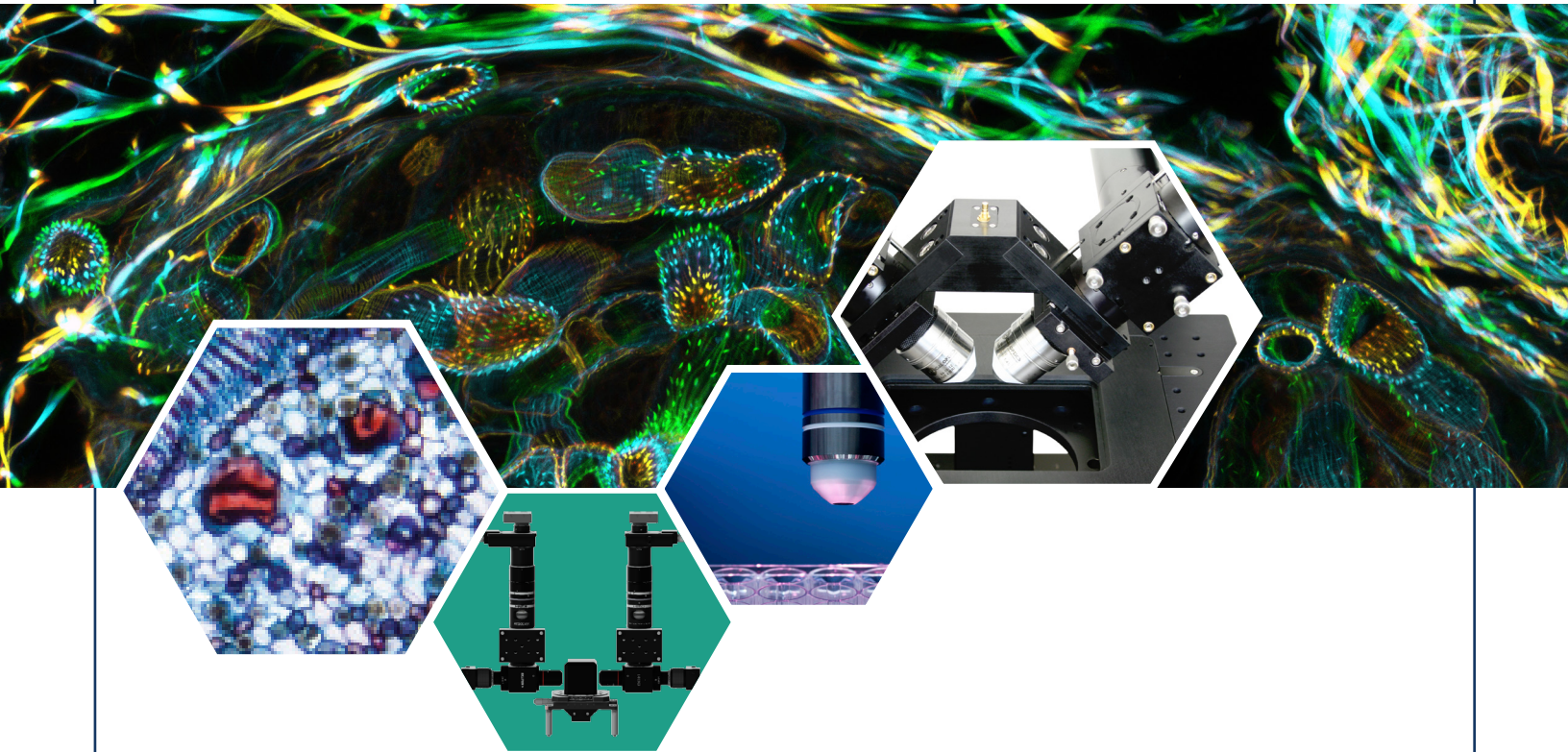


CUSTOM MICROSCOPY SYSTEMS AND INTEGRATED IMAGING SOLUTIONS

FOR OEM MEDICAL & LIFE SCIENCE INSTRUMENTS,
RESEARCH, AND INDUSTRIAL EQUIPMENT



Experts in Optical Imaging Design & Manufacturing
Successfully Bringing Your Concept to Production

Custom Components & Integrated System Solutions

Better Components Combined in One Unified Solution

Our years of optical and mechanical design experience, manufacturing capabilities, modular product lines and customer-centric approach set us apart from other providers. We strive to significantly improve the performance of your imaging systems and help you be the leader in your industry by offering:

- Higher NA
- Wider Field of View (FOV)
- Diffraction Limited Performance
- Superior Unit-to-unit Repeatability
- Superior Wavefront, Color and Distortion Correction
- Optical Design Data for System Modeling
- Traceability and Complete Product History
- System Integration
- On-time Delivery/Availability
- Product Warranty and Unbeatable Support

COMBINING CUSTOM & CORE COMPONENTS

Imaging Lenses

Navitar lens products include: zoom, fixed, motorized, wide angle, large format, HDR, 4K, high resolution, low magnification, diffraction limited, relay/non-relay and F-theta designs. We have experience designing compact, lightweight assemblies, and robust, ruggedized models, for extreme temperature ranges, and near-0 vacuum environments.

Industrial and Microscopy Cameras

Image quality and optical requirements guide our camera recommendations. We offer camera formats ranging from 1/3" to 4/3", resolutions from 2 MP–20 MP, USB-3 to 10 GigE interfaces, board level, enclosed, off-the-shelf and custom configurations. All base models can be modified to meet unique performance and physical requirements.

Custom Microscope Objectives and Tube Lenses

Our designs span working distances of 0.3 to 55mm, cover wavelengths from visible (390-750nm) to near infrared (700-1400nm), can be modified for aqueous, oil and vacuum environments with housings of stainless, ultem or titanium. Super wide tube lenses combined with our wide FOV objectives, increasing the amount of data acquired with each image.

Illumination

Uniform illumination is required to optimize image performance. We partner with industry experts; companies with years of experience supporting applications for life science, fluorescent imaging, machine vision and microscopy. We can address a variety of wavelengths, types and control.



CREATING COMPLETELY INTEGRATED SYSTEMS & SUBSYSTEMS

Our Product Design Process

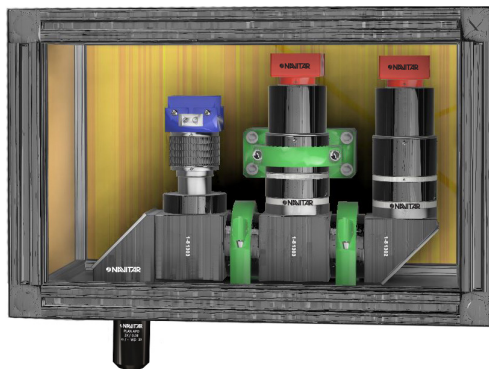
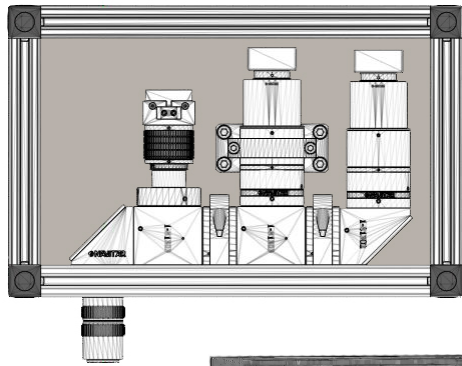
Let Us Help Support Your Most Innovative Ideas

Navitar supports you from proof of concept through the design process and into production. We work with large established OEM Life Science and Industrial equipment makers along with researchers and new start up companies. In all cases, we help jump-start your project by providing:

1. Quick feasibility analysis of the product development project,
2. Preliminary estimate of the design,
3. Rapid turn-around of diffraction limited performing samples,
4. Seamless transition to volume production, and
5. Unit-to-unit consistency for the lifetime of your product's production.

We Have INNOVATIVE SOLUTIONS to Help Unlock Your TECHNOLOGICAL CHALLENGES

OUR DEVELOPMENT PROCESS: WHAT TO EXPECT



Fit assessment of your project -
Determine resources required

Specification review and business case discussion
- timeline, cost of ownership, other considerations for competitive success.

Feasibility phase involving technical risk reduction study to choose a design path for success

Development phase - several iterations of solution are validated and design for manufacturing is explored

Prototype hardware development, verification and initial testing

Full scale production
Ready to meet your cost target, delivery schedules and product release

CONTACT US FOR A FIT ASSESSMENT

WE ARE READY TO BRING YOUR NEXT PROJECT TO PRODUCTION

Custom Optical Design

The Imaging Performance You Need To Be A Leader In Your Industry

Navitar custom component and subsystem designs are driven by innovative ideas, unconventional solutions, requirements and applications brought to us by our customers. These unique applications often require optical solutions that go beyond the limits of commercial systems.

