative
Lat	+5.8 mm	+5.8 mm
Long	+164.6 mm	-35.4 mm
Vert	-489.8 mm	+10.2 mm
Rot	+0.8 °	+0.8 °

Posture

	Relative
Roll	-0.4 °
Pitch	+0.2 °

Lat=0 Long=200 Vert=-500 Rot=0.0

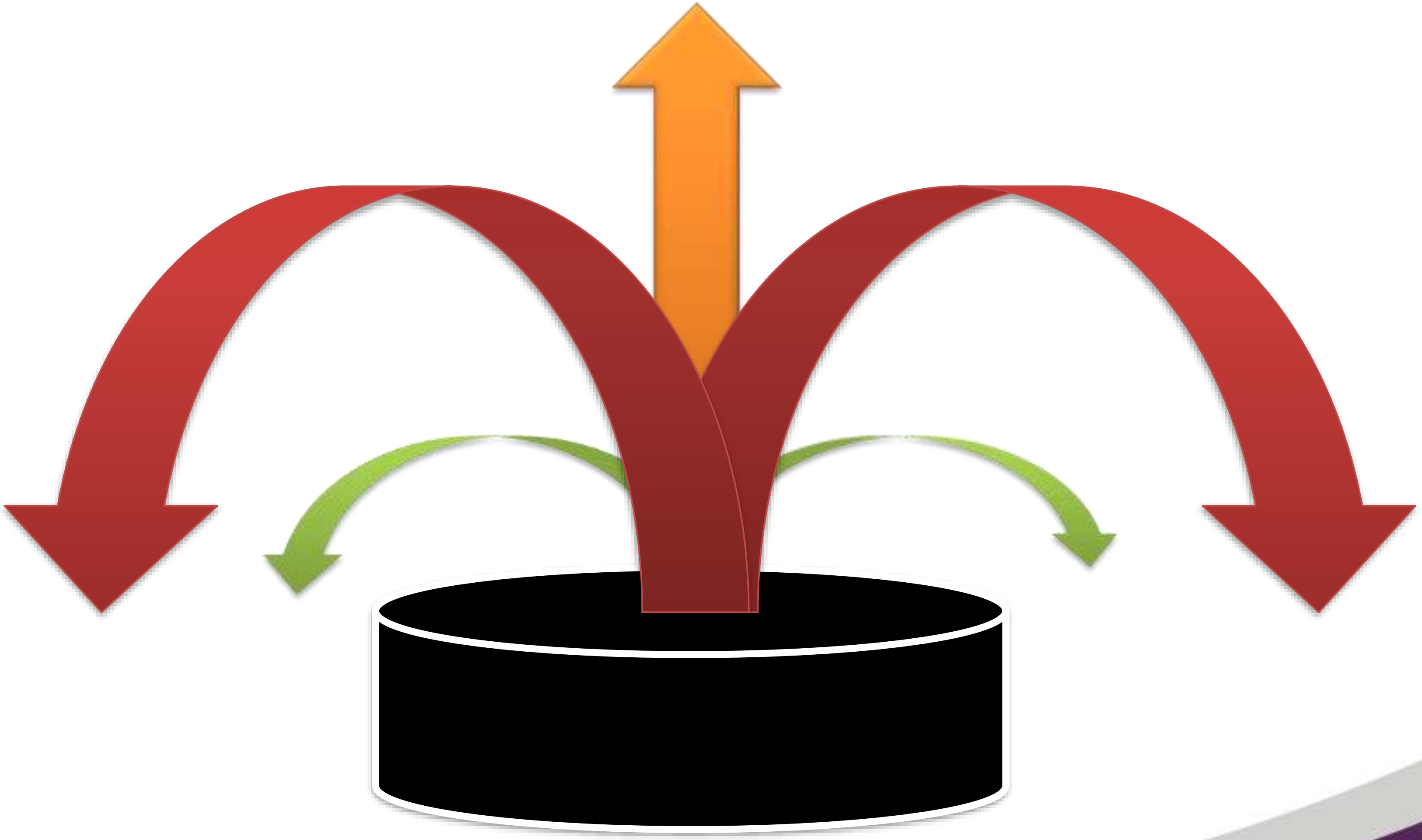
BODY

6 DOF
+
„Couch control“

Sicherheitsfenster (konfigurierbar)

