User’s guide

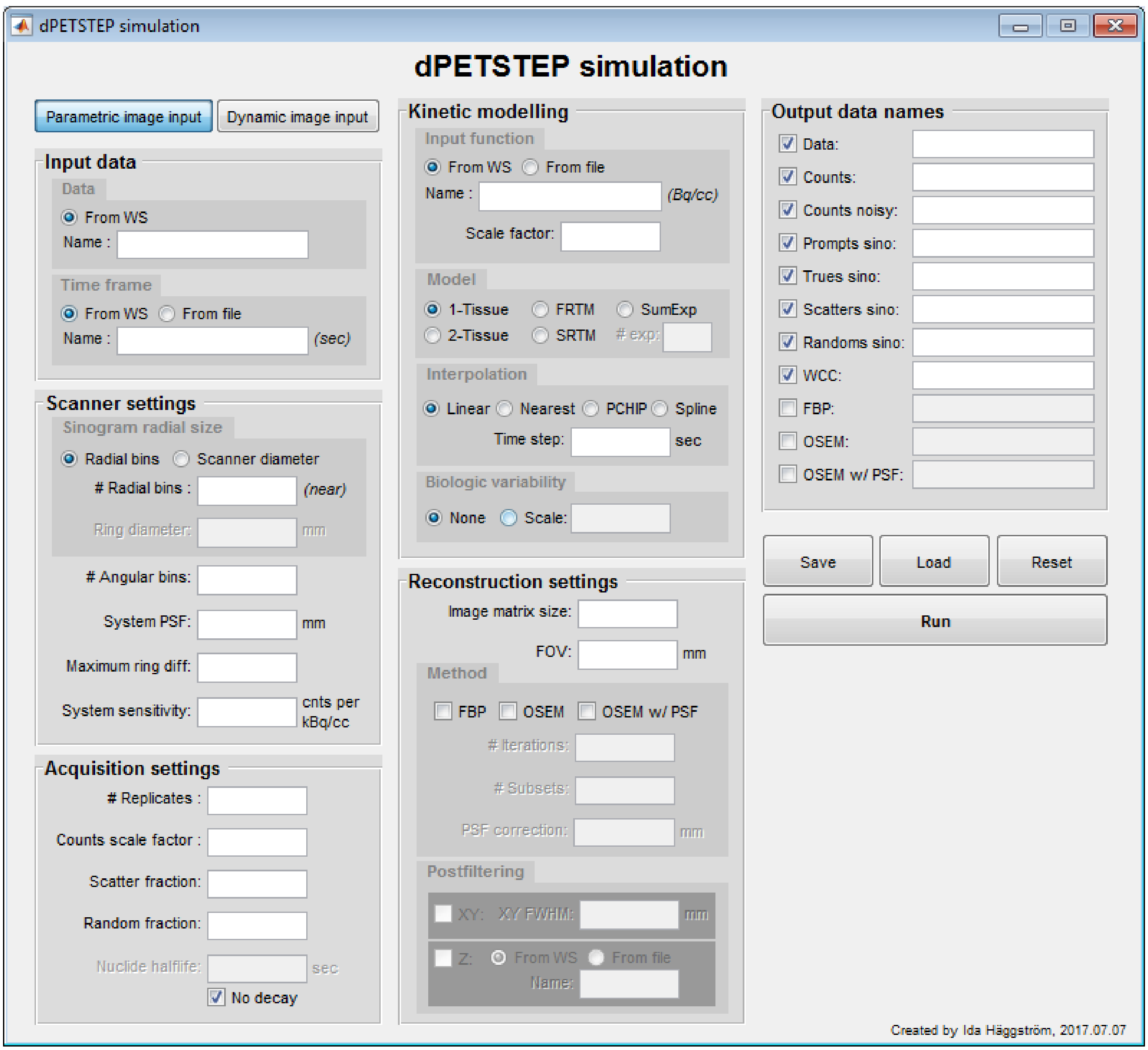
dPETSTEP simulation GUI

This document shows the usage of the dPETSTEP GUI for PET image simulation, and explains the different inputs to the GUI.

