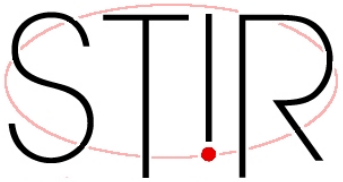


STIR

Software for Tomographic Image Reconstruction

http://stir.sourceforge.net

Kris Thielemans
Charalampos Tsoumpas
Nikos Efthimiou

ASC

UCL

Future contributions

- TOF
  Nikos Efthimiou, Elise Emond et al.
- SPECT developments
  Ben Thomas in collaboration with UK National Physics Laboratory
- Additional support for Siemens mMR
- Support for GE PET-MR
  Palak Wadwha et al.
- Block detector geometry
  Parisa Khateri et al.
- Hybrid Kernel EM
  Daniel Deidda et al.

STIR

Other developments

- STIR on github
  https://github.com/UCL/STIR
  https://github.com/UCL/STIR-exercises

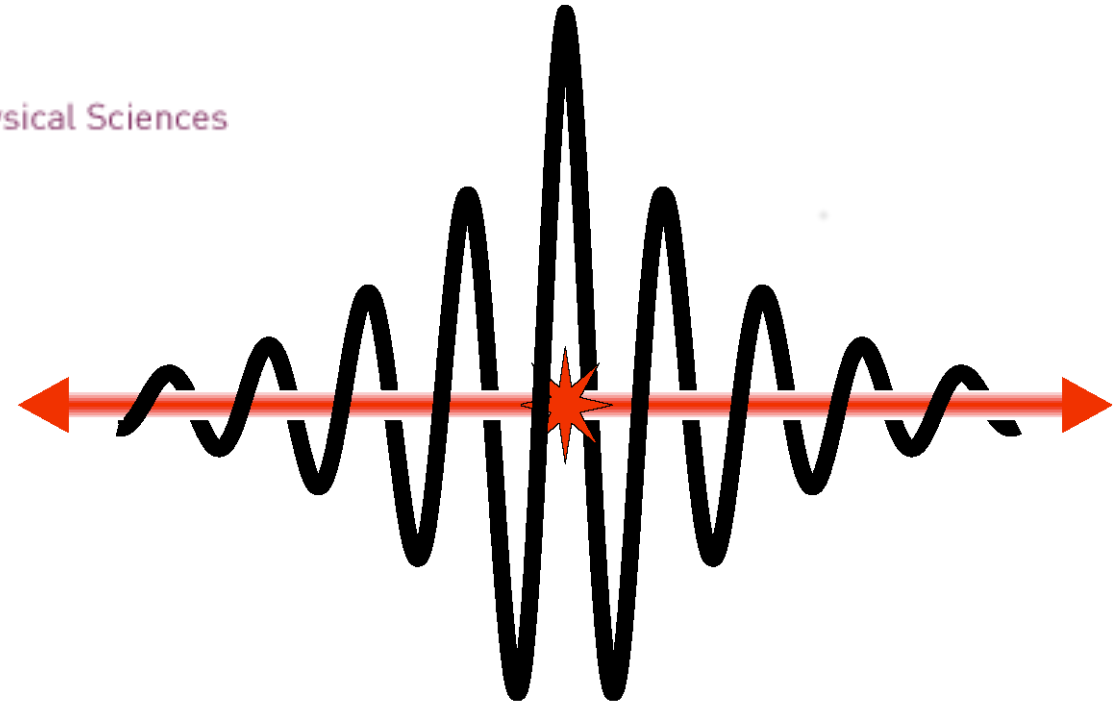
- Virtual Machine with STIR pre-installed
  Ubuntu, STIR+Python (via CCP PETMR)

- STIR on Azure
  https://github.com/UCL/terraform-azure-stir
  Ben Thomas

- CCP PETMR & SIRF progress

EPSRC

Engineering and Physical Sciences Research Council



Synergistic PET-MR Reconstruction

STIR

CCP in Synergistic PET-MR Reconstruction

- **5 year** funding (April 2015 – March 2020)

- Budget for networking activities

  £140K (RC contribution)

- Budget for management (PI, CoIs)

  £110K (RC contribution)

