

# APPLICATIONS IN HIGH ENERGY PHYSICS





## EDWARDS THE PARTNER OF CHOICE

**Edwards is a world leader in the design, technology and manufacture of vacuum pumps with over 95 years' history and more than 75 years' manufacturing experience.**

We believe in delivering results that bring value to our customers by using our breadth of industry experience to identify and apply solutions to your problems. Using the most innovative and up-to-date modelling techniques, we can optimise the pumping configuration for customers to provide a system design giving the maximum performance in the most reliable and cost-effective way.

## PERFORMANCE YOU CAN RELY ON

**High energy physics is the science of the very small, the study of the fundamental building blocks of nature and the origins of the universe around us.**

Research and development in the field of high energy physics is full of complexity and twists and turns, driven by the desire to understand and explain the basic constituents of matter. This has paved the way to challenging and exciting experiments, whose feasibility and success are highly dependent on the sustainability of a stable vacuum environment and resilient equipment for this.

Edwards, a technology leader in vacuum, has a deep understanding of High Energy Physics applications and the critical role that vacuum plays at every stage. This experience, coupled with class-leading products and application know-how, allows us to offer a broad range of solutions enabling you to push the boundaries of modern physics.

From the smallest school laboratory to the world's largest particle accelerators, Edwards' products and services are facilitating education, development and scientific evolution across the globe.

Optimised solutions for performance from atmospheric pressure to ultra-high vacuum

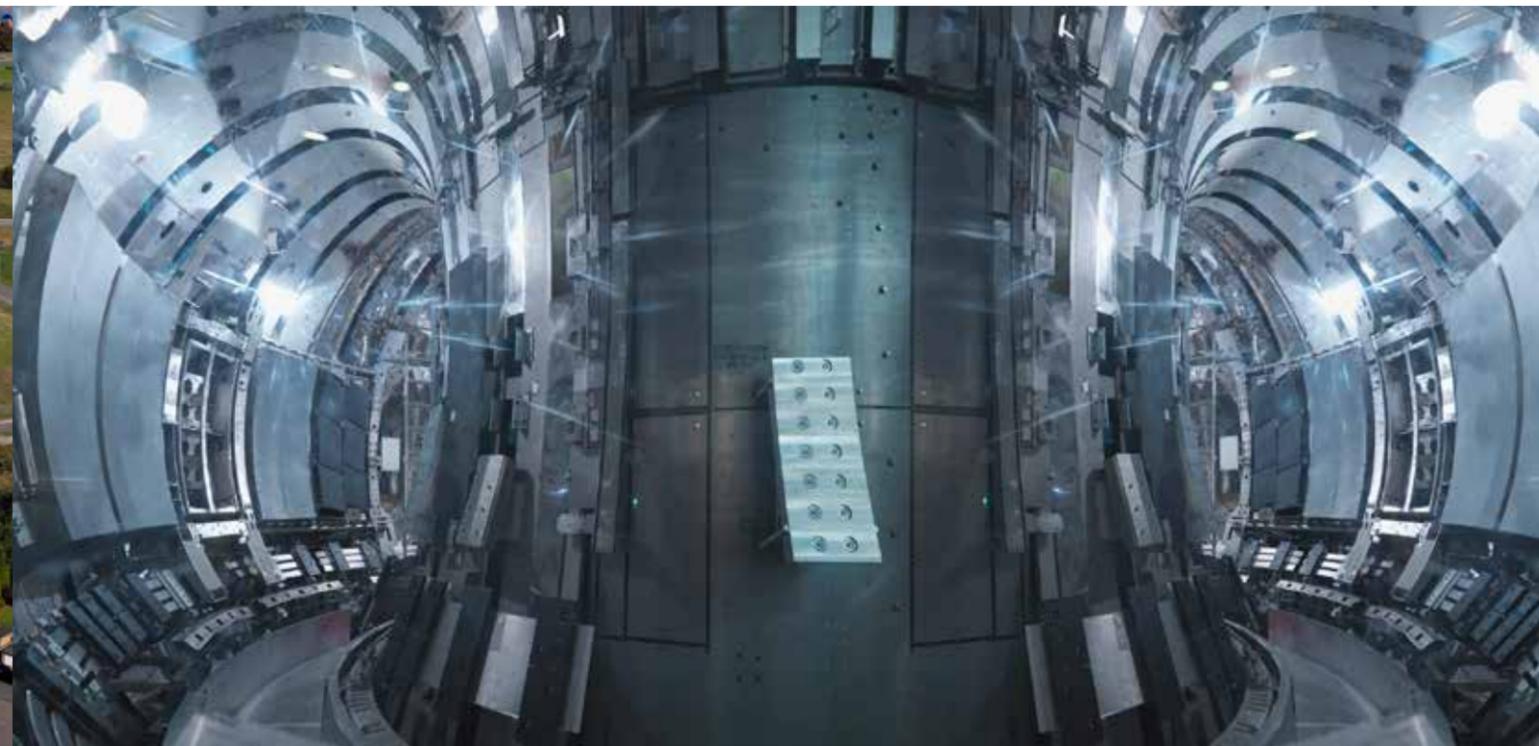
**The widest portfolio of pumping mechanisms**

