

# 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

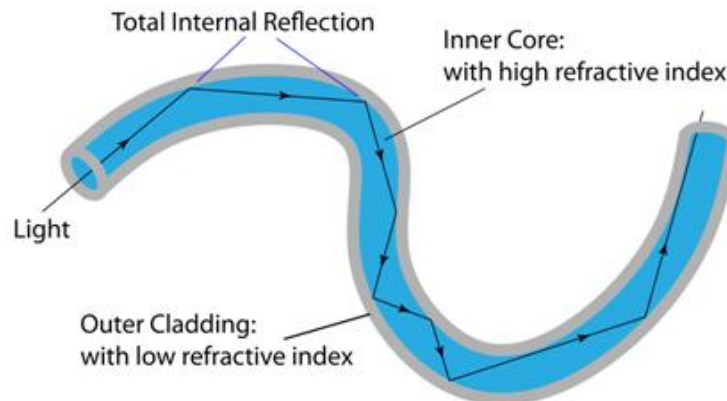
# PRINCIPLE

✓ Based on the **science of optics**

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

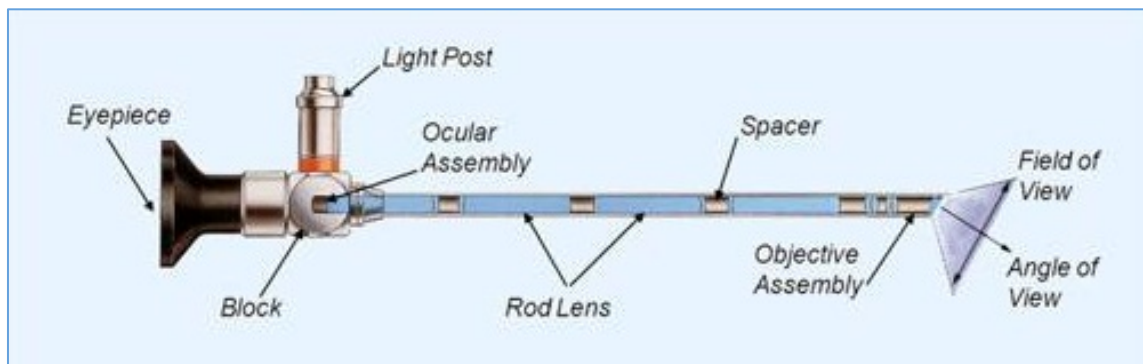
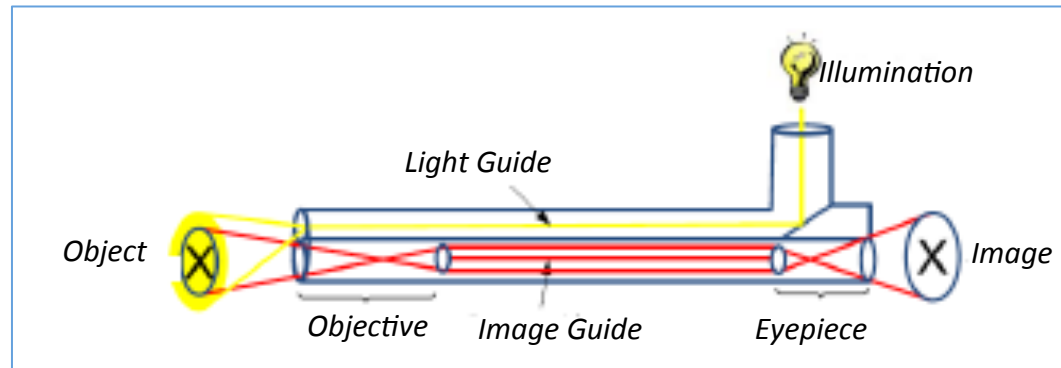
➤ Based on Relay Lens System in Rigid Endoscope Systems

