Me and Medical Physics: passion and perseverance, positrons and parenting

Dr Heather Williams

Senior Medical Physicist for Nuclear Medicine,
Central Manchester University Hospitals
Honorary Lecturer, University of Manchester
Director, ScienceGrrl
Chair of Women in Physics Group, IoP

Central Manchester University Hospitals NHS
NHS Foundation Trust

MANCHESTER 1824
The University of Manchester

IOP
Institute of Physics

SCIENCE GRRL


Neurostimulator Clinic
4008S


Occupied
BIOHAZARD
ACDP CONTAINMENT LEVEL 3
RESTRICTED ENTRY
DEFRA
GROUP 3
RESTRICTED ENTRY

What is Healthcare Science?

55,000 healthcare scientists (clinical scientists and supporting technical staff) work in the NHS or its related bodies, the Health Protection Agency and NHS Blood and Transplant, representing the largest group of scientists in a single employment sector in the UK.

Their vast scientific knowledge and skill base stretches across some 45 scientific specialisms encompassing biology, genetics, physiology, physics and bioengineering.

What difference do Healthcare Scientists make?

The knowledge and experience of healthcare scientists has a crucial and unique role in :

– providing complex and specialist diagnostic services (more than 80% of all diagnoses are reached with a contribution from healthcare scientists.)

– offering direct therapeutic service provision and support

– introducing technological and scientific advances into healthcare, and undertaking research and development

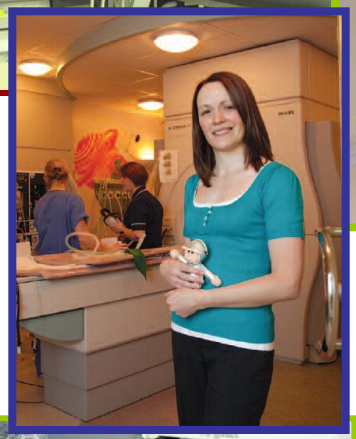
– providing performance and quality assurance, risk management and clinical safety design and management

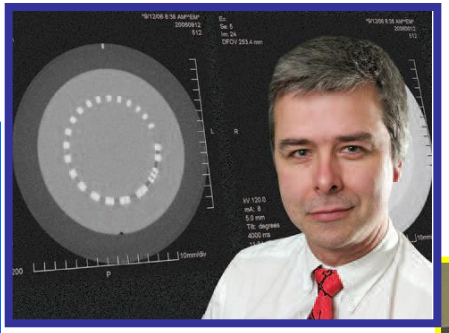
– teaching, training and providing a specialist consultancy and clinical advice service to other clinicians

What difference do Medical Physicists make?





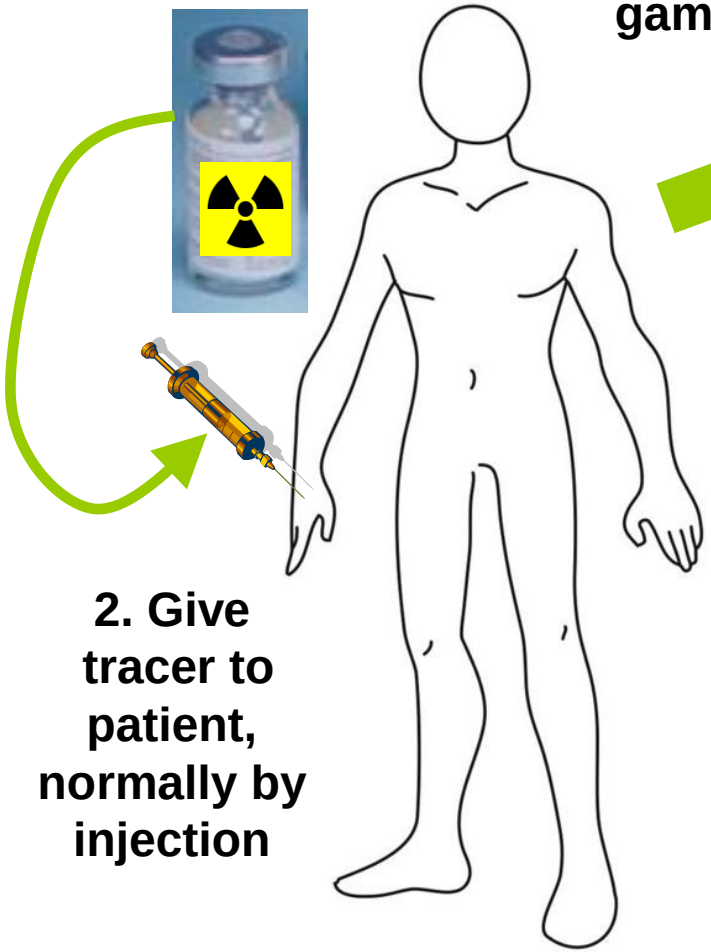






Imaging in Nuclear Medicine

1. Make slightly radioactive tracer



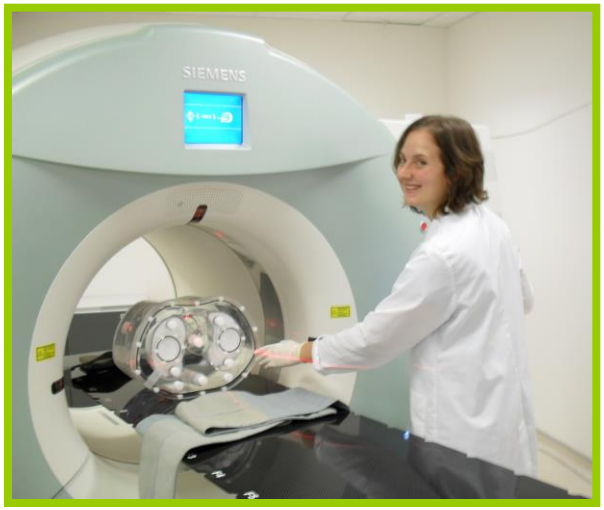
2. Give tracer to patient, normally by injection

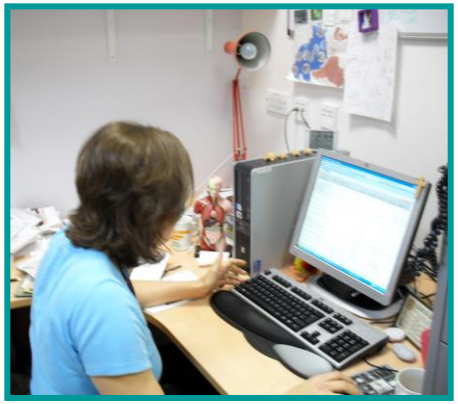
Image gamma rays directly using a gamma camera

3. TAKE PICTURES

Image positrons indirectly using gamma rays detected by a PET camera

In Nuclear Medicine…



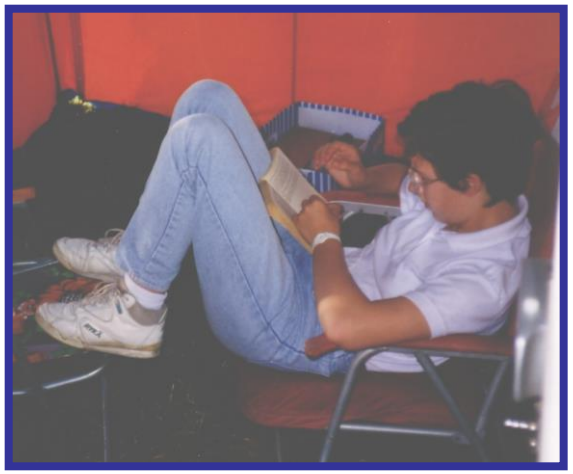


Medical physicists

- Test scanning equipment to see how well it is working
- Help process images to get useful pictures and measures of how well tissue is working
- Work out new and better ways of doing scans
- Make sure radioactive material is used safely

How did I get here?

How I became a Medical Physicist



Naturally inquisitive, into everything!
Worked hard and enjoyed science at school

At 16: work experience in Medical Physics
Decided to become a Medical Physicist

Did well in GCSEs

September 1988 - July 1993 Archbishop Thurstan School Hopewell Road, Hull	10 G.C.S.E. (with grades): Science (Dual Award, AA), English Language (A), English Literature (A), Mathematics (B), Music (A), Humanities (A), Geography (A), French (A), Art (A). Also: Crest Award (Bronze) for a Technology Project and Young Enterprise Europe Business Examination (Distinction) following post as Sales & Marketing Director of Company making traditional children's toys.

At 16: work experience in Medical Physics
Decided to become a Medical Physicist

Did well in GCSEs

Did Maths, Physics and Chemistry at college

Did well in A-levels

September 1993 - July 1995 Wilberforce College Saltshouse Road, Hull	4 G.C.E. 'A' - levels (with grades): Physics (A), Salter's Chemistry (A), Mathematics (A), General Studies (B).

Peripatetic and Private Tuition	Violoncello, Grades I - VIII (Distinction) Pianoforte, Grades I - VI Music Theory, Grade V

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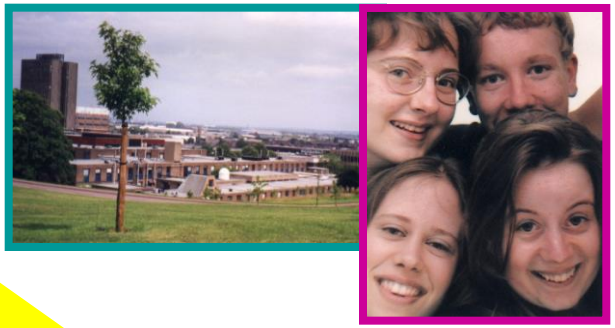
Did Physics degree at Nottingham Uni



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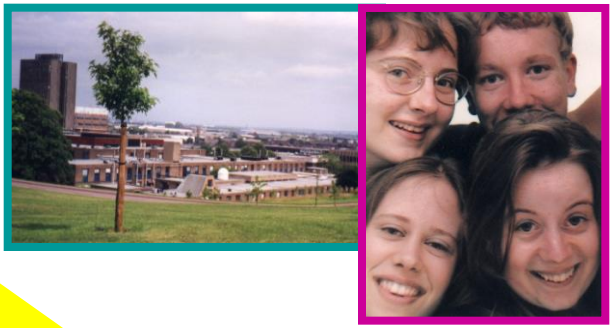
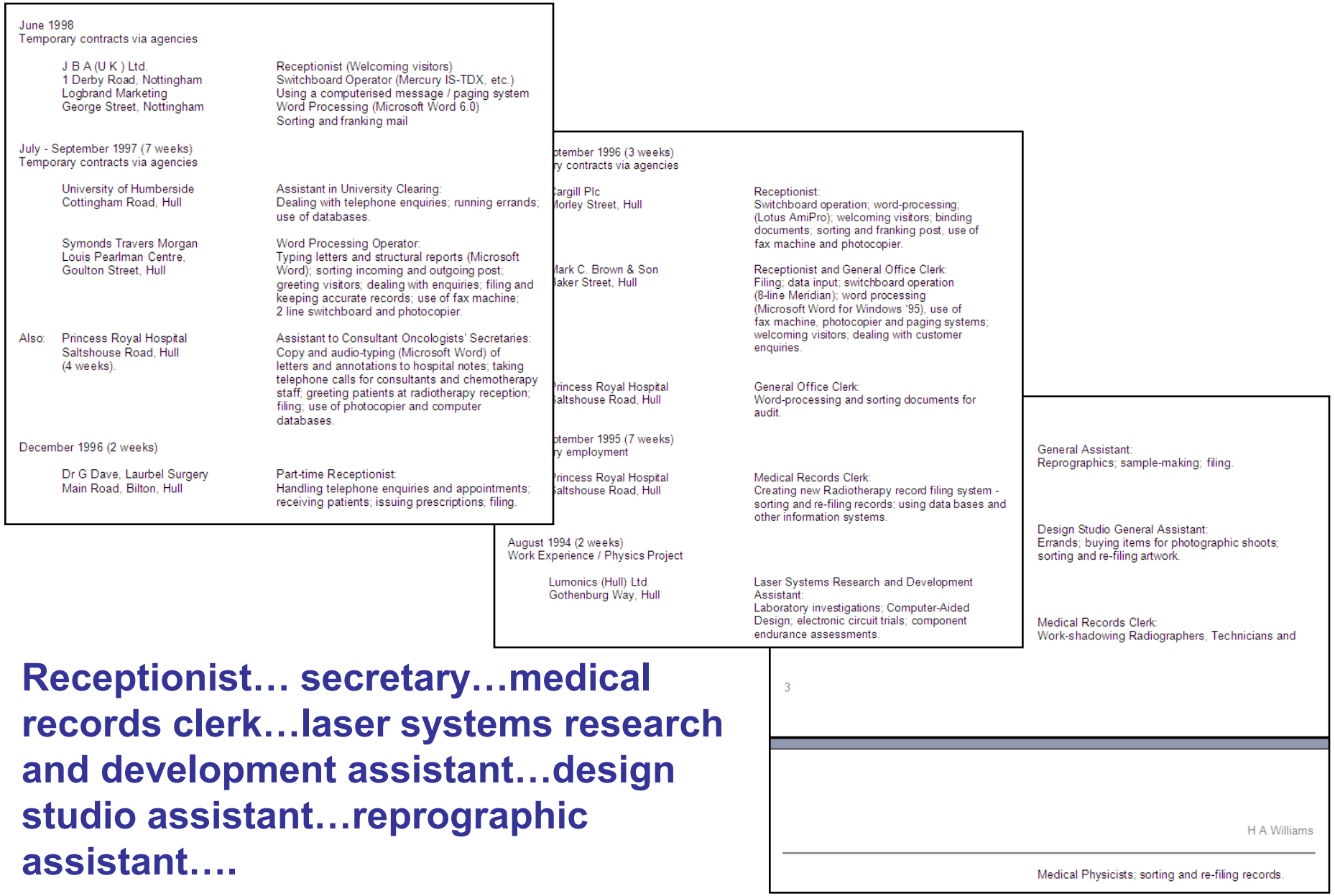


Got a good degree…

September 1995 - July 1998 University of Nottingham University Park, Nottingham	First Class Honours (70.3% overall) BSc Degree in Physics with Medical Physics

The importance of work experience



June 1998
Temporary contracts via agencies

J B A (U K) Ltd.
1 Derby Road, Nottingham
Logbrand Marketing
George Street, Nottingham

Receptionist (Welcoming visitors)
Switchboard Operator (Mercury IS-TDX, etc.)
Using a computerised message / paging system
Word Processing (Microsoft Word 6.0)
Sorting and franking mail

July - September 1997 (7 weeks)
Temporary contracts via agencies

University of Humberside
Cottingham Road, Hull

Assistant in University Clearing:
Dealing with telephone enquiries; running errands; use of databases.

Symonds Travers Morgan
Louis Pearlman Centre,
Goulton Street, Hull

Word Processing Operator:
Typing letters and structural reports (Microsoft Word); sorting incoming and outgoing post; greeting visitors; dealing with enquiries; filing and keeping accurate records; use of fax machine; 2 line switchboard and photocopier.

Also: Princess Royal Hospital
Saltshouse Road, Hull
(4 weeks).

Assistant to Consultant Oncologists' Secretaries:
Copy and audio-typing (Microsoft Word) of letters and annotations to hospital notes; taking telephone calls for consultants and chemotherapy staff; greeting patients at radiotherapy reception; filing; use of photocopier and computer databases.

December 1996 (2 weeks)

Dr G Dave, Laurbel Surgery
Main Road, Bilton, Hull

Part-time Receptionist:
Handling telephone enquiries and appointments; receiving patients; issuing prescriptions; filing.

tember 1996 (3 weeks)
y contracts via agencies

Cargill Plc
Morley Street, Hull

Receptionist:
Switchboard operation; word-processing; (Lotus AmiPro); welcoming visitors; binding documents; sorting and franking post, use of fax machine and photocopier.

Mark C. Brown & Son
Baker Street, Hull

Receptionist and General Office Clerk:
Filing; data input; switchboard operation (8-line Meridian); word processing (Microsoft Word for Windows '95), use of fax machine, photocopier and paging systems; welcoming visitors; dealing with customer enquiries.

Princess Royal Hospital
Saltshouse Road, Hull

General Office Clerk:
Word-processing and sorting documents for audit.

tember 1995 (7 weeks)
y employment

Princess Royal Hospital
Saltshouse Road, Hull

Medical Records Clerk:
Creating new Radiotherapy record filing system - sorting and re-filing records; using data bases and other information systems.

August 1994 (2 weeks)
Work Experience / Physics Project

Lumonics (Hull) Ltd
Gothenburg Way, Hull

Laser Systems Research and Development Assistant:
Laboratory investigations; Computer-Aided Design; electronic circuit trials; component endurance assessments.

General Assistant:
Reprographics; sample-making; filing.

Design Studio General Assistant:
Errands; buying items for photographic shoots; sorting and re-filing artwork.

Medical Records Clerk:
Work-shadowing Radiographers, Technicians and

3

H A Williams

Medical Physicists; sorting and re-filing records.

Receptionist… secretary…medical records clerk…laser systems research and development assistant…design studio assistant…reprographic assistant….

At 16: work experience in Medical Physics
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Did well in GCSEs

Did Maths, Physics and Chemistry at college

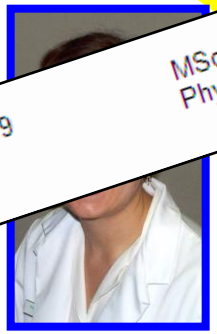
Did well in A-levels

Did Physics degree at Nottingham Uni

Got a good degree…

…and a job as a trainee Medical Physicist

Did Medical Physics training in Manchester



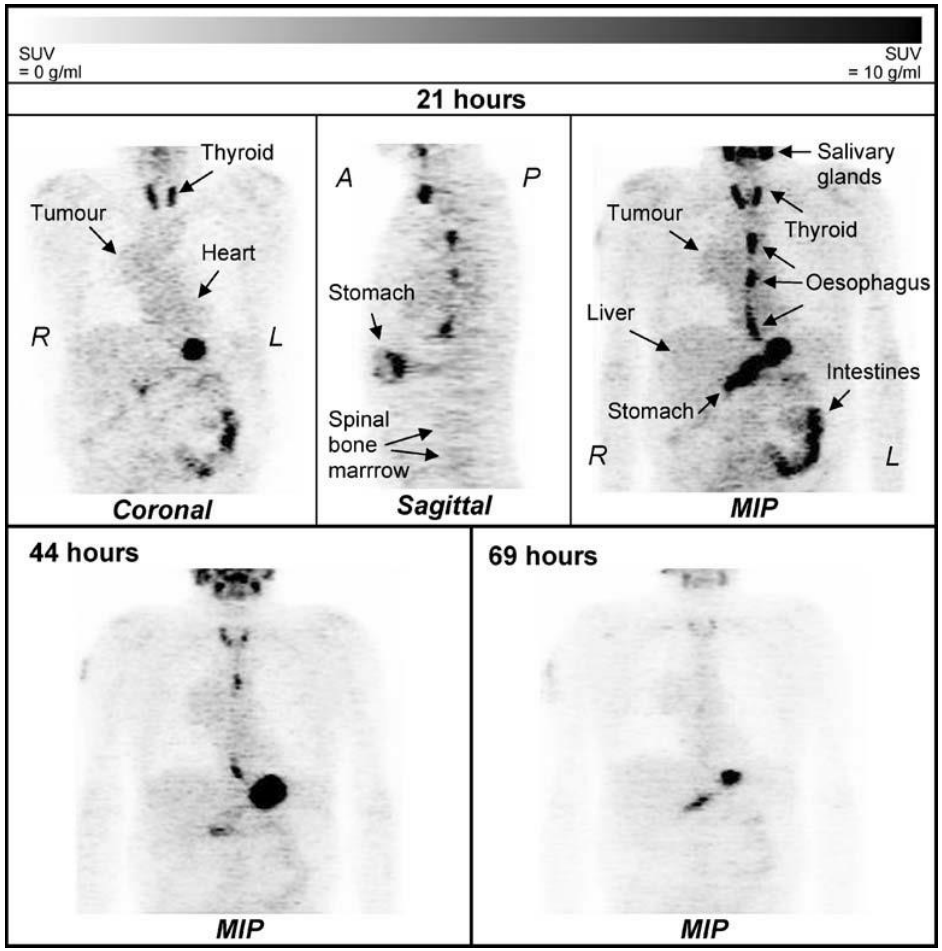
September 1998 - December 1999
University of Manchester
Oxford Road, Manchester

MSc degree (70.8% overall) in
Physics and Computing in Medicine and Biology

Graduated from the training

Decided to do a PhD while I had the chance! (not essential for my job)

The key finding of my PhD

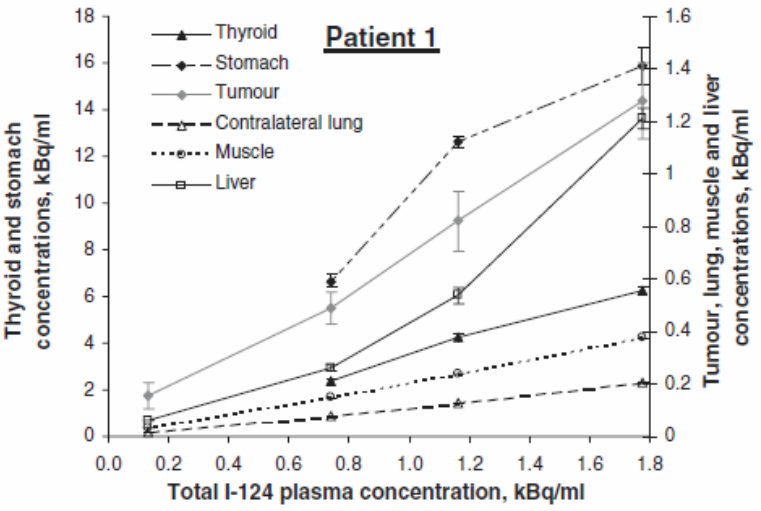


Eur J Nucl Med Mol Imaging (2007) 34:301–303
DOI 10.1007/s00259-006-0107-5
Published online: 16 November 2006

Does ^{124}Iodo-deoxyuridine measure cell proliferation in NSCLC? Initial investigations with PET imaging and radio-metabolite analysis

Answer?

