

ARC TREATMENT PLANNING FOR LUNG TUMOR PHYSICIST PERSPECTIVE

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INTRODUCTION

- ▶ LUNG CANCER IS ONE OF THE MOST COMMON CANCER
- ▶ TREATMENT – SURGERY, RADIOTHERAPY & CHEMOTHERAPY
- ▶ RADIOTHERAPY FOR LUNG TUMOR:
 - As primary treatment
 - After surgery to eliminate any cancer cells that remain in the treated area
 - To treat lung cancer that has spread to the brain or other areas of the body
- ▶ Challenges in Radiotherapy – Heterogeneity

When photon beams traverse heterogeneous tissues, several effects occur nearby the interface between low-density media (lung, sino-nasal, pharyngeal, tracheal or bronchial air cavities) and tissues of higher density (including tumours).

These effects are due to a loss of electron equilibrium: arriving electrons are not completely balanced in number by the produced (leaving) electrons.

TREATMENT TECHNIQUES

1. CONVENTIONAL RADIOTHERAPY
2. 3D CONFORMAL RADIOTHERAPY
3. IMRT
4. ROTATIONAL IMRT – HELICAL TOMOTHERAPY
5. VMAT
6. RESPIRATORY GATED RADIOTHERAPY

WORKFLOW

1. CT SIMULATION
2. CONTOURING
3. TREATMENT PLANNING
4. PRE TREATMENT VERIFICATION – IMRT, VMAT AND TOMOTHERAPY
5. IMAGE VERIFICATION
6. TREATMENT EXECUTION

CT SIMULATION

1. PATIENT POSITIONING
2. CHOOSING CORRECT IMMOBILIZATION
3. VERIFY PATIENT POSITIONING USING TOPOGRAM
4. CHOOSING SCANNING VOLUMES
5. SLICE THICKNESS AND SCANNING MODE (Helical or Axial)
6. 4DCT – FOR RPM

Why do we need IMRT ?

- ▶ If the tumour is large or very close to the spinal cord
- ▶ If the tumour is wrapping around spinal cord
- ▶ For N3 disease where there are 2 distinct areas of disease
- ▶ For irregular shaped contours

- ▶ Then V_{20} constraint can be impossible to meet
- ▶ Estimated spinal cord dose may be too high
- ▶ Or both of these problems

What are our options then

- ▶ IMRT – multiple fields and segments
- ▶ VMAT – more conformed and faster to deliver
- ▶ Tomotherapy

- ▶ Big Problems are:
 - ▶ Low dose bath, ie high V-5.
 - ▶ Interplay between moving MLCs and moving target

- ▶ If the expected benefits are greater than the uncertainties then IMRT/VMAT should be used.

