

Thermal Vacuum



VACUUM

is at the centre of everything we do. We specialise in solving the most challenging vacuum/technology problems, to enable innovation and exploration. Nanovac has been designing advanced vacuum systems since 1993, ranging from general vacuum systems to advanced thin film equipment. One of our most commonly supplied solutions are vacuum chambers used to simulate the harsh environment in space. This particular brochure outlines some of our standard solutions, as well as touches on our custom system capabilities. A vast majority of thermal vacuum test chambers are built to customer specifications, and thus, almost all chambers end up being custom solutions, however, we base all our solutions on built and previously delivered equipment.

We employ a standard approach to the automation of our vacuum systems, We use Rockwell Automation PLC (programmable logic controllers) to ensure deterministic and robust performance. The benefit of using PLCs that are industrially proven is that you achieve a very high level of safety, coupled with robust performance and field proven reliability.



CREATE

is what we do. Custom solutions, cost effective and robust solutions. We take pride in developing the best possible solutions for our customers. We thrive to ensure that you stay competitive and have the best capabilities the industry can offer. But more than anything, we want to create value for our customers.

We use only the best of solutions when designing and building our systems, and we use the latest technology solutions to ensure that our equipment offers long, problem-free operation at our customer sites. We were one of the first companies in the industry to adopt remote diagnostic capabilities over industrial VPN services to ensure that our customers enjoy the highest uptime in the industry. The extensive remote support capabilities also enables us to quickly and efficiently diagnose any system issues (including all components on-board), as well as deploying recommended upgrades with minimum interference to our customers operations.

In our engineering department we work with the latest tools in regards with mechanical design, simulation and software design. A considerable amount is spent each year on ensuring that the equipment we have in our facility enables us to deliver the highest quality to our end-users. This includes advanced analytical equipment such as RGA (residual gas analysers) and Helium leak detectors to assist us in making sure that

our systems adhere (and exceed) to the strictest industry standards, We also have a vast internal inventory of in-house developed testing equipment used to qualify the various designs we build and assemble. As our solutions are unique we need to develop unique testing capabilities.

Our systems are always built with the operator safety as the highest priority. User friendliness and ease of use are factors that contribute to this, coupled with the use of tier 1 OEM components in all aspects of our builds.

SPACE

holds the future of mankind, in so many ways. We are thrilled to provide the solutions that allow our customers to put their ideas to the test. Our chambers have already been instrumental in testing hardware going into space, both in earth orbital missions as well as interplanetary missions. Our chambers have been used to test propulsion systems, antennas, transmitters, receivers and electronics. We even have chambers that were used to simulate the surface of an asteroid, under challenging conditions.

Space also is also synonymous with what we specialise in. Vacuum. We have dedicated ourselves to inventing and developing the finest vacuum hardware, often to very demanding specifications. We are excited to take on every challenge and demanding specification put in front of us. And, we also have a wide range of “off the shelf” ready solutions.

We look forward on working closely with you on your future vacuum system project. Regardless of the requirement. No project is too small, or too big. We are here to help you solve your vacuum system problems.



HORIZONTAL

LOADED chambers allow for the DUT (device under test) to be introduced into the test volume through a door either on the front and/or on the rear of the testing chamber. We have delivered horizontal load chambers as large as 4 meters in diameter, but there is no real limit on the diameter. It is driven by your requirement. We offer a number of standard chambers in horizontal configuration, ranging from 300mm in diameter up to 2000mm. The systems can be equipped with different types of high vacuum pumps, typically though they are equipped with cryo pumps and/or turbo molecular pumps. All our chambers are manufactured from either stainless steel or aluminium. It depends on the requirement of the end-user.

We always recommend adding as many ports as possible, as there is always a time, where you would wish for one more. That being said, each ports come at a cost. We also provide custom rectangular port interfaces that can have literally any shape or form, and be designed to have replaceable mating flange adaptors that allows for a multitude of connectors and interfaces to the DUT.

