

The first bending magnet for the 800 MeV Booster being tested following its arrival at CERN. Note that the magnet has four apertures since the Booster consists of four identical synchrotron rings mounted one on top of the other. Magnetic field measurements are under way in the top aperture.

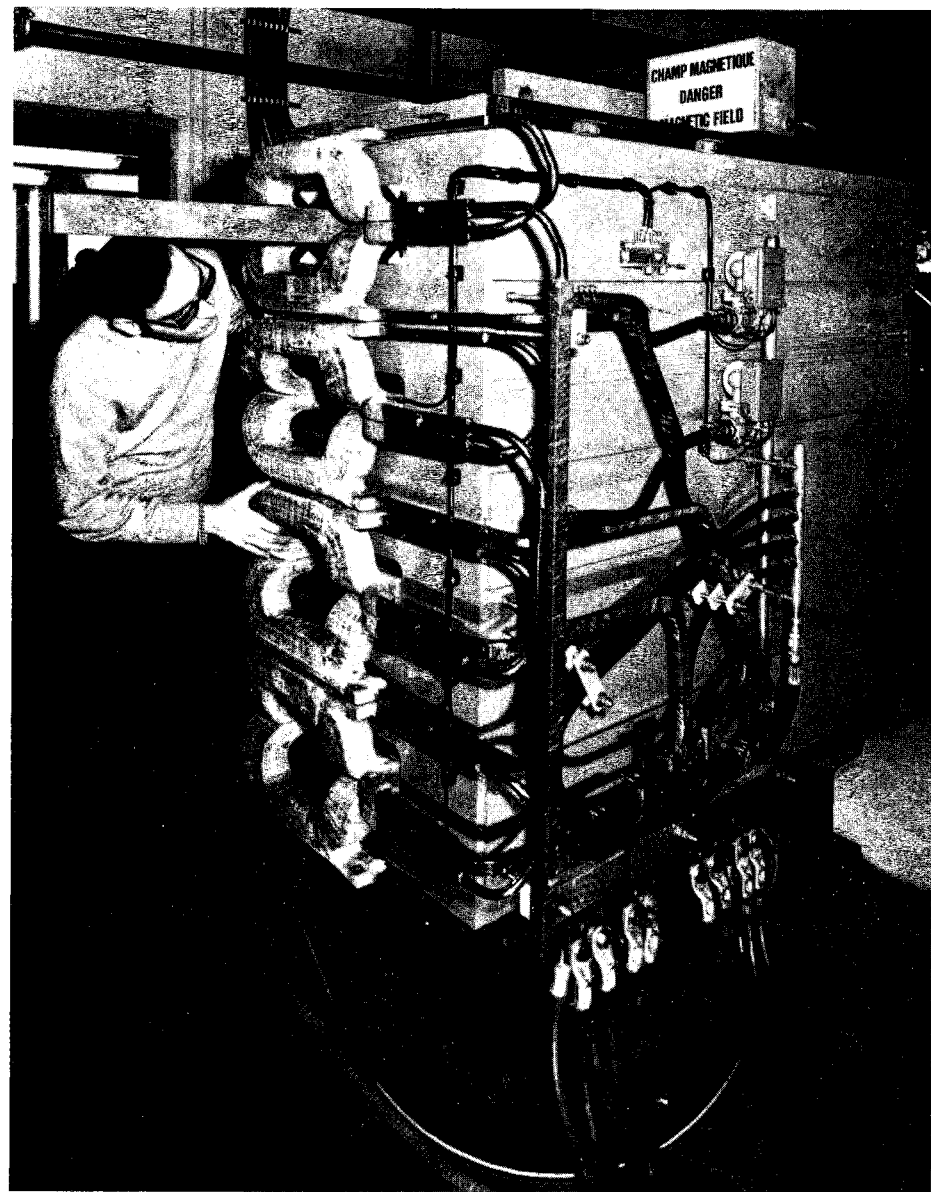
Protons have already been brought 45 m along the injection line from the linac towards the Booster (see below). It is hoped that in the course of next year they can be injected into the four completed rings to begin commissioning of the machine.

ISR beam dump

Whereas the intensity of the beam circulating in the PS is of the order of 80 mA, a current of up to 20 A per ring is planned to be stored in the ISR. As long as the stored beams circulate under control there are no problems, but if in the course of operation there is a fault such as a power failure, or disturbance from other sources, the beam would go out of control and strike the walls of the vacuum chamber... which could over-heat and even melt, lead to vacuum implosion, put the machine out of action and cause a considerable amount of damage. To avert such danger, an emergency dumping system is provided to direct the beam into a block of metal which is well able to withstand local heating without damage, and which safely localises the resulting radioactivity.