VMAT



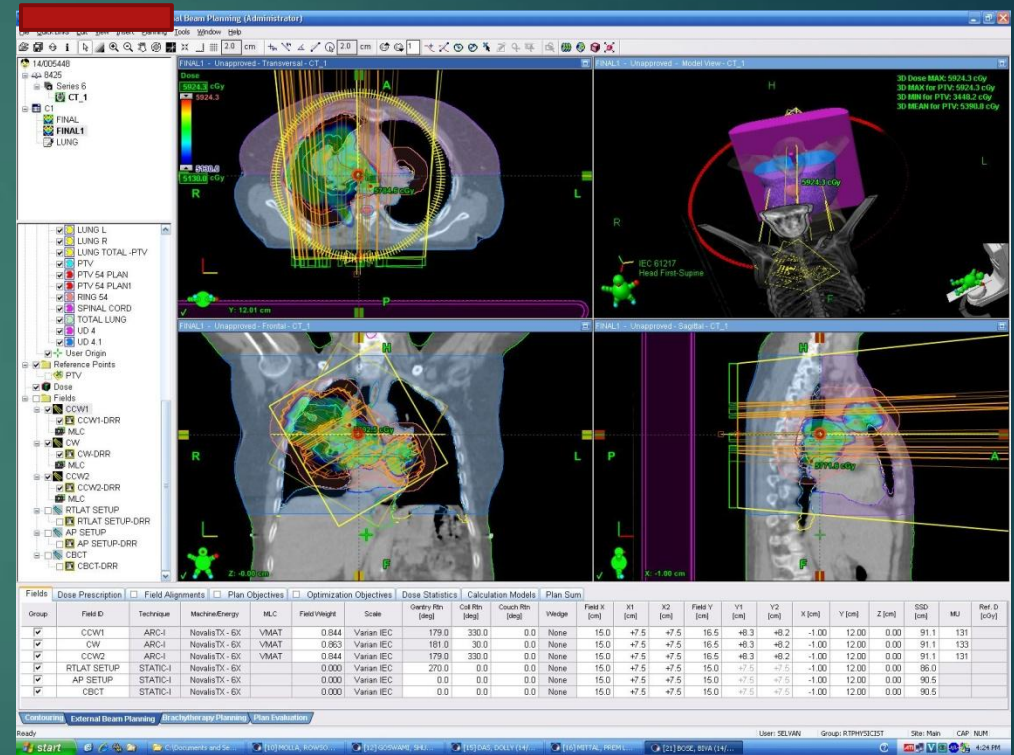
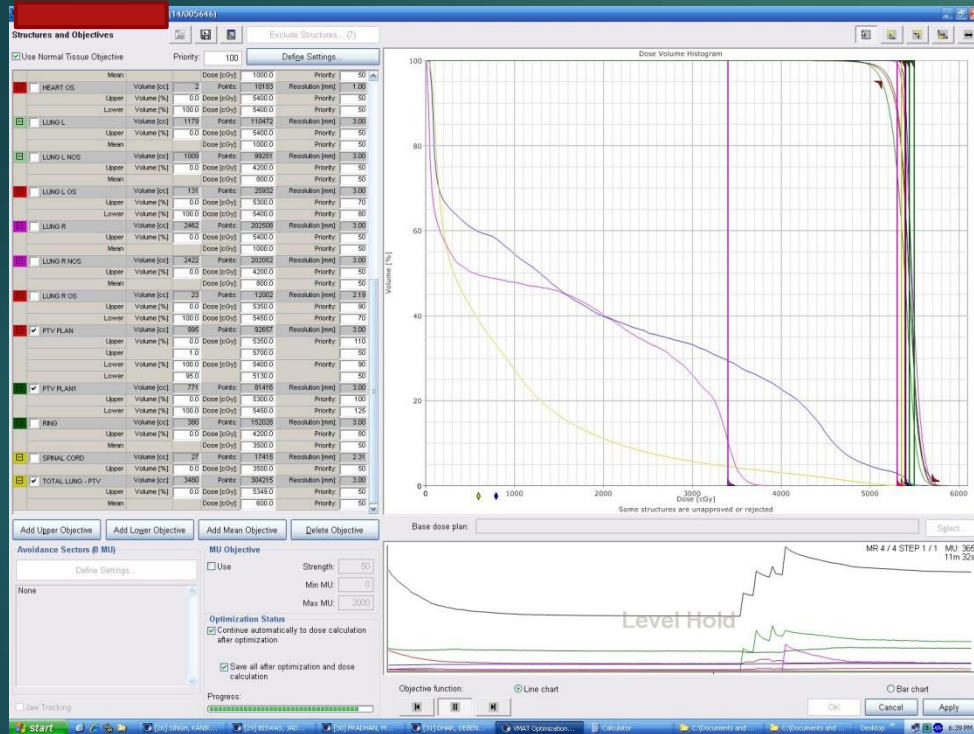
VMAT

