Improving the accuracy of gamma radiation measurements in radiation monitoring.

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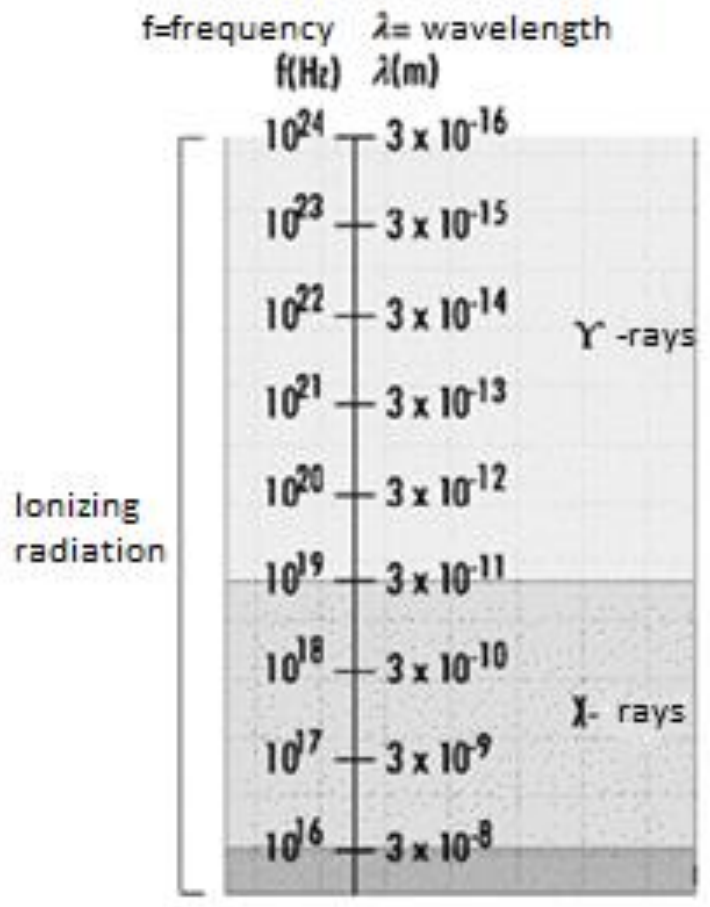
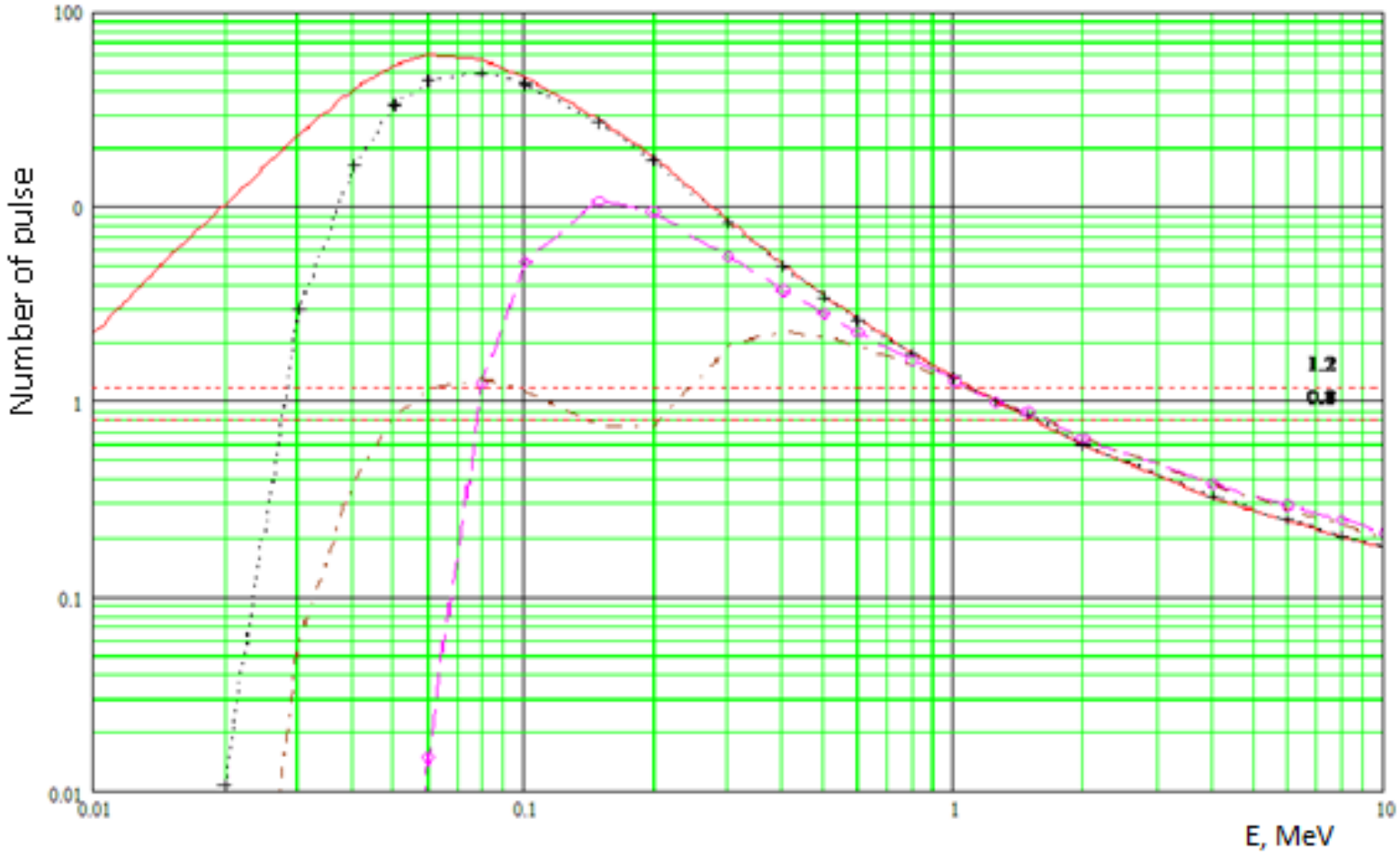
Abstract.

