Nucleonica “Lab”: An Overview of the Nuclear Science Portal with “hands-on” exercises

Dr. Joseph Magill, Nucleonica GmbH, Karlsruhe
Case Study: Characterisation of an Irradiated fuel sample (UOX) from a PWR

A: Calculate the activities of actinide and fission products in the sample (webKORIGEN)

B: Create a nuclide mixture of the 10 nuclides with highest activities (Nuclide Mixtures)

C: Estimate the gamma dose rate from this material – both unshielded and shielded (Dosimetry & Shielding)

D: Generate the gamma spectrum for a HPGe detector (Gamma Spectrum Generator) and identify the main lines.

E: Generate a transport report to determine which type of packaging is required to transport this sample (e-Ship)

F: Use the Decay Engine++ to see how the activity of the sample decreases over 5000 y.
Nucleonica: Web-based Software Tools for Simulation and Analysis

- Nuclear Data Resources in Nucleonica
- Nuclear Science Applications & Tools
  - Decay Engine
  - Dosimetry & Shielding
  - Virtual Cloud Chamber
  - Gamma Spectrum Generator
  - webKORIGEN
  - e-Ship
- Education & Training with Nucleonica
  - Nucleonica Mobile
  - Karlsruhe Nuclide Chart
- Knowledge Management with Nucleonica
These lectures are available online:

Previous Training Courses

Sept. 2013 Ispra, Italy


This year, the Ispra summer school is organised around several technical sessions and will feature five visits to JRC-ISPRA’s laboratories that are involved in decommissioning and nuclear and radioactive waste management. During these visits, participants will be invited to assist in some real measurements. The Nucleonica training sessions will form one such “laboratory” where participants can learn how to use Nucleonica applications effectively in this area. During the course of the week, four 1.5 h Nucleonica “lab” sessions will be held each afternoon.

Links to the presentations:
- Nucleonica Overview (J. Magill)
- Case Study: Characterisation of an irradiated fuel sample (UGX) from a PWR
  A: Calculate the activities of actinide and fission products in the sample (webKORIGEN)
  B: Create a nuclide mixture of the 10 nuclides with highest activities (Nuclide Mixtures)
  C: Estimate the gamma dose rate from this material – both unsheilded and shielded (Dosimetry & Shielding)
  D: Generate the gamma spectrum for a HPGe detector (Gamma Spectrum Generator) and identify the main lines.
  E: Generate a transport report to determine which type of packaging is required to transport this sample (e-Ship)
- Nucleonica Tips & Tricks (J. Magill)
- Nucleonica brochure [Link]
How can Nucleonica help you?

• Nucleonica provides you with user friendly access to the latest reference data from internationally evaluated nuclear data.

• A unique feature is the wide range of validated web-based nuclear science applications for decay calculations, dosimetry & shielding, gamma spectrometry, etc.

• In addition Nucleonica offers a range of introductory and advanced training courses in various areas of nuclear science.
Nucleonica is already being used by thousands of scientists and students worldwide in over 92 countries. Due to its advanced IT features, user friendly and intuitive environment, the platform has recently been endorsed by the Sustainable Nuclear Energy Technology Platform (www.snetp.eu):

“Nucleonica plays … an important role in making nuclear education more attractive and in building nuclear knowledge for a new generation of engineers and scientists”
Nucleonica Architecture & Logical Structure…

Applications

Web page

Wiki
(explicit AND implicit knowledge)

Forum, Blog
News, Calendar

Databases
(nuclear data)

The NUCLEONICA Structure
Which browser?

Nucleonica supports mainly Chrome, Firefox, and IE9, and Safari.
Main Nucleonica database JEFF3.1 contains decay data on 3852 nuclide.
Nuclear Data Resources in Nucleonica:

Nuclide Datasheets++

User friendly access to internationally evaluated nuclear data with Nucleonica’s Nuclide Datasheets++

Nuclide Datasheets++ is an innovative, user-friendly web-based application for displaying nuclear decay data from internationally evaluated data libraries such as JEFF-3.1, ENDF/B-VIII.1, etc. Through the use of filters, different types of spectral data (gamma, alpha, beta, etc.) from different sources can be compared.

