

DISTANCE DETECTION

EE 594 - Consumer Optoelectronics

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March 17, 1999

MOTIVATION

- My Motives
 - Concept is simple
- Why others may be interested
 - Distance/Velocity measurement is an essential tool in many commercial and military applications
 - Endless possibilities for future development and research

OVERVIEW

- Many ways to detect distances using wave propagation properties
 - visible light (380 - 770 nm)
 - infrared (> 800 nm)
 - microwaves (> 4000nm)
- Best Detection Method depends on Level of Detection desired
 - Application Specific: Range of distance desired? Error allowed? Coherent Signals? Pros/Cons?

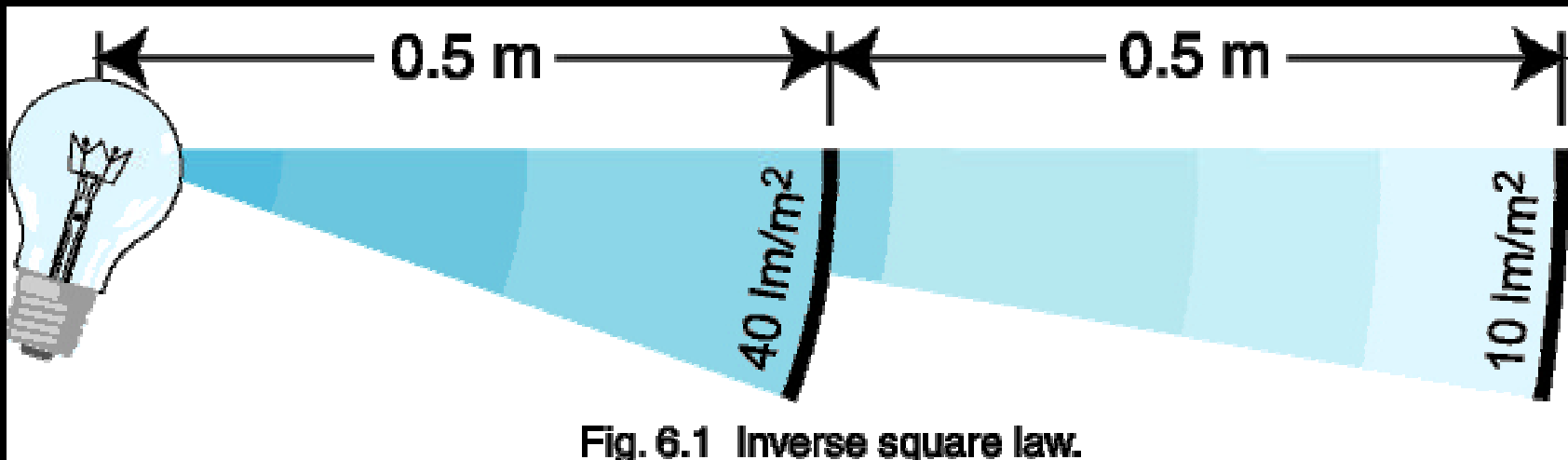
} Laser Sources

BASIC CONCEPT

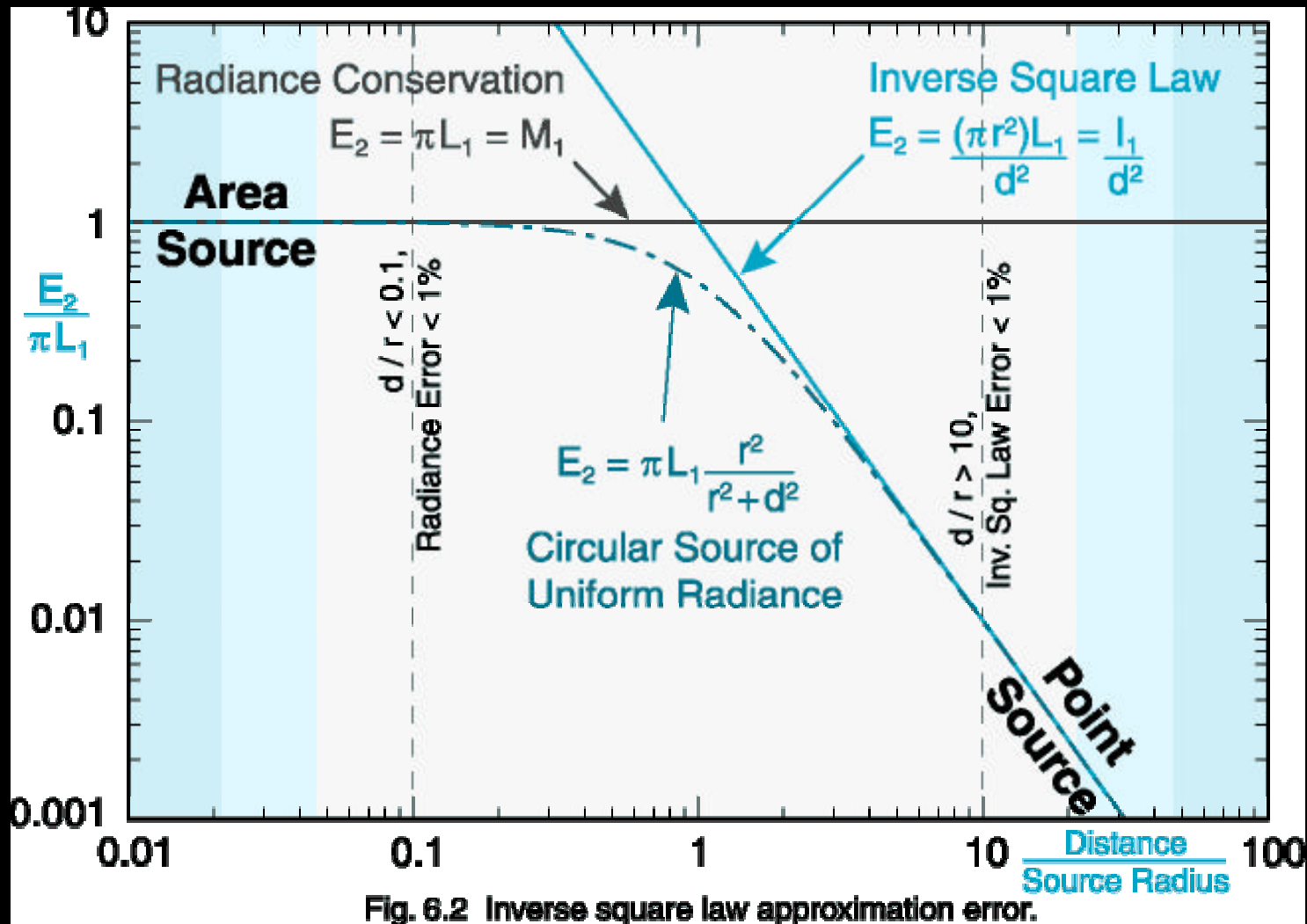
- Emitter: Direct a beam at approaching or receding object
- Receiver: Portion of beam is reflected and received by Detection Unit
- Translation of Signal
 - Point Light Source: **Flux Dens** $\propto 1/\text{distance}^2$
 - Lasers: **Time** dependent using 'c' as reference; Distance = $RT / 2$
 - Interferometry: **Phase Difference** $\propto$ Distance
 - Microwaves: **Δ Frequency** $\propto$ velocity

