Centre for the Clinical Application of Particles
Radiotherapy Physics Perspective

Dr Ruth McLauchlan
Department Radiation Physics & Radiobiology

Outline

- Who are we?
- What do we do?
- What equipment do we have?
- Working with CCAP so far
- Future Developments in RT

Who are we?

- Department of Radiation Physics and Radiobiology
  - 13 physicists
  - 2 Physics assistants
  - 2 trainees
  - 3 Linac engineers
  - 2 Mechanical workshop engineers
  - 1 Mould room technical officer
  - 1 Unsealed sources technical officer
  - Radiotherapy Planning Team: 9 Dosimetrists (since Oct 2019)

What do we do?

- Scientific support to Department of Radiotherapy
  - Maintenance/QA of equipment
    - Calibration of equipment traceable to NPL following UK IPEM Codes of Practice
  - Advise on patient treatment planning including issues during treatment
    - Immobilisation/modality/ technique/imaging
  - Independent checking of patient treatment plans
  - Commission new equipment/implement new techniques
  - Clinical trials/audit
  - Teaching/training

What do we do?

- What are we treating?
- What dose is/was delivered?
- How will the tissues (tumour and normal tissue) respond?

- Dept. of Radiotherapy treats >1800 patients per year
  - Delivering > 28000 # of EBRT
  - Delivering > 250 # of Brachy

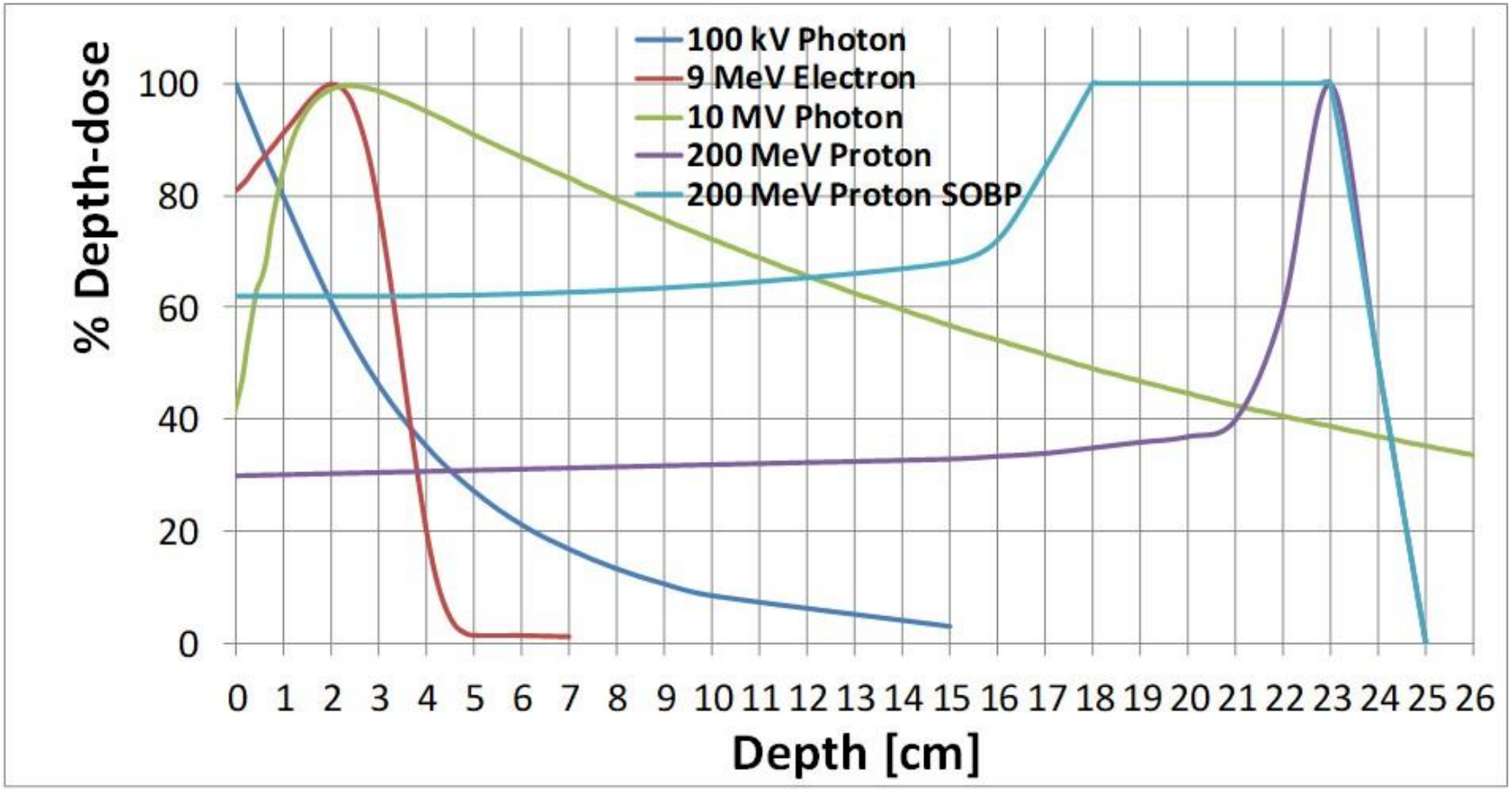
What equipment do we have?

