

The ROYAL MARSDEN
Private Care

Radiotherapy at RMH: State of the art

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Consultant Clinical Oncologist



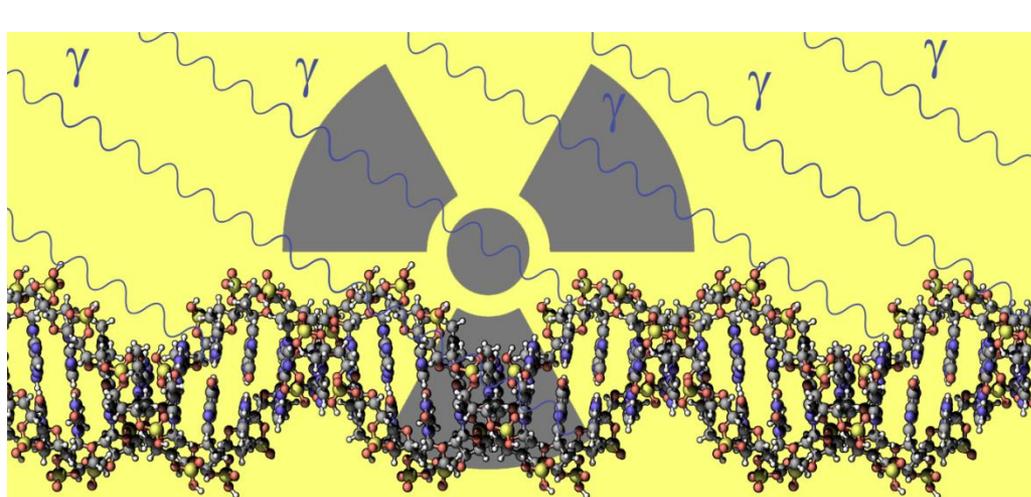
Overview

- Why do we use radiotherapy?
- Principles of radiotherapy
- Radiotherapy innovation at RMH

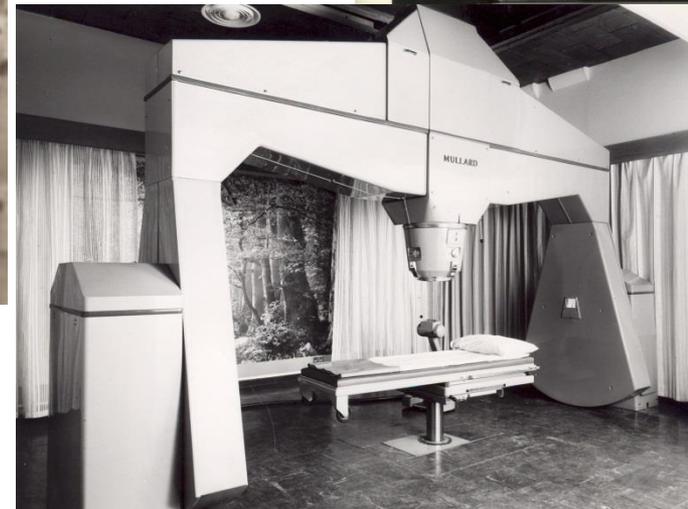
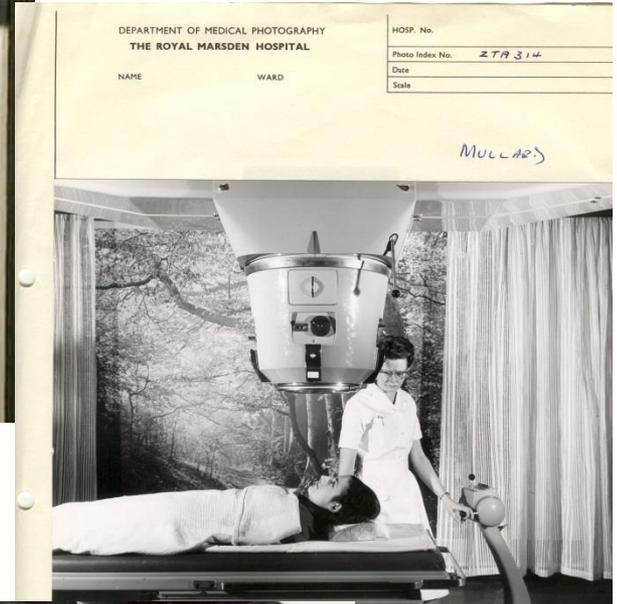
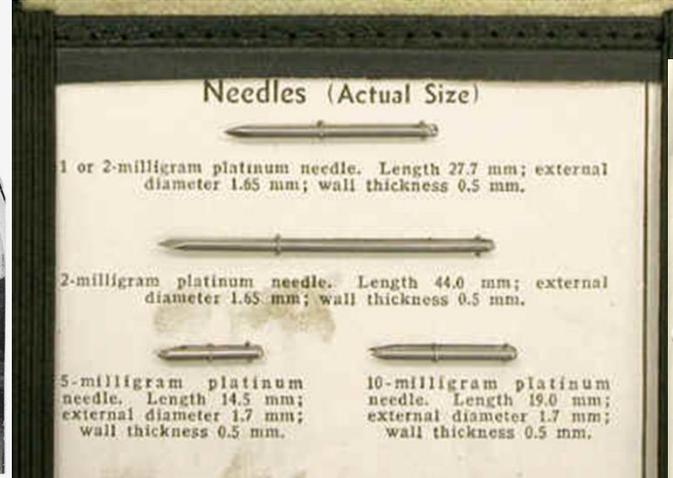


What is radiotherapy?

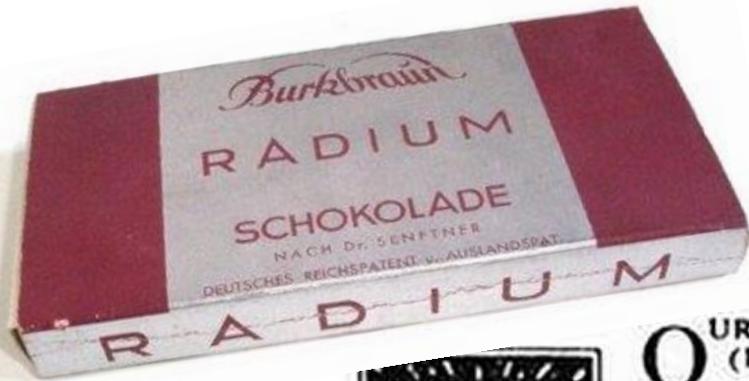
- Ionising radiation damages tumour DNA through
 - direct double strand break
 - indirect free radical damage



