45. How the laser from Măgurele changes the world

How the laser from Măgurele changes the world. THE LARGEST SCIENTIFIC PROJECT from Romania PHOTO and VIDEO

09 feb 2012, 07:32 |

dan.arsenie | REALITATEA.NET

The laser from Măgurele – project which benefits of a record-financing in the amount of 293 million Euros – will be 1000 times more powerful than the most competitive laser which exists now in the world. If the project succeeds, after a few tens of years, a laser will be able to do the job of a huge particle accelerator. The one from Geneva has a diameter of 27 kilometers. The laser can be accommodated in a building of a few tens of square meters.

«
ELI-NP. This is how it will look, in 2014, the area which will house the project. We talk about 20 ha of land which is the property of the institute.
Image 1/9

»

What could do the laser? “An interesting application is to succeed the separation of the useful uranium by the not-useful one”, says Nicolae Zamfir, the director of the Institute of Physics and Nuclear Engineering “Horia Hulubei”. Such a result could have immediate economical implications. While the uranium 238 (an isotope of the uranium) is completely un-useful, the uranium 235 (another isotope) is the one used in reactors, for the production of electric power, for instance.

The separation of the un-useful uranium from the useful one

The separation could be done with the help of the laser. The uranium 238 is heavier, because it has three additional neutrons. Thus, a sample from an uranium deposit could be taken and with the help of the laser, we could accurately say if it is worth to be exploited, function of the abundance of the presence of the isotope 235.

Furthermore, on the basis of the laser, a method to measure the quantity of fuel from the bars of radioactive material could be found. At the moment when they were taken out of the production, some of the bars wasted for a long time their fuel, while others could be used for a while.

Processing of the radioactive wastes – a shorter neutralization time

But the laser could have also an immediate application, in the field of the nuclear wastes. These wastes have a very long neutralization time, of thousands of years. Therefore, these wastes are kept in huge and attentively-isolated warehouses. With the laser, the researchers can transform, by irradiation, the radioactive nuclei into nuclei with a smaller halving time (in the sense of the neutralization).

In Romania, the radioactive wastes resulting from the reactor from Măgurele are deposited at Băiţa Bihor. The dangerous fuel was also transported in Russia. But, states such as Germany that decided to greatly give up to the nuclear power, have thousands of containers with nuclear wastes that must be deposited somewhere.

A revolution of the prices – accelerator vs. laser

Another immediate application would be in medicine. At present, the hospitals buy with huge amounts of money accelerators for proton therapy. Shortly, these equipments send a beam of accelerated protons into a tissue, with the purpose to precisely destroy a sick cell, without affecting the surrounding ones. Such accelerators migrated from paper into practice, and Siemens built such equipments. The Universitary Hospital from Heidelberg, for instance, has such an equipment, for the simple reason that this medical unit from Germany can afford it. The cost of the equipment is of 100 million of dollars.

“It is a price which the hospitals from many European countries cannot afford and which will not significantly drop in time. Think a little: 100 million dollars for just one hospital. What to say about Romania? In exchange, the price of the equipments which use laser drops rapidly. A

simple pointer cost tens of thousands of dollars in the 60's, now it costs 2 lei", says Zamfir. Also in medicine, the laser could facilitate the production of radioisotopes very important for medicine. The radioisotopes (the radiopharmaceuticals) serve, in medicine, for the diagnose and the non-invasive treatment of some serious and frequently met illnesses, such as cancer or the cardiovascular illnesses. The biological molecules marked with medical radioisotopes are called "scorers" because when they are administered in very small quantities, they allow us to follow certain biological processes.

Radioisotopes for the medical use

The most common medical radioisotopes are produced in nuclear reactors. In 2008, the unexpected break of the activity of the three European reactors which produce radioisotopes led, in the European Union, to an acute lack of radioisotopes for the medical use (Molibden-99/ Technetiu-99m). The situation is the same worldwide, because the greatest producer of Molibden-99, the Canadian reactor National Research Universal (NRU) is closed for repairs from May 2009. Therefore, the request could be extremely high and the laser from Măgurele could be a supplier of such radioisotopes.