2017	2019
6 Linear Accelerators (Varian) delivering 6/10 MV photons, 6/9/12/16/20 MeV electrons	
2 x TrueBeam & 2 x SXi @ Charing Cross Hospital	3 x TrueBeam and 1 x STX @ Charing Cross Hospital More advanced imaging and treatment delivery inc. 2 x ExacTrac imaging systems & 2 x 6DOF couch
2 x SXi @ Hammersmith Hospital MV portal imaging/IMRT	
Xstrahl Unit @ Charing Cross 80/150/300 kV x-rays	
HDR Brachytherapy unit @ Hammersmith Basic cases	NEW HDR Brachytherapy unit @ Hammersmith Complex planning
Philips Brilliance Big Bore CT scanner @ Charing Cross 4DCT capability	
TPS: Oncentra; Eclipse; ProSoma	TPS: Oncentra; Eclipse; ProSoma -> RayStation
Access to MRI & PET	

Linear accelerator

http://www.int03.co.uk/vertual/demoes/varian.htm

Modalities

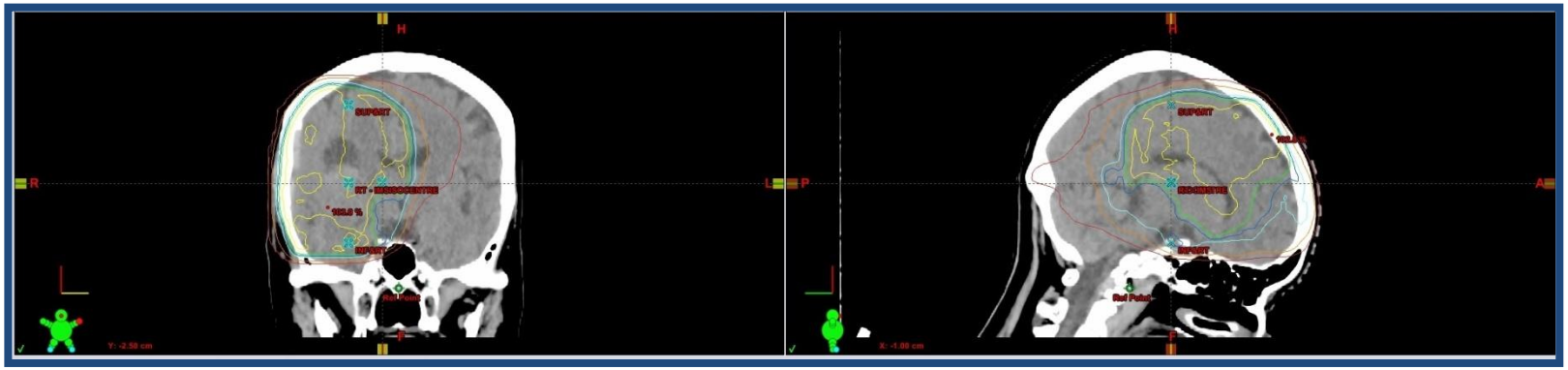

% Depth-dose
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Depth [cm]
100 kV Photon
9 MeV Electron
10 MV Photon
200 MeV Proton
200 MeV Proton SOBP