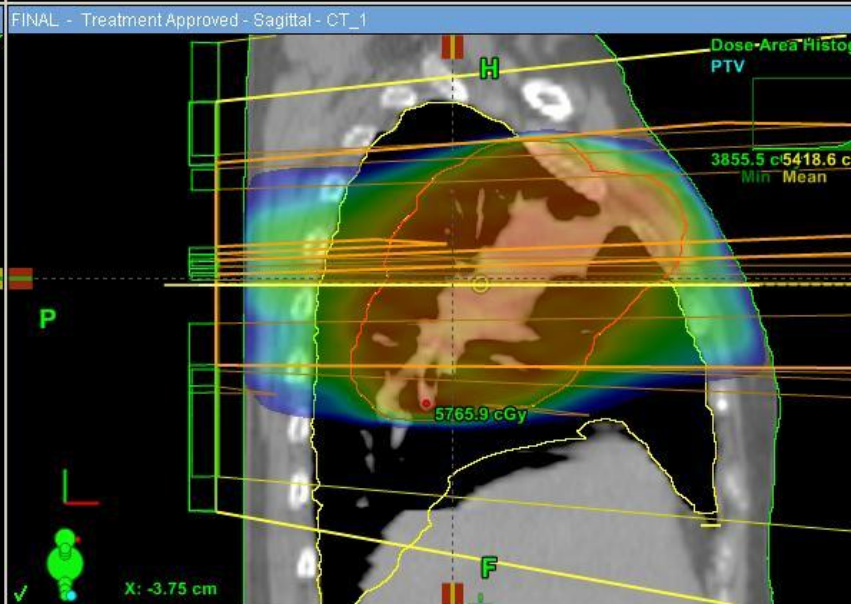
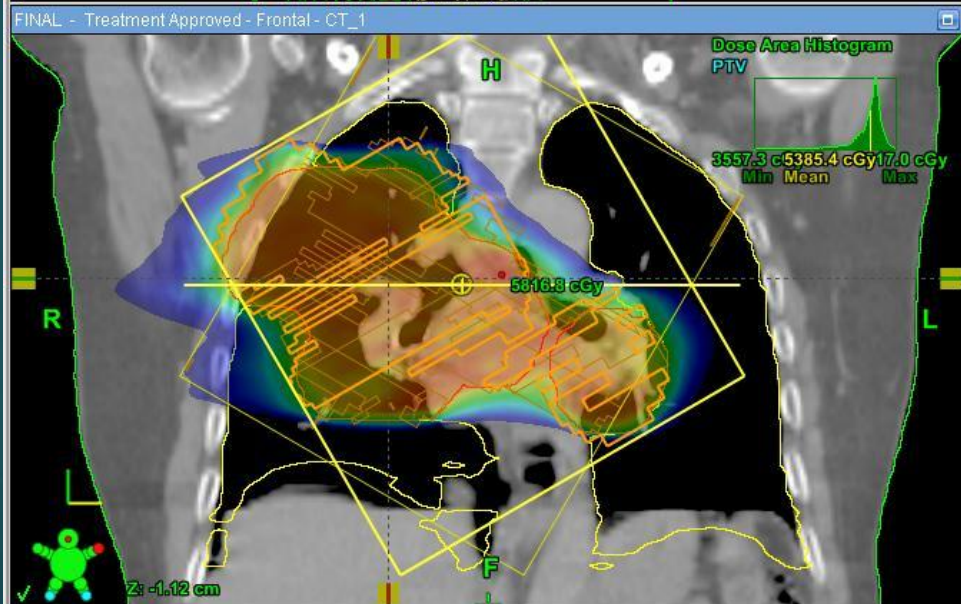
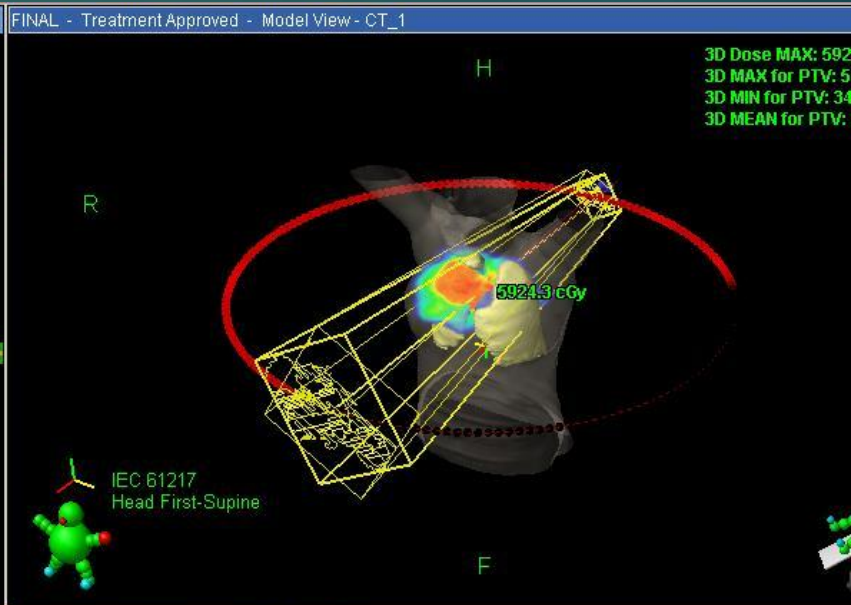
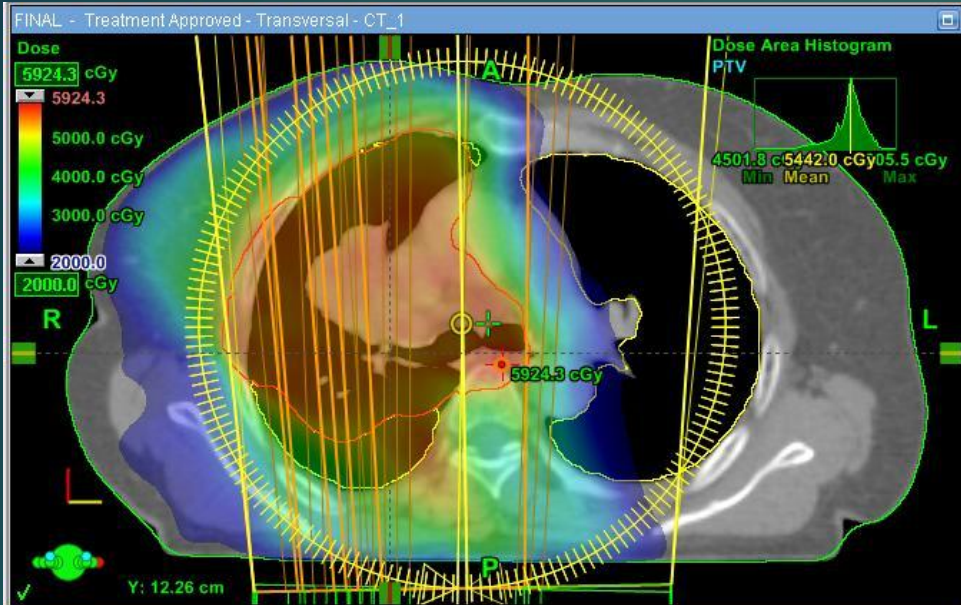
- ▶ Volumetric Arc Therapy – delivers radiation through gantry rotation
- ▶ Dose Dynamic Arc where the MLC shape and dose per degree change dynamically while the beam is on
- ▶ Variable dose per degree is achieved with variable dose rate and variable gantry speed
- ▶ Treatment is based on volumetric dose optimization