A broad depth of application and simulation experience across the vacuum industry

**Not just pumps but complete solutions**

High uptime solutions with proven repeatable performance

**Increased productivity and dependable reliability**



## Synchrotron

A synchrotron is a type of particle accelerator able to produce intense beams of x-rays, infrared or ultraviolet light which can be as much as 10 billion times brighter than the sun. These beams can then be used to allow scientists to study samples of any material from metal to bacteria in incredible detail. In order to produce these high intensity beams with particles that travel at almost the speed of light, there is a need for a vacuum similar to that of outer space.

### Application example:

Edwards STP maglev turbomolecular pumps have been used extensively in the **NSRRC** (National Synchrotron Radiation Research Centre) in Taiwan, one of the world's brightest synchrotron facilities. Known for their reliability and high performance, STP maglev turbomolecular pumps can help obtain the optimum vacuum required for an increased photon quality and lifetime.

Edwards have also developed bespoke turbomolecular pumping stations for **Diamond Light Source**, the largest UK funded scientific facility. Each of these stations includes a turbomolecular pump, a dry scroll backing pump, a high vacuum valve, gauges and an integrated controller. By combining these elements within a compact and mobile 'plug and play' unit, researchers can avoid the cost and space required for fixed pumps on each beamline. These turbomolecular pumping stations are used for the initial pump down of the beamlines. Gamma Vacuum TiTan ion getter pumps are then used to achieve and maintain the UHV pressures needed for operation.

## Nuclear Fusion

Nuclear fusion is the process of combining atomic nuclei to produce a new bigger atomic nucleus. When atomic nuclei combine they release a large amount of energy, giving hope for a new source of power in the future. Research in this field largely involves attempts to recreate a reaction similar to that occurring in the sun by fusing two types of hydrogen, deuterium and tritium, to create helium. This requires considerable energy as the gas has to be heated to very high temperatures, up to 100 million degrees Celsius, causing it to become a plasma.

Nuclear fusion research, to a large extent, involves understanding the behaviour of plasma. One of the major challenges faced by scientists is the ability to sustain plasma by maintaining the right pressure. Hence the need for large-scale, effective vacuum systems that ensure ultra-high vacuum in the large reactor vessels/cryogenic system surrounding the superconducting magnetic field coils, and which can withstand very high temperatures, ionising radiation and high magnetic fields.

### Application example:

To meet this ever evolving demand, Edwards has designed and developed a special bespoke pump, based on our nEXT turbomolecular pump technology, which will be evaluated in some of the major facilities including **ITER** (International Thermonuclear Experimental Reactor). Equipped with a unique radiation resistant envelope around its rotor and electronics, the pump is also capable of providing an increased magnetic resistance. This, along with the flexibility of end-user serviceability, makes it ideal for nuclear research facilities.



## Gravitational Waves

Gravitational waves are ripples in the curvature of space-time which propagate as a wave, travelling outward from the source. Detecting these waves helps to confirm the explanation of gravity as predicted by Einstein's theory of general relativity. These waves propagate as vibrations in space and travel at the speed of light, which presents a number of experimental challenges to physicists.

