



SimSET's recently added features

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Recently added features

- Time-of-flight
- Random coincidences
- Block detectors

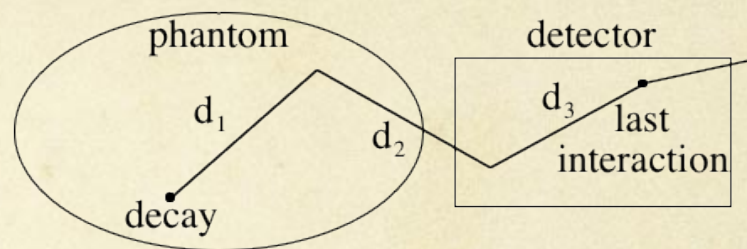
Time-of-flight (TOF) setup

- In detector parameters file:
 - # Specify a TOF resolution as a per-photon
 - # % full-width-half-maximum in nanoseconds.
 - REAL photon_time_fwhm_ns = 0.424
 - # (equivalent to 0.6 ns coincidence TOF resolution)
- In binning parameters file:
 - # Time-of-flight binning
 - # Number of bins, and maximum and minimum acceptable time-of-flight differences in nanoseconds.
 - INT num_tof_bins = 32
 - REAL min_tof = -4.0
 - REAL max_tof = 4.0
- Treated like any other binning field (i.e., fastest varying variable is last field listed in the file).

Time-of-flight (TOF) algorithm

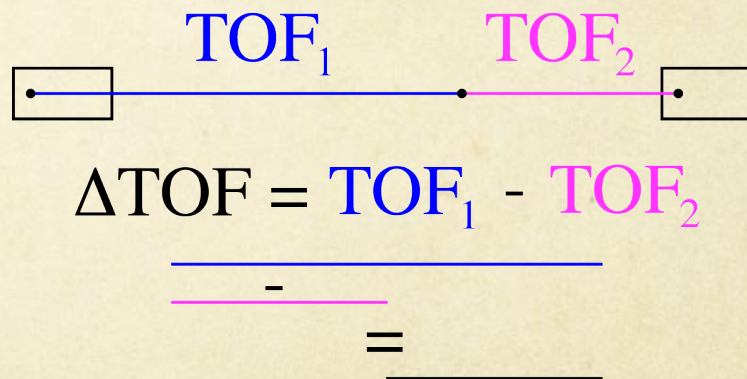
- The TOF of a photon is computed from the decay/annihilation time/location and the TOF resolution:

$$TOF = \left(\sum_{\text{annihilation}}^{\text{last interaction}} d_i / c \right) + N(0, \sigma(FWHM)^2)$$



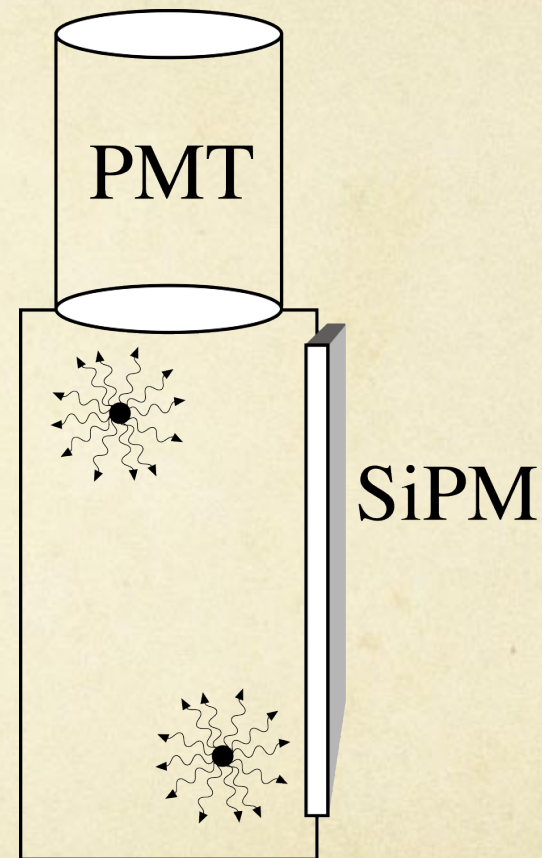
- The binned value is the TOF differential between the two photons:

$$\Delta TOF = TOF_{\text{photon1}} - TOF_{\text{photon2}}$$



Time-of-flight shortcomings

- SimSET does not account for:
 - Transit time of scintillation photons.
 - Time measurement process.
 - Effect of multiple interactions.
- Is using the time of the last interaction reasonable?



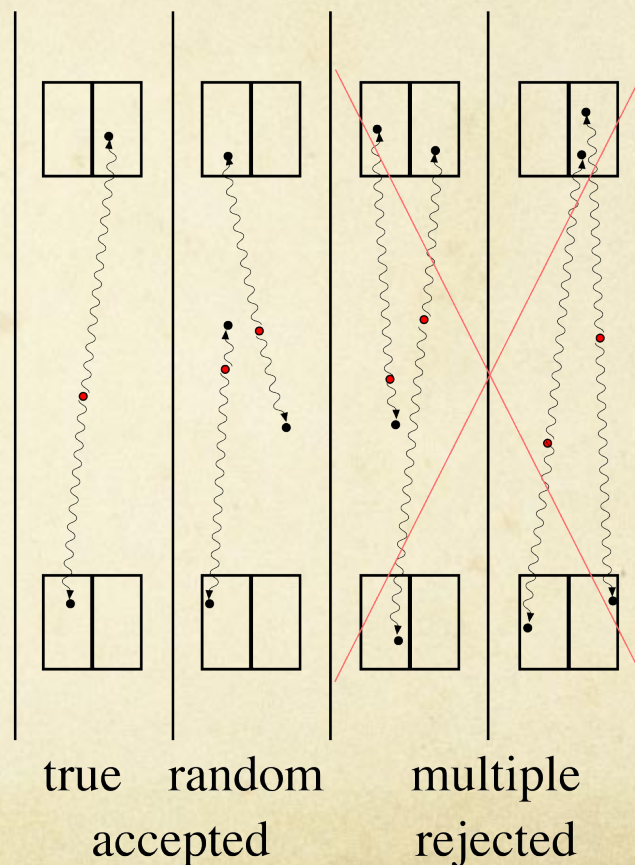
Random coincidence setup

- In run parameters file:
 - `BOOL simulate_PET_coincidences_plus_singles = true`
- Create a parameters file for timesort -
 - Sorts the list mode file by detection time.
- Create a parameter file for addrandoms -
 - Specify the coincidence timing window.
 - Adds random coincidences to the list mode file.
- Create a run parameters file for the bin utility.
 - Bins the list mode file into user-specified output array.
- For more detail see the user's guide online.

Random coincidence algorithm

- Sort decays by detection time.
- Add random events (delete multiples).
- Bin into output array.
 - Options for:
 - True/random/scatter.
 - Number of scatters.

Detected photons in a time window

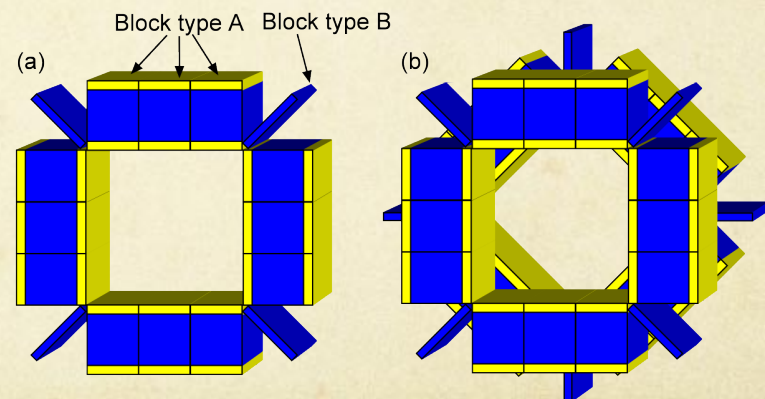
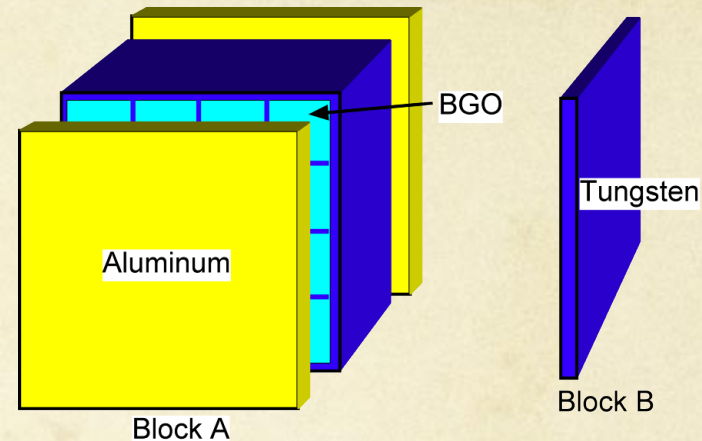


Random coincidence shortcomings

- Requires multiple copies of large list mode files.
- Much slower but only marginally more accurate than computing randoms from singles.
- Simplistic model for detector/electronics.

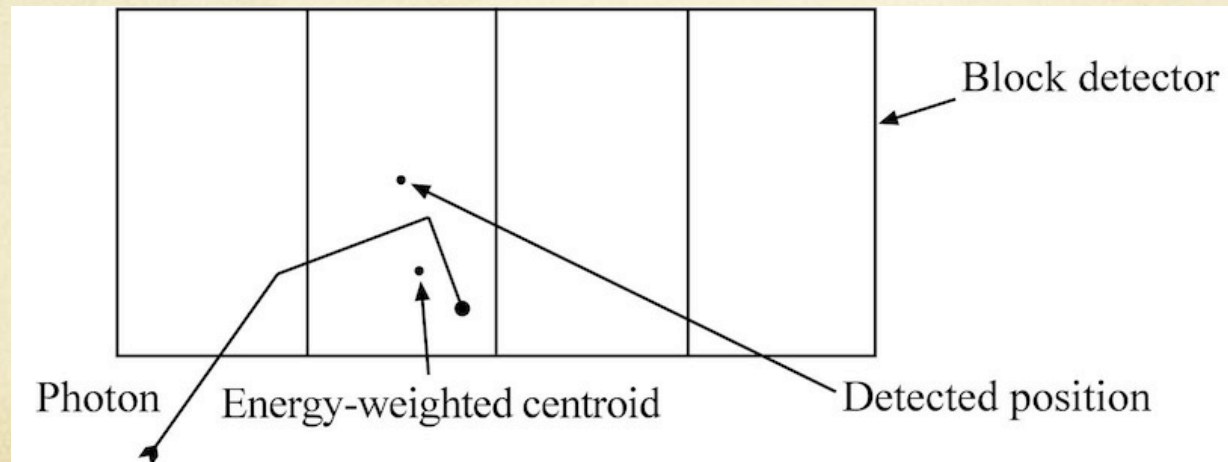
Block detector setup

- Define blocks
 - Right rectangular boxes subdivided along boundaries parallel to one of the block faces.
 - Each element in the block assigned a material.
- Define rings
 - Place detector blocks to create ring.
 - All detector blocks in a ring must have the same axial extent.
- Stack rings to create tomograph.
- MatLab scripts simplify input.



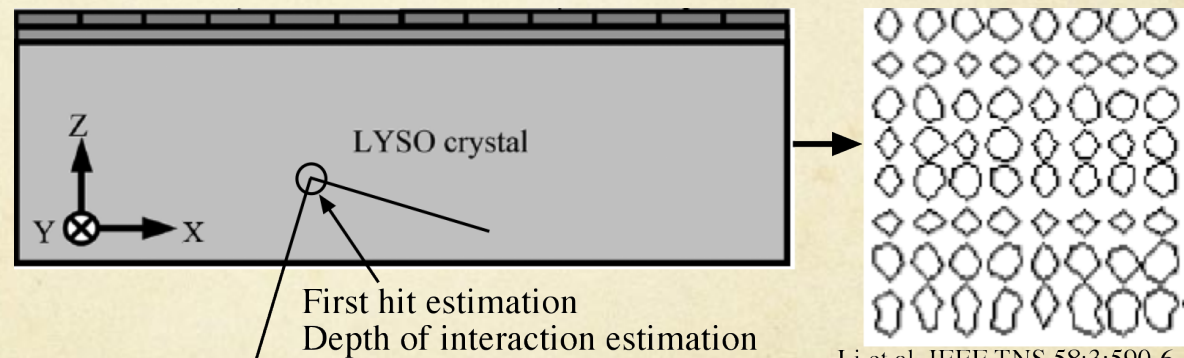
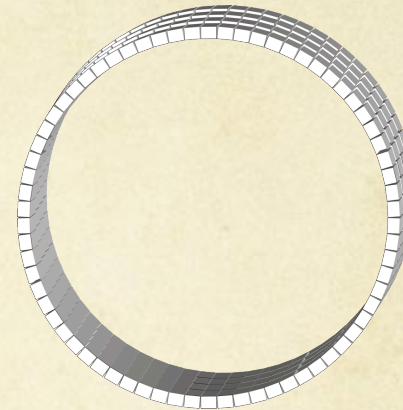
Block detector algorithms

- Photons tracked normally through detectors.
- An energy-weighted average of the interactions in scintillator is calculated.
- The detected position is the center of the crystal containing this average.



Block detector shortcomings

- Input and visualization.
- Using the energy-weighted centroid to locate determine the detection crystal is not a very good model for some tomographs:
 - Depth-of interaction.
 - Block edge effects.
 - First hit estimation.



Li et al, IEEE TNS 58:3:590-6

PET model finished!

- Not really.
- These three features complete the 'outline' of SimSET's PET model.
- We hope to address many of the the model's shortcomings.
- Open source additions?

