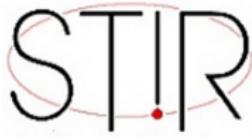


STIR in MATLAB

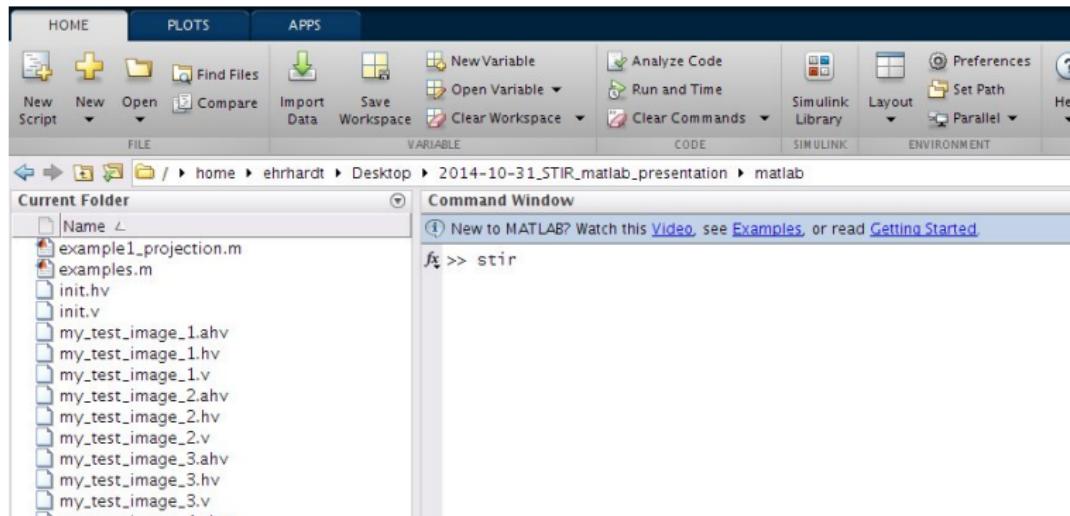
More tools for Emission Tomography

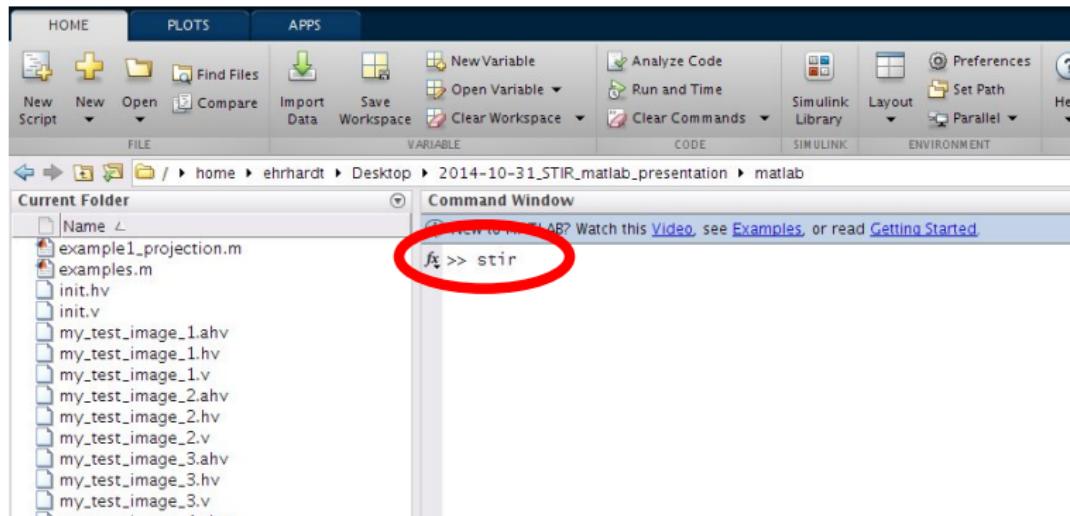
Matthias J. Ehrhardt, Kris Thielemans
University College London, UK

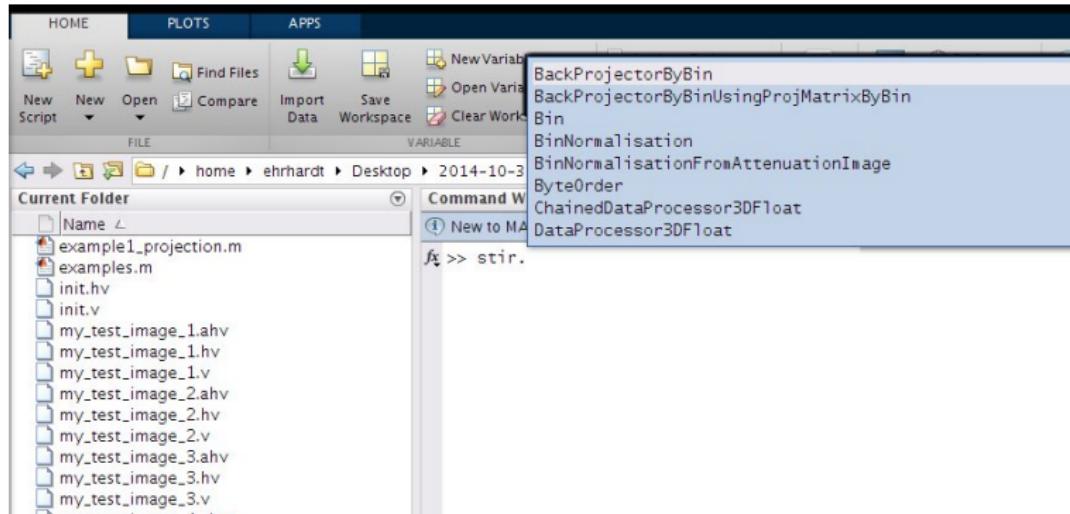


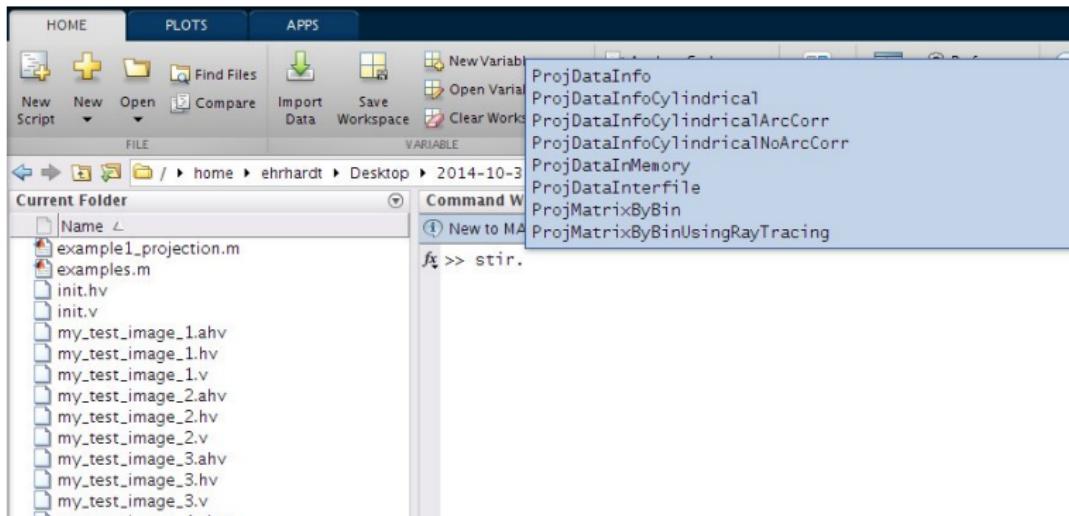
- ▶ interface to combine STIR with MATLAB
- ▶ allows easy prototyping
- ▶ MATLAB tools can be used for emission tomography (visualization etc)
- ▶ other software can be easily combined with STIR (research software often only available in MATLAB)

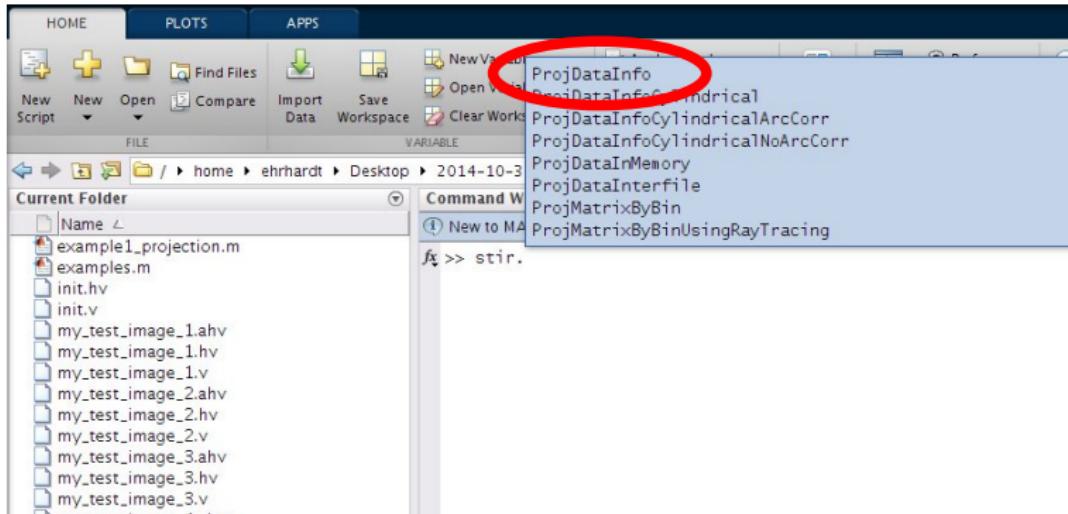
- ▶ automatically generates a MATLAB interface from C/C++ code
- ▶ swig can do many more languages (Python etc)
- ▶ interface will be (almost) the same in Python etc

