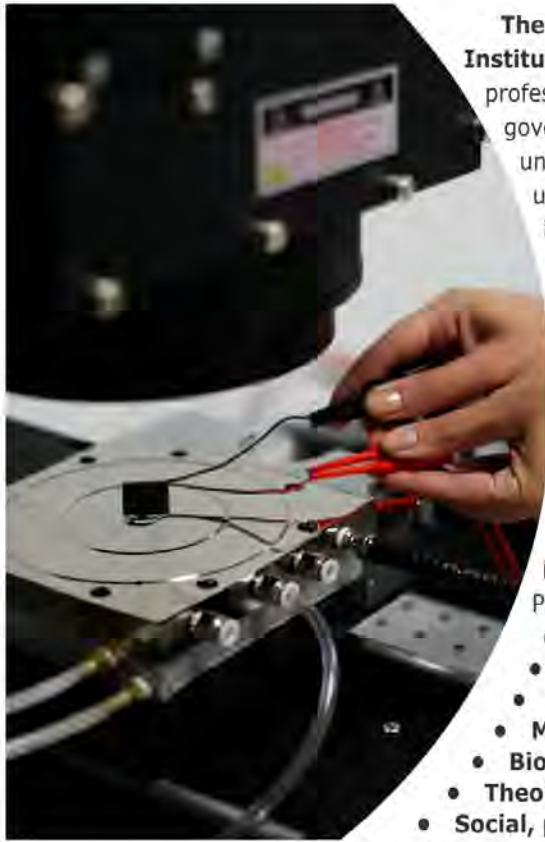




# **Institute of Multidisciplinary Research for Science and Technology "Valahia" University of Targoviste**

***EQUIPMENT AND RESEARCH SERVICES***





**The Multidisciplinary Scientific and Technologic Research Institute (ICSTM)** of "Valahia" University of Targoviste (UVT) is a professional and independent organization, apolitical and non-governmental, legally dependent of UVT, created to attend the university personnel and the other specialized collaborators of the university in realizing research projects, financed by national and international programs and trough contracts with businesses.

The ICSTM mission is to provide, coordinate, monitor and support scientific research, experimental development, innovation and technological transfer, consultancy, expertise, training and professional development in the areas of scientific competence of UVT. ICSTM reunites all the research centers accredited institutional in UVT. Now, ICSTM is composed of 17 research centers where the active staff and associated holders of UVT operate. Research infrastructure is spread over an area of 6720 m<sup>2</sup> developed area and 2220 m<sup>2</sup> built area, which includes 35 research laboratories and its own administrative body. Priority research fields of ICSTM are:

- **Renewable energy and electric systems;**
- **Environment and physico-chemical processes;**
- **Nanomaterials and micromechanics;**
- **Mechanical engineering and materials science;**
- **Biotechnologies and biotechniques;**
- **Theology ;**
- **Social, political and communication sciences;**
- **Economical sciences.**

The Institute has the latest IT systems, software for designing and modeling in specific research areas. Among most representative features, we can include: experimental photovoltaic and wind power platform, experimental thermosolar platform, system for developing and prototyping PV modules, inductively coupled plasma mass spectrometer (**ICP-MS**), electric vacuum deposition and dielectric layers by sputtering, scanning electron microscope (**SEM**), facility for processing micromaterials and microchannels with focused electron beam (**FEB**), atomic force microscope (**AFM**), laser ablation, nanoindenter. In our research laboratories can be realized structural analysis, qualitative and quantitative analysis, morphological and structural determinations, atomic force microscopy (2D and 3D topography, phase contrast, adhesion forces etc.), electrical characterizations, prototyping and designing.

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## *ANNEX*

## A. Nanomaterials and nanotechnologies

### SCANNING ELECTRON MICROSCOPE (SEM) SU-70 COUPLED WITH ENERGY DISPERSIVE SPECTROMETER (EDS), WITH WAVELENGTH DISPERSIVE SPECTROMETER (WDS) AND E-BEAM LITHOGRAPHY SYSTEM (EBL) (Annex – position no. 1)

**The Scanning Electron Microscope (SEM) SU-70** (manufactured by Hitachi, Japan) is a very sensitive research equipment, with field emission, and is based on a Schottky electron source. SU-70 includes several modules required for surface analysis of materials; for processing materials nanolithography (EBL), energy dispersive spectrometry (EDS) and wavelength dispersive spectrometry (WDS).

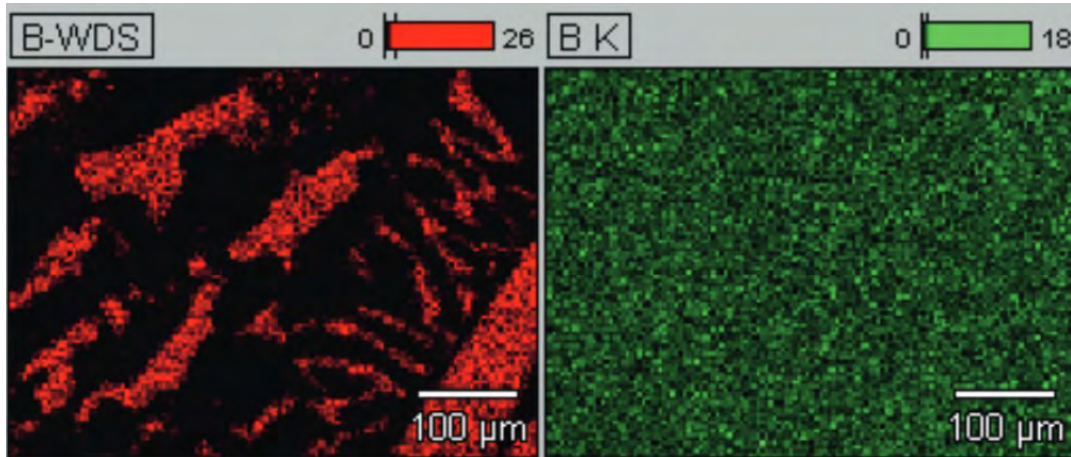
All these modules are attached to the equipment. The accelerating voltage ( $V_{acc}$ ) may vary from 0.1 kV to 30 kV. SEM magnification range of 30X-800.000X and resolution at 15 kV acceleration voltage is 1 nm. EDS spectrometer attached allows qualitative and quantitative analysis (from Be ( $Z = 4$ ) to Pu ( $Z = 94$ )) on the point, rectangle, circle or the free choice and multiple choice line analysis, X-ray mapping, solutions to overlapping peaks. WDS spectrometer attached allows qualitative and quantitative analysis (from B ( $Z = 5$ ) to Pu ( $Z = 94$ )).



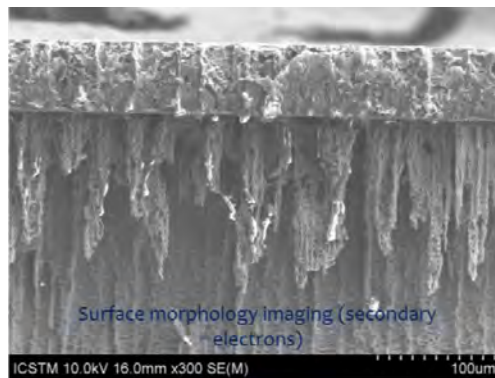
Applications field of SEM (coupled with EDS, WDS and EBL) is wide: characterization of micro- and nanomaterials, qualitative and quantitative analysis of samples, electron beam lithography and the achievement of "lab-on-chip" etc.

**Applications:**

- ✓ surface morphology imaging (secondary electrons) – SEM;
- ✓ surface topography imaging and compositional contrast (secondary and backscattering electrons) – SEM+BSE;
- ✓ elemental analysis and elements distribution on sample surface – EDS+WDS.



*Chemical map obtained by WDS.*



## NANOINDENTER AGILENT G200 *(Annex – position no.2)*

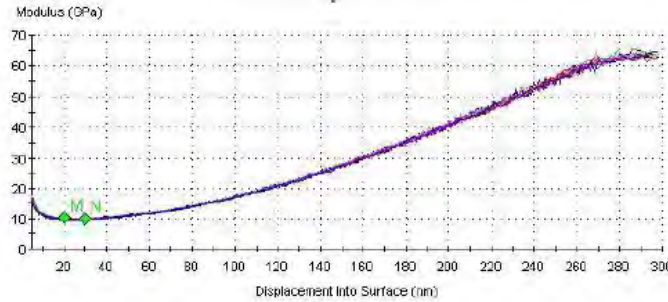
**Nanoindenter Agilent G200** is an instrument for indentation and scratch tests, thus mechanical properties can be determined for a wide range of materials including metals, composites, ceramics, polymers, fibers, thin films.

**Nanoindenter Agilent G200** is the world's most accurate, flexible and user-friendly instrument for nanoscale mechanical testing. Electromagnetic actuation allows the Nano Indenter G200 to achieve unparalleled dynamic range in force and displacement. Load capacity can be expanded to 500mN, maximum depth of indentation 500  $\mu\text{m}$ , load resolution is  $\leq 50$  nN, force at contact  $\leq 10$   $\mu\text{N}$ , scratching maximum distance  $> 100$  mm and speed of scratching - 100nm/s to 2mm/s.

**Nanoindentation** is a technique for measuring mechanical properties such as hardness and elastic modulus Young of small volumes of materials. A tiny tip of very precise geometry is made to press into a sample using a small load in order to make minute indentations on the sample. The load applied and the depth of penetration of the tip into the surface are measured in real-time during the indentation process. As the geometry of the indenter tip is known, the data recorded can be analysed to determine the indentation area.

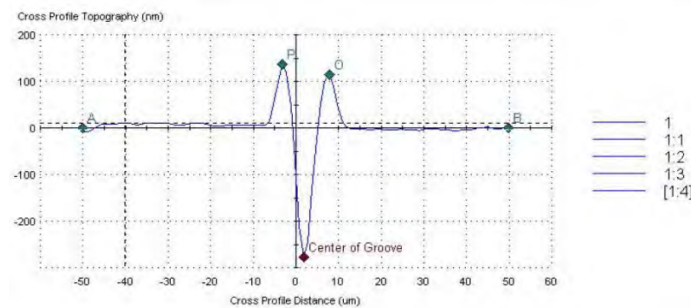


From these analyses, the mechanical properties of the sample can be measured.



*Indentation Test: Young Modulus - Displacement Curve*

**Test method according to ISO 1457.** The samples used in indentation and scratch tests can have a maximum size of the sample:  $\varnothing 30\text{mm} \times 10\text{mm}$ .



*Scratch Test : Cross Profile Topography – Cross Profile Distance Curve*

**Applications:**

- ✓ semiconductor, thin films, MEMs (wafer applications);
- ✓ hard coatings, DLC films;
- ✓ composite materials, fibers, polymers;
- ✓ metals, ceramics;
- ✓ biomaterials, biology.



## ATOMIC FORCE MICROSCOPE (Ntegra Prima by NT-MDT) *(Annex – position no.3)*

The device is capable of performing more than 40 measuring methods, which allows analyzing physical and chemical properties of the surface with high precision and resolution. It is possible to carry out experiments in air, as well as in liquids and in controlled environment. The new generation electronics provides operations in high-frequency (up to 5MHz) modes. By **AFM** three-dimensional images of surfaces can be obtained (insulators or conductors) with a nano resolution in the lateral plane and subangstrom vertically. This device is used in basic research as well as on larger scale in the industry where it has a special role in the development of nanotechnology. AFM is the most used technique of the Surface Scanning microscopy (SPM). There are several scanning types implemented in **NTEGRA Prima**: scanning by the sample, scanning by the probe and dual-scanning. On account of that, the system is ideal for investigating small samples with ultra-high resolution (atomic or molecular level) as well as for big samples and scanning range up to  $100\ \mu\text{m} \times 100\ \mu\text{m} \times 10\ \mu\text{m}$ . Built-in three axes closed loop control sensors trace the real displacement of the scanner and compensate unavoidable imperfections of piezoceramics as non-linearity, creep and hysteresis.



The sensors, which are used by NT-MDT, have the lowest noise level, thus allowing working with closed loop control on the very small fields (down to 10nm x 10 nm). NTEGRA Prima has a built-in optical system with 1  $\mu\text{m}$  resolution, which allows imaging the scanning process in real-time.

### **Measuring modes and techniques:**

#### **In air & liquid:**

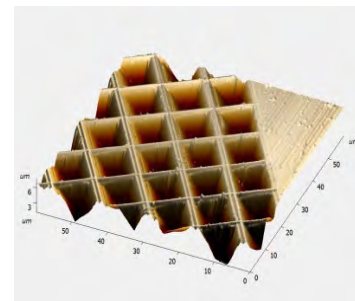
- ✓ AFM (contact + semi-contact + non-contact) / Lateral Force Microscopy / Phase Imaging / Force Modulation / Adhesion Force Imaging/ Lithography: AFM (Force);

#### **In air only:**

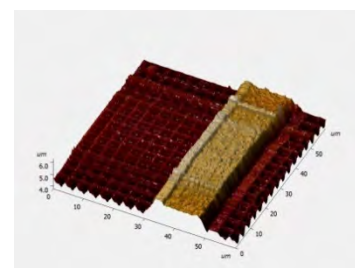
- ✓ STM/ Magnetic Force Microscopy/ Electrostatic Force Microscopy/ Scanning Capacitance Microscopy / Kelvin Probe Microscopy/ Spreading Resistance Imaging / Lithography: AFM (Current), STM/ AFAM (optional).

#### **Applications:**

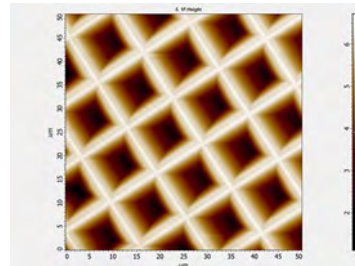
- ✓ biology and biotechnology;
- ✓ proteins, DNA, viruses, bacteriums, tissues;
- ✓ materials science;
- ✓ surface morphology, surface morphology, local piezoelectric properties, local adhesion properties, local tribological properties;
- ✓ magnetic materials;
- ✓ magnetic domain structure visualization, observation of magnetization reversal processes that depend on external magnetic field, observation of magnetization reversal processes under different temperatures;
- ✓ semiconductors, electric measurements;
- ✓ polymers and thin organic films;
- ✓ data storage devices and medias: CD, DVD disks, storages for terabit memories with thermomechanical, electric and other types of recording;
- ✓ nanomaterials;
- ✓ nanostructures.



*3D surface image of a photovoltaic cell 10  $\mu\text{m}$*



*3D surface image of a photovoltaic cell 3  $\mu\text{m}$*

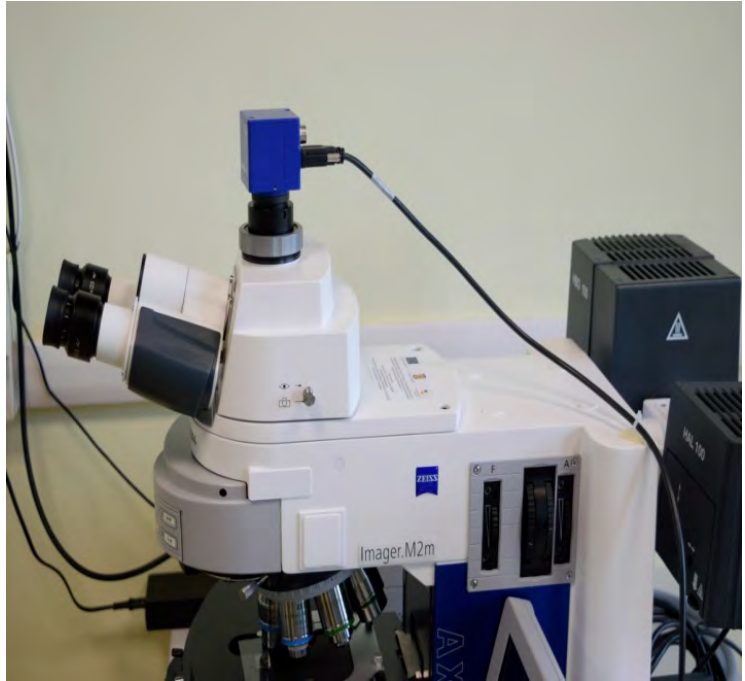


*2D surface image of a photovoltaic cell*

## AXIO IMAGER M2M MICROSCOPE *(Annex – position no.4)*

Research microscope for examination of specimens by transmitted light brightfield, phase contrast and bright field incident light and dark fluorescence, **Axio Imager M2M** combines high quality optics and bright fluorescence to provide clearer images. Contrast control and light provides certainty using the microscope in different ways and obtaining reproducible results. It is designed as a platform dedicated to applications in cell biology, neuroscience, molecular genetics and pathology.

The device is equipped with a motorized stand for sample, motorized epifluorescence objectives (5X – 100X) plus camera and software that allows the microscope to be optimally used for different applications with maximum efficiency and comfort.



### **Advantages:**

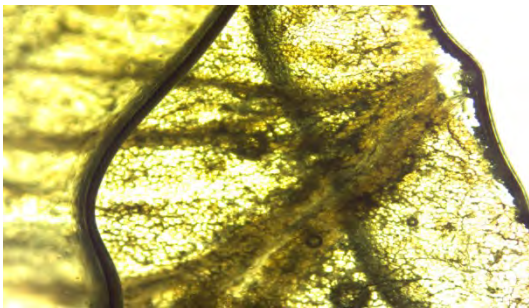
- ✓ an optimized operating concept;
- ✓ improved optics with superb contrast and excellent resolution;
- ✓ forward-looking stand concept for upgradeability;
- ✓ innovative design for maximum stability and vibration-free work;
- ✓ an integrated system approach for digital imaging;
- ✓ it can retain more profiles for multiple users preferences.

## PRIMO STAR MICROSCOPE *(Annex – position no.5)*

**Primo Star** has been developed with long-term use and great durability in mind. It incorporates all of ZEISS's experience in optical microscopy adapted to the most sophisticated environmental conditions in classroom settings and laboratory work.

Together with its many practical accessories, Primo Star can be used for education, in the laboratory, doctors' practice field.

It offers the possibility to investigate the samples in transmitted light at a magnification between 4X and 100X. Optional, to the equipment it can be attached a digital video camera (Axiocam 105) which, by the microscope software allows real-time data acquisition. The obtained images could easily be converted from 2D format in 3D through its software for a better viewing.

