



Developing proton therapy

Dr R I MacKay

The Christie NHS Foundation Trust



Radiotherapy News

Testing underway for UK proton beam cancer treatment

Advanced Oncotherapy has begun testing its groundbreaking Light machine for the UK's first proton beam therapy centre, in what is expected to be a cancer treatment milestone when it opens by the end of next year.

[The Telegraph](#) - [Comment on this story](#)

Will the UK become the proton therapy centre of Europe?

Several companies are opening proton beam therapy centres across the UK as the treatment becomes more popular. Recent independent medical research suggests that proton beam cancer therapy treatment is far less harmful and traumatic to cancer patients than chemotherapy. Proton Partners International will bring the world's first digital PET CT system to Wales. The equipment fitted at the UK's first proton beam therapy centre will provide cancer patients with the most advanced cancer technology available.

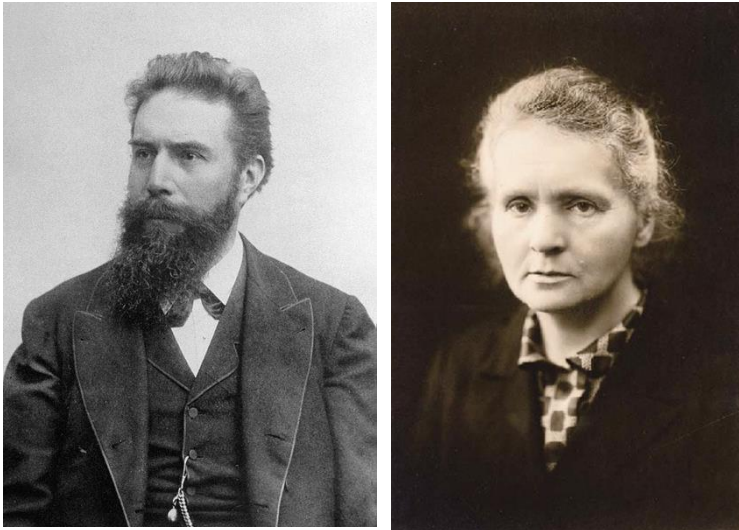


Radiotherapy

- After surgery, it is the next most important method of curing cancer.
- 40% of all patients cured of cancer are cured by radiotherapy.
- 50% of all cancer patients will benefit from receiving radiotherapy as part of their cancer management.
- Its use is continuing to expand. This is due to better patient pathways, the role of multi-disciplinary team meetings and more integrated treatments.

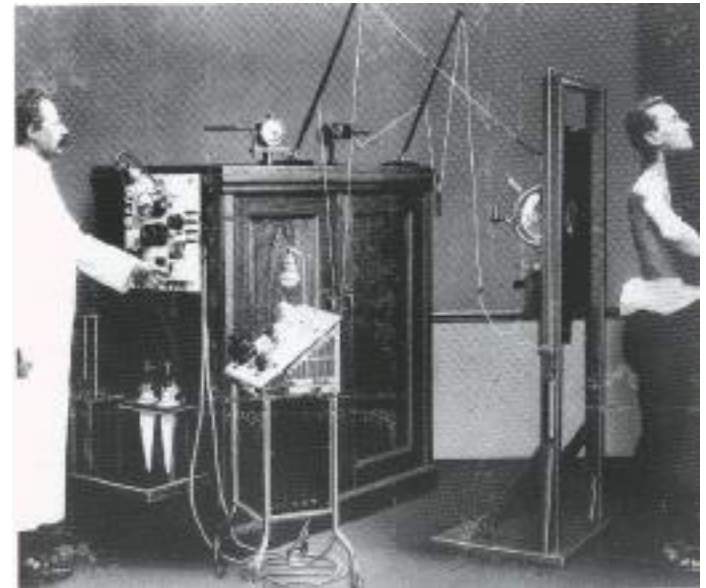
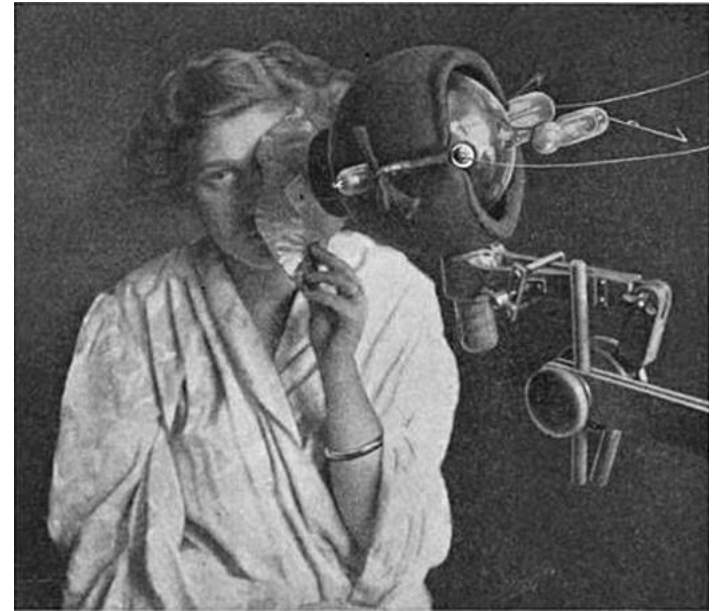


A little history...

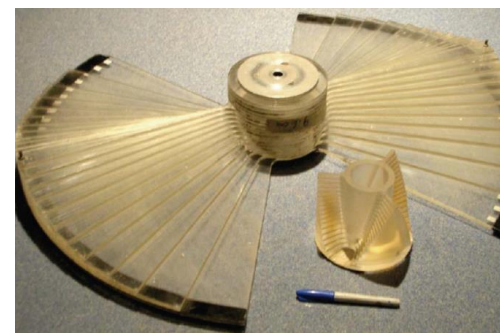
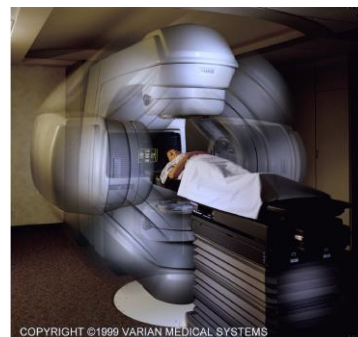
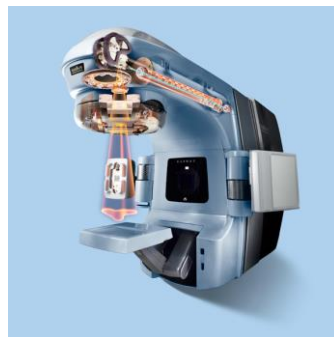
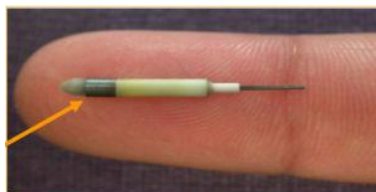
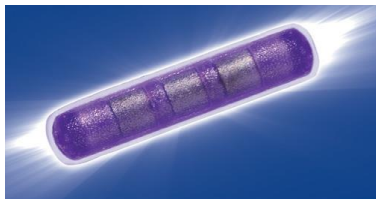


Very quickly after Roentgen's discovery of X-rays and Marie Curie's discovery of radioactivity, they were both being used to treat disease, including cancer

Freund/Schiff 1896 – skin treatments
Emil Grubbe 1897 – cancer treatment
Herbert Jackson 1896 – use of electron focusing



A smorgasbord of radiotherapy



Brachytherapy:

X, γ , β

Ir-192, Co-60, Cs-137,
Au-198
I-125, Ra-226

Teletherapy

γ

Co-60, Cs-137

X-ray
radiotherapy

X

6-40 MeV
electrons onto W
target

Particle therapy

p, C, etc.

Cyclotrons,
synchrotrons etc.

