Convegno per il:
50° anniversario del
Reattore TRIGA MARK II

Presentazione INCS
Flavia Groppi

Pavia 06/11/2015
The International Nuclear Chemistry Society (INCS) was founded by Prof. Turan Unak of Ege University, Izmir, Turkey, during the first Congress of the Society (1st INCC) held in Kusadasi, Turkey, in May 2005.

Prof. Turan Unak was the President of the Society until 2014 and now he serves as the Past President.

At the 4th INCC Prof. Flavia Groppi of the Università degli Studi di Milano, Italy was elected as the new President.
General Aim and Scope of the Society

The general aim is to build a bridge between individuals, institutions, and commercial companies and to establish close cooperation between them worldwide.

The scope: It is expected to be a large umbrella which covers all scientists dealing with chemical studies and applications of ionizing radiations with the understanding that Nuclear Chemistry is a branch which covers all kinds of subjects related to radioactive materials and nuclear radiation and to their applications in different fields of science and technology.
Main Goals of the Society

1. Organization of International Nuclear Chemistry Congresses;
2. Organization of summer schools, and international courses for training, education, and motivation of young generation;
3. Supporting international collaborations and successful young scientists;
4. Supporting the activities of national, regional, and local organizations and societies related to nuclear science and technology, and their applications;
5. Forcing the conditions for rapidly increasing the number of young scientists in the nuclear field in the following decades;
6. Establishment of grants for research and development;
7. Publication of an International Nuclear Chemistry Journal;
8. Publication of an electronic INCS bulletin;
9. Establishment of close collaboration with other scientific organizations such as NAMLS, NRC, MARC, and MTAA;
10. Supporting all kinds of peaceful applications of nuclear science and technology; and
11. Creation of an International Nuclear Chemistry Research and Training Center.
Management of the Society

- The society will be managed by an elected President who will work in close collaboration with the elected Presidential Board Members and elected Regional Representatives.

- Persons filling the above positions will be elected during the General Assembly held during each International Nuclear Chemistry Congress.

- The President, Presidential Board Members, and Regional Representatives may be reelected.

- INCS may offer memberships under three different categories: (i) Individual Membership, (ii) Institutional Membership, and (iii) Industrial Membership.
Current Presidential Board

PRESIDENTIAL BOARD
The President of the International Nuclear Chemistry Society (INCS) and the Presidential Board Members have been elected by delegates participated at the 4th General Assembly of INCS on 18 September 2014 during the 4th International Nuclear Chemistry Congress (4th-INCC) which was held between 14 – 19 September 2014 in Maresias, São Paulo, Brazil.

President:
Favia GROPPI (Italy)
Università degli Studi and INFN-Milano, L.A.S.A., Radiochemistry Laboratory, via F.lli Cervi 201, I-20090 Segrate, Milano, Italy
E-mail: groppi@incs-org.net

Presidential contact information:
E-mail: President@incs-org.net or Secretary@incs-org.net
Other details will be announced soon.

Associate President:
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Presidental Board Members:
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E-mail: bennett@incs-org.net

T. Unak.
Founder, Past President, Turkey

F. Groppi.
President, Italy

X. Hou.
Denmark

M. Navarrete.
Mexico

B. Smodis.
Slovenia

S. Aggarwal.
India

J.W. Bennett.
Australia

M. Vasconcellos.
Brazil
Current Elected Regional Representatives

ELECTED REGIONAL REPRESENTATIVES OF THE INCS

Europe:
Dag Øistein ERIKSEN (Norway)
Institute for Energy Technology, P.O.Box 40, NO-2027 Kjeller, Norway
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Commonwealth of Independent States (CIS):
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Institute for Nuclear Research of Russian Academy of Sciences
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Istambu, Turkey
E-mail: kildir@incs-org.net
The International Nuclear Chemistry Congress – INCC is held every three years.

The abstract books published during the last four INCCs have the same format and view. These books already published and the ones will be published for the next congresses will form a regular series of INCC Abstract Books.
INCS News is the official newsletter of the International Nuclear Chemistry Society.

It is electronically published and distributed in four issues per year.

Since 1\textsuperscript{st} January 2005 are published XI Volumes and 44 Issues

ISSN: 2146 – 5339

The INCS NEWS invites the readers to submit their scientific papers. The contents of an article should be related to nuclear sciences and technology and their applications.
The Next Steps of the INCS

As the new President I would like to continue to involve and ask for effective collaboration of the Presidential Board and Regional Representatives Members.

The main goals of the INCS are determined by the 11 items as indicated in the Constitution of the Society.

