"Will Armenia realize its potential in delivering advances in the fundamental sciences while developing an ecosystem for high technology innovations?"

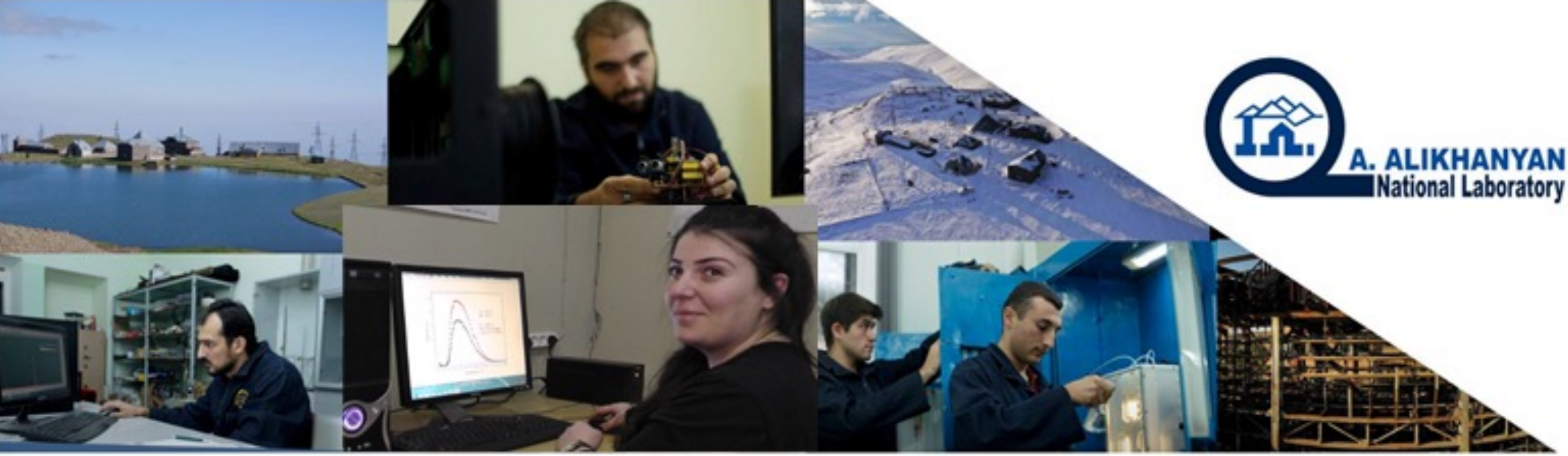
Professor Ani Aprahamian

A. Alikhanyan National Science Laboratory of Armenia

and

University of Notre Dame

Armenia
Post Soviet Republic
Independent for 30 years
High Potential for STEM sciences (World Bank)



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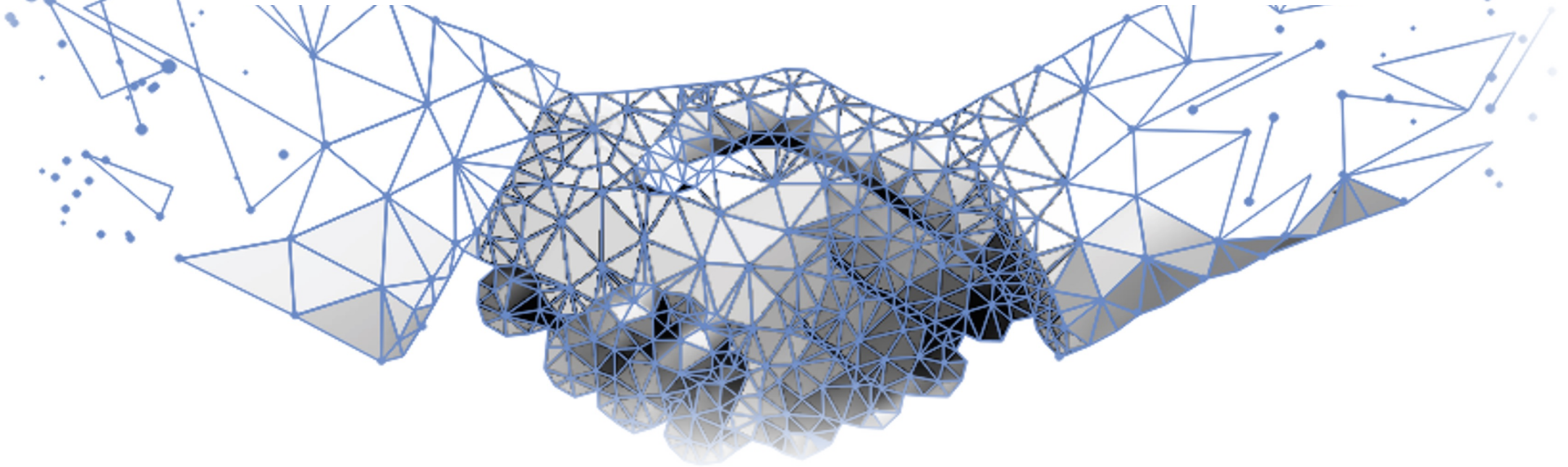
A. Alikhanyan is the National Science Laboratory of Armenia

Yerevan Physics Institute

Change the World with Science



PASSION FOR SCIENCE: Facing global challenges
June 20, 2022


founded in 1943
Abraham Alikhanov and Artem Alikhanian
YerPhi
Kurchatov Institute

Armenia was a scientific center in the Soviet Union

Produced Computers on 5 yr plans of Soviet Union

Scientific Firsts:

Internet to Armenia – First in the region

Two neutrino double beta decay

7 GeV electron accelerator in the 70's

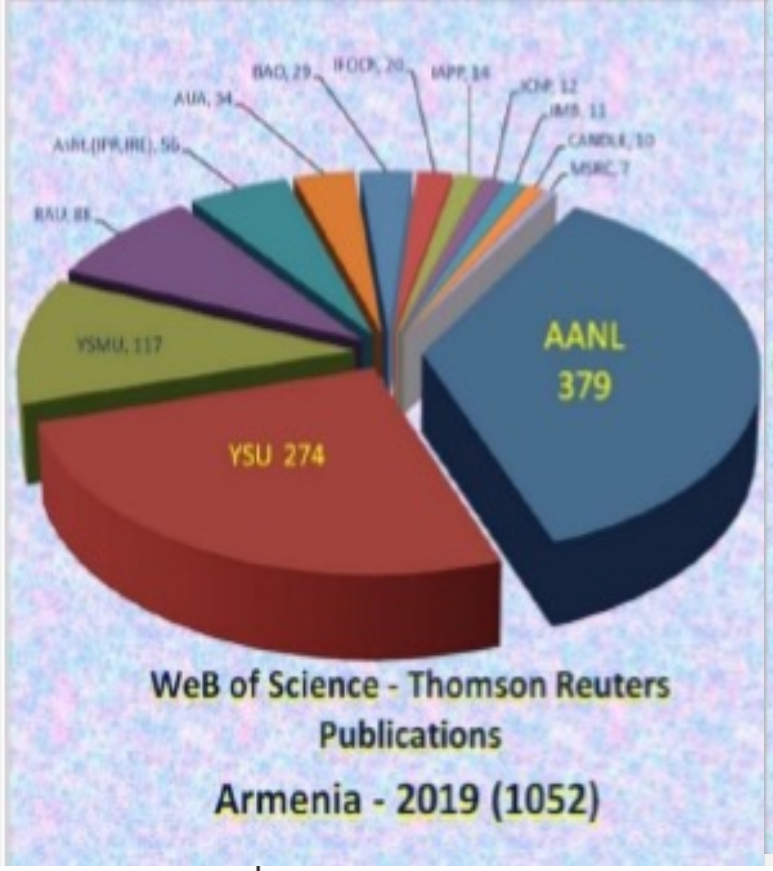
(Helped build 6 GeV electron accelerator CEBAF in USA in the 90's)

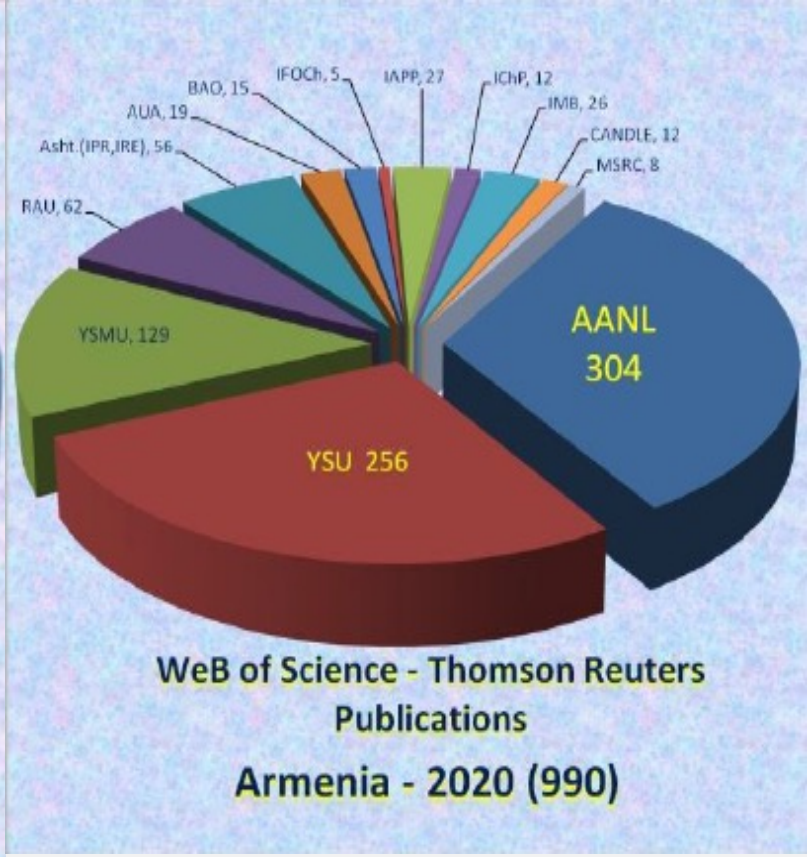
A. ALIKHANYAN NATIONAL SCIENCE LABORATORY OF ARMENIA

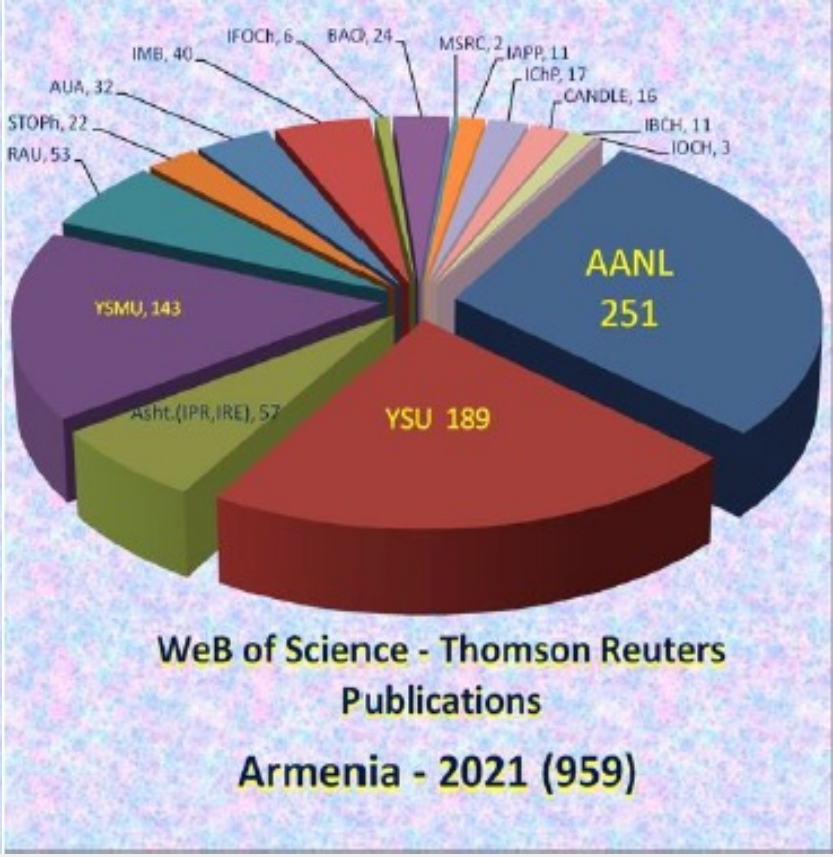
- Soviet Union >3000 scientists and staff (4500 Max)
- Today 350 people
- 6 GeV electron accelerator (until 1991)
- 75 MeV **electron LINAC (upgrade 2018)**
- 18 MeV **cyclotron (operational since 2019)**

