

Motion hexapods catalog



# Welcome

Welcome to SYMETRIE! In browsing this catalogue, you will find the best possible dynamic solutions to cater to your demanding applications.

Always looking to increase the performance of our hexapods, our growing team works hand in hand to integrate the latest available technology.

This is why SYMETRIE is first and foremost an R&D company. Thanks to our experience providing hexapods for industry and research laboratories, we will be able to quickly answer your needs.

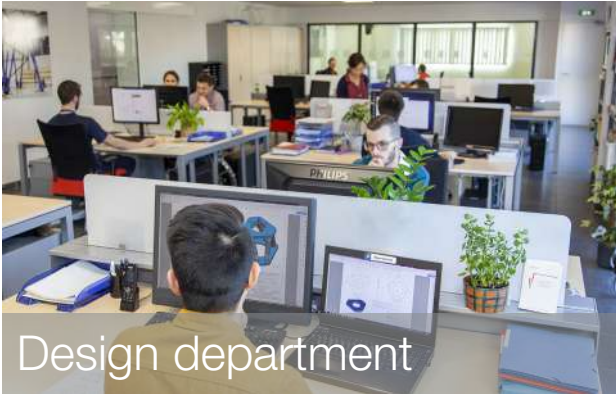
Olivier Lapierre & Thierry Roux  
Co-founders, CEO & CTO

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# SYMETRIE company

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Design department

SYMETRIE's engineering office consists of mechanical, electronics and software engineers. Our R&D department is continuously seeking for improvement, with a major effort on control software.



Workshops

All our hexapods and controllers are assembled in our mechanical and electronics workshops using standardized procedures.



Clean room

In our ISO 7 (class 10000) clean room, we mount the hexapods for applications, which are sensible to environmental contamination, such as optics, space or particle accelerators. In a clean room the concentration of particles is controlled and minimized.



Metrology laboratory

To demonstrate high precision performances, SYMETRIE is equipped with a wide range of metrology tools: laser interferometers, laser trackers, coordinate measuring machine (CMM), electronic inclinometers, capacitive sensors, accelerometers.

# A promising experience and vision

## SYMETRIE's trusted R&D skills led to the birth of the positioning and motion hexapods

SYMETRIE was created in 2001 with the hexapod technology as a baseline. This innovative system was quickly spotted by the highest research institutions which asked SYMETRIE for a high precision hexapod to position the target of the MegaJoule Laser, a high energy inertial confinement fusion device in France.

The following contracts, still more ambitious, trusted the company to add dynamic motion capabilities to its hexapods systems. SYMETRIE succeeded once again in delivering up to 1g acceleration to slosh 10 ton liquid gas tanks for maritime transportation.

The acquired experience and trust built among a nascent network of customers were the beginning of an involvement in a wide array of technological projects, such as the Gaia satellite and the James Webb Space Telescope among others.

**Innovation** is a key factor of our development. Our R&D department works every day to improve our technologies and control systems using the latest generation components and techniques for higher quality products.



*High precision positioning system of the target of Laser MegaJoule with 1  $\mu\text{m}$  resolution in the convergence center of 240 laser beams. Harsh environment: high vacuum, radiations.*

*A 4 meter tall swell simulation hexapod with up to 10 ton payload, 1 m/s speed and 1 g acceleration.*



## From standard hexapods to custom designs

To cater to your needs in the smoothest way, SYMETRIE offers a range of turnkey hexapods.

- Better price and lead time: We look forward to offering hexapods which have already been designed.
- Ease project definition: Offering a coherent range where the hexapods differentiate between each other with unique features allows you to easier select and understand the capabilities that you will get.

SYMETRIE remains a trustworthy designer for customized solutions and can provide custom designs in a short time thanks to an in-house software enabling to quickly create a hexapod geometry with respect to the customer's input parameters.

With more than 10 years hexapod background, SYMETRIE is experienced in choosing and using the most adapted technologies in terms of motors, encoders, joints... according to the customer's application.



## Our roots: metrology specialists with innovative minds

The two co-founders of SYMETRIE, Olivier Lapierre and Thierry Roux, were previously working for LNE, the French national metrology and testing laboratory. Specialized in **dimensional metrology**, they were looking for an innovative and efficient 6 DOF measurement system to quickly calibrate machine-tools and thought of the hexapod as a perfect solution.

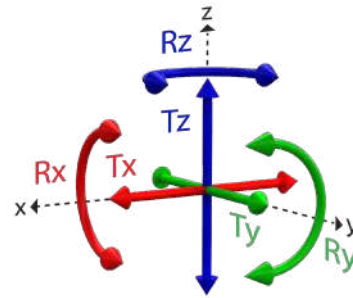
The dimensional metrology grain remains running through the veins of SYMETRIE at each one of its footsteps. Thanks to an experienced metrology staff, SYMETRIE knows how to qualify and test the hexapods before delivery to validate conformity.

# Hexapod technology

## 6 Degrees Of Freedom

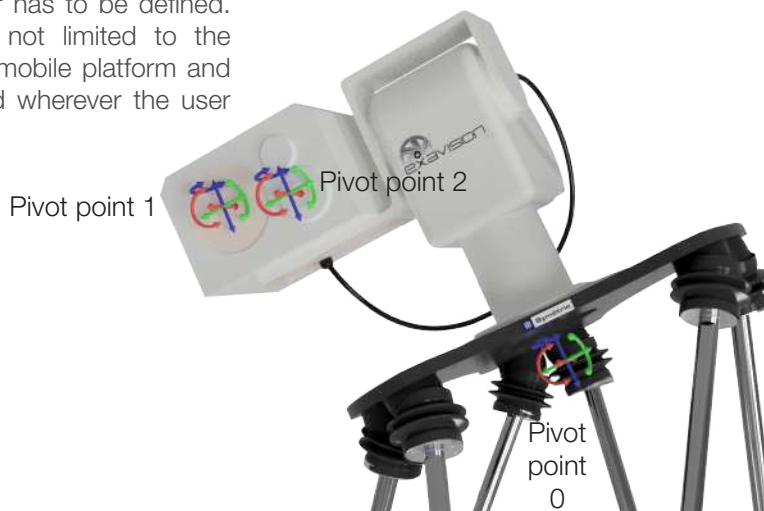
A hexapod is a parallel kinematic structure composed of a mobile platform linked to a fixed platform with 6 actuators.

