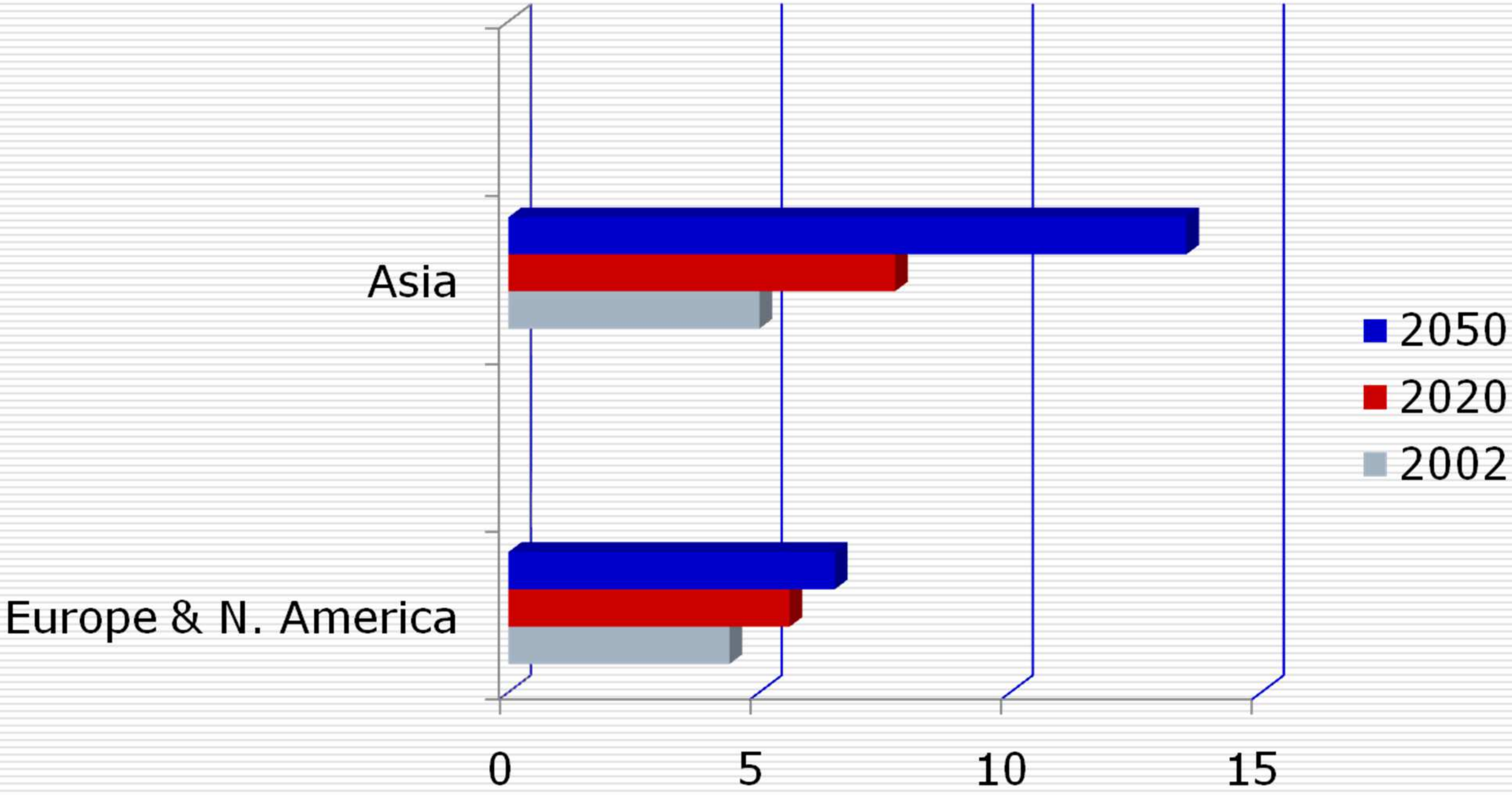
Treatment Advances in Treatment Delivery Radiation Onclogy

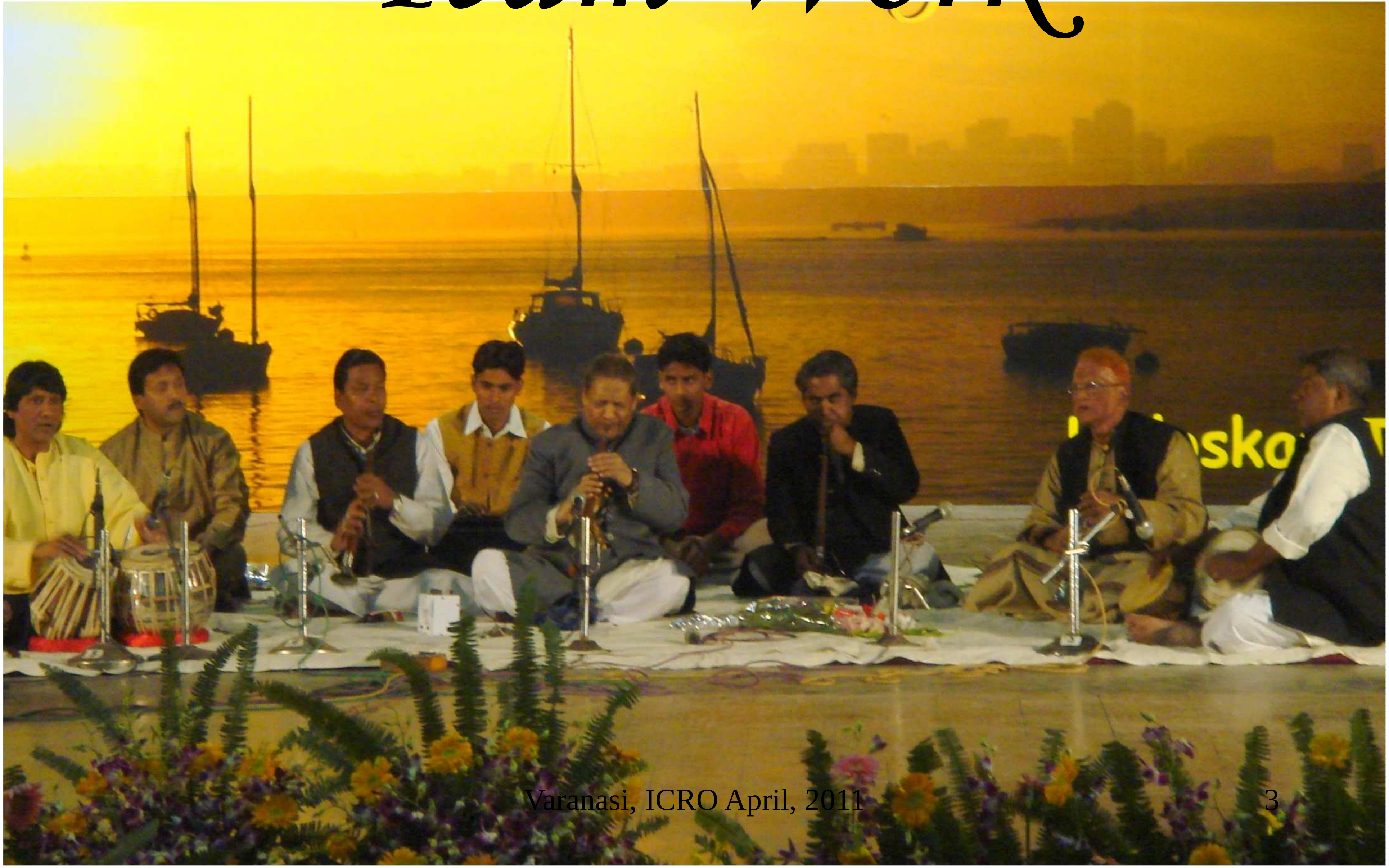
**DEPARTMENTS OF
RADIATION ONCOLOGY & MEDICAL PHYSICS**
Tata Memorial Hospital, Mumbai, India

Cancer Incidence 2002-2050



Globocan 2010

Team Work



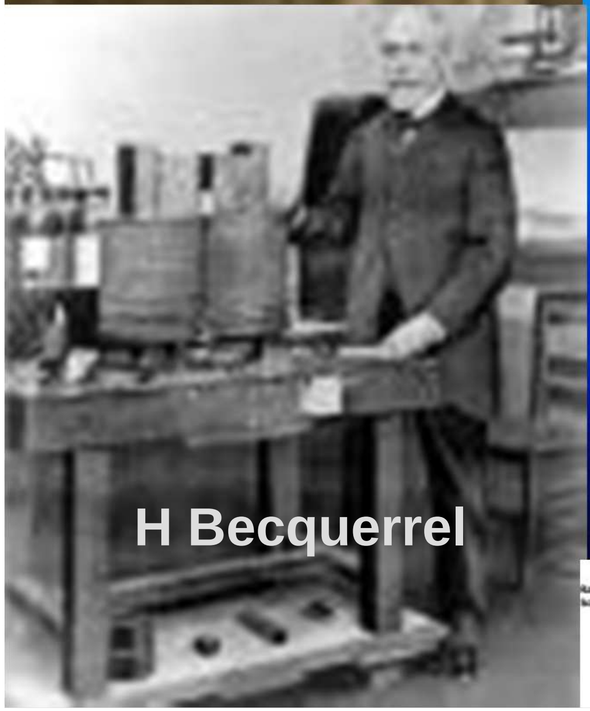
Treatment of cancer

Team work for optimal management

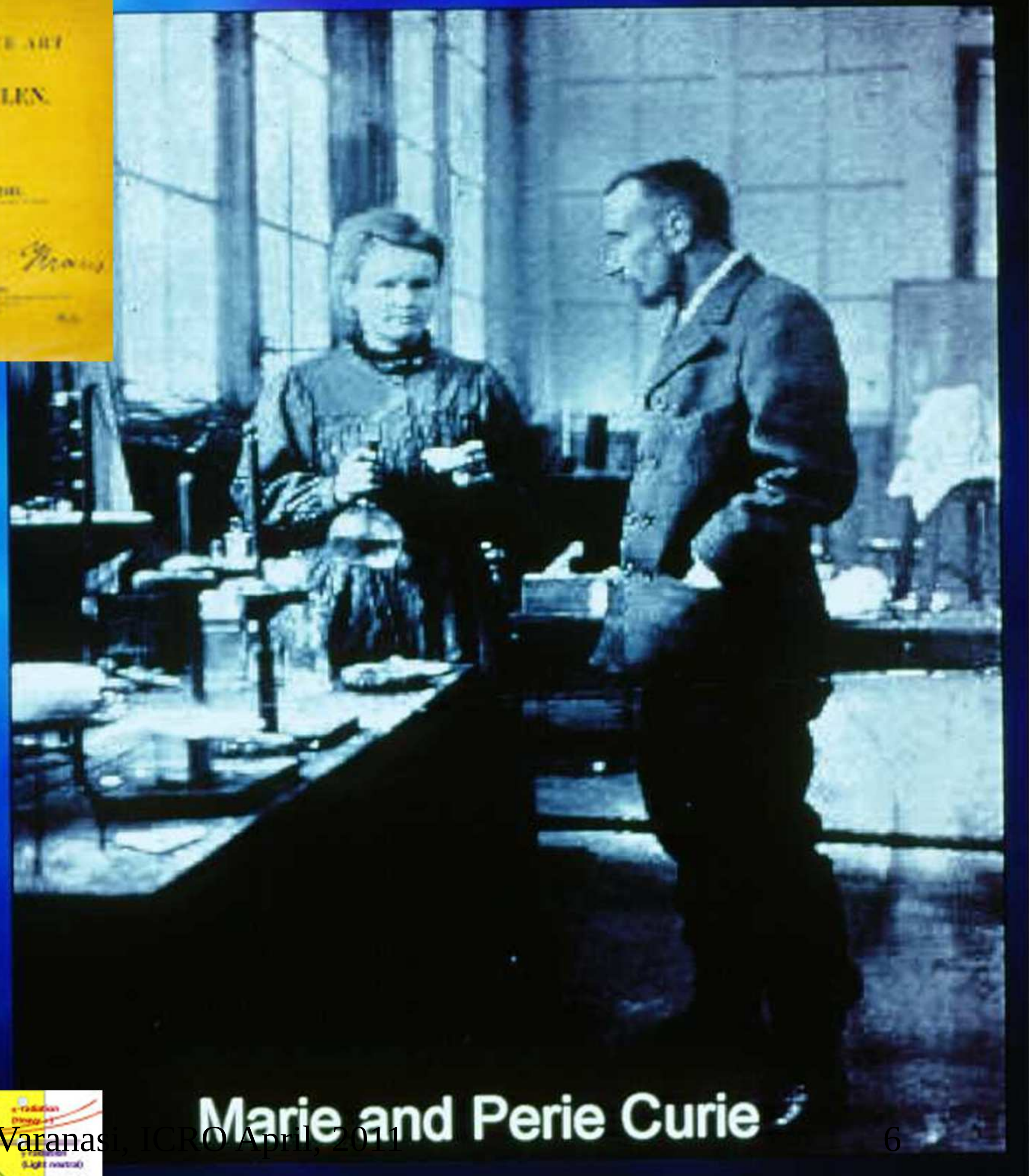
- Oncologist: Radiation, Surgical & Medical
- Medical Physicist
- Radiotherapy Technologists
- Nursing staff
- Dental Surgeon/ Anesthesiologist
- Nutritionist
- Medial Social Workers
- Occupational/ Speech therapist


28/11/2003

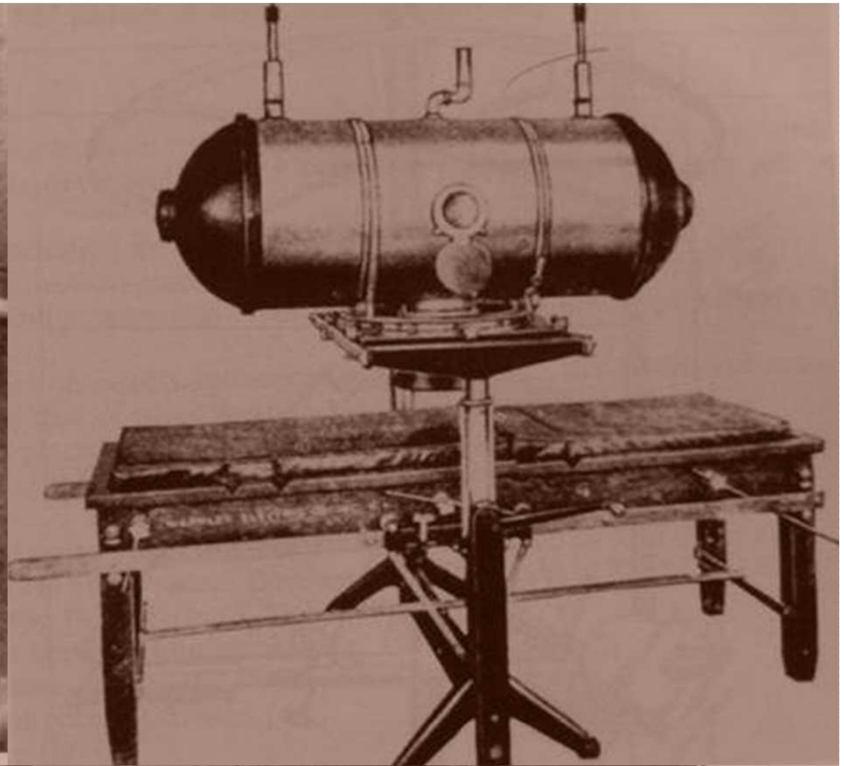
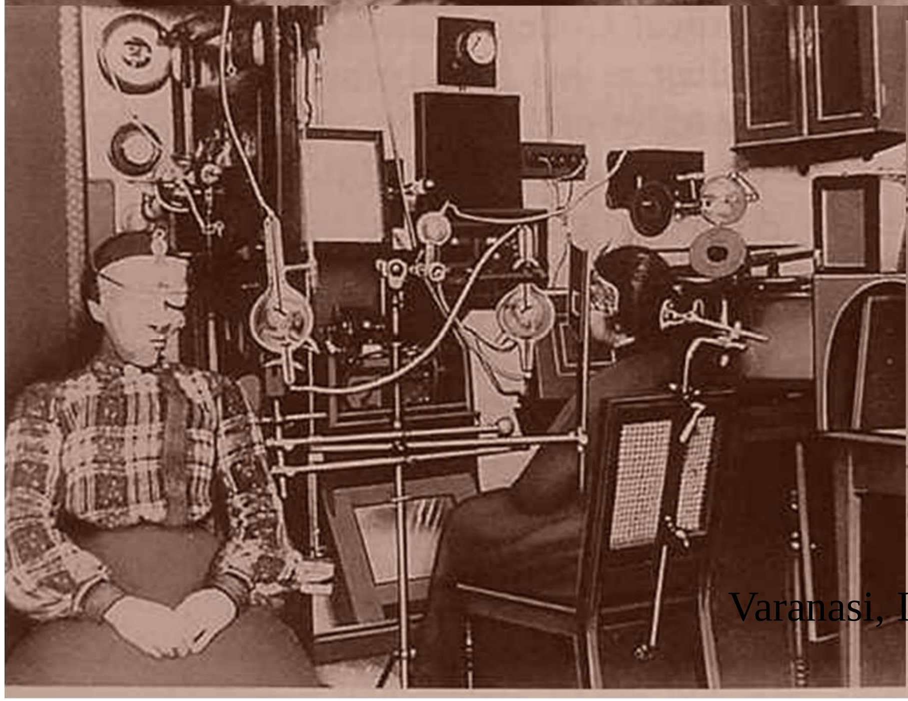
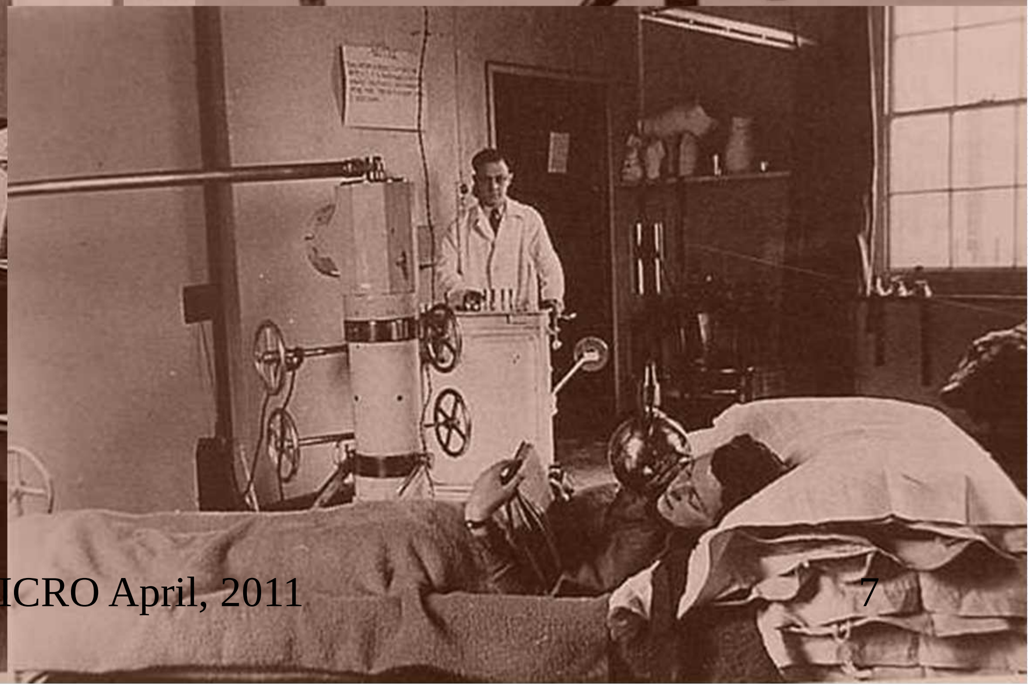
WC Roentgen