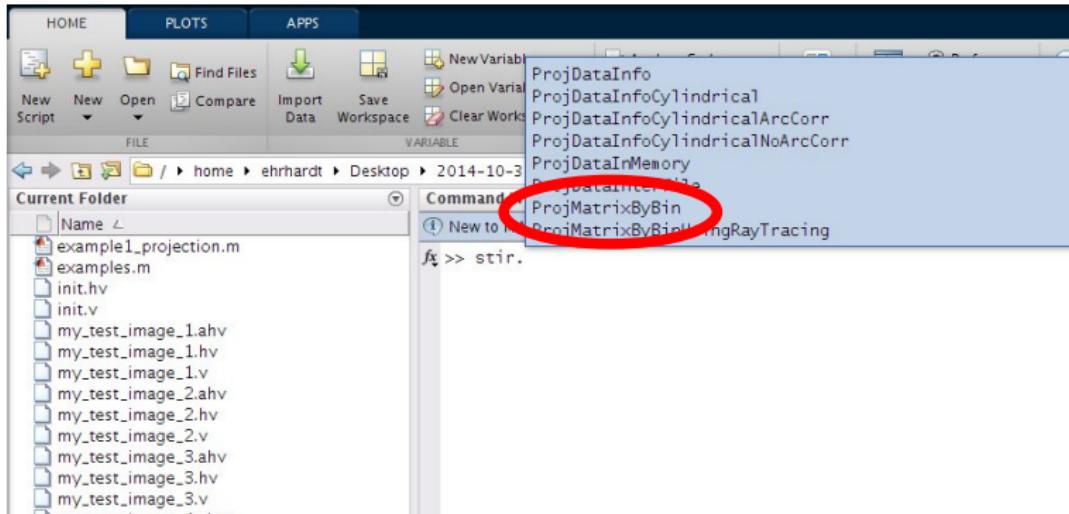


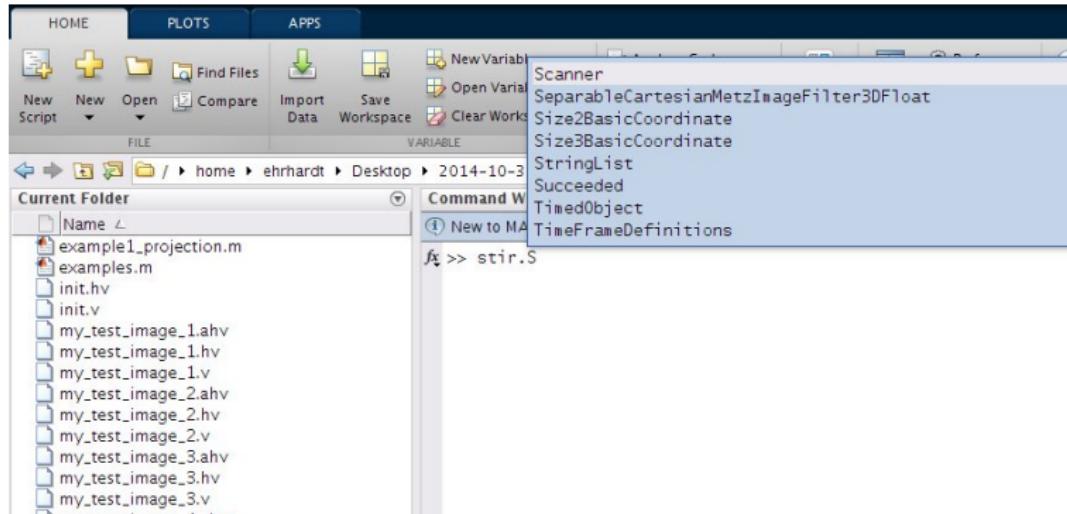


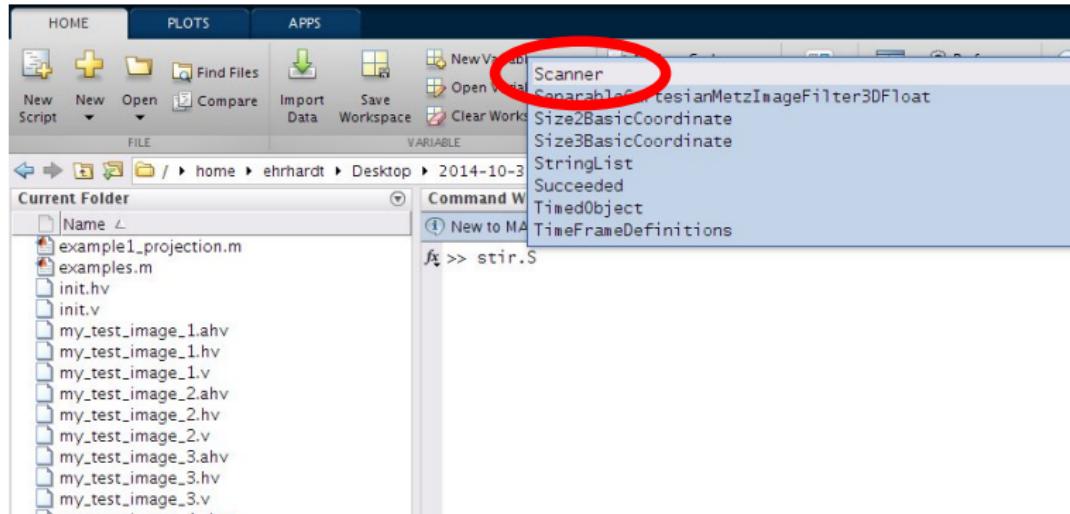






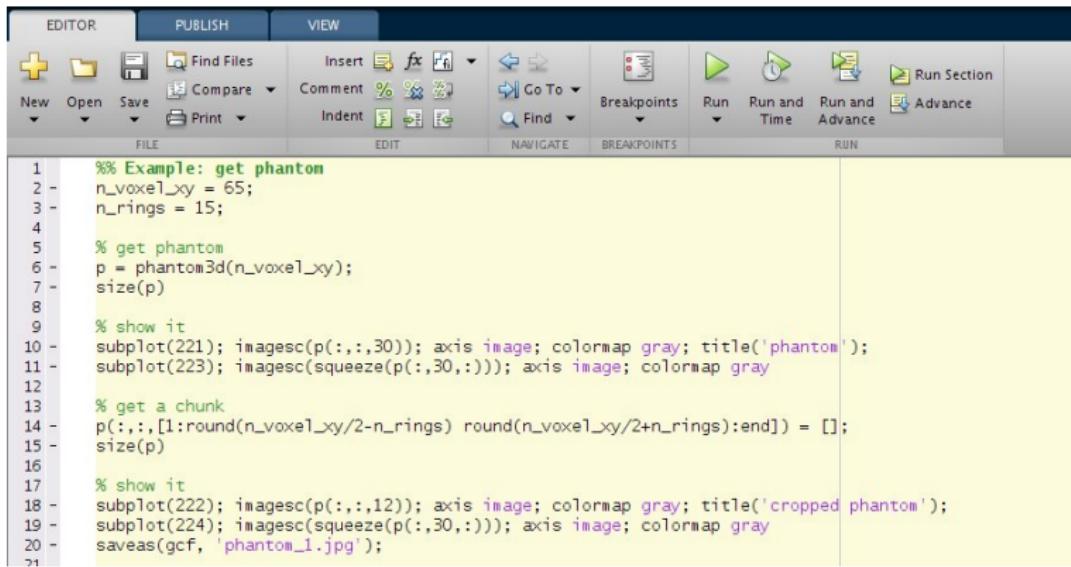






Example: Projection

Step 1: Get a phantom



The screenshot shows the MATLAB interface with the code for generating a phantom image. The code uses the phantom3d function to create a phantom image and then crops it to a smaller size.

```
% Example: get phantom
n_voxel_xy = 65;
n_rings = 15;

% get phantom
p = phantom3d(n_voxel_xy);
size(p)

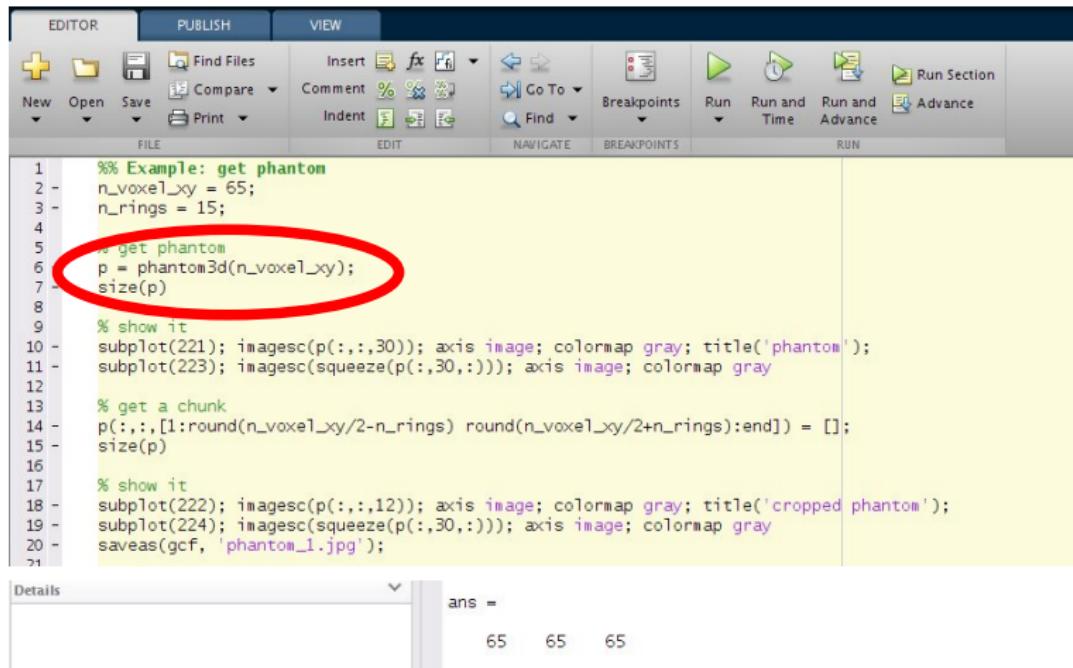
% show it
subplot(221); imagesc(p(:,:,30)); axis image; colormap gray; title('phantom');
subplot(223); imagesc(squeeze(p(:,30,:))); axis image; colormap gray

% get a chunk
p(:,:,1:round(n_voxel_xy/2-n_rings):round(n_voxel_xy/2+n_rings):end) = [];
size(p)

% show it
subplot(222); imagesc(p(:,:,12)); axis image; colormap gray; title('cropped phantom');
subplot(224); imagesc(squeeze(p(:,30,:))); axis image; colormap gray
saveas(gcf, 'phantom_1.jpg');
```

Example: Projection

Step 1: Get a phantom



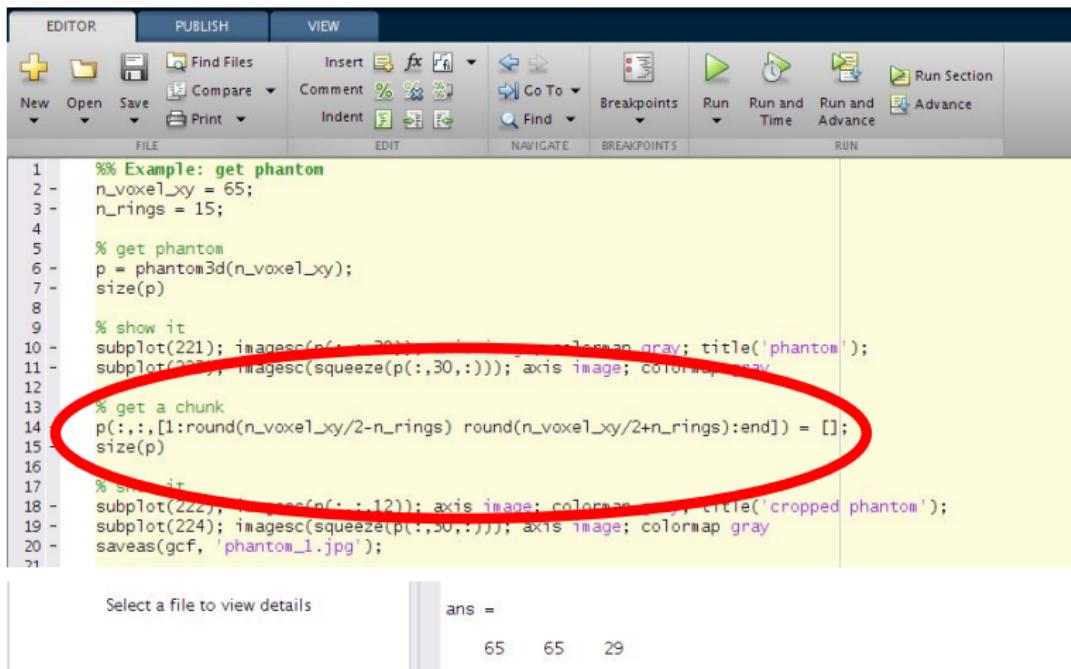
The screenshot shows the MATLAB IDE interface. The menu bar includes EDITOR, PUBLISH, and VIEW. The toolbar contains icons for New, Open, Save, Print, Find Files, Compare, Insert, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section. The code editor window displays the following MATLAB script:

```
1 % Example: get phantom
2 - n_voxel_xy = 65;
3 - n_rings = 15;
4
5 % get phantom
6 p = phantom3d(n_voxel_xy);
7 size(p)
8
9 % show it
10 subplot(221); imagesc(p(:,:,30)); axis image; colormap gray; title('phantom');
11 subplot(223); imagesc(squeeze(p(:,30,:))); axis image; colormap gray
12
13 % get a chunk
14 p(:,:,1:round(n_voxel_xy/2-n_rings):round(n_voxel_xy/2+n_rings):end) = [];
15 size(p)
16
17 % show it
18 subplot(222); imagesc(p(:,:,12)); axis image; colormap gray; title('cropped phantom');
19 subplot(224); imagesc(squeeze(p(:,30,:))); axis image; colormap gray
20 saveas(gcf, 'phantom_1.jpg');
21
```

A red circle highlights the line of code `p = phantom3d(n_voxel_xy);`. In the 'Details' pane at the bottom, the variable `ans` is shown with the value `65 65 65`.

