

ENDOSCOPE IN NEUROSURGERY

Presented by:
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Endoscopy

-1805

- ✓ Refers to looking inside
- ✓ Endoscope is used to illuminate, examine and document difficult to access areas
- ✓ Enables the surgeon to look around the corners

NEUROENDOSCOPY

-1910

- ✓ Pediatric Endoscope- First Neuroendoscopic Surgery
- ✓ 1918 - Contrast Ventriculography
- ✓ 1922-Third Ventriculostomy, First Endoscopic Plexectomy
- ✓ 1923-intraventricular photography in hydrocephalic child
- ✓ 1923-First purely Endoscopic third Ventriculostomy-movable coagulation probe & irrigation system

- ✓ 1935- ventriculoscope with angular view
- ✓ 1948- zoom lenses
- ✓ 1954- an attempt to improve the surgical field observation (endoscope coupled with video camera and screen projection)
- ✓ 1960- rod lenses (advantage over glass lenses)
- ✓ 1969-invention of CCD

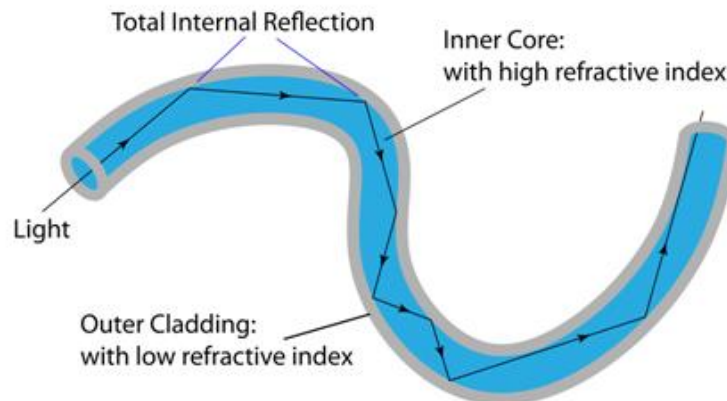
PRINCIPLE

✓ Based on the **science of optics**

➤ Based on TIR (Total Internal Reflection) in Flexible Endoscope Systems

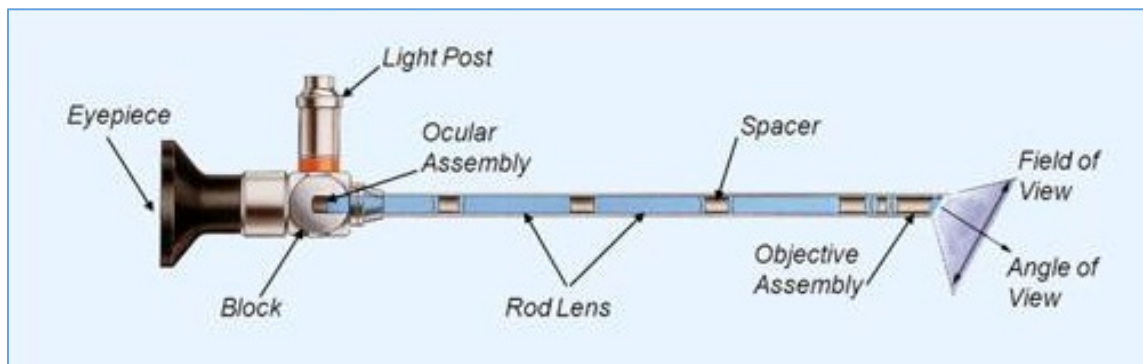
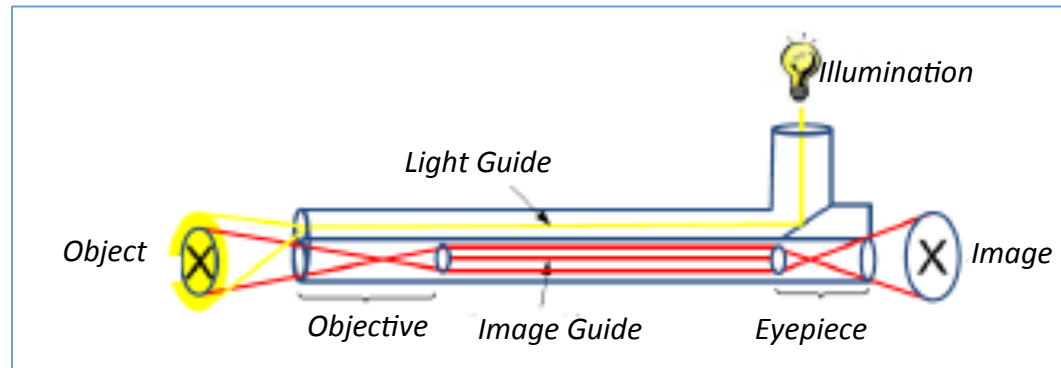
➤ Based on Relay Lens System in Rigid Endoscope Systems

✓ Illumination relies on TIR



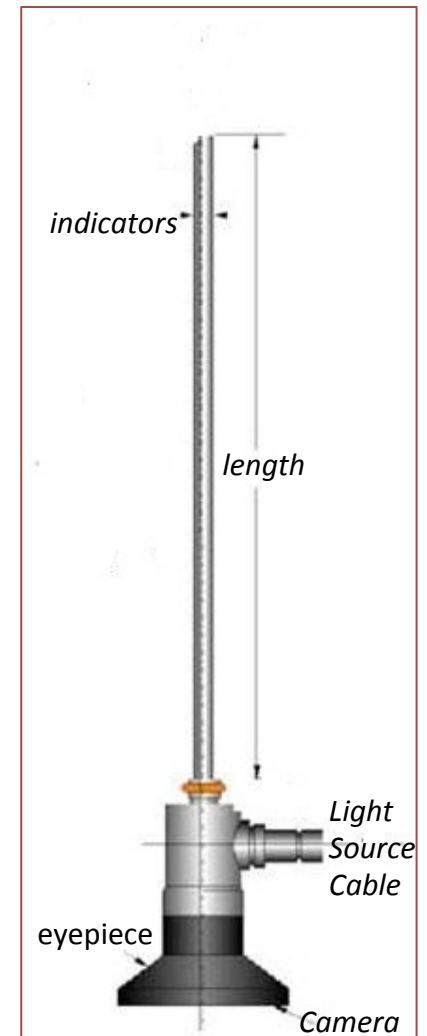
COMPONENTS OF AN ENDOSCOPE

- ✓ A rigid or flexible tube
- ✓ A light delivery system
- ✓ An Objective
- ✓ An Image Guide
- ✓ An eyepiece
- ✓ Additional channel(s)



FEATURES

- ✓ Diameter- 3-6mm
- ✓ Diameter greater than 8mm not acceptable
- ✓ Length varies from 4-20 cm
- ✓ Angulated Optics
- ✓ Tactile Feedback
- ✓ Rotating Knob
- ✓ Calibrated indicators on the shaft



