PLAN EVALUATION IN IMRT

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"A dose plan and treatment delivery that is optimized using inverse or forward planning techniques for modulated beam delivery, using EITHER a binary collimator OR with a conventional MLC system, using either "Sliding Window "(DMLC) OR "Step and Shot" (SMLC) modes"

National Cancer Institute Guidelines for IMRT in Clinical Trials

AIM OF RADIATION THERAPY

- TUMORICIDAL DOSE TO TUMOUR
- LEAST DOSE TO SURROUNDING NORMAL TISSUE

CONVENTIONAL RADIOTHERAPY

- RECTANGULAR / SQUARE FIELDS
- LIMITED NO. OF FIELDS
- UNIFORM DOSE INTENSITIES IN THE FIELD

CONVENTIONAL RADIOTHERAPY

NORMAL TISSUE SPARING :

- WEDGE FILTERS
- BEAM MODIFICATION DEVICES
- SHIELDING BLOCKS
- X RAY SIMULATION
- IMMOBILISATION **etc…**

CRITICAL PARAMETERS

- PRECISION IN DOSE DELIVERY
- REPRODUCIBILITY
- TUMOUR AND NORMAL TISSUE DELINEATION

ADVANCES

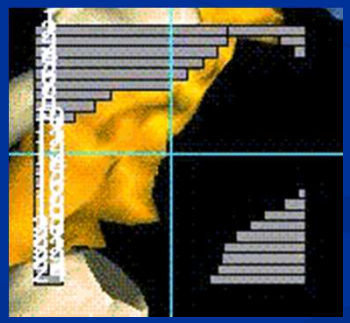
- 3D RECONSTRUCTIONS (CT/MRI/PET)
- 3D COMPUTERISED TREATMENT PLANNING SYSTEM
- MULTILEAF / MICROMULTILEAF COLLIMATION

ABILITY NOW TO

- VISUALISE STRUCTURES IN 3D
- SHAPE IRREGULAR RADIATION FIELDS IN 3D
- MATCH THE VISUALISED TUMOUR SHAPE AND RADIATION DOSE SHAPE TO EACH OTHER

LATEST TOOL TO ENHANCE THE MATCH BETWEEN TUMOUR AND DOSE SHAPE AND SPARE NORMAL TISSUE:

INTENSITY MODULATED RADIATION THERAPY (IMRT)



INTENSITY MODULATED RADIATION THERAPY (IMRT)

REQUIREMENTS

- LINEAR ACCELERATOR 6 MV
- MULTILEAF/MICROMULTILEAF COLLIMATOR
- 3D TPS WITH CT/ MRI / PET FUSION
- INVERSE – PLANNING SOFTWARE
- IMMOBILISATION
- SPECIALIZED IMRT QA EQUIPMENT

INVERSE PLANNING

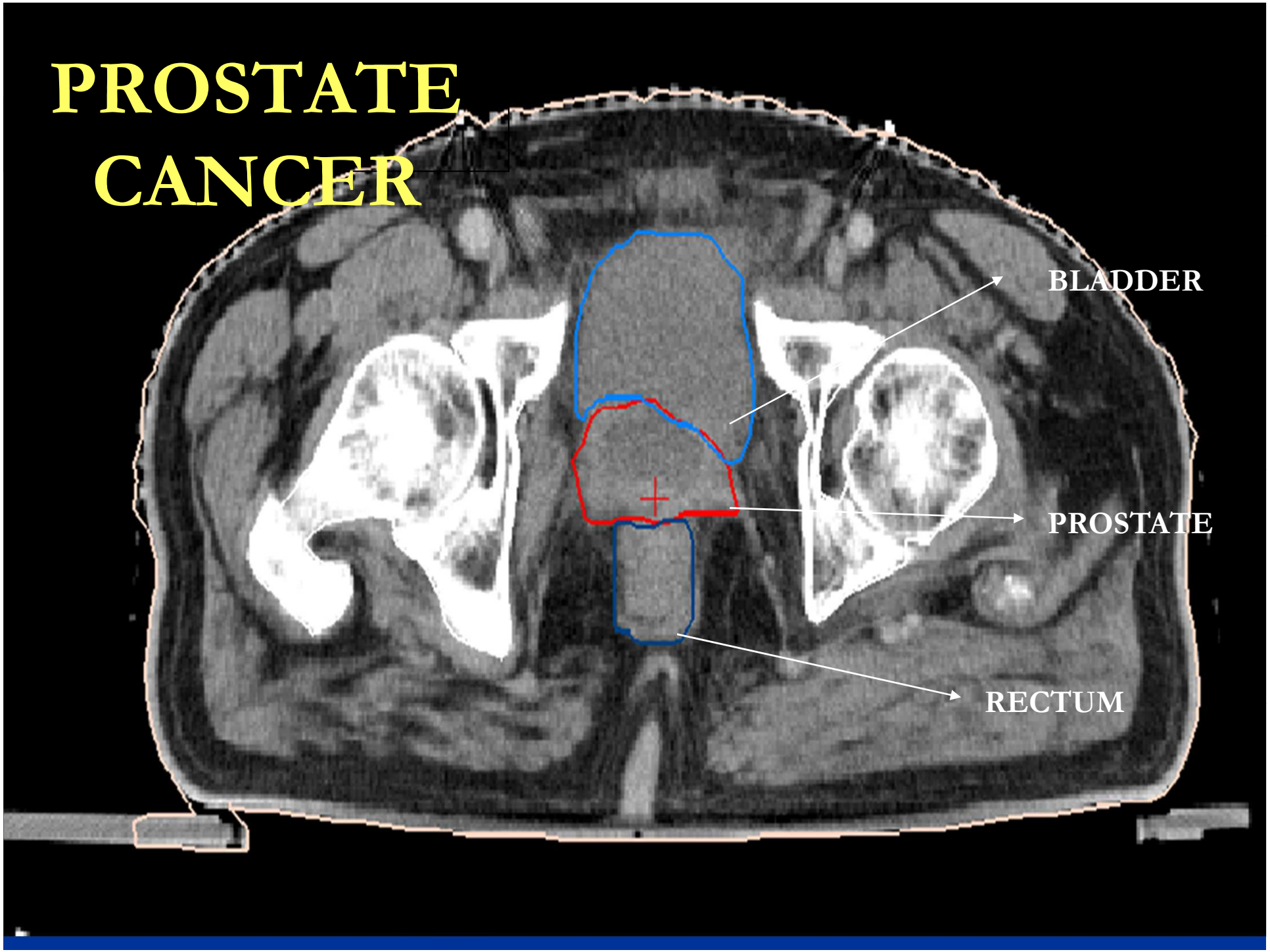
COMPUTER ALGORITHM ALLOWS TO SPECIFY DOSE CONSTRAINTS TO NORMAL TISSUE (eg BLADDER, RECTUM,CORD etc) WHILE GIVING TUMOUR REQUIRED DOSE