The laser acceleration that we talked about at the beginning is the long-term objective. Also on the long-term, the project ELI hopes to offer a solution for one of the greatest 11^{th} misteries which remained unsolved in the modern physics: the production of heavy elements, heavier than the iron, in the Universe.

What is ELI-NP

Extreme Light Infrastructure (ELI) is a project which is in progress in three EU states: The Czech Republic, Hungary and Romania.

In the Czech Republic, the project (the pillar) named Beam Lines will be implemented. "We talk about applications of the secondary beams", says Nicolae Zamfir. When the laser interacts with the matter, X-rays are also produced. The project of the Czechs will have applications in the study of the materials and in the life sciences.

In Hungary, the project has the name "Attosecond Facility". The Hungarian researchers will develop the laser with the precise purpose to obtain and study extremely short fascicles. To be more precise, we talk about fascicles whose duration is measured in attoseconds. An attosecond represents a time unit of a billion of billions smaller than the second.

"The dynamics to the cellular level is observed, and there is the chance to make successive photos during this process", says Prof. Zamfir. The immediate applications of the Hungarian Project will aim at the study of the materials and in medicine.

The project from Romania has the name ELI-NP. NP comes from Nuclear Physics. The powerful laser will act upon the electrons and ions of a material, these particles have to be accelerated with

speeds close to that of the light.

“It is for the first time when the lasers are used in order to accelerate particles in the purpose of the nuclear physics”, says Zamfir. “The idea is that, after 20 years, the lasers should represent an alternative to the existing particle acceleration methods. Think at the accelerator from Geneva, which measures 27 kilometers. With the lasers, we could do the same activity with a device installed in a building of a few tens of square meters”, explains the director of IFIN-HH. Compared to the Czech Republic and Hungary, where the studies will be performed exclusively on visible light, in Romania will have both visible and invisible light. To be more precise, we speak about gamma rays, which are very high frequency electromagnetic waves produced by the interactions between subatomic particles, such as during the radioactive disintegrations or during the collision and the annihilation of a pair electron-positron. On the basis of these rays, diagnose methods were developed for different conditions, one of the most interesting helps in the diagnosis of the extension of the cancer in the system. Nevertheless, the rays are so strong that they can divide, “break” the DNA molecule, in the case of a long exposure.

How and why Romania was chosen

First of all, we must mention that ELI is a project which offers a great chance for the researchers of the EU member states from Central and Eastern Europe. But, the institute from Măgurele presented various advantages in the battle for the financing and the implementation of the project.

The first laser put in operation at IFA (The Institute of Atomic Physics – the old name of the institute) is from 1962. Five years before this event, at Măgurele the first research reactor and the first cyclotron from Romania were put in operation. The production of radioisotopes, one of the purposes of ELI-NP is an activity which the institute develops since 1974. The same year, the institute was supplied with a tandem accelerator and a center for the processing of the radioactive wastes.

In 2000, in collaboration with another two European countries, a multiple purposes irradiation center was open at Măgurele, the project was called IRASM.

How powerful is the laser

7-8 years ago, the European Union started to discuss about the development of a laser 1000 times more powerful than the one existing at that time. Today, the situation of the lasers in the world did not change very much. They still work at the level of the terawatts (the terawatt is a unit with a power of a billion kilowatts), while at Măgurele they want to build, in the final version, a laser of a few hundred of petawatts. A petawatt equals 1000 terawatts.

“It was noticed that the step towards a few hundred petawatts is too big. So, it was decided a two-steps development”, says Zamfir. So, first, at Măgurele two lasers of a few tens of petawatts will be built and the best form for their synchronization will be studied. Then, several lasers will

be synchronized and powers of hundred of petawatts will be obtained, the objective of ELI-NP.

Important data:

- the white book of the project was submitted in 2010

- the project was evaluated by Jaspers, an institution with a support role in order to obtain the European financing

- Jaspers gave its OK for the project, which was qualified for a financing from BERD and CE. This happened in the summer of 2011

- the technical project was finalized in December 2011

- the start of the construction, planned for the autumn of 2012

- the finalization of the construction, planned for the autumn of 2014

- the first step of the research infrastructure, in 2015

- operational in December 2016

The financing of the project is of 293 million Euros. 17% of this amount comes from the state budget, the rest of the amount is European money.