CHAPTER 21

INTRODUCTION

21.1 SITUATION

Two new transfer lines, TI 2 and TI 8, with a combined length of 5.6 km are being built to transport protons at 450 GeV/c and ions from the SPS to the LHC. The geographical layout of these lines is shown in Fig. 21.1. Also shown are some of the main geometrical parameters. An overview of these lines including the LHC injection systems has been given in [1,2].

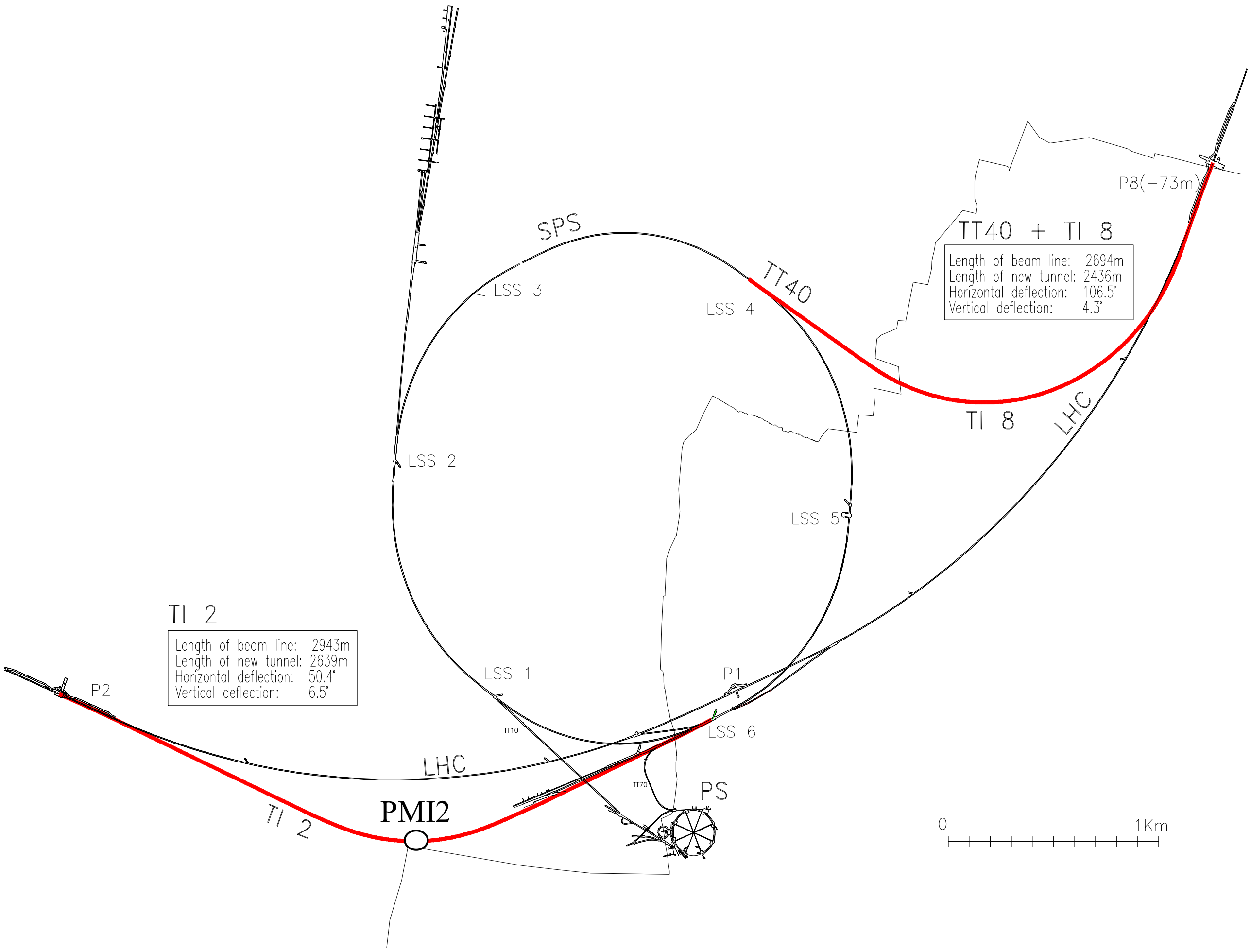

Figure 21.1: Overall layout of TI 2 and TI 8

The TI 2 line branches off from the existing SPS transfer line, TT60, in the switchyard, TCC6. The switchyard is some 250 m downstream of the LSS6 extraction point (see Chap. 18). TI 8 transports the beam over about 2.9 km to the injection point into LHC Ring 1, about 150 m left of IP2. The present slow resonant extraction in LSS6 will be converted into a fast extraction [3] after the closing of the SPS West Area at the end of 2004.

