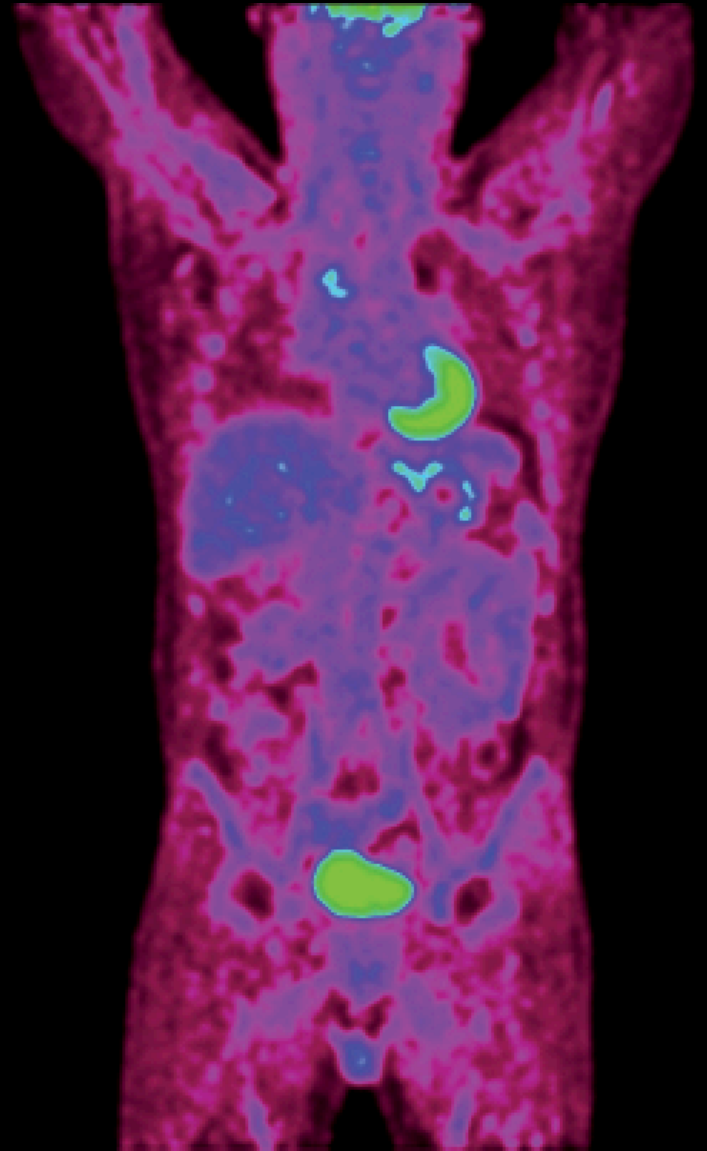


# Drawing with Antimatter

Piergiorgio Cerello  
INFN - Torino

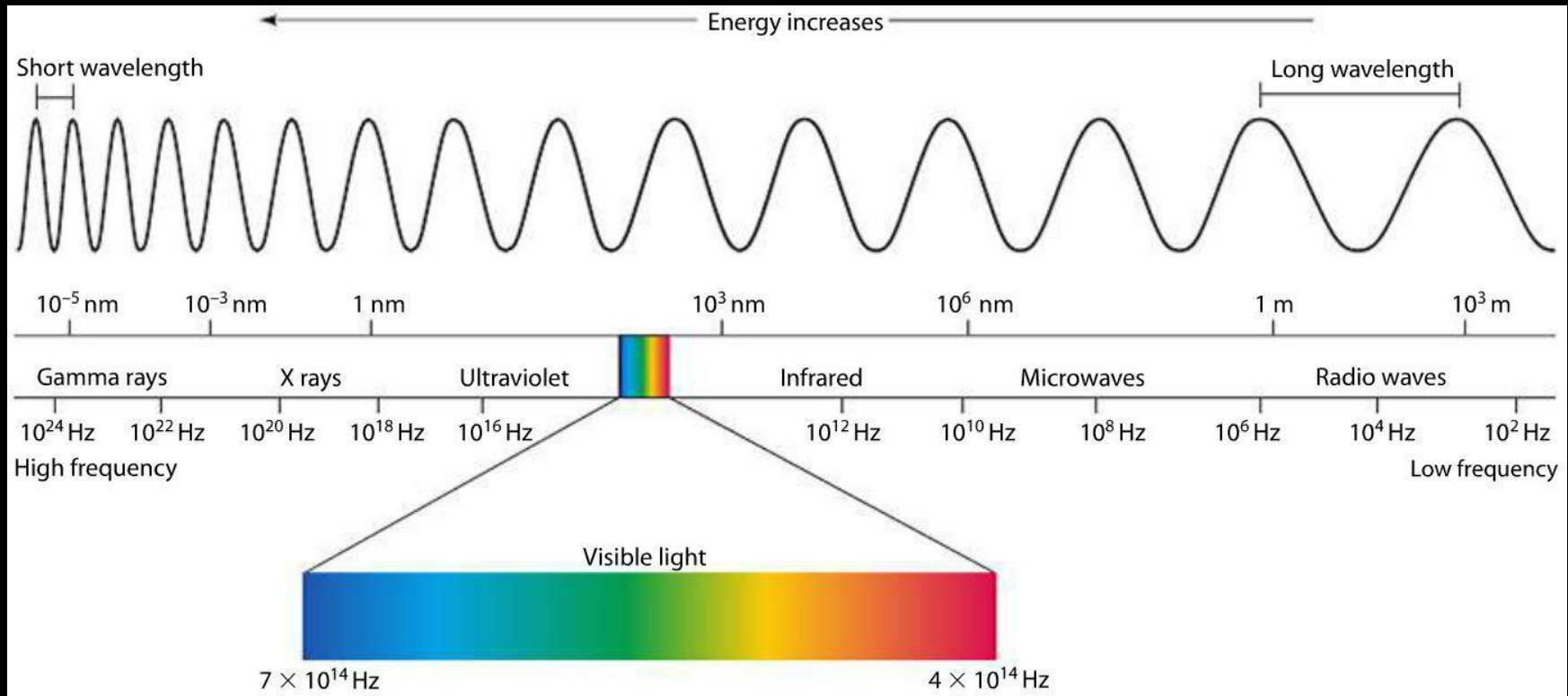


# Roentgen



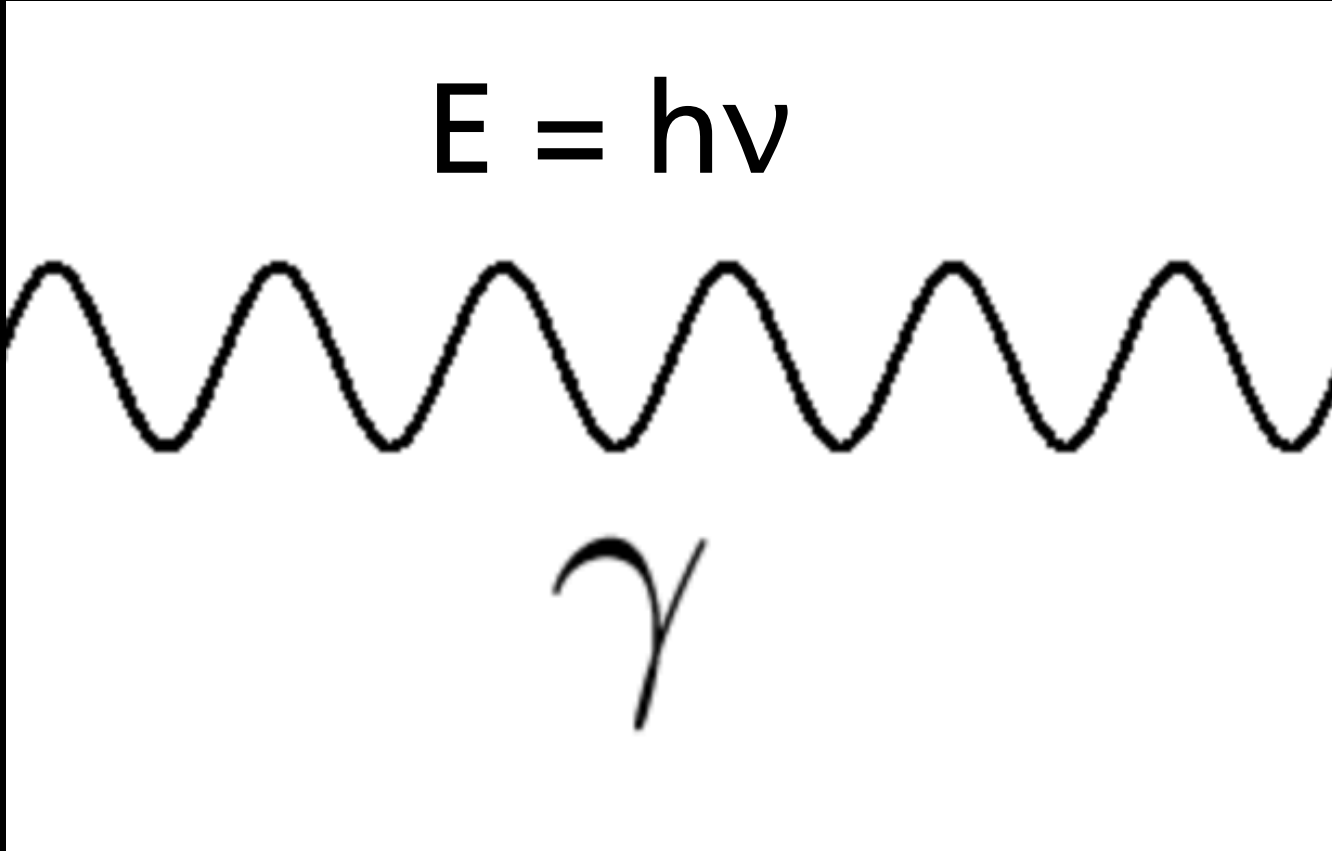
- 1895
- X-rays
- Radiography
- Looking through matter

