

Treatment Planning in clinical environment

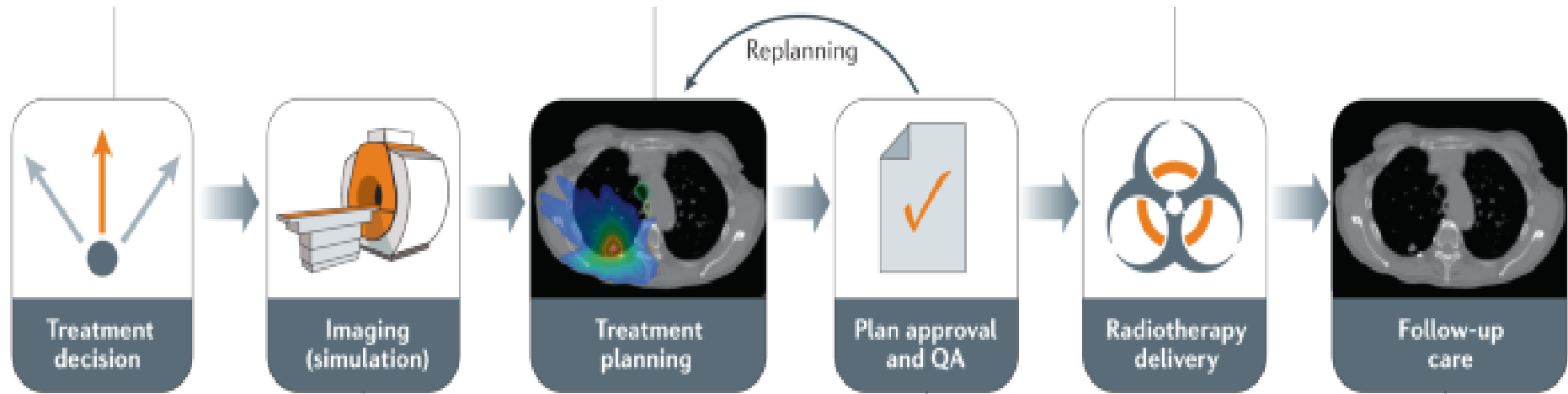
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Work-Flow



So...what we will see today

Treatment decision

Imaging - Simulation

Treatment Planning

Treatment Decision



Initial Assessment: Review medical history, perform a physical examination and evaluation of diagnostic tests (CT, MRI, PET)



Radiotherapy is it appropriate?



Treatment Plan: Type (external beam or internal) and duration of treatment

CT Simulation

Positioning

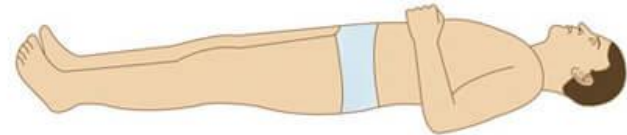
Immobilization Systems

Scan protocol

Marking the Area-Reference Marking

Positioning

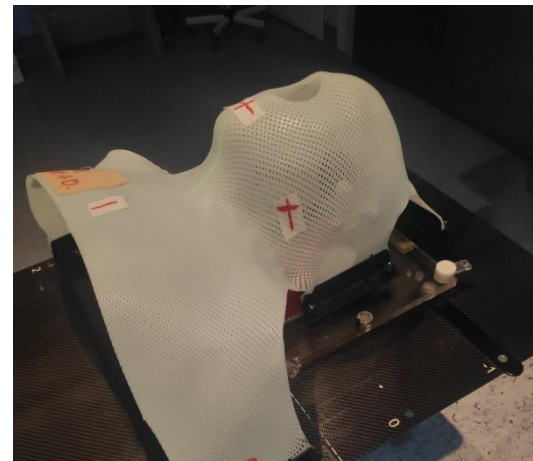
- Supine Position
- Lateral Position
- Prone Position
- Hands up or down
- Head or feet first



Immobilization Systems

- Precision and accuracy for beam delivery.
- Depends on the anatomical region for external immobilization device
- Immobilization devices help enhance the consistency and stability of the setup
- The accessories can be:
 - 1) Thermoplastic mask, 2) Knee, Head rest,
 - 3) Mouthpiece, 4) Wedges of foam, 5) Vacuum bag,
 - 6) Bellyboard, 7) Breastboard, 8) Shoulder Traction tube.

Immobilization Systems



Scan Protocol

- Anatomical Region
- Kv, mAs
- Slice Thickness 1.25
- Pitch factor
- Slice spacing
- Field of View

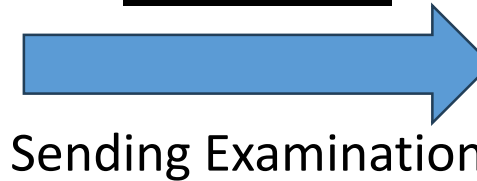
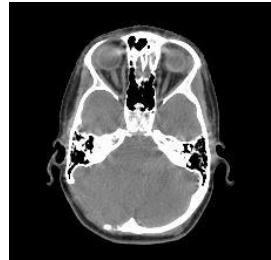


Marking the Area - Reference Marking

- Reference marks must be applied to the patient to ensure accuracy and repeatability of the position for the treatment at the linear accelerator
- BBs (radiopaque markers) help to precisely align and position the patient
- Tattoo
- LASERs can help

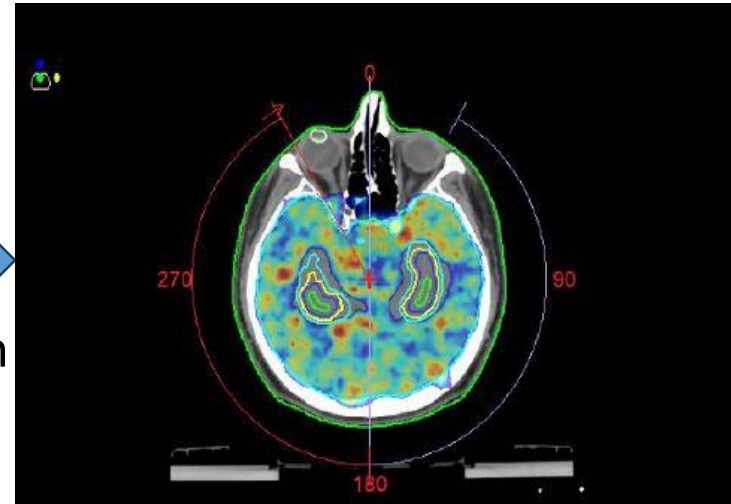
Treatment Planning System

CT-Simulation



Sending Examination

Treatment Planning System



Treatment Planning System

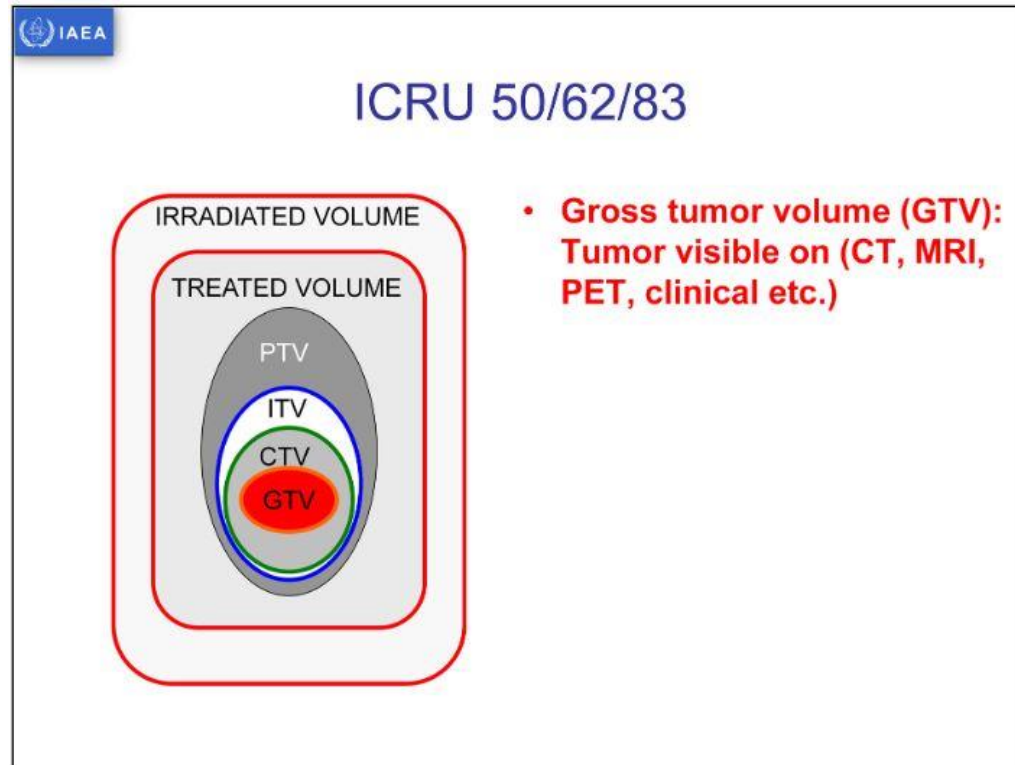
Contouring

Origin & Isocenter

Treatment Technique

Contouring

- Accurate contouring is crucial in creating an effective and safe treatment plan, as it ensures the radiation precisely targets the tumor while sparing vital organs and healthy tissue.
- GTV, CTV, PTV
- Organs at Risk (OARs)
- Fusion Images (MRI,PET)