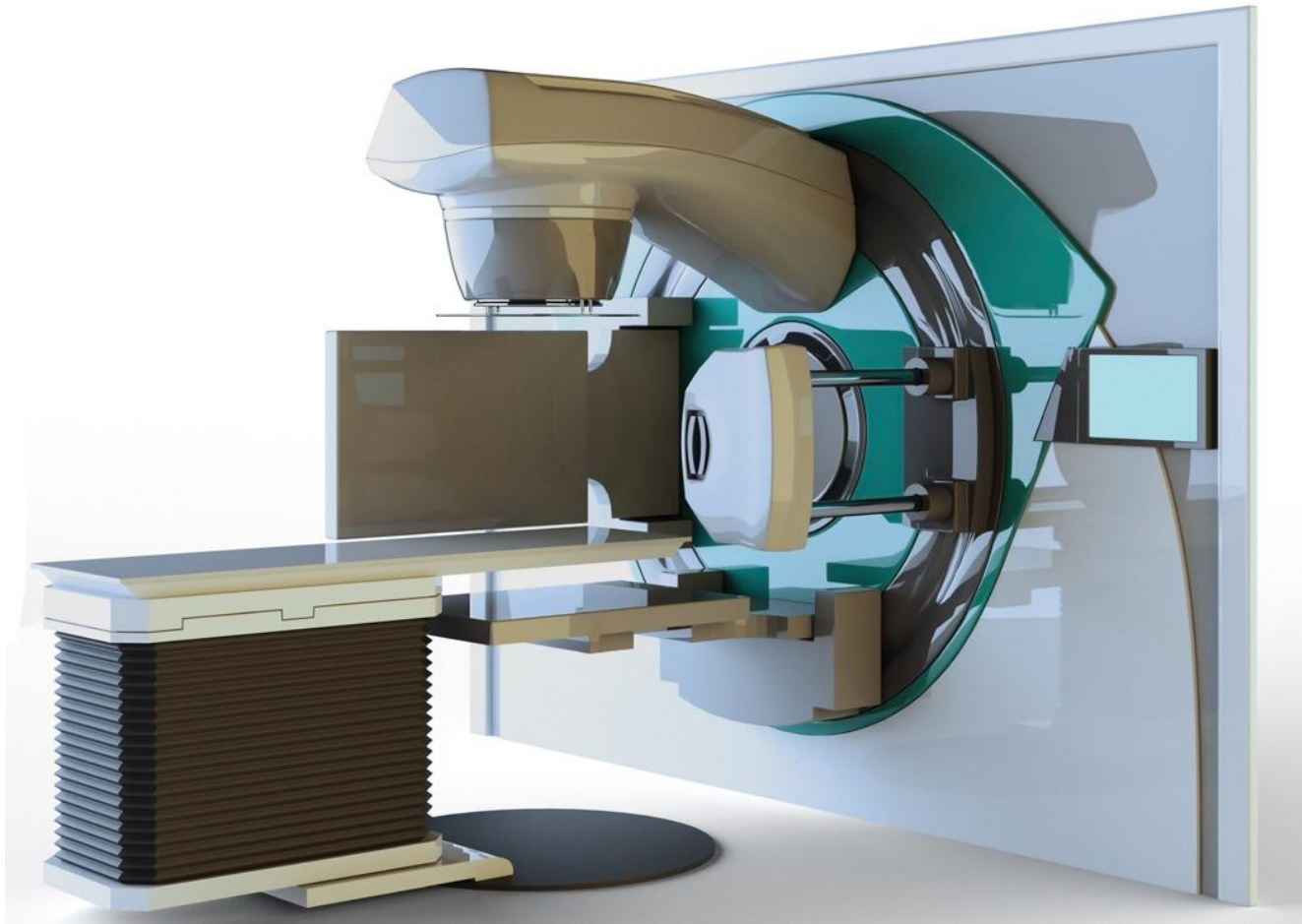


Radiotherapy Linear Accelerator

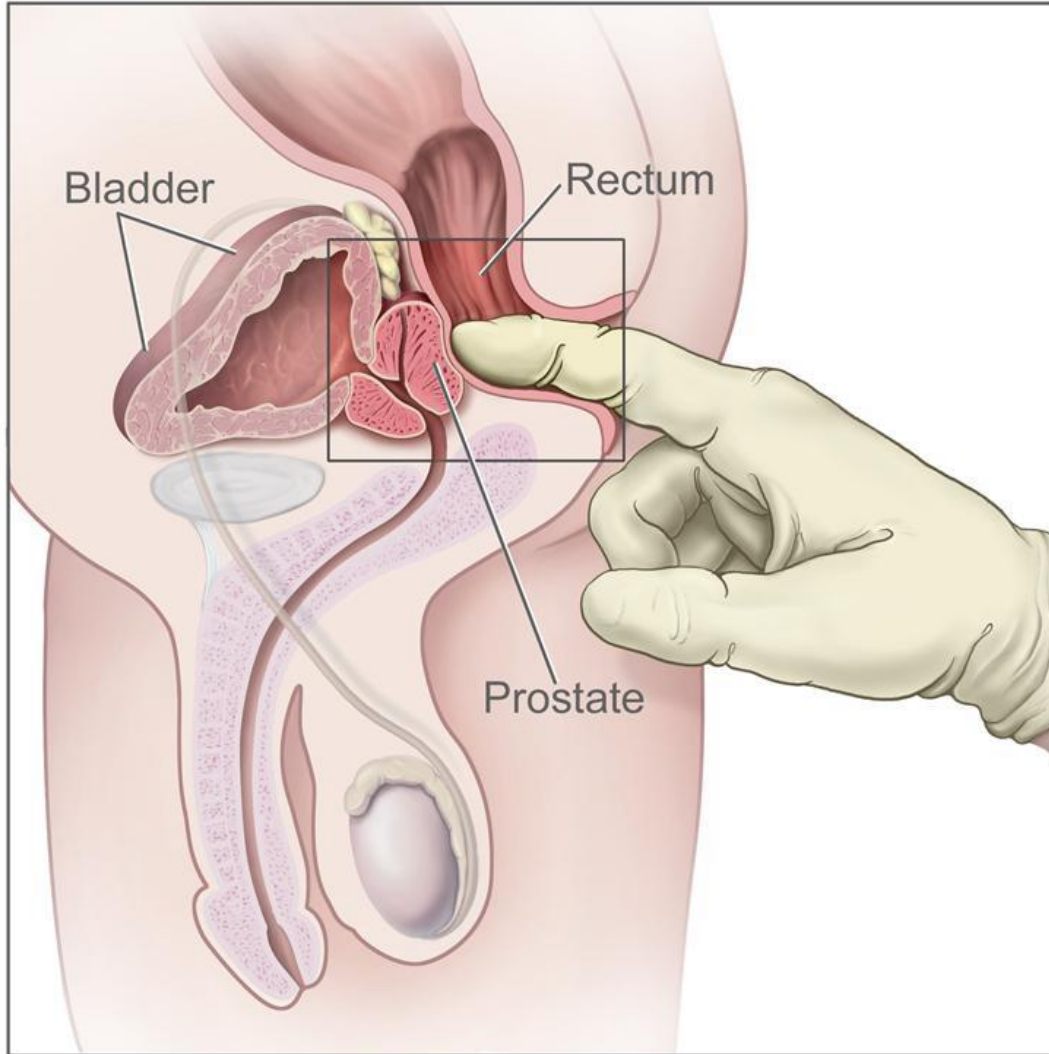
- Electron
- Standing or travelling wave
- 4- 20 MV but most commonly 6 -10MV
- Dose rate for photons ~ 5Gy a minute
- Field size 30x40cm – 5mm MLC
- Electrons impact on a tungsten transmission target to produce x-ray beam
- Beam flattened and shaped