Example: Projection

Step 1: Get a phantom



The screenshot shows the MATLAB IDE interface with the following details:

- EDITOR Tab:** Active tab.
- PUBLISH Tab:** Available tab.
- VIEW Tab:** Available tab.
- FILE Menu:** Contains New, Open, Save, Find Files, Compare, Print, Insert, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, Run Section, and Advance.
- EDIT Menu:** Contains Find, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Advance.
- NAVIGATE Menu:** Contains Find, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Advance.
- BREAKPOINTS Menu:** Contains Run, Run and Time, Run and Advance, and Advance.
- RUN Button:** Large green play button.

The code in the editor is:

```
1 % Example: get phantom
2 n_voxel_xy = 65;
3 n_rings = 15;
4
5 % get phantom
6 p = phantom3d(n_voxel_xy);
7 size(p)
8
9 % show it
10 subplot(221); imagesc(p(:,:,30)); axis image; colormap gray; title('phantom');
11 subplot(222), imagesc(squeeze(p(:,:,30))); axis image; colormap gray;
12
13 % get a chunk
14 p(:,:,1:round(n_voxel_xy/2-n_rings): round(n_voxel_xy/2+n_rings):end) = [];
15 size(p)
16
17 % show it
18 subplot(223), imagesc(p(:,:,12)); axis image; colormap gray; title('cropped phantom');
19 subplot(224); imagesc(squeeze(p(:,:,30,:))); axis image; colormap gray;
20 saveas(gcf, 'phantom_1.jpg');
```

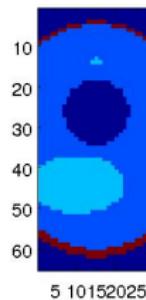
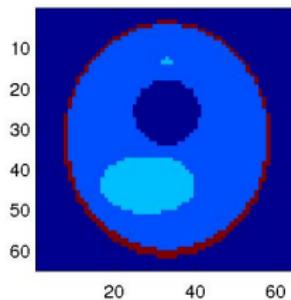
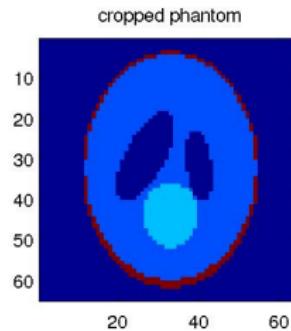
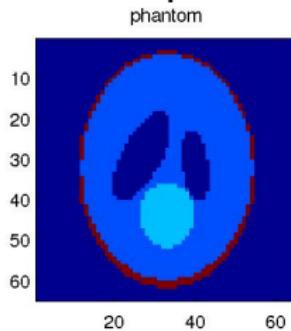
A red oval highlights the line of code: `p(:,:,1:round(n_voxel_xy/2-n_rings): round(n_voxel_xy/2+n_rings):end) = [];`

Below the code editor:

- Left panel: "Select a file to view details".
- Right panel:
 - ans =
 - 65 65 29

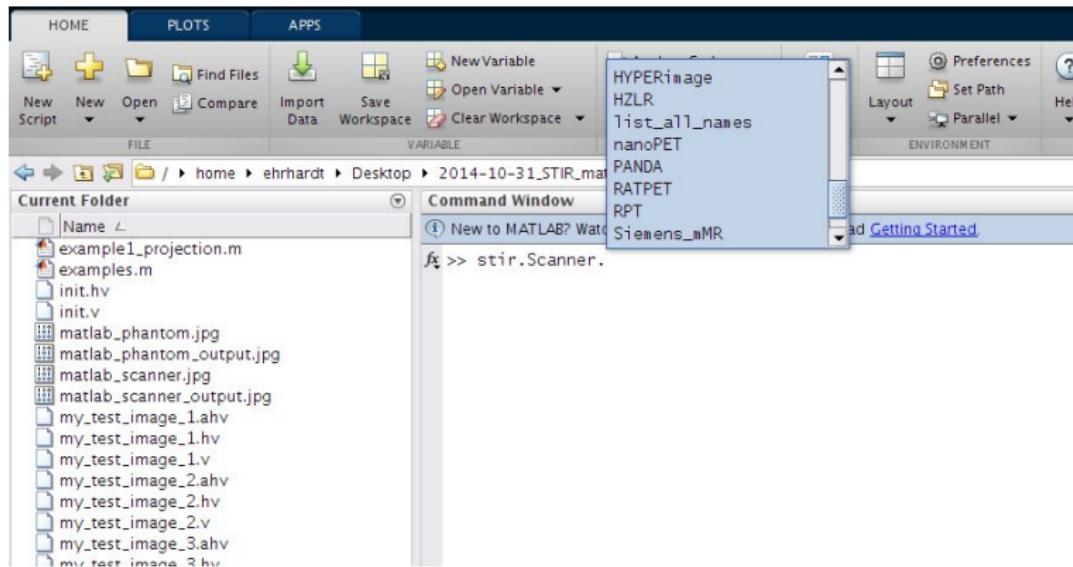
Example: Projection

Step 1: Get a phantom



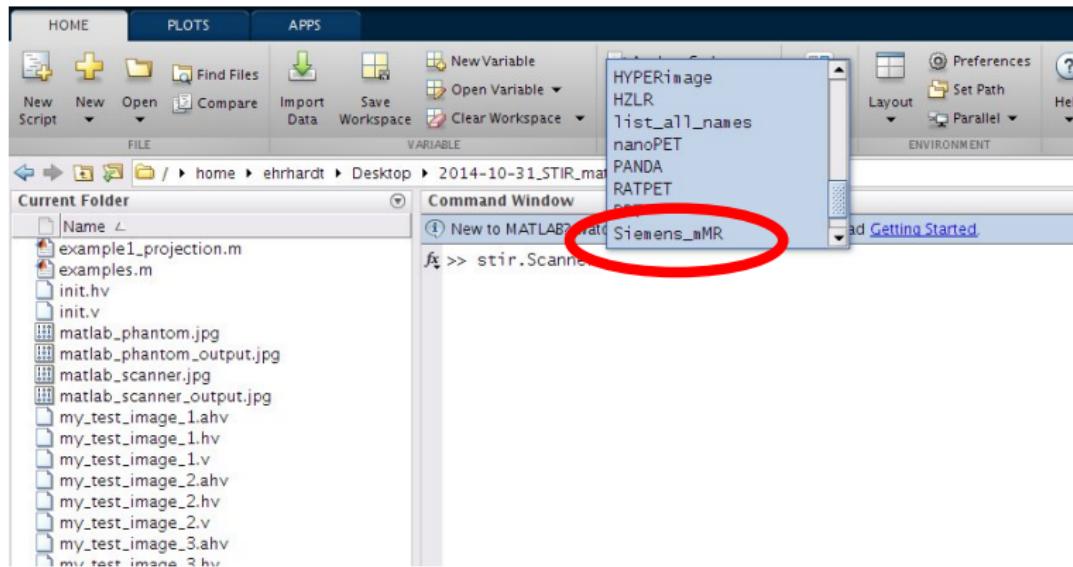
Example: Projection

Step 2: Get a scanner



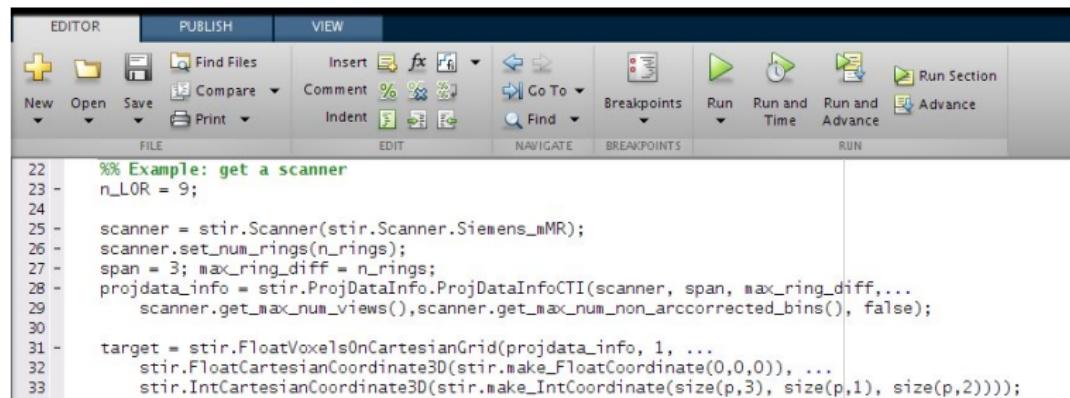
Example: Projection

Step 2: Get a scanner



Example: Projection

Step 2: Get a scanner

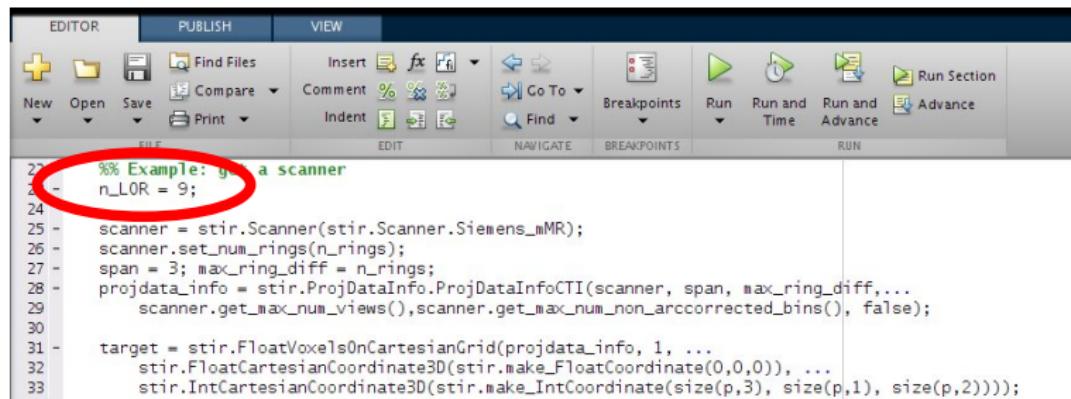


The image shows a screenshot of a MATLAB IDE. The menu bar at the top includes 'EDITOR', 'PUBLISH', and 'VIEW'. Below the menu bar is a toolbar with various icons for file operations like 'New', 'Open', 'Save', 'Print', and editing functions like 'Comment', 'Indent', 'Go To', 'Breakpoints', and 'Run'.

```
22 % Example: get a scanner
23 n_LOR = 9;
24
25 scanner = stir.Scanner(stir.Scanner.Siemens_MR);
26 scanner.set_num_rings(n_rings);
27 span = 3; max_ring_diff = n_rings;
28 projdata_info = stir.ProjDataInfo.ProjDataInfoCTI(scanner, span, max_ring_diff, ...
29     scanner.get_max_num_views(), scanner.get_max_num_non_arccorrected_bins(), false);
30
31 target = stir.FloatVoxelsOnCartesianGrid(projdata_info, 1, ...
32     stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(0,0,0)), ...
33     stir.IntCartesianCoordinate3D(stir.make_IntCoordinate(size(p,3), size(p,1), size(p,2))));
```