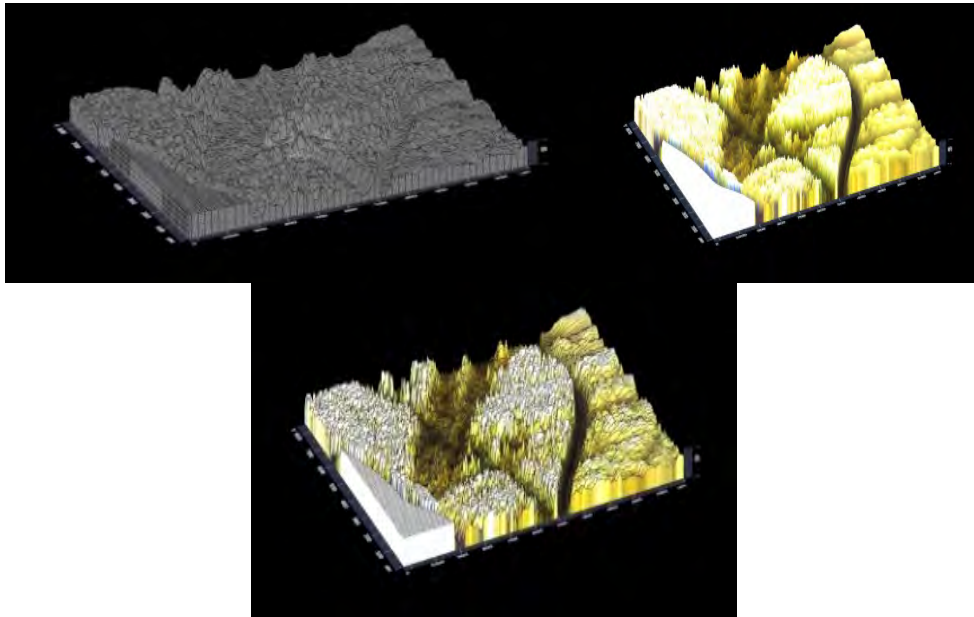


*3D Surface image of walnut membrane*



**Advantages:**

- ✓ easy to operate;
- ✓ robust and durable;
- ✓ quality optics from ZEISS;
- ✓ modular illumination concept;
- ✓ 5-step LED-display intensity indicator panel on both sides of stand;
- ✓ all functions can be learned quickly;
- ✓ suitable for education and routine work in all areas of microscopy.



*3D images of walnut membrane*

## INSTALLATION FOR METAL AND DIELECTRIC LAYERS DEPOSITION BY SPUTTERING *(Annex – position no.6)*

This equipment is a physical vapor deposition (PVD) method for creating thin films, using **sputtering depositions**. The device contains two sputtering sources or magnetrons, which can be loaded with the material of the desired coating composition; the sputtering is achieved with high voltage DC or RF argon plasma, but other gases can be used to create coatings via the reactive sputtering method. This equipment is configured for argon and nitrogen. Up to 6 materials sequentially on substrates up to 250 mm may be submitted.

Deposition chambers connected to a vacuum system have the following features:

- ✓ stainless Steel Chamber 454mm height x 454mm width x 454mm length;
- ✓ working mode, in vacuum and high vacuum ( $< 5 \times 10^{-8}$  torr);

### ***The system includes:***

- ✓ high voltage DC or RF argon plasma;
- ✓ rotating the substrate holder with the scale 4";
- ✓ heatable up to 350°C substrates support;
- ✓ system for measuring the thickness of layer deposited in situ using a quartz crystal microbalance;
- ✓ system for introducing gas (Ar, N<sub>2</sub>, and compressed air) ;
- ✓ exhaust system;



**Applications:**

- ✓ thin-film solar cells;
- ✓ semiconductors;
- ✓ metals conductive/ resistive metal /insulator;
- ✓ magnetic multilayers with giant magnetoresistance (GMR, TMR);
- ✓ sensors from thin layers;
- ✓ transparent electrical conductors (eg. ITO);
- ✓ applications of optical communications (eg „pump lasers”);
- ✓ coatings for lenses (reflective, antireflective, color);
- ✓ precious metals (with maximum use of the cathode);
- ✓ coatings for surgical implants/medical.

**Comparison with other deposition methods**

An important advantage of sputter deposition is that even materials with very high melting points are easily sputtered while evaporation of these materials in a resistance evaporator or Knudsen cell is problematic or impossible. Sputter deposited films have a composition close to that of the source material. The difference is due to different elements spreading differently because of their different mass (light elements are deflected more easily by the gas) but this difference is constant. Sputtered films typically have a better adhesion on the substrate than evaporated films. A target contains a large amount of material and is maintenance free making the technique suited for ultrahigh vacuum applications. Sputtering sources contain no hot parts (to avoid heating they are typically water cooled) and are compatible with reactive gases such as oxygen. Sputtering can be performed top-down while evaporation must be performed bottom-up.

## Comparison of Typical Thin Film Deposition Technology

Process	Material	Uniformity	Impurity	Grain Size	Film Density	Deposition Rate	Substrate Temperature	Directional	Cost
Thermal Evaporation	Metal or low melting-point materials	Poor	High	10 ~ 100 nm	Poor	1 ~ 20 A/s	50 ~ 100 °C	Yes	Very low
E-beam Evaporation	Both metal and dielectrics	Poor	Low	10 ~ 100 nm	Poor	10 ~ 100 A/s	50 ~ 100 °C	Yes	High
Sputtering	Both metal and dielectrics	Very good	Low	~ 10 nm	Good	Metal: ~ 100 A/s Dielectric: ~ 1-10 A/s	~ 200 °C	Some degree	High
PECVD	Mainly Dielectrics	Good	Very low	10 ~ 100 nm	Good	10 - 100 A/s	200 ~ 300 °C	Some degree	Very High
LPCVD	Mainly Dielectrics	Very Good	Very low	1 ~ 10 nm	Excellent	10 - 100 A/s	600 ~ 1200 °C	Isotropic	Very High



## INSTALLATION FOR THIN FILM DEPOSITION IN VACUUM WITH ELECTRON BEAM (E-BEAM) *(Annex – position no.7)*

**HEX MANTIS Deposition LTD** is a modular system for submitting metal and dielectric thin films in high vacuum.

### SPECIFICATIONS:

- Quick change of deposition sources without having to use tools;

- Quartz microbalance with (QCM) and independent shutters from sources and sample holder with the size of 100mm, which allow highly accurate thin films up to monolayer and sub-monolayer;

- An electron beam evaporator in vacuum, with 32mm diameter, water cooled and electronic control of software for monitoring the flow rate control;

- Power supply 250W, with bar evaporation and crucible without requiring hardware changes;



- A crucible Molybdenum volume 390mm<sup>3</sup> and a Molybdenum connector for bar evaporation;

- The turntable that sits the sample contained cooling water to allow the deposition of metal films on a polymeric substrate (lift-off procedure) for processing samples lithographed;

- Turbomolecular pump capacity 80 l/s;

- Software that allows programming sequences for submission by the user from the computer;

- The rate of deposition evaporator to 100mm distance: submonolayer/min  $\approx$  5 nm/min from bar and  $\approx$ 20nm/min from the crucible;

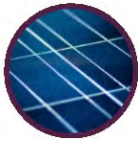


- An automatically shutter for the flow of electrons and one for QCM;
- Quartz system for independent monitoring of deposits, measurement resolution deposits is 0.1Angstrom;
- Electronics for power and control of deposits (temperature, pressure, layer thickness).

**APPLICATIONS:**



- Research and development of new coatings;



- Research and development of thin metal films and thin film arrangement corrosion;



- Corrosion protection of mild steel by depositing anticorrosive films of Cu and Cu-Zn; Zn, Cd, Sn and Sn-Zn-Cd; Al-Zn; Ni, Cr and Ni and Cr alloys;
- Electrical contacts for solar Cells and semiconductor applications;



- Anticorrosive film nitrides and carbides and antioxidant properties of transition metals;



- ITO coatings;
- Education and training.

## INSTALLATION FOR THIN FILM DEPOSITION BY SPINNING (SPIN-ON) *(Annex – position no. 8)*

**VTC-100A** is a optimal equipment for deposition of layers on different surfaces by spinning. The device is compact, the sample it is mounted on the support by of vacuum and this equipment is used for sol-gel deposition on substrates of up to 100 mm in diameter.

### Specifications:

- Aluminum casting case to keep spinning stable;
- Disk made of Polypropylene (PP) to resist most of the corrosive solutions;
- Drainage outlet and vacuum pump connector are on back panel;
- Vacuum pump oil:
  - Max. Air Flow: 7.2 m<sup>3</sup>/h (120 l/min);
  - Voltage/Frequencies: 230V/ 50Hz;
  - Power: 600W;
  - Noise Level: 60 dB(A);
  - Ultimate Vacuum: less than 100 torr;
- Chamber diameter: 225 mm;

### Technical specifications:

- ✓ Rotational speed: programmable from 500-8000 rot/min;
- ✓ Substrates diameter: from 10 mm to 200 mm;
- ✓ 3 sets of mounting support for anti corrosive substrates with diameters of 25.4 mm, 50.8 mm and 200 mm;
- ✓ A mounting support (adhesive tape) for substrates less than 10 mm in diameter and irregularly (irregular substrate is placed on the tape, the vacuum chuck will then hold the tape suction).



## INSTALLATION FOR THIN FILM DEPOSITION BY SOL-GEL COATING (DIP COATER) *(Annex – position no. 9)*

The **Nadetech ND 3D Multi Axis Dip Coater** is an optimal equipment for the deposition of layers on different surfaces through different deposition techniques such as Layer-by-Layer assemblies, Sol-gel coatings, or Self-assembled monolayers. The ND-3D Coater enjoy a 2 axis programmable system. One axis is for vertical displacement and the other for movement in the horizontal plane. This configuration offers a high versatility for multistep deposition which requires the consecutive immersion in vessels with different solutions in a higher space.

The range of immersion and dipping-out speed is very broad, from a minimum speed of 0,6 millimeter per minute to a maximum of 1000 mm per minute. The vertical axis has a maximum displacement of 250 mm and the horizontal axis may work in an area of 500 x 200 mm. Depending on the volume and size of the vessels or trays arranged for the deposition cycles, multi-step immersions in different solutions can be programmed in a single work cycle.

### Technical specifications:

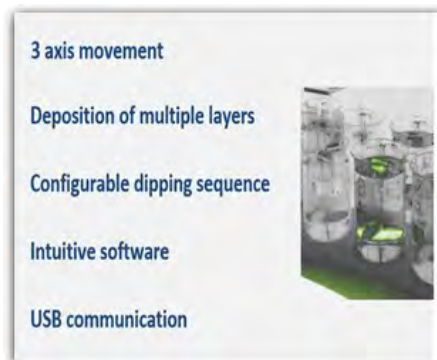
Vertical displacement: 200 mm

Horizontal displacement: 500x250 mm

Minimum Dipping Speed: 0,6 mm/min

Maximum Dipping Speed: 1000 mm/min

Maximum weight sample: 1500 g



## REACTIVE ION ETCHING (RIE)

(Annex – position no. 10)

**The RF Nano-PC installation** has a unitary construction that ensure all equipment functions, in compliance with protection from corrosive gases, Faraday cage for industrial frequency generator, protective coating and gas filtration. The equipment is equipped with 2-channel gas: resistant to corrosive gas type CF<sub>4</sub>, SF<sub>6</sub> (from stainless steel), channels controlled by MFC (Mass Flow Controllers) from the computer. The equipment can be used for etching with gases such as: O<sub>2</sub>, N<sub>2</sub>, Ar, CF<sub>4</sub>, SF<sub>6</sub>, air or any combination of these gases.

The basic control parameters are: base pressure, pumping time, flow through the MFC, radio frequency power generator, operating time, the time ventilation, temperature, alarm in case of opening the door during the process, display errors.

### **Reaction chamber**

- ✓ stainless steel tanks;
- ✓ shamber volume 24 liters;
- ✓ aluminium door with quartz window;
- ✓ special electrode RIE (Reactive Ion Etching) with shower included.



**Radiofrequency Generator:**

- ✓ fixed frequency 13.56 MHz;
- ✓ manually adjustable power between 0 and 300 W (with accuracy of  $\pm 1$  W);
- ✓ PC for automatic adjustment of power;
- ✓ display of power generated and frequency of work;
- ✓ protection against opening the door during the process.

**Maximum sample size is 200mm x 400mm x 200mm**

**Applications:**

- ✓ cleaning of surfaces before processing them;
- ✓ activation of surfaces;
- ✓ corrosion of surfaces;
- ✓ surface treatment.

Areas of application may include research into: REM; TEM; archeology; electronics and microelectronics; elastomers; medical technology; semiconductors; sensors, etc.

## B. Physical and Structural Characterisation of Materials

### X-RAY DIFRACTOMETER (XRD) *(Annex – position no. 11)*

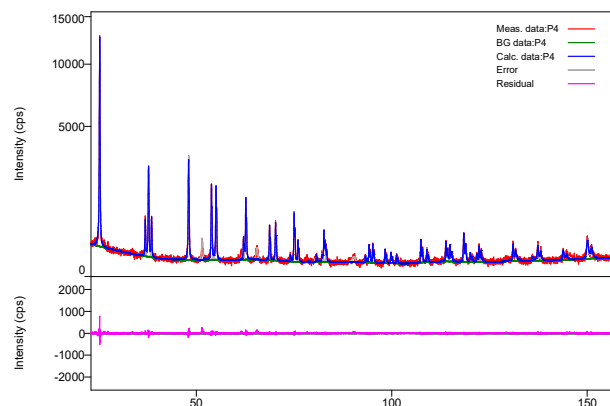
#### **Technical Characteristics:**

- ✓ multipurpose and multifunctional X-ray diffraction (XRD) system, incorporating a vertical goniometer  $\theta/\theta$  (radius: 285 mm), geometry G/9, cross beam optics (CBO) technology for permanently mounted, permanently aligned;
- ✓ full automated alignment under computer control;
- ✓ X-ray tube – Cu anode (2kW); NaI detector, limited  $>700000$  cps;
- ✓ symmetrical and asymmetrical geometries (optical configuration user-selectable): focused high resolution Bragg Brentano geometry, high resolution parallel beam geometry for X-ray reflectivity (XRR) and grazing incidence X-ray diffraction (GIXRD), transmission and reflection SAXS geometry (Small Angle X-Ray Scattering), micro-area X-ray diffraction;
- ✓ scanning axis: Ts (tube height), Zs (slit height),  $\theta D$ ,  $\theta S$ ;
- ✓ flexible optical system; slits with: scanning axis Ts: 0.001mm,  $\theta D, \theta S$ : 0.0001;
- ✓ minimum step on coupled  $\theta D/\theta S$ : 0.0002 and independent  $\theta D/\theta S$ :  $0.0001^0 - 6^0$ .



**Applications:**

- ✓ phase identification, quantitative analysis, crystallographic structure determination, crystal lattice type, crystallinity percentage, crystal size/strain analysis, lattice parameters, Rietveld refining;
- ✓ microstructure – preferential orientation in pole –figure analysis, residual stress (sin  $2\psi$ , bi-axial);
- ✓ thin films applications (phase identification, orientation/structure, strain/stress, thickness/profile depth on film, interface roughness, density);
- ✓ SAXS applications (molecular structure and orientation of polymeric materials);
- ✓ nanoparticle size distribution in suspensions;
- ✓ particle size distribution in bulk type nanomaterials;
- ✓ molecular morphology and orientation in nanocomposites;
- ✓ high resolution X-ray reflectivity, mapping in 3D reciprocal space.

XRD spectrum of TiO<sub>2</sub> sample

**Sample:** powders, nanopowders, solid bulk materials, thin films.

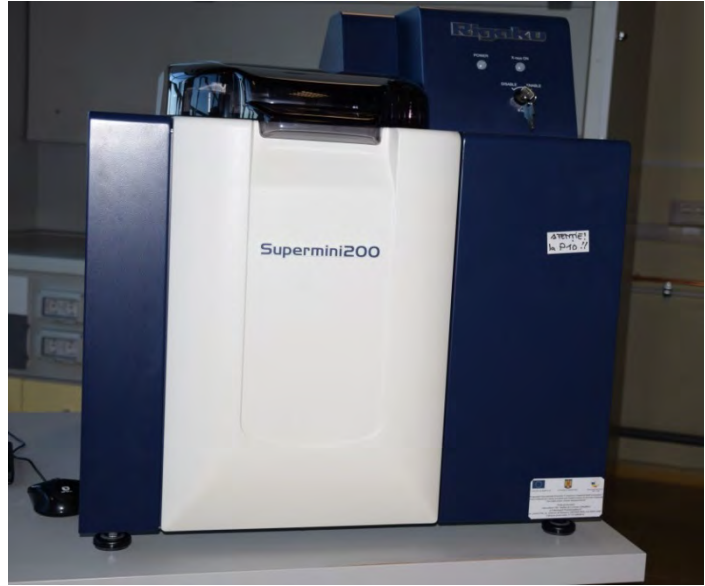
**Domains:** environment, nanotechnology, food industry, agriculture, cosmetics, metalurgy, chemical and petrochemical industry, polimers, semiconductor manufacturing, photovoltaic systems, materials, etc.



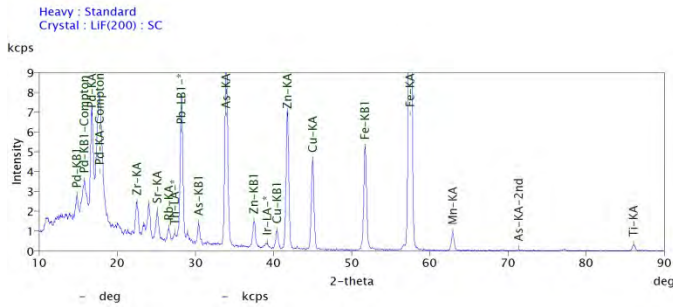
**WAVELENGTH DISPERSIVE X-RAY FLUORESCENCE SPECTROMETER (WDXRF) (Annex – position no. 12)**

**Technical Characteristics:**

- ✓ sequential wavelength dispersive X-ray fluorescence benchtop spectrometer for elemental analysis ;
- ✓ PC controlled system, equipped with automatic sampler 12 places (solid and liquid samples accessorized) in vacuum, air or helium atmosphere;
- ✓ system equipped with 3 position crystal changer: LiF (200) for heavy elements (Ti-U), PET and RX 25 for light elements (O-Mg and Al-Sc);
- ✓ X-ray tube, 50 kV, 4 mA, 200W, Pd anode;
- ✓ Detection limit: 1ppm - 10ppb; Precision <0.1-0.5%.



**Applications:** qualitative and quantitative elemental analysis, (between 80 and 92U) in solid (powder, alloys, thin films) and liquid samples, in vacuum, air or helium atmosphere.



