ERATO Meeting July.29.2015

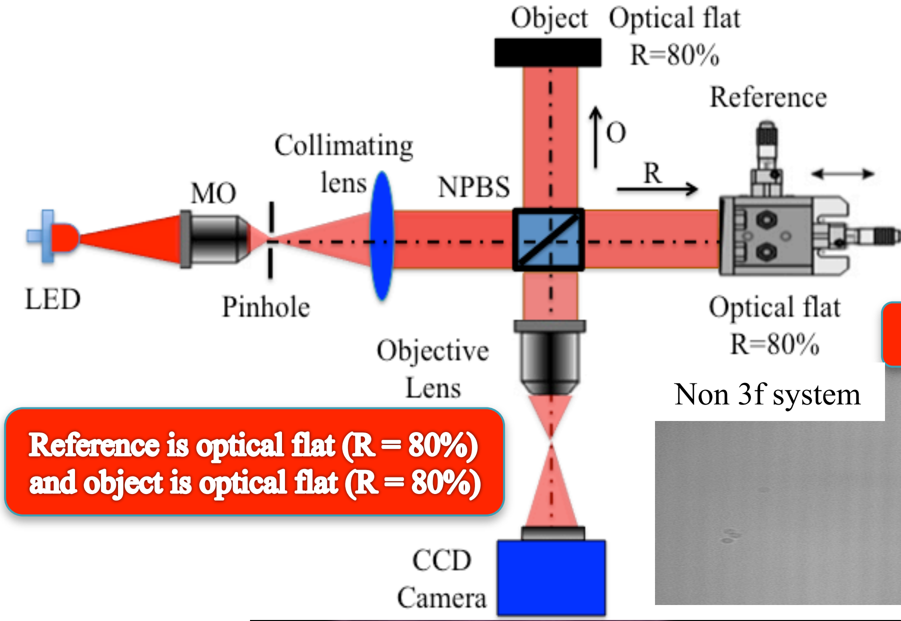
1- High brightness LED fringes based on 3f system; surface topography measurement

2- Resolving the individual lines of an 80 MHz frequency comb by use of 2D disperser; virtually imaged phased array and grating

By

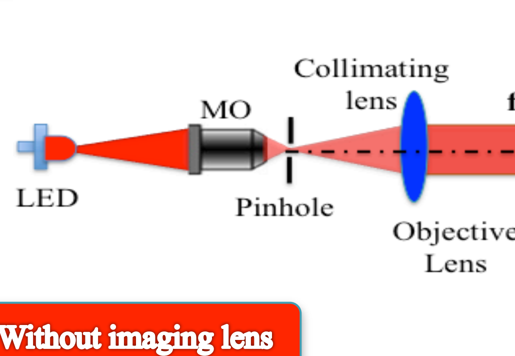
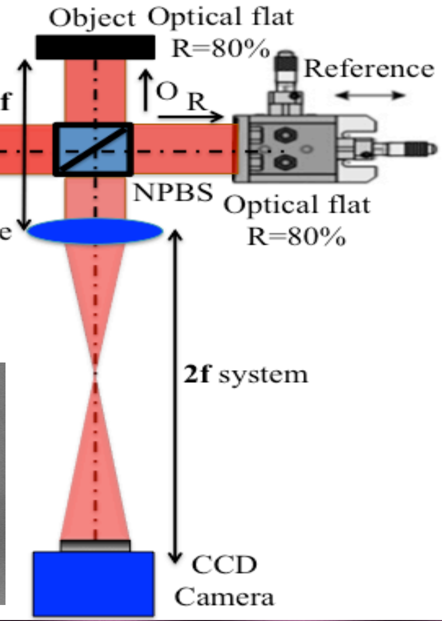
D.G.Abdelsalam

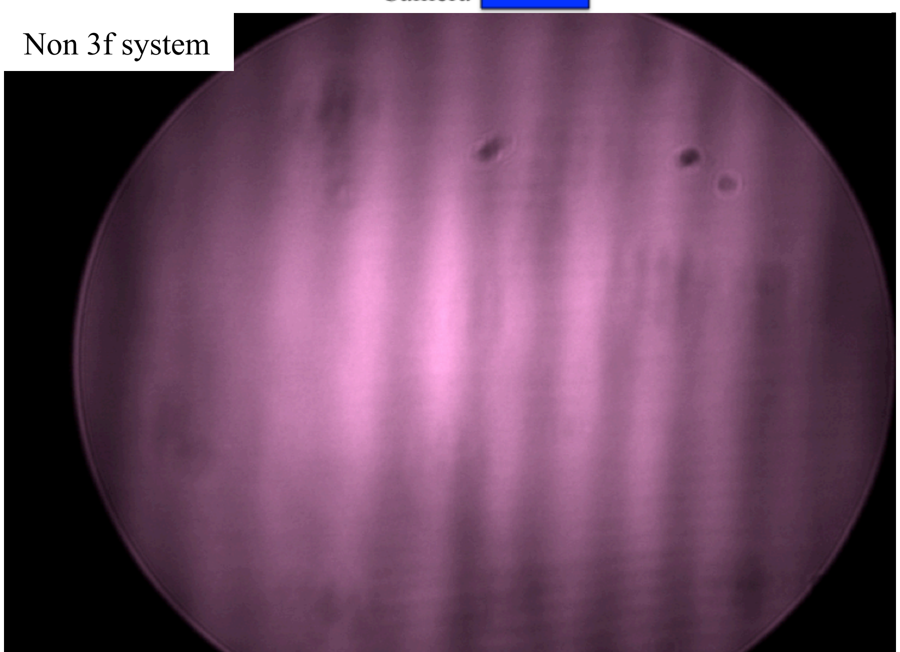
1- High brightness LED fringes based on 3f system

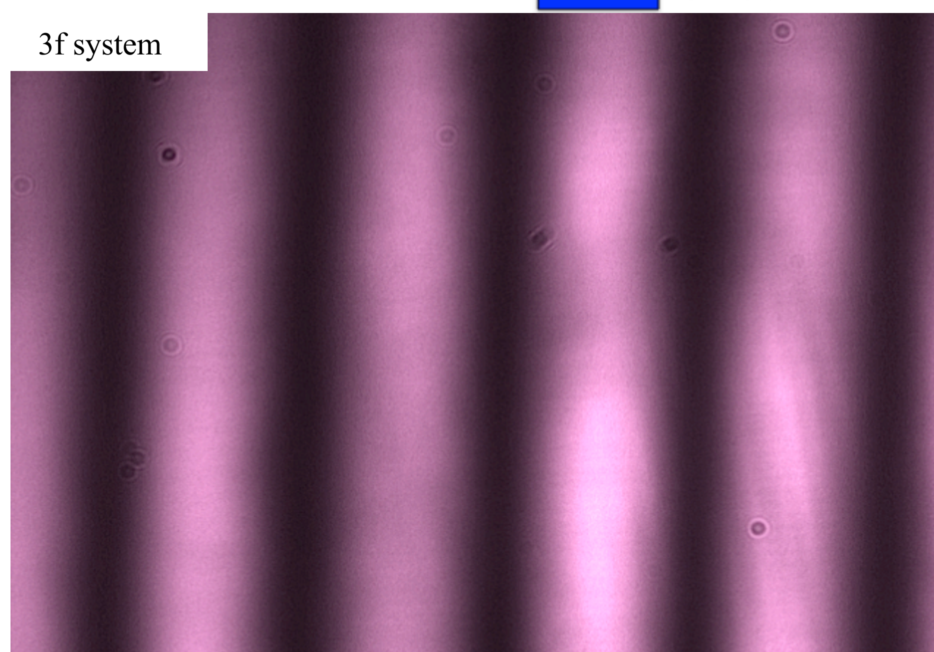


Reference is optical flat (R = 80%) and object is optical flat (R = 80%)

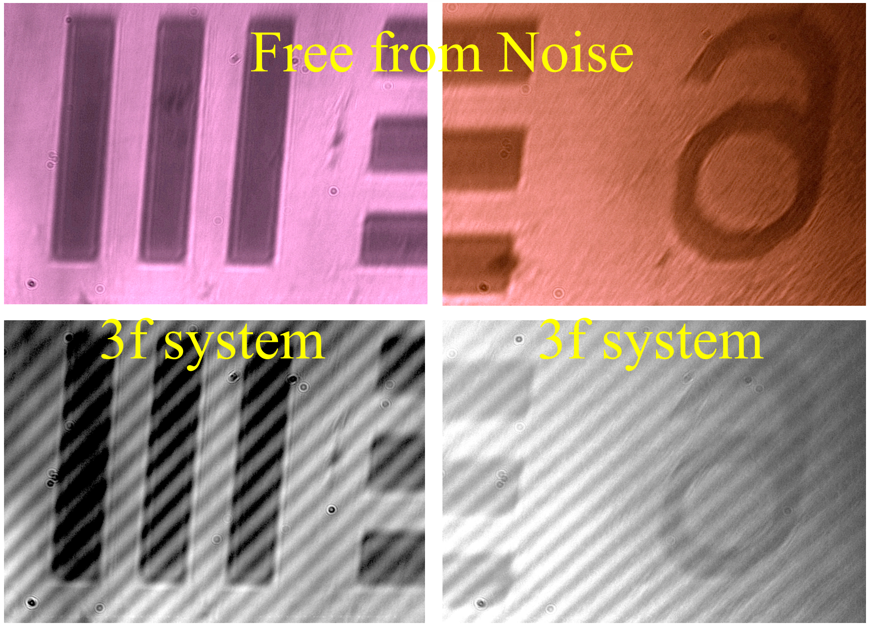
Without imaging lens

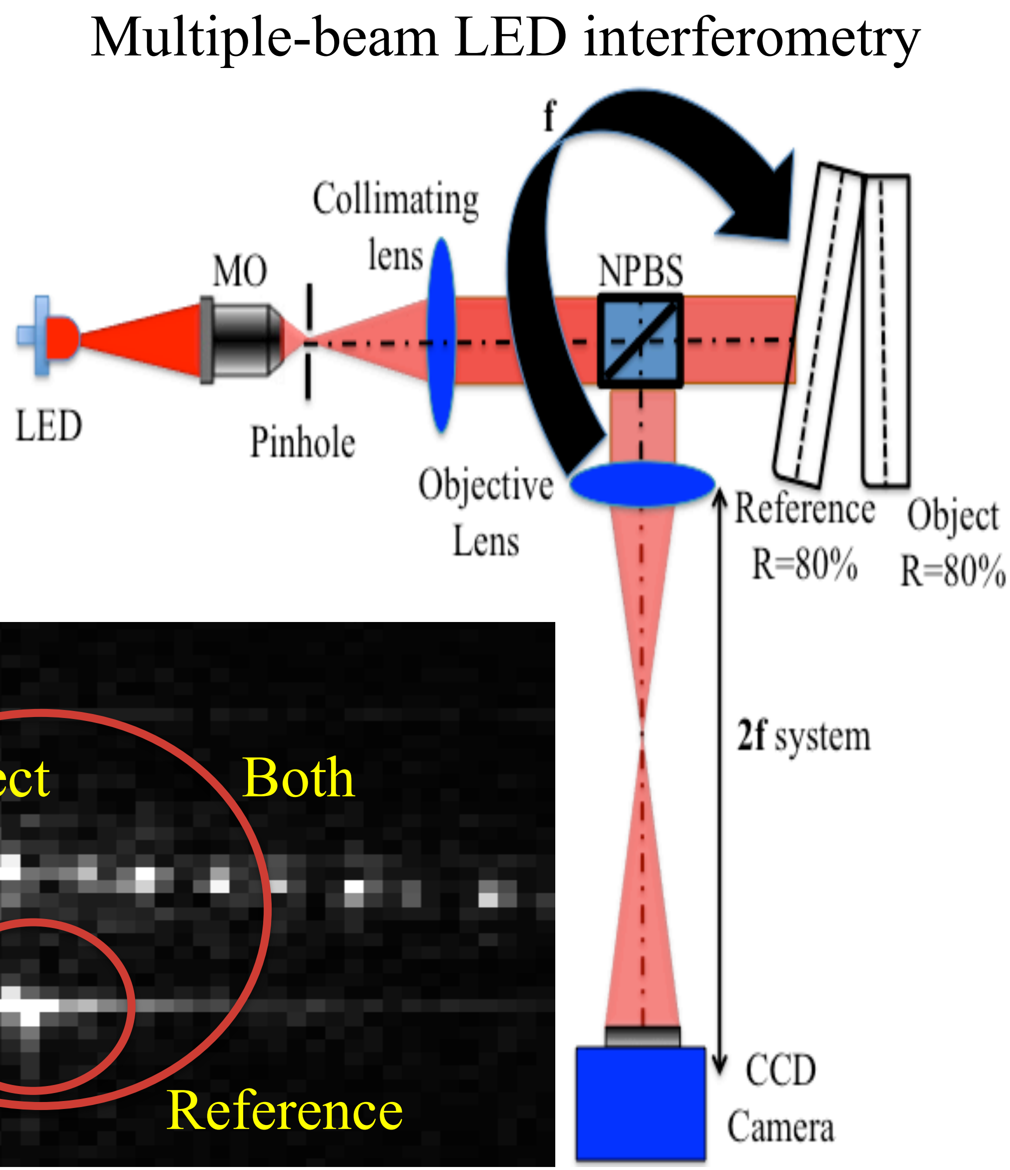



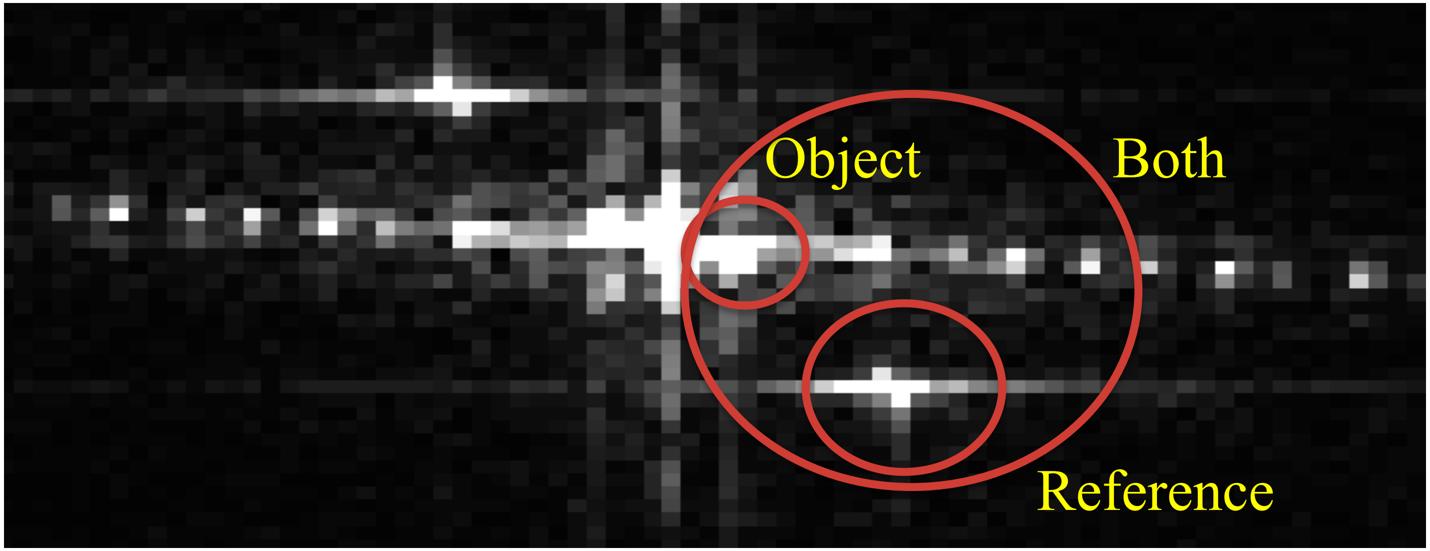




1- High brightness LED fringes based on 3f system; surface topography measurement, reference is optical flat and object is USAF



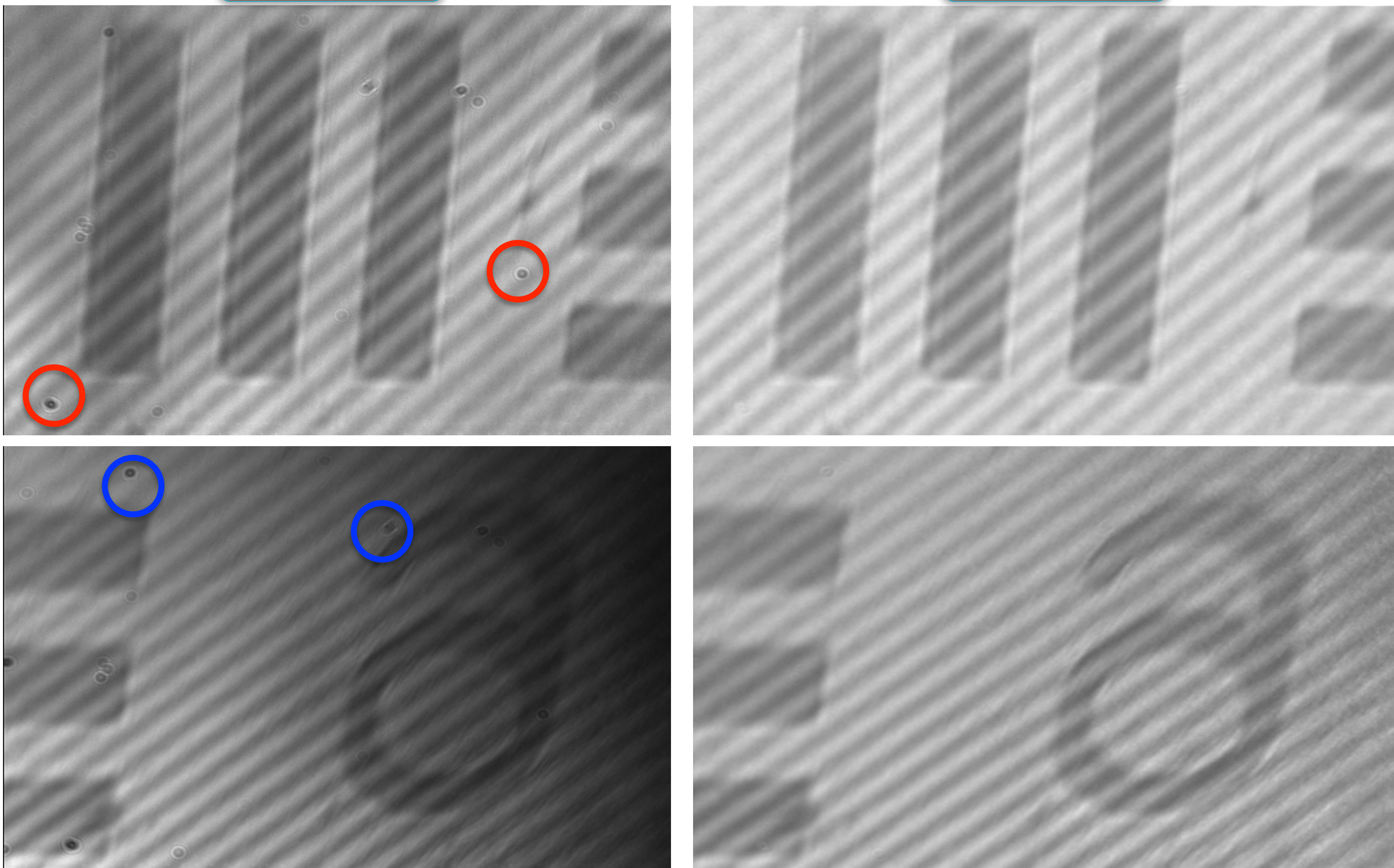




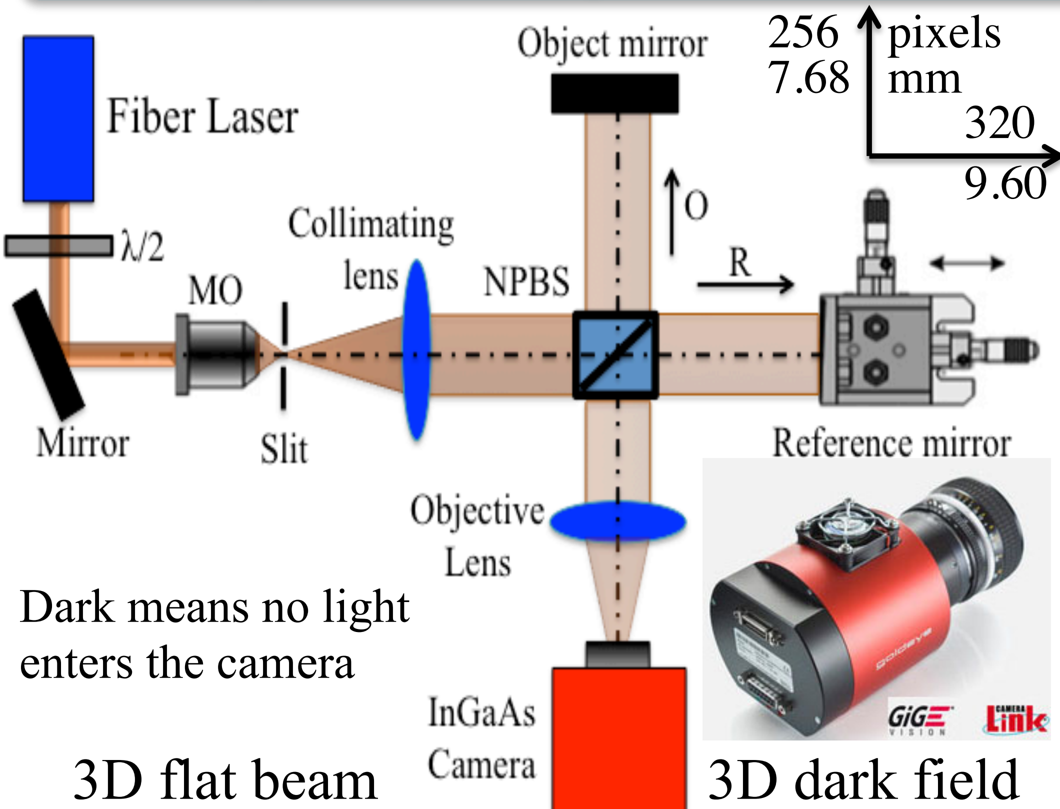
Application of flat fielding for noise reduction (LED holograms)

Original

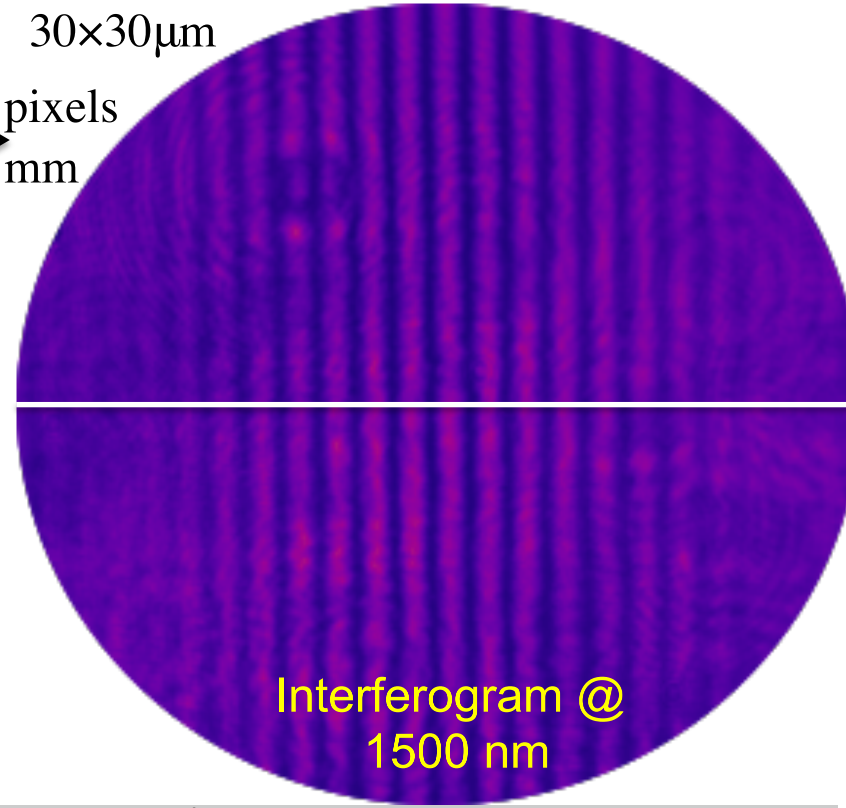
Corrected



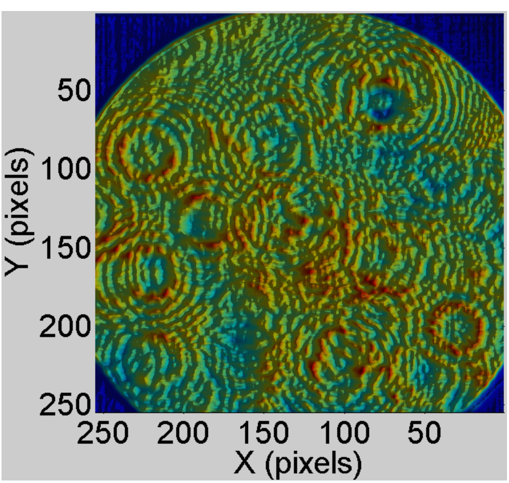
Checking the minimal power of the InGaAs Camera @ 1500 nm (Fiber laser)



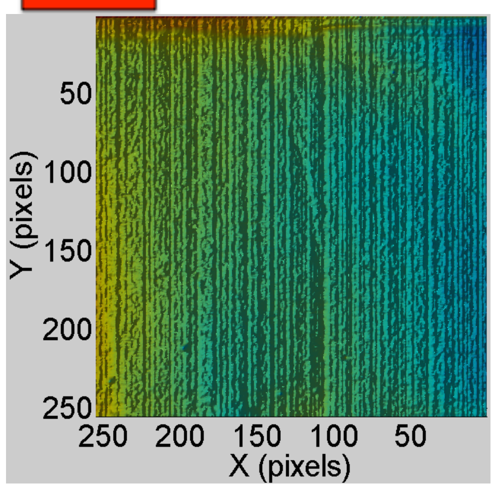
Dark means no light enters the camera

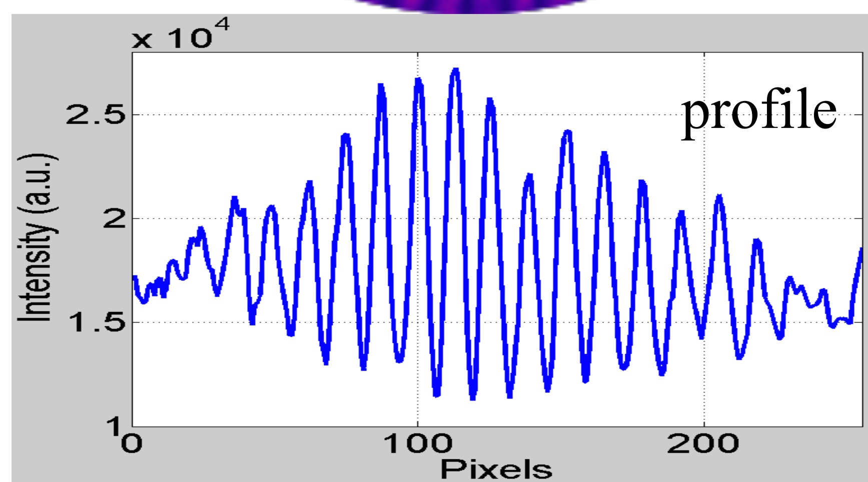


3D flat beam

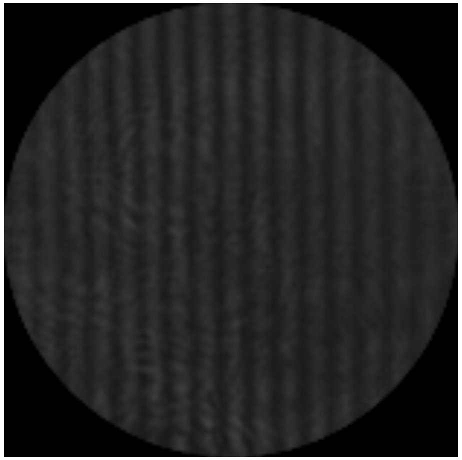


3D dark field

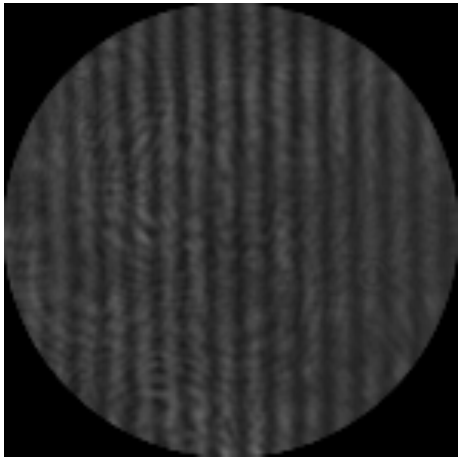




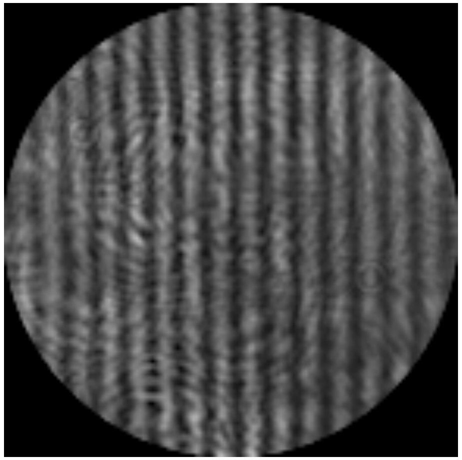
Checking the minimal power of the InGaAs Camera @ 1500 nm (Fiber laser)



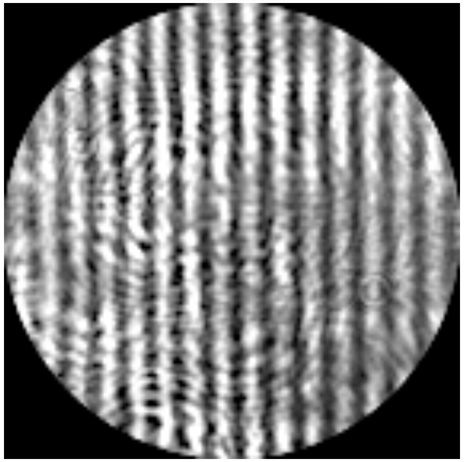
2400 nW



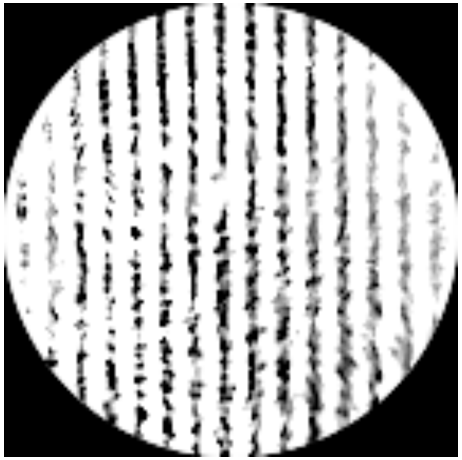
7500 nW



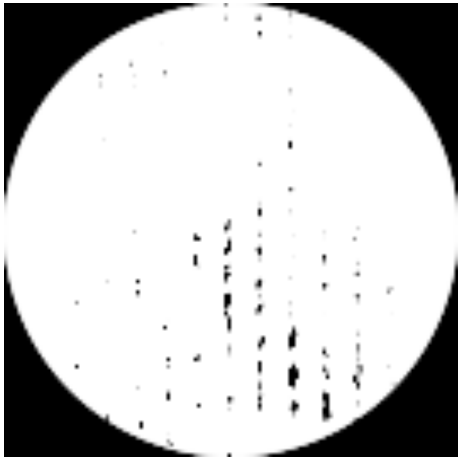
24,000 nW



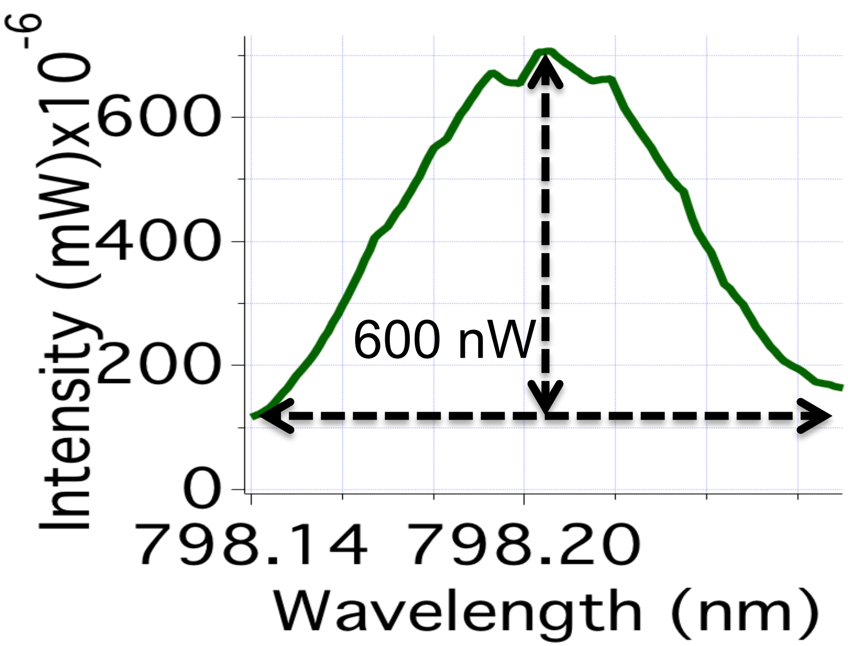
75,000 nW



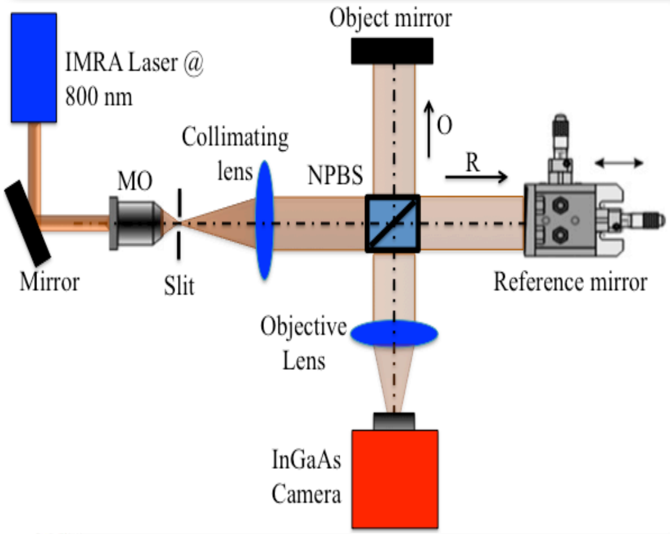
240,000 nW

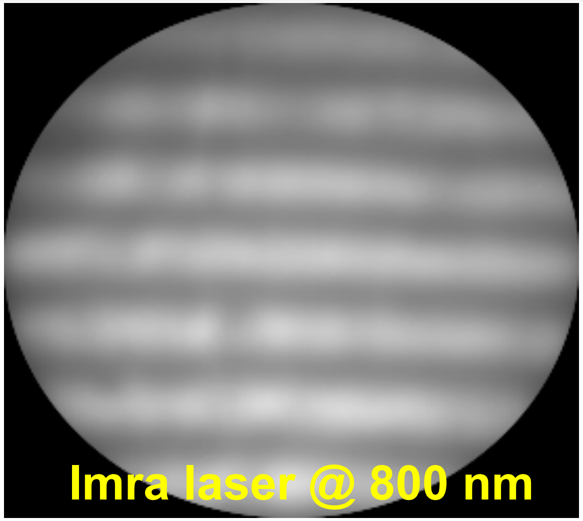


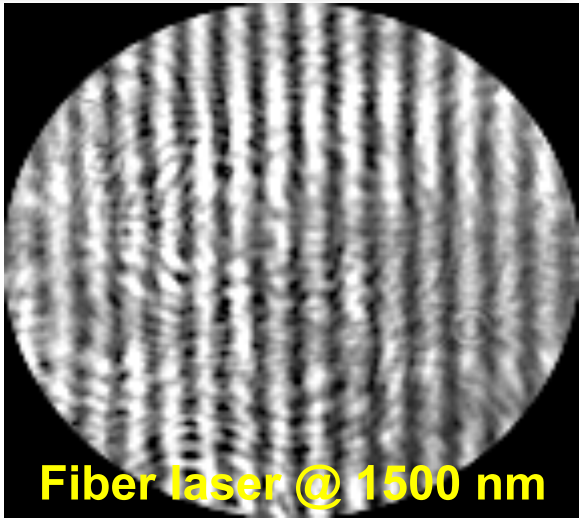
684,000 nW

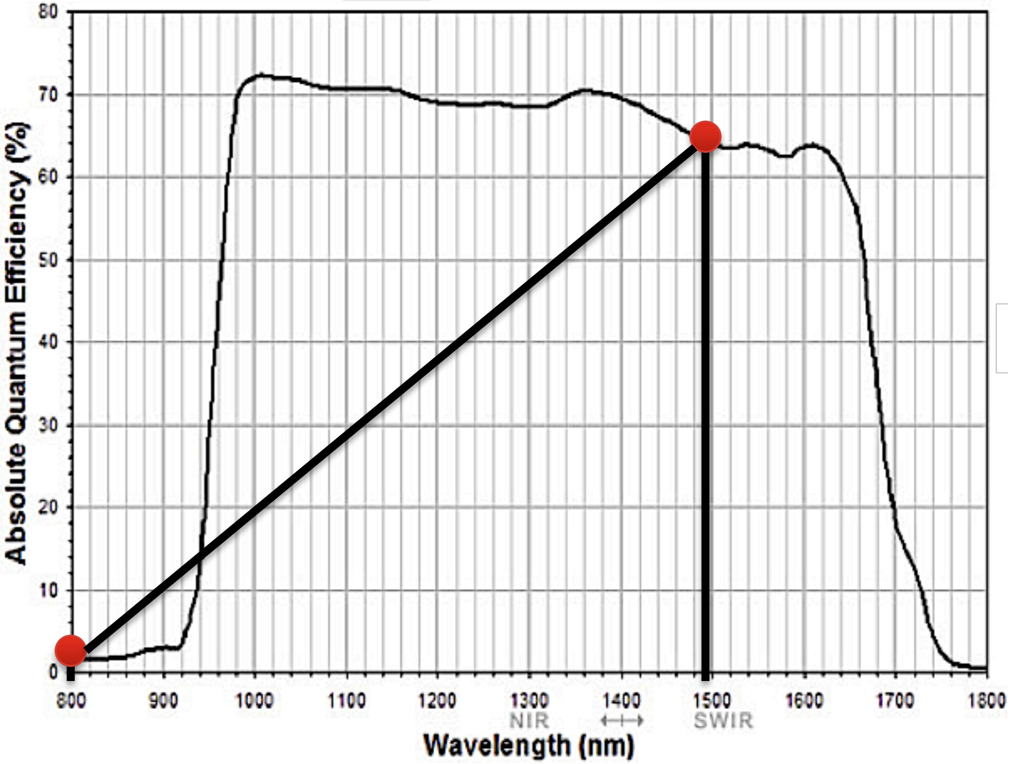


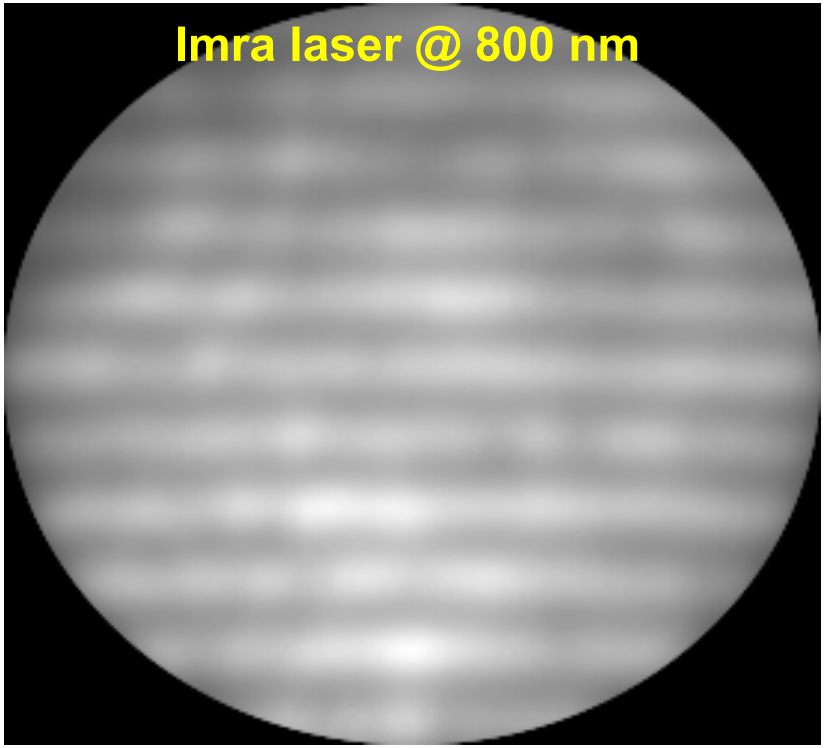
Checking the sensitivity of InGaAs camera @ 800 nm (Imra laser)



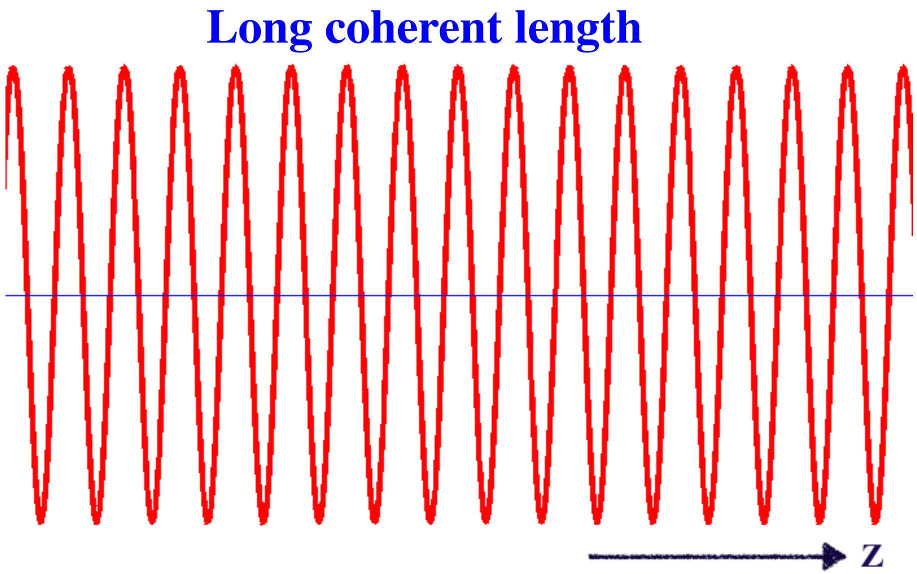


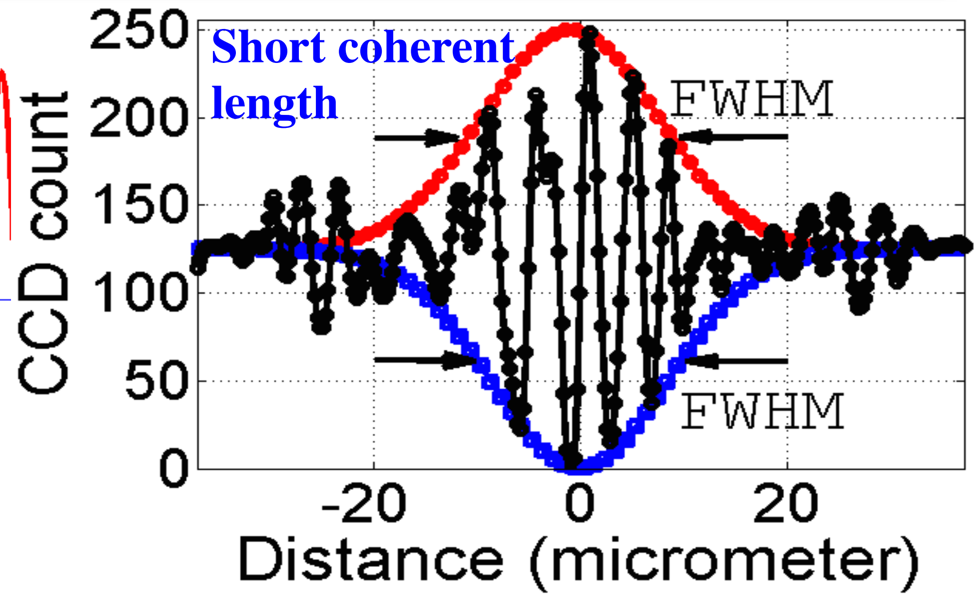


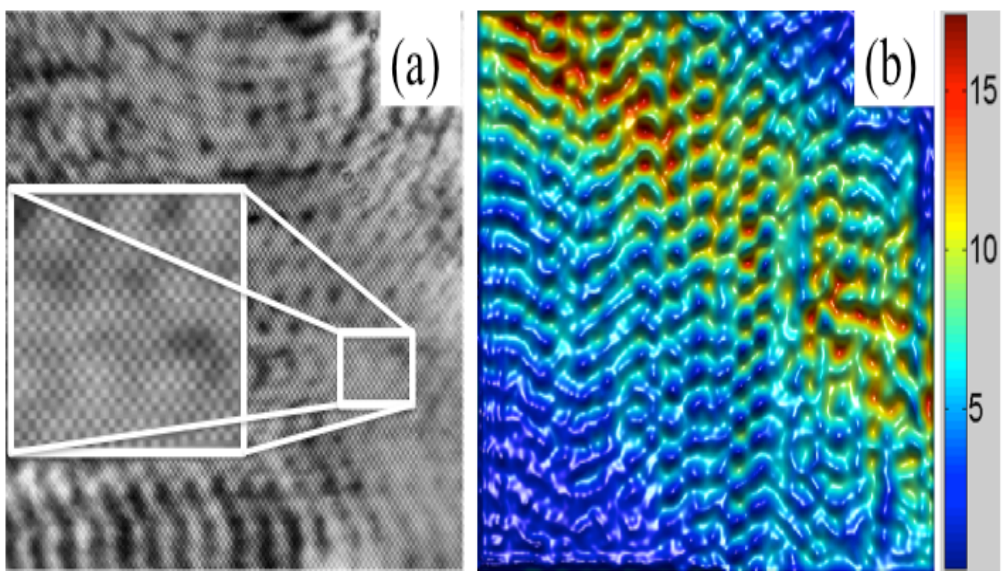


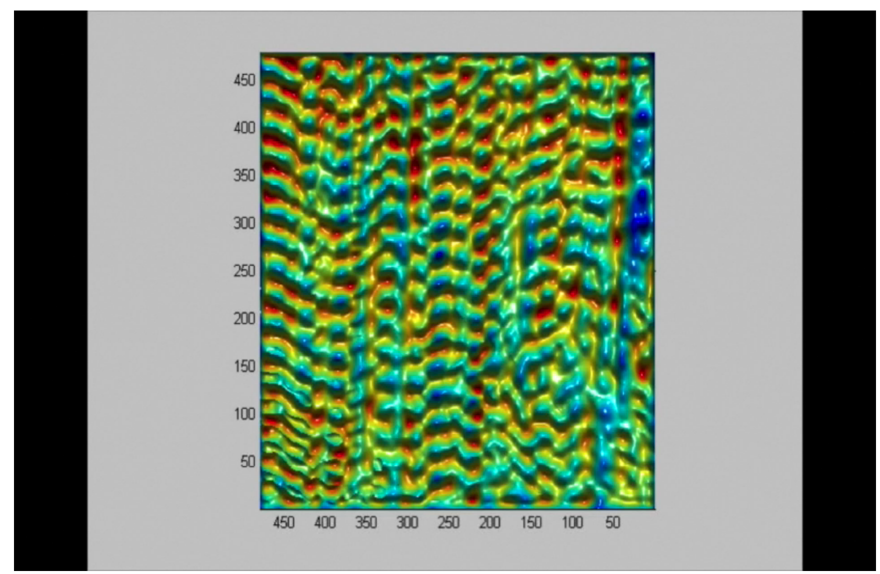


Full-field image synthesize for off-axis ultrashort digital holographic microscopy; effect of long and short coherent lengths



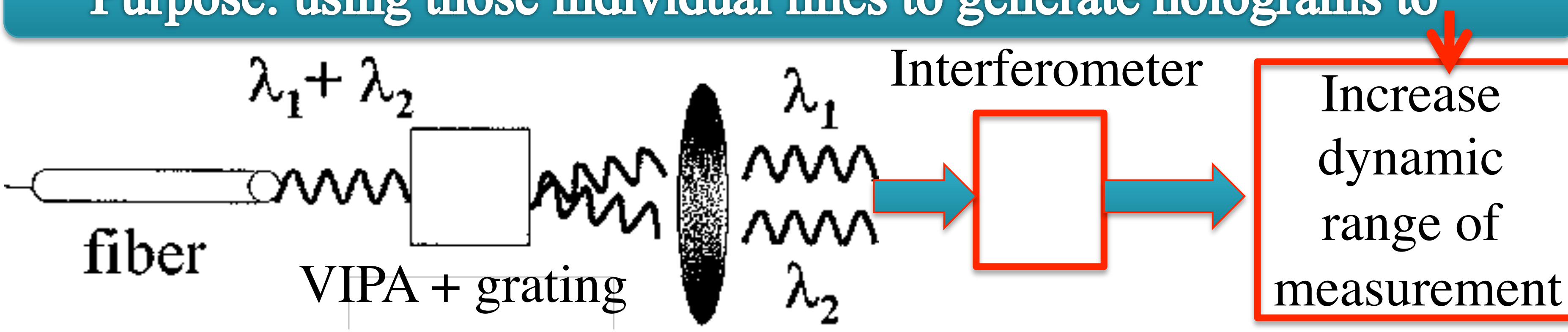






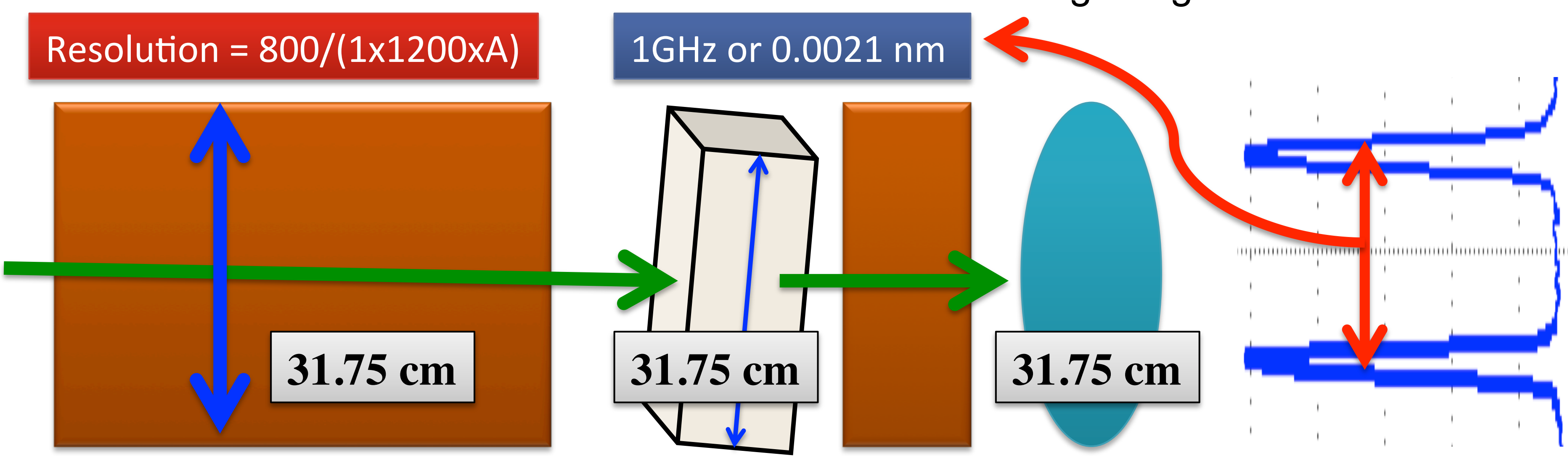
2- Resolving the individual lines of an 80 MHz frequency comb by use of 2D disperser; virtually imaged phased array and grating

Purpose: using those individual lines to generate holograms to

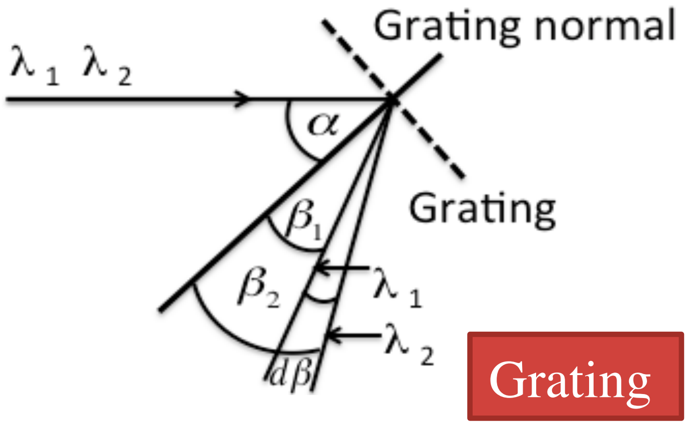


Why not using the diffraction grating only?

To resolve 1 GHz difference i.e. 0.0021 nm we need a grating of size 31.75 cm

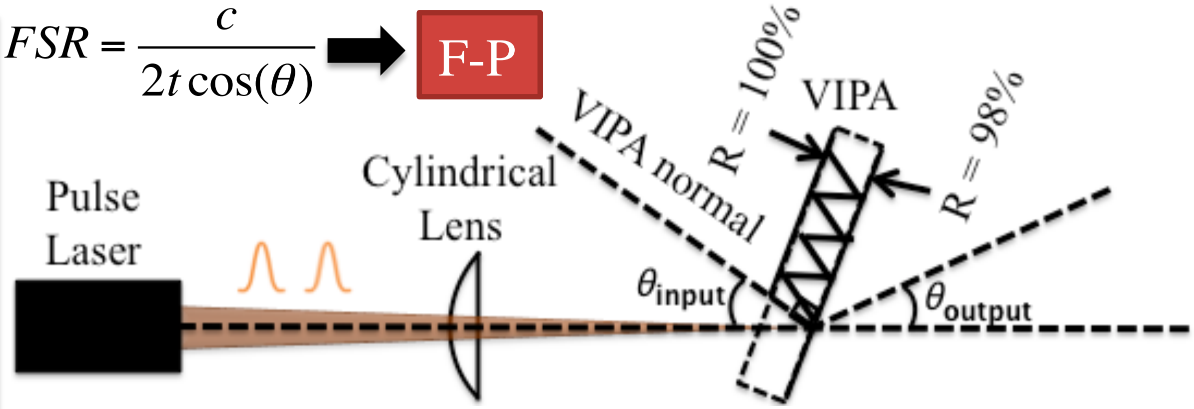


Dispersion Law of Grating, F-P, and VIPA (working @ 800 nm)



$$d\beta / d\lambda = (2/\lambda)\tan\beta.$$
$$@\ \alpha = \beta$$

$$FSR = \frac{c}{2t\cos(\theta)}$$



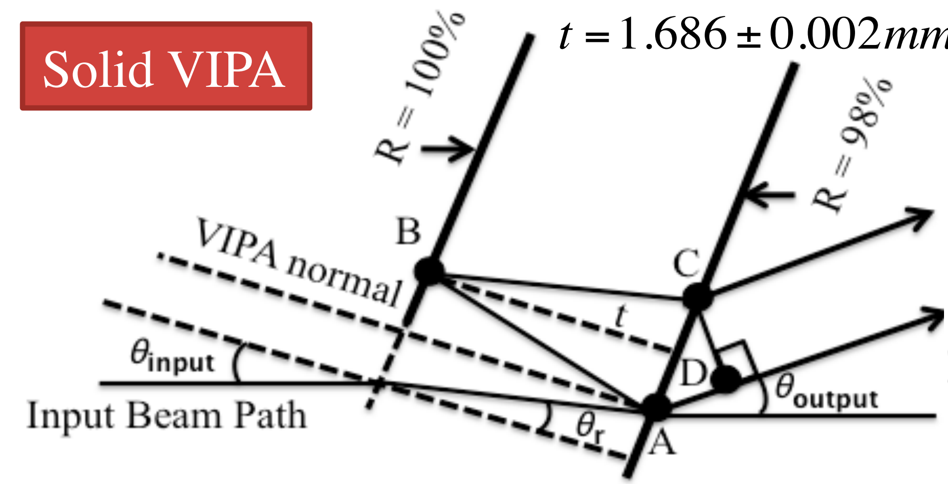
The VIPA dispersion is given by ABC - AD

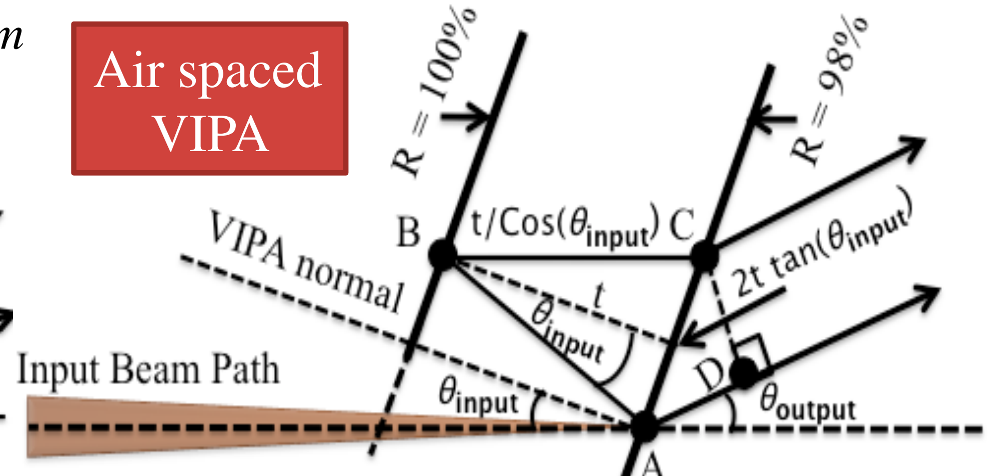
$$2tk\left(\frac{1}{\cos(\theta_{input})}\right) - 2tk\left(\tan(\theta_{input})\sin(\theta_{input} + \theta_{output})\right) = 2m\pi$$

$$FSR = \frac{c}{2t}\left[\frac{n}{\cos(\theta_r)} - \tan(\theta_r)\sin(\theta_{input} + \theta_{ouput})\right]^{-1}$$

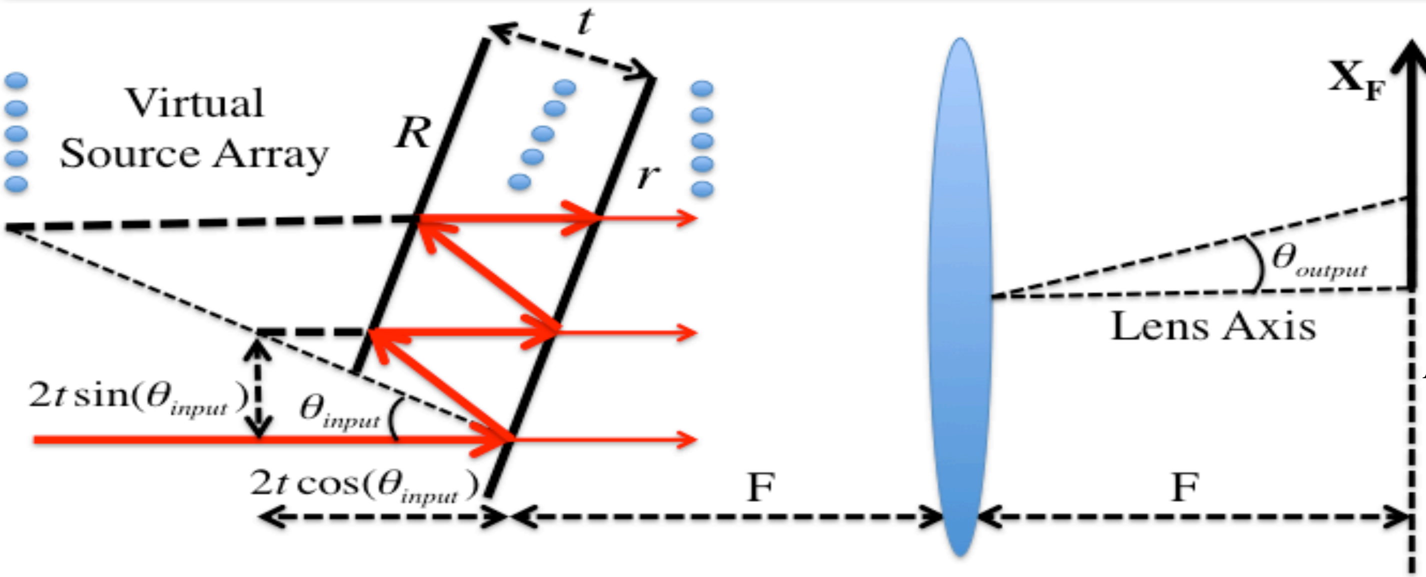
$$FSR = \frac{c}{2t}\left[\frac{1}{\cos(\theta_{input})} - \tan(\theta_{input})\sin(\theta_{input} + \theta_{ouput})\right]^{-1}$$

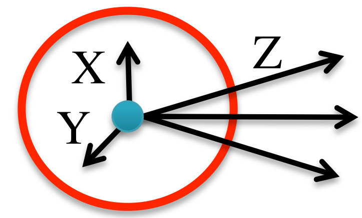
$$t = 1.686 \pm 0.002mm$$





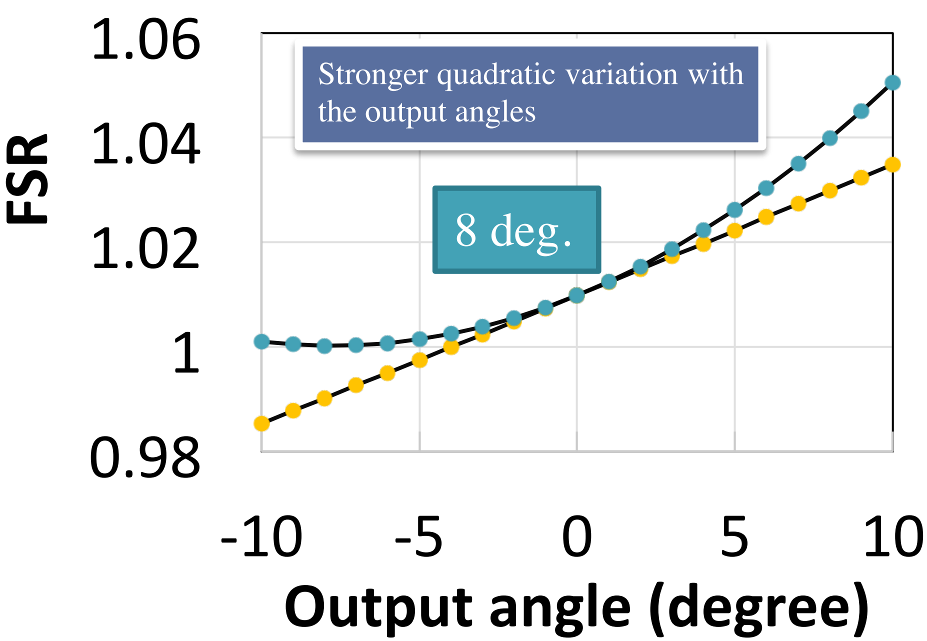
Analytical FSR of VIPA; plane wave and paraxial wave models





$$R = Z\sqrt{1+\frac{X^2}{Z^2}+\frac{Y^2}{Z^2}} \cong Z + \frac{\rho^2}{2Z}$$

$$\theta_{output} \cong \frac{X_F}{F}$$



Plane wave

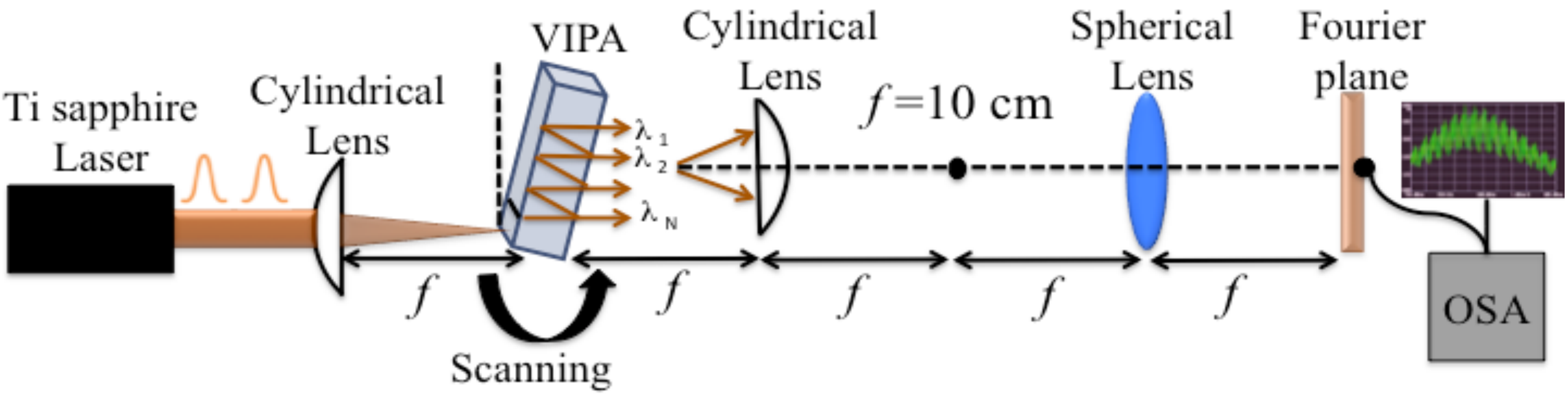
$$FSR = \frac{c}{2t\cos(\theta_{input})}\left[1+\tan(\theta_{input})\theta_{output} + \frac{1}{2}\tan^2(\theta_i)\theta^2_{output}\right]$$

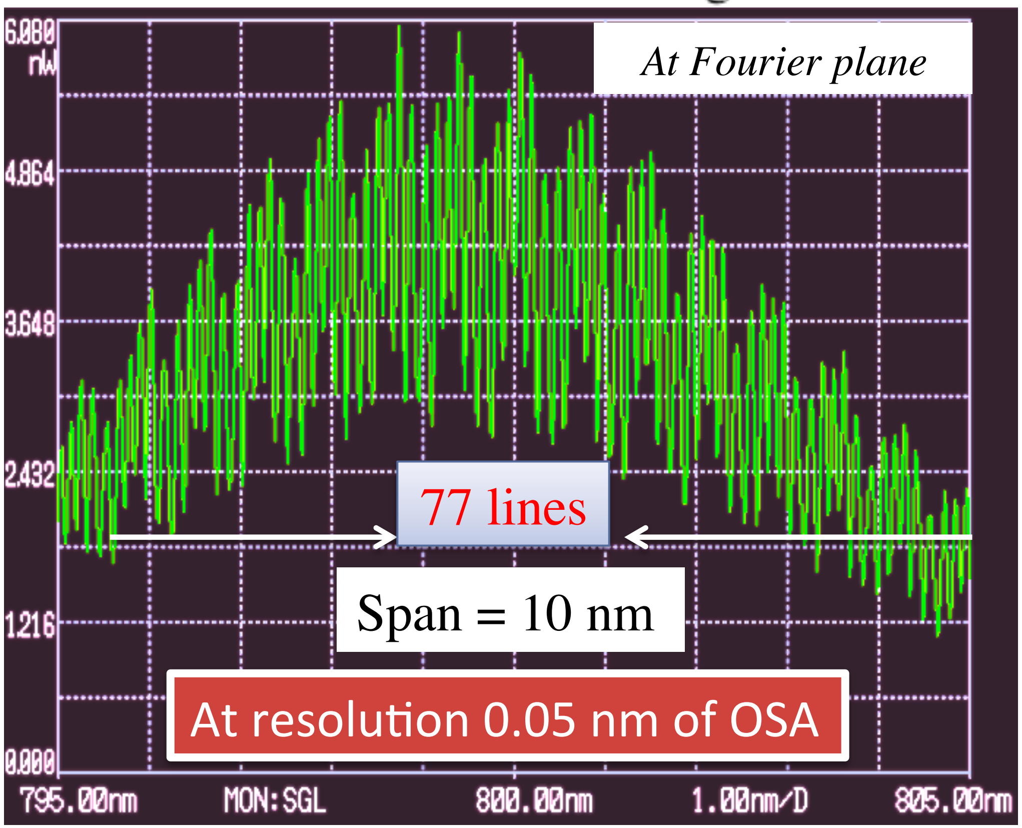
Spherical wave

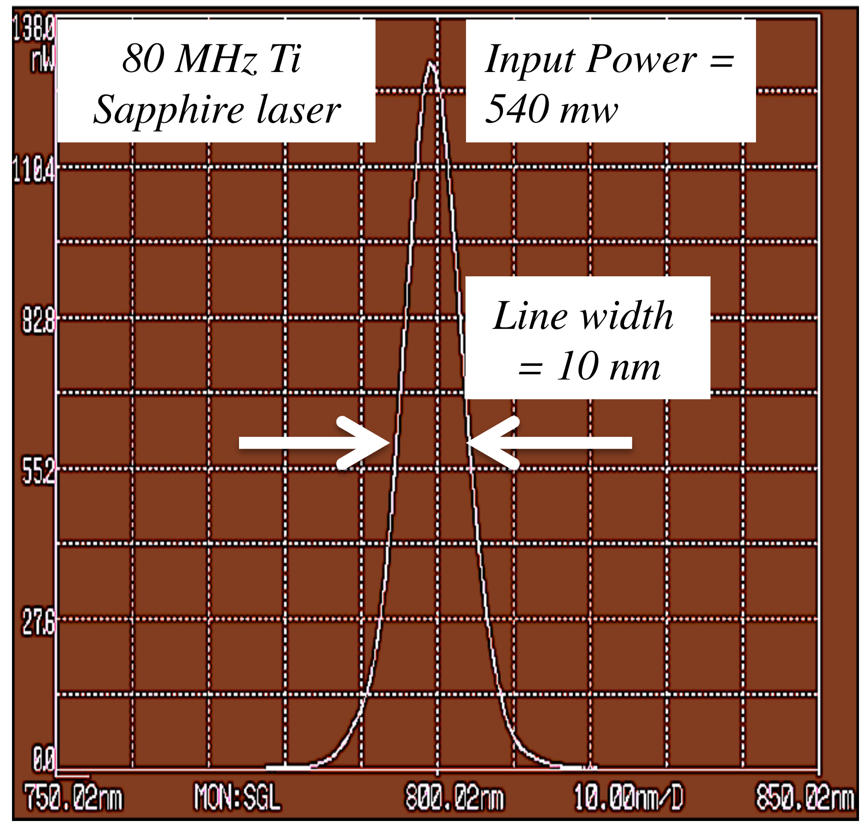
Paraxial approximation

$$FSR = \frac{c}{2t\cos(\theta_{input})}\left[1+\tan(\theta_{input})\theta_{output} + \left[\frac{1}{2}+\tan^2(\theta_{input})\right]\theta^2_{output}\right]$$

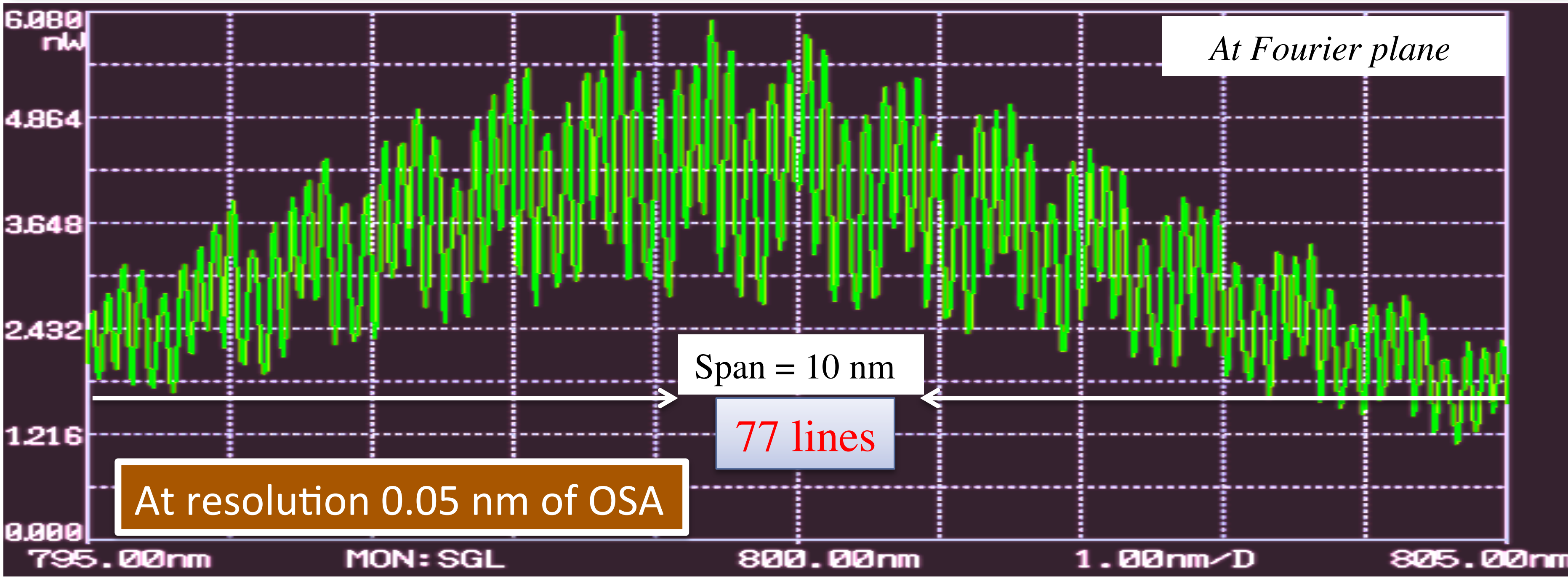
Experimental results with VIPA (60 GHz) disperser (spectra at Fourier plane)

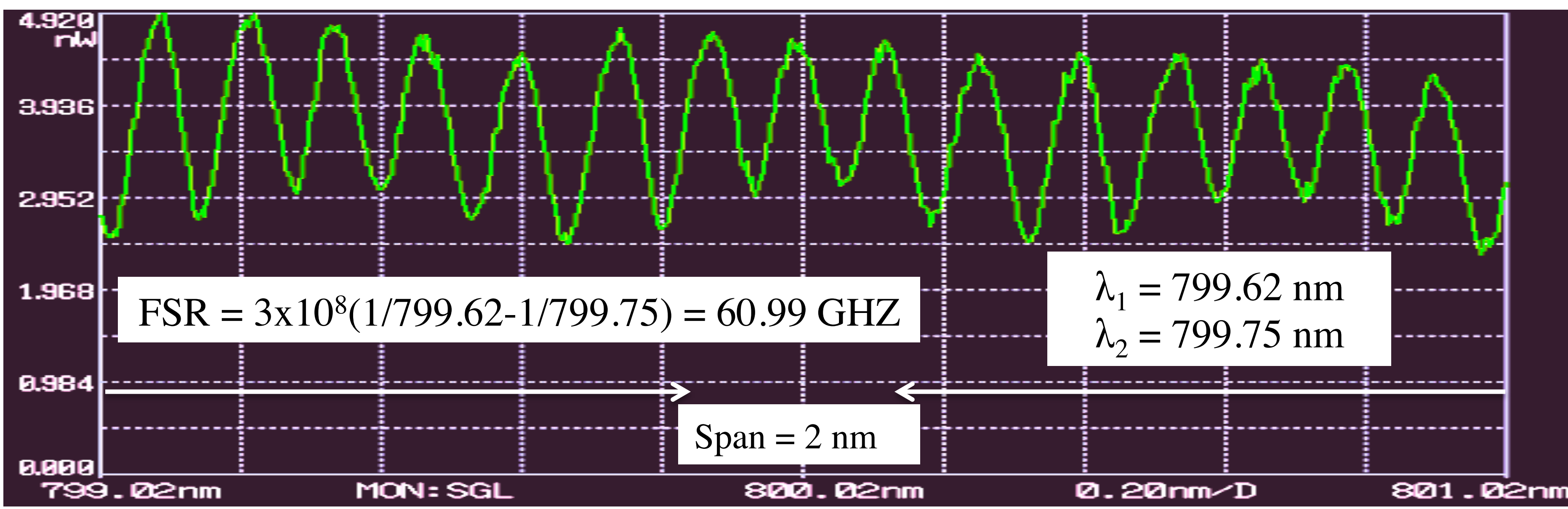




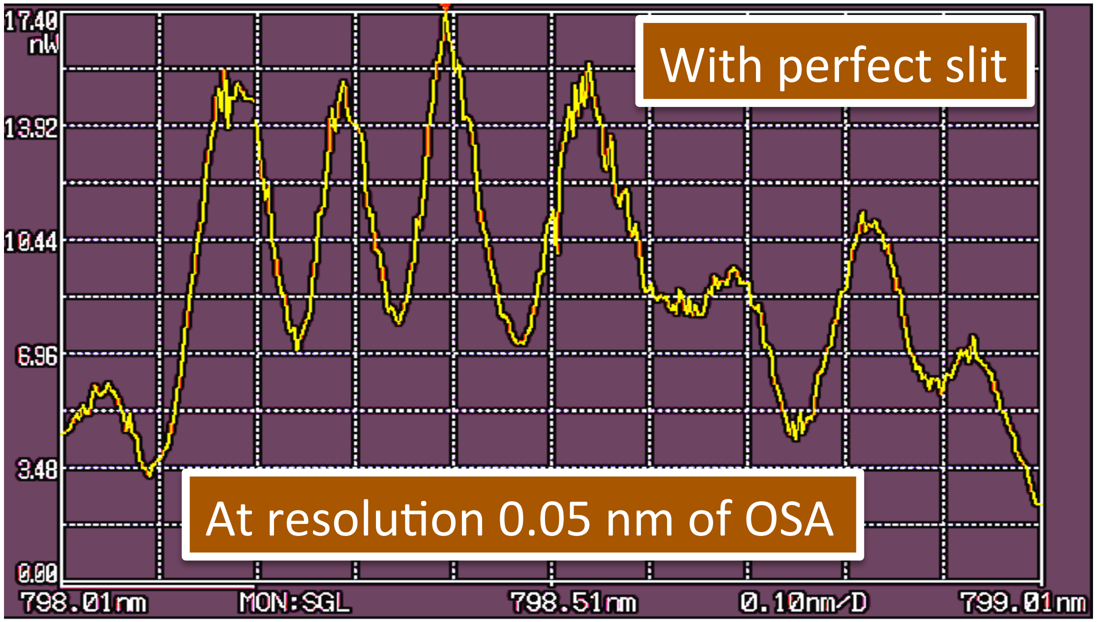


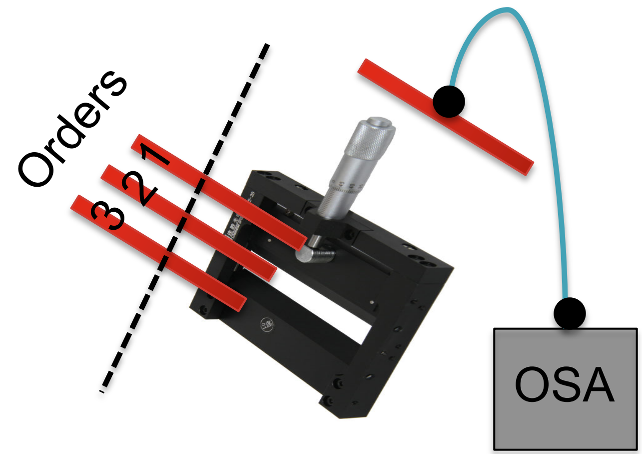
Intensity of spectrum at Fourier plane as a function of wavelength

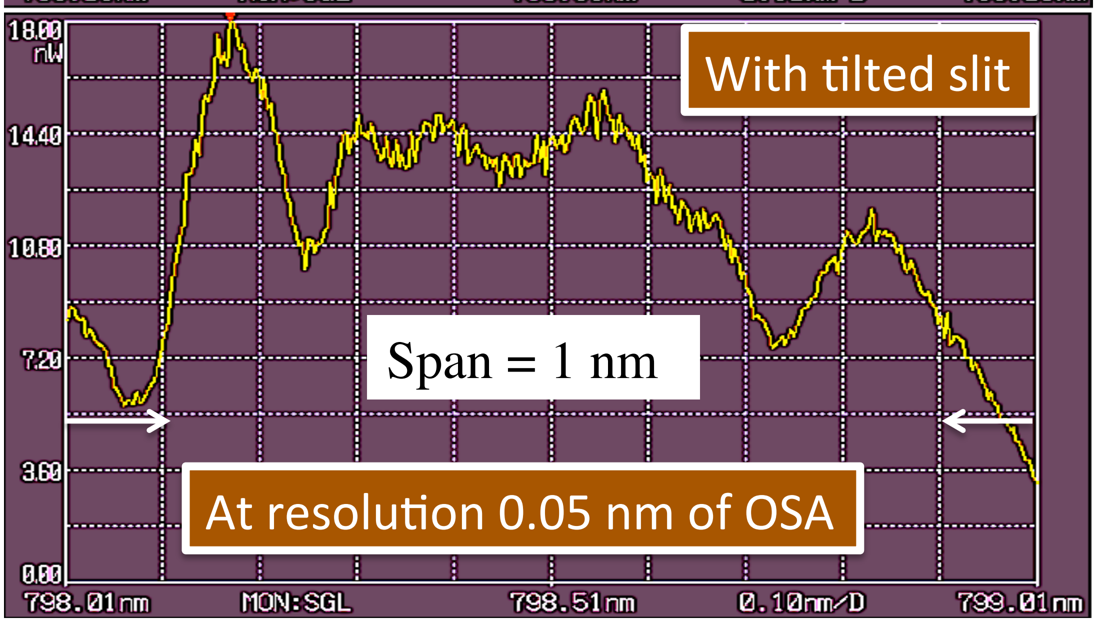


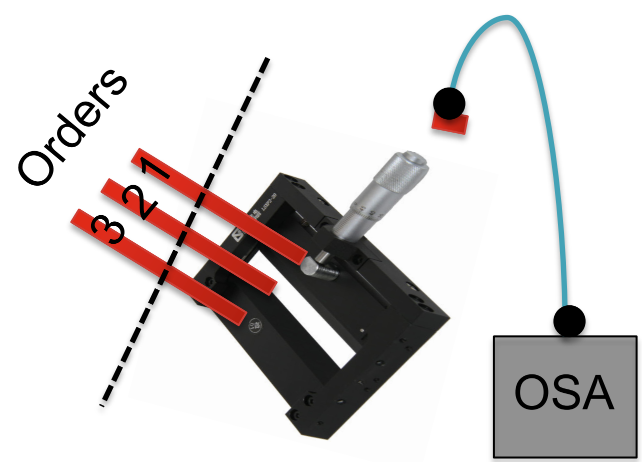


Mode trapping of VIPA output by use of spatial gate (tilted slit width)

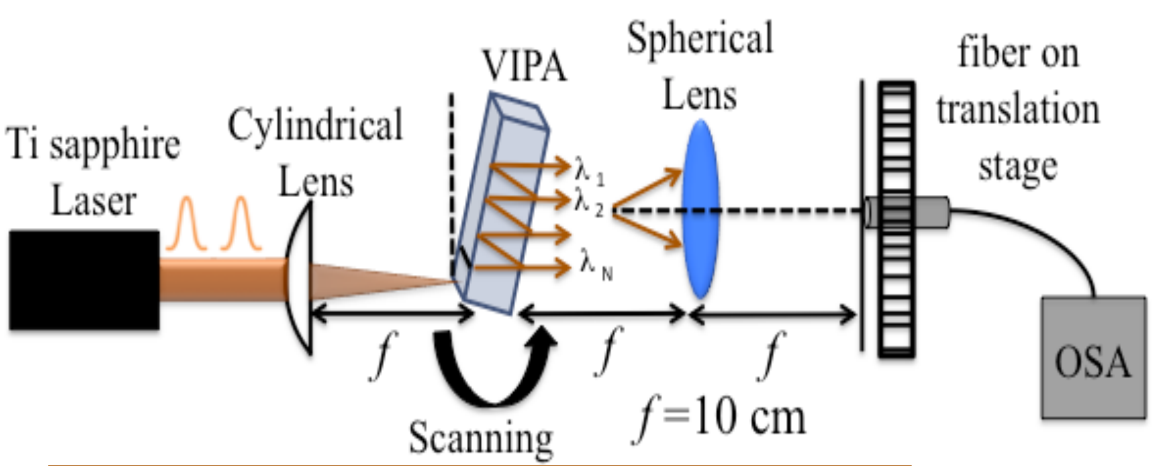


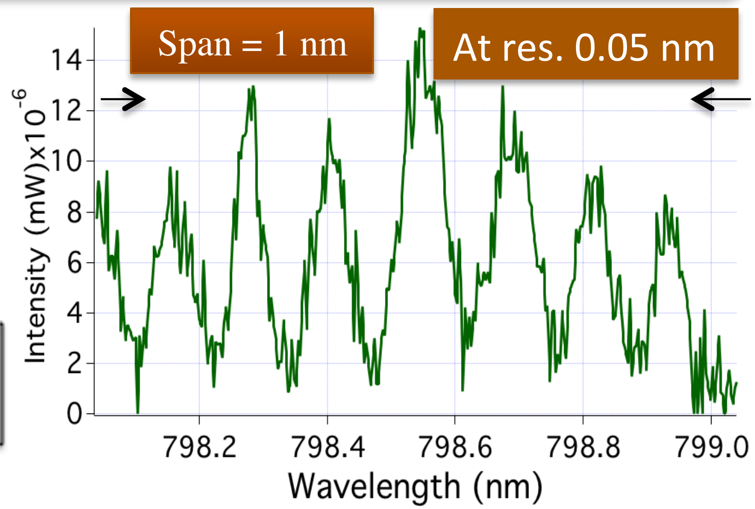


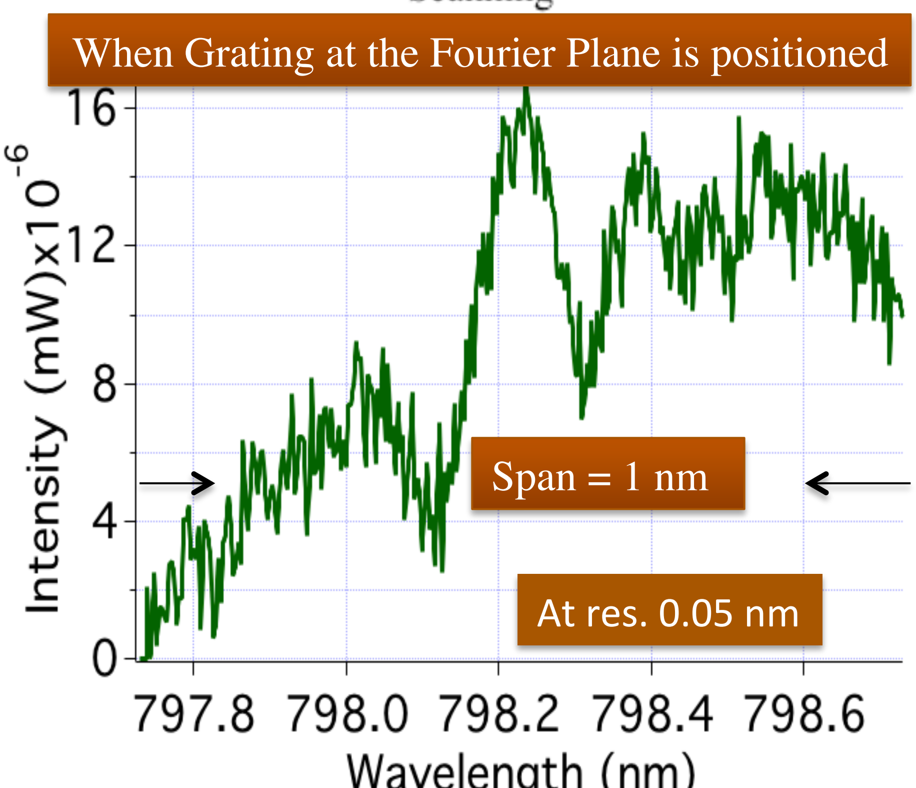


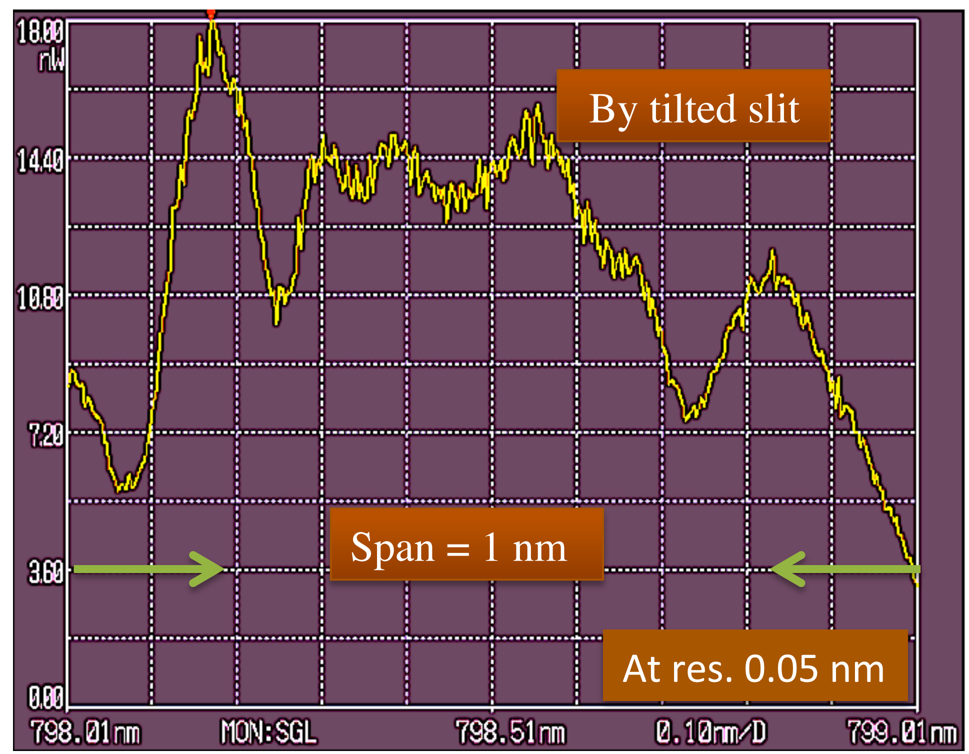


Output spectra of VIPA by use of spherical lens

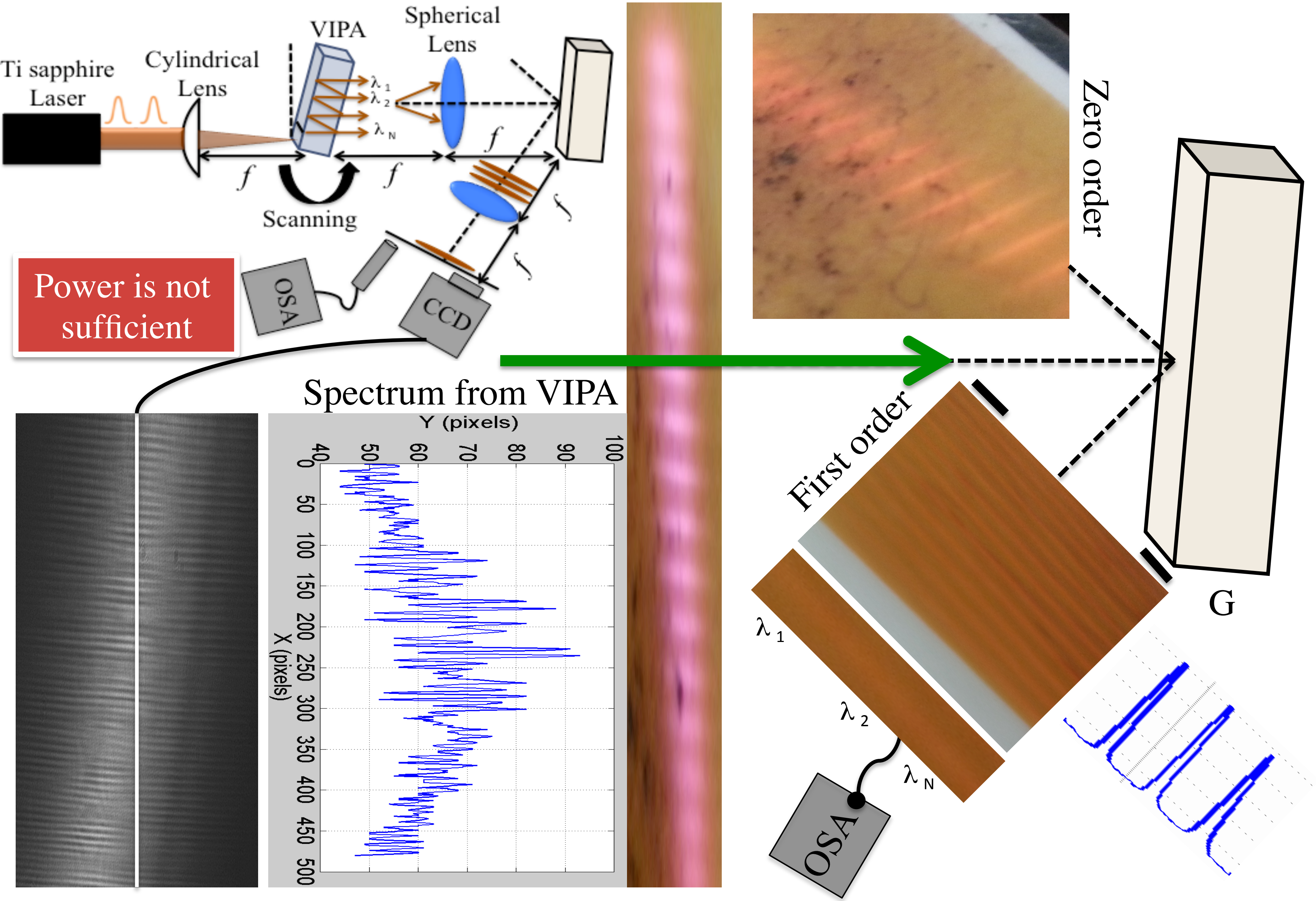




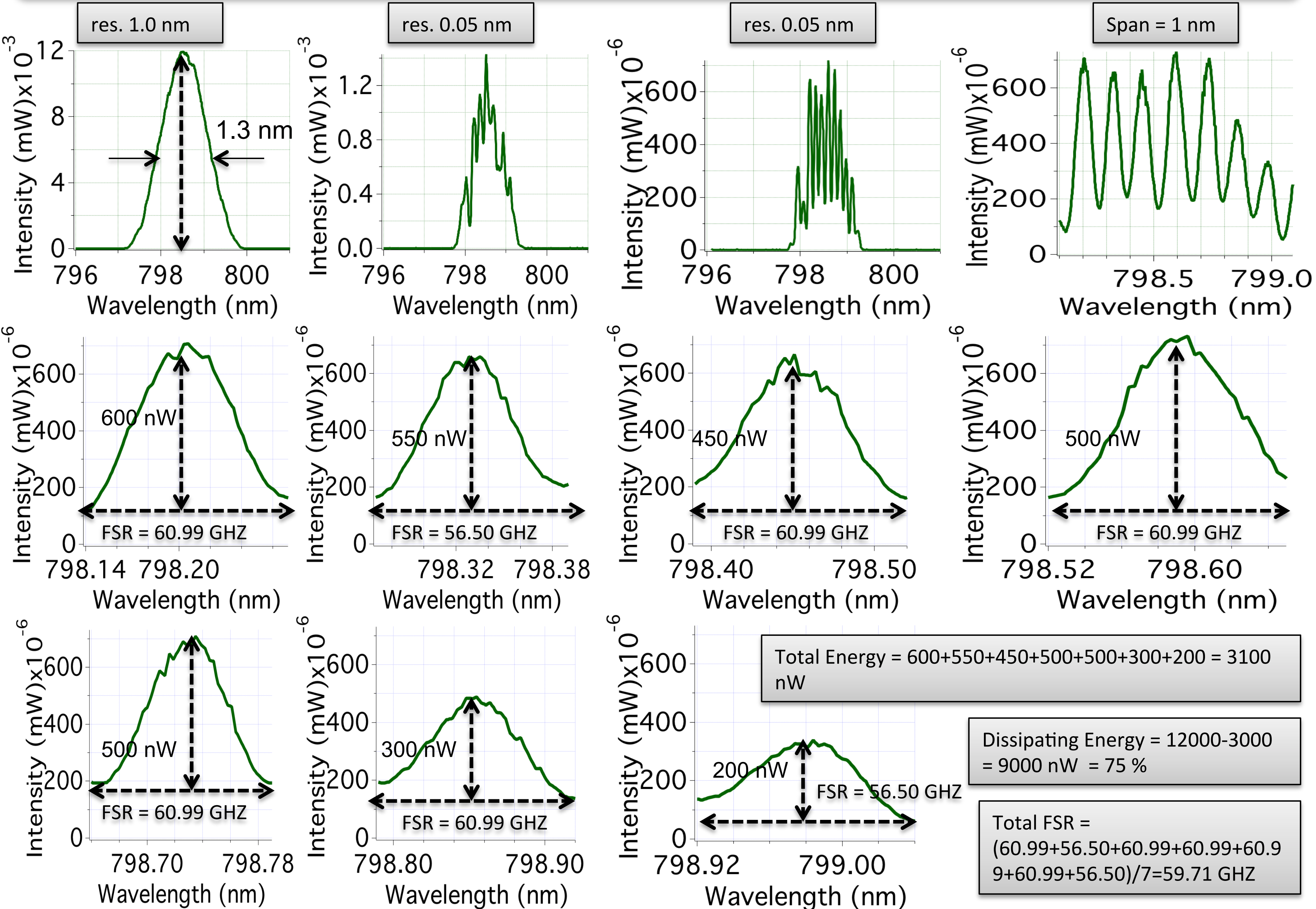




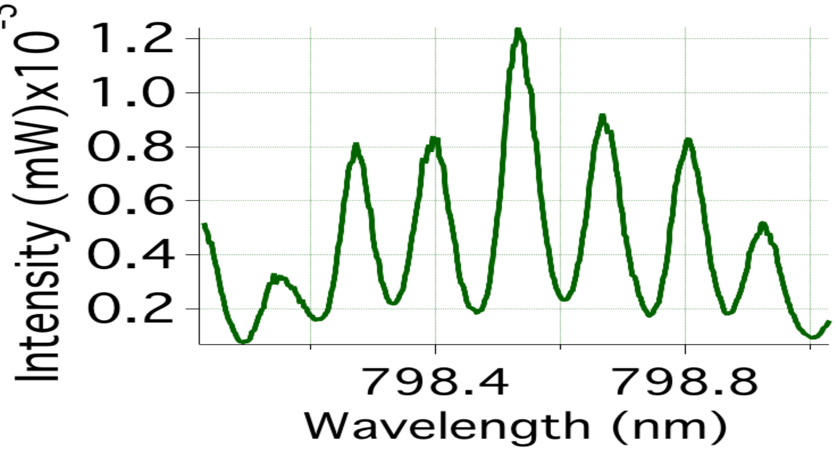
Output spectra from VIPA and Grating (G is positioned at the Fourier plane)

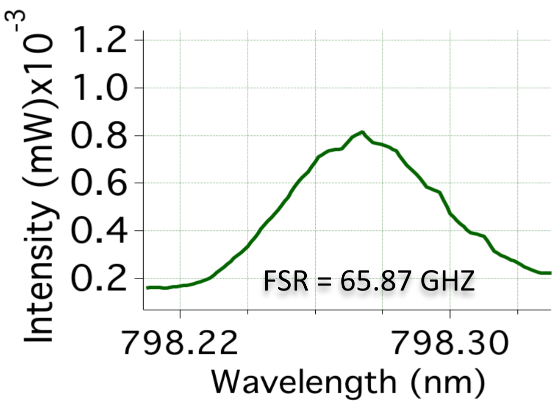


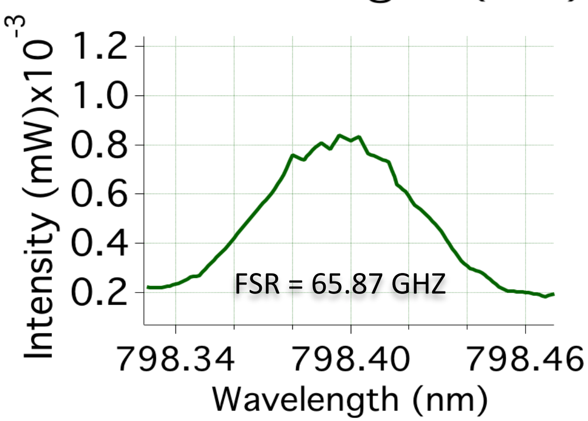
Mean power and average FSR calculation; where is the dissipated Energy?

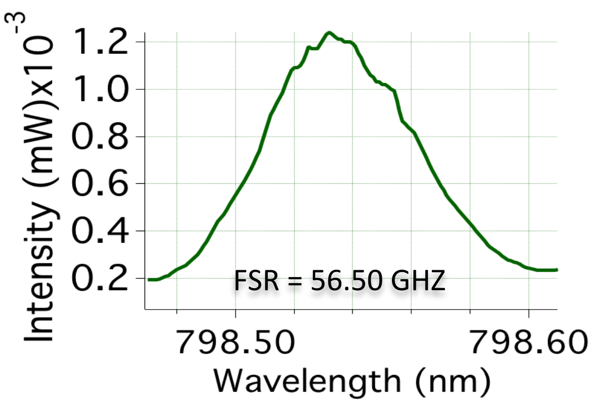


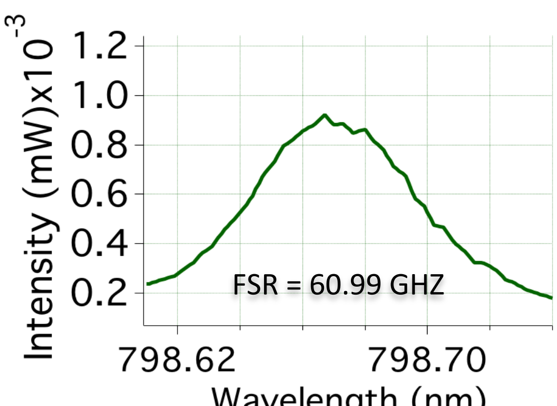
FSR calculation with varying the incidence angle slightly

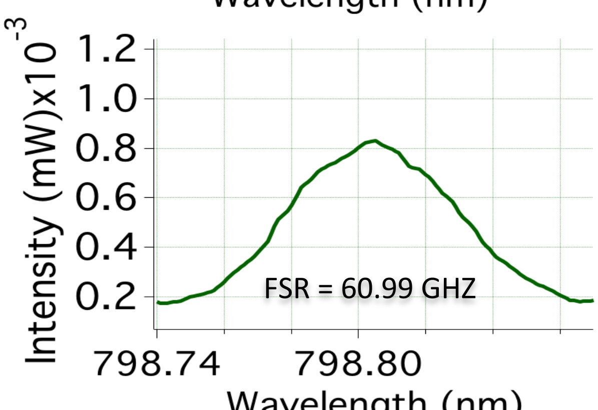






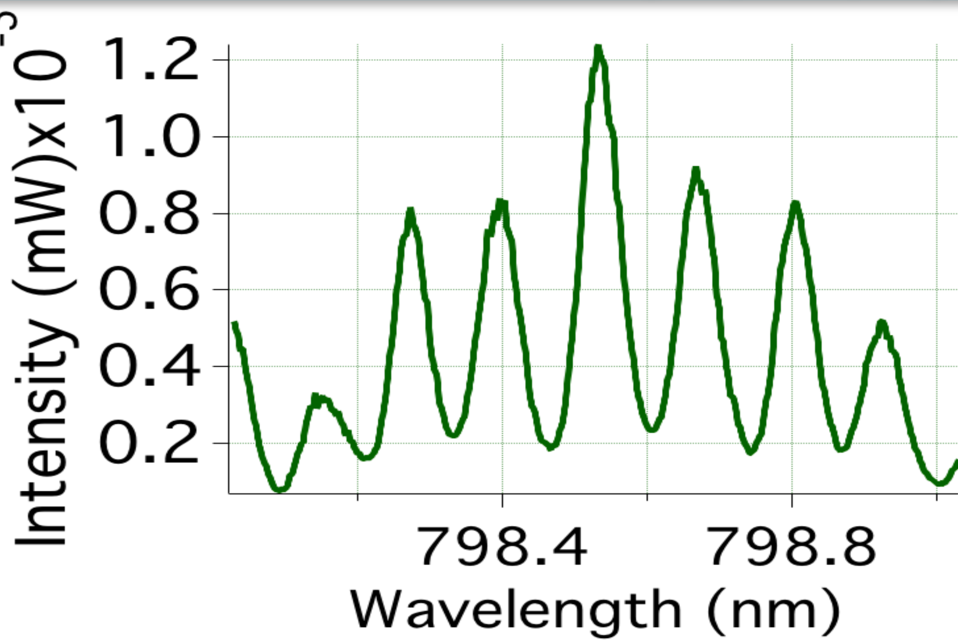


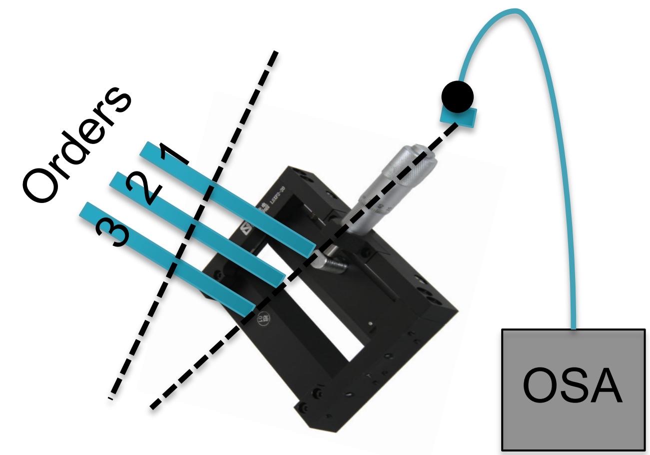


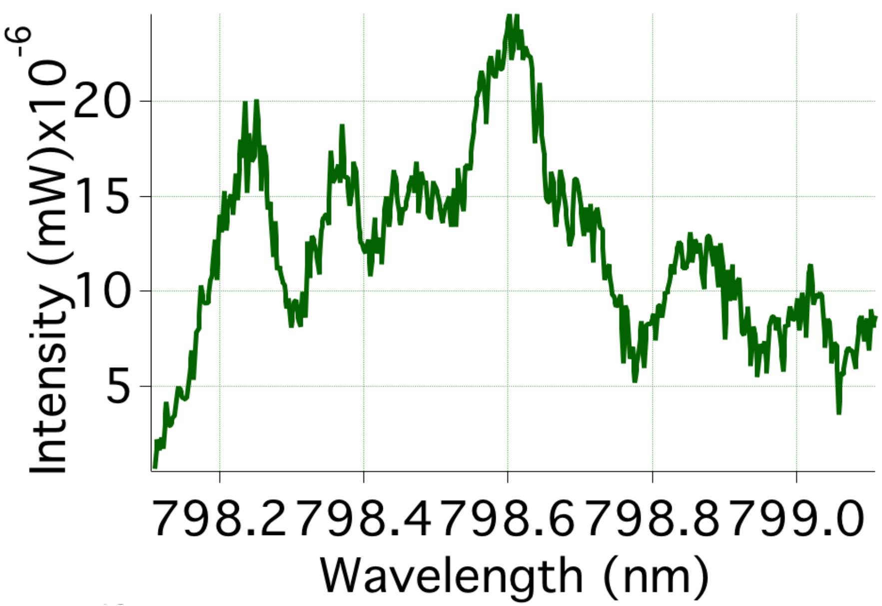


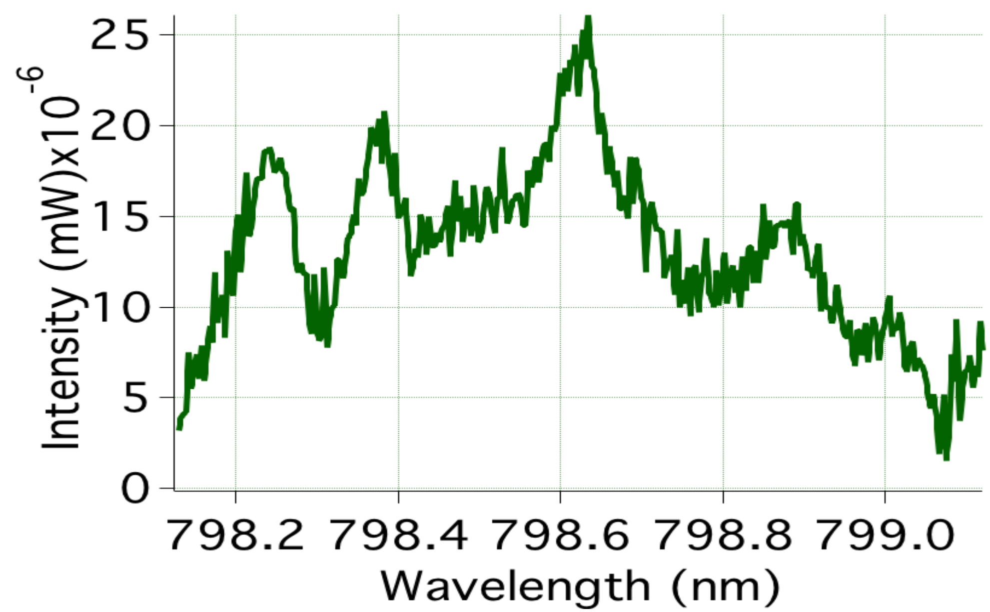
Total FSR = (65.87+65.87+65.50+60.99+60.99)/5 = 63.84 GHZ

FSR calculation with slightly varying the incidence angle

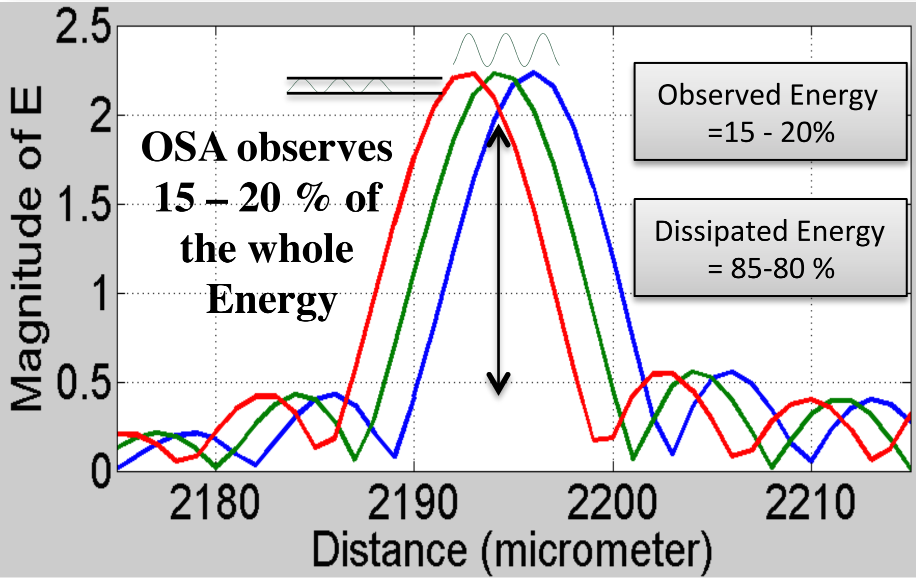


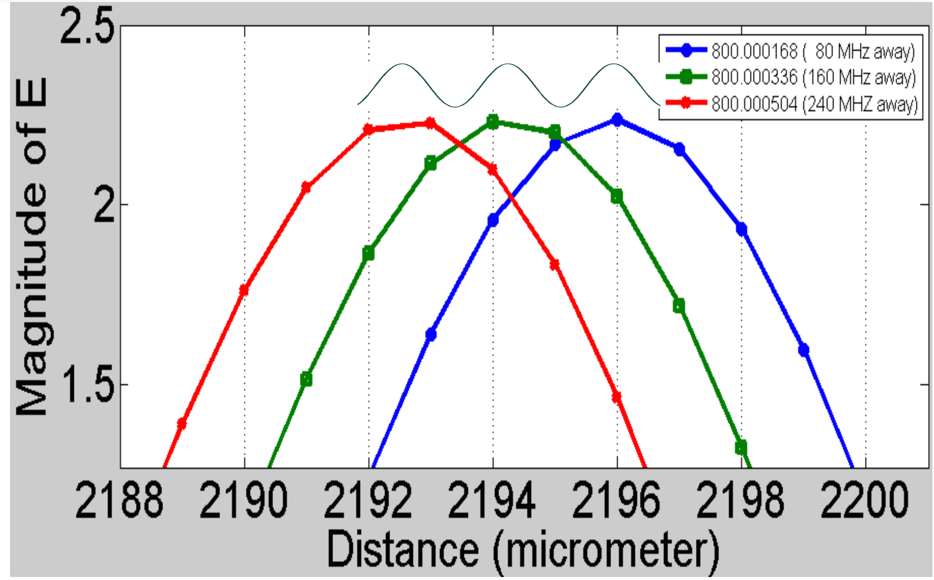


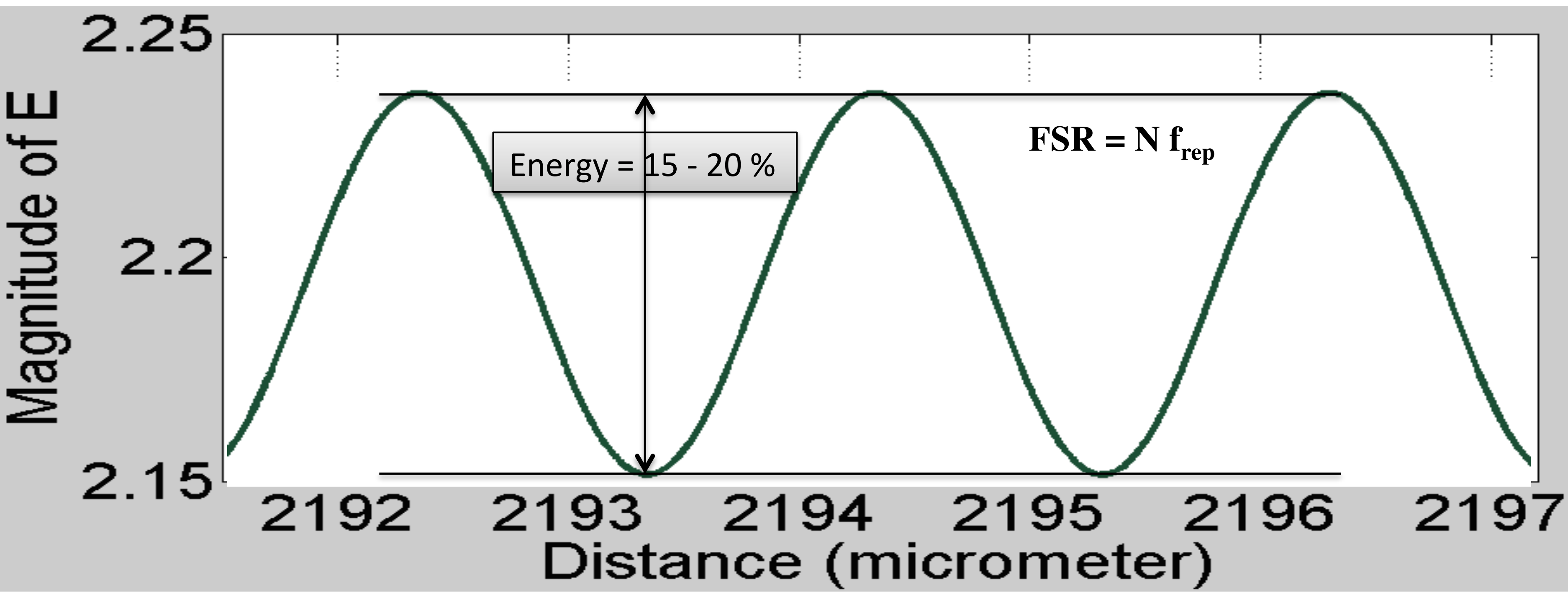




Influence of repetition rate f_{rep} on spectral resolution

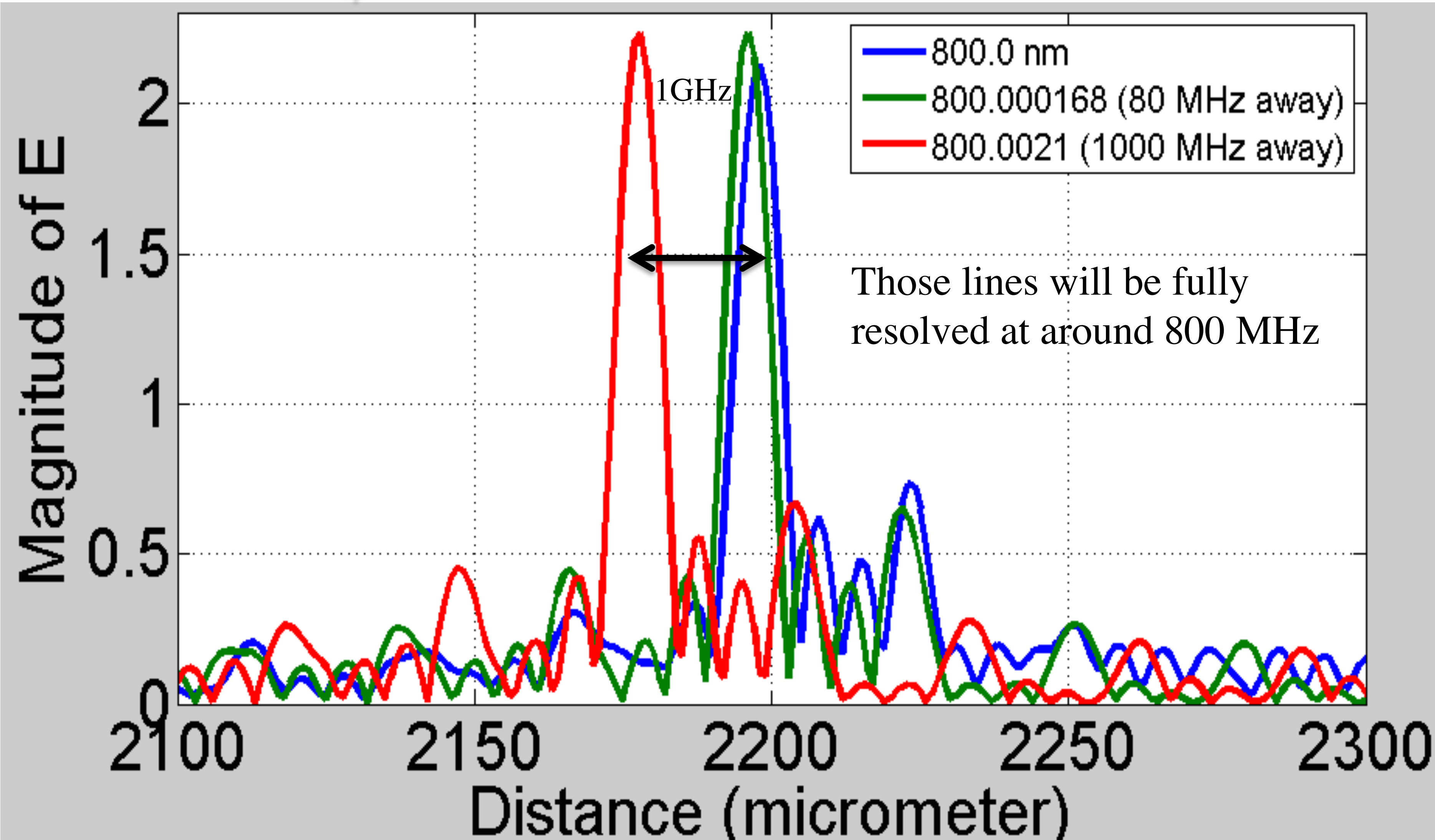






Influence of repetition rate f_{rep} on spectral resolution

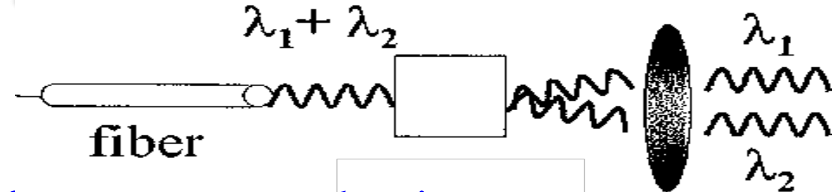
High repetition rate f_{rep} is desired (easy to resolve line by line) 1 GHz gives 0.0021 nm
Low repetition rate f_{rep} (difficult to resolve line by line) 80 MHz gives 0.000168 nm



Impact of coherence length of the divided wavelengths (new equations for the new divided wavelengths system should be established)

A light source having a Gaussian spectrum centered at wavelength λ_0 and a bandwidth $\Delta\lambda$ has a coherence length given by

$$L_C = \frac{2\ln 2}{\pi} \cdot \frac{\lambda_0^2}{\Delta\lambda}$$



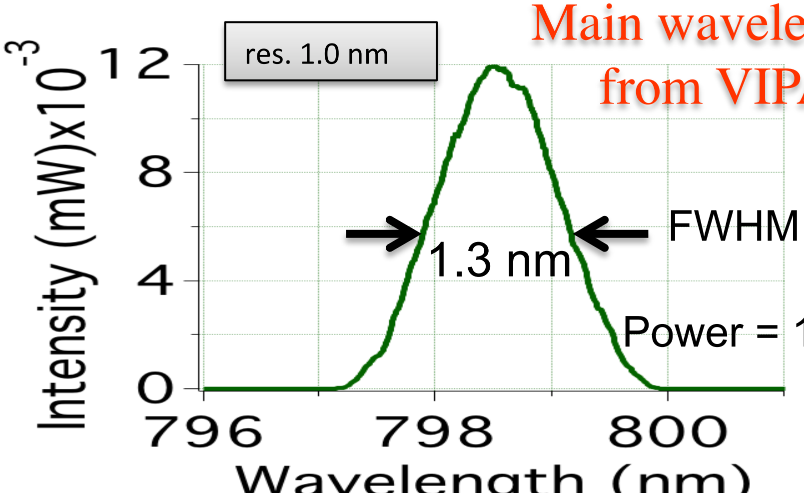
The narrower the spectral bandwidth of a wave, the higher its temporal coherence will be.

Coherence is 20 times greater

When $\Delta\lambda = 0.07$ nm and $\lambda_0 = 798.20$ nm $L_C = 0.44 \, x \, (798.20)^2/(0.07) = 0.4 \, cm$

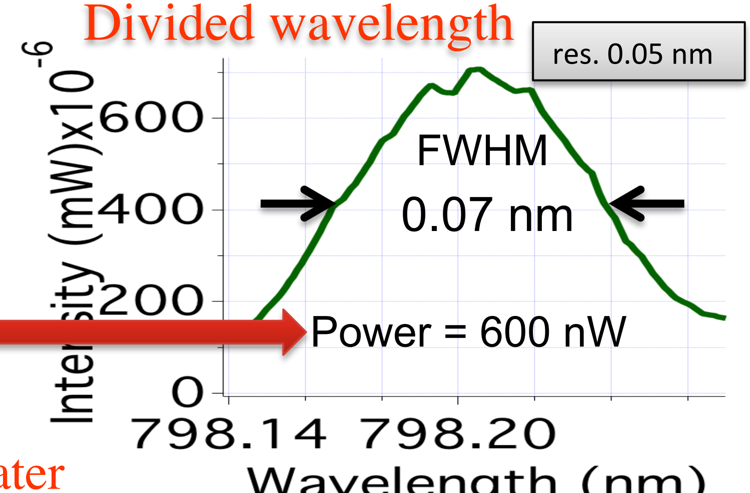
When $\Delta\lambda = 1.3$ nm and $\lambda_0 = 798.50$ nm $L_C = 0.44 \, x \, (798.50)^2/(1.3) = 0.02 \, cm$

Main wavelength from VIPA



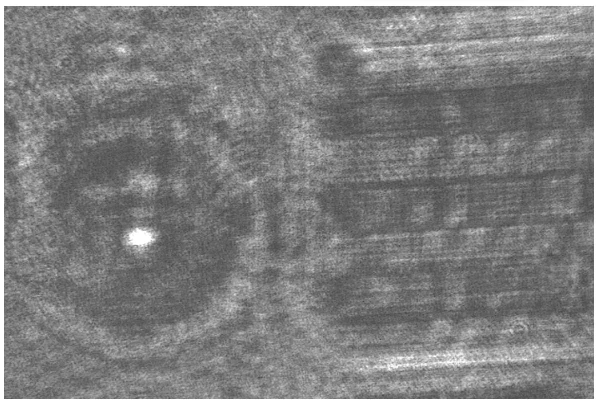
Power
20 times greater

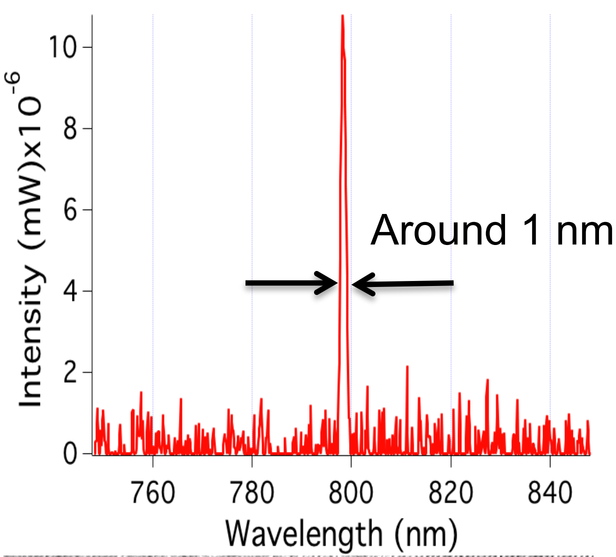
Divided wavelength

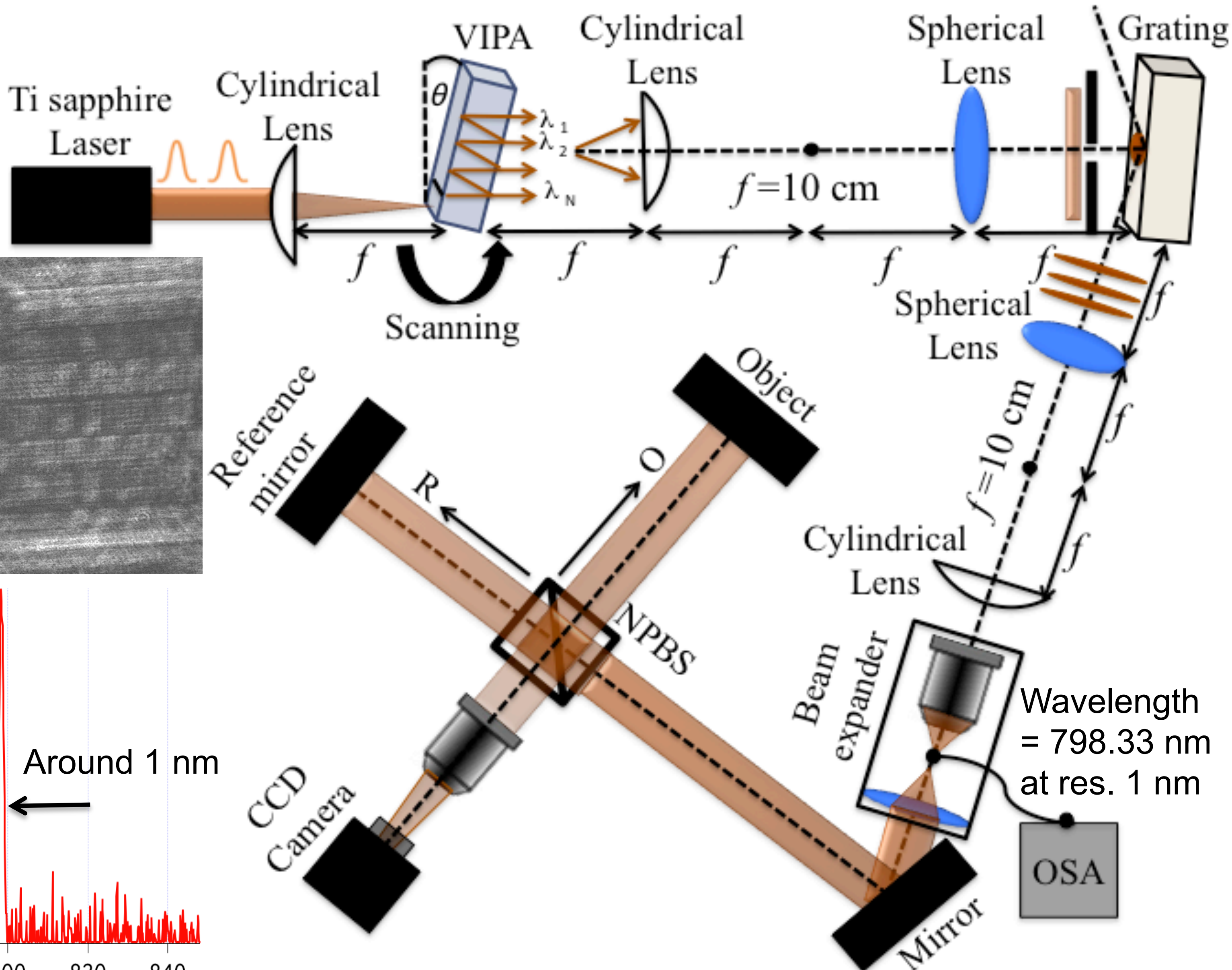


Application; holography with filtered mode @ 798.33 nm with 1nm width

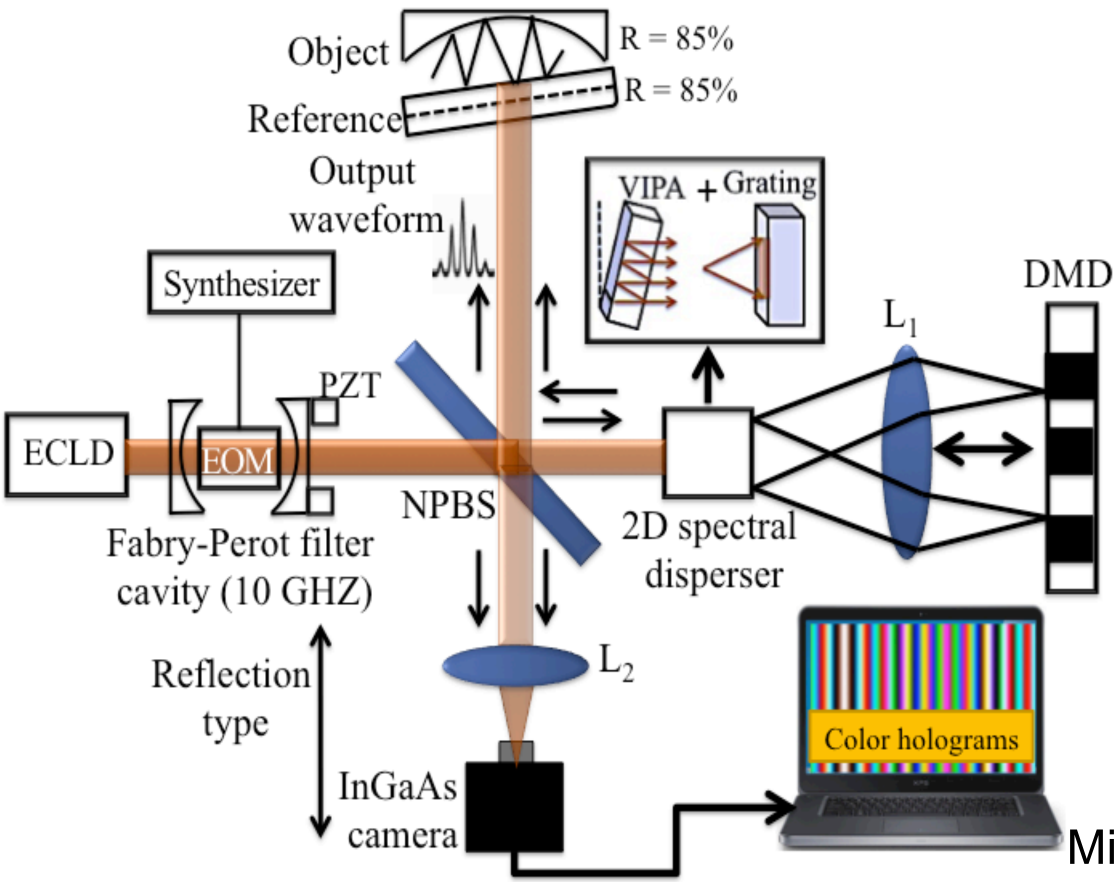
Fundamental wavelength = 800 nm,
Power = 530 mW

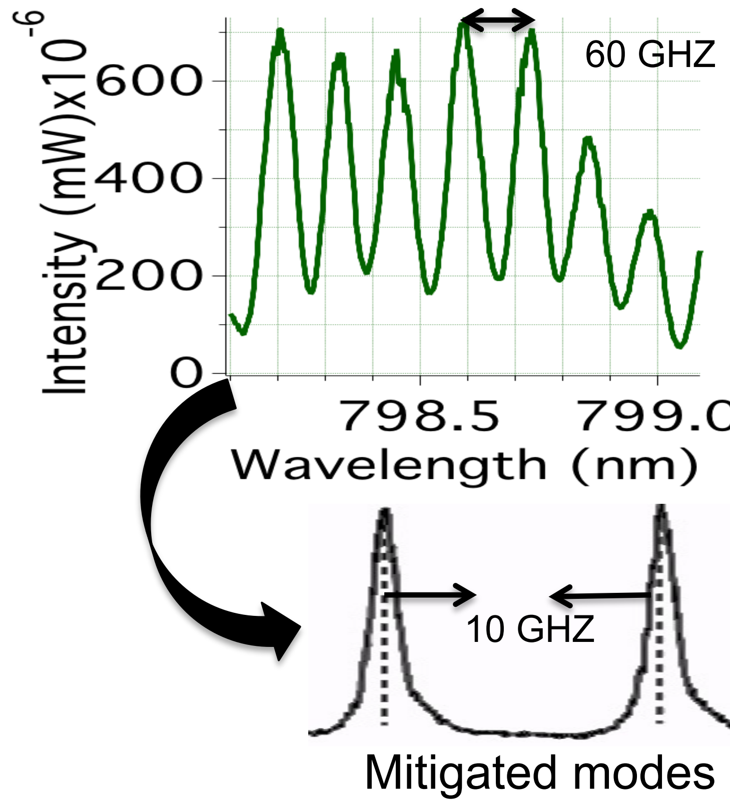


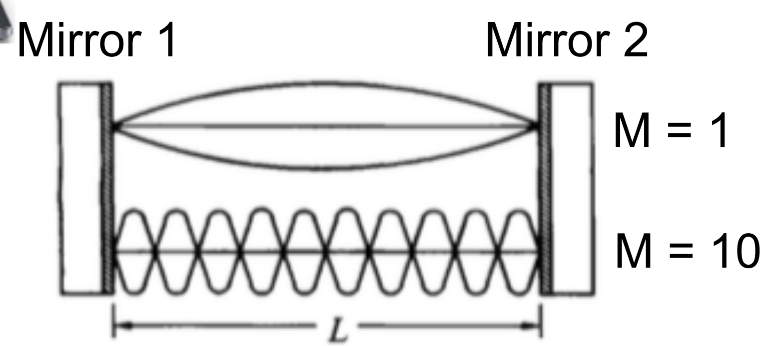




Mitigating the number of modes by use of ECLD and scanning Fabry-Perot interferometer







- Wavelength against FSR (no change)
- Wavelength against half width (changed)

Thank you for listening.
Any questions or suggestions?