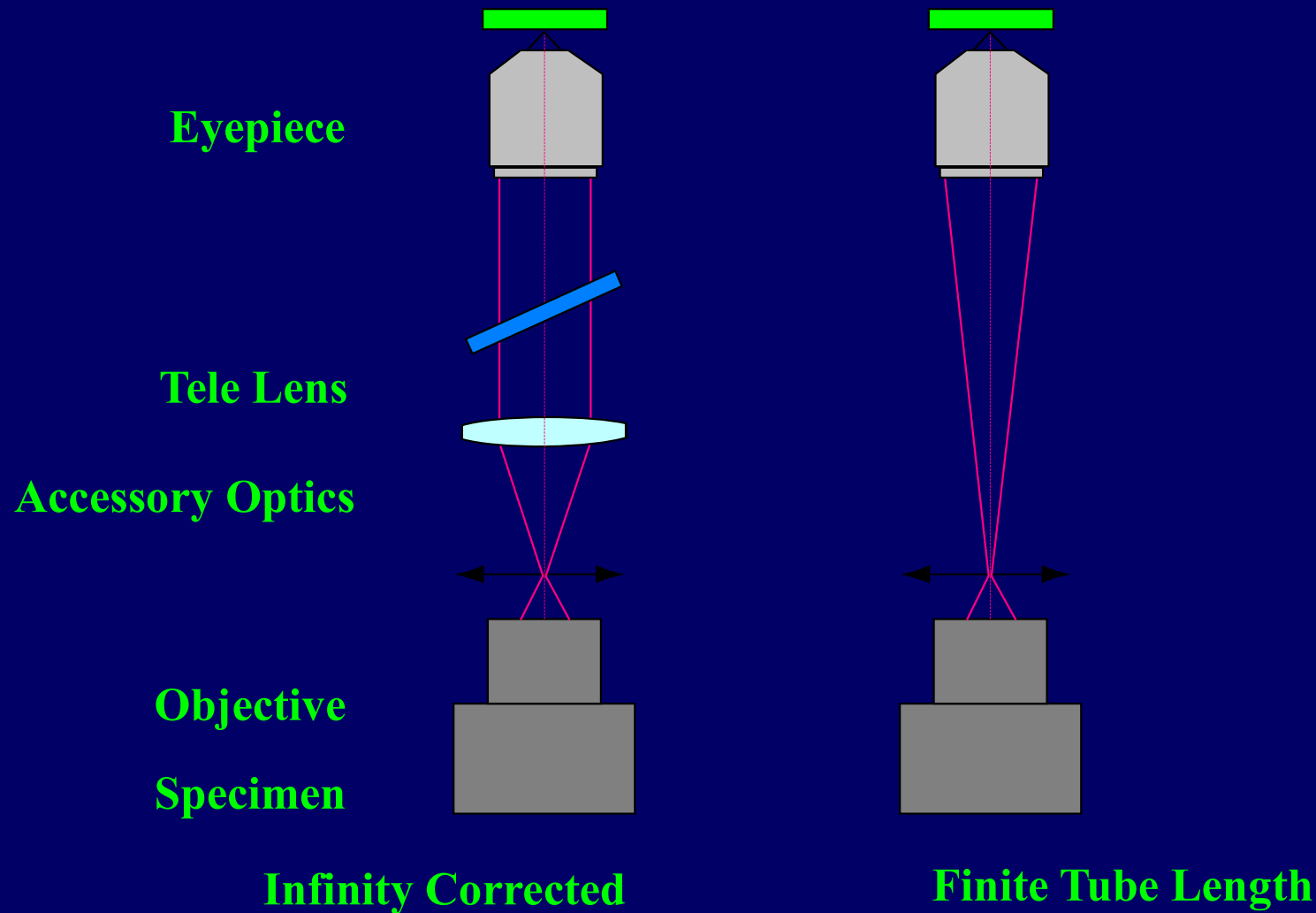


Design and Performance of a New Reflecting Microscope for FT-IR Microspectroscopy