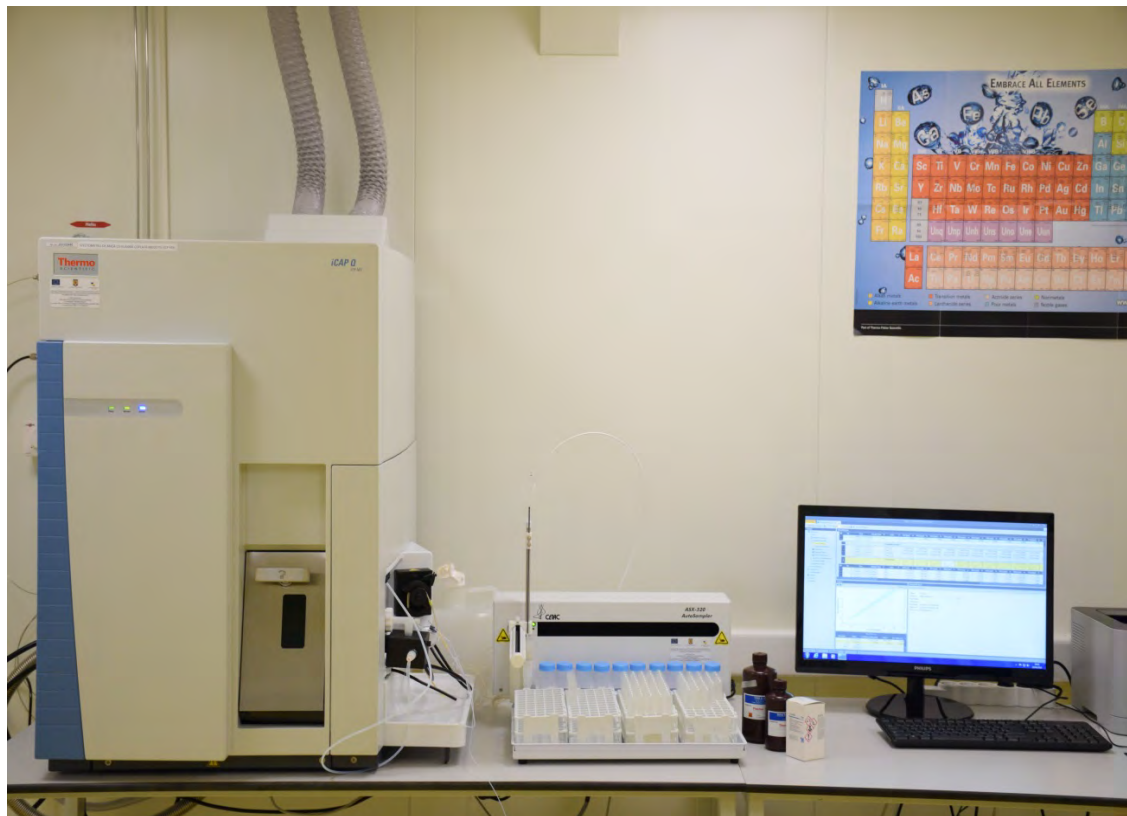
**Domains:** environment (waters/drinking, waste, soil), food industry and agriculture, pharmaceutical and cosmetic industry, geology, metallurgy, analysis of materials, semi-conductors, polymers, electronics, energy, medicine, petroleum industry etc.

## INDUCTIVELY COUPLED PLASMA MASS SPECTROMETER (ICP-MS)

(Annex – position no. 13)

### **Technical Characteristics:**

- ✓ complete system with an advanced technology enhancing high-performance analysis combined with total reliability and ultra-flexibility;
- ✓ innovative RAPID (Right Angle Positive Ion Deflection) lens technology (90° ion optics done right) for separation of ions and neutrals;
- ✓ innovative interface with skimmer cone featuring unique, user-replaceable inserts mounted behind the cone tip to control memory effects;



- ✓ high-performance quadrupole analyzer is pumped by a novel split flow turbo pump backed by a single rotary;
- ✓ new, simultaneous analog/PC detector with real time multi-channel analyzer electronics provides >9 orders of dynamic range suitable for both steady state and transient signal analysis;
- ✓ robust RF generator with fast dynamic frequency impedance matching for high plasma stability.

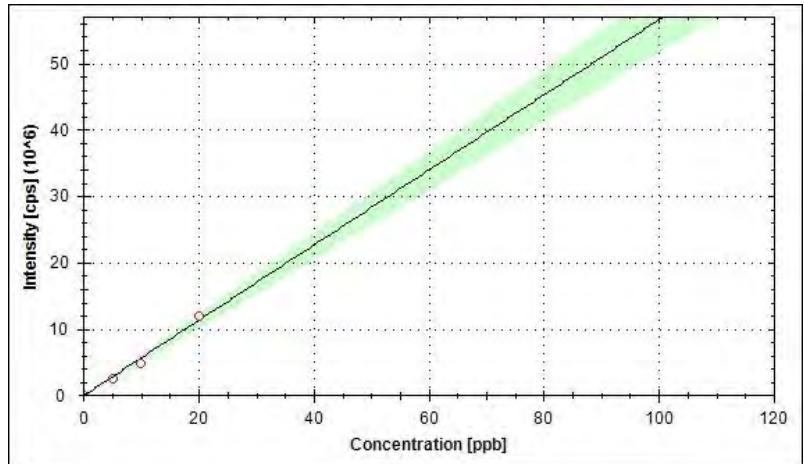
Detection limits:  $^9\text{Be}$  <0,5 ng/l(ppt);  $^{115}\text{In}$  <0,1 ng/l(ppt);  $^{209}\text{Bi}$  <0,1 ng/l(ppt); Oxides  
 CeO/Ce<2%;

Stability: short term (%RSD):<2% (10 min); long term (%RSD): <3% (2h);

Isotopes precision ratio:  $^{107}\text{Ag}/^{109}\text{Ag}$ < 0,1(%RSD)

**Applications:** quantitative and qualitative elemental analysis (in the range  $^7\text{Li}$  ...  $^{238}\text{U}$ ), in liquid homogenous samples.

**Domains:** environment (waters/ drinking, waste etc, soil), food industry and agriculture, pharmaceutical and cosmetic industry, geology, energy, medicine, cement industry, metalurgy, oil industry etc.



Calibration curve for Mn standard

## FOURIER TRANSFORM INFRARED SPECTROMETER COUPLED WITH HIGH RESOLUTION INFRARED MICROSCOPE *(Annex – position no. 14)*

**FT-IR** spectroscopy system for advanced research consists of: FT-IR spectrometer Vertex 80 and high-resolution microscope Hyperion 3000. The system is designed for advanced research activities in various fields: physics of materials, environmental studies, studies of inorganic, organic, macromolecular and pharmacology, molecular and cellular biology, research in ceramics and semiconductor, composites and nanomaterials research, food analysis, study of documents and art objects and other fields.

Vertex 80 spectrometer is a rugged equipment which eliminates atmospheric moisture absorptions and provides PEAK sensitivity and stability, especially in the far IR spectral regions. The new automatic beamsplitter exchange (BMS-c) unit allows software controlled extension of the spectral range without break of the spectrometer vacuum.

Hyperion 3000 is used for highest sensitivity at the highest spatial resolution in FT-IR microscopy and chemical imaging. It is designed without compromises, to combine best performance for visible inspection and infrared spectral analysis of any sample.



	<b>Vertex 80</b>	<b>Hyperion 3000</b>
Spectral range	350-8000 $\text{cm}^{-1}$	600-7500 $\text{cm}^{-1}$
Spectral resolution	0.2 $\text{cm}^{-1}$	Depinde de Vertex 80
Accuracy	0.1% T	$\pm 1\mu\text{m}$

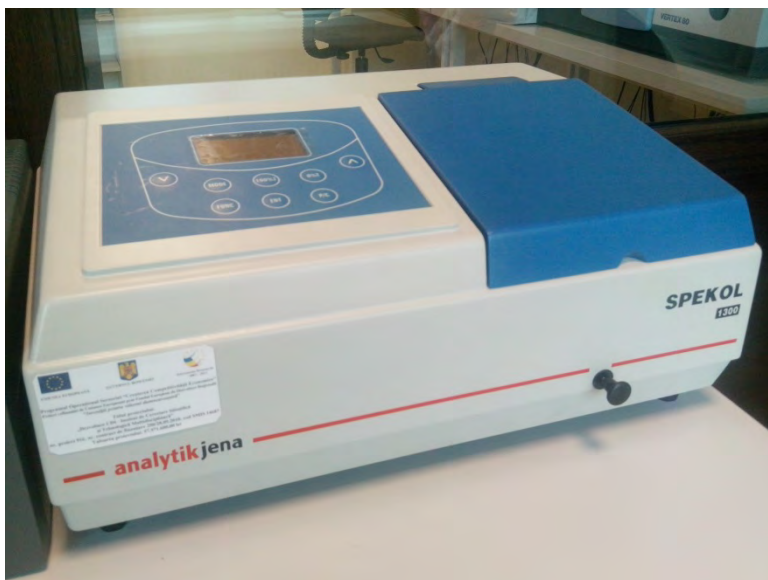
## UV VIS SPECTROPHOTOMETER SPEKOL 1300 - Analytik Jena (Annex – position no. 15)

The instrument is a single beam spectrophotometer, compact and ruggedness. Sample compartment accepts cells from 10 mm to 100mm path length. It is equipped with a LCD display and water-proof touch-sensitive keyboard and allows connection to printer.

**Applications:** biochemistry, petro- chemistry, environmental protection, various fields of quality control.

**Technical data:**

- ✓ wavelength Range: 190 nm to 1100 nm;
- ✓ wavelength Accuracy:  $\pm 2$  nm;
- ✓ repeatability: 1 nm;
- ✓ photometric range: 0 % to 125.0 % T; -0.1 A to 3, 0 A; 0 to 9999 C.



## UV VIS DOUBLE-FASCICLE SPECTROPHOTOMETER EVOLUTION 260 BIO – Thermo Scientific *(Annex – position no. 15)*

**Thermo Scientific Evolution 260 spectrophotometer** offers performance, reliability and high quality results. It allows advanced research with the possibility of adapting to the rapid changes which take place in the life sciences. The instrument is controlled by software which contains methods for the following **applications:**

- ✓ environmental analysis (Al, BOD, Ca, Fe, Mo, N, P, Ag, S, alcohol, B, C, F, Pb, Ni, O, K, Na, COD, Au, Mg, O<sub>3</sub>, Zn, Cd, Cu, I, Hg, phenol);
- ✓ cosmetic industry (including methods for color analysis);
- ✓ clinical chemistry and health;
- ✓ food (including kinetic methods: ascorbic acid, formaldehyde, glycerin, alcohol, cholesterol, formic acid, glucose, sucrose, ammonia, hydrazine, etc.);
- ✓ materials analysis.

**Technical data:**

- ✓ wavelength Range: 190 to 1100 nm;
- ✓ wavelength Accuracy:  $\pm 0.8$  nm;
- ✓ repeatability:  $\leq 0.1$  nm;
- ✓ photometric Range:  $>3.5$  A.



## PORTABLE RAMAN SPECTROMETER IR IN TWO LENGTHS XANTUS-2 – Rigaku *(Annex – position no. 16)*

**Portable dual wavelength Raman analyzer** equipped with options of 785 and 1064 nm stabilized laser, providing high sensitivity. Xantus-2 utilizes integrated software combining open architecture with customizable, user-defined settings for optimized sampling parameters that result in comprehensive and actionable data analysis. This device does not require special preparation of samples; liquid and solid samples can be analysed.



## NUCLEAR MAGNETIC RESONANCE (NMR) SPECTROMETER *(Annex – position no. 17)*

### **Technical Characteristics:**

- ✓ complete pulsed Fourier transform liquid-phase proton NMR spectrometer, PC controlled;
- ✓ the unit includes a capillary cartridge, a permanent magnet (2 Tesla), radio-frequency transmitters and receivers, digital data acquisition and signal processing, a programmable pulse sequencer, and a web-server interface;
- ✓ system configuration includes MNova licenced software for data processing, simulation and reporting;
- ✓ 40 microliters liquid sample is injected with a syringe into the instrument capillary system (replaceable cartridge); max. sample kinematic viscosity 40 - 45 cSt;
- ✓ permanent magnet is temperature controlled (from ambient + 8°C to 45°C, no need of cryogen liquids);
- ✓ Larmor resonance frequency  $82 \pm 2$  MHz;
- ✓ resolution Better than 18 ppb;
- ✓ signal-to-Noise Ratio Better than 4000 for water, single pulse.



**Applications:** identification and structure evaluation of various chemical compounds structure in liquid homogenous samples (i.e. organic synthesis, etc).

**Domains:** environment (waters / drinking, waste etc, soil), food industry and agriculture, pharmaceutical and cosmetic industry, medicine, petroleum industry, etc.



## ATOMIC ABSORPTION SPECTROMETER (AAS) *(Annex – position no.18)*

### **Technical Characteristics:**

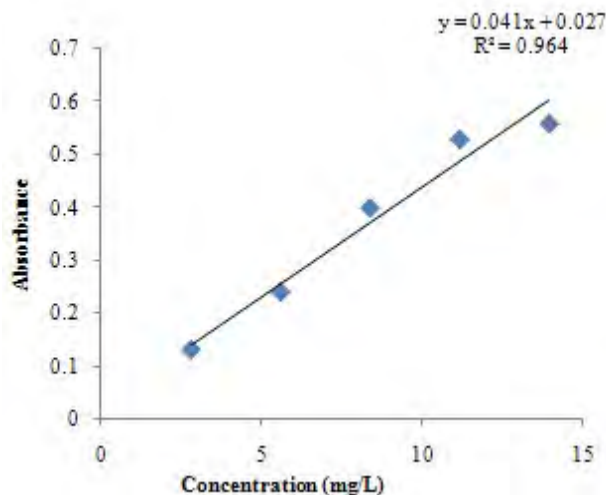
- ✓ complete system, PC controlled, equipped with 6 lamps turret, with automatic alignment optimized Czerny-Turner monochromator, wavelength and slit automatic selection wavelength range: 185 – 900 nm; slit automatic selection: 0.2; 0.5; 0.8, 1.2 nm;
- ✓ source: hollow cathode lamps (of the metal to be determined), HCL, SHCL, D2HCL;
- ✓ detector – photomultiplier UV sensitive, extended spectral range;
- ✓ background correction for flame and graphite furnace techniques – high frequency Deuterium lamp (300Hz);
- ✓ compensation up to 3 Abs, enhanced signal-noise ratio;
- ✓ zeeman background correction for graphite furnace technique – bipolar magnetic field, transverse, 2-field and 3-field correction mode.



*Display:* Absorbance (-0,01 up to 3,00), Concentration (units selection: mg/l, µg/l, others] with, 5 digits (0,001 to 99999);  
Calibration curve up to 30 standards (linear, non-linear).

**Applications:** quantitative elemental analysis in liquid homogenous samples (after digestion and specific preparation); with present instrument configuration one can determine concentration of Pb, Ca, Mg, Cr, Fe, Zn, Na, Al, K, Ti, Ni, Cu, Ge, Se, Sr, Y, Zr, Ag, Cd, Mn, Au up to 1 ppm detection limit (flame technique), respectively 1 ppb (graphite furnace).

**Domains:** environment (waters / drinking, waste etc, soil), food industry and agriculture, pharmaceutical and cosmetic industry, geology, metallurgy, analysis of materials, semi-conductors, polymers, electronics, energy, medicine, petroleum industry etc.



Calibration curve for Fe standard

## GAMMA SPECTROMETER *(Annex – position no. 19)*

### **Technical Characteristics:**

- ✓ high-performance spectrometer, 16k channels with data security system for in-situ analysis;
- ✓ multichannel portable analyzer, detector NaI (TI) detector (NaI crystal dimensions 3"x3"; energetic resolution max. 7 % at 661 keV);
- ✓ digitally stable: consistent answers for long counts, changing count-rates and temperatures;
- ✓ built-in backlit LCD display and control keypad — live display of acquiring data;
- ✓ energy calibration using keypad;
- ✓ nuclide ID and activity calculation for nine Regions of Interest (ROI);
- ✓ high throughput — over 100,000 processed pulses per second;
- ✓ holds 23 16k spectra in internal memory (614 at 512 resolution);
- ✓ fast USB communications.

**Applications:** measurements of activity of gamma-emitting radionuclides in environment samples and other radioactive material; portable analyzer, appropriate for mobile, in situ measurements, as well as laboratory tests.

**Domains:** environment, geochemical investigations, food industry, waste management, etc.



## KARL FISCHER COULOMETRIC TITRATOR (Annex – position no. 20)

### Technical Characteristics:

- ✓ compact equipment with coulometric cell without diaphragm, titration vessel, platinum electrode, automatic system for draining / solvent manager (ISO 10337 or equivalent compatible);
- ✓ sample weight (liquid / solid) : 10 µg – 200 mg; colour displayed (selectable measurement unit);
- ✓ method creation and saving, through existing software (memory for operator, working parameters, sample data, etc.);
- ✓ water content in samples, from 1 ppm to 5%, Resolution H<sub>2</sub>O: 0,1 µg.

**Applications:** water content determination from various samples (i.e. oils, fuels, ketones, etc).

**Domains:** petroleum industry, cosmetics, pharmaceuticals, food industry etc.



## HALOGEN MOISTURE ANALYZER METTLER TOLEDO HS153

**MODEL** (*Annex – position no. 21*)

### **Technical characteristics:**

- ✓ equipment consisting of a balance and a halogen heating unit;
- ✓ the halogen unit provides a fast heating and a precise temperature control, shorter heating – cooling cycles can also be performed ;
- ✓ sample weight is shown on the digital display color (selectable measure unit);
- ✓ correction factors can be used, through software setting;
- ✓ measurement range (resolution): Weight 2 – 150 g (1 mg), Temperature: 40°C - 230°C (1°C);
- ✓ moisture content – resolution 0,01% (sample weight min. 10 g), respectively 0,05 % (sample weight min. 2 g)

**Applications:** moisture determination of solid samples, through differential weighing - before and after heating process.



## ELEMENTARY ANALYZER C, S AND CL SOLIDS ANALYSIS Multi EA 4000 - Analytik Jena *(Annex – position no. 22)*

**Multi EA 4000** is a device used for the determination of carbon (TC, TIC), sulfur (TS) and chlorine (TCl) of solid samples or viscous paste. The operating principle of the device is based on the high-temperature combustion (1000 - 1500 ° C) of samples in oxygen flow. The core of the device is the furnace which provide high temperature necessary for sample decomposition (pyrolysis and combustion oxidation).

### **Determination of C and S:**

The gas generated from burning arrive on NDIR detector (Non-Dispersive Infrared), which following molecular absorption of CO<sub>2</sub> / SO<sub>2</sub> at specific wavelengths, transmits the signal to the recording system and data processing.

Software MultiWin plot the combustion curve of the sample. The area of the curve is directly proportional to the concentration of the element in the sample.



