In [18]:
```
from astropy.table import Table
from astropy.io import fits
import numpy as np
from matplotlib.colors import LogNorm
import os
import pandas
#import datashader
# Set up matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
from astropy.visualization import astropy_mpl_style

plt.style.use(astropy_mpl_style)
```

In [ ]:
```
```

In [19]:
```
#filename = "/lfs/usrhome/msc/ph22c040/scratch/station_beam.fits"
filename = "/lfs/usrhome/msc/ph22c040/scratch/station_beam.fits"
```

In [90]:
```
hdulist = fits.open(filename)
print(len(hdulist))
#hdulist[0]
print(hdulist[0].header)
```

```
1
SIMPLE  =                    T  /                                               BITPIX  =
-32  /                                                NAXIS   =                    3  /
NAXIS1  =                 2560                                                  NAXIS2  =
2560                                                  NAXIS3  =                  901  /
EXTEND  =                    T  /                                               BSCALE  =    1.00000000000
E+00  /                                               BZERO   =    0.00000000000E+00  /
CRPIX1  =                 1280                                                  CDELT1  = -0.0044444444444
4800                                                  CRVAL1  =    0.00000000000E+00  /
CTYPE1  = 'RA---SIN'  /                                                         CRPIX2  =
1280                                                  CDELT2  = 0.004444444444448001
CRVAL2  =   -3.00000000000E+01  /                                               CTYPE2  = 'DEC--SIN'  /
CRPIX3  =    1.00000000000E+00  /                                               CDELT3  =    1.00000000000
E+05  /                                               CRVAL3  =    1.06000000000E+08  /
CTYPE3  = 'FREQ    '  /                                                        CELLSCAL= 'CONSTANT'  /
EPOCH   =    2.00000000000E+03  /                                               DATAMAX =    1.00000214577
E+00  /                                               DATAMIN =    4.54502196590E-06  /
HISTORY CUNIT1  = 'deg     '                                                    HISTORY CUNIT2  = 'deg
'                                                     HISTORY CUNIT3  = 'Hz      '
HISTORY FITS: Miriad fits: Revision 1.37, 2021/12/21 22:54:58 UTC               HISTORY FITS: Executed on:
2022-09-20T14:27:16.0                                 HISTORY FITS: Command line inputs follow:
HISTORY FITS:   op=xyin                                                         HISTORY FITS:   in=AB02_mi
ni.fits                                               HISTORY FITS:   out=AB02_mini
HISTORY REGRID: Miriad regrid: Revision 1.19, 2021/06/02 04:45:09 UTC           HISTORY REGRID: Executed o
n: 2022-09-20T14:27:17.0                              HISTORY REGRID: Command line inputs follow:
HISTORY REGRID:   in=AB02_mini                                                  HISTORY REGRID:   axes=1,2
HISTORY REGRID:   desc=0.0,1024.0,-0.005555555555555556,2048,-30.0,1024.0,0.0055HISTORY REGRID:   tol=0.49
9                                                     HISTORY REGRID:   out=AB02_maxir
HISTORY IMBLR: Miriad imblr: Revision 1.5, 2013/08/30 01:49:21 UTC              HISTORY IMBLR: Executed o
n: 2022-09-20T14:32:28.0                               HISTORY IMBLR: Command line inputs follow:
HISTORY IMBLR:   in=AB02_maxir                                                  HISTORY IMBLR:   out=AB02_
maxi                                                  HISTORY FITS: Miriad fits: fits: Revision 1.37, 2021
/12/21 22:54:58 UTC         HISTORY FITS: Executed on: 22SEP21:06:55:00.0
HISTORY FITS: Command line inputs follow:                                       HISTORY FITS:    op=xyout
HISTORY FITS:    in=AB02_maxi                                                   HISTORY FITS:    out=AB02_
```

```
maxi.fits                                                HISTORY FITS: NOTE: Use options=varwt if loading int
o Miriad                    ORIGIN  = 'Miriad fits: Revision 1.37, 2021/12/21 22:54:58 UTC'  /
END
```

In [21]:
```
from astropy.io import fits
from astropy.utils.data import get_pkg_data_filename

image_file = get_pkg_data_filename('/lfs/usrhome/msc/ph22c040/scratch/station_beam.fits')
```

In [13]:
```
fits.info(image_file)
```

```
Filename: /lfs/usrhome/msc/ph22c040/scratch/station_beam.fits
No.    Name      Ver    Type      Cards   Dimensions   Format
  0  PRIMARY       1 PrimaryHDU      55   (2560, 2560, 901)   float32
```

