

## Vacuum Solutions for the LHC

The German company *Pfeiffer Vacuum* has received yet another major order for turbopumps and turbo pumping stations from CERN. CERN is situated in Geneva on the Franco-Swiss border and is the largest center for particle physics research in the world. It runs the Large Hadron Collider (LHC); with a circumference of some 27 kilometers, it is the world's largest particle accelerator which is used for colliding proton and ion beams at nearly the speed of light.

The accelerated particles travel in beam lines, which require ultra-high vacuum (UHV) conditions. These beam lines are pre-evacuated with turbo pumping stations. Furthermore, turbopumps with a very high compression ratio for light gases are then responsible for generating the insulation vacuum. The insulation vacuum is necessary for the operation of the superconducting magnets at a temperature of  $-271\text{ }^{\circ}\text{C}$ . The new order comprises the construction and installation of several hundreds turbopumps

“HiPace” and turbo pumping stations of the “HiCube” series. The special technical challenge is the installation of the pump controls outside the radiation-exposed space. That requires wiring with a length up to 1000 m (350 ft).

The cooperation between CERN and *Pfeiffer Vacuum* is based on many years of working together in a spirit of trust. As early as 1958, the former *Arthur Pfeiffer GmbH* developed the turbopump with the objective to generate a hydrocarbon-free vacuum. At that time, CERN was one of the first customers to buy this innovative technology and has continued to be a major user of what is being supplied by *Pfeiffer Vacuum*.

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## Fastest Laser Wavelength Meter

**Manufacturer:** Bristol Instruments.

**Distribution:** MG Optical Solutions.

**Product:** Laser Wavelength Meter “871” series which provides the fastest, most reliable method to accurately measure the wavelength of CW and pulsed lasers.

**Features:** The “871” Series measures laser wavelength to an accuracy as high as  $\pm 0.2$  part per million and is automatically calibrated with a built-in wavelength standard, which maintains its performance over time. Due to its unique Fizeau etalon design, it also offers exceptional measurement repeatability:  $\pm 0.0075$  parts per million ( $\pm 2.25$  MHz at 1000 nm) for the model “871A” and  $\pm 0.1$  part per million ( $\pm 30$  MHz at 1000 nm) for the model “871B”. In addition, the series provides a sustained measurement



rate of 1 kHz, which is the fastest available. The resulting time resolution of 1 ms provides the most detailed wavelength characterization of tunable lasers, as well as the fastest feedback for laser wavelength stabilization.

Software is provided to control measurement parameters and to report data, or the system can become part of an experiment using a library of commands for custom or LabVIEW programming. In addition, an integrated PID controller

benefits researchers who need active regulation of their laser's frequency. This can be useful for applications such as laser cooling, ion trapping and manipulation as well as for all kinds of spectroscopy. Last but not least it is well established for reliable quality control in development and production.

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## Power Meter For High Power Densities

**Manufacturer:** PRIMES.

**Product:** New power meter “Cube M” which enables measurements up to power densities of  $250\text{ kW/cm}^2$ .

**Features:** The device features an ultra-compact design ( $60 \times 65 \times 80$  mm), which enables the use in the smallest of spaces. It is designed to monitor laser power in day to day production, directly underneath the processing optics. As the angle of beam incidence may vary

$\pm 20^{\circ}$ , the power meter is ideal for micro machining and additive manufacturing applications. The device comes with an easy, single button operation while the Bluetooth interface enables a convenient and wireless control with a smartphone or tablet PC. The “Cube App” enables the graphical display and interpretation of measured values, as well as the definition of presets for measurement series.

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## High-density Arbitrary Waveform Generator

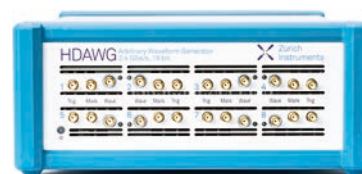
**Manufacturer:** Zurich Instruments.

**Product:** Arbitrary waveform generator “HDAWG” with the highest channel density and shortest trigger latency (<50 ns) on the market.

**Features:** The device comes in either a 4 or 8 channel configuration, both offering a 16-bit output and signal cache of 500 MSamples per channel. The maximum sample rate is 2.4 GSa/s at a signal bandwidth of 750 MHz, and each signal output has both a TTL marker-output and a TTL trigger input. Furthermore, there is a 32-bit digital Input/Output which can produce and read complex bit-patterns. For applications where a large number of channels are required, multiple instruments can be synchronized and centrally controlled. The device is controlled via the browser-based “LabOne” user inter-

face and through MATLAB, LabView, Python, .NET, or C. Sequences can be easily written, edited and compiled using the embedded scripting language and compiler. The resulting sequences are lean and can be swiftly transferred to the instrument over 1 Gb Ethernet or USB 3.0. This saves time and increases workflow efficiency, and allows the user to maintain an overview of complex signal patterns.