# The Electromagnetic Spectrum

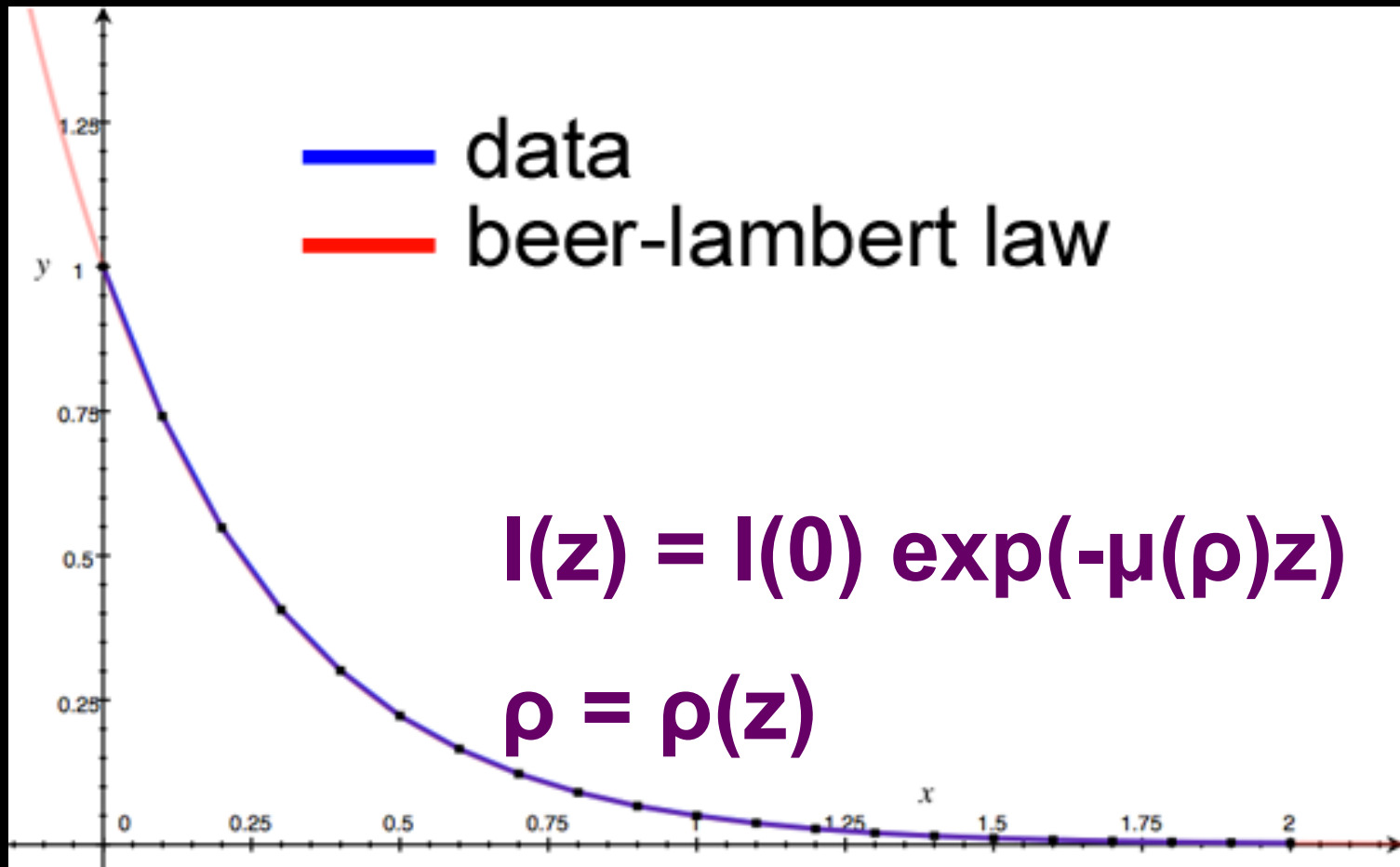


# The photon

$$E = h\nu$$



# Photons through matter



# X-ray tubes



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# X-ray detectors



@artandscienceacrossitaly

# Radiography



@artandscienceacrossitaly

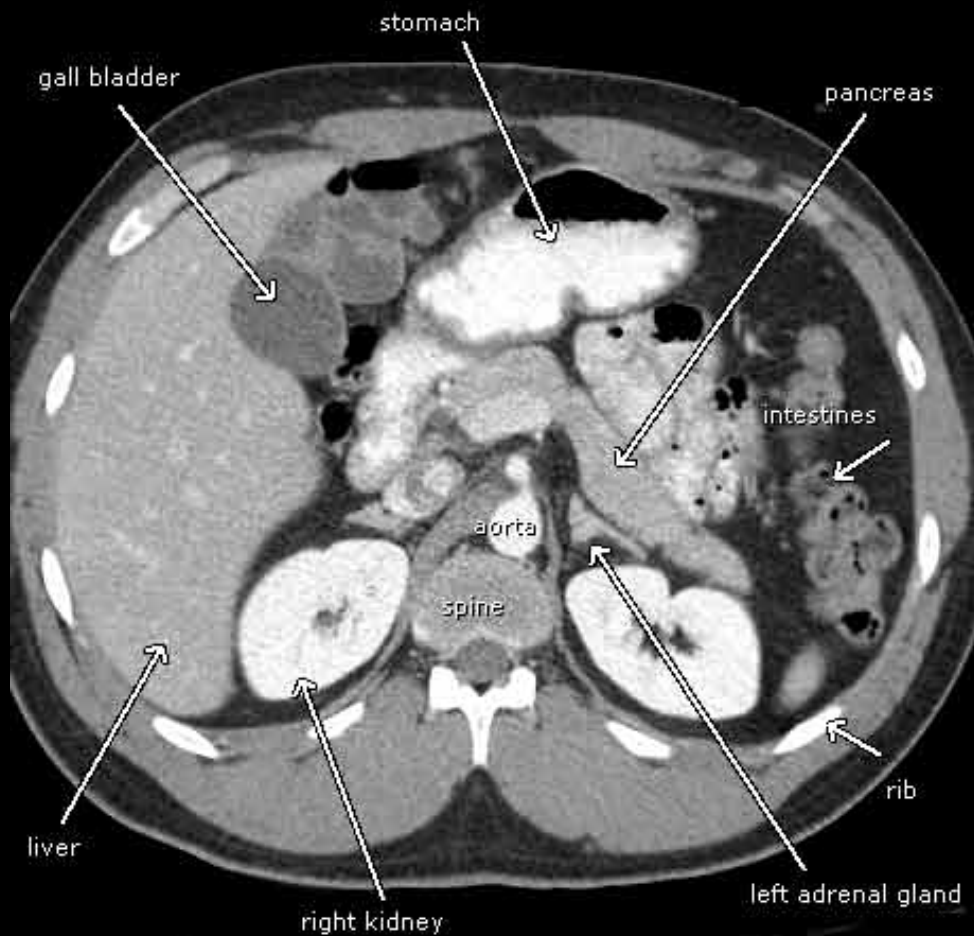


# Computed Tomography



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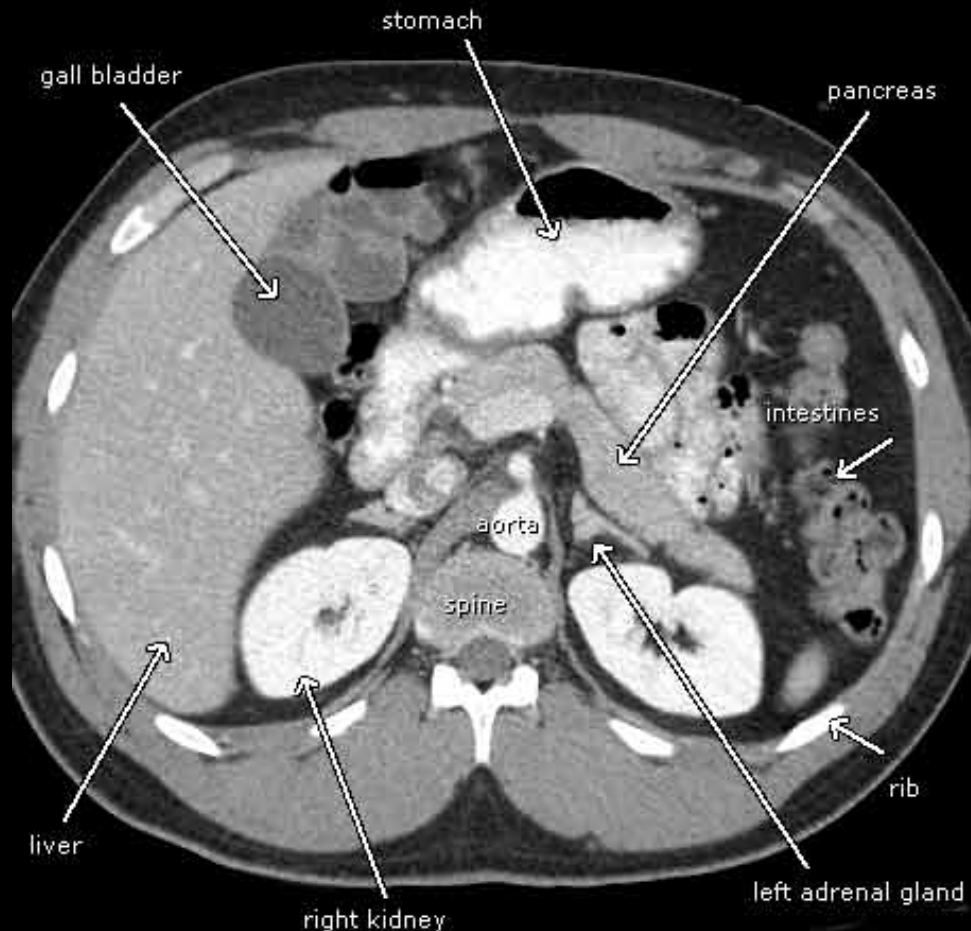
# Computed Tomography



- Hounsfield
- From 2D to 3D
- Computing power
- Speed

# Computed Tomography

## Morphological imaging



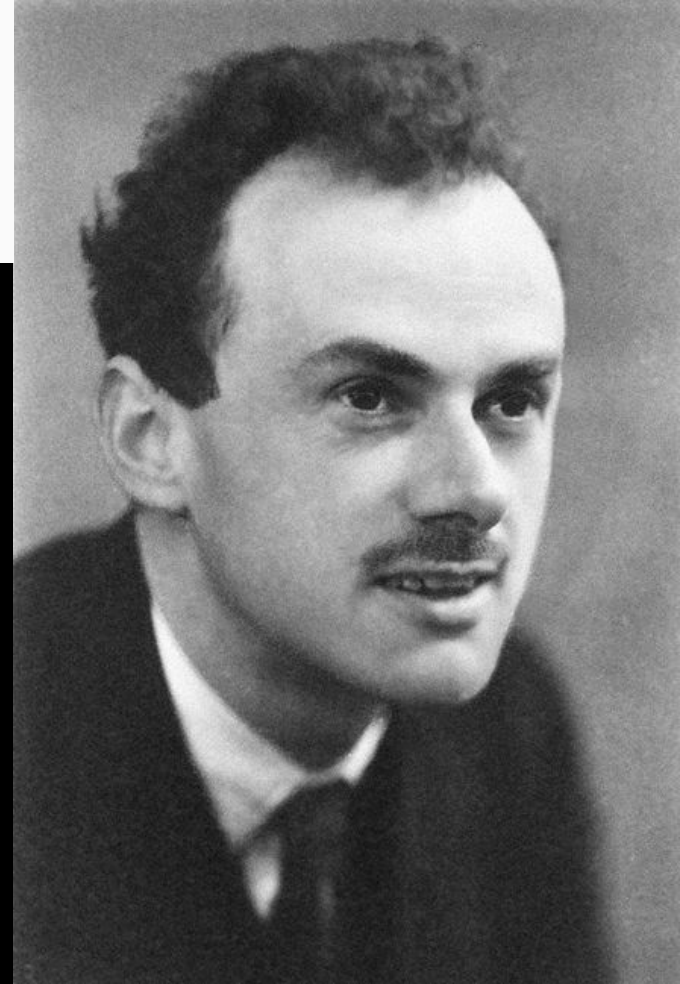
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# Antimatter

