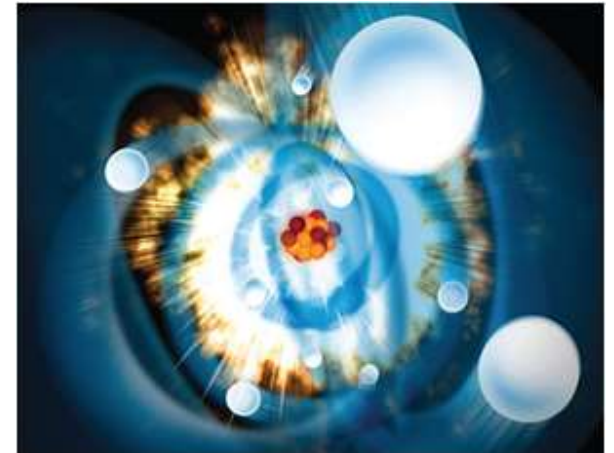




# AREAL and Laboratories. Activities at CANDLE

B. Grigoryan



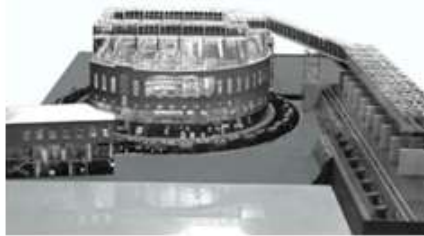


# Our Story

6 GeV synchrotron (1967)



A.I. Alikhanian



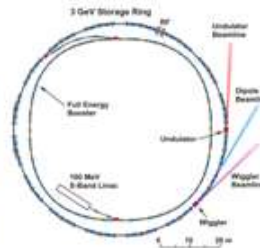
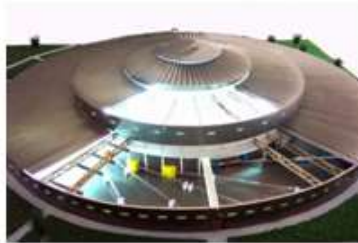
3 Synch Rad Beamlines (1973)



3 GeV CANDLE Light Source 2002



V.M. Tsakanov



*The strong user community will emerge as the facility is readied.*

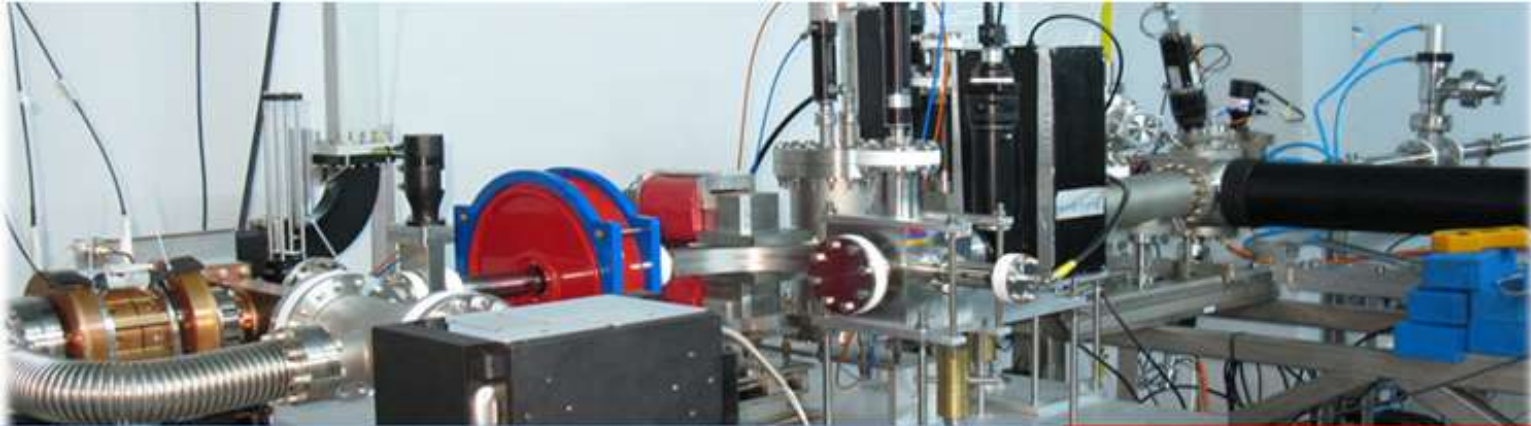
|               |        |
|---------------|--------|
| Energy        | 3 GeV  |
| Current       | 350 mA |
| Circumference | 216 m  |
| Emittance     | 8.4 nm |