Origin & Isocenter

Scan Reference Point
X: Y: Z:
 Lock Scan Reference Display Scan Reference

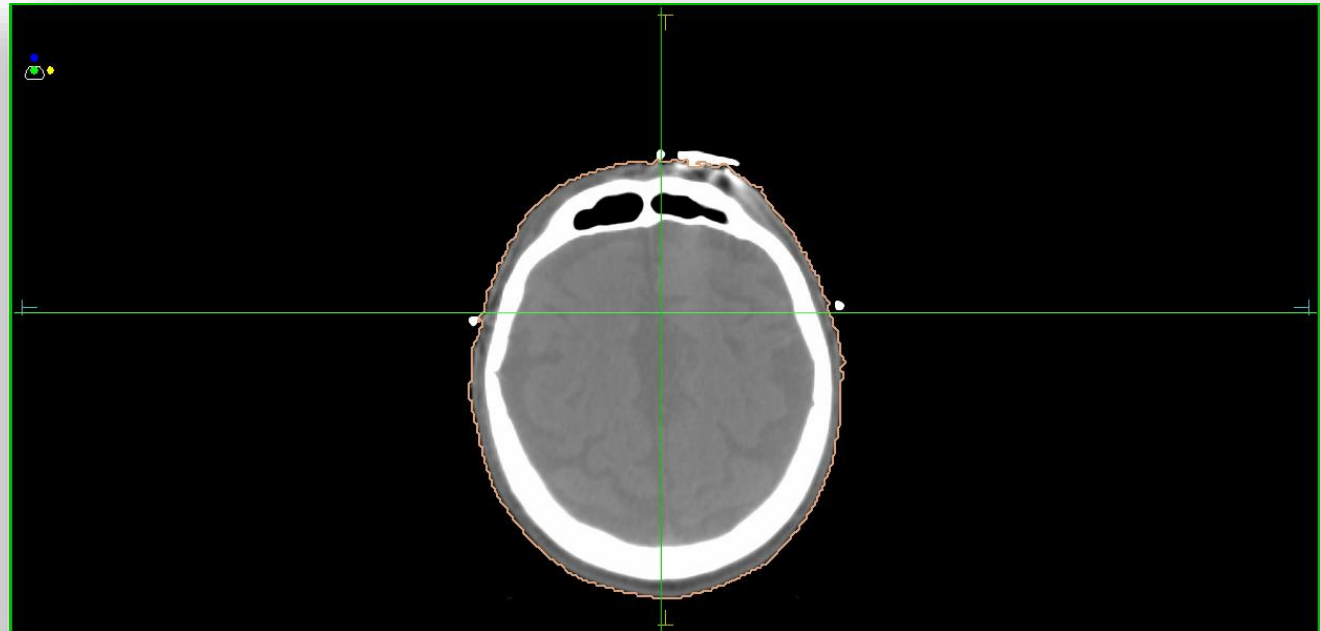
Setup Reference Point
X: Y: Z:
Selected Point:

Patient orientation when scanned:
 Autorun

Shift (Setup Reference - Scan Reference)
X: Y: Z:
 Left Right Superior Inferior Anterior Posterior
 Lock Shift

Absolute Coordinates
Note: A patient orientation must be selected.
Sagittal Laser: cm
Table Longitudinal: cm
Table Height: cm Scan Table Height

WARNING: Information displayed will not be saved for use with individual plans. It can be opened and modified at any time and for any plan belonging to the study set.



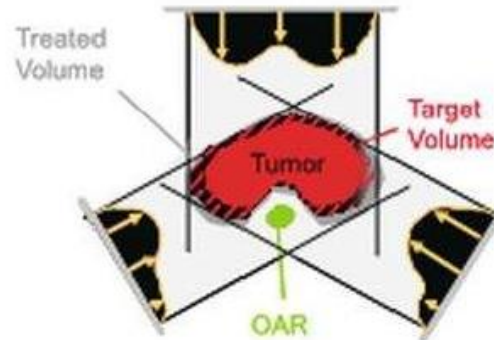
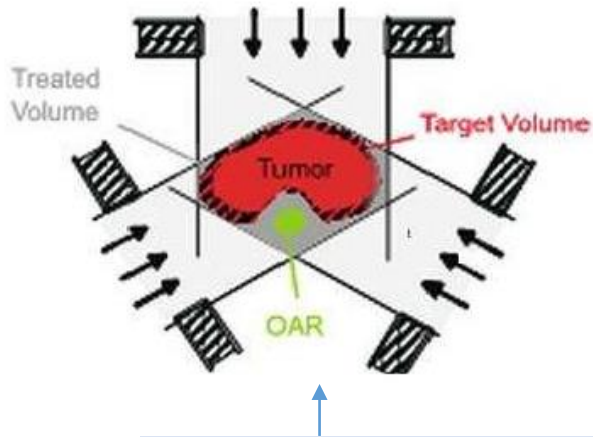
- Origin is the beginning of everything
- Isocenter is preferred to be in the center of PTV

