

cross-section (including insulation) of $1.5 \times 3 \text{ mm}^2$ carrying an average current density of 220 A/mm^2 . The maximum field inside the entirely impregnated coil will be 49 kG. (A model coil has been wound using copper conductor and some preliminary field measurements have been carried out). The bending field and current density parameters have been chosen conservatively — priority is being given to having a magnet system which will be reliable and durable since its efficient functioning will be an essential part of the physics programme with the 3.7 m chamber.

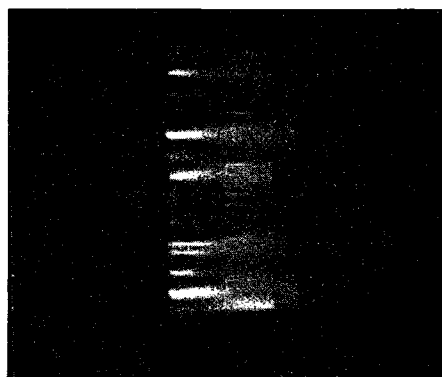
Conductor samples from various potential suppliers have been tested in the form of small solenoids, producing a maximum field strength and an approximate field gradient corresponding to the required values for the dipoles. The test solenoids were completely impregnated and surrounded by a glass-epoxy layer at least 10 mm thick, so that the cooling of the conductor was very poor. Nevertheless, in some cases critical currents well above the required values and in accordance with the short sample characteristics were achieved.

Cost estimates were made for a conventional magnet system and a superconducting magnet system (including power supplies and controls). Both came out close to 1 million Swiss francs. This does not include refrigeration for the superconducting magnets (which would add about 0.3 MSF) since, fortunately, the 1800 watt cooling plant for the chamber itself can easily absorb the extra 30 to 40 watts for the magnets. Another advantage comes with the operating costs where power consumption will save over 100 000 SF per year compared with a conventional system.

(A paper on the superconducting bending magnets was presented by G. Kessler, P. Lazeyras and F. Schmeissner at the DESY Magnet Conference at the end of May.)

Streamers in hydrogen

The EMSA (Electromagnetism Studies and Applications) Group of the Track Chambers Division has started a programme to study the formation of streamers in



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hydrogen with the aim of developing an isotopic chamber which can be triggered like the present helium-neon streamer chambers, but in which the detecting medium also acts as a target as in the hydrogen bubble chamber.

The first part of this programme consisted in building a small chamber (reported in TC-L 70-7) to test the feasibility of taking photographs of streamers in hydrogen. The 'useful' field volume is $15 \times 15 \times 4 \text{ cm}^3$. A chamber specially built was preferred to the use of one of the streamer chambers already in existence at CERN because of some special requirements when using hydrogen. The chamber was designed :

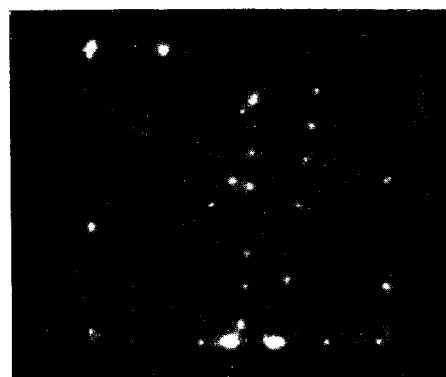
- 1) to be capable of operation at 10^{-5} torr, working at such low pressure is impossible with conventional streamer chambers, which operate under pressure, in which slight leaks are not a nuisance ;
- 2) to attain the high fields needed to obtain streamers in hydrogen (50 kV/cm at 760 torr).

The first photographs in which the visible streamers have been achieved were reported in June (TC-L 70-10). They were taken, using beta particles to produce the ionized tracks, under the following conditions : pressure — 250 torr ; composition — hydrogen 99.6 %, hydrocarbons 0.19 %, $\text{H}_2\text{O} + \text{CO} + \text{N}_2$ 0.5 %, He + Ne 0.16 % (residual traces of previous fillings with helium-neon mixture); electrodes — black, oxidized aluminium; pulse — triangular in shape provided by a Marx generator, 10 ns at the base; field — 25 kV/cm.

