Appendix

Matlab programme is used for reconstructing the lasing emission intensity in the full region of micro-cavity. One image represents the intensity of the mode at a particular wavelength in the whole region of the cavity. And the image is plotted by multi single linear image abstracted from each spatially resolved spectrum from different positions. Each spectra appears as a matrix and by combing all the measured data the matrix can be converted into an image that shows the spatial distribution of the emission intensity. The basic programme and principle is described in the following:

The programme mainly consists of three sections:

- Reading the original asc format spectra images (data)
- Abstracting the required matrix at a particular wavelength from each of spatially resolved spectrum
- Combine the abstracted linear images into a big matrix result in the reconstruction of the image in 3D coordinate system.

Partial codes of the programme in matrix abstracting parts are omitted.

Programme code:

```
clear all
close all
datestr(now)


% Define the value of variable % lambda range of wavelength
```

Description: This function is to select the required range of wavelength.

```
% minW=sym('579.7'); % minimum wavelength
% maxW=sym('579.9'); % maximum wavelength

minW=sym('584.6'); % minimum wavelength
maxW=sym('584.8'); % maximum wavelength

% minW=sym('583.35'); % minimum wavelength
% maxW=sym('583.55'); % maximum wavelength
```

Description: Reading the original image spectra data (asc format) as matrix.

```
%%  Data1  a  (spatial order)
a=1,b=2,c=3,d=4,e=5,f=6,g=7,h=8,i=9,j=0,aj=10,aa=11,ab=12.....
%% Main programme in reading asc image reading was written by Tobias
Großmann

amode=dlmread('Posi.1 para 40%80%0.30uj80Hz (from right).asc');
amode=transpose(amode) ;
[aindy,aindx]=size(amode) ;

%Wellenlängen einlesen

%lambda=dlmread('calibrierung_krypton_korrekt.asc');
%lambda=lambda(1:indy,1);
%lambda=transpose(lambda);
% Achsen
ay=[1:1:aindy-2];
alambda=amode(1,2:aindx);

% Intensität
aintensity=(amode(2:aindy-1,2:aindx));
aintensity=log(abs(aintensity));
aintensity(isinf(aintensity))=0;
min=min(aintensity);

% Plotten
% figure
%subplot(2,2,1)
surf(alambda,ay,aintensity)%'FaceColor','FaceLighting','phong')
% load('MyColormapswhite','mycmap')
% set(gcf,'Colormap',mycmap)
%image(lambda,-y,intensity)
set(gca,'DataAspectRatio',[1 80 4],'fontsize',20,
'TickDir','out','YTickLabel',[])
set(gca,'YTick',[])
v=colorbar('v','fontsize',20);
%set(get(v,'title'),'string','Log(Intensität)','fontsize',20)

%title('norm. Feld')
shading interp %flat %interp
view([0 90])
ylim([ay(1,1) max(ay)])
xlim([alambda(1,1) max(alambda)])
% zlim([-1 1])
xlabel('Wellenlänge (nm)','fontsize',20)
%ylabel('Pixel','fontsize',20)
```