FLEXIBLE ENDOSCOPE



✓ *Also called as Ventriculoscope*

- ✓ used to navigate in the ventricular system and around corners when used as an assist-device during microsurgical operations
- ✓ 1-15mm (depending on no. of fibers) outer diameter

Based on fiber optic illumination – TIR

✓ *Optical Fibers are used to manipulate the returning light and form an image on the eyepiece*

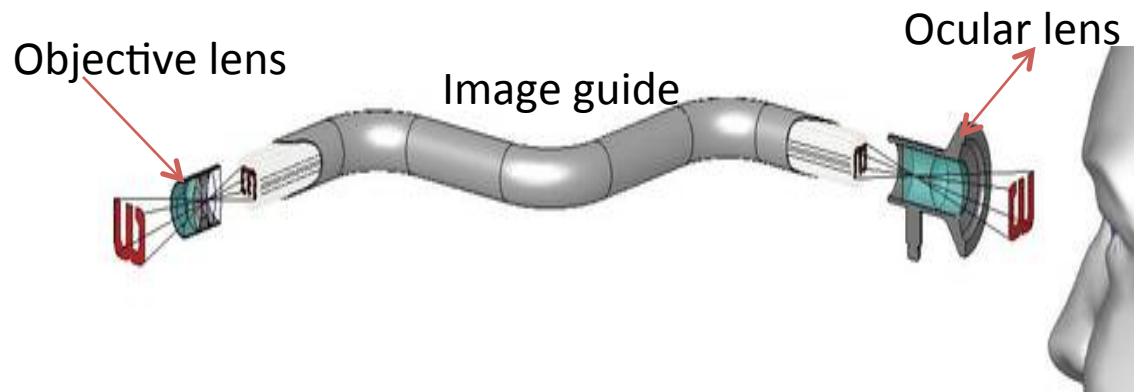
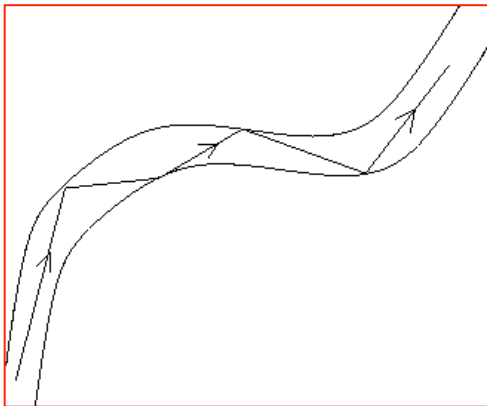
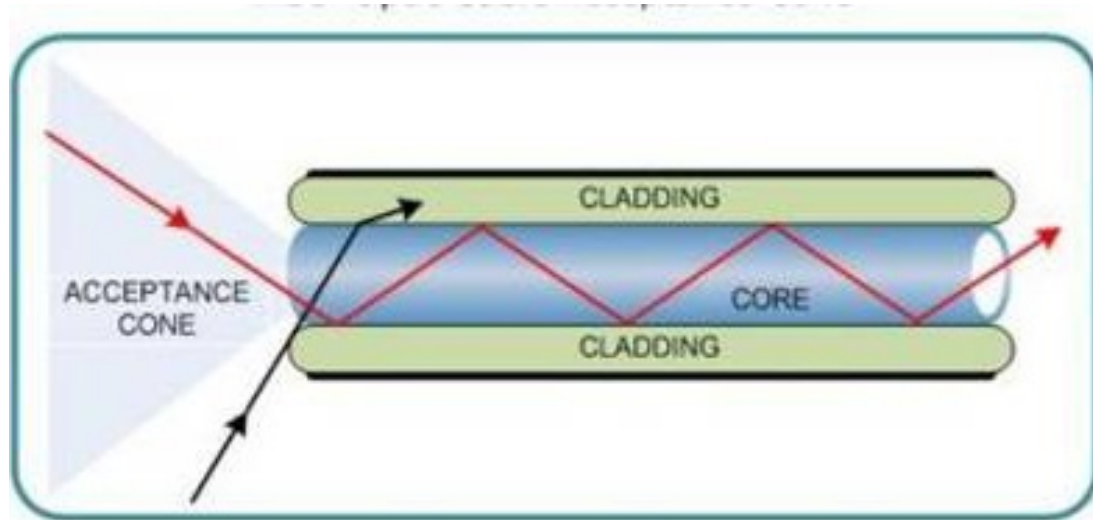
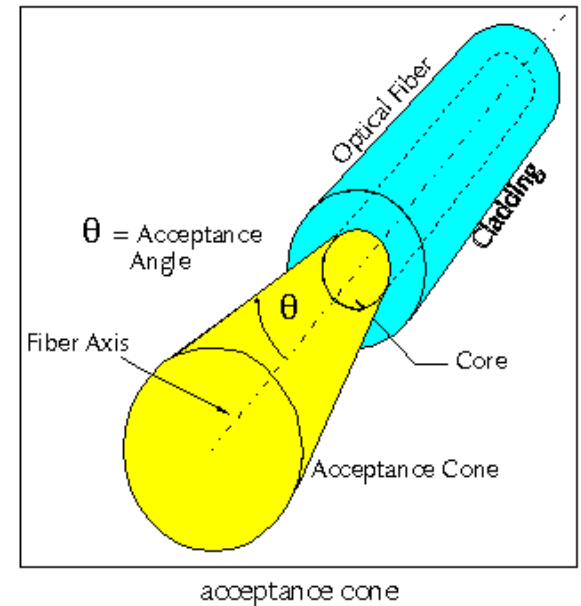


