QA Dosimetry for IMRT Prostate Treatments

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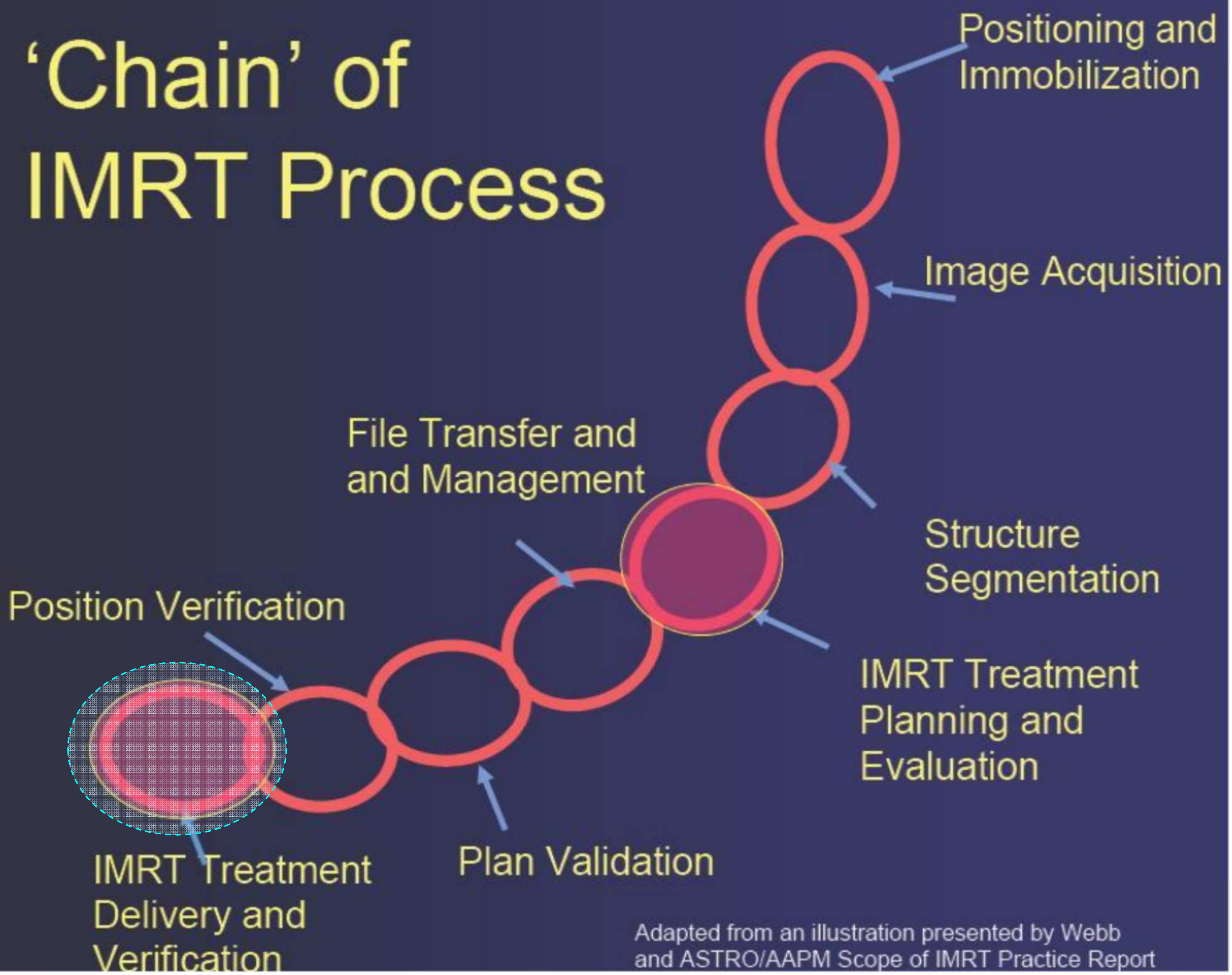
Why QA ?

- IMRT – Needs high precision and accuracy.
- Reduces the uncertainties and errors
- Improving dosimetric and geometric accuracy and precision of dose delivery.
- likelihood of accidents and errors occurring, it also
- increases the probability that they will be recognized and rectified sooner
- Inter-comparison of results among different radiotherapy centers
- Ensuring a more uniform and accurate dosimetry and treatment delivery.

'Chain' of IMRT Process



Adapted from an illustration presented by Webb and ASTRO/AAPM Scope of IMRT Practice Report

IMRT QA

Two types of QA

System related

- Accuracy of delivery system
- Treatment planning system data integrity
- Various test to be added to periodic QA

Patient Specific

- Check of plan parameters
- Independent check of planned dose calculation

Machine QA for IMRT

- Many segments with small MUs
  – Dose linearity @ low MUs
  – Startup characteristics (flatness & symmetry)
  – Know the limitations of your machine – set limits on minimum MUs for planning