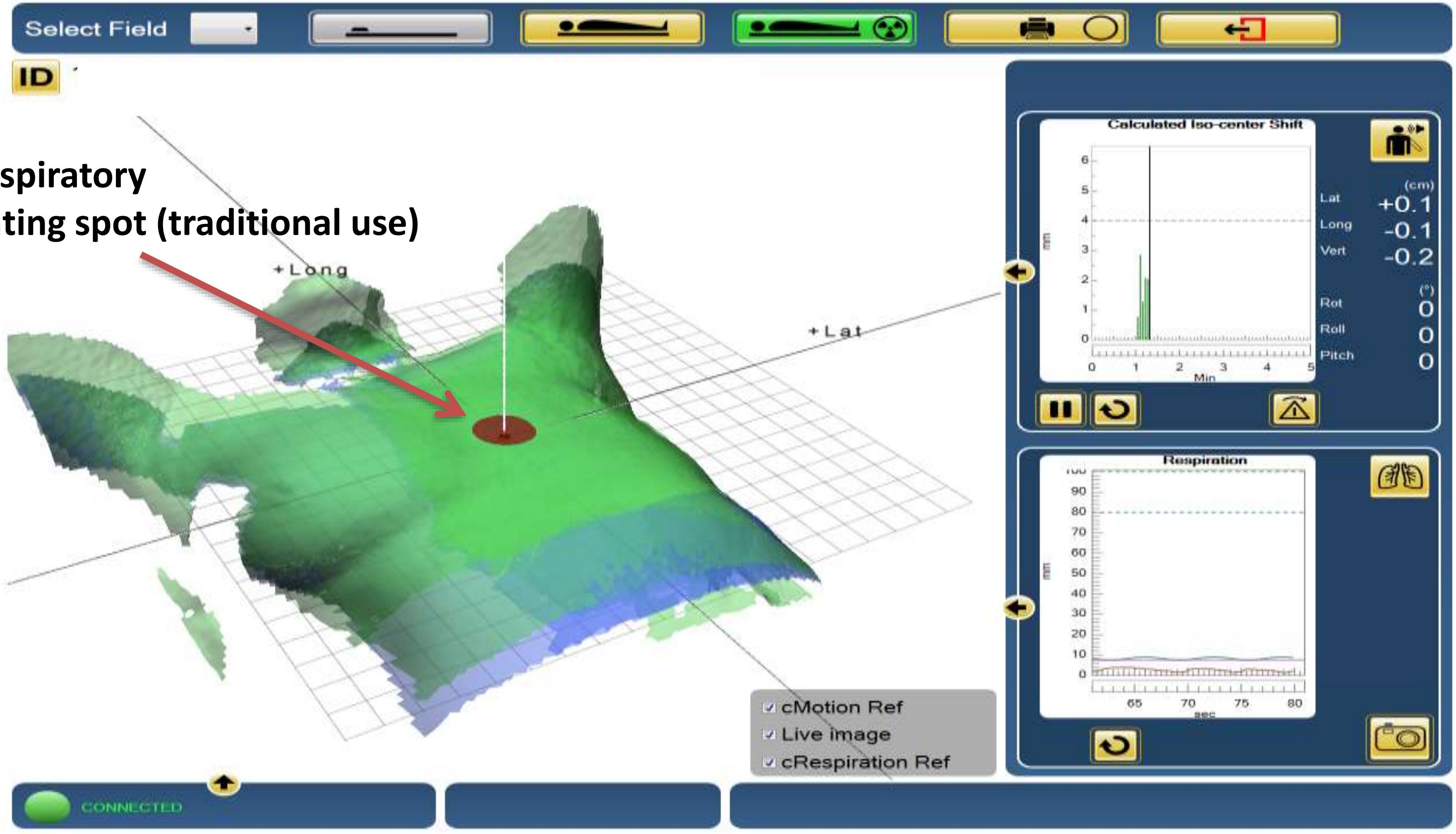
Lagerungshilfe Infomationen …

… and now … let us think „out of the box“



Flexibilität des Systems … mit / ohne Brille

Respiratory Gating spot (traditional use)



(cm)
Lat +0.1
Long -0.1
Vert -0.2

(°)
Rot 0
Roll 0
Pitch 0

☑ cMotion Ref
☑ Live image
☑ cRespiration Ref

Head & Neck … ohne Masken … (Sweden)