It is aimed at professionals for fast lookup of relevant nuclear data. Nuclide Datasheets++ is particularly suitable for education and training of young scientists, engineers and technicians in the nuclear domain.

Datasheets++ is ideal for physicists, chemists, and technical experts from the nuclear industry, nuclear research organizations, universities, regulatory authorities and nuclear medicine institutes. It can be used in the fields of radiation protection, health physics, radiochemistry, nuclear waste characterization, decommissioning, nuclear security, nuclear forensics, nuclear medicine, etc.

Register now for free access to test the Datasheets++

Further information:
- More Information on Nucleonica
- Nucleonica brochure
- Nuclide Datasheets++ wiki page
- Nucleonica Blog

Contact us at info@nucleonica.com
Radioactive Decay Calculations with Nucleonica’s Decay Engine++

Nucleonica's Decay Engine++ is an innovative user-friendly web-based application for investigating the radioactive decay of nuclides and nuclide mixtures. It is based on the exact mathematical solution to the Bateman equations.

It is suitable for professionals for everyday calculations and for testing, validating and verifying complex computer models. The Decay Engine++ is particularly suitable for education and training of young scientists, engineers and technicians in the nuclear domain.

Decay Engine++ is ideal for physicists, chemists, and technical experts from the nuclear industry, nuclear research organizations, universities, regulatory authorities and nuclear medicine institutes. It can be used in the fields of radiation protection, health physics, radiochemistry, nuclear waste characterization, decommissioning, nuclear security, nuclear forensics, nuclear medicine, etc.

Register now for Free access to test the Decay Engine++

Further information:
- More information on Nucleonica
- Nucleonica brochure
- Decay Engine++ wiki page
- Nucleonica Blog

Contact us at info@nucleonica.com
Radiation dosimetry and shielding calculations
with Nucleonica’s Dosimetry & Shielding++

Nucleonica’s Dosimetry & Shielding++
is an innovative, user-friendly web-based application for investigating the
gamma dose rates from radioactive nuclides and nuclide mixtures based
on the point source kernel method. More than 1,300 gamma and X-ray
emitting nuclides with 53,000 gamma and X-rays are available in the
Nucleonica database, together with data for ten different shield materials
and their associated buildup factors.

It is suitable for professionals for everyday calculations and is suitable
for education and training of young scientists, engineers and technicians
in the nuclear domain.

Dosimetry & Shielding++ is ideal for physicists, chemists, and technical
experts from the nuclear industry, nuclear research organizations,
universities, regulatory authorities and nuclear medicine institutes. It can be
used in the fields of radiation protection, health physics, radiochemistry,
nuclear waste characterization, decommissioning, nuclear security, nuclear forensics,
nuclear medicine, etc.

Register now for Free access to test the Dosimetry & Shielding++

Further information:
- More information on Nucleonica
- Nucleonica brochure
low energy photons (energy 100 keV) are attenuated with a thick (15 cm) water shield. This combination of low energies and thick shields give rise to multiple scattering of the radiation.

Electron-positron pairs are created using 10 MeV photons on lead. By “switching off” energy loss mechanisms, the charged particles are seen to spiral in the applied magnetic field.

The red particles (3 MeV positrons) are blocked by a lead shield (green). When the positrons collide with the shield, they combine with electrons (blue) to create gamma radiation (white). Only a few gamma photons pass through the shield material.
Some animations made with the VCC

- betas in air.mp4
- Electrons-positrons_inBfield_VR.mp4
Validated Nuclear Science Applications & Tools

Gamma Spectrum Generator

$\gamma$-spectrum simulated for $^{60}$Co 100 kBq source and NaI ($3'' \times 3''$) detector:

$\gamma$-spectrum simulated for $^{152}$Eu 100 kBq source and HPGe detector.

Fukushima: Gamma spectrum of contamination at the Daiichi plant. Contamination is almost entirely to cesium-137 and cesium-134.
Validated Nuclear Science Applications & Tools

webKORIGEN

fuel depletion calculations & neutron activation

webKORIGEN was developed from the Oak Ridge Isotope Generation and Depletion code ORIGEN. Starting with a given initial reactor fuel or a single target nuclide, it calculates the time evolution of nuclide densities changing due to decays and neutron-induced reactions, and determines derived nuclear properties such as masses, radioactivities, heat releases, radiotoxics, emission of radiation, etc.