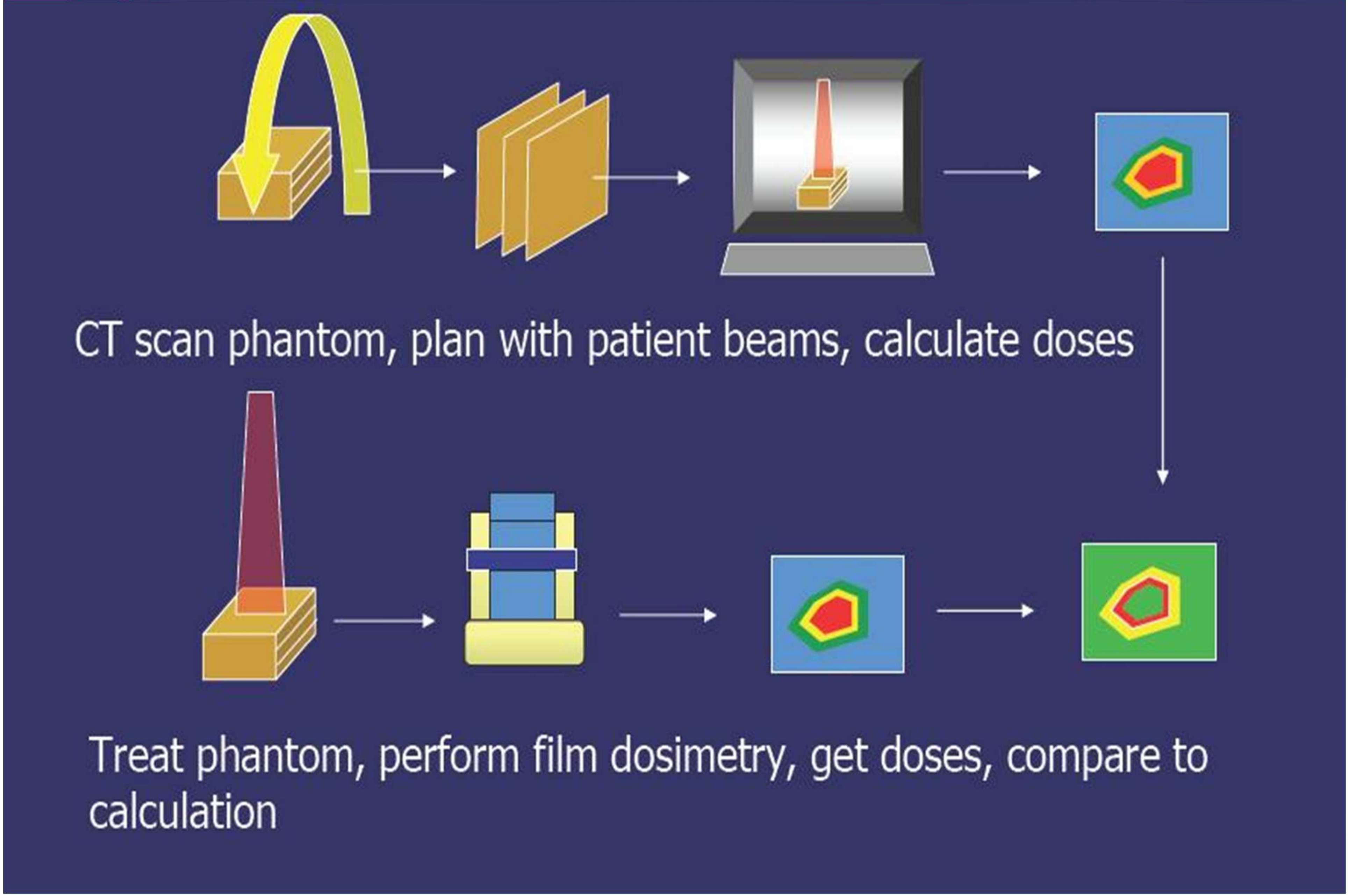
Machine QA for IMRT

- Many small segments, often asymmetric
  – Output factors sensitive to small changes in size
  – Know the limitations of your dose calculation – set limits on minimum segment size for planning
- MLC positional accuracy at off axis

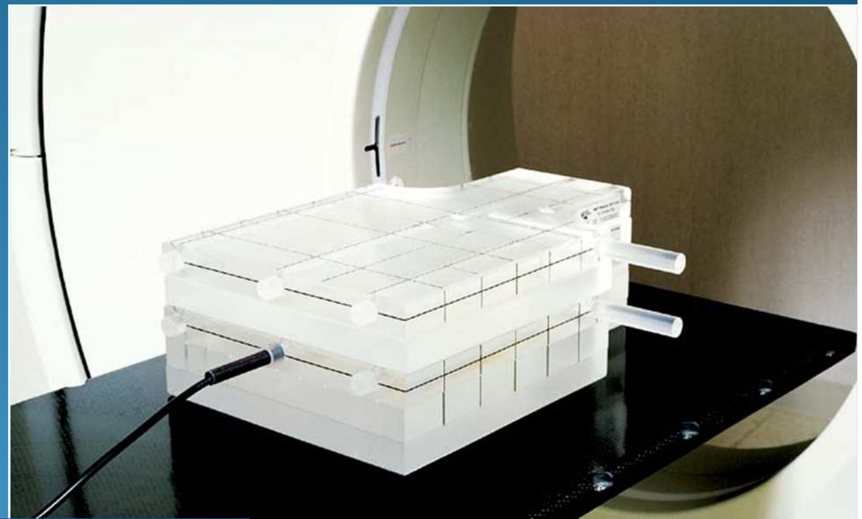
Patient Specific QA

- Point dose measurement
- Evaluation of Fluence map generated by the TPS
- Leaf positioning Check (BEV)

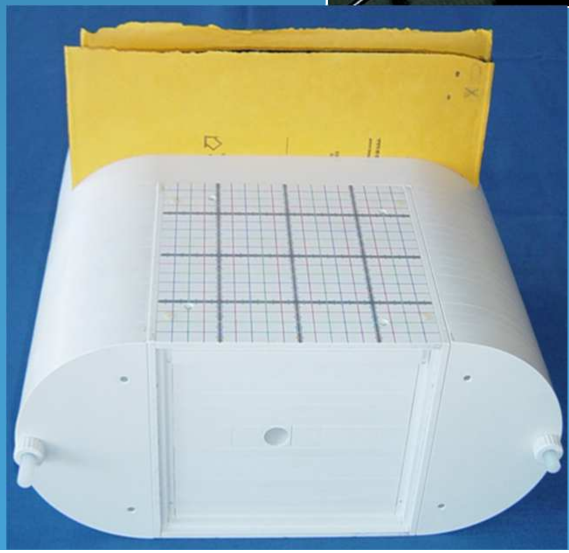
IMRT QA WORK FLOW

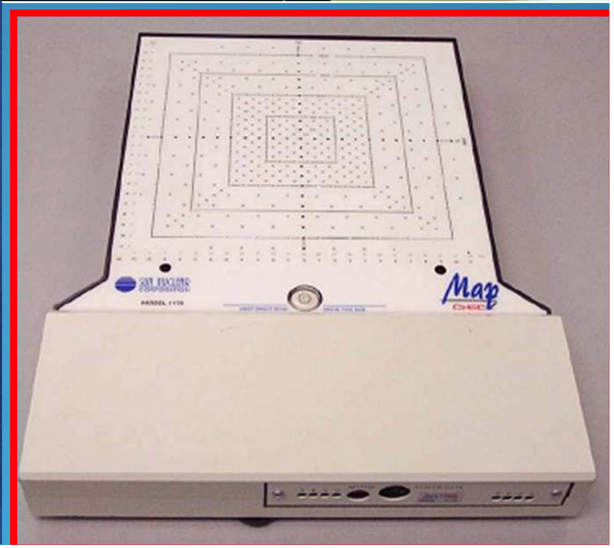


Dose Verification Procedure (Prostate Example)



