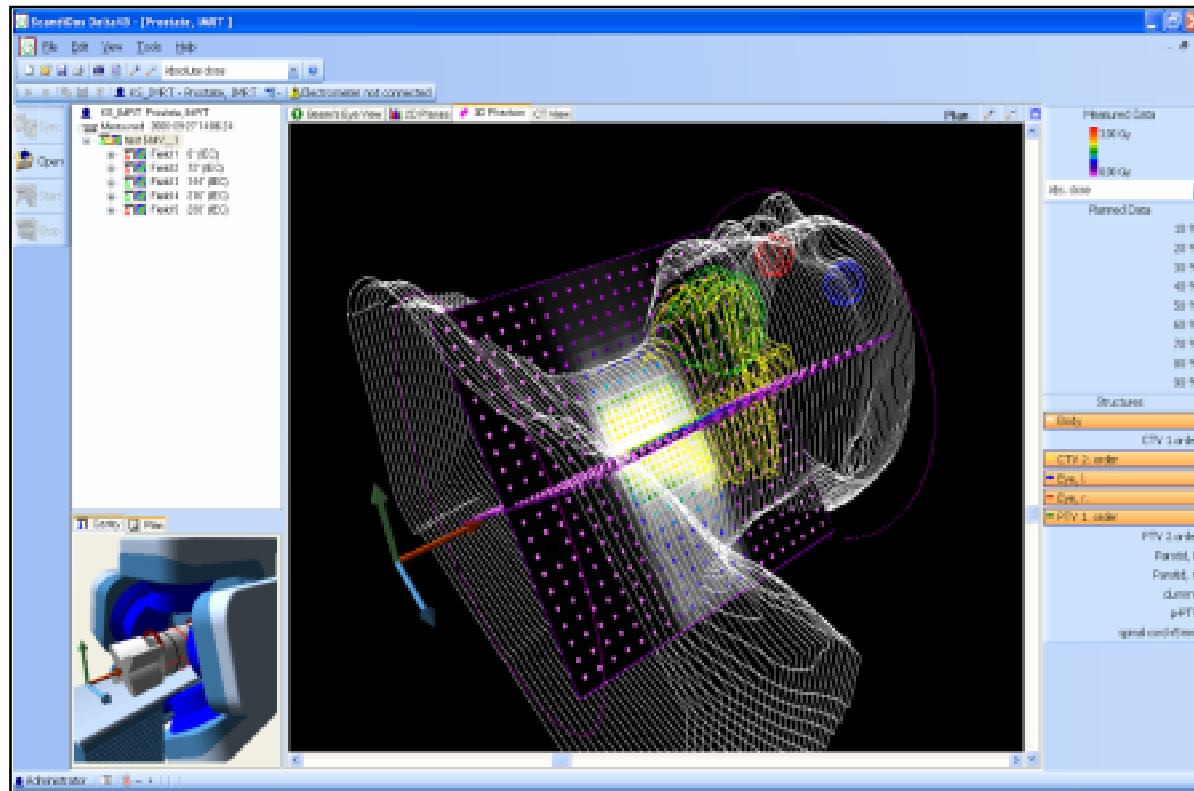


ScandiDos



Delta⁴ – "The difference is clear"

Delta⁴



- Analyse der Fraktionsdosis
 - Schnell
- Abweichung?
 - 3D Fraktionsdosis zusammen mit Patientstrukturen
 - Klinische Relevanz
 - Analyse auf Beam- und Segmentniveau
 - Ursache
- 4D
 - 4D RT, Gating, Arc, IMAT, IGRT, Tomotherapy

ScandiDos AB

- Gegründet 2002
- 6 Physiker und Ingenieure
- Wissenschaftliche Zusammenarbeit



www.scandidos.se

Deutschland



Conmedica GmbH

R. Kramer

S. Kaufhold

Heidelberg

www.conmedica.com

IMRT QA – Wo drückt der Schuh?

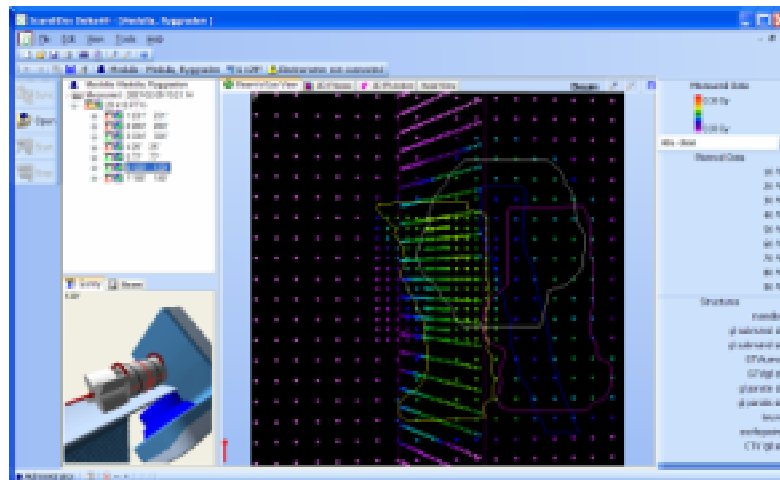
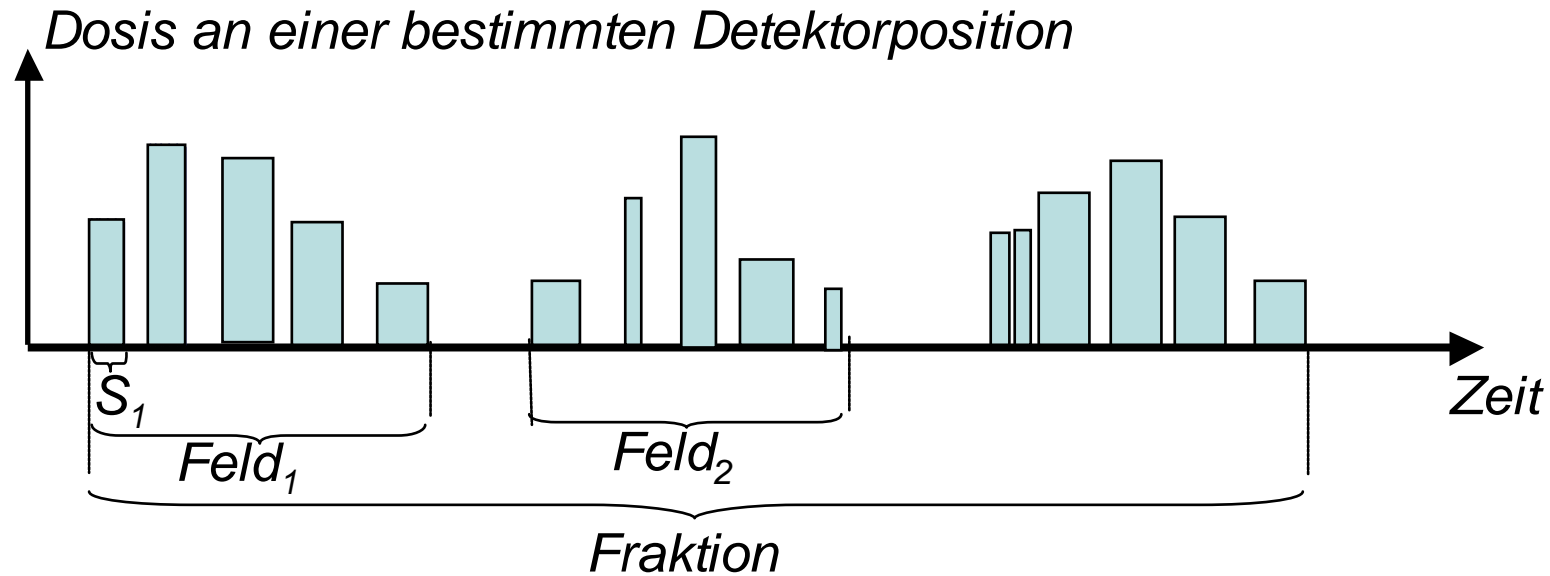
- Zeitraubend, auch für Pläne die OK sind.
- Abweichung entdeckt– Was dann?
 - Signifikanz?
 - Ursache?
- Zukünftige Methoden (4DRT ...) → gestiegene Komplexität:
 - Wie überprüfen?

Delta⁴



- 3D Dosisverteilung
 - Absolut
 - Relativ
- 4D Zeitauflösung
 - Synchronisiert mit Strahlpuls
 - Individuelle Strahlpulse werden je nach Status sortiert + gespeichert
 - Gating: ON oder OFF
 - 4D: Atmungs- oder Bewegungsphase
 - ARC, IMAT: Gantrywinkel
 - Analyse auf Fraktions-, Feld- und Segment- oder Kontrollpunktsniveau

Zeitauflösung

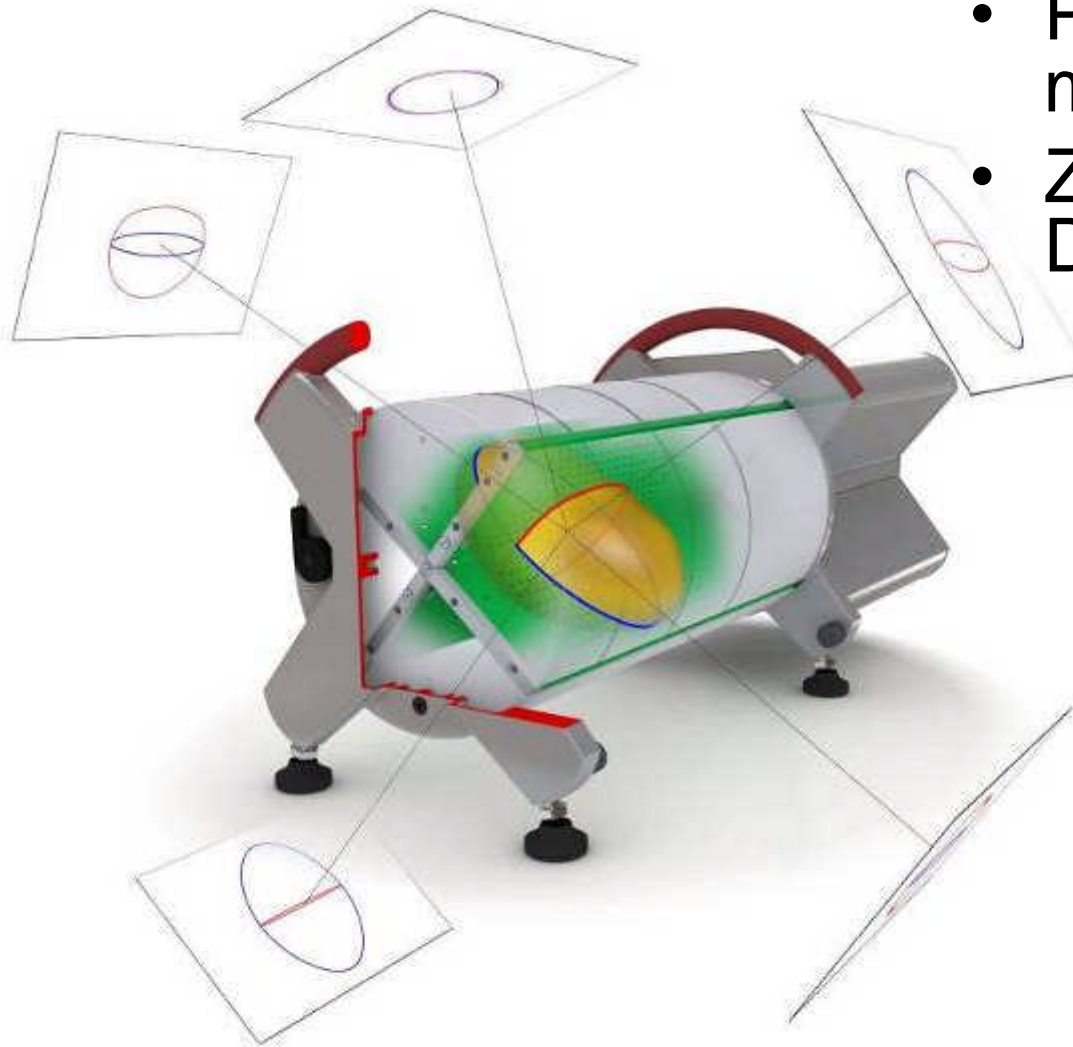


Fraktions-, Feld-, Segmentdosis



- Analyse der Fraktionsdosis
→ Schnell
- Abweichungen?
 - 3D Fraktionsdosis zusammen mit Patientstrukturen
→ Klinische Relevanz
 - Analyse auf Beam- und Segmentniveau
→ Ursache