This design allows to move an object placed on the mobile platform with 6 DOF (Degrees Of Freedom). In other words, the hexapod can move an object along the 3 translations ( $T_x$ ,  $T_y$ ,  $T_z$ ) and the 3 rotations ( $R_x$ ,  $R_y$ ,  $R_z$ ); any combination is possible.











## Configurable pivot point

In order to orientate the mobile platform in the desired way, a 3D rotation center has to be defined. This point is not limited to the center of the mobile platform and can be placed wherever the user needs it to be.



# Overview of the product range

	Name	Payload	Linear travel range	Angular travel range	Speed	Height at midrange
	<b>HEGOA</b>	50 kg	± 100 mm	± 23°	200 mm/s	0.42 m
	<b>NOTUS P</b>	200 kg	± 250 mm	± 20°	800 mm/s	1.10 m
	<b>NOTUS V</b>	100 kg	± 250 mm	± 20°	1 200 mm/s	1.10 m
	<b>MISTRAL 600P</b>	1 000 kg	± 400 mm	± 30°	1 000 mm/s	1.44 m
	<b>MISTRAL 600V</b>	500 kg	± 400 mm	± 30°	1 200 mm/s	1.44 m
	<b>MISTRAL 800P</b>	1 000 kg	± 460 mm	± 30°	1 000 mm/s	1.77 m
	<b>MISTRAL 800V</b>	500 kg	± 460 mm	± 30°	1 200 mm/s	1.77 m
	<b>SIROCCO</b>	2 000 kg	± 600 mm	± 40°	2 500 m/s	2.85 m
	<b>AQUILON</b>	6 000 kg	± 800 mm	± 40°	1 800 m/s	3.31 m

# SYM\_Motion software

SYM\_Motion is the main interface software to control our dynamic hexapods. It has to be installed on a control computer.

All functionalities necessary to control the hexapod are included, such as trajectory generation, scenarios management and several configuration features (pivot point, custom limitations ...)

The hexapod control is facilitated by an ergonomic and intuitive graphical user interface (GUI). This software is well suited for the customer who does not need to integrate the hexapod in an external system.

Otherwise, an API is supplied, allowing the user to directly control the hexapod using simple command words.

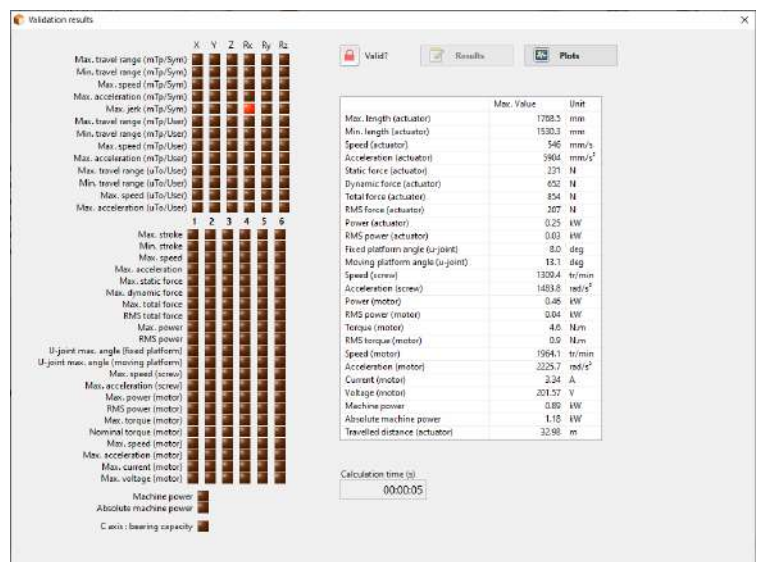
Optionally, a real time acquisition feature (up to 500 Hz), and an External Real Time Trajectory (ERTT) control feature (up to 200 Hz) are available. This lets the user control the hexapod in real time using its own trajectory generator that can be coupled to sensors, cameras, remote control systems etc.



The main window of SYM\_Motion allows the user to set the target position of the hexapod and provides feedbacks about the current hexapod state.

A trajectory generation module supports the operator in designing and combining simple sinusoidal trajectories. It also provides an importation feature to load some trajectories, designed on third-party software.

SYM\_Motion embeds a complete validation module checking the feasibility of any motion commands. A full report, including graphics, allows to identify the reason of a rejection, helping the redesigning of the trajectory. Once a trajectory is validated, it can be saved as such and stacked in a scenario list, where numerous trajectories can be executed and managed.



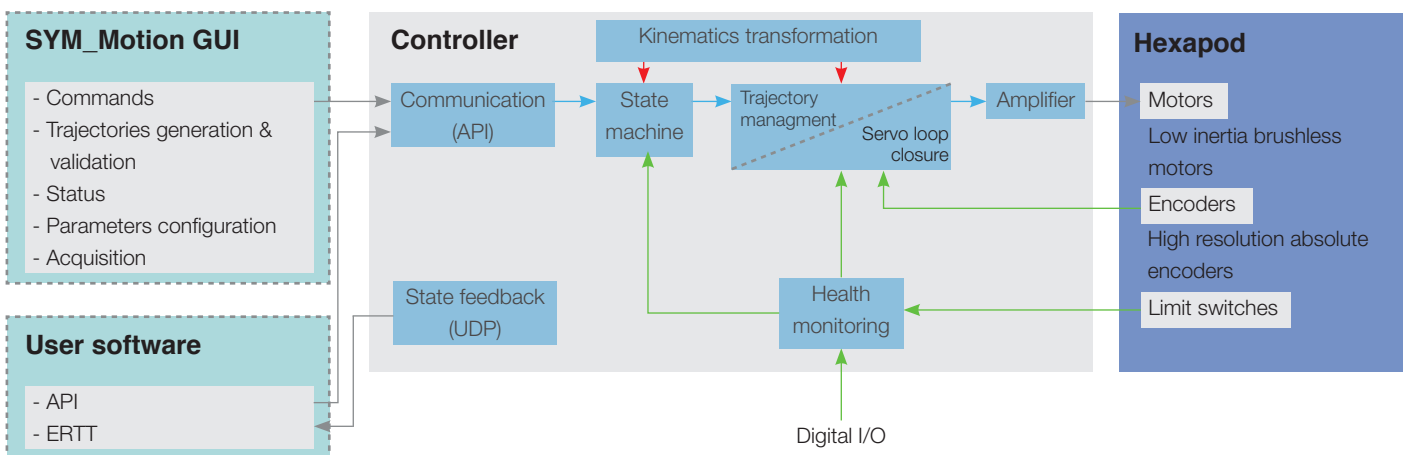


# Controller technology

The motion controller is integrated with Ethercat compatible drives amplifiers in an industrial control enclosure. It brings a simple and flexible architecture to adapt our embedded software to fulfill your requirements. In particular, the controller:

- **Communication:** communicates with the graphical interface software or a user system through the Application Programming Interface (API) and broadcasts the system status through a UDP server.
- **State machine:** executes a state machine, responsible for the control of the hexapod. The state machine uses the hardware inputs and data received from the Application Programming Interface (API) to determine what to do.
- **Kinematics transformations:** performs the conversion from commanded poses and trajectories, regarding to the defined coordinate systems, to actuators' lengths.
- **Coordinate systems:** transformations are calculated inside the motion controller at a low level.
- **Servo loop closure:** ensures that the position error between the target actuator position and the measured one is kept as low as possible thanks to advanced control laws.
- **Health monitoring:** the motion controller checks the state of hardware inputs and control loop deviations from normal operating conditions.
- **Trajectory profile generation:** the motion controller implements an interpolation algorithm to produce smooth synchronized motions to guarantee a low operational cross-coupling.
- **Validation process:** before each motion the controller checks for its feasibility, considering the hexapod parameters, user-supplied payload information and including safety limits.
- **ERTT real-time control** (Optional): receives external real-time trajectories from the user software to safely control the hexapod motions.
- **Acquisition** (Optional): gathers the hexapod operational poses and write them into saved files.

## From the user to motion:



The software embedded on the motion controller is developed by SYMETRIE. Thus, it is customizable to integrate the more complex customer application requirements (examples: integrating an additional axis control and/or specific state machine, customize digital outputs, add safety sensors, etc.).

# Some applications

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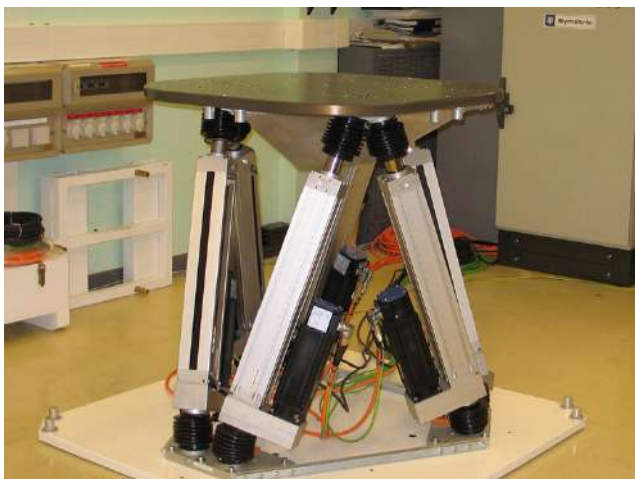
## Motor test bench

This engine test bench allows to realize de-oiling and de-wetting tests by simulating the inclination of the vehicle.

A major French car manufacturers trusted our hexapods to simulate a vehicle movement, in order to reproduce real conditions in factory.

The hexapod can support up to 500 kg equipment load with angles of  $\pm 51^\circ$  in roll and pitch.

After equipping the bench, the user launches a series of automatic tests in order to acquire the various engine parameters (temperature, pressure, etc.) according to the different degrees of freedom.



## Motion sensor testing

This hexapod has been designed for the control and qualification of high precision inertial motion units.

For this IMU manufacturer, we have integrated a measuring octopod to the hexapod.

This specific assembly allows the qualification and control of the inertial units during various experiments.

This hexapod is adapted to carry out tests embedded in vehicles. Moreover, a servo-control can be carried out thanks to the information coming from the IMU.



## Ship simulation

Here, NOTUS hexapod is simulating a ship deck agitated by the swell, on which a helicopter is trying to land.

This system is installed inside a wind tunnel at a research centre in Canada.

Thanks to this hexapod they recreate outdoor conditions in an indoor test centre, allowing more specific tests to be carried out while limiting costs.

# Some applications



## Wave basin

A wave basin is a research facility for testing ships and offshore structures in the most realistic conditions.

Hexapods are used by maritime laboratories that study the hydrodynamic effects of swell, the phenomena of sloshing or cavitation for example. Wave basins are used by a diversity of naval actors, such as ships and propellers designers, renewable marine energies (floating wind turbines) and offshore (floating production units, anchored or articulated).

The hexapod is attached downwards to a trolley, which moves along the basin. The mobile platform of the hexapod moves the ship model or any other tested component to reproduce the hydrodynamics effects of the swell.

The hexapod is prepared for the maritime environment and the fixed platform is reinforced for upside down use.



## Antenna testing

Hexapods are used by the R&D departments developing SATCOM antennas in order to test the stabilization performances of the antennas motorized systems.

These antennas are later installed on boats, trucks or any other kind of vehicles, so the motorization needs to be adjusted in order to enable the highest communication performances between the antenna and the satellite.

These hexapods can be prepared for outdoor and sometimes integrate an extra Rz rotation in the mobile platform to be able to simulate the U-turn of a boat for example.



## Sloshing

GazTransport & Technigaz designs containment systems for the transport of LNG (Liquefied Natural Gas). The temperature of LNG is  $-163^{\circ}\text{C}$  during transportation so the tanks have to be well isolated to limit LNG evaporation.

GTT is using several dynamic hexapods from SYMETRIE to simulate the impact of sea voyages on their cryogenic membranes. The effects of sloshing, which is the movement of a liquid inside a moving tank, need to be studied by GTT in order to correctly define the width of the membranes and to reinforce them intelligently.

Hexapods have allowed GTT to make great progress in understanding the phenomenon of liquid movements.