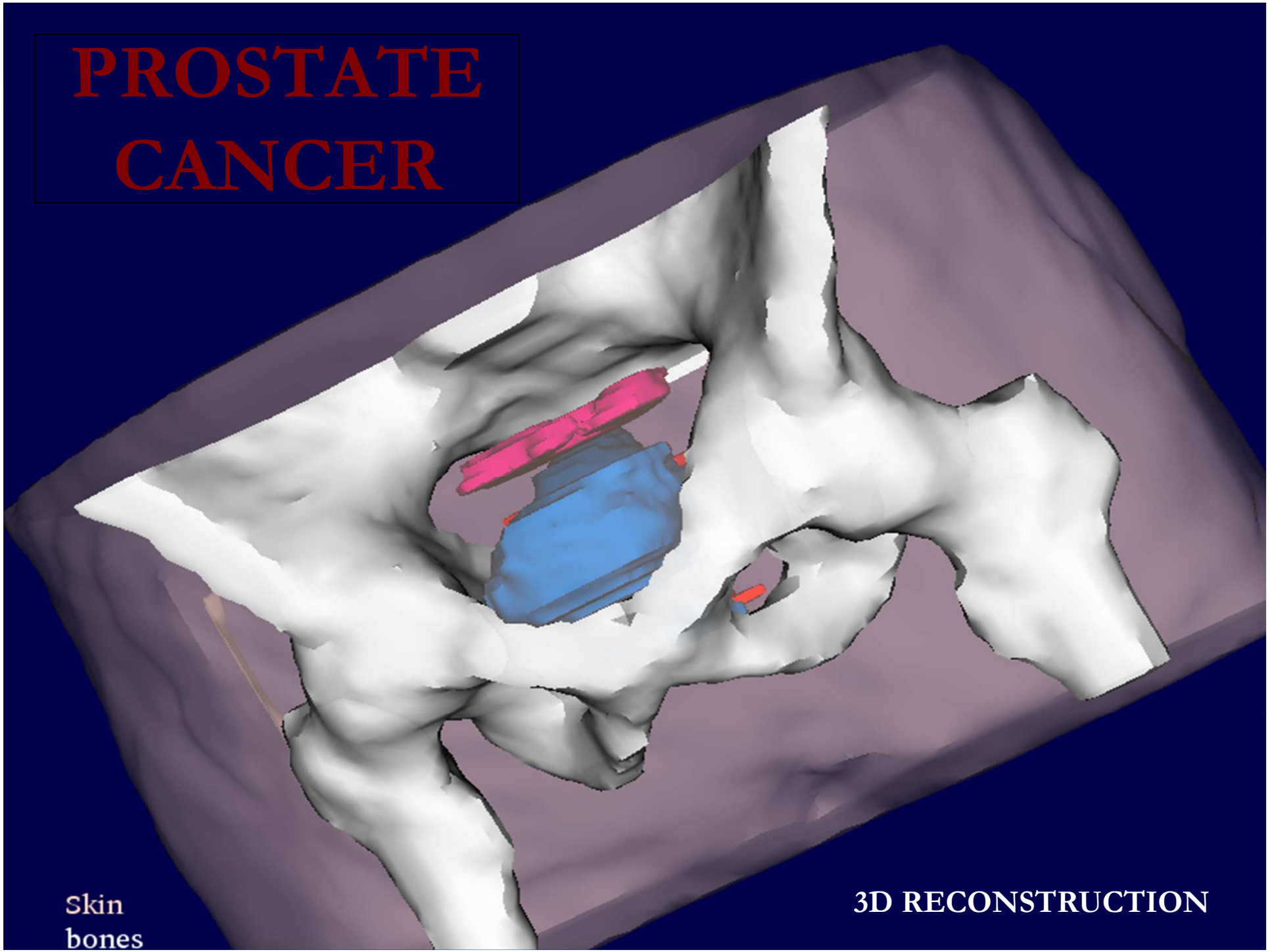
[Cf Forward planning]

