**ECE 474 / EXPERIMENT 6**

 **MATLAB CODE (GaussianbeamR.m)**

% This is receiver plane intensities of Gaussian beams - 17.04.2012

clear;clc;clf;warning off MATLAB:divideByZero;close all

lamda = 1.55e-6; k = 2\*pi/lamda;Ac = 1;zarr = [0 500 1e3 5e3];

sxst = -1.e-1:0.2e-2:1e-1;syst = sxst;

rxst = -1.e-1:0.2e-2:1e-1;ryst = rxst;

sxset = sxst\*0.2;syset = syst\*0.2;

%%%%% Source settings %%%%%%%%%%

Fs = 1e15;alfas = 5e-2;alfa = 1./(k\*alfas^2) + j./(2\*Fs);

rxset1 = rxst\*0.2;ryset1 = rxset1;rxset2 = rxst\*0.4;ryset2 = rxset2;rxset3 = rxst\*1;ryset3 = rxset3;

rxmat = [sxset;rxset1; rxset2; rxset3];rymat = [syset;ryset1; ryset2; ryset3];

%%%%%%%%%%%%%%%%%%%%%%%%%% Source Gaussian BEAM %%%%%%%%%%%%%%%%%%%%%%%%%%%%%

%[sx,sy]=meshgrid(sxset,syset);[Fis, s] = cart2pol(sx,sy);

%%%%%%%%%%%%% Source Beam %%%%%%%%%%%%%%%%%%

[sx,sy]=meshgrid(sxset,syset);[Fis, s] = cart2pol(sx,sy);

Us = Ac\*exp(-k\*alfa\*s.^2); % In cylindrical coordinates

I\_s = Us.\*conj(Us);maxgen = max(max(I\_s));I\_s = I\_s / max(max(I\_s));

I\_rarr = I\_s;

for ib = 2:length(zarr)

z = zarr(ib);

rxset = rxmat(ib,:);ryset = rymat(ib,:);[rx,ry]=meshgrid(rxset,ryset);[Fir, r] = cart2pol(rx,ry);

%%%% Expression in terms of alpha and electric field

Ur = Ac/(1 + 2\*j\*alfa\*z)\*exp(-k\*alfa\*r.^2/(1 + 2\*j\*alfa\*z)); % In cylindrical coordinates

%I\_r = Ur.\*conj(Ur);

%%%% Intensity expression in terms of alpha\_s and F\_s

I\_r = Ac^2\*k^2\*alfas^4\*Fs^2/(k^2\*alfas^4\*Fs^2 - 2\*k^2\*alfas^4\*Fs\*z + 4\*Fs^2\*z^2 + k^2\*alfas^4\*z^2)\* ....

 exp(-r.^2\*2\*k^2\*alfas^2\*Fs^2/(k^2\*alfas^4\*Fs^2 - 2\*k^2\*alfas^4\*Fs\*z + 4\*Fs^2\*z^2 + k^2\*alfas^4\*z^2));

I\_r = I\_r / maxgen;

I\_rarr = cat(3,I\_rarr,I\_r);

end

figure(1)

%%%%%%%% Four Individual 3D Intensity Plots %%%%%%%%%%%%%%%%%

for ib = 1:length(zarr)

I\_r = I\_rarr(:,:,ib);subplot(2,2,ib);

rxset = rxmat(ib,:);ryset = rymat(ib,:);[rx,ry]=meshgrid(rxset,ryset);rxn = rx / 1e-2;ryn = ry / 1e-2;

meshc(rxn,ryn,real(I\_r));view([35 45]);colormap([0 0 0])

xlabel('\itr\_x\rm\bf axis in cm','FontSize',10,'FontWeight','bold','Rotation',-12);

ylabel('\itr\_y\rm\bf axis in cm','FontSize',10,'FontWeight','bold','Rotation',25)

if ib == 1;xlabel('\its\_x\rm\bf axis in cm','FontSize',10,'FontWeight','bold','Rotation',-12);end

if ib == 1;ylabel('\its\_y\rm\bf axis in cm','FontSize',10,'FontWeight','bold','Rotation',25);end

