## 1. Project title

Design of the charge sensitive preamplifier for the studying of the properties of SHEs with using of the semiconductor detectors.

## 2. Introduction

For 40 years various theoretical models have been predicting the existence of the domain of the heaviest (the superheavy) nuclei. The elements close to the doubly magic spherical nucleus $^{298}114_{184}$ are called the superheavies. The main feature of the studying of such nuclei is their unknown decay properties. So, to identify the new nuclei from each other, which occur with very low probability (for example, one nucleus of isotope $^{288}115$ in 4-5 days of $^{243}$Am target irradiation by $^{48}$Ca) in complete fusion nuclear reactions, it is strongly necessary to measure their decay properties (energy and life-time) and position in the detector precisely.

In our experiments we employ the Dubna gas-filled separator (DGFRS) of the recoil nuclei. The separator is designed to collect the products of the complete fusion reaction on the focal plane and to separate them from the beam of the bombarding ions, elastically scattered nuclei and products of the incomplete fusion reactions. The synthesized nuclei are implanted into the focal-plane detector (see Fig. 1). This is composed of the 12 separate silicon semiconductor 4×1-cm$^2$ detectors (strips), each measuring the energy of the incoming nucleus and the energy of its α decay and spontaneous fission and also determining their vertical position on the detector surface. When a nucleus is implanted into some position of a strip its decay products, i.e., α particles or fission fragments should be observed in the same position. To register the α particles that escape the focal-plane detector the latter is surrounded by the eight side detectors (4 cm × 4 cm) forming a box-like structure with an open side that faces the separator.

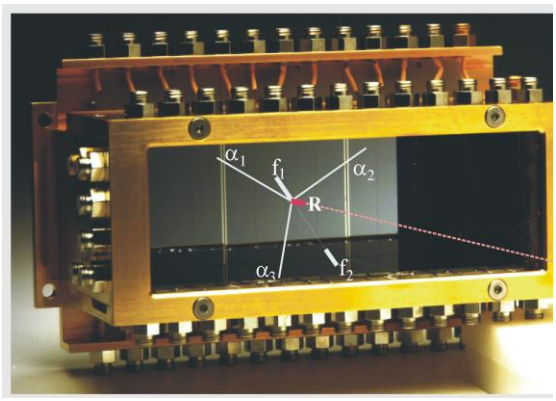


Fig.1. Focal plane detectors array

When a semiconductor detector such as Si (see Fig.2) is used for the detecting of charge particles (protons, ē, α-particles, fission fragments), the output signal is a weak charge pulse having a pulse width of several tens of nanoseconds. So, the main destination of the charge-sensitive preamplifier is to amplify this useful pulse with the best ratio to the noise.

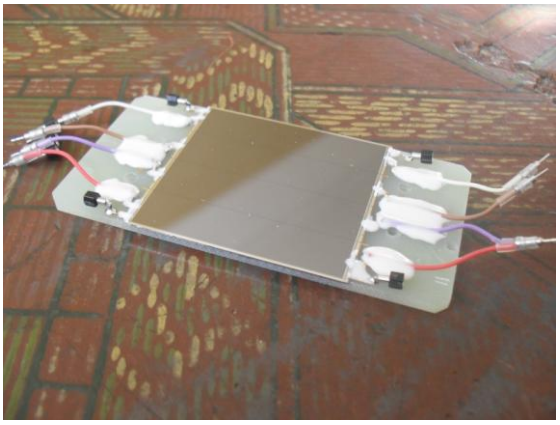


Fig.2. Si position sensitive PIPS detector

## 3. Description of project

a) Items that will be explained and discussed:

- Principles of the operation and the usage of the position sensitive silicon semiconductor detectors;
- Features of the detecting of the superheavy nuclei by DGFRS focal plane detector;
- Main demands for the construction of the preamplifiers of the detector's signal;
- Measuring tools for the study of the main characteristics of the charge-sensitive preamplifier

b) Main task of project:

The project is devoted to the explanation of all steps of operating of the semiconductor detector and the design of the appropriate preamplifier (Fig.3) for the getting truthful information about registered charge particle. The following steps of preamplifier construction will be considered: composition of the principal scheme of the preamplifier, calculation of the main components of the scheme, getting some practice information about the PCB layout of the precision analog schemes, soldering of the device's

surface mounting components, and researching the output characteristics, definition of the internal resolution of the unit and when apply Si detector.

c) Results of student's practical work:

Probationer will become proficient in the field of semiconductor radiation detectors, will get skill on soldering and employment of measurement tools. As a result, one can obtain the workable spectroscopic device (Fig.4), which could be used with a semiconductor detector for the studying of the charged particle properties.