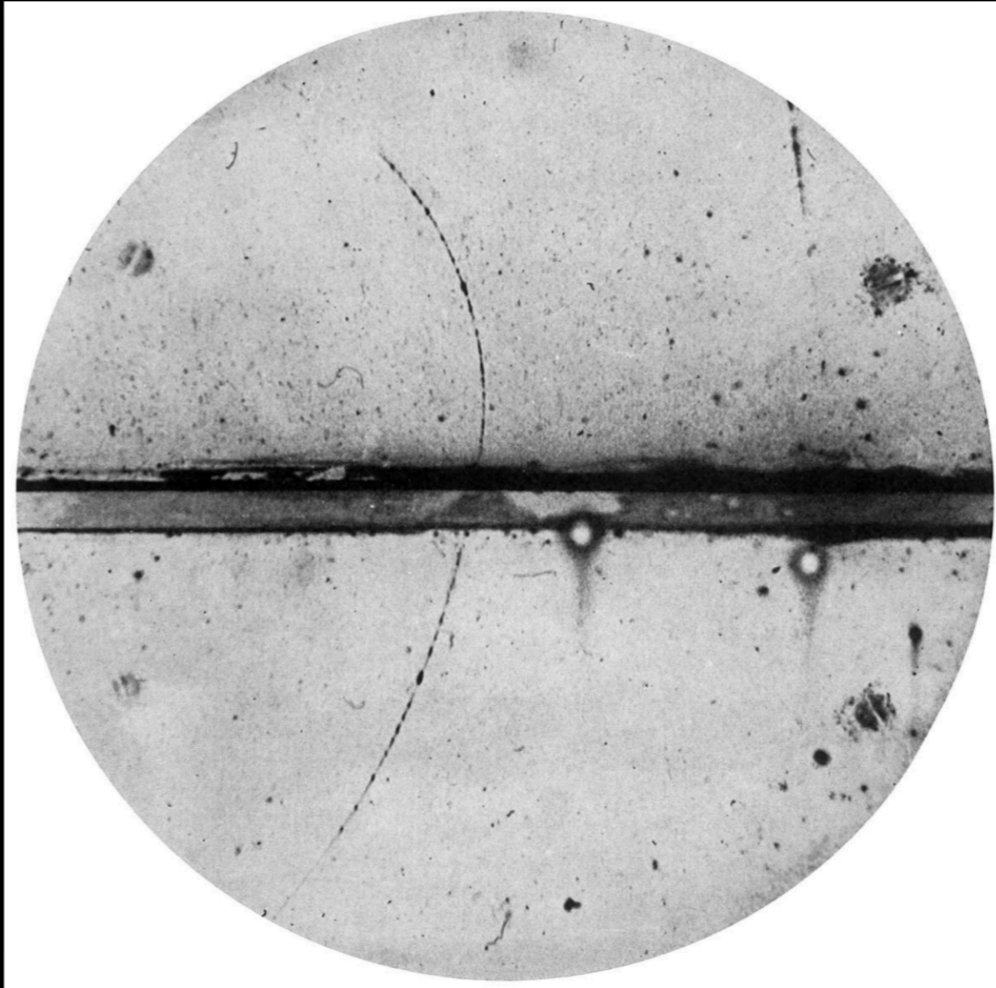
# Antimatter

$$(i\partial\!\!\!/ - m)\psi = 0$$



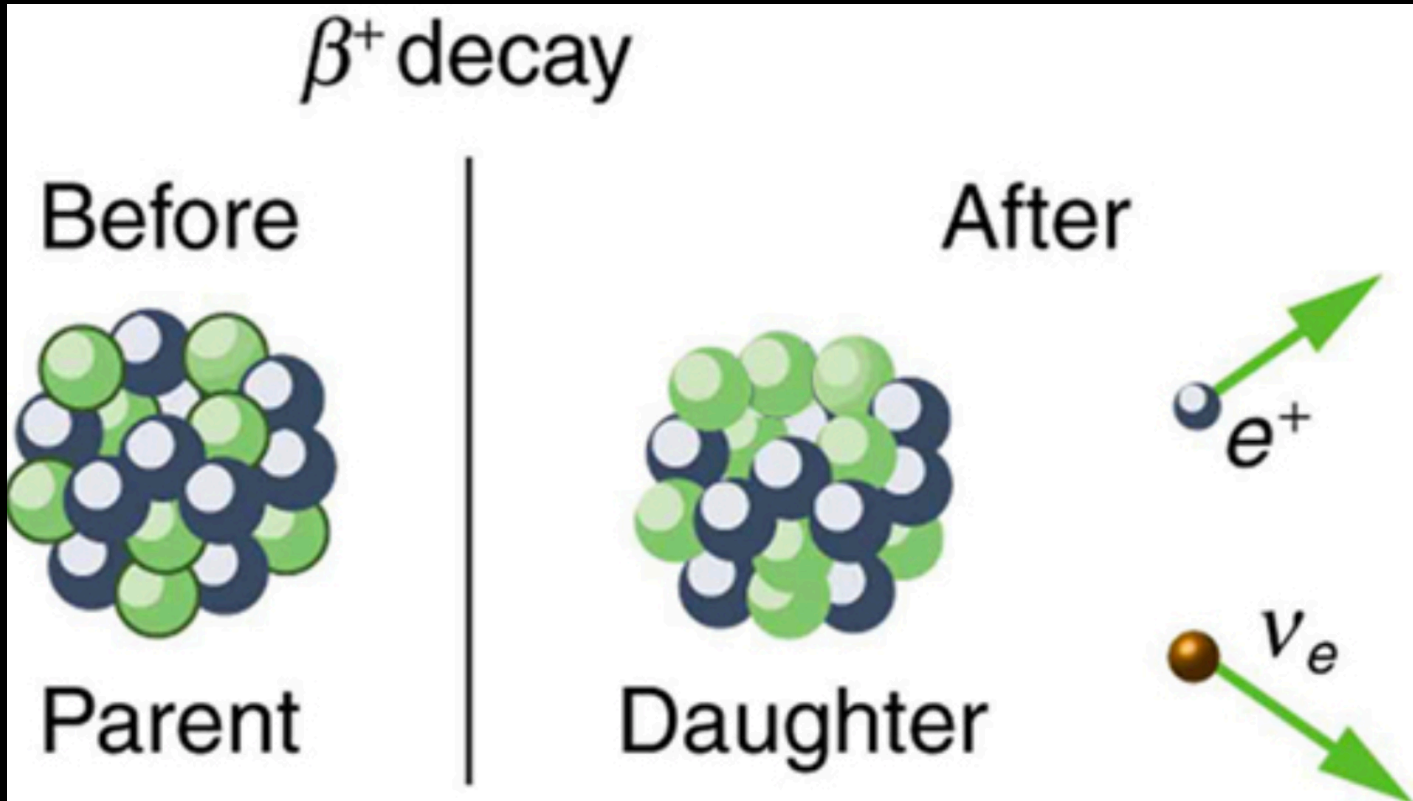
- Dirac, 1928
- Solutions with negative energy

# Antimatter

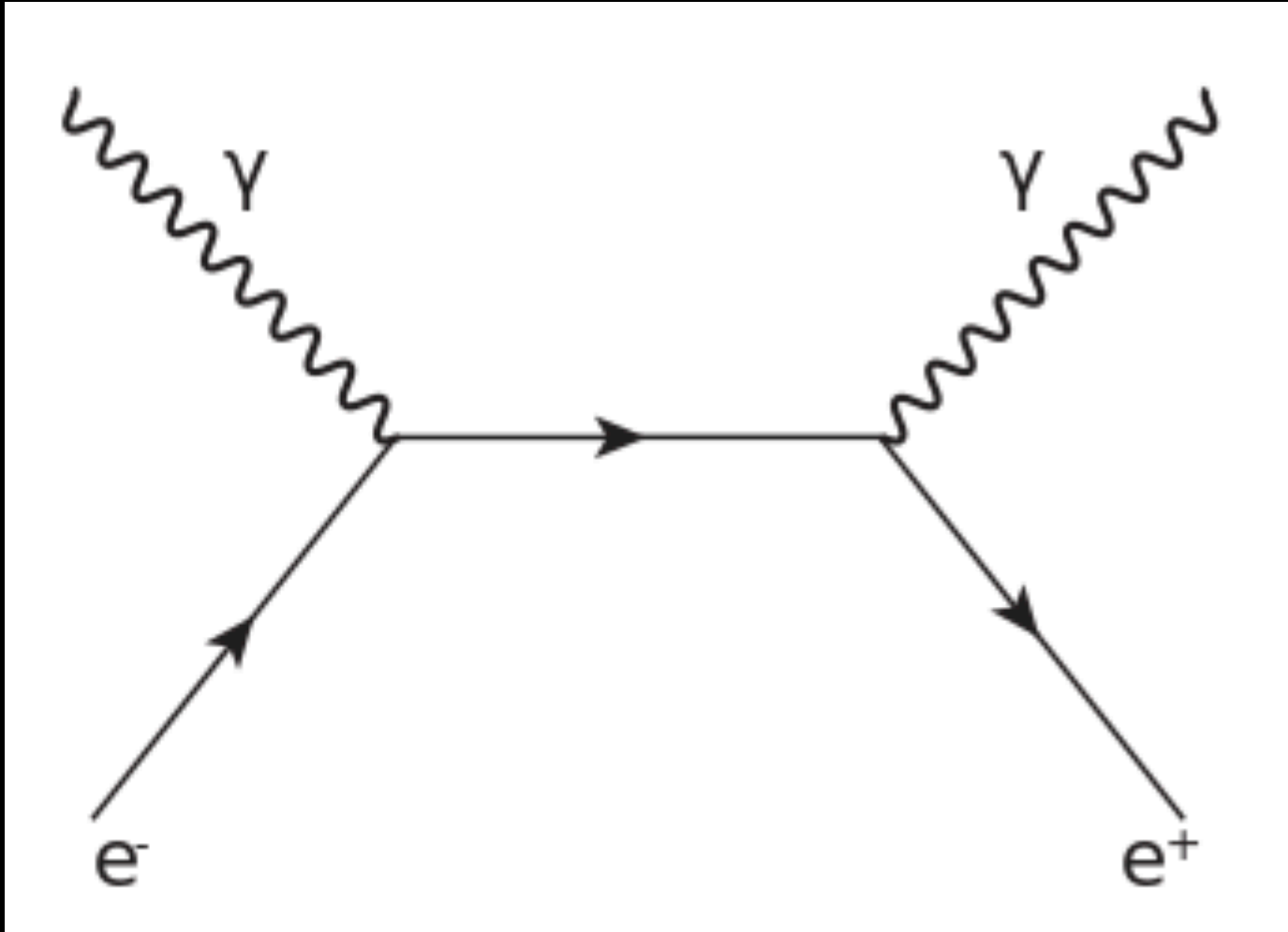


- Anderson, 1932
- the positron ( $e^+$ )
- $e^+e^-$  annihilation

# The $\beta$ decay



# $e^+e^-$ annihilation at rest





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# Why?