zlabel('\fontname{Verdana}\fontsize{12}\itI\_r\_N','FontSize',12,'FontWeight','bold')

zstr = [' \itz \rm\bf= ' num2str(zarr(ib)/1e0,'%3.0f') ' m '];

leg1 = ['Receiver intensity plot for Gaussian beam with ' zstr];if ib == 1;leg1 = ['Source intensity plot for Gaussian beam with ' zstr];end

title(leg1,'FontSize',10)

set(gcf,'Renderer','Zbuffer');set(gcf,'Color','White');set(gca,'FontSize',11);

axis ([min(min(rxn))\*1 max(max(rxn))\*1 min(min(ryn))\*1 max(max(ryn))\*1 0 max(max(I\_r))]);

end

figure(2)

%%%%%%%% Four Individual Contour Plots %%%%%%%%%%%%%%%%%

for ib = 1:length(zarr)

I\_r = I\_rarr(:,:,ib);subplot(2,2,ib);

rxset = rxmat(ib,:);ryset = rymat(ib,:);[rx,ry]=meshgrid(rxset,ryset);rxn = rx / 1e-2;ryn = ry / 1e-2;

[C,h] = contour(rxn,ryn,I\_r,'-k');axis square;fax = 1;

axis ([min(min(rxn))\*1 max(max(rxn))\*1 min(min(ryn))\*1 max(max(ryn))\*1]);

line([min(min(rxn))\*fax max(max(rxn))\*fax],[0 0],'LineWidth',1.8,'color','black','LineStyle','--');

line([0 0],[min(min(ryn))\*fax max(max(ryn))\*fax],'LineWidth',1.8,'color','black','LineStyle','--');

xlabel('\itr\_x\rm\bf axis in cm','FontSize',10,'FontWeight','bold');

ylabel('\itr\_y\rm\bf axis in cm','FontSize',10,'FontWeight','bold');

if ib == 1;xlabel('\its\_x\rm\bf axis in cm','FontSize',10,'FontWeight','bold');end

if ib == 1;ylabel('\its\_y\rm\bf axis in cm','FontSize',10,'FontWeight','bold');end

zstr = [' \itz \rm\bf= ' num2str(zarr(ib)/1e0,'%3.0f') ' m '];

leg1 = ['Receiver intensity plot for Gaussian beam with ' zstr];if ib == 1;leg1 = ['Source intensity plot for Gaussian beam with ' zstr];end

title(leg1,'FontSize',10)

%set(gcf,'Renderer','Zbuffer');set(gcf,'Color','White');set(gca,'FontSize',11);

set(h,'LineWidth',1.2);H = clabel(C,h);set(H,'FontSize',6,'LineWidth',3)

set(gca,'FontSize',11);set(gcf,'Color',[1 1 1])

end

figure(3)

%%%%%%%% Four Individual Crosssection Plots %%%%%%%%%%%%%%%%%

for ib = 1:length(zarr)

I\_r = I\_rarr(:,:,ib);subplot(2,2,ib);

rxset = rxmat(ib,:);ryset = rymat(ib,:);

R = sqrt(rxset.^2+ryset.^2);RR = [-R(1:round(numel(R)/2)) R(round(numel(R)/2)+1:end)];RRn = RR / 1e-2;

plot(RRn,diag(I\_r),'-k','LineWidth',2);

set(gcf,'Renderer','Zbuffer');set(gcf,'Color','White');set(gca,'FontSize',14);grid on;

axis ([min(RRn)\*1 max(RRn)\*1 0 max(max(I\_r))\*1.05]);

xlabel('\itr\rm\bf axis in cm','FontSize',10,'FontWeight','bold');

ylabel('\fontname{Verdana}\fontsize{12}\itI\_r\_N','FontSize',12,'FontWeight','bold')

if ib == 1;xlabel('\its\rm\bf axis in cm','FontSize',10,'FontWeight','bold');end

if ib == 1;ylabel('\fontname{Verdana}\fontsize{12}\itI\_s\_N','FontSize',12,'FontWeight','bold');end

end