History of radiotherapy



Radium revolution



VITA RADIUM SUPPOSITORIES

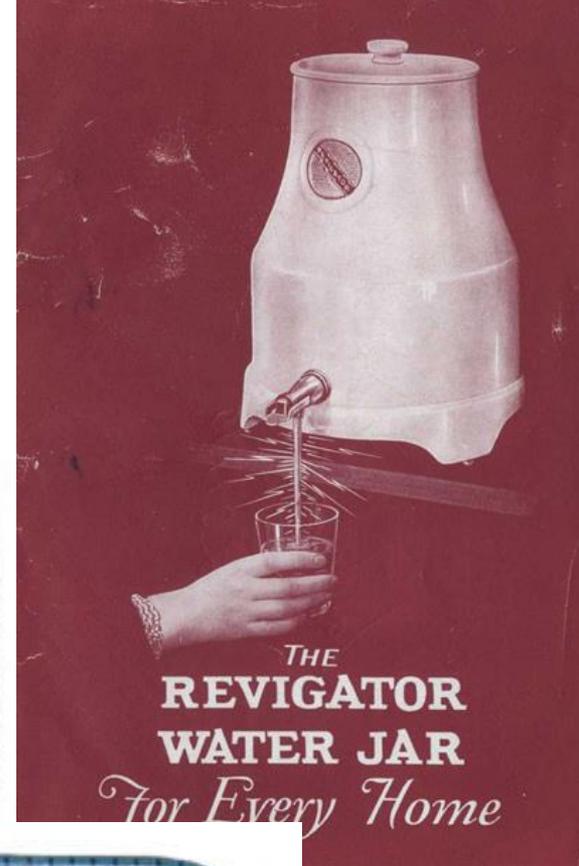
OUR VITA RADIUM SUPPOSITORIES (HIGH STRENGTH) are one of the outstanding triumphs of Radium Science. These Suppositories are guaranteed to contain REAL RADIUM—in the exact amount for most beneficial effect. They are inserted per rectum, one each night, this being one of the several practical and successful ways of introducing Radium into the system.



After inserted, it dissolves and enters the walls of the rectum, it enters the entire length of the body electrically, thus having an effect on the human battery.

Remember, Radium is continuing its curative effect and is NOT merely temporary.

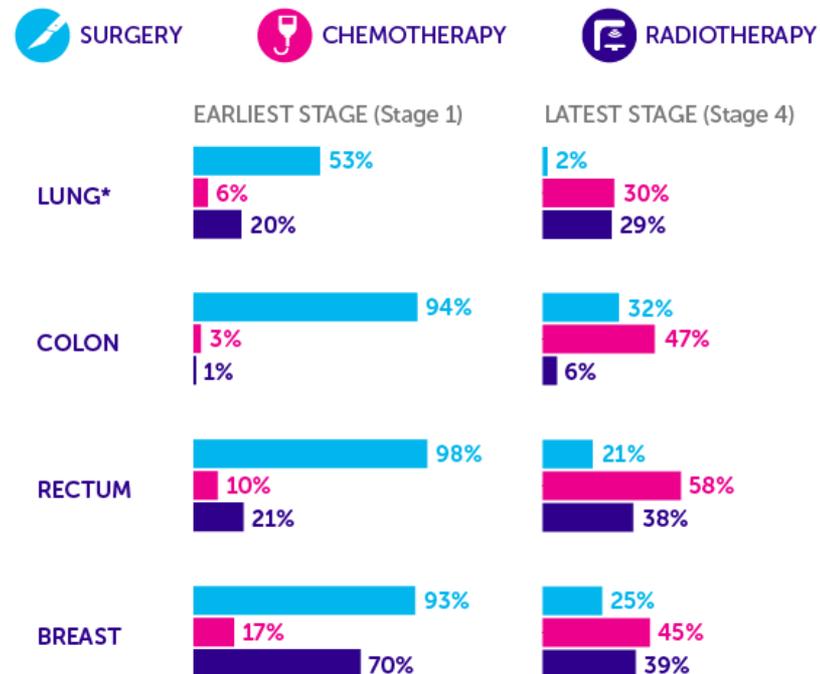
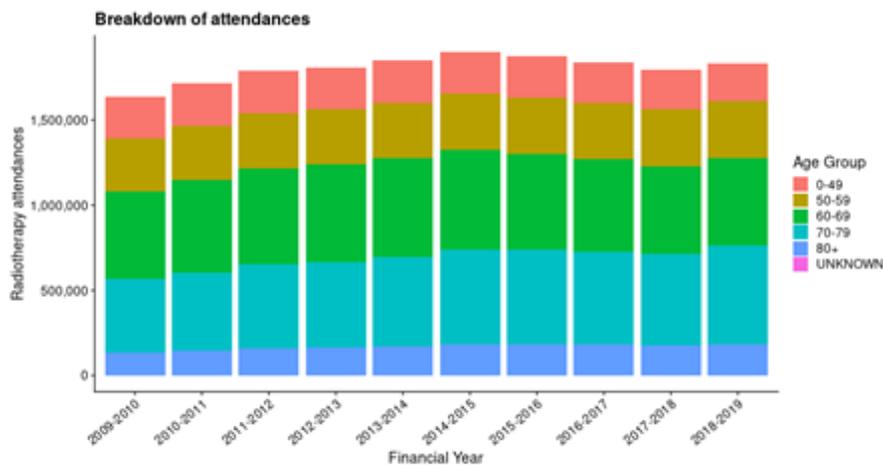
A RADIUM SUPPOSITORY—they are perfectly due solely to the Radium.



THREE RUBBER PROPHYLACTICS
No. 33 Rolled
Sold for protection against disease
"GET NEXT TO NUTEX"
Ask for them by name
RADIUM NUTEX are fine quality prophylactics
They are carefully inspected and tested.
SOLD IN DRUG-STORES
Manufactured by
THE NUTEX COMPANY
Sales Office Phila., Pa.
Made in U. S. A.
3 for 50c **Doz. \$1.50**



