Eur. Phys. J. Plus (2022) 137:1192
https://doi.org/10.1140/epjp/s13360-022-03408-w

THE EUROPEAN PHYSICAL JOURNAL PLUS

Editorial

New technologies for detection, protection, decontamination, and developments of the decision support systems in case of CBRNe events: editorial

Andrea Malizia[1,2,a], **Parag Chatterjee**[3,4], **Marco D'Arienzo**[5]

[1] Department of Biomedicine and Prevention, University of Rome Tor Vergata, Via Di Montpellier 1, 00133 Rome, Italy
[2] Department of Industrial Engineering and Faculty of Medicine and Surgery, International Master Courses in Protection Against CBRNe Events, Via Di Montpellier 1, 00133 Rome, Italy
[3] Department of Biological Engineering, University of the Republic, Montevideo, Uruguay
[4] National Technological University, Buenos Aires, Argentina
[5] Azienda Sanitaria Locale Roma H, Via Borgo Garibaldi 12, 00041 Albano Laziale, Rome, Italy

The global crisis related to the reduction of energy fossil resources, the reduction of potable water resources, and the war for the control of energy sources is part of some of the causes which can lead to an intentional CBRNe (Chemical, Biological, Radiological, Nuclear, and explosive) event. These kinds of events could also be the consequence of an intentional or unintentional release of substances (i.e., an accident of a truck containing a Toxic Industrial Chemical), or of natural events like a tsunami or an earthquake. Especially in today's global scenario, a sharp rise in the potential risks puts seminal importance on the development of new solutions to prevent such events, handle emergency situations and restore normalcy. The focus point is "New Technologies for Detection, Protection, Decontamination and Developments of the Decision Support Systems in Case of CBRNe Events" host some of the most innovative works presented during the second edition of the conference SICC Series—CBRNe Conference 2020 held in the virtual platform in December 2020 (https://www.sicc-series.com/).

The major impact, in the papers selected for this focus point, is constituted by research on **radiological and nuclear events (RN).** The authors have published work on these main areas:

- *Detection and Identification*
  Yale University and the University of Pisa developed an active interrogation system based on detectors containing liquid droplets that vaporize when exposed to fast neutrons but are insensitive to X-rays. With this system, it is possible to detect a sample of natural uranium either uncovered or shielded under heavy loads of wood or steel pipes which is an important application for the detection of special nuclear materials hidden in shipping containers [1]. The University of Sergipe and the University of Pisa have presented research that shows the potential of Allium cepa as a sensitive support system for dosimetry, detection, and screening of cellular effects produced by low doses of environmental radiation [2]. ENEA Casaccia Research Centre has developed a spectrometric monitoring method, based on a portable HpGe detector Trans-Spec-DX-100 for the fast screen of the contamination of a large number of individuals involved in a RN emergency [3]. University of Rome Tor Vergata and the Department of Italian Firefighters analyze the case study of the recovery of an orphan source of 60Co inside a maritime cargo full of metal wastes in the Italian Harbor of Genova [4]. The University of Pisa and the University of Rome Tor Vergata developed a prototype of a gamma ray detection and spectroscopy system based on affordable and commercially available technologies [5].
- *Numerical methods and simulations*
  University of Rome Tor Vergata evaluated the imaging performance of a novel muon tomography scanner based on resistive plate chamber detectors through Monte Carlo simulations [6]. ENEA and the University of Rome Tor Vergata developed a model mixing and transport of radioactive effluents in the course of time between two water reservoirs to estimate the amount of radioactivity concentration in both water reservoirs at any time, information that can be used for radiation protection purposes [7]. The University of Rome Tor Vergata, the University of Pisa, and the University of Sergipe reviewed the main results regarding the correlation between ionizing radiation and dicentric chromosomes in cytogenetic bio-dosimetry [8].
- *Protection and RN innovative applications*
  ENEA proposed an approach that has the potential to be routinely applied by clinic decision-makers to assess release criteria in the nuclear medicine practice using the MicroShield® to derive a more realistic model for the emission of radioactivity by patients treated with radiopharmaceuticals [9]. University of Rome Tor Vergata provided additional guidelines for radioprotection workers to determine the optimal concentration of barite in mixed gamma/neutron radiation environments [10]. ENEA is developing an accelerator-driven 14 MeV neutron source exploiting the deuterium–tritium fusion reaction to produce 99Mo medical radioisotope

[a] e-mail: malizia@ing.uniroma2.it (corresponding author)
https://www.cbrngate.com

Published online: 28 October 2022

as an alternative production route not based on fission reactors [11]. Spain Guardia Civil and CIEMAT presented a work that addressed the resistance of classical forensic evidence to radiation. Thus, gamma post-irradiation results of DNA profiling from relevant biological samples are presented and discussed providing threshold values of radiation that, depending on the matrix, degrade DNA evidence [12].