Some items in this list seem to be very difficult to realize and require significant efforts, considerable capital, and a long period of time. Of course, this is true, but I believe, as Turan pointed out, that these are not impossible aims and can be achieved with the support of the scientific community and the scientists, who sincerely believe in the useful applications of nuclear sciences and technologies for the improvement of human life and ecological systems on our planet. Of course, each activity, an important one or a basic one, requires economic input, without which it is very difficult, sometimes impossible, to be carried out.

The first steps will be

✓ Organization of 5th INCC in order to continue the series of the Congresses that is one of the more important activities of INCS
✓ Continue the “INCS News” publication
✓ Re-organize the website in order that INCS can have visibility
✓ Start a campaign to recruit funds for start new initiatives
Radionuclides Production for Biomedical, Nanotoxicological and Environmental Applications

Mauro L. Bonardi, Flavia Groppi, Simone Manenti, Luigi Gini

Radiochemistry Laboratory, LASA, Universita’ degli Studi and INFN

e-mail: flavia.groppi@mi.infn.it
Main research fields related to Health Physics, Radiochemistry and Nuclear Chemistry

- Optimization studies for production of radionuclides with high specific activity and short half life, produced in No Carrier Added form and by no conventional way and not available on the market by Cyclotron or Nuclear Reaction irradiations

- Quality Control System of compounds labelled with radionuclides with short half life and high Specific Activity

- Environmental radioactivity measurements

- Nanotoxicological studies
ARRONAX Cyclotron (Nantes)  
deuterons energy range: 15-35 MeV  
Protons energy: up to 70 MeV

Other Cyclotrons in replacement of JRC one

LENNA  
Research Nuclear Reactor for QC or INAA

Radiochemistry Laboratory

LASA  
Physics and Chemistry Laboratory
Optimization study for the production of radiotracers and labelled compounds produced in No Carrier Added form and high $A_S$

$^{103}$Rh (d,2n) $^{103}$Pd NCA
prostate brachytherapy (SS or Ti seeds)

$^{89}$Y (p,n) $^{89}$Zr or $^{89}$Y (d,2n) $^{89}$Zr NCA
PET and radioimmunotherapy

$^{110}$Pd (d,2n) $^{111}$Ag NCA
silver nanospheres and metal chelates

$^{198}$Pt (d,2n) $^{199}$Au NCA
gold nanospheres and metal chelates

SET UP a Quality Control System on the $^{99m}$Tc production and on $^{100}$Mo recovery targets

Experimental determination of radionuclidic and radiochemical purity of recovered $^{100}$Mo targets in collaboration with Pavia Unit.
GELMAN SAMPLERS
SIMULATE HUMAN
RESPIRATORY SYSTEM
(Fractionation cut points at 1 ACFM)

Preimpactor ≥ 9.0
Stage 1 6.0 - 9.0
Stage 2 4.6 - 6.0
Stage 3 3.3 - 4.6
Stage 4 2.15 - 3.3
Stage 5 1.08 - 2.15
Stage 6 0.70 - 1.08
Stage 7 0.41 - 0.70
Backup Filter 0 - 0.41

Pharynx
Trachea & Primary Bronchi
Secondary Bronchi
Terminal Bronchi
Alveoli
Alveoli
Alveoli
50-years of key contributions of the Triga Mark II of Pavia to life science research activities at JRC-Ispra (and LASA) by nuclear/ radiochemical techniques

1966-1969 Developing neutron activation analysis methodologies
- Development of inorganic ion exchangers (hydrated antimony pentoxide (HAP), hydrated manganese dioxide (HMD), acid aluminum oxide (AAO), tin dioxide (TDO), cupric sulphide (CUS) worldwide used for the removal of strong interfering radionuclides in neutron activation analysis (\(^{24}\text{Na}, {^{52}\text{Mn}, {^{32}\text{P, }{^{64}\text{Cu}}}\) (Carlo Erba patent)
- Development of Radiochemical Separation Neutron Activation Analysis of nuclear materials (terphenyls, zircaloy, ultrapure aluminium)

1970-1980 Developing nuclear methods for biological sciences
Nuclear and radiochemical techniques in biochemical toxicology research project:
- development of radiochemical separation schema for multielement neutron activation analysis for environmental, toxicological and biomedical research
- research on isolated nucleic acids and proteins (determination of molecular weight of DNA microsamples and strand breaks induced by radiation; research on metalloenzymes)
- metallobiochemistry of trace metal pollution research (speciation and metabolic pathways of trace metals in laboratory animals under long term-low dose exposure)

