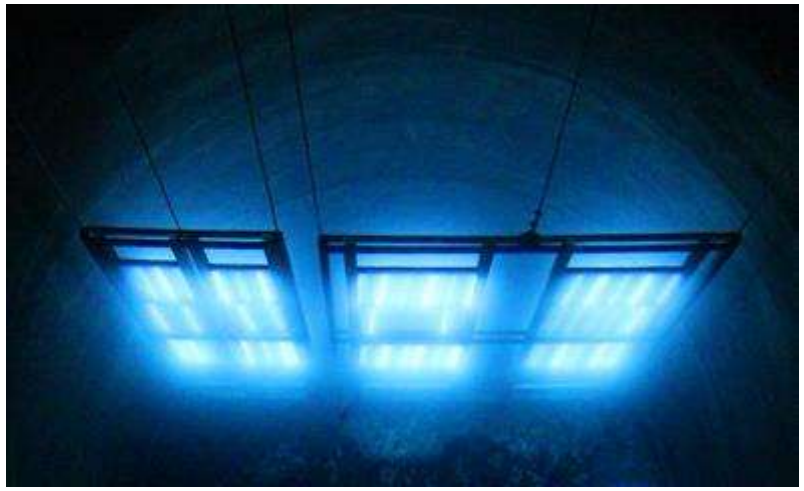
CRP: F22082

Development and Implementation of Cultural Heritage Preservation using Ionizing Radiation Technology





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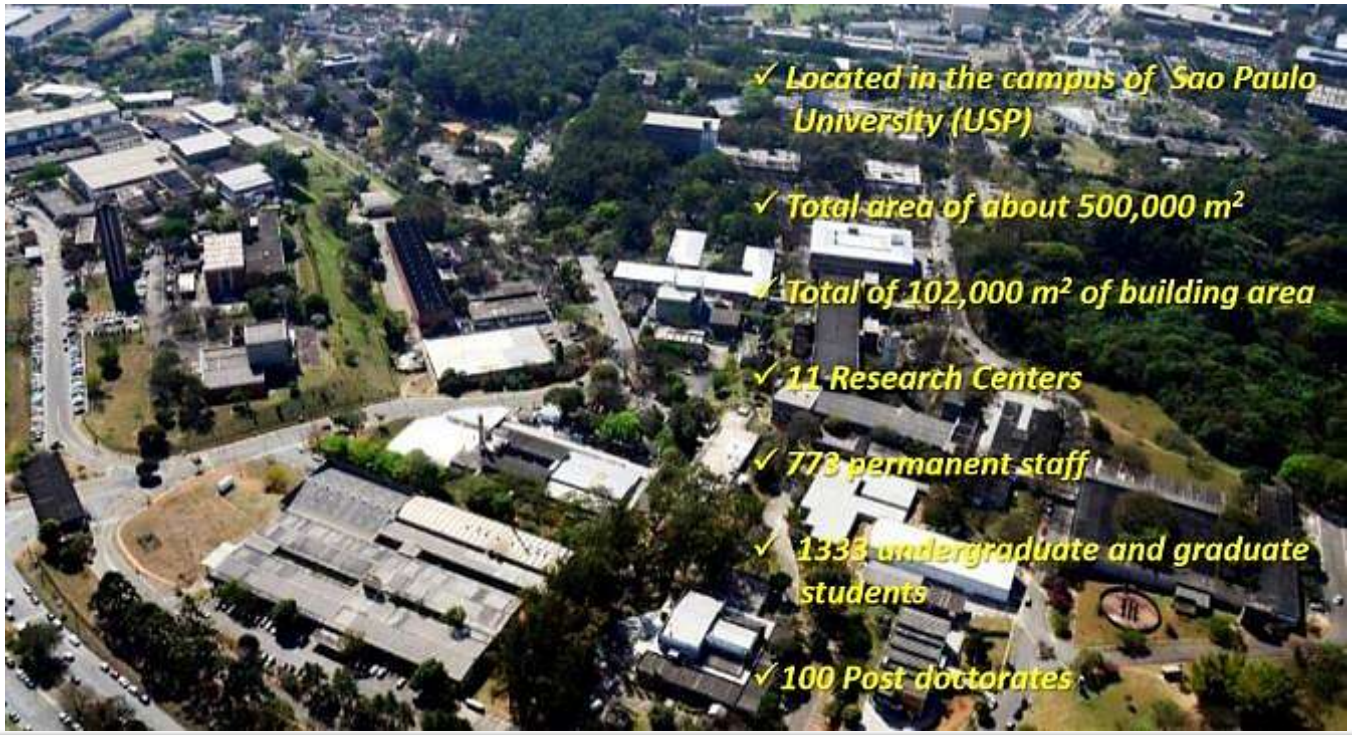
Ministry of Science and Technology

