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Strangeness in nucleon and nuclei

The HyperNIS project

Report on 2019-2021 upgrade of the spectrometer

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Abstract

The experimental program of the HyperNIS project is aimed at the investigation of the role which strangeness plays in nuclei. The first part of the program is aimed at studying the lightest neutron-rich hypernuclei; in particular, it is necessary to establish firmly if the hypernucleus ${}^{6}_{\Lambda}$H really exists. It should be noted that in the same experiment the lifetimes and production cross sections of ${}^{4}_{\Lambda}$H and ${}^{3}_{\Lambda}$H will be investigated. If the existence of ${}^{6}_{\Lambda}$H is confirmed it will be naturally to push forward the investigation of ${}^{6}_{\Lambda}$H properties and the search for ${}^{8}_{\Lambda}$H, the most neutral nucleus among relatively heavy and complicated nuclei. The further experiment will be the study of ${}^{6}_{\Lambda}$He, the next step of this program is aimed to determine the binding energy of the loosely bound ${}^{3}_{\Lambda}$H hypernucleus.

The spectrometer has been upgraded: new readout electronics have been elaborated and installed, as well as new power supply modules for proportional chambers. The RPC wall has been installed for TOF measurements (slow pions), all modules of VME crate (TQDC, synchronization) are new, as well as server, trigger modules, high voltage and gas supply systems. The spectrometer is ready for the first hypernuclear experiments. Meanwhile, the spectrometer site can be adapted for the aparatus of Short Range Correlations experiment as well, and this possibility will be analyzed to present a new project for two experiments.

1 Introduction

The project is aimed to study the lightest neutron-rich hypernuclei; in particular, to search for (study of) ${}^{6}_{\Lambda}$H. Simultaneously, the lifetimes and production cross sections of ${}^{4}_{\Lambda}$H and ${}^{3}_{\Lambda}$H will be studied in the same experiment because we will use the reaction
^{7}Li + C $\rightarrow {}^{A}_{\Lambda}$H + K+ p(d,t,n)+ ... $\rightarrow {}^{A}$He + π^{-} + ... (where A=3,4,6). Moreover, the production of ${}^{4}_{\Lambda}$H and ${}^{3}_{\Lambda}$H hypernuclei is the precise reference signal to ensure that ${}^{6}_{\Lambda}$H should be seen or that there are no stable forms of ${}^{6}_{\Lambda}$H if it is not observed in the same run. This task is regarded as the very first experiment because in the Frascati experiment [1, 2, 3] the evidence of only three events was reported and controversial data were obtained at J-PARC [4], where no signal was detected (instead of the expected 50 events). However, it should be taken into account, that to produce ${}^{6}_{\Lambda}$H using ^{6}Li target, a double charge exchange reaction is necessary. The process is suppressed, and a lot of uncertainties should be solved to predict production rate. It means that J-PARC experiment cannot be regarded as crucial one. If ${}^{6}_{\Lambda}$H will be observed in our experiment we will change task to search for ${}^{8}_{\Lambda}$H hypernucleus.

The study of poorly investigated hypernucleus ${}^{6}_{\Lambda}$He will be a natural continuation of Li beam experiments. With carbon beams, the program can be extended by determining ΛN$\rightarrow$NN weak interaction effective Hamiltonian.

2 Physics motivation

The Hypernuclear program in Dubna [5, 6] was started in 1988 with the setup based on a 2-m streamer chamber. The investigation of the light hypernuclei production and decay [7] was carried out, namely, the lifetime of ${}^{4}_{\Lambda}$H and ${}^{3}_{\Lambda}$H, as well as their production cross sections, were measured. It has been shown that the approach, in which the momentum of hypernuclei produced in the beams of relativistic ions is close to the momentum of the projectiles, was quite effective for measuring of hypernuclei lifetimes and production cross sections. The dedicated and very selective trigger on two body hypernuclei decays with a negative pion was the key point of this approach. Threfore, the accuracy of lifetime measurements was restricted only by statistical errors. The values of the experimental cross section were in good agreement with the results of the calculations (refs. [8] of H.Bandō, M.Sano, J.Žofka and M.Wakai, see also review [9]) performed using the coalescence model. It should be noted that hypernucleus lifetime up to now remains an actual problem. At the Conference HYP2015 on hypernuclear physics (Sendai, Japan, 2015), a special section was organized to discuss the puzzle of the light hypernuclei low lifetime. Most of the measurements [10, 11, 12] have shown ${}^{3}_{\Lambda}$H lifetime values of 140-200 ps (155ps at STAR, 181ps at ALICE), while the theory predicts 240-260 ps (256 ps, H.Kamada [13], 233-244 ps, T.Motoba [14]). For example, see Fig. 1. At the next Conference controversial ${}^{3}_{\Lambda}$H lifetime results were reported by ALICE $\tau = 223^{+41}_{-33}(stat.)$±20(syst.)ps [15] and STAR $\tau = 142^{+24}_{-21}(stat.) \pm$ 29(syst.)ps [16].

