A preliminary proposal for Interfile keys for PET (version 0.3)

At the moment, we are in the process of merging this proposal with SPECT (and some support for MRI and CT as well) into an Interfile v4.0 standard. More news will follow soon.

The current proposal tries to strike a balance between compatibility with the existing 3.3 standard (for gamma cameras and SPECT), and the need for restructuring because of the more complicated situation of PET. To understand some decisions, you will probably have to compare with the original 3.3 standard document. The official Interfile site is http://www.keston.com/Interfile/.

See notes at the end for things to do and questions that remain.
Just before the notes there are some examples. They are probably the place to start.

See here for a PDF file, which has a few minor embellishments.

See notes at the end for things to do and questions that remain. Just before the notes there are some examples. They are probably the place to start.

Please contact kris.thielemans@ic.ac.uk if you have any comments, suggestions, ...

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15 May, 2001

Contents

Complete description of the header format

*New keys are marked with **NEW**.*
The syntax of the proposal is as specified in the 3.3 document. In particular, a semicolon starts a comment. There is one new type however. <listof type> means an entry <type> or {<type>, <type>,...} For conciseness, we cut out other data types than PET from the 3.3 document.

!INTERFILE := <NULL>
;to indicate that this is an Interfile file

!imaging modality := <ASCII> nucmed
;only nucmed is defined for the purpose of this document

!originating system := <ASCII>
;eg.GAMMA-11, CTI 953B etc.

!version of keys := <Numeric> 3.31
;future versions shall increment

date of keys := <DateFormat> 1997:06:18
;date of version in date format

conversion program := <ASCII>
;name of program used

program author := <ASCII>
;your chance of fame and fortune

program version := <Numeric>
;to keep track of conversion programs

program date := <DateFormat>
;date of program

originating file format := <ASCII>
;**NEW**

!GENERAL DATA := <NULL>
;required but can be treated as comment

original institution := <ASCII>
;name of hospital etc.

contact person := <ASCII>
;another chance of fame (and fortune?)

data description := <ASCII>
;whatever you want

!data starting block := <Numeric> 0
;the value is the offset in blocks of 2048 bytes in either the
;administrative or the data file depending on the key value for
;name of data file (see below)
| ;OR
!data offset in bytes:= <Numeric> 0
;as above but the offset may be specified freely in bytes
;**NEW**, This keyword can be dropped if the vectored form is used below.

!name of data file := <ASCII> <NULL>
;<NULL> if no image data exists
;key is a name of the file where the data are present, either when
;in a separate binary data file, or when in a combined
;administrative/binary data file

patient name := <ASCII>
;last name, first name (recommended)

!patient ID := <ASCII>
;as used in your hospital

patient dob := <DateFormat>
;date of birth

patient sex := <ASCIIlist> Unknown M|F|Unknown
;default is Unknown!

patient dexterity := <ASCIILIST> Unknown L|R|Unknown
;**NEW**

patient height (cm) := <Numeric>
;**NEW**

patient weight (kg) := <Numeric>
;**NEW**

!study ID := <ASCII>
;as local conditions dictate

exam type := <ASCII>
;description of procedure as above

data compression := <ASCII> none
;name of algorithm if present- e.g. JPEG, etc.

data encode := <ASCII> none
;name of method of encoding if present- e.g. uuencode etc.

!GENERAL IMAGE DATA := <NULL>
;again required but treated as comment

!type of data := <ASCIIlist> Other
  Static|Dynamic|Gated|Tomographic|Curve|ROI|PET|Other
;important - this key is used for many conditionals
;**NEW** value PET
; static,dynamic and gated are defined for Gamma cameras
; tomographic is for SPECT (GSPECT is being proposed for gated SPECT)
; PET type encompasses static,dynamic and gated data (all tomographic)