VMAT PLANNING

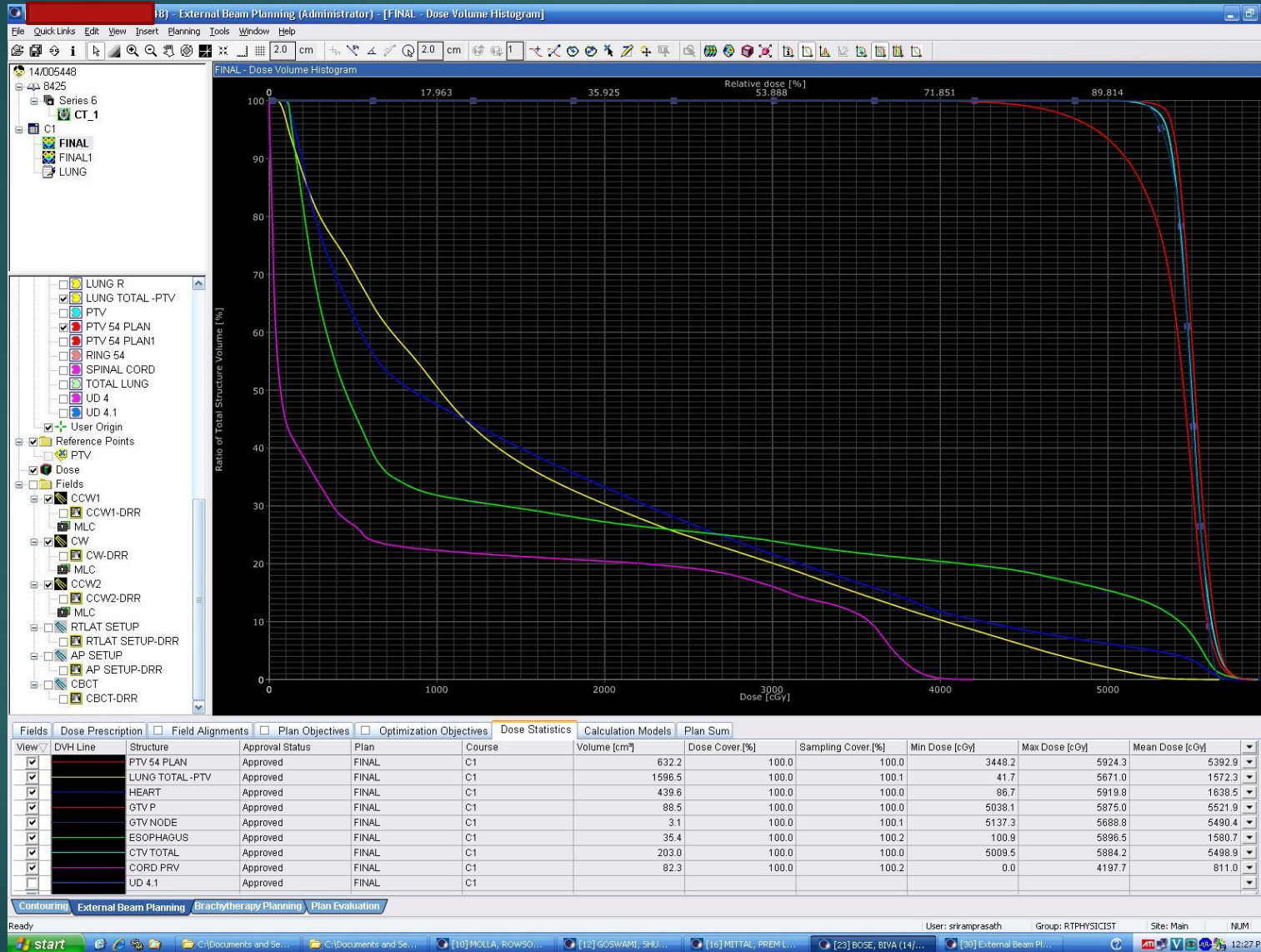
- ▶ Dose Prescription - 60 Gy/30#, 55 Gy/20#, 54 Gy/36# (CHART)
- ▶ No of Arcs and Arc angles
- ▶ Skip Arc
- ▶ Partial Arc
- ▶ Optimization
- ▶ Dose Constraints – PTV and OAR
- ▶ PTV – ICRU 62 & 83 recommendation
- ▶ OAR – Lung (V_{20} , V_{10} and V_5), Spinal Cord, Liver, Esophagus and Heart

