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The South East European (SEE) region is an integral part of Europe but needs the help of other European countries to develop a sustainable economy and social cohesion. The creation of an international institute devoted to sustainable technologies would be an essential element in such endeavours. Scientific and technological cooperation, including knowledge transfer and training of the younger generation, would strengthen innovation, improve information exchange, and enhance human capacity-building.

A large-scale scientific research facility that promotes excellence and engages in internationally competitive activities would provide a significant means of addressing common challenges. Since the development of such a facility cannot be realized by a single country, it requires regional cooperation, and thus the primary mission of attaining scientific excellence would be complemented by peaceful collaboration in a region with a history of considerable political friction.

An initiative to this end was first presented to the World Academy of Arts and Sciences in 2016, and the government of Montenegro, a country which has good relations with its neighbours, was the first to officially support such a proposal regardless of the final location of the scientific facility. Thanks to the engagement of the Montenegrin Minister of Science, Sanja Damjanović, a meeting of Ministers of Science or their representatives took place on 25 October 2017 (see Fig. 1.1), in which a Declaration of Intent was signed to create an international laboratory in the SEE region with the double objective, following the spirit of CERN, of promoting science and technology and improving relations between countries. To demonstrate that all signatory parties are treated on an equal level and have the same rights, the meeting took place at the neutral premises of CERN and was chaired by H. Schopper, a former Director-General of CERN. The eight parties signing the declaration were Albania, Bosnia and Herzegovina, Bulgaria, Kosovo**, the FYR Macedonia, Montenegro, Serbia, and Slovenia. Croatia also agreed to participate, but for formal reasons had to delay its signature. Greece participated as an observer. In the Declaration of Intent it is stated that the institute shall operate with the mission of ‘Science for Peace’ and that the parties have a common vision and encourage the cooperation of their researchers.

Thus, this initiative to establish a ‘SEE institute for sustainable technologies’ has become a regional project. It was also decided to set up a steering committee to guide future decisions.

The success of a similar initiative following the CERN model has been demonstrated recently by the SESAME Project in Jordan, which unifies member states with different political systems and religions in the Middle East, all of which work peacefully together.

Two options are being considered for the initiative:

- i) 4th Generation Synchrotron Light Source for Science and Technology (SEE-LS);
- ii) Facility for Tumour Hadron Therapy and Biomedical Research (SEE-HTR).

These two options have been proposed because of their outstanding promise in achieving the objectives of promoting cooperation in science, technology, and industry, and facilitating the education and training of talented young people and engineers based on the transfer of knowledge and technology from European centres.

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**This designation is without prejudice to positions on status and is in line with UNSC 1244/1999 and the ICJ opinion on the Kosovo Declaration of Independence.

Two groups of international experts have worked out conceptual designs for the two options. These designs are presented in this document. In some respects the two options offer similar benefits to the SEE region, but they also have different and complementary aspects that justify the presentation of both.

The first objective, which both options have in common, is not only to extend existing research activities but also to create completely new opportunities for cutting-edge research and technological development for the welfare of the region. Secondly, it is hoped that, by struggling and working together towards a common goal, the human relations between scientists and engineers as well as between administrators and politicians from countries with different and sometimes problematic histories will be an essential element in building up mutual trust, as has been successfully demonstrated by the examples of CERN and SESAME.



Fig. 1.1: Representatives at the signing of the Declaration of Intent. From left: Prof. Blazenka Divjak, Minister of Science and Education, Republic of Croatia; Prof. Vladimir Popovic, State Secretary, Republic of Serbia; Dr Tomaz Boh, State Secretary, Republic of Slovenia; Mr Ervin Demo, Vice Minister of Education and Sports, Republic of Albania; Mr Shyqiri Bytyqi, Minister of Education, Science and Technology, Kosovo[‡]; Dr Sanja Damjanović, Minister of Science, Montenegro; Prof. Herwig Schopper, former Director-General of CERN; Prof. Renata Deskoska, Minister of Education and Science, The FYR of Macedonia; Mr Andrija Pejovic, Minister of European Affairs, Montenegro; Dr Adil Osmanovic, Minister of Civil Affairs, Bosnia and Herzegovina; Prof. Kostadin Kostadinov, Advisor to the Minister of Education and Science, Republic of Bulgaria; Prof. Costas Fountas, scientist, Hellenic Republic.

Both options also have in common that training of the younger generation is an essential and integral part of the initiative. Realization of these projects will take several years, which would provide sufficient time not only to train the team that will build and later operate these installations but also to form a user community. In both cases, specialized users in the important fields that will be served by the facilities do not yet exist in the SEE region and have to be created. This will be an essential part of capacity-building. The training will mainly consist of two parts. First, fellowships will be granted to young people so that they can go to European laboratories for one or two years to receive education and training as scientists or engineers in various specialist fields. The management of such a programme would be the responsibility of the projects, which will select promising candidates from the region and find laboratories to host them. The second component of training is the organization of workshops and schools for future users. This would be done by a training programme committee to be set up under the initiative. Contacts have already been established with IAEA at Vienna, and the hope is to obtain financial contributions for such a training programme, as in the case of SESAME.