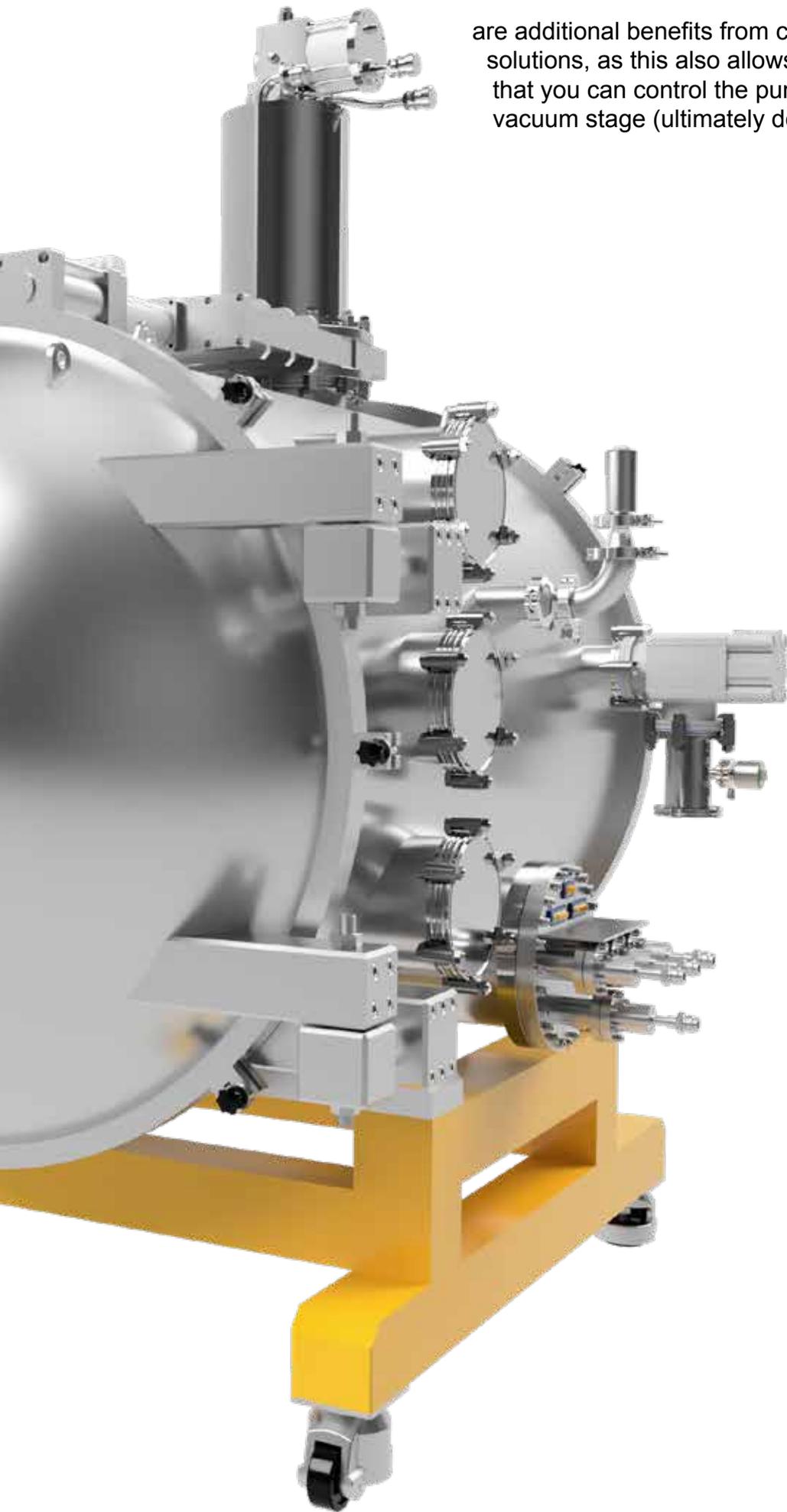
The chambers can be fitted with a very wide array of internal furniture, ranging from passive tables/shrouds to temperature active tables/shrouds. A lot of our configurations are delivered with a thermal test plate alone, but with means to retrofit a thermal shroud should it be required. The chambers are equipped with mounting brackets and mounting lugs within the vacuum volume to simplify installation of new hardware as it is required. The same brackets can also be used to route testing cables and other materials required to set up the test campaign.

Due to the open format architecture of our control system, it is easy to add features and functionality to the system as requirements change and develop over time. For example, it may be in the future that an RGA (residual gas analyser) is required in a test campaign, and with our automation suite it is very easy to implement both the hardware but also the software and generated log data and tie it into the SQL data logging capabilities of our software package. This also ensures that both legacy and future data-logging adheres to the ANSI ISA 88 standard that we use on all our data logging platforms. The open format also allow for easy integration of new hardware on the system, including gauges, sensors, and other analytical equipment required. It is also possible to add remote control functionality so that the cycle recipes can trigger events that modify operational parameters on the DUT. The variations and configuration options are virtually limitless.

All our systems are sold as turn key systems, this means that in a normal configuration ALL the required vacuum pumps, gauges and valves are included in our delivery. For rough vacuum (initial pump out of test volume and DUT) we recommend using dry vacuum pumps to eliminate the risk of contaminating the volume with lubricants from the roughing pumps. There

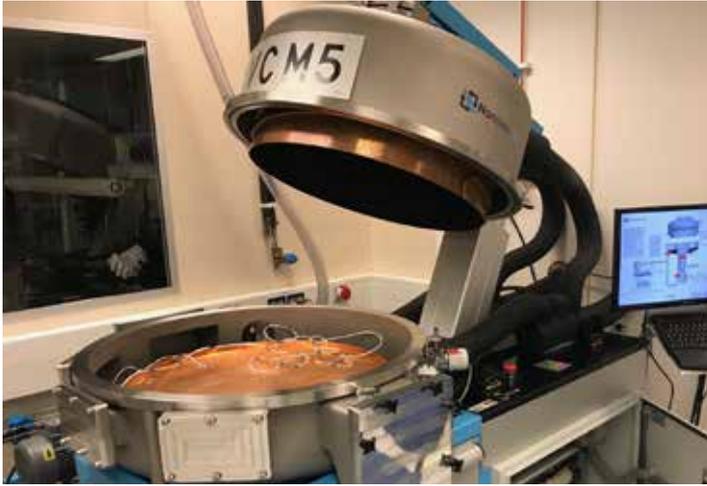


are additional benefits from choosing our dry vacuum pump solutions, as this also allows for frequency control, meaning that you can control the pumping speed during the rough vacuum stage (ultimately down to the $1e^{-3}$ mbar range).



VERTICAL

LOADED chambers allow for the DUT (device under test) to be introduced into the test volume through an opening in the top (or bottom) of the system. We have delivered vertical load chambers as large as 3 meters in diameter, but there is no real limit on the diameter. It is driven by your requirement. We offer a number of standard chambers in vertical configuration, ranging from 300mm in diameter up to 2000mm. We also offer "clam shell" designs, where the top part of the