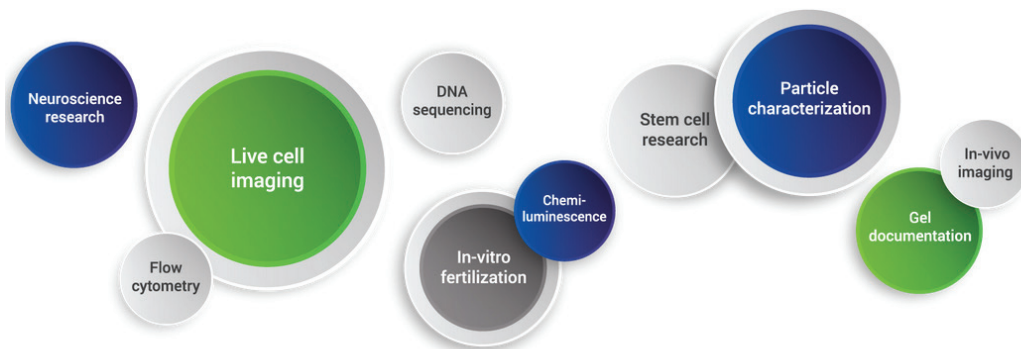
Navitar has a vast selection of modular core products, extensive background IP and a catalog of designs to help get things started and shorten design time. Our integrated solutions incorporate custom and/or catalog products optimized for price, performance and success.

CUSTOM OPTICAL DESIGN

FOR OEM MEDICAL & LIFE SCIENCE INSTRUMENTS, RESEARCH, AND INDUSTRIAL EQUIPMENT

EXAMPLES OF NAVITAR CUSTOM DESIGNS

- DNA Sequencing – Custom components for 4-channel fluorescence microscope system
- InVitro Fertilization – Custom objective lens, tube lens, camera and illumination system
- 3D and Thick Tissue Imaging – Custom water immersion objectives
- Light Sheet Microscopy – Custom water dipping objectives and tubes lenses
- Cleared Tissue Imaging – Custom objectives and tube lenses
- Cell Sorting – Custom microscope objectives, tube lenses and camera systems
- Cell Viability and Analysis Systems – Custom microscope objectives and camera systems
- Diagnostics – Custom camera systems
- Immunoimaging - Custom microscopy components optimized for high-speed, large area, multicolor imaging



DESIGNS FOR

Cell Screening & Analysis Systems
In Vivo NIR/SWIR Tissue Imaging
Microfluidic Imaging Systems
Fluorescence Imaging
Digital Pathology & Holographic Microscopy
Live Cell Imaging
Tissue Diagnostics

Super Resolution Microscopy Systems
Specimen Tomosynthesis
Flow Cytometry
Chemiluminescence
Biomedical Imaging
Cancer Diagnostics
Infectious Disease Research



Optical Design

- Design for Manufacturability
- Lens Optimization
- Performance Modeling
- Image Simulation
- Finite Element Analysis
- Illumination Analysis
- Stray Light Analysis



Optomechanical Design

- Structural Design
- Materials Selection
- Athermalization/Ruggedization
- Lens Mounting & Positioning
- Precision Centration
- Zoom/Focus Mechanisms
- Custom System Interfaces
- Accurate Assembly/Alignment

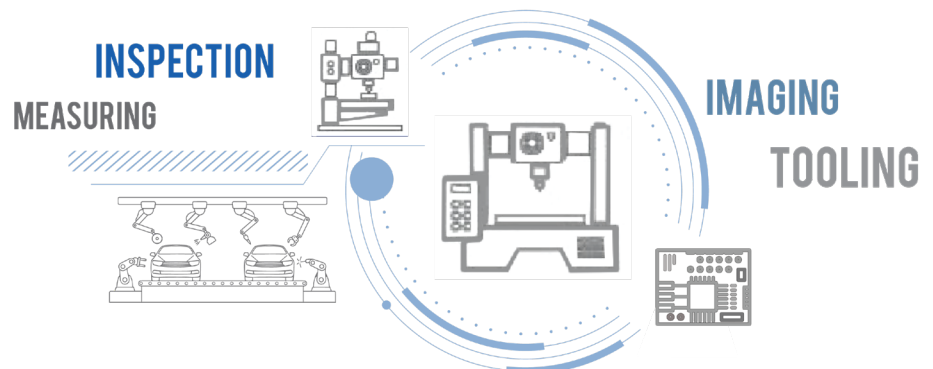


System Engineering

- Feasibility/Risk Reduction Analysis
- Specification Development
- Cost Budget Analysis
- Optical & Mechanical Tolerancing
- System Performance Verification
- Lens-Sensor Integration/Alignment
- Integrated System Testing
- HDR Lens Modules

