IN THE NAME OF GOD

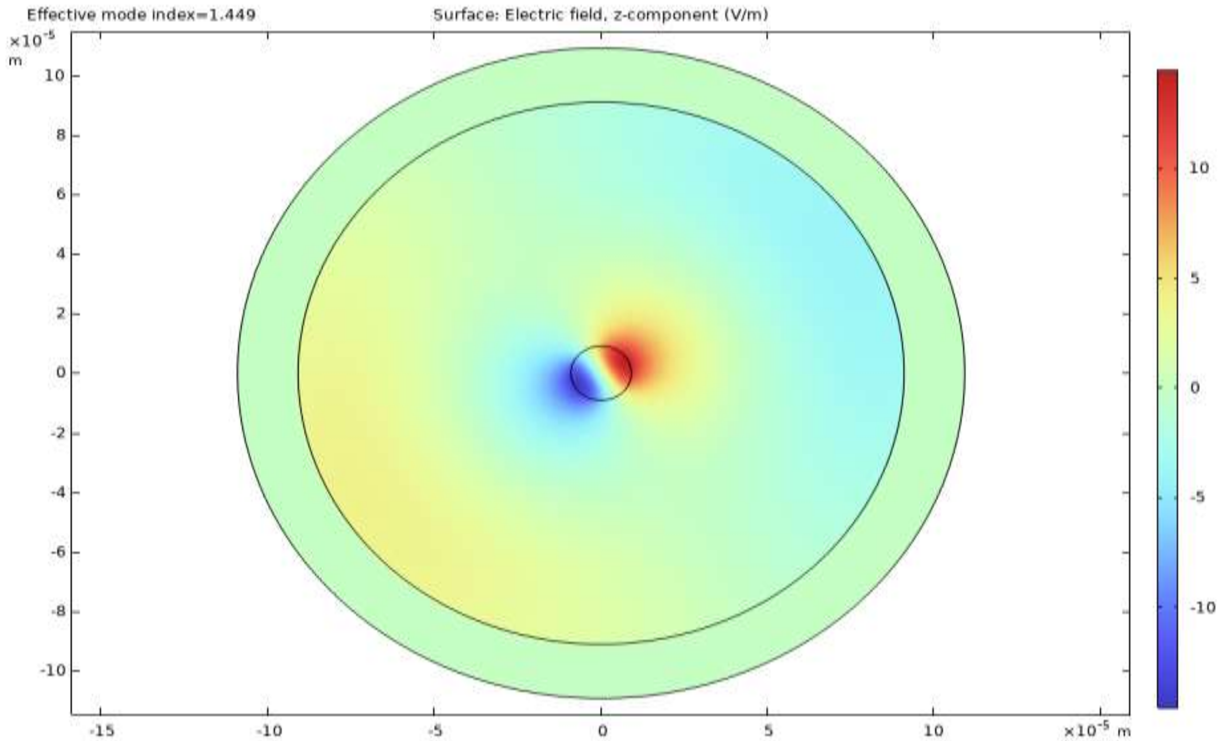
Meysam Asady……………………………………….…99101116

Electromagnetic Fields and waves

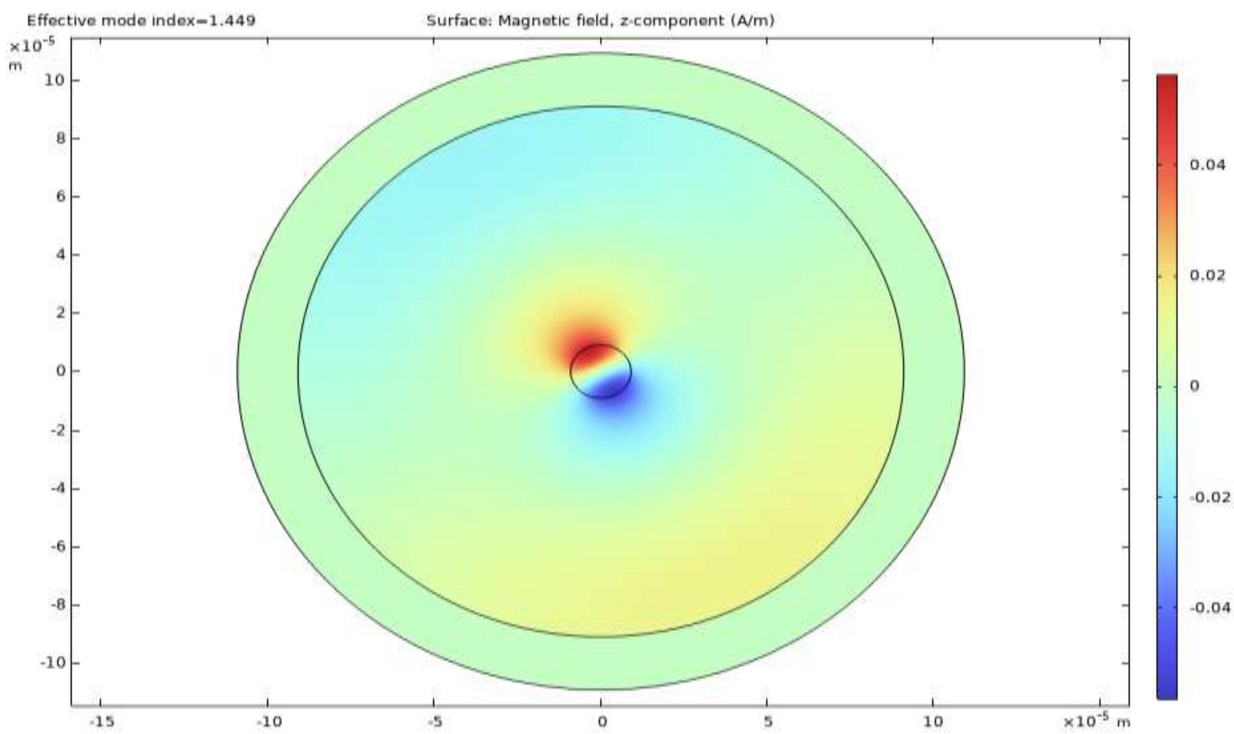
Project

1)

a)

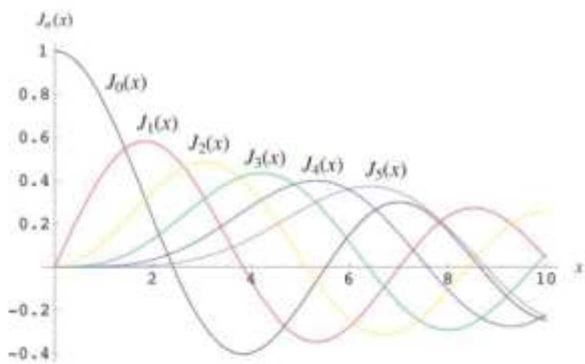


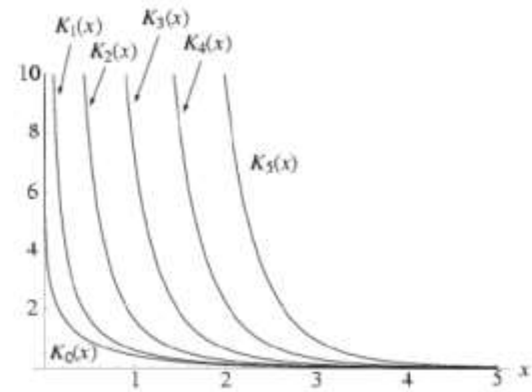
Effective mode index=1.449
Surface: Electric field, z-component (V/m)
×10^-5 m
10
8
6
4
2
0
-2
-4
-6
-8
-10
-15
-10
-5
0
5
10
×10^-5 m
10
5
0
-5
-10



Effective mode index=1.449
Surface: Magnetic field, z-component (A/m)
×10^-5 m
10
8
6
4
2
0
-2
-4
-6
-8
-10
-15
-10
-5
0
5
10
×10^-5 m
0.04
0.02
0
-0.02
-0.04

we know that Bessel Functions of first- and second-degree approach zero as we go further from the origin.





The figures of the previous page show that the magnitude of electric and magnetic fields fade away as we get further from the center of the circle.

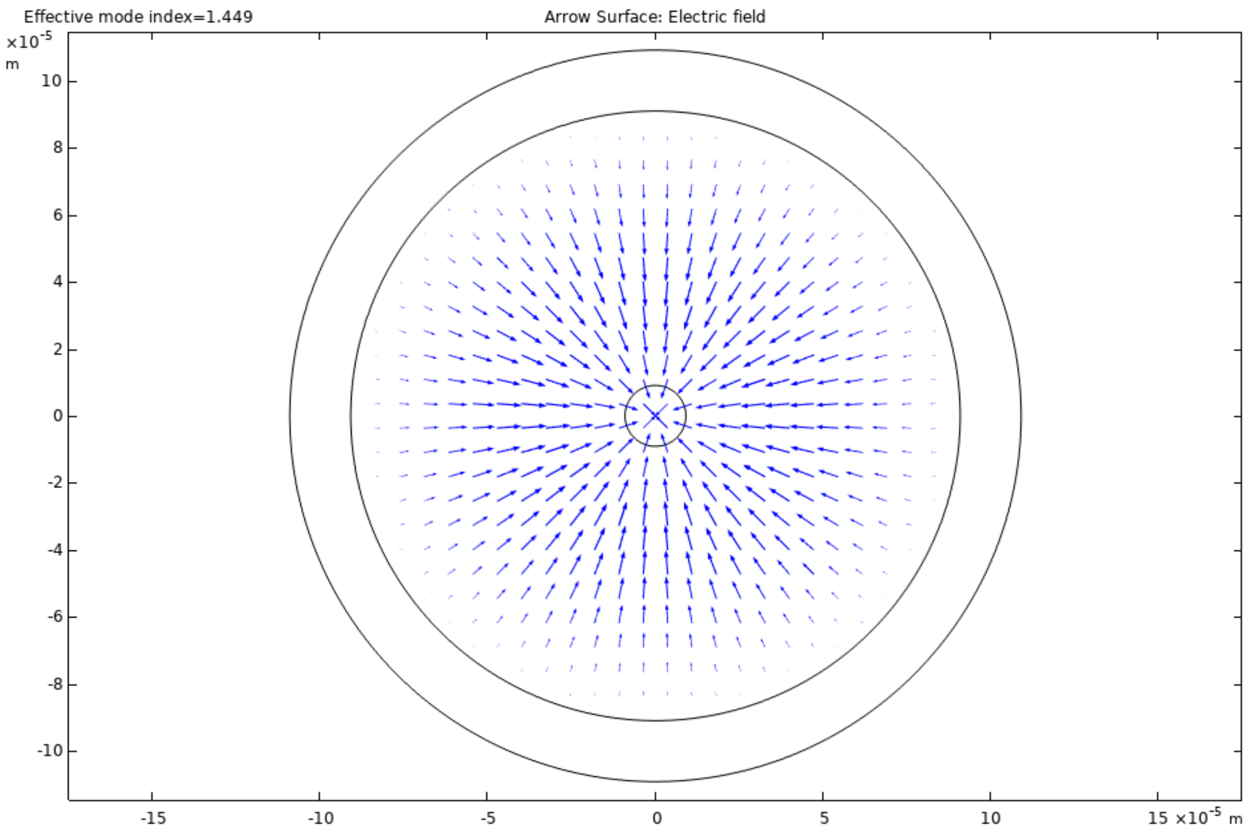
According to the equations below, the electric and magnetic fields vary in a periodic way with respect to ϕ.

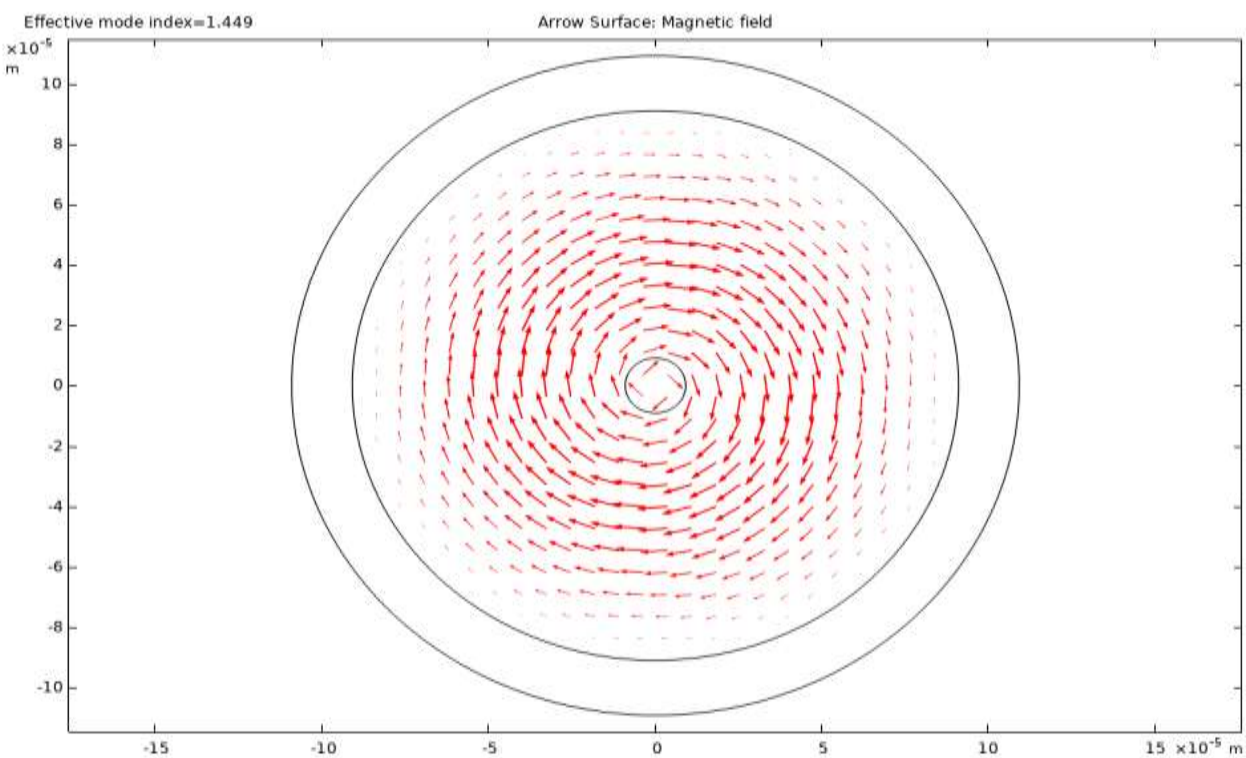
$$E_z = \begin{cases} AJ_m(p\rho)exp(im\phi)exp\,(i\beta z); & \rho \leq a, \\ CK_m(q\rho)exp\,(im\phi)exp\,(i\beta z); & \rho > a. \end{cases}$$

$$H_z = \begin{cases} BJ_m(p\rho)exp\,(im\phi)exp\,(i\beta z); & \rho \leq a, \\ DK_m(q\rho)exp\,(im\phi)exp\,(i\beta z); & \rho > a. \end{cases}$$

