IPEN – Nuclear and Energy Research Institute
An important nuclear research institute in Brazil

Institution of the State of São Paulo

Supported and operated technical and administratively by the
Brazilian Nuclear Energy Commission (CNEN)
of the
Ministry of Science, Technology, Innovation and Communication

Associated to the University of São Paulo (Education)

A little of our history

The IEA R1 reactor was inaugurated on 25th January 1958 in the presence of the President of Brazil (Juscelino Kubitschek).

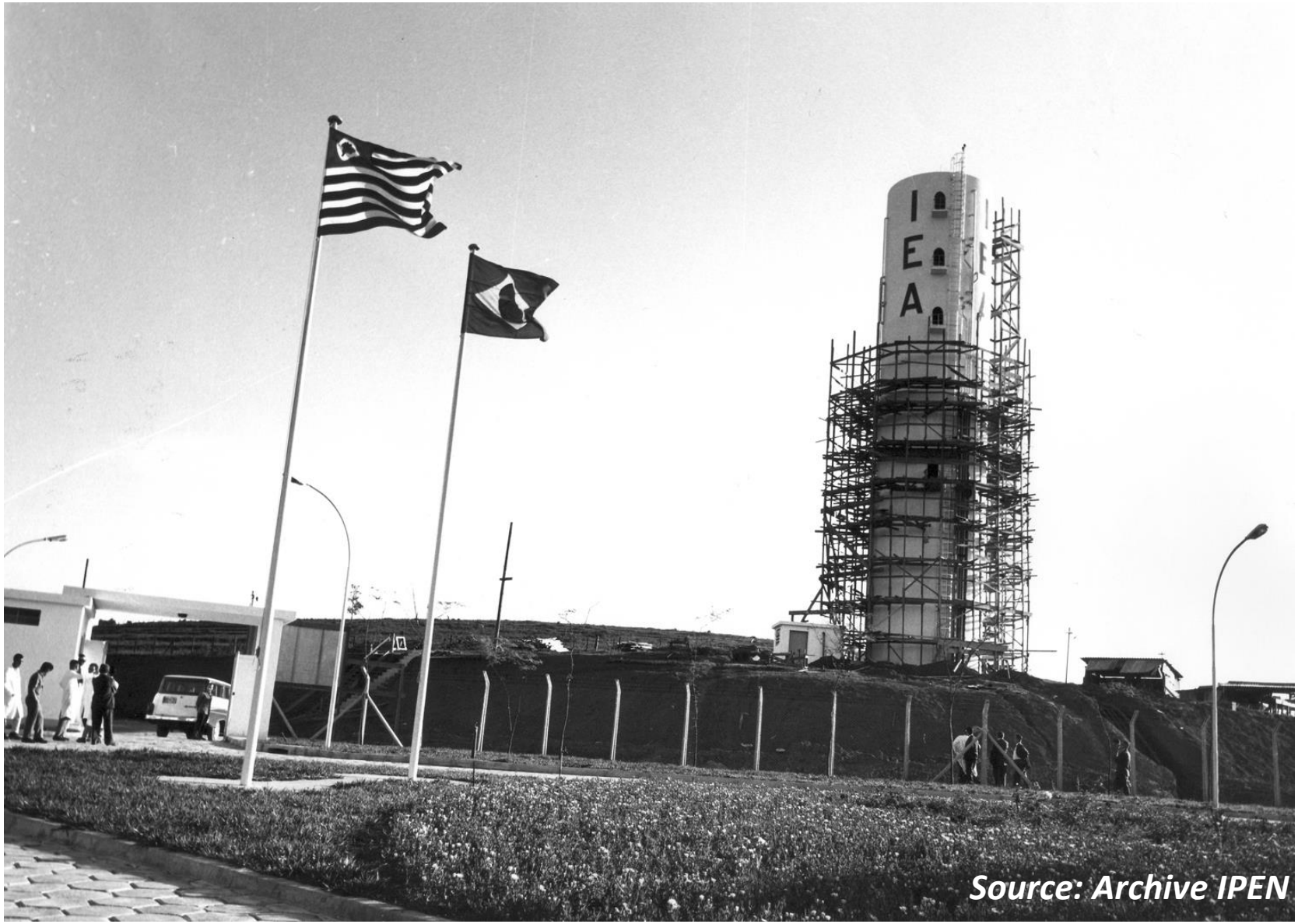
Source: O Globo

A little of our history

IPEN stablished its post-graduation program in Nuclear Science and Technology with USP-1976

A little of our history

New areas developed to dominate the technology on the Fuel Cycle



Aerial View of IPEN today

IPEN - Nuclear and Energy Research Institute

GOVERNO DO ESTADO DE SÃO PAULO

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÕES

Photo : Marcello Vitorino

MISSION

"Our commitment is to improve the quality of life of the Brazilian population, producing scientific knowledge, developing technologies, generating products and services in a safe way and training human resources in the nuclear and related areas."

