4.4.2. RESEARCH OF THE SPATIO-TEMPORAL DESCRIPTIONS DETECTOR WITH PIN HOLE COLLIMATOR OF THE BACK SCATTERING RADIATION

Kapranov B.I., Mudrov M.A., Education Institution of High Professional Education Tomsk Polytechnic University "Research Institute of Introscopy", Tomsk, Russia

The X-Ray tomography became one of the most effective methods of diagnostics both in technical appendixes, and in medicine in the last decade. The basic task of Compton tomography is a transfer of information about the density of elementary volume in controlled material (scattering voxel (SV)) in a parameter in the proper point of detector. SV is consistently exposed to the X-rays radiation to on to three to the coordinates and information is consistently brought in the proper point of recorder. A disadvantage of such method is the low productivity. For the increase of control speed measuring time in every point it has to do small. It does not allow creating good statistics at measuring of stream of the scattered quanta. So in tomograph "Comscan 200" (Germany) at minimum speed of scanning in times of measuring in one pixel takes 1000 quanta. A statistical error is 3 % here. Using a such information for development of algorithms of reconstruction is not possible, and promoting settling ability to the tenth stakes of millimetre is impossible without a mathematical reconstruction. Therefore there is a task of increase of the productivity of collection of information. One of ways of decision is the use of two-coordinate position-sensible detector with a pin hole aperture, providing the simultaneous transfer of information from the SV plane on the plane of detector is shown on fig. 1. The report is devoted the theme of a modernization of the collimation systems, containing pin hole (hole of small diameter (usually to 10 mm)), to research of their descriptions for providing of high efficiency and productivity of control and possibility of the use of methods of mathematical treatment for the increase of the spatial resolution.

The calculation of passing of the scattered radiation through pin hole allows to define an aperture function (formula 1), resulted on a fig. 3 (in the case of geometry sizes are shown in fig. 2).

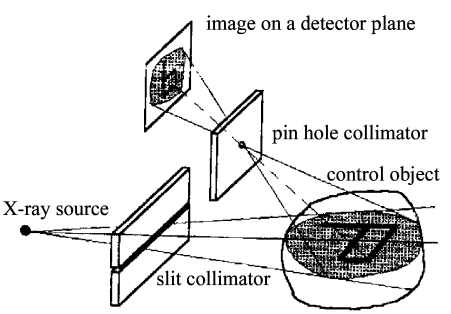

Fig. 1. Scanning chart on the basis of the flat detector matrix and pin hole aperture

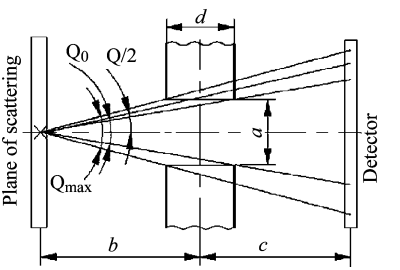

Fig. 2. Geometry of the weakening in the walls of pin hole ($a = d = 1$ mm, $b = c = 50$ mm)

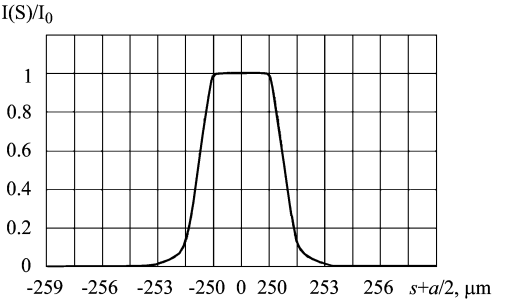

Fig. 3. Aperture function of the pin hole system of selection

$$I(Q/2)/I_0 = \exp\left(-7.022\frac{50{,}50\cdot\mathrm{tg}(Q/2) - 0{,}25}{\sin(Q/2)}\right). \quad (1)$$

In the known works about using a pin hole as a collimator, as a rule, the factor of heterogeneity of the systems of registration is not taken into account, related to the form of "sponges" of pin hole. The detailed description of the aperture function of the scattering volume (AFSV) of pin hole must take into account both geometrical distortions and account of absorption in "sponges".