Decision of the Technique with photons

3D CRT

IMRT

VMAT



WEDGE & FIF

SEGMENTS

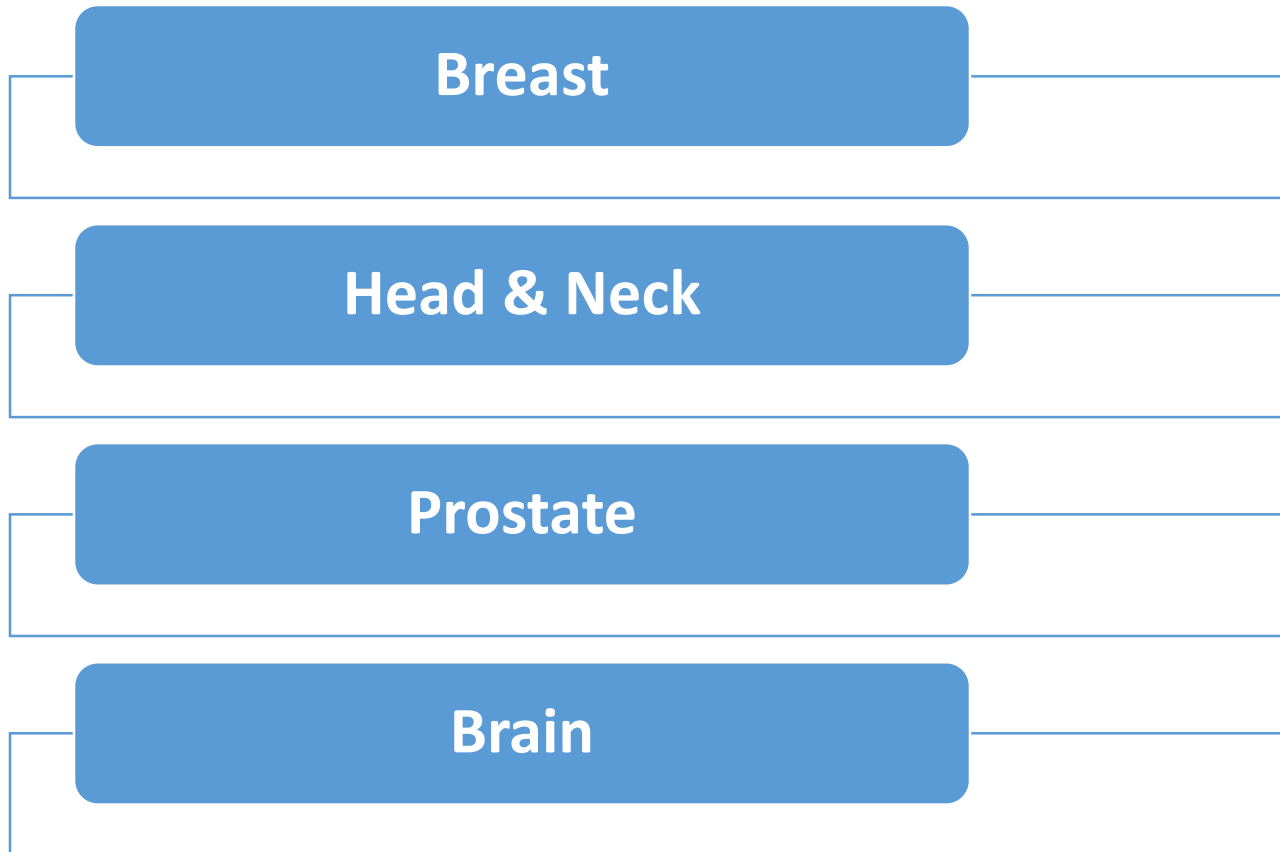
Wedge, FIF and Segment

- **Wedge** is a beam-modifying device used in external beam radiotherapy to adjust the dose distribution within a radiation field.
- **Field-in-field (FIF)** is used to improve dose uniformity by dividing the radiation field into smaller subfields.
- **Segments** in radiotherapy refer to smaller radiation fields created by a multileaf collimator (MLC) to shape and modulate the radiation beam, for more conformal treatment.

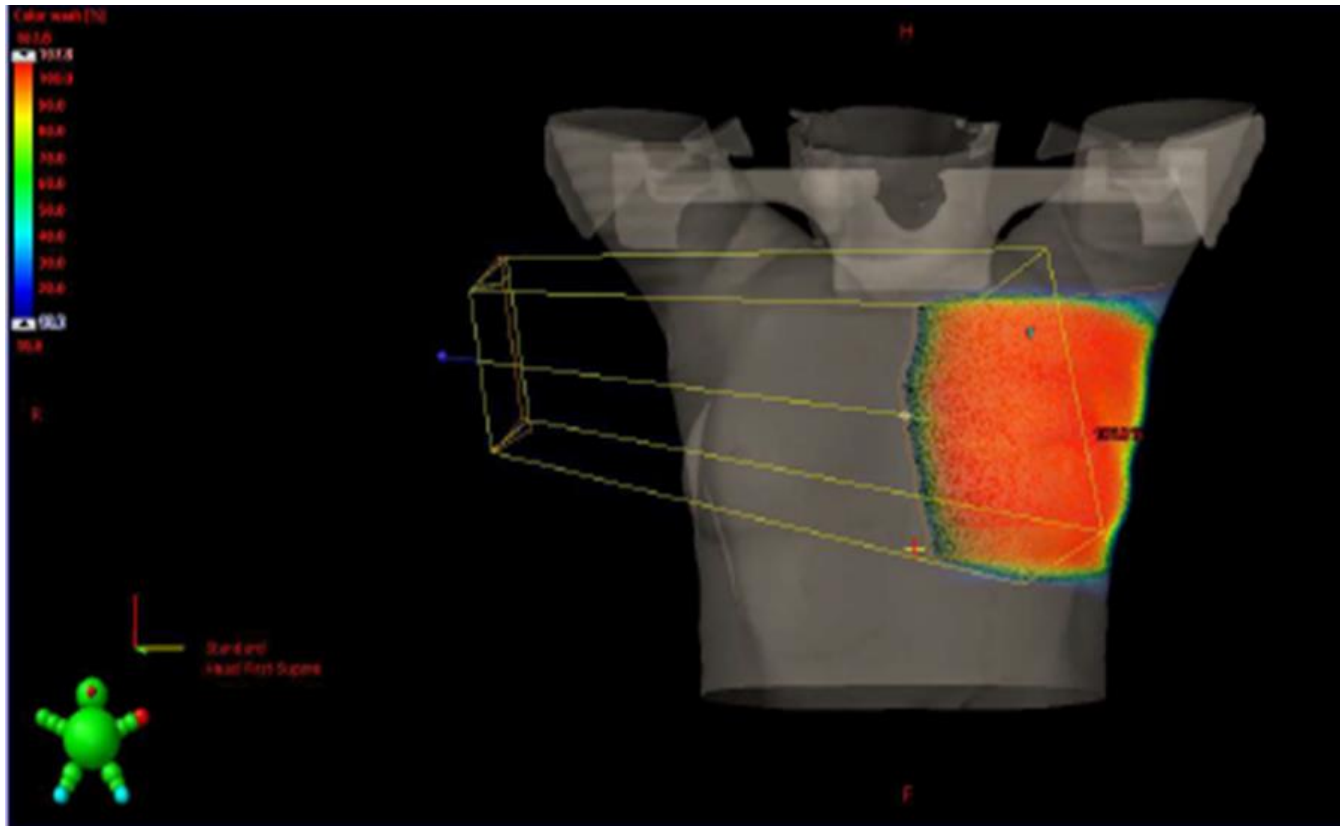
Dosimetry Algorithms

- **Pencil Beam Algorithm (PBA):** Simple and fast but limited accuracy.
- **Collapsed Cone Convolution (CCC):** Accurate in heterogeneous tissues, good for most clinical use.
- **Anisotropic Analytical Algorithm (AAA):** Highly accurate for various tissue types, commonly used in IMRT and VMAT.
- **Monte Carlo (MC):** The most accurate but computationally intensive.
- **Acuros XB:** Combines Monte Carlo accuracy with faster computation times.
- **Superposition/Convolution Algorithms:** Balances accuracy and speed for clinical practice.