Research – Services – Production - Education

Research Centers (11)

Radiopharmacy

Radiation Technology

Nuclear Fuel Production

Radioprotection

Nuclear Engineering

Radiation Metrology

Research Reator

Fuel Cells & Hydrogen

Radioactive waste

Lasers & Applications

Chemistry & Environment

Science & Technology of Materials

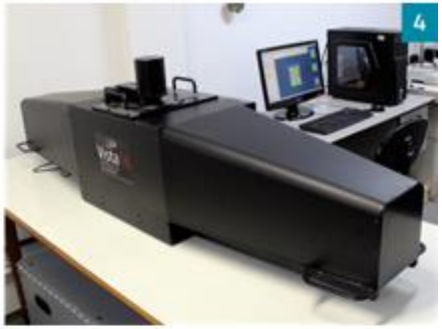
Biotecnology

Infrastructure (highlights)

Cyclone 18 - 18Mev cyclotron particle accelerator

37 PBq ^{60}Co Multipurpose irradiator

1.5 Mev electron accelerator and 65mA beam



Optical computerized tomography used in 3D radiotherapy dosimetry

Cyclone 30 - 30 Mev particle accelerator

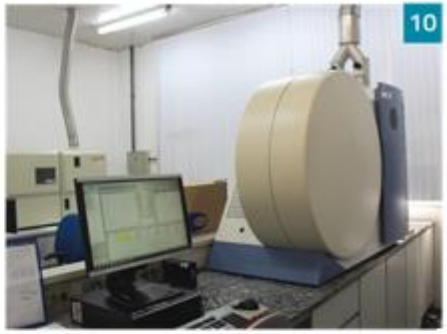
1.5 Mev electron accelerator and 25mA beam

Differential electrochemical mass spectroscopy for fuel cell testing

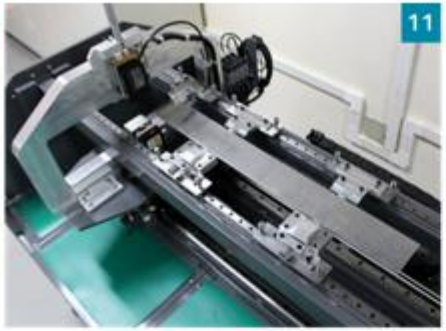
IPEN/MB-01 100w critical nuclear reactor

Infrastructure (highlights)

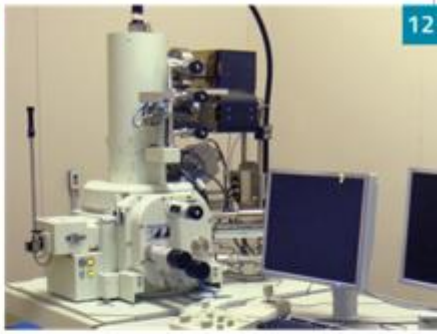
Animal facility (Bioterium)



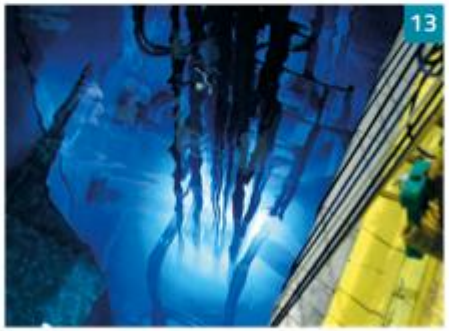
Argon plasma optical emission spectrometry (ICP-OES)



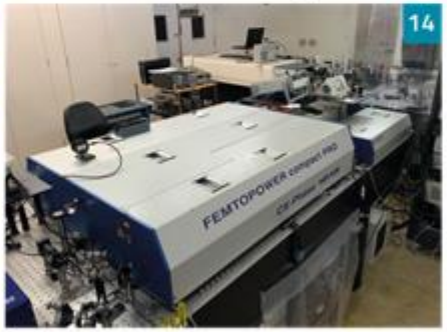
Automatic machine for measuring combustible plates by laser triangulation



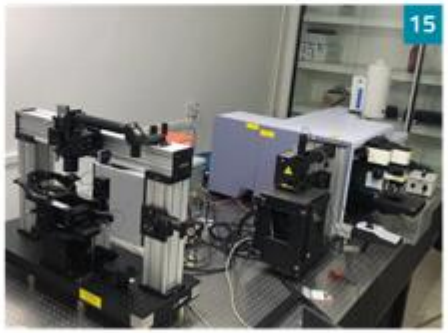
Scanning electron microscope with field emission gun (SEM-FEG)



5 MW IEA-R1 Research Nuclear Reactor



1/2 TW peak power laser



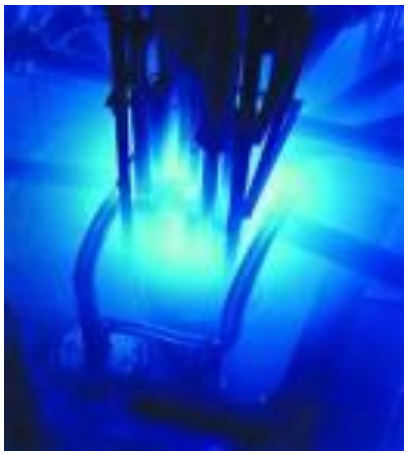
SNOM – Scanning Near-field Optical Microscopy