H Becquerrel



Marie and Perie Curie

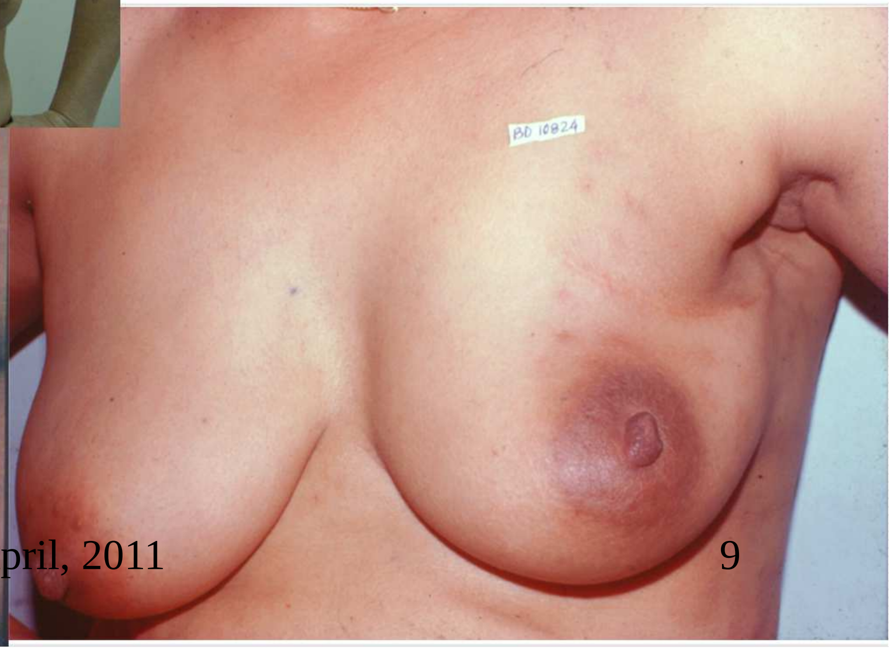





COBALT MACHINE

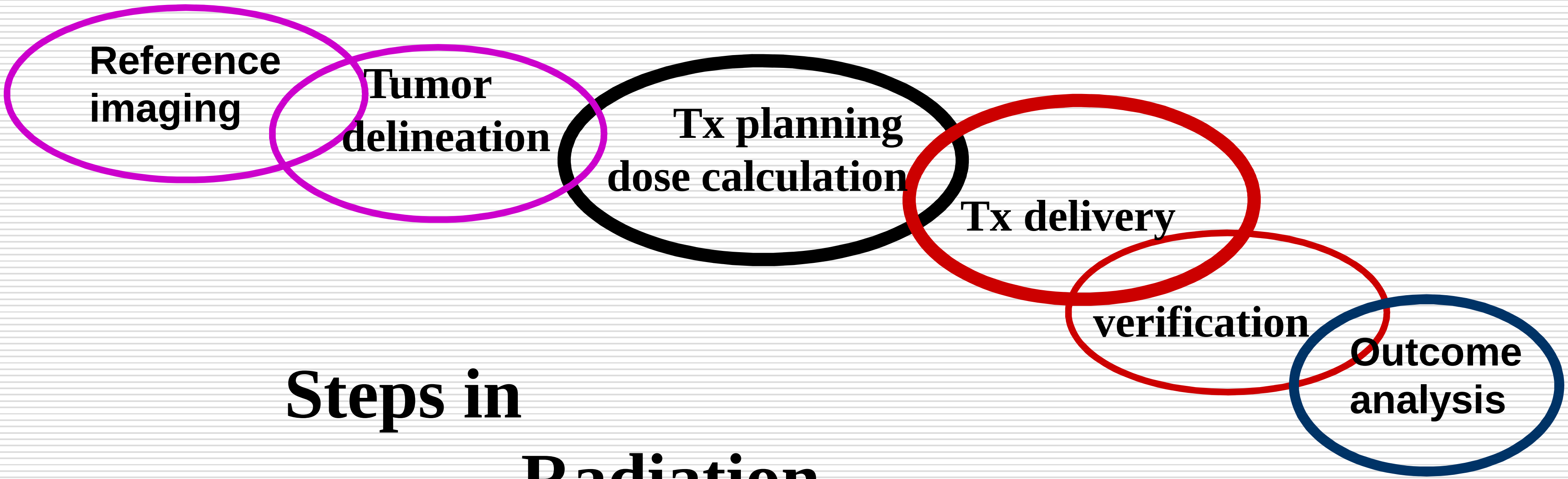
LINEAR ACCELERATOR

RADIOTHERAPY SIMULATOR

BRACHYTHERAPY MACHINE

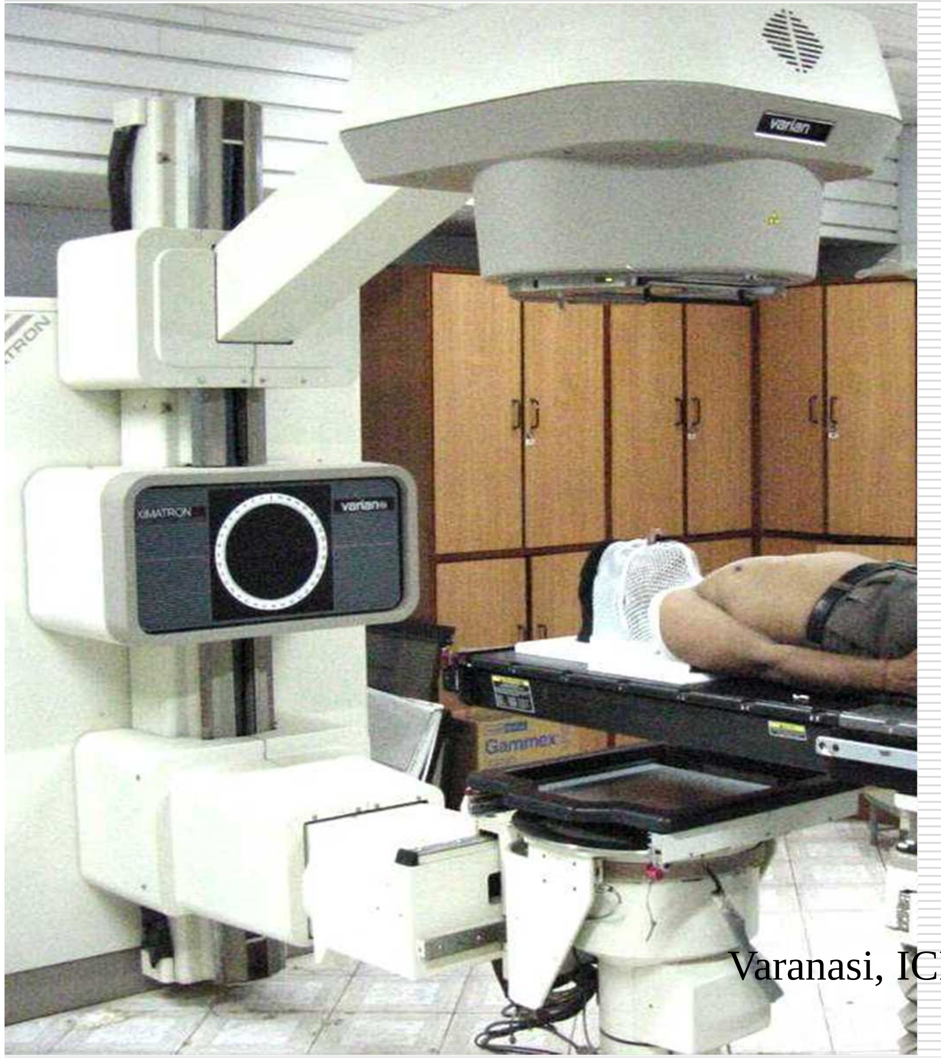

BD 10824

Teletherapy



Steps in Radiation Therapy

Conventional Physical Simulation

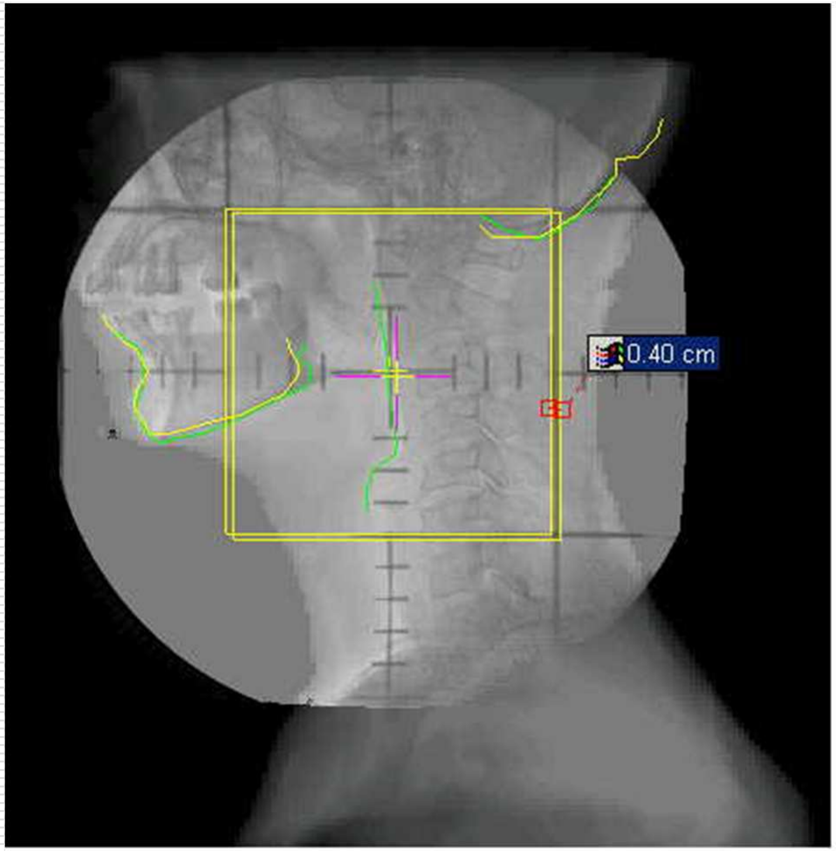


- Ability to simulate treatment machine mechanically
- High-definition real-time fluoroscopic images

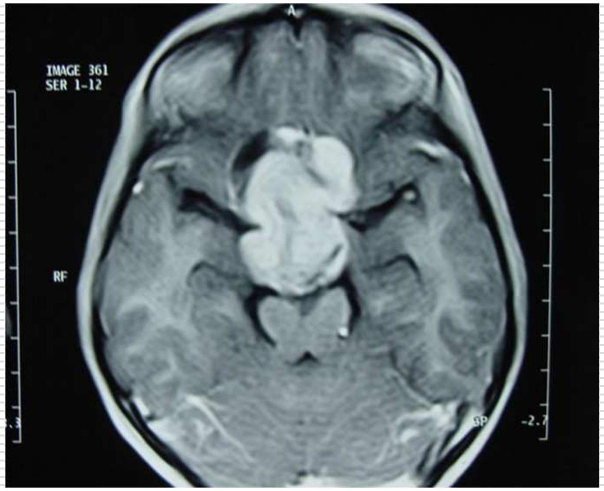
Physical simulator in plan implementation and verification

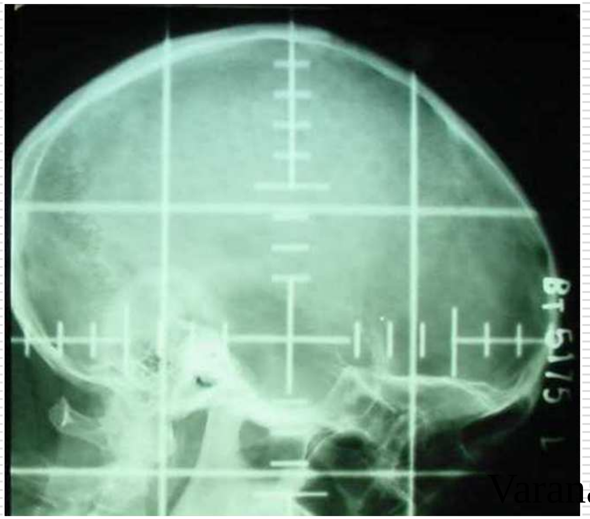
- Implementation and verification of TPS Plan isocenter on patient

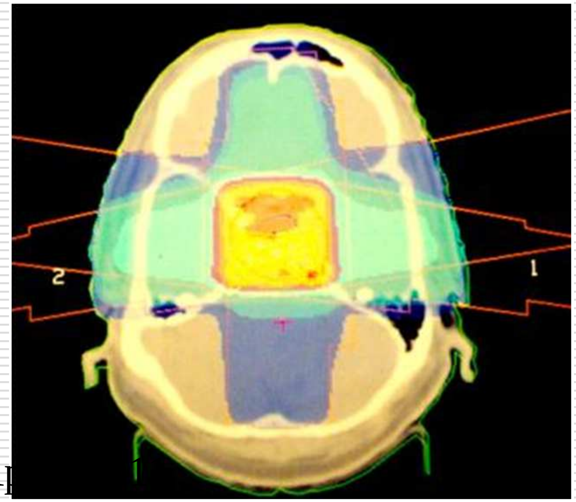
- Verification of treatment port



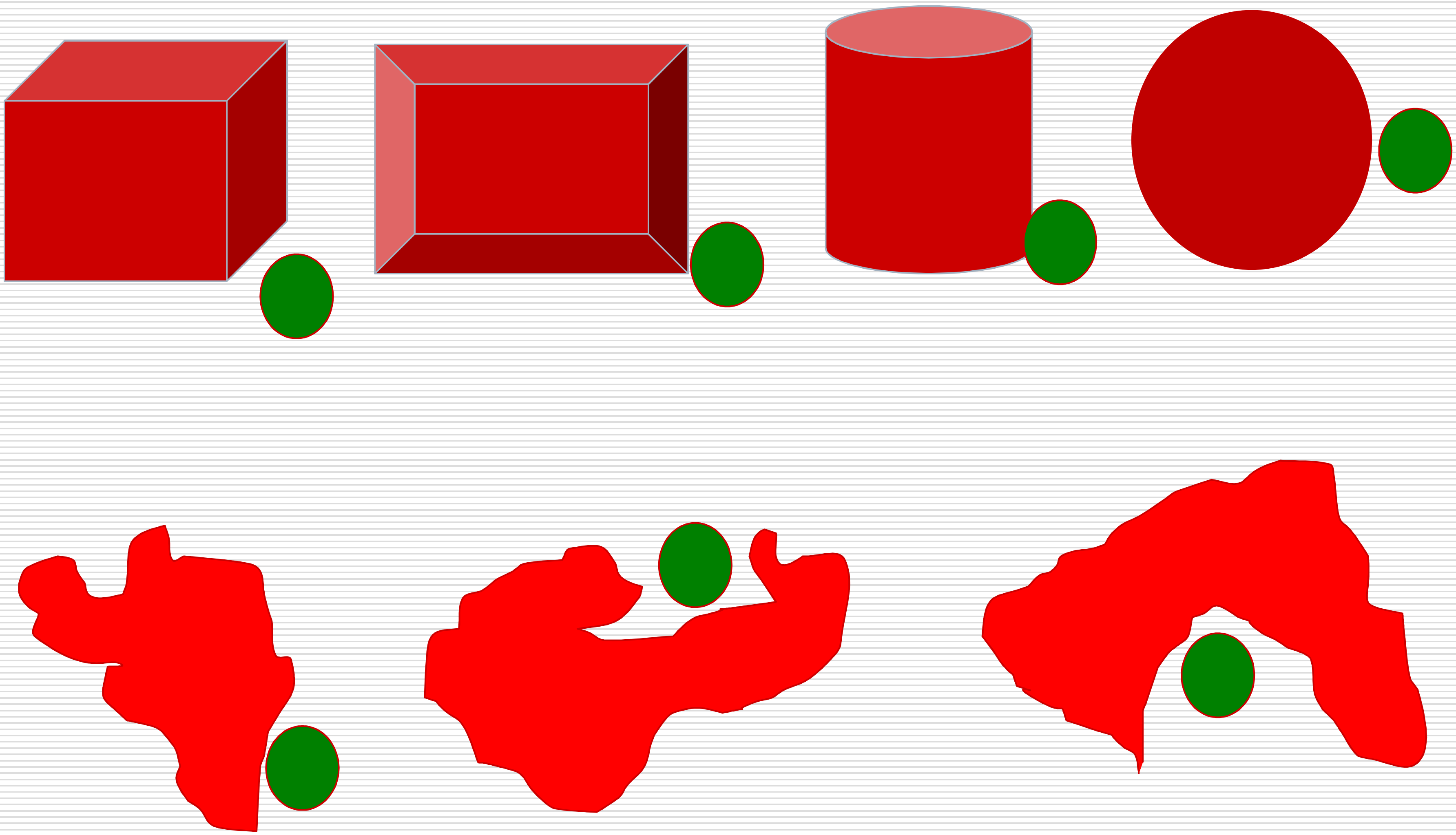
Conventional Radiotherapy





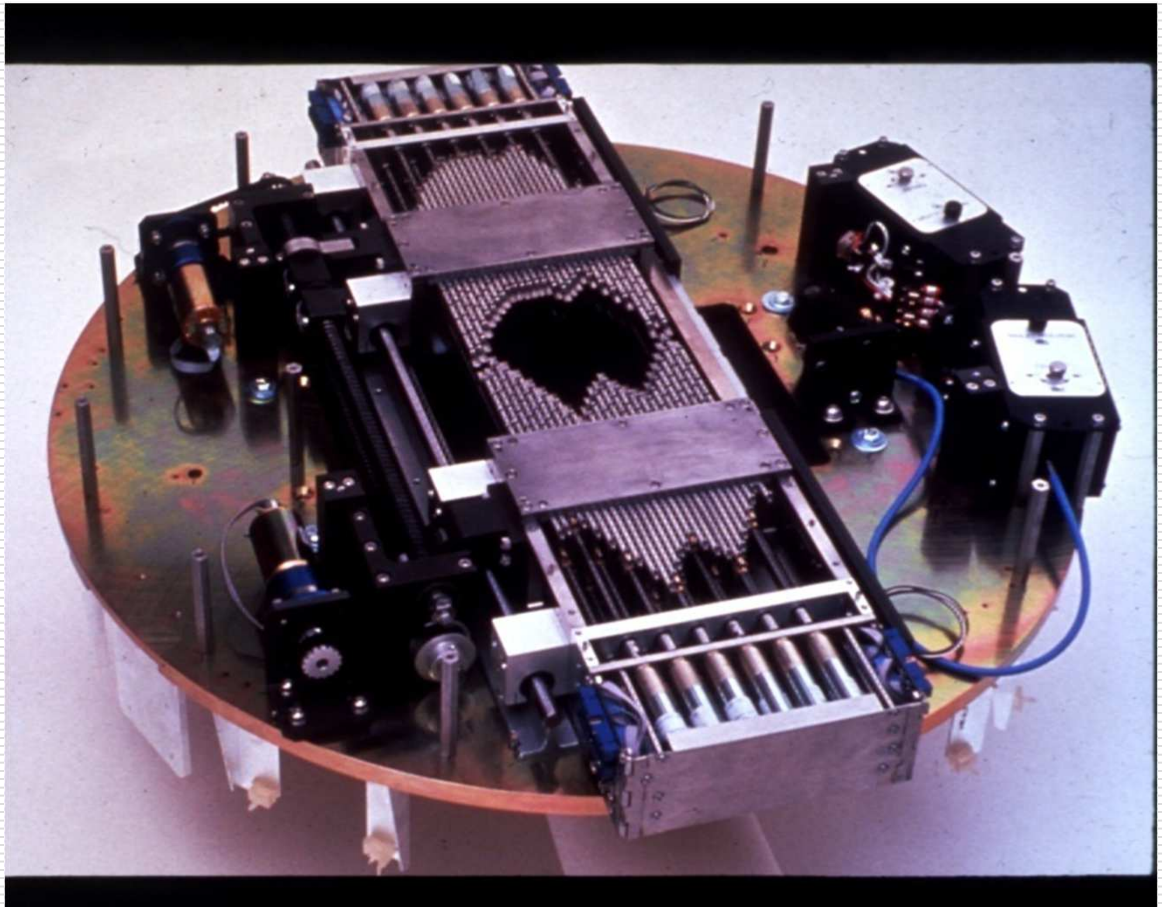


Tumor Shape? Normal organ



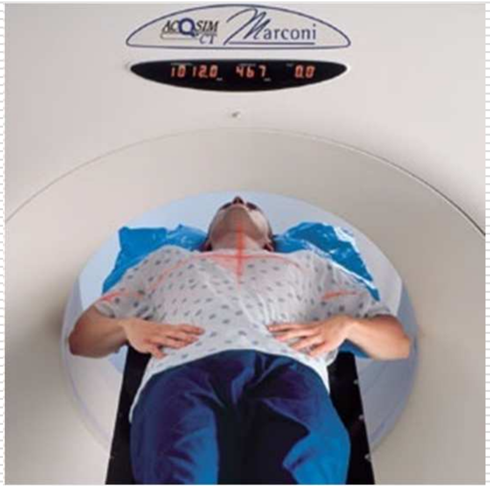
DMLC (Dynamic Multileaf Collimator)

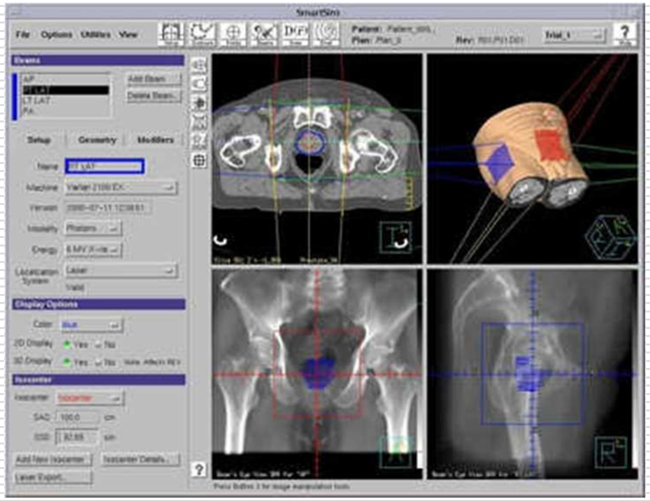
A multileaf collimator with computer-controlled leaves that move during radiation delivery to produce intensity modulated fields.



CT Simulators

Widely available
CT scans for treatment planning
Patient localization lasers in room
Operated by RT personnel
Flat couch
Virtual simulation software.



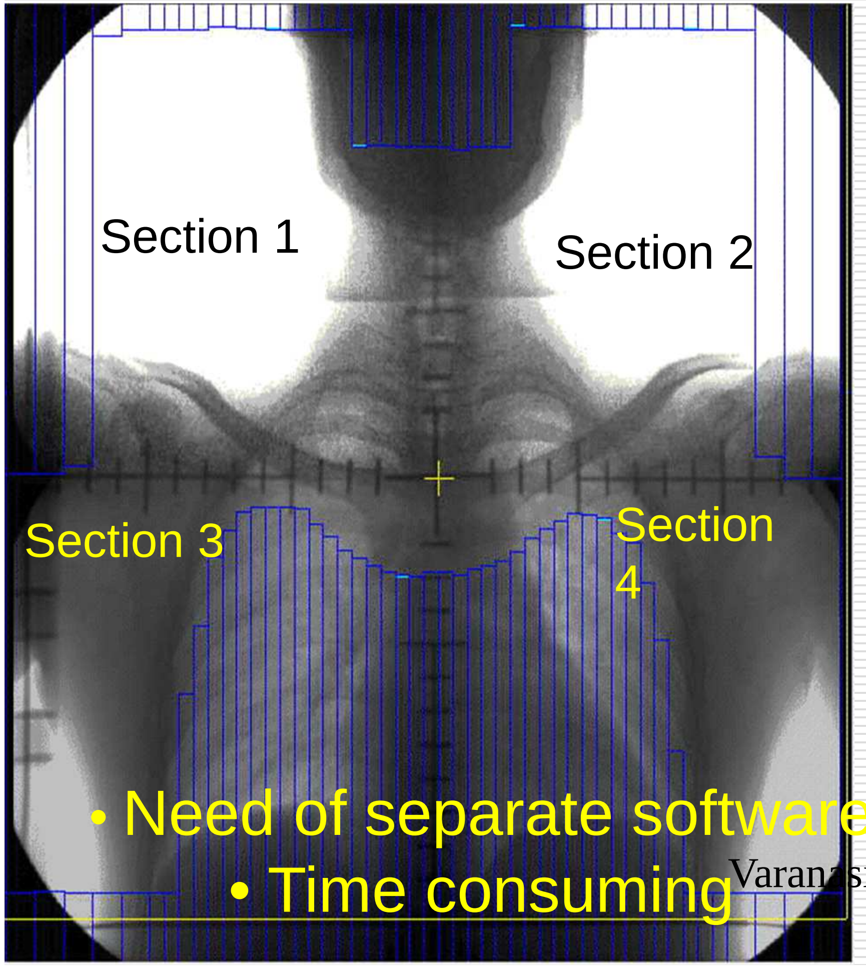


Physical Simulation

- 4/2 sections are acquired Separately & Quard merge using separate software
- MLCs are overlay on a vision workstation

