Management of Nuclear Knowledge: Applications of Nuclear Science

Claudio Tuniz

The Abdus Salam International Centre for Theoretical Physics (ICTP)
Trieste, Italy

Email: ctuniz@ictp.trieste.it

Nuclear science for sustainable development

- energy
- agriculture
- nutrition
- human health
- water resources
- climate change
- environment
- new materials
- industrial applications
- safety and security
Issues

- Nuclear Data
- Scientists and technologists for nuclear physics applications
- Standards, Quality, ...
- Access to facilities and instruments
- Access to information

Nuclear Data

- IAEA (International Nuclear Data Committee)
  - Data Base needs:
    - [work needed over the next decades (2000-2020) on the measurement, calculation and evaluation of improved nuclear data for emerging applications (IAEA, AGM, 2000); Meeting INDC 2002]
    - Nuclear Reaction Data Base for Accelerator Applications (e.g. Ion Beam Analysis - NRA, ...).
    - Nuclear Data for Actinides (e.g. Th-U fuel cycle, ADS)
      - Neutron cross sections
      - Fission yields
      - Decay data
    - Low-energy neutron data for light nuclei for controlled fusion studies
    - Database of Generalized Nuclear Constants for Activation Analysis
Nuclear Data (cont.)

IAEA (International Nuclear data Committee)

Data Base needs (cont.):

- Charged particle and neutron nuclear data for medical isotopes (diagnostic & therapeutic)
  - Excitation functions and thick target yields up to 100 MeV
- In radiation therapy, protons, $^4$He and heavy ions find increasing applications → several types of reaction cross section data are needed.

34,400 patients treated with ions (IAEA, 2002)

Nuclear Data (cont.)

IAEA (International Nuclear data Committee)

Data Base needs (cont.):

- Low-energy charged particle and neutron data for astrophysics
- Shielding of semiconductors for space applications
- Data Base for nuclear reactions used in thin layer activation for wear, corrosion and erosion measurements
- Single-event upsets in microelectronics
Nuclear Data (cont.)

- IAEA (International Nuclear Data Committee)
  - Dissemination and International Coordination
    - NEA
    - ICTP
    - ICRM

Nuclear Data (cont.)

- IAEA (International Nuclear Data Committee)
  - Training and Technology Transfer
    - Radiation shielding
    - Activation analysis
    - New fuel concepts
    - Accelerator-driven systems
    - Calculation methods for therapy and diagnosis
    - Astrophysics
    - Cosmogenic investigations (*see example*)
    - Nuclear security and safety
Rock exposure dating

AMS and $^{10}$Be, $^{26}$Al EXPOSURE-AGE DATING

Exposure-ages from Antarctica support a 'dynamic' behaviour of the East Antarctic Ice Sheet over the past 2 Ma.

Dating glacial cycles in Tasmania and New Zealand over the past 100 ka.

$6\ ^{10}$Be atoms /gram SiO$_2$/yr

$27\ ^{26}$Al atoms /gram SiO$_2$/yr
Nuclear security

Nuclear smuggling

Dirty Bombs

Nuclear forensics

Source: by Dr. Kelly, A.F.S., Testimony to US Senate

Other data bases

IAEA Global Network Isotopes in Precipitation
Quality/Standards

Need more IAEA involvement in some areas

Micro samples: precision
Access to facilities and instruments

- accelerators
  - ions
  - synchrotron radiation
- research reactors
- nuclear instrumentation
  - detectors

Scientists and technologists for nuclear physics applications

- To bridge the gap between the studies of basic and applied nuclear science. In particular, we need motivating new evaluators of nuclear data by providing them with the necessary background in theory, experimental methods and evaluation methodologies.
Promote application of advanced methodologies

- Neutron scattering
- Accelerator mass spectrometry
- Heavy ion microprobes
- Synchrotron radiation microscopes

Access to knowledge and information

- ICTP & UNESCO help cyber connectivity
  - eJournals Delivery Service
  - Monitor internet connectivity in institutions located in developing countries
  - Low cost wireless networks
Urgent needs

- Web-based access to nuclear data
  - Medicine
  - Accelerator analysis (elemental, isotopic, structure)
  - Environment
  - Agriculture
  - Nutrition
  (regional nuclear data centres)
Urgent needs (cont.)

- IAEA/ICTP Ph. D. and Post-doctoral training
  - to reverse the trend of diminishing expertise in a number of nuclear data disciplines (nuclear structure, cross sections, nuclear reaction analysis, particle and radiation detection)

Conclusion

- Development and dissemination of good quality nuclear data, education of nuclear experts, access to reliable nuclear facilities are critical to ensure credibility, safe operation and application of a wide range of nuclear methods that can contribute in a unique way to sustainable development.
- IAEA, ICTP, NEA, WNU, national nuclear institutions and others have a critical role.