The need for an extremely fast response to any machine failure excludes the sort of system used for example between the linac and the PS where a stopper falls across the beam to prevent it entering the PS. We have to resort to beam ejection. This is done conventionally with a fast kicker magnet system with the following features :

1. the beam is bent vertically (upwards for one ring, downwards for the other) ;
2. the dump block is not outside the ring but surrounds the beam, and as such is part of the vacuum chamber (thus the beam can be dumped by a fairly small deflection) ;



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3. the magnets are not ferrite yoke (giving high outgassing in ultra high vacuum) but parallel stainless steel electrode magnets, four in each ring, placed in series and giving a field of a few hundred gauss. An 8 kV current passing through them for $3.6 \mu\text{s}$ results in a bending angle of 2 mrad with a 28 GeV/c beam.

The dumping was programmed and operated automatically from the first injection into the ISR. At present stored beams with an intensity of 4.3 A are dumped by pressing the appropriate button when required.

In addition to programmed and 'manual' triggering, the beam is dumped automatically under various circumstances, namely :

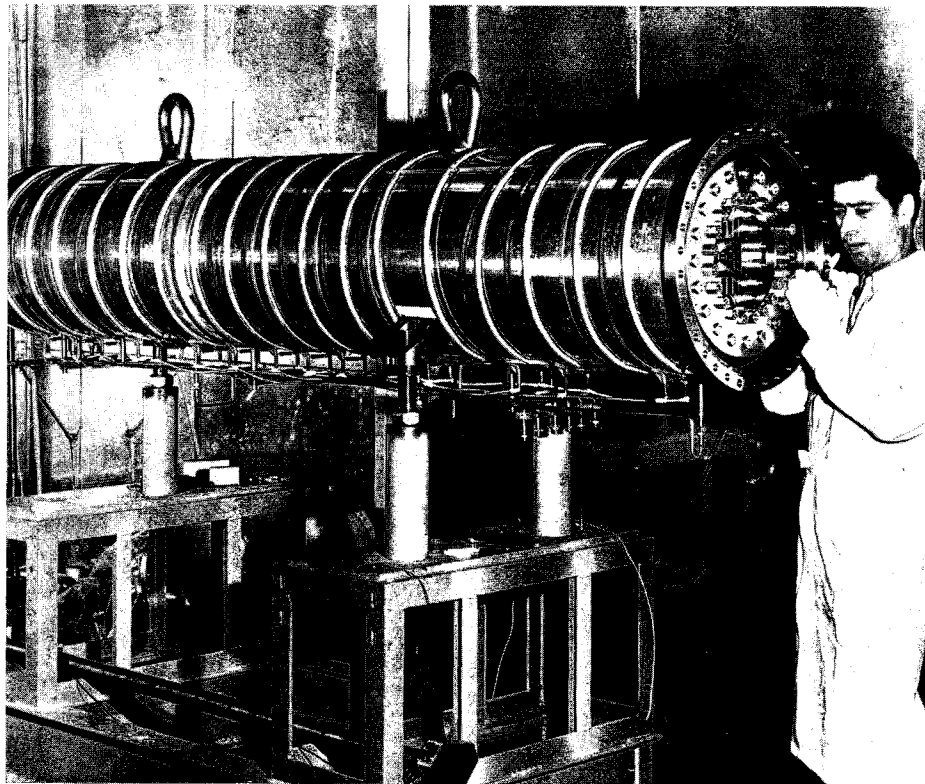
1. break-down of the generators supplying the main ring magnets or a power failure ;
2. a sudden increase in the vacuum pressure ;
3. closing of a sector valve ;

4. high rate of beam loss in the vacuum chamber ;

5. tunnel access doors opening when this could be dangerous.

Some of these causes influence the beams only slowly, and a fairly long reaction time from the dumping system would be sufficient. But others act quickly and the dumping system has been designed to react within milliseconds. The reaction time will include the time taken to signal the fault, to trigger the dump magnet pulse generators and to establish the field in the magnets. The last two operations can be carried out in less than $1 \mu\text{s}$. The pulse generators consist of delay lines of 3 ohms impedance which can be charged up to 60 kV and are discharged by triggered deuterium thyratrons.