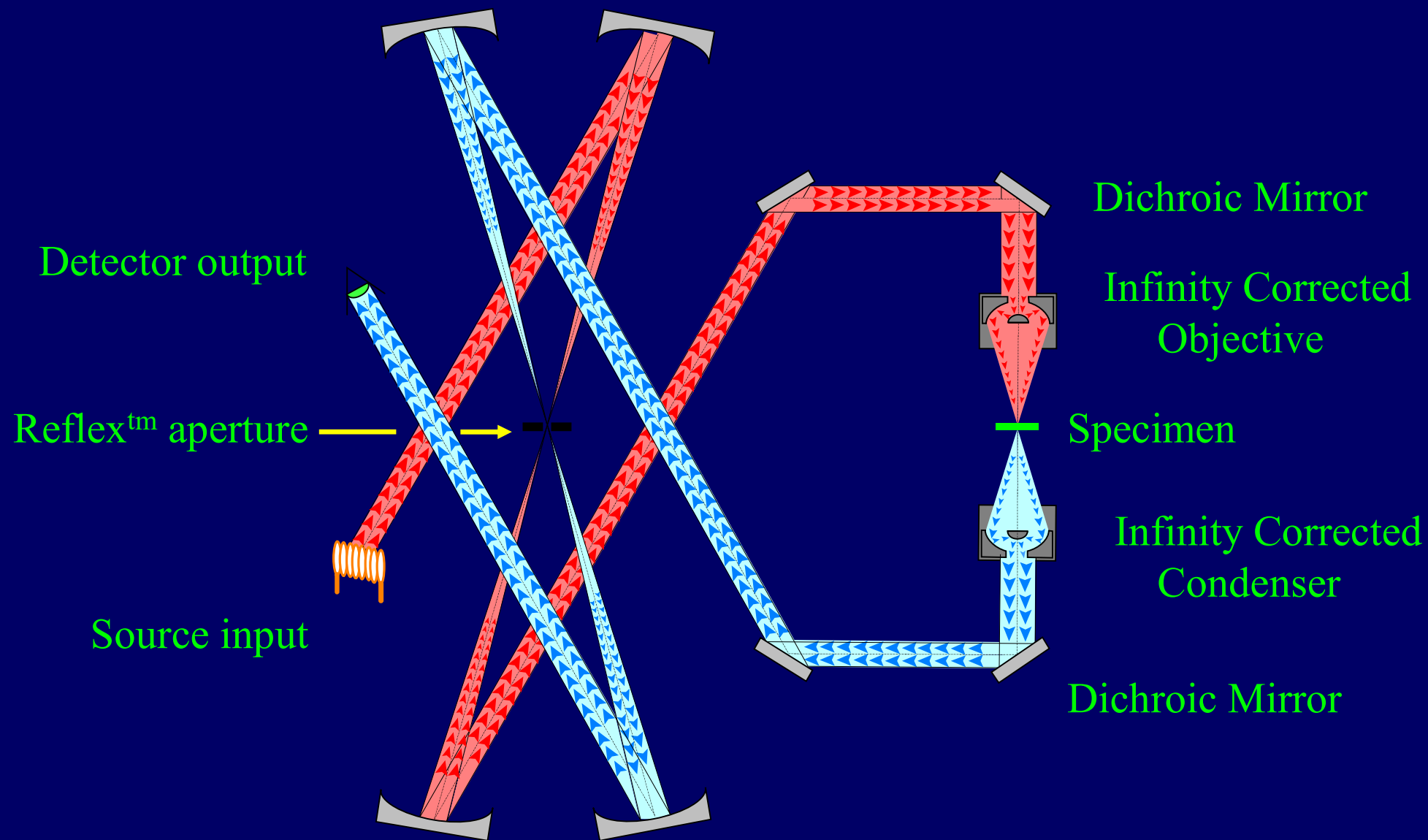
Infinity Corrected Microscope Optics



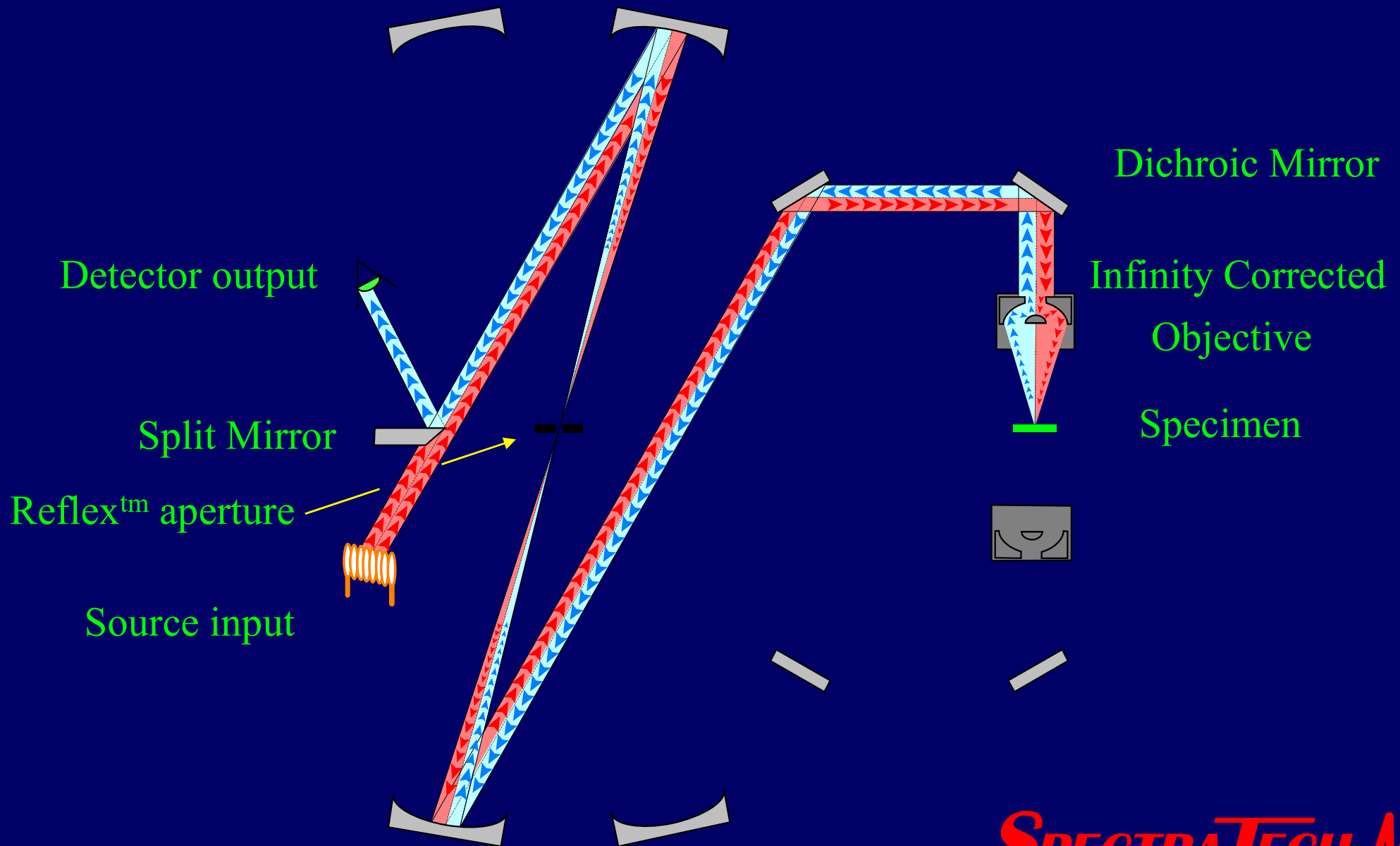
Infinity Corrected IR Microscopes

- InspectIR was first example - US Patent 5,581,085
- Better Image Quality
 - Schwarzschild theory based on infinite conjugate
- Better IR performance
- Flat mirror relay optics - simplicity, alignment
- Ease in introducing optical modules
 - future upgrades
- Intermediate optical surfaces not focussed

Continuum IR Ray Diagram - Transmission



Continuum IR Ray Diagram - Reflection



Continuum IR Optical Design

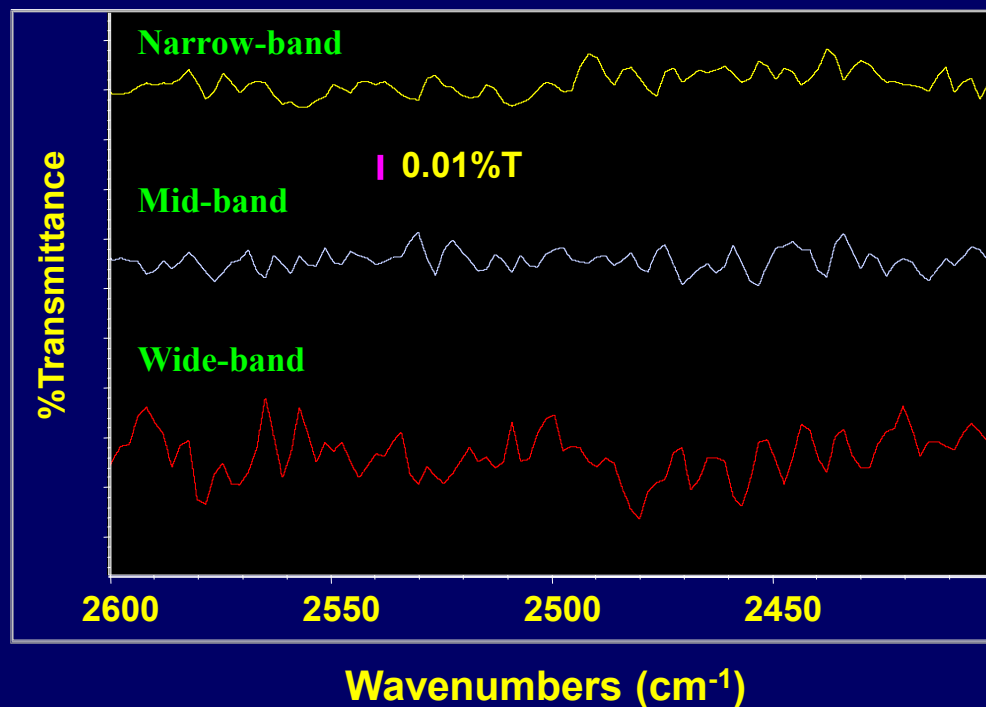
- Single ReflexTM aperture
- Infinity corrected reflecting objectives, condensers
- Dichroic mirrors (3) for simultaneous viewing (TruViewTM), IR data collection, and aperture illumination (TruViewTM)
- Dual detector capability
- Correction for focal shift, spherical aberration

Continuum IR Optical Design

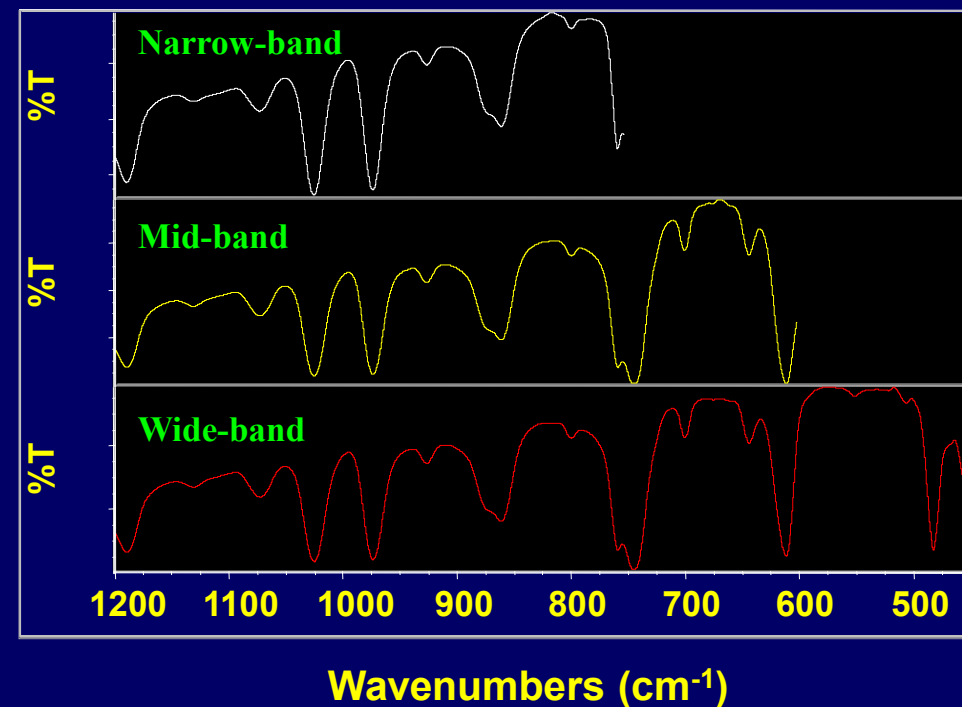
ReflexTM Aperturing

- Single aperture, dual pass
- Patent pending
- Ease-of-use
- Unsurpassed FT-IR microscopy performance
 - S/N, spatial resolution, photometric accuracy
- Performance equivalent to dual aperturing systems
 - US Patent 4,877,960