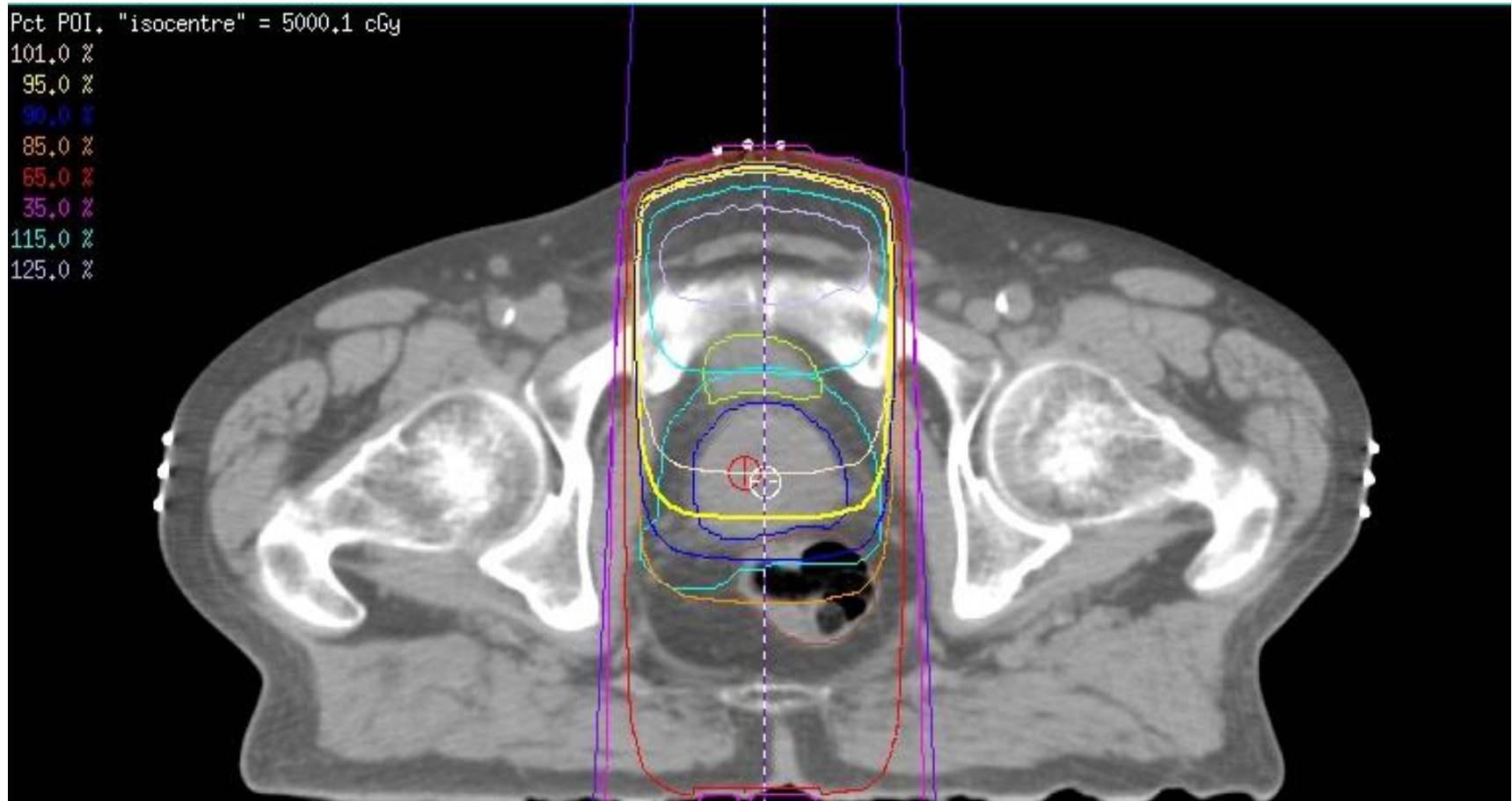
External Beam Radiotherapy



Prostate



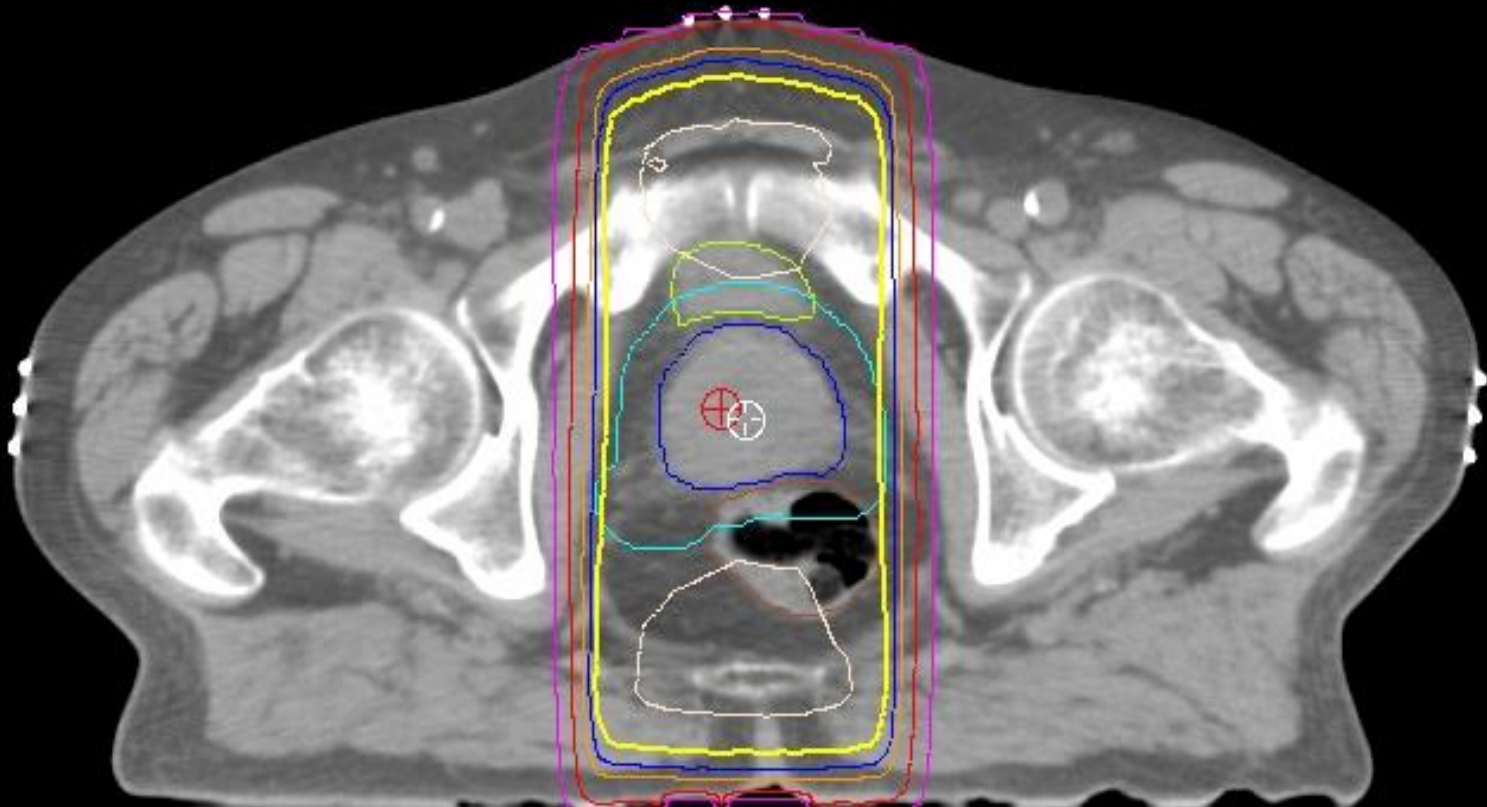
Single beam isodose plot



Parallel opposed pair

Pct POI, "isocentre" = 4999,4 cGy

101,0 %
95,0 %
90,0 %
85,0 %
65,0 %
35,0 %
115,0 %
125,0 %

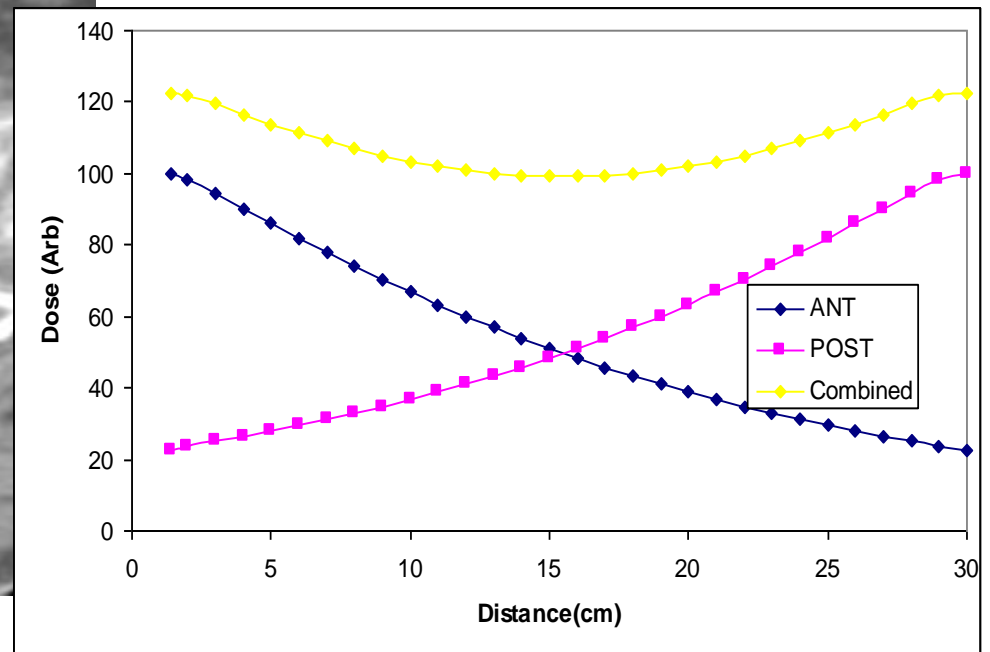
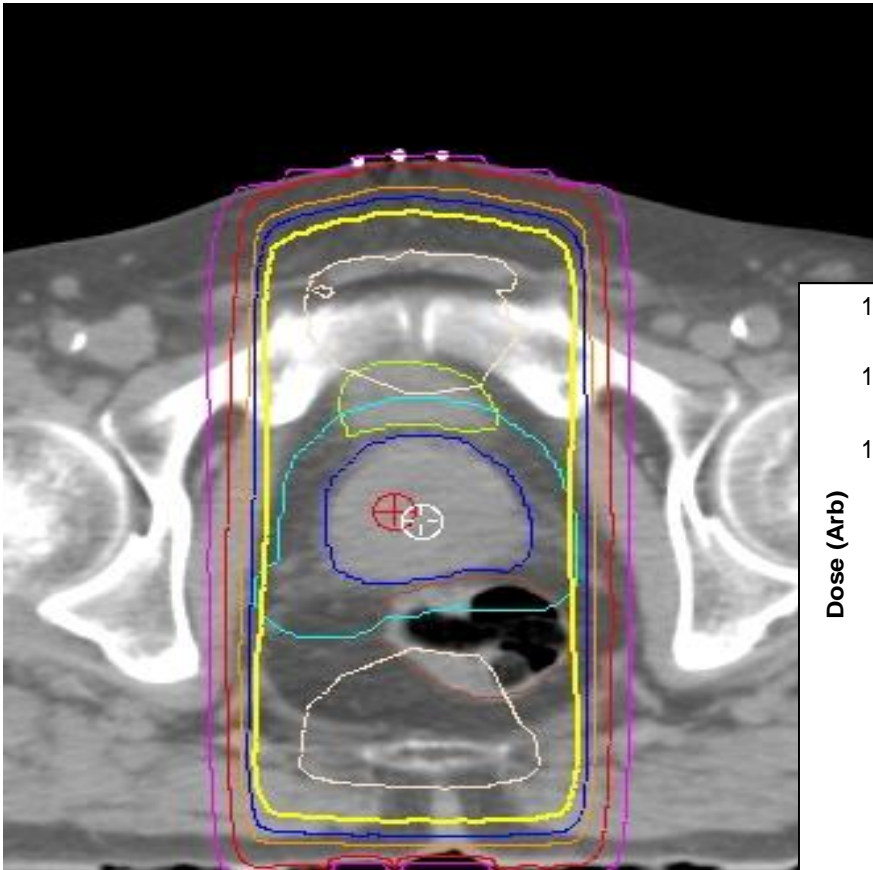


