Using STIR to reconstruct PET data from the Siemens Biograph mMR

UCL

CONSIDERED EXAMPLE:
Germanium (^{68}Ge) phantom scanned for 24hrs
(actually scanned for 60 hrs but the scanner recorded only the first 24 hrs)

Other clinical data is also shown

Reconstruction pipeline:

– Conversion of the Siemens Dicom files containing normalisation and raw emission data to the STIR interfile format.

– Histogramming the emission list-mode data into sinograms of span 11.

– Component-based normalisation.

– Correction for random events.

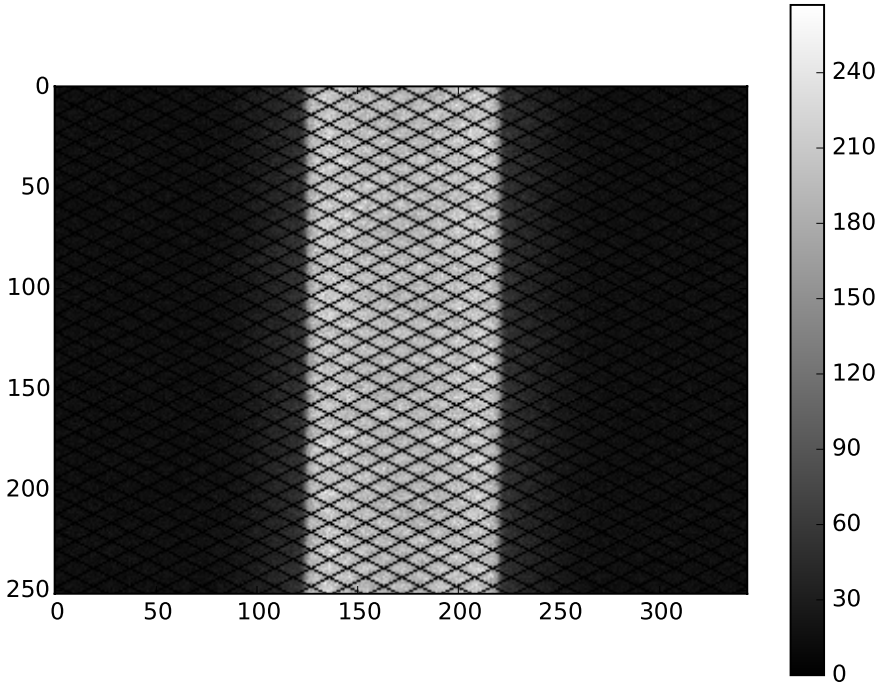
– Scatter correction using single scatter simulation which makes use of the provided μ-map.

– Attenuation correction based on the provided μ-map.

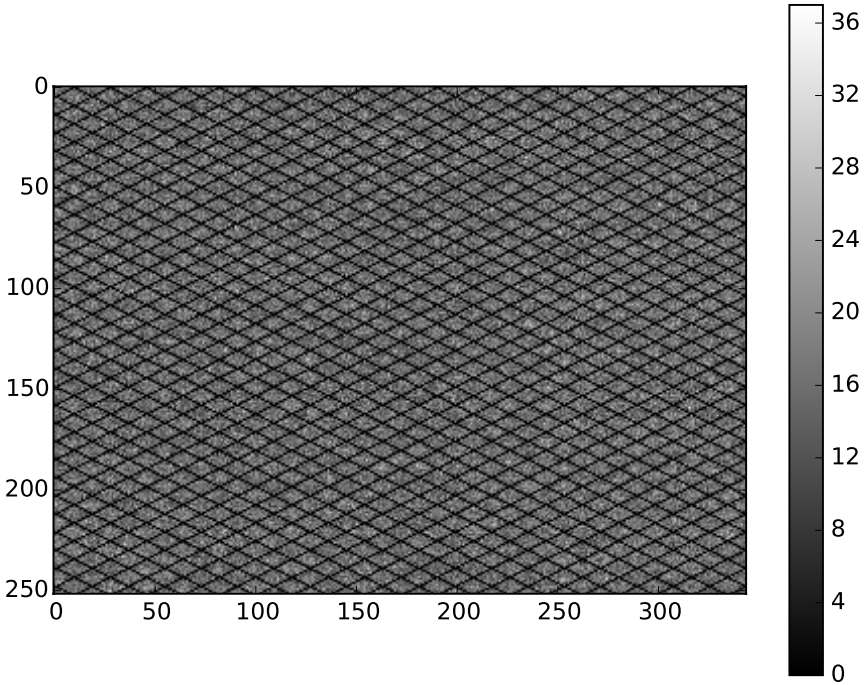
– Reconstruction using OSMAPOSL iterative algorithm based on the one step late (OSL) algorithm [4] and ordered subsets expectation maximisation (OSEM) [5] with a median root prior [6] (other possibilities exist).