The beam to be sent down TI 8 leaves the SPS through the new fast extraction in LSS4, which was commissioned in 2003 [4] and arrives after about 2.7 km some 160 m right of IP8 for injection into Ring 2 (this IP is displaced away from the injection point by 11.22 m). The first 100 m of this new beam line is in common with the primary proton line to the CNGS facility [5]. Following the normal SPS nomenclature, this section of beam-line is called TT40.

A detailed description of the LHC injection systems is given in Chap. 16 of Vol. I, while the SPS extraction channels for the LHC are described in Chap. 18 of the present report.

The vertical profiles of the two tunnels are given in Fig. 21.2 and Fig. 21.3. Also shown is a line showing the approximate transition level between the limestone rock (below) and the glacial moraine (above). TI 8 drops some 70 m to bridge the altitude difference between the SPS and the LHC in that area. It is built completely in solid limestone rock. In order to stay entirely in the rock TI 2 has to pass below an underground river. In spite of the fact that the start and end point are at approximately the same altitude, additional vertical deflection is required to move the tunnel below the river, before raising it to the level of the LHC. More civil engineering related details are contained in Chap. 2 of Vol. II.

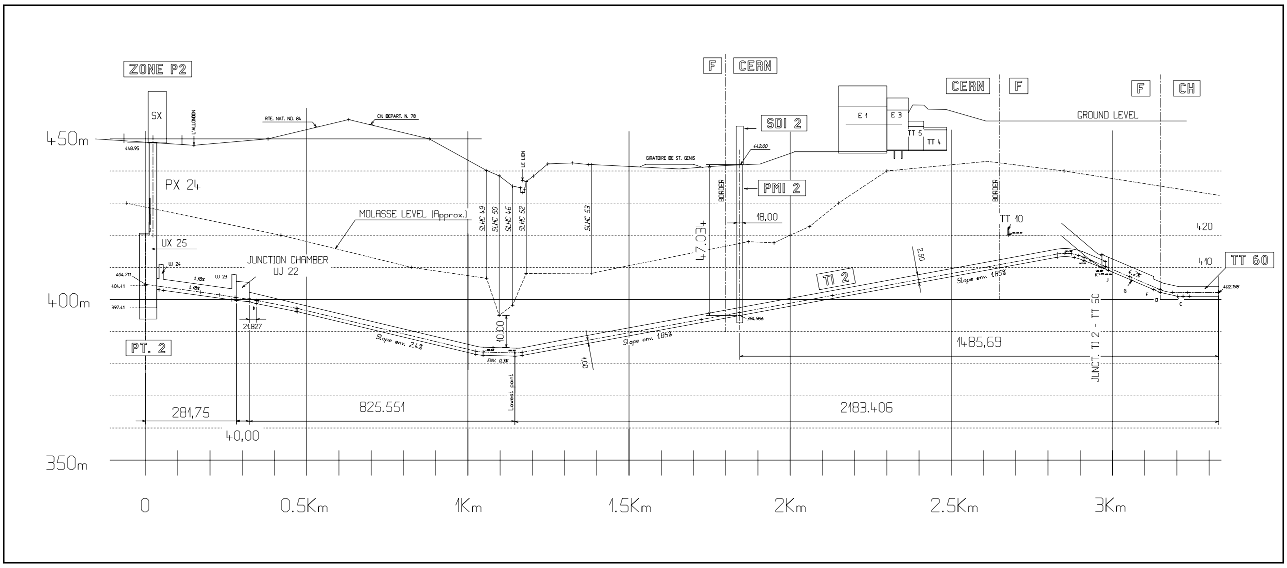

Figure 21.2: Vertical Profile of TI 2.