VMAT PLANNING AND DVH EVALUATION





DVH VMAT



ADVANTAGES

- ▶ BETTER FLEXIBILITY PLANNING
- ▶ Superior to 3DCRT with regards to dose conformity and sparing OAR
- ▶ Faster delivery time and reduces patient intra fraction motion
- ▶ LESSER MU THAN IMRT

DISADVANTAGES

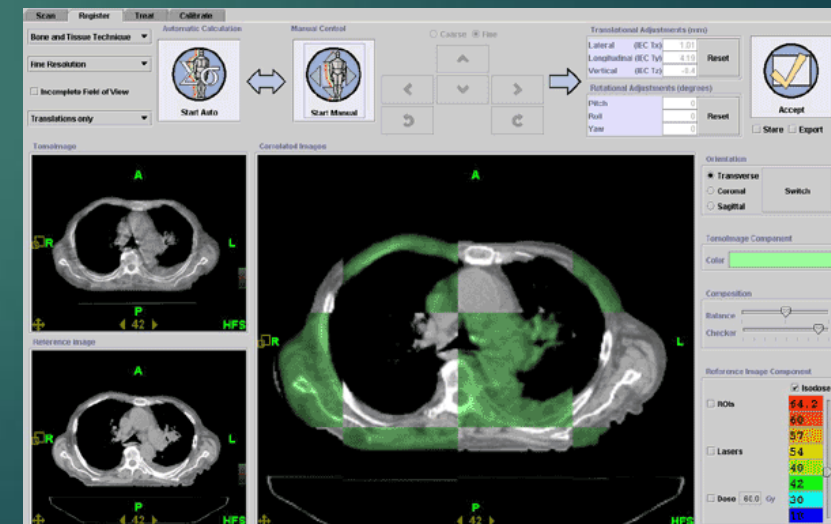
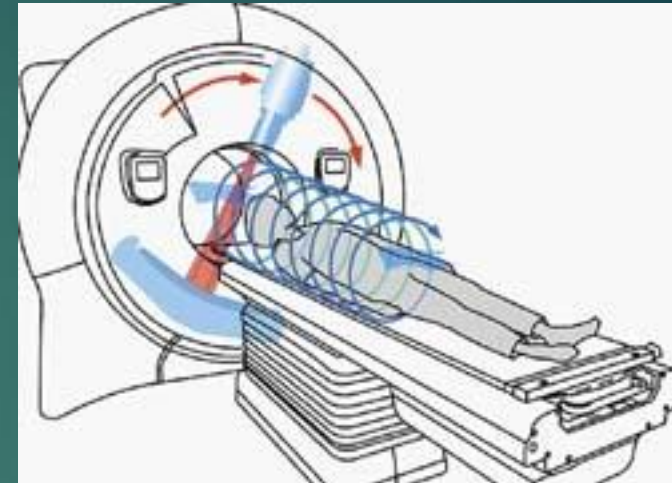
- ▶ Lesser clinical trials
- ▶ Clinical trials are essential to confirm the safety and efficacy of VMAT techniques
- ▶ Lower dose delivered to large volume of lung
- ▶ Requires QA tests for plan verification