Gravitational waves are detected using interferometers on the ground and in space. It is essential that the observatories housing the interferometers are perfectly clean and extremely stable; the whole interferometer must remain as optically perfect as possible. Any residual gas would affect the measurements, so the light beam has to operate under an ultra-high vacuum.

### Application example:

Edwards' XDS scroll pumps have been used for over 10 years by **Virgo** in Italy. The Virgo detector for gravitational waves has two 3km long tubes, each 1.2m diameter, which are the largest ultra-high vacuum vessels in Europe and the second largest in the world. With their innovative design and robustness, the XDS dry scroll pumps have been used for various experimental set-ups, including pre-evacuation and baking out of large vacuum chambers.

For more than 20 years the two LIGO observatories in the USA, which were the first gravitational wave observatory to detect gravitational waves, have relied on Edwards oil free dry pumps and STP magnetically levitated turbomolecular pumps.



## Colliders

Colliders are extensively used as a research tool for accelerating elementary particles to a very high kinetic energy and letting them collide with other particles. Analysis of the by-products of these collisions gives scientists good evidence of the structure of the subatomic world. Providing the right environment for highly evacuated beam lines and chambers has always been a challenge but Edwards is a pioneer in the development of vacuum products and can offer the best solutions - we understand that operating in such extreme domains is essential for the study of successful particle physics.

### Application example:

Years of experience in scientific application has helped Edwards provide vacuum solutions to **CERN's Large Hadron Collider**. Our XDS and nXDS dry scroll pumps are hermetically sealed with the bearings fully isolated from the pumping mechanism. This in turn means there are no lubricants under vacuum, eliminating the need for regular oil changes, hence reducing maintenance and eliminating the possibility of contamination which is vital for use in highly evacuated beam lines and chambers.