POINT SOURCE

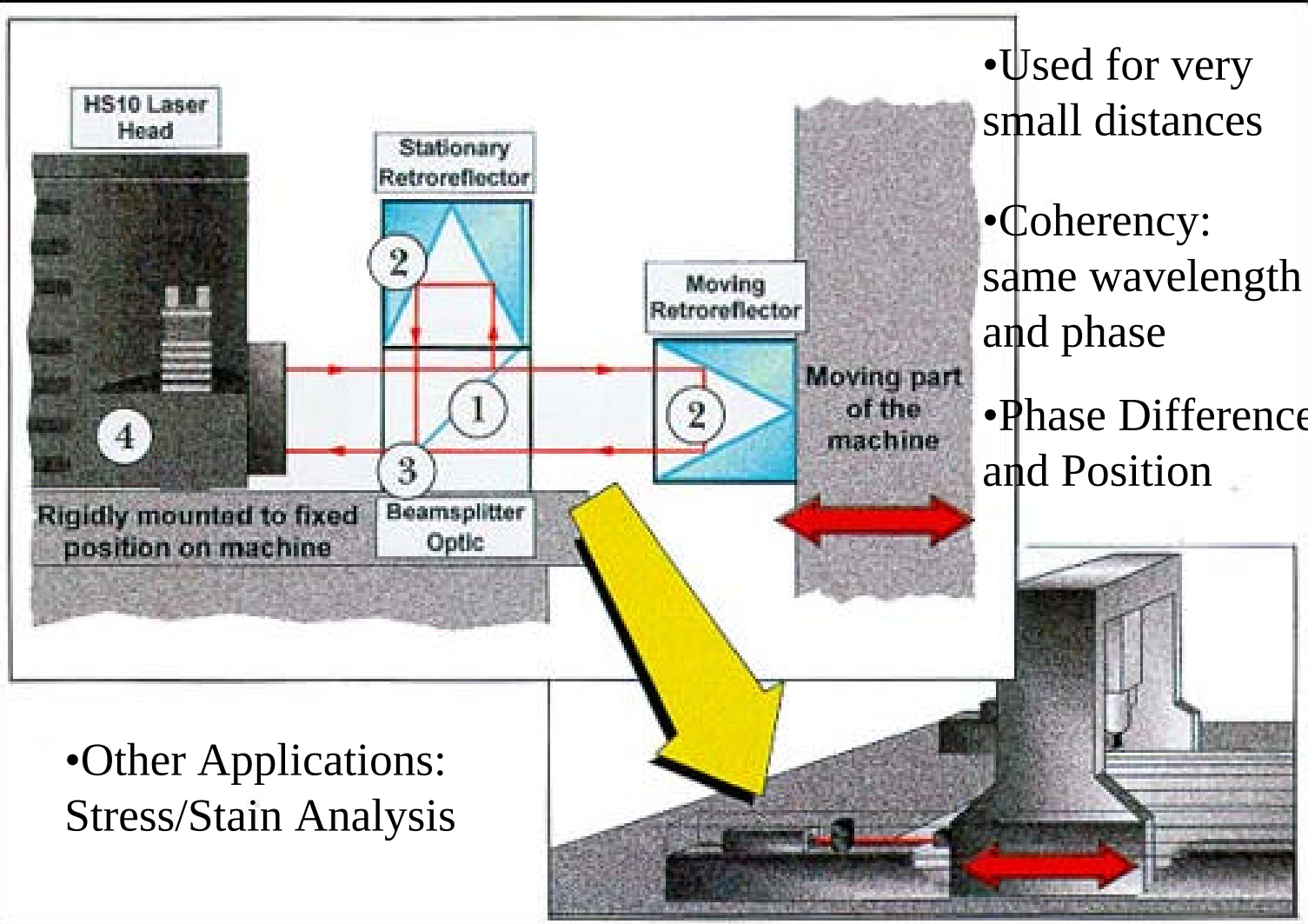
$$\text{Flux Density} = I / d^2$$



POINT SOURCE ERROR

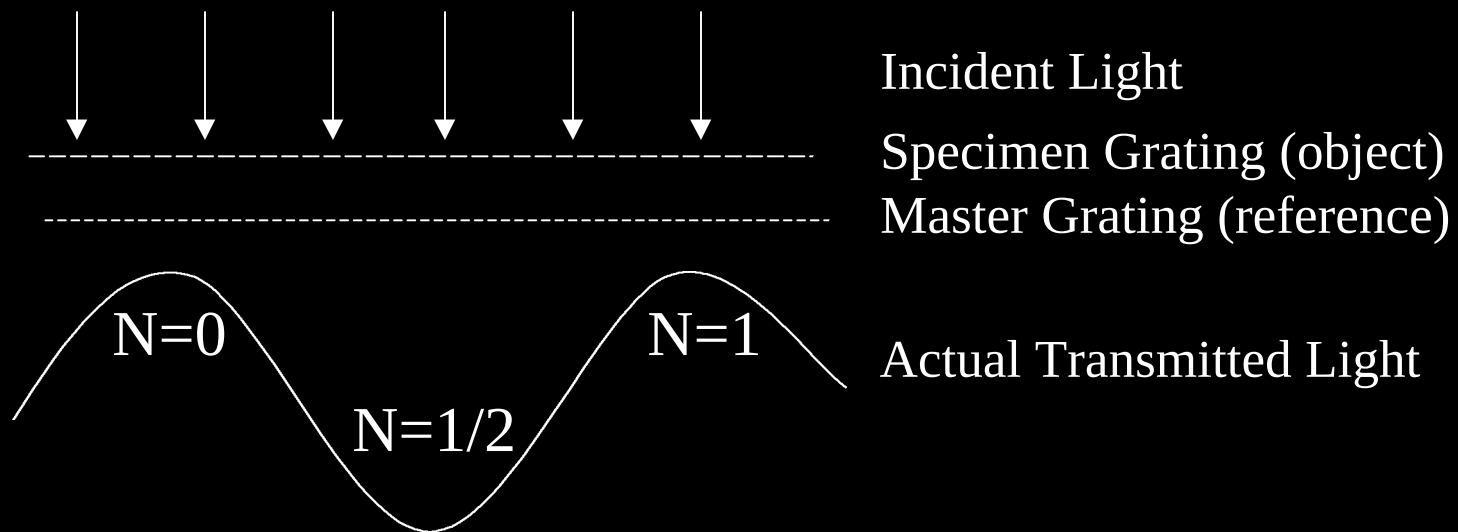


INTERFEROMETRY



MOIRE EFFECT

- Mechanical Interference of light by superimposed network of lines



$$X = N * p ; \quad \text{where } N = \text{Order}$$
$$p = \text{pitch of master}$$

SPEED DETECTION

- Radar Microwaves
 - Supported by the Doppler Effect:
 - $\Delta \text{Frequency} \propto \text{velocity}$
 - beam of microwave energy (~9000-28000nm) hits target and a portion of it is reflected
 - reflected beam is shifted in frequency proportional to velocity of target => Signal Processing
 - Scatterability
- Lasers
 - Similar concept as radar except:
 - Coherent light source
 - sample of change in distance over a period of time
 - Accuracy of reading are affected by:
 - halogen lamps, weather, reflection and refraction of beam

APPLICATIONS

- Commercial
 - Vehicles, Speed Regulation
 - Personal use: Room Dimensions
 - Manufacturing, Robotics
- Military
 - Positioning / Locating applications
- Education/Research
 - NASA/NSF: Shuttle missions, measurement of distance in other mediums (ie. atmospheres, space)

SUMMARY

- General concept with lots of potential
- Many ways of interpreting and manipulating signals
- The method we use to analyze it relies heavily on the requirements of the application

REFERENCES

- General Laser Reference Sites
 - <http://www.fastguy.com/>
 - <http://www.intl-light.com/handbook>
- Laser measurement
 - <http://www.renishaw.com/laserscale/>
- Position Determination Using Lasers
 - <http://on-trak.com/psd>
- Laser Range Finders (LIDAR)
 - http://www.meos.com/_Pages/EXP15-ENG-NAV.htm
 - http://ranier.oact.hq.nasa.gov/Sensors_page/Laser/LaserOV.html
 - <http://www.ksc.nasa.gov/shuttle/missions/sts-64/mission-sts-64.html>
- Distance Detection Using Interferometric Techniques
 - <http://web.wse.nadn.navy.mil/wse/academic/courses/es300/supplem/interfer.htm>