# HEGOA hexapod

Compact dynamic hexapod

## KEY FEATURES

- Payload capacity 50 kg
- Angular travel range  $\pm 23^\circ$
- Compact height: 420 mm



## APPLICATIONS

- |                    |              |           |
|--------------------|--------------|-----------|
| ■ Motion simulator | ■ Automotive | ■ Defense |
| ■ Naval            | ■ Biomedical | ■ Optics  |



*HEGOA hexapod with stabilized Giro optical component for motion compensation test.*



*Hexapod HEGOA with a drone equipped with a camera to test the reactions of the whole during movements in flight, simulated by the hexapod.*

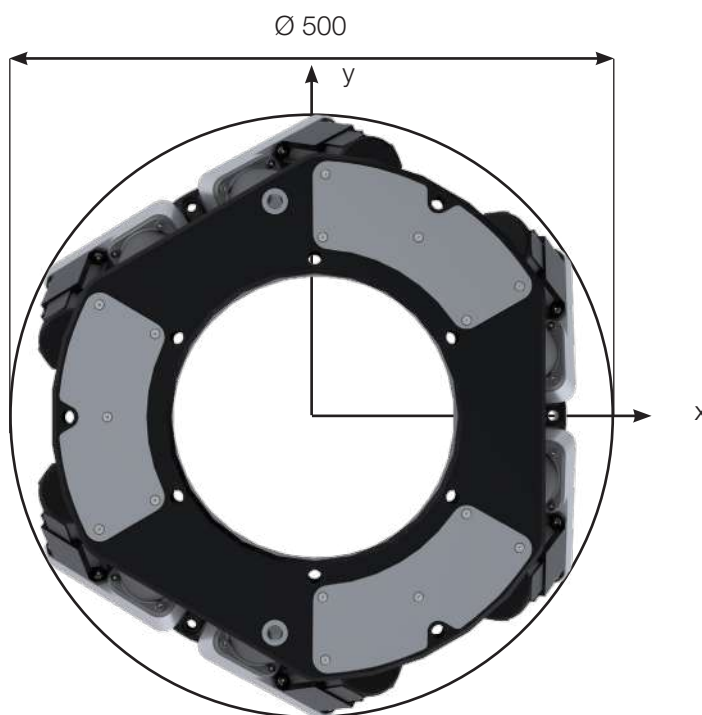


	HEGOA
<b>Motion and positioning</b>	
Travel range Tx, Ty (mm)	± 100
Travel range Tz (mm)	± 50
Travel range Rx, Ry (deg)	± 23
Travel range Rz (deg)	± 30
Speed Tx, Ty, (mm/s)	± 200
Speed Tz (mm/s)	± 120
Speed Rx, Ry, Rz (°/s)	± 50
Acceleration Tx, Ty, Tz (mm/s <sup>2</sup> )	8 000
Acceleration Rx, Ry, Rz (°/s <sup>2</sup> )	200
<b>Mechanical properties</b>	
Payload capacity (kg) (vertical orientation / horizontal orientation)	50 / 15
Motor type	Brushless
<b>Miscellaneous</b>	
Operating temperature range (°C)	10 to + 40
Size mobile platform (mm)	Ø 425
Height in middle position (mm)	420
Mass (kg)	30
Cable length (m)	5
Options	Outdoor Acquisition and storage of motions API Customized platform design ERTT
<b>Controller</b>	
Interface	Ethernet
Power supply	110-240 VAC / 50-60 Hz

The performances are specified for single axis motions, with all other axes at midrange and for a rotation center in the middle of the mobile platform.



Hexapod in middle position



# NOTUS hexapod

Mid-sized dynamic hexapod

## KEY FEATURES

- Payload capacity 200 kg
- Linear travel range  $\pm 250$  mm
- Angular travel range  $\pm 25^\circ$
- Compact

## APPLICATIONS

- Motion simulator
- Naval
- Swell simulator
- Biomedical
- Defense
- Optics



Credits: ONERA

*NOTUS enables testing the gyroscopic platform of a cold atom gravimeter that will be later installed on a ship by ONERA. The hexapod reproduces the swell motions and the ship vibrations.*



*NOTUS hexapod allows to test the stabilization system of a camera that can be later installed on a tank, a truck or a boat.*

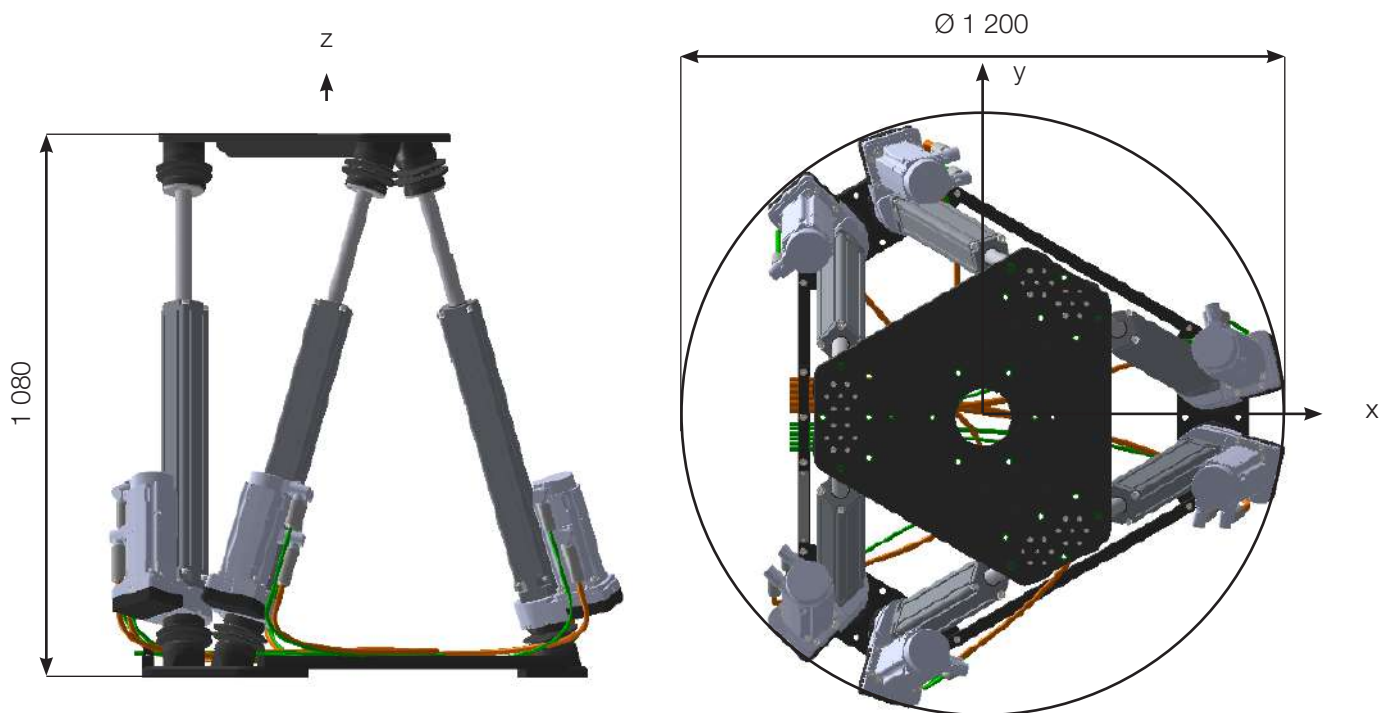


Credits: SPHEREA Test & Services

*NOTUS hexapod helps to characterize and calibrate electro-optics gimbals that will be later installed on helicopters.*

