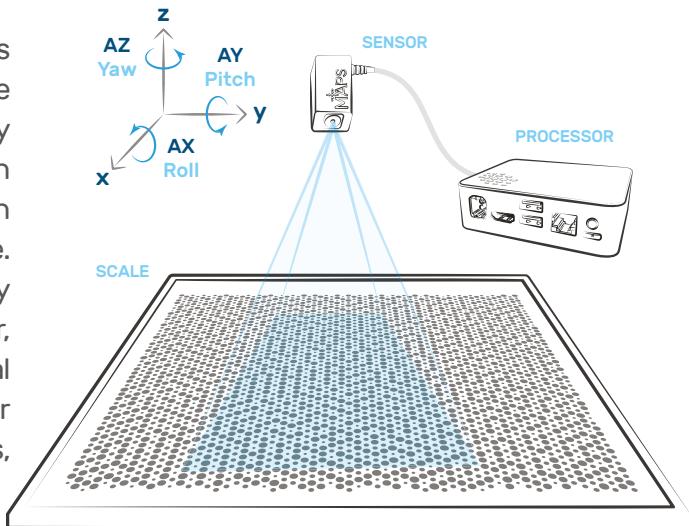


Anemos' mid-performance MAPS™ Mistral systems measure one to a full six position dimensions, 6DoF, at one point in space/time with phenomenal precision using a tiny lightweight sensor. MAPS revolutionises mechatronics with direct reporting of Abbe and other system error sources with unprecedented dynamic range and measurement envelope. Mistral optoelectronics includes an Anemos proprietary scale (a metrological reference or map), specialised sensor, and custom high-performance GPU platform for spatial computing at nanometre and microradian levels as a superior alternative to traditional interferometers, autocollimators, and single-axis encoders.



## Key Features and Benefits

All-axis, 6DoF	Provides a complete picture of linear and angular motion – no single axis can be precisely measured without all axis information.
High accuracy and superb resolution	Obtain uniquely detailed system behaviour insights. Insensitive to atmospheric conditions, MAPS often beats performance of interferometers operating in air.
Absolute not incremental	Enables reliable/repeatable (re)calibration over time – even after reassembly. Homing unnecessary, results immediately available.
Single point measurement	Work-point readings decimate Abbe and other inter-axis anomalies.
Strobe illumination	Enables microsecond-level position capture for high-speed analysis (even at relatively slow sample rates).
Compact	Integrates easily, retrofits to existing systems.
Ease of use	Setup and go in minutes without finicky adjustments and zeroing.
Smart networked computing	Software-defined function and Ethernet/WiFi networked results makes host application implementations extensible and readily upgradable.
Laser-free	Obviates mirrors, retroreflectors, complex alignment tasks. No health and safety concerns. Robust, transportable.

## Applications & Industries

- Motion metrology, qualification, calibration
- Cosine, Abbe, scaling, play, runout, out-of-plane
- Ultra-precise squareness, straightness, angle
- Machine motion mapping and compensation
- Error characterisation and debugging
- Q&A, certification, traceability
- Scanning microscopy, optical inspection
- Position sensor test and calibration
- Precision machine tools, CNC, CMM
- XY motion stages, indexing tables
- Mechatronics, nanotech, life sciences
- Semiconductor, robotics

# Specifications<sup>1</sup>

Measurement			
AXIS	ACCURACY <sup>2</sup>	RESOLUTION <sup>3</sup>	TRAVEL
X,Y	100 nm	5 nm	110 X 110 mm
Z	1 µm	10 nm	>±250 µm
AZ	5 µrad	10 nrad	>2π rad
AX, AY	25 µrad	100 nrad	>30 mrad

Sampling	
Rate	10 Hz nominal, extendable up to 50 Hz.
Modes	Free-run, software triggered, hardware triggered.
Communication	Straightforward Anemos protocol over WebSocket based networking.