No



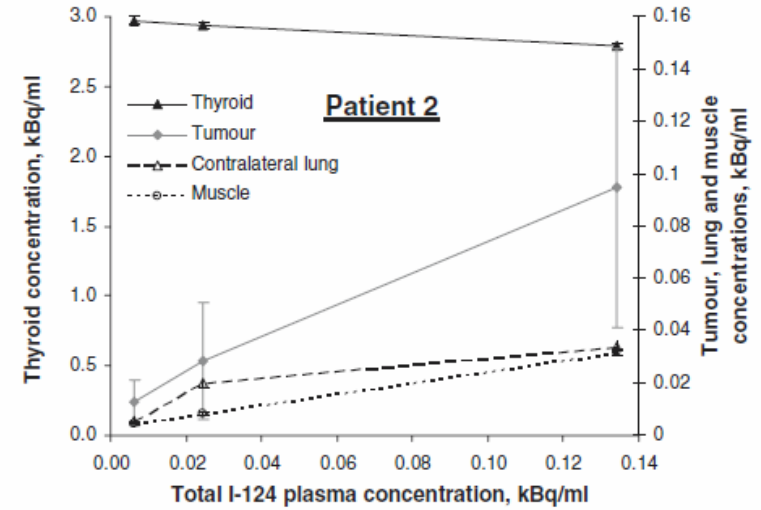


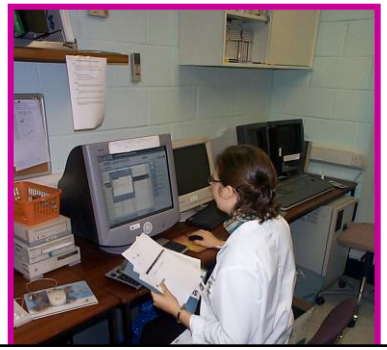
Fig. 2. Variation of tissue radioactivity concentration (kBq/ml) with total blood plasma ^{124}I concentration (kBq/ml) for patients 1 and 2

Decided to do a PhD while I had the chance! (not essential for my job)

Got PhD

January 2001 - December 2004	UMIST (DIAS) PhD titled 'Developing quantitative measures for clinical response assessment using Positron Emission Tomography' Including extensive phantom studies and image analysis, plus dynamic ^{18}FDG and sequential ^{124}IUdR imaging of NSCLC patients.

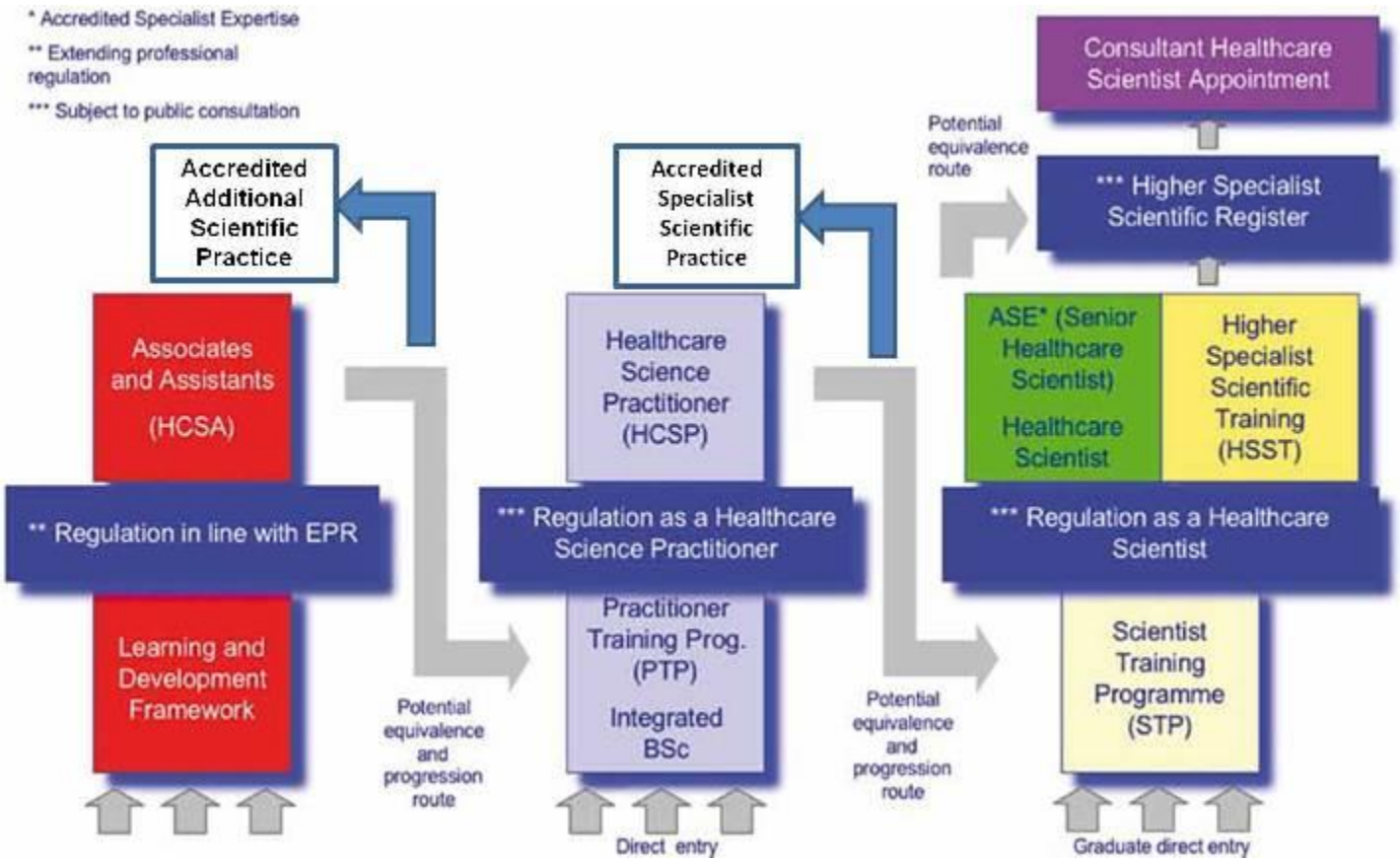
Started current job as Medical Physicist in Nuclear Medicine at Manchester Royal Infirmary



February 2006 - present	Central Manchester University Hospitals Nuclear Medicine Centre Senior Medical Physicist (Band 8A) Supporting clinical diagnostic and therapeutic work through R&D, teaching and training. PETCT specialist.
February 2006 - present	University of Manchester, Faculty of Medicine and Health Sciences Honorary Lecturer (Education)
January 2004 - February 2006	Manchester Royal Infirmary Nuclear Medicine Department Medical Physicist (Grade B8-11)
September 1998 - December 2000	Christie Hospital NHS Trust Trainee Medical Physicist (Grade A) Postgraduate training, including placements in: Nuclear Medicine; Diagnostic Radiology; Magnetic Resonance Imaging; Radiotherapy.

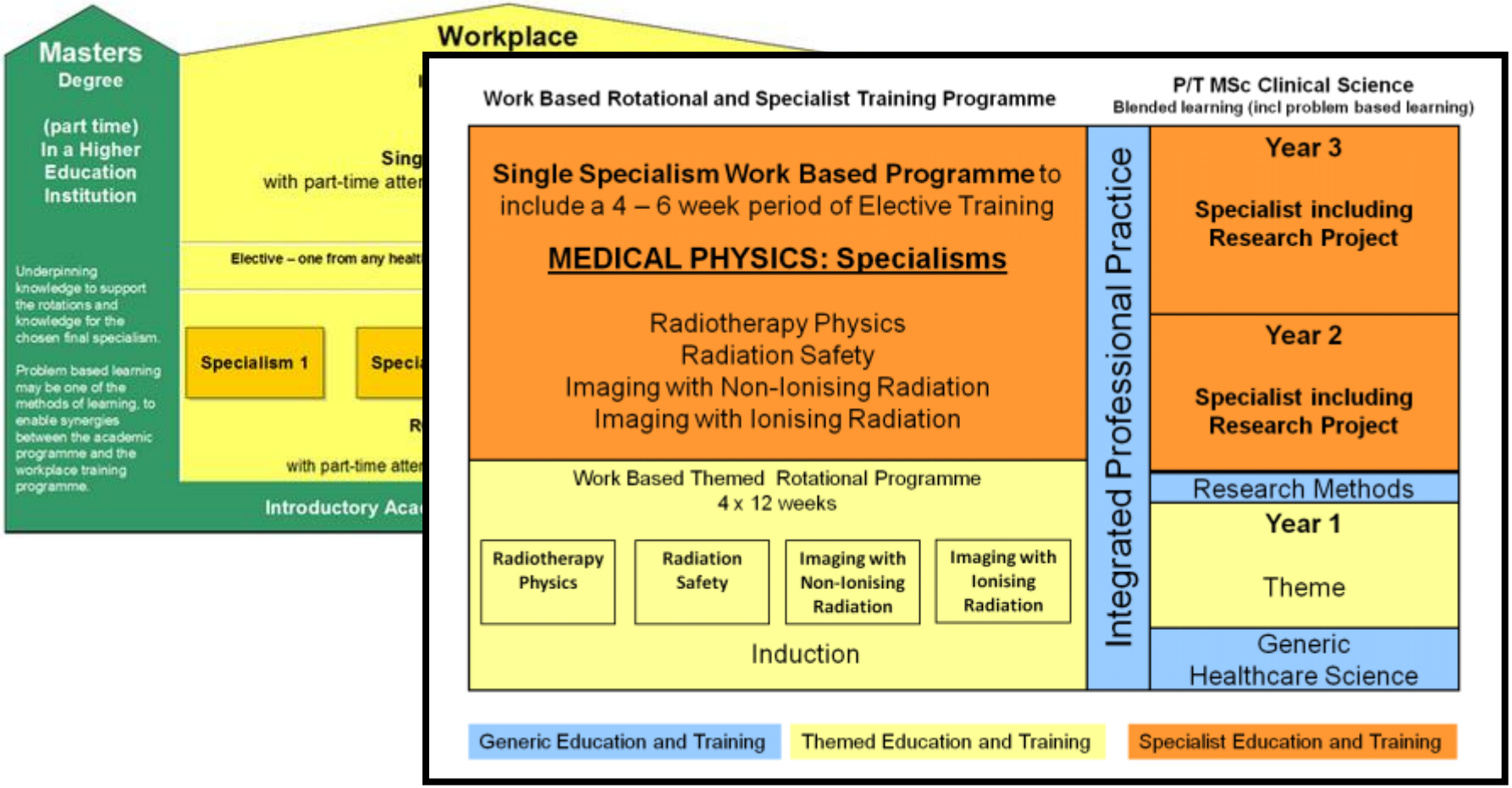
PS. ALL CHANGE! Current training scheme

Modernising Scientific Careers

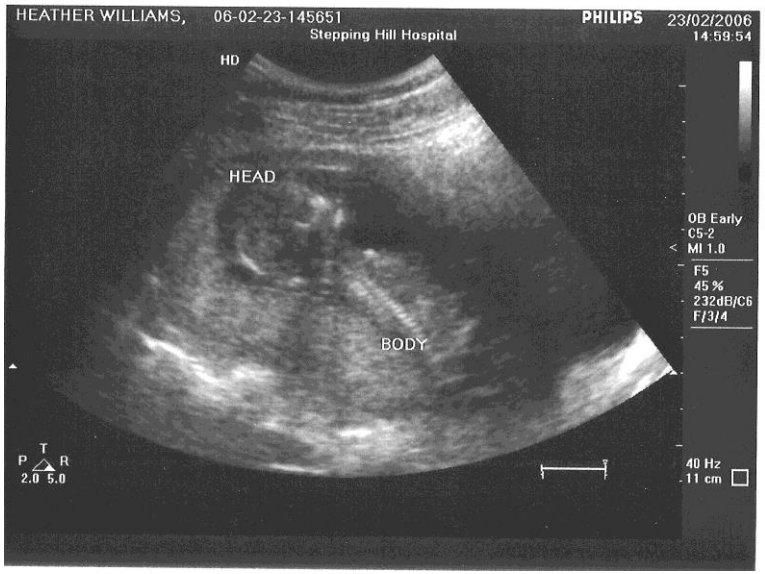


PS. ALL CHANGE! Current training scheme

Structure and rotations for NHS Scientist Training Programme



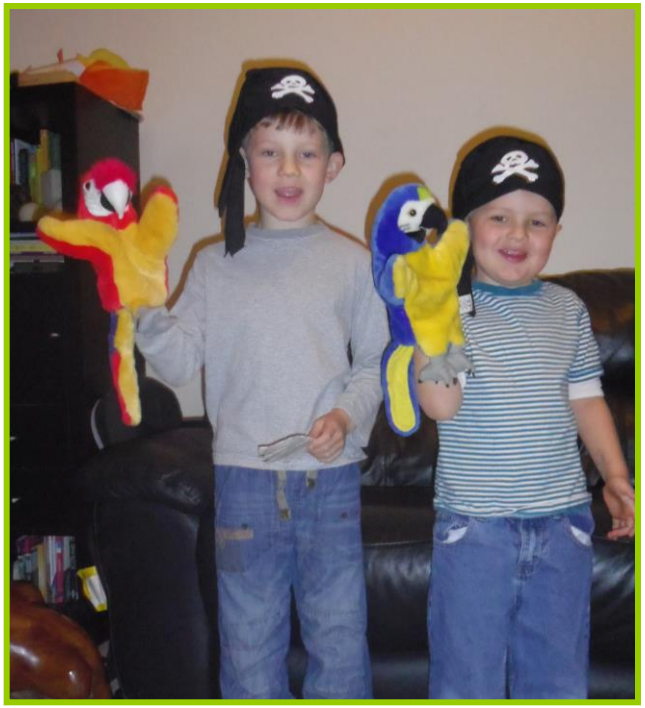
http://www.nhscareers.nhs.uk/explore-by-career/healthcare-science/modernising-scientific-careers/



And then there were BABIES ☺

Lars

Bryn



Decided to do a PhD while I had the chance! (not essential for my job)

Got PhD

Got State Registration

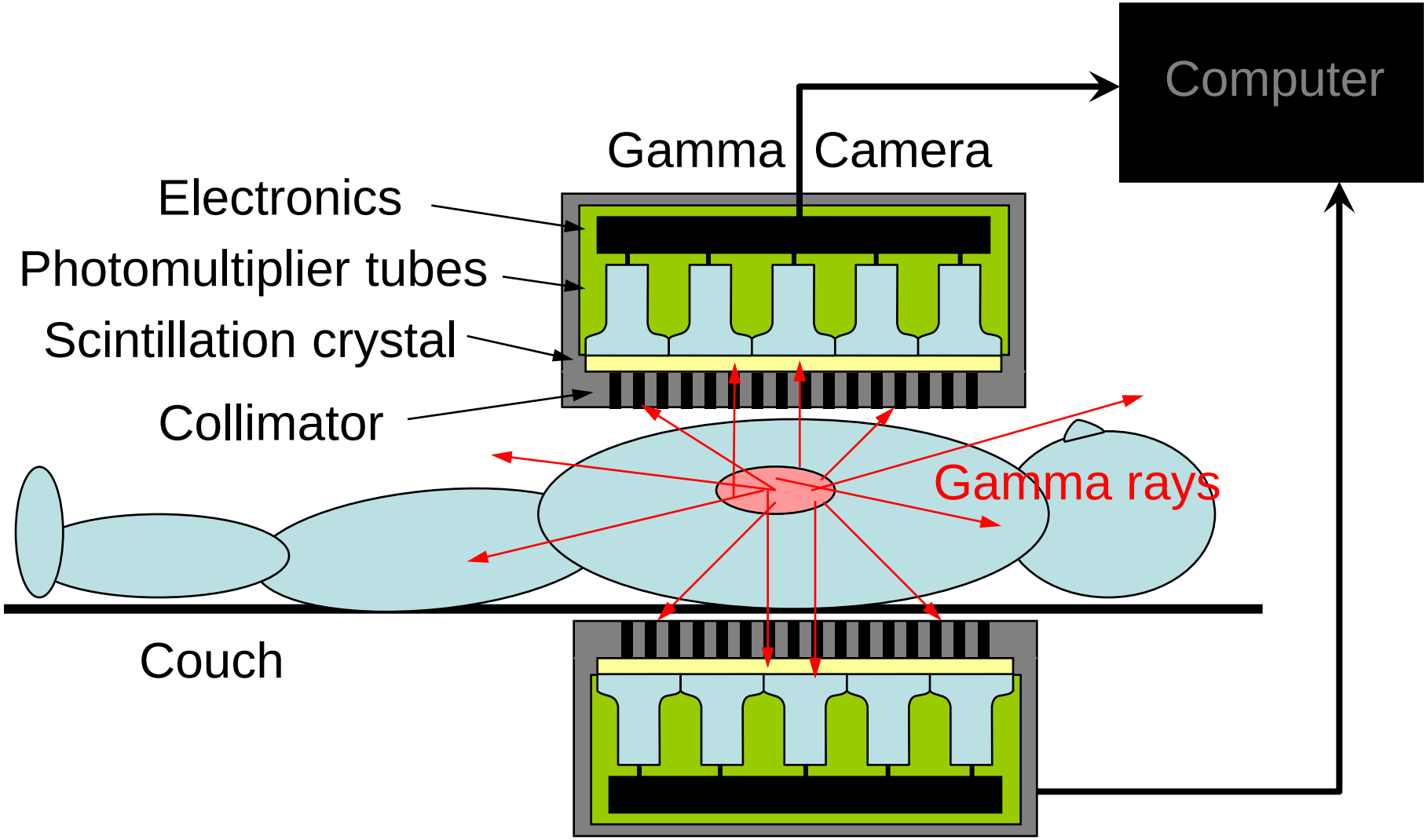
Started current job as Medical Physicist in Nuclear Medicine at Manchester Royal Infirmary

What do I do every day?

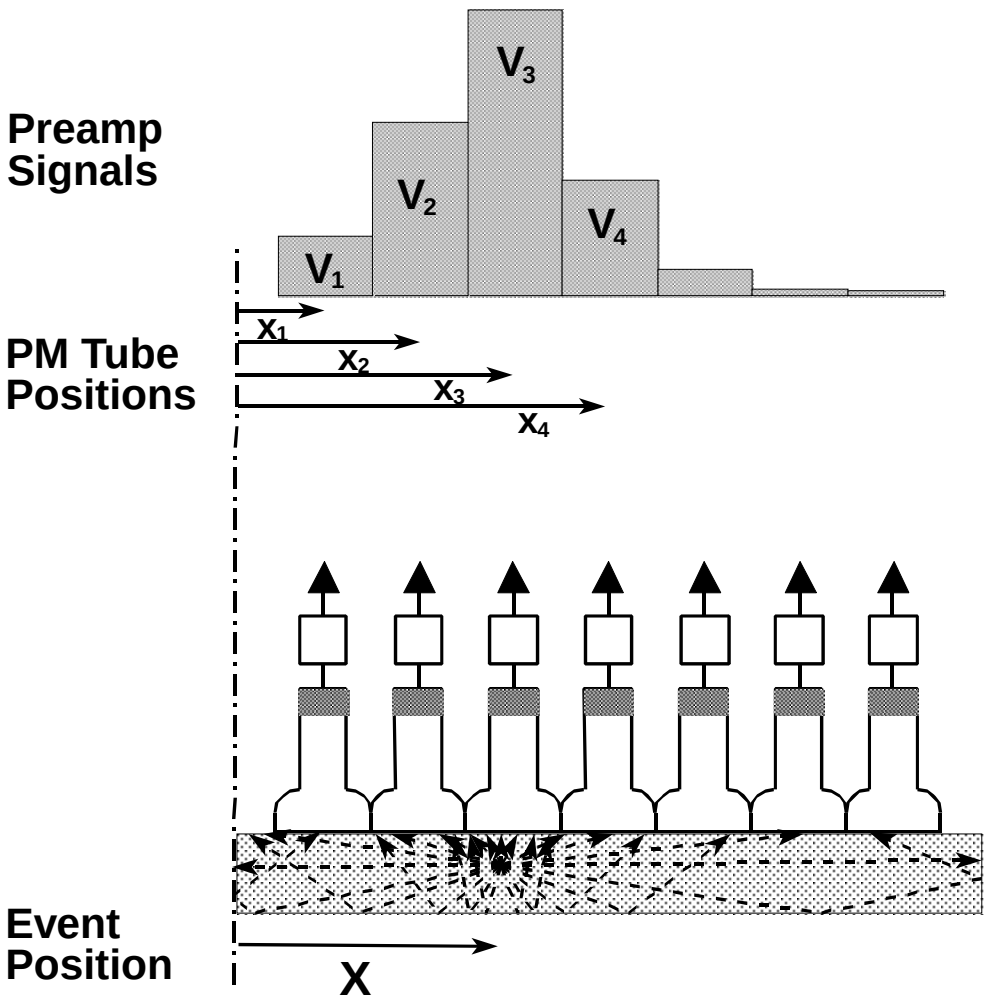
- Routine data archiving, patient image analysis and camera performance tests
- Respond to requests about analysing unusual images, modifying scanning protocols for individual patients, resolving or working around camera malfunctions
- Advise patients and colleagues on radiation safety and compliance with relevant regulations
- Teach (theory) and train (practice) junior colleagues, medics, and post-graduate students
- Set up, oversee and analyse data from research projects

