4	NAME	**Lidija Nikolaevna Gall**
	Nominating Society	**Russian Society for MS**
	Supplementary Information and Description of Achievement	

Lidia Nikolaevna Gall

Biography of Lidia Gall is worthy of a novel, written by a professional writer. The following text describes just the most important milestones of her life in brief. She was born 1 September, 1934 in Leningrad in the family of an engineer. Due to very friendly and loving parents and relatives from her mother side coming from the Russian aristocratic intelligentsia, she was growing in the atmosphere of literature, music, and poetry at least in three foreign languages. The happy childhood was the basis of her fantastic optimism, which Lidia managed to keep through all her life.

Lidia and her mother were in the village Perekopovka in Ukraine 22 June 1941 when the II World War started for Russia. Due to the illness of Lidia they were not able to return immediately to Leningrad and thus managed to avoid blockade. Maybe this illness saved their lives as all their relatives died in 1941-1942 due to cold and hunger. Her farther was at the front and could not help them as well. Anyway at the end of August 1941 they decided to return to Leningrad. Refugees were traveling on the roof of the rail coach. One night the fascist aviation attacked their echelon. Lidia and her mother fell from the roof at the different sides of the coach. The echelon was burning while the plains were shooting people on the flyby. Panic threw people away to the night steppe. Some strangers took Lidia on their hands rushing from the fire. They tried to calm her as she was crying “Mama, mama”. Thus she lost her mother for long 5 years. All the war in the age 7-11 years she was along in the middle of the warring country.

The winter of 41-42 she spent at the banks of Volga in a childless family of Old Believers. They were trying hard to re-educate her mainly by regular beating. As soon as spring came she run away from them trying to reach Leningrad. As a result of numerous trips in a company of other homeless children she found herself in Ural region and spent the winter of 1942-1943 in an orphanage in Nizhniy Tagil. Once she heard by radio a speech of her grand mother. She decided to try to find her grand parents and in the beginning of summer of 1943 she run away from the orphanage with her playmate Rita and went to Udmurtiya. Unfortunately reaching Bolshaya Ucha village they did not find the relatives as they had moved to another place trying to save their younger son, heavily wounded in the Kursk battle. The winter of 1943-1944 she spent in that village. She went to school, directly to the 3d form. The next winter Rita and Lidia were already in Moscow, continuing their schooling and earning their leaving working as yard cleaners. They met the end of the war over there spending the Victory day at the Red square among the triumphant people. With the help of the teachers Lidia managed to find the address of her grand mother and in autumn 1945 she returned to empty Leningrad. Later on her parents one by another contacted their parents and found out that she was still alive. Thus she found again her family while Rita has remained her best friend through all the life.

In 1945 she entered the secondary school for the girls in Leningrad and graduated from it with a gold medal in 1951. She was extremely capable in all the disciplines while physics and mathematics were the favorite ones. However the major passion was for the theater. Simultaneously with the school she was studying in the Theatre Institute and was about to graduate from it. After 5 years of education she had to participate in her diploma performance. However at that time she faced the back side of the morals and manners of the theatrical media and having a tendency to strong actions she resolutely left the theater forever.

Lidia entered the physico-mechanical department of the Leningrad Polytechnic Institute and graduated

from it as a specialist in physical electronics in 1957 being one of the best students of the year ("red diploma"). During last years in the Institute she was fond of theoretical physics. She visited Moscow every week actively participating in the performance of the theoretical seminar of Landau in the Institute of Physical Problems of Academy of Sciences of the USSR. She prepared two diploma projects. The first one was presented at the chair of theory of Physics (supervisor Prof. Ter-Martirosyan) and was entitled "Stability of movement of protons in accelerator of protons". The second was dealing with modeling of the volume charge in electronic emission objective (supervisor academician Kelman). Both reports were successfully presented.

