The SARAF Project – Soreq Applied Research Accelerator Facility

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Overview

The relevance of particle accelerators to society, in the use of their primary and secondary beams for the analysis of physical, chemical and biological samples and for modification of properties of materials, is well recognized and documented. Nevertheless, apart of the construction of small accelerators for nuclear research in the 1960's and 70's, Israel has so far neglected this important and growing field. Furthermore, there is an urgent need in Israel for a state of the art research facility to attract and introduce students to current advanced physics techniques and technologies and to train the next generation of experimental scientists in various branches and disciplines. Therefore, Soreq NRC recently initiated the establishment of a new accelerator facility, named SARAF – Soreq Applied Research Accelerator Facility.

SARAF will be a continuous wave (CW), proton and deuteron RF superconducting linear accelerator with variable energy (5 – 40 MeV) and current (0.04 -2 mA). SARAF is designed to enable hands-on maintenance, which means that its beam loss will be below 10^{-5} for the entire accelerator. These specifications will place SARAF in line with the next generation of accelerators world wide. Soreq expects that this fact will attract the Israeli and international research communities to use this facility extensively.

Soreq NRC intends to use SARAF for basic, medical and biological research, and non-destructive testing (NDT). Another major activity will be the research and development of radio-isotopes production techniques. Given the availability of high current (up to 2 mA) protons and deuterons, a major activity will be research and development of high power density (up to 80 kW on a few cm^2) irradiation targets.

The construction of SARAF at Soreq

Soreq is currently in the process of constructing the SARAF facility. The goal of Soreq is to enable the continuous, reliable and safe operation of SARAF by the year 2009. To achieve this goal, Soreq established a task group which is to carry out the following missions: Detailed characterization of the accelerator, procurement of the accelerator, construction of the accelerator building and infrastructure, development and construction of infrastructure for experiments and applications, and the preparation of technical and scientific personnel to operate the facility. A schematic overview of the SARAF project is given in Figure 1.

The RF superconducting linear accelerator (SC-Linac) will be delivered by the German company Accel, which is a world leader in designing and manufacturing accelerator components, and also has expertise in design and delivery of full accelerator systems [1]. Due to the technical novelty in this accelerator, the project has been divided to 2 phases; in phase I, Accel will deliver the Injector (ECR Ion Source [2] + Radio Frequency Quadrupole, RFQ [3]), a Prototype Superconducting Module (PSM), housing six Half Wave Resonators (HWR) [4], the necessary beam transfer lines (low energy beam transport – LEBT, medium energy beam transport – MEBT), RF supplies, and a control and diagnostics system. Phase I will deliver 2 mA of protons and deuterons at 4-6 MeV, and is planned to be ready during 2006.

After the feasibility phase, Accel will deliver the rest of the superconducting modules (SM1 – SM5), housing eight HWRs each, to complete Phase II of the accelerator by the year 2009. Phase III of the project refers to future enhancements of the experiments and applications hall.

In order to follow the design of the accelerator and to enable future control and modifications of the accelerator parameters, Soreq established a beam dynamics simulation group that is operating several simulation programs. The group is focusing on generating