National Nuclear Energy Commission CNEN



ipen ⟷ USP UNIVERSITY OF SÃO PAULO

Brazilian weather conditions + tangible materials

Natural disasters

Insects

Fungi attack

Ionizing Radiation to Support Conservation and Preservation of Tangible Cultural Heritage (CH)

1. Disinfection by ionizing radiation

Gamma rays /Electron Beam-EB / X-rays

Insect & microorganisms (fungi) biocidal action

2. Consolidation by ionizing radiation

Impregnation of Porous Material with resins

– polymerization – cross linking – radio curing

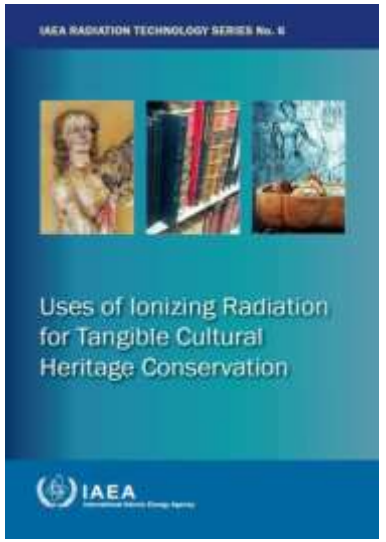
3. Developing of new nanostructured materials for cleaning surfaces of CH by ionizing radiation

R&D, natural polymers, blends

Background

Previous CRP:

F23032 "**Developing Radiation Treatment Methodologies and New Resin Formulations for Consolidation and Preservation of Archived Materials and Cultural Heritage Artefact**" (2015-2021)



- **20 participating institutions** (14 increasing to 20)
- **Increased use of radiation technologies** for conservation and consolidation in MS
- **77 publications** and theses
- **2 Books** (based on protocols and DB)
- 3 Research Coordinating Meetings (RCM) and 2 Technical Meetings (TM)
- 2 Side Events during General Conference (GC)
- **Increased number of TC Projects and expert supports**
- 1 new CC (NCRRT, Egypt) designated

Background

Previous CRP remarks & recommendations

- **New tangible materials** (e.g. taxidermic specimens, botanic collections) need to be studied in the future.
- **Protocols and guidelines** for preparation of materials before and after processing (e.g. **storage conditions)** should be developed and **addressed to the conservators/curators**.
- **IAEA support** for coordination works in the area of Cultural Heritage preservation across the world, in order to expand the possibilities of applications of radiation technologies

Wider acceptance and use of radiation processing techniques for conservation and consolidation of Cultural Heritage Artefacts.

New CRP
F22082

Extending the outreach of the radiation technology to **end-users and conservators** and to improve the inter-institutional collaborations

New CRP F22082 : Development and Implementation of Cultural Heritage Preservation using Ionizing Radiation Technology

IAEA Project Officers: Mr Bum Soo Han, Ms Celina Horak
Radiochemistry and Radiation Technology Section

Overall Objective

Extending the outreach and use of **radiation technology** to preserve cultural heritage for **end-users and conservators** improving inter-institutional collaborations by developing of **good practice procedures**

New CRP F22082 : Development and Implementation of Cultural Heritage Preservation using Ionizing Radiation Technology