TOMOTHERAPY



TOMOTHERAPY OVERVIEW

- ▶ Combination of IMRT with a helical CT
- ▶ A Megavoltage linear accelerator mounted on a ring gantry Delivers photon fan beam as the patient progress through the ring
- ▶ Tomotherapy uses slice therapy delivering IMRT using fan beam and binary MLC's
- ▶ Ability to produce Megavoltage CT image
- ▶ Daily MVCT images reduces patient



TOMOTHERAPY FOR LUNG CANCER

- ▶ Dose Prescription - 60 Gy/30#, 55 Gy/20#, 54 Gy/36# (CHART)
- ▶ FIELD WIDTH
- ▶ MODULATION FACTOR
- ▶ PITCH VALUE
- ▶ DIRECTIONAL BLOCK
- ▶ COMPLEYE BLOCK

PLANNING AND DVH EVALUATION

Planning Station - User Name: sriramprasad

Plan Label: CHART TOMO
Plan Status: Approved
Plan Date: Jun 23, 2014 7:57:09 PM
Position: HFS

Sex: Female
ID: 14.005448
Oncologist: Chatterjee*sanjoy
Disease: 8425

What's Next
Plan Approved
Click Generate Plan Report to create a plan report
You may now perform Delivery Quality Assurance to verify the planned dose.

Prescription
% Vol For: PTV 54 PLAN1 70.00 % will receive 54.00 Gy

Name	Display Color	Blocked	Use Importance	Max Dose [Gy]	Max Dose Pen	DVH Vol	DVH Dose [Gy]
PTV 54 PLAN1	1	Unblocked	50	54.00	4000	70.00	54.00
ESOPHAGUS OS	2	Unblocked	10	52.00	100	95.00	52.00
HEART OS 54	3	Unblocked	10	52.00	100	95.00	52.00

Name	Display Color	Blocked	Use Importance	Max Dose [Gy]	Max Dose Pen	DVH Vol	DVH Dose [Gy]	DVH Pt Pen
CORD PRV	1	Unblocked	4	30.00	200	1.00	25.00	
SPINAL CORD	2	Unblocked	1	25.00	100	1.00	20.00	1
HEART	3	Unblocked	1	52.00	100	30.00	20.00	1
HEART NOS	4	Unblocked	1	50.00	100	20.00	10.00	1
LUNG TOTAL-P	5	Unblocked	25	52.00	1	20.00	20.00	500
ESOPHAGUS	6	Unblocked	1	52.00	1	30.00	10.00	1

Optimize
Dose Calc Grid: Normal
Field Width: 2.5 cm - Jaws...
Modulation Factor: 2.200
Pitch: 0.287

STANDARD Cumulative DVH Relative

Wednesday, July 9, 2014 21:18:45

Planning Station - User Name: sriramprasad

Plan Label: CHART TOMO
Plan Status: Approved
Plan Date: Jun 23, 2014 7:57:09 PM
Position: HFS

Sex: Female
ID: 14.005448
Oncologist: Chatterjee*sanjoy
Disease: 8425

What's Next
Plan Approved
Click Generate Plan Report to create a plan report
You may now perform Delivery Quality Assurance to verify the planned dose.