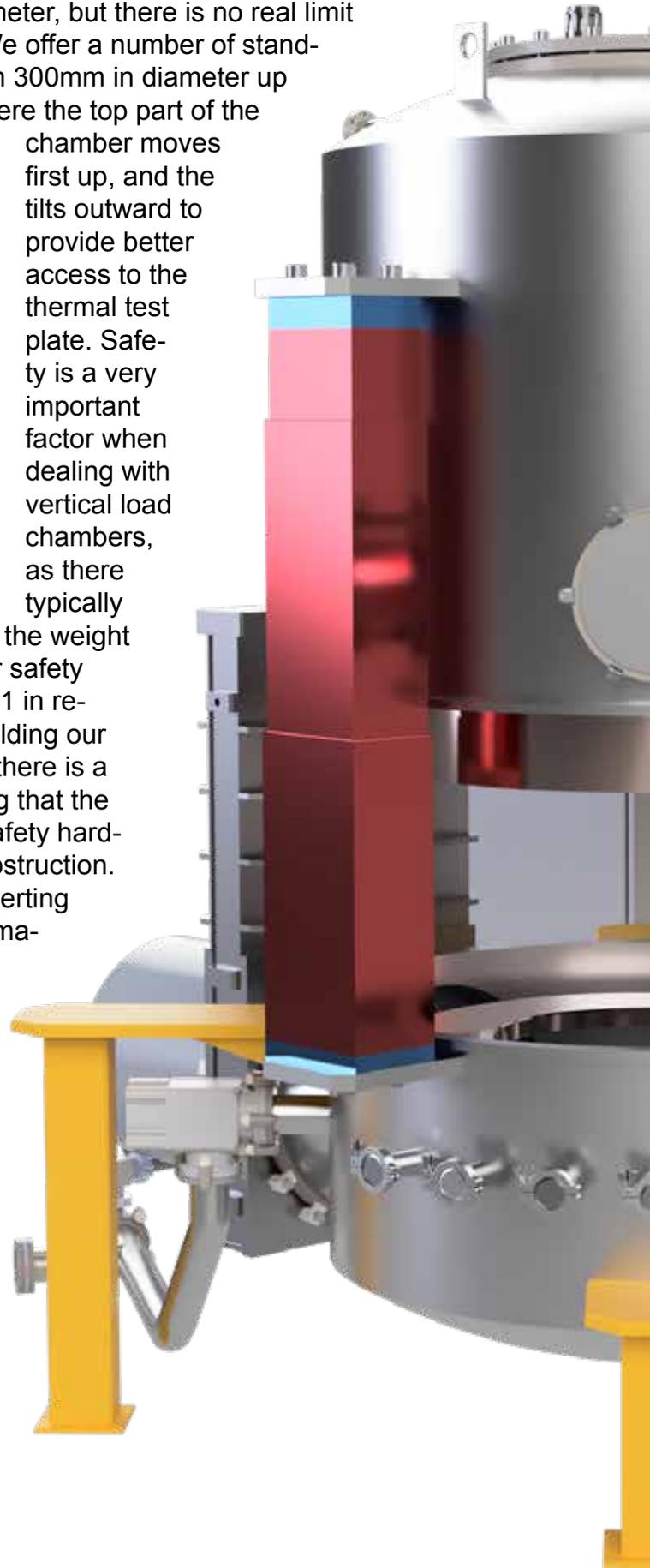


chamber moves first up, and the tilts outward to provide better access to the thermal test plate. Safety is a very important factor when dealing with vertical load chambers, as there typically

is a moving (and sometimes tilting) component. As the weight of these chamber parts can be quite high, operator safety is our main concern. We adhere to EN ISO 13849-1 in regard with operator safety when developing and building our vertical load chambers. In most cases this means there is a dual hand control for chamber movement (ensuring that the operator has both hands in a safe position), and safety hardware to ensure the mating flanges are free from obstruction. Normally also an audible/visual signal is present alerting people adjacent to the system that there is heavy material movement going on. We can also provide custom solutions to safely transfer the DUT in and out of the testing chamber.

The systems can be equipped with different types of high vacuum pumps, typically though they are equipped with cryo pumps and/or turbo molecular pumps. All our chambers are manufactured from either stainless steel or aluminium. It depends on the requirement of the end-user.

We always recommend adding as many ports as possible, as there is always a time, where you would wish for one more. That being said, each ports come at a cost. We also provide custom rectangular port interfaces that can have literally

