

Image Guidance In Radiation Therapy



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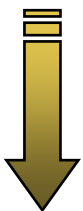
Few changes in last 10- 15 yrs – “New Toys”

- Visualization



- 15yrs ... X-rays
- Now ... CT-scanning and MRI

- Treatment Planning



- 10yrs ... Standard field shapes and arrangements
- Now ... Individualized field shapes and arrangements
... Intensity Modulated Radio-Therapy (IMRT)

- Treatment Delivery



- 10yrs ... Treatment x-ray films
- Now ... Enhanced electronic images



Planning of Radiation Therapy

- Image guidance during prostate radiotherapy has changed in 2 major areas:
 - Before treatment
 - X-Ray simulator to CT simulator
 - During treatment
 - Portal films to Cone beam CT



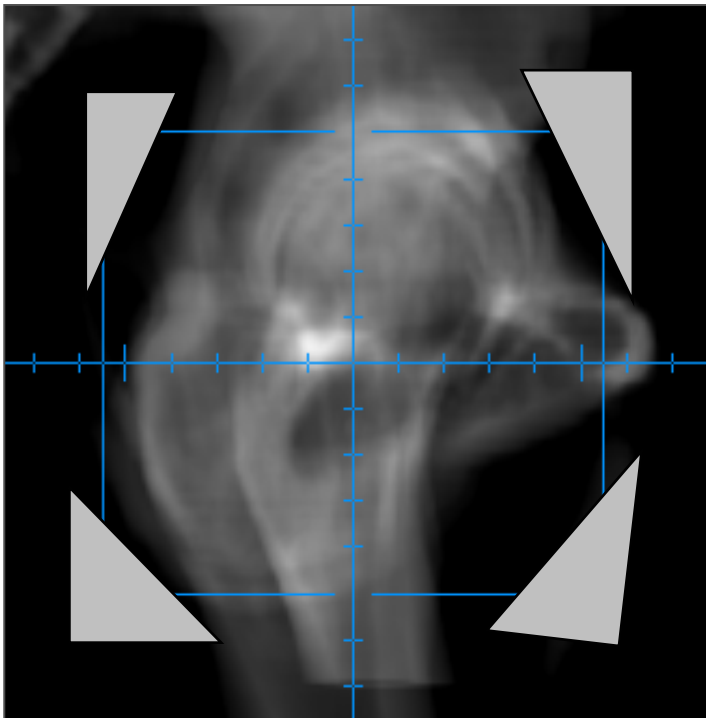
X-Ray Simulator



- Standard X-Ray unit
- Mounted like a treatment unit
- ‘Simulates’ where the treatment will go



X-Ray Simulator

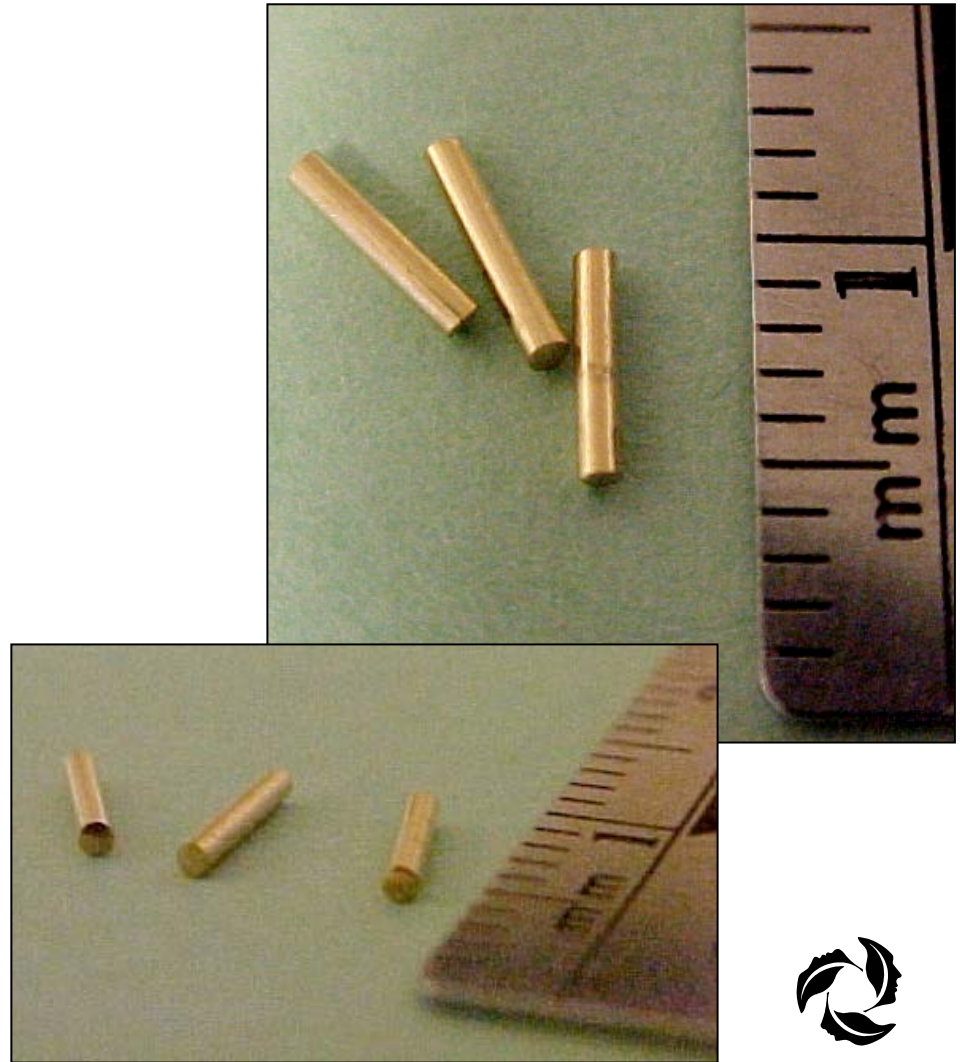


- Takes ordinary X-Ray films
- Oncologist marks on shielding based on standard anatomy



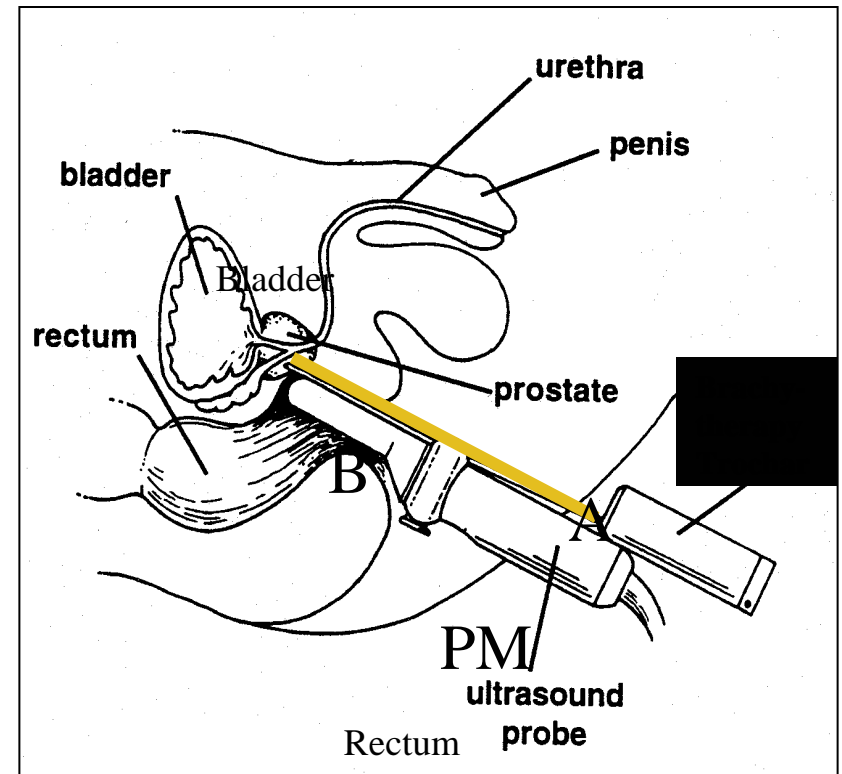
What Are They?

- ‘Gold Seeds’
 - Manufactured by jeweller
 - 18 Ky Gold
 - 1 mm in Diameter
 - 5mm in Length
- Steam sterilised prior to insertion



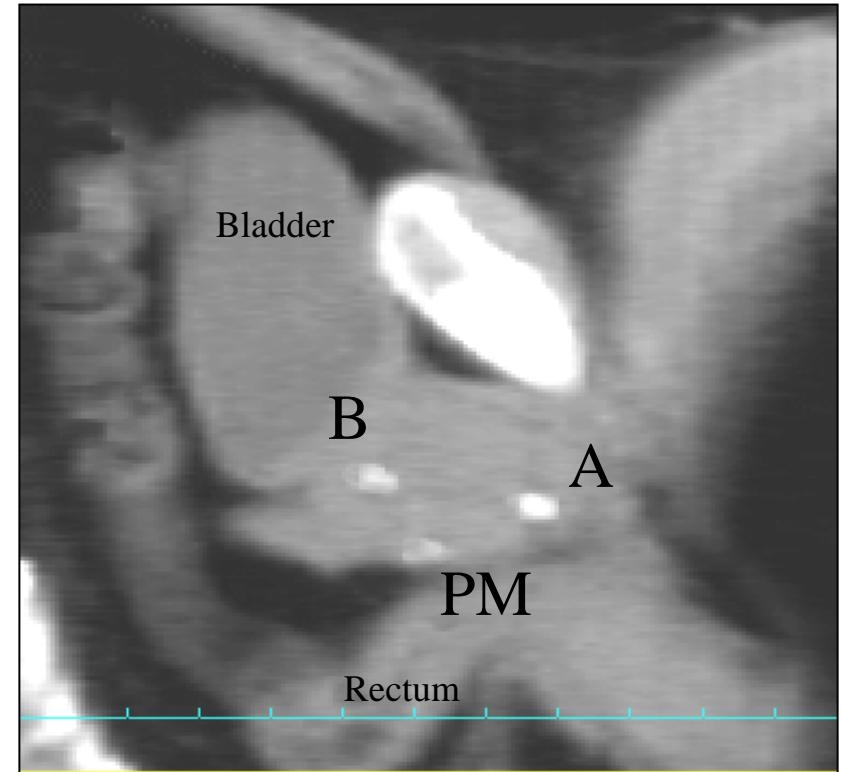
Where Are They?

