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Development of a national primary standard for positron emitters in gas

Maria Marouli

ARMUG
8th November

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Contents

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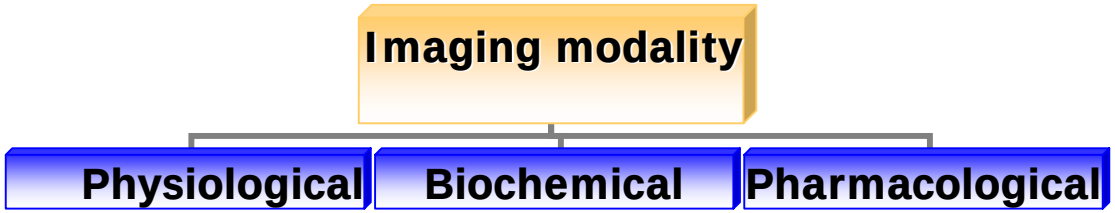
Positron Emission Tomography



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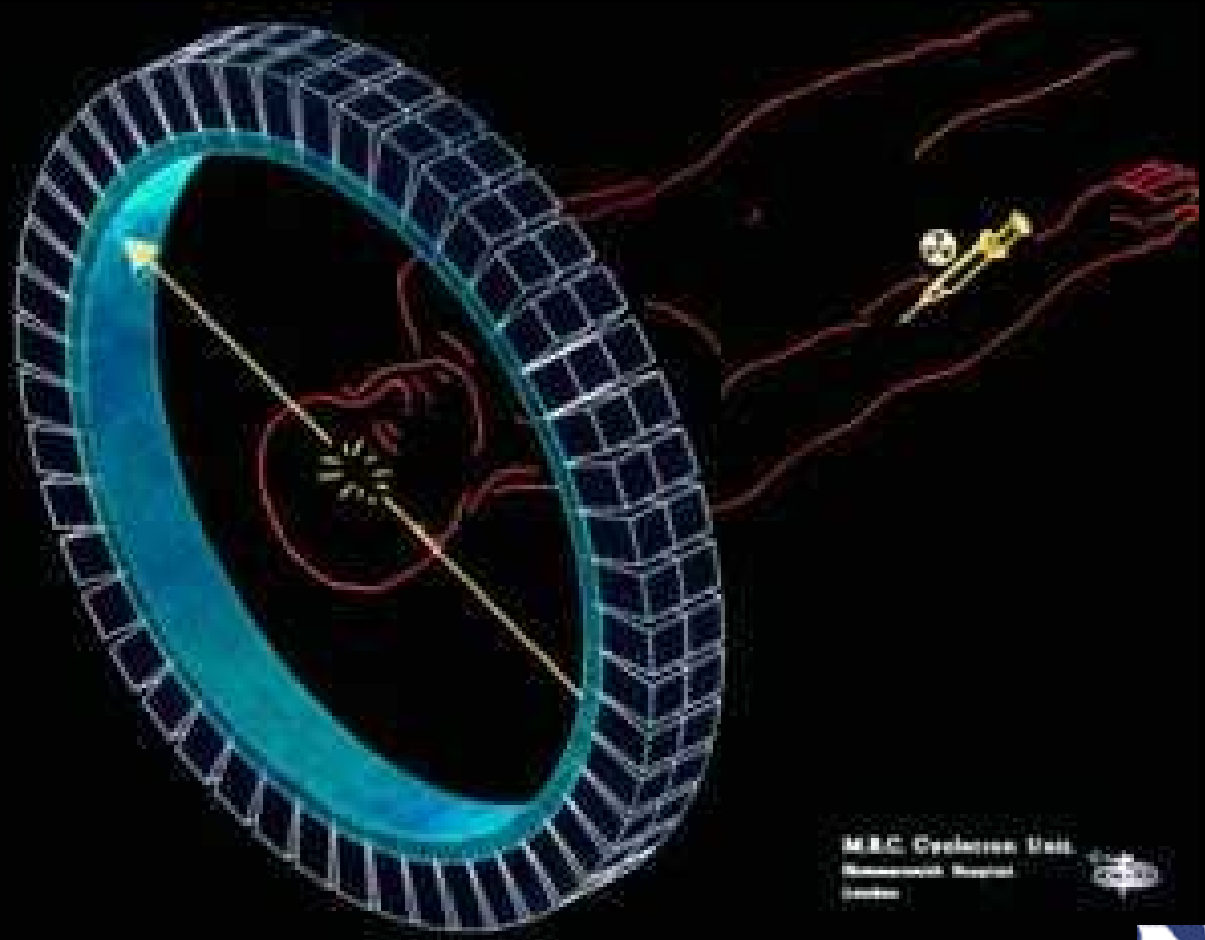