In all previous hypernuclei experiments (except the above mentioned Dubna experiments and the Heavy Ion Beam experiment at GSI, Darmstadt [18, 19]) the hypernuclei are produced in various processes of target excitation. A common feature of all such experiments is the momenta of the produced hypernuclei are low and they decay almost at the production point inside the target.

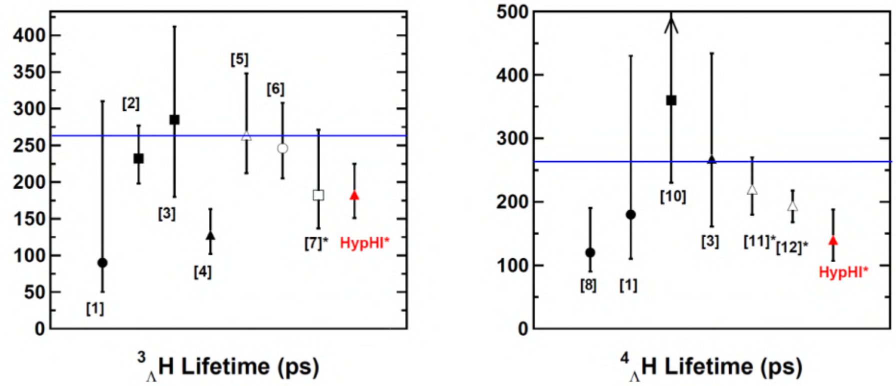

Figure 1: World data comparison of $^{3}_{\Lambda}$H and $^{4}_{\Lambda}$H lifetimes presented by Rappold in Proceedings [12] where references are listed. It should be said that the $^{4}_{\Lambda}$H lifetime value noted as [11] is the result of our previous experiment [17]. The values deduced in the HypHI experiment are indicated by "HypHI". The horizontal line at 263.2 ps shows the known lifetime of the Λ hyperon. References to counter experiments are marked by an asterisk.

On the contrary, in Dubna experiments [20], the energy of hypernuclei is only slightly lower than that of the beam nuclei. Therefore, the hypernuclei lifetime in the laboratory reference frame is increased by the Lorentz factor 3-7, and a significant part of the hypernuclei decays far behind the production target. Thus, the location of the decay vertices can be used for identification of the hypernuclei decay and for determination of the lifetime of the observed hypernuclei by measuring of their flight path distribution.

The HyperNIS program is focused on **the properties of neutron rich halo hypernuclei**. In the last time, the properties of neutron rich hypernuclei and double hypernuclei are highly anticipated to revise the theory (EOS) of neutron stars to solve the hyperon puzzle in this case. The baryon energy distribution in neutron stars predicts that a part of the baryons should be Lambda particles, but Lambdas can change most of temporary suggestions for EOS so that 1.4–1.5 of Solar masses should be limit, of a neutron star, while the mass of two of them is equal to 2 Solar masses [21]. Recently, the theory has suggested how to solve the problem [22] but new hypernuclear experimental data will help to choose the proper way.

First of all, the study of the $^{6}_{\Lambda}$H hypernucleus will be carried out with the ^{7}Li beam:

$$^{7}\mathrm{Li} + C \rightarrow ^{A}_{\Lambda}\mathrm{H} + \ \mathrm{p(d,t,n)} + \ldots \rightarrow ^{A}\mathrm{He} + \pi^{-} + \ldots \quad \text{where A=3,4,6.} \tag{1}$$

We have chosen the ^{7}Li beam because an extra proton from ^{7}Li can be stripped by fragmentation, while an additional charge exchange reaction is necessary if a ^{6}Li beam is used to produce the $^{6}_{\Lambda}$H hypernucleus. The probability of fragmentation is much higher then that of charge exchange reaction.

An evidence from Frascati for three $^{6}_{\Lambda}$H hypernuclei has been reported [1, 2]. In the concluding remarks at the closing of the 11th International Conference on Hypernuclei and Strange Particle Physics (held in 2012 in Barcelona) the first observation of $^{6}_{\Lambda}$H was mentioned by T.Nagae [24] as one of the four main achievements in hypernuclear physics reached during the last years. On the other hand, the E10 collaboration in the J-PARC experiment did not observe a missing mass peak corresponding to the $^{6}_{\Lambda}$H production [4, 23].