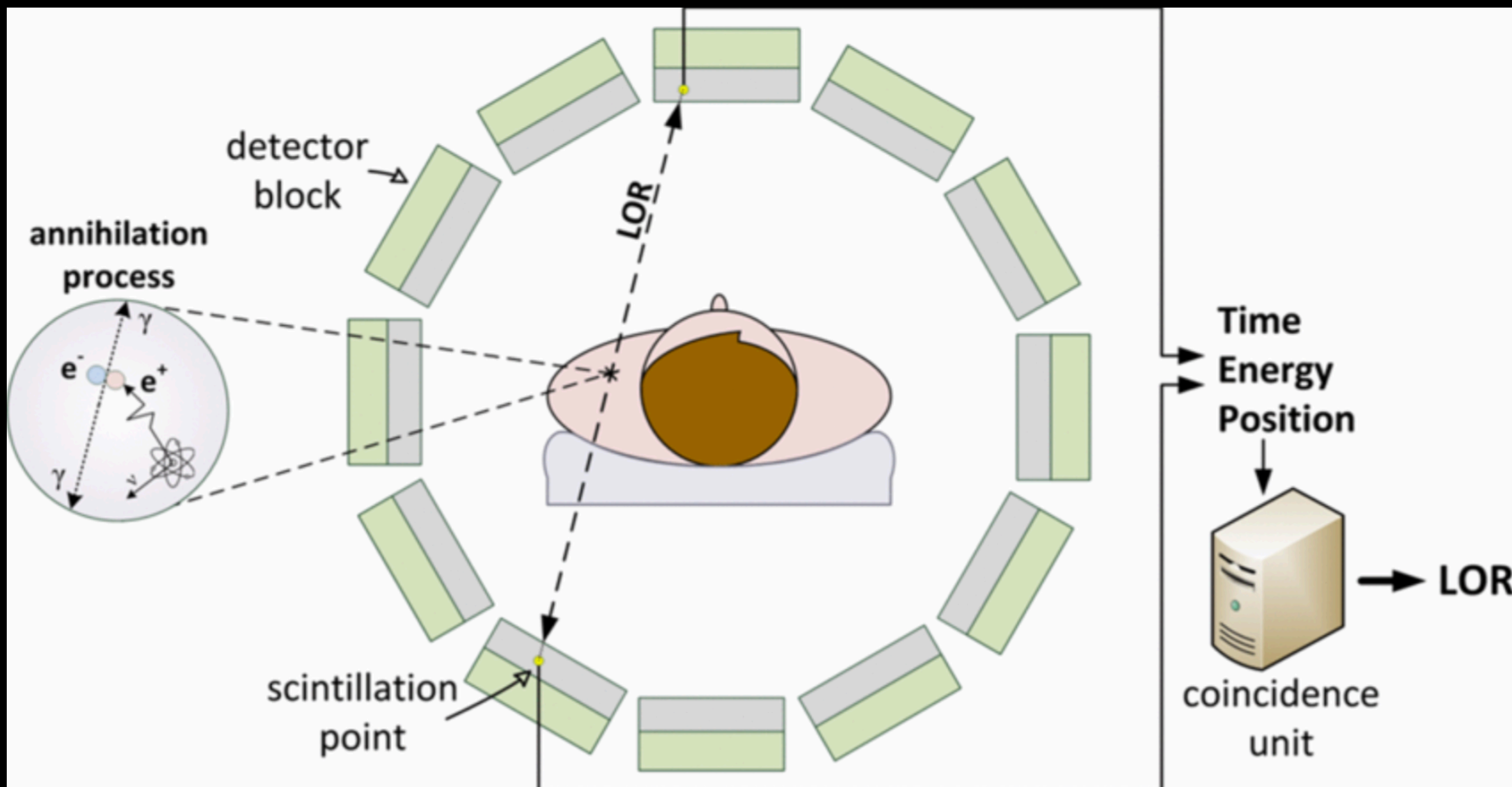
@artandscienceacrossitaly

# Functional Imaging!

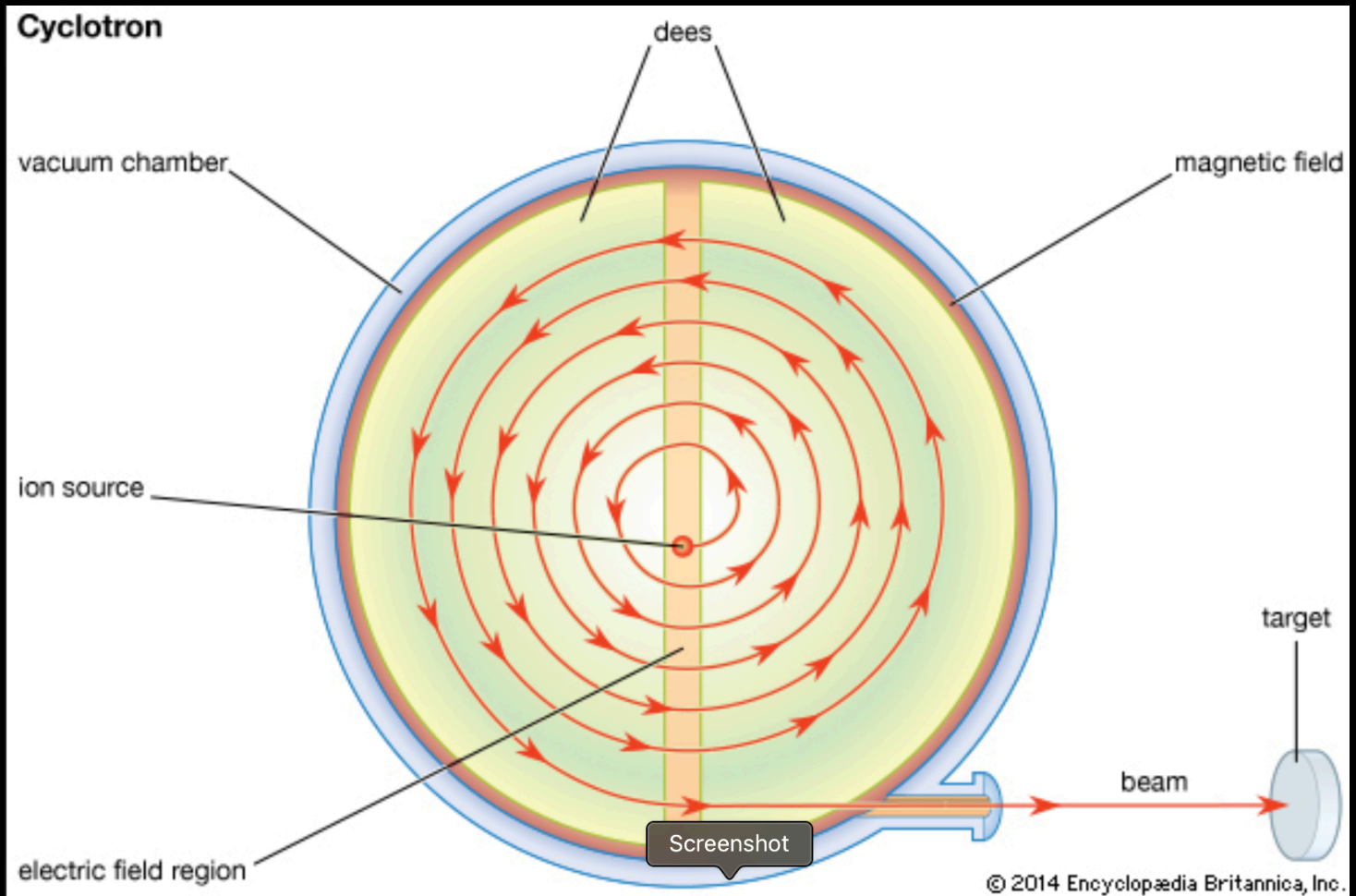


# Positron Emission Tomography

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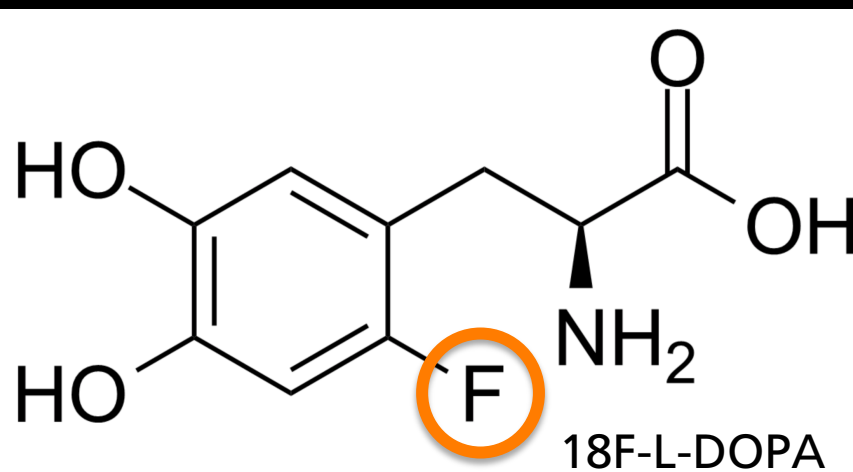
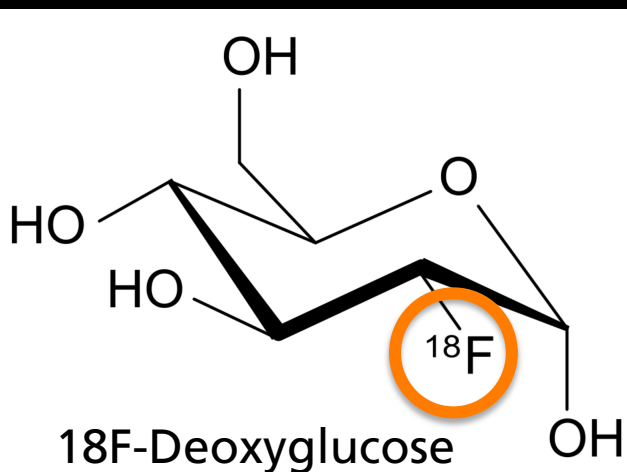
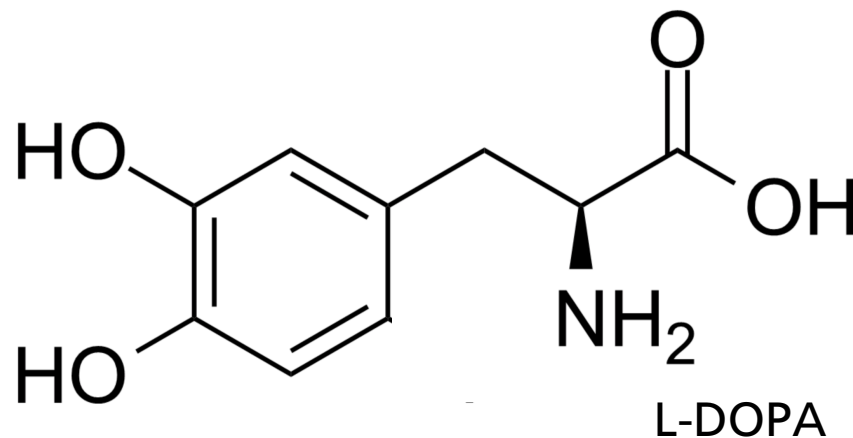
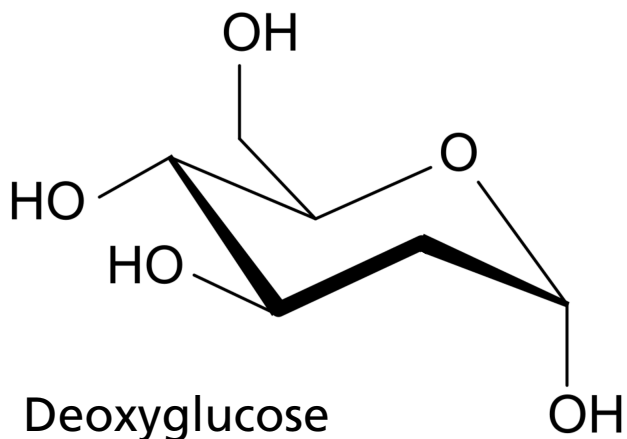