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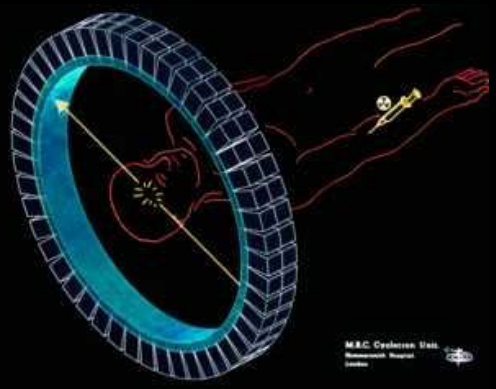

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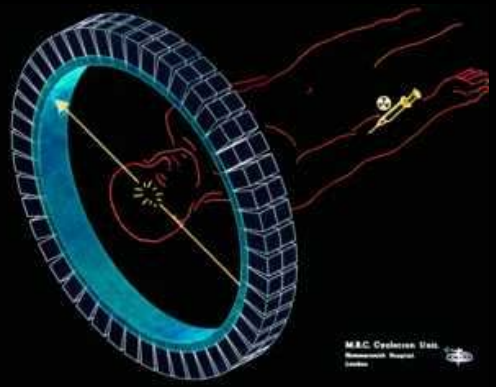