Signal-to-Noise and Detector Response Performance

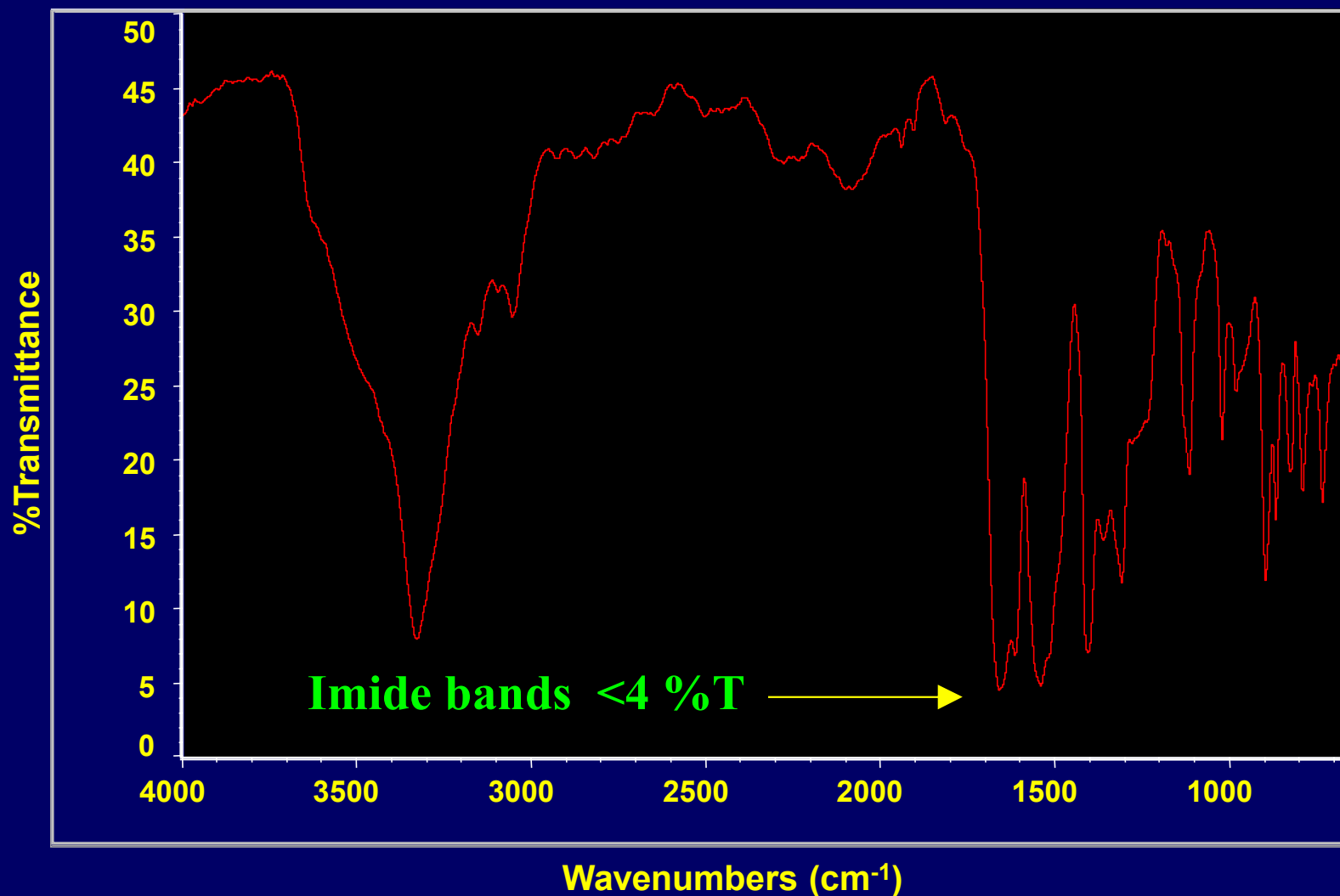


Baseline Noise



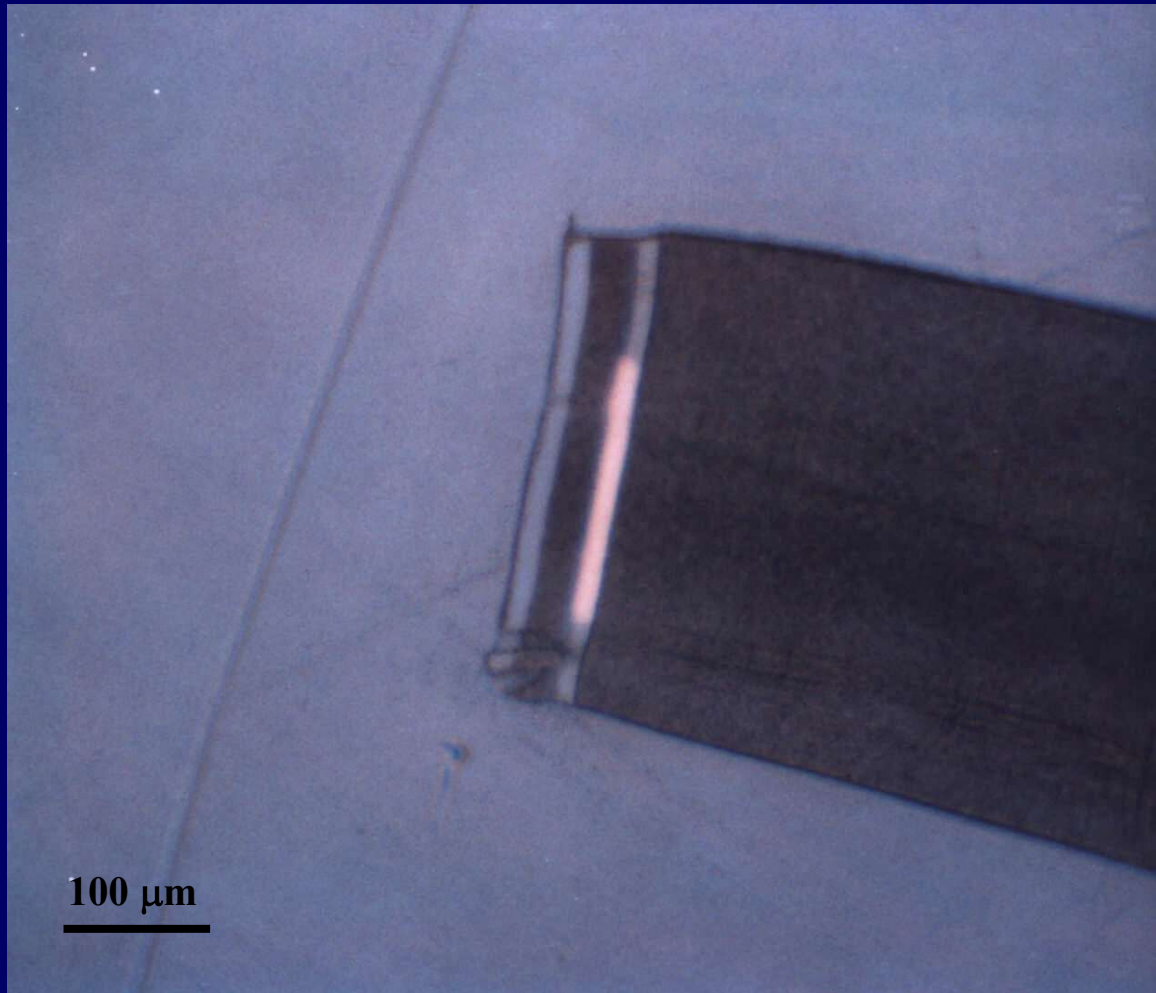
Caffeine Spectra

Photometric Accuracy



12 μm diameter Kevlar™ Single Fiber Spectrum

IR Spatial Resolution

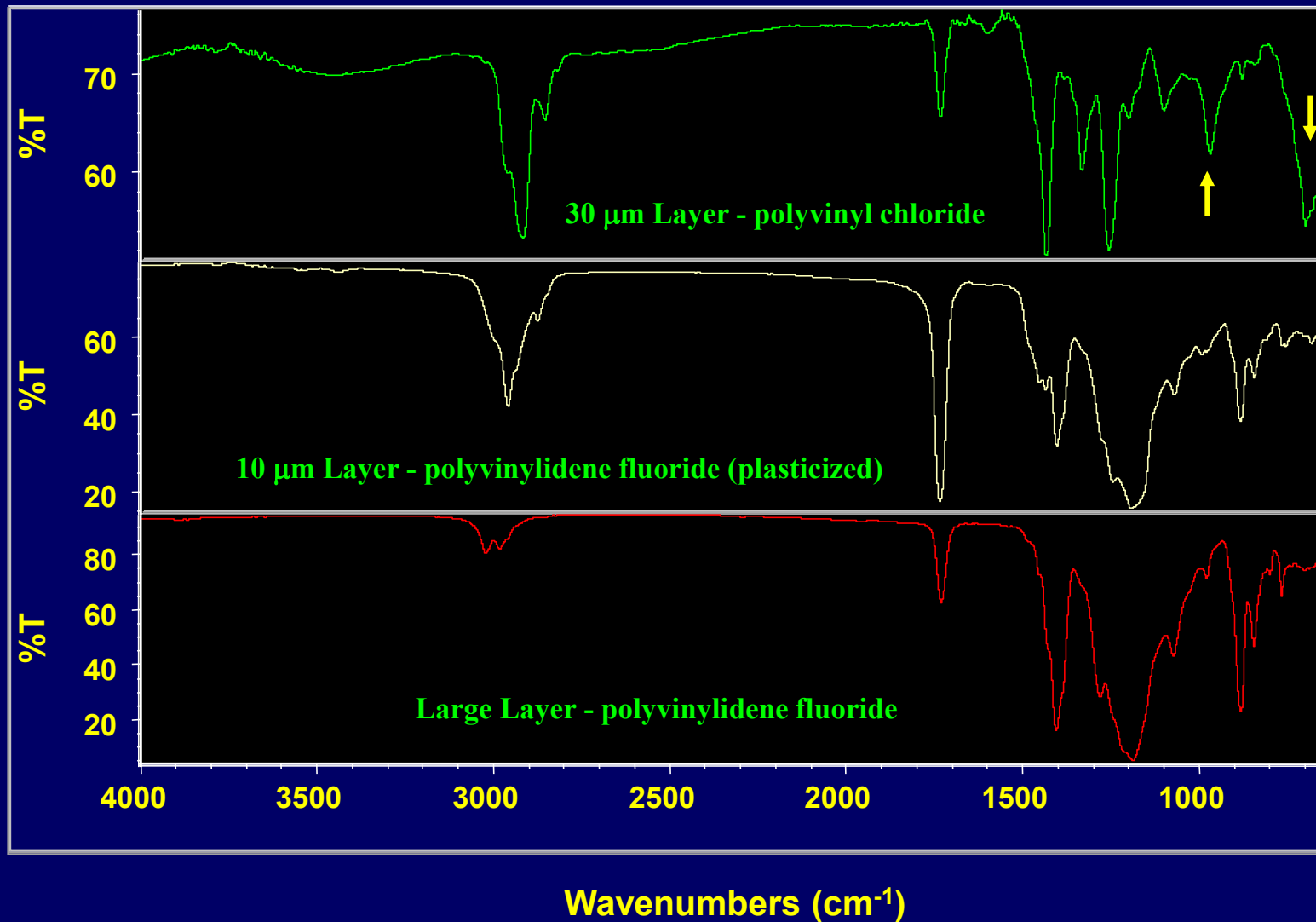


Polymer Laminate - 10 μm layer illuminated

***SPECTRA*TECH_{TM}**

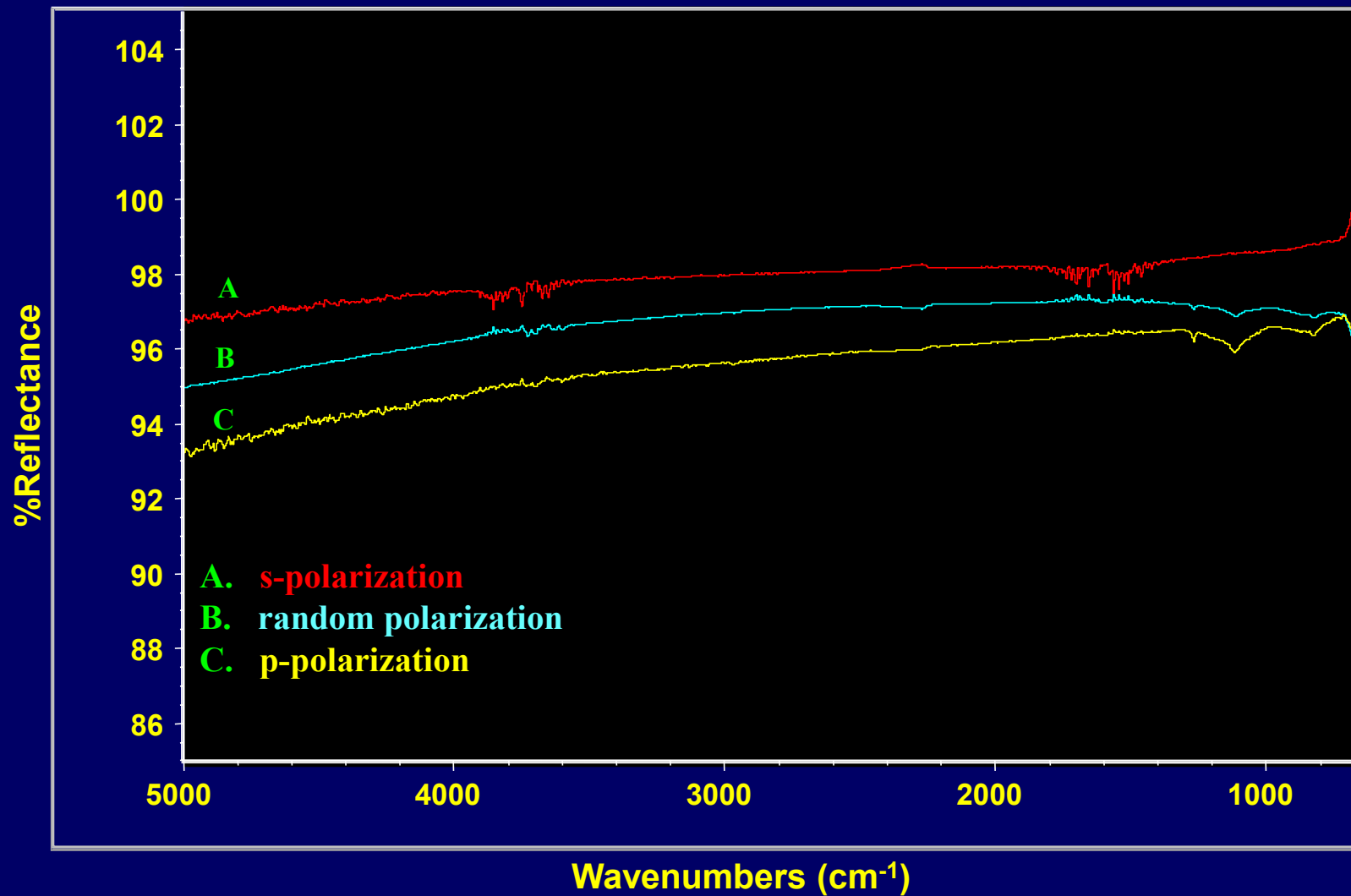