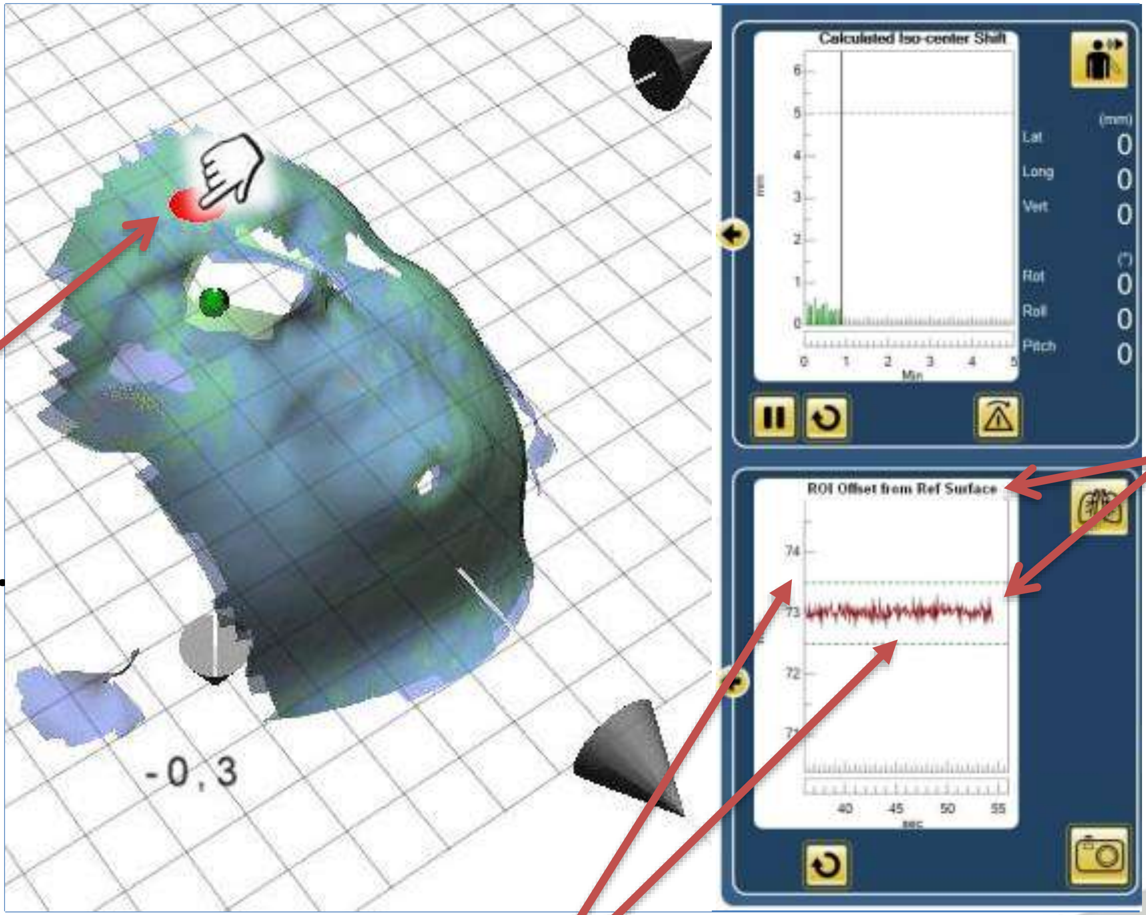
“Reduced fixation with optical monitoring for palliative whole brain radiotherapy treatment”.

Silke Engelholm at al.

Radiation Physics, Skåne University Hospital, Lund, Sweden

„Gating“ primary spot …

Secondary spot also available.