Image formation in a flexible endoscope with glass fibre bundle

TOTAL INTERNAL REFLECTION



Light within acceptance cone only can enter the optical fiber to undergo TIR

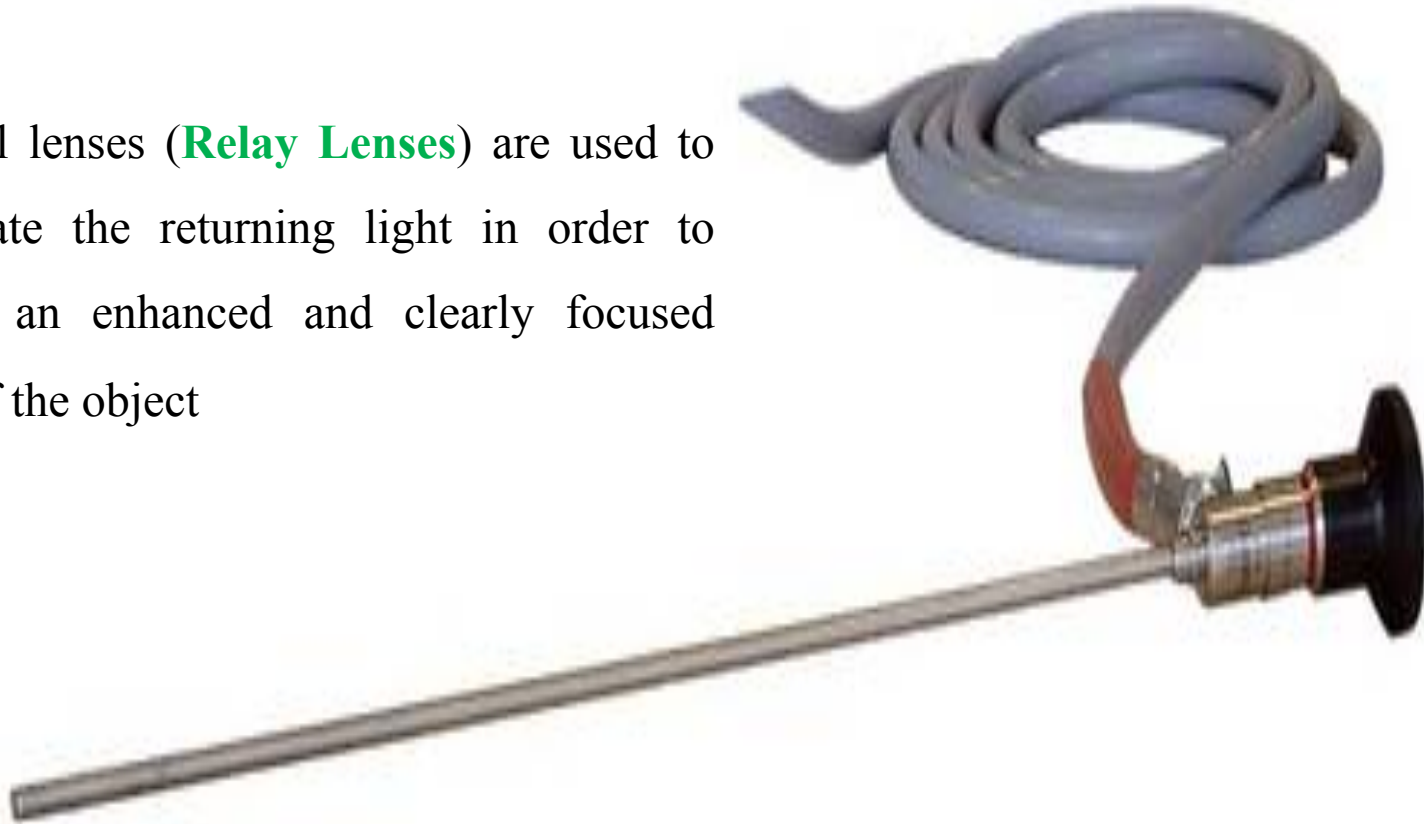


DISADVANTAGES OF FLEXIBLE ENDOSCOPE

- ✓ Optics are worse than those of rigid endoscopes
- ✓ Cannot be autoclaved and must be gas-sterilized, which limits their longevity
- ✓ Frequent use can damage the fiber bundle, which further decreases the image resolution

RIGID ENDOSCOPE – *most frequently utilized Endoscope in Neurosurgery*

✓Optical lenses (**Relay Lenses**) are used to manipulate the returning light in order to produce an enhanced and clearly focused image of the object



Sheath with a single channel for the endoscope

RIGID OPERATING ENDOSCOPES



Endoscope with irrigation and suction port, light cable and forceps

OPERATING ENDOSCOPE WITH TWO WORKING CHANNELS

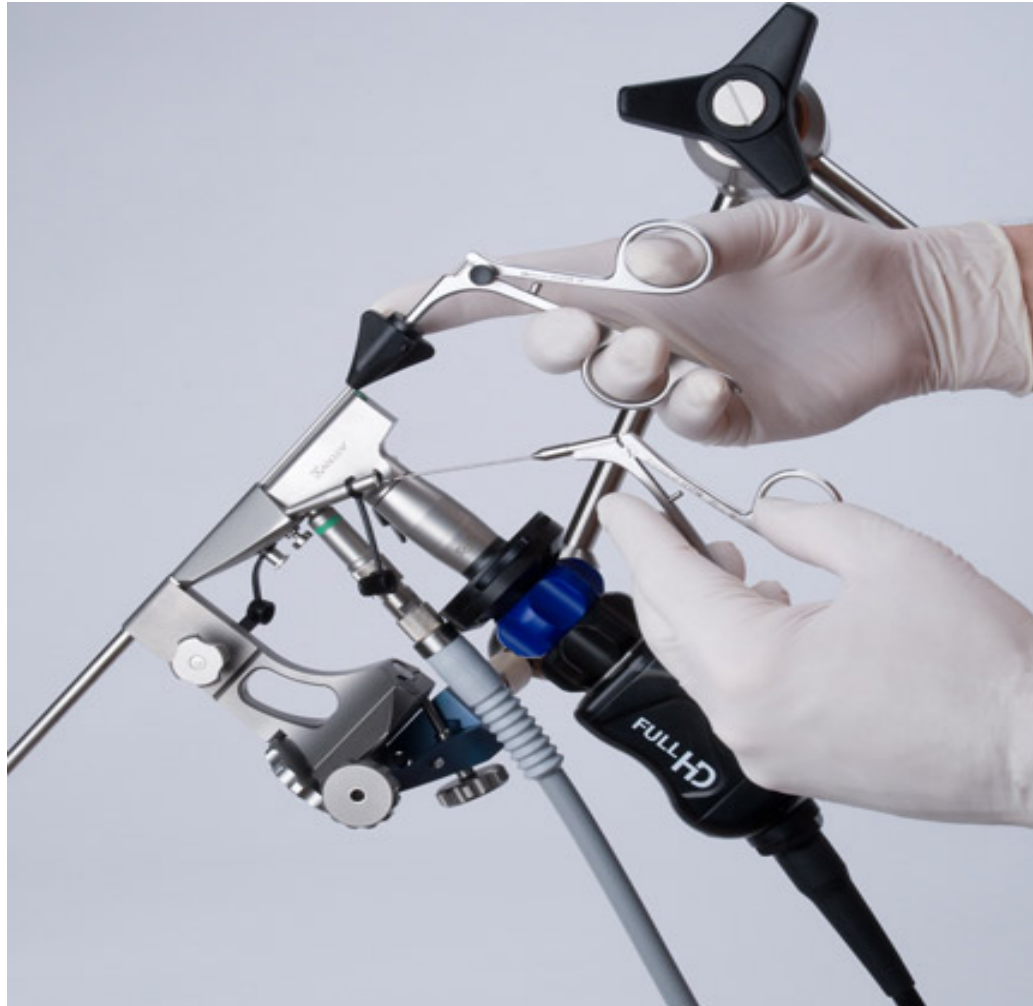
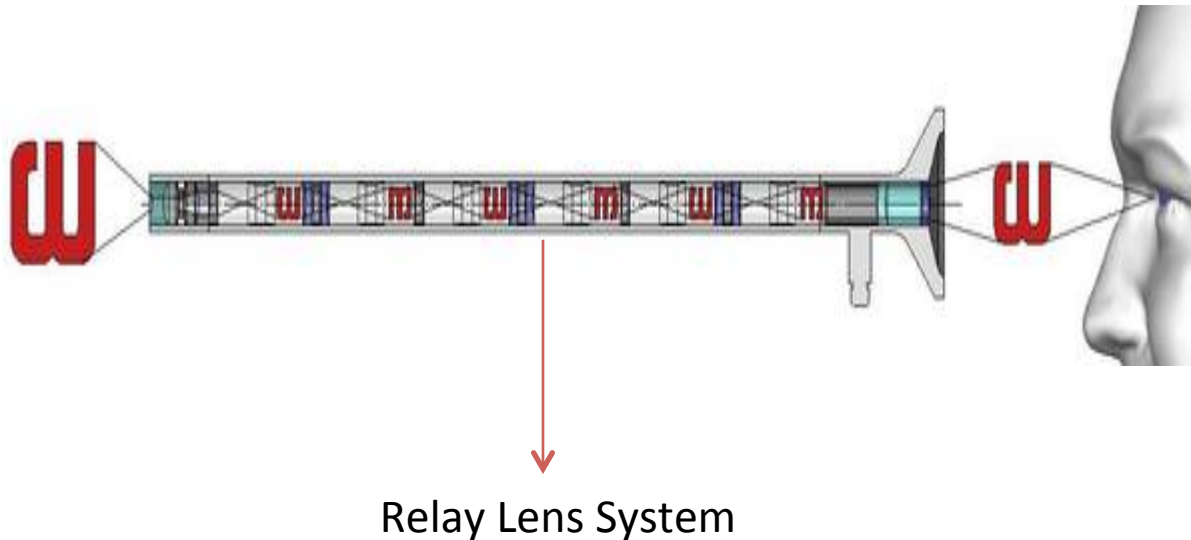


