Work Package 7:
Development of some course material examples (text book, e/b-learning module,…)

CEA - INSTN
French atomic energy commission and alternative energies
National Institute for Nuclear Science and Technology
France

ENETRAP-II

SCK·CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

instn

Ciemat

KIT
Karlsruher Institut für Technologie

MŰEGYETEM 1782

EUTERP workshop
Radiation Protection training in Europe
Cyprus
27th – 30th March 2011

Philippe MASSIOT, Paul LIVOLSI*
*Presented by

Objectives

WP 7: Development of some course material examples (text book, e-learning module,…)

- WP 7-1: Accompanying text for at least one module of the RPE or the RPO training scheme
- WP 7-2: Development of modern learning tools (e-learning…) for the RPE or RPO training

Tasks achieved

- We identified and collected the training resources provided by ENETRAP II members
  - The resources were transmitted by our partners in different languages….
- We did research on web sites according to criteria
  - Books in English or in French
  - Key words: “radiation protection” and “radioprotection”
  - Text books published after 1990
  - Text books related to all RP fields (medicine, regulation, industry…)
  - Content: theory, exercises, auto evaluation
- We established a table recording relevant text books (66)
  - Characteristics are:
    - Theory; exercises; auto evaluation; form; authors; date; editor; ISBN; target audience; utilization; key-words; field; origin
  - Then, we only selected text books corresponding to the ENETRAP training scheme: according to the table of content
- We chose the most relevant book

Results

66 entries

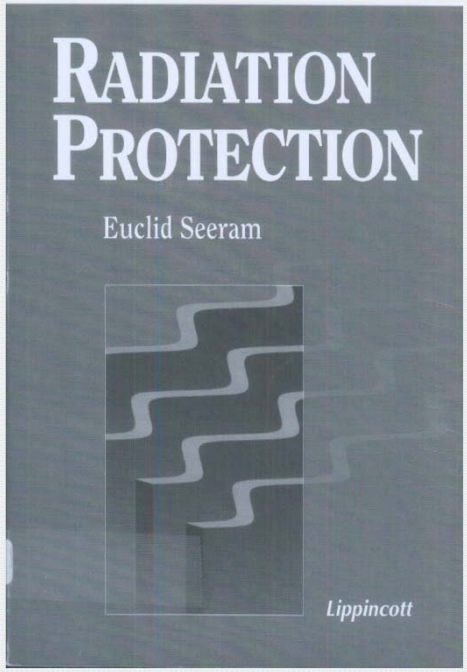
List for each country

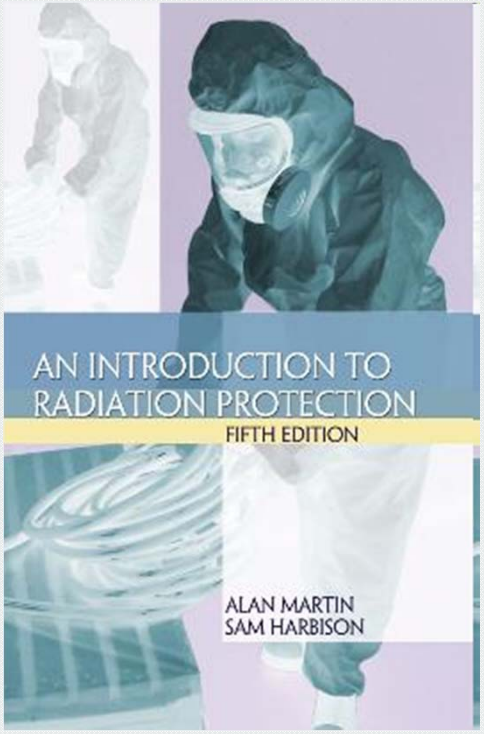
In english, published after 1990

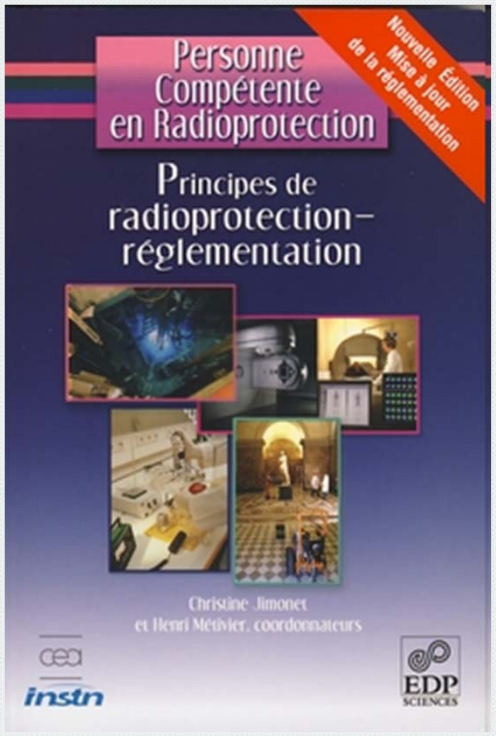
TITLE	Theory	Exercice	Auto Evaluation	Form	Authors	Date
Radiation Protection: A Guide for Scientists and Physicians	x			Text book	Jacob SHAPIRO	1990
Radiation Protection Off Site for Emergency Services in the Event of a Nuclear Accident	x			Text book	Health and Safety Executive (HSE)	1991
Anticarcinogenesis and Radiation Protection 2	x			Text book	Oddvar F. NYGAARD & Arthur C. UPTON	1991
Occupational Radiation Protection	x			Text book	British Nuclear Energy Society	1991
Advances in Radiation Protection	x			Text book	M. OBERHOFER	1991
Problems and Solutions in Radiation Protection		x	x	Text book	J.E. TURNER ; BOGARD ; HUNT & RHEA	1992
The Biological Basis of Radiation Protection Practice	x			Text book	William A. MILLS & Kenneth L. MOSSMAN	1992
CRC Handbook of Management of Radiation Protection Programs	x			Text book	Kenneth L. MILLER & W.A. WEIDNER	1992
Radiation Protection of Patients	x			Text book	R. WOOTTON	1993
Radiation Protection	x			Text book	William H. HALLENBECK	1994
Practical Radiation Protection and Applied Radiobiology	x			Text book	Steven B. DOWD	1994
Radiation Protection in the X-ray Department	x			Text book	Simone R. PLAUT	1994
Radiation Protection in Interventional Radiology	x			Text book	K. FAULKNER & D. TEUNEN	1995
Radiation Protection	x			Text book	Euclid SEERAM	1997