- TRUS guided
- 3 markers per patient
- Inserted into prostate
 - Base
 - Posterior Midline
 - Apex



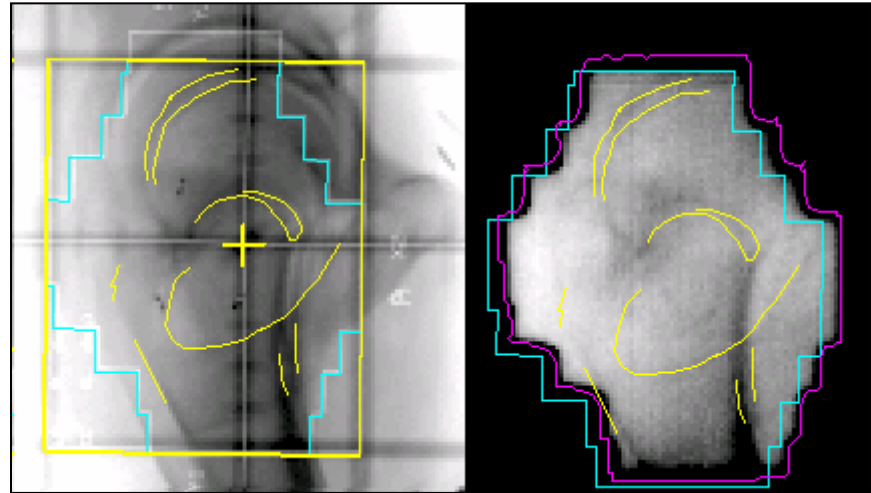
Where Are They?

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Background

- Planning for dose escalation
 - Reduce margins to smallest possible
 - But ensure coverage of the prostate 99% of the time



Using

- Rigid pelvic immobilisation
- Online pre-treatment isocentre correction
- Offline systematic prostate motion correction



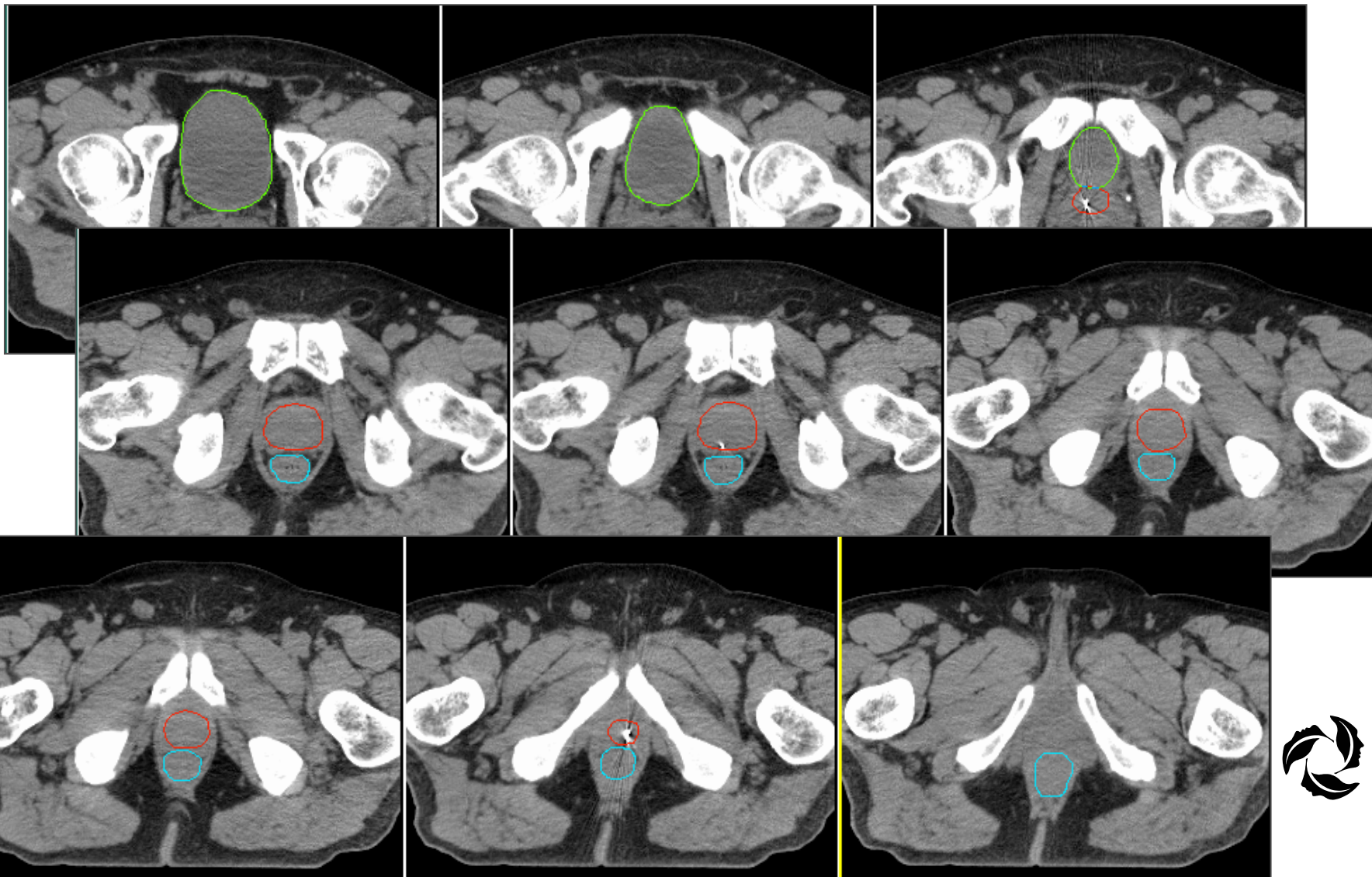
CT simulators



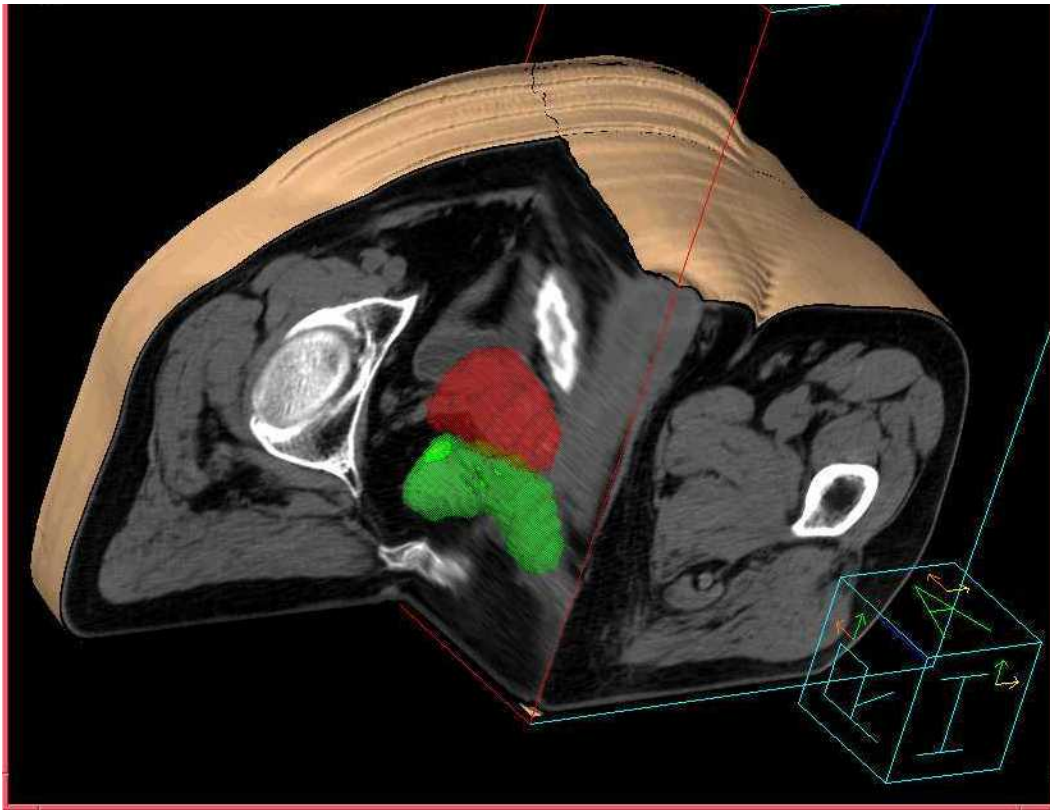
- Specially made for radiotherapy planning
- Can see internally, not just bones
- Produces hundreds of CT ‘slices’ to visualise the prostate within the pelvis