Modern Gamma Camera

How a gamma camera works



Determining energy and position

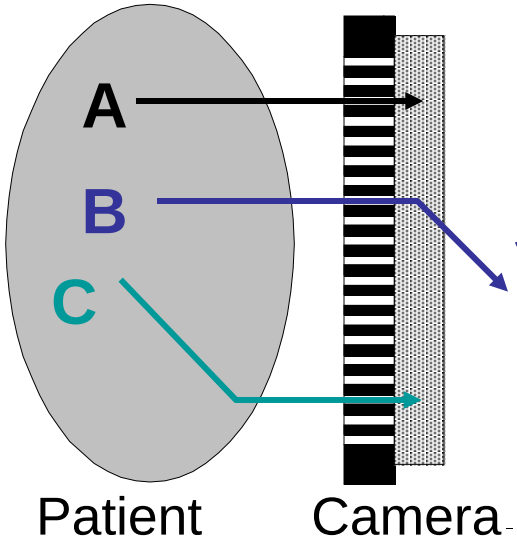


$$E = V_1 + V_2 + V_3 + V_4 + \ldots$$

$$X = \frac{x_1V_1 + x_2V_2 + x_3V_3 + x_4V_4 + \ldots}{E}$$

$$Y = \frac{y_1V_1 + y_2V_2 + y_3V_3 + y_4V_4 + \ldots}{E}$$

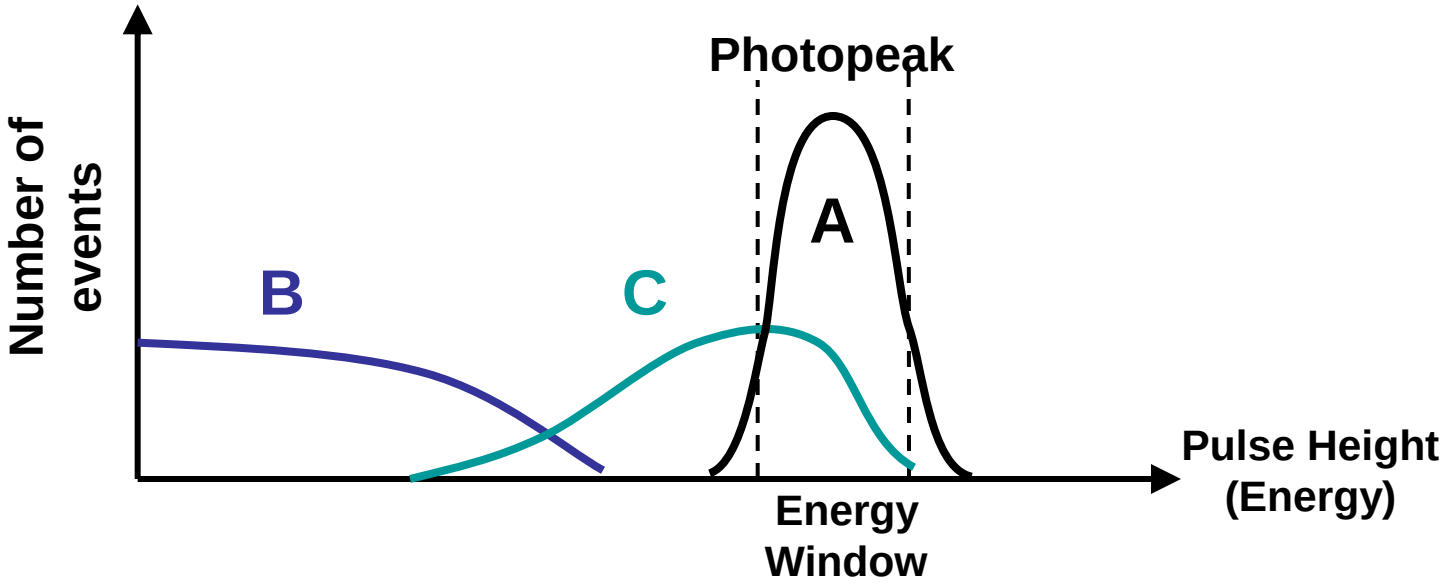
Scatter Rejection



No scatter

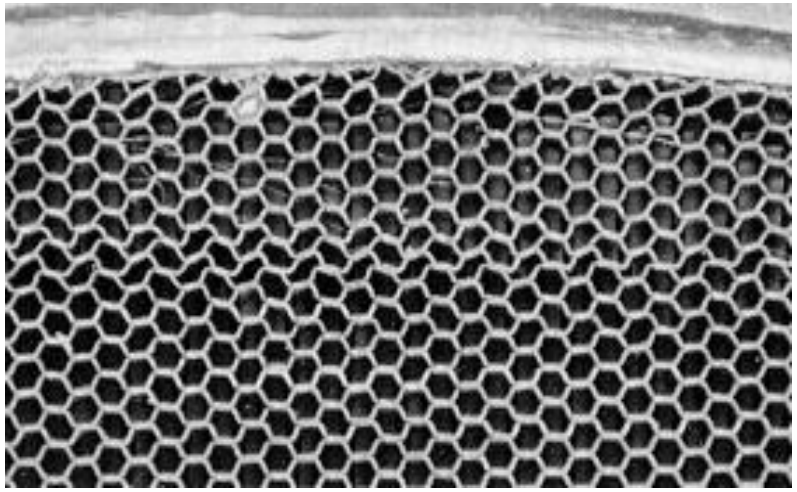
Scatter in crystal

Scatter in patient

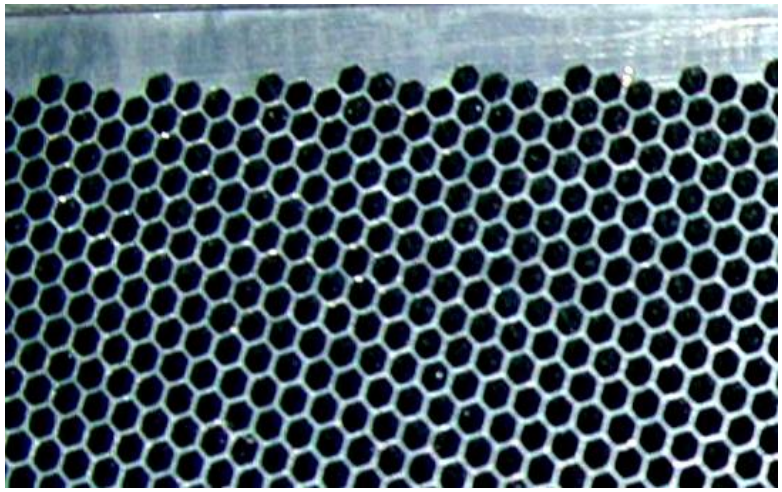


Collimators

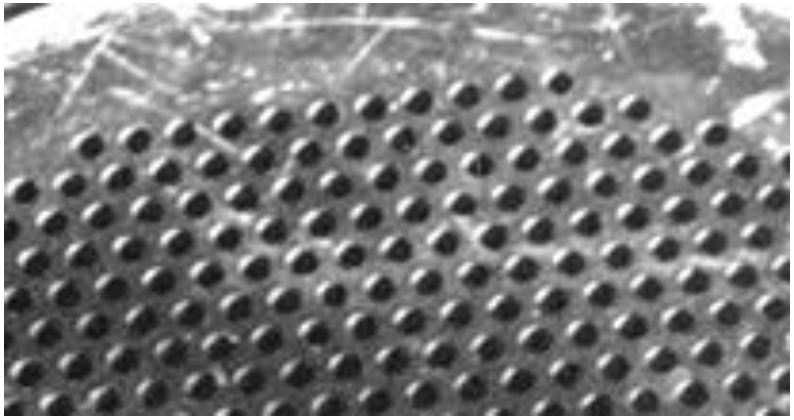
Low Energy Collimators



Foil construction



Cast construction

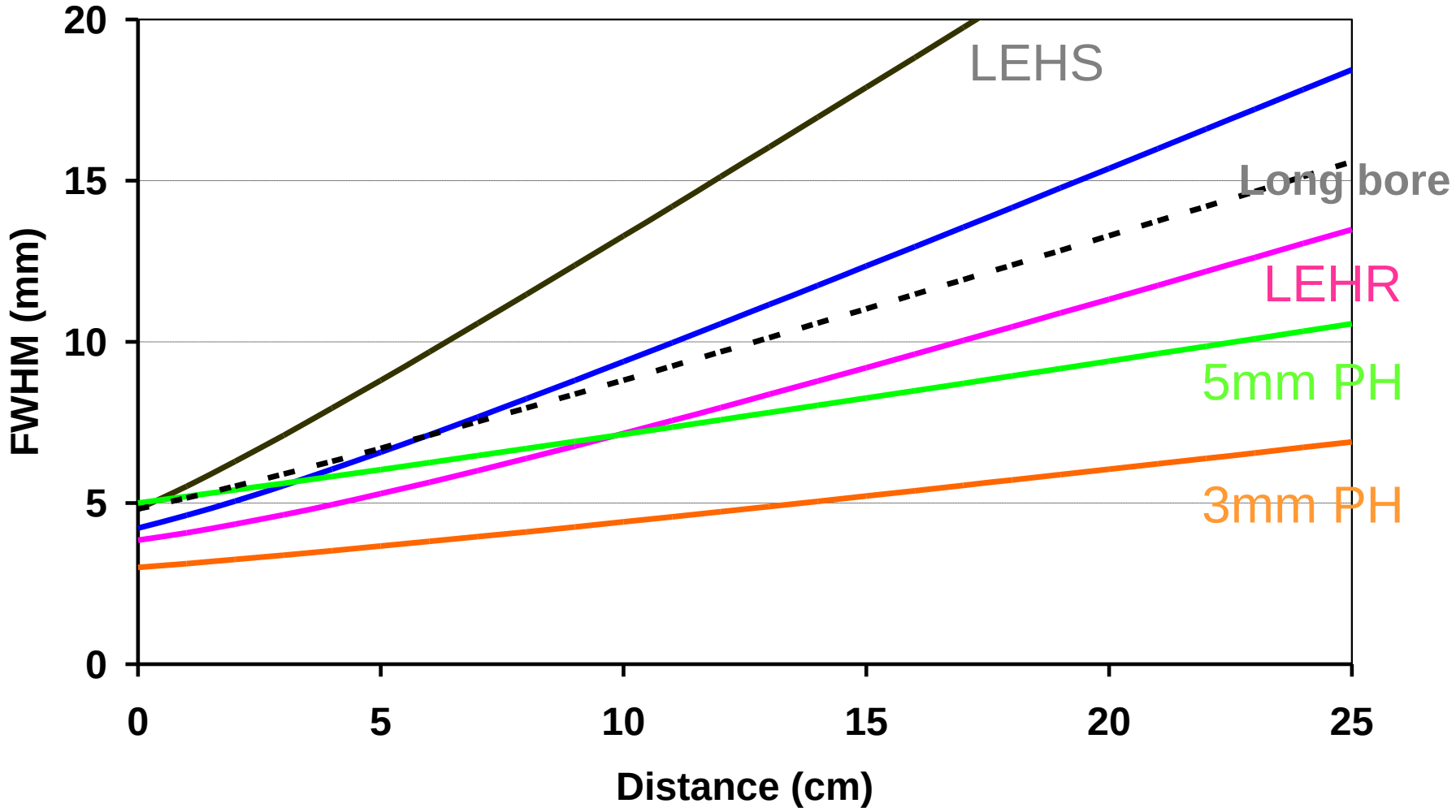


High Energy Collimator

Pinhole collimator

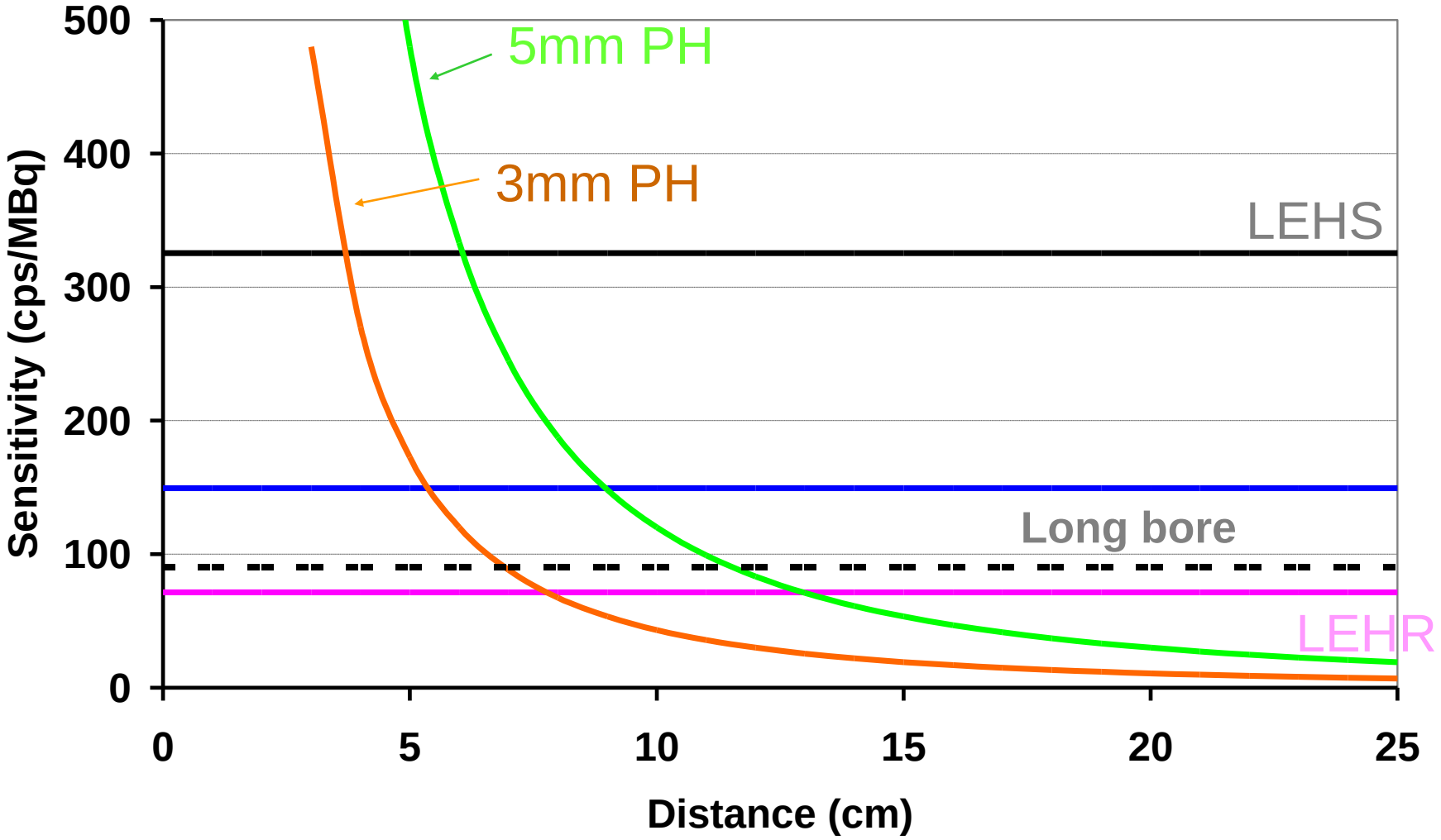
Performance – impact of collimator

Spatial resolution



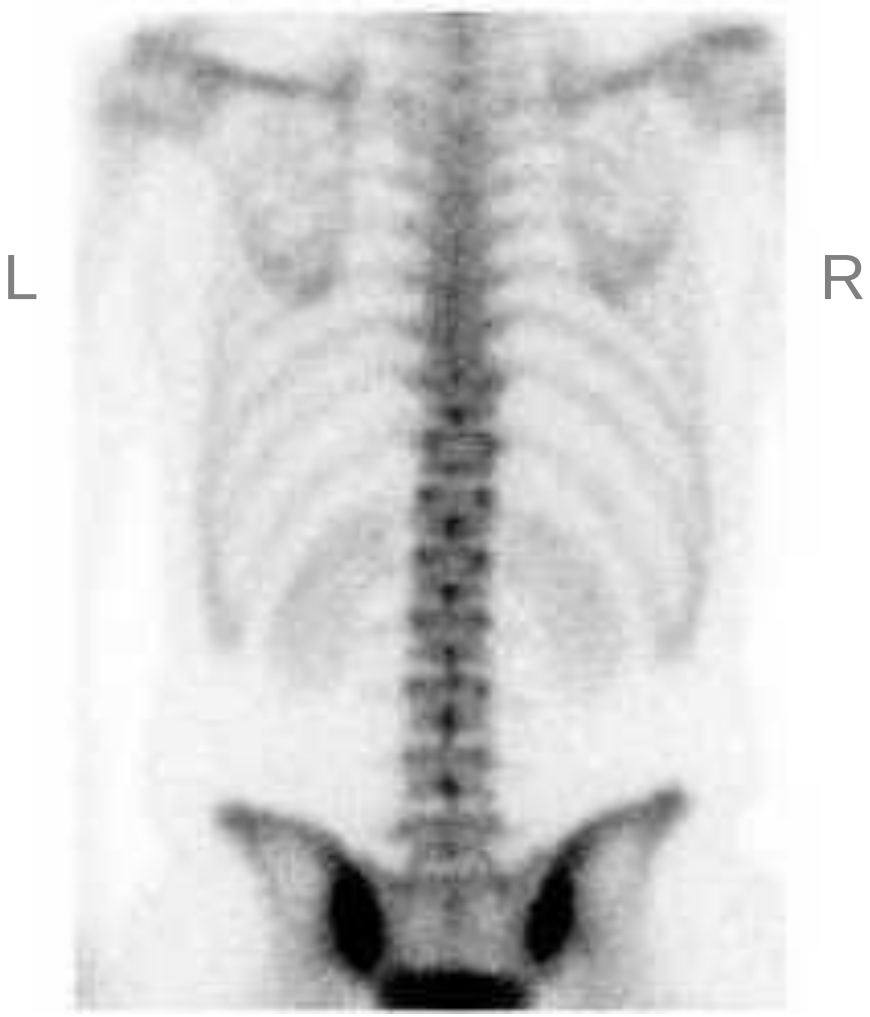
Performance – impact of collimator

Sensitivity



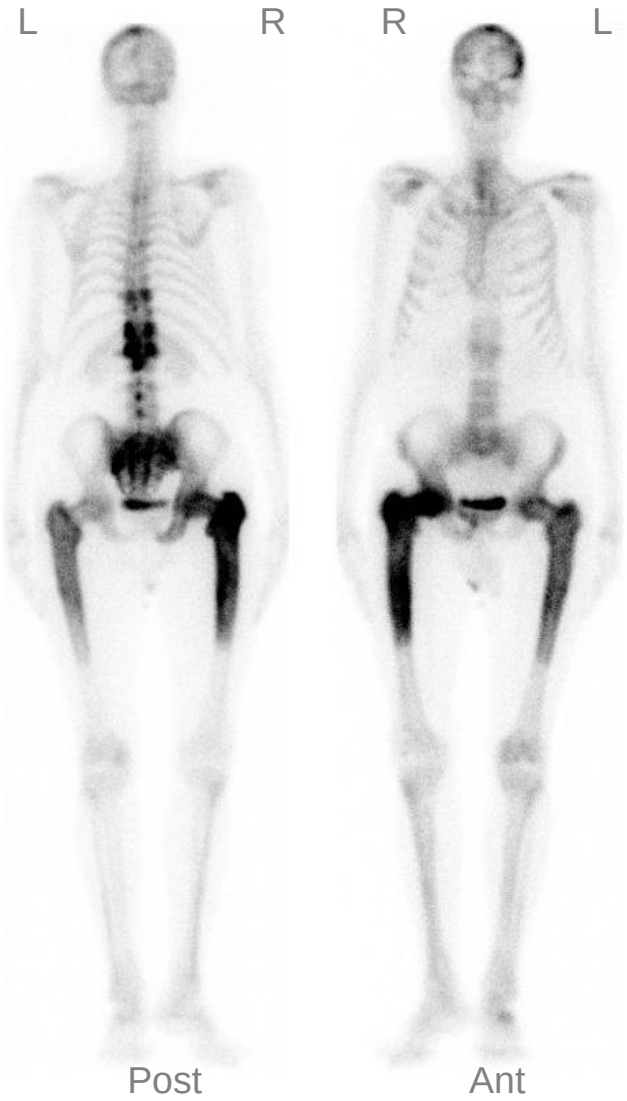
Examples –
gamma camera images

Normal Bone Scan

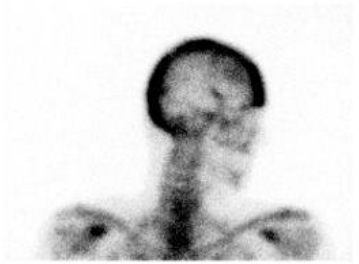


Posterior View (from the back)