In [81]:
```
image_data = fits.getdata(image_file, ext=0)
channel_1=image_data[0]
channel_450=image_data[449]
channel_451=image_data[450]
channel_901=image_data[900]
```

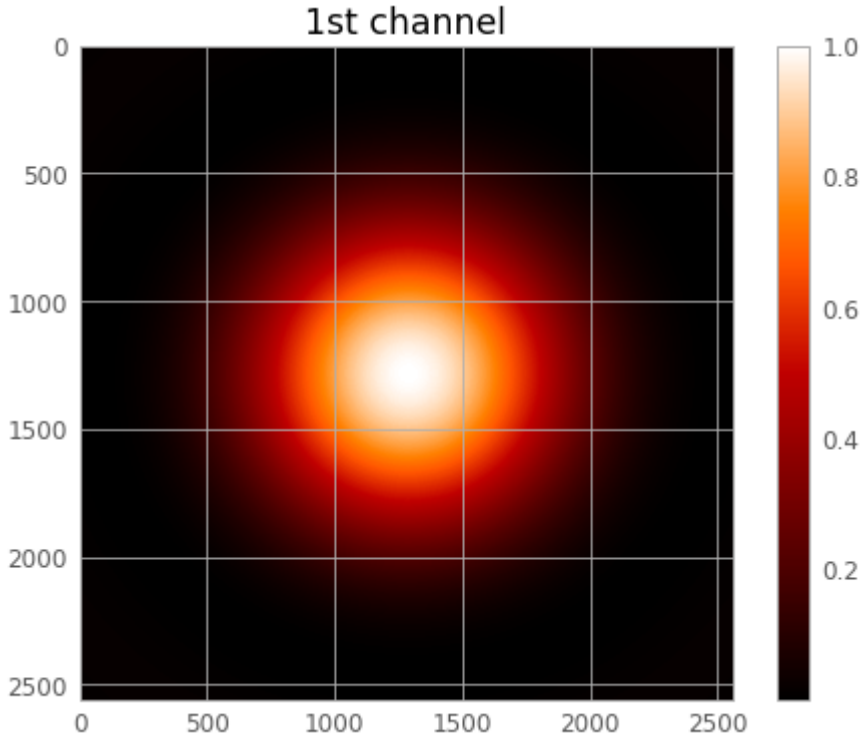
In [75]:
```
print(image_data.shape)
print(channel_1.shape)
```