CT simulators



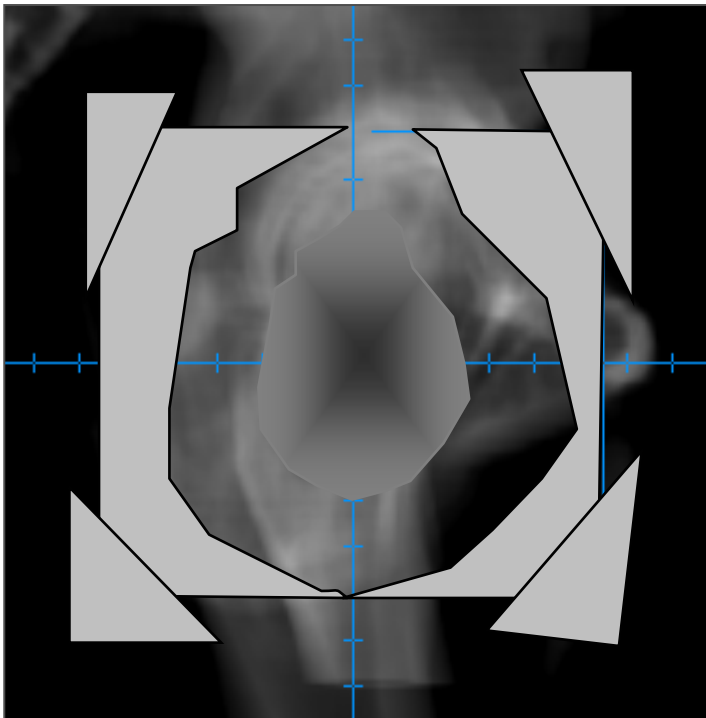
CT simulators



- Specially designed software adds the slices together to create target volumes
- Planners use software to visualize target and normal tissues in 3D
- Individually shaped beams



CT Simulator

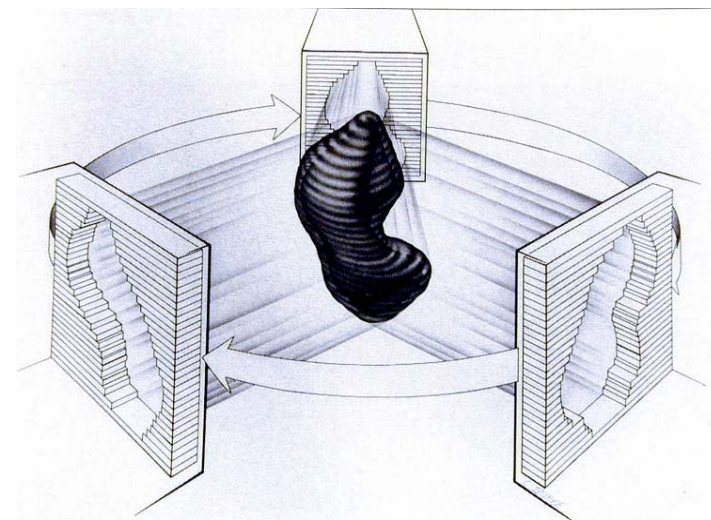
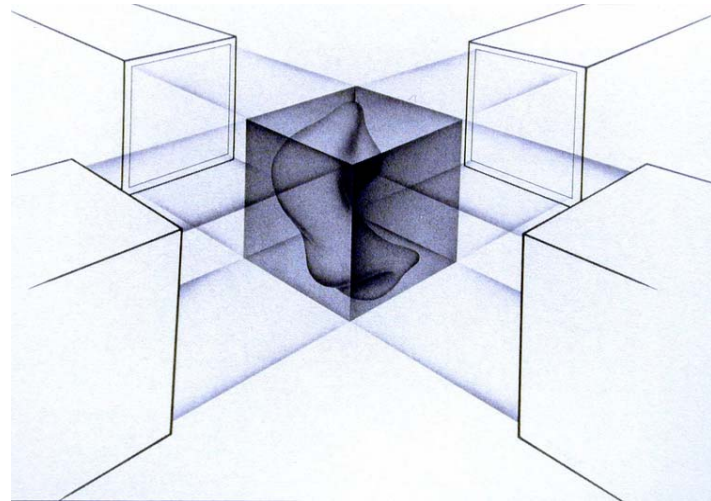


- Shielding now based on individual
 - Shape of patient
 - Shape of prostate



3-D Conformal Radiation Therapy

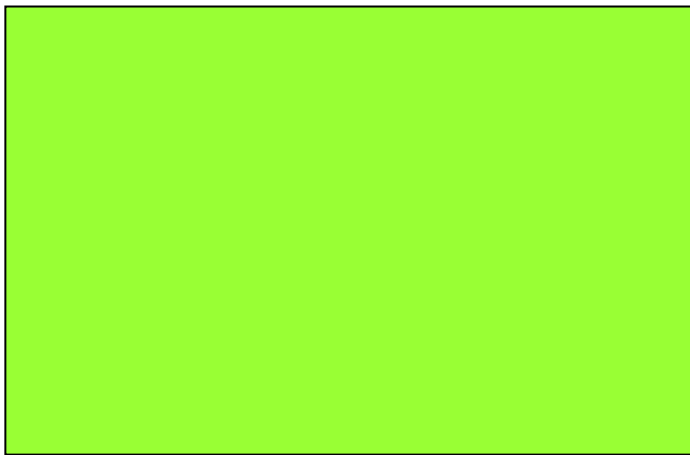
- Conventional techniques must irradiate adjacent normal tissues.
- Techniques which conform volume irradiated closely to the cancer can be achieved.



Intensity Modulated Radiation Therapy - IMRT

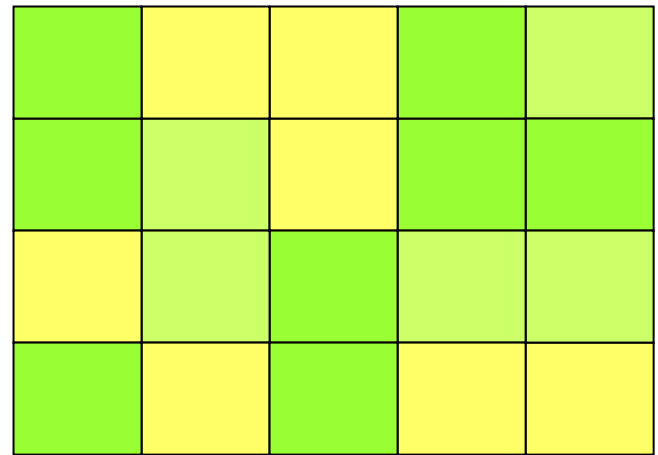
Conventional RT

Uniform dose intensity

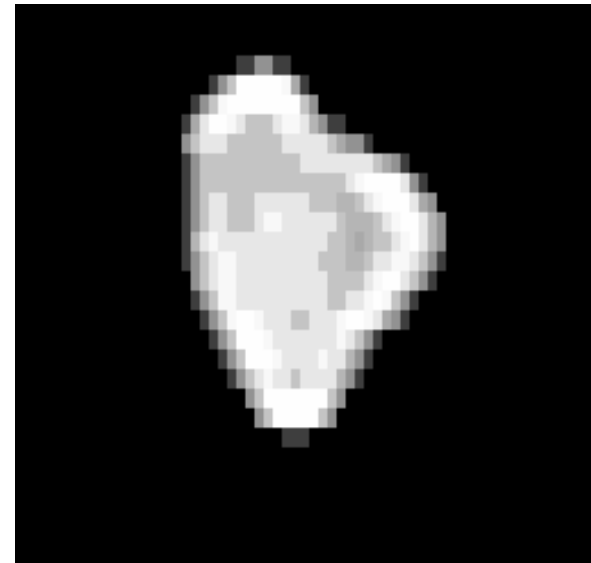
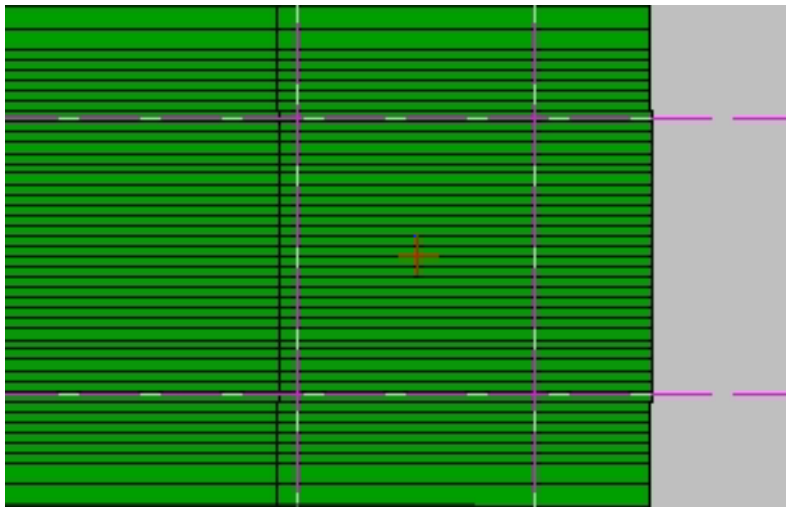


