THE CERN PS EAST AREA IN THE LHC ERA

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Abstract

Experiments planned at the CERN Large Hadron Collider (LHC) will require a well-equipped test area with low momentum (<15 Gev/c) secondary particle beams. These beams will be used to test some of the LHC detectors components (ALICE, ATLAS, CMS, LHC-B). In addition another recently approved experiment (DIRAC) will be installed in the PS East Area. This experiment will require a primary proton beam of 24 GeV/c to test QCD predictions. In this context, the EHNL project (East Hall New Look) has been launched. The major modifications include (i) an extension of the present area with a primary 24 GeV/c beam line, (ii) a new secondary beam line lay-out with test areas at 3.5, 7, 10 and 15 GeV/c, (iii) an additional irradiation area, (iv) an improved facility for beam sharing between the various users. This paper describes the scope of the project, its new features, the planned facilities and its installation schedule.

1 INTRODUCTION

Following the approval of the Large Hadron Collider, the planned LHC experiments are now preparing parts of their detectors. Before full scale manufacture and assembly are launched, tests and optimization of these components are needed under adequate beam conditions. Part of these tests require low-energy particle beams and can be performed in the East Hall, either with a primary proton beam provided by the PS or with secondaries produced by the PS beam hitting a target [1]. Merging these needs with the additional request of housing the DIRAC experiment to be running with primary 24 GeV/c protons in the same East Area, led to the decision to carry out a major reshuffling of the PS East Hall under the project name EHNL, for East Hall New Look [2]. This project aims at upgrading and renewing the area for use by physicists before and beyond LHC start-up.

2 SCOPE OF THE PROJECT

The DIRAC experiment [3] will make use of a primary proton beam of 24 GeV/c from the PS delivered by means of a resonant extraction process (300 ms spill) to a new, dedicated channel[4]. This experiment has very stringent requirements on beam quality: very low residual intensity modulation, low beam halo [5], small secondary particles contamination and high geometric stability.

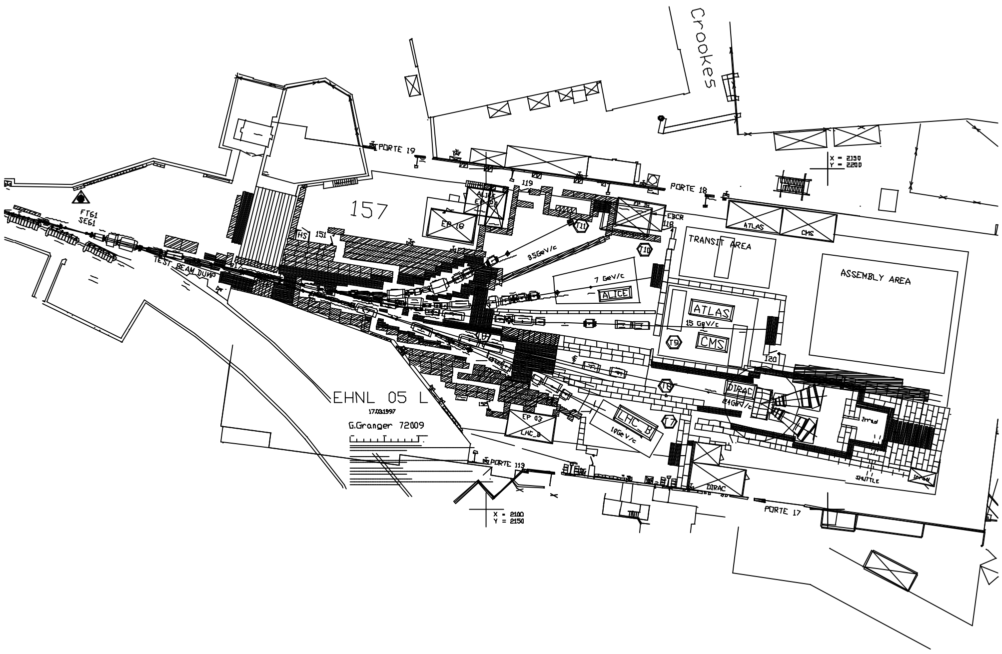

Fig 1. General lay out of the new PS East Area

LHC experiments will use secondary particles selected in momentum and polarity but not separated by species, produced from a very similar proton beam hitting a target. As at present, there will be 2 targets in the area: one on the undeflected beam of the North branch, feeding 3 secondary channels, T9, T10 and T11, and another one on the beam deflected to the South branch by the splitter magnet, feeding the secondary channel T7. The equipment modules to be tested are up to several cubic meters in volume and the various test places should be able to house them.