Although the results are encouraging, they are preliminary ones. Stray discharges are generated on the edges of the elec-

Photographs of tracks taken in a hydrogen filled streamer chamber. The plane of photograph 1 is parallel to the electric field, and the photograph shows the discharges travelling from one electrode to the other and also, virtually equidistant from the electrodes, the 'arrested' streamers which are much shorter and which have formed on the track of an ionizing particle.

In photograph 2, the plane is perpendicular to the field lines, and it shows streamers along two ionizing particle tracks. The larger spots are the discharges which form preferentially along the rounded edge of the cathode, where the field is higher.



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trodes but, as the physical condition of the electrodes was most probably the cause of such discharges, it is hoped that they can be eliminated, even at higher fields, by shaping the electrodes in the same way as now done on the HT separators (see CERN COURIER, vol. 9, page 208). Experiments will be carried out using stainless steel and titanium electrodes.

Finally, in order to increase the luminosity of the streamers :

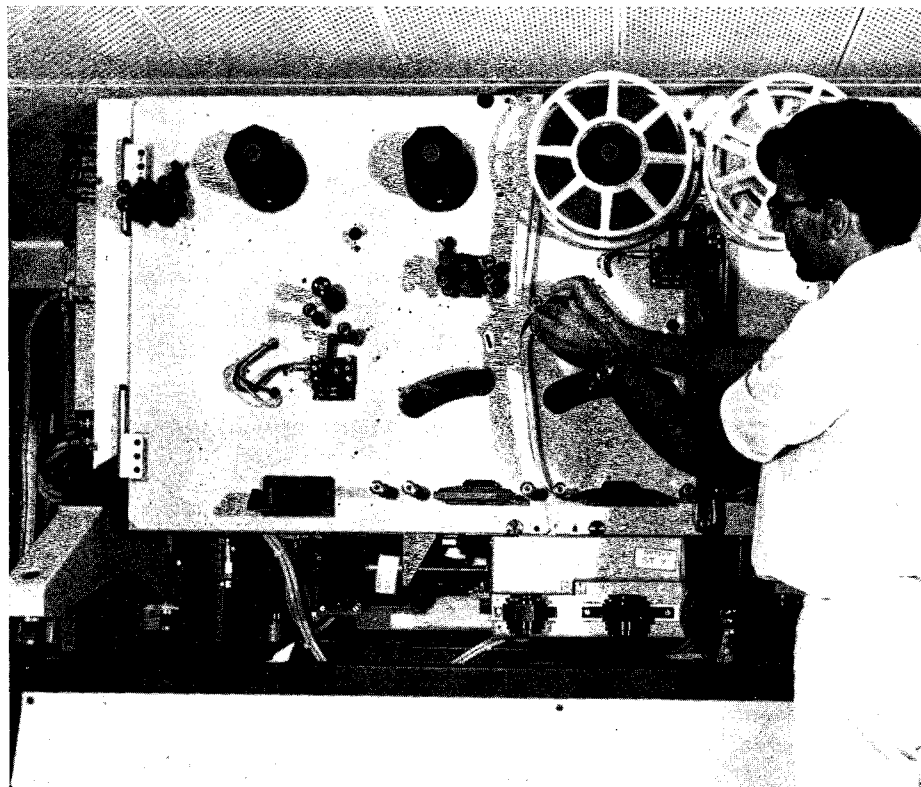
- 1) the effects of minutes traces of different gases added to the hydrogen is being studied ;
- 2) generators producing shorter and more rectangular pulses (Blümlein tri-coaxial line) are being built.

In another part of the programme, the design of a pulse generator to give 2 MV pulses of 5 to 10 ns duration suitable for supplying a chamber with two gaps of 25 cm is being examined. This equipment will consist of a 2 MV Marx generator, a spark gap and a 50 ns Blümlein line.

ADAM and EVA

Different problems are encountered in scanning photographs taken in large bubble chambers compared with those taken in conventional chambers and specially designed scanning and measuring equipment has to be developed.

