ROADMAP ON ATOMIC, MOLECULAR AND OPTICAL RESEARCH

Raul Barrachina

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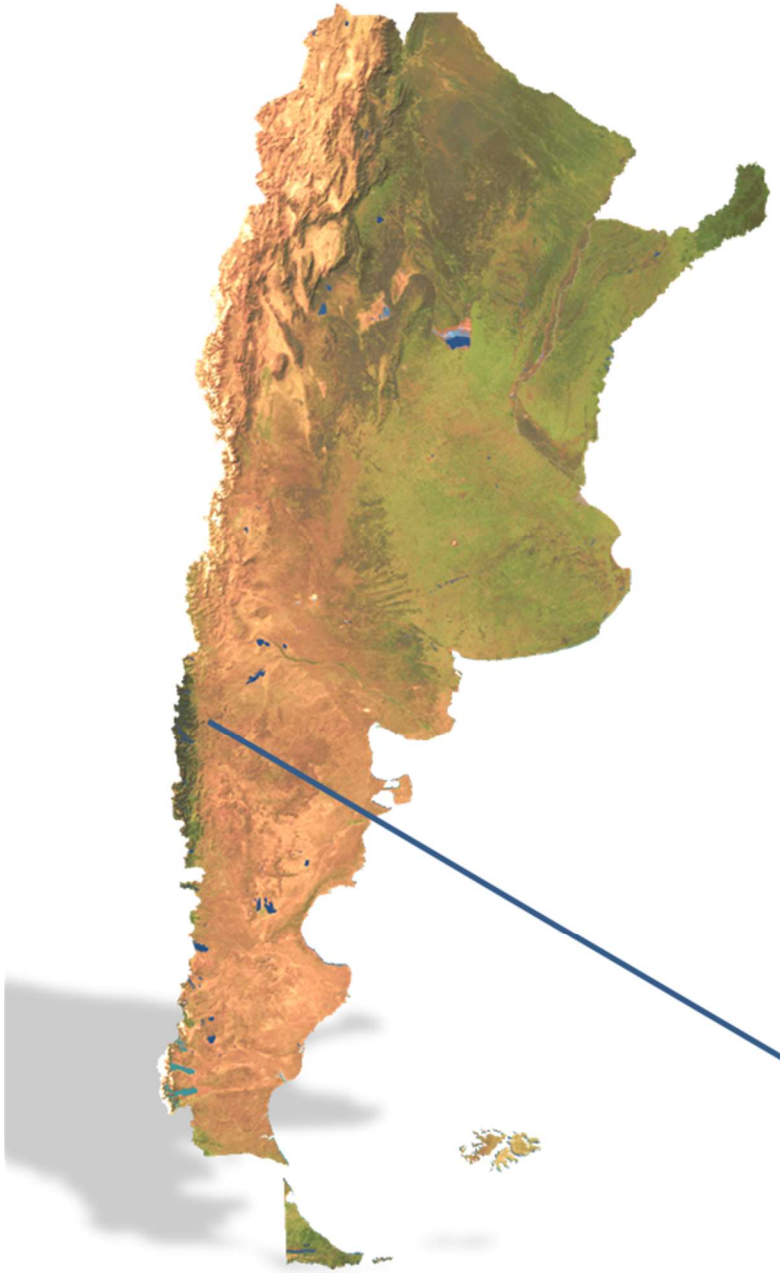
AT THE ARGENTINE ATOMIC ENERGY COMMISSION

ATOMIC, MOLECULAR AND OPTICAL PHYSICS
ARGENTINA

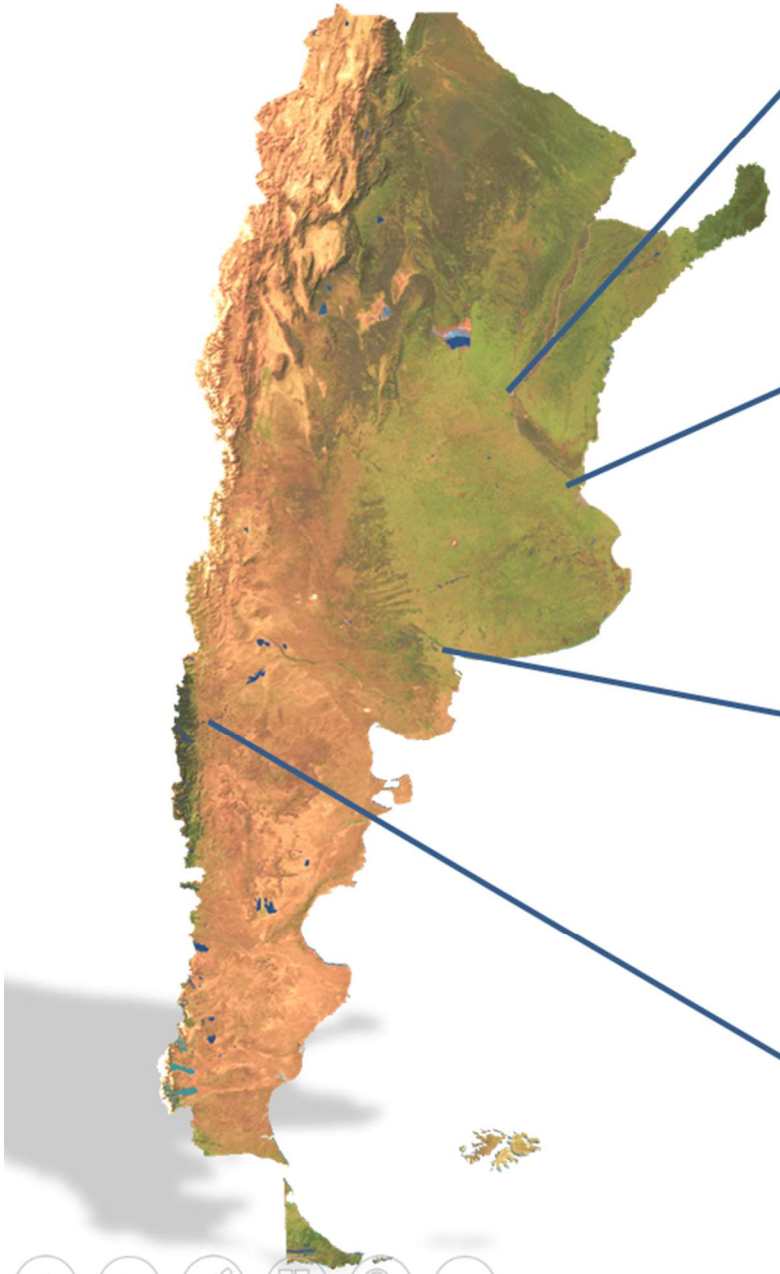


WOLFGANG MECKBACH
(1919 – 1998)

BARILOCHE
ATOMIC CENTRE

ATOMIC, MOLECULAR AND OPTICAL PHYSICS

ARGENTINA



UNIVERSIDAD NACIONAL DE ROSARIO

CONICET

IFIR Rosario

UNIVERSIDAD DE BUENOS AIRES

CONICET

IAFE Buenos Aires

UNIVERSIDAD NACIONAL DEL SUR

BAHIA BLANCA

CONICET

IFISUR Bahía Blanca

CNEA

BARILOCHE
ATOMIC CENTRE

COMISION NACIONAL DE ENERGIA ATOMICA

AN OBVIOUS TRUISM

It would not be a good practice
to do AMO physics
outside the context,
priorities and needs
of the Atomic Energy Commission.

ANOTHER OBVIOUS TRUISM

For CNEA it has always been about looking for those rare niches of local and regional interest, and where we can compete at an international level.