**Applications:** The “HDAWG” has been developed to meet the highest R&D requirements, for example, in Quantum Computing Applications to produce pulsed signal sequences with minimal noise. Further applications include NMR, electronic component testing, spectroscopy, and Radar/Lidar.



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## High-Power DPSS Laser in Red

**Manufacturer:** Laser Quantum.

**Product:** High-powered red DPSS laser “axiom 660” with excellent noise and stability as well as a market-leading power output up to 6 W at 660 nm.

**Features:** The laser has an integrated diode pump in head for easy incorporation into equipment, without the complexities associated with fiber delivery of the pump light. Together with its ultra-compact power supply unit, it forms a small-scale laser system unique for the power level of several watts. Thanks to its innovative stress-free cavity architecture, it has excellent beam characteristics ( $M^2$  near 1) and a power stability of < 1.0% RMS. The laser can be cooled via internal water channels.

**Application:** The laser is suitable for a range of applications, particularly PIV, Raman imaging and optical trapping. PIV is an optical technique used to visualize flow and direction of a fluid. The

high-power intensity and the ability to shape the beam allow a 2-dimensional light sheet to be created and form a canvas of the image. The high power will enable visualization of a larger flow cross-section or a brighter image, and the excellent beam pointing stability minimizes any corruption of velocity tracking within the light sheet. Raman imaging generates detailed chemical images based on a sample’s Raman spectrum. The wavelength of 660 nm is commonly used for Raman spectroscopy and the high power allows imaging of Raman emission over a large area, not possible with lower powers. Optical trapping uses a range of wavelengths, largely determined by the absorption spectrum of the sample or the medium in which it is held. With its beam parameters, and its impressive pointing and power stability, the laser allows precise control of the position and strength of the trap.



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## Online Tool for the Selection of Vacuum Pumps

**Supplier:** VACUUBRAND.

**Product:** Online tool “Vacuum Pump Selection Guide” (www.vacuubrand.com/vpsg) which makes the process of finding the right technology and the best vacuum pump match for individual requirements much easier.

**Features:** With a few simple clicks, the user can select the chosen application and specify a few important parameters to reduce the choices down to the best proposed options. A more detailed de-

scription and the technical data allow the direct comparison between the different models. For further technical questions, the product specialists can be contacted with just one further click. Thus the users can choose the right system for their application and their specific requirements without the need for any additional help or expert knowledge. In addition, it is always possible to contact the company’s product specialists by phone.

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## True Non-Contact Atomic Force Microscope

**Manufacturer:** Park Systems.

**Product:** True Non-Contact AFM “NX10”, featuring industry-leading Z-servo speed, XYZ scanner linearity, closed-loop detector noise, and minimized thermal drift.

**Features:** With industry-leading Z-servo speed, the device improves *Park Systems’* “True Non-Contact Mode” for even higher accuracy, faster scan speeds, and longer tip life. The advanced XYZ closed-loop scanning is based on *Park Systems’* industry-leading low-noise Z position sensor. By using a Z position sensor to monitor the real-time extension of the Z scanner, the AFM records the true heights of sample surface features, even during high-speed scanning, without the effects of piezo creep or edge overshoot. With its

advanced closed-loop scanning design, it records true sample topography without any need for frequent and cumbersome recalibration.

The AFM will be featured during the 1st NanoScientific Forum Europe 2018 (NSFE), in Freiberg, Germany, October 10 to 12 (registration at [www.parkafm.com/NSFE2018](http://www.parkafm.com/NSFE2018))

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## New Spectrograph

**Manufacturer:** Andor Technology.

**Distribution:** LOT-QuantumDesign.

**Product:** Flexible spectrograph “Kymera 328i” for advanced applications in spectroscopy. The device is successor of the successful spectrograph “Shamrock 303i”.