Specific Research Objectives

1) Research on **effect of irradiation on the functional properties** of different materials (textiles, ceramic, dyes, silk, etc.).
2) **Inter-laboratory collaboration** of results obtained in the radiation treatments of cultural heritage artefacts using different techniques and numerical simulation
3) **Establishing of appropriate procedures** for irradiation of cultural heritage artefacts to predict dose uniformity during the irradiation process
4) **Developing of new materials** with enhanced compatibility with cultural heritage artefacts to consolidation considering the ethics on conservation

Examples of Cultural Heritage Artefacts Considered in CRP

Archives Disinfection



Insect eradication in sculptures, instruments, furniture





Consolidation and Restoration of wood





Fungal Decontamination of Paintings, textiles etc

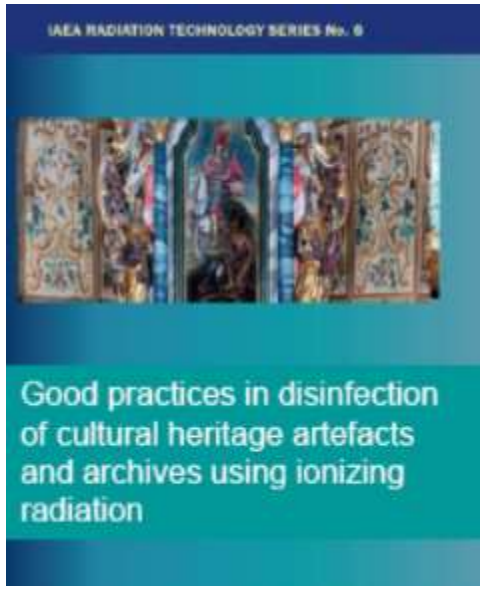


New CRP F22082 : Development and Implementation of Cultural Heritage Preservation using Ionizing Radiation Technology

Development and improvement of **good practice procedures** using ionizing radiation.

- Protocols / Guidelines of **procedures and technical requirements** including optimal radiation doses and practical examples for the radiation treatment of CH objects:

  publication ongoing - IAEA Technology Series

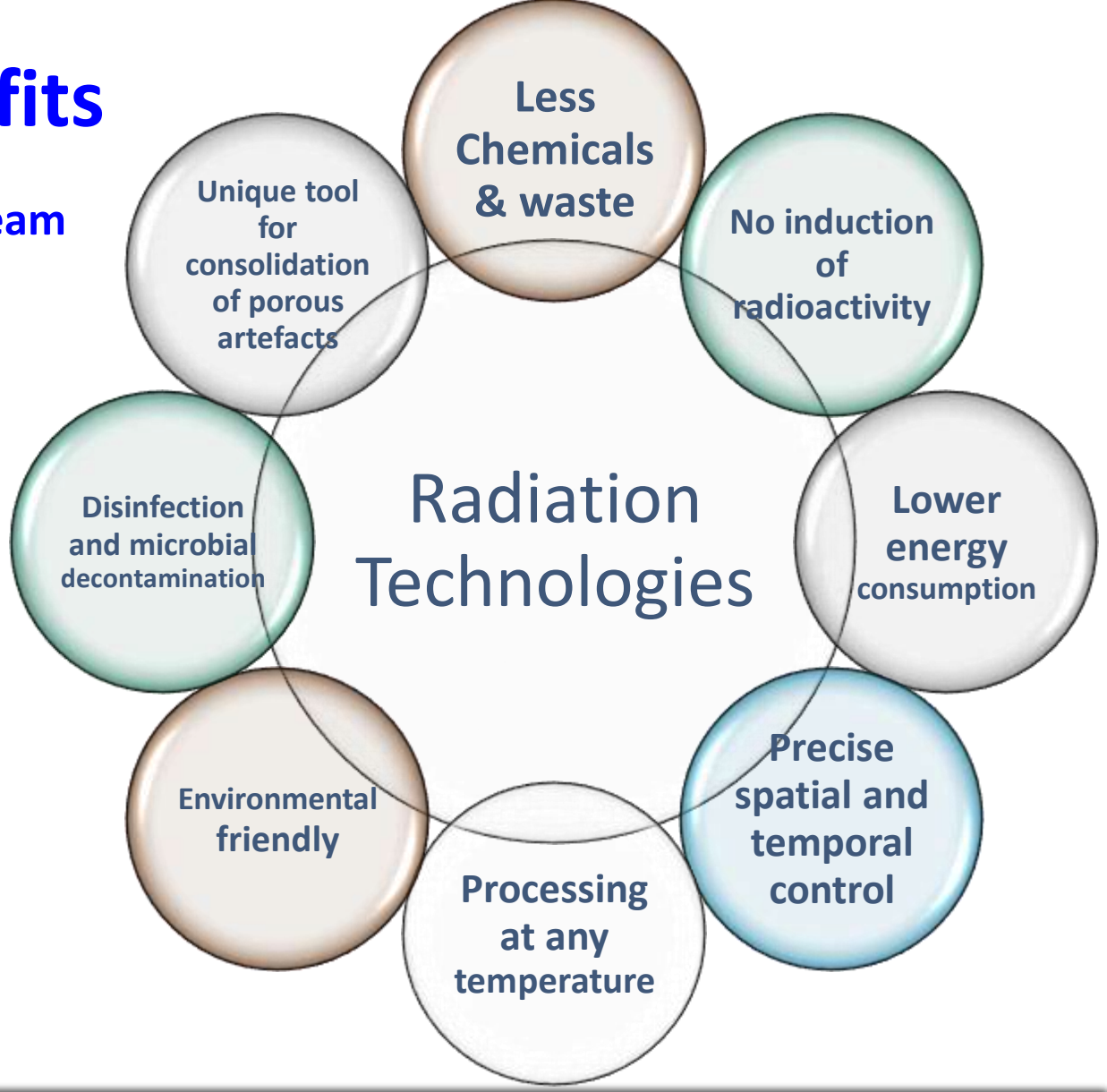


Benefits to Member States

1) Creating **national and regional competence** in preservation of cultural heritage by use of radiation technology.
2) Participation in **international cooperation network**, opportunities for training, staff exchange, future collaboration, and joint applications.
3) Opportunity of **technology transfer** between MSs in very innovative fields.
4) Creating basis for future national & regional **TC projects** to address specific needs in preservation of cultural heritage.
5) **"Custom-made" solutions** for consolidation of porous artefacts and microbial decontamination by ionizing radiation.

Radiation technologies benefits

Ionizing radiation as **gamma rays, X rays, and electron beam** used for preservation and consolidation processes for cultural heritage artefacts



Planned Activities

Mr Bum Soo Han / IAEA

ACTIVITY	2022	2023	2024	2025	2026	2027
Accepting and Evaluating Proposal from MSs	□□					
Selecting participants and award contracts and agreements		□				
Organizing the first RCM (Cairo – Egypt May 2023		■				
Investigation on key factors for effect of irradiation on the functional properties of different materials		□□	□□□□			
Networking of collaboration in inter-laboratories		□□	□□□□	□□		
Scientific Forum during GC			■			
Organizing the second RCM			■			
Establishment of appropriate procedures for irradiation of artefacts (dose mapping, dose limit ratio, simulation)			□□	□□□□	□□□□	
Extend the outreach of the radiation technology to end-users and conservators				□□□□	□□□□	
Organizing the third RCM					■	
Evaluation of the CRP and submitting report						■
Publication(s)					□□□□	□□□□

Duration, Budget and MSs participation

- **Potential participating countries**

Algeria, Argentina, Austria, Azerbaijan, Bangladesh, Brazil, Bulgaria, Cambodia, China, Cuba,Egypt, France, Greece, Hungary, India, Indonesia, Iran - Islamic Republic of, Italy, Japan, Korea - Republic of, Malaysia, Mexico, Morocco, Netherlands, Oman, Philippines, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Sri Lanka, Syrian Arab Republic, Thailand, Tunisia, Türkiye, Ukraine, United Kingdom, United States of America, Viet Nam

- **Link to TC Projects:**

EGY1027 - Applying nuclear techniques for the consolidation and preservation of archived materials and cultural heritage artefacts