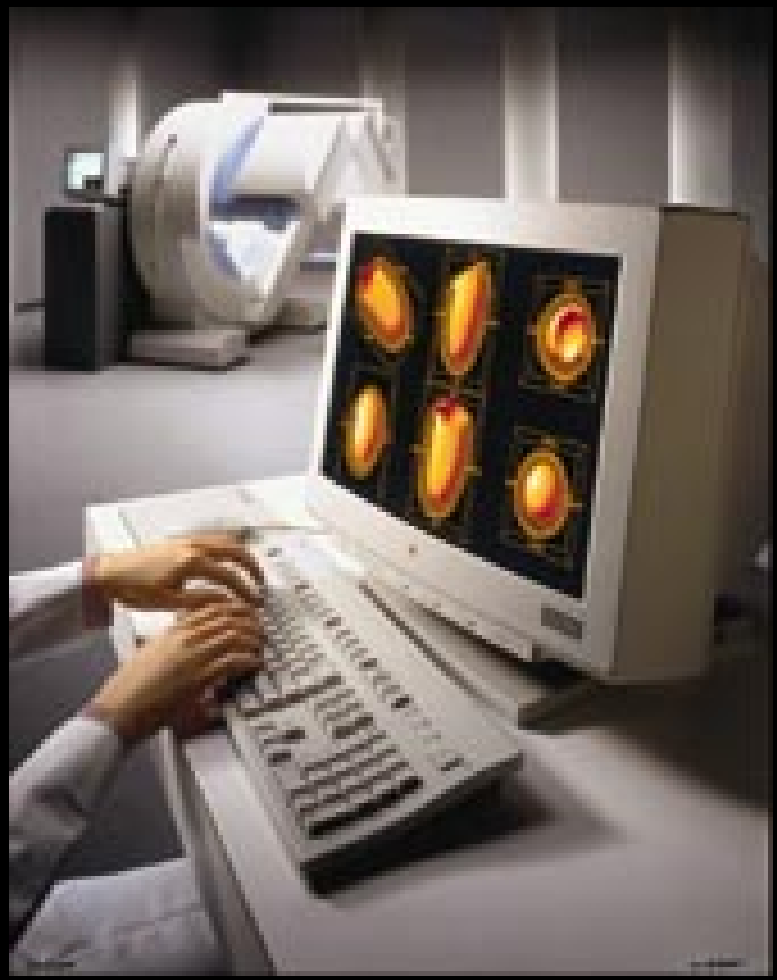

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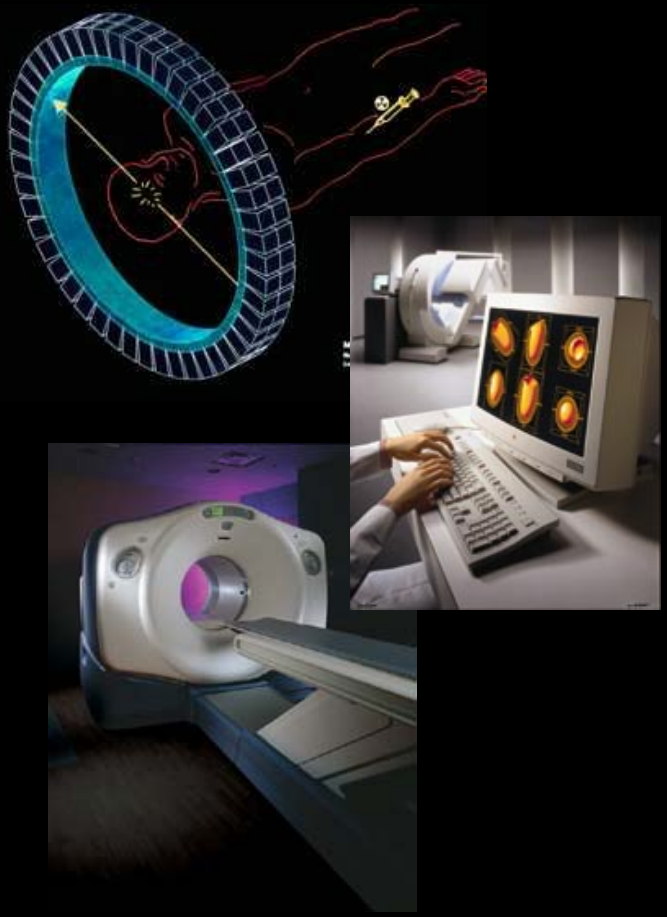

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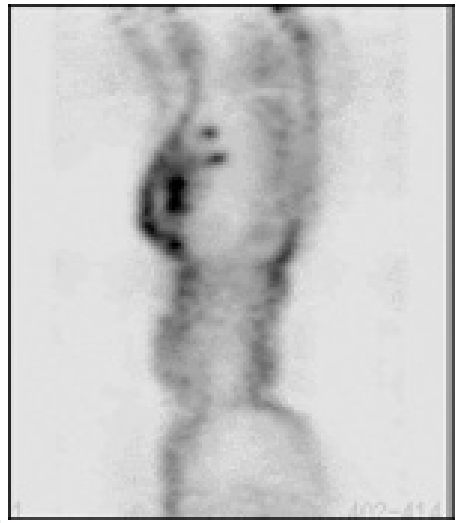
Positron Emission Tomography

Common PET medical imaging radionuclides and their properties

Description	Units	Fluorine-18 (^{18}F)	Oxygen-15 (^{15}O)	Nitrogen-13 (^{13}N)	Carbon-11 (^{11}C)
Maximum Energy of β^+	MeV	0.633	1.738	1.197	0.959
Most probable energy of β^+	MeV	0.202	0.696	0.432	0.326
Half-life	min	**109.728**	**2.041**	**9.967**	**20.37**
Max. path length in water	10^{-3}m	2.4	8.2	5.4	5.0
Radial range in water (FWHM)	10^{-3}m	1.0	1.5	1.4	1.1



