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FISA 2022

BOOK OF ABSTRACTS

10th European Commission Conferences
on EURATOM Research and Training in Safety of
Reactor Systems & Radioactive Waste Management

30 May – 3 June **Lyon, France**

In cooperation with

With the support of

FISA 2022 – Book of Abstracts

European Commission
Directorate-General for Research and Innovation
Directorate C — Clean Planet
Unit C.4 — Euratom Research

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FISA 2022

Book of Abstracts

Directorate-General for Research and Innovation
Euratom Research and Training Programme

2022

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FISA 2022
EURADWASTE'22

FOREWORD

It is with a great pleasure to welcome you here, at the Hôtel de Région Auvergne-Rhône-Alpes, in Lyon!

The European Commission (EC) is proud to co organise the 10th EU/Euratom conferences - FISA 2022 and EURADWASTE '22 – jointly with the French Atomic and Alternative Energies Commission (CEA), under the scope of the French Presidency of the Council of the EU in 2022, and the Région Auvergne-Rhône-Alpes kindly hosting all events taking place during this week. Thank you!

Gathering some 500 stakeholders and policy makers, the FISA 2022 and EURADWASTE '22 conferences objectives are:

- To present progress and key achievements of some 80 Euratom research and training projects co-funded since its previous edition in June 2019, in Pitesti, in Romania, as part of the Horizon 2020 Euratom Research and Training Framework Programme (FP), all projects totalising EUR 300 million Euratom contribution for a total budget of around EUR 500 million during the last 4 years,
- To stimulate discussions on the state of play of Research and Innovations, key national, European and international challenges and opportunities, as well as exploring future perspectives in the framework of Horizon Europe, and
- To interact within dedicated parallel and poster sessions, exhibitions, business and Young Generation Nuclear researchers' matchmaking interviews (ENS YGN) and to reward relevance and excellence performed in nuclear research and innovation: ENEN PhD Event & Prize, calls for PhD and MSc posters, R&D topics and Nuclear Innovation Prizes

FISA 2022 and EURADWASTE '22 conferences will address and engage with all relevant stakeholders involved: research and training organisations, academia, industry, small and medium enterprises, spin-offs and start-ups, national and European policy makers, national government officials, European technology platforms, technical support organisations, European fora, European civil society and International Organisations e.g. IAEA, OECD/NEA.

A common introduction and closure to the two conferences will provide a unique opportunity to set the scene at EU / national / international levels and to obtain a synthetic overview of issues and policies regarding the status of research on safety and implementation of programmes in both reactor systems, and radioactive waste management and geological disposal in Europe.

FISA 2022 technical sessions will cover progress of the research carried out through 60 projects such as safety of existing nuclear installations; severe accidents prevention and mitigation including emergency management; advanced nuclear systems and fuel cycles for increased safety and sustainability, numerical simulation and digitalisation, innovative materials, low dose radiation protection, decommissioning, research infrastructures, education & training and mobility of researchers, as well as cross-cutting actions such as International Cooperation.

There will be many opportunities for interaction and dialogue among stakeholders, through dedicated parallel and poster sessions. Additionally, the traditional FISA thematic workshops benefit from the great opportunity of organising instead, and alongside the conferences, the 2022 edition of SNETP Forum on: a) SMRs; b) Nuclear codes and standards and supply chain; c) Digital and robotics; d) R&D&I facilities; e) Waste minimization and fuel cycle; and f) The role of nuclear energy in mitigating climate change including non-electrical applications e.g. hydrogen, heat for energy-intensive industries and the potential of cogeneration.

MSc/PhD and R&D awards, Nuclear Innovation prizes and ENS Young Generation celebrating the – 2022 European Year of Youth, Science and Open innovation beyond technology, rising stars and shining lights, to build a better future - with Awards given to estimated 25 MSc/PhD/R&D, out of 100 invited to compete in the framework of the 2022 European Year of Youth.

Technical visits of emblematic nuclear sites will close the events on Friday 3 June.

All scientific papers presented in the Conferences will be gathered within FISA 2022 and EURADWASTE '22 Proceedings (together with all materials presented at the conferences) and the most valuable of them will be published in two dedicated peer-reviewed topical issues of an international Open Access Journal, the European Physics Journal for Nuclear Sciences & Technologies (EPJ-N).

We wish you a pleasant and productive FISA 2022 conference with many fruitful discussions for future international cooperation and partnerships in research and innovation!

Your participation, as honourable guests or speakers, co-chairs, rapporteurs, high-level experts, to the Euratom conferences FISA 2022 and EURADWASTE ’22, in Lyon, in France, or even online, is highly appreciated by the entire research community and will contribute for sure to a successful 10th edition of these high level scientific and policy events.

A great thank you to everyone participating in our events!

Yours sincerely,

On behalf of the Organising and Programme Committee

Roger Garbil and Seif Ben Hadj Hassine (EC DG RTD, FISA 2022 - EURADWASTE ’22 Co-chairs)

Valérie Vandenberghe, Danielle Gallo and Philippe Montarnal (CEA and French Presidency, Co-chairs)

Karolina Janatkova, Marie Fonteneau, Claudine Dubiau and Isabelle Auffret Babak

HOTEL DE REGION - AUVERGNE-RHONE-ALPES	Monday 30/05/2022				Tuesday 31/05/2022				Wednesday 1/06/2022				Thursday 2/06/2022				Friday 3/06/2022		
	Morning	Lunch	Afternoon	Evening	Morning	Lunch	Afternoon	Evening	Morning	Lunch	Afternoon	Evening	Morning	Lunch	Afternoon	Evening	Morning	Lunch	Afternoon
Level 0 - Hemicycle (500 p.)	Workshop EURAD-2 - EC / MS Fission Programme Commitee Representatives - 10:00 - 12:30 [RESTRICTED]		Workshop EURAD-2 - EC / MS Fission Programme Committee Representatives - 14:00 - 16:30 [RESTRICTED]		Joint High-Level - Opening - FISA 2022 - EURADWASTE '22 - 08:30 - 12:30		FISA 2022 Session 1 - Safety of nuclear installations - 14:00 - 18:30		FISA 2022 Session 2 - Advanced nuclear systems and fuel cycles - 08:30 - 12:30		FISA 2022 Session 3 - Education and training, research infrastructures, low dose radiation protection, decommissioning and international cooperation - 14:00 - 18:00	FISA 2022 - EUARADWASTE ' 22 ----- Dinner reception, Nuclear Innovation Prize, PhD Awards and ENEN PhD Prize ----- 19:00 - 23:00	Joint High-Level - Conclusion FISA 2022 - EURADWASTE '22 & Opening SNETP Forum - 08:30 - 10:30 SNETP Session 1 (AM) 11:00-12:30		SNETP Session 1 (PM) - 14:00-17:00		Visits All Day		
Level 0 - Room 1 to 5 (200 p.)							EURADWASTE '22 Session 1 - Collaborative Research, Development and Demonstration in Radioactive Waste Management - 14:00 - 18:30		EURADWASTE '22 Session 2 - Strategic Research Studies in Radioactive Waste Management - 08:30 - 12:30		EURADWASTE '22 Session 3 - Knowledge Management in Radioactive Waste Management - 14:00 - 18:00		SNETP Session 2 - 11:00 - 12:30 SNETP Session 3 - 11:00 - 12:30		SNETP Session 2 - 14:00 - 17:30 SNETP Session 3 - 14:00 - 17:30				
Level 1 - Room 6 & 7 (70 pers.)							ORIENT-NM EERA-JPNM - 14:00 - 18:30 [RESTRICTED]		ENEN PhD Event & Prize - 09:00 - 12:30		ENEN PhD Event & Prize - 14:00 - 17:00		SNETP Session 4 - 11:00 - 12:30		SNETP Session 4 - 14:00 - 17:30				
Level 1 - Room 8 & 9 (70 pers.)			ENS YGN Young Generation Ice Breaker - 15:00 - 17:00				Young Generation Workshop 1 - 14:00 - 16:00 - AWARD & PRIZE Pitches - 16:30 - 18:30		Young Generation Workshop 2 - 09:30-11:30		Young Generation Workshop 3 - 15:30-17:30								
Level 1 - Le Plateau Level 0 - La Verrière		Lunch WS --- 12:30 - 14:00	(Install) EXHIBITION POSTERS B2B Matchmaking	Welcome - Cocktail - 17:00-18:30	EXHIBITION POSTERS All Day B2B Matchmaking All day	Lunch --- 12:30 - 14:00	EXHIBITION POSTERS All Day B2B Matchmaking All day	YGN Cocktail 18:30-20:00	EXHIBITION POSTERS All Day B2B Matchmaking All day	Lunch --- 12:30 - 14:00	EXHIBITION POSTERS All Day B2B Matchmaking All day		EXHIBITION POSTERS All Day B2B Matchmaking All day	Lunch --- 12:30 - 14:00	EXHIBITION POSTERS All Day B2B Matchmaking All day				

Tuesday 31 May 22

Day 1 AM

Joint introduction FISA 2022 / EURADWASTE '22
Co-chair: Bernard SALHA (FR, SNETP)
Co-chair: Rosalinde VAN DER VLIES (EC, DG RTD)
Rapporteur: Henri PAILLERE (FR, Expert)

08:30 (15') **Welcome**

08:45 (15') **Mariya GABRIEL** (EC) European Commissioner for Innovation, Research, Culture, Education and Youth
Keynote: Euratom Research and Training and Horizon Europe framework programmes: Opportunities and challenges in the EU Innovation landscape

09:00 (15') **Claire GIRY** (Ministry, FR), Directrice Générale de la recherche et de l'innovation, Ministère de l'Enseignement Supérieur
Keynote: From Higher Education to Research and Innovation, a 'Team Europe and Global' approach / De l'enseignement supérieur à la recherche et à l'innovation : une approche globale et « équipe d'Europe »

09:15 (15') **Laurent MICHEL** (Ministry, FR), Directeur Energie et Climat, Ministère de la Transition Ecologique
Keynote: Challenges and levers for the energy and climate transition - Evolutions of the energy mix and nuclear - Challenges of R&D and innovation for the ecological transition / Enjeux et leviers pour la transition énergétique et climatique. Évolutions du mix énergétique et place du nucléaire. Enjeux de R&D et d'innovation au service de la transition écologique

09:30 (15') **Rafael Mariano GROSSI** (IAEA), Director-General of the International Atomic Energy Agency
Keynote: IAEA Research and Innovation for safe, secure and safeguarded nuclear for every citizen, in support of the UN Sustainable Development Goals

09:45 (15') **Sama BILBAO Y LEON** (WNA), Director-General of the World Nuclear Association
Keynote: WNA Promoting a wider understanding and streamlining international licensing and regulatory frameworks

10:00 (15’)	**William D. MAGWOOD IV** (OECD/NEA), Director-General of OECD Nuclear Energy Agency Keynote: OECD/NEA Nuclear Research and Innovation Successes and Accomplishments, Looking to the future
10:15 (15’)	**Pierre-Marie ABADIE** (ANDRA, FR), Director-General of Agence Nationale de Gestion des déchets radioactifs ANDRA Keynote: European and international status of the management and disposal of radioactive waste, developments and challenges ahead / La gestion et le stockage des déchets radioactifs en Europe et à l‘international, situation et perspectives
10:30 (15’)	**Mariya GABRIEL** (EC) European Commissioner for Innovation, Research, Culture, Education and Youth Awards ceremony for the Euratom Nuclear Innovation Prize
Coffee Break (30’)	
11:15 (15’)	**François JACQ** (CEA, FR), Administrateur Général, Commissariat à l’Energie Atomique et aux Energies alternatives Keynote: Research and Innovation interdisciplinary opportunities and challenges to enable sustainable and decarbonised societies / Recherche et innovation : une approche interdisciplinaire pour relever les défis d'une société durable et décarbonée
11:30 (15’)	**Cristian-Silviu BUŞOI** (ITRE, EP), Chair of the Committee for Industry, Research and Energy, European Parliament Keynote: Let’s join Euratom Research and Training and Horizon Europe forces, investments and ideas for making research and innovation the driving force of our future
11:45 (15’)	**Baiba MILTOVIČA** (EESC, EU), President of the section for Transport Energy, Infrastructure and Information Society, European Economic and Social Committee Keynote: Research and Innovation missions and benefits from continuous and meaningful Civil Society’s involvement to tackle today’s Societal Challenges
12:00 (15’)	**Marta ZIAKOVA** (ENSREG), Chair of the European Nuclear Safety Regulators Group Keynote: ENSREG commitment to continuous improvement of nuclear safety when new knowledge and experience are available: Progress, Lessons learned and Challenges

12:15 (15’)	**Yves DESBAZEILLE** (FORATOM), Director-General of the European Nuclear Industry Association FORATOM Keynote: Research and Innovation benefits for a low-carbon and climate neutral economy, Industrial Competitiveness and sustainable development
12:30 (15’)	**Jadwiga NAJDER** (ENS YGN), Chair of the Young Nuclear Generation of the European Nuclear Society Keynote: The future of Nuclear: Collaboration, Vision and Innovation – perspectives from YGN
Lunch (75’)	

Day 1 PM	**FISA 2022 – Session 1: Safety of nuclear installations** Co-chair: Myriam CALACICCO (FR, NUCLEAR VALLEY) Co-chair: Rosalinde VAN DER VLIES (EC, DG RTD) Rapporteur: Ferry ROELOFS (NL, Expert)

The first session is devoted to key Research and Innovation (R&I) projects' results, challenges and opportunities, ensuring a safe and long-term operation (LTO) of the current Generation-II-III reactors, including innovative small and modular reactors (SMRs). It will highlight R&I achievements in areas such as reactor performance, systems' reliability, instrumentation and control, advanced numerical simulation and modelling for reactor safety, innovative Gen-II-III and research reactors' fuels and materials, along with probabilistic safety assessments, severe accidents' evaluations of (internal and external) any potential event on nuclear power plants, and the impact of mitigation strategies. They are identified, among others, within the latest SNETP Strategic Research and Innovation agenda (SRiA), and its first pillar, NUGENIA technical research areas related to Generation-II-III water-cooled reactor technology. Most countries' industrial and public/private nuclear research operators have the important challenge of ensuring a safe and long-term operation of nuclear power plants, and research reactors, from an originally foreseen 40 years' to 60+ years of operation. Both nuclear operators and regulators need to have, in addition to a skilled and well-trained workforce, reliable tools to assess the ageing and degradation processes of components and structures and safe management. It also covers methods and guidelines for their validation and verification, up to date guidelines on nuclear and radiological emergency management and preparedness, within Europe, but also across the whole continent and around the world. As such, joint experimental research activities allow an optimum use of unique and/or distributed research infrastructures, sharing of competences and mobility of human resources. Capitalising further successful coordinated approaches, methodologies, data and tools, will highly benefit from a close pan-European cooperation between EU/Euratom Member States but also at international level.

14:00 (20')	**Bernard SALHA** (EDF, FR) *SNETP* Keynote: SNETP-NUGENIA-ESNII-NC2I Research and Innovation in Nuclear, a non-profit international organization to promote Research & Innovation
	Reactor Performance, system reliability: Long-Term Operation
14:20 (20')	**Marta SERRANO** (CIEMAT, ES) *ENTENTE – ATLASplus – NOMAD – STRUMAT-LTO*

14:40 (20')	**Tomasz BRYNK** (SCK-CEN, BE) *FRACTESUS – MEACTOS – INCEFA-SCALE*
15:00 (20')	**Albannie CAGNAC** (EDF, FR) *sCO2-4-NPP – APAL –* CAMIVVER
	Reactor Performance, system reliability: Instrumentation and control
15:20 (20')	**Morgane BROUDIN** (EDF, FR) *TEAM-CABLES – EL-PEACETOLERO*
	Advanced numerical simulation and modelling for reactor safety
15:40 (20')	**Christophe DEMAZIERE** (CHALMERS, SE) *CORTEX – McSAFER – METIS*
Coffee Break (30')	
	Innovative Gen-II -III and Research Reactors' Fuels and Materials
16:30 (20')	**Ville TULKKI** (VTT, FI) *ELSMOR – PASTELS – NUCOBAM*
16:50 (20')	**Jared WIGHT** (SCK-CEN, BE) *EU-QUALIFY – LEU-FOREvER*
	Safety assessments and severe accidents, impact of external events on nuclear power plants and on mitigation strategies
17:10 (20')	**Luis Enrique HERRANZ PUEBLA** (CIEMAT, ES) *MUSA – PIACE – AMHYCO*
	Probabilistic Safety Assessment for internal and external events on nuclear power plants and on mitigation strategies

17:30 (20’)	**Atte HELMINEN** (VTT, FI) *BESEP – NARSIS – R2CA*
17:50 (40’)	**General discussion and research perspectives for the safety of nuclear installations, long term operation, reactor performance and systems reliability, and advanced modelling, safety assessments and severe accidents mitigation strategies**
18:30 (90’)	***YGN Cocktail Dating, Meet and Match Lounge***

Wednesday 1 June 2022

Day 2 AM

FISA 2022 – Session 2: Advanced nuclear systems and fuel cycles
Co-chair: Hamid AIT ABDERRAHIM (BE, SCK-CEN)
Co-chair: Massimo GARRIBBA (EC, DG ENER)
Rapporteur: Teodora RETEGAN-VOLLMER (RO, Expert)

This second session is devoted to key Research and Innovation (R&I) projects' results, challenges and opportunities, on safety of advanced/innovative nuclear systems and fuel cycles, reactor designs and licensing of these technologies, including innovative small and modular reactors (SMRs). It will highlight R&I achievements in priority areas identified, among others, within the latest Strategic Research and Innovation agenda (SRiA) of SNETP, and its second pillar, the European Sustainable Nuclear Industrial Initiative (ESNII), covering fast reactor technologies and sustainable fuel cycles, but also within the latest R&D and technology roadmaps of Generation-IV International Forum (GIF). The important areas of innovative fuels and materials benefit from the relevant developments and support from EERA-JPNM (European Energy Research Alliance Joint Programme on Nuclear Materials for fission and fusion). Additionally, closing the fuel cycle with Generation-IV reactors, supported by research on in-pile behaviour and recycling of Mixed Oxide fuels (MOX), on partitioning and transmutation moving from laboratories' R&D towards industrial-scaled demonstrations. A true circular economy resulting from better valorisation of waste streams, minimisation of high-level waste and use of natural resources, to tackle the community's sustainable goals. Other applications for nuclear fission will also be presented, in priority areas identified, among others, within the SNETP SRiA and its third pillar on Nuclear Cogeneration Industrial Initiative (NC2I). High benefits potentially exist for a carbon-neutral economy, based upon large-scale decarbonisation of energy-intensive industrial applications such as cogeneration of heat and electricity, using e.g. High Temperature Reactors technologies (HTRs). Cross-cutting nuclear data activities supporting the OECD/NEA (in cooperation with IAEA) Joint Evaluated Fission and Fusion (JEFF) Nuclear Data Library Project will also be discussed. As identified by high-level expert groups, new high-priority experimental measurements and validation of correlated nuclear data, allow updating internationally recognized data bank libraries, simulation codes, and reducing uncertainties. As such, it also supports fulfilling today's requirements from end users and operators, but also regulators for even safer and more sustainable developments, to enhance operational confidence and economical margins of existing and future fission (and fusion) reactors and nuclear fuel cycles.

08:45 (15’)	**Welcome**
09:00 (20’)	**Stefano MONTI** (IAEA), Head of section Nuclear Power Technology Development Keynote: Global trends in nuclear power: advanced reactors including SMR integrated in hybrid energy systems. Challenges and opportunities for increased sustainability
09:20 (25’)	**Konstantin MIKITIUK** (PSI, CH) *ESFR-SMART – SafeG – ECC-SMART – ACES – SAMOSAFER* R&D in support to safety assessment, design and licensing of ESNII/Gen-IV
09:45 (25’)	**Nathalie CHAUVIN** (CEA, FR) *PUMMA – GENIORS - INSPYRE* Closing the fuel cycle with Gen IV reactors : research on in-pile behaviour and recycling of mixed oxide fuels
10:10 (25’)	**Paul SCHUURMANS** (SCK-CEN, BE) *PATRICIA - PASCAL* Partitioning and Transmutation, contribution to an EU strategy for HLW management
Coffee Break (25’)	
11:00 (25’)	**Lorenzo MALERBA** (CIEMAT, ES) *ORIENT-NM – GEMMA – M4F* Innovative Gen-IV Fuels and Materials, EERA-JPNM, Fission and Fusion
11:25 (20’)	**Josef SOBOLEWSKI** (NCBJ, PL) *GEMINI-PLUS* Nuclear Cogeneration with High Temperature Reactors
11:45 (15’)	**Carola FRANZEN** (HZDR, DE) *ARIEL – SANDA* Nuclear data activities
12:00 (30’)	**General discussion and research perspectives for the safety of advanced nuclear systems and fuels cycles, innovative designs, fuels and materials, partitioning and transmutation, and nuclear data**
Lunch (90’)	

Day 2 PM	**FISA 2022 – Session 3: Education and training, research infrastructures, low dose radiation protection, decommissioning and international cooperation** Co-chair: Tatiana IVANOVA (FR, OECD/NEA) Co-chair: Roger Garbil (EC, DG RTD) Rapporteur: Said ABOUSAHL (FR, Expert)

This third second session is devoted to key Research and Innovation (R&I) projects' results, challenges and opportunities, on Education and training, research infrastructures, low dose radiation protection, decommissioning and international cooperation. EU/Euratom Research and Training framework programmes help stimulating joint funding from Member States (MS) and/or enterprises, European joint programming, and a dialogue at European level enabling innovative cross-cutting fission/fusion/non-nuclear initiatives. Benefits are being capitalised from the increasing interactions between research organisations, academia, industry, technical safety organisations and regulators, European technology platforms, EU stakeholder fora and Strategic Energy Technology SET-Plan Member States, as well as International Organisations cooperation such as OECD/NEA and IAEA. Nuclear safety always remains top priority and the European Union has an outstanding nuclear safety record, while supporting the implementation of EU/Euratom treaties and EU/Euratom main directives (safety, radioactive waste management and basic safety standards), or international conventions and legislations, and sharing of best practices between the European nuclear industry, TSOs, ENSREG and WENRA. All legislative mandatory requirements (e.g. Directives on Safety (Art.7), on Nuclear Waste Management (Art.8), Basic Safety Standards (Ch.4) and IAEA Convention on Nuclear Safety) confirm that research must continue to support maintaining the highest levels of nuclear safety, security and safeguards. Moreover, each MS shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and re-training are available for all safety-related activities in - or for each - nuclear installation throughout its life. The latest situation reports from the European Human Resources Observatory in the Nuclear Energy Sector provide detailed quantified evaluations (EHRO-N implemented by JRC and created in 2009 by the European Nuclear Energy Forum (ENEF)). The European nuclear sector is characterised by cutting-edge technologies and provides several hundred thousand people with highly skilled employment. To ensure our safety for today and in the future, skilled and well-trained personnel, well-equipped and world-class nuclear research infrastructures are of paramount importance, and availability of these highly qualified resources is a crucial prerequisite. Europe can retain its technological leadership only if Member States maintain a diverse ecosystem and well-funded nuclear R&I capability, a fit-for-purpose system for the education, training, tutoring and mobility of scientists and engineers. Availability of state-of-the-art and shared research infrastructures is fundamental. It applies through the whole lifecycle of any project (large or small scale), nuclear power and non-power applications (e.g. radiation protection including medical applications, production and use of radioisotopes), contributing to the implementation of UN SDGs, where reinforced international cooperation in key strategic areas with leading third countries, bilaterally or multilaterally, benefits to every citizen around the world.

14:00 (20’)	**Marco UTILI** (ENEA, IT) Keynote: Growing Synergies between Fission and Fusion Research towards demonstration plants. Towards more integrated Fusion and Fission programmes.
14:20 (30’)	**Joerg STARFLINGER** (ENEN, DE) *ENENplus – GREaT-PIONEeR – ENEEP – PIKNUS – A-CINCH* Education, Training and mobility, knowledge management: towards a common effort to assure a future workforce in Europe and abroad
	Radiation protection and medical applications, European challenges and opportunities
14:50 (20’)	**Isabelle THIERRY-CHEF** (ISGLOBAL, ES), **Christoph HOESCHEN** (OVGU, DE) *MEDIRAD – HARMONIC – SINFONIA – EURAMED rocc-n-roll*
15:10 (20’)	**Ulrike KULKA** (BFS, DE) *RADONORM*
15:30 (20’)	**Hildegarde VANDENHOVE** (SCK-CEN, BE) *MEENAS*
Coffee Break (30’)	
	Improved expertise and innovations in decommissioning
16:20 (20’)	**Robert WINKLER** (CEA, FR) *SHARE*
16:40 (20’)	**Nicolas MALLERON** (EDF, FR) *INNO4GRAPH – PLEIADES – LD-SAFE – CLEANDEM - INSIDER*

	Supporting Access to key pan-European research infrastructures and international cooperation
17:00 (20’)	**Petri KINNUNEN** (VTT, FI) *JHOP2040 – TOURR – JHR ACCESS RIGHTS – OASIS JRC Open Access*
17:20 (20’)	**Tatiana IVANOVA** (OECD/NEA) *OECD/NEA* Keynote: NEA Seeking Excellence in Nuclear Education, Training, Knowledge Management and Supporting Research Infrastructure Insights of the NEA Education initiatives and the Framework for Irradiation Experiments (FIDES)
17:40 (20’)	**General discussion and research perspectives for Education and training, research infrastructures, radiation protection, decommissioning and international cooperation**
19:00 (4h)	***Dinner reception, MSc/PhD/R&D Awards and ENEN PhD Prize Ceremony***

Thursday 2 June 22

Day 3 AM	**Joint conclusion FISA 2022 / EURADWASTE '22** Co-chair: Philippe STOHR (FR, CEA) Co-chair: Bernard MAGENHANN (EC, DG JRC) Rapporteur: Henri PAILLERE (FR, Expert)
08:15 (15')	**Welcome**
08:30 (20')	**Bernard MAGENHANN** (EC, DG JRC), Deputy Director-General of the Joint Research Centre Keynote: JRC's role in Euratom Research and Training and Horizon Europe
08:50 (20')	**Hans FORSSTROM** (SE, Expert), General Rapporteur EURADWASTE '22 - Key messages and future perspectives
09:10 (20')	**Henri PAILLERE** (FR, Expert), General Rapporteur FISA 2022 - Key messages and future perspectives
09:30 (20')	**Laurent WAUQUIEZ** (FR, or AURA representative), President of the Region Auvergne-Rhône-Alpes Keynote: Région Auvergne-Rhône-Alpes, promoting Innovation Ecosystems and Strategic Clusters
09:50 (20')	**Philippe FRANTZ** (FR, NUCLEAR VALLEY), President of Nuclear Valley Keynote: Nuclear Valley's Pôle de competitivé, the Nuclear Industry Cluster in the Région Auvergne-Rhône-Alpes and GIFEN (Groupement des Industriels Français de l'Energie Nucléaire)
10:10 (20')	**Philippe STOHR** (FR, CEA) and **Bernard MAGENHANN** (EC, DG JRC) Closing remarks from the French Presidency and the European Commission
Coffee Break (30')	


FISA 2022
EURADWASTE'22

Day 3 AM-PM	SNETP Forum 2022
11:00 (1h30) 14:00 (4h)	SNETP annual FORUM in 2022 workshops to launch new project ideas: • SMRs • Nuclear codes and standards and supply chain • Digital and robotics • R&D&I facilities • Waste minimization and fuel cycle • The role of nuclear in mitigating climate change

The SNETP Forum 2022 edition (https://snetp.eu/2022/02/28/save-the-date-for-the-snetp-forum-2022/) will be held on 2 June 2022 in Lyon, France, in conjunction with FISA 2022 (10th Euratom Conference on Reactor Safety) and EURADWASTE '22 (10th Euratom Conference on Radioactive Waste Management).

The SNETP Forum 2022 will aim at discussing and analysing recent technological innovations in different fields selected by the SNETP Scientific Committee as to cover major topics of interest to the stakeholders of SNETP.

Technical sessions

SMRs

New innovative solutions are needed to ensure cost competitiveness with other power generation technologies, as well as speed of construction and implementation in local systems. In addition to the nuclear reactors in operation and those under construction, Europe needs to expand the range of reactors technologies available to meet national/local specificities. The development of different SMRs, based on most matured technologies or on other advanced technologies, offers the possibility to deploy flexible options for both power and non-power applications and contribute to decarbonisation of the economy. Research & Development & Innovation (R&D&I) should support the development of SMRs to make them safe and competitive with other means of production as part of a global deployment strategy over the coming decades.