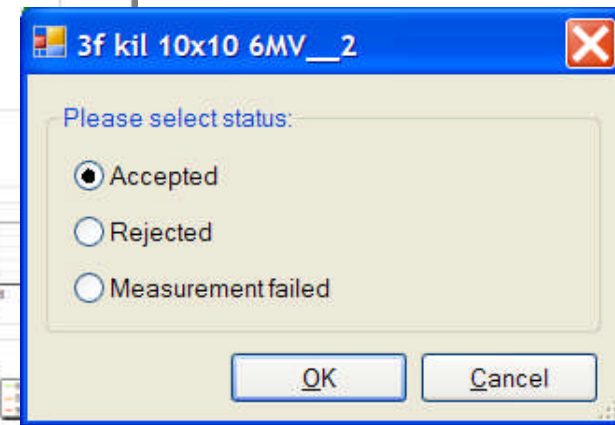
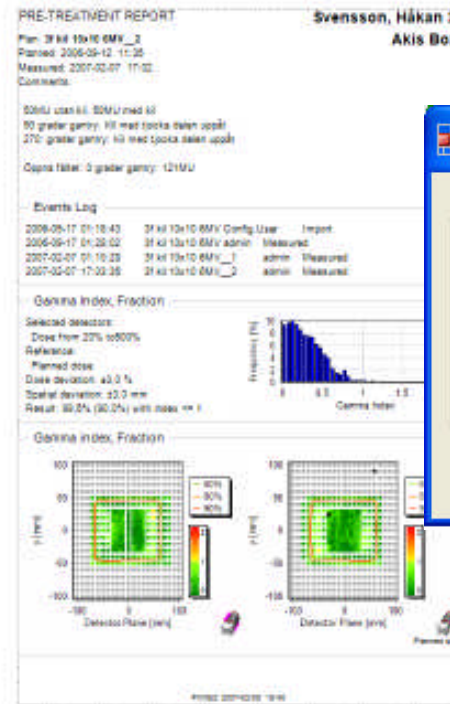
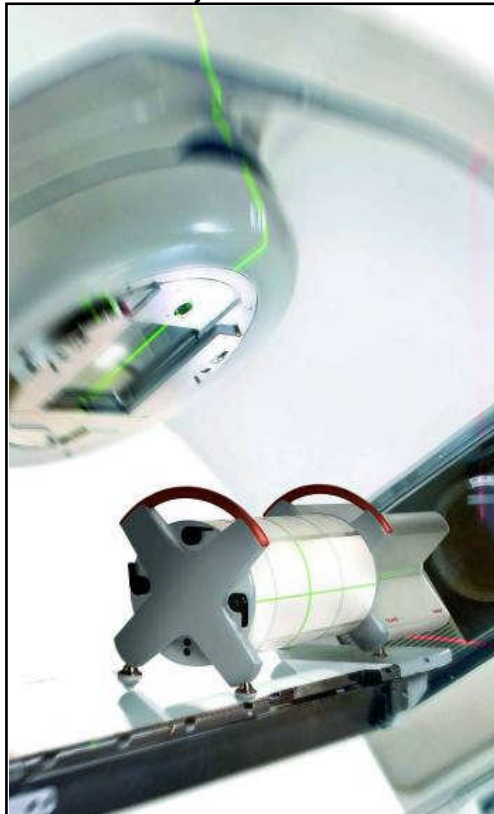
Delta⁴ 3D



- Phantomsubstitutionsmethode
- Zwei orthogonale Detektorebenen
 - Für JEDEN Einfallswinkel wird die Dosistopographie mit hoher Auflösung gemessen
 - Dosisdaten im gesamten 3D Volumen

Set up

- Messung wird exakt so ausgeführt wie die Patientbehandlung
- Pläne, die OK sind: schnelle Verifikation;



Beispiel

The screenshot displays the ScandiDos software interface. A central dialog box titled "Pass / Fail Criteria" is open, showing the following settings:

- Dose Deviation:**
 - Pass if 90.0 % have a deviation within \pm 5.0 %
 - Include detectors with expected dose in the range 50 to 500 %
- Distance to Agreement, DTA:**
 - Pass if 50.0 % have a DTA \leq 3.0 mm
 - Include detectors placed max 5.0 mm from 80 % isodose
- Gamma Index:**
 - Pass if 95 % have a gamma index \leq 1.0
 - Max dose deviation \pm 3.0 %
 - Max spatial deviation \pm 3.0 mm
 - Include detectors with expected dose in the range 30 to 500 %
- MLC Leafs:**
 - Max deviation \pm 2.0 mm

Buttons on the right side of the dialog include OK, Cancel, Help, Set Default, and Get Default. The background interface shows a patient plan with a color scale for "Measured Data" (14% to -8%), a "Planned Data" list (10% to 90%), and three histograms at the bottom: "Dose Deviation [%]", "Distance to Agreement [mm]", and "Gamma Index". The status bar at the bottom indicates "Administrator", "100% - 1.01 Gy", and coordinates "x: -46,1 mm y: 49,9 mm z: -38,7 mm Ref: 1,10 Gy".

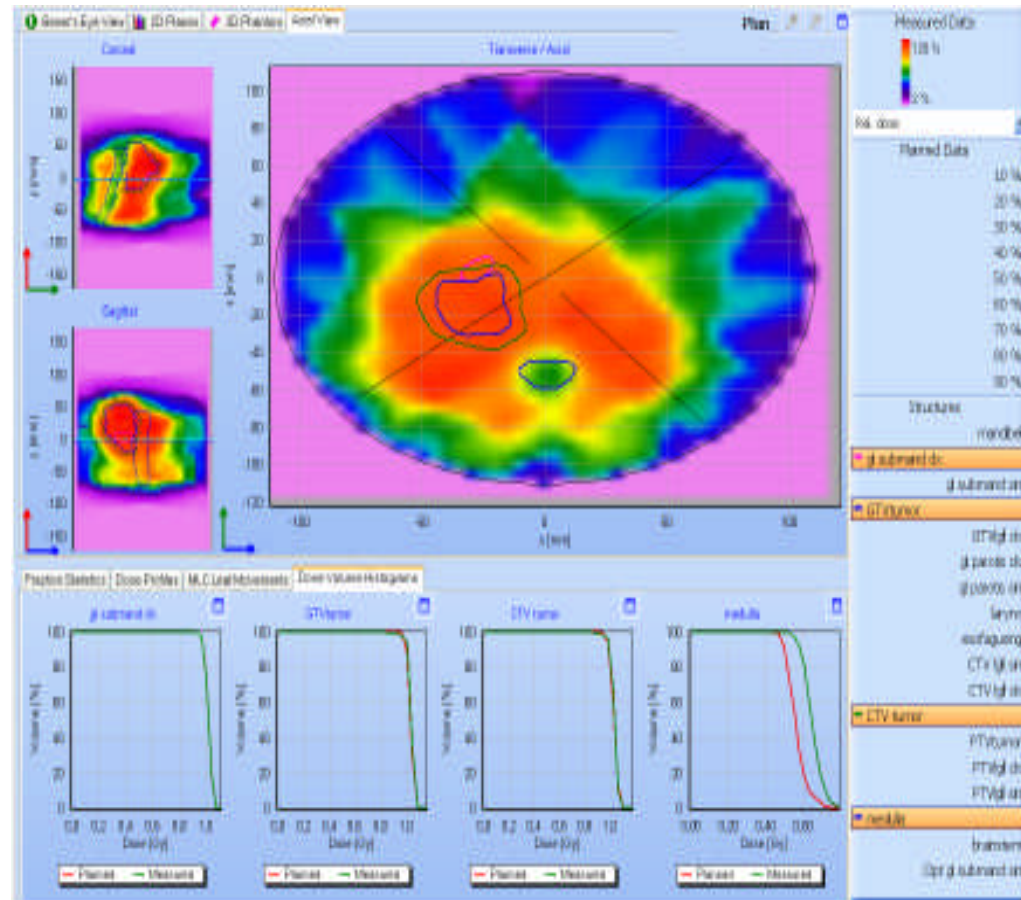
Abweichung?

- Klinische Relevanz?