- The article suggests the use of unmanned vehicles for monitoring the radiation situation. The paper analyzes data on the radiation situation at nuclear power plants and identifies the main factors of external radiation exposure. It is shown that the existing means of measuring gamma radiation in real conditions have to be used in an extended energy range. To improve the measurement accuracy while simultaneously expanding the energy range of gamma radiation levels, a method is proposed for automatically compensating for additional error due to the energy dependence of the sensitivity over the entire measurement range in real time by introducing pre-calculated correction coefficients. Simulation of the proposed circuit design is performed.

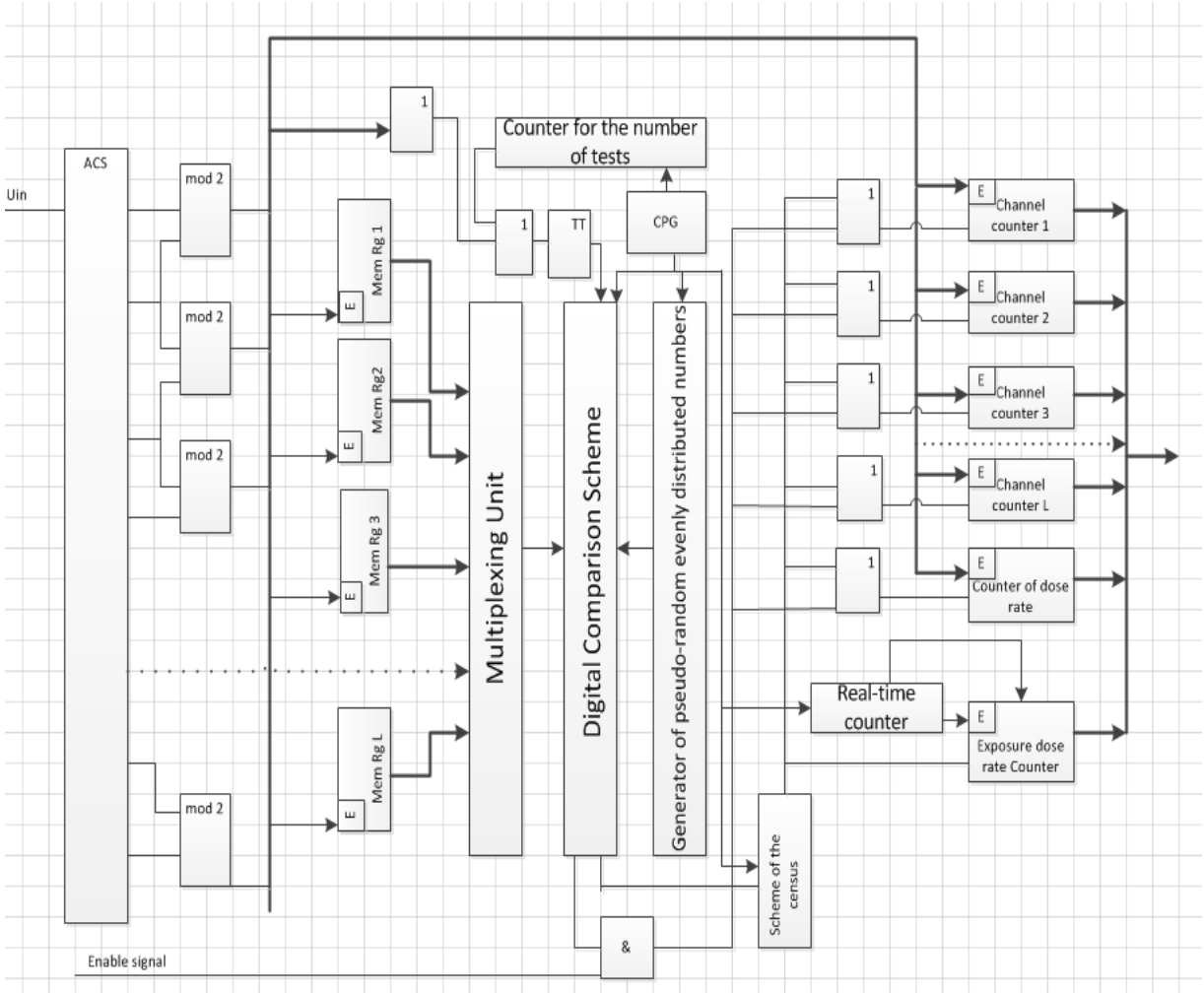
Range of gamma radiation in the spectrum of ionizing electromagnetic radiation



EDS PC with various compensation filters and their combination



Functional diagram of a probabilistic amplitude analyzer of a wide-range gamma-ray spectrometer of high accuracy



Conclusion

The paper solves an important scientific and practical problem of improving the accuracy of gamma radiation measurement in radiation monitoring at nuclear power plants based on the developed wide-range gamma spectrometer of increased accuracy, which implements the method of automatic compensation of ESR in the entire energy range of measurement (0.01-10.0) MeV, works on a real-time scale and has a small hardware volume. Based on the research, the following scientific and practical results were obtained:

It is established that the main factor of external radiation exposure at NPPs in normal operation and in emergency situations is gamma radiation with a total contribution to the total radioactivity of ≈ 85 %, with a continuous energy spectrum in the range from 0.01 MeV to 10 MeV, in which it is proposed to perform radiation monitoring..

