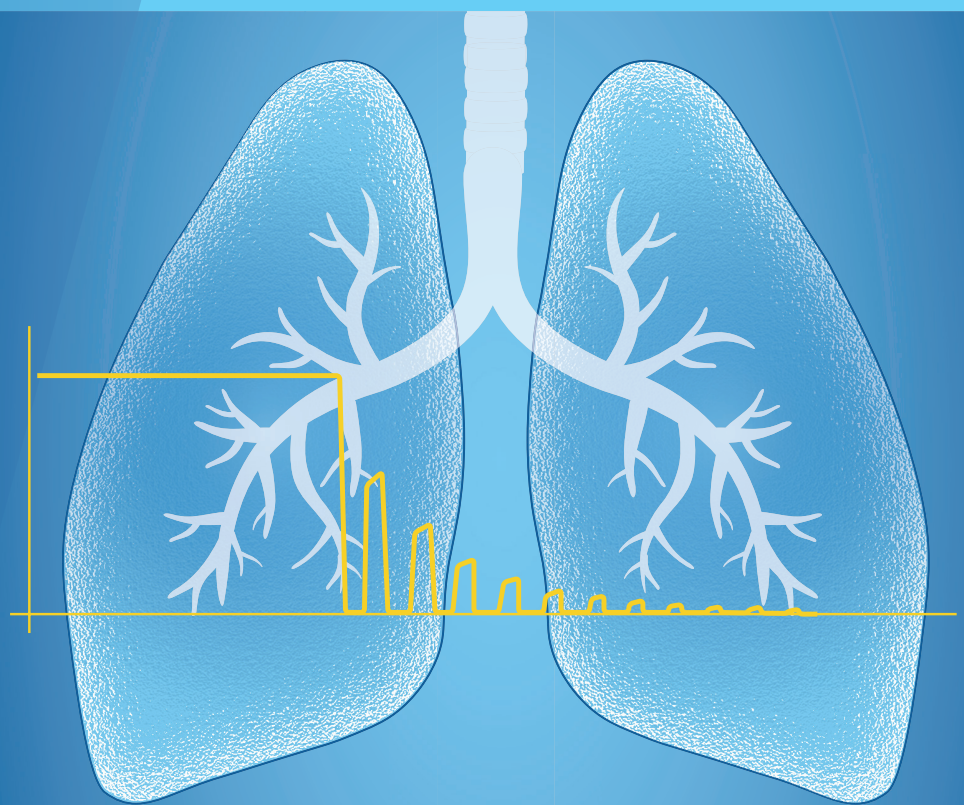


PULMONARY FUNCTION TESTING

EXHALYZER® Plus

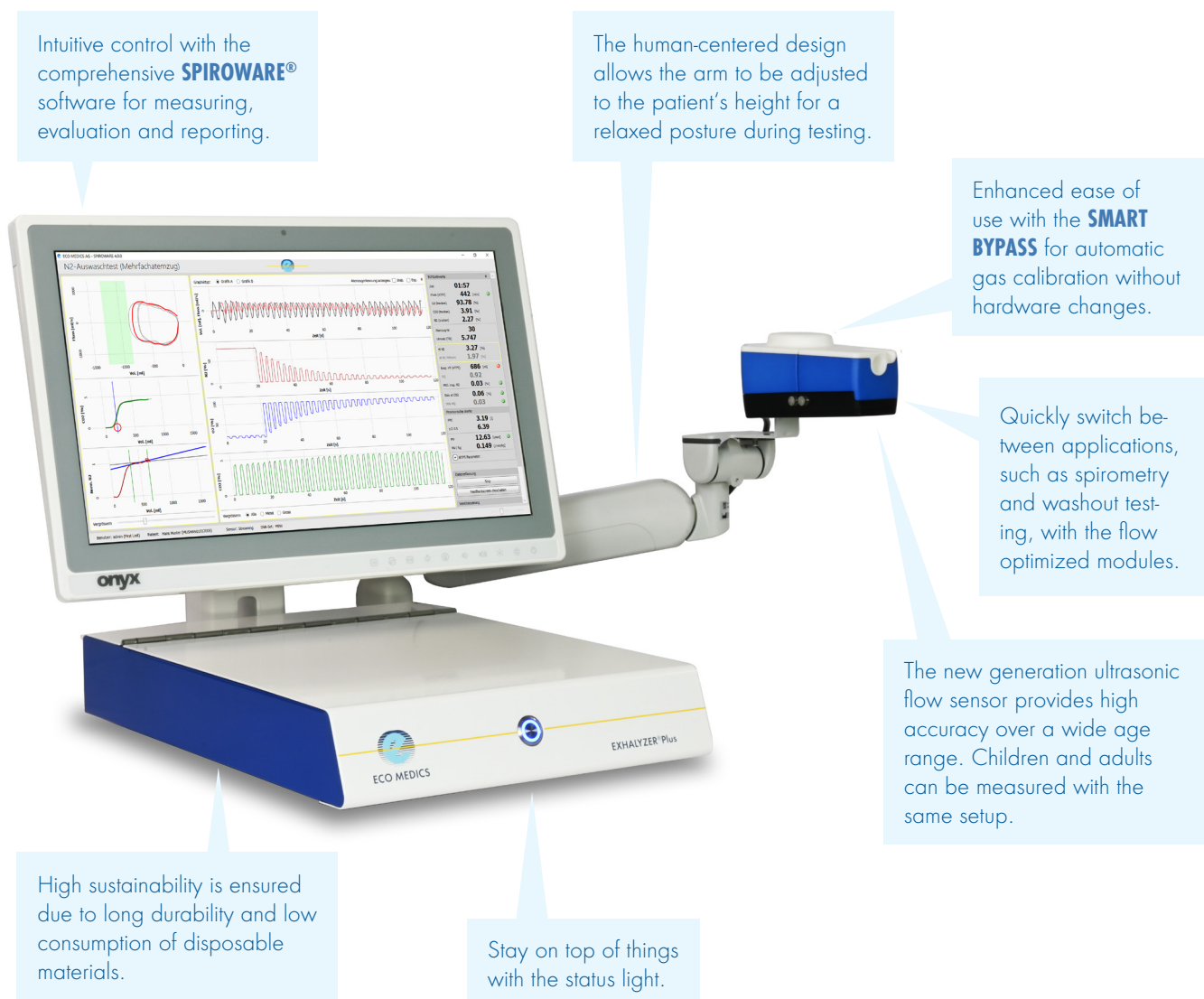


COMPREHENSIVE PULMONARY FUNCTION TESTING

Early detection of small airway disease such as asthma, chronic obstructive pulmonary disease (COPD) and cystic fibrosis (CF) is of great importance for further disease progression. The **EXHALYZER®Plus** offers comprehensive possibilities for effective pulmonary function testing, including the

most widely applied spirometry and more sensitive multiple breath washout, revealing detailed information on the small airways. Controlled by **SPIROWARE®** software, it is easy to use and meets highest standards of functionality.

EXHALYZER®Plus



References:

1. Robinson, P. D. et al. Consensus statement for inert gas washout measurement using multiple- and single-breath tests. *European Respiratory Journal* 41, 507–522 (2013).
2. Robinson, P. D. et al. Preschool Multiple-Breath Washout Testing. An Official American Thoracic Society Technical Statement. *Am J Respir Crit Care Med* 197, e1–e19 (2018).
3. Stanojevic, S., Bowerman, C. & Robinson, P. Multiple breath washout: measuring early manifestations of lung pathology. *Breathe (Sheff)* 17, 210016 (2021).
