Hello, today I am going to talk about the development of digital X-ray detector for osteodensitometry.

The main aim of my project is to develop [fast-operating](http://www.lingvo-online.ru/ru/Search/Translate/GlossaryItemExtraInfo?text=%d0%b1%d1%8b%d1%81%d1%82%d1%80%d0%be%d0%b4%d0%b5%d0%b9%d1%81%d1%82%d0%b2%d1%83%d1%8e%d1%89%d0%b8%d0%b9&translation=fast-operating&srcLang=ru&destLang=en) X-ray detector implementing spectrometric method of counting X-ray photons to measure bone mineral density (densitometry)

At present, densitometers are not produced in Russia, although they was invented in the World long ago. Therefore, our task is not only to develop the device, but also to develop the detector, which will surpass the existing analogues in the world.

Densitometer is a device that allows to determine bone mineral density in order to start early treatment of osteoporosis. Osteoporosis is a disease characterized by low bone density and increased risk of fracture.

As for the detector, it should be noted several variants of its realization. There are three main ways of collecting information from the detector: an integrating mode, a counting mode and a spectrometric mode. When working in the integrating mode signal is proportional to the number of detected photons, but we cannot recover their original number. Counting mode allows us to distinguish each individual X-ray photon. Work in spectrometric mode means that we not only separates each individual photon, but also register its energy.

Use of spectrometric detectors allows us to obtain a higher signal to noise ratio and, therefore, to apply them at lower doses, which is especially important for public health screenings.

The detector consists of a scintillator and SiPM. The following requirements is applied to scintillator: it should be non-hygroscopic, bright, fast-acting, have a high density and atomic number and, most importantly, have a high energy resolution.

In the study we identified two scintillators which are the most suitable for this role: YAP: Ce and LuYAG: Pr. Of course, there are detectors with better energy resolution and lower emission time (CdTe or HPGe), but the former is not technological and requires special electronics and the latter is too expensive for everyday use, because it requires cooling.

Selection of a SiPM was not much trouble, because its main characteristic significantly affecting the energy resolution is quantum efficiency. Recently, SiPM produced by KETEC Company has been bought for researches with the declared quantum efficiency over 40%.

Using SiPM KETEK scintillator and YAP: Ce 17% energy resolution at the energy of 59.5 keV has been achieved. However, there is currently no clear answer what is necessary energy resolution of the detector because that depends on many factors. It is estimated that the energy resolution should be about 20% FWHM at an energy of 40 keV.

To obtain a self-consistent model taking into account all the main parameters of the installation, you should be able to model the response of the detector, to know the incident X-ray spectrum, the number of particles in it and, most importantly, be able to calculate the error of determining bone density from obtained spectrum.

First of all, the simplest model was considered - the case of two monoenergetic sources. This model allows us in the first approximation to calculate the energy that is necessary to irradiate the person, as well as to calculate the error determining bone density. In result, the lower energy should be about 40 keV, and the higher - as high as possible.

At present, one consider a more precise and complex model taking into account nonideal nature of spectra.

To sum up, in the course of the work one produced detector based on the combination of SiPM - scintillator allowing to reach the energy resolution of 17% at an energy of 59.5 keV with high counting rate. The model of the two monoenergetic sources allowing in the first approximation to estimate the error of determining bone density was considered.