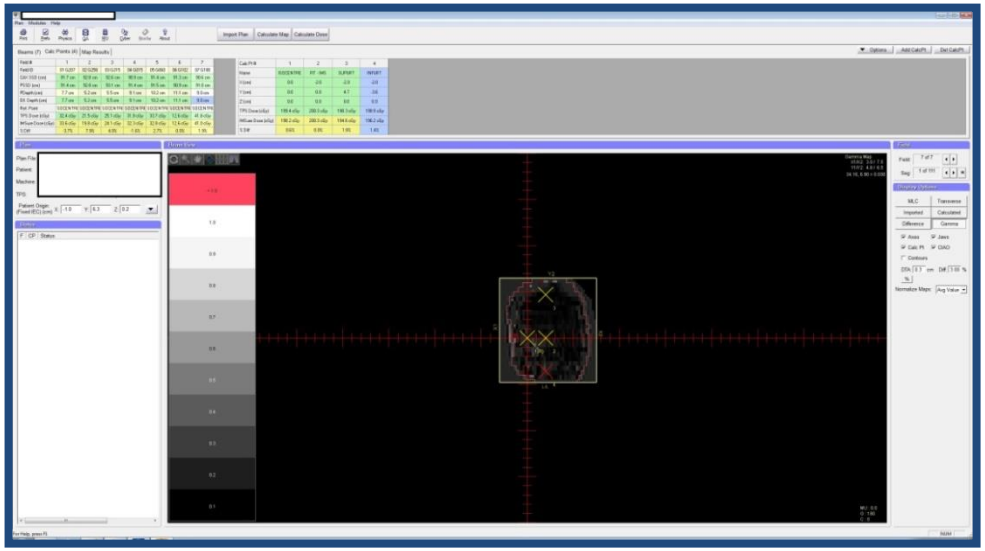
Equipment Calibration

- Are we giving the dose as prescribed?
  - Point dose measurement/calibration (ion chamber)
    - Photons – farmer chamber; pinpoint; diamond
    - Electrons – parallel plate NACP/Roos
  - Daily constancy checks
    - Beamchecker
  - Confirm dose to patient
    - Invivo dosimetry - diodes

Patient Specific Verification

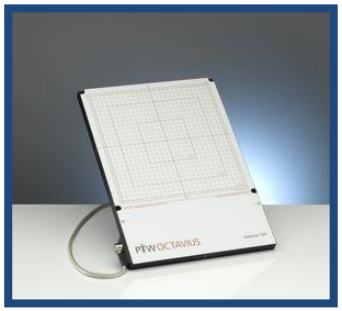
- Independent dose calculation software - IMSure