IR Spatial Resolution

Laminate Spectra

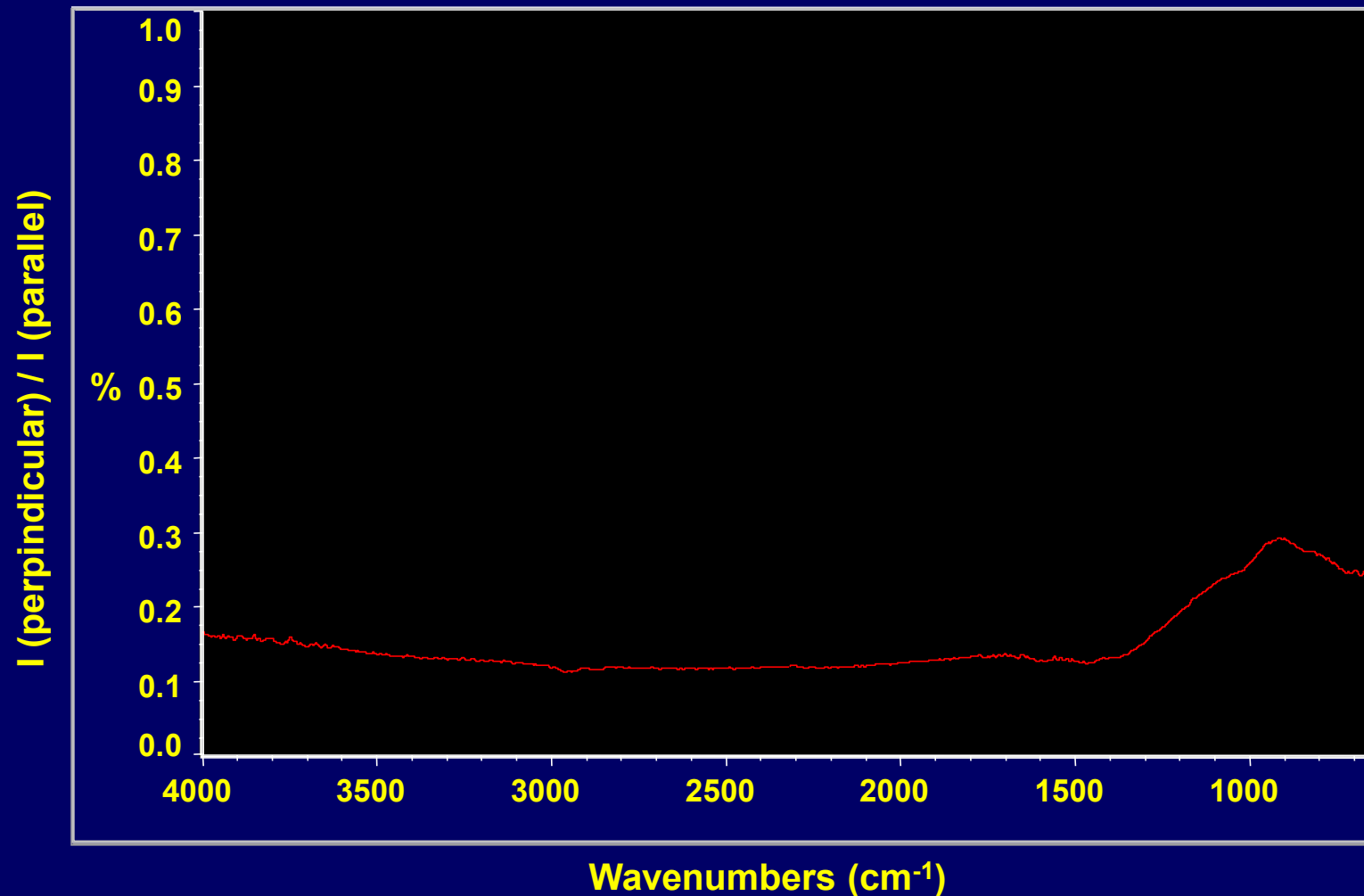


Dichroic Reflectivity

vs. Au 45 degrees incidence



System Polarization Efficiency



Koehler Illumination

Illuminator Filament

Focussing Lens

Aperture Iris

Filament Image

Field Iris

Focussing Lens

Cassegrain Secondary

Filament Image

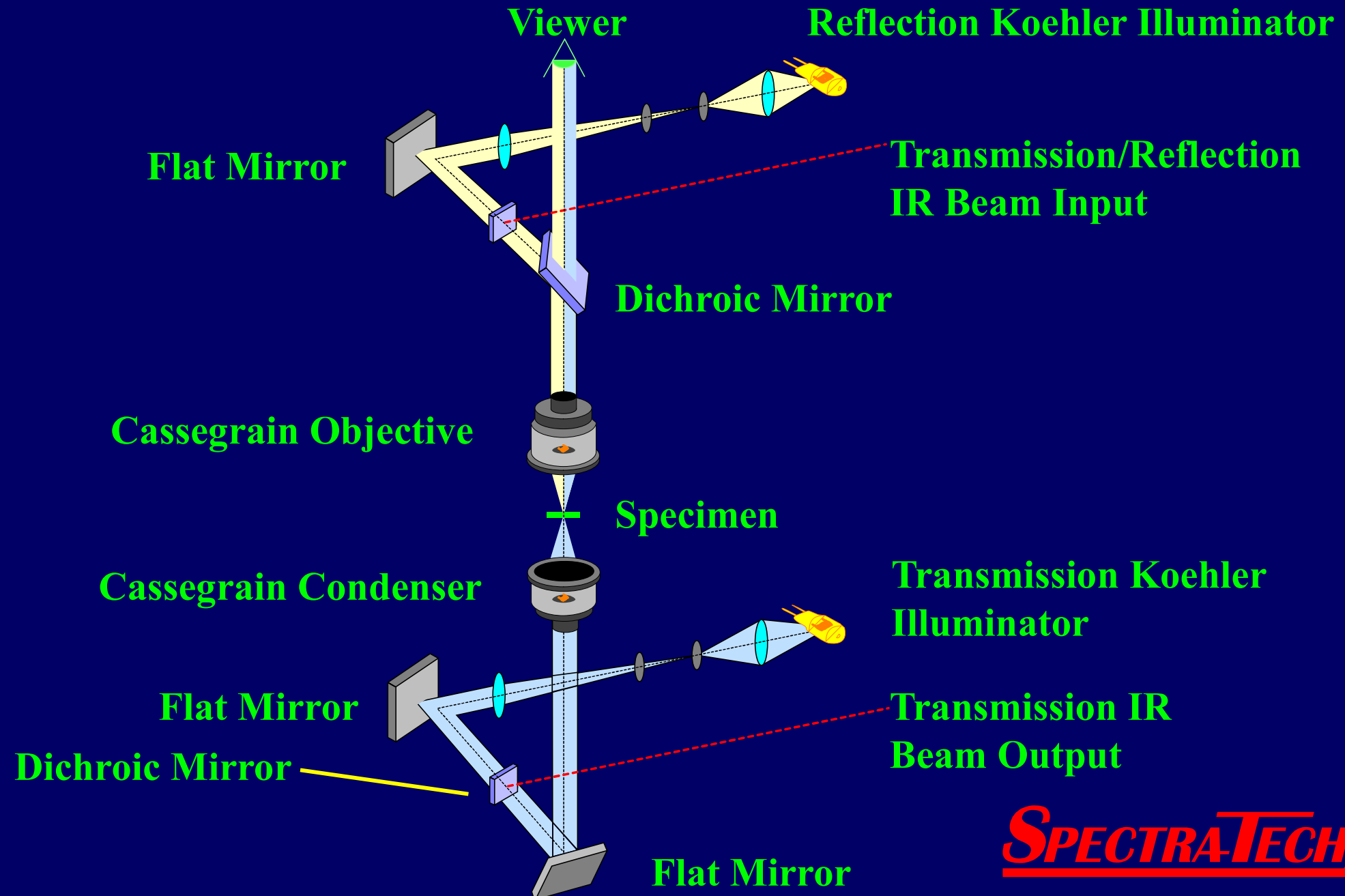
Specimen

Field Iris Image

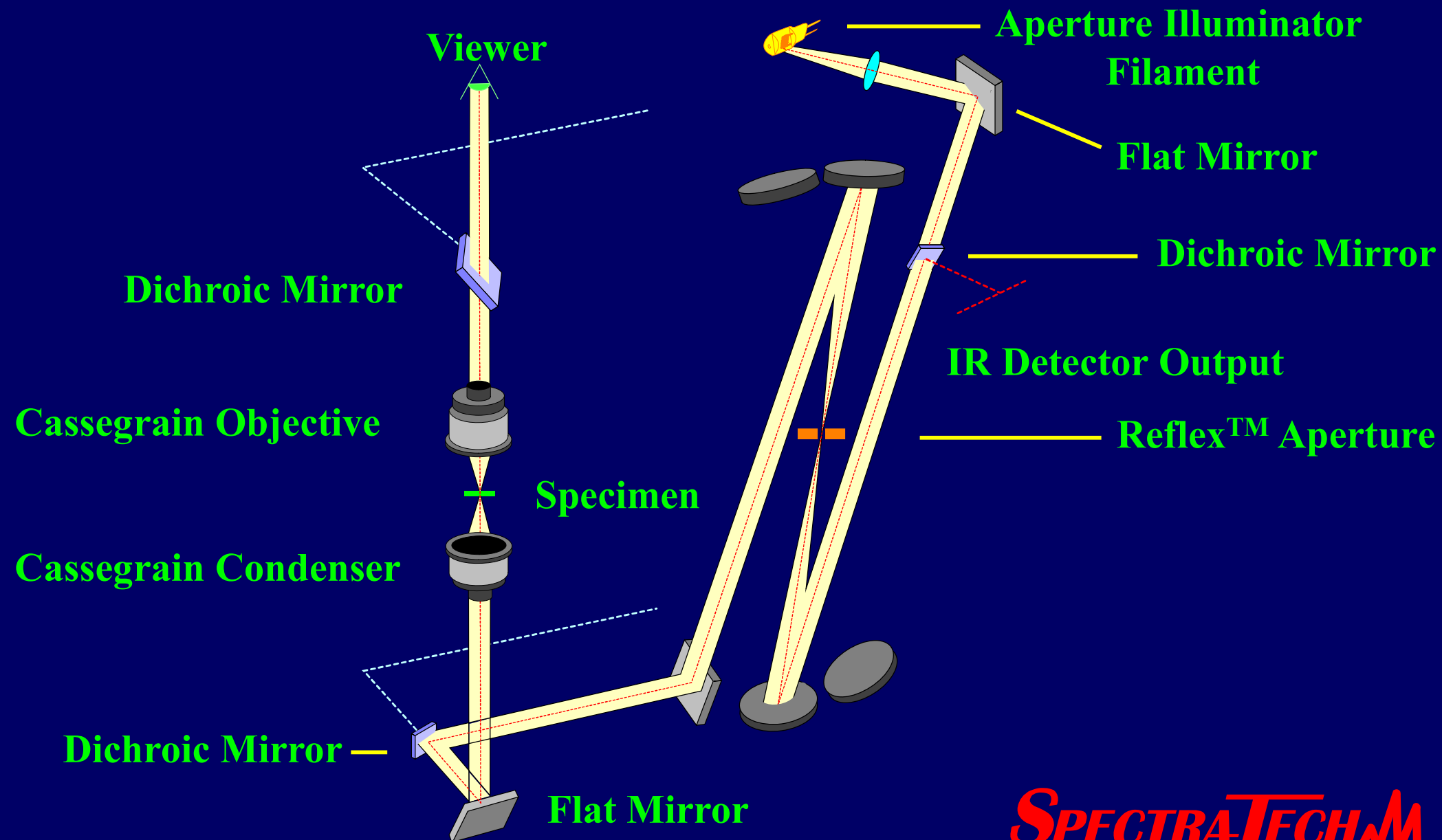
Koehler Illumination

- NIC / ST provides the only *true* Koehler illumination system for FT-IR Microscopes
 - transmission & reflection
- Field stop (iris) imaged at specimen
 - uniform illumination intensity
- Adjustable aperture iris
 - contrast control (illumination intensity reduced)
- Adjustable field iris
 - only in focus when specimen plane is focussed, helps finding a low contrast specimen plane

