Site Studies for the SuperB Collider and Synchrotron Radiation Facility Project

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Abstract

The SuperB complex project [1] aims at the construction of a very high luminosity ($10^{36}cm^{-2}s^{-1}$) asymmetric e^+e^- B-factory and a few X-ray synchrotron beam lines (SR). The project has been recently approved by the Italian Government as part of the National Research Plan. The Tor Vergata University location has been chosen and a Consortium among INFN, University of Rome II Tor Vergata and the Research Ministry is being signed, allowing for the constitution of the "Cabibbo Laboratory", where the SuperB project will be hosted. This paper presents and describes the status of the preliminary design of the site layout, related issues for the chosen site and the preliminary ground motion (GM) measurement results.

INTRODUCTION

The SuperB Project has been approved by the Italian Research Minister as part of the Italian National Research Plan, with a 5 years construction budget [2]. A Consortium agreement between INFN, Tor Vergata University and the Research Ministry is being signed, allowing for the constitution of the "Cabibbo Laboratory", where the SuperB project will be hosted. The Consortium will be in charge of facilities construction and operation. Last June the site for the SuperB construction has been selected on the campus of the Tor Vergata Rome II University, at about 4 km from the Frascati National Laboratories following good results of recent GM measurements. Presently, the site consists of about 30 hectares of green field. The area nearby Rome is very stable from a geological point of view because it was created by the Laziale volcano about 600000 years ago while the volcano activity can be considered in active for about 35000 years. The seismic activity is very low compared with central Italy. No very important archaeological remains are on the area because it was part of the Roman countryside during the Roman Empire period. In Figure 1 is a preliminary layout of the site. Logistically the site is in a very good position being close to the highway, not far from the Fiumicino international airport and very close to the University of Tor Vergata and the Frascati Laboratories. On the other hand the vicinity to the highway and other main roads brings unwanted annoyances like the cultural noise. A first vibration measurement campaign was performed on different points of the site last April 2011 and showed that the vibrations induced by the cultural noise damp in few meters from the source due to the special composition of the soil.

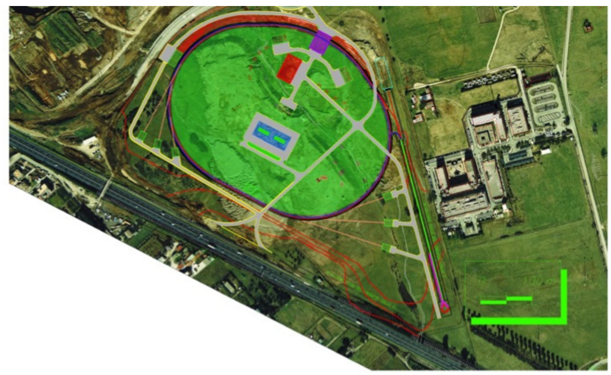

Figure 1: Layout of SuperB rings at the Tor Vergata site.

SITE LAYOUT

The SuperB collider is described in a revised edition of the Conceptual Design Report [1] where the design principles are described in detail. The main parameters are summarized in Table 1.

Table 1: SuperB main parameters with 10^{36} $cm^{-2}s^{-1}$

Parameter	**HER (e^+)**	**LER (e^-)**
C (m)	1260 m	1260 m
E (GeV)	6.7	4.18
I (mA)	1900	2440
$\varepsilon_{x/y}$ (nm/pm) (with IBS)	2/5	2.5/6.2
IP $\sigma_{x/y}$ (μm/nm)	7.2/36	8.9/36
σ_l (mm)	5	5
N. bunches	978	978
Part/bunch	$5.1x10^{10}$	$6.6x10^{10}$
RF (MHz)	476	476

HER and LER rings have the same circumferences and are housed in the same tunnel. Three to six SR beam lines of different length, from a minimum of few meters to a maximum of about 250 m will be built around the HER. Also the LER can have possible SR lines. A LINAC, of about 500 m will run from the South to the North direction with the capability to extend further North in the future allowing the construction of a free electron laser. Two parallel tunnels have been considered, one to house the LINAC and one for modulators and klystrons housing. The study and optimization of injection points and injection lines is underway so the injection lines reported in Figure 1 are very preliminary and will change considerably in the next months. A large building to house the Damping Ring is planned at the beginning of the LINAC. The collider hall will be on the North side very close to the roundabout with a double access to facilitate the experimental set up installation and maintenance. The main electrical substation is indicated in Figure 1 with a red rectangle while other 6 to 9 secondary electrical substations will be distributed around the main rings and along the LINAC. A large three story office-lab complex (about 4500 m^2 total) will be built in the middle of the facility.