In this work the complex analysis of influencing of geometrical factors and property of material of collimator is first conducted on a mathematical form AFSV. Geometry and results of calculation of change of corporal corner Ω of registration are shown on fig. 4 and 5.

Figure 5 shows the graph of dependence of diminishing of corporal corner is resulted from the coordinate of point scatterer for the optimized geometry of sponges of pin hole collimator, having a three-cornered form. Also mathematical expression was calculated and the aperture function is built for this type of pin hole as shown on fig. 6.

These aperture functions are the basis for development of an algorithm of reconstruction in the Compton tomography. The results in this article allow first to pawn in an algorithm of reconstruction presentation AFSV as a continuous function.

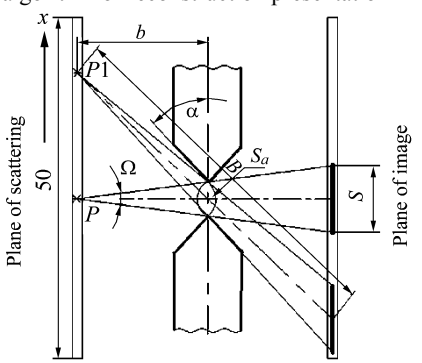

Fig. 4. Geometry of change of corporal corner depending on a coordinate *x*

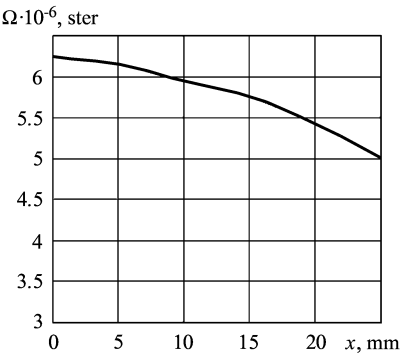

Fig. 5. Graph Ω(*x*)

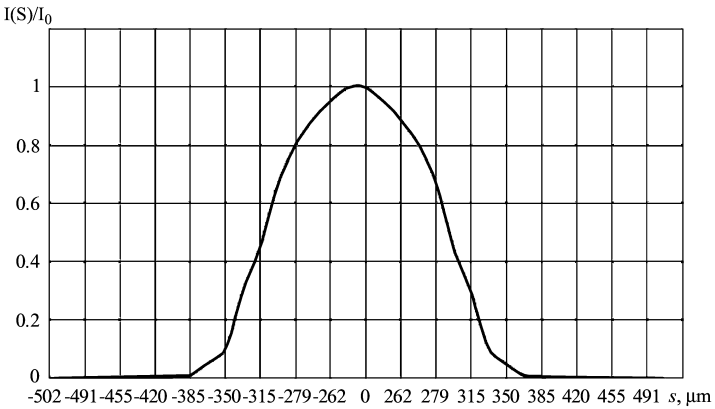

Fig. 6. Aperture function of the pin hole with triangle form sponges

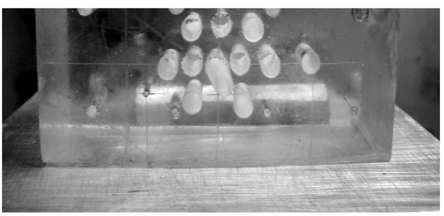

Fig. 7. Control object (material – organic glass)

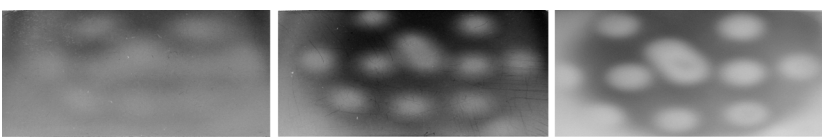

Fig. 8. Images made a pin hole with a diameter 3, 2, 1 mm (from the left)

After the necessary calculations of descriptions, resulted higher, the images of section phantom (fig. 7) were made on X-Ray film of "KODAK" by the systems of selection of the back scattering radiation on a base of pin hole. An experiment was conducted for 3 cases of diameters: 3, 2 and 1 mm.

Thus, it's possible to make a conclusion that pin hole with 1 mm opening diameter provides a spatial resolution about 1 mm after the experiment (fig. 8).