Description: Abstracting the desirable linear image at selected range of wavelength as matrix, the abstracted matrix is defined as a branch matrix of the final big matrix.

```
% Lasing mode distribution spectrum
[x1,y1]=find(minW<alambda&alambda<maxW);%Finding the matrix coordinate(y1)
of selected wavelenghth range%
M1=aintensity(:,y1);%Finding the matrix of intensity which locate in the
target wavelenghth range %
```

```
S1=sum(M1);%Finding the column which has the maximum sum of column value %
[xx1,yy1]=max(S1);%Finding the coordinate which has the maximum sum of
column value %
MM1=M1(:,yy1);%Selecting the matrix%
```

```
%%   Data2  b   (spatial order)
a=1,b=2,c=3,d=4,e=5,f=6,g=7,h=8,i=9,j=0,aj=10,aa=11,ab=12.....

amode=dlmread('Posi.2 para 40%80%0.30uj80Hz (from right).asc');
amode=transpose(amode) ;
[aindy,aindx]=size(amode) ;

%Wellenlängen einlesen

%lambda=dlmread('calibrierung_krypton_korrekt.asc');
%lambda=lambda(1:indy,1);
%lambda=transpose(lambda);
% Achsen
ay=[1:1:aindy-2];
alambda=amode(1,2:aindx);

% Intensität
aintensity=(amode(2:aindy-1,2:aindx));
aintensity=log(abs(aintensity));
aintensity(isinf(aintensity))=0;
% min=min(aintensity);

% Plotten
figure
%subplot(2,2,1)
surf(alambda,ay,aintensity)%'FaceColor','FaceLighting','phong')
% load('MyColormapswhite','mycmap')
% set(gcf,'Colormap',mycmap)
%image(lambda,-y,intensity)
set(gca,'DataAspectRatio',[1 80 4],'fontsize',20,
'TickDir','out','YTickLabel',[])
set(gca,'YTick',[])
v=colorbar('v','fontsize',20);
%set(get(v,'title'),'string','Log(Intensität)','fontsize',20)

%title('norm. Feld')
shading interp %flat %interp
view([0 90])
ylim([ay(1,1) max(ay)])
xlim([alambda(1,1) max(alambda)])
% zlim([-1 1])
xlabel('Wellenlänge (nm)','fontsize',20)
%ylabel('Pixel','fontsize',20)
```

```
% Lasing mode distribution spectrum
[x2,y2]=find(minW<alambda&alambda<maxW);%Finding the matrix coordinate(y1)
of selected wavelenghth range%
M2=aintensity(:,y2);%Finding the matrix of intensity which locate in the
target wavelenghth range %
```

```
S2=sum(M2);%Finding the column which has the maximum sum of column value %
[xx2,yy2]=max(S2);%Finding the coordinate which has the maximum sum of
column value %
MM2=M2(:,yy2);%Selecting the matrix%
```

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```
%%  Datak-1  aa  (spatial order)
a=1,b=2,c=3,d=4,e=5,f=6,g=7,h=8,i=9,j=0,aj=10,aa=11,ab=12.....

amode=dlmread('Posi.k-1 para 40%80%0.30uj80Hz (from right).asc');
amode=transpose(amode) ;
[aindy,aindx]=size(amode) ;

%Wellenlängen einlesen

%lambda=dlmread('calibrierung_krypton_korrekt.asc');
%lambda=lambda(1:indy,1);
%lambda=transpose(lambda);
% Achsen
ay=[1:1:aindy-2];
alambda=amode(1,2:aindx);

% Intensität
aintensity=(amode(2:aindy-1,2:aindx));
aintensity=log(abs(aintensity));
aintensity(isinf(aintensity))=0;
% min=min(aintensity);

% Plotten
% figure
%subplot(2,2,1)
surf(alambda,ay,aintensity)%'FaceColor','FaceLighting','phong')
% load('MyColormapswhite','mycmap')
% set(gcf,'Colormap',mycmap)
%image(lambda,-y,intensity)
set(gca,'DataAspectRatio',[1 80 4],'fontsize',20,
'TickDir','out','YTickLabel',[])
set(gca,'YTick',[])
v=colorbar('v','fontsize',20);
%set(get(v,'title'),'string','Log(Intensität)','fontsize',20)

%title('norm. Feld')
shading interp %flat %interp
view([0 90])
ylim([ay(1,1) max(ay)])
xlim([alambda(1,1) max(alambda)])
% zlim([-1 1])
xlabel('Wellenlänge (nm)','fontsize',20)
%ylabel('Pixel','fontsize',20)
```

```
% Lasing mode distribution spectrum
```

```
[x(k-1),y(k-1)]=find(minW<alambda&alambda<maxW);%Finding the matrix
coordinate(y1) of selected wavelenghth range%
M(k-1),=aintensity(:,y(k-1),);%Finding the matrix of intensity which locate
in the target wavelenghth range %

