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PROGRESS REPORT
on
THE FAST EJECTION SYSTEM FOR CHANNEL A
of the
SERPUKHOV 70 GEV PROTON SYNCHROTRON

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Prepared for the fifth session of the Joint Scientific Committee of the CERN/Serpukhov collaboration, to be held at Serpukhov, May 1970.

1. GENERAL

Since issue of the last progress report[1] the studies on various prototypes have been rounded off successfully during the second half of 1969 and the beginning of 1970. Orders have been placed in the same period for most large parts and components to be made in industry and delivery times in keeping with the programme[2] have been obtained. The detailed mechanical and electrical design of the remaining parts is under way and manufacture has commenced.

All the equipments will be assembled in a large hall as it is being delivered before the end of the year, for checkout, and to be life tested as a whole. Preparations for this "linkup" have started.

Two collaborators from IHEP have joined the fast ejection team in summer 1969 and are now well integrated in the activities. Two further engineers have arrived recently and receive their first orientation. The language problem proves to be a major one and may take up to six months. The short time remaining until installation makes arrival of the other two agreed collaborators extremely urgent. It is becoming clear that the requested 6 persons constitute a bare minimum for a successful takeover. On a more technical/mechanical level two more collaborators[3] are necessary to cope with installation and maintenance of the many fine mechanical components constituting the fast ejection system.

2. BEAM OPTICS

The "final" trajectory having been finally fixed jointly[4] last year, the recent unilateral modification of this by IHEP must be jointly reexamined in the light of the desirable reserves in the equipment of channel A.

For the problem of the beam diameter and its strong radial dependence[5] CERN expects to receive a written statement from IHEP as well as a programme showing what steps are being taken to achieve an adequate situation by mid 1970, and how this will be affected by beam sharing with slow ejection.

As a contribution to this problem, crucial for operation of the fast ejection, CERN have prepared a first study[6] on the influence of non-linearities, their possible corrections with pole face windings, and achievement of "constant Q" in the accelerator.

Related to this is the problem of "beam gymnastics". CERN has formulated preliminary specifications[7] for these and awaits a written technical proposal for the provision of these facilities by IHEP.

3. BUILDING AND INSTALLATION

Agreement has been reached last year on the final layout and plans of the ejection building, provided utilities and special facilities, as cranes etc. No agreement[8][9] has yet been obtained on the geometry of the connection tunnel with the accelerator ring.

Agreement has been reached on the principle of execution and earthing of the shielded rooms and CERN is awaiting the precise technical[10] drawings. CERN has solved now the problem of the feed-through filter and an order will soon be placed in industry.

Outstanding points, urgently needing definition are : the foundation of the vacuum tanks and the hydraulic actuators for which specifications[11][12] have been formulated last year. We need the promised technical designs from IHEP without which our design work will be seriously delayed.

Final agreement[13][14] has been reached on the division of responsibilities for the cabling, not so for the responsibilities[15][16][17] around the hydraulic tubing.

As construction of the ejection building makes progress, it becomes urgent that IHEP presents a detailed planning so that this may be integrated into a general planning for channel A as proposed by CERN[2].

4. CONTROL PHILOSOPHY

After IHEP's decision for a local control room in the ejection building, it becomes necessary to decide its contents and layout, for which IHEP made a preliminary proposal[18]. Since on one hand one starts from zero and on the other hand fairly complete beam sharing schemes will be installed into this control room within a relatively short lapse of time, it seems useful to consider this matter carefully, from the operational point of view. For this CERN makes a contribution[19] at this meeting, based on experience at the CPS. These recommendations will be finalized after discussions with the IHEP specialists. They may partially guide IHEP in its final decision.

5. KICKER MAGNET

The successful operation of the prototype lumped full aperture magnet permitted to opt for an aperture of 140x100 mm^2 and a line voltage of 80 kV. Further measurements on low voltage full scale models and numerical computations permitted selection of the final variant[20], called "Janus" after the Roman god with two faces. It is a 2 section hybrid between lumped and delay line magnet and combines a favourable rise time to a short reflection which may be placed between bunches. The prototype of this magnet is now pulsing at design voltage. The mechanical parts for the 10 magnet modules are presently being designed. Delivery of the ferrite for its magnetic circuits starts in August.

The prototype delay line pulser has now made many millions of shots at full voltage. The experience gained permits the detailed design of the final pulse generator, which is in progress. For simplification the pulsers will be combined two by two into one structure. A new version of sparkgap designed for a fast current rise time, great charge and of construction convenient for series fabrication has been successfully tested. Mechanical design of the final version is in progress. Delivery of the H.V. capacitors for the pulsers starts in June, delivery of the pulse cables in November. Delivery of the H.V. charging supplies starts in October.

6. SEPTUM MAGNET

The prototype septum magnet, its pulse generator and H.V. charging supply have now made many millions of pulses. The first magnetic field mapping of the uncorrected magnet showed strong inhomogeneities[21]. A study on the compensation[22] of these shows already in its preliminary stage such good results that the future is envisated with confidence. Compensation is obtained by shimming the conductors and the extremities of the magnetic circuit. The magnet length and apertures of SM24 and SM26 have now been fixed as respectively 1500 x 30 x35 and 3000 x 30 x 60mm. The detailed mechanical design of the magnets and their pulse generators is in progress. IHEP's request for a small programmable negative deflection by SM26 is under study. The H.V. storage capacitors for the pulsers are due for delivery this summer, the H.V. charging supplies will be delivered starting from October.

7. HYDRAULIC ACTUATOR

The performance of the prototype electrohydraulic actuator has been so satisfactory that it is now being prepared for installation into the fast ejection system of the CPS where it will move a second small aperture KM in straight section 13. Design of the final version for Serpukhov is under way. The hydraulic pumping station has been ordered as a whole in industry and delivery of it is due in October.

8. VACUUM

The two prototype vacuum tanks have been tested in presence of the prototypes of KM and SM. They showed end pressures and pumpdown times as expected in the design study. Design of the final stainless steel vacuum tanks is under way. Practically all pumps, valves and other material have been purchased. Drawings have been received from IHEP for the enlarged vacuum chambers in the ejection region of the accelerator. Since the radial inner dimensions of the chamber were not clear from the drawings, only a partial agreement[23] could be given by CERN, the responsibility for some of the dimensions remaining entirely IHEP's.

A prototype of a dynamic bellows for sealing the moving shaft of SM 24 has been life tested. It broke at 3 millions operations. Further tests are being prepared. The construction will also be compatible with a sliding seal which will be manufactured as a reserve.

9. ELECTRONICS

Design of the timing system has been completed. It is now being manufactured in industry and delivery is due in September.

Controls and interlocks for the H.V. charging supplies have been defined and will be incorporated by the manufacturer. The same line is followed for the pumping station. Interlocks for the magnets and pulse generators will be defined as design of the equipment is more advanced.

Design of the vacuum controls is almost completed. They will be manufactured in industry.

The prototype passive integrator for the fast monitoring system has been tested. Definition of the channel selector and display equipment will be done when design of the other equipments is further advanced.

The hydraulic programmer has been designed and is being constructed at CERN.

Design of the multiplexed precision voltage regulation is well advanced.

Prototypes of electronics for electrostatic pickups and beam current transformers have successfully operated in the laboratory and are being prepared for beam tests in the CPS. A prototype beam profile monitor is also being prepared.

The interfaces with the beam data handling computer are ready. The series production of all nixie display must be in progress in industry and delivery is planned in September.

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