Under the provisions of the CERN/Serpukhov agreement, CERN will have access to some of the film taken in Mirabelle (the large hydrogen bubble chamber built at Saclay for Serpukhov — described in CERN COURIER vol. 9, page 308). To cope with this film CERN has built a new scanning and measuring device intended primarily for Mirabelle



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but which could also be easily adapted for film from Gargamelle or the 3.7 m European bubble chamber. It has tortuously acquired the name 'ADAM and EVA' from the French 'Appareil de Dépouillement et d'Analyse pour Mirabelle et Eventuellement d'Autres Chambres' (scanning and analysing equipment for Mirabelle and possibly for other chambers). A group from the Data Handling Division led by C. Verkerk is responsible for its development.

'ADAM and EVA' is a highly automated, manually operated device combining the operations of scanning and measuring, to which is connected an on-line computer (CDC 3200) which immediately processes the data. (Several 'ADAM and EVA's could use the same computer). The operator has access to the results from the computer during the scanning and measuring process to give him a useful guide as to what is happening and he also has controls available which actuate certain semi-automatic operations. A keyboard is provided for communication with the computer.

'ADAM and EVA' has several other important features :

- 1) all movements are controlled via a PDP 8/L control computer ;
- 2) measurement is made in the film plane, giving greater accuracy ;
- 3) projection (at least in the version installed at CERN) is direct without the use of mirrors.

Optics: The ten lenses, giving a magnification of 17, are fitted in the same stage. The image is moved by movement of the stage and by coordinated movements of

the lamps, while the film remains stationary. An overlap is arranged between the projection of the different parts of the film so that the images follow one another exactly in the plane of the beam in the chamber. The image projected onto the table, can be further magnified up to three times by a television camera.

Movements : The lens stage can be moved accurately along x and y directions to within $\pm 2 \mu$ by means of Heidenhain linear encoders. Correspondingly, the lamps can be moved linearly along the y direction and with a tipping action along the x direction. The amplitude of the movements is such that each view can be brought directly in front of the operator.

Control computer : A PDP 8/L computer is used to centralize the control commands, whatever their origin (e.g. operator, on-line computer or the PDP 8/L itself) and to retransmit them uniformly. It also carries out the following operations :

- a) storing and counting the pulses from the encoders ;
- b) controlling the movement and correcting any errors in positioning compared with instructions received ;
- c) transmission of measurement data to the CDC 3200 on-line computer ;
- d) checking operation and providing warning signals.

Eventually, it is intended to use it to control the major part of the automatic track following.

Operation : After bringing the required exposure into position, the operator causes a fixed reticle with rotatable axes to coincide with the track to be measured by

View of the upper part (projector and lens carrier) of the 'ADAM and EVA' scanning and measuring equipment. The images are projected on to a table four metres below.

moving the film image. To do this, he uses a track ball for fine control together with a push button for coarser control and a reticle orientation control.

In an initial stage, it is intended to provide an aid to the operator in the form of a system for automatically causing the reticle to coincide with any point of which the coordinates have already been determined and are stored in the computer program — the Vertex, for instance. Eventually, an automatic track following device will be added.

The prototype 'ADAM and EVA' will be operational at the end of 1970 with its CDC 3200 on-line computer, but with an incomplete software system. It will then be possible to make initial measurements on film taken with Mirabelle at Saclay ; the first photographs taken at Serpukhov will not be available until later.

Various study programmes on the PDP 8/CDC 3200 interface and on the detailed method of guiding the operator during scanning and measuring (operator — CDC 3200 communication) are very close to completion.

Soviet scientists have already expressed interest in having several 'ADAM and EVA's', and Saclay has undertaken the construction of a 'Gallicised' version using certain pieces of French equipment which are cheaper than imported components. Initial contacts have been made with industry with a view to a small production run.

Teaching aid

Under the general title 'Travaux pratiques sur la physique des particules' a first brochure entitled 'Interactions de la particule K⁻' has been edited by J. Flechon and G. Baumann (Faculté des Sciences, Nancy University) and H. Annoni (Faculté des Sciences, Strasbourg University) in collaboration with CERN.

The brochure is available (at present in French only) together with a set of twelve slides, $5 \times 5 \text{ cm}^2$. It is designed to help science students become acquainted with the study of particle interactions. Teachers who would like to make use of this material should contact CERN, Ref. PIO/EM, 1211 Geneva 23, Switzerland.