	NOTUS P	NOTUS V
	for 200 kg payload	for 100 kg payload
Motion and positioning		
Travel range Tx, Ty (mm)	± 250	± 250
Travel range Tz (mm)	± 200	± 200
Travel range Rx, Ry (deg)	± 25	± 25
Travel range Rz (deg)	± 30	± 30
Speed Tx, Ty, (mm/s)	800	1 200
Speed Tz (mm/s)	300	600
Speed Rx, Ry, Rz (°/s)	50	100
Acceleration Tx, Ty (mm/s²)	10 000	10 000
Acceleration Tz (mm/s²)	6 000	10 000
Acceleration Rx, Ry, Rz (°/s²)	500	1 000
Mechanical properties		
Payload capacity (kg) (vertical orientation only)	200	100
Motor type	Brushless	Brushless
Miscellaneous		
Operating temperature range (°C)	0 to + 50	0 to + 50
Size mobile platform (mm)	Ø 660	Ø 660
Height in middle position (mm)	~1 080	~1 080
Mass (kg)	~ 120	~ 120
Cable length (m)	7	7
Options	Outdoor Acquisition and storage of motions API ERTT	
Controller		
Interface	Ethernet	
Power supply	400 VAC (three-phase) / 16 A / 50-60 Hz	

The performances are specified for single axis motions, with all other axes at midrange and for a rotation center in the middle of the mobile platform.



Hexapod in middle position

# MISTRAL hexapod

Dynamic hexapod for motion

## KEY FEATURES

- Payload capacity up to 1 ton
- Linear travel range  $\pm 460$  mm
- Angular travel range  $\pm 30^\circ$



## APPLICATIONS

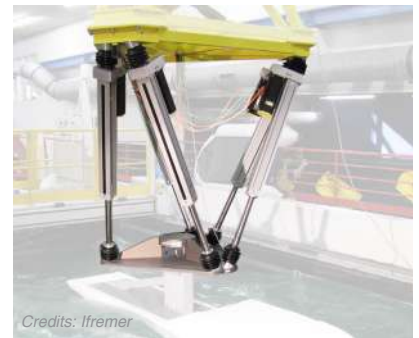
- Motion simulator
- High payload positioner
- Driving simulator
- Swell simulator



MISTRAL hexapod reproduces ship motions to test the stabilization performances of large maritime SATCOM antennas.



MISTRAL hexapod simulates the motion of a floating gas production unit to characterize hydrodynamic effects of swell on the chemical reactions in a gas deacidification column. These tests allow to improve performance and robustness of the processing units.



MISTRAL hexapod orientates a ship model in a wave basin to reproduce maritime conditions and test the shipbuilding techniques.

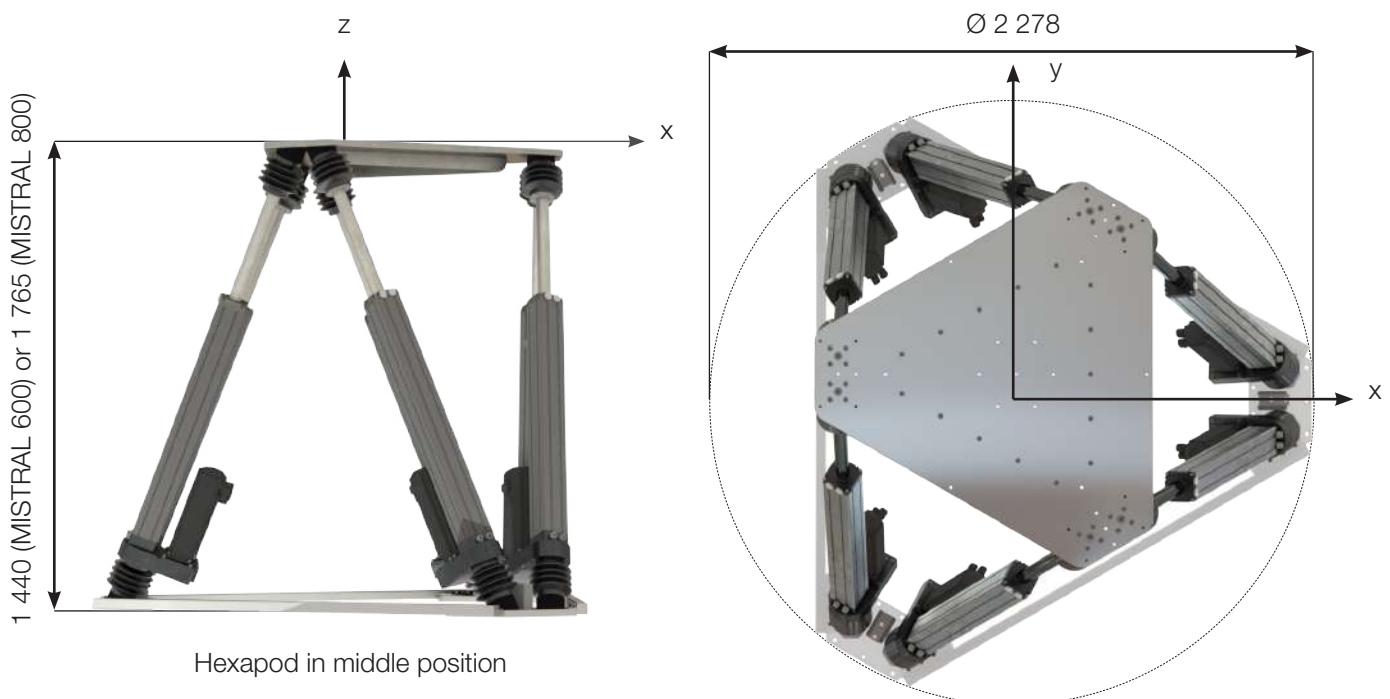


The surfers can practice various wave situations played by our Simusurf hexapod and improve their gestures through practice and analysis by recording their movements with additional sensors. Simusurf hexapod can be used as a discovery and learning tool for the casual surfer or as a performance and training tool for the professional surfer.