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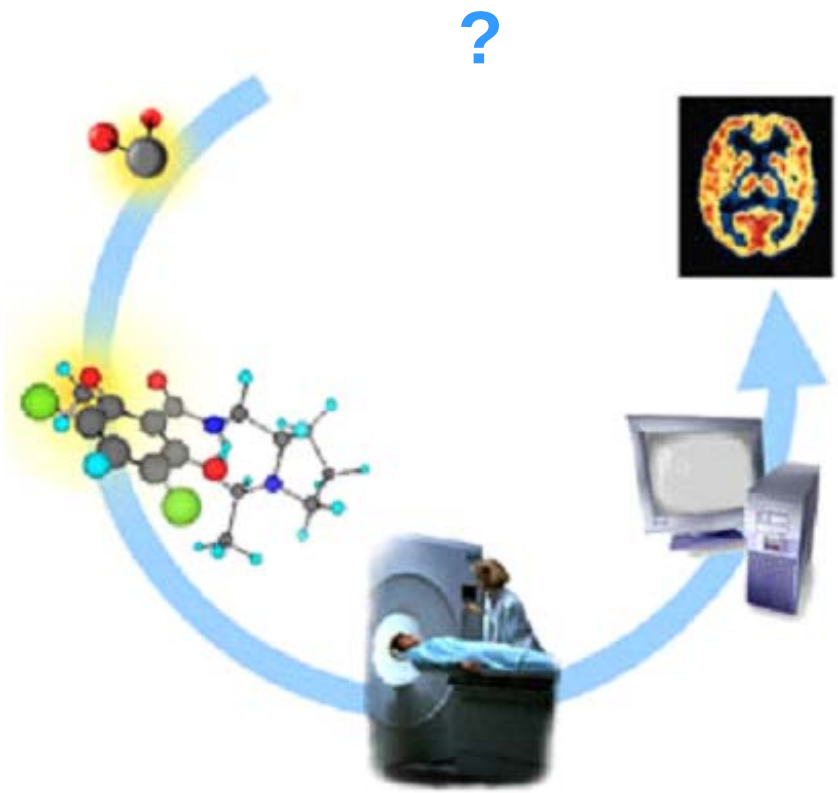
Production of positron emitting radionuclides



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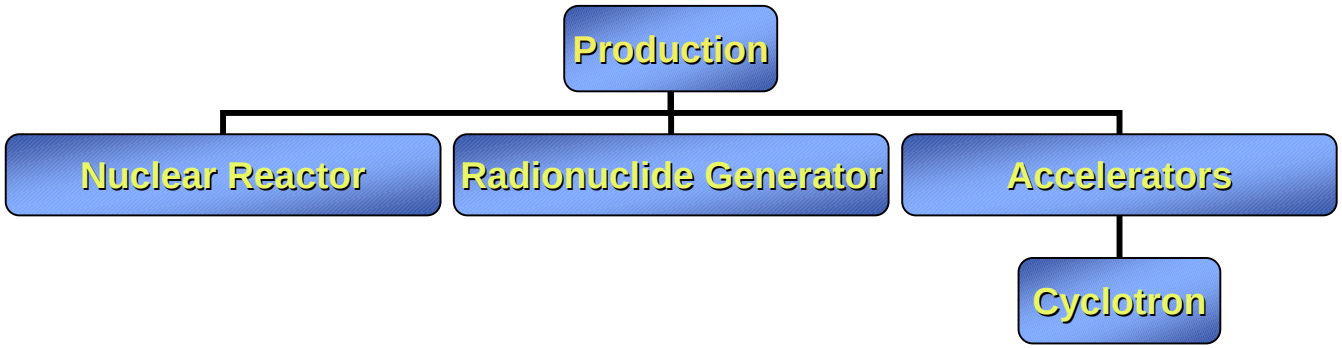
Production of positron emitting radionuclides