Nuclear codes and standards and supply chain

Safety-related structures, systems and components (SSCs) of nuclear power plants are normally designed and produced according to stringent nuclear codes & standards (NC&S). Supplying such SSCs normally requires companies to establish and maintain costly nuclear quality-assurance (QA) programme. In response to growing supply chain challenges, European NPP operators started looking into greater deployment of high-quality non-nuclear industry standard components and equipment for safety-related SSCs of NPPs (i.e. commercial-grade dedication) and launched corresponding pilot projects with approval of their regulators. This is supported by European and international nuclear organisations like Foratom and the IAEA by providing guidance in this area. The further development of NC&S remains high on the agenda. Novel materials, manufacturing methods and technologies need to be included in NC&S before being allowed to be used for safety-related SCCs. This and also NC&S development for advanced reactors (SMRs, Gen IV) require significant R&D&I efforts. In this session, ongoing NC&S development activities and needs and supply chain related activities and challenges for the current reactor fleet and advanced reactors will be presented and discussed.

Digital and robotics

Digital: The digital transformation has become a cross-cutting trend to all industrial sectors and nuclear is no exception to this. The European Commission digital strategy aims to make this transformation work for people and businesses, while helping to achieve its target of a climate-neutral Europe by 2050. As such, it is essential for nuclear to be fit for the digital age, to achieve digital twins and a Digital Nuclear Reactor. Concerted R&D&I work is essential to make progress in terms of multi-physics modelling and simulation, high performance computing, data analysis and analytics, visualisation, virtual reality, advanced instrumentation (e.g. Internet Of things) and I&C.

Robotics: NPP operation combines a number of interlinked human, organisational and technical factors. A strong drive to opt for advanced robotics in nuclear industry appeared after the Three Mile Island incident and the development of engineering technologies. Improving nuclear power plant operation, health and safety of operators, managing safely their decommissioning are considered to be key, but also for further public acceptance of nuclear. If robots take over the human personnel in conducting risky operations, the latter will have a reduced exposure to radioactivity. Significant investments in artificial intelligence sustain this eventuality. Moreover, the ability to maintain the nuclear power infrastructure may depend on robots being able to carry out maintenance tasks that would otherwise be impossible, thus significantly extending the lifetime of reactors.

R&D&I facilities

Several R&D facilities have been shut down in the EU over the last decade. The loss of critical research infrastructures (i.e. facilities, capabilities and expertise) remains a concern to all EU policy makers, Member States and SNETP stakeholders as a whole. SNETP and some of its members took initiative to set up the “OFFERR” project in response to the Euratom Research and Training 2021-22 call for proposals. It aims to capitalise the Euratom R&D community's operational and financial schemes facilitating open and inclusive trans-national access to infrastructures for R&D experts. The latest will be able to perform high-priority experiments within the best infrastructures available, with the benefit of co-funded grants (in-kind/in-cash) by Euratom, the consortia and/or Member States' research infrastructure owners. The goal is to build a sustainable "User facility network (UFN)". This session shall discuss the way this network of existing smaller networks shall be further managed, while providing the current status of research facilities available, which will also support the implementation of the SNETP Strategic Research and Innovation Agenda (2021), MS and Euratom Research and Training objectives, and beyond.

Waste minimization and fuel cycle

The current and projected fleet of plants consists largely of water-cooled, water-moderated reactors. These reactors have over time achieved a high degree of maturity in terms of economic performance and safety. To achieve major steps in terms of sustainability (by reducing high-level waste production, better use of resources and higher thermal efficiencies), new types of reactors based on other coolant technologies and high-temperature non-electrical applications, should be envisaged and combined with more advanced fuel cycles. The use of fast reactors in a closed fuel cycle approach will allow a large decrease in consumption of natural resource (uranium) and a significant reduction of high-level radioactive waste in terms of radiotoxicity and volume, which is one of the major concerns of society, towards a more sustainable implementation of nuclear energy. Advanced reprocessing and fuel manufacturing techniques, from a laboratory to an industrial scale of deployment, are needed to recycle for instance minor actinides. This session shall discuss how sustainability in terms of resource utilization and high level waste minimization can be gradually increased.

The role of nuclear energy in mitigating climate change including non-electrical applications (hydrogen, heat, etc)

With increased awareness of climate change in recent years, nuclear energy has received renewed attention. Nuclear energy can make a significant contribution to reducing greenhouse gas emissions (GHGs) worldwide, while at the same time meeting the increasing demand for energy of a growing world population and supporting global sustainable development. Nuclear energy has considerable potential to meet the challenge of climate change mitigation by providing a secured supply of electricity, district heating and high temperature heat for industrial processes while producing almost no GHGs. This session will focus on the different possible uses of nuclear to contribute to the EU 2050 decarbonisation strategy.

SNETP FORUM TECHNICAL SESSIONS – 2 June 2022				
#	**Room 1**	**Room 2**	**Room 3**	**Room 4**
	TS1: SMRs **Moderators: Ferry Roelofs (NRG), Jozef Sobolewski (NCBJ)**	**TS4: R&D&I facilities** **Moderators: Pavel Kral (UJV), Petri Kinnunen (VTT)**	**TS2: Nuclear codes & standards & supply chain** **Moderators: Oliver Martin (JRC)**	**TS6: Nuclear to mitigate climate change including non-electricity applications** **Moderators: Ronald Schram (NRG), Michael Fütterer (JRC),**
11:00	**P1:** SMR-partnership, **DG-ENER** **P2:** Market analysis, **Bernard Dereeper** **P3:** Licensing harmonization, **ENSREG**	**P1**: OFFERR project, **Charles Toulemonde (EDF)** **P2**: Setting up the "European User Facility Network", **Jiri Zdarek (UJV)** **P3**: RJH, **Petri Kinnunen (VTT)**	**P1:** Comparison of pipe integrity concepts for LWRs, **Bruno Autrusson (nuclear consultant, formerly IRSN)** **P2:** Ongoing development activities on RCC-MRx and its enlargement to Gen IV reactor systems with coolants other than sodium, **Karl-Fredrik Nilsson (JRC)** **P3:** The NUCOBAM project – Incorporation of additive manufacturing into NC&S, **Oliver Martin (JRC)**	**P1**: N.N., NC2I: Introductory Scene Setter (new Euratom projects, NEA, GIF, IAEA) **P2**: **Andrei Goicea, Foratom**, EU: EU's energy sector integration and hydrogen strategies **P3**: **Agnieska Boettcher, NCBJ**, PL: Polish GOSPROSTRATEG project **P4**: **Jacek Jagielski, NCBJ**, PL: NOMATEN Centre of Excellence in Multifunctional Materials for Industrial and Medical Applications
12:00	**P4:** Supply Chain, **Roberto Adinolfi (Ansaldo)** **P5:** R&D&I - **Sylvain Takenouti** **P6:** Core and Fuel - **Eric Hanus (CEA)** **P11:** Non-electricity (power) applications, **Ville Tulkki (VTT)**	**P4**: NEA task Force on Nuclear Safety Research support facilities for existing and advanced reactors, **François Barré (IRSN)** **P5**: BR2, **Joris Van den Bosch (SCK.CEN)** **P6**: PKL/SACO, **Simon Schollenberger (Fra-G)**	**P4:** R&D challenges in improving civil structures design rules for sustainable nuclear energy technology, **Etienne Gallitre (nuclear consultant, formerly EDF)** **P5:** Qualification of electrical equipment according to RCC-E **Benedict-John Willey (EDF)** **P6:** European Commercial-grade Dedication Guidelines: **Andrei Goicea (Foratom)** **)**	**P5**: Integrated Energy Systems and the pathway to Net Zero by 2050 (a UK context), **Paul Newitt (NNL)** **P6**: **Michael Fütterer, JRC**, NL: GEMINI+ nuclear process heat applications, hydrogen, steel **P7**: **Andre Faaij, TNO**, NL: "Deployment of nuclear energy in deep decarbonization of the energy system." **P8**: **Geert-Jan de Haas, NRG**, NL: "Exploring the deployment of advanced reactor systems for decarbonization of future energy generation: research highlights of molten salt reactors and liquid metal cooled reactors." Wrap-up by **Ronald Schram, NRG**, NL: Wrap-up
13:00	**Lunch Break**			
	TS1: SMRs **Moderators: Ferry Roelofs (NRG), Jozef Sobolewski (NCBJ)**	**TS4: R&D&I facilities** **Moderators: Pavel Kral (UJV), Petri Kinnunen (VTT)**	**TS3: Digital & Robotics** **Moderators: Eero Vesaoja (FORTUM), Christophe Schneidesch (Tractebel), Elisabeth Guillaut (ORANO)**	**TS5: Waste minimization and fuel cycle** **Moderators: Erika Holt (VTT), Anthony Banford (NNL)**
14:00	**P7:** NSSS **Oliver Martin (JRC)** **P8:** Passive systems **F. Mascari** **P9:** Severe Accidents, **P. Dejardin** **P10:** Modularity, **M. Marconi (Ansaldo)**	**P7**: PASI-CWC, **Riikonen etc (LUT) (TBC)** **P8**: COSMOS-H, **Stefan Gabriel (KIT)** **P9**: HFR / Pallas, **Ronald Schram (NRG)**	**P1:** French Digital Reactor Initiative, **XXX – EDF** **P2:** Combination between Digital Twin and AI for anomaly detection for industrial processes, **Aurélien Schwartz - Métroscope, EDF group** **P3:** Data-sharing technologies, connectivity in the nuclear sector, **Vincent Champain – Framatome**	**P1:** Euratom introductory address, **Seif Ben Hadj Hassine (EC)** **P2**: Fuel Handling and Waste issues for Molten Salt Reactors, **Jiri Krepel (PSI)** **P3:** Plutonium management in GENIV reactors, **Francisco Alvarez Velarde (CIEMAT)**
15:00	**P12:** Energy Well – Czech molten salt SMR concept, **Marek Ruščák**	**P10**: Czech research infrastructure for	**P4:** AI in requirements engineering, **Santeri Myllynen – FORTUM**	**P4:** Waste minimization /recycle through whole fuel cycle, **Paul Nevitt (NNL)**

	– CVR **P13**: Conceptual design of EUHTER (Polish experimental HTGR), **prof. Mariusz Dąbrowski**	supporting the implementation of the SNETP strategic research agenda, **Marek Mikloš (CVR)** **P11**: Open access of research infrastructures, **Rachel Eloirdi (JRC)**	**P5:** Digital Solution Projects, **A. Duchêne – Tractebel**	**P5:** Recycling and circular economy of metallics– advanced reprocessing
15:40	**Coffee Break**			
		TS4: R&D&I facilities Moderators: Pavel Kral (UJV), Petri Kinnunen (VTT)	**TS3: Digital & Robotics Moderators: Eero Vesaoja (FORTUM), Christophe Schneidesch (Tractebel), Elisabeth Guillaut (ORANO)**	**TS5: Waste minimization and fuel cycle** **Moderators: Erika Holt (VTT), Anthony Banford (NNL)**
16:00		**P12**: Education and training and facilities, **Leon Cizelj (IJS)**	**P6:** Modelling and simulation-assisted engineering of cyber-physical systems throughout their life cycle, **T. Ngugen – IAEA consultant** **P7:** Robotics and drone program, **Anders Wik – Vattenfall** **P8:** SHARK ROBOTICS, **Joseph PESME**	**P6:** Advanced Separation for the Optimum management of spent Fuel – portioning, fuel fabrication, secondary waste streams, **Christophe Bruggeman (SCK CEN)** **P7:** Unique for SMR spent fuel and waste management, **Timothy Schatz (VTT)** **P8:** SRA documentation development from projects SHARE and PREDIS, **Anthony Banford (NNL) and Erika Holt (VTT)**
17:00			**P9:** AERACCESS, **Jean-Luc AYRAL** **P10:** Robotics in VVER SG inspection/cleaning, **Ville Lestinen - Fortum**	Guided Discussion: going forward topics and plan (future collaboration ideas) **– chairpersons**
18:00				


FISA 2022
EURADWASTE'22

Tuesday 30 May to Thursday 2 June 22	**SIDE EVENTS**
Day 1 to 3 AM-PM	**Face-to-face networking opportunities and B2B matchmaking** Poster (60 per day, Euratom projects, MSc/PhD/R&D, 180 in total) - Exhibition (20 per day, 20 in total) - B2B Matchmaking (estimated 200 in total)

Poster (60 per day, Euratom projects, MSc/PhD/R&D, 180 in total)

An opportunity to present your research results, within or related to the topics covered, at the conferences, to the Euratom and International Research Community. Euratom projects, PhD/MSc Students (under 35 years' old) are encouraged to submit abstracts related to the dedicated topics of the conferences, as well as R&D researchers from organisations not directly involved in projects co-funded by Euratom.

Exhibition (20 per day, 20 in total)

Exhibition booths will be set up for almost 20 organisations to showcase advancements in various cross-cutting innovative, engineering, industrial and high-tech technologies relevant to nuclear and non-nuclear applications, radiation protection, radioactive waste management and geological repository development. Exhibition booths will remain open during all sessions and breaks and will give the opportunity for intensive B2B meetings.

ENS-YGN events & B2B Matchmaking (estimated 200 in total)

ENS-YGN is a vibrant network connecting all Nuclear Young Generation Networks over Europe. These events, including Young Generation workshops, are a huge opportunity for Students, MSc/PhDs or young professionals to meet national / European / International leading managers, innovators and researchers from public and private research organisations.

Around 200 candidates will be selected after having submitted their CV. In depth 30 min face-to-face matchmaking interviews and networking opportunities will be organised for them with leading national / international managers, participating companies or even recruiters. This event will allow companies active in the nuclear industry, public and private research organisations or academia, to meet and interview students, graduates, engineers and experienced professionals to start or pursue their career within Europe and beyond. Institutions such as Nuclear Valley or GIFEN will take part in the event.

At the conference, an iOS and Android App

An iOS and Android App will be available to all confirmed registered participants at the conferences. The app will show the programme in an interactive manner and facilitates communication among the participants, sharing all information, also enabling scheduling B2B meetings, notifications and announcements.

Tuesday 30 May 22

SIDE EVENT

Day 1 PM
16:30 (2h)

AWARD and PRIZE pitches

OPEN CALL – POSTER COMPETITION

➔ MSc/PhD awards, Student competition (10 in total)

➔ R&D Topics Awards (4 in total)

➔ Euratom Projects (2 in total)

NUCLEAR INNOVATION PRIZES (7 in total)

ENS High Scientific Council PhD Awards (2 in total)

The Programme Committee will invite MSc/PhD/R&D Award, ENS High Scientific Council PhD and Nuclear Innovation Prize winners the opportunity to present a compelling 180 seconds spoken presentation of their research topic to the international Research Community during a dedicated Session of FISA 2022 – EURADWASTE ’22

Tuesday 30 May to Wednesday 1 June 22

Day 1 to 2
AM-PM

Nuclear innovation prizes in Safety of reactor systems and in radioactive waste management

The first Nuclear Innovation Prize contest will be organised will be organized in the framework of the FISA 2022 and EURADWASTE ´22 Conferences in Lyon, France, on Monday 30 May to Friday 3 June, by the European Commission and the organizers of the international conferences.

https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/prizes/nuclear-innovation-prize_en

The 'Nuclear Innovation Prize' (**call closed**) is meant to give visibility to the most dynamic, forward-looking and innovative researchers, research teams or industrial contestants, with a prize planned to be delivered by European Commissioner Mariya Gabriel for Innovation, Research, Culture, Education and Youth (tbc).

Nuclear Innovation Prize in safety of reactor systems
1st place: EUR 50,000 / 2nd place: EUR 30,000 and 3rd place: EUR 20,000

Nuclear Innovation Prize in radioactive waste management
1st place: EUR 50,000 / 2nd place: EUR 30,000 and 3rd place: EUR 20,000

Six (seven in 2022) awarded Nuclear Innovation Prizes related peer-reviewed papers should be published within the international Open Access Journal (EPJ-N) topical issue on FISA 2022 – EURADWASTE '22 Awards and later within the conferences proceedings.

Euratom funded research in fission safety, waste management and radiation protection benefits from consistent success in pursuing excellence across a broad range of nuclear science and technologies.

Together with EU countries the programme has continuously helped maintain a high-level of competences, underpinned by sound and advanced research.

Nuclear researchers and engineers are constantly challenging state-of-the-art in the field and improving evolving technologies thereby creating conditions for innovations beyond technologies and scientific breakthroughs, towards a more dynamic and competitive European industry for the benefit of every citizen and the whole of society.

Wednesday 1 June 22

Day 2
AM-PM

16th ENEN PhD Event & Prize 2022

The 16th ENEN PhD Prize 2022 will be organized in the framework of the FISA 2022 and EURADWASTE ´22 Conferences in Lyon, France, on Monday 30 May to Friday 3 June, by the European Nuclear Education Network (ENEN) Association, in cooperation with the Joint Research Centre of the European Commission and the organizers of the international conferences.

Every year the ENEN PhD Event & Prize is organized to promote and support the work of young researchers in Europe (https://enen.eu/index.php/phd-events/).

ENEN PhD Event & Prize is an action of the European Nuclear Education Network to support the Research and Science in the Nuclear fields promoting the works of the young scientists and researchers who start their careers finishing their PhD. It takes place on a yearly basis in the framework of the international congress in the field of nuclear science.

ENEN PhD Event will consist of up to 12 PhD presentations nominated by ENEN Members and selected by the ENEN PhD Prize Jury. The event will be divided into several sessions according to the subjects. Participants will make a presentation of their research work for 25 minutes followed by 5 minutes of questions and discussion in a competitive but friendly environment.

All presentations will be judged by the Jury members taking into account the quality of the submitted paper as well as the quality of the presentation itself. Moreover, the participation in the discussion and the clarity in answering the questions received will also be taken into account in selecting the winners.

The **best three presentations** will be awarded the ENEN PhD Prize. And three awarded ENEN PhD Prizes related peer-reviewed papers should be published within the international Open Access Journal (EPJ-N) topical issue on FISA 2022 – EURADWASTE ’22 Awards and later within the conferences proceedings.

Tuesday 30 May and Wednesday 1 June 22	
	European Nuclear Society Young Generation Network workshops (ENS YGN) ENS YGN will be organising three workshops, in the framework of the European Year of Youth 2022 and of FISA 2022 and EURADWASTE ´22 Conferences
Day 1 PM 14:00 (2h)	**Kick-off of B2B sessions - Are you ready for the international job market?** This workshop provides attendees with information and practical advice that they can use to understand and access the international job market
Day 2 AM-PM 09:30 (2h)	**2. Communicating science - Don't waste it!** This workshop will teach how to provide facts in an understandable way, using simple comparisons and handy references. Come and learn how to lead an engaging conversation!
15:30 (2h)	**3. Nuclear for Climate - positive campaigning of nuclear topics** Imagine the enormous impact you, as a single individual, has in the climate change conversation. Your voice is powerful, and when directed in the right places, highly impactful. And now imagine what would happen if we compounded all our efforts, sharing the same message across the globe, to communicate to leaders and decision makers that 'enough is enough: we need action now'. It would be immense. Join the Nuclear for Climate team as they guide you through this engaging, action-focused workshop. Open to all backgrounds, viewpoints, experiences. #Togetherisbetter

ENS YGN 1st Workshop – As a kick-off to the B2B sessions YGN proposes a workshop ***"Are you ready for the international job market?"***

31 May, Tuesday 14:00 – 16:00

Co-organised by Thomas Thor and ENEN

Attendees – young professionals with 1-10 years experience in the industry/research

Workshop overview

The session will be a joint insight of Thomas Thor Associates – recruitment consulting and young professionals who took a chance to start international careers in different sectors of nuclear science and industry.

The workshop will be enriched by the recent results of the global project measuring the attitude of young people towards nuclear jobs – the World Young Generation Nuclear Thermometer.

The aim of the workshop is to provide attendees with information and practical advice that they can use to understand and access the international job market.

Join us and ask everything you always wanted to know about a career in nuclear!

Moderators: Callum Thomas, Thomas Thor and Andrea Kozlowski, ENS-YGN

Programme

Introduction with career testimonials of young professionals

Session 1 – Understanding your own motivations & priorities (30 minutes)

Introduction, and then working in pairs to ask each other questions and create a picture of what each of you are looking for (example questions will be provided in the introduction)

Session 2 – Mapping your motivations & priorities to opportunities in the international job market (30 minutes)

Introduction, and then working in the same pairs again to create an outline of which countries, organisations and projects match each person's capabilities, motivations and priorities

Session 3 – Tools and techniques for successful international careers (30 minutes)

- Information sources that can help you gather relevant information

- How to find and work with mentors and sponsors
- Network building
- Getting involved in areas of interest and building your personal brand

Summary and Close – (10 minutes)

A recap on what has been covered and suggestions of follow up and next steps

ENS YGN 2nd Workshop - "Communicating science - Don't waste it! "

Wednesday, 1 June at 09:30 – 11:30

As scientists and nuclear professionals, we often have the opportunity to speak about nuclear and to share our passion for it. How do we best get this across? How can we communicate science?

Let's take the example of nuclear waste. We are often confronted with questions about it. Don't waste the opportunity and provide facts in an understandable way, using simple comparisons and handy references. Come and learn how to lead an engaging conversation!

Moderators: John C.H. Lindberg – author of a communications guide to conversations about nuclear.

Elsa Lemaitre, Chief Internal Auditor, CEA and Deputy Head of French YGN on Innovation

On the agenda: hands-on training on communications. We will all together develop a simple guide on communicating about nuclear waste.

What is important before you start

The magic of the first sentence

Facts about waste

Comparisons and visuals

Conclusion

ENS YGN 3rd Workshop - "Nuclear for Climate - Positive campaigning of nuclear topics"

Wednesday, 1 June 15:30 – 17:30

Imagine the enormous impact you, as a single individual, has in the climate change conversation. Your voice is powerful, and when directed in the right places, highly impactful. And now imagine what would happen if we compounded all our efforts, sharing the same message across the globe, to communicate to leaders and decision makers that 'enough is enough: we need action now'. It would be immense.

Global climate activism describes a growing movement of young people across the world taking action to halt the devastating effects of climate change. We are determined to reach net zero before 2050, and firmly believe that following the science and being technology inclusive is the best way to achieve this. Nuclear energy working alongside other clean energy technologies is essential to reaching this goal.

Using the 'I, us, we' principles of climate activism, this interactive, thought-provoking workshop will equip you with the necessary tools to communicate nuclear energy to friends, family, strangers, and everyone in between. This two-hour session will explore how trust, people and action lie at the heart of a successful climate campaign and how we can use the principles of compound interest to prepare for COP27. It will also give attendees the opportunity to explore their personal voice and contributions to the climate conversation, especially around discovering how to become bold, vocal climate champions.

We will draw on the experience and learnings of the hugely successful #NetZeroNeedsNuclear COP26 campaign, and workshop how we can build upon these achievements for November's COP27 conference.

Join the Nuclear for Climate team as they guide you through this engaging, action-focused workshop. Open to all backgrounds, viewpoints, experiences. #Togetherisbetter

Moderator: Sophie Zienkiewicz

Friday
3 June 22

Day 4
AM-PM

Technical visits

- JACOMEX
- SILEANE
- VELAN
- CEA Marcoule
- ANDRA Cigeo

JACOMEX

https://www.jacomex.com/

Jacomex is leader in the design and manufacturing of:

- inert gas purification units,
- glove boxes for the nuclear, R&D and industrial sectors,
- pharmaceutical isolators,
- customized containment enclosures of all sizes.

The company has a multi-skilled and established 75-years experience and has its main services, as design and production, located at Dagneux, close to Lyon.

Jacomex is worldwide renowned from having permanently focused on technique, strong tightness control and safety. Therefore, the company has developped a varied range of gloveboxes and systems designed for specific applications:

- gloveboxes and filtered containment enclosures operating in negative pressure under air or inert gas for the protection of operators and the environment,
- gloveboxes in positive pressure working under highly pure inert gas for the protection of air-sensitive products,
- standard and custom gloveboxes,
- climatic glove boxes,
- nuclear purified glove boxes.

The company has also developped specific nuclear ventilation safety equipment, like regulating and safety valves, filter housings and ventilation accessories which have been now in use for decades.

Terms of registration

Departure: 9:00 a.m at Lyon Perrache train station
Expected return: 12:15 p.m at Lyon Perrache train station
30 minutes journey by bus

Required: have your identity papers on the day of the visit.

SILEANE

https://www.sileane.com/en/

Siléane's men and women have been serving their customers since 2002. They give eyes and hands to "blank" robot arms and endow them with analysis capabilities for many industrial applications (agri-food industry, pharmacy, HPC, environment, plastics industry, micro-technology, automobile, etc.).

Handling, packing, assembling, … sorting waste, deconstructing for recycling, bin picking all kinds of objects, … these are all activities that our technologies serve efficiently for the automation of gestures in random or unknown contexts, where blind robots can no longer operate.

Our teams use all their enthusiasm to innovate in many disciplines (mechanics, mechatronics, robotics, cobotics, vision, artificial intelligence, etc.). So Siléane robots analyse their environment and adapt their gestures and movements in real time to act meticulously, accurately, delicately and speedily. This is what makes them so different!

At the crossroads of digital, optics and automation, Siléane's activity and R&D stimulates the industrial sectors, proof of which is seen in its market-leader products.

Located in Saint-Etienne, Siléane now has nearly 90 members of staff and has a turnover in the order of 11 million Euros.

Terms of registration
Departure at 8:30 a.m at Lyon Perrache train station
Expected return at 6:00 p.m at Lyon Perrache train station
50 minutes journey by bus

Required: have your identity papers on the day of the visit.

VELAN

https://www.velan.com/

Velan France was established in 1974 for supplying the newborn French Nuclear Industry. Located in Lyon (France) in a 20 000 m^2 plant, Velan France is specialized in the design and manufacture of High performance valves for Nuclear, Cryogenic and specific applications (300 people, 70 M€ turnover). With an installed base in 350 nuclear power reactors worldwide and with over 50 years of uninterrupted nuclear experience, Velan is the leading valve supplier for all nuclear reactor technologies: PWR, EPR, VVER, HUALONG, AP1000, BWR, PHWR, CANDU, FBR, AGR and HTR…

As an actor of upstream research and continuous innovation, Velan constantly develops new technologies in order to anticipate the technical and regulatory requirements of future generation of Nuclear Reactors such as GENIII PWR reactors, GENIV sodium cooled Fast Breeder and HTR reactors or GENV "TOKAMAK" fusion reactors.

Terms of registration
Compagnie at Lyon, meeting on site at 10:00 a.m (precise address communicated later)
Access by public transport (tram or metro)

Required: have your identity papers on the day of the visit.

Both CEA and CIGEO visit are submitted to security clearance

CEA Marcoule

https://www.cea.fr/Pages/le-cea/les-centres-cea/marcoule.aspx

The CEA is a key player in research, development and innovation in four main areas: energy transition, digital transition, technology for the medicine of the future and defense and security. Its research activities at Marcoule site are involved in circular economy for low carbon energies. This centre also carries out highly technical clean-up and dismantling projects. During these visits, you will discover 3 facilities: Atalante (fuel cycle), G2/G3 (dismantling projects), and a waste conditioning facility.

Terms of registration

Departure at 7:15 a.m at Lyon Perrache train station
Expected return at 6:30 p.m at Lyon Perrache train station
2 hours journey by bus

Required: if you register for this visit, you agree to send us a copy of your ID (both sides) by email before Thursday, May 19 at 3pm.

ANDRA - Cigéo

https://international.andra.fr/

Cigéo (Industrial Centre for Geological Disposal) is the deep geological disposal facility for radioactive waste to be built in France. Cigéo will serve for disposal of highly radioactive long-lived waste produced by France's current fleet of nuclear power plants, until they are dismantled. This waste results from the reprocessing of spent fuel from these plants. Until the disposal facility is built, the centre includes the Bure Underground Research Laboratory (URL). The scientific and technological research carried out within the Callovo-Oxfordian host clay layer at the Bure URL has supported the Cigéo project for more than 15 year today. Located at - 490 m depth, it now represents a 1,800-metre network of drifts, monitored by more than 11 000 sensors, where over 50 experiments and studies are conducted in real conditions. More than 1000 samples have been drilled for characterisation purposes.

Terms of registration

Departure on Thursday June 2nd afternoon (by bus, to be confirmed), from Lyon
4 hours journey by bus

Required: Please note that for the visit to take place you will be asked to confirm by Friday 13/05 and to provide the necessary information as soon as possible.

The participants will have to book a room in one specific hotel (further information will follow after confirmation of the visit). The participants will be back to Lyon on Friday afternoon (around 6:00 pm).