!total number of images := <Numeric>
;how many images are there altogether in total in the associated
;data file (for all windows etc.). This overrides any other way of
;calculating the total number of images.
;this is an old Interfile key, more suitable for 2D data

study date := <DateFormat>
;date of the first image included in the data file

study time := <TimeFormat>
;time for the start of first image specified

number of isotopes := <Numeric> 1
;**NEW**

for (number of isotopes, isotope_num)
{

        isotope name[<isotope_num>] := <ASCII>
        ;**NEW**

        isotope beta halflife (sec) [<isotope_num>] := <Numeric>
        ;**NEW**

        isotope gamma halflife (sec) [<isotope_num>] := <Numeric>
        ;**NEW**

        isotope branching factor[<isotope_num>] := <Numeric>
        ;NEW
        ; ratio of beta over gamma decays
        ; useful for well counter measurements (single photons) to beta counts.
}

radiopharmaceutical := <ASCII>
;**NEW**

relative time of tracer injection (sec) := <Numeric>
;**NEW**, relative to study time

tracer activity at time of injection (MBq) := <Numeric>
;**NEW**

injected volume (ml) := <Numeric>
;**NEW**

imagedata byte order := <ASCIIlist> BIGENDIAN
            BIGENDIAN|LITTLEENDIAN
;BIGENDIAN is the default if unspecified

if(type of data = "PET")
;**NEW**
{   **!PET STUDY (General) := <NULL>**
        ;**NEW**

        scanner quantification factor := <Numeric> 1
        ;**NEW**

;Would normally be used to convert from counts per second measured
;to absolute activity in Bq/ml. See also the quantification factors
;listed for each volume below.

quantification units := <ASCII> Bq/ml
;**NEW**
;Units of the data after using volume and scanner quantification
;factors. Can be superseded by a unit listed for each volume
;below. Defaults to Bq/ml, but could be different for functional
;images.
;quantification units := None means that the image does not
;contain quantitative information

patient orientation := <ASCIIlist> head_in
        head_in|feet_in|other

patient rotation := <ASCIIlist> supine
        prone|supine|other

decay corrected := <ASCIIlist> N Y|N
;not corrected if unspecified

!PET data type := <ASCIIlist>
        Emission|Transmission|Blank
        AttenuationCorrection|Normalisation|
        Image
;**NEW**, used below in conditionals - MUST be defined
;use 'emission' also for corrected data
;This keyword could be discarded by moving the information
;into the 'data type' keyword. However, by using
;'data type := PET' we single out PET from the rest.
;The keyword stresses the information content of the file,
;as opposed to the format (see 'data format' below).

if (PET data type = "Emission"|"Transmission"|"Blank")
{   *process status := <ASCIIlist> Acquired*
      Acquired|Simulated
      ;**NEW** value
      ;Simulated is for 'software acquisitions', although this info
      ;could be given in the field 'data description' as well.

      Simulator used := <ASCII>
      ;**NEW**
}

if (PET data type = "Image")
{   *process status := <ASCIIlist> Reconstructed*
      Reconstructed|Functional|PhantomDescription
      ;**NEW** values
      ;PhantomDescription is for an image that describes an
      ;object for which a scan can then be simulated.
      ;Only pixel/voxel type of phantoms supported at the moment.
      ;Functional is for functional images, i.e. output of a modelling calculation.
}

if (PET data type = "Emission"|"Transmission"|"Blank"|
                  "AttenuationCorrection"|"Normalisation")
{
      data format := <ASCIIlist> sinogram
        Sinogram|CoincidenceList
      ;**NEW**, sinogram is intended as a general term including 2D
      ;sinogram, 3D sinogram and 3d 'planagram'
      ;AttenuationCorrection and Normalisation files should always
      ;be in sinogram format. A 'corrected' emission sinogram would be
      ;formed by *multiplying* the emission with normalisation and
      ;attenuationcorrection.
}

if (PET data type = "Image" or data format != "CoincidenceList")
{
      !number format := <ASCIIlist> unsigned integer

          signed integer|unsigned integer
          |long float|short float|bit|ASCII
;as specified