At this point one should note that in the Frascati and J-PARC experiments no hypernuclei were directly observed, only secondary effects like negative pions assumed as products of the ${}^{6}_{\Lambda}$H decay or the missing mass of a possible production reaction were determined. Since the statistics at Frascati were very low (3 candidates), and no signal was observed at J-PARC , the situation is controversial. Therefore, a crucial experiment can be carried out at the VBLHEP of JINR. The search for ${}^{6}_{\Lambda}$H with the HyperNIS spectrometer to obtain sufficiently high statistics (several hundred of detected events) should be done in order to measure the lifetime and production cross sections.

In fact, in the Dubna experiment, three isotopes of hydrogen hypernuclei (${}^{3}_{\Lambda}$H, ${}^{4}_{\Lambda}$H, ${}^{6}_{\Lambda}$H) should be produced simultaneously. It should be stressed that ${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H can be used as a "reference points" to confirm the production and decay of ${}^{6}_{\Lambda}$H. Of course, the lifetimes of all these hypernuclear isotopes can be measured as well.

It was also noted that a ${}^{8}_{\Lambda}$H hypernucleus can be possible. If the first experiment with ${}^{6}_{\Lambda}$H is successful, the following search for the ${}^{8}_{\Lambda}$H hypernucleus will be the most natural aim. We propose to use ^{9}Li beam for such an experiment. The ^{9}Li beam will be created as a secondary beam when carbon is accelerated. The chain of possible processes is as follows

$$^{12}\mathrm{C} + \mathrm{Al} \rightarrow {}^{9}\mathrm{Li} + \mathrm{C} \rightarrow {}^{8}_{\Lambda}\mathrm{H} + \mathrm{p} \rightarrow {}^{8}\mathrm{He} + \pi^{-} + \mathrm{p}$$

The lifetimes of ^{9}Li and ^{8}He are on the order of one hundred milliseconds, which is long enough for the experiment.

The expected production cross sections of the lightest hypernuclei are given in Table 1. New data from the present project will significantly improve the description of the hypernuclei production process. Taking into account these values, we have estimated possible counting rate for ${}^{4}_{\Lambda}$H pionic decays equal to 600 events per day in the case of ideal Nuclotron operation conditions (spill length of 5 s, no intensity pulsations, etc.). However, real tests have shown that this value should be reduced few times to 150-200 events per day.

The study of nonmesonic decays of the ${}^{10}_{\Lambda}$Be and ${}^{10}_{\Lambda}$B hypernuclei is planned in the present project as well. This study is aimed at the **determination of the** ΛN $\rightarrow$ NN **weak interaction matrix elements** and implies measurements of the branching ratios $\Gamma^{n\,(p)}_{\alpha\alpha\,i}$ for the exclusive decays of the ${}^{10}_{\Lambda}$Be and ${}^{10}_{\Lambda}$B hypernuclei [20, 39].

In such an experiment, one should register the chain of decays, for example, ${}^{10}_{\Lambda}$B which decays without the emission of a pion (nonmesonic decay) into ${}^{10}_{\Lambda}\mathrm{B} \rightarrow \mathrm{n} + \mathrm{p} + {}^{8}\mathrm{Be}^{*}$ with subsequent ^{8}Be* decay emitting two α's within a very small angle.

3 Spectrometer scheme

Configuration of the spectrometer is presented in Fig. 2. In the ^{7}Li beam nuclei interactions with carbon target (12 cm along the beam and 3×3 cm^{2} cross section, 20.4 g/cm^{2}), when hypernuclei (${}^{3}_{\Lambda}$H, ${}^{4}_{\Lambda}$H or ${}^{6}_{\Lambda}$H) are produced, pionic decay

$${}^{A}_{\Lambda}\mathrm{H} \rightarrow \pi^{-} + {}^{A}\mathrm{He} \quad (\mathrm{A}{=}6,4,3)$$

will occur inside the vacuum vessel with rather high probability. The Čerenkov and scintillation counters (trigger detectors B,C correspondingly) are tuned to measure the charge difference between the hypernucleus and its decay products. Taking into account that the resolution of the

Table 1: Measured and estimated hypernuclei production cross sections. Beam kinetic energy: GeV per nucleon; calculations are from ref. [8]. In ^{7}Li beam on C target we have measured [35] the cross section of the charge change $\sigma_{cc} = 650 \pm 20 mb$, this value is close to σ_{in}.