NUCLEAR RESEARCH REACTORS

1957	1965	1966	1968	1972	1982	1988	1989	1997	1998	2006
RA1	**RA0**	**RA2**	**RA3**	**RA4**	**RA6**			**RA8**		
40 KW	1 MW	0.1 W	10 MW	1 MW	1 MW			100 W		

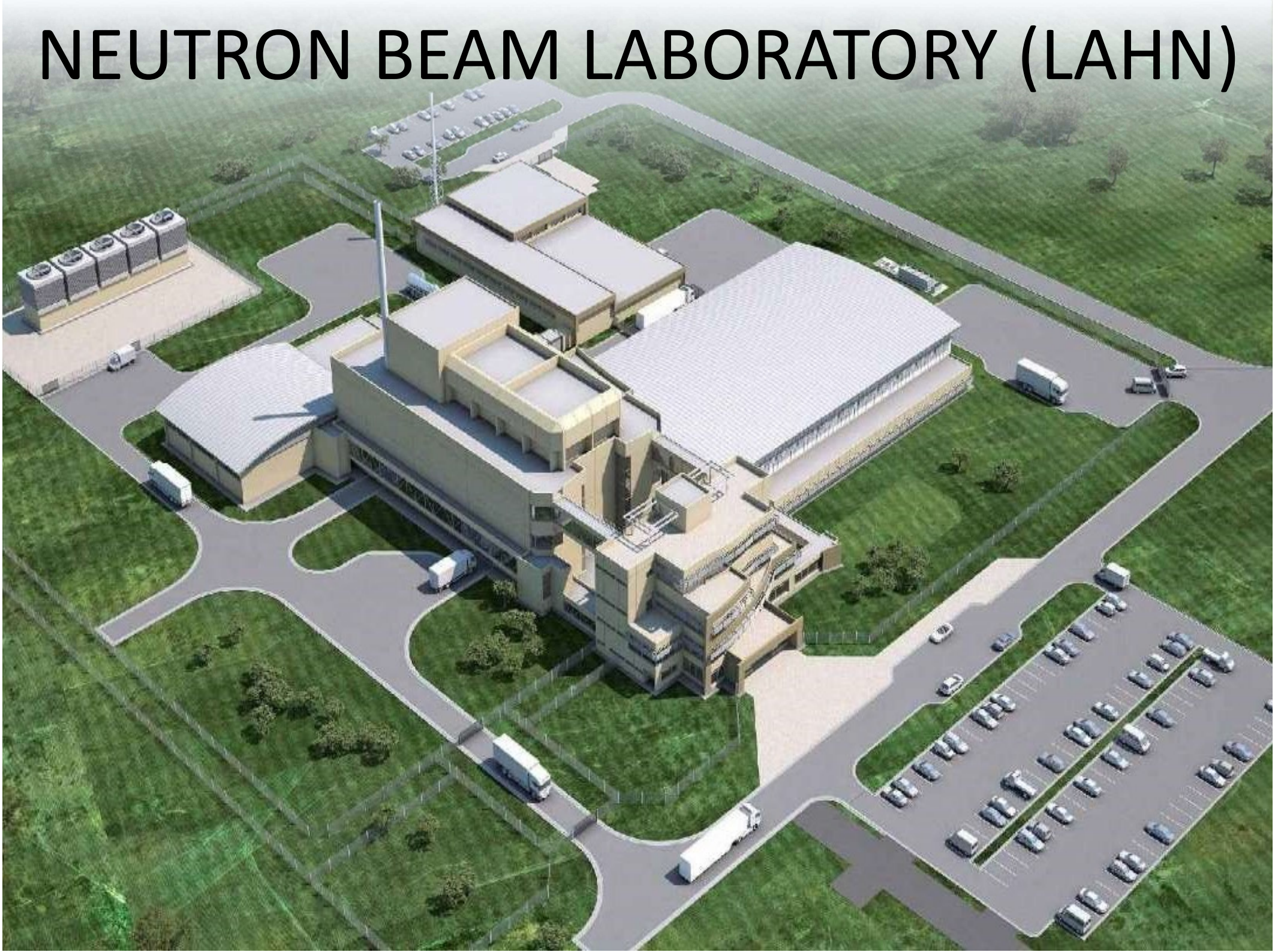
PERU	ALGERIA	EGYPT	AUSTRALIA
RP10	**NUR**	**ETRR**	**OPAL**
10 MW	1 MW	22 MW	20 MW

OPAL NRR (AUSTRALIA)

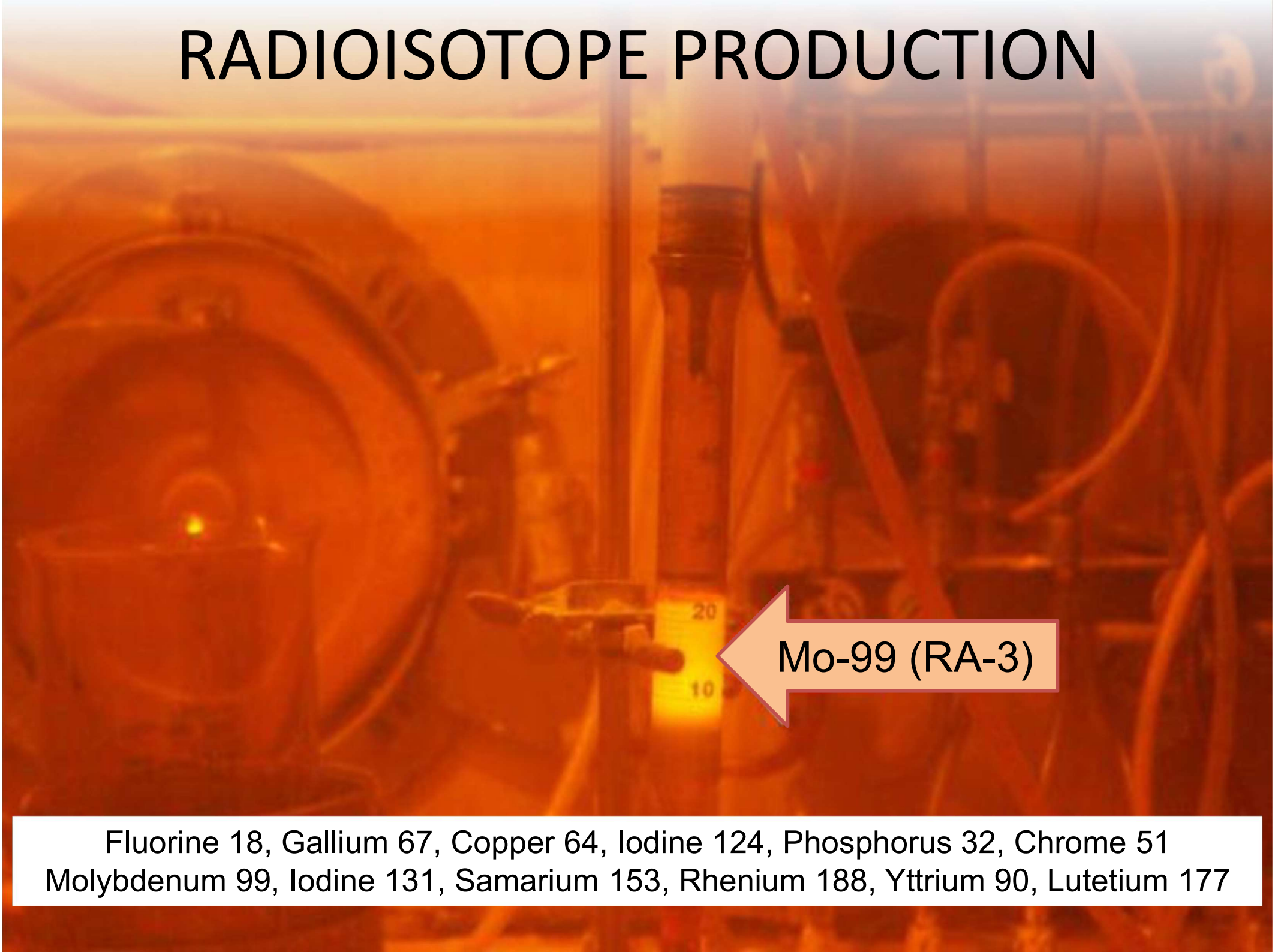
PALLAS PROJECT (NETHERLANDS)