It is found that the existing fleet of gamma radiation MMT often does not cover even the standard energy range (0.01 – 3.0) MeV. if the MMT are used to measure the dose and dose rate of gamma radiation in the proposed energy range, this leads to additional measurement errors, dispersion of results, and significant errors in calibration and verification operations.

It is proved that the existing methods of correction of EDS are reduced to the selection and combination of compensation filters with the calculated parameters-the filter material and the degree of perforation, but this approach allows to compensate for EDS only in a very narrow energy range and does not cover the entire necessary range from 0.01 MeV to 10 MeV.

A method has been developed for automatic compensation of EDS in the entire proposed energy range from 0.01 MeV to 10 MeV by introducing correction coefficients, which allows increasing the measurement accuracy by more than 200 %. A software package has been developed that implements this method in order to calculate the correction coefficients of EDS for detectors with specified characteristics.

A circuit solution is proposed and implemented – an amplitude analyzer of a wide-range gamma-ray spectrometer of high accuracy, which allows measuring the spectrum, dose and dose rate of gamma radiation in the entire proposed energy range from 0.01 MeV to 10 MeV with a given accuracy on a real-time scale.

The application of a probabilistic form of data representation is proposed, which significantly reduces the hardware volume of a probabilistic wide-range gamma-ray spectrometer of high accuracy and thus provides the possibility of its application when using unmanned vehicles for radiation monitoring.