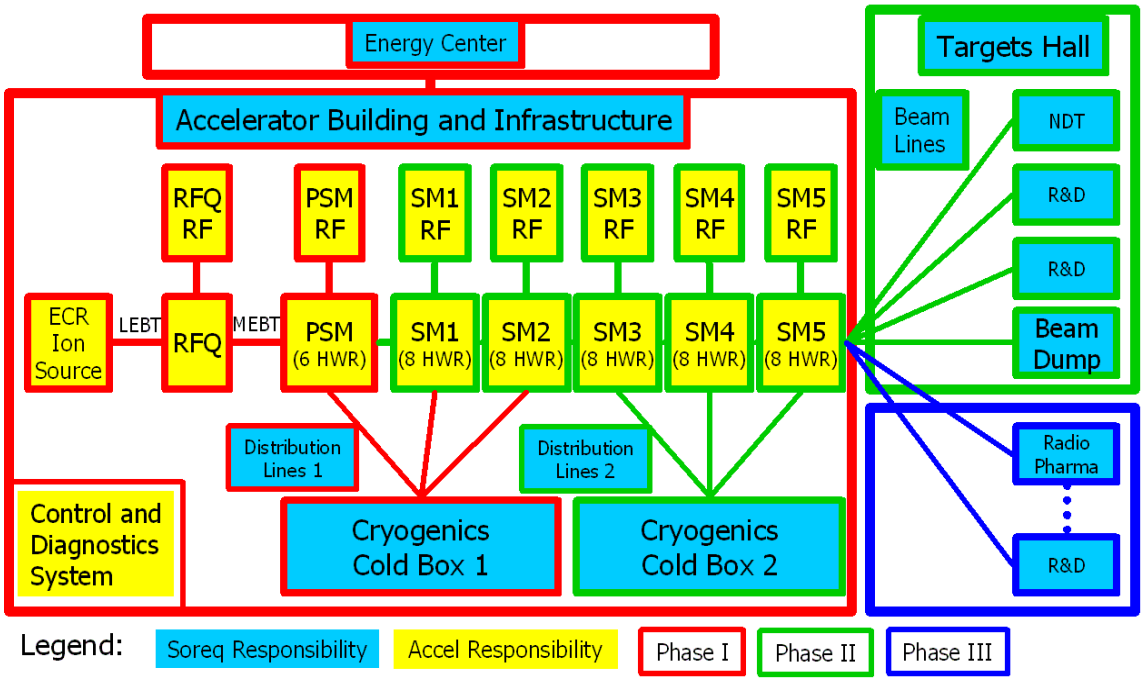

Figure 1 – A schematic overview of the SARAF project. The overview shows the different project phases and the scope of the accelerator that is procured from Accel. Details of the components in the scheme are given in the text.

different types of ion distributions and propagating them throughout the simulated accelerator, while checking the beam quality and the loss of ions. The progress of this group is reported in this conference [5].

Soreq is responsible for the design and construction of the building and infrastructure for the accelerator and its experimental areas. This project is handled by an Israeli civil engineering firm, in tight collaboration with Soreq for a clear definition of the requirements and the interfaces. A major requirement of the building is compliance with safety regulations, in particular radiation safety, which is handled by a dedicated group [6]. Monte Carlo simulations of the radiation that is generated from the accelerator and the target stations determined the amount of needed shielding and thus the thickness of the building walls [7]. Figure 2 shows an overview of the main floor of the accelerator building.

As part of the infrastructure, Soreq shall provide the cryogenic refrigerator system that will enable to keep the superconducting modules at their operating temperature of 4.5 K. This system will be purchased as a turnkey system, but requires a detailed definition of the specifications and interfaces by Soreq. This will be the largest Helium liquefier in Israel.

In parallel to constructing the accelerator facility, research and development is carried out at Soreq on the subjects of irradiation target cooling [8], NDT with thermal neutrons [9] and

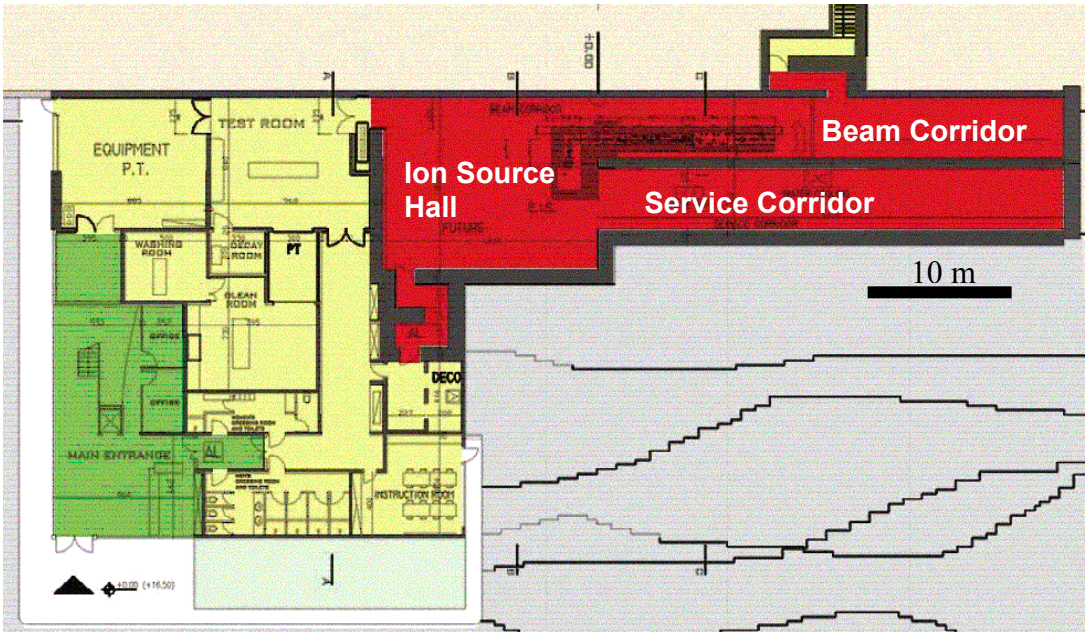

Figure 2 – An overview of the main floor of the SARAF accelerator building. The red, yellow and green colors refer to safety zones. The main control room, RF supplies and cryogenics system are on the 1st floor. Other facility utilities are in a separate energy center. Experimental areas are on the right hand side of the beam corridor.

development of radio isotopes for medicine [10]. These activities are performed in collaboration with the accelerator group, to ensure successful operation of these applications.

Project status

Currently, Phase I of the accelerator is in an advanced detailed design stage. A critical design review (CDR) has been presented to Soreq by Accel, and manufacturing of some of the components is already under way. As for the building, a preliminary design review (PDR) has been presented to Soreq and Accel by the civil engineering firm, and detail design will commence soon. The cryogenic system is in the final stages of its conceptual design. For the time being, the SARAF project is on schedule and its operation is expected to start at 2009.

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