Text books identified before the 3rd Steering Committee

- We identified the three most relevant text books which could be used as reference for the creation of the WP7 text book
  - « *Radiation protection* » Euclid Seeram 1997
  - « *An introduction to radiation protection* » Martin and Harbison 2006
  - « *Principes de radioprotection-réglementation* » Jimonet and Métivier 2009







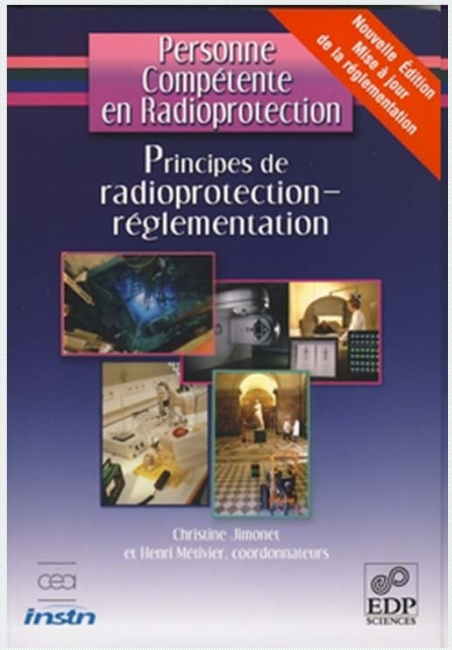
Selected book during the 3rd Steering Committee

- **ENETRAP II project members selected the following text book** during the 3rd Steering Committee at Grenoble **March, 30th , 2010**

« ***Principes de radioprotection-réglementation*** »

Jimonet and Métivier 2009

Published by EDP Sciences



- **All the essential characteristics are present:**
  - **Theory**
  - **Auto evaluations**
  - **Exercises with corrections**

And last but not least,

the pedagogical approach is interesting

Pedagogical aspects

- Pedagogical aspects elaborated in this type of text book

READER becomes ACTOR of his own training

The pedagogy developed in practical works during the training period, has been transposed and adapted in this type of training text book:

- the trainee has questions to answer
- with pictures, he has to find the answer and to fulfill tables

…

Questions

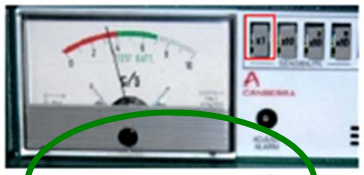
Q8 *Pour les sources de plutonium-238 et césium-134, Nous devons effectuer de nouvelles mesures en intercalant les écrans définis plus haut entre la source et la sonde, afin de faire une discrimination entre les particules chargées et les rayonnements électromagnétiques. Les photos ci-après illustrent les mesures réalisées sur les différentes sources à l'aide des sondes SA, SB, SBM et SX. Notez le résultat des mesures sous chacune des photos et reportez-les dans le tableau 3.6. Vous compléterez le tableau en calculant les rendements de détection dans les conditions de mesure.*

Source de plutonium-238 (mesure avec écran de papier)

Sonde SA

n_{bc} = $i.s^{-1}$

Sonde SB



n_{bc} = $i.s^{-1}$

Sonde SBM

n_{bc} = $i.s^{-1}$

Sonde SX

n_{bc} = $i.s^{-1}$

answers

Source de césium-134 (mesure avec écran 250 mg.cm^{-2})

Sonde SA

n_{bc} = $i.s^{-1}$

Sonde SB

n_{bc} = $i.s^{-1}$

Sonde SBM

n_{bc} = $i.s^{-1}$

Sonde SX

n_{bc} = $i.s^{-1}$

Tableau 3.6. Résultats des mesures réalisées sur les sources de plutonium-238 et césium-134.

Sonde	Source de ^{238}Pu (mesure avec écran de papier)	Source de ^{134}Cs (mesure avec écran 250 mg.cm^{-2})
SA		
SB		
SBM		
SX		

answers

Avant d'aller plus loin, faisons un point d'arrêt.

Q9 *Quels sont les rayonnements mesurés par les différentes sondes en présence des écrans ?*

Source de plutonium-238 ☐

- ☐ **Rayonnement alpha**
- ☐ **Rayonnement X**
- ☐ **Rayonnement bêta**

Source de césium-134 ☐

- ☐ **Rayonnement gamma**

Q10 *Compléter le tableau 3.7 de synthèse suivant pour les sources de plutonium-238 et césium-134.*

Tableau 3.7. Synthèse des mesures avec et sans écran pour les sources de plutonium-238 et césium-134.