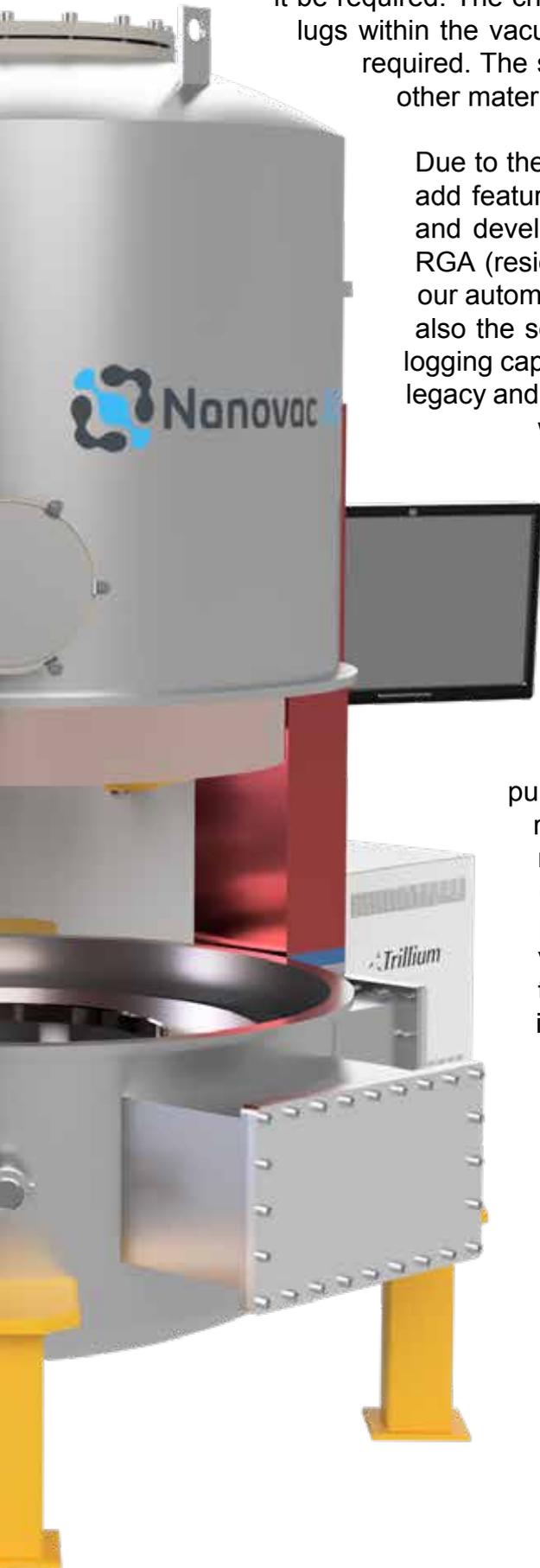


any shape or form, and be designed to have replaceable mating flange adaptors that allows for a multitude of connectors and interfaces to the DUT.

The chambers can be fitted with a very wide array of internal furniture, ranging from passive tables/shrouds to temperature active tables/shrouds. A lot of our configurations are delivered with a thermal test plate alone, but with means to retrofit a thermal shroud should it be required. The chambers are equipped with mounting brackets and mounting lugs within the vacuum volume to simplify installation of new hardware as it is required. The same brackets can also be used to route testing cables and other materials required to set up the test campaign.

Due to the open format architecture of our control system, it is easy to add features and functionality to the system as requirements change and develop over time. For example, it may be in the future that an RGA (residual gas analyser) is required in a test campaign, and with our automation suite it is very easy to implement both the hardware but also the software and generated log data and tie it into the SQL data logging capabilities of our software package. This also ensures that both legacy and future data-logging adheres to the ANSI ISA 88 standard that we use on all our data logging platforms. The open format also allow for easy integration of new hardware on the system, including gauges, sensors, and other analytical equipment required. It is also possible to add remote control functionality so that the cycle recipes can trigger events that modify operational parameters on the DUT. The variations and configuration options are virtually limitless.

All our systems are sold as turn key systems, this means that in a normal configuration ALL the required vacuum pumps, gauges and valves are included in our delivery. For rough vacuum (initial pump out of test volume and DUT) we recommend using dry vacuum pumps to eliminate the risk of contaminating the volume with lubricants from the roughing pumps. There are additional benefits from choosing our dry vacuum pump solutions, as this also allows for frequency control, meaning that you can control the pumping speed during the rough vacuum stage (ultimately down to the $1e^{-3}$ mbar range).