SITE GEOLOGY

The SuperB site is about 400 m away from the "Sport City" facility which is being built in the Tor Vergata campus. The geological activity started in this area more then 600000 years ago when the Laziale volcano started its activity in the middle of the Mediterranean sea. The activity lasted for many millennia and about 35000 years ago ended leaving the countryside in a situation very similar to the present one. Even if a dedicated study of the SuperB site geology has not been performed yet, preliminary data of the nearby area exist because of a geological campaign survey performed in 2005 before the construction of the sport city. Data are known up to a depth of about 30m. A cross section of the ground is reported in Figure 2.

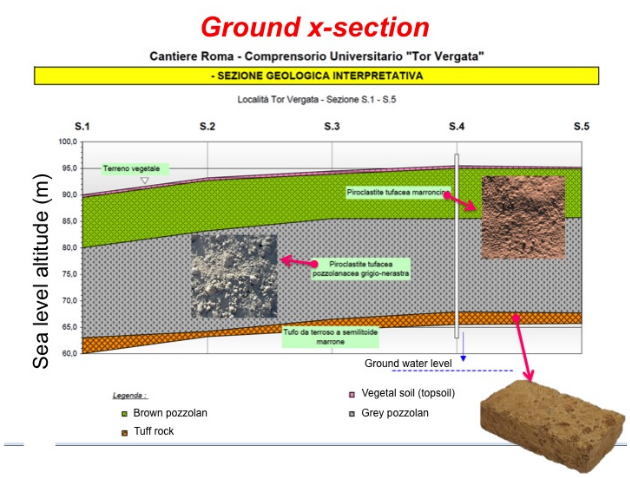

Figure 2: Ground cross section at the Tor Vergata site.

Starting from the ground surface, there is a first layer of vegetable soil with a thickness of about 1 m. Below, there is a 10 m layer of uncompact brown pyroclastic material then about 15-20 m of more compacted grey pyroclastic material and finally at 30 m below the surface we can find a very thick layer of tuff rock. The material of the two pyroclastic layers consists of compacted sand and clay that exhibits excellent damping properties and is able to support heavy loads. Moreover, these two layers have good draining, in fact the underground water can be found at about 40 m depth well below the pyroclastic layers. A dedicated geological campaign with holes boring and geotechnical tests will be carried out soon on the area reserved for the construction of SuperB.

SITE VIBRATION MEASUREMENTS

The first campaign of ground vibration measurements was performed on the Tor Vergata site in April 2011 with the collaboration of experts from LAPP laboratory, (Annecy France) and from CERN (Geneva, Switzerland). Seven different points have been measured in five days in order to characterize the site and to compare the influence of various vibration sources. The locations correspond to critical spots of the future SuperB: IP (1-6), injection area (4-7), electron source (2-5), SR laboratory (3). Short term measurements have been performed at points 1-2-3-5-6 while long term measurements were performed at points 4 and 7. See in Figure 3.

	Point measured
Monday 18	1 (afternoon)
Tuesday 19	2-3 (morning – afternoon)
Wednesday 20	4 (all day long)
Thursday 21	5-6 (morning – afternoon)
	7 (all night long)

Figure 3: Vibration measured points at Tor Vergata site.

GM has been measured in the frequency range of [0.1; 100] Hz. Below 1Hz, GM is due to earth motion, mostly to the micro seismic peak while above 1Hz, GM is due to "cultural noise" that means human activities [3,4]. However, a beam-based feedback in accelerators is usually used to stabilize directly the beam below 0.1Hz (and often at higher frequencies) and the amplitude of GM is very low above 100Hz, sufficient for the SuperB accelerator. In order to measure vertical GM in this wide frequency range, geophones (model Guralp CMG-40T from Geosig company) and accelerometers (model Endevco 86 from Brüel & Kjaer company) have been used. Point 2 was measured first, see Figure 3. Instruments were located at about 10 m from the highway border and about 6 m below the highway asphalt floor. In Figure 4 is shown the power spectral density (PSD). The frequency range [5; 25Hz] of the high peak corresponds exactly to the traffic noise. Amplitude of PSD is almost the same versus time in the three directions. The corresponding integrated RMS of vertical GM has been calculated. The GM in the range [0.2; 100Hz] is almost the same as the data from 5Hz to 25Hz. As a consequence, most of the noise comes from the highway and it can be considered a very high source of vibrations. The vertical displacement varies from 73 to 94 nm in the frequency range [1; 100Hz].