Visible Illumination Ray Diagram



Aperture Illumination Transmission



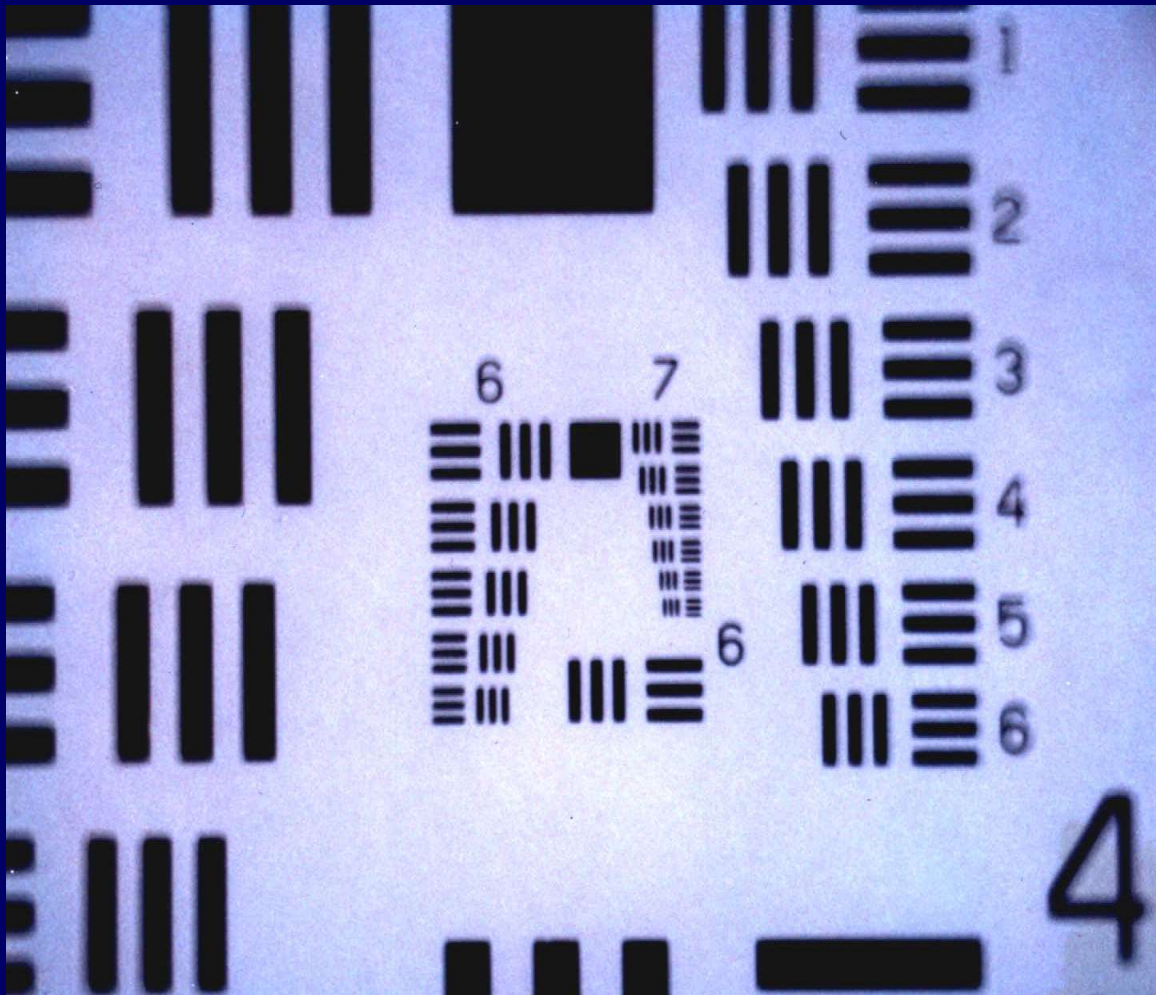
Optical Microscope Design

Features

- **Infinity corrected**
- **High intensity illuminators (3) for transmission, reflection, and aperture illumination**
- **High visible transmission dichroics**
 - **simultaneous view/IR, aperture illumination (Tru View™)**
- **Olympus research grade viewers, 4-place nosepiece, infinity corrected refracting objectives**
- **Koehler illumination**
- **Optional Reflachromat™ IR objectives for diffraction-limited performance**
- **Optional Polarized Light Microscopy**
- **Optional Differential Interference Contrast (DIC)**
- **Research grade optical microscopy**

Image Quality

1951 USAF Resolution Test Target 15X Reflachromat

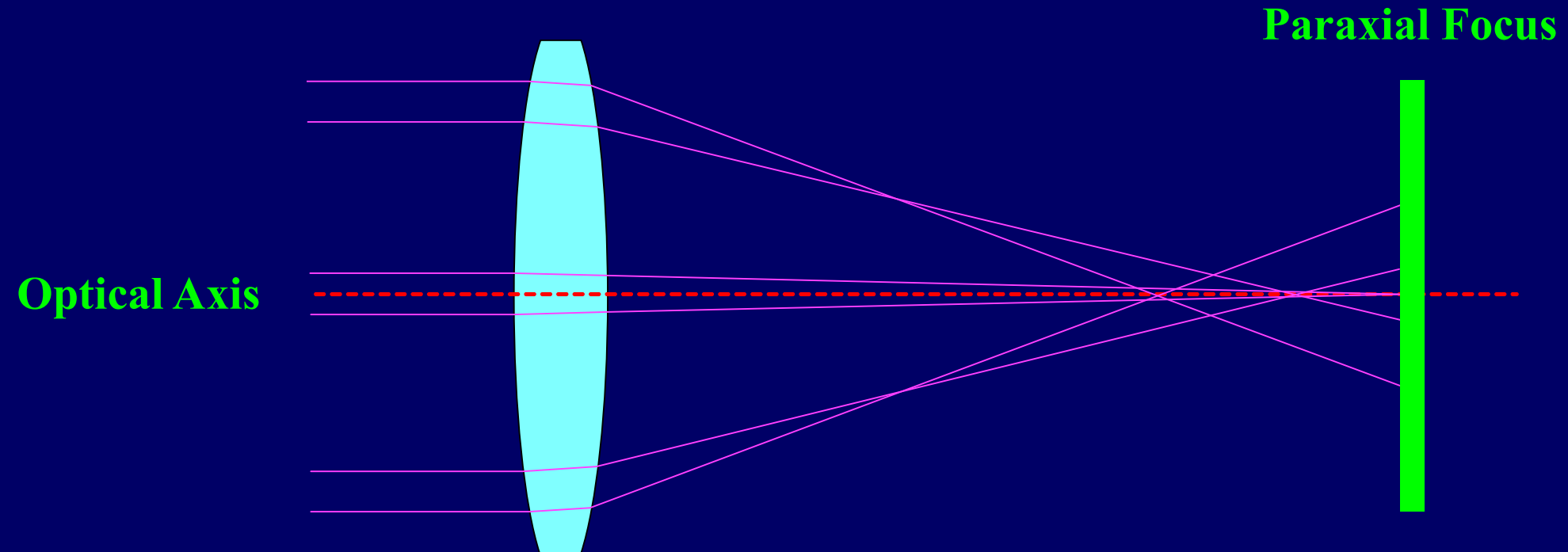


Smallest Bar Separation- 4.4 μm : Optical Resolution better than 1 μm

***SPECTRA*TECH**

Spherical Aberration

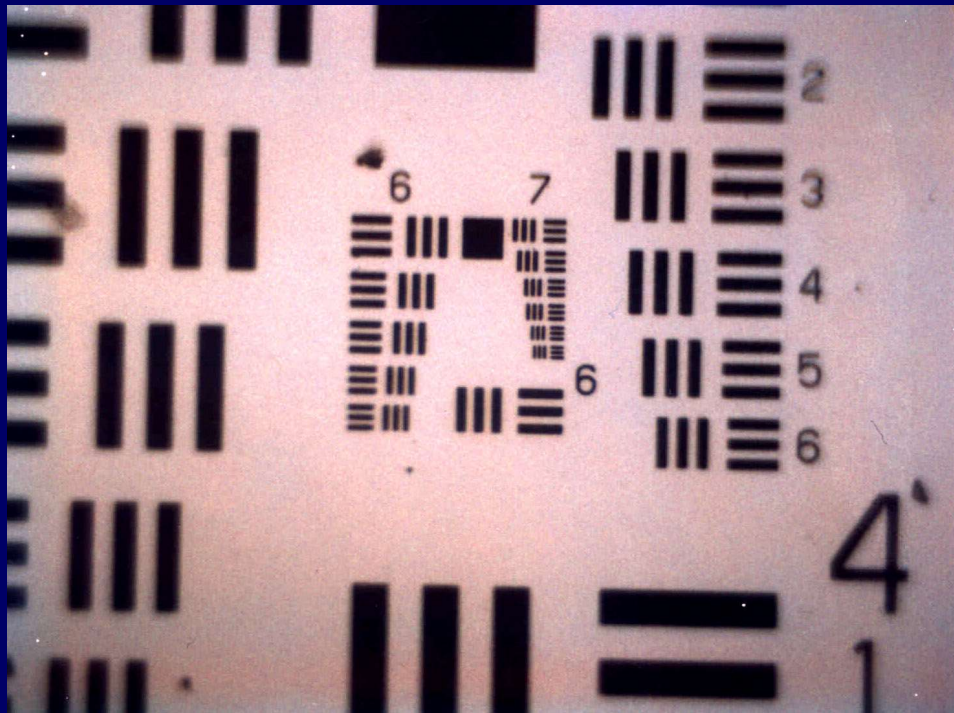
(Variation of Focus with Aperture)