✓ Illumination relies on TIR



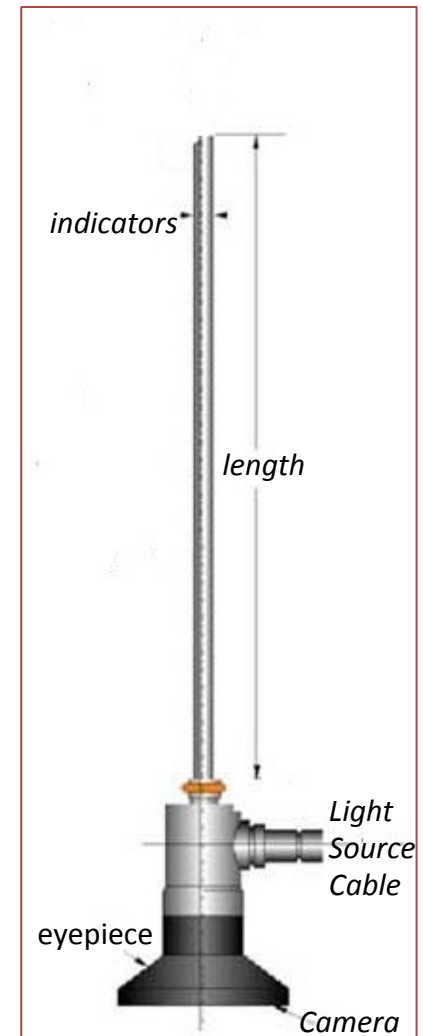
# COMPONENTS OF AN ENDOSCOPE

- ✓ 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



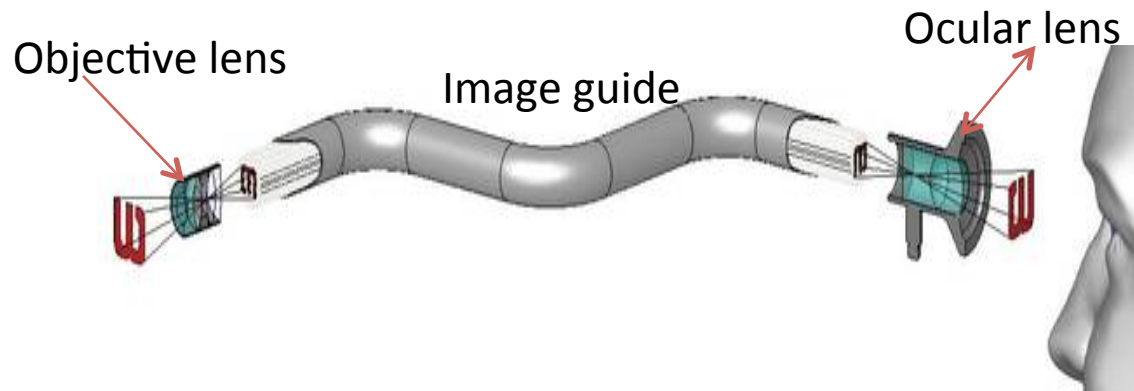
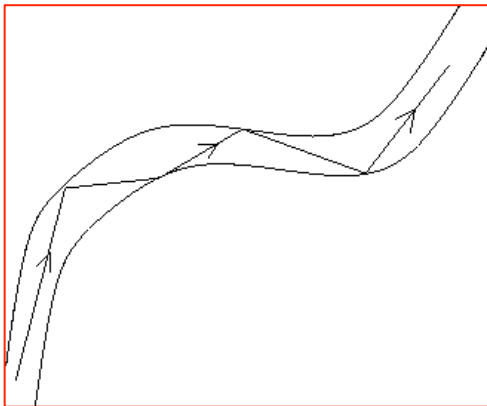
✓ *Also called as Ventriculoscope*

✓ 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**

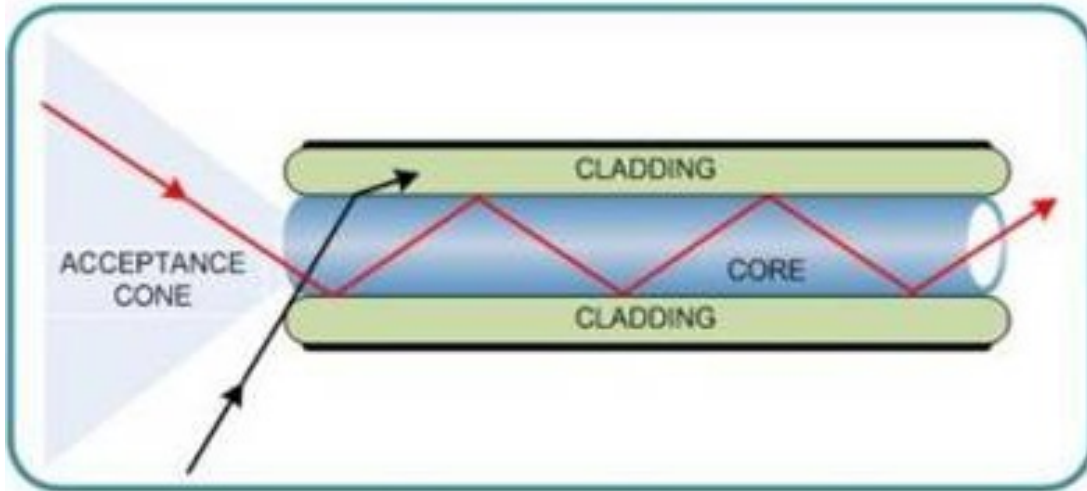
✓ *Optical Fibers are used to manipulate the returning light and form an image on the eyepiece*



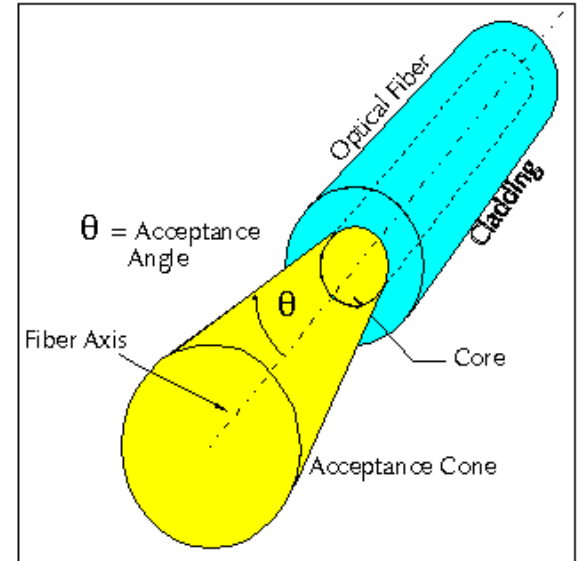
*Image formation in a flexible endoscope with glass fibre bundle*