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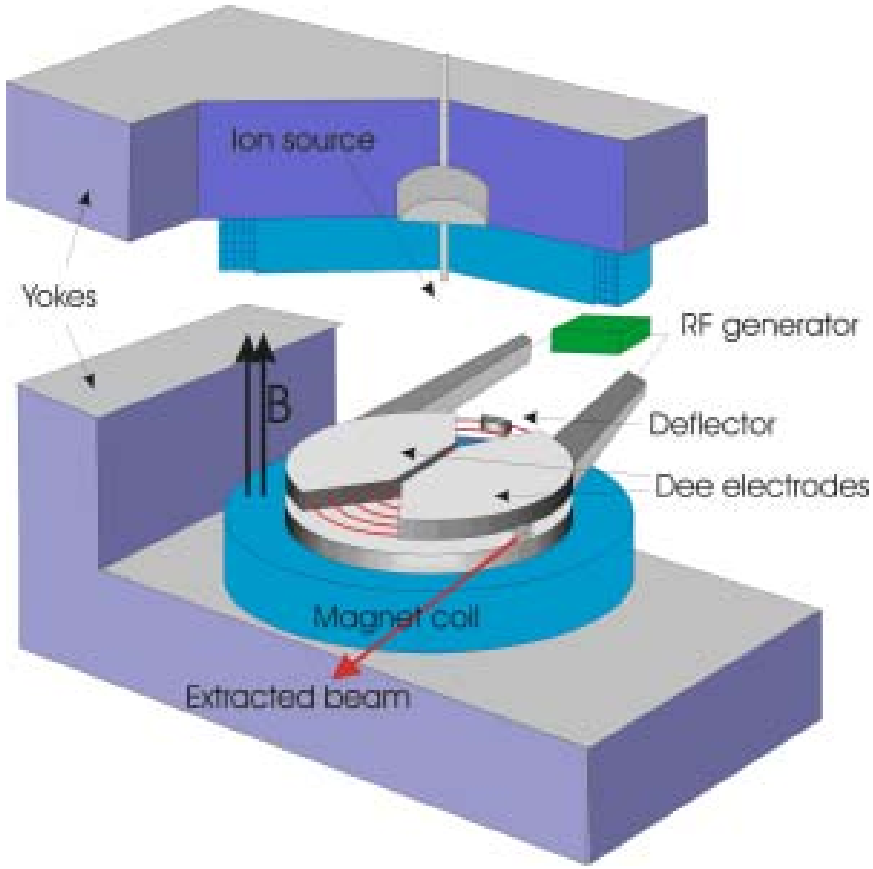
Cyclotron



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PET in UK

Country	Number of PET scanners (by Sept. 2004)	Indications	Planned PET installations over 5 years
Belgium	15	Oncology, cardiology and neurology	4
Finland	3	Oncology, cardiology and neuropsychiatry plus Alzheimer's disease and Huntingdon's disease diagnosis	5
France	57	Oncology, all tumour types, cardiology and neurology	24
Hungary	2	All oncology, cardiology and neurology indications	no data
Luxembourg	1	In line with German guidelines	no data
Republic of Ireland	no data	In line with Medicare guidelines	no data
Spain	43	Oncology, and epilepsy in the neurology field	21
United Kingdom	14	Oncology, cardiology, neuropsychiatry, neurology including epilepsy, early dementia. Also HIV, other immunosuppressive conditions.	8

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Airborne Radioactivity

cyclotron

"hot" cells for radiopharmaceutical synthesis

~ 1-100mCi

Environment

Exhaust Duct

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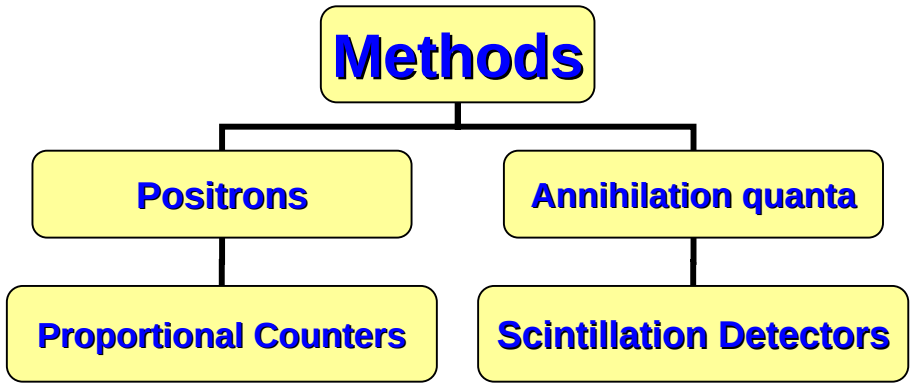
Monitoring of Airborne Radioactivity



Monitoring of Airborne Radioactivity

Specifications

- Accuracy
- Sensitivity
- Adequate temporal response

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Monitoring of Airborne Radioactivity

A primary standard for positron emitters in gas is essential to ensure the accuracy of the measurements