Sources	Sonde SB			Sonde SBM			Sonde SA			Sonde SX		
	n ($i.s^{-1}$)	n_1 ($i.s^{-1}$)	n_2 ($i.s^{-1}$)	n ($i.s^{-1}$)	n_1 ($i.s^{-1}$)	n_2 ($i.s^{-1}$)	n ($i.s^{-1}$)	n_1 ($i.s^{-1}$)	n_2 ($i.s^{-1}$)	n ($i.s^{-1}$)	n_1 ($i.s^{-1}$)	n_2 ($i.s^{-1}$)
^{238}Pu												
^{134}Cs												

Avec : n : taux de comptage net sans écran, n_1 : taux de comptage net avec écran, n_2 : taux de comptage issu de la différence entre n et n_1.

Q11 *Reporter le résultat des tableaux 3.6 et 3.7 dans le tableau 3.8 ci-dessous. (On ne reportera que les taux de comptage nets et il est précisé entre parenthèses quel taux de comptage est à reporter).*

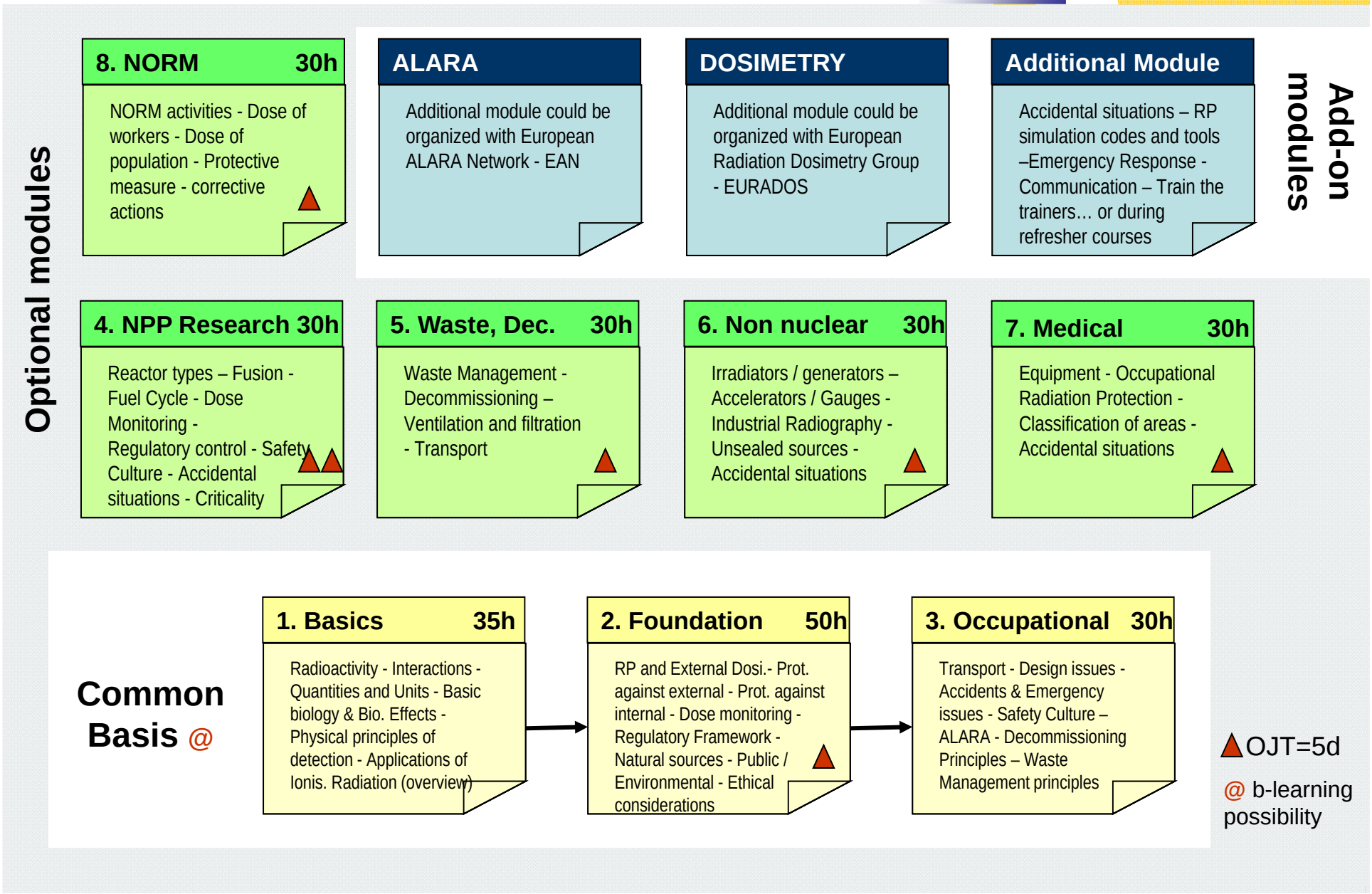
Text books to richmedia resources

- The methodology developed in text books could be transposed in a richmedia environment where pictures are improved with short videos.
- More detailed explanations could be given by trainers using synchronised PPT + video.