International Committee of Experts
to Establish YerPhi
as
The National Science Laboratory of Armenia
2012

Science Publications

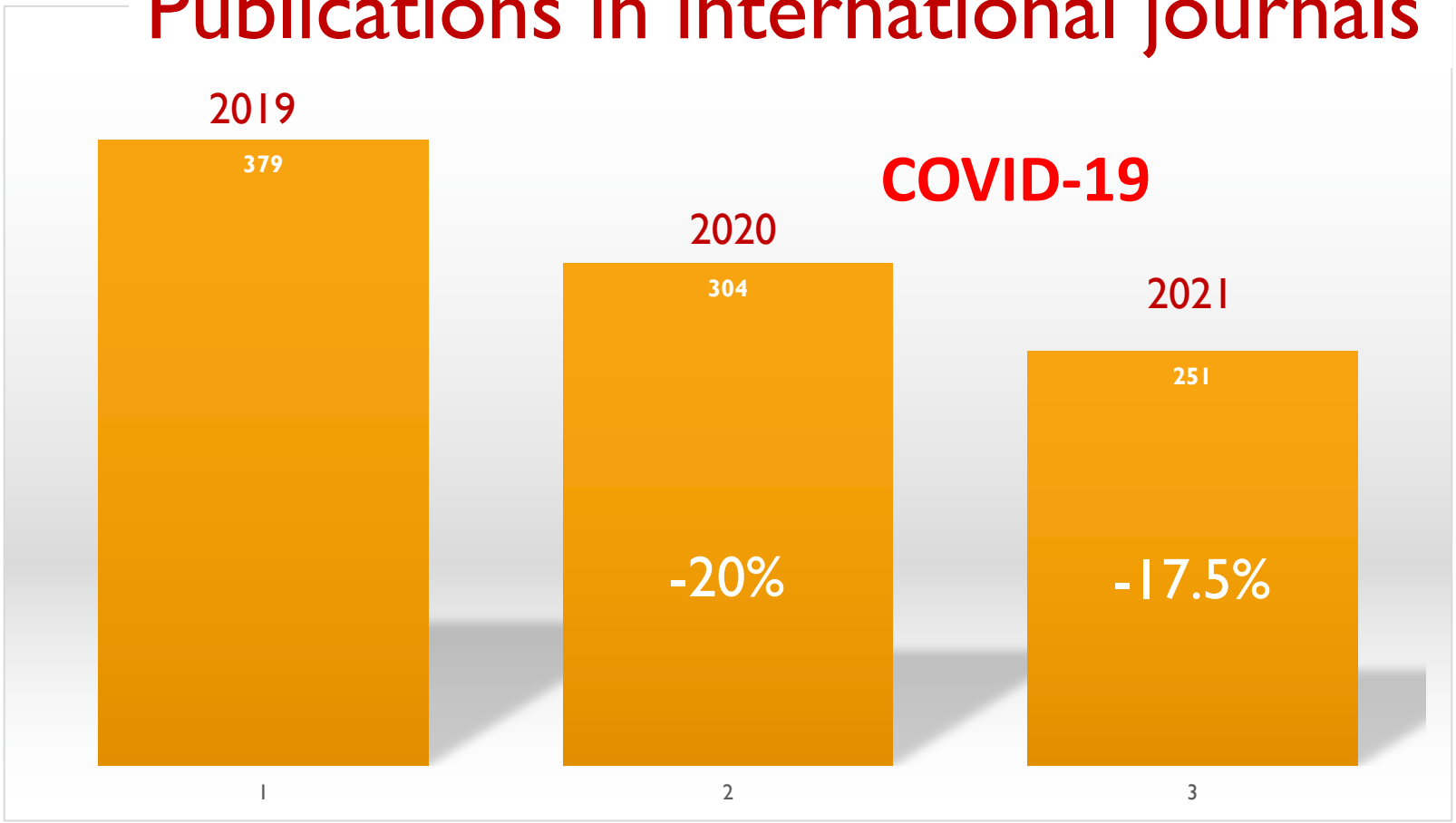






Տարի	*2019*		*2020*		*2021*	
	Հրատ.	Հղում.	Հրատ.	Հղում.	Հրատ.	Հղում.
Հայաստան	**1273**	**25800**	**1142**	**26078**	**959**	**25743**
ԱԱԳԼ	**411**	**17600**	**325**	**17648**	**251**	**17251**
%	**32%**	**68%**	**28%**	**68%**	**26%**	**67%**

Publications in international journals



Center of Excellence
In
The Region

154 scientists + 107 engineers and technicians

354 people

The National Science Laboratory concept is new in Armenia?

Concept is originally German: Wilhelm Kaiser and now **Max Planck Institutes**

Science: World Class Research

Education: Training and education of next generation of STEM scientists

Economy of Armenia: Impacts of applied sciences to economic growth

Health, Wealth and Defense: Protection of the borders, health of the people of Armenia, impact on innovations and technologies

Vision: AANL to remain as a **regional center of excellence** in high energy physics, astrophysics, **nuclear physics and nuclear medicine** and related applications to **advance scientific research**, **healthcare, IT,** and **economic development**.

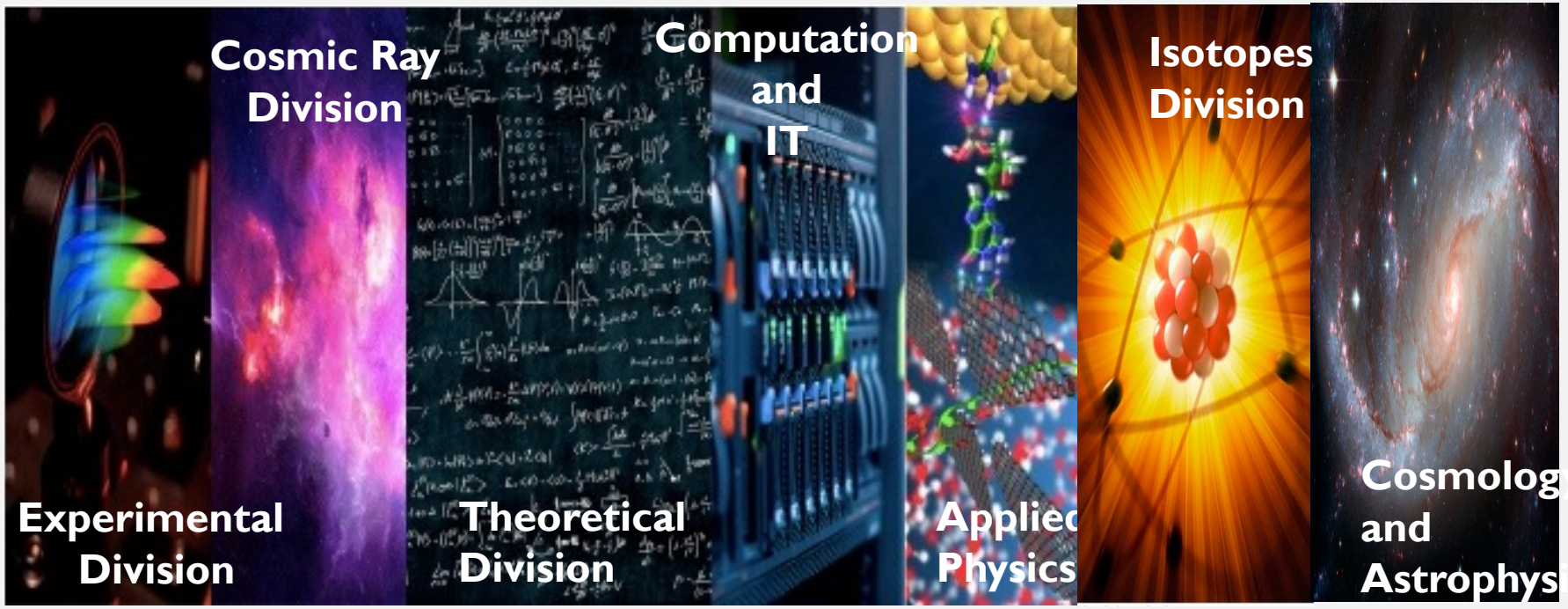
Approach: (Build on existing strengths + develop new ones)

Research, Scientific Infrastructure, & Education

A. ALIKHANYAN National Laboratory

A. Alikhanyan is the National Science Laboratory of Armenia

Yerevan Physics Institute



7 Divisions +

Isotopes Production and Research Division (10 yrs ago)

Quantum Technologies new group (2022)

Transition from Yerevan Physics Institute to national science laboratory concept

A. ALIKHANYAN National Laboratory

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(ԵՐԵՎԱՆԻ ՖԻԶԻԿԱՅԻ ԻՆՍՏԻՏՈՒՏ)

Science: World Class Research

Vision: AANL is to be a **regional center of excellence** in high energy physics, nuclear physics, and astrophysics, material science, and applications

International Collaborations: Worldwide Big Experiments

DESY.