Uncompressed (span-1) direct sinogram from the axial centre of the scanner

PROPMPT SINO



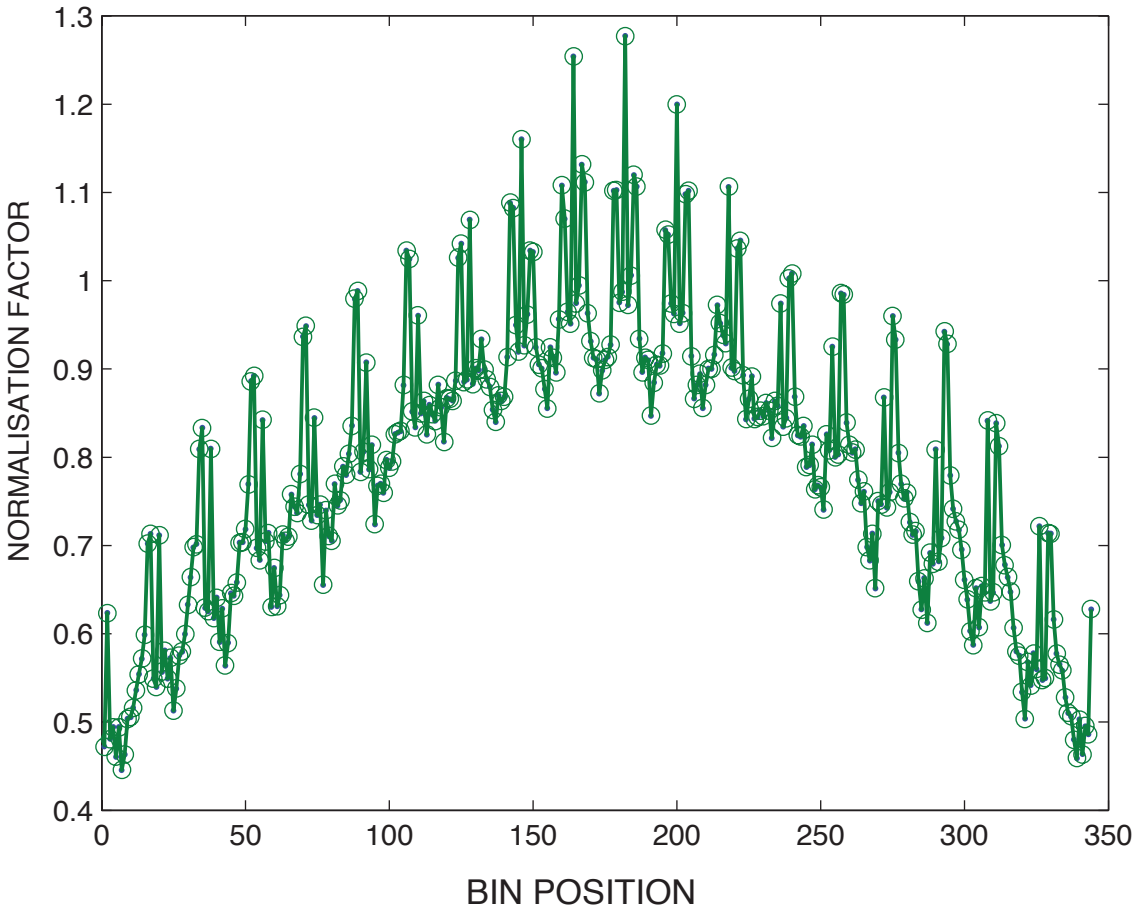
DELAYED SINO

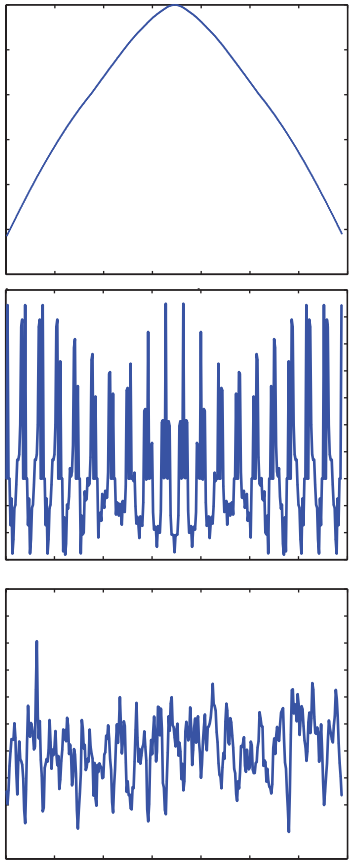


Component-based normalisation:

The sinogram with normalisation factors are found by taking the product of the components (found in the norm file outputed by the scanner).

Profile through a row of normalisation sinogram with three miniatures showing geometric effects, crystal interference and efficiency components (only these





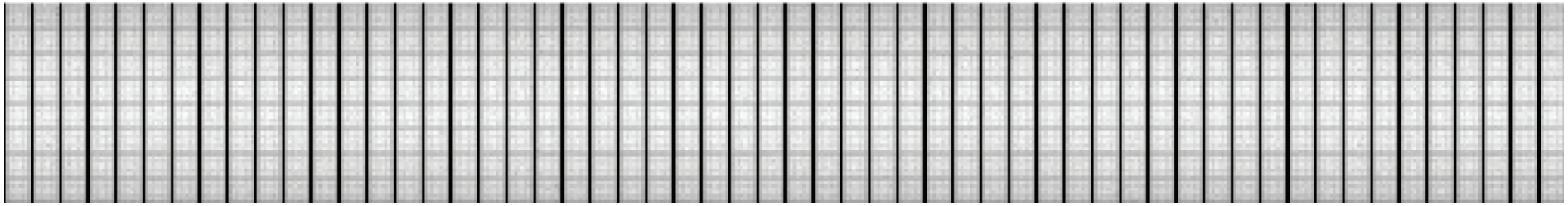
GEOMETRIC EFFECTS

CRYSTAL INTERFERENCE

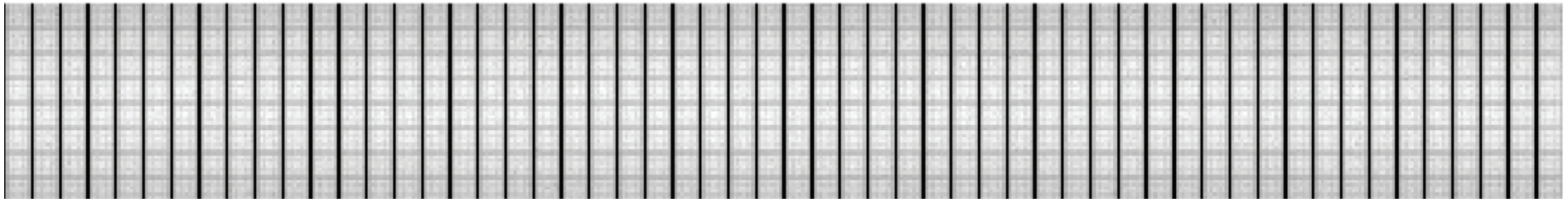
CRYSTAL EFFICIENCY

Estimation of randoms (for noise reduction) based on the delayeds

Fansums (64 rings x 504 crystasl)



ML estimated detector singles



Estimation of accidental coincidences

Randoms From Singles (RFS)

$$R_{ij} = 2\tau S_i S_j$$

Randoms rate

Singles rates

Maximum Likelihood Randoms From Delayeds

$$\hat{d}_{ij} = 2\tau S_i S_j$$

d_{ij}: measured delayeds

$\hat{d}_{ij}$: model for delayeds

$$L(\hat{d}, d) = \sum_{ij} d_{ij} \log \hat{d}_{ij} - \hat{d}_{ij}$$
$$= \sum_{ij} d_{ij} (\log S_i + \log S_j) - \hat{d}_{ij} + cst$$
$$= 2 \sum_{ij} d_{ij} \log S_i - \hat{d}_{ij} + cst$$

