Contents


```
% Eksempel p� enkelt fasestyrt array i Field II
```

make sure that field_init has been called

```
eval('field_init(0)','1;')
```

```
*-------------------------------------------------------------*
*                                                             *
*                     F I E L D   I I                         *
*                                                             *
*              Simulator for ultrasound systems               *
*                                                             *
*             Copyright by Joergen Arendt Jensen              *
*    Version 3.24, May 12, 2014 (Matlab 8.20 version)         *
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*-------------------------------------------------------------*
```
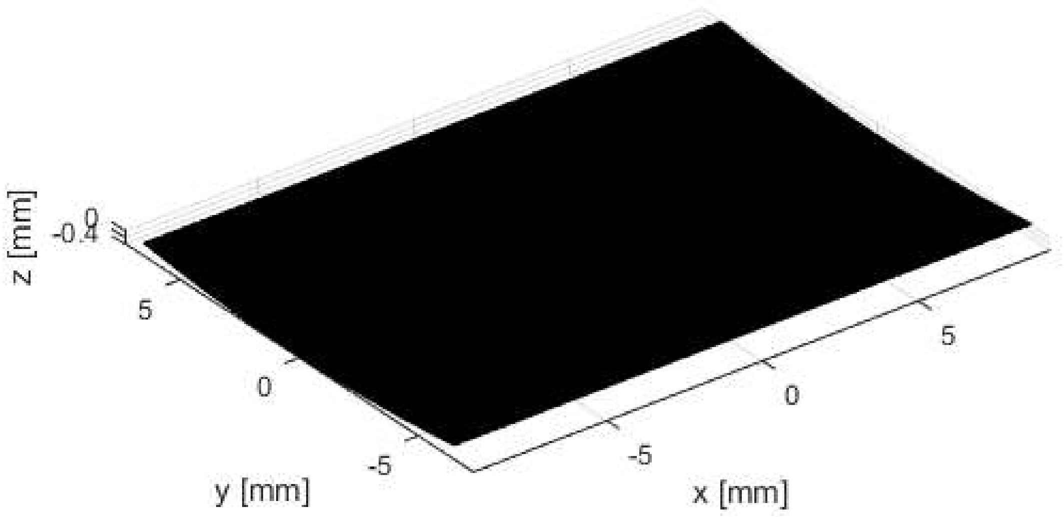

DEFINE ARRAY

```
c = 1540;                       % Speed of sound
f0 = 2.5e6;                     % Transducer center frequency [Hz]
fs = 100e6;                     % Sampling frequency [Hz]
lambda = c/f0;                  % Wavelength
element_height = 13/1000;       % Height of element [m] (elevation direction)
pitch = 0.290/1000;               % Distance between element centers
kerf = 0.025/1000;              % Width of fill material between the ceramic elements
element_width = pitch-kerf;     % Element width [m] (azimuth direction)
Rfocus = 60/1000;               % Elevation lens focus (or radius of curvature, ROC)
focus = [0 0 60]/1000;          % Fixed emitter focal point [m] (irrelevant for single element
 transducer)
N_elements = 64;                % Number of physical elements in array
N_sub_x = 5;                    % Element sub division in x-direction
N_sub_y = 30;                   % Element subdivision in y-direction
```

GENERATE TRANSMIT APERTURE

```
emit_aperture = xdc_focused_array (N_elements, element_width, element_height, kerf, Rfocus
, N_sub_x, N_sub_y, focus);
eval('close(1)','1;')
figure(1)
show_xdc_geir(emit_aperture, 1);
axis equal; view(3)
h_txAp = gcf;
```

```
Read rectangular data for plotting....
Plots aperture with physical element number...
```