Intensity Modulated RT

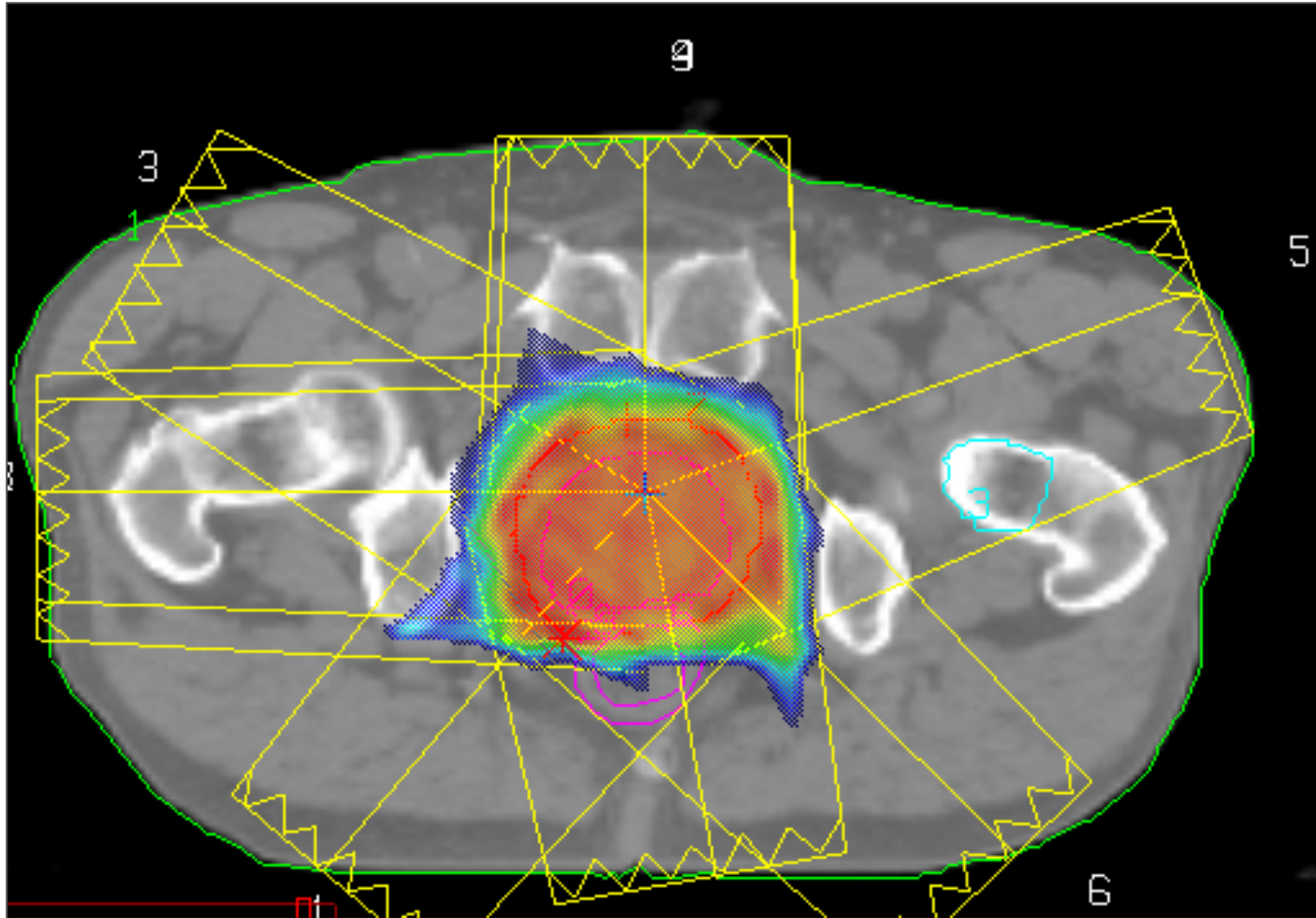
Intensity adjustable in each beamlet



INTENSITY MODULATED RADIATION THERAPY



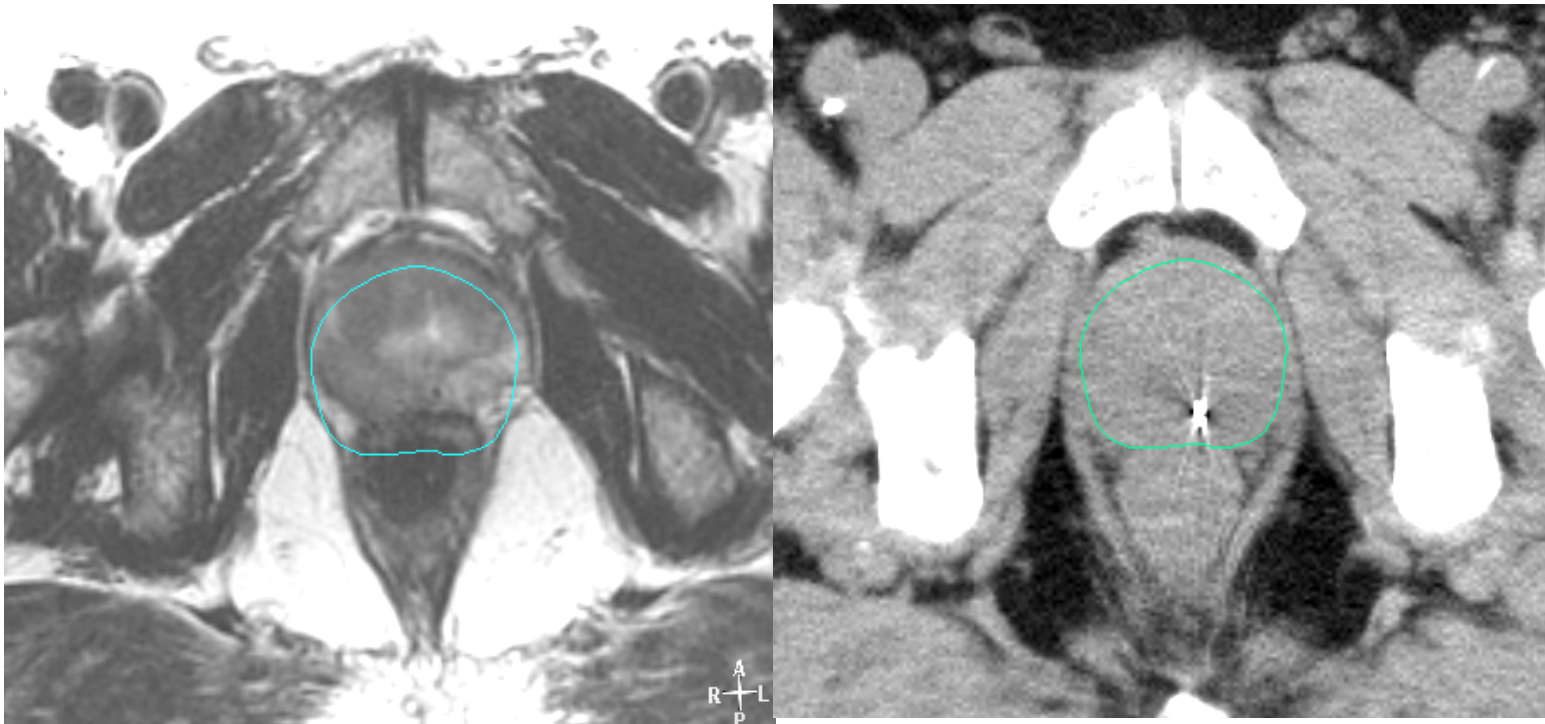
Beam arrangement



MRI SIMULATION

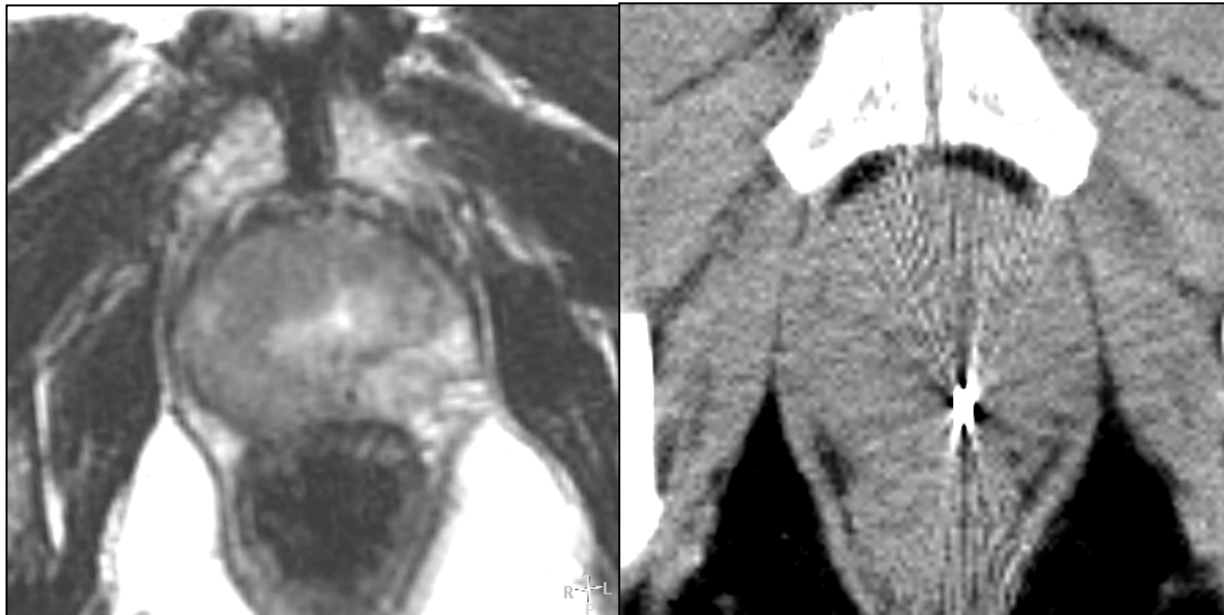
Prostate Carcinoma MRI- CT Co-Registration

C Parker et al Radiotherapy & Oncology.