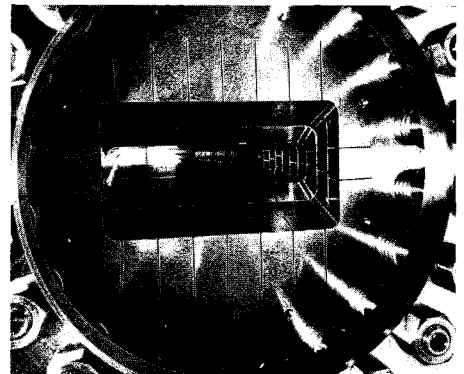
The dump blocks, 2.5 m long, are made of stainless steel with a core of titanium discs over the first 70 cm. They can also be moved vertically



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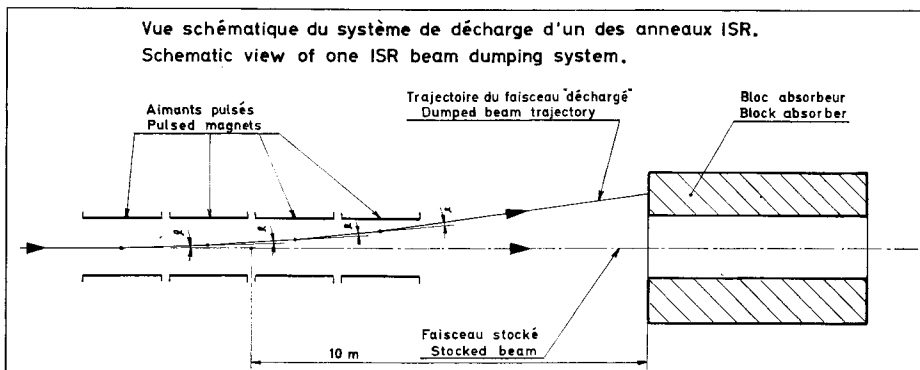
1. and 2. An ISR beam dump block, made of titanium and steel, viewed along its length from the outside and also looking into its bore. Stored beams are directed vertically into the block during normal emptying of the rings or in case of emergency.

3. A schematic diagram of the layout of the beam dumping system for one ring of the ISR with its four deflecting magnets and dump block.



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2.



3.

across the vacuum aperture so that they act as beam scrapers trimming the height of the beams.

Installation of the dumping system in Ring 1 was completed a day and a half before the first tests began in October 1970. Right from the start, it functioned as designed. The system in Ring 2 was ready for the tests in January. Adjustments to the automatic triggering devices and improvements, particularly concerning the development of a resonant charging power supply system to avoid voltage holding problems when the ISR is operating at the highest energies, are being made.

PS linac, which are accurate to within one part is a million! We are not that good, it should have read one part in a thousand. Our mistake provides us with an excuse to say a little more about these converters, developed in the linac group. They are, by now, virtually a mass-produced item (over 120 are in use on the linac, the PS ring and in the PS experimental halls, and some are scheduled for Serpukhov).

The need at the linac is to get hold of many machine and beam parameters within a few microseconds in each second. This can be achieved by using one ADC with a multiplexer in front of it (feeding through, one after the other, the data collected and stored in 'sample and hold' circuits) or by using many ADCs, one for each parameter. The second alternative was chosen because it emerged that ADCs could be made for the same price (total cost for components,

assembly and testing is less than 500 Swiss francs per unit) as the sample and hold circuits and could give the same precision. Also, only recently, has industry put units with $1\mu\text{s}$ sampling time on the market and their cost is rather high.

Some technical details: In general ADCs can have either a parallel or serial output for their digitized information. With parallel output, each output signifies one bit and therefore the number of outputs determines the maximum possible precision. The data acquisition system must be designed with the desired number of parallel wires from the beginning. With serial output the number of pulses being sent on the single output cable gives the digitized value. An increase in precision means an increase in the number of pulses. Serial output was selected since such ADCs can be simply and cheaply realized. The single output can supply the digitized information to simple numerical ('Nixie') displays, to scalars (which can store and send the information on request to the PS control computer via the 'STAR' system) and to digital to analogue converters (for presentation, for example, using a pen recorder). The displays, scalars and DACs using serial input are about the same price as equivalent units using parallel inputs. The single wire output also makes easier any adaptation for the transmission of signals across

Those ADCs

In the English edition of the last issue (page 68) we mentioned some analogue to digital converters, used in data acquisition and control at the