IPEN IEA-R1 research reactor

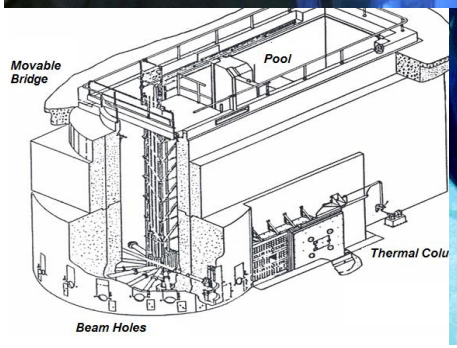
The Nuclear Reactor IEA-R1 operates since 1957 (officially inaugurated in 1958) for research and radionuclides production, mainly for nuclear medicine.

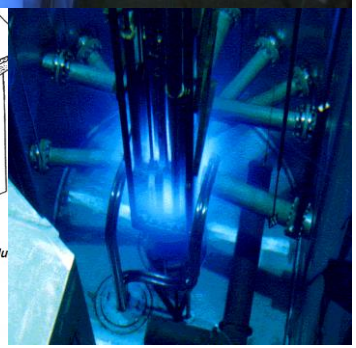
The uses for research are nuclear physics, neutron activation, radiochemistry, etc,

Training for reactor operation.



IPEN IEA-R1 research reactor





Main characteristics

- ***Constructor: Babcok-Wilcox***
- ***First criticality: September 16th, 1957***
- ***Type: open pool type reactor***
- ***Moderator and coolant: light water***
- ***Nominal power: 5 MW***
- ***Thermal flux: 1 x 10^{14} n cm^{-2} s^{-1}***
- ***Fast flux: 1.3 x 10^{13} n cm^{-2} s^{-1}***
- ***8 radial and 2 tangential beam holes;***
- ***Operating cycle: 9h per day, 3 days per week***