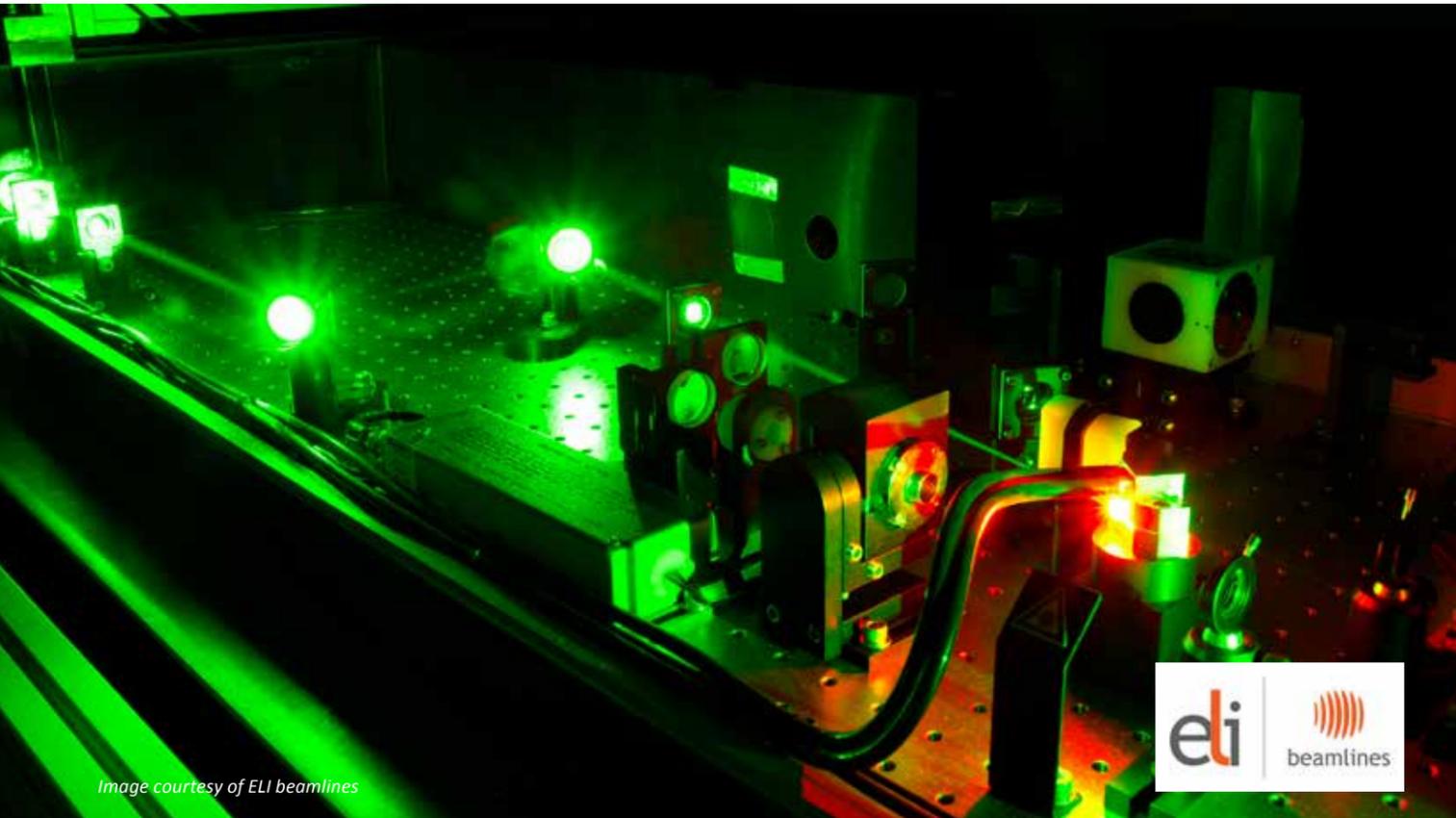


Image courtesy of ELI beamlines

## High Powered Laser Beams

High power laser beams are being increasingly used to investigate a wide range of domains from new fields in fundamental physics and gravitational physics to applications in medical science, material study and nuclear material management. These laser beams travel through multiple amplifiers to produce powerful pulses in the shortest interval possible. However, operation of these high intensity laser beams requires careful consideration in the design and building of the large vacuum systems to ensure maximum stability.

### Application example:

With a wide range of skills, experience and specialisation in unique tools and techniques, Edwards has been able to provide a first-class vacuum consultancy and training service to the **ELI** (Extreme Light Infrastructure) project in the Czech Republic, the high-power laser facility of the European Union. Specialising in unique tools and techniques, Edwards offer a vacuum modelling capability that is the best in the industry and can help you select the right pump, pipe and port sizes to ensure that the experiments and tests conducted cater to your requirements. In this case ELI were able to use the information on required pumps to help determine the size of the building needed to house the experiment. Edwards has also helped to train the vacuum team to enable them to understand the fundamentals that will help them maintain the vacuum systems in the future.

## Products

Edwards offers a broad range of vacuum products to meet the challenges presented by today's research and development laboratories. Whatever your vacuum pumping requirements, Edwards has the product solution.

### nEXT Turbomolecular Pumps

nEXT turbomolecular pumps are built on decades of experience and are based on our tried and trusted EXT and STP ranges. nEXT pumps offer superior performance, reliability and end user serviceability, setting the benchmark for scientific turbomolecular pumps.



Exceptional pumping speeds and compression ratios  
**Superior performance**

Field proven reliability in the most demanding environments  
**No unplanned downtime**

Huge install base of turbomolecular pumps  
**turbomolecular pumps**

End user serviceable  
**Low cost of ownership**

### STP Magnetically Levitated Turbomolecular Pumps

Edwards STP maglev turbomolecular pumps are at the forefront of vacuum for R&D institutes and high energy physics. The multi-axis, non-contact magnetic bearing system ensures there is no risk of contamination, while minimising noise and vibration. This also means zero maintenance for most applications and low cost of ownership, making the STP maglev turbomolecular pumps the ideal choice for critical and demanding applications.

Lubricant free  
**For zero risk of process contamination**

Ultra low noise and vibration levels  
**Stable process and work environment**

Intelligent and easy to use controls  
**Simple operation**

Self-adjustment and re-balancing  
**Zero maintenance, low cost of ownership**



## Gamma Ion Pumps

Gamma Vacuum, now part of Edwards, offers a wide product portfolio including ion getter pumps, TSPs, newly introduced NEG's and a range of control systems. Complementing its existing range of products, the addition of Gamma allows Edwards to offer a complete vacuum solution from atmosphere to UHV.



