ON THE FUNCTIONS OF A GROUP TO STUDY FUTURE ACCELERATORS AT A.E.R.E.

Many ideas (some as yet very vague) for possible future accelerators have been put forward in the last few years. Some of these require extensive engineering assessment to see whether they are practical, some still require a fundamental 'bright idea' whereas others appear to be impractical and of academic interest only. An attempt to tabulate the more important of these has been made in the accompanying chart. It will be seen that there is no shortage of work to be done.

The problem of how an experimental 'future machines' group should function will now be discussed, with reference to the A.E.R.E. group.

Four main functions, all requiring rather a different outlook can be distinguished.

a) Dreaming up 'ideas', keeping in touch with other branches of physics, assessing critically suggestions from other groups.

b) Fundamental experimental studies with no specific machine in mind.

c) Concentrated and single-minded attacks on specific problems selected for study, (for example our model electron cyclotron).

d) Engineering assessment of machines shown theoretically and by model work if necessary (here and elsewhere) to be basically sound.

The balance between these categories depends very much on the personalities available for the work, and the size of the teams. Furthermore it must be remembered that much of the work is in category (a) and all the detailed theoretical assessment work will be carried out in the theoretical section.

The most important item is undoubtedly (c), this keeps the group down to earth, and gives the necessary sense of day-to-day purpose. Our electron cyclotron analogue is in this category, and the programme requires a considerable amount of detailed work in a wide variety of fields. If the job is to be done in a reasonable time a fairly substantial team must be put on it, the members of which must be single-minded and not diverted by thinking too much about other things. (This conflicts to some extent with the requirements of (a)).

Engineering assessment (d) of large machines can only be done on a very limited scale, since anything like a full design study requires much effort and men with experience of large engineering installations. Such studies are only appropriate when the actual construction of a machine is being actively considered.

Clear cut work on speculative ideas is not possible, the best that can be done

is basic work in the same field. Good basic work with small resources is not easy; we are however attempting small scale work on neutralised electron streams. This is exploratory in nature, but if anything is to come out of it instrumentation and auxiliary techniques will have to be developed.

At present two lines of experimental work are being pursued, the spiral ridge cyclotron model and the electron stream work. At least one E.O. is urgently required in the model section to help with the general assembly and instrumentation. Also if anything definite is to come out of the electron stream work, more elaborate and detailed instrumentation is necessary, so that a further E.O. will be required there.

There is no question of undertaking any further work at present, next year however the pressure on the model should be relieved, and if another project is to be started a further S.O. and E.O. will be required, to join one or two of the staff at present working on the model. Later on still it is hoped that some of the senior staff on the 7 GeV programme will be available to take an active interest in future machines.

In addition to getting new staff, exchanges with other groups are of great value. Our job is not just to try to make original contributions to the accelerator art, but to keep the whole field in constant review. To do this requires continuous contact with other groups, especially M.U.R.A. and Oak Ridge who are attacking the most promising new lines of development with considerable vigour.

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SCHEME	BASIC THEORY	GENERAL STATUS	TO BE DONE	PROSPECTS
FFAG Mk I. a) plain	Well understood.	2 small models working. (MURA and Oak Ridge)	Engineering study	Too cumbersome to be useful.
b) intersecting beams	'single particle' dynamics understood. collective picture not yet clear.	Stacking problem being studied by MURA	Possibility of adequate stacking to be established	Of great interest if the required intensity can be got.
c) constant radius vertical travel version	Understood	Not being actively studied	Possibilities to be assessed, and, if promising, model to be built.	Possible high current electron machine in 10-100 MeV range.
Mk V a) large synchrotron	Well understood.	Principle not yet demonstrated experimentally. Some design studies have been made by MURA, but in outline only.	Magnet practicability studies. R.F. studies to assess yield as compared with conventional synchrotron	Uncertain, but a double machine competes with Mk I as an intersecting beam machine
b) high intensity (cw?) cyclotron	Well understood, resonances serious but might be overcome by good design.	Electron model, and full scale model of a possible machine centre under construction at AERE. Active study continuing at Oak Ridge.	Study of conventional cyclotron to find method of reducing radial oscillations to be made. Engineering assessments to be made if model experiments successful. Possible conversion of AERE cyclotron	Good for machine of a few hundred Mev. Less certain for 900 MeV machine
Storage Rings	Understood	Difficulties in filling ring are well known and understood. Suggestions have been made, but none is fully satisfactory.	Ideas wanted	?
Ironless synchrotron	Understood	Several machines have been made or are under construction	Technical and economic assessment and comparison with present machines to be made	Nothing startling, but factors of a few may emerge.
PLASMA MACHINES a) Budker Ring	Idealised theory well understood in parts, but by no means understood throughout.	Held up for ideas on how to set up beam. Fundamental difficulties are encountered.	Far reaching fundamental idea needed. Establish (by theory and limited experiment) limit of what can be done on present ideas.	Bleak, especially for a 'cheap & simple' ultra-high energy machine.
b) Plasma Waveguide	Idealised linear theory well understood.	Theory is highly idealised, one cannot cut up bodies of 'plasma' to tight tolerances as if it were a metal	Nothing, since no great advantage over conventional linear machines appears to exist	Poor
c) 'Run-away' electron machines.	Partly understood.	Large run away currents of 50 kv electrons have been observed	Extend work to lower pressures and work with a stable discharge, to see whether a cheap, high current machine at a few MeV can be made for technical irradiation work.	Not hopeless, but not exciting
d) Electron drag accelerator e) Radiation pressure accr f) Coherent impact accr	Understood in outline	Numbers show the schemes to be impractical; of academic interest only.	Nothing	Nil
g) 'Dontexyton'	Understood in outline	It is not possible to set such a device up with present techniques	Idea to be kept in mind	Poor, even if it works it would not produce high energy or intensity
h) Electron Bundle Proton accr	Not clear	Half forgotten	Idea to be kept in mind and clarified if possible	?
A. N. OTHER	Not yet worked out	Not yet invented	Bright idea needed	There is always hope.