Dynamic analysis and measurement of ground motion for the Solaris — National synchrotron radiation centre in Cracow

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