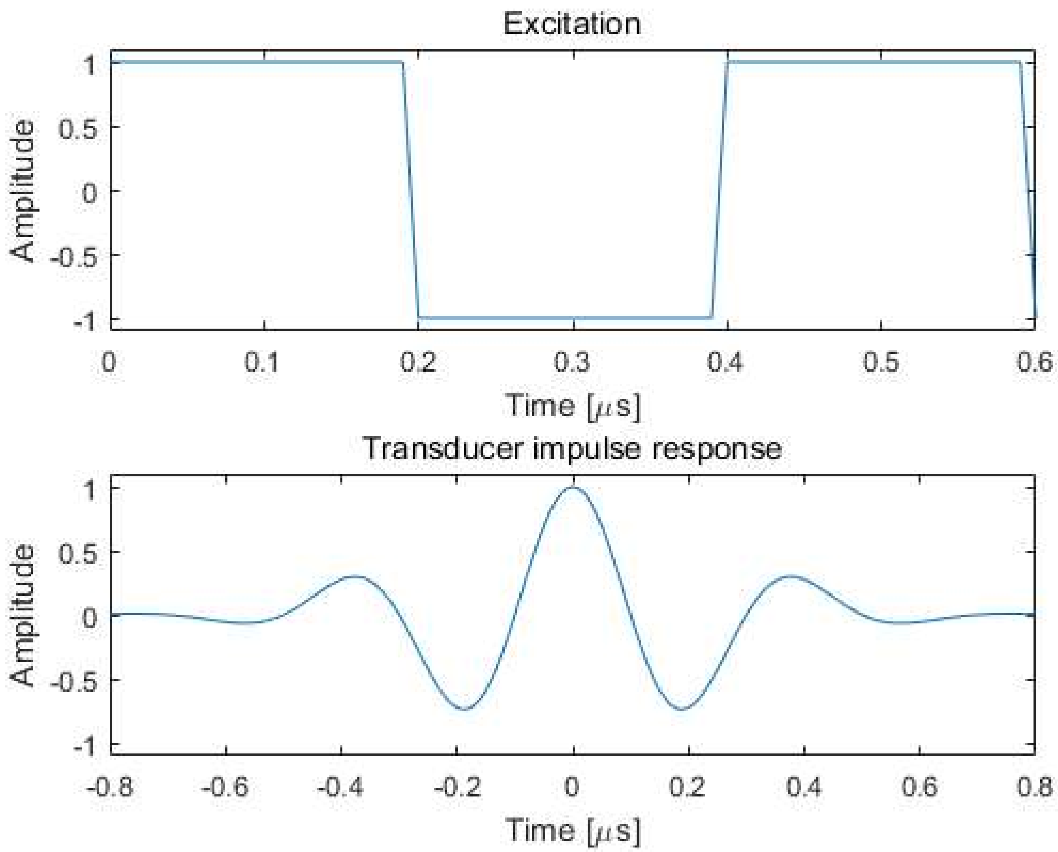


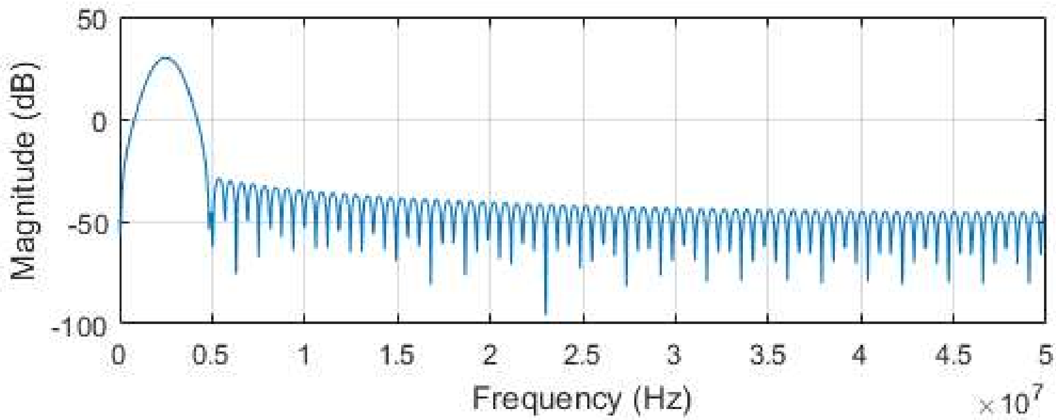
SET THE IMPULSE RESPONSE AND EXCITATION OF THE TRANSMIT APERTURE

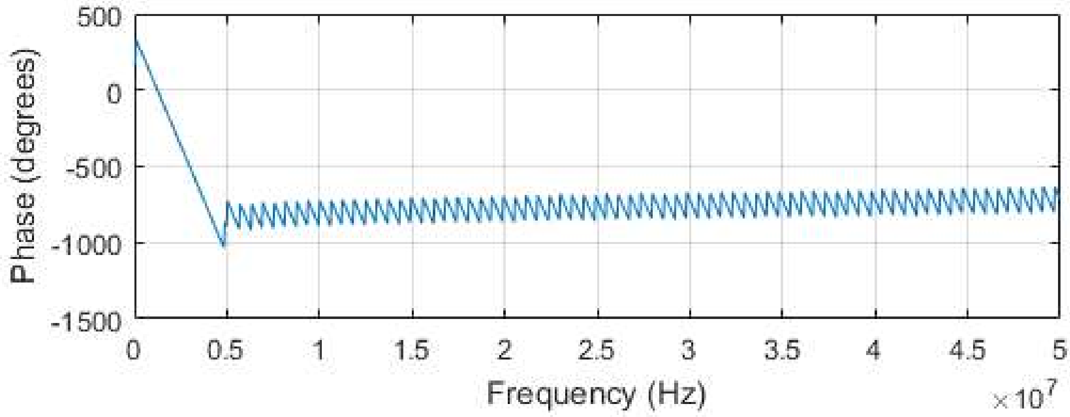
```
t_ir = -2/f0:1/fs:2/f0;
Bw = 0.6;
impulse_response=gauspuls(t_ir,f0,Bw);
set_sampling(fs);
xdc_impulse (emit_aperture, impulse_response);

ex_periods = 1.5;
t_ex=(0:1/fs:ex_periods/f0);
excitation=square(2*pi*f0*t_ex);
xdc_excitation (emit_aperture, excitation);

figure(2);
subplot(211);plot(t_ex*1e6, excitation);ylim([-1.1 1.1]);
title('Excitation'); xlabel('Time [\mus]');ylabel('Amplitude');
subplot(212);plot(t_ir*1e6, impulse_response);ylim([-1.1 1.1]);
title('Transducer impulse response'); xlabel('Time [\mus]');ylabel('Amplitude');
```

```
figure(3);
freqz(impulse_response, 1, 1024, fs)
```

```
Warning:  Remember to set all pulses in apertures for the new sampling frequency
```