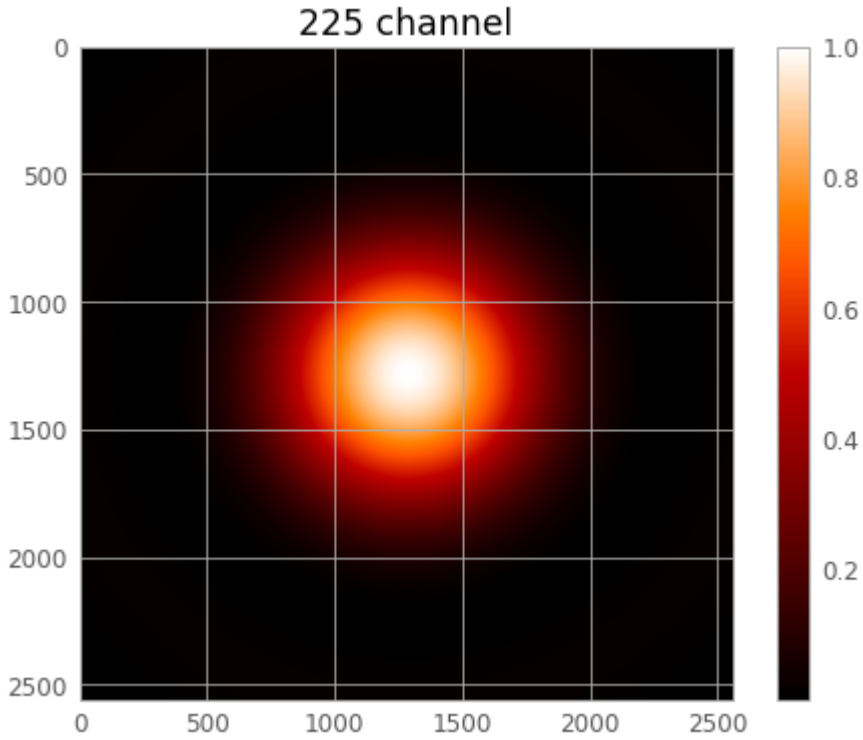
```
(901, 2560, 2560)
(2560, 2560)
```

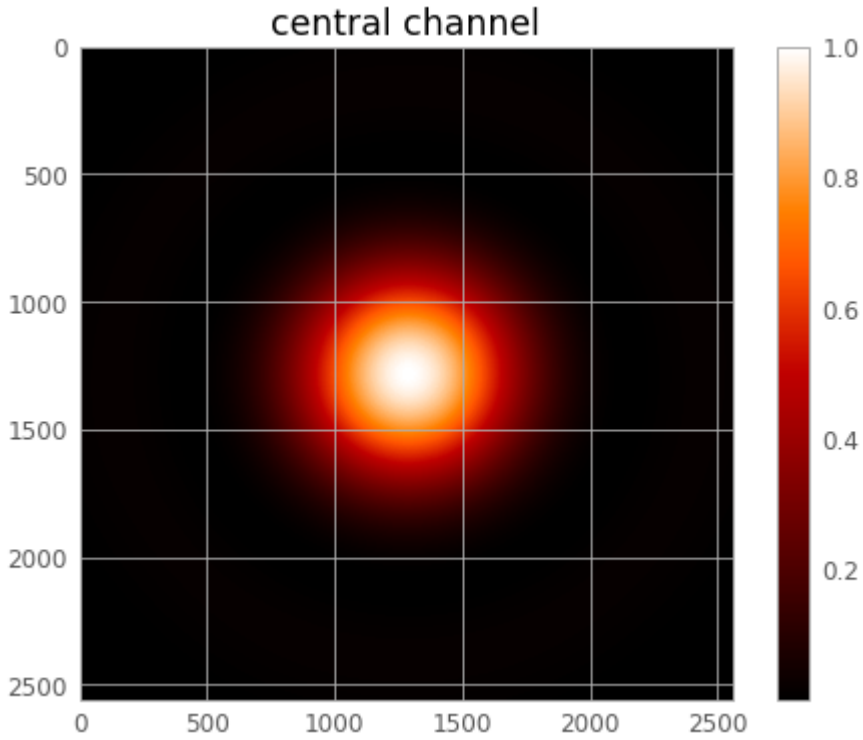
In [96]:
```
import time

start_time=time.time()

plt.figure()
plt.imshow(channel_1)
plt.title("1st channel")
plt.colorbar()

plt.figure()
plt.imshow(image_data[224])
plt.title("225 channel")
plt.colorbar()


plt.figure()
plt.imshow(channel_450)
plt.title("central channel")
plt.colorbar()


plt.figure()
plt.imshow(channel_451)
plt.title("central channel")
plt.colorbar()


plt.figure()
plt.imshow(image_data[674])
plt.title("675 channel")
plt.colorbar()


plt.figure()
plt.imshow(channel_901)
plt.title("last channel")
plt.colorbar()


"""we can see that as the channel no. increases the size of the primary beam becomes narrower"""
```

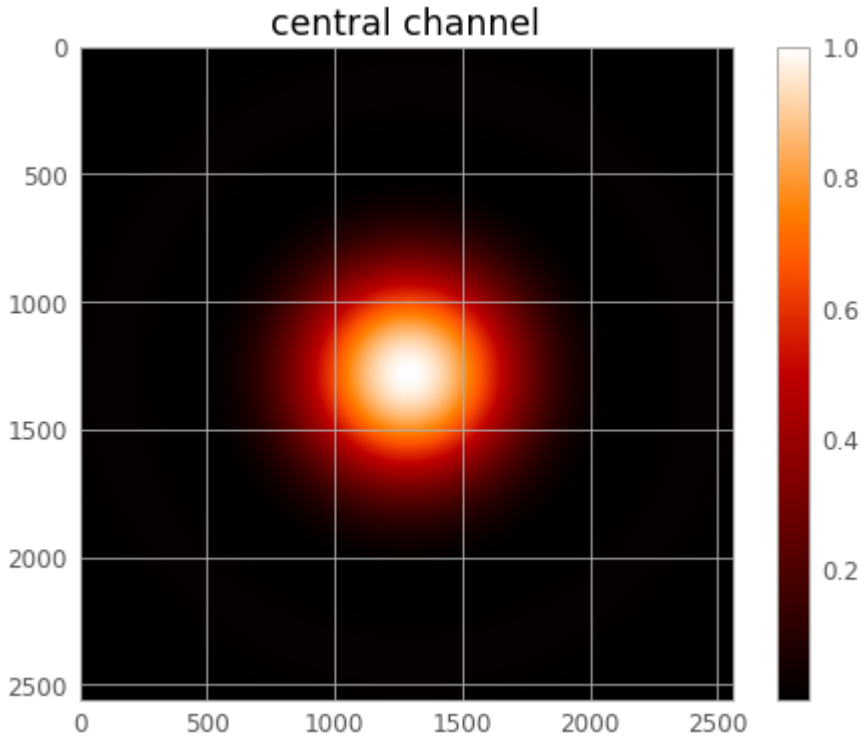
```
end_time=time.time()

total_time=end_time-start_time
print("total time for running",total_time,"seconds")
```

```
total time for running 0.488128662109375 seconds
```