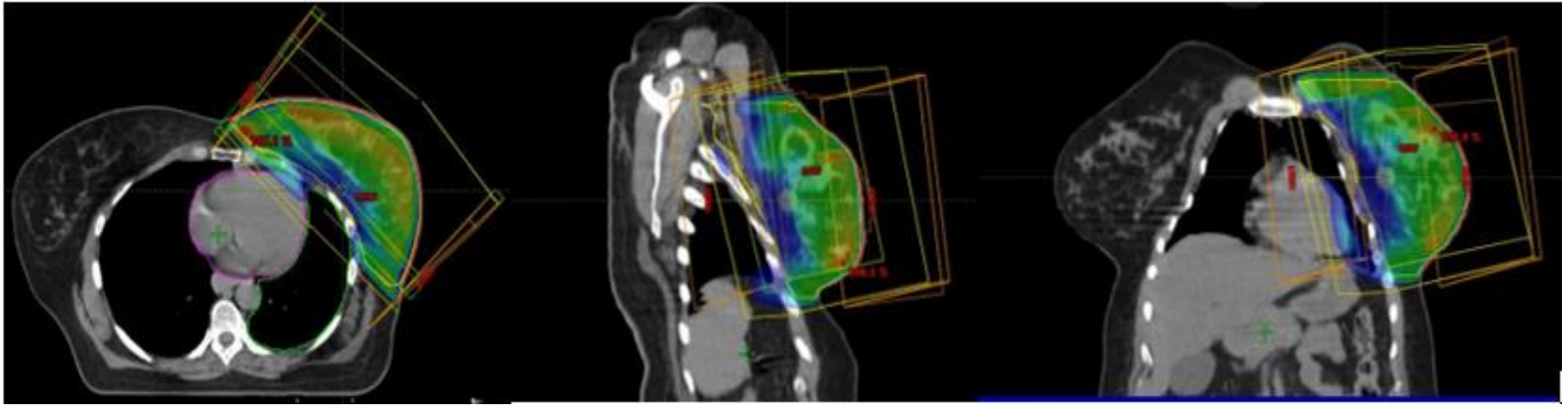
Treatment Plans examples



Breast treatment plan

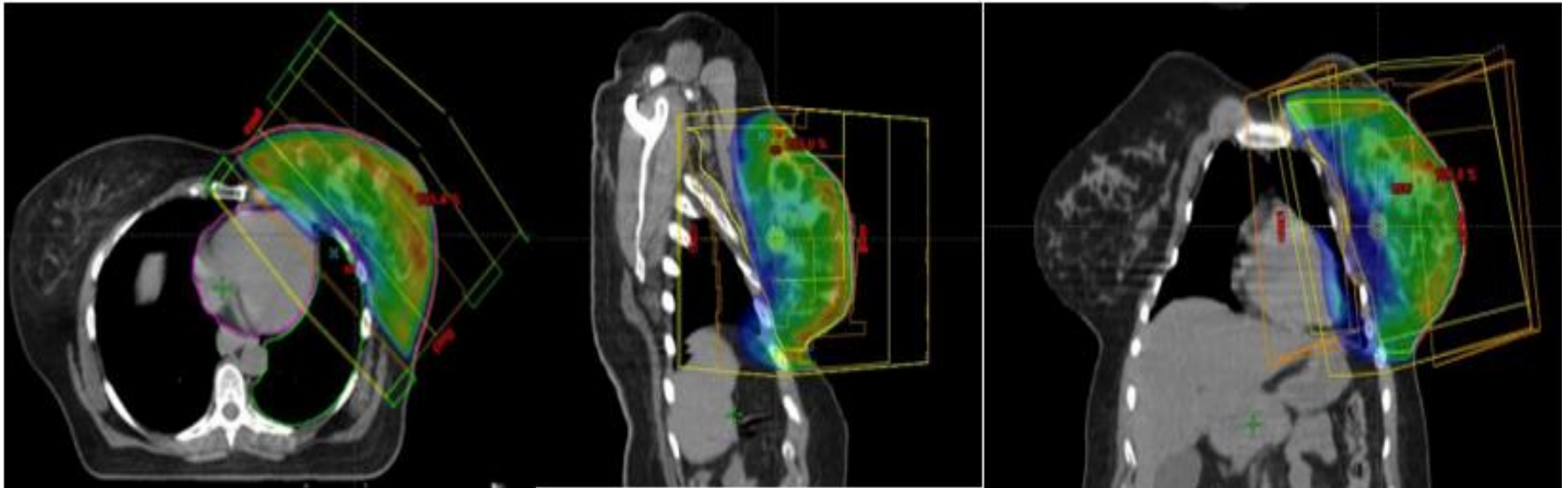


Breast 3D-CRT with wedges



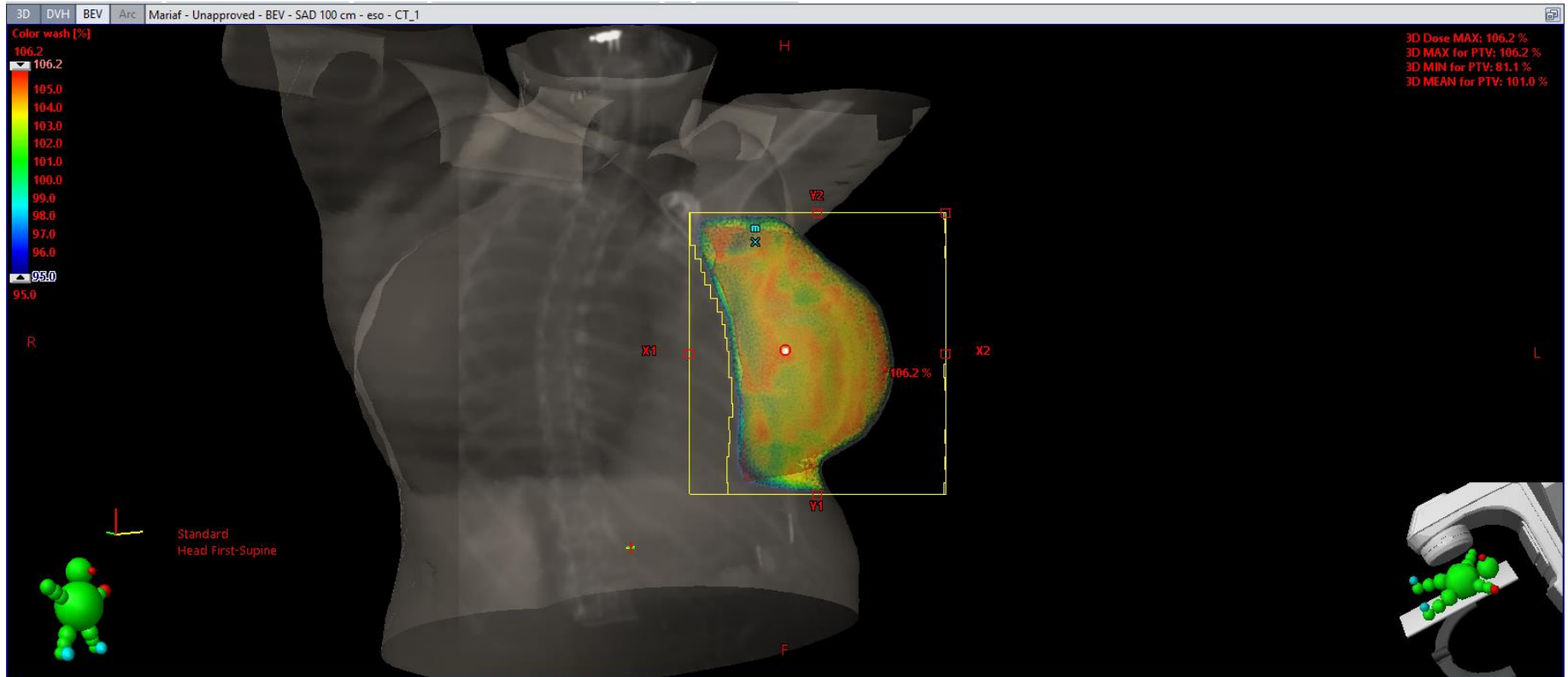
- Two basic tangential Fields 6MV with wedges
- The angle of the wedges various 10° - 25°
- FIFs 6MV or 10 -18 MV
- Constraints for Lungs and Heart