**Determination of Cl:**

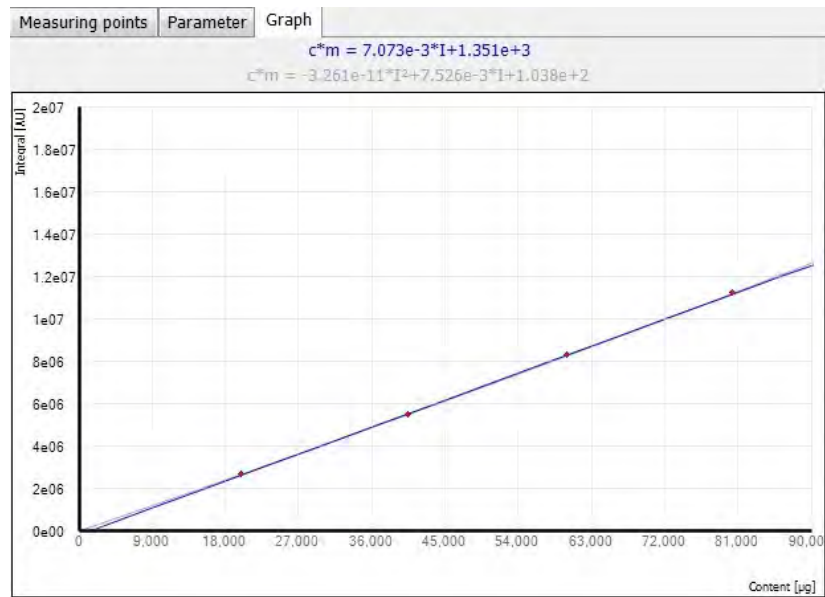
It is based on the colorimetry principle: chloride ions react with electrolytically generated silver ions resulting silver chloride.

**Fields of application:**

- ✓ waste management (determination of C and S in waste, of Cl in surrogate fuel);
- ✓ environmental monitoring (determination of C and S in soils, sediments, vegetables samples);
- ✓ energy industry (determination of C and S in carbon and residual ash);
- ✓ materials engineering (determination of C and S in building materials: cement, plaster, ceramics, glass, etc.).

**Measuring range:**

- C: 0-100%
- S: 0-20%
- Cl: 0-20%



## CALORIMETER - 6400 AUTOMATIC ISOPERIBOL CALORIMETER – Parr Instrument Company (*Annex – position no. 23*)

**Parr 6400 Calorimeter** is used to determine the specific heat of the sample, relative to a standard sample heat. The burning is accomplished in metal pressure vessel and controlled atmosphere of oxygen - called "bomb". The energy released from the combustion is absorbed by the calorimeter and the result - temperature changes - is determined.

**The 6400 Automatic Isoperibol Calorimeter** represents the next evolutionary step in the Parr automated calorimeters. Inclusive and compact, the instrument incorporates a closed loop cooling subsystem into the calorimeter. This subsystem uses a thermoelectric cooler assembly attached directly to a one liter water tank which supplies cooling water to the calorimeter. An external nitrogen pressurized tank is used to supply rinse water to the calorimeter.





***Samples types:***

- ✓ coal and coke, fuel oil, gasoline and kerosene, combustible wastes;
- ✓ foodstuffs and supplements for human nutrition, forage crops and supplements for animal nutrition;
- ✓ building materials;
- ✓ explosives, rocket fuels and related propellants.

***Samples*** can be: solids (compact, large particles, powders).

***Temperature resolution:*** 0.0001 °C

***Calorie sample range:*** 5000 – 8000 cal.



## MERCURY ANALYZER MERCUR DUO – Analytik Jena (Annex – position no.24)

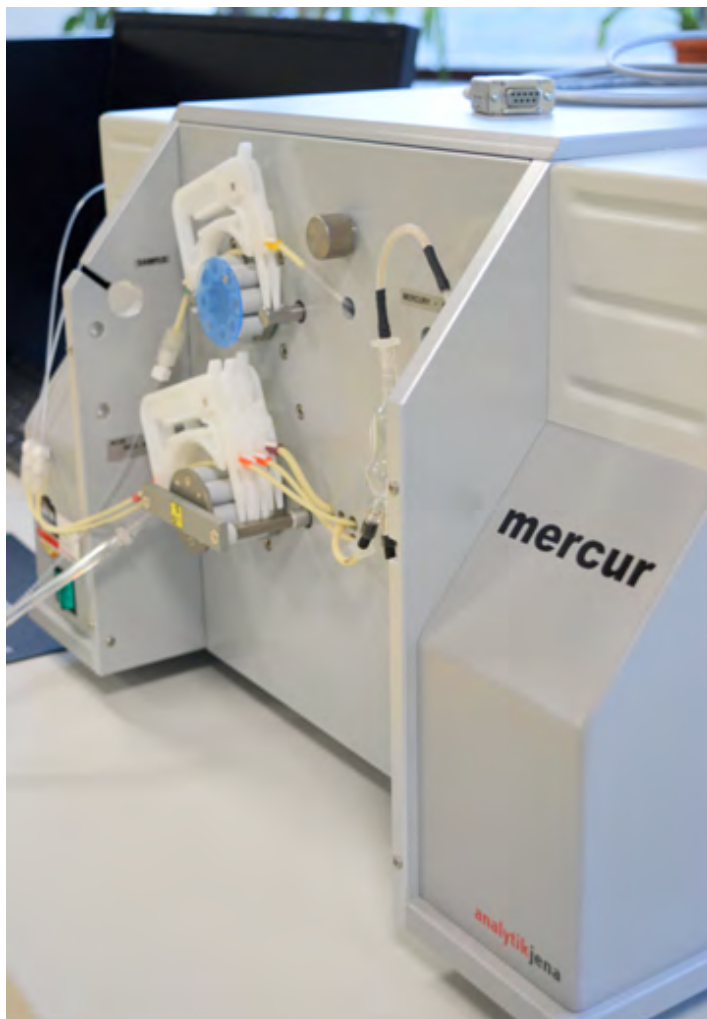
**Mercur Duo** is a device used for the determination of Hg by two methods: atomic absorption (AA) and atomic UV fluorescence (FA). Using these two methods the application range is extended from ng / L (ppt) to mg / L (ppb). Determination of mercury in liquid samples is performed; the samples require prior mineralization using acid mixtures.

Mercur Duo is mainly used in water and wastewater laboratories and for environmental analysis.

### **The analysis principle:**

- ✓ atomic fluorescence: detection of the mercury fluorescence radiation at the 90 ° angle;
- ✓ atomic absorption: detection of absorption of lamp radiation energy in the sample.

Mercury is released using stannous II chloride ( $\text{SnCl}_2$ ) as reducing medium and transported in atomic form. The released mercury can be measured directly without being enriched.



## QUARTZ CRYSTAL MICROBALANCE (Annex – position no.25)

**Quartz Crystal Microbalance (QCM)** is a very sensitive sensor, capable of measuring mass changes in the spectrum of nanogram / cm<sup>2</sup> with a wide dynamic spectrum to 100 mg / cm<sup>2</sup>.

QCM is a rapid method for analysis, but an expensive at the same time.

QCM can be used as:

- ✓ chemical and biochemical sensor;
- ✓ immunosensor;
- ✓ system auto-submission of monolayers (Self-Assembled monolayer - SAM).

**Measurements** realized with QCM can be categorized as follows:

- ✓ static;
- ✓ dynamic;
- ✓ electrochemical (E-QCM);
- ✓ with dissipation (QCM-D).

Quartz crystal microbalance (QCM) is used either for precise nanoscale deposition of masses and as the chemical sensor with high selectivity for organic compounds deposited layers. Mass changes occur in all chemical processes in the preparation of materials in electrochemical processes in biotechnology, in thin films formation in natural environment, adsorption / desorption of proteins, cell adhesion, degradation of polymers and biofilm, bio-impurities and drug analysis.



## OXIDATION STABILITY TESTER PetroOxy – Anton Paar (Annex – position no.26)

**PetroOxy** has been developed as a testing device for the oxygen stability, of commercially available fuels stability. The patented Rapid Small Scale Oxidation Test (RSSOT) provides a complete oxidation stability analysis of petroleum products, automatically in a very short test time. The results include all volatile and non-volatile oxidation products, providing a comprehensive analysis of the sample.

**Samples types:**

- ✓ fuels (gasoline, diesel, biodiesel, Fatty Acid Methyl Esters (FAME), blends);
- ✓ mineral oils;
- ✓ additives;
- ✓ insulating oils etc.



## DIGESTOR TOP WAVE *(Annex – position no.27)*

The system works with an innovative concept of sensors. Individual samples temperatures and internal pressures are measured and displayed individually and in real time. Do not use immersion sensors or mechanical sensors - measuring system uses optical principles. There is no sensor installed, connected, cleaned or replaced - handling is thus simplified and consumables removed.

The system provides:

- ✓ pressure microwave assisted digestion;
- ✓ a safe operation due SCS;
- ✓ smart design for safe operation;
- ✓ large number of samples;
- ✓ data available for digestion of any evidence;
- ✓ intuitive operation;
- ✓ minimum number of supplies.



TOP wave is equipped with a touch-sensitive controller for controlling reactions and manipulating data. The algorithm monitors all parameters and adjusts the microwave power accordingly. There are a number of pre-installed applications, a list of favorite applications containing 12 programs frequently used. You can store about an infinite number of new applications. The software is intuitive, enabling remote operation via network connection and includes 6 languages. An internal memory can be used to store data that can then be exported via the USB jack.

## VISCOMETER PREMIUM – Fungilab *(Annex – position no.28)*

The software compatible with Windows allows the following data displayed: Selected speed rpm spindle selected SP, dynamic viscosity reading cP (mPa.s) or cSt kinematics, percentage of full scale%, °C or °F temperature probe (optional), the rate shear (coaxial rod) SR (s<sup>-1</sup>), shear (coaxial rod) SS (N/m<sup>2</sup>), density (inserted by the user) g/cm<sup>3</sup>, status of the program step by step, analysis and visual features (flow curves). The machine has self-test function with acoustic alarm AUTO-RANGE function, with accuracy of ± 1% of full scale and resolution viscosity range of 0.1 to less than 10,000 cP, spindle is made of stainless steel AISI 316 features programming: for torsional timeout 10 working memories, programmable multi-step ramp.



## CHEMICAL REACTOR *(Annex – position no.29)*

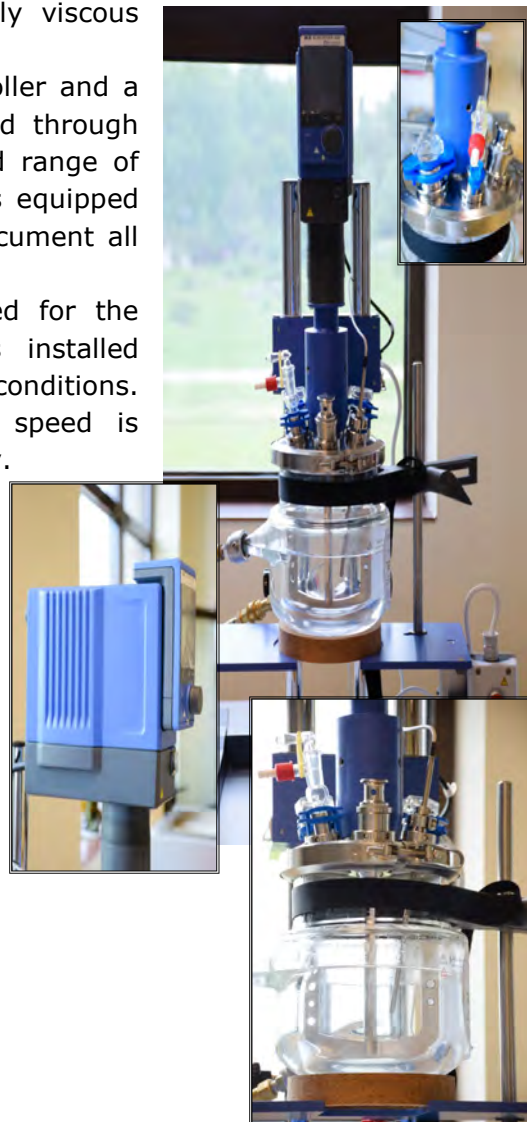
Extremely powerful laboratory stirrer for highly viscous applications for quantities up to 100 l (H<sub>2</sub>O).

It is designed with a removable wireless controller and a digital TFT display. It automatically adjusts the speed through microprocessor controlled technology within the speed range of 0/4 - 530 rpm (two speed ranges). The stirrer comes equipped with a RS 232 and a USB interface to control and document all parameters.

An integrated torque trend display is provided for the measurement of viscosity changes. Safety circuits installed ensures automatic cut-off in an anti-stall or overload conditions. Continuous comparison of shaft speed to desired speed is maintained and variations are adjusted automatically. This guarantees a constant speed even with changes in viscosities of the sample.

### **Multilingual TFT display:**

- ✓ programmable functions;
- ✓ integrated temperature measurement;
- ✓ interval operation;
- ✓ timer function;
- ✓ adjustable safety circuit;
- ✓ locked function;
- ✓ infinitely adjustable speed;
- ✓ overload protection;
- ✓ short-term overload operation;
- ✓ slim casing;
- ✓ quiet operation;



**FAT EXTRACTOR N 6 – Selecta** (*Annex – position no.30*)

A **Soxhlet Extractor** has three main sections: A percolator (boiler and reflux) which circulates the solvent, a thimble (usually made of thick filter paper) which retains the solid to be laved, and a siphon mechanism, which periodically empties the thimble.

The solvent is heated to reflux. The solvent vapour travels up a distillation arm, and floods into the chamber housing the thimble of solid. The condenser ensures that any solvent vapour cools, and drips back down into the chamber housing the solid material. The chamber containing the solid material slowly fills with warm solvent. Some of the desired compound dissolves in the warm solvent. When the Soxhlet chamber is almost full, the chamber is emptied by the siphon. The solvent is returned to the distillation flask. The thimble ensures that the rapid motion of the solvent does not transport any solid material to the still pot. This cycle may be allowed to repeat many times, over hours or days.





## BERGHOF DIGESTOR MWS2 *(Annex – position no.31)*



The instrument uses the microwave pressure digestion system, which considerably reduces duration of sample preparation (organic and inorganic matrixes) with safety operation. Suitable for samples derived from areas such as the environment, agriculture, nutrition, animal feed, geochemistry, petro-chemistry, metallurgy, human biology and pharmacy, others.

### **Characteristics:**

- ✓ compact stainless-steel oven with a capacity of 27 liters;
- ✓ interior temperature of the sample vessels (8 pcs) is determined with a contact-free IR thermometer, thus absolutely contamination-free

temperature determination being insured;

- ✓ closeable rotors with collecting vessel ensures top level safety and long service life;
- ✓ simple retrofitting of an evaporation/concentration unit because of integrated suction feature;

the integrated control enables the system to be operated after charging with samples.

## MULTIMETER – MULTI 9430 *(Annex – position no.32)*

Digital precision meter for:

- ✓ pH (0...14);
- ✓ conductivity (0.00  $\mu\text{S}/\text{cm}$  ... 2000  $\text{mS}/\text{cm}$ );
- ✓ dissolved oxygen measurements (0.00 ... 19.99  $\text{mg}/\text{l}$  );
- ✓ 3 dedicated electrodes and selectable resolution (0.001/0.01/0.1).

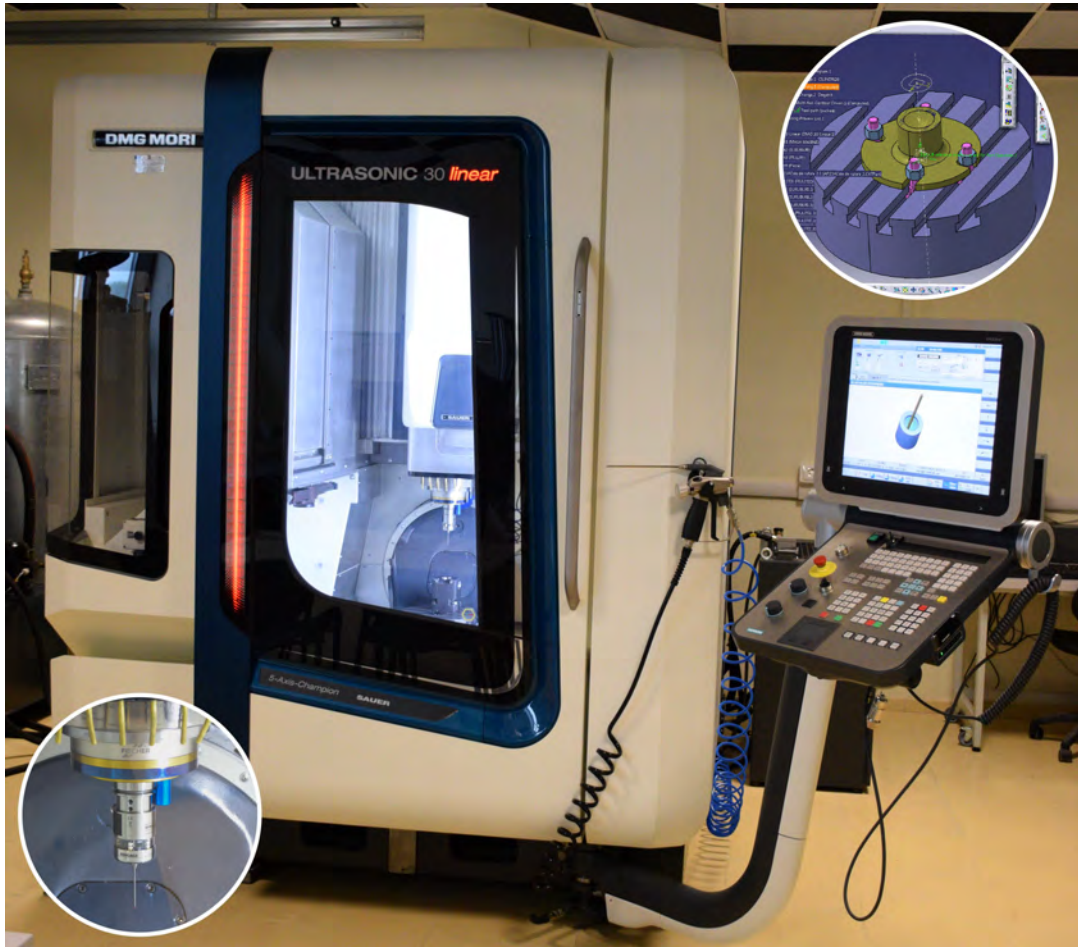
### **Functions:**

- ✓ proven calibration procedures (max. 5 points);
- ✓ automatic stability control;
- ✓ automatic sensor recognition;
- ✓ selectable measurement units;
- ✓ automatic temperature control;
- ✓ continuous measurement control.



### C. Prototyping and Testing Process

## 5 AXES CNC ULTRASONIC 30 LINEAR VERTICAL MACHINING CENTER *(Annex – position no.33)*



The machining equipment **ULTRASONIC 30 LINEAR on 5 axes** is equipped with Sinumerik 840D solutionline numerical control and 3D control technology through the programming and simulating module ShopMill and it can machine complex geometry parts throughout various methods such as milling, drilling, boring, threading, for metal and non-metal materials. The machine is equipped with an ultrasound generator. When it's activated, the ultrasounds propagate to the tool holder, and by doing that to the normal rotatory movement of the tool is added a supplementary axial oscillation, of the milling tool (like a hammering of the part's surface), needed in the machining of the brittle materials. The quality of the machined surfaces is greater. The machining forces are lowered and so the finishing process of the surfaces is a better quality one. Depending on the material's properties, the surfaces can have a roughness under 0.1 microns. The machine integrates on a single machine more procedures such as normal milling (HSC) ultrasound milling (HSK), which allows the machining of a big variety of materials. The equipment allows the machining of soft materials or rough ones (sapphire, ruby, titanium, CoCr for medial materials) and new composite materials (CFRP materials, GFRP or multilayer). Using diamond tools with a very defined geometry, you can machine SiC, Si<sub>3</sub>N<sub>4</sub>, Al<sub>2</sub>O<sub>3</sub>, ZrO<sub>2</sub> and other materials. The maximum rotation in ultrasonic field and also in normal milling is 40.000 rot/min, the oscillating frequency in the ultrasonic domain is 20 kHz – 50 kHz; the maximum advance on the X, Y, Z, axis is 320mm, 300 mm and 280 mm, and the maximum admitted weight is 200 kg. The machine can be operated directly by the numerical control which is equipped with or by the mean of the postprocessor, connected to the computer, allowing in this way the machining of the 3D modelled parts in Catia or SolidWorks and for witch it has been generated the CNC program using Catia Machining.