Mechanical			
	SIZE	WEIGHT	NOTE
Scale	120 x 120 m	~ 0.1 kg	Size and material options available
Processor	90 x 85 x 35 mm	~ 0.6 kg	Enclosure
Sensor	20 x 20 x 40 mm	~ 0.05 kg	Not including cable
Sensor operating distance from Scale	~ 10 mm		Factory configurable
Flight case	336 x 234 x 104 mm	~ 2.0 kg	

<sup>1</sup> Specifications are subject to change without notice and undergo continuous improvement. Enhancements and new features can be provided via software update.

<sup>2</sup> Accuracy is defined as measurement within 1-sigma error limit over full travel envelope under 20.0°C constant-temperature conditions. Other potential thermally induced errors will depend principally on system implementation and scale material chosen.

<sup>3</sup> Useful resolution is ultimately limited by low-level sensor noise (not the A/D resolution of conventional systems) and MAPS can achieve an unprecedented dynamic range of over 10 decades. Resolution, noise floor, and repeatability are generally equivalent or interchangeable, and do not degrade with XY measurement distance. Further improvement to these figures can be achieved through sample averaging.

# Included in the Package



- Scale, sensor, processor, and software
- Power supply and cables
- Setup fixture and host software
- 2-year parts and labour warranty
- 1-year support and software upgrades
- Rugged flight case

## Options and Accessories

Mistral systems are delivered ready to plug in and go. However, optimal configurations for specific applications generally involve some customisation including the following.

### Scales

- Standard scales are offered at 120 x 120 mm
- Up to 300 x 300 mm glass scales can be supplied
- Photographic film scales of several square metres have been manufactured
- Soda-lime glass standard, low-TCE fused-quartz glass optional
- Zerodur, film, paper, or other materials by special arrangement

### Sensor

- Backlight of front-side illumination
- Very high-speed strobe lighting
- Hardware slave mode sampling and cables
- Thermostatic sensor head control

### Processor

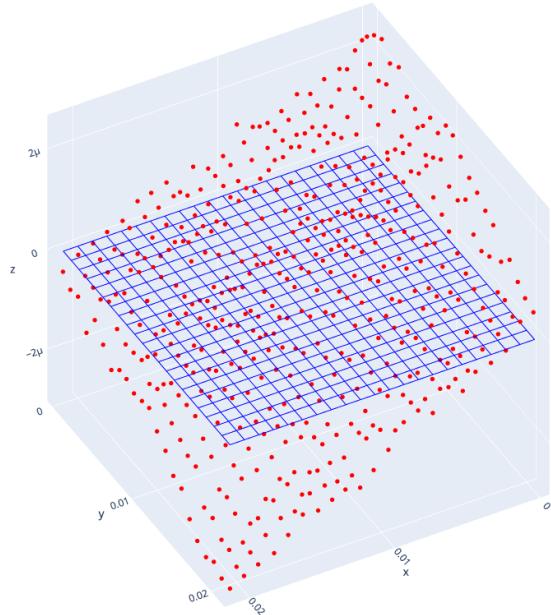
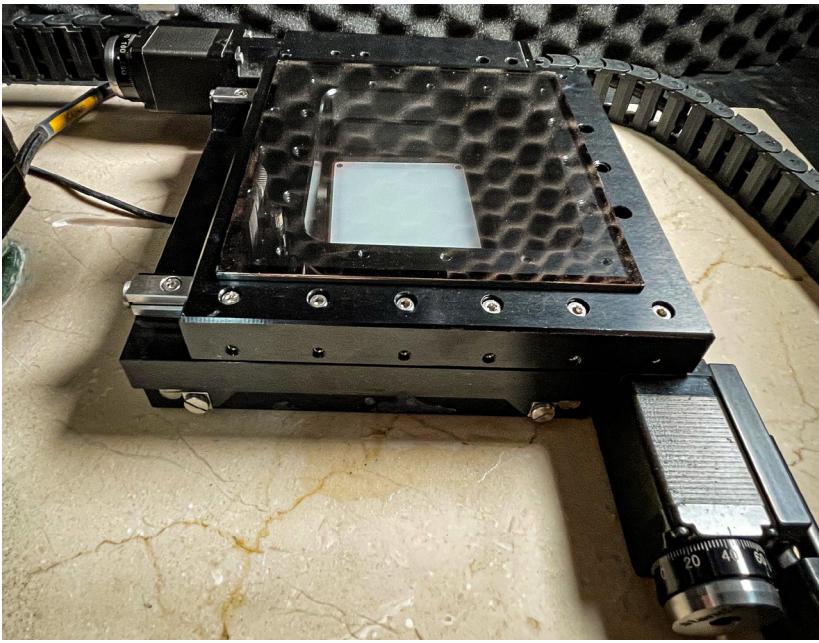
- 21 TFLOPS GPU standard, upgrades available
- 1 Gbit/s Ethernet RJ45 standard, other on request
- Alternate 2.4 Gbit/s Wi-Fi 6E adapter connection

