**PhD Research Course (New solid state radiation detectors)**

**Silicon photomultipliers and other new solid state radiation measurement technology.** Malmö 19-23 October 2015

*Day 1-3:* **Silicon photomultipliers (SiPM)**

A silicon photomultiplier (SiPM) is a device using multiple avalanche photodiode pixels operating in Geiger mode. SiPM:s are attractive candidates for the replacement of the conventional PMTs since they provide high gain with low voltage and fast response. They are very compact and magnetic field compatible. SiPM:s have excellent photon-counting capability and can be used in various applications for detecting extremely weak light. Latest PET technology uses SiPM detectors instead of PM tubes to be able to combine PET and MR equipment.

*Day 4-5:* **Other photon counting detectors, MEDIPIX, and study visits**

Medipix is a family of photon counting and particle tracking pixel detectors. Photon counting pixel detectors represent the next generation of radiation imaging detectors. The photon counting technology overcomes limitations of current imaging devices.

The course consists of lectures, exercises and demos from invited and local speakers as well as study visits. Matlab is used for some exercises.

There is no charge for the course. Participants pay themselves for travelling and lodging as well as for lunches.

*Teachers and instructors:*

Professor Massimo Caccia, Dipartimento di Scienza e Alta Tecnologia, Universita’ degli Studi dell’Insubria, Como, Italy

Professor Christer Fröjdh, Avdelningen för elektronikkonstruktion, Mittuniversitet, Sundsvall

Doc. Mikael Gunnarsson, Strålningsfysik SUS, Malmö

Civ. ing. Lars Herrnsdorf, doktorand, Medicinsk strålningsfysik, Malmö

Fil. lic. Mattias Jönsson, Medicinsk strålningsfysik, Malmö

Senior professor Sören Mattsson, Medicinsk strålningsfysik, Malmö

*Location:* Medical Radiation Physics (MRP), Malmö University Hospital, Inga-Marie Nilssons gata 49, and Konferenscentrum (KC), Jan Waldenströms gata 5, Malmö, Sweden.

# The course locations are less than 10 minutes walking time from Triangeln railway station.

# Travel by train from Copenhagen Airport CPH to Malmö Triangeln takes16 minutes.

**Course program** 2015-09-30/LH, SM, MG

Applications to [Lars.Herrnsdorf@med.lu.se](mailto:Lars.Herrnsdorf@med.lu.se)

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| **Day** | **Course content** | **Time** | **Room** | **Lecturer/Instructor** |
| **Monday**  **19 Oct.** | Welcome to the course. Coffee  Presentation of participants | 10.30-11.00 | KC | All |
|  | Introduction – goal of course – Logistics  Presentation of individual projects | 11.00-11.30 | KC | Lars Herrnsdorf  Sören Mattsson |
|  | Introduction to the CAEN educational kit | 11.30-12.00 | KC | Lars Herrnsdorf  Massimo Caccia |
|  | Basic introduction to SiPM , past –present- future | 12.15-13.00: | KC | Massimo Caccia |
|  | Lunch | 13.00-14.15 |  |  |
|  | Maria och Lars Herrnsdorfs donation to Medical radiation physics Malmö | 14.15-14.30 | KC | Lars Herrnsdorf  Lars E Olsson |
|  | Introduction to *Exercise 1*: Studies of SiPM characteristics using the CAEN kit | 14.30-15.15 | KC | Massimo Caccia  Lars Herrnsdorf |
|  | Coffee | 15.15-15.30 | MRP |  |
|  | *Exercise 1*, individual training using the CAEN kit | 15.30-17.00 | MRP | Massimo Caccia  Lars Herrnsdorf |

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| **Tuesday**  **20 Oct.** | Presentation of an ultra low-cost, pre-clinical table-top PET scanner | 09.00-09.45 | KC | Massimo-Caccia |
|  | Demo of a detector for *in situ* measurement of 90Sr/90Y deposition | 09.45-10.30 | KC | Mattias Jönsson  Sören Mattsson |
|  | Introduction to *Exercise 2*: SiPM/scintillator for PET applications | 10.30-11.30 | KC | Massimo Caccia |
|  | Lunch | 11.30-12.15 |  |  |
|  | *Exercise 2*, individual training using the training material | 12.15-14.45 | MRP | Massimo Caccia  Lars Herrnsdorf |
|  | Coffee | 14.45-15.15 | MRP |  |
|  | *Exercise 2*, individual training using the training material , cont. | 15.15-17.00 | MRP | Massimo Caccia  Lars Herrnsdorf |
|  | Demo of SiPM output to determine highly resolved time variation of x-ray tube output radiation pulses using a Hamamatsu evaluation board | 17.00-18.00 | MRP | Lars Herrnsdorf  Mikael Gunnarsson |
| **19.00-** | Course Dinner |  |  |  |

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| **Wednesday**  **21 Oct.** | Repetition , what have we learnt so far | 09.00-10.00 | KC | Massimo Caccia  Sören Mattsson  Lars Herrnsdorf |
|  | Work on individual applications and projects, discussion | 10.00-10.45 | KC |  |
|  | Introduction to *Exercise 3*, Plastic scintillator | 10.45-11.30 | KC | Massimo Caccia |
|  | Lunch | 11.30- 13.00 |  |  |
|  | *Exercise 3*, individual training using the training material | 13.00-15.00 | MRP | Massimo Caccia  Mattias Jönsson  Lars Herrnsdorf  Sören Mattsson |
|  | Coffee | 15.00-1530 | MRP |  |
|  | *Exercise 3*, individual training using the training material, cont. | 15.30-17.00 | MRP | as before coffee |

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| **Thursday**  **22 Oct.** | Introduktion – Other solid state technologies | 9.00-9.15 | KC | Lars Herrnsdorf  Christer Fröjdh |
|  | Information about ERDIT "European Radiation Detection and Imaging Technology Platform", ref http://www.erdit.eu/ | 9.15-10.00 | KC | Christer Fröjdh |
|  | Coffee | 10.00-10.15 | MRP |  |
|  | Demo of point dose alpha portable detector | 10.15-10.45 | MRP | Lars Herrnsdorf  Ünal Ören |
|  | Demo of a MEDIPIX image photon counting detector education system X-ray /high energy physics/ cosmic radiation/radon daughters | 10.45-12.00 | MRP | Christer Fröjdh |
|  | Lunch | 12.00-13.00 |  |  |
|  | Transport to Imaging lab at LTH | 13.00-13.45 |  |  |
|  | Visit to 4D-imaging lab at LTH/Lund to understand the optical x-ray microscope detector | 14.00-17.00 |  | Stephen Hall |
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| **Friday**  **23 Oct.** | Individual time for exercise/home work /questions using the Educational kit/MEDIPIX | 09.00-10.30 | MRP | Lars Herrnsdorf  Christer Fröjdh  Sören Mattsson |
|  | Summing up the course | 10.30-11.30 | KC | Lars Herrnsdorf  Christer Fröjdh  Sören Mattsson |
|  | Lunch | 11.30-12.15 |  |  |
|  | Transport to Lund/ Visit to MAX-IV | 12.15-13.00 |  |  |
|  | What detectors is presently used at Max IV /Lund for radiation protection purposes. Future need of detectors | 13.00-15.00 |  | NN  Ünal Ören |