Presets
Lines
Gy %
57.8 Gy
56.7 Gy
51.3 Gy
48.6 Gy
43.2 Gy
27.0 Gy
16.0 Gy

Target
HEART OS 54
PTV 54 PLAN
ESOPHAGUS

Regions at Risk
GTV NODE
HEART NOS
CTV P
CTV N
PTV
CORD PRV
CTV TOTAL
LUNG TOTAL-H
ESOPHAGUS
SPINAL CORD
RING 54
DUMMY POST
DUMMY ANT
LUNG L
ESOPHAGUS
LUNG R
BODY

Wednesday, July 9, 2014 21:16:50

Planning Station

Patient: [REDACTED] Plan Label: **CHART TOMO** User Name: **sriramprasath**
 No Photo Sex: **Female** Plan Status: **Approved** **Plan Approved**
 ID: **14/005448** Plan Date: **Jun 23, 2014 7:57:09 PM** Click **Generate Plan Report** to create a plan report
 Oncologist: **Chatterjee^sanjoy** Position: **HFS** You may now perform Delivery Quality Assurance to verify the planned dose.

Save

Contouring ROIs Plan Settings Beam Angles Optimization Fractionation

Presets
 Lines
 Gy %
 57.8 Gy
 56.7 Gy
 54.0 Gy
 51.3 Gy
 48.6 Gy
 43.2 Gy
 37.0 Gy
 27.0 Gy
 20.0 Gy
 Edit

Target

Name	Color	Visible
HEART OS 54	Blue	<input type="checkbox"/>
PTV 54 PLAN	Red	<input checked="" type="checkbox"/>
ESOPHAGUS C	Pink	<input type="checkbox"/>

Regions at Risk

Name	Color	Visible
GTV NODE	Dark Blue	<input type="checkbox"/>
HEART NOS	Blue	<input type="checkbox"/>
CTV P	Red	<input type="checkbox"/>
CTV N	Blue	<input type="checkbox"/>
PTV	Red	<input type="checkbox"/>
CORD PRV	Cyan	<input type="checkbox"/>
CTV TOTAL	Cyan	<input type="checkbox"/>
LUNG TOTAL -I	Green	<input checked="" type="checkbox"/>
ESOPHAGUS M	Pink	<input type="checkbox"/>
SPINAL CORD	Pink	<input type="checkbox"/>
RING 54	Pink	<input type="checkbox"/>
DUMMY POST	Blue	<input type="checkbox"/>
DUMMY ANT	Blue	<input type="checkbox"/>
LUNG L	Yellow	<input type="checkbox"/>
ESOPHAGUS	Green	<input checked="" type="checkbox"/>
LUNG R	Yellow	<input type="checkbox"/>
BODY	Pink	<input checked="" type="checkbox"/>
TOTAL LUNG	Green	<input type="checkbox"/>

Transverse Coronal Sagittal

Options << >> []

96 129 127

Thursday, July 10, 2014 18:30:57

Start Planning Station TomoTherapy DQA Station Calculator 6:30 PM

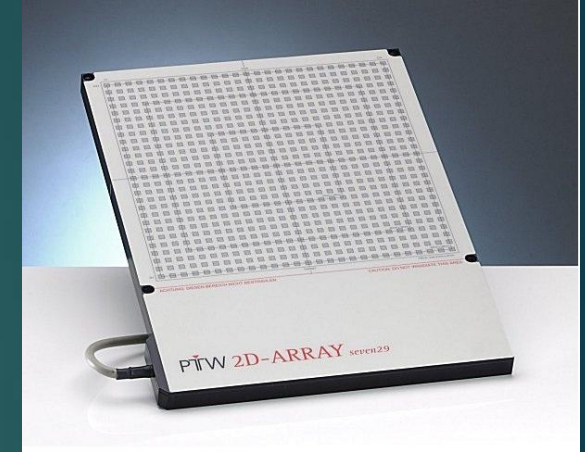
Pre-delivery checks

- ▶ Complex plans may hit the target precisely and miss the target precisely
- ▶ Need quality checks to avoid treatment delivery problems
- ▶ Need to ensure that dose intended is the dose delivered to the areas intended
- ▶ Patient-specific QA is necessary