!number of bytes per pixel := <Numeric>
;e.g. 1|2|4.. [this key ignored for bit data]

!number of dimensions := <Numeric> 2
;**NEW**, but proposed in the 3.3 document, defaults to 2
;for planes

for (number of dimensions, dim)
{   *!matrix size [dim] :=<listof Numeric>*
    ;**NEW** type (is Numeric in 3.3)
    ;<listof Numeric> format to accommodate non-constant sizes
    ;e.g. for 3D sinograms, see example below

    matrix axis label [dim] := <ASCII>
    ;**NEW**, but proposed in the 3.3 document

    scaling factor (mm/pixel) [<dimension>] := <Numeric>
    ;pixel/voxel size
}

;The 'axis labels' used in the examples below are *mandatory*.
;This enables an automatic reader to distinguish between the
;different storage orders used for sinograms. See Terminology.

;example for 3D sinograms
;Number of dimensions := 4
;matrix axis label[4]:=tangential coordinate
;matrix size[1]:=288
;matrix axis label[2]:=view
;matrix size[2]:=288
;matrix axis label[3]:=axial coordinate
;matrix size[3]:=**{**95,85,85,67,67,49,49,31**}**
;matrix axis label[4]:=segment
;matrix size[4]:=9

;example for 3D 'planagrams' (sometimes called view mode)
;Number of dimensions := 4
;matrix axis label[4]:=tangential coordinate
;matrix size[1]:=288
;matrix axis label[2]:=axial coordinate
;matrix size[2]:=**{**95,85,85,67,67,49,49,31**}**
;matrix axis label[3]:=view
;matrix size[3]:=288
;matrix axis label[4]:=segment
;matrix size[4]:=9

;example for (a stack of) 2D sinograms
;Number of dimensions := 3
;matrix axis label[1] := tangential coordinate
;matrix size[1]:=288
;matrix axis label[2] := view
;matrix size[2]:=288
;matrix axis label[3] := axial coordinate
;matrix size[3]:=31
}

if (PET data type != "Image" and data format = "CoincidenceList")
{
    ;description of file format
    ;to be filled in
}

;Below are loops that describe the data. The most general
;situation is covered for (I hope) : a dynamic gated scan with
;different bed positions where the acquisition covers
;multiple energy windows and data types

;(prompts/delayeds/multiples).
;If the index of a loop takes only one value, some loops
;are optional, for other loops the index of the keywords
;can be dropped.

horizontal bed translation := <ASCIIlist> stepped
                stepped|continuous
;**NEW**
;For continuous mode, 2 bed positions (initial and final)
;should be specified below

start horizontal bed position (mm) := <Numeric>
;**NEW**

end horizontal bed position (mm) := <Numeric>
;**NEW**, only useful for continuous mode

start vertical bed position (mm) := <Numeric>
;**NEW**

number of time frames := <Numeric> 1
;**NEW**, dynamic scans

for (number of time frames<b>, f)
{
        frame[<f>] := <ASCII>
        ;**NEW**, optional description of the data
}

number of time windows := <Numeric> 1
;gated scans

;if there is no gating, do not insert the next information
for (number of time windows, g)
{
        time window number[<g>] := <Numeric>
        ;starting from 1

        gate[<g>] := <ASCII>
        ;**NEW**, optional description of the data

        framing method[<g>] := <ASCIIlist> Forward
                Forward|Backward|Mixed|Other
        ;default is forward

        time window lower limit (sec) [<g>] := <Numeric>
        ;float normally expected, for THIS time window

        time window upper limit (sec) [<g>] := <Numeric>
        ;float normally expected

        R-R histogram[<g>] := <ASCIIlist> N Y|N
        ;flag to indicate that one exists!!
}

;The energy window information is moved from top level in the 3.3 standard.