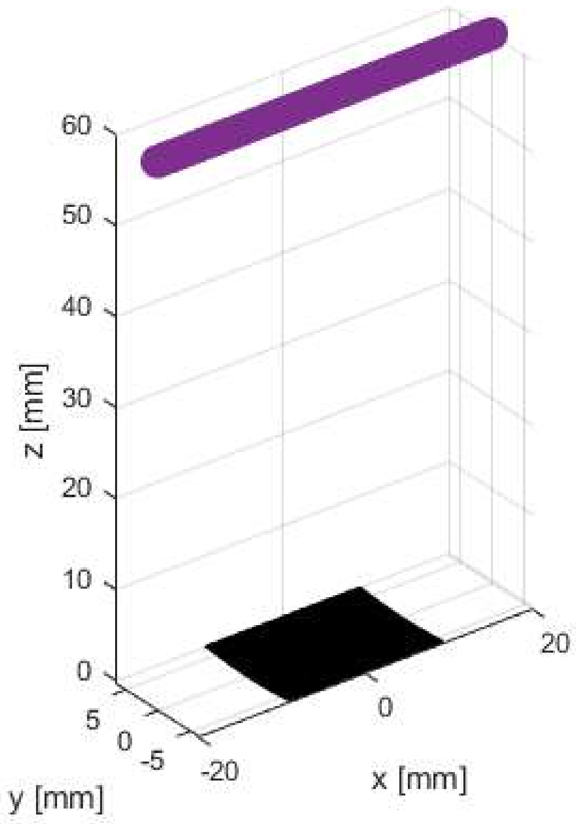






DEFINE MEASUREMENT POINTS

```
measDepth = 60/1000;     % Depth  along z-axis to place measurement points
xStart = -20/1000;       % Start position of measurement points in x direction
xEnd = 20/1000;          % End position of measurement points in x direction
Nmp = 101;

mx = linspace(xStart,xEnd,Nmp)';
my = zeros(Nmp, 1);
mz = measDepth*ones(Nmp,1);
measurement_points = [mx,my,mz];
figure(h_txAp);
hold on;
plot3(measurement_points(:,1)*1000,measurement_points(:,2)*1000,measurement_points(:,3)*10
00, 'o', 'linewidth', 6)
axis tight
```



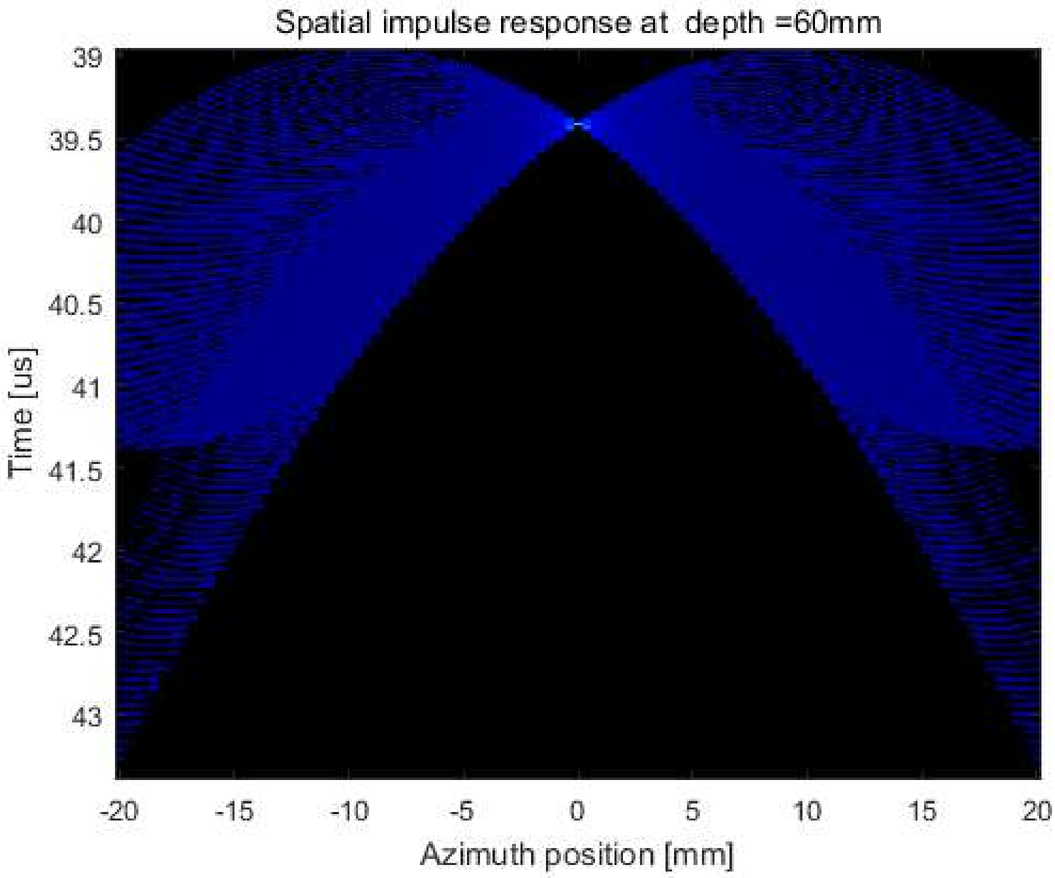
CALCULATE SPATIAL IMPULSE RESPONSE AND TRANSMIT PRESSURE