# TOTAL INTERNAL REFLECTION



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



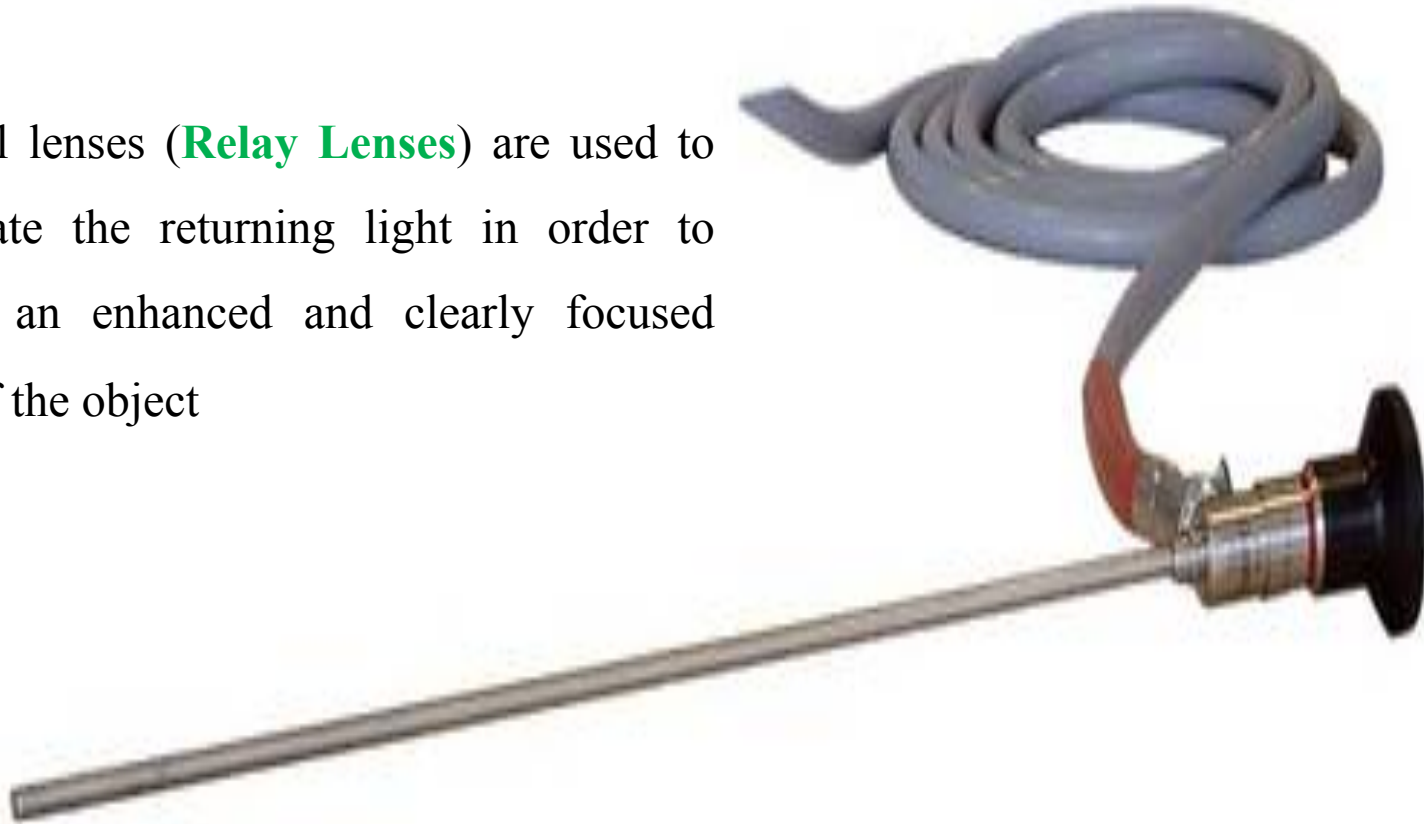
acceptance cone

# 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



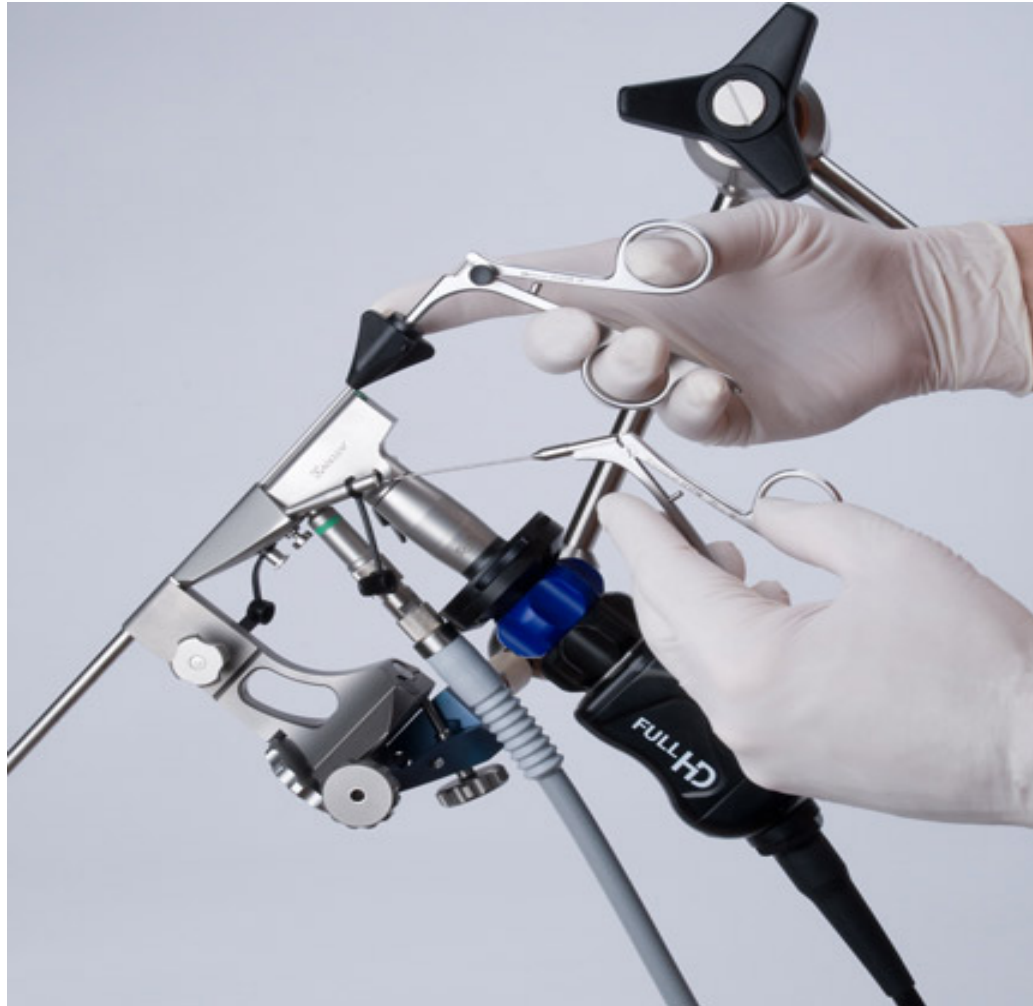
*Sheath with a single channel for the endoscope*