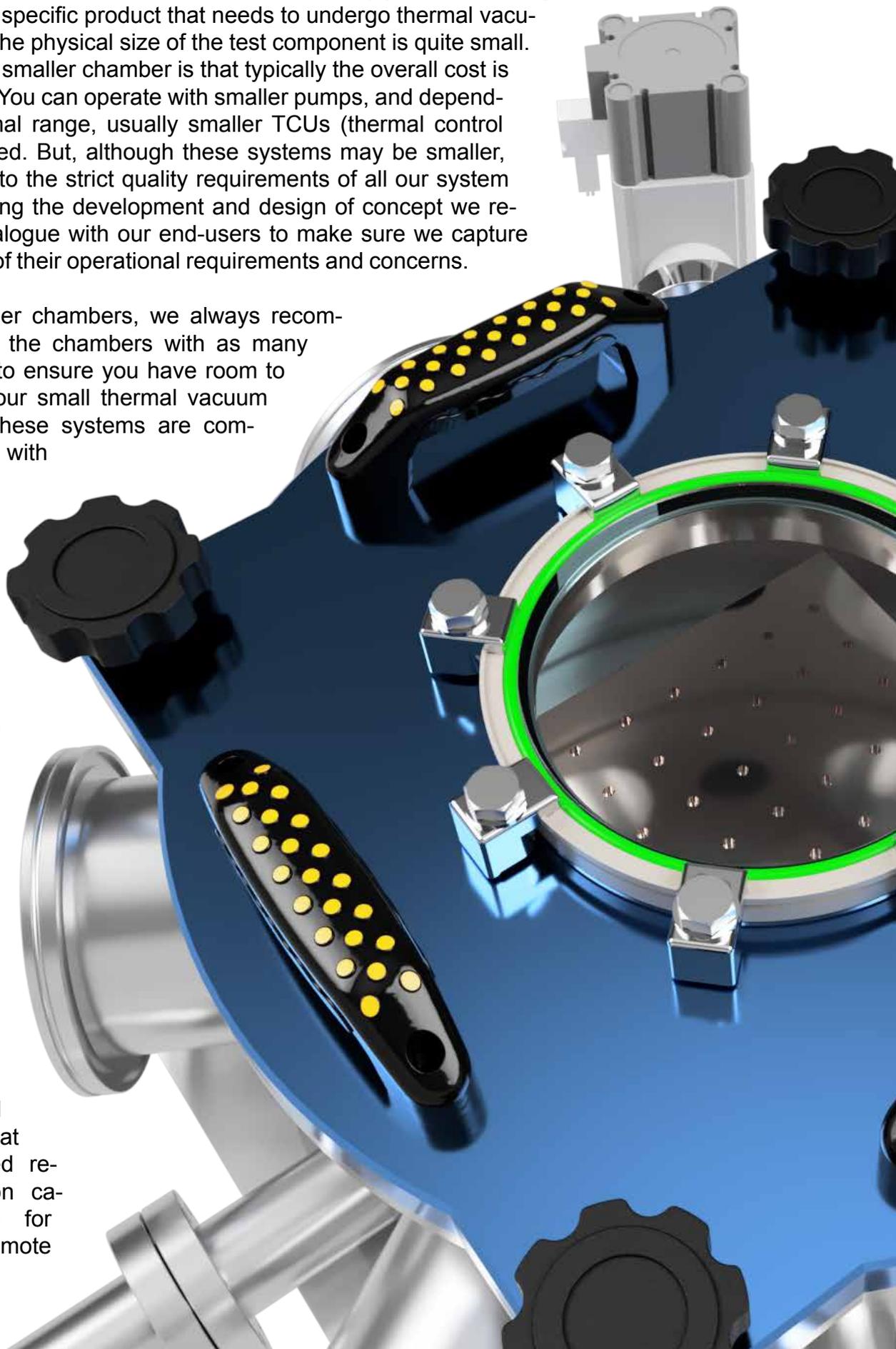


SMALL

CUSTOM chambers are ideally suited for testing small(er) space hardware. We deliver quite a few smaller custom chambers every year. The driving point is usually a specific product that needs to undergo thermal vacuum tests, where the physical size of the test component is quite small. The benefits of a smaller chamber is that typically the overall cost is greatly reduced. You can operate with smaller pumps, and depending on the thermal range, usually smaller TCUs (thermal control units) can be used. But, although these systems may be smaller, they still adhere to the strict quality requirements of all our system builds. Also, during the development and design of concept we remain in close dialogue with our end-users to make sure we capture and consider all of their operational requirements and concerns.

As with our larger chambers, we always recommend equipping the chambers with as many ports as viable, to ensure you have room to grow, even in your small thermal vacuum test chamber. These systems are commonly equipped with our smaller GUI (graphical user interfaces) that are touch-screen based. The GUI provides the operator with an easy to use interface and also the capability to program simple cycle recipes.

Just as with our larger chambers the small chambers utilize the same award winning control architecture that allows advanced remote connection capabilities (both for us to provide remote

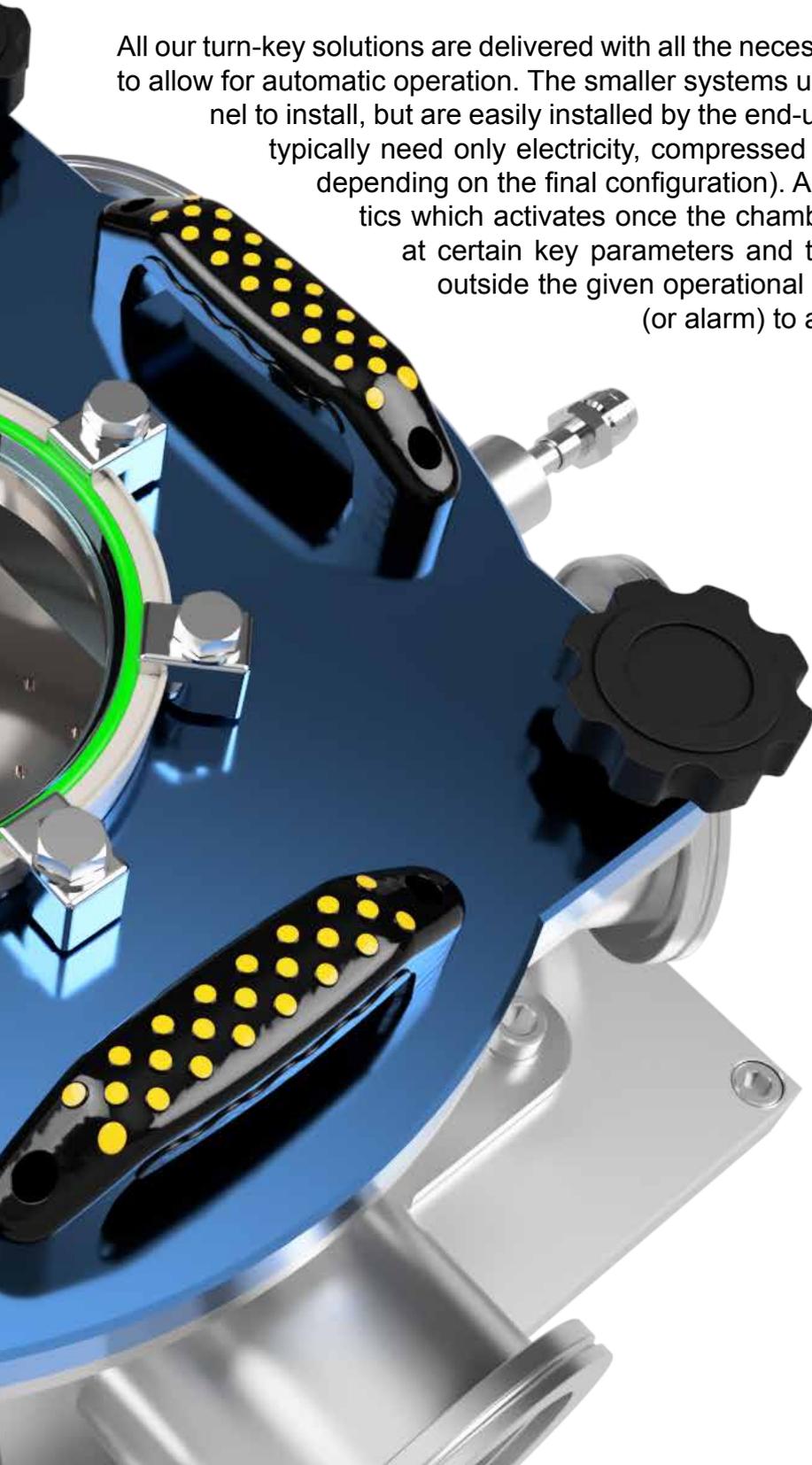


support, but also for your team to remotely access the system).

The variations and configurations available is virtually limitless. We have a range of standard format chambers that we can offer, but, in most cases we end up doing a custom solution based on the "templates" that we have available. These chambers can delivered naked (no chamber furniture fitted) or fully configured with thermal test plate and thermal shrouds. Depending on the thermal requirements, the chambers can operate with recirculating TCUs or use liquid nitrogen (LN₂) to achieve lower operating temperatures.