NUCLEAR RESEARCH REACTOR RA-10

NEUTRON BEAM LABORATORY (LAHN)

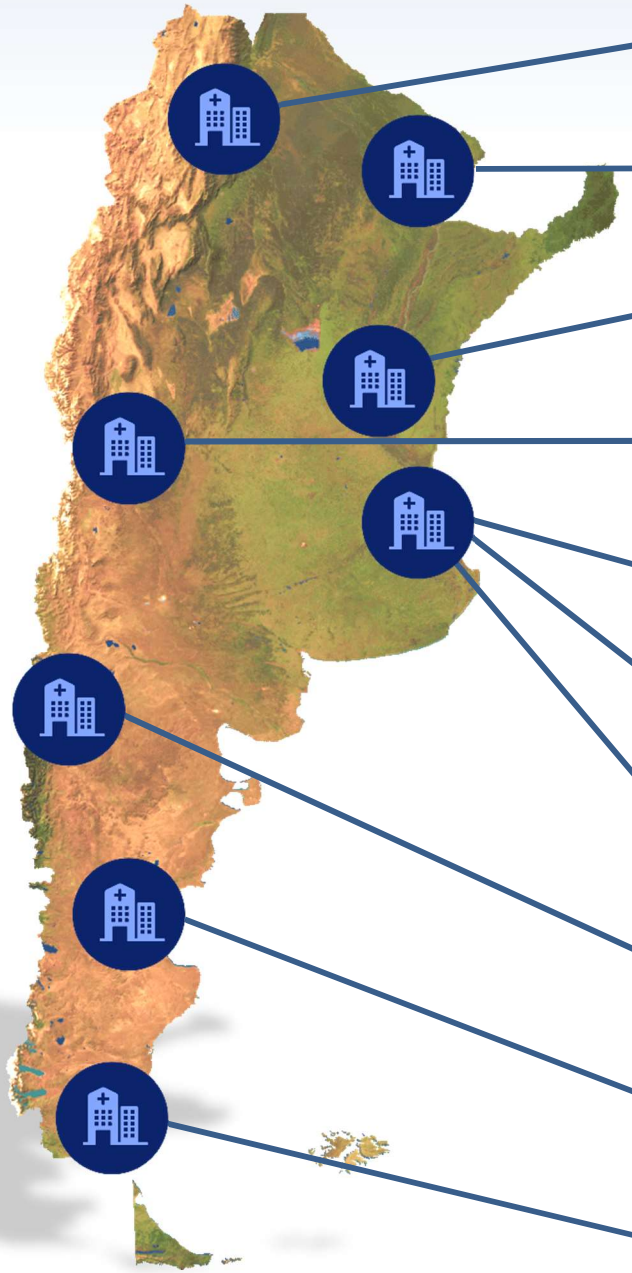


RADIOISOTOPE PRODUCTION



Fluorine 18, Gallium 67, Copper 64, Iodine 124, Phosphorus 32, Chrome 51
Molybdenum 99, Iodine 131, Samarium 153, Rhenium 188, Yttrium 90, Lutetium 177

NUCLEAR MEDICINE PLAN



- CMN – SALTA
- PERÓN – FORMOSA
- CEMENER – ORO VERDE
- FUESMEN – MENDOZA
- ROFFO – BUENOS AIRES
- FCDN – BUENOS AIRES
- CLÍNICAS – BUENOS AIRES
- INTECNUS – BARILOCHE
- CABIN – CDRO. RIVADAVIA
- CEMNPA – RÍO GALLEGOS

INTECNUS (BARILOCHE)

NUCLEAR MEDICINE

BORON NEUTRON CAPTURE THERAPY (BNCT)

PROTON THERAPY CENTRE (CEARP)

SMALL MODULAR REACTOR (CAREM)

URANIUM ENRICHMENT

DIFFUSION
PILCANIYEU (1983)

CENTRIFUGE

LASER

OTHER FACILITIES

- ✓ **NUCLEAR POWER PLANTS**
  - ATUCHA I
  - EMBALSE
  - ATUCHA II
  - FOURTH NPP (PROJECT)
- ✓ **FUEL MANUFACTURING PLANT** (CONUAR)
- ✓ **HEAVY WATER PLANT** (ENSI)
- ✓ **ZIRCALOY TUBES AND SPECIAL ALLOYS** (FAE)
- ✓ **URANIUM MINING**
- ✓ **URANIUM DIOXIDE POWDER PRODUCTION** (DIOXITEK)

NON NUCLEAR PROJECTS

SATELLITES

1996:	**SAC-B** (Failure of the Pegasus-XL launcher)	200 kg
1998:	**SAC-A**	68 kg
2000:	**SAC-C**	500 kg
2011:	**SAC-D** (NASA's Aquarius salinity sensor)	1350 kg
2014:	**ARSAT-1** (Geostationary Communication Satellite)	3000 kg
2015:	**ARSAT-2** (Microwave Observation Satellite)	3000 kg
2018:	**SAOCOM 1A**	3000 kg
2019:	**SAOCOM 1B** (Planned)	
	ARSAT-3 (Under construction)	
	SABIA-MAR (Argentine-Brazilian collaboration)	

INVAP

NON NUCLEAR PROJECTS

Radars

- First Argentine primary 3D radar
- Secondary radars network (air traffic control)
- Tactical 3D radar for Air Defense

Monitoring and Control System

- MOCC: Satellites' Operations and Control Center
- SIMPO: Fishing and Oceanographic Information
- PATAGONIUS: Bovine Monitoring in Patagonia

Radiotherapy equipment

- UNISIM: Radiotherapy universal simulator
- TERADI 800: Isocentric Cobalt-60 teletherapy system