Jefferson Lab

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

CERN

JOINT INSTITUTE FOR NUCLEAR RESEARCH

H.E.S.S. High Energy Stereoscopic System

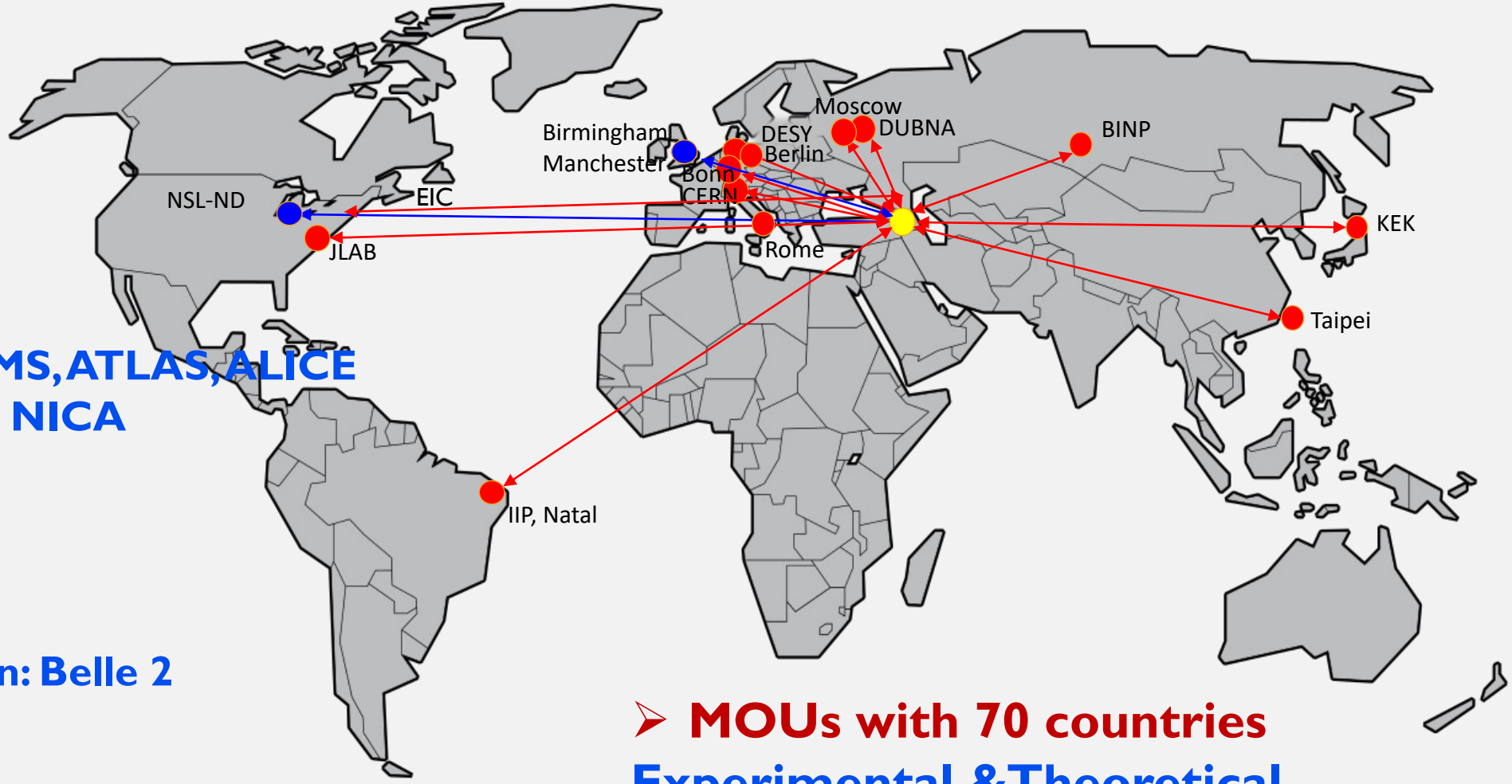
COSMIC ASEC

KEK

A. ALIKHANYAN National Laboratory

UNIVERSITY OF NOTRE DAME

Today: A. Alikhanyan is center of scientific engagements



CERN: CMS, ATLAS, ALICE
DUBNA: NICA
DESY
JLAB
EIC
DUNE:
KEK Japan: Belle 2
HESS
MAGIC
AMBER
SpinQuest

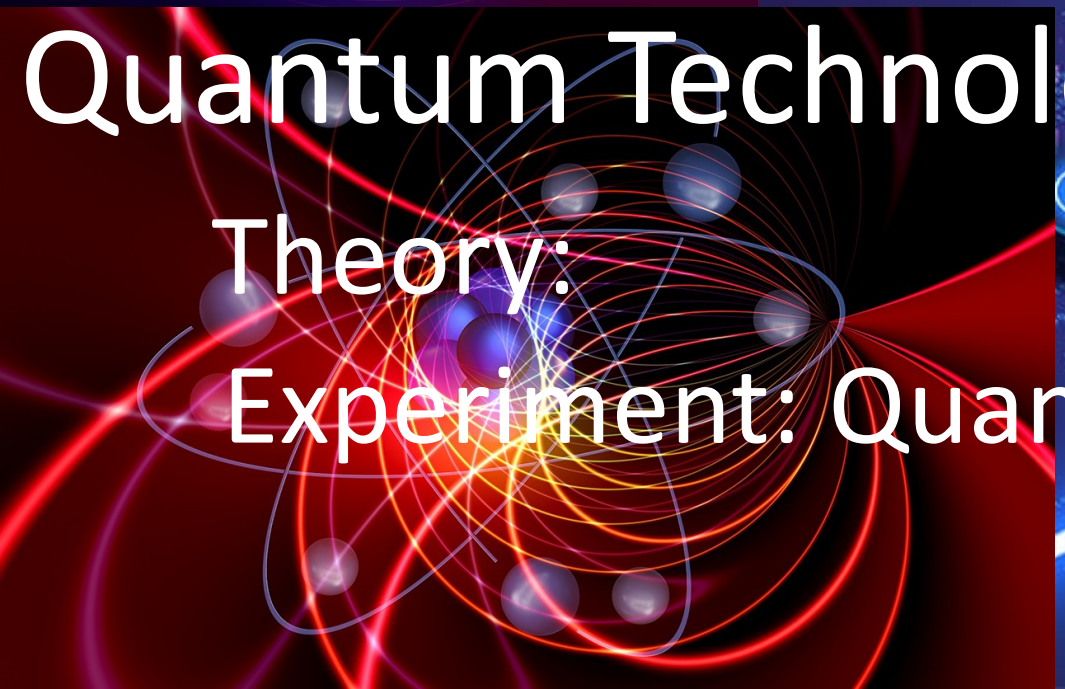
- **MOUs with 70 countries**

Experimental & Theoretical

12 International Conferences in 2019

Innovations in Science:

The next revolution in computers



Quantum Technologies

Theory:

Experiment: Quantum Sensors

Quantum Sensors:

RF timer ps time measurement

Ge detectors: MIT, Notre Dame (USA)

Cyclotron Beam line Development (Notre Dame)

RF timer:

AANL

CANDLE Synchrotron Research Institute,

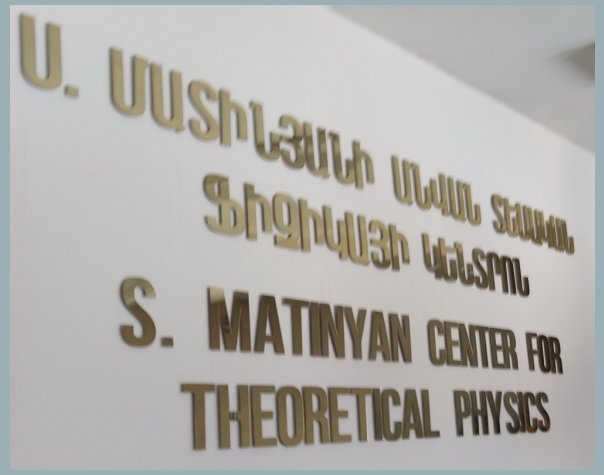
University of Glasgow, Scotland

Johannes Gutenberg-Universität (Mainz, Germany)

Extreme Light Infrastructure- Nuclear Physics (ELI-NP), Romania

University of Tokyo, Tokyo, Japan

THEORY DIVISION



ICTP Proposal:
A regional center?
Leveraging the Science reputation

Education: M.Sc.

Collaborations with AUA (language English)

STEM workforce inflow into Armenia

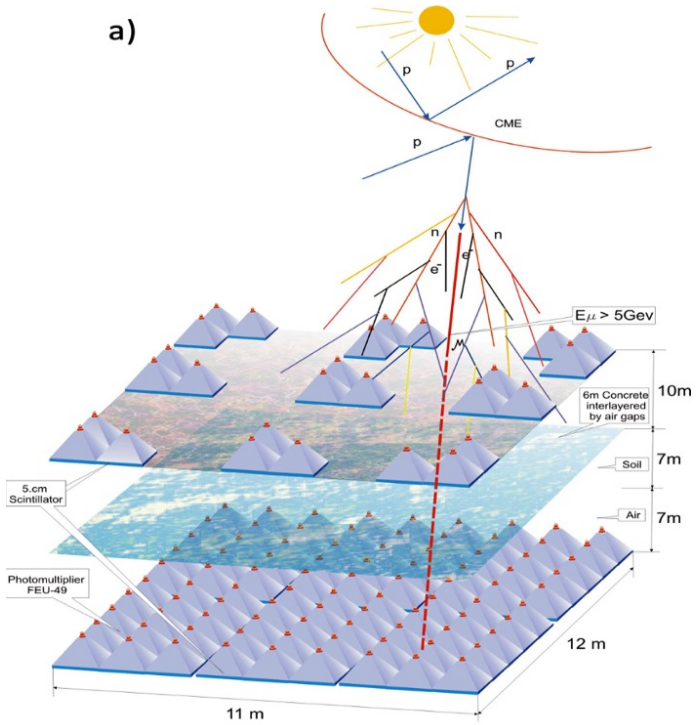
Many International Collaborators: For Regional Center

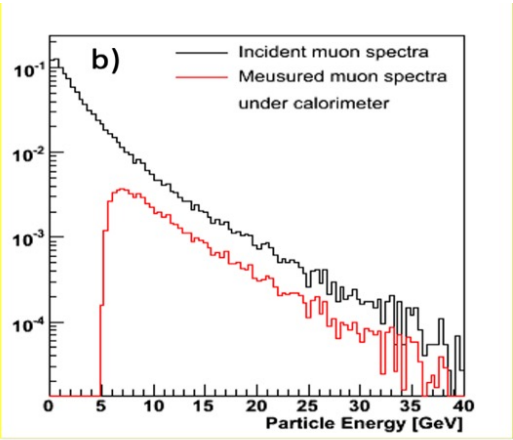
ICTP: Italy

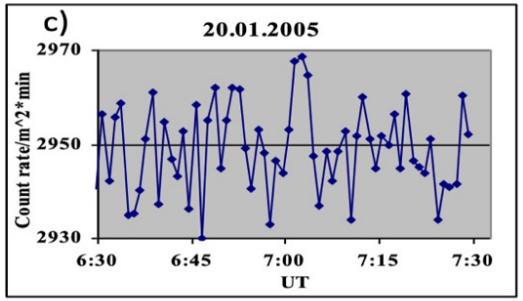
AUA: Armenia

AANL:

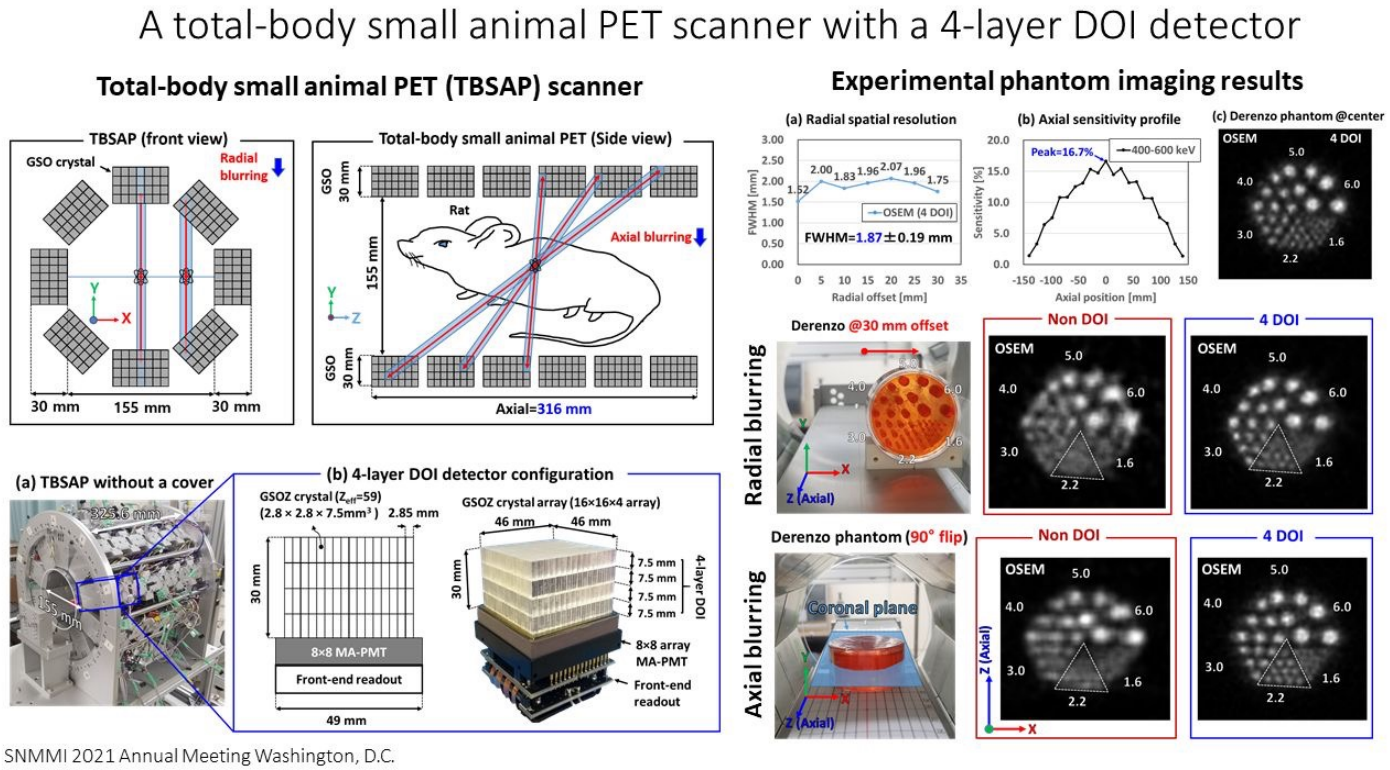
CRD + Experimental Division: New Detector Developments