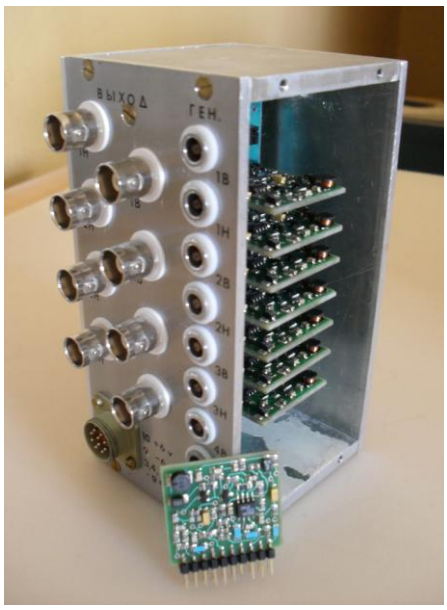


Fig.3. Preamplifiers' box for a position sensitive detector

## 4. Desirable level of knowledge

Foundations of electricity and analog circuits.

## 5. References

1. Subbotin V.G. *et al.*, Acta Physica Polonica B **34**, 2159-2162 (2003).

2. Tsyganov Yu.S. *et. al.*, Nuclear Instr.and Meth. in Phys. Res. A **525**, 213-216 (2004).

3. Goulding FS; Landis DA; "Signal Processing for Semiconductor Detectors", IEEE Trans. Nuc. Sci., NS-29, p.1125, (1982).

4. Radeka V; "Low-Noise Techniques in Detectors", Ann. Rev. Nucl. Part. Sci., 38, p.217, (1988).

5. Bertuccio G; Pullia A; "A Method for the Determination of the Noise Parameters in Preamplifying Systems for Semiconductor Radiation Detectors", Rev. Sci. Instrum., 64, p.3294, (1993).

## 6. Number of students

2-4.

## 7. Head of project

Dr. Alexey Voinov, head of measuring equipment group of sector N 1 "Synthesis and decay properties of superheavy nuclei", Flerov Laboratory of Nuclear Reactions.

Scientific interests: Synthesis and decay properties of the heaviest nuclei, nuclear electronics, charge particles detectors.

Scientific results: During last ten years we synthesized 38 new nuclides with proton numbers $Z$=104-118 and neutron numbers $N$=161-177 in the complete-fusion reactions of $^{238}$U, $^{237}$Np, $^{242,244}$Pu, $^{243}$Am, $^{245,248}$Cm, $^{249}$Bk and $^{249}$Cf targets with $^{48}$Ca beams. Six new superheavy elements 113-118 were observed for the firs time. Decay energies and lifetimes of the neutron-rich superheavy nuclei as well as their production cross sections indicate a considerable increase in the stability of nuclei with the approach to the theoretically predicted nuclear shells with $N$=184 and $Z$=114 and can be considered the experimental proof of the existence of enhanced stability in the region of superheavy elements.