Parallel opposed pair

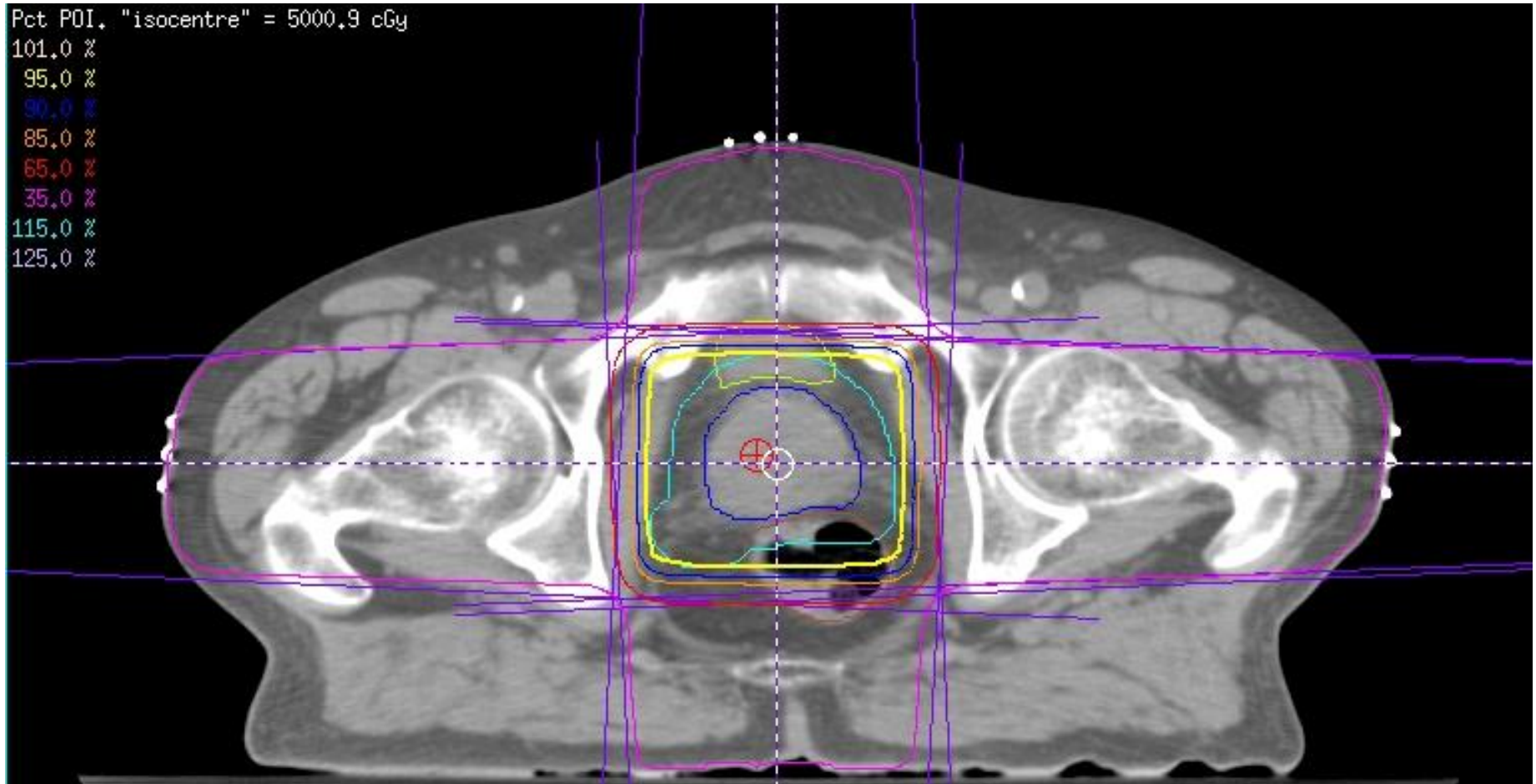
Reduced the area of high dose

Still treating a large volume of normal tissue (in particular the rectum in this case)

CAX plot:



Four field brick



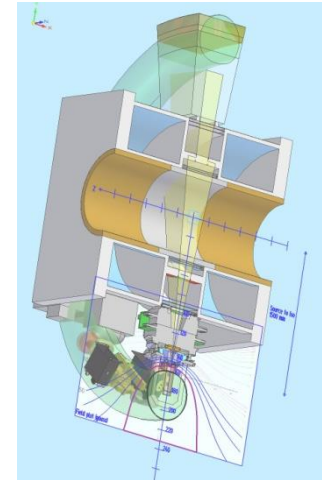
Radiotherapy Development Timeline



IGRT



MR Linac

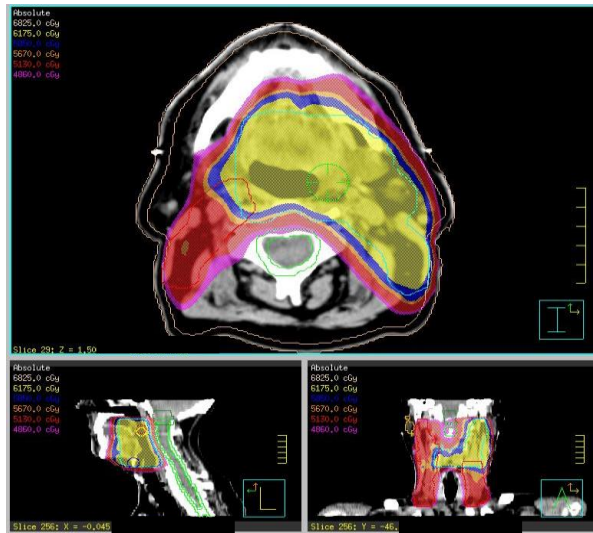


1990 MLC

2000

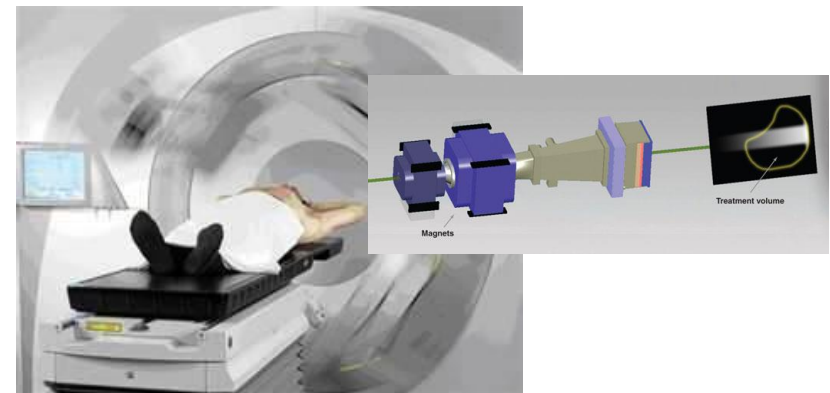
2010

IMRT



VMAT

Proton therapy



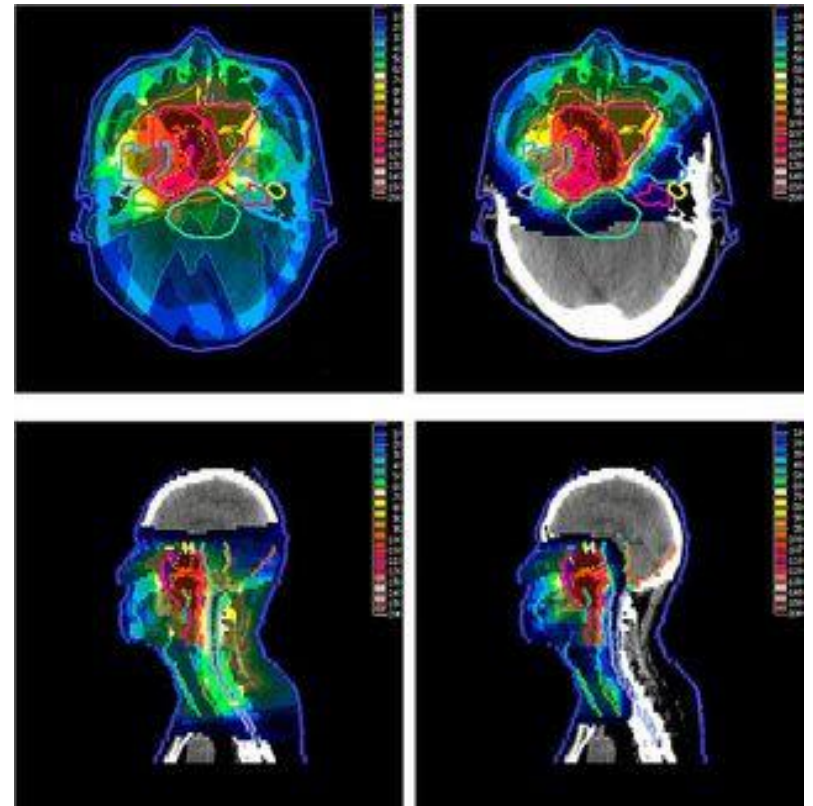
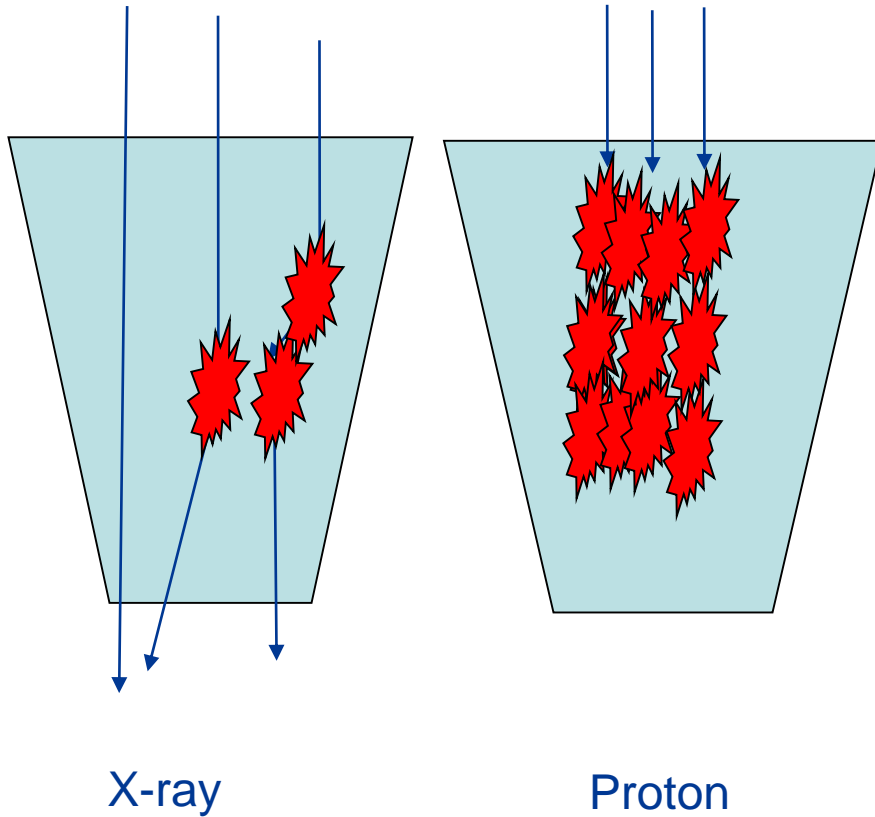