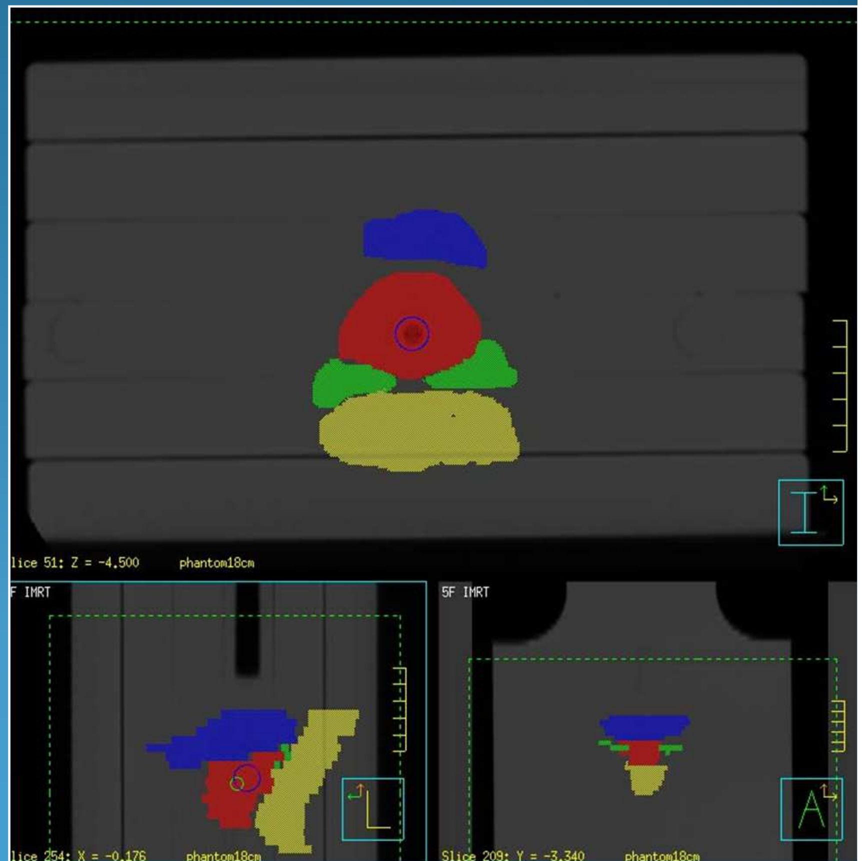
- Phantom positioned on the simulator couch ready to be scanned
- It is important to choose a phantom with a versatile design that allows for many configurations to simulate individual treatment plans