The above requirements have imposed the redesign of three of the secondary lines [6] [7] [8] and major modifications in the target area and the switchyard in addition to the new primary channel. The facility, presently covering 2/3 of the building area, will extend to the whole available space.

Downstream of the DIRAC experiment an irradiation facility has been added using the beam catcher upstream the beam dump. It will be used to test the radiation hardness of voluminous (4 x 4 x 2.4 m^3) equipment such as the planned liquid argon calorimeter of ATLAS. The expected rate of secondaries produced by 2 x 10^{11} primary protons/spill imposes quite a massive shielding.

These modifications, undertaken with restricted resources, will make maximum use of existing hardware.

User	Line	Momentum	Particle	Particles/spill
General use	T11	3.5 GeV/c	secondary	10^6
ALICE	T10	7 GeV/c	secondary	10^6
ATLAS/CMS	T9	15 GeV/c	secondary	10^6
DIRAC	T8	24 GeV/c	primary p	2 x 10^{11}
LHC-B	T7	24 GeV/c	secondary	10^6

Table 1. Users and beam characteristics.

3 NEW FEATURES

In order to allow maximum operational flexibility, most lines will be able to run simultaneously, taking advantage of the PS multi-user feature. While sharing between both secondary targets is achieved, as at present with a septum (splitter) magnet, a laminated switching magnet is used to serve two users with different needs. For cost reasons, switching between the 2 optics will be carried out with the available solid yoke quadrupoles. Preliminary tests have been conducted showing that induced currents can be limited with a suitable current rate of change, giving adequate performance in terms of stability and heating.

Since the completion of the antiproton programme at the end of 1996, the intensive proton cycles from the PS are no longer required for antiproton accumulation. The PS can now feed the East Area with 2 slow extracted spills within a 14.4 s supercycle. Thanks to the PS multi-user facility, each of these 2 spills can be dedicated to different East Area users. For example, while the first one can be used by DIRAC only (as single user), the second one can be shared by all other users or given to any of the North or South branches (see Table 2).

In the PS itself, an additional tuning device will be implemented in the slow extraction process to control the instantaneous extracted intensity and reduce the low-frequency spill modulation as required by DIRAC.

4 PLANNED FACILITIES

These are shown in Fig. 1. with their main characteristics and assigned users described in table 1. For secondary lines, the momentum and intensity quoted are the maximum of the line while for the primary line, they are nominal. Irradiation of small samples as done today close to the south target position will still be possible but will be incompatible with the use of beamline T8.

The secondary lines are based on the double monochromator design and provide full momentum recombination in the user area. Momentum resolution is a fraction of a percent and the momentum is freely adjustable by each experiment up to the maximum.

The beam transport uses a full set of optimised optics to ensure the best possible beam characteristics in the user areas. Two examples are depicted on Fig. 2 and 3.

BEAM LINE	SPLITTER MAGNET ON: All beam within splitter gap and deflected to South branch		SPLITTER MAGNET ON: Beam shared by splitter between North and South (deflected) branch		SPLITTER OFF or Beam outside splitter gap
	Beam to T7	Beam to T8	Beam to T7	Beam to T8	All beam to North (undeflected) branch
T7	Primary p+ or Secondaries < 10 GeV/c	No Beam	Primary p+ or Secondaries < 10 GeV/c	No Beam	No Beam
T8	No Beam	24 GeV/c p+ (unscraped)	No Beam	24 GeV/c p+ (scraped)	No Beam
T9	No Beam		Secondaries < 15 GeV/c		Secondaries < 15 GeV/c
T10	No Beam		Secondaries < 7 GeV/c		Secondaries < 7 GeV/c
T11	No Beam		Secondaries < 3.5 GeV/c		Secondaries < 3.5 GeV/c

Table 2. Possible beam sharing combinations between the 5 East Area beam lines.