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Transfer of technology and know-how in general are also vital parts of the initiative. In order to make this efficient, for both options it is suggested not to order the basic accelerator complexes as a unit from industry but rather, with the help of existing experts and laboratories in Europe, to create the appropriate team for the facility in question. This is the usual way in which most scientific laboratories have been created in Europe. Only conventional equipment would be bought off-the-shelf from industry; for new developments, prototypes will be ordered, and later production contracts will be awarded to industry. This allows for great flexibility in using the most modern technologies for the projects and, as experience has shown, provides an extremely efficient means of technology transfer to industry. It also reduces the total cost of the projects, as the global risk burden is not placed on the shoulders of industry. To facilitate collaboration with industry, it is envisaged that a kind of ‘training programme for and with industry’ will be established, with the task of explaining to firms not yet in contact with research institutions how to cooperate and how to present proposals for adjudication of contracts.

With the construction of the SEE-LS there will be many opportunities for technology transfer to the SEE countries. First, procurement of the different components for the machine and beam lines (magnets, vacuum system, girders, power supplies, control system, etc.) can be preferentially assigned to local industries. Wherever the capabilities of local industries are lacking, a joint R&D programme for pre-series prototypes could be established, thus promoting these industries. The prototypes should be manufactured in the SEE-LS member countries by giving their industries special education/training from other synchrotron radiation light source (SRL) facilities and from the staff of the SEE-LS. With production of the prototypes, the member countries’ industries should be encouraged to respond to a later call in the tendering process. As for the procurement of components, it will be necessary to educate the local industries in how to bid successfully according to the procurement rules of the most advanced EU countries.

We believe that, like the training programme, the technological know-how transfer programme outlined above would help to create a skilled community of scientists who will be attracted to working at the facility and will no longer seek employment elsewhere in Europe, thus reversing or ameliorating the brain drain suffered by the region.

Finally, it should be mentioned that both projects could give rise to spin-off activities not directly linked to the facilities but which can provide an initial spark for new activities in the region. We mention two examples. Both of the proposed facilities are based on particle accelerators and so need electric power, which would account for a non-negligible part of the operating costs. To reduce the cost of electricity, one could consider installing solar panels. This should not be done for the facility in isolation, since power is needed also when the sun is not shining; on the other hand, solar-generated power can be supplied to the general network when the accelerator is not working. Therefore, such an installation must be integrated into the regional power network. A second spin-off development might be the creation of regional broadband digital networks. Both facilities would serve large user communities, spread across the region and even all of Europe. To transmit data from the central laboratory to users, a network constructed for the facility and its users could become a model for a wider network for the region, much as the World Wide Web originally created for users of CERN has become a global network.

In some respects the two options presented are quite different, however, which justifies their individual consideration and is part of why they are attractive in complementary ways for the region. We discuss a few aspects in which they differ.

The two facilities would serve quite different ‘user communities’. An SRL would be attractive to scientists in universities and in many fields of industry, ranging from the medical and life sciences to chemistry, physics, material science, and environmental sciences, and even extending to studies of cultural heritage. About a thousand scientists would be associated with the SEE-LS facility, designing and constructing special beams, even if many similar facilities exist in Europe. As in most fundamental sciences, it will take some time before any new discoveries can propagate to the market. Also, the creation of new spin-off firms could take time.

A hadron therapy and research (HTR) facility would yield immediate benefits for the health of society as well as long-term results for biological and medical science. Every year many hundreds of foreign medical doctors and scientists will work at the facility, mainly in radiobiology. On the other hand, its target is a rather special community, consisting mainly of researchers and clinicians in oncology, biomedicine, radiobiology, and medical physics. Hence the scope of the HTR facility for general capacity-building would be more restricted than that of an SRL. However, given its proposed combination of therapy and biomedical research, with about 50% of daily time devoted to research, it would be the first such facility in Europe.

As far as financing is concerned, the two options are rather complementary. The SRL facility would be used almost exclusively for research. Therefore the funds for investments and operation would have to come mainly from research programmes, of both the European Commission and the national partners. The HTR facility, on the other hand, would be used to treat patients for about 50% of its operating time; hence its operation would be partially financed from fees paid mainly by national health programmes. The investment contributions from the European Commission would be expected to come from programmes dedicated to infrastructure development.

This report presents the conceptual design for the SEE-LS option. It is not a replacement for the full proposals that will have to be produced by the teams responsible for implementation. Hence, in this report a number of variants are mentioned, leaving room for future choices tailored to the final conditions and needs.

The proposed 4th generation light source, with a circumference of 350 m and 16 straight sections, has for an energy of 2.5 GeV an emittance of 178 pmrad. At a later stage the machine could be upgraded to 3 GeV. The estimated budget is roughly €170 million, and the first X-rays should be emitted in six years. The conceptual design shows that for 2.5–3 GeV, a 4th generation light source can be built with a circumference of 350 m.

The members of the committee were R. Bartaloni, A. Nadji, Ch. Quitmann, T. Rayment, P. F. Tavares, and D. Einfeld (chairman). All members had only limited time in which to work on the project because of duties at their home institutes. To produce a detailed conceptual design report a team of up to 20 people is needed for a period of up to two years.