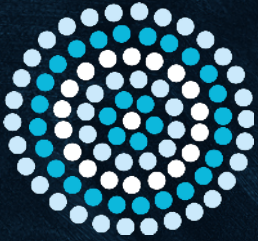


# mu-DM

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High-end deformable mirror  
for microscopy and ophthalmology



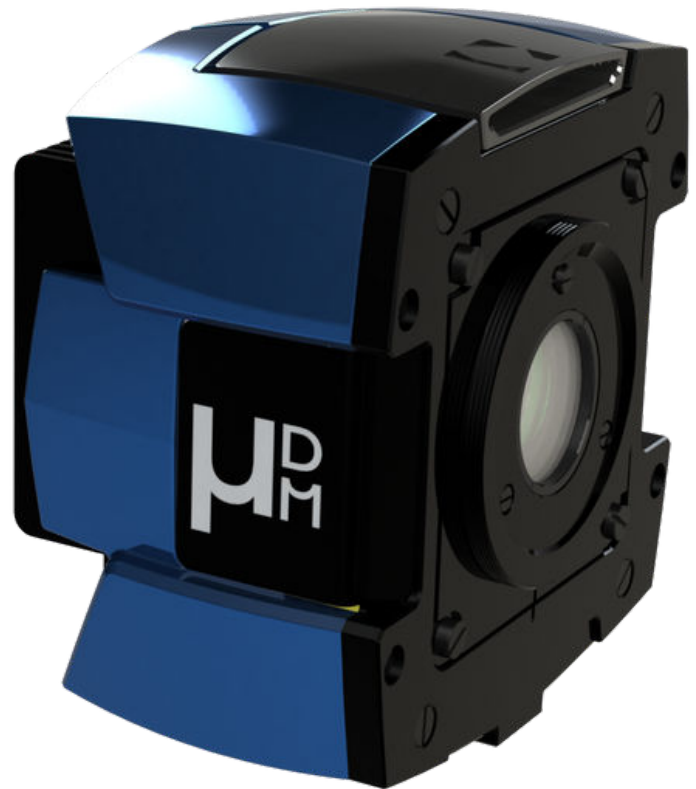
High density  
of actuators



Embedded electronics  
for easy implementation



High dynamic range  
linearity & stability



mu-Imagine

a division of imagineoptics

## Applications

### **With Adaptive Optics (AO) for microscopy :**

- Image deeper in your sample with correction capabilities that restore diffraction-limited Point Spread Function (PSF) in non-linear (like multiphoton) or light-sheet microscopy
- Navigate in 3D in Single Molecule Localization Microscopy (SMLM) by shaping the PSF to your needs, using astigmatism or tetrapod

### **With AO for retinal imaging :**

- Explore retinal cells at high-resolution by correcting ocular aberrations in Optical Coherence Tomography (OCT), Scanning Laser Ophthalmoscopes (SLO) or flood illumination modalities

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## Features

- ✓ **Fast closed-loop convergence and accurate sensorless correction** with perfect linearity and absence of hysteresis
- ✓ **Preserved photon budget** with achromatic, highly reflective and continuous membrane
- ✓ **Long-term stability** with temporal drift automatic compensation
- ✓ **Large dynamic range** with 50% of actuators stroke still available while generating 40 microns PtV of focus
- ✓ **Fine timing control** with trigger-in and trigger-out features
- ✓ **Easy integration** with electronics embedded in a single-piece design and connection via a USB3 cable
- ✓ **Correction up to 10th Zernike order** thanks to optimized actuator layout

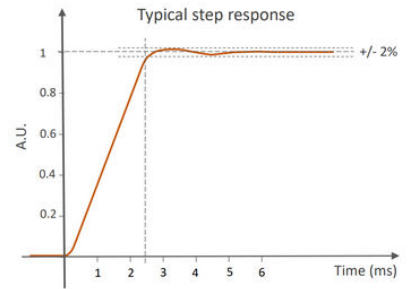
**Boost your imaging  
performance :**

Adaptive Optics  
made  
easy and efficient

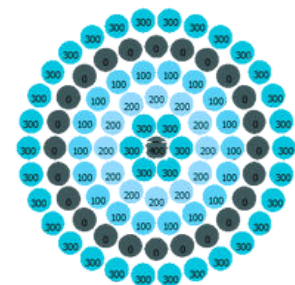


# Specifications

Optical specs	
Surface quality	7 nm RMS (Optional : down to 4 nm RMS)
Coating	Protected silver
Linearity	> 99.5%
Histeresis	< 0.1%
Operating specs	
Number of actuators	91
Maximum generated wavefront (PV)	
<ul style="list-style-type: none"> <li>1 actuator</li> <li>7 actuators</li> </ul>	<ul style="list-style-type: none"> <li>&gt; 10 <math>\mu\text{m}</math></li> <li>&gt; 50 <math>\mu\text{m}</math></li> </ul>
Effective diameter	15 mm
Spatial frequency correction	Zernike orders up to 10
Rise time	2.4 ms
Max frequency	Typically 300 Hz
Temporal stability	< 15 nm RMS over 12h
MISC	
Dimensions	93.8 x 98.3 x 67.2 mm <sup>3</sup>
Weight	185 g
Working temperature	19-25°C
Interface / Power consumption	USB 3.0 / 30 W
Operating system	
	Windows 10



