



# TECHNOLOGY TRANSFER STRATEGY OF CANDLE SYNCHROTRON RESEARCH INSTITUTE



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# Technology Transfer Strategy of CANDLE Synchrotron Research Institute

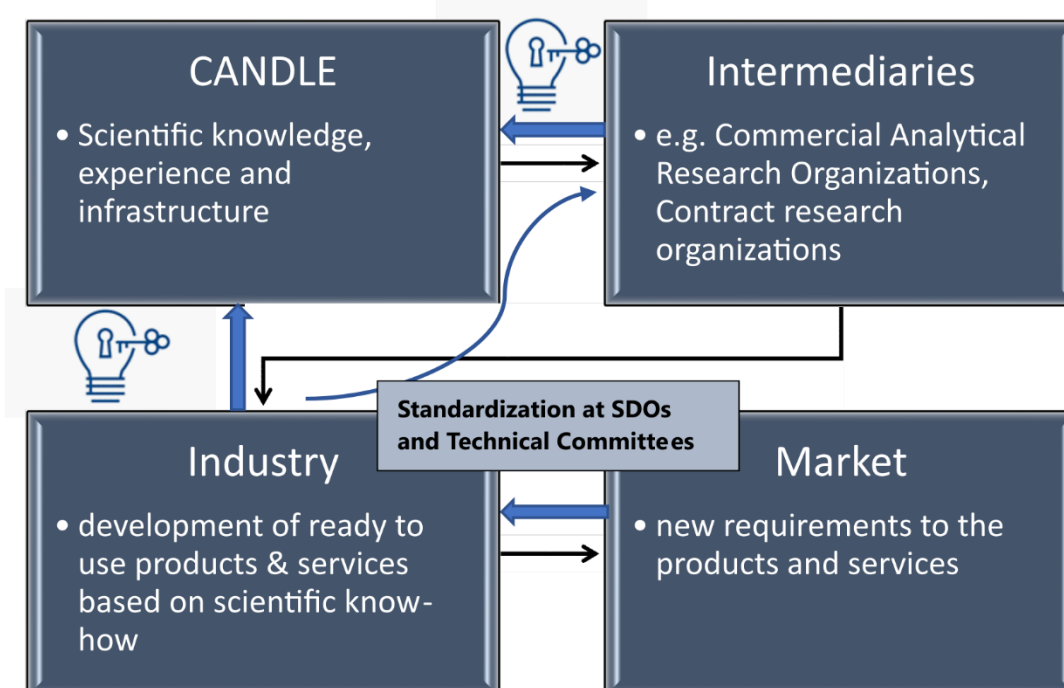
## Introduction

CANDLE (Center for the Advancement of Natural Discoveries using Light Emission) Synchrotron Research Institute is a publicly funded research organization with a mission to develop fundamental science in the field of accelerator physics and technique.

The main activity directions of the Institute are:

- Accelerator Physics and Technology
- Brilliant Light Sources and Free Electron Lasers
- Ultrafast Sciences and Techniques
- Life and Materials Sciences

Technology Transfer at CANDLE is viewed as an important channel to reach out and engage industrial stakeholders at national, regional and international levels. It is considered to be a mutually beneficiary process between the scientific, intermediary and business entities dealing with R&D and Innovation activities. The overall process of Technology Transfer is perceived as a means of boosting a knowledge-based economy and innovation in Armenia through available at Research Institutions or Infrastructures (RIs) research intelligence, scientific know-how and technological infrastructure.



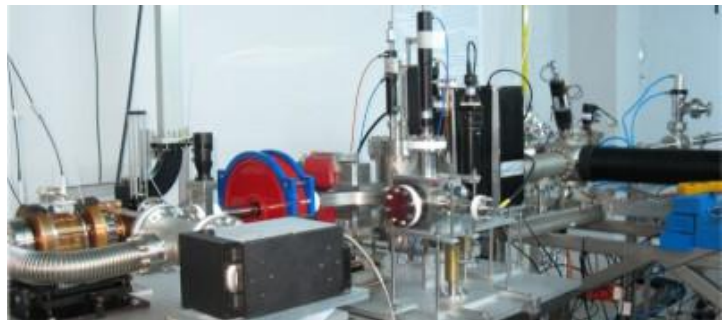
## Underlying organizational and country frameworks

### Technology Portfolio

CANDLE SRI offers technologies to be applied in a wide range of industrial and research fields. The Institutes activity and infrastructure allow not only ready to use technologies/products but also developing new ones based on the demand of the offering interested stakeholders.