The small test chambers are overwhelmingly delivered with turbo molecular high vacuum pumps rather than cryogenic high vacuum pumps. The chambers can be delivered with isolation valves or without, all depending on the budgetary requirements.

All our turn-key solutions are delivered with all the necessary vacuum pumps, valves and gauges to allow for automatic operation. The smaller systems usually does not require any field personnel to install, but are easily installed by the end-user in their own laboratory. The systems typically need only electricity, compressed air to operate (may need cooling water depending on the final configuration). All our systems have built in self diagnostics which activates once the chamber is powered on. The diagnostics look at certain key parameters and their operational values, and if they are outside the given operational window, the system will issue a warning (or alarm) to alert the operator on a potential issue.



LARGE

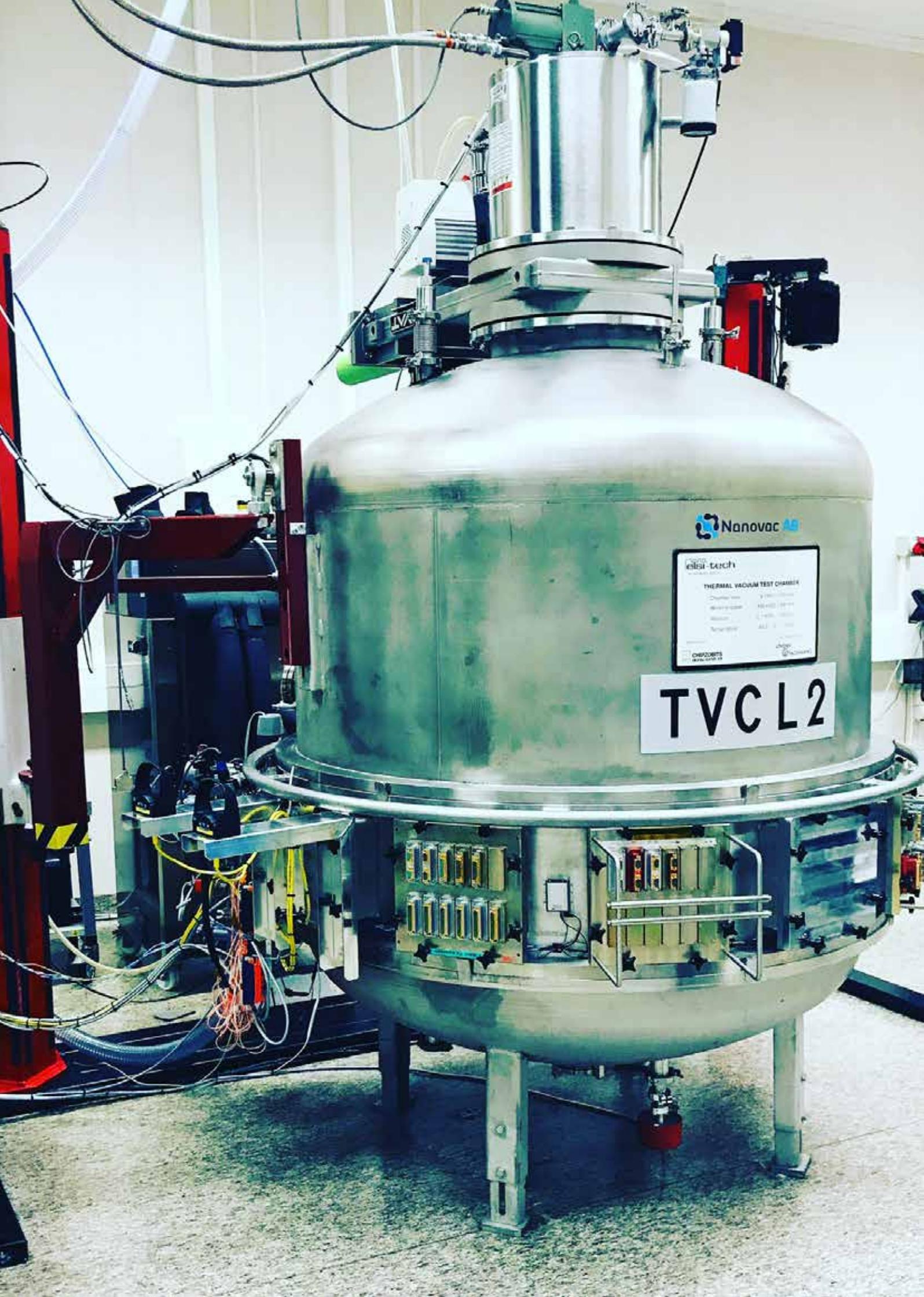
CUSTOM chambers are always built to custom requirements, with custom chamber furniture and associated hardware. The auxiliary equipment is driven by the final configuration requirement, and may require several high vacuum pumps and roughing pumps depending on the final size and pump down requirements.



A vast majority of our large thermal vacuum chambers are manufactured in stainless steel. All surfaces are either electro-polished or polished (depends on size, and end-user requirements). The chambers are always built according to best vacuum practice, and each chamber and sub-component is helium leak tested to meet a requirement of a leak rate that is $<1 \times 10^{-8}$ std cc/s.

UPGRADES

OF EXISTING CHAMBERS is also something we frequently are asked to do. This ranges from control system upgrades to hardware upgrades including chamber thermal plates and shrouds as well as vacuum hardware (pumps, gauges). Our upgrade solutions brings new life and performance into existing systems, at a reasonable cost. We execute upgrades both on-site and on systems being sent to our facility for rework.