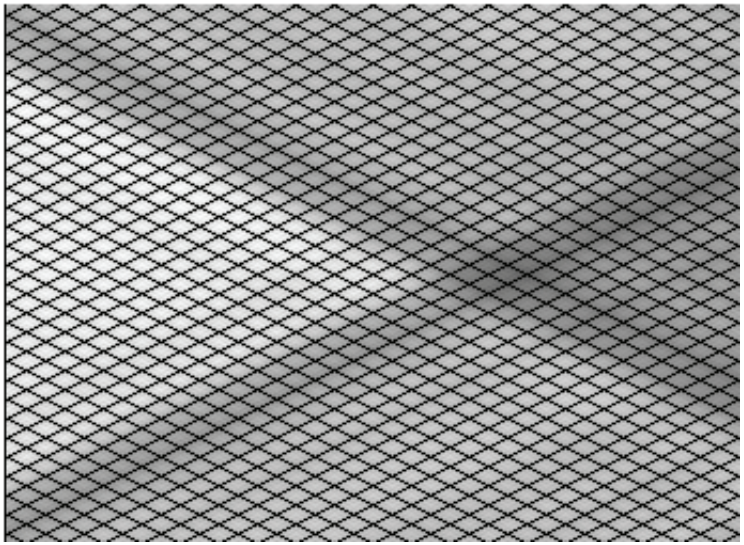
Hogg et al , Panin et al, etc

ML estimate only depends on fansums $\sum_j d_{ij}$

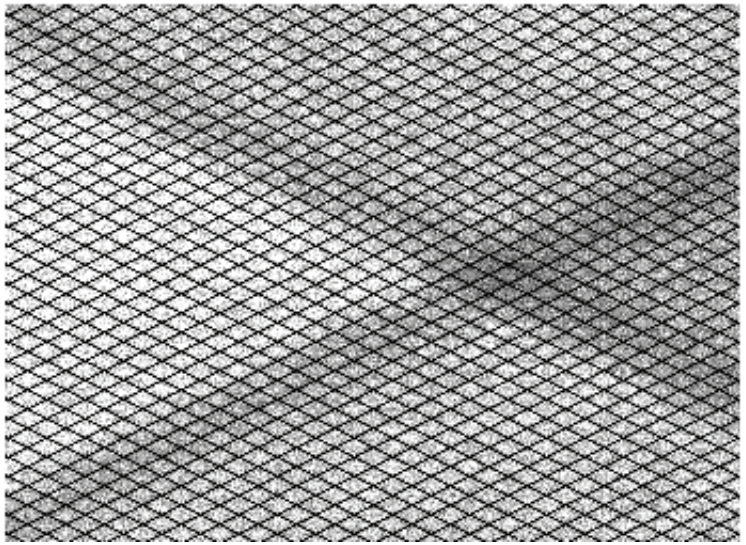
Estimation of randoms (for noise reduction) based on the delayeds

Patient data (bed effect is visible)