FISA 2022
EURADWASTE'22

FISA 2022 SESSION 1 - Safety of nuclear installations
003-inv-fisa-s01-abs-rev00-SERRANOGARCIA_Marta
015-inv-fisa-s01-abs-rev00-BRYNK_Tomasz
021-inv-fisa-s01-abs-rev00-CAGNAC_Albannie
034-inv-fisa-s01-abs-rev00-BROUDIN_Morgane
008-inv-fisa-s01-abs-rev00-DEMAZIERE_Christophe
002-inv-fisa-s01-abs-rev00-TULKKI_Ville
009-inv-fisa-s01-abs-rev00-WIGHT_Jared
057-inv-fisa-s01-abs-rev00-HERRANZ_Luis
036-inv-fisa-s01-abs-rev00-HELMINEN_Atte

ENSURING SAFETY WITH PASSIVE SYSTEMS – ELSMOR AND PASTELS PROJECTS

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Safety issues are at the forefront in the design of nuclear power plants. The Fukushima Daiichi nuclear accident showed the vulnerability of nuclear power plants to a long-term loss of electrical power and consequently the insufficient performance of residual heat removal. Prevention and mitigation strategies for these events were analysed and led to the need for safer and more reliable residual heat removal solutions. To address these challenges, new designs, in particular small modular reactors, rely on passive safety functions to ensure high level of safety with simplified systems. Within the framework of the European H2020 programme, two projects are currently underway to enhance the knowledge of European nuclear actors in their ability to design and deliver such innovative passive safety systems. On the one hand, the ELSMOR project, which started in September 2019, develops systematic methods for safety assurance of new and innovative reactors. The project also aims to demonstrate that European experimental infrastructures and modelling tools are ready to be used in the safety assurance of SMRs with passive safety systems. Initial work has focused on the identification of the safety approaches proposed by different SMR designs and the evaluation of phenomena critical to their operation. On the other hand, PASTELS project, launched in September 2020, aims to develop the knowledge of innovative passive systems for residual heat removal and focuses on two types, namely the safety condenser and the containment wall condenser. The ability of thermal-hydraulic system codes and CFD codes to accurately model the key phenomena such as natural circulation and condensation will be evaluated using existing and new experimental databases carried out during the project.

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REACTOR PERFORMANCE, SYSTEM RELIABILITY: LONG TERM OPERATION

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The recent decision of the European Commission to include nuclear activities within the draft text of the Taxonomy Complementary Delegated Act means that nuclear would facilitate the transition towards a predominantly renewable-based future. This target should be achieved, among other actions, by establishing long term operation (LTO) programs on existing European nuclear capacity. Long-term operation can be defined as operation of a nuclear power plant, justified by a comprehensive safety assessment that goes beyond a previously established time frame corresponding to initial design assumptions. This paper will summarize the status of the following projects directly devoted to support a safe LTO methodology, funded under H2020-Euratom: European Database for Multiscale Modelling of Radiation Damage (ENTENTE GA : 900018) that aims to design a new European experimental/modelling materials database to collect and store highly-relevant data on radiation damage of Reactor Pressure Vessel (RPV) steels; STRUctural MATerials research for safe Long Term Operation of LWR NPPs (STRUMAT-LTO GA 945272) that aims to address individual and synergetic effects of Ni, Mn and Si on RPV embrittlement and the validity of existing embrittlement trend curves at high fluence regimes by exploiting the Lyra-10 specimens; Nondestructive Evaluation (NDE) System for the Inspection of Operation-Induced Material Degradation in Nuclear Power Plants (NOMAD GA 755330) which objective is the development, demonstration and validation of a non-destructive evaluation (NDE) tool for the local and volumetric characterization of the embrittlement in operational reactor pressure vessel steels (RPVs).; and Advanced Structural Integrity Assessment Tools for Safe Long Term Operation (ATLAS+ GA 754589) focused on open technology gaps, identified in the NUGENIA road map, related to piping components, not covered by other ongoing projects.

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Advanced numerical simulation and modelling for reactor safety – contributions from the CORTEX, McSAFER and METIS projects

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Numerical simulations have always represented one of the pillars of nuclear reactor safety, with safety analyses carried out either in a deterministic or in a probabilistic sense. Although well-established methods have been used for the current fleet of reactors for decades, recent developments in modelling capabilities make it possible to address new situations and conditions. In this paper, an overview of the latest advancements in simulation and modelling in the Euratom-funded projects CORTEX, McSAFER and METIS is given. In CORTEX, deterministic and Monte Carlo neutron transport simulations of postulated anomalies are combined with machine learning architectures to detect existing perturbations in operating nuclear reactors, classify them and, when relevant, identify the location of the perturbation. In McSAFER, the existing simulation platforms based on the multi-physics and multi-scale approach are adapted to Small Modular Reactors, focusing on the neutron transport, thermal-hydraulic and fuel thermo-mechanic simulations, and their interdependencies. An experimental program in three EU facilities (MOTEL, COSMOS-H and HWAT) to investigate safety-relevant thermal hydraulic phenomena in the core, reactor pressure vessel and heat exchanger of integrated SMR-concepts complements the numerical investigations. In METIS, a multidisciplinary approach is proposed for the seismic safety assessment of reactors, based on numerical simulations, use of observations for model updating and the uncertainty propagation through the three steps of the analysis, from hazard via structural and equipment fragility analyses to risk quantification. Although the three projects have different objectives, they also present common features. First, various complementary modelling tools with different levels of sophistication are used depending on the target conditions and situations. This also allow assessing the area of validity of low order fast running models versus high-fidelity computationally intensive tools. Second, all modelling approaches require an extensive verification of the tools and validation against experiments. Finally, the assessment of the reliability of the simulations requires complementing the simulations with uncertainty and sensitivity estimates. The paper will detail the development of the modelling capabilities within the three projects, the lessons learnt and the required future developments.

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Innovation and Qualification of LEU Research Reactor Fuels and Materials

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Two projects within the Euratom Research and Training Programmes 2014-2018 and 2019-2020 are focused on the innovation and qualification of novel nuclear fuels for conversion from highly-enriched uranium to low enriched uranium (LEU) and for securing the supply chain of EU research reactors into the future. The LEU-FOREvER project is drawing to a close and has made significant progress developing and demonstrating the uranium-molybdenum fuel system, demonstrating the viability of a high-density uranium-silicide fuel for EU high-performance research reactors (BR2, RHF, FRM-II, JHR). This project has significantly increased the fabrication know-how and fuel performance understanding of the uranium-molybdenum and high-density uranium-silicide dispersion fuel systems. Further, a new, innovative and increased performance design for the LVR-15 research reactor fuel assembly has been engineered and demonstration is planned in 2022. In the EU-QUALIFY project, which began in 2020, the planning of four demonstration irradiation tests has been nearly completed and fabrication development of the various fuel systems is ongoing, including the establishment of an EU monolithic uranium-molybdenum fabrication capability. It is expected that the results of this project will begin or complete the data gathering necessary for generic fuel qualification of the LEU uranium-molybdenum dispersion and monolithic fuel systems, and the LEU high-density uranium-silicide fuel system.

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INCREASE OF NUCLEAR INSTALLATIONS SAFETY BY BETTER UNDERSTANDING OF MATERIALS PERFORMANCE AND NEW TESTING TECHNIQUES DEVELOPMENT (MEACTOS, INCEFA-SCALE AND FRACTESUS H2020 PROJECTS)

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Research on the better understanding of various phenomena influencing materials and components performance are important for increasing the safety of Generation II and III nuclear plant. A crucial step in obtaining the benefit to nuclear safety is the development of new experimental techniques that can provide the necessary data to justify those improvements. The three H2020 projects presented in this paper MEACTOS (2017-2022), INCEFA-SCALE (2020-2025) and FRACTESUS (2020-2024) cover the steps needed to realise those safety improvements.

The goal of the MEACTOS project is to improve the resistance of critical locations, including welds, to environmentally-assisted cracking through optimising surface machining and treatments. The project is currently in its final stage and the complete analysis of the data is finished.

The main objective of INCEFA-SCALE is to improve predictions of component fatigue life when subjected to Environmentally-Assisted Fatigue (EAF). The strategy consists of producing guidance on how to appropriately accommodate variable amplitude and plant relevant loading in EAF assessments. Increasing the understanding of the EAF mechanism based on a substantial testing, characterisation and analysis programme will support the INCEFA-SCALE strategy.

The FRACTESUS project will validate the use of miniaturized compact tension specimens by comparing the results of master curve oriented fracture toughness tests performed with small and large specimens. The round robin exercises will use irradiated and non-irradiated Reactor Pressure Vessel (RPV) materials. The material selection process is complete in time for the project to enter the testing phase. The output of the project will be beneficial from a long-term operation perspective and a saving in the material amount needed for RPV surveillance programs.

Even though each project is devoted to different research areas, common aspects are clearly visible. All three projects are investigating phenomena that are relevant to the performance and safe operation of nuclear plant. Moreover, each project will provide valuable databases and analysis of test results for materials that are relevant for components in nuclear plant. The output of these projects will be of a great value to the nuclear industry. This paper presents current progress for each project emphasising the common research domains between the projects.

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CODES AND METHODS IMPROVEMENTS FOR SAFETY ASSESSMENT AND LTO: VARIED APPROACHES

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Nuclear safety has always been at the heart of the concerns of nuclear power plant operators and developers, as well as of various nuclear research organizations and regulatory authorities.
Over the last decades, all these nuclear actors have developed and integrated a large number of calculation codes and other tools into their safety work. From the system approach to the local understanding of a phenomenon on a given component, from neutronics to operation optimization for long-term operation, these methods and codes have been constantly evolving since their appearance, in order to be able to integrate new plant designs and components, improve the results of modelling physical phenomena or quantify and thus reduce the uncertainties of these results.
Currently, several H2020 Euratom projects are working on the improvement of these codes and methods. This article will focus on three of these projects: CAMIVVER (Codes And Methods Improvements for VVER comprehensive safety assessment), APAL (Advanced PTS Analysis for LTO) and sCO2-4-NPP (innovative SCO2-based heat removal technology for an increased level of safety of Nuclear Power Plants) in order to illustrate our thinking on the improvement of calculation frameworks.
First, we will present the work and the approach adopted with regard to the different calculation codes and methods used in each of these three projects. We will then conclude with an overall analysis of these three approaches, highlighting the difficulties and successes of these three projects, and identifying areas of work for the general improvement of the calculation codes.

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Methodologies for efficient and reliable NPP polymer ageing management

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The lifetime of existing NPPs can potentially be extended to between 60 and 80 years if safety and operability of facilities can be guaranteed. This means that all equipments must keep satisfactory characteristics regarding those specified in the plant design time, with respect to normal operation but also during design basis accidents (DBA) and design extension conditions (DEC) respectively. This requires efforts in terms of equipment qualification and ageing management to support stakeholders and decision makers. Polymers ageing are fully concerned with these programs because they are necessary for the safe operation of an NPP and due to their large number (for example an average of 25 000 cables for a total length of 1 500 km per NPP unit), the monitoring their integrity remains a challenge.

Up to now, polymer ageing control methods are of two types. Firstly, sampling of deposit or real equipment (for example coring) and subsequently expertise of the material in a laboratory. If this method meets the criteria of reliability, this is invasive, expansive, and time-consuming. Secondly, non-destructive exams like indentation. In this case, criteria are based on material-dependent and poorly understood correlations between the measured property and the end-of-life criteria. These correlations are material dependent and require previous establishment of abacus. Thus, within the H2020-Euratom R&D programs two complementary innovative projects have been launched, namely:

- TeaM Cables, that aims to develop new multiscale approach and tools for polymer ageing management in cables, especially their insulation and jacket materials that might be vulnerable to ageing degradation during normal operation and accidents. The project allows to establish physics-based predictive tools to ensure that cable ageing does not lead to unsafe operation. These models are being developed and validated on dedicated laboratory, experiments and in-field expertise.
- El Peacetolero project that aims to set up a miniaturized and portable optoelectronic system able to characterize chemical changes in a polymer. This equipment, usable by a non-specialized operator or by a remote-controlled device, would allow instantaneous and non-destructive analysis

which will increase the reliability and drastically simplify the operations (reducing maintenance costs but also an increase of radioprotection).

The combination of these 2 projects allows to provide the community with highly efficient tools, non-destructive and predictive, that can help assessing the reliability and functionality of the polymer’s-based components such as cables or pipes.

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PROBABILISTIC SAFETY ASSESSMENT FOR INTERNAL AND EXTERNAL EVENTS ON NUCLEAR POWER PLANTS AND ON MITIGATION STRATEGIES / H2020 EUROPEAN PROJECTS NARSIS, R2CA AND BESEP

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The response to the 2011 Fukushima nuclear accident has led to stringent safety requirements in many EU countries. To verify the fulfilment of the stringent safety requirements proven and justified safety analysis methods should be developed and applied in the European nuclear industry. Such methods have been studied and developed for internal and external events and on mitigation strategies in three EU projects: NARSIS, R2CA and BESEP.

The NARSIS project aimed at improving assessment methodologies to be integrated in "extended Probabilistic Safety Assessment" (PSA) procedures for nuclear plants in case of single, cascade and combined external natural events. An open-access framework tool has been released to build multi-hazard scenarios, keeping only hazard parameters relevant for the safety assessment of the main critical plant structures, systems and components. Various risk integration approaches (e.g. Bayesian Networks) have been implemented and compared as well, identifying their advantages and limits. The project achievements have led to recommendations useful for further collaborative research activities.

The R2CA project aims at harmonizing the safety analysis methods for best estimate evaluations of the radiological consequences in case of Design Basis Accidents and Design Extension Conditions without significant fuel melting. It is planned to improve models and upgrade existing simulation tools and calculation chains used in safety studies. Among results, some guidelines to design and implement new Accident Management Procedures and safety devices are expected, as well as the development of innovative approaches (e.g. artificial intelligence) for anticipated accidental situation diagnosis.

Finally, the BESEP project aims to support safety margins determination, by developing best practices for safety requirements verification against external hazards, using efficient and integrated set of Safety Engineering practices and PSA. The core of the project is a benchmark exercise based on case studies previously performed by the consortium participants. In the benchmark, the performance of various safety analyses (i.e. Deterministic Safety Analysis, PSA and Human Factors Engineering) and Safety Engineering practices are compared to common safety requirements defined for the project. Expected project result is best practices and guidance for the verification of evolving and stringent safety requirements against external hazards.

036-inv-fisa-s01-abs-rev00-HELMINEN_Atte

SAFETY ASSESSMENTS AND SEVERE ACCIDENTS, IMPACT OF EXTERNAL EVENTS ON NUCLEAR POWER PLANT AND ON MITIGATION STRATEGIES

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Nuclear safety has ever been one of the main research domains in EURATOM programs for decades, and accident prevention and mitigation have got much of the attention paid along the years in this framework. In the essence of this concern are the struggles for designing reliable systems capable of removing decay heat under any off-nominal condition, for developing accurate assessing methods to estimate risk and for implementing efficient accident management measures, , among others. This is, respectively, the focus of PIACE, MUSA, and AMHYCO projects.

PIACE, coordinated by ENEA and participated by 10 European organizations, will demonstrate the feasibility and reliability, with the aim to achieve an increased technology readiness level (TRL) and shortening the time to market, of an innovative Decay Heat Removal (DHR) system, based on an isolation condenser with non-condensable gases, to manage the variable decay heat in passive way. The innovative concept has the important peculiarity to be completely passive and to have the flexibility to be adapted both to liquid metal and water cooled reactors. The system is based on the concept of isolation condenser as ultimate heat sink and natural circulation for mass and energy transport. Non-condensable gases areadded to the system to passively control the rate of energy transferred to the environment.

MUSA (Management and Uncertainties Of Severe Accidents), coordinated by CIEMAT and participated by 28 organizations (European and non-European), will build a harmonized approach for the analysis of uncertainties and sensitivities associated with Severe Accidents (SA) and, particularly, with the Source Term to the environment. Major steps have been given in the identification and quantification of uncertainty sources and the familiarization with uncertainty and sensitivity analytical tools (WP2 and WP3, respectively), and the project is fully immersed in the phase of application both in reactor (WP5) and spent fuel pools (WP6). Preceding those applications, partners have used the PHEBUS-FPT1 scenario to test their approaches for the BEPU analyses of SA (WP4) and a number of useful insights have been gained for the WP5 and WP6 applications.

AMHYCO (Towards and enhanced Accident Management of the Hydrogen/CO combustion risk), coordinated by UPM and participated by 11 organizations (all of them from Europe, except CNL from Canada), will investigate potential innovative enhancements in the way combustible gases are managed in case of a severe accident. By conducting experiments addressing H_2/CO combustion and mitigation with PARs (Passive Autocatalytic Recombiners), and optimizing the current code predictability, it is foreseen that the Severe Accident Management Guidelines (SAMG) with respect to combustible gases risk will be enhanced.

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FISA 2022 SESSION 2 – Advanced nuclear systems and fuel cycles
099-inv-fisa-s02-abs-rev00-MIKITYUK_Konstantin
053-inv-fisa-s02-abs-rev00-SHUURMANS_Paul
006-inv-fisa-s02-abs-rev00-MALERBA_Lorenzo
004-inv-fisa-s02-abs-rev00-SOBOLEWSKI_Josef
108-inv-fisa-s02-abs-rev00-FRANZEN_Carola

REVIEW OF EURATOM PROJECTS ON DESIGN, SAFETY ASSESSMENT, R&D AND LICENSING FOR ESNII/GEN-IV FAST NEUTRON SYSTEMS

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The European Sustainable Nuclear Industrial Initiative (ESNII) aims at demonstrating Generation IV Fast Neutron Reactor technologies and supports relevant research infrastructures, fuel facilities and research and development (R&D) work. ESNII was established in 2010 under an umbrella of Sustainable Nuclear Energy Technology Platform (SNETP) to promote the European Union (EU) contribution to Generation-IV reactors. SNETP has prioritised the different Generation-IV systems and is proposing to develop the following projects: the sodium-cooled fast neutron reactor technology ASTRID as the reference solution; the lead-cooled fast reactor ALFRED supported by a lead-bismuth irradiation facility project MYRRHA as a first alternative; the gas-cooled fast reactor ALLEGRO as a second alternative. The Molten Salt Fast Reactor (MSFR) is considered as a very attractive long-term option. The EU framework programs have supported a number of R&D activities on these systems as well as on other Generation-IV technologies, including a European Sodium Fast Reactor (ESFR) as well as some cross-cutting activities. The paper briefly presents in terms of key objectives, results and recommendations five Euratom projects started since late 2017 in support of the infrastructure and R&D of the four Generation-IV reactor systems.

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PATRICIA & PASCAL: CONTRIBUTING TO HLW WASTE MANAGEMENT BY PARTITIONING AND TRANSMUTATION

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Management of high-level waste (HLW) by closing the fuel cycle is crucial to advance sustainability of nuclear energy. Partitioning of spent fuel, multiple Pu reuse and transmutation of minor actinides (MA) like Am, Cm and Np are essential as altogether, they drastically improve fuel efficiency and lighten the burden on geological disposal. Indeed, thorough (multiple) partitioning and transmutation (P&T) has the potential to reduce the time needed to bring down the radiotoxicity of HLW to that of natural uranium from a geological time scale (> 100 000 y) to a human time scale (300 y). Realisation of P&T requires four building blocks: partitioning of Pu and MA from spent fuel, conversion into MA bearing fuel for transmutation, irradiation using fast neutrons in a critical reactor or a dedicated subcritical accelerator driven system (ADS) and finally, partitioning of the MA bearing fuel after irradiation since several cycles will be needed. Regarding prioritization of the R&D for these four blocks, it is clear that the first three are all needed in the demonstration phase whereas the fourth mainly comes into play when HLW P&T is scaled up to an industrial level. The EU supports management of HLW waste by P&T through the PATRICIA and PASCAL projects. PATRICIA (Partitioning And Transmuter Research Initiative in a Collaborative Innovation Action) has four technical domains that respectively work on partitioning Am from PUREX raffinate, development, improvement and validation of fuel performance codes for MA bearing fuel, the safety of the driver fuel of the MYRRHA ADS system and finally ADS system safety. The PASCAL (Proof of Augmented Safety Conditions in Advanced Liquid-metal-cooled systems) project is closely linked to PATRICIA, focusing on MYRRHA and ALFRED as the demonstrators of ADS and lead-cooled fast reactors (LFR), i.e., both options for transmutation systems, by exploiting the large synergy between them. PASCAL assesses the augmented safety of heavy liquid metal systems by addressing retention mechanisms of fission products in case of barrier failure within the fuel pin system, the coolant system and the containment system. In addition, PASCAL will study phenomena that can impair the integrity of the barriers. In the paper presented here, the activities of both projects are shown in detail.

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TOWARDS A SINGLE EUROPEAN STRATEGIC RESEARCH AND INNOVATION AGENDA ON MATERIALS FOR ALL REACTOR GENERATIONS THROUGH DEDICATED PROJECTS

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The ORIENT-NM project is elaborating a single European strategic research and innovation agenda (SRIA) that should set the path for future activities on nuclear materials in the EU, until 2040, serving all reactor generations. The key in this endeavour is to focus on advanced materials science practices that, combined with digital techniques, will enable acceleration in materials development, manufacturing, supply, qualification, and monitoring, in support of nuclear energy safety, efficiency, economy and sustainability. This research agenda will not come out of the blue: it will be rooted in existing virtuous examples of materials science projects that target nuclear energy innovation. Here three of them are considered, that cover different reactor generation applications. NUCOBAM aims at developing the qualification process and provide the evaluation of the in-service behavior of additively manufactured components in nuclear installations, as a promising technique to tackle obsolescence challenges in operating reactors and manufacture new components with optimized design, for increased safety and efficiency. GEMMA addresses a number of key areas concerning materials development and qualification for GenIV reactor conditions, namely: corrosion-resistant austenitic steels for application in heavy-liquid metal-cooled systems; production of welds on available austenitic steels and their characterization in terms of internal stresses; testing of all these materials (baseline, welds and advanced) under representative conditions in contact with heavy liquid metals and helium; development of physical models for the prediction of the behaviour of austenitic alloys under long term irradiation. Finally, the M4F project creates a bridge between fission and fusion materials communities, by applying physical modelling techniques to target two objectives: understand and predict the origin and effects of localised deformation under irradiation in ferritic/martensitic steels affecting the mechanical behaviour of components for future fission and fusion reactors, so as to enable their design based on robust standards; to develop good practices to use ion irradiation as a tool to evaluate radiation effects on materials, also applied to ferritic-martensitic alloys. This paper will report on the key ideas of the

ORIENT-NM SRIA and will highlight selected results of the NUCOBAM, GEMMA and M4F projects.

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Nuclear Cogeneration with High Temperature Reactors

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The Nuclear Cogeneration Industrial Initiative (NC2I), one of the three pillars of the (European) Sustainable Nuclear Energy Technology Platform (SNETP), emphasizes that non-electric energy needs (industry, transport, district heating, etc) represent a large fraction of energy needs in industrialized countries. Almost entirely produced by fossil fuels today, they cause the largest part of the emission of CO_2 and other noxious gases. NC2I partners were therefore working together in the GEMINI+ project co-funded by Euratom towards nuclear CO_2-lean solutions in non-electric applications. The result is a conceptual design and safety approach for a High Temperature Gas-cooled Reactor (HTGR) for industrial cogeneration.
The Polish government has declared its interest in replacing coal and gas with nuclear energy in industry offering an opportunity for near-term demonstration of nuclear industrial high temperature cogeneration with an HTGR. In the frame of national strategy program GOSPOSTRATEG, the National Centre for Research and Development was granted about €4M (2019 – 2022) for preparation of law, organization and technical instruments to deploy the HTGR.
GEMINI+ focused on the support of such a demonstration, aligning the characteristics of the proposed design to the needs of Polish industry where the priority is to replace fossil-fired boilers. The system is flexible to adapt in many industrial sites, which implies having components compact enough to be transportable to the site by road and to shorten works at construction site, and to adapt without design change to various fractions of process steam and electricity. Flexibility is also required in accommodating load variations on a local industrial site.
In 2021, the Polish Ministry of Education and Science signed with NCBJ the contract for further design work towards a research and demonstration HTGR. The conditions for preparing construction of this reactor within three years will be created and most of the basic design will be accomplished. The reactor will be a prismatic type HTGR using TRISO fuel producing approximately 30-40 MWth at an outlet temperature of 750^{o}C. The 3 year contract value is €14M.
For the new Euratom Programme, NC2I partners submitted the GEMINI 4.0 project proposal. GEMINI 4.0 is to clear the way towards demonstration and subsequent deployment of high temperature industrial nuclear cogeneration with the system developed in GEMINI+, by addressing open questions regarding system safety demonstration and confirmation of its licensing readiness, the capacity of

polygeneration of process heat, hydrogen and electricity with this system and feasibility of a consistent fuel cycle.

004-inv-fisa-s02-abs-rev00-SOBOLEWSKI_Josef (GEMINI-PLUS)

ARIEL & SANDA NUclear DATA Activities

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Nuclear data are fundamental quantities for the development of nuclear energy concepts and research. They are essential for the simulation of nuclear systems, safety and performance calculations and reactor instrumentation. Nuclear data improvement requires a combination of many different know-hows that are distributed over many small and medium sized institutions along Europe. In the EURATOM call for Nuclear Fission and Radiation Protection NFRP-2018 two nuclear data projects were started in September 2019: The Coordination and Support Action ARIEL (Accelerator and Research reactor Infrastructures for Education and Learning) and the Research and Innovation Action SANDA (Solving Challenges in Nuclear Data for the Safety of European Nuclear facilities).
The ARIEL project brings together the most modern and state-of-the-art European neutron beam laboratories using the full range of neutron sources from high-energy proton synchrotons to research reactors. Measuring and improving nuclear data is a complex process, which relies on neutron facilities and on highly-trained nuclear physicists. Twenty-six partners from 15 European countries are working together for the education and training of a new generation of young scientists and technical staff.
The ARIEL project provides: transnational access to neutron facilities, training of early-stage researchers through scientific visits, four summer schools for students to increase attractiveness at the university level, and three scientific workshops and progress meetings.
The SANDA project unites the majority of the European nuclear data community, infrastructures (35 partners from 19 countries) and resources. The main goals are to improve and develop differential experiments, data evaluation and validation, and dissemination to the very high level required quality required to comply with the needs for the safety standards that are mandatory for present and future European nuclear reactors and other installations using radioactive materials. The selection of activities has been made taking into account the relevance, expected impact and priorities of the resulting data according to the NEA/OECD and IAEA high priority lists. The impact has been evaluated from the perspective of a safe, efficient and competitive use of nuclear technologies.
The talk will show the progress of the ARIEL and SANDA projects, highlighting important results reached and despite some difficulties in scientific work and mobility of researchers.

108-inv-fisa-s02-abs-rev00-FRANZEN_Carola

FISA 2022 SESSION 3 - Education and training, research infrastructures, low-dose radiation protection research, decommissioning and international cooperation
005-inv-fisa-s03-abs-rev00-PAVEL_GabrielLazaro
044-inv-fisa-s03-abs-rev00-HIERATH_Monika (ALL RADIOPRO)
100-inv-fisa-s03-abs-rev00-KULKA_Ulrike
023-inv-fisa-s03-abs-rev00-VANDENHOVE_Hildegarde
007-inv-fisa-s03-abs-rev00-WINKLER_Robert
089-inv-fisa-s03-abs-rev00-MALLERON_Nicolas (PAPER)
001-inv-fisa-s03-abs-rev00-KINNUNEN_Petri

EDUCATION, TRAINING AND MOBILITY, KNOWLEDGE MANAGEMENT: TOWARDS A COMMON EFFORT TO ENSURE A FUTURE WORKFORCE IN EUROPE AND ABROAD

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The European Commission through its Euratom Program continuously supports the initiatives in the nuclear field through both collaborative projects (Indirect Actions) or via direct research activities implemented by the European Commission Joint Research Centre, JRC (so-called Direct Actions). Both types of actions support research contributing to increased knowledge and competences for nuclear safety and safeguards. A dedicated line of recent collaborative projects addresses the specific needs in the sector such as lack of personnel (ENENplus) and provide state-of-the-art approaches and in-depth knowledge when it comes to reactor physics (GRE@T-PIONEeR) or nuclear radiochemistry (A-CINCH). A highly skilled nuclear engineer must undoubtedly undergo experimental work to better observe theoretical principles at work. Following the ENEEP initiative, a network of research reactors is made available for performing such activities. Another issue found is that results of Euratom funded research activities are spread across multiple platforms and websites making it difficult to find relevant information within a reasonable timeframe. To cope with this situation, the PIKNUS project aims to define a concept of a knowledge management (KM) method and tool to improve the sharing and availability of Euratom research results.
As methodologies to tackle the lack of personnel and to substantially contribute to the revival of the interest of young generations to the nuclear sector, several actions are undertaken under the ENENplus project to attract, retain and sustain the nuclear talents throughout their entire E&T career. Under both A-CINCH and GRE@T-PIONEeR projects, state-of-the-art tools and methodologies are proposed for enhancing knowledge retention, such as: active learning, flipped classes, video materials, interactive live sessions, computer simulators and computer-based modeling, 3D virtual reality, "learn through play" – lessons gamification, virtual robo-laboratory,

NucWiki, MOOCs, etc. Within the ENEEP consortium, a dedicated platform is created and shared with the community to provide both access to nuclear facilities but also a pre-defined set of actions in regard to hands-on training. Within the PIKNUS project, the developed information system will provide a single platform to access the aggregated knowledge of both Direct and Indirect Actions of Euratom programmes.