Review Panel





# AREAL Accelerator



## AREAL General Parameters:

|                            |                                       |
|----------------------------|---------------------------------------|
| Charge                     | 10 - 850* pC (150-250 pC nominal)     |
| Bunch length -FWHM (ps)    | 0.4 - 10                              |
| Repetition rate            | 1- 50 ** Hz                           |
| Transv. beamsize (x/y)     | 2/3 (@ straight) 20 / 8 mm (@ dipole) |
| Norm. Transv. emitt. (x/y) | $\leq 1$ mm-mrad                      |
| Energy                     | $\leq 5.0$ MeV                        |
| Energy spread (at dipole)  | $< 0.5\%$                             |
| Experiment duration        | 1 - 744*** hours                      |

\* High charge regime for dedicated experiments (achieved November 2015)

\*\* Tests were performed up to 47 Hz with nominal charge of 150 pC. (end 2015)

\*\*\* 31 days of uninterrupted operation in May-June 2014, September-October 2018.

## Fields of Potential Interest:

Solid State Physics

Biology

Molecular Physics

Optics

Material Science

-----

Food Processing

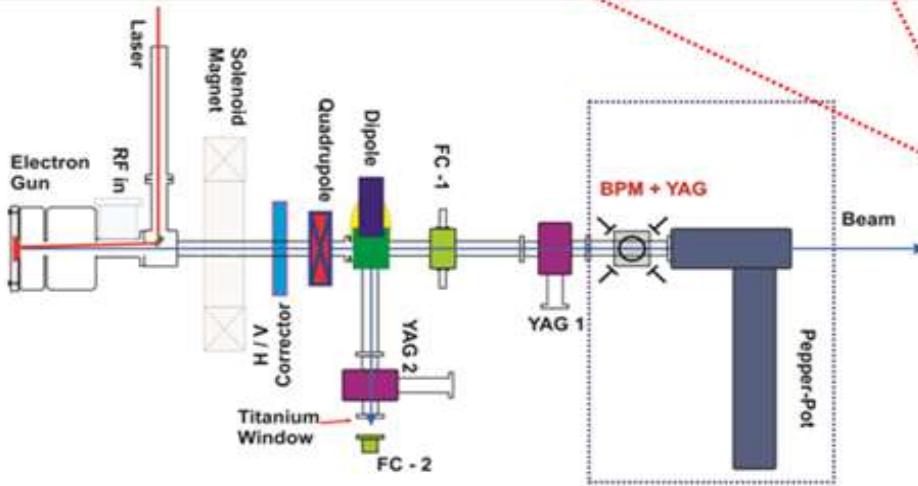
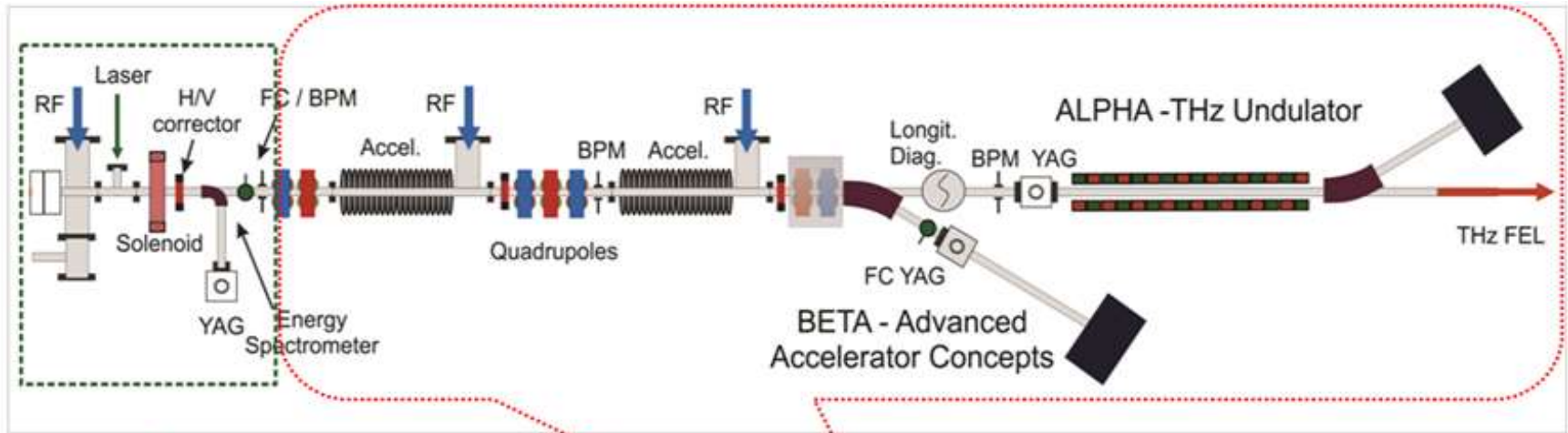
Chemistry