4. Graham, B. L. et al. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. *Am J Respir Crit Care Med* 200, e70–e88 (2019).

WIDE RANGE OF PULMONARY FUNCTION TESTS

From tidal breathing analysis to inert gas washouts, from volumetric capnography to spirometry, the **EXHALYZER®Plus** offers various tests to assess lung function.

→ MULTIPLE BREATH WASHOUT (MBW)

is a more sensitive method for early detection of lung disease and damage to the small airways than spirometry, which assesses the larger airways. The test measures how fast an inert gas can be removed from the lungs. Typically, the decline in nitrogen concentration is measured while breathing pure oxygen.^{1,2,3}

→ LUNG CLEARANCE INDEX (LCI, Scond, Sacin)

is the main outcome of the multiple breath washout. It describes the overall gas mixing efficiency of the lung. Further parameters can distinguish the location of ventilation inhomogeneity.

→ SINGLE BREATH WASHOUT (SBW)

presents a quick alternative to assess ventilation inhomogeneity.¹

→ TIDAL BREATHING ANALYSIS

is a simple and noninvasive tool, requiring only minimal patient cooperation.³

→ SPIROMETRY

is widely used to assess and monitor overall lung function.⁴

→ VOLUMETRIC CAPNOGRAPHY

allows the determination of further physiological information based on CO₂ dynamics.