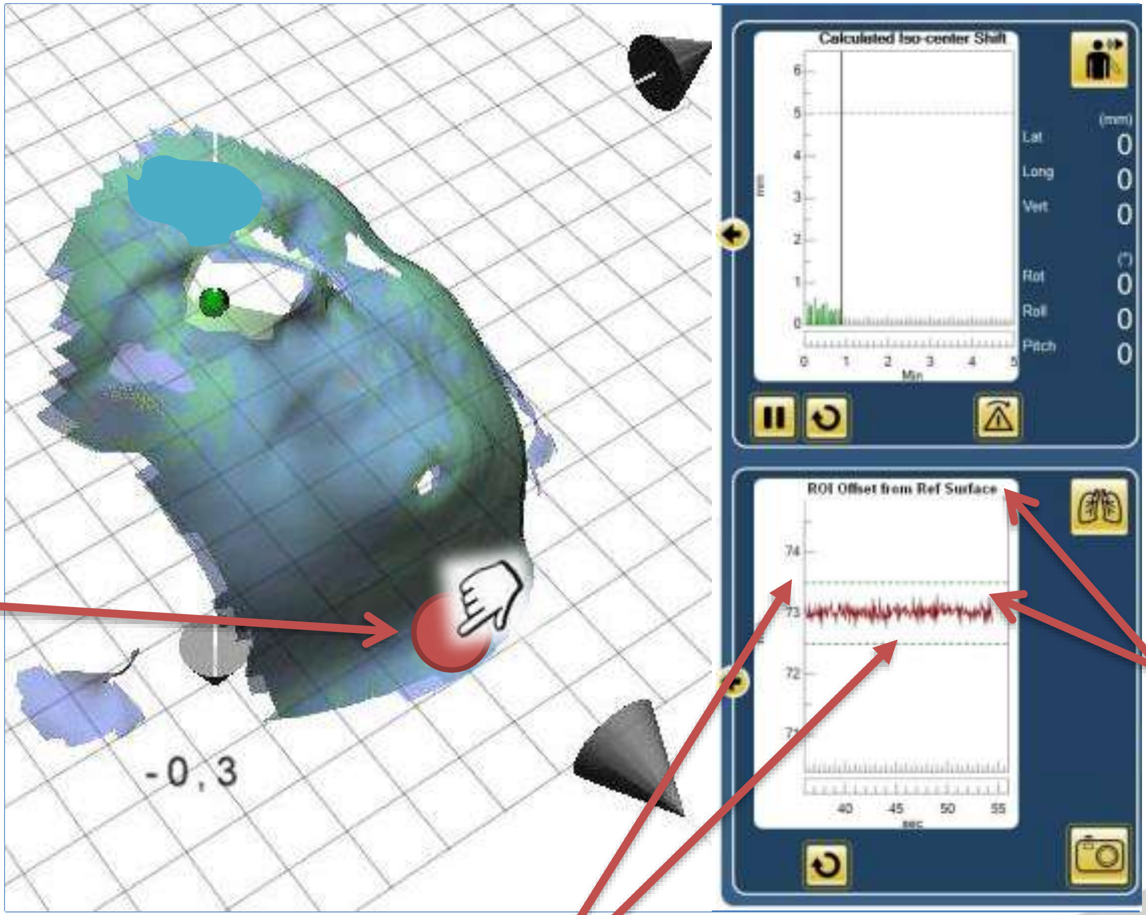


Sicherheitsfenster

Head & Neck … ohne Masken … (USA)

“Application of Surface Mapping in detecting Swallowing for Head & Neck Cancer”