Beam	Hyper-nuclei	Energy (GeV)	Cross sec. (μb) Theory	Exp.
^3He	$^3_\Lambda$H	5.14	0.03	$0.05^{+0.05}_{-0.02}$
^4He	$^3_\Lambda$H	3.7	0.06	< 0.1
	$^4_\Lambda$H	2.2	0.08	< 0.08
		3.7	0.29	$0.4^{+0.4}_{-0.2}$
^6Li	$^3_\Lambda$H	3.7	0.09	$0.2^{+0.3}_{-0.15}$
	$^4_\Lambda$H	3.7	0.2	$0.3^{+0.3}_{-0.15}$
^7Li	$^7_\Lambda Li$	3.0	0.11	< 1
	$^6_\Lambda He$	3.0	0.25	< 0.5

Čerenkov counters is better, a block of four Čerenkov counters is used as B detector (as discussed above). Blocks of proportional chambers PC_1 (four chambers 38×38 cm^2) and PC_2 (two chambers 130×80 cm^2) register hits from the pion and the daughter nucleus (He), allowing the reconstruction of the decay vertex. In addition, the set of all proportional chambers (PC_{1-4}) is used to measure the momentum of the He nucleus. The chambers PC_{3-4} are of the same size as the chambers PC_2. With the ^{7}Li beam the full set of the chambers allows the detection of the secondary proton (p) or another Li fragment and the momentum separation of the hydrogen hypernuclei daughter nuclei – He isotopes. The scintillation counter SciHe is used to measure and record the signal amplitude at the location where ^{6}He daughter nuclei are expected to separate them between the tritium fragments produced together with $^4_\Lambda$H hypernuclei.

4 Experimental method

We underline four main features of the method elaborated at JINR. 1.) It is based on an idea to investigate high energy hypernucleus produced due to beam nucleus excitation. 2.) Such a hypernucleus decays outside the target that allows one to organize selective trigger and to identify produced isotopes separating the momenta of daughter nuclei. 3.) The trigger is tuned to find pionic decays of hypernuclei when the charge of the daughter nucleus is higher than that of the hypernucleus and no physical event can simulate such a charge (and consequently counter signal) relation. 4.) Decay products are forward collimated, therefore the spectrometer acceptance is high. 5.) We analyze events when the hypernucleus decay vertex is observed in vacuum, where no background interaction can simulate the decay. 6.) Momenta of different hypernuclei isotopes are

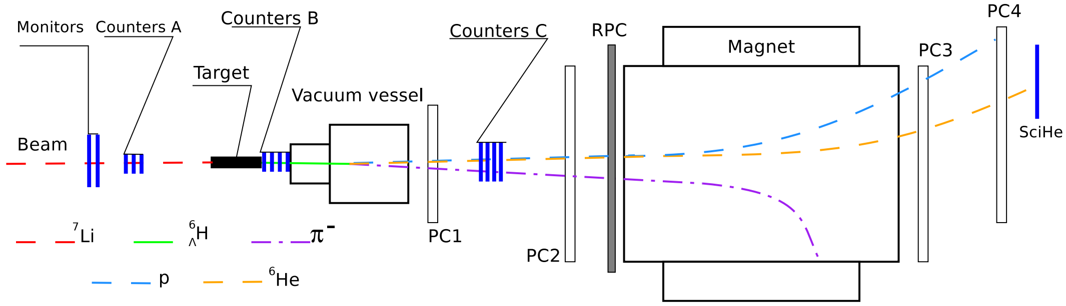

Figure 2: Configuration of the HyperNIS spectrometer. In particular for the search of $^6_\Lambda$H hypernuclei with the ^{7}Li beam (not in scale). Target – carbon 12 × 3×3 cm, 20.4 g/cm^2; beam monitors; A,B,C – trigger counters; vacuum decay vessel of 55 cm length; the analyzing magnet of 0.6T; PC_{1-4} – proportional chambers, RPC – TOF stations, SciHe – Scintillation counter to confirm registration of ^{6}He nuclei.

separated by large gaps (like momenta of daugter nuclei measured by the spectrometer), therefore it is easy to identify isotopes ^{3}He, ^{4}He and ^{6}He. In Fig. 3 we present the calculated ^{3}He, ^{4}He and ^{6}He momentum distribution for reactions

$$^7\mathrm{Li} + \mathrm{C} \rightarrow ^A_\Lambda\mathrm{H} + p(d,t,n) + \ldots \rightarrow ^A\mathrm{He} + \pi^- + \mathrm{p(d,t,n)} \qquad \text{(A=6,4,3)}.$$

for example, in the case of large possible momentum measurment errors (for example – 2%), but peaks are clearly separated.