Example: Projection

Step 2: Get a scanner



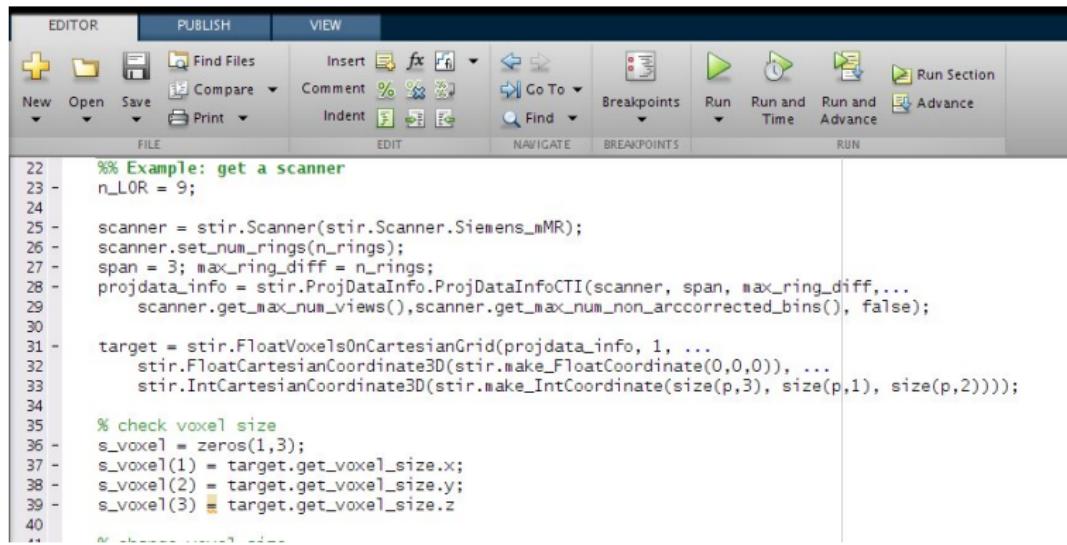
A screenshot of the MATLAB IDE interface. The menu bar includes 'EDITOR', 'PUBLISH', and 'VIEW'. The toolbar contains icons for New, Open, Save, Print, Find Files, Compare, Insert, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section. The code editor window shows the following MATLAB script:

```
%% Example: get a scanner
n_LOR = 9;
scanner = stir.Scanner(stir.Scanner.Siemens_MR);
scanner.set_num_rings(n_rings);
span = 3; max_ring_diff = n_rings;
projdata_info = stir.ProjDataInfo.CTI(scanner, span, max_ring_diff, ...
    scanner.get_max_num_views(), scanner.get_max_num_non_arccorrected_bins(), false);
target = stir.FloatVoxelsOnCartesianGrid(projdata_info, 1, ...
    stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(0,0,0)), ...
    stir.IntCartesianCoordinate3D(stir.make_IntCoordinate(size(p,3), size(p,1), size(p,2))));
```

The first line of code, '% Example: get a scanner', is highlighted with a red oval.

Example: Projection

Step 2: Get a scanner

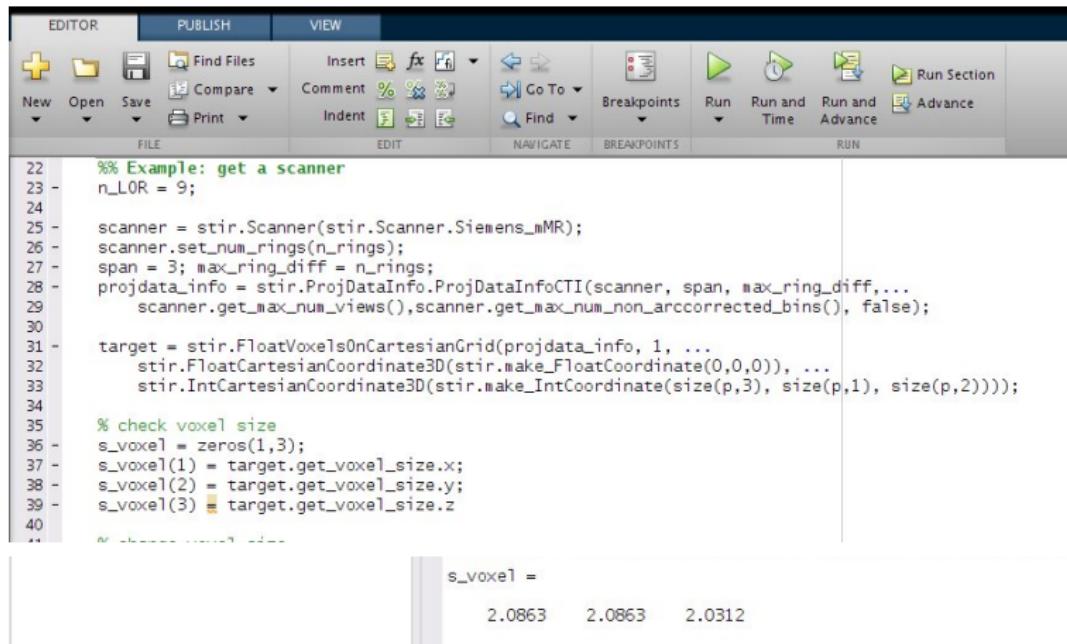


The screenshot shows the MATLAB IDE interface with the 'EDITOR' tab selected. The menu bar includes 'EDITOR', 'PUBLISH', and 'VIEW'. The toolbar contains icons for New, Open, Save, Find Files, Insert, Comment, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section. The code editor displays the following MATLAB script:

```
22 % Example: get a scanner
23 n_LOR = 9;
24
25 scanner = stir.Scanner(stir.Scanner.Siemens_MR);
26 scanner.set_num_rings(n_rings);
27 span = 3; max_ring_diff = n_rings;
28 projdata_info = stir.ProjDataInfo.ProjDataInfoCTI(scanner, span, max_ring_diff, ...
29     scanner.get_max_num_views(), scanner.get_max_num_non_arccorrected_bins(), false);
30
31 target = stir.FloatVoxelsOnCartesianGrid(projdata_info, 1, ...
32     stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(0,0,0)), ...
33     stir.IntCartesianCoordinate3D(stir.make_IntCoordinate(size(p,3), size(p,1), size(p,2))));
34
35 % check voxel size
36 s_voxel = zeros(1,3);
37 s_voxel(1) = target.get_voxel_size.x;
38 s_voxel(2) = target.get_voxel_size.y;
39 s_voxel(3) = target.get_voxel_size.z
40
% change current slice
```

Example: Projection

Step 2: Get a scanner

A screenshot of the MATLAB interface showing a code editor window. The menu bar includes 'EDITOR', 'PUBLISH', and 'VIEW'. The toolbar contains icons for New, Open, Save, Print, Find Files, Compare, Insert, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section. The code editor displays a script with the following content:

```
22 % Example: get a scanner
23 n_LOR = 9;
24
25 scanner = stir.Scanner(stir.Scanner.Siemens_MMRT);
26 scanner.set_num_rings(n_rings);
27 span = 3; max_ring_diff = n_rings;
28 projdata_info = stir.ProjDataInfo.ProjDataInfoCTI(scanner, span, max_ring_diff, ...
29     scanner.get_max_num_views(), scanner.get_max_num_non_arccorrected_bins(), false);
30
31 target = stir.FloatVoxelsOnCartesianGrid(projdata_info, 1, ...
32     stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(0,0,0)), ...
33     stir.IntCartesianCoordinate3D(stir.make_IntCoordinate(size(p,3), size(p,1), size(p,2))));
34
35 % check voxel size
36 s_voxel = zeros(1,3);
37 s_voxel(1) = target.get_voxel_size.x;
38 s_voxel(2) = target.get_voxel_size.y;
39 s_voxel(3) = target.get_voxel_size.z
40
% change to 1000
s_voxel =
```

The output window below the editor shows the resulting vector:

```
2.0863    2.0863    2.0312
```

Example: Projection

Step 2: Get a scanner

```
25 - scanner = stir.Scanner(stir.Scanner.Siemens_MR);
26 - scanner.set_num_rings(n_rings);
27 - span = 3; max_ring_diff = n_rings;
28 - projdata_info = stir.ProjDataInfo.ProjDataInfoCTI(scanner, span, max_ring_diff, ...
29 -     scanner.get_max_num_views(),scanner.get_max_num_non_arccorrected_bins(), false);
30
31 - target = stir.FloatVoxelsOnCartesianGrid(projdata_info, 1, ...
32 -     stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(0,0,0)), ...
33 -     stir.IntCartesianCoordinate3D(stir.make_IntCoordinate(size(p,3), size(p,1), size(p,2)))); 
34
35 % check voxel size
36 - s_voxel = zeros(1,3);
37 - s_voxel(1) = target.get_voxel_size.x;
38 - s_voxel(2) = target.get_voxel_size.y;
39 - s_voxel(3) = target.get_voxel_size.z
40
41 % change voxel size
42 - s_voxel(1) = 4*s_voxel(3);
43 - s_voxel(2) = 4*s_voxel(3)
44
45 - target.set_voxel_size(stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(...
46 -     s_voxel(3),s_voxel(1),s_voxel(2))));
47
48 - dummy = zeros(1,3);
49 - dummy(1) = target.get_voxel_size.x;
50 - dummy(2) = target.get_voxel_size.y;
51 - dummy(3) = target.get_voxel_size.z
```

Example: Projection

Step 2: Get a scanner

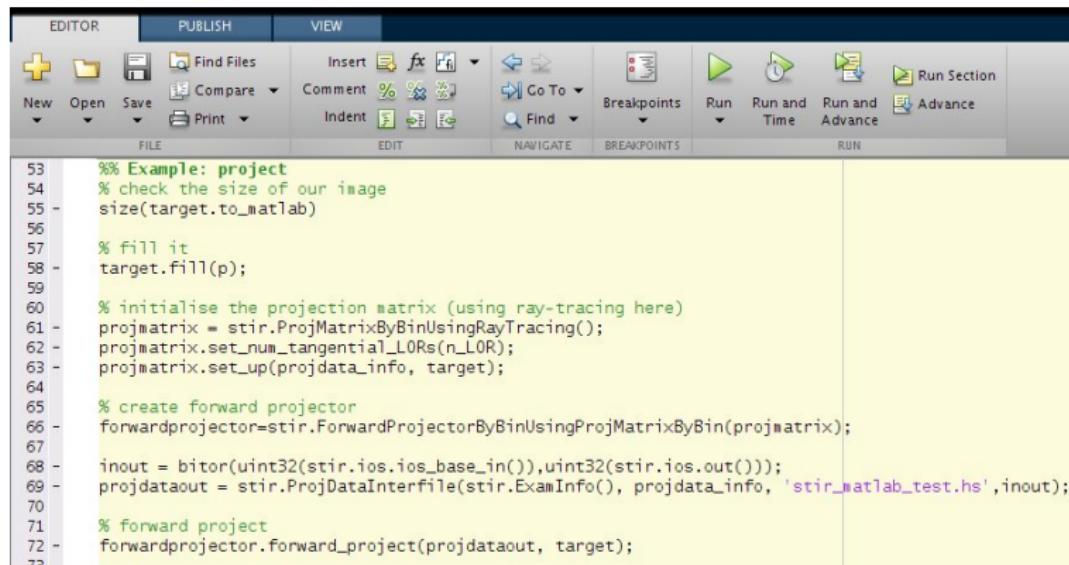
```
25 - scanner = stir.Scanner(stir.Scanner.Siemens_MR);
26 - scanner.set_num_rings(n_rings);
27 - span = 3; max_ring_diff = n_rings;
28 - projdata_info = stir.ProjDataInfo.ProjDataInfoCTI(scanner, span, max_ring_diff, ...
29 -     scanner.get_max_num_views(),scanner.get_max_num_non_arccorrected_bins(), false);
30
31 - target = stir.FloatVoxelsOnCartesianGrid(projdata_info, 1, ...
32 -     stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(0,0,0)), ...
33 -     stir.IntCartesianCoordinate3D(stir.make_IntCoordinate(size(p,3), size(p,1), size(p,2)))); 
34
35 % check voxel size
36 - s_voxel = zeros(1,3);
37 - s_voxel(1) = target.get_voxel_size.x;
38 - s_voxel(2) = target.get_voxel_size.y;
39 - s_voxel(3) = target.get_voxel_size.z
40
41 % change voxel size
42 - s_voxel(1) = 4*s_voxel(3);
43 - s_voxel(2) = 4*s_voxel(3)
44
45 - target.set_voxel_size(stir.FloatCartesianCoordinate3D(stir.make_FloatCoordinate(...
46 -     s_voxel(3),s_voxel(1),s_voxel(2))));
47
48 - dummy = zeros(1,3);
49 - dummy(1) = target.get_voxel_size.x;
50 - dummy(2) = target.get_voxel_size.y;
51 - dummy(3) = target.get_voxel_size.z
```