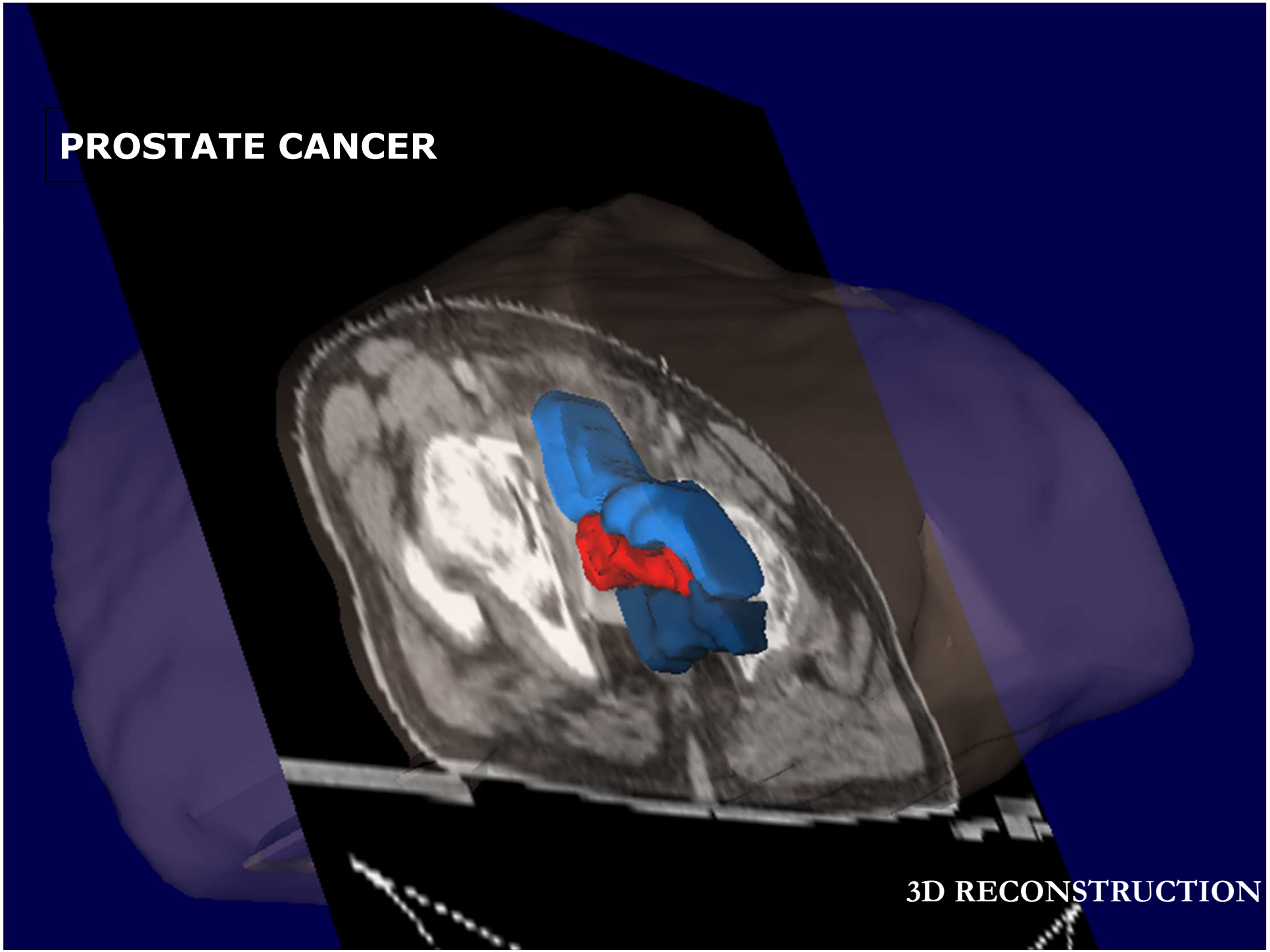
IMRT INDICATIONS

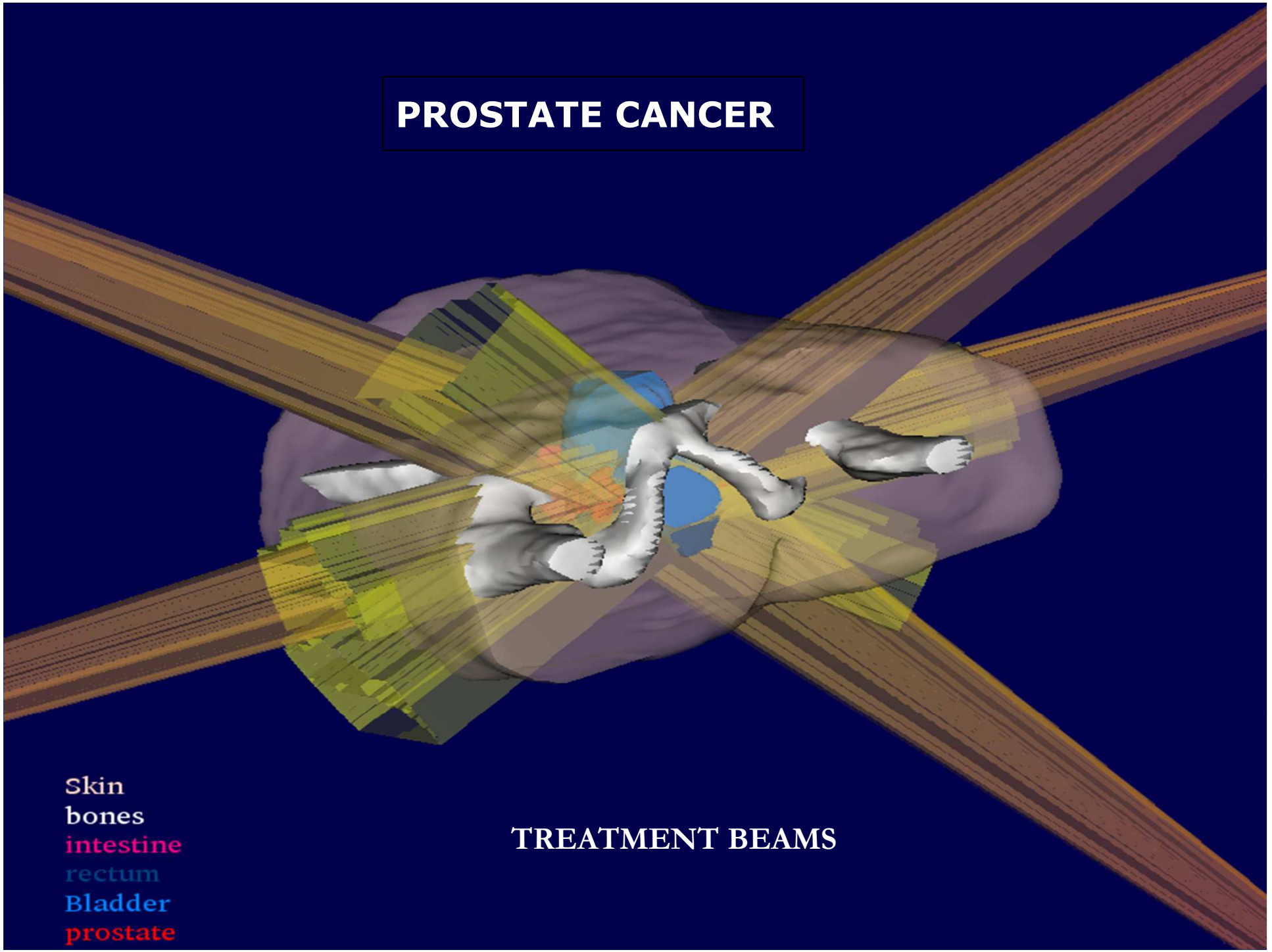
- AS SOLE MODALITY
- AS BOOST TREATMENT

