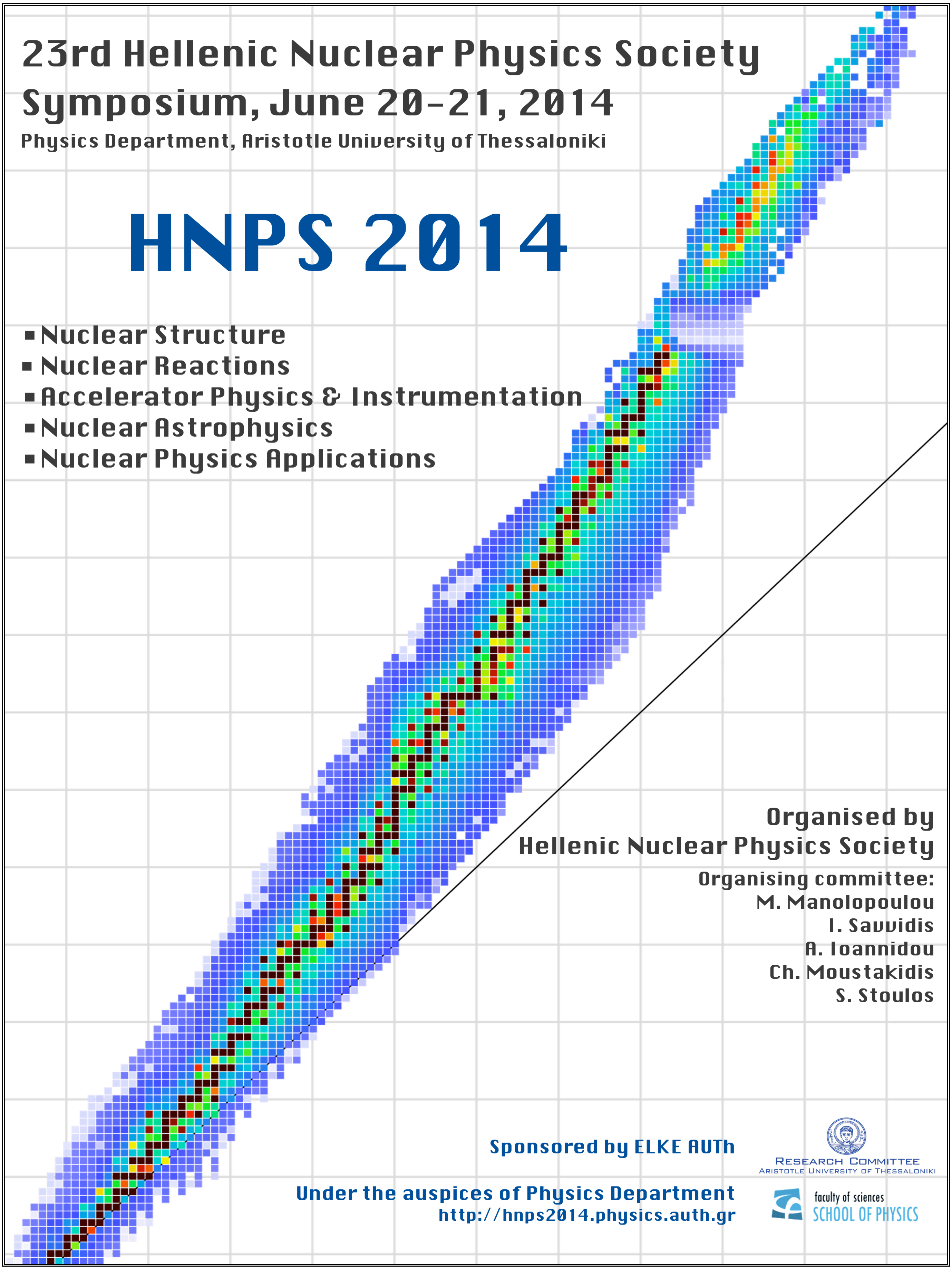
23rd Hellenic Nuclear Physics Society Symposium, June 20-21, 2014

Physics Department, Aristotle University of Thessaloniki

HNPS 2014

- Nuclear Structure
- Nuclear Reactions
- Accelerator Physics & Instrumentation
- Nuclear Astrophysics
- Nuclear Physics Applications



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23rd ANNUAL SYMPOSIUM OF THE HELLENIC NUCLEAR PHYSICS SOCIETY (HNPS – 2014)
Jun 20 – 21, 2014, Aristotle University of Thessaloniki, Greece.

FRIDAY 20 / 6 / 2014

08:15 – 08:45	**REGISTRATION**		
08:45 – 09:00	Welcome addresses (S. Pavlides, Dean of Faculty of Sciences ; G. Kitis, Vice-President of Physics Department)		
TIME	**Speaker**	**Affiliation**	**Title**
SESSION I	**Chair: T. Kosmas**	**UOI**	
09:00 – 09:10	T. Kosmas	UOI	Introductory presentation of Dr. K. Langanke
09:10 – 09:40	K. Langanke	GSI	Opportunities at the Facility for Antiproton and Ion Research in GSI Darmstadt (*invited talk*)
09:40 – 10:00	M. Veselsky	ASB	Nuclear physics at the Institute of Physics of SASc in Bratislava
10:00 – 10:30	S. Harissopoulos	NCSR	CALIBRA: A Research Infrastructure proposal for the National Roadmap
10:30 – 11:00	**COFFEE BREAK**		
SESSION II	**Chair : S. Harissopoulos**	**NCSR**	
11:00 – 11:20	M. Zamani - Valasiadou	AUTH	Super Heavy Elements –SHE
11:20 – 11:35	M. Diakaki	NTUA	Measurement of the ^{237}Np(n,f) cross section with the FIC detector at the CERN n_TOF facility
11:35 – 11:50	A. Tsinganis	NTUA	Measurement of the ^{242}Pu(n,f) cross-section at the CERN n_TOF facility
11:50 – 12:05	N. Vonta	UOA	Microscopic Calculations of Low and Medium Energy Fission with the CoMD Model
12:05 – 12:20	I.E. Stamatelatos	NCSR	Analysis of neutron streaming through penetrations in the JET biological shielding
12:20 – 12:35	A. Lagoyannis	NCSR	Study of the ^{10}B(p,$\alpha\gamma$)^{7}Be and ^{10}B(p,p'γ)^{10}B reactions for PIGE purposes
12:35 – 12:50	N. Patronis	UOI	Neutron reaction studies in the rare earth region: First results for the ^{162}Er(n,2n)^{161}Er physics case
12:50 – 13:05	A. Kalamara	NTUA	Activation cross section for the (n,2n) reaction on ^{197}Au
13:05 – 13:20	V. Paneta	NTUA	The benchmarking procedure: Implementation in the case of proton backscattering
13:20 – 15:00	**LIGHT LUNCH**		
SESSION III	**Convener: E. Florou**	**NCSR**	
15:00 – 15:30	**POSTER SESSION**		
SESSION IV	**Chair: A. Clouvas**	**AUTH**	
15:30 – 15:45	C. Tsabaris	HCMR	Modelling the vertical distribution of ^{137}Cs at the deep basins of the Aegean Sea
15:45 – 16:00	M. Sotiropoulou	AUTH	Simulation of radionuclides transfer in the terrestrial environment of Greece using dosimetry models
16:00 – 16:15	D.L. Patiris	HCMR	Use of natural and artificial radionuclides in marine sedimentology study of Shatt Al-Arab estuary (Persian Gulf)
16:15 – 16:30	G. Elefteriou	NTUA	Sedimentation Rates from Four Different Aquatic Environments at NE Mediterranean
16:30 – 16:45	F. Papageorgiou	UOA	Estimation of the environmental impact of phosphogypsum stockpile in Schistos waste site (Piraeus, Greece)
16:45 – 17:00	F.K. Pappa	NTUA	Radiotoxic metals concentration measurement in sediments due to gold mining activities, Chalkidiki
17:15 – 17:30	A. Clouvas	AUTH	Indoor radon in Greek workplaces
17:30 – 17:45	M. Gini	NCSR	In situ size distribution measurement of Radon decay products activity concentrations in thermal baths of Ikaria
17:45 – 18:00	C. Potiriadis	GAEC	Localization and Identification of Gamma Ray Sources Using Pixelated CdTe Detectors
18:00 – 18:30	**COFFEE BREAK**		
ASSEMBLY	**Chair: R. Vlastou**	**NTUA**	
18:30 – 20:30	**HNPS General Assembly & Elections (HNPS members only)**		
21:00	**SYMPOSIUM DINNER**		

23^{rd} ANNUAL SYMPOSIUM OF THE HELLENIC NUCLEAR PHYSICS SOCIETY (HNPS – 2014)
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SATURDAY 21 / 6 / 2014

TIME	Speaker	Affiliation	Title
SESSION V	**Chair: K. Langanke**	**GSI**	
09:00 – 09:15	C. Moustakidis	AUTH	Neutron star structure and collective excitations of finite nuclei
09:15 – 09:30	M.C. Papazoglou	AUTH	Symmetry energy effects on isovector properties of neutron rich nuclei with Thomas-Fermi approach
09:30 – 09:45	D.K. Papoulias	UOI	Nuclear study of the exotic neutrino interactions
09:45 – 10:00	P.G. Giannaka	UOI	The role of e^--capture in neutrino-nucleosynthesis
10:00 – 10:15	K. Valasi	NCSR	The response of an autonomous underwater telescope to high energy neutrinos for the observation of GRBs
10:15 – 10:30	G. Provatas	NCSR	Systematic cross section measurements of (α,γ) reactions for astrophysics
10:30 – 10:45	V. Foteinou	NCSR	Proton capture reactions in medium-heavy nuclei relevant to p-process nucleosynthesis
10:45 – 11:00	A. Psaltis	UOA	First cross-section measurements of the $^{112}Cd(p,\gamma)^{113}In^*$ reaction at astrophysical energies
11:00 – 11:30	**COFFEE BREAK**		
SESSION VI	**Chair: I. Stamatelatos**	**NCSR**	
11:30 – 11:45	K.C. Stamoulis	UOI	Use of everyday materials in retrospective nuclear accident dosimetry
11:45 – 12:00	I.M. Tsodoulos	UOI	Use of the OSLuminescence Dating and X-Ray Fluorescence Spectrometry Methods as Tools in Paleoseismolog
12:00 – 12:15	E. Vagena	AUTH	Measurements and Monte Carlo simulations of neutron production at a medical accelerator
12:15 – 12:30	M. Zioga	UOA	A Compton Camera for Medical Applications
12:30 – 12:45	A.N. Raspomanikis	UOA	Time Filtering and Image Detection Efficiency in the Time Resolved Optical Tomography
12:45 – 13:00	A. Tsilimidou	UOA	TETRA-SPECT: A Four-Head Rotating System for Mammography
13:00	**CLOSING OF THE SYMPOSIUM**		

Posters to be display at the POSTER SESSION

Poster No	1^{st} author name	Affiliation	Title
No 1	A. Stamatopoulos	UOA	Benchmarking the proton elastic scattering cross sections on ^{19}F and ^{nat}B using $\Delta E/E$ silicon telescopes
No 2	K. Preketes-Sigalas	NCSR	Study of the $^{11}B(p,p'\gamma)^{11}B$ reaction for PIGE applications
No 3	Z. Kotsina	NCSR	Rate Theory Analysis of Point Defect Migration in Irradiated Fe-Cr alloys
No 4	E.M. Asimakopoulou	UOA	Incorporation of Ion Post Stripper in the APAPES Experimental Setup
No 5	E.G. Androulakaki	NTUA	Spectrum analysis based on Monte Carlo simulations for *in situ* γ-ray measurements in the marine environment
No 6	A. Kanellakopoulos	UOA	HDA input lens voltages optimization using SIMION
No 7	V. Lagaki	UOA	A new γ-spectroscopy station at the University of Athens
No 8	I.E. Stamatelatos	NCSR	Large Sample Neutron Activation Analysis of Ceramic Matrix Composites
No 9	M. Kapnisti	AUTH	Adsorption of ^{152}Eu from aqueous solutions using amorphous Titanium Phosphates
No 10	N. Marosi	NTUA	External dose estimations from natural radioactivity and ^{137}Cs in marine organisms using the RESRAD-BIOTA tool.
No 11	H. Papaeftymiou	UOP	Activity concentrations of natural radionuclides and ^{137}Cs in marine sediments from Amvrakikos Gulf
No 12	N. Evageliou	CEA/CNRS	Validating Global Models Using the Fukushima Nuclear Power Plant Accident: Japanese, Greek and global networks

LIST OF PARTICIPANTS

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Mr	Chatzipanagiotidis	Dimitrios	AUTH
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Prof.	Vlastou	Roza	NTUA
Ms	Vonta	Nikoletta	UOA
Prof.	Zamani Valasiadou	Maria	AUTH
Ms	Zioga	Maria	UOA
Ms	Zoupa	Ioanna	UOA

ORAL PRESENTATIONS

Opportunities at the Facility for Antiproton and Ion Research in GSI Darmstadt

Karlheinz Langanke

Director of Research, Head of Research Department, GSI Darmstadt, Germany

During the coming years the Facility for Antiproton and Ion Research (FAIR) in Europe will be constructed in Darmstadt, adjacent to the GSI campus. FAIR enhances the GSI facility by a novel accelerator and ring complex and a suite of detector systems allowing for unprecedented research in hadron, nuclear, atomic and plasma physics as well as in applied sciences.

In particular FAIR will allow producing and studying many of the nuclei far-off stability which comes briefly to life in astrophysical scenarios. More than 2500 scientists and engineers from more than 50 countries are engaged in preparing for research at FAIR.

The talk will discuss specific topics in nuclear physics which are important for supernova dynamics and r-process nucleosynthesis. In particular we highlight progress in the description of weak-interaction processes like electron capture on nuclei and scattering of neutrinos on nuclei and their influence on supernova dynamics. Furthermore we discuss r-process nucleosynthesis, focusing on open questions and the influence of properties of neutron-rich nuclei like their masses and half-lives.

Nuclear physics at the Institute of Physics of SASc in Bratislava

Martin Veselsky

Institute of Physics of Slovak Academy of Sciences in Bratislava

The activities at the Institute of Physics of SASc in Bratislava in the fields of nuclear structure and nuclear reactions will be described. In collaboration with the CERN-ISOLDE, two proposals for experiments with radio-active beams were approved recently, one concentrating on study of shape coexistence in the neutron-deficient isotopes of gold and the other one aiming at first direct measurement of fission barriers of neutron-deficient isotopes between thallium and francium. As a complement to international collaboration, the new facility is presently under construction in Piestany and it will be briefly described. Furthermore, overview of activities in the model description of nuclear reaction will be given, focusing on production of exotic nuclei in the Fermi energy domain and on possibilities of reaction studies at the ELI-NP facility.

CALIBRA:
Cluster of Accelerator Laboratories for Ion-Beam Research and Applications
A Research Infrastructure proposal for the National Roadmap

Sotirios V. Harissopoulos

TANDEM Accelerator Laboratory, Institute of Nuclear and Particle Physics, NCSR "Demokritos", Aghia Paraskevi, Athens, Greece

During 2013, the Greek funding agency GSRT announced the establishment of a roadmap for large Research Infrastructures of national interest. Within the respective call, an accelerator-based research infrastructure with the acronym CALIBRA was proposed. The concept of the proposed Research Infrastructure (RI) is to establish, operate and exploit a Cluster of Accelerator Laboratories for Ion-Beam Research and Applications, in short CALIBRA, at the National Centre for Scientific Research "Demokritos" in Athens, Greece. The cluster will be based on the operation of five accelerators. These machines will be grouped into three strongly interacting laboratories, i.e., the TANDEM, the CYCLOTRON and the AMS-X Labs, equipped with state-of-the art setups and scientific instruments that will integrate a number of common auxiliary facilities and supporting workshops.

The ground idea behind CALIBRA is to take advantage of a wide variety of ion species delivered from the accelerators, partly with very high intensity, as well as of secondary neutron beams in order to produce new scientific knowledge in the fields of nuclear astrophysics, nuclear reactions and atomic physics with accelerators, develop novel analytical techniques and provide highly specialized services related to human health, cultural heritage, nanotechnology, environmental monitoring including climate change, and development and testing of advanced materials and detectors. CALIBRA will operate as an open-access RI for national and European research groups, providing annually with more than 4000 hours of beam time as well as a wide spectrum of state-of-the art facilities for R&D and innovative applications, education and training for students. CALIBRA aims also at linking the local scientific community with large-scale European facilities and the ESFRI Infrastructures SPIRAL-2, FAIR and the ESS.

CALIBRA has been evaluated by an international scientific committee and scored excellent (19/20). In the present talk, we report on the physics and technical case of CALIBRA together with its funding perspectives.

Super Heavy Elements –SHE

Maria Zamani – Valasiadou

Nuclear Physics Laboratory, School of Physics, AUTH, Greece

Uranium is the last of the natural elements. All the elements heavier than Uranium were produced artificially in various nuclear reactions. In the area of transuranium elements a drastic decrease of nuclear stability is observed with the increase of the atomic number.

When increasing the atomic number of the last element – Pb- by 44% we observe an impressive sight of super vivability of atomic nuclei. In the area of the limiting Coulomb forces, owing to the effect of the new nuclear shells, the ground state nuclear binding energy increases, there appears the fission barrier that results in the existence of a vast domain of stability of Super Heavy Elements [1].

Fundamental predictions of modern theory regarding the limiting masses of the atomic nuclei have got a direct experimental proof.

References

[1] Yuri Oganessian, Flerov Laboratory of Nuclear Reactions, JINR, Dubna, Nuclear Physics News International, 2013, Vol.23, p.15

Measurement of the 237Np(n,f) cross section with the FIC detector at the CERN n_TOF facility

M. Diakaki [1], D. Karadimos[1], R. Vlastou[1], M. Kokkoris[1], L. Audouin, U. Abbondanno, G. Aerts,H. Alvarez, F.,…………………………………, A. Ventura, D. Villamarin, V. Vlachoudis, F. Voss, S. Walter, M. Wiescher and K. Wisshak

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(The n_TOF collaboration www.cern.ch/ntof)

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There is an increasing need for accurate cross section data on neutron-induced reactions -especially fission- for nuclear technology applications, concerning the design of new systems for safe and clean energy production and nuclear waste transmutation, such as the subcritical Accelerator Driven Systems (ADS) or the future Generation-IV fast nuclear reactors. The long-lived 237Np is the major component of the spent nuclear fuel in existing reactors, mainly produced by neutron captures in 235U and (n,2n) reactions in 238U, thus the transmutation of this isotope is a very important issue. There is a number of data in literature on the 237Np(n,f) reaction that present discrepancies up to 8% while the new evaluations ENDF/B-VII.1 and JENDL-4.0 present differences up to 3% above 2 MeV.

The 237Np(n,f) cross section has been measured, relative to 235U and 238U cross sections, at the n_TOF facility, CERN, from ~100keV to 10MeV [1-2]. The most important features of this setup is the high instantaneous neutron flux and the excellent energy resolution. The fission fragments were detected with use of a fast ionization chamber (FIC) [3], and fast electronics were used, including Time to Digital Converters (TDC) and Flash Analog to Digital Converters (FADC). An adapted analysis procedure has been developed [4] in order to obtain the relative cross sections of each actinide. The high accuracy 237Np(n,f) cross section data from this analysis will be presented, and their comparison to previous data and evaluations will be discussed.

References

[1] C. Rubbia, et al., A high resolution spallation driven facility at the CERN-PS to measure neutron cross-sections in the Interval from 1 eV to 250 MeV, CERN/ LHC/98-02 (EET).
[2] U. Abbondanno, et al., n TOF Performance Report. CERN/INTC-O-011 INTC-2002, 2002, p. 037.
[3] M. Calviani et al, Nucl. Instr. Meth. A 594 (2008) 220.
[4] D. Karadimos et al., Nucl. Instr. Meth. B 268 (2010) 2556-2562.

Measurement of the ^{242}Pu(n,f) cross-section at the CERN n_TOF facility *

A. Tsinganis[1], E. Berthoumieux[2], C. Guerrero[3], N. Colonna[4], M. Calviani[3], V. Vlachoudis[3], R. Vlastou[1], M. Kokkoris[1], S. Andriamonje[3] and the n_TOF Collaboration

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[3] *European Organisation for Nuclear Research (CERN)*
[4] *Istituto Nazionale di Fisica Nucleare (INFN), Bari, Italy.*

The accurate knowledge of relevant nuclear data, such as the neutron-induced fission cross-sections of various plutonium isotopes and other minor actinides, is crucial for the design of advanced nuclear systems, such as Generation-IV reactors and Accelerator Driven Systems (ADS). At the same time, experimental cross-section data are essential for the development of theoretical models of nuclear fission. The ^{242}Pu(n,f) cross section was measured at the CERN n_TOF facility taking advantage of the wide energy range (from thermal to GeV) and the high instantaneous flux of the neutron beam. In this work, results for the ^{242}Pu(n,f) measurement are presented along with a description of the experimental setup, Monte-Carlo simulations and the analysis procedure, and a theoretical cross-section calculation performed with the EMPIRE code.

* This work was carried out within the EURATOM-FP7 ANDES project (contract no. 249671) and received support from the ERINDA project (contract no. 269499).

Microscopic Calculations of Low and Medium Energy Fission with the CoMD (Constrained Molecular Dynamics) Model

N. Vonta[1], G.A. Souliotis[1], A. Bonasera[2], M. Veselsky[3]

[1]Lab. of Physical Chemistry, Dep. of Chemistry, University of Athens, 15771, Greece.
[2] Cyclotron Institute, Texas A&M University, College Station, Texas, USA.
[3]Institute of Physics, Slovak Academy of Sciences, Bratislava, Slovakia.

The microscopic description of the mechanism of nuclear fission still remains a topic of intense nuclear research. Understanding of nuclear fission, apart from the theoretical many-body point of view, is of practical importance for energy production, as well as for the transmutation of nuclear waste. Furthermore, nuclear fission is essentially the process that sets the upper limit to the periodic table of the elements and plays a vital role in the production of heavy elements via the astrophysical rapid neutron-capture process (r-process).

Motivated by the present state of affairs regarding fission research, we initiated a systematic study of low-energy fission calculations using the code CoMD (Constrained Molecular Dynamics) of A. Bonasera and M. Papa [1]. The code implements an effective interaction with a nuclear-matter compressibility of K=200 (soft EOS) with several forms of the density-dependence of the nucleon symmetry potential. In addition, CoMD imposes a constraint in the phase space occupation for each nucleon (restoring the Pauli principle at each time step of the collision). Proper choice of the surface parameters of the effective interaction has been made to describe fission. In this talk, we present results of fission for the following reactions: p(27MeV)+^{232}Th, p(63MeV)+^{232}Th, p(30MeV)+^{235}U, p(30MeV)+^{235}U, p(10 MeV) + ^{235}U, p(60 MeV) + ^{235}U, p(100 MeV) + ^{235}U, p(100 MeV) + ^{238}U and p(660 MeV) + ^{238}U. Moreover, we show calculations for transfer/fusion reaction ^{238}U (6 MeV) + ^{12}C in inverse kinematics. Calculated mass and energy distributions will be shown and compared with the experimental data from the above reactions [2,3]. We conclude that the microscopic code CoMD is able to describe the complicated n-body dynamics of the fission process. However, proper adjustment of the parameters of the effective interaction and possible improvements of the code may necessary to achieve a satisfactory quantitative description of presently available experiment data.

References

[1] M. Papa et al., Phys. Rev. C 64, 024612 (2001).
[2] P. Demetriou et al., Phys. Rev. C 82, 054606 (2010).
[3] S.I. Mulgin et al., Nucl. Phys. A 824, 23 (2009).

Analysis of neutron streaming through penetrations in the JET biological shielding *

I.E. Stamatelatos [1], T. Vasilopoulou [1], P. Batistoni [2,3], S. Conroy [2,4], B. Obryk [5], S. Popovichev [2], D.B. Syme [2], and EFDA JET contributors**

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*** See the Appendix of F. Romanelli et al, Proceedings of the 24th IAEA Fusion Energy Conference 2012, San Diego, USA*

The Joint European Torus (JET) is currently the largest tokamak in the world. The experiments and design studies performed by JET are consolidated to a large extent into the design of its successor ITER and the demonstration reactor DEMO. Among others, experiments are being carried out at JET aiming to validate in a real fusion environment the neutronic codes and nuclear data applied in ITER nuclear analyses. In particular, measurements and calculations of the neutron fluence through the penetrations of the JET shielding walls aim to assess the capability of numerical tools to accurately predict neutron transport along the long paths and the complex geometries characterizing the ITER biological shield. Neutron streaming through large ducts and labyrinths of the JET biological shielding configuration was evaluated. Monte Carlo calculations using the MCNP code were performed for both D-D and D-T toroidal plasma discharge sources. Neutron fluence and ambient dose equivalent along the ducts were calculated. The results of the study were compared against measurements performed by Orbryk et al [1] using thermoluminescence detectors. The calculated C/E values for the detectors with statistically valid results were in the range of 1.5 – 3. This difference was attributed to limitations in the complex geometry modeled. Further work will be directed towards model refinement and improving measurement and computational statistics. This work supports the operational radiation protection effort to minimize collective radiation dose to personnel at JET. Moreover, provides important information from JET experience that may assist in the optimization and validation of the radiation shielding design methodology used for ITER and DEMO.

* This work was supported by EURATOM and carried out within the framework of the European Fusion Development Agreement (EFDA) under JET Fusion Technology task JW13-FT-5.48. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

References

[1] B. Obryk et al, Fusion Engineering and Design (2014)

Study of the $^{10}B(p,\alpha\gamma)^{7}Be$ and $^{10}B(p,p'\gamma)^{10}B$ reactions for PIGE purposes *

A. Lagoyannis[1], K. Preketes - Sigalas[1], M. Axiotis[1], V. Foteinou[1], S. Harissopulos[1], M. Kokkoris[2], P. Misaelides[3], V. Paneta[1,2], N. Patronis[4]

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Differential cross section were measured at 8 angles and at proton energies from 2.0 to 5.0 MeV for the $^{10}B(p,\alpha\gamma)^{7}Be$ and $^{10}B(p,p'\gamma)^{10}B$ reactions using two thin targets. The γ-rays emitted at E_γ = 429 and 718 keV were detected by four HPGe detectors placed on a motorized turntable. The overall systematic uncertainty of the measurements was estimated to be ~ 8% while the statistical errors did not exceed 5%. The validity of the obtained cross sections was tested by performing a thick target benchmarking experiment. The results of the present work are compared with existing ones from literature and possible explanations for the observed differences are discussed.

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Neutron reaction studies in the rare earth region:
First results for the ^{162}Er(n,2n)^{161}Er physics case

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The study of neutron threshold reactions is of considerable importance for testing nuclear models as well as for providing new and updated nuclear data information for Nuclear Physics Applications.

Erbium, as well as other rare earth elements, is extensively used in the Nuclear Reactor Technology as neutron absorbers. In view of the on-going research towards to the development of fast neutron nuclear reactors, accurate nuclear data are urgently needed. Erbium-162 is the lightest stable isotope of Erbium with abundance of just 0.139%. Thus, the experimental study of (n,x) reactions for this isotope is truly challenging. For this reason, the existing (n,2n) reaction cross section experimental information is limited to just a few data-points at energies around 14 MeV with discrepancies up to ~30%. Unfortunately, there is no experimental information at energies close to the reaction threshold neither to higher energies where other competitive reaction channels (e.g. n,3n) are open. At both energy regions the determination of the (n,2n) reaction cross section is important as to investigate the sensitivity of the input parameters in the Hauser-Feshbach theory.

Accordingly, within the present work the experimental study of the ^{162}Er(n,2n)^{161}Er reaction cross section was taken over. The reaction cross section was determined for the first time at two near threshold energies (11.0 and 11.3 MeV) by using the neutron activation technique. In the present work the experimental setup and technique is presented along with preliminary experimental results.

Activation cross section for the (n,2n) reaction on ^{197}Au

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The cross section of the reaction $^{197}Au(n,2n)$ has been experimentally determined relative to the $^{27}Al(n,\alpha)^{24}Na$ reaction at incident neutron energies of 16.0 and 17.1 MeV by means of the activation technique. The monoenergetic neutron beam was produced at the 5.5 MV Tandem accelerator of NCSR "Demokritos", by means of the $^{3}H(d,n)^{4}He$ reaction implementing a new Ti- tritiated target consisted of 2.1 mg/cm^2 Ti-t layer on a 1 mm thick Cu backing for good heat conduction. After the end of the irradiations, the activity induced by the neutron beams at the targets and reference foils, has been measured by HPGe detectors. The cross sections for the population of the second isomeric state (m2) of ^{196}Au and the sum of the ground and first isomeric state (g+m1) population cross sections were independently determined. Theoretical calculations of the above cross sections were carried out with the use of the EMPIRE code.

The benchmarking procedure: Implementation in the case of proton backscattering

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Ion Beam Analysis (IBA) techniques, such as Elastic Backscattering Spectroscopy (EBS) and Nuclear Reaction Analysis (NRA), are widely used in material studies to quantify the concentration of light natural elements and isotopes in complex samples while simultaneously providing depth profiling data. The accurate application of these analytical techniques critically depends on the accuracy of the cross sections of the reactions involved. The benchmarking procedure in IBA regards the validation of charged-particle differential cross-section data via the acquisition of EBS spectra from uniform thick target of known composition followed by their detailed simulation.

In the present work such benchmarking measurements have been performed for the elastic scattering of protons on ^{nat}Si, ^{23}Na, ^{31}P and ^{nat}S in the energy range of 1–3.5 MeV in steps of 250 keV at three backward angles, at 120.6°, 148.8° and 173.5° in order to validate the corresponding existing evaluated cross-section datasets from SigmaCalc and to facilitate their extension at higher energies. The measurements were performed using the 2 MV Tandetron Accelerator of the Ion Beam Center of the University of Surrey. The EBS spectra acquired were compared with simulated ones using the DataFurnace code, along with an a posteriori treatment of the surface roughness. All the experimental parameters were thoroughly investigated and the results obtained and the discrepancies found are discussed and analyzed.

Moreover, the benchmarking procedure in complicated cases, such as the ^{nat}B(p,p) and the ^{nat}Mg(d,d) reactions studied at NCSR "Demokritos", where background contributions exist, is also presented.

Modelling the vertical distribution of ^{137}Cs at the deep basins of the Aegean Sea

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^{137}Cs is a long-lived radionuclide which is commonly used to understand the processes of water dynamics from the tracer origin. An empirical one-dimensional advection-diffusion decay balance model was developed to better understand the vertical distribution and behaviour of ^{137}Cs at the deep basins of the North and Central Aegean Sea. Maximum volumetric activities were predicted at the bottom of the basins while the minimum volumetric activity of ^{137}Cs corresponds to the intermediate layer, where Levantine Water masses exist. The surface water activity is between the aforementioned activities and its origin come from the Black Sea water masses. The model reproduces reliably the experimental data of ^{137}Cs and estimates the mean depth of Levantine Intermediate Water masses at the studied basins. In addition the model validation with the experimental data provides average values for the vertical effective mixing velocities and the diffusivities for each basin. In the case of full re-suspension of ^{137}Cs on the basins' slopes, the maximum estimated diffusivities by the proposed model, exhibit an average value of 2.4×10^{-4} m^2/s in Athos basin, 3.4×10^{-4} m^2/s in North Skyros basin (DB3) and 3.5×10^{-4} m^2/s in Chios basin. The particulate ^{137}Cs effective vertical migration velocity exhibits the following values: in Athos basin (0.8 ± 0.6) m/day, in North Skyros (5.1 ± 2.8) m/day and in Chios basin (11.7 ± 7.1) m/day.

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Simulation of radionuclides transfer in the terrestrial environment of Greece using dosimetry models

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For the evaluation of the radiological impact and the characterization of the risk of ionizing radiation to non-human biota suitable software programs and applications have been developed, based on dose rates calculations. In the present study, the ERICA Assessment Tool 1.0 (November 2012) [1] is implemented in order to simulate the transfer of radionuclides between the abiotic components and the selected organisms of the terrestrial environment in Greece, as well as, to estimate the risk of exposure, based on real time measurements.

For the adaptation and simulation of radionuclide behavior in relation to the studied organisms, activity concentration measurements of gamma emitting radionuclides in the environmental components have been performed. Samples of abiotic components (soil) and organisms (grass and mammals' tissues) have been collected from the natural and semi-natural terrestrial environment of Greece and properly treated and measured for natural and artificial radionuclides using the hpGe gamma-spectrometry systems of ERL [2].

The measured activity concentrations were imputed to the ERICA Tool and the consequent dose rates received by the biota were estimated, whereas the radionuclide transfer parameters were also evaluated. Besides, the results of the simulations were compared to the results of the measurements, indicating that specific considerations should be taken into account at the application of the Tool. The origin of radionuclides, the pathway of exposure, the biological characteristics of the organisms and the environmental characteristics of the ecosystem have to be considered in order to be the ERICA Tool more applicable in site specific ecological features.

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Use of natural and artificial radionuclides in marine sedimentology study of Shatt Al-Arab estuary (Persian/Arabian Gulf)

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A previous study on seabed sediments from the estuary of Shatt al-Arab River, Persian/Arabian Gulf, enabled us to identify several relations between sedimentological variables and activity concentrations of natural and anthropogenic radionuclides. The activity concentration of ^{40}K, ^{226}Ra, ^{232}Th and ^{137}Cs of surface sediment samples was used as input data to a semi-empirical sedimentology model for granulometric facies determination [1, 2] and the model's results were compared with experimental ones. Also, the relation of activity concentration with grain size, major and minor elements was examined. Statistical methods were used to investigate possible sorption process differences between natural and technical radionuclides onto sediment of various sizes and origin.

Sedimentation Rates from Four Different Aquatic Environments at NE Mediterranean

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The activity concentrations of ^{226}Ra ^{210}Pb and ^{137}Cs in sediment samples have been measured in different aquatic environments located in the NE Mediterranean region. Specifically, four resent sediment cores were collected from the center of Elefsis Gulf, the coastal area of Litohoro, the Southern part of Korinthikos Gulf and from the Ulubat Lake, located at the Sea of Marmara region. The activity concentrations have been measured by means of gamma ray spectrometry using HPGe detector at the Hellenic Centre for Marine Research. The average sedimentation rates were calculated applying various models based on the excess of ^{210}Pb (^{210}Pb$_{ex}$) and the vertical distribution of ^{137}C along the sediment cores, being in good agreement between each other.

Estimation of the environmental impact of phosphogypsum stockpile in Schistos waste site (Piraeus, Greece) using a combination of laboratory techniques with Geographical Information Systems

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Ten million tons of phosphogypsum were deposited into an old limestone quarry during 1979 – 1989, as a result of the operation of the fertilizer industry in Drapetsona (Greece). Recently, the phosphogypsum stockpile has been remediated with the use of geomembranes and thick soil cover with vegetation. The purpose of the present study was to characterize representative samples of phosphogypsum, using diffraction (powder-XRD), microscopic (SEM-EDS), analytical (ICP-MS), and spectroscopic techniques (HiRes gamma-ray spectrometry and XRF).

The natural radioactivity is mainly due to the ^{238}U series and particularly ^{226}Ra (max: 629 Bq/kg). Systematic soil sampling from the cover of the deposit and the surrounding area was assisted by GPS. Samples, representing the geological background, were found to contain much less radioactivity. The radionuclide activity values of all types of solid samples were combined to generate GIS maps showing the spatial distribution of radioactivity in the area. Furthermore, leaching experiments using TCLP procedures and rainwater, together with ICP-MS, were performed to assess the potential release of natural actinides and heavy metals in the environment.

Radiotoxic metals concentration measurement in sediments due to gold mining activities, Chalkidiki.

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The gold-mining operation and tailing deposits in Stratoni region, Northern part of Greece, make monitoring activities necessary both in the terrestrial and coastal areas. As a part of a preliminary monitoring action, in summer of 2012, surface sediment samples in the coastal area of Stratoni (in Ierissos Gulf) were collected and measured aiming a) to obtain concentration levels of (Natural Occurring Radioactive Materials) NORM and heavy metals (e.g. As, Zn, Cu, Pb and Mn,), b) to identify minerals composition and c) to determine the distribution of the grain size. The activity concentrations of ^{238}U, ^{232}Th daughters and ^{40}K were found between (20-100) Bq/kg, (20-35) Bq/kg and (420-700) Bq/kg, respectively. The concentrations of the most toxic heavy metals were found, (8-4100) ppm for As, (30-4000) ppm for Zn, (7-200) ppm for Cu, (40-1700) ppm for Pb and (400-26000) ppm for Mn. In addition, granulometric analysis reveals mostly sandy and sandy-mud sediments (97 – 53% content of sand). In general, enhanced levels of heavy metals and radionuclides were located near the load-out pier area of the coastal region. So, the input mechanisms of them (via local streams, rainfall, floods or others) into the sea and their levels has to be periodically investigated through more concerted monitoring actions.

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Indoor radon in Greek workplaces

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Greece is divided into 13 administrative regions. From 1999-2012, 1360 passive radon detectors were installed in 680 workplaces in 8 of the 13 regions of Greece. The duration of the radon measurements was from 3 months up to one year. The majority (75.4%) of the workplaces are schools and the rest (24.6%), are workplaces mainly in public buildings (town halls, police, fire brigade, hospitals) and few in private enterprises (shops, hotels etc). The majority of the rooms where indoor radon measurements were performed are located at the ground floor. In each workplace two electrets ionization chambers were installed in the same room. The radon concentration distribution can be well described by a lognormal distribution. The arithmetic and geometric mean of the radon concentrations are 136 Bq m^{-3} and 114 Bq m^{-3} respectively. The minimum and maximum measured value of radon gas concentrations are 29 Bq m^{-3} and 958 Bq m^{-3} respectively. In the workplace (school) with the higher annual radon concentration (958 Bq m^{-3}) was performed for 2 weeks radon measurements every 10 minutes. The value of the arithmetic mean radon concentration when the school was in operation (8h-16 h) was 104 Bq m^{-3}. The mean radon concentration for these specific two weeks was seven times higher (700 Bq m^{-3}). For all regions studied, the mean radon concentration in schools was higher than in other workplaces. A rather good linear correlation, with a proportional factor of about 1.45 was observed between the mean radon concentrations in schools and other workplaces. This factor could be useful in the interpretation of future radon surveys. Indoor gamma dose rate measurements, with a portable NaI(Tl) detector, were also performed in the same workplaces. As expected, no correlation between radon gas concentration and indoor gamma dose rate was observed in the 680 workplaces. However, if only mean values of each region are considered, a linear correlation between radon gas concentration and gamma dose rate is apparent.