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First Approach…

1. Proportional counters for β^- emitters

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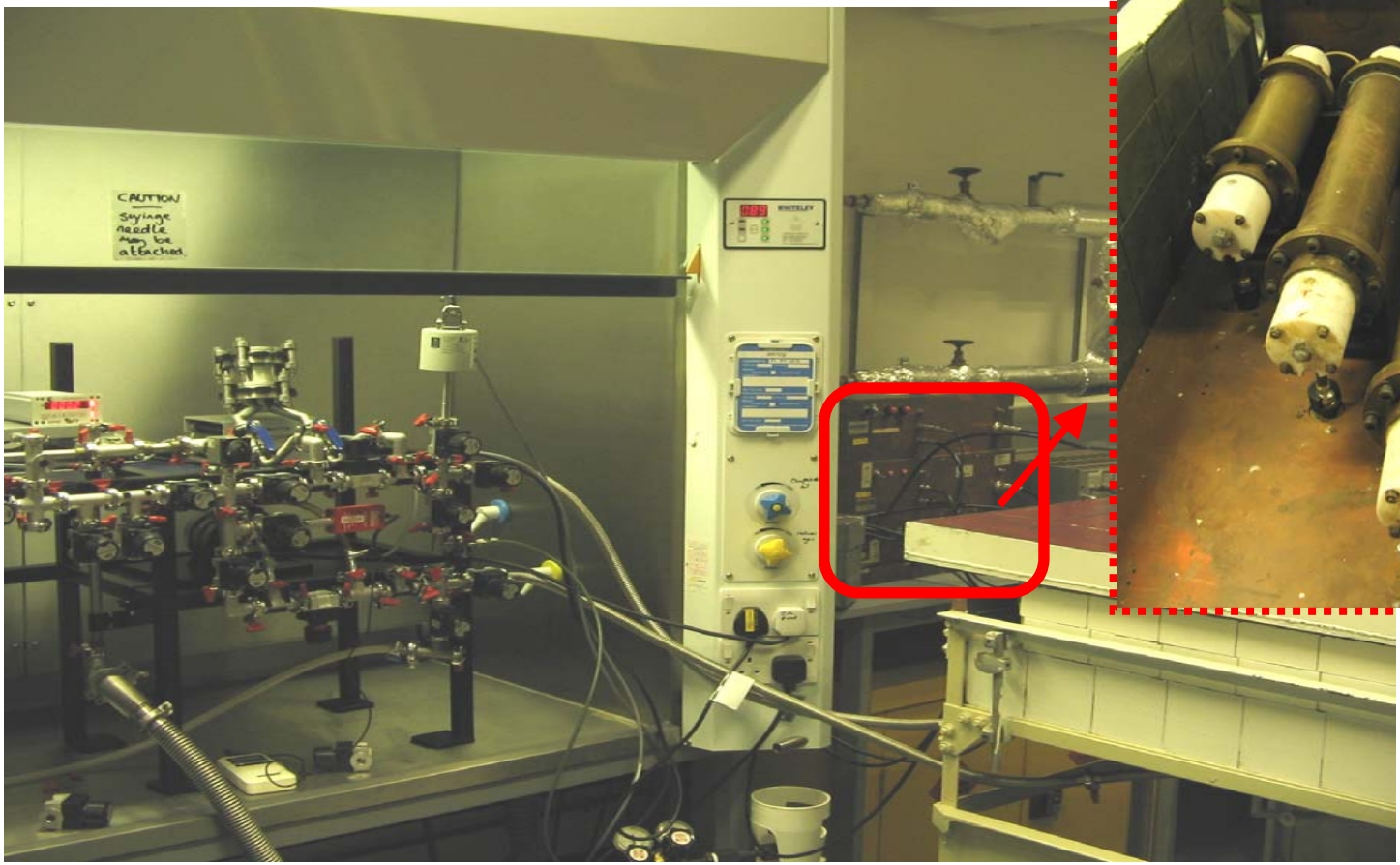
1. Proportional counters for β^- emitters