# The Cyclotron

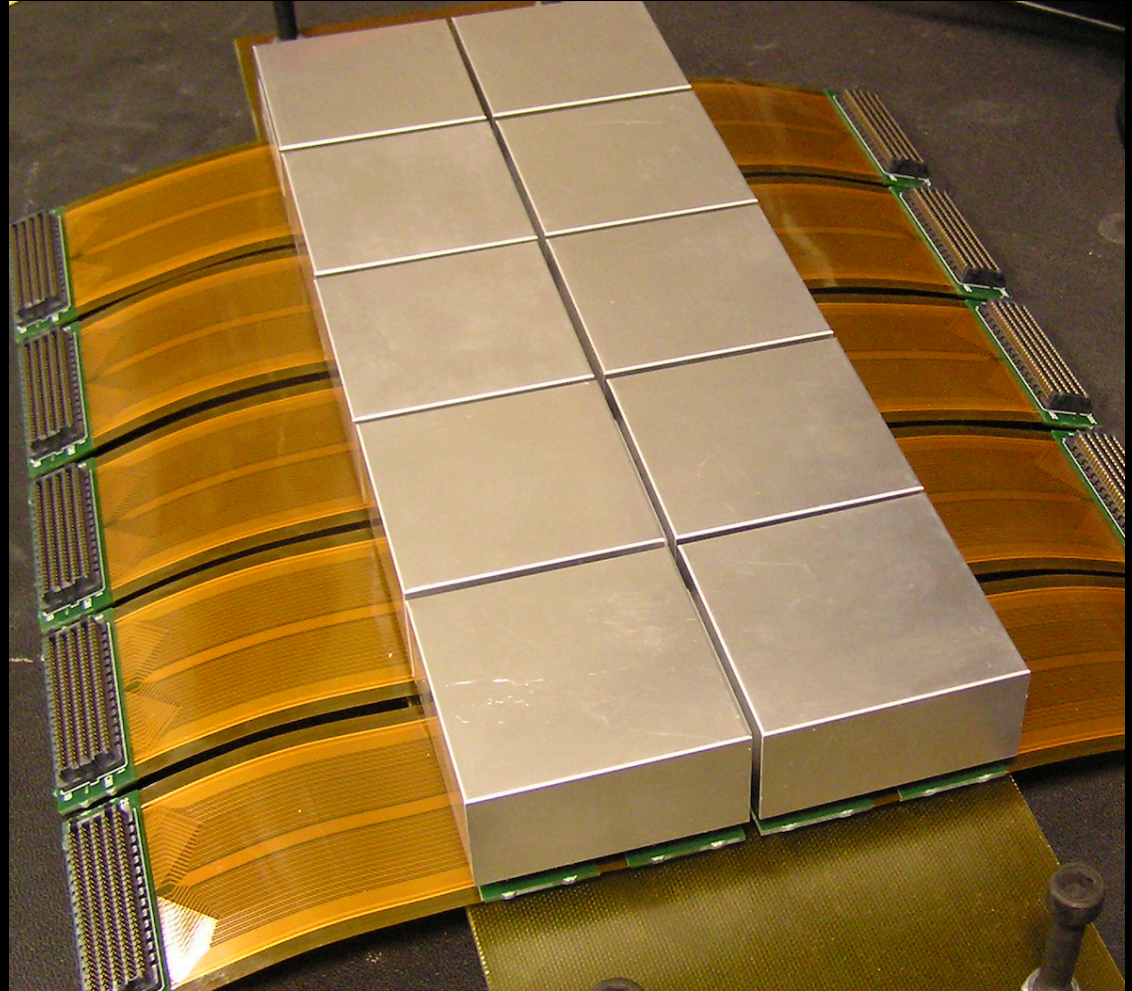
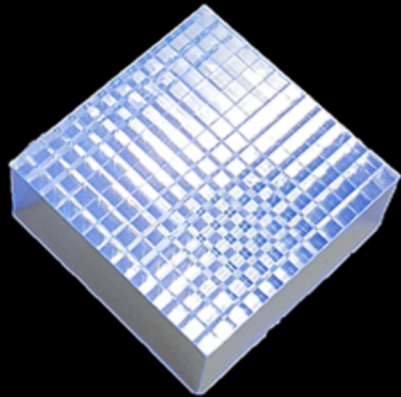
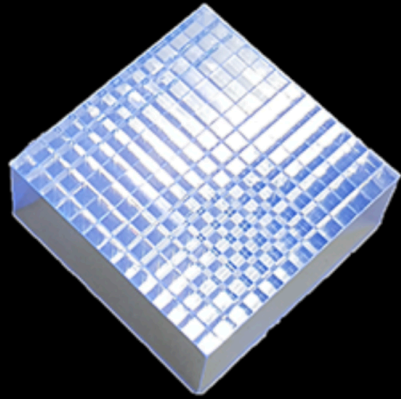


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# The Radiotracer

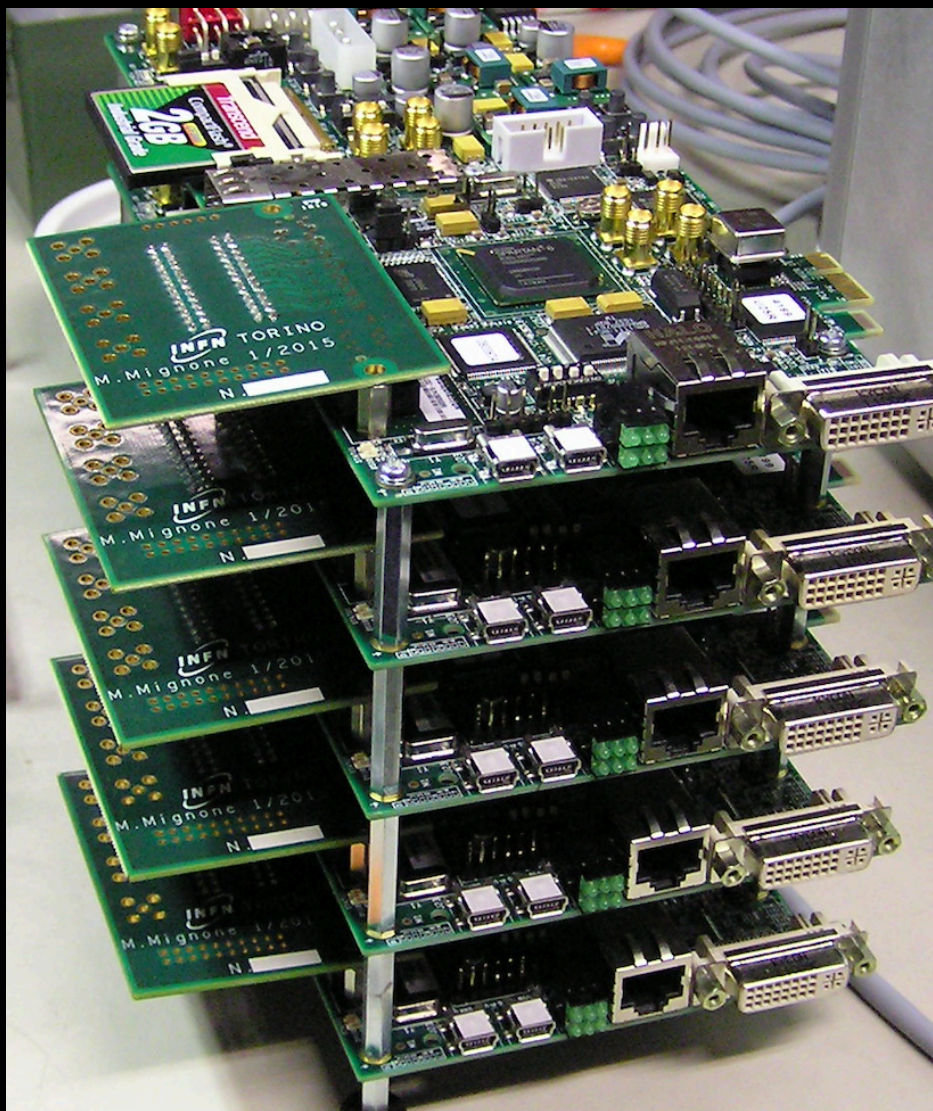


# PET detectors



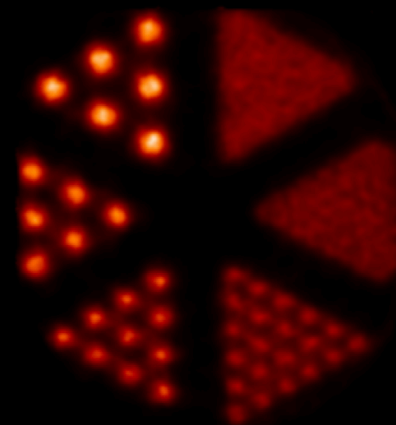
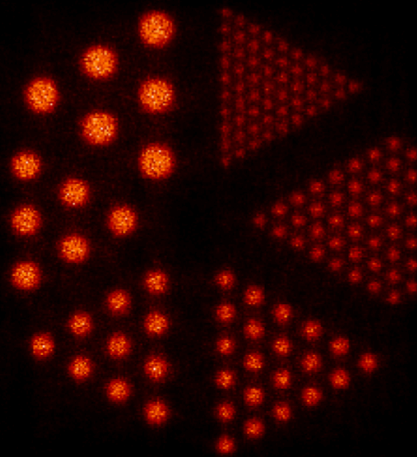
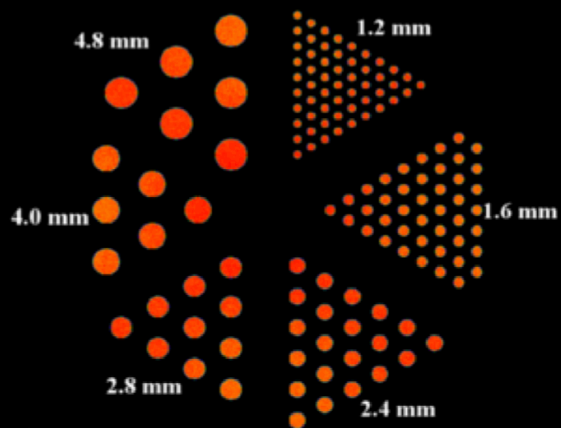
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# PET detectors