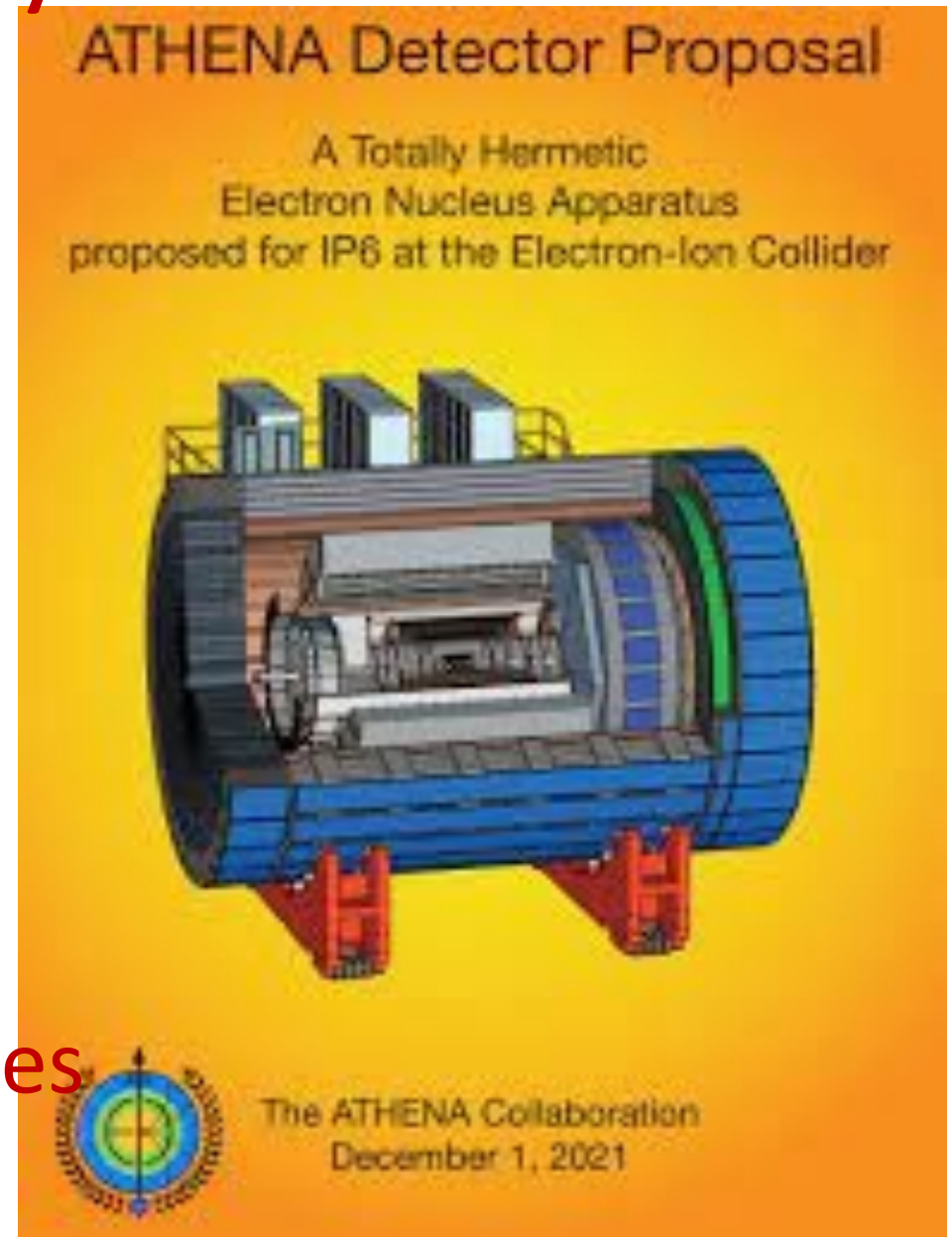
Advanced Detector Laboratory: 2021

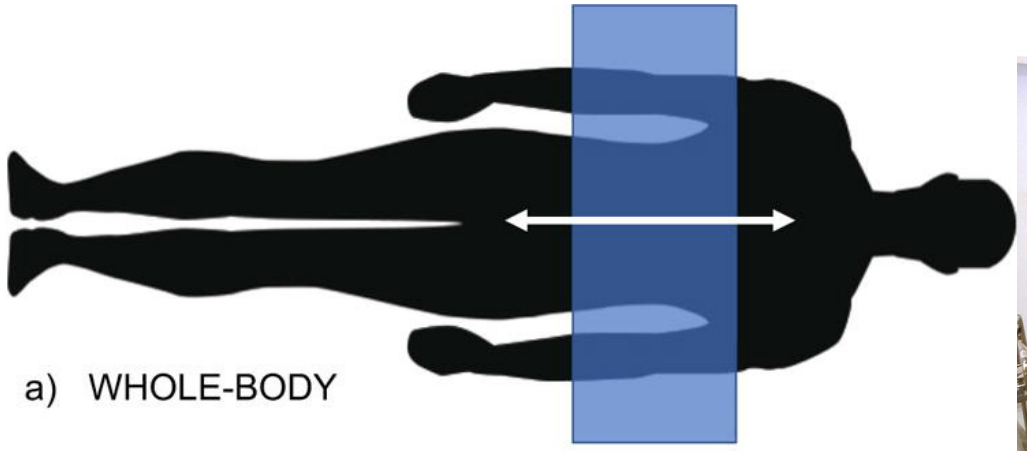


SNMMI 2021 Annual Meeting Washington, D.C.

USA project EIC:

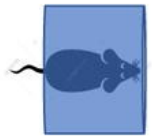
Armenia registered as one of 32 countries

