The Compton Camera Imager

Compton camera systems offer the option to trace back the direction of the incident hard X – and Gamma rays by measuring all kinematic parameters of a Compton scattering process. A first step towards the goal of a full size instrument for medical research is the development of a Compton Camera Imager (CCI) for small animals for pharmaceutical research. With e.g. 830 keV (Se^{72}) incident Gamma rays a position resolution of 200 µm – 300 µm can be reached. The efficiency of the colimatorless system is about a factor of 10^3 higher as compared to existing SPECT systems. Its spatial resolution is superior to that of PET systems.

Compton Camera Imagers (CCI) for medical diagnosis are under investigation since many years. A new approach was proposed in 2003 since new scatter detectors became available with adequate specifications, among those: position resolution of 150 µm in all directions, good energy resolution at room temperature, fast trigger signal of Δt better than 5 ns, high count rate capability. We have designed, fabricated and tested a controlled silicon drift detector which fulfills the above requirements to be implemented as scatter detector in a CCI system.

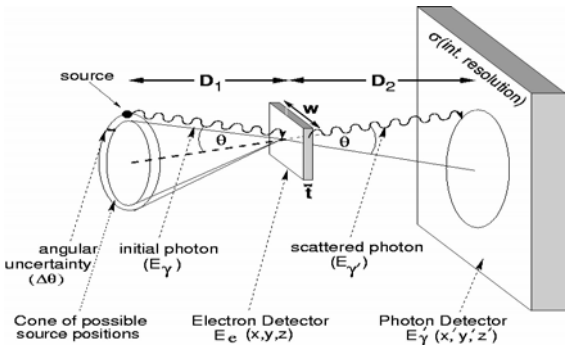

Fig.1: Basic geometry of a CCI. The incident photon hits the scatter detector. The position of the scatter process, the deposited energy of the electron and the time is measured precisely. The electron is stopped in the scatter (electron) detector, while the scattered photon is detected in the absorption (photon) detector.

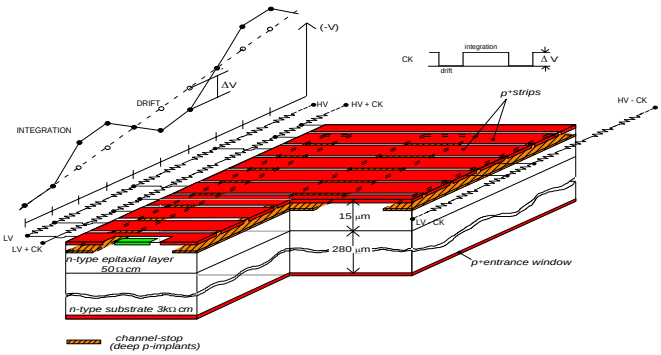

Fig.2: The controlled silicon drift detector as a scatter detector. The electrons of the signal charge cloud drift to the front side in the channel guide structure of the CDD, the holes are detected at the rear side for the fast timing signal.

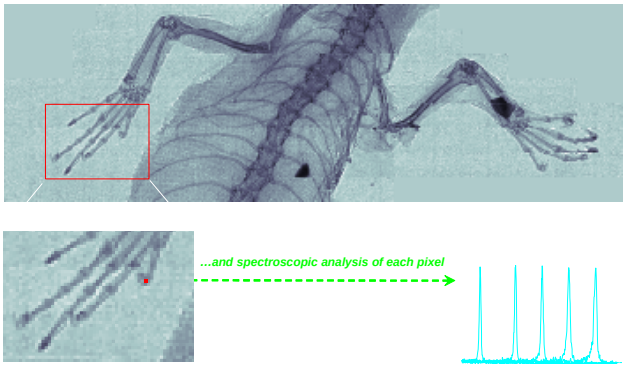

Fig.3: Image recorded at 100.000 frames per second with a CDD in a single photon counting mode. The energy resolution at room temperature was better than 250 eV FWHM. (The measurements were made at the synchrotron in Trieste by A. Castoldi, C. Guazzoni, Politecnico di Milano.

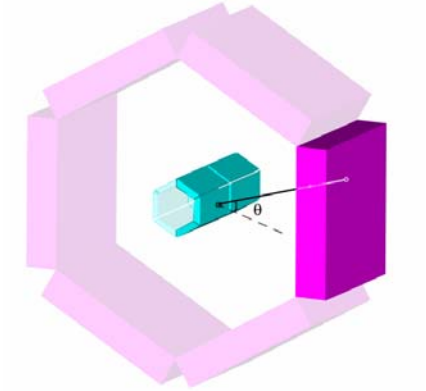

Fig.4: The inner (green/blue) detector must be as close as possible to the ``patient´´. The outer detector ring is the absorption detector for the detection of the position, time and energy measurement of the scattered photon from the Compton process.

The following institutions are part of the collaboration: Universität Siegen, Politecnico di Milano, Universität Bonn, Universität Essen, Forschungszentrum Jülich, University College London, SIEMENS medical Chicago, Vanderbilt University, University of Rome.

References:

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• Conka-Nurdan, T. et al., IEEE, TNS, Vol. 51, No. 3, 2003