uncertainty of 6 cm fwhm. In conventional tomography, the annihilation point is only known to lie somewhere along the line between the two coincident detectors. The time-of-flight information is able to reduce the rms statistical uncertainty in the reconstructed image by the ratio of the distance across the emitting region to the time-of-flight uncertainty times twice the speed of light (15 cm per nsec).[21–28] For example, for a time-of-flight uncertainty of 6 cm and a 24 cm diam emission region, the time-of-flight information reduces the statistical uncertainty by a factor of 2 which corresponds to a four-fold decrease in the imaging time.[29,30] The detection efficiency ϵ and the timing resolution τ can be combined in the figure of merit ϵ^2/τ where ϵ^2 is proportional to the number of events detected and $1/\tau$ is proportional to the statistical value of each event.[8]

Quantitative Accuracy–systematic factors

PET data are subject to the following systematic errors:

1) Attenuation of the annihilation photons in the tissue[31,32]

2) Partial volume effects due to limited axial resolution[33]

3) In-plane smearing due to limited in-plane resolution[34]

4) Background events due to accidental coincidences (unrelated annihilation photons detected in coincidence by chance)[35–38] and prompt scattered events (annihilation pairs from the same positron where one or both have scattered).[37,39–42]

5) Deadtime losses in the detectors and electronic circuits.[43,44]

Temporal resolution

The ability to measure the tracer concentration with good temporal resolution (i.e. in a series of rapid time sequence images) requires the collection of a large number of events during the study, which requires good detection efficiency, low deadtime, high maximum data rates, and a minimum of detector motion. Note the ability to fit compartment model rate constants to PET data depends primarily on the total number of events collected in the study and the temporal resolution. The number of events in each time sequence image is of lesser importance.

Spatial resolution factors

Quantitation within regions of size D requires an overall system spatial resolution with fwhm $\leq$ D/2. Principal components of the system resolution are discussed below: