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Group Seminar

July 21, 2006

Focal Engineering in CARS Microscopy - A qualitative descrption

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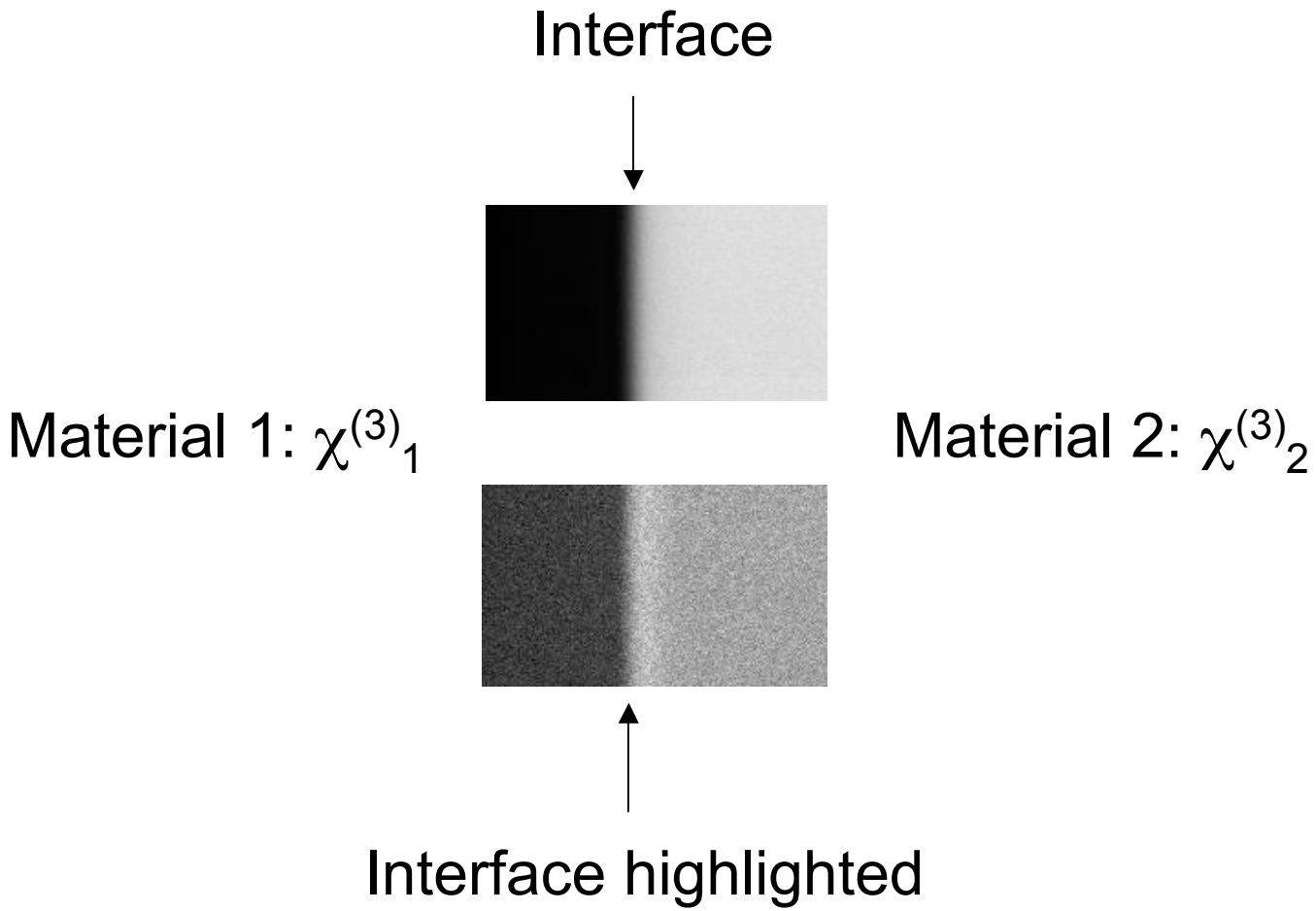
Motivation

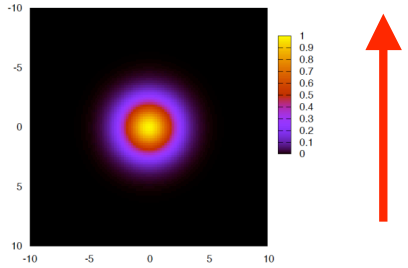

Interface
Material 1: $\chi^{(3)}_1$
Material 2: $\chi^{(3)}_2$
Interface highlighted

Contents

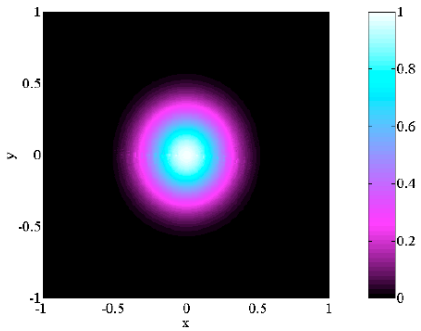
- Focal engineering : A review
- A closer look at CARS generation
- CARS due to a modified focal spot
- First results of interface detection

Focal Engineering

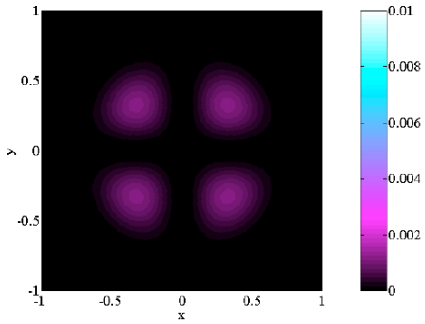
Focal distribution:



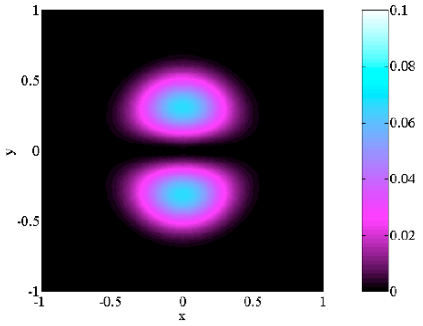
Input: Linearly polarized Gaussian beam



I_x



I_y

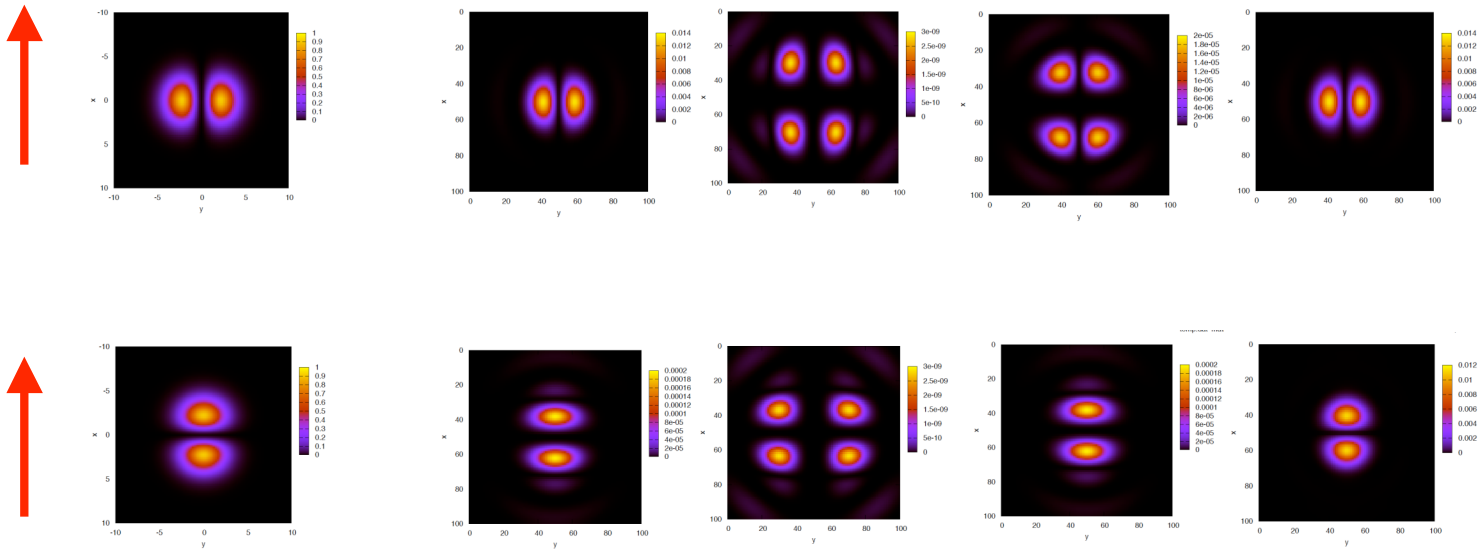


I_z

$$I_{total} = I_x + I_y + I_z$$

Focal Engineering

Modifying input distribution:

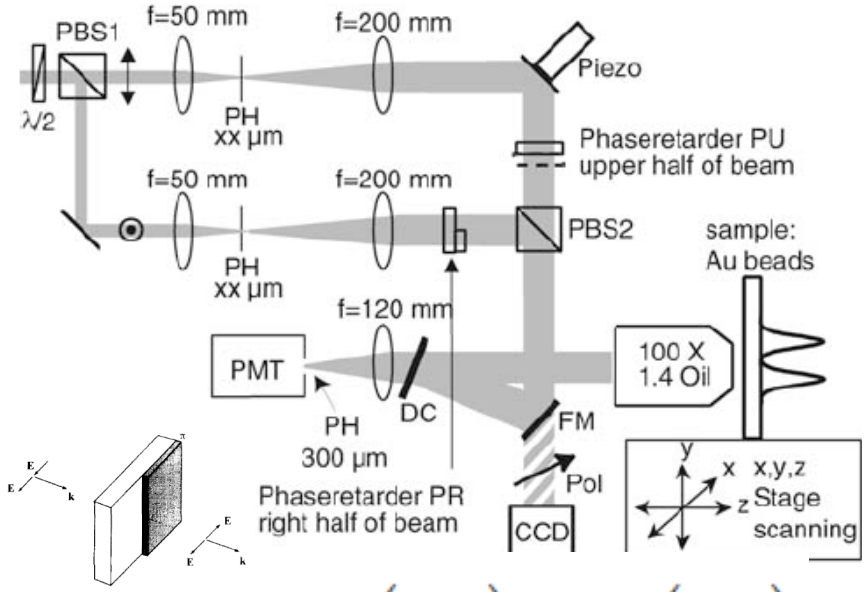


Input x y z T

Focal engineering = shaping of beam focus

Focal Engineering

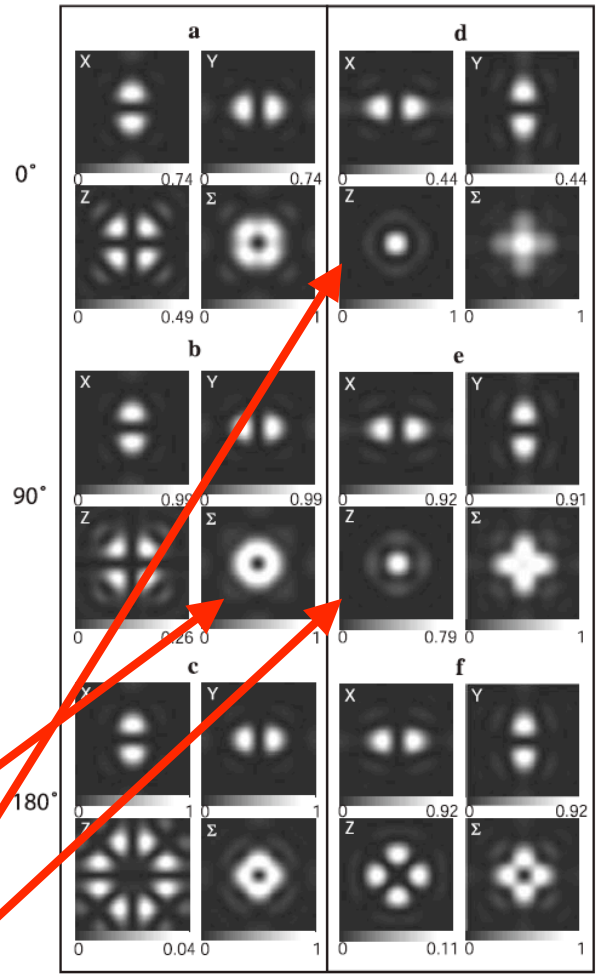
An Example:



$$\boldsymbol{E} = \boldsymbol{E}_1 + \mathrm{e}^{\mathrm{i}\delta}_{\boldsymbol{E}_2} = \begin{pmatrix} E_{1,x} \\ E_{1,y} \\ E_{1,z} \end{pmatrix} + \mathrm{e}^{\mathrm{i}\delta} \begin{pmatrix} E_{2,x} \\ E_{2,y} \\ E_{2,z} \end{pmatrix}$$

STED

Molecular orientation



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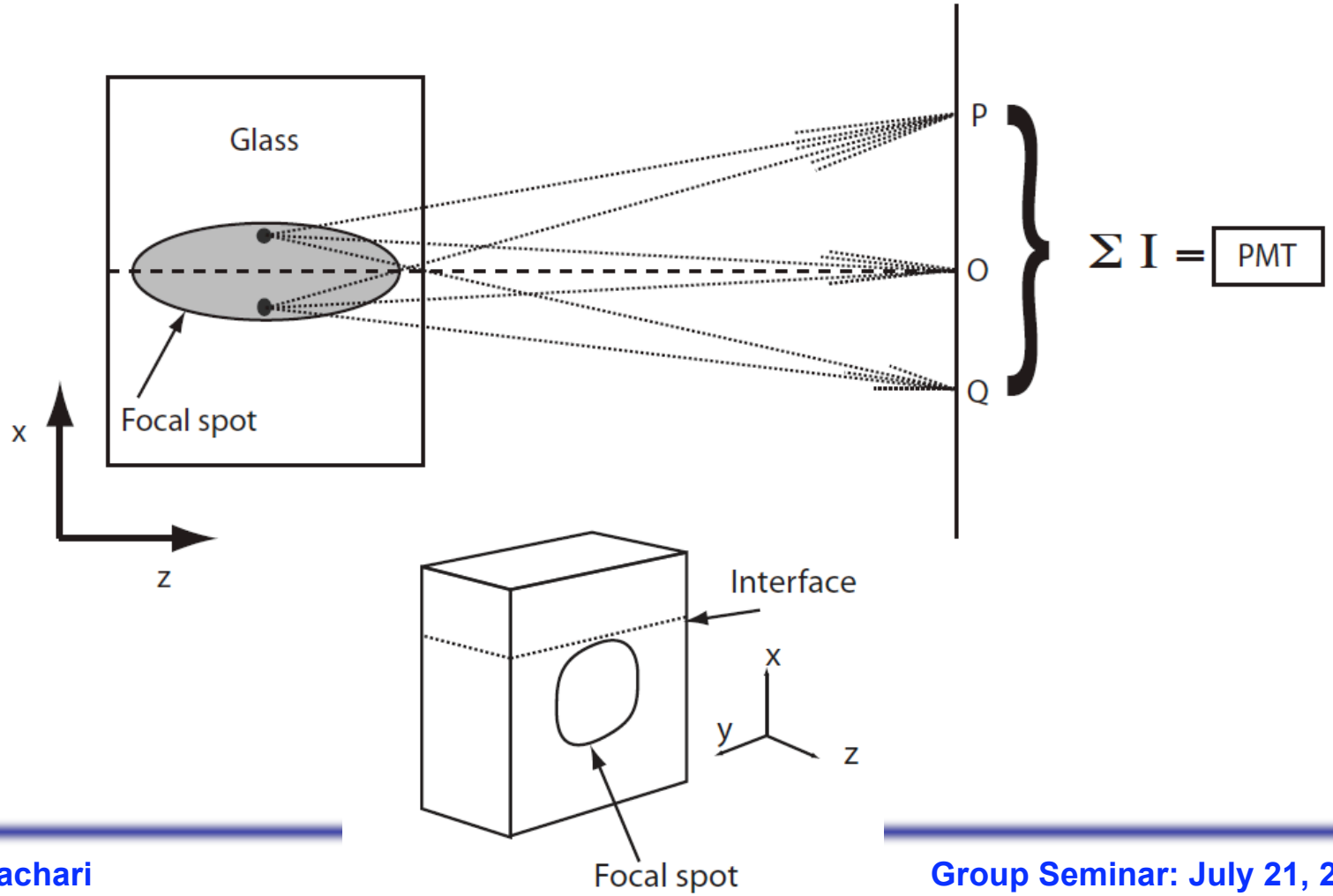
CARS generation

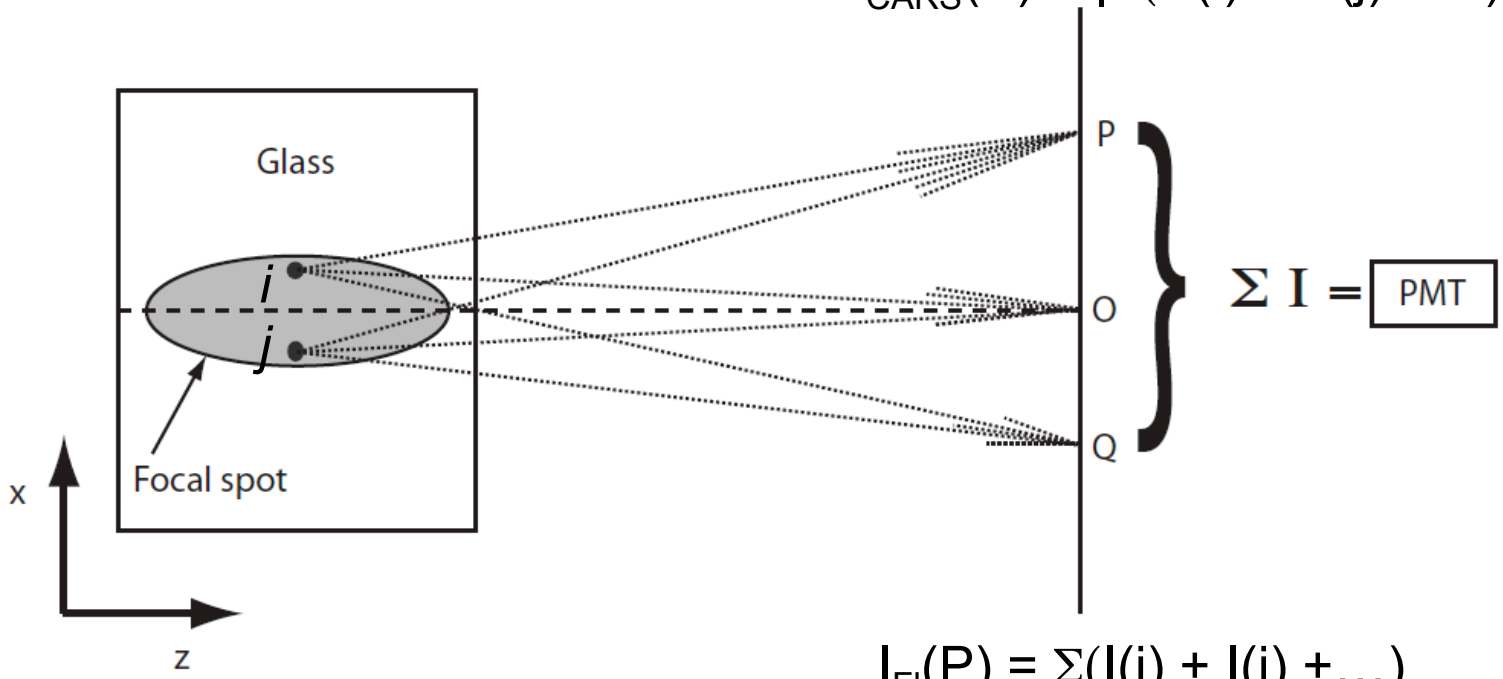
Geometry



CARS generation

CARS vs Fluorescence

$$I_{CARS}(P) = |\Sigma(E(i) + E(j) + \ldots)|^2$$



$$I_{FI}(P) = \Sigma(I(i) + I(j) + \ldots)$$

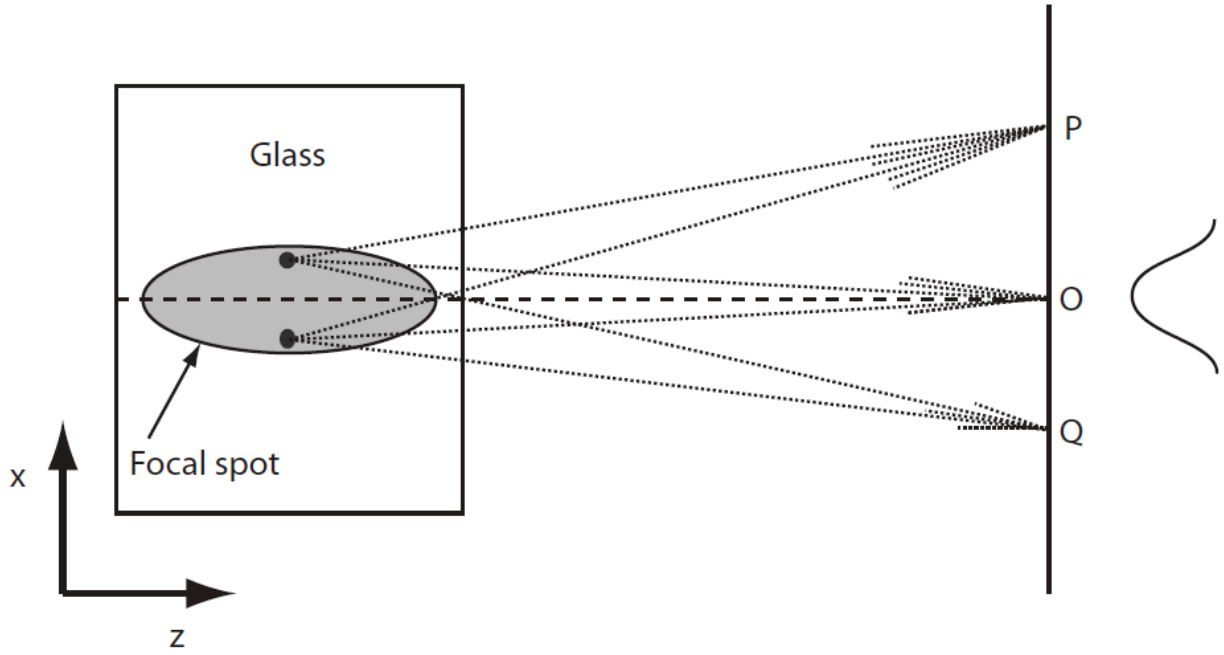
Intensity at P or O or Q:

CARS ⇒ interference of individual amplitudes

Flourescence ⇒ sum of individual intensities

CARS generation

CARS : Homogeneous sample

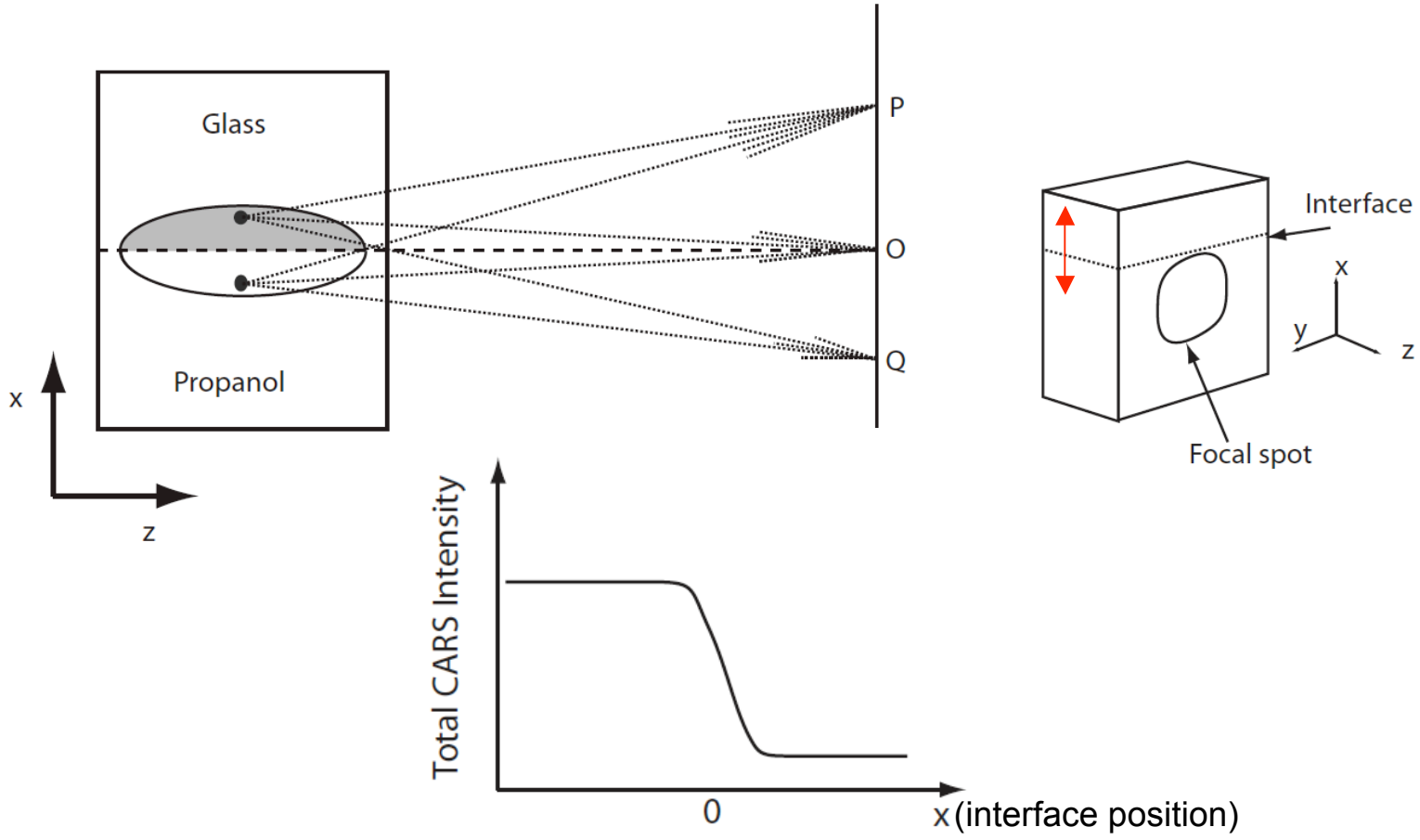


Intensity at P or O or Q:

CARS ⇒ interference of individual amplitudes

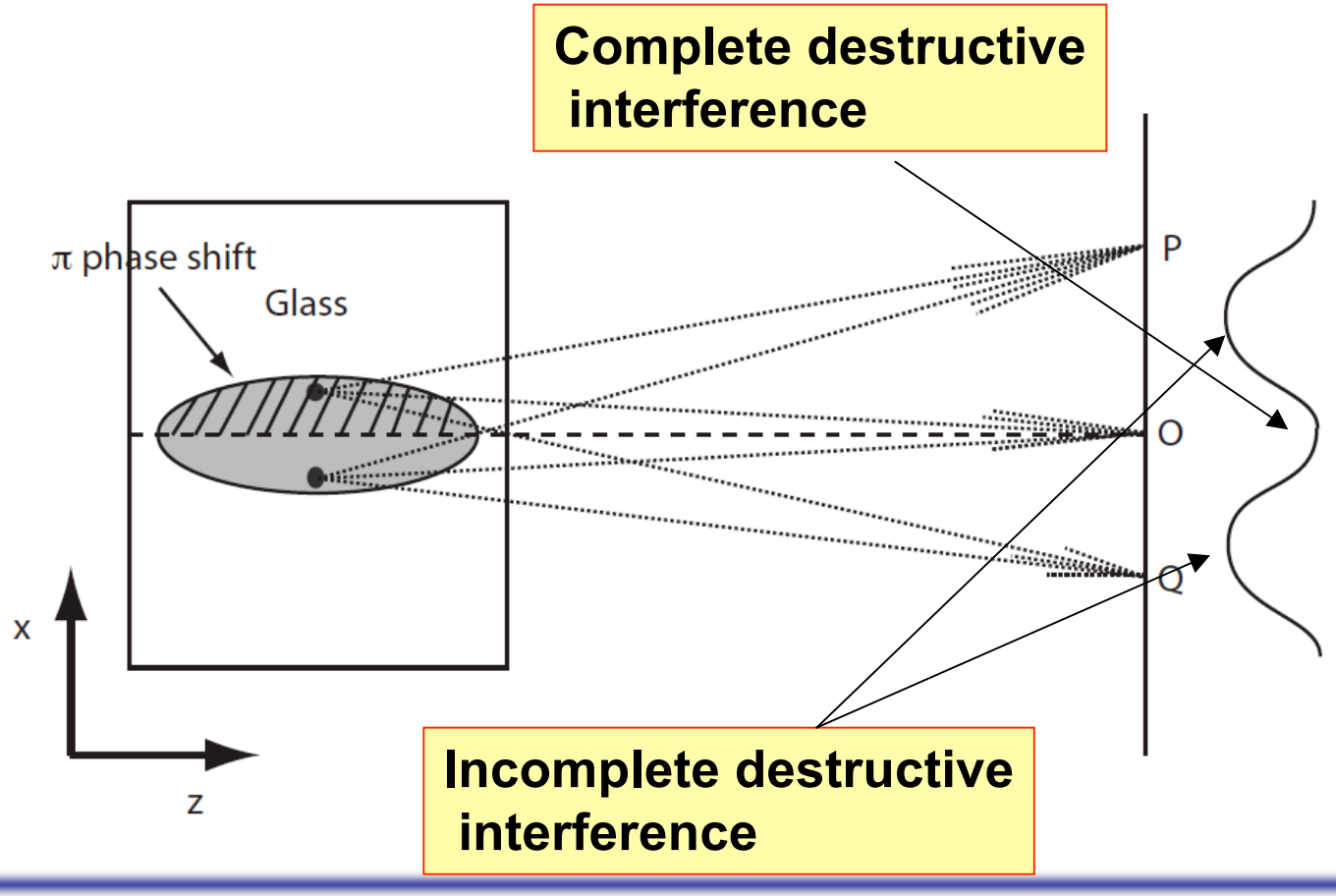
CARS generation

CARS : Interface



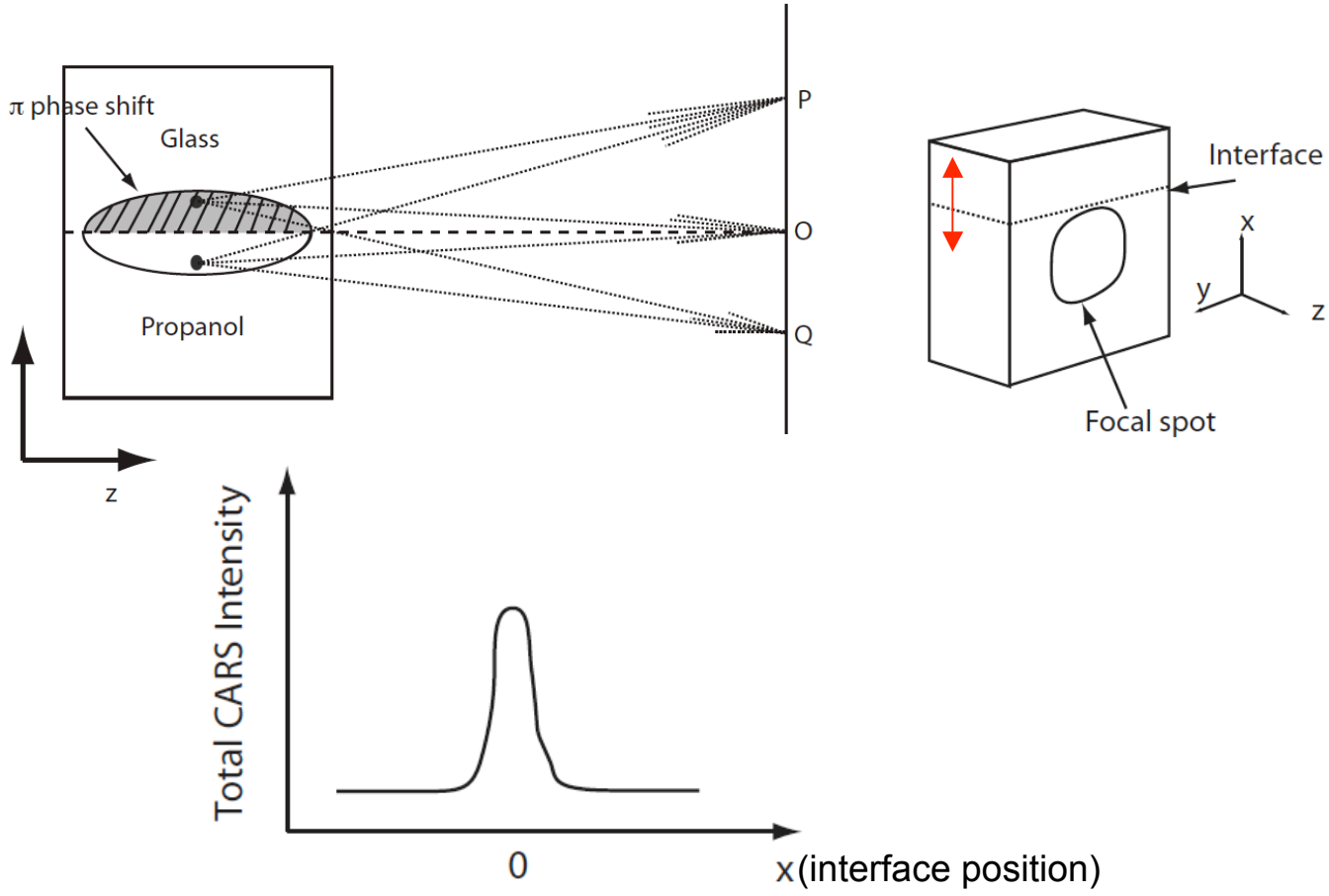
CARS due to modified focal spot

π phase jump at focal spot - Homogeneous sample



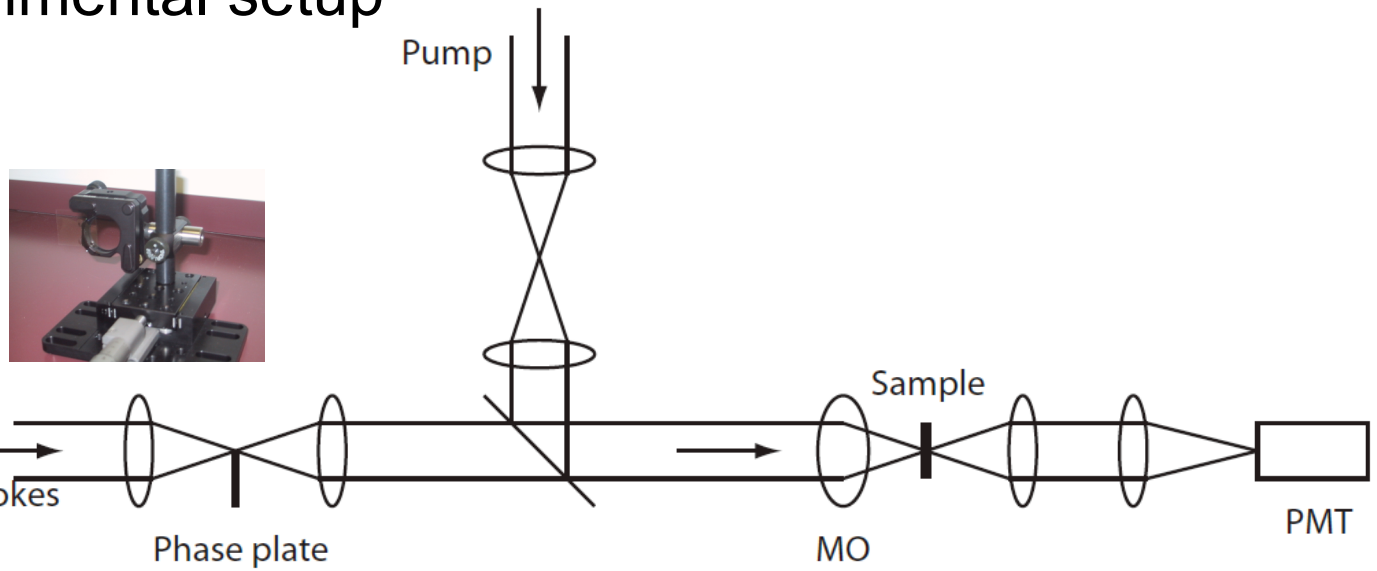
CARS due to modified focal spot

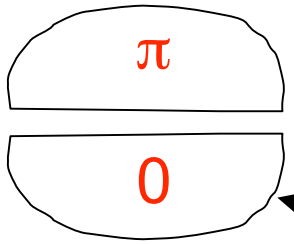
π phase jump at focal spot - Interface



First Results

Experimental setup





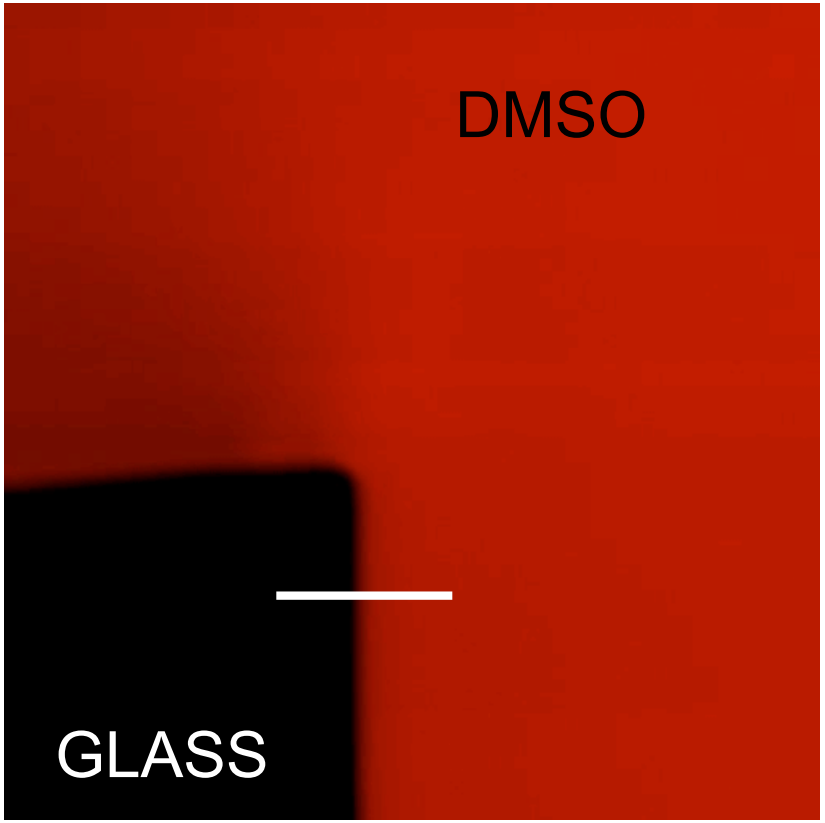
$\phi_{CARS} = 2\phi_p - \phi_S - \pi$

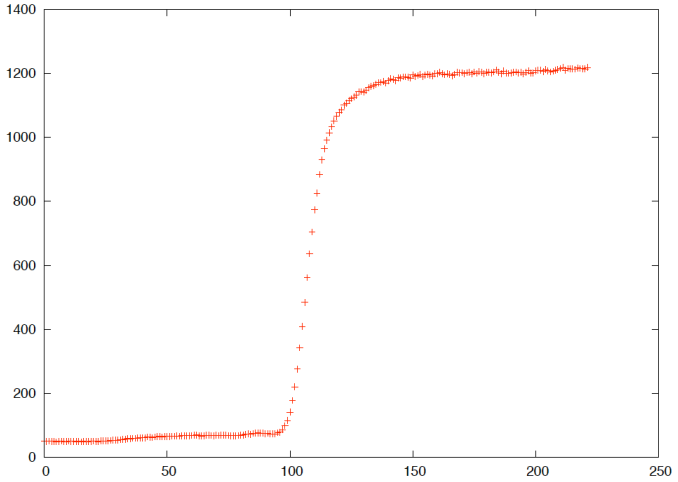
$\phi_{CARS} = 2\phi_p - \phi_S$

Focal spot cross section

First Results

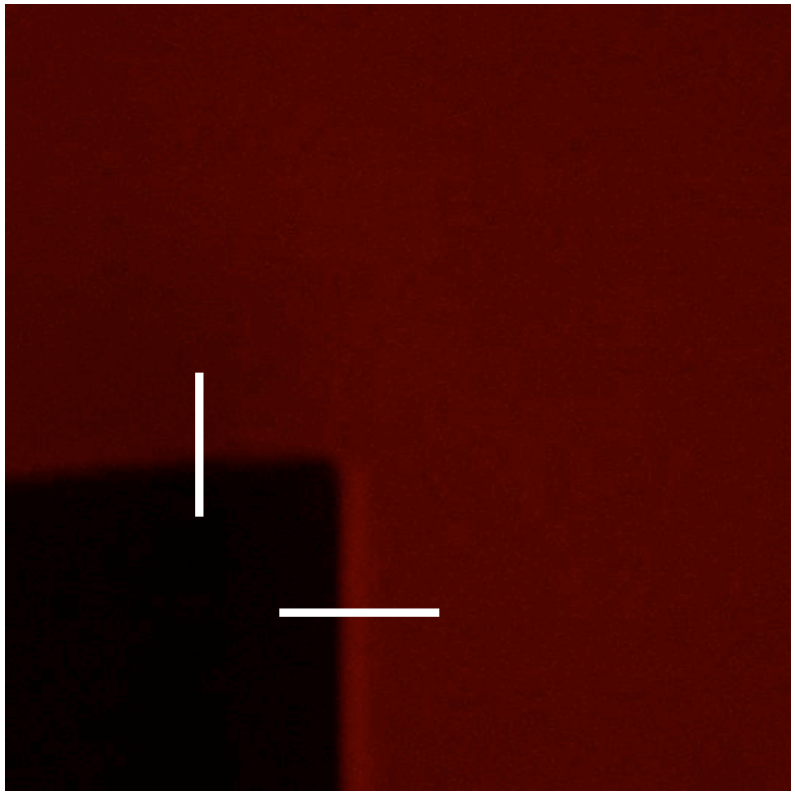
Glass DMSO interface - No phase shift

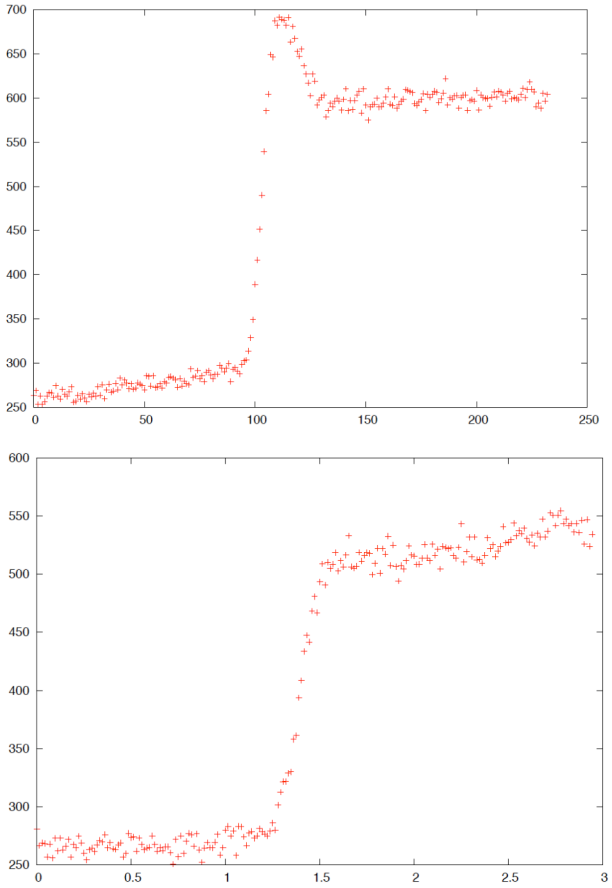




First Results

Glass DMSO interface - With phase shift





Conclusion

- CARS intensity - spatial interference
- Focus shaped CARS ⇒ interface detection