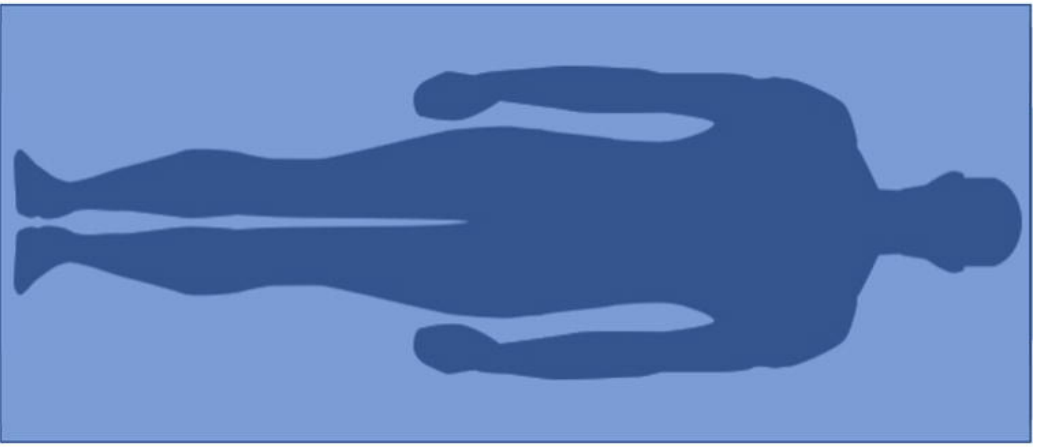


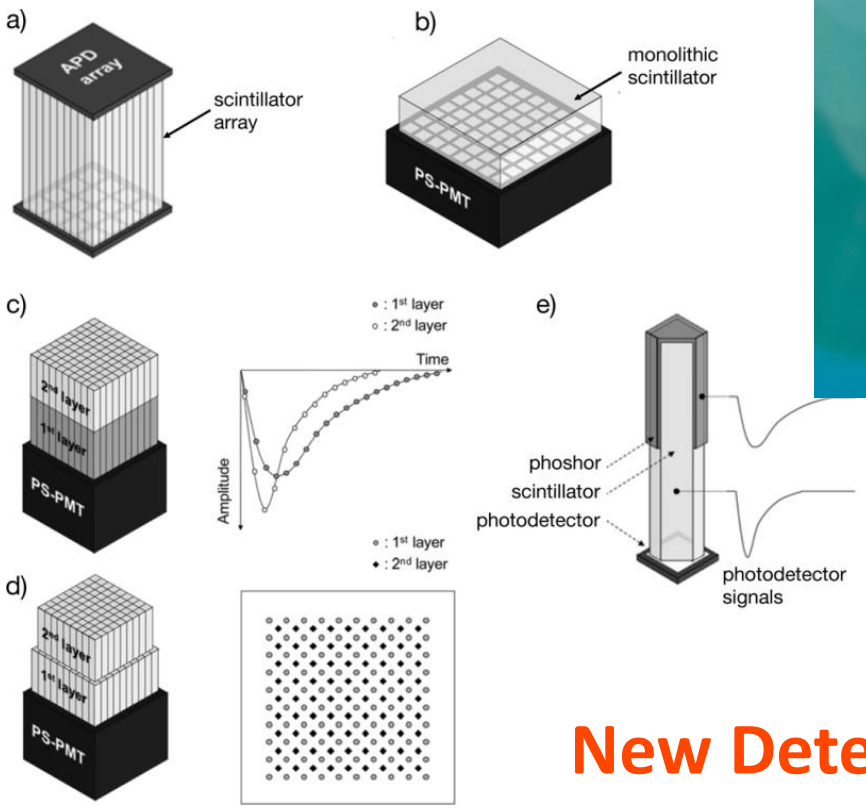


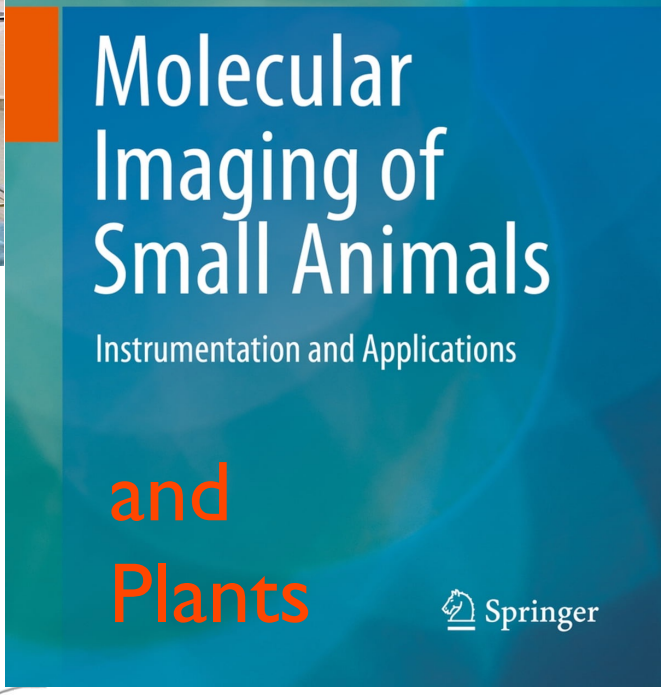

b) BRAIN


c) BREAST


d) RODENT


e) TOTAL-BODY





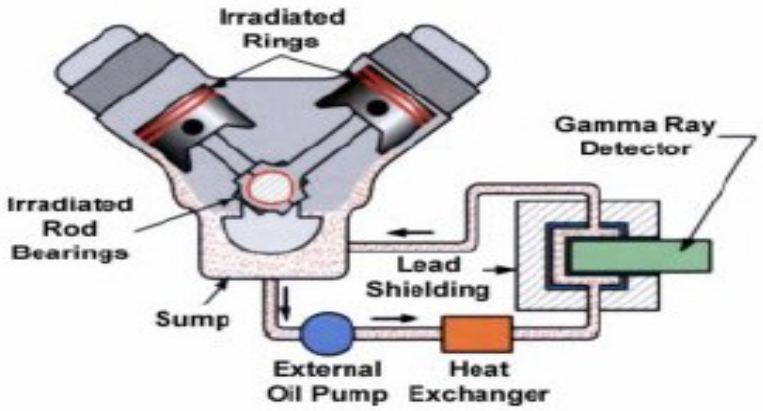
New Detector Development

PET imaging of small animals and plants

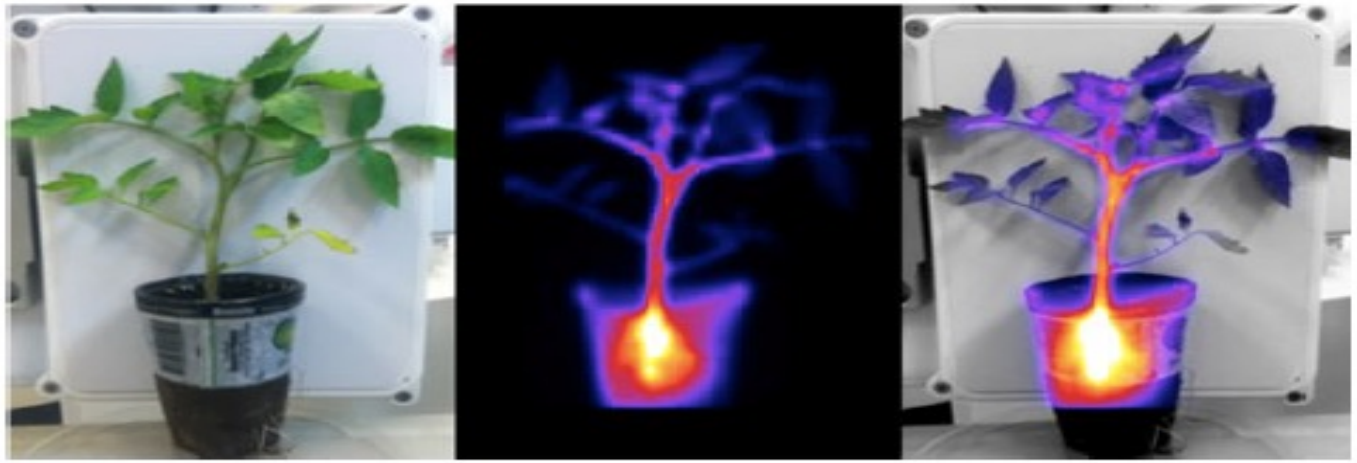
Radioisotope Tracers in Industry

Radioisotopes can be detected with high sensitivity, spurious amounts attached to material allows tracing the material (George de Hevesy, lecture 3).

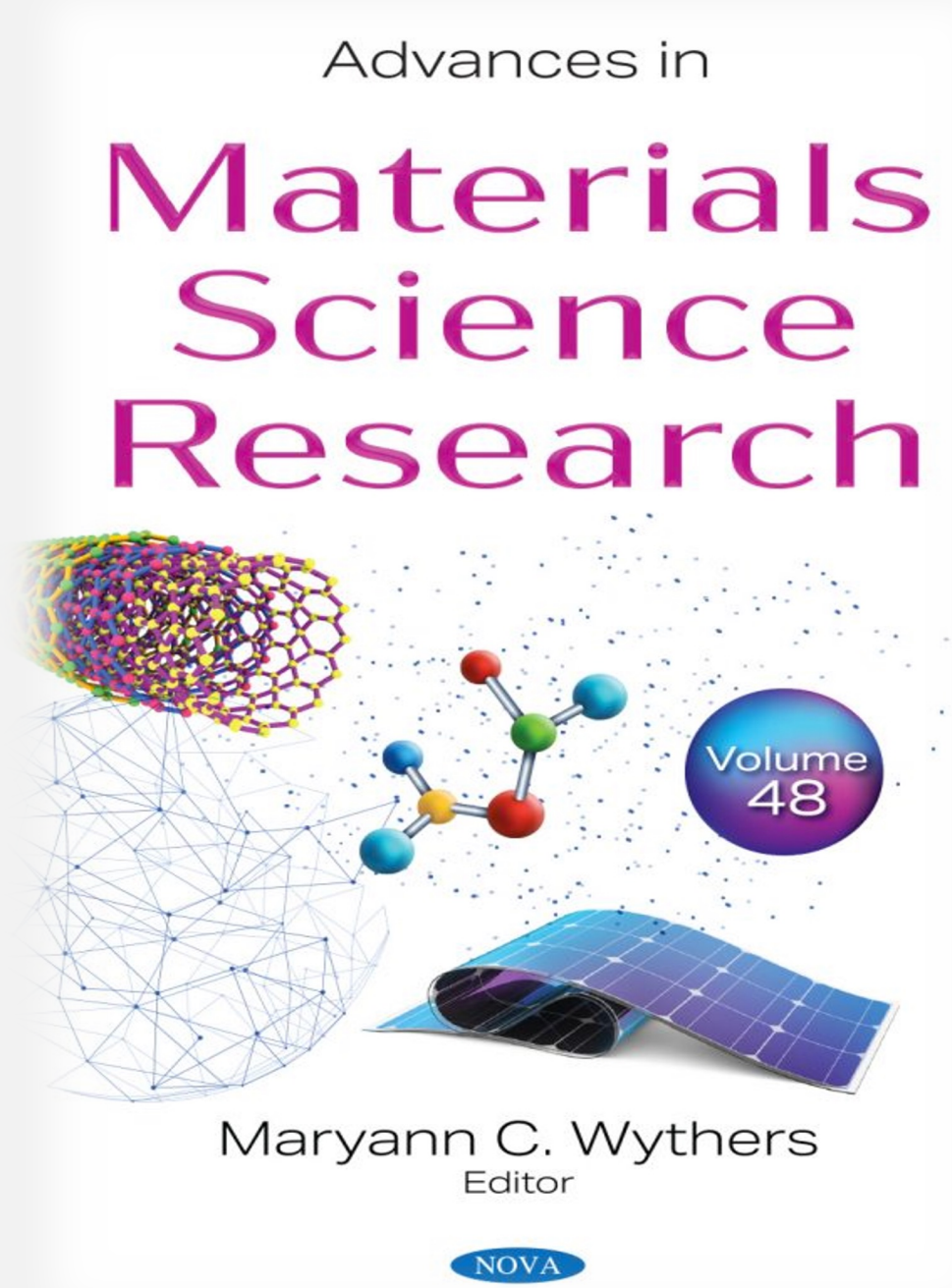
Frequent application in medical industries and agricultural industries. Further applications are the tracing of chemical reactions with the radioisotope replacing a stable isotope. Other applications are the measurement of wear and tear of new materials, with radioisotopes introduced at the surface.



Wear and tear on engine parts by measuring the increase of radioactivity in the lubricant



Up-take of nutrients doted with radioactive phosphorus (^{32}P $T_{1/2}$=14.26 d) in plants.



New Materials
Resistant to Radiation, Corrosion, Robust

Biophysics
- Biological macromolecules
- Biomaterials/Biofilms
- Biological physics
- Biofluids

Combustion Science
- Spacecraft fire safety
- Droplets
- Gaseous – premixed and non-premixed
- High pressure/Supercritical
- Solid fuels

Fluid Physics
- Adiabatic two-phase flow
- Boiling and condensation
- Capillary flow
- Interfacial phenomena
- Cryogenic propellant storage and transfer

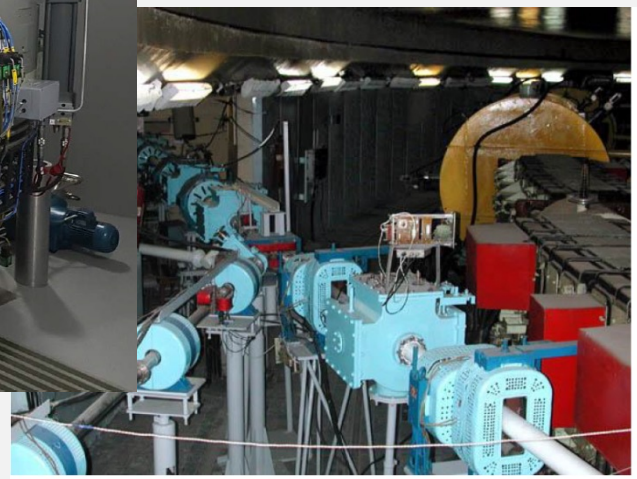
Materials Science
- Glasses and ceramics
- Granular materials
- Metals
- Polymers and organics
- Semiconductors

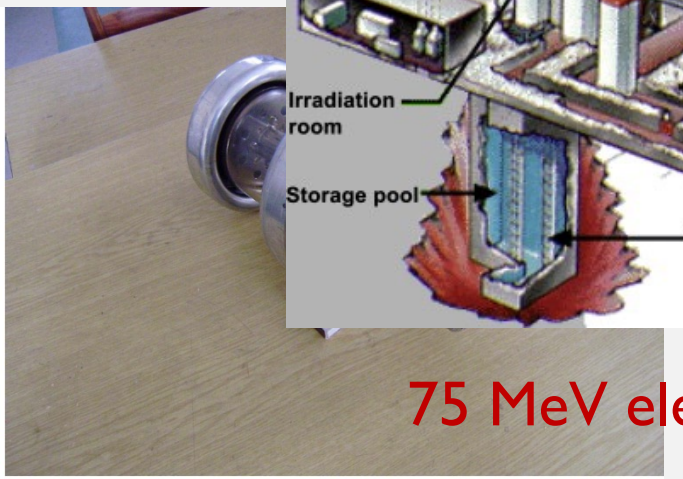
Fundamental Physics
- Quantum coherence and entanglement
- Quantum interferometry and precision measurements
- Quantum matter
- Complex plasmas
- Many-Body systems

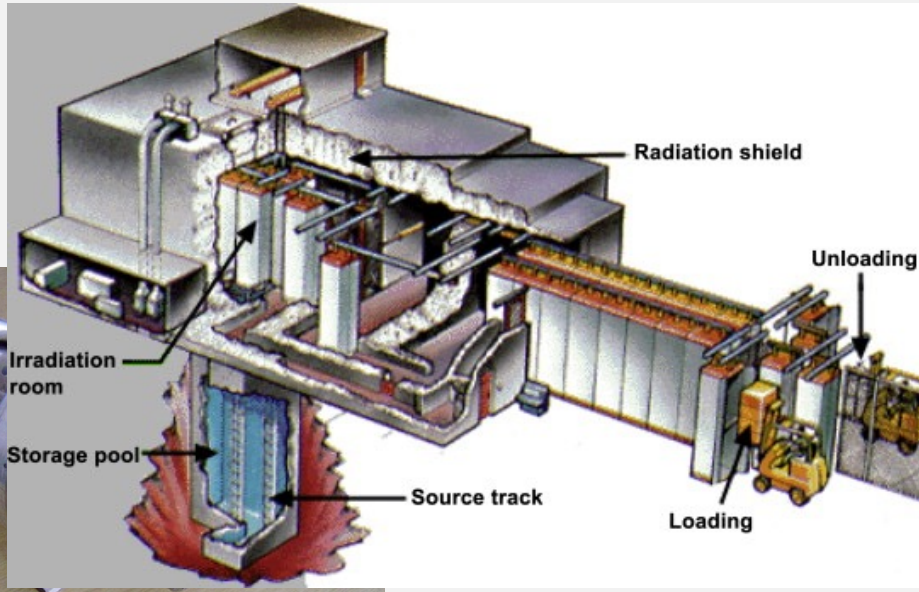
Complex Fluids
- Colloids
- Liquid crystals
- Foams
- Gels
- Granular flows