INVAP

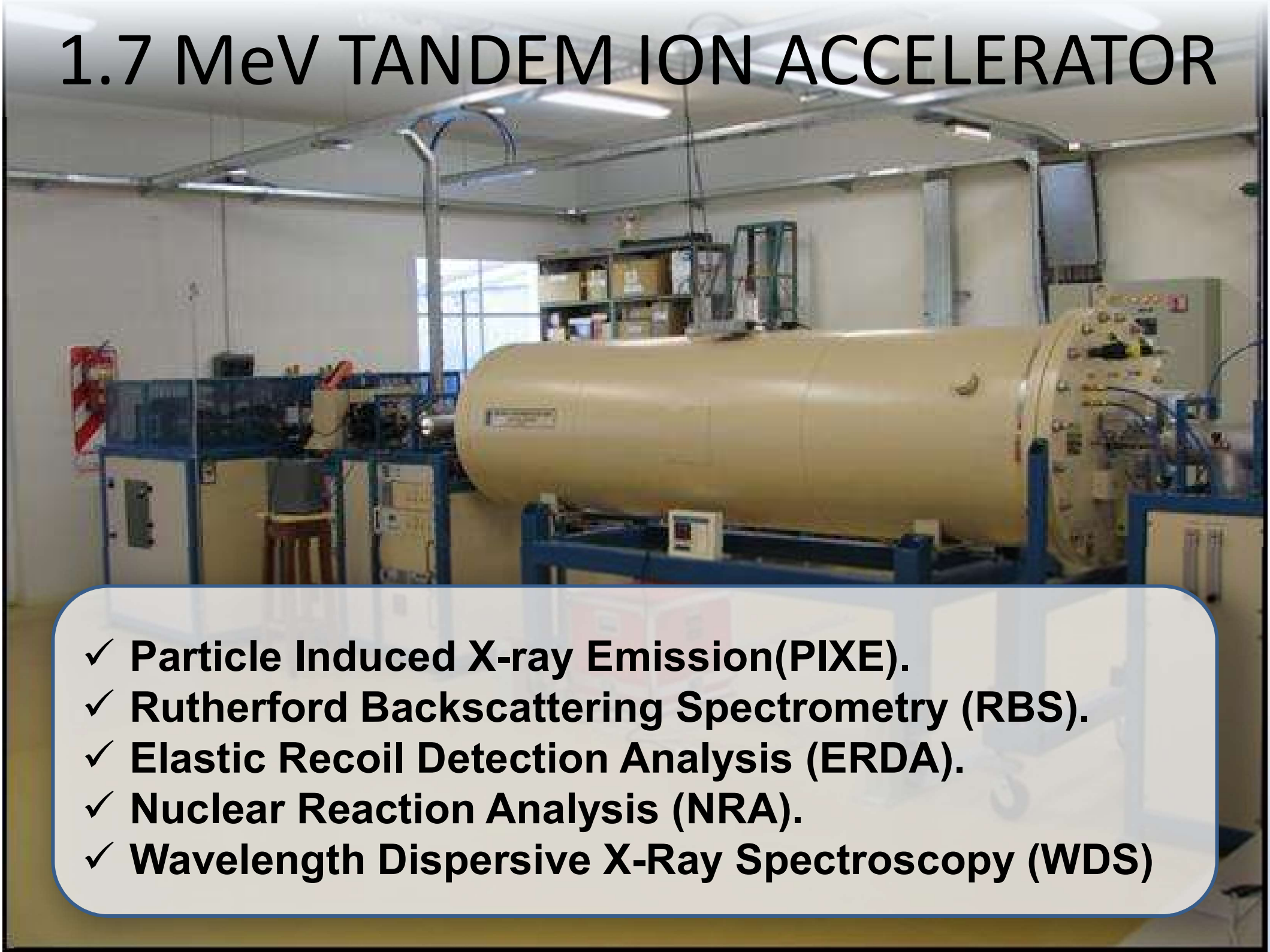
PIERRE AUGER OBSERVATORY

AND HERE WE ARE…

It would not be a good practice
to do AMO physics
outside the context,
priorities and needs
of the Atomic Energy Commission.