	MISTRAL 600		MISTRAL 800	
	P: 1000 kg payload	V: 500 kg payload	P: 1000 kg payload	V: 500 kg payload
Motion and positioning				
Travel range Tx, Ty (mm)	± 400	± 400	± 460	± 460
Travel range Tz (mm)	± 300	± 300	± 400	± 400
Travel range Rx, Ry (deg)	± 30	± 30	± 30	± 30
Travel range Rz (deg)	± 40	± 40	± 40	± 40
Speed Tx, Ty, (mm/s)	1 000	1 200	1 000	1 200
Speed Tz (mm/s)	600	1 000	600	1 000
Speed Rx, Ry (°/s)	50	100	50	100
Speed Rz (°/s)	70	140	70	140
Acceleration Tx, Ty, (mm/s²)	5 000	8 000	5 000	8 000
Acceleration Tz (mm/s²)	6 000	8 000	6 000	8 000
Acceleration Rx, Ry (°/s²)	500	800	500	800
Acceleration Rz (°/s²)	700	1 100	700	1 100
Mechanical properties				
Payload capacity (kg) (vertical orientation only)	1 000	500	1 000	500
Motor type	Brushless	Brushless	Brushless	Brushless
Miscellaneous				
Operating temperature range (°C)	0 to + 50		0 to + 50	
Size mobile platform (mm)	Ø 1 386		Ø 1 386	
Height in middle position (mm)	~1 440		~1 765	
Mass (kg)	~ 400		~ 450	
Cable length (m)	10		10	
Options	Outdoor Acquisition and storage of motions API Customized platform design ERTT			
Controller				
Interface	Ethernet			
Power supply	400 VAC (three-phase) / 32 A			

The performances are specified for single axis motions, with all other axes at midrange and for a rotation center in the middle of the mobile platform.



# SIROCCO hexapod

Dynamic hexapod with high amplitude

## KEY FEATURES

- Payload capacity 2 tons
- Linear travel range  $\pm 600$  mm
- Angular travel range  $\pm 40^\circ$

## APPLICATIONS

- Motion simulator
- High payloads positioner
- Vehicle simulator
- Swell simulator



Credits: GTT

GTT designs cryogenic membrane containment systems used in the shipbuilding industry for the transport of liquid natural gas (LNG). SIROCCO hexapod allows GTT laboratories to study the impact of moving liquid, also called sloshing, on their insulation.



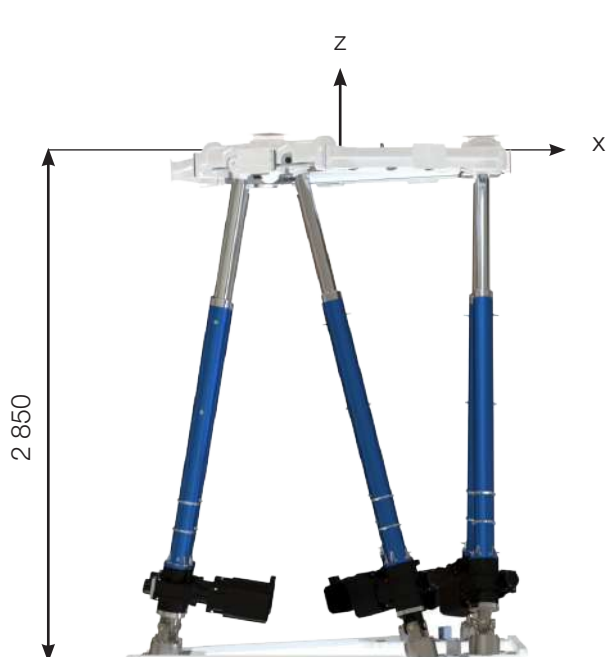
DCNS uses SIROCCO hexapods as submarine simulators for training purposes to reproduce the emergency situations that submarine crews might encounter during a mission.



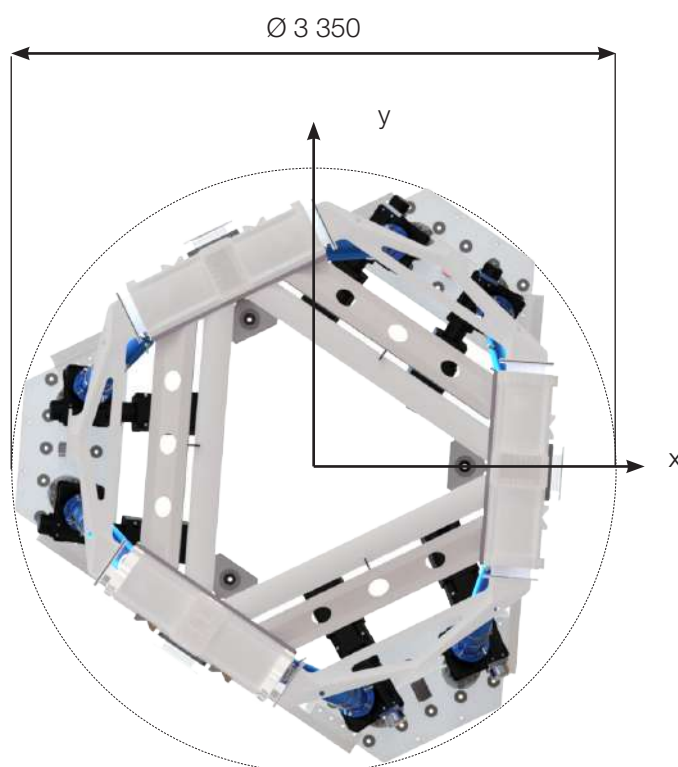
FMC Technologies uses two SIROCCO XL hexapods to test a  $\frac{1}{4}$  scale LNG loading arm. These hexapods simulate the swell motion to qualify the loading arm that will connect a gas carrier to an offshore gas production factory. One hexapod simulates the gas carrier, the other the offshore factory.