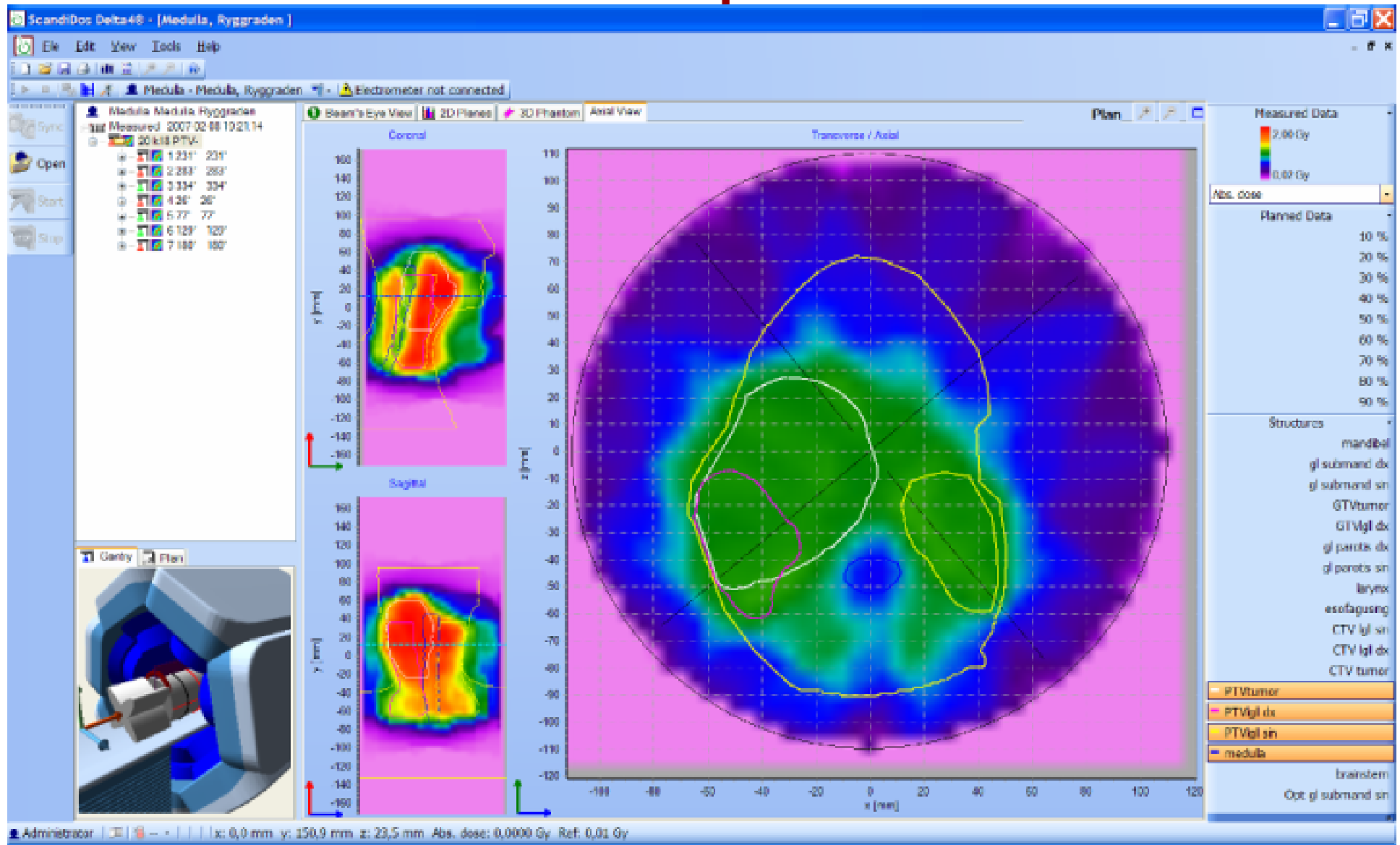
Display von

→ ROI

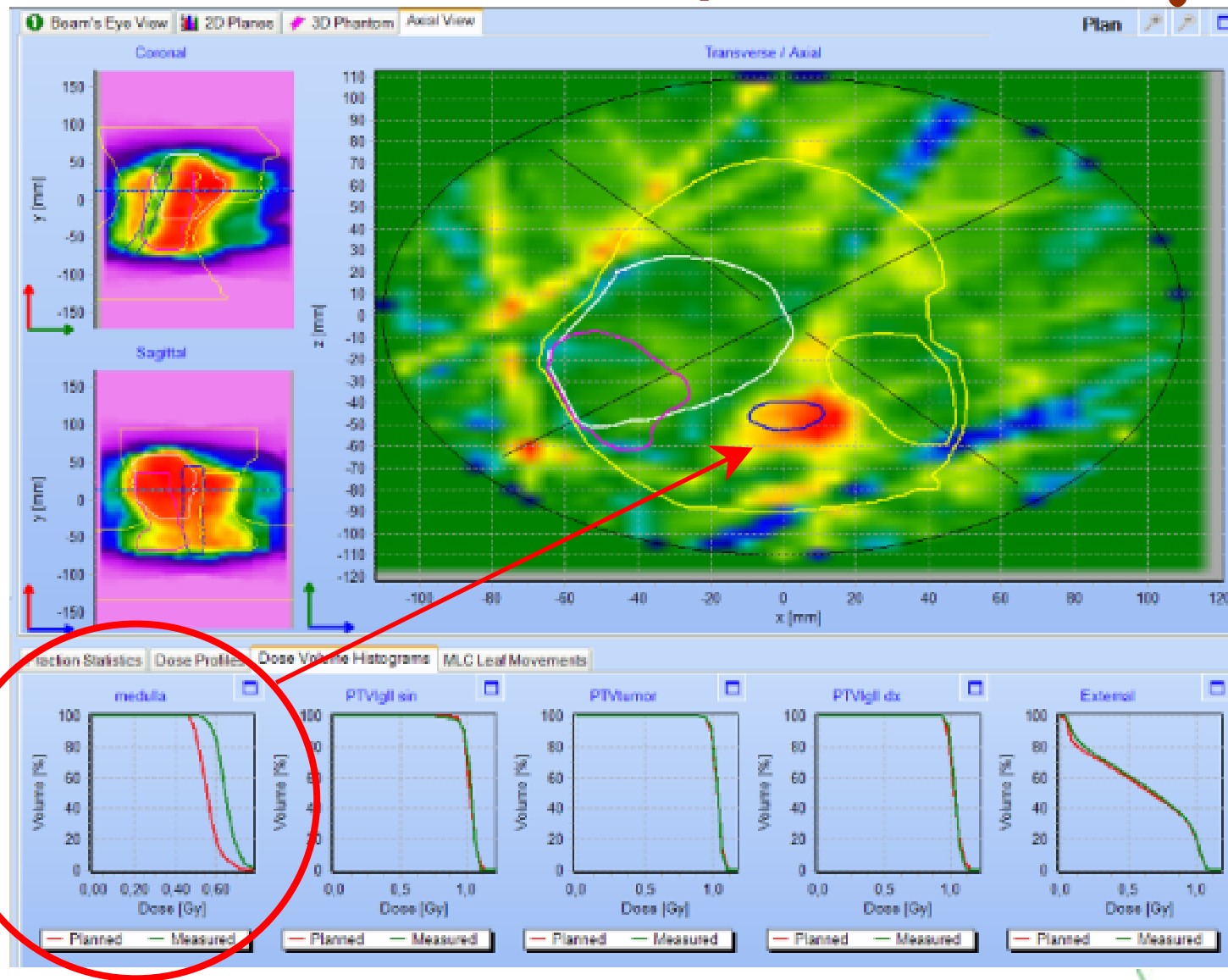
→ DVH



Beispiel

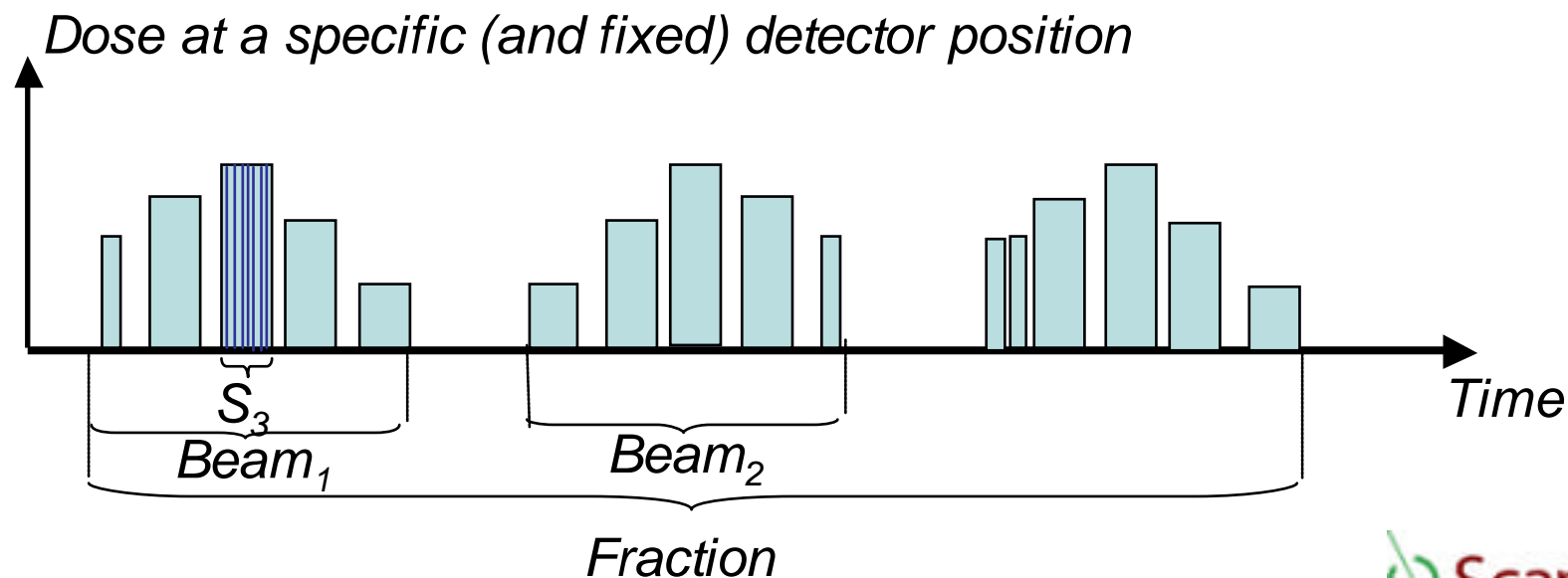


Beispiel



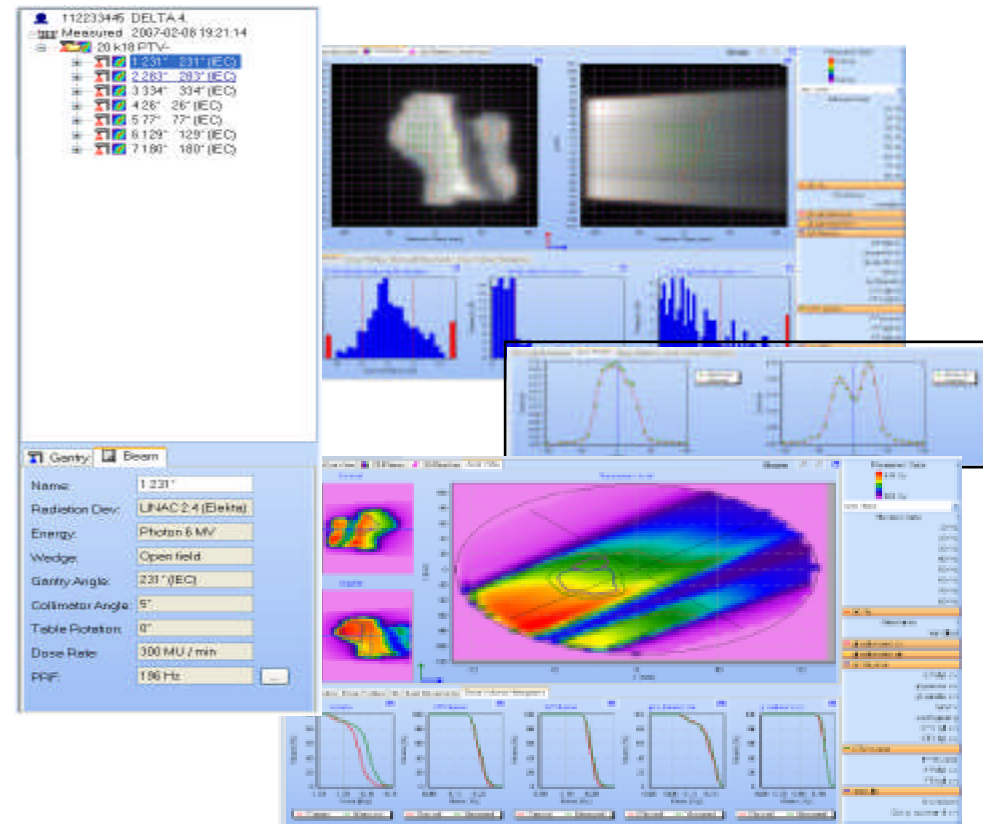
Abweichung?

- Klinisk relevans?
- Ursache?
 - Tiefergehende Analyse ausgehend von den Ursprungsdaten



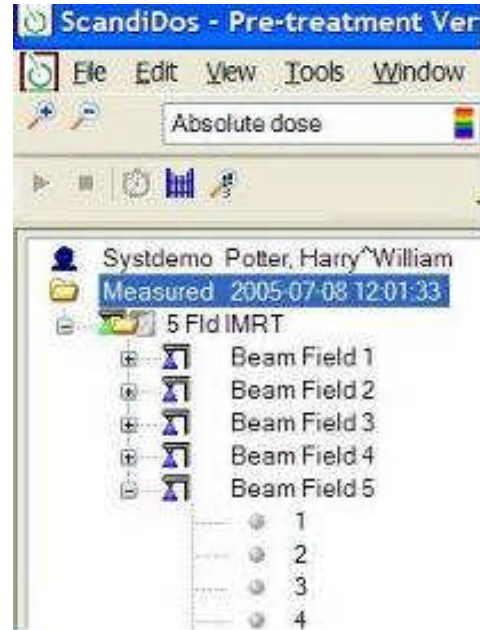
Analyse der Meßdaten

- Dosisverteilung
 - Relativ
 - Absolut
- Dosisabweichung
 - Relativ
 - absolut
- DTA
- Gammaindex