EVOLUTION FROM WRITTEN MODE TO AUDIO AND VIDEO

- In this kind of pedagogical resources, the scenarisation of tasks and activities proposed to the learners, required a lot of attention (cf. ENETRAP – WP5 and b-learning pilot session WP7).

ENETRAP II - RPE training scheme



Module 1 : Basics

Objectives

At the end of the course, the participant will be able:

- to understand the physical aspect of ionizing radiations, the biological bases of radiological protection,

- to describe and use the principal type of radiation detectors,

- to describe the different usages of ionizing radiations in the different domains and to know the type and range of used radioactive sources

Contents

- *1.1 Inaugural conference*
- *1.2. Radioactivity and nuclear physics*
- *1.3. Interaction of radiations with matter*
- *1.4 Dosimetry: quantities and units*
- *1.5. Biological effects of radiations*
- *1.6. Physical principles of detection*
- *1.7. Applications of ionizing radiation (overview)*

Module 2 : Fundamental aspects of the operational radiation protection

Objectives

At the end of the course, the participant will be able:

- to estimate the doserate to different distances from a radioactive point source (beta or photon),

- to determine the collective and individual protective means both for external and internal exposure,

- to assess individual dose for both external and internal exposure,

- to determine the features of a dose monitoring program (area and individual),

- to explain the process from ICRP, IAEA recommendations to national regulatory.

Contents

- *2.1. Radiation protection external dosimetry*
- *2.2. Protection against external exposure*
- *2.3.Protection against internal exposure*
- *2.4. Dose monitoring*
- *2. 5. Regulatory context*
- *2.6 Natural sources of ionizing radiation*
- *2.7 Public and environmental radiation protection*

Module 3: All other aspects common to the different domains of the radiation protection

Objectives

At the end of the course, the participant will be able:

- to know the regulatory process in order to complete transportation of radioactive material

- at his level, to mitigate the consequences of an accident or emergency issues,

- to integrate the ALARA principles and a safety culture in his practices,

- to know the principles of waste management and decommissioning

Contents

- 3.1. *Transport*
- 3.2. Design Issues
- 3.3. *Accidents and emergency Issues*
- 3.4. *Safety Culture*
- 3.5. *ALARA*
- 3.6. *Principles of decommissioning*
- 3.7 *Principles of waste management*

Selected book chapters

There are 11 chapters

- ***1** Radioactivity and nuclear physics / **Radioactivité***
- ***2** Interaction of radiations with matter / **Interactions rayonnements-matière***
- ***3** Radiation from generators and accelerators / **Rayonnements d'origine électrique : rayonnements X et accélérateurs***
- ***4** Biological effects of radiation / **Effets biologiques des rayonnements***
- ***5** Applications of ionising radiation (overview) / **Principales utilisations des sources de rayonnements ionisants et gestion des déchets générés***
- ***6** Physical principles of detection and dosimetry / **Détection des rayonnements ionisants***
- ***7** Protection against external exposure / **Protection contre l'exposition externe***
- ***8** Protection against internal exposure / **Protection contre l'exposition interne***
- ***9** Regulatory context / **Réglementation en radioprotection***
- ***10** Transport / **Transport de matières radioactives***
- ***11** Elements of mathematics / **Éléments de mathématiques***

Number of published modules

Question: How many modules of ENETRAP II training scheme are we going to publish? The first, the first two, or the first three ?

- **At the beginning of our analysis, we thought we would publish the first three modules. But it was too ambitious !**

Why don't we want to publish the first three modules? For 2 main reasons:

1. The selected book represents 2/3 of contents of the three modules. So, 2/3 would be a translation, the 1/3 left is not written yet. It will be too long to write this missing part and to finish before the end of the project.

2. For the first three modules, the cost of translation would be too high
   - The cost of translation for the first module is already about 10 000€ ! (The participation of the EC is only 5000 €)

In the future, the European authors are welcome to complete the missing parts.

Now, we consider publishing only the first module of ENETRAP II training scheme

Selected chapters

- **To write the objectives and the contents which corresponds to the module 1 “Basics” of ENETRAP training scheme,**

we have to translate 5 chapters of the selected book.

- ***1 Radioactivity and nuclear physics /*** *Radioactivité*
- ***2 Interaction of radiation with matter and dosimetry /*** *Interactions rayonnements-matière et dosimetrie*
- ***4 Biological effects of radiation /*** *Effets biologiques des rayonnements*
- ***5 Applications of ionising radiation*** *(overview) / Principales utilisations des sources de rayonnements ionisants*
- ***6 Physical principles of detection /*** *Détection des rayonnements ionisants*

But an analysis more precise is required to correlate these contents with the module 1 of the ENETRAP II training scheme

Correlation between the selected book and the ENETRAP training scheme for the module 1 1/3