Vibration-free operation  
**Stable process**

Bakeability  
**Clean vacuum environment**

Ease of use of controllers  
**Simple operation**

Specialised variants available  
**Configured to your needs**

Widest portfolio of ultra-high vacuum pumps  
**Optimum solution for your requirements**

## Non-Evaporable Getter Pumps

Newly introduced into the Gamma portfolio, a range of Non-Evaporable Getter Pumps (NEG) pumps further extends the Edwards UHV capable product offering. NEG's have the capability to run without power (once activated) for extended periods of time and are particularly useful both for rapid pump-down to UHV pressures and for maintaining vacuum once achieved. NEG's can be integrated within an IGP for an extremely efficient pump combination.

Large gas capture capacity  
**Efficient pumping solution**

Operate without power (once conditioned)  
**Pump-down and stay-down**

Useful for maintaining UHV under shipping conditions  
**Retains system vacuum integrity**

Small and compact  
**Can be mounted close to chamber**



## T-Station 85 Turbomolecular Pumping Station

The T-Station 85 turbomolecular pumping station seamlessly combines the nEXT85H turbomolecular pump with either a dry pump or oil sealed pump and a simple controller and provides pumping speeds of 47 to 84  $\text{ls}^{-1}$ . This compact and robust turbomolecular pumping station is supplied fully assembled and ready to go for quick and easy operation.



Compact  
**Minimal footprint**

Fully assembled  
**No systemisation required**

Robust construction  
**High reliability**

End user serviceable  
**Low cost of ownership**

## nEXT Turbomolecular Pumping Stations

nEXT turbomolecular pumping stations have been developed to provide a comprehensive vacuum solution with the latest technological advances for easy installation and operation. With speeds of 47  $\text{ls}^{-1}$  to 400  $\text{ls}^{-1}$ , and now available with the nXDS dry scroll pump, the nEXT turbomolecular pumping station enables you to configure the most appropriate combination of turbomolecular and backing pump for your application.

A wide choice of turbomolecular and backing pumps  
**Configured to your needs**

Intelligent and easy to use controls with serial communications  
**Simple operation**

Fully assembled  
**No systemisation required**

End user serviceable  
**Low cost of ownership**



## Customised Turbomolecular Pumping Stations

In applications where one of our standard turbomolecular pumping stations does not fulfil your needs, Edwards also offer custom built turbomolecular pumping stations to meet your exact requirements. These can incorporate any of our nEXT turbomolecular pumps or our STP maglev turbomolecular pumps plus our full range of backing pumps and accessories.

## nXDS Dry Scroll Pumps

The nXDS has taken scroll vacuum technology to the next level. Improved performance, quiet operation and extended service intervals make nXDS the ultimate dry choice.



Quiet operation  
**Better work environment and low environmental impact**

Intelligent and easy to use controls  
**Simple operation**

Hermetically sealed for a lubricant free vacuum environment  
**No contamination and no oil to dispose**

Long service interval and low power consumption  
**Low cost of ownership**

Superior vapour handling  
**Quicker process**

## RV Oil Sealed Rotary Vane Pumps

The RV series of rotary vane pumps are the result of more than 75 years' experience and a clean sheet design programme to produce the ultimate range of small oil sealed rotary vane pumps. These rugged vacuum pumps offer an excellent ultimate, with good pumping speeds as well as superior vapour handling capabilities and quiet operation.

Fast acting, automatic inlet valve for best in class anti-suck back protection  
**Safe process and systems**

Mode selector and two position gas ballast  
**Configured to meet your vacuum needs**

Superior particulate handling  
**High reliability**

High vapour handling  
**Quicker process**

Designed for easy maintenance  
**No unplanned downtime**



## EPX High Vacuum Primary Pumps

The EPX series uses a unique, patented, single-shaft regenerative / Holweck® stage mechanism. They are ideal for applications where a better base pressure is required than can be delivered by a typical primary pump and where otherwise a turbomolecular pump and primary pump would be required and also for applications that cycle frequently from atmosphere to low pressures.



