STUDY OF A EUROPEAN SPALLATION SOURCE

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Abstract

A brief account is given of a study proposed for a European Pulsed Spallation Neutron Source.

1. Introduction

Following a 1990 report on "Large Facilities" to the Commission of the European Community, (CEC), on how to secure neutron scattering in Europe beyond the year 2000, a series of meetings on Accelerators, Target Technologies and Neutron Scattering Instrumentation were held in 1991 and 1992 under a joint initiative of KFA, Jülich and RAL, Didcot, and which was supported by the CEC.

The conclusion of these meetings was that a two year, site independent feasibility study was needed for an Accelerator Driven, Pulsed Spallation Neutron Source (ESS), of the following specification:

5 MW average proton beam power at spallation targets, giving average thermal neutral fluxes comparable to that of the ILL Research Reactor;
Proton pulse durations of less than 3 μs; and
Pulse repetition rates of ≤ 50 Hz and 10 Hz at separate target stations.

The aims of the feasibility study were:

Produce a design with definite options;
Produce a realistic capital and operating cost estimate, to within ± 20%;
Relate the source performance to costs;
Identify future research and development, including prototypes; and
Evaluate safety aspects and availability of the proposed source.

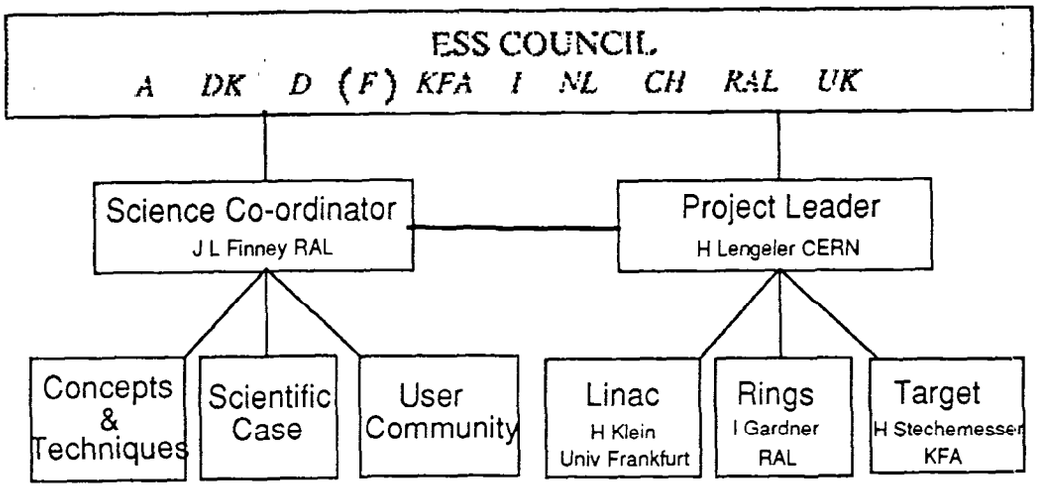
An ESS Council has been constituted, and the Council has agreed on the 2 year, site independent ESS study and on the management structure shown on the appended table.

European Spallation Source

Proposed Management Structure

for the

ESS Study Project



2. Accelerator Options

The main accelerator options are shown on a schematic diagram of the 5 MW source. The ring of the schematic represents one of the following:

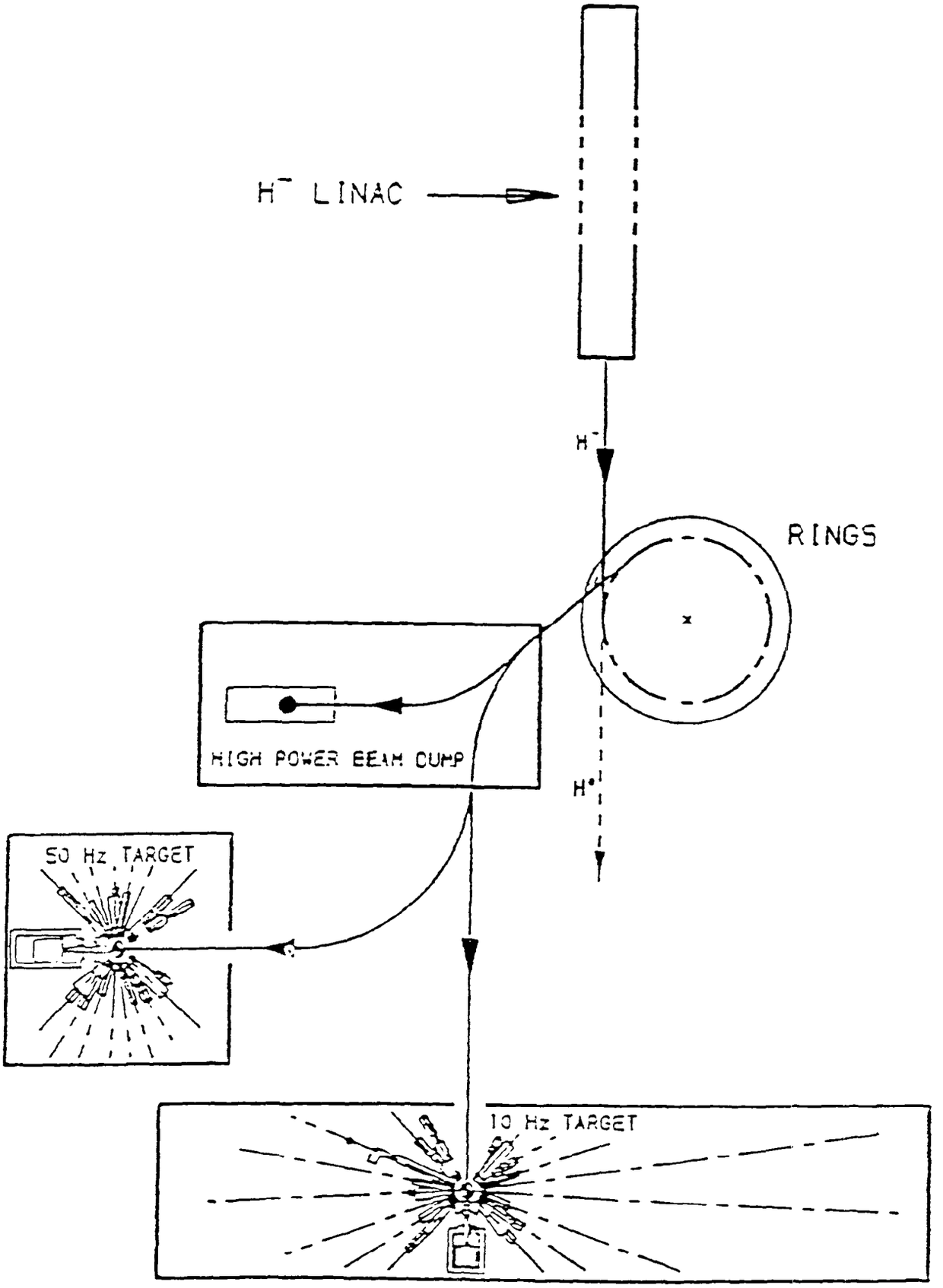
a 0.46 - 3 (or 1.6) GeV Fixed Field Alternating Gradient Accelerator, FFAG;
a 0.8 to 3 GeV Rapid Cycling Synchrotron, RCS;
a single 2.4 GeV Accumulator Ring;
two 1.2 GeV Accumulators; or
three 0.8 GeV Accumulators.

For all these options, the H^- linear accelerator injector operates at 50 Hz, with the output energy as indicated. Two further options include a 1 GeV linear induction accelerator and a 30 GeV KAON Factory type accelerator. The linac consists of a radio frequency quadrupole unit (RFQ), fed from a H^- ion source, and followed by a drift tube and coupled cavity linac. A further option is the use of superconducting low-β cavities in place of the drift tube linac, and superconducting high-β cavities in place of the coupled cavity linac. The important design issues for the linacs include:

The requirement of low beam losses for hands-on-maintenance;
The further development of H^- ion sources;
The need (or not) of low energy linac funneling; and
The question of optimum beam chopper design.

Large circulating currents are needed in the rings, 2 10^{14} protons for the FFAG and RCS, and 2.6 10^{14} for the Accumulators. By comparison, the ISIS RCS has stored 4 10^{13} at 70 MeV and accelerated 2.5 10^{13} to 800 MeV. The important ring design issues are:

Choices of options;
Very low injection losses (problem of H° excited states);
Very low losses at all stages of storage, acceleration and extraction;
Use of complex, space charge, beam dynamic codes;
Specialised beam diagnostics and beam loss monitoring; and
High efficiency, localised beam loss collection.



SCHEMATIC OF 5 MW SOURCE

3. Target and Material Research

Beam powers envisaged at the targets are 1 MW at 10 Hz and up to 5 MW at the 50 Hz station. Possible options for the 5 MW target, which has a power density of 2 MW/litre (2½xISIS), include:

A fixed, solid target;
A rotating, solid target; and
A liquid target.

The important design issues are:

Material problems due to radiation damage;
Optimum target, moderator and reflector configurations; and
Technology of liquid targets.

Innovative engineering solutions appear necessary.

4. Manpower and Possible Study Programme for ESS

The manpower estimate for the two year study is 45 man years. Various laboratories and universities will provide some resources for an interim phase, and this will grow to 25 man years in the CEC funded phase. In addition, a CEC contribution of 20 man years has been requested. A possible time scale for the ESS study is shown.

5. Final Remarks

Three study areas are emphasised:

a. New ideas and technologies may open up new options;
b. Reliable costing requires detailed collaboration with industry; and
c. Very high availability and reliability of the source is demanded to meet the stringent demands of ~ 2000 users, undertaking ~ 900 experiments per year.

Possible programme for ESS