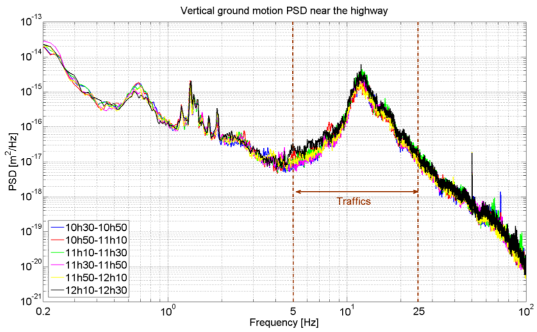

Figure 4: Vertical power spectral density at point 2.

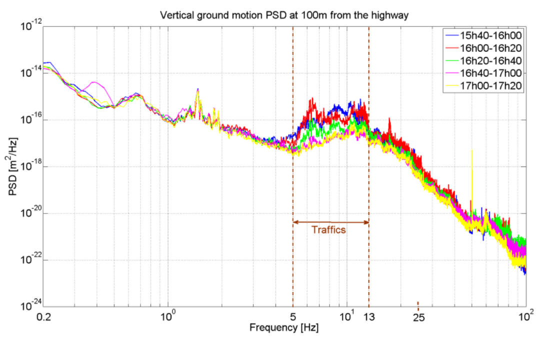

Figure 5: Vertical integrated RMS of GM at point 3.

Considering that we are very close to the highway, that SuperB should be built at a minimum distance of 100 m from it and that the high vibration peak disappears at 100 away from it (see in Figure 5), then can be said that the Tor Vergata site is acceptable. Measurements were performed also at points 1 and 6 (see Figure 3) where the future collider hall and final focus magnets will be installed. In the vertical direction the amplitude and the frequency range of traffic peak are very small moreover the PSD amplitude does not change versus time and versus day. See Figure 6. The amplitude of GM is very small on average and even in transient (sigma): around 20nm above 1Hz and 40nm above 0.2Hz. Points 4 and 7 are very close to each other. Point 4 was measured during the day while point 7 was measured during the night because of logistic reasons. Amplitude variations are small in average and transient between 10 nm and 30 nm above 1Hz in the three directions over the 24 hours data taking period.

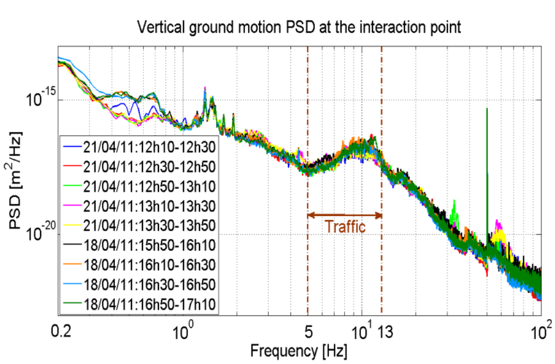

Figure 6: Vertical PSD at points 1 and 6.

The minimum value is reached during the night at 2h50 and the maximum at 9h30 in the morning mainly due to increased traffic. The vertical RMS integrated in the frequency range [1; 100Hz] is shown in Figure 7 for all the points. Note that the blue curve corresponds to the measurements performed directly near the shoulder of the highway (Point 5). Amplitude of ground motion decreases with the distance from the highway and is almost the same for all the points located at a minimum distance of 100m from the highway.

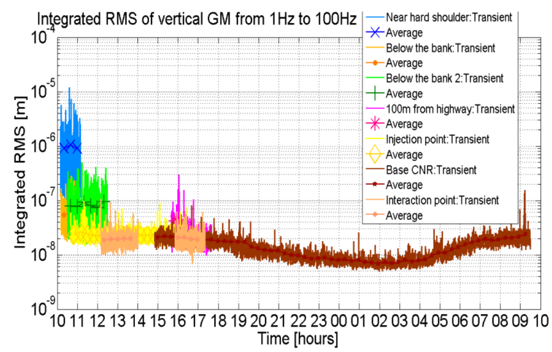

Figure 7: Vertical RMS of ground motion for all the points integrated in the frequency range [1; 100Hz].

CONCLUSION

The SuperB site has been recently chosen in the Tor Vergata University campus. Good results coming from the first campaign of ground motion measurements enforce this choice. The composition of the ground is very stable and suitable to damp the vibrations coming from the highway which is the main source of noise. At a distance of about 100 m from the highway the vibration amplitude is very low. In the three axes the amplitude vary from 8 nm to 30 nm for all measured points above 1 Hz and from 30 nm to 60 nm above 0.2 Hz. It is worth noting that these values are very good if compared to those measured at LNF Frascati and ATF2 Japan. Near the interaction point a new road is planned to be opened to the traffic soon but since there is also a high bank, vibrations should be well damped. Several new vibration measurement campaigns, including underground measurements as in reference [4], are planned in the near future.

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