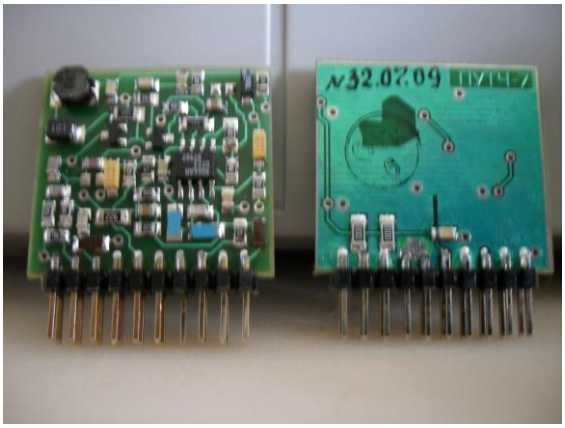
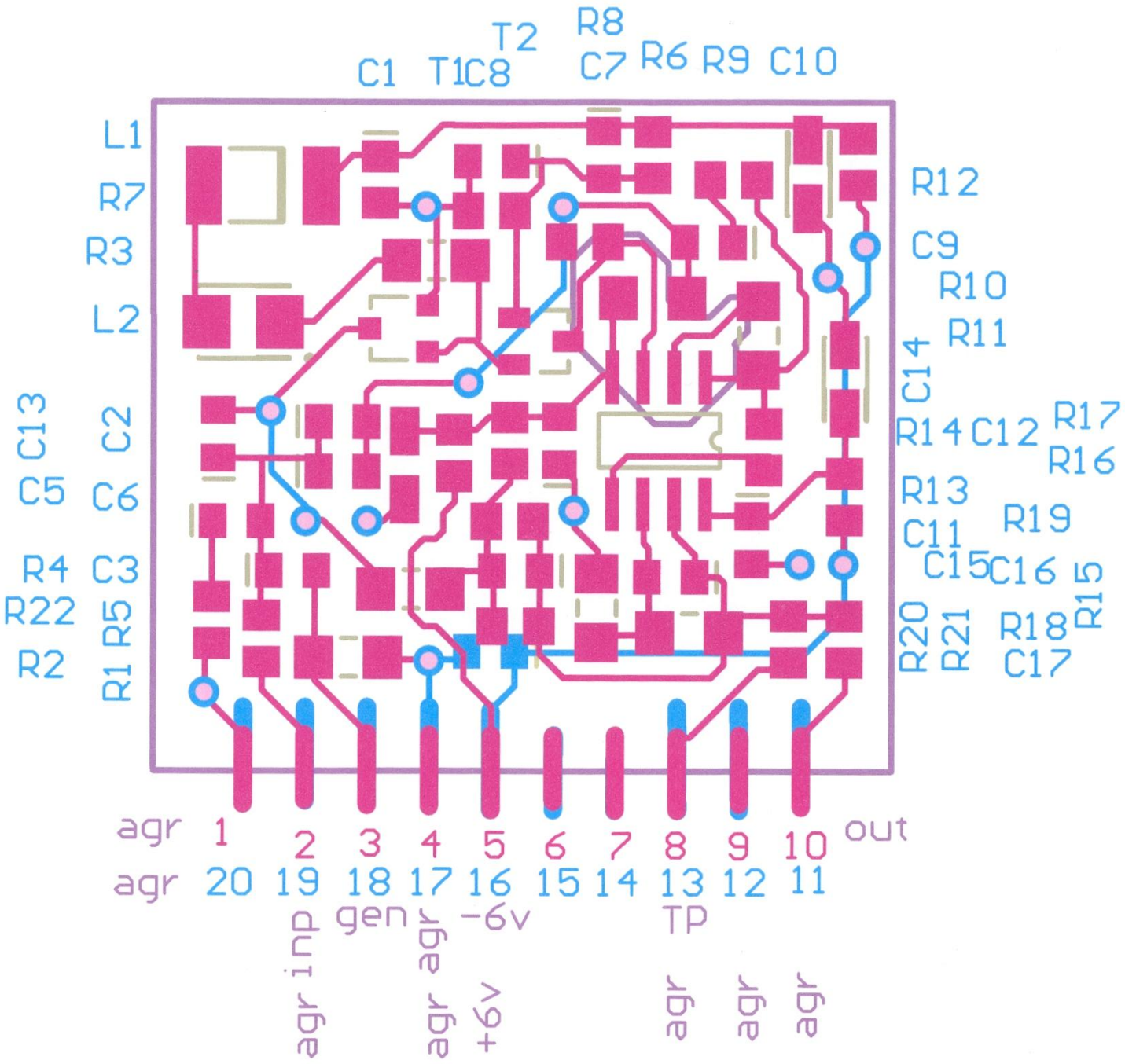


Fig.4. Charge-sensitive preamplifier for the one channel of the detector

http://flerovlab.jinr.ru/flnr/showme_mine.php?surname=VOINOV&name=Alexei&phone=64345


C1
T1
C8
T2
R8
C7
R6
R9
C10
L1
R7
R3
L2
C13
C2
C5
C6
R4
C3
R22
R5
R2
R1
R12
C9
R10
R11
C14
R14
C12
R17
R16
R13
R19
C11
C15
C16
R15
R20
R21
R18
C17
agr 1 2 3 4 5 6 7 8 9 10 out
agr 20 19 18 17 16 15 14 13 12 11
agr inp
gen
agr agr
-6v
+6v
TP
agr
agr
agr