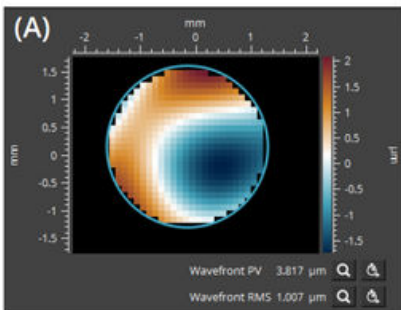
Optimized temporal control achieves a settling time of 2.4 ms with minimal overshoot (<math>\pm 2\%</math>)



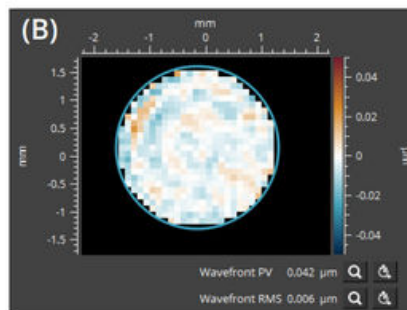
Centro-symmetrical layout is ideal to generate Zernike polynomials in closedloop and open-loop

High linearity leads to a remarkable behavior as you can see below :

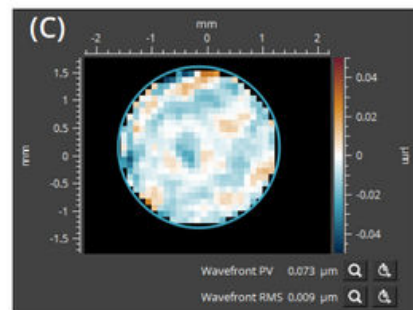
(A) Input wavefront (B) Results in closed-loop (C) Results in open-loop



Target wavefront is 1.007  $\mu\text{m}$  RMS (combination of Zernike polynomials up to the 4th order)

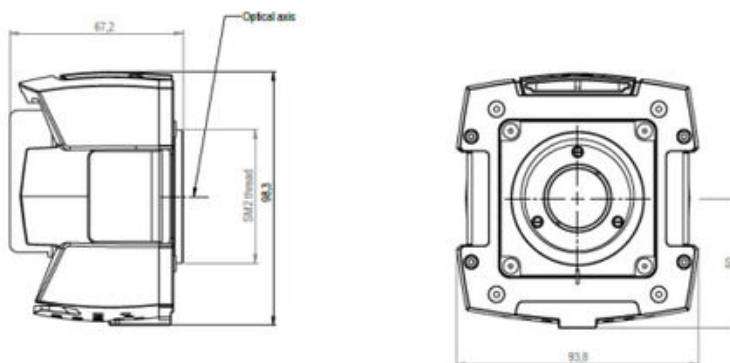


Wavefront error in closed-loop WFE = 6 nm RMS



Wavefront error in open-loop WFE = 9 nm RMS

# Dimensions





## Available AO software

### WAVETUNE

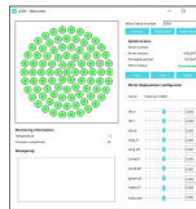
WaveTune is a unique software that seamlessly combines wavefront measurement and correction features with extensive instrument diagnostics. This software contains all the necessary tools to calibrate the Deformable Mirror (DM). It can also operate the DM in closed-loop with HASO wavefront sensor, as well as in open-loop and perform beam shaping.



### mu-DM Suite

mu-DM Suite is a free software delivered with every mu-DM.

It does not require calibration of deformable mirror with a wavefront sensor but with it you can apply a flat shape or first Zernike modes which can be handy for a first, quick alignment of the deformable mirror.



### WAVEKIT BIO

WaveKit Bio is a Software Development Kit (SDK), available in C++ and Python, specifically designed for microscopy applications. In particular, it contains all the necessary functions to implement sensorless AO, using image-based iterative algorithms (e.g. 3N).



## Mounting & Accessories

Several mounting options are available, including adaptors for the most common mechanical stages, to simplify integration of mu-DM into an optical setup.

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