225 channel
0
500
1000
1500
2000
2500
0
500
1000
1500
2000
2500
1.0
0.8
0.6
0.4
0.2


central channel
0
500
1000
1500
2000
2500
0
500
1000
1500
2000
2500
1.0
0.8
0.6
0.4
0.2

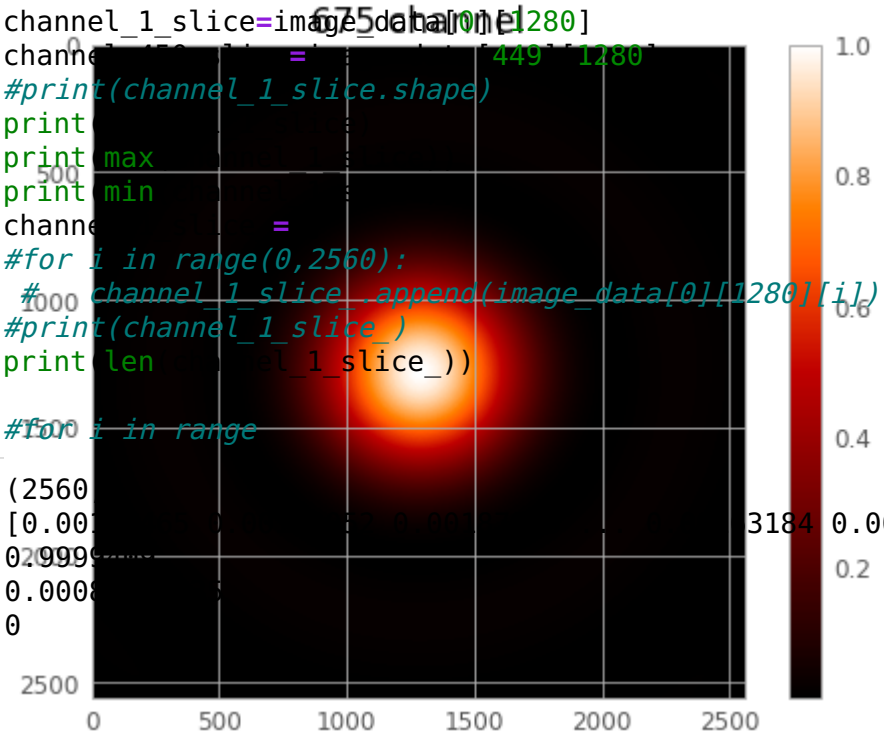


In [102]:
```
"""we can see that as the channel no. increases the size of the primary beam becomes narrower"""
```

Out[102]:
```
'we can see that as the channel no. increases the size of the primary beam becomes narrower'
```

In [ ]:
```

```

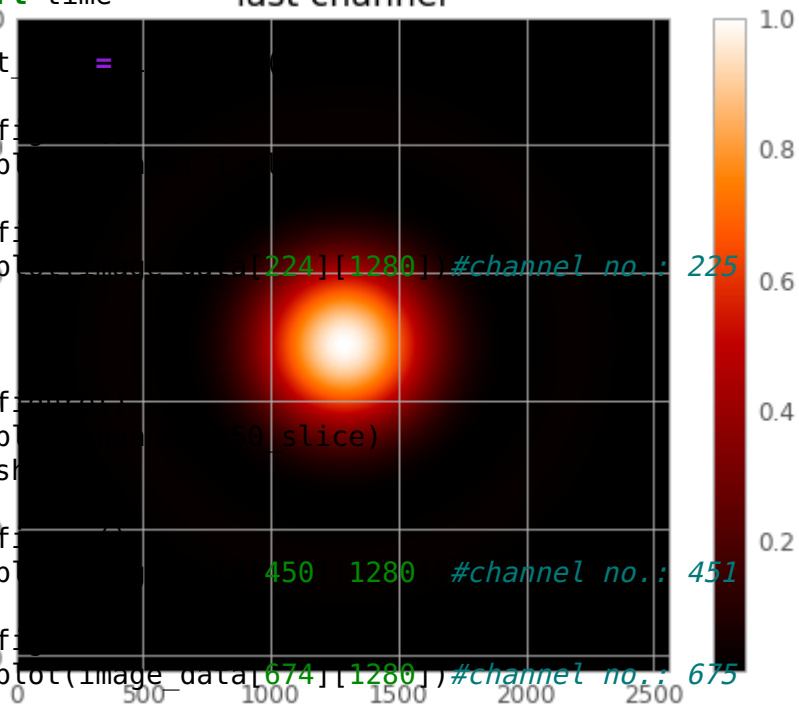
In [78]:
```
channel_1_slice=image_data[0][1280]
channe                =                [449][1280]
#print(channel_1_slice.shape)
print(
print max
print min
channe                =
#for i in range(0,2560):
#    channel_1_slice_.append(image_data[0][1280][i])
#print(channel_1_slice_)
print len                _1_slice_))

#for i in range
```



