



## Basic information about the project

# ELECTRON SYNCHROTRON AS THE MOST APPROPRIATE INVESTMENT INTO RESEARCH AND DEVELOPMENT

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*Almost everything that distinguishes the modern world from earlier centuries is attributable to science*

*Bertrand Arthur William Russell*

At Christmas two years ago, I was considering the issue of what type of big research investments would be the most convenient for the Czech Republic. I was surprised at advantages of electron synchrotrons (ESs). These are employed as sources of very intensive light, which is utilized for both research in various fields and development of technologies applied in a private sector. The electron synchrotron is a very popular type of accelerator. In the world, there are approximately 100 such facilities; and 20 which are under construction or have been finished recently. In Europe, there are 18 synchrotrons, two of which, namely DIAMOND and SOLEIL, have been put into operation recently; ALBA and MAX IV are under construction. All these new ESs have electron energy of 3 GeV, as well as the new accelerator NSLS II in Brookhaven, USA. The parameters of these medium-size facilities, the cost of which ranges from € 200 to 400 million, have parameters approaching the largest and more expensive ESs, which were built earlier. Therefore, I decided to clarify progressively possibilities of an electron synchrotron establishment in the Czech Republic and to compare its advantages and disadvantages with other types of scientific investment projects.

*Thinking about the above risen question, i.e. what type of scientific investment project is the most convenient for the Czech Republic, we need to take into consideration such general criteria as a fundamental and long-term increase in the level of research and development (R&D), an achievement of a real and massive international collaboration, an assurance of realization and operation, etc. There are more ways how to achieve these aims. Beside investments consisting of establishment of big solitary facilities (such as a reactor, accelerator, neutron generator, free-electron laser ...), it is a case of large R&D centres, which include construction of buildings and equipping of them with commercially available devices (hereinafter referred to as centres), or projects of extensive additional equipping of existing research capacities with missing devices (hereinafter referred to as distributed investment). All cases are very meritorious acts. Nevertheless, certain aspects of particular types of the projects differ.*

Obviously, establishment of the above mentioned centres and equipping of them with numerous commercially available devices, which are less expensive in comparison to large facilities, increase the research and development (R&D) level of the establishing subjects. Besides, founders of these facilities become more attractive for young scientists and experts from abroad. Hence, a certain expansion

of R&D is possible to plan. Nevertheless, if we take the point of view of an excellent foreign scientist, we will realize that such scientific centres are not attractive for them (with a possible exception of the most expensive equipments). If we add low salaries in the Czech Republic, we will further realize that the contribution of these projects to integration in the European research area may be even less explicit. Some Czech scientists currently working abroad will probably return, which will increase the effectiveness of the investments. However, the “wave” of such “repatriation” is not probable to be huge though. Moreover, devices which are commercially produced and available on the market become morally obsolete rather quickly; hence the investment is to be renewed rather soon. For this purpose, enormous financial means are necessary to procure and invest annually (15 % for modernization and another 10 % for operation). Thus, a question rises of how reasonable it is to focus merely on establishment of R&D centres, the significance of which is – as the above mentioned reasons prove – rather regional. As a matter of fact, the cardinal question of R&D is how to employ the available financial means most effectively.

*Under the terms of the Operational Programme Research & Development for Innovations (OP R&DI), more than € 2 billion is supposed to be invested into R&D in the Czech Republic, mainly from the Structural Funds of the EU. These means are to be employed in regions that qualify for funding, i.e. outside Prague, to improve the efficiency of the CR in the field of R&D. As far as research is concerned, a well known fact is easily obtainable at publicly accessible databases (e.g. Web of Science) that the vast majority of research is conducted in Prague, a lesser part in Brno (approximately 1/3 in comparison with Prague), and the other regions of the CR altogether contribute to the Czech research productivity to the similar degree as Brno. As setting the programme, a key question rises of what type of investment into Research and Development for Innovations is the most convenient in those regions which can benefit from the OP R&DI, and what area would be convenient to invest into. This is crucial particularly in a case of so called “major projects”, i.e. projects over € 50 million. With regard to the fact that a scientist can be educated merely by another scientist, the most convenient areas for investing into R&D are logically surroundings of Prague and Brno. Naturally, the other regions can employ certain means, yet their real absorptive capacity is significantly lower. Major projects are not to be utilized efficiently for R&D in such regions where a certain level of R&D has not been achieved.*

