Brief information about the project

Name of the project	AP09058014 «Physical features of the formation of large-sized silicon nuclear radiation detectors»
Relevance	Relevance and novelty: a deep theoretical study of the physical processes occurring in large-size nuclear radiation detectors with two-way diffusion and drift is a huge contribution to the creation of a theoretical basis for the physical features of the formation of Si(Li) p-i-n Know-how: a new method of obtaining silicon detectors of nuclear radiation by two-way drift and diffusion reduces the time of obtaining detectors by 4 times compared to the traditional method.
Purpose	The aim of the project is to study the physical processes in the manufacture of highly efficient nuclear radiation detectors based on large-diameter bulk silicon single crystals, as well as to study and optimize the physical processes of diffusion and drift of lithium atoms in semiconductor bulk crystals by exposing them to a temperature and electric field
Objectives	Study of the features of physical properties of silicon wafers with large diameters and thicknesses. Investigation of physical features of double-sided diffusion of lithium into a silicon monocrystalline of large volumes. Investigation of physical processes occurring in large-size silicon-lithium structures obtained by the method of double-sided drift of lithium ions. Study of the influence of inhomogeneities on the properties of silicon-lithium p-i-n structures of large sizes. Investigation of the effect of a pulsed electric field on the formation of large sized silicon-lithium detector p-i-n structure. Determination of physical conditions and operating modes for compensation of large-volume monocrystalline silicon. Study of the distribution of lithium ions and the accuracy of compensation for silicon - lithium p-i-n structures of large sizes. Study of the influence of interfaces on the electrophysical characteristics of large-size detector structures. Study of the electrophysical and spectrometric characteristics of the detector structures.
Expected and achieved results	*Results of the work*: the optimal lithium diffusion mode for obtaining large-diameter detectors (≥ 100 mm) with width of a sensitive layer of more than 4 mm was determined; mathematical models of the electric field distribution profiles during double sided drift were obtained, taking into account the influence of the counter electric field. A mathematical model of the particle trajectory under the influence of potential fields of crystal lattice inhomogeneities was obtained; it was found that a pulsed electric field accelerates the drift process and reduces the inhomogeneity degree in the distribution of lithium ions throughout the entire

	volume of the silicon crystal; temperature and drift compensation modes for silicon during detector manufacturing were determined. A flux density model of lithium ions in a silicon crystal with double sided drift was obtained; a method is shown for obtaining the optimal width of the dead layer of the detector, due to which the detectors have a very high level of current sensitivity. An equivalent circuit of a nuclear radiation detector was obtained, its electrical properties were studied, and simulations of the effect of alpha particles on the constructed equivalent circuit of the detector were performed.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	Джапашов Нурсултан, PhD, Индекс Хирша – 4, ORCID: 0000-0002-6338-8132 ResearcherID: A-8243-2015 Scopus Author ID: 57196373551 Сайымбетов Ахмет, к.ф.-м.н., проф. Индекс Хирша – 11, ORCID: 0000-0003-3442-8550 , ResearcherID: A-8265-2015 Scopus Author ID: 58529450500
List of publications with links to them	Saymbetov A. Muminov R., Japashov N., Toshmurodov Y., Nurgaliyev M., Koshkarbay N., Kuttybay N., Zholamanov B., Jing Z. Physical processes during the formation of silicon-lithium pin structures using double-sided diffusion and drift methods //Materials. – 2021. – Vol. 14. – No. 18. – P. 5174. https://doi.org/10.3390/ma14185174 Scopus: SJR 0.604, процентиль – 68, Q2 Web of Science: Импакт-фактор 3.748, Q2 Саймбетов А. К., Джапашов, Н., Нұрғалиев, М., Құттыбай, Н. и Қошқарбай, Н. Оптимальный режим двухсторонней диффузии в монокристалл кремния для детекторов ядерного излучения //Вестник «Физико-математические науки». – 2022. – Т. 78. – №. 2. – С. 82-86. https://doi.org/10.51889/2022-2.1728-7901.10. Nursultan Japashov, Ramizulla Muminov, Yorkin Toshmurodov, Ahmet Saymbetov, Zhang Jing, Madiyar Nurgaliyev, Nurzhigit Kuttybay, Nursultan Koshkarbay, Batyrbek Zholamanov. Double Sided Drift Method Reduces the Effect of Crystals' Inhomogeneity to Si(Li) Detector's ElectroPysicsal Characteristics // International Journal of Innovative Science and Research Technology. 2022.-Vol. 7 Issue. 9, - P.686-689. https://doi.org/10.5281/zenodo.7133897 Saymbetov A., Muminov, R., Jing, Z., Nurgaliyev, M., Japashov, N., Toshmurodov, Y., Koshkarbay, N. Equivalent circuit of a silicon–lithium p–i–n nuclear radiation detector //Scientific Reports. – 2023. – Vol. 13. – No. 1. – P. 1252 https://doi.org/10.1038/s41598-023-39710-5 Scopus: SJR 0.973, процентиль – 92, Q1 Web of Science: Импакт-фактор 4.6, Q2

	Saymbetov A. K., Muminov, R. A., Japashov, N. M., Toshmurodov, Y. K., Nurgaliyev, M. K., Kuttybay, N. B., Zholamanov, B. N. Optimal regime of the double-sided drift of lithium ions into silicon monocrystal //Physical Sciences & Technology. – 2023. – Vol. 10. – No. 1. – P. 19-25.
Patents	-