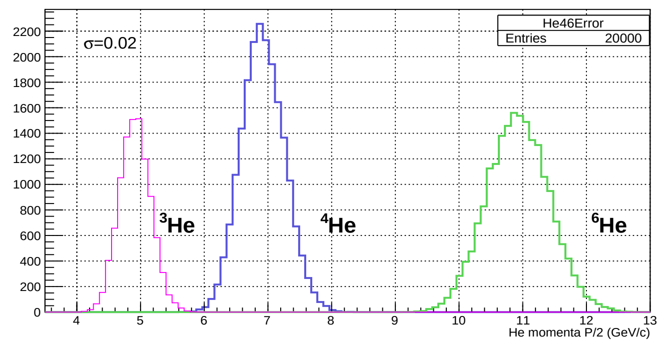

Figure 3: Expected distribution of He (hydrogen hypernuclei daughter nuclei) momenta values divided by their charge in case of 2% momenta error distribution. If $^6_\Lambda$H are produced $^4_\Lambda$H and $^6_\Lambda$H peaks can be easily separated.

In 2021 two GEM detectors of 40×40 cm in size will be obtained and installed in 2022 in order to reduce the number of events rejected due to a narrow opening angle (see below) and to increase the accuracy of hypernuclei decay point location. Thus, tracking efficiency will be improved as well. All MC calculations have been done to choose the optimal geometry of target and proportional chambers. We should remind that the decay products, pions and daughter nuclei, are forward collimated so that we could find chamber positions to register more than 90% of decay pions. Of course, all daughter nuclei hit proportional chambers.

The trigger aimed to detect pionic decays of hypernuclei was developed and successfully used in the previous experiment in Dubna [5, 7, 20]. When the $^6_\Lambda$H *hypernucleus is produced*, the Li nucleus should emit the spectator proton, while remaining core ^{6}He nucleus is being changed into $^6_\Lambda$H what later decays into helium and negative pion (the trigger is tuned to detect this decay

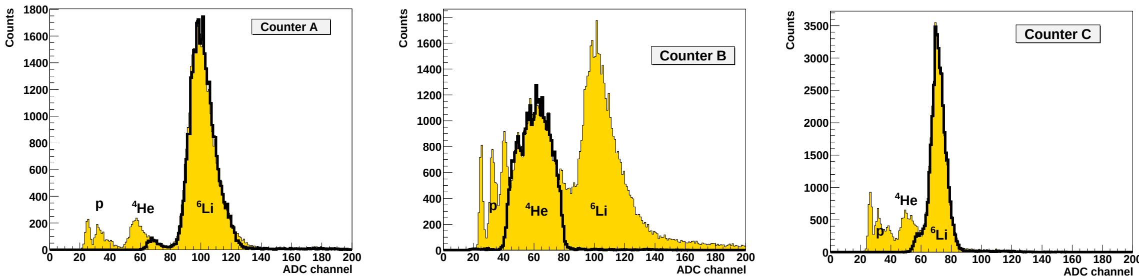

Figure 4: Tuning of trigger (scintillation) counters with ^{6}Li beam for $^{6}_{\Lambda}$He production and decay. Example of signal amplitude spectra obtained for counters of beam monitors A, counters of sets B and C correspondingly. Signal amplitude peaks correspond to the lithium beam and its fragments from interactions with Al target inserted into the beam to produce different lithium fragments: helium, protons, deuterons. The thick line contours part of the spectrum determined by discriminators of counters A and C, which are tuned to register lithium, counter B – helium. As it was mentioned, scintillation counters B are replaced with Čerenkov counters now.

channel). Since the trigger counter response is proportional to Z^2 of the interacting particle, the B and C counters create signals what allows to discriminate the $^{6}_{\Lambda}$H production and decay rejecting background. Counters SciHe (see Fig 2) are not a part of the trigger, their signals are recorded and used to check that ^{6}He was registered in chambers PC3, PC4 but not ^{3}H background. Some results of the trigger tests were presented in [40, 41].

As noted above, a significant part of hypernuclei decays only after the target. For example, if one assumes the $^{6}_{\Lambda}$H hypernucleus lifetime to be equal to 190 ps than the ^{7}Li beam of 27 GeV/c momentum (the highest value available at the beam line, 3.8 GeV/c per nucleon) produces hypernuclei with a lifetime at the laboratory frame of about 760 ps due to the Lorentz factor with a possibility to expect 70% of hypernuclei decays inside our vacuum vessel if it is located at a distance of 5 cm from the target. All MC simulations have been done to optimize proportional chamber location. See as an example Fig 5.