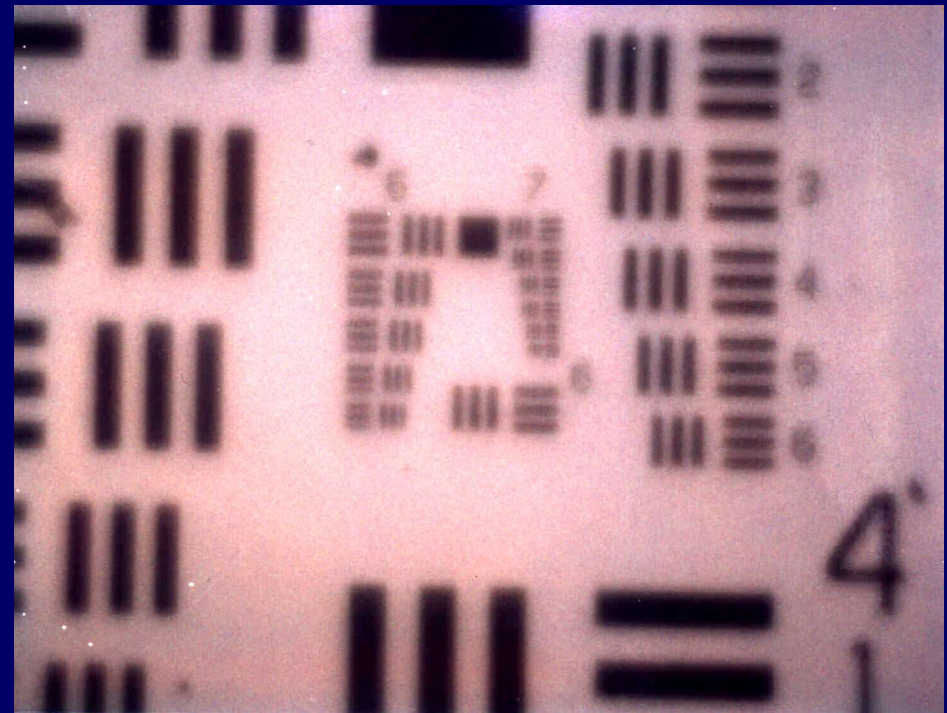
Window substrate causes extreme rays to focus before rays near the optical axis

Image Quality - Compensation for Spherical Aberration

1951 USAF Resolution Target with 2mm BaF₂ Cover Window

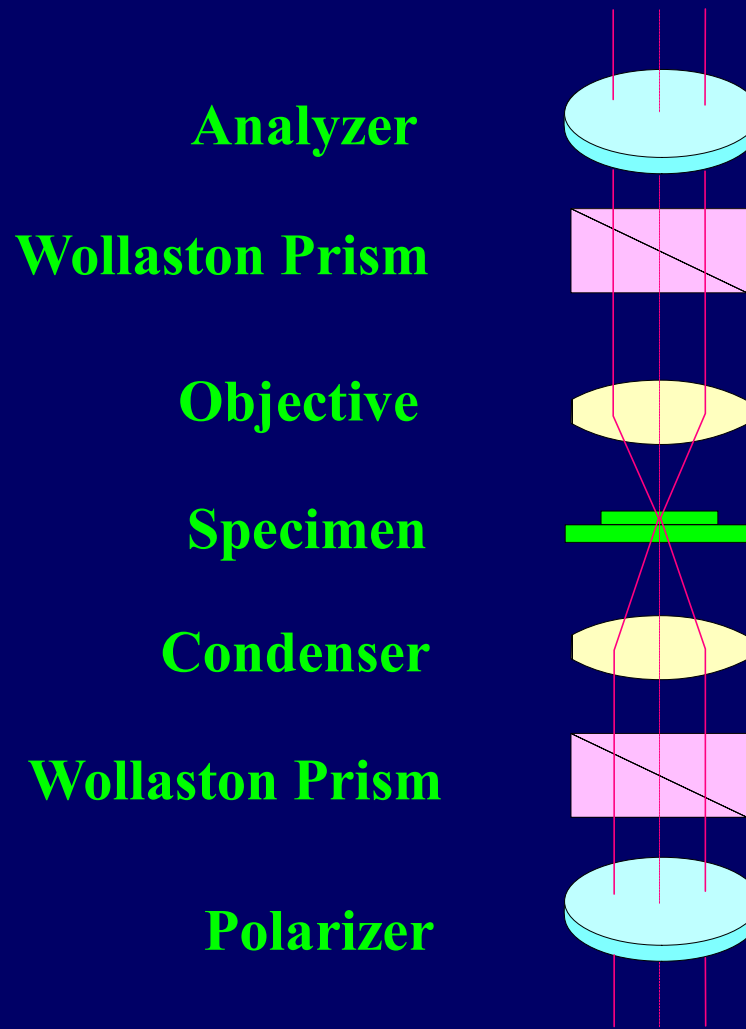


15X Reflachromat Objective
Compensated



15X Reflachromat Objective
Focused, Not Compensated

Differential Interference Contrast

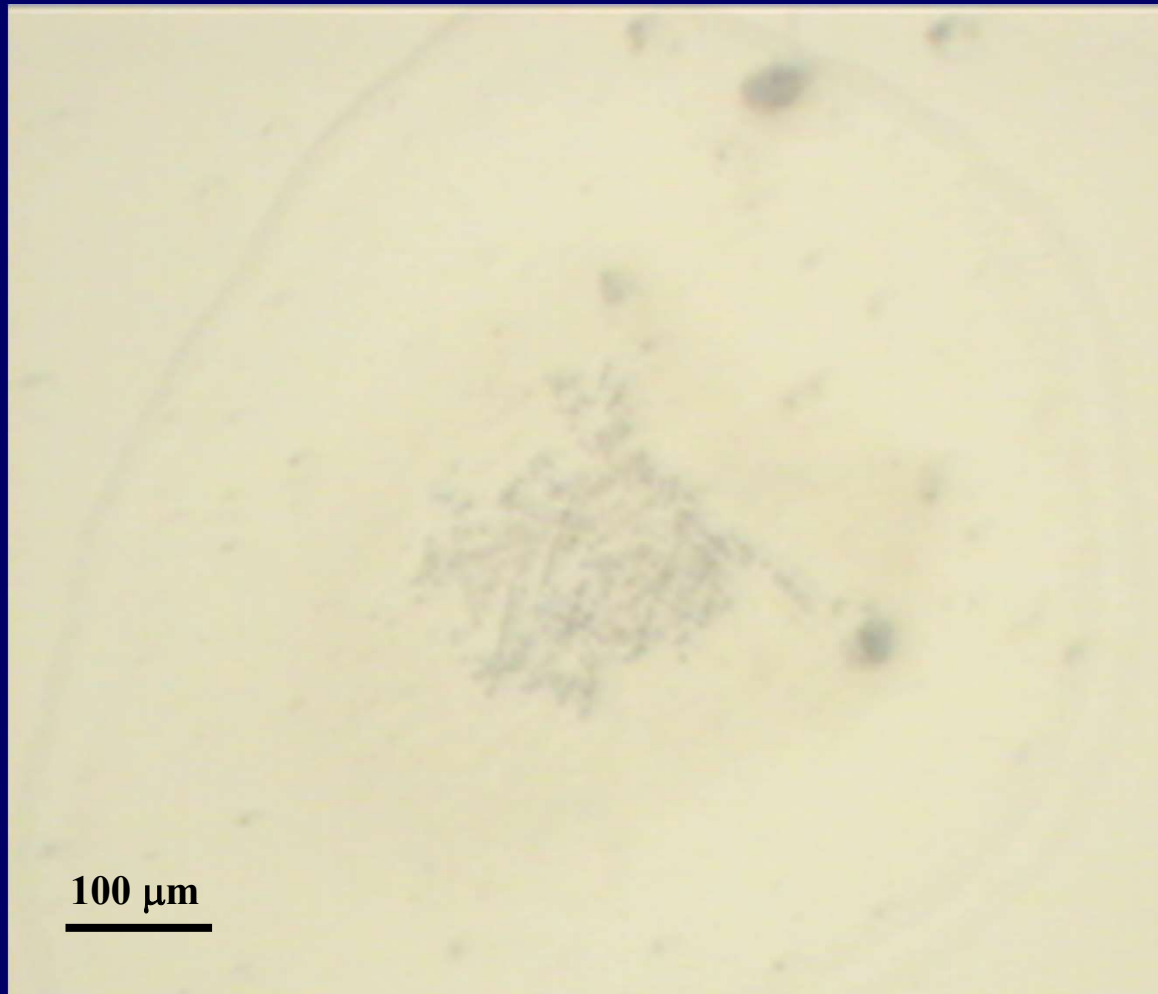


Differential Interference Contrast

- First polarizer splits light into two polarized rays
- Enhancement of separation by first Wollaston prism
- Shadowing effect evident when 2 polarized beams pass through sample
- Beams recombined by second Wollaston prism and polarizer
- Crossed polarizers eliminate all light not altered by sample - shadow is all that passes