Chapitre 1 : Radioactivité . ***1.2 Radioactivity and nuclear physics***

1.1. Généralités . . . . . .
1.1.1. Structure de la matière . . . . . .
1.1.2. Définitions et nomenclature . . . . . .
1.1.3. Isotopes et isobares . . . . . .
1.2. Stabilité et instabilité nucléaire . . . . . .
1.2.2. Noyaux radioactifs . . . . . .
1.3. Énergie et intensité d'émission d'un rayonnement . . . . . .
1.3.1. Énergie d'un rayonnement . . . . . .
1.3.2. Intensité d'émission d'un rayonnement . . . . . .
1.4. Modes de transformation du noyau . . . . . .
1.4.1. Désintégrations radioactives . . . . . .
1.2.1. Alpha decay
- Description - characteristics of the daughter nucleus. Decay scheme, Ground or excited state of the daughter nucleus. . Examples of decay schemes
1.2.2. Beta minus decay
- Description, characteristics of the daughter nucleus. Repartition of the available energy between the electron and the neutrino, energy spectrum of the electron, examples of decay schemes
1.2.3. Beta plus decay and electron capture
- Beta plus decay: Description, characteristics of the daughter nucleus. Repartition of the available energy between the positron and the neutrino. Energy spectrum of the positron, examples of decay scheme
- Electron capture: Description, characteristics of the daughter nucleus, examples of decay scheme , competition between beta plus decay and electron capture

---

1.4.2. Désexcitation gamma . . . . . .
1.2.5. Gamma emission and internal conversion
- Gamma emission: Description, examples of decay schemes
- internal conversion: description, consequences: X-ray or Auger emission

---

1.4.3. Radionucléides métastables . . . . . .
1.5. Grandeurs physiques et propriétés fondamentales . . . . . .
1.2.6. Evolution of the activity
- Exponential law: decay constant, half-life
- Decay chain with two isotopes. Special cases: T1 >> T2 and T1 << T2
- Decay chain with n isotopes.
- Activity law, relationship between mass and activity of a sample
1.5.1. Activité. . . . . .
1.5.2. Taux d'émission . . . . . .
1.5.3. Décroissance et période radioactive . . . . . .
1.5.4. Filiation radioactive . . . . . .
1.5.5. Relation masse - activité . . . . . .

1.5.6. Production de radionucléides artificiels : cas particulier de l'activation neutronique d'un produit stable . . . . . .
1.2.7. Producing radionuclides by nuclear reaction
- Cross section. Evaluation of the activity created in a thin target. Activity of the irradiated sample. The case of thick targets

---

- Production of artificial radioactive substances: examples (for medical or industrial purposes)

1.6. Faites le point . . . . . .
1.7. Annexe : Classification périodique de Mendeleiev . . . . . .

Chapitre 2 : Interactions rayonnements-matière . ***1.3 Interaction of radiations with matter***

2.1. Définition et classification des rayonnements ionisants . . . . . .
1.3.1. Directly ionising radiations
- Heavy charged particles (α, atomic particles): ionisation, excitation, stopping power, range.
- Light charged particles (electrons): ionisation, excitation, stopping power, range, brehmstrahlung effect.
- Linear transfer of energy
- Case of the positrons: annihilation phenomenon
2.2.1. Interaction des électrons avec la matière . . . . . .
2.2.2. Interaction des particules chargées lourdes avec la matière :cas des rayonnements alpha . . . . . .

2.3. Interaction des rayonnements électromagnétiques avec la matière . . . . . .
1.3.2. Non directly ionising radiations
- Electromagnetic radiation: Compton effect, photoelectric effect, pair creation. Repartition of energy angular distribution of secondary electron and diffused photon. Influence of the energy, relative importance of the three effects.
2.3.1. Effet photoélectrique . . . . . .
2.3.2. Effet Compton . . . . . .
2.3.3. Effet de production de paires . . . . . .
2.3.4. Domaine de prépondérance de chacun des effets . . . . . .
2.3.5. Loi d'atténuation des rayonnements électromagnétiques . . . . . .

2.4. Interaction des neutrons avec la matière . . . . . .
- Neutrons: ranges of energy and types of slowing-down and attenuation.
2.4.2. Absorption des neutrons . . . . . .
2.4.3. Diffusion des neutrons . . . . . .
2.4.4. Loi d'atténuation des neutrons . . . . . .

2.5. Notions de dose absorbée et de débit de dose absorbée . . . . . .
1.4 Dosimetry: quantities and units
1.4.1 Physical and dosimetric quantities
- Radiometric description of a radiation field: fluence and energetic fluence
- Dosimetric quantities: exposure, kerma, absorbed dose
- Relationships between radiometric and dosimetric quantities
- Calculation of absorbed dose in radiation equilibrium conditions
2.5.1. Dose absorbée . . . . . .
2.5.2. Débit de dose absorbée . . . . . .

2.6. Faites le point . . . . . .

Correlation between the selected book and the ENETRAP training scheme for the module 1 2/3

***Chapitre 4 : Effets biologiques des rayonnements* 1.5. Biological effects of radiations**

4.1. Effets moléculaires de l'interaction des rayonnements ionisants . . . . . .
1.5.1 Basic biology

4.2. Effets cellulaires, conséquences des effets moléculaires . . . . . .
1.5.2 Cellular and molecular effects, Tissue lesions

4.3. Effets déterministes . . . . . .
1.5.3 Deterministic effects
- Global irradiation, partial irradiation.

4.3.1. Effets d'une irradiation localisée . . . . . .
1.5.5 Exposure of the pregnant woman and exposure of the foetus
4.3.2. Effets d'une irradiation unique, globale et homogène de tout l'organisme . . . . . .
4.3.3. Caractéristiques des effets déterministes . . . . . .

4.4. Effets stochastiques. . . . . .
1.5.4 Stochastic effects
- Cancer induction, genetic effects
- Notion of detriment linear non-threshold dose response hypothesis
- Equivalent dose and effective dose, radiation weighting factor w_R and tissue weighting factor w_T, committed effective dose.