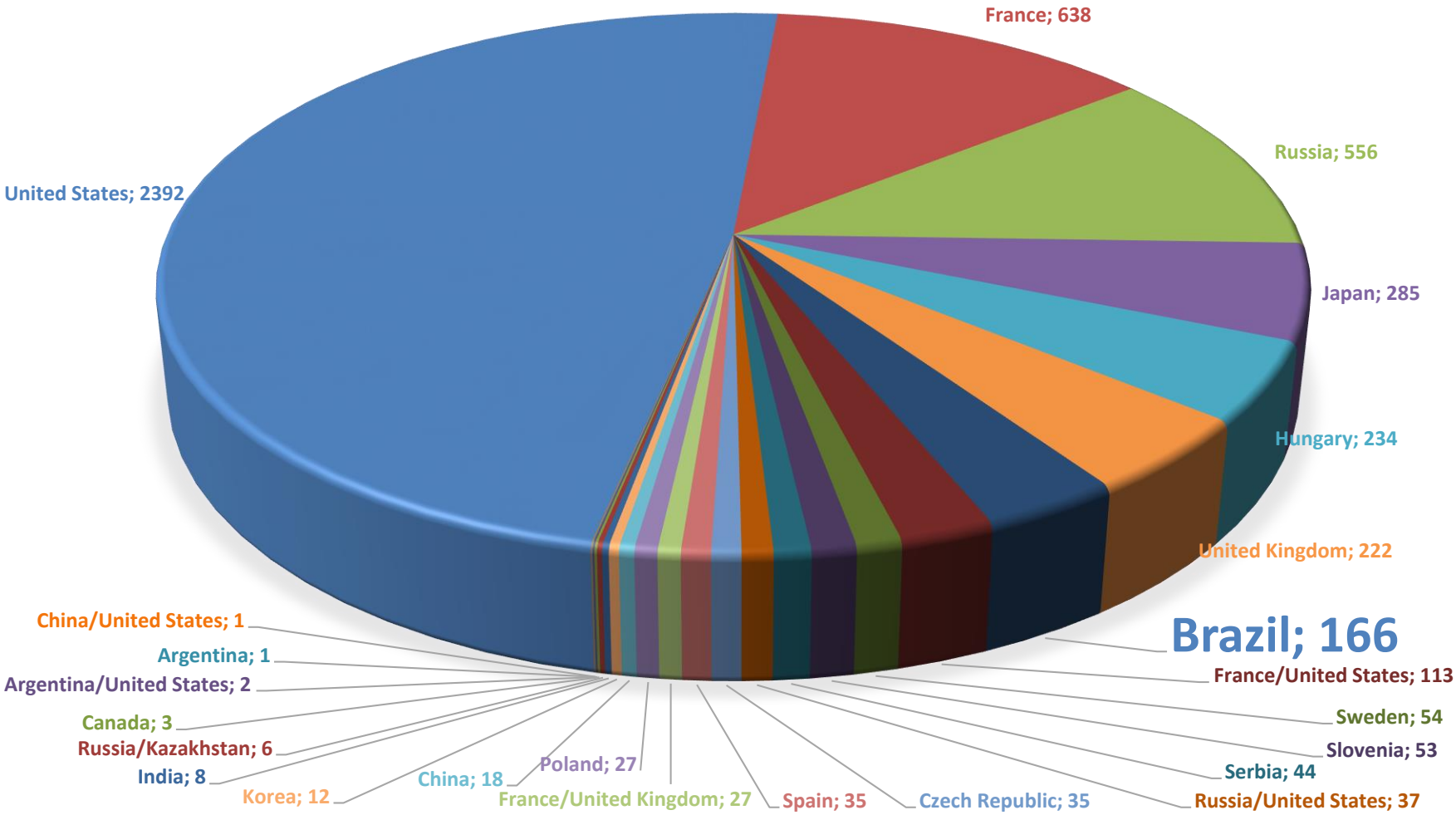
IPEN/MB-01 research reactor

IPEN/MB-01 reactor,
100 W critical facility
(Built by Ipen with the collaboration of the Brazilian Navy – first criticality in 1988)

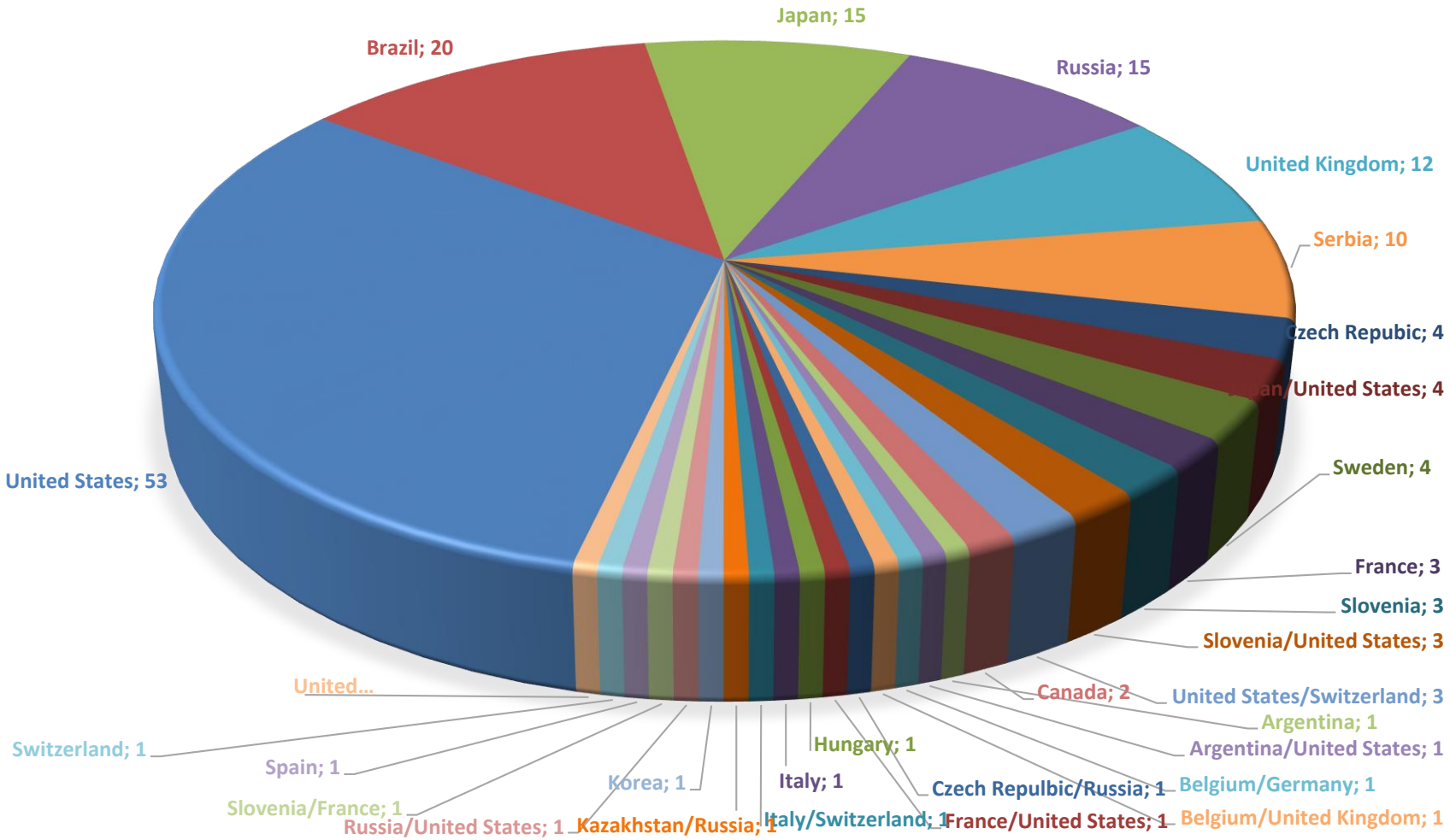
- Nuclear fuel performance and irradiation damage studies.
- Thermal hydraulic, structural and risk analysis.
- Ageing management of mechanical components.
- Probabilistic safety assessment.