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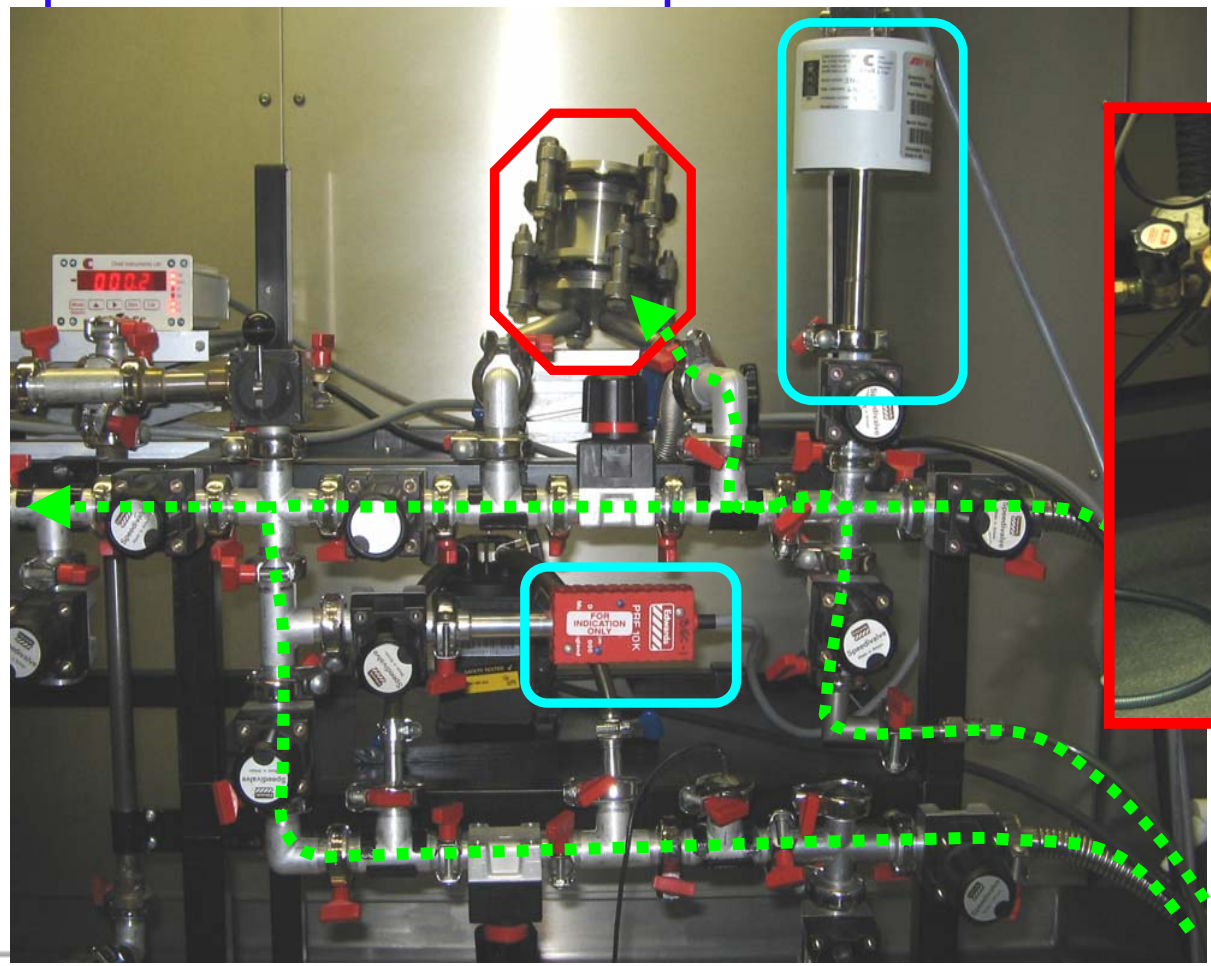
First Approach…

1. Proportional counters for β^- emitters



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First Approach…

1. Proportional counters for β^- emitters
2. Model the response (PENELOPE)
3. Transfer Instrument
4. Validation

Summary

1. Cyclotrons-PET in UK

2. Measurement of airborne radioactivity

3. The first steps for the development of the primary standard for positron emitters in gases

References

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- http://interactive.snm.org/img/whatisnm.jpg
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- European Association of Nuclear Medicine, Sep 4-8 2004, Helsinki-Fair Centre, Finland- A Review
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Thank you!