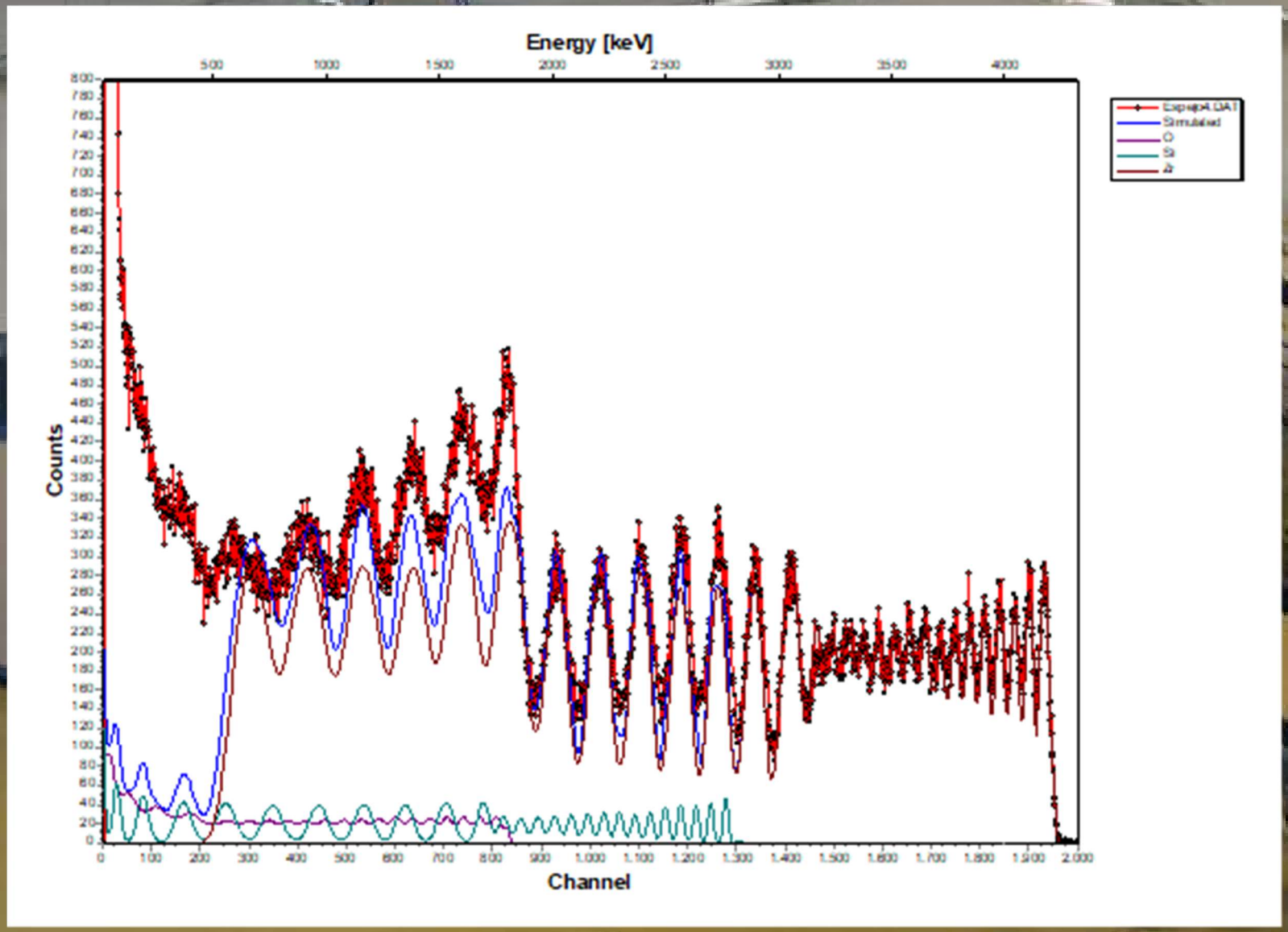
1.7 MeV TANDEM ION ACCELERATOR

1.7 MeV TANDEM ION ACCELERATOR



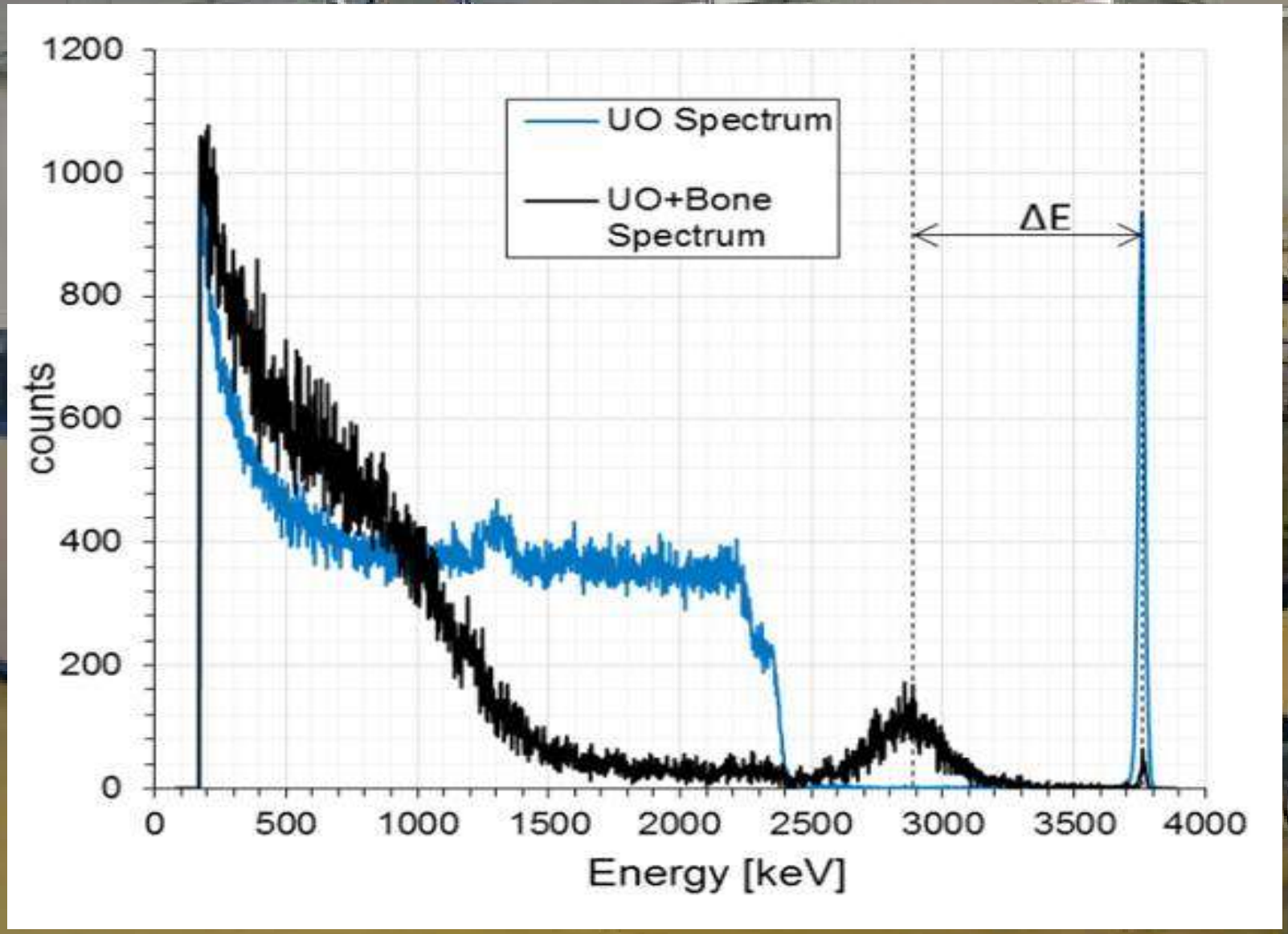
- ✓ **Particle Induced X-ray Emission(PIXE).**
- ✓ **Rutherford Backscattering Spectrometry (RBS).**
- ✓ **Elastic Recoil Detection Analysis (ERDA).**
- ✓ **Nuclear Reaction Analysis (NRA).**
- ✓ **Wavelength Dispersive X-Ray Spectroscopy (WDS)**

1.7 MeV TANDEM ION ACCELERATOR



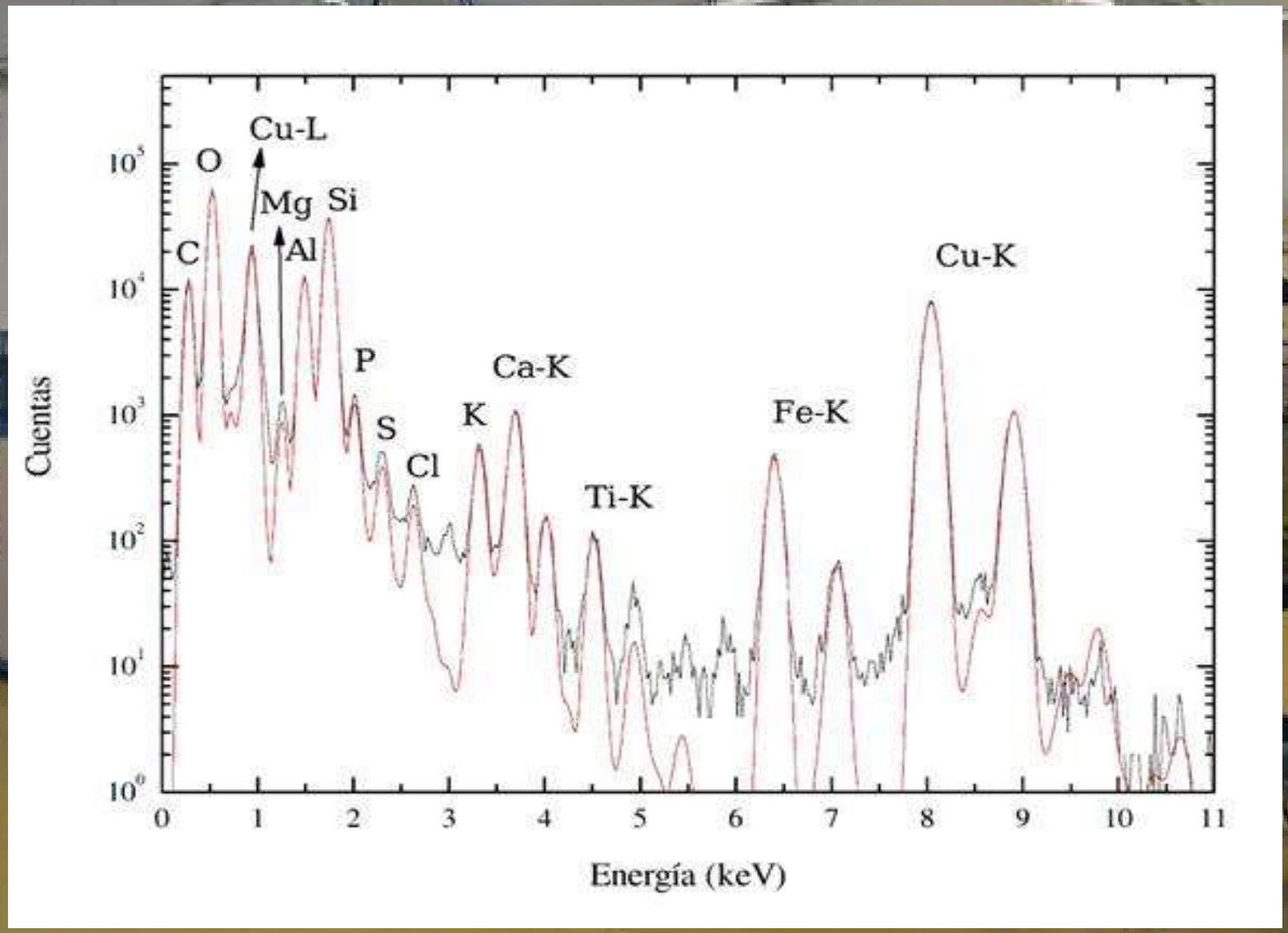
RBS spectrum for a multilayer ZrO2/SiO2 sample and the fit obtained with the SIMNRA software

