2.3 Machine Detector Interface

The Machine-Detector Interface (MDI) at the ILC covers all aspects that are of common concern to both detectors and to the machien. This usually covers topics like beam induced backgrounds, integration of the machine and detector elements in the Interaction Region (IR) as well as phyics related beam instrumentation issues (e.g. polarisation and energy measurements). This section deals with those MDI topics that are of common concern to both detectors and that are not specific to the respective implementation of the IR: common assembly procedures, experimental area layouts, the push-pull system. Detector concept specific MDI topics are discussed in the respective chapters of the SiD and ILD sections in this report.

2.3.1 The Push-Pull Concept

Other as in a storage ring, the total integrated luminosity in a linear collider does not scale with the number of interaction regions. The violent beam-beam interaction degrades the beam quality after the collisions so far, that each bunch of particles can only be used once and is disposed in the beam dump afterwards. Nevertheless, it is a broad consensus, that two complementary detectors, that are run by two independent collaborations, are mandatory to exploit the benefits of healthy competition and to allow for independent cross-checks of the measurements. While the beam delivery system of the ILC is a complex and rather expensive system, a duplication of the interaction region is excluded for economic reasons. Therefore the ILC design foresees to have two detectors that share one interaction region in a push-pull operation scheme. In that scheme, one detector would take data, while the other one is waiting in the close-by maintenance position. At regular schedules, the data-taking detector is pushed laterally out of the interaction region, while the other detector is being pulled in. As the data taking intervals for each experiment should be short enough to avoid a potential discovery by one detector alone, the transition time for the exchange of the detectors needs to be short, i.e. in the order of one day, to keep the total integrated luminosity at the ILC high.

The technical design of the push-pull system is a novel and challenging engineering task. Of importance is the definition of the interfaces and boundary conditions that are needed to allow for the friendly co-existence of the two experiments and the accelerator. The top level interfaces and requirements have been laid down in a common publication of the detector concepts and the ILC machine group [1]. Major requirements that needed to be defined comprise among others geometrical boundary conditions, vibration tolerances, alignment requirements, vacuum conditions, radiation and magnetic environment.

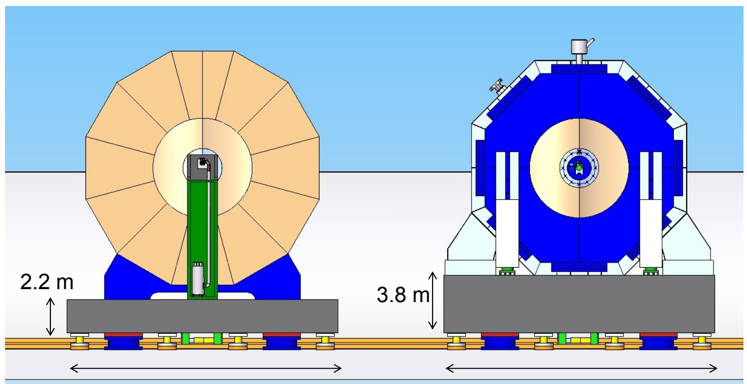

Figure 2.0: The push-pull system at the ILC: SiD and ILD on concrete platforms.

One important subject was the conceptual development of the detector transport system for the push-pull operations. The recently agreed upon scheme foresees a platform-based movement system, where each detector would be placed on a platform of reinforced concrete that runs on a suitable transportation system, e.g. a rail based system or on air pads. Of major concern were the possible amplifications of ground motion in this system; detailed simulations that were cross-checked with measurements at existing structures showed that these effects can be controlled [2]. An engineering study has been performed to study the behaviour of a 20 m $\times$ 20 m large platform [3] that could carry the detectors. The more challenging case is the ILD detector because of its large mass ($\approx$ 1.5 kt) and its larger outer dimensions that requires a thinner platform with a height of 2.2 m. Simulations show that the distortions of a properly designed platform underneath the detector stay within the limit of 2 mm and that the acceleration of the detectors during the motion stay below 0.5 m/s^2. Two different schemes for the platform movement system have been studied, air pads and Hilman rollers. Both solutions would work for the push pull system. Figure 2.0 shows a schematic configuration of the ILC experimental hall with both detectors on a platform-based push-pull system.

2.3.2 Detector Installation Schemes and Timelines

The installation schemes of the detectors and the layout of the experimental areas on surface and underground depend on the geographical situation of the possible ILC sites. While the European and American sample sites assume a flat surface area, the Asian sample sites in Japan are located in the mountains where the requirements for the conventional facilities and buildings are different.