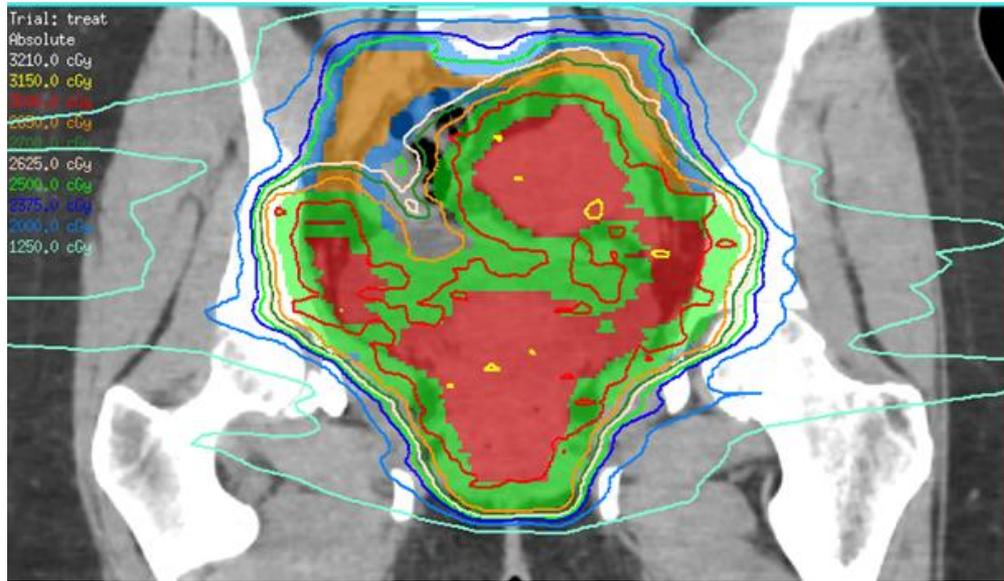
Radiotherapy in the UK today



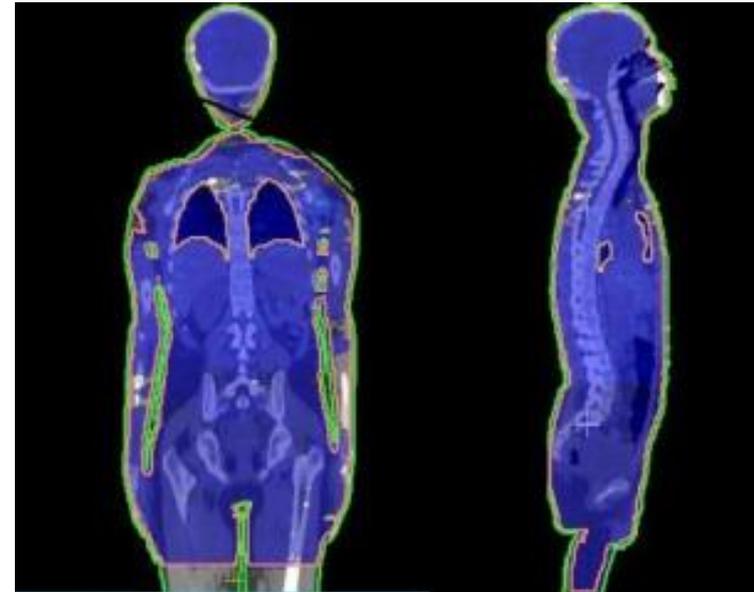
- 50% of all cancer patients will receive RT
- 40% will receive RT with curative intent
- >1.7m RT attendances in the UK /year



What do we treat : BIG TARGETS

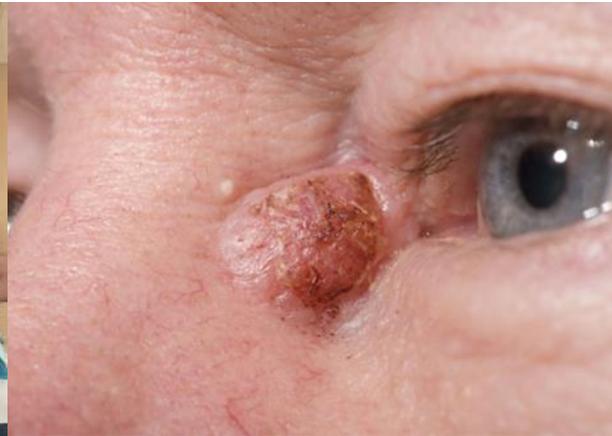
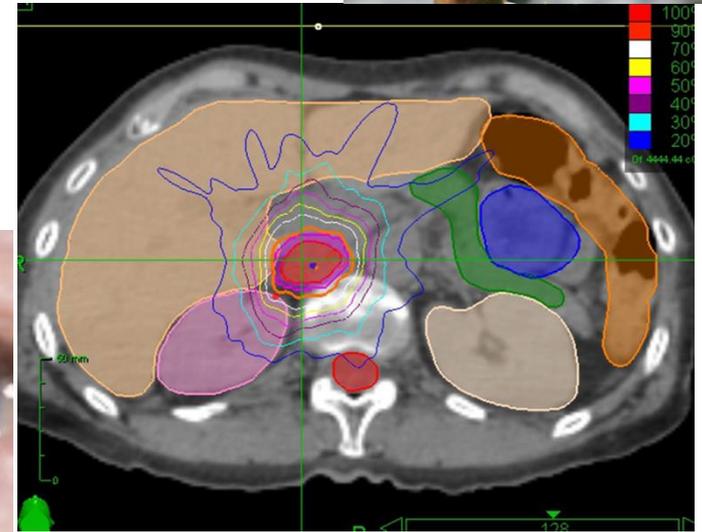
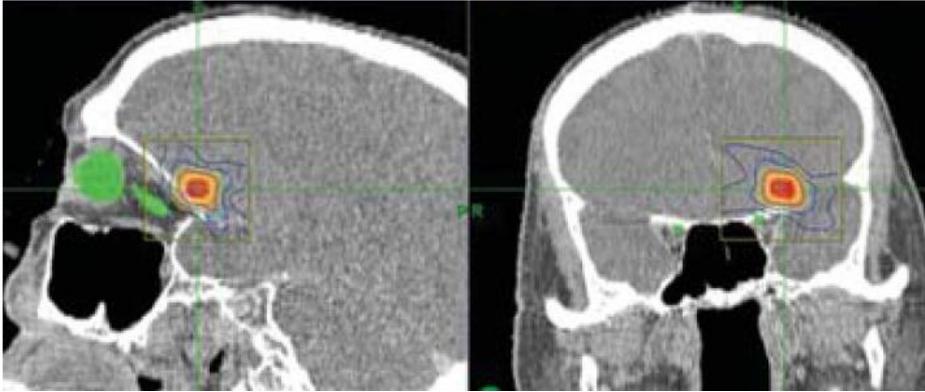


Central pelvic tumour and draining lymph nodes



Total Body irradiation

What do we treat: SMALL TARGETS



What do we treat: Moving targets



The RMH RT team



Core Staff

30 consultants

110 radiographers

35 clinical physicists

Supported by

Clinical nurse specialists

Admin team

Research team

Play therapists



**Treat approximately 5,000 patients per year
equating to 75,000 attendances per year**

Radiotherapy Service: Chelsea

Equipment

- Four Varian True Beam linacs
- all IMRT/IGRT capable
- Varian True Beam
- Cyberknife
- HDR Brachytherapy
- Dedicated planning CT