4.5. Synthèse . . . . . .
4.6. Évaluation du risque . . . . . .
1.4.2 Radiation protection dosimetry
- Need for protection quantities to assess the risk of exposure to ionizing radiations
-The new approach in ICRP 60, ICRU 51 and EC Directives: equivalent dose and effective dose,
radiation weighting factor w_R and tissue weighting factor w_T, committed effective dose.
1.5.6 Epidemiology

4.6.1. Effets cancérigènes . . . . . .
4.6.2. Effets génétiques . . . . . .
4.6.3. Quantification du risque total d'apparition des effets stochastiques
4.6.4. Grandeurs utilisées . . . . . .

4.7. Grands principes de la CIPR . . . . . .
4.8. Faites le point . . . . . .

***Chapitre 5 : Principales utilisations des sources de rayonnements ionisants et gestion des déchets générés* 1.7 Applications of ionising radiation (overview)** *no content in ENETRAP scheme*

5.1. Sources naturelles de rayonnements ionisants . . . . . .
5.1.1. Rayonnement cosmique. . . . . .
5.1.2. Rayonnement tellurique . . . . . .

5.2. Applications médicales des rayonnements ionisants . . . . . .
5.2.1. Diagnostic . . . . . .
5.2.2. Thérapie . . . . . .
5.2.3. Autres installations . . . . . .
5.3. Applications industrielles des rayonnements ionisants . . . . . .
5.3.1. Radiographie industrielle . . . . . .
5.3.2. Appareils de métrologie et d'analyse . . . . . .
5.3.3. Irradiateurs industriels. . . . . .
5.3.4. Utilisations diverses de radionucléides en sources scellées . . . . . .
5.3.5. Utilisations de radionucléides en sources non scellées dans l'industrie et la recherche
5.4. Industrie nucléaire civile . . . . . .
5.4.1. Combustible nucléaire . . . . . .
5.4.2. Extraction du minerai d'uranium. . . . . .
5.4.3. Fabrication du combustible nucléaire . . . . . .
5.4.4. Réacteur nucléaire, de type « Réacteur à Eau sous Pression » . . . .
5.4.5. Traitement du combustible nucléaire . . . . . .

5.5. Déchets radioactifs (d'après *Dossier thématique du CEA* 14) . . . . . .
5.5.1. Classification des déchets . . . . . .
5.5.2. Principes de sûreté et confinement . . . . . .
5.5.3. Stockage . . . . . .

Correlation between the selected book and the ENETRAP training scheme for the module 1 3/3

Chapitre 6 : Détection des rayonnements ionisants/ Physical principles of detection and dosimetry

1.6.1 General principles of detection

6.1. Détecteurs . . . . . .

6.1.1. Détecteurs à scintillations . . . . . .

1.6.3. Luminescence phenomenon.

- Scintillators (solids and liquids). Thermoluminescence. Photoluminescence. Optically Stimulated Luminescence dosimeter

---

6.1.2. Détecteurs à gaz . . . . . .

1.6.2. Ionisation of gas

- Ionisation chambers
- Impulsion detectors (proportional counters, GM counters),
- efficiency, dead-time
- detection threshold

6.1.3. Détecteurs semi-conducteurs . . . . . .

1.6.4. Ionisation into solids.

- Semi-conductors.

6.1.4. Émulsions photographiques . . . . . .

- Photographic dosimeters

6.1.5. Détecteurs radioluminescents . . . . . .

6.1.6. Autres types de détecteurs . . . . . .

1.6.5. Physical and chemical phenomenon.

. Traces detectors

6.2. L'électronique associée . . . . . .

1.6.6 Detector functioning

- Pulse functioning: amplificator, discriminator, mono and multi channel selector, ratemeter.
- Current functioning: amplificator, signal acquisition system.
- measurement chain

6.2.1. Régimes de fonctionnement . . . . . .

6.2.2. Unités électroniques . . . . . .

6.3. Principes de mesure . . . . . .

6.3.1. Dénombrement des rayonnements : mesure de la contamination .

- background and noise
- uncertainty of a measurement

6.3.2. Mesure en continu des rayonnements . . . . . .

6.3.3. Cumul du débit de dose : mesure de la dose absorbée . . . . . .

6.3.4. Mesure de la contamination atmosphérique . . . . . .

6.4. Faites le point . . . . . .

To conclude:

For the first module of ENETRAP II training scheme, with these five chapters:

- **90% of the content are already written and must be translated**
- **10% has to be written, including L.O.**

Remaining tasks

- We deal with the private publisher EDP Sciences, and we hope to sign the contract before June 2011
- We work on the structure of this new book according to

1. Having the 90% selected chapters translated into English according to the module 1 of ENETRAP II training scheme
2. Writing the 10% left part in English

- WP7-2
  - Development of "modern" learning tools (e/b-learning) for the RPE or RPO training