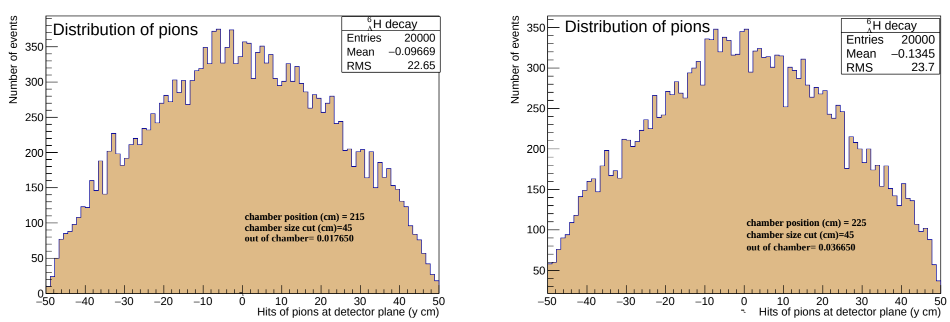

Figure 5: Pion hits at the last chamber to register pions. Geometric efficiency depends on a 10 cm shift of the target position in few percent loss. A distance of 215 cm is chosen for the experiment.

5 Last years results

During the Nuclotron run #50 the ^{7}Li beam was for the first time delivered to the spectrometer. The obtained beam time was used mostly for tests and tuning of the modernized trigger system in the new counting room (located in a new place in the experimental hall). The background suppression factor which is much higher than 10^4 was reached.

Recently, a new tracking upgrade has been performed, the software has become more effective. Some results of tests using MC generated events are presented in Fig. 6,7.

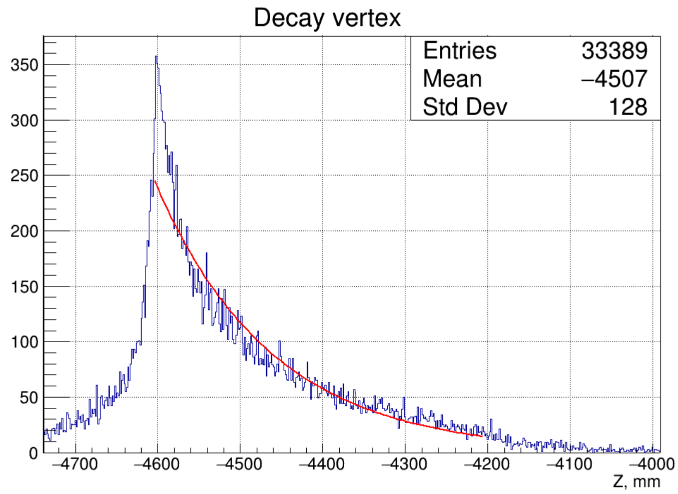

Figure 6: Properly reconstructed decay points allow one to measure the lifetime of the hypernucleus. Z=-4600mm is the beginning of the fiducial decay volume.

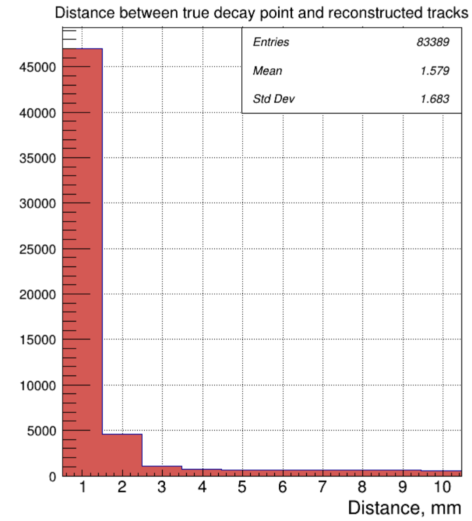

Figure 7: Decay points can be localized in two mm.

The most important improvement consisted of R&D and the production of new front-end electronics for proportional chambers. 200 analog signal cards (32 inputs in each card) were produced in Minsk. The digital part of the FEE cards (see Fig. 8,9) was designed and tested in JINR.

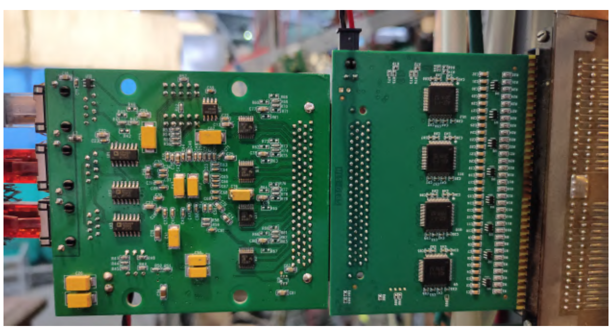

Figure 8: FEE cards: right – chamber output contacts and the analog signal amplifier part, left – the digital part for data processing and transfer.