005-inv-fisa-s03-abs-rev00-PAVEL_GabrielLazaro

MEDICAL APPLICATIONS OF IONIZING RADIATION AND RADIATION PROTECTION FOR EUROPEAN PATIENTS, POPULATION AND ENVIRONMENT

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Medical applications of ionising radiation represent a key component of diagnostic and treatment of many diseases, guaranteeing efficient health care for European citizens. The use of ionising radiation in medicine, the largest source of general population exposure to radiation, is potentially associated with increased risk of cancer and non-cancer diseases. It is particularly important to evaluate the magnitude of these detrimental effects to provide evidence-based input for risk benefit evaluations. In parallel, efforts are undertaken to contribute to better safety and efficacy of all medical applications through optimisation of doses from ionising radiation.

The European Commission, through the Euratom research and training programme, is enhancing research in the field of radiation protection with particular attention to medical applications. The four multidisciplinary projects presented here have been selected for funding as they contribute, in a complementary fashion, to 1) improve knowledge on the most important sources of diagnostic and therapeutic applications and 2) transfer the research results into clinical practice. A common aim is to optimize use at the individual level, taking into consideration education and training and ethical aspects, especially related to implementation of modern technologies based on artificial intelligence.

MEDIRAD, SINFONIA and HARMONIC consider detrimental effects from medical exposure in adult and paediatric cancer patients: MEDIRAD in breast and thyroid cancer patients; HARMONIC in paediatric cancer patients; and SINFONIA develops novel methodologies to provide a risk appraisal of detrimental effects of exposure in lymphoma and brain tumour patients, as well as in workers, carers and comforters, the public and the environment.

MEDIRAD also studies the carcinogenic effects of diagnostic paediatric CT scanning, while HARMONIC investigates these effects in paediatric cardiac catheterization. MEDIRAD also studies patient and staff exposures/doses associated with fluoroscopically guided procedures and doses from CT in adult and paediatric patients. Moreover, it fosters optimisation by combining patient-based organ dose information and image quality assessment.

All three projects will ultimately provide the scientific and medical communities with specific recommendations, with EURAMED rocc-n-roll considering all of these to build, in collaboration with the EU Radiation Protection platforms, a strategic research agenda and a roadmap. These will identify and prioritise research needs for medical applications of ionising radiation, as well as for the corresponding radiation protection, including ethical aspects and needed infrastructures.

044-inv-fisa-s03-abs-rev00-HIERATH_Monika (ALL RADIOPRO)

RADONORM - TOWARDS EFFECTIVE RADIATION PROTECTION BASED ON IMPROVED SCIENTIFIC EVIDENCE AND SOCIAL CONSIDERATIONS – FOCUS ON RADON AND NORM

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RadoNorm aims at managing risks from radon and NORM exposure situations to assure effective radiation protection based on improved scientific evidence and social considerations.

The project findings and outcomes will have a significant impact on radiation protection in Europe and beyond, thanks to its focus on 1) Initiation, support and implementation of multidisciplinary, innovative, integrated research and technology activities, 2) Integration of education and training in the research and development work of the project and 3) Dissemination of project results through specific actions targeting broad stakeholder community including among others the public, regulators, and policy makers. The project supports European states and the EU Commission in implementing the Basic Safety Standards for protection against ionising radiation hazards at the legislative, executive, and operational levels (Directive 2013/59 / EURATOM) with the aim to significantly reduce uncertainties in all steps of radiation risk management for radon and NORM (naturally occurring radioactive materials). Scientific, societal, and technical aspects of exposure conditions are addressed and clarified, also including exposure from TENORM (technologically enhanced naturally occurring materials). The objectives are achieved through work packages, including scientific research-related topics (exposure, dosimetry, biology, epidemiology, societal aspects), cross-cutting topics (education and training, dissemination, ethics) and project management. The outputs of the project will include guidelines and recommendation at legal, executive and operational levels. It will enable consolidated, harmonized and sound decision-making in the field of radiation protection considering societal aspects and sustainable knowledge transfer. Thus, RadoNorm contributes in a pioneering way to the implementation of the Basic Safety Standards (BSS), inter alia through knowledge in the field of exposure, dose assessment, effects and risks, as well as countermeasures.

The project also fits seamlessly into the EC's activities to further optimise radiation protection in a consistent and joint manner, as has already been done in previous Commission activities, including the establishment of radiation protection platforms such as MELODI, as well as the promotion of projects such as DoReMi NoE, OPERRA, and partnerships such as CONCERT-EJP and PIANOFORTE. Studies, e.g. addressing exposure, dosimetry and effects and risks of radon and NORM add to knowledge on science underpinning the System of Radiation Protection and may thus impact future international recommendations by the ICRP.
The RadoNorm activities and achievements since the project start are presented.

100-inv-fisa-s03-abs-rev00-KULKA_Ulrike

The importance of MEENAS in the European radiation protection research and innovation scene

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The six European radiation protection platforms represent the divers and multidisciplinary European radiation protection research community. Together we highly value integration and the expression of a common vision to ensure that radiation protection research and innovation maximally respond to the societal needs for radiation protection of human and environment. Therefore, MEENAS, the Consortium of European Radiation Protection Research Platforms, MELODI, EURADOS, EURAMED, NERIS, ALLIANCE and SHARE, was officially established March 2020.

The broad objectives of MEENAS are to:

- Promote the integration and the efficiency of European R&D in radiation protection to better protect humans (public, patients, workers) and environment.
- Advance scientific excellence.
- Further develop and implement the joint R&D roadmap.
- Maintain and develop European research capacity.
- Encourage scientific education and training and foster key research infrastructures in the field of radiation protection.
- Foster international collaboration and collaboration with sister organisations and networks in a non-exclusive manner by open interaction with the wider research community and stakeholders.

We operate as a strong shared-voiced vehicle towards third parties, such as the European Commission (EC), and intend to enforce the position of radiation protection research in Europe and beyond.

MEENAS contributed to the shaping of European radiation protection Research and Innovation landscape. A robust radiation protection co-funded partnership vision document was established by MEENAS and representatives of several radiation protection institutions in close interaction with the entire radiation protection community prepared, following the EC recommendations

This vision document formed the basis of our radiation protection R&D community response to the HORIZON-EURATOM-2021-NRT-01-09 call (European Partnership for research in radiation protection and detection of ionising radiation). The vision supported by this Partnership is to provide a pan-European scientific and technological basis for a robust system of protection and more consolidated science-based policy recommendations to decision makers in all these different fields and – at the same time - to innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches always considering radiation safety. In the long term, these efforts will translate into additional or improved practical measures through innovation and improved scientific insights in view of a better outcome of patients suffering from cancer and the effective protection of people (public, workers and patients) and the environment. Highlights and importance of the PIANOFORTE project will be presented.

023-inv-fisa-s03-abs-rev00-VANDENHOVE_Hildegarde

SHARE - A roadmap for Research in Decommissioning

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The H2020 EU-funded SHARE project (StakeHolders- based Analysis of REsearch for Decommissioning) aimed to provide an information base for enhancing international collaboration in research activities related to nuclear decommissioning. The objective of SHARE was to establish an inclusive roadmap for research, in technical and non-technical areas, in the EU and abroad, to enable stakeholders to jointly improve safety, reduce costs and minimize environmental impact in the decommissioning process of nuclear facilities. The SHARE project approach was primarily based on consultation processes (including a survey and a number of workshops) aiming at identifying the needs and opinions of stakeholders throughout the value chain. The project also considered existing and emerging innovative solutions, as well as international best practices in nuclear decommissioning.

The survey covered a total of 71 sub-thematic areas categorized under 8 thematic groups. In-depth analysis of the responses resulted in a detailed assessment of stakeholders' needs to improve the status quo. Simultaneously, an extensive literature review was carried out along the same thematic areas focusing on surveying existing methodologies and current international initiatives. The identified needs, on-going projects and existing solutions were then further analysed and consolidated by stakeholders feedback and input during various public workshops. A gap analysis was carried out resulting in a list of proposed actions in collaboration with the stakeholders.

The gap analysis also provided the basis for the development of the SHARE Strategic Research Agenda (SRA) and the corresponding roadmap. The SHARE roadmap is a framework organising the priorities identified in the SHARE SRA on a time scale. The SHARE SRA identifies the most promising research activities that will help policymakers in the EU to understand needs and propose strategic areas to be recommended for investment and collaboration in the coming decades.

007-inv-fisa-s03-abs-rev00-WINKLER_Robert

EUROPEAN COLLABORATIVE EFFORTS TO ACHIEVE EFFECTIVE, SAFE, AND COST-CONTROLLED DISMANTLING OF NUCLEAR FACILITIES

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This paper aims to give an overview of very recent European coordinate efforts to implement technologies of the "4.0 Industry" in the nuclear deconstruction sector. This objective aims to benefit from the lever of efficiency and reliability represented by innovative technologies on all the value chain of the dismantling, from early characterization to the dismantling operations themselves through engineering studies, waste management, project management and coordination of multiple stakeholders of each project.
The outcomes of five projects (INNO4GRAPH, LD-SAFE, PLEIADES, CLEANDEM and INSIDER) are summarized here. They result in a unique data and knowledge common base, as well as in a significant sharing of experience based on dismantling projects already carried out or to come. They also result in designing new tools or methods natively taking into account the needs of a maximum of dismantling operators, as well as new test facilities. This will allow the undertaken joint work and collaboration to be continued.
All of this pave the way to further collaborative projects and developments, in order to continue to implement reliable new technologies and processes in European dismantling projects to make the future dismantling operations more efficient, safer and more cost-effective.

089-inv-fisa-s03-abs-rev00-MALLERON_Nicolas (PAPER)

SUPPORTING ACCESS TO KEY PAN-EUROPEAN RESEARCH INFRASTRUCTURES AND INTERNATIONAL COOPERATION

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Large research infrastructures, especially nuclear ones, are extremely expensive to build and operate. Therefore, to develop expertise and competences in nuclear research is more efficient to have a limited number of complementary specialized large nuclear research infrastructures, shared by European researchers from different countries.

Since 2002, JRC has been providing access to its installations through two projects ACTUSLAB (research infrastructures in the field of physics and chemistry of actinides) and EUFRAT (Facilities for Nuclear Reaction and Decay Data Measurements). In 2019 JRC and the Commission DG RTD started a project to provide financial support to the users of the JRC's nuclear research infrastructures. The agreement allowed also enhancing the accessible JRC's infrastructures, opening for external users, additionally, the hot-cells and materials properties laboratories.

The TOURR project is the first well-coordinated action among European Research Reactors (RRs) operators aiming at a strategy for the optimal use of the European RR fleet. The goal is to evaluate the current and future need for neutron sources in Europe along 5 science and technology axes: education and training; basic and fundamental research and its instruments; medical applications, including radioisotope R&D and beam applications; material testing, including fuel, structural material and its instrumentation; core physics testing for reactors in "zero power" installations. Based on this thorough evaluation a strategy for maintaining and upgrading existing RRs and building new ones shall be proposed for the benefit of the European Research Area.

One of the future key infras in Europe will be Jules Horowitz Materials Testing Reactor (JHR). JHR will be a reference high power research Reactor to perform R&D program on innovative nuclear fuels and materials for enhancing safety and competitivity of existing and future power plants as well as providing even up to 50% of the radioisotopes for medical applications for European needs. The consortium is gathering today 15 partners (one of them being the European Commission) and each consortium member has acquired Access Rights giving access to the JHR experimental capacity for the whole life of operation of the reactor. Such Access Rights could be used either for proprietary projects (bilateral contract) or for joint research and development projects.

In particular, these joint R&D projects will be open to non-members of the JHR consortium for the benefit of all European Member States and of the international community.
As Euratom owns 6% of access right to the reactor capacity, it is of utmost importance that these access rights are used effectively. The EU-JHOP2040 project is developing the first roadmaps for JHR's operations to cover the first 15 years of operation.

001-inv-fisa-s03-abs-rev00-KINNUNEN_Petri


FISA 2022
EURADWASTE'22

FISA 2022 SESSION 1 - Safety of nuclear installations	
ENTENTE	130-proj-fisa-s01-abs-rev00-SERRANO-GARCIA_Marta (ENTENTE)
ATLASplus	
NOMAD	
STRUMAT-LTO	
FRACTESUS	160-proj-fisa-s01-pptA0-rev00-BRYNK_Tomasz (FRACTESUS)
MEACTOS	
INCEFA-SCALE	
sCO2-4-NPP	
APAL	
CAMIVVER	
TEAM-CABLES	
El-Peacetolero	
CORTEX	
McSAFER	098-proj-fisa-s01-abs-rev00-SANCHEZ-ESPINOZA_Victor-Hugo
METIS	102-proj-fisa-s01-abs-rev00-ZENTNER_Irmela (METIS)
ELSMOR	166-proj-fisa-s01-pptA0-rev00-TULKKI_Ville (ELSMOR)
PASTELS	158-proj-fisa-s01-abs-rev00-MONTOUT_Michael (PASTELS)
EU-QUALIFY	
LEU-FOREvER	
MUSA	046-proj-fisa-s01-abs-rev00-HERRANZ_Luis (MUSA)
PIACE	
AMHYCO	010-proj-fisa-s01-abs-rev00-JIMENEZ_Gonzalo (AMHYCO)
BESEP	161-proj-fisa-s01-pptA0-rev00-HELMINEN_Atte (BESEP)
NARSIS	085-proj-fisa-s01-abs-rev00-FOERSTER_Evelyne (NARSIS)
R2CA	

European Database for Multiscale Modelling of Radiation Damage (ENTENTE)

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This poster summarize the objectives and first results for the ENTENTE "European Database for Multiscale Modelling of Radiation Damage" project Euratom 2019-2020 Grant Agreement number 9000018. ENTENTE aims to design a new European experimental/modelling materials database to collect and store highly-relevant data on radiation damage of Reactor Pressure Vessel (RPV) steels, according to FAIR (Findability, Accessibility, Interoperability, and Reusability) principles. The project can be seen as three interconnected blocks:

DATABASE Design

- Multi-disciplinary teams (materials scientists, engineers, software developers) will define new effective data formats suitable for microstructural and modelling data, and interfaces needed to ensure interoperability.
- Interface the SOTERIA platform with the ENTENTE database so that experimental data and metadata can be retrieved and post processed in order to correctly parametrize modelling tools.

ADVANCED experiments/models

- Microstructural characterisation, linked with appropriate models, by means of advanced (S)TEM techniques, APT, -XRD and in-situ TEM for mapping the radiation induced defects and associated strain-stress fields.
- In-depth analysis of segregation and structural, chemical nature and strength of grain boundaries to study hardening and non-hardening embrittlement.

INNOVATIVE data analysis and hybrid models

- Simulation tools that enable the description of radiation damage up to length and time scales that are comparable with those reached in experiments on RPV steels. Accelerated physically informed fracture laws with a reasonable predicting capability on heterogeneous microstructures.
- First application of Integrated Computational Materials Engineering (ICME) approaches to enable virtual studies of alternative neutron embrittlement scenarios

- -Machine learning and artificial neural networks approaches not only to support atomistic modelling but also to predict hardening and/or embrittlement

The exploitation of the ENTENTE data base, including the interface with SOTERIA Platform, will allow the integrity assessment of Reactor Pressure Vessel to be improved both in a Long Term Operation (LTO) perspective and for new Gen III+ reactors.

130-proj-fisa-s01-abs-rev00-SERRANO-GARCIA_Marta (ENTENTE)

H2020 MCSAFER: HIGH-PERFORMANCE ADVANCED METHODS AND EXPERIMENTAL INVESTIGATIONS FOR THE SAFETY EVALUATION OF GENERIC SMALL MODULAR REACTORS

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The High-performance advanced methods and experimental investigations for the safety evaluation of generic Small Modular Reactors (McSAFER) project is a research and innovation project funded by the Horizon 2020 research program of the European Commission. McSAFER started in September 2020 and will last until August 2023. Thirteen partners from nine countries form the Consortium. The main objective of McSAFER is to provide new experimental data gained in three different facilities (KIT, KTH, and LUT) under conditions relevant for light-water cooled Small Modular Reactor (SMR)-concepts. Moreover, the purpose of the project is to compare different safety analysis methodologies (industry-like standard methods, advanced and high-fidelity numerical tools) to analyse the behaviour of the core, the Reactor

Pressure Vessel (RPV) and the integral plant under selected transient conditions. The safety evaluations focus on four SMR-concepts: the French boron free F-SMR, the Argentinian CAREM system based on natural circulation and hexagonal core, the US NuScale design, and the Korean SMART reactor. The advanced numerical tools selected for the safety investigations are based on multi-scale (RPV and plant) and multi-physics (core) methods developed partly in former European projects, such as NURESAFE, HPCM and McSAFE. Beyond the involvement of industry (PEL, JACOBS, TRACTEBEL) and research centres (VTT, CEA, HZDR, UJV, CNEA), universities (KIT, KTH, LUT, UPM) are also engaged. The universities foster the education, training (master and doctoral students), and dissemination activities of the knowledge generated inside the project. The McSAFER project is structured around four technical Work Packages and one devoted to dissemination, exploitation and communication.

098-proj-fisa-s01-abs-rev00-SANCHEZ-ESPINOZA_Victor-Hugo

INNOVATION AND CHALLENGES FOR SEISMIC SAFETY ASSESSMENTS ADRESSED BY EURATOM METIS

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EURATOM METIS (Methods and Tools Innovation for Seismic Safety Assessments https://metis-h2020.eu/) has started in September 2020 under the EURATOM Horizon 2020 program and is running until 2024. It addresses the three ingredients of seismic safety assessment in an overall approach: seismic hazard; structural and equipment fragility analyses and integration in the full Probabilistic Safety Assessment (PSA) framework to determine plant failure probabilities.

The overall framework for probabilistic safety assessment is well established but the partitioning into disciplines prevents from integration of common approaches, for example for uncertainty propagation.

In the recent years, there have been significant advances in the scientific and engineering community to develop statistical and numerical approaches for “bestestimate” and site specific assessments. METIS follows these paths and further develops methods to improve the predictability of beyond design analyses. The project further develops the use of databases, numerical simulations and uncertainty propagation to improve fidelity and accuracy of the engineering models.

In this context, one major technical objective of METIS is to develop, improve, and disseminate open-source tools for seismic hazard, fragility and risk assessment. Open-source tools for Probabilistic Seismic Hazard Assessment (PSHA) and structural analyses are getting more and more commonly used both by the scientific and engineering communities and allow for numerous collaborations. One of the high-level objectives of METIS is the development and dissemination of an open-source tool for PSA computations.

This contribution presents the challenges and first results obtained by the METIS consortium.

102-proj-fisa-s01-abs-rev00-ZENTNER_Irmela

THE MUSA PROJECT – MANAGEMENT AND UNCERTAINTIES OF SEVERE ACCIDENTS

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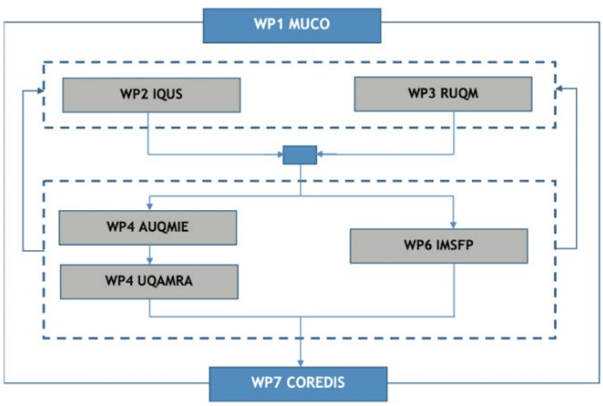
Management and Uncertainties Of Severe Accidents (MUSA) project was founded in HORIZON 2020 EURATOM NFRP-2018 call on "Safety assessments to improve Accident Management strategies for Generation II and III reactors". Coordinated by CIEMAT (Spain) and participated by 28 Organizations from 16 countries, MUSA overall budget is 5.768,452.50 €, more than 55% of which is contributed by the EU. The project started on June 1st, 2019 for a duration of 48 months. On July 7th, 2018, MUSA project received the NUGENIA label recognizing the excellence of the project proposal.

MUSA was devised to build a harmonized approach for the analysis of uncertainties and sensitivities associated with Severe Accidents (SA) and, particularly, with the Source Term to the environment. In this regard, MUSA plans to go beyond the current state-of-the-art regarding the predictive capability of SA analysis codes by assessing/developing methodologies for their use in combination with the best available Uncertainty Quantification (UQ) tools. In order to meet such a purpose a solid work structure has been put in place in the form of technical working packages (WP) properly coordinated.



As shown in the Figure, MUSA consists of 7 WPs: WP1, MUSA COordination and project management (MUCO) led by CIEMAT; WP2, Identification and Quantification of Uncertainty Sources (IQUS) led by GRS; WP3, Review of Uncertainty Quantification Methodologies (RUQM) led by KIT; WP4, Application of UQ Methods against Integral Experiments (AUQMIE) led by ENEA; WP5, Uncertainty Quantification in Analysis and Management of Reactor Accidents (UQAMRA) led by

JRC; WP6, Innovative Management of SFP Accidents (IMSFP) led by IRSN; and WP7, COmmunication and Results DISsemination (COREDIS) led by UNIPI.

After more than two years, major steps have been given in the identification and quantification of uncertainty sources and the familiarization with uncertainty and sensitivity analytical tools (WP2 and WP3, respectively), and the project is fully immersed in the phase of application both in reactor (WP5) and spent fuel pools (WP6). Preceding those applications, partners have used the PHEBUS-FPT1 scenario to test their approaches for the BEPU analyses of SA (WP4) and a number of useful insights have been gained for the WP5 and WP6 applications. It is worth noting that the experiences gained in the "practical WPs" will feedback WP2 and WP3 to eventually formulate recommendations. Specific aspects of the progress made so far will be summarized in this paper.

046-proj-fisa-s01-abs-rev00-HERRANZ_Luis (MUSA)

AMHYCO PROJECT – TOWARDS AN ENHANCED ACCIDENT MANAGEMENT OF THE H2/CO COMBUSTION RISK

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Severe accidents in nuclear power plants are costly and potentially dangerous to both humans and the environment. To prevent and/or mitigate the consequences of these accidents, it is paramount to have adequate accident management measures in place. During a severe accident, combustible gases — specifically hydrogen and carbon monoxide — are released into the containment, potentially leading to combustion events. These combustible gases need to be managed to avoid threatening the containment integrity, as a containment failure would result in unacceptable releases of radioactive material into the environment. The main objective of the AMHYCO project is to investigate potential innovative enhancements in the way combustible gases are managed in case of a severe accident in currently operating reactors. To reach this main objective, the AMHYCO project has three specific objectives: (1) To experimentally investigate relevant phenomena related to H_2/CO combustion and mitigation with PARs (Passive Autocatalytic Recombiners) under realistic accidental conditions. (2) To improve the predictability of analysis tools - Lumped Parameter (LP), 3D and Computational Fluid Dynamic (CFD) codes - used for explosion hazard evaluation inside the reactor containment. (3) To improve the Severe Accident Management Guidelines (SAMG) with respect to combustible gases risk management, using theoretical, simulation and experimental results. Officially launched on 1 October 2020, AMHYCO is an EU-funded Horizon 2020 project that will last 4 years from 2020 to 2024. This international project consists of 12 organizations (from six different European countries and Canada) and it is led by the Universidad Politécnica de Madrid (UPM). AMHYCO will benefit from the worldwide experts in combustion science, accident management and nuclear safety in its Advisory Board. The paper will

give an overview of the work program and the main outcomes produced in its first year.
010-proj-fisa-s01-abs-rev00-JIMENEZ_Gonzalo

New Progress in Probabilistic Safety Assessment of NPPs against CASCADE AND combined natural hazards

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The H2020-NARSIS project (2017-2022) aimed at proposing improvements regarding the Probabilistic Safety Assessment (PSA) procedures for nuclear plants in case of external natural hazards.

One of the key objectives in NARSIS was to provide a Multi-Hazard (MH) framework, in order to quantify and assess primary and secondary hazards including cascading effects as well as uncertainty, allowing to study the consequences of combinations of potential well-characterised physical threats due to different external hazards and scenarios. Many natural hazards, most being identified as priorities by the PSA End-Users community in ASAMPSA_E were addressed: earthquakes, flooding, tsunamis, extreme weather (lightening, high winds, rainfall, heat waves, ice, hail) and volcanoes (tephra). Some improvements were explored regarding the existing Probabilistic Hazard Assessment methodologies for tsunamis, flooding and extreme weather, as well as the re-evaluation of the screening criteria for main critical plant systems, structures & components (SSC), so to keep only relevant parameters for each hazard in the final framework. An open-access tool is available, which enables developing plant-specific scenarios for Design Basis Events, proposing datasets collected from various EU decommission sites.

NARSIS was also to develop refined fragility derivation methods in order to increase the estimation accuracy of SSC failure rates, thanks to current advances in quantitative hazard modelling and computational capacities. Hence, the benefits of using vector-valued Intensity Measures for fragility assessment of SSC against single (earthquake) and multiple hazards (earthquake & flood), were investigated. For MH scenarios, the approach relies on the combination of failure modes due to single hazard loadings and on the assessment of cumulative hazard effects on the studied systems, provided the required hazard-specific physical models are available.

Finally, NARSIS was to propose improvements in the risk integration combined with a suitable uncertainty treatment and constraining (also for expert-based information), to support the risk-informed decision making and a risk metrics comparison within extended PSA. Hence, various approaches (Bayesian Network (BN) and Extended Best Estimate Plus Uncertainty (E-BEPU)) were implemented, identifying their advantages and limits. A BN-based multi-risk integration framework was developed, where the vector-based fragility assessment methodology and a novel BN-based method for Human Error Probability were used. The contribution of the E-BEPU methodology was demonstrated through its application on the NARSIS standard design plant model, for evaluation of Defence-in-Depth, Design Extension Conditions and Severe Accident Management Guidelines.

The project has delivered some recommendations regarding the proposed improvements, together with further research needs.

085-proj-fisa-s01-abs-rev00-FOERSTER_Evelyne (NARSIS)

FISA 2022 SESSION 2 – Advanced nuclear systems and fuel cycles	
ESFR-SMART	
SafeG	132-proj-fisa-s02-abs-rev00-HATALA_Branislav (SAFEG)
ECC-SMART	
ACES	
SAMOSAFER	
PUMMA	
GENIORS	
INSPYRE	123-proj-fisa-s02-abs-rev00-BERTOLUS_Marjorie
PATRICIA	
PASCAL	
ORIENT-NM	124-proj-fisa-s02-abs-rev00-TARANTINO_Mariano
GEMMA	169-proj-fisa-s02-abs-rev00-AGOSTINI_Pietro (GEMMA)
M4F	125-proj-fisa-s02-pptA0-rev00-MALERBA_Lorenzo
NUCOBAM	
GEMINI-PLUS	004-inv-fisa-s02-abs-rev00-SOBOLEWSKI_Josef
SANDA	
ARIEL	

SafeG – Safety of GFR through innovative materials, technologies and processes

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The safety of the GFR demonstrator ALLEGRO is to be enhanced with the help of innovative technologies, innovative materials, and unique know-how that has been built both inside and outside Europe over the last 20 years. The most important areas of ALLEGRO safety improvements tackled by SafeG project are:

- To solve remaining open questions in residual heat removal in accident conditions, leading to practical elimination of severe accidents, through innovative design of the reactor core, diversified ways of passive reactor shutdown, passive decay heat removal systems, and instrumentation.
- To strengthen the inherent safety of the key reactor components by review of obsolete material and technologies reference options, selection of innovative options, and designs based on these innovative options.
- Review the GFR reference options in materials and technologies, using experience gained in national research programs, know-how of the consortium and stakeholders, and experience from operation of various research facilities and high-temperature nuclear reactors. The aim is to increase inherent safety of GFRs.
- Adapting GFR safety to changing needs in electricity consumption worldwide with increased and decentralized portion of nuclear electricity by study of various fuel cycles and their suitability from the safety and proliferation resistance points of view.
- Boosting interest in GFR research by wide involvement of universities, promotion of GFR-oriented topics of master theses and dissertations, organizing topical workshops including hands-on training and on-job training connected with staff exchange.
- Deepen collaboration with international non-EU research teams and relevant European and international bodies (GIF, standardization bodies) and partners with experience/interest in GFR.