# RIGID OPERATING ENDOSCOPES



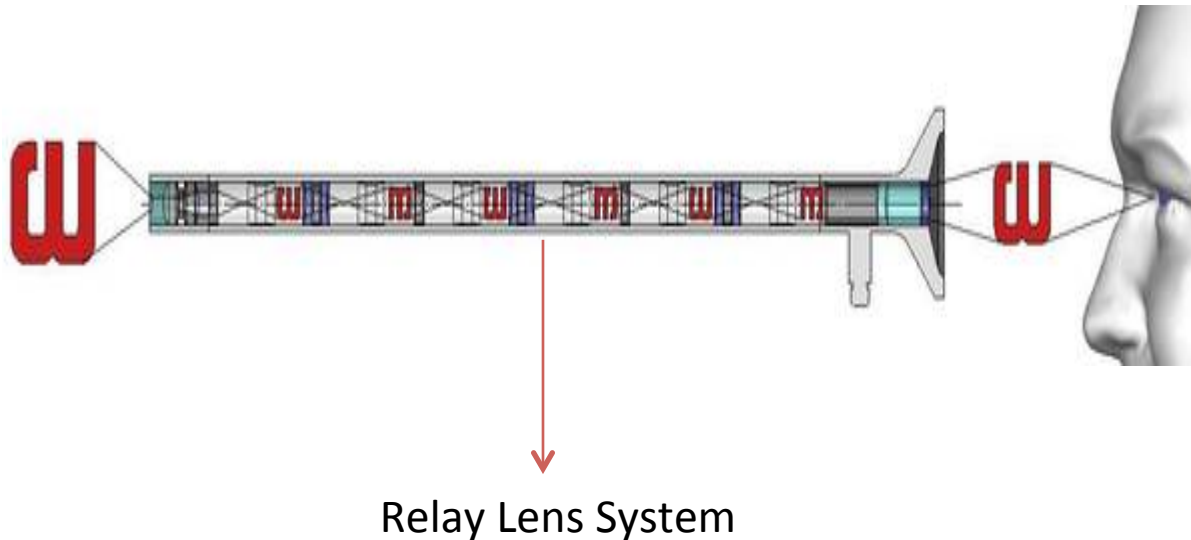
*Endoscope with irrigation and suction port, light cable and forceps*

# OPERATING ENDOSCOPE WITH TWO WORKING CHANNELS



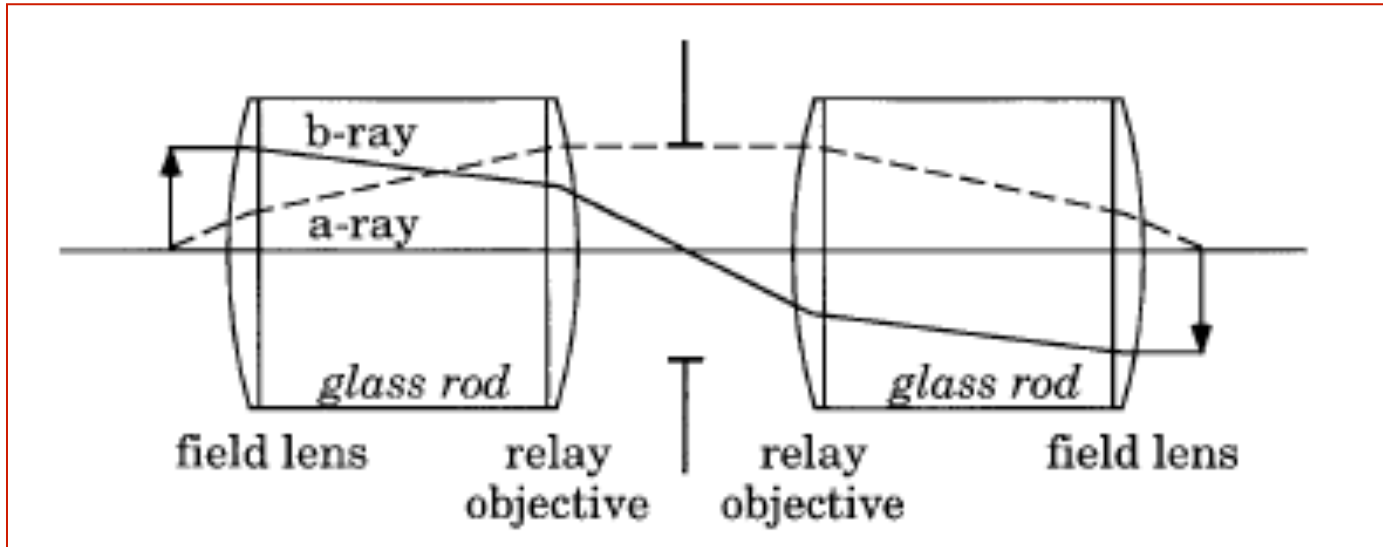
# IMAGE FORMATION IN A RIGID ROD LENS ENDOSCOPE