### Fixtures

- Scale mounting and frames
- Sensor mounting hardware
- Processor bracket

## Ordering information

Please consult the factory for your application's the ideal configuration and quotations. Mistral systems are also available on short-term rental to serve intermittent calibration and product evaluation requirements.

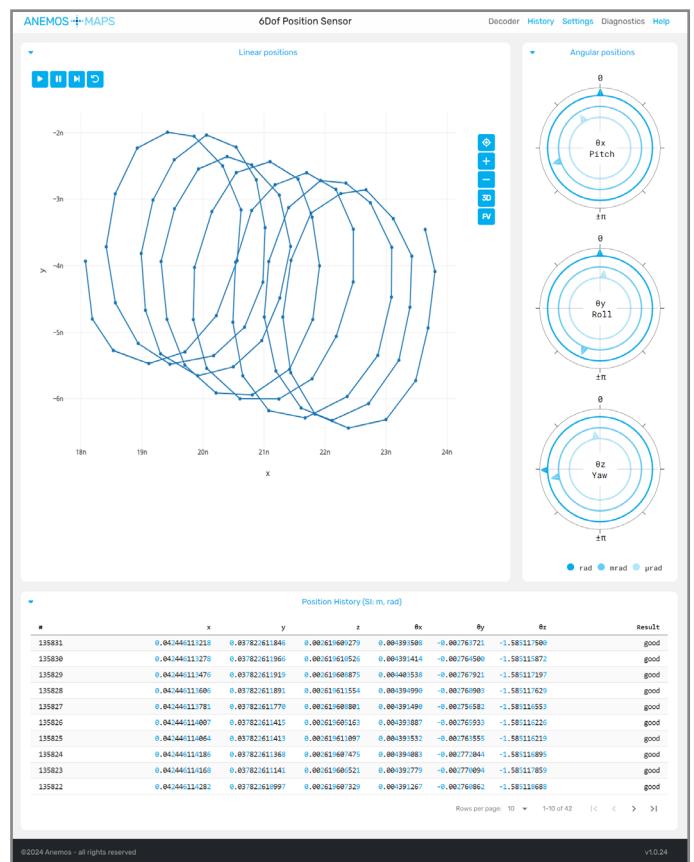
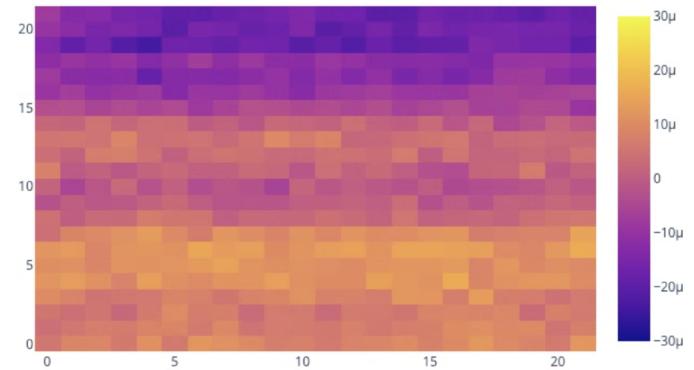


## Example Use Case

Mistral is being used to characterise microscope XY stages, precisely assessing squareness (causing cosine errors), scale factor, backlash, out of plane Z deviation, rotational variance (responsible for Abbe errors), and so on. The results provide a calibration report for the stage's customers, and QA feedback to manufacturing. Systemic error mapping can then be used in drive electronics compensation algorithms to improve absolute accuracy and product value. The commercial stage pictured was exercised through thousands of 20 mm grid scans at Anemos. The scale is seen placed on top of the stage with no particular care or alignment – software finds best fit of MAPS 6DoF results to stage's inferred frame of reference.