number of energy windows := <Numeric> 1
;defaulted to one if unspecified

for (number of energy windows, energy window)
{
        energy window[<energy window>] := <ASCII>
        ;ASCII text- for example "Tc99m" for SPECT
        ;PET could use "normal" and "scatter"
        ;this starts as "energy window [1]" and then increments to
        ;energy window[2]:= <ASCII>
        ;and then on to
        ;energy window[3]:= <ASCII>
        ;etc. etc.

energy window lower level [<energy window>] := <Numeric>
;value of lower energy level in keV for the corresponding window
;starts off as "energy window lower level [1]"
;and continues [2],[3] .. as above

energy window upper level [<energy window>] := <Numeric>
;value of upper energy level in keV for the corresponding window
;starts off as "energy window upper level [1]"
;and continues [2],[3] .. as above
}
; end of loop over energy windows

;data types. The word 'data type' is already used above, so we use
;'scan data type' or 'image data type'

if (PET data type = "Emission"|"Transmission"|"Blank")
{
     number of scan data types := <Numeric> 1
     ;**NEW**

     for (number of scan data types, d)
     { *scan data type description[<d>] :=*
            <ASCIIlist> Corrected prompts
                Prompts|Delayed|Multiples|Corrected prompts
          ;**NEW**
          ;'corrected prompts' is prompts-delayed
     }
 }

if (PET data type = "Image")
{
     number of image data types := <Numeric> 1
     ;**NEW**

     for (number of image data types, d)
     { *image data type description[<d>] := <ASCII>*
          ;**NEW**
          ;useful for functional images
     }
 }

!PET STUDY (<PET data type> data) :=
; e.g. PET STUDY (Emission data)

if (PET data type = "Emission"|"Transmission"|"Blank"|
                         "AttenuationCorrection"|"Normalisation")
{
       ;the definitions below are probably specific to ring scanners
       ;I guess we should have a keyword:
       ;PET scanner type := cylindrical

       transaxial FOV diameter (cm) := <Numeric>
       ;**NEW**

       number of rings := <Numeric>
       *;**NEW***

       number of detectors per ring := <Numeric>
       *;**NEW***

       distance between rings (cm) := <Numeric>
       ;**NEW**

       gantry tilt angle (degrees) := 0
       ;**NEW**

       gantry rotation angle (degrees) := 0
       ;**NEW**

       bin size (cm) := <Numeric>

;**NEW**, only in cm after arc correction
;This does not necessarily correspond to detector size due to
; interpolation, etc..

view offset (degrees) := <Numeric>
;**NEW**, angle that the first view is offset from the vertical line

septa state := <ASCIIlist> extended   extended|retracted|none
;**NEW**

minimum ring difference per segment := <listof Numeric>
;NEW
;number of elements in the list has to be equal to the number of segments
;as specified in the 'matrix*' keywords.
;segments are listed in the order they occur in the binary data

maximum ring difference per segment := <listof Numeric>
;NEW
;see above

applied corrections := <listof ASCII> none
;**NEW**, roughly replaces 'preprocessed' key
;non-exhaustive list of possible values
;   arc correction|normalised|attenuation|scatter|randoms|
;   dead time|decay|moothed|Wiener filter
;multiple corrections can be given as a list
;e.g. applied correction := **{**attenuation, scatter**}**

method of attenuation correction := <ASCII> none
;**NEW**, e.g. "measured", "calculated"

method of scatter correction := <ASCII>

} ; end of not reconstructed PET

if(PET data type = "Image")
{
       slice orientation := <ASCIIlist> Transverse
         Transverse|Coronal|Sagittal|Other
       ;default is transverse if unspecified

       method of reconstruction := <ASCII>
       ;non-exhaustive list of possible values
       ; PROMIS, FAVOR, SSRB+FBP, MSRB+FBP, FORE+FBP, FORE+MLEM,
       ; MLEM, OSEM, MAP, ART

       ;next three keywords are really for FBP type reconstructions
       ;they still have to be modified for the 3D case

       filter name := <ASCII>
       ; e.g. Hann, Hamming, Butterworth

       filter parameters := <ASCII>
       ;Nyquist freq etc.

       z-axis filter := <ASCII>
       ;method [1,2,1] etc.