The GUI can be run by typing in the MATLAB command prompt:

```
>> dPETSTEPgui_sim
```

This command opens the full window seen below. All fields have tool tips to guide you.

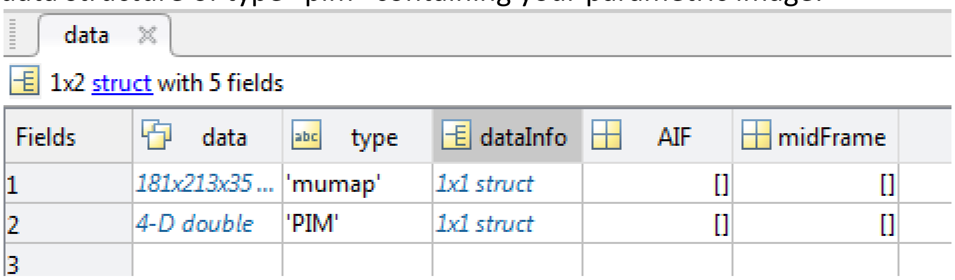


1. Run test example

1.1 data_ex_dPETSTEP_kineticModelling

This is for choosing "Parametric image input", i.e. starting with a parametric image, which simulates a pristine 4D PET image, and finally a realistic PET acquisition (noisy) of that image. Download the test example data found on Github at
https://github.com/CRossSchmidtlein/dPETSTEP/blob/master/example_kineticModelling.

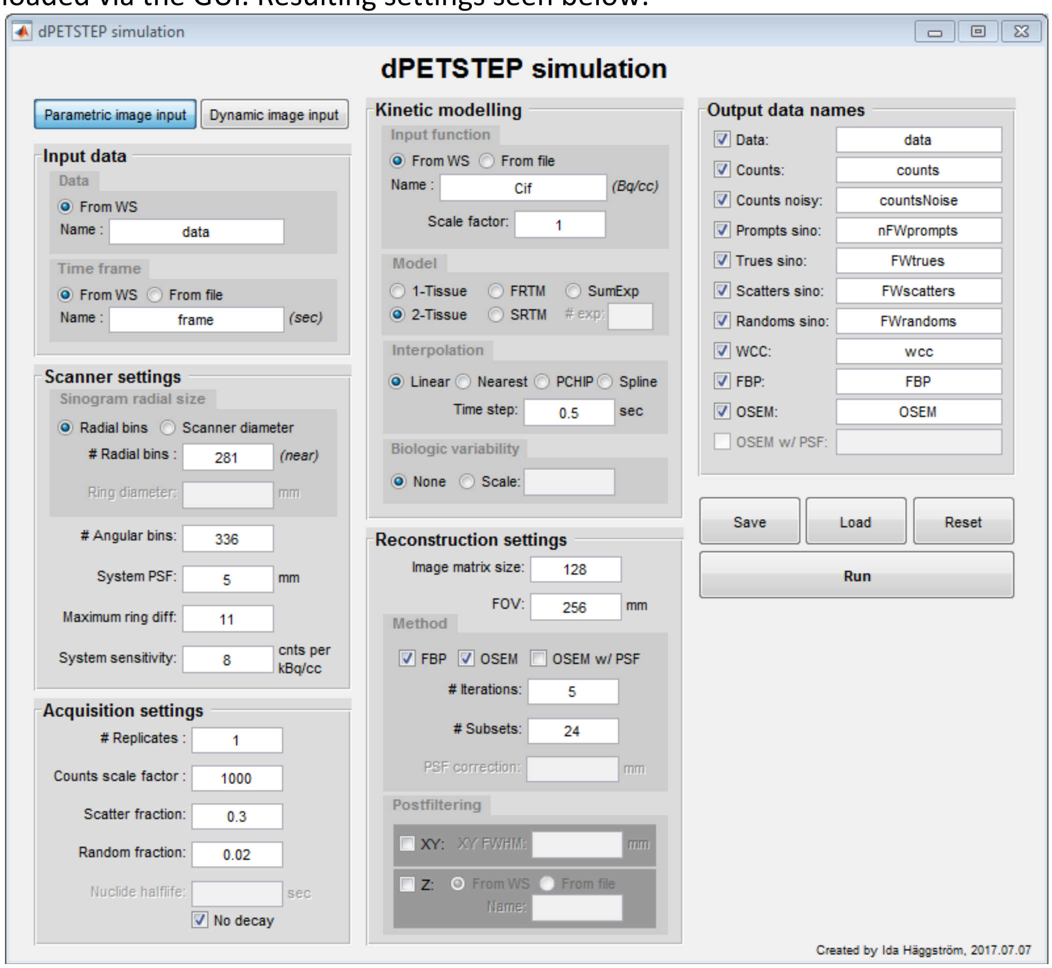
Load into Matlab the data "data_ex_dPETSTEP_kineticModelling.mat". There should be a field in that data structure of type "pim" containing your parametric image:


data

1x2 struct with 5 fields

Fields	data	type	dataInfo	AIF	midFrame
1	181x213x35 ...	'mumap'	1x1 struct	[]	[]
2	4-D double	'PIM'	1x1 struct	[]	[]
3					

Example settings can be found in "settings_dPETSTEPgui_simulation_kineticModelling.xls", and loaded via the GUI. Resulting settings seen below:



1.2 data_ex_dPETSTEP_dynamicImage

This is for "Dynamic image input", simulating a realistic PET acquisition (noisy) of an input dynamic PET image. Download the test example data found on GitHub at https://github.com/CRossSchmidtlein/dPETSTEP/blob/master/example_dynamicImage.

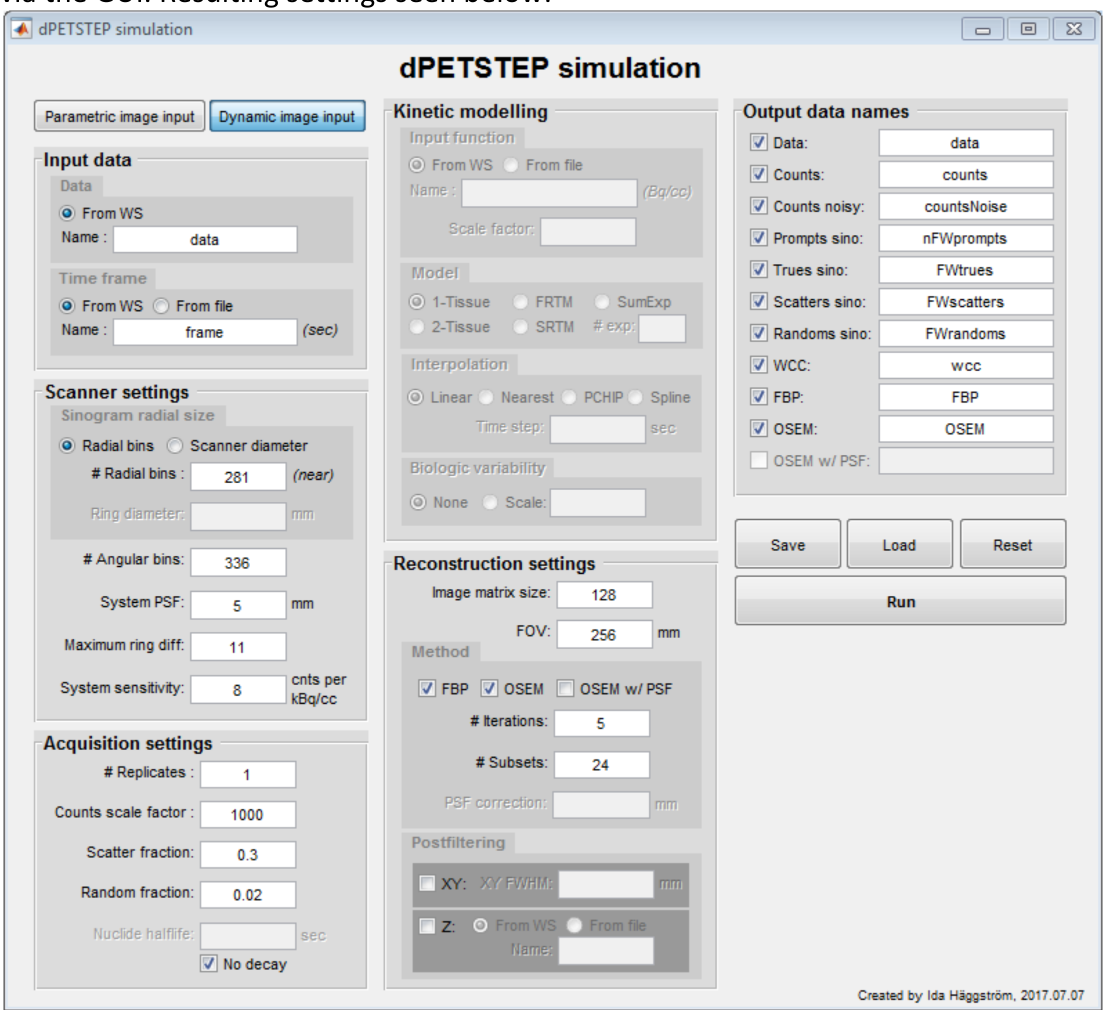
Load into Matlab the test data "data_ex_dPETSTEP_dynamicImage.mat". There should be a field in that data structure of type "pt" or "pt pristine", containing your 4D image.