Radiotherapy Service: Sutton

Equipment

- Seven Elekta Synergy linacs
- All IMRT/IGRT capable
- Two planning CT scanners
- Superficial radiotherapy
- UK's first MR Linac (Unity)
- Cyberknife (Summer 2020)
- Raystation



A history of technological innovation through research

- **1940s**
First hospital in the UK to use artificial radioisotopes for the treatment of patients
- **1980s**
Lead for practice changing trials such as START trial in breast cancer, showing large and less fractions as good as longer course
- **1990s**
First hospital in the UK to test multi-leaf collimation. This led to the development of IMRT and more conformal, normal tissue sparing RT
- **2000s**
First hospital to treat a patient with Intensity Modulated Radiation Therapy (IMRT). **2008**



A history of technological innovation through research

- **2008**

We were the first in the world to deliver volumetric intensity modulated arc therapy (VMAT).

- **2010s**

Lead on international CHHiP trial showing that fewer, larger doses of IMRT work are as good as longer courses for men with prostate cancer.

- **2011**

One of the first NHS Trusts to introduce a [CyberKnife](#) to deliver stereotactic radiotherapy, facilitating pinpoint therapy in few fractions. Currently leading the international PACE trial using CyberKnife.

- **2018**

We are the first hospital in the UK and one of only seven centres in the world to install an [MR Linac](#) - a state-of-the-art machine which will allow us to see the target with the best imaging there is and then adapt the treatment to it with real time adaptive radiotherapy.



Technology benefits everyone

- IMRT/VMAT delivered as standard for radical treatments
 - Normal tissue sparing = reduced toxicity
 - Integrated boost = less fractions

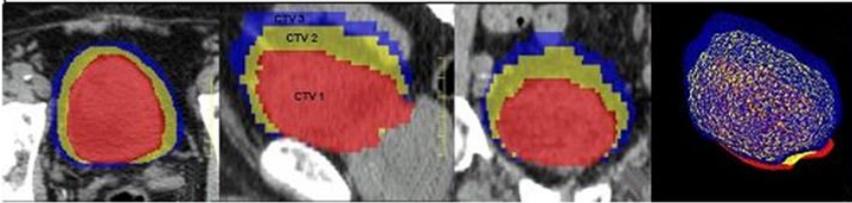


- IGRT (image guidance) incorporated into ALL treatment verification schedules
 - Daily IGRT reduces set up error
 - Greater accuracy of delivery



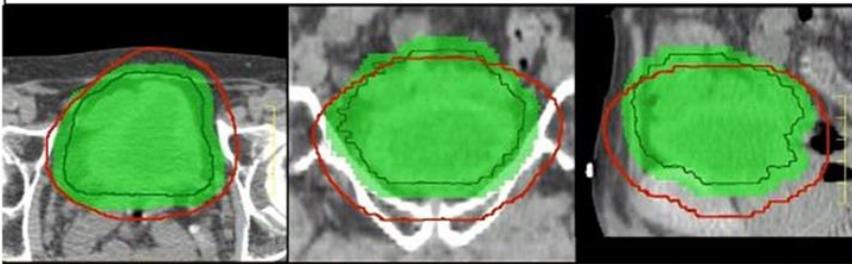
IGART: Plan of the day

1. Planning CT at 0, 15 and 30 minutes post void

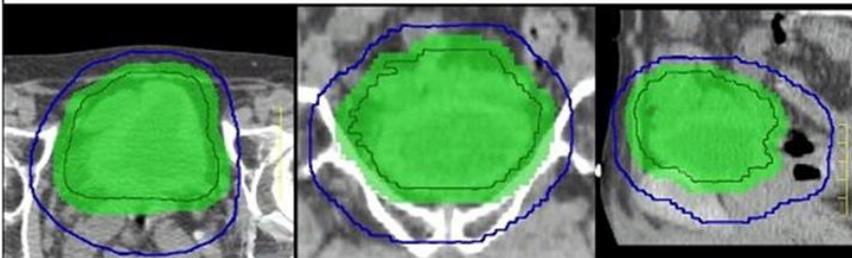


2. Plan 1, Plan 2, Plan 3 based on time-deformity patterns

3. Pre treatment CBCT to assess target coverage



4. Select more appropriate plan from "library"



5. Post treatment CBCT to confirm selection

51% of fractions demonstrated a need for adaptive planning.
73% of fractions would have been delivered correctly using A-POLO.

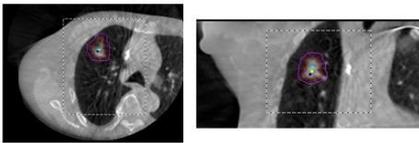
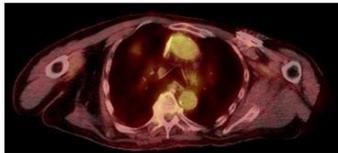
Plan of the day now standard practice for bladder cancer RT

Advanced practice skills & training for staff

The ROYAL MARSDEN

CLINICAL COMPETENCY WORKBOOK

On-line verification for Lung Stereotactic Body Radiotherapy (SBRT)



Name	Date
Competence Confirmed by	Date

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Advanced practitioners in urology

Training programmes for technological competencies

The presentation board displays the following content:

The ROYAL MARSDEN
NHS Foundation Trust

Implementation of radiographer-led IGRT for cervix cancer
Sophie Alexander¹, Naomi Hooper¹, Louise Latham¹, Amanda Taylor¹, Helen Arthur¹
¹The Royal Marsden NHS Foundation Trust, The Institute of Cancer Research

Background
IGRT in cervical cancer treatment delivery is complex due to significant target and organ at risk (OAR) motion. Implementing image assessment of soft tissue target and OAR positions to improve accuracy is recommended¹. Yet no standard IGRT solution or guidelines for radiographer review exist. This drove us to develop our own dedicated cervical cancer soft-tissue image review training and competency programme (TCP).

Methodology
TCP created agreed by a multi-disciplinary team comprising clinical oncologists, radiographers, and physicians.
Training: Inter-professional didactic lectures and practical sessions, supported by a comprehensive workbook.
Competency assessment: Radiographers reviewed a database of 20 cervical cancer (CCT) images. Their soft-tissue review proficiency (after body anatomy registration) was assessed against the gold standard. All reviews were graded pass or fail based on assessment of target coverage and decision taken in concordance with the gold standard.
Gold standard: Consultant clinical oncologist soft-tissue assessment of cervical cancer CCT image database.
Target: Radiographer pass threshold set at 80% concordance with clinical oncologist review, akin with similar studies².