1981-1990 Role of trace elements in human life
Trace metals and energy production project (environmental/health impact of heavy metals from coal-fired power plants, municipal incinerators, long-lived radionuclides (\(^{237}\text{Np}, {^{99}\text{Tc}}\) from planned geological disposal of nuclear waste and from fertilizers and pesticides uses)
1991-2000  Watch on Trace Metal Exposure and Health Effects
EURO TERVHIT-Trace Element Reference Values in Human Tissues project (normal concentrations of trace elements in biological specimens (blood, serum, urine, hair, sperma) in EU inhabitants (trace element status of general population)

HAMBIHT-Hard Metal Biomonitoring In Human Tissues project (concentrations and metabolic pathways of hard metals (Co, W, Ta, Nb, Ti,) in tissues of lung diseased workers (occupational medicine research)

MERED- Metal- Related Diseases project: pathogenetic role of trace elements in human diseases (infertility, lung and brain diseases, chronic renal failure and hemodialysis, cardiomyopathy) (clinical and biomedical research)

2001- 2007  Biological role of trace elements by in vitro studies by alternative testing methods (cell cultures)
IMETOX-In vitro Metal TOXicology research project (uptake and intracellular distribution of metal compounds , in relation to their cytotoxicity, genotoxicity, carcinogenic potential, neurotoxicity, renal toxicity, by in vitro toxicity testing)

INATOX -In vitro NAnoTOXicology research project:
• radiolabelling of metal-based engineered nanoparticles and applications in nanotoxicity studies
  ( uptake, subcellular distribution, binding with intracellular components )
• development of Instrumental Neutron Activation Analysis for the determination of metal constituents of nanoparticles in consumer and biological samples (cosmetics, tattoo inks, cell cultures) using short-lived radioisotopes (fast rabbit)
George Hevesy Medal Award

1976  Francesco Girardi  2002  Enrico Sabbioni

From development … … to application

With the fundamental contribution of the Triga Mark II of the LENA!
Health Physics Courses

Each year visit of LENA and Triga Marc II Nuclear Reactor by the Students of the Health Physics Courses

RADIOLAB Project

Project devoted to High School Students for the dissemination of Scientific Culture.
Each year the students of some schools involved in the project come to visit LENA and of the Triga Marc II Nuclear Reactor
LENA LAB. and TRIGA MARC II NUCLEAR REACTOR

A Laboratory that presents characteristics that are:

Fundamental and essential for the Research in Nuclear Sciences and their applications;

Fundamental for training new generations;

It could be very well inserted in First Line for a collaboration with INCS especially for the education and training objectives

We wish them another 50 years of successful activities
## Table 1

<table>
<thead>
<tr>
<th>No.</th>
<th>1968–1982 citations*</th>
<th>Bibliographic data</th>
</tr>
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*Citations/year data are in parentheses.
Some relevant applications of raditracers and labelled compounds produced in *No Carrier Added* form and with high $A_S$

- **1. metallo-biochemistry**
  - Behaviour of different chemical forms of trace elements
  - Speciation studies
  - Synergistic effects
- **2. cellular biology**
  - Environmental toxicology at low doses
  - Speciation studies
  - Dose-effect relationships
- **Environmental Toxicology at Low Doses**
  - Low Level and Long Term Exposure (LLE) to ultra-trace elements
- **1. Nuclear Medicine**
  - Radiodiagnostics (SPECT, PET)
  - Systemic radionuclide tumour radiotherapy
- **2. Metabolic Radiotherapy**
  - Radioimmunotherapy of tumours
Production, radiochemical separations and quality control systems for compounds produced in No Carrier Added (n.c.a.) form

Main Steps

- Nuclear Reaction Studies
  - Thin-target excitation functions
  - Thick-target yields
  - Irradiation conditions optimisation

- N.C.A. radiochemical processing
  - Ultra-high purity chemicals
  - Ultra-high purity targets
  - Ultra-high purity equipments

- Quality Control
  - Radionuclidic Purity
  - Radiochemical Purity
  - Specific Activity

- Chemical Purity

N.C.A. Labelled compound
Occupazionale/Lavoratori

Preparazione di nanoparticelle su vasta scala (migliaia di tonellate dinanotubi di carbonio, di nanoparticelle di argento e di biossido di titanio…)

Ambientale/Popolazione generale, consumatori

Emissione da marmitte catalitiche (Pt on Al203, CeO$_2$…), cosmetici (TiO$_2$ ZnO), industrie alimentari, (SiO$_2$, Ag, TiO$_2$…), disinquinamento (Fe)
Tecniche Nucleari e Radioanalitiche in Nanotossicologia

Alla nanotossicologia si riconosce oggi un ruolo centrale di riferimento scientifico per la prevenzione dei rischi e per lo sviluppo responsabile delle nanotecnologie in ragione delle attese ricadute industriali e socio-economiche. Questa disciplina deve affrontare la comprensione dei meccanismi di tossicità che stanno alla base di alcuni peculiari responsi tossici indotti dall’esposizione a NPs. L’utilizzo di tecniche nucleari e radioanalitiche nella ricerca nanotossicologia permette di superare particolari difficoltà analitiche sperimentali.