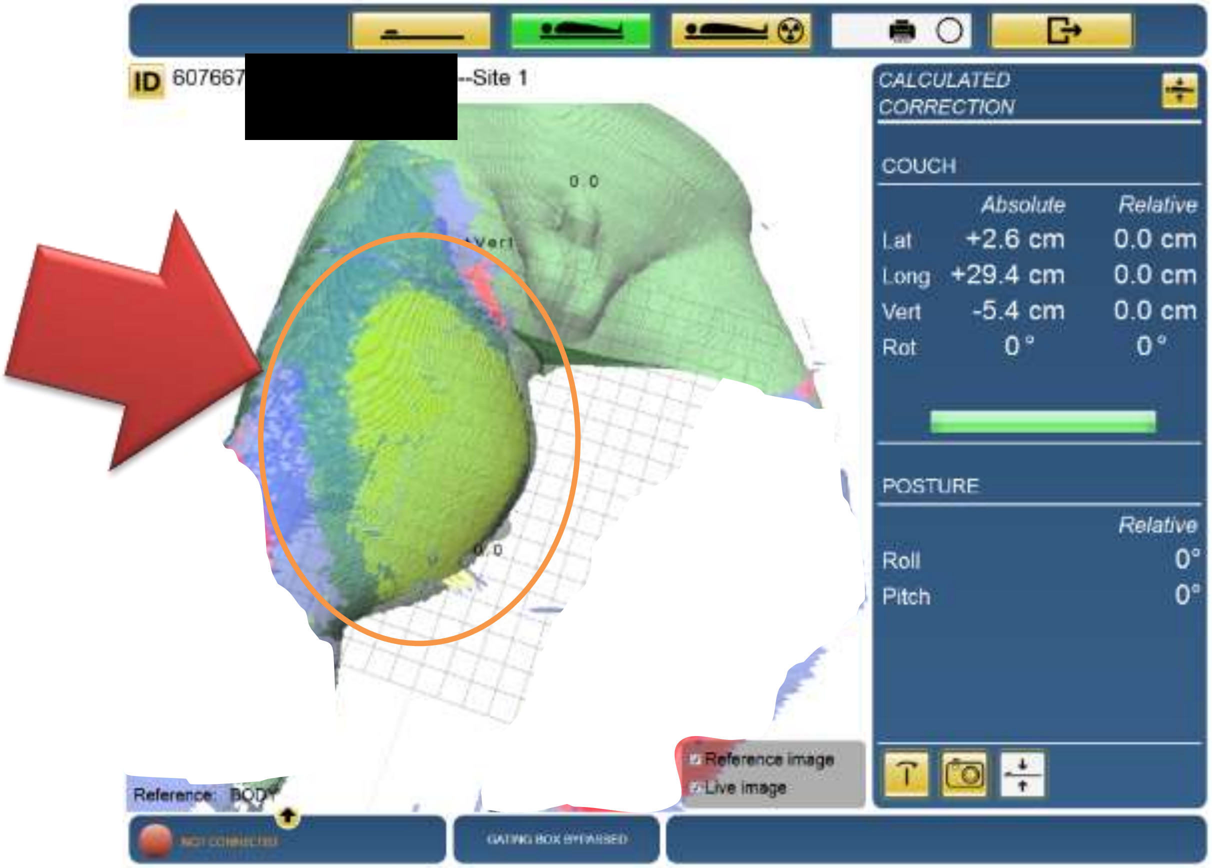
David Shepard et al. - Swedish Hospital Seattle, USA



„Gating“ spot …

Sicherheitsfenster

Sarcoma Positioning after / during Pharmaceutical Treatment (with “crop” function)



ID 607667[redacted]--Site 1

CALCULATED CORRECTION

COUCH

	Absolute	*Relative*
Lat	+2.6 cm	0.0 cm
Long	+29.4 cm	0.0 cm
Vert	-5.4 cm	0.0 cm
Rot	0 °	0 °

POSTURE

	Relative
Roll	0°
Pitch	0°

☑ Reference image
☑ Live image

Reference: BODY

C-RAD Catalyst‘s „cPositioning“ shows fraction-by-fraction surface changes …

NEW ! C-RAD SGSRT solution

Stereotactic radiation therapy including frameless SRS and SBRT workflow

Visit our Stand at ESTRO in Vienna 2017

SRT POWERED

All-in-one solution for SRS and SBRT!

C-RAD

Clinical Training Process

Technical Training as part of the Installation

Target group: Physicist and Lead Therapist

Performed by: C-RAD Installation Engineer

4 hours

On-Site Clinical Application Training

Target Group: Physicians, Physicists and all therapists

Performed by: C-RAD Clinical Application Specialist

3 days

Optional: C-RAD Training center

Target group: “Super user”