In situ size distribution measurement of Radon decay products activity concentrations in "Apollon" thermal baths/SPA of Ikaria

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Radon is a naturally occurring radioactive gas released from the normal decay of uranium in rocks, soil and water. Radon and radon progeny are recognized as the most significant natural source of human radiation exposure. Radon is considered a health hazard to humans, especially when it enters the respiratory tract. When deposited in the lung, alpha decays from certain Radon progeny deliver a radiation dose, causing adverse health effects (e.g. lung cancer). Considerably higher concentrations of radon and radon progeny have been observed in thermal SPAs, posing additional risk to the health of personnel and bathers, when compared to NORM levels in Greece. Radon and its decay products are absorbed on the surface of aerosol particles. The behaviour of the airborne radionuclides is determined by the behaviour of the aerosol particles in the atmosphere. The size of aerosol particles affects the deposition of aerosol particles in various compartments of human respiratory tract. The aim of this study was to measure the size distribution of radon and its decay products activity concentration in the "Apollon" thermal SPA of Ikaria, which is considered as one of the highest in activity concentrations in Europe, as well as to calculate the effective doses received by workers and patients as a result of radon inhalation and its short-living progenies in air. A three-day measurement campaign was conducted in February 2014. The activity size distribution of radon decay products were measured by means of a Gottingen online alpha impactor, with six stages and cut-off diameters between 50nm and 1700nm. Radon equilibrium equivalent concentration in the waiting room ranged between 158 Bq/m^3 and 1236 Bq/m^3, whereas lower concentrations (56 Bq/m^3-358 Bq/m^3) were measured in the bath (window was open during sampling). In Fig. 1 the variation of radon progeny concentrations is presented. During the measurement campaign, the windows in most of the baths were kept open during the sampling, whereas the windows in the waiting room where workers spent most of their working hours, were kept open during the working hours of the SPA but they were closed during the night. The observed variation in the concentrations of radon and its progeny in air, depends on several factors governing the Air Exchange Rate such as, meteorological conditions, wind speed, as well as atmospheric conditions affecting particle size and radon emanation rate.

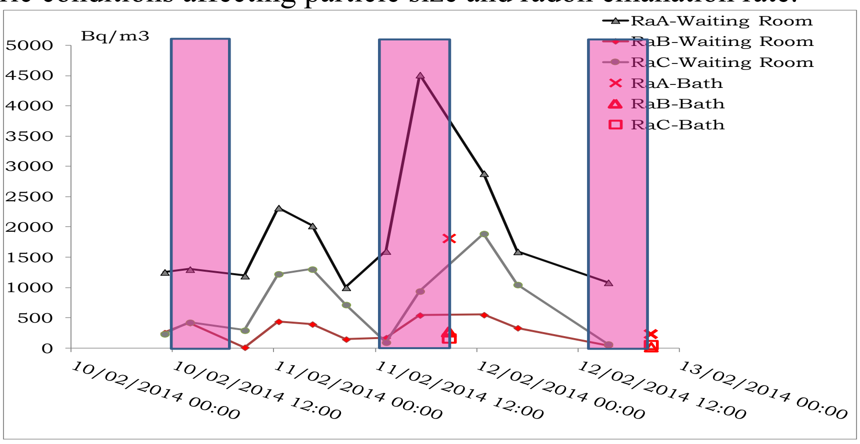

Fig. 1: Daily variation of radon progeny concentration in the "waiting room" as well as in the "bath". The pink areas represent the working hours of the SPA.

Localization and Identification of Gamma Ray Sources Using Pixelated CdTe Detectors

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We are developing portable devices for the spectroscopic identification and the spatial localization of radioactive sources. These systems can be used in security inspections at the borders (airports, seaports etc) for the determination of the position and the strength of potential radioactive sources, at metal recycling factories for the detection of possible radioactive sources embedded into scrap metal loads and in various medical and industrial imaging applications. Two methods are exploited for the spatial localization: coded aperture imaging and the reconstruction of the Compton scattered photons in the detector.

The devices are based on the hybrid pixel detector technology. The gamma ray is converted to electron – hole pairs within a pixelated CdTe semiconductor crystal and the induced signals are processed by CMOS pixel electronics flip chip bonded to this crystal. The CMOS pixel electronics developed provide for each converted photon the charge collected and a time stamp. The two techniques and their application will be presented and results will be discussed. For experiments with coded aperture imaging we are using a setup of two gamma cameras and a video camera, while the result of the gamma source localization is fused to the video image. The device for Compton scatter imaging is under development.

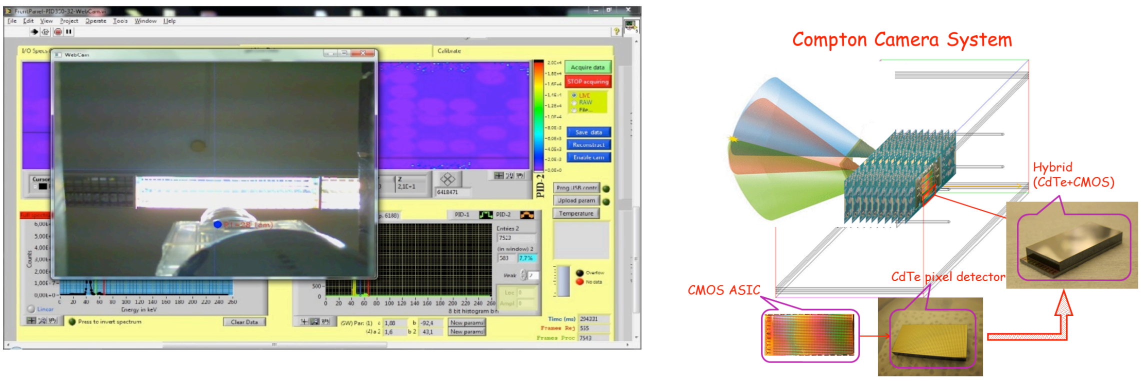

Fig. 1: Left: Snapshot of the data acquisition user interface for the coded aperture imaging. The blue dot indicates the estimated position of the 241Am radioactive. The indication next to the blue dot is the estimated distance of the source. Right: The conceptual design of the Compton imaging device, together with the developed technology components.

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Neutron star structure and collective excitations of finite nuclei

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A method is introduced that establishes relations between properties of collective excitations in finite nuclei and the phase transition density n^2 and pressure Pt at the inner edge separating the liquid core and the solid crust of a neutron star. A theoretical framework that includes the thermodynamic method, relativistic nuclear energy density functionals and the quasiparticle random-phase approximation is employed in a self-consistent calculation of (nt, Pt) and collective excitations in nuclei. Covariance analysis shows that properties of charge-exchange dipole transitions, isovector giant dipole and quadrupole resonances, and pygmy dipole transitions are correlated with the core-crust transition density and pressure. A set of relativistic nuclear energy density functionals, characterized by systematic variation of the density dependence of the symmetry energy of nuclear matter, is used to constrain possible values for (nt, Pt). By comparing the calculated excitation energies of giant resonances, energy weighted pygmy dipole strength, and dipole polarizability with available data, we obtain the weighted average values: nt=0.0955 ± 0.0007/fm^3 and Pt=0.59 ± 0.05 MeV /fm^3. This approach crucially depends on experimental results for collective excitations in nuclei and, therefore, accurate measurements are necessary to further constrain the structure of the crust of neutron stars.

Symmetry energy effects on isovector properties of neutron rich nuclei with Thomas-Fermi approach

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We employ a variational method, in the framework of the Thomas-Fermi approximation, to study the effect of the symmetry energy on isovector properties of various neutron rich nuclei. In this work we concentrate our interest on ^{208}Pb, ^{24}Sn, ^{90}Zr, and ^{48}Ca. In our approach, the isospin asymmetry function a(r), which is the key quantity to calculate isovector properties of various nuclei, is directly related with the symmetry energy and the Coulomb interaction is included in a self-consistent way and its effects can be separated easily from the nucleon-nucleon interaction. We confirm, both qualitatively and quantitatively, the strong dependence of the symmetry energy on the various isovector properties for the relevant nuclei, using possible constraints between the slope and the value of the symmetry energy at the saturation density.

Nuclear study of the exotic neutrino interactions

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The nuclear physics aspects [1] of the exotic neutrino-nucleus processes, predicted to occur within various new-physics models [2], are studied by using the quasi-particle RPA [3]. Our main purpose is to explore the role of the ν-nucleus non-standard interactions (NSI) [4, 5, 6] in the leptonic sector. More specially we are interested in the following exotic reactions: (i) the lepton flavour violating (LFV) processes involving neutrinos ν_ℓ ($\bar{\nu}_\ell$), $\ell = e;\mu;\tau$ and (ii) the charged lepton flavour violating (cLFV) processes involving charged leptons ℓ^- (ℓ^+).

As concrete nuclear systems, to perform detailed calculations, we have chosen the ^{27}Al and the ^{48}Ti isotopes, i.e. the stopping targets of the ongoing $\mu^- \rightarrow e^-$ conversion experiments, the Mu2e [7] at Fermilab as well the COMET [8] and the PRIME/PRISM [9] at J-PARC, respectively. These experiments expect to reach a single event sensitivity of $10^{-16} - 10^{-18}$ in searching for cLFV events. By taking advantage of our extensive nuclear structure calculations and employing the present limits/sensitivity of the aforementioned experiments, we put severe bounds on the parameters entering the NSI Lagrangians.

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The role of e^--capture in neutrino-nucleosynthesis

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The charge changing electroweak processes of $e^{\pm}$-capture, $\beta^{\pm}$-decays etc, by nuclei, are very important processes in understanding the late stages of stellar evolution. To this aim, in this work we study the e^--capture by medium-weight nuclei which plays a crucial role in the presupernova and supernova (SN) collapse. In presupernova phase e^--capture on fp-shell nuclei proceeds at temperatures 300keV $\leq T \leq$ 800keV. At temperatures T ' 1:0MeV and higher densities during the core-collapse SN phase, electrons are also captured by heavier and neutron rich nuclei ($Z < 40$, $N \leq 40$) [1, 2]. We concentrate on a detailed study of the e^--capture by iron group nuclei at presupernova conditions and also by ^{66}Zn and ^{90}Zr isotopes at SN conditions. Moreover, we perform original cross sections calculations for e^--capture by these nuclei at laboratory conditions (initially the target nucleus is in the ground state and no temperature dependence is considered).

The nuclear physics aspects of the above processes are studied by using the quasi-particle random phase approximation, QRPA. The nuclear ground state is constructed in the context of the BCS method while the excited states are calculated by solving the QRPA equations, using as residual two-body interactions that of the Bonn C-D potential [3, 4].

