


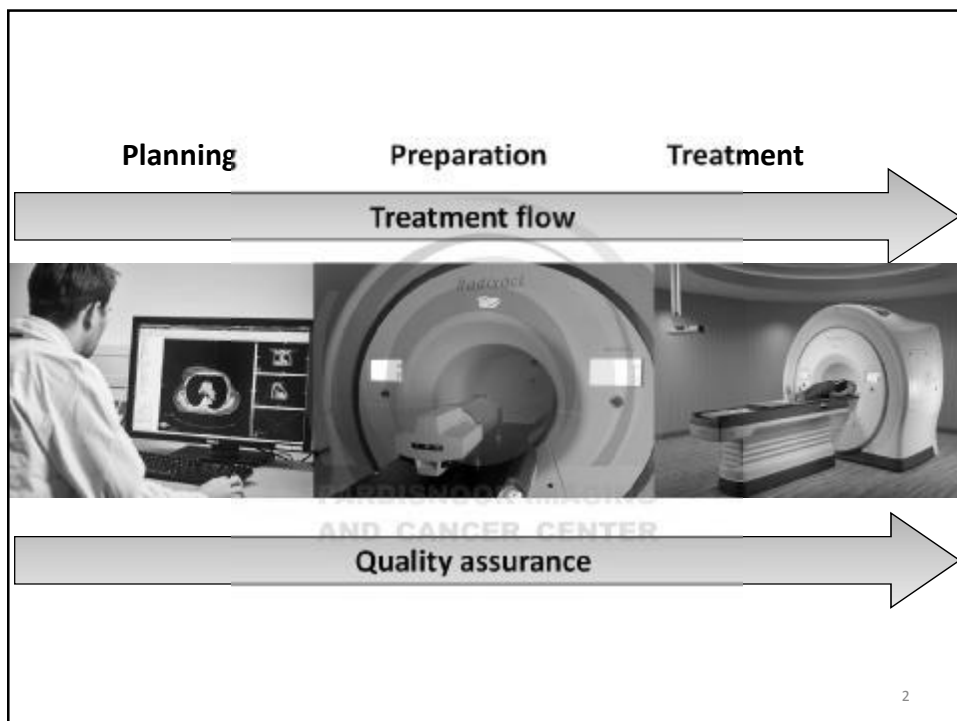
## Tomotherapy and Patient QA (Part 1)