How Are They Useful?

- **Later:**
 - Pt and equipment available for prostate oxygenation study
 - Location of Apex and Base for contouring
 - Volume info from US available for contouring
 - CT / MR co-registration for contouring



Results

- Helps radiation oncologist contour

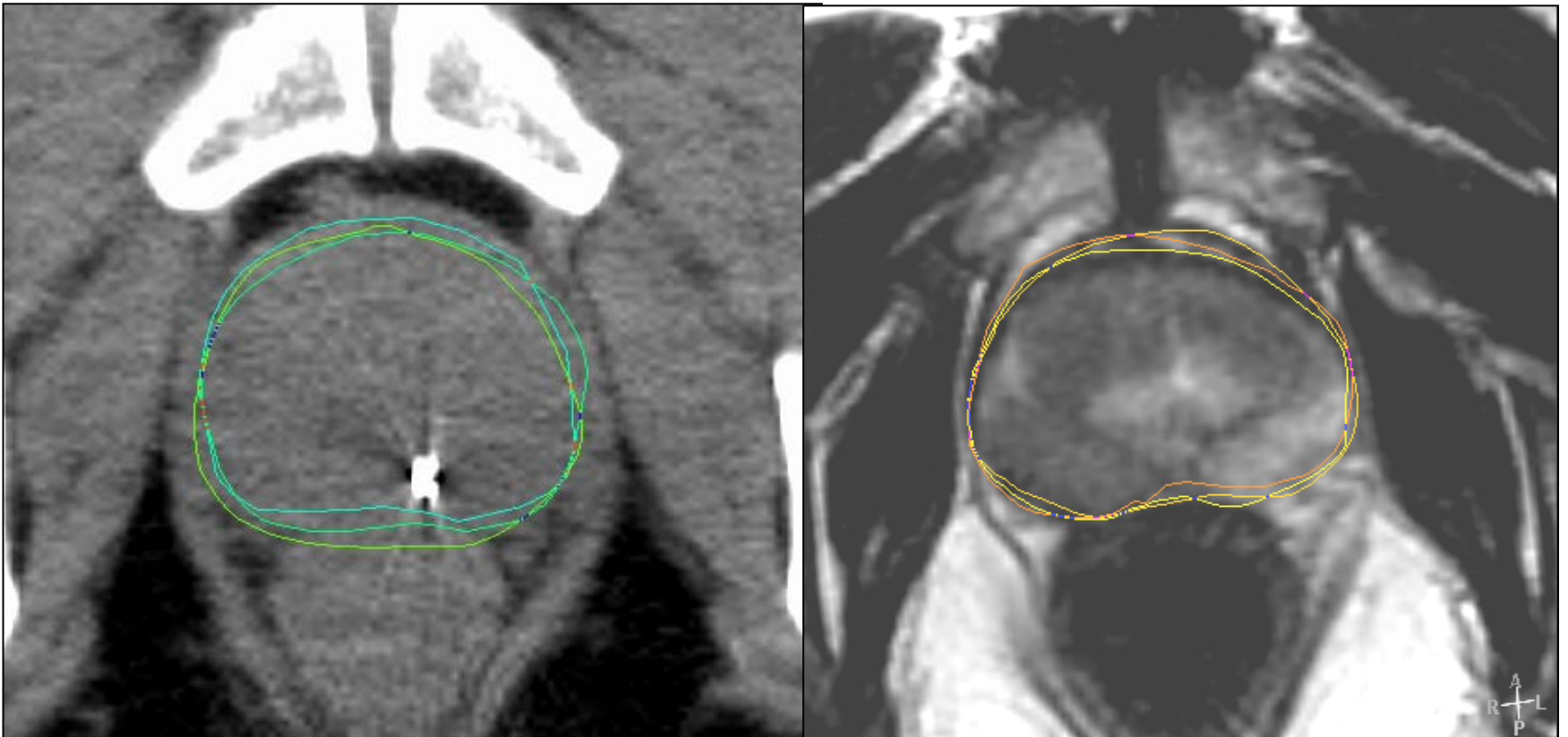


Image Guidance for Prostate

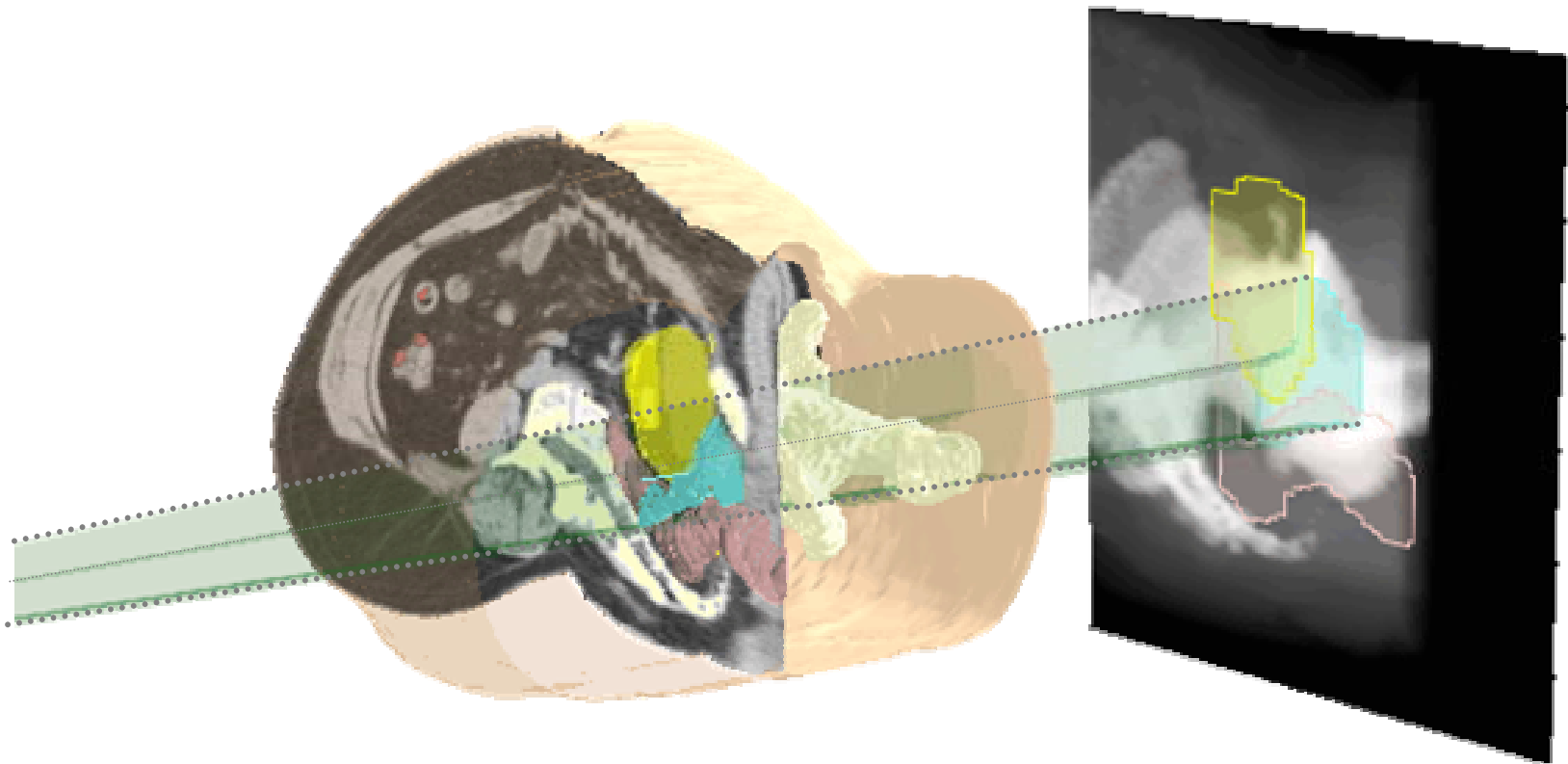
- Image guidance during prostate radiotherapy has changed in 2 major areas:
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Portal Images