Oncology

Medical Equipment Sterilization



# AREAL Accelerator



## AREAL-50 Upgrade Program

- 20,50 MeV electrons
- FEL Radiation
  - Wavelength 2- 6.7  $\mu\text{m}$
  - Frequency 45 -125 THz
  - Pulse energy 60-100  $\mu\text{J}$





# The Strategy of Institute

- **Accelerator Physics**

- CANDLE Storage ring, AREAL development
- Establishment of user community, development of accelerators for user demands
- New materials, joints, advanced properties based on technology developments. Applications.
- Scientific experiments in accelerator physics and new radiation sources

- **Applications of Radiation**

- Electron beam
- Lasers, laser processing,
- THz radiation (laser based) + undulator based (ALPHA , BETA - future program)
- X-Ray processing

- **Technology Development, Materials Science**

- Advanced materials researches (ferroelectric, ferromagnetic)
- Thin film coating
- Vacuum Welding, Brazing
- Specific scientific instrument production
- Femtolaser Fabrication
- Optical equipment development

- **Integration into International Research Infrastructures**

(European – ERIC/CERIC, Grant programs, Memberships, etc.)





# Theoretical Studies & Simulations

## • *Beam Dynamics & EM Fields*

- Concepts of new accelerators
- New sources of radiation
- Upgrade of CANDLE and AREAL

## • *RF Systems Laboratory*

- RF resonators, waveguides
- Radiation sources

## • *Advanced Materials & Microdevices*

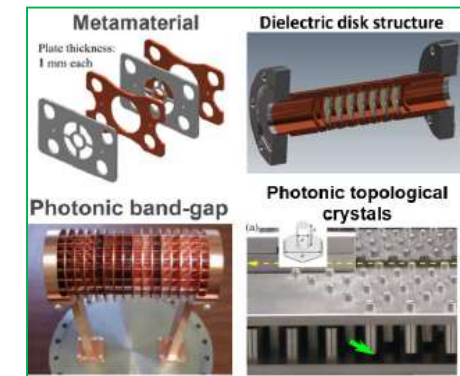
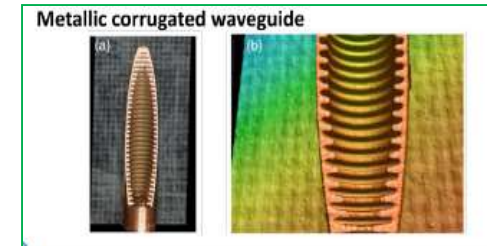
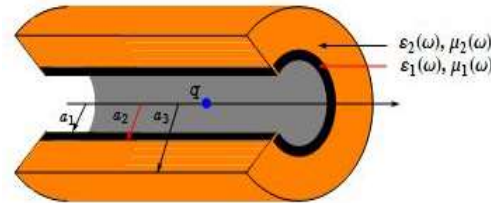
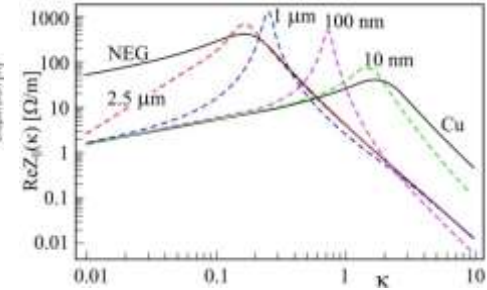
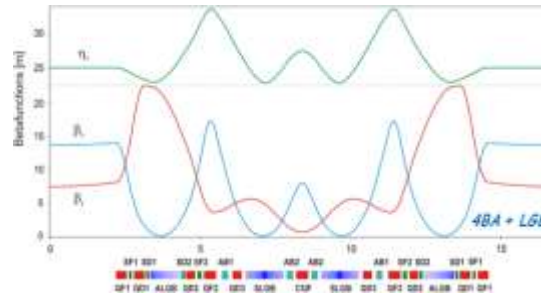
- New materials for accelerators
- New types of solar cells