Breast 3D-CRT with FIF

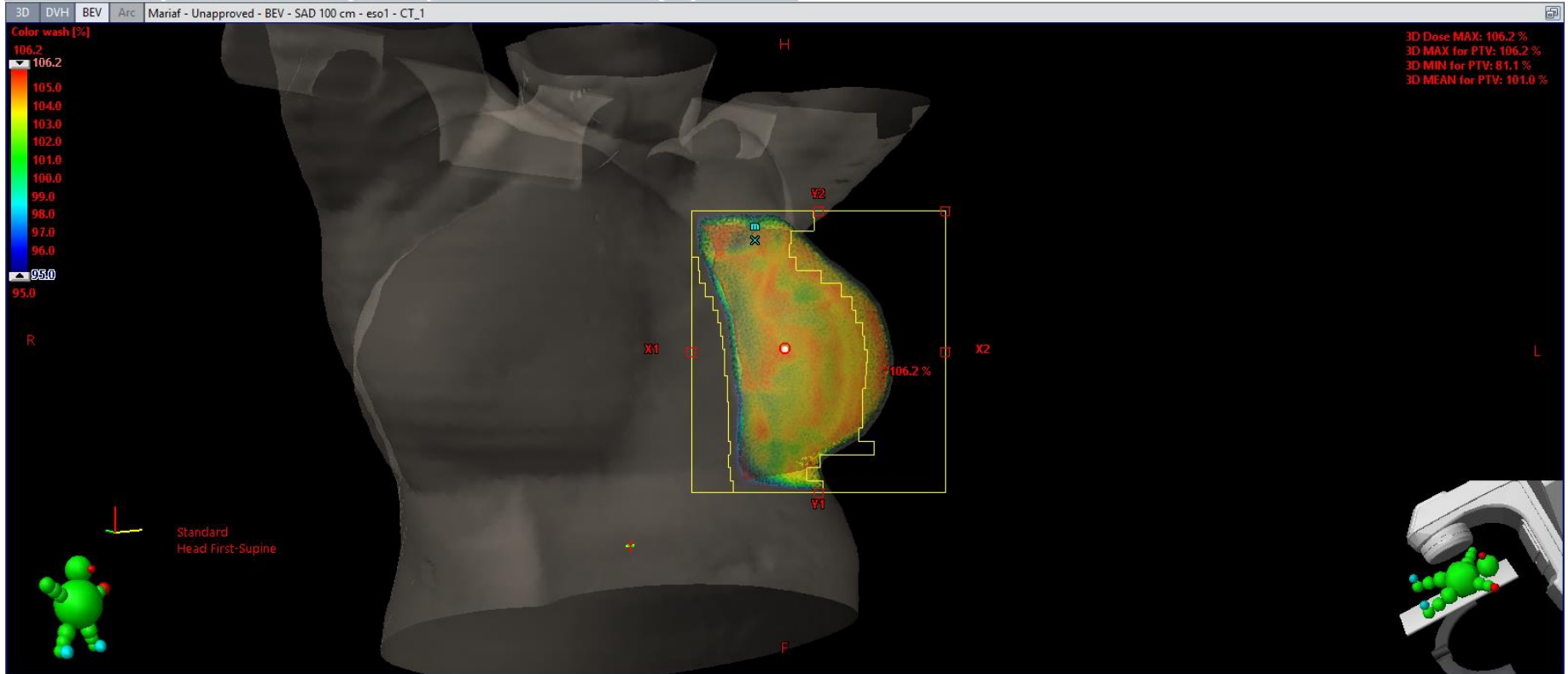


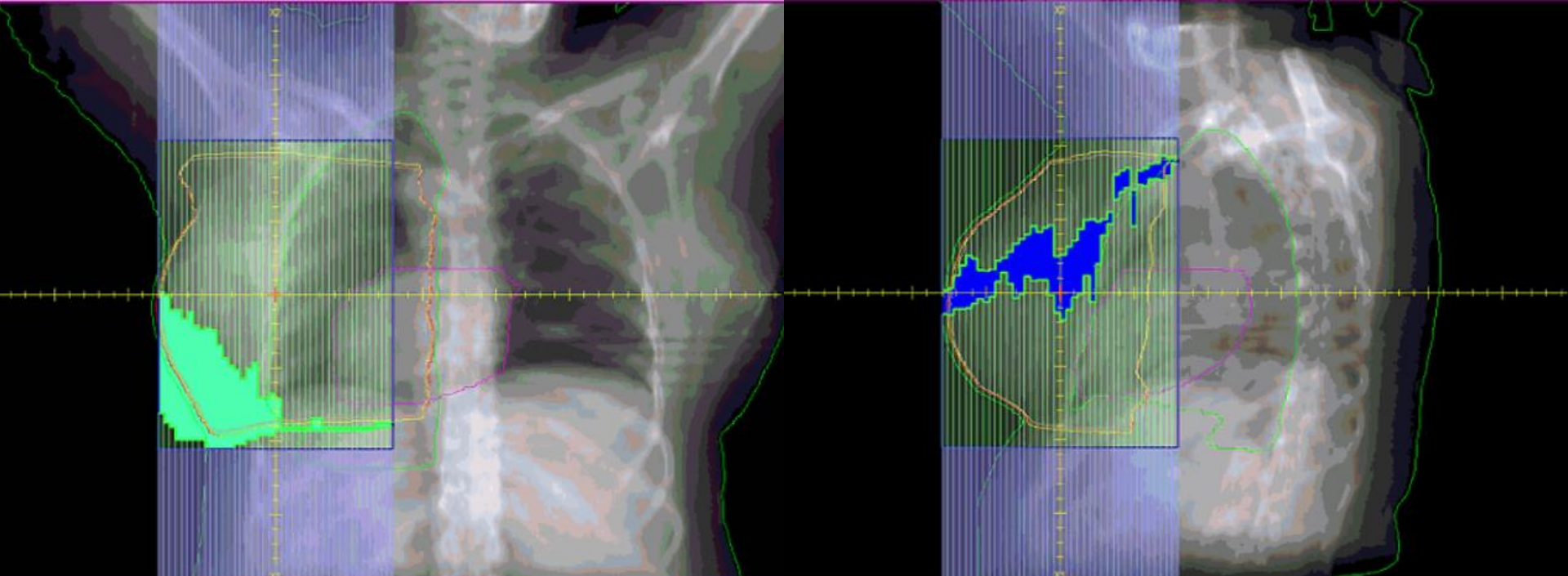
- Two basic tangential Fields 6MV
- FIFs 6MV or 10 -18 MV
- Constraints for Lungs and Heart

Breast 3D-CRT with FIF



Breast 3D-CRT with FIF

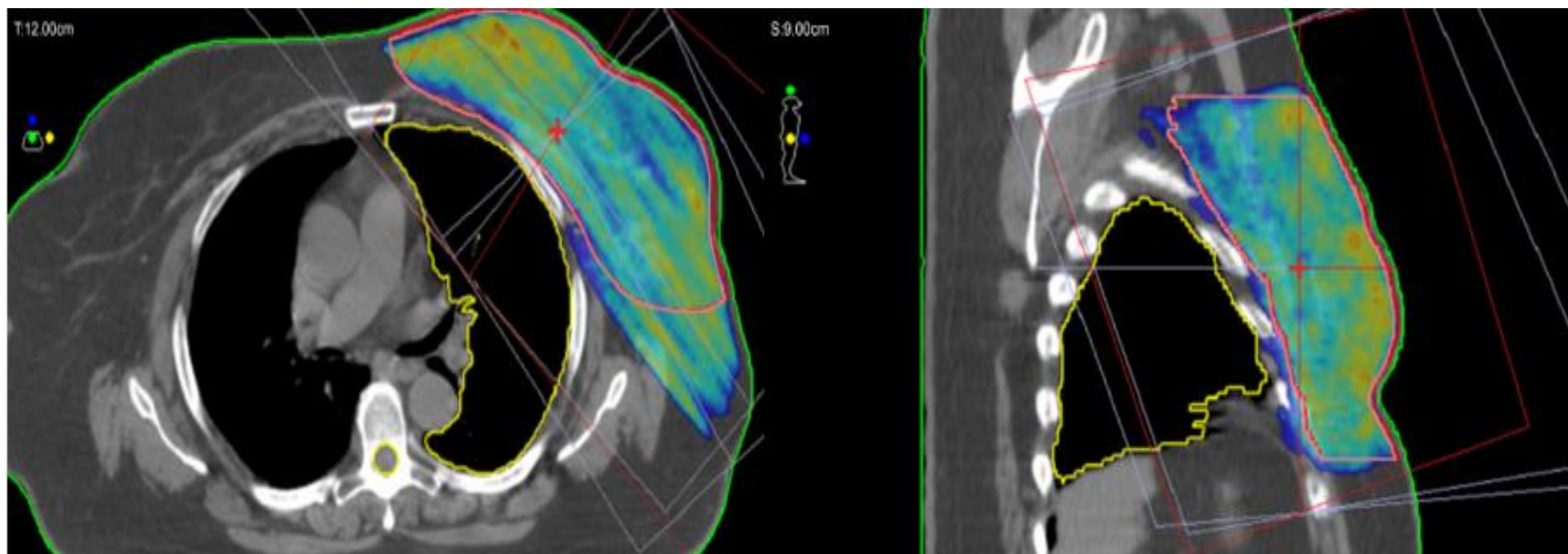




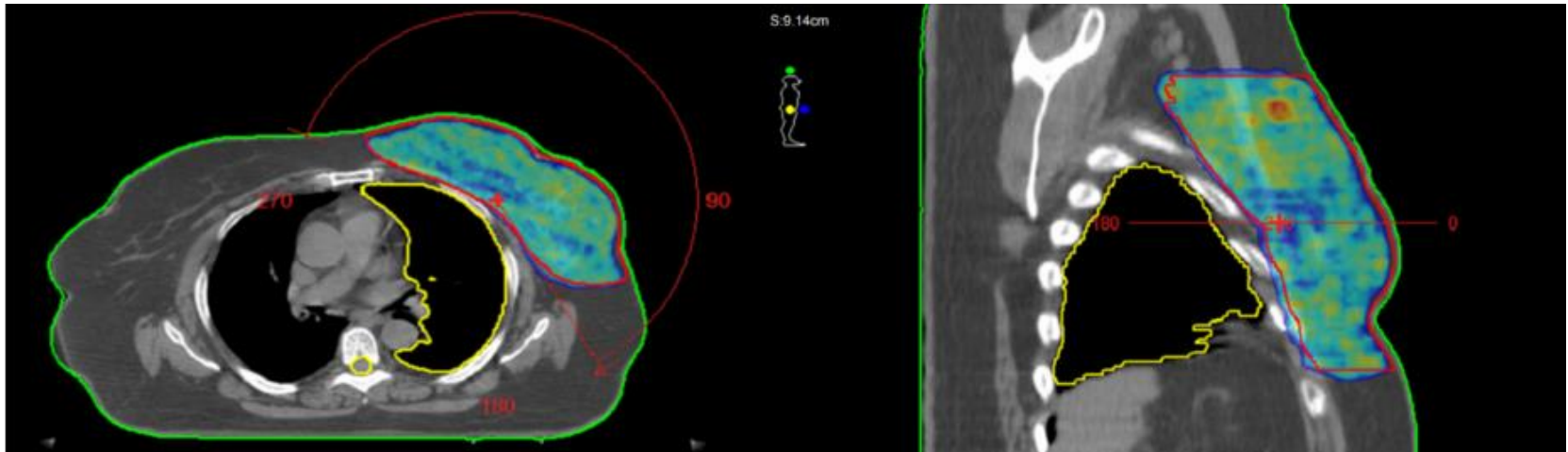
- From 3 up to 7 beams with different angles.
- Two basic Tangential Fields 6 MV.
- Can also be used beam 10 MV.
- Segments.