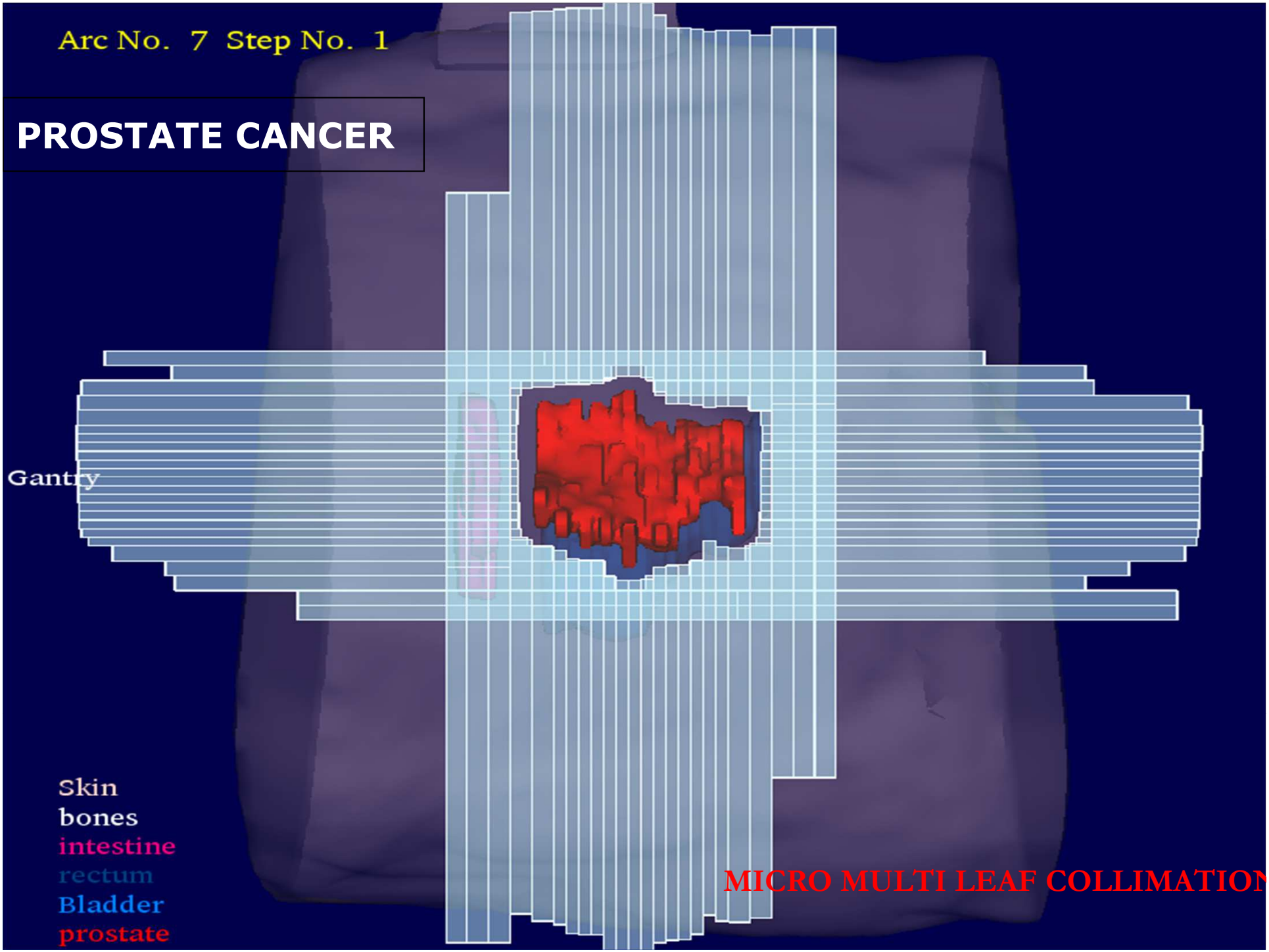
(PROSTATE, HEAD AND NECK,BRAIN, BREAST, CERVIX, PARASPINAL TUMOURS , LUNG, BLADDER etc..)