Display results for nuclides/elements dominant at 6 y decay

Nuclides during 6 y decay of 26 tHM PWR UOX 55 MWd/kg
Validated Nuclear Science Applications & Tools

e-Ship:
package classification for radioactive transports

| Nucleides | Activity (Bq) | Emitted Energy (MeV) | beta (MeV) | alpha (MeV) | gamma (MeV) | 89 Am | 90 Sr | 91 Zr | 92 Nb | 93 Mo | 94 Tc | 95 Te | 96 Ru | 97 Ag | 98 Zr | 99 Mo | 100 Ru |
|------------|---------------|----------------------|------------|-------------|--------------|--------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Be-7       | 3.116±4       | 2.07±1               | 1.07±1     | 1.07±1      | 1.07±1       | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 | 1.07±1 |
| Ca-40      | 1.166±3       | 1.166±3              | 1.166±3    | 1.166±3     | 1.166±3      | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 | 1.166±3 |
| Co-57      | 1.00±3        | 1.00±3               | 1.00±3     | 1.00±3      | 1.00±3       | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 | 1.00±3 |
| Cr-51      | 1.60±2        | 1.60±2               | 1.60±2     | 1.60±2      | 1.60±2       | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 | 1.60±2 |
| Cs-137     | 4.78±5        | 4.78±5               | 4.78±5     | 4.78±5      | 4.78±5       | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 | 4.78±5 |
| Mn-54      | 7.88±5        | 7.88±5               | 7.88±5     | 7.88±5      | 7.88±5       | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 | 7.88±5 |
| Mo-99      | 1.00±4        | 1.00±4               | 1.00±4     | 1.00±4      | 1.00±4       | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 | 1.00±4 |
| Tc-99m     | 1.14±7        | 1.14±7               | 1.14±7     | 1.14±7      | 1.14±7       | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 | 1.14±7 |
| Te-105     | 1.68±3        | 1.68±3               | 1.68±3     | 1.68±3      | 1.68±3       | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 | 1.68±3 |
| Ru-106     | 1.00±5        | 1.00±5               | 1.00±5     | 1.00±5      | 1.00±5       | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 | 1.00±5 |

Activity reported: 2013-02-20 00:00
Education & Training with Nucleonica

Nucleonica for Smartphones: and Tablet PCs: M-Learning
Standalone version of Nucleonica

• specially developed for mobile labs and field workers or for use on Notebooks/PCs where an internet connection cannot be guaranteed

• faster than internet version

• allows for more particles in Monte Carlo calculations than the internet version

• allows Monte Carlo dosimetry and shielding calculations (provided you have an MCNP license!)
Education & Training with Nucleonica

Karlsruhe Nuclide Chart

- Fold-out Chart
- Wall-Chart
- Auditorium Chart
- Nuclide Carpet

Nuclide „carpet“
1m x 6.5m
Unique mosaic tiles for the Institute for Transuranium Elements, Karlsruhe

15m x 7m
Knowledge Management with Nucleonica

In this slide, the Nucleonica web portal is considered from a knowledge management perspective. Nonaka and Takeuchi have proposed the “knowledge spiral” (shown) in which there are four modes of knowledge conversion: socialization, externalization, combination, and internalization (SECI model).

Socialisation: conversion of tacit knowledge to tacit knowledge

- **Socialisation**: conversion of tacit knowledge to tacit knowledge, e.g., an apprentice who works with a tutor and learns from observing and imitating the tutor's actions.

Externalisation: conversion of tacit to explicit knowledge

- **Externalization**: conversion of tacit to explicit knowledge. For example, conversion of tacit knowledge to explicit knowledge through a process like watching a tutor perform a task and noting their actions.

Combination: systemizing explicit knowledge

- **Combination**: systemizing explicit knowledge. This is the process of taking two or more explicit pieces of knowledge and combining them into a new, more comprehensive piece of knowledge or system.