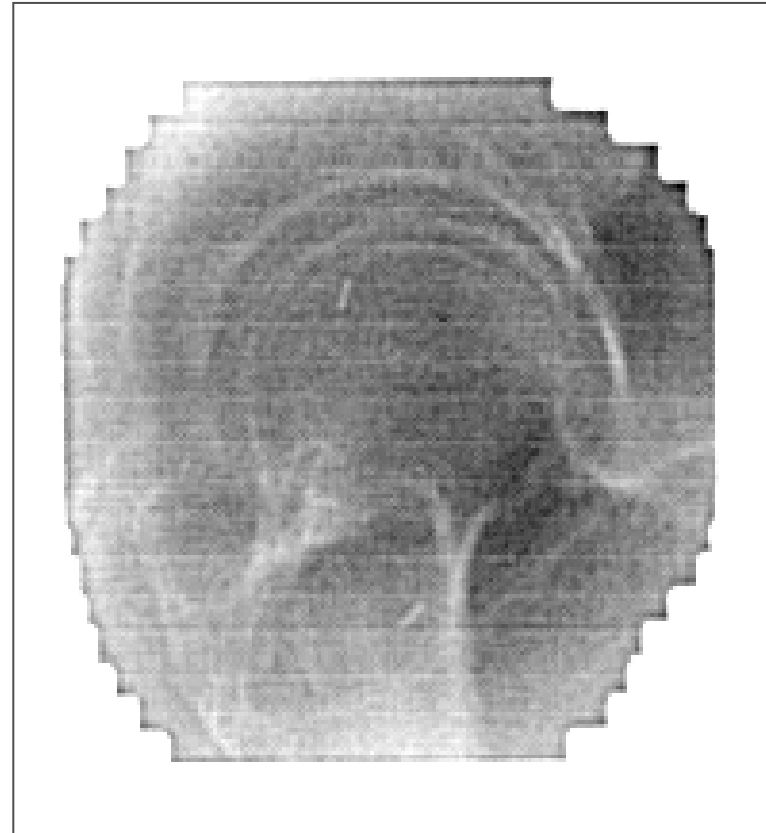


Portal Images

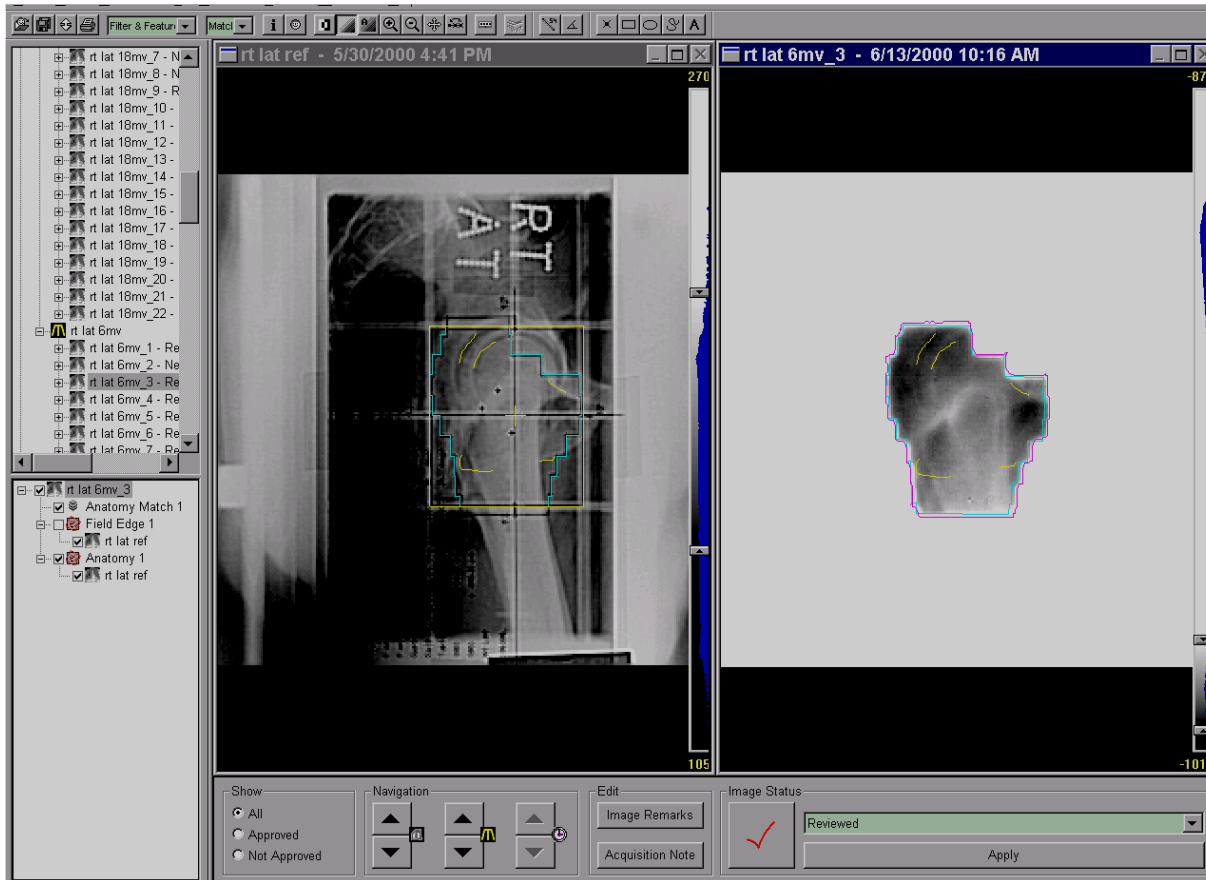


Portal Images

- Quick, accurate and efficient
- Good images of bones in pelvis
- But can't see internal tissues
 - Must implant gold markers to see where prostate is



Portal images and on line correction



- Daily On-Line Portal Image Comparison



Cone Beam CT

Treatment Machine



New Conebeam X-Ray Unit



Cone Beam CT



- Patient aligned in same way as usual
- Conebeam CT can be taken and then treatment given right after