**Features:** The new grating turret design provides enhanced flexibility by four gratings that guarantee maximum transmission through on-axis configuration. It also optimizes resolution, bandwidth and grating efficiency for various spectral ranges from UV to NIR. Further turrets are automatically recognized to the spectrograph and software by RFID transponders. The spectrograph comes in all combinations with one or two input and exit ports. This facilitates two different, even complex, experiments and the use of various detectors like CCD, EMCCD, ICCD, sCMOS and InGaAs cameras. One of the exit ports can be furnished



with a slit to turn the spectrograph into a monochromator with photodiode or photomultiplier. The patented “Adaptive Focus Technology” uses a motorized main mirror to ensure optimum focusing of the spectrum for each grating and wavelength with a click of the mouse. A focal length of 328 mm and an outstanding imaging optic facilitates a typical spectral resolution of 0.1 nm with a grating of 1200 lines/mm and a CCD detector with a 13.5 µm pixel size. With an iris diaphragm, it

is possible to further increase the resolution to <0.07 nm (“TruRes”). Depending on the shutter diameter, the resolution improves by over 30% as off-axis beams are suppressed at small apertures. Spectral lines that are very close together can thus be separated more easily and/or be resolved at all. Furthermore, “TruRes” prevents aberrations at the edges of the focusing area at the exit port. This way, more spectra can be detected at the same time.

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## New Generation of Stainless Steel Connections

**Manufacturer:** Schwer Fittings.

**Product:** Pipe connections “Zero-Con-Crown” made of solid high-purity stainless steel (stainless steel 1.4435 according to EN 10088-3). The fittings serve as a safe and quick threaded connection of pipe networks, pipe joints and welded systems.

**Features:** Thanks to its consistent material quality, the connection is absolutely leak-tight (Helium-leak-rate ≤ 10<sup>-12</sup> mbar). It offers highest-grade surface finish (Ra ≤ 0,4 µm) and zero material

outgassing. There are zero dead spaces and zero flow disturbances. The fittings in their aseptic design form a perfect pharmaceutical barrier without risk of bio-burdening. The robust connection is suitable for application under high-pressure, critical vacuum and extreme temperature conditions. The interlocking geometry designed to prevent influence of external forces and moments provides dynamic stress resistance. The connection is temperature-stable, from -273 °C to +450 °C.

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## FIB-SEM for Nanofabrication

**Manufacturer:** Raith.

**Product:** Focused Ion Beam-SEM “Velion” for FIB-centric nanofabrication, the world’s only FIB-SEM which truly defines FIB as the priority technique. The system and its fascinating application range will be presented at the EIPBN in Puerto Rico (May 29 to June 1).

**Features:** To meet the most demanding requirements both in R&D nano prototyping as well as sample preparation and microscopy, the ion column is installed vertically in the system. Supported by a proprietary fast field emission SEM column and its unique Laser Interferometer Stage, the SEM is equipped for various research and development tasks. It provides versatile FIB nanofabrication across large areas with all direct and 3D patterning techniques. Complementing Electron

Beam Lithography it helps to achieve scientific results faster by easy in-situ optimization and less process steps. At the same time sample preparation and inspection applications like X-section analysis and TEM lamella are enabled by live high resolution SEM imaging. FIB and even multiple non-contaminating ion species beyond Gallium and new patterning approaches are now available with lithography class stability and precision.

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## New options for the Physical Property Measurement System (PPMS)

**Manufacturer:** Quantum Design.

**Distribution:** LOT-QuantumDesign.

**Product:** The “Physical Property Measurement System” (PPMS) is a multifunctional platform with various options for sample characterization (for example, specific heat, magnetic properties or transport phenomena). The PPMS now features options for optical experiments, a complete set-up for Raman spectroscopy and the elastic properties by ultrasound.

**Features:** The easiest way to transport light to or from a sample is the “Multi-Function-Probe” (MFP) fiber. It consists of a set of fibers that perfectly match the MFP. The MFP can be used with either one or two optical fibers, for instance for sample illumination. In combination with an electrical measurement the photo-conductivity of a sample can be determined. As an alternative, there is an “Optical-Multi-Function-Probe” (OMFP) that allows free-beam access to the sample via optics. The OMFP comes with a positioner that facilitates positioning and for example the exposure to focused laser beams in selected areas.



The Raman option allows spectroscopic measurements in the field and temperature range of the PPMS. The Raman package includes all components necessary for measurements, like laser, spectrograph, optics etc. Integration with the system software “Multi-Vu” allows the automated collection of spectra.

With the brand-new “USEC”-option (ultrasonic elastic constant) there is now for the first time a commercial solution for measurements of elastic properties by ultrasound available. The measurement principle is rather simple: An ultrasonic pulse is created on the sample surface by a piezoelectric transducer. This pulse travels through the sample and can either be detected on the opposite side or its reflection is measured. The option detects even the slightest changes in velocity and is well suited for tracking phase transitions.

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