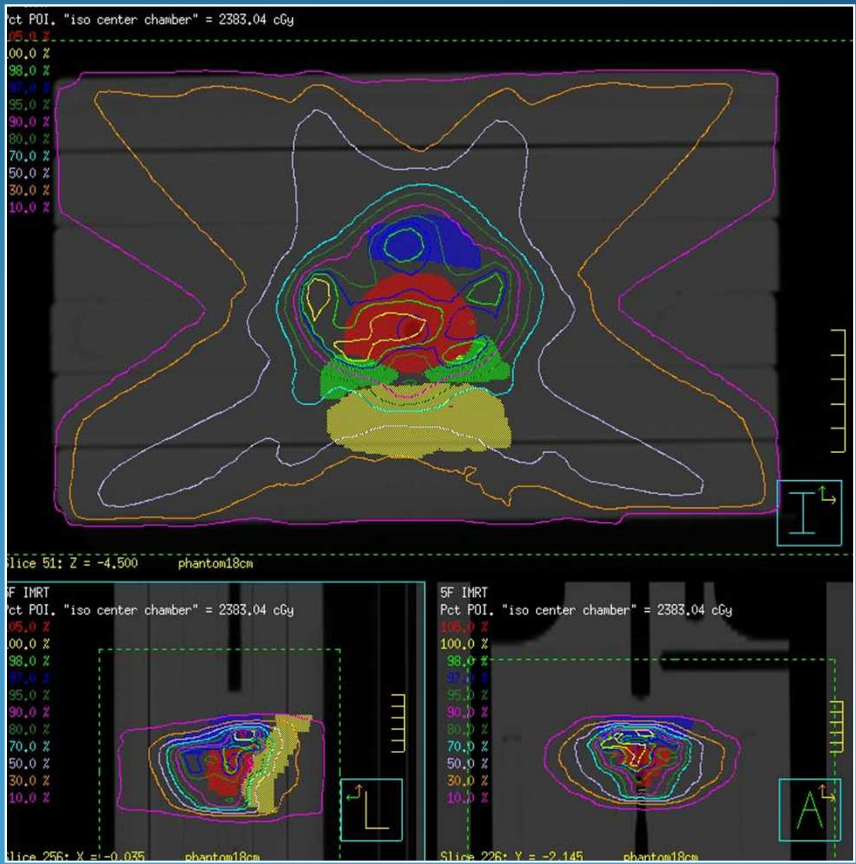
Dose Verification Procedure

Three view scan of the phantom in the treatment planning system



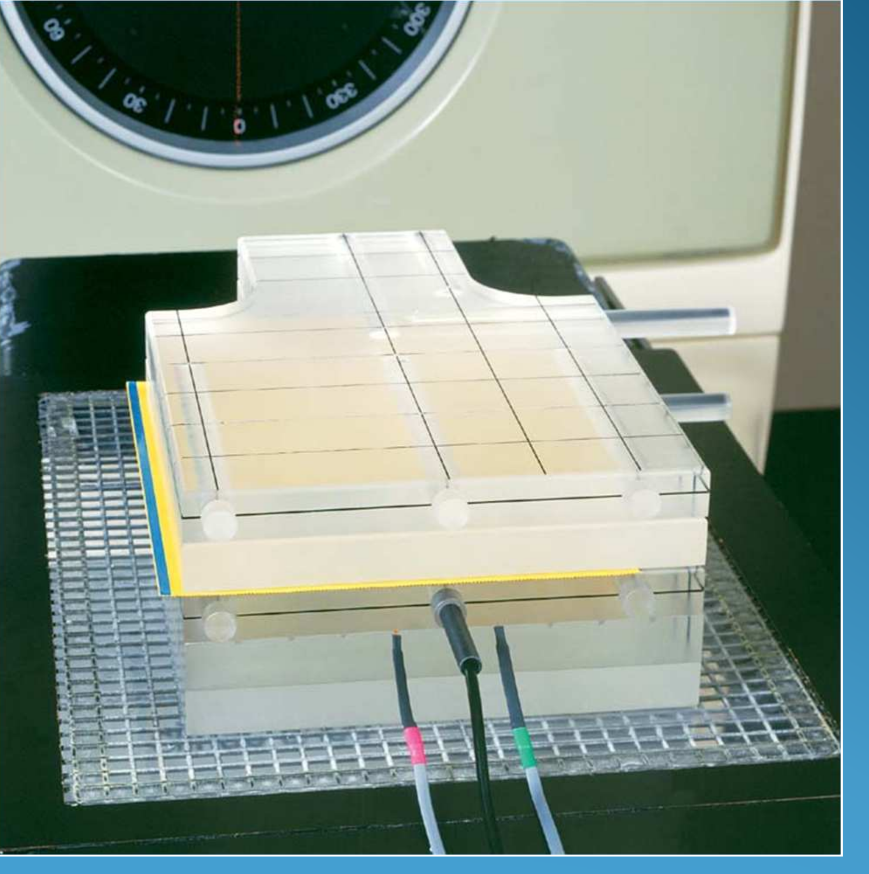
Dose Verification Procedure

- The three view treatment plan is transposed onto the phantom scan
- RTPS applies the planned fluence on a solid water phantom at a known depth
- Computes the dose at that depth and generates a dose map file



Dose Verification Procedure

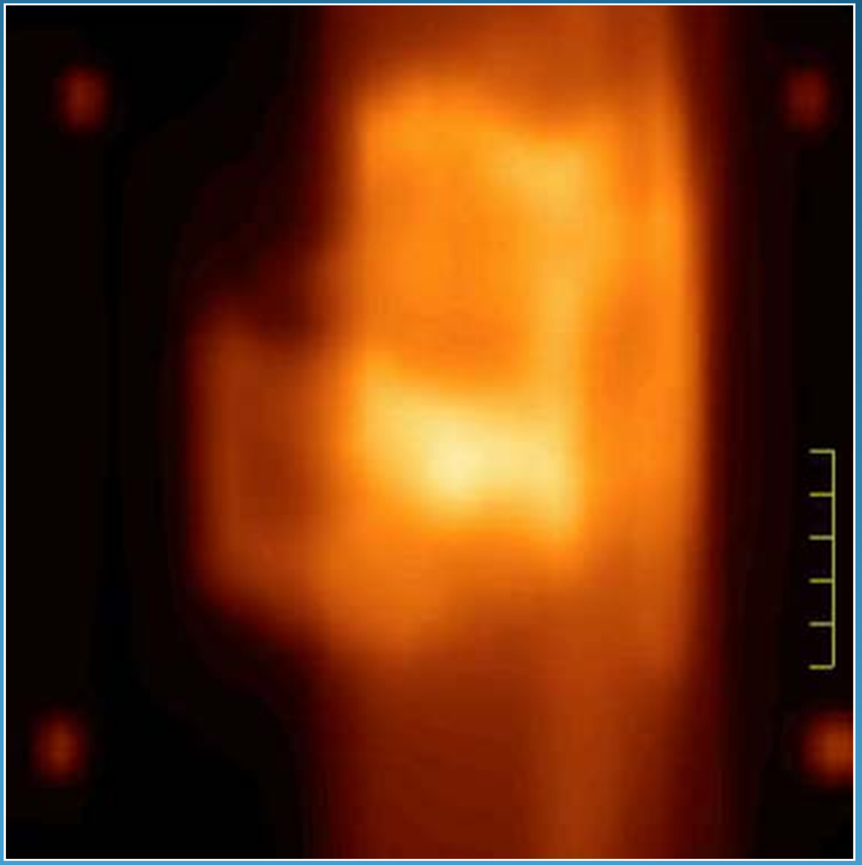
- Phantom on accelerator treatment couch ready for treatment
- Treat the phantom and measure the doses
    - Ion-chambers, Films, MOSFET dosimeter
    - Compare the doses generated by the TPS



- Chamber is at isocenter
- Diodes are offset, left and right of the chamber
- Expose a film – Convert OD to dose
- Compare with dose map generated by RTPS

Dose Verification-Analysis

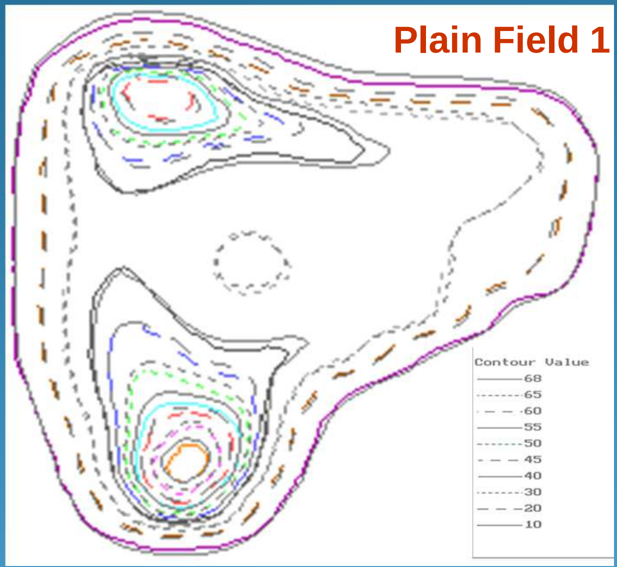
Examine the fluence dose image of a film placed between acrylic slabs of the IMRT Phantom