KAM1002 - Conserving and Preserving Cultural Heritage

RAS1021 - Harnessing Nuclear Science and Technology for the Preservation and Conservation of Cultural Heritage

RAS1027 - Improving the Utilization of Nuclear Techniques for Cultural Heritage Characterization, Consolidation, and Preservation

RER1021 - Enhancing the Use of Radiation Technologies in Industry and Environment

RLA1019 - Strengthening Capabilities for the Utilization of Nuclear and Radiation Technology to Characterize, Conserve and Preserve the Cultural Heritage

SYR1012 - Building National Capacity in the Protection, Conservation and Restoration of Historical Objects and Documents Using Radiation Processing of Monomers/Polymers

Participating Member States

Bangladesh	BGD 26718	Inst. of Food and Radiation Biology, Bangladesh Atomic Energy Commission
Brazil	BRA 26683	IPEN
Croatia	CRO 26656	Institute Ruder Boskovic
Cuba	CUB 26646	Centro de Aplicaciones Tecnologicas y Desarrollo Nuclear (CEADEN)
Egypt	EGY 26863	National Centre for Radiation Research and Technology (NCRRT)
	EGY 26680	Beni Suef University
France	FRA 26648	Atelier de Recherche et de Conservation ARC-Nucléart , France
Hungary	HUN 26671	Centre for Energy Research
Italy	ITA 26645	ENEA FSN
Japan	JPN 26651	Osaka Metropolitan University
Korea	ROK 26664	Advanced Radiation Technology Institute, KAERI
Poland	POL 26639	Institute of Nuclear Chemistry and Technology
Portugal	POR 26739	Centro de Ciencias e Tecnologias Nucleares, Instituto Superior Tecnico
Romania	ROM 26654	Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering
Thailand	THA 26653	Thailand Institute of Nuclear Technology
Tunisia	TUN 26636	Centre National des Sciences et Technologies Nucléaires (CNSTN)
Türkiye	TUR 26647	Turkish Energy, Nuclear and Material Research Agency (TENMAK)
Vietnam	VIE 26720	DaLat University

Mr Bum Soo Han
IAEA

First Research Coordination Meeting on

"Development and Implementation of Cultural Heritage Preservation Using Ionizing Radiation Technology"

08-12 May 2023

National Centre for Radiation Research and Technology (NCRRT)

Egyptian Atomic Energy Authority (EAEA)

Cairo, Egypt (EVT2104097)

Cooperative and Networking Activities among the Participating Laboratories

⊗ Consolidation

⊗ Side-effects

⊗ Machines

⊗ Microbiology

	Bangladesh	Brazil	Croatia	Cuba	Egypt D	Egypt H	France	Hungary	Italy	Japan	Korea	Poland	Portugal	Romania	Thailand	Tunisia
Bangladesh										⊗⊗	⊗⊗					
Brazil			⊗⊗ ⊗⊗	⊗			⊗⊗	⊗	⊗⊗ ⊗⊗			⊗		⊗⊗		
Croatia		⊗⊗ ⊗⊗					⊗⊗	⊗	⊗⊗ ⊗⊗		⊗	⊗	⊗	⊗⊗		
Cuba		⊗												⊗		
Egypt D							⊗		⊗	⊗⊗						
Egypt H							⊗									
France		⊗⊗	⊗⊗		⊗	⊗			⊗⊗		⊗				⊗	⊗
Hungary		⊗⊗	⊗				⊗⊗		⊗⊗			⊗	⊗⊗	⊗⊗		
Italy		⊗⊗ ⊗⊗	⊗⊗ ⊗⊗		⊗	⊗	⊗⊗	⊗		⊗		⊗		⊗⊗		
Japan	⊗⊗								⊗		⊗⊗					
Korea	⊗⊗									⊗⊗						
Poland		⊗	⊗					⊗	⊗				⊗ ⊗			
Portugal												⊗ ⊗		⊗		
Romania		⊗⊗	⊗⊗	⊗					⊗⊗				⊗			
Thailand	⊗	⊗					⊗			⊗	⊗					
Tunisia		⊗			⊗		⊗									
Türkiye													⊗			⊗
Vietnam		⊗			⊗		⊗			⊗⊗	⊗					