Audit round one
• 19 radiographers, of varying experience, volunteered
• Office image review, verification and decision making process
• A series of review guided by a traffic-light decision support system

Results audit round one
• 20/21 radiographers completed the TCP
• 96%/20 (95%) of image reviews concordant with the gold standard
• All radiographers achieved a 80%, signifying parity
• Supported clinical implementation of radiographer-led review

Action plan based on round two results
Further 30 anatomy training and more clinical examples added to TCP. Imaging workflow implemented and image review process available from offline to online verification.

Audit round two
• 21 radiographers, of varying experience, volunteered
• Online verification and decision making

Results audit round two
• 20/21 radiographers completed the TCP
• 96%/20 (95%) of image reviews concordant with the gold standard
• All radiographers achieved a 80%, signifying parity
• Supported clinical implementation of radiographer-led review

Conclusion
A dedicated TCP facilitated implementation of Radiographer-led

New MRI competent practitioners



Technical capabilities: Planning

RT planning

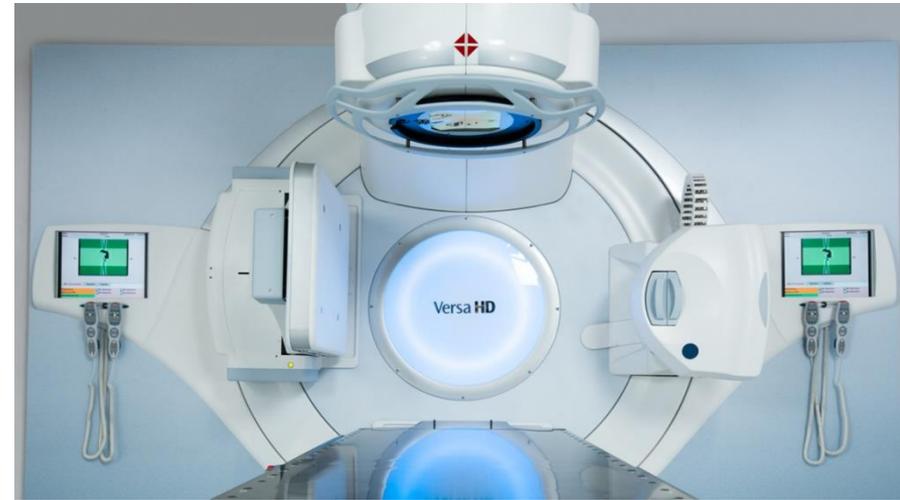
Techniques available to support
internal organ immobilisation
4DCT
Active breathing control
Voluntary breath hold

Fast optimal planning system



Linear Accelerators

- Small and large field treatments
- On board CBCT IGRT
- 30-40 patients / day
- Treatment slots 10-20 mins



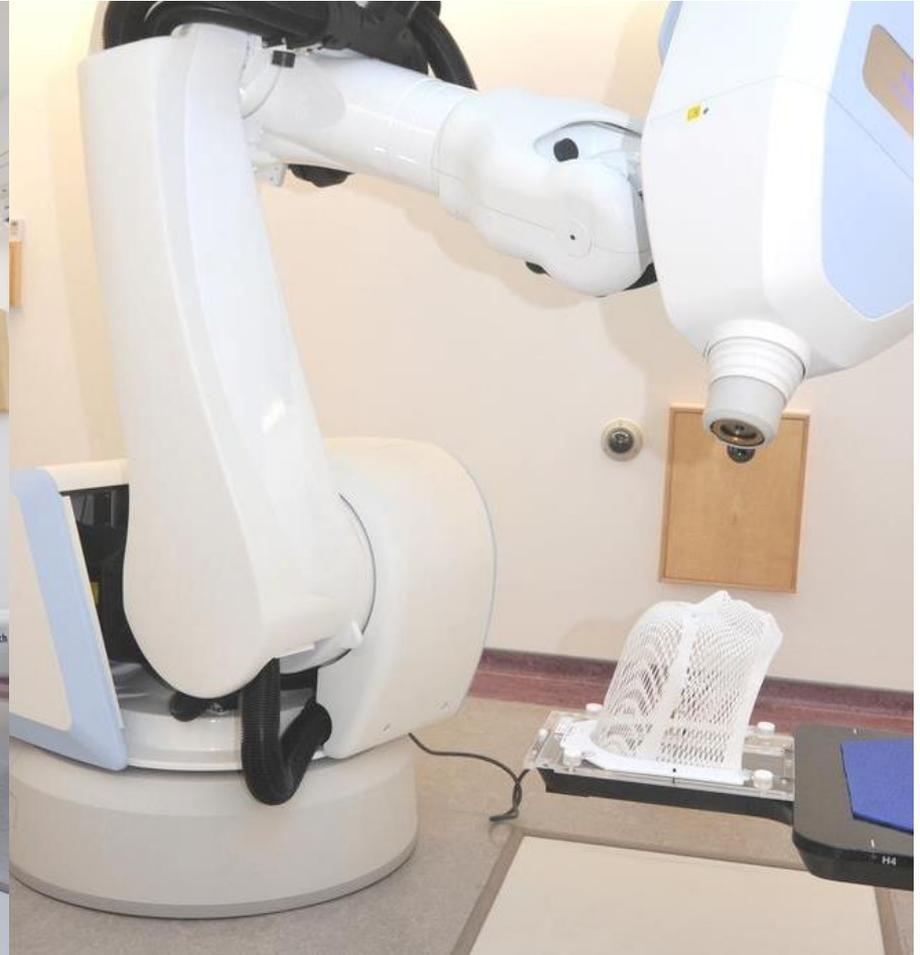
Advanced Linac IGRT technology

With a range of 11 Linear accelerators (and brachytherapy afterloader) we can deliver the most advanced types of radiotherapy

- Volumetric Arc Therapy
- Daily Advanced Image Guidance
- Stereotactic Body Radiotherapy
- Tumour and organ at risk immobilisation
- Adaptive radiotherapy
 - Re-planning to changes in tumour volume and patient shape
 - Online plan of the day selection
- Image guided adaptive brachytherapy