S(k-1),=sum(M(k-1),);%Finding the column which has the maximum sum of
column value %
[xx(k-1),,yy(k-1),]=max(S(k-1),);%Finding the coordinate which has the
maximum sum of column value %
MM(k-1),=M(k-1), (:,yy(k-1),);%Selecting the matrix%
```

```
%%   Datak  aa  (spatial order)
a=1,b=2,c=3,d=4,e=5,f=6,g=7,h=8,i=9,j=0,aj=10,aa=11,ab=12.....

amode=dlmread('Posi.k para 40%80%0.30uj80Hz (from right).asc');
amode=transpose(amode) ;
[aindy,aindx]=size(amode) ;

%Wellenlängen einlesen

%lambda=dlmread('calibrierung_krypton_korrekt.asc');
%lambda=lambda(1:indy,1);
%lambda=transpose(lambda);
% Achsen
ay=[1:1:aindy-2];
alambda=amode(1,2:aindx);

% Intensität
aintensity=(amode(2:aindy-1,2:aindx));
aintensity=log(abs(aintensity));
aintensity(isinf(aintensity))=0;
% min=min(aintensity);

% Plotten
% figure
%subplot(2,2,1)
surf(alambda,ay,aintensity)%'FaceColor','FaceLighting','phong')
% load('MyColormapswhite','mycmap')
% set(gcf,'Colormap',mycmap)
%image(lambda,-y,intensity)
set(gca,'DataAspectRatio',[1 80 4],'fontsize',20,
'TickDir','out','YTickLabel',[])
set(gca,'YTick',[])
v=colorbar('v','fontsize',20);
%set(get(v,'title'),'string','Log(Intensität)','fontsize',20)

%title('norm. Feld')
shading interp %flat %interp
view([0 90])
ylim([ay(1,1) max(ay)])
xlim([alambda(1,1) max(alambda)])
% zlim([-1 1])
xlabel('Wellenlänge (nm)','fontsize',20)
%ylabel('Pixel','fontsize',20)
```

```
% Lasing mode distribution spectrum
[x(k),y(k)]=find(minW<alambda&alambda<maxW);%Finding the matrix
coordinate(y1) of selected wavelenghth range%
M(k)=aintensity(:,y(k));%Finding the matrix of intensity which locate in
the target wavelenghth range %

S(k)=sum(M(k));%Finding the column which has the maximum sum of column
value %
[xx(k),yy(k)]=max(S(k));%Finding the coordinate which has the maximum sum
of column value %
MM(k)=M11(:,yy(k));%Selecting the matrix%
```

Description: Converting the matrix groups into 3D images.

```
MM1r=MM1';
MM2r=MM2';

    ⋮

MM(k-1)r=MM(k-1)';
MM(k)r=MM(k)';


A=[MM1r; MM2r;.................;MM(k-1)r;MM(k)r];

A0=A';
% K = wiener2(A0,[10 10]);
% imshow(K);
% J = imnoise(Ao,'gaussian',0,0.025);

s=surf(A0);
colormap hsv

% surf(peaks);
% shading flat;
shading interp
% shading faceted
% s=peaks(A0);

% title('Lasing emission. Wavelength: 579.8±0.10 nm');
%(581<lambda&lambda<581.2)
title('Lasing emission. Wavelength: 584.6nm~584.8nm');
%(585.6nm<lambda&lambda<585.8nm)
% title('Lasing emission. Wavelength: 583.35nm~583.55nm');
%(585.6nm<lambda&lambda<585.8nm)

xlabel('X spatial direction');
ylabel('Y spatial direction');
```

```
zlabel('Intensity (arb.u.)');
axis([0 35 0 80 0 15]);%(581<lambda&lambda<581.2)
% axis([0 67 130 240  0 15]);%(585.6nm<lambda&lambda<585.8nm)
% axis equal
% axis square
axis normal
% axis fill
% axis square

% S=smooth3(A0,'gaussian');
% % meshz(A0);
```

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