Experimental Division: Accelerator Complex

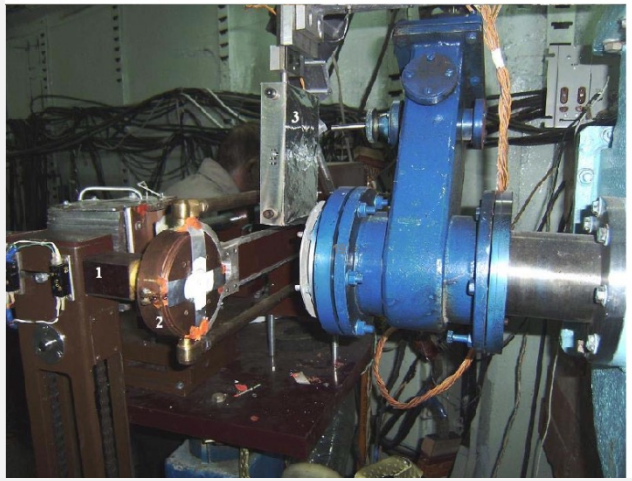
18 MeV Cyclotron

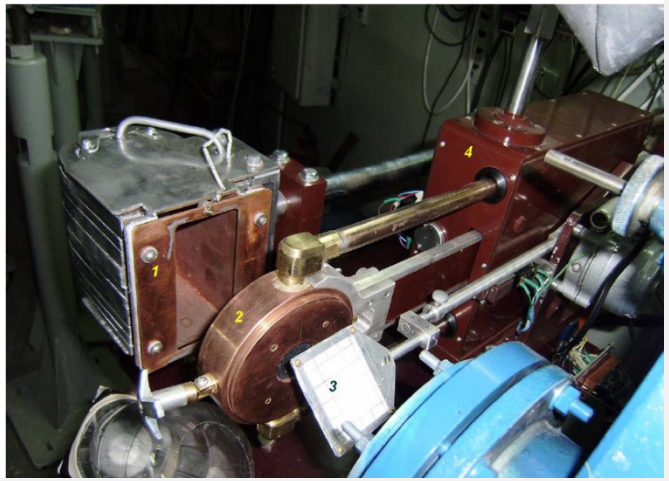






75 MeV electron accelerator





Analysis, Research & Planning for Armenia

1000 Class Cleanroom: 2022
Accelerator Complex for Irradiation
Academy Institute of Physical Chemistry

FIRST 1000 CLASS CLEAN ROOM IN ARMENIA

WHO WILL CONDUCT RESEARCH IN THE CLEANROOM?

International US Naval Research

Research teams from

- A. I. Alikhanyan National Science Laboratory
- Chemical Physics Institute, NAS RA
- Institute of Physical Research, NAS RA
- Yerevan State University
- Armenian State Pedagogical University
- Private Sector
- University of Notre Dame (USA)

FACILITY: CYCLONE 18/18

18 MeV Cyclotron Proton Beams

^{64}Cu

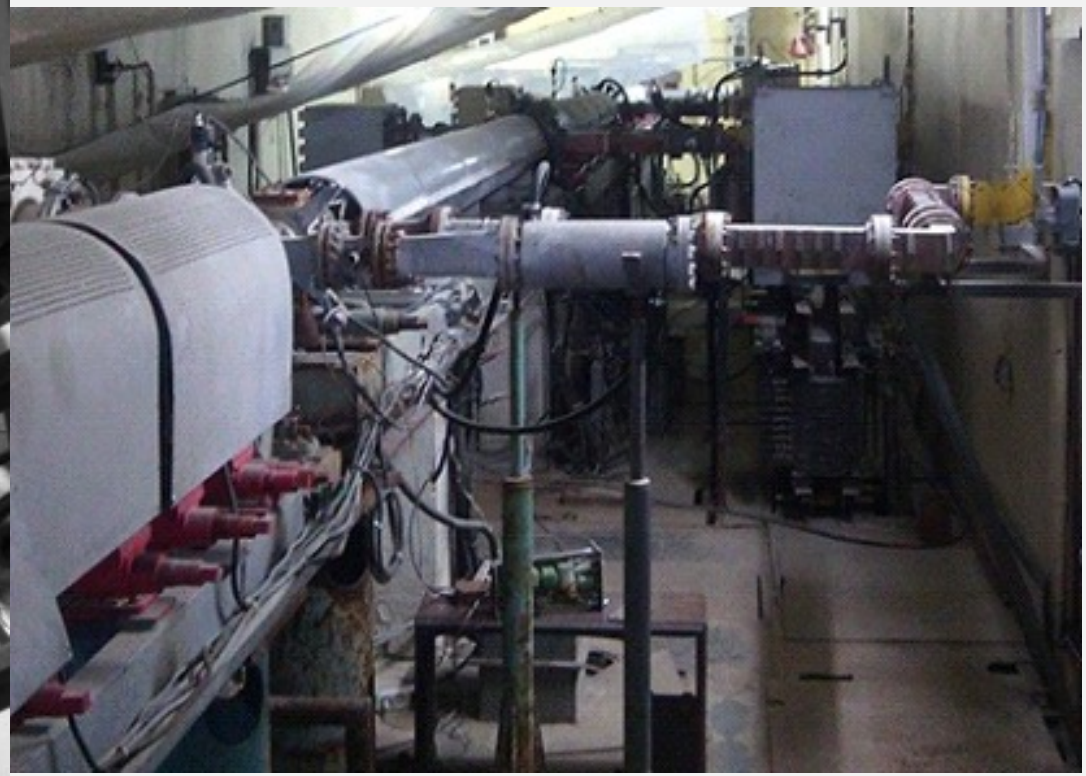
^{68}Ga

^{99}Mo

PET-1

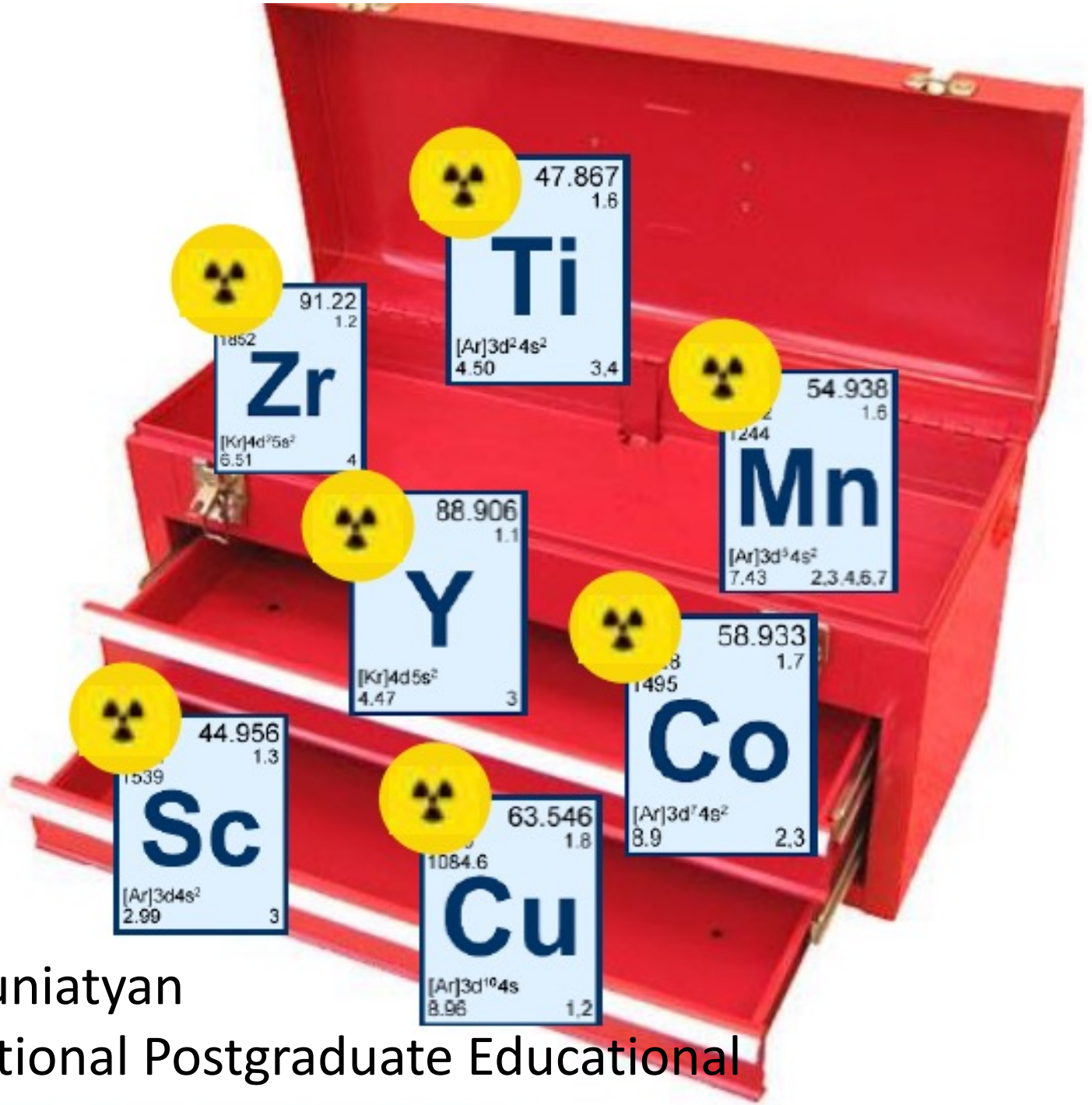
SPECT-5

ARUS electron synchrotron



75 MeV Linear Accelerator

EXPANDING THE TOOLCHEST FOR ISOTOPES



International Collaborators:

IAEA

U of Birmingham, U of Surrey, UK

U of Notre Dame

Armenia:

(Pharmaceutical Institute)

