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STATUS OF THE DEVELOPMENT OF PLASMA LENSES AND HIGH-POWER PSEUDO-SPARK SWITCHES AT CERN AND OUTLOOK TO THE FUTURE

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STATUS

The fundamental physics and properties of plasma lenses and pseudo-spark switches have been dealt with earlier and reported in References (1) to (7).The present stage of development is mainly concerned with the technology and the long term behaviour of such devices. A sufficiently long life-time is crucial for their application in ACOL or other CERN machines.

Life tests have been started in our laboratory with a dedicated pulse generator, which can deliver 500 kA pulses into a plasma lens or up to 1 MA into a low inductance short-circuit. Four high current pseudo-spark switches are incorporated into the generator and will be simultaneously tested with the plasma lens. First runs have shown that both elements work as expected. The only question, which remains to be answered, is : for how long?

A successful performance of the plasma lens will not only have beneficial effects for ACOL. A plasma lens could be also used to focus colliding beam down to submicron cross sections. Very high luminosities could be obtained in this way, which no other device could achieve. This is not only due to the very short focal length of a plasma lens, but also to the space charge neutralization of the interacting beams by the surrounding plasma. A plasma lens could be matched to the detector around the interaction region in order to reduce the perturbation of the measurement to a minimum (Example : SLC).

Other applications of current carrying plasmas are seen in future accelerator schemes, like plasma beat-wave and plasma wake-field accelerators, as well as in high density beam transport systems (see example of the Advanced Technology Accelerator - ATA - in Livermore).

Already now we can make the statement that pseudo-spark switches represent a remarkable progress in high power switching technology. There are no commercial switches available which could do the job of our pseudo-spark switches in the plasma lens test pulse generator. Special high pressure spark gaps could have been developed, but their erosion rate is much higher compared with that of pseudo-spark switches.

The main future applications we see for pseudo-spark switches, apart from replacement of conventional switches in existing pulsed power installations, are as primary switches in high power pulse compression systems for large laser systems, high beam current accelerators and in IFC-installations. Pseudo-spark switches possess the necessary precision ($<$ 1 ns) required in compression systems with photoconductive and passive magnetic switches.

FUTURE SCENARIOS

Depending on the results of the present plasma lens life-test, different ways of continuation may be envisaged.

1. In case of a satisfying performance of the plasma lens, one could decide to build a plasma lens for the start-up of ACOL. This requires the construction of an adequate pulse generator including a new power supply, specially tailored striplines, capacitor banks and a magnetic switch supporting 10^8 Gy/year. The existing plasma lens design has to be improved and adapted to the target area requirements. Table 1 shows an approximate budget estimation. The manpower needs are 2 applied physicists, 1 mechanical engineer, 1-2 technicians, drafting (in-house) and installation (hired) effort.

   Due to manpower limitations, very little effort will be available in this scenario for development in future accelerator technology or preliminary plasma lens tests (at dump D3). Only a very limited measurement programme with the lens foreseen for ACOL can be carried out and even for this we rely on external help (University of Erlangen, Imperial College, University of Naples).

TABLE 1

Approximate cost estimate for the construction and installation of a plasma collector lens at ACOL

Power supply	0.10 MF
Capacitor banks	0.13 "
Magnetic switches	0.06 "
Plasma lens	0.13 "
6 x High current pseudo-spark switches	0.12 "
Striplines	0.10 "
Cooling	0.04 "
Vacuum	0.07 "
Triggers	0.02 "
Gas injection	0.03 "
Diagnostics	0.07 "
Controls	0.04 "
Installation	0.05 "
	0.96 MF

2. The PL life-test is not fully satisfying our expectations. We then might consider the plasma lens as a long-term development for a later ACOL stage. A test of a plasma lens in a beam prior to installation at the target may be considered as useful. A possible area for such a test is the dump D3 region. The purpose of such a test would not be again long term performance but demonstration of focussing power, and pilot testing of different components to be used later in a definite application.

Table 2 shows the budget estimate for such a D3-test.

TABLE 2

Approximate cost estimate for a plasma lens test at D3

Power supply + triggers	existing	
Capacitor		30 kF
Plasma lens (without cooling)		20 kF
Magnetic switch prototype		15 kF
2 x High current switches		40 kF
2 x Striplines		30 kF
Vacuum and gas injection		15 kF
Installation		20 kF
		200 kF

3. The PL life-test is not conclusive and a D3-test will not be envisaged. In this case, a limited development programme for plasma lenses, pseudo-spark devices and plasma acceleration methods could be carried on. This would happen in collaboration with the Phys. Inst. of the University of Erlangen, Imperial College, London, and the University of Naples. Furthermore I would try to get support in manpower and money from the European Community and the German Ministry of Research and Technology. The financial contribution of CERN should be at least 50 kF/year.

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