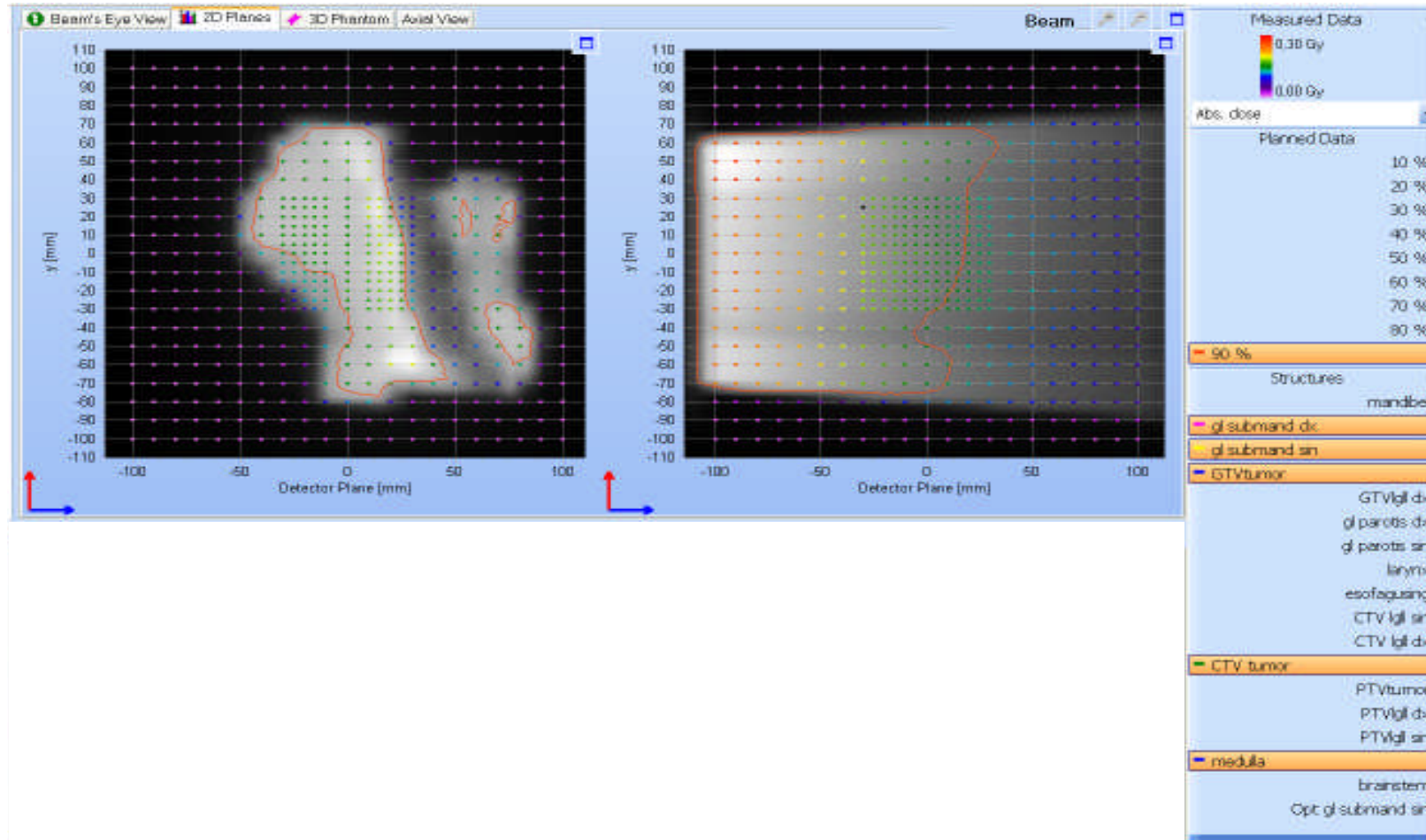


Analyse der Meßdaten

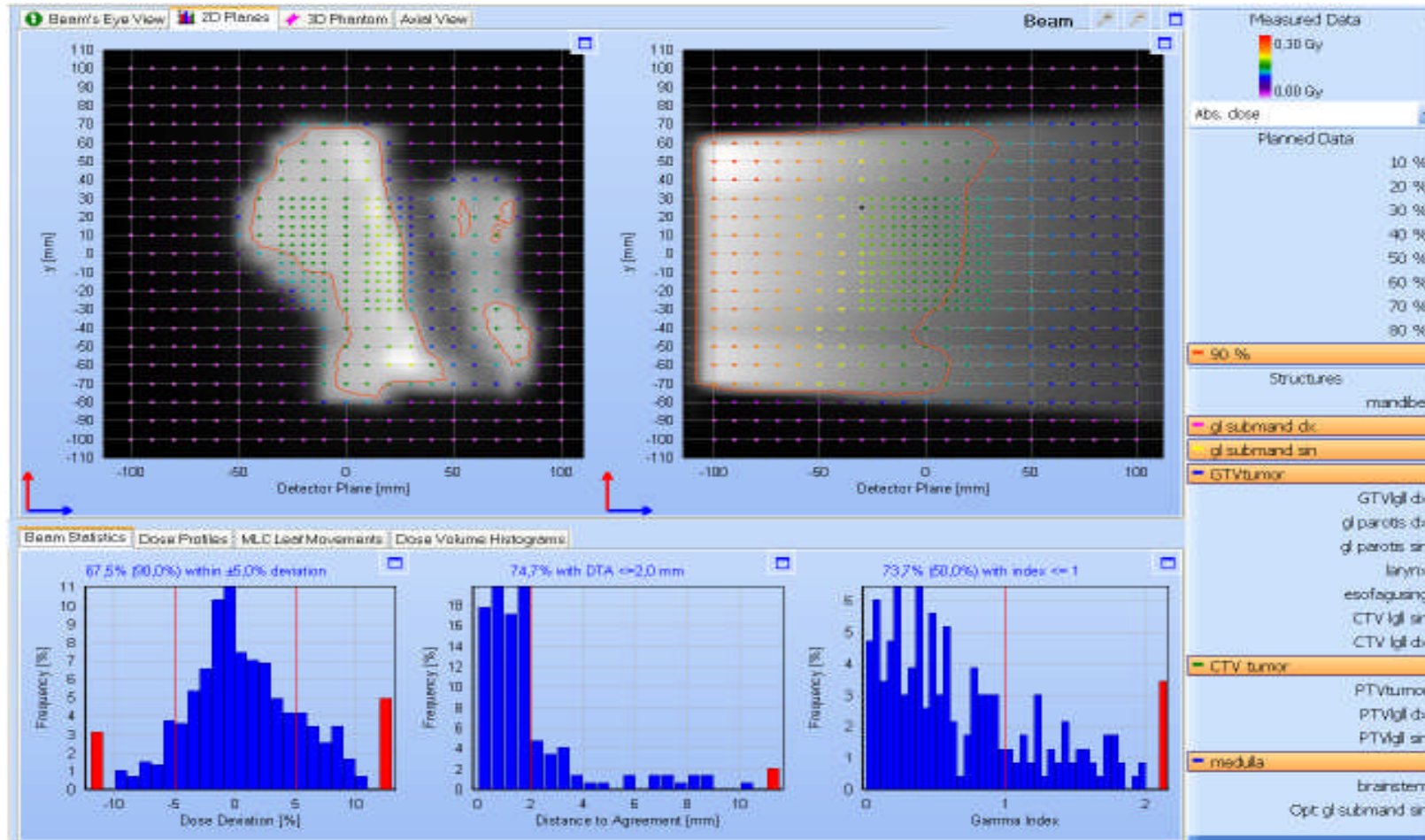
- Dosisverteilung
- Dosisabweichung
- DTA
- Gammaindex
- Fraktion
- Beam
- Segment/
Kontrollpunkt