Zero routine maintenance with a 5 year service interval  
**Extremely reliable with low cost of ownership**

No grease or oil under vacuum and resents no other source of potential contamination  
**Ultra clean mechanism**

Low noise and vibration  
**Better working environment**

Unique patent protected pumping mechanism  
**Continuous operation at all inlet pressures**

## Measurement and Control

We offer a wide choice of vacuum measurement and control products – from dial gauges to microprocessor based gauge controllers. Within each product range, there is a family of models designed to meet the widest user specification.

Measurement over the range 2000 to  $10^{-11}$  mbar  
**Correct gauge to meet your needs**

Advanced microprocessor based controllers  
**Robust and reliable**

Certification of instruments to UK national standards available  
**Traceable vacuum measurement**



			HIGH ENERGY PHYSICS				
			Accelerators/LINAC	Beamlines & End Stations	Accelerators/LINAC	Gravitational Waves	Lasers
Rotary Vane Pumps	Single Stage	ES	+	+	+	+	+
	Two Stage	E2M small	+	+	+		+
		RV	+	+	+		+
		E2M medium and large	+	+	+		+
Small Dry Pumps	Diaphragm Pumps	XDD1	✓		✓		
	Scroll Pumps	nXDS, XDS	✓	✓	✓	✓	✓
Large Dry Pumps and Systems	Multi Stage Roots Pumps	iXL120 (clean pumping)	✓	✓	✓		✓
		iXM (medium duty)	✓	✓	✓		✓
	Roots Claw Pumps	iXH (Harsh duty)	✓	✓	✓		✓
		iGX (light and medium duty)	+	+	+		+
		iH (harsh duty)	+	+	+		+
	Screw Pumps	GXS	✓	✓	✓		✓
	Screw Pumps for ATEX Environments	CXS	✓	✓	✓		✓
High Vacuum Primary Pump		EPX	✓	✓	✓	✓	✓
Turbomolecular Pumps	Hybrid Bearing	nEXT	✓	✓	✓	✓	✓
	Magnetic Bearings	STP	✓	✓	✓	✓	✓
	Pumping Stations	Turbomolecular pumping stations	✓	✓	✓	✓	✓
UHV Pumps	Ion Getter Pumps		✓	✓	✓		✓
	Titanium Sublimation Pumps		✓	✓	✓		✓
	Non Evaporable Getter Pumps		✓	✓	✓		✓
Oil Vapour Diffusion Pumps		Diffstaks		+	+		
		HT Diffusion Pumps			+		
		Vapour Boosters			+		
Vacuum Instruments	Measurement and Control		✓	✓	✓	✓	✓
	Leak Checkers		✓	✓	✓	✓	✓
Vacuum Hardware	Valves		✓	✓	✓	✓	✓
	Pipeline Components		✓	✓	✓	✓	✓
	Flanges and Fittings		✓	✓	✓	✓	✓
Lubricants and Sealants	Oil		+	+	+		+
	Grease		+	+	+		+

✓ Recommended technology  
+ Conventional technology



## Service you can trust

At Edwards we pride ourselves on developing service solutions that deliver optimum performance and up-time for our customers. Convenience, quality and value are at the heart of everything we do. Whether you are looking for immediate help and advice, or require a long-term total service partner, we make the performance of your business our priority.

## Well-maintained systems last longer

Maximise the lifetime of your product by servicing your own products regularly using original parts and tooling. Edwards can support you with spares, maintenance kits, tools and training. Combining the reliability of original spare parts with quality tools means you are well on the way to achieving years of trouble-free operation.

## Prolonged peace of mind

Extending the new equipment warranty gives you a simple opportunity to add peace of mind to your purchase of new equipment, should a fault occur as a result of a manufacturing defect, equipment is expressly repaired or replaced. Cover is available on many of our products allowing the original factory warranty to be extended from 12 months to 2 years and beyond.

## Your global partner

We understand the importance of local support. Edwards has a number of major service facilities located throughout the world, each location is supported by an extensive team of engineers and technicians to provide local, rapid response and great value service. All our service operations are conducted at the highest international standards in accordance with ISO9001 (Quality), ISO14001 (Environmental), and OHSAS18001 (Workplace safety).



## GLOBAL CONTACTS

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