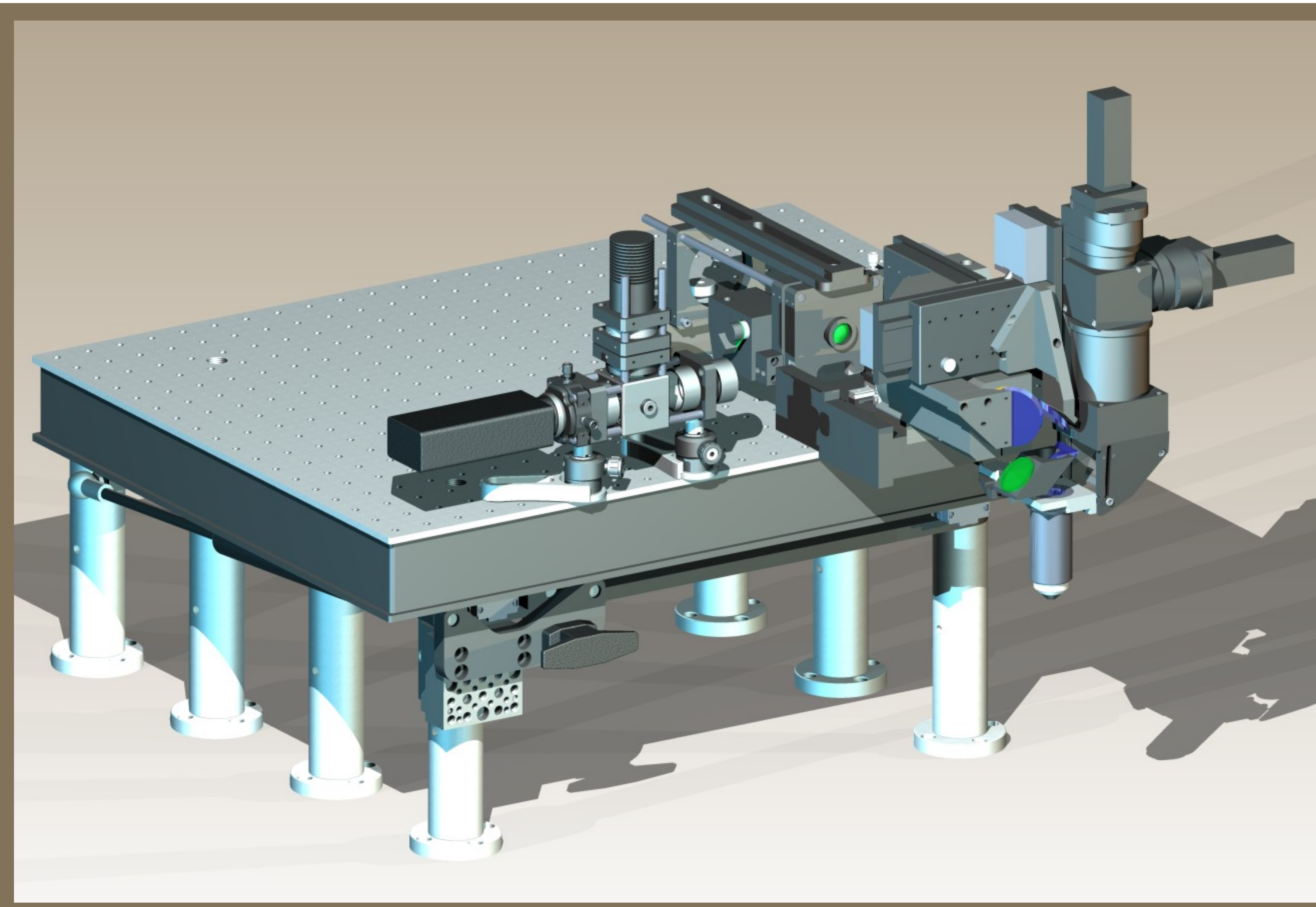


# MIMMS: A modular, open design microscopy platform for *in vivo* imaging of neural tissues

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MIMMS (Modular *In vivo* Multiphoton Microscopy System) is a modular platform for performing two-photon laser scanning microscopy (TPLSM) optimized for *in vivo* applications. Designs and documentation are freely available at <http://openwiki.janelia.org>. The microscope has an open-frame type design to allow for maximum flexibility for switching out major components. Optical and mechanical designs emphasize the use of well-stocked, commercially available parts where possible. All components are compatible with the open-source ScanImage software ([www.scanimage.org](http://www.scanimage.org)) for microscope control and imaging. MIMMS microscopes are used in a wide variety of TPLSM experiments and their performance characteristics are comparable to or exceed those of some commercially available systems. Work is ongoing to optimize existing modules and develop new ones.