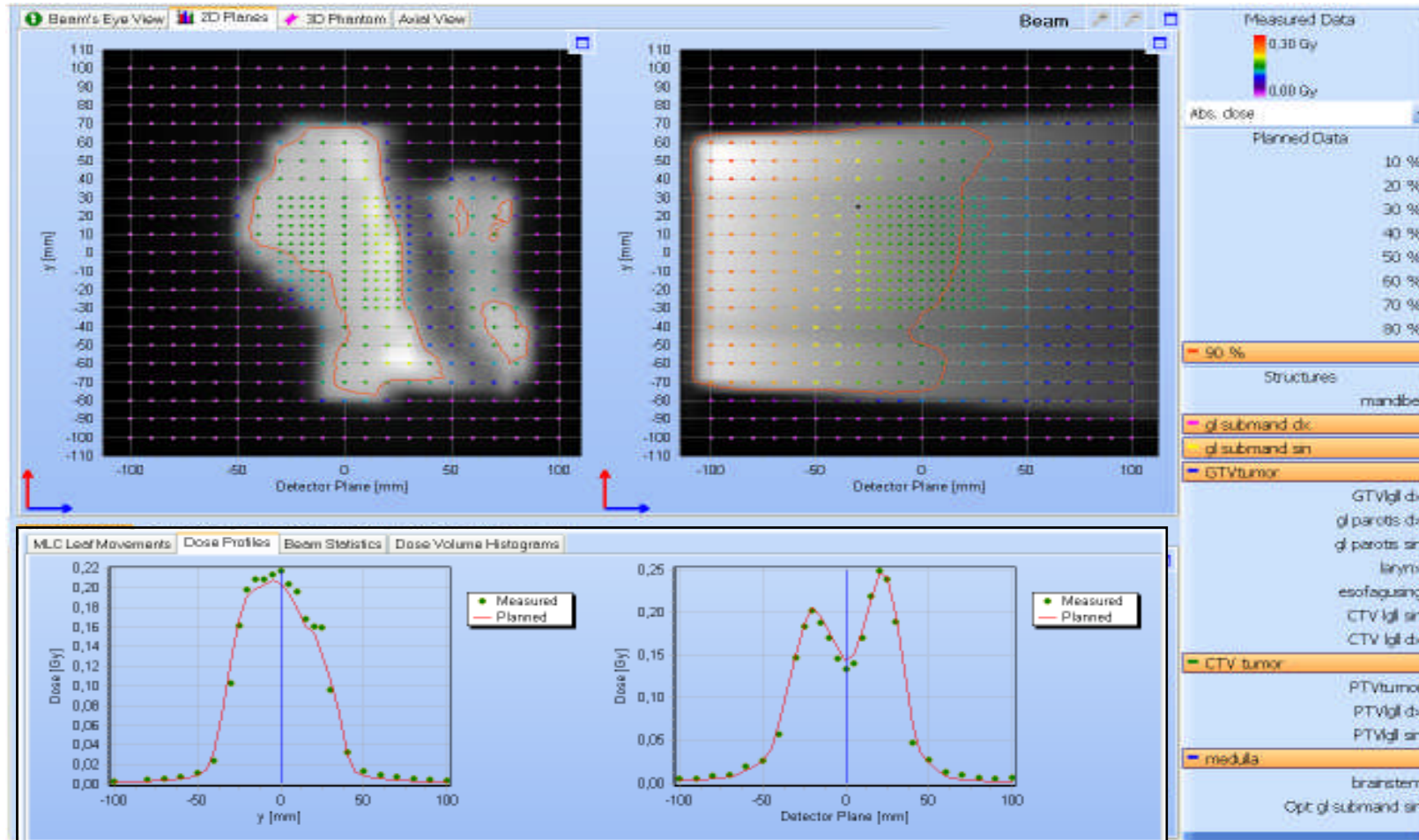
2D



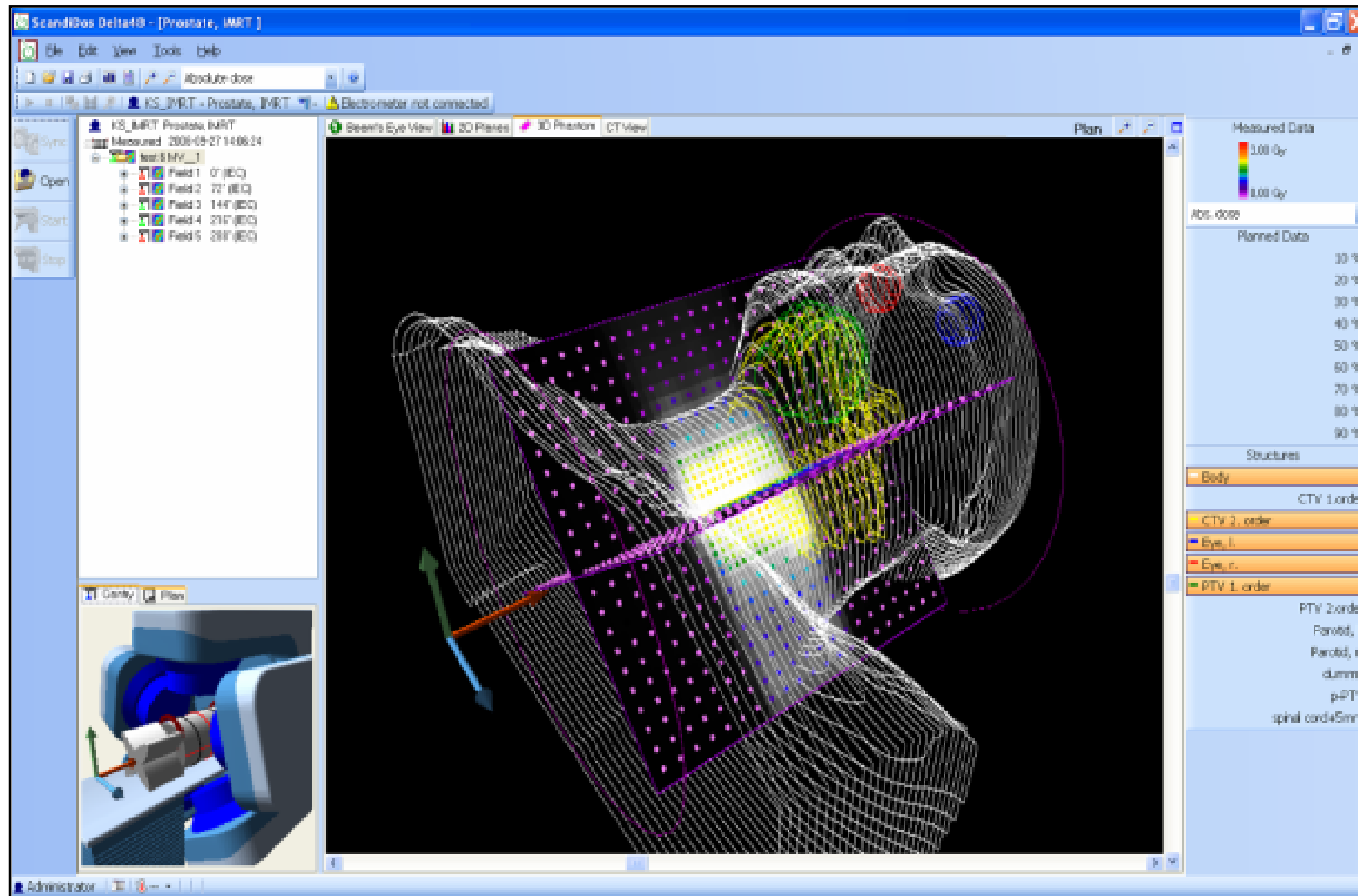
Histogramm



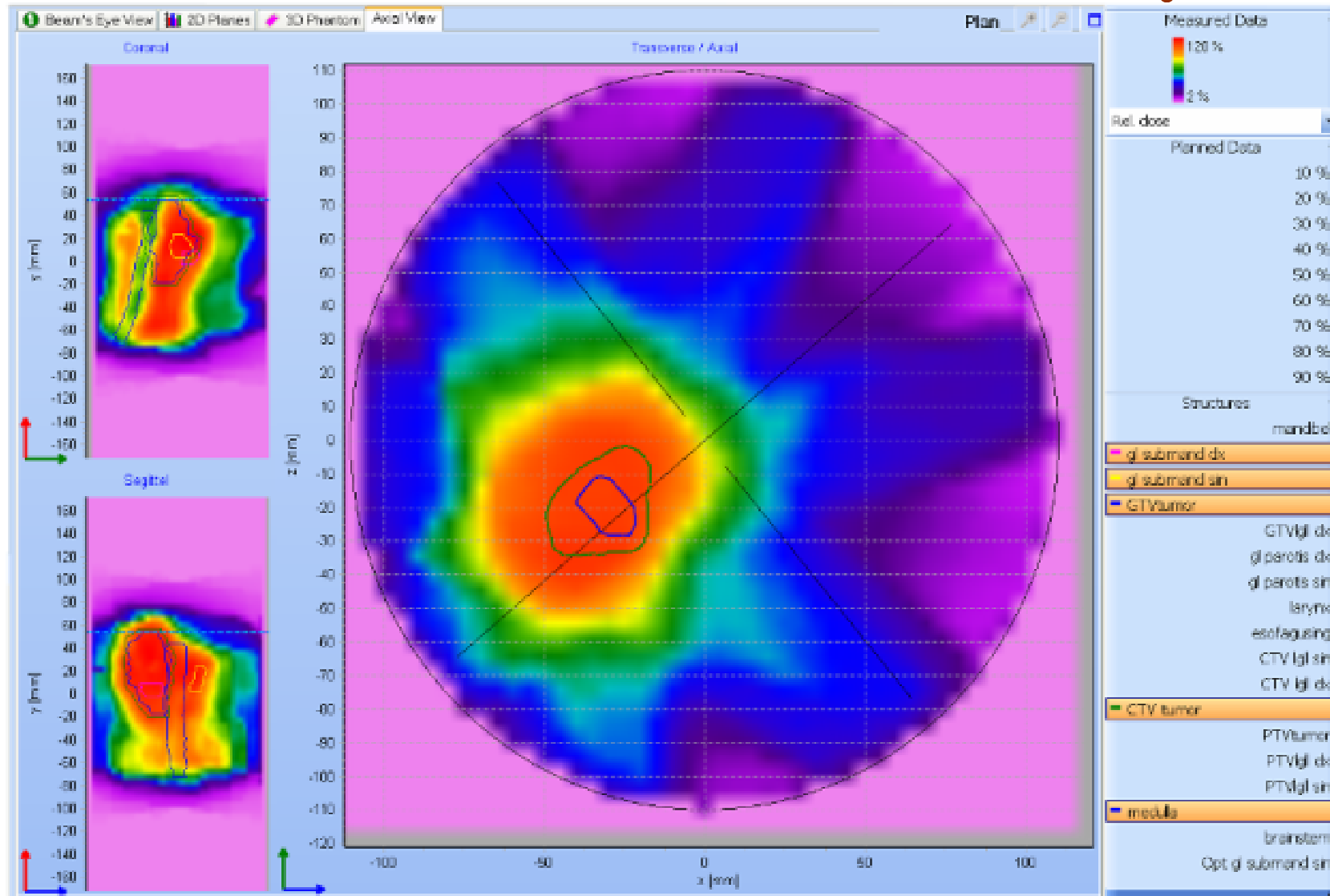
Profile



3D



CT-Ansicht

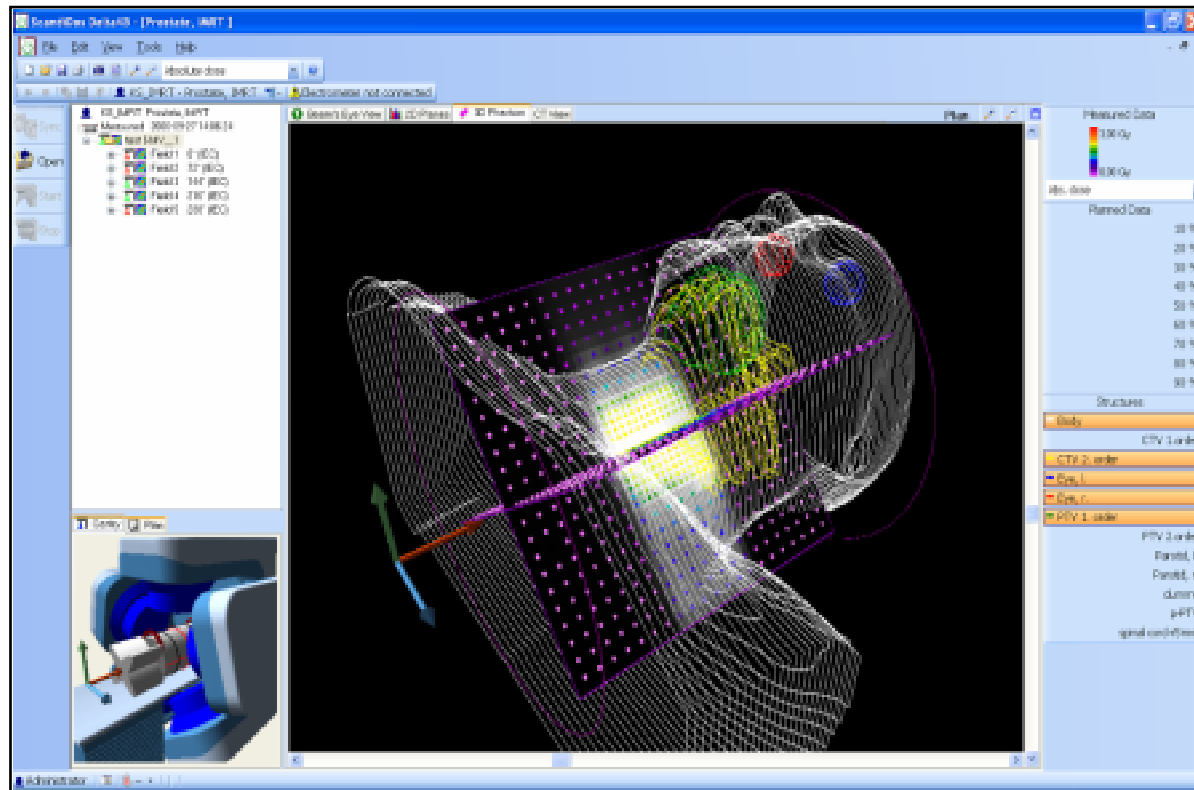


Delta⁴



- Analyse der Fraktionsdosis
 - Schnell
- Abweichung?
 - 3D Fraktionsdosis zusammen mit Patientstrukturen
 - Klinische Relevanz
 - Analyse auf Beam- und Segmentniveau
 - Ursache
- 4D
 - 4D RT, Gating, Arc, IMAT, IGRT, Tomotherapy

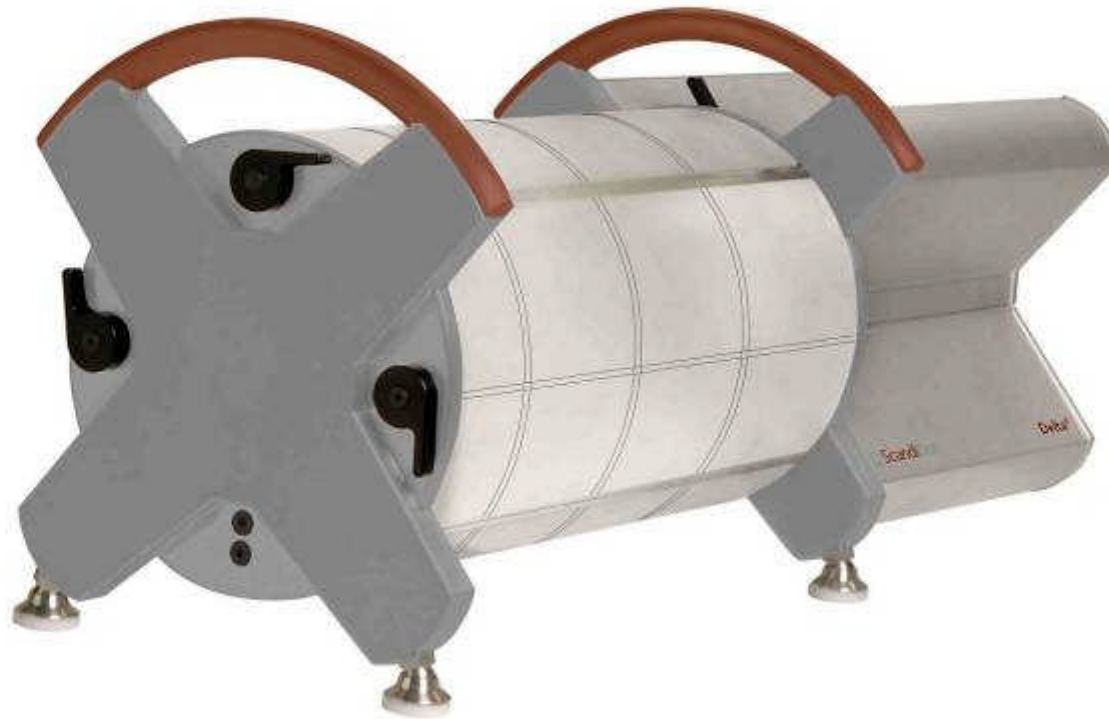
ScandiDos



Vielen Dank!