Contribution by Country

International Criticality Safety Benchmark Experiments - ICSBEP Configurations



Contribution by Country
International Reactor Physics Experiments-IRPhEP
Experimental Series



Nuclear Fuel

Since 1987, IPEN has been manufacturing the fuel for the research reactors

In last years a new program to fabricate fuels with high uranium density has been started

Brazilian Multipurpose Reactor (RMB)

The new Reactor will provide Brazil with a key infrastructure to national development activities of the nuclear sector in the areas of social, strategic, industrial, scientific and technological development and application

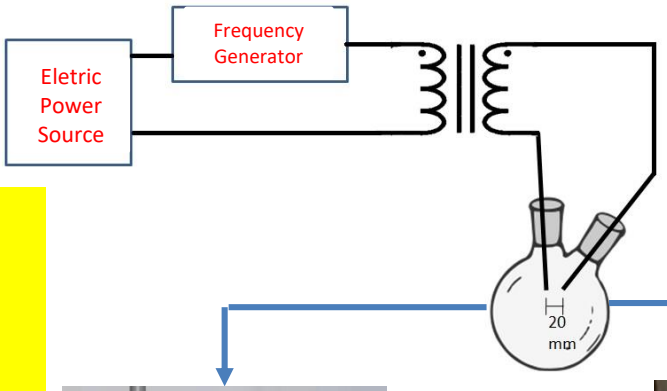
Main Functions:

- **Radioisotope Production for Medical/Industrial Applications**
- **Fuel and Materials Irradiation Testing**
- **Neutron Beam Laboratory**
- **Education and Training**

Important research being developed at IPEN

Advanced 2D Materials obtained by low-cost cold plasma methods

- Fast, simple, clean and scalable simple method for producing 2D materials Includes
- Bottom-Up and Top-Down strategies
- Synthesis of materials in solid, liquid or gas phase



materialstoday ADVANCES
Volume 12, December 2021, 100181

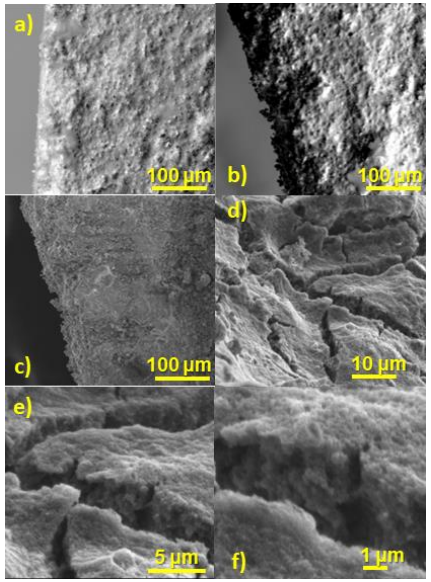
Facile, clean and rapid exfoliation of boron-nitride using a non-thermal plasma process

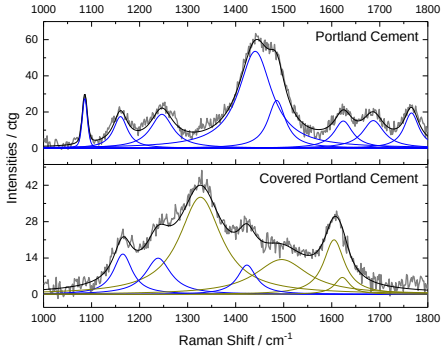
Rodrigo F.B. de Souza, Victoria A. Maia, Priscilla J. Zambiazzi, Larissa Otubo, Dolores R.R. Lazar, Almir O. Neto

Synthesis of high purity graphene by botton-up process

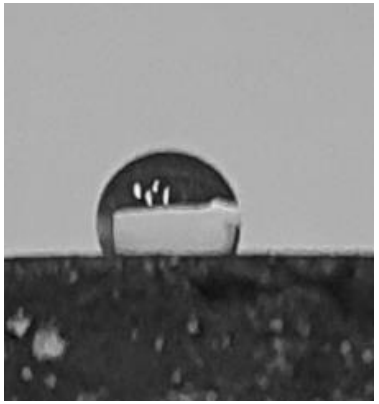
Synthesis of Boron Nitride Nanosheets by dry top-down process