@artandscienceacrossitaly

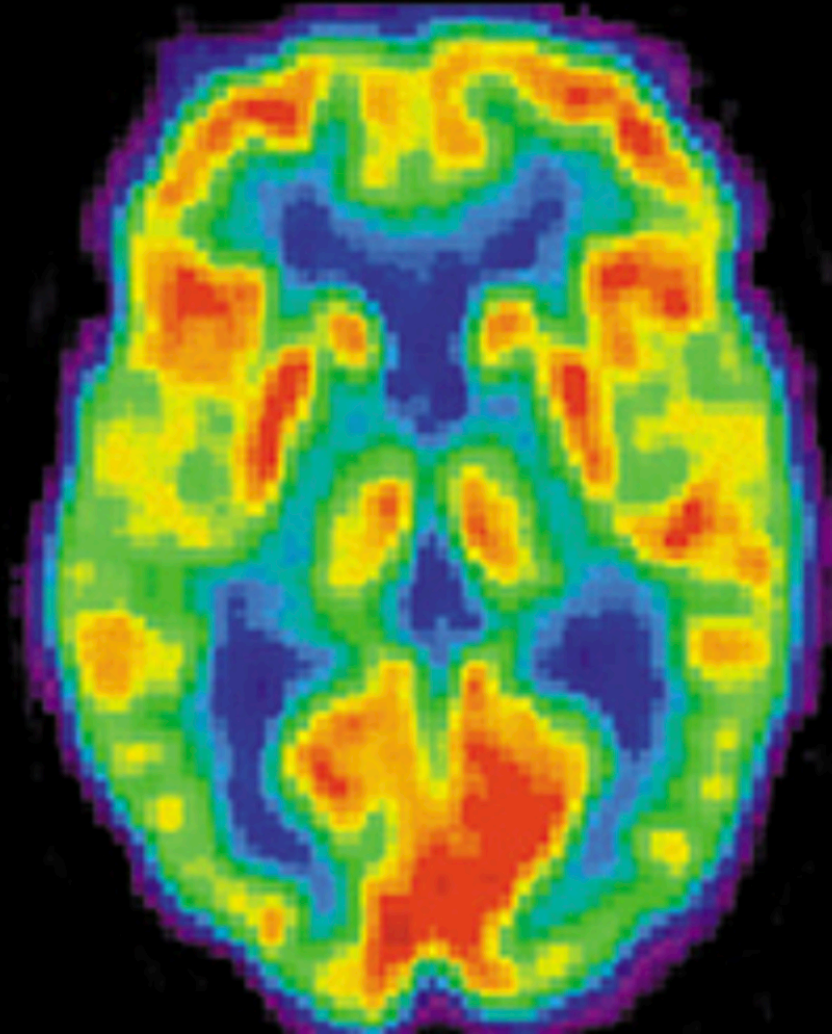
# PET Phantom



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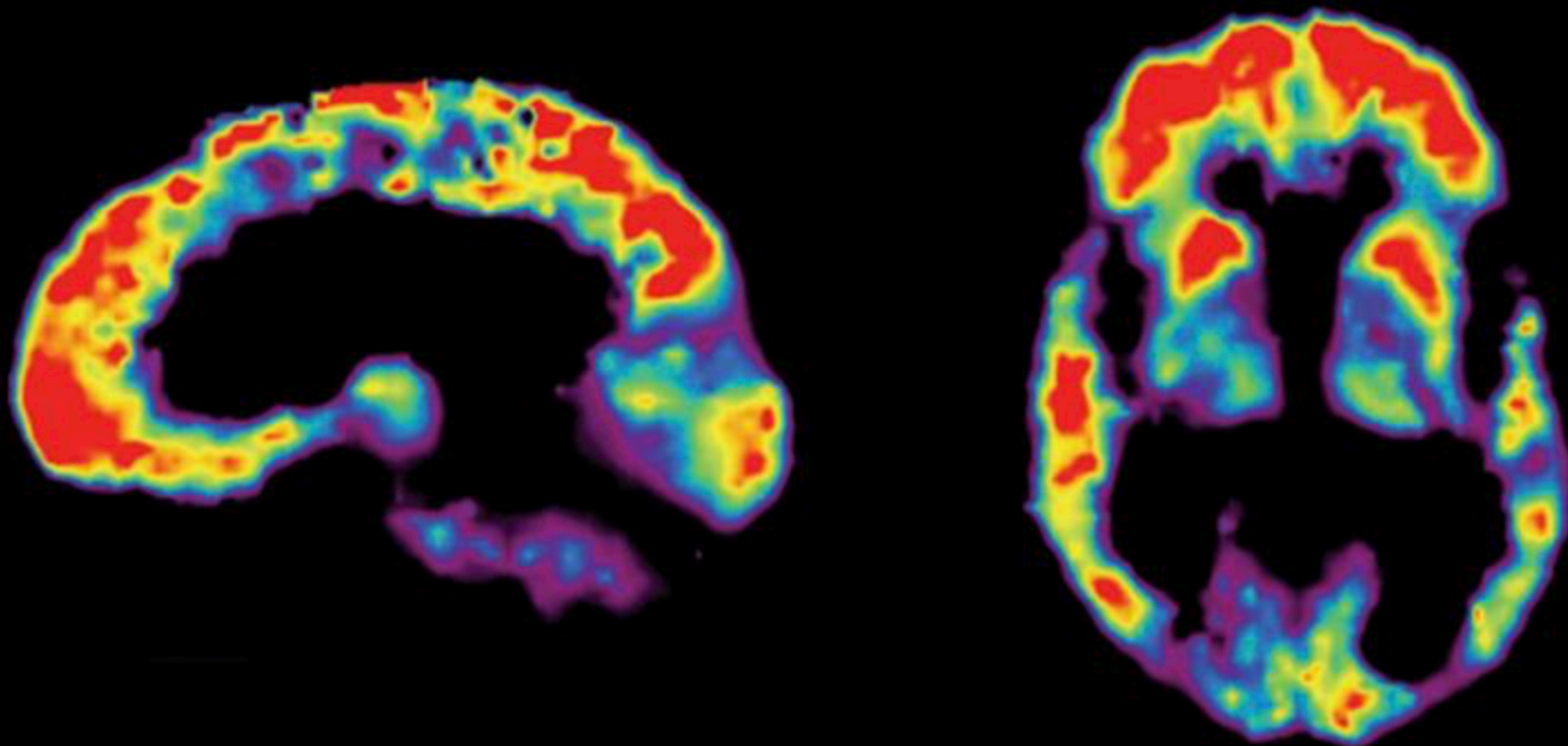