- ✓ 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

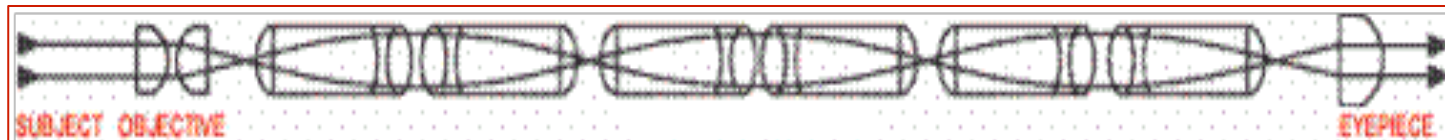


# ROD LENS SYSTEM

✓ Developed by Hopkins and hence called as Hopkins System

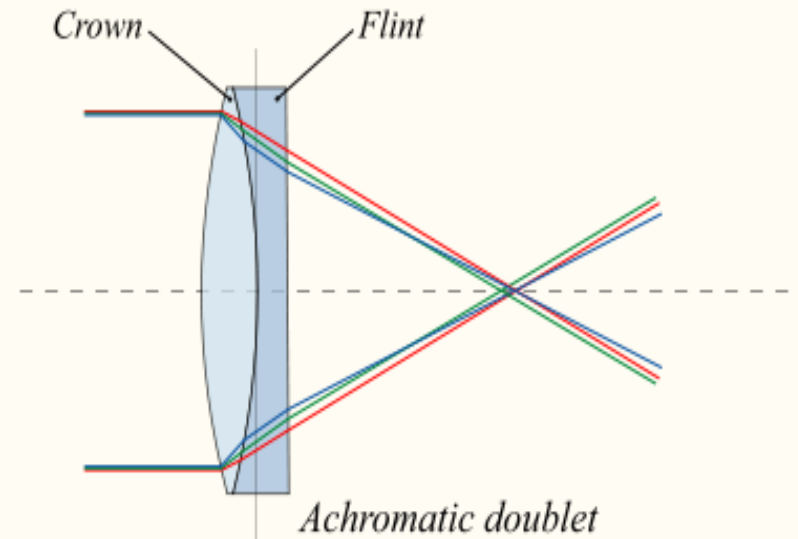
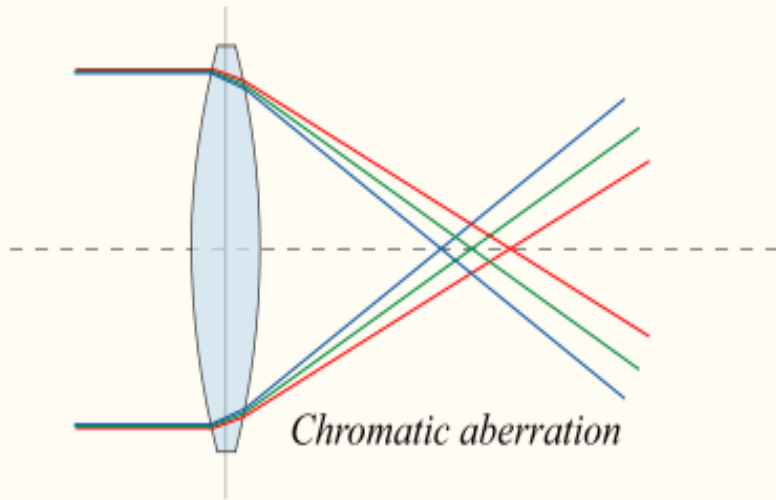


One stage of Hopkins Rod Lens



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

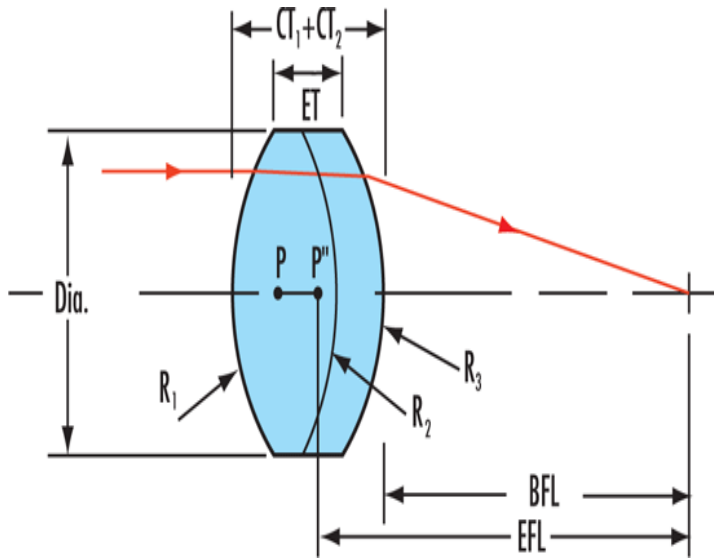
# ACHROMATIC DOUBLET



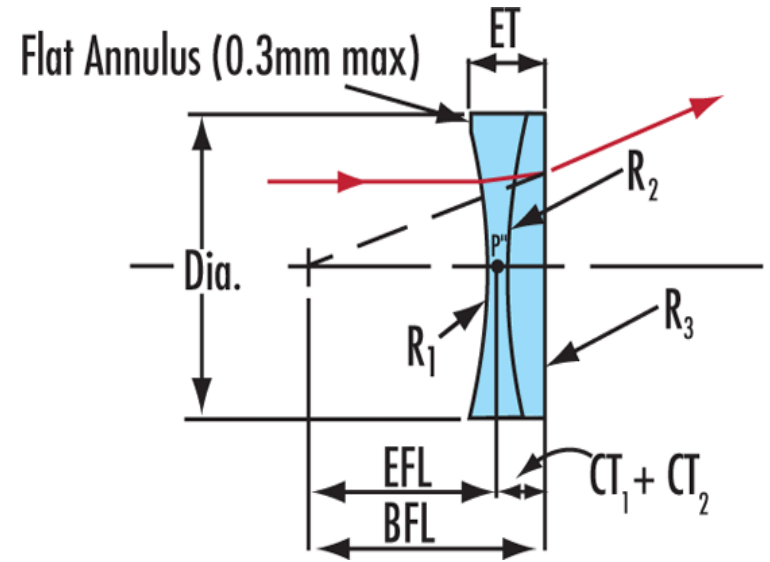
*Image formation using Achromatic Doublets*