132-proj-fisa-s02-abs-rev00-HATALA_Branislav (SAFEG)

The INSPYRE project: Investigations Supporting MOX Fuel Licensing in ESNII Prototype Reactors

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Nuclear fuel constitutes an essential component of the performance and safety of nuclear reactors. It is composed of complex actinide-bearing materials with specific properties and is subjected under irradiation to a large number of diverse but interconnected phenomena. One way of increasing significantly the efficiency in designing and qualifying innovative fuels for the next generation of reactors is to enhance the predictive capability of fuel behaviour simulation by improving the understanding of fuel behaviour in reactor and developing a more physically based description of nuclear fuels.

To this aim, INSPYRE partners used an efficient approach complementing the examination of neutron-irradiated materials by a basic research approach combining separate effect experiments and multiscale modelling. Harnessing basic and applied research, INSPYRE has brought significant advances in the understanding and simulation of uranium-plutonium mixed oxide fuels on four paramount operational issues: margin to fuel melting; atom transport properties and fission gas behaviour; mechanical evolution of fuel pellets and thermochemistry of irradiated fuels. This was supported by the development of numerous set-ups in the project partner hot labs enabling the detailed characterization of Pu and Am bearing oxides. To capitalize the results of INSPYRE investigations, numerous physics-based models were developed to describe the fuel behaviour under irradiation at the grain and macroscopic scales. These models were implemented in three European fuel performance codes, GERMINAL, MACROS and TRANSURANUS and the improved predictive capabilities of the codes were assessed against a selection of irradiation experiments. Finally, the new versions of the codes were applied to the simulation of the cores of ESNII prototypes.

INSPYRE has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 754329. This project is part of the research activities portfolio of the Joint Programme on Nuclear Materials.

123-proj-fisa-s02-abs-rev00-BERTOLUS_Marjorie (INSPYRE)

ORIENT-NM: Organisation of the European Research Community on Nuclear Materials

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ORIENT-NM explores the possibility, and critically assesses the added value, of establishing a Co-Funded European Partnership (CEP) to support a coordinated European research and innovation programme on nuclear materials, thereby positively impacting Europe’s competitiveness in the nuclear field at world scale. Accordingly, ORIENT-NM is: (1) Producing a single vision and a corresponding strategic research agenda (SRA) for nuclear materials until 2040 which should be consistent with national programmes and industrial needs, considering supply chain constraints, standardisation issues, and availability of infrastructures, availed by more than 50 European nuclear materials experts; (2) Elaborating an efficient CEP governance and implementation, observant of: decision-making processes; intellectual property issues; promotion of innovation; implementation schemes: quality assurance, SRA updating, knowledge & data management. (3) Developing protocols to interact with other relevant stakeholders: International organisations, Standardisation bodies & Technical safety organisations, research communities, infrastructure managers, industry. To achieve its objectives, ORIENT-NM established a dialogue with the research community, through associations and beneficiaries, with stakeholders at large through specific workshops, and, crucially, with the Member States and the European Commission.

124-proj-fisa-s02-abs-rev00-TARANTINO_Mariano (ORIENT-NM)

GEMMA: GEN IV Materials MAturity

PIETRO AGOSTINI, *ENEA*, ALFONS WEISENBURGER, *KIT*, KAMIL TUCEK, *JRC*, MAYLISE NASTAR, *CEA*, ERICH STERGAR, *SCK-CEN*, MASSIMO ANGIOLINI, *ENEA*, CAMILLO SARTORIO, *ENEA*

GEMMA EU Project addressed materials development and testing for Sodium, Heavy Liquid Metals and High Temperature Helium to be employed in GEN IV reactors.
The main areas addressed are: (1) protective coatings and advanced alumina forming corrosion-resistant austenitic steels for application in heavy-liquid metal-cooled systems; (2) testing of structural steels, protective coatings as well as welds of different type under representative conditions in contact with heavy liquid metals and helium; (3) development of physical models for the prediction of the behaviour of austenitic alloys under long term irradiation.

The poster describes some relevant and interesting new results and observations

169-proj-fisa-s02-abs-rev00-AGOSTINI_Pietro (GEMMA)

M4F: Multiscale Modelling for Fusion and Fission Materials

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The M4F project brings together the fusion and fission materials communities working on the prediction of radiation damage production and evolution and its effects on the mechanical behaviour of irradiated ferritic/martensitic (F/M) steels. It is a multidisciplinary project in which several different experimental and computational materials science tools are integrated to understand and model the complex phenomena associated with the formation and evolution of irradiation induced defects and their effects on the macroscopic behaviour of the target materials. In particular the project focuses on two specific aspects: (1) To develop physical understanding and predictive models of the origin and consequences of localised deformation under irradiation in F/M steels; (2) To develop good practices and possibly advance towards the definition of protocols for the use of ion irradiation as a tool to evaluate radiation effects on materials. Nineteen modelling codes across different scales are being used and developed and an experimental validation programme based on the examination of materials irradiated with neutrons and ions is being carried out. The project is now finished. This poster overviews the structure of the project, highlighting its impact for fission and fusion materials science.

125-proj-fisa-s02-abs-rev01-MALERBA_Lorenzo (M4F)


FISA 2022
EURADWASTE'22

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ENENplus	
GREaT-PIONEeR	052-proj-fisa-s03-abs-rev00-DEMAZIERE_Christophe (GREaT PIONEeR)
ENEEP	
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A-CINCH	126-proj-fisa-s03-abs-rev00-CIRILLO_Roberta (A-CINCH)
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CLEAN-DEM	
INSIDER	
JHOP2040	
TOURR	127-proj-fisa-s03-abs-rev00-CIRILLO_Roberta (TOURR)
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GRE@T-PIONEER: TEACHING COMPUTATIONAL AND EXPERIMENTAL REACTOR PHYSICS USING INNOVATIVE PEDAGOGICAL METHODS

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With the advent of cheap computing power, modelling and simulations represent an increasingly important part of a nuclear engineer's work. These tools rely on sophisticated models, databases and algorithms, which the engineer needs to understand, so that the tools are used most efficiently and in relevant applications. Although reactor physics has always been a core discipline in nuclear engineering, computational reactor physics is often taught via advanced courses with fewer students. Due to the decrease of student enrolment in nuclear engineering programs in Europe, maintaining those courses open has become increasingly difficult. In response to the closing of such specialised courses, the GRE@T-PIONEeR project – Graduate Education Alliance for Teaching the PhysIcs and safety Of NuclEar Reactors – was launched on November 1st, 2020 for a duration of three years, with funding from the European Union's Euratom 2019-2020 research and training program. The project gathers eight universities throughout Europe. It aims at developing and providing specialised and advanced courses in computational and experimental reactor physics at the graduate level (MSc and PhD levels) and post-graduate level, as well as to the staff members working in the nuclear industry. Beyond the technical contents of the courses being developed, the novelty of the project lies with the use of innovative pedagogical methods aimed at promoting student learning. In order to maximise the time students spend with the teachers, flipped classes are offered. The self-paced learning elements rely on handbooks specifically written for the various courses, short videos summarising the key concepts and online quizzes allowing testing one's understanding of those concepts. These elements need to be taken before attending interactive sessions organised under the close supervision of the teachers. The interactive sessions are based on active learning, during which the students have to implement and use the learned techniques in hands-on training exercises designed to promote learning. The exercises are computer-based modelling assignments (either implementing algorithms and techniques from scratch or using already existing nuclear simulation tools) and hands-on training sessions on research reactors. In addition to the flipped classroom pedagogy, most of the interactive sessions are offered in a hybrid format: the students can decide to attend the interactive sessions either onsite or online. The sessions are also given in a condensed format. Combined with the hybrid set-up, the courses are very well suited for lifelong learning.

052-proj-fisa-s03-abs-rev00-DEMAZIERE_Christophe (GRE@T-PIONEER)

AUGMENTED COOPERATION IN EDUCATION AND TRAINING IN NUCLEAR AND RADIOCHEMISTRY – The A-CINCH Project

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Expertise in nuclear and radiochemistry (NRC) is of strategic relevance in the nuclear energy sector and in many vital applications. The need for radiochemistry expertise will even increase as the focus shifts from safe nuclear power plant operation to decontamination and decommissioning, waste management and environmental monitoring. The non-energy fields of NRC applications are even much broader ranging from life sciences – radiopharmaceuticals, radiological diagnostics and therapy – through dating in geology and archaeology, (nuclear) forensics and safeguards operations, to radiation protection and radioecology. The A-CINCH project primarily addresses the loss of the young generation's interest for nuclear knowledge by focusing on secondary / high school students and teachers and involving them by the "Learn through Play" concept. This will be achieved by bringing advanced educational techniques such as state-of the art 3D virtual reality NRC laboratory, Massive Open Online Courses, RoboLab distance operated robotic experiments, Interactive Screen Experiments, NucWik database of teaching materials, or Flipped Classroom, into the NRC education. All the new and existing tools wrapped-up around the A-CINCH HUB – a user-friendly and easy-to-navigate single point of access – will contribute increasing the number of students and trainees in the field of nuclear and radiochemistry. Nuclear awareness will be further increased by the High School Teaching Package, Summer Schools for high school students, Teach the Teacher package and many others. A-CINCH project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945301.

126-proj-fisa-s03-abs-rev00-CIRILLO_Roberta (A-CINCH)

RADIATION RISK APPRAISAL FOR DETRIMENTAL EFFECTS FROM MEDICAL EXPOSURE DURING MANAGEMENT OF PATIENTS WITH LYMPHOMA OR BRAIN TUMOUR: THE SINFONIA PROJECT

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The main objective of the SINFONIA (Radiation risk appraisal for detrimental effects from medical exposure during management of patients with lymphoma or brain tumour) project is to develop novel methodologies and tools that will provide a comprehensive risk appraisal for detrimental effects of radiation exposure on patients, workers, carers and comforters, the public and the environment during the management of patients suspected or diagnosed with lymphoma and brain tumours. Personalised dosimetry methods and AI-assisted tools to estimate the radiation burden to patients undergoing imaging and radiation therapy procedures for diagnosis, staging, treatment response and follow-up are currently being developed. A computational system for real time dose assessment of nuclear medicine staff is under development. The impact on human and biota from the release of radiopharmaceuticals by hospitals is being assessed by developing appropriate transport models. Research work is in progress to determine the degree of intra-, and inter-individual variability for the risk of developing second malignant neoplasms (SMN) after radiotherapy and to validate functional and genetic biomarkers of susceptibility to SMN. Data will be collected in a shared depository. A training programme is currently being developed to train young clinicians, medical physicists, radiobiologists and other healthcare professionals as a team.

040-proj-fisa-s03-abs-rev00-DAMILAKIS_John (SINFONIA)

EURAMED ROCC-N-ROLL: DEVELOPING A EUROPEAN STRATEGIC RESEARCH AGENDA AND A CORRESPONDING ROADMAP FOR MEDICAL APPLICATIONS OF IONIZING RADIATION

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Radiation protection in medicine is well established throughout Europe, however still facing challenges like large differences in procedures between countries, but also within a country and even within a hospital. Novel promising approaches and technologies for medical applications of ionising radiation such as personalized medicine and artificial intelligence are developing and need further research including new medical radiation protection issues. Acknowledging the importance of medical applications as the largest man-made source of exposure and the great possibilities of applying ionizing radiation in medicine, the EURATOM programme has launched a call for a coordination and support action to develop a strategic research agenda (SRA) on medical applications of ionizing radiation also identifying the potential to improve links to other research programmes in the fields of health and digitalization.

A consortium called “EURAMED rocc-n-roll” has been put together to develop such an SRA, partially based on the existing EURAMED SRA on medical radiation protection. In addition, it will also develop a roadmap describing how this research agenda can be implemented. An interlink document showing the potential contributions of the different European research programmes to such defined approaches will also be developed. All these documents need to be derived based on a broad consensus of all stakeholders including especially the patients’ perspective. Therefore, EURAMED rocc-n-roll is based on a series of workshops and consultation panels. The workshops

allow contributions by interested stakeholders in person or through members of the consortium. EURAMED rocc-n-roll is committed to developing the SRA and the roadmap with a strong focus on the patient perspective and highlighting the potential for individualized radiation-based medicine for combating cancer and other diseases.
This poster will provide an overview of the activities of EURAMED rocc-n-roll. It will show the current status including the achieved consensus on a structure for the SRA to be developed. It will summarize the results of the first (online) workshops and highlight the possibilities to contribute to the documents to be developed, i.e., the SRA, the roadmap and the interlink document.

033-proj-fisa-s03-abs-rev00-HOESCHEN_Christoph (EURAMED ROCC-N-ROLL)

IMPROVING SCIENCE AND CLINICAL PRACTICE OF MEDICAL RADIATION PROTECTION - RESULTS AND RECOMMENDATIONS OF THE MEDIRAD PROJECT

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The MEDIRAD project aims to enhance the scientific bases and clinical practice of radiation protection in the medical field and addresses the need to better understand and evaluate the health effects of low-dose ionising radiation exposure from diagnostic and therapeutic imaging and from off-target effects in radiotherapy.

A multi-disciplinary consortium involving research groups focusing on radiology, nuclear medicine, radiotherapy, dosimetry, radiobiology, computer science, epidemiology, radiation protection and public health worked together to develop innovative tools to increase the efficiency of future radiation protection research activities and to support good clinical practice, as well as to improve the understanding of low-dose ionising radiation risks associated with major medical radiation procedures. Key results include (1) image quality assessment tool, organ dosimetry calculation tool, imaging and dose repositories and guidance for dose evaluation and optimization in CT, fluoroscopy-guided procedures and nuclear medicine; (2) standardised quantitative I-131I imaging for dosimetry in thyroid cancer patients, freeware dosimetry tools for molecular therapy and recommendations for a large-scale epidemiological study; (3) development and validation of a prediction model to assess the risk of acute coronary events after RT in individual breast cancer patients based on 3D cardiac dose distributions (BRACE Study); identification and validation of the most important cardiac imaging and circulating biomarkers of radiation-induced cardiovascular changes after breast RT; development of preclinical models as well as different modelling approaches; (4) extended follow-up of major cohorts from the EPI-CT study of paediatric CT patients, implementation of a nested case-control study of brain and haematological malignancies and identification of potential biomarkers of susceptibility to low dose radiation induced cancer.

Based on MEDIRAD's research findings, a set of consensus recommendations has been developed in collaboration with a broad range of stakeholders to address the scientific and clinical communities as well as policy makers, encourage professional/regulatory guidance, follow-up research activities as well as to ensure that the research findings and tools developed under MEDIRAD find their uptake in clinical practice and thus benefit Europe's patients.

The main results and recommendations of the project will be highlighted in the poster, together with plans for their dissemination and exploitation.

039-proj-fisa-s03-abs-rev00-CARDIS_Elisabeth (MEDIRAD)

HEALTH EFFECTS OF CARDIAC FLUOROSCOPY AND MODERN RADIOTHERAPY IN PAEDIATRICS (HARMONIC)

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The use of ionising radiation (IR) for medical diagnosis and treatment procedures has had a major impact on the survival of paediatric patients. Although the benefits of these techniques largely outweigh the risks, the evidence to date suggests that children are more sensitive than adults to the carcinogenic effects of IR. Therefore, there is a need to better understand the long-term health effects of such exposures in order to optimise treatment in these young patients and reduce the risk of late toxicities.

HARMONIC aims to improve our understanding of the health effects of exposure to medical IR in children, specifically cancer patients treated with modern radiotherapy techniques, and cardiac patients treated with cardiac fluoroscopy procedures (CFP). HARMONIC also develops dosimetric data collection software tools to allow dose reconstruction in both CFP and radiotherapy.

The project builds on a multi-disciplinary collaboration to investigate long-term outcomes (endocrine dysfunction, cardiovascular and neurovascular damage, quality of life (QoL) and social impacts, and secondary cancers) of paediatric cancer patients after the application of modern radiotherapy modalities. Instruments for harmonised demographic, clinical and dosimetric data collection were defined serving as a pilot phase for a future pan-European registry.

The cardiac component of HARMONIC builds a pooled cohort of approximately 100,000 patients who underwent CFP in 7 countries, while aged under 22 years. The cohort, based on data collection from hospital records and/or insurance claims data, will be followed-up using national registries and insurance records to determine vital status and cancer incidence. Where available, information on organ transplantation (a major risk factor for cancer development in this patient group) and/or other conditions predisposing to cancer will be obtained from national or local registries and health insurance data. The relationship between estimated radiation dose and cancer risk will be investigated using regression modelling.

With its prospective design and the creation of a biobank for the collection of biological samples, HARMONIC also aims at providing a mechanistic understanding of radiation-induced adverse health effects and identify potential biomarkers indicative of vascular adverse effects and secondary cancer. These biomarkers could ultimately contribute to early diagnosis, treatment and prevention of adverse effects.

031-proj-fisa-s03-abs-rev00-THIERRYCHEF_Isabelle (HARMONIC)

RADONORM - TOWARDS EFFECTIVE RADIATION PROTECTION BASED ON IMPROVED SCIENTIFIC EVIDENCE AND SOCIAL CONSIDERATIONS – FOCUS ON RADON AND NORM

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RadoNorm aims at managing risks from radon and NORM exposure situations to assure effective radiation protection based on improved scientific evidence and social considerations.

The project findings and outcomes will have a significant impact on radiation protection in Europe and beyond, thanks to its focus on 1) Initiation, support and implementation of multidisciplinary, innovative, integrated research and technology activities, 2) Integration of education and training in the research and development work of the project and 3) Dissemination of project results through specific actions targeting broad stakeholder community including among others the public, regulators, and policy makers. The project supports European states and the EU Commission in implementing the Basic Safety Standards for protection against ionising radiation hazards at the legislative, executive, and operational levels (Directive 2013/59 / EURATOM) with the aim to significantly reduce uncertainties in all steps of radiation risk management for radon and NORM (naturally occurring radioactive materials). Scientific, societal, and technical aspects of exposure conditions are addressed and clarified, also including exposure from TENORM (technologically enhanced naturally occurring materials). The objectives are achieved through work packages, including scientific research-related topics (exposure, dosimetry, biology, epidemiology, societal aspects), cross-cutting topics (education and training, dissemination, ethics) and project management. The outputs of the project will include guidelines and recommendation at legal, executive and operational levels. It will enable consolidated, harmonized and sound decision-making in the field of radiation protection considering societal aspects and sustainable knowledge transfer. Thus, RadoNorm contributes in a pioneering way to the implementation of the Basic Safety Standards (BSS), inter alia through knowledge in the field of exposure, dose assessment, effects and risks, as well as countermeasures.

The project also fits seamlessly into the EC's activities to further optimise radiation protection in a consistent and joint manner, as has already been done in previous Commission activities, including the establishment of radiation protection platforms such as MELODI, as well as the promotion of projects such as DoReMi NoE, OPERRA, and partnerships such as CONCERT-EJP and PIANOFORTE. Studies, e.g. addressing exposure, dosimetry and effects and risks of radon and NORM add to knowledge on science underpinning the System of Radiation Protection and may thus impact future international recommendations by the ICRP.
The RadoNorm activities and achievements since the project start are presented.

100-inv-fisa-s03-abs-rev00-KULKA_Ulrike

TOWARDS OPTIMIZED USE OF RESEARCH REACTORS IN EUROPE – THE TOURR PROJECT

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Nuclear research reactors (RR) have been constructed in countries implementing nuclear power plants and used in experiments necessary to develop commercial reactors and training programmes. Neutron irradiations techniques have found new applications in the adaption and production of existing and new materials, as well as medical radioisotopes. The latter enabled development of new diagnosis and treatment techniques, for the benefit of millions of people. Europe has a broad and very diverse landscape of RRs, many of them since long time in operation, well maintained and regularly upgraded. Yet financial pressure, caused by combination of declining interest and the absence of a sound financial model, led to closure of many of them and a few others will close soon. This negative scenario calls for a coordinated European action to assess the impact of the decreasing number of RRs, identify future needs (including new neutron sources), draw a roadmap for upgrade of the existing RR fleet, and a model for harmonized resource management. TOURR project is a response to this challenge. Its primary objective is to develop a strategy for RR in Europe and prepare the ground for its implementation. This strategic goal can be divided into specific objectives: assessment of the current status of European RR fleet, including plans for upgrade; evaluation of urgent EU needs; developing tools for optimal use of RR fleet. rising awareness among decision makers on the (future) role of RRs. The ambition of TOURR project is to secure access and availability of RRs as a vital part of the European Research Area and to support stable supply of medical radioisotopes. The TOURR project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945 269.

127-proj-fisa-s03-abs-rev00-CIRILLO_Roberta (TOURR)


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s03 R&D	107-call-fisa-s03-abs-rev00-COGNET_Gerard
s02 PhD	109-call-fisa-s02-abs-rev00-MAGNI_Alessio (ENEN PhD Invited)
s02 PhD	110-call-fisa-s02-abs-rev00-NJAYOU-TSEPENG_Eris-Karson
s01 PhD	112-call-fisa-s01-abs-rev00-TALAROWSKA_Anna
s02 PhD	115-call-fisa-s01-abs-rev00-PEDROCHE_Gabriel (ENEN PhD Invited, ENS)
s02 PhD	117-call-fisa-s01-abs-rev00-PETROVIC_Dorde
s02 PhD	118-call-fisa-s02-abs-rev00-KUCAL_Ewelina
s01 PhD	119-call-fisa-s01-abs-rev00-ALGUACIL_Javier (ENEN PhD Invited)
s02 PhD	122-call-fisa-s02-abs-rev00-ESZTER_Csengeri (ENEN PhD Applicant)
s01 R&D	129-call-fisa-s01-abs-rev00-CUESTA_Alejandra (NIP RESA-TX)
s01 PhD	133-call-fisa-s01-abs-rev00-SERRA-LOPEZ_Luis
s02 R&D	134-call-fisa-s02-abs-rev00-SEVECEK_Martin (NIP MULTIPROTECT FUEL, Win-1)
s01 PhD	139-call-fisa-s01-abs-rev00-KRUSTEVA_Veronika
s01 R&D	142-call-fisa-s01-abs-rev00-VAIANA_Florian (NIP DIPSICOF)
s01 PhD	145-call-fisa-s01-abs-rev00-SMIGELKIS_Edgaras
s02 PhD	148-call-fisa-s02-abs-rev00-PORTO_Giulia
s02 PhD	149-call-fisa-s02-abs-rev00-LABONNE_Baptiste
s03 R&D	153-call-fisa-s03-abs-rev00-HERNANDO_Jesus (NIP MITMAT, Win2)
s01 PhD	154-call-fisa-s01-abs-rev00-DOMINGUEZ-BUGARINAR_Araceli (idem 068)
s01 R&D	157-call-fisa-s01-abs-rev00-GALBALLY_David

s01 R&D	159-call-fisa-s01-abs-rev00-LEGRADY_David (NIP GUARDYAN, Win3b)
s03 PhD	165-call-fisa-s03-abs-rev00-LUNGHI_Giacomo (ENS)
s03 PhD	171-call-fisa-s03-abs-rev00-ARAGON_Pau (ENS WORKSHOP)
s03 PhD	177-call-fisa-s03-abs-rev00-MOHAMMAD_Rafiean (ENEN Applicant)

POST-TEST ANALYSIS OF THE HYMERES-2 H2P5 SERIES ON THE SPRAY SAFETY SYSTEM USING GOTHIC8.3 (QA)

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HYMERES-2 was a 4-years OECD/NEA Project dedicated, among other topics, to extending the experimental database on hydrogen behaviour in a large vessel. Specifically, the H2P5 Series studied the cooling effect and the mixing ability of a spray system when actuated in a pre-stratified gas mixture with three gases: air, steam, and helium. The H2P5 Series consisted of two tests with different configurations of the spray system, one using a single nozzle and the other, for the first time in PANDA, a spray ring with several nozzles. After a dedicated assessment of the experimental measurements, the two experiments of the H2P5 series were modelled using GOTHIC 8.3(QA) with a 3D model of approximately 47000 cells. The analysis was separated into a thermal part (cooling effect of the spray) and a dynamic part (mixing ability of the droplets). The main differences between the two experiments were the faster cooling and mixing in the single nozzle case, both qualitatively captured by the simulations. However, from a quantitative perspective, the pressure of the vessel and the gases concentrations evolution of the reference simulations were improvable. The deviations between the experimental measurements and the simulations were addressed by a comprehensive parametric variation of the variables affecting the most important phenomena, i.e., the liquid re-evaporation and the steam condensation onto droplets for the thermal part, and the momentum transfer from the disperse droplet phase to the continuous gas phase for the dynamic part. Especially for the thermal part, there were no defensible hypotheses that could justify the faster pressure decrease obtained in all the simulations. The only approach that reproduced the pressure decay rates was an unrealistic decrease of the spray flow rate, which indicated that the steam condensation onto droplets might be overestimated when using the actual flow rate.

s01 PhD 050-call-fisa-s01-abs-rev00-VAZQUEZRODRIGUEZ_Carlos

DAMAGE OCCURRENCE AT THE JUNCTION OF COVERING LAYERS IN THE COATED PARTICLES OF NUCLEAR FUEL SAMPLES.