In comparison with regional R&D centres, an electron synchrotron is a more demanding investment, because it is impossible to purchase. It has to be constructed gradually. In addition, its establishment is criticized from different sides. Some people say: “we do not have experts who are familiar with the issue,” some argue: “why to build it if we can leave for other ESs in the EU to work,” others ask: “who assures finances for the operation?” Nevertheless, what are the real facts connected with synchrotron operation?

*In a region where a medium-size ES has been established, there is a rapid increase in cutting-edge R&D in numerous fields of science and technology. Scientists come to this region not only from the wide surroundings (200–300 km) but also from more remote places, depending on what unique parameters the particular facility provides. The region becomes a junction where experience and the most up-to-date findings on research and new technology results are exchanged. These findings are absorbed by the research community concentrated around a synchrotron. The process itself of designing an accelerator and particular experimental facilities is an inherently international activity – otherwise, it is impossible for the project proposal to be formed. Beside the significant increase in the R&D level, the ES creates an outstanding perspective for industrial technologies. ESs are even considered to be a decisive power driving the future development of modern technologies, such as biotechnologies, nanotechnologies, etc. An apparent disadvantage of the ES consisting of a complicated establishment becomes an advantage, taking into consideration that the ES utilization is up to 30 years, hence a potential delay in establishment or utilization is not to depreciate the investment (on contrary to centres in which an immediate utilization is necessary to assure). The investment is not to be renewed soon, and – what is necessary to emphasize – operation finances are reduced to approximately 10% of the acquisition costs of the investment (which is significantly less than at regional centres of R&D, the operation and modernization costs of which reach 25%). Another important advantage related to the ES establishment consists of participation of companies in the establishment, the result of which is a significant upgrade of high-tech industry. In fact, the invested financial*

*means are employed twice. Frequent talks between the academia and private sector are to increase the cultural level of these relations.*

After due consideration, I started to examine the feasibility of an ES establishment in the Czech Republic. First of all, I concentrated on the smallest and cheapest facility, namely AURORA 2D. This ES is acquirable at approximately € 10 million as an ensemble, including guarantee, service – in short “key ready”. Moreover, the number of technicians who operate this ES is quite small, e.g. the University of Hiroshima employs only two technicians, one of whom being a student, to assure the AURORA 2D synchrotron maintenance. Having examined the parameters, however, I understood the lack of interest in this ES in the world. The features of the light generated by this ES are comparable to other laboratory sources of light (lasers). Beams of precisely defined wavelength are impossible to produce by this ES (with exception of so called undulators), a microbeam is impossible to create, etc. Talks with Joan Bordas, director of the ALBA project (the medium-size ES) in Barcelona, confirmed my confidence that such an ES as the Spanish ALBA is what we should endeavour to establish in the Czech Republic if we want to invest effectively the finances for R&D from the Structural Funds of the EU.

With regard to the industrial tradition of our country, I believe that we will be able to manage successfully both the establishment and subsequent operation of the facility. We are not to be left on our own – we are to be helped by an extensive international community of scientists. With respect to our cultural tradition, I hope for us to be united enough and for the establishment of the Central European Synchrotron Laboratory – CESLAB – to be supported not only by scientists from the branch but also by the significant part of our public, ministry officials, politicians, etc. Unity is fundamentally needed for realization of our intent. I believe that as the establishment has been finished we will be proud of having an outstanding and top-ranking facility, which is not only to attract scientists from the whole world but also to enable numerous findings to be achieved, many of which are to be recorded in our children's textbooks.