       ;next two for iterative algorithms
       number of iterations := <Numeric> 1
       ;**NEW**

       stopping criterion := <ASCII>
       ;**NEW**

       reconstruction method details := <ASCII>
       ;**NEW**, this keyword can be used to include all other info

       applied corrections := <listof ASCII> none
       ;**NEW**, roughly replaces 'preprocessed' key
       ;non-exhaustive list of possible values

; attenuation|scatter|randoms|
; dead time|decay|smoothed|Wiener filter
;multiple corrections are given as a list
;e.g. applied correction := **{**attenuation, scatter**}**

method of attenuation correction := <ASCII> none

method of scatter correction := <ASCII> none

};end of PET data type = "image"

!IMAGE DATA DESCRIPTION := <NULL>
;**NEW**, treat as comment, but shows structure of the file

;Here follows a multilevel loop giving information on the
;data (like counts, maxima,...).
;An alternative would be to have this in a long list. This
;would be much more concise, but it requires careful counting to
;find a particular image back.

!total number of data sets := <Numeric> 1
;A 'data set' (volume or sinogram) is a collection of data of dimension
;'number of dimensions'.
;The number of 'data sets' should be equal to
;   'number of time frames' *
;   'number of time windows' * 'number of energy windows' *
;   'number of data types'

!index nesting level := <listof ASCIIlist>
        time frame|gate|energy window|data type
;**NEW**, this is used to specify the meaning of the vectored indices.
;The order should ALWAYS correspond
; **{** time frame, gate, energy window, data type**}**
;If a particular index takes only one value and its loop
;contains only optional keywords, simply drop it and
;adjust 'index nesting level' keyword.
;The convention proposed in 3.3 on vectored indices is used:
;if not all indices are specified, values of the keys are valid for all
;remaining indices. See the section on vectored indices below.

 for (number of time frames, f)
 {
        ;dynamic scan or a scan with different bed positions (which
        ; have to be on different times anyway)

        !image duration (sec)[<f>] := <Numeric>
        ;eg. 120.0 i.e. normally a float, for each image
        ;if this is a gated scan, the 'image duration' adds up all gates

        !image start time[<f>] := <TimeFormat>
        ;time for each image
        ; or
        !image relative start time (sec)[<f>] :=
                <Numeric> 0

        !relative horizontal bed position (mm)[<f>] :=
                <Numeric> 0
        ;**NEW**

        !relative vertical bed position (mm)[<f>] :=
                <Numeric> 0
        ;**NEW**

        for (number of time windows, g)
        ;gating
        {
         number of cardiac cycles (observed)[<f>][<g>] := <Numeric>
         ;total number of cycles during scan

9

% R-R cycles acquired this window[<f>][<g>] := <Numeric>
;if known

number of cardiac cycles (acquired)[<f>][<g>] := <Numeric>
;total number of cycles accepted, eg 356 , if known

study duration (acquired) sec[<f>][<g>] := <Numeric>
;total acquisition time duration for
;this window only (if it can be computed!!) as
;opposed to total acquisition time (when different)

for (number of energy windows, e)
{
      ;these 5 should be listed only for acquired data

      total prompts[<f>][<g>][<e>] := <Numeric>
      ;**NEW**

      total delayed[<f>][<g>][<e>] := <Numeric>
      ;**NEW**

      total multiples[<f>][<g>][<e>] := <Numeric>
      ;**NEW**

      total trues[<f>][<g>][<e>] := <Numeric>
      ;**NEW**, estimate (prompts - randoms)

      total singles[<f>][<g>][<e>] := <Numeric>
      ;**NEW**

      for (number of data types, d)
      {
            !maximum pixel count[<f>][<g>][<e>][<d>] := <Numeric>
            ;for scaling purposes, for each image

            minimum pixel count[<f>][<g>][<e>][<d>] := <Numeric>
            ;**NEW**, for scaling purposes, for each image
            ; LLN proposes image_extrema