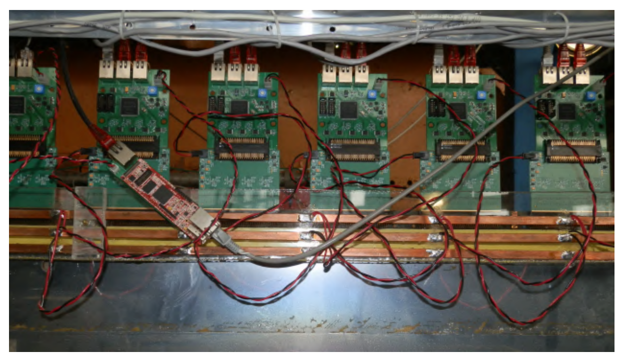

Figure 9: FEE cards on a proportional chamber.

Electronic modules of the trigger system were replaced with new ones too. All modules in VME crate (TQDC modules, data acquisition and service modules as well) and the main DAQ server are new.

Systems of on-line service – beam control, monitoring of chamber efficiencies, slow control for high voltage supply units and others were elaborated, tested and used. Since the beam intensity in the hypernuclei experiments is relatively low ($10^5 - 10^6 s^{-1}$), it was necessary to organize Internet access to the beam control data for the Nuclotron staff. Moreover, taking into account the experience of test runs, this system is upgraded from run to run. All data from trigger counters are available in the Nuclotron control room and can be used by the staff to improve the beam tuning.

A new High Voltage supply system was introduced for trigger photomultiplier tubes. It has up to 64 high stability outputs driven by the WIENER MPOD crate controller and programs adapted by HyperNIS personal. Proportional chambers are driven using CAEN high voltage supply modules. In the time, low voltage systems for proportional chambers were obtained and installed as well. Recently, a block of four Čerenkov trigger counters has been produced. the carbon target is located inside of the block close to the quartz radiators in order to minimize the losses of the observed hypernuclei due to decays (approximately 20% of the hypernuclei decay along the very first five centimeters after the target). The produced Čerenkov block was tested and the amplitude resolution higher than in the case of the scintillation counter block was obtained.

As a result, the spectrometer is prepared to carry out experiments dedicated to study neutron rich hypernuclei: the search for the hypernucleus ${}^{6}_{\Lambda}$H and the study of the properties, if it exists, the search for the ${}^{8}_{\Lambda}$H hypernucleus, the study of the hypernucleus ${}^{6}_{\Lambda}$H.
The most important technical result of the project is the commissioning of the multipurpose magnetic spectrometer with modern detectors and electronics which is ready for hypernuclear experiments using extracted Nuclotron beams. The spectrometer will also be available for other experiments (tests of detectors).

6 Present status of the apparatus.

After test runs on the Nuclotron beam, the HyperNIS spectrometer was commissioned. The extracted deuteron and ^{6}Li as well as ^{7}Li beams with kinetic energy of 1.0-3.5 GeV/nucleon and intensity of $10^4 \div 10^5$ 1/sec were used in the test runs of the Nuclotron.

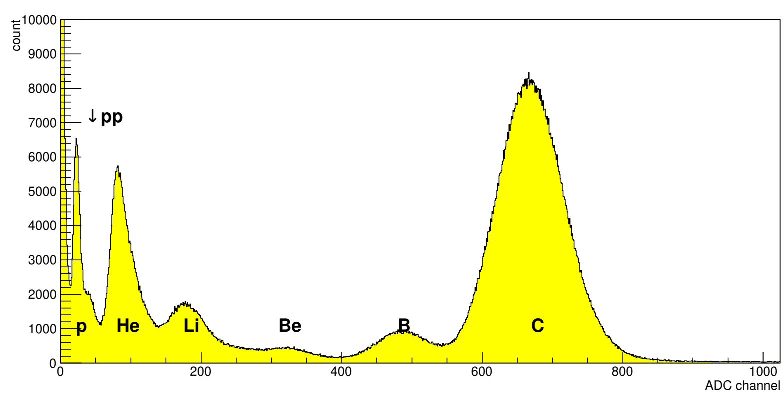

Figure 10: Amplitudes of a trigger scintillation counter measured with carbon beam and mixture of fragments (Al target in the beam).

To provide particles with different electric charges for the trigger tests, the ^{6}Li beam passed through the Al target. The composition of the resulted beam after the target is shown in Fig. 4. Similarly, counters response linearity and resolution was tested with a carbon beam (see the example of the carbon and fragment signal amplitude spectrum in Fig. 10).

