

# CIRTEN Activities

## on safe spent fuel and radioactive waste management, decommissioning

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# CIRTEN: Intra-University Consortium for Nuclear Technology Research



CIRTEN is the Consortium of the Italian Universities involved in nuclear science and technology research activities, and where educational programmes (MSc, PhD) on nuclear engineering are offered to the young generations.

CIRTEN is active in several national and European R&D projects, through its competence areas:

- Nuclear safety
- Decommissioning, nuclear waste management and environmental remediation
- Innovation and technology development of nuclear fission (GenIII, GenIV, SMRs) and fusion reactors
- Nuclear fuel and fuel cycle
- Radiation protection
- Radiation measurement and instrumentation
- Medical and industrial applications of ionising radiations

Characterization of radioactive materials + dismantling technologies & strategies



R. Zanino et al.

- Development of a hybrid Monte Carlo/deterministic calculation scheme to asses the residual activation of RPV and RVIs in PWRs
- Development of a methodology to compare the best cutting technologies for Sogin's LWRs

### L. Savoldi et al.

- HYPEX <sup>®</sup> is an innovative process, developed by green-land company from Brescia in collaboration with Politecnico di Torino, for the treatment and conditioning of spent radioactive ion exchange resins (IEXs). The process is currently under qualification by qualified laboratories, to meet the requested specifications by the Italian Regulatory (Guida Tecnica 33, ISIN).
- CHEDOX process: a chemical decontamination process of stainless-steel materials developed from green-land company of Brescia in collaboration with Politecnico di Torino. It is an optimization of the old HP-CORD process



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### CIRTEN activities: UNIPI

## Qualification/Licensing of Packaging Systems for RW Transport & Storage

R. Lo Frano et al.

The LIN laboratory (ISO 9001/ UNI EN ISO) @ Pisa University is the only Italian Test Station accredited by the IAEA for the qualification (licensing) of packaging systems for RW transport and storage.

Tests have been carrying out for about 50 years for national and international institutions.

Thermo-mechanical characterization tests of materials used in the RWM are also carried out in order to determine, e.g. durability, aging effects, etc.

#### National & International Collaborations:

Sogin, Nucleco, Ansaldo, Comecer, Lemer Pax, etc.

**EC Funded Research Projects:** 

PETRUS III, PREDIS, NUMAD2, CDP



(Rif. IAEA- TECDOC- 295)

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Radiological characterization of radioactive materials Mariani et al.

Radiological characterization of samples from NPP, nuclear medicine, industrial plants (NORM and TENORM), environmental and dietary matrices

- Radiochemical procedures for HTM radionuclides
- Radiometric analysis (Alpha-Beta LSC, Alpha & Gamma-X Spectrometry)
- Non radiometric analysis (ICP-MS, ICP-OES, XRF)
- Isotopic analysis at trace and ultra-trace level
- Computational methods (MCNP6) for activated materials
- Several contracts (SOGIN, NUCLECO, ENI, ANN, AITEC...) and peer-reviewed papers
- Several collaborations (ARPA, JRC, IAEA-GRAPA, H2020-INNO4GRAPH...)

















Dismantling technologies and decontamination strategies Mariani et al.

TOP VIEW

BOTTOM VIEW

- Development of innovative cutting technologies for dismantling of NPP components (e.g. abrasive water jet)
- Development and pilot testing of an integrated process for superficial decontamination of contaminated metallic waste and vitrification of residues





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Conditioning matrices for disposal of radioactive waste POLITECNICO **MILANO 1863** Mariani et al.

Development of matrices for the immobilization of challenging radioactive waste like liquid/solid organic waste, metallic waste, i-graphite...

cement, concrete, geopolymers, glass...



- - Physico-chemical-mechanical-thermal-leaching-radiation stability

A. Santi, E. Mossini et al., Frontiers in Materials (2022) DOI: 10.3389/fmats.2022.1005864



**Collaborations** with several well-established European Companies (ENRESA, NUCLECO, SOGIN, ENCO, ISTEDIL, ORANO ...), Universities and Research Centers (e.g. CEA, SCK-CEN, PSI, NNL, VTT, CVRez, ...)

PREDIS

H2020 «PRE-DISposal management of radioactive waste» project







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Partitioning of spent nuclear fuel Mariani et al.

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- Development of innovative hydrometallurgical processes for separation of fission products, Major and Minor Actinides from the spent nuclear fuel
- Study of radiation stability and complexation capability of extraction systems

**Long-lasting collaborations** with several well-established European Universities and Research Centers (e.g. CEA, NNL, KIT, FZJ, Chalmers, Ciemat, UNIPr...)

#### Several EU-funded projects since 1998:

FP4-NEWPART, FP5-PARTNEW, FP6-EUROPART, FP7-ACSEPT, FP7-SACSESS, H2020-GENIORS, H2020-PATRICIA

**Dozens of peer-reviewed papers** on well-established International journals: J. Am. Chem. Soc.; Inorg . Chem.; RSC Advances; ACS Omega; Ind. Eng. Chem. Research; Solvent Extr. Ion Exch.; J. Radioanal. Nucl. Chem.; Radiochim. Acta...