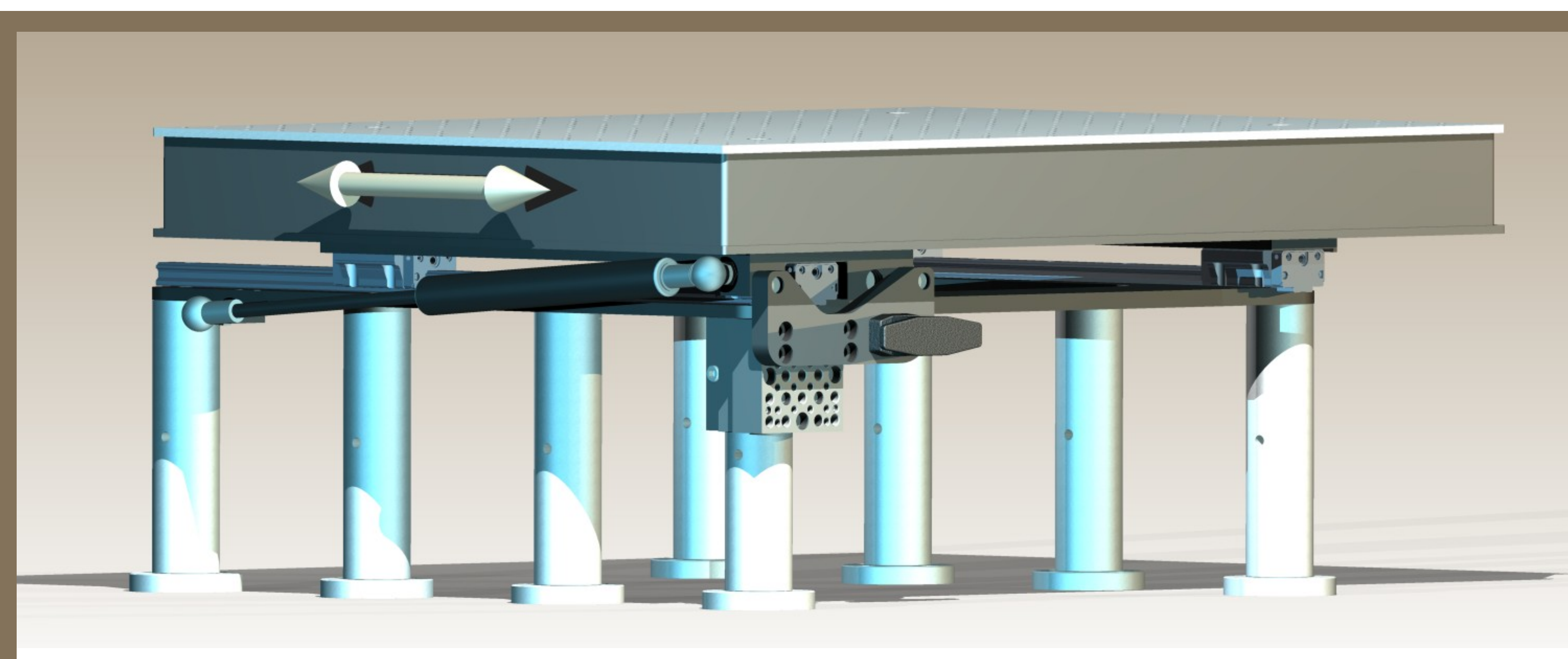
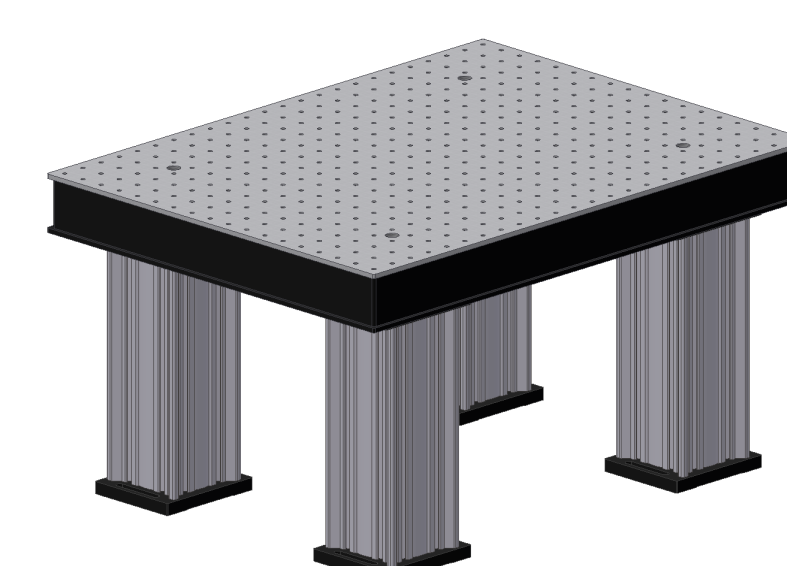