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The TRistructural ISOtropic (TRISO) nuclear fuel is commonly used in high-temperature reactors (HTRs). The characteristic feature of this fuel is the presence of four covering layers. Due to the TRISO-particle fuel irradiation in the reactor core, the damage in the covering layers occurs, which approach defect fractions of 10^{-5}. Still, an unsolved aspect is the damage of the TRISO sample at the junction of the two layers, called buffer and inner pyrolytic carbon (IPyC). The aim of this study is to prepare a surrogate TRISO sample to investigate the level of damage at the buffer-IPyC layer junction. For this purpose, the TRISO sample consisting only of these two layers was subjected to a polishing process in order to obtain a cross-section on which further examination could be performed. To reflect the damage that may occur as a result of irradiation, the ion implantation technique can be used to quickly determine the level of damage to the layers, through the parameter such as displacements per atom (DPA). In order to determine the level of damage to the sample that corresponds to the final irradiation in the reactor core, it is first necessary to determine the fluence with which the ion implantation should be performed. For this purpose, appropriate calculations must be performed with the use of the SRIM and MCNP codes.
Finally, samples may be implanted at a fluence that corresponds to the neutron flux of the HTR reactor. Therefore, the damage level of the analyzed TRISO sample can be estimated experimentally. Preliminary results indicate that damage occurs at a fluence of $3.8*10^{16}$ ions/cm^2 which corresponds to the neutron flux of $1.6*10^{13}$ neutrons/cm^{2}s. The damage level data are represented with the use of Scanning Electron Microscopy (SEM) and Raman spectroscopy technique. The obtained results will be used to simulate the level of damage in the TRISO fuel layers, produced during the irradiation of samples in the reactor core, through the BISON program.

s02 PhD 061-call-fisa-s02-abs-rev00-KRAJEWSKA-Zuzanna

IMPACT OF GEOMETRICAL MODIFICATIONS ON CONTAINMENT THERMAL HYDRAULICS AND COMPUTATIONAL COST USING GOTHIC 8.3(QA)

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Three-dimensional computational codes have become a useful tool regarding containment analysis due to their capacity to simulate phenomena in detail. The GOTHIC 3D capacities are achieved through the porous media approach, which implies that fluid and solid phases are allowed to coexist inside the same computational cell. Having that characteristic causes some numerical cells with particularly problematic configurations (low free volume or transversal area compared with the surrounding cells) to appear, which lead to numerical instabilities when simulating large mass and energy releases, causing an important increase in computational costs. To avoid the appearance of these problematic cells, the Universidad Politécnica de Madrid (UPM) has developed what has been called "preventive methodology". It consists of modifying the original geometry to adapt it to the GOTHIC Cartesian mesh. Aiming to reduce its computational cost, the preventive methodology is applied to optimize the Almaraz NPP full containment model. In order to assess whether the geometric modifications have a significant impact on the model capacities for accurately representing the containment phenomenology during an eventual accident, a comparative study against previous models without such geometric modifications is conducted. The agreement between both models is adequate. It is possible as the combination of the porous media approach with the built-in correlations for friction and heat transfer allows maintaining the model thermal hydraulics by keeping the same free volume, transversal areas, and heat transfer surfaces. Finally, it must be pointed out that the computational cost for the preventive methodology model is one order of magnitude lower than the previously developed model. As the model accurately represents the containment thermal hydraulics, it can be concluded that the preventive methodology has proven to be a powerful tool for model optimization with the GOTHIC code.

s01 PhD 063-call-fisa-s01-abs-rev00-ARFINENGODELCARPIO_Sofia

MODEL BASED SYSTEM ENGINEERING, AN INDUSTRIALIZATION PATH FOR DECOMMISSIONING PROJECTS BY ASSYSTEM

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Conventional engineering development cycle are too long to accommodate the uncertainties inherent to the decommissioning and waste retrieval and conditioning projects, leading to costly hazard detection. Dismantling projects will last between 10 and 50 years and will generate a significant volume of data. How to make the decision with an important part of unknown, how to drive project and monitor the risk, How to standardize the dismantling industrialization and in what extent the standardization can reduce the cost and how far can we go without all the keys data. All these questions are key for project owners, and engineering must provide solutions, to lead project to success. To meet the challenges of uncertainties such as industrialization, the use of digital solutions is seen as a performance lever for projects with a very strong impact, especially in the engineering phases, for which the development process are, for decades, to linear to manage uncertainties.
Industrialization of the engineering of dismantling should offer the sufficient confidence of the initial state of the installation to state the dismantling scenarios while offering data flexibility and continuity through the project lifetime, notably regarding evolution of regulatory constraints and waste management path while reducing time and costs to reengineer scenarios.Thanks to its mastery of model based system engineering, Assystem has developed a digital suit: « DEMologist » which, coupled with a number of dedicated digital tools, act as a co-designed platform between the project owner and the prime contractor. That digital suit include an asset hub information combine with all the applications connected between them: digital tool combine with AI to read, understand and structure disparate and scattered data in technical achieves GDI; digital tool to simulate the impact of dismantling scenario (ADS/DEM, DEM+, …) : waste, schedule, costs, … ; realization of digital twin coupled with the BIM of the installation for the real time feedback of the installation ; artificial intelligence for default prediction ; virtual reality to simulate dismantling scenario, training the operators and increase the safety and human factor engineering and digital tool for technical inspection FIELD STUDIO (waste, safety, security, schedule, …).

s03 PhD 064-call-fisa-s03-abs-rev00-ROFFINO_Brice

A COMBINED LIDAR CAMERA AND COMPTON CAMERA SYSTEM FOR VISUALIZATION AND LOCALIZATION OF HOTSPOTS

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The localisation, characterisation and remediation of hotspots during a nuclear decommissioning project is an important activity to avoid unneeded dose-uptake for operators. The current practise for identifying hotspots is by performing manual radiological measurements. However, due to the high dose rate of the hotspots at some locations, special measures are necessary to protect workers and the available time to perform mapping and characterisation steps is limited. This not only introduces the risk of missing sources or performing inaccurate measurements and other specific ALARA related challenges, but it is a time consuming and inefficient way of mapping. In the ARCHER project, an (semi) autonomous robotic platform was developed. Using this robot can limit the need for human intervention and therefore also minimises human dose uptake during these measurements. However, this platform currently still uses this inefficient and time-consuming way of mapping. During this research, a Compton camera was developed and combined with a 3D camera as an alternative to the more common scanning based spectrometric approach for radiological mapping. The Compton camera was identified as being more advantageous as sources can be localised without performing many time-consuming robot manipulator manoeuvres. Furthermore, the measurements with the Compton camera are performed relatively far away from the source, thus limiting the chance of contaminating the robot platform. A measurement was made where a 137Cs source was located in front from the detector setup. A direct back projection algorithm was used for the Compton camera to retrieve the direction of the source. This radiological data was then combined with a point cloud of a Realsense L515 lidar 3D camera to visualise the measurements. After a correction was applied for the physical distance between the two detectors, the measurement of the Compton camera was superimposed with the point cloud to visualise the hotspot. The source location was accurately found and visualised in 3D.

s03 PhD 065-call-fisa-s03-abs-rev00-SIMONS_Mattias

FROM THE PLANT LAYOUTS TO AN OPTIMIZED 3D PWR-KWU CONTAINMENT MODEL WITH GOTHIC 8.3 (QA)

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Containment geometry characteristics play a key role in many accident and severe-accident phenomena, such as flammable gas distribution, accumulation and deflagration dynamics. The containment buildings of nuclear power plants have complex geometries and extracting the data required to build detailed computational models from plant layouts is a demanding task. Using Computational Aided Design (CAD) software as a cornerstone of the modelling process serves as a bridge between the containment layouts and the thermal-hydraulic models. This work will describe all the steps of the methodology used to build a 3D PWR-KWU containment model in GOTHIC from its detailed CAD model. Firstly, an intermediate model with several geometric simplifications will be developed in the CAD environment. These simplifications are intended to avoid problematic configurations when adapting the actual geometry to the porous cartesian mesh of GOTHIC, avoiding numerical instabilities and resulting in shorter simulation times. The simplified geometry is imported into GOTHIC, and it is tested by simulating a Large Loss of Coolant Accident (LB-LOCA) in one of the cold legs. This is the most convenient scenario to check the specific numerical instabilities within the porous cartesian space discretization of GOTHIC, which mainly arise from the massive release of mass and energy during the blowdown. Although the initial containment model did perform adequately in the initial phases of the LOCA, a detailed assessment of the numerical stability revealed several points for improvement in further stages of the simulation. Namely, the accumulation of liquid in sump-type regions with low-porosity problematic cells, hampered the simulation at specific periods of time. Then, the final modifications of the geometry achieved a reduction of the computational costs up to one order of magnitude. Part of this work is included within the AMHYCO project (Euratom 2019-2020, GA No 945057) which main objective is to improve experimental knowledge and simulation capabilities for the H_2/CO combustion risk management in nuclear power plant containments during severe accidents (SAs).

s01 PhD 067-call-fisa-s01-abs-rev00-SERRA_Luis

PARUPM: A SIMULATION CODE FOR PASSIVE AUTOCATALYTIC RECOMBINERS.

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In the event of a severe accident with core damage in a water-cooled nuclear reactor, combustible gases (H_2 and possibly CO) get release into the containment atmosphere. An uncontrolled combustion of a large cloud with a high concentration of combustible gases could lead to a threat to the containment integrity if concentrations within their flammability limits are reached. To mitigate this containment failure risk, many countries have proceeded to install passive auto-catalytic recombiners (PARs) inside containment buildings. These devices represent a passive strategy for controlling combustible gases, since they are capable of converting H_2 and CO into H_2O and CO_2, respectively. In this work, the code PARUPM developed by the Department of Energy Engineering at the UPM is described. This work is part of the AMHYCO project (Euratom 2014-2018, GA No 945057) aiming at improving experimental knowledge and simulation capabilities for the H_2/CO combustion risk management in severe accidents (SAs). Thus, enhancing the available knowledge related to PAR operational performance is one key point of the project. The PARUPM code includes a physical-chemical model developed for the study of surface chemistry, and heat and species mass transfer between the H_2/CO/air/steam/CO_2 mixture and the catalytic plates in a PAR channel. This model is based on a simplified Deutschmann reaction scheme for surface combustion of methane, and the Elenbaas analysis for buoyancy-induced heat transfer between parallel plates. Mass transfer is considered using the heat and mass transfer analogy. PARUPM is capable of simulating the recombination reactions of H_2 and CO inside the catalytic section of the PAR. In addition, this model allows studying the effect of CO in the mixture, allowing to explore the effect of this compound on transients related to accidents that advance towards the ex-vessel phase. Finally, a thorough analysis of the code capabilities executed by comparing the numerical results with experimental data obtained from the REKO-3 facility. This analysis allows to establish the ranges in which the code is validated and to further expand the capabilities of the simulation code which will lead to its coupling with thermal-hydraulic codes in future steps of the project.

s01 PhD 068-call-fisa-s01-abs-rev00-DOMINGUEZ-BUGARIN_Araceli

VALIDATION OF ATHLET-CODE FOR SIMULATING PASSIVE RESIDUAL HEAT REMOVAL VIA LOW-PRESSURE LOOP THERMOSYPHONS

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Inherent reactor safety and advanced passive technologies (APT) are common design features in emerging Small Modular Reactors (SMRs). Among APTs, passive residual heat removal systems (PRHRS) are responsible for the removal of residual core-generated heat after plant shutdown. PRHRS rely on naturally-driven forces to transfer the residual heat to an intermediate containment-adjacent heat sink (Emergency cooling tank - ECT). PRHRS lose their cooling capability once the ECT-water is depleted, hence, the residual heat must be transferred via a secondary loop to an ultimate heat sink (Surroundings or an air-cooling tower – ACT) to extend the grace period of ECTs. Loop thermosiphons (LTS) are considered suitable secondary loops, as the inner natural circulation can be achieved by the temperature gradient and height between ECT and ACT. LTS are usually operated at sub-atmospheric pressures to guarantee a two-phase operation and ensure a sufficient temperature gradient between the ECT-water and the working fluid of the LTS. Datasets from a scale-appropriate LTS-experimental facility operating at sub-atmospheric pressure were used to assess and validate the performance of LTS-models developed with the ATHLET-code. The facility is equipped with an independent hot water circuit which serves as the heat source and an air-cooling tower as the heat sink. A total of 27 stationary states were studied, featuring variations in the filling ratio, heat input i.e. hot water inlet temperature, and air velocity in the cooling tower. Prediction of heat transfer coefficients (HTC), working fluid mass flows, fluid and wall-temperature profiles, along with pressure losses (PL) in inclined condensation sections is studied in detail. A solid agreement between simulated and experimental outputs regarding wall temperatures and hot water pool temperature profiles was achieved. Moreover, a proper prediction of loop instabilities for the two-phase operation was reached. Even though slight overestimations of the working fluid's pressure drop in the inclined condensation sections were evidenced, ATHLET seems suitable for simulating low pressure LTS-facilities. Further empirical correlations for HTC- and PL-computing for two/phase narrow channels could be integrated in ATHLET to enhance its thermohydraulic prediction and close the gap between simulated and experimental data.

s01 PhD 073-call-fisa-s01-abs-rev00-RINCON-SOTO_NelsonFelipe

AN INNOVATIVE SUPERCRITICAL CARBON DIOXIDE CYCLE FOR DECAY HEAT REMOVAL IN EXISTING AND FUTURE NUCLEAR POWER PLANTS

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The supercritical carbon dioxide (sCO_2) heat removal system is an innovative, self-propelling and modular decay heat removal system for existing and future nuclear power plants which is based on a simple closed Brayton cycle with sCO_2 as the working fluid. In PWRs, the system could be attached to the steam generator in the secondary loop providing a continuous decay heat removal from the core to a diverse ultimate heat sink, the ambient air, and simultaneously generating electricity which might be useful in the case of station blackout. The conceptual design, layout and control of this compact modular system were developed in the European project sCO2-4-NPP. One sCO_2 cycle module provides a heat removal capacity of 10 MW_{th} and consists of a compact heat exchanger, an air cooler and a compressor and a turbine. By changing the number of sCO_2 modules, the heat removal capacity can be adapted to different plant sizes and types (like EPR, KONVOI, VVER).
To analyze the performance and the interaction of the system with nuclear power plants, the thermal-hydraulic system code ATHLET was extended with the ability to simulate sCO_2 cycles. A scenario with long-term station blackout and loss of ultimate heat sink was simulated for a generic KONVOI PWR with a thermal power of 3840 MW_{th} equipped with four sCO_2 cycles. After the ramp-up, the system runs at its design heat removal capacity to minimize the inventory loss in the PWR. With decreasing decay heat over time, the sCO_2 cycles are moving from nominal to part-load conditions. In this phase, controlling the turbine inlet temperature to 260 °C via the turbomachinery shaft speed and subsequent shutdown of 3 of the 4 cycles balance the heat produced by the decay and the heat removed by the sCO_2 cycles quite perfectly, enabling a very stable operation. Moreover, keeping the design compressor inlet temperature constant at 55 °C by controlling the air cooler fan speed is a viable strategy at any ambient or steam-side boundary condition.
Further analyses consider the failure of single sCO_2 cycles, valves or control systems to provide a deeper insight into the dynamic behaviour of the system.
The ATHLET simulations demonstrated that this very innovative compact heat removal system applied to a nuclear power plant of the KONVOI type with four sCO_2 cycles attached to the steam generators will safely remove the decay heat for more than 72 h.

s01 PhD 076-call-fisa-s01-abs-rev00-HOFER_Markus

MODELLING KD (U) BASED ON SOIL PROPERTIES

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Naturally Occurring Radioactive Materials (NORM) are defined as materials, usually originating from industrial waste, which are contaminated with Naturally Occurring Radionuclides (NOR), such as uranium, thorium, or plutonium, and their decay products, such as radium or radon. Some of these materials originate from industrial activities provoking an increase in NOR concentration in their wastes. As the amount of NORM is continuously increasing, this situation leads to the need of building robust, NOR mobility prediction models for the risk assessment, management of NORM-affected sites and in-situ decision making.

Radionuclide (RN) partitioning between solid and liquid phases largely affects the RN mobility and bioavailability in soils and is often quantified by the solid-liquid distribution coefficient (K_d). Risk assessment models use soil K_d values to derive RN concentration in solution from the concentrations of RNs in contaminated soils to estimate their transfer to plants, the leaching to groundwater or the diffusion-driven transport through soils. The value of the K_d parameter of a target RN depends mainly on factors such as: 1) the speciation of the RN in certain experimental or environmental conditions; 2) the characteristics of the solid and liquid phases of the soil; 3) the methodology used to determine the K_d value; and 4) the elapsed time since RN incorporation in the soil (interaction dynamics).

Focusing on uranium, previous studies have been carried out to find out the role of its speciation in soil interaction and to identify the key soil factors affecting K_d (U), mainly pH, water-soluble carbonates, and soil organic matter content. However, datasets created from literature present a huge variability in K_d (U) values due to methodological differences between studies. Consequently, models to predict K_d (U) are capable of only describing a small amount of this variability. In this work, framed in the context of RadoNorm Work Package 2 (www.radonorm.eu/workpackages/wp2/), batch tests are applied in a set of soils to confirm the soil properties governing interaction mechanisms and uranium speciation. Following this, the potential effect of the interaction dynamics on K_d (U) variability is examined by comparing K_d (U) derived from different methodological approaches, such as sorption vs. desorption tests, or using recently spiked soils with U vs. indigenous U. Finally, the use of statistical tests and probabilistic functions will permit to build new parametric models based on soil properties and to derive more reliable best-estimate K_d (U) values for the specific scenario to be assessed by prediction models.

s03 PhD 079-call-fisa-s03-abs-rev00-SERRAIMA-LOPEZ_Didac

ELUCIDATING THE MECHANISMS GOVERNING THE INTERACTION OF RADIUM IN SOILS

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Naturally Occurring Radionuclide Materials (NORM) are geological materials rich in indigenous radioactive elements. Some of these Naturally Occurring Radionuclides (NOR) are present in many geological resources (e.g., mining ores), whose exploitation by non-nuclear industries (e.g., phosphate, oil and gas production,…) represents a huge challenge for environmental and human protection, since large volumes of NORM are processed and exposed to the surface. The NOR in these materials can be unintendedly concentrated during the processing and more exposed to environmental factors that may increase their mobility. Difficulties in assessing the human exposure originating from NORM sites arise from a lack of reliable data, which often are site-specific and not transferable to other scenarios. Consequently, understanding NOR interaction mechanisms and subsequent mobility is important to upgrade existing risk assessment models involving NOR such as uranium, thorium and their radioactive decay products such as radium. Ra-226 (Ra) is a natural, alpha emitter radionuclide. Along with its daughter radon-222, it represents a potential hazard due to its radiological impact on ecosystems and contribution to human exposure. A key step to examine the interaction/mobility of Ra in soils is the obtention of sorption and desorption parameters such as the solid-liquid distribution coefficients (K_d) at laboratory scale, to elucidate the main mechanisms and soil properties governing the interaction, by also decreasing secondary sources of variability. Recently, a compilation of K_d (Ra) values in soils and other related environmental samples has been constructed in the frame of the European project RadoNorm that has evidenced that there are still relevant gaps of information for K_d (Ra). This work is framed within the Work Package 2 ("Exposure") of RadoNorm project, specifically the task 2.7 (www.radonorm.eu/workpackages/wp2/), which focuses on the identification of geochemical and biological processes controlling NOR mobility to derive more robust K_d. In this work, laboratory batch sorption and desorption experiments with a set of uncontaminated soils with contrasting edaphic properties are performed to obtain K_d (Ra) values. Statistical analyses are also performed to assess the soil properties involved in the sorption process, such as calcium and magnesium status, pH, water-soluble anions and organic matter content. Furthermore, the usefulness of barium as chemical analogue for Ra is also examined, in order to contribute to filling sorption data gaps with data originated from non-radioactive experiments.

s03 PhD 080-call-fisa-s03-abs-rev00-SERRA-VENTURA_Joan

EVALUATION AND VALIDATION OF ATHLET-CODE FOR BAYONET HEAT EXCHANGERS

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Many SMRs take advantage of the use of innovative heat exchangers as steam generators or within heat removal systems. Because of their compact design and ability to operate as part of passive systems, bayonet heat exchangers have particularly received interest. In parallel to the introduction of new technologies also the thermal-hydraulic tools, that are a common and widely accepted approach to the design, operation, licensing, and safety assessment of nuclear power plants, should be updated to simulate reliably such systems. The objective of the Ph.D. work is to extend the capabilities of the thermal hydraulic system code ATHLET (Analysis of Thermal-Hydraulics of Leaks and Transients, developed by GRS) with modelling methodologies for the bayonet heat exchangers, in addition to U-tube or straight tube steam generators, which are commonly used in present light water reactors. The approach to reach this goal is to apply existing models to bayonet heat exchangers, to identify needs for improvements, to develop and implement suitable approaches and finally to validate the modelling by comparison with experimental data. In the present study, this is exemplarily shown for the application of the ATHLET code to HERO-2 experiments. The modelling of the test facility within the ATHLET simulation is presented and the choice and reasoning for assumptions, which are necessary due to some experimental uncertainties, are discussed. By comparisons of experimental results with the ATHLET predictions especially the capabilities to correctly predict two-phase heat transfer and pressure losses are evaluated, which are crucial for correctly simulating the natural convection in passive systems. The modelling of pressure losses in relatively narrow tubes/ducts, which are typical for the annular design of bayonet heat exchangers, was identified as a potential for model improvement and additional empirical laws from literature were implemented in ATHLET. The model extensions are assessed against the previous status and against experimental data. Conclusions on the validation status are presented. For further work, especially systematic uncertainty analyses are proposed which consider both uncertainties in experimental data and modelling approaches.

s01 PhD 081-call-fisa-s01-abs-rev00-CEVIKALP-USTA_Sinem

POSITIVE CAMPAIGNING OF NUCLEAR TOPICS

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Imagine the enormous impact you, as a single individual, has in the climate change conversation. Your voice is powerful, and when directed in the right places, highly impactful. And now imagine what would happen if we compounded all our efforts, sharing the same message across the globe, to communicate to leaders and decision makers that 'enough is enough: we need action now'. It would be immense. Global climate activism describes a growing movement of young people across the globe taking action to halt the devastating effects of climate change. We are determined to reach net zero before 2050, and firmly believe that following the science and being technology inclusive is the best way to achieve this. Nuclear energy working alongside other clean energy technologies is essential to reaching these goals. Using the 'I, us, we' principles of climate activism, this interactive, thought-provoking workshop will equip you with the necessary tools to communicate nuclear energy to friends, family, strangers, and everyone in between. This two-hour session will explore how trust, people and action lie at the heart of a successful climate campaign and how we can use the principles of compound interest to prepare for COP27. It will also give attendees the opportunity to explore their personal voice and contributions to the climate conversation, especially how to become bold, vocal climate champions. We will draw on the experience and learnings of the hugely successful #NetZeroNeedsNuclear COP26 campaign, and workshop how we can build upon these achievements for November's COP27 conference. With just five months until COP27, it is imperative we coordinate a global effort to continue the successes of the global youth activist movement. Join the Nuclear for Climate team as they guide you through this engaging, action-focused workshop. Open to all backgrounds, viewpoints, experiences. #Togetherisbetter #NetZeroNeedsNuclear

s03 PhD 084-call-fisa-s03-abs-rev01-ZIENKIEWICZ_Sophie (YGN-Workshop)

REVIEW OF IN-SERVICE INSPECTION METHODS OF REACTOR INTERNAL BAFFLE-TO-FORMER BOLTS

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One of the internals of a typical pressurised water reactor is the core barrel. The purpose of the core barrel is to support and orient the fuel assemblies, create way to the control rods as well as drive the coolant through the core. This equipment comprises of three main parts. The outer cylindrical shell, which forms the wall of the barrel, the core baffle, that is a set of vertical plates surrounding the outer rim of the fuel assemblies and the vertical former plates, that make up the structure connecting the baffle plates to the inside surface of the cylindrical shell. The baffle plates are connected to the former plates through hundreds of so-called baffle-to-former bolts. These fastening bolts are subjected to neutron irradiation and mechanical stresses during reactor operation. Operational experience in many nuclear power plants shows that after a certain operating time, radiation-assisted stress corrosion cracking of the bolts may occur, which in some cases causes bolt fracture and loss of integrity of the equipment. Thus, a degradation mechanism considering all effects is proposed. In recent years, the detection of bolt damage through identifying cracks has been a major focus of nuclear power plant service life extension projects. This is illustrated by a statistical analysis of bolt test results. Historical data and the evolution of international recommendations for mitigation are also reviewed. Visual and ultrasonic non-destructive testing methods of bolts are presented and evaluated. Since the equipment is highly radiated, to eliminate doses the inspection is performed using remote controlled manipulators. The different techniques, both mast and diving robot, are described and a comparison is made with respect to the technical specifications of each technique, the performance of the tests and their integrability in periodic in-service inspections. These results essentially contributed to meeting the relevant requirement in the service life extension decisions of Hungary's four operating units.

s01 R&D 093-call-fisa-s01-abs-rev00-SZEKELY_Levente-Csaba

PASSIVE HEAT REMOVAL FUNCTION FOR A DISTRICT HEATING REACTOR

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Development of a low-temperature nuclear reactor for district heating purposes was launched at VTT in 2020. The design goes under the name LDR-50, and features a 50 MW reactor module, capable supplying heat at 65-120ºC temperature. The aim of the project is to enable transition from fossil fuels to low-carbon technologies within the heating sector, which is a major source of CO_2 emissions in Finland and other countries with cold winter climate. Since alternative near-term solutions are based on bioenergy and natural gas, the nuclear option can also be seen as an effective means to reduce the reliance on imported fuels. One of the major challenges for district heating reactors is that heat, unlike electricity, cannot be transported cost-effectively over long distances. Production has to be located near consumption, which in turn creates new challenges for licensing and public acceptance. High level of safety and reliability can be accomplished by inherent passive safety features, taking advantage of low operating temperature and pressure. The invention presented here is related to the passive heat removal function of the LDR-50 reactor module. The reactor vessel is enclosed inside a larger containment vessel, with the intermediate space partially filled with water. The reactor module is submerged into a large pool, which acts as the final heat sink. In normal operating mode heat is removed from the reactor vessel via the primary heat exchangers. Temperature in the intermediate space remains under the boiling point of water, and the reactor is thermally insulated from the environment. When the primary heat removal route is compromised, the reactor falls back to the passive cooling mode. Temperature inside the reactor vessel begins to rise, which initiates boiling in the intermediate space between the two vessels. The upper part of the containment vessel is filled with steam, which condenses on the cool outer wall and transfers heat into the reactor pool. The passive cooling mode is actuated without any mechanical moving parts, and it does not involve breaching any defence-in-depth release barriers. The feasibility of the concept has been demonstrated by computational analyses, and the invention has been granted a patent in November 2021.

s03 R&D 095-call-fisa-s03-abs-rev00-LEPPANEN_Jaakko (NIP DH LDR, Win-3(a))

TURBULENCE-INDUCED VIBRATIONS PREDICTION: THROUGH USE OF AN ANISOTROPIC PRESSURE FLUCTUATION MODEL

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Due to the complicated design of nuclear reactors, many complex phenomena can cause points of failure. In the case of nuclear fuel rods, the axial flow that cools the rods can induce vibrations due to the turbulent nature of the flow. Turbulence-induced pressure fluctuations create small but significant vibration amplitudes, which in turn can cause structural effects such as material fatigue and fretting wear. For this reason, turbulence-induced vibrations have been the subject of many studies, with a recent focus on the development of computational methods, so called Fluid-Structure Interaction (FSI) simulations. While scale-resolving methods can predict pressure fluctuations directly, they are typically too expensive for industrial nuclear applications in FSI. Instead, an Unsteady Reynolds-Averaged Navier-Stokes (URANS) approach coupled with a pressure fluctuation model can be used, to reduce the computational cost. While showing promising results, this approach generally underestimated the vibration amplitudes. For this reason, an improved pressure fluctuation model, called AniPFM (Anisotropic Pressure Fluctuation Model), was developed. It models velocity fluctuations based on existing methods for synthetic turbulence. In turn, these velocity fluctuations are used to obtain the pressure fluctuations. AniPFM improves the prediction of the pressure fluctuations in three ways. First, whereas previous iterations could only represent the turbulence as isotropic, in the current model anisotropic Reynolds stresses can be embodied. Second, only the scales that can be resolved on the grid are represented by the velocity fluctuations, causing a more realistic distribution of energy along the different wavelengths. Finally, time correlation is introduced based on the transport and decorrelation of turbulence. From simulating decaying homogeneous isotropic turbulence, we find that this time correlation method gives a significant improvement over previous methods. From turbulent channel flow simulations, our results show that for anisotropic turbulence, the pressure fluctuations are overestimated, but they are still within a reasonable range of 10% compared to high-resolution data. AniPFM doubles the cost of simulation, compared to a URANS simulation. Even though that is a steep increase, the cost is still much lower than scale-resolving methods. While further validation is ongoing, the AniPFM has demonstrated its potential for cheaper simulations of turbulence-induced vibrations in industrial nuclear applications.

s01 PhD 103-call-fisa-s01-abs-rev00-VAN-DEN-BOS_Nout

TRAINING AND TUTORING FOR THE NUCLEAR SAFETY EXPERTS OF COUNTRIES OUTSIDE THE EU

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Keywords: Training and tutoring, nuclear safety, radiation protection, Nuclear Regulatory Authorities, Technical Support Organizations

Safe utilization of nuclear energy requires competent, independent, and adequately financed National Nuclear Regulatory Authorities (NRAs) and Technical Support Organizations (TSOs). Because of the high demands on technical competence, the continuous availability of new information (development of new reactor types, new safety mechanisms or new assessment methodologies), the recruitment of new staff, there is always a need for general, in-depth and specific training for the experts of NRAs and TSOs to build and maintain their necessary knowledge and skills. The European Union (EU) supports the achievement of the above in countries outside the EU through the Instrument for Nuclear Safety Cooperation (INSC) and has initiated several actions to provide training for countries in need of technical assistance.
Training & Tutoring initiative to support competence building worldwide is part of the INSC's efforts towards making the EU a global reference in matters of nuclear safety and radiation protection, emergency preparedness and regulatory framework.
Phase 5 of the European Commission's INSC project has been launched in January 2022. It is implemented by a Consortium led by EK (Hungary), having members of NucAdvisor (France), N.IN.E. S.r.l. (Italy), VUJE, a. s. (Slovakia), Uni-Energy Ltd. (Hungary) and ENEN (Belgium). Throughout the nearly three years of the project, several courses – both in the form of trainings and several weeks tutoring – and assistance will be provided for the experts of non-European countries' NRA(s) and TSO(s) to strengthen their capabilities with regard to their tasks and responsibilities related to radiation protection and nuclear safety. Developing such expertise is more than a matter of education, as it involves not only the transfer of technical knowledge, experiences, and best practices, but also helps promoting the European nuclear safety culture.
The programme of the current project will be presented as well as the lessons learned from the previous phases.

s03 R&D 107-call-fisa-s03-abs-rev00-COGNET_Gerard

MOX-FUELLED PINS FOR FAST REACTOR CONDITIONS: MODELLING ADVANCEMENTS AND ASSESSMENT

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Fuel performance codes (FPCs) are mainly tailored on the materials and irradiation conditions of current commercial LWRs. Their development towards fast reactor (FR) irradiations supports the FR fuel design and licensing, and complements the challenging in-reactor experiments. From the modelling point of view, this work focuses on the thermal conductivity and melting temperature of U-Pu mixed-oxide (MOX) fuels, safety-relevant properties determining the fuel temperature profile and the compliance with the margin to fuel melting as fundamental safety criterion. The state-of-the-art correlations for these thermal properties are mostly empirical and limited, since built on experimental data of fresh LWR MOX and neglecting some important effects, e.g., the deviation from fuel stoichiometry and the initial actinide (Pu, Am, Np) contents, relevant in view of MOX applications in FR incinerators and transmuters. The physically-grounded models proposed in this work represent a step beyond the state of the art, since accounting for critical dependencies of FR MOX thermal properties in wide ranges targeted by future Gen-IV systems. Hence, the FPC capability to reliably simulate the fuel performance under fast neutron spectra is extended. The novel correlations for MOX fuels are statistically assessed based on the regressor p-values, justifying the included dependencies based on the fitting dataset, and validated against separate-effect data, both experimental and from atomic-scale calculations. The validation step is complemented by an uncertainty analysis, performed by propagating the uncertainties concerning the most relevant regressors to the calculated property values. The developed models are implemented in the TRANSURANUS FPC and employed for the integral code assessment against available data from FR irradiation experiments. The irradiations considered are HEDL P-19, a power-to-melt test on FR-type MOX fuel in fast start-up conditions, and SUPERFACT-1, representative of homogeneous (Am, Np)-MOX irradiation up to significant burn-up. The pin performance analyses focus on the fuel thermal behaviour and encompass engineering-level, safety-relevant outcomes, e.g., the margin to fuel melting and the fission gas release in the fuel-cladding gap, representing a potential life-limiting factor for FR pin operation. The propagation of the thermal property uncertainties to the pin behaviour is performed to conservatively verify the compliance with safety requirements, and fits in the current trend of developing and applying best estimate plus uncertainty methodologies.

s02 PhD 109-call-fisa-s02-abs-rev00-MAGNI_Alessio (ENEN PhD Invited)

APPLICATION OF THE TRANSPOSITION METHOD INVOLVING EDF NUCLEAR PLANTS MEASUREMENTS: CASE OF REACTIVITY.