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The response of an autonomous underwater telescope to high energy neutrinos for the observation of Gamma-ray bursts (GRBs)

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The response of an underwater neutrino detector is discussed for investigating its performance to the detection of muons and high energy neutrinos. The aforementioned telescope consists of an autonomous battery operated detector string to a central 4-floor tower. In this aim, we utilized a fast detector simulation program, SIRENE, to simulate the hits from Cherenkov photons at ultra high energies (as high as 10^{20} eV). In order to optimize the detector, analytical studies for different configurations and characteristics of the photo-multiplier tubes inside the optical modules[1] of the telescope was also examined.

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Systematic cross section measurements of (α,γ) reactions for astrophysics

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This work is part of a research program involving systematic reaction cross section measurements, carried out by the Nuclear Physics group of NCSR "Demokritos" at energies far below the Coulomb barrier. This program aims at testing the models developed so far for the optical potential for protons or alpha particles and the nuclear level densities. These models along with other parameters, such as the γ-ray strength function, enter in cross section calculations by Hauser-Feshbach (HF) theory. Testing HF predictions allows for understanding the discrepancies between the observed solar system isotopic abundances of a group of nuclei known as "p-nuclei" and those predicted by models developed for the description of the mechanism that is responsible for their creation ("p-process") at explosive stellar environments.

A major nuclear physics uncertainty entering abundances calculations of p-nuclei refers to the alpha-particle nucleus optical model potential (α-OMP). Aiming at developing a global microscopic α-OMP we performed a series of (α,γ) reaction cross-section measurements by using the 4π γ-summing technique [1]. The present contribution reports on the results of a number of (α,γ) reactions cross-section measurements in the Ni-Pd region. Furthermore the data are compared with statistical model predictions of optical model potentials, nuclear level densities and γ-ray strength functions. The latter theoretical calculations were performed using the TALYS code [2] .

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Proton capture reactions in medium-heavy nuclei relevant to p-process nucleosynthesis

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Cross sections of proton-capture reactions on Molybdenum and Selenium isotopes have been measured at astrophysically relevant energies. The experiments were carried out at the Dynamitron accelerator that used to operate in the University of Stuttgart (IfS) and at the Dynamitron Tandem accelerator (DTL) of the University of Bochum by means of γ-ray angular distribution measurements [1] and the 4π γ-summing technique [2], respectively.

The aim of these measurements was to derive cross-section data that can be used in testing the existing proton-nucleus Optical Model Potentials entering the Hauser Feshbach theory. Theoretical calculations were performed using the statistical model code *TALYS* [3].

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First cross-section measurements of the $^{112}Cd(p,\gamma)^{113}In^{*}$ reaction at astrophysical energies

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Astrophysical models describing the origin of the neutron-deficient *p* nuclei require experimental input of proton-capture cross sections at low energies. Such experimental data are scarce and more measurements are necessary to improve our understanding of the reactions governing the astrophysical processes.

A campaign of measurements at the Tandem Accelerator Laboratory of NCSR "Demokritos" was undertaken over a period of one year, focusing on cross sections of the reaction $^{112}Cd(p,\gamma)^{113}In$. The measurements were performed by both in-beam and activation techniques. The latter was used to take into account a low-lying isomeric state in ^{113}In (391.7 keV, $t_{1/2}$=99.5 m). Accelerated proton beams impinged on a 99.7% enriched ^{112}Cd target at energies between 2.8-3.4 MeV, while an array of four 100% HPGe detectors was employed to detect gamma radiation of the de-exciting ^{113}In nuclei. A full angular distribution was measured and reaction cross sections were deduced for the first time [1]. Preliminary results will be presented, compared to theoretical TALYS 1.6 calculations [2].

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Use of everyday materials in retrospective nuclear accident dosimetry

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Following a large-scale nuclear event, a quantitative estimate of the radiation dose to the general population necessitates the availability of adequate procedures for the assessment of doses. Amongst the methods applied for dose reconstruction, or retrospective dosimetry in relation to the local population after a nuclear accident, are solid state methods based on luminescence, including Thermoluminescence (TL) and optically stimulated luminescence (OSL), which can be used to measure the integrated absorbed dose.

In the present work everyday materials - such as common salt, water softener tablets and porcelain – were examined for their suitability and efficiency for natural dosimeters, using TL and OSL measurements. The results of the present study have shown that such materials may be used as dosimeters provided they fulfil specific requirements so to allow a satisfactory assessment of the post-accident situation and facilitate the application of appropriate countermeasures.

Use of the Optically Stimulated Luminescence Dating and X-Ray Fluorescence Spectrometry Methods as Tools in Paleoseismology*

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The evaluation of earthquake hazards is based on the understanding of the past behavior of seismogenic faults [1]. The successful completion of a paleoseismic evaluation requires the determination of dates of past earthquakes and slip rates of faults. Among the dating techniques, the use of luminescence dating methods for dating earthquake-related deposits appears to offer great potential [2]. We have investigated the application of luminescence dating to sediment and pottery samples from a paleoseismological trench excavated in the Gyrtoni Fault, Tyrnavos Basin, Central Greece. The samples were dated following the Optically Stimulated Luminescence (OSL) dating method, using the Riso TL/OSL DA-20 reader. The OSL ages were obtained from chemically purified quartz and a single-aliquot regenerative-dose (SAR) protocol was followed for the equivalent dose (De) determination [3]. Also, to estimate dose rates, the natural radioactivity of soil from the surroundings of the original sample location was measured, using gamma spectrometry.

Moreover, to document the magnitude of displacement in past faulting events, observed in excavated paleoseismological trenches across faults, stratigraphic and structural relationships imprinted on the walls should be interpreted [4]. Often, the interpretation is not straightforward due to poor stratification of the lithologic units exposed on the downthrown block. In this work, to overcome this issue, additional samples from the same paleoseismological trench, from the upthrown fault block and the downthrown fault block, were collected and analyzed with X-ray Fluorescence (XRF) Spectrometry to differentiate strartification through their elemental compositions. The samples were dried, pulverized and pressed into standard pellets before carrying out XRF spectrometry measurements. Radioisotope sources (^{109}Cd and ^{241}Am) were used for sample excitation, while X-ray spectra were acquired using a Si(Li) detector coupled with standard electronics. The XRF data were submitted to Principal Component Analysis (PCA). This statistical handling aimed to distinguish from which part of the upthrown fault block scarp-derived colluvium and colluvial wedges, parts of the downthrown block were derived and thus estimate displacement.

The results indicated that both the OSL dating method and the XRF analysis combined with PCA can serve as useful tools for paleoseismological investigations.

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Measurements and Monte Carlo simulations of neutron production at a medical accelerator

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Electron accelerators are being routinely used for cancer treatment. Due to high operational energy (up to 25 MeV), a significant number of neutrons is created by (γ,n) reactions when high energy photons interact with the materials of the accelerator head. Neutron leakage radiation reaches the patient, contributing additional unwanted dose to the patient and thus the total neutron fluence must be measured precisely. Neutron activation detectors are one of the best options for the measurement of the leaked neutrons, yet the majority of previous studies are calculating neutron fluencies with Monte Carlo simulations. Usually gold and indium are used as activation detectors in experimental studies.

In this preliminary work, we measured neutron fluencies with neutron activation technique. The LINear ACcelerator (LINAC) under consideration is an 18 MeV Varian Clinac 2100C electron accelerator operating at Papageorgiou Hospital, Thessaloniki, Greece. We measured the total neutron and photon fluence at the isocenter within a 10x10 cm2 X-ray field by nickel, indium, and natural uranium activation foils. All foils returned comparable results. For instance, the total neutron fluence derived from indium foil is 7×10^6 n/cm^2/Gy. This number is in the range with other studies of similar accelerators.

The results of our Monte Carlo simulations, which replicate the experimental set up, are presented and discussed.

A Compton Camera for Medical Applications

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Conventional medical gamma-ray systems utilize mechanical collimation to provide information on the position of an incident gamma-ray photon. Utilizing the Compton Effect, which is the most significant interaction in the energy domain of the commonly used radiotracers, an electronic collimation is feasible with the potential to offer significant improvements in sensitivity. A Compton Camera system implies two different detectors in coincidence, the Scatterer and the Absorber, and exploits the kinematics of Compton Scattering process to reconstruct the position of the emitted radiation. Based on the detected position of the scattered and absorbed photon for a given tracer energy, a cone can be formed, which represents the locus of the source. All crucial architectural parameters regarding the geometry of the scatterer and the absorber for the design of an efficient system are presented in this study. A Compton Camera, with a Double-Sided Silicon Strip Detector (DSSD) as a scatterer and a homogeneous CsI crystal as absorber coupled to a Position Sensitive Photomultiplier Tube (PSPMT), has been simulated by means of the GEANT4/GATE Monte-Carlo toolkit. A variety of Si-scatterer thicknesses ranging from 100μm to 2000μm has been studied for different radiotracers. Taking into account the significant physical background, which mainly consists of false inverse-coincidences and deficit in the deposition of the total energy, the efficiency of the system is calculated and comparative results for different architectures are discussed.

Time Filtering and Image Detection Efficiency in the Time Resolved Optical Tomography

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In a Time Resolved Optical Tomographic (TROT) scheme, proper time filtering of the detected events discriminates the non-scattered photons and thus provides the proper planar image of a certain physical structure in the tissue environment. The correlation between different time cuts, aiming to achieve the optimal planar information, and the obtained image quality is thoroughly examined by means of Monte-Carlo simulations in this study. An optical phantom consisted of five off-axis and totally absorbing spheres, immerged in a tissue-like medium, is investigated. Different scattering lengths for the radiation through the medium have been taken into account and the propagation of all photons has been simulated. The optimal planar images obtained by the exclusion of the divergent photons are axially sliced and reconstructed using iterative algorithms, providing the tomographic images and from them the final 3D image of the optical phantom. This work will serve as a feasibility study, which examines the potential use of a TROT modality as a diagnostic tool, capable to provide the necessary anatomical and functional information in modern Medical Imaging.

TETRA-SPECT: A Four-Head Rotating System for Mammography

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Common clinical devices dedicated to the Single Photon Emission Computed Tomography (SPECT) acquire planar images with one or maximum two rotating γ-Camera heads. Since the majority of them is devoted to whole-body scanning, there is an increasing demand for cameras optimized to image the breast or other smaller organs. In this study, a four-head rotating prototype SPECT device is designed and its performance is examined by means of a Monte-Carlo simulation. The proposed TETRA-SPECT apparatus restricts its field of view to a single breast and is expected to achieve a higher performance than the conventional systems in clinical mammographic studies.