2.3.2.1 Flat surface ILC sites

In ILC sites with a flat surface, it is foreseen to have the underground experimental halls connected vertically with shafts to the surface area. In these conditions, the ILC detectors follow the assembly scheme that has been adopted by the CMS experiment at the LHC. The detectors will be pre-assembled, cabled and tested as much as possible in surface assembly buildings. The underground excavations and installations are done in parallel at the same time. Therefore the time schedule for the detector assembly, the civil construction, and the machine installation are mostly decoupled. Rather late in the construction period, about 1-2 years before the first beam is in the machine, the large detector parts will be lowered into the underground cavern through a large vertical shaft. The diameter of the shaft and the capacity of the temporary gantry crane for this procedure is defined by the largest detector part. This will be the central iron yoke ring of ILD with the mounted solenoid coil and installed barrel calorimeters. The big detector parts for both, ILD and SiD, can be loaded directly onto the respective platform. The final installation and commissioning of the detectors should then be performed in the maintenance areas of the underground cavern. Figure 2.0 (top) shows a generic timeline for installation of the detectors in the flat surface sites.

2.3.2.2 Mountainous ILC sites

The ILC sites that are under study in Japan are in mountain regions. Therfore it is not possible to have vertical access shafts of $\approx$100 m length into the underground caverns. Instead, access will be provided by means of a horizontal access tunnel of $\approx$1 km length. The diameter of this tunnel will be given by the largest parts that need to be delivered into the experimental cavern in one piece. This would be the coil of the ILD detector solenoid that has a diameter of $\approx$9 m; so the tunnel diameter would be in the order of 11 m. The transport system in the tunnel limits the mass of the parts to a maximum of $\approx$400 t.

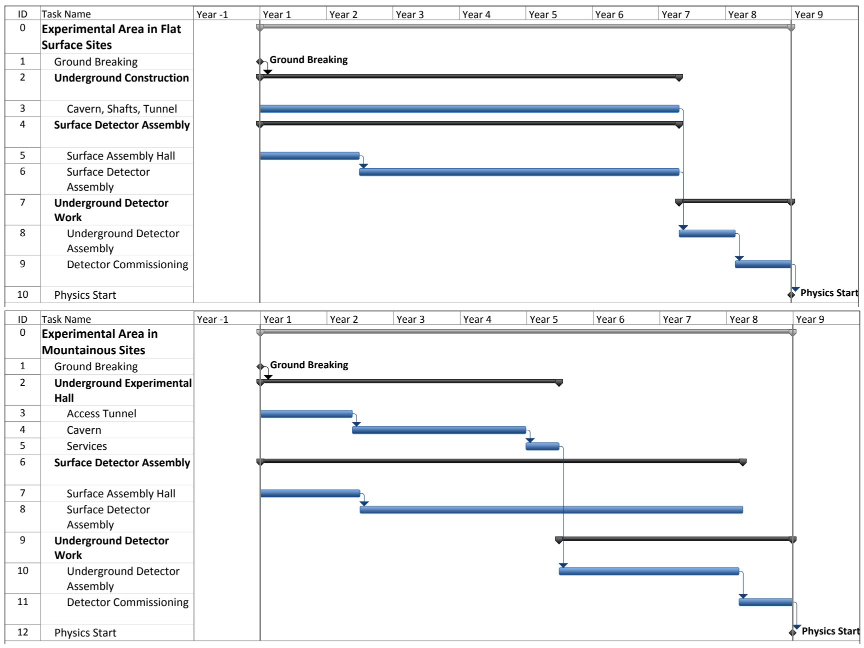

Figure 2.0: Generic detector assembly time lines for flat surface (top) and moutainous (bottom) ILC sites.

Due to this boundary conditions, a modified detector installation scheme needs to be followed. In that case, still the most parts of the detector would be pre-assembled and tested in the surface areas. However, more assembly work needs to be done underground. As, e.g., the big yoke rings of ILD could not be transported through the tunnel, the assembly of the iron yoke needs to be done in the underground cavern. Also the installation of the solenoid and the calorimeters needs to be done in situ. Additional underground space and working time is needed in the mountain site cases of the ILC. Figure 2.0 (bottom) shows a generic timeline for the installation of the detectors in the mountain sites. The timelines for the detector assemblies, the civil construction and the machine installation are interwoven.