Bone scan - Paget's Disease



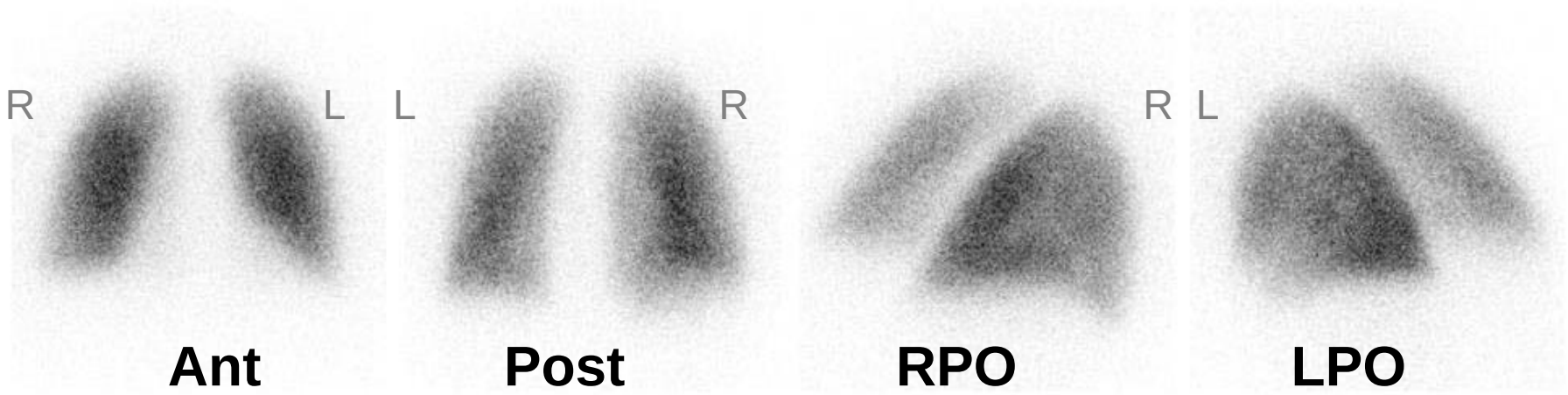
Left lateral

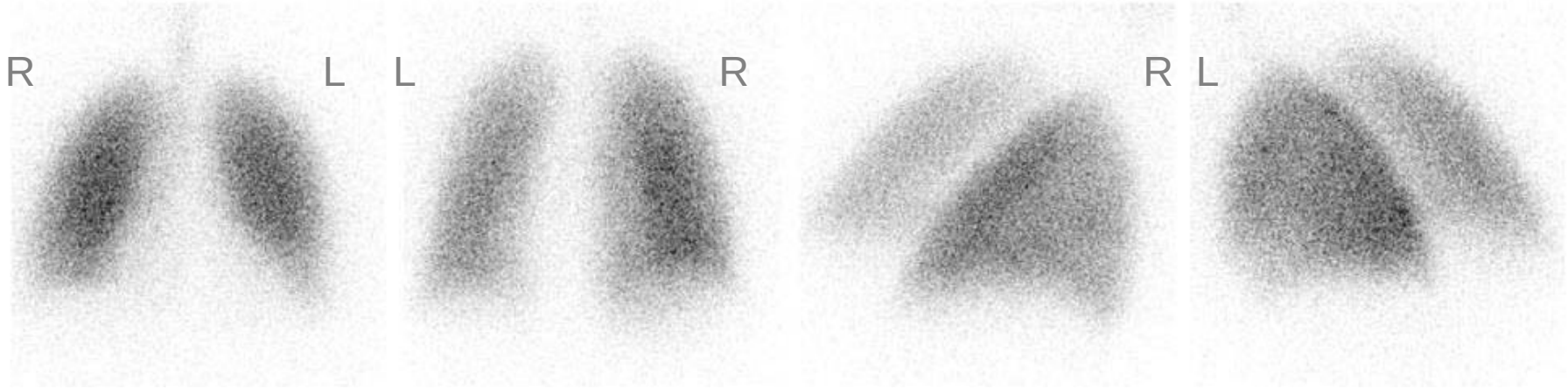


Right lateral

Normal ventilation and perfusion lung scan

Perfusion

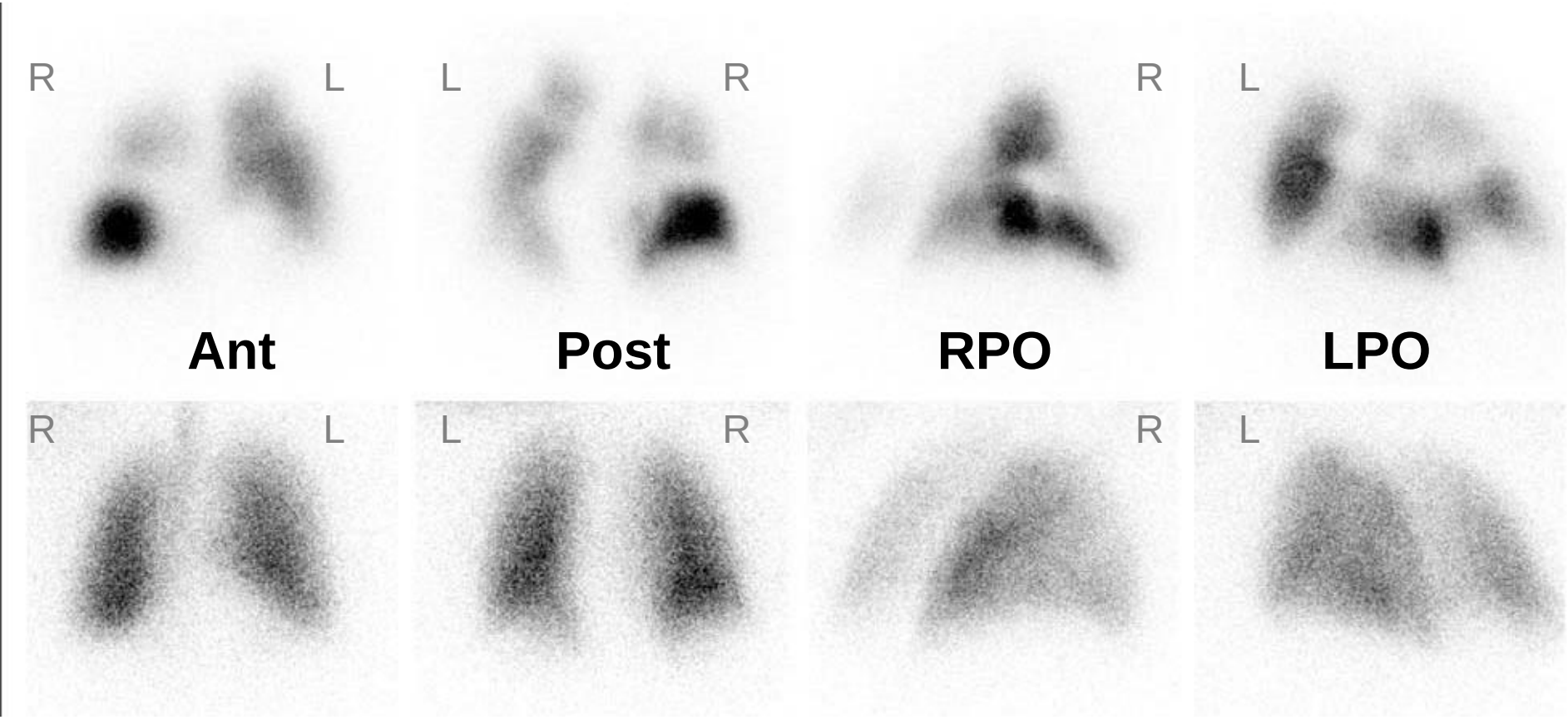




Ventilation (Kr)

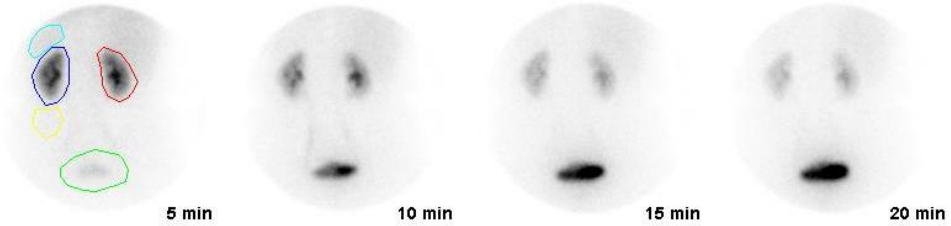
Lung scan - High Probability of Pulmonary Embolus

Perfusion



Ventilation (Kr)

Renogram - Normal

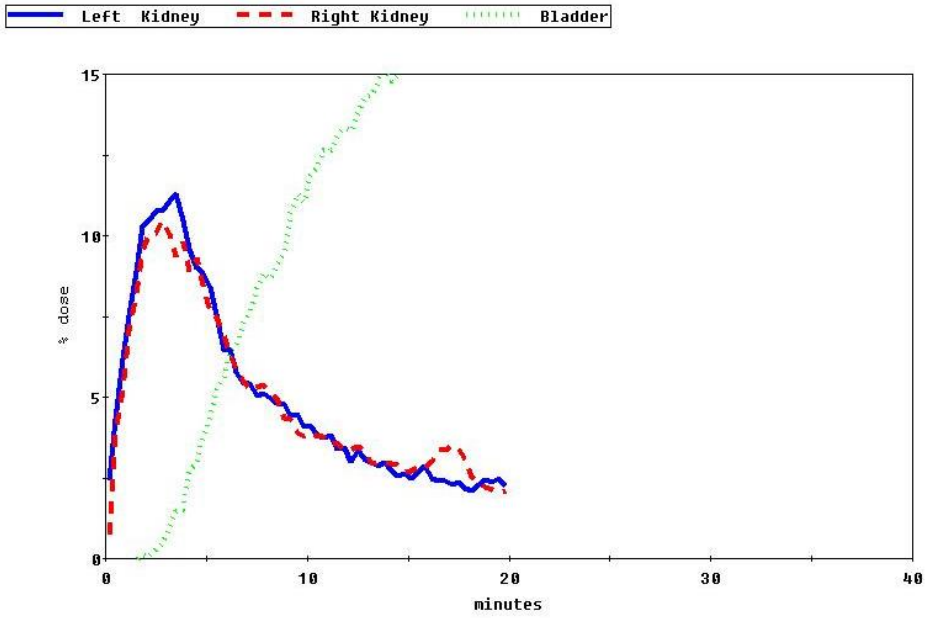


	RF	2min	3min	Tpeak
Left Kidney	52%	10.3%	10.8%	3.5mir
Right Kidney	48%	9.5%	10.5%	2.8min

Relative Function

Left kidney 52 %

Right Kidney 48 %



49.6 MBq
99mTc MAG3

Adult
Posterior, Erect
Elscint LEGP

Frusemide: None

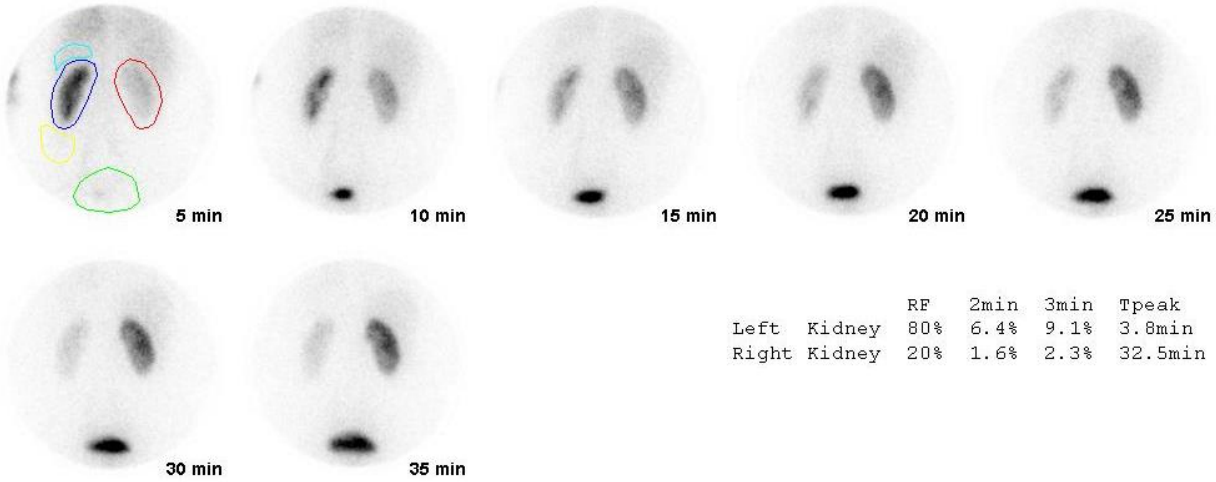
Processed by RSL
Background: Rutland

ManRen v2.4

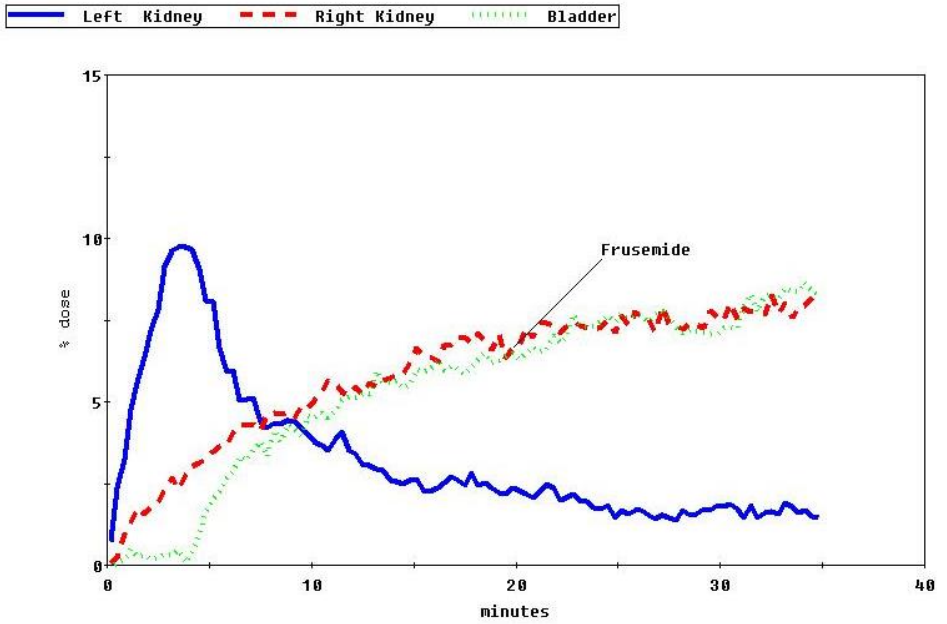
Both kidneys equal uptake

Both kidneys empty quickly

Renogram – Obstructed kidney



		RF	2min	3min	Tpeak
Left	Kidney	80%	6.4%	9.1%	3.8min
Right	Kidney	20%	1.6%	2.3%	32.5min



28.0 MBq
99mTc MAG3

Adult
Posterior, Erect
Elscint LEGP

Frusemide: 20 minutes

Processed by RSL
Background: Rutland

ManRen v2.4a

Relative Function

Left kidney 80 %

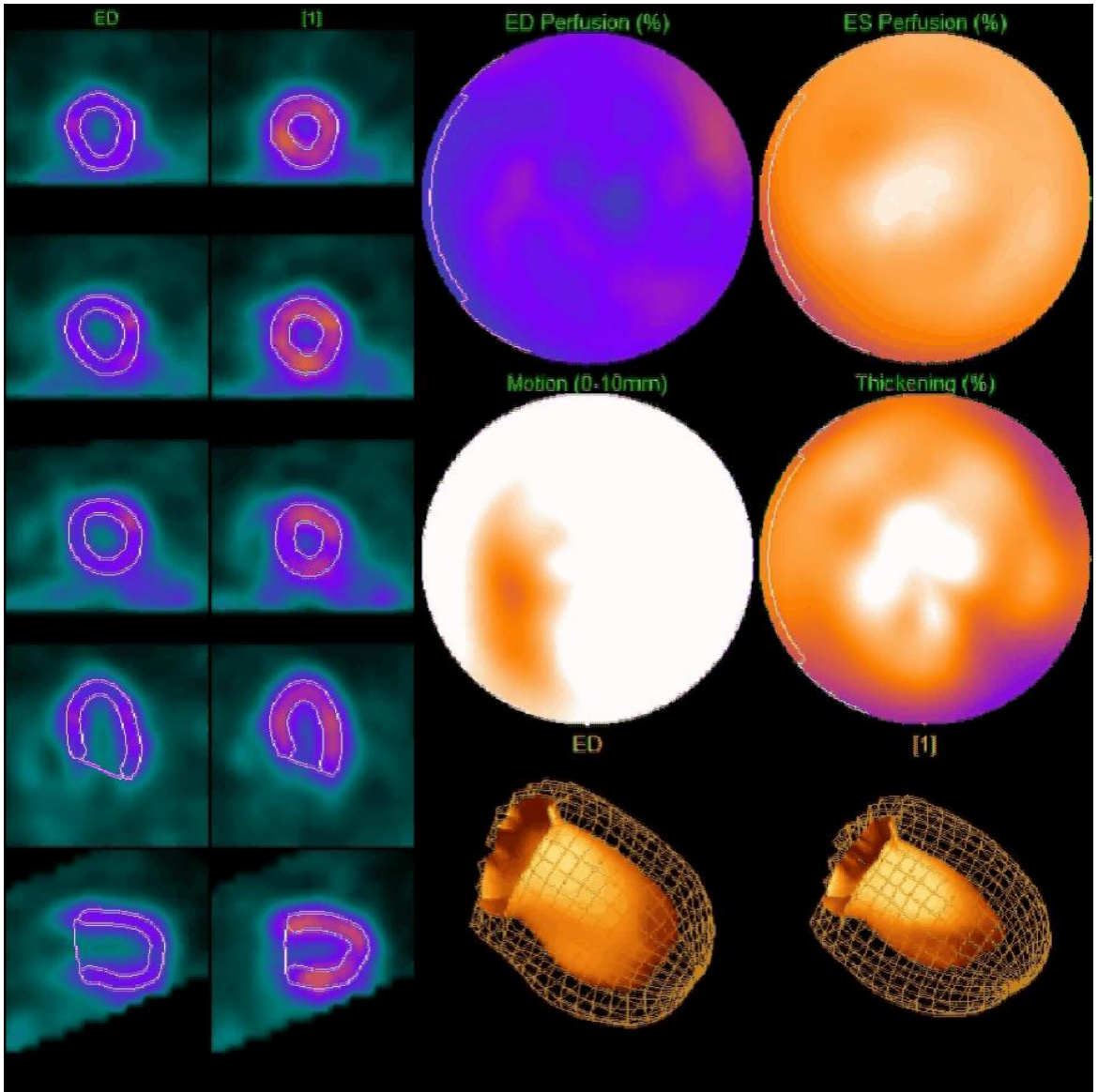
Right Kidney 20 %

Right kidney has worse uptake and fails to empty despite frusemide

Gated Myocardial Perfusion Study

ED ES

Normal Study

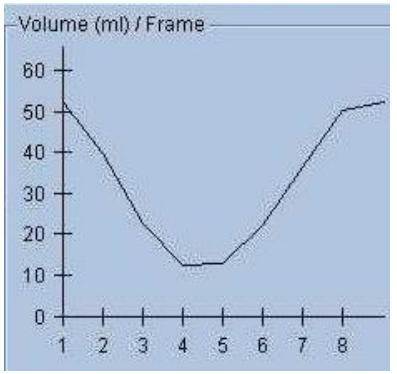


EDV = 54 ml

ESV = 11 ml

SV = 43 ml

EF = 79 %

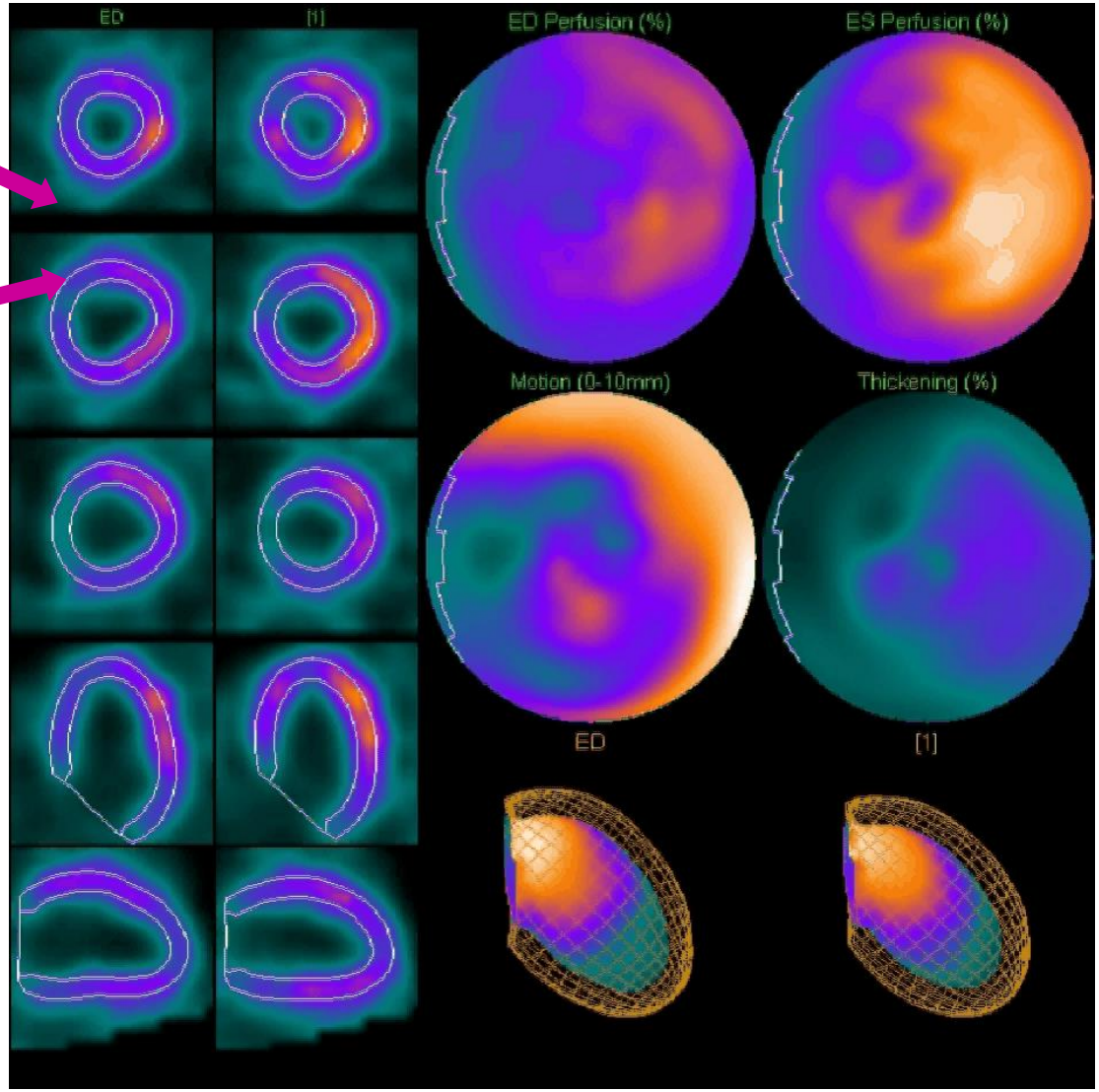


Gated Myocardial Perfusion Study

ED ES

Abnormal Study:

Infarct

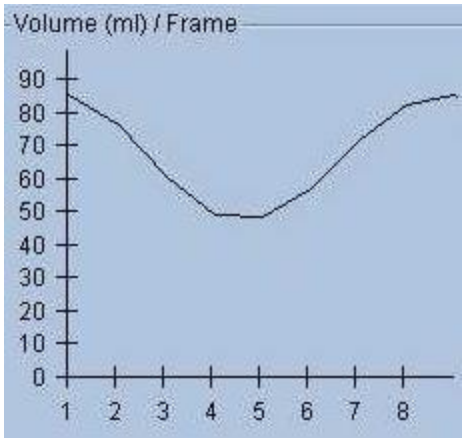


EDV = 87 ml

ESV = 51 ml

SV = 36 ml

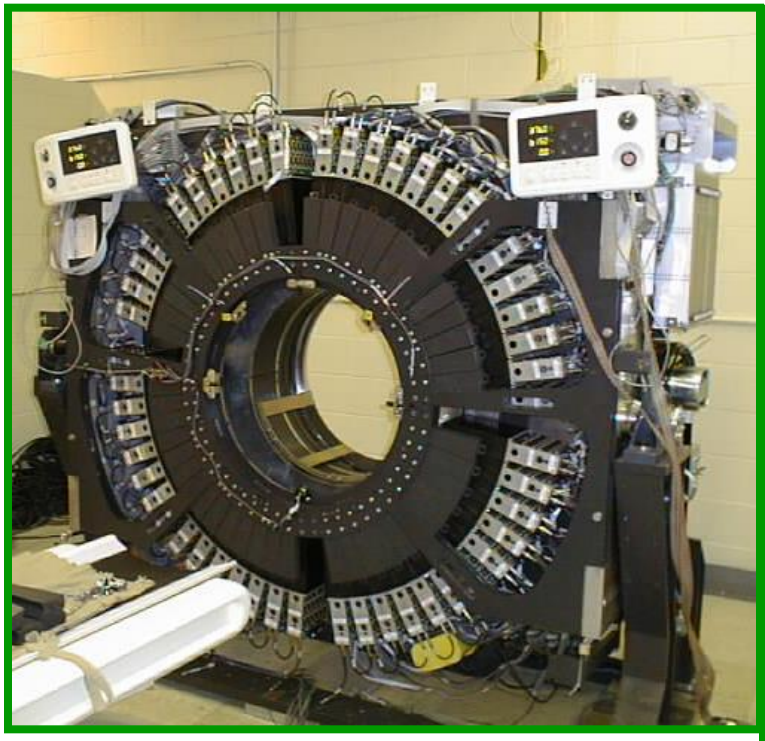
EF = 42 %

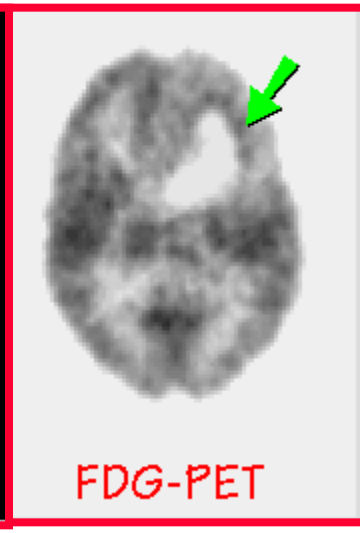


Modern PET scanner

- Commerically available in mid-1980s

  Full ring systems, eg. GE Advance, 2000

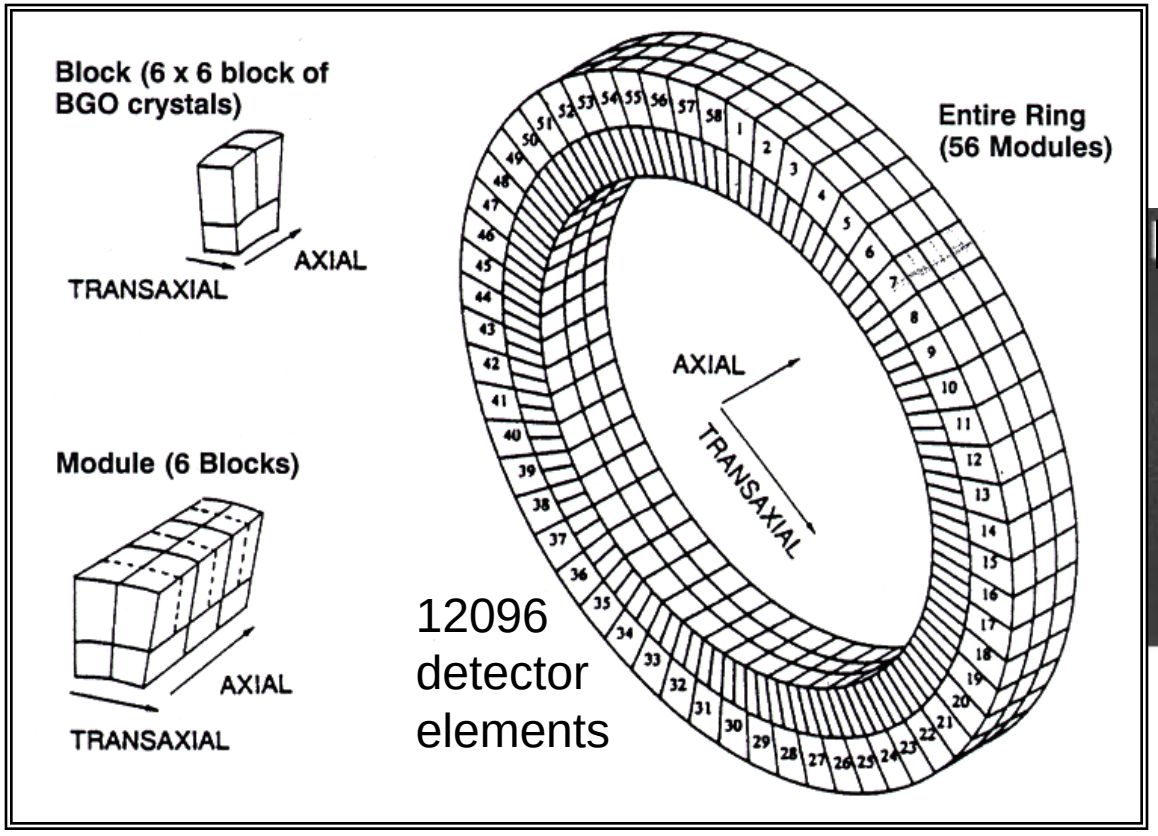


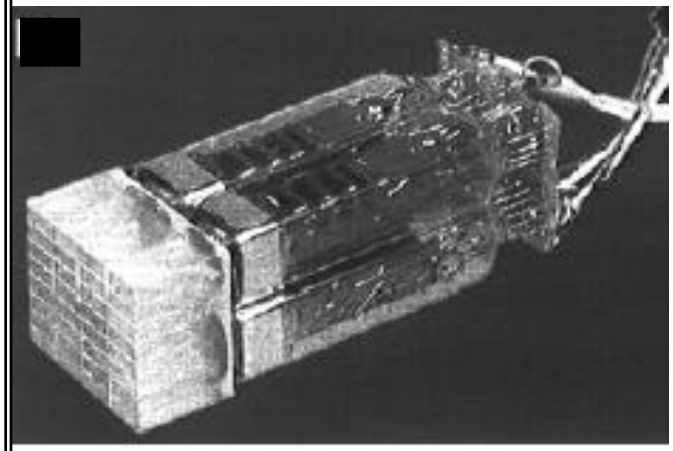


The development of PET scanners

- Commerically available in mid-1980s

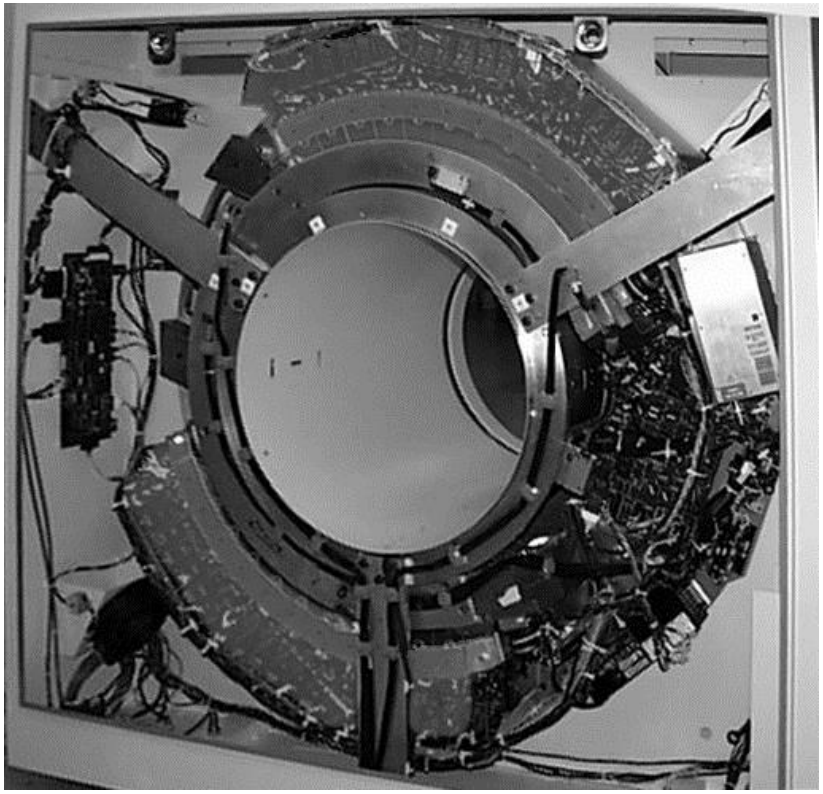
  Full ring systems, eg. GE Advance, 2000



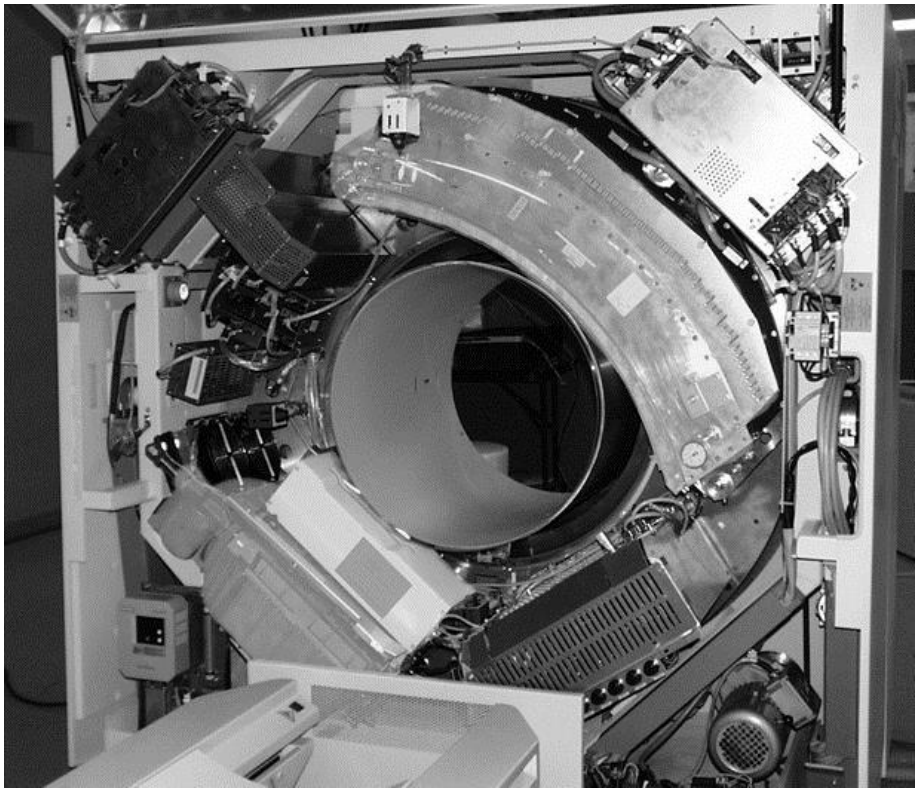


PETCT : in the beginning, there was...

- Partial Ring PET



- CT



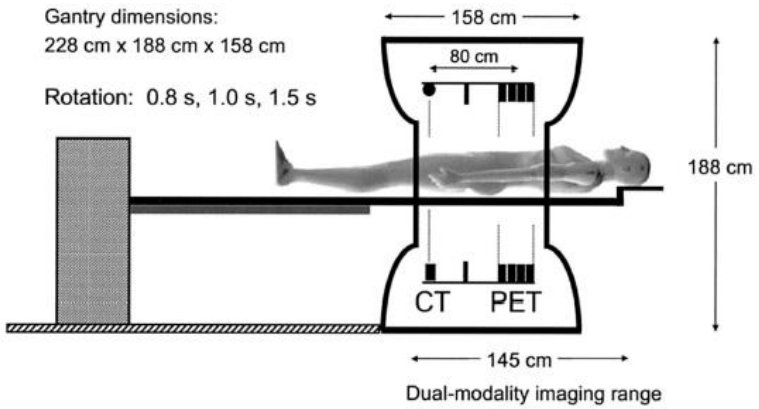
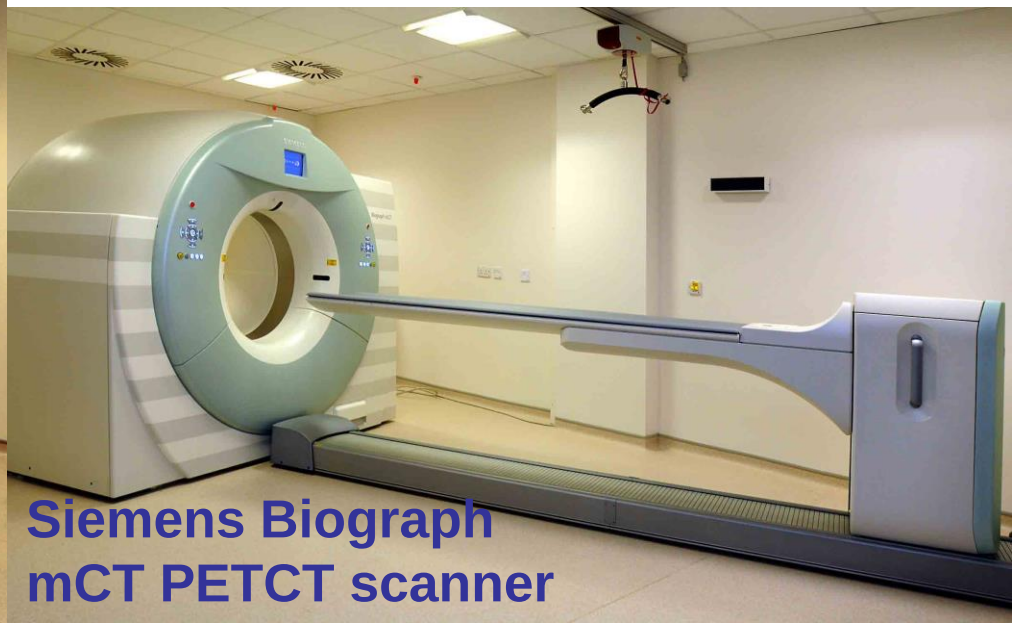
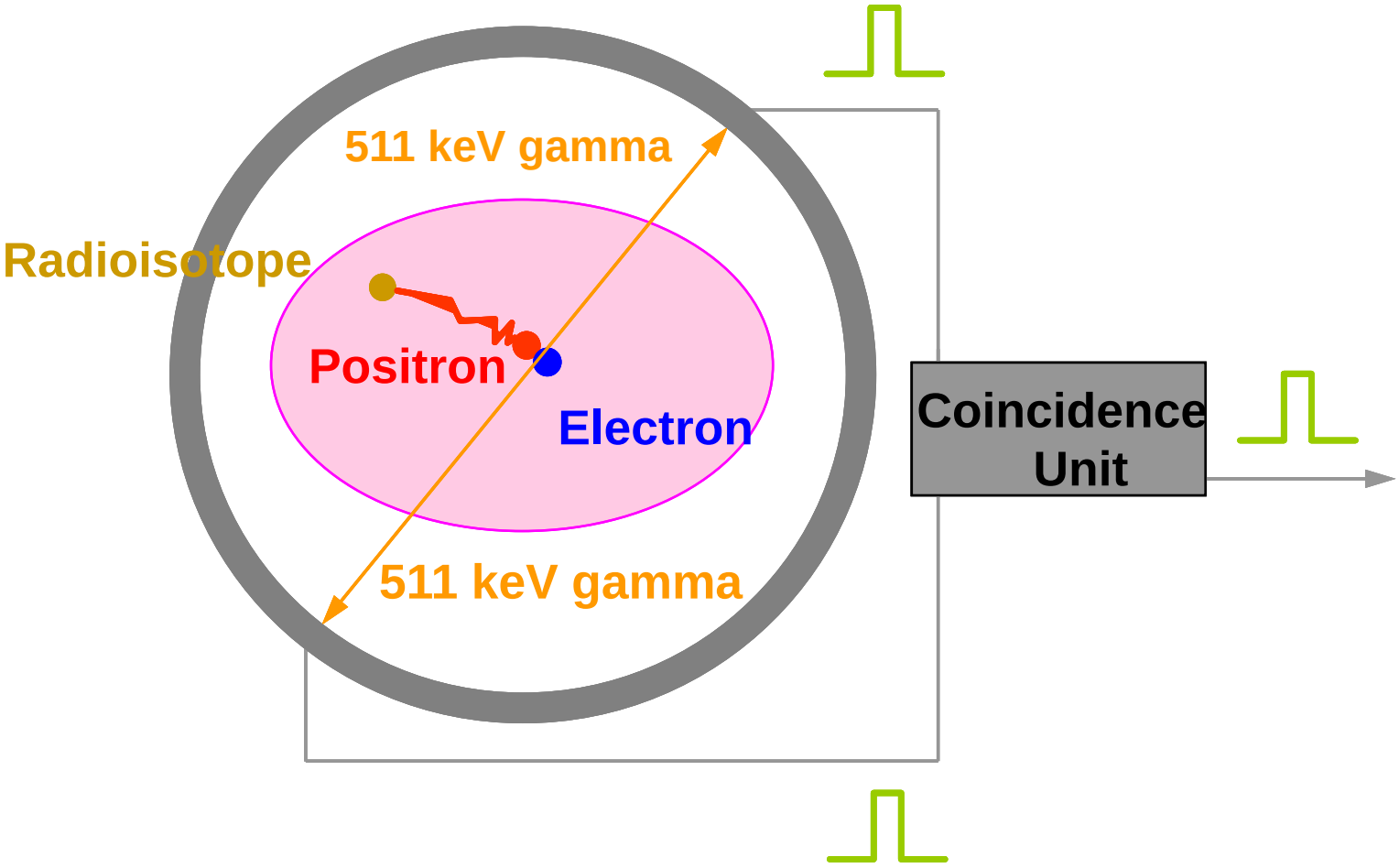


Fig 3. A schematic of the biograph PET/CT scanner. The axial separation of the two imaging fields is 80 cm. The co-scan range for acquiring both PET and CT is 145 cm maximum.