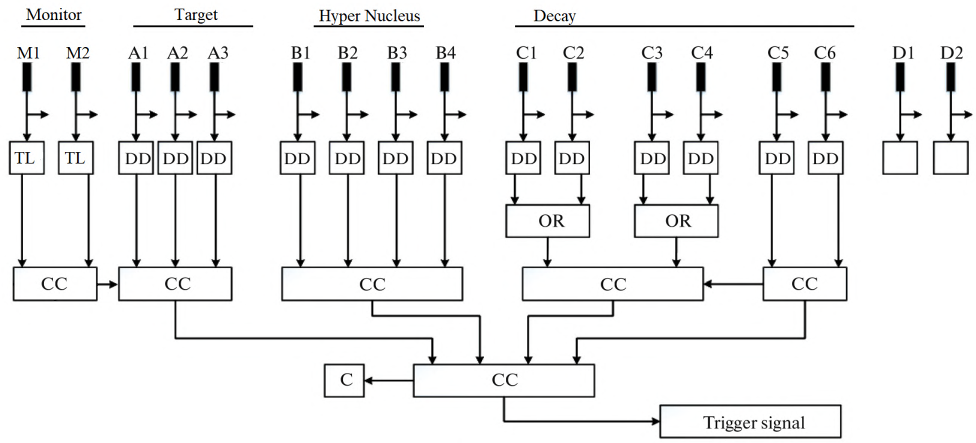

Figure 11: Trigger signal reception scheme: (filled rectangles) PEMs, (DD) differential discriminators, (TL) time locking scheme, (OR) logical adders, (CC) coincidence circuits, and (C) counting circuit.

It should be noted once again that the trigger electronics has been upgraded in the last few years. Therefore, any possibility to have a beam was used to test the trigger for the hypernuclei study. Even if the beam was not suitable for hypernuclear experiments. While early tests give background suppression of the order of $\sim 2.5 \cdot 10^3$ (see, for example [41]), background rejection of the order of $\sim 10^4$ was achieved when a test run with a ^{7}Li beam was carried out. It should be added that we use two triggers simultaneously. One of them is aimed to search for the hypernuclei production and decay, while the second one is organized to check that the spectrometer performance is OK. Since the hypernuclei trigger rate is low, the second trigger was tuned to detect events every 100 msec when the MIP particle crosses the counters and proportional chambers. This trigger was used for checking the efficiency of all the chambers and for on-line control in the analysis of systematic errors.

In case of detecting such a sequential change of the charge ($3 \to (1+1) \to \geq 2 < 3$) the trigger generated a signal as shown in Fig. 11 for

$$^7\mathrm{Li} + \mathrm{C} \to {}^A_\Lambda\mathrm{H} + p(d,t,n) + \ldots \to {}^A\mathrm{He} + \pi^- + \mathrm{p(d,t,n)} \quad \text{(A=6,4,3)}.$$

A test run with the high energy (A$\times$3.0 GeV) ^{7}Li beam and renovated trigger system located in the new counting room showed that the trigger can be tuned to suppress the background by a factor much higher than 10^4 [43].

7 Conclusions

The study of the properties of the lightest hypernuclei is relevant, has high importance and can be performed in JINR with beams from the Nuclotron. The trigger of the HyperNIS spectrometer works with a high suppression factor and efficiency. The installation and commissioning of the new FEE allow us to significantly improve the tracking efficiency and to carry out the proposed hypernuclear experiments. This can give answers to open questions in hypernuclear physics which are very difficult to answer with alternative methods and approaches. As it was proposed, **the**

spectrometer is the best tool for the search and study of $^{6}_{\Lambda}$H and $^{8}_{\Lambda}$H neutron rich hypernuclei, it has a significant advantage if one investigates the $^{6}_{\Lambda}$He hypernucleus. As it was analyzed, the spectrometer is also aimed at the determination of the $\Lambda N \rightarrow NN$ weak interaction matrix elements in the study of nonmesonic hypernuclei decays of $^{10}_{\Lambda}$B and $^{10}_{\Lambda}$Be. To solve these tasks for a research program for 5-7 years we can start data taking in 2022.

Taking into account that the spectrometer site is suited for additional detectors, there is a possibility to install Short Range Correlations (SRC) experiment detectors so that detectors of both experiments are partly used for two tasks. The option is being analyzed to present a new project.

At present, the HyperNIS spectrometer is being tested using beta sources and cosmic muons. It should be noted that the HyperNIS spectrometer and the beam line can be easily used to test detectors. HyperNIS test runs were used (and can be used in future) to test pixel detectors (TimePix) from Prague (IEAP), microstrip detectors for satellite experiment, etc. TimePix tests were carried out together with the Prague team. These tests provided good experience for young Czech researchers. Also, several students for JINR were trained. Upgrade of the spectrometer, tuning of new modules and counters, test runs have shown that the HyperNIS team is ready to achieve the proposed aims.

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