# TYPES OF ACHROMATIC DOUBLET

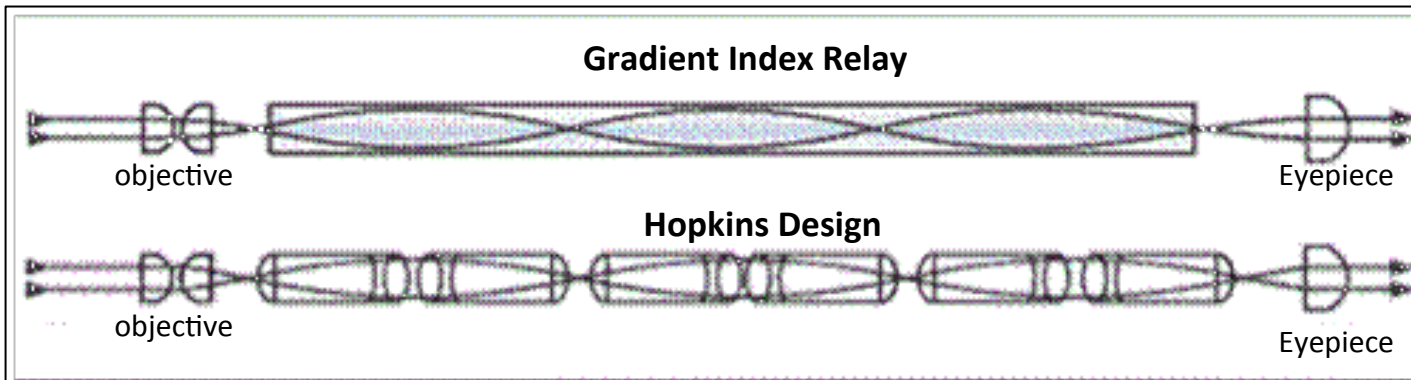


**Positive Doublet**

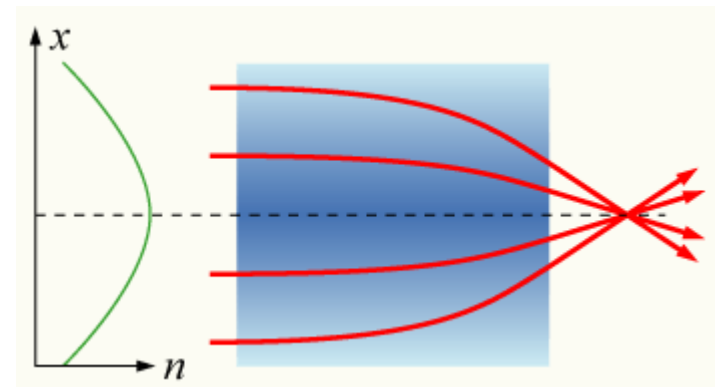


**Negative Doublet**

# 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)

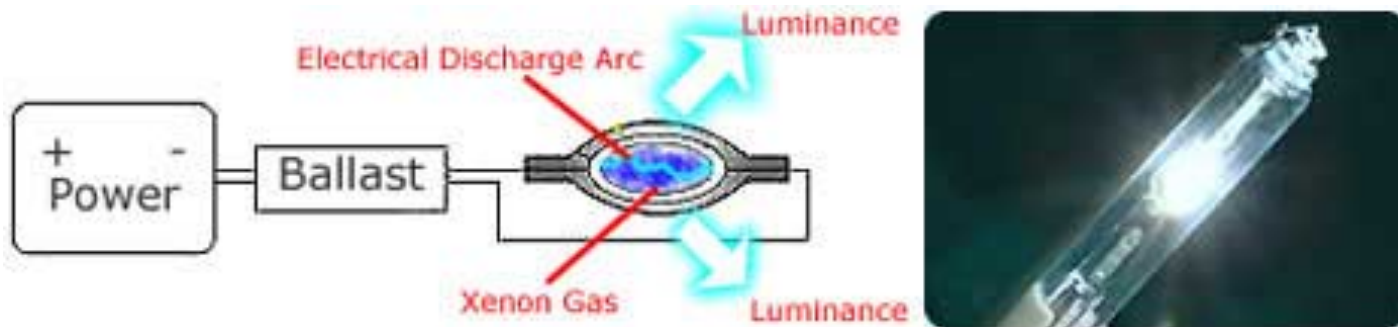
✓ produce light with an electric arc between the tungsten electrodes housed in a fused Quartz (or Alumina) tube