After graduation Lidia appeared in the laboratory of mass spectrometry of the Leningrad Special Design Department. Thus she started her life in mass spectrometry 1 April 1957. Isotopic mass spectrometry was declared as a priority issue of nuclear industry of the USSR at that time. The authorities of the Special Design Department decided to use young scientists for this research. R.N.Gall (future husband of Lidia) became the leader of the project, being at that time 30 years old, while Lidia became the head of the group responsible for the development of ion-optical system of the future instrument. The Russian mass spectrometry made its first steps at that time. The researchers did not have experience, but a lot of courage and even daredevilry allowing them proposing absolutely new technical solutions. This work resulted in creation of MI 1306 instrument. Many systems of this mass spectrometer were new: the mass analyzer with round borders and double focus, the deflecting detector accepting ion beam either on Faraday cap or on ion counter. Lidia is especially proud of the ion source with spatial focusing of the ion beam, allowing its successful passing through the mass analyzer. All the modern Russian solid phase instruments with surface thermo ionization use ion sources based on the principles of that (the first one). The parameters of the instrument were really impressive by that time: at $R_{5\%}$ better than 500 its sensitivity towards U was 10^{-15} g (10 attomol) with isotopic sensitivity 2×10^{-5} (in "The catalogue of the developed mass-spectrometers", MI-1306, NAUKA, Leningrad, 1973, in Russian). This design became forefather of all isotopic mass spectrometers of the Soviet nuclear industry, while the scientific ideas were reproduced in many commercial instruments.

In 1961 Lidia Gall proposed another original ion-optical solution – reversed geometry of ion optics in the double focusing scheme of Nier-Jonson (in "The catalogue of the developed mass-spectrometers", MI-3301, NAUKA, Leningrad, 1973, in Russian). In her opinion B-E version should have increased the isotopic sensitivity. Later this construction was reproduced all over the world in many instruments, but she was never cited. Anyway at that time she was busy with her young children and fighting for the priority seemed something not of priority level.

The corresponding serial mass spectrometer with this type of mass analyzer (MI 3301) was built in the USSR for the National Nuclear Center in 1965. Besides the analyzer Lidia Gall proposed and developed a new ion source with surface ionization and a direct channel hollow tubular ionizer made of wolfram foil. The parameters of the instrument were really unique: isotopic sensitivity 5×10^{-8}, absolute sensitivity 10^{-17}, i.e. 0.1 attomol or 60 000 atoms of U in the sample. Its resolving power $R_{5\%}$ was better than 2 500 (in "The catalogue of the developed mass-spectrometers", MI-3301, NAUKA, Leningrad, 1973, in Russian). These parameters look pretty good even now. That first mass spectrometer MI 3301 has been successfully used in the National Nuclear Center in Sarov for more than 30 years (till "Perestroika").

Later she participated in the development of 6 other isotopic mass spectrometers for nuclear industry and for geochronology studies. In her lab they managed to apply vertical focusing declining popular Kervin type of analyzers. She got her PhD in 1973 for the work entitled "Physical principles defining the ion-optical properties of ion sources for mass spectrometers". It is worth mentioning that due to closeness of the Soviet science the scientific exchange with the Western countries was extremely difficult. That is why an impressive

list of Gall's achievements in the field of ion optics remained unknown to the overwhelming majority of the researchers all over the world.

Be the end of 1960s the main direction of Gall's research shifted towards molecular mass spectrometry. She was a head of the laboratory developing new ion-optic systems and new mass spectrometers. The main task involved an increase of the resolving power without the loss of sensitivity. Thus she was developing a theory of static instruments mainly with electron ionization. Her main idea engaged application of the principles of transport of ion beams earlier used only in the calculations of particle accelerators. It is worth mentioning that her formulas proposed to calculate stability in accelerators are valid till nowadays (Journal of Technical Physics, 1977, v.47, №10, p.1618, in Russian). Now these formulas are treated as "traditional" as the last scientists who remembered the real author finished their carrier 10-20 years ago. The principles of ion transport put forward by Lidia Gall became a breakthrough as they allowed improving resolving power and sensitivity simultaneously. They were applied to all Soviet static mass spectrometers built in these years.

She did not pay serious attention to patenting issues, discussing her ideas with Soviet and foreign colleagues as well as representatives of mass spectrometry companies, including foreign ones, which became quite active in the USSR by the end of 70th. Probably due to this fact or due to exodus of Russian mass spectrometrists after the split of the USSR in 90th ideology of ion beams transport now represents the basis of ion optic calculations all over the world. Without this theory calculations of new separation systems, including TOF, are impossible. Mathematical principles have been changed nowadays, but the physical aspects are the same: calculation of emittance of ion beams and search for the beast version of their conjunction with the acceptances of mass spectrometric analyzers. Unfortunately the pioneer works of Lidia Gall have been never cited (i.e. Int. J. Mass Spectrom. & Ion Phys. 1983, v.46, p. 43-46). Anyway as she says she is very proud with this achievement as even the terms by that time were used neither in Europe nor in the USA.