Stereotactic radiotherapy



Cyberknife



Robotic mounting

Image guidance / tracking
Skull based tracking
X-sight spine
Fiducials

Mechanical accuracy
0.12 millimeter
Total targeting accuracy
0.5-0.7mm

Routine delivery of 150 to 200 beams
per fraction

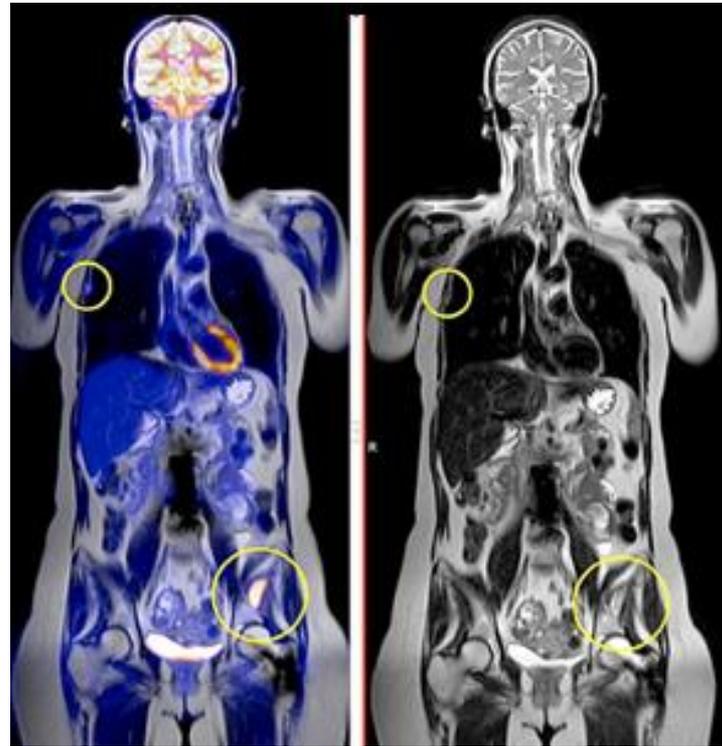
Treatment times 25-120 mins



Can radiotherapy improve outcomes in 'metastatic disease'?



Widespread metastases



'Oligo' metastases



New Treatment Paradigms

- SABR – 3-5 highly focussed ablative doses of radiotherapy
- Fewer treatments
- Cure in (oligo-metastatic) disease?
- Re-irradiation scenarios

Research Leadership:
CORE: Dr Vincent Khoo
HALT : Dr Fiona McDonald
NHSE CtE and PACE: Dr Nick Van As

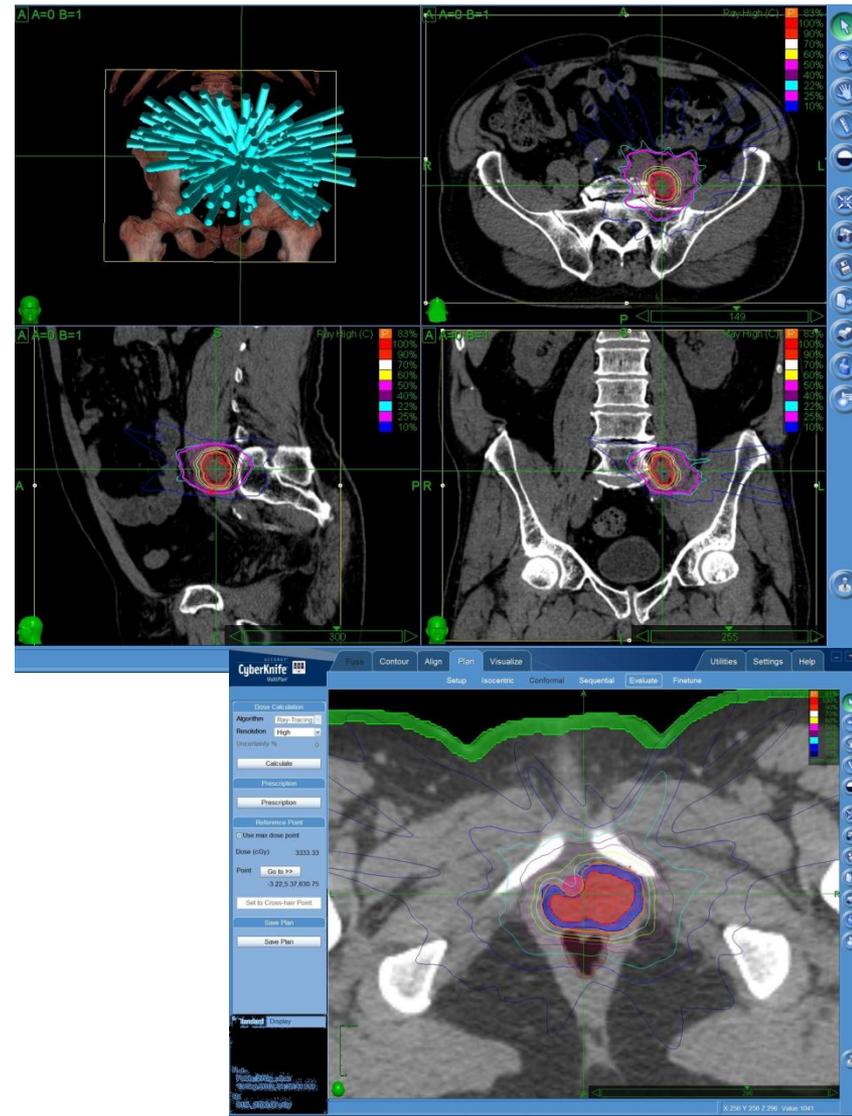
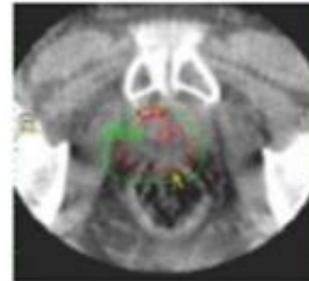
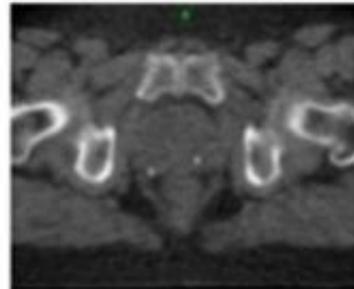
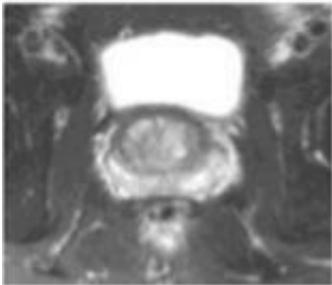
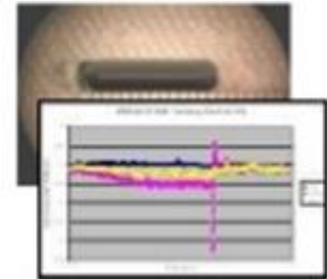
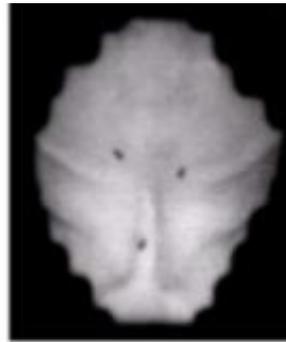
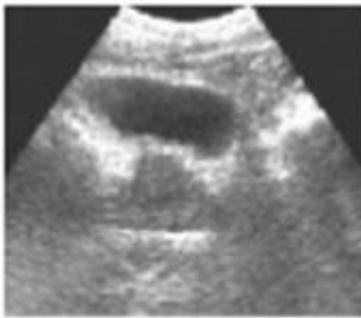