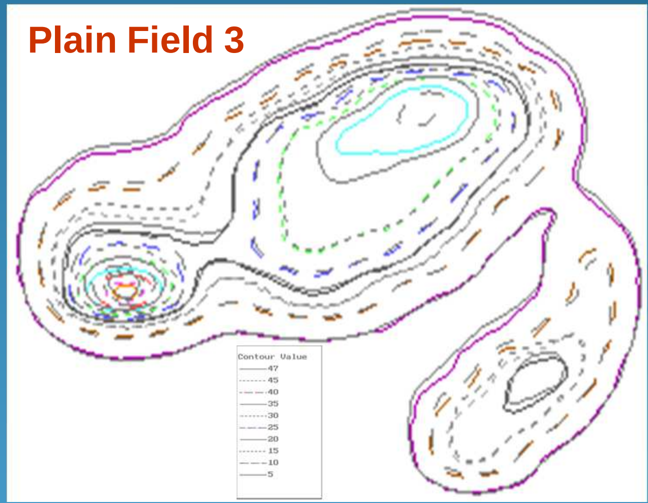


Evaluation & Comparison of Calculated and Measured values:

1. Iso-line compare
2. Profile compare & its difference in all planes.
3. Dose difference.
4. Distance to Agreement(DTA).
5. Gamma Method

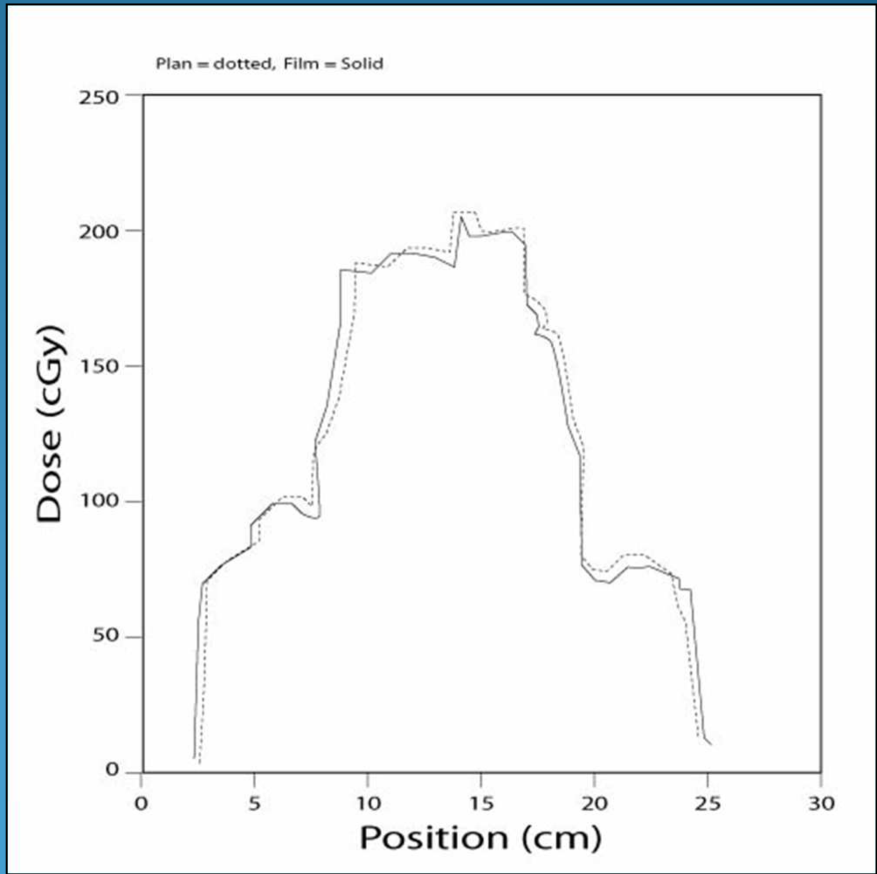
Iso-line compare





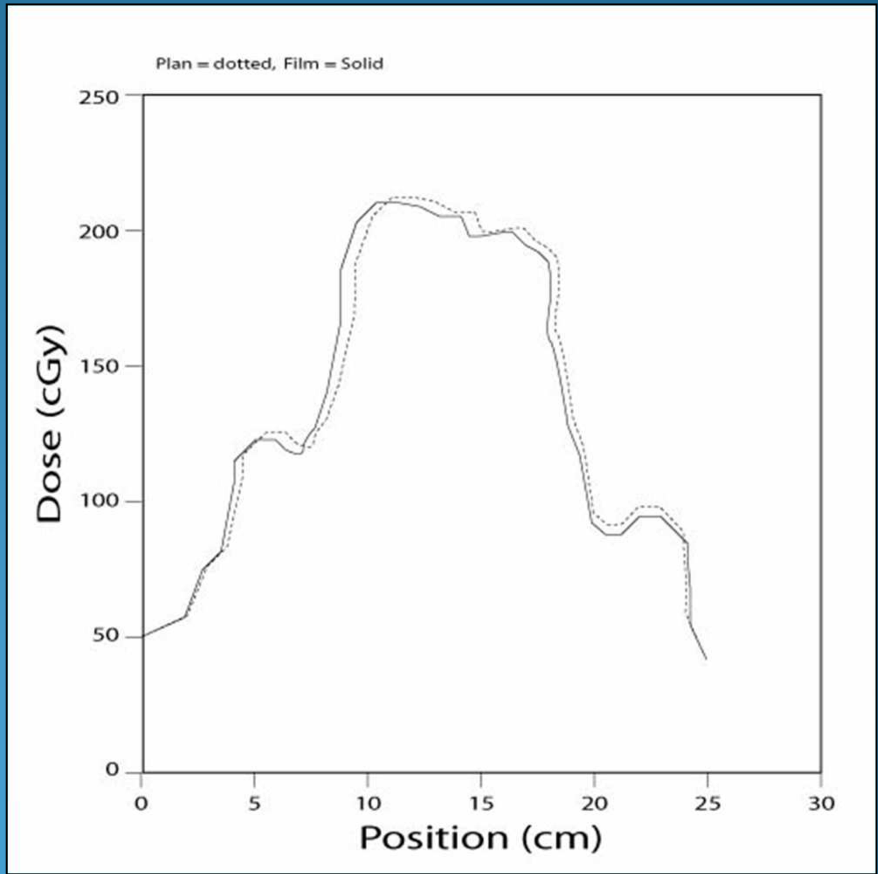
Profile Comparison Analysis

Analysis of a vertical fluence dose profile of the measured film versus the calculated dose on the radiation treatment plan with position