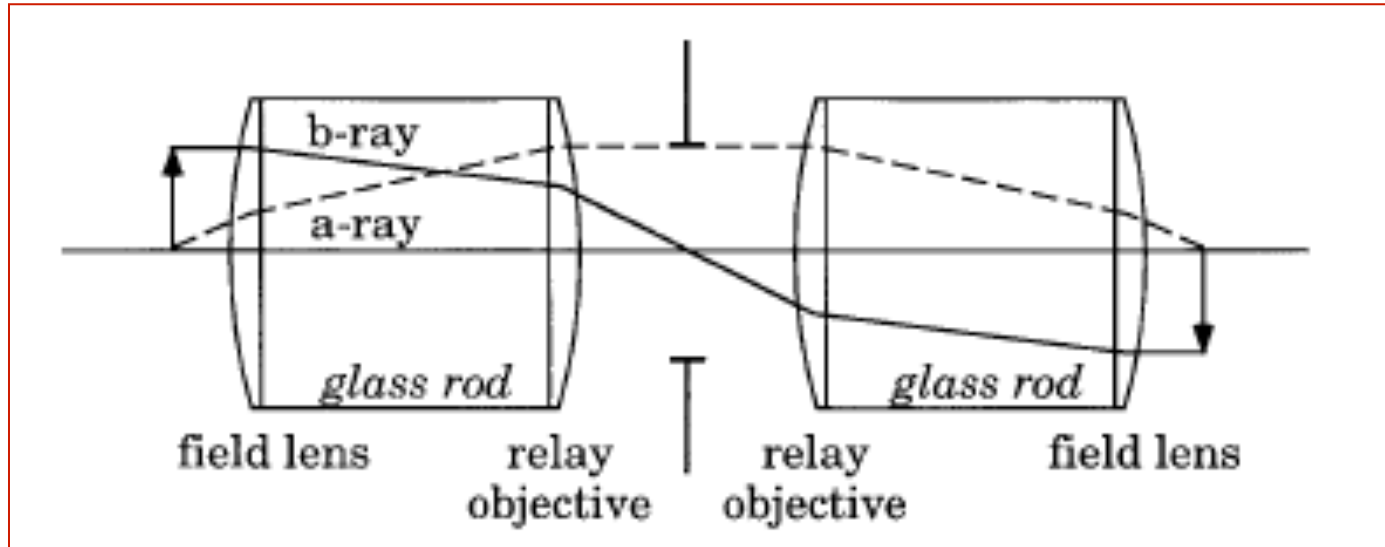
IMAGE FORMATION IN A RIGID ROD LENS ENDOSCOPE

- ✓ Objective / lens - for image formation
- ✓ Relay lens system - for image transport- also called as Image Reversal System
(Rod Lens, Achromatic Doublets, GRIN Relay)
- ✓ Ocular lens - for image magnification