**Tecnica con radiotraccianti**: permette la radiomarcatura di NPs metalliche mediante:
- radioattivazione diretta delle NPs metalliche con neutroni in reattori nucleari o acceleratori di particelle;
- sintesi radiochimica di NPs partendo da precursori ionici radioattivi di sali inorganici. Le NPs radiomarcate mantengono le caratteristiche chimico-fisiche, (distribuzione dimensionale e potenziale Z) delle NPs “fredde”.

**Analisi per radioattivazione neutronica (strumentale, INAA; con separazioni radiochimiche, RNAA)**: permette la determinazione di un gran numero di elementi con elevata sensibilità, riproducibilità ed eccellente accuratezza.

**Spettrometria gamma ad alta risoluzione**, mediante rivelatori HPGe: permette l’analisi qualitativa e quantitativa dei radionuclidi indotti.
Caratterizzazione (purezza) chimica di NPs. Importante per evitare artefatti nell’interpretazione del risposto tossico indotto dall’esposizione dei sistemi biologici a NPs;

Dissoluzione di NPs in fluidi biologici e mezzi di coltura: Fattore chiave per ascrivere gli effetti biologici osservati in vivo ed in vitro, alle NPs come tali e/o ai prodotti di dissoluzione generati (specie ioniche);

Accumulo in plantule di ferro zerovalente nanoscopico, da utilizzarsi nel trattamento di diverse forme di inquinamento del suolo. La radiomarcatura con $^{59}\text{Fe}$ delle particelle di Fe ha permesso la misura quantitativa del Fe accumulato ex novo nelle plantule rispetto al Fe normalmente già presente, e la sua distribuzione tra foglie, germoglio e radici.

Passaggio in vivo di AgNPs attraverso la barriera emato-testicolare (BTB): L’INAA è stata applicata per studiare il passaggio in vivo di AgNPs attraverso la BTB del coniglio, determinando l’Ag nello sperma raccolto a diversi tempi dopo la somministrazione intravenosa.

Studio della penetrazione delle nanoparticelle negli alimenti

Studio degli inchiostri per tatuaggi: possibile sorgente di esposizione a nichel
Tecniche Nucleari e Radioanalitiche in Nanotossicologia

PROGETTO RAINTOX

NANOCARATTERIZZAZIONE CHIMICA NPs
- Purezza Chimica
- Titolo delle sospensioni di esposizione
- Stabilità delle radiomarcature

IMPATTO AMBIENTALE e SANITARIO
- Dissoluzione/biodisponibilità nei fluidi biologici/mezzi di coltura
- Biocinetiche (ADME) in vegetali, organismi acquatici, colture cellulari

SUPPORTO ALLE INDUSTRIE
- Incorporazione su materiali nanostrutturati
- Rilascio da materiali nanostrutturati

Caratterizzazione morfologica (dimensioni, forma, area superficiale)

Profili tossicologici (relazioni concentrazione-risposta)
- genotossicità/cancerogenesi
- immunotossicità
- tossicità riproduttiva/sviluppo

Richieste specifiche dei produttori/utilizzatori sul grado di sicurezza dei nanomateriali

Meccanismi di nanotossicità rilevanti all'analisi del rischio da esposizione a NPs
Prospettive di lavoro

-Figura dell’Esperto Qualificato di Radioprotezione per la Protezione dalle Radiazioni Ionizzanti.
Iscrizione nell’elenco Nominativo degli EQ di I, II, III grado possibilità di esercitare la libera professione.

Richiede:
aver seguito il percorso di Fisica Sanitaria un tirocinio di 120 giorni per ciascuno dei gradi e il superamento di un esame presso il Ministero.

-Dottorato di Ricerca

-Scuola di Specializzazione in Fisica Medica, ottenendo il titolo di Fisico Specialista, con caratteristiche, competenze e ruoli ben chiari e diversi da quelli dell’EQ.
La Scuola permette di non effettuare i tirocini per accedere all’esame di EQ.
Best Theratronics has been awarded a contract to construct a 70 MeV Cyclotron at its Kanata plant for the INFN National Laboratory of Legnaro, Italy – on MEDICALPHYSICSWEB (19 Oct. 2010)

Some proton-cyclotron isotope production
(*enriched target)
Possibility of twin target irradiation

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