# 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 – Heterogenity

**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.**

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# TREATMENT TECHNIQUES

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

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# WORKFLOW

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

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# 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

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# 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

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# 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.

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# VMAT


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# 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

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# 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

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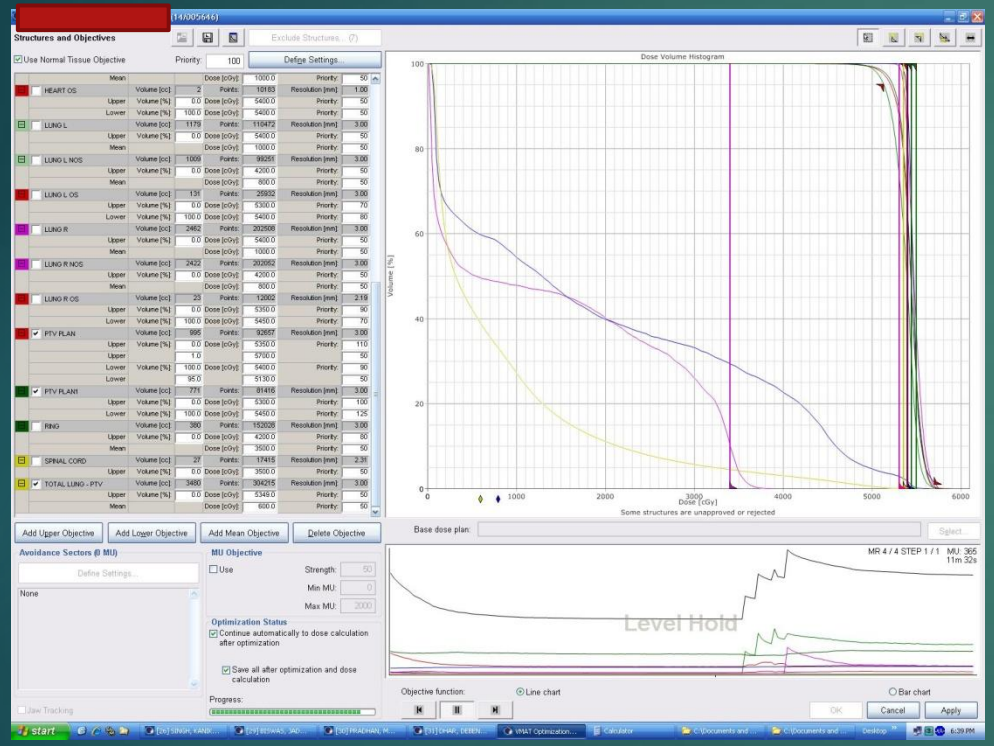
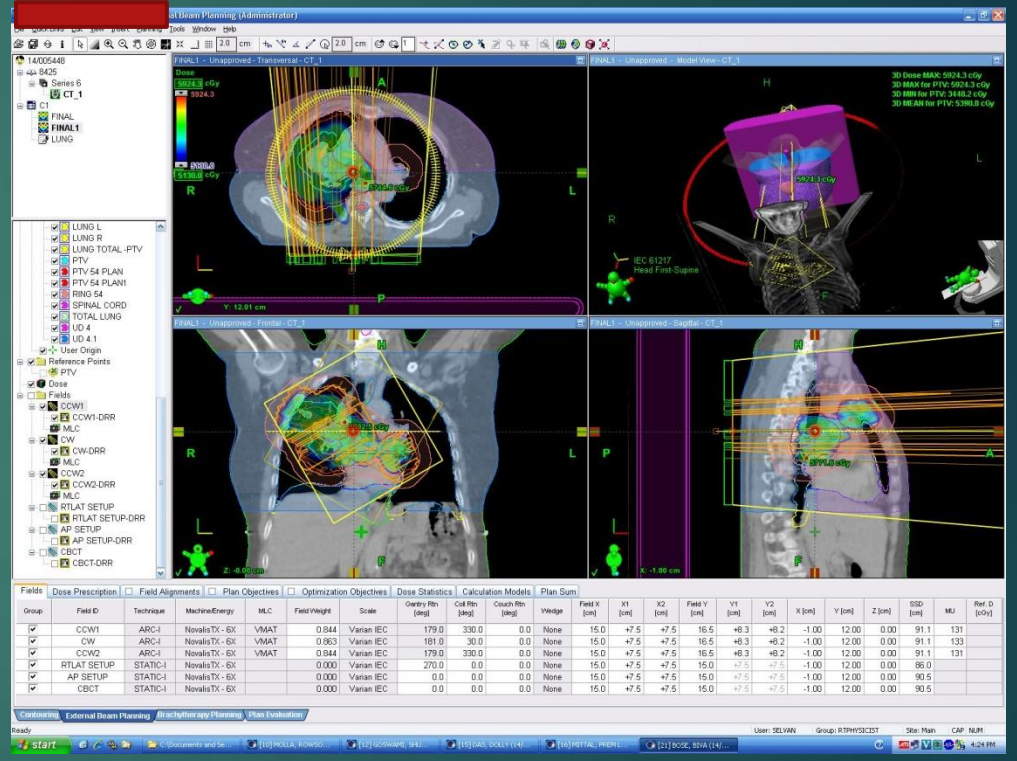
# VMAT PLANNING AND DVH EVALUATION