data

1x3 struct with 3 fields

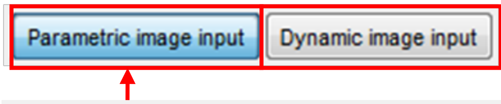
Fields	data	type	dataInfo
1	*181x213x35 ...*	'mumap'	*1x1 struct*
2	[]	[]	[]
3	*4-D single*	'PT pristine'	*1x1 struct*
4			

Example settings can be found in "settings_dPETSTEPgui_simulation_dynamicImage.xls", and loaded via the GUI. Resulting settings seen below:



2. GUI field explanations

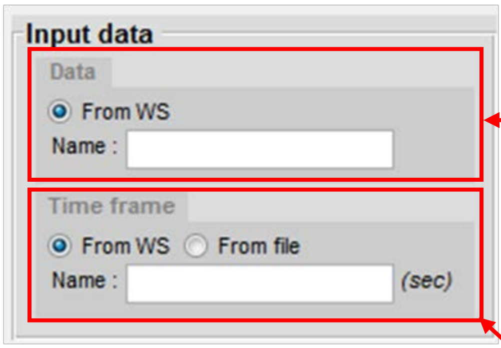
Buttons for type of simulation



Start with pristine dynamic uptake image to simulate realistic PET scan of it.

Start with parametric image, which calculates to a pristine dynamic uptake image which is used to simulate realistic PET scan.

Input data



Read data structure (containing attenuation data, and parametric image or dynamic image) either from workspace (WS), or from *.mat-file. Enter the name (string) of the WS variable/file. The *.mat-file has to contain ONLY the data structure, no other data.

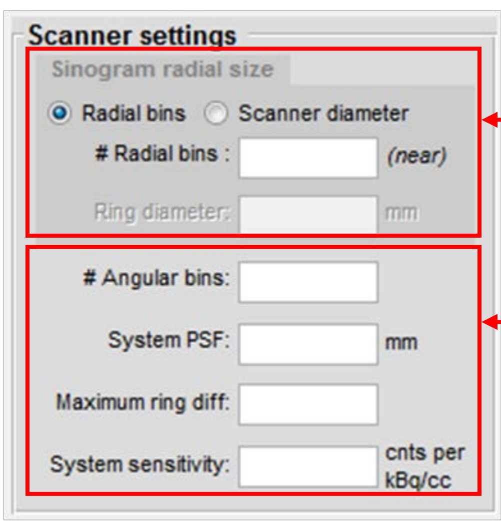
For parametric image input, the structure should contain parametric image.