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Key words: nuclear data, sensitivities, uncertainties, covariance matrices, representativity, assimilation, transposition, industrial measurements.

Usually, comparisons to experimental data are performed to validate a calculation code in a specific domain (called the validity domain). However, the lack of experimental data of new reactor concepts (EPRs, SMRs, …) has made the transposition method becoming more widely used for domains which have insufficient experimental data. The use of this method is discussed by the French Safety Authority (ASN) in its “guide 28”, related to first barrier safety. It has been in use for several years now in the field of experimental research reactors (by the CEA in France for example) and has given satisfactory results, especially for designing new critical mock-up experimental programs. Therefore, the main concern of this paper is to study its application to an industrial concept (such as an EPR) with experimental data coming both from mock-up and power plant measurements, the later making the approach quite innovative. The goal is to improve predictability of industrial codes. One observable is studied: the reactivity. First order Standard Perturbation Theory (SPT) is used to compute the nuclear data sensitivities, whose uncertainties are propagated to the outputs through the “Sandwich rule”. The covariance matrices are those of the CEA (COMAC), based on JEFF-3.1.1. The transposition formulas are used to compute the posterior outputs and uncertainties. At this time, only an intermediate scale (several assemblies at various burn-up steps) has been treated to set up the process and analyse the 8 group COMAC consistency, freshly constructed for our needs and not yet validated. The results showed that transposition leads to biases and uncertainties reduction (up to 40%). Some unexpected behaviour of the given 8 group COMAC (inconsistent propagated uncertainties on supposed known nuclear data) has been bypassed by using the validated 36 group COMAC and conserving the uncertainty information during its condensation to new 8 group matrices. The paper details the used methodology. We also point out the robustness of the sensitivity calculation versus the calculation scheme degradation. We expect that the inclusion of industrial measurements in the transposition process, using

industrial calculation codes, will increase their predictability (same target value with reduced uncertainty).

s02 PhD 110-call-fisa-s02-abs-rev01-NJAYOU-TSEPENG_Eris-Karson

NEUTRON CONVERTER SAFETY LIMITS DETERMINATION BY MEANS OF CFD ANALYSIS.

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In the National Centre for Nuclear Research (NCBJ) in Poland, the so-called H2 experimental facility for BNCT research, as a part of a new laboratory, is being constructed as a part of a new laboratory at one of horizontal neutron beam channels of MARIA reactor. One of the significant technical challenges is to provide a high-quality beam, required for various targets irradiations. Since the primary neutron energy spectrum from the reactor includes both fast neutrons and thermal ones, it is essential to shape the beam accurately. The beam spectrum will be based dependent on two systems: a neutron converter and the beam shaping assembly. The neutron converter is a subcritical system absorbing thermal neutrons to produce fast ones. Its main active parts are small plates containing uranium dioxide. Since the fission reactions occur within the plates, a significant amount of heat is released. That is why the proper cooling of the system has to be ensured. In the paper, the aim of determining the heat transfer and the coolant flow conditions using Computational Fluid Dynamics is shown. In addition, the safe levels of the operational reactor parameters are proposed. The specific objectives are to determine the flow characteristics in the neutron converter installation, to investigate heat transfer from the plates to water, and to model the coolant flow blockage event. The applied initial and boundary conditions in the test cases cover the entire spectrum of neutron converter operating conditions within the reactor core. The results presented in this study were used to determine whether the existing MARIA Research Reactor pool cooling conditions are able to ensure the safe operation of the neutron converter.

s01 PhD 112-call-fisa-s01-abs-rev00-TALAROWSKA_Anna

E-LITE 360º NEUTRONICS MODEL OF THE ITER TOKAMAK

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ITER is the flagship fusion project, conceived as an experiment to select and develop the technologies for the first demonstration reactor, DEMO. Nuclear analysis is a core discipline in support of the design, commissioning and operation of the machine. To date, ITER nuclear analysis has been conducted with increasingly detailed partial MCNP models, which represented toroidal segments of the tokamak. These models have successfully allowed to address most of the questions regarding ITER nuclear analyses until now. However, the limitations of using partial models became evident as estimates of quantities relevant to design, safety and operation showed unquantifiable uncertainties, which is a risk. Thanks to increasing high-performance computing capabilities and improvements in the memory management by the codes over the years, it is now feasible to overcome such limitations. In this PhD thesis a 360° MCNP model of the ITER tokamak, called E-lite, was developed. This model reflects the most faithful, realistic and up-to-date MCNP representation of the complete machine configuration ever achieved. It is demonstrated that the model is usable and practical. Furthermore, several examples are used to illustrate qualitatively and quantitatively how E-lite solves previously intractable problems with marked benefits for the future nuclear analysis of ITER, with applications to DEMO and future reactors. Definitely, E-lite constitutes a milestone in the field of ITER nuclear analysis in terms of realism in the evaluation of key quantities. It has already been adopted as a reference model of the ITER tokamak by the ITER project and, consequently, it has already been used in nuclear analyses of relevance and will be extensively used in the future. The value of E-lite has been highly recognized by the ITER neutronics community. In fact, an article about the model was recently published in the prestigious Nature Energy journal *(R. Juarez, G. Pedroche et al., A full and heterogeneous model of the ITER tokamak for comprehensive nuclear analyses, Nature Energy, Volume 6, 2021)*

s02 PhD 115-call-fisa-s01-abs-rev00-PEDROCHE_Gabriel (ENEN PhD Invited, ENS)

INVESTIGATION OF A HYPOTHETICAL CORE DISRUPTIVE ACCIDENT SCENARIO IN MYRRHA

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Multipurpose hYbrid Research Reactor for High-tech Applications (MYRRHA) is a fast neutron spectrum facility cooled by Lead-Bismuth Eutectic (LBE), currently under development at Belgian Nuclear Research Centre (SCK CEN). The main purpose of MYRRHA is to demonstrate the feasibility of an Accelerator Driven System based on a Lead-cooled Fast Reactor. As an ultimate safety barrier in the case of a severe accident, MYRRHA intends to rely on in-vessel retention of the nuclear fuel material. In order to determine the viability of the in-vessel retention strategy, an enveloping case is postulated: the Hypothetical Core Disruptive Accident (HCDA). In the course of the HCDA, core degradation and subsequent fuel relocation are assumed to happen in a way that will lead to a compaction of fissile material with a maximum increase of core reactivity. This further results in a power excursion that leads to coolant boiling and consequent overpressure in the reactor vessel. Three phases are considered to describe the HCDA: a core compaction phase leading to prompt supercriticality, a power-buildup phase until delayed supercriticality and a fuel-dispersion phase. The focus of this contribution is on the power-buildup phase. Within this phase, mechanism of reactivity reversal and sequence of events that lead to the disassembly are determined. The reactivity evolution in this phase is driven by a reactivity insertion due to the compaction and countered by the negative reactivity feedbacks due to Doppler effect and thermal expansion of core materials. The power-buildup phase is effectively terminated by fuel expansion due to fuel melting. The reference for the phenomena related to the HCDA in MYRRHA was established by employing computer code SIMMER-III. Since the power profile does not change significantly up until the point of LBE boiling, a point kinetics approach can be used to reproduce the reactivity evolution in the power-buildup phase. A simplified approach to analysis of HCDA, based on a coupled neutronic/thermodynamic solver, has been developed at SCK CEN in order to investigate the evolution of reactor core parameters during the power-buildup phase. The core reactivity evolution indicates that the reactivity reversal is caused by the combination of Doppler effect and thermal expansion of the core materials. For large power excursions, further expansion is provided by the fuel melting which rapidly drives the core reactivity to delay supercritical level. Due to thermal inertia, LBE boiling begins during the delay supercritical phase and will result in fuel dispersion, thereby stopping the core compaction. Sensitivity studies indicate that the reactivity reversal mechanism and the sequence of events considered within the power-buildup phase do not depend on the magnitude of the reactivity insertion rate.

s02 PhD 117-call-fisa-s01-abs-rev00-PETROVIC_Dorde

COMPUTING PRIMARY ION RADIATION DAMAGE IN SILICON CARBIDE

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The very-high-temperature reactors (VHTR) are a further step in the evolutionary development of nuclear reactors. One of the biggest challenge for VHTR is material selection. VHTRs materials have to retain their mechanical properties and withstand corrosion processes under a large neutron flux in a very high temperatures (800^{o}C – 1000^{o}C). The safety long-term operation of nuclear reactors depends on materials degradation, which begins from the primary radiation damage. Silicon Carbide (SiC) has been considered as a good candidate for use in VHTR due to excellent high-temperature properties, good corrosion resistance, low neutron absorption cross-section and stability under irradiation. Understanding the behaviour of SiC under ion and neutron irradiation in very high temperatures is crucial. In order to reduce the experimental time, ion irradiation is taken into consideration to use instead of neutron irradiation to damage creation. This work is focused on computing ion irradiation primary damage in TRIM Monte Carlo code and in LAMMPS molecular dynamic code. TRIM different approaches have been examinated: Quick Calculation and Full Cascades, using the vacancy.txt and damage energy method. Results from TRIM have been compared to results from LAMMPS code. Molecular dynamics simulations have been performed with and without using two-temperature model, which considering the electronic stopping and electronic-phonon coupling effects. MD and MC simulations of radiation damage in SiC calculations results have been discussed.

s02 PhD 118-call-fisa-s02-abs-rev00-KUCAL_Ewelina

PROPAGATION OF STATISTICAL UNCERTAINTY IN MESH-BASED R2S CALCULATIONS

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The Rigorous-Two-Steps (R2S) is one of the most powerful methods to estimate the Shutdown Dose Rate (SDR) due to material activation in nuclear facilities with intense and spread neutron fields. The most advanced R2S tools couple neutron and photon transport, which are often simulated using Monte Carlo (MC) codes, through an activation simulation using mesh-based techniques to improve the spatial resolution of both the neutron flux and the decay gamma source. One of the problems of the methodology is that the statistical uncertainty of the neutron flux, estimated by the MC transport codes, is not considered by most R2S implementations. Consequently, larger tolerance must be assumed in the design of the nuclear facilities. During the last years, several schemes have been proposed to estimate this uncertainty in R2S calculations, however, all of them assume the so-called “Single neutron interaction and low burn-up” (SNILB) conditions during the activation step. This limitation significantly limits their applicability because R2S methodology is more relevant in high fluence facilities, where the SNILB conditions are not met. The work performed during my thesis consisted in developing a scheme that enables the calculation of the SDR statistical uncertainty without any additional assumptions than those taken into account by the R2S methodology, particularly without being limited by the SNILB conditions. In addition, the proposed approach is suitable for cell and mesh-based R2S implementations. This methodology, and other features required to calculate the input data needed to use the methodology, were implemented in R2S-UNED code. Among these extra features, it is worth mentioning the capability to calculate the neutron flux uncertainty (covariance matrix) required for the accurate estimation of the SDR uncertainty, because the estimation of this quantity is the step that currently limits the estimation of the SDR stochastic uncertainty in R2S calculations. The principal issue to estimate this matrix is that its size is, in realistic cases, around thousands of GB. Consequently, it can not be calculated during the MC transport calculation as R2SUNED does. For this reason, efforts were dedicated to optimising the R2S simulation to reduce the size of this matrix. As result, a guideline and a methodology were developed to increase the applicability degree of this scheme to realistic cases. Finally, the last part of the work consisted in applying the scheme in different relevant application cases: the ITER benchmark exercise and the SDR estimation in the JET facility after of the last campaign.

s01 PhD 119-call-fisa-s01-abs-rev00-ALGUACIL_Javier (ENEN PhD Invited)

DYNAMIC MODELLING OF REACTOR DEBRIS UNDER SFR SEVERE ACCIDENT CONDITIONS

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The topic of this paper is related to the analysis of an innovative severe accident mitigation strategy in Sodium-cooled Fast Reactors (SFR), in particular, to the discharge phenomena of degraded core inventory via dedicated mitigation devices. In order to predict the mitigation scenario of controlled fuel removal towards core catcher with a higher confidence, the relocation mechanism of solid debris has to be addressed. In this context, a new modelling set describing the dynamic behaviour of dense debris flows is developed in the SIMMER-V code environment and presented in this work. The modelling set takes into account the effect of collisions and friction between the debris particles following a shear dependent granular rheology. This brings an entirely new physics and a more conservative description into the numerical prediction of the mitigation performance, and consequently, it provides a more robust demonstration of SFR severe accident scenarios. The validation and comparative analysis of such models is carried out at three different levels. Firstly, their capability to account for the unique physics of granular systems is studied through simplified test cases for which analytical solutions exists. Secondly, an in-pile experimental scale validation is performed to estimate the model behaviour on an integral level. Lastly, the impact of the newly developed particle dynamics is evaluated through a full scale simulation of the ASTRID reactor in case of a reference Unprotected Loss Of Flow (ULOF) accidental sequence. Following the entire transient evolution, the mitigation performance applying the new models is assessed.

s02 PhD 122-call-fisa-s02-abs-rev00-ESZTER_Csengeri (ENEN PhD Applicant)

REACTOR SAFETY ANALYSIS TOOLBOX RESA-TX

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The Reactor Safety Analysis Toolbox RESA-TX is a software and data package managed by AI powered big data algorithms that combines the automatisation of all established procedures for Deterministic Safety Analysis (DSA), the integration of expert know-how and a large database including most relevant information required for conducting a DSA. In the current state of the art, DSA is a complex and thus error prone process that is highly time consuming and repetitive. The reliability of the result is strongly dependent on the availability of plant data and expert know-how. The idea of RESA-TX arose at GRS out of the necessity to cope with these conditions. The innovative approach proposes an automated and standardised procedure, supported with a large database of plant design characteristics, plant behaviour, regulatory rules and DSA expert knowledge incorporated within the tool. Its application allows the end user to automatically generate and verify an input deck, as well as conduct design basis accident (DBA) calculations for a certain design with highly reduced manual intervention. The databases can be extended depending on available information or other boundary conditions. Enabled by AI powered algorithms, a heuristic approach is integrated in the model generation and verification process, where users often suffer from a lack of information about the facility under consideration. These heuristics can be replaced when higher information quality is available or enhanced over time, which can lead to more reliable results with increasing usage of the tool. As a result, the application of RESA-TX highly increases the efficiency of the DSA process, reducing both repetitiveness as well as user induced errors. This in return will lead to an improvement in quality of the analysis and reliability of the results. In consequence, RESA-TX will allow for a DSA to be conducted more frequently in situations where time or budget were a limitation before, hereby contributing to an increase in reactor safety.

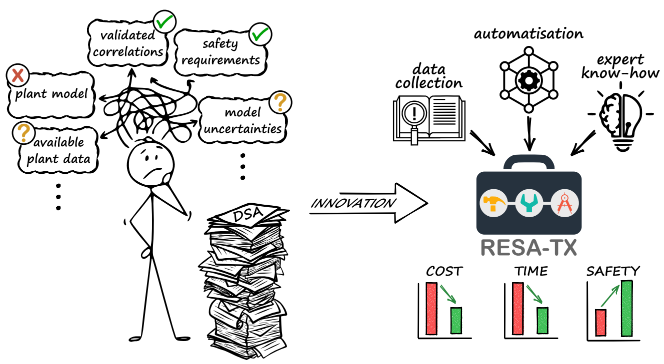

Figure 1State of the art DSA vs. innovative approach of RESA-TX

s01 R&D 129-call-fisa-s01-abs-rev00-CUESTA_Alejandra (NIP RESA-TX)

FROM THE PLANT LAYOUTS TO AN OPTIMIZED 3D PWR-KWU CONTAINMENT MODEL WITH GOTHIC 8.3 (QA)

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Containment geometry characteristics play a key role in many accident and severe-accident phenomena, such as flammable gas distribution, accumulation and deflagration dynamics. The containment buildings of nuclear power plants have complex geometries and extracting the data required to build detailed computational models from plant layouts is a demanding task. Using Computational Aided Design (CAD) software as a cornerstone of the modelling process serves as a bridge between the containment layouts and the thermal-hydraulic models. This work will describe all the steps of the methodology used to build a 3D PWR-KWU containment model in GOTHIC from its detailed CAD model. Firstly, an intermediate model with several geometric simplifications will be developed in the CAD environment. These simplifications are intended to avoid problematic configurations when adapting the actual geometry to the porous cartesian mesh of GOTHIC, avoiding numerical instabilities and resulting in shorter simulation times. The simplified geometry is imported into GOTHIC, and it is tested by simulating a Large Loss of Coolant Accident (LB-LOCA) in one of the cold legs. This is the most convenient scenario to check the specific numerical instabilities within the porous cartesian space discretization of GOTHIC, which mainly arise from the massive release of mass and energy during the blowdown. Although the initial containment model did perform adequately in the initial phases of the LOCA, a detailed assessment of the numerical stability revealed several points for improvement in further stages of the simulation. Namely, the accumulation of liquid in sump-type regions with low-porosity problematic cells, hampered the simulation at specific periods of time. Then, the final modifications of the geometry achieved a reduction of the computational costs up to one order of magnitude. Part of this work is included within the AMHYCO project (Euratom 2019-2020, GA No 945057) which main objective is to improve experimental knowledge and simulation capabilities for the H_2/CO combustion risk management in nuclear power plant containments during severe accidents (SAs).

s01 PhD 133-call-fisa-s01-abs-rev00-SERRA-LOPEZ_Luis

MULTICOMPONENT NUCLEAR FUEL CLADDING WITH SAFETY AND OPERATIONAL BENEFITS

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Accident Tolerant or Advanced Technology Fuels (ATF) are one of the hottest research topics in the nuclear engineering research and development area since the Fukushima-Daiichi events with the first concepts inserted into commercial nuclear power plants in 2019. The most advanced ATF cladding concept is Cr-coated Zr-based alloy which was chosen as the near-term ATF solution by fuel vendors operating on the EU nuclear fuel market - Framatome, Westinghouse Electric Company, and TVEL. The research group at CTU in Prague identified several new degradation phenomena linked to this concept such as material interdiffusion, Cr enhanced embrittlement, and Zr-Cr eutectic formation. The optimization of advanced coating techniques and fuel cladding design led the team to develop and qualify innovative multicomponent Cr/CrN coated Zr alloy cladding that limits the degradation effects such as Cr enhanced embrittlement and delays the eutectic reaction to much higher temperature making the cladding more resistant and accident tolerant in comparison with both traditional Zr-based alloys as well as pure Cr coated Zr alloys. This innovative solution was qualified out-of-pile and is now under in-pile investigation in the LVR-15 research reactor. In the next phase, this innovative nuclear fuel cladding will be inserted into a commercial reactor as a non-fueled material, the fabrication process will be qualified for industrial production, and the complete solution will be offered to fuel vendors as an advanced near-term nuclear fuel cladding for the current generation of light water reactors.

s02 R&D 134-call-fisa-s02-abs-rev00-SEVECEK_Martin (NIP MULTIPROTECT FUEL, Win-1)

INVESTIGATION OF HYDROGEN BEHAVIOUR IN THE TEST FACILITY THAI BY SIMULATION OF SEVERE ACCIDENT CONDITIONS IN THE CONTAINMENT

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Key words: THAI, ASTEC, Hydrogen deflagration and combustion

This work presents an analysis of the results received in a simulation of hydrogen deflagration and combustion and flame propagation during experiment HD- 22 in the test facility THAI. The analysis has been performed by the integral computer code ASTEC. For this purpose, modules for processing hydrogen behaviour in the containment have been developed. This work considers the behaviour of the hydrogen during a hypothetical severe accident. Various risk studies have shown that hydrogen combustion is one of the major risk contributors to early containment failure in the case of a severe accident in a nuclear power plant. Therefore, it is very important to properly simulate the processes in the containment. In the past two decades, the different aspects of this issue, namely hydrogen sources, distribution in the containment, combustion behaviour and loads, have been investigated in many research programs, including single effect tests and integral experiments, model and code development and nuclear plant analysis. Hydrogen mitigating and controlling systems like recombiners, igniters have been proposed and developed and their practical implementation is underway. To assess the related risk for hydrogen specific accident scenarios, and to design and optimize mitigating systems, quantitative hydrogen analysis has to be carried out. Necessary input for such an analysis is the knowledge of the hydrogen release conditions, especially source rates, total mass and time sequence. The hydrogen burns as a diffusion flame and, by rising hot combustion products, increases the mixing of the atmosphere by entangling fresh oxygen and hydrogen rich gas into the flame. Depending on the hydrogen and steam content and the temperature, volumetric combustion can also take place. If these processes occur on the same time scale as the debris dispersal process, they contribute to the peak pressure in the containment. The pressure increase due to hydrogen combustion may be higher than that by other processes. Due to the flammability limits for hydrogen-air- steam mixtures not all available hydrogen will burn. Between 30% and 90% of the available hydrogen has been observed to burn in experiments. The hydrogen burning follows the Shapiro's diagram i.e. depends also on the oxygen and steam concentration; burning is not possible in steam inerted atmosphere when most of the oxygen has completely reacted. For this reason, oxygen and steam concentrations have been investigated in the present work and compared with the results from test HD-22 performed in THAI facility.

DIPSICOF, DIAGRID INTEGRATED PASSIVE SYSTEM LIMITING CORE FLOWBYPASS IN ACCIDENTAL CONDITION FOR ADVANCE FBR REACTOR

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Within the Generation IV reactors design exploration framework, Framatome investigates many options to optimize the reactor designs and their costs.

On the today existing sodium fast breeder reactors, including the pool or loop concepts, 3 or 4 primary pumps components are installed within the main vessel. These pumps feed the core by flowing the coolant in a first step through the LIPOSO, and then inside the Diagrid, before feeding the fuel assemblies bundle that constitute the reactor core. In the case of one primary pump malfunction or a severe leakage onto the LIPOSO pipe, the core is partially fed and cooldown by the remaining pumps. But a certain amount of the coolant is rerouted through the failed pump or the damaged LIPOSO breach. To respect the safety criteria in such an accident, at least 3 pumps were installed with 2 LIPOSO per pump, allowing to justify one pump loss in extended Design Basis Accident.

Among the reactor design investigated by Framatome, optimizations related to the safety behavior are a priority. This is performed considering the global cost investment limitation. For that, Framatome Engineering Technical Direction has recently decided to assess a fast breeder Advanced Reactor using only two primary pumps within the primary circuit.

The goal is to avoid worsening the safety behavior specially in the case of the loss of one pump. In accidental conditions, as loss of one of the two pumps, this could be acceptable when accounting a dedicated device that would limit the core flow bypass. To do so, Framatome design team has explored an innovation aiming at enhancing the reactor passive safety in such a case.

The Framatome innovation idea introduced in the present poster consists in implementing a passive dedicated device within the core support structure. It aims at limiting the core coolant reverse flow through the failed pump. This is possible by reorganizing cleverly the dynamic flow distribution within the Diagrid volume. It will enable the minimum core cooling during any hypothetical accident, as for instance one primary pump loss.

Framatome innovation idea is named DIPSICOF for Diagrid Integrated Passive System LImiting Core Flow bypass in accidental condition for advanced FBR reactor.

The "DIPSICOF" innovation proposed by Framatome is increasing reactors safety, it is simple, fully passive, and implementable onto many reactor types options. It enables

significant economy. It will contribute to ease the public acceptance and realistic nuclear reactors deployment.
The innovation principle is exposed, preliminary results are showed, the prospects and envisioned next steps to reinforce the justification are emphasized.

s01 R&D 142-call-fisa-s01-abs-rev00-VAIANA_Florian (NIP DIPSICOF)

POST-TEST THERMAL-HYDRAULIC ANALYSIS OF PKL III I3.1 EXPERIMENT ON LOSS OF RHRS DURING MID-LOOP OPERATION WITH ATHLET

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Every Pressurized Water Reactor (PWR) is periodically brought to Low-Power and Shutdown (LPS) operations, to perform maintenance and refueling. As long as the reactor core is loaded with nuclear fuel, uninterrupted reactor core cooling has to be maintained. During LPS operation modes, the Residual Heat Removal System (RHRS) is used. However, there is 10^{-2} probability of RHRS failure [1], which might lead to the reactor core damage or more severe events. The PKL III i3.1 experiment was conducted in the international framework of the OECD/PKL4 project targeting safety related issues of current and new design PWR plants. In the scope of this project three major areas were emphasized: i) complex heat transfer mechanisms under two-phase flow; ii) boron dilution and precipitation; iii) cooldown procedures [2]. Particularly, this experiment considers the loss of RHRS during low-power and shutdown conditions accident, where a reactor is brought to a reduced coolant inventory state, so called mid-loop operation. The test facility is configured to 3-loop operation mode, the reactor coolant system is assumed to be closed, and a single Steam Generator (SG) is available at the beginning of the transient. In the evolution of the transient, coolant inventory is displaced towards the available SG as a consequence of vapor condensation inside the U-tubes. As the accident progresses the Natural Circulation mode inside the system changes from pure reflux condensation to oscillatory, then to carry-over, and finally to natural circulation mode. Since there is a gap on publicly available studies on such accident sequences performed with best-estimate System Thermal-Hydraulic (SYS-TH) code ATHLET, a dedicated model of the test facility is being built and executed with ATHLET. Such studies serve as code validation and establishment of numerical benchmark to different code cross-comparison. The aim of the present poster is to introduce the sequence of loss of RHRS accident and ongoing post-test analysis of PKL III i3.1 RUN 1 using best-estimate SYS-TH code ATHLET.