Breast IMRT

BREAST IMRT

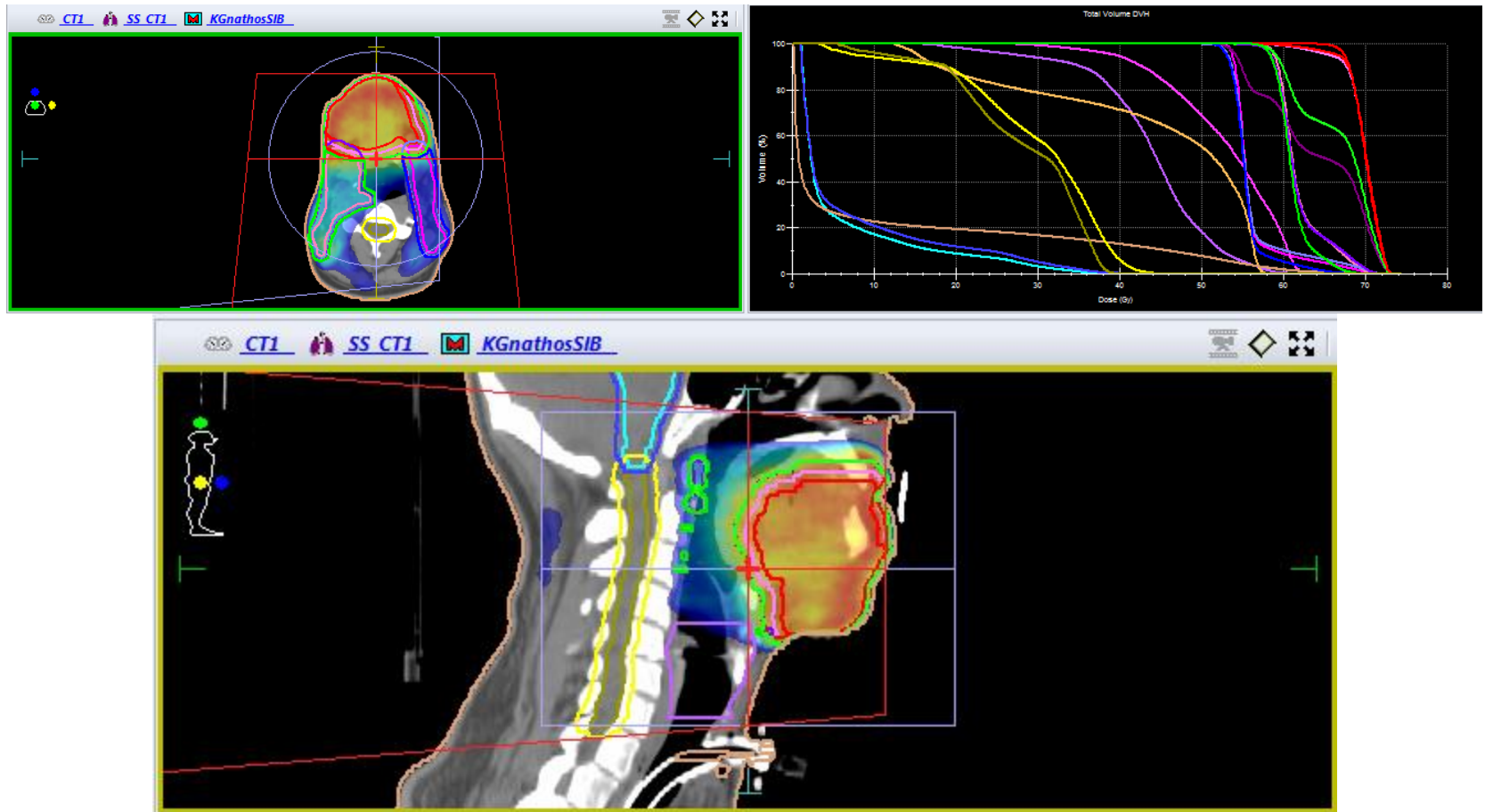


BREAST VMAT



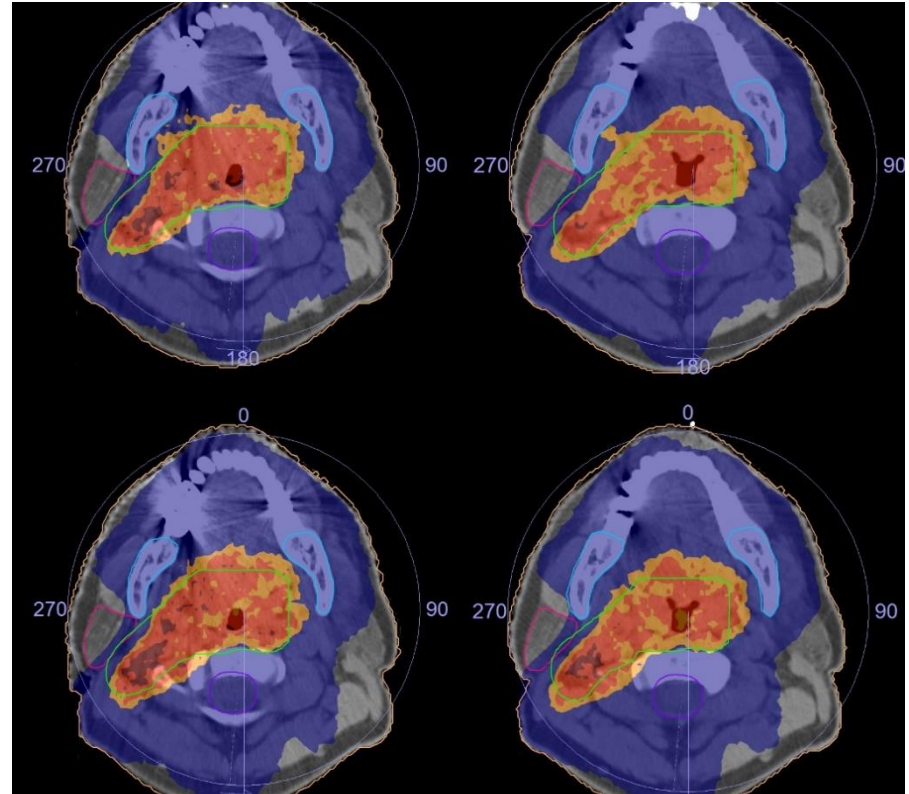
- Double Half Arc (Arc=180° or more)
- Two Double Tangential arcs (Arc= 40-60°)
- Collimator Depends
- Energy 6MV or 10 MV
- Constraints for Lungs and Heart