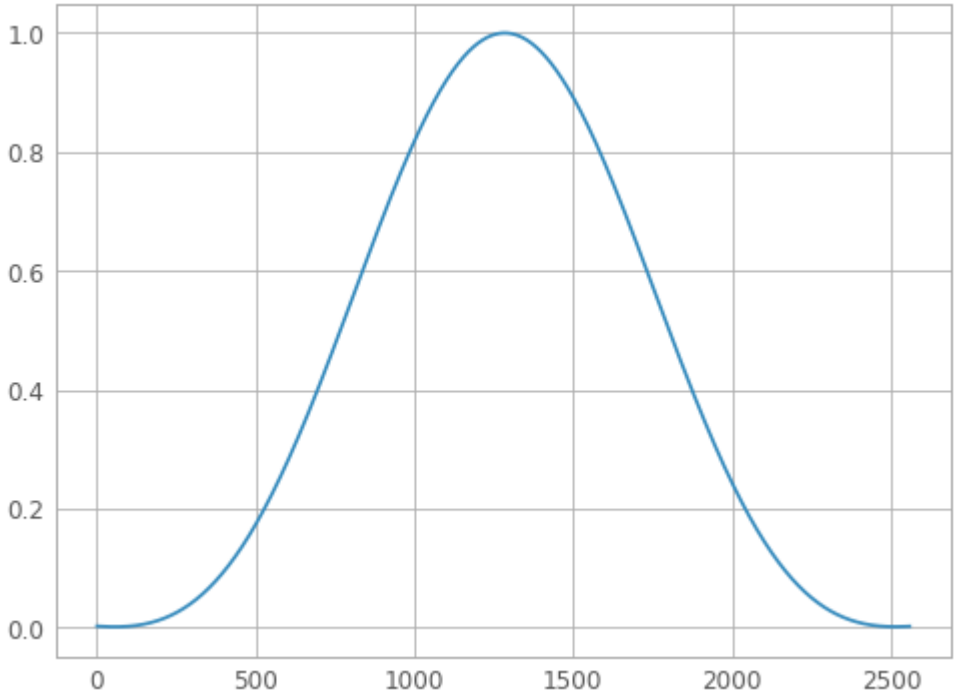

```
(2560
[0.001                                                    3184 0.0016663  0.00169475]
0.999
0.000
0
```

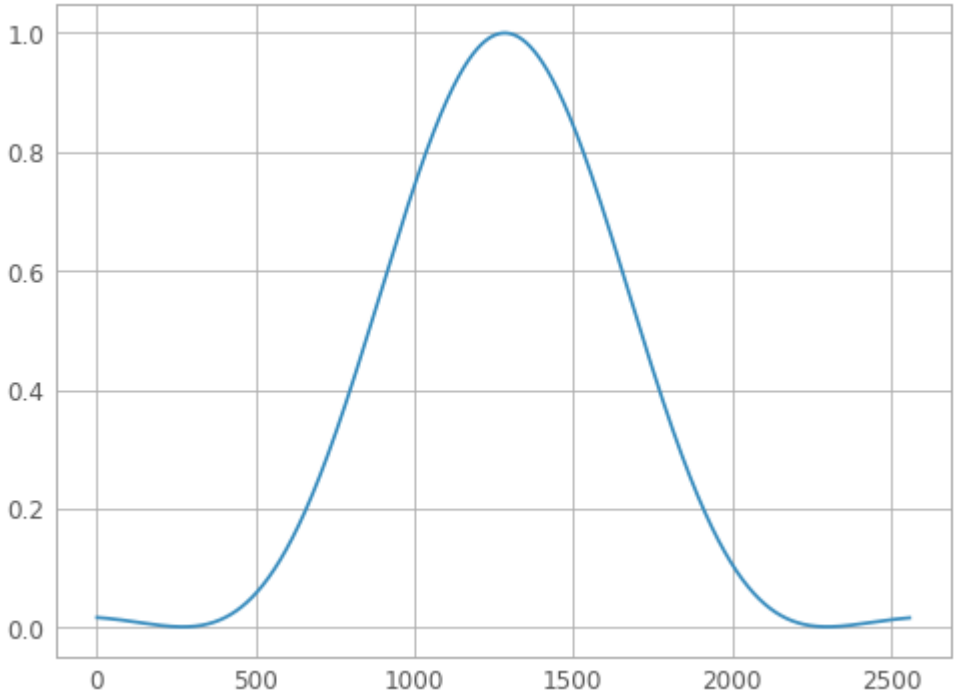
In [100]:

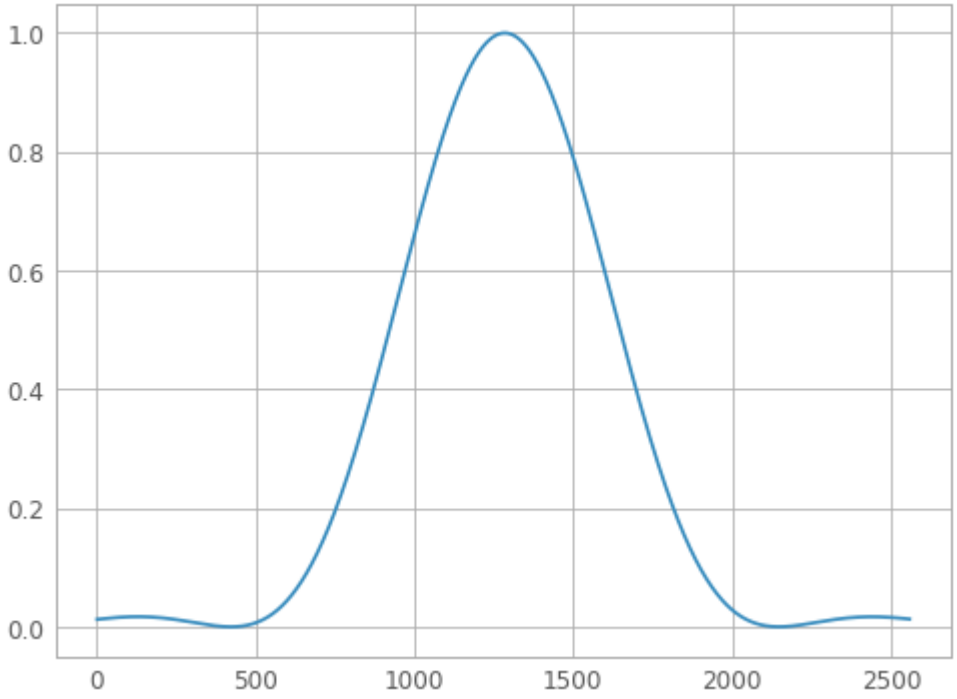
```
import time
start_     =

plt.f
plt.p

plt.f
plt.p                                    [224][1280],#channel no.: 225



plt.f
plt.p                                    50,slice)
plt.s

plt.f
plt.p                                    450  1280  #channel no.: 451

plt.f
plt.plot(image_data[674][1280])#channel no.: 675
```

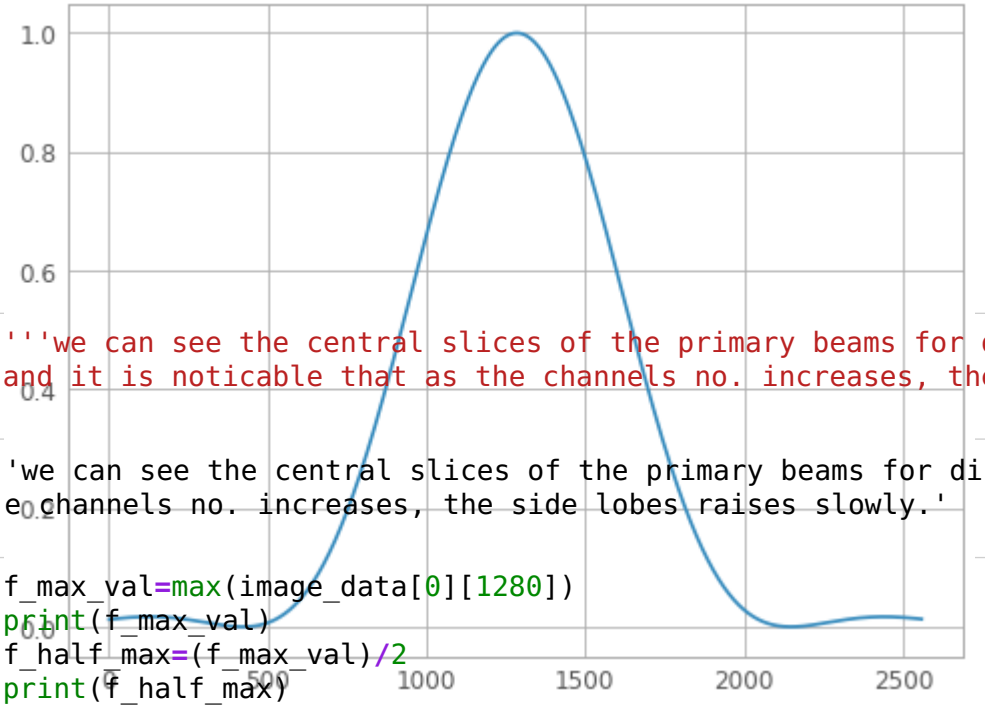



```
plt.figure()
plt.plot(image_data[900][1280])#channel no.: 901
plt.show()


end_time=time.time()

total_time=end_time-start_time
print("total time for running",total_time,"seconds")
```


