Improved Acousto-Optic Modulator for Ultrafast Laser Pulse Shaping

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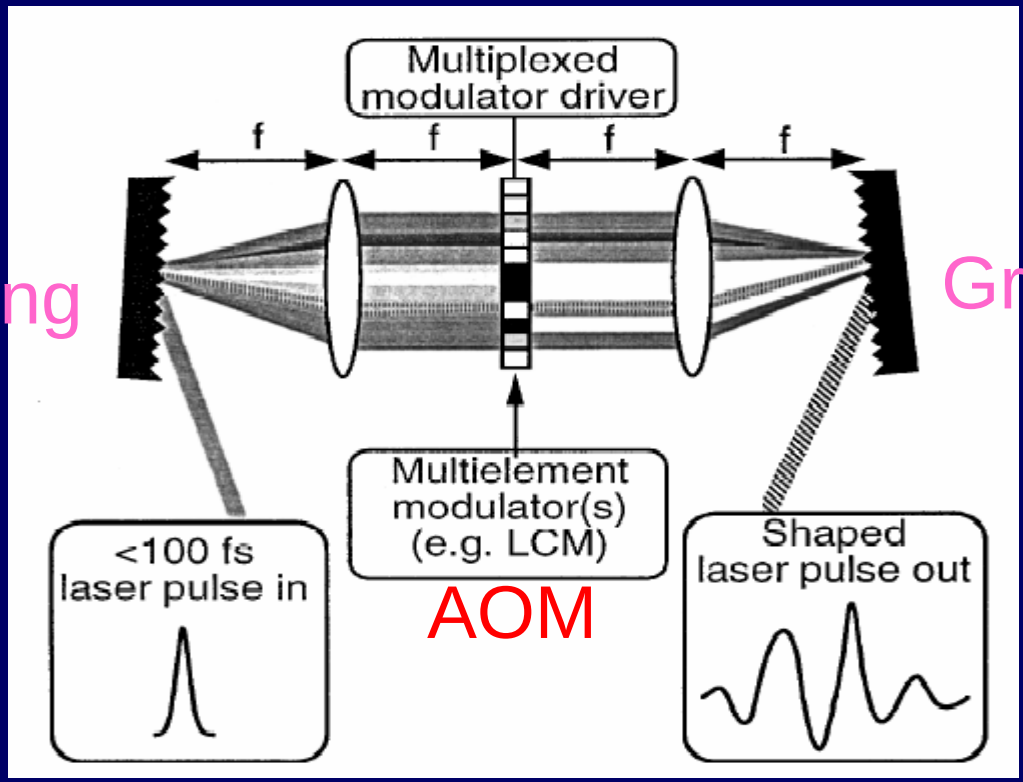
Optical Rotation

Synopsis

- Ultrafast laser pulse shaper
- Acousto-optic modulators
- Propagation of ultrasonic waves in crystal
  - Fresnel diffraction
  - Fraunhofer diffraction
- Use He-Ne laser to map the transmission function of AOMs- problem of the old AOM
- An AOM with newly-designed diamond transducer
- Measured data and simulation
- Summary

Ultrafast Laser Pulse Shaper

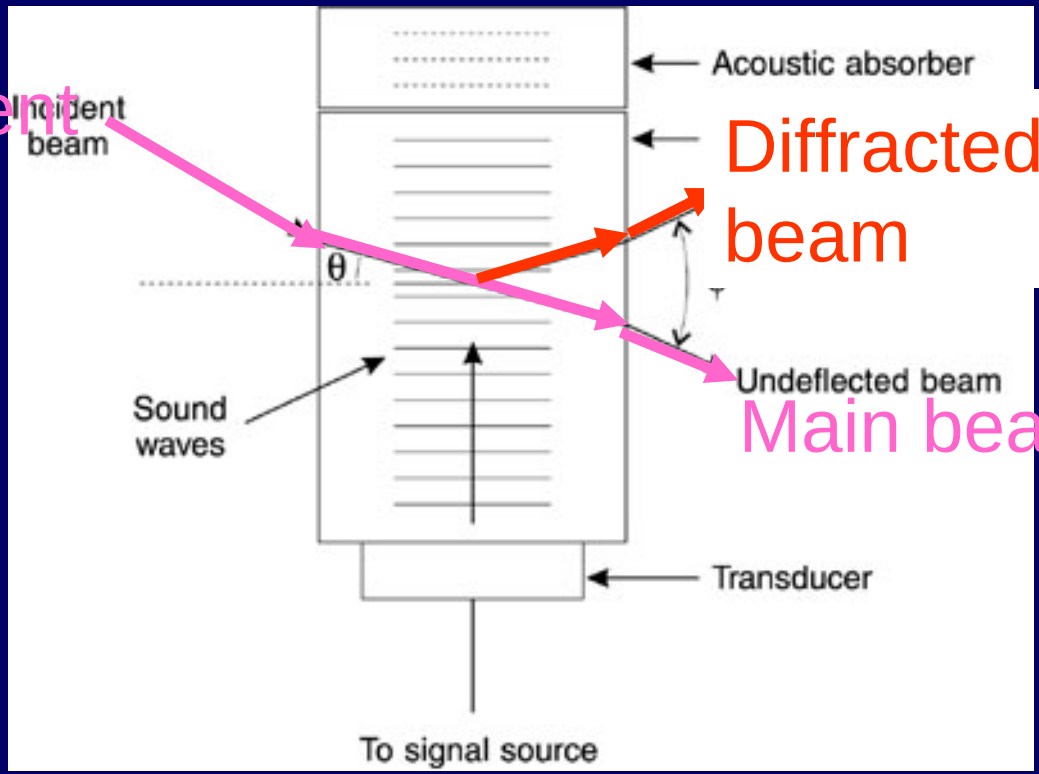
Grating

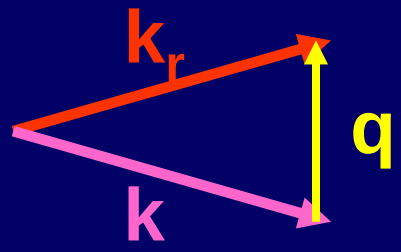


Grating

- AOM diffracts the spectrally dispersed optical beam
- AOM modulates the phase and amplitude of the light

Acousto-optic Modulators





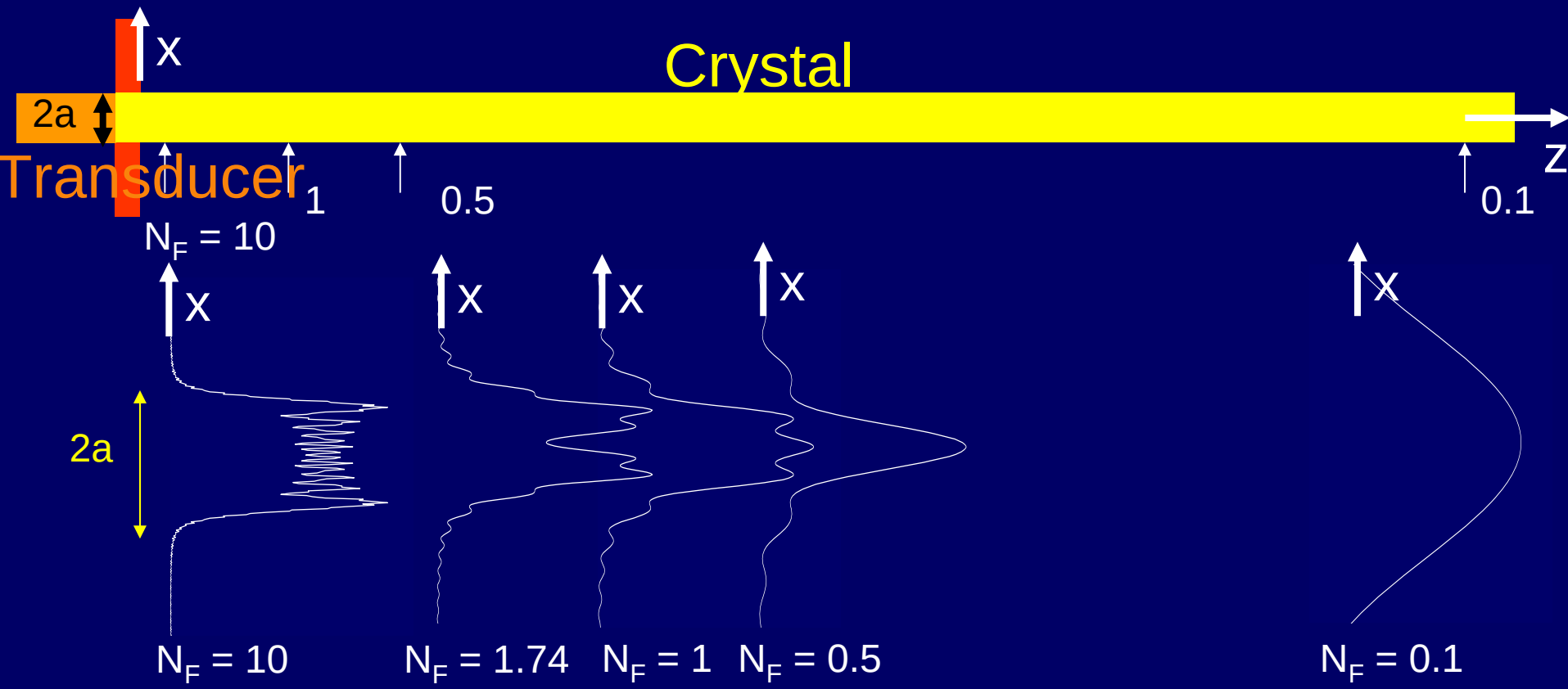
$k_r = k + q$

Bragg Condition

- Linear analog modulator of light
- Optical switch
- Will the diffracted beam maintain the same beam shape?

Propagation of Ultrasonic Waves in Crystal

- Fresnel diffraction
- Fraunhofer diffraction

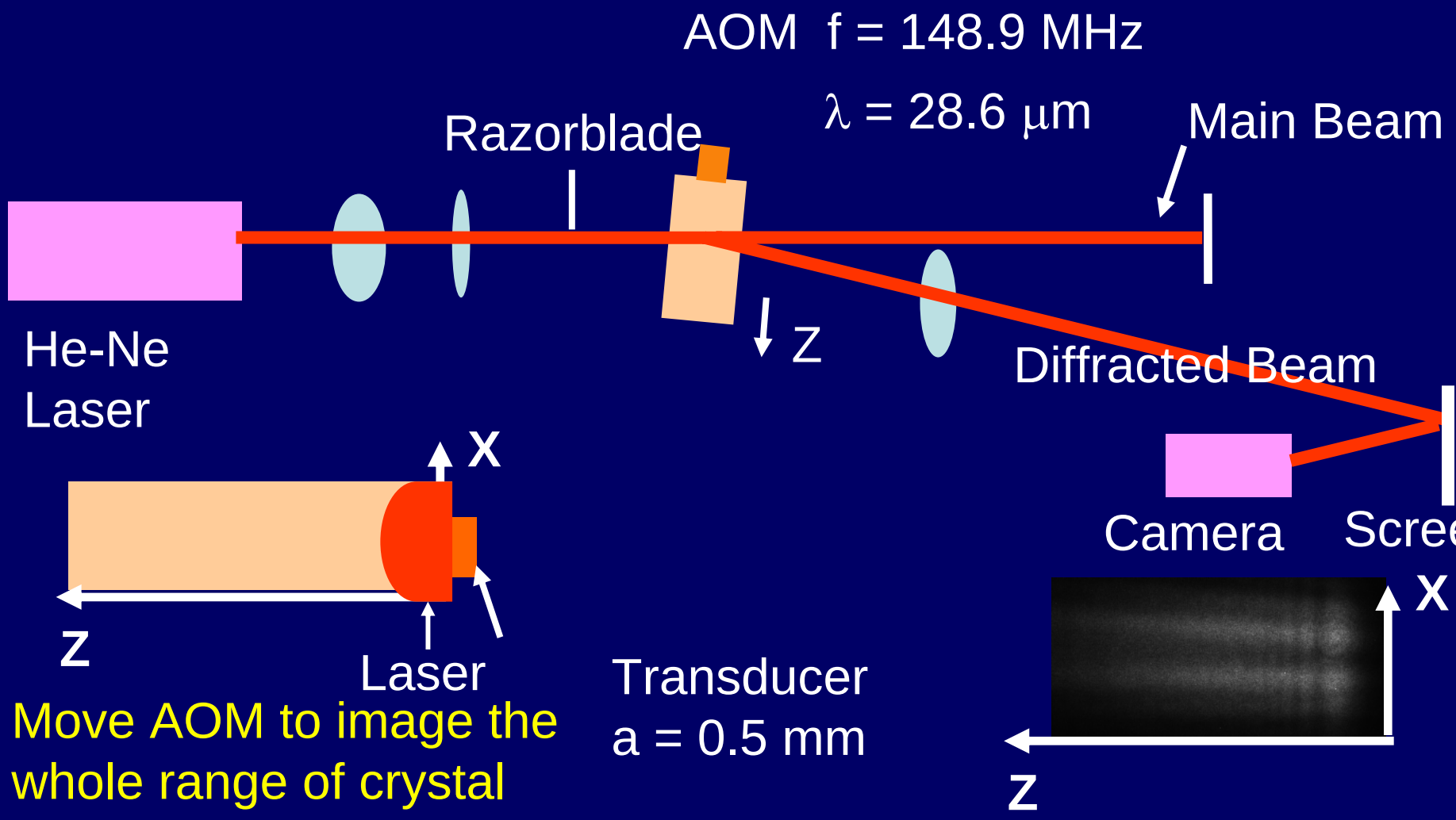


Single slit

$$I(x) = \left| \int_{-\sqrt{N_F}}^{\sqrt{N_F}} \exp\left[-\frac{i\pi}{\lambda z}(x - x')^2 \right] dx' \right|^2$$

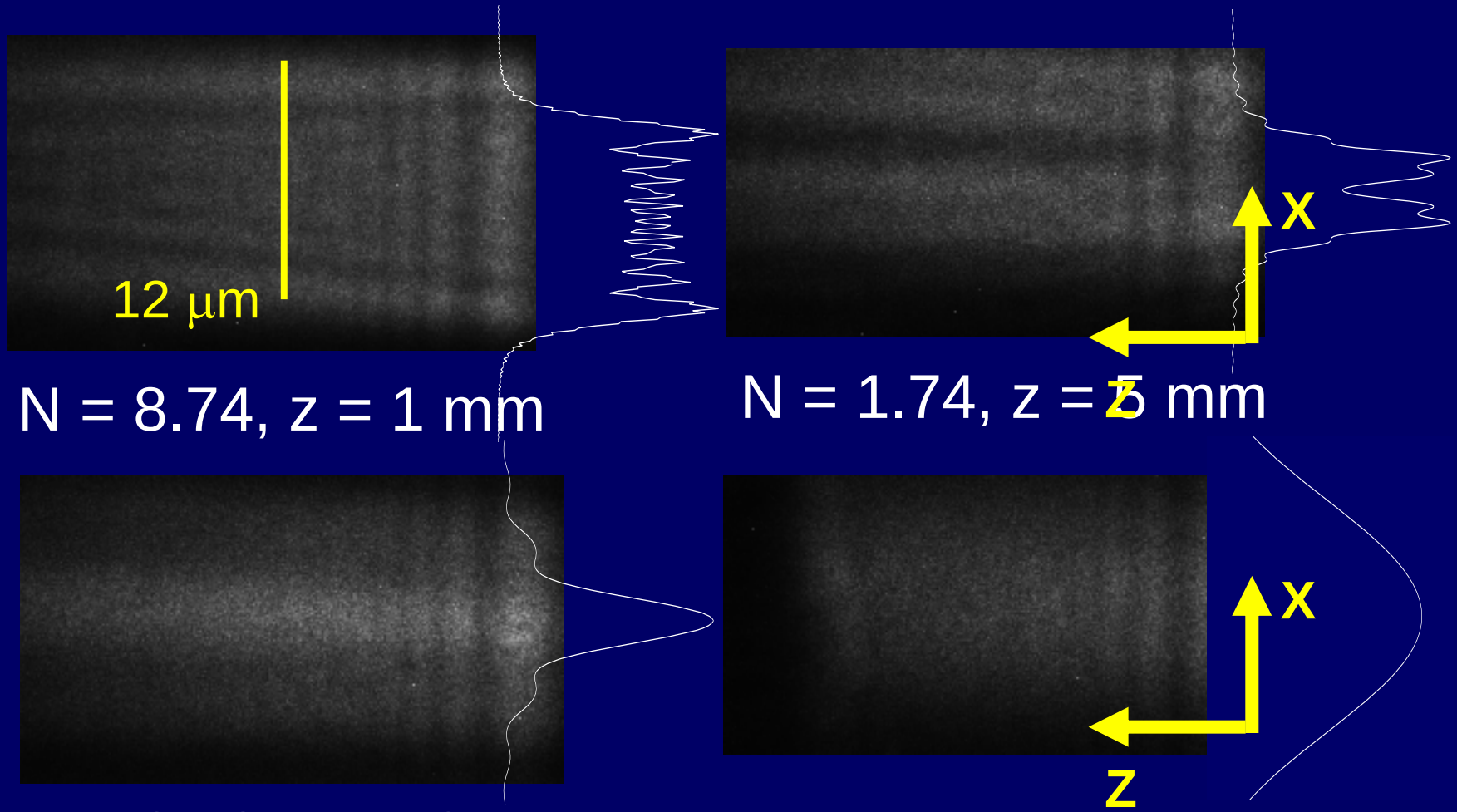
$$N_F = \frac{a^2}{\lambda z}$$

Experimental Setup



X: vertical Z: acoustic beam propagation direction

Transmission Function of AOM with Rectangular Transducer



N = 8.74, z = 1 mm

N = 1.74, z = 5 mm

N = 0.72, z = 12 mm

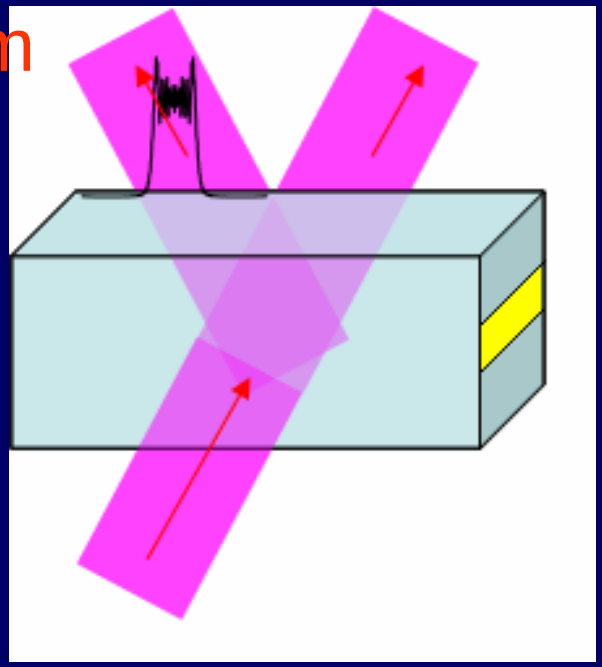
N = 0.27, z = 32.7 mm

X: vertical Z: acoustic beam propagation direction

How to Eliminate the Fringes?

Diffracted beam

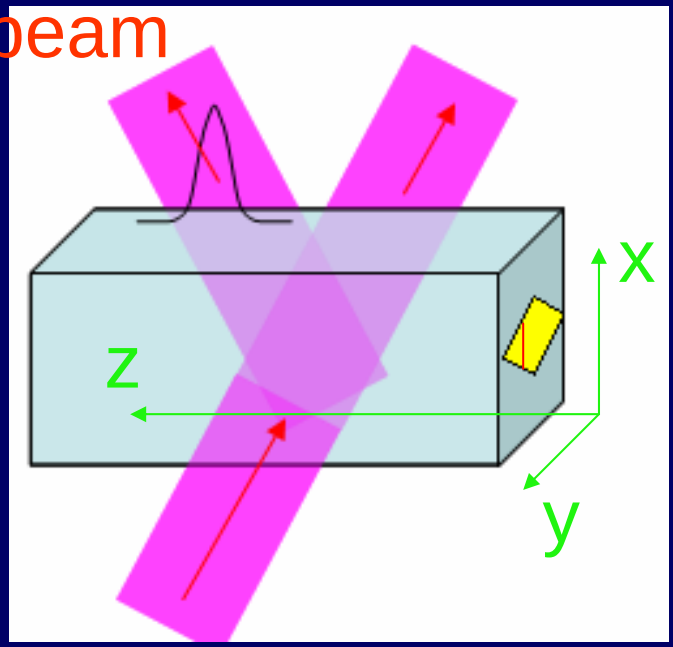
Main beam



- Rectangular transducer

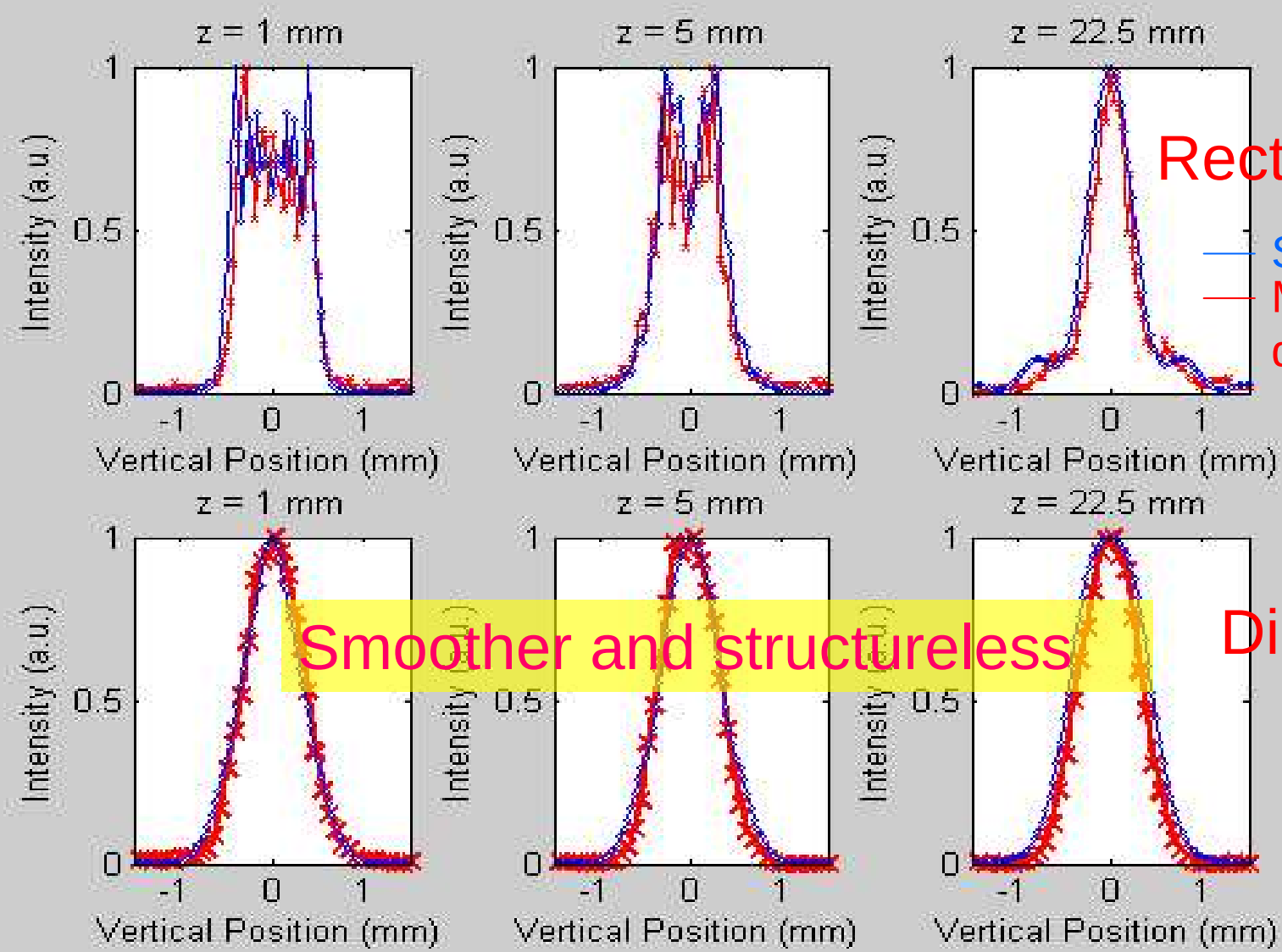
Diffracted beam

Main beam



- Diamond transducer
- Fringes from different y position cancel with each other

Transmission Function of AOM with Rectangular or Diamond Transducer



Conclusion

- Use He-Ne laser to map the transmission function of AOMs with rectangular or diamond transducer.
- The transmission function of AOM with diamond transducer is smooth and structureless.
- Put the diamond transducer AOM into a ultrafast laser pulse shaper

References

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3. H. A. Haus, *Waves and Fields in optoelectronics,* Prentice-Hall, Englewood Cliffs, NJ, 1985

4. M. A. Dugan, J. X. Tull, and W. S. Warren, *J. Opt. Soc. Am. B* **14,** 2348 (1997).

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Thank you!