Many authors have presented interesting works related to research on **chemical and explosives events (Ce)**. The two main areas have been:

- *Detection and Identification*
  The University of Rome Tor Vergata and the University of Pisa have developed and presented a CWA detection system that can be mounted on the UAV [13]. CBRN Protection has presented the trials and evaluations with a new PTR–ToF–MS technology, using Chemical Warfare Agents as contaminants that can be used to determine safe levels of surface contamination in real time [14]. Ultraviolet Raman spectroscopy measurements have been taken at German Space Agency in Lampoldshausen to detect NATO SET-237 standard samples of RDX [15]. German Space Agency has also developed a method, with Raman spectroscopy, that can be performed on highly sensitive explosives like triacetone triperoxide (TATP) with an observed reduction in unwanted fluorescence signal in the spectral data [16]. ENEA showed that finding markers to detect and identify compounds and components related to an explosive is an important task that could reduce threats of unlawful use of explosives. They demonstrated the capability of Raman spectroscopy to characterize the chemical composition of explosive compounds and the analysis of stable isotope ratios could be useful to identify specific markers to identify the origin of the material used [17].
- *Decontamination*
  Spain Guardia Civil and CIEMAT demonstrated the capability at the real scale of the COUNTERFOG® system for minimizing the effect of chemical and/or radionuclide dispersion in the atmosphere has been confirmed [18]. The University of Alcalà with a group of partners demonstrated how COUNTERFOG® can be proposed as rapid decontamination and disinfection technology that uses dynamic submicrometric-disinfecting fog cones [19].

The focus point host also works related to research on **biological events (B)**. The principal area has been infectious diseases, UCSI University of Kuala Lumpur showed how a water cooler fulfills its purpose of filtering and trapping germs and can provide clean drinking water from the rivers in Malaysia [20]. University of Rome Tor Vergata developed new methods to predict the spread of diseases, the aim of the work is to investigate the use of an ensemble of recurrent neural networks for disease prediction, using real flu data to train and develop an instrument with the capability to determine the future flues [21]. The University of Sergipe and the University of Pisa presented the results of the application of Ultraviolet germicidal irradiation (UVGI) uses short-wave ultraviolet (UVC) light to inactivate organisms like viruses, bacteria, and fungi, demonstrating the effectiveness of the installation, suggesting that similar devices should be installed in HVAC systems to avoid biological risk to people inside buildings [22]. University of Rome Tor Vergata has presented a tool important to understand both the virus spreading in terms of people infected, hospitalized, dead, and recovered and the effectiveness of containment measures [23].

In conclusion, this focus point hosts a platform to highlight some of the novel and innovative technologies for detection, protection, and decontamination in case of CBRNE events and subsequent development of decision support systems that together with global partnerships focused on safety security and cooperation among national and international entities is of paramount importance to reduce the risk factors in an ever-changing scenario, with non-conventional and CBRNe threats whose impact could often extend across international borders, jeopardizing the safety of the population of different countries.

References

1. A.V.S. Alves, F. d'Errico, Simulation of an active interrogation system for the interdiction of special nuclear materials. Eur. Phys. J. Plus **136**, 995 (2021). https://doi.org/10.1140/epjp/s13360-021-01971-2
2. M.N. Xavier, S.M. Pantaleão, R. Scher et al., Allium cepa used as a dosimetry system in nuclear and radiological emergencies. Eur. Phys. J. Plus **136**, 682 (2021). https://doi.org/10.1140/epjp/s13360-021-01674-8
3. L. Ciciani, I. Vilardi, A. Rizzo et al., In vivo public monitoring in emergency exposure scenarios. Eur. Phys. J. Plus **136**, 490 (2021). https://doi.org/10.1140/epjp/s13360-021-01442-8
4. A. Malizia, R. Perna, R. Melmeluzzi et al., Lesson learned from the recovery of an orphan source inside a maritime cargo: analysis of the nuclear instrumentations used, and measures realized during the operations. Eur. Phys. J. Plus **135**, 468 (2020). https://doi.org/10.1140/epjp/s13360-020-00487-5
5. A. Chierici, A. Malizia, D. di Giovanni et al., A low-cost radiation detection system to monitor radioactive environments by unmanned vehicles. Eur. Phys. J. Plus **136**, 314 (2021). https://doi.org/10.1140/epjp/s13360-021-01276-4
6. A. Cianchi, C. Andreani, P. Camarri et al., Evaluation of the imaging performance of the TECNOMUSE muon tomograph and its feasibility in a real scenario. Eur. Phys. J. Plus **136**, 658 (2021). https://doi.org/10.1140/epjp/s13360-021-01635-1
7. M. D'Arienzo, A. Malizia, G.M. Contessa, Modelling mixing and transport of radioactive effluents in water reservoirs: an application to the operation of a fusion facility. Eur. Phys. J. Plus **136**, 1045 (2021). https://doi.org/10.1140/epjp/s13360-021-01771-8
8. G.M. Ludovici, M.G. Cascone, T. Huber et al., Cytogenetic bio-dosimetry techniques in the detection of dicentric chromosomes induced by ionizing radiation: a review. Eur. Phys. J. Plus **136**, 482 (2021). https://doi.org/10.1140/epjp/s13360-021-01447-3
9. M. D'Arienzo, G.M. Contessa, S. Sandri et al., Management of patients receiving radionuclide therapy with unsealed radionuclides: a proposed approach to the definition of release criteria in Italy. Eur. Phys. J. Plus **136**, 1055 (2021). https://doi.org/10.1140/epjp/s13360-021-01735-y