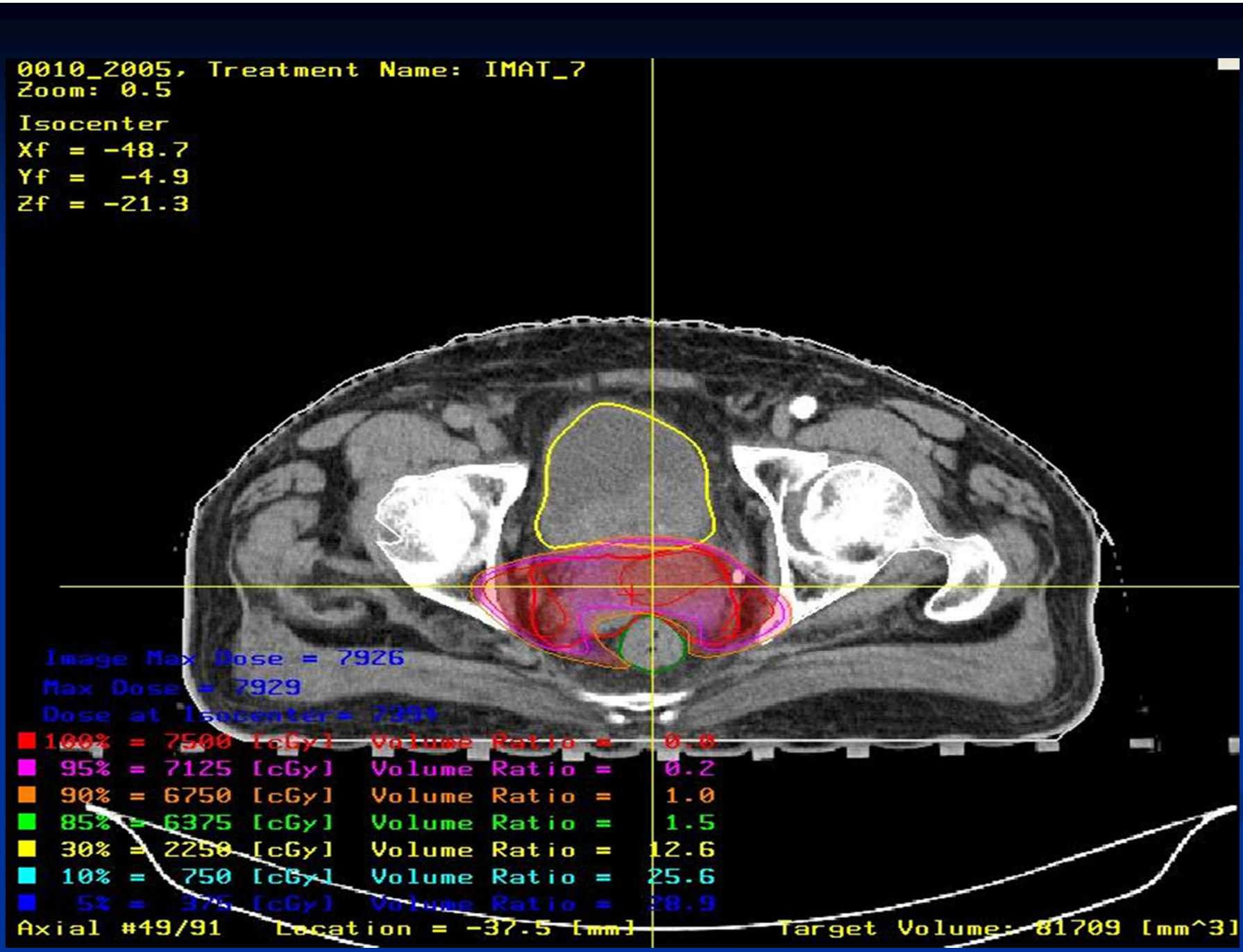

PROSTATE CANCER
BLADDER
PROSTATE
RECTUM

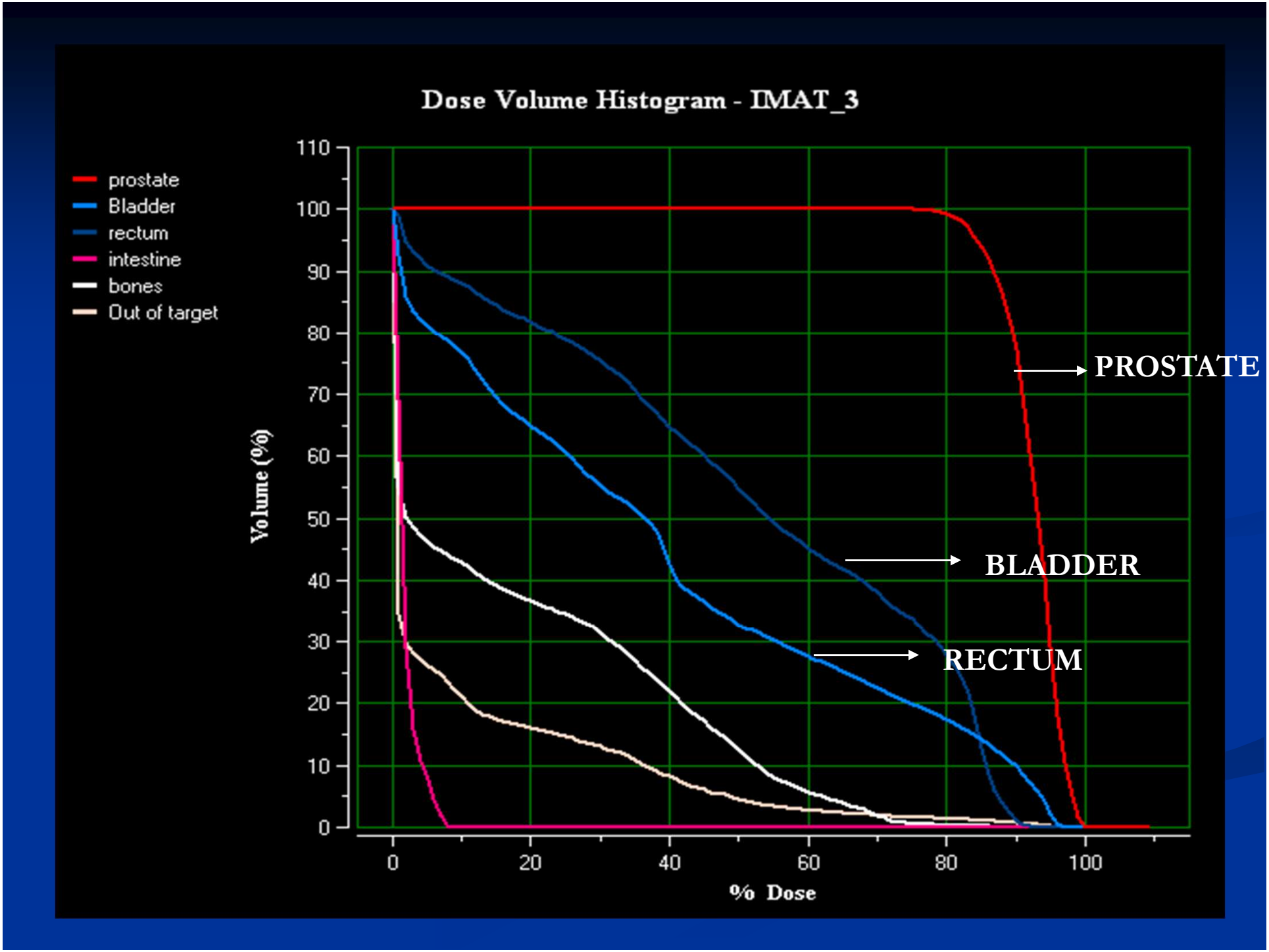

PROSTATE CANCER
Skin
bones
3D RECONSTRUCTION

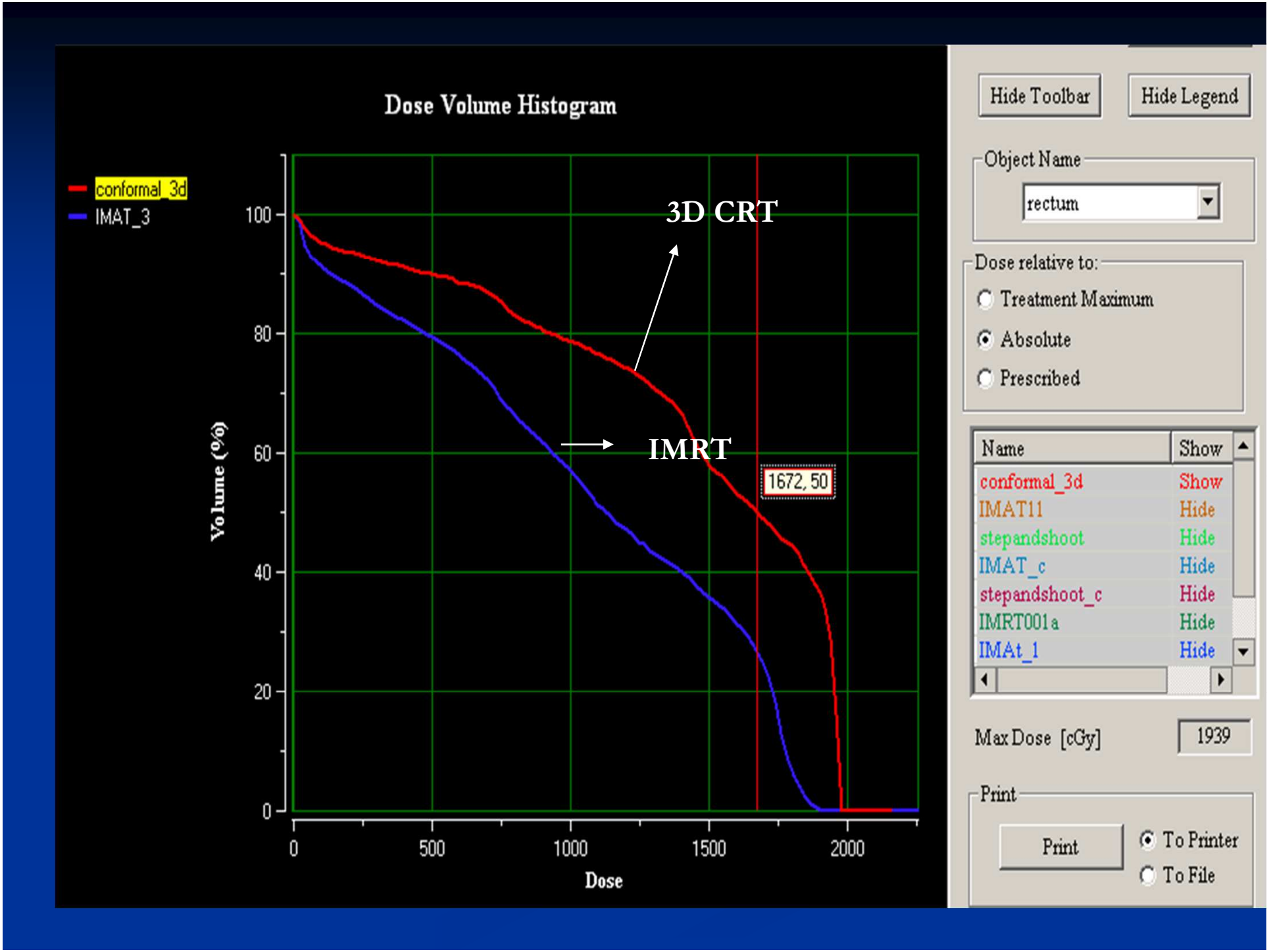

PROSTATE CANCER
3D RECONSTRUCTION


PROSTATE CANCER
Skin
bones
intestine
rectum
Bladder
prostate
TREATMENT BEAMS


Arc No. 7 Step No. 1
PROSTATE CANCER
Gantry
Skin
bones
intestine
rectum
Bladder
prostate
MICRO MULTI LEAF COLLIMATION


0010_2005, Treatment Name: IMAT_7
Zoom: 0.5
Isocenter
Xf = -48.7
Yf = -4.9
Zf = -21.3