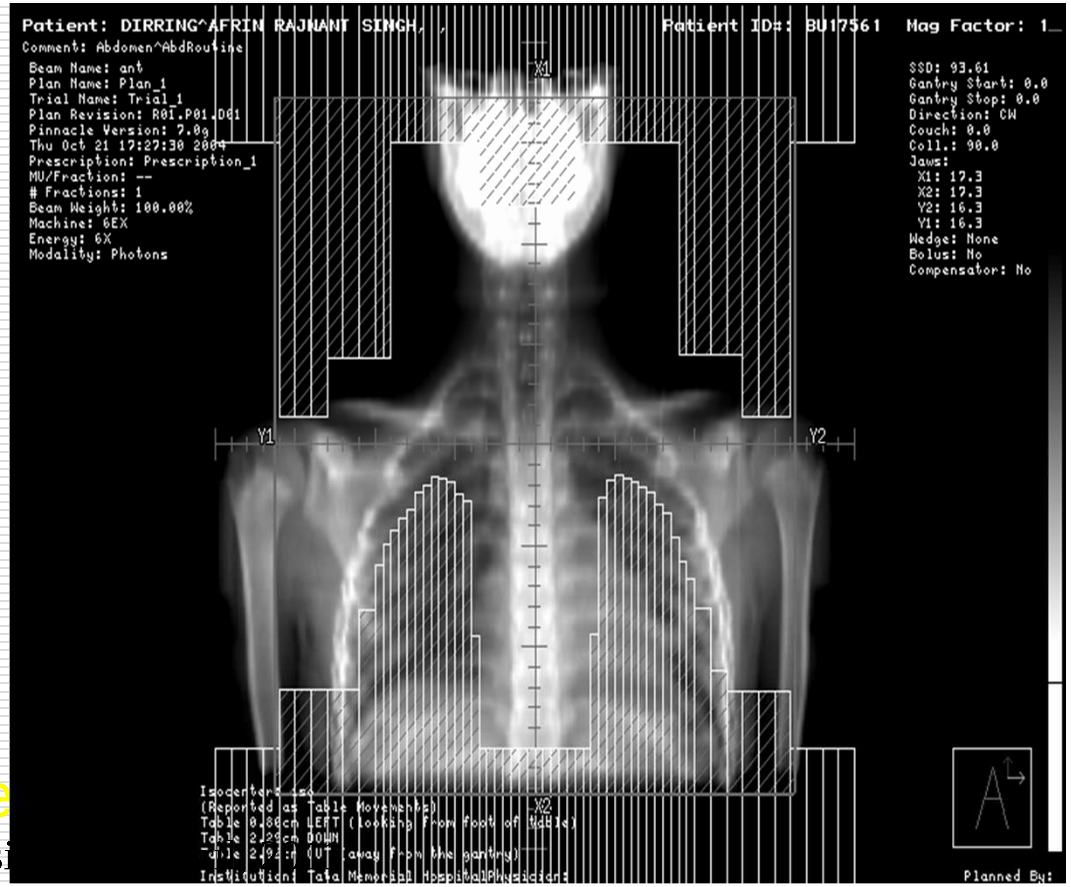
Virtual Simulator

- 5-8 mm CT slices
- MLCs shaping on DRR

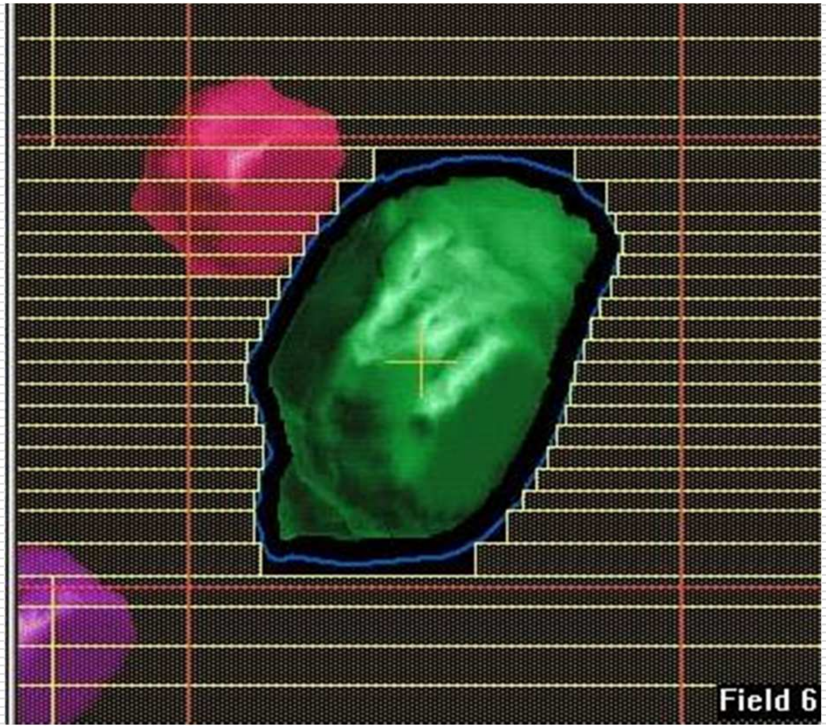


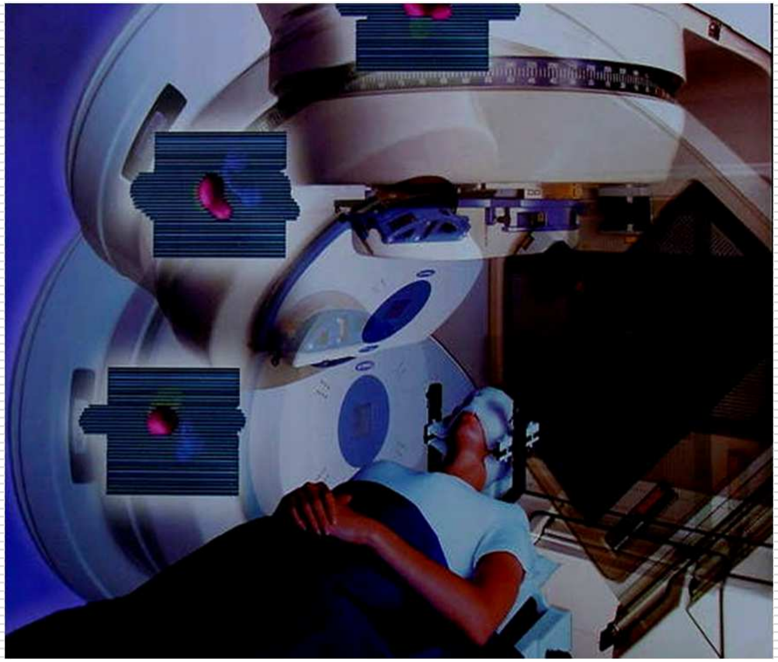
- Need of separate software
- Time consuming

Varanasi



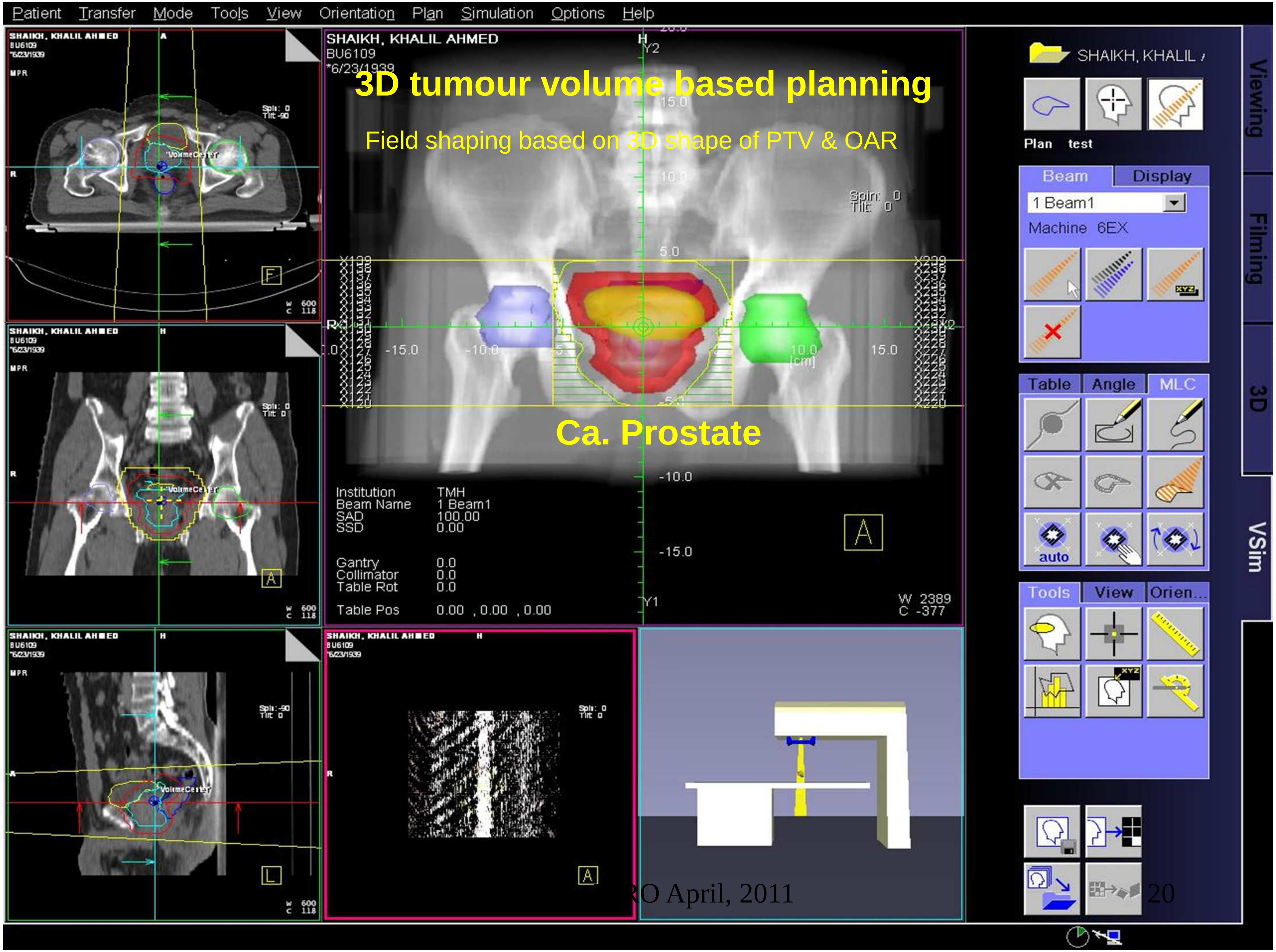
Multileaf collimators (MLC)





3D tumour volume based planning

Field shaping based on 3D shape of PTV & OAR



Ca. Prostate

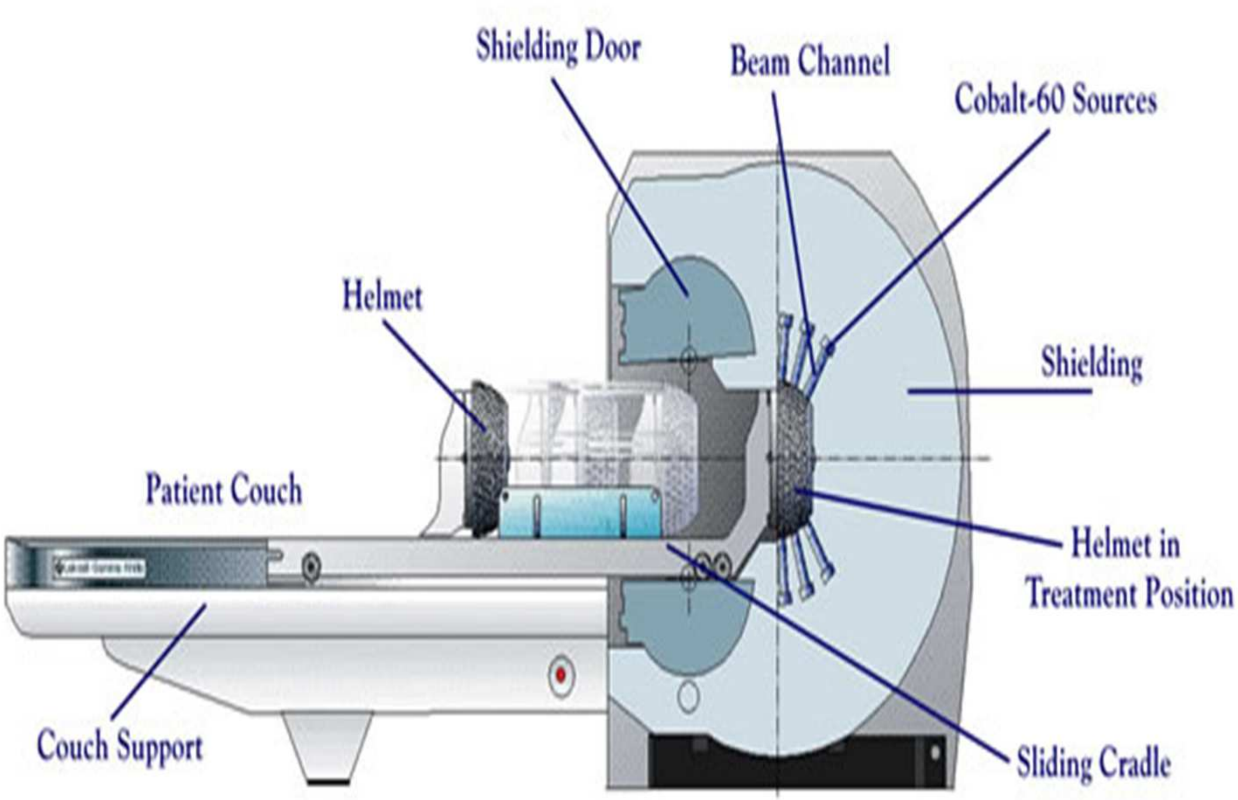
Stereotactic radiosurgery

Stereos - solid

- Gamma knife
- **Modified Linacs**
- Proton beam

Firm immobilisation (stereotactic frames)
Treatment planning (dedicated workstations)
precise treatment delivery (high QA)

GAMMA KNIFE



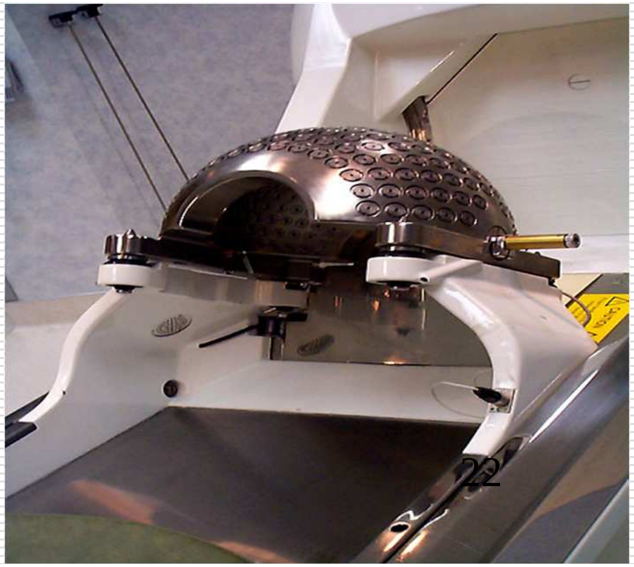
No. Sources -201

Each Source -30 Ci

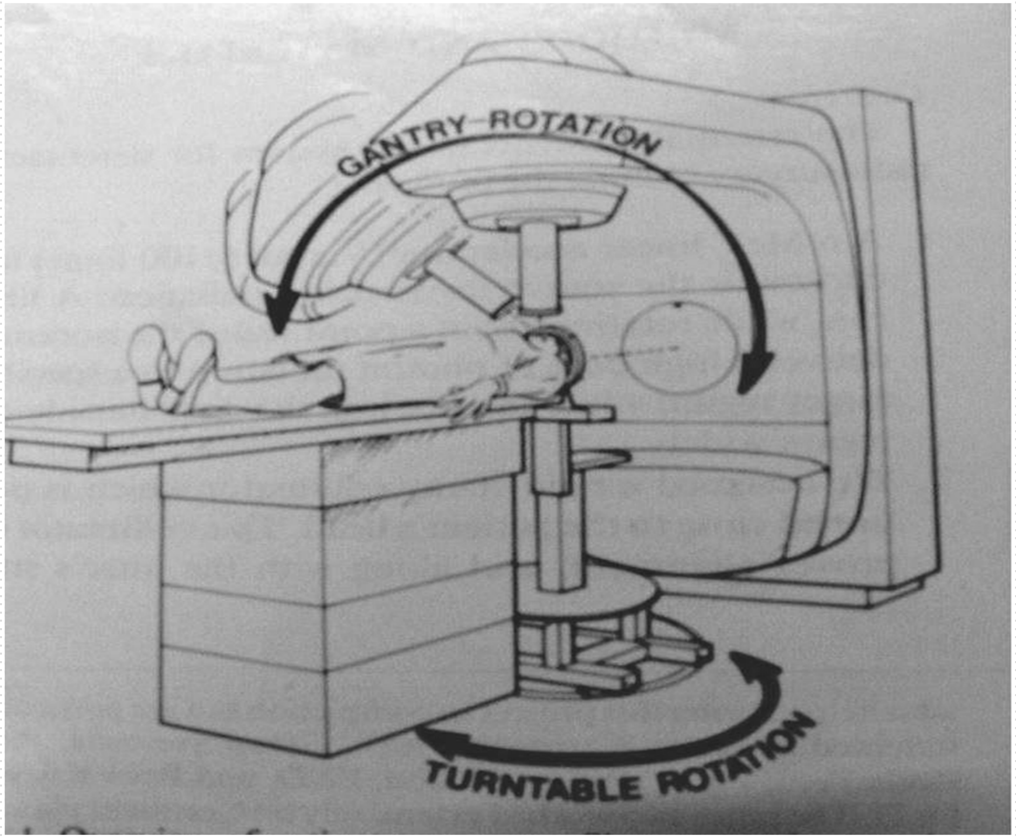
Total ~ 6000 Ci activity

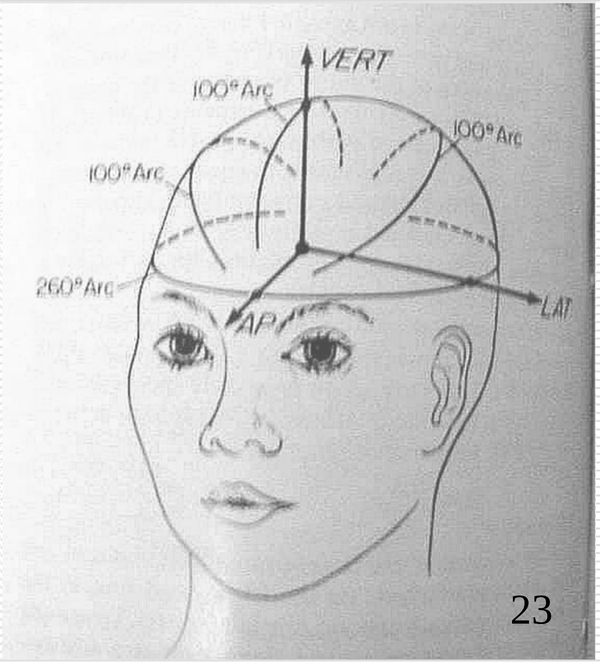
Each Source:

- **Length - 2 cm**
- **Diameter - 1 mm**
- **12-13 pellets in each source**



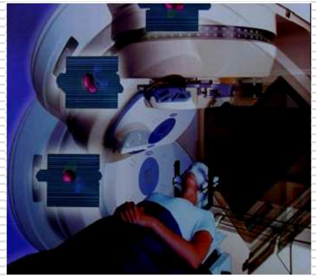
LA based Radiosurgery



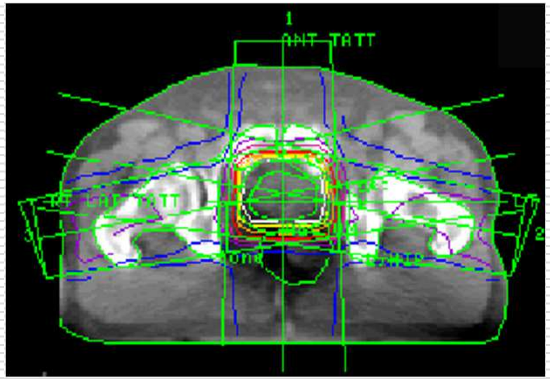


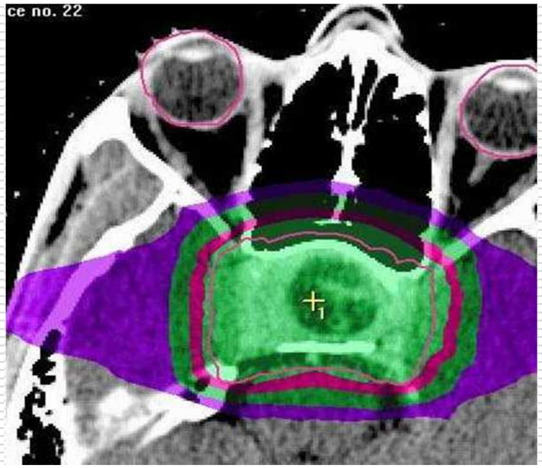
Lutz IJROBP 1988; 14: 373-81

3D CRT



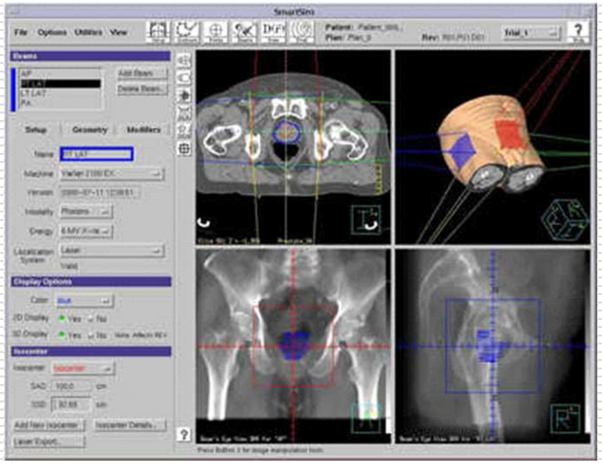
Uniform Beam Intensity





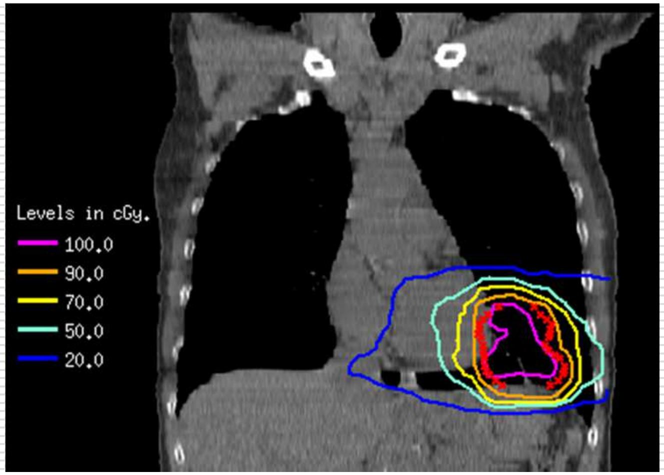
- Large body of evidence including prospective and randomised data in various sites
- reduction of side effects
- possible dose escalation

3DCRT

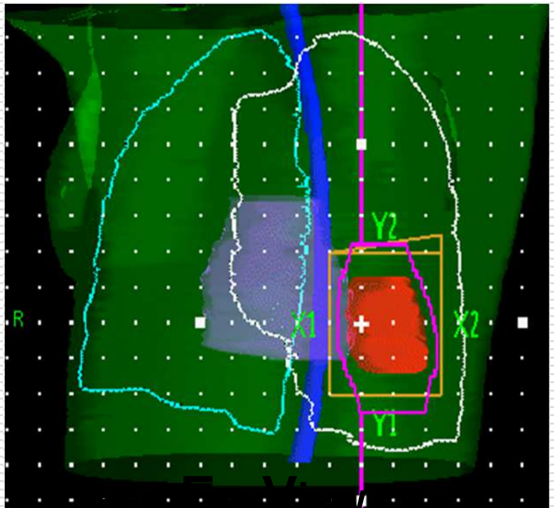


Virtual Simulation

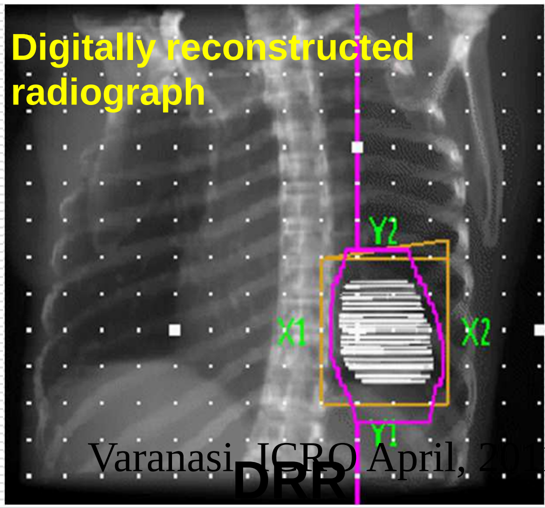
(Use CT image set to choose 'good' beam directions)