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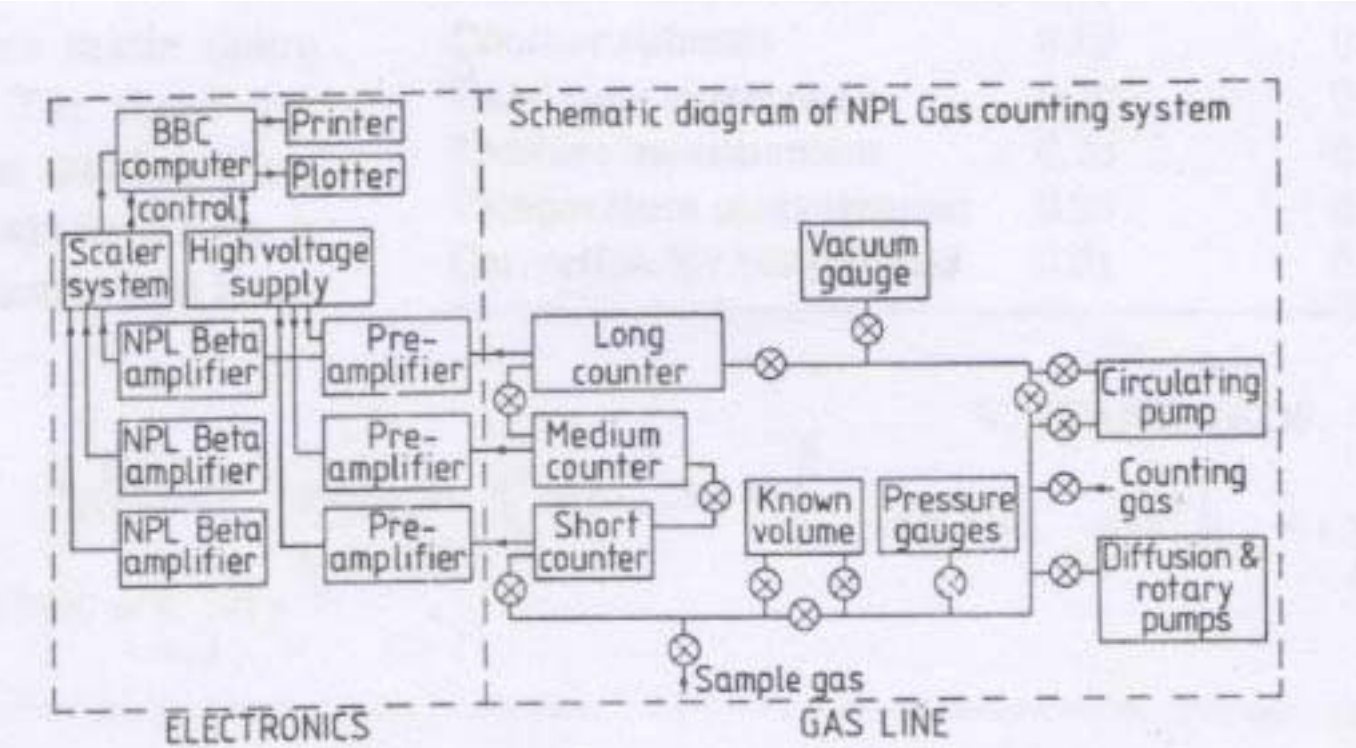
First Approach…

1. Proportional counters for β^- emitters



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Cyclotron

Commonly used PET radionuclides and methods of production

Nuclide	Production route	Energy range (MeV)	Thick target yield (MBq/μA h)	Target	In-target product
^{11}C	$^{14}N(p,\alpha)$	13 → 3	3820	$N_2(O_2)$	^{11}CO, $^{11}CO_2$
^{13}N	$^{16}O(p,\alpha)$	16 → 7	1665	$H_2{}^{16}O$	$^{13}NO_2^-$, $^{13}NO_3^-$
^{15}O	$^{14}N(d,n)$	8 → 0	2368	$N_2(O_2)$	^{15}OO,
	$^{15}N(p,n)$	10 → 0	2220	$N_2(O_2)$	^{15}OO
^{18}F	$^{18}O(p,n)$	16 → 3	3893	$H_2{}^{18}O$	$^{18}F^-_{aq}$,
				$^{18}O_2/(F_2)$	$[^{18}F]F_2$
	$^{20}Ne(d,\alpha)$	14 → 0	1110	$Ne(F_2)$	$[^{18}F]F_2$

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