1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500


1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500


1.0
0.8
0.6
0.4
0.2
0.0
0
500
1000
1500
2000
2500



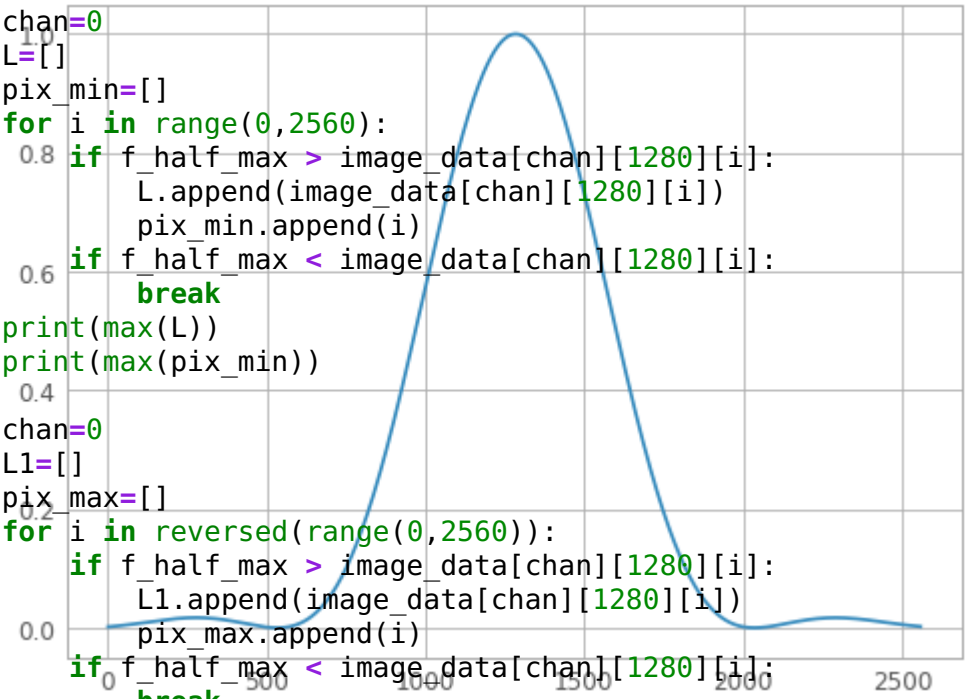
In [101]:
```
'''we can see the central slices of the primary beams for different channels
and it is noticable that as the channels no. increases, the side lobes raises slowly.'''
```

Out[101]:
```
'we can see the central slices of the primary beams for different channels\nand it is noticable that as th
e channels no. increases, the side lobes raises slowly.'
```

In [147]:
```
f_max_val=max(image_data[0][1280])
print(f_max_val)
f_half_max=(f_max_val)/2
print(f_half_max)
```