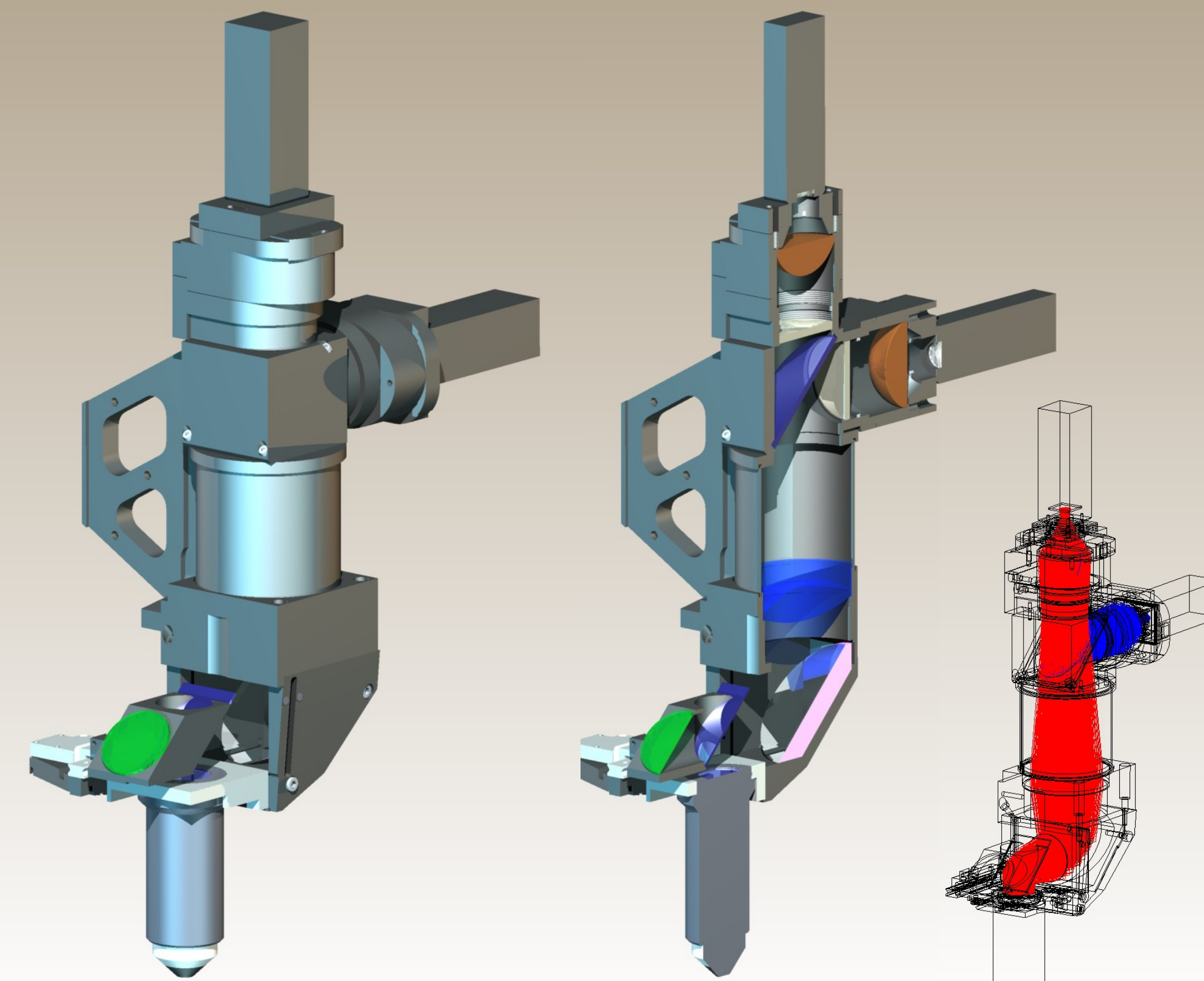