# The brain in the early times



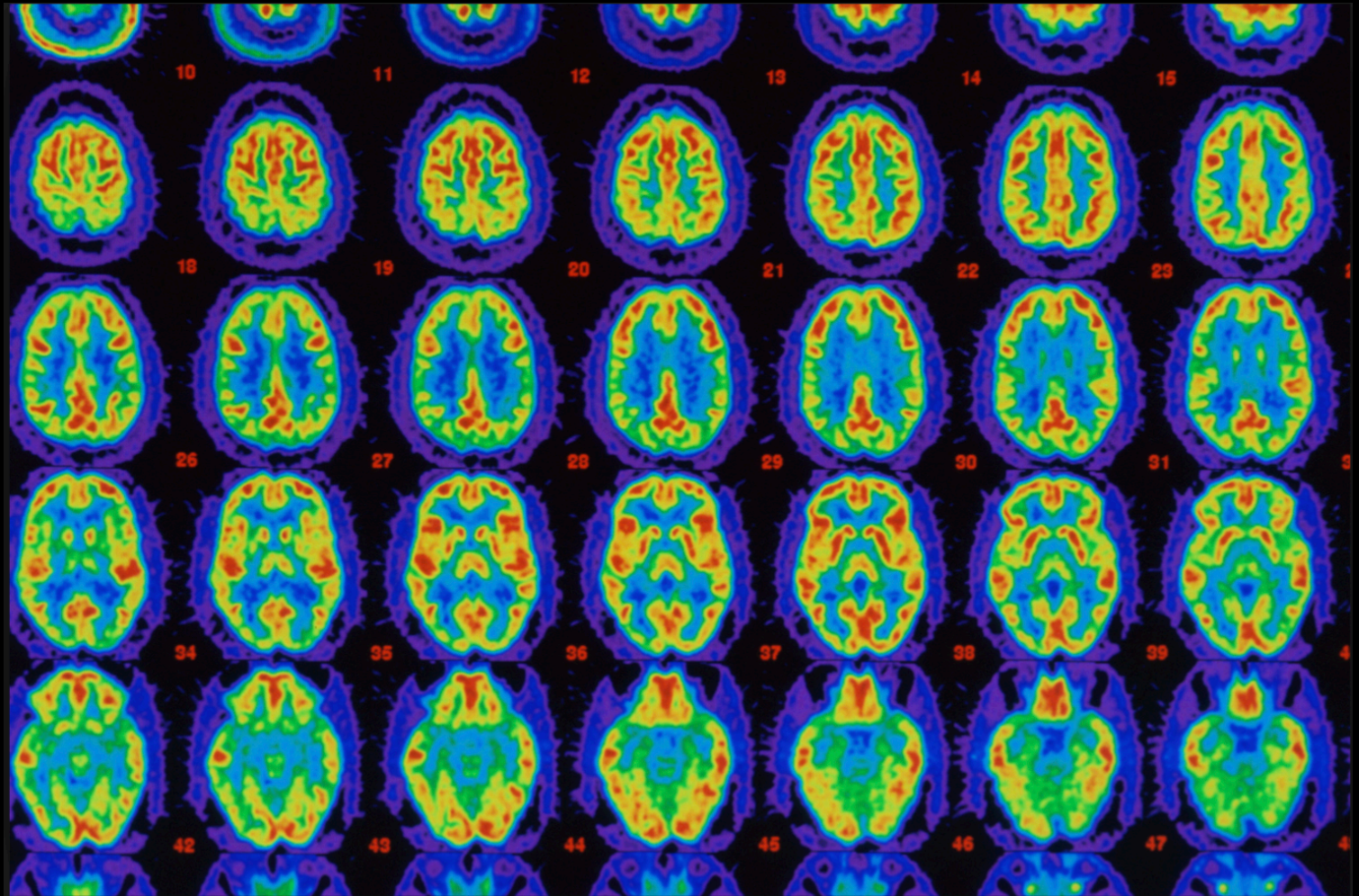
@artandscienceacrossitaly

# Brain Views



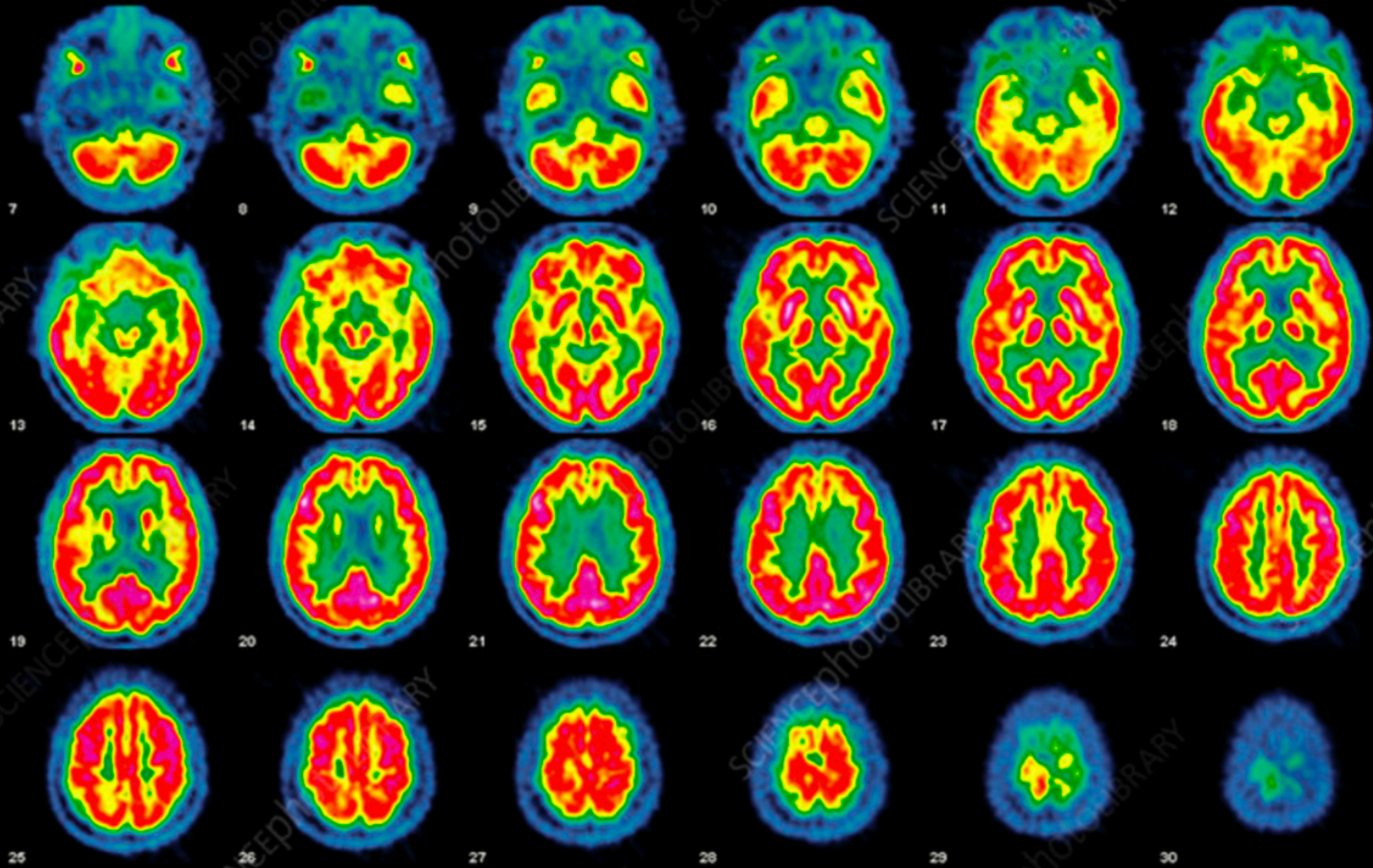
@artandscienceacrossitaly

# Brain PET



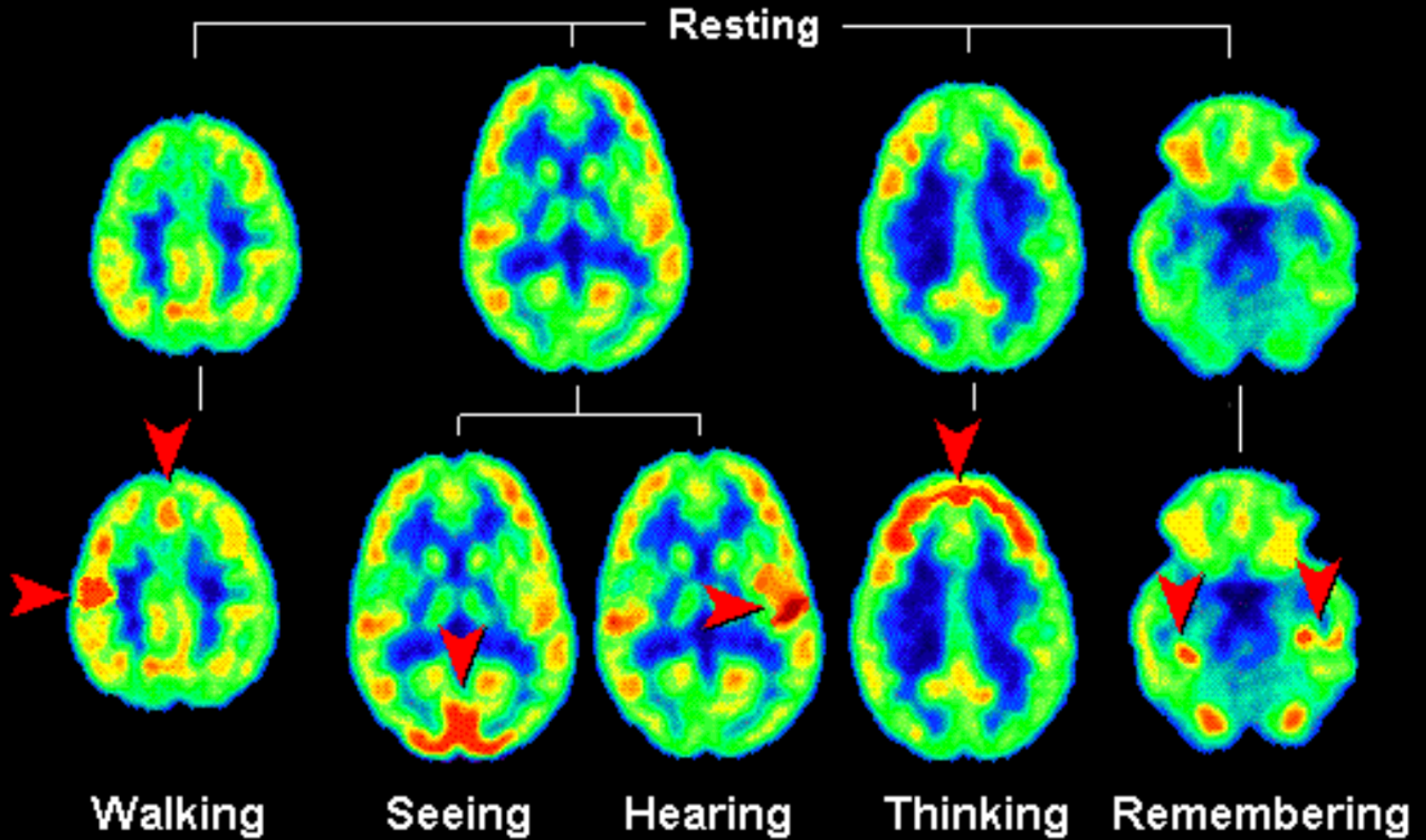
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# Normal Brain Activity



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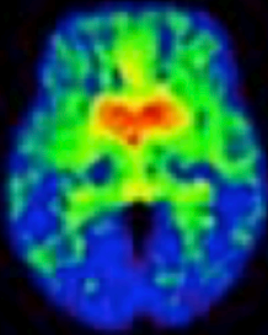
# Brain at Work



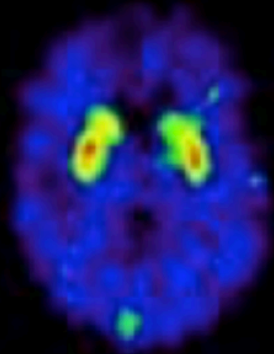
Phelps & Mazziotta, UCLA

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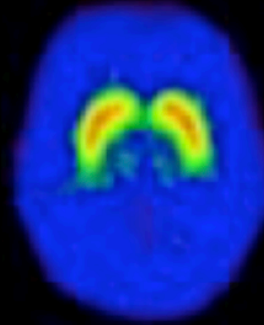
# Health Issues



