Master thesis in applied physics:

Investigating new materials for ultrafast single photon detection

Motivation - Given the growth and aging of the world population, innovative solutions for sustainable energy and health are needed. Novel technologies play an enabling role in the realization of such solutions. Better devices for the detection of annihilation quanta resulting from positron annihilation are an example. In material science these detectors are needed for research on renewable energies and innovative energy storage using *Positron Annihilation Lifetime Spectroscopy (PALS)*. In medicine they are required for diagnosis, staging, and treatment monitoring of diseases using *Time-of-Flight Positron Emission Tomography (TOF-PET)*.

Background - In both fields—PALS and TOF-PET—time resolution is a key parameter. Sub-100 picosecond resolution is needed but not yet available. The EU-project PALADIN (positron annihilation detection beyond the limits) aims to overcome present technological limits and pushing time resolution beyond current boundaries. Therefore, detectors based on monolithic scintillation crystals will be read out with *digital photon counter (DPC) arrays* (see figure). The future detector is currently being designed and will be incorporated in a PALS setup at the Reactor Institute at TU Delft. There it will be used for TU Delft's materials research on renewable energy. Hence, the detector will be investigated for application in clinical TOF-PET devices allowing to go beyond state-of-the-art spatial and temporal resolution.

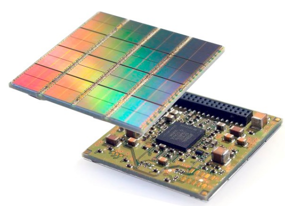
Thesis project - The student will perform experimental studies on ultrafast single photon detection. He/She will investigate the (yet unknown) characteristics of new promising detector materials and will work on methods to reduce effects corrupting the detector performance. Results of the measurements will have impact on the ongoing design future detector. Our collaboration with *Philips* allows us to provide the most recent single photon detection technology in our lab. If wanted the student is encouraged to take responsibility for her/his project and investigate own ideas after an introductory phase. Optional short term visits to our collaboration partners Philips (Germany), TU Vienna/MedAustron (Austria) and SMI Vienna (Austria) could be arranged. A detailed work plan of the thesis will be elaborated together with the student acknowledging her/his research interests.

Requirements - Interest and basic understanding of radiation detection, interest in experimental investigations, basic data analysis, basic optics

Collaboration partners - TU Delft, Philips Digital Photon Counting, Austrian Academy of Sciences, TU Vienna

Contact - Dennis Schaart or Stefan Brunner, Faculty of Applied Physics, TU Delft (Radiation Science & Technology Dept., Radiation and Isotopes for Health), D.R.Schaart@tudelft.nl or S.E.K.Brunner@tudelft.nl

Project website - http://fasttiming.weebly.com



Ultrafast digital single photon counter (Philips).

TU Delft