Hydrophobic Graphenoid Layer on Portland Cement for Non-Thermal Plasma Method

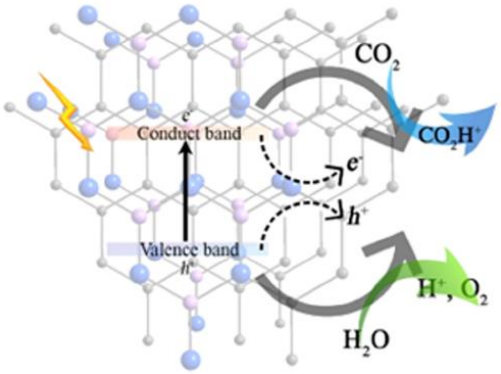




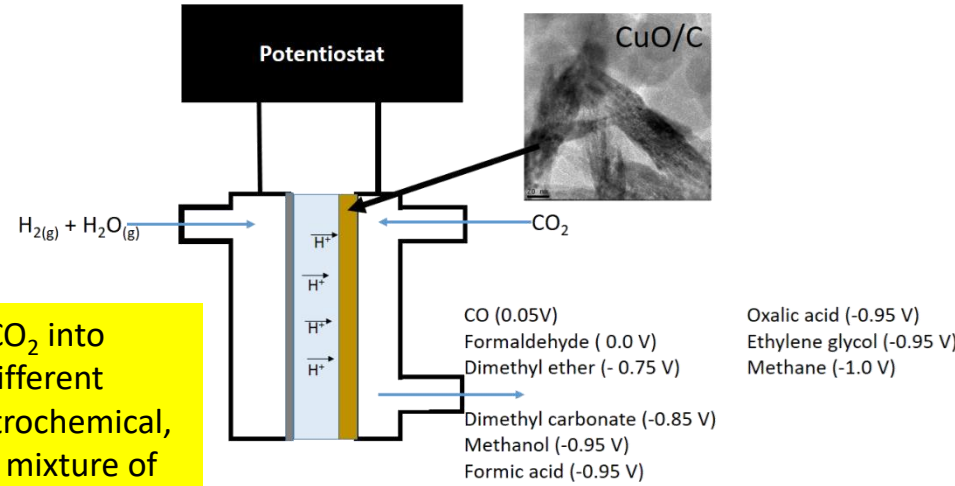
- Hydrophobic coating on ready-made surfaces
- Prevents infiltration
- No need for paints or polymers
- deep application of graphenoid directly into concrete



CO_2 into Products



Transformation of CO_2 into products through different routes such as electrochemical, photochemical or a mixture of both



Applied Materials Today 29 (2022) 101605

Contents lists available at ScienceDirect

Applied Materials Today

journal homepage: www.elsevier.com/locate/apmt

Layered graphene/hexagonal boron nitride nanosheets (Gr/*h*-BNNs) applied to the CO_2 photoconversion into methanol

Paulo V.R. Gomes [a], Nathalia F.B. Azeredo [a], Luis M.S. Garcia [a], Priscilla J. Zambiazi [a], Giovanni R. Morselli [b], Rômulo A. Ando [b], Larissa Otubo [a], Dolores R.R. Lazar [a], Rodrigo F.B. de Souza [a], Debora F. Rodrigues [c], Almir O. Neto [a,*]

[a] Instituto de Pesquisas Energéticas e Nucleares, Av. Prof. Lineu Prestes 2242, São Paulo CEP 05508-000, Brasil
[b] Laboratório de Espectroscopia Molecular, Departamento de Química Fundamental, Instituto de Química, Universidade Estadual de São Paulo – USP, Av. Prof. Lineu Prestes, 740, São Paulo CEP 05508-000, Brasil
[c] Department of Civil and Environmental Engineering, University of Houston, TX 77204-4003, United States

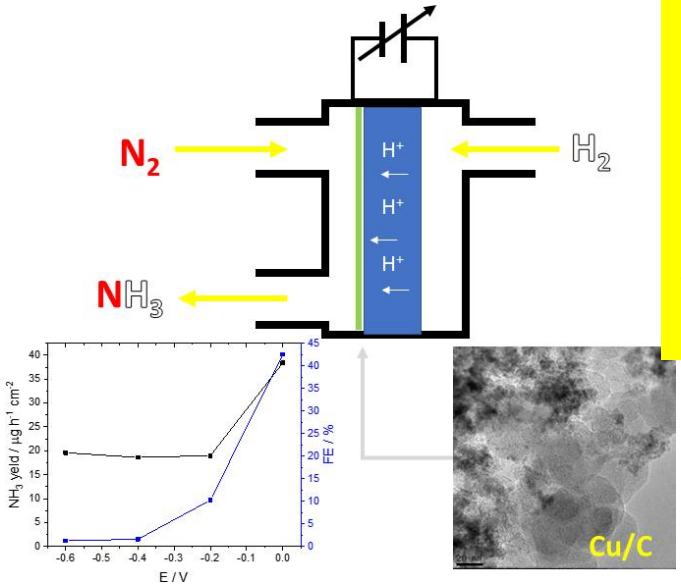
International Journal of Hydrogen Energy

Volume 47, Issue 6, 19 January 2022, Pages 4010-4017

CO_2 reduction on Cu/C used as a cathode in a polymeric electrolyte reactor - Fuel cell type

Mariana Lima, Camila M. Godoi, Monique C.L. Santos, Julio Nandenha, Almir O. Neto, Rodrigo F.B. De Souza

Electrification of Ammonia Synthesis



Obtaining ammonia electrochemically using a polymer electrolyte, making it possible to obtain the gas without salt contamination and with higher energy efficiency than the traditional Habber-Bosh.