Internalisation: conversion from explicit to tacit knowledge

- **Internalization**: conversion from explicit to tacit, triggered through “Learning by Doing”. It involves the process of converting explicit knowledge into tacit wisdom through experience and development.
Nucleonica: Web-based Software Tools for Simulation and Analysis

- Nuclear Data Resources in Nucleonica
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  - Nucleonica Mobile
  - Karlsruhe Nuclide Chart
- Knowledge Management with Nucleonica
The Nucleonica Wiki...

Welcome to the Nucleonica Wiki

The Nucleonica wiki is an open knowledge resource for the nuclear sciences. In contrast to Wikipedia, which can be edited by anyone, the Nucleonica wiki articles are written by experts and practitioners in the field and cannot be edited. The Nucleonica wiki is devoted specifically to nuclear science. Wiki technology is best suited for this purpose since it allows addition of content at any time from any location.

Another aim the Nucleonica wiki is to provide the technical documentation in support of the Nucleonica nuclear science portal www.nucleonica.com. Whereas the Nucleonica portal requires registration to access its applications and data pages, the wiki is an "open" knowledge resource.

How this Wiki is organized

The Sidebar panel to the left of this window provides quick links to a number of important pages in this wiki. The links are grouped under:

- navigation
- support
- tools
- search
- toolbox

The wiki contains a collection of articles. Each article has a title (by which it is referenced) and optionally one or more categories. Under Special / Categories you can see all current existing categories. Thus, it is possible to navigate through all documents by the category and subcategory tree feature of the Wiki.

Of special importance is the Help link. This page contains a collection of articles and is used specifically to support the Nucleonica applications and nuclear data pages. For users logged into the Nucleonica Portal, the context sensitive Help in Nucleonica will lead the user to the corresponding page in the wiki.

Another important item is the Search box. By entering a character string here, the entire wiki is searched. The search results are structured in a coherent way. Enter a piece of text into the Search box (e.g. "Came") and try out this powerful search tool.

What is Nucleonica?

Nucleonica Newsletter
Start of the Name Approval Process for the Elements of Atomic Number 114 and 116

February 19th, 2012
by Joseph Magill

A joint IUPAC/IUPAP Working Party (JWP) has confirmed the discovery of the elements with atomic numbers 114 and 116. In accord with IUPAC procedures, the discoverers proposed names as follows: flerovium and symbol, Fl, for the element with Z = 114 and livermorium with the symbol Lv for the element with Z = 116. The Inorganic Chemistry Division recommended these proposals for acceptance.


Comments should be sent to Prof. John Corish at jcorish@cd.ie.

Extract from the new 8th Edition (2012) of the Karlsruhe Nuclide Chart showing the isotopes of flerovium and livermorium.
### The Nucleonica Forum...

### Forum: General

If this is your first visit, be sure to check out the [FAQ](#) by clicking the link above. You may have to [register](#) before you can post; click the register link above to proceed. To start viewing messages, select the forum that you want to visit from the selection below.

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<tr>
<th>Title / Thread Starter</th>
<th>Replies / Views</th>
<th>Last Post By</th>
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<tr>
<td>Emergency preparedness analysis for decision-making</td>
<td>0/21</td>
<td>Jeremy Muswama 13-04-12 13:02</td>
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<td>Core Inventory calculations</td>
<td>1/20</td>
<td>HotCel 12-04-12 18:19</td>
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<td>Functionality of the &quot;Gamma Library&quot;</td>
<td>4/60</td>
<td>Jeremy Muswama 12-04-12 17:52</td>
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<tr>
<td>Being notified for a new thread in the forum</td>
<td>4/314</td>
<td>Spectro 15-03-12 10:59</td>
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<td>Reference book or paper about cross section for neutron induced reactions</td>
<td>1/227</td>
<td>jmagill 09-02-12 07:44</td>
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<tr>
<td>Free users and WESPA</td>
<td>1/243</td>
<td>jmagill 30-01-12 14:49</td>
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<td>NuTRoNS-2 Monte Carlo, Monaco</td>
<td>10/2,047</td>
<td>zaynep_yarar 17-11-11 22:09</td>
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<td>Fission products from spontaneous fission</td>
<td>1/246</td>
<td>FAQ 09-11-11 07:17</td>
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<td>webKORIGEN output in EXCEL format</td>
<td>1/599</td>
<td>HotCel 25-09-11 13:16</td>
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<td>Why does HEU produce fewer counts than pure U235 in the Gamma Spectrum Generator?</td>
<td>1/464</td>
<td>HotCel 22-09-11 12:02</td>
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</tbody>
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Training courses...
Course Folders...
## Nucleonica: Basic, Core and Advanced Applications