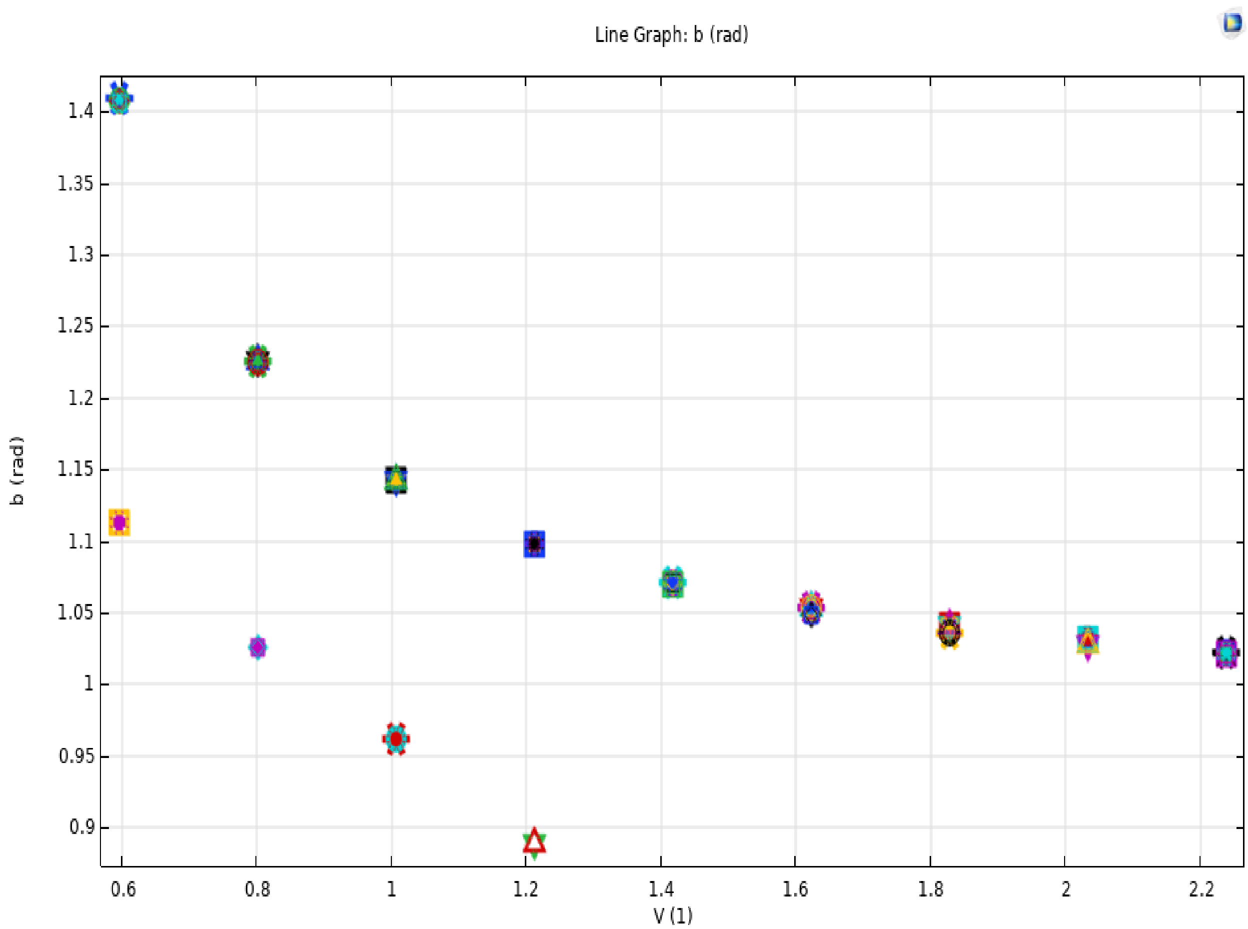
The figures of previous page verify this claim.

b)


Effective mode index=1.449
Arrow Surface: Electric field
×10^-5 m
10
8
6
4
2
0
-2
-4
-6
-8
-10
-15
-10
-5
0
5
10
15 ×10^-5 m


Effective mode index=1.449
Arrow Surface: Magnetic field
×10^-5 m
10
8
6
4
2
0
-2
-4
-6
-8
-10
-15
-10
-5
0
5
10
15 ×10^-5 m

c)


Line Graph: b (rad)
b (rad)
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
1
0.95
0.9
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
V (1)

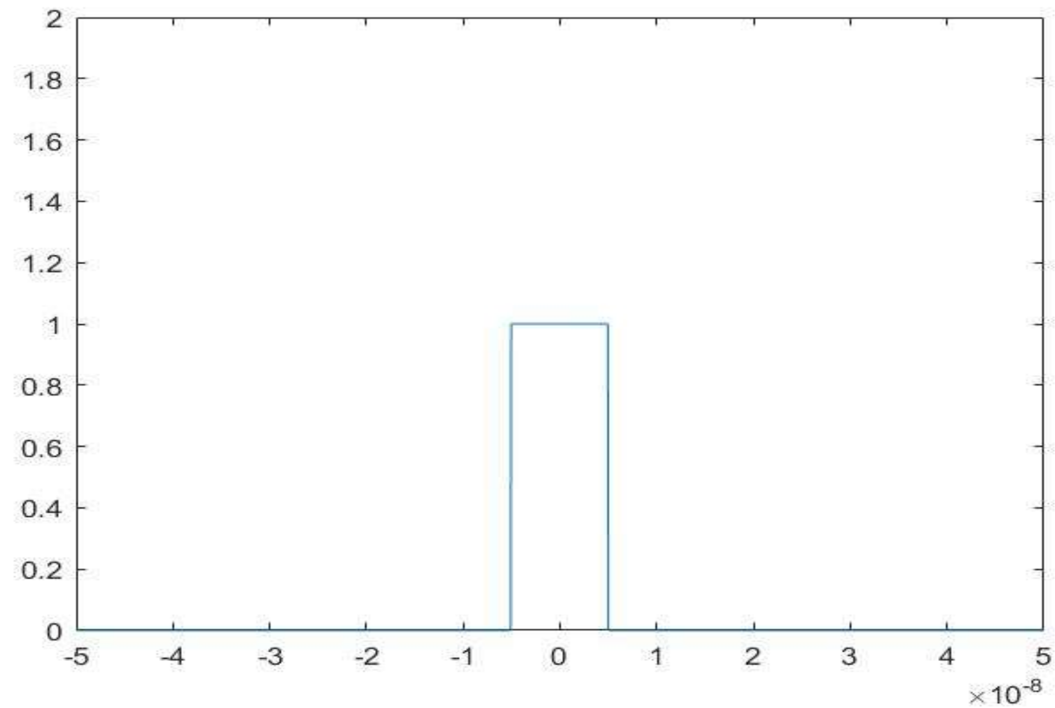
2)

a)

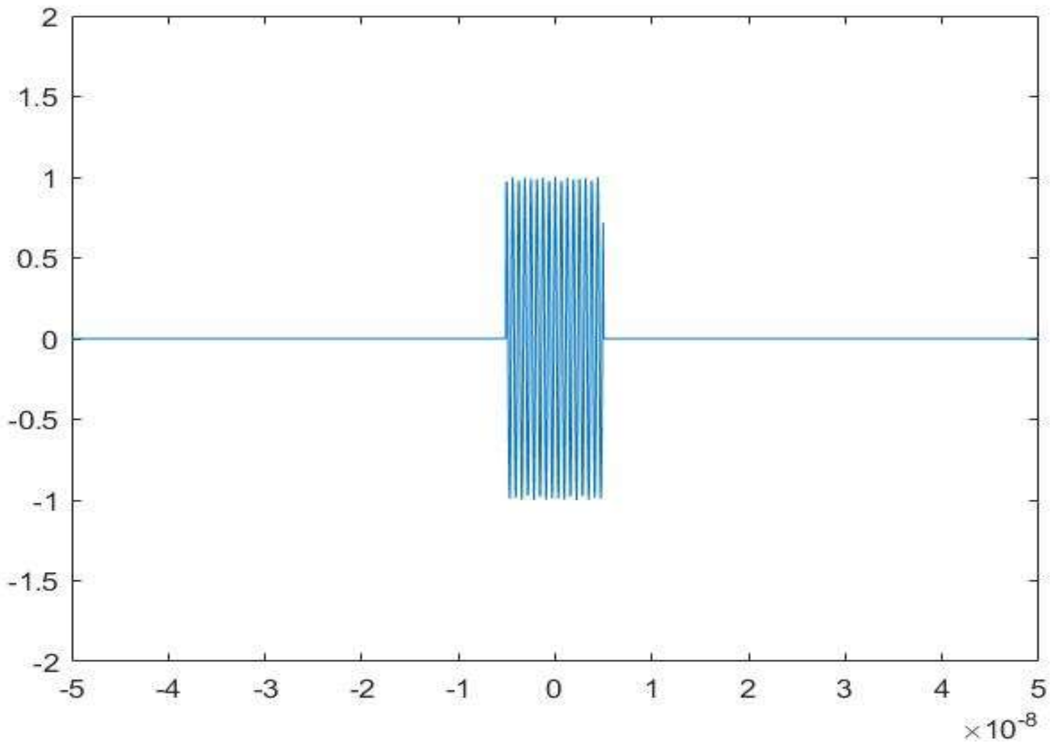
we know that $f_c = 6.56 * 10^9 Hz$ and the second mode has a cutoff frequency higher than 10GHz.

Guide	Size (inch)	Rec. (GHz)	f_c (GHz)	Band	(GHz)
WR650	6.500×3.250	1.12 - 1.70	0.91	L	(1.0 - 2.0)
WR284	2.840×1.340	2.60 - 3.95	2.08	S	(2.0 - 4.0)
WR187	1.872×0.872	3.95 - 5.85	3.15	C	(4.0 - 8.0)
WR90	0.900×0.400	8.20 - 12.40	6.56	X	(8.0 - 12.0)
WR62	0.622×0.311	12.40 - 18.00	9.49	Ku	(12.0 - 18.0)
WR42	0.420×0.170	18.00 - 26.50	14.05	K	(18.0 - 27.0)
WR28	0.280×0.140	26.50 - 40.00	21.08	Ka	(27.0 - 40.0)

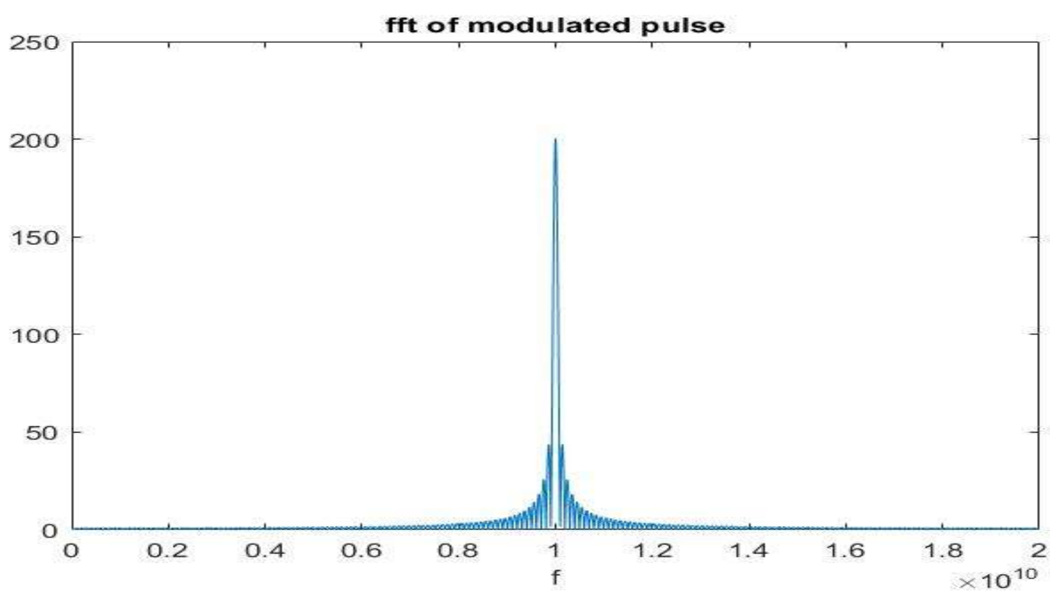
Let's generate the pulse.



And this is the modulated pulse.



The below figure is fft of mod pulse.



Now we have to cancel out the frequencies below the f_c

because they can’t propagate.

```
%cancel frequancies below cutoff
for i=1:length(f)
    if (f(i)<fc)
        f(i)=0;
    end
end
```

Calculation of propagation constant

```
%calculating propogation constants
beta=sqrt(1-(fc./f).^2);
```

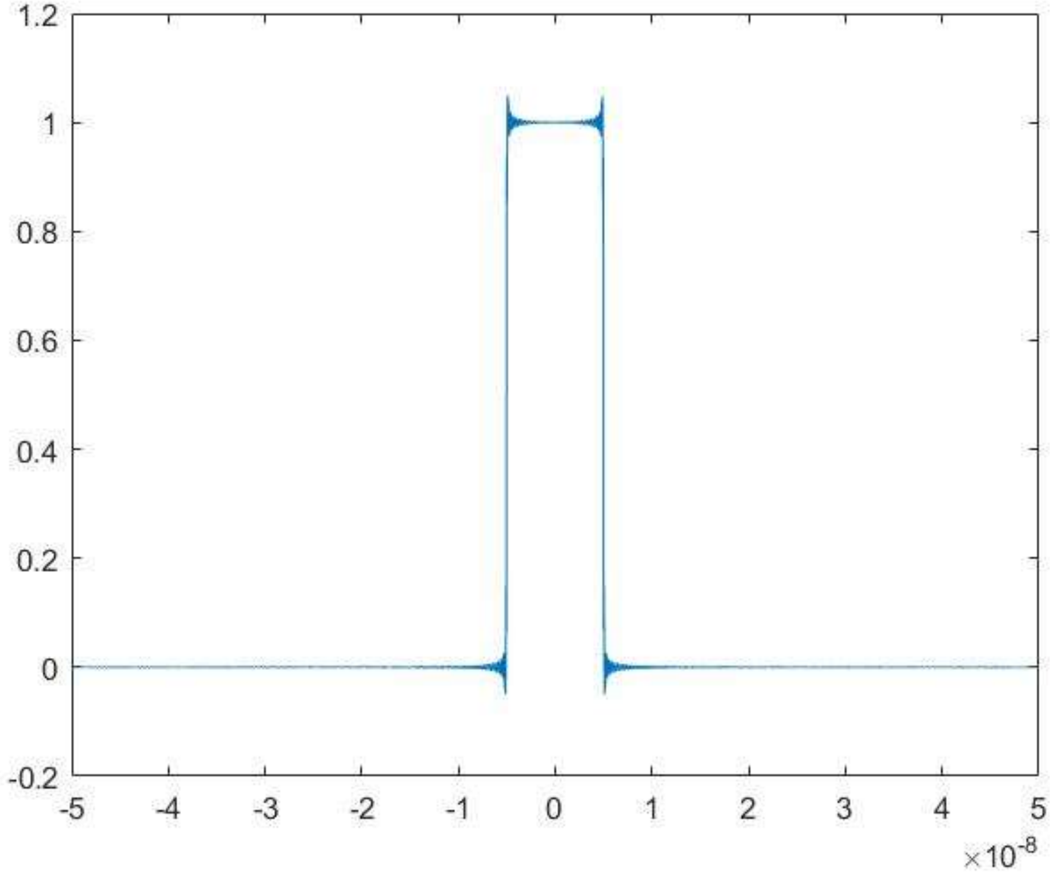
After a distance z=10cm we will have:

```
%calculating propogation constants
beta=sqrt(1-(fc./f).^2);
%shape of pulse in z=10
z=1e-2;
fftpulse2=fftpulse2(m:end);
for i=1:length(fftpulse2)
    fftpulse2(i)=fftpulse2(i).*exp(-1i*z*beta(i));
end
```

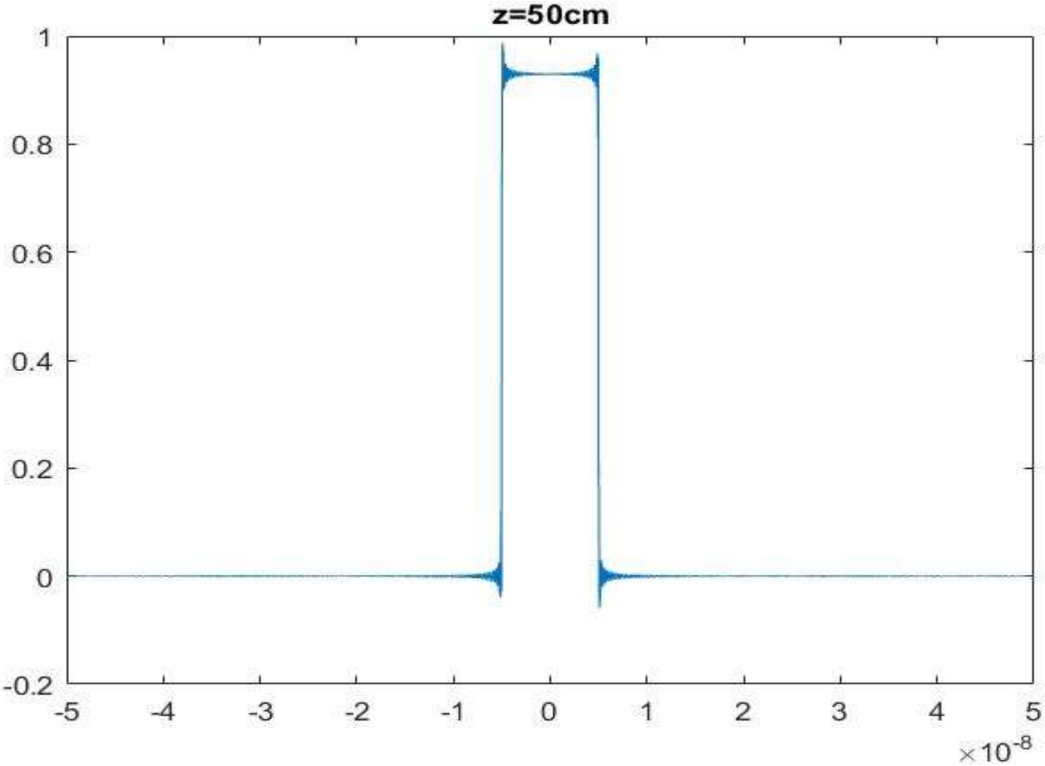
Now we have to take an ifft and demodulate to find the result.

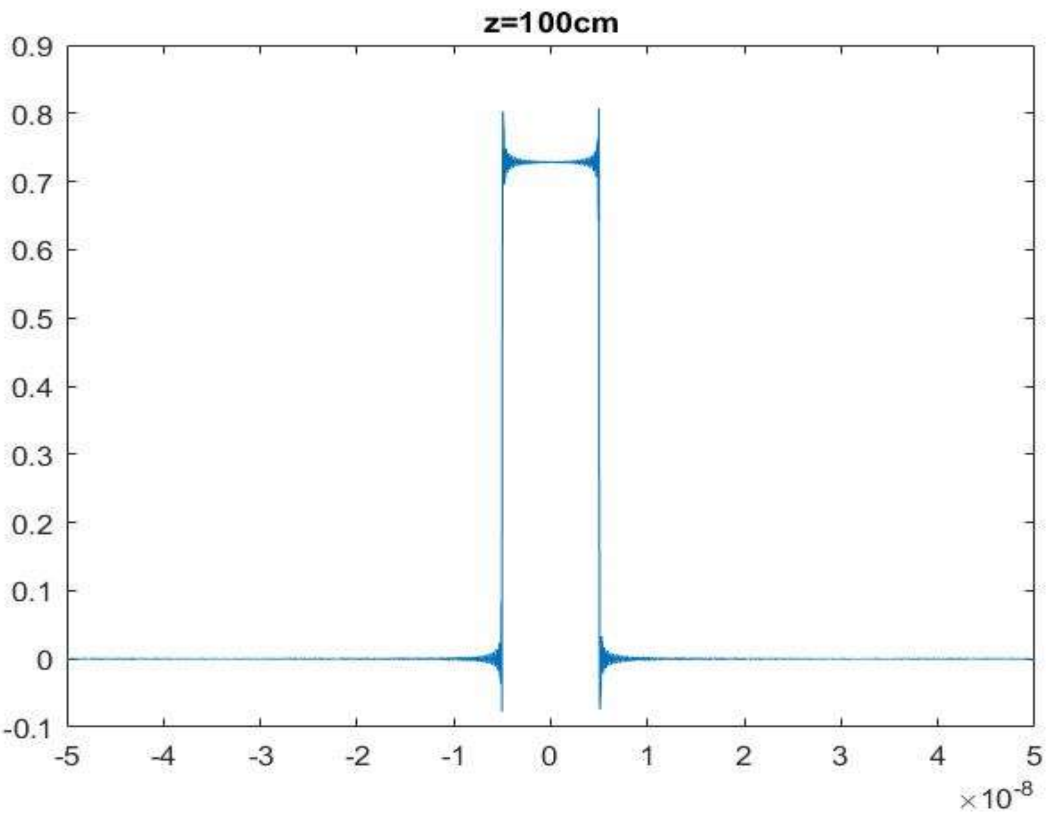
```
%%
%calculate ifft to find the result signal
disppulse=ifft(fftpulse3);
disppulse2=disppulse.*exp(-1i*w0*t);
plot(t,real(disppulse2))
```

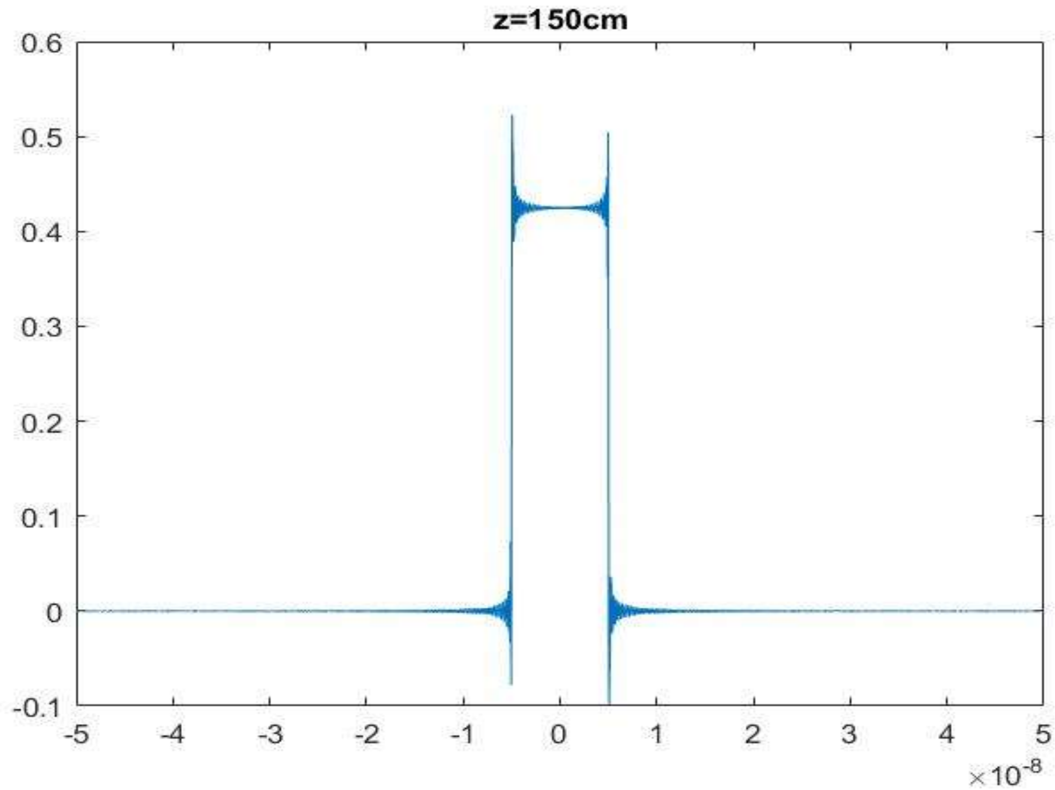
The result is:

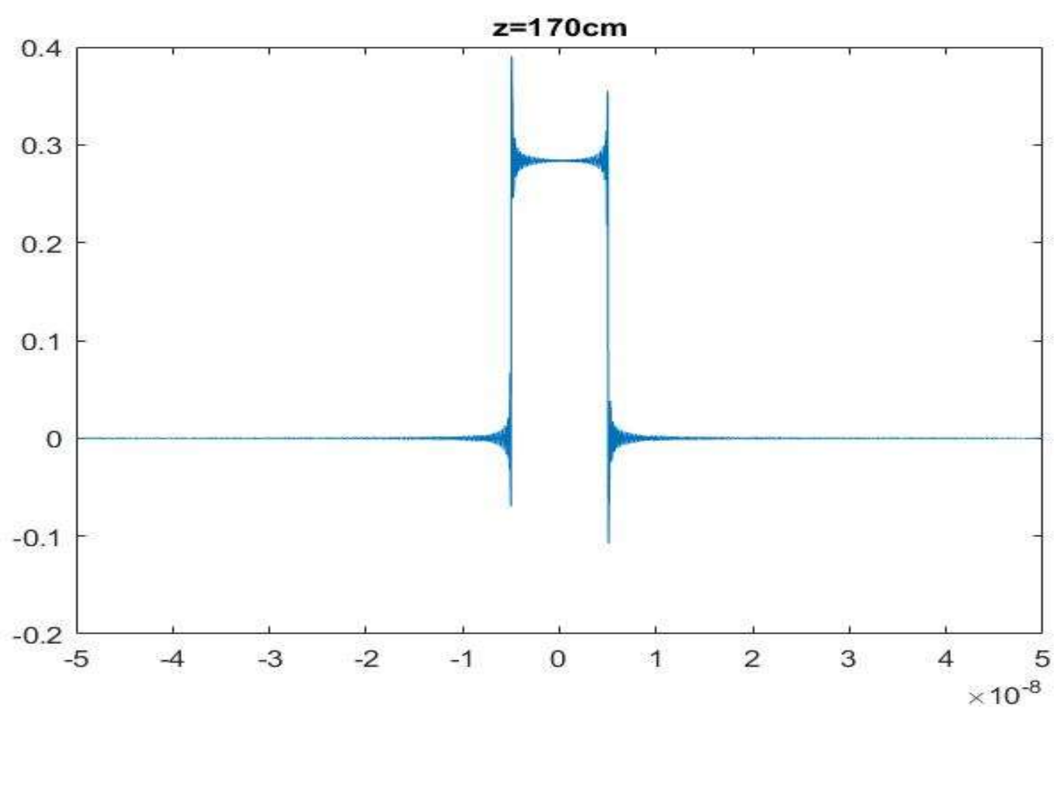


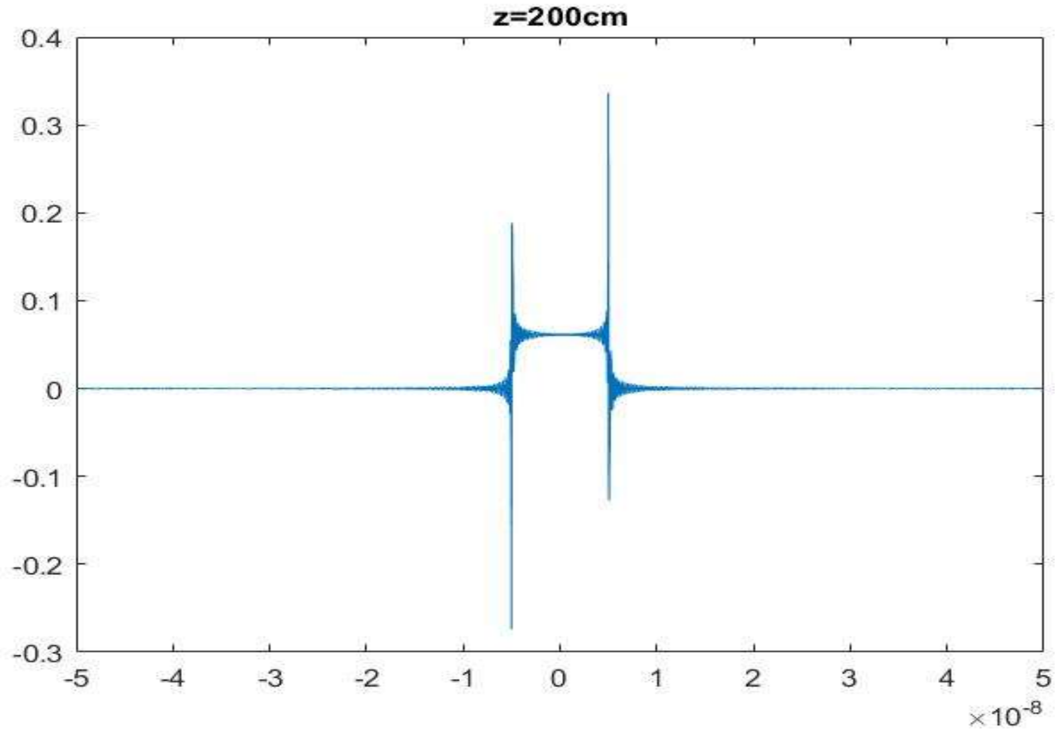
Now let’s try different distances to see when the pulse is totally corrupted.

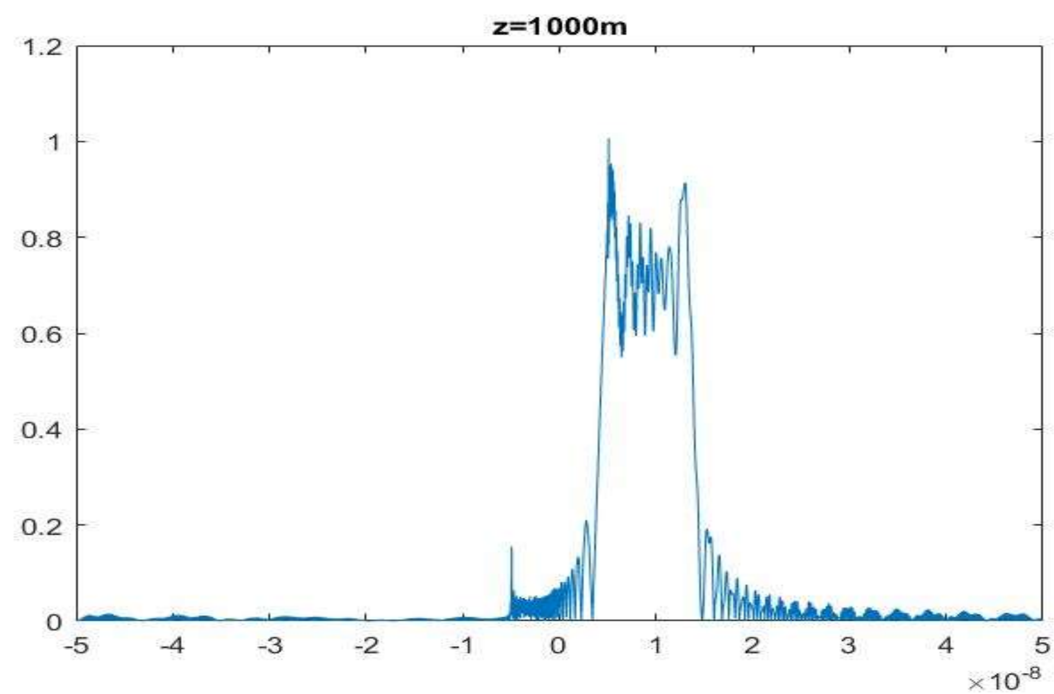

z=50cm
1
0.8
0.6
0.4
0.2
0
-0.2
-5
-4
-3
-2
-1
0
1
2
3
4
5
$\times 10^{-8}$


z=100cm
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-5
-4
-3
-2
-1
0
1
2
3
4
5
$\times 10^{-8}$


z=150cm
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-5
-4
-3
-2
-1
0
1
2
3
4
5
$\times 10^{-8}$


z=170cm
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-5
-4
-3
-2
-1
0
1
2
3
4
5
$\times 10^{-8}$

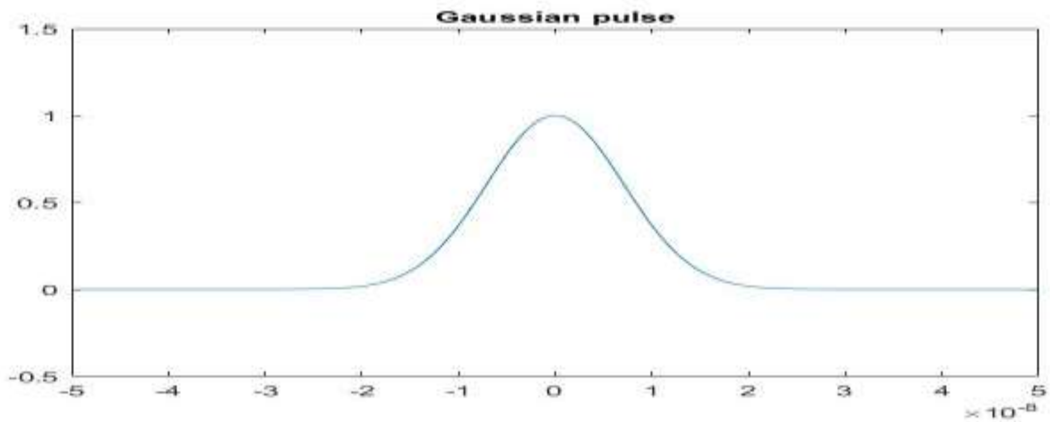

z=200cm
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-5
-4
-3
-2
-1
0
1
2
3
4
5
×10-8

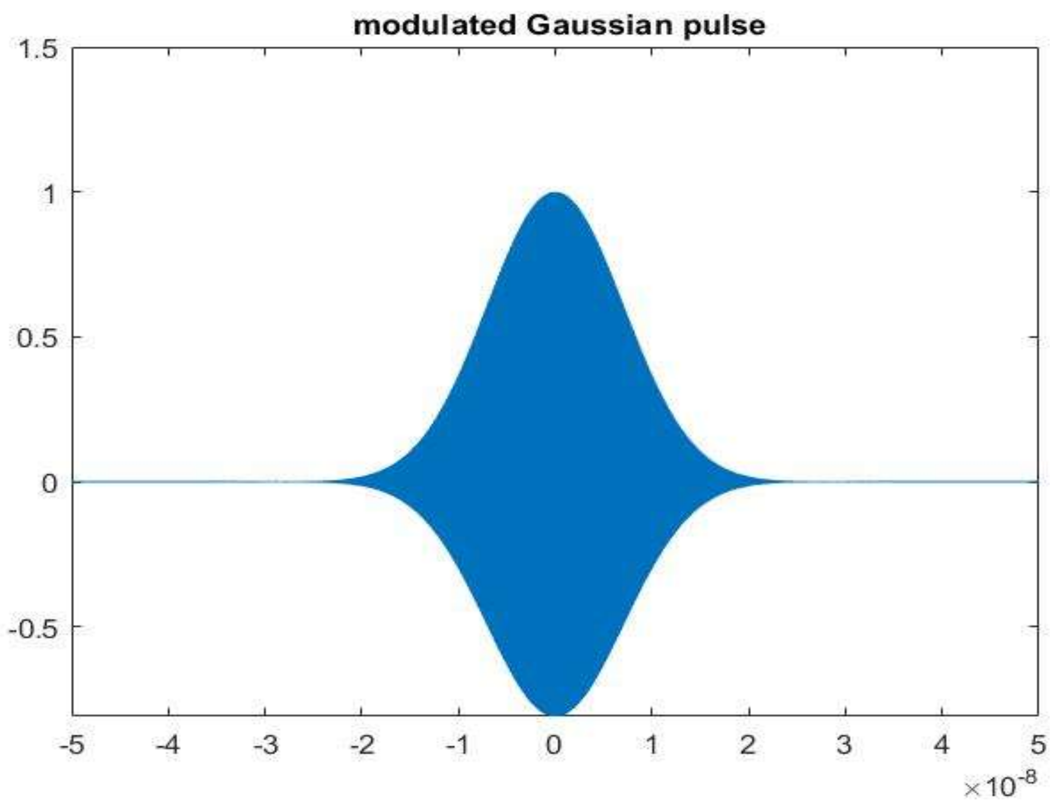

z=1000m
1.2
1
0.8
0.6
0.4
0.2
0
-5
-4
-3
-2
-1
0
1
2
3
4
5
×10-8

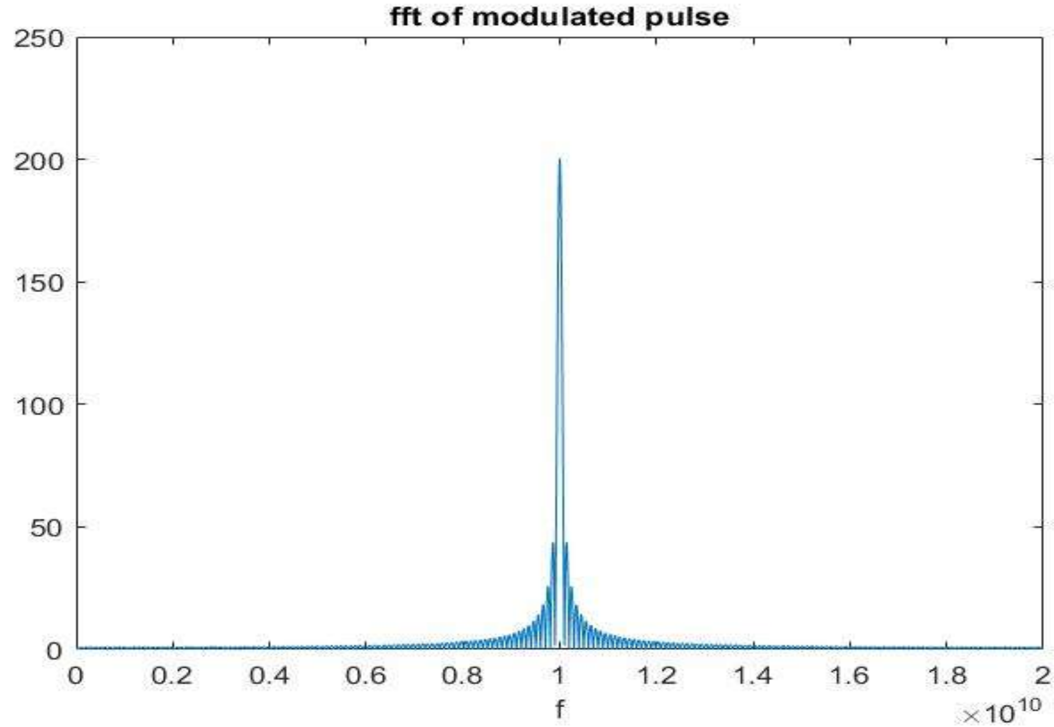
Just by inspecting the results, we can claim that after about 2 meters, the pulse is totally destroyed.

b)

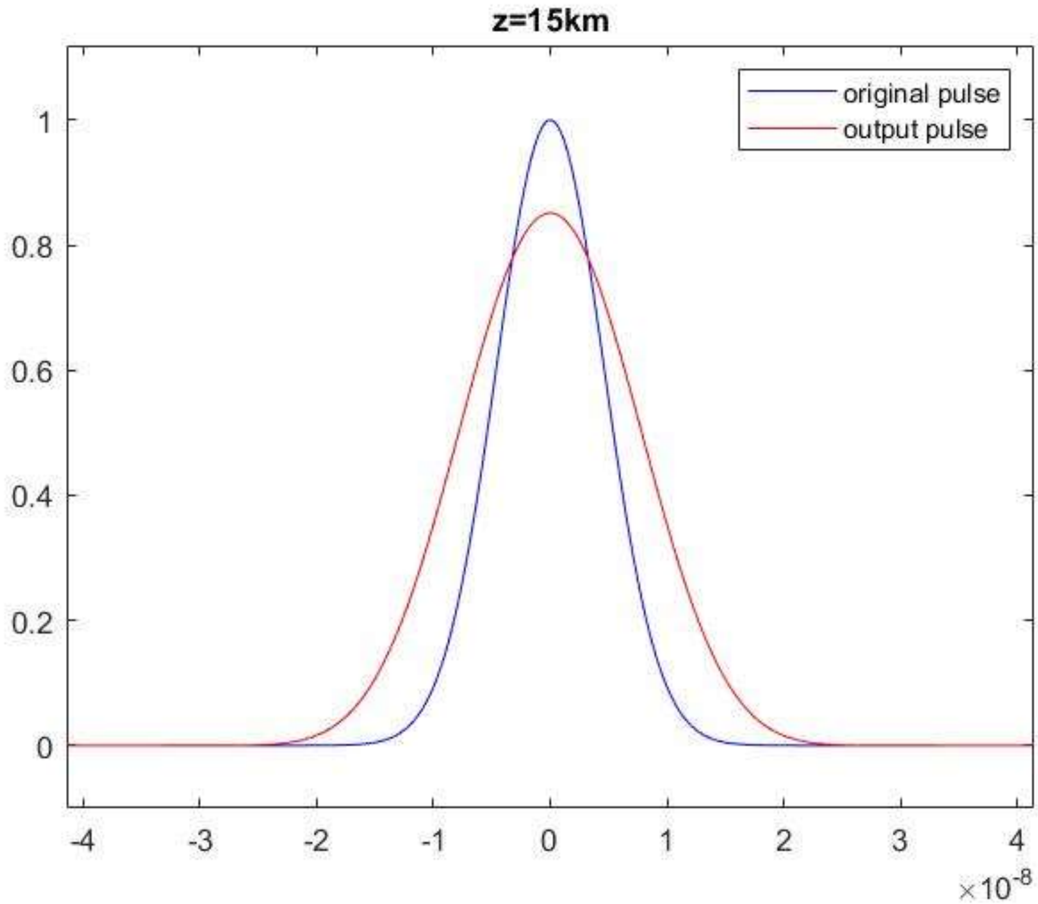
the same procedure is followed for the gaussian pulse.







The final result for dispersion of a gaussian pulse is as follows:



As you can see it takes a very long distance for a gaussian pulse to become distorted.