- Core support
  - Scientific programmers: **1 FTE** (for 5 years)
  - Administration: **0.25 FTE** (for 5 years)

STIR

Aims

- Network formation: bringing together expertise in each modality
  - advancing understanding of PET-MR
  - enhancing understanding of the algorithms used for each modality

- Developing software infrastructure
  - creating an Open Source software platform for integrated PET-MR image reconstruction
  - standardisation of data formats
  - database with test cases

STIR

Software

- ***Framework*** for 3D and 4D reconstruction of PET-MR data
- ***Simple enough*** for education and teaching
- ***Powerful enough*** for processing of real data in a research context
- ***Open Source***
- ***Easy installation***
  (e.g. installation script, precompiled, virtual machine, Docker)

STIR

Architecture overview

POSSUM

Standard file format for (almost) 'raw' data (PET and MR)

Framework

- PET package 1
- PET package 2
- Optimisation Code 1
- MR package 1
- MR package 2

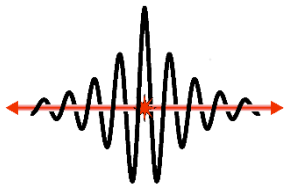
Images (DICOM, Nifti,…)

File format translators supplied by/developed with manufacturers

Software distribution

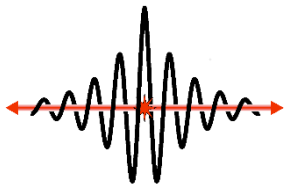
- https://github.com/CCPPETMR
  - All source code (Apache 2.0 license)
  - Installation instructions

- Virtual Machine (VirtualBox)
  http://www.ccppetmr.ac.uk/downloads
  - Preinstalled STIR, Gadgetron
  - Preinstalled CCP-PETMR software for Python
  - Easy update mechanism
    (choice between stable and experimental)



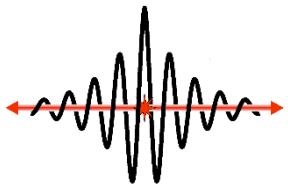
PET functionality

- OSMAPOSL reconstruction
- OSSPS reconstruction
- OSL reconstruction with PLS prior *– new in 1.1.0*
- FBP2D reconstruction *– new in 1.1.0*
- Acquisition model accounts for
  - bin efficiencies
  - attenuation
  - randoms
- Listmode-to-sinograms conversion *(single frame only)*



MR functionality

- Fully sampled reconstruction
- Undersampled reconstruction wth GRAPPA
- Simple way to create Gadgeron gadget chains from script
- Multi-chain reconstruction with user-implemented processing of intermediate data
- Coil sensitivities estimation
- Access to all acquisition and image data parameters (slice, repetition etc.)



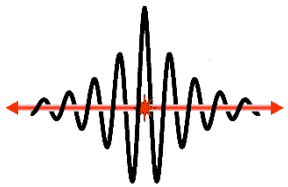
Common functionality

- Objective Function and Acquisition Model objects and acquisition/image data algebra allow the user to design own/use 3rd party optimization algorithms
  - PET:

```
grad = obj_fun.get_subset_gradient(image, subset)
fun = lambda x: -obj_fun.value(image + x*grad)
x = scipy.optimize.fminbound(fun)
```

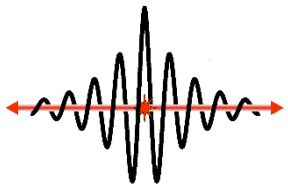
  - MR:

```
simulated_data = acq_model.forward(reconstructed_image)
grad = acq_model.backward(simulated_data – acquired_data)
w = acq_model.forward(grad)
refined_image = reconstructed_image – grad * (grad*grad)/(w*w)
```



SIRF coming soon

- Image registration and motion correction
  - Uses NiftyReg
  - See Richard Brown's presentation
  - https://github.com/CCPPETMR/SIRF/pull/211
- 5D PET/MR simulation
  - Johannes Mayer (PTB)



Main publication:

Thielemans, Tsoumpas, *et al* (2012) STIR: Software for Tomographic Image Reconstruction Release 2, *Physics in Medicine and Biology*, 57(4):867-83.

Thanks

- File formats
  - GE Healthcare
  - Siemens Healthineers
- Sponsoring:
  - CCP PET-MR
  - IEEE