From: Townsend et al. 2003
Sem Nucl Med 33: 193

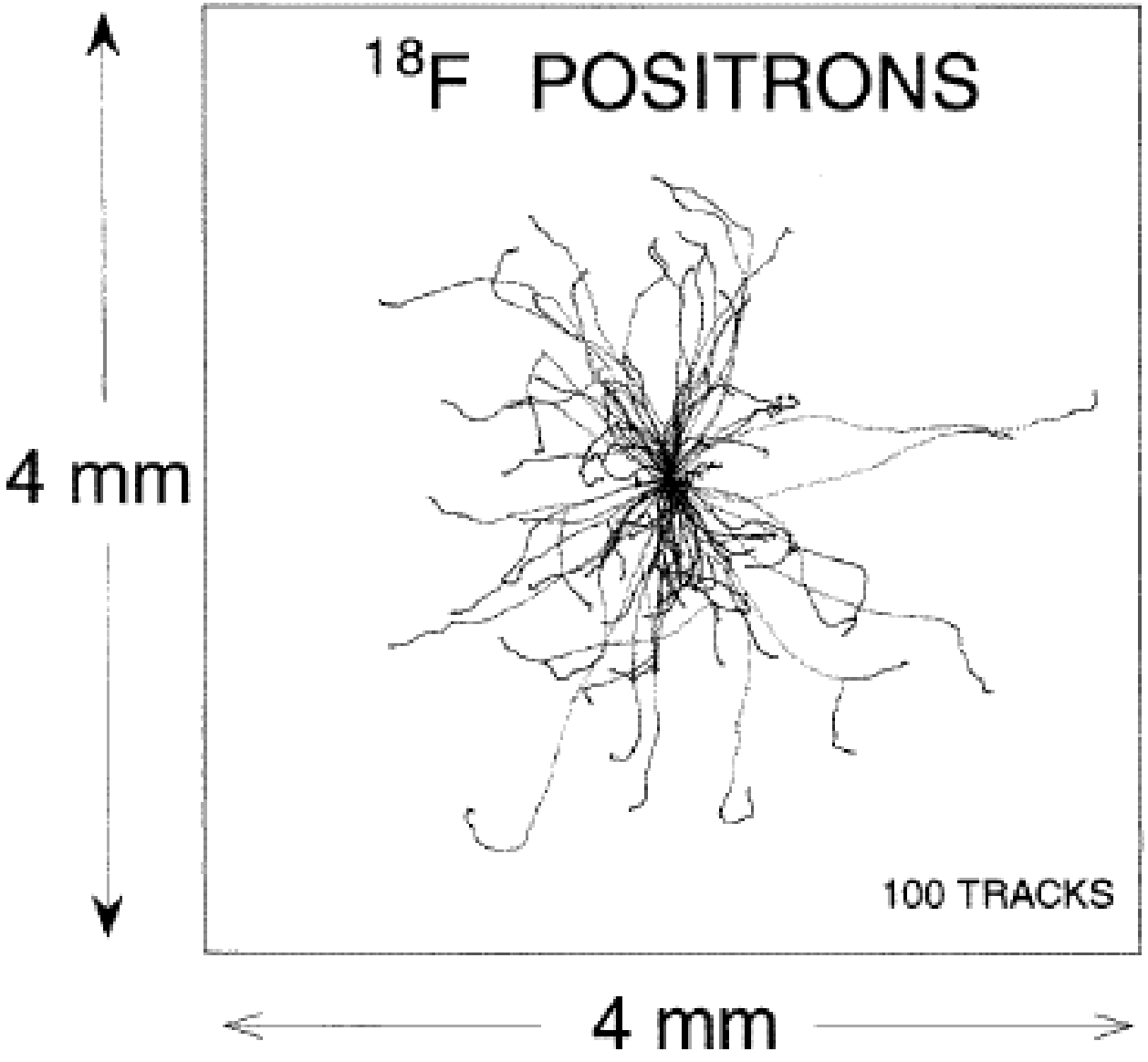


Annihilation and coincidence detection



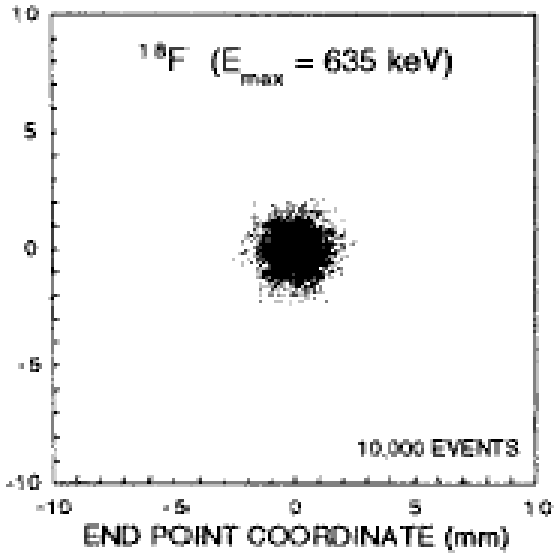
Physical limits on resolution in PET

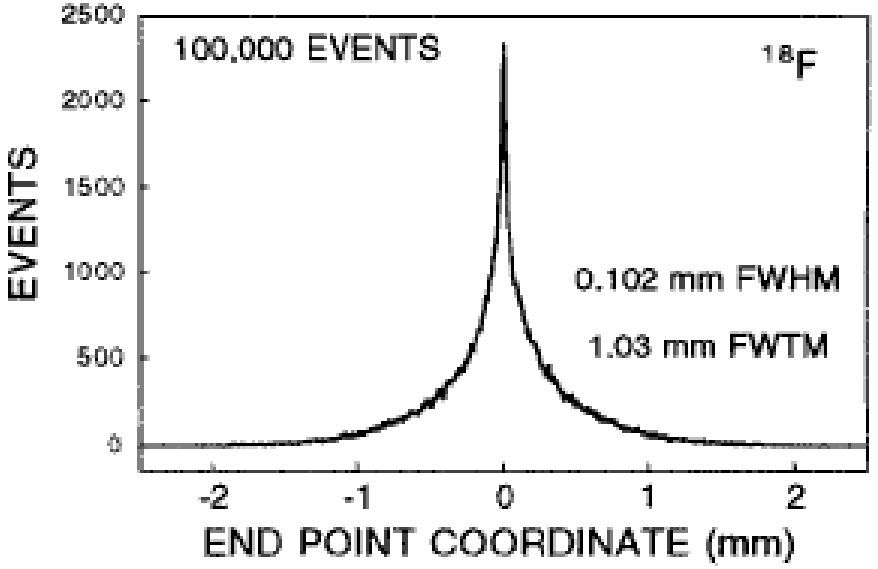
Positron range

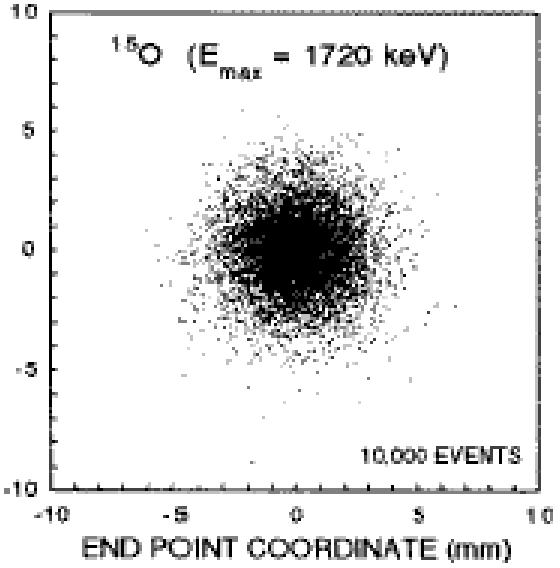


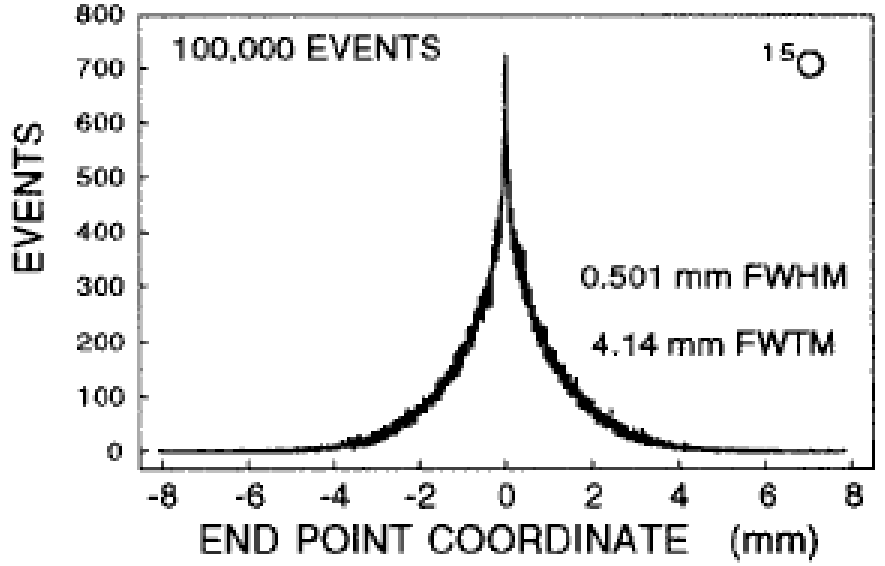
Simulated ^{18}F positron tracks from a point source in water.

Variation of resolution with positron energy



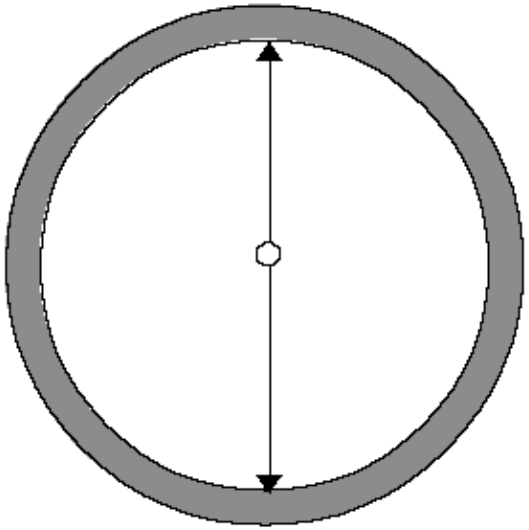




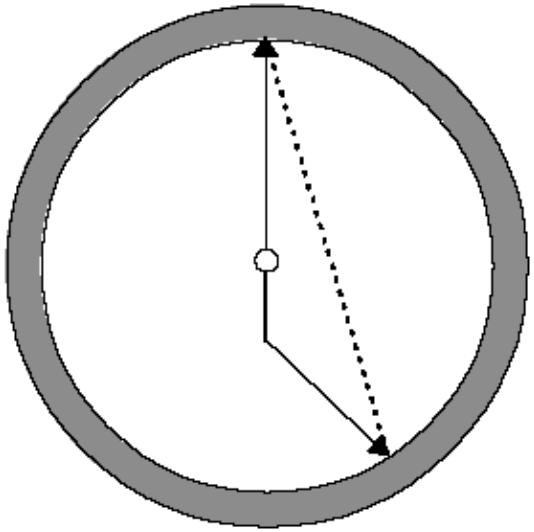


Types of Events in PET

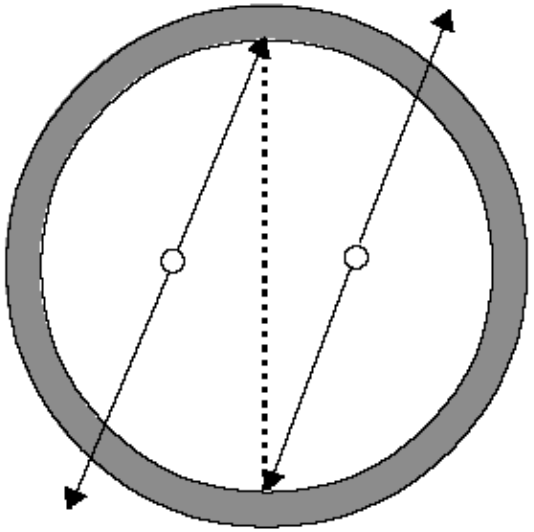
Trues



Scattered

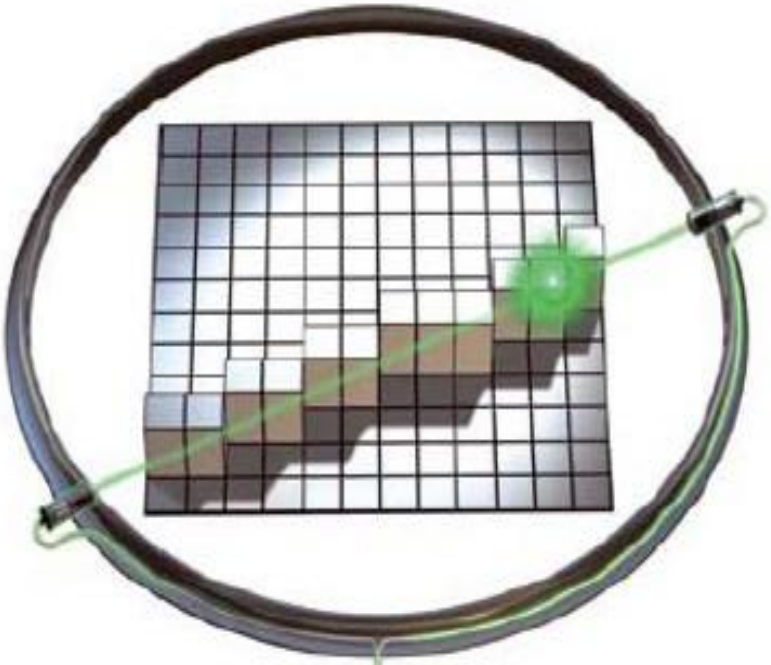


Random



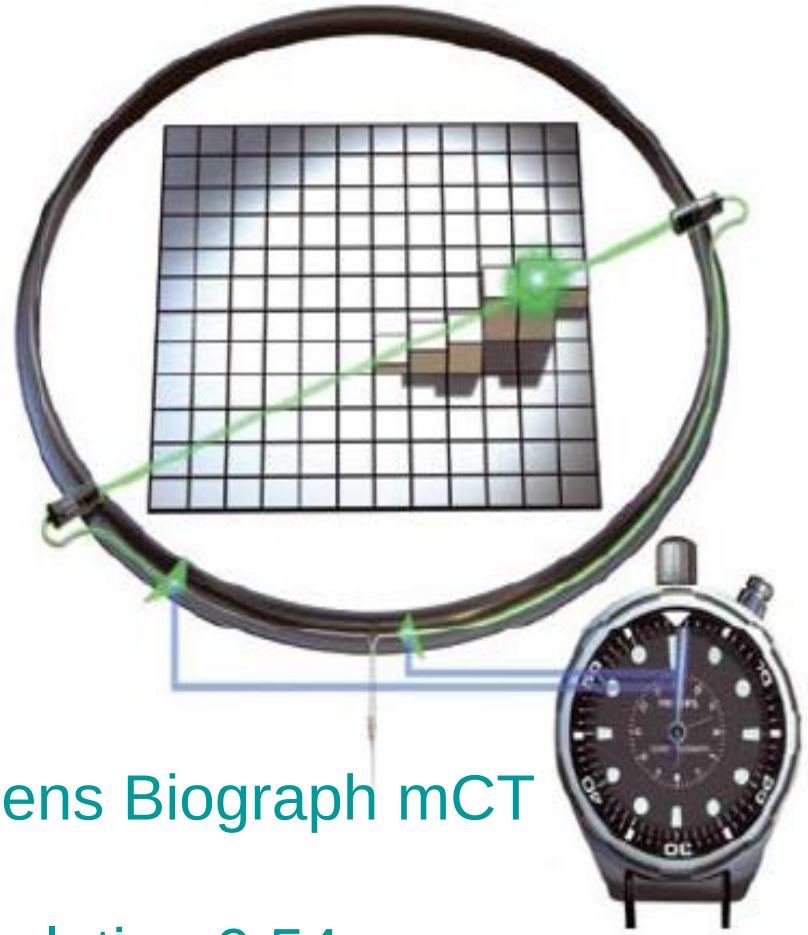
Improvements with better timing resolution : “Time-of-Flight” capable ring systems

Non-ToF-capable



e.g. Discovery ST
[BGO]
timing resolution ~6ns

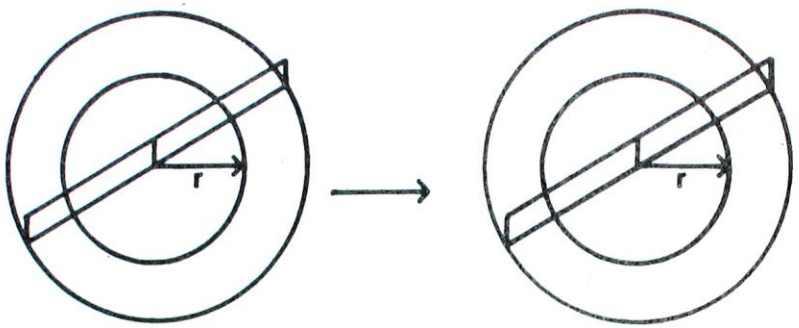
ToF-capable



e.g. Siemens Biograph mCT
[LSO]
timing resolution 0.54ns

Time of Flight

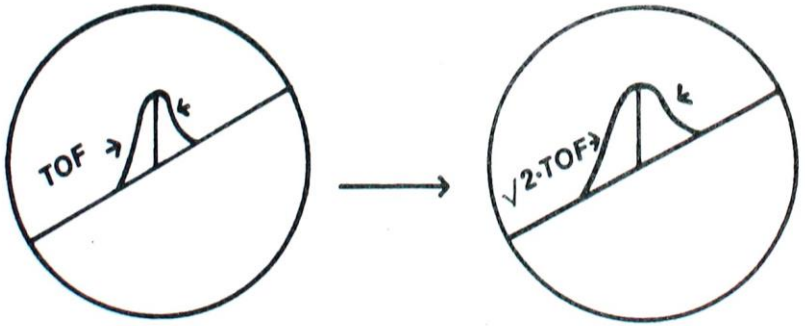
Conventional Positron Emission Tomography Back Projection (Point Source) For A Detector Pair



$$PSF = \frac{1}{r}$$

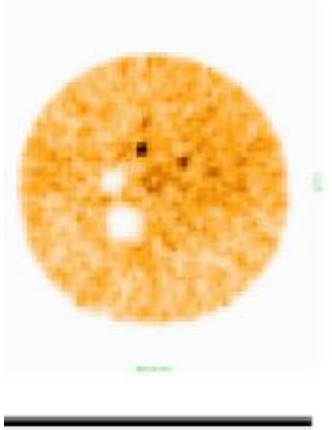
Count = 1 Count = ∞

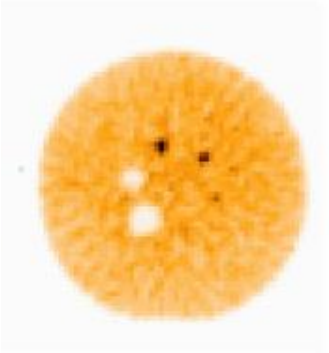
Time-of-Flight Positron Emission Tomography Back Projection (Point Source) For A Detector Pair



$$PSF = \frac{\exp\left\{-\frac{r^2}{2(\sqrt{2}\cdot TOF)^2}\right\}}{r}$$

Count = 1 Count = ∞





35 cm

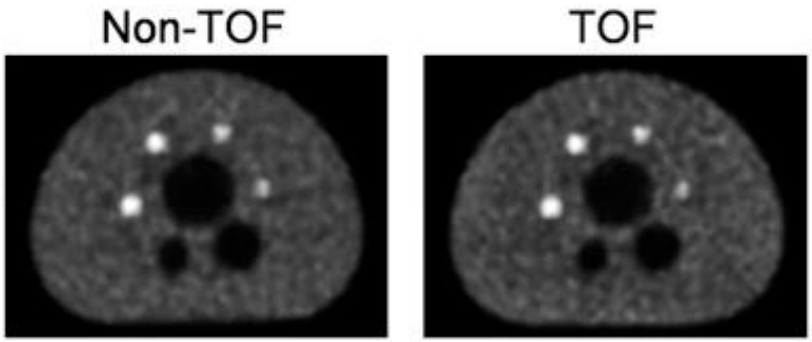
Wong et al 1983 JNM 24(1) 52-60

Karp et al 2005
IE^3-NSS/MI Conf Record

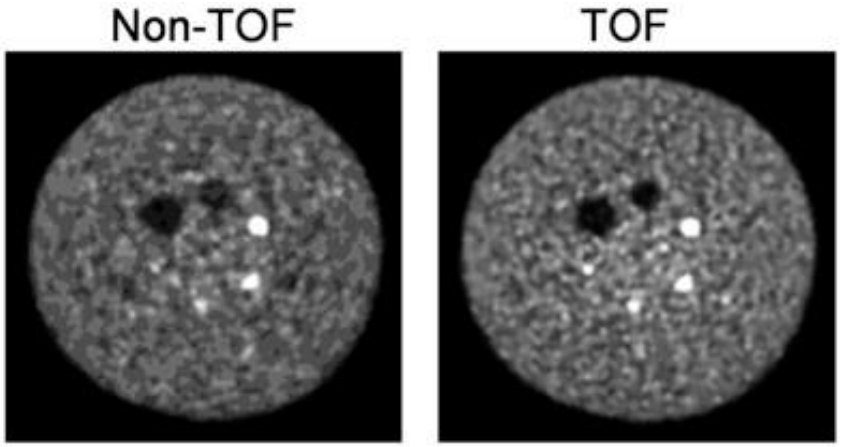
Improvements with better timing resolution : “Time-of-Flight” capable ring systems

GEMINI TF (timing resolution 0.7ns)

LIGHT

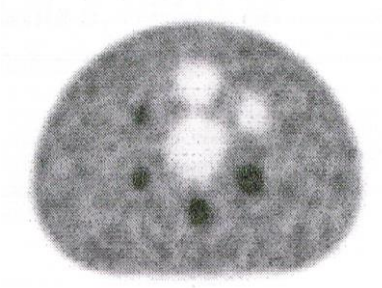


HEAVY

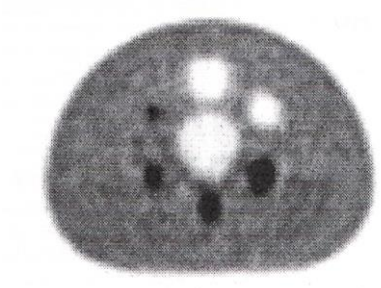


DISCOVERY ST

LIGHT (2D)



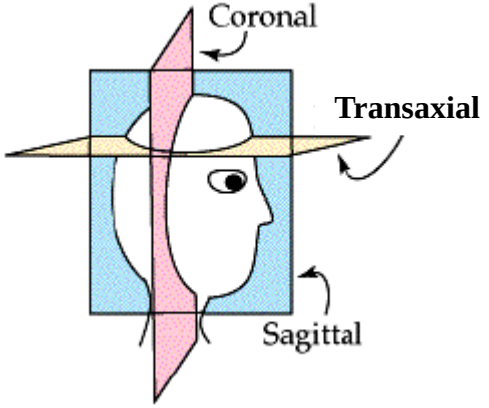
LIGHT (3D)



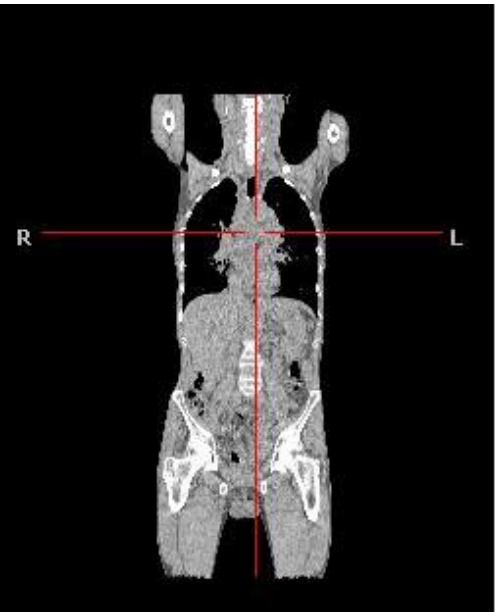
ToF gives better spatial resolution and better rejection of random and scattered co-incidences, resulting better image quality, particularly in large patients