Details ▾

dummy =	
	8.1250 8.1250 2.0312

Example: Projection

Step 3: Project



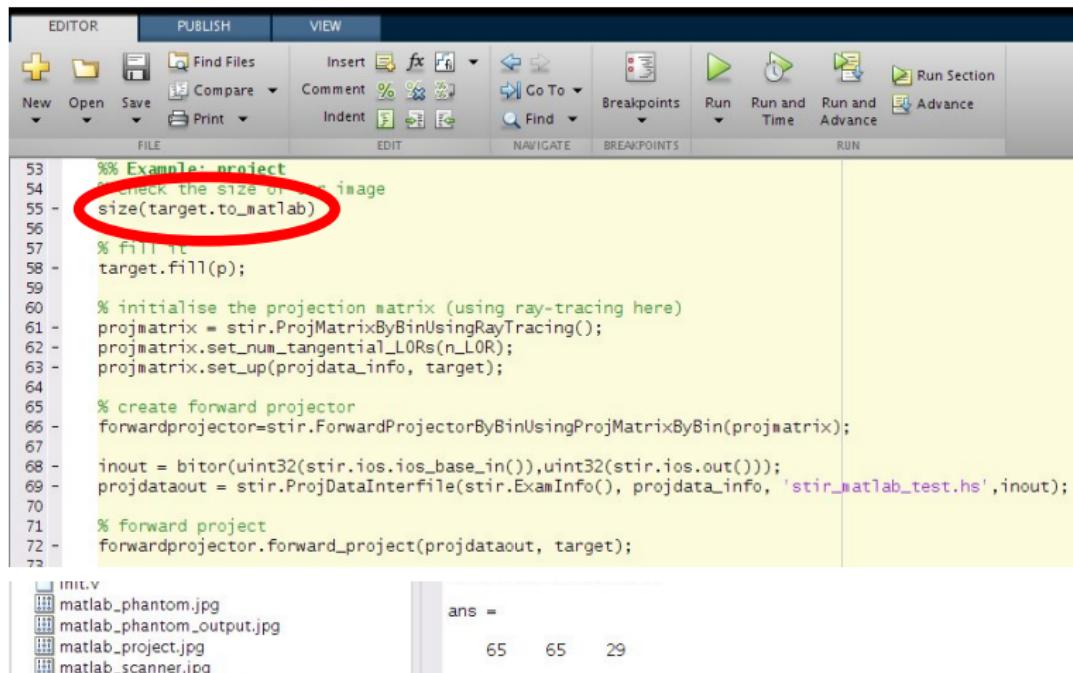
The screenshot shows the MATLAB IDE interface with the following details:

- Toolbar:** Includes buttons for New, Open, Save, Print, Find Files, Compare, Comment, Insert, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section.
- Code Area:** Displays MATLAB code for initializing a projection matrix and performing forward projection. The code uses the STIR library.

```
53 %% Example: project
54 % check the size of our image
55 - size(target.to_matlab)
56
57 % fill it
58 - target.fill(p);
59
60 % initialise the projection matrix (using ray-tracing here)
61 - projmatrix = stir.ProjMatrixByBinUsingRayTracing();
62 - projmatrix.set_num_tangential_LORs(n_LOR);
63 - projmatrix.set_up(projdata_info, target);
64
65 % create forward projector
66 - forwardprojector=stir.ForwardProjectorByBinUsingProjMatrixByBin(projmatrix);
67
68 - inout = bitor(uint32(stir.ios.ios_base_in()),uint32(stir.ios.out()));
69 - projdataout = stir.ProjDataInterfile(stir.ExamInfo(), projdata_info, 'stir_matlab_test.hs',inout);
70
71 % forward project
72 - forwardprojector.forward_project(projdataout, target);
73
```

Example: Projection

Step 3: Project



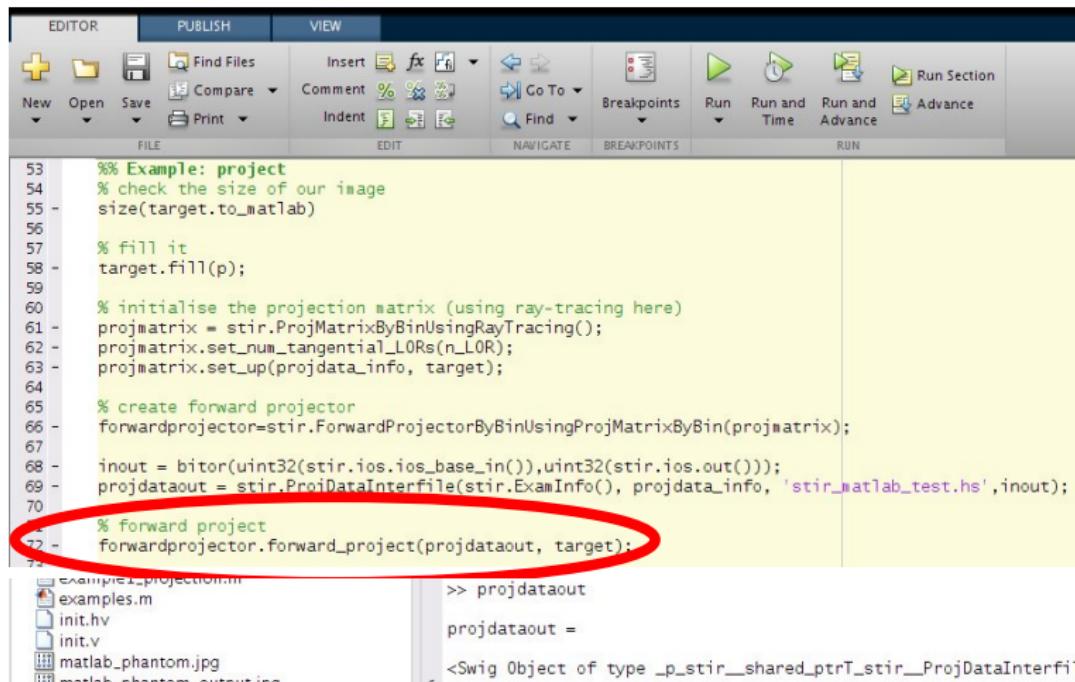
The screenshot shows the MATLAB IDE interface with the following details:

- Toolbar:** Includes buttons for New, Open, Save, Print, Find Files, Comment, Insert, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section.
- Code Editor:** Displays a script named `stir_exam.m` containing MATLAB code. A red circle highlights the line `size(target.to_matlab)`.

```
% Example: project
% check the size of the image
size(target.to_matlab)
% fill it
target.fill(p);
% initialise the projection matrix (using ray-tracing here)
projmatrix = stir.ProjMatrixByBinUsingRayTracing();
projmatrix.set_num_tangential_LORs(n_LOR);
projmatrix.set_up(projdata_info, target);
% create forward projector
forwardprojector=stir.ForwardProjectorByBinUsingProjMatrixByBin(projmatrix);
inout = bitor(uint32(stir.ios.ios_base_in()),uint32(stir.ios.out()));
projdataout = stir.ProjDataInterfile(stir.ExamInfo(), projdata_info, 'stir_matlab_test.h5',inout);
% forward project
forwardprojector.forward_project(projdataout, target);
```
- Current Folder Browser:** Shows files: INIT.v, matlab_phantom.jpg, matlab_phantom_output.jpg, matlab_project.jpg, and matlab_scanner.ipd.
- Command Window:** Displays the output: `ans =` followed by the values `65 65 29`.

Example: Projection

Step 3: Project



The screenshot shows the MATLAB IDE interface with the following details:

- Toolbar:** Includes buttons for New, Open, Save, Print, Find Files, Compare, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section.
- Code Editor:** Displays MATLAB code for initializing a projection matrix and performing forward projection. A red oval highlights the line of code: `forwardprojector.forward_project(projdataout, target);`.
- File Explorer:** Shows files: `example1_projection.m`, `examples.m`, `init.hv`, `init.v`, `matlab_phantom.jpg`, and `matlab_phantom_output.hv`.
- Command Window:** Displays the command `>> projdataout` and its output: `projdataout =` followed by the text `<Swig Object of type '_p_stir__shared_ptrT_stir__ProjDataInterf`.

```
53 %% Example: project
54 % check the size of our image
55 - size(target.to_matlab)
56
57 % fill it
58 - target.fill(p);
59
60 % initialise the projection matrix (using ray-tracing here)
61 - projmatrix = stir.ProjMatrixByBinUsingRayTracing();
62 - projmatrix.set_num_tangential_LORs(n_LOR);
63 - projmatrix.set_up(projdata_info, target);
64
65 % create forward projector
66 - forwardprojector=stir.ForwardProjectorByBinUsingProjMatrixByBin(projmatrix);
67
68 - inout = bitor(uint32(stir.ios.ios_base_in()),uint32(stir.ios.out()));
69 - projdataout = stir.ProjDataInterfile(stir.ExamInfo(), projdata_info, 'stir_matlab_test.hv',inout);
70
71 % forward project
72 - forwardprojector.forward_project(projdataout, target);
73
```

Example: Projection

Step 3: Project

```
55 - size(target.to_matlab)
56
57 % fill it
58 - target.fill(p);
59
60 % initialise the projection matrix (using ray-tracing here)
61 - projmatrix = stir.ProjMatrixByBinUsingRayTracing();
62 - projmatrix.set_num_tangential_LORs(n_LOR);
63 - projmatrix.set_up(projdata_info, target);
64
65 % create forward projector
66 - forwardprojector=stir.ForwardProjectorByBinUsingProjMatrixByBin(projmatrix);
67
68 - inout = bitor(uint32(stir.ios.ios_base_in()),uint32(stir.ios.out()));
69 - projdataout = stir.ProjDataInterfile(stir.ExamInfo(), projdata_info, 'stir_matlab_test.hs',inout);
70
71 % forward project
72 - forwardprojector.forward_project(projdataout, target);
73
74 % convert to matlab
75 data = STIR_projdata2cell(projdataout);
```

init.nv

init.v

matlab_data_output.jpg

matlab_phantom.jpg

matlab_phantom_output.jpg

matlab_project.jpg

matlab_project_output.jpg

matlab_project_output2.jpg

matlab_scanner.jpg

matlab_scanner_options.jpg

matlab_scanner_output.jpg

data =

[344x252x7 double]

[344x252x13 double]

[344x252x19 double]

[344x252x25 double]

[344x252x29 double]

[344x252x25 double]

[344x252x19 double]

[344x252x13 double]

[344x252x7 double]