## • *Engineering Dept., Vacuum Laboratory*

- Mechanical machining simulations
- Study of vacuum-tight materials

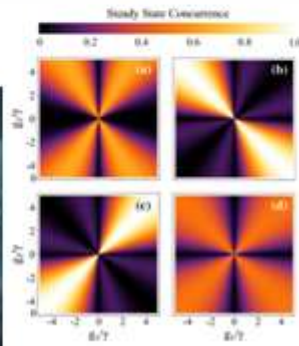
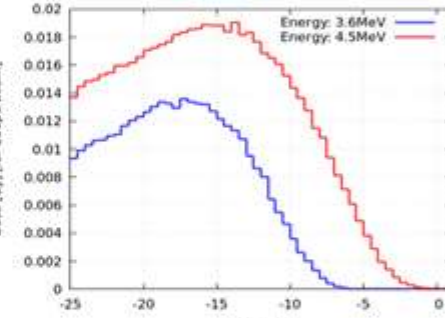
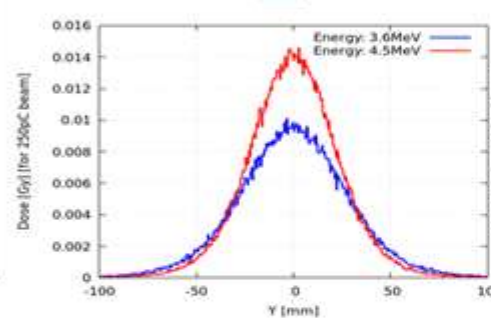
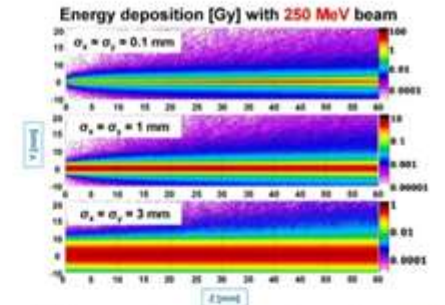
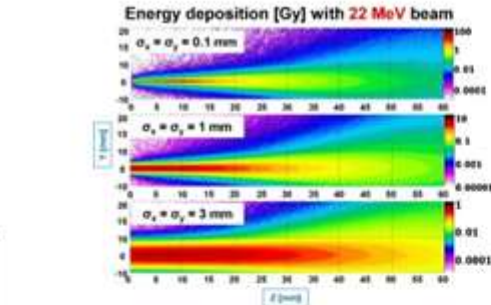
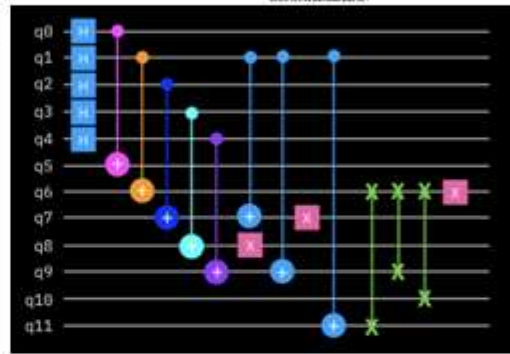
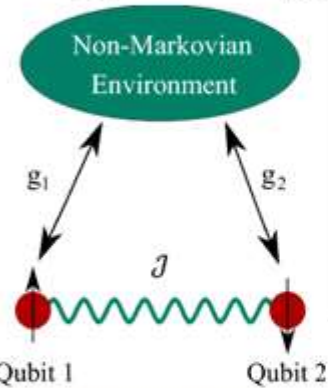
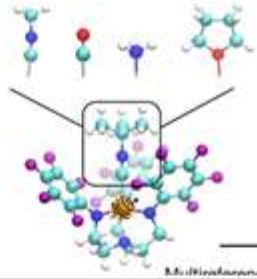
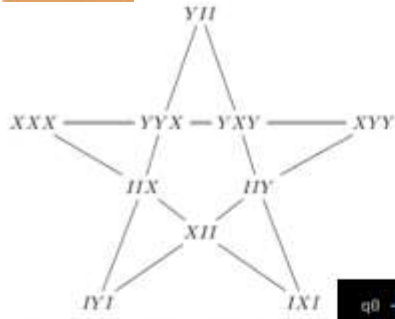
## • *Laboratory of Experimental Biology*