For dynamic image input, the structure should contain dynamic uptake image.

Read frame time points either from workspace (WS), or from *.mat, *.txt, or *.xls file. Enter the name (string) of the WS variable/file. The data file has to contain ONLY the frame vector, no other data.

The frame data vector [nt+1,1] should be in unit (sec).

Scanner settings



Choose if you want to set the number of radial bins directly, or have it calculated indirectly via the scanner diameter.

Number of radial bins is an integer number, and the program will get to the desired number as closely as possible (uneven number).

The ring diameter is a number in unit (mm).

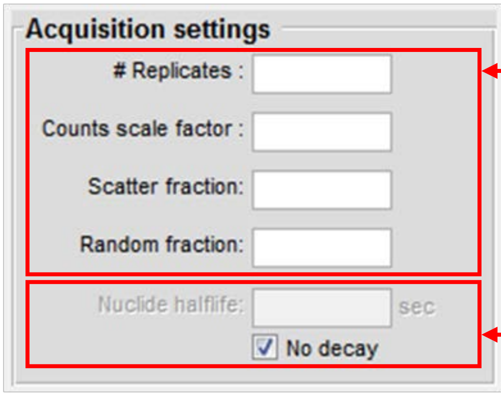
The number of angular bins is an integer number.

The system PSF is the blurring point spread function FWHM of the imaging system in unit (mm).

The maximum ring difference is an integer number with max separation between scanner rings allowed for coincidences.

The system sensitivity is the number of counts per kBq/cc for the particular scanner.

Acquisition settings



Number of replicates is an integer with number of desired noise realizations of the simulation.

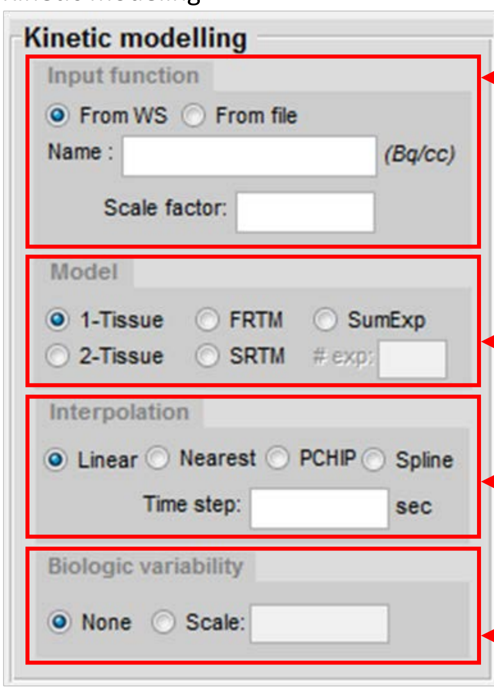
Counts scale factor is a factor that scales the dynamic image activity, in turn number of counts (noise level).

Scatter fraction is a unitless number, SF=S/(T+S).

Random fraction is a unitless number RF=R/(T+S+R).

Uncheck if you want to simulate physical decay, and specify nuclide halflife in unit (sec).

Kinetic modeling



Read input/reference function vector either from workspace (WS), or from *.mat,*.txt or *.xls-file. Enter the name (string) of the WS variable/file. The data file has to contain ONLY the input/ref function vector, no other data.

The input/ref function vector [nt,1] should be in units (Bq/cc).

The unitless scale factor is a multiplicative scalar that scales the amplitude of the input function. Set to 1 for no scaling.

Choose which kinetic model to simulate. For general sum of exponentials model (SumExp), also specify number of exponentials (integer number).