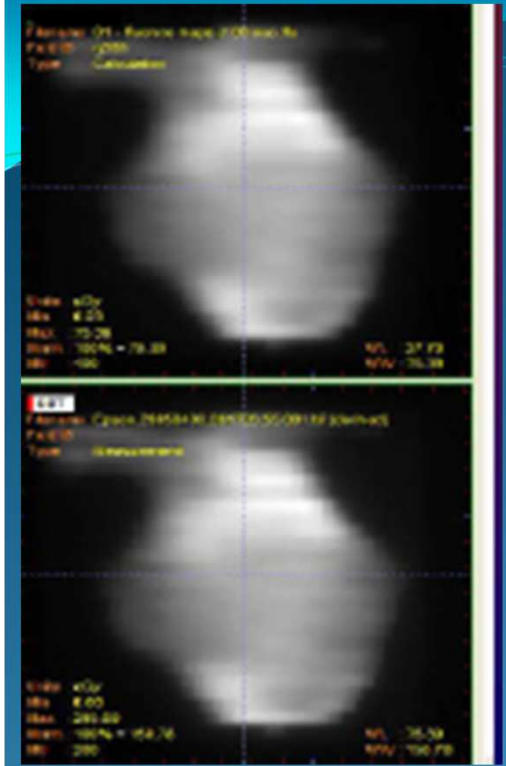


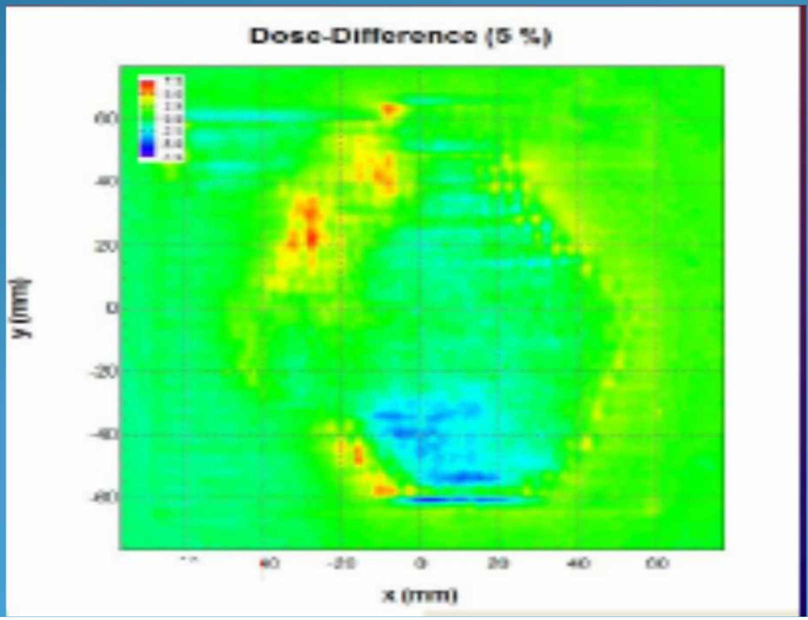
Profile Comparison Analysis

Analysis of a horizontal fluence dose profile of the measured film versus the calculated dose on the radiation treatment plan with position



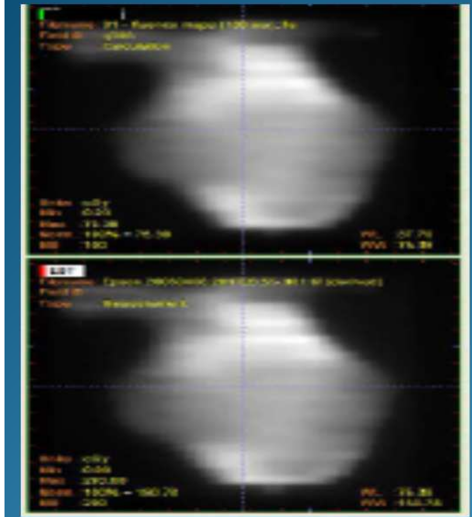
Dose difference test

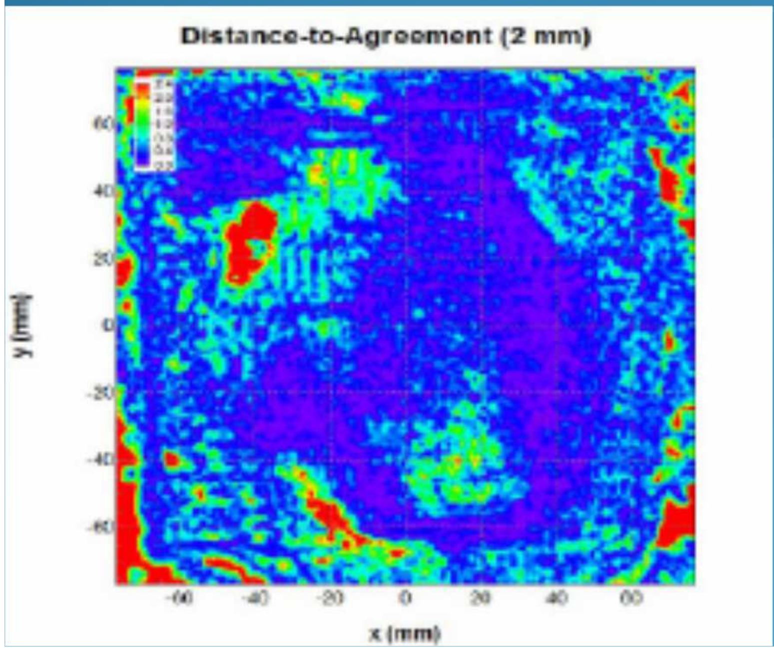




- A dose-difference distribution can be displayed and identifies the regions where the calculated dose distributions disagree with measurement.
- In high dose gradient regions, a small spatial error, either in the calculation or the measurement, results in a large dose difference between measurement and calculation.