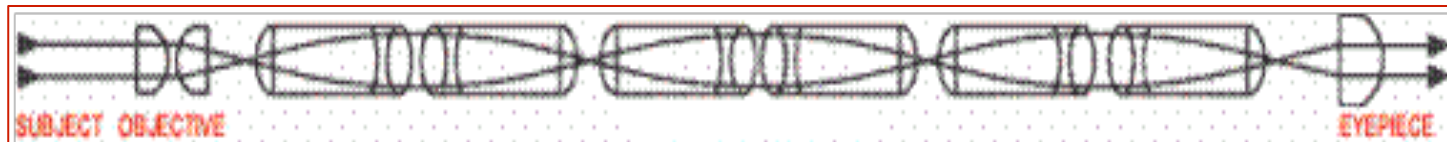


ROD LENS SYSTEM

✓ Developed by Hopkins and hence called as Hopkins System



One stage of Hopkins Rod Lens



Three stages of Rod Lens- image Reversal Occurs after every stage

ACHROMATIC DOUBLET

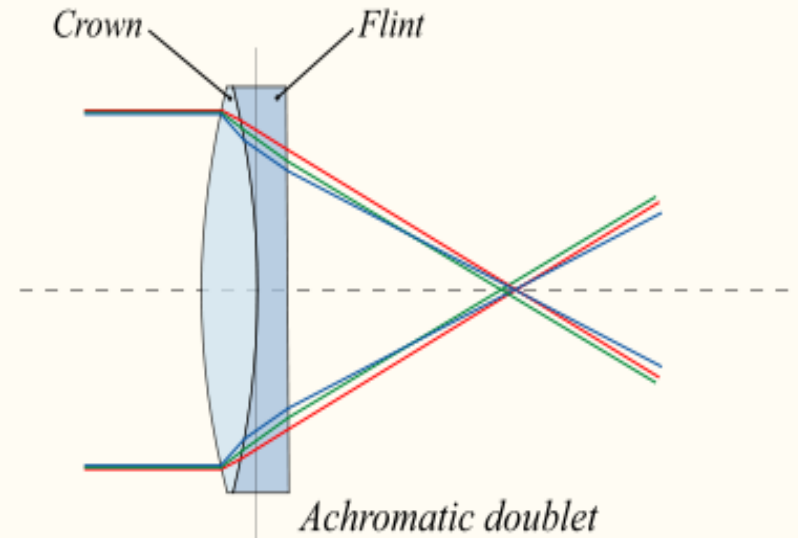
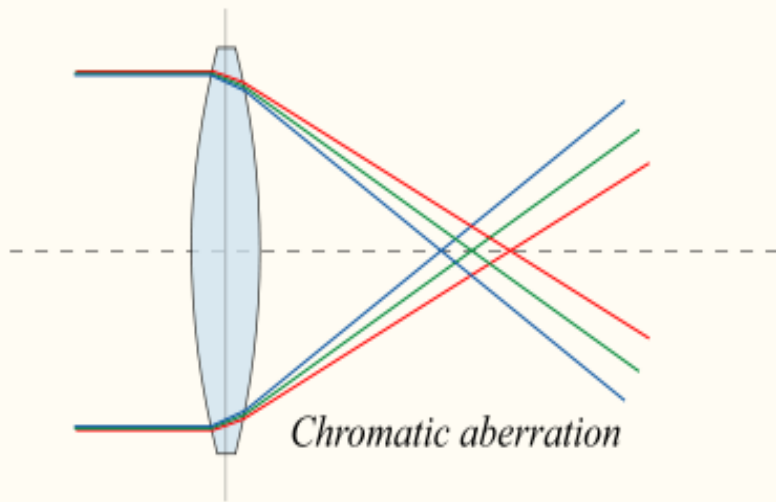
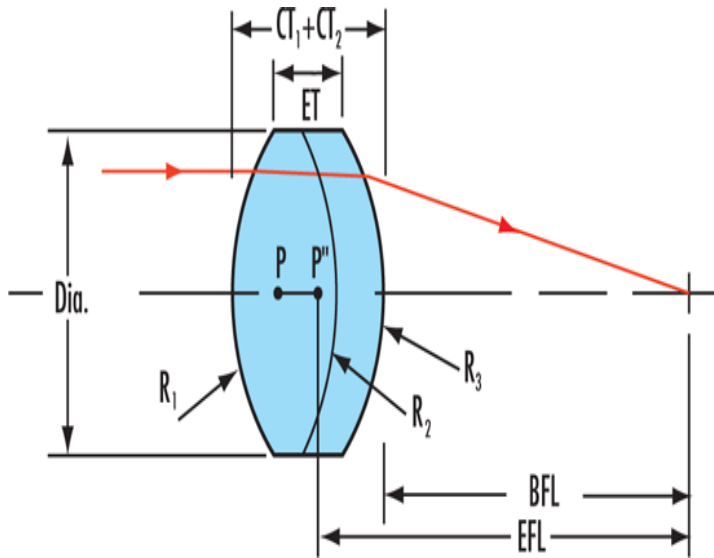
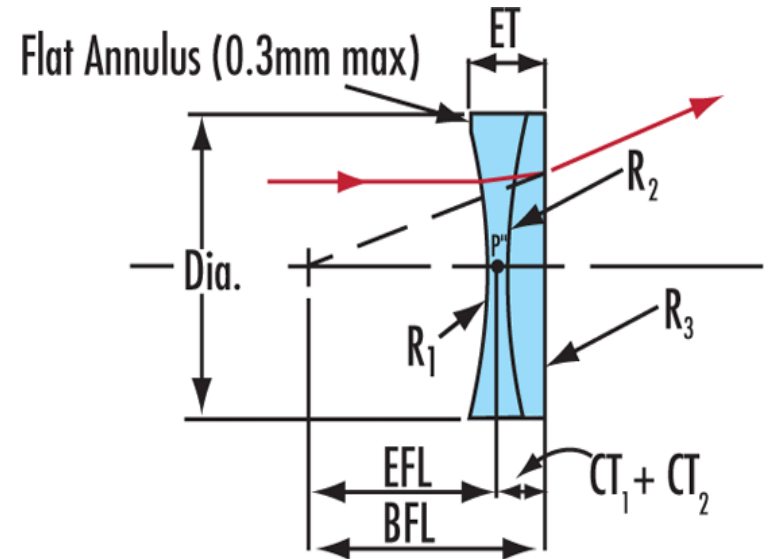


Image formation using Achromatic Doublets

TYPES OF ACHROMATIC DOUBLET

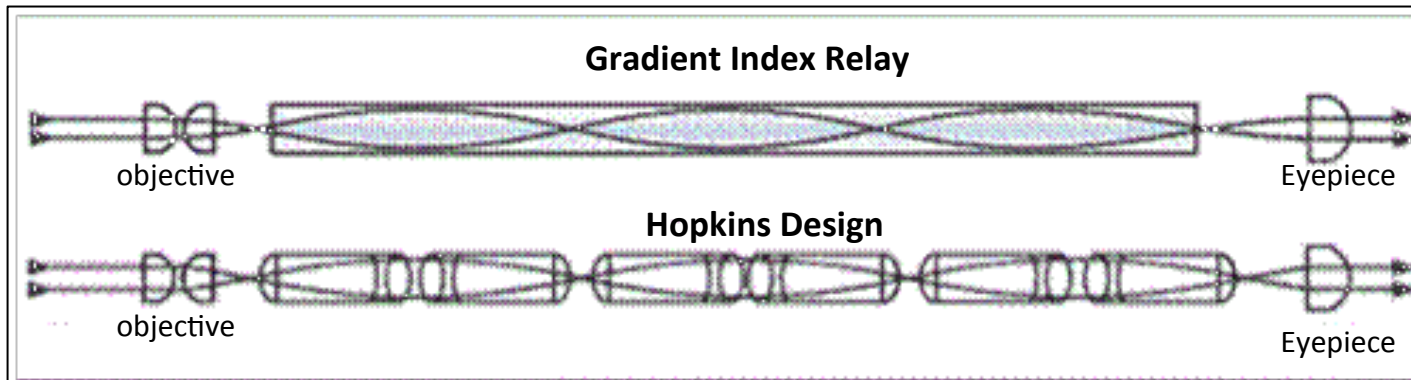


Positive Doublet

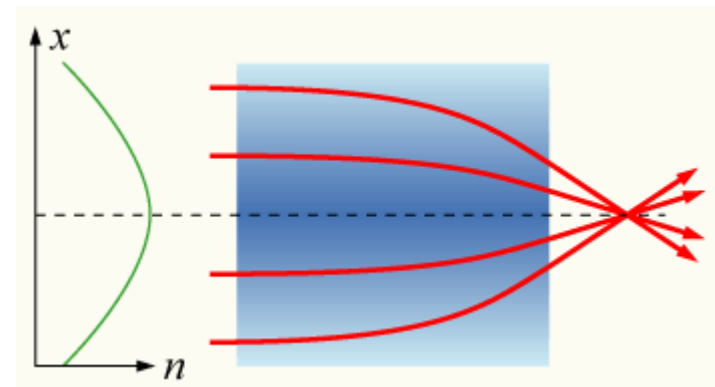


Negative Doublet

GRADIENT INDEX (GRIN) RELAY V/S HOPKINS ROD-RELAY



- ✓ GRIN Relay use flat ends glass rod
- ✓ GRIN Relay use much less components and is therefore cheaper