- ✓ 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

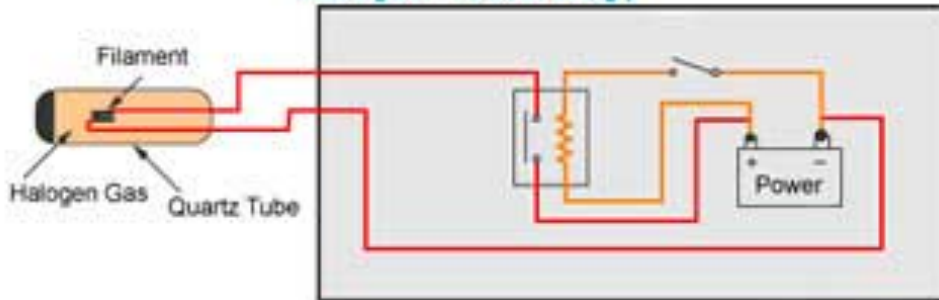
## *Xenon Arc Lamp*

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

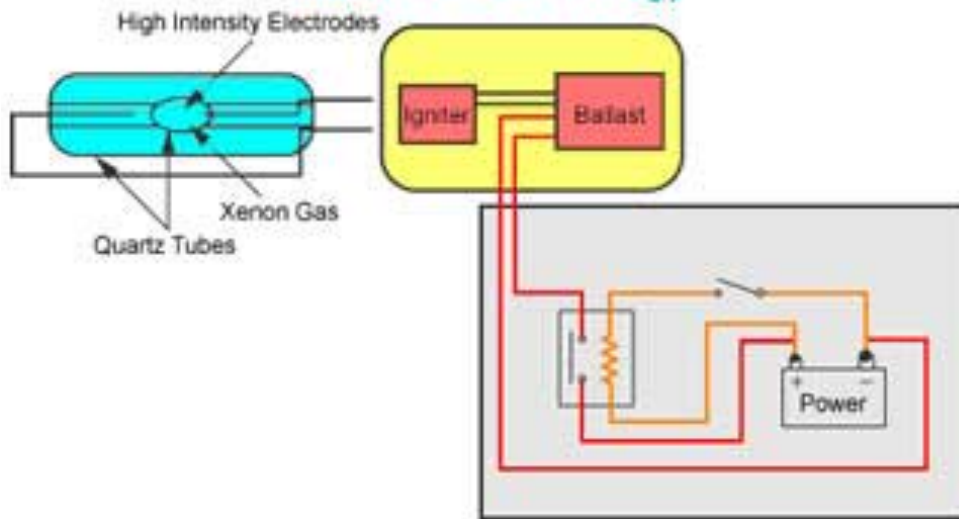


# HALOGEN LIGHT V/S XENON LIGHT SOURCE

## 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

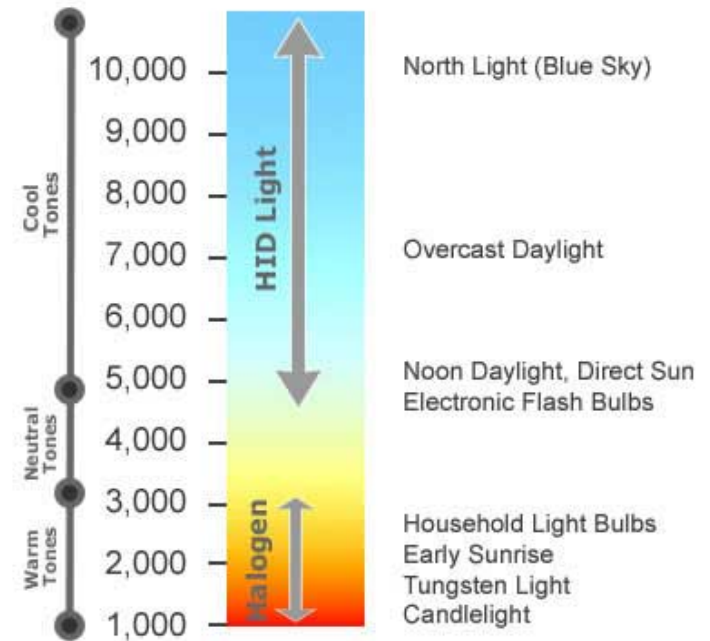
✓ Xe source provides increased contrast and color vision