Institute of Biochemistry after H. Buniatyan

UNESCO Chair-Life Sciences International Postgraduate Educational

Therapeutic Isotopes: Big Advance in Cancer Treatment

Targeted Radioisotope Therapy

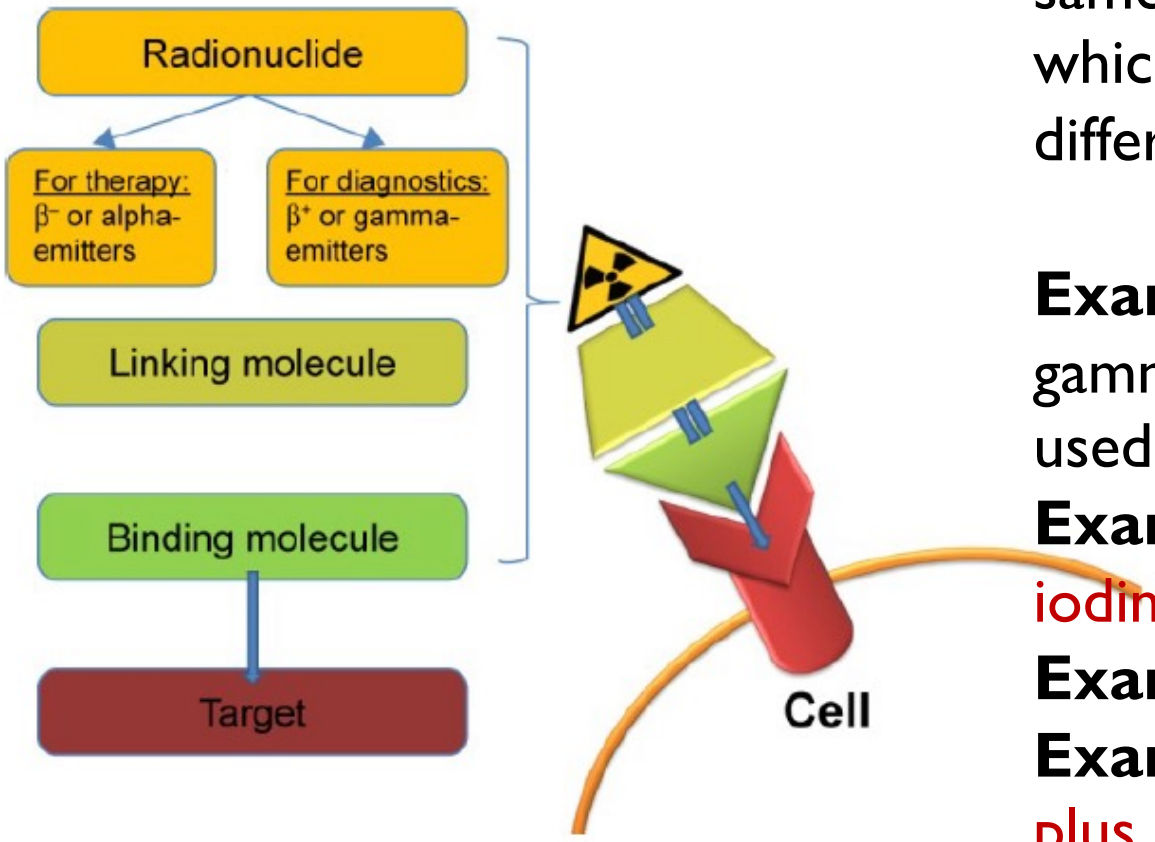
β^-, alpha, and Auger electrons

Isotopes that decay by the emission of β-, alpha, and Auger electrons can be used to kill/damage tumor cells

Challenge is in the delivery of the radioisotope

- Must be highly selective and targeting the tumor (antibodies)
- Examples: ^{90}Y or ^{131}I do not need targeting since they naturally accumulate

Theranostic Approach



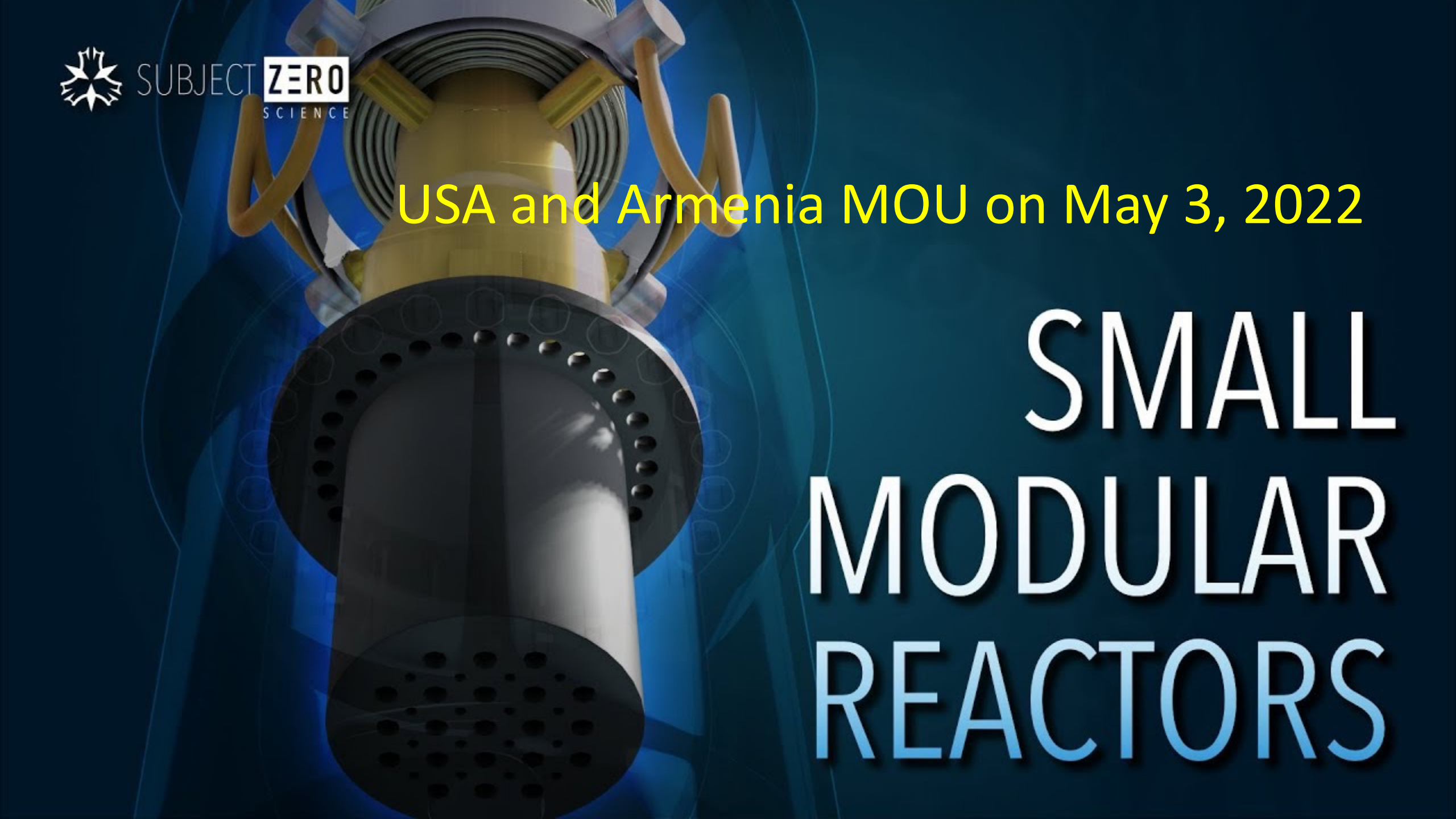
The theranostic approach in nuclear medicine couples diagnostic imaging and therapy using the same molecule or at least very similar molecules, which are either radiolabeled differently or given in different dosages.

Example 1: iodine-131 and lutetium-177 are gamma and beta emitters; thus, these agents can be used for both imaging and therapy.

Example 2: iodine-123 (gamma emitter) and iodine-131 (gamma and beta emitters)

Example 3: yttrium-86/yttrium-90

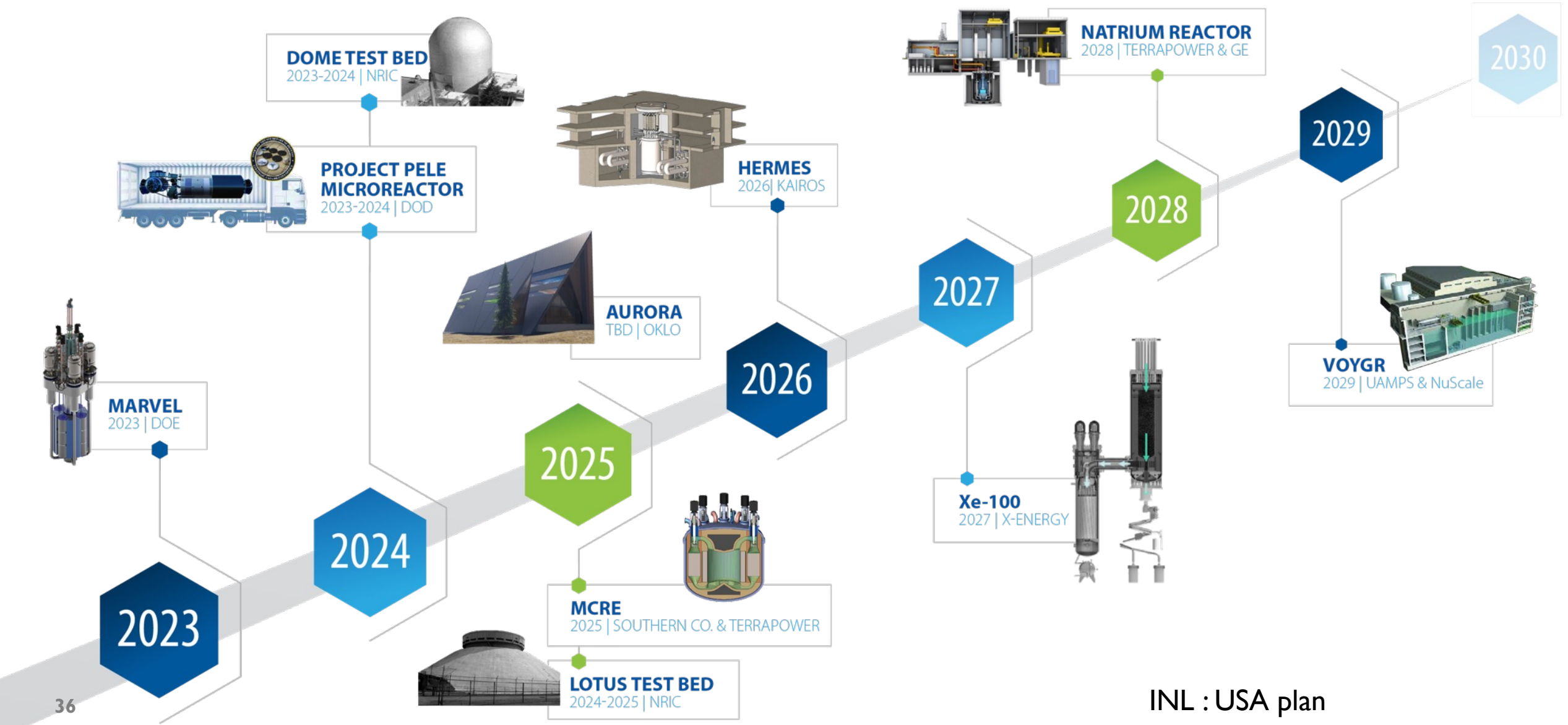
Example 4: terbium isotopes (Tb): ^{152}Tb (beta plus emitter), ^{155}Tb (gamma emitter), ^{149}Tb (alpha emitter), and ^{161}Tb (beta minus particle).


SUBJECT ZERO SCIENCE
USA and Armenia MOU on May 3, 2022
SMALL MODULAR REACTORS

Conceptual Design and Prototype:

- Yerevan State University
- Polytechnic University
- AANL
- EcoAtom – company in Armenia
- ORNL, INL (USA)
- FRANCE

ACCELERATING ADVANCED REACTOR DEMONSTRATION & DEPLOYMENT



INL : USA plan

Harvard Business Review

Locate the company's R&D near the talent.

