

Novel Semiconductor Detectors for Fundamental and Applied Research

Project extension for the period 2021-2023

G.A.Shelkov

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The success of both scientific research and their application, primarily in medicine and biology, is determined by the level of development of detectors and other tools. Progress in the CMOS technology has led to the rapid development of semiconductor pixel detectors of particles and gamma rays. It became possible to place $\sim 10^4$ transistors on an area of (55x55) microns.

The development and creation of such custom chip requires financial resources that exceed the usual funds for R&D of individual institutions. This was the reason for the creation of large international collaborations with an entry fee. One of the most successful examples that has existed for 23 years is the Medipix collaboration. In 2016, the JINR group got the opportunity to enter into a collaboration creating the most high-tech pixel chip Medipix4 to date. The collaboration fee of 250 kCHF was paid by JINR (50%) and a grant from the Ministry of Science of Russia (50%). See Photo 1.

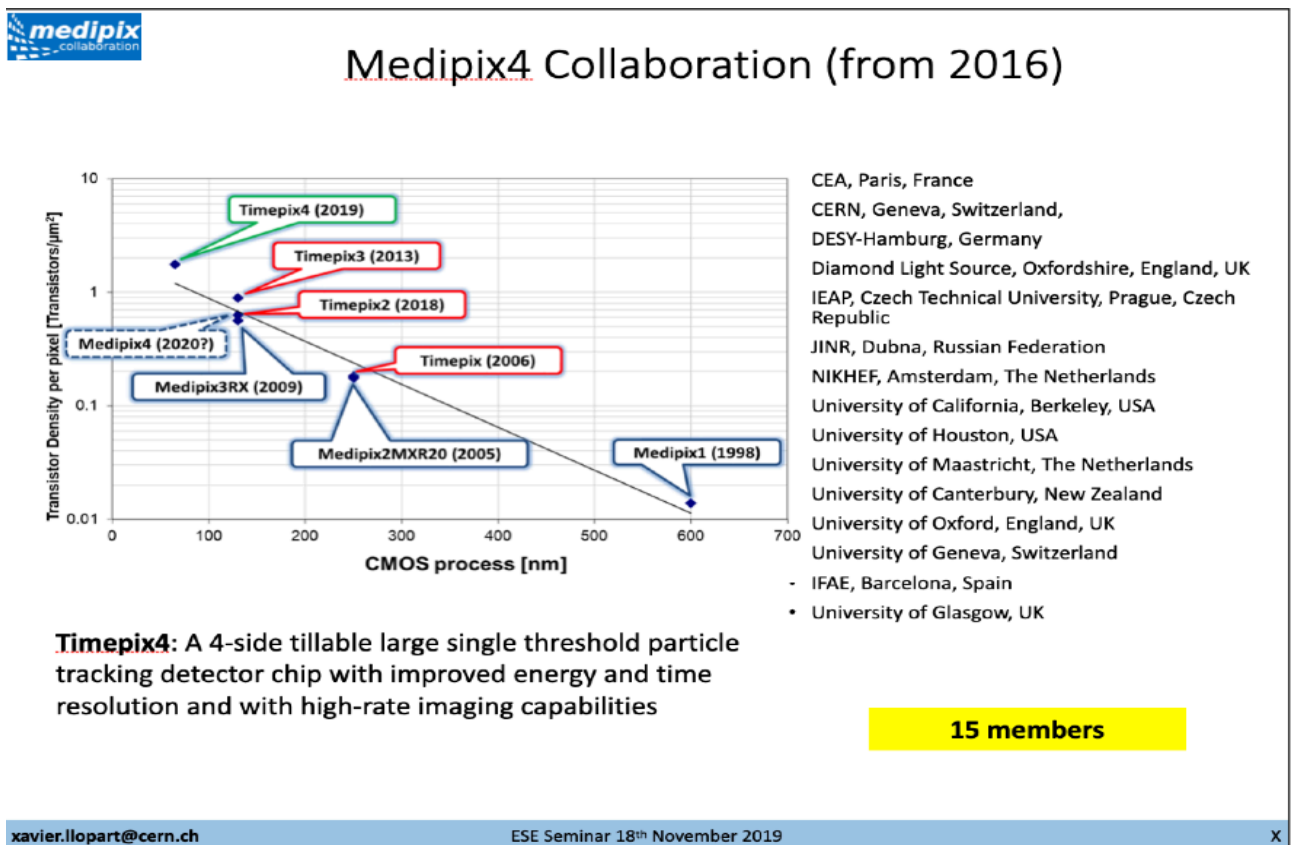


Photo 1.

	Timepix4 (2020)
Technology CMOS	65nm – 10 metal
Pixel Size (Coordinate resolution)	55 x 55 μm
Pixel arrangement	4-side buttable 512 x 448
Sensitive area	6.94 cm^2
TOT energy resolution	< 1Kev
Time resolution	~200ps
Target global minimum threshold	<500 e ⁻

The first samples of the chips have already been manufactured and are being tested. The JINR group gets access to all technical documentation and has the right to develop and create new detecting systems. Detectors with such a set of capabilities (see Table 2) will make it possible to implement new solutions for use in physical experiments and numerous applications, starting with computed color CT in medicine. (see Photo 2).

Table 1

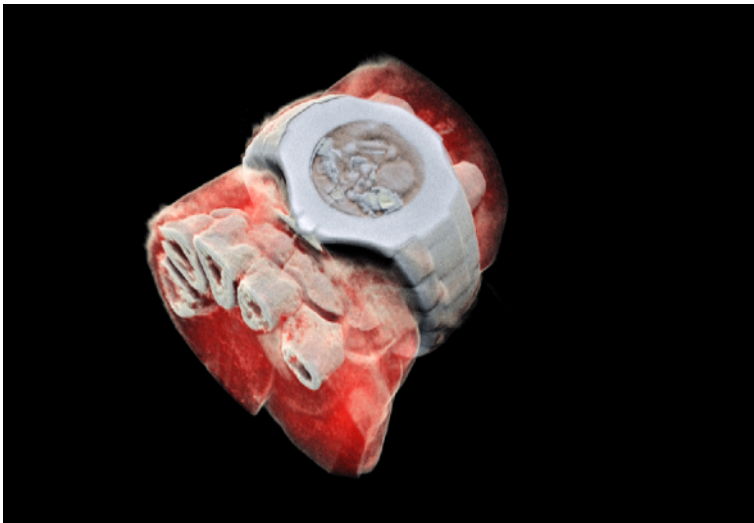


Photo 2

The authors of the project obtained a number of interesting results recorded in a series of publications, two patents and two candidate dissertations and set as their goal the further development of these studies.

Future plans

The main tasks of the project in 2021-2023:

1. Completion of work on the creation of a working prototype “head” energy-sensitive CT.
2. Development and setting up of existing prototypes of pixel detectors based on the Timepix4 chip.
3. Together with specialists from the Faculty of Biological and Medical Physics of the Moscow Institute of Physics and Technology and MSU, the establishment of a group to carry out joint biomedical research using the JINR MARS micro-CT.
4. Continuation of research on the creation and testing of new radiation-resistant semiconductor materials on JINR particle beams together with a group of TSU (Romania grant)
5. Participation in the creation and testing of a full-scale prototype of the FCAL module including readout electronics (BMBF grant).