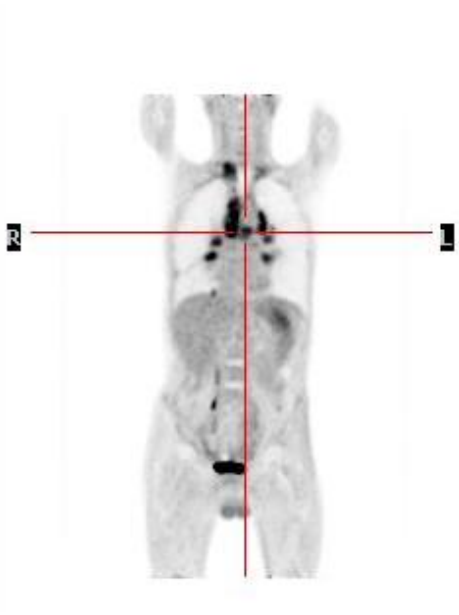
Examples – PET images

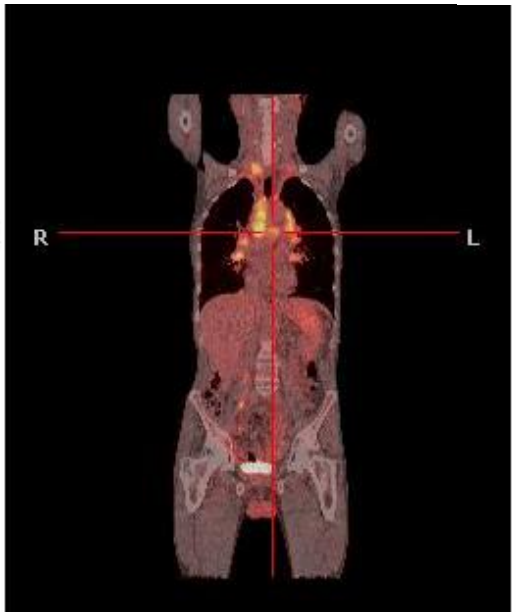
^{18}FDG PETCT scan of patient with lymphoma

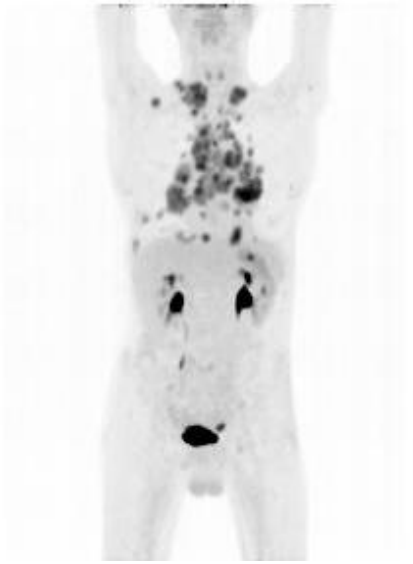


Coronal planes





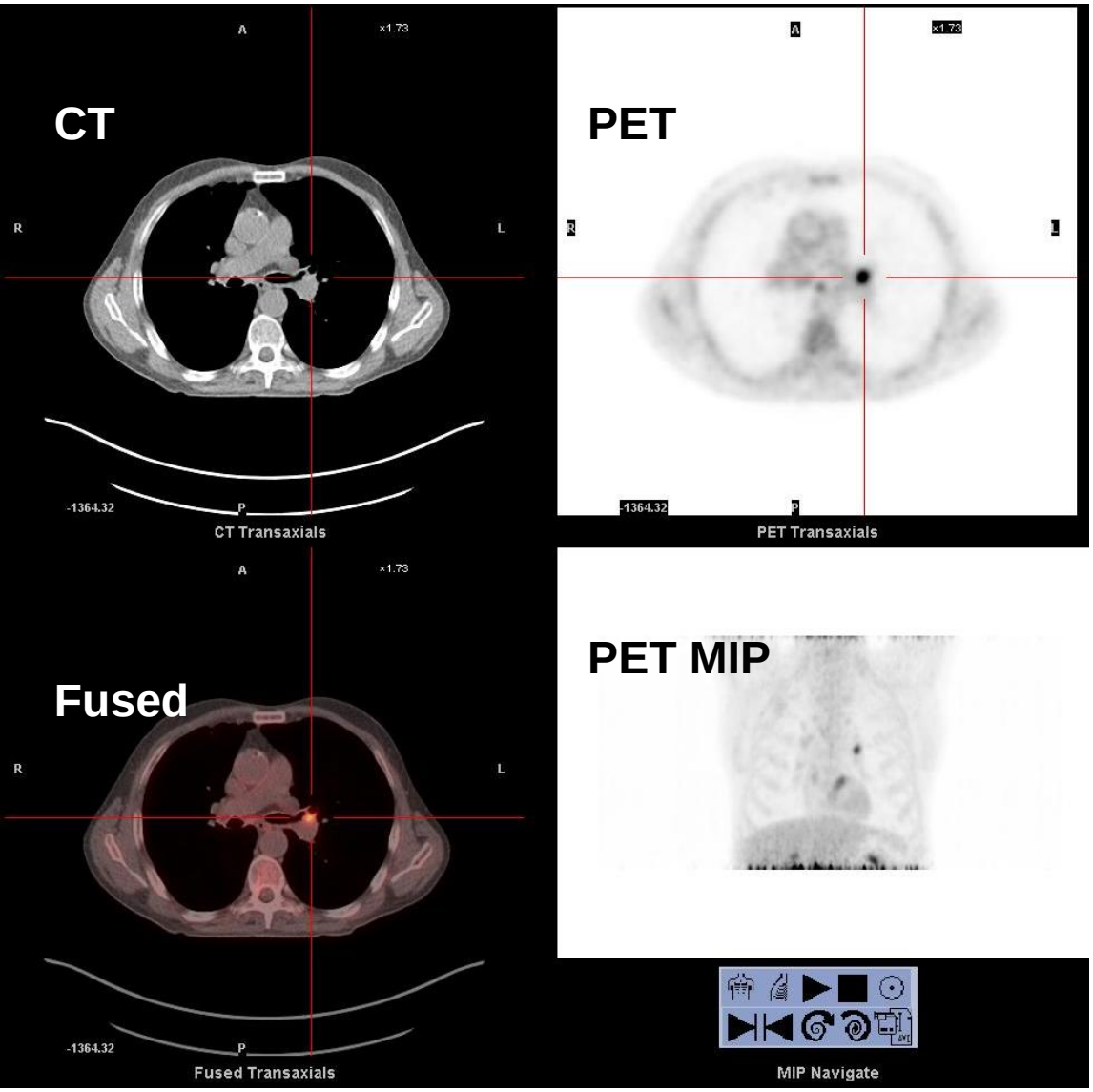


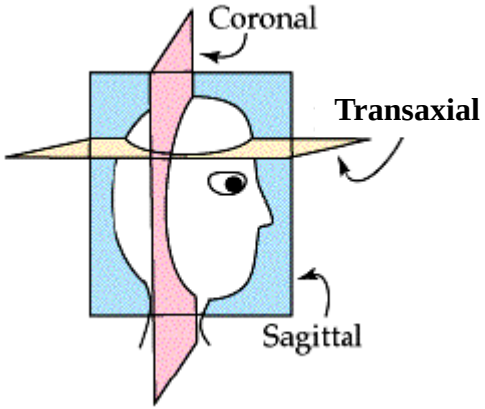


CT **PET** **Fused** **PET MIP**

Very extensive cancer, may respond to chemotherapy

PETCT = best of both?



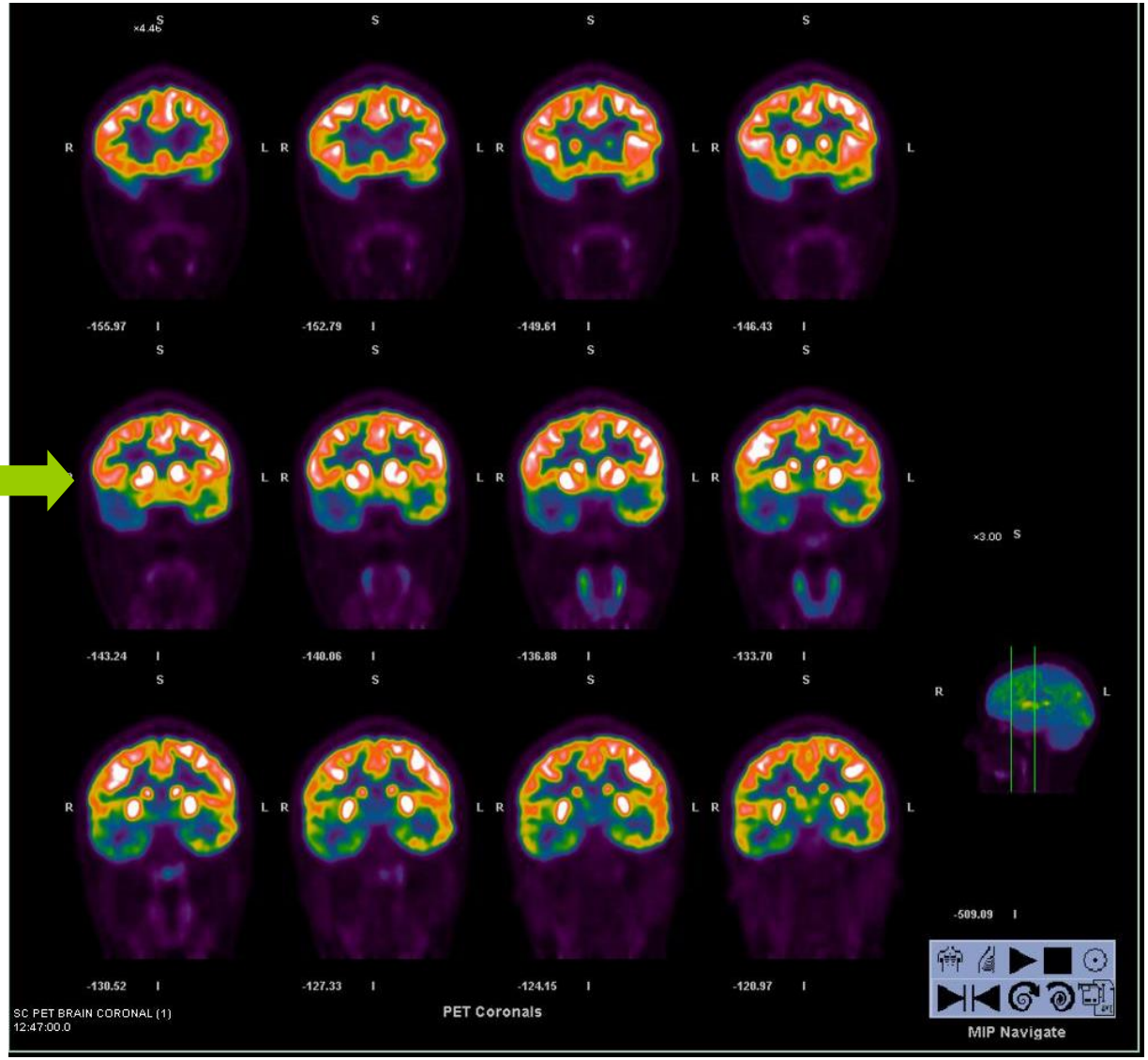


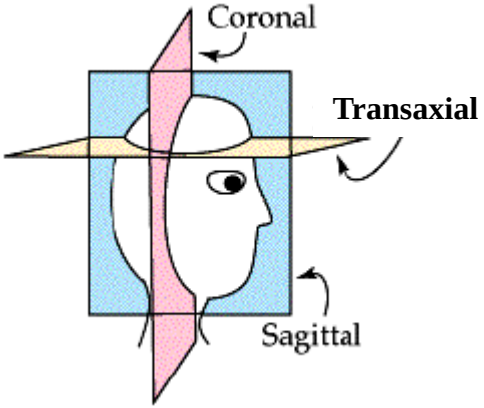
Transaxial planes

When we put PET information about function on top of CT information about structure, we can see exactly where it is

Lung tumour – in bronchus (large airway)

^{18}FDG PET scan of patient with epilepsy

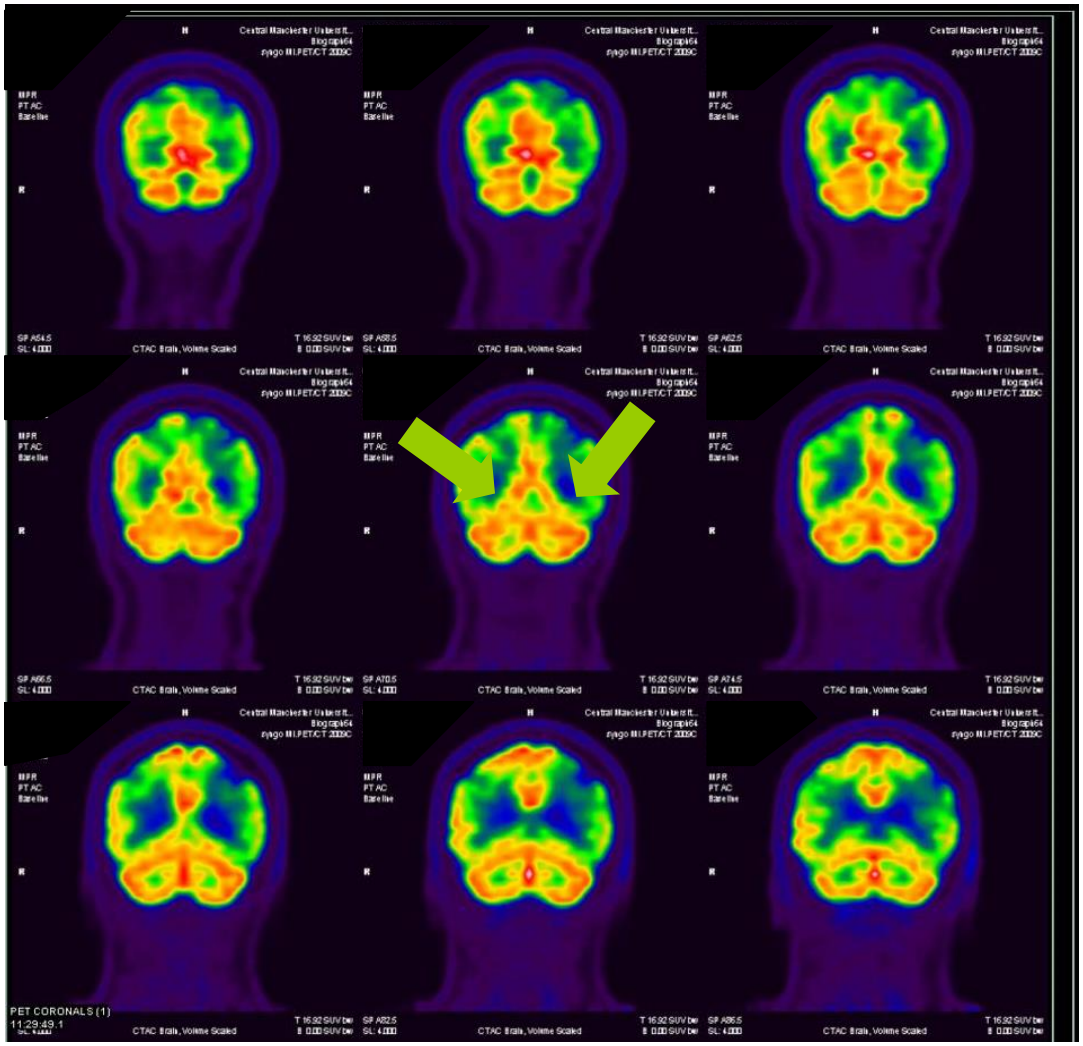


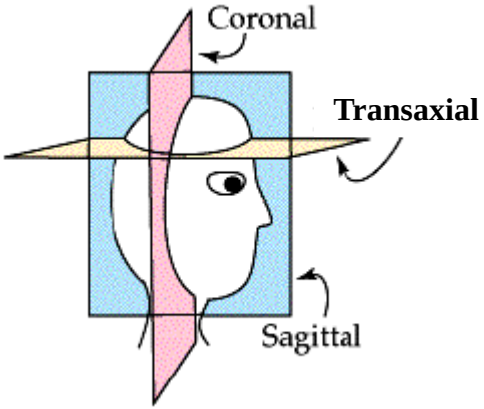


Coronal planes

Areas of low uptake on right side of the brain which probably coincide with the origin of the patient's seizures

^{18}FDG PET scan of patient with dementia, including language difficulties

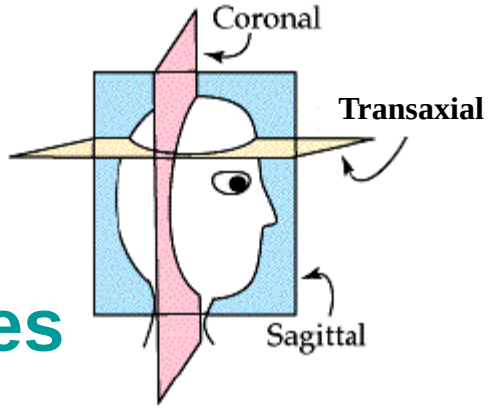




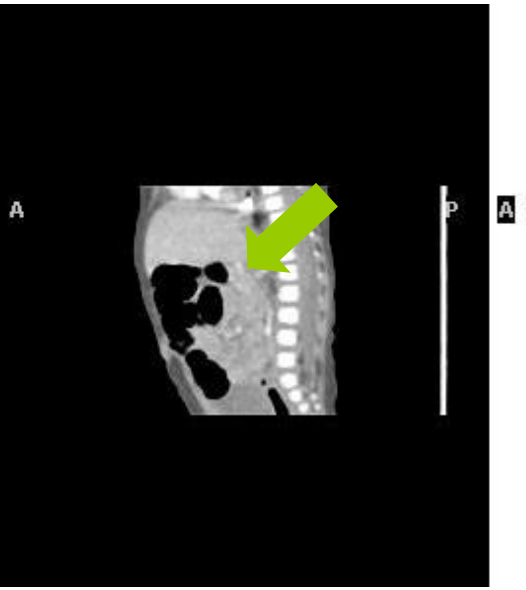
Coronal planes

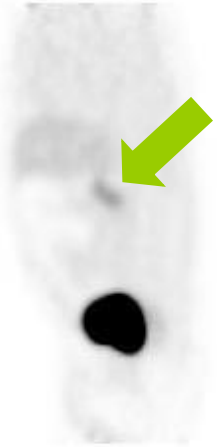
Patterns of low uptake on both sides of the brain, typical of Alzheimer's disease

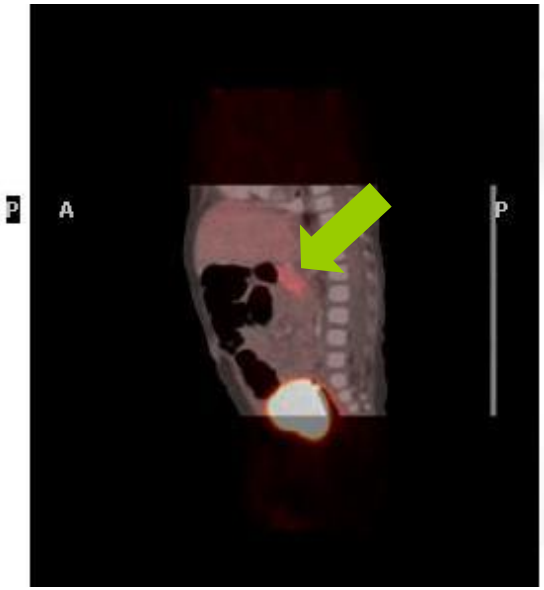
Not all ^{18}FDG! ^{18}FDOPA PETCT scan of child with CHI

