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Nuclear medicine

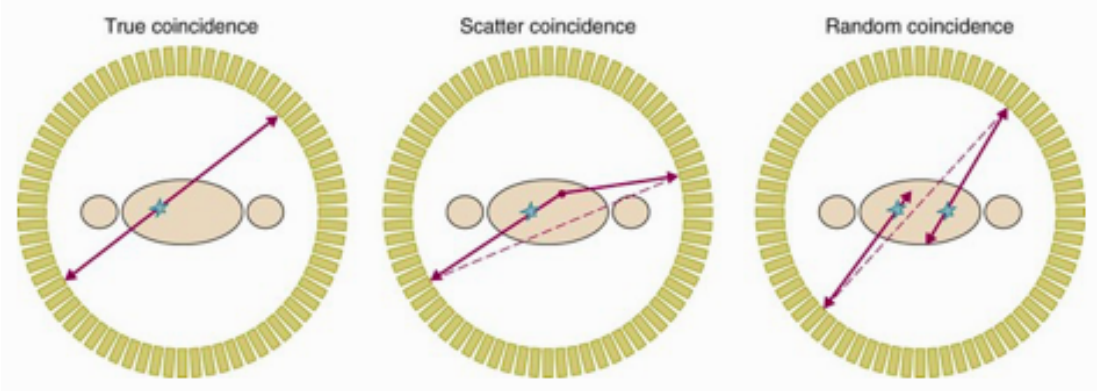
Week 3; Lecture 6; Section 1: Event types in PET

K. Long (k.long@imperial.ac.uk)
Department of Physics, Imperial College London/STFC
R. McLauchlan (ruth.mclauchlan@nhs.net)
Radiation Physics & Radiobiology Department, Imperial College Healthcare NHS Trust

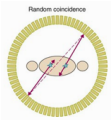
Section 1

Event types in PET

Types of coincidence event



Random coincidence



A random coincidence arises when two PMTs each receive a signal within the coincidence time window $\Delta t = 2\tau$

"Singles rate" in detectors i and j are $\mathcal{R}_{si}$ and $\mathcal{R}_{sj}$, random-coincidence rate:

$$\mathcal{R}_{\text{random}} = \Delta t \mathcal{R}_{si} \mathcal{R}_{sj}$$

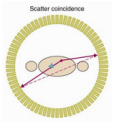
Ratio of random to true coincidences $\propto \Delta t$; small Δt of benefit

$\mathcal{R}_{\text{random}}$ is proportional to the square of the activity in the body; true-coincidence rate rises linearly

Singles rates, and therefore $\mathcal{R}_{\text{random}}$, can be reduced with absorptive septa at the price of efficiency

Source of random coincidences not localised. Typical rates: $\sim 0.1\,\text{Hz}$ (brain) to $\sim 1\,\text{Hz}$ (abdomen). Reduces contrast & increases error in estimation of total dose

Scatter coincidence



Scatter of one (or both) photons from single annihilation event in tissue or scanner

Pernicious since:

- Energy of scattered photon often differs little from decay photon
  $\rightarrow$ falls within the energy detection window
- Scattered photon is in coincidence with unscattered photon
  tiny ($<< \Delta t$) additional delay from the increased path length

$\mathcal{R}_{\text{scatter}}$ proportional to activity in body; same dependence as true-coincidence rate

$\mathcal{R}_{\text{scatter}}$ can be reduced with absorptive septa at the price of efficiency

Typical rates: $0.2 - 0.5\,\text{Hz}$ (brain) to $0.4 - 2\,\text{Hz}$ (abdomen); scatter-event fraction can be as high as $60 - 70\%$ for abdominal scans. Reduces contrast.

Summary of section 1

Event types distinguished:

- True coincidence;
- Random coincidence;
- Scatter coincidence