- AI based bioinformatics

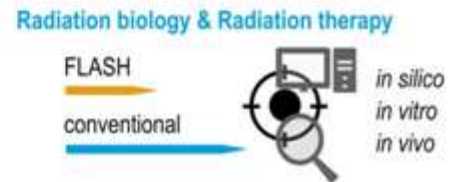
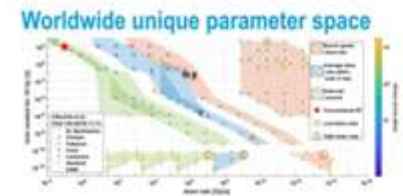




# Theoretical Studies & Simulations

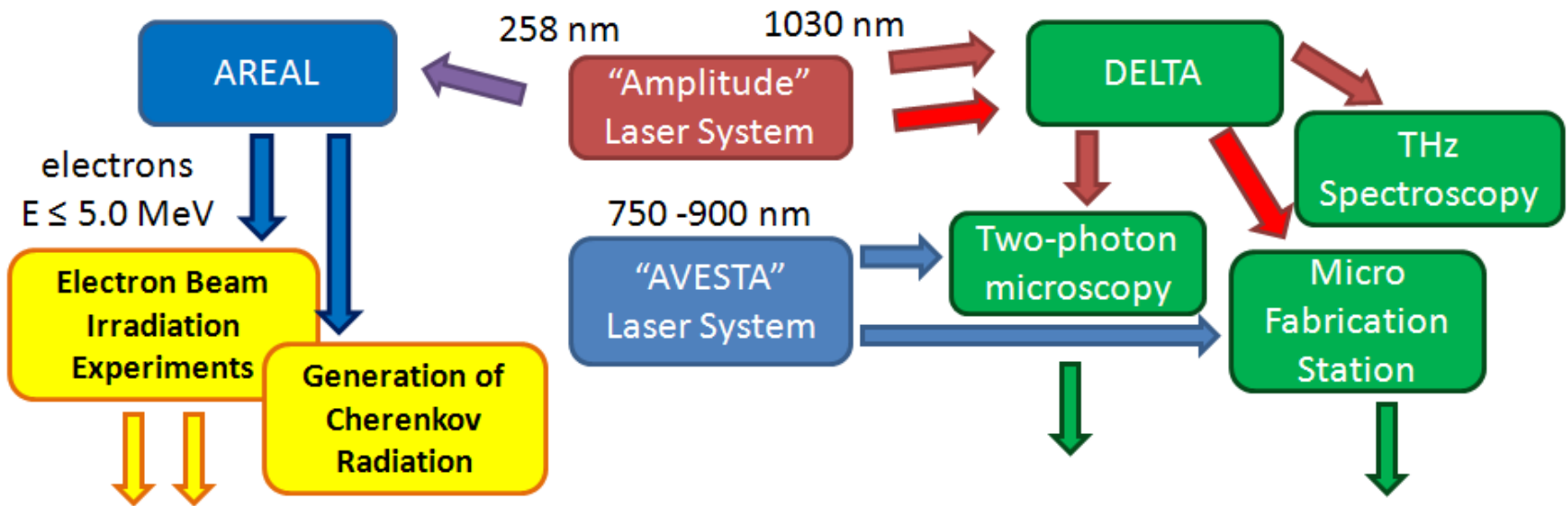


## FLASHlab@PITZ





# Experimental Possibilities at CANDLE



## Actual possibilities

## Upcoming / Upgrade

|  |  |
|--|--|
| RF Measurements,<br>(Rohde&Schwarz joint educ. center),<br>Timing and Synchronization LAB. | X-Ray Irradiation<br>processing            |
| Experimental<br>Biology LAB  | Vacuum Technology,<br>Brazing, Welding LAB |