	SIROCCO
<b>Motion and positioning</b>	
Travel range Tx, Ty (mm)	± 600
Travel range Tz (mm)	± 500
Travel range Rx, Ry, Rz (deg)	± 40
Speed Tx, Ty, (mm/s)	± 2 000
Speed Tz (mm/s)	± 1 800
Speed Rx, Ry (°/s)	± 200
Speed Rz (°/s)	± 100
Acceleration Tx, Ty, Tz (mm/s²)	6 000
Acceleration Rx, Ry, (°/s²)	1 200
Acceleration Rz (°/s²)	600
<b>Mechanical properties</b>	
Payload capacity (kg) (vertical orientation only)	2 000
Motor type	Brushless
<b>Miscellaneous</b>	
Operating temperature range (°C)	0 to + 50
Size mobile platform (mm)	Ø 3 350
Height in middle position (mm)	~ 2 850
Mass (kg)	~ 850
Cable length (m)	15
Options	Outdoor Acquisition and storage of motions API Customized platform design ERTT
<b>Controller</b>	
Interface	Ethernet
Power supply	400 VAC (three-phase) / 250 A

*The performances are specified for single axis motions, with all other axes at midrange and for a rotation center in the middle of the mobile platform.*



Hexapod in middle position



# AQUILON hexapod

Dynamic hexapod with very high amplitude

## KEY FEATURES

- Payload capacity 6 tons
- Linear travel range  $\pm 800$  mm
- Angular travel range  $\pm 40^\circ$



## APPLICATIONS

- Motion simulator
- Heavy payload positioner
- Swell simulator



*Hexapod AQUILON for sloshing tests.*

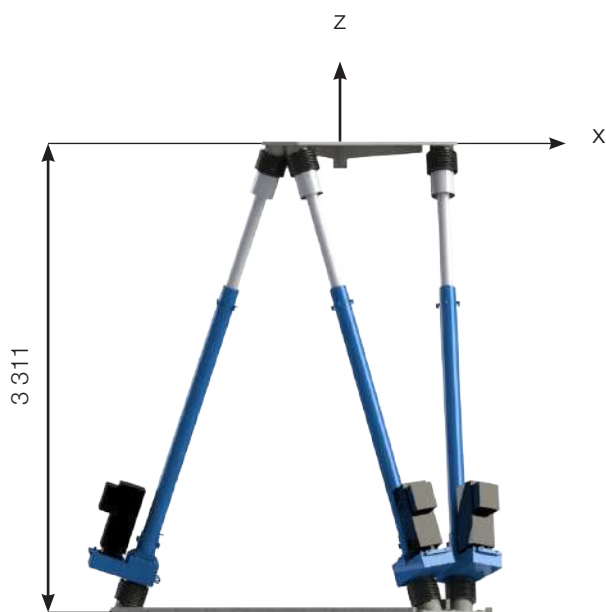


*Sloshing tests hexapod AQUILON with a 10T payload.*

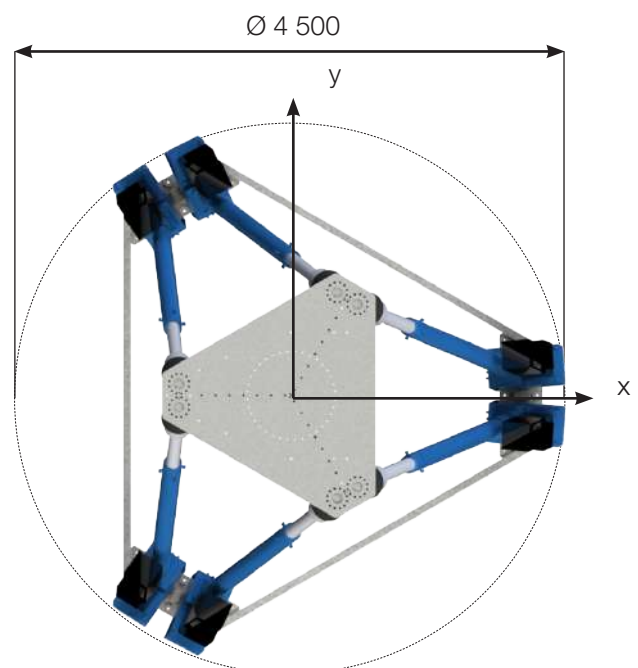


	AQUILON
<b>Motion and positioning</b>	
Travel range Tx, Ty (mm)	± 800
Travel range Tz (mm)	± 650
Travel range Rx, Ry, Rz (deg)	± 40
Speed Tx, Ty, (mm/s)	± 1 800
Speed Tz (mm/s)	± 1 600
Speed Rx, Ry (°/s)	± 200
Speed Rz (°/s)	± 100
Acceleration Tx, Ty, Tz (mm/s²)	7 000
Acceleration Rx, Ry, (°/s²)	1 200
Acceleration Rz (°/s²)	600
<b>Mechanical properties</b>	
Payload capacity (kg) (vertical orientation only)	6 000
Motor type	Brushless
<b>Miscellaneous</b>	
Operating temperature range (°C)	0 to + 50
Size mobile platform (mm)	Ø 2 100
Height in middle position (mm)	~ 3 311
Mass (kg)	~ 3 000
Cable length (m)	15
Options	Outdoor ATEX compatibility Acquisition and storage of motions API Customized platform design ERTT
<b>Controller</b>	
Interface	Ethernet
Power supply	400 VAC (three-phase) / 250 A

The performances are specified for single axis motions, with all other axes at midrange and for a rotation center in the middle of the mobile platform.