## CTX 310 ECOLINE CNC HORIZONTAL TURNING MACHINE

(Annex – position no.34)



**The CTX 310 ECOLINE** turning machine is an horizontal one, with a maximum rotation diameter of 330 mm (260 mm above the transversal sledge) and turning machining possibilities of revolution parts, to which you can add the advantages of using rotative tools, fixed and moved by a turret with horizontal AX with 12 holders with the lathe is equipped, using the C axis CNC. The lathe is equipped with Sinumerik 840D CNC solutionline, providing a 3D control technology, by module ShopTurn. The maximum diameter the lathe can have is 200 mm; stroke of X axis (the diameter) is maximum 180 mm; stroke of Z axis (length) is maximum 400 mm; advance work on X and Z is up to 20 m/min; maximum speed is 5000 rev/min; positioning accuracy is 15 microns. The machine can be controlled directly from the control with which it is equipped, or by using the postprocessor which connects with computer, allowing the pieces, modeled in 3D in Catia or SolidWoks, which were previously generated and simulated CNC program, using Catia Machining and dedicated postprocessor, developed specifically for this machine.

**LASER ABLATION SYSTEM** (Annex – position no.35)

The system is designed so that the LASER, optical parts, control system, and travel system be encased in a special housing with a granite table with a vibration damping and protection for Class 1 LASERS. This system is equipped with a diode-pumped solid-state laser- DPSS (Diode Pumped solid State) in the visible, capable of drilling, polishing, cutting thin materials such as metals, ceramics and semiconductors. For accurate processing, the system is equipped with control systems displacements on X, Y and Z. The maximum size of the sample is 15 cm x 15 cm.



**Laser specifications:**

- ✓ solid state laser type DPSS emitting at 532 nm;
- ✓ the maximum Laser power is 8 watts;
- ✓ the laser works in pulse. The pulse duration is less than 50 ns. Length can be fixed or programmable in the range 5-50 ns.;
- ✓ pulse repetition rate between 1 kHz and 20 kHz / 21 kHz and 150 kHz;
- ✓ stability pulse to pulse energy of less than 3% RMS;
- ✓ the maximum angle beam divergence is less than 2 mrad;
- ✓ motorized axes X, Y and Z.

Axis Name	Z
Travel (mm)	<150
Resolution (µm)	0.5
Repeatability (µm)	±1
Accuracy (µm)	±6
Max Speed (mm/s)	100

Axis Name	X	Y
Travel (mm)	<450	<450
Resolution (µm)	0.25	0.25
Repeatability (µm)	± 0.75	± 0.75
Accuracy (µm)	±2	±2
Max Speed (mm/s)	250	250

**Applications:**

- ✓ drilling (percussion and trepanning);
- ✓ cutting (circles, rectangles, slots);
- ✓ milling (rectangular pockets).

## WIRE BONDER MACHINE *(Annex – position no.36)*

The **KS – 4526** Auto-Stepback Wedge Bonder is used with aluminum wire, gold wire and ribbon. It is especially appropriate for your high quality applications requiring tight control of wire length and loop formation. The KS-4526 offers control of individual bond parameters and programmable loop formation along with the capability of using a wide variety of wires. The new bonding head, with the deep access option and tail adjust system, makes it ideal for deep cavity microwave applications where tight control over the tail length is required. It has an motorised step back axis (Y), that allow to control the length of wire and repeatable operations. Has a large work platform allowing to carry electronic connections between small and large

### Specifications

Conductors:

- Gold wire 12.7 – 76  $\mu\text{m}$ ;
- Aluminium wire 20 – 76  $\mu\text{m}$ ;
- Gold ribbon 25  $\mu\text{m}$  x 250  $\mu\text{m}$ ;
- Spool 12.7 mm;

Machine specifications:

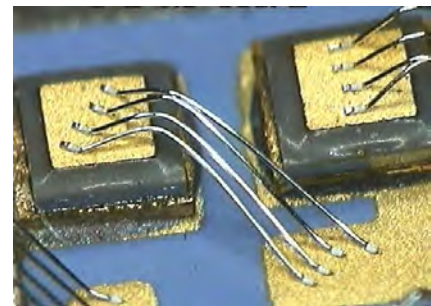
- Bonding area – 134 mm x134 mm;
- Throat depth – 143 mm;
- Gross table motion – 140 mm;
- Fine table motion – 14 mm;

Motorised Y axis:

- Stepback – up to 4 mm;
- Kink height – up to 0,5 mm;

Z axis:

- Low reset – 6,6 mm;
- High reset – 12,7 mm;
- Ultrasonic system Q - 60 kHz;
- Low ultrasonic power – 1,3 W;
- High ultrasonic power – 2,5 W;
- Bond time 10 ms - 100 ms / 10 ms - 1000 ms;
- Wire termination – clamp tear;
- Modes of operation – semi-auto, manual Z, stitch, lange coupler;
- Temperature controller – up to 250°C;





## FORM 1 STEREOLITHOGRAPHY MACHINE RAPID PROTOTYPING

(Annex – position no.37)

The equipment builds 3D parts made of liquid photopolymer resin.

**Stereolithography** or SLA is a 3D printing technology consisting in a process of optical fabrication by photo-solidification of liquid resins used to produce models or small prototypes.



*Part ready to print (positioned on the bed and printer)*

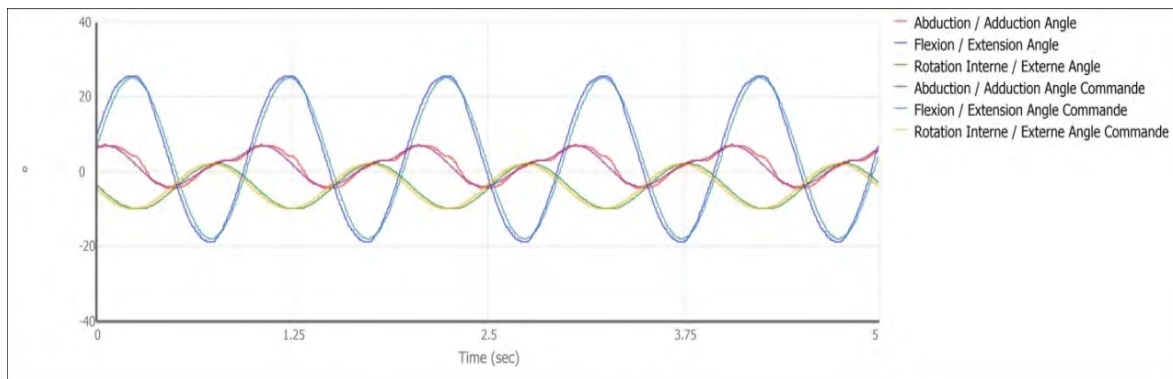
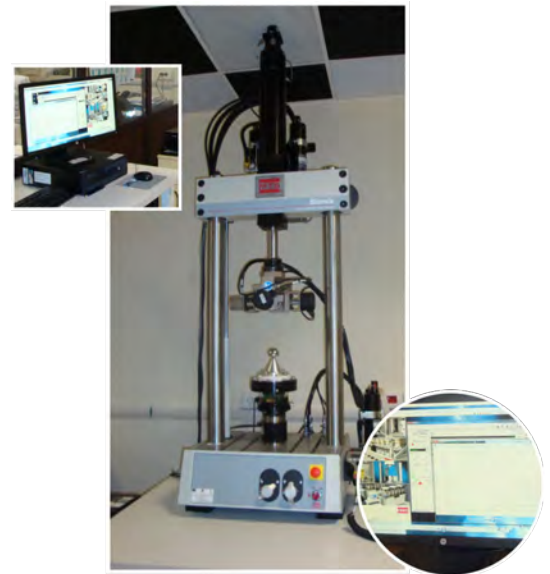
During the proto-polymerization process, a high precision system directs a UV LASER beam on the surface of the tank containing the liquid resin: resolution up to 25  $\mu\text{m}$ , maximum build volume: 120 mm x120 mm x160 mm, minimum size of the built element: 300  $\mu\text{m}$ , minimum layer thickness (measured on the Z axis): 25  $\mu\text{m}$ , operating temperature: between 18-28  $^{\circ}\text{C}$



## MTS BIONIX TESTING SYSTEM *(Annex – position no.38)*

The load unit is a stand-alone testing structure. It consists of the following components: load frame, crosshead lifts, manifold, actuators, servovalves, accumulators, transducers.

The testing system has four modules: first module is for traction, the second for compression, third is for bending and the fourth is for torsion. The later allows testing orthopedic hip implants in terms of tribological behavior. The system consists of 3 hydraulic rotary acutators, each controlled by a valve-manifold, powered by pressure regulators. The 3 actuators perform the 3 types of movement specific to the joint implant: internal-external rotation, flexion-extension and abduction-adduction. The oil nominal pressure set on the hydraulic unit is 210 bar. The dynamic load is  $F=\pm 1500$  kgf,  $M=\pm 150$  Nm. The maximum flow rate is 57 l/min. The maximum frequency is 200 Hz.



## EXASCAN 3D PORTABLE SCANNER *(Annex – position no.39)*



**The 3D Exascan portable scanner** is a portable, optical, data acquisition system that captures every detail and provides high resolution exact geometries for an accurate representation of the scanned item.

The scanning process is of the plug & play type. It uses the triangulation method to determine its position relative to the part in real time.

It is a data acquisition system, and its own positioning system at the same time.

It is a precision research tool used in the field of mechanics, with **multiple applications**:

- ✓ reverse engineering / styling, design and analysis;
- ✓ quality control / inspection;
- ✓ museology / heritage preservation

Used for scanning various size and various geometry parts:

- ✓ provides 25,000 measurements / s;
- ✓ resolution 0.2 mm;
- ✓ accuracy up to 0.040 mm (0.0016 inch);
- ✓ depth of field:  $\pm 150\text{mm}$  ( $\pm 6\text{inch}$ );
- ✓ volumetric accuracy (with MaxSHOT 3D): minimum 0.020 mm + 0.025 mm/m
- ✓ software: VXelements, Catia V5, V6;
- ✓ output format type: .dae, .fbx, .ma, .obj, .ply, .stl, .txt, .wrl, .x3d, .x3dz, .zpr

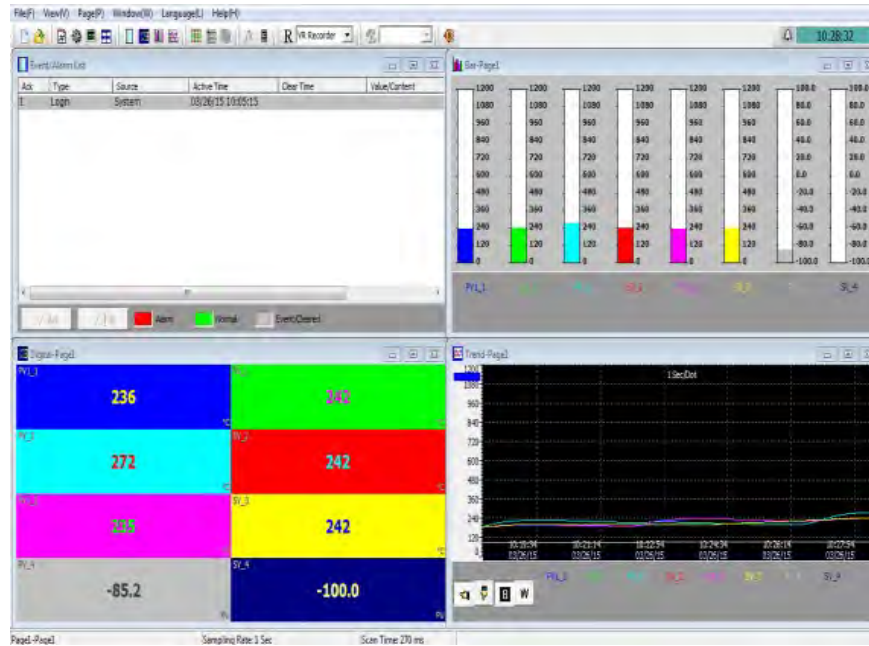


## HEAT TREATMENT OVEN *(Annex – position no.40)*



**Heat treatment** oven is an electric oven with rapid heating which is used both for the controlled heating and heat treatments at temperatures up to 1100 °C, as well as impurities diffusion in the material. Also, it can be used in the synthesis of metal materials or alloys. The oven includes a quartz tube with diameter of 125 mm and length of 1400 mm. At both ends of the quartz tube it has a pair of flanges for connection to the vacuum booster pump and the carrier gas / thermocouple. The temperature is controlled so as to have a very high stability on a broad landing and provide an increase or decrease in temperature with  $\pm 1$  °C.

The heating zone is 800 mm, heating rate 20 ° C / min and temperature control can be done either manually (by temperature programming with the regulator of the electronic box) and automatically using the computer provided.



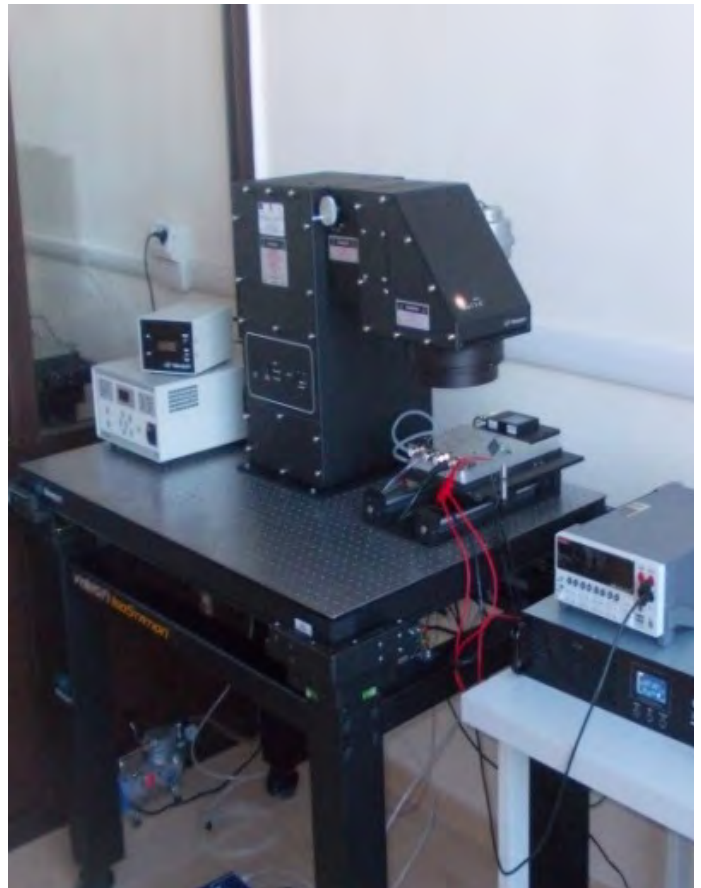
*Heat treatment analysis: parameters,  
Heating diagram and recorded temperatures in real time*

Programmed parameters (temperature and time) and pressure are digitally displayed. Also, the display shows the time for each land. The oven can be programmed for automatic shutdown and it is announced by audible warning, but it can be stopped any time. It is equipped with a microcontroller PID with overheating protection and alarm.

## *D. Photovoltaic Cells Testing. Photovoltaic Modules Testing. Printed Circuit Boards Prototyping. Electrical Measuring*

### **CHARACTERIZATION SYSTEM MODULE AND SOLAR CELLS ORIEL SOL3A CLASS AAA SOLAR SIMULATORS** (Annex – position no. 41)

**The Oriel Sol3A simulator** determines I-V characteristic, short circuit current  $I_{SC}$ , open circuit voltage  $V_{OC}$ , maximum power  $P_{max}$ , maximum current  $I_{max}$ , maximum voltage  $V_{max}$ . It use a single lamp design to meet not one or two, but all three performance criteria without compromising the 1 Sun output power, providing true Class AAA performance. Oriel Sol3A also integrates a partial sun attenuating device to allow easy variation of the output from 0.2 - 1.0 suns with the simple turn of a knob. The Oriel Sol3A uses a black non-reflective finish to minimize stray light, incorporates captive screws for all panels requiring user access to facilitate lamp replacement, alignment, and filter changes, and incorporates safety interlocks to prevent inadvertent exposure to UV light. Photovoltaic cell research and manufacturing are evolving rapidly, with new technologies like thin film processes tandem junction and multi-junction cells, organic thin films and dye sensitized cells all requiring careful evaluation of their performance. The Sol3A simulators have been designed to meet Class A performance for all 3 of the test requirements, Spectral Match, Non-Uniformity of Irradiance and Temporal Instability of Irradiance as called out by IEC 60904-9 Edition 2 (2007) JIS C 8912 and ASTM E 927-05.



## **ORIEL INSTRUMENT'S IQE-200 MEASUREMENT SYSTEM** (*Annex – position no.42*)

**Oriel Instrument's IQE-200** system allows the measure of External Quantum efficiency (EQE) also known as Incident Photon to Charge Carrier Efficiency (IPCE) as well as Internal Quantum Efficiency (IQE) for solar cells, detectors or any other photon-to-charge converting device.

### ***Operating principle:***

The electronic band structure in a photovoltaic device introduces a wavelength dependent optical absorptivity. A photon with energy larger than the band gap is typically absorbed by the material, while the material is transparent for a photon with energy smaller than the band gap. The absorbed photon energy creates an electron-hole pair, which leads to creation of photocurrent.

The spectral response for a photovoltaic device is dependent on this induced photocurrent and on the wavelength of incident light.





The IQE-200 System uses a 250W QTH lamp as the light source for the monochromatic light for the system. The monochromatic (1nm spectral resolution) modulated beam is obtained using the system consisting of the filter wheel, the chopper, and the 1/8th meter monochromator.

The three - way beam splitter delivers the light simultaneously to the sample and to the reference detector. The PC controls, the monochromator, the lock-in amplifier as well as the multiplexer used for simultaneous data acquisition from the three detectors.

**Results:**

The QE software performs the needed computations and calibrations. The power spectral responsivity,  $R_{pa}$ , for collected electrons per incident photons may be converted to external quantum efficiency, QE and then to internal quantum efficiency, IQE.