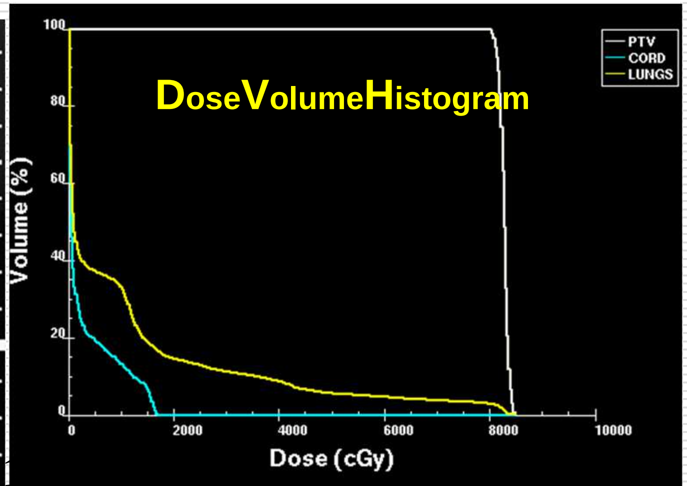
3D Dose calculation/display



BeamEyeView

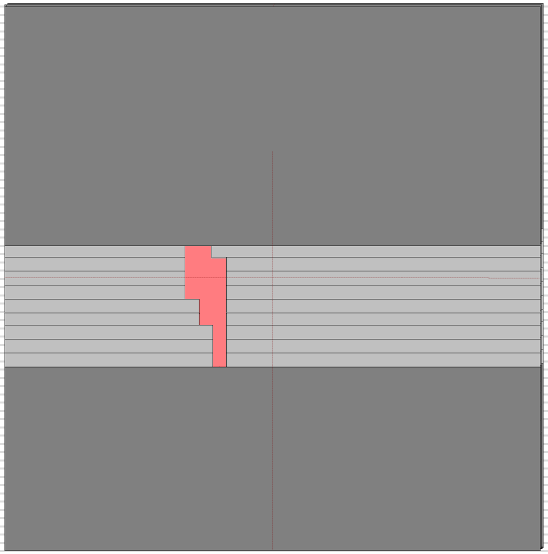


DRR

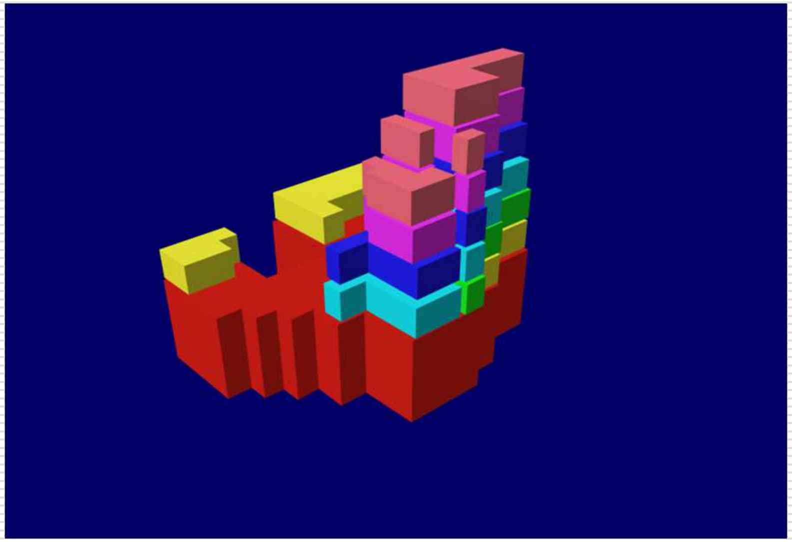


IMRT

MLC

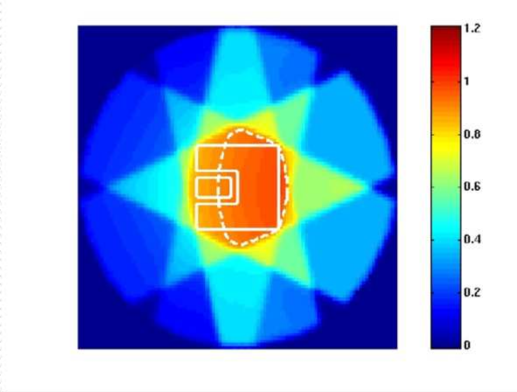


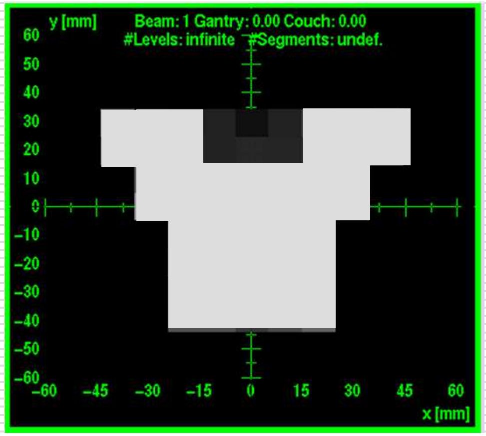
Desired dose

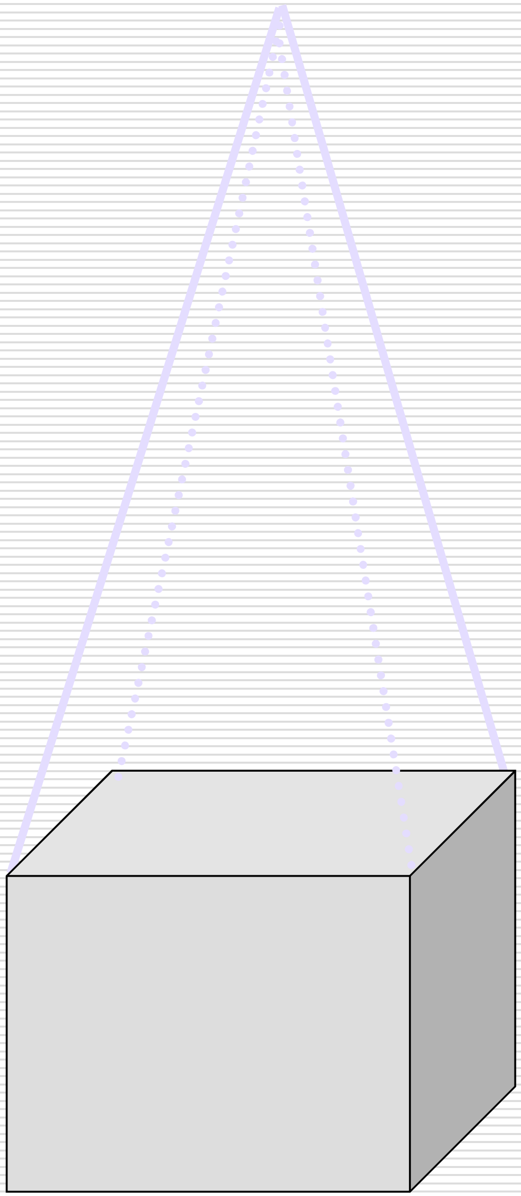


- Revolutionary concept
- Change the MLC leaves to create desired intensities

CRT

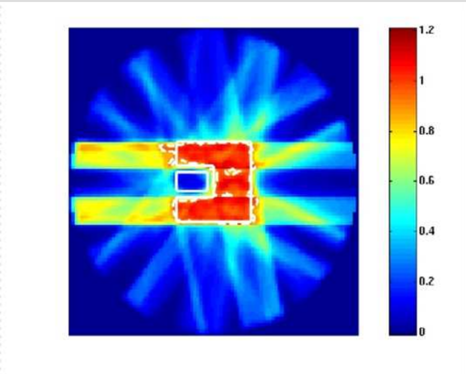


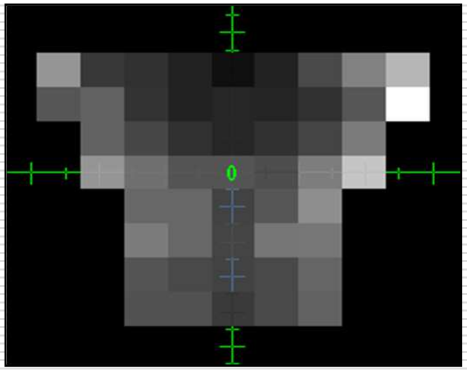


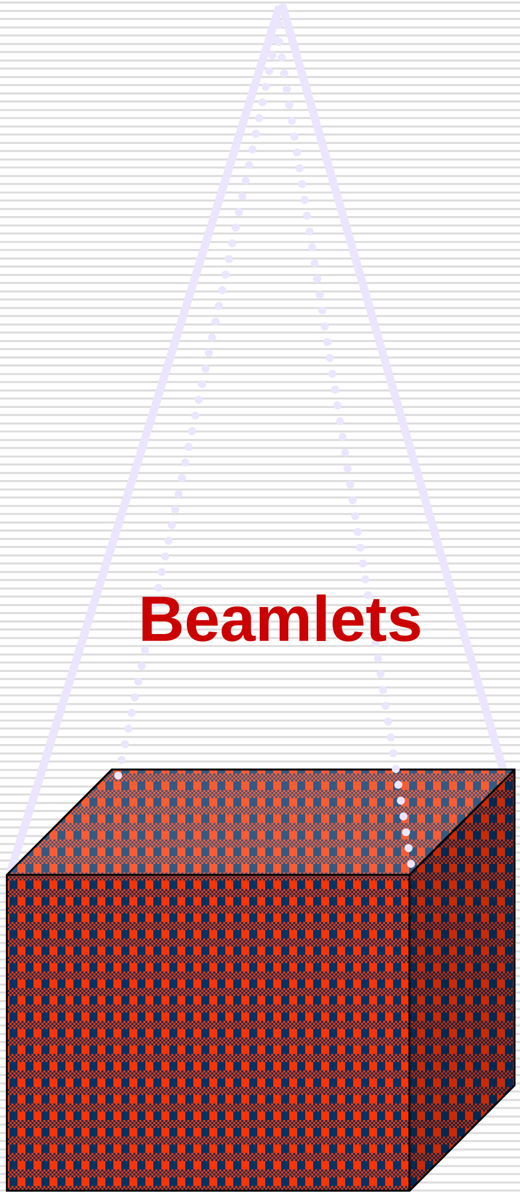


Uniform intensity

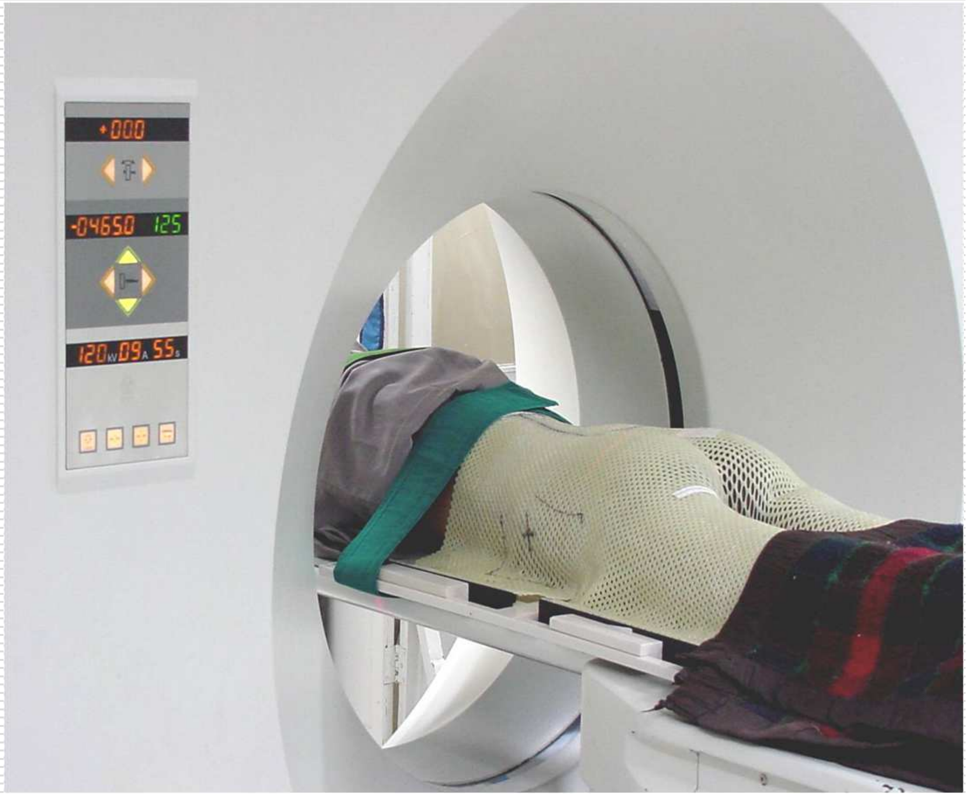
IMRT





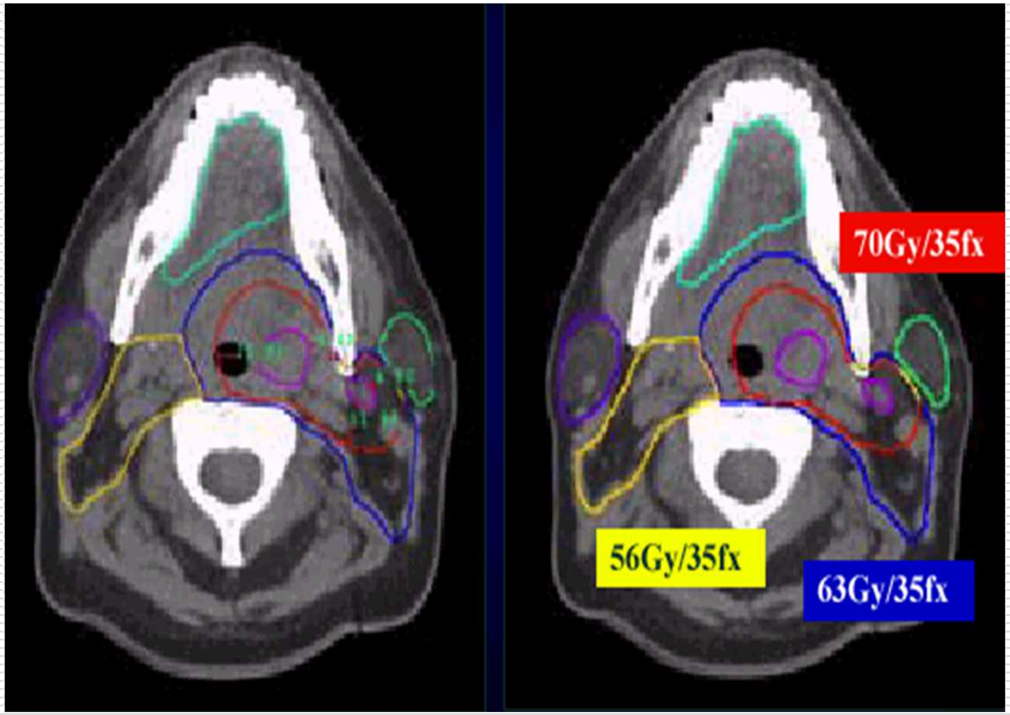


Immobilisation

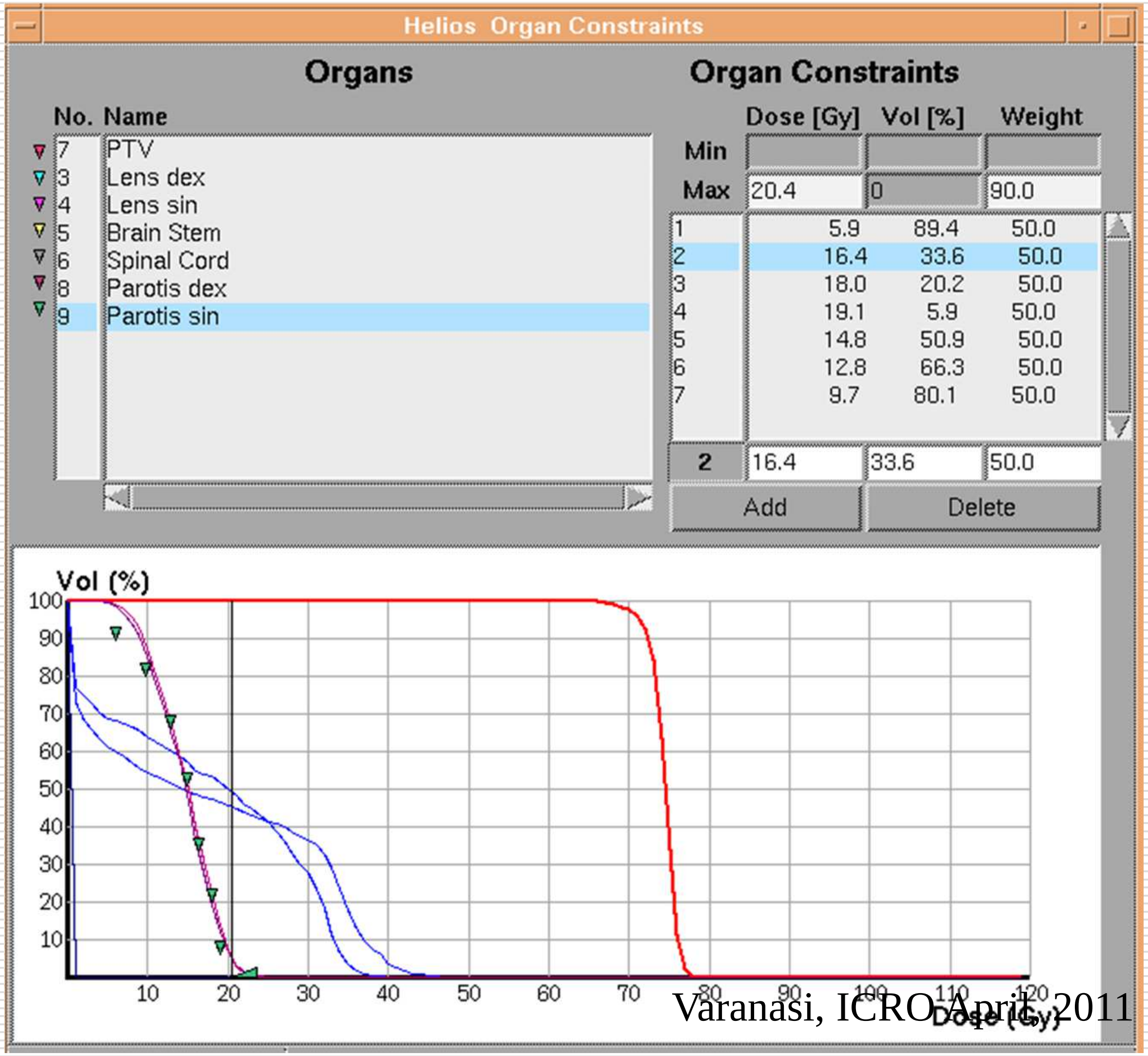


Volume delineation

critical step

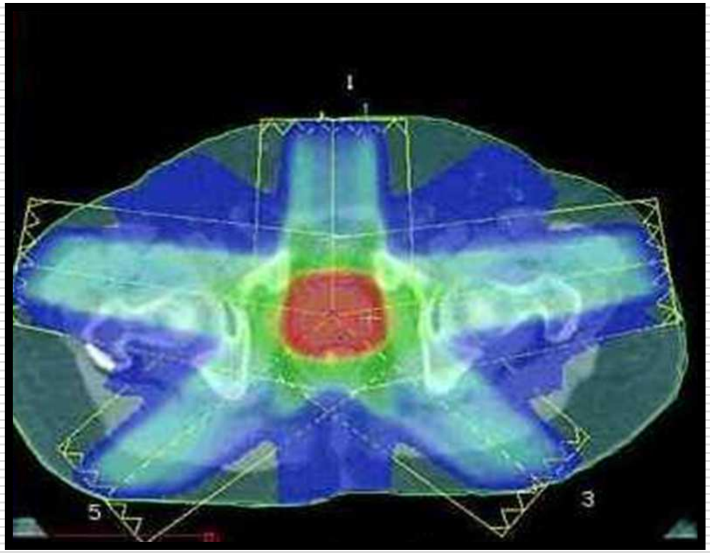


Inverse planning
Dose constraints

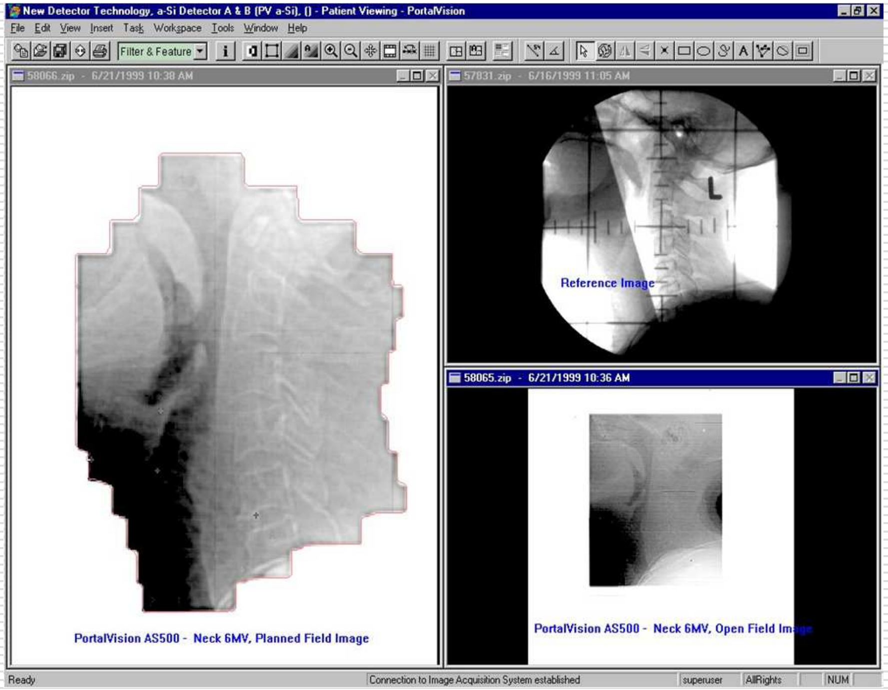


- Clinical data for all organs not available, a bit arbitrary
- Experience is needed to determine which constraints are more important