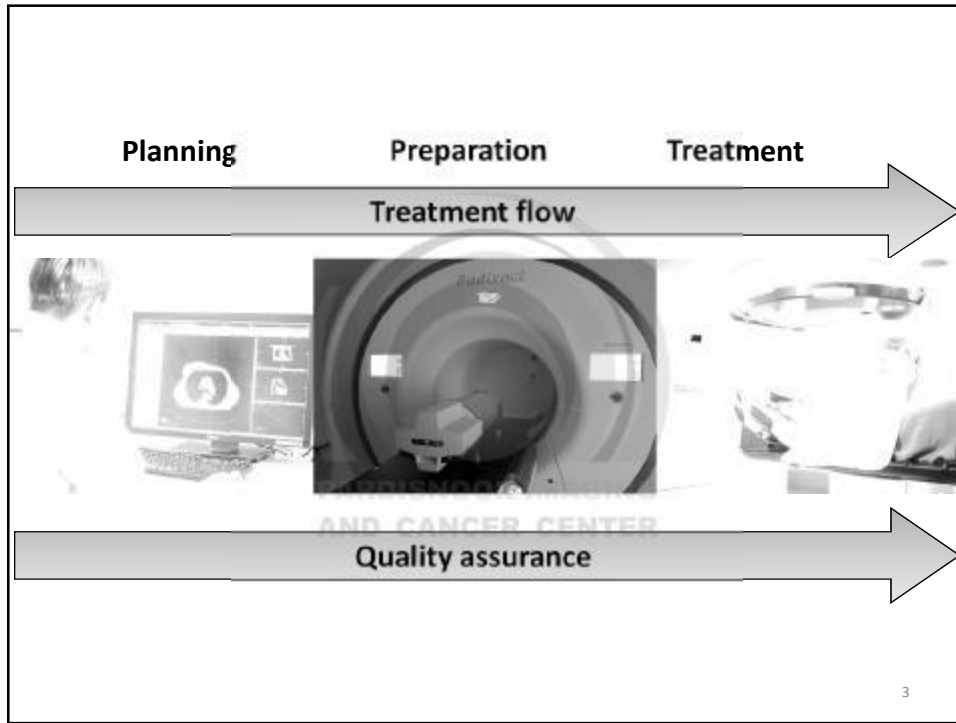


Aliasghar Rohani  
Medical Physicist


1

The image shows a Tomotherapy machine, which is a type of linear accelerator used for radiation therapy. It consists of a gantry that can rotate around a patient lying on a treatment table. The gantry contains a linear accelerator that can deliver radiation from multiple angles. To the left of the main machine, there are two smaller images: one showing a cylindrical component, possibly a detector or a part of the gantry, and another showing a circular component, possibly a detector or a part of the gantry. The background features a watermark logo for PardisNoor Imaging and Cancer Center.

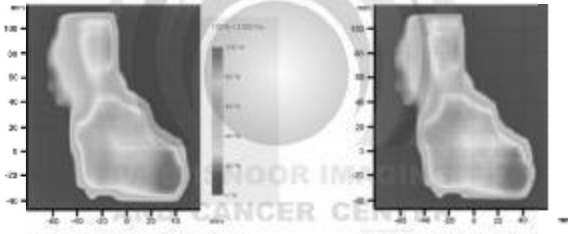




### Patient Specific QA




**Aim :**  
**Compare the calculated dose ditribution to the measured dose distribution .**



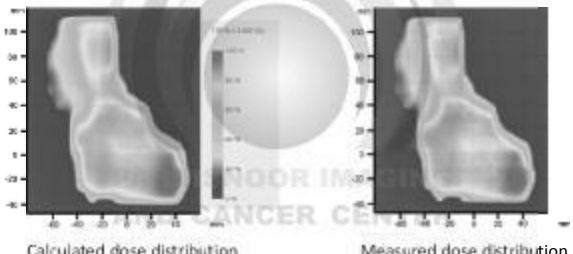
Calculated dose distribution Measured dose distribution

4

### Patient Specific QA



**Aim :**  
**Compare the calculated dose distribution to the measured dose distribution .**



Calculated dose distribution      Measured dose distribution

- **For individual Patients**
- **Before first treatment session**


5

### Source of Errors

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- Errors in Treatment Planning Systems
- Errors in Treatment Delivery Machine
- Errors in PS-QA Process
- Errors in Calibrations

*What should be checked?*




PARDISNOOR IMAGING AND CANCER CENTER

6

Patient Specific QA

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**What is the acceptable value to approve the PS-QA?**




7

Patient Specific QA

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**What is the acceptable value to approve the PS-QA?**

- The American Association of Physicists in Medicine(AAPM) TG-119 reported that the **3% dose difference and 3 mm DTA** criteria is most commonly used by physicists in pretreatment IMRT QA.




8


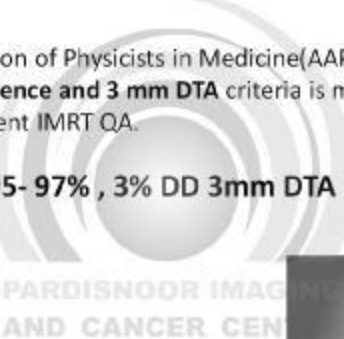
### Patient Specific QA

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**What is the acceptable value to approve the PS-QA?**

- The American Association of Physicists in Medicine(AAPM) TG-119 reported that the **3% dose difference and 3 mm DTA** criteria is most commonly used by physicists in pretreatment IMRT QA.