CUSTOM INDUSTRIAL DESIGN

- Semiconductor Front-End Equipment
- Semiconductor Back-End Equipment
- Electronic Inspection Equipment
- Factory Automation Systems
- Laser Processing Equipment
- Contamination Analysis Systems
- Atomic Force Microscopy (AFM)



Manufacturing Capabilities

We recognize that producing high resolution, diffraction-limited lens systems is often dependent, not only on the optics themselves, but on the quality of the mechanical parts used for assembly. Our mechanical design team works closely with our optical and electronic designers to produce fully integrated opto-mechanical systems and sub-systems.

Using state-of-the-art mechanical design software, we insure your lens systems are both technically feasible and mechanically manufacturable.

We utilize conventional optics, precision mechanics and world class assembly to deliver full OEM lens modules that meet demanding image quality requirements.

Assembly

Air-Space Tolerances Held to 1 Micron
Continuous Lens Design Reoptimization During Assembly
Centration, Wedge and Tilt Tolerances Held to Better than 1 Micron
Air-Bearing Assembly and Alignment

Testing

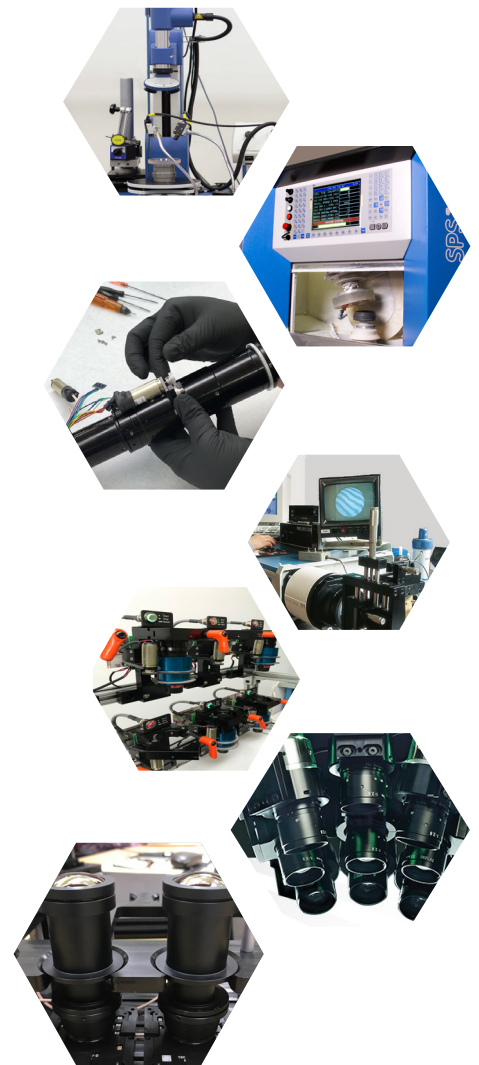
Interferometers @ 405, 532, 632 and 1064 nm
Radius Measurement to Within 1 Micron Sagittal Height
Centration to Within 1 Arc Second
Flatness and Regularity to Within 1/20 Wave
Transmission and Reflection Wavefront Error

Fabrication and Polishing

Glass and Crystal Polishing
Precision Grinding & Optics Polishing from 4 - 280 mm in Diameter
Over 1000 Test Plates on Hand
Surface Regularity Better than 1/20 Wave, 10-5 Surface Quality
Standard Radii from 2 to 13,931 mm

In-House Lens-Sensor Active Alignment IP

Active alignment of a lens and sensor enables accurate, cost-effective production of high resolution, precision camera modules. The alignment process ensures the full capability of the lens and sensor are carried over to the completed module.