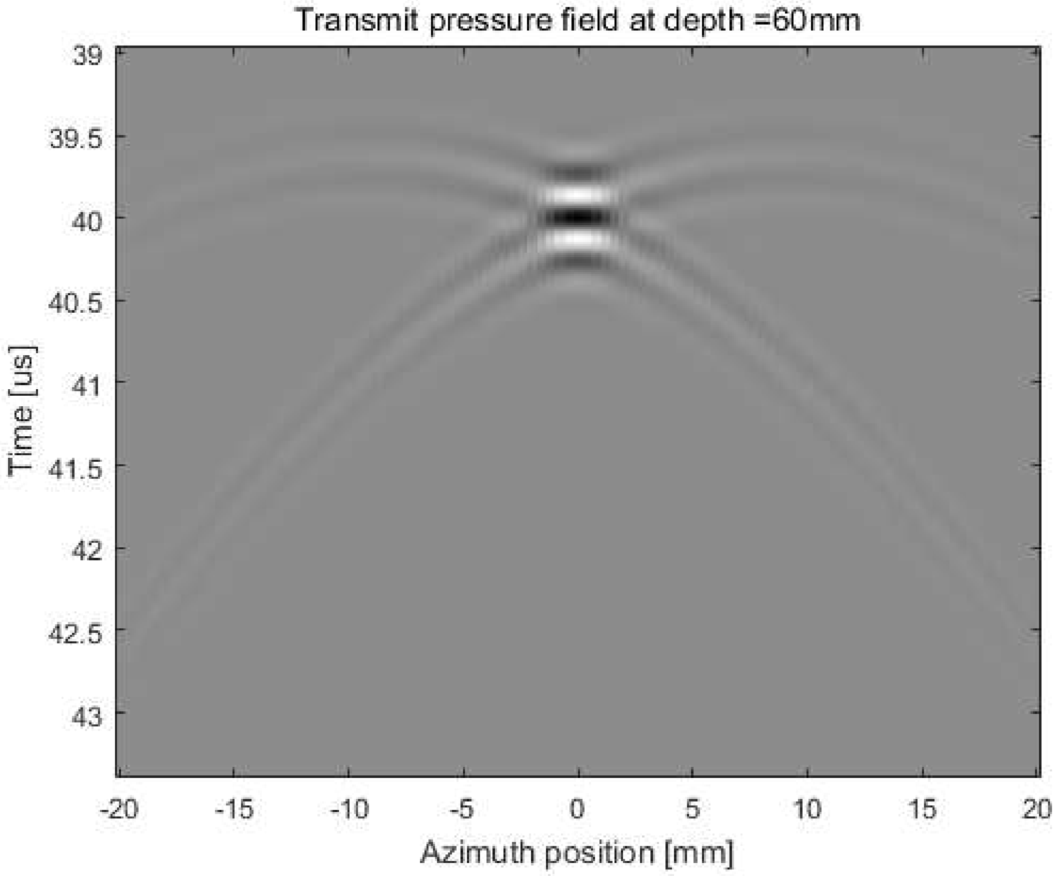
```
[spatImpResp_tx, startTime_tx] = calc_h(emit_aperture, measurement_points);
[pressure_tx, startTime_tx] = calc_hp(emit_aperture, measurement_points);
```