 **95- 97% , 3% DD 3mm DTA**

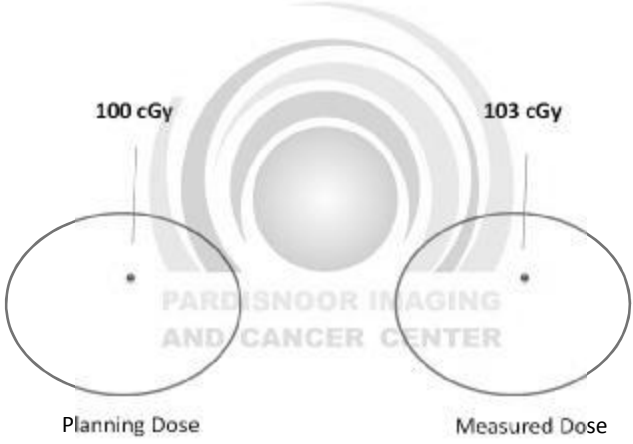


9

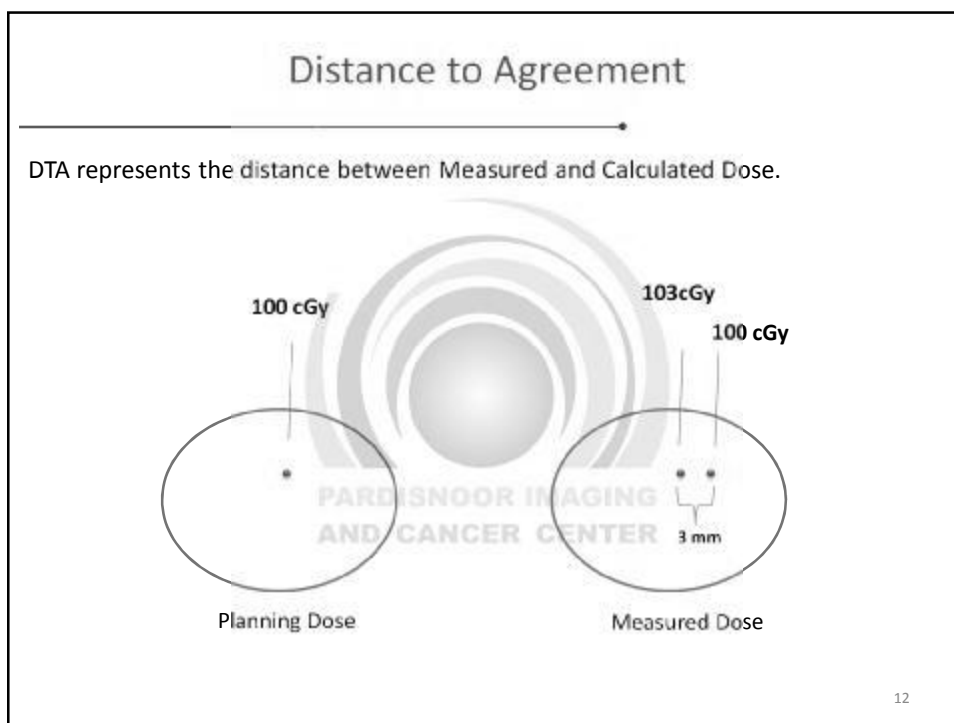
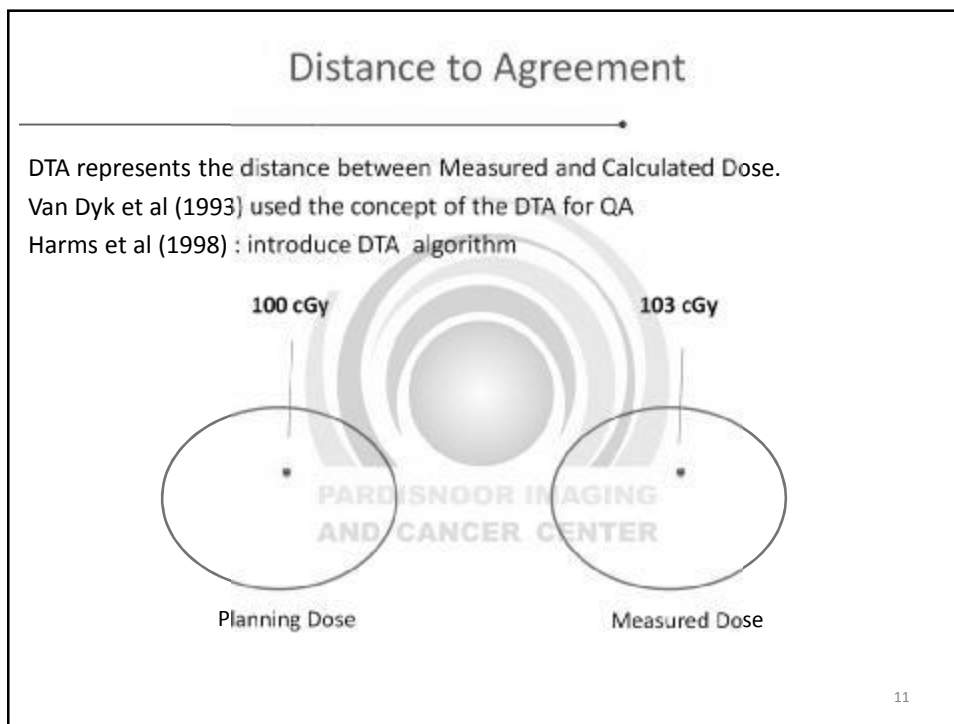
### Dose Deviation