Treatment Planning and delivery



Daily verification

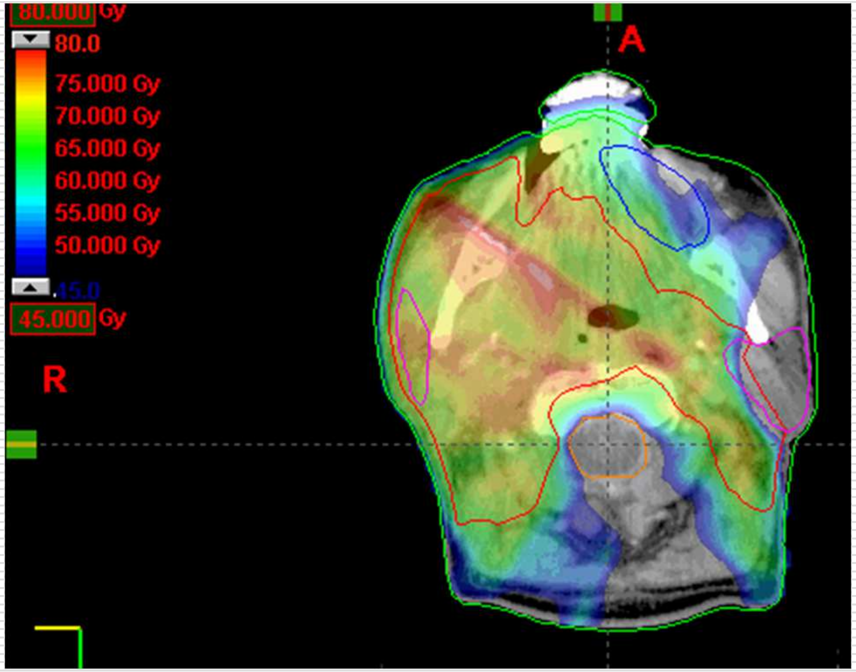


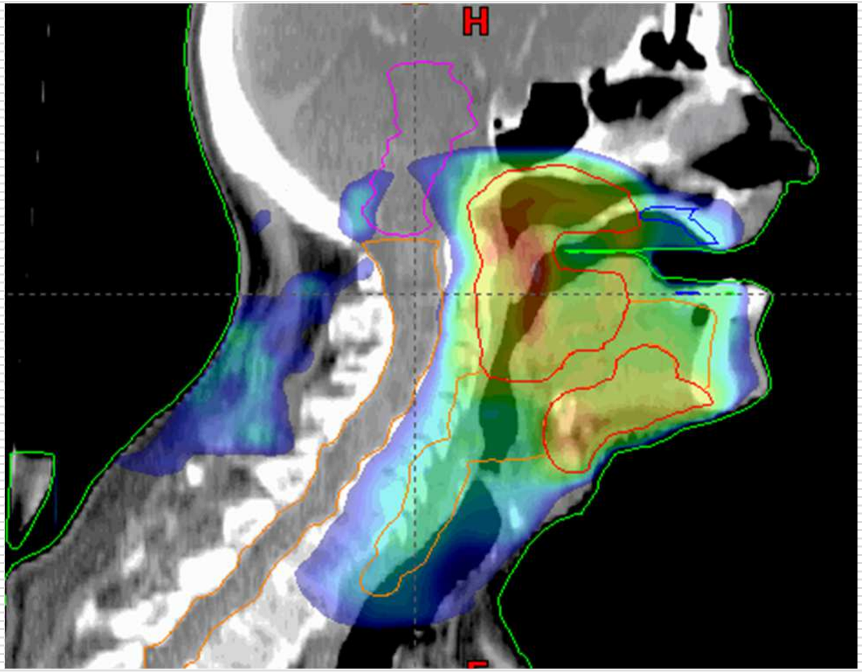
Electronic Portal Imaging Device (EPID)

Cone CT

IMRT for Head and neck cancers

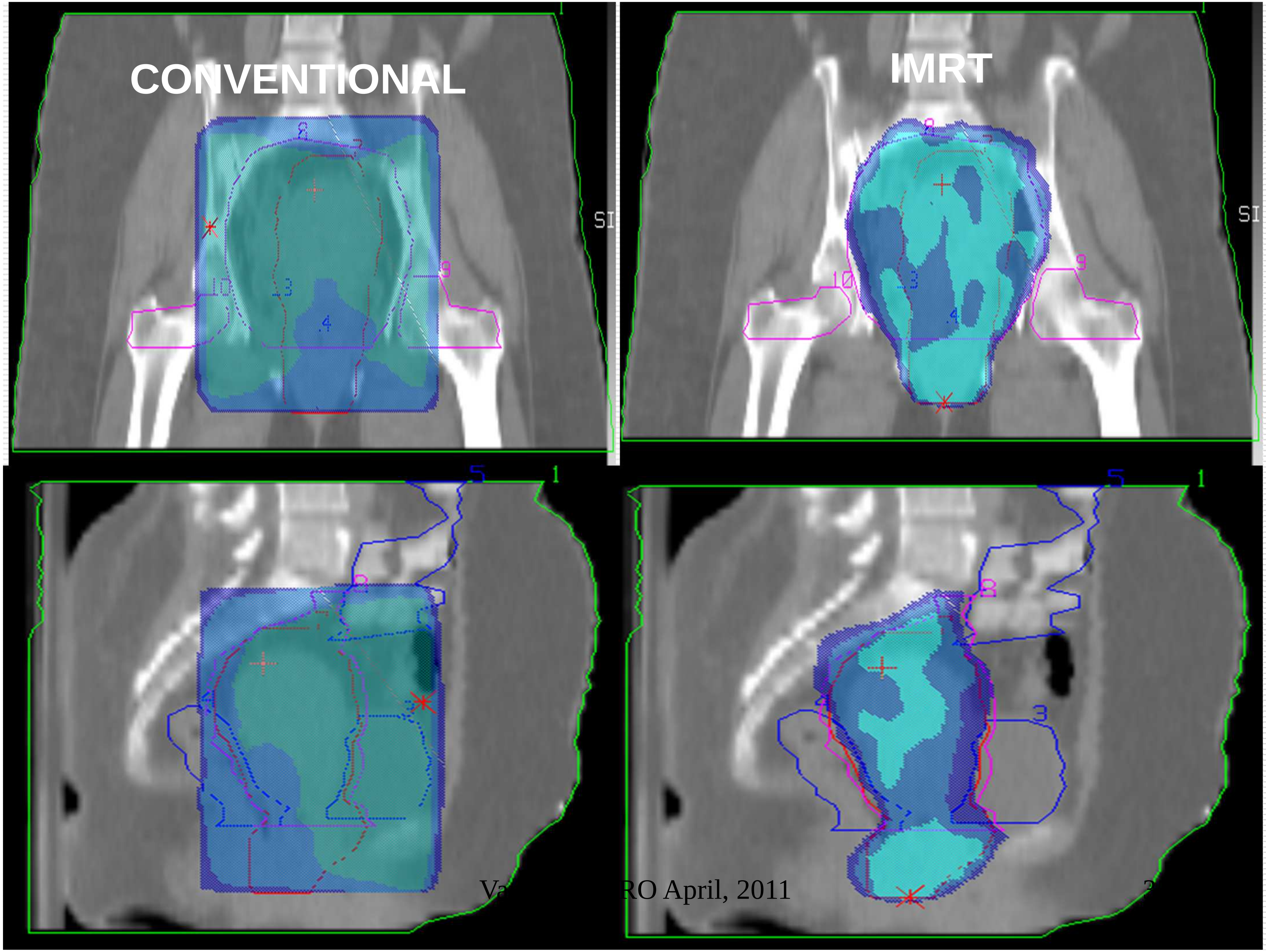
a lot of potential; very exciting





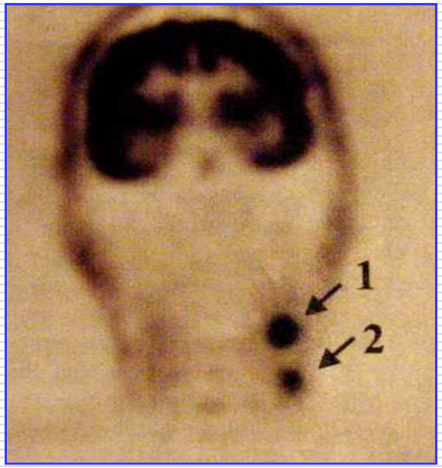
Characteristics

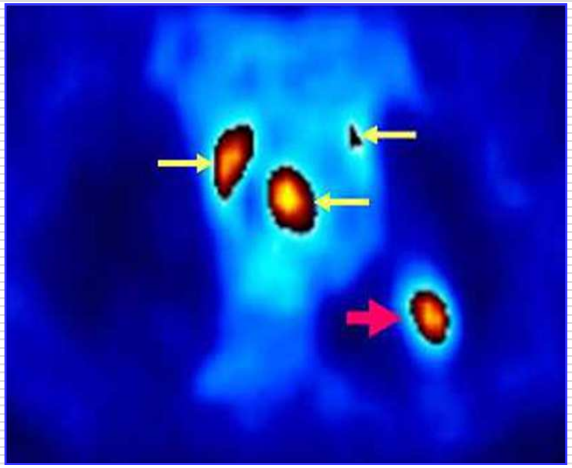
- Sparing of spinal cord
- Sparing of parotid gland
- Dose escalation possible


CONVENTIONAL
IMRT
SI
SI

Metabolic image-based Planning

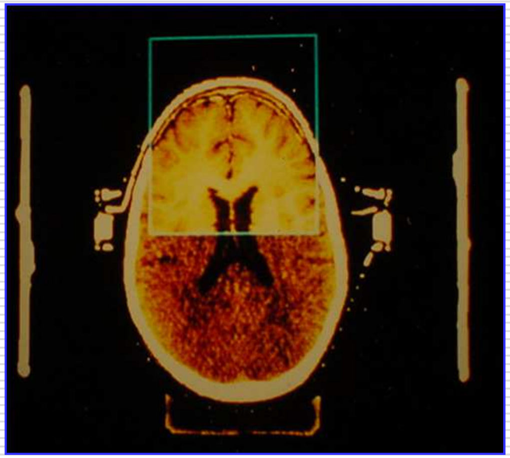
Tremendous enthusiasm





PET used in cancers of lung, head & neck, cervix, brain

Biological target Volume (BTV)



Radiotherapy and Oncology 82 (2007) 254–264
www.thegreenjournal.com

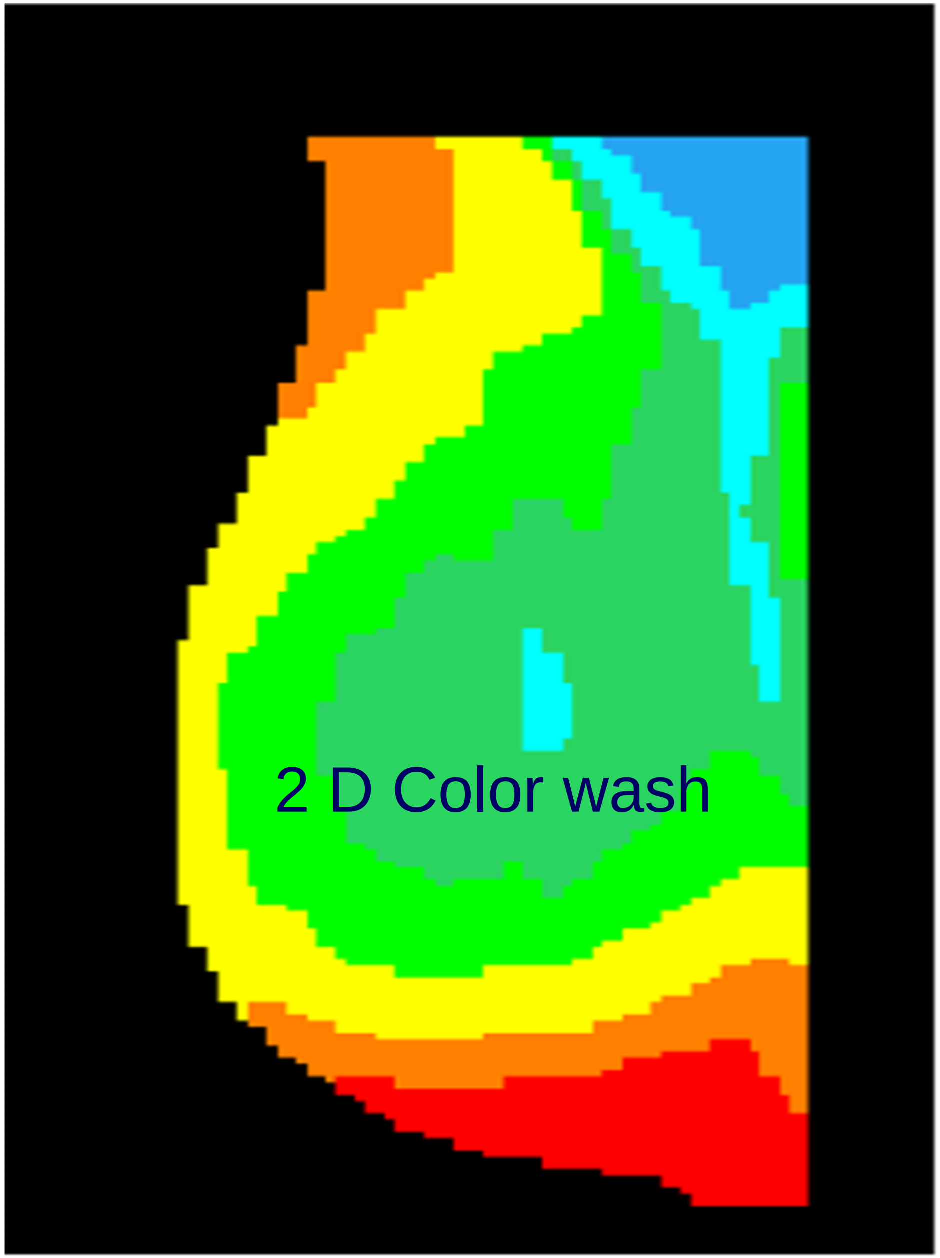
Phase III randomised trial

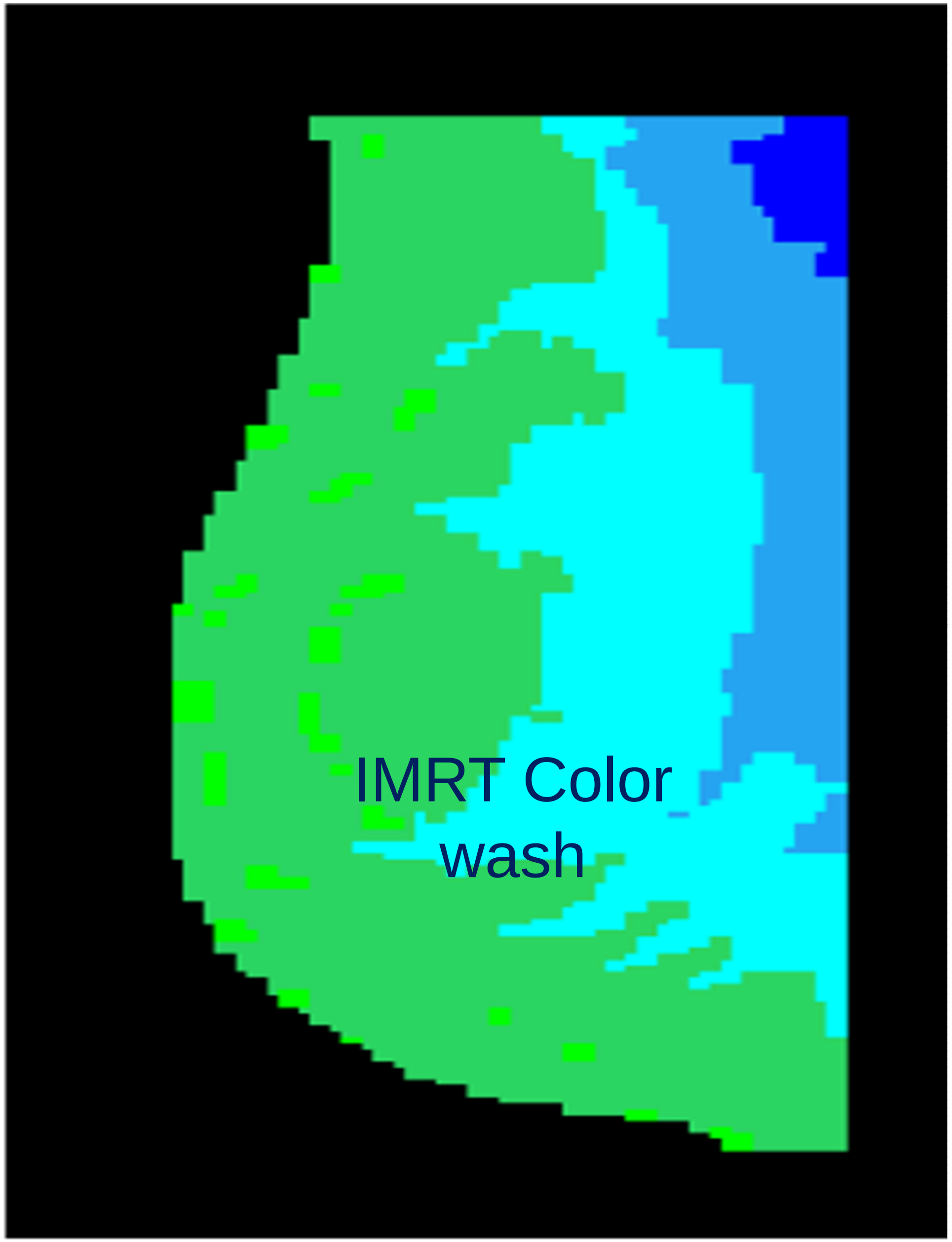
Randomised trial of standard 2D radiotherapy (RT) versus intensity modulated radiotherapy (IMRT) in patients prescribed breast radiotherapy

Ellen Donovan[a], Natalie Bleakley[a], Erica Denholm[b], Phil Evans[a], Lone Gothard[c], Jane Hanson[c], Clare Peckitt[b], Stephanie Reise[a], Gill Ross[d], Grace Sharp[c], Richard Symonds-Tayler[a], Diana Tait[c], John Yarnold[c,*], on behalf of the Breast Technology Group

[a]Joint Department of Physics, Royal Marsden Hospital and Institute of Cancer Research, Sutton, Surrey, UK, [b]Clinical Trials & Statistics Unit (ICR-CTSU), Institute of Cancer Research, Sutton, Surrey, UK, [c]Department of Radio2;therapy, Royal Marsden Hospital, Sutton, Surrey, UK, [d]Department of Radiotherapy, Royal Marsden Hospital, Chelsea, London, UK

Donovan E, Radiotherapy and Oncology 2007





Donovan E, Radiotherapy and Oncology 2007

Medical Dosimetry, Vol. 34, No. 2, pp. 140-144, 2009

0958-3947/09/$–see front matter

doi:10.1016/j.meddos.2008.08.006

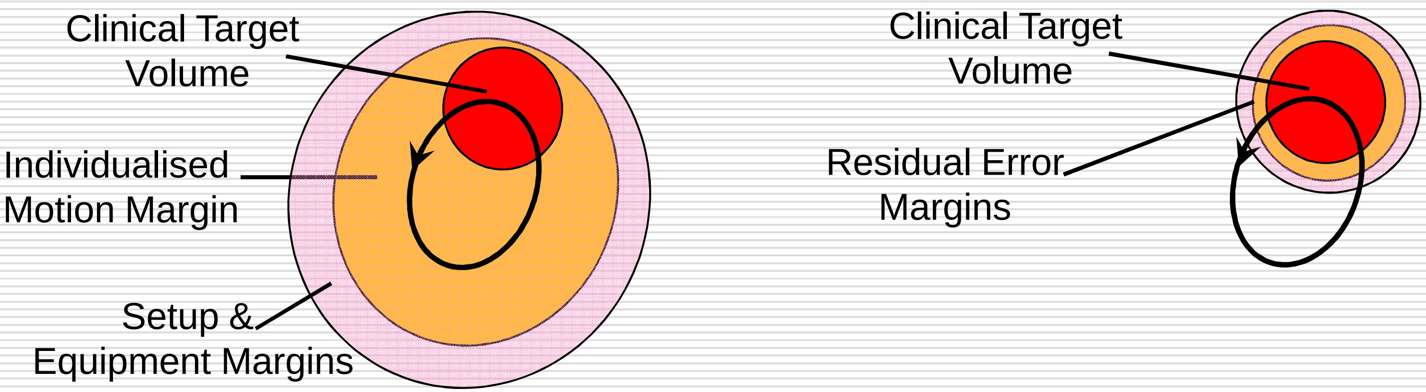
ELSEVIER

DO ALL PATIENTS OF BREAST CARCINOMA NEED 3-DIMENSIONAL CT-BASED PLANNING? A DOSIMETRIC STUDY COMPARING DIFFERENT BREAST SIZES

ANUSHEEL MUNSHI, M.D., D.N.B., RAJESHRI H. PAI, M.SC., D.R.P.,
REENA PHURAILATPAM, M.SC., D.R.P., ASHWINI BUDRUKKAR, M.D., D.N.B.,
RAKESH JALALI, M.D., RAJIV SARIN, M.D., F.R.C.R., D.D. DESHPANDE, M.SC.,
SHYAM K. SHRIVASTAVA, M.D., D.N.B., and KETAYUN A. DINSHAW, F.R.C.R.
Department of Radiation Oncology, Tata Memorial Hospital, Parel, Mumbai, Maharashtra, India

	Superior slice	Inferior slice
Large Breast	9%	15%
Medium Breast	8%	8%
Small Breast	5%	5%

Potential of IGRT

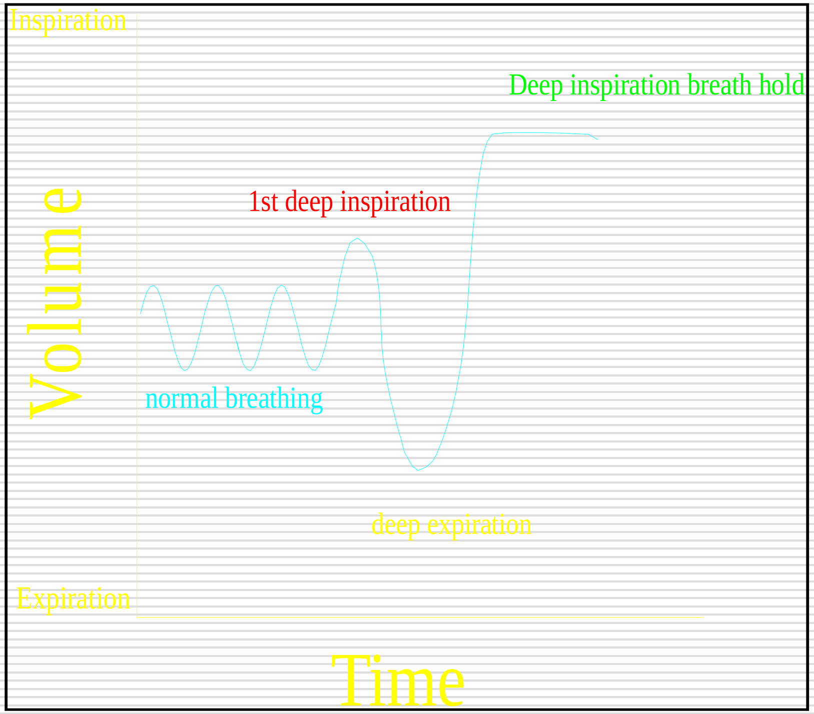


Planning Target Volume

Target tracking Treatments

- Removal of motion encompassing margins may reduce normal tissue dose
- Reduction in normal tissue dose may facilitate tumour dose escalation
- Higher doses delivered to the tumour could result in an improved cure rate

Deep Inspiration Breath Hold



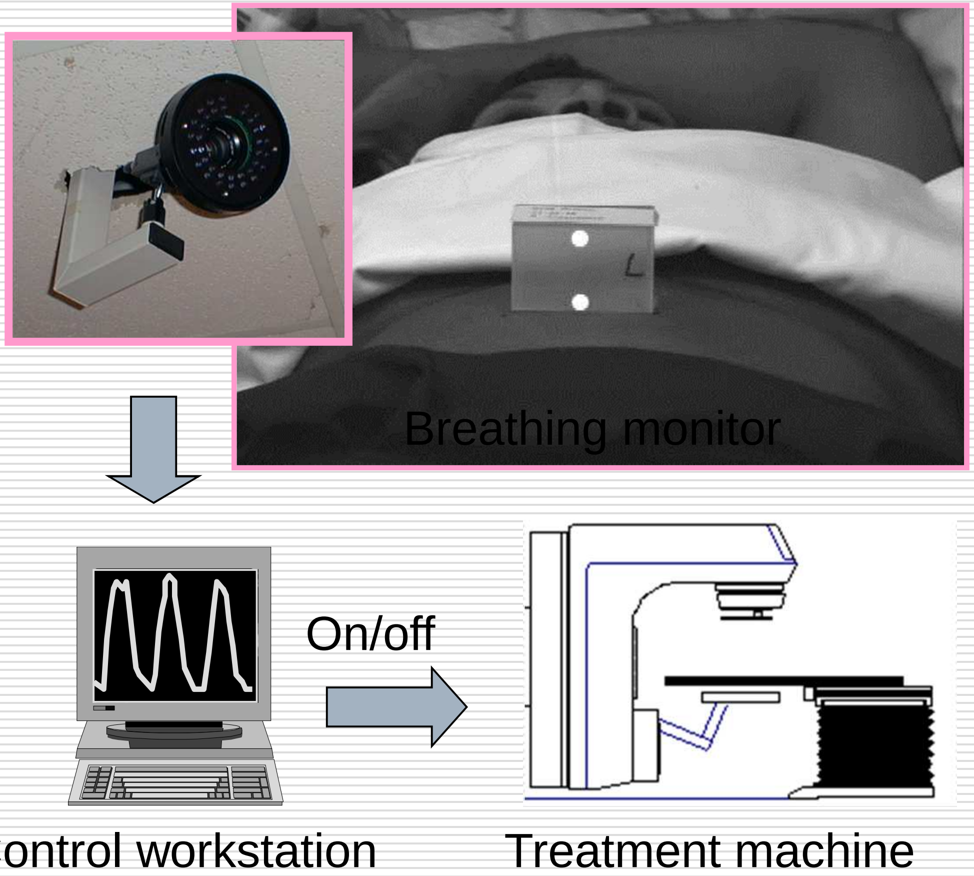
Patient breaths through PC-interfaced spirometer. Coached through Slow Vital Capacity maneuver. Monitored by trained person using custom software.