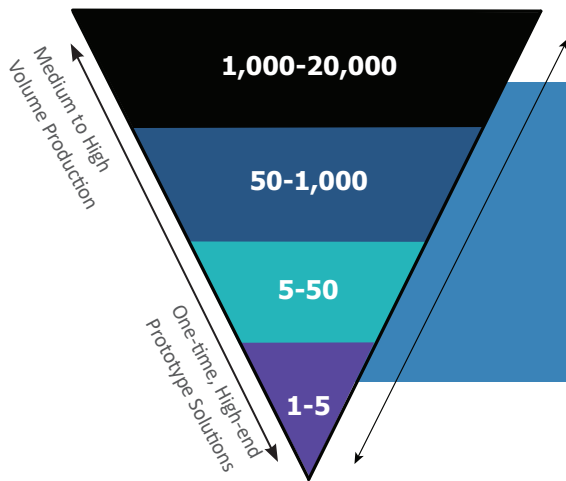


Vertically Integrated Production Capabilities

Navitar is one of the few lens companies that can seamlessly integrate optical and mechanical engineering, rapid prototyping and volume custom lens production.

Eliminating the complexity of managing multiple suppliers reduces the entire design and prototyping process. Cycle times are shortened and a consistently better product is delivered routinely, month-after-month.

We produce large volume commercial orders and complex, custom-built prototypes to exact customer specifications.



Prototype – Pilot – Full Scale Production

- Manufacturing Maturity
- Vertical Integration of All Processes
- Reliable Supply Chain
- Low Volume to Full Scale Production
- Experienced Assemblers and Equipment

Manufacturing Tolerances

Attribute	Commercial Quality	Precision Quality	Ultra Precision Quality
Diameter (mm)	+0.00/-0.10	+0.000/-0.05	+0.000/-0.025
Center Thickness (mm)	0.150	0.050	0.025
Radius (power)	0.2% (8 rings)	0.1% (4 rings)	0.05% (2 rings)
Irregularity (waves @ 633nm)	1	0.25	0.10
Wedge (mm)	0.05	0.005	0.0025
Decenter (arc min)	0.05	0.01	0.005
Scratch - Dig	80 - 50	60 - 40	20 - 5
AR Coating (r avg)	< 1.5%	< 0.5%	< 0.25%



Completely Integrated Imaging Systems

Assembled and Tested to Meet All Design Criteria
Going Beyond the Limits of Commercially Available Systems

Custom Microscope Objectives

Our expertise includes designing multi-element high NA precision assemblies with diffraction limited performance as well as objectives for single wavelength sampling with modest resolution demands requiring commercial tolerance assembly techniques.

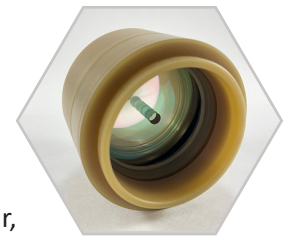
Preengineered High N.A. Objectives

WORKING DISTANCES	0.3mm to 55mm
ENVIRONMENTS	Aqueous, Oil, Vacuum
WAVELENGTHS	Visible (390-750nm) to NIR (700-1400nm)
HOUSING	Stainless, Ultem, Titanium Proprietary Non-Metallic Chemically Resistant Sealant
MEDIA	Ethyl Cinnamate, TDE, Mineral Oil, Silicone Oil, FocusClear, Scale, Other Organic Media, Other Aqueous-based Solutions
OTHER	Mounting Threads, Parfocal Distance, Housing Tip Angle, Field of View



Custom Microscope Objective Examples

- **Stanford University Department of Neurobiology**
0.96 NA objective, stainless housing for life science research in aqueous environment
F#: 0.52, Aperture: 23, EFL: 12, WD: 1.5mm water, FOV: 0.4
- **Janelia Research Campus, HHMI**
0.65 NA Water Immersion Microscope objective lens used for excitation in the Bessel Beam Structured Plane Illumination Microscope designed by Eric Betzig
- **Schleier-Smith Lab at Stanford University**
0.6 NA, EFL: 38mm, FOV: 0.2mm, WD: 8.91mm Vacuum + 3.175mm Silica + 2.59mm Air,
AR Coating: 320nm, 780-852nm, 1064nm. Researchers trap the atoms at that distance and resolve single atoms (at 852 nm) with the objective.
- **Applied Scientific Imaging (ASI)**
Immersion objective lens specifically designed for light sheet microscopy of cleared tissue samples, including ASI's Dual-view Selective Plane Illumination Microscopy system (diSPIM). 0.4 NA objective, FOV: >1 mm, MAG: ~17x, WD: 12 mm



Designed for dipping media RI ranging from 1.33 to 1.56, an enhanced chemically resistance sealant and non-metallic cover make the lens compatible with a wide range of media including:

- water with salt, sugars, and other non-aggressive solutes including routine-use biological buffers
- FocusClear (CLARITY)
- glycerol
- mineral oil
- silicone oil
- TDE (2,2-thiodiethanol)
- ethyl cinnamate
- benzyl benzoate (benzyl alcohol & BABB not yet tested)
- other proprietary organic media
- possibly DBE (initial tests indicate potential compatibility but further tests are needed)

Camera Customization

Navitar offers camera formats ranging from 1/3" to 4/3", resolutions from 2 MP – 31 MP, USB3 and 10 GigE interfaces, board level and enclosed, tethered sensor boards, and off-the-shelf or custom configurations. All base product models can be modified to meet unique performance and physical requirements.

Our technology, products and people makes all the difference. We specialize in:

- FPGA-based cameras for unique custom solutions
- Robust, fault tolerant firmware and software
- OEM and custom camera design and manufacturing
- Support of direct connection cable lengths from 3m up to 100m
- Camera packages with 4K HDR lenses for maximum stray light rejection
- Phenomenal engineering and support



Camera Customization Examples Include:

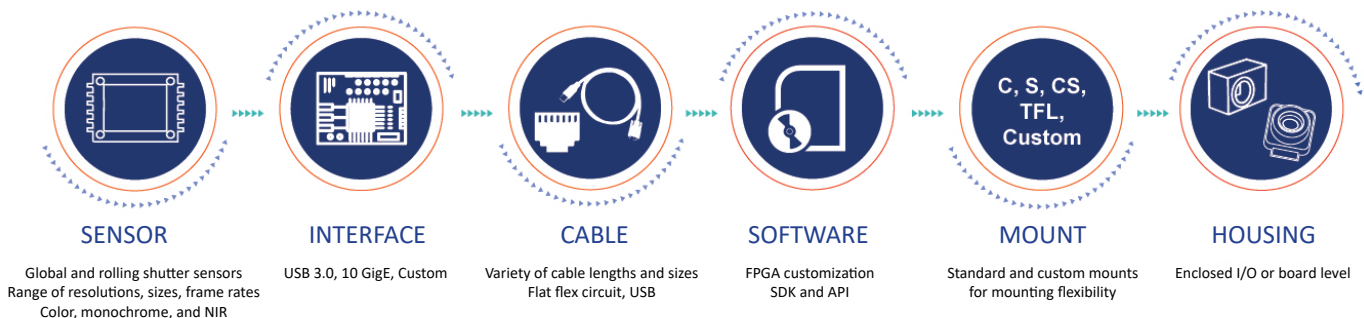


- Custom firmware/FPGA
- Implementation of customer's application specific functions in the FPGA, Firmware or host drivers
- Special customer's entry in camera flash
- Multi-camera synchronization
- IR filter or clear glass removal or replacement
- Cover glass, sensor glass and micro-lens removal
- Custom sensor board mechanicals
- Mount removal or custom designed
- GPIO/Trigger customization to customer's requirements
- Custom sensor-lens integration and alignment
- Custom sensor calibrations for different specifications or environments
- Custom I/O and connector interfaces
- Remote sensor with custom length and design of flat flex cables

Navitar's Pixelink Camera Division Offers You:

- A flexible camera architecture that allows for rapid prototyping and quick time-to-market
- Customized software, firmware, mechanical, and hardware design
- Seamless integration with your existing engineering team
- OS support (32 and 64-bit versions of Windows and Linux)
- Board level or enclosed cameras
- FCC Class B and CE EMI Certification requirements
- Cameras designed with quality and assembled with care
- Low, industry-leading return rate - a testament to our focus on quality
- Project management expertise ensuring timely communication, up-to-date information, and milestones are met throughout the life of the custom project

Build your Custom Camera with Pixelink



CUSTOM MICROSCOPY SYSTEMS INTEGRATED IMAGING SOLUTIONS DIFFRACTION LIMITED DESIGNS

FOR OEM MEDICAL & LIFE SCIENCE INSTRUMENTS,
RESEARCH, AND INDUSTRIAL EQUIPMENT



**CONTACT NAVITAR
TODAY**

**LET US DO A FIT ASSESSMENT
AND HELP BRING YOUR NEXT
PROJECT TO PRODUCTION**

**WWW.NAVITAR.COM
585-359-4000**



Experts in Optical Imaging Design & Manufacturing
Successfully Bringing Your Concept to Production