1.7 MeV TANDEM ION ACCELERATOR



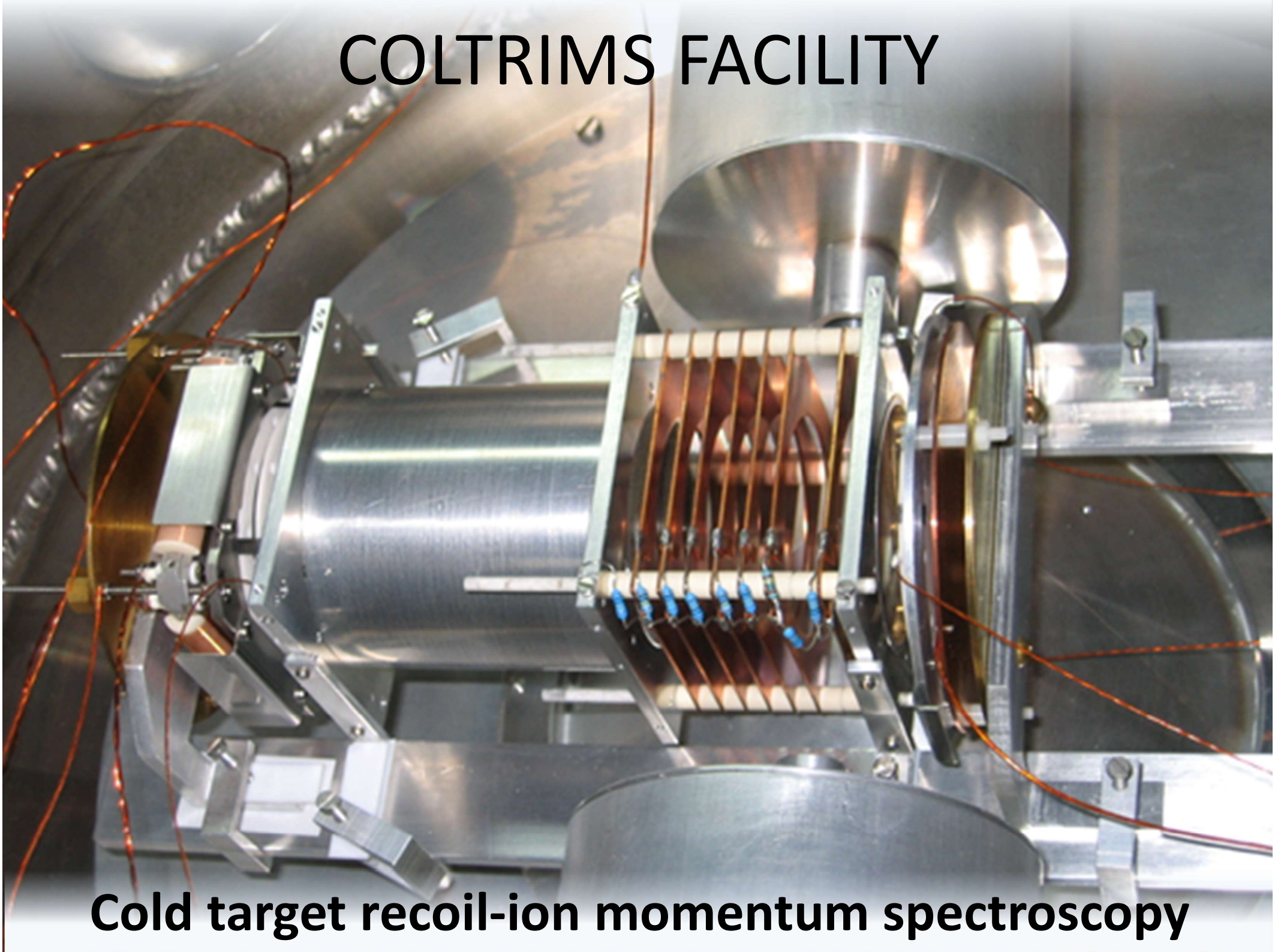
Stopping power of α particles in compact bone for research in BNCT (Boron Neutron Capture Therapy)

1.7 MeV TANDEM ION ACCELERATOR



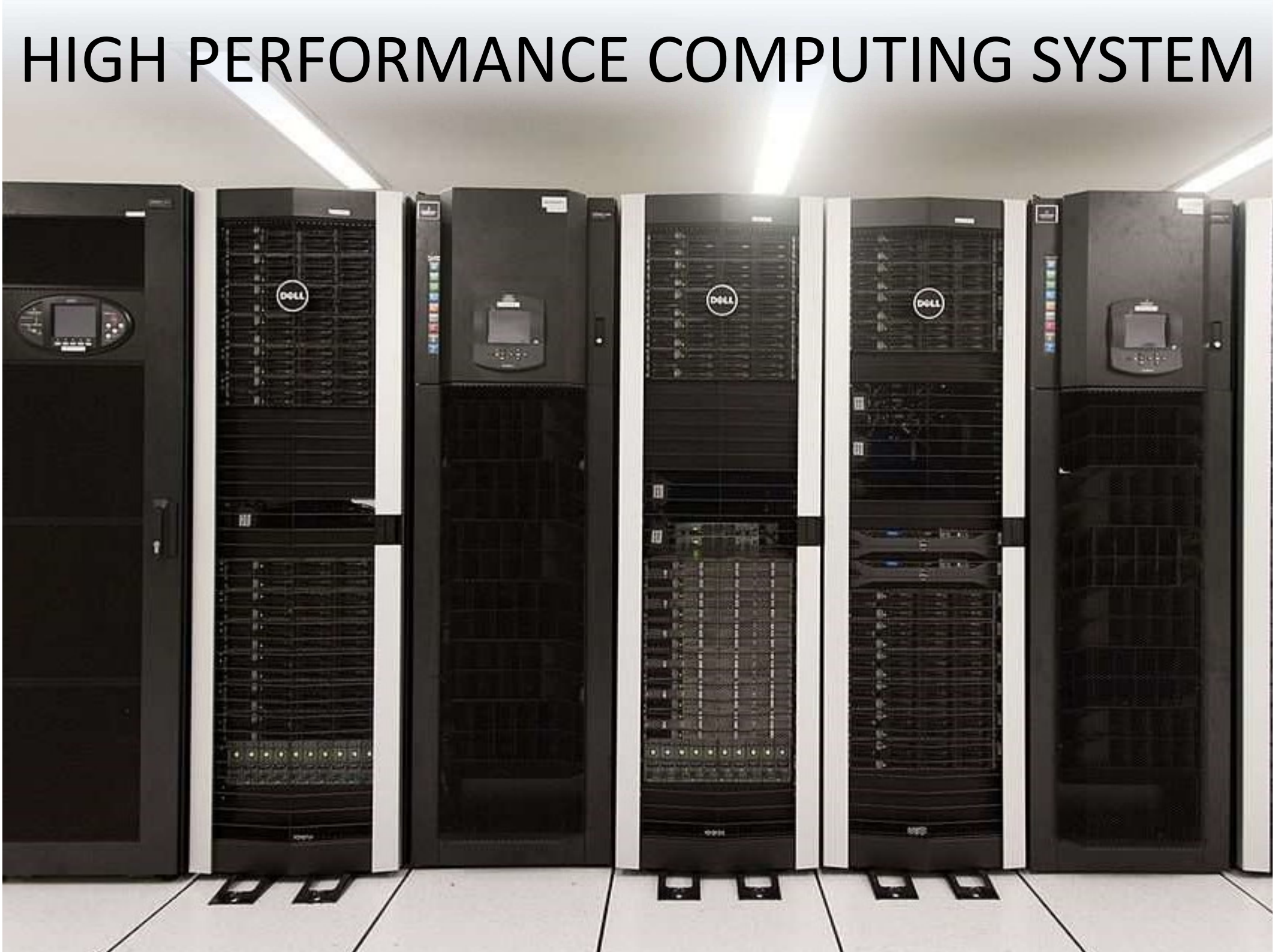
X-ray spectrum of a Patagonian archeological sample and fit obtained with the GUPIX software