10. M. Martellucci, G. Romanelli, S. Valeri et al., The neutron cross section of barite-enriched concrete for radioprotection shielding in the range 1 meV–1 keV. Eur. Phys. J. Plus **136**, 259 (2021). https://doi.org/10.1140/epjp/s13360-021-01243-z
11. G.M. Contessa, M. D'Arienzo, M. Frisoni et al., Preliminary evaluations of the environmental impact for the production of 99Mo by fusion neutrons. Eur. Phys. J. Plus **136**, 637 (2021). https://doi.org/10.1140/epjp/s13360-021-01404-0
12. J. Quinones Diez, M. Fernández, E. Mingorance et al., DNA resistance to radiation field: forensic genotyping in a radiological incident scenario. Eur. Phys. J. Plus **136**, 413 (2021). https://doi.org/10.1140/epjp/s13360-021-01407-x
13. F. Fumian, A. Chierici, M. Bianchelli et al., Development and performance testing of a miniaturized multi-sensor system combining MOX and PID for potential UAV application in TIC, VOC and CWA dispersion scenarios. Eur. Phys. J. Plus **136**, 913 (2021). https://doi.org/10.1140/epjp/s13360-021-01858-2
14. D. Rothbacher, Real-time detection of Chemical Warfare Agents at clearance decontamination levels for surface contamination: a challenge for civilian authorities. Eur. Phys. J. Plus **136**, 519 (2021). https://doi.org/10.1140/epjp/s13360-021-01344-9
15. E.C.A. Gallo, L.M.L. Cantu, F. Duschek, RDX remote Raman detection on NATO SET-237 samples. Eur. Phys. J. Plus **136**, 401 (2021). https://doi.org/10.1140/epjp/s13360-021-01336-9
16. D. Wild, C. Theiß, G. Holl, Contact-free and fast detection of energetic materials in containments. Eur. Phys. J. Plus **136**, 437 (2021). https://doi.org/10.1140/epjp/s13360-021-01406-y
17. A. Rizzo, C. Telloli, A. Ubaldini et al., Fast characterization of compounds and components of explosives. Eur. Phys. J. Plus **137**, 269 (2022). https://doi.org/10.1140/epjp/s13360-022-02404-4
18. J. Quiñones, J.A. Domínguez, L. Pascual et al., COUNTERFOG system applied inside the warehouse: verification of the counter response against radiochemical attack scenario. Eur. Phys. J. Plus **136**, 1053 (2021). https://doi.org/10.1140/epjp/s13360-021-02005-7
19. J.L. Pérez Díaz, J. Sánchez García-Casarrubios, P. Méndez-Vigo Carranza et al., Fast surface disinfection with COUNTERFOG® SDR-F05A+. Eur. Phys. J. Plus **136**, 393 (2021). https://doi.org/10.1140/epjp/s13360-021-01353-8
20. V.R. Bai, A.C. Kit, G. Kangadharan et al., Experimental study on total coliform violations in the complied NH2CL, O3, and UV treated municipal water supply system. Eur. Phys. J. Plus **137**, 689 (2022). https://doi.org/10.1140/epjp/s13360-022-02891-5
21. A. Puleio, Recurrent neural network ensemble, a new instrument for the prediction of infectious diseases. Eur. Phys. J. Plus **136**, 319 (2021). https://doi.org/10.1140/epjp/s13360-021-01285-3
22. S.O. de Souza, A.A. Cardoso Jr., A.S.C. Sarmento et al., Effectiveness of a UVC air disinfection system for the HVAC of an ICU. Eur. Phys. J. Plus **137**, 37 (2022). https://doi.org/10.1140/epjp/s13360-021-02240-y
23. F. Baldassi, F. D'Amico, A. Malizia et al., Evaluation of the Spatiotemporal Epidemiological Modeler (STEM) during the recent COVID-19 pandemic. Eur. Phys. J. Plus **136**, 1072 (2021). https://doi.org/10.1140/epjp/s13360-021-02004-8