#### Dozens of M.Sc. And Ph.D. Theses

**<u>Reference winner molecule</u>** (over > 500 candidates) for i-SANEX process



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CIRTEN activities: SAPIENZA

Study and Application of a PSA methodology to Decommissioning activities Frullini and Caruso

> Sogin-CIRTEN Research Grant on Safety Management (3-years AdR – Luca Cretara)

New methodologies have been developed for risk assessment and management in decommissioning activities.

Development of a Probabilistic Safety Assessment (PSA) methodology, integrating those currently in use at international and national level:

- Assessment of the source term and preliminary classification of radiological risk.
- Determination of doses to workers and the general public.
- Application of THERP methodology for the assessment of risk deriving from human error (task analysis and development of a calculation tool (*DECO PSA*) based on Monte Carlo methods).
- Construction of the event tree and calculation of probabilities for various operating conditions.





DECC	PSA PROGRAM	
PRELIMINARY HAZARD ANALYSIS I	OE-1027	
	DA	TABASE TAXONOM
THERP MONTE CARLO	CPC	URDATE TAXONOS
SPAR-H ANALYSIS	202	OF DATE TRACTION
	ROOT DIRECTORY	
		Close





### CIRTEN activities: SAPIENZA

Study of materials (cementitious and metallic) for the barriers of the National Repository Giannetti et al.

2023-2024 BRiC project (INAIL)

The project includes numerous tests on materials to simulate their mechanical behaviour over time, taking into account all those ageing factors that can lead a certain barrier to conditions as likely as possible to those at the end of its life.

Analyses, tests and numerical simulations will allow a real characterization of the materials, "qualifying" them for the construction of all the structures for the safe containment of radioactive waste of ILW type, including metal containers.

Cooperation with Sapienza Chemical Engineering Dep. (Prof. Di Palma) and RINA Consulting.









CIRTEN: Current H2020 Euratom Projects on Topic

**PATRICIA -** *Partitioning And Transmuter Research Initiative in a Collaborative Innovation Action* 

- 2020-2024
- Coordinator: SCK CEN
- Partners: SCK CEN, CEA, CHALMERS, CIEMAT, FZJ, NNL, POLIMI, UHEI, ULeeds, CVR, JRC, KIT, KTH, NRG, TU Delft, VTT, ENEA, RATEN, CERN, CRS4, IVKDF, PSI, UGent, TEES, KAIST, UNIPI
- Total grant: 6.5 M€
- https://patricia-h2020.eu/

PATRICIA



CIRTEN: Current H2020 Euratom Projects on Topic

**PREDIS** - Pre-disposal management of radioactive waste

- 2020-2024
- Coordinator: VTT
- 47 Partners: VTT, NNL, JRC, IMT, CEA, SCK CEN, BAM, MAGICS, TUS, CTU, CVRez, SURO, UJV, CNRS, Univ Helsinki, ECL, ISRN, ORANO, DMT, FZJ, KIT, NRCS, Isotoptech, SORC, TS Enercon, ANN, ENEA, INFN, NUCLECO, POLIMI, SOGIN, UNIPisa, FTMC, NRG, IFE, RATEN, AMPHOS, CIEMAT, CSIC, ENRESA, UAM, PSI, GSL, UoM, USFD, KIPT, IGNS.
- Total budget: 23.7 M€
- Total grant: 14 M€;
- <u>https://predis-h2020.eu/</u>





CIRTEN: Current H2020 Euratom Projects on Topic

**INNO4GRAPH** - INNOvative tools FOR dismantling of GRAPHite moderated nuclear reactors

- 2020-2023
  Coordinator: EDF
- Partners: EDF, ENRESA, GRAPHITECH, CYCLIFE DIGITAL SOLUTIONS, CEA, SOGIN, LEI, CIRTEN (POLIMI), Uni Manchester, Westinghouse, ANN, TECHNATOM, ARTTIC
- Total budget: 3.8 M€
- Total grant: 3 M€;
- EU H2020 Inno4Graph Project





# CIRTEN: Current H2O2O Euratom Projects – Nuclear Education&Training

**A-CINCH** - AUGMENTED COOPERATION IN EDUCATION AND TRAINING IN NUCLEAR AND RADIOCHEMISTRY

- 2020-2023
- Coordinator: CTU Czech Technical University
- Partners: CTU, LUH, POLIMI, JSI, Chalmers, UH, UNIVLEEDS, OVGU, NNL, IMT, ENEN, UCY, UiO, CEFAS, Evalion
- Total grant: 2.49 M€
- <u>https://www.cinch-project.eu/</u>



**ENEN2Plus** - Building European Nuclear Competence through continuous Advanced and Structured Education and Training Actions

- 2022 2026
- Coordinator: ENEN
- Partners: CIRTEN (PoliMi, UNIPI, UNIRM1) + 49 organizations
- Total grant: 6.82 M€
- <u>https://enen.eu/index.php/portfolio/enen2plus-project/</u>



CIRTEN: Other current H2O20 Euratom-Fission Projects

- ELSMOR
- PASCAL
- TANDEM
- ANSELMUS
- ECOSENS
- SASPAM-SA

- INSPYRE
- R2CA
- PuMMA
- ESFR-SIMPLE
- OperaHPC

CIRTEN activities

## Thank you!



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