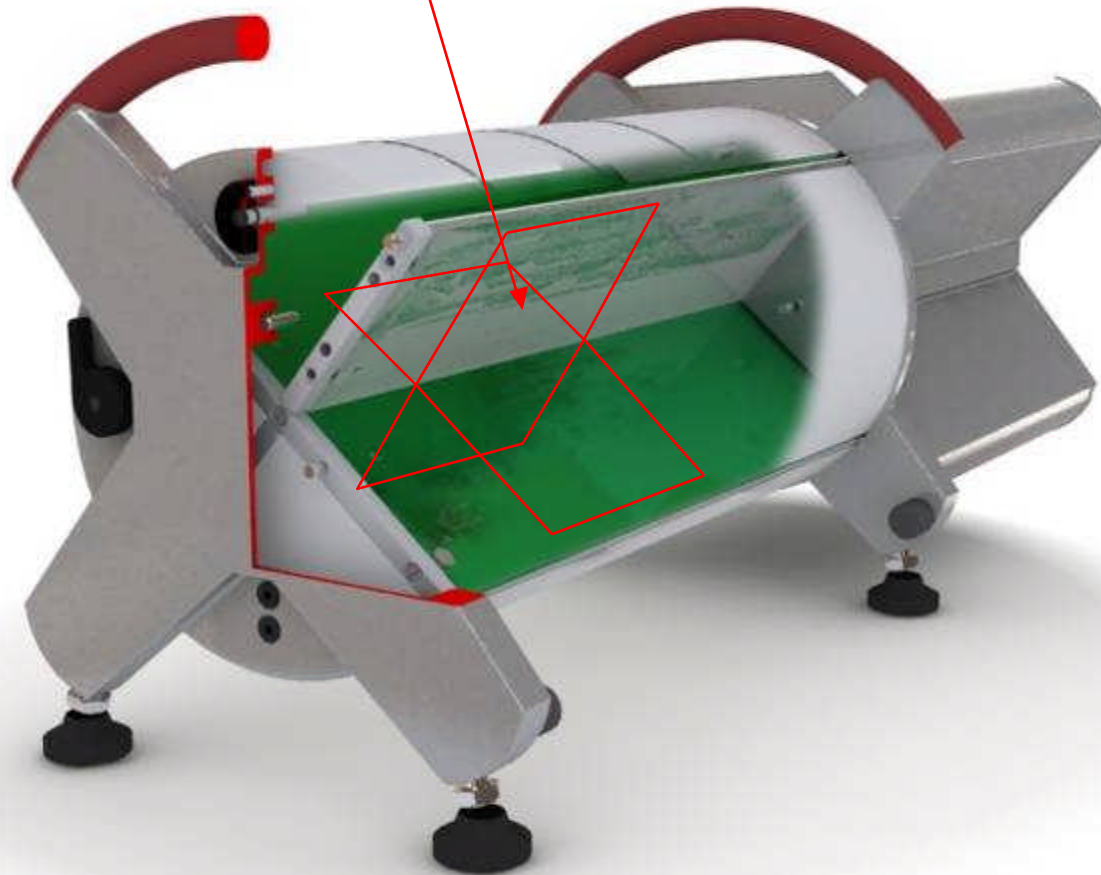
Delta⁴

Cylindrical phantom: Ø: 22 cm, length: 40 cm



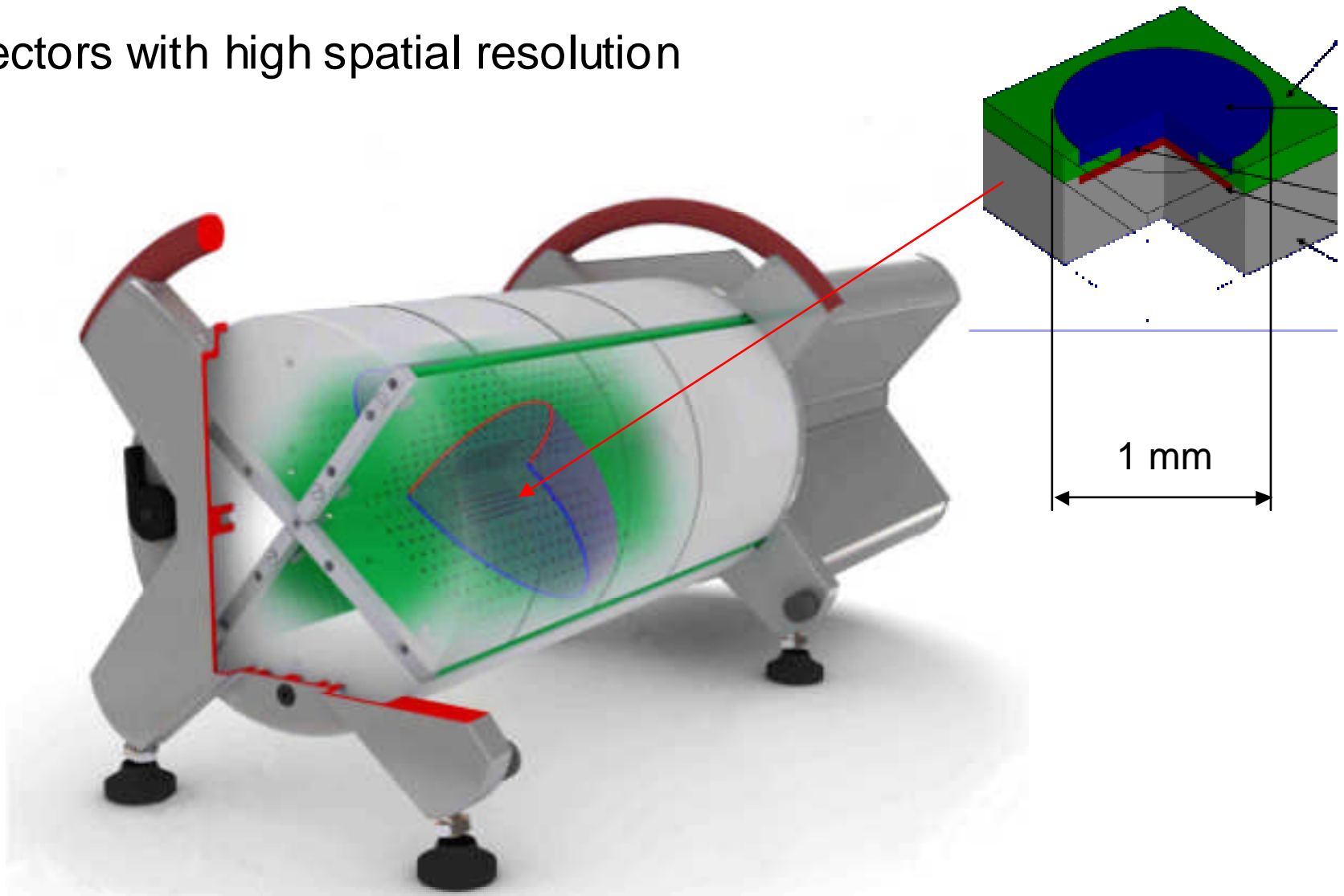
Delta⁴

Detection area: 20 x 20 cm



Delta⁴

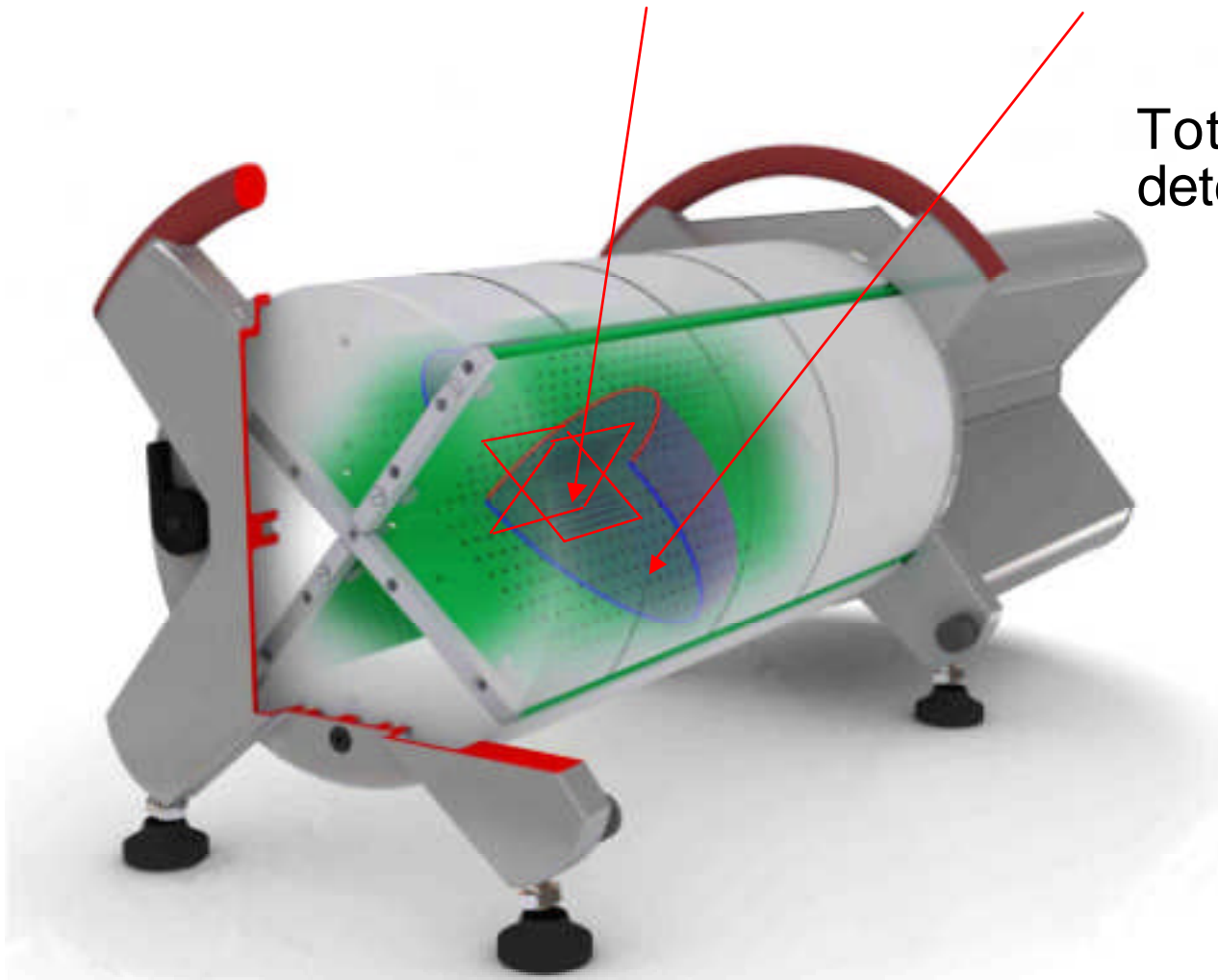
Detectors with high spatial resolution



Delta⁴

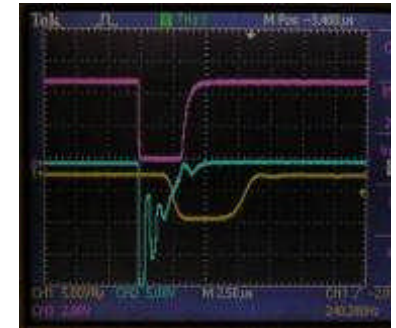
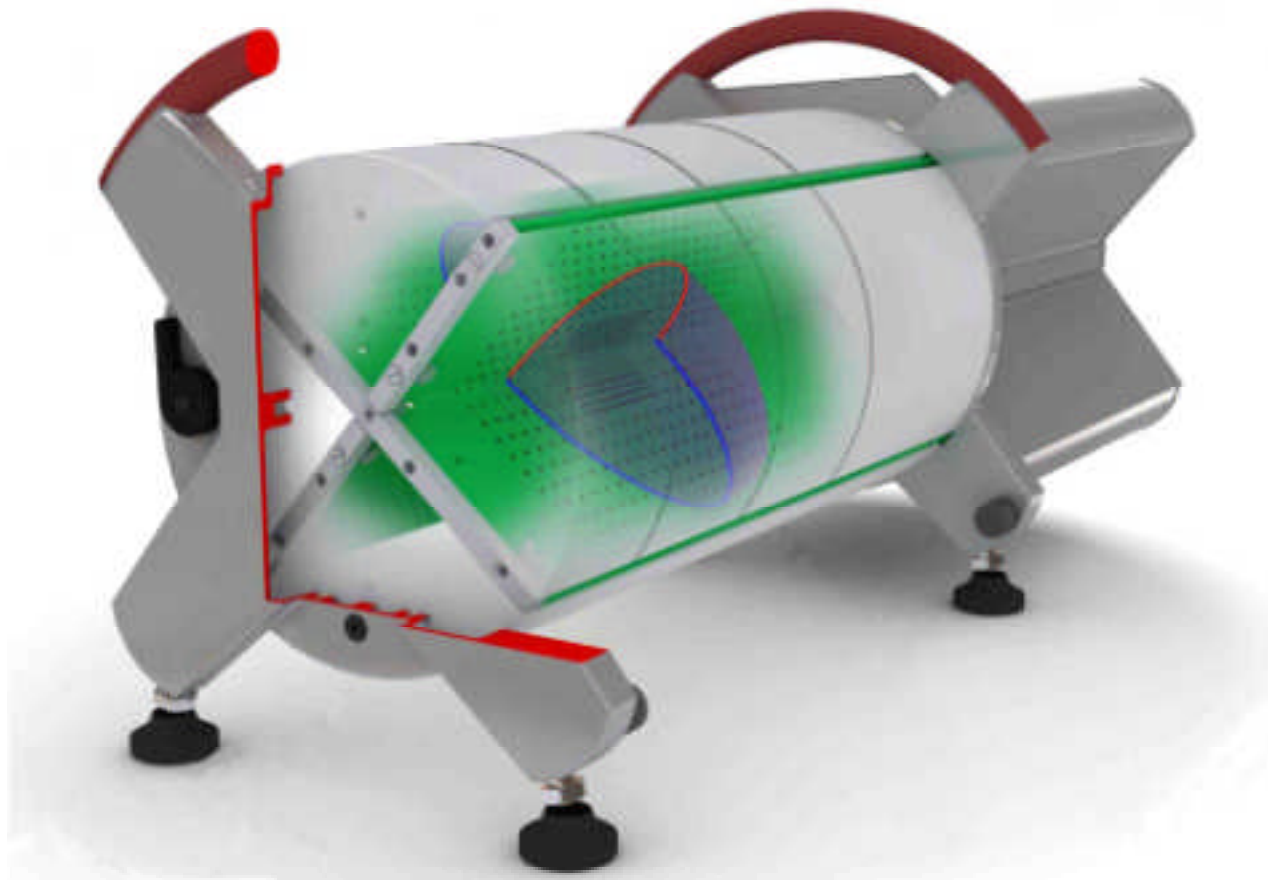
Distance between detectors: Central area 5 mm, Outer area 10 mm

Total number of detectors: 1069



Delta⁴

Unique time resolution: Each accelerator pulse is measured individually and stored with its delivery status