#### *1. AREAL (Advanced Research Electron Accelerator Laboratory)*

AREAL-Advanced Research Electron Accelerator Laboratory is an electron linear accelerator facility (see **Error! Reference source not found.**) based on photocathode RF gun. Currently the facility is able to provide ultra-short electron bunches with about 0.5 ps bunch length with a particle charge up to 800 pC. For irradiation researches sub-picosecond long electron bunches with energies up to 5 MeV guarantee a short interaction time with the sample material, meanwhile delivering sufficient radiation dose due to bunch energy and hundreds of pico-Coulombs charge. Two experimental stations of AREAL facility provide a possibility to extract machine electrons (out of machine vacuum) and perform irradiation experiments in-air. One of the experimental stations is located on the spectrometer magnet bend arm, which allows avoiding secondary emitted electrons and gamma radiation traveling along with the electron pulse participation in sample irradiation process. The basic advantage of AREAL accelerator is the generation of electrons using photocathode illuminated by the powerful UV laser. The use of photoemission provides electron beam parameters formation control during the emission process by varying the laser parameters. As a photocathode material a specially treated copper was used to compromise good quantum efficiency (number of emitted electrons per photon of illuminating laser) and long lifetime. A high peak power UV laser pulses are used to generate electron bunches from photocathode. A short response time of a cathode order of 10 fs and Gaussian profile of energy distribution of the laser pulse provide emission of electrons with a Gaussian longitudinal and transverse distribution with a pulse length similar to the laser pulse (~450fs FWHM).



*Application domain:* **Physics, Material science**

*Area of expertise:* **Particle accelerator**

**Link**

<http://candle.am/areal/>

#### *2. Vacuum heat treatment*

**Project/technology description:**

Vacuum technology laboratory implements procedures of vacuum heat treatment for copper, steels, crystals, glasses, etc. Vacuum heat treatment is conducted in vacuum furnaces with different ultimate temperature and active volume.

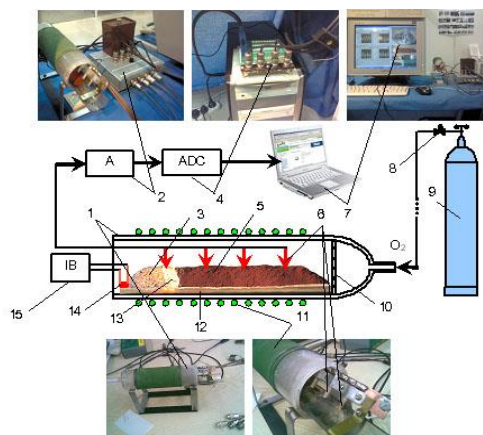
Experts of the laboratory can provide consultancy and training of proprietary laboratory techniques and technology of vacuum heat treatment. The laboratory is also specialized in the studies and research of vacuum heat treatment of specific, not standard and unique materials.

*Application domain:* **Engineering technologies**  
*Area of expertise:* **High and ultra-high vacuum**  
**Link**

<http://candle.am/portfolio/vacuum-heat-treatment/>

### 3. *Advanced materials and microdevices*

**Project/technology description:** The works carried out at the laboratory of Advanced materials and micro devices include design, fabrication/synthesis (by non-traditional way: Self Propagating High Temperature Syntheses) and characterization of novel advanced multifunctional materials (such as ferroelectrics, hard/soft magnetic materials, multiferroics, solid-oxide fuel cell components, membranes, etc.) and devices for energy, microwave, environmental and biomedical applications, as well as, preparation and optimization of technologies for producing nanolayers and nanostructures. The efforts are directed towards understanding the kinetics and mechanism of structure formation and prediction of their functional physical-chemical properties. This understanding is used to enhance the efficiency of technological processes and material properties.



*Application domain:* **Chemical technologies, Micro- and nano-technology, Biomedical devices and equipment**

*Area of expertise:* **Materials Science**

**Link**

<http://candle.am/portfolio/advanced-materials-and-micro-devices/>

### 4. *Deposition of thin films*

**Project/technology description:** Thermal vacuum thin film deposition using different evaporation sources (tungsten, tantalum, quartz, molibdenum, corundum (Al<sub>2</sub>O<sub>3</sub>)) enables obtaining thickness on the substrate from nanometers to micrometers. The technology offered allows obtaining thin films from aluminium, chrome, germanium, silver, gold and copper on the substrates from different materials (e.g. quartz, glass, steels, copper, ceramics, etc.).

*Application domain:* **Semiconductors, Plating, Mirrors' production, Optical coatings, Accelerators' cathode (electron source) coating**

*Area of expertise:* **Materials Science**

**Link**

<http://candle.am/portfolio/deposition-of-thin-films/>

### 5. *Vacuum brazing of specific high technology components*

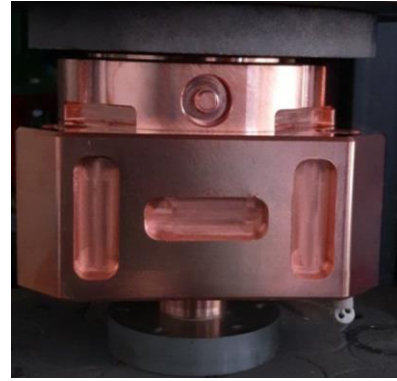
**Project/technology description:** Vacuum technology laboratory implements procedures of vacuum brazing for copper, stainless steel, ceramics and glasses. Brazing is conducted in vacuum furnaces with different ultimate temperature and active volume. Vacuum brazing gives possibility to obtain strength and

vacuum tight joints between similar metals (copper-copper) and non-similar metals (copper-stainless steel, stainless steel- ceramics).

