Continuing Education Program

An excellent set of short courses will be given at the start of the NSS/MIC programs, covering a wide range of nuclear and medical technology. All courses include refreshments, lecture notes, and a certificate of completion as part of the registration fee. Full day courses also include lunch.

Claus Grupen
Short Course Program Chair

Short Course Name	**Date**	**Cost**[1]
NSS Courses		
SC1: Radiation Detection and Measurement	Saturday October 16	EUR 300[2]
SC2: Detectors for Astroparticle and Synchrotron Radiation Experiments	Saturday October 16	EUR 150
SC3: Semiconductor Strip, Pixel and Voxel Arrays	Saturday October 16	EUR 220[2]
SC4: GEANT4	Sunday October 17	EUR 250
MIC Courses		
SC5: Detectors for SPECT and PET	Monday October 18	EUR 250
SC6: Biomedical Applications of Particle Detectors	Monday October 18	EUR 150
SC7: Optical Imaging	Monday October 18	EUR 150
SC8: Statistical Methods for Image Reconstruction	Tuesday October 19	EUR 150

[1] Cost is for registration before September 25. Add EUR 50 per course for on-site registration. IEEE members qualify a EUR 50 discount per course.
[2] Text book included.

Short Course 1
Radiation Detection and Measurement

Saturday, October 16, 08:30 - 18:00 Room Tarragona

Organizer: Konrad Kleinknecht, Universität Mainz
Instructors: Archana Sharma, CERN
Dietrich Wegener, Universität Dortmund
Jochen Schwiening, SLAC
Konrad Kleinknecht, Universität Mainz

The course will start with a description of the interactions of particles and radiation with matter. Elementary particles are usually not directly detected but rather their interaction products. Depending on the purpose of the experiment one can do tracking with gaseous detectors with the aim e.g. of momentum measurement in a magnetic field. For higher energies calorimetric techniques yield excellent results with electromagnetic or hadronic calorimeters for electrons and hadrons. In many cases the nature of the incident particle has to be determined. For that purpose different techniques like dE/dx measurements, Cherenkov and transition radiation detection or time-of-flight techniques can be employed. The course follows closely the book on Radiation Detection and Measurement (Konrad Kleinknecht, Cambridge University Press), which will be provided by the organizer.

Short Course 2
Detectors for Astroparticle and Synchrotron Radiation Experiments

Saturday, October 16, 08:30 - 12:30 Room Cesarea

Organizer: Albert H. Walenta, Universität Siegen
Instructors: Razmik Mirzoyan, MPI München
Albert H. Walenta, Universität Siegen

Particle detectors can have a large variety of applications. The subject of astroparticle physics has evolved from the field of cosmic rays. Cosmic ray experiments in the past were mainly involved with earthbound detectors. e.g. to measure the various cosmic ray components at sea level. More recently experiments in space have provided a wealth of informations on primary particle spectra and electromagnetic radiation in many different spectral ranges. The detectors used for these applications are similar to experiments at accelerators, however they have to work under relatively harsh conditions.
In contrast, synchrotron radiation experiments require techniques for the measurement of keV photons at high repetition rates. In addition, the reduction of noise, and the use of large area detectors is a challenge for dedicated detectors in this field.

Short Course 3
Semiconductor Strip, Pixel and Voxel Arrays

Saturday, October 16, 14:00 - 18:00 Room Cesarea

Organizer: Lothar Strüder, Semiconductor Lab.;
MPI for Physics and Extraterrestrial Physics, München
Instructors: Gerhard Lutz, MPI München
Lothar Strüder, MPI München

The measurement of ionizing radiation like optical photons, X- and γ-rays on one side and electrons, protons, α or other massive particles on the other side is of great interest in many fields of basic science (e.g. astrophysics, high energy physics), applied science (e.g. material analysis, medical imaging, synchrotron research) and industrial science (e.g. X-ray fluorescence analysis, quality control). Semiconductor detectors, in particular with the introduction of new concepts and principles have very strongly improved the measurement capabilities.
This half day course intends to review the basic physics of semiconductor devices used as detectors as well as for integrated electronics. A short treatment of further signal processing electronics will be given. Resulting implications for front-end electronics will be discussed.