System Overview

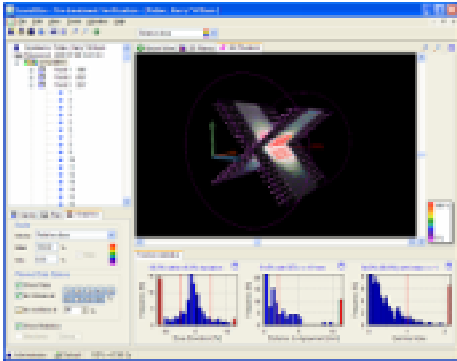
Delta⁴ Phantom



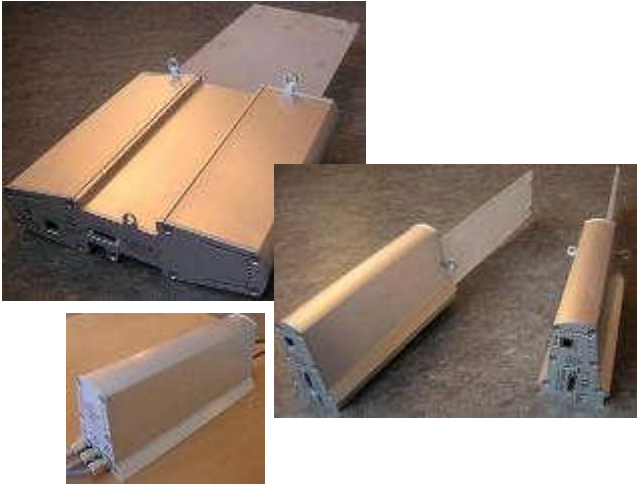
Calibration Phantom



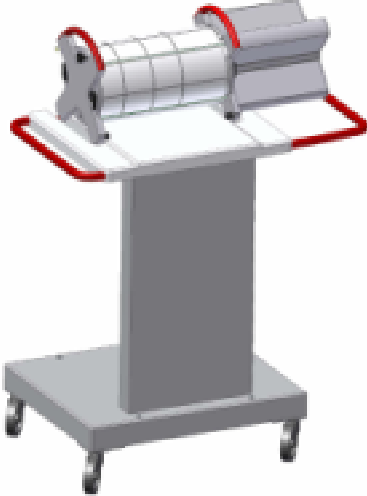
Software



Detector Units



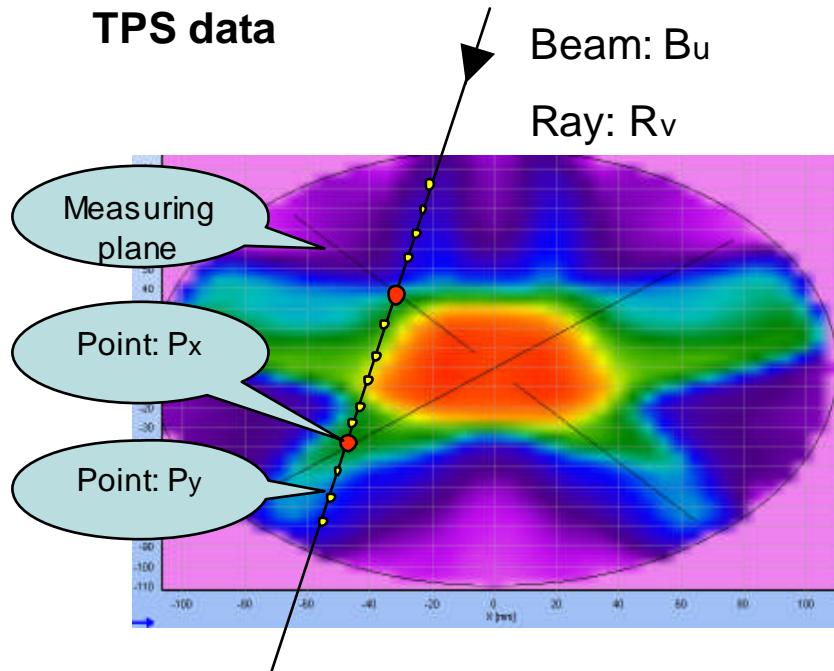
Phantom Trolley (optional)



Delta⁴

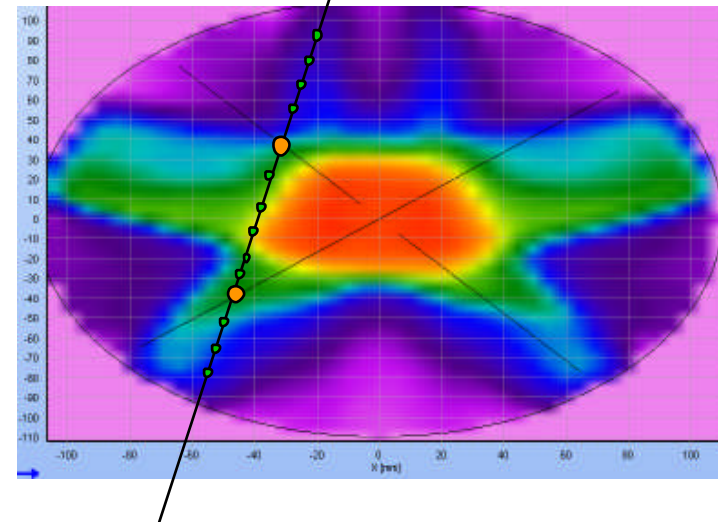
Measurement data in full-3D

TPS data



- TPS data in any point along the ray; except the measuring plane
- TPS data along the ray, in the measuring plane

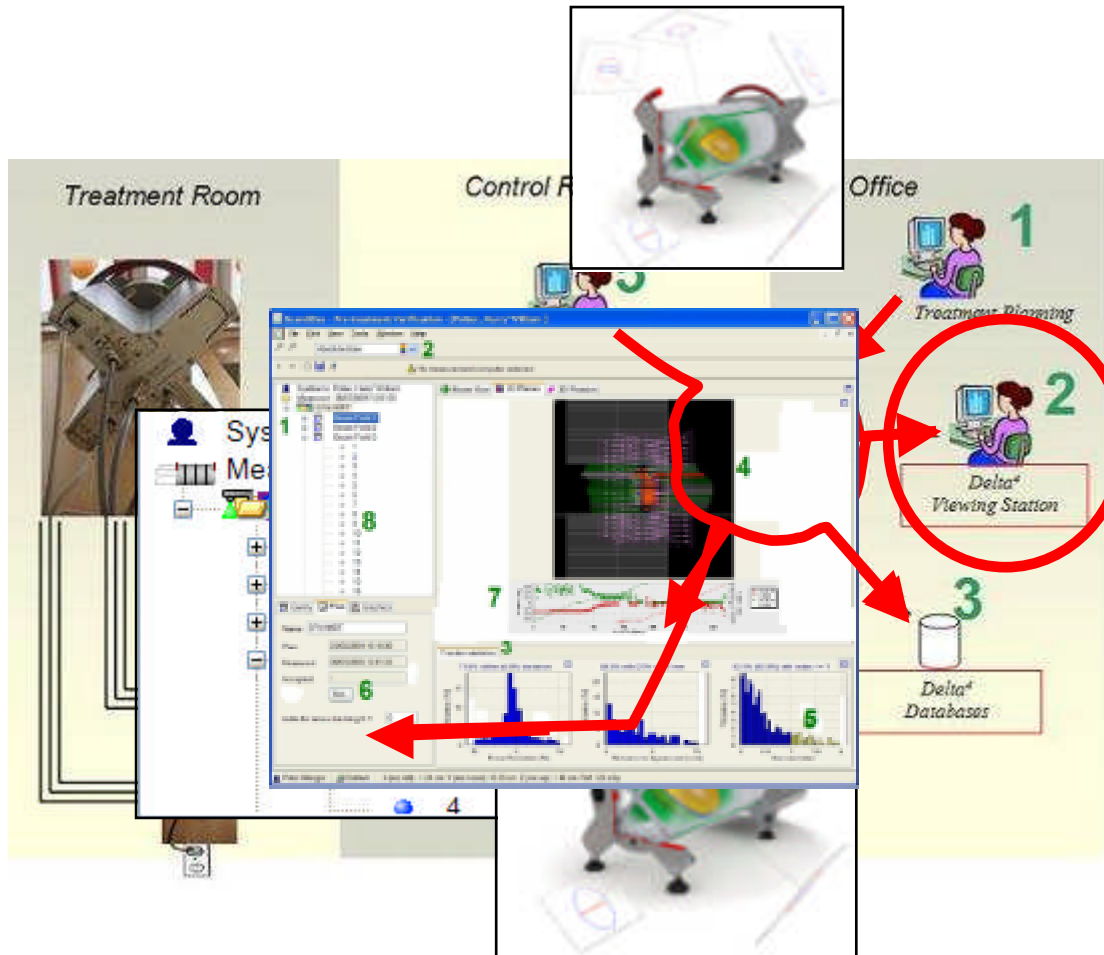
Measurement and Semi-measurement data



- Measured data along the ray, in the measuring plane
- Semi-measured data along the ray, except the measuring plane.

$$D(B_u, R_v, P_y) = D(B_u, R_v, P_x) * D(B_u, R_v, P_y) / D(B_u, R_v, P_x)$$

Mode of operation



- From TPS: Export of RT Plan, RT Dose
- From Delta⁴: Import of RT Plan, RT Dose
- Delta⁴ creates a patient specific treatment structure
- Measurement process is remote controlled by a treatment control system (R&V)
- Measurement data are saved
- Analysis

