

# **Nordic Research Training Course in Detector Technology for Particle Physics**

**Hands-on exercises in Helsinki 2-6.11.2015**

**Course Plan as of 29.10.2015**

**VENUE:** Helsinki Institute of Physics / Detector Laboratory,  
Physicum, University of Helsinki, Gustaf Hällströmin katu 2a, 00560 Helsinki

**WEBPAGE:** <https://indico.nbi.ku.dk/conferenceDisplay.py?ovw=True&confId=758>

## **CONTENTS:**

Laboratory exercises will provide the students with hands-on & minds-on training in detector technologies, used in particle physics experiments. The work will include semiconductor detectors, gas detectors, and detector read-out systems.

## **LEARNING TARGETS:**

After the laboratory course the student will be able to:

- 1) work in a scientific laboratory environment taking into account strict safety rules such as caution for high-voltages, gases, chemicals, delicate instruments, and radiation safety.
- 2) construct gas-filled radiation detector starting from simple everyday materials such as lemonade can and knots and bolts,
- 3) Construct simple signal amplifier device using basic electronic components,
- 4) operate radiation detectors and data acquisition systems using typical laboratory equipment, such as source-meter-unit, radiation sources, gas piping, preamplifier, linear amplifier, multi-channel analyzer, and oscilloscope,
- 5) understand the differences and similarities between gas-filled and semiconductor radiation detectors.

## **ASSESSMENT:**

After having contributions recognized, each student will be assigned 5 ECTS.

- 1) On-line assessment: Students' achievement and progress will be observed during the laboratory work. Teachers will observe the students' procedural and problem solving skills, ability to use hands, engagement in the given exercise, cooperation within the group, and communication skills.
- 2) Off-line assessment: Each group will write report about the tasks, explaining theory, methodology, analysis and results. The reports must be sent to Timo.Hilden@helsinki.fi and Jens.Brucken@helsinki.fi (TASK A) and Richard.Brenner@cern.ch (TASK B). Report deadline will be announced later.

# Nordic Detector Technology Course, Helsinki 2-6.11.2015

## TASKS:

The students (20) will be divided in five groups of four persons (5X4). Experimental and theoretical physicists will be mixed in the groups. Each group will do two tasks:

### A) Construction and measurement of gas-filled wire-chamber detector

Students will construct their own particle detector using the traditional gas-filled wire chamber technology. Everyday materials such as copper tube and Cu/Be wire are used in the work. In addition, the detector and appropriate data acquisition equipment are used to measure the energy spectrum of a radiation source. The chain of data acquisition contains preamplifier, linear amplifier, multi-channel analyzer and oscilloscope. All the groups will work simultaneously in the laboratory, each group with their own wire-chamber detectors. Instructors are available for questions all the time.

Instructors: Dr. Camille Belanger-Champagne, Dr. Erik Brücken, Dr. Francisco Garcia, Dr. Timo Hildén, Dr. Pauli Peura, Lab.Eng. Jouni Heino, Lab.Eng. Rauno Lauhakangas, Lab.Tech. Raimo Turpeinen, Aneliya Karadzhinova, Tiina Naaranoja, Alexander Winkler.

Venue: Laboratory B307.

### B) Response of silicon detectors to irradiation & silicon detector readout

The task consists of several steps:

- The students will be given an introduction to clean room environment;
- The students will use probe station to measure electrical properties (current-voltage and capacitance-voltage) of irradiated and non-irradiated silicon detectors;
- The detectors are wire-bonded to simple Printed Circuit Boards (PCBs);
- The students will construct simple amplifier units using soldering iron and basic electronics components (diodes, transistors, etc);
- The students measure the radiation response of the silicon detector connected to data acquisition equipment (preamplifier, linear amplifier, MCA, oscilloscope).

Instructors: Prof. Richard Brenner, University of Uppsala, Sweden, with Dr. Panja Luukka, Dr. Esa Tuovinen, Timo Peltola (silicon detector task), lab.eng. Jouni Heino (clean room operations), Doc. Ivan Kassamakov, Tatyana Arsenovich, Aneliya Karadzhinova, and Tiina Naaranoja (clean room measurements).

Venue: Clean Rooms AK108 & Laboratories B304.

### C) Visit to Okmetic Oyj @ Friday November 6<sup>th</sup> afternoon

Okmetic is a Finnish company working in the field of semiconductor wafer manufacture. The students will familiarize themselves with the basics of resistivity and oxygen concentration in semiconductor ingots. In addition, the students will visit the factory.

Instructor: Dr. Esa Tuovinen

Host: Vesa-Pekka Lempinen, Senior Manager, Customer Support, Okmetic Oyj

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## TIMETABLE:

November 2.-6., each day 9:00-17:00.

## HELSINKI PERSONNEL:

Prof. Paula Eerola, course supervisor  
Doc. Eija Tuominen, course coordinator  
Dr. Francisco Garcia, radiation safety, gas detectors  
Lab.Eng. Jouni Heino, laboratory safety, clean room instructions, gas detectors  
Lab.Eng. Rauno Lauhakangas, gas detectors  
Lab.Tech. Raimo Turpeinen, logistics & mechanics  
Doc. Ivan Kassamakov, clean room measurements  
Dr. Camille Belanger-Champagne, gas detectors  
Dr. Panja Luukka, silicon detectors  
Dr. Erik Brücken, gas detectors  
Dr. Timo Hildén, gas detectors  
Dr. Pauli Peura, gas detectors  
Dr. Esa Tuovinen, silicon detectors, Okmetic excursion  
M.Sc. Tatyana Arsenovich, clean room measurements  
M.Sc. Aneliya Karadzhinova, gas detectors, clean room measurements  
M.Sc. Tiina Naaranoja, gas detectors, clean room measurements  
M.Sc. Timo Peltola, silicon detectors  
M.Sc. Alexander Winkler, gas detectors  
([name.surname@helsinki.fi](mailto:name.surname@helsinki.fi))

## FROM UPPSALA:

Prof. Richard Brenner (Richard.brenner @cern.ch), silicon detector task