RESEARCH & DEVELOPMENT

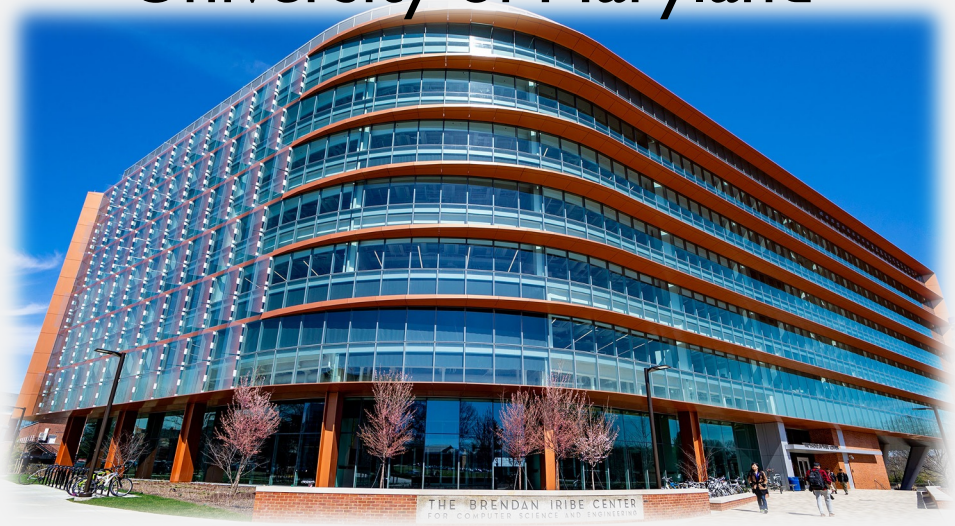
Why Companies and Universities Should Forge Long-Term Collaborations

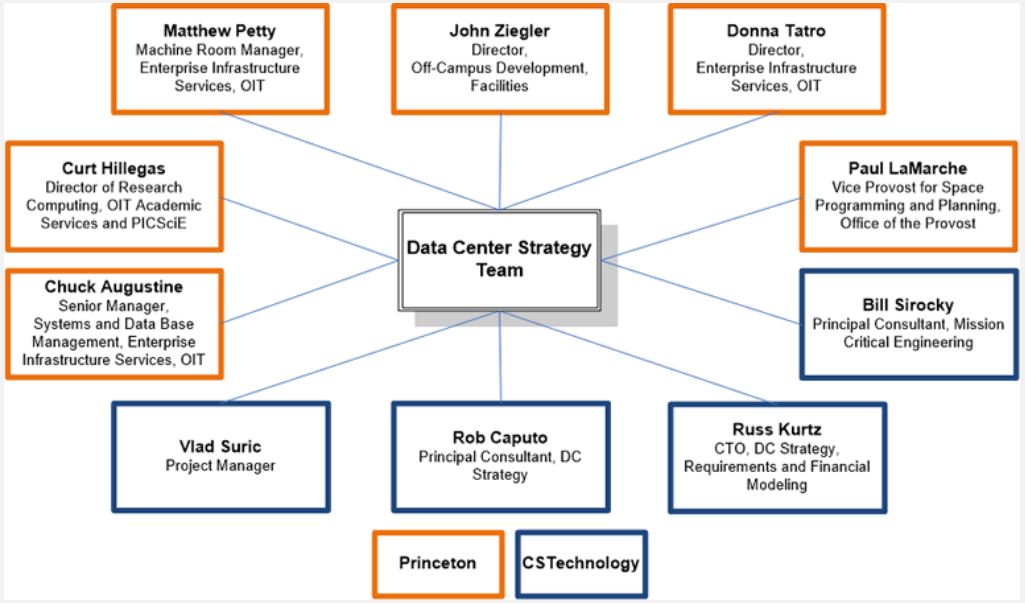
by Kenneth R. Lutchen

JANUARY 24, 2018

Research/University and IT

University of Maryland



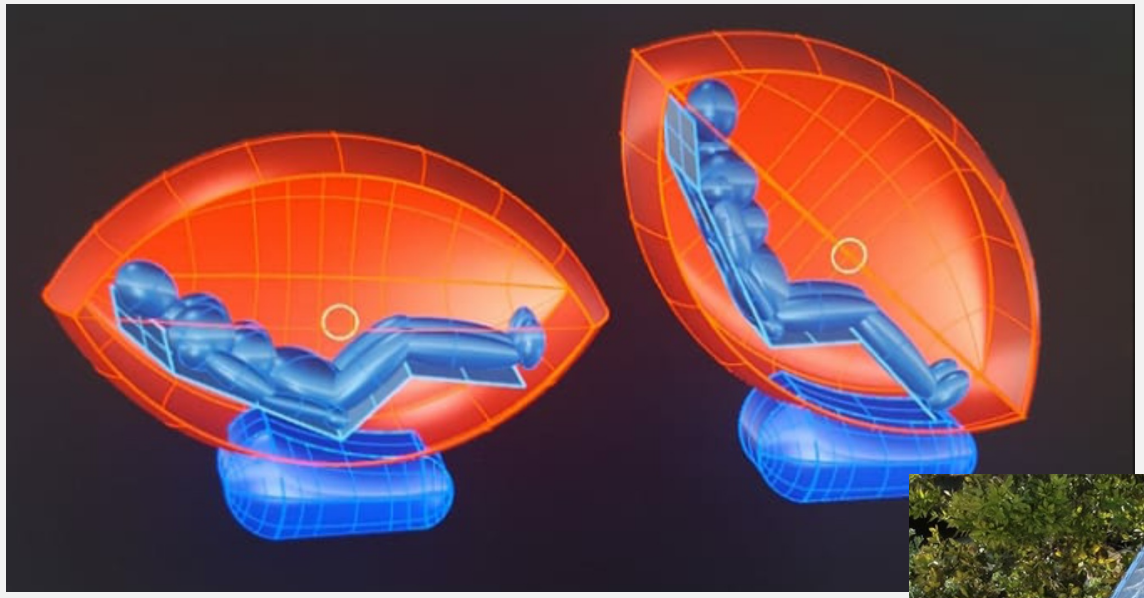


DeepMind for Google

DeepMind for Google takes cutting-edge machine learning research pioneered by DeepMind and uses it to have real-world impact at Google scale.

Nissan, Microsoft, UBER

Production Capability Improvements: Modernize



Societal Applications: Patents, Production Capabilities

Covid 19:

Nanoparticle masks

Resin 3-D printed masks

Ozonators

Collaborations with

TESLA Crystals

IPR Bio-molecular Institute

International Collaborations (ICTP center)

State Science Committee new call proposals

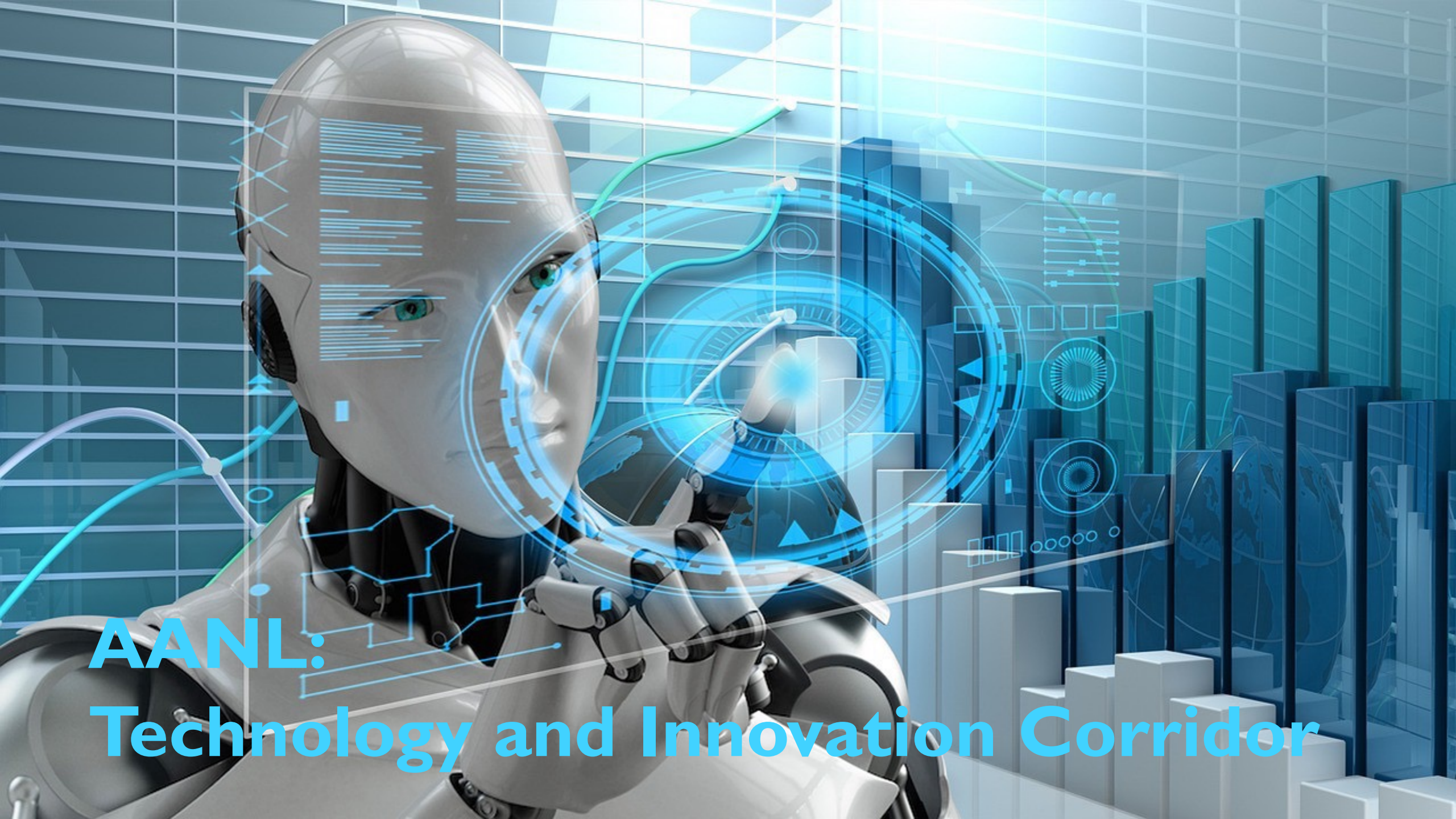
International US Navy/Army

World Bank HUB proposal

Armenian Society of Fellows – Institute of Advanced Studies

Cyclotron: New Directions

Cultural Heritage
New Beginning in Armenia


AANL:
Technology and Innovation Corridor

Campuses of AANL

Cosmic Ray Stations:

Aragats 3200 m

Nor Amberd 2000m

Underground Salt Mine:

Yerevan

https://www.aps.org/units/fip/newsletters/201103/aprahamian.cfm

A Comprehensive Science & Innovation Hub for Armenia

February 2021

- Mathematical Institute for Complex Systems Science
- Institute for Applied Physics
- Institute for Translational Life Sciences

Most Valuable Resource

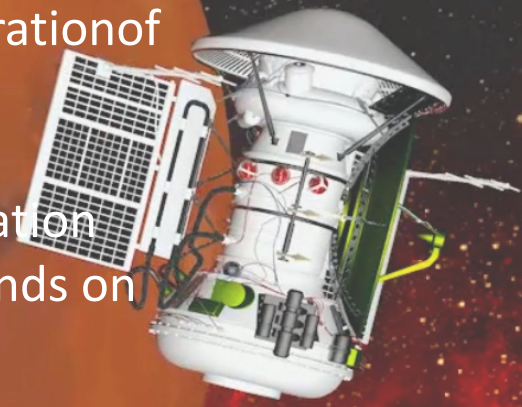
11 Interns from USA and Armenia
83 student-volunteers from Armenia for conferences
Scholarships from Diaspora scientists

Hands-on museum development, grants
Library cleanup and renovations

STARMUS VI

50 years on MARS

Sept. 5-10, 2022
Yerevan Armenia



Our aim is to inspire andeducate the next generationof explorers and regeneratethe spirit of discovery

Starmus is a global festival ofscience communication andart that brings together themost brilliant minds on theplanet

Starmus combines art, musicand science to enhance thescience communication.

We want to engage humanityin the biggest questions ofour time