2 days

Follow up On-Site Clinical Application Training

Target Group: Physicians, Physicists and all therapists

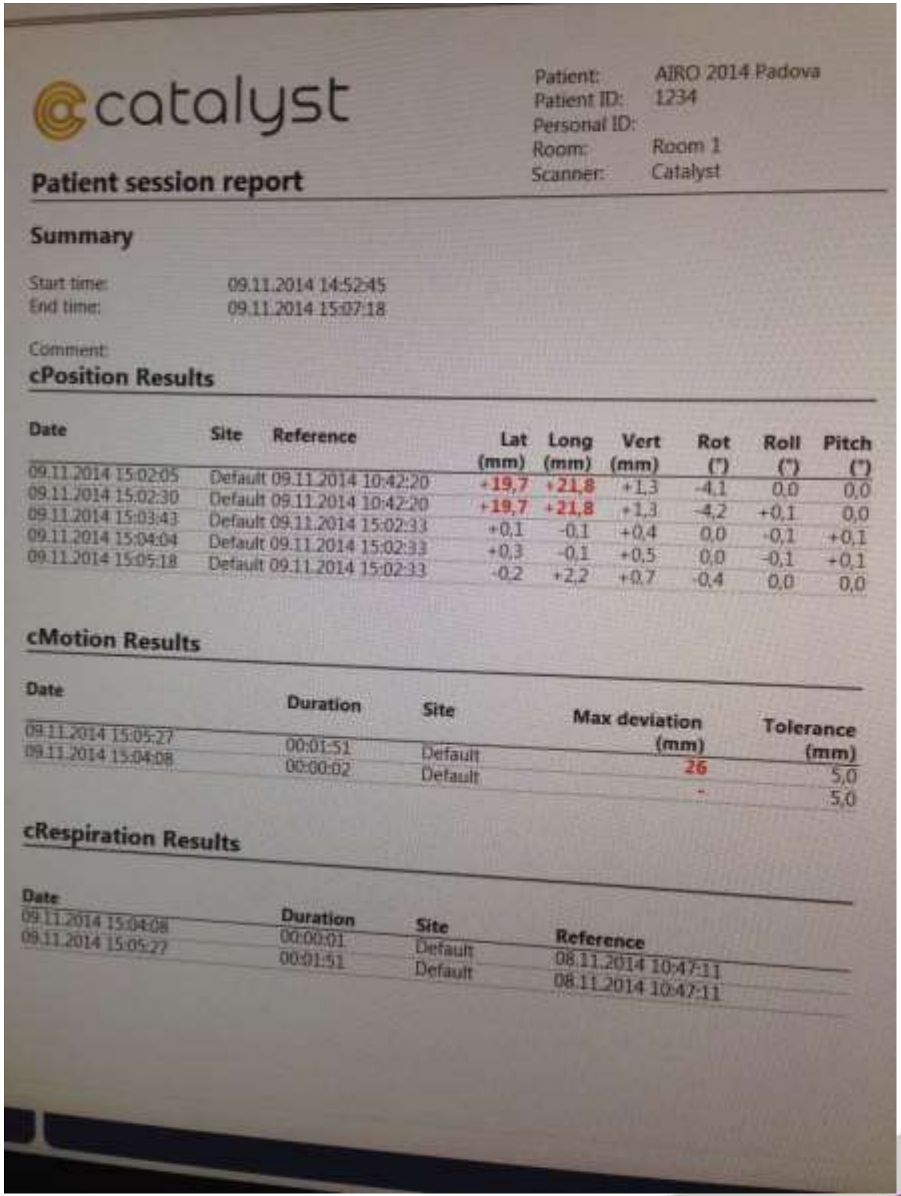
Performed by: C-RAD Clinical Application Specialist

2-3 days

Training and support on demand

Reporting

(on screen and in .pdf)



catalyst

Patient: AIRO 2014 Padova
Patient ID: 1234
Personal ID:
Room: Room 1
Scanner: Catalyst

Patient session report

Summary

Start time: 09.11.2014 14:52:45
End time: 09.11.2014 15:07:18

Comment:

cPosition Results

Date	Site	Reference	Lat (mm)	Long (mm)	Vert (mm)	Rot (°)	Roll (°)	Pitch (°)
09.11.2014 15:02:05	Default	09.11.2014 10:42:20	+19,7	+21,8	+1,3	-4,1	0,0	0,0
09.11.2014 15:02:30	Default	09.11.2014 10:42:20	+19,7	+21,8	+1,3	-4,2	+0,1	0,0
09.11.2014 15:03:43	Default	09.11.2014 15:02:33	+0,1	-0,1	+0,4	0,0	-0,1	+0,1
09.11.2014 15:04:04	Default	09.11.2014 15:02:33	+0,3	-0,1	+0,5	0,0	-0,1	+0,1
09.11.2014 15:05:18	Default	09.11.2014 15:02:33	-0,2	+2,2	+0,7	-0,4	0,0	0,0

cMotion Results

Date	Duration	Site	Max deviation (mm)	Tolerance (mm)
09.11.2014 15:05:27	00:01:51	Default	26	5,0
09.11.2014 15:04:08	00:00:02	Default	-	5,0

cRespiration Results

Date	Duration	Site	Reference
09.11.2014 15:04:08	00:00:01	Default	08.11.2014 10:47:11
09.11.2014 15:05:27	00:01:51	Default	08.11.2014 10:47:11