The Christie Advanced Radiotherapy Summer School (11th - 14th July 2016)

The Christie, Manchester, UK, M20 4BX

Further info: <http://adv-radiotherapy.eventbrite.co.uk>

X-ray - Proton Therapy

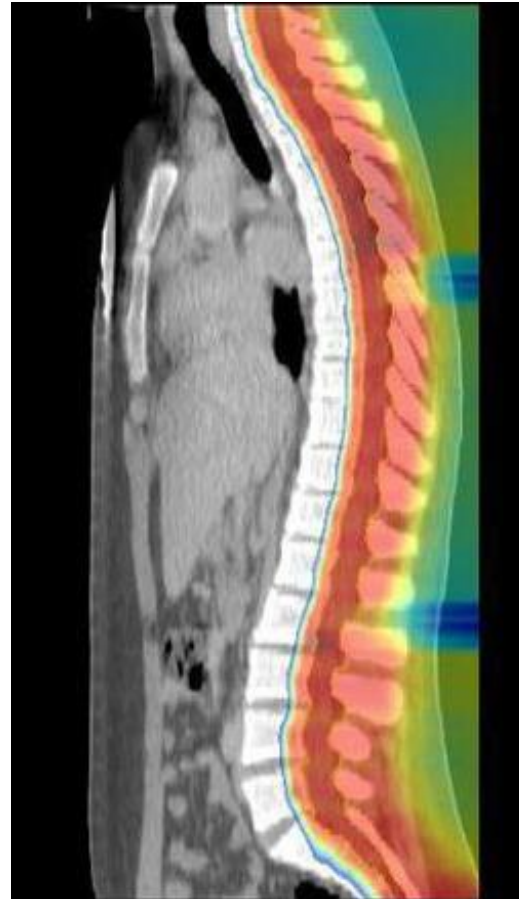


Benefits of protons

Photon (x-ray) treatment



Proton treatment



Superior dose distribution



24 October 2014 Last updated at 13:11

Ashya King finishes proton beam therapy treatment



DAILY Mirror
 55p THURSDAY SEPTEMBER 4, 2014

HOSTAGE BRIT WAS IN SYRIA TO HELP
Judy's on the loose!
 SHE'S BACK ON OUTRAGE TO SEE 2000

CANCER HELL FAMILY REUNITED



Ashya's missed us so badly it's broken his spirit

15 YEAR BROTHER SEEMINGLY WITH DELIGHT BRIST AND HEADPHONES AS HE REUNITED WITH HIS MOTHER BUT SAYS THAT SHE HAD "HAD THE SPIRIT" FOR THE LAST FEW MONTHS. HE ADMITS THAT HE HAS BEEN "VERY SAD" SINCE SHE LEFT HIM IN SYRIA. FULL STORY PAGE A10

15 MONTHS IN SYRIAN JAIL STAY TOOK TOLL ON SON, 5



THE SCOTSMAN

Our goal is for no-one to remain in poverty
 Stephen Gallacher earns Ryder Cup wildcard place

Criminal charges dropped for Ashya's parents

Police chief says sorry to Ashya's family

Second American journalist shot dead in video released by Islamic State terrorists



THE Sun
 THE PEOPLE'S PAPER

STARTS TODAY FROM **£9.50**

197 LOCATIONS TO CHOOSE FROM
 4 COUNTRIES IN EUROPE ON UK

Severe UK alert on terror

FREE INSIDE

EXCLUSIVE KELLY REVEALS ALL
 STUNNING PICTURES PAGES 2 & 3

COPS HUNT DYING TUMOUR BOY, 5

FIND ASHYA
 from hospital bed
 family of 9 on run



10p DAILY EXPRESS

FREE ECHINACEA CAPSULES

Shock as Government raises daily calorie limit

WORKERS ARE FIRED FOR BEING BRITISH

MP makes amazing claim in Parliament

Donna Air: Why I'm backing the Wealth Lottery



London Evening Standard

ERIKSEN'S WAR TO LIVERPOOL

HUNT FOR PARENTS WHO TOOK TUMOUR BOY FROM HOSPITAL

FAMILY FLEE ON FERRY TO FRANCE
 5-YEAR-OLD COULD DIE, POLICE WARN



15p DAILY STAR

Thurs & easy for Teds

FREE INSIDE: Britain's Not Sober postcard

TREBLE X

FACTOR FIX SHOCK

Big Ben Claims in hospital

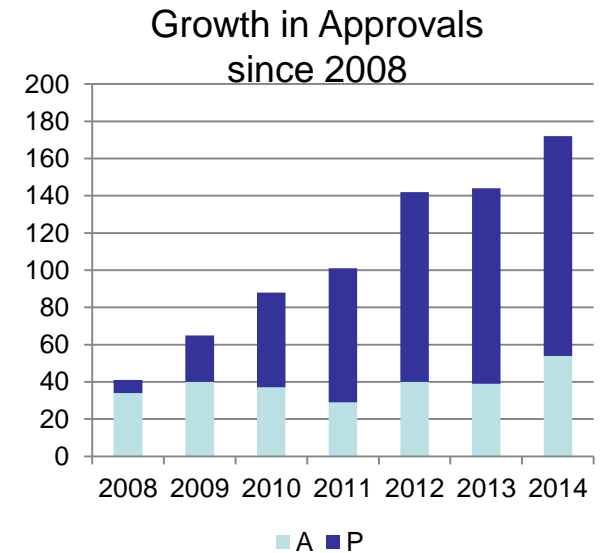
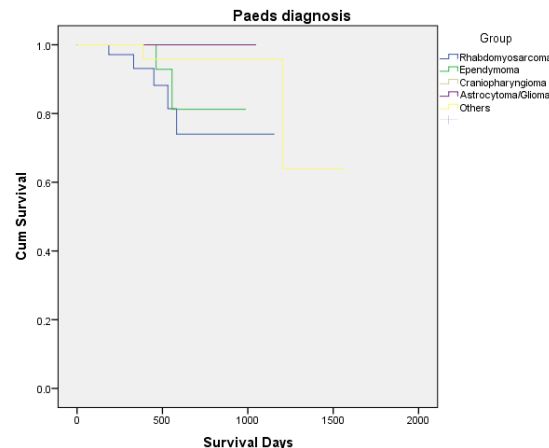
But bury at Ashya court trial



NHS Proton Overseas Programme

- Structured Approach
- Curative Intent
- Clinical Policies and Defined Criteria
- All Cases Reviewed by National Panel
- Equity of Access
- 2 Centres USA,
 - Jacksonville and Oklahoma
 - PSI Villigen
- Outcomes Tracking
- High patient satisfaction

	Approved	Treated
Paediatric	483	429
Adult	197	145
Total	680	574
Total Referred	861	



Capacity - Patient Groups

- 1% all RT Capacity
- NHS England Service Review Radiotherapy
- Business as usual
- Highly Specialised Commissioning