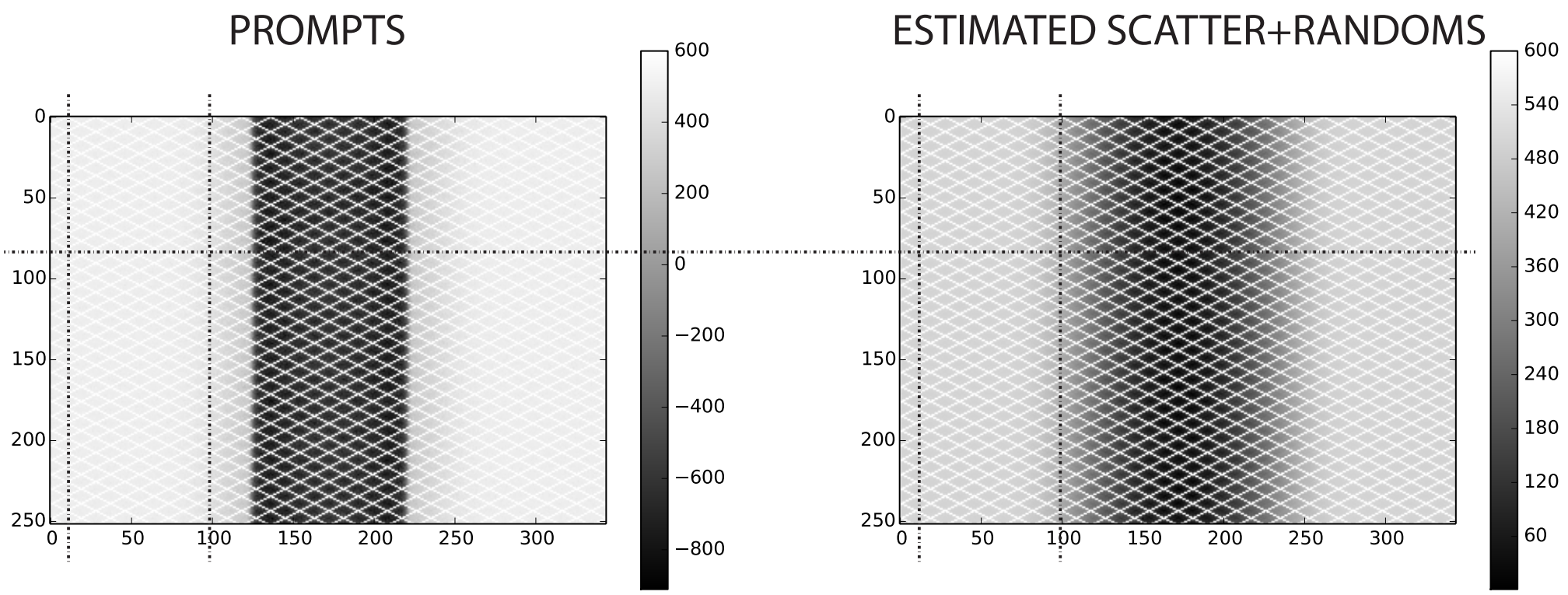
ML solution



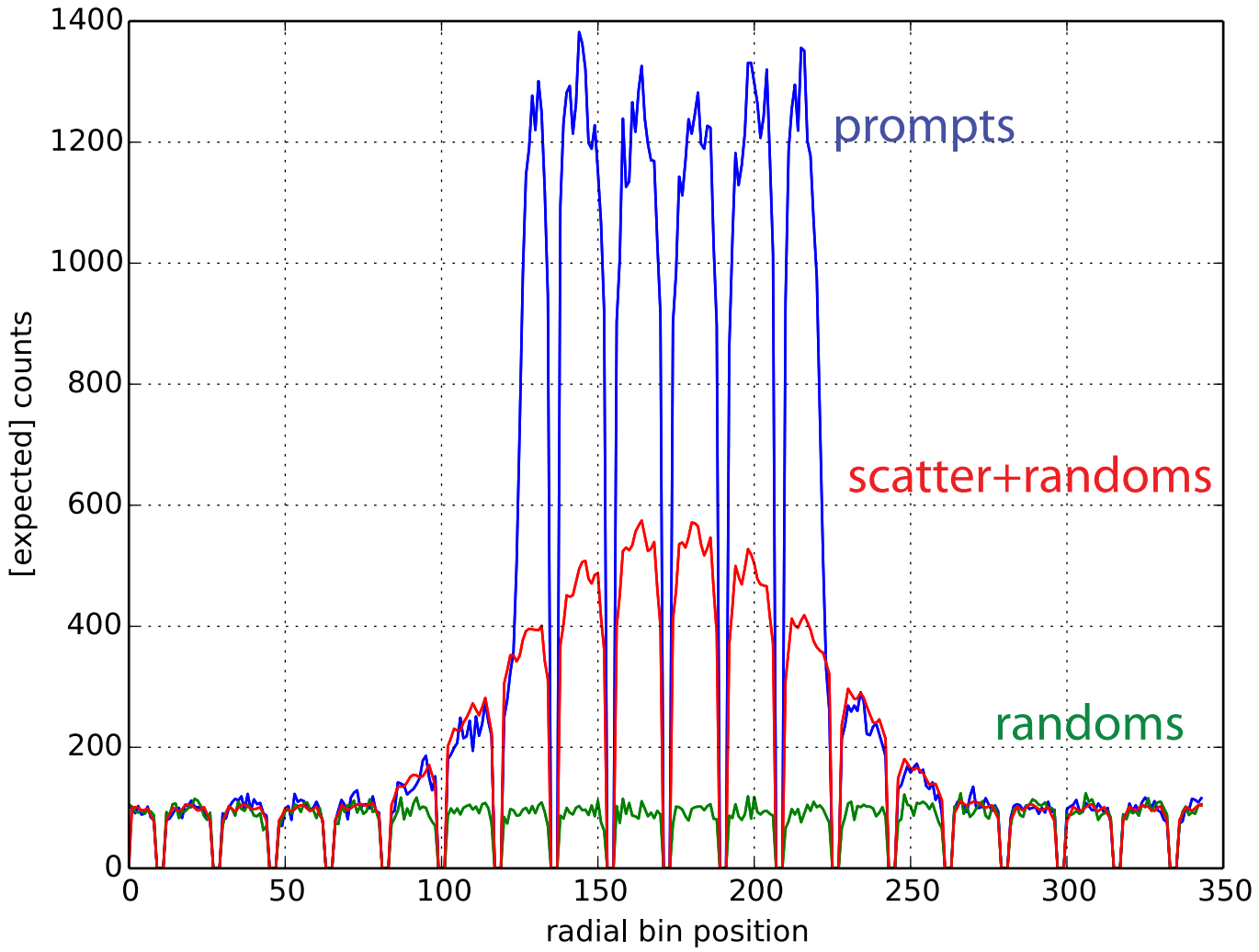