## PHOTOVOLTAIC MODULES PROTOTYPING TESTING AND DEVELOPING SYSTEM *(Annex – position no. 43)*

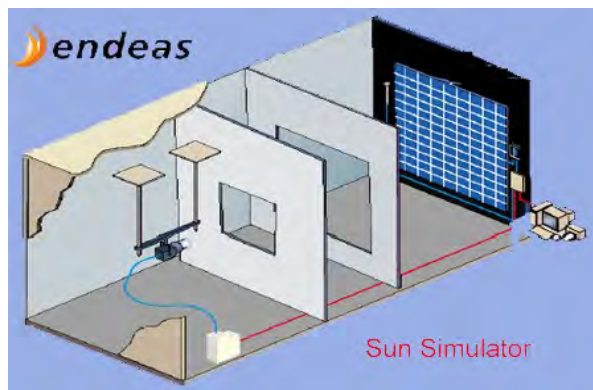
The developing, testing and prototyping system is composed of the following equipment:

- ✓ Connection and assembling of photovoltaic cells;
- ✓ Photovoltaic modules laminator;
- ✓ Photovoltaic modules solar simulator;
- ✓ Testers for characterization of photovoltaic modules strings.

**The equipment used for photovoltaic cells connection and assembling** allows the connection in series and/or parallel of the photovoltaic cells in the initial photovoltaic module. These can also achieve the following post-lamination steps: finishing, mounting of junction box and framing. The photovoltaic cells size can range between 20 mm x 20 mm and 15,6 cm x 15,6 cm, while the cells thickness can vary between 180  $\mu\text{m}$  and 300  $\mu\text{m}$ .

**Photovoltaic modules laminator** allows the lamination of photovoltaic cells in the initial solar glass photovoltaic module, EVA foil and PVE backsheets. Solar modules dimensions – maximum 600 mm x 600 mm, the temperature domain being in between 30 °C and 180 °C.

**Photovoltaic modules solar simulator** is dedicated for solar modules characterization. The system is capable of modules parameters characterization in a wide range of measurements, including: conversion efficiency, I-V characteristic, short circuit current  $I_{SC}$ , open circuit voltage  $V_{OC}$ , maximum power  $P_{max}$ , maximum current  $I_{max}$ , maximum voltage  $V_{max}$ . The equipment makes the tests under the STC (Standard Test Conditions) according to IEC 61215 standard.



### Testers for strings characterization of photovoltaic modules:

➤ **Tester for single phase and three phase PV systems**

**SOLAR300N** allows measurements according to EN50160 standard, for one photovoltaic module, one or multiple strings of modules. The equipment can make voltage measurements up to 600 V (cat. IV grounded) and up to 1000 V (cat. III between inputs), single-phase and three-phase voltage measurement (DC-AC TRMS), single and three-phase current measurement DC-AC, energy measurement in AC, power factor measurement PF, solar radiation measurements ( $W/m^2$ ), measuring the ambient temperature and PV module, registration of harmonic voltages and currents up to the 49th harmonic and recording of voltage spikes in time with a resolution of 5 ms.



➤ **Tester for performance and security of photovoltaic installations** **PVCHECK** is designed for testing and characterization of photovoltaic systems according to IEC/EN62446 standard. The equipment can make security tests on photovoltaic installations, conductors insulation continuity tests with 200mA minimum, insulation tests with minimum voltages of 250, 500, 1000 VDC, voltage measurements, DC current and power, short-circuit current measurements up to 10A DC minimum, angle of incidence determination.



➤ **Tester for ground resistance measurements**

**MACROTESTG1** is designed for grounding testing according to IEC/EN61557-1 standard. The equipment can make ground resistance tests and soil resistivity using 2/3/4 points method, power analysis up to the 25th harmonic, insulation continuity with a 200mA minimum.



➤ **Tester for voltage insulation of photovoltaic modules**

**HT7051** makes electric security tests on photovoltaic modules. The equipment can make programmable voltage measurements of alternative current (AC) ranged between 100 V and 5000 V, of  $\leq 3$  mA current, programmable voltage measurements of direct current (DC) ranged between 100 V and 5000 V, of  $\leq 3$  mA current, maximum measurable insulation resistance (to 5000 VDC) of minimum 10 GOhm.



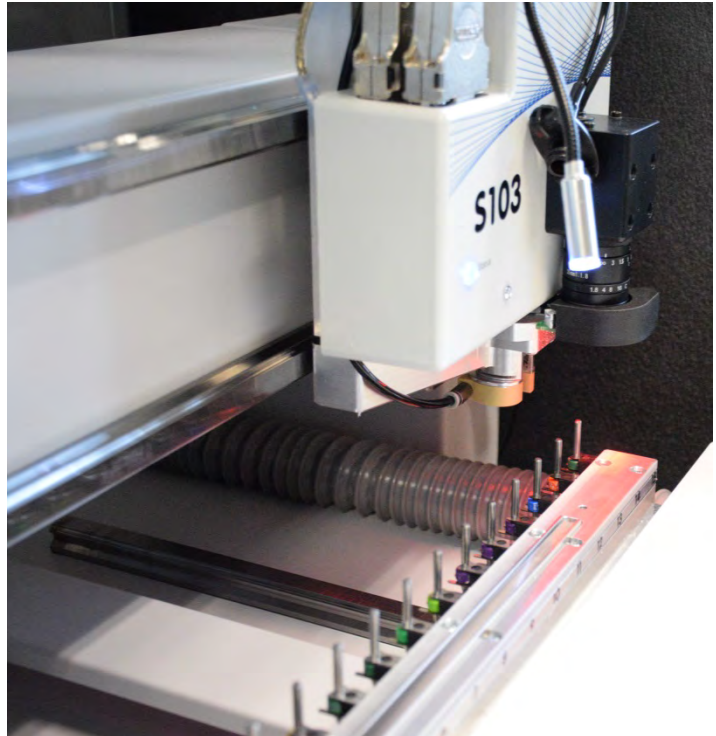
## PRINTED CIRCUIT BOARD PROTOTYPING LINE *(Annex – position no.44)*

PCBs offer both mechanical and electrical support for connections between electronic components. The PCB line gives the possibility of having a complete functional electronic circuit, starting from the basic design of the electronic circuit, in a CAD program, till the final stage of testing its electric and electronic functionality.

The laboratory's PCB line contains the following technologies:

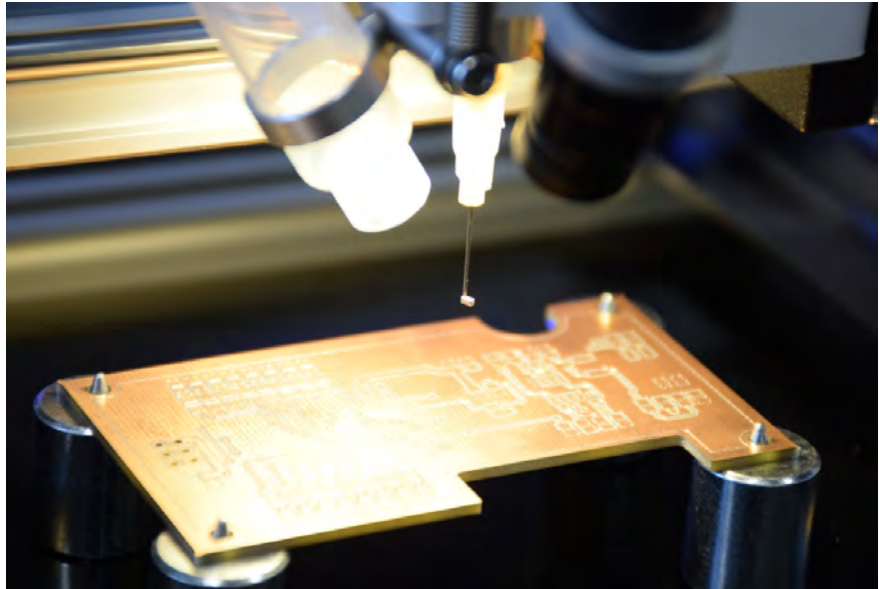
- **Desktop PC:** for controlling ProtoMat S103 machine and for CAD software processing of electronic schematics and boards aswell.

- **ProtoMat S103:** 3 axis plotter and auto-tool magazine, designed for mechanical copper removal of FR4 PCBs, or flexible ones, all with the max. dimensions of 210mm x 297mm, single layer, double or multi layer, using milling and drilling processing. The machine has a material processing speed of 150mm/s, with a 100.000rot/min rotational speed and a 0.25µm resolution. This machine has an illuminated video camera, for position detection and PCB size identification, it also has a vacuum system for steady holding of the PCBs and for aspiration of microparticles resulted from the mechanical processing.



- **Contac RS & Via Cleaner:** chemical bath equipment for electrogalvanization preparation of PCBs than need through the hole plating. The equipment has bath temperature monitoring, preset user profiles with probe movement and automated process ending. The maximum PCB probe dimension is of 460mm x 330mm.

- **ProMask/ProLegend:** kits for masks and legends applicable on the PCBs, for solder resistance.
- **UV Unit:** UV treatment unit for polymerisation of applied masks on the PCBs that have the maximum dimension of 210mm x 297mm.
- **Unox:** hot air oven for thermal curing of masks and legends applied on PCBs that have the maximum dimension of 210mm x 297mm.
- **ProtoPrint S:** precision manual stencil printer for solder paste placement on PCBs that have the maximum dimension of 210mm x 297mm.
- **ProtoPlace S:** semiautomated vacuum equipment for SMD and solder paste placement on PCBs that have the maximum dimension of 297mm x 420 mm. It also has a video camera and a monitor, adjustable table and rotative magazine for electronic components extraction, but it also has a XYZ blocking system for better overall precision enhancement.
- **ProtoFlow S:** convection reflow oven, for soldering SMD electronic components on PCBs. The oven is equipped with 3 temperature sensors for monitoring of thermal sensitive electronic components placed on PCB. The equipment has programmable user profiles. The insertion area is of 200 mm x 160 mm and can hold multiple boards.
- **Hameg HMO724:** DSO generation oscilloscope, which serves the measurement and analysis of electrical signals from electronic circuits, but also for measuring and testing of electronic components and their characteristics (measurements eg.: voltage and time, impedance, voltage drop, frequency, harmonics, analog and digital signal, ripple etc.).
- **Konstanter SLP:** laboratory programmable power supply 20V/10-20A, for testing and powering of electronic circuits.



## FLUKE TI400 THERMAL IMAGER (Annex – position no.45)

### **Short description of the equipment - basic characteristics:**

- ✓ standard infrared lens and autofocus with technology LaserSharp;
- ✓ temperature range : -20° C and 1200° C;
- ✓ thermal sensitivity:  $\leq 0.05^{\circ}$  C at a target temperature of 30° C;
- ✓ resolution: 320 x 240 (76,800 pixels);
- ✓ spatial resolution: 1.31 mRad;
- ✓ field of view: 24° horizontal x 17° vertical.

### **Types of tests:**

- ✓ identification of hot spots in electrical installations;
- ✓ thermal inspection of mechanical systems (motors, pumps, etc.);
- ✓ supervision of industrial processes;
- ✓ scanning thermal heating systems, furnaces;
- ✓ viewing areas with air or water leaks at home;
- ✓ scanning thermal insulation of buildings and assessment.

### **Sample type:**

electrical, electronic circuits, mechanical systems, buildings.

### **Application areas:**

energy, electrical, electronics and microelectronics, motor industry, oil and metallurgy / steel.



## HDO6104-MS HIGH DEFINITION OSCILLOSCOPE (Annex – position no.46)

### Short description of the equipment - basic characteristics:

- ✓ bandwidth: 350 MHz – 1 GHz;
- ✓ analogic channels: 4;
- ✓ digital channels: 16;
- ✓ sample rate (all channels): 2.5 GS/s;
- ✓ memory (per channel): 50 Mpts/ch;
- ✓ digital sample rate: 1.5 GS/s;
- ✓ minimum detectable pulse width: 2ns;
- ✓ maximum input frequency: 250 MHz.

### Types of tests:

- ✓ the ability to locate unusual events in a single capture - WaveScan function;
- ✓ report generation for the waveform and the possibility of direct annotation on the oscilloscope screen - LabNotebook function;
- ✓ playback - scroll back for previous time waveform and isolating signal anomalies - History function;
- ✓ automatic determination of peak frequency - display markers, interactive tables with the frequency, automatic identification and marking of the fundamental frequency and harmonics;
- ✓ spectrogram which can display a 2D or 3D history of the frequency content (how the spectrum changes in time).

**Sample type:** electrical and electronic components and circuits.

**Application areas:** energy, electrical, electronics and microelectronics.



## ENERGY ANALYZER C.A. 8435 *(Annex – position no.47)*

**The C.A. 8435** (Qualistar+) is a three-phase network analyzer with colour graphic display and built-in rechargeable battery.

It plays three roles, and can be used to measure the RMS values, powers, and perturbations of electric distribution networks, to deliver a snapshot of the principal characteristics of a three-phase network, to track the variations of various parameters over time.

The measurement uncertainty of the device is better than 1% (not counting the uncertainties due to the current sensors). The device is also very flexible, with a choice of sensors allowing measurements ranging from a few milliamperes (MN93A) to several kiloamperes (AmpFLEX™).

The CA 8335 is intended for the technicians and engineers of electrical installation and network inspection and maintenance teams.

The principal measurements made are:

- ✓ the RMS values of AC voltages up to 1000 V between terminals. By using the ratios, the device can measure voltages up to hundreds of gigavolts;
- ✓ the RMS values of AC currents up to 6500 amperes (neutral included). By using the ratios, the device can measure currents up to hundreds of kiloamperes;
- ✓ the DC components of voltages and currents (neutral included);
- ✓ minimum and maximum half-cycle RMS voltage and current values (excluding neutral);
- ✓ peak voltage and current values (neutral included);
- ✓ the frequency of 50 Hz and 60 Hz networks;
- ✓ current and voltage peak factors (neutral included);
- ✓ calculation of the harmonic loss factor (FHL), application to transformers in the presence of harmonic currents;





## GAS ANALYZER THREE SENSORS KIGAZ 200 PRO *(Annex – position no.48)*

### **Description Tests:**

**KIGAZ Tool 200** is a gas analyzer that can be supplied with two interchangeable sensors ( $O_2$  and  $CO-H_2$ ) being able to add another sensor ( $NO$  or  $CH_4$ ) and three interchangeable sensors ( $O_2$ ,  $CO$ ,  $H_2$  and  $NO$ ) having the possibility to add a 4th sensor ( $CH_4$ ).

Main functions are:

- ✓ autozero duct;
- ✓ protection of  $CO$  sensor with a solenoid valve;
- ✓ LED illumination probe handle in dark places;
- ✓ condensate Trap outdoor;
- ✓ screen 3.5 " greyscale;
- ✓ 2 connectors for thermocouples;
- ✓ memory 2GB.

### **Technical characteristics:**

- ✓ comax. ambient  $CO$  exhaust gas air excess yield%, differential pressure, circulation, ambient temperature and cart, DT, DHW temperature, dew point, 15 + 5 predefined fuels choice smoke index;

automatic measurement, autotest, issue and print directly test certificate,  $CO-H_2$  sensor protection by solenoid valve, 2 inputs for thermocouple measurements 100,000 memory.

Kit contains holster with magnet, silicone hoses 2m x 1m, probe gas sampling a single connector, length 300mm condensate trap and light source, Li-Ion battery, power supply, software ligase (database creation and issue certificate verification), USB cable, carrying case, built-in printer.



## *E. Experimental Platforms*

### **THERMOSOLAR EXPERIMENTAL PLATFORM**

The **thermosolar experimental platform** is composed of two types of solar collectors: plane (plane solar collectors with heat exchanger and plane solar collectors with thermosiphon) and with vacuum tubes, designed for heating the tap water used for the institute building and for the air conditioning system using a refrigeration – cogeneration system.

The solar collectors are placed on a 45° angle on the top of the Research Institute building, on the west side, on a surface of 20 m x 18 m.



## PHOTOVOLTAIC EXPERIMENTAL PLATFORM

The purpose of the **photovoltaic experimental platform** is to support the research activity in energy domain produced by photovoltaic panels. The photovoltaic platform has several functional components with flexible reconfiguration possibilities:

✚ **On-grid photovoltaic generator**, mounted on top of the Research Institute building, by a surface of approximately 600m<sup>2</sup>, with 33.15 kW installed power. The photovoltaic system mounted on top of the building is composed of three groups with different installed power. Each group have it's own type of photovoltaic modules, respectively using different fabrication technology (70 modules Q.Cells Q.Pro-G3 245 W, 70 modules Calyxo CX3 80 W and 40 modules Bauer Solartechnik BS-260-6MB-5 260 W).



✚ **Off-grid photovoltaic generator mounted as sun visor (SV)**

The SV photovoltaic system has an installed power of 31.70 kW and is designed as a sun visor, for research and power production purpose. The system is comprised of three groups with different installed powers and it is installed as a sun visor on the southern windows of the Research Institute building. The SV system is mounted in front of the windows on each floor. All the groups are made with semi transparent photovoltaic modules Altius AFP 250W, the dimensions of the panels being of 1.5 m x 1.5 m.

The groups of photovoltaic modules are connected to the inverter fitted to the building's basement. The system is supported by accumulators for storing the energy produced during daytime. Battery charging is performed by the inverter by means of a regulator. Each inverter is fitted with its own distribution box for connections between the inverter, battery charger and charging regulator.



✚ **Off-grid photovoltaic generator - curtain wall (CW)**, mounted on the southern side of the building of the institute, has an installed power of 12.74 kW, it integrates 52 photovoltaic modules of Q.Cells Q.Pro-G3 BLK 245 W type and an electronic LED display.

✚ **Positioning platforms** with two axis orientation, dedicated to Solar Array installations.