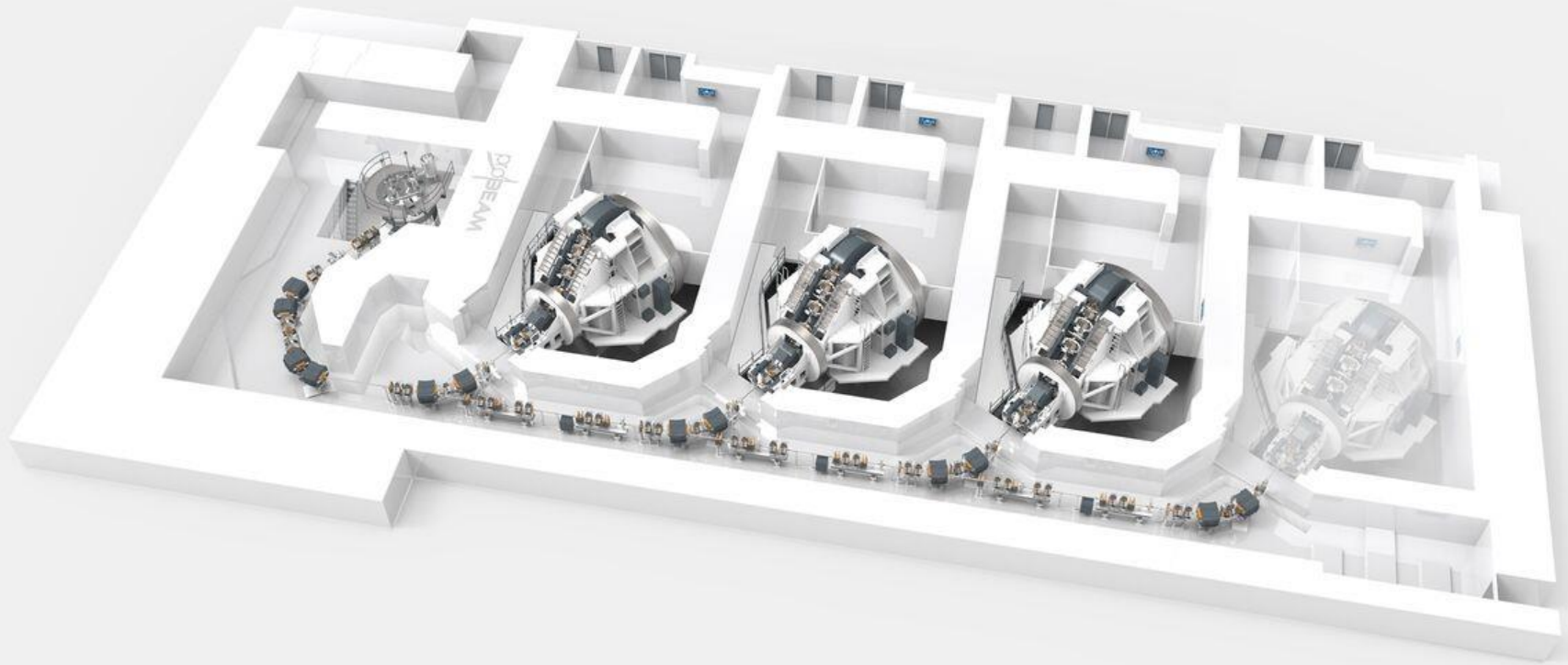
- Clinical Trials
 - Breast
 - Lymphoma
 - Brain and Spinal Cord
- Evaluative Commissioning (CtE)
- 'Enhanced Commissioning Research'

Categories	1500
Paediatric	278
TYA	185
Adult Core	314
Devolved Administrations	147
Total	924
Remaining Capacity	576



Country	Population	Rooms	% of all RT
Sweden	9.5M	2	14%
Denmark	5.6M	3	7%
Holland	17M	7	10%
Norway	5.1M	6	
England	56M	6	1%

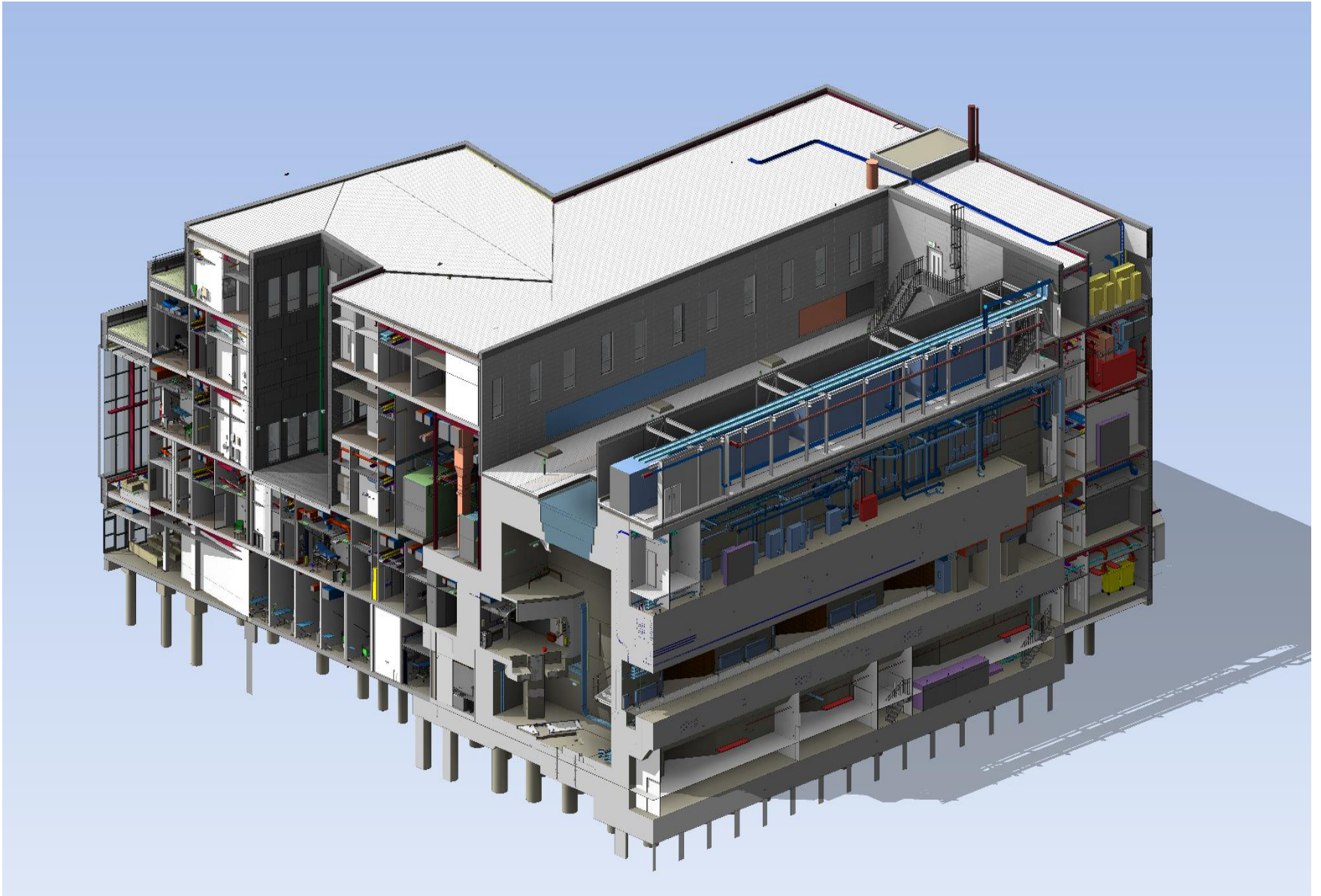




Beam Parameters

- Beam energy ~ 60- 240MeV
- Spot size at max beam energy in air ~ 3.5mm
- Dose rate 2Gy to one litre in 1min
- Field size 30x40cm