Delta⁴

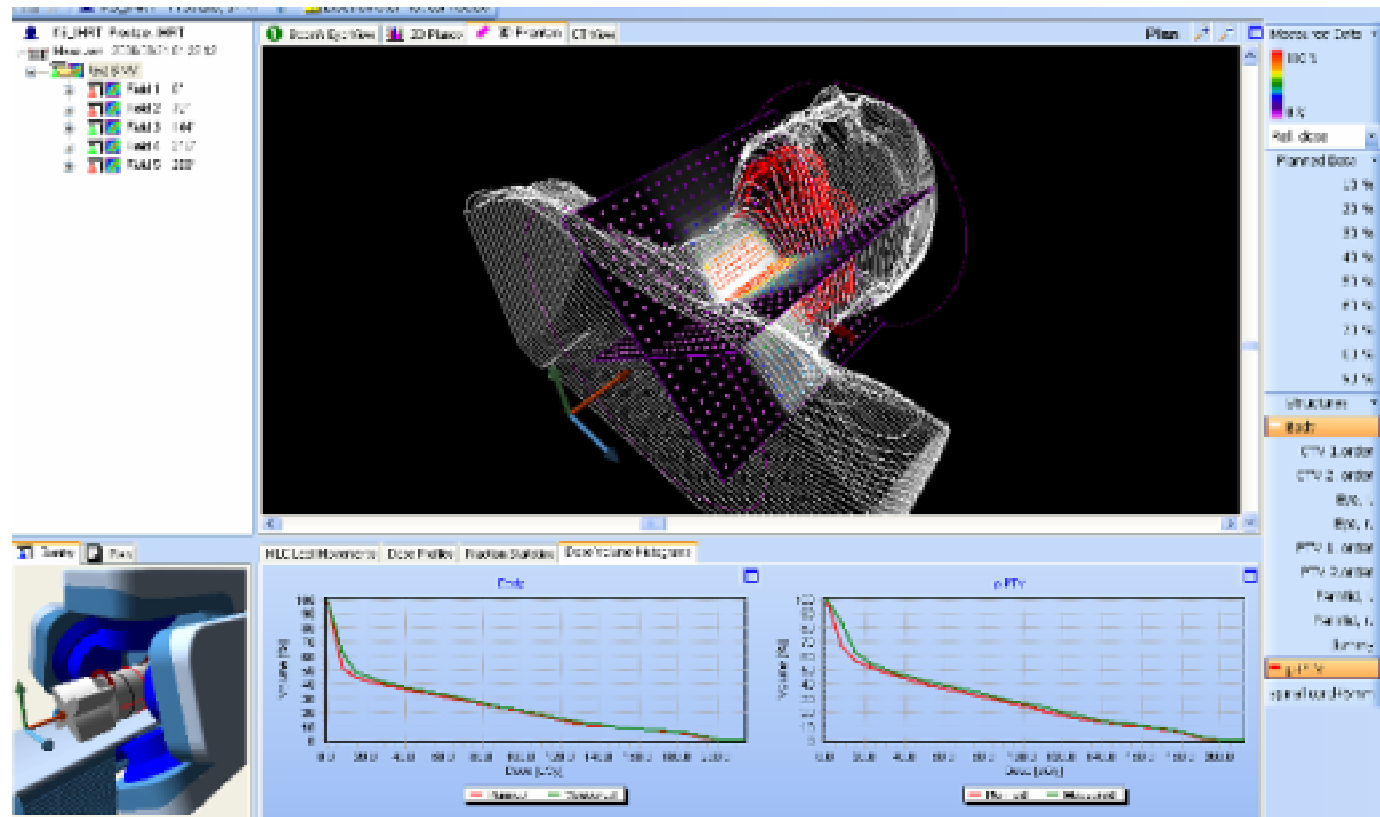
Dose data in 3D – evaluation using DVH

☐ Dose data in phantom

- 3D TPS data
- Measured data in crossing planes
- 3D semi-measured data

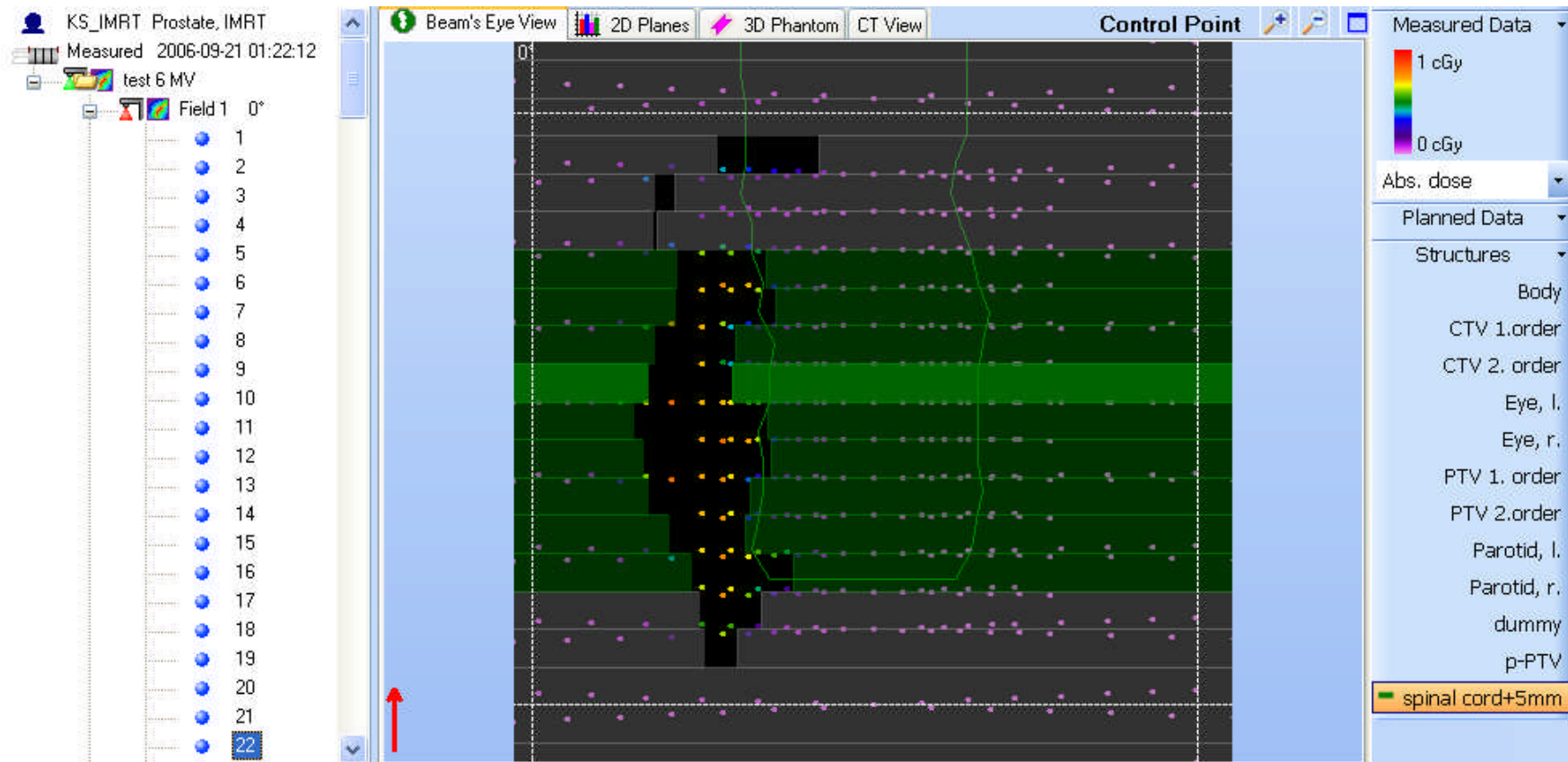
☐ Structures

- Patient structures
- DVH; phantom dose in patient structure
- DVH per beam and plan



Delta⁴

Structures displayed in BEV



Patient specific QA

- IMAT and Arc
 - Inclinator: For independent verification of gantry angle.
 - Data sorted per angle segment.

Patient specific QA

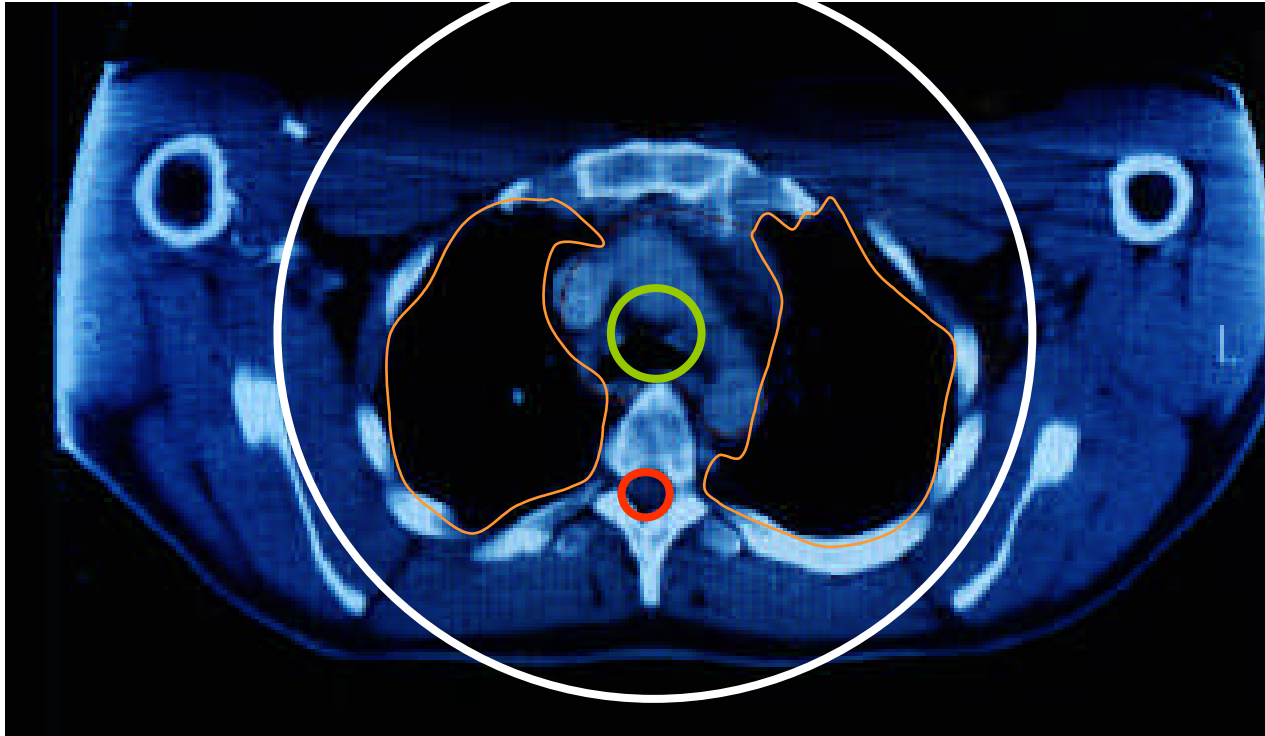
Gating:

- Beam on/beam off.

Tumour tracking

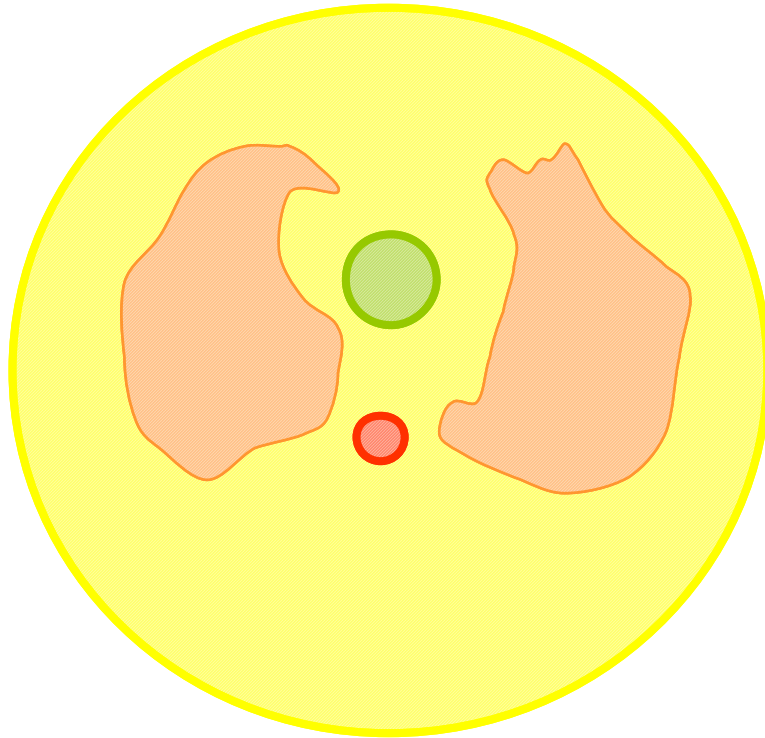
- Beam on/beam off.
- Delivery of 'moving' plans according to the tumour motion phase.
 - The tumour moves in position and has the shape is deformed due to respiration.

Delta⁴



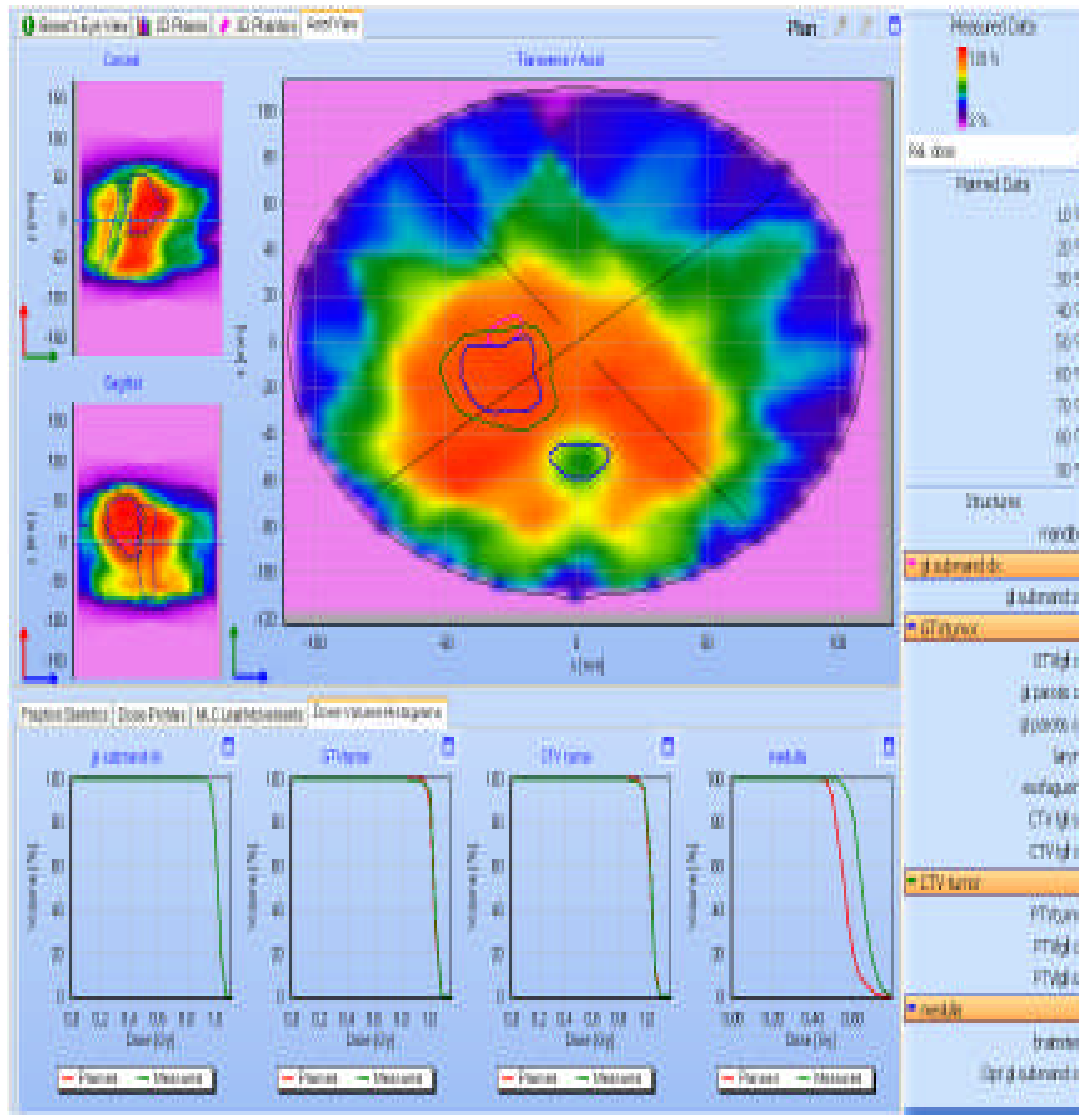
- Patient anatomy
- Tumor
- Risk organ
- Delta⁴ Phantom

Delta⁴



- Patient anatomy
- Tumor
- Risk organ
- Delta⁴ Phantom
- Structures in phantom
- Calculated TPS dose in phantom
- TPS phantom-dose for each structure

Delta⁴



- Patient anatomy
- Tumor
- Risk organ
- Delta⁴ Phantom
- Structures in phantom
- Calculated TPS dose in phantom
- TPS phantom-dose for each structure
- DVH – TPS data in phantom
- DVH – measured data in phantom
- DVH – compare

Delta⁴



- Komplette IMRT QA
 - IMRT:
 - Step and shoot
 - Sliding window
 - Gating
 - Tumour tracking
 - Arc Therapy
 - IMAT
- Integriert in den Arbeitsablauf