The TETRA-SPECT prototype consists of four identical small field but high resolution γ-Camera devices equipped with CsI scintillation crystals and placed in axially symmetric positions (90^{o}-angle) around the rotation axis. Appropriate parallel-hole collimators are designed for low energetic radiotracers (^{99m}Tc, ^{201}Tl). The overall performance of the system is studied with the GEANT4/GATE simulation package. Radioactive sources with various sizes and in different background conditions have been simulated inside a breast phantom and the projection image of each detector head is extracted and analyzed. The achieved spatial resolution on the planar and the tomographic level of this prototype is further discussed. It is argued, that the geometric acceptance of the system allows a reasonable efficiency of the camera even for minimal dose-rates and a small number of projections. 3D-reconstruction results will be presented for tomographic images acquired only by three angular camera positions (30^{o} step) and the obtained resolution will be compared to asymptotically ideal values.

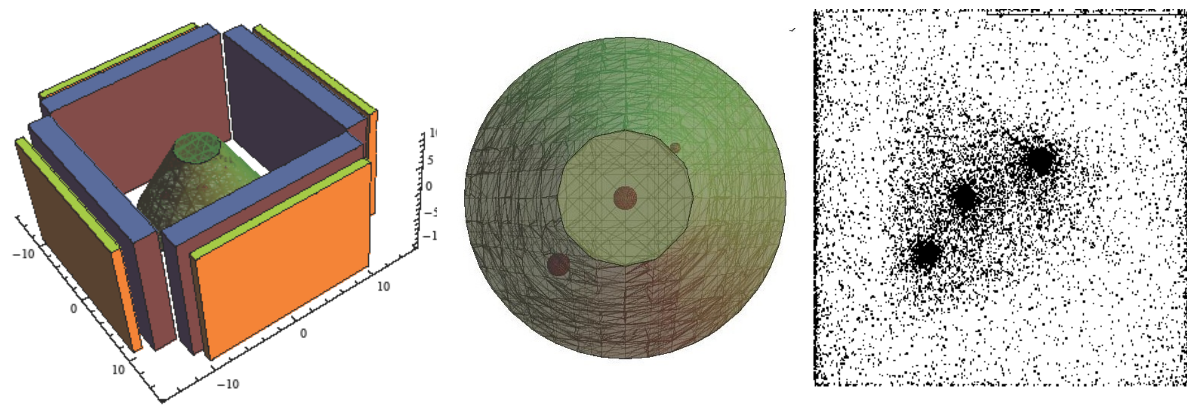

Figure 1: TETRA-SPECT Camera with a breast phantom and the planar projection of three radiotraced lesions as it is detected by one of the four heads.

POSTER PRESENTATIONS

Benchmarking the proton elastic scattering cross sections on ^{19}F and ^{nat}B using ΔE/E silicon telescopes

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The implementation of the existing Ion Beam Analysis (I.B.A.) depth profiling techniques critically depends on the accuracy of the available differential cross sections for the reactions involved. Unfortunately the existing experimentally determined differential cross-section datasets, as well as, the evaluated ones are still not adequately validated. A carefully designed benchmarking experimental procedure (i.e. the validation of differential cross-section data via the acquisition of thick target spectra from uniform targets of known composition followed by their detailed simulation) is thus mandatory. Benchmarking can also provide feedback for the adjustment of the parameters of the nuclear model used in the evaluation process and can help in assigning realistic uncertainties to the cross sections. This high precision procedure is seriously impeded in the case of the elastic scattering of protons by certain ultra-low Z nuclei by the existence of background contributions originating from (p,α) reactions.

The present work deals with the benchmarking of $^{19}F(p,p)$, $^{nat}B(p,p)$ since the quantitative determination of fluorine in various samples is of great importance for material science as well as for medical and environmental studies while boron is widely used in the semiconductor industry as a dopant for Si and Ge substrates let alone it's use as an essential ingredient of hard coatings on the walls of thermonuclear plants. The experiment was performed using highly pressurized ZnF_2 and Boron pellets, in the energy range of 1-4 MeV, for three backward angles namely at 170^o, 150^o, 120^o. A thin layer of gold was evaporated on each target for normalization purposes.

A ΔE/E silicon telescope was mounted at each angle exploiting the difference in the stopping power between elastically scattered protons and a-particles. This technique, using event-by-event acquisition based on standard CAMAC electronics, will be further implemented in the case of d-induced reactions in the near future.

Study of the $^{11}B(p,p'\gamma)^{11}B$ reaction for PIGE applications

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Boron is a highly regarded technological element and has numerous applications in various fields. It is widely used in the semiconductor industry as a dopant for Si and Ge substrates and it is also an essential ingredient of hard coatings on the walls of thermonuclear plants. Thus, the accurate quantitative determination of boron depth profile in heavy and light matrices or substrates is of great importance. One of the Ion Beam Analysis (IBA) methods, that can yield accurate results and has been used successfully in the past, is Nuclear Reaction Analysis (NRA) and especially Particle Induced Gamma ray Emission (PIGE).

In the present work, differential cross section were measured at 6 angles (0˚, 15˚, 90˚, 105˚, 150˚ and 165˚) and at proton energies from 2.5 to 5.0 MeV (20 keV step) for the $^{11}B(p,p'\gamma)^{11}B$ reaction. The γ-ray emitted (2125 keV) was detected by three HPGe detectors placed on a motorized turntable. The results of the present work are compared with existing ones from literature and possible explanations for the observed differences are discussed.

Rate Theory Analysis of Point Defect Migration in Irradiated Fe-Cr alloys *

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The Fe-Cr alloy system is the base of ferritic steels which are considered as candidate structural materials for the future Fusion Power Plants. However, the behavior of Fe-Cr alloys under irradiation is not yet fully understood. Experimental and theoretical work is carried out worldwide in order to clarify the basic processes involved in these alloys under irradiation. The main goal is to predict the behavior of these materials under the extreme conditions that will prevail in the future Fusion Power Plant.

During irradiation, atoms are displaced from their lattice sites by the transfer of kinetic energy from the energetic irradiating particles. Vacant lattice sites and an equal number of displaced atoms wedged into the interstices of the lattice are created. These basic defects, vacancies and interstitials, respectively, are responsible for the evolution of the microstructure during irradiation and thus form the foundation for all observed effects of irradiation on the physical and mechanical properties of materials. Therefore, the study of the basic mechanisms that govern the evolution of point defects induced by irradiation in materials is of primary importance.

In a series of irradiation campaigns carried out at the TANDEM accelerator of NCSR "Demokritos", high purity Fe-Cr alloys were irradiated at cryogenic temperatures by 5MeV protons. The cryogenic temperature ensures the immobilization of the produced defects in the lattice. After the total dose is delivered to the sample, the temperature is gradually increased and the radiation induced point defects are removed through thermal atomic movements. This 'recovery' is observed *in-situ* by measurements of the associated changes in the electrical resistivity of the sample. The rate of recovery as a function of annealing temperature reveals a spectrum of distinct peaks, each one attributed to a different thermally activated mechanism. To interpret these spectra and extract important information about recovery mechanisms, we used rate theory calculations. Assuming a model for the interactions between point defects, the kinetics are treated on the basis of diffusion controlled chemical rate equations. Comparisons with experimental data indicate the existence of trapping centers, which capture the interstitials and delay their annihilation. The physical parameters of this mechanism, e.g., the activation energy for interstitial migration and the binding energy for interstitial trapping, have been estimated.

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Incorporation of Ion Post Stripper in the APAPES Experimental Setup

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The APAPES research group focuses on atomic physics experimental research with use of accelerators, and works specifically on projectile electron spectroscopy. The experiments will be carried out in the TANDEM accelerator at the NCSR "Demokritos".
In view of the nature of the experiments that will be performed, it was considered necessary to incorporate a second stripping point along the beam line of the setup. Therefore a post stripping unit will be constructed and placed in the beam line, with the purpose of allowing selection of either foil or gas stripping of the ion beam that will be used.

For the construction of the mentioned unit it's vital that certain assessments are made. For the best implementation of the experiments a charge state analysis code will be used in order to predict charge distribution after stripping and achieve optimal charge selection. Nikolaev-Dmitriev's [1], Sayer's [2] and other more recent formulas [3,4] particularly applicable to lighter Z-ions such as Li to F (of direct interest in this project) will be used to derive the predictions.

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Spectrum analysis based on Monte Carlo simulations for *in situ* γ-ray measurements in the marine environment

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The MCNP-CP Monte Carlo code was implemented to simulate seawater spectra acquired using a NaI scintillation detector (system KATEPINA). The generation of the most prominent γ-rays emitted from the decay of 40K, and the series of 232Th and 238U, was included in the simulation run. The primary generation events were sampled in a spherical volume to simulate the standard 4π seawater measurement setup. The simulated γ-ray spectra were qualitatively compared with the corresponding experimental data acquired with the *in-situ* NaI spectrometer. Activity concentrations (in units of Bq/m3) were deduced from the simulated γ-ray spectra using full spectrum analysis. The validation of the results was performed by laboratory measurements on collected seawater samples using a HPGe detector, showing a satisfactory agreement.

HDA input lens voltages optimization using SIMION

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We report on the optimization of the new atomic physics experimental station located at the Tandem Accelerator Laboratory (TAL) of INPP, NSCR "Demokritos"[1]. The station consists a hemispherical deflector analyzer (HDA) with a 4-element injection lens and 2-D position sensitive detector (PSD).

The optimization was carried out by simulations using the SIMION 8.1 package [2]. Utilizing the finite difference method, SIMION solves the Laplace equation in the lens and HDA for the given simulated geometry of the experimental setup. Simple initial distributions were used to fly electrons through the lens entry aperture and record their distribution as detected at the PSD. Lens voltages were optimized using a special interactive SIMION- Lua program which searched for the lens voltages giving rise to the narrowest beam widths at the PSD. The simulations were carried out for various lens pre-retardation factors for which the behavior of the system for various voltages was derived. Results for this work are presented.