Beam-on during the deep inspiration breath-hold

Real-time Position Management (RPM) Respiratory Gating System

Components:

- **Infrared illuminator / CCD camera**
- **Reflective external markers placed on abdomen or chest**
- **Workstation to process signals & generate trigger (CT) or gate beam (linac)**



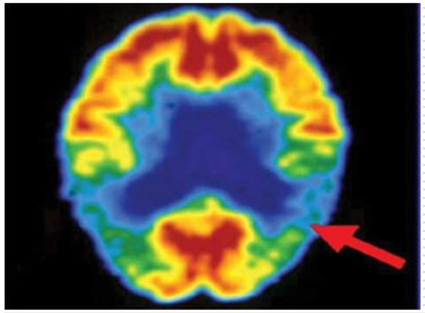
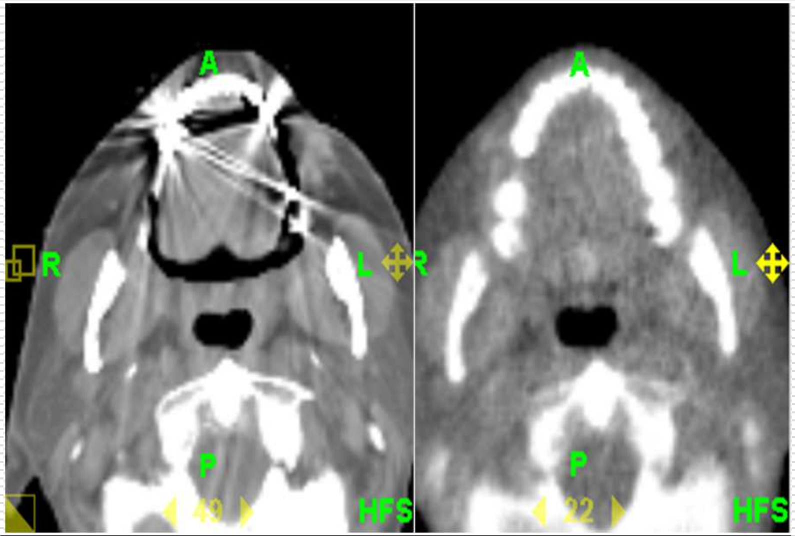
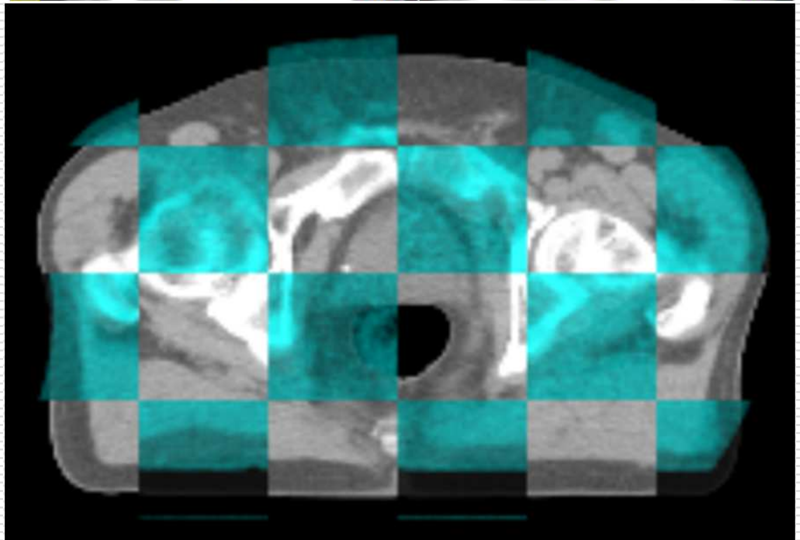


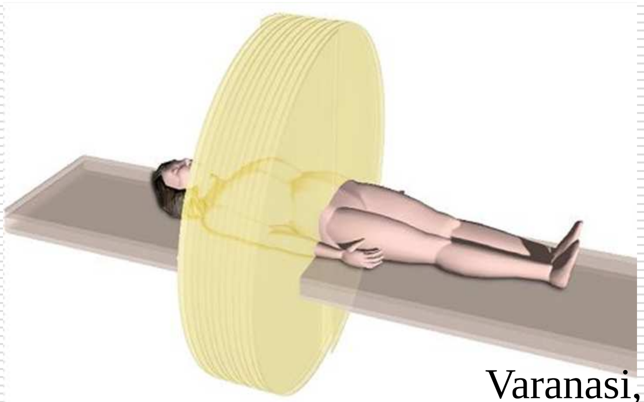
Image guided radiotherapy

- Modern radiotherapy techniques are dependent upon imaging for planning and verification
- High Precision techniques (3D CRT, SRS/SRT, IMRT) depend upon imaging (CT, MRI, PET etc) for accurate tumour and critical structure delineation on the planning computer
- A margin is given around the gross tumour to account for imaging uncertainties/ microscopic extensions (CTV)
- A margin is also given for daily inaccuracies during 6-7 weeks of daily radiotherapy (PTV)
- Both margins can be potentially reduced to improve dose conformality and reduce doses to critical structures and possibly dose escalation

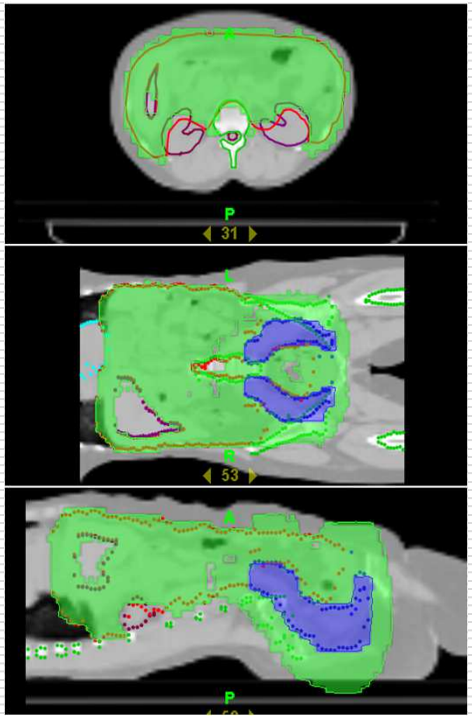
Tomotherapy



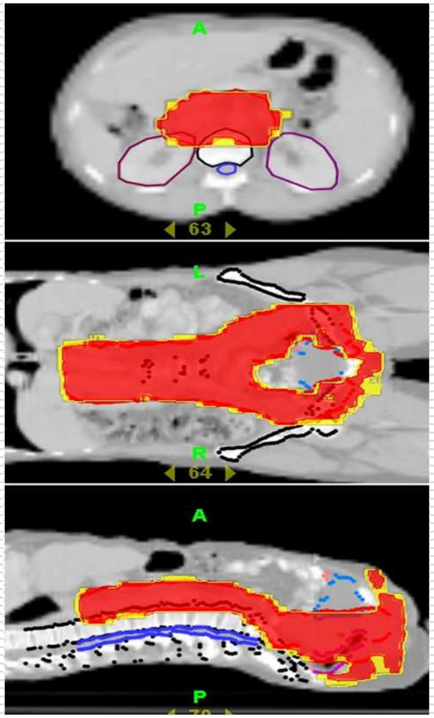




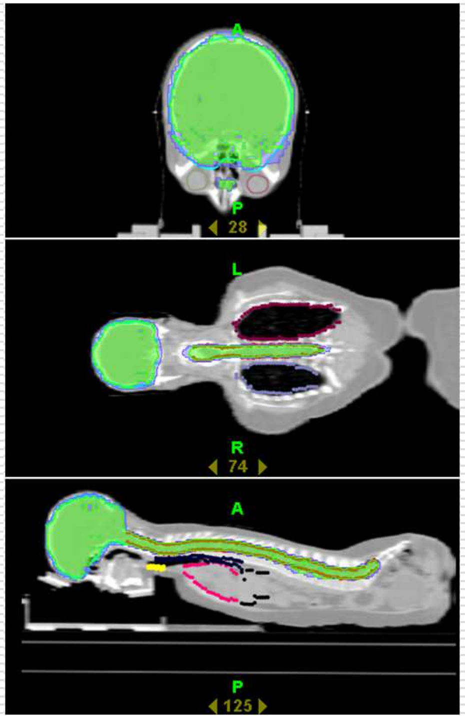
Tomotherapy



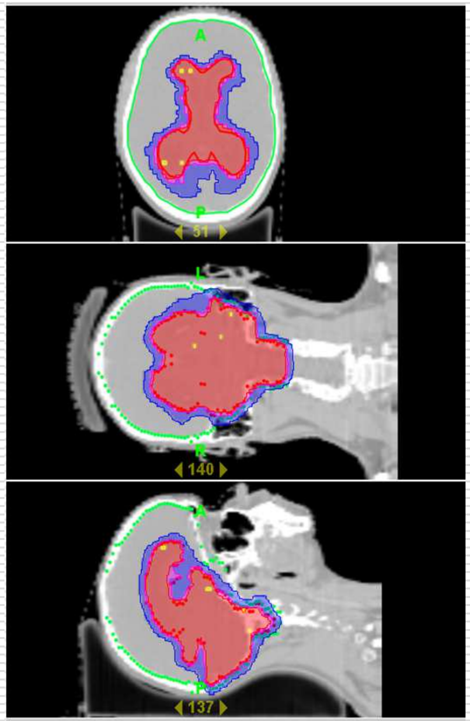
WAR



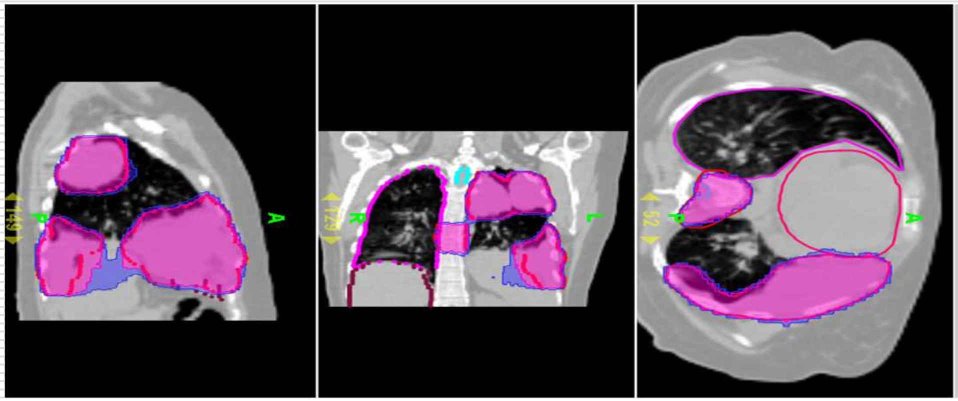
EFRT-Cx



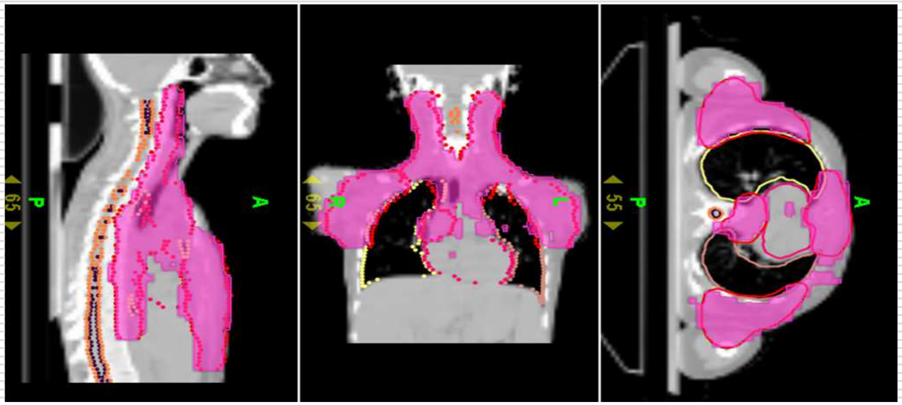
CSI



VENTRICLE RT

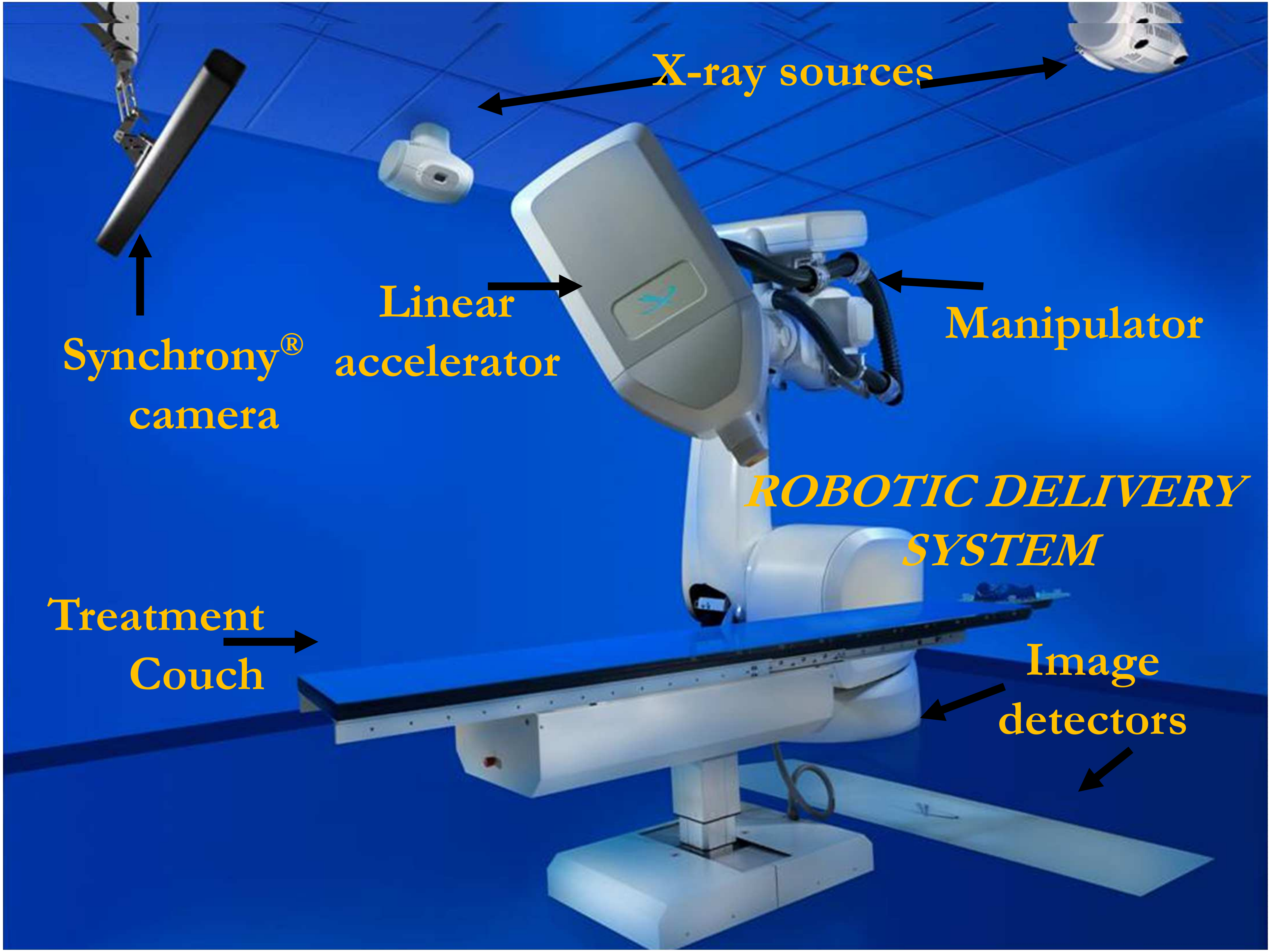


MESOTHELIOMA & BONE METS

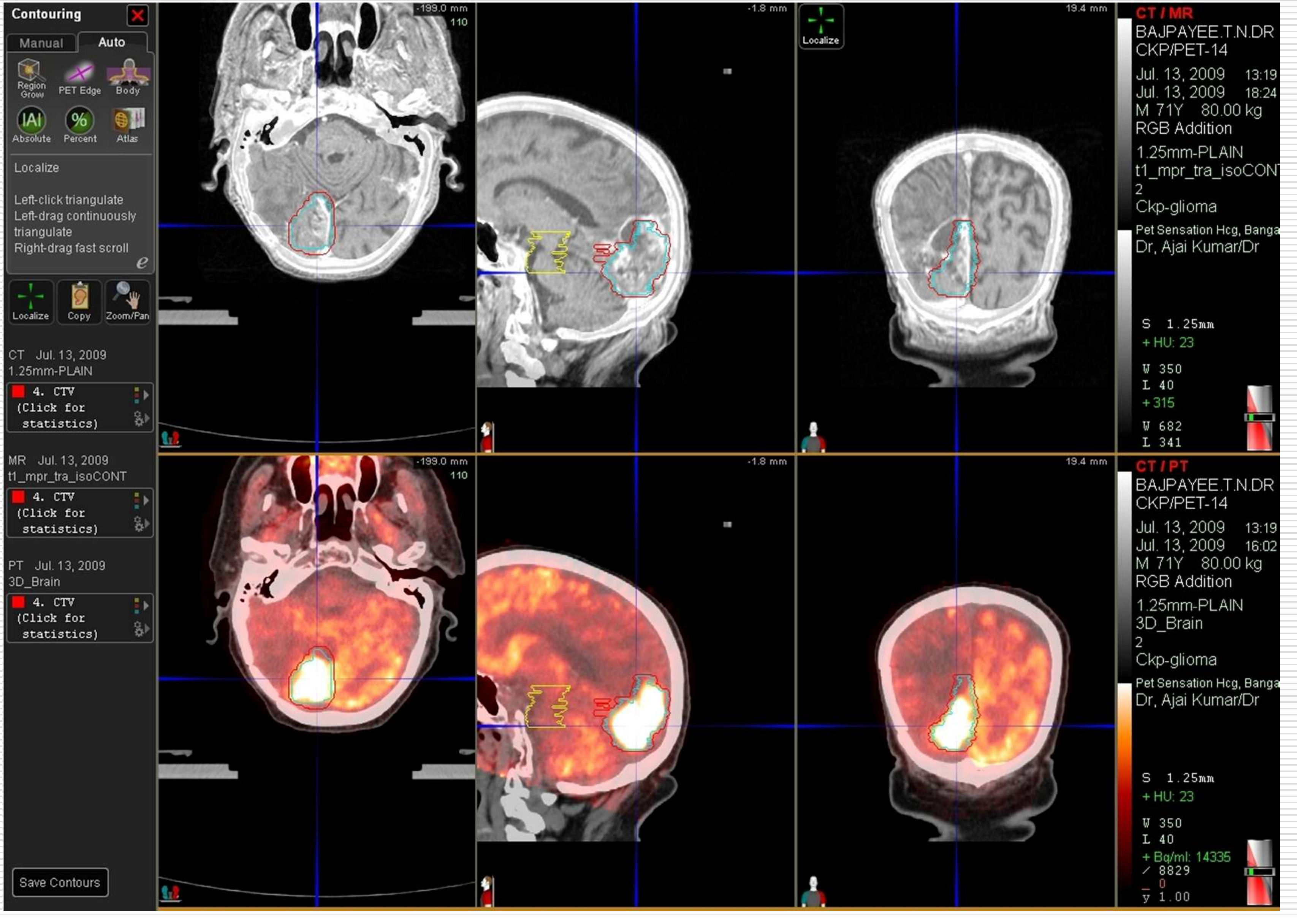


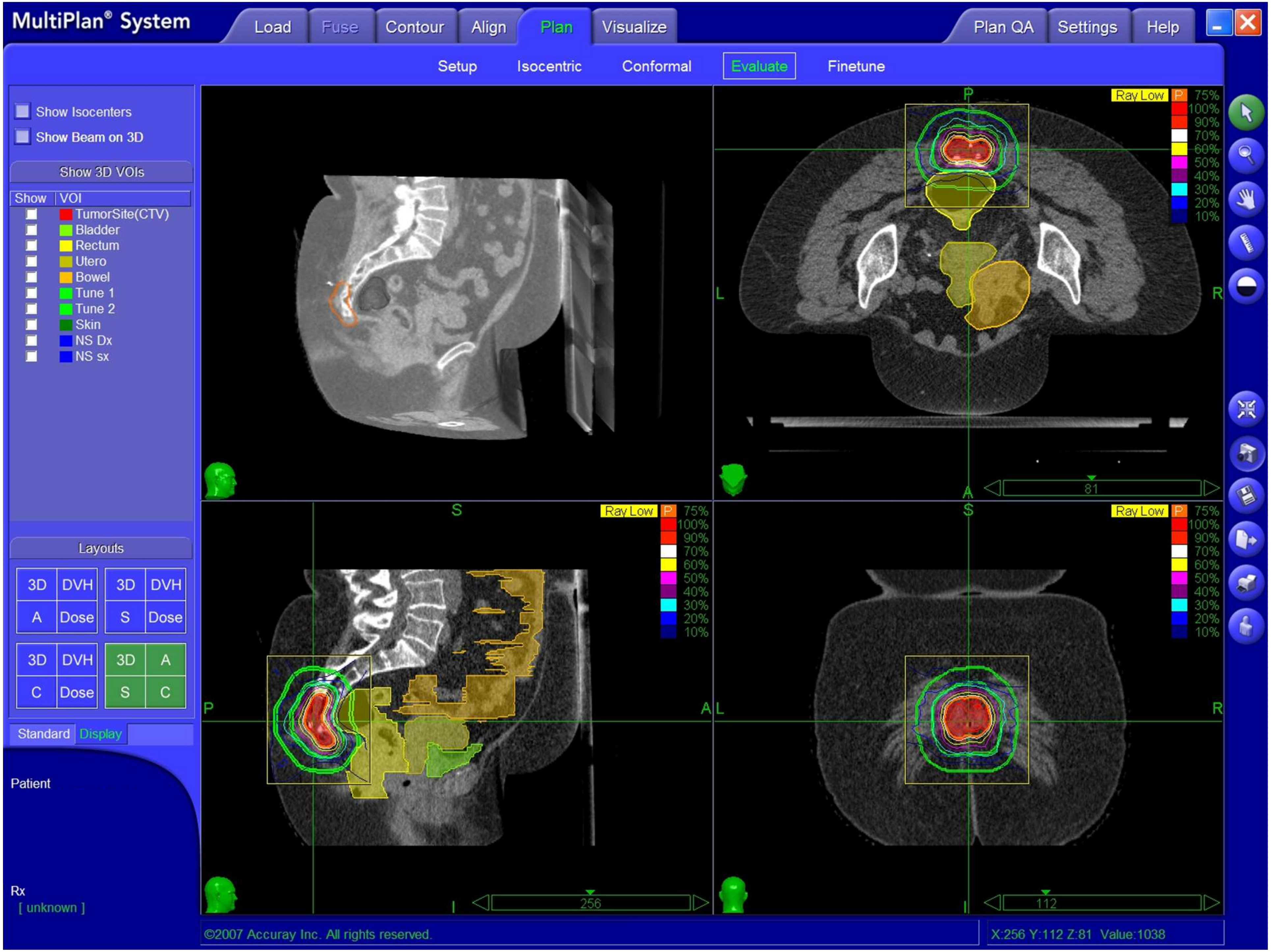
MOD MANTLE FIELD


CYBERKNIFE® ROBOTIC RADIOSURGERY SYSTEM
architecti


X-ray sources
Synchrony®
camera
Linear
accelerator
Manipulator
ROBOTIC DELIVERY
SYSTEM
Treatment
Couch
Image
detectors