Distance to Agreement (DTA)



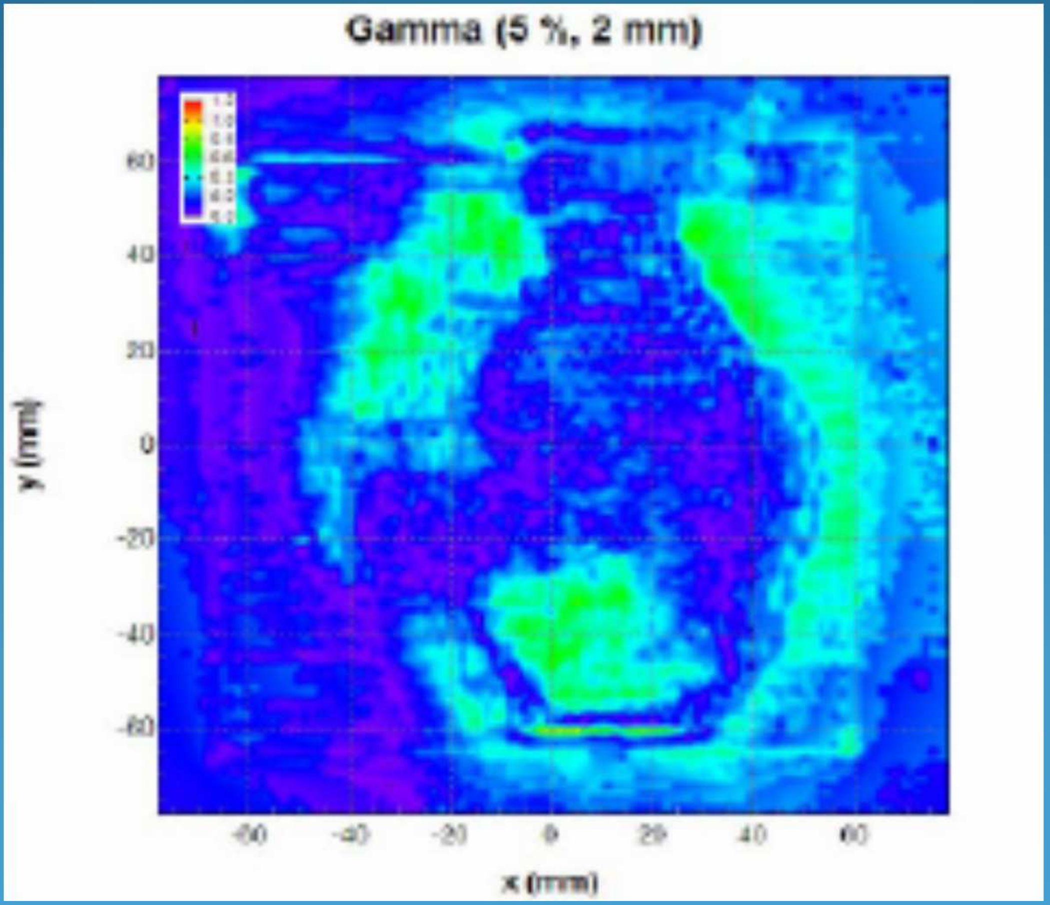


- Dose difference in high dose gradient may therefore be relatively unimportant,
- Concept of a Distance-to-Agreement distribution is use to determine the acceptability of the dose calculation.
- The DTA is the distance between a measured data point and the nearest point in the calculated dose distribution that exhibits the same dose.

Gamma Method

- The dose-difference and DTA evaluations complement each other when used as determinants of dose distribution calculation quality.
- Gamma method uses a passfail criterion of both the dose difference and DTA.
- Each measured point is evaluated to determine if both the dose difference and DTA exceed the selected tolerances(e.g. 3% and 3 mm, respectively)

Gamma Method



PATIENT SPECIFIC ABSOLUTE DOSE MEASUREMENT

BEAM DOSE MEASUREMENT

Date : 28/07/2007

Patient Name :
Patient IMRT No. : 0186_2007
Tem. : 22.2° C
Pressure : 914 mbar
Ionization Chamber : 0.13cc chamber
Model : Compact chamber CC13
Make : Scanditronix wellhofer
Absorbed-dose-to-water calibration factor $N_{D,w}$: 26.36×10^{7} Gy/C

Beam No.	M.U	Meter Reading				Dose (cGy)		Variation in Dose cGy
		R1	R2	R3	Avg.	Mes.	TPS	
1(15%)	118	117.1	117.1	117.1	117.1	116.5	116	+0.5
2(15%)	12							
3(16%)	108	115.0	115.0	115.0	115.0	114.4	113	+1.4
4(16%)	11							
5(16%)	115	117	117	117	117	116.41	116	+0.41
6(16%)	11							
7(16%)	113	113	113	113	113	112.4	112.5	-0.1
8(16%)	12							
9(16%)	112	119	119	119	119	118.4	116.9	+1.5
10(16%)	11							
11(16%)	115	124	124	124	124	123.4	123	+0.4
12(16%)	12							
13(14%)	117	114.4	114.4	114.4	114.4	113.8	113.6	+0.2
14(14%)	12							

Measurement at a depth of 10 cm of perspex

Average difference in dose is 0.616 cGy

Measured By

Medical Physicist

TOLERENCE ≤ 2cGy OR ≤ 3%

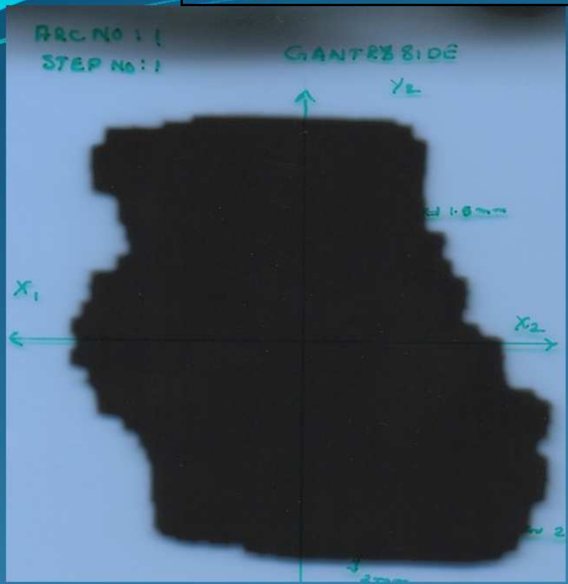
DTA : Planned Vs Measured

- If DTA passes at 3%/3mm level proceed with the treatment .