Table base

- Large raised surface allows for easy mounting of additional imaging systems which require close proximity to intermediate image plane, such as additional scan systems or widefield cameras
- Moving base allows entire microscope to be translated back 6 inches, providing clearance for experimental setup
- Locks into place securely and repeatedly

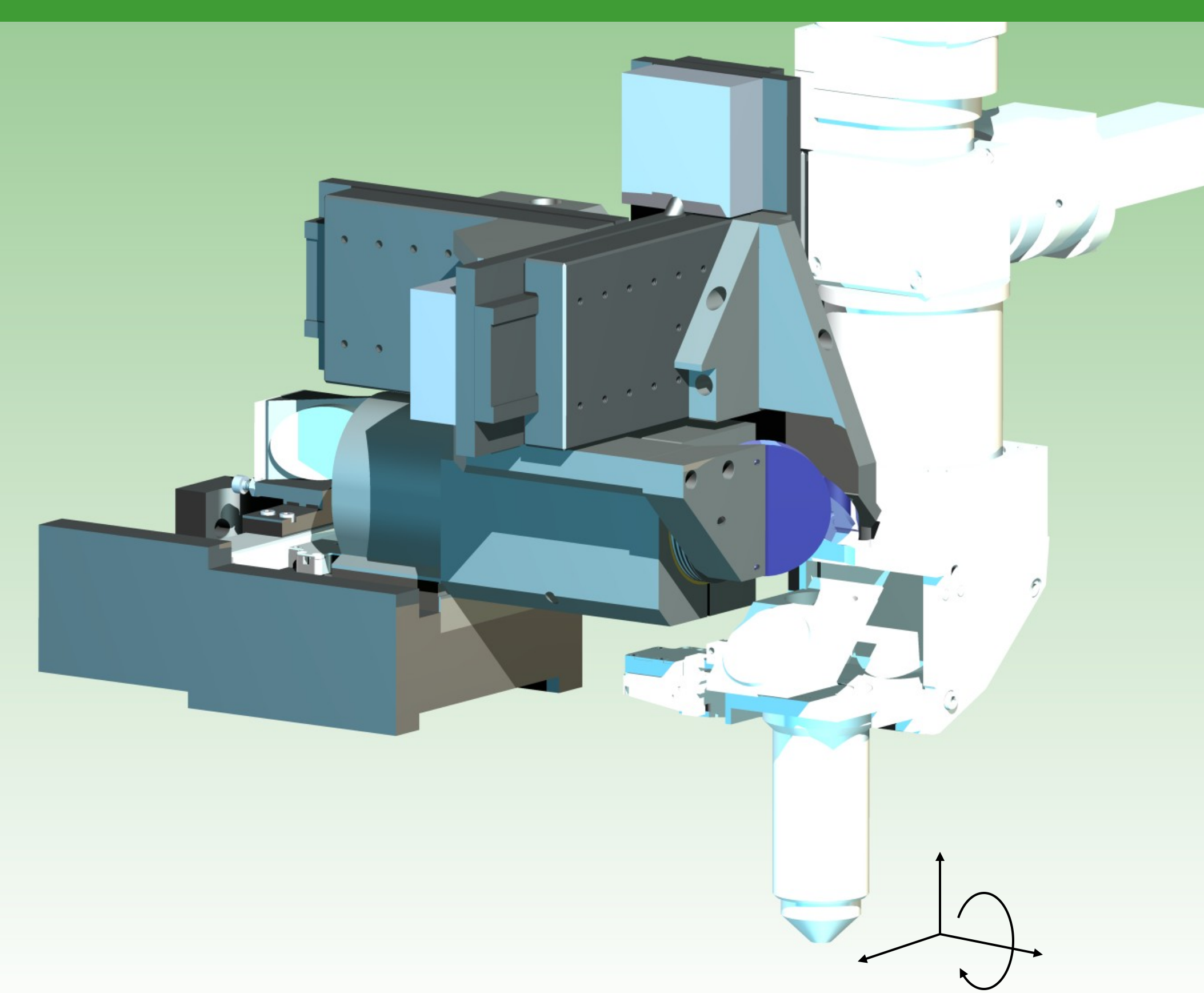


Alternate: stationary base



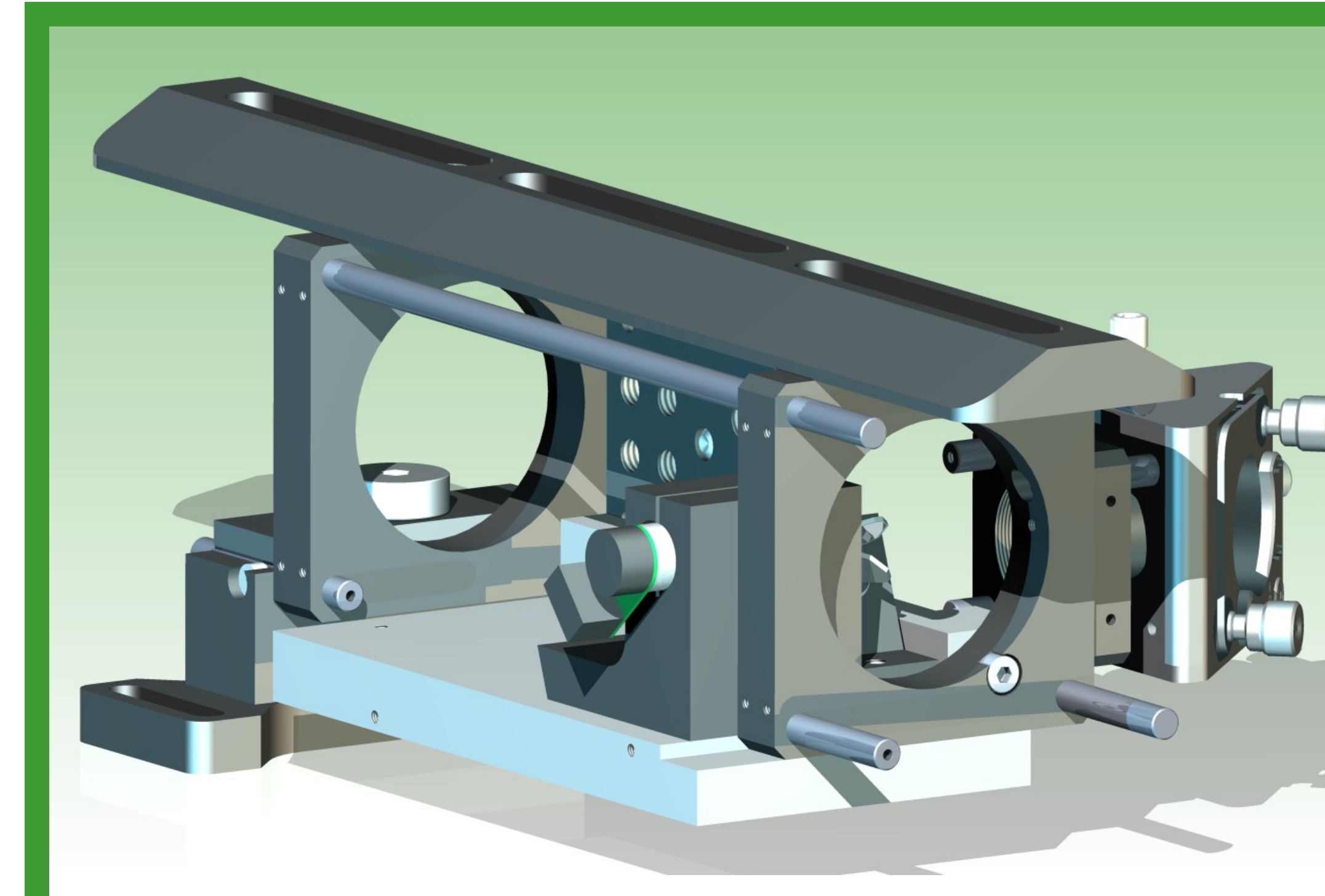
Non-descanned detection arm

- Large aperture optics for full acceptance of light from an objective with 18mm back pupil diameter and 8 degree angular spread of emission (corresponds to typ. four times the designed FOV area of objectives) for efficient collection of scattered light<sup>1</sup>
  - Designed for GaAsP high-QE PMTs. Designs for mounting 1 1/8" side on PMTs (R3896) exist as well
  - Emission splitting dichroic and emission filters are custom sized for full collection efficiency, but stock sizes will work for shallower imaging and/or smaller aperture objectives
  - Dichroics and emission filters can be swapped easily
- <sup>1</sup>Oheim M, Beaufrepaire E, Chaigneau E, Mertz J, Charpak S, J. Neuro. Met. 111 (2001), 29-37.