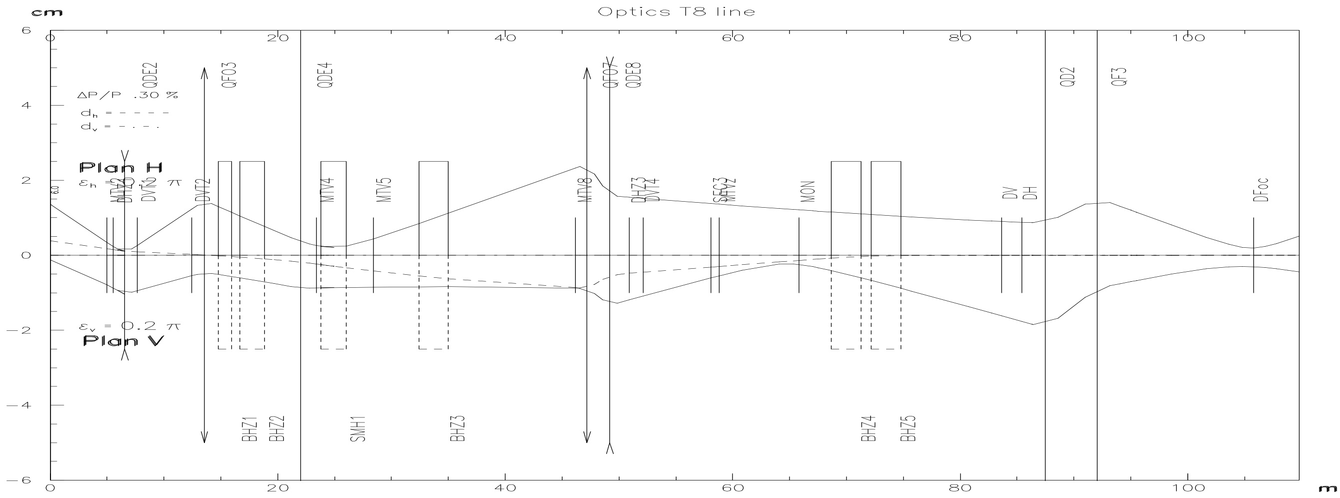

Fig. 2. Beam optics of primary line T8 for the DIRAC experiment

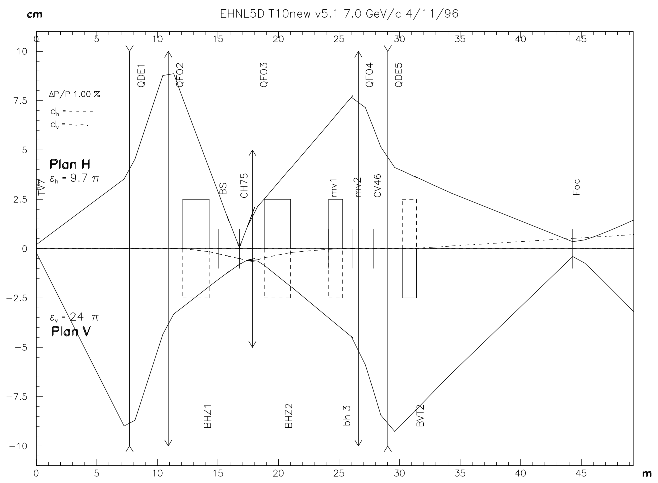

Fig. 3. Beam optics of secondary line T10 for ALICE

5 INSTALLATION SCHEDULE

Installation is planned during a long (9 months) shut-down of the area, starting at the end of September 1997. After dismantling some of the shielding and modifications of the target area and switchyard, transformation of the secondary lines will take place. In parallel, maintenance of recovered elements will be carried out, before their reinstallation. After shielding replacement, during DIRAC installation, the experimental lines will be commissioned and sequentially put back into operation, starting with the least affected line T11 and ending with the new line T8. The whole area coming back again to life in the fall of 1998.

6 CONCLUSIONS

At the end of 1998, after completion of the EHNL project, the CERN PS East Area will house a major physics experiment while providing the physics community with a convenient detector test facility for the years to come. This facility will then be mainly devoted to tests of parts of LHC experiment including the capacity for testing radiation hardness of key components.

7 ACKNOWLEDGEMENTS

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