```
hold off
%Data taken using photodiode and knife
%x data is in mils measured from an arbitrary point
%y data is photodiode reading

x1=[200,220,240,256,259,263,266,269,271,273,276,279,283,300,325,350];
y1=[810,809,800,731,702,639,567,456,386,316,233.4,171,111,32.6,8.4,3.1];

x2=[175,200,230,237,242,248,275,325];
y2=[810,808,717,595,417,222.6,26.7,2.5];

x3=[150,200,238,242,245,248,251,254,256,258,262,265,300,350];
y3=[810,809,752,715,670,603,505,378,304,245,152.8,106.7,11.2,3.2];

x4=[150,200,223,227,230,233,236,238,241,242,244,250,275,350];
y4=[810,809,747,697,635,531,390,300,199.5,173.3,128.6,63.4,10.3,1.7];

x5=[150,175,205,217,221,223,225,227,230,234,250,275,300];
y5=[810,809,796,702,594,513,412,312,201.2,111.2,25.2,6,2.9];

x6=[150,175,200,215,232,236,238,239,240,241,243,245,250,275,300];
y6=[810,810,809,806,704,596,494,443,385,332,240,174,79.9,10.6,3.6];

x7=[150,175,200,225,250,255,257,258,259,260,261,263,270,300,325,350];
y7=[810,810,810,809,722,588,479,416,353,298,249.2,175.6,57,4.5,1.6,3.2];


%the points along the direction of propagation that we use
positions=[3.0015,2.925,2.7455,2.4095,2.2515,2.1365,2.0075];
positions=positions.*1000; %convert to mils
positions=positions';

allWs=0;

%%D4sigma did not work that well
%allWs(1)=D4sigma(makeMeanX(x1),makeIProf(x1,y1));
%allWs(2)=D4sigma(makeMeanX(x2),makeIProf(x2,y2));
%allWs(3)=D4sigma(makeMeanX(x3),makeIProf(x3,y3));
%allWs(4)=D4sigma(makeMeanX(x4),makeIProf(x4,y4));
%allWs(5)=D4sigma(makeMeanX(x5),makeIProf(x5,y5));
%allWs(6)=D4sigma(makeMeanX(x6),makeIProf(x6,y6));
%allWs(7)=D4sigma(makeMeanX(x7),makeIProf(x7,y7));
%allWs=allWs';

allSs=[0,0,0,0];

allSs(1,:)=beamWaistCalculator(x1,y1);
allSs(2,:)=beamWaistCalculator(x2,y2);
allSs(3,:)=beamWaistCalculator(x3,y3);
allSs(4,:)=beamWaistCalculator(x4,y4);
allSs(5,:)=beamWaistCalculator(x5,y5);
allSs(6,:)=beamWaistCalculator(x6,y6);
allSs(7,:)=beamWaistCalculator(x7,y7);
```

```
%beamWaistCalculator just fits it. You gotta multiply by sqrt(2)
%yourself to get the beam radius
fitWaists=allSs(:,2)*sqrt(2);
allPositions=-1000:10:5000;


%our two fit functions
%.0160539764 is the wavelength in mils
f=inline('a(1).*sqrt(1.+((x-a(2)).*(0.0160539764)./(pi.*(a(1))^2)).^2)','a','x');
errorF=inline('sum((f(a,x)-y).^2)','a','x','y');

f2=inline('a(1).*sqrt(1.+(1+a(3).^2).*((x-a(2)).*(0.0160539764)./(pi.*
(a(1))^2)).^2)','a','x');
errorF2=inline('sum((f2(a,x)-y).^2)','a','x','y');

aa=fminsearch(@(a)errorF(a,positions,fitWaists),[.43347,8400], optimset('TolX', 1e-12))

aaa=fminsearch(@(a)errorF2(a,positions,fitWaists),[aa(1),aa(2),0], optimset('TolX',
1e-12))


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%PLOT%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

allPositions=min(positions)-5000:abs(min(positions)-
max(positions))/100:max(positions)+5500;
%now to convert to mm
plot(allPositions*.0254,f(aa,allPositions)*.0254,'b-','linewidth',5)
hold on
plot(allPositions*.0254,f2(aaa, allPositions)*.0254,'r-','linewidth',2)
hold on
plot(positions*.0254,fitWaists*.0254,'k*','markersize',10)
hold on
h=legend('Fit with M squared = 1','Fit with M squared determined by fit','Measured waist
values')
set(h,'fontsize',18)
legend(h,'location','northeast')
xlabel('knife position along beam path (mm)')
ylabel('second moment width (mm)')
set(findall(gcf,'type','text'),'FontSize',18)
xlim([-10,100])
ylim([0 1])
print -depsc waistExample.eps

%now, output the answer. aa(1) is the waist at the narrowest point, assuming M^2=1, or in
other words, for the purposes of intensity calculations, it will be no smaller than that:
printf('\n\nthe waist in this direction is %5.8f \n\n\n\n\n',aa(1));
```