Example: Projection

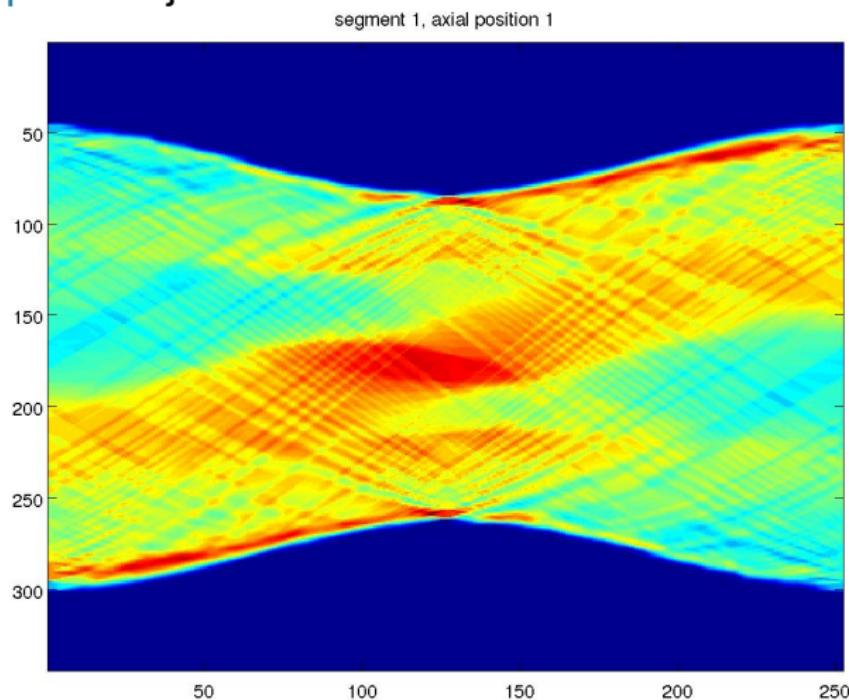
Step 3: Project

```
FILE EDIT NAVIGATE BREAKPOINTS RUN

53 % Example: project
54 % check the size of our image
55 - size(target.to_matlab)
56
57 % fill it
58 - target.fill(p);
59
60 % initialise the projection matrix (using ray-tracing here)
61 - projmatrix = stir.ProjMatrixByBinUsingRayTracing();
62 - projmatrix.set_num_tangential_LORs(n_LOR);
63 - projmatrix.set_up(projdata_info, target);
64
65 % create forward projector
66 - forwardprojector=stir.ForwardProjectorByBinUsingProjMatrixByBin(projmatrix);
67
68 - inout = bitor(uint32(stir.ios.ios_base_in()),uint32(stir.ios.out()));
69 - projdataout = stir.ProjDataInterfile(stir.ExamInfo(), projdata_info, 'stir_matlab_test.hs',inout);
70
71 % forward project
72 - forwardprojector.forward_project(projdataout, target);
73
74 % convert to matlab
75 - data = STIR_projdata2cell(projdataout);
76
77 ...
78 - data_short = STIR_project(p, projmatrix, projdata_info, s_voxel, true);
```

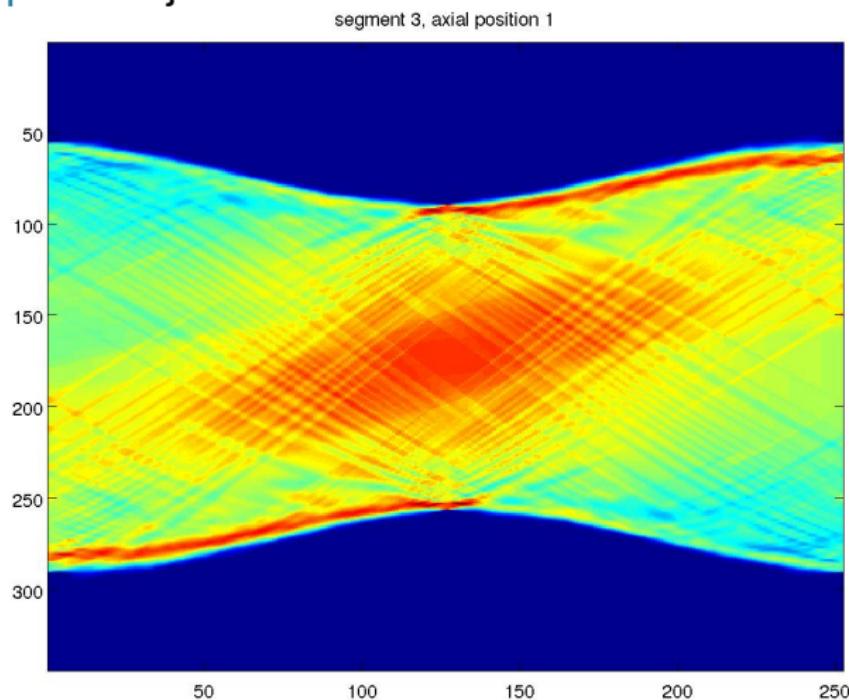
Example: Projection

Step 3: Project



Example: Projection

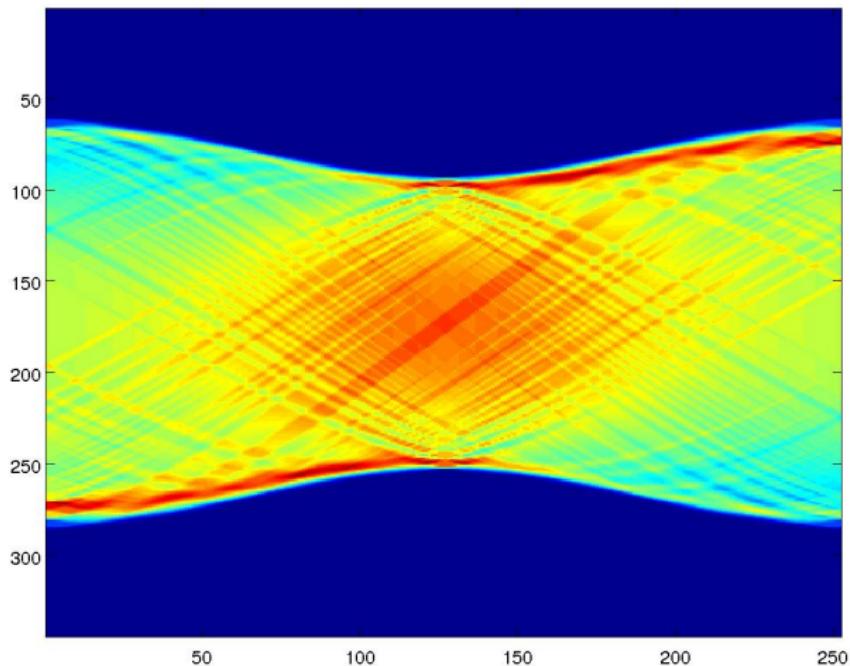
Step 3: Project



Example: Projection

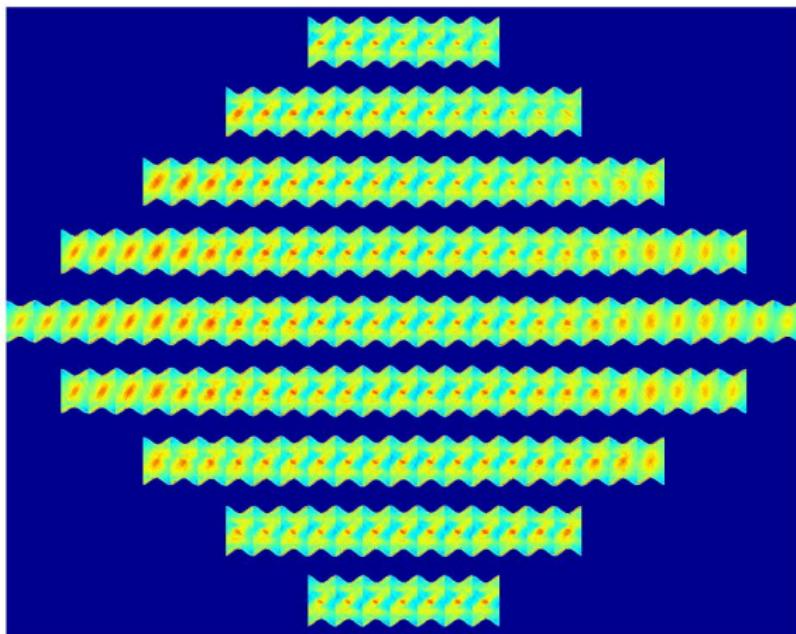
Step 3: Project

segment 5, axial position 27



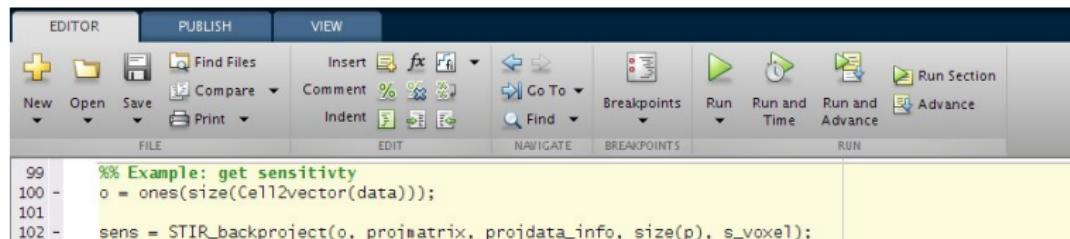
Example: Projection

Step 3: Project



Example: MLEM

Step 1: Get sensitivity

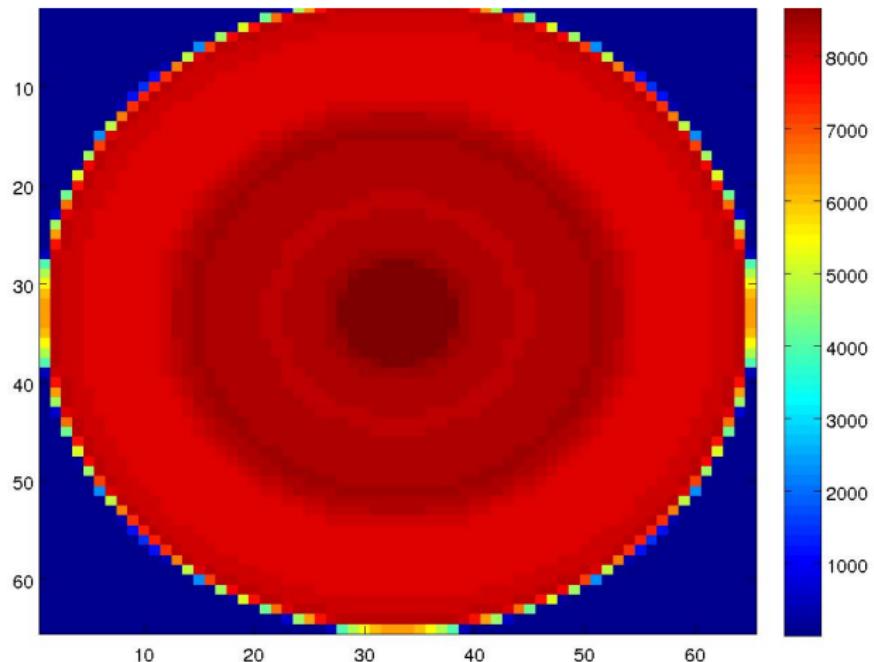


The screenshot shows the MATLAB IDE interface with the code for generating a sensitivity matrix:

```
99 % Example: get sensitivity
100 o = ones(size(Cell2vector(data)));
101
102 sens = STIR_backproject(o, projmatrix, projdata_info, size(p), s_voxel);
```