Head & Neck treatment plan

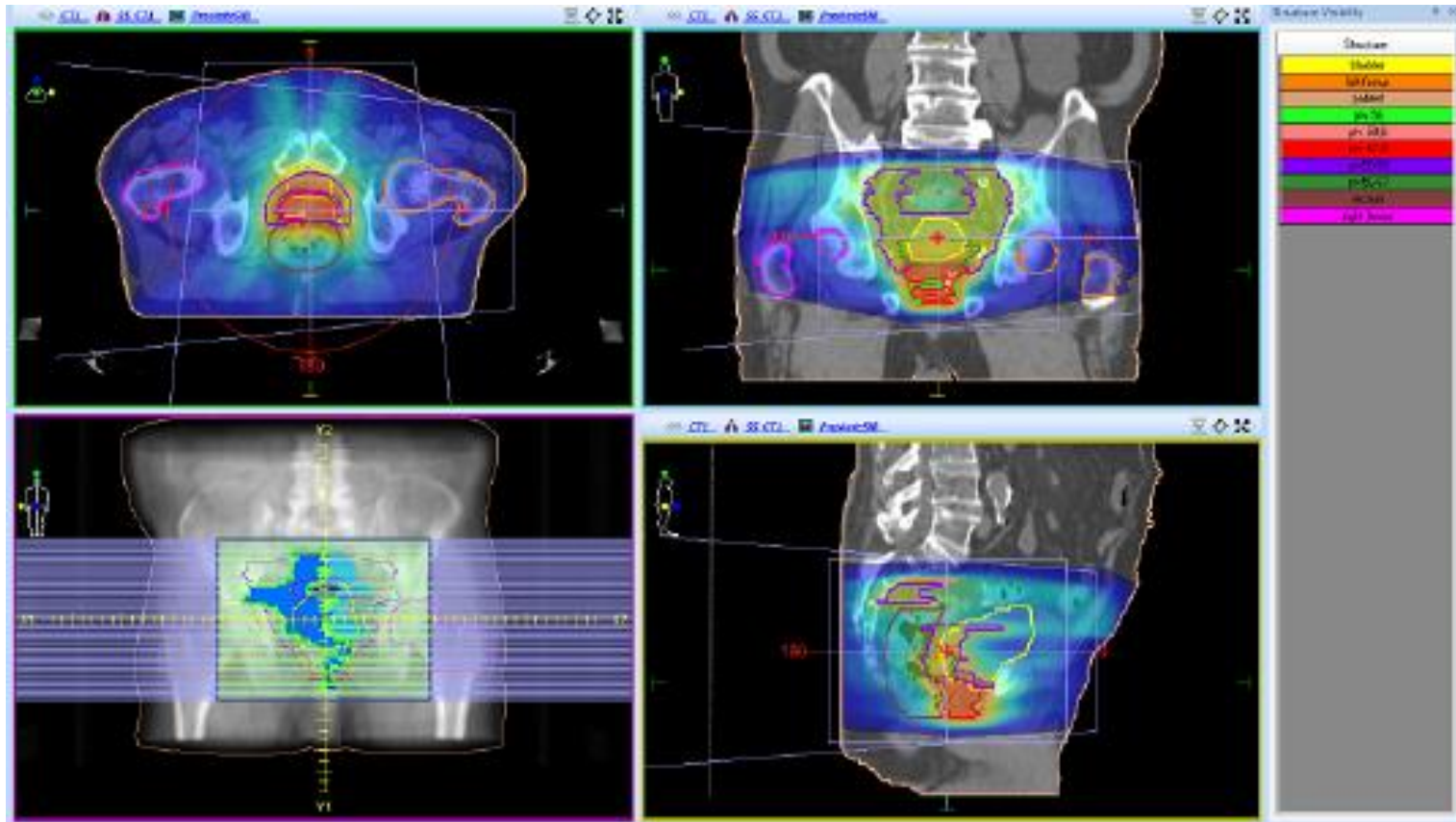


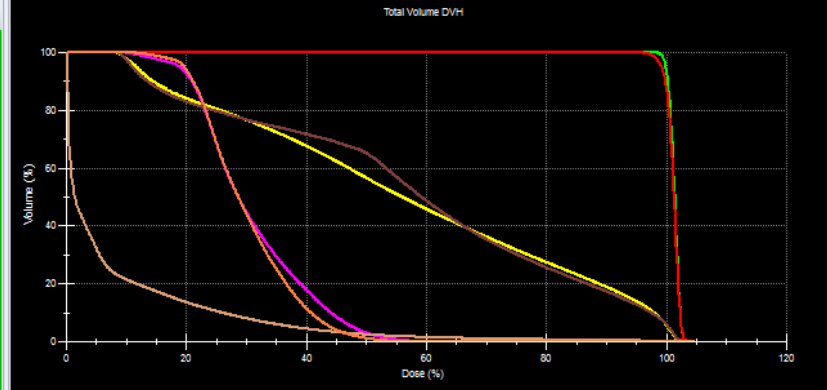
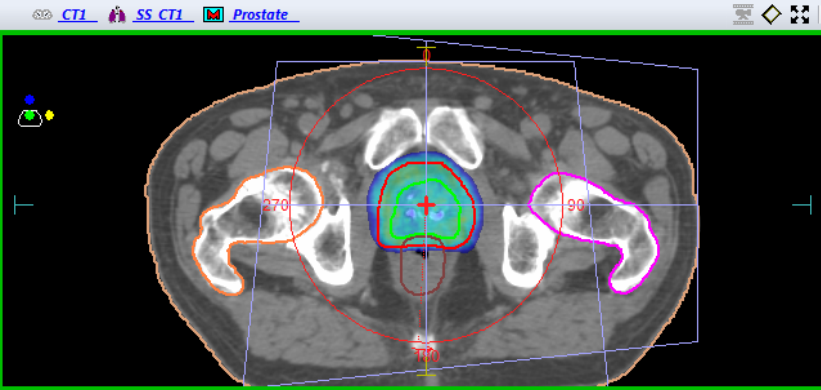
Head & Neck treatment plan

- Double Arc = 360°
- Collimator Depends
- Energy **6MV**
- Constraints for Larynx, Esophagus, Parotid Glands, Submandibular Glands, Lips, Mandible, Oral cavity, Pharyngeal constrictors and others.

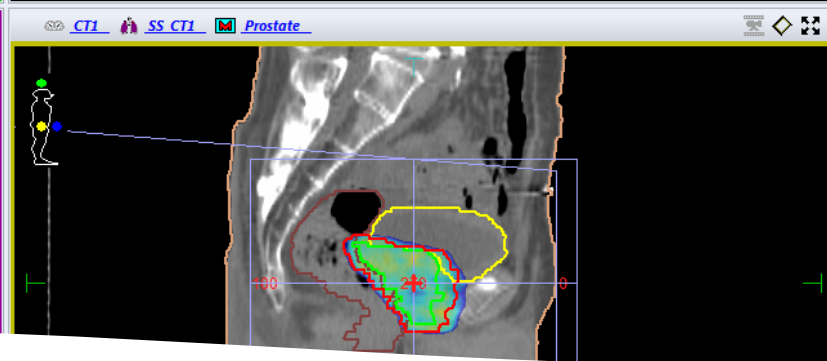
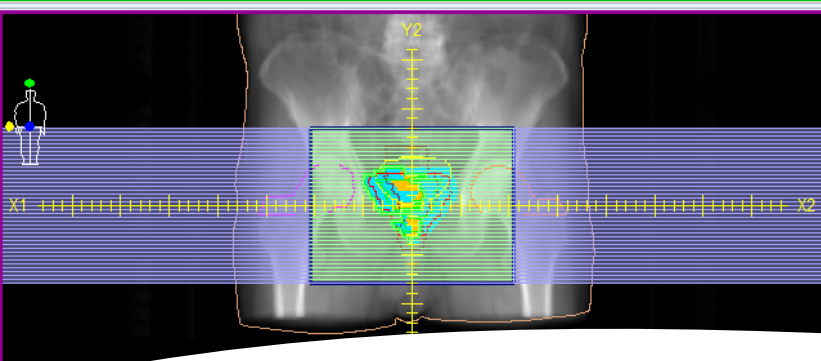