There are two important achievements of Lidia Gall in the 70th. The first one is **a double focusing instrument MX 3301**, with resolving power 100,000. Lidia was responsible for the whole ion-optic system. She realized calculations of the electron ionization ion source, mass analyzer (E-B) and detector. The automatic processing of mass spectra was another feature of the instrument. Besides record parameters it had great maintenance characteristics. Due to these features it was very popular among the Soviet researchers and was actively used in many institutions of the USSR. **In mid-70th this instrument got the gold medal at the exhibition in Paris.** Unfortunately its use all over the world did not realize due to political reasons of the USSR.

There was another important effort committed in 70th. It involved the development of new prismatic optic for mass analyzers. This optic was used since 50th in β-spectroscopy being proposed by V.M.Kelman, who supervised Lidia work when she was a student. Already in 50th Kelman asked Lidia to test the applicability of this technique to mass spectrometry and the first paper on this issue was published by them in 1961 (Journal of Technical Physics, 1961, v.31, №9, p.1083-1091, in Russian)) . However the first attempt to build a mass spectrometer based on this theory was done only in 1979. Actually prismatic optics has unlimited possibilities to increase resolving power without any decrease of sensitivity. The calculations were done in collaboration with an institution in Alma-Ata (Kazakhstan) where at that time worked Kelman. The instrument demonstrated the record resolving power – 200,000. Unfortunately this direction was closed due to non scientific reasons. Anyway the instrument built in 70th is successfully used even now in the laboratory of Prof. Zelenov in the Institute of Energy Problems of Chemical Physics.

In January 1984 Lidia Gall successfully presented her D.Sc. thesis in Leningrad Polytechnic Institute, dealing besides the theory of beam transport in mass spectrometers with the new ionization method -

electrospray. It was a period of active penetration of mass spectrometry into the field of biology and medicine. The laboratory of Lidia Gall in Leningrad has actively started these studies as well. Unfortunately their works were not so famous in the world due to “iron curtain”. However it was already possible to meet well known mass spectrometrists in the USSR (for example in the laboratory of Victor Talrose). Lidia met there Barlington, Kebarle, Fenn. Western publications became more available to the Soviet scientists.

Field desorption and plasma ^{252}Cf desorption, electro hydrodynamic spray, thermospray and pneumo spray were tested and rejected. Finally **in 1979** the first experiments with the technique, **called in future electrospray**, started. The method was called ERIAD which is a Russian abbreviation for “Extraction and spraying of ions at atmospheric pressure”. **By 1981 the spectra of amino acids up to bradykinin, multicharged ions of insulin and non volatile salts were recorded.** The closeness of the Soviet science played a cruel joke with this invention. The authors were not able to publish their results in an international journal. Besides that the method was severely criticized by the leaders of the Soviet mass spectrometry. E.Skurat declared the results to be a fraud. A.A.Polyakova insisted that pouring water into a mass spectrometer was nonsense. V.Talrose rejected to back up the idea as well. That is why the corresponding publication was stopped for a couple of years and appeared in Proceeding of Academy of Sciences (Russia) only in **April 1984, (v.** 277, №2, p. 379-383). The Gall’s article became available to the international mass spectrometry community being translated and published recently in Rapid Communications in Mass Spectrometry (2008, vol.22, p.267-270). In 1979-1984, i.e. before the official publication, the results were reported at numerous scientific meetings in the USSR. Unfortunately these results were never mentioned abroad, as a visit abroad was not allowed to ordinary scientists, while V.Talrose refused to mention these results at the international meetings. The results were discussed with a number of foreign scientists during their visits to the USSR. In 1983 the authors had a fruitful discussion with John Fenn, who mentioned that their approach was very promising and he would definitely tried it in his lab. As a result the well known paper of Fenn appeared in **September 1984.** He never cited Lidia Gall. The result is known pretty well to the mass spectrometry community.