PRE TREATMENT VERIFICATION

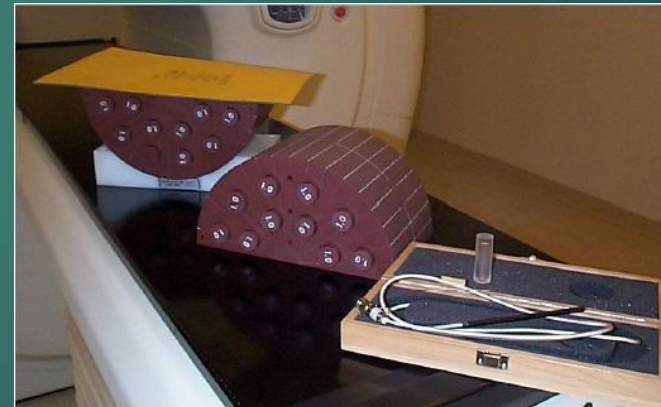
Fluence

- ▶ Analyse gamma evaluation and DTA (3% & 3mm)
- ▶ Film with cheese or Octavius Phantom or 2D Array with Octavius Phantom



Point Dose

- ▶ Verify TPS calculated Dose
- ▶ Cheese Phantom or Octavius Phantom using small volume ion chamber
- ▶ % Deviation - $\pm 3\%$



VMAT QA CHECK

Administrative Data

Institution: Tata Medical Center
 Physicist: TAMIL/ SRIRAM/AIZ
 PatientID: 14/005448
 Patient Name: [REDACTED]
 Comment: [REDACTED]

Data Set A

X:\BIVA_BOSE-14-005448\RD.1.2.246.352.71.7.485553952.346336.20140619173851.dcm
 Slices: -1.05 mm

Data Set B

C:\Documents and Settings\Administrator\Local Settings\Temp\tmp4D4.tmp

Gamma 2D - Parameters

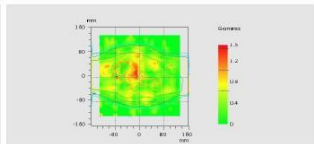
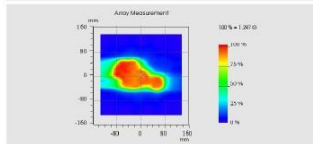
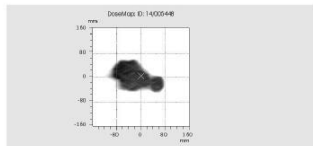
3.0 mm Distance- To- Agreement
 3.0 % Dose Difference with ref. to Max. dose of measured data set
 Use increased tolerance of 3.0 % Dose Diff. for values below 1.0 Gy (or AU)
 Suppress doses below 3.0 % of max. dose of measured data set

Statistics

Number of Dose Points	729
Evaluated Dose Points	567 (77.8 %)
Passed	550 (97.0 %)
Failed	17 (3.0 %)
Result	97.0 % (Green)

Settings

Passing criteria	Gamma \leq 1.0
Green	90.0 % to 100.0 %
Yellow	75.0 % to 90.0 %
Red	0.0 % to 75.0 %



TOMOTHERAPY QA CHECK

What's Next

- Save DOA Data
 - Click Save Film Data to save current data for this procedure.
 - Click Save POIs to save POI data.

Delivery QA Setup | Delivery QA Analysis

Dose Profile | Gamma Histogram

Dose Profile Comparison

Dose (Gy) vs. Distance along arrow (cm)

Legend: ■ measured dose (Gy) ■ calculated dose (Gy)

Display Options

- No contours
- Show film profile
- Show calc profile
- Show gamma
- Show these contours:
 - Film background
 - Phantom background
- Show film contours
- Show calc contours
- Show patient ROIs

Buttons: Stop Gamma Calc, Calculate Gamma, Save Film Data, Save POIs

Gamma Display

Reference dose: 1.5 Gy
 Status: Performed On
 Machine: 0210297
 Proc number: 1

Buttons: Read Film File, Read Cal File, Convert To Dose, Plot Cal Table, Extract Dose Plane, Flip Image, Scale Film Dose

Film Registration

Register Film Position
 Registration type: Coronal patient slice: 114
 Current step:

Buttons: Accept Point, Cancel Registration

Points of Interest

Add Point of Interest	Name	Comment	Color	x (cm)	y (cm)	z (cm)	Calc Dose	Meas Dose	Diff (Gy)
Remove Selected POI	POI_00		Red	-4.31	7.07	2.17	1.189	1.167	0.022
Show Selected POI									
Move Selected POI									

System tray: Friday, July 11, 2014 12:17:28

THANK YOU

S. SRIRAM PRASATH
MEDICAL PHYSICIST
TATA MEDICAL CENTER
KOLKATA

ACKNOWLEDGEMENTS

- ▶ Mr.TAMIL SELVAN
- ▶ Mr.ARUN
- ▶ Mr.AZIZ
- ▶ MS.ANURUPA MAHATA