COLTRIMS FACILITY

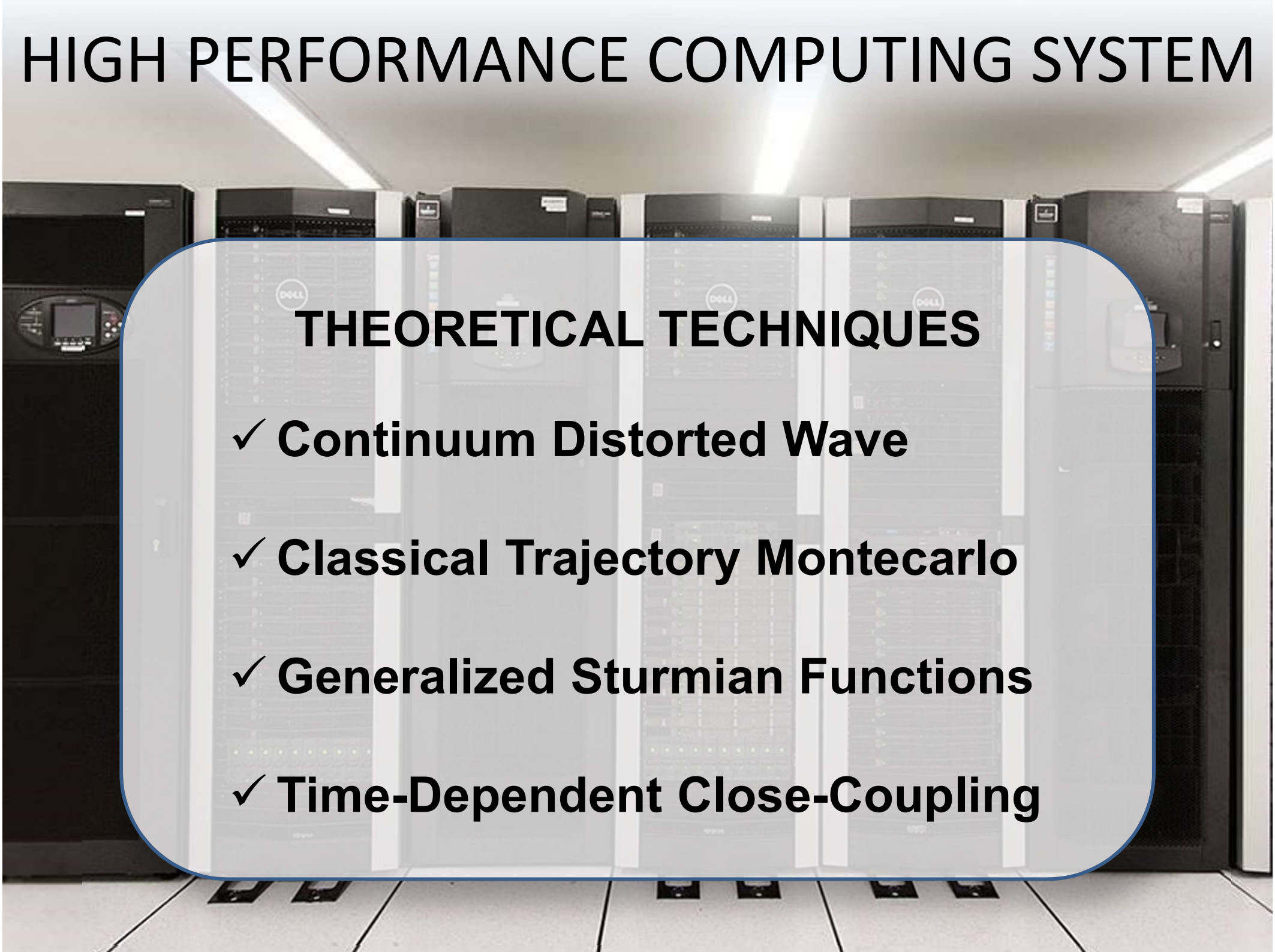


Cold target recoil-ion momentum spectroscopy

HIGH PERFORMANCE COMPUTING SYSTEM



HIGH PERFORMANCE COMPUTING SYSTEM



THEORETICAL TECHNIQUES

- ✓ Continuum Distorted Wave
- ✓ Classical Trajectory Montecarlo
- ✓ Generalized Sturmian Functions
- ✓ Time-Dependent Close-Coupling

SO, WHERE ARE WE?

SO, WHERE ARE WE?

SO, WHERE ARE WE?

WHAT HAPPENED WITH *JOHN DOE*?

Affiliation(s):

Centro Atomico Bariloche, Rio Negro, Argentina View more

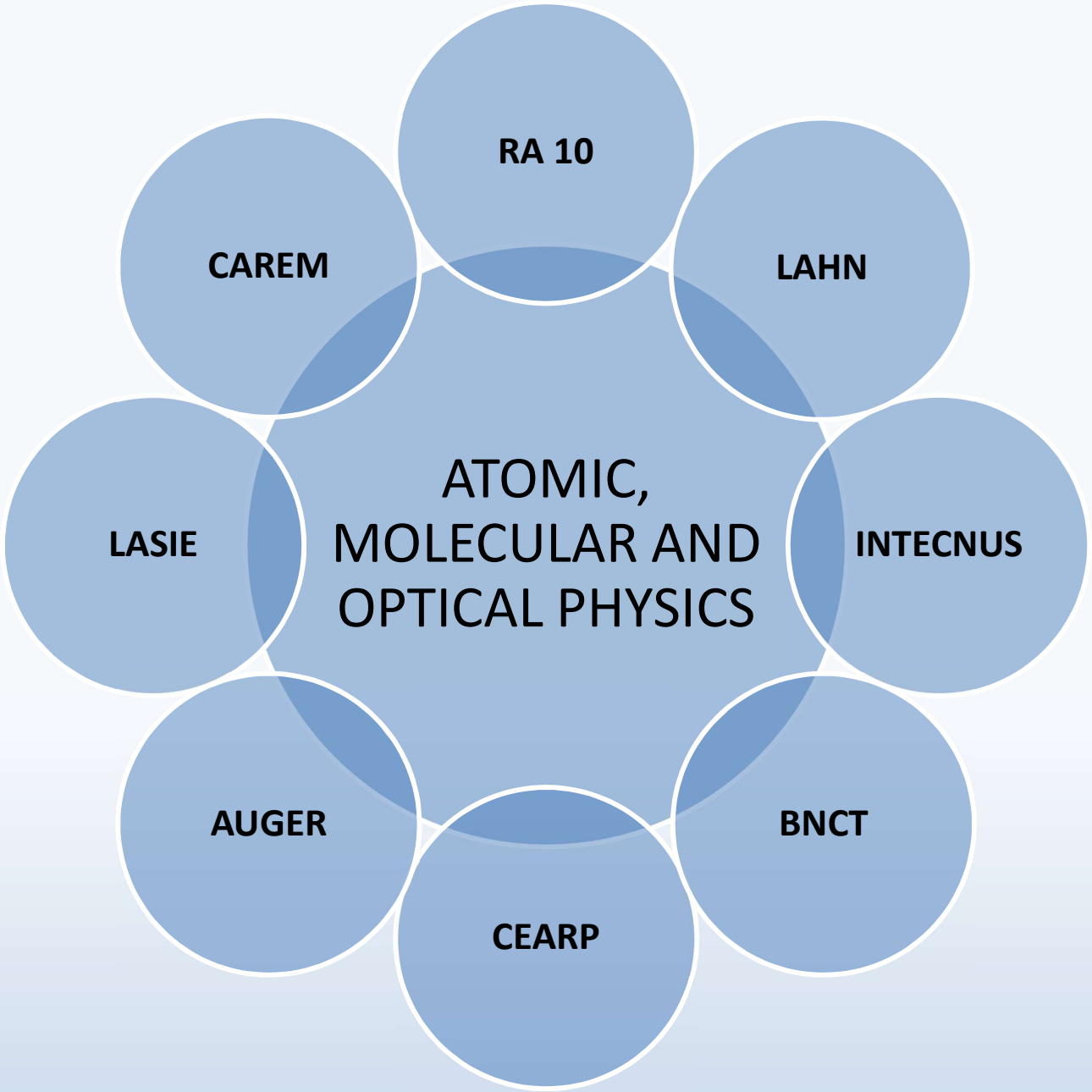
Subject area: Physics and Astronomy | Materials Science | Medicine | Agricultural and Biological Sciences | Biochemistry, Genetics and Molecular Biology | Engineering | Chemistry | Health Professions | Mathematics