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DD represents the Measured and Calculated Dose differences .



10



### Gamma Index

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This method, first introduced by Low et al (1998).  
 This standard method evaluates the coincidence between the calculated and measured dose distributions by utilizing the percent dose difference (DD) and distance to agreement (DTA).

$$\Gamma(\mathbf{r}_R, \mathbf{r}_E) = \sqrt{\frac{\Delta r^2(\mathbf{r}_R, \mathbf{r}_E)}{\delta r^2} + \frac{\Delta D^2(\mathbf{r}_R, \mathbf{r}_E)}{\delta D^2}}$$

$\gamma \leq 1$  Pass  
 $\gamma > 1$  Fail

**100% passing is ideal but not practical.**

13

### Gamma Index

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- Global Gamma Index
- Local Gamma Index

The contrast between the two types is the way the dose difference is calculated.

$$DD = \frac{\text{Measured} - \text{Calculated dose}}{\text{Normalization Value}}$$

14

### Gamma Index

- **Global Gamma Index**

Normalization Value = Max Dose of the Plan
- **Local Gamma Index**

$$\frac{103 - 100}{210}$$

The contrast between the two types is the way the dose difference is calculated.

$$DD = \frac{\text{Measured} - \text{Calculated dose}}{\text{Normalization Value}}$$

15

### Gamma Index

- **Global Gamma Index**

Normalization Value = Max Dose of the Plan
- **Local Gamma Index**

$$\frac{103 - 100}{210}$$

Normalization Value = Calculated dose at the currently evaluated pixel

$$\frac{103 - 100}{100}$$

The contrast between the two types is the way the dose difference is calculated.

$$DD = \frac{\text{Measured} - \text{Calculated dose}}{\text{Normalization Value}}$$

16



### Gamma Index

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**Dose Thresholding:**

The American Association of Physicists in Medicine Task Group 119 instructed institutions to use a low-dose threshold of 10% or a region of interest determined by the jaw setting when they collected gamma analysis quality assurance (QA) data for the planar dose distribution.