Nanovac AB

elsi-tech
THERMAL VACUUM TEST CHAMBER

Chamber Size	Ø 1000 x 1000
Working Pressure	10 ⁻⁵ Torr / 10 ⁻³ Pa
Material	Al 6061-T6
Temperature	400 - 1000

CHIVORITE
www.chivorite.com

TVCL2

AUTOMATION

DRIVES our solutions and ensures safe, deterministic and robust performance. All our system solutions are based on PLC (programmable logic controllers). This ensures reliable and robust performance, and the ability to add or modify functionality over the lifetime of your equipment. Another benefit of using PLCs is that the code developed is IEC 1131-3 compliant, which ensures performance and reliability and ease of transfer for the customer cases where we also supply the source code for our projects.

We also have a number of variations on how the GUI (graphical user interface). We have touch screen solutions, that allows you to operate the system from a single touch screen interface. We also have industrial PC options where the GUI runs on an industrial PC with the latest approved Windows version. This allows for virtually unlimited recipe space storage, as well as data logging capabilities. All of our recipe/cycle and data logging solutions are ANSI ISA 88 compliant, ensuring traceability throughout the lifetime of your system. In addition to logging data during the actual cycle runs (campaigns) our software suite also logs key parameters when idle. The software also monitors key parameters and triggers maintenance events for the service personnel ensuring that all the system critical components are maintained according to the recommended intervals.

Ease of use and a clear visible graphical user interface ensures that the operators are always aware about the current status of the system, and what the actual operating parameters are. Any values that are out of compliance or not within a set operational window will be highlighted on the screen to alert the operator. Detailed log files are also generated for not only the cycle parameters but also for all key events taking place on the system, including valve open/closures, pump contactors and circuit breaker statuses as well as other machine relevant information.

All of our systems are delivered with our award winning remote support capability (NVsEwon). This feature enables us and our techsupport team to monitor and diagnose systems remotely. We can also deploy software upgrades (including instrumentation firmware) remotely. The remote connection capabilities can also be used by the end-user, allowing remote access capabilities for free during the warranty period. Benefits with remote diagnostic and connection capabilities are not limited to support issues, but we often also perform housekeeping tasks as a service to our end-users during the warranty period. The systems are also set up (provided the end-user allows it) to alert our service organisation if a parameter is out of specification, or a component is not performing as expected. In our support centre, the system will be highlighted on an interactive map, indicating that the system is having some issue. And, this may not just be "hard down" issues, but could also be if a component or subsystem is operating outside of a designated operational window. There are several benefits from this, as uptime and availability of the chamber is increased, and



scheduled downtime can be planned more accurately, further increasing the availability of your chamber. In addition to this, preventive maintenance activities are typically significantly less expensive than a hard, unplanned failure.

Finally, our user interfaces adhere to the strictest standards in regard with user friendliness and operational ergonomics. We also

typically modify the GUI to meet specific customer requirements. This is a unique approach, as we will tailor the interface of your system, to meet your exact requirements. All customers and users have different key parameters, or product of key parameters that they want displayed or visualised on the user interface. We design it to meet your requirements.

We also supply all of our systems with our EquTrack tracking system. This keeps track of service intervals of selected OEM components on your system, to reduce down time and ensure reliable operation. This can include (not limited to) vacuum pumps, gauges, mass flow controllers, valves etc. The service intervals are adaptable, so that they are tied into the physical actual use, rather than being based on time.

All to make your system more available, and reduce cost of ownership.



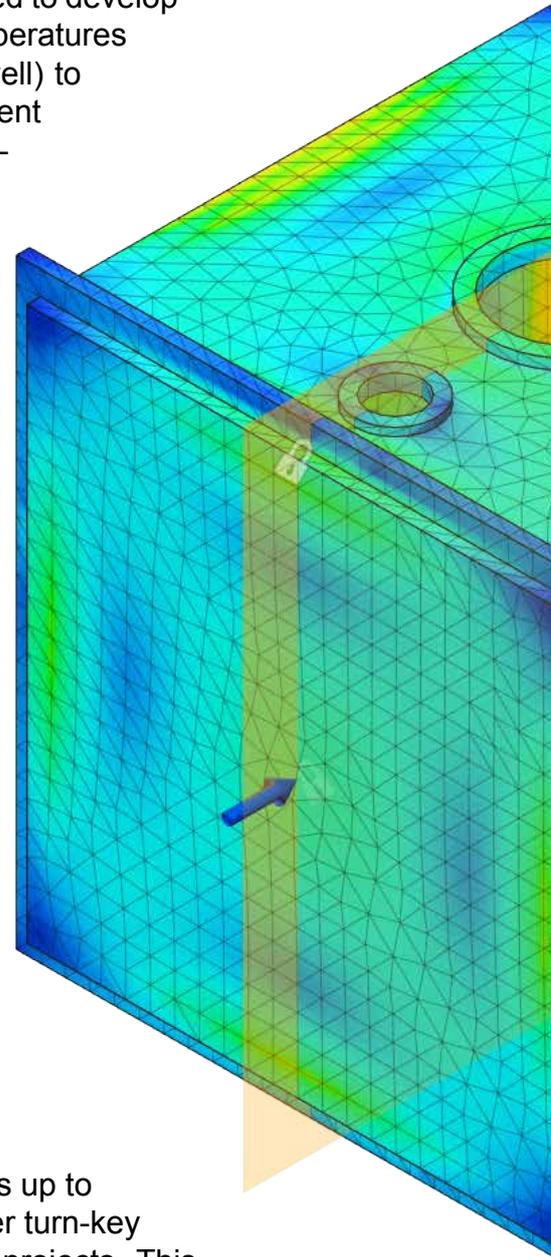
CUSTOM

SOLUTIONS is core to what we do. As our customers and end-users are active in the front-line of science and technology, almost all projects require custom solutions or the development of new technology solutions. It could be from very simple solutions to manipulate the height of a DUT in a test chamber, to being able to mask certain parts of a DUT during different parts of the test. Due to the nature of the business that our customers are in, dealing with extreme temperatures is critical, and in response to this we are required to develop interfaces and thermal units and solutions that can deal with temperatures from as low as -180°C (lower temperatures have been done as well) to up over $+200^{\circ}\text{C}$. In many cases there are interfaces between different materials, which requires custom seals and custom sealing solutions. We work with the leaders in the industry to solve these problems, and of course in close communication with our customers. The key objective is to meet (and exceed) the requirements of our end-users, ensuring that they can test their products so they can survive the harsh environment of space. Vacuum is not the only challenge, but temperature is a key testing parameter. We can also assist in simulating sunlight in our chambers, as well as having solutions that can handle propulsion tests. In all aspects of the development the crucial part is selecting the best, and most suitable components to achieve the requirements of the test.