LIGHT SOURCE

- ✓ Tungsten - Halogen Light Source
- ✓ Xenon Light Source - preferred for documentation



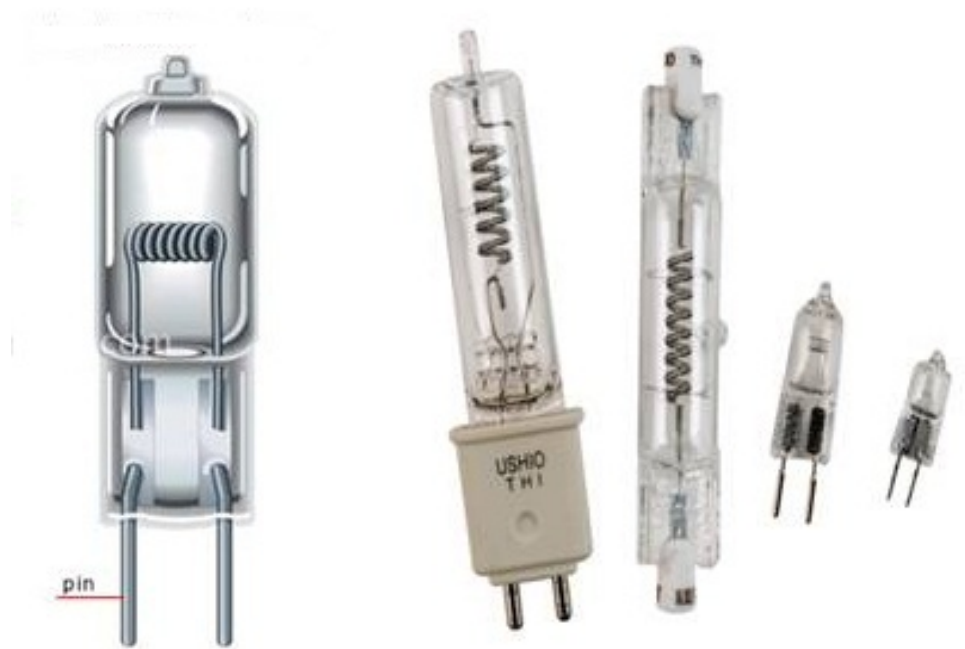
Basic (Xenon) Unit

*Advanced Unit – with
digital display and
standby feature*



TUNGSTEN-HALOGEN LIGHT SOURCE

- ✓ Works on the principle of **Incandescence**
- ✓ Uses a tungsten Filament
- ✓ Quartz Envelope with enclosed gas from the Halogen group (Cl, Br, I...)
- ✓ Halide gases combine with Tungsten at higher temperatures and produces a Halogen Cycle Chemical Reaction
- ✓ Require IR Filter



ADVANTAGES OF TUNGSTEN HALOGEN LIGHT SOURCE OVER NORMAL LIGHT SOURCE

- ✓ Offer up to 20 percent greater energy efficiency
- ✓ longer service life
- ✓ **Whiter, Brighter Light-** Halogen lamps have higher colour temperatures than standard incandescent lamps—their light output contains more blue and green. Halogen lamps therefore appear whiter and brighter.

XENON LIGHT SOURCE (HID)

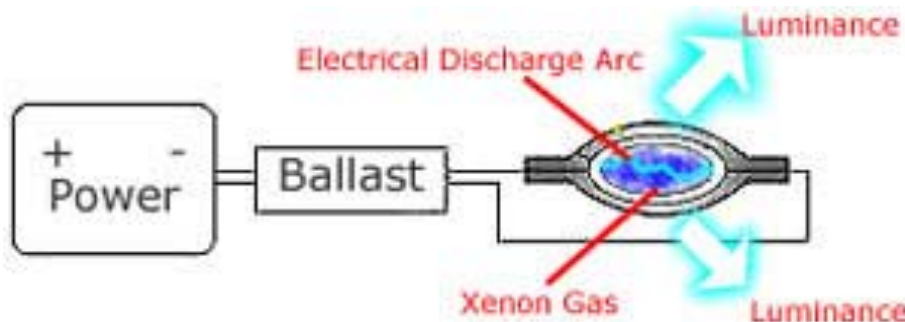
- ✓ produce light with an electric arc between the tungsten electrodes housed in a fused Quartz (or Alumina) tube



- ✓ Tube is filled with both gas and metal salts
- ✓ Produce blue-white light that is closer to natural daylight
- ✓ Longer life and whiter light
- ✓ Require UV Filter

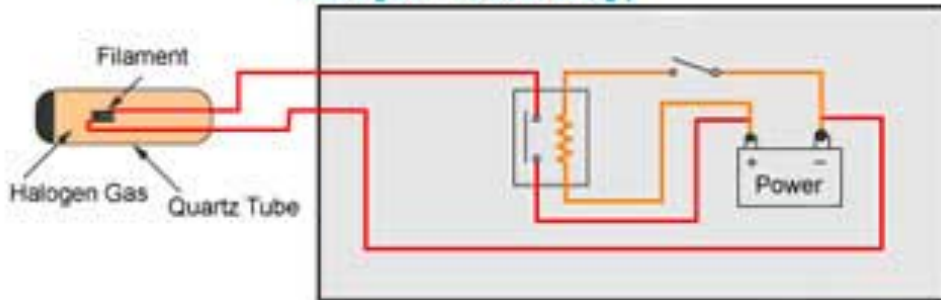
Xenon Arc Lamp

- ✓ produce more light for a given level of power consumption than ordinary tungsten and tungsten-halogen bulbs