Image guidance: current best practice



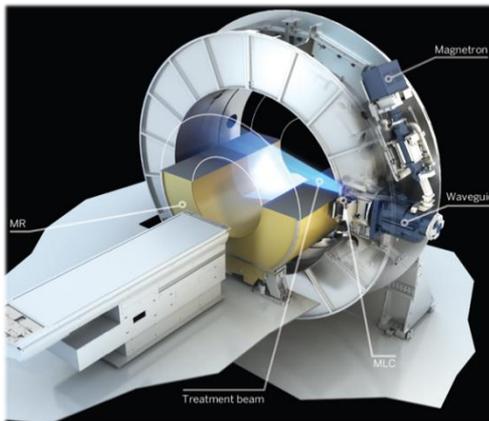
Room for improvement



MR Linac Concept: Radiotherapy delivery with real time MR imaging

Full integration of three subsystems

- State of the art Radiotherapy system
 - Treatment volume coincident with MRI imaging volume
 - Linac rotates around the MRI magnet
 - Modified to make it compatible with the MR environment
- 1.5T MRI system
 - Modified to make it compatible with Linac based radiotherapy
- Online adaptive workflow
 - Integrated user experience
 - Online adaptive treatment planning



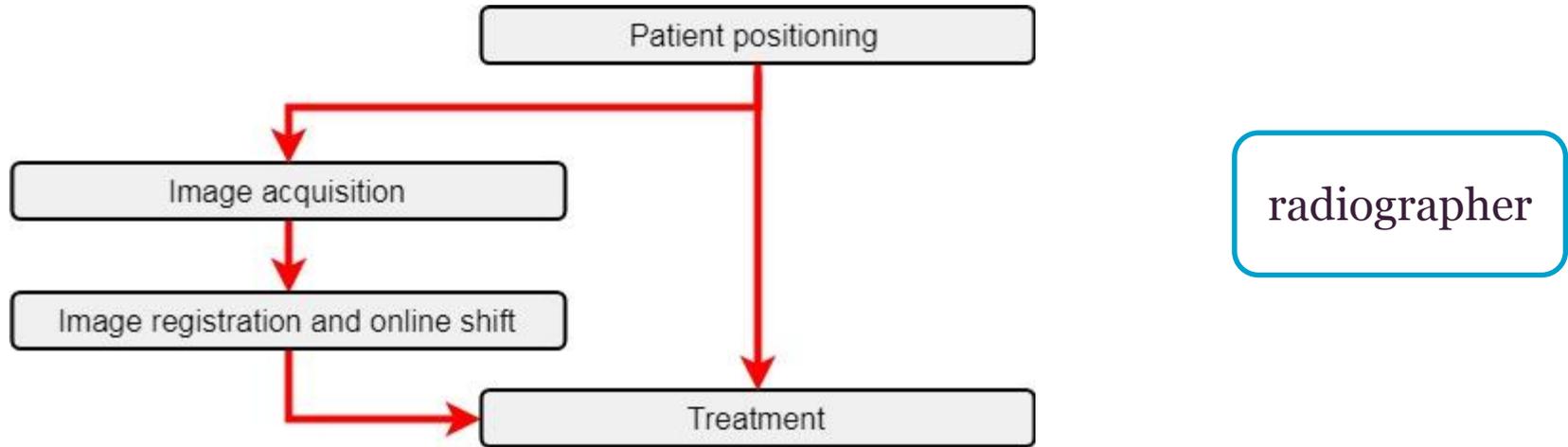
Unity MR-linac



2015



Radiotherapy on a conventional linac



MRL Treatment unit workflow



Physicist
(checker)

Physicist
(planner)