| Advanced Materials<br>& Microdevices LAB   | Scientific Engineering<br>Workshop         |
|  | Scanning Electron<br>Microscope            |
|  | Magnetic<br>Measurements LAB               |

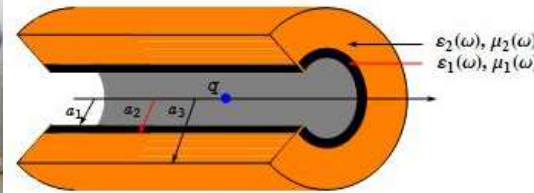
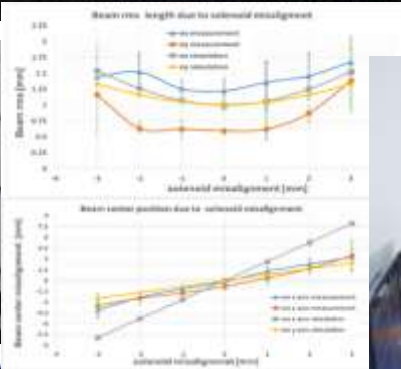
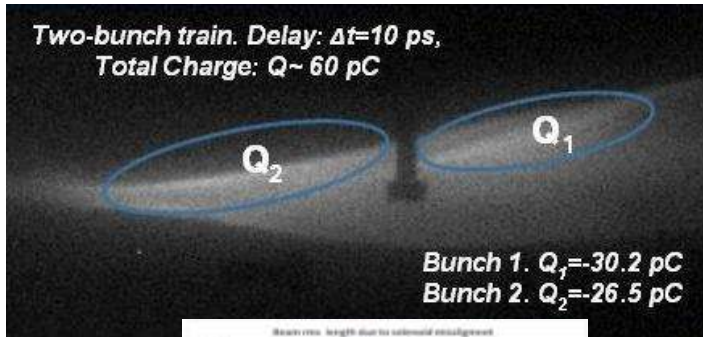
|  |
|--|
| Electron Beam<br>E = 20, 50 MeV  |
| FEL (ALPHA) $\lambda = 2.5 - 30 \mu\text{m}$<br>pulse energy 60-100 mJ |
| 0.35 THz Radiation &<br>acceleration (BETA)                            |