Electrochemistry Communications 146 (2023) 107421

Contents lists available at ScienceDirect

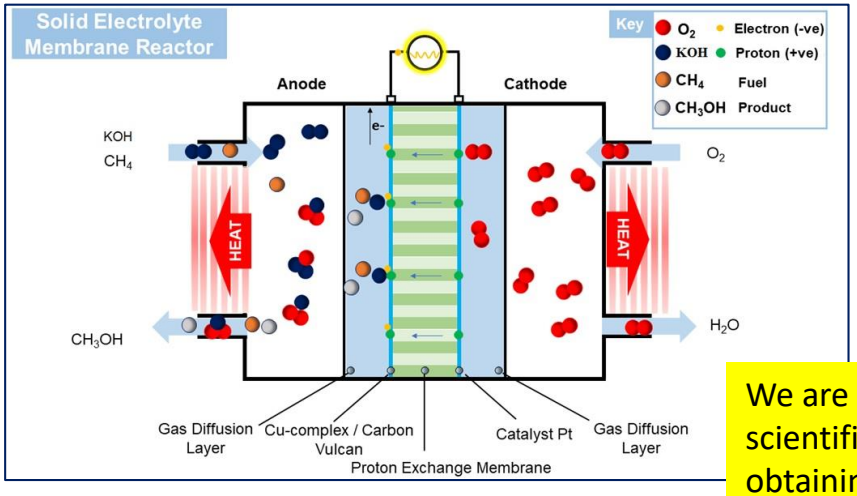
Electrochemistry Communications

journal homepage: www.elsevier.com/locate/elecom

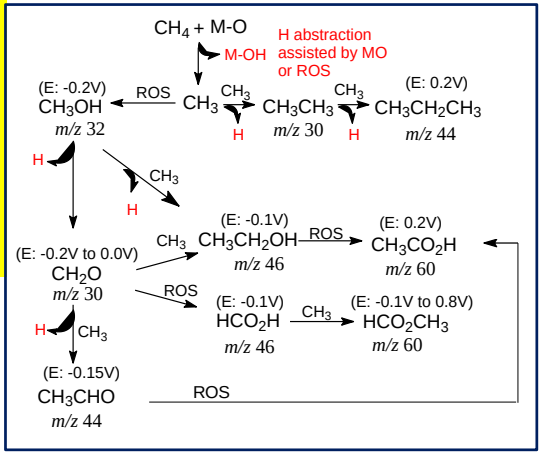
Conversion of nitrogen to ammonia using a Cu/C electrocatalyst in a polymeric electrolyte reactor

Victoria A. Maia [a], Camila M.G. Santos [a], Nathália F.B. Azeredo [a], Priscilla J. Zambiazi [a], Ermete Antolini [b], Almir O. Neto [a,*], Rodrigo F.B. de Souza [a]

Methane in Chemical Inputs



We are currently at the scientific frontier in obtaining liquid hydrocarbons from methane electrochemically at mild conditions.



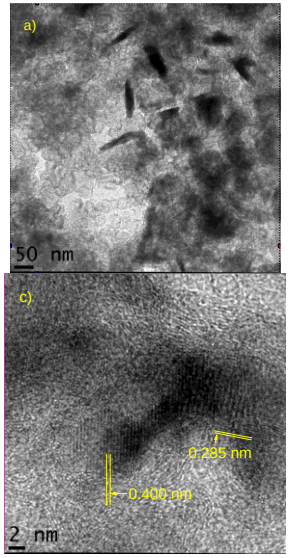
catalysts
MDPI

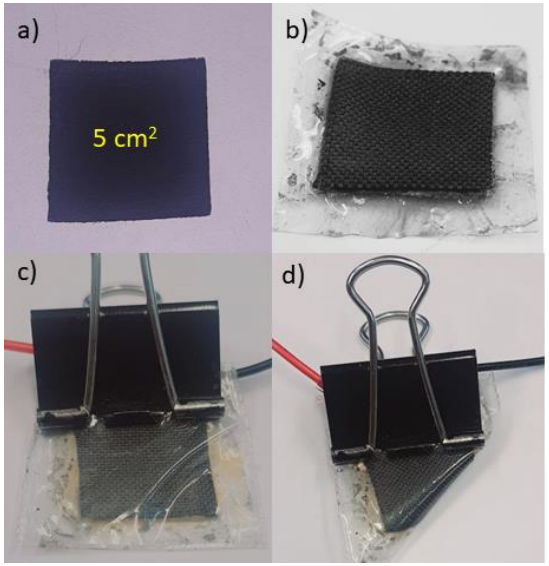
Review

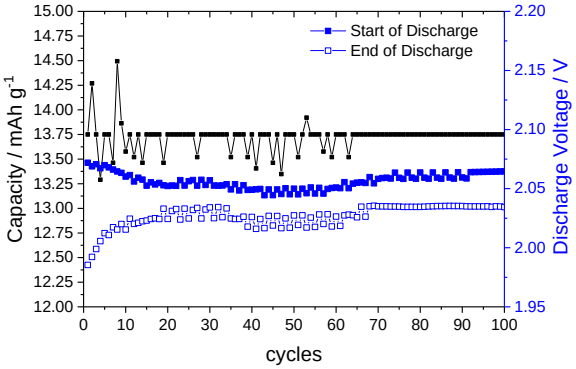
Partial Methane Oxidation in Fuel Cell-Type Reactors for Co-Generation of Energy and Chemicals: A Short Review