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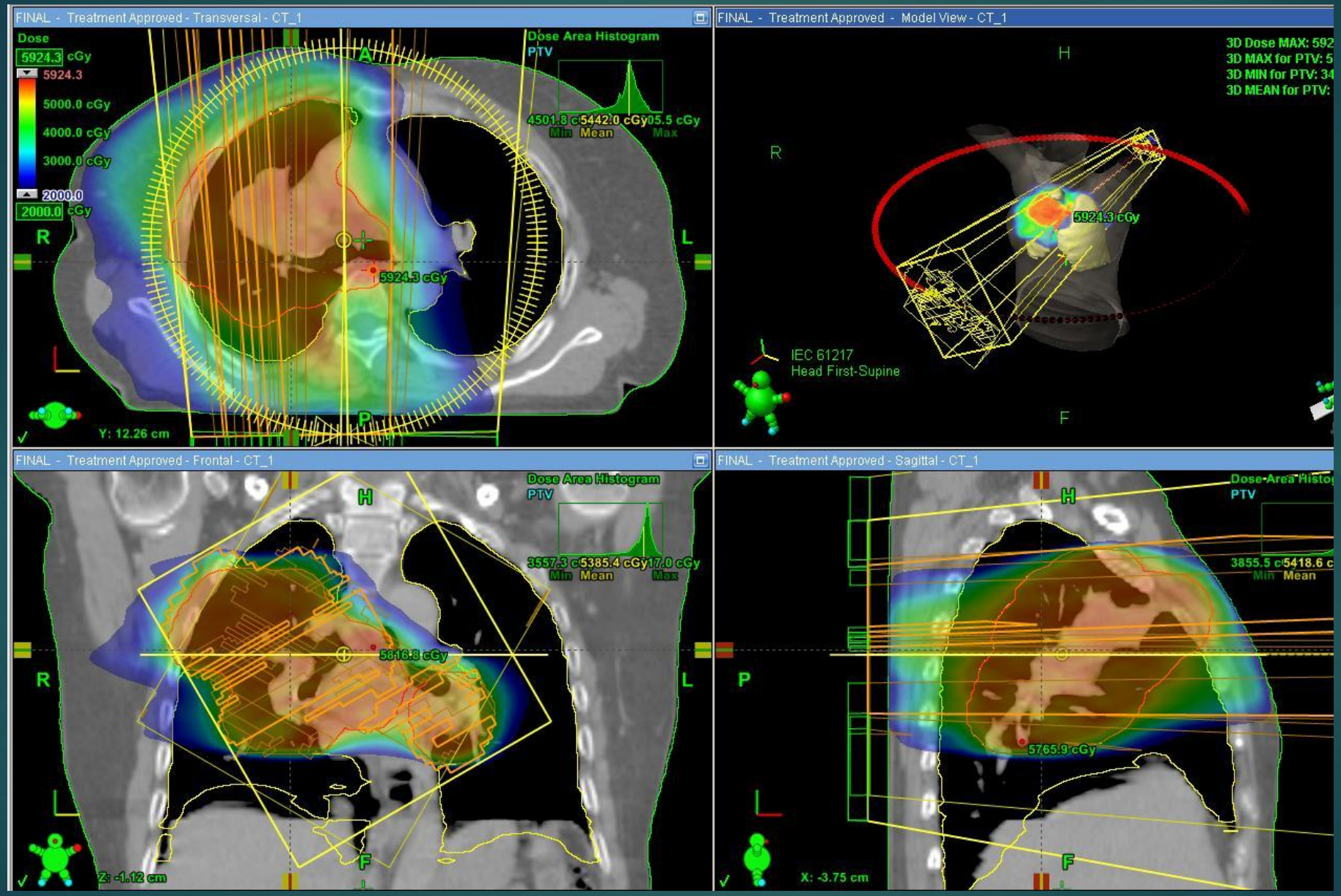


