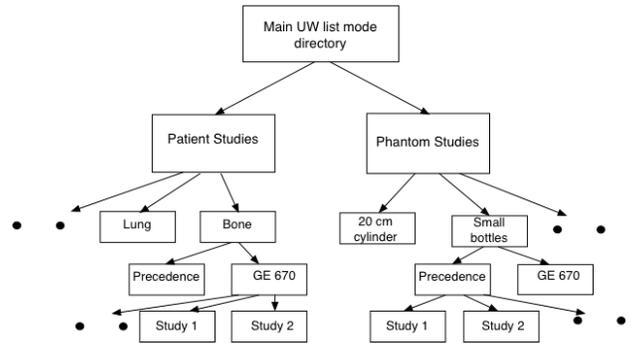


# University of Washington List Mode Data Library Format Definitions

**Last Revised:** 15 February 2017

University of Washington List Mode Library - disk file organization

**Introduction:** This document defines the file types and formats used for storage of list mode data files from SPECT/CT scanners used for research studies in the clinics at the University of Washington Medical Center. The data on the server is organized in a file structure as indicated in the figure.



All data sets (Study N files) include three basic files – 1) A text file with information about the study and other files associated with the study (studyDef.txt); 2) CT images in DICOM format; and 3) a binary file of the SPECT list mode data. The format of the list mode file is described in the studyDef.txt file.

The CT data sets are standard DICOM export files and are not further defined here. The rest of this document defines the structure of the studyDef.txt and SPECT list mode data files.

## Definition of the studyDef.txt file.

The entries in this file are all of the form /key/value. All entries are in ascii text and each entry terminates with a new line character. Note all entries are included in all studies. For example, if only one isotope is imaged, then the key pair /Isotope2/second isotope is not included in the file. Another example is the number of energy windows used. In both of these examples, the intent to allow any number of isotopes or energies, we just impose the the list be sequential as Energy1, Energy2, Energy3, Energy4,... The energy values are the lower PHA window offset from center, the center energy, and the upper window offset from the center energy for the window.

Some vendors also define a scatter window associated with each energy window. That will show up as additional /Energy window parameters. For example, for a GE scanner with only a Tc window set, but scatter included will result in a /Energy1/xxx and a /Energy2/xxx set of parameters where the /Energy2 is the scatter window.

Some systems do not apply energy correction to events outside of the energy windows. We have a flag for that below, but we also record the energy uncorrected and correcte3d (when the vendor has both in the list file) and so once can check if the event is not corrected by comparing those two values. The allowed entries with an example (after the :) are:

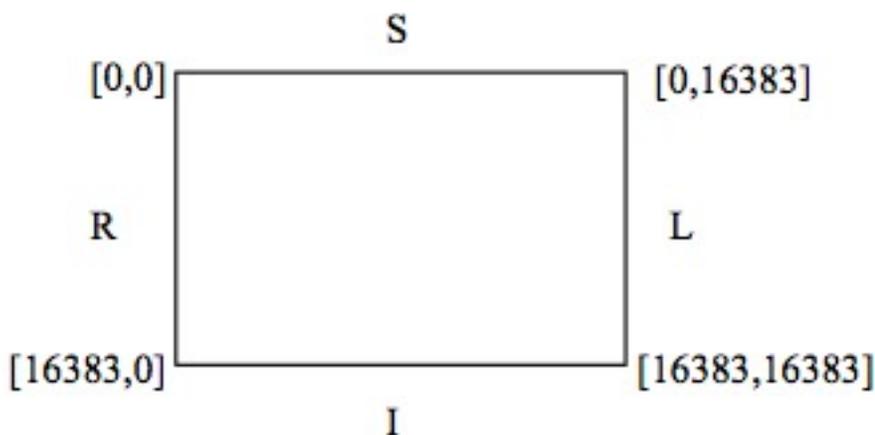
/StudyType/type of study	:/Study/phantom
/StudyName/study name	:/20 cm circular phantom
/CT/name of CT DICOM file	:/CT/CTimage.dcm
/SpectFile/file name	:/SpectFile/phantom_1.data
/Vendor/name of vendor	:/Vendor/GE
/Model/model of vendor system	:/Model/670-16
/Collimator/collimating model	:/Collimator/HR
/Mode/gantry head angular separation	:/Mode/180
/Isotope1/isotope used	:/Isotope1/Tc99

/Isotope2/second isotope	:/Isotope/In
EnergyUnits/in unites of Kev/NN	:/EnergyUnits/32
/NumEsets/	:/NumEset/2
/Energy1/lower, center, upper	:/Energy1/20, 140, 20
/Energy2/ lower, center, upper	:/Energy2/10,120,10
/Energy3/ lower, center, upper	:/Energy3/15,160 ,15
/CorrectionsInWindow/type,type,	:/Corrections/linearity, energy, uniformtiy,
/CorrectionsOutOfWindow/type,	:/CorrectionsOutOfWindow/energy,
/GantryPositionsPerHead/	:/gantryPositionsPerHead/64
/AngleRangePerHead/	:/angleRangePerHead/180
/StartAngle/degrees	:/startAngle/0.0
/TimePerStopInSeconds	:/timePerStopInSeconds/20.0
/PixelScale/mm per pixel	:/pixelScale/0.5
/MatrixSize/pixels	:/matrixSize/512 note:the matrix used for pixelScale
/DetectorMaxBins/xxx	:/detectorMaxBins/16384
/DetectorOrigin/{LL,LR,UL,UR}	:/detectorOrigin/LL note: in this case the lower left
/ZoomFactor/ value	:/ZoomFactor/1.5
/Xshfit/pixels	:/Xshift/5.0
/Yshfit/pixels	:/Yshift/0.0
/StartAngle/degrees	:/startAngle/0.0 start angle
/BodyContour/Boolean	/ BodyContour/true

**The coordinate system used for processing:**

The DetectorOrigin is used to help define the vendor specific detector coordinate system in the original data. We convert the data in our list mode output to the same coordinate system regardless of vendor, but kept this bit of information for possible issues of a vendor changes coordinate systems in our validation testing.

Orientation: Value of [X,Y] = [0,0] refers for to the top left corner for an orientation shown below.



**Zoom and matrix values:** The zoom, shift, and matrix sizes set for the acquisitions are in the .txt file but are not applied to the list mode data which includes all detected events, in and out of the PHA windows set for the acquisition. Energy windowing, zooming and offsets options are left to whatever tool or code is used to bin the list mode data.

**Definition of SPECT data file: (studyName.dat) format**

Three types of records – gantry movement or event data. The data formats are (all little indian):

### Time Type

Sd	Number type	Allowed values
Type	Byte	0xF1
Physiological gate	Byte	Usually 0 or 1
TimeStamp	uint32	milliseconds

### Movement Type

Sd	Number type	Allowed values
Type	Byte	0xF2
FrameStart	Byte	0xFF
RotationPosition	int32	Units of 0.1 degree, signed int
Head1RadialPosition	uint32	Units of 0.1 mm
Head2RadialPosition	uint32	Units of 0.1 mm
TableLinearPosition	uint32	Units of 0.1 mm

### Event Type

Sd	Number type	Allowed values
Type	Byte	0xF0
EnergyUncorrected	uint16	Units of 1/NN Kev (NN from .txt file)
EnergyCorrected	uint16	Units of 1/ NN Kev (NN from .txt file)
DetectorHeadNumber	Byte	0x00 or 0x01
EventWeight	uint16	Weight x 1000 to reflect uniformity correction
Xposition (pixel)	uint16	Unsigned integer, from detector origin
Yposition (pixel)	uint16	Unsigned integer, from detector origin