            !image scaling factor[<f>][<g>][<e>][<d>] :=
                <Numeric>
            ;**NEW**, scaling factor to scanner counts
            ;should be used like
            ; absolute activity =
            ;   image_data* image_scaling_factor*
            ;   scanner_quantification_factor

            data offset in bytes[<f>][<g>][<e>][<d>] := <Numeric>
            ;**NEW**, offset of one sinogram/volume
            ;if this keyword is not specified, the data are assumed to be
            ;continuous in the file, and ordered
            ;according to 'index nesting level' (left
            ;index runs slowest).

        }
      }
    }
  }

}
;End of PET

!END OF INTERFILE := <NULL>

EXAMPLE image file (dynamic study)

INTERFILE :=
imaging modality := nucmed
originating system := CTI 966
version of keys := 3.31
date of keys := 1997:06:18
GENERAL DATA :=
original institution := MRCCU
contact person := Kris Thielemans
data description := generic 3d image file
name of data file := myfile.v
patient name := some phantom
patient ID := 1
study ID := 12345
GENERAL IMAGE DATA :=
type of data := PET
study date := 1997:05:01
study time := 10:00:01
isotope name := O-15
isotope beta halflife (sec) := 122
isotope branching factor := 1.0
radiopharmaceutical := water
image data byte order := LITTLEENDIAN
PET STUDY (General) :=
scanner quantification factor := 1.0
quantification units := Bq/ml
PET data type := Image
process status := Reconstructed
number format := signed integer
number of bytes per pixel := 2
Number of dimensions := 3
matrix axis label [1] := x
matrix size [1] := 128
scaling factor (mm/pixel) [1] := 2.5
matrix axis label [2] := y
matrix size [2] := 128
scaling factor (mm/pixel) [2] := 2.5
matrix size [3] := 96
matrix axis label [3] := z
scaling factor (mm/pixel) [3] := 2.5
start horizontal bed position (mm) := 288
number of time frames := 2
PET STUDY (Image data) :=
slice orientation := Transverse
method of reconstruction := FAVOR
filter name := Hamming
applied corrections := {attenuation, scatter}
method of attenuation correction := measured
method of scatter correction := CTI scatter correction
IMAGE DATA DESCRIPTION :=
index nesting level := {time frame}

image duration (sec)[1] := 10
image relative start time (sec)[1] := 0
maximum pixel count[1] := 32000
minimum pixel count[1] := -201
image scaling factor[1] := 1.0

image duration (sec)[2] := 20
image relative start time (sec)[2] := 15
maximum pixel count[2] := 32000
minimum pixel count[2] := -2
image scaling factor[2] := 1.0
END OF INTERFILE :=