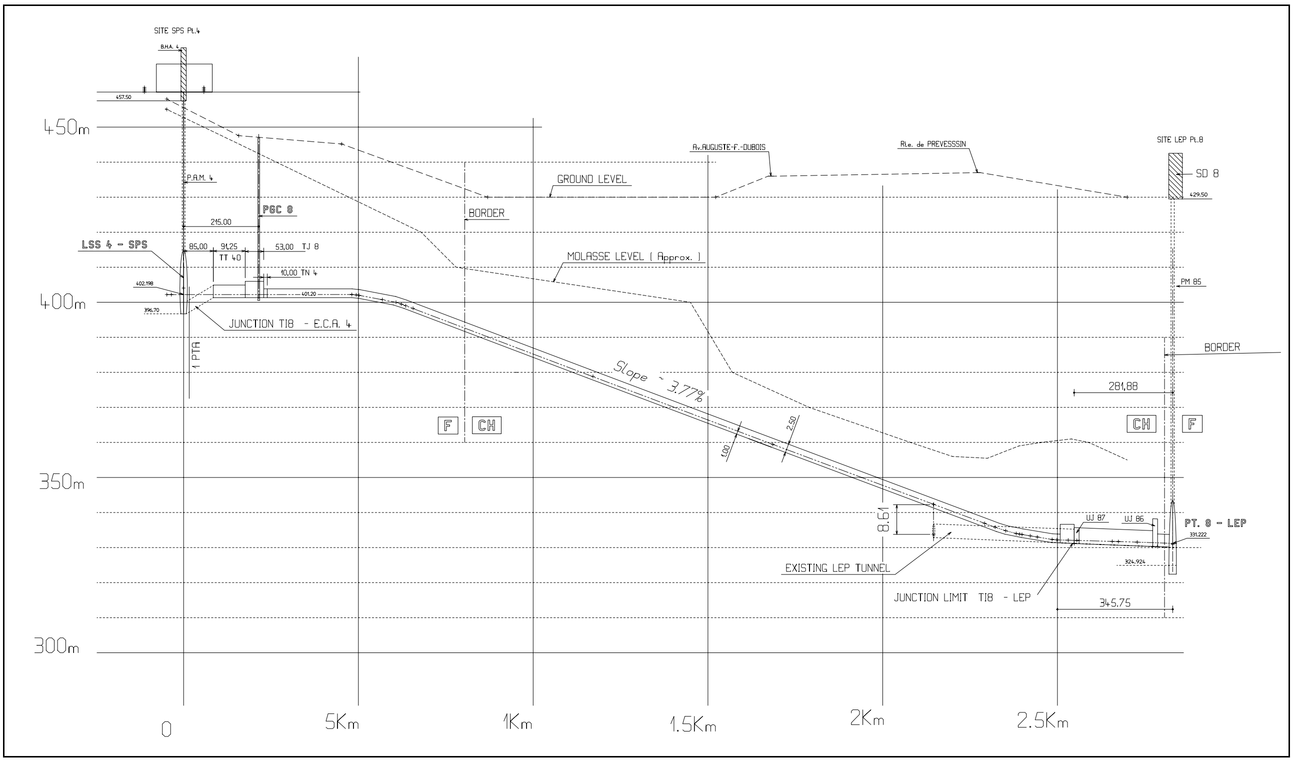

Figure 21.3: Vertical Profile of TI 8.

21.2 OVERALL DESIGN CONSIDERATIONS

A number of different variants to transfer beam from SPS to LHC have been considered during the design phase, including polarity reversal of the SPS to fill both LHC rings and the use of superconducting magnets. Since the lines will only be used during a fraction of the time (the possible filling schemes are described in

Chap.12 of this Volume) considerations of overall economy have finally led to the adoption of the present scheme based on room temperature magnets. The layout chosen also has the advantage that it leaves the LHC high-luminosity insertion in IR1 unaffected.

To reduce cost, the transfer line tunnels have a diameter of just 3 metres. Many components have been recuperated from closed down installations and existing infrastructure is used as much as possible. Classical magnets of compact design are used for the main dipole and quadrupole series. These were built by the Budker Institute for Nuclear Physics at Novosibirsk, in the framework of the contribution of the Russian Federation to the LHC.

A careful control of the trajectory and the preservation of the very small emittance during transfer and injection are of key importance. The main design goals in terms of beam performance and optics were to meet the LHC orbit with high precision and reproducibility (including all errors to better than $\pm 1.5\sigma$), to achieve a perfect optical match and to remain sufficiently flexible to accommodate future changes in both the SPS and the LHC optics.

21.3 STATUS AND PLANNING

Civil engineering and general services installation is finished for both tunnels. During the summer of 2004 the beam line in TI 8 will be installed [6]. Beam commissioning of the entire TI 8 line (with the exception of the LHC injection) is scheduled for October 2004 [7]. Line installation in the upstream part of TI 2, up to a point 200 m away from the access shaft PMI2 (indicated in Fig. 21.1 and Fig. 21.2), is foreseen to start towards the end of 2004.

The downstream part of the TI 2 tunnel will be used to transport LHC cryomagnets into the machine. For this reason the beam line will not be installed until the transport of the LHC components is complete [8].

REFERENCES

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