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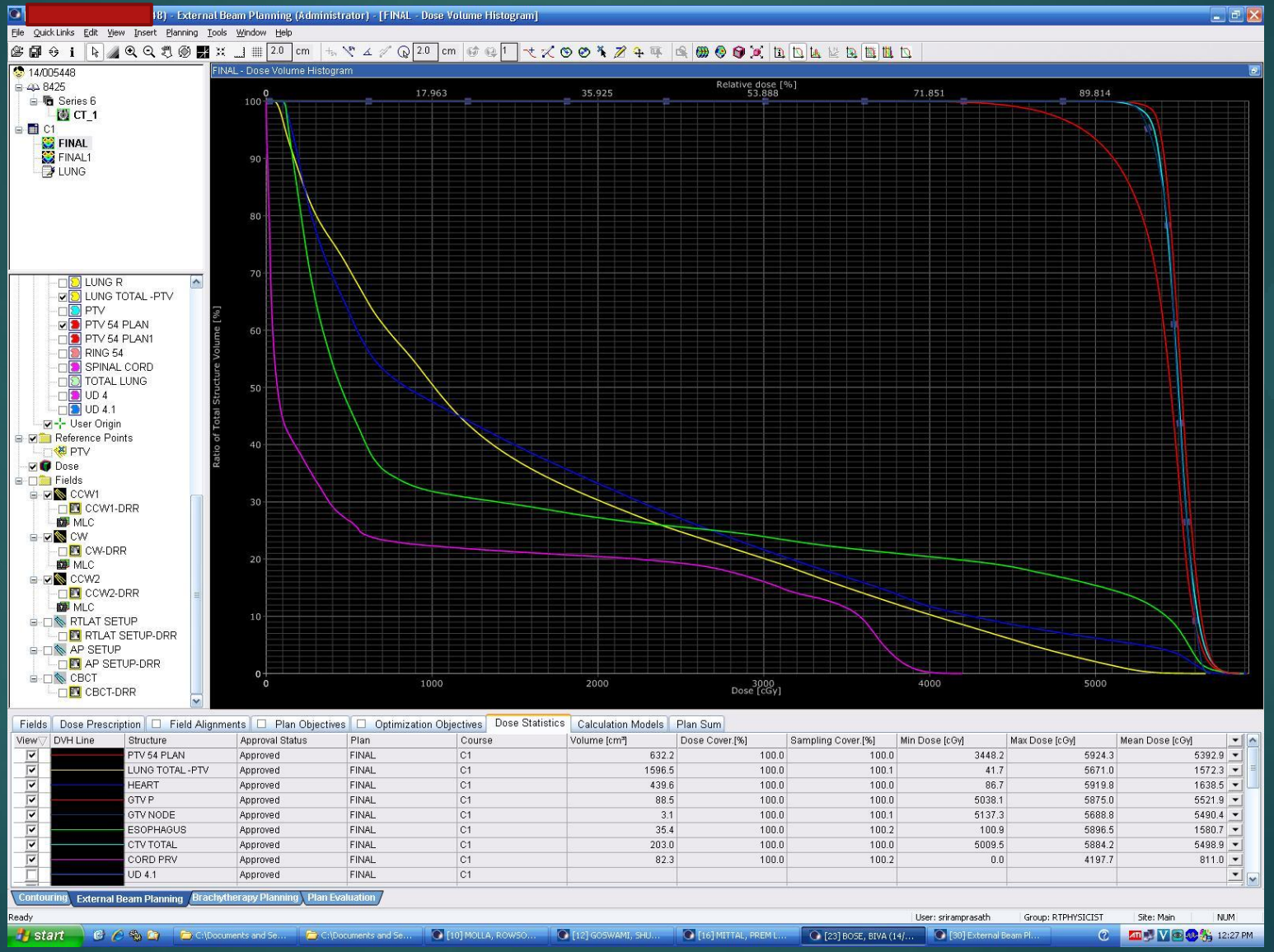
# DVH VMAT