Image Max Dose = 7926
Max Dose = 7929
100% = 7500 [cGy] Volume Ratio = 0.0
95% = 7125 [cGy] Volume Ratio = 0.2
90% = 6750 [cGy] Volume Ratio = 1.0
85% = 6375 [cGy] Volume Ratio = 1.5
30% = 2250 [cGy] Volume Ratio = 12.6
10% = 750 [cGy] Volume Ratio = 25.6
Axial #49/91 Location = -37.5 [mm]
Target Volume: 81709 [mm^3]


Dose Volume Histogram - IMAT_3
prostate
Bladder
rectum
intestine
bones
Out of target
Volume (%)
110
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
% Dose
PROSTATE
BLADDER
RECTUM


Dose Volume Histogram
conformal_3d
IMAT_3
3D CRT
IMRT
1672, 50
Volume (%)
Dose
0
20
40
60
80
100
0
500
1000
1500
2000
Hide Toolbar
Hide Legend
Object Name
rectum
Dose relative to:
Treatment Maximum
Absolute
Prescribed
Name
Show
conformal_3d Show
IMAT11 Hide
stepandshoot Hide
IMAT_c Hide
stepandshoot_c Hide
IMRT001a Hide
IMAt_1 Hide
Max Dose [cGy]
1939
Print
Print
To Printer
To File

IMRT PLAN EVALUATION PARAMETERS

A . CLINICAL PARAMETERS

- Patient selection
- Site, Stage
- Psychology
- 3DCRT Vs IMRT
- Target delineation
- Immobilization
- Dose prescription guidelines

