

## **Appendix:**

```
d = [6e-06 -1.7e-05 4e-06 -4e-06 0 1.9e-05 -5e-06 5e-06]';
```

```
% Construct system matrix for the ray path models
```

```
s2=sqrt(2);
```

```
G = [1,0,0,1,0,0,1,0,0;  
     0,1,0,0,1,0,0,1,0;  
     0,0,1,0,0,1,0,0,1;  
     1,1,1,0,0,0,0,0,0;  
     0,0,0,1,1,1,0,0,0;  
     0,0,0,0,0,1,1,1,1;  
     s2,0,0,0,s2,0,0,0,s2;  
     0,0,0,0,0,0,0,0,s2];
```

```
% Get the singular values for the system matrix
```

```
[U,S,V] = svd(G);
```

```
[m,n] = size(G);
```

```
%rank
```

```
p=rank(G);
```

```
N0.1 Find the trace of Rm
```

```
% model resolution matrix
```

```
Vp=V(:,1:p);
```

```
Rm=Vp*Vp';
```

```
trace_Rm = trace(Rm)
```

```
Plot
```

```
figure(13)
```

```
clf
```

```
colormap('gray')
```

```
imagesc(Rm)
```

```
set(colorbar,'FontSize',18);
```

```
set(gca,'xtick',[1,2,3,4,5,6,7,8,9]);
```

```
set(gca,'ytick',[1,2,3,4,5,6,7,8,9]);
```

```
xlabel('j')
```

```
ylabel('i')
```

```
title('Model resolution matrix R_{m}')'
```

```
Rmdia=reshape(diag(Rm),3,3)'
```

## **N0.2**

```
Gdagger = V(:,1:p)*inv(S(1:p,1:p))*U(:,1:p)';
```

```
Rd = G*Gdagger;
```

```
figure(10)
```

```
clf
```

```
colormap('gray')
```

```
imagesc(Rd)
```

```
%caxis([-0.1 1.0])
```

```
set(colorbar,'FontSize',18);
```

```
set(gca,'xtick',[1,2,3,4,5,6,7,8,9]);
```

```
set(gca,'ytick',[1,2,3,4,5,6,7,8,9]);
```

```
xlabel('j')
```

```
ylabel('i')
```

```
title('Data Resolution Matrix')
```

**find the trace of Rd**

```
trace_Rd = trace(Rd)
```

```
Rddiag=reshape(diag(Rd),4,2)'
```

**N0.3 Verify that**

```
Rmi = Rm - eye(n)
```

```
Vo = [V(:,8) V(:,9)];
```

```
VV = -(Vo*Vo')
```

```
verify = isequal(Rmi,VV)
```

**Calculate the norm**

```
Norm_bias = norm(Rmi)
```

**N0.4 Plot the recovered models.**

```
% Spike resolution test
```

```
figure(4)
```

```
for i = 1:9
```

```
    % Construct spike model
```

```
    mtest=zeros(n,1);
```

```
    mtest(i)=1;
```

```
    % Get noise free data for the spike model (forward problem)
```

```
    dtest=G*mtest;
```

```
    mdagger=pinv(G)*dtest;
```

```
    subplot(3, 3, i) ;
```

```
    colormap('gray')
```

```
    imagesc(reshape(mdagger,3,3)');
```

```
    %caxis([-0.1 1.0])
```

```
    set(colorbar,'FontSize',18);
```

```
    set(gca,'xtick',[1,2,3]);
```

```
    set(gca,'ytick',[1,2,3]);
```

```
    xlabel('j')
```

```
    ylabel('i')
```

```
    title('Recovered Model Data')
```

```
end
```

```
set(gcf,'Position',[600,600,850,700])
```

**N0.5 Find the condition numbers of G and Gdagger**

```
C_G = cond(G)
```

```
C_Gdagger = cond(Gdagger)
```