2.3.3 Experimental Area Layout

The experimental area layouts for the different ILC sites need to fulfill the boundary conditions that are given by the installation schemes of the detectors, the needs for a safe and efficient running of the machine and both detectors in push-pull mode, and need to allow for efficient maintenance of the technical installations.

2.3.3.1 Flat surface ILC sites

Figure 2.0 shows the conceptual design of the underground experimental cavern for the flat surface ILC sites. The hall layout follows a z-shape where the platforms tranport the detectors perpendicular to the beam line. Each detector has a parking cavern where the detector could be opened for service and maintenance. One bit 18 m diameter shaft enters the hall directly over the interaction point (IP). This shaft will be used for the initial assembly of both detectors. The large pre-assembled parts can be loaded directly onto the platforms. Two service shafts in the maintenance caverns will be used for services and for access in maintenance periods of one detector while the other one is taking data on the IP. Two smaller elevator shafts are foreseen for people and material transport as well as for safety egress.

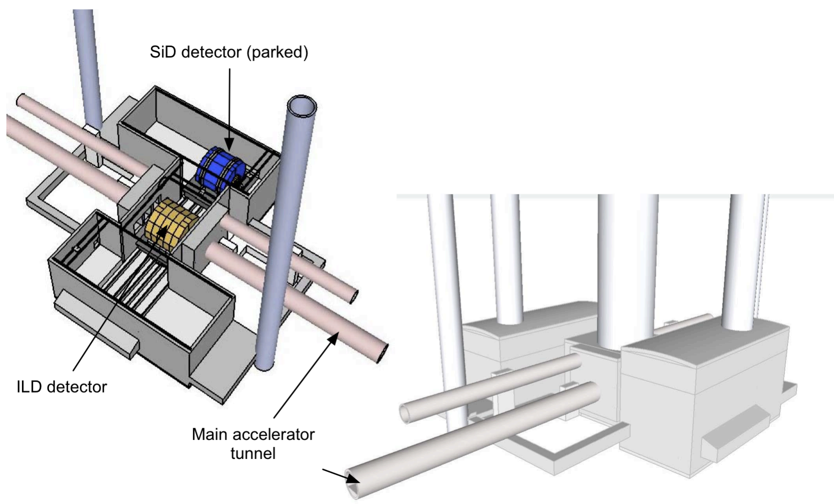

Figure 2.0: SiD and ILD in the experimental hall for flat surface ILC sites.

2.3.3.2 Mountainous ILC sites

The conceptual design of the experimental cavern for the mountainous ILC sites is shown in figure 2.0. The push-pull system will be very similar to the one in the flat surface case. Alcoves in the cavern enlarge the parking positions of the detectors to allow for the lateral opening and servicing of the detector parts. Access to the hall is foreseen by means of a ≈1 km long 11 m diameter access tunnel. This tunnel enters the hall twice, at the ILD and at the SiD side, to minimise the interference during the detector installation phase. The tunnel passes underneath the ILC beamline tunnel and extends towards the central region where the damping rings are located.

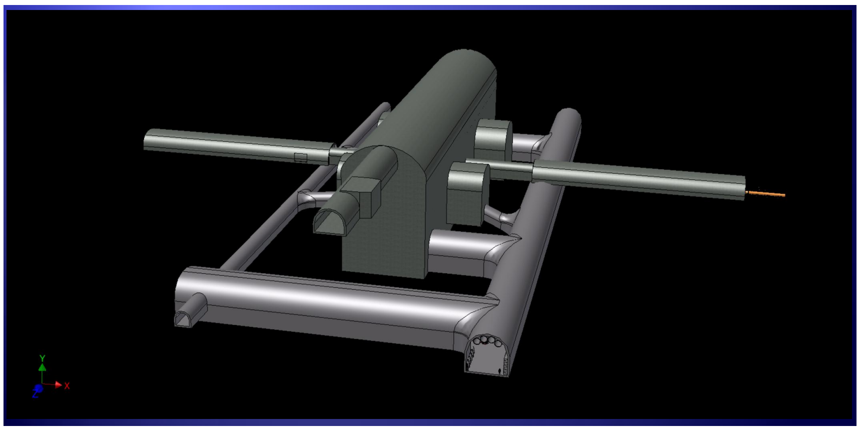

Figure 2.0: The experimental hall for mountainous ILC sites.

2.3.4 Integration with the Machine

2.3.4.1 Shielding

2.3.4.2 Final Focus Magnets

Bibliography

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