Documents by author	Total citations	*h*-index:
139	2763 by 1371 documents	30

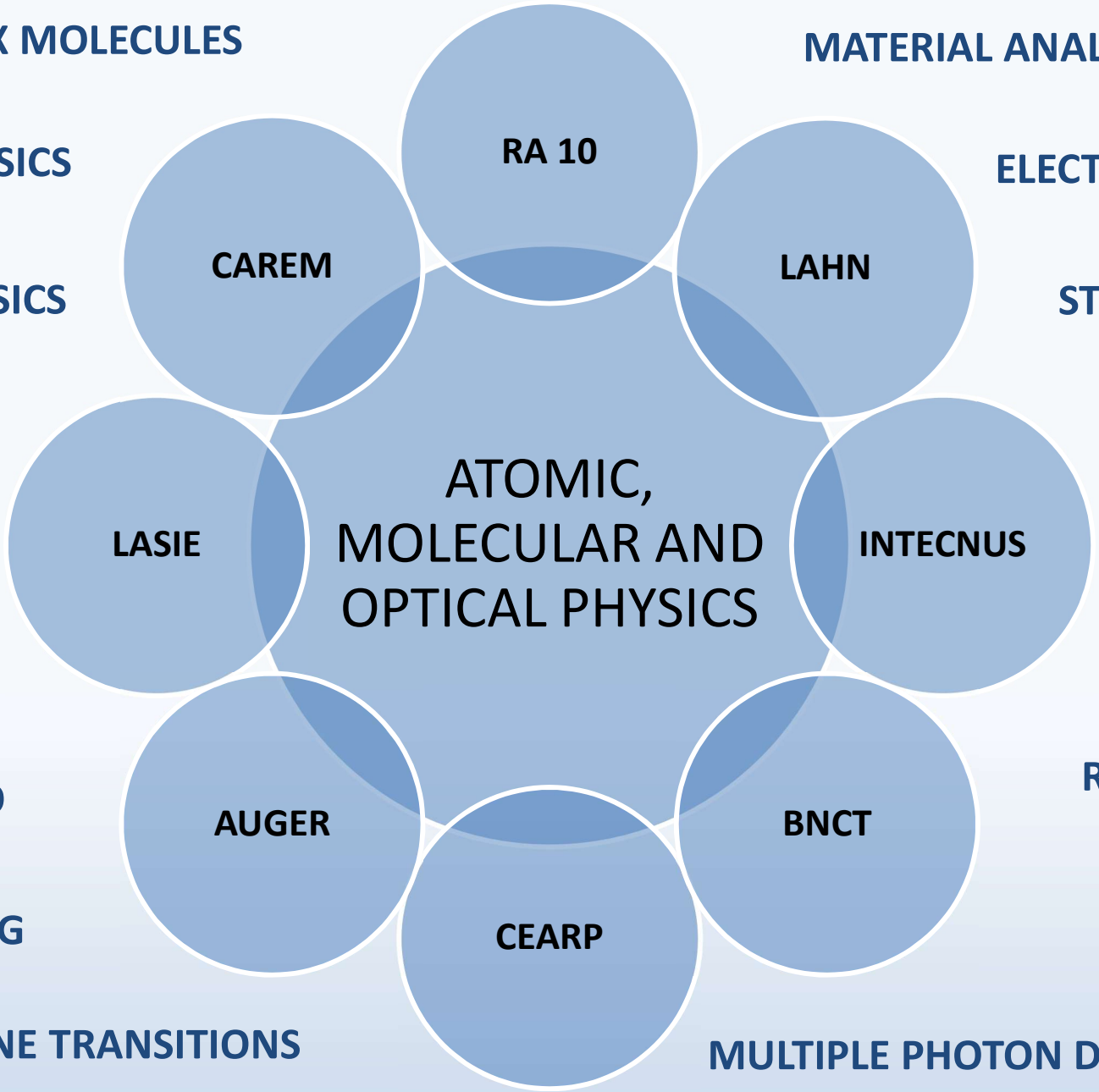
Document and citation trends:

139 Documents | Cited by 1371 documents | 170 co-authors | Topics

A DRIVING FORCE FOR AMO PHYSICS



A DRIVING FORCE FOR AMO PHYSICS



COMPLEX MOLECULES

SURFACE PHYSICS

POSITRON PHYSICS

IONIZATION

LASERS

CASCADES

MONTE CARLO

SPUTTERING

HYPERFINE TRANSITIONS

MATERIAL ANALYSIS

ELECTRON CAPTURE

STOPPING POWER

TRAPPING

RAMAN

FLUORESCENCE

RADIOBIOLOGY

ACELERATORS

MULTIPLE PHOTON DISSOCIATION

COMISIÓN NACIONAL DE ENERGÍA ATÓMICA
ARGENTINA

Dinamo

DATOS Y CÓDIGOS INFORMÁTICOS
NUCLEARES, ATÓMICOS, MOLECULARES Y ÓPTICOS

COMISIÓN NACIONAL DE ENERGÍA ATÓMICA
ARGENTINA

Dinamo

DATOS Y CÓDIGOS INFORMÁTICOS NUCLEARES, ATÓMICOS, MOLECULARES Y ÓPTICOS

- Provide fundamental NAMO data for CNEA's nuclear and non-nuclear science and technological projects.
- Coordinate the generation, collection and critical assessment of the required data by NAMO groups in Argentina.

COMISIÓN NACIONAL DE ENERGÍA ATÓMICA
ARGENTINA

Dinamo

Datos y Códigos Informáticos Nucleares, Atómicos, Moleculares y Ópticos

• MCNP	Bariloche	4-8 November 2019
• PHITS	Buenos Aires	6-10 March 2020
• FLUKA		2nd Semester 2020
• PENELOPE		1st Semester 2021

NEA
Nuclear Energy Agency

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms

Volume 408, 1 October 2017, Pages 50-55

The IAEA stopping power database, following the trends in stopping power of ions in matter

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[b] Division of Physical and Chemical Sciences, International Atomic Energy Agency, Vienna, Austria

A B S T R A C T

The aim of this work is to present an overview of the state of art of the energy loss of ions in matter, based on the new developments in the stopping power database of the International Atomic Energy Agency (IAEA). This exhaustive collection of experimental data, graphs, programs and comparisons, is the legacy of Helmut Paul, who made it accessible to the global scientific community, and has been extensively employed in theoretical and experimental research during the last 25 years. The field of stopping power in matter is evolving, with new trends in materials of interest, including oxides, nitrides, polymers, and biological targets. Our goal is to identify areas of interest and emerging data needs to meet the requirements of a continuously developing user community.

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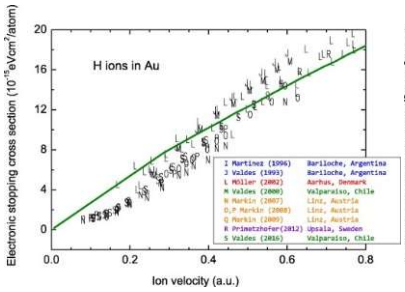

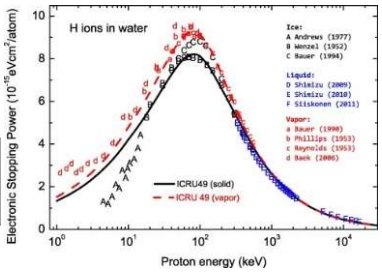

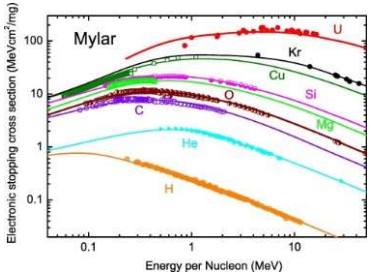

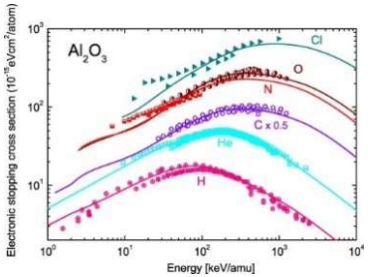

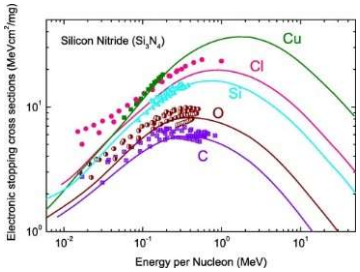

THERMAL SCATTERING FOR HEAVY WATER AT ROOM TEMPERATURE

PLADEMA INSTITUTE

PLAsma DEnsos MAgnetizados

EXPERIMENTAL TECHNIQUES

- Projectiles: H/D/T , He, Li beams.
- Targets: Atoms, Molecules, Surfaces
- Energies: ≈ 30 keV – 3 MeV

THEORETICAL TECHNIQUES

- CDW codes
- CTMC
- Generalized Sturmian Functions
- Time-Dependent Close-Coupling

THANK YOU FOR YOUR ATTENTION