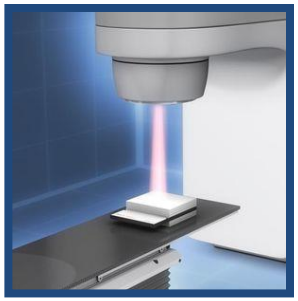


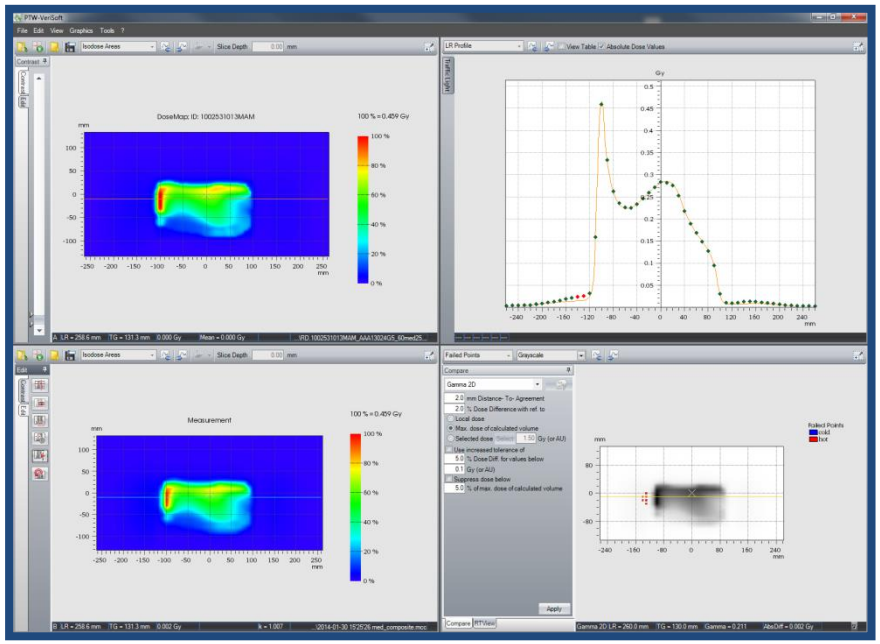


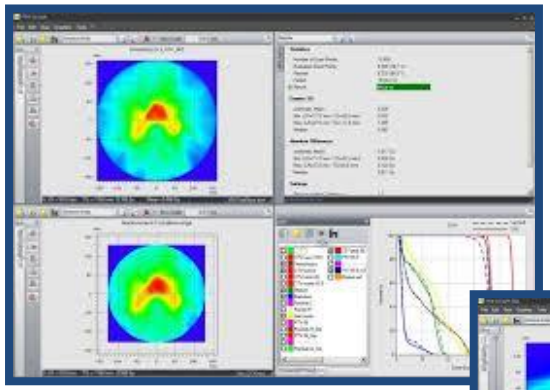
Patient Specific Verification

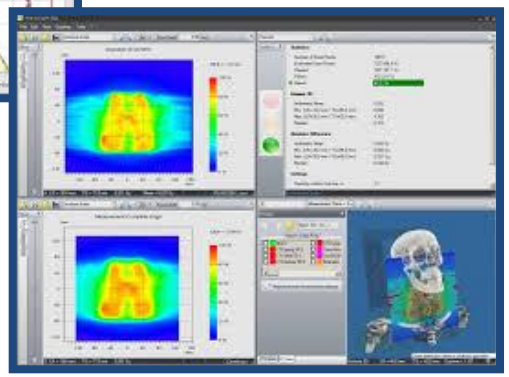
- Independent dose measurement/fluence checks, e.g. PTW729 array, PTW SRS array & Octavius