# 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**

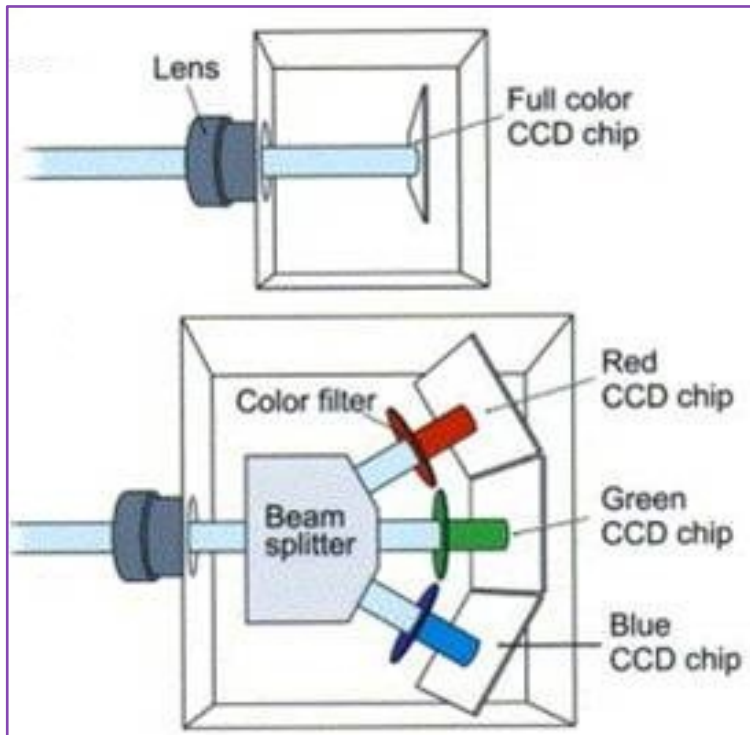
# ONE CHIP CAMERA V/S THREE CHIP CAMERA

## One Chip Camera

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

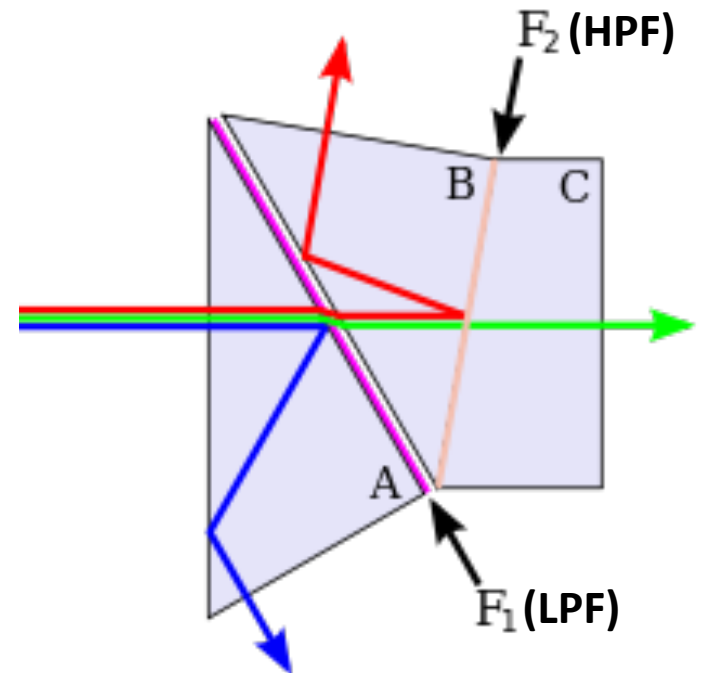
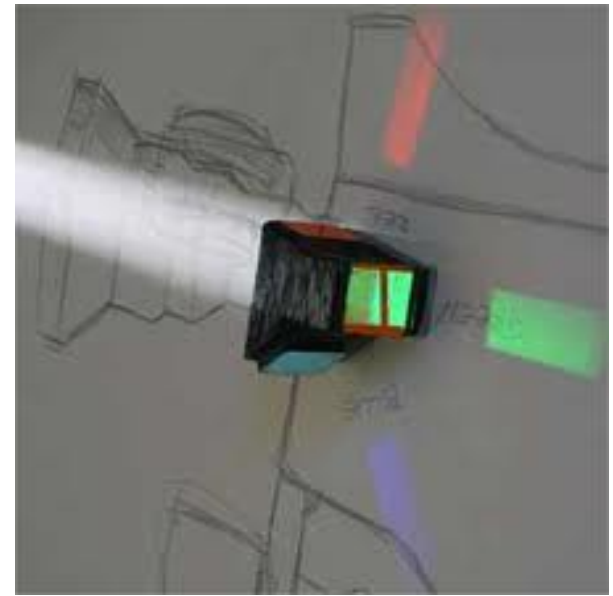
## Three Chip Camera

- ✓ 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

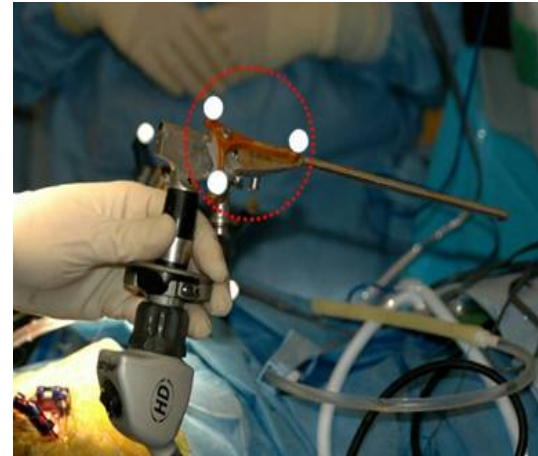
- ✓ Rigidity - one cannot maneuver them in the intraventricular or intracranial spaces as freely as flexible endoscopes
- ✓ It is crucial to plan the entry burr hole in such a location as to allow for the greatest freedom of movement without endangering any neurovascular structures

# 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

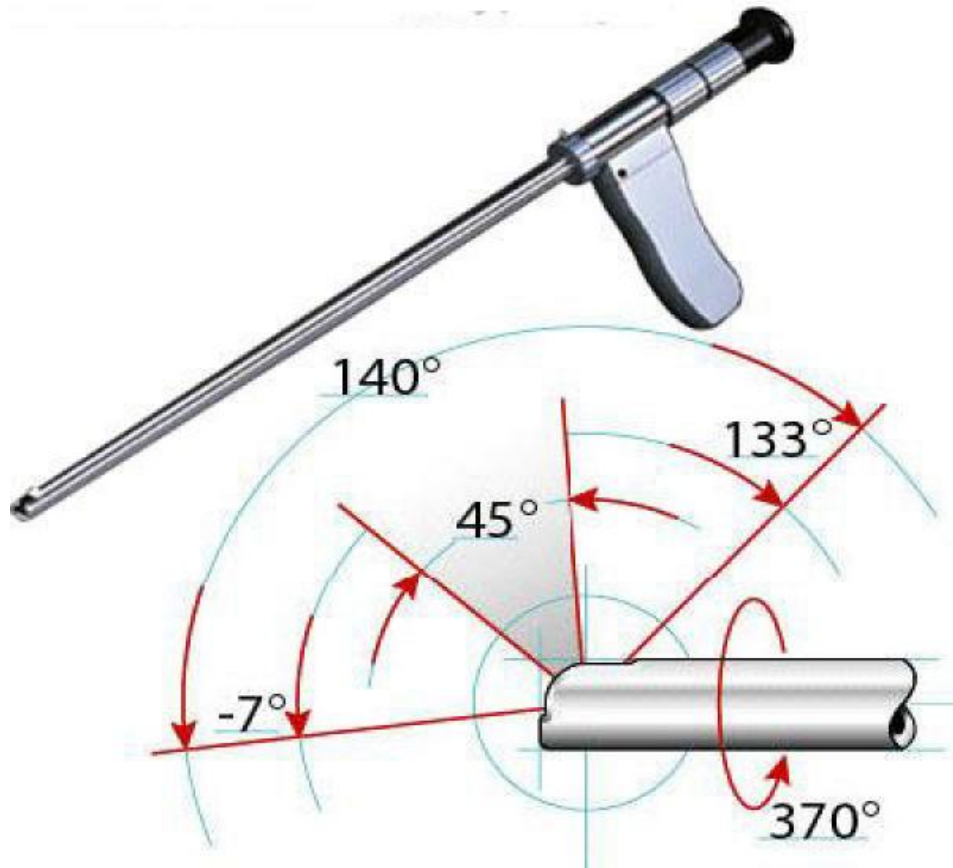
# BENEFITS

- ✓ 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

