



Custom input file format class for reading arbitrary crystal positions into STIR

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Motivation

- SAFIR project: develop new preclinical PET detector
- Simulate different geometries for performance evaluation
 - Spatial resolution, phantoms, NECR, etc.
- Need generic way of reading simulated data into STIR
- Idea (K. Thielemans): Give LOR as two points to STIR to be sorted into cylindrical scanner projection data template

Implementation

- Need several classes
 - CListModeDataSAFIR:
 - class for reading SAFIR-style list-mode data
 - CListRecordSAFIR:
 - class to provide a coincidence list-mode record format
 - layer foreseen but not tested
 - type labels time or event record
 - InputFileFormatSAFIR:
 - reader to read CListRecordSAFIR from binary file
 - ListEventRecordMapFromFile:
 - generate mapping detector indices to coordinates from file
 - `stir::DetectionPosition<>` to `stir::CartesianCoordinate3D<float>`
 - Doxygen information in source files

```
#if STIRIsNativeByteOrderBigEndian
    unsigned type : 1;
    unsigned reserved : 15;
    unsigned long time : 48;
#else
    unsigned long time : 48;
    unsigned reserved : 15;
    unsigned type : 1;
#endif
```

```
#if STIRIsNativeByteOrderBigEndian
    unsigned type : 1;
    unsigned isRandom : 1;
    unsigned reserved : 6;
    unsigned layerB : 4;
    unsigned layerA : 4;
    unsigned detB : 16;
    unsigned detA : 16;
    unsigned ringB : 8;
    unsigned ringA : 8;
#else
    unsigned ringA : 8;
    unsigned ringB : 8;
    unsigned detA : 16;
    unsigned detB : 16;
    unsigned layerA : 4;
    unsigned layerB : 4;
    unsigned reserved : 6;
    unsigned isRandom : 1;
    unsigned type : 1;
#endif
```

Usage

Installation and preparation

- Available as add-on to STIR from <http://doi.org/10.5905/ethz-1007-22>
- Put in STIR_LOCAL directory, instructions included (“INSTALL”)
- Read data from binary file
 - 32 bytes header, signature: "SAFIR CListModeData\0"
 - 8 byte records, format on previous slide
- Crystal map file
 - text file, separator: tab or comma
 - 5 columns: ring, detector, x, y, z
 - 6 columns: ring, detector, layer, x, y, z
 - lines interpreted as commented if first character is ‘#’

```
# This is an example of a crystal map (no layer index)
#ring  detector    x    y    z
0  0  63.019  0.000  -99.000
0  1  62.981  2.199  -99.000
0  2  62.865  4.396  -99.000
0  3  62.674  6.587  -99.000
0  4  62.406  8.771  -99.000
0  5  62.062 10.943  -99.000
0  6  61.642 13.102  -99.000
0  7  61.147 15.246  -99.000
0  8  60.578 17.370  -99.000
```

Usage

Reading data

- Create appropriate proj_data_template, best resembling your scanner
- Create parameter file
- Use this as input filename for Im_to_projdata
 - this will create Interfile projection data file
- Example provided in archive
- Use any STIR reconstruction from here on to get an image

```
CListModeDataSAFIR Parameters:=  
  listmode data filename:= point_5.clm.safir  
  crystal map filename:= crystal_map_front.txt  
  template projection data filename:= safir_20.hs  
END CListModeDataSAFIR Parameters:=
```

Usage

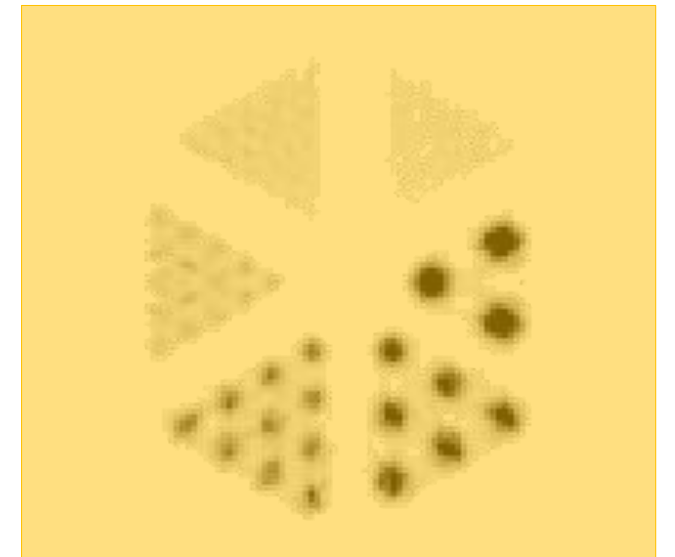
The full chain

- Simulation output (ASCII)
 - 500M decay events, 61 GB
- Coincidence sorter (long)
- CListRecordSAFIR (binary)
 - 183 MB
- Im_to_projdata (~20 s)
- Sinograms
 - 512 MB
- Reconstruction
- Image
 - 23 MB

| MC ID | ring | detector | energy | time information |
|-----------|-------|----------|------------|----------------------------------|
| 429753083 | 10071 | 55 171 | 321.230 80 | 0.000 138.3 142.8 263.2 194.0 |
| 429753083 | 10072 | 55 172 | 189.768 50 | 13.077 168.2 1466.1 2262.8 194.0 |
| 359805858 | 10669 | 59 49 | 255.251 79 | 7.788 81.8 796.4 2125.6 206.1 |
| 359805858 | 10670 | 59 50 | 255.748 65 | 0.000 81.9 1350.2 1507.8 206.1 |
| 359805858 | 4286 | 23 146 | 0.415 0 | 108.111 -1.0 -1.0 -1.0 206.1 |

```

00000000 53 41 46 49 52 20 43 4c 69 73 74 4d 6f 64 65 44 |SAFIR CListModeD|
00000010 61 74 61 00 00 00 00 00 00 00 00 00 00 00 00 |ata.....|
00000020 00 00 00 00 00 00 00 80 37 26 84 00 1e 00 00 00 |.....7&.....|
00000030 1c 41 89 00 23 00 00 00 3e 1f 9b 00 73 00 00 40 |.A..#...>...s..@|
00000040 15 54 ac 00 52 00 00 00 21 40 6b 00 17 00 00 00 |.T..R...!@k.....|
00000050 12 48 8a 00 2a 00 00 00 2c 2e ad 00 43 00 00 00 |T * C
  
```



Outlook

- List-mode reconstruction
- Raytracing using actual coordinates
- To be fixed: ban use of `const_cast` in `InputFileFormatSAFIR` (see discussion on `stir-devel`)
- <http://doi.org/10.5905/ethz-1007-22>