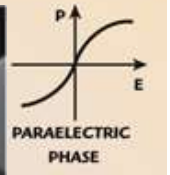
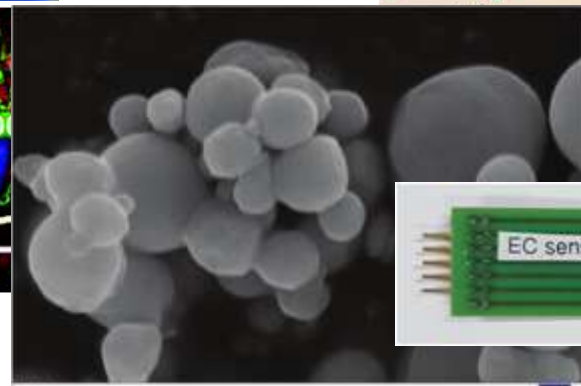
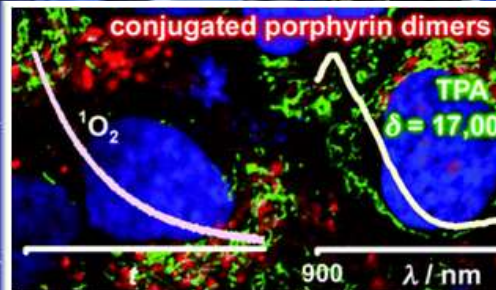
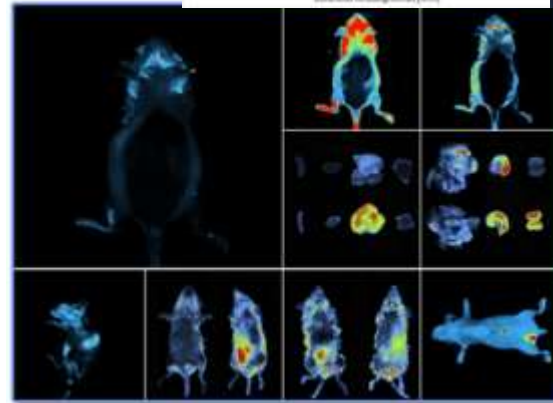
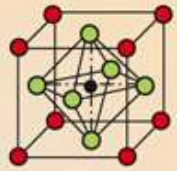




# Experimental Activities



- BARIUM, STRONTIUM
- OXYGEN
- TITANIUM



2001 nm DUT = 10.00 kV Signal A = InLens Date: 20 Oct 2014 FEI  
WD = 9.6 mm Mag = 10.00 KX Time: 10:25:00





# Experimental Activities

## • Running Experiments:

- Material Science (4)
- Radiation Biology (5)
- Accelerator Concepts (4)
- New equipment developments for accelerators (3)

## • Participating Institutes

- Alikhanyan National Lab (YerPhi)
- Institute of Molecular Biology NAS RA
- Yerevan State University
- Armenian National Agrarian University
- National Polytechnic University of Armenia
- Institute of Applied Problems of Physics, NAS RA

## • International Collaboration on Experimental Program

- DESY – Hamburg, Germany
- PIZ (DESY) – Berlin, Germany
- PSI – Villigen, Switzerland
- INFN – Rome, INFN-Milano, Italy
- Universities of Bologna and Brescia, Italy
- Federal Medical-Biophysical Center after A.I. Burnazyan, RF
- [Royal Holloway University of London](#)
- [Joint Institute for Nuclear Research –JINR](#)



Федеральное государственное бюджетное учреждение  
«Государственный научный центр Российской Федерации – Федеральный медицинский биофизический центр имени А.И. Бурназяна»  
Федерального медико-биологического агентства