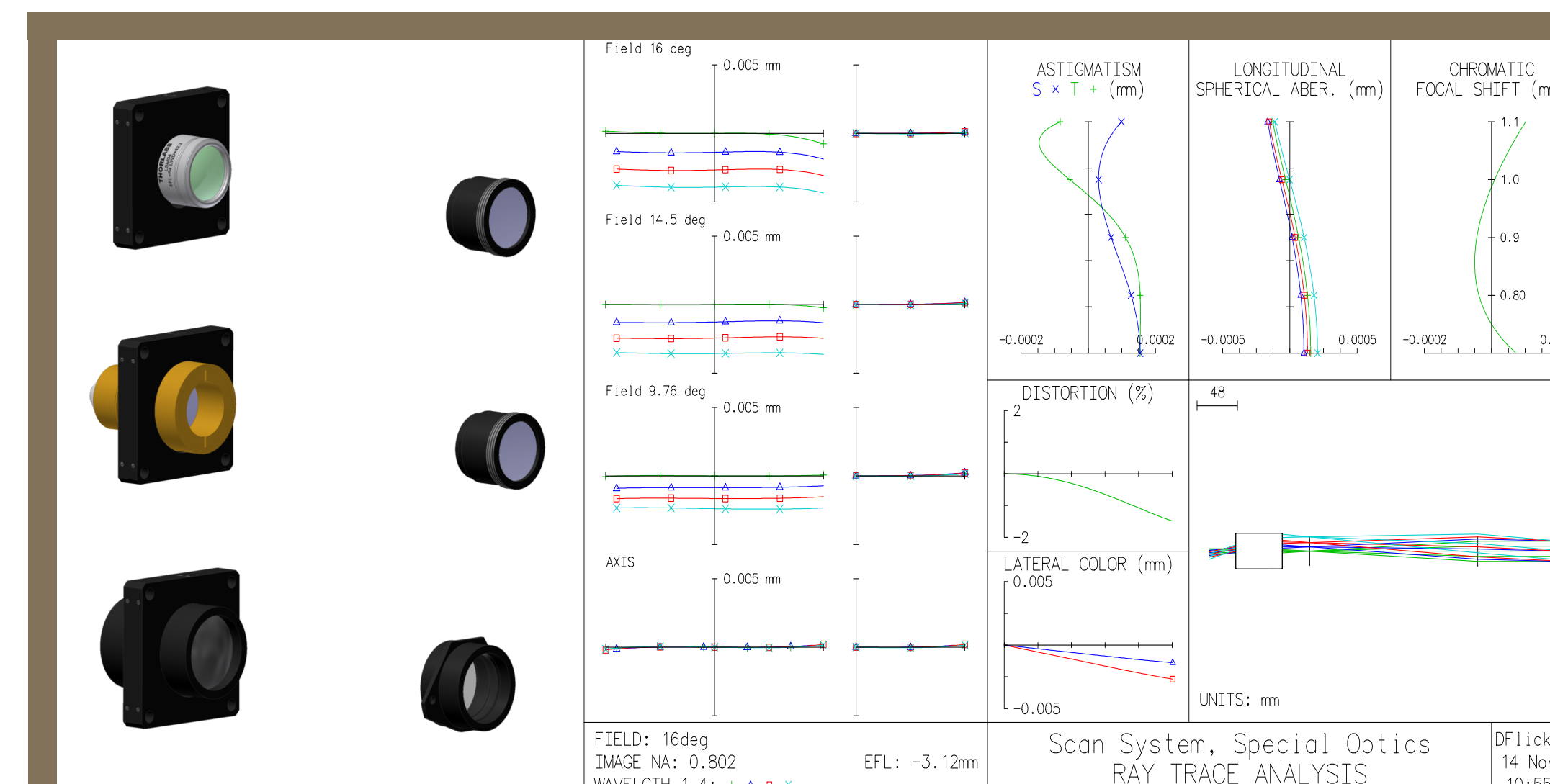
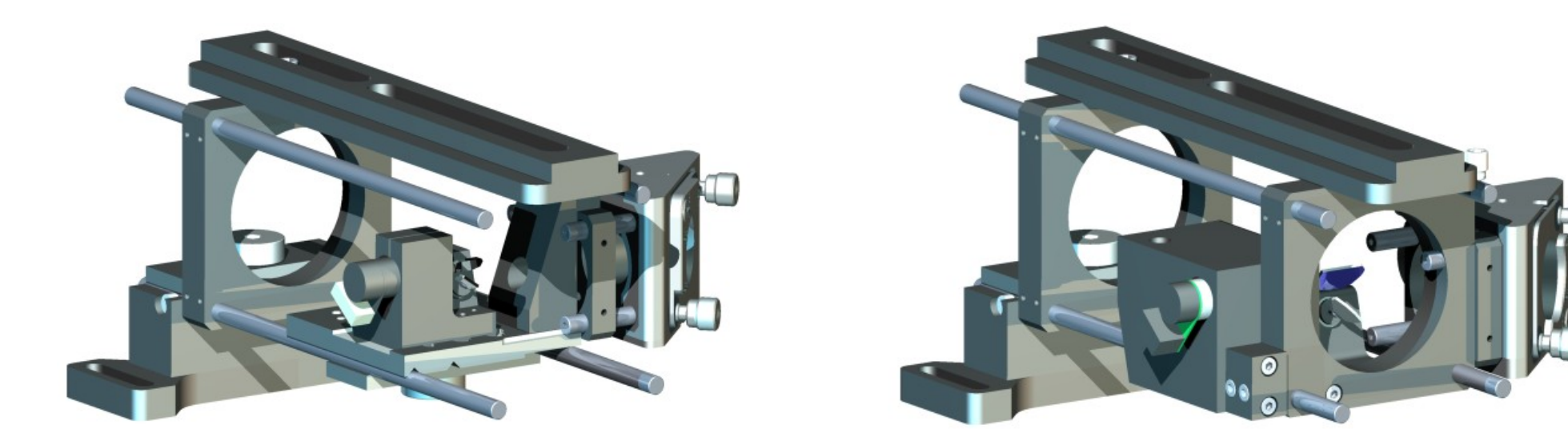
Head unit

- Commercially available unit with custom mounting hardware
- Objective and detection optics move on 3-axis manipulator stages with +/- 10mm ranges
- Head can be rotated out of ground plane +/- 80° to allow for imaging areas on sides of animals during awake behavioral tasks
- Optics in head unit and detection arm are motorized to allow for easy switching between 2P and widefield imaging modes
- Alternate designs: static head with coarse vertical movement for static table configuration