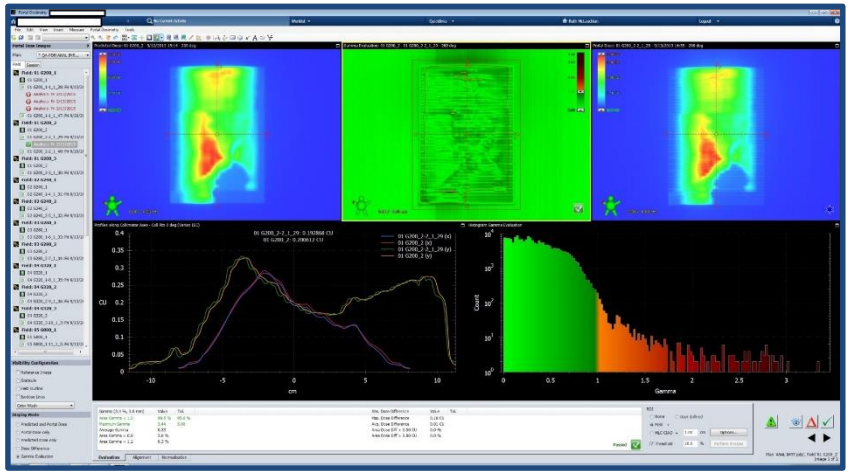






Patient Specific Verification

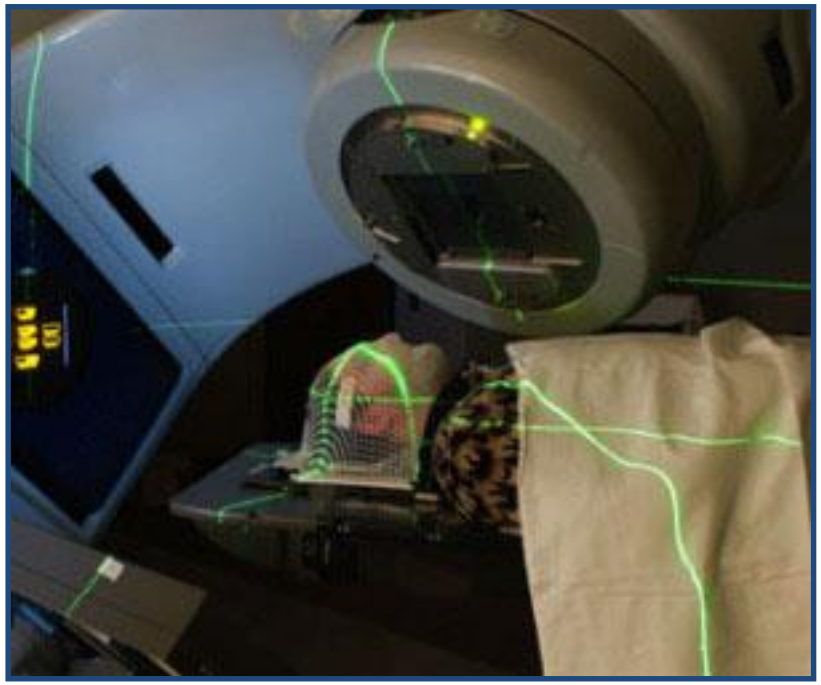
Portal Dosimetry



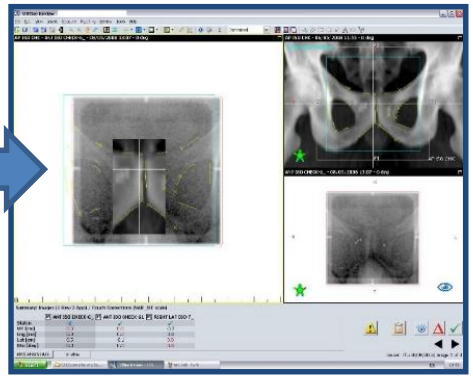
Transit Dosimetry

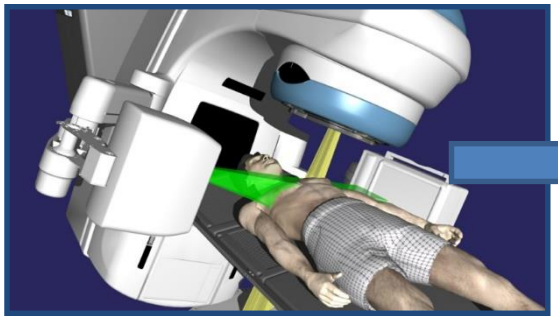
- Portal Dosimetry using calibrated EPID
- Back-project dose projection
- Use the patient rather than a phantom

Accurate treatment set-up



On-board imaging





Working with CCAP so far

- Image Guided Verification for the future
  - Towards CBCT auto-match and analysis
    - CASE proposal
    - BSc student project
- EPSRC Discipline Hopping call investigated
  - "*Investigators must be academic employees (lecturer or equivalent)…*"
- FLASH-RT
  - Possibility of adapting linac at Hammersmith
    - Stalled due to clinical need for machine

Future Developments in RT

- Treating small volumes/Hypofractionation/SABR
  - Improved localisation
    - Imaging/Surface guided RT
    - Immobilisation
  - Accurate dosimetry
- Adaptive Radiotherapy
  - Movement of tumour during delivery
  - Shrinkage/growth of tumour
    → MRI linac
- FLASH RT
  - Linac
  - Protons
- Radiobiological planning