EXAMPLE for 3D corrected emission sinogram (dynamic study)

```
INTERFILE  :=
imaging modality := nucmed
originating system := CTI 966
version of keys := 3.31
date of keys := 1997:06:18
GENERAL DATA :=
original institution := MRCCU
contact person := Kris Thielemans
data description := generic 3D sinogram file
name of data file := myfile.s
patient name := some phantom
patient ID := 1
study ID := 12345
GENERAL IMAGE DATA :=
type of data := PET
study date := 1997:05:01
study time := 10:00:00
isotope name := O-15
isotope beta halflife (sec) := 122
isotope branching factor := 1.0
radiopharmaceutical := water
PET STUDY (General) :=
scanner quantification factor := 1.0
quantification units := Bq/ml
PET data type := Emission
process status := Acquired
data format := sinogram
number format := signed integer
number of bytes per pixel := 2
Number of dimensions := 4
matrix axis label [1] := tangential coordinate
matrix size [1] := 160
matrix axis label [2] := view
matrix size [2] := 192
matrix axis label [3] := axial coordinate
matrix size [3] := { 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1}
matrix axis label [4] := segment
matrix size [4] := 31
start horizontal bed position (mm) := 288
number of time frames := 2
energy window lower level := 120
energy window upper level := 720
PET STUDY (Emission data) :=
minimum ring difference per segment := { -15,-14,-13,-12,-11,-10,-9,-8,-7,-6,-5, \
  -4,-3,-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}
maximum ring difference per segment := { -15,-14,-13,-12,-11,-10,-9,-8,-7,-6,-5, \
  -4,-3,-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15}
 septa state := none
applied corrections := {attenuation}
method of attenuation correction := measured
IMAGE DATA DESCRIPTION :=
index nesting level := {time frame}

image duration (sec)[1] := 10
image relative start time (sec)[1] := 0
maximum pixel count[1] := 32000
minimum pixel count[1] := -201
image scaling factor[1] := 1.0
data offset in bytes[1] := 2048
image duration (sec)[2] := 20
image relative start time (sec)[2] := 15
maximum pixel count[2] := 32000
minimum pixel count[2] := -2
image scaling factor[2] := 1.0
data offset in bytes[2] := 32008
END OF INTERFILE :=
```

Terminology and conventions

x-axis : horizontal axis, pointing right when looking from the bed into the gantry
y-axis : vertical axis, pointing upwards
z-axis : the scanner axis, pointing from the gantry towards the bed

For (3D) sinograms:
segment : before axial compression, this is the ring difference between the rings detecting the LOR, hence it is related to angle between LOR and z-axis.
view : angle of LOR projected on a plane perpendicular to the z-axis, runs anticlockwise looking along the z-axis
axial coordinate : distance along the z-axis of the first ring where the event is detected
tangential coordinate : for a given segment, view and z, there are a number of (approximately) parallel and coplanar LORs. They have to be stored in anticlockwise (looking along z-axis) order. The bins are assumed to lie on an arc of a circle, unless arc correction is performed.

New parsing rule

When the last character in the line is a backslash '\', the parser should append the next line to the current (after discarding the backslash). This new rule is introduced to because the lists of numbers can be quite long.

Vectored keys

This section intends to clarify the use of vectored keys. Here is an extract from the 3.3 document:
>   a new form for a key is suggested
>   key ([index](..[index]))
>   where the round brackets indicate optionality and the square brackets indicate the presence of an index [...]
>   Possible new rules:
>   A) The innermost loop would be expressed by the rightmost index etc., as in C.
>   B) If the maximum value for any index defaults to 1, it may be omitted.
>   C) An index of [*] would be used as a convention for all images at that level.
>   D) When multiple frames have the same attribute, for example size, that attribute will be inherited for the whole series.
>   E) Indices may be omitted, starting with the innermost index to indicate that the attribute applies to the whole series.

We now give an extract from a dynamic, multi-bed study (2 time frames for both bed positions) as example.

!IMAGE DATA DESCRIPTION :=
!index nesting level := {time frame}
!image duration (sec)[1] := 0
!image duration(sec)[2] := 10
!relative horizontal bed position (mm)[*] := 10
!image duration (sec)[1] := 30
!image duration(sec)[2] := 30

Notes

<u>To do:</u>
- *Keep log of transformations on image, correspond to mt_1_1 in CTI image subheader*
- *dead time correction info, requires singles per detector (or bucket) for a scan, and 'a and b' factors from normalisation*
- *filter keywords for reconstructed images are not detailed enough*
- *For sinograms, we need to allow for different types of scanners which wouldn't give data in rings.*
- *Description of Coincidence Listmode format.*
- *Formalise the way that the 'matrix size' keywords can accept lists*
- *Better specify the vectored key convention*
- *What about 'leaves' as proposed in 3.3?*
- *We are working on unifying PET and SPECT support in this new standard, and have some support for CT and MRI as well.*

<u>Questions:</u> *(please send us your opinions)*
- *Version number of this standard ?*