Experts of the laboratory can provide consultancy and training to proprietary laboratory techniques and technology of brazing. The laboratory is also specialized in the design of advanced technology for brazing of specific, not standard and unique parts for mentioned similar classes of materials.

Consultancy and training of proprietary technique and technology in:

- Suitable brazing alloy for different materials.
- Brazing stages and complicated assembly.
- Design and fabrication of brazing parts for ultra-high vacuum systems.
- Brazing of parts for accelerators.
- Suitable materials for brazing.
- Metal-ceramics brazing.



*Application domain:* **Engineering technologies**

*Area of expertise:* **High and ultra-high vacuum**

**Link**

<http://candle.am/portfolio/vacuum-brazing-of-specific-high-technology-components/>

## ***6. The ultrafast laser micro-processing station***

**Project/technology description:** The ultrafast laser micro-processing station at CANDLE SRI is an integration of a high-performance workstation for sample 3D positioning/motion and a highly stable, femtosecond laser system. Combined with a sample motion and pulse-parameter control units and software, the station represents an entire lab on an optical table for diverse scientific and R&D applications. A range of laser and scanning parameters can be varied to select among different types of the material treatment: selective material removal, laser-induced modification of chemical, electronic and optical properties, ablation-deposition, two-photon polymerization, etc. Depending on the material and the treatment type, micron and sub-micron feature sizes can be achieved in hole-drilling, cutting, surface patterning and in-volume writing in transparent materials.

Particular fields of expertise of the Group include:

- High-precision patterning of soft and inorganic surfaces, micromachining of microelectronics and optoelectronics parts;
- Surface and 3D (in-volume) direct laser writing of complex patterns in glasses and other transparent materials for optical and photonics applications;
- Two-photon polymerization and precision fabrication of hybrid organic/inorganic polymer structures for micro-optics and optoelectronics applications.



*Application domain:* **Micromachining**

*Area of expertise:* **Ultrafast laser processing**

**Link**

<http://candle.am/portfolio/the-ultrafast-laser-micro-processing-statio/>

## ***7. Experimental biology***

**Project/technology description:** The Laboratory of Experimental Biology is a research platform providing access to state-of-the-art techniques for the biomedical experiments conducted at CANDLE, as well as for the external visitors and users for sample and experiment preparation.

Currently the laboratory manages the one two-photon laser scanning microscope equipped with two types of lasers providing excitation at 1030 nm and 725-900 nm wavelengths mentioned above, and one Agilent Cary Eclipse fluorescent spectrophotometer with Agilent Cary WinFLR software. Equipped with accessories (sample holders) for liquid samples, solids, powders and pastes, as well as temperature control monitoring system, this fluorescent spectrophotometer provides measurements in steady-state fluorescence, phosphorescence, bio-/chemiluminescence or time-resolved delayed fluorescence modes in different sample sizes, from high-throughput microplate reading to cuvettes and macro sizes.



*Application domain:* **Biology, Molecular physics**  
*Area of expertise:* **Molecular biology**

## **8. Precision machining**

**Project/technology description:** Mechanical workshop based in CANDLE SRI provides high precision machining using CNC milling and lathe machines. Main capacities of the mechanical workshop include production of non-standards non-series parts from different advanced materials (Oxygen free copper, GLIDCOP, Stainless steel (316LN), hard metals etc.), with special requirements. The following equipment is available on site:

### **HAAS TM-1P**

The TM-P models include a 10-pocket automatic tool changer, a faster spindle, and higher rapids.

- Operates on single- or three-phase power
- Conversational programming system
- User-friendly Haas control
- Affordable full CNC capabilities
- HaasConnect remote monitoring
- Accuracy 5  $\mu\text{m}$

### **ST-10**

The Haas ST Series high-performance turning centers were designed from the ground up to provide setup flexibility, extreme rigidity, and high thermal stability.

The ST-10 has an extra-small footprint, yet provides a generous work envelope. This machine offers the best performance for the money – the best value – in its class.