The first LC/MS instrument was developed in the USSR in 1985 and in 1987 the first serial LC/MS double focusing sector mass spectrometer 3301 with ERIAD ion source appeared. Together with A.Dodonov ERIAD interface was coupled to reflectron. However the resolving power did not exceed 500. Later A.Dodonov upgraded the instrument with an orthogonal introduction of ions into TOF analyzer which is now used all over the world.

At the same years Lidia Gall working with Yu.Golikov continued ion optic studies for TOF instruments and proposed field structure for the perfect focusing of charged particle beams. The Abel task for isochrone was resolved. This approach was used by Alexander Makarov in his development of Orbitrap. Alexander always cites this work (Scientific Instrumentation, 1989, p.3-7, in Russian).

The events of 1988-1994 in the USSR (Russia) were extremely painful for the Russian mass spectrometry and for all high tech disciplines as well. The new fundamental studies stopped completely due to the absence of any financial support. Thousands of Russian scientists went abroad. By that time Lidia Gall was interested in biophysics and physics of living systems. A series of articles was published.

Due to her optimistic and creative character Lidia Gall always has a lot of young scientists around her. She has supervised the work of more than 100 master students while 37 her postgraduate students became PhDs. They work all over the world, including Europe, USA, Australia. She still treats them as her children as she managed to give them her love to people, to science, to mass spectrometry. She is an author of 100+ scientific publications and more than 50 patents.

At the beginning of 21st century Russian nuclear industry was interested in new isotopic mass spectrometers. Lidia Gall headed the research and developed 4 types of instruments which is now commercially available in Russia: MTI-350G – for gases; MTI-350GP – for impurities; MTI-350T – for solids; and MTI-350GC – for sublimation. They provide a complete nuclear fuel cycle of Russian nuclear industry. The ion-optic scheme of these instruments was designed using all the previous experience. Thus the main instrument of the series MTI-350G is definitely among the best in the world taking into account its simplicity and efficiency.

Lidia Gall often remembers her teachers in the world of mass spectrometry. She names V.L.Talrose – the leader of the Soviet mass spectrometry and a recipient of the Thomson medal in 2004; V.M.Kelman – a classic of Russian ion optic and developer of prismatic ion systems; A.F.Malov – one of the creators of the theory of static mass spectrometers; A.M.Shershevskii – one of the founders of the Soviet mass spectrometry; R.N.Gall – her husband, who successfully worked in the field of mass spectrometry during the golden age of this discipline in the USSR. She specially names Larkin Kervin, as their discussions during his visits to the USSR in 60th gave her a great impact in her self-position as a scientist.

Definitely the major achievements of Lidia Gall involve static mass spectrometers. These instruments nowadays are not fashionable any more. However Lidia mentions that in her life there were a lot of trends in mass spectrometry. In the 60th it seemed that the future would belong to the double focusing static machines, in the 70th quadrupoles seemed to have great future, later ion traps, ICRs, now TOF instruments. The time made its corrections and all the instruments are occupying their own niches. Nobody can ague the mass range of TOF or unprecedented resolving power of ICR. However she believes that the new interest towards magnetic instrument is a matter of not a distant future. Only these instruments can provide an excellent shape of the mass line, allowing registering minor peak in the presence of major ones and ideal for the following mathematic processing. Maybe the new instrument she is now developing could be the first one in the raw of new generation of static mass spectrometers. The new instrument will have a completely new ion optic scheme and completely new design.

The mainstream of the scientific interests nowadays involves the discovery of the nature of life, understanding the structure and the essence of living systems. Lidia Gall started research dealing with physical model of living matter and discovering of the role of water in the self-consistent molecular foxholes of the living cells. She claims mass spectrometry could be of great help in these studies. As early as 1987 she registered peaks of the long series of water clusters using ERIAD to study magic numbers of the water structures. With the developing of the bases of biopolymer hydration in the living systems these studies could be revived at the new level. Her laboratory is deeply involved in the process of the development of new methods of ion formation and their introduction via gas-dynamic interfaces. The principal aim engages the increase of sensitivity and efficiency of molecules' identification, as well as new principles of study of hydrated molecules. Lidia claims that the new instruments will allow analyzing bio molecules in their natural aquatic surrounding, as only combination of water and macro molecules creates the bases of the phenomenon which is called "LIFE".