Choice of material, and choice of OEM (original equipment manufacturer) supplier is critical in achieving project success. Nanovac focuses on working with tier one suppliers, ranging from manufacturers of vacuum pumps, to control automation and thermal control units. Where there is no suitable manufacturer or supplier, we develop our own solutions to ensure the best possible performance. Our extensive experience in vacuum and system automation ensures that you get the best possible solution, with the lowest cost of ownership. And, because of the fact that we have a large number of installed solutions worldwide, it is quite likely that we have already built and designed something that meets your requirements.

The typical lead time for our custom solutions range from 6 months up to 12 months depending on the level of complexity. We always deliver turn-key solutions, and installation and start-up is always included in our projects. This means that our experienced engineers will come to your facility and assist in installing the system, and then bringing it up and running. We spend time training the people who are supposed to be operating the machine. Both operators and service personnel. We work with your team to ensure we understand the expectations on the equipment, as well as defining the operational limits of the equipment.

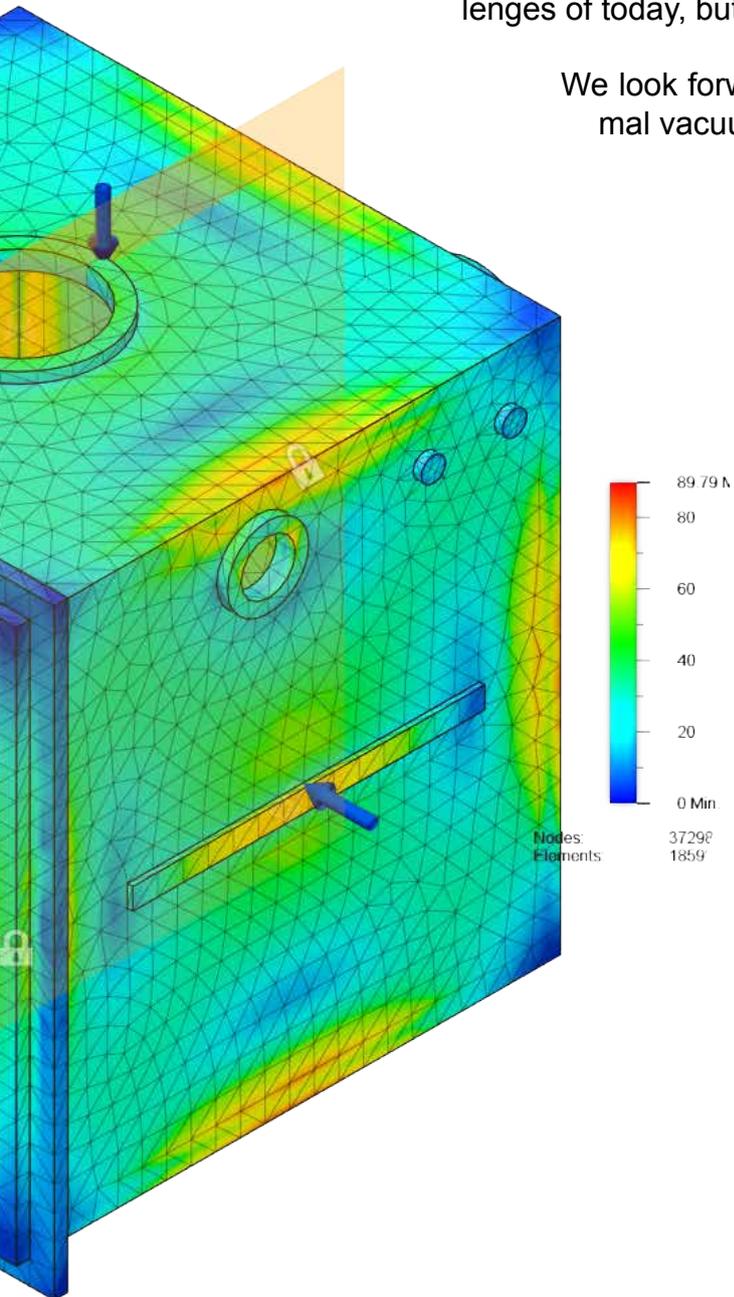
All the documentation (operations, maintenance) provided is provided as PDF files, and in some cases there are also video material supplied, outlining the various tasks required. We also deliver all our systems with a standard 24 month warranty on all parts and labour, excluding con-



sumables.

We see all of our customers as partners, and we see each relationship as long lasting relationships where we assist you in your growth. We pride ourselves on having a larger number of returning customers where we have delivered not only one chamber, but multiple chambers. We also believe strongly that the equipment that we deliver need to be able to meet future requirements, and this is achieved by building solutions that are flexible, not only from a mechanical point of view but also from an automation and control capability point of view. Our chamber should last for a long time, and be able to meet not only the challenges of today, but also the challenges of tomorrow.

We look forward on working closely with you on your future thermal vacuum requirements.





Företagsvägen 3, 245 34 Staffanstorps, Sweden
@ : info@nanovac.se - <https://nanovac.se>