- Extra-small footprint
- High rpm and rapid speeds
- Ideal for high-volume, high-production environments
- Accuracy 5  $\mu\text{m}$

*Application domain:* **Mechanical engineering**  
*Area of expertise:* **Metal cutting**

### **Link**

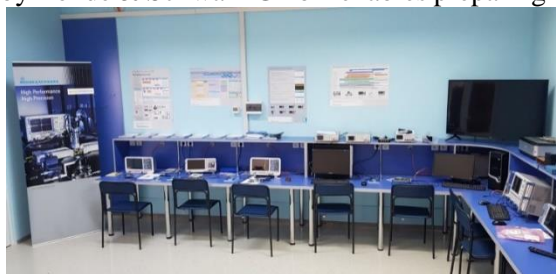
<http://candle.am/products/>

## 9. RF (Radio frequency) experiments

**Project/technology description:** The RF system at AREAL facility provides frequencies, timings and synchronization between all sub-systems at a precision of 1ns. The MO provides all necessary frequencies: 3GHz, 1GHz, 500MHz, 250 MHz, 125MHz, 81MHz, 10MHz, 9MHz, 1Hz and 2Hz all phase locked. The timing jitter of MO is only 6 fs. Therefore, synchronization at all mentioned frequencies can be assured for new installed devices with high time accuracy.

### **CANDLE-Rohde & Schwarz educational training center**

The center equipped with state of the art equipment provided by Rohde & Schwarz GmbH enables preparing and training students in the field of RF (measurement methods and technique) not only connected to accelerators, but also in all other fields requiring relevant knowledge and skills, such as Telco. Among the valuable equipment available at the educational training center are: ZVB 14 vector network analyzer and FPL1000 spectrum analyzer. Based on specific requests from scientific and/or industrial users relevant staff training can also be organized at the center.



*Application domain:* **Radio physics**

*Area of expertise:* **RF systems**

## 10. Scanning electron Microscope

The SEM equipped with a set of high-end detectors and state-of-the-art analytical tools enabling high resolution, high quality imaging, structural and compositional analyses of both conductive and non-conductive surfaces. With resolution of better than 3 nm and magnification up to 1 million times, this characterization technique is an essential supplement to CANDLE research infrastructure enabling to carry out comprehensive chain of studies in the materials and life sciences fields. Another important feature of the purchased SEM is the modular design which allows configuring and upgrading the equipment in accordance with ongoing and emerging research demands. This includes, in particular, the possibility of upgrade of electron sources for higher resolution, pressure chambers for environmental (high-pressure) microscopy, integration of an optical microscope for correlative microscopy, etc.



*Application domain:* **Microscopy**

*Area of expertise:* **Electron microscopy**

## TT Prospects at CANDLE

Collaboration with industry: Illustration of cases

### **Collaboration with industry**

✓ Following the [MOU](#) signed on the 18th of July 2018 between the **Rohde & Schwarz International GmbH (Germany)** and **CANDLE SRI**, in presence of the President of the Republic of Armenia Armen Sarkissian, a new [Training and Educational center](#) has been opened on 04 July 2019 at CANDLE Institute



during the international workshop on “Ultrafast Beams and Applications”. Rohde & Schwarz GmbH is a world leading technological company in the fields of communication, information and security.

Taking into account the importance of promoting, developing and exploiting the high-end telecommunications, RF and microwave components for advanced accelerators, both parties state that the collaboration on these topics is mutually beneficial to lead to new technical and scientific achievements.

The new laboratory is equipped with state-of-the-art radio-frequency test stands and corresponds to the world-class training centers on advanced telecommunication and control, RF and Microwave devices. This center will be open for the scientific and educational and industrial organizations of Armenia and beyond, and will promote the creation of the new generation of scientists and engineers in advanced fields of science and technology.

### The opening ceremony of CANDLE-Rohde& Schwarz educational-training center



In the framework of the joint CANDLE-AVESTA project on “Development of Laser Technologies for Investigations of Ultrafast Processes at AREAL Facility”, “AVESTA” Ltd, a leading Russian company in the fields of ultrafast laser systems, diagnostics and spectroscopy, has successfully completed a new research stand with tunable IR laser and THz spectrometer in August, 2019. The project was conducted within the Russian-Armenian joint Call, launched by the Foundation for Assistance to Small Innovative Enterprises in Science and Technology (known as Bortnik Foundation, Russia) and State Committee of Sciences MES (Armenia).

**Figure 1. AVESTA laser system**



The AVESTA tunable laser system with phase synchronization has been installed at DELTA bio-medical laboratory, widening the research highlights of the laboratory in multi-photon microscopy. In addition, the new system will promote the pump-probe experiments for studying the dynamics of ultrafast processes at molecular and atomic levels.

The THz spectrometer will support the Terahertz program at the Institute, aimed to develop advanced high-frequency acceleration and radiation concepts. (see more info at <http://avesta.ru/en/tif-100st-f6-femtosecond-ti-s-oscillator-with-frep-locking-for-multiphoton-microscopy-at-candle-armenia/>)

The full list of our industrial partners is available at <http://candle.am/industrial-partners/>.