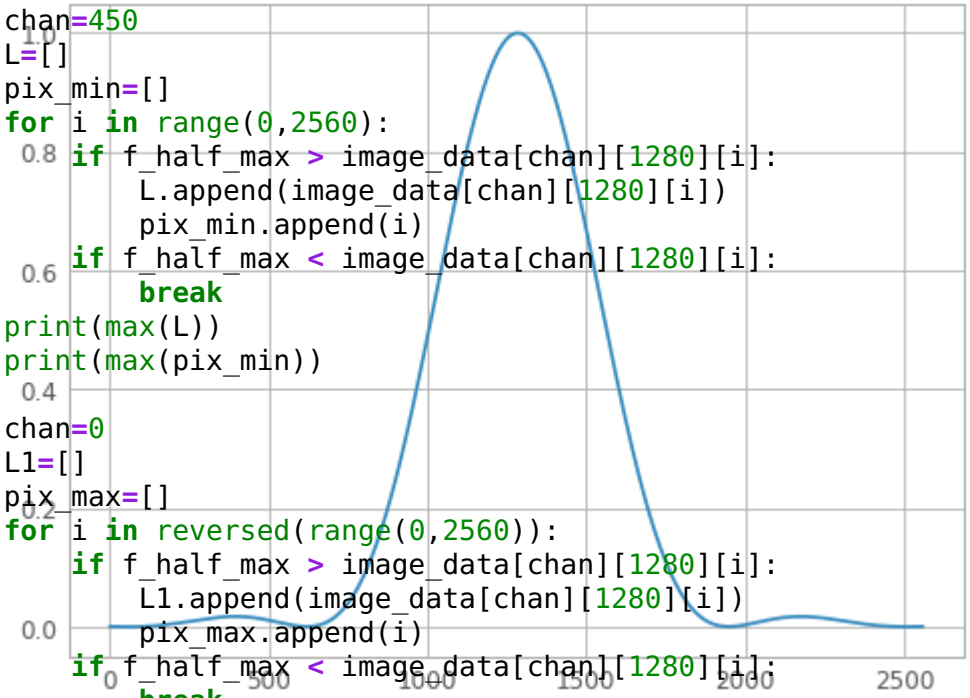
```
0.9999409
0.4999704360961914
```

In [143]:
```
chan=0
L=[]
pix_min=[]
for i in range(0,2560):
    if f_half_max > image_data[chan][1280][i]:
        L.append(image_data[chan][1280][i])
        pix_min.append(i)
    if f_half_max < image_data[chan][1280][i]:
        break
print(max(L))
print(max(pix_min))
chan=0
L1=[]
pix_max=[]
for i in reversed(range(0,2560)):
    if f_half_max > image_data[chan][1280][i]:
        L1.append(image_data[chan][1280][i])
        pix_max.append(i)
    if f_half_max < image_data[chan][1280][i]:
        break
print(max(L1))
#print(max(pix_max))
print(min(pix_max))

FWHM=min(pix_max)-max(pix_min)
print("the value of FWHM in pixel for channel no.",chan,"=",FWHM)
```




```
0.49943495
766
0.4992515
1802
the value of FWHM in pixel for channel no. 0 = 1036
```

In [145]:
```
chan=450
L=[]
pix_min=[]
for i in range(0,2560):
    if f_half_max > image_data[chan][1280][i]:
        L.append(image_data[chan][1280][i])
        pix_min.append(i)
    if f_half_max < image_data[chan][1280][i]:
        break
print(max(L))
print(max(pix_min))

chan=0
L1=[]
pix_max=[]
for i in reversed(range(0,2560)):
    if f_half_max > image_data[chan][1280][i]:
        L1.append(image_data[chan][1280][i])
        pix_max.append(i)
    if f_half_max < image_data[chan][1280][i]:
        break
print(max(L1))
#print(max(pix_max))
print(min(pix_max))

FWHM=min(pix_max)-max(pix_min)
print("the value of FWHM in pixel for channel no.",chan,"=",FWHM)
```




```
total time for running 0.6702406406402588 seconds
0.4988432
920
0.4992515
1802
the value of FWHM in pixel for channel no. 0 = 882
```

In [146]:
```
chan=900
L=[]
pix_min=[]
for i in range(0,2560):
    if f_half_max > image_data[chan][1280][i]:
        L.append(image_data[chan][1280][i])
        pix_min.append(i)
    if f_half_max < image_data[chan][1280][i]:
        break
print(max(L))
print(max(pix_min))

chan=0
L1=[]
pix_max=[]
for i in reversed(range(0,2560)):
    if f_half_max > image_data[chan][1280][i]:
        L1.append(image_data[chan][1280][i])
        pix_max.append(i)
    if f_half_max < image_data[chan][1280][i]:
        break
print(max(L1))
#print(max(pix_max))
print(min(pix_max))

FWHM=min(pix_max)-max(pix_min)
print("the value of FWHM in pixel for channel no.",chan,"=",FWHM)
```

```
0.49735835
1003
0.4992515
1802
the value of FWHM in pixel for channel no. 0 = 799
```

In [156]:
```
"""the value of FWHM decreases as the channel no. increases """
```

Out[156]:
```
'the value of FWHM decreases as the channel no. increases '
```