Day	Topics (preliminary schedule)	
1	Welcome	*Course presentation & practical issues*
	Biology	*DNA & Cellular structures: an overview*
2	Radiation Physics	*Interaction radiation-matter: an overview*
		Introduction to radiation detection (I)
	Radiation Physics/Biology: Laboratory Session	*Physics laboratory* *Radiobiology laboratory* (half students per lab)
3	Radiation Physics	*Introduction to radiation detection (II)*
	Radiation Physics/Biology: Laboratory Session	*Physics laboratory* *Radiobiology laboratory* (half students per lab)
4	Radiation Physics	*Interaction neutron-matter: an overview*
		Cross section calculation for track structure simulations
	Radiation Biophysics	*General introduction – Mechanisms of time and space evolution of radiobiological damage*
5	Modelling Radiation Biophysics: Mechanistic approach	*Track structure simulation, temporal evolution of track structure, pre-chemical phase, chemical phase, biological phase*
		Initial damage dependence on Radiation quality.
	Modelling Radiation Biophysics: Phenomenological approach	*Modelling mixed field effects, microdosimetry and applications to hadrontherapy and radiation protection*
6	Modelling radiobiological damage (mechanistic)	*Modelling DNA damage and repair*
		Modelling Cell Survival
		Diffusion-like processes
		Modelling Bystander effect and cell communication
7	Modelling radiobiological damage (epidemiology)	*Cancer risk from human cohorts: from epidemiology to models of carcinogenesis*
8	Radiation Therapy & Modelling	*Modelling in radiotherapy* *Clinical radiobiology, TCP, NTCP*
		Treatment plans and optimization
9	Radiation Therapy & Modelling	*Secondary cancer in radiotherapy*
	General Modelling	*Systems Radiation Biology: NF-kB example*
	Model Testing	*Statistical methods for model testing*
10	Summary and discussion	Summary and discussion
		Final test &Questionnaire

DoReMi is a EURATOM-funded Network of Excellence set up to promote and integrate European research into the risks of exposure to low doses of ionising radiation. In addition, DoReMi will facilitate and promote training and education in support of the research programme within the project, and also make more widely available training opportunities in order to help attract top-level students into the field. As part of this initiative, a short course of two weeks duration on **Modelling radiation effects from initial physical events** has been organized at the University of Pavia.

Information for applicants:

There is no course fee. A limited number of free lodgings in Pavia colleges will be available. No financial support will be provided. A certificate will be issued to each participant.

People wishing to apply should submit preferably by email the following documents

- A letter of application
- A CV with a description of the scientific career
- A supporting letter from the supervisor/head of laboratory.

to the Director of the course:

Andrea Ottolenghi
Dipartimento di Fisica Nucleare e Teorica
Università degli Studi di Pavia
Via Bassi 6 I-27100 Pavia, Italy
andrea.ottolenghi@pv.infn.it, with copy to
doremi.training@pv.infn.it.

The deadline for applications is:

April 15th, 2012 (information confirming the acceptance will be sent to the applicant).

For any questions please write an email to: doremi.training@pv.infn.it

UNIPV-DFNT

DoReMi
Integrating Low Dose Research

EURATOM

A two week course on

Modelling radiation effects from initial physical events

Learning modelling approaches and techniques in radiation biophysics and radiobiology research, from basic mechanisms to applications

May 28th to June 8th, 2012

Physics Depts., University of Pavia,
Via Bassi 6, Pavia, Italy

The course is open to

- **students (e.g. MSc, PhD and specialization students),**
- **young investigators,**
- **continuing professional education,**

in particular with interest in scientific disciplines related to:

- **Radiation Biophysics**
- **Radiobiology**
- **Radiation protection.**

Course aims:

The general objective of the course (in its second edition) is to provide the theoretical bases for designing radiobiological research activities and to integrate experimental and theoretical activity, including experimental design and models.

In particular, at the end of the course, the students will be able to understand the basics relative to:

- the principal mechanisms of interaction between radiation and matter
- the processes that lead to the formation of radiobiological damage, starting from physical early events, to DNA and chromosomal damage.
- experimental techniques to radiation detection.
- the Monte Carlo method.
- track structure codes and their theoretical background.
- different modelling approaches to investigate radiobiological damage at different levels, such as:
    - DNA damage and repair
    - Mutation,
    - Chromosomal aberration,
    - Transformation,
    - Cell survival.
    - Non Targeted effects
- models developed in the context of radiotherapy, such as:
    - TCP
    - NTCP
    - Models to estimate the RBE of mixed fields
    - Secondary Cancers
- the systems biology approach
- best fit methods

Course topics and contents

The course will introduce students to mechanisms and theoretical modelling approaches relative to the physical, chemical and biological effects of radiation at sub-cellular, cellular, and organism level. The course will start with a general introduction on the atomic and nuclear structure of matter, on the DNA structure and on the general features of radiobiological damage. The interaction of radiation with matter (ions, electrons, photons and neutrons) and experimental radiation detection will be described in detail, with a laboratory session where, *inter alia*, the spectrum of ^{60}Co decay will be measured with solid-state detectors.

After this preliminary description of the physical stage of radiation-matter interaction, during the first week, the investigation of the early events of radiobiological damage will be explained, covering also the chemical (radiation chemistry of water and DNA solutions) and biological (radiation damage to DNA in a cellular environment) effects of radiation. Monte Carlo techniques and track structure simulation codes will be presented as examples of possible models developed to theoretically investigate these processes.

During the second week the student will receive lectures on modelling of the biological processes induced after irradiation at molecular, cellular and *supra*-cellular level.

Modelling Radiation Biology. During these lectures the problem of modelling the biological phenomena induced by irradiation will be presented, focusing in particular on the different approaches and methods adopted, e.g. Monte Carlo *vs* deterministic, discrete *vs* continuous, macroscopic *vs* microscopic, predictive *vs* exploratory *etc.*

In particular, as examples, there will be presented:

a. Models of DNA damage (and repair) with different approaches: Monte Carlo (*PARTRAC*) or phenomenological (based on differential equations)

b. Models of chromosomal damage with Monte Carlo techniques.

c. Models of cell transformation/survival with deterministic approaches (e.g linear-quadratic method)

Modelling Radiation Therapy. During this session an introduction to the basic modelling approach adopted in radiation therapy will be presented. In particular a detailed description of Tumour Control Probability (TCP) and Normal Tissue Control Probability (NTCP) models will be given, with also a general introduction on the approaches adopted to model secondary tumour formation. Modelling activity to account for different radiation qualities within the radiation therapy framework will be presented (e.g. RBE quantification for mixed fields).

General Modelling. To conclude, during the last session of the course the general and theoretical questions arising from modelling activity will be addressed, focusing on the general features of the models developed so far. A General introduction on systems biology and its methods (e.g. *top-down vs bottom-up approach*) will be presented. Definitions of complexity, robustness, and modularity of the biological systems will be given and discussed.