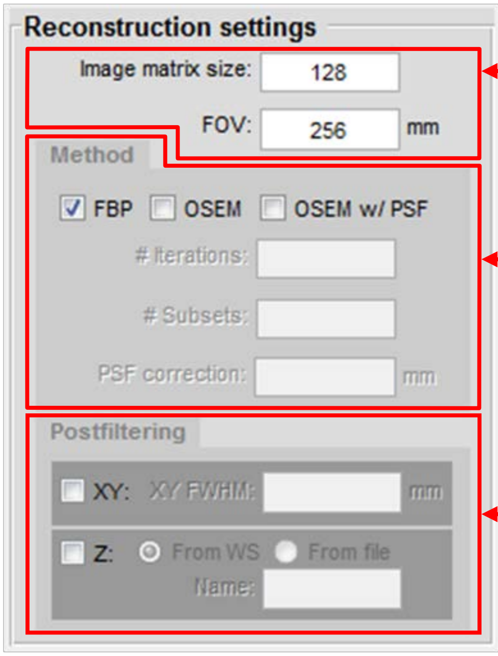
If uneven time sampling, the data will be interpolated to even sampling (for convolution) during fitting. Choose interpolation method, and time step for the interpolation.

The time step is a number in units (sec).

Chose if you want to simulate biologic variability by setting the scale to a unitless number.

Scale of added varaibility: variance of Gaussian noise = image value/scale.

Reconstruction settings



Set desired simulated image matrix XY-size (integer number).

Set image XY field of view (FOV) in (mm). Pixel size will be FOV/matrix size.

Check which type of reconstructed images you want to simulate; filtered back projection (FBP), ordered subset expectation maximization (OSEM), and/or OSEM with point spread function (PSF) correction.

For OSEM and OSEM+PSF, specify number of iterations (integer) and number of subsets (integer).

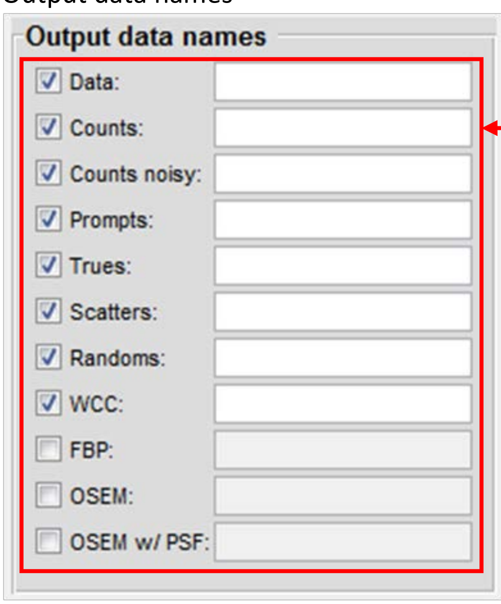
For OSEM+PSF, specify the correction PSF FWHM in (mm).

Check boxes if you want to perform XY and/or Z postfiltering.

Set the XY-postfilter Gaussian FWHM in (mm).

Read the Z-filter either from workspace (WS), or from *.mat,*.txt or *.xls-file. Enter the name (string) of the WS variable/file.

Output data names



Choose what data you want as output from the simulation, and set the name (string) of that data. Will end up in your WS after run.

Data is the structure used as input, with (for parametric image input) a field of the pristine dynamic uptake image added.

Counts is the noiseless sinogram counts of prompts, trues, scatters and randoms.

Counts noisy is the noisy sinogram counts of prompts, trues, scatters and randoms.

Prompts is the prompts sinogram matrix.

Trues is the trues sinogram matrix.

Scatters is the scatters sinogram matrix.

Randoms is the randoms sinogram matrix.

WCC is the well counter calibration factor to calibrate reconstructed image to (Bq/cc).

FBP is the reconstructed 4D FBP image.

OSEM is the reconstructed 4D OSEM image. Each iteration is saved.

OSEM w/ PSF is the reconstructed 4D OSEM w/ PSF correction image. Each iteration is saved.

Buttons

Load settings from chosen *.xls-file.

Reset all settings.

Executes the simulation main program.

Save all current settings to *.xls-file.