Delayeds



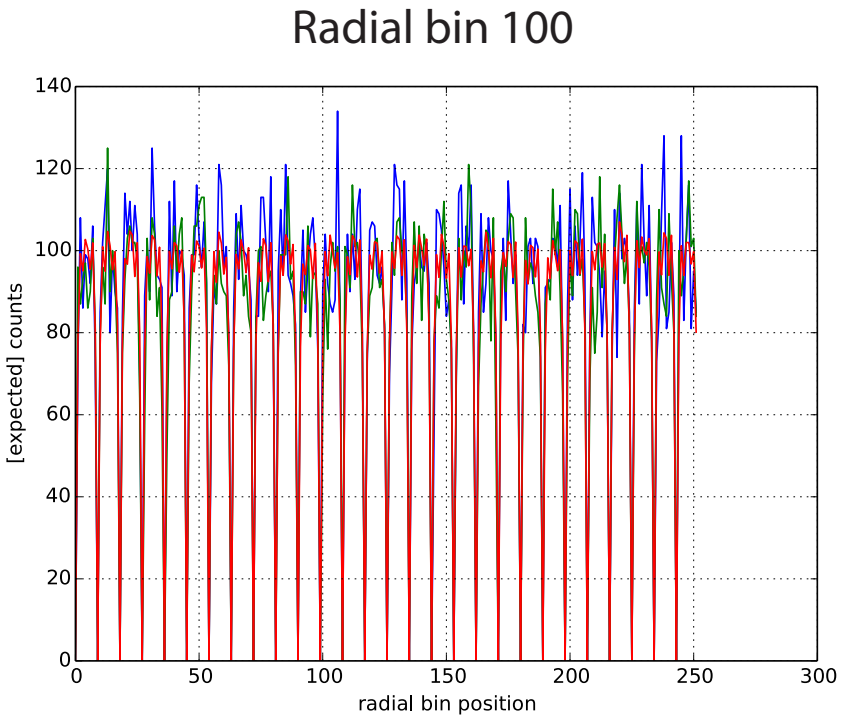
Sinograms for prompts and scatter+randoms