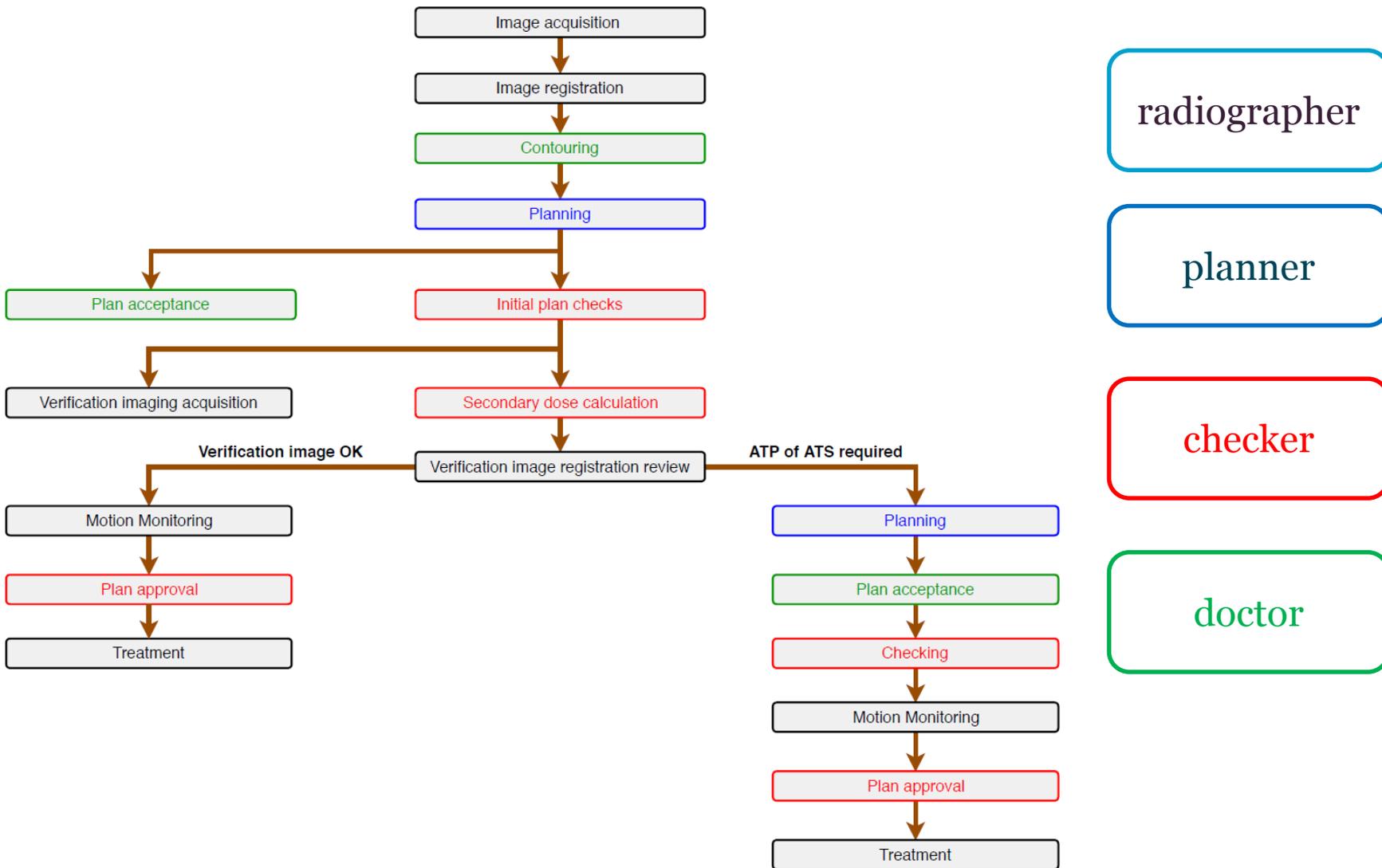
Radiographer

Doctor

Radiographer

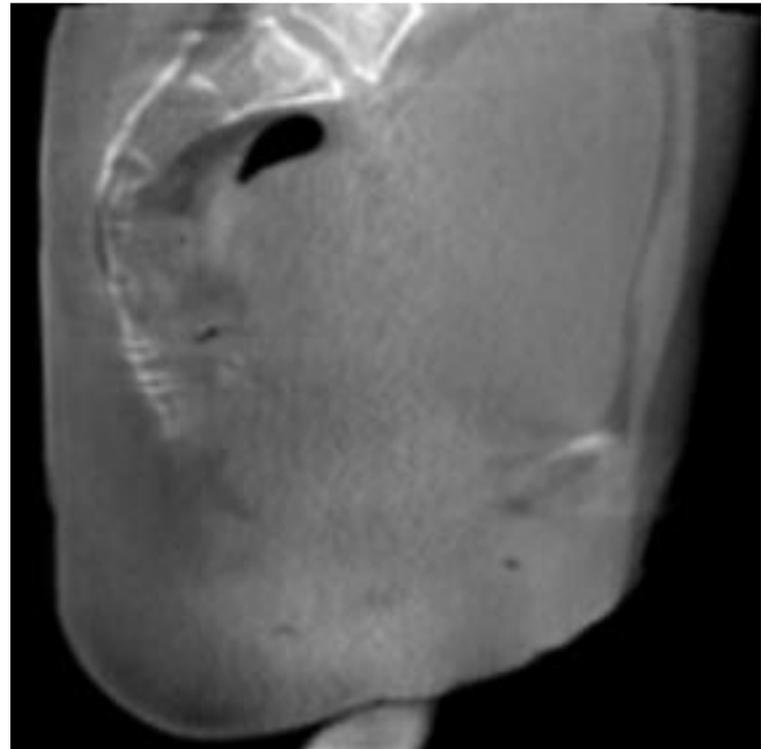


Online adaptive radiotherapy on the MR Linac

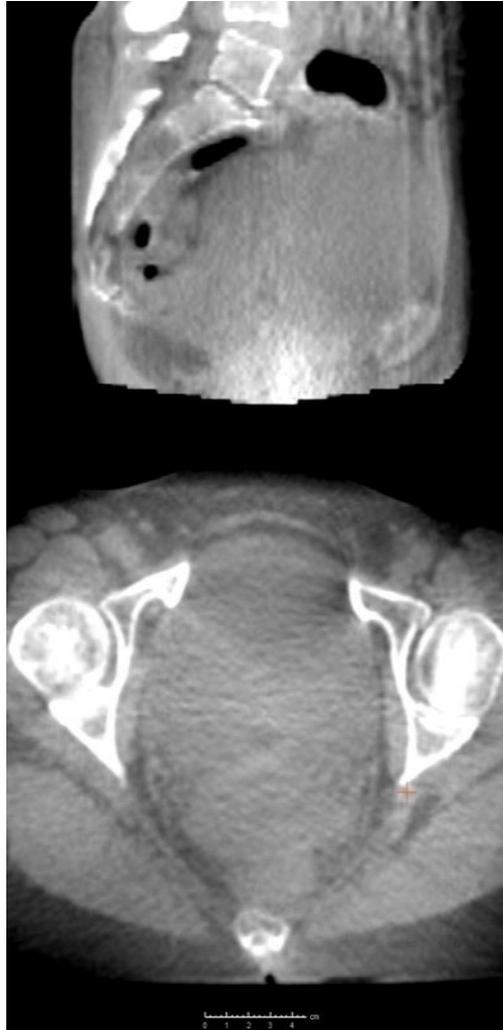


Key advantages - Resolution

Current best practice - cone beam CT



CBCT vs MRI



Future Radiotherapy Planning Pathway

MRI image acquisition

Autocontouring target and OAR

Functional target identification

Generation plan of the day



Dose delivery

Dose accumulation

Prediction of subsequent plan

MR linac: Changing Paradigms & Expanding Indications

RMH is again at the forefront of implementing new technology:

- first in UK to image and treat (September 2018) using MRL
- leadership in international research consortium
 - Dr Alison Tree – prostate
 - Dr Anna Kirby – breast
 - Dr Susan Lalondrelle – gynaecology
- radical ideas for changing radiotherapy delivery



In Summary...

- Europe's largest comprehensive cancer centre
- Our MDTs bring together world leading experts
- Complete range of treatment modalities offered
- Multi-professional decision making to improve clinical outcomes
- Leadership in cancer research and innovation



The ROYAL MARSDEN
Private Care

Thank you





FOUNDED IN 1851 BY
WILLIAM MARSDEN M.D.

We are Europe's oldest and largest comprehensive cancer centre. Rated as one of the top 3 cancer centres in the world, we deliver exceptional levels of patient care.