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# 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

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# 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


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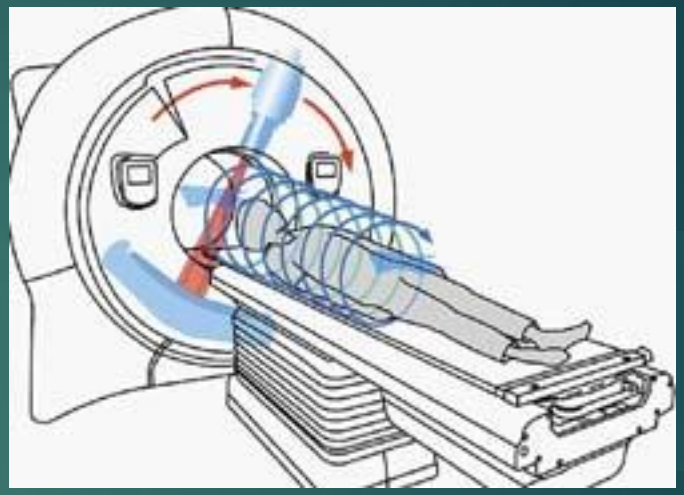
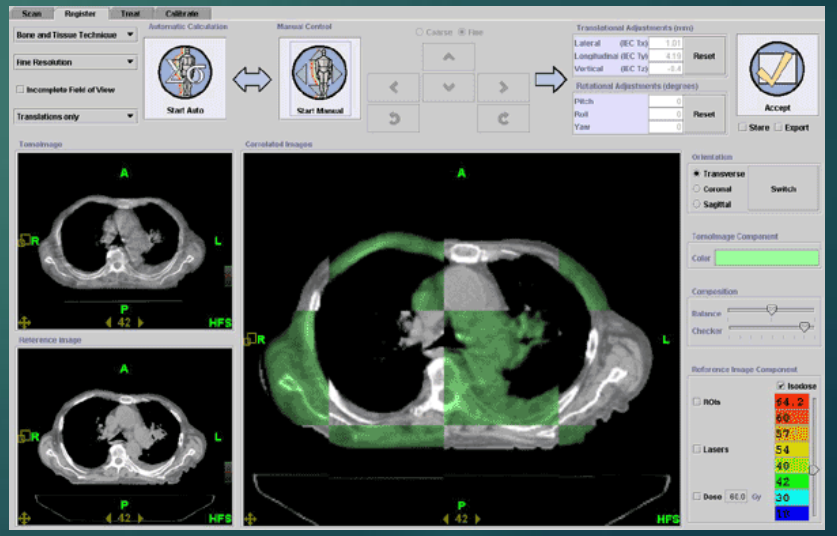
# TOMOTHERAPY OVERVIEW

- 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



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# 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