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s01 PhD 145-call-fisa-s01-abs-rev00-SMIGELKIS_Edgaras

ATOMISTIC SIMULATION TO INVESTIGATE MOX PROPERTIES AND THE IMPACT OF THE IRRADIATION

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Due to the possibility of recycling spent fuel, non-proliferation concerns, and economic considerations, Mixed oxide (MOX) fuel meets the safety requirements of GEN-IV reactors. Thermodynamical properties of MOX fuels are poorly known and several authors in the literature consider the recommendations of MOX to be the same as those for UO_2. Nonetheless, the available recommendations do not rely on updated data and do not reproduce some material behaviours correctly, such as the Bredig transition occurring in superionic materials [1].
The reliability and robustness of Fuel Performance Codes, which simulate the behaviour of the fuel under irradiation in the reactor, depend significantly on the knowledge of the physical and chemical properties of nuclear fuels. This is the reason why a complete investigation of the MOX fuel properties as a function of irradiation and Pu content is strictly required, in particular in hypostoichiometric conditions which represent the initial conditions of the MOX fuel in Fast neutron reactors.
Due to the high radio-toxicity of the Plutonium, the experimental data regarding the MOX fuel are lacking and affected by significant uncertainties, and computer simulations may represent an excellent tool to obtain data, especially in extreme conditions. In particular, as D. Bathellier proved [2], atomistic simulation is a valid means to reproduce the thermodynamic properties of the MOX fuel at high temperatures and in stoichiometric conditions.
To simulate the irradiation in the MOX fuel, fission products, stoichiometry and defects can be involved in classical Molecular Dynamics simulation, providing information concerning irradiated MOX properties.
Employing the Cooper-Rushton-Grimes empirical potential [3], Molecular Dynamics simulations have been carried out for the first time for hypostoichiometric $U_{1-y}Pu_yO_{2-x}$ compounds (with y in the range 0 ÷ 1 and x in the range 0 ÷ 0.08) at high temperatures and the obtained simulation data were used to compute the heat capacity and the linear thermal expansion coefficient. The analytical law of the heat capacity for stoichiometric mixed-oxide fuels $U_{1-y}Pu_yO_2$ developed by D. Bathellier [4] has been modified introducing the deviation from stoichiometry as a variable, and a good agreement is found.
The obtained results show two regions for both thermodynamic quantities: at low temperatures, the trend is independent of the plutonium content, as in the stoichiometric case, whilst at temperatures around 0.8 T_m, where the Bredig transition occurs, a peak appears and its intensity varies with the deviation from stoichiometry.

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s02 PhD 148-call-fisa-s02-abs-rev01-PORTO_Giulia

INTERATOMIC POTENTIAL INVESTIGATION OF THERMODYNAMIC PROPERTIES OF URANIUM-AMERICIUM MIXED OXIDES

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Americium is a chemical element produced by neutron capture in nuclear reactors, whose strong radiotoxicity is a major issue for the management of nuclear waste. One solution envisaged to reduce the amount of americium in the waste is to separate it from the other elements present in the spent fuel, to include it into new fuels such as actinide oxides, and to transform it in reactor into a less radiotoxic element thanks to a transmutation reaction [1]. It is therefore necessary to evaluate the impact of Americium on the behaviour of these fuels, and in particular on their high temperature thermal properties.

One way of increasing significantly the efficiency in qualifying transmutation fuels is to develop a more physically based description of these fuels. Basic research approaches combining multiscale modelling and separate effect experiments can bring significant insight into materials properties and key phenomena involved in the evolution of fuels in reactor.

In particular, atomic scale modelling methods are now essential complements to the experimental characterizations of nuclear fuels. We show in this study the contribution of these methods to the improvement of the knowledge of the Uranium – Plutonium – Americium – Oxygen thermodynamic system, and especially of the (U-Am-O) ternary system for which very little data is available, especially at high temperature [2].

We will first describe the empirical interatomic potential that we developed to study Uranium-Americium mixed oxides. We will then present the structural and thermodynamic properties of $(U,Am)O_2$ as a function of temperature and composition yielded by this potential: thermal expansion, density, enthalpy increment, heat capacity and melting temperature.

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This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945077.

s02 PhD 149-call-fisa-s02-abs-rev02-LABONNE_Baptiste

COLLABORATIVE VIRTUAL ENVIRONMENT FOR SPENT FUEL CASK LOADING

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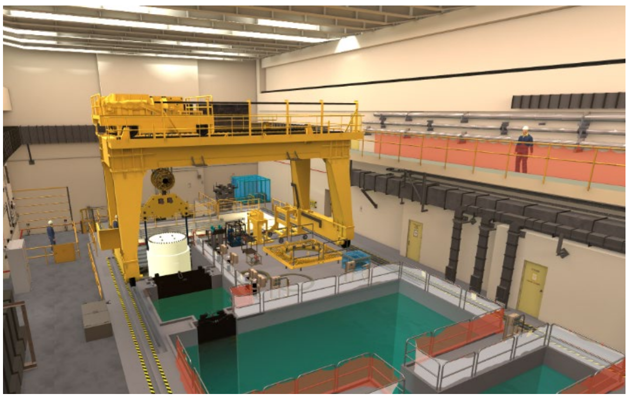
3D animation has been used in the nuclear industry for many years, producing detailed animated videos to provide a simplified way to inform about future projects or activities.
Due to the complexity of the creation process of these animations, only graphic designers were able to modify, never in real time, these virtual recreations, thus limiting the technical approach provided by end users or developers of the activities that have been animated. Consequently, these animations have been used as a passive tool: once the animation has been developed, final is not able to interact in real time or provide inputs that could be used to redefine the process.

During the spring of 2021 Cofrentes NPP performed the first loading campaign of dry storage fuel casks. Given the importance of this process and its pioneering nature in this plant, the development of a virtual collaborative environment was valued as a great opportunity for the preparation of the work of all the organizations previously involved without the need to access the radiologically impacted areas or traveling from different work centers to the site, a complex fact during the global COVID-19 pandemic.



This project is pioneering for management and planning of processes in Spanish nuclear power plants, paving the way for their use in many other complex activities within the plants, minimizing the exposure time inside radiological areas both in the preparation phase of the task as well as during the execution phase, thus reducing the exposure times of the personnel.

s03 R&D 153-call-fisa-s03-abs-rev00-HERNANDO_Jesus (NIP MITMAT, Win2)

PARUPM: A SIMULATION CODE FOR PASSIVE AUTOCATALYTIC RECOMBINERS.

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In the event of a severe accident with core damage in a water-cooled nuclear reactor, combustible gases (H_2 and possibly CO) get release into the containment atmosphere. An uncontrolled combustion of a large cloud with a high concentration of combustible gases could lead to a threat to the containment integrity if concentrations within their flammability limits are reached. To mitigate this containment failure risk, many countries have proceeded to install passive auto-catalytic recombiners (PARs) inside containment buildings. These devices represent a passive strategy for controlling combustible gases, since they are capable of converting H_2 and CO into H_2O and CO_2, respectively. In this work, the code PARUPM developed by the Department of Energy Engineering at the UPM is described. This work is part of the AMHYCO project (Euratom 2014-2018, GA No 945057) aiming at improving experimental knowledge and simulation capabilities for the H_2/CO combustion risk management in severe accidents (SAs). Thus, enhancing the available knowledge related to PAR operational performance is one key point of the project. The PARUPM code includes a physical-chemical model developed for the study of surface chemistry, and heat and species mass transfer between the H_2/CO/air/steam/CO_2 mixture and the catalytic plates in a PAR channel. This model is based on a simplified Deutschmann reaction scheme for surface combustion of methane, and the Elenbaas analysis for buoyancy-induced heat transfer between parallel plates. Mass transfer is considered using the heat and mass transfer analogy. PARUPM is capable of simulating the recombination reactions of H_2 and CO inside the catalytic section of the PAR. In addition, this model allows studying the effect of CO in the mixture, allowing to explore the effect of this compound on transients related to accidents that advance towards the ex-vessel phase. Finally, a thorough analysis of the code capabilities executed by comparing the numerical results with experimental data obtained from the REKO-3 facility. This analysis allows to establish the ranges in which the code is validated and to further expand the capabilities of the simulation code which will lead to its coupling with thermal-hydraulic codes in future steps of the project.

s01 PhD 154-call-fisa-s01-abs-rev00-DOMINGUEZ-BUGARINAR_Araceli (idem 068)

MITIGATION AND REAL TIME MONITORING OF ACOUSTIC RESONANCES IN MAIN STEAM SYSTEMS OF NUCLEAR REACTORS

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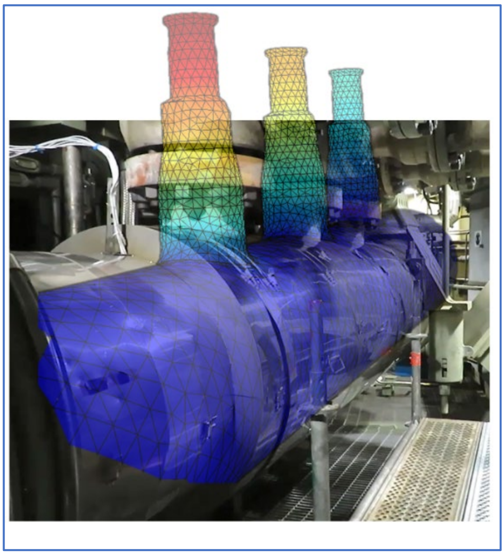
In the last two decades, the nuclear fleet worldwide has experienced a relatively high number of events related to damage sustained by different main steam components and reactor internals caused by acoustic resonances. In some cases, this damage has resulted in the malfunction of safety related equipment, such as main steam safety valves and main steam isolation valves in BWRs. Therefore, acoustic resonances have proven capable of causing a deleterious impact on the safety of reactor systems.

The innovation of the work presented in this application is twofold: first has developed a first-of-a-kind sleeve that can be integrated in the nozzle of safety relief valves in order to eliminate resonances without any need for modifying the main steam system. Second, a non-invasive real-time monitoring system has been developed, implemented and tested. This system is capable of determining the amplitude of the pressure waves inside the main steam lines and providing valuable information to the plant operator in order to avoid continued operation in regions where the resonance intensity is capable of damaging the valves or other safety related equipment.



s01 R&D 157-call-fisa-s01-abs-rev00-GALBALLY_David

CAPABILITIES OF THE GPU-BASED DYNAMIC MONTE CARLO CODE GUARDYAN.

D. LEGRADY, G. TOLNAI, M. PUKLER, B. BABCSANY, E. PAZMAN and J. KOPHAZI
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Targeting ultimate fidelity coupled reactor physics and thermal-hydraulics calculations has recently entered the forefront of reactor safety analysis research enabled by the vast forward leap of High-Performance Computing (HPC). Our project has achieved a breakthrough by introducing Graphics Processing Units (GPUs) to the prodigiously progressive Dynamic Monte Carlo (DMC) method, where time dependence is handled explicitly rather than by a series of static calculations, achieving simulations very faithful to nature. Algorithms were devised to optimally fulfill DMC requirements and adapt to GPU specificities. Moreover, attention was paid to keeping the statistical variance of the population low. In 2016 the GUARDYAN (GPU Assisted Reactor Dynamic Analysis) code development started and recently reached the capabilities to accomplish full core VVER-440/V213 calculations with meaningful detector reading simulation results. This indicates that with the inventions conceived and implemented in GUARDYAN, the DMC method was promoted from proof-of-concept to application to realistic power plants.
The code has been verified and validated against 30 ICSBEP benchmark scenarios by comparison to MCNP6.1 for approximately 440 000 data points; further, by performing experiments using the Budapest University of Technology and Economics (BME) Training Reactor of a Cd sample insertion and rod drop experiments, and even further by replicating a recent safety rod drop experiment results of the Paks Nuclear Power Plant for a VVER-440/V213 unit with realistic burnup values, each comparison was concluded with complete success.
The code GUARDYAN fused existing and novel Monte Carlo techniques with GPU-based high-performance computing advocating DMC to be the gold standard of reactor physics, a calculation tool devoid of obscure approximations. A high-fidelity simulation tool enables more optimal use of design safety margins and creates room for efficiency improvement of power plants.

s01 R&D 159-call-fisa-s01-abs-rev00-LEGRADY_David (NIP GUARDYAN, Win3b)

MULTIMODAL HUMAN-ROBOT INTERFACE FOR HETEROGENEOUS ROBOTIC SYSTEMS CONTROL IN HARSH ENVIRONMENT

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The development of robotic solutions is of great interest for modern industries, especially for those hosting facilities potentially hazardous for their personnel, such as nuclear research centers and nuclear plants. Currently available commercial solutions are often not appropriate for the specific organization needs and require additional work upon purchase for providing satisfactory results. More in details, common robotic platforms for tele-intervention in unplanned scenarios, which could be useful, for example, in extraordinary maintenance in hazardous environments, still do not provide a level of usability and flexibility to improve their diffusion. Human-Robot Interfaces play a critical role in this context, as they are the primary interaction tool with the remote agents. The usability of the interface is essential to improve the accessibility to the robots to more operators. The presented work aimed to create a modular interface for the control of heterogeneous robotic systems for remote unplanned interventions in hazardous environments, ensuring safety, usability, and learnability through multiple interaction modalities. The proposed Human-Robot Interface provides a unique and complete system during the entire robotic intervention process, including preparation, training, optimization, data collection and analysis. Furthermore, it implements high- level functionalities and multiple interaction modalities, which assist inexperienced operators in the accomplishment of their goals. Finally, its modularity ensures the adaptability of the interface to heterogeneous hardware and to new functionalities that could be available in future. The proposed interface has been validated through various tests to prove its usability and learnability, as well as its reliability in several scenarios, such as communication limitations and challenging environmental constraints. Moreover, the proposed interface is currently used at CERN, the European Organization for Nuclear Research, in its particle accelerators, and has been validated, at the time of writing, in more than 120 real interventions and 300 hours of operation.

s03 PhD 165-call-fisa-s03-abs-rev00-LUNGHI_Giacomo (ENS)

NEW INITIATIVES OF THE SPANISH YOUNG GENERATION NETWORK

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The organization of activities to disseminate knowledge about the many applications of nuclear science and technology, as well as their role in the well-being of our society, is a fundamental pillar of the Spanish Young Generation Network (Jóvenes Nucleares). Over the years, some of them have been integrated into our DNA, such as the talks in schools, the basic courses in universities, the seminar on advanced reactors, and the technical visits to nuclear installations. All of this is reinforced through an active participation in social media, which allows us to reach a wider audience. The continuous incorporation of young talents, who always bring valuable ideas and perspectives into the organization, combined with our willingness to anticipate the needs of the global energy scene, has enabled Jóvenes Nucleares to expand its range of activities in view of the long-awaited return to normality. This poster aims to present some of the most recent initiatives, highlighting their motivation, their alignment with our strategic objectives, and the lessons learnt after their completion. In particular, we will focus on the activities carried out as co-organizers of the IAEA Nuclear Energy Management School, which was held last September 2021 in Tarragona during the ENYGF'21. Furthermore, we will analyse the outcome of our most recent seminar entitled '*Nuclear Tech: The Future is Now!*' on neural networks and their applications in the nuclear sector. Finally, we will comment on the experiences gained through the social media initiative '*NuclearSí*', launched in close collaboration with Women in Nuclear Spain (WiN), and the future implementation of practice-oriented debates to further develop our communication skills, in light of the growing presence of Jóvenes Nucleares in the media.

s03 PhD 171-call-fisa-s03-abs-rev00-ARAGON_Pau (ENS WORKSHOP)

MEDICATION SYSTEMS FOR BLENDED PILLAR RADIOTHERAPY WITH AT THE SAME TIME OPTIMIZED PHOTON WHATS MORE ELECTRON BEAMS.

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In distinction to electron beams, gauge boson beams have a really tiny penumbra and targets will be treated the least bit locations within the patient as a result of the exponential dose fall-off. Using the gauge boson multiyear collimator for ray registration rather than cut-outs placed within the lepton device is usually recommended to form electron treatments additional economical and to facilitate advanced treatment techniques for modulated electron radiation and MBRT. it had been shown that today's single electron field treatment arranges mistreatment cut-out collimation will be replaced by plans of comparable treatment plan quality using pMLC collimation with accurately calculated dose distributions at an outsized source-to-surface distance range of 70-100 cm. Energy modulation was found to be of considerably larger price than intensity modulation to extend treatment arrange quality for MERT.
To explore the dosimetric potential of MBRT, a treatment coming up with method was developed permitting to get pMLC primarily based step and shoot MBRT plans with at the same time optimized and town calculated gauge boson and vi negatron contributions. Beside of lepton beams, standard C-arm treatment units provide conjointly alternative degrees of freedom, that aren't utilized with the present progressive treatment techniques. Thus, a non-coplanar treatment technique for dynamic flight radiation was developed, which utilizes combined dynamic gantry, table associated collimator rotations throughout beam on of a gauge boson beam. For 2 head and necks, a lung, a muscle system and a prostate case, it had been shown that DTRT improves treatment set up quality compared to VMAT.
Combining photon dynamic trajectories with step and shoot modulated electron beams, known as dynamic mixed beam radiotherapy , would end in a treatment technique utilizing additional DoFs than the other treatment technique given before for standard C-arm treatment units. The results of the expeditiously and accurately deliverable MBRT arranges counsel victimization MBRT for future clinical applications to treat targets with a minimum of a superficial a part of any treatment website with improved treatment plan quality compared to photon-only techniques.

s03 PhD 177-call-fisa-s03-abs-rev00-MOHAMMAD_Rafiean (ENEN Applicant)


FISA 2022
EURADWASTE'22

INVITED INVITED SPEAKERS

FISA 2022 SESSION 1 - Safety of nuclear installations
003-inv-fisa-s01-abs-rev00-SERRANOGARCIA_Marta
015-inv-fisa-s01-abs-rev00-BRYNK_Tomasz
021-inv-fisa-s01-abs-rev00-CAGNAC_Albannie
034-inv-fisa-s01-abs-rev00-BROUDIN_Morgane
008-inv-fisa-s01-abs-rev00-DEMAZIERE_Christophe
002-inv-fisa-s01-abs-rev00-TULKKI_Ville
009-inv-fisa-s01-abs-rev00-WIGHT_Jared
057-inv-fisa-s01-abs-rev00-HERRANZ_Luis
036-inv-fisa-s01-abs-rev00-HELMINEN_Atte

FISA 2022 SESSION 2 – Advanced nuclear systems and fuel cycles
099-inv-fisa-s02-abs-rev00-MIKITYUK_Konstantin
053-inv-fisa-s02-abs-rev00-SHUURMANS_Paul
006-inv-fisa-s02-abs-rev00-MALERBA_Lorenzo
004-inv-fisa-s02-abs-rev00-SOBOLEWSKI_Josef
108-inv-fisa-s02-abs-rev00-FRANZEN_Carola

FISA 2022 SESSION 3 - Education and training, research infrastructures, low-dose radiation protection research, decommissioning and international cooperation
005-inv-fisa-s03-abs-rev00-PAVEL_GabrielLazaro
044-inv-fisa-s03-abs-rev00-HIERATH_Monika (ALL RADIOPRO)
100-inv-fisa-s03-abs-rev00-KULKA_Ulrike
023-inv-fisa-s03-abs-rev00-VANDENHOVE_Hildegarde
007-inv-fisa-s03-abs-rev00-WINKLER_Robert
089-inv-fisa-s03-abs-rev00-MALLERON_Nicolas (PAPER)
001-inv-fisa-s03-abs-rev00-KINNUNEN_Petri

EURATOM PROJECTS

FISA 2022 SESSION 1 - Safety of nuclear installations	
ENTENTE	130-proj-fisa-s01-abs-rev00-SERRANO-GARCIA_Marta (ENTENTE)
ATLASplus	
NOMAD	
STRUMAT-LTO	
FRACTESUS	160-proj-fisa-s01-pptA0-rev00-BRYNK_Tomasz (FRACTESUS)
MEACTOS	
INCEFA-SCALE	
sCO2-4-NPP	
APAL	
CAMIVVER	
TEAM-CABLES	
El-Peacetolero	
CORTEX	
McSAFER	098-proj-fisa-s01-abs-rev00-SANCHEZ-ESPINOZA_Victor-Hugo
METIS	102-proj-fisa-s01-abs-rev00-ZENTNER_Irmela (METIS)
ELSMOR	166-proj-fisa-s01-pptA0-rev00-TULKKI_Ville (ELSMOR)
PASTELS	158-proj-fisa-s01-abs-rev00-MONTOUT_Michael (PASTELS)
EU-QUALIFY	
LEU-FOREvER	
MUSA	046-proj-fisa-s01-abs-rev00-HERRANZ_Luis (MUSA)
PIACE	
AMHYCO	010-proj-fisa-s01-abs-rev00-JIMENEZ_Gonzalo (AMHYCO)
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R2CA	

FISA 2022 SESSION 2 – Advanced nuclear systems and fuel cycles	
ESFR-SMART	
SafeG	132-proj-fisa-s02-abs-rev00-HATALA_Branislav (SAFEG)
ECC-SMART	
ACES	
SAMOSAFER	
PUMMA	
GENIORS	
INSPYRE	123-proj-fisa-s02-abs-rev00-BERTOLUS_Marjorie
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GEMMA	169-proj-fisa-s02-abs-rev00-AGOSTINI_Pietro (GEMMA)
M4F	125-proj-fisa-s02-pptA0-rev00-MALERBA_Lorenzo
NUCOBAM	
GEMINI-PLUS	004-inv-fisa-s02-abs-rev00-SOBOLEWSKI_Josef
SANDA	
ARIEL	

FISA 2022 SESSION 3 - Education and training, research infrastructures, low-dose radiation protection research, decommissioning and international cooperation	
ENENplus	
GREaT-PIONEeR	052-proj-fisa-s03-abs-rev00-DEMAZIERE_Christophe
ENEEP	
PIKNUS	
A-CINCH	126-proj-fisa-s03-abs-rev00-CIRILLO_Roberta (A-CINCH)
SINFONIA	040-proj-fisa-s03-abs-rev00-DAMILAKIS_John
EURAMED rocc-n-roll	033-proj-fisa-s03-abs-rev00-HOESCHEN_Christoph
MEDIRAD	039-proj-fisa-s03-abs-rev00-CARDIS_Elisabeth
HARMONIC	031-proj-fisa-s03-abs-rev00-THIERRYCHEF_Isabelle
RadoNorm	156-proj-fisa-s03-abs-rev00-KULKA_Ulrike (RADONORM)
SHARE	
INNO4GRAPH	
PLEIADES	
LD-SAFE	
CLEAN-DEM	
INSIDER	
JHOP2040	
TOURR	127-proj-fisa-s03-abs-rev00-CIRILLO_Roberta (TOURR)
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Open Call FISA 2022 MSc/PhD/R&D and Prizes

Open Call FISA 2022 MSc/PhD/R&D and Prizes FOR Session 1-2-3	
s01 PhD	050-call-fisa-s01-abs-rev00-VAZQUEZRODRIGUEZ_Carlos
s02 PhD	061-call-fisa-s02-abs-rev00-KRAJEWSKA-Zuzanna
s01 PhD	063-call-fisa-s01-abs-rev00-ARFINENGODELCARPIO_Sofia
s03 PhD	064-call-fisa-s03-abs-rev00-ROFFINO_Brice
s03 PhD	065-call-fisa-s03-abs-rev00-SIMONS_Mattias
s01 PhD	067-call-fisa-s01-abs-rev00-SERRA_Luis
s01 PhD	068-call-fisa-s01-abs-rev00-DOMINGUEZ-BUGARIN_Araceli
s01 PhD	073-call-fisa-s01-abs-rev00-RINCON-SOTO_NelsonFelipe
s01 PhD	076-call-fisa-s01-abs-rev00-HOFER_Markus
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s03 PhD	080-call-fisa-s03-abs-rev00-SERRA-VENTURA_Joan
s01 PhD	081-call-fisa-s01-abs-rev00-CEVIKALP-USTA_Sinem
s03 PhD	084-call-fisa-s03-abs-rev00-ZIENKIEWICZ_Sophie (YGN-Workshop)
s01 R&D	093-call-fisa-s01-abs-rev00-SZEKELY_Levente-Csaba
s03 R&D	095-call-fisa-s03-abs-rev00-LEPPANEN_Jaakko (NIP DH LDR, Win-3(a))
s01 PhD	103-call-fisa-s01-abs-rev00-VAN-DEN-BOS_Nout
s03 R&D	107-call-fisa-s03-abs-rev00-COGNET_Gerard
s02 PhD	109-call-fisa-s02-abs-rev00-MAGNI_Alessio (ENEN PhD Invited)
s02 PhD	110-call-fisa-s02-abs-rev00-NJAYOU-TSEPENG_Eris-Karson
s01 PhD	112-call-fisa-s01-abs-rev00-TALAROWSKA_Anna
s02 PhD	115-call-fisa-s01-abs-rev00-PEDROCHE_Gabriel (ENEN PhD Invited, ENS)
s02 PhD	117-call-fisa-s01-abs-rev00-PETROVIC_Dorde
s02 PhD	118-call-fisa-s02-abs-rev00-KUCAL_Ewelina
s01 PhD	119-call-fisa-s01-abs-rev00-ALGUACIL_Javier (ENEN PhD Invited)
s02 PhD	122-call-fisa-s02-abs-rev00-ESZTER_Csengeri (ENEN PhD Applicant)
s01 R&D	129-call-fisa-s01-abs-rev00-CUESTA_Alejandra (NIP RESA-TX)
s01 PhD	133-call-fisa-s01-abs-rev00-SERRA-LOPEZ_Luis
s02 R&D	134-call-fisa-s02-abs-rev00-SEVECEK_Martin (NIP MULTIPROTECT FUEL, Win-1)
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s01 R&D	142-call-fisa-s01-abs-rev00-VAIANA_Florian (NIP DIPSICOF)
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s03 R&D	153-call-fisa-s03-abs-rev00-HERNANDO_Jesus (NIP MITMAT, Win2)

s01 PhD	154-call-fisa-s01-abs-rev00-DOMINGUEZ-BUGARINAR_Araceli (idem 068)
s01 R&D	157-call-fisa-s01-abs-rev00-GALBALLY_David
s01 R&D	159-call-fisa-s01-abs-rev00-LEGRADY_David (NIP GUARDYAN, Win3b)
s03 PhD	165-call-fisa-s03-abs-rev00-LUNGHI_Giacomo (ENS)
s03 PhD	171-call-fisa-s03-abs-rev00-ARAGON_Pau (ENS WORKSHOP)


FISA 2022
EURADWASTE'22

List of PROJECTS [Grant Agreement number] covered

Acknowledgments
The research PROJECTS leading to these results have received funding from the H2020 Euratom Research and Training Framework Programmes under grant agreements n° [number].

FISA 2022
ENTENTE [900018], ATLASplus [754589], NOMAD [755330], STRUMAT-LTO [945272], FRACTESUS [900014], MEACTOS [755151], INCEFA-SCALE [945300], sCO2-4-NPP [847606], APAL [945253], CAMIVVER [945081], TEAM-CABLES [755183], El-Peacetolero [945320], CORTEX [754316], McSAFER [945063], METIS [945121], ELSMOR [847553], PASTELS [945275], EU-QUALIFY [945009], LEU-FOREvER [754378], MUSA [847441], PIACE [847715], AMHYCO [945047], BESEP [945138], NARSIS [755439], R2CA [847656], ESFR-SMART [754501], SafeG [945031], ECC-SMART [945234], ACES [900012], SAMOSAFER [847527], PUMMA [945022], GENIORS [755171], INSPYRE [754329], PATRICIA [945077], PASCAL [945341], ORIENT-NM [899997], GEMMA [755269], M4F [755039], NUCOBAM [945316], GEMINI-PLUS [755478], SANDA [847552], ARIEL [847594], ENENplus [755576], GREaT-PIONEeR [847602], ENEEP [847555], PIKNUS [AA35567], A-CINCH [945301], SINFONIA [945196], EURAMED rocc-n-roll [899995], MEDIRAD [755523], HARMONIC [847707], RadoNorm [900009], SHARE [847626], INNO4GRAPH [945273], PLEIADES [899990], LD-SAFE [945255], CLEAN-DEM [945335], INSIDER [755554], JHOP2040 [899360], TOURR [945269], JHR ACCESS RIGHTS, OASIS JRC Open Access [AA35658]

EURADWASTE '22
EURAD [847593], CHANCE [755371], MICADO [847641], PREDIS [945098], CORI, FUTURE, MODATS, CONCORD, ACED, DONUT, BEACON [745942], MAGIC, GAS, HITEC, SFC, UMAN, ROUTES, SOK, GUIDANCE, T&M, IGD-TP, SITEX

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https://cordis.europa.eu/search?q=contenttype=%27project%27%20AND%20(programme/code=%27H2020%27%20OR%20programme/code=%27H2020-Euratom%27)%20AND%20(%27euratom%27)&p=1&num=100&srt=Relevance:decreasing

The 10th Edition of the Euratom research and training conference on fission safety of reactor systems (FISA 2022) will be organised in parallel to the 10th Edition of the Euratom research and training conference on radioactive waste management (EURADWASTE '22) by the CEA and the European Commission with the participation of all relevant stakeholders. These events are organised under the scope of the French Presidency of the Council of the European Union. Nuclear Valley, the Sfen and the SNETP are also strongly involved. Région Auvergne-Rhône-Alpes is kindly hosting and supporting all events taking place during that week.

Studies and reports

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