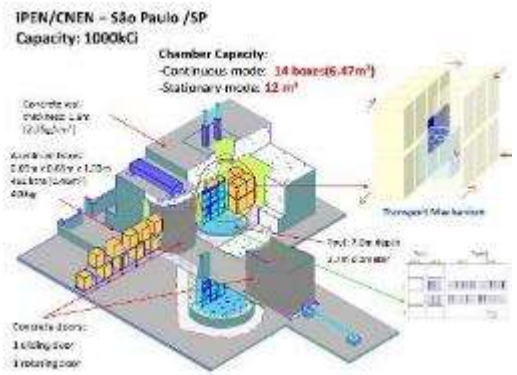
Experience on Preservation of Cultural Heritage objects using ionizing radiation at IPEN/Brazil

Summary

Research line for Preservation and Conservation of Cultural Heritage using Ionizing Radiation

CRP participating member

Multipurpose Gamma Irradiation Facility



Brazilian technology - 2004 :
1000kCi
Category IV (IAEA -SSG-8)

Gamma Irradiation **Cobalt-60**

E-Beam Accelerators

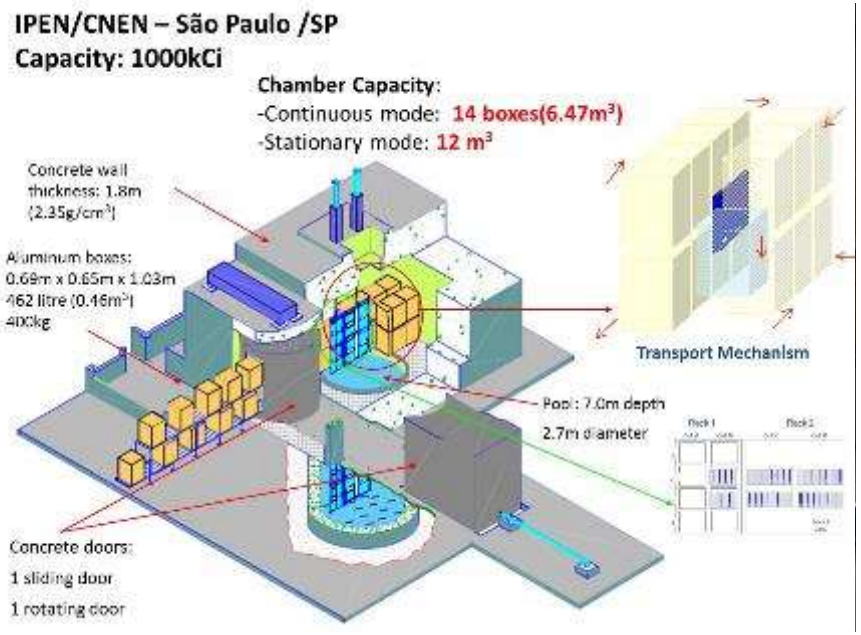
JOB 188 – 1,5 MeV 37.5kW
Radiation Dynamics, Inc. (RDI)
R&D

-Mobile Unit

JOB 307 - 97.5 kW, 1.5MeV
Continuous treatment system (300 m/min)
Commercial applications

0.7MeV-20kW

Gamma radiation processing as an alternative to disinfection of cultural heritage artifacts and archived materials



Multipurpose Gamma Irradiation Facility at IPEN

Brazilian technology - Capacity: 1000kCi - Category IV (IAEA –SSG-8)

- **Advantages:** safety, efficiency, reliability, capacity, process time and safe for environment.
- **Strong interaction program with conservation and preservation institutions** - diffusion of the irradiation technique – National and IAEA support
- **Since 2004**, more than **50,000 cultural artifacts** preserved by this technology.