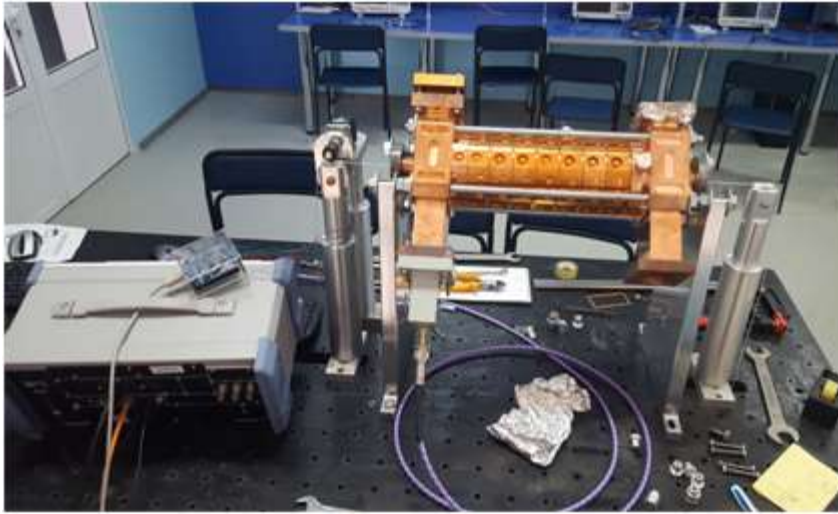


# Scientific Instrumentation Workshop

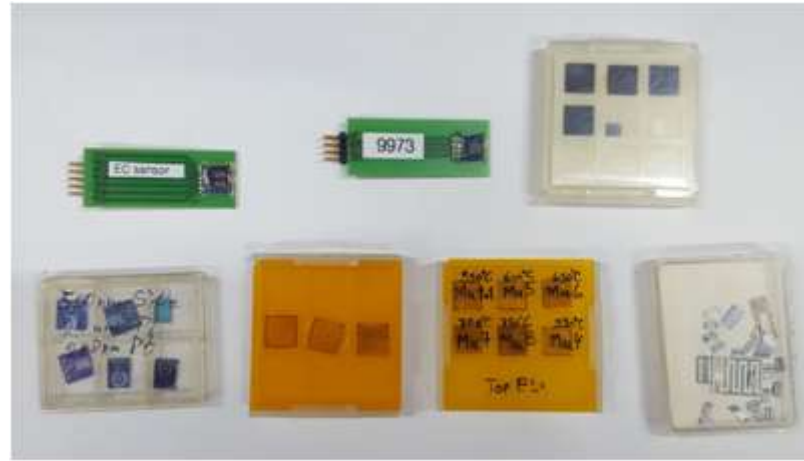




# Technology Developments

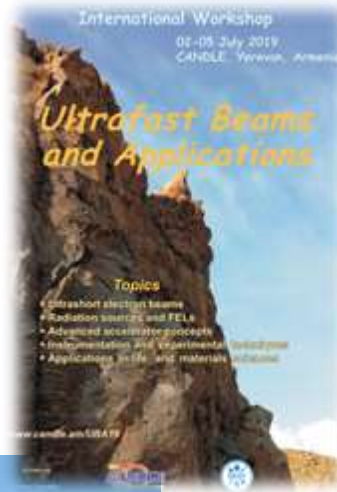


- RF Technologies
- Thin film coating
- Vacuum technologies, brazing/welding
- Ferro-electric, Ferro-magnetic materials
- New material joints for accelerators
- Accelerator equipment development
- Development of THz radiation sources





# Ultrafast Beams and Applications - UBA



- *Ultra-short electron beams*
- *Radiation sources and FELs*
- *Advanced accelerator concepts*
- *Instrumentation and experimental techniques*
- *Applications in life and materials sciences*

B. Grigoryan



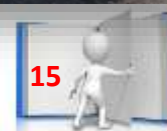


# German Armenia Practical Course on Accelerators



16 - 24 September, 2023  
Offered topics:

- *Electron Beam Parameter Measurements*
- *Generation and Acceleration of ultra-short electron bunches*
- *Femtosecond lasers for linear electron accelerators*
- *Vibrating wire monitors and beam profile measurements*
- *Radiofrequency techniques in accelerators*
- *Vacuum technology in accelerators*
- *Accelerator magnets and magnetic field measurements*
- *Beam – matter interactions and radiation dose measurements*





# International Collaborations



UNIVERSITÀ  
DEGLI STUDI  
DI BRESCIA



POLITECNICO  
MILANO 1863  
DIPARTIMENTO DI FISICA



TECHNISCHE  
UNIVERSITÄT  
WIEN  
Vienna | Austria





# Summary of Activities

- Advanced materials researches for:
  - New concepts of accelerators
  - Radiation sources
  - Advanced instrumentation (microchips, controllers, etc.)
- Radiation biology
  - Ischemic diseases
  - Oncology
  - Genetics
  - Organs on chip (Recently Started)
- Electric and magnetic properties changes of materials under direct irradiation by low energy **ultrashort** electron beams.
- Scientific engineering and instrumentation development







# THANK YOU FOR ATTENTION !