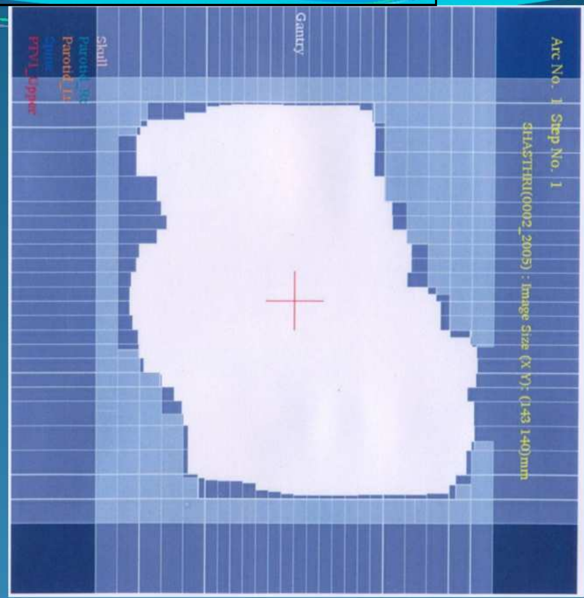
- At the 5%/5mm level examine sources of discrepancies. Proceed with treatment only if
  - Discrepancies can be resolved or
  - Region of error are clinically insignificant

- Beyond 5%/5 mm, Perform the measurement

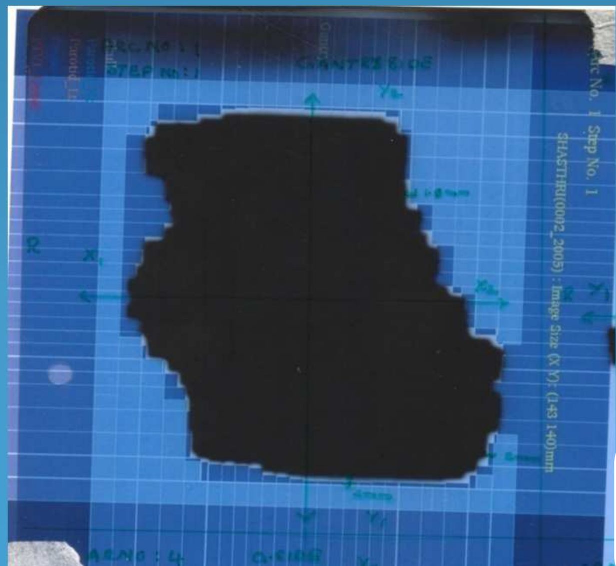
BEAM EYE VIEW VERIFICATION



RADIATION FIELD



TPS FIELD

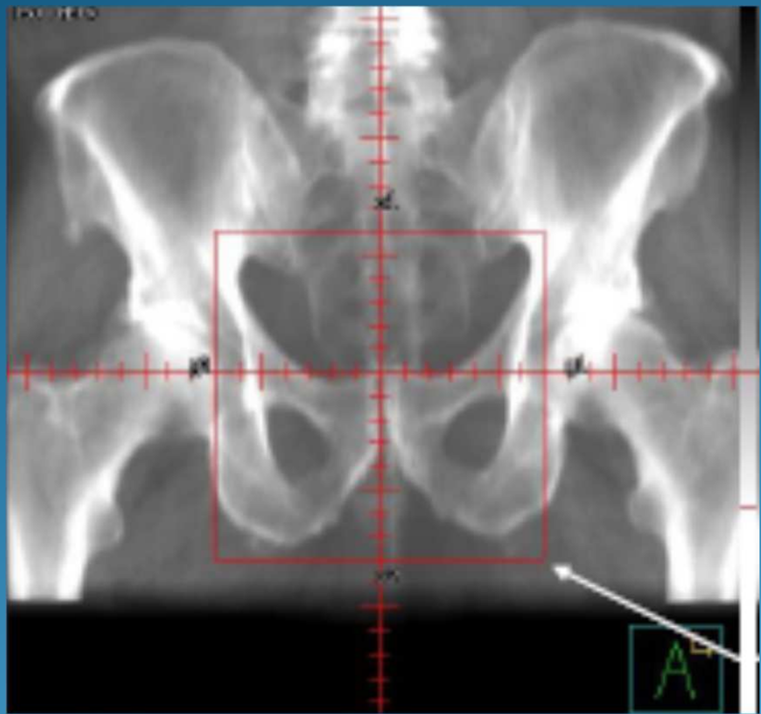


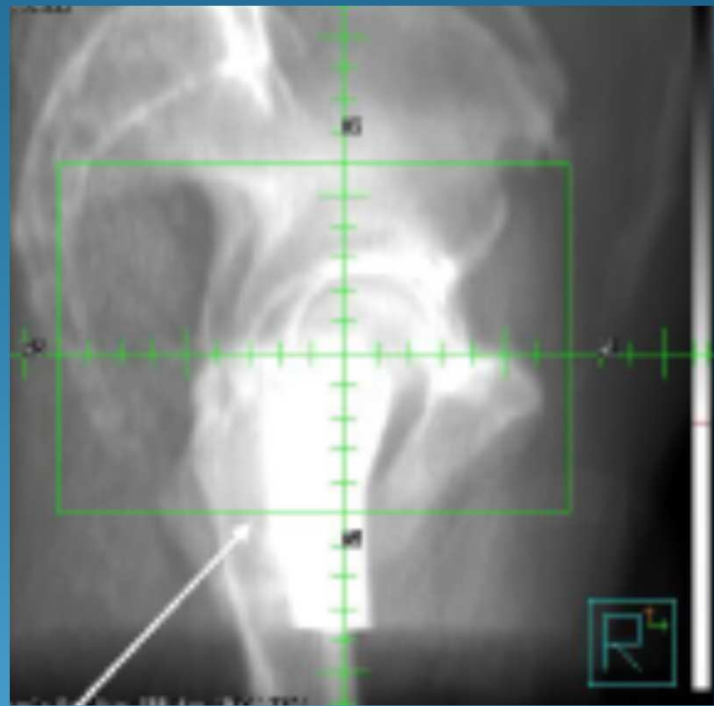
FUSION

Acceptable limited
is less than 2 mm

At HCG ~ 200 fields checked
and found less than 2 mm

LEAF POSITIONING & ISOCENTRE CHECK (DRR vs PORT FILM)





TOLERANCE : 5mm

What to Do With Errors Detected?

- ALWAYS correct gross errors!
- Small errors needs to be studied to find out if they are random (treatment errors), or systematic errors (planning errors)
- Image first 3 days of treatment, correct systematic error if greater than tolerance,
- then image once per week

REFFERENCES

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"Intensity Modulated Radiation therapy , The state of the art"

Palta, J.R., Mackie, T.R., eds.,

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THANK YOU......