The basic physical limitations of the measurement precision will be derived from physical concepts. Special emphasis will be given to the physical limits of position resolution, energy resolution, time resolution, the quantum efficiency and the 'cleanliness' of the spectra. Basic effects affecting the long-term stability under various experimental boundary conditions will be discussed.
We will concentrate on pn-junction type detectors as single and double sided silicon strip detectors, pin and pad detectors, silicon drift detectors, charge coupled devices and active pixel sensors. The impact of those detectors on readout and data acquisition strategies will be derived from the intrinsic detector properties and the specific application and its primary measurement goal.
For all detector types examples of applications will be presented. A textbook (G. Lutz, Semiconductor Radiation Detectors, Springer) will be supplied and is part of the registration fee.

Short Course 4
Simulation Techniques using GEANT4

Sunday, October 17, 08:30 - 18:00 Room Tarragona

Organizer:	Maria Grazia Pia, INFN Genova
Instructors:	Katsuya Amako, KEK
	Makoto Asai, SLAC
	Gabriele Cosmo, CERN
	Susanna Guatelli, Univ. and INFN Genova
	Aatos Heikkinen
	Maria Grazia Pia, INFN Genova

Geant4 is a software toolkit for the simulation of the interaction of particles with matter, developed and maintained by a world-wide collaboration of physicists and computer scientists. Its application areas include high energy physics experiments, astrophysics and astroparticle physics, space science, medical physics and medical imaging, nuclear physics, radioprotection and radiation background studies. It exploits advanced software engineering techniques and Object Oriented technology to achieve transparency of the physics

implementation, as well as openness to extension and evolution.
Geant4 provides a wide set of tools for all the domains of detector simulation, such as Geometry modeling, Detector Response, Run and Event management, Tracking, Visualisation and User Interface. An abundant set of Physics Processes handles the diverse interactions of particles with matter across a wide energy range, as required by Geant4 multi-disciplinary nature; for many physics processes a choice of different models is available.
The Geant4 source code and libraries are freely available, accompanied by an extensive set of user documentation.
The course provides an overview of Geant4 capabilities, and illustrates in detail the major features available in the toolkit to simulate an experimental set-up. Specific lectures are devoted to Geant4 capabilities for medical applications. Finally, the students are guided through a real-life simulation example, offering a practical implementation of the basic concepts of a user application. As a result of the course the students would learn how to develop simulation applications based on the Geant4 Toolkit.
A CD with Geant4 source code and libraries, examples and further training material is distributed to all course participants.
To best profit of the course, some basic knowledge of the C++ computing language is recommended.
For more details of the course, see
http://www.ge.infn.it/geant4/events/nss2004/geant4course.html

Short Course 5
Detectors for SPECT and PET

Monday, October 18, 08:30 - 18:00 Room Cesarea

Organizer:	Harrison Barrett, Univ. Arizona
Instructors:	Lars Furenlid, Univ. Arizona
	Harrison Barrett, Univ. Arizona

This course will survey the state of the art in gamma-ray detectors for SPECT and PET, with a discussion of emerging technologies as well as traditional semiconductor and scintillator devices. Considerable emphasis will be placed

on statistical characterization of the detectors and on optimal estimation methods that take the statistical properties into account. Advanced data-acquisition methods will be discussed, and examples will be given of some current detector projects at the Center for Gamma-ray Imaging of the University of Arizona.
Topics will include:

Survey of technologies for gamma-ray detection

Detector requirements for SPECT and PET

State of the art in scintillation detectors

State of the art in semiconductor detectors

Statistical modeling and estimation methods

Data acquisition systems

Examples of applications

Short Course 6
Biomedical Applications of Particle Detectors

Monday, October 18, 08:30 - 12:00 Room Tarragona

Organizer: Ralf H. Menk, ELETTRA, Trieste
Instructors: Fulvia Arfelli, Trieste Univ., and INFN Trieste
Ralf H. Menk, ELETTRA, Trieste

The course starts with the discussion of the concept of basic properties for the detection of X-rays in various particle detectors. The relevant quantities are the conversion probability of photons into charged particles (quantum efficiency), the signal to noise ratio, the spatial resolution, the point spread function and the noise power spectrum. These considerations result in a characteristic 'detective quantum efficiency DQE' for a detector.

In the following these concepts are applied to examples like

non invasive coronary angiography

bronchography

multi energy tomography

mammography

Special emphasis will be placed on the digital subtraction technique to obtain images of suitable contrast allowing a reliable diagnosis. The detector types used for these applications are segmented ionization chambers, Si(Li) drift detectors, segmented 'edge on' silicon detectors and germanium detectors.

Short Course 7
Optical Imaging

Monday, October 18, 14:00 - 18:00, Room Tarragona

Organizer:	Rinaldo Cubeddu, Politecnico Milano
Instructors:	Paola Taroni, Politecnico Milano
	Alessandro Toricelli, Politecnico Milano
	Rinaldo Cubeddu, Politecnico Milano

This half-day course will cover Optical Imaging for medical and biological applications, focusing on non-invasive techniques for in vivo bulk tissue investigations, while not dealing with techniques for microscopic (cellular and/or structural) studies (like optical coherence tomography and microscopy).
The study of light propagation in highly diffusive media, like biological tissues, has gained much interest due to the exciting challenge to develop novel in vivo, non-invasive diagnostic tools. Indeed, the possibility to explore bulk tissues by analyzing photons that have traveled through tissue - after being injected or generated by fluorescence - offers potential for applications with great social impact such as tumor detection in the female breast and functional imaging of the brain.

The course is organized in four modules covering: i) Fluorescence lifetime imaging; ii) Photon Migration; iii) Optical Mammography; and iv) Molecular Imaging.
The course is targeted to three types of attendees: engineers/physicists who desire understanding the basics of photon migration and fluorescence in order to develop/use related type of instrumentation; engineers/physicists/managers who need to understand these technologies and the performance achievable in order to manage or work with a development team utilizing these technologies; and people interested in an overview for personal technical development.
In detail the following subjects will be presented:

fluorescence

photon migration

optical mammography

molecular imaging

Short Course 8
Statistical Methods for Image Reconstruction

Tuesday, October 19, 08:30 - 12:30 Room Cesarea

Organizer: Jeffrey A. Fessler, Univ. Michigan
Instructor: Jeffrey A. Fessler, Univ. Michigan

The recent commercial introduction of iterative algorithms for tomographic image reconstruction, and the increasing interest in scanners with nonstandard imaging geometries, has brought new relevance and timeliness to the topic of statistical methods for image reconstruction. This course will provide an orderly overview of the potpourri of statistical reconstruction methods that have been proposed recently. Rather than advocating any particular method, this course will emphasize the fundamental issues that one must consider when choosing between different reconstruction approaches. The intended audience is anyone who would like to reconstruct 'better' images from

photon-limited measurements, and who wants to make informed choices between the various methods. Recent advances in convergent forms of 'ordered subsets' algorithms will be given particular attention, since these algorithms can be both practical for routine use, while also having desirable theoretical properties. Both emission tomography and transmission tomography algorithms will be discussed.

Attendees should be familiar with photon-counting imaging systems at the level presented in the Medical Imaging short course offered in previous years. Some past attendees have commented that at least a little experience with some type of iterative reconstruction (e.g., ART or OS-EM) would be helpful for getting the most value from this course.