Possible pedagogical resources

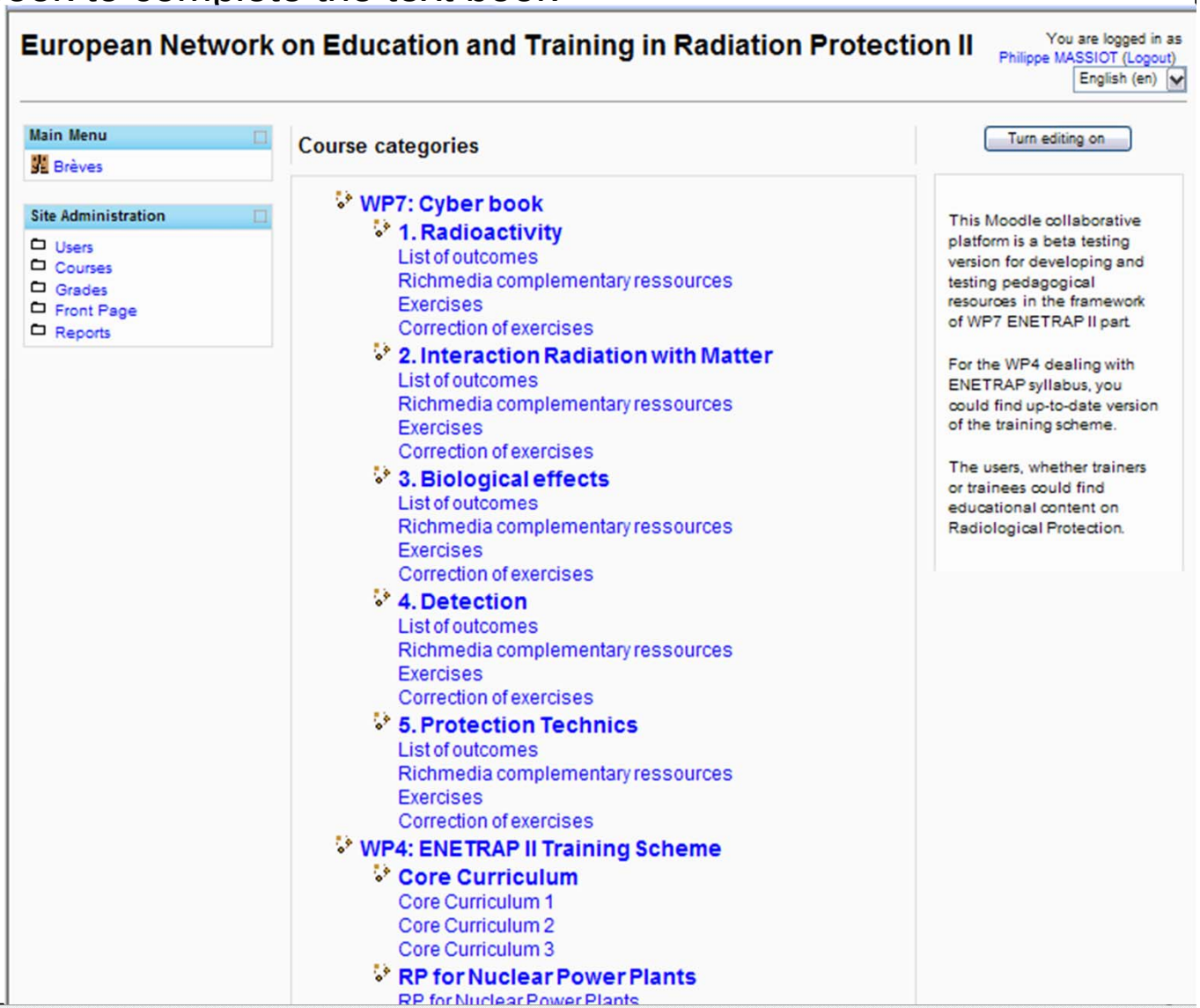
- Identification of different types of multimedia resources…
  - **Hypermedia** (use of LMS/CMS: Moodle platform)
  - **Cyber-book (including additional rich media content)**
  - **Powerpoint soundtrack (rapid learning, webcasting…)**
  - Simulation (look-like workshop, augmented reality…)
  - Serious game
  - **Forum (exchange in RP community)**
- …evaluation of these 6 types of resource materials…
  - Adapted to RP domains
  - Feasibility
  - Cost
  - Efficiency
- … according to the fact that RPE and RPO training targets adult professionals…
  - Can be reluctant to change their previous structure of knowledge (link with value system)
  - People attending the training have already knowledge on RP
  - People do not have the same previous knowledge (different level of expertise)
- … and RP content