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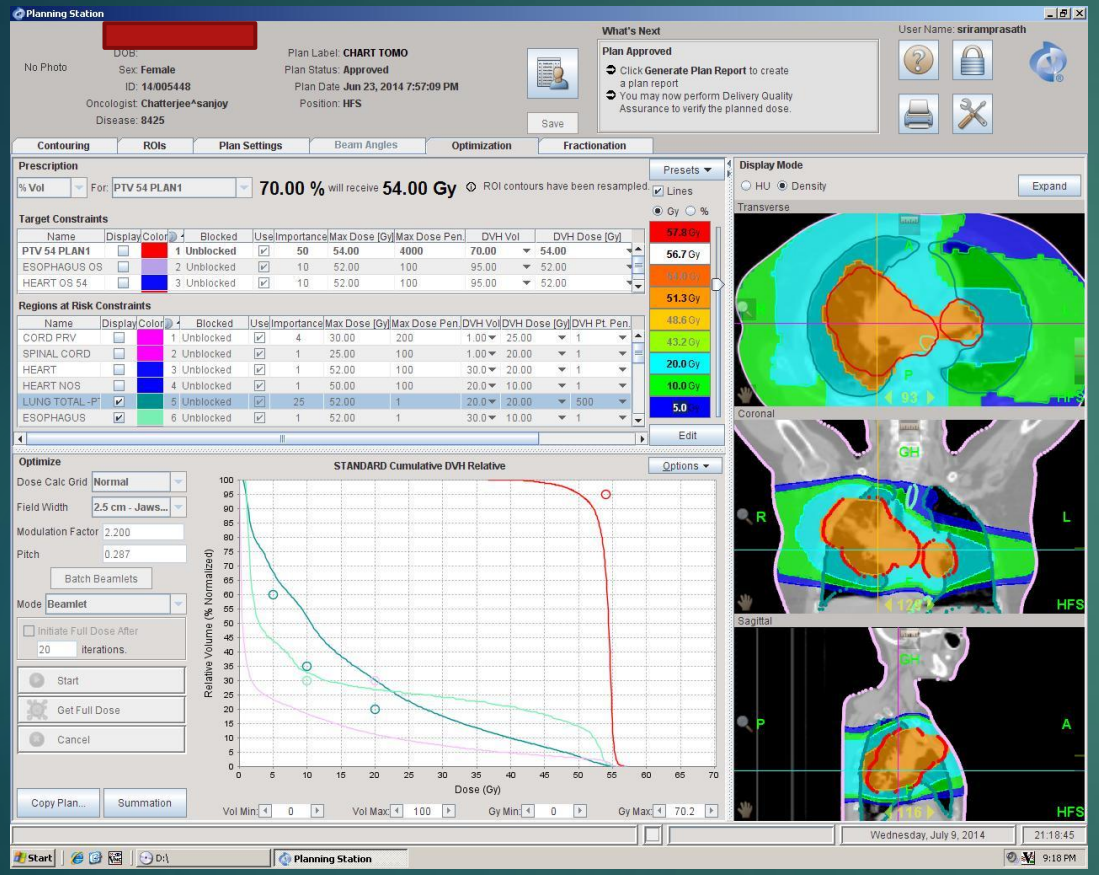
# PLANNING AND DVH EVALUATION





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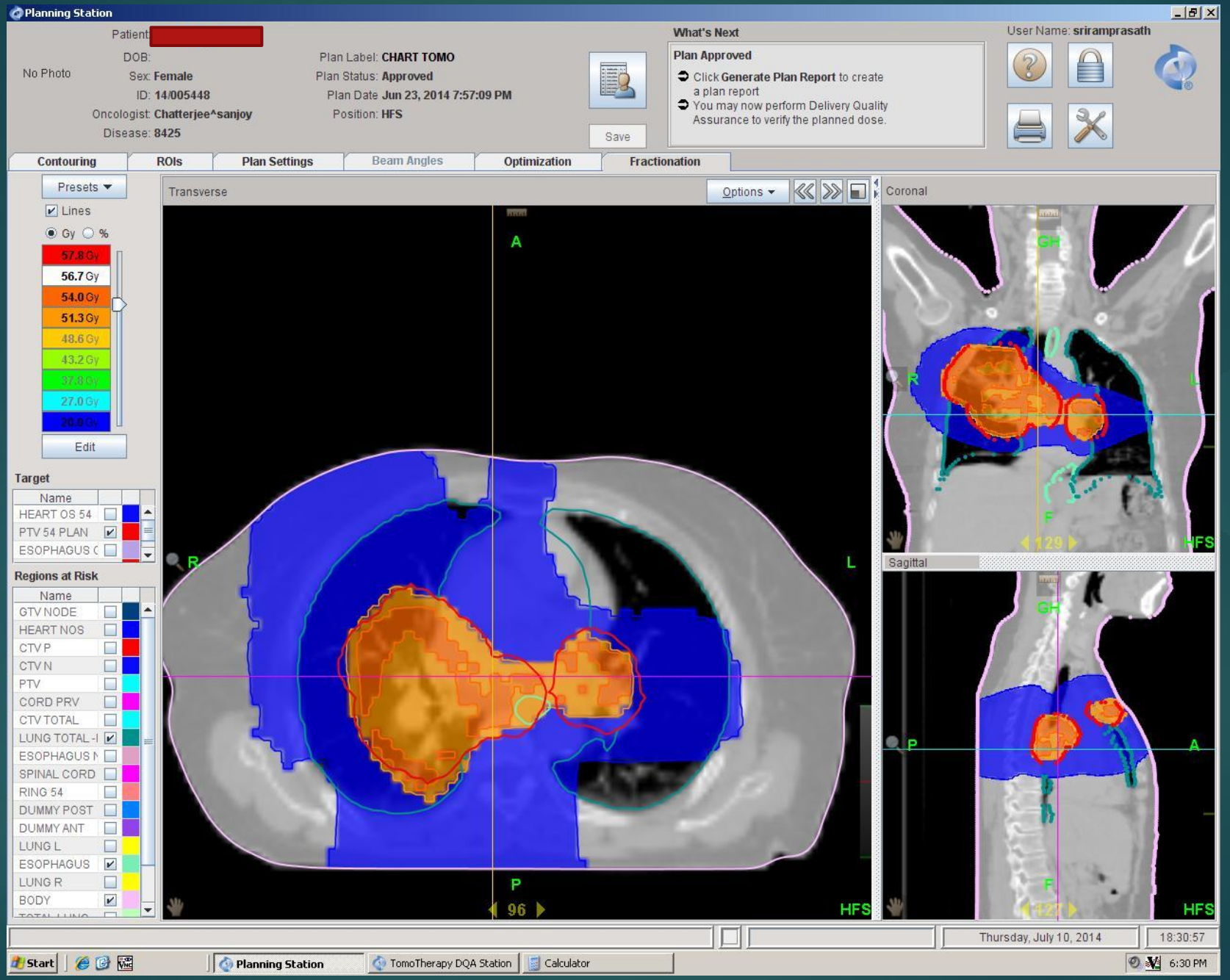