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A new γ-spectroscopy station at the University of Athens

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A high-resolution γ-spectroscopy system comprising a high-purity germanium detector (HPGe, nominal efficiency 23%) and lead shielding was recently acquired. The γ-spectroscopy station aims at supporting the environmental radioactivity studies program of the NUSTRAP group at UoA. In this work, detailed efficiency calibration studies of the HPGe detector have been performed with three point sources: ^{60}Co, ^{152}Eu and ^{137}Cs. In addition, the Monte Carlo N-Particle transport code (MCNP ν.5) [1] was used to perform simulations of the γ-spectroscopy station. The specific detector geometry, shielding and source characteristics were examined to establish optimal settings for future measurements. Additional geometries are considered to accommodate realistic cases, using IAEA standards. The results of the MCNP calculations and actual spectra will be shown and compared.

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Large Sample Neutron Activation Analysis of Ceramic Matrix Composites *

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Neutron activation of structural materials used for future fusion plants may result in radiation doses to personnel, which in the medium-term could complicate the handling of components in maintenance operations. Furthermore, it may produce long-term activation products, which could require special treatment, storage or disposal as waste at end of life of the station. Therefore, advanced prediction of the induced activity and the resulting radiation dose rate levels after plant shut-down is an essential precondition for the choice of materials for fusion. The calculation of activity and dose rate levels is based on detailed evaluation of the activating neutron fluence and knowledge of the actual elemental composition of the materials and components. Carbon fiber reinforced SiC ceramic matrix composites (Cf/SiC) are promising new structural materials for a variety of high-temperature aerospace and energy applications. Moreover, since the matrix elements are C and Si, they present low activation after neutron irradiation and therefore are materials of particular interest for fusion technology applications.

In the present work, Large Sample Neutron Activation Analysis (LSNAA) was applied to determine the elemental composition and activity of two $50\times50\times2.5$ mm^3 Cf/SiC specimens joined using a high temperature graphite based adhesive. The neutron irradiations and gamma ray measurements were performed at the BISNIS facility of the Hoger Onderwijs Reactor, TU Delft. Monte Carlo simulations using the MCNP code were performed to evaluate correction factors for neutron self-shielding and gamma attenuation within the sample.

The results of this study demonstrated the feasibility of application of LSNAA as a cost-effective method for non-destructive multi-elemental composition analysis of whole ceramic specimens enabling the calculation of induced activity and dose rate after sample irradiation in different fusion neutron spectra.

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Adsorption of ^{152}Eu from aqueous solutions using amorphous Titanium Phosphates

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Europium is an element of the lanthanide series and can be used as analogue to trivalent actinides (Pu, Am). Tetravalent metal phosphates are known for their ion exchange properties. In this work a study of trivalent europium retention onto amorphous titanium phosphates is presented. Three amorphous titanium phosphates (TiP) were obtained by direct precipitation of soluble salts of titanium (IV) with phosphate salt solution. The Ti:P ratio varied (from 1:1.5 up to 1:5) in order to obtain materials with improved sorption properties. Characterization of the prepared materials as composition, microstructure and surface morphology by means of X-ray diffraction, Fourier Transformed Infrared spectroscopy (FT-IR) and Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS) were studied. Batch Sorption Experiments were carried out in order to investigate the metal sorption mechanisms. ^{152}Eu equilibrium concentration was determined by γ-spectroscopy. The effect of pH, contact time, weight of the sorbent material and initial concentration on the uptake percent of ^{152}Eu were studied. The equilibrium sorption data were described by the Langmuir and Freundlich isotherm models. The highest value of Langmuir maximum uptake Q_{max} was found to be 62, 40 and 270 $mg \cdot g^{-1}$ for TiP1, TiP2 and TiP3 respectively demonstrated that the synthesized TiP materials can be used successfully in the management of radioactive waste.

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External dose rate estimations from ^{40}K, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{232}Th, ^{238}U and ^{137}Cs in marine organisms using the RESRAD-BIOTA tool.

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In the present study, activity concentration measurements from natural (^{40}K, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{232}Th,^{238}U) and artificial (^{137}Cs) gamma emitters, are simulated implementing the RESRAD-BIOTA tool (version 1.5/2009) in order to provide an assessment for the external dose rates for selected species of marine biota.

The external dose rates are calculated based on the assumption of immersion of each marine organism in the abiotic materials of its habitat (water, sediment and water-sediment inter-layer). Therefore three different species of organisms are examined, according to their habitat: (1) demersal Fish that live 100% in sediment, (2) pelagic Fish that live 100% in seawater and (3) demersal-pelagic Fish that live in the seawater-sediment inter-layer (50% seawater-50% sediment). The absorbed dose rate calculations are based on two assumptions in terms of the habitat: (1) an infinite radioactive space (4π geometry) for demersal and pelagic Fish and (2) two semi-infinite radioactive spaces (2π geometry) of different activity, for demersal-pelagic Fish. RESRAD-BIOTA combines the default radiological parameters (i.e. Dose Conversion Factors) with the input concentration data, for the derivation of the external dose rates per habitat, for each organism.

The purpose of the present study is to evaluate the external dose rates for the exposed marine species considered as critical for the three distinct eco-modelled spaces and examine the reliability of the RESRAD-BIOTA tool for use in emergency cases and forecast.

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Activity concentrations measurements of natural radionuclides and ^{137}Cs in marine sediments from Amvrakikos Gulf using γ-ray spectrometry

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Amvrakikos Gulf is a shallow (< 65m) marine semi-enclosed embayment lying on the west coast of Greece. The Gulf receives suspended sediments, as well as fresh water inputs from the rivers Arachthos and Louros, which contain contaminants related to agricultural (orthophosphate fertilizers), as well as to industrial and domestic activities. Moreover, Louros and Arachthos run over areas of sedimentary rocks containing phosphate minerals. Five sediment cores, collected from Amvrakikos Gulf, were examined with respect to their natural and artificial radionuclides' content (^{238}U ^{232}Th, ^{226}Ra, ^{40}K), to get information on contamination levels. The activity concentration measurements were performed using γ-ray spectrometry. The duration of counting varied from 1 to 3 days according to sample activity.

Results showed important differences between ^{238}U and all other measured natural radionuclides. The activities of ^{226}Ra and ^{232}Th (20.9 ± 3.3 and 28.8 ± 7,5 Bq/kg, respectively) were consistent, whereas those of ^{238}U and ^{40}K (68.8 ± 25 and 742± 202 Bq/kg, respectively) were higher in almost all sediment samples collected as compared to the activities obtained for neighbouring areas [1], [2] and the world and Greek average values [3] as well. In addition, while the down core activities of ^{226}Ra, ^{232}Th and ^{40}K was roughly the same in all cores examined, the vertical profile of ^{238}U did not presented a uniform distribution pattern. The high activity values of ^{238}U are attributed, besides the lattice-held fraction, to phosphate fertilizer inputs in the Gulf via the rivers Arachthos and Louros and/or to alteration processes of phosphate ores located mainly in the drainage basin of the river Louros. The elevated activity values of ^{40}K could be attributed to the mineralogical composition of the sediments and to phosphate fertilizers containing potassium.

^{137}Cs, which was introduced in the early 1960s as a result of the fallout of atmospheric nuclear bomb test and in 1986 following the Chernobyl nuclear power plant accident, was found in measurable concentrations in all surface layers of the examined sediment cores. The average ^{137}Cs activity concentrations in the sediments are comparable to those obtained for sediments collected from Messolonghi [1] and Butrint Lagoons [2] and it enters the Gulf via the riverine inputs from the Arachthos and Louros and also via direct run-off from the shoreline.

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Validating Global Models Using the Fukushima Nuclear Power Plant (NPP) Accident: Japanese, Greek and global networks *

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A large debate about the exact emissions after the Fukushima NPP accident is still ongoing more than 3 years after the original disaster. Chino et al. [1] and Terada et al. [2] reported the total release of ^{137}Cs to be 13 PBq ($\times 10^{15}$ Bq), based on an inverse modelling using Japanese data only, whereas the IRSN reported releases of ^{137}Cs to be 20.6 PBq [3]. In the present study, we used the emission inventories for ^{137}Cs and ^{133}Xe reported by Stohl et al. [4] estimated by inverse modelling using the CTBTO (Comprehensive Nuclear Test Ban Treaty Organisation) and Japanese networks (36.7 PBq of ^{137}Cs and 15.3 EBq of ^{133}Xe). For the simulations of the accident, three different versions of the LMDZORINCA model were used; A regular one with a grid resolution of 2.50º×1.27º for the global comparison with the CTBTO network (19 and 39 vertical layers), and a zoom version over Europe and Asia (0.45º×0.51º for 19 levels) resulting after "stretching" the grid using the same number of grid points to assess what happened in Greece, and Japan. Caesium isotopes were treated as sub-micronic aerosols, whereas ^{133}Xe as a passive tracer within the model, whereas several other radionuclides were estimated from reported isotopic ratios. Our results for the global assessment fit well to the observations. They differ about 0.04% from the measurements for ^{137}Cs, and around 40% for xenon. The most significant deviations were observed for the northernmost stations due to both scavenging processes and transport over the Arctic. Scattered measurements of several radionuclides from Japan were adopted from literature [5]. The comparison showed a significant quality of our model, although some isotopes are miscalculated. This shows that the reported isotopic ratios might be biased somehow. Finally, in Greece, few measurements of ^{131}I, ^{134}Cs and ^{137}Cs were adopted from Potiriadis et al. [6] and Kritidis et al [7], as well as from a northernmost region (NCRRP, Bulgaria) [8]. The correlation improves to the north probably due to the higher abundance of the radionuclides in the atmospheric aerosol. A general comment is that the source must be re-assessed by the official authorities. Our model, as well as many others employed by several modeling groups, concludes that the initial emission of ^{137}Cs and ^{133}Xe must be doubled. The results will be published in the frame of the AeroCom (http://aerocom.met.no).

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