Radiation Technology: the industrial revolution behind the scenes

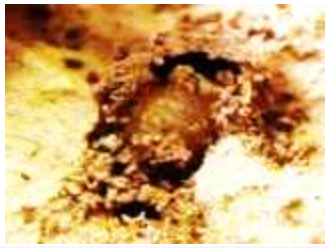
Disinfection: more than 50,000 cultural artifacts preserved by this technology













Disinfection: more than 50,000 cultural artifacts preserved by this technology







Disinfection: more than 50,000 cultural artifacts preserved by this technology

Before irradiation

Before irradiation+ cleaning

Several paintings disinfected by gamma radiation at IPEN.

Remarkable Modern Brazilian Paintings:

Tarsila do Amaral
Anita Malfatti
Di Cavalcanti
Clóvis Graciano
Candido Portinari
Alfredo Volpi
Tomie Ohtake

Disinfection: more than 50,000 cultural artifacts preserved by this technology

Disinfection: more than 50,000 cultural artifacts preserved by this technology



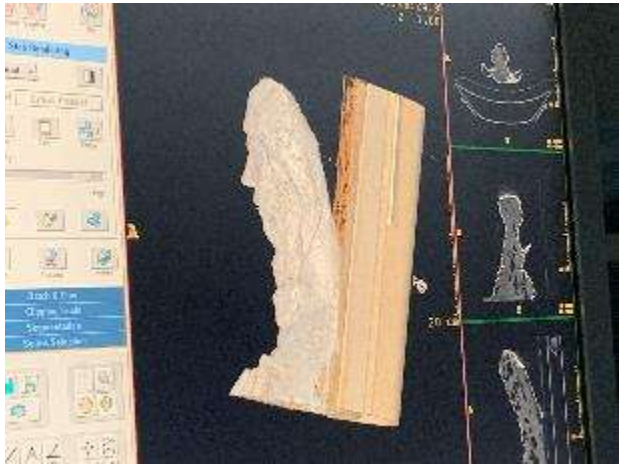


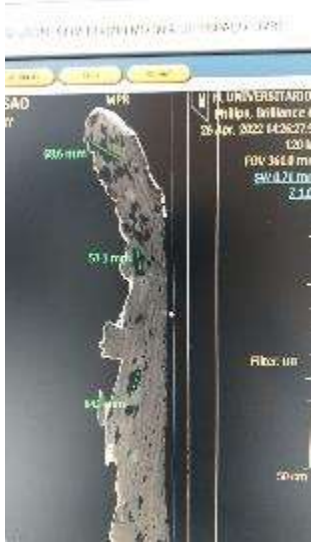


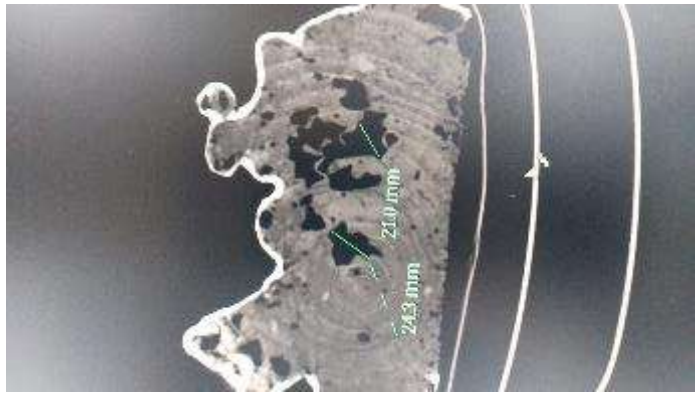

In 2022 was performed at IPEN the first impregnation and consolidation by ionizing radiation of a wooden sculpture of São Geronimo – Bandeirantes Palace Museum