AUTOMATIC CALIBRATION

The new **SMART BYPASS** of the **EXHALYZER®Plus** is designed to automatically calibrate the gas concentrations for reproducible and precise operation.

ATS/ERS COMPLIANCE

All lung function tests are performed and evaluated according to the current recommendations of the ATS and ERS.^{1,2,3}

UNMATCHED ACCURACY

The **EXHALYZER®Plus** incorporates a next-generation ultrasonic flow measurement that reduces the influence of turbulence, humidity and temperature changes in the respiratory flow.

WIDE AGE RANGE

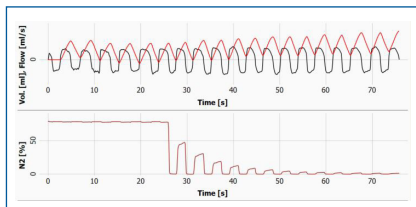
Exchangeable accessories guarantee optimal conditions for the measurement of different age groups from children to adults.

STEP-BY-STEP USER GUIDANCE

Operator and patient are guided with easy to follow instructions through the preparation and execution of a measurement.

EXHALYZER®Plus APPLICATIONS

INERT GAS WASHOUT (N₂MBW)

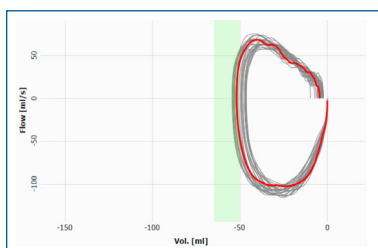


The washout test measures the efficiency of gas mixing in the lungs and is a very sensitive method for the diagnosis of small airway disease. The test requires the inhalation of pure oxygen to eliminate the lung's resident nitrogen. The washout test can be performed as a single breath or multiple breath test.

SELECTED PARAMETERS

→ FRC	→ Pacin*VT	→ Pacin	→ Vd CO ₂ Fowler
→ LCI _{2.5}	→ M1/M0	→ 1st breath SnIII*VT	→ Vd CO ₂ Langley
→ LCI ₅	→ M2/M0	→ 1st breath SnIII	→ TBVFL RQ
→ Scond*VT	→ Scond	→ norm. et N ₂ @TO ₆	→ TBVFL etCO ₂
→ Sacin*VT	→ Sacin	→ TLC	

TIDAL BREATHING ANALYSIS

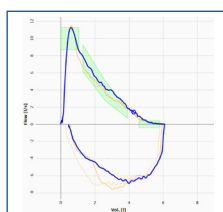


The analysis of tidal flow and volume is a simple, yet very valuable method to study lung function even in non-cooperating subjects.

SELECTED PARAMETERS

→ VT	→ TEF 75%	→ TEF ₅₀ /TIF ₅₀	→ O ₂ consumed
→ RR	→ TEF 50%	→ TEF ₇₅ /PEF	→ CO ₂ emitted
→ PIF	→ TEF 25%	→ TEF ₅₀ /PEF	→ Vd CO ₂ Fowler
→ PEF	→ TEF 10%	→ TEF ₂₅ /PEF	→ Vd CO ₂ Langley
→ MV	→ TIF 50%	→ TEF ₁₀ /PEF	

SPIROMETRY

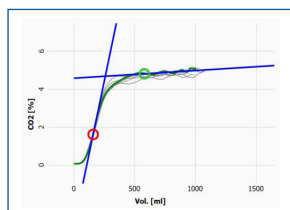


Spirometry is the most common pulmonary function test and measures the volume and flow of the inhaled and exhaled air.

SELECTED PARAMETERS

→ FVC	→ FEV _{0.75}	→ Insp. VC	→ FEF ₂₅
→ FEV ₁	→ FEV _{0.75} /FVC	→ FET	→ FEF ₅₀
→ FEV ₁ /FVC	→ FEV _{0.5}	→ Time to PEF	→ FEF ₇₅
→ PEF	→ FEV _{0.5} /FVC	→ FEF ₂₅₋₇₅	

VOLUMETRIC CAPNOGRAPHY (INDIRECT CALORIMETRY)



Volumetric Capnography reveals physiological information about metabolic production, circulatory transport and CO₂ elimination within the lungs, as well as the determination of dead space.

SELECTED PARAMETERS

→ etCO ₂	→ V'CO ₂	→ FACO ₂	→ VD _{alv}
→ CO ₂ emitted	→ Mean CO ₂ Exp.	→ VD _{daw}	
→ Reinsp. CO ₂ Vol.	→ SIII	→ VDBohr	
→ VolCO ₂ Netto	→ KPlv	→ VD _{phys}	