Publications :

Hepp R, Ammerpohl M, Morgenstern C, Nielinger L, Erichsen P, Abdallah A,Galalae R. Deep inspiration breath-hold (DIBH) radiotherapy in left-sided breast cancer : Dosimetrical comparison and clinical feasibility in 20 patients. Strahlenther Onkol. 2015 Apr 18. [Epub ahead of print]

Deep inspiration breath-hold (DIBH) Radiotherapy in left-sided breast cancer: Dosimetrical comparison and clinical feasibility in 20 patients

Bestrahlung der linken Brust in tiefer Inspiration und Atemanhaltetechnik (DIBH) bei linksseitigem Brustkrebs:
Dosimetrischer Vergleich und Prüfung der klinischen Durchführbarkeit in 20 Patientinnen.

Rodrigo Hepp M.D.[1];
Nielinger[1, 2] B.Eng., P
M.D.

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Evangelische Kliniken

[2]Hochschule Hamm-L

[3]Klinik für Senologie
Evangelische Kliniken

[4] Medizinische Fakult

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Sentinel/Catalyst surface tracking system for respiratory gating. Tests performed at Skåne University Hospital, SUS, Malmö.

Charlotte Thornberg, Mattias Jönsson, Sofie Ceberg, Malin Kugele, Fredrik Nordström

Introduction

In radiation treatment, gating can be used in different ways to minimize the absorbed dose to risk organs. A positive correlation has been observed between cardiac dose-volume and the level of excess risk of cardiac mortality from ischemic heart disease (1) as well as between the irradiated lung volume and radiation pneumonitis (2). Respiratory gating for breast cancer patients is a simple and straightforward way to reduce the absorbed dose to the heart and lungs (3). In Malmö, gating of left sided breast cancer patients has been in use clinically since 2007 (Varian Real-time Position Management (RPM) system). A Sentinel system was installed in2009 for evaluation and development of gating functionalities. In 2011, the Sentinel system in the treatment room was moved to the CT room and replaced by a Catalyst system.

This report describes some of the initial tests performed in the implementation of the gating functionality, as well as comparisons with the RPM system.

Material and methods

Catalyst

The Catalyst system is installed in connection with two treatment machines (Varian Xi 2100 Clinacs), and there is also a system in a training room for gating evaluation. Measurement in the Catalyst system is based on the principle of optical triangulation. A rapid and near-invisible sequence of patterns is projected onto the surface of the object to be measured. At the same time, images are captured by a camera, which is mounted at an angle from the projector. By analyzing the recorded image sequence, a high resolution 3D surface model can immediately be reconstructed. A complete surface can be captured in fractions of a second, with an accuracy of a few tenths of a millimeter – measured at a distance of several meters away.

Fig.1. The Catalyst system

SWEDISH

Application of Surface Mapping in Detecting Swallowing for Head-&-Neck Cancer

Daliang Cao, Xin Xie, Vivek Mehta, David M. Shepard
Swedish Cancer Institute, Seattle, WA