- *quantification units potentially vary for functional images, so should we move this keyword in the list after "IMAGE DATA DESCRIPTION" ?*
- *at the moment, the values of the ' image scaling factor' and 'data offset in bytes' keywords are valid for a whole volume (or 3D sinogram for projection data). Is it desirable to allow for one or more additional indices for e.g. planes?*
- *Is there need to allow for more than 1 tracer injection ?*
- *Interfile 3.3 allows only long float|short float. However,the long/short attribute overlaps with the* `number of bytes per pixel'` *keyword. Should we drop the long/short qualifier?*

Information currently dropped from CTI main header:

patient orientation "decubitus right/left"

Suggestions by Jon Treffert (CTI):
- *include keys for rigid body transformation as used by coregistration programmes*
- *For dead-time correction, include uncorrected singles information as a (comma delimited, potentially multi-line) list as part of the IMAGE DATA DESCRIPTION loop. The mapping of this information to detector topology is presumably vendor/model specific. This would add a lot of bulk to the header, but this can possibly be solved by having a multifile header (as proposed in the 3.3 standard).*
- *instead of having the current '!type of data' key, use a hierarchical key with 3 levels:*
     PET|SPECT
     Planar |Tomographic
     Static|Dynamic|Gated|Multi-bed
  the problem here is incompatibility with the original standard. Also, the 3rd level gives information which can be derived from the 'number of time frames' and similar keys

History of changes to this proposal

first public version (5 Sep 97)

second version (20 October 97)
- *changed notation for vectored indices from [1,2,3] to [1][2][3] to conform with the 3.3 suggestion*
- *changed the way of specifying bed positions and time frames to allow for 'inhomogeneous' cases, for instance*
     bed position 1: 3 frames
     bed position 2: 1 frame
  we now give a 'number of time frames' for every bed position. This should cover the most general situation.
- *included vertical bed positions*
- *changed the time window information (gating) syntax to vectored keys as everything else in the proposal.*
- *added patient height, patient weight, gantry tilt, total number of data sets as new keywords*

version 0.3 (08 May 2001)
- *introduced new parsing rule for continuation of the line*
- *for projection data, changed the conventions for the 'matrix axis label' keywords. Bin/z/angle has been changed to tangential position/axial position/view.*
- *In the examples, reversed the order of numbering in the vectored key indices for the 'maxtrix*' keywords to conform with standard practices: the fastest running index should have level [1].*
- *Introduced new keyword 'number of isotopes' and made the isotope keywords vectored. (suggested by Jon Treffert (CTI))*
- *Split the 'isotope half-life' into 2 keywords: ' isotope beta halflife' and ' isotope gamma halflife'*
- *Changed ' gantry tilt angle (deg)' keyword to ' gantry tilt angle (degrees)'*
- *Added 'gantry rotation angle (degrees)' keyword*
- *Added 'number of detectors per ring' keyword*
- *Changed 'bin size (in cm)' keyword to 'bin size (cm)' to conform to conventions used in other keywords*
- *Dropped the 'bin size (in degrees)' and 'angular compression' keywords. Only useful for (non-arccorrected) cylindrical PET data, in which case it can be inferred from the 'number of detectors per ring' keyword.*
- *Changed 'angle offset (degrees)' keyword to 'view offset (degrees)'*
- *For a sinogram, dropped the explicit list of 'number of segments', 'number of angles, etc. and forced the convention on 'matrix axis label'.*
- *Dropped 'axial compression' keyword and introduced new keywords 'minimum ring difference per 'maximum ring difference per segment'*

- *Fixed the order in which the values of the 'index nesting level' keyword are allowed. This is done to simplify parsing.*
- *Changed 'bed translation' keyword to 'horizontal bed translation'*
- *Dropped 'number of bed positions' and the corresponding index in the '!IMAGE DATA DESCRIPTION' section. In effect, the 'bed positions' are now merged with the 'time frames'.*