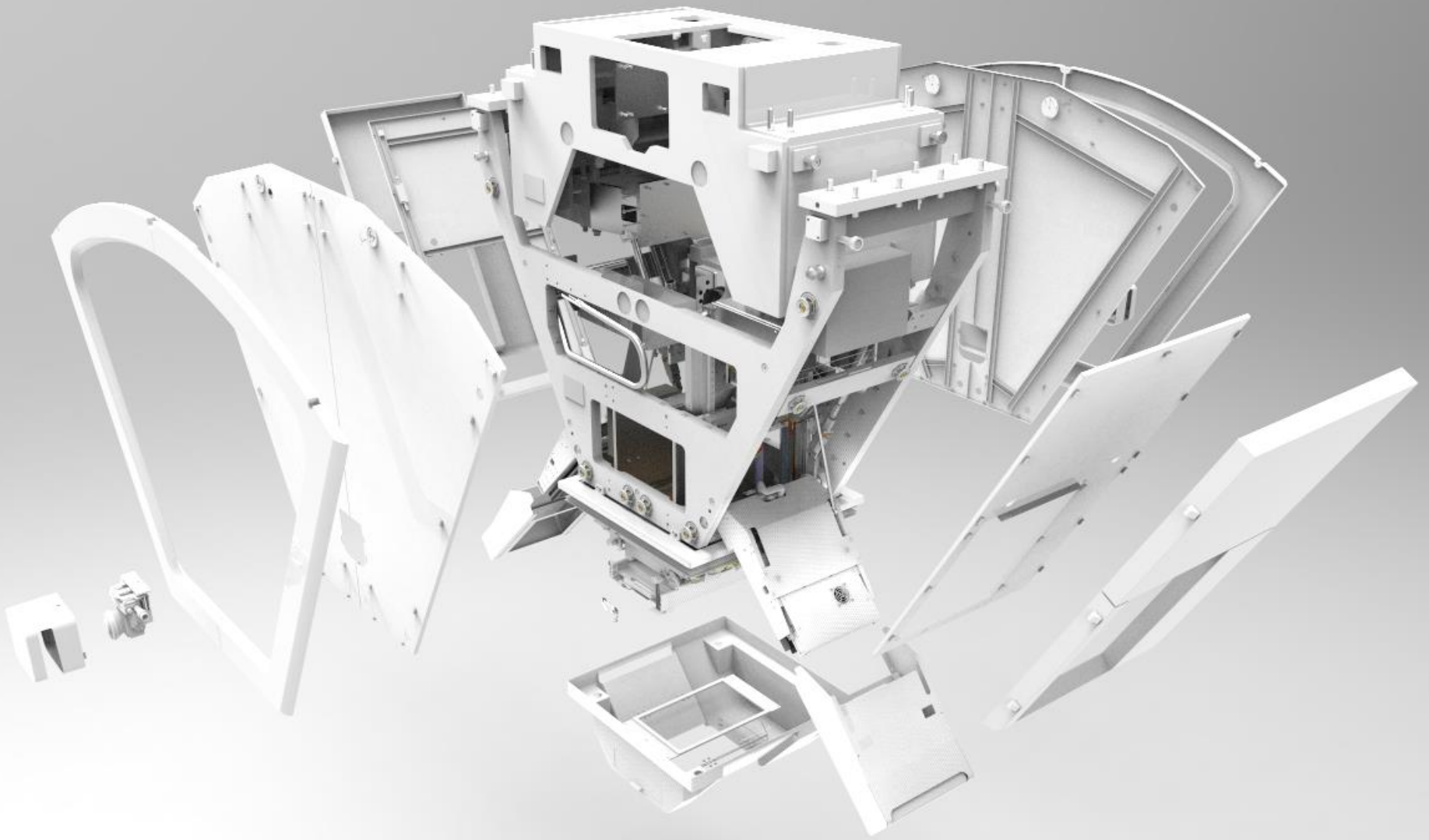




VARIAN
medical systems

ProBEAM





1st scanner magnet Y



2560 mm

2nd scanner magnet X

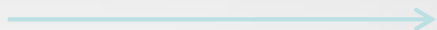


2000 mm

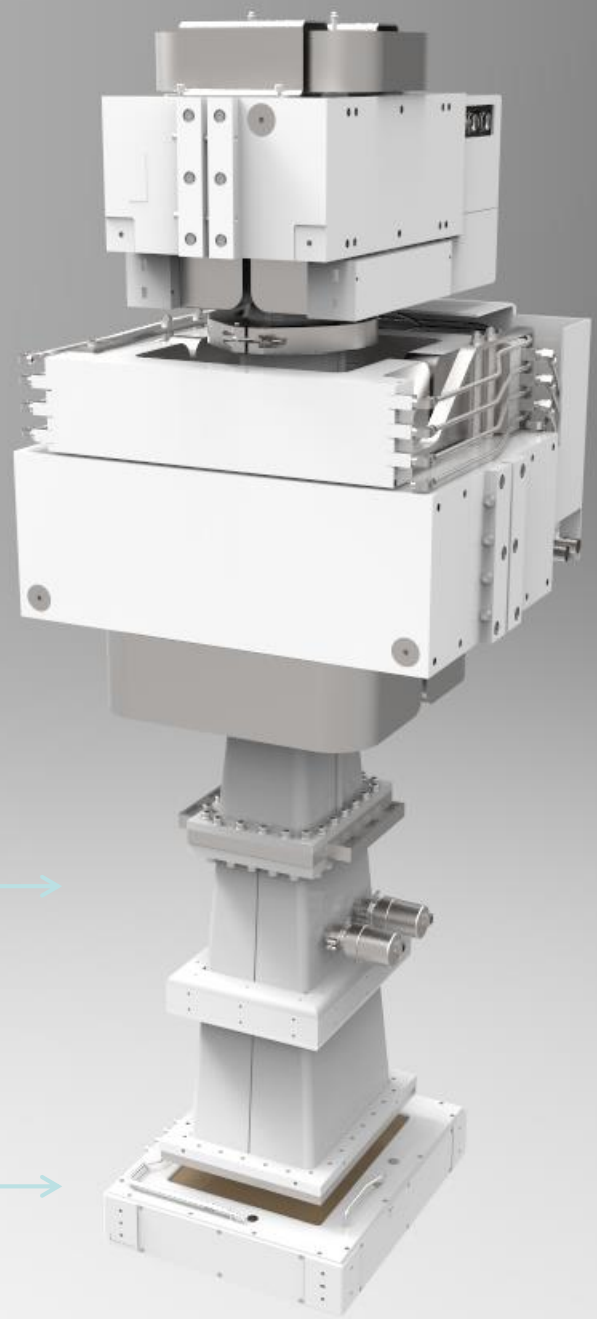
vacuum drift tube



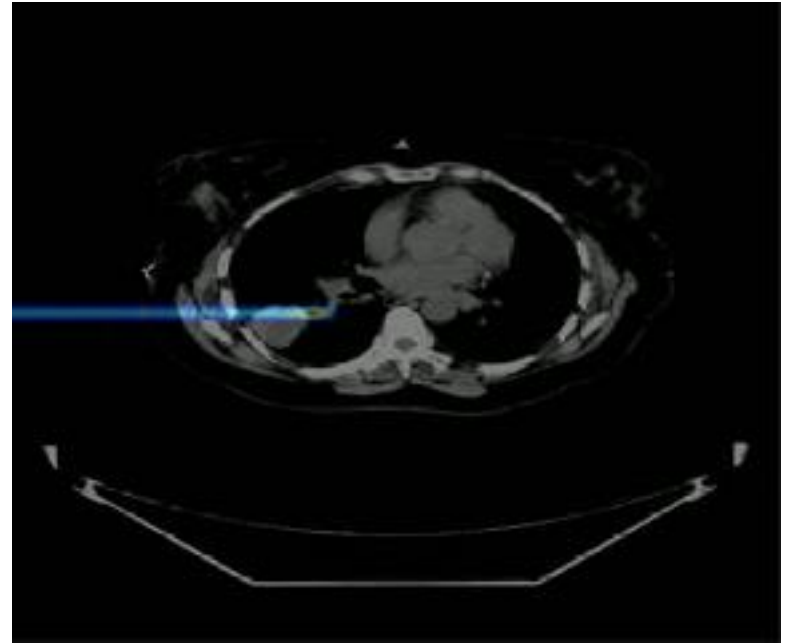
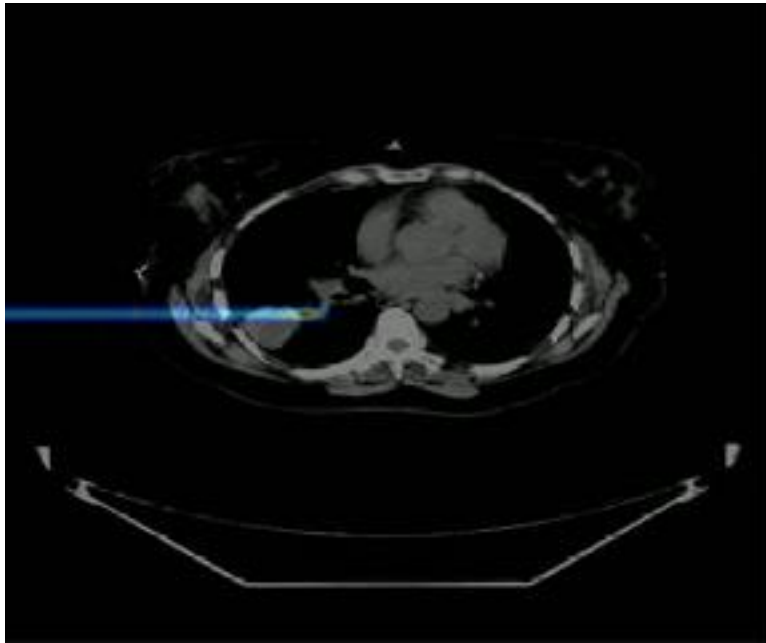
dose and position monitor



895 mm

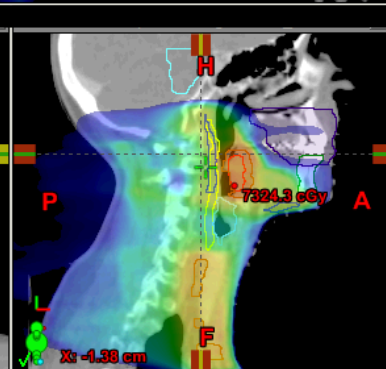
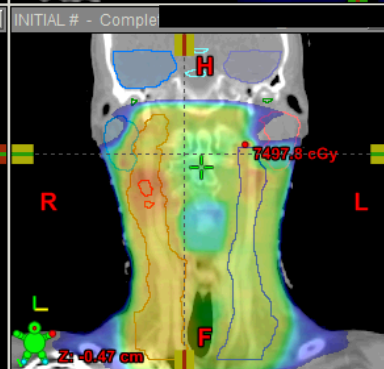
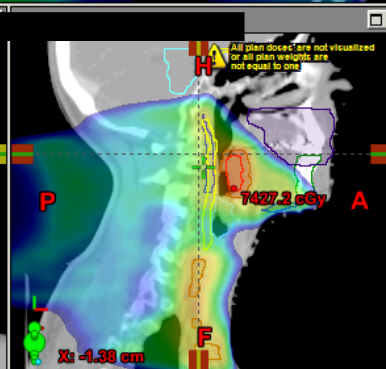
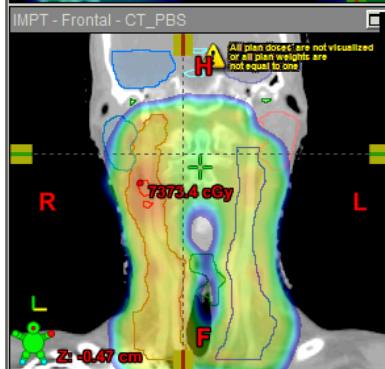
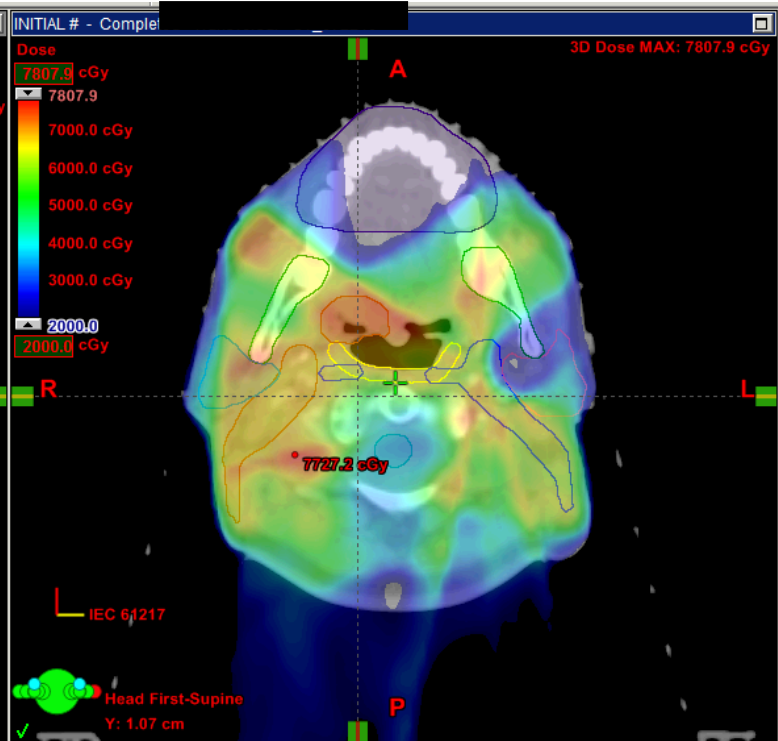