72yrs/M/Recurrent GBM





MultiPlan® System
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Contour
Align
Plan
Visualize
Plan QA
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Help
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Isocentric
Conformal
Evaluate
Finetune
Show Isocenters
Show Beam on 3D
Show 3D VOIs
Show
VOI
TumorSite(CTV)
Bladder
Rectum
Utero
Bowel
Tune 1
Tune 2
Skin
NS Dx
NS sx
Layouts
3D
DVH
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Standard
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P
75%
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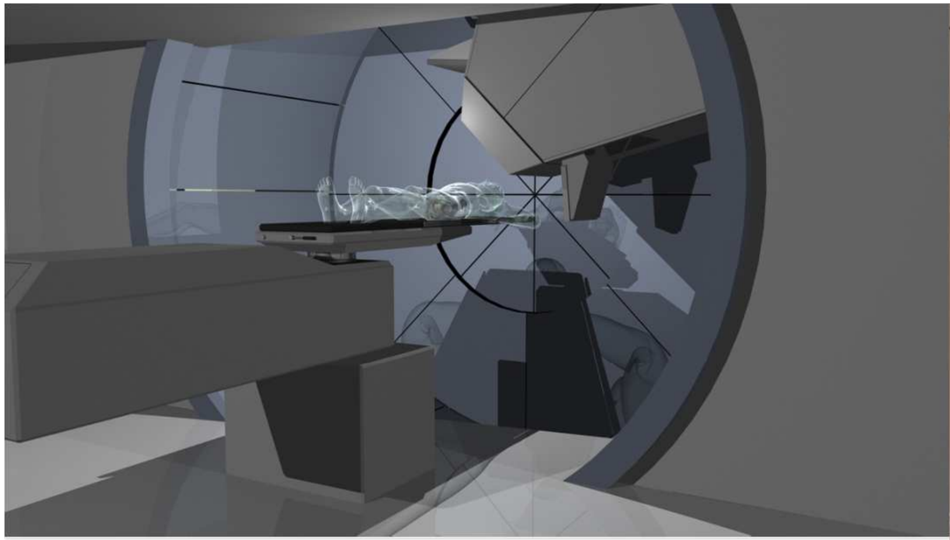
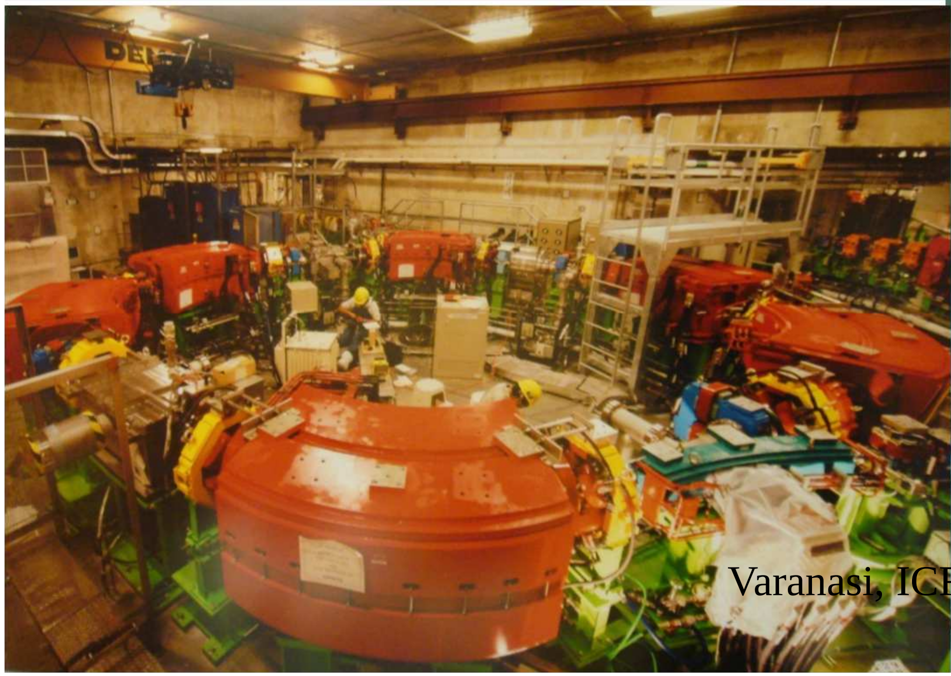
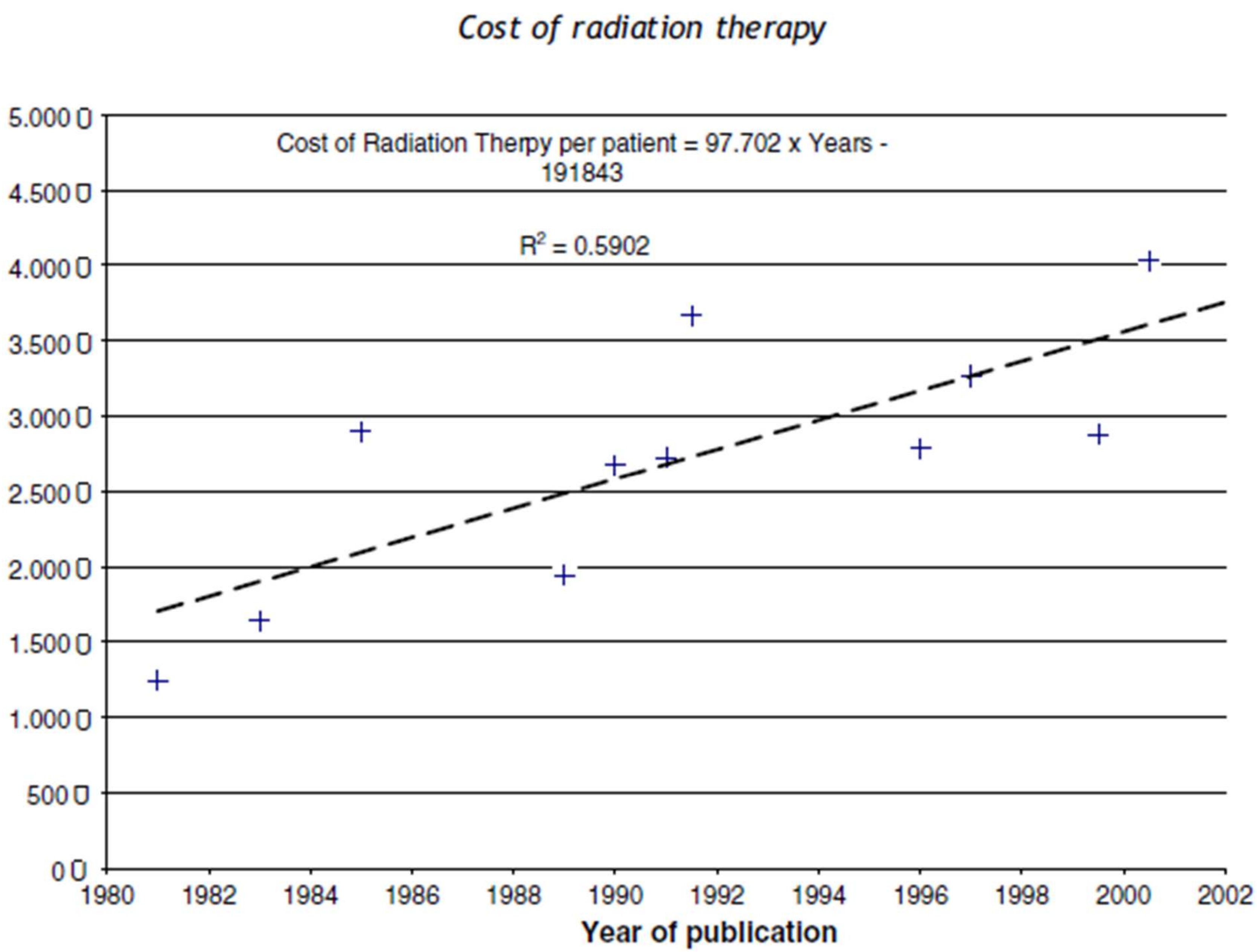


Proton Therapy





Ploquin et al, Radiotherapy and Oncology 2008

ELSEVIER

Radiotherapy and Oncology 52 (1999) 137–148

RADIOTHERAPY & ONCOLOGY
JOURNAL OF THE EUROPEAN SOCIETY FOR THERAPEUTIC RADIOLOGY AND ONCOLOGY

www.elsevier.nl/locate/radonline

Continuous, hyperfractionated, accelerated radiotherapy (CHART) versus conventional radiotherapy in non-small cell lung cancer: mature data from the randomised multicentre trial

Michele Saunders[a,*], Stanley Dische[a], Ann Barrett[b], Angela Harvey[c], Gareth Griffiths[c], Mahesh Parmar (on behalf of the CHART Steering committee)[c,1]

[a]*Marie Curie Research Wing, Mount Vernon Hospital, Northwood, Middlesex, UK*
[b]*Beatson Oncology Centre, Western Infirmary, Glasgow, UK*
[c]*Medical Research Council Cancer Trials Offic*

Received 6 October 1998; received in revised form 24 Ma

❖WHO performance status of 0 or 1 Pathologically proven, inoperable NSCLC,

❖First Phase: Tumour, mediastinum ,ipsilateral hilar, paratracheal nodes with a 1 cm margin.

❖Second phase, primary tumour and known nodal involvement with a 1 cm margin

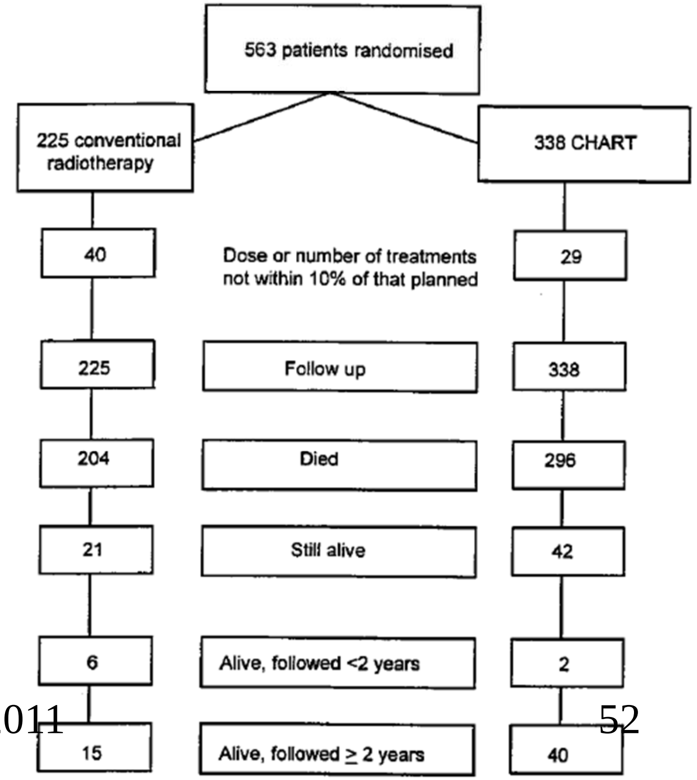


CHART Results (Absolute %)

Endpoints	2-Year				3-Year					
	Conventional (%)	CHART	Difference	95% C.I.	Conventional	CHART	Difference	95% C.I.	Hazard ratio	95% C.I.
All patients										
Survival	21	30	9	2, 16	13	20	7	2, 13	0.78	0.65–0.94
Local tumour control	16	23	7	1, 15	12	17	5	1, 14	0.86	0.70–1.06
Disease-free interval	13	18	5	− 2, 11	9	12	3	− 1, 10	0.79	0.63–0.98
Metastasis-free interval	44	48	4	− 5, 13	33	40	7	− 4, 14	0.89	0.69–1.14
Squamous only										
Survival	20	33	13	5, 20	11	21	10	4, 17	0.70	0.57–0.86
Local tumour control	14	24	10	2, 19	7	13	6	1, 13	0.76	0.60–0.97
Disease-free interval	12	19	7	1, 16	9	17	8	2, 16	0.73	0.57–0.93
Metastasis-free interval	42	52	10	1, 20	31	43	11	1, 21	0.75	0.56–0.99
Non-squamous only										
Survival	27	21	− 6	− 18, 8	21	15	− 6	− 15, 8	1.22	0.80–1.85
Local tumour control	25	22	− 3	− 17, 14	19	11	− 8	− 16, 6	1.12	0.67–1.87
Disease-free interval	23	14	− 9	− 19, 6	21	17	− 4	− 15, 14	1.36	0.84–2.18
Metastasis-free interval	57	40	− 17	− 36, 2	42	24	− 18	− 32, 2	1.62	0.95–2.75

Saunders et al Radiotherapy and Oncology 1999

Quality research for optimal resource utilisation

Five versus six fractions of radiotherapy per week for squamous-cell carcinoma of the head and neck (IAEA-ACC study): a randomised, multicentre trial

Lancet Oncology 2010

Jens Overgaard, Bidhu Kaylan Mohanti, Naseem Begum, Rubina Ali, Jai Prakash Agarwal, Maire Kuddu, Suman Bhasker, Hideo Tatsuzaki, Cai Grau

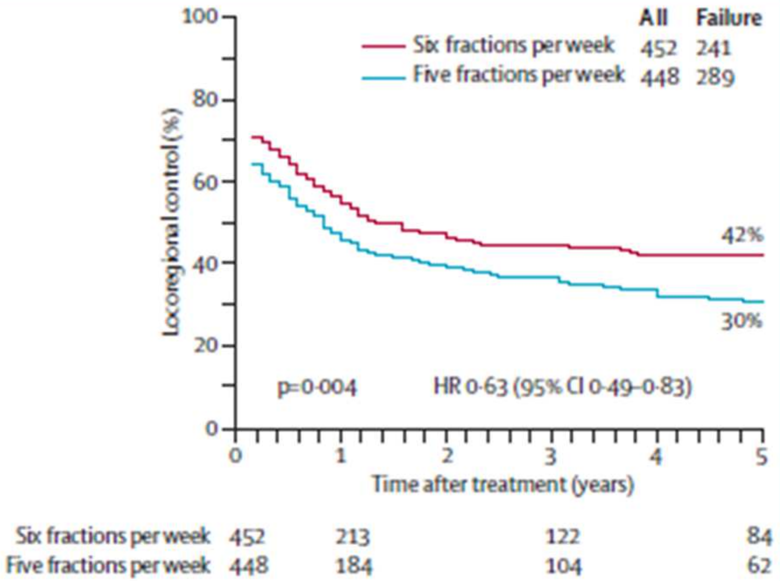
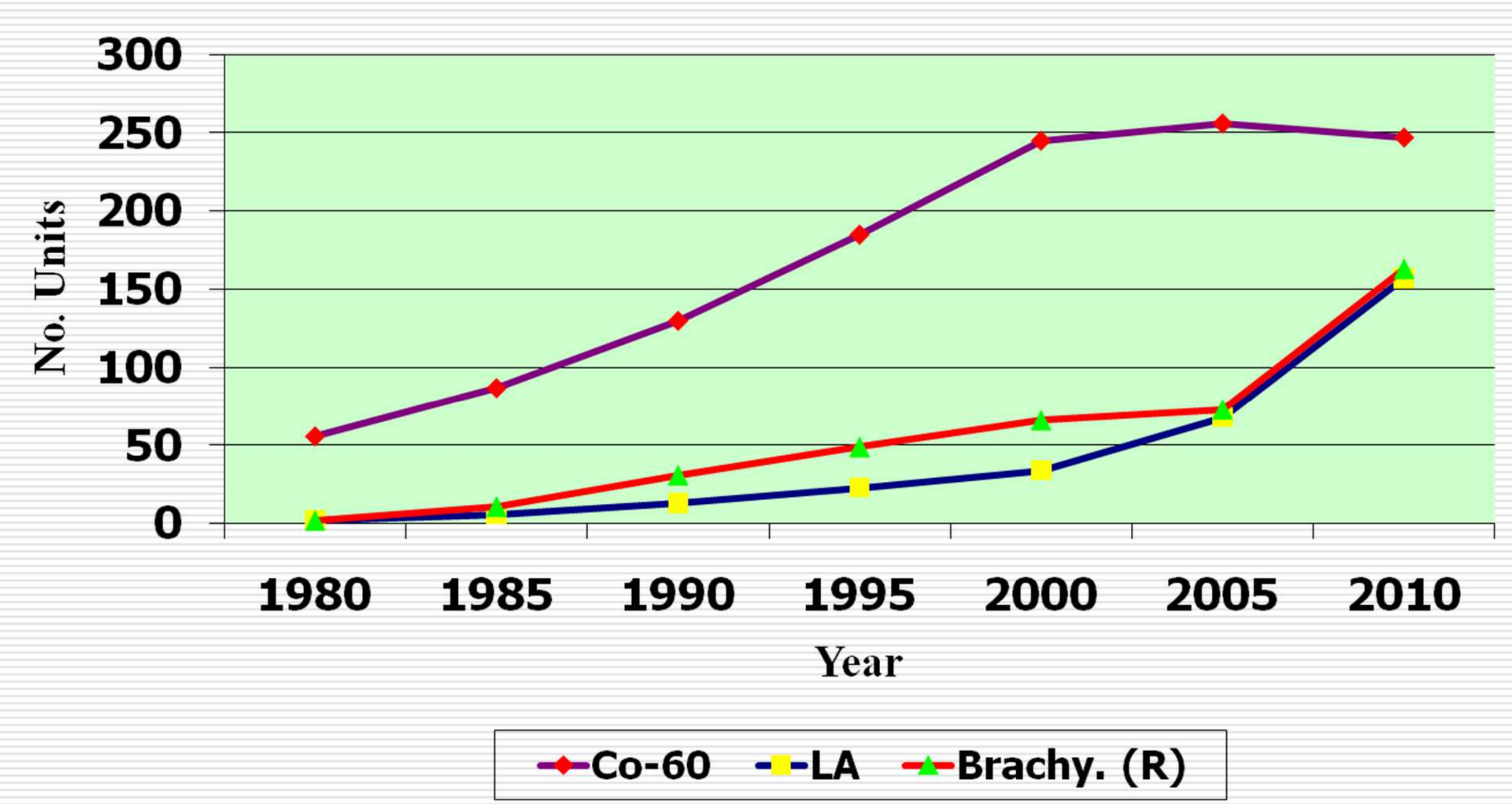


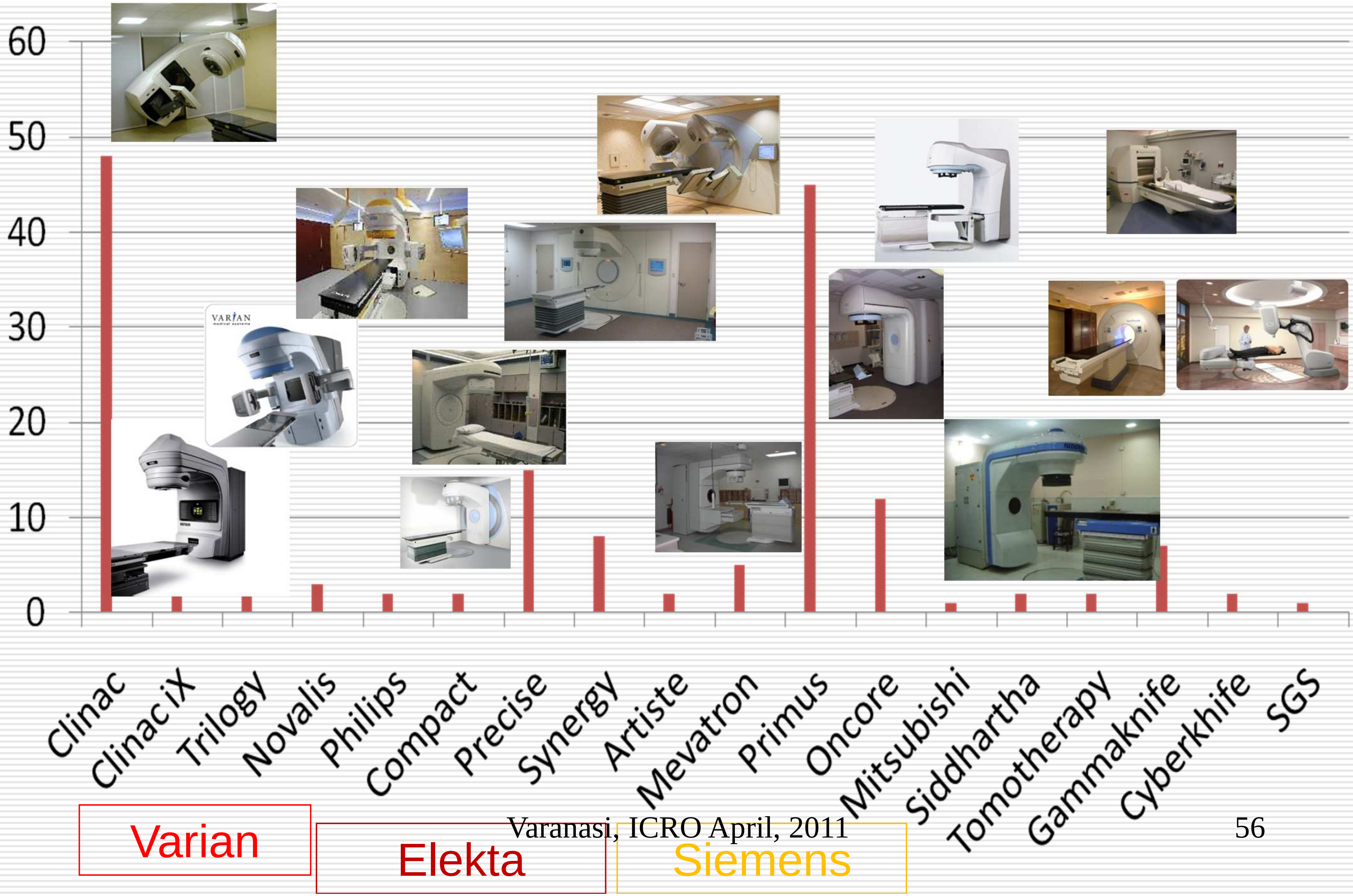
Figure 2: Locoregional tumour control

	Five fractions per week (N=448)	Six fractions per week (N=452)
Recruiting centre		
New Delhi	126 (28%)	128 (28%)
Peshawar	104 (23%)	105 (23%)
Islamabad	70 (16%)	69 (15%)
Mumbai	64 (14%)	63 (14%)
Tallinn	53 (12%)	53 (12%)
Santiago	14 (3%)	12 (3%)
Riyadh	9 (2%)	10 (2%)
Cape Town	6 (1%)	10 (2%)
Beirut	2 (1%)	2 (1%)