Prostate treatment plan





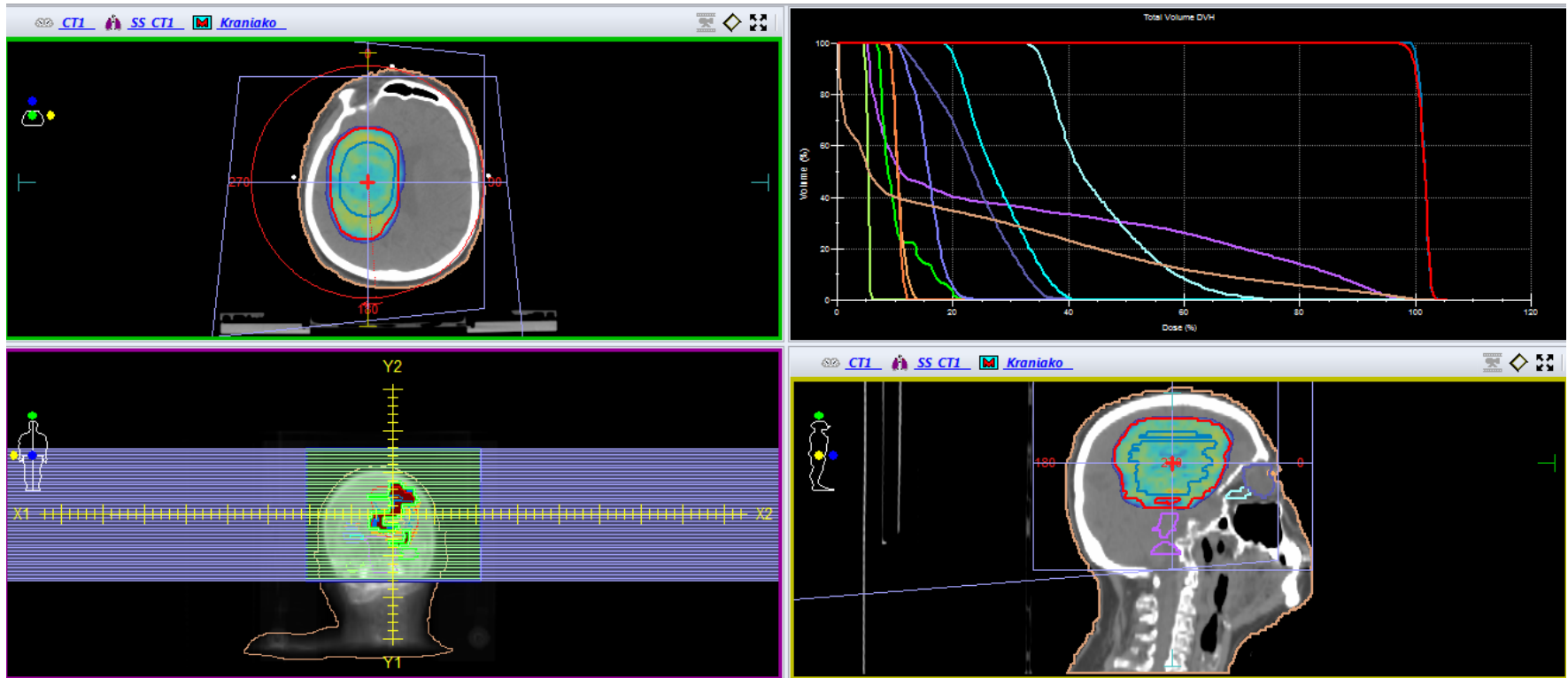
Structure Visibility	
Structure	Visibility
bladder	Visible
ctv 70	Visible
left femur	Visible
patient	Visible
ptv 70	Visible
rectum	Visible
right femur	Visible



Prostate

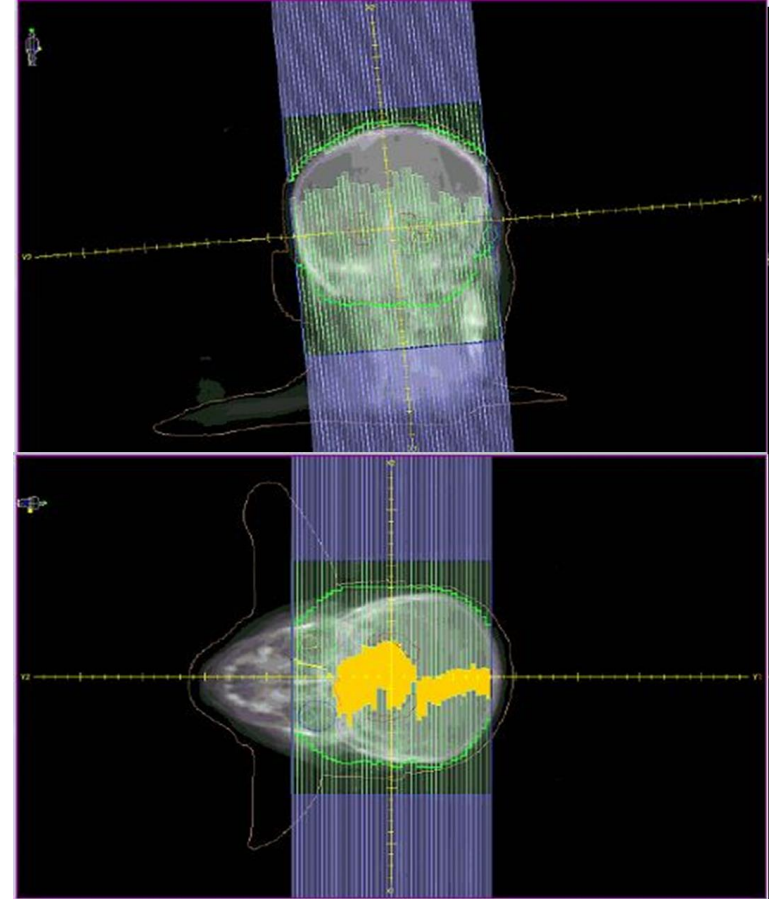
- Double Arc =360°
- Collimator Depends
- Energy 10MV better
- Constraints for Rectum, Bladder, Femoral Heads, Testis, Penile Bulb and Bowel Bag.

Brain treatment plan



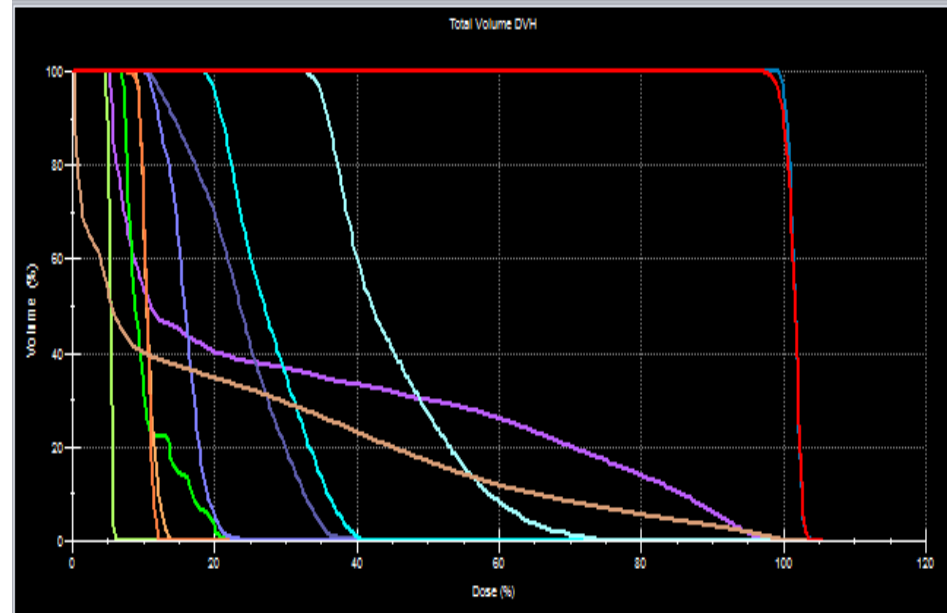
Brain treatment plan

- Double Arc = 360°
- Collimator Depends
- Couch Rotation maybe needed
- Energy 6MV better
- Constraints for Lens, Brain Stem, Optic Chiasm, Optic Nerves, Lacrimal Gland, Brain, Cochlea Pituitary gland and more.



Dose Volume Histogram

- Treatment Evaluation - PTV Coverage:
 - V95% \geq 95%** at least 95% of the PTV volume to receive 95% or more of the prescribed dose,
 - D95% = 100%** of the prescribed dose
 - D2%** is the dose to 2% of the PTV (close to the maximum dose),
 - D98%** is the dose to 98% of the PTV (close to the minimum dose),
 - D50%** is the median dose.
- Risk Assessment
- Plan Comparison.



PSQA of the plans

- Execution of the plan.
- Gamma Analysis.
- Acceptance Criteria
3%/3 mm, 2%/2 mm, and
1%/1 mm
- >95% in Gamma Pass
Rate (GPR).



THANK YOU