Training course with "Hands on" exercises. To be held at the IRMM, IRCCGeel, Belgium

### 3 Oct. – Basic & Core Nucleonica Applications

<table>
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<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30</td>
<td>Training Course / Nucleonica Overview</td>
<td>J. Magill</td>
<td>1</td>
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<tr>
<td>9:30</td>
<td>Mass Activity Converter</td>
<td>J. Magill</td>
<td>2a</td>
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<tr>
<td>10:00</td>
<td>Nuclide Mixtures</td>
<td>R. Droher</td>
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<tr>
<td>10:30</td>
<td>Coffee</td>
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<td>10:50</td>
<td>Participants introduction</td>
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<td>11:15</td>
<td>Nuclear Data: from the Karlsruhe Nuclide Chartto</td>
<td>Nucleonica, Z. Seti (ITU)</td>
<td>3</td>
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<tr>
<td>12:30</td>
<td>Break</td>
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<td>13:30</td>
<td>Decay Engine</td>
<td>J. Magill</td>
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<td>15:00</td>
<td>Coffee</td>
<td></td>
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<td>15:20</td>
<td>Virtual Cloud Chamber</td>
<td>J. Magill</td>
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<td>16:00</td>
<td>Gamma Dosimetry &amp; Shielding (D&amp;S)</td>
<td>J. Magill</td>
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### 4. Oct. – Advanced Nucleonica Applications

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<td>E-Ship: Radiological Transport Assistant</td>
<td>Y. Donjoux  (CERN)</td>
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<td>10:00</td>
<td>Coffee</td>
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<td>10:20</td>
<td>webKORIGEN: nuclide depletion calculations</td>
<td>J. Zigrail  (TU)</td>
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<tr>
<td>11:20</td>
<td>Gamma Spectrum Generator</td>
<td>J. Zigrail</td>
<td>9a</td>
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<tr>
<td>12:30</td>
<td>Break</td>
<td></td>
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<tr>
<td>13:30</td>
<td>Gamma Libraries</td>
<td>J. Zigrail</td>
<td>9b</td>
</tr>
<tr>
<td>14:30</td>
<td>Wiki, Forum, Blog, Glossary, Knowledge Objects</td>
<td>Z. Soti</td>
<td>10</td>
</tr>
<tr>
<td>15:00</td>
<td>Coffee</td>
<td></td>
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<tr>
<td>16:00</td>
<td>Nucleonica Tips &amp; Tricks</td>
<td>J. Magill</td>
<td></td>
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<tr>
<td>16:15</td>
<td>Feedback/Questionnaire, Certificate</td>
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<tr>
<td>16:30</td>
<td>End of Training Course</td>
<td></td>
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Supplementary material (additional exercises)
Forthcoming training courses…

Oct. 2013: Nucleonica - Basic, Core and Advanced Applications
*To be held at the IRMM JRC Geel, Belgium*

Oct. 2013: Introduction to Nucleonica - Core Applications and Tools,
*to be held in CERN, Switzerland*

Nov. 2013: Nucleonica for New comers
*to be held at Insitute for Transuranium Elements, Karlsruhe*

Nov. 2013: Nucleonica for Nuclear Security
*to be held at the Federal Office for Radiation Protection (BfS), Berlin*

April 2014: Introduction to Nucleonica - Core Applications and Tools,
*to be held in KIT/FTU, Karlsruhe*

For more information see our webpage…

We can also arrange a dedicated Nucleonica training course for your organisation…

Contact us at
info@nucleonica.com
Thank You!