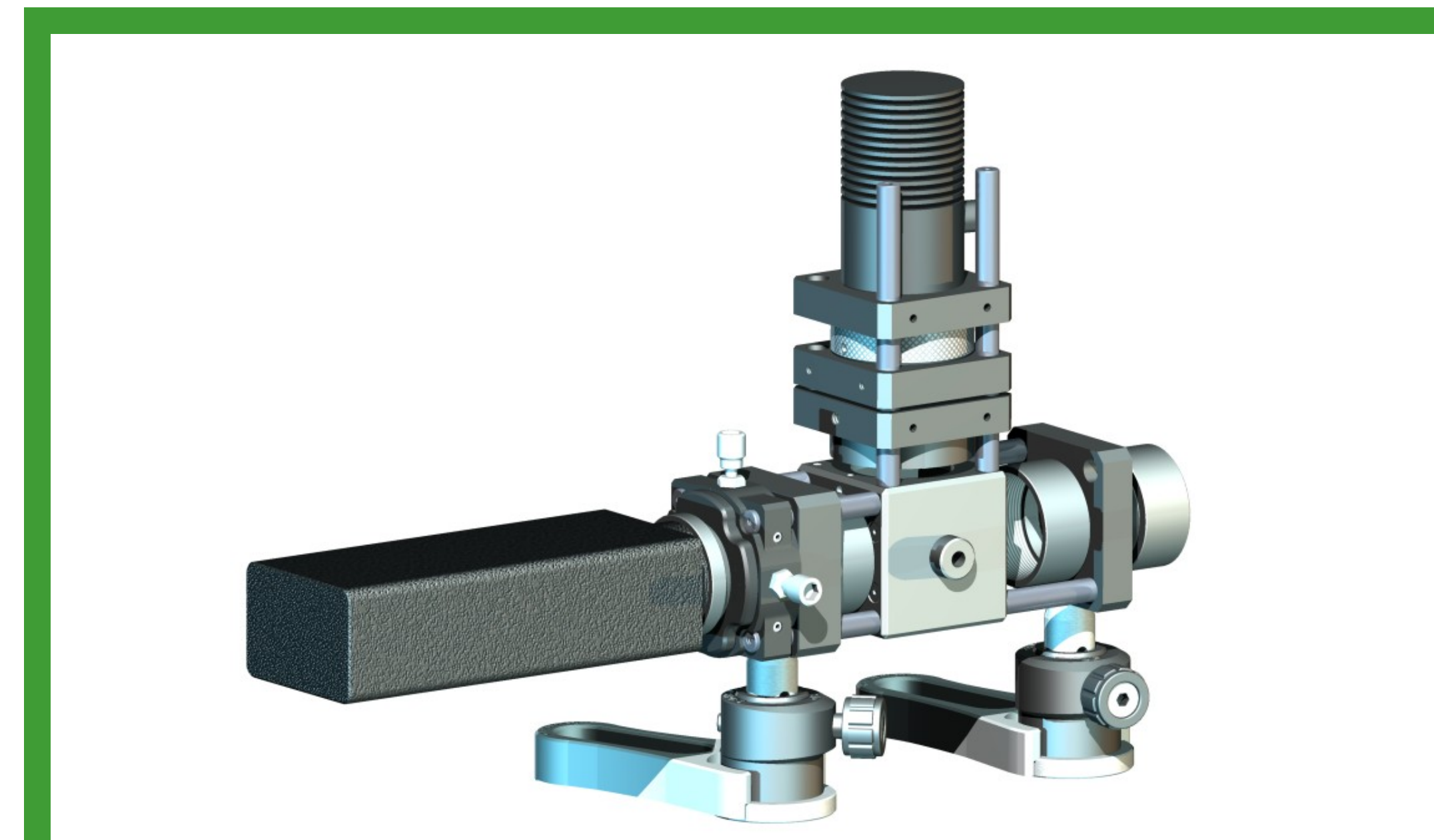
Scan mirrors

- Designs exist for mounting 3mm, 5mm, and 6mm galvanometer scanner sets from Cambridge Technology. 5mm mirror mounting is compatible w/ active cooling



Scan optics

- System has been used with several sets of scan optics with different scan magnifications (custom designs specified/analyzed with optical design software):
  - 5.33x: Custom scan and tube lens from Special Optics
  - 4x: Zeiss or Thorlabs scan lens and Nikon tube lens
  - 2.7x Custom scan and tube lens from Special Optics
- Open architecture means that it's very easy to accommodate different scan lenses.