## EXPERIMENTAL WIND PLATFORM

The experimental wind platform is comprised of:

- ✚ **OnGrid terrestrial wind generator**, with an installed power of 20 kW
  - ✓ Wind turbine with horizontal shaft type Aeolos HAWT 10 kW
  - ✓ Wind turbine with vertical shaft type Aeolos VAWT 10 kW



- ✚ **OffGrid wind generator** located on the terrace of the Research Institute, with an installed power of 5 kW
  - ✓ Wind turbine vertical type Typmar Maglev 3 kW
  - ✓ Wind turbine with horizontal shaft type Aeolos HAWT 1kW
  - ✓ Wind turbine with vertical shaft type Aeolos VAWT 1kW



🚧 **Environmental parameters monitoring system**

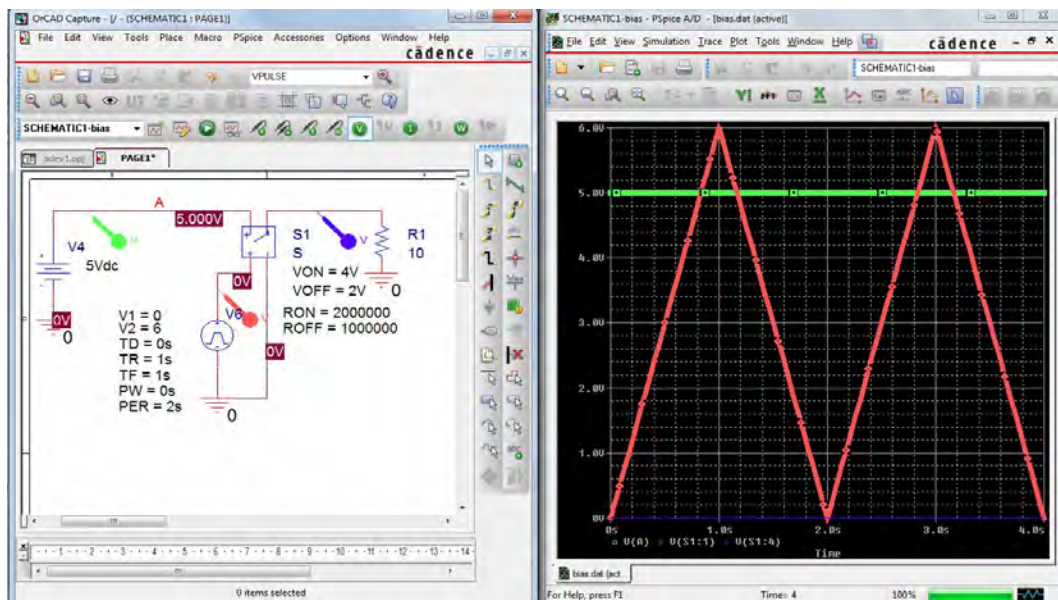
- ✓ Weather station Kipp & Zonen Solys 2 (three pyranometer type CMP22, one pyrgeometer type CGR4, one pyrheliometer type CHP1, one data logger type Campbell Scientific CR1000)
- ✓ Multi-sensor Gill Instruments MetPak
- ✓ Ultrasonic anemometer Wind Master Pro 3D



## F. Software

### OrCAD

**OrCAD** design environment is a software of Computer Aided Design (CAD) category created for designing and simulation of Printed Circuit Boards (PCB) and electrical schematics of electronic circuits. **OrCAD** contains multiple software blocks dedicated to specific activities. The most important and most frequently used blocks are: PSpice-simulates how the electrical schematic works, Capture - is used to achieve the electrical schematics of electronic circuits, the Layout is used for designing electronic circuits wiring.





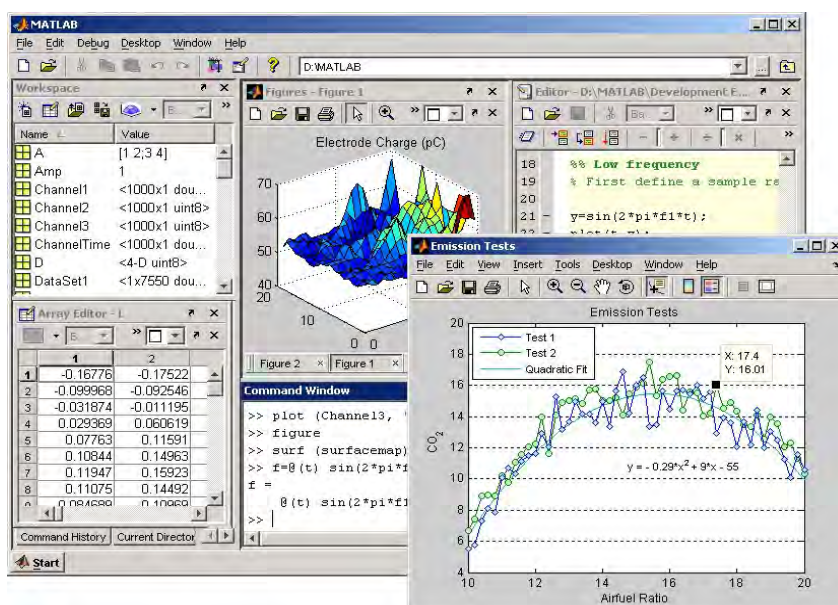
## MATLAB

**Matlab** is a development environment for numerical calculation and statistical analysis capabilities, handling of matrices, visualization of the functions, implementation of algorithms, creation of user interfaces, etc.

**Matlab** can be used in a wide variety of applications, including image processing and signals, financial analysis and modeling, and by adding additional libraries extend these applications to solve problems specific to a particular field.

The main functions are:

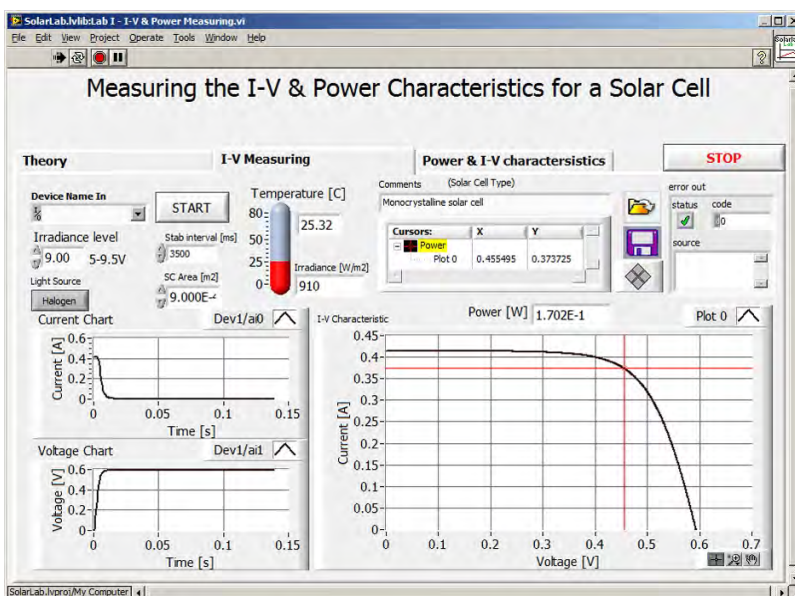
- Functions for 2D and 3D visualizations of data;
- Mathematical functions for linear algebra, statistics, Fourier analysis, filtering, optimization, and numerical integration;
- Tools for building a customized interfaces;
- Functions for integrating Matlab algorithms in external applications and languages such as C, C++, Fortran, Java, COM, Microsoft Excel.



## LabVIEW

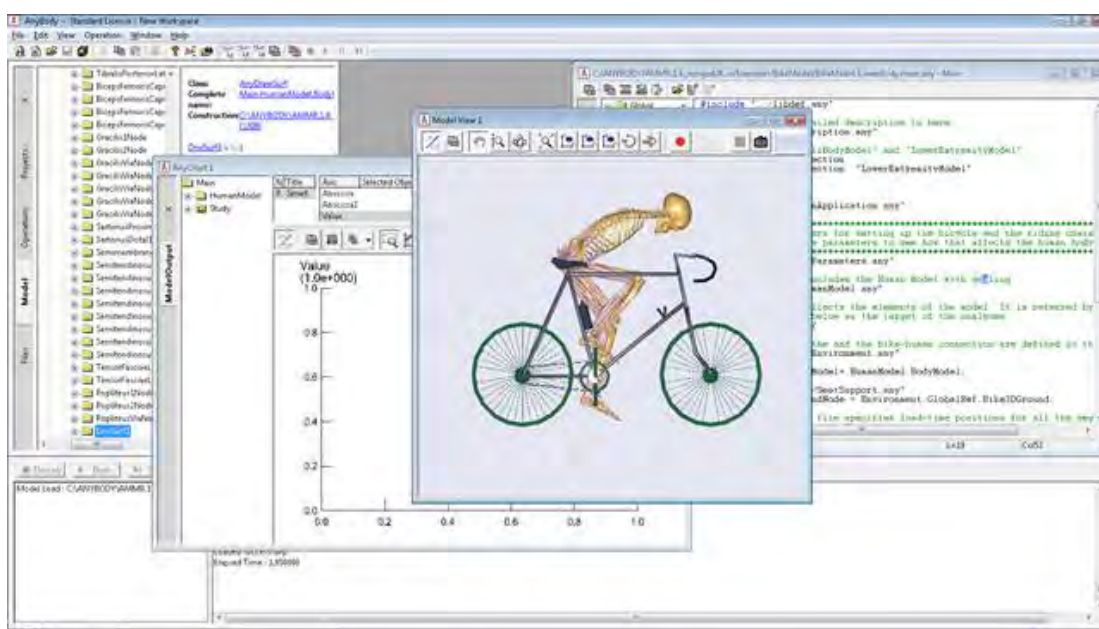
LabVIEW (**L**aboratory **V**irtual **I**strumentation **E**ngineering **W**orkbench) is a programming environment that is used especially for carrying out measurements and monitoring of processes automated. For writing programs in LabVIEW graphical language is used, the programming language of the 5th generation, LabVIEW environment containing several libraries of built-in functions for acquisition, processing, display and transmission of data. The programs made in LabVIEW are called virtual instruments (Visual Instruments-VI), at the base of their concepts of modularization and the tree hierarchy.

Fields of application: data acquisition and signal processing, testing and validation of automated systems, industrial measurements and control, embedded systems design.



## ANYBODY

**ANYBODY** is a software used in order to simulate human movement. Its use allows modeling scheleto-muscle groups (or of the whole body), can calculate the muscle forces, joint reacțiunile, metabolism, work, efficiency, for all kinds of movements. **ANYBODY** software finds its application both in basic research and for solving practical problems enabling complex studies of human biomechanics (kinetic and kinematic analysis) studies ergonomics (designing an optimal place for repetitive work, designing the dashboard or seats for vehicles etc.), studies regarding optimum scheleto-muscular recovery (applying electrical muscle stimulation for obtaining the desired movement), sports studies (which is the ideal anthropometric model for a sportsman in a particular discipline), medical studies (how can the central nervous system release the burden over an affected articulation, a muscle, a ligament, or what are the consequences for the rest of the scheleto-muscular system).

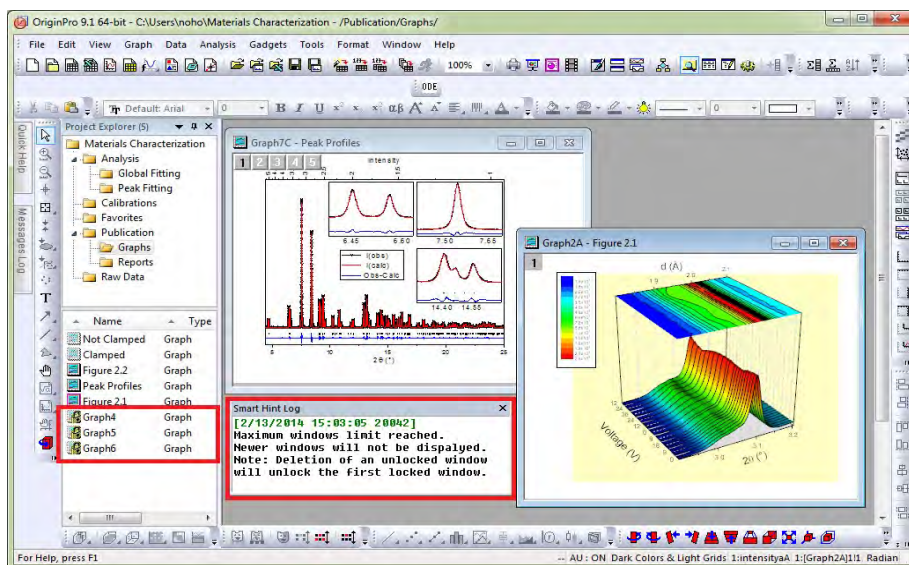


## ORIGIN PRO

**Origin Pro** software is a software that includes tools for advanced statistical analysis, regression and nonlinear curve fitting, analytical signal processing, image processing and analysis of peaks.

The results of these procedures can be used to generate single or multiple reports, such as for example the analysis report.

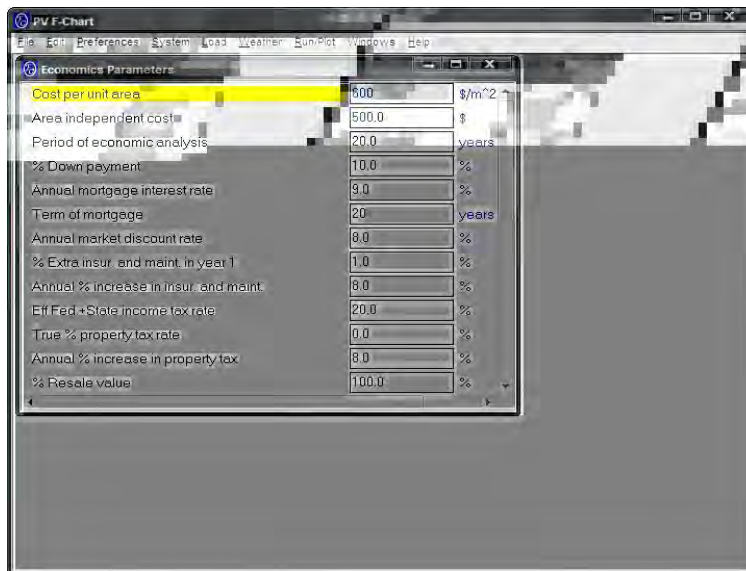
**OriginPro** provides advanced statistical analysis tools, 3D fitting, image processing and analytical signal.



## PV F-CHART

**PV F-Chart** is a useful software for the design and economic analysis of photovoltaic systems. The software was developed at the University of Wisconsin (USA) - Solar Energy Laboratory to estimate long-term energy performance of photovoltaic systems following:

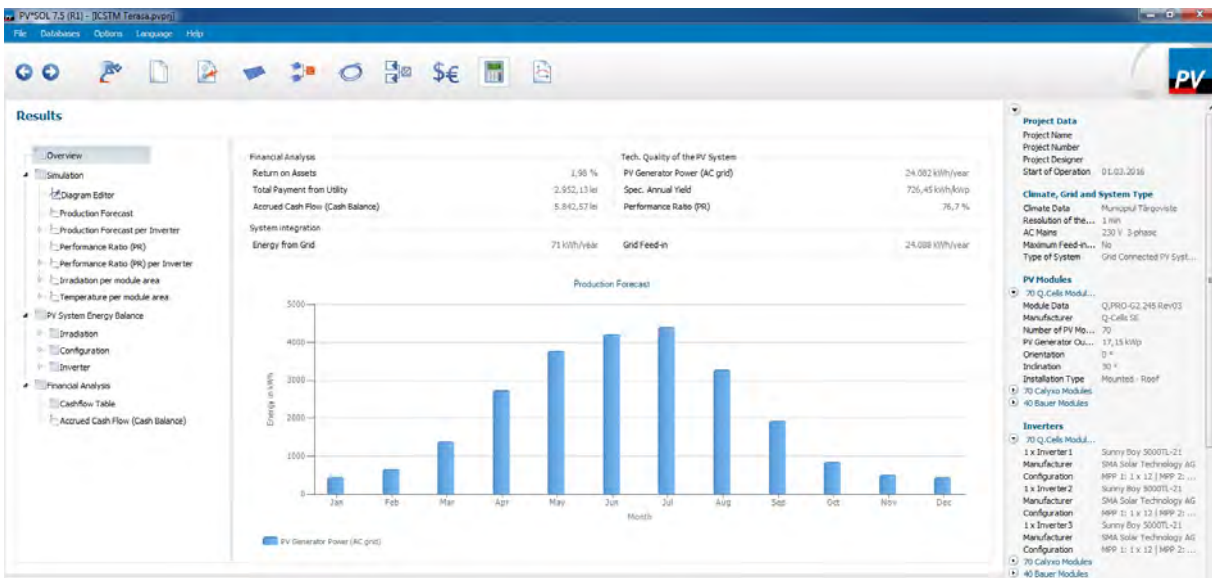
- ✓ user interface systems;
- ✓ systems with storage batteries;
- ✓ systems without user interface and storage (stand-alone).



## PV SOL

**PV SOL** is a useful simulation software for design and simulation of photovoltaic systems.

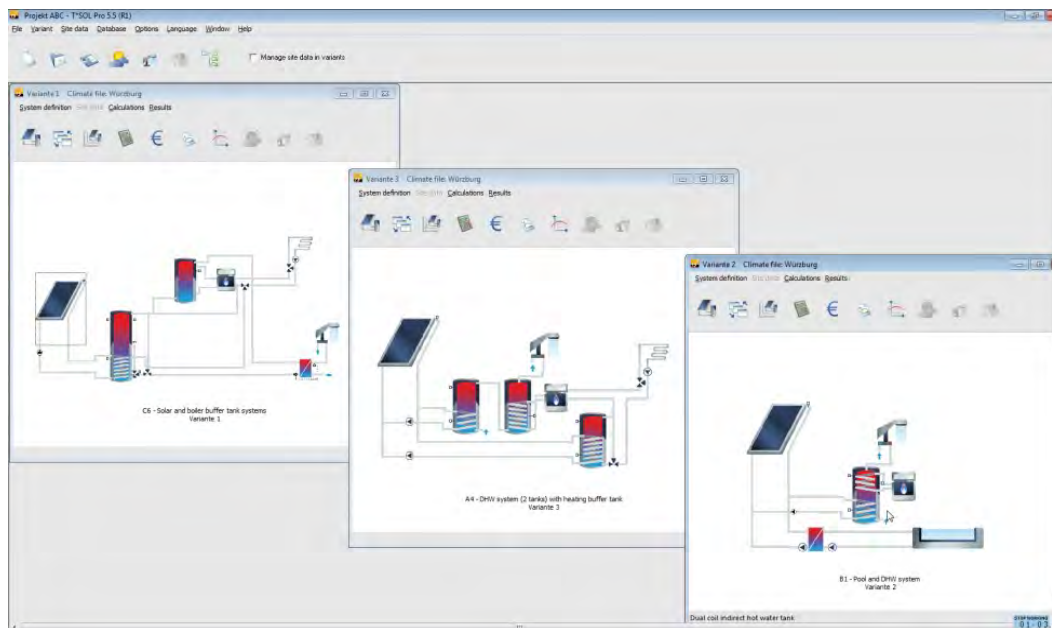
- ✓ It contains a database of photovoltaic modules, inverters and climate records from various locations;
- ✓ Calculate all configurations based on combinations of photovoltaic modules and inverters viable;
- ✓ Generates a complete set of reports both energy efficiency of the system and the economic profitability of the solution chosen.