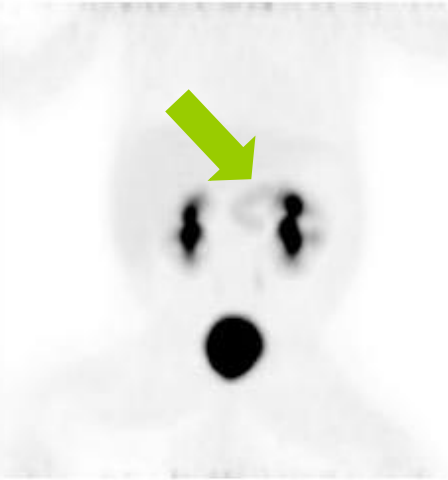


Sagittal planes





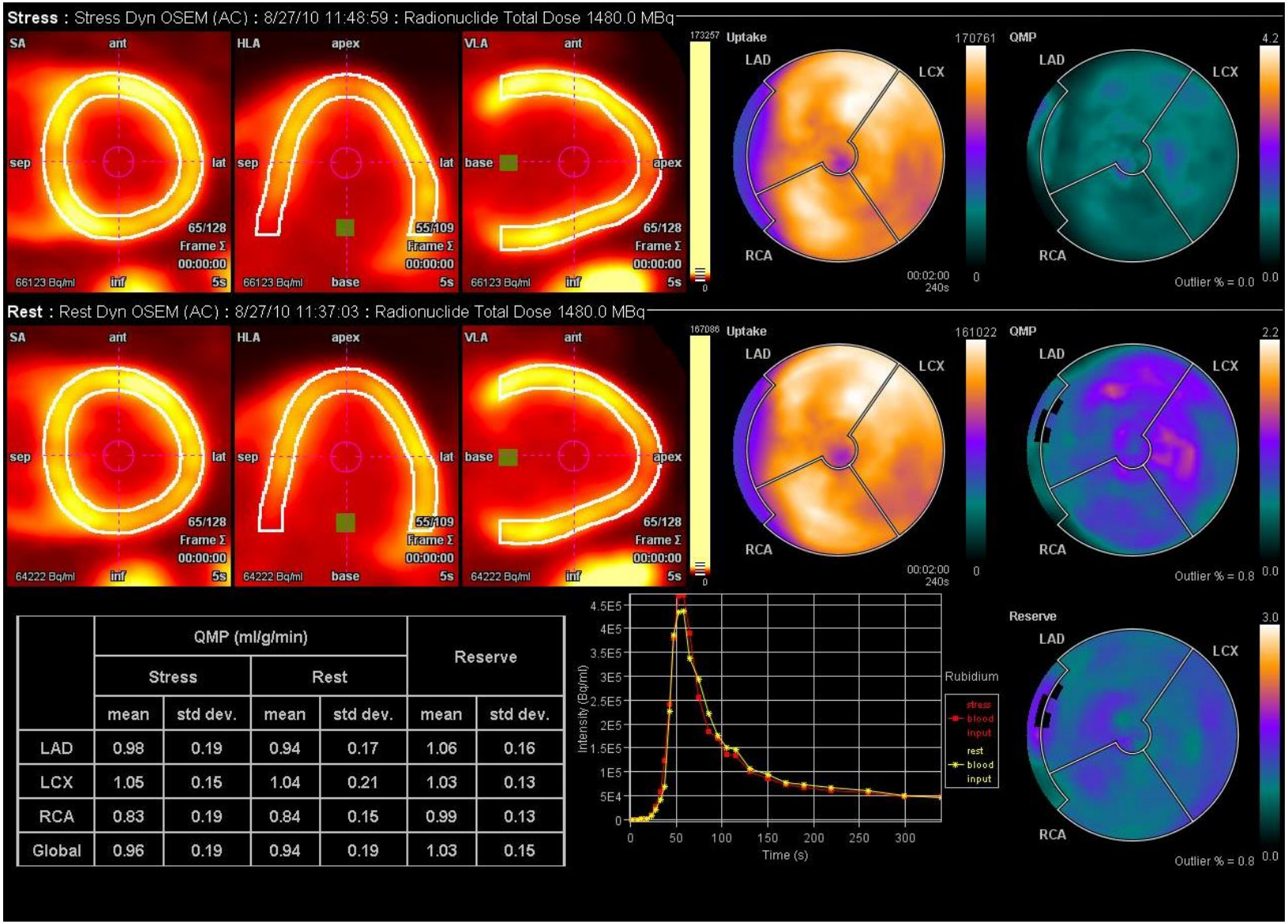




CT PET Fused PET MIP

Overactive cells spread evenly throughout pancreas

Not all ^{18}F! ^{82}Rb PETCT in the heart



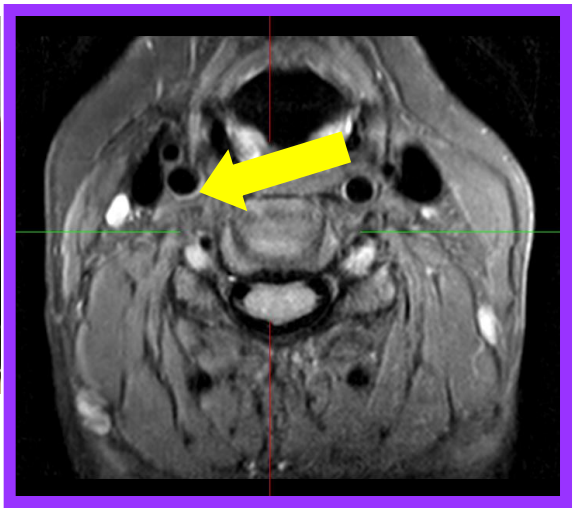
	QMP (ml/g/min)				Reserve	
	Stress		Rest			
	mean	std dev.	mean	std dev.	mean	std dev.
LAD	0.98	0.19	0.94	0.17	1.06	0.16
LCX	1.05	0.15	1.04	0.21	1.03	0.13
RCA	0.83	0.19	0.84	0.15	0.99	0.13
Global	0.96	0.19	0.94	0.19	1.03	0.15

Screen capture from pre-release version of Siemens Circulation software for Syngo

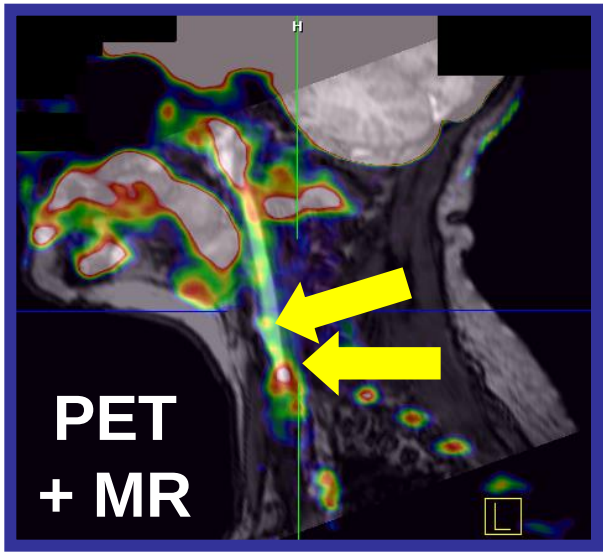
Current research

^{18}FDG carotid PET + MR

Assessing fatty plaques on the walls of carotid arteries using MR and PET in patients with rheumatoid arthritis



MR



Also measure:

Assessment of joint inflammation

rheumatoid factor,anti-CCP

endothelial microparticles (EMPs)

My new toy - PETMR

(please??)

Compensating for blurring due to body motion

Accurate Markerless **Breathing** Tracking For Gated Whole Body PET Using the Microsoft Kinect

Philip J. Noonan*† *Student Member IEEE*, Jon Howard† *Member IEEE*, Deborah Tout‡, Ian Armstrong‡
Heather A. Williams‡, Tim F. Cootes§, William A. Hallett† *Member IEEE*, and Rainer Hinz* *Member IEEE*
*Wolfson Molecular Imaging Centre ‡Central Manchester University Hospitals §Human and Medical Sciences
University of Manchester, Manchester, UK
†Imanova Imaging Centre, Hammersmith, London, UK

***Abstract*—The motion due to respiration**
greatly reducing image quality of whole bod
tomography, PET. A simple method to pro

Fig. 2. Kinect surface created using the Point Cloud Library opensource implementation [2] of the KinectFusion algorithm [3].

l these criteria to be met. Recently, a similar use of the
o track a respiratory signal has been demonstrated [1].
stem
ect's
llow
d, an
very
poor
hat al
ect an
erpen
and
amplitude based respiratory gating.

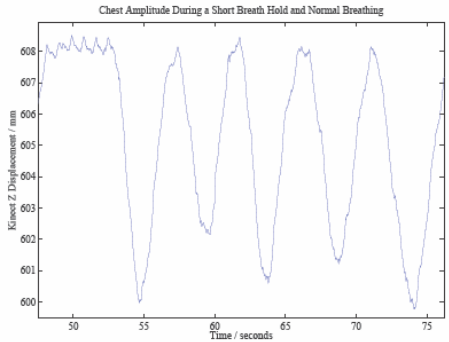


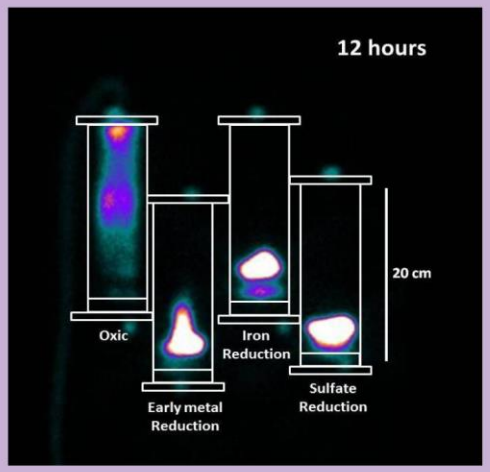
Fig. 4. Due to the high accuracy of the Kinect, 5 pulses can be easily observed during a breath hold, beginning at 48.1 and ending at 52.5 seconds. 68.6 beats per minute agrees with the calculated heart rate in Figure 5.

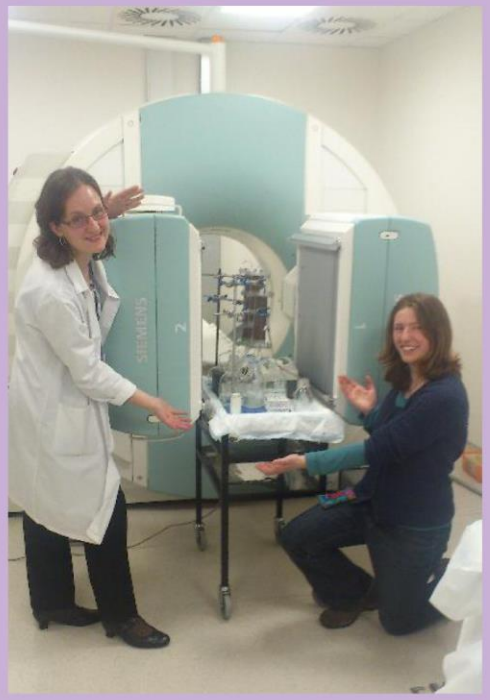
II. MATERIALS AND METHODS

Tidying up after myself – earth sciences research into capturing environmental contamination

Imaging environmental samples helps manage the UK's nuclear legacy

Researchers from the Nuclear Medicine Centre are working with colleagues in the Research Centre for Radwaste and Decommissioning, University of Manchester, to image the movement of technetium (as 99mTc, t1/2 = 6 hours) in flowing sediment columns. The work is co-sponsored by EPSRC and Sellafield Ltd. and focuses on treating sediments so that technetium 'sticks' and is immobile even when water is pumped through the column. This simulates ground contamination at nuclear facilities where technetium (as 99Tc, t1/2 = 2.15 x 105 years) is a mobile subsurface contaminant. The sediment and water chemistries used are typical of the Sellafield nuclear facility, Cumbria, UK. In a technique called biostimulation, acetate is added to the columns as an electron donor (food) to stimulate the natural microbial community present in the sediments. Utilization of the electron donor by microbes leads to chemical and mineralogical changes in the sediments and they become chemically reduced. Thanks to images from the Nuclear Medicine Centre gamma camera, it is clear that technetium sticks to biostimulated sediments as it enters the chemically reduced sediments. By contrast, when the sediments are untreated it flows through unreduced oxic sediment and remains mobile and therefore a problem. These data will help Sellafield Ltd. to decide whether they can use biostimulation at the Sellafield site where there is a multi-million pound legacy of nuclear contamination.





PUBLICATIONS AND AWARDS

Proffered papers

Reader AJ, Julyan PJ, Williams H, Hastings DL & Zweit J (2002) "EM algorithm resolution modeling by image-space convolution for PET reconstruction" *In: IEEE Medical Imaging Conference*, 2002, Norfolk, Virginia.

Williams HA, Julyan PJ (2003) "What you see ain't what you get: investigating concentration recovery in PET" *Nuc Med Comm* 24:456

Julyan PJ, Taylor JH, Hastings DL, Williams HA, Zweit J (2004) "SUV_{peak}: A new parameter for quantification of uptake in FDG PET" *Nuc Med Comm* 25:407

Gillies JM, Smith N, Williams H, Julyan P, Hasting D, Vaidyanthan G, Zweit J (2004) "Evaluation of PET nucleoside analogues in tumour cells" *Nuc Med Comm* 25:413

Williams HA, Julyan PJ, Ranson M, Zweit J, Hastings DL (2004) "Image-based Patlak analysis of dynamic ^{18}FDG PET studies: incorporating recovery-loss correction and blood curve normalisation to improve quantitative accuracy" *In:* Ruechert D, Hajnal J, Yang G-Z. *Medical Image Understanding and Analysis*, Imperial College, London.

Williams HA, Hardy M, Lawson R (2005) "Are ^{81m}Kr uniformity measurements possible with a point source phantom?" *Nuc Med Comm* 26:276

Purser NJ, Williams HA, Tonge CM, Arumugam P, Lawson RS (2006): "A phantom study to investigate the effect of arm truncation on attenuation correction of myocardial perfusion SPECT" *In: BNCS Annual Meeting*, 2006, London, UK

Purser NJ, Williams HA, Tonge CM, Lawson RS (2007) "Apical thinning - real or artefact?" *Nuc Med Comm* 28:A7

Williams HA, Bradley A, Lawson RS, Ellis BL (2007) "Validation of a Phosphor Imager for Radiochemical Purity Determination" *Nuc Med Comm* 28:A12

A, Armstrong IS, Lawson RS, Prescott MC, Shields RA, igh count rate performance of the PET scanner prior to urements with Rubidium-82" *Nuc Med Comm* 32:427

D, Armstrong IS, Williams H, Lawson RS, Shields RA, to successful implementation of a Clinical Rubidium 440

s HA, Prescott MC (2012) "Impact of PSF modelling and ead and neck lesions" *Nuc Med Comm* 33:534

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Mahmood S, Erlandsson K, McGowan DR, Yatigammana D, Zolfagharinia H, Wise R, Divoli A, Murray I, Williams H, Talboys M, Kenny K, Ryder W, Holubinka M (2013). "TOF Versus Non-TOF PET for the Quantification of Cardiac Defects". *In: IEEE Nuclear Science Symposium and Medical Imaging Conference*, 2013, Seoul, North Korea.

Zhang W, James J, Hatsukami T, Yuan C, ng atherosclerotic plaque inflammation in in a single centre cohort". *Rheumatology*

rescott M (2007) "A Retrospective Study of nages and the Impact of Laxatives and

2010) "Count rate capability: the krypton

ne of Flight Performance Using Analytic : *IEEE Medical Imaging Conference, 2010,*

Accuracy and variability of quantitative ation and resolution modelling" *In: IEEE Medical Imaging Conference, 2011, Valencia, Spain.*

Williams HA, Harding R, James J (2012). "Individualised vs. universal preparation for ^{18}FDG PETCT for oncology: the impact on systemic ^{18}FDG distribution in medication-controlled diabetics, in comparison to normal controls" *Nuc Med Comm* 33:552

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Williams HA (2012). Principles of Positron Em
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London: Springer, 93-96.
Armstrong IS, Kelly MD, Williams HA and Mat
modelling and time of flight on FDG uptak
filtering strategies". *EJNMMI Physics* 1:99

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Reader AJ, Julyan PJ, Williams H, Hastings DL & Zweit J (2003) "EM algorithm system modeling by image-space techniques for PET reconstruction" *IEEE Trans Nucl Sci* 50: 1392 - 1397.

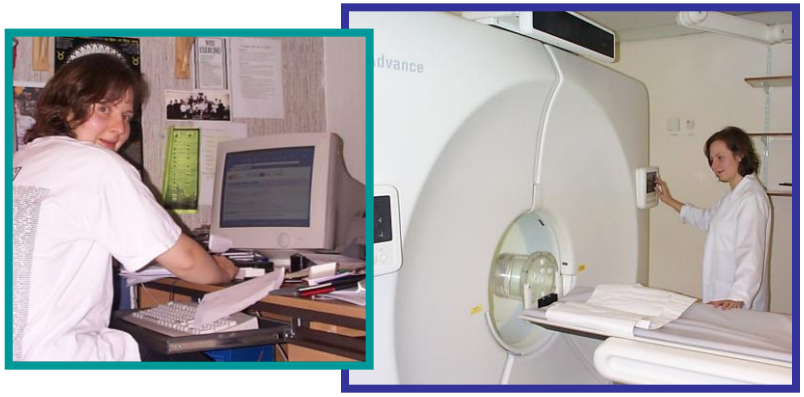
Williams HA, Robinson S, Julyan P, Zweit J, Hastings D (2005) "A comparison of PET imaging characteristics of various copper radioisotopes" *Eur J Nuc Med Mol Im* 32: 1473 - 1480

Williams HA (2006) "Ring the changes" *Body&Soul, The Times. 12th August.*

Prizes

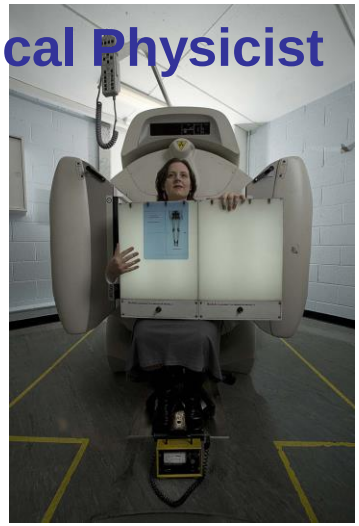
2001 - First prize, Medical Physics Essay competition, Medical Physics Group, IoP
2003 - Third prize, Student Paper competition, 31st Annual Meeting, BNMS
2007 - Young Investigator Prize (for MSc student), 35th Annual Meeting, BNMS
2010 - Third prize, Poster competition, 38th Annual Meeting, BNMS
2012 - First prize, Poster competition, 40th Annual Meeting, BNMS
2014 - Named as one of the 100 Leading Practising Scientists, Science Council

Decided to do a PhD while I had the chance! (not essential for my job)



Got PhD

Started current job as Medical Physicist in Nuclear Medicine at Manchester Royal Infirmary



Got State Registration

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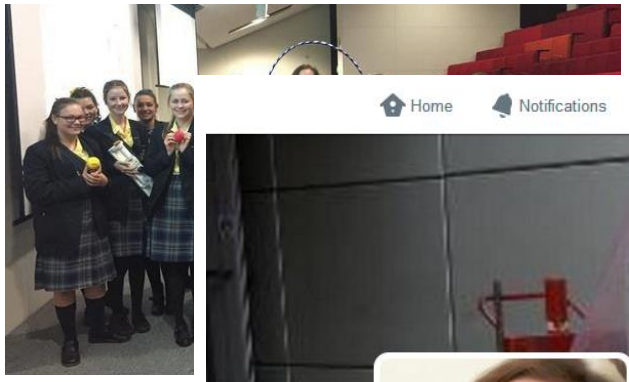
Progress within NHS

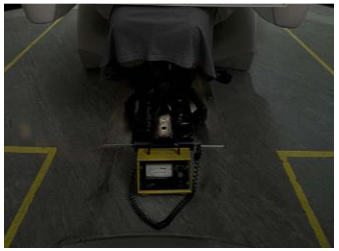
Work overseas

Move to industry

Return to research

Science Communication





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From the Directors 2014/2015

ScienceGrrl Report: Through Both Eyes: The Case For a Gender Lens in STEM

"Through Both Eyes" is a report researched and written by ScienceGrrl, in response to a request from Sir Peter Luff MP to devise practical and actionable recommendations to the STEM sector about how to increase equality of access to STEM careers. You can download it, free, from our website.

The recommendations have been widely accepted by the STEM community and we have received letters of support from a variety of companies including Boeing, Ultra Electronics and Finmeccanica. We have used the report to build strong and sustainable relationships with key actors in the STEM outreach and diversity community including organisations such as WISE, WES, STEMNET British Science Association and EngineeringUK. We have also had strong political buy-in with letters of support from Nick Clegg, David Willetts and Jenny Willot, amongst others. Our findings were also addressed to the Prime Minister during PMQs where he was asked to comment on how the government planned to respond to the recommendations. We have also had the opportunity to help shape the YourLife campaign alongside number 10, BIS and the DfE.

We are pleased with the impact this report has had, but we hope this is just the beginning. We are using the report as our manifesto, folding our recommendations into our future conversations, and the resulting plans and strategy.

She Blinded Me With Science

In November, Violet Transmissions re-released Thomas Dolby's 'She Blinded Me With Science' as the title track of their latest EP. Prof Tim Bussey, lead vocalist and Oxford don, got in touch several months previously to discuss using the song to promote the contribution of women to science and highlight how often this is overlooked. The video accompanying the song featured 5 ScienceGrrls - Roma Agrawal, Lia Ying Li, Suzi Gage, Ceri Brenner, and Suze Kundu. We worked closely with Tim and producer Ben to make sure they were depicted authentically and came across with integrity, charisma and energy. The video also featured footage from the BBC TV series 'Orphan Black' showing female geneticists at work. To date, it has had over 10,000 views on youtube.

The release of the video was accompanied by short videos and blogs from the 5 ScienceGrrls about themselves and their work. We also used the Twitter hashtag #sheblindedmewithscience to enable people to share their stories of female scientists who had blinded them with science.

Hi Everyone,

This year at ScienceGrrl has been our most exciting yet. We've expanded our network and strengthened our roots, made strong connections within science, technology, engineering and maths (STEM) both locally and nationally, and have seen our work grow in reach and impact.

This success has been in no small part due to our wonderful network of dedicated and enthusiastic volunteers who work across our 20 chapters to make ScienceGrrl what it is. Our chapters have worked tirelessly to support and celebrate women in STEM. They have put on networking and mentoring events, they've presented at science festivals, schools and careers fairs to spread the word about life in science and the opportunities it presents, and in doing so they have showcased amazing role models and have inspired countless people.

At a national level we have also been making great strides in celebrating women in STEM and highlighting the issues they still face. Our 'Through Both Eyes' report has been an extraordinary vehicle for lobbying government, articulating the real issues faced by women and girls whilst demanding change through constructive recommendations. The video accompanying 'She Blinded me with Science' took our science role models to a whole new audience.

We hope you agree that this annual report summarises the impressive extent and impact of our work this year. We are also extremely proud that alongside this hard work and dedication our core team and chapters have maintained the positive and inclusive energy that has always defined ScienceGrrl. We are looking forward to deepening our impact in the coming years and are confident that we have a firm foundation from which to develop our work.

And we're very grateful to have you with us as we continue this journey. Thank you so much for your continued support.

Heather, Anna & Ellie

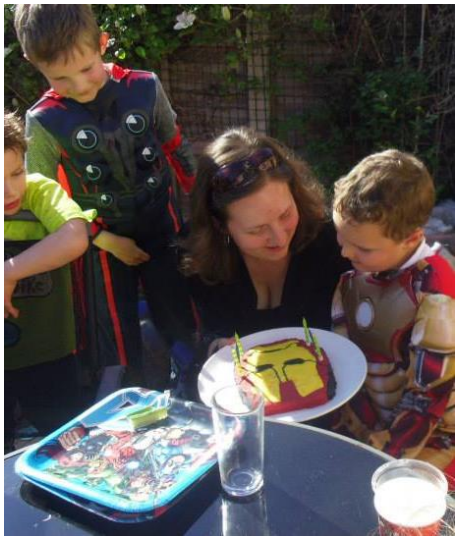
20 chapters

15,000+ followers

500+ members

National voice and profile

You can’t work ALL the time…



For more information on careers in the NHS and healthcare science in particular, go to www.nhscareers.nhs.uk

Thanks for listening!

Any questions?

@alrightPET