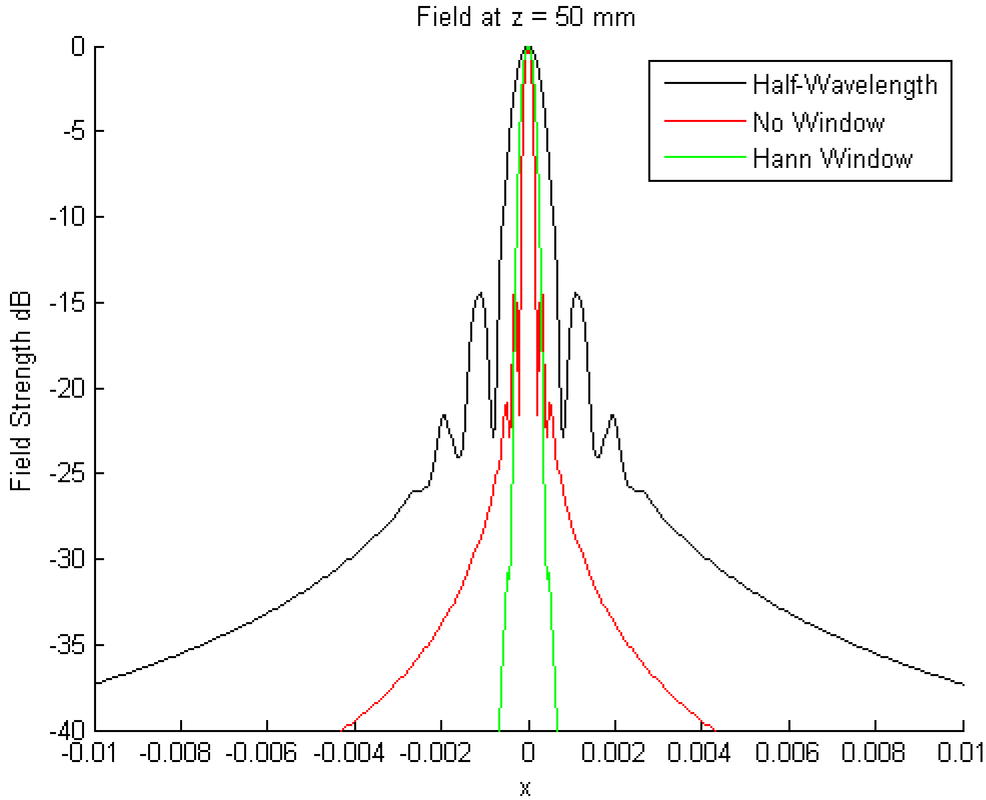
```
% Program to create array beam plot

clear all
j=sqrt(-1);

vel=1540;                                          % Speed of sound - all units MKS
num_elems=128;                                      % Number of elements
fc=10e6;                                            % Center frequency
pitch= vel/(2*fc);                                     % Array element pitch
z_foc=50e-3;                                       % Range direction focal distance
theta_steer=0*pi/180;                             % Steer angle


fs=fc/64;                                          % Define a sampling frequency (not cri
f=[fs:fs:8*fc];                                    % Define an adequate frequency range
w=2*pi*f;                                          % Angular frequency radians
ns=length(f);                                      % Number of samples

tdel=1.0e-6;                                       % Use a fixed time offset so that base

bw=30;                                             % Fractional bandwidth as percent
sig=bw*fc/100;                                     % Width of Gausian
gauss_pulse=exp(-pi*((f-fc)/sig).^2);              % Generate Gaussian pulse (frequency d

gauss_pulse=gauss_pulse.*exp(-j*w*tdel);           % Apply timed delay so 0 for t<0


gauss_t=real(ifft(gauss_pulse));                   % Time domain of base waveform for ref
env_gauss_t=abs(hilbert(gauss_t));                 % Envelope calculation
tstep=1./max(f);                                   % Time steps after using Inverst FFT
t=[1:ns].*tstep;                                   % Define time axis

weight=ones(num_elems,1);                         % Define the weighting function (you ca

xres = 0.050;
% Increase resolution for calculation in the x field.
x_pts=[-50:xres:50].*1e-3;                          % Define X-direction field locations
z_pts=[0.01:2.0:50.01].*1e-3;                      % Define Z-direction field locations

% Create focal delays
for i=1:num_elems
    x_elem(i)=((i-1)-(num_elems-1)./2).*pitch;  % Calculate locations of each arra

    foc_del(i)=(sqrt(x_elem(i).^2+z_foc^2)-z_foc)./vel; % Calculate focusing delay

    steer_del(i) = i*pitch*sin(theta_steer)/vel;

    foc_del(i)=foc_del(i)+steer_del(i);            % You can included steering and focusi

end

for j=26:length(z_pts)                              % Loop over field locations

    for i=1:length(x_pts)
        sum_pulse=zeros(size(gauss_pulse)); % Initialize sum of waveforms to zero
        for k=1:num_elems

            prop_del=(sqrt((x_elem(k)-x_pts(i)).^2+z_pts(j)^2))./vel;
            % prop_del = ???? for each elem location, calculate actual
            % propagation time out to current field point
            sum_pulse=sum_pulse+weight(k).*gauss_pulse.*exp(-sqrt(-1)*w.*(prop_del
        end
```

```
        sum_pulse_t=real(ifft(sum_pulse));  % Convert to time domain

        field_val(j,i)= max(abs(hilbert(sum_pulse_t)));

    end
    field_val(j,:)=field_val(j,:)./max(field_val(j,:));
    field_db(j,:)=20*log10(field_val(j,:));
end

% Find -6 dB Points
mask = field_db(26,:) > (-6);
mask = mask*1;
six_dB_width = sum(mask)*xres

figure(1)
hold on
plot(x_pts,field_db(26,:),'k');
xlabel('x');
ylabel('Field Strength dB');
title('Half-Wavelength Spacing - Field at z = 50 mm');
axis([-0.01 0.01 -40 0])


UltrasoundHomework_Task2(1);
legend('Half-Wavelength', 'No Window', 'Hann Window')
```

```
six_dB_width =

  9.5000e-001


six_dB_width =

  2.5000e-001


six_dB_width =

  4.5000e-001
```



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