Introduction

Methods & Materials

Results

Results

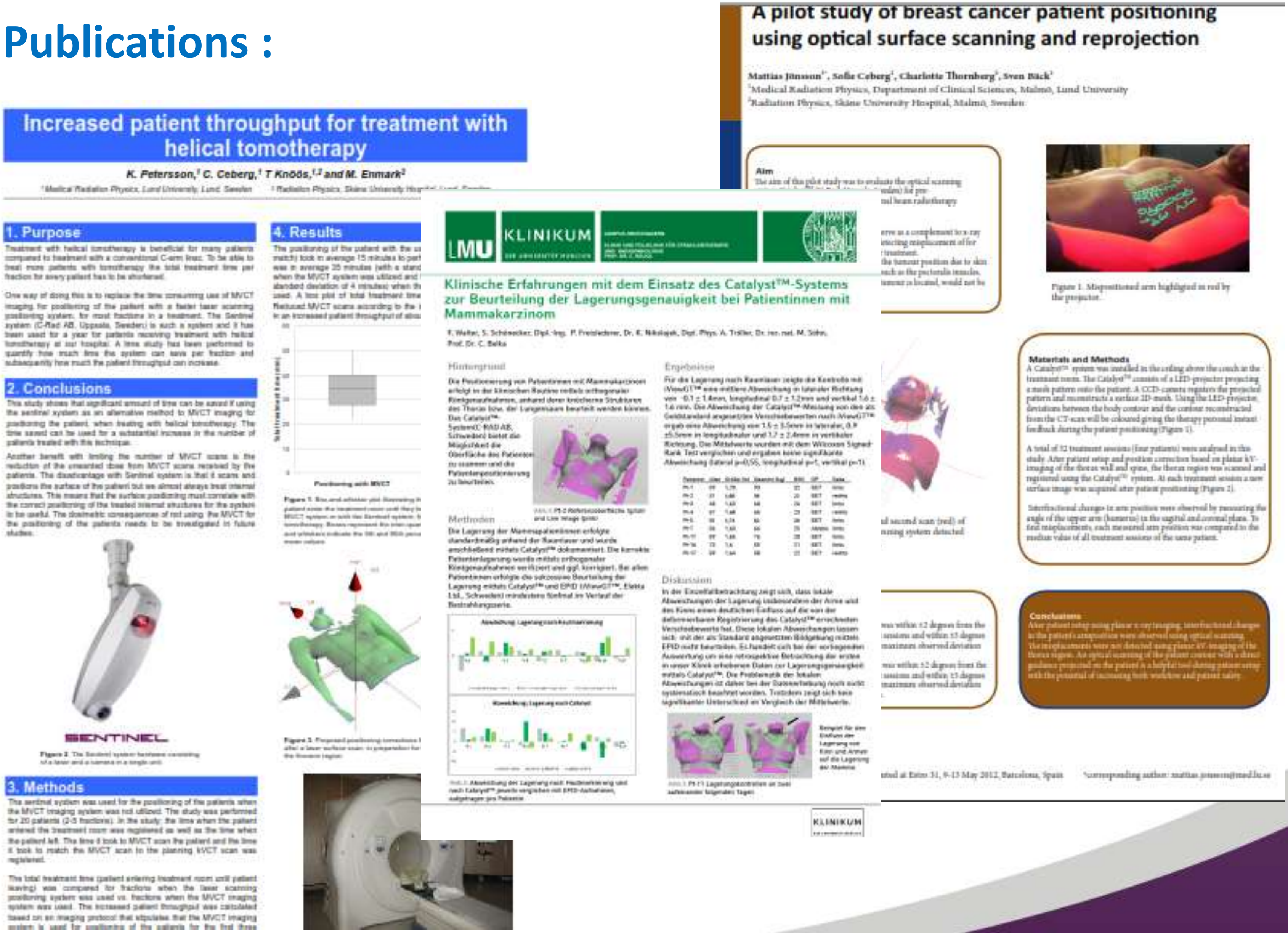
Original article

A novel surface imaging system for patient positioning and surveillance during radiotherapy

A phantom study and clinical evaluation

F. Stieler · T. Wenz · M. Shi · F. Lohr

Publications :



Increased patient throughput for treatment with helical tomotherapy

K. Petersson,[1] C. Ceberg,[1] T Knöös,[1,2] and M. Enmark[2]

[1]Medical Radiation Physics, Lund University, Lund, Sweden

1. Purpose

2. Conclusions

SENTINEL

3. Methods

4. Results

KLINIKUM

Klinische Erfahrungen mit dem Einsatz des Catalyst™-Systems zur Beurteilung der Lagerungsgenauigkeit bei Patientinnen mit Mammakarzinom

Hintergrund

Methoden

Ergebnisse

Diskussion

A pilot study of breast cancer patient positioning using optical surface scanning and reprojection

Mattias Jönsson[1*], Sofie Ceberg[1], Charlotte Thornberg[2], Sven Bäck[2]
[1]Medical Radiation Physics, Department of Clinical Sciences, Malmö, Lund University
[2]Radiation Physics, Skåne University Hospital, Malmö, Sweden

Aim

Materials and Methods

Conclusions

Figure 1. Mispositioned arm highlighted in red by the projector.

Thank you for your attention !

→ **Videos**

www.c-rad.se

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