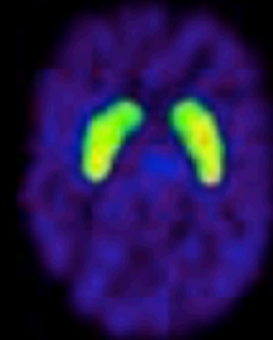
**Smoker**



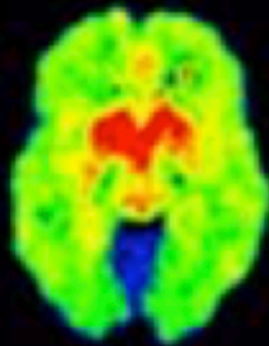
**Alcoholic**



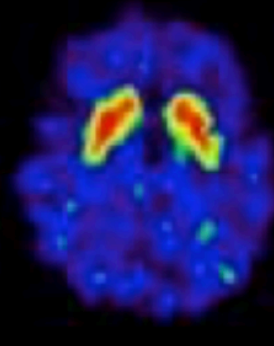
**Obese**



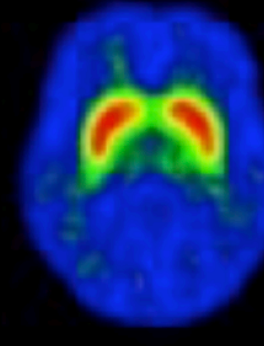
**Cocaine**



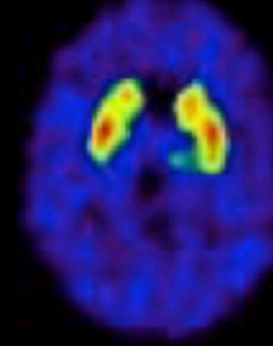
**Non-Smoker**



**Normal**



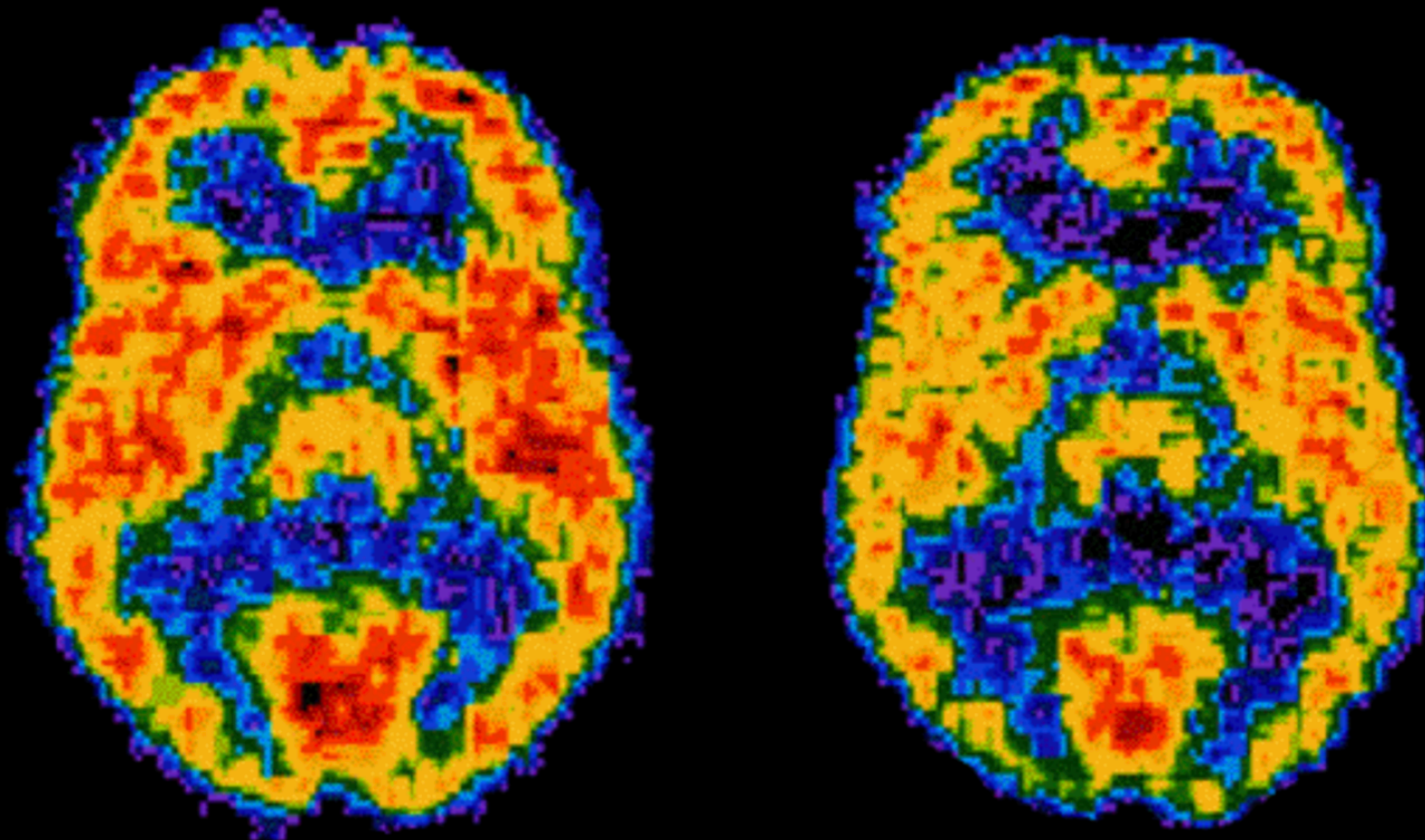
**Normal**



**Normal**

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# Normal vs. Cocaine



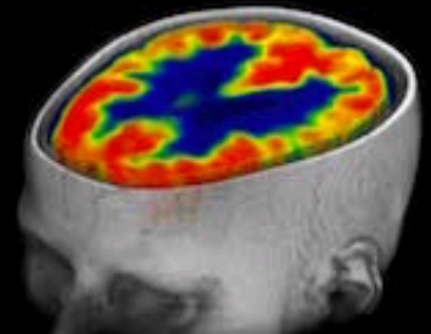
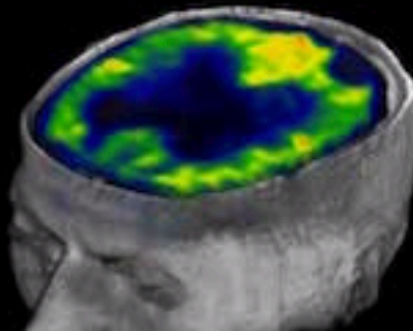
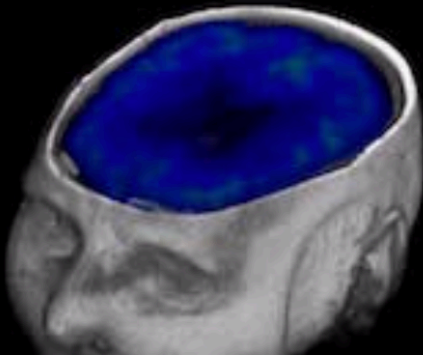
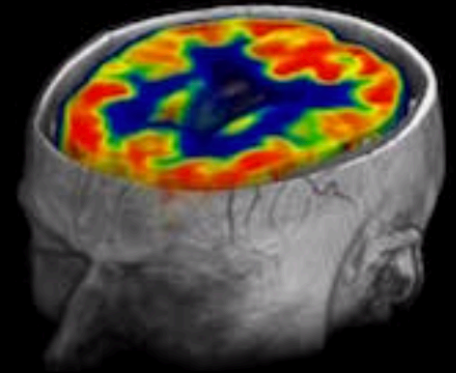
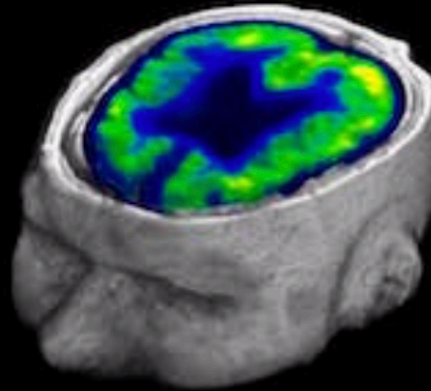
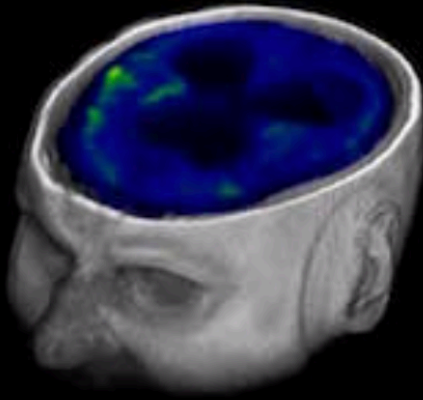
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# Brain Status

Vegetative

Minimally Conscious

Fully Conscious

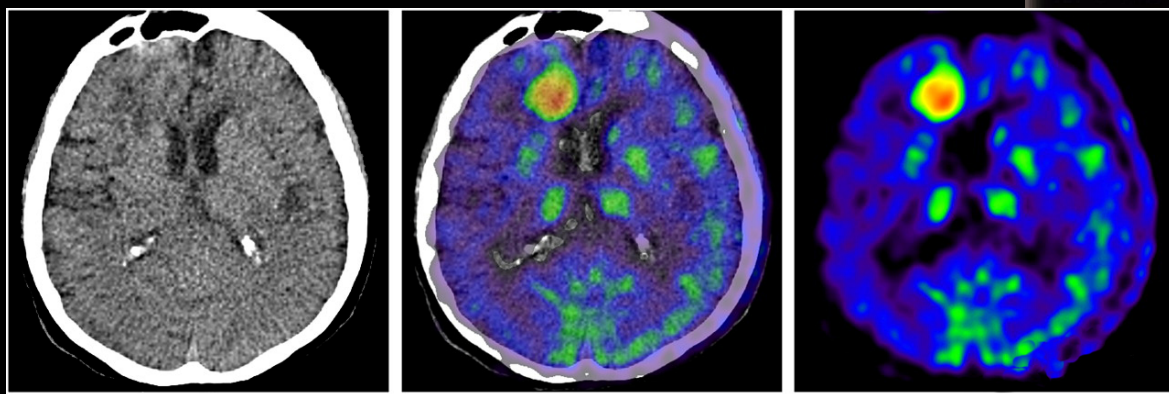
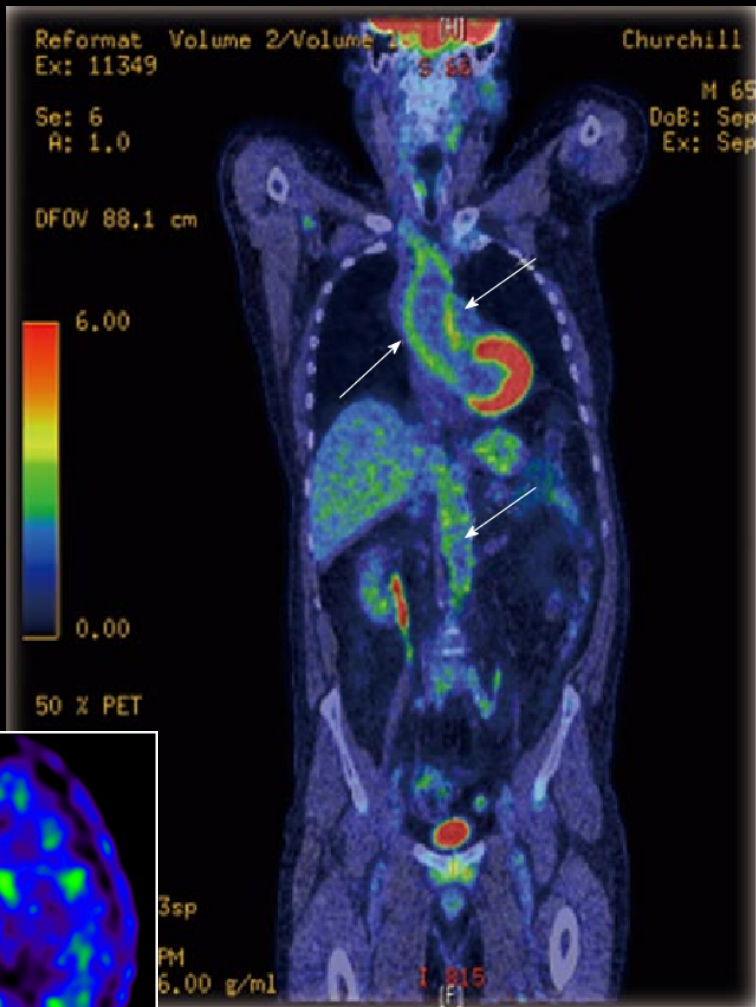


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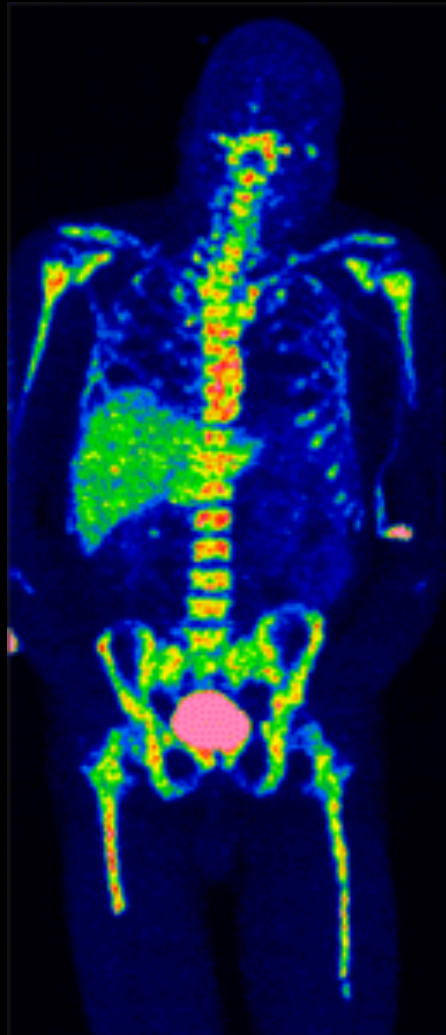
# PET/CT – Hybrid Imaging

David  
Townsend



@artandscienceacrossitaly

# Full-body PET



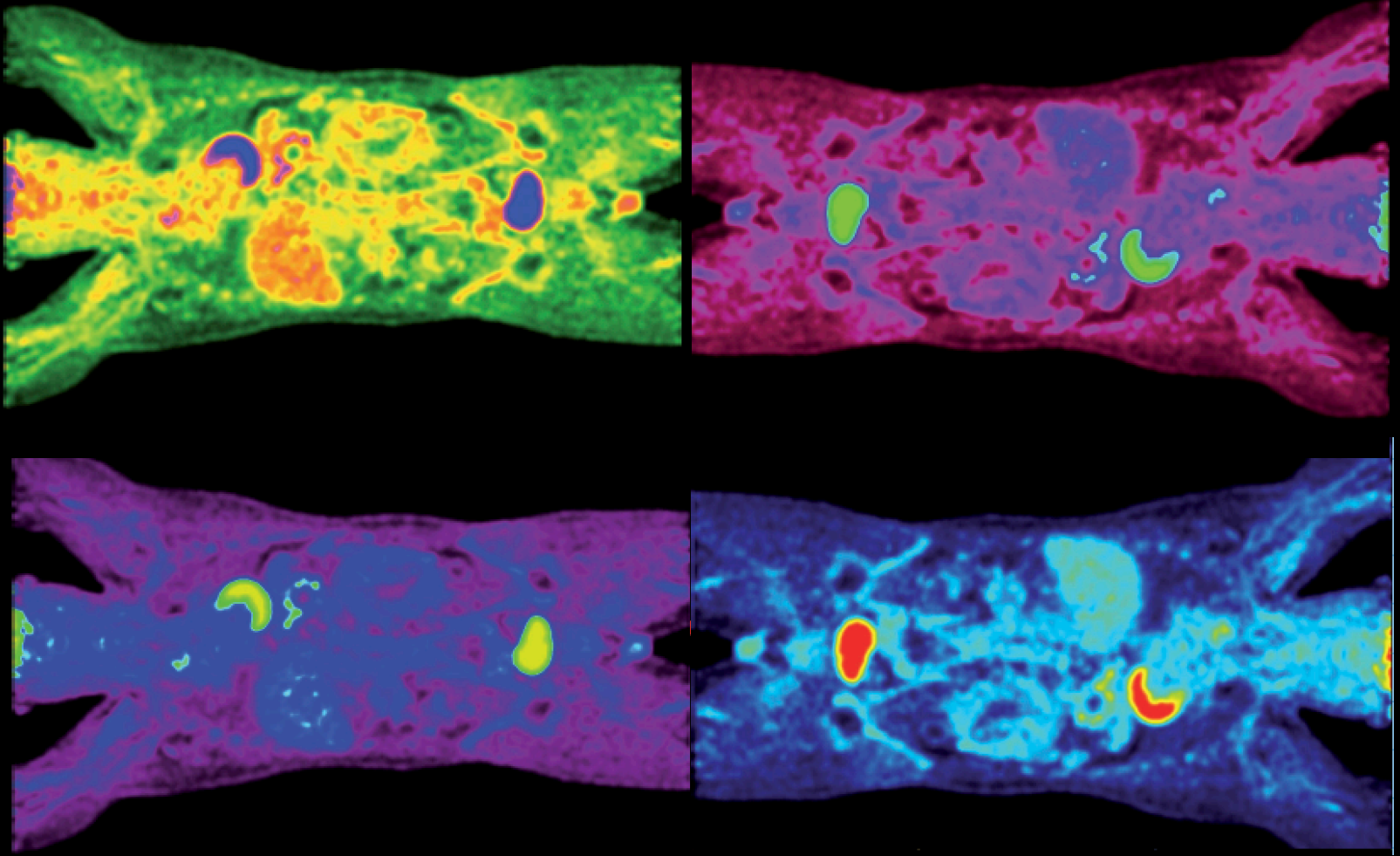
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# Brain colours



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# Full-body PET



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# What have we learnt?