Scanning Beams



PBS

IMRT



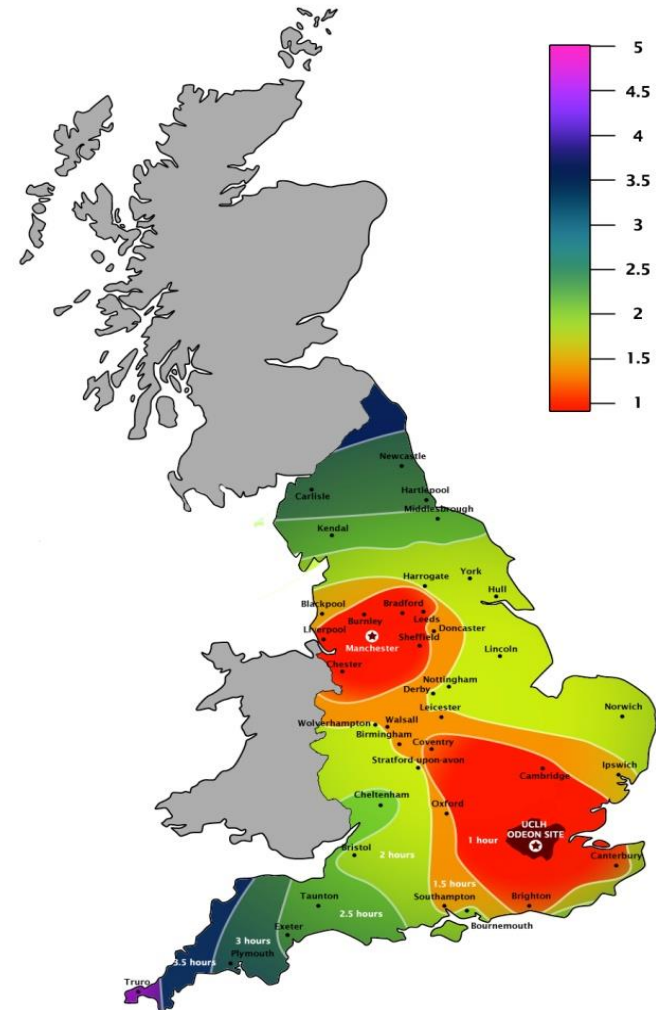
NHSe commissioned provision

— Care within a wider NHS setting

- Mostly rare tumours/indications
- Complex pathway management
- Comprehensive outcomes analysis
 - Core and evaluative indications
- Established research environment

— Care within established Cancer Centres

- Protons - 3 Gantries, 360°
- Advanced photon capacity
- Comprehensive support services
 - Paediatric/TYA/Adult
 - Acute care
 - Diagnostics
 - Chemotherapy
 - Patient Support
 - Academic/Research environment
 - Accommodation



Key issues

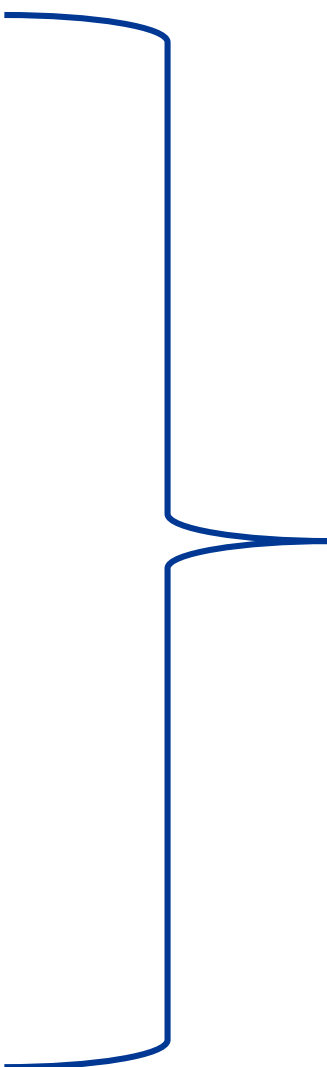
- Complexity
 - It shall deliver proton radiotherapy for the prescribed Indication List
 - Complex indication list with high proportion of paediatrics

Dose

- Improved dose distributions compared to photon radiotherapy

Throughput

- It shall deliver the improved dose distribution to as many patients as possible

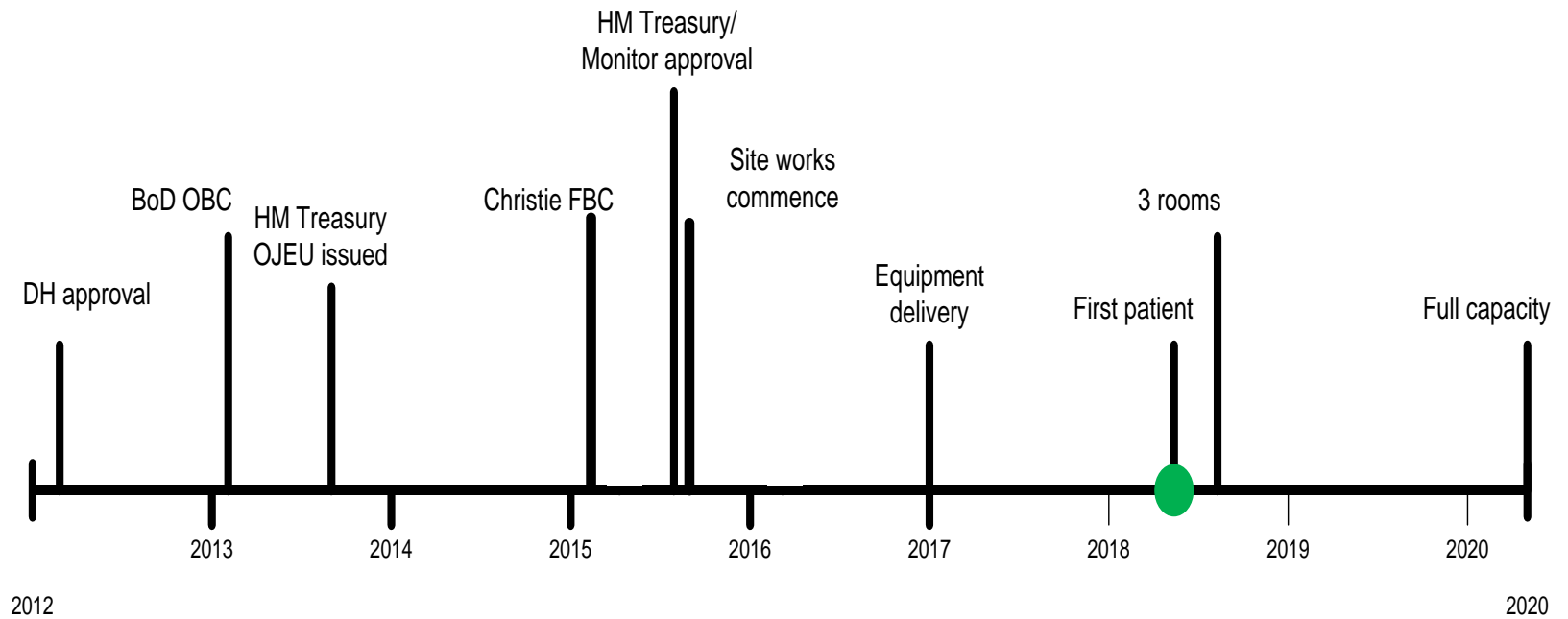


Value for money



Indicative timeline

Projected proton therapy programme





The Christie





Summarise

- Radiotherapy is an effective treatment of cancer and has advanced considerably over the last 20 years
- Proton therapy is one development of radiotherapy that improves dose distribution and enhances outcome for patients
- The national facilities at the Christie and UCLH UK will offer a limited provision for patients that currently have to go abroad for treatment
- Research into the technology and benefits of proton therapy is an important part of proton therapy developments in the UK

