GROUND MOTIONS MEASUREMENTS FOR SYNCHROTRON

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Abstract

For more than two decades, ground vibration measurements were made by different teams for feasibility studies of linear accelerators. Recent measurements were performed in the SPS tunnel and at different CERN sites on the surface. The devices to measure vibrations of magnitude ranging in nanometres, the analysis techniques and the results are critically discussed and compared with the former measurements. The implication of the measured integrated R.M.S. displacements for the Crab cavities cavern are mentioned.

The equipment used in this study consists of 2 state-of-the-art Guralp broadband triaxial seismometers. Models CMG-T60-0004 (Guralp Systems) performed measurements in three directions V, N/S and E/W.

The first analysis was to evaluate the power spectral density for each direction of sensors and event. The power spectral density is calculated from the auto power spectrum.

The power spectral density shows a typical curve for the geophones with the micro seismic peak between 0.2 and 0.4 [Hz]. It is important to point that ground vibrations should not be ignored in planning accelerator facility. Actually it is one of the limiting factor in the optimization of future accelerators.

SENSORS

Each author should submit the PDF file and all source files (text and figures) to enable the paper to be reconstructed if there are processing difficulties.

Models CMG-T60-0004 (Guralp Systems) performed measurements in three directions V, N_S and E_W. The geophones measure velocity with a sensitivity of about 2000 [V/(m/s)] and a frequency range between 30 [s] and 100 [Hz].

Geophones were adjusted to have the vertical direction parallel to the gravitation force. Longitudinal north-south and east west directions for geophones were pointed in the same directions. The results obtained from these sensors are dependent on good operational conditions and give a good signal to noise ratio only if all conditions are correct. The geophones need to be well protected against fluctuation in temperature and turbulent airflow.

In order to have a constant temperature for the geophones during operation, they were located and switched on 1 hour before any measurement was started. Then they had time to reach thermal equilibrium, this also reduces the DC offset from the measurement.

RESULTS

The first analysis was to evaluate the power spectral density for each direction of sensors and event. The ground motions at several locations measured in are plotted in (Figure 1). These locations are divided into three groups. The first group (red lines) is the synchrotron bunker, the second group (green lines) is the experimental hall and the third group (black lines) is the tunnel linac.

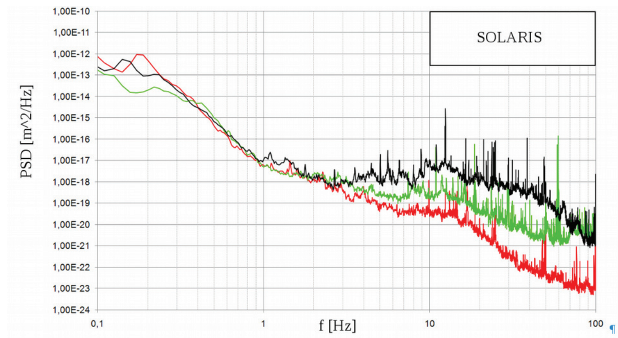

Figure 1: PSD for SOLARIS synchrotron.

RMS Integrated is used to sum up the total vibration of the PSD. It gives the RMS (Root Mean Square) value of the total vibration The integrated RMS ground motion in vertical direction for all these locations are plotted in (Figure 2). The (Table 1) show the value Integrated RMS value at 1 [Hz].

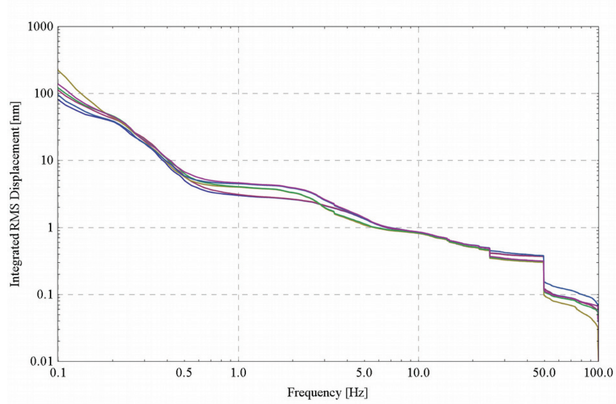

Figure 2: Ground motion all measured locations.

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Table 1: The Value Integrated RMS Value at 1 [Hz]

RMS Integraded values	**@1 Hz [nm]**
SOLARIS	4,8
CLEX experiment (Bld.2013)	13,3
AEGIS experiment (Bld.193)	13,0
PSI particle accelerator	11,8
CMS experiment	6,8
CesrTA particle accelerator	3,8
LSS4 Caver-SPS Accelerator	4,1
TT1 tunnel (ISR)	2,3
LHC tunnel (DCUM584)	1,9

CONCLUSIONS

The ground motion spectrum can be separated in two main regions. The low frequency region below about 2 Hz which is dominated by natural motions sources like ocean waves and earth tides, and the high frequency region above 2 Hz which is dominated by cultural motion sources like traffic, industry, transformers, pumps and people walking. The power spectral density graphs above clearly shows the distinction between these two regions. In the low frequency region, all locations have a similar ground motion dominated by well correlated natural motions. In higher frequencies the ground motion is dominated by the local cultural noise, and the highest ground motions occur at locations with high cultural activity.

Measurements performed at one location several times during a day show varying levels of ground motions, with a highest cultural noise during daytime.