Radiation Therapy Units: Expansion



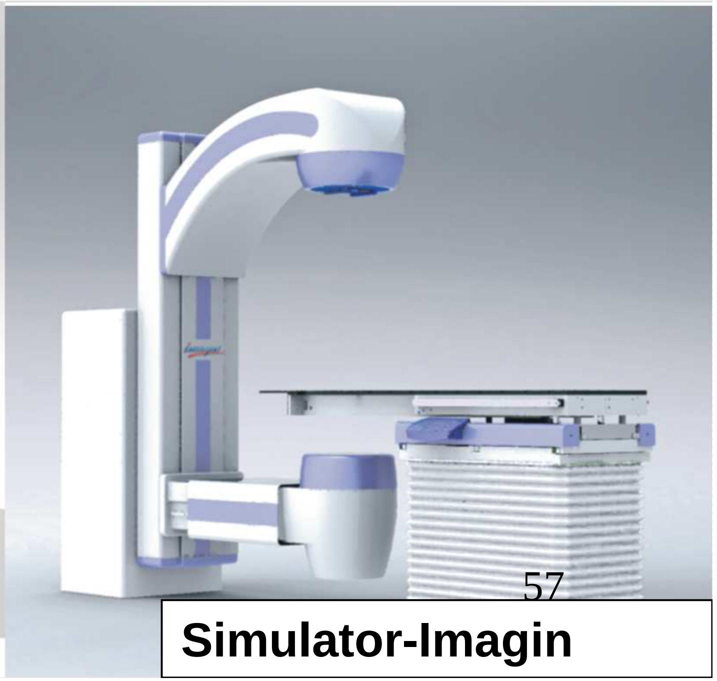
Accelerators in India 164: December 2010



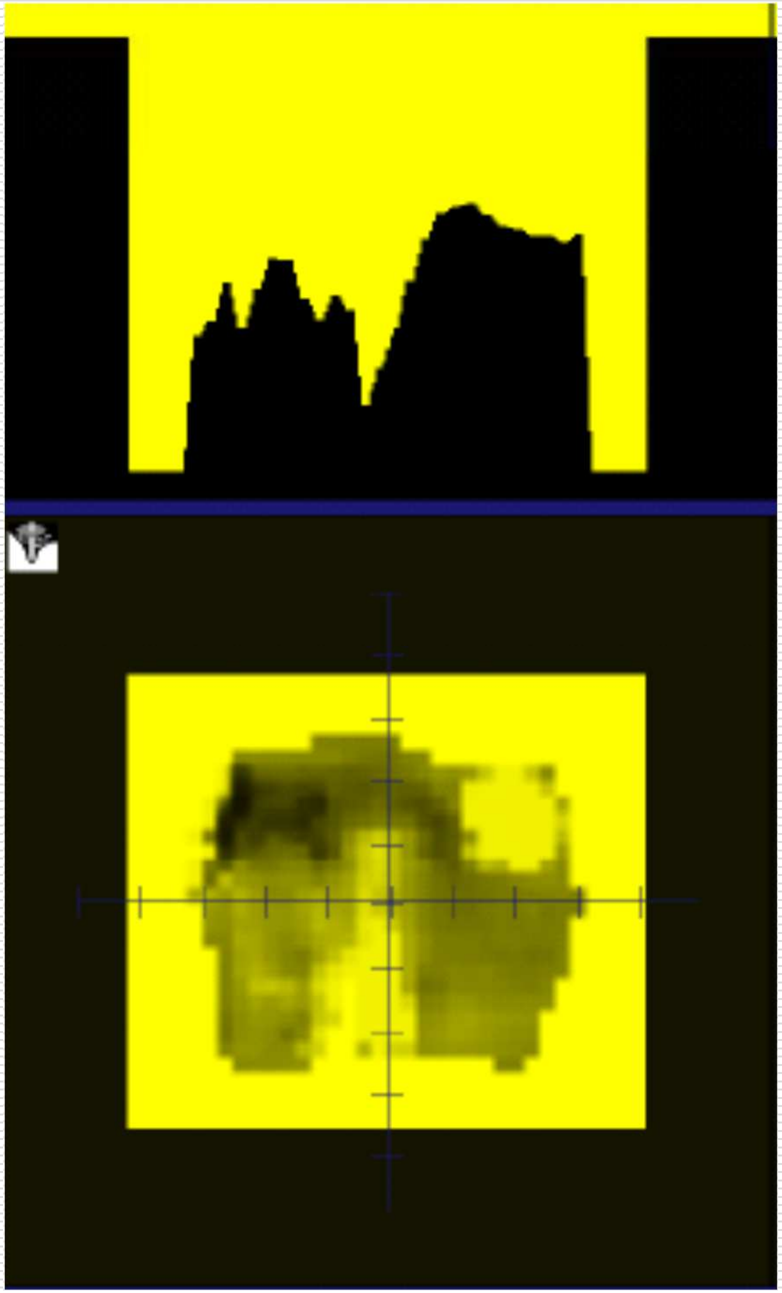
Bhabhatron II

Siddhartha

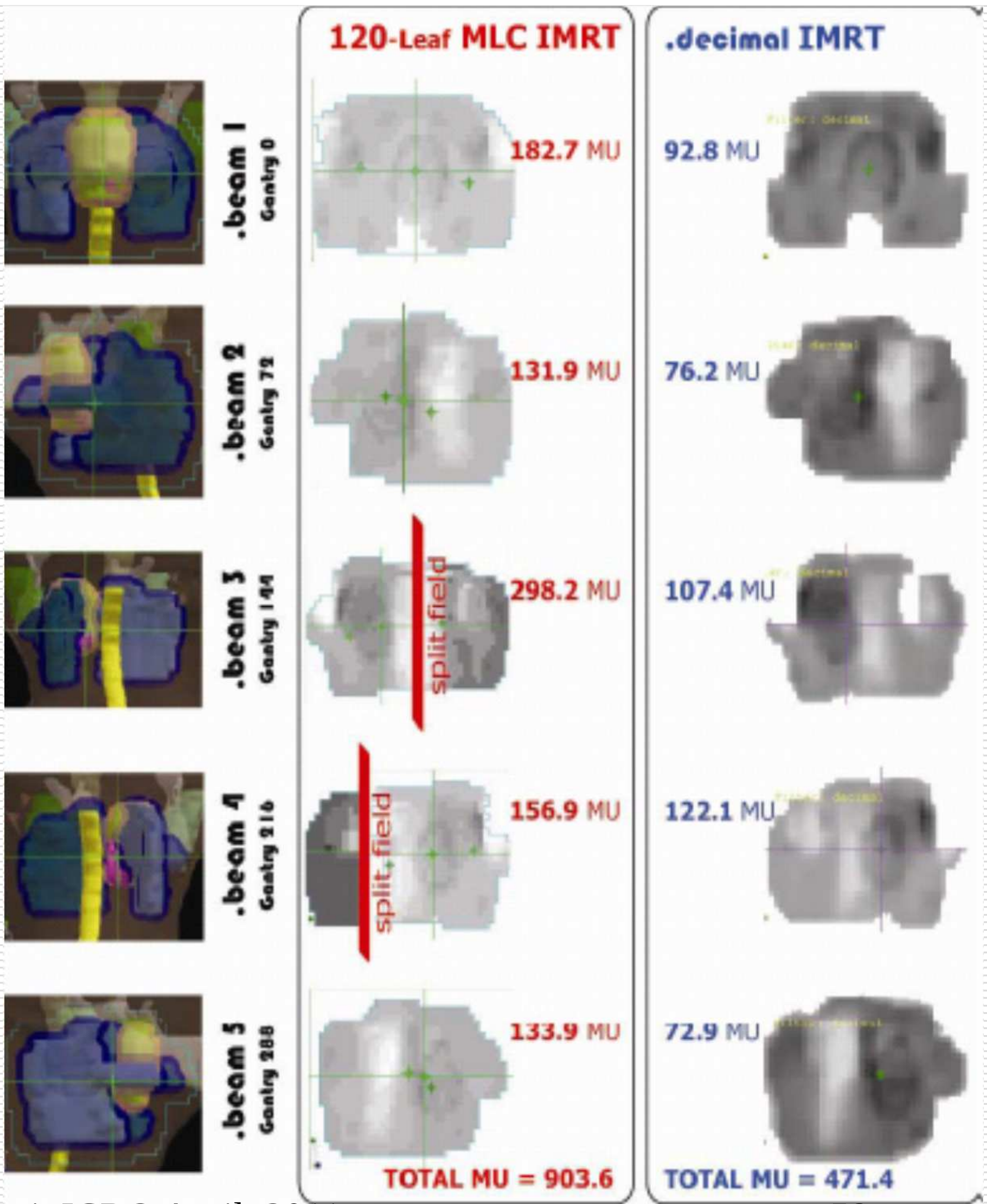
HDR Brachy



Simulator-Imagin

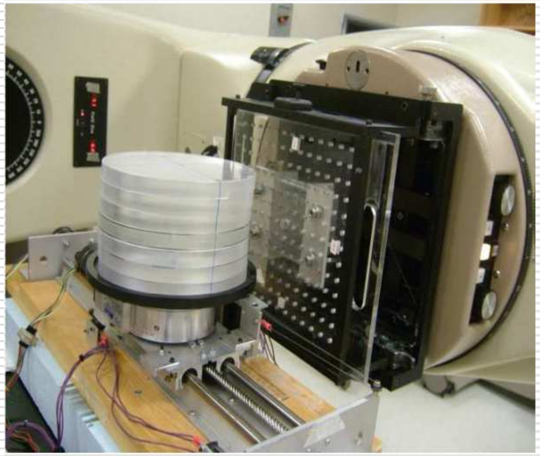


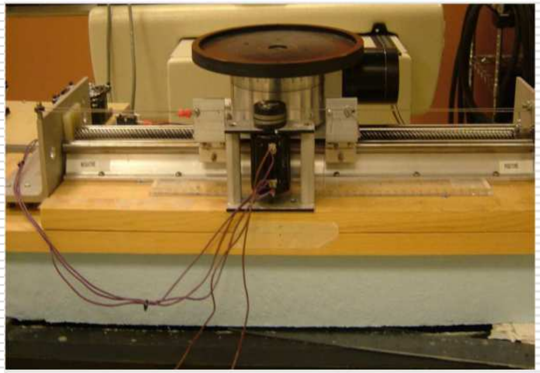
Fluence transfer for milling

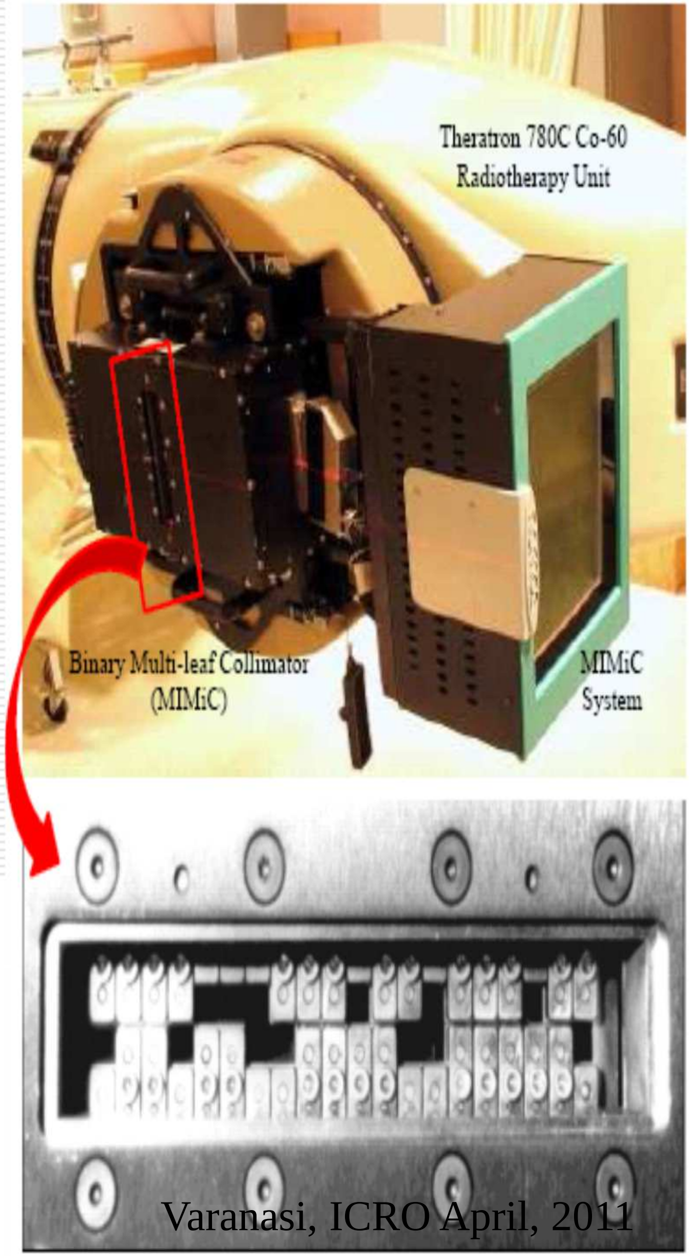


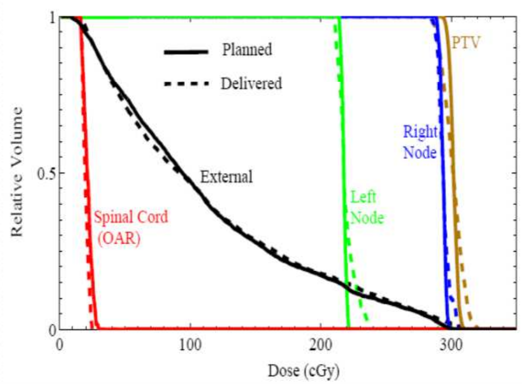
Lesser MUs with compensator based IMRT

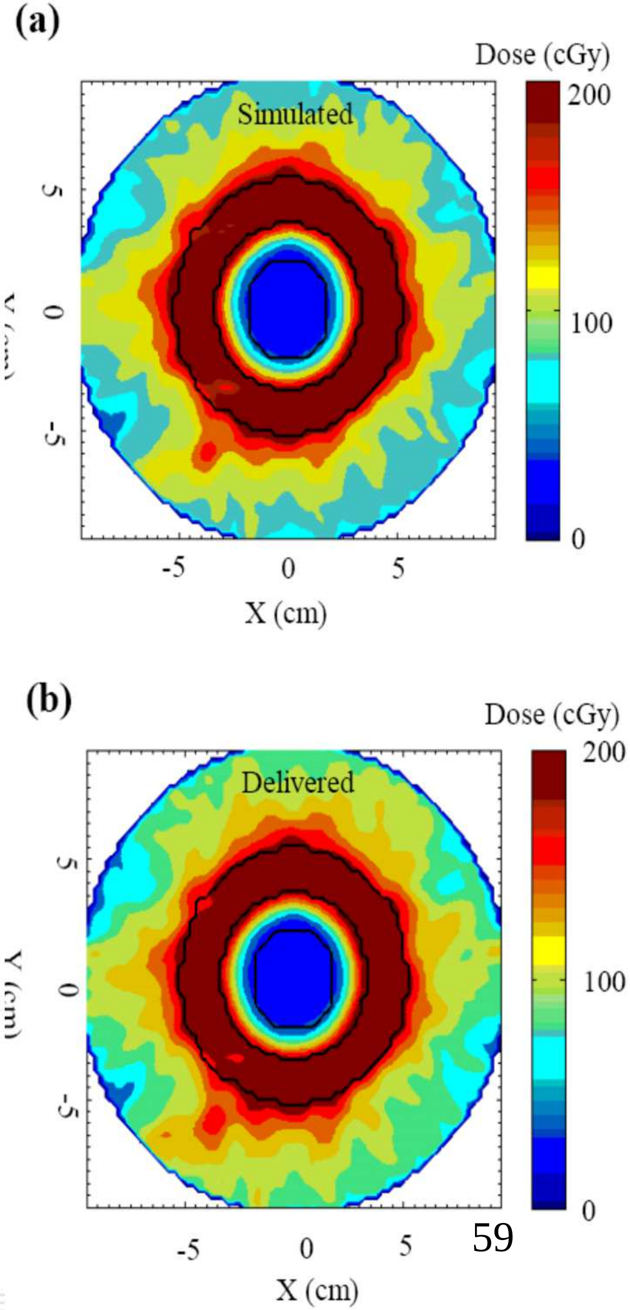
A commercial telecobalt adapted for prototype Co-60 tomotherapy







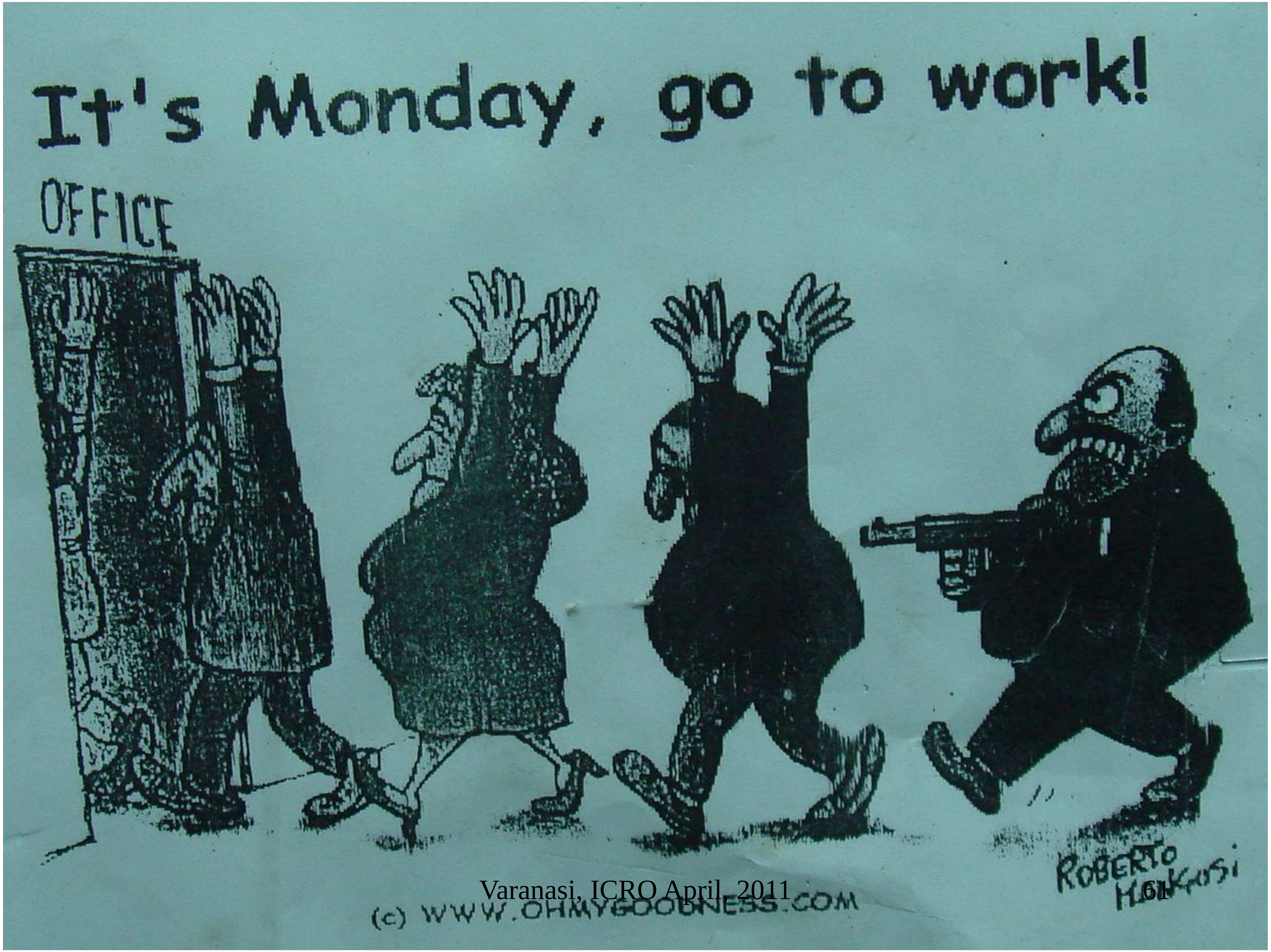


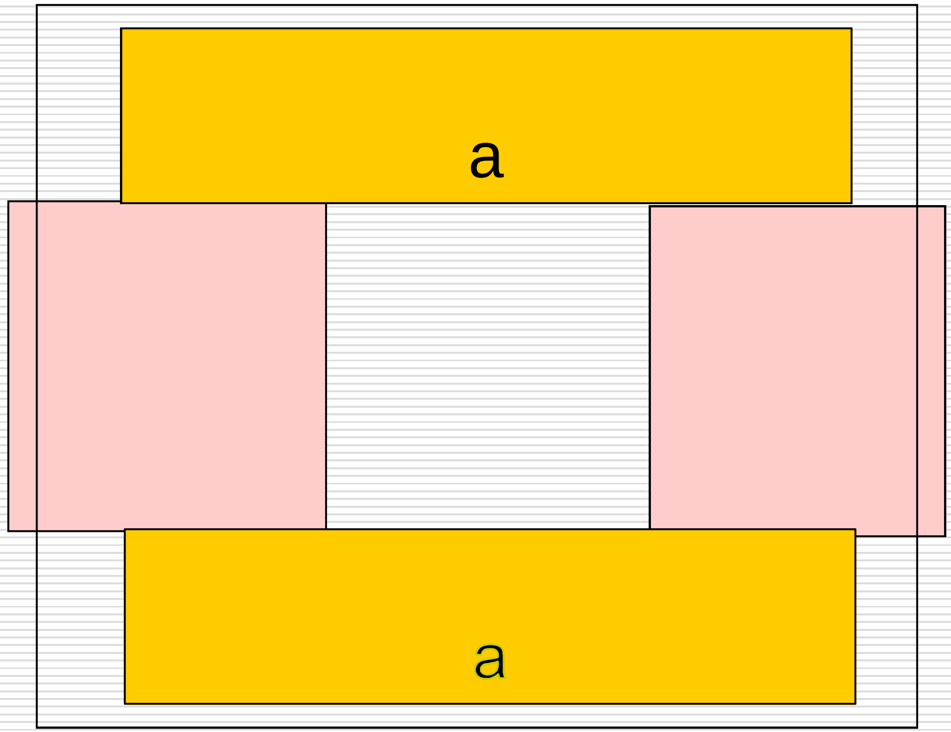


Impact

- Dosimetric precision - <2%
- Precision in target volume definition: Obstacle
- Functional Imaging:
  - Clinical Target volume – Real Target volume
- Cost benefit
  - Hypo-fractionation (Breast, Prostate…)
- Evidence Based Radiotherapy

……Long way to go……


It's Monday, go to work!
OFFICE
ROBERTO
(c) WWW.OHMYGOODNESS.COM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