Best possible phase contrast

Non-DIC



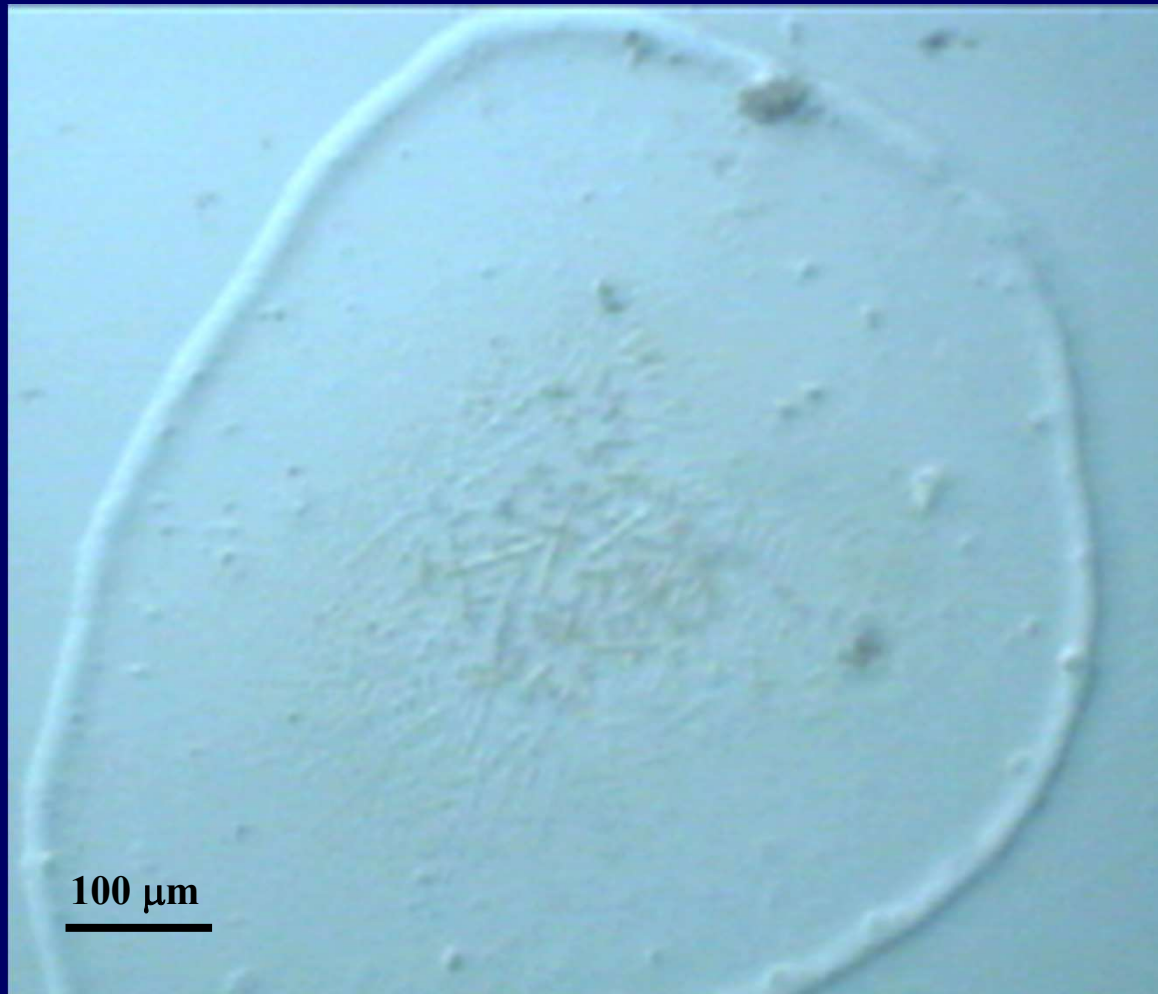
Human epithelial cell

Black and white DIC contrast



Human epithelial cell

Pale Blue DIC Image

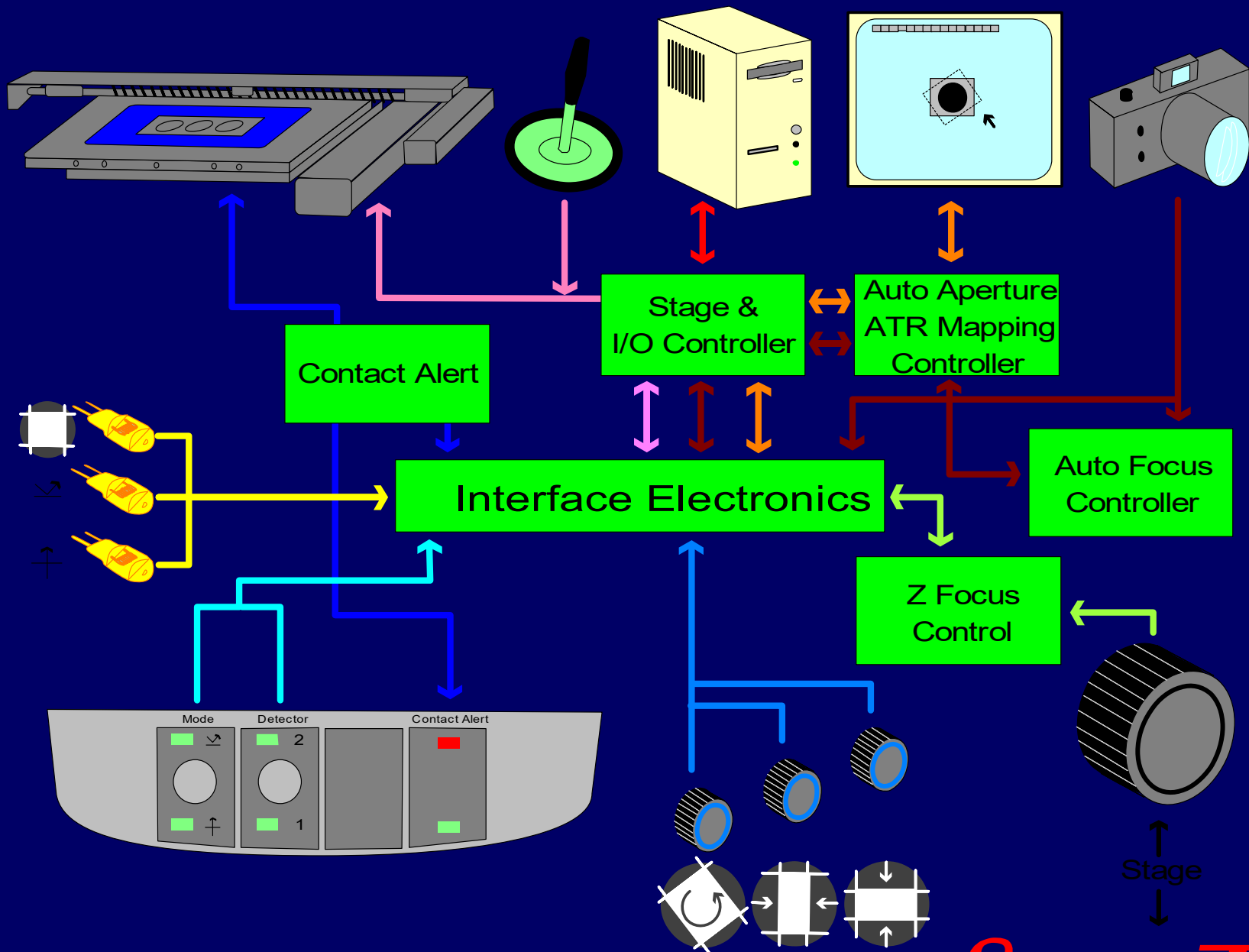


Human epithelial cell

Differential Interference Contrast

- First use of reflecting optics for DIC
 - Patent Pending
 - Aperture under DIC observation
- Lockout Specification
- Previously implemented using refracting optics - optical microscopes
- Requires infinity corrected optical path
- Applications - Biological, Biomedical, Mineralogical, Polymeric, Semiconductor, Materials Science

Continuum Electronics



Electronics Description

- Virtually all microscope functions can be automated
- FULL upgradeability from basic system to complete automation
- All components fully integrated

Modes of Operation

- Transmission/reflection switching
 - Front panel control for viewing ease
 - Software control for data collection
- Detector switching
 - Controlled by OMNIC

Illumination Intensity Controls

- Field illuminators for transmission and reflection modes of operation
- Reflex aperture illumination to simplify sample definition and masking
- Variable intensity controls to maximize usage of aperture and field irises as well as color filters, polarizers, etc.

Motorized Aperture

- Single aperture is used for pre- and post sample masking
- Two speed motor assisted drive mechanism for precise movement
 - Transparent and always centered
 - Single adjust for each axis (x,y, θ) of movement
- Auto-aperture control in Atlas
 - Draw desired aperture size and orientation with mouse
 - Software input of desired aperture settings is also available

Motorized Stage

- Control unit is now internal to microscope
- Precision stepping to better than 1 micron
- Joystick control of stage
- Point and click sample positioning
- Mosaic assembly for large samples
- Spectral mapping (Transmission, Reflection, ATR)

Motorized Focus

- Precision 2-speed focus control
- Z-focus limit switch to protect condensers
- Manual focus control in Atlus software
- Autofocus control from Atlus
 - Uses visual contrast to focus on sample image
 - Mapping (ATR, Trans., Refl.)

Contact Alert

- Pressure sensing plate for ATR spectroscopy
- Front panel LED display showing when contact is optimal
- Control unit is internal
- Feedback for ATR mapping
- Quantitative results better than 1% are achievable with ATR