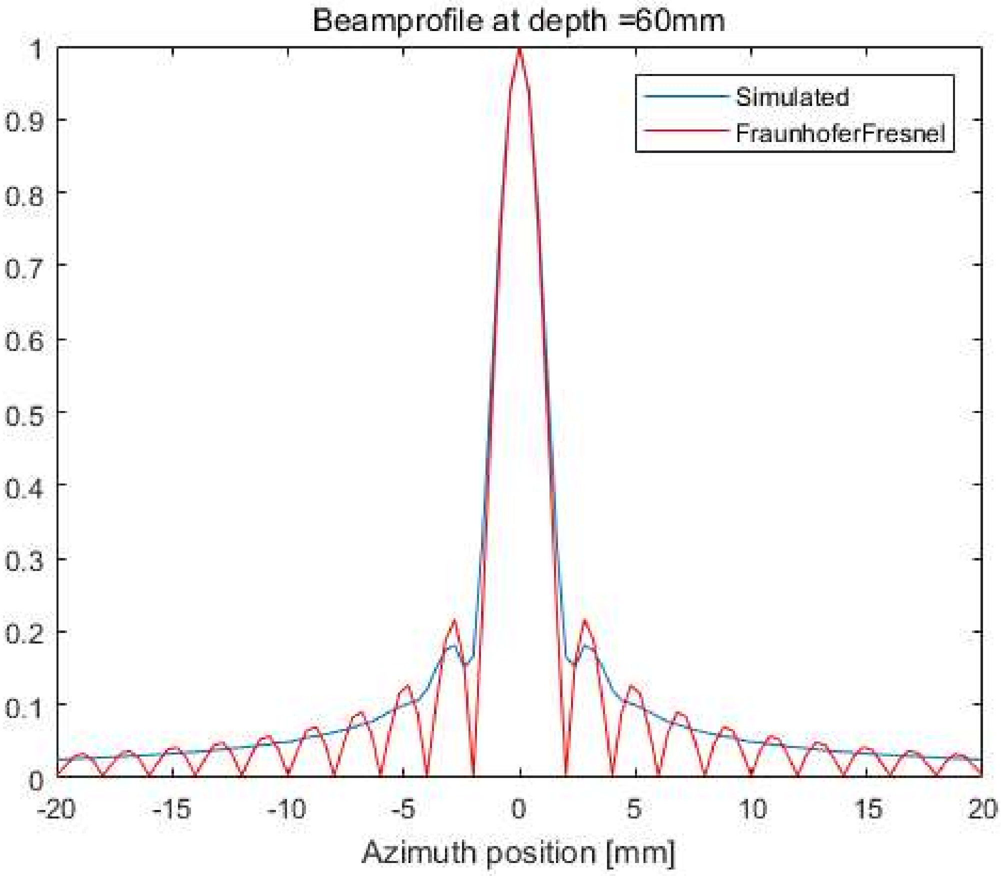
PLOT RESULTS

```
figure(4);
tAxh = startTime_tx + (0:size(spatImpResp_tx,1)-1)/fs;
imagesc(mx*1000, tAxh*1e6, spatImpResp_tx);
title(sprintf('Spatial impulse response at  depth =%0.3gmm', measDepth*1000));
xlabel('Azimuth position [mm]');
ylabel('Time [us]');
cmap = jet(256);
cmap(1,:) = [0,0,0];
colormap(cmap);
axis tight

figure(5);
tAxhp = startTime_tx + (0:length(pressure_tx)-1)/fs;
imagesc(mx*1000, tAxh*1e6, pressure_tx);
title(sprintf('Transmit pressure field at depth =%0.3gmm', measDepth*1000))
xlabel('Azimuth position [mm]');
ylabel('Time [us]');
colormap(gray(256));
axis tight

figure(6)
bpx = sqrt(mean(pressure_tx.^2));
bpx=bpx/max(bpx);
plot(mx*1000, bpx);
title(sprintf('Beamprofile at depth =%0.3gmm', measDepth*1000))
```

```
xlabel('Azimuth position [mm]');


% Plot the Fraunhofer/Fresnel derived pressure field (sinc)
if measDepth==focus(3)
    aTx = pitch*N_elements-kerf;
    F = focus(3);
    bpx_f = sinc(mx/F*aTx/c*f0);
    hold on;
    plot(mx*1000, abs(bpx_f),'r');
end

legend('Simulated', 'FraunhoferFresnel');
```




Transmit pressure field at depth =60mm
Time [us]
39
39.5
40
40.5
41
41.5
42
42.5
43
-20
-15
-10
-5
0
5
10
15
20
Azimuth position [mm]


Beamprofile at depth =60mm
Simulated
FraunhoferFresnel
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-20
-15
-10
-5
0
5
10
15
20
Azimuth position [mm]