The cyber book

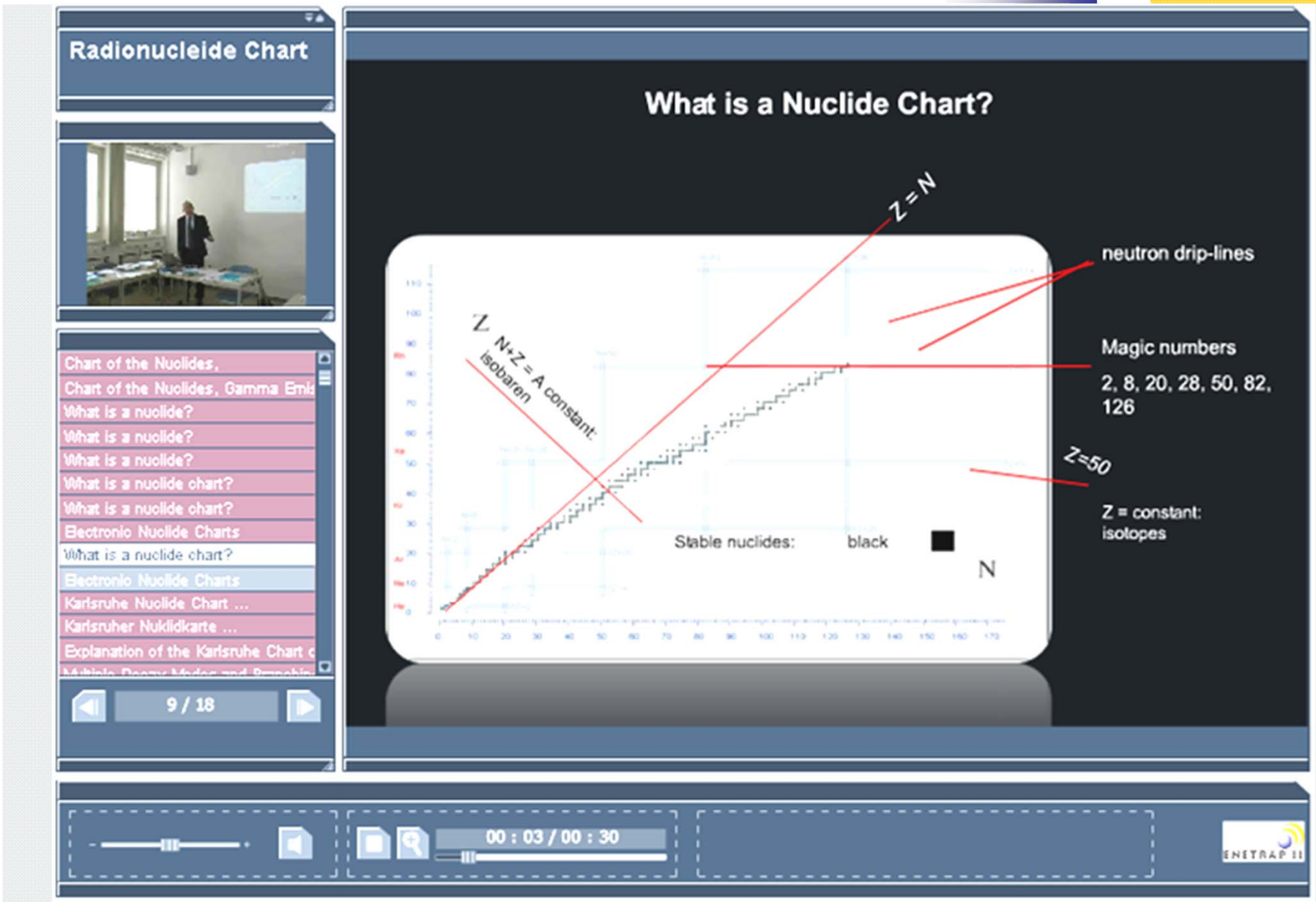
We are creating a cyber book to complete the text book

To have online

- courses
- Exercises and corrections
- Webcasted courses…
- Link to RP Forum



Synchronised PPT



PPT video webcasting: some remarks

- To be authorized (lecturer and participants)
  - Intellectual property
- Video and audio quality
  - Size of file (eg. HD)
  - Classroom lighting
  - Color of slides
  - Adapted microphone for lecturer and participants
- Ergonomic
  - Laser cursor not visible →capture of mouse cursor
  - Slide title
  - Which kind of lecturer are you? (static or dynamic)
  - Post synchronization is time consuming if problem occurs
- Only one shot: (backup with webcam)
- Easy to use but difficult to configure
  - Directly recorded by participants or students or video professional
- Cost
  - 3 500€ (min.) video camera, sound system and software
  - Webex DMS will be tested

Share experience: forum

www.rpcirkus.com

PCR Travaux Publics L'actualité du réseau, Divers	1	4	Mar 23 Mar - 6:13 SKATING
RaMiP Journées, Groupes de travail, S'investir dans le réseau RAdioprotection MIdi-Pyrénées	3	22	Mer 3 Mar - 21:33 KLOUG

UN PEU DE THÉORIE	SUJETS	MESSAGES	DERNIERS MESSAGES
Physique nucléaire et radioactivité Tout sur la physique du phénomène.	19	291	Hier à 18:48 thesweetgirl
Interaction rayonnement-matière Rayonnements secondaire, lésions moléculaires, descriptif de l'impact.	4	31	Hier à 15:45 Radisivert
Calcul et dimensionnement de protections biologiques Calcul d'épaisseur, pertinence des matériaux, épaisseur de plomb.	3	56	Lun 15 Fév - 18:30 KLOUG
Code de calcul et transport de particules Amateur de Panthère, MCNP, Tripoli, Mercurad, Fluka, Microshield, j'en passe et des meilleurs, défoulez vous, cette rubrique est pour vous !	3	12	Hier à 9:59 Nico27027
Effets biologiques des rayonnements Seul le monde médical devrait voir des effets biologiques positifs.	2	13	Mer 24 Fév - 17:49 KLOUG

RÉGLEMENTATION	SUJETS	MESSAGES	DERNIERS MESSAGES
Décryptage réglementaire Pour ceux qui ne savent pas comment interpréter les différents textes.	29	270	Aujourd'hui à 11:30 Radisivert
Mise en conformité Pour respecter au mieux les textes et réussir ses audits.	7	75	Aujourd'hui à 14:43 Nico
La RP au niveau international Pour parler un peu de l'AIEA et des bonnes pratiques dans le monde.	1	3	Mer 2 Déc - 0:28 KLOUG

Thank you for your attention!!!

philippe.massiot@cea.fr
paul.livolsi@cea.fr