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# Pre-delivery checks

- 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

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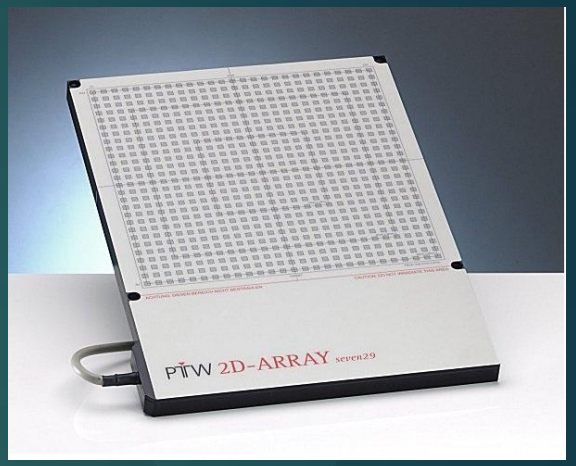
# PRE TREATMENT VERIFICATION

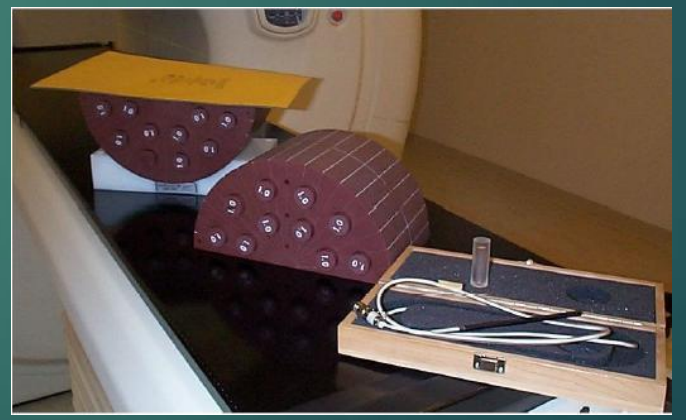
## Fluence

- 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 - ± 3%



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# VMAT QA CHECK

**Administrative Data**
Institution Tata Medical Center
Physicist TAMIL/ SRIRAM/AIZ
PatientID 14/005448
Patient Nam [redacted]
Comment

**Data Set A**
X:\BIVA BOSE-14-005448\RD.1.2.246.352.71.7.485553952.346336.20140619173851.dcm
Slice: -1.05 mm
**Data Set B**
C:\Documents and Settings\Administrator\Local Settings\Temp\tmp4D4.tmp