Widefield imaging system with LED illumination

- Used for experimental setup, visualizing craniotomy window/blood vessel map, and guiding initial approach of patch recording pipettes before 2P imaging
- Has crossed polarization system for rejecting glare off of craniotomy window

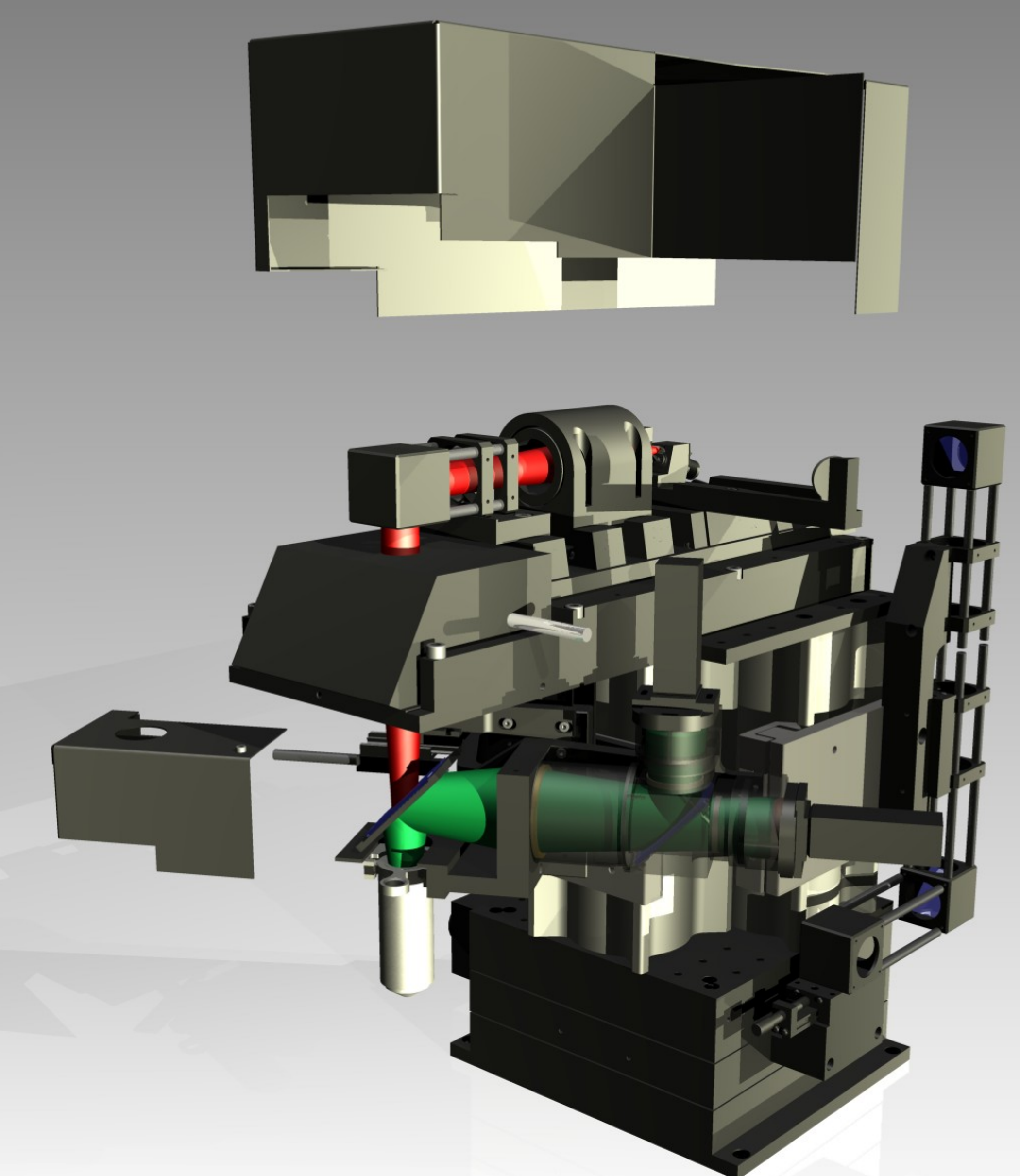
Existing MIMMS system designs—these will be released after implementation and successful use

- Resonant scanner/galvo pair scanning for increased imaging rate
- Two independent scanning systems, mixed with dichroic before tube lens, for simultaneous imaging and photostimulation/uncaging

MIMMS designs in progress

- Epifluorescence widefield imaging
- Widefield optogenetics illumination system
- Two different fast focus scanning systems:
  - Direct piezo objective scanning
  - Two objective remote focusing

## Non-MIMMS *In Vivo* microscope



This is a separate microscope that uses the same non-descanned detection optics as the MIMMS system. In contrast to the MIMMS system it:

- provides for three degrees of freedom of objective movement (no rotation of obj is possible)
- uses an Olympus trinocular assembly, allowing for visual observation mode
- has a less complete parts list and set of mechanical drawings, due to lack of recent design efforts at JFRC

## Existing implementations

- MIMMS microscopes: four exist at JFRC (three are in use, one is in building phase)—publications are pending
- Non-MIMMS *In Vivo* microscopes: one is in use at JFRC and more have been built in US and abroad

**Info and designs at [openwiki.janelia.org](http://openwiki.janelia.org)**