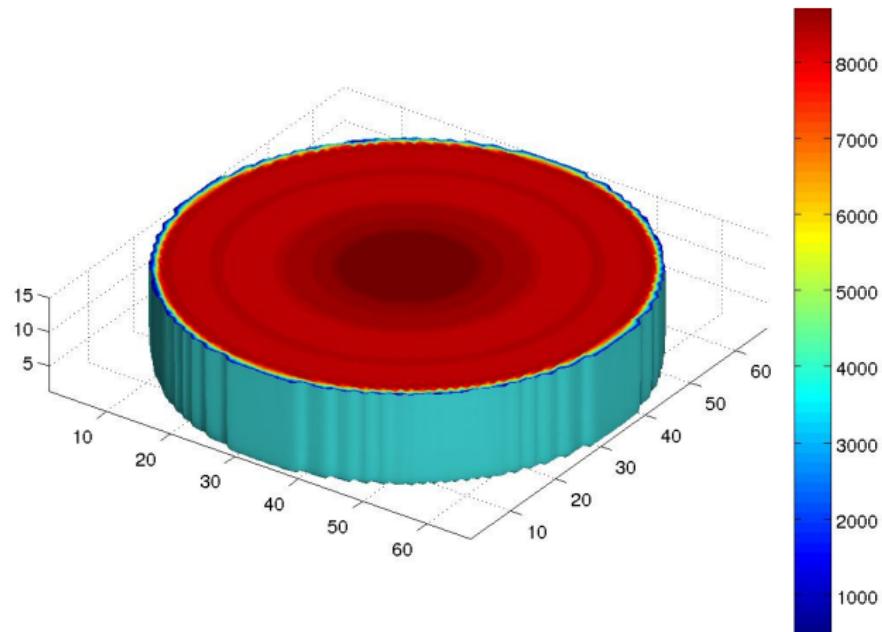
Example: MLEM

Step 1: Get sensitivity



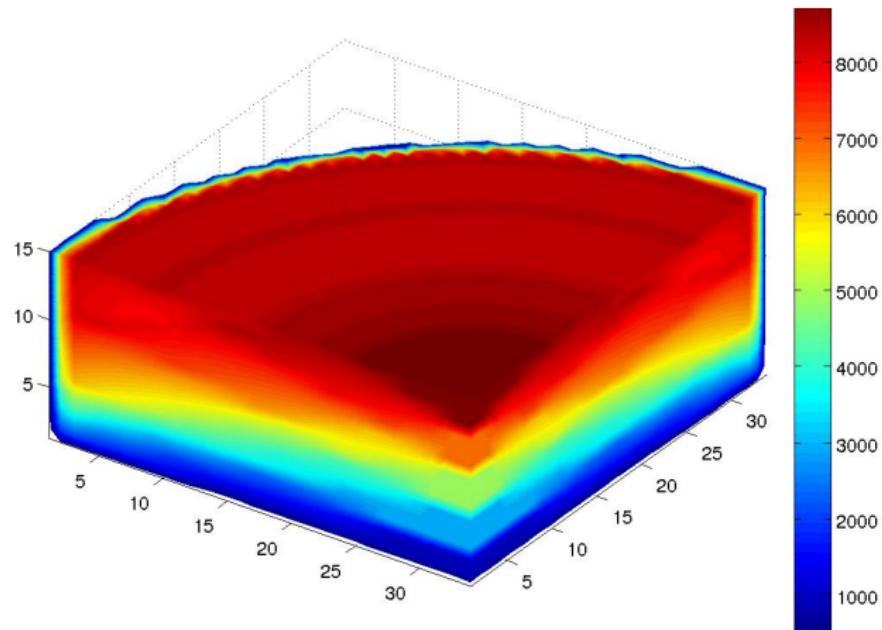
Example: MLEM

Step 1: Get sensitivity



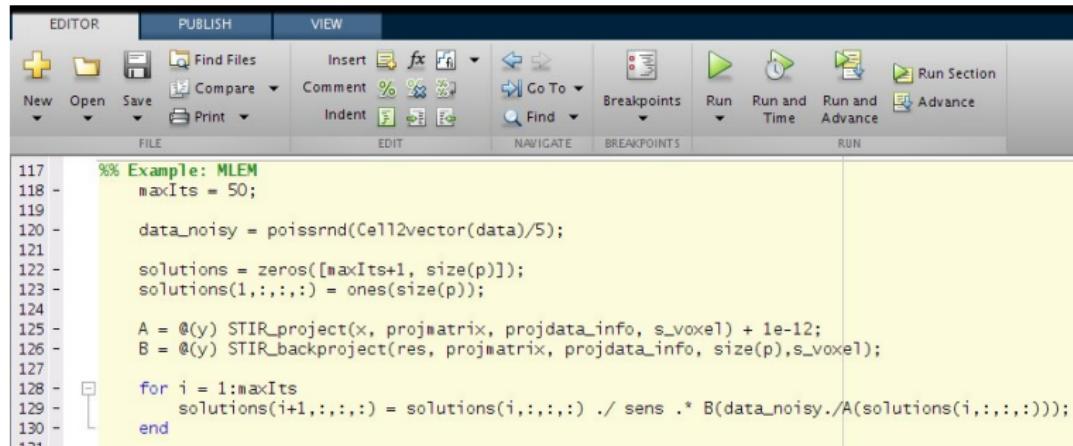
Example: MLEM

Step 1: Get sensitivity



Example: MLEM

Step 2: Run iterations

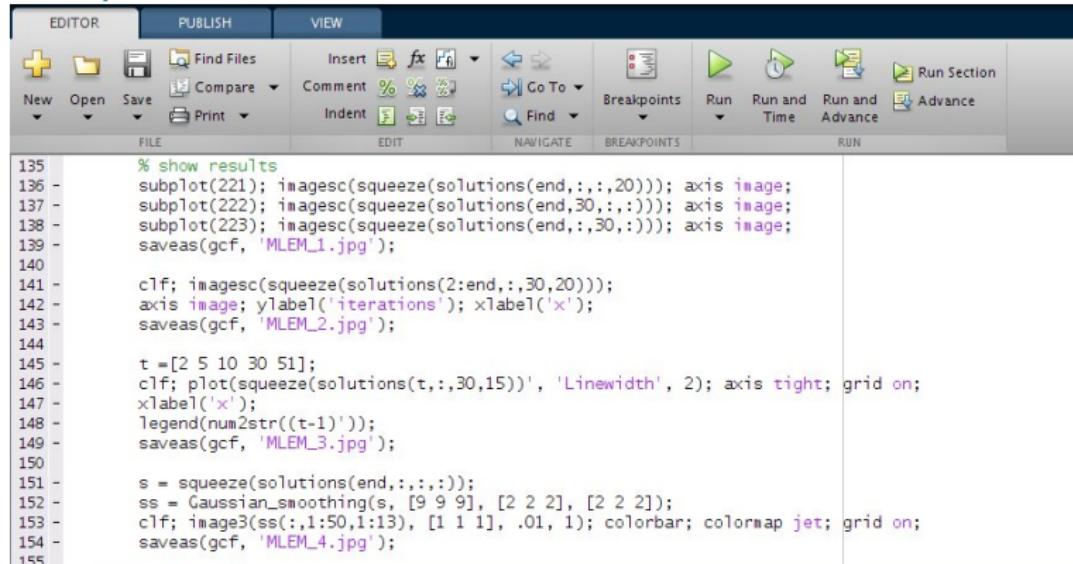


The image shows a screenshot of the MATLAB graphical user interface. The menu bar includes 'EDITOR', 'PUBLISH', and 'VIEW'. The toolbar contains icons for file operations like 'New', 'Open', 'Save', and 'Print', as well as tools for 'Insert', 'Comment', 'Indent', 'Find', 'Breakpoints', and various run options like 'Run', 'Run and Time', 'Run and Advance', and 'Run Section'. The code editor window displays the following MATLAB script:

```
117 %% Example: MLEM
118 - maxIts = 50;
119 -
120 - data_noisy = poissrnd(Cell2vector(data)/5);
121 -
122 - solutions = zeros([maxIts+1, size(p)]);
123 - solutions(1,:,:,:) = ones(size(p));
124 -
125 - A = @(y) STIR_project(x, projmatrix, projdata_info, s_voxel) + 1e-12;
126 - B = @(y) STIR_backproject(res, projmatrix, projdata_info, size(p),s_voxel);
127 -
128 - for i = 1:maxIts
129 -     solutions(i+1,:,:,:) = solutions(i,:,:,:)./ sens .* B(data_noisy./A(solutions(i,:,:,:)));
130 - end
```

Example: MLEM

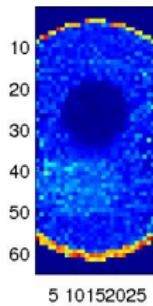
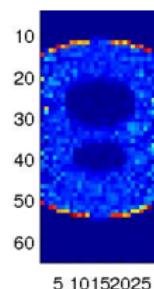
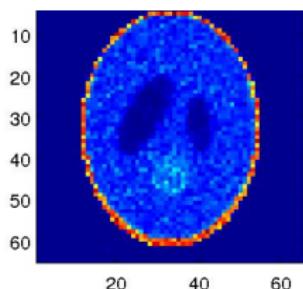
Step 3: View results

A screenshot of a MATLAB IDE interface. The menu bar includes 'EDITOR', 'PUBLISH', and 'VIEW'. The toolbar contains icons for New, Open, Save, Print, Find Files, Compare, Insert, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section. The code editor window displays the following MATLAB script:

```
135 % show results
136 subplot(221); imagesc(squeeze(solutions(end,:,:,:20))); axis image;
137 subplot(222); imagesc(squeeze(solutions(end,30,:,:))); axis image;
138 subplot(223); imagesc(squeeze(solutions(end,:,:,:30,:))); axis image;
139 saveas(gcf, 'MLEM_1.jpg');
140
141 clf; imagesc(squeeze(solutions(2:end,:,:,:30,20)));
142 axis image; ylabel('iterations'); xlabel('x');
143 saveas(gcf, 'MLEM_2.jpg');
144
145 t =[2 5 10 30 51];
146 clf; plot(squeeze(solutions(t,:,:,:30,15))', 'Linewidth', 2); axis tight; grid on;
147 xlabel('x');
148 legend(num2str((t-1)));
149 saveas(gcf, 'MLEM_3.jpg');
150
151 s = squeeze(solutions(end,:,:,:,:));
152 ss = Gaussian_smoothing(s, [9 9 9], [2 2 2], [2 2 2]);
153 clf; image3(ss(:,1:50,1:13), [1 1 1], .01, 1); colorbar; colormap jet; grid on;
154 saveas(gcf, 'MLEM_4.jpg');
155
```