Hexapod in middle position



# A worldwide presence

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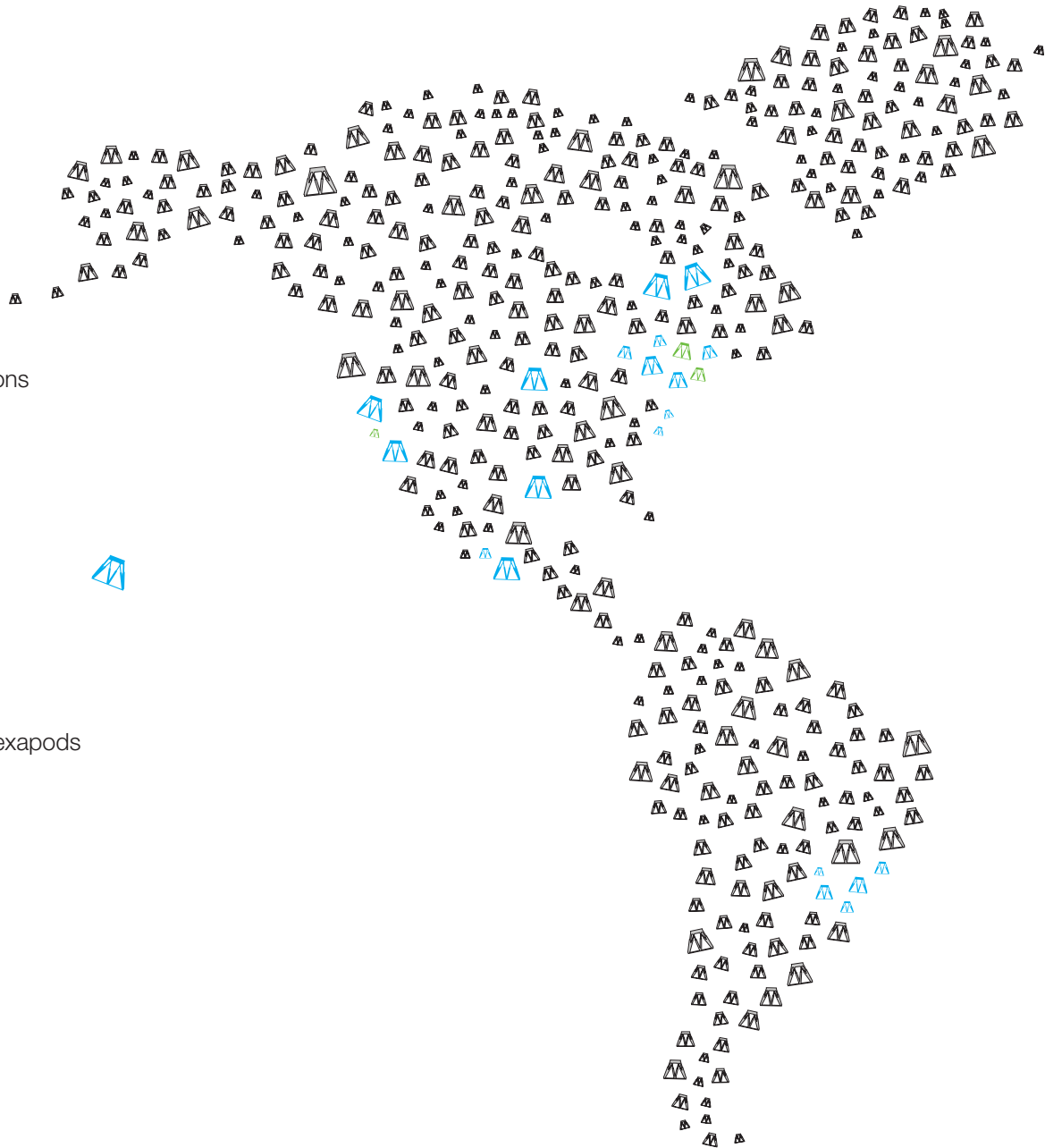
SYMETRIE hexapods locations

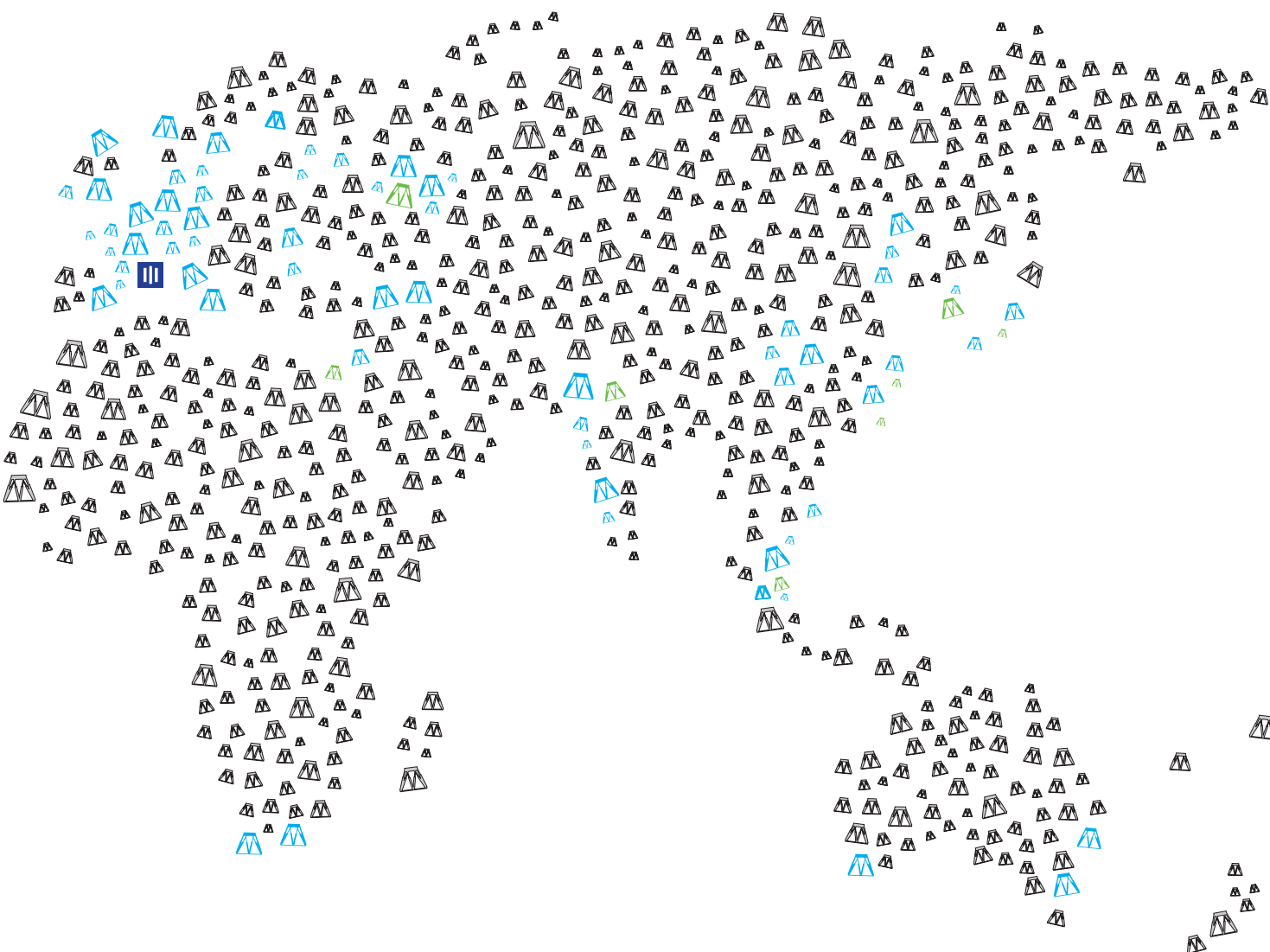


Distributors of SYMETRIE hexapods



SYMETRIE headquarters





Our hexapods all over the world

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