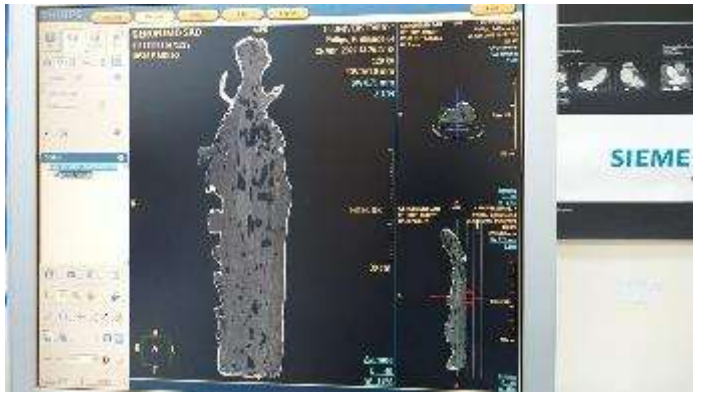
Preliminary Characterization

Tomography tests
Before and after consolidation

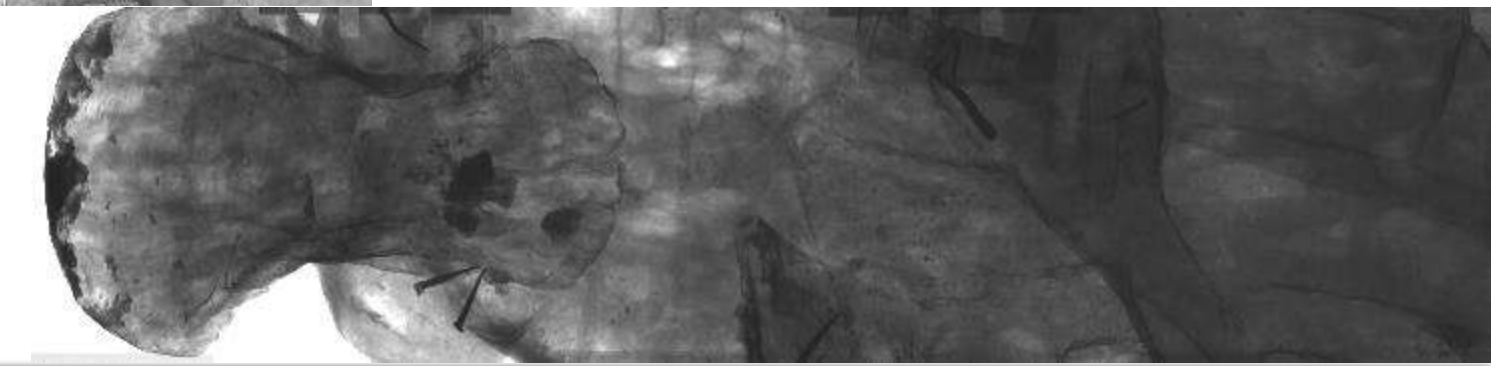








X ray tests
Before and after consolidation



Impregnation with polyester/styrene 50%/50%







Irradiation with gamma rays

Final Restoration process

IPEN actions for the Conservation and Preservation of Cultural Heritage in Brazil

End Users
National Museums & Conservation Institutes, etc.

IPEN
Support & Provider
-Radiation Technology
-Characterization - R&D
-Basic Guidelines to decontamination of CH by ionizing radiation

-Extensive dissemination and **training workshops** aimed to restorers and conservators
-Promotional material: videos, newspapers, TV and internet:
-Research & Scientific Publications

Cooperation with National Museums & National Conservation Institutes

-Institute o Brazilians Studies - IEB/USP
-Afro Brazil Museum
-Lina Bo & P.M. Bardi Institute
-Modern Art Museum - MAM
-Mario de Andrade Public Library
-*Pincacoteca* of the Sao Paulo State
-Sao Paulo Cultural Center – CCSP
-Public Archive of the Sao Paulo State (APESP)
-Government State *Bandeirantes* Palace Museum
-Butantan Institute Historic Museum
-Historic Museum of the Medical School of the Sao Paulo University
-Immigration Museum of the Sao Paulo State
-Contemporary Art Museum of the Sao Paulo University – MAC
-Santo Andre Museum
-Libraries of the Sao Paulo University: Laws School, Communications and Arts School, Chemistry School, etc.
-Integrated Library System SIBi-USP
-National Center for Industrial Learning – SENAI
-City Co. - planning and development -
-MRIZZO Restorations
-Margot Crescenti – Research and Restorations
-Visual Arts Museum – MAV of the University of Campinas – UNICAMP
-Moreira Salles Institute
-Tomie Ohtake Institute
-Lasar Segall Museum among others.

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