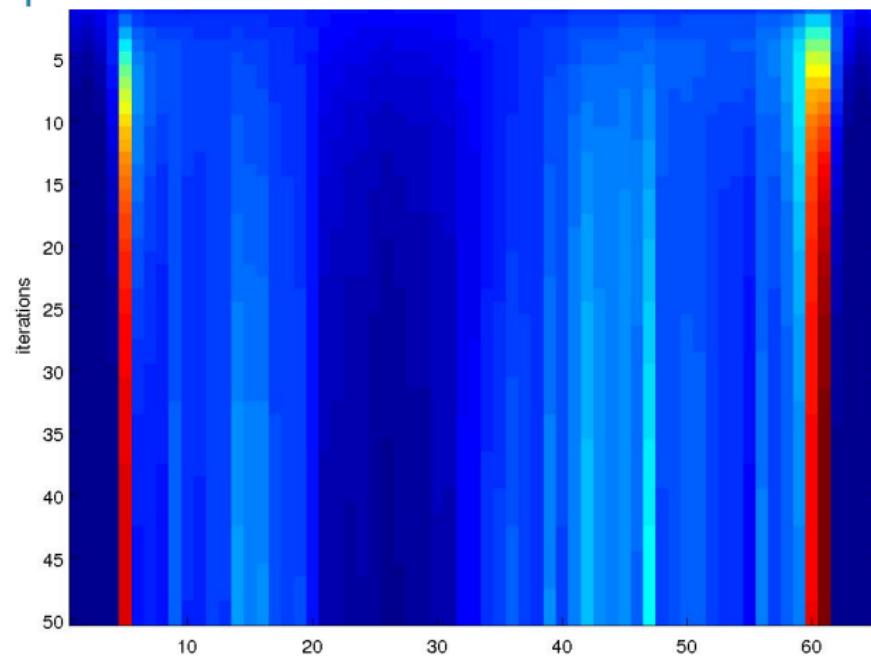
Example: MLEM

Step 3: View results



Example: MLEM

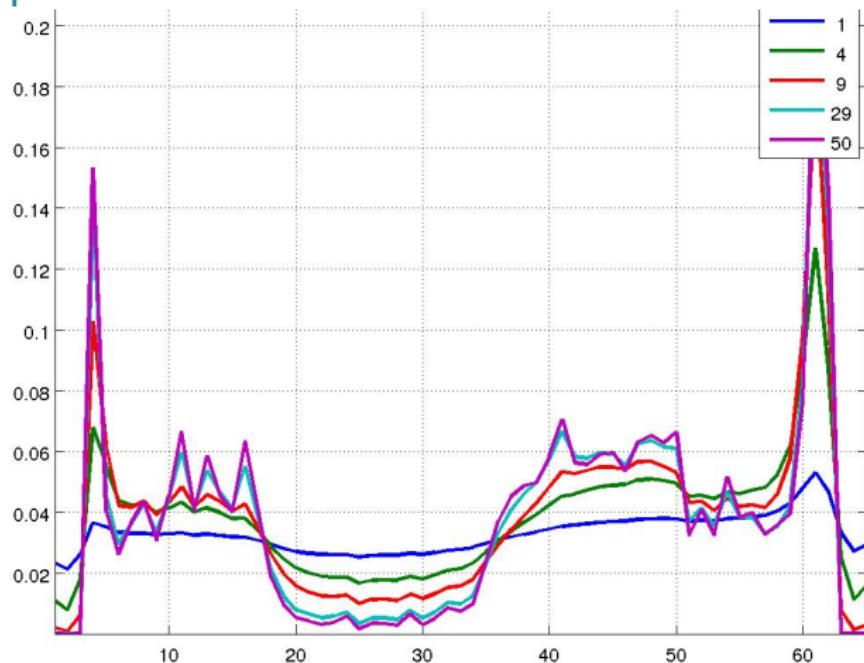
Step 3: View results



.

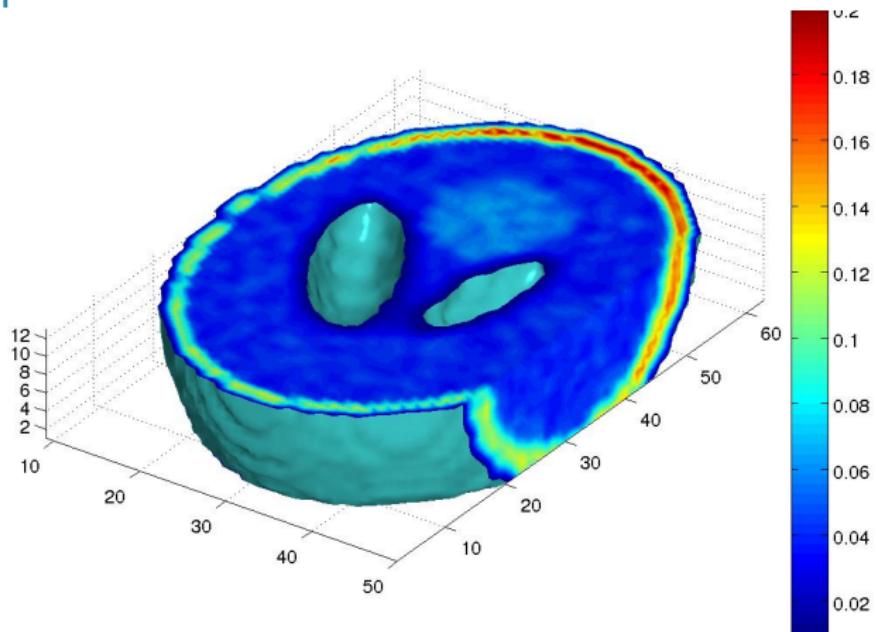
Example: MLEM

Step 3: View results

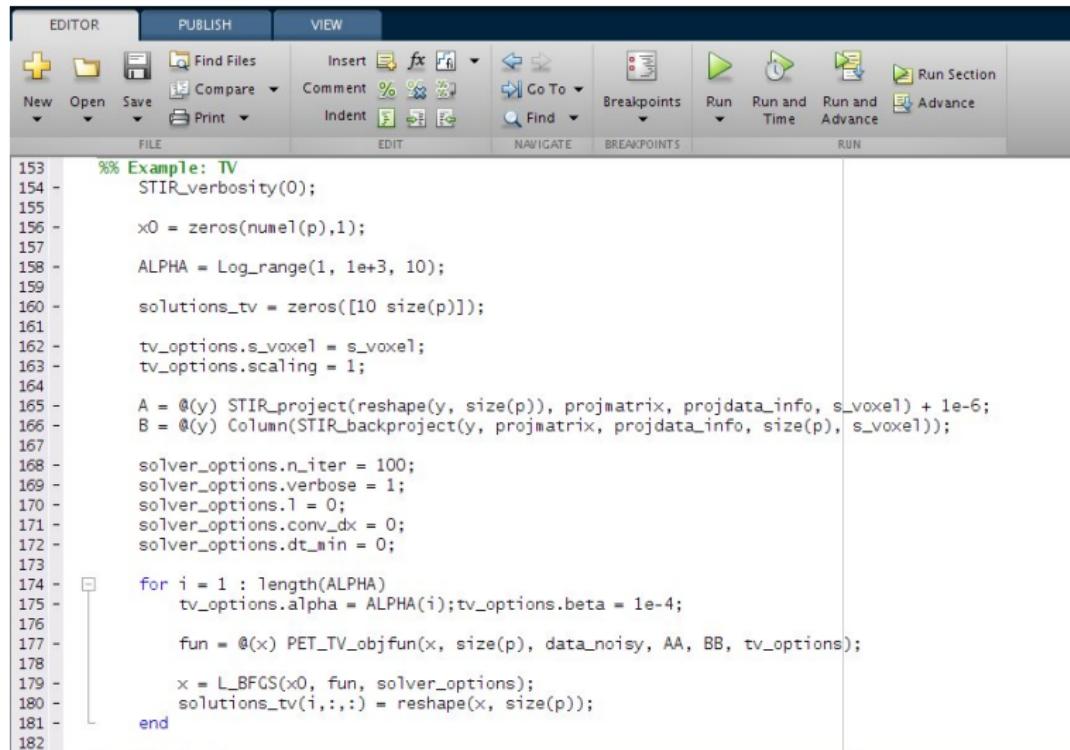


Example: MLEM

Step 3: View results



Example: Total Variation



The screenshot shows the MATLAB IDE interface with the following details:

- Toolbar:** Includes buttons for New, Open, Save, Find Files, Compare, Insert, Comment, Indent, Go To, Find, Breakpoints, Run, Run and Time, Run and Advance, and Run Section.
- Code Area:** Displays MATLAB code for a Total Variation (TV) reconstruction example. The code uses the STIR library and includes solver options and a loop for different alpha values.

```
% Example: TV
STIR_verbose(0);

x0 = zeros(numel(p),1);

ALPHA = Log_range(1, 1e+3, 10);

solutions_tv = zeros([10 size(p)]);

tv_options.s_voxel = s_voxel;
tv_options.scaling = 1;

A = @(y) STIR_project(reshape(y, size(p)), projmatrix, projdata_info, s_voxel) + 1e-6;
B = @(y) Column(STIR_backproject(y, projmatrix, projdata_info, size(p), s_voxel));

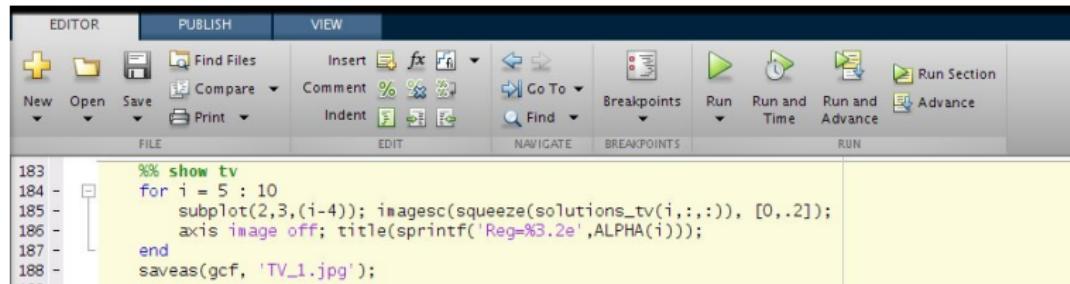
solver_options.n_iter = 100;
solver_options.verbose = 1;
solver_options.l = 0;
solver_options.conv_dx = 0;
solver_options.dt_min = 0;

for i = 1 : length(ALPHA)
    tv_options.alpha = ALPHA(i);tv_options.beta = 1e-4;

    fun = @(x) PET_TV_objfun(x, size(p), data_noisy, AA, BB, tv_options);

    x = L_BFGS(x0, fun, solver_options);
    solutions_tv(i,:,:)= reshape(x, size(p));
end
```

Example: Total Variation

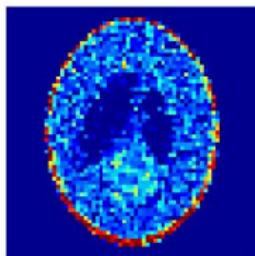


A screenshot of the MATLAB IDE interface. The menu bar includes 'EDITOR', 'PUBLISH', and 'VIEW'. The toolbar contains icons for New, Open, Save, Print, Insert, Comment, Indent, Go To, Breakpoints, Run, Run and Time, Run and Advance, and Run Section. The code editor window shows the following MATLAB script:

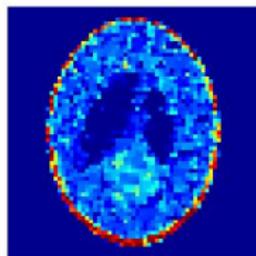
```
183 %% show tv
184 for i = 5 : 10
185     subplot(2,3,(i-4)); imagesc(squeeze(solutions_tv(i,:,:)), [0,.2]);
186     axis image off; title(sprintf('Reg=%3.2e',ALPHA(i)));
187 end
188 saveas(gcf, 'TV_1.jpg');
```

Example: Total Variation

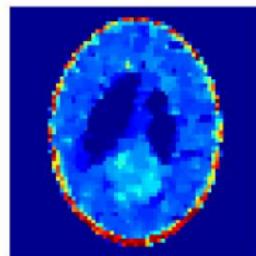
Reg=2.15e+01



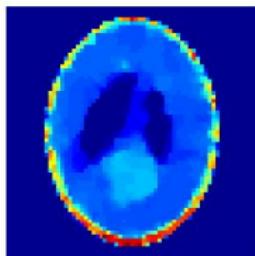
Reg=4.64e+01



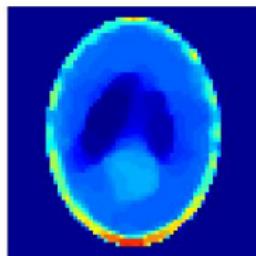
Reg=1.00e+02



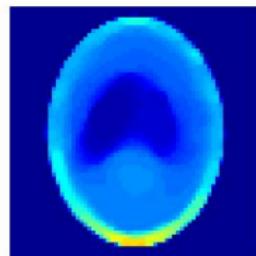
Reg=2.15e+02



Reg=4.64e+02



Reg=1.00e+03



STIR in MATLAB ...

- ▶ ... is easy to use
- ▶ ... allows great MATLAB tools for emission tomography
- ▶ ... allows easy combination with other software

STIR in MATLAB ...

- ▶ ... is easy to use
- ▶ ... allows great MATLAB tools for emission tomography
- ▶ ... allows easy combination with other software

- ▶ ... is still work in progress ...
- ▶ ... needs documentation
- ▶ ... is not yet compatible with par-for