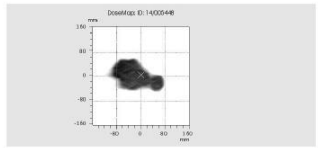
**Gamma 2D - Parameters**
3.0 mm Distance- To- Agreement
3.0 % Dose Difference with ref. to Max. dose of measured data set
Use increased tolerance of 3.0 % Dose Diff. for values below 1.0 Gy (or AU)
Suppress doses below 3.0 % of max. dose of measured data set

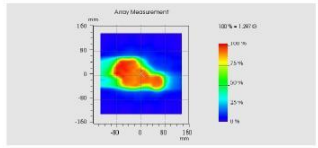
**Statistics**

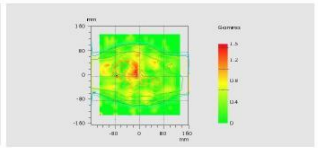
| | |
|---|---|
| Number of Dose Points | 729 |
| Evaluated Dose Points | 567 ( 77.8 %) |
| Passed | 550 ( 97.0 %) |
| Failed | 17 ( 3.0 %) |
| Result | 97.0 % (Green) |

**Settings**

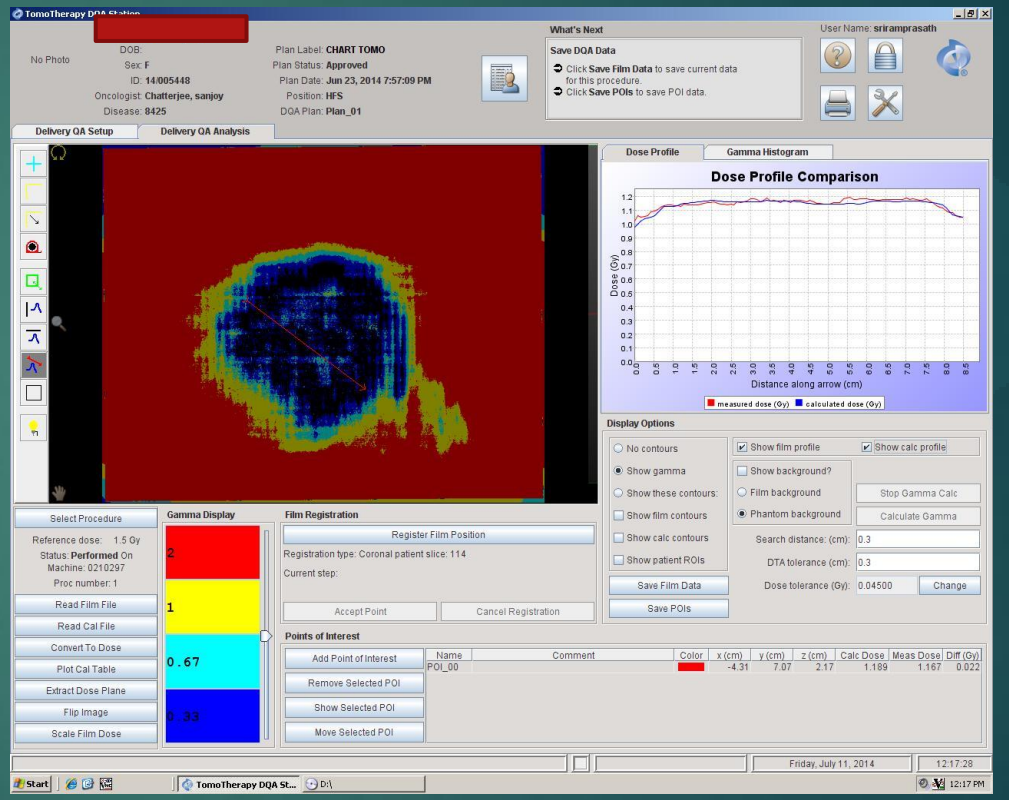
| | |
|---|---|
| Passing criteria | Gamma ≤ 1.0 |
| Green | 90.0 % to 100.0 % |
| Yellow | 75.0 % to 90.0 % |
| Red | 0.0 % to 75.0 % |







# TOMOTHERAPY QA CHECK

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# THANK YOU

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