## T SOL

**T SOL** provides all the necessary tools to designers, specialists and researchers involved in thermal solar industry.

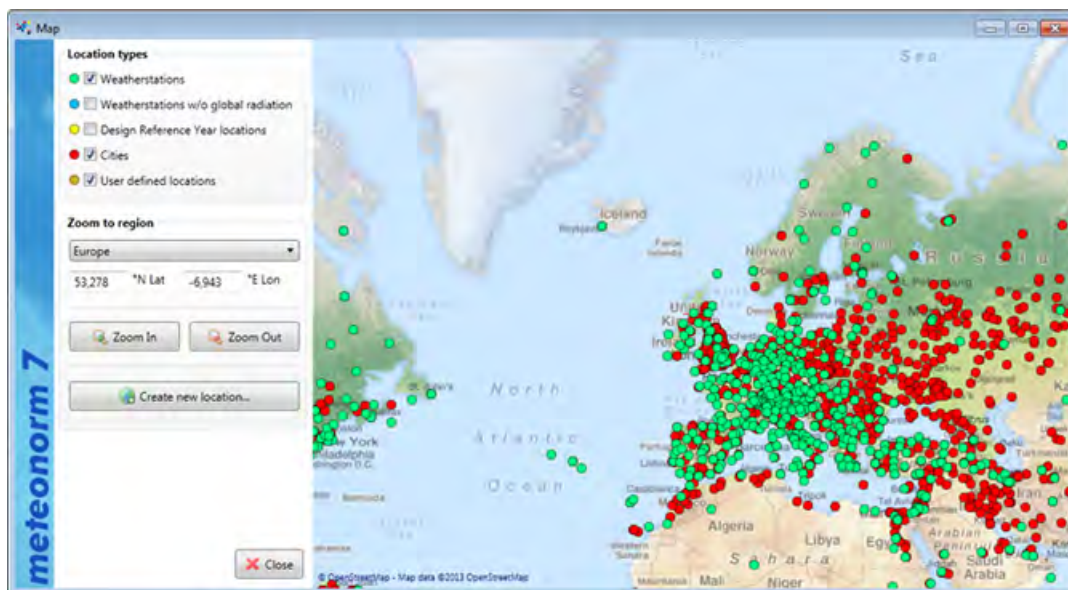
- ✓ Integration of dedicated modules for solar heating of swimming pools ("Swimming Pool" mode);
- ✓ Installation of large size systems ("Large Scale" mode);
- ✓ Providing solar energy to the neighborhoods heating systems ("District Heating" mode).



## METEONORM

**METEONORM** is a useful software for generating meteorological data. Meteorological data are obtained from measurements made under different weather stations located across the globe. You can export data in various formats related to the annually, monthly and even hourly evolution of several meteorological parameters (temperature, humidity, solar radiation, rainfall etc.).

**METEONORM** uses a method for calculation of the solar radiation on the primary surfaces oriented randomly in any location. This method consists in the structure of databases and algorithms for interpolation on a predetermined scheme.



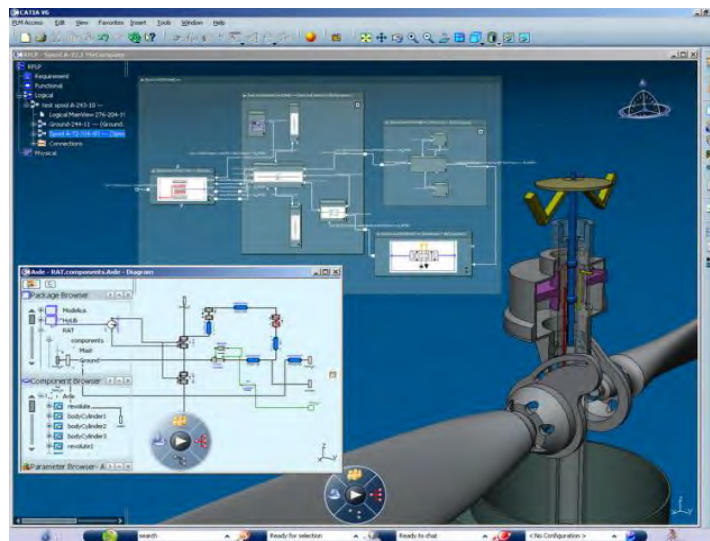


## CATIA

**CATIA V5** is an application reference in the field of computer-aided design. The software provides an integrated solution, which in addition to the facilities related to solid modeling, representative to all common applications, offers as well, modules for stylists, thereby allowing expansion of computer use in earlier stages of design and construction.

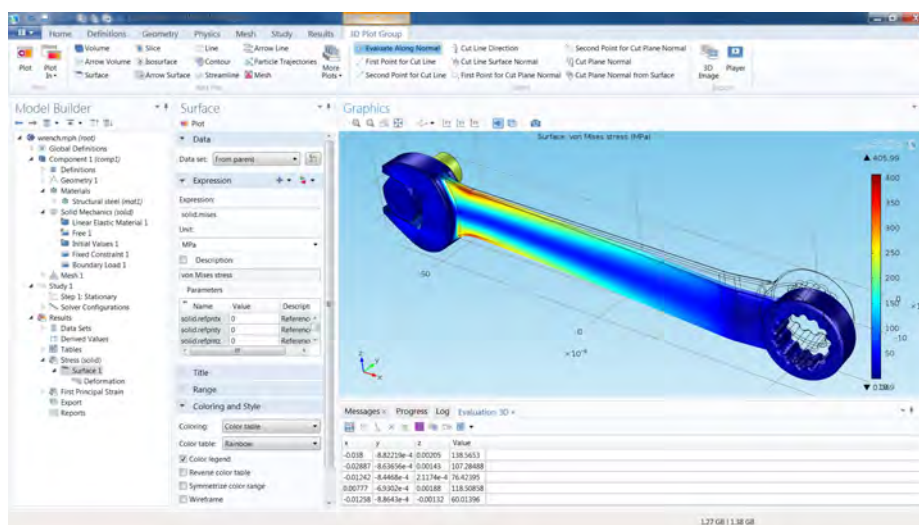
**CATIA V5** is the solution for developing software and complete digital product definition model. Through its development-oriented process, **CATIA V5** covers the entire development process - from the idea concept to maintenance.

**CATIA V6** offers a full range of solutions for the development of various disciplines and global collaboration in developing virtual teams. The capabilities of **CATIA V6** go beyond the traditional 3D-CAD software applications, through an unique digital experience based on 3DEXPERIENCE platform. **V6** version enables the planning of all aspects of the product, to unique specifications, multi-physical simulations and realistic visualization.



## COMSOL MULTIPHYSICS

**COMSOL Multiphysics** is a finite element analysis, solver and simulation software package (FEA/FEM software) for various physics and engineering applications, especially coupled phenomena, or multiphysics. **The COMSOL Multiphysics** simulation environment facilitates all the steps in the modeling process – defining your geometry, meshing, specifying your physics, solving, and then visualizing your results. It also serves as a platform for the application specific modules. Model set-up is quick, thanks to a number of predefined physics interfaces for applications ranging from fluid flow and heat transfer to structural mechanics and electrostatics. Material properties, source terms, and boundary conditions can all be spatially varying, time-dependent, or functions of the dependent variables. You can freely mix physics interfaces into new multiphysics combinations as well as couple with any application specific module. As an alternative to writing your own simulation code, the COMSOL Multiphysics user interface gives you the option to specify your own partial or ordinary differential equations (PDEs or ODEs) and link them with other physics interfaces.



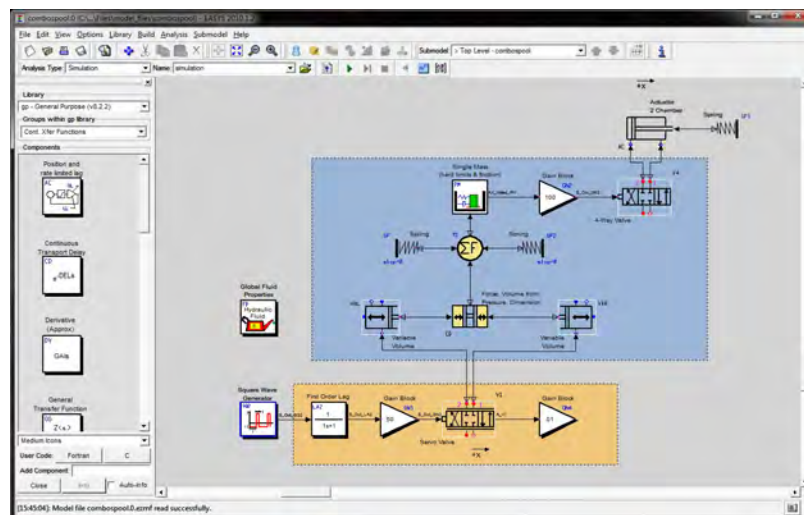
## EASY5

**Easy5** is an advanced software for modeling and simulation of dynamic systems.

**Easy5** simplifies the construction and analysis systems through a schematic chart that provides a comprehensive set of components stored in its library-specific applications.

The specific applications for Easy5 include hydraulic control systems, pneumatic, gas streams, thermal, electrical, mechanical, refrigeration, environmental control, lubrication systems etc.

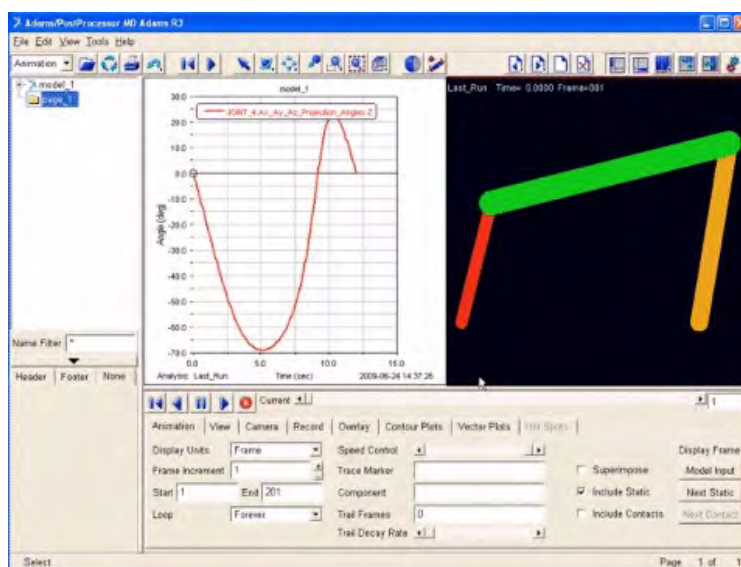
In **Easy5** software, the systems can be modeled mathematically, can be predefined components that represent complex physical elements (pumps, gears, valves, valves, heat exchangers etc.), empirical data (multidimensional tables) but also user-defined codes.



## ADAMS

**Adams** is a simulation program for analyzing complex behaviors motion of mechanical assemblies that allows testing virtual prototypes and optimize project performance, safety and comfort, without the need for physical construction and testing of numerous prototypes.

**Adams** is a family of interactive simulation applications motion. The basic package (Adams / View, Adams / Solver, and Adams / Postprocessor) allow the importing of geometry from most CAD systems or building from scratch a solid model of the mechanical system. A library of joints and constraints is available for creating linkages. Once a virtual prototype is complete, **Adams** checks the model and then simultaneously running numerous simulations equations required static, quasi-static, kinematic and dynamic. The results are visible in the form of graphs, charts plotter, reports, or colorful animations that can be distributed.



## ANNEX

No.	Equipment and research services	Price (includes VAT)
1.	<b>Scanning Electron Microscope (SEM)</b> Surface morphology imaging (secondary electrons) – SEM Surface topography imaging and compositional contrast (secondary and backscattering electrons) – SEM+BSE SEM+EDS Analysis Elemental analysis and elements distribution on sample surface – EDS+WDS	920.00 RON/sample 991.00 RON/sample 1162.00 RON/sample 1425.00 RON/sample
2.	<b>Nanoindenter - Nanoscratcher</b> Determination of stiffness, hardness in nanometric layers	329.00 RON/sample
3.	<b>Atomic Force Microscope (AFM)</b> Atomic Force Microscopy (surface analysis)	318.00 RON/sample
4.	<b>Axio Imager M2M Microscope</b> Optical microscopy	97.00 RON /sample
5.	<b>Primo Star Microscope</b> Optical microscopy	73.00 RON /sample
6.	<b>Installation for Metal and Dielectric Layers Deposition by Sputtering</b> Metal And Dielectric Layers Deposition By Sputtering	465.00 RON/sample
7.	<b>Installation for thin film deposition in vacuum with electron beam (E-BEAM)</b> Thin film deposition in vacuum with electron beam	221.00 RON /sample
8.	<b>Installation for thin film deposition by spinning (SPIN-ON)</b> Thin film deposition by spinning (SPIN-ON)	88.00 RON /sample
9.	<b>Installation for thin film deposition by Sol-Gel coating (DIP-COATER)</b> Thin film deposition by Sol-Gel coating (DIP-COATER)	87.00 RON /sample
10.	<b>Reactive Ion Etching (RIE)</b> Corrosion of surfaces in plasma with reactive ions	191.00 RON /sample

<b>No.</b>	<b>Equipment and research services</b>	<b>Price (includes VAT)</b>
<b>11.</b>	<b>X-RAY Diffractometer (XRD)</b> Analysis	43.00 RON/sample
<b>12.</b>	<b>Wavelength Dispersive X-Ray Fluorescence (WDXRF)</b> Analysis - qualitative and quantitative	157.00 RON /sample
<b>13.</b>	<b>Inductively Coupled Plasma Mass Spectrometer (ICP-MS)</b> - Elemental Quantitative and Qualitative Analysis	766.00 RON/sample
<b>14.</b>	<b>Fourier Transform Infrared (FT-IR) Spectrometer</b> - Spectral Analysis	138.00 RON /sample
<b>15.</b>	<b>UltraViolet-VISible (UV-VIS) Spectrophotometer</b> single beam, double beam - Spectral Analysis	68.00 RON /sample
<b>16.</b>	<b>RAMAN Spectrometer</b> Qualitative Analysis, Spectra Analysis	40.00 RON /sample 40.00 RON /sample
<b>17.</b>	<b>Nuclear magnetic resonance (NMR) Spectrometer</b> Structure determination of chemical compounds	54.00 RON /sample
<b>18.</b>	<b>Atomic Absorption Spectrometer (AAS)</b> Quantitative analysis by Atomic Absorption Spectrometry  Quantitative analysis by Atomic Absorption Spectrometry	340.00 RON/sample (when it use acetylene) 516.00 RON/sample (when it use nitrous oxide)
<b>19.</b>	<b>GAMMA Spectrometer</b> Radioactivity determination of substances	38.00 RON /sample
<b>20.</b>	<b>Titration</b> Water content determination	66.00 RON /sample
<b>21.</b>	<b>Halogen Moisture Analyzer Mettler Toledo HS153 model</b> Moisture determination	30.00 RON sample
<b>22.</b>	<b>Elementary Analyzer C, S and Cl Solids Analysis</b> Carbon content determination Sulphur content determination Chlorine content determination	42.00 RON/sample 42.00 RON/sample 120.00 RON/sample

<b>No.</b>	<b>Equipment and research services</b>	<b>Price (includes VAT)</b>
<b>23.</b>	<b>Calorimeter</b> Specific Heat Determination	66.00 RON/sample
<b>24.</b>	<b>Mercury Analyzer</b> Mercury content determination	30.00 RON/sample
<b>25.</b>	<b>Quartz Crystal Microbalance</b> Determination of adsorbed mass per surface unit	240.00 RON/sample
<b>26.</b>	<b>Oxidation Stability Tester</b> Oxidation stability testing	60.00 RON/sample
<b>27.</b>	<b>Top Wave</b> Sample microwave digestion	72.00 RON /sample
<b>28.</b>	<b>Viscometer</b> Viscosity Determination	15.00 RON/sample
<b>29.</b>	<b>Chemical Reactor</b> Chemical Reactions Modeling (reagents costs not included)	57.00 RON/sample
<b>30.</b>	<b>Fat Extractor</b> Fat extraction	128.00 RON/sample
<b>31.</b>	<b>Berghof Digestor MWS2</b> Sample microwave digestion	72.00 RON /sample
<b>32.</b>	<b>Multimeter</b> pH measurement Conductivity/TDS measurement Dissolved Oxygen measurement	30.00 RON /sample 25.00 RON /sample 32.00 RON /sample
<b>33.</b>	<b>5 Axes CNC ULTRASONIC 30 LINEAR Vertical Machining Center</b> - Mechanical processing of metallic, plastic, ceramic and composite materials by milling, drilling and threading	321.00 RON/sample
<b>34.</b>	<b>CTX 310 ECOLINE CNC Turning machine</b> Mechanical processing by lathing	321.00 RON/sample
<b>35.</b>	<b>LASER Ablation System</b> Drilling / cutting / milling / printing alpha-numeric text by laser ablation	335.00 RON /sample

<b>No.</b>	<b>Equipment and research services</b>	<b>Price (includes VAT)</b>
<b>36.</b>	<b>Wire Bonder Machine KS-4526</b> Bonding with gold wire HD 2 - 25µm Bonding with gold wire HD 2 - 35µm Bonding with AlSi wire 1% - 25µm Bonding with AlSi wire 1% - 50µm	230.00 RON/sample 230.00 RON/sample 180.00 RON/sample 140.00 RON/sample
<b>37.</b>	<b>StereoLitography Machine</b> Rapid prototyping by repeated solidification of liquid resin by a UV LASER	25.00 RON + 3 RON/ ml resin
<b>38.</b>	<b>MTS BIONIX Testing System</b> Mechanical tests in dynamic conditions: tensile, compression, torsion, hip orthopedic implants test	576.00 RON/sample
<b>39.</b>	<b>EXASCAN 3D Portable Scanner</b> 3D Scanning	200.00 RON/sample
<b>40.</b>	<b>Heat Treatment Oven</b> Heat treatment	400.00 RON/sample
<b>41.</b>	<b>Characterization System Module and Solar Cells ORIEL. Solar Simulators</b> IV characteristics determination for photovoltaic cells	590.00 RON/sample
<b>42.</b>	<b>ORIEL Instrument's IQE-200 Measurement System</b> Quantum efficiency measurement	518.00 RON /sample
<b>43.</b>	<b>Photovoltaic Modules Prototyping Testing and Developing System</b> Prototyping of photovoltaic modules Testing of photovoltaic modules	410.00 RON /module 220.00 RON /module
<b>44.</b>	<b>Printed Circuit Board (PCB) Prototyping Line</b> Single sided PCB prototyping without holes metallization Single sided PCB prototyping with holes metallization Double sided PCB prototyping with holes metallization Component planting on prototype PCB (10 pcs./side) CAD generated prototype project using an electronic schematic	492.00 RON/sample 552.00 RON/sample 792.00 RON/sample 36.00 RON / sample 60.00 RON /sample



<b>No.</b>	<b>Equipment and research services</b>	<b>Price (includes VAT)</b>
<b>45.</b>	<b>FLUKE TI 400 Thermal Imager</b> Thermal analysis	96.00 RON/sample
<b>46.</b>	<b>High Definition Oscilloscope</b> Analysis of analog/digital signals with professional HD 06104 MS Oscilloscope	96.00 RON/sample
<b>47.</b>	<b>Energy Analyzer</b> Determination of power quality	192.00 RON /sample
<b>48.</b>	<b>Gas Analyzer</b> Determination of nitrogen and oxygen concentration in confined spaces	24.00 RON/sample

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