IMRT PLAN EVALUATION PARAMETERS

B . PHYSICAL PARAMETERS

- TPS (Algorithms etc.)
- Dose constraints
- DVH
- GTV $\longrightarrow$ PTV (setup errors)
- OARs
- QA

IMRT PLAN EVALUATION PARAMETERS

C. EQUIPMENT PARAMETERS

- Linear Accelarator
- Type of MLC / µMLC
- Mould room
- Simulation
- Port films
- MU (DR)
- TPS

CLINICAL CONSIDERATIONS

- IMMOBILIZABLE SITE
- IRREGULARLY SHAPED CONCAVE EDGES
- ADJACENT TO CRITICAL ORGANS
- COOPERATIVE PATINETS

} IDEAL FOR IMRT

Morbidity obese, poor immobilization
Claustrophobic patient, moribund

} POOR CANDIDATES

CLINICAL CONSIDERATIONS

"HOT" and "COLD" SPOTS IN 3D.

- MAGNITUDE
- VOLUME
- LOCATION

"COLD" - NOT WITH IN GTV - AS FAR AWAY.

"HOT" - DESIRED IN-HOMOGENITY

CLINICAL CONSIDERATIONS

FOLLOW GUIDELINES : Egs :

HEAD & NECK	:	RTOG H-022 TRIAL 95% PTV BY PRESCRIPTION ISODOSE
GYNAEC	:	RTOG 0418

PHYSICS PARAMETERS
IMRT vs 3DCRT

-LARGE VOLUME OF NORMAL TISSUE RECEIVE LOW DOSES

-↑ MONITORING UNITS NEEDED FOR DELIVERY

-VERIFICATION PORT FILMS REQUIRED

-↑ PATIENT EXPOSURE FROM HEAD LEAKAGE, NEUTRON PRODUCTION AND SCATTER

? ↑ RISK OF 2nd MALIGNANCY

?? ↑ RT PNEUMONITIS IN THORACIC IMRT

PHYSICS PARAMETERS

- BETTER FOR CONCAVE SURFACE S
- PLANNING IS LESS DEPENDENT ON BEAM ENERGY
- CONFORMITY AT THE EXPENSE OF LOW DOSE TO LARGE VOLUME.

ie CHECK 30% ISODOSE

PHYSICS PARAMETERS

- PLANNING IS TIME CONSUMING

  ie NOT FOR RAPID PLANS

  Eg . EMERGENCY Rx etc.

- ALGORITHM FOR ITERATION IMPORTANT

  HETEROGENITY CORRECTION TO BE USED

PHYSICS PARAMETERS

- AVOID MATCHING TWO IMRT FIELDS OR IMRT +PHOTONS/ELECTRON
- ORGAN MOTION AND SET UP ERRORS CAUSE DOSIMETRIC PROBLEMS (PATIENTS MOVES / ORAGAN MOVES)

IMRT PROSTATE
DOSE VOLUME CONSTRAINTS – OAR

AUTHOR	RECTUM	BLADDER	OTHERS
1.Zelefsky et al	≤30% to get ≥75.6 ≤53% to get ≥47	≤53% to get ≥47	NS
2.Ezzell et al	≤40% to get ≥65 ≤30% to get ≥70 ≤10% to get ≥75	≤30% to get ≥75 D max≤ 81	FH Dmax ≤ 50
3. Sethil et al	≤30% to get ≥65	≤30% to get ≥65	PP ≤25% To get ≥ 40%

IMRT PROSTATE
TARGET DEFINITIONS

	CTV	PTV	Prescription (TD/ Fr) Gy
1.Zelefsky 81 Gy plan 86.4 Gy plan	 P+ SV P + SV	 CTV +1 cm UE CTV + 1 cm	PTV 81/1.8 ≥90% to get ≥70 PTV 86.4/1.8 ≥85% to get ≥86.4
2.Ezzell	P + SV	CTV + 1 cm UE	75.6/1.8 to get ≥95% CTV
3. Sethil et al		PTV1=(P +SV)+1 cm UE PTV2 =(p) + 1 cm UE	PTV1 55.8/1.8 PTV2 18/1.8 ; 25.2/1.8

EQUIPMENT PARAMETERS

- BEAM DIRECTION IMPORTANT
- AVOID TREATMENT THROUGH IMMOBILIZATION DEVICES WHICH ATTENUATE BEAM
- AVOID LONG TREATMENT TIME
  - INCOVENIENT
  - ? RADIOBIOLOGICAL
- USE APPROPRIATE TPS

EQUIPMENT PARAMETERS

- STRINGENT QA IS CENTRAL TO SUCCESS OF IMRT
    - PROPER IMMOBILIZATION IS CRUCIAL
    - LASERS IN CT SIMULATOR IS MUST
    - FLAT CT COUCH FOR SIMULATION
- SET UP ERRORS – SYSTEMATIC & RANDOM
- QA OF LINAC AND TPS IS ESSENTIAL

FINALLY

IMRT IS AN EXCELLENT TECHNIQUE IF USED APPROPRIATELY BY A COMPETENT AND EXPERIENCED TEAM USING THE NECESSARY HIGH QUALITY MOULD ROOM AND SIMULATION PARAMETERS AND IMPLIMENTED UNDER A STRINGENT QA PROGRAMME

REMEMBER : G – 1- G.0 !

THANK YOU….