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REPORT ON VISITS CONCERNING HIGH-CURRENT PULSED POWER SUPPLIES

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The upgrading of the Antiproton Accumulator target station is being considered in order to increase the number of antiprotons that can be stored. The most promising schemes involve special lenses around the target operating with pulsed currents up to 1000 kA. Although CERN staff have experience in the technology of pulsed supplies, the current range proposed is beyond that found in the PS Division. Furthermore, it has been impossible to find staff with the time to devote to the new problems involved because of existing commitments. Since high current pulsed supplies have been used in the past for plasma fusion applications, it was decided to try and enlist the aid of an external institute, already working in this field, to help identify any technological problems likely to arise at CERN and ascertain if any direct participation by the institute would be possible.

Initial telephone enquiries were made to Mr. T. James of the Engineering department at Culham Laboratory, U.K., and Dr. Cassini at ISPRA, Italy. Immediate interest and an offer of help came from Culham. Dr. Cassini pointed out that not many fusion laboratories were still employing the type of pulsers required at CERN and that there was no work of this type continuing at ISPRA, but suggested contacting Dr. Knobloch of the Max Planck Institute for Plasma Physics at Garching, Germany. Once again I was told that this type of work had been discontinued, but Dr. Knobloch suggested a visit as there were still some of the people who had been working on plasma pinches there and would be available for a discussion. In addition he said that there was work currently going on with high current discharges at the Dutch Institute for Plasma Physics.

It was therefore decided to visit the laboratories at Culham, Garching and Nieuwegein in the Netherlands. Meanwhile, B. Autin had made parallel enquiries in France and suggested that we should visit the Ecole Polytechnique in Paris. G. Brianti also suggested contacting the Plasma Physics Laboratory of CNEN in Frascati, Italy.

Ecole Polytechnique, Paris.

We found the work here was not directly related to our needs at CERN. Although high current discharges were used, the pulse length was very short (nanosecond range) and a high voltage Marx generator was being used. However there was common interest in another aspect of this work ; viz. the use of special magnetic material for saturable reactors that could be used in producing short but very high current pulses.

FOM-Instituut voor Plasmafysica, Nieuwegein.

Here I met Dr. A. Oomans, project manager for the Spica plasma pinch experiment. The currents required in this project are about 2.5 MA and are generated by switching successively two capacitor banks. The first is a high voltage (20 kV) bank switched by spark-gaps to ionize the plasma and give a rapid risetime (11 microseconds), followed by a mechanical crowbar switch which connects a low voltage electrolytic capacitor bank to maintain the current for times of the order of milliseconds. The total stored energy is 2 to 3 megajoules. In terms of stored energy and current these values exceed those required at CERN, as do the problems associated with the feed lines. It was considered that the electrical problems of the CERN pulsers and feedlines would present no problems provided sufficient care was taken with the engineering. However there might be special problems at CERN because of the radiation environment and the the requirement for high reliability and continuous operation with a cycle time of 2.4 seconds. Clearly, switching with spark-gaps and mechanical switches was inappropriate. It was interesting to see that the high-voltage capacitor banks and switching equipment had been supplied by the Culham laboratory.

The Institute is not very large and the existing staff is fully engaged in their own activities. It was considered that it would be

impossible that any effort could be found to assist CERN.

Culham Laboratory, Abingdon.

At Culham, I met Mr. T. James, head of the Engineering Design Division and Mr. J. Grey. We discussed, at considerable length, the CERN requirements as it seemed possible that Culham was in a position to enter into a contract for a design-study. The staff exists there with experience in almost all aspects of the work needed in the target area, i.e capacitor bank discharge supplies, feed line and high current transformers. Furthermore, Culham has a mandate to enter into commercial operations, at least for the development of single systems. Again, the greatest problem for the Culham staff were the requirements on reliability and continuous operation. Normally, for typical plasma physics experiments, the apparatus is built for higher currents and stored energy but with life-times of 50,000 to 100,000 pulses at repetition rates of a few pulses per hour. However it was thought that the requirements could be met, as of course, they are already met at CERN although for somewhat smaller systems than now proposed. There is a problem in timing a design-study. It should be executed as soon as possible and finished within two or three months. Provided approval can be obtained quickly, Mr. James thought that the Culham engineering program could be modified to fit in such a design study.

During a tour of part of the Culham laboratory, I was able to see pulser systems similiar to those required by CERN.

Max Plank Institut fur PLasmaphysik, Garching.

A discussion was held with Dr. Knobloch who had been responsible for the construction of a 2.6 megajoule capacitor system at Garching. Work on this project was completed several years ago but work on the theta-pinch project for which this supply was built has since been discontinued and the pulser disassembled. However, Dr. Knobloch could see no major difficulties in the pulsers required by CERN. Once again, because of the work going on at his Institute, he did not believe that any direct help could be given to CERN. An offer was made of used capacitors, free of cost, and some charging power supplies at modest prices.

While I was there, he telephoned the head of a group engaged on a plasmafocus experiment at the University of Stuttgart to see if they might be interested in assisting us but again the answer was that the staff there was already fully occupied.

I learnt also that Dr. Toschi of the plasma laboratory in Frascati was also present at Garching and was able to meet him. After I explained the reason for my visit, he informed me that he did not think that any assistance was possible from his laboratory nor for that matter did he know, off-hand, where any might be available in Italy. However, he expressed the hope that Italian industry would become involved in the project at the construction phase.

Both Dr. Knobloch and Dr. Toschi expressed the view that the laboratory most likely to be of assistance was the Culham laboratory.

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