Pass / Fail Criteria

Detectors Discover + MLC

Dose Deviation

Pass if 90.0 % have a deviation within  $\pm 3.0$  %

Include detectors in dose range 20 % to 500 %

Distance to Agreement, DTA

Pass if 90.0 % have a DTA  $\leq 3.0$  mm

Include detectors where gradient is  $\geq 1.0$  %/mm

**Gamma Index**

Pass if 97.0 % have a gamma index  $\leq 1.0$

Max dose deviation  $\leq 3.0$  %

Max spatial deviation  $\leq 3.0$  mm

**Include detectors in dose range 10 % to 500 %**

Normalize deviation to local dose (Local Gamma)

OK  
Cancel  
Help  
Set Default  
Get Default

17

### Gamma Index

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**Ji-Hye Song and et al .2015**

performed a gamma analysis

- A total of 30 treatment plans (Brain , H&N and Prostate)
- with various low-dose thresholds in the range of 0% to 15%
- both global and local normalization
- different acceptance criteria (3%/3 mm, 2%/2 mm, and 1%/1 mm)
- e Portal Dosimetry software

**For Global Gamma normalization : The %GP decreased as the low-dose threshold increased from 0% to 15%**

**For Local Gamma normalization : The %GP increased as the low-dose threshold increased from 0% to 15%**

Global Gamma

Low dose threshold (%)	Head & neck (%)	Brain (%)	Prostate (%)
0%	~98.5	~98.0	~97.5
5%	~97.5	~97.0	~96.5
10%	~96.5	~96.0	~95.5
15%	~95.5	~95.0	~94.5

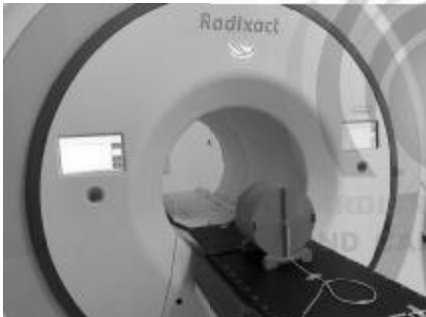
Local Gamma

Low dose threshold (%)	Head & neck (%)	Brain (%)	Prostate (%)
0%	~92.0	~91.5	~91.0
5%	~95.0	~94.5	~94.0
10%	~97.0	~96.5	~96.0
15%	~98.0	~97.5	~97.0

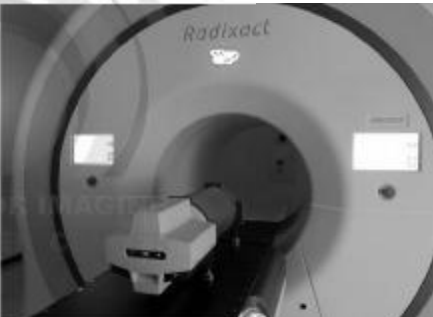
### Tomo Patient Specific QA

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**Cheese Phantom**



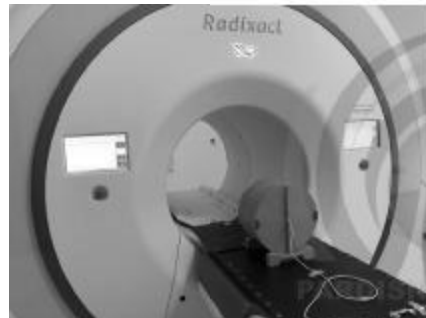
**Delta4+ Phantom**




19

### Tomo Patient Specific QA (Cheese Phantom)


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**Standard Imaging A1SL  
"Slimline Miniature Shonka Chamber"**




Collecting Volume:	0.055 cm <sup>3</sup>
Nominal Calibration Factor:	60 RHC
Centroid of Collecting Volume:	4.1 mm from lip of chamber
Collector Diameter:	5.0 mm
Outside Diameter of Shell:	6.25 mm
Wall Thickness:	1.1 mm
Shell, Collector, and Guard Material:	A1SL - Shonka Air-Equiv. plastic C562



20

### Tomo Patient Specific QA


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The image shows a Tomotherapy machine on the left and a cylindrical QA device labeled 'AMCHECK' on the right. A watermark for 'PARDISNOOR IMAGING AND CANCER CENTER' is visible in the background.

21

## Thank You For Your Attention



The image features a decorative graphic with concentric circles and a sphere in the background. In the foreground, there are four 3D blocks spelling out 'Q & A'. A watermark for 'PARDISNOOR IMAGING AND CANCER CENTER' is visible in the background.

22