Rodrigo F. B. de Souza [1], Daniel Z. Florio [2], Ermete Antolini [3] and Almir O. Neto [1,*]

Innovative Lead-Carbon Battery Utilizing Electrode-Electrolyte Assembly Inspired by PEM-FC Architecture







Using Pb/C nanostructured on fuel cell architecture we construct a flexible, light and very stable lead acid battery

IAEA Technical Cooperation Projects

Ionizing radiation applied for reducing plastic and microplastics pollution: standardization of methods for detection, characterization and treatment demonstration in situ
Sustainable and residue-free nuclear fuel fabrication for research reactors in Brazil
Strengthening industrial gamma tomography technology to characterize Brazilian reservoir rocks and quality control of refining towers and pipes for enhancement of oil production.
Development of radioisotope and radiopharmaceutical Ac225-PSMA for applicability in the treatment of prostate cancer

IAEA Technical Cooperation Projects

Development of mobile unit using an electron beam accelerator for treatment of effluent from petroleum industry and degradation of toxic organic compounds in wastewater for reuse in industrial processes and cleaning purposes
Improving of Brachytherapy Production Quality for Cancer Treatment in Brazil
Project RLA1020 (ARCAL CLXXIX) - Promoting Radiation Technology in Natural and Synthetic Polymers for the Development of New Products, with Emphasis on Waste Recovery
Projeto Arcal RLA 2020016 "Implementación del proceso de irradiación de frutas frescas y secas com fines cuarentenários. Cooperation with Argentina

IAEA Technical Cooperation Projects

Programme: Coordination Research Projects - CRP

Enhancing the Beneficial Effects of Radiation Processing in Nanotechnology
Development of Radiation-Grafted Membranes for Cleaner and Sustainable Energy
Radiation based technologies for treatment of emerging organic pollutants
Determination of Lethal and Sterilizing Doses of gamma radiation for all life cycle stages of Plutella xylostellaa (Linnaeus, 1758) (Lepidoptera:Plutellidae) diamondback moth for phytosanitary treatment
Radiation Processing For Preservation of Cultural Heritage Objects
Radiation Effect on Polymer Materials Commonly Used in Medical Devices

Recent meeting organized by IPEN-CNEN with the support of IAEA

Course organized by IPEN-CNEN with support of IAEA)

Photo : E. R. Paiva

Products and Services

Production of Radioisotopes and Radiopharmaceuticals






Function: Products and Services

Production of Fuel Elements for Research Reactors

Function: Products and Services

Provision of Technological Services

- ✓ **Characterization, treatment and storage of radioactive waste**
- ✓ **Risk analysis of nuclear facilities**
- ✓ **Radioprotection training**
- ✓ **Shielding calculation**
- ✓ **Radiologic Emergency Care**
- ✓ **Inspection of Fuel Elements**

Function: Teaching

Function: Teaching

Postgraduate program in Nuclear Technology

Started in 1976
Concept 6
CAPES Assessment

Degrees: End of 2021
Doctorate - 1,052
Master's - 2,094
TOTAL - 3,146

IPEN was contemplated with the award of Best Thesis of 2014 in Engineering (Area II)
Source: Archive IPEN

Function: Teaching

Professional Masters in Radiation Technology in Health Sciences

Photos : E. R. Paiva

Stricto sensu
Started in 2019
2022: Fourth class

Function: Teaching

Number of enrolled students

Year	2016	2017	2018	2019	2020	2021
NT	418	441	460	430	428	424
MP	-	-	-	26	55	76
TOTAL	418	441	460	456	483	500

Marie Sklodwska-Curie Scholarship Program

Master student granted

Lilian Ninoska Braguin (2020)
Art: Katia Itioka

Ana Gabryele Moreira (2021)
Art: Katia Itioka

Stephanie Rodrigues Pavão (2022)
Art: Katia Itioka

Monise Vasconcelos Andrade (2023)
Art: Katia Itioka

Function: Research and Development

International Collaborations

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

BEA
Battelle Energy Alliance

INL
Idaho National Laboratory

Fraunhofer
FEP

ULL
Universidad de La Laguna

DLR
Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

UR | UNIVERSITÉ DE LA RÉUNION

UNIVERSITY of HOUSTON

NATIONAL RESEARCH NUCLEAR UNIVERSITY • MOSCOW ENGINEERING PHYSICS INSTITUTE • MEPhI

UNIVERSITY OF Nebraska Lincoln

UNIVERSIDAD NACIONAL DE CAAGUAZÚ
Coronel Oviedo
PARAGUAY
ARANDU POTY REKAVO
2007

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instituto de pesquisas
energéticas e nucleares

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Thank you

Спасибо

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