Results revealed consistent 22  $\mu\text{rad}$  skew in the XY squareness. Up to 1  $\mu\text{m}$  play and submicron repeatability were also evident along with 2  $\mu\text{m}$  tilt and 150 nm out of plane Z variation. The results for one scan are shown in the 3D graph with errors from XY nominal positions exaggerated by  $\times 100$  factors. A yaw variance of  $\pm 15 \mu\text{m}$  (potentially contributing to micron-level errors) is shown in the heatmap and was less consistent over time. This may indicate cross-roller guide play or roughness. Diurnal lab temperature drift was obvious over several days of testing. Larger effects from motor heating (e.g. scale factor changes) were mitigated by constant replay of same movement path, however, a scaling error of approximately 0.1% from the manufacturer's specification was detected.

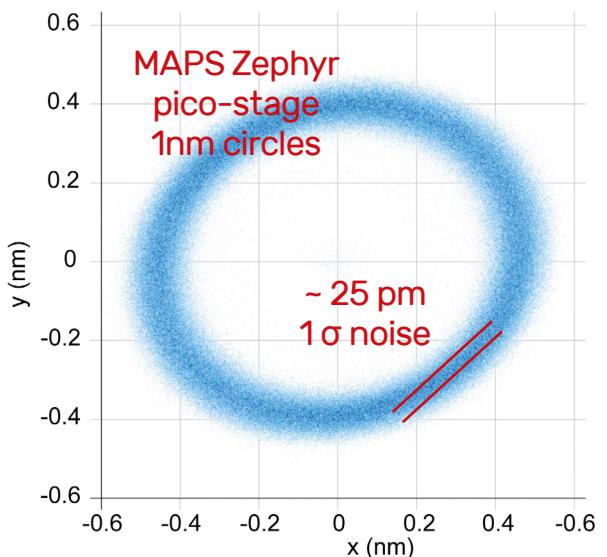
The MAPS embedded web interface, shown right, provides real-time views of results and status via wired or wireless network on any computer, phone, or tablet browser.



# MAPS Technology

MAPS™ is a patented, broadly scalable technology that is being applied across deep nanotech (where subatomic resolution has been demonstrated), through high-precision machining and microscopy, all the way to surveying applications and IoT remote monitoring.

System combinations are available at value points covering diverse industries including metrology, machine tools, life sciences, nanotech, semiconductors, robotics, and more. This extraordinary new technology is performance proven through extensive in-house qualification and simulation, at customers, and through a series of validation experiments over several years at the [National Physical Laboratory](#), UK. Anemos packaged offerings are currently divided into three product line series.



Mistral	Scirocco	Zephyr
Mid-performance MAPS systems targeted at submicron characterisation and calibration of microscope stages, CNC, CMM, and similar tasks measuring XYZ and all rotational axes.	An enhanced MAPS series using high-resolution scales which yield deep sub-nanometre XY performance for nanotech industries and super-resolution microscopy among other applications.	The ultimate bespoke metrology tools. Multi-MAPS sensor configurations further enhance all 6DoF axes delivering uncompromising rotational accuracy and subatomic XYZ resolution.

## Additional resources

The Anemos main website is complemented with a wiki for detailed technical information and first-line support. The Online Lab provides interactive web demos of various product lines in action, and a MAPS simulator workbench for application software integration and testing. Please enquire about any custom, OEM, or development service requirements.



Info and Support



Online Demos



Anemos-NPL Paper



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<sup>4</sup> MAPS is not qualified for medical, life support, military, or any application where its failure, use, or misuse may result in harm or injury. Use of Mistral in critical systems is expressly prohibited and Anemos is not responsible or liable for third-party damage and loss incurred through use or misuse of its products or services.

<sup>5</sup> NPL neither endorses nor warrants fitness for purpose of third-party products or services.