Cone Beam CT

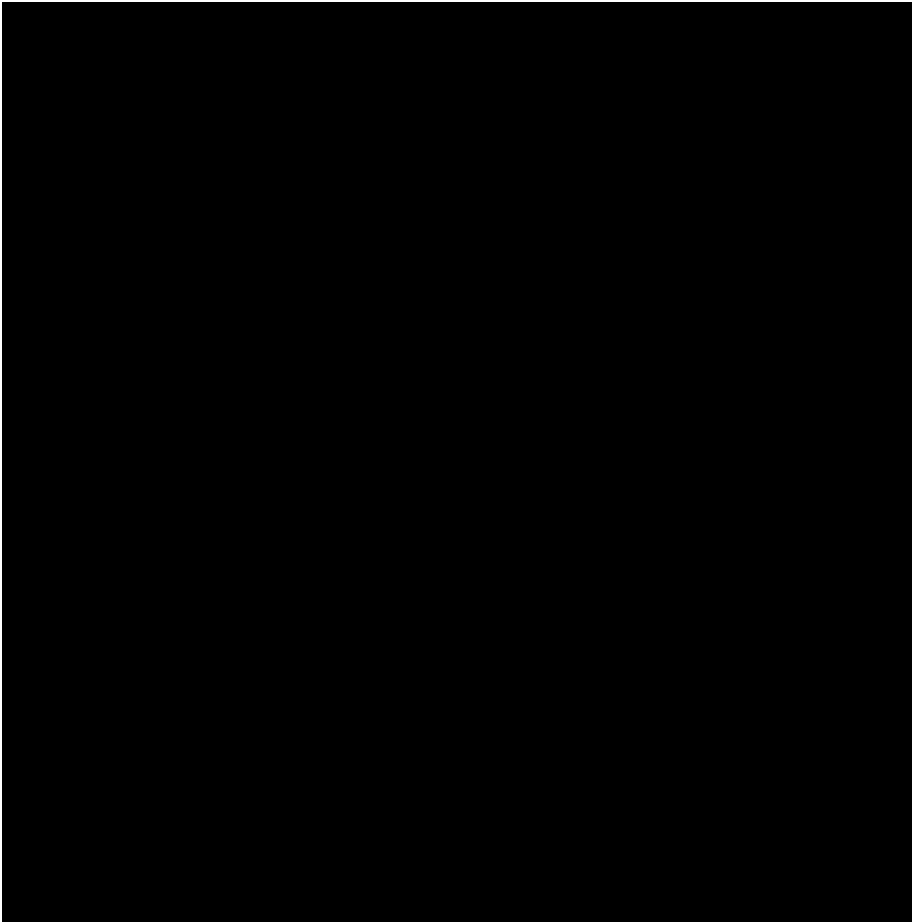


Cone beam machine rotates around

X-Ray images are taken
as it rotates



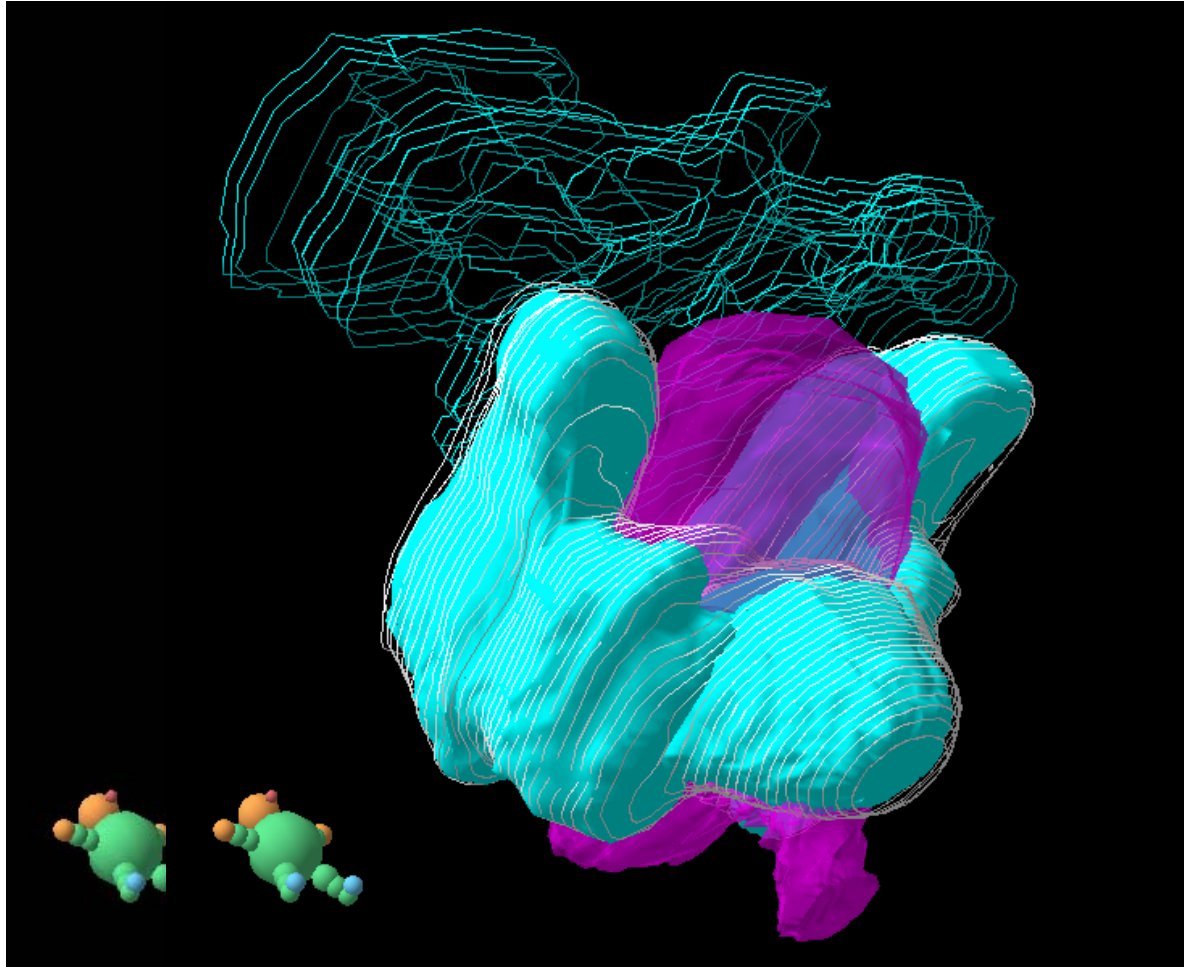
Cone Beam CT



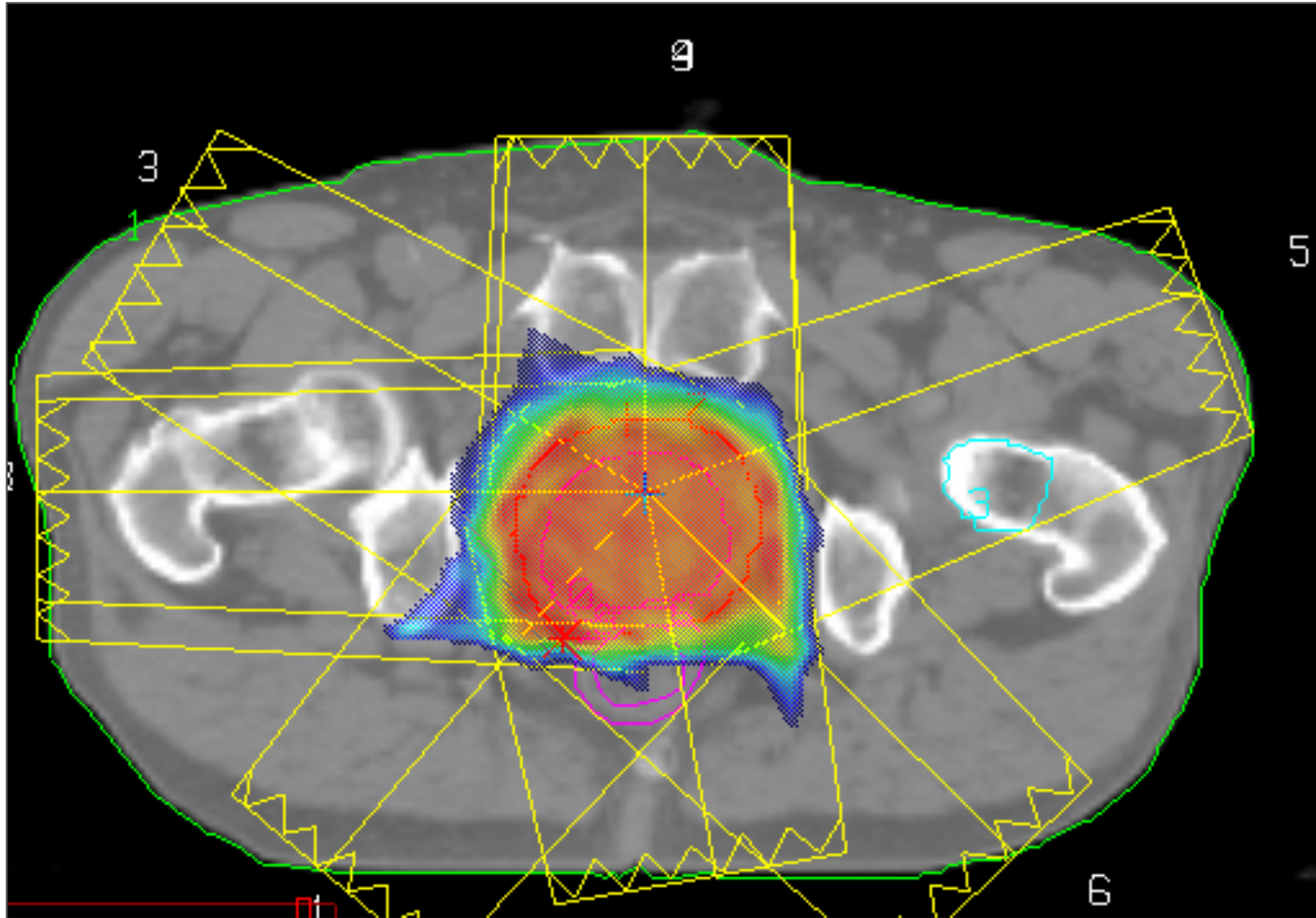
- Can visualize the position of the prostate without using markers
- Done at time of treatment
 - Can adjust treatment to incorporate new information
- Can also see other tissues such as rectum



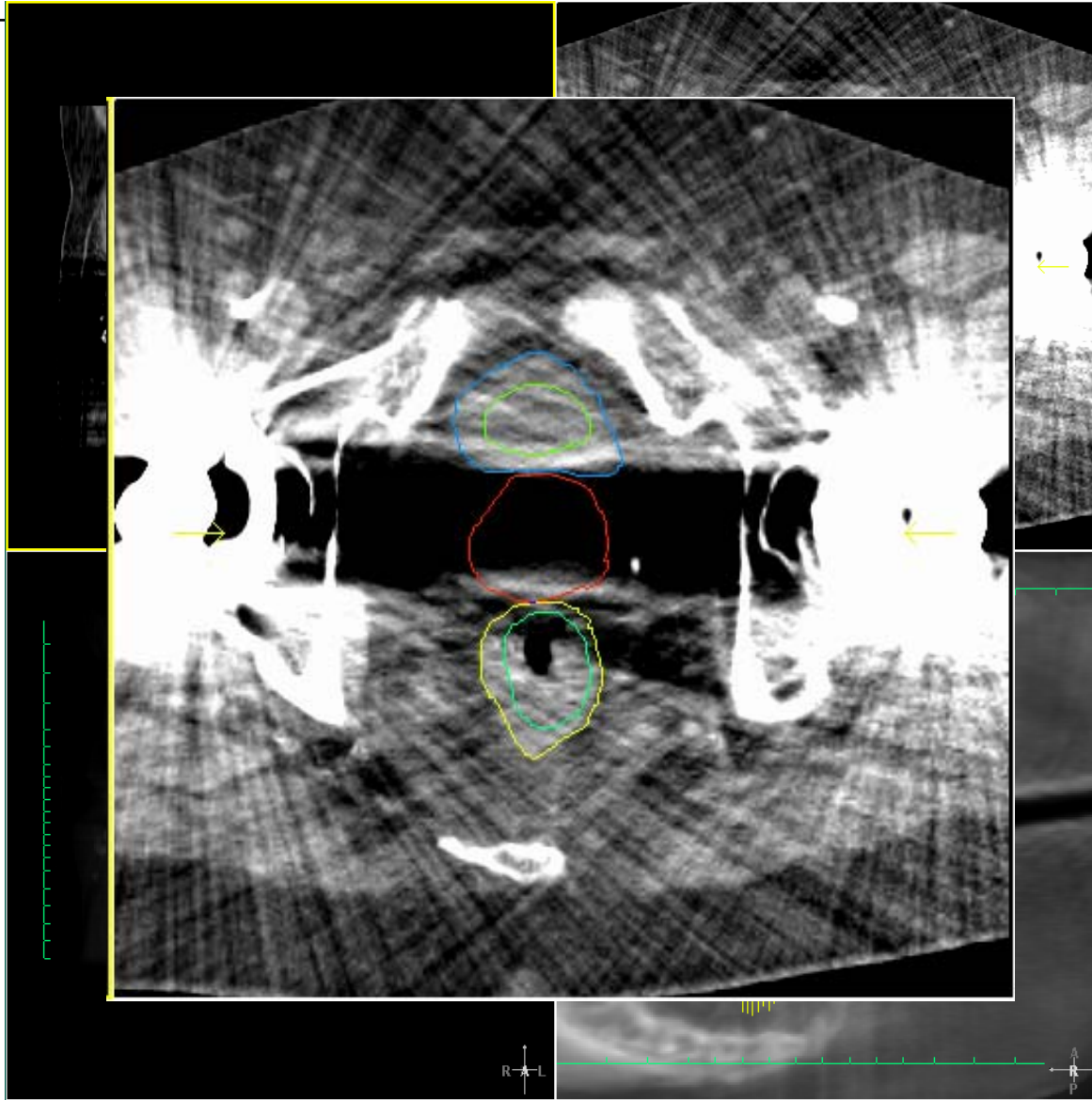
KEY CONCEPT: Precision with Cone-Beam CT (Image-guided RT)



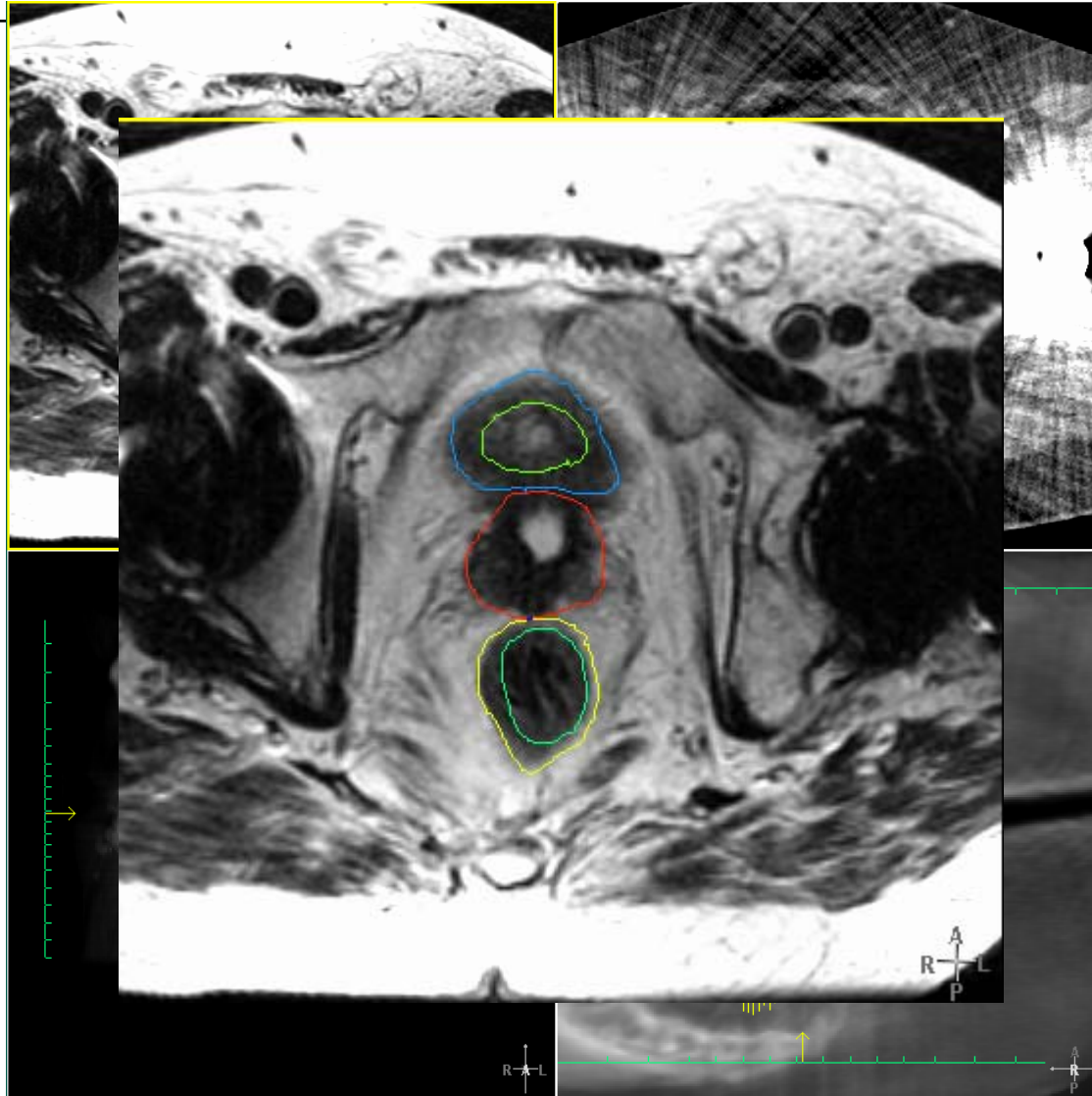
Beam arrangement



Special cases



Special cases



Special cases

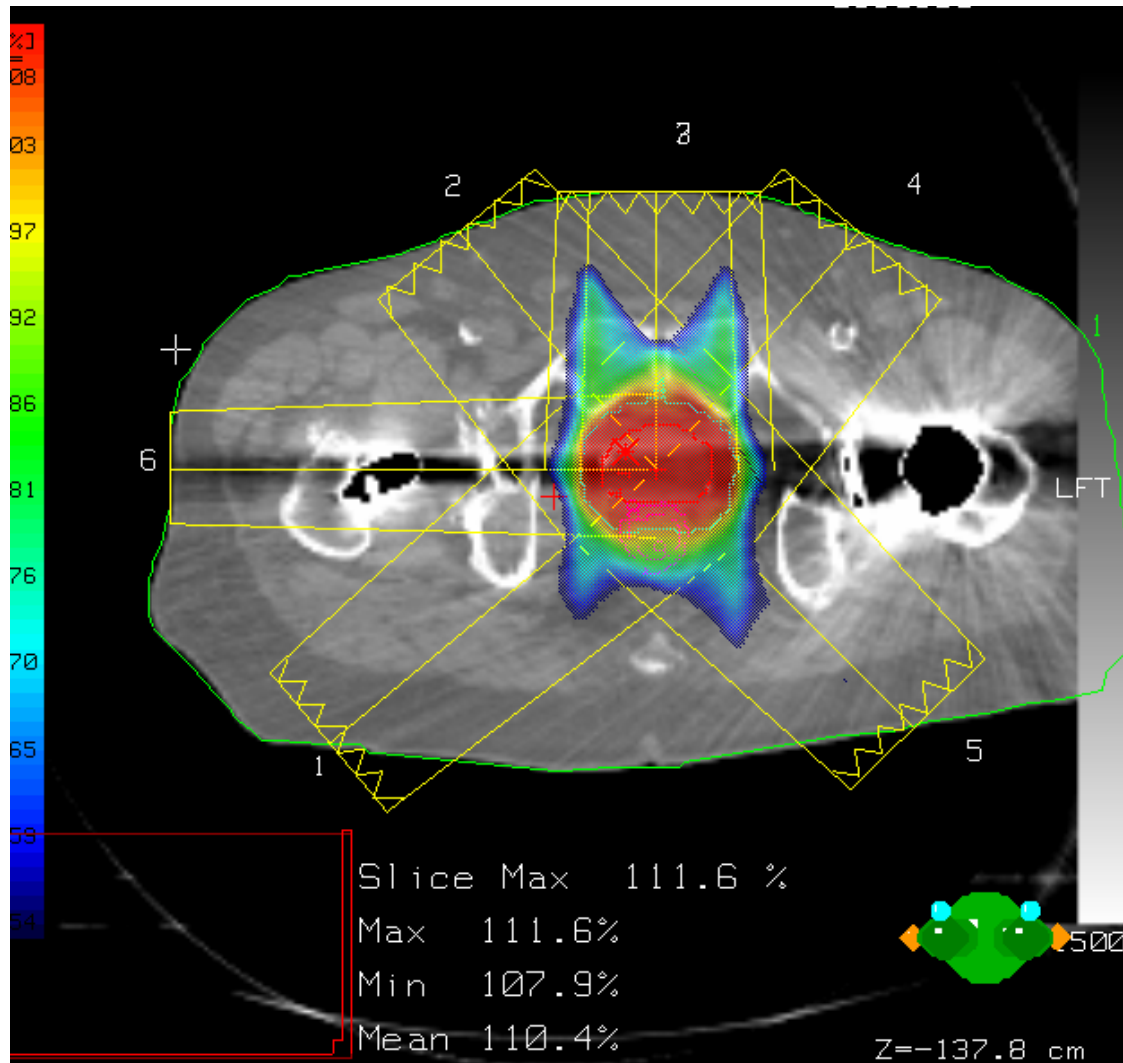


Image Guidance for Prostate

- What's next?
 - We have a new MRI simulator
 - Better images for accurate prostate outlining
 - New CT-PET
 - Not just structure but also the activity of the cancer
 - PET can monitor the response of tumor to radiation



Acknowledgements:

Colleagues in Radiation Oncology

Bristow, Catton, Cheung, Crook, Gospodarowicz, McLean,
Menard, Milosevic, Warde

Colleagues in Radiation Therapy:

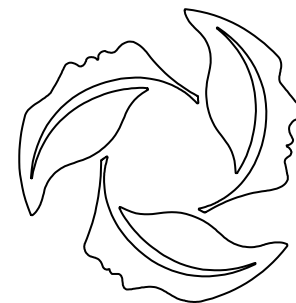
T. Rosewall and all the MRT(T)s who help plan and deliver
treatment

Colleagues in Radiation Physics:

Alasti, Cho, Craig, Damyanovich

Patients and Support / Advocacy Groups 

The Importance of Clinical Trials & Image Guidance In Radiation Therapy



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