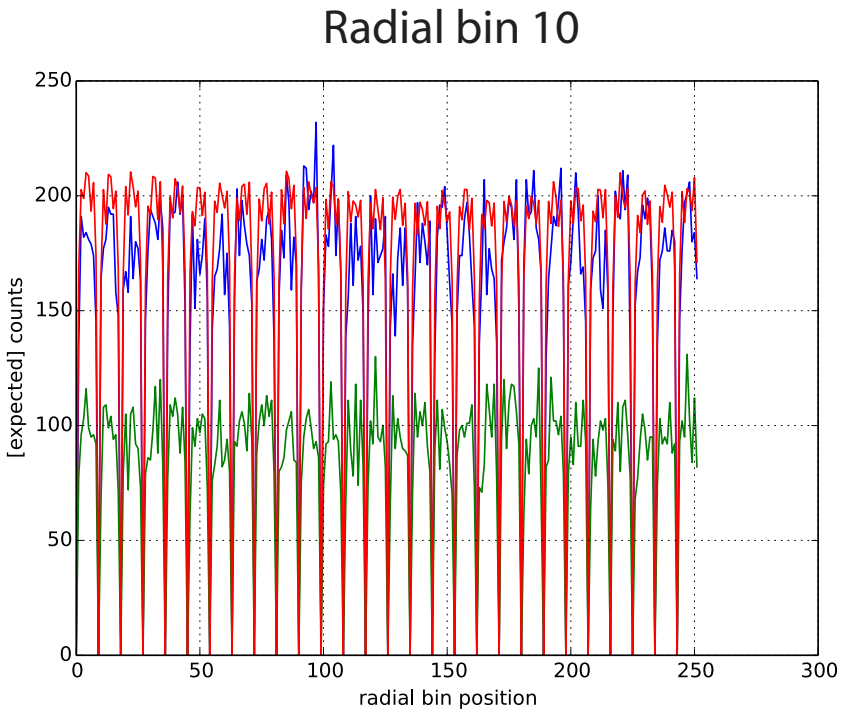


Sinogram profile for prompts, scatter+randoms, randoms

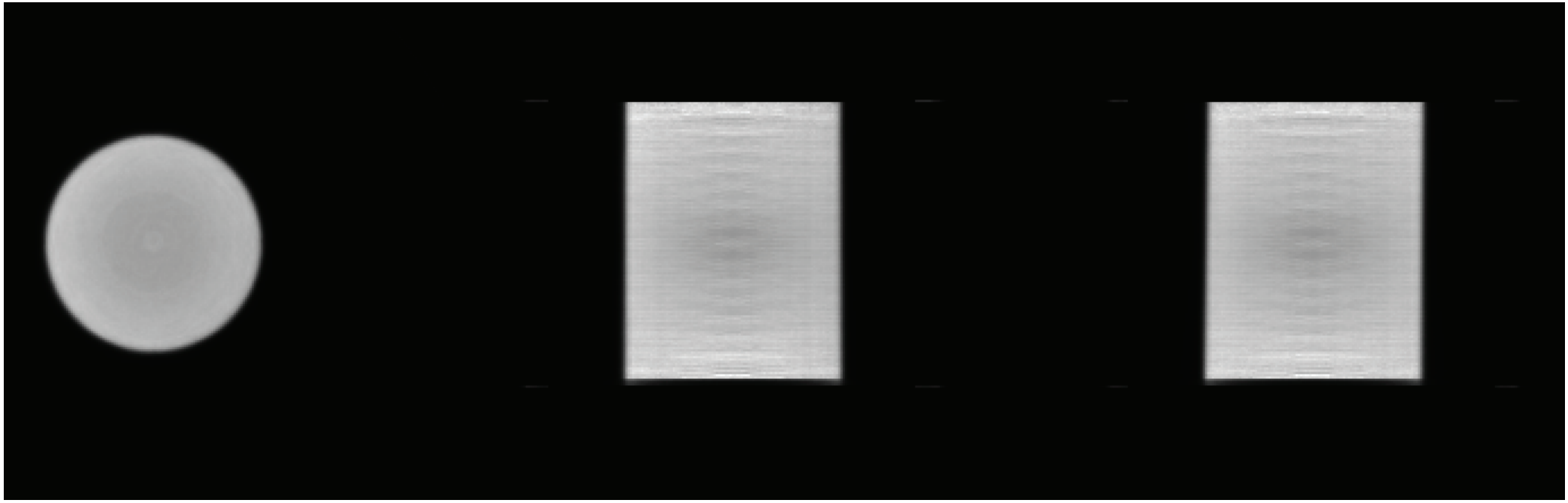


Sinograms profiles for prompts and estimated scatter+randoms

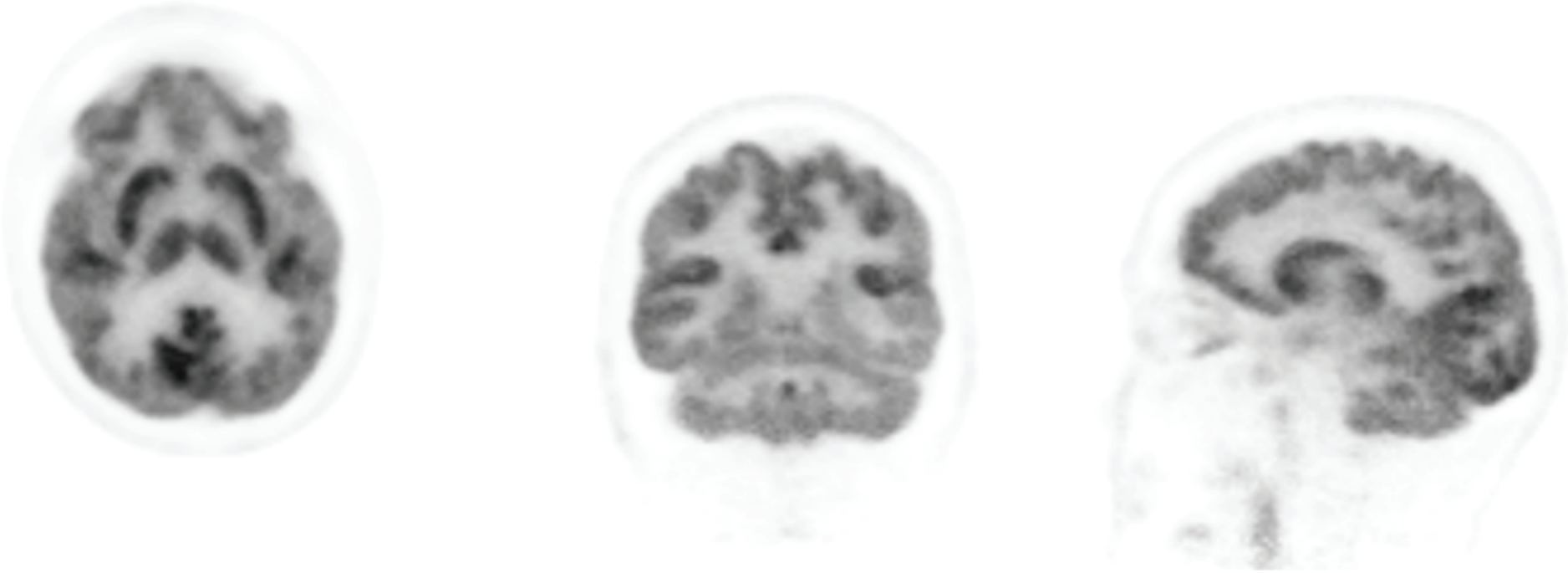




STIR reconstruction of the long acquisition phantom data

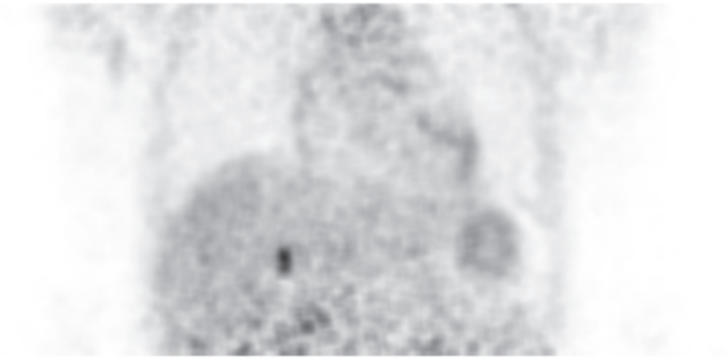


STIR reconstruction of the brain FDG PET data



STIR reconstruction of the thorax FDG PET data

No motion correction



With motion correction