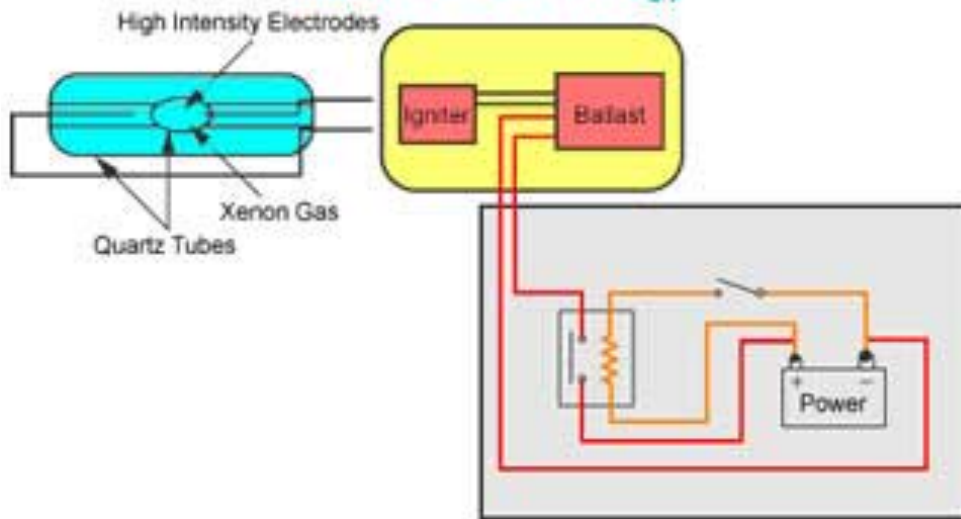


HALOGEN LIGHT V/S XENON LIGHT SOURCE

Halogen Technology



HID Xenon Technology



✓ Xenon Source last 2-3 times longer

✓ Xenon source produce brighter light

✓ Xe Source use less energy

✓ Xe Source provide more uniform intensity in lighting

✓ Xe consume much less power & generate much less heat

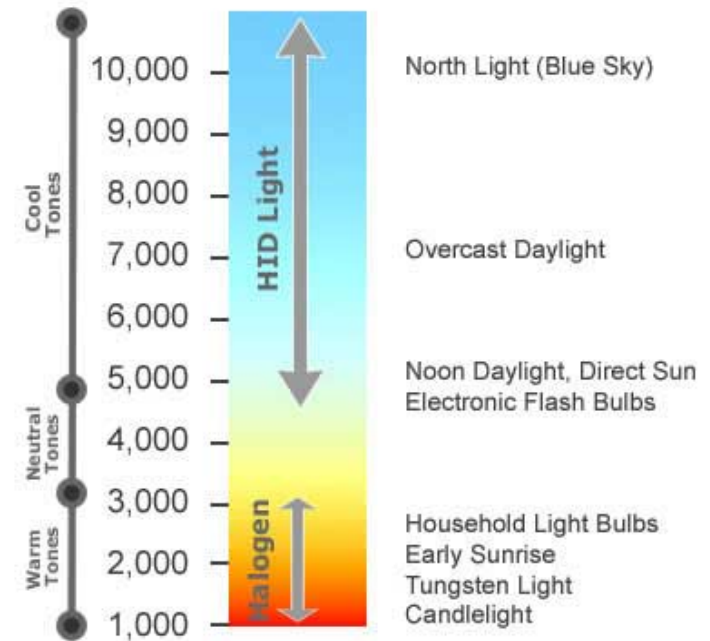
✓ Xe source provides increased contrast and color vision

COLOR TEMPERATURE

Measurement in Degrees Kelvin that indicates the hue of light Source



Color Temperatures in K (Degrees Kelvin)



CAMERA

- ✓ Attach to the eyepiece
- ✓ Greatly improve endoscopic capability



Basic camera with a Focusing Ring



Advanced models with Focus & zoom functions, & many more digital functions

Require gas sterilization & so can be either sterile or draped in a plastic sheath to increase their longevity

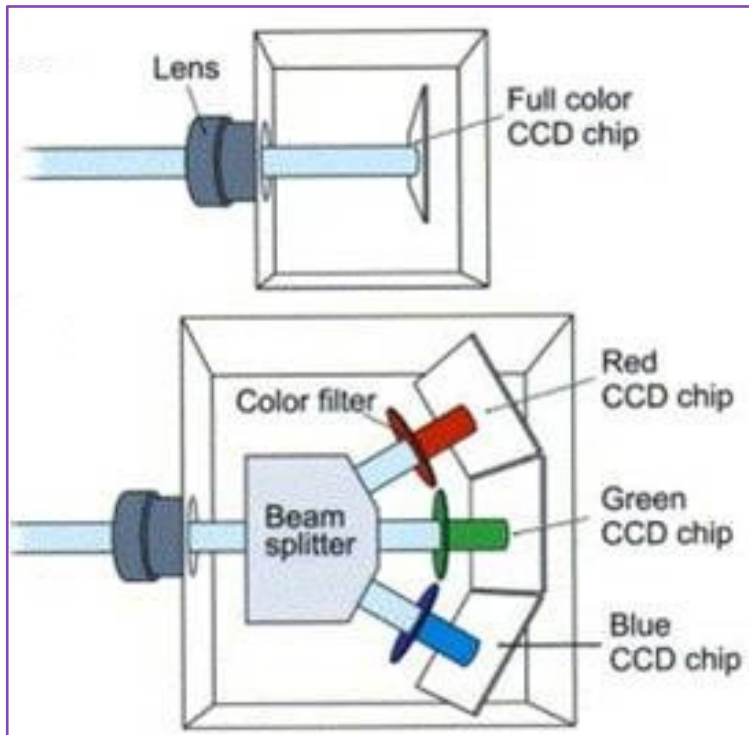
ONE CHIP CAMERA V/S THREE CHIP CAMERA

One Chip Camera

- ✓ Detect only one-third of the color information for each pixel
- ✓ Much lower effective Resolution
- ✓ Low cost

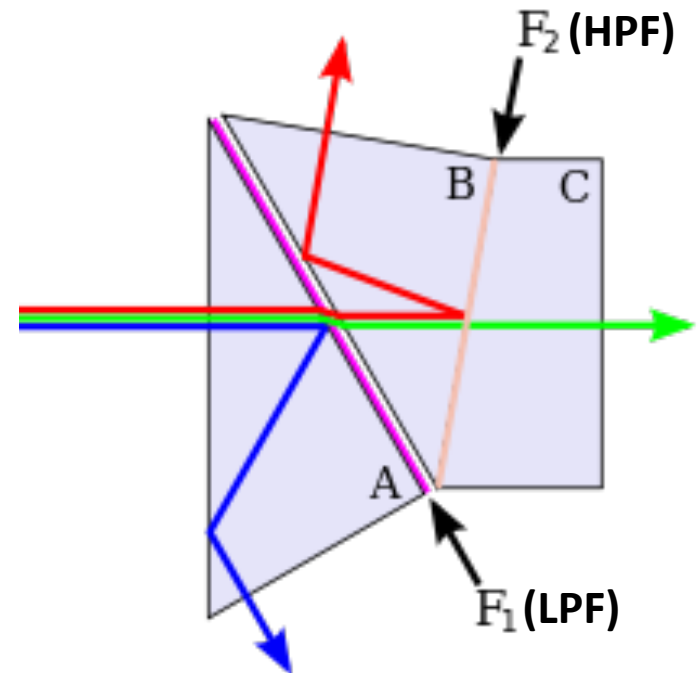
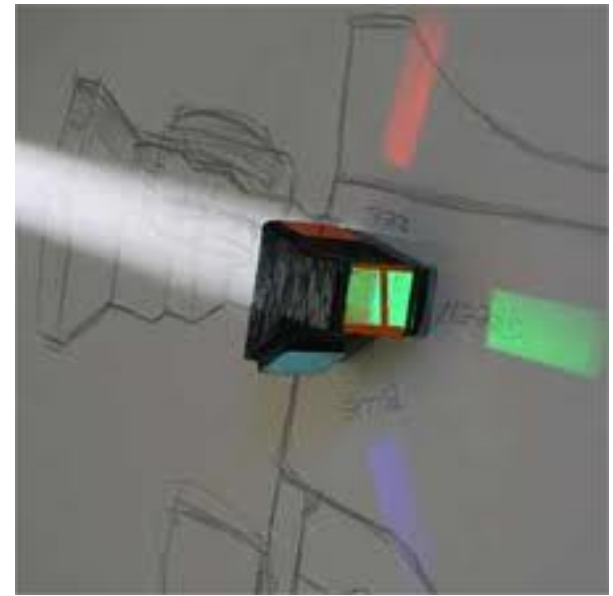
Three Chip Camera

- ✓ Separate readings of Red, Green and Blue values for each pixel
- ✓ Enhance Resolution
- ✓ Reduce Video Noise
- ✓ Improve SNR
- ✓ Better Precision
- ✓ High Cost



3 CHIP CAMERA

- ✓ Uses 3 chips, one each for red, green and blue colors
- ✓ Use trichroic prism assembly to split the white beam into red, blue and green beams
- ✓ The chips are hard mounted to the prism so that the images on all three are directly superimposed
- ✓ Yield the highest quality pictures
- ✓ Used in best quality cameras
- ✓ High cost is the only disadvantage



RECORDING



Recording in Hard Disk

MONITOR



Monitors need to be positioned such that the surgeon, the assistant and the OR personnel can all view them

ADVANTAGES OF RIGID ENDOSCOPE

- ✓ Superior optics
- ✓ Autoclavable, reusable
- ✓ Less fragile

DISADVANTAGES OF RIGID ENDOSCOPE

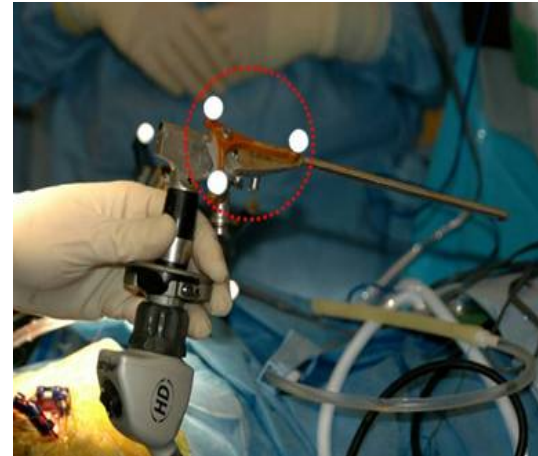
- ✓ Rigidity - one cannot maneuver them in the intraventricular or intracranial spaces as freely as flexible endoscopes
- ✓ It is crucial to plan the entry burr hole in such a location as to allow for the greatest freedom of movement without endangering any neurovascular structures

PLANNING THE NEUROENDOSCOPIC APPROACH

Stereotactic Neurosurgical Technique



Neuronavigation –advantageous



(surgeon has greater degree of freedom in the manipulation of the endoscope when it does not need to be attached to the stereotactic frame)

CURRENT OPERATIVE STANDARD – Neuroendoscopy + Neuronavigation

APPLICATIONS

- ✓ Biopsy procedures
- ✓ Resection of colloid cysts & tumours
- ✓ CSF sampling
- ✓ Visualization of Tumours
- ✓ Assist with traditional Skull Base Surgery
- ✓ Microsurgery & Aneurysm Surgery
- ✓ Treatment of Craniosynostosis

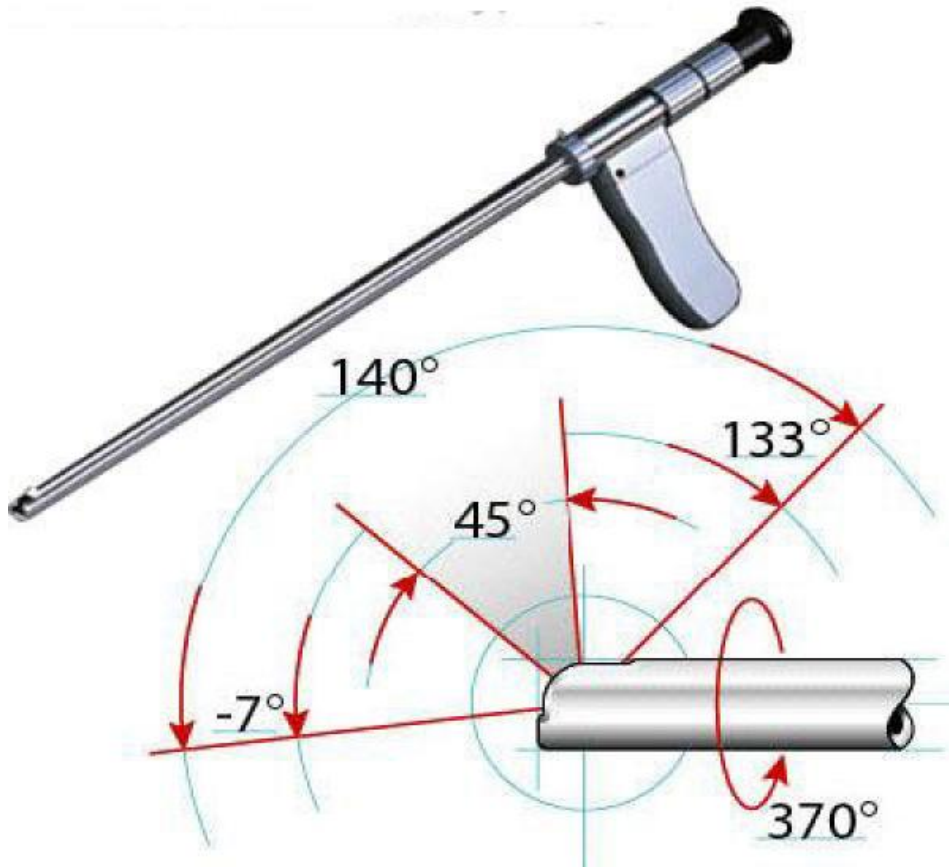
BENEFITS

- ✓ Less pain than traditional surgery
- ✓ Faster recovery than traditional surgery
- ✓ Minimal scarring- minimal tissue disruption
- ✓ Unmatched image resolution- Enhanced visualization
- ✓ Improved cosmetic results
- ✓ Less surgical morbidity

VIRTUAL VENTRICULOSCOPY

- ✓ Imaging technique
- ✓ Currently in the process of development
- ✓ Enables 3-D planning of endoscopic procedures so that they can be performed preoperatively in a Virtual Environment

SWING PRISM ENDOSCOPE



- ✓ Allows to continuously adjust the viewing angle
- ✓ Adjustable Angle comes from the tip Prism
- ✓ Reduce setup costs
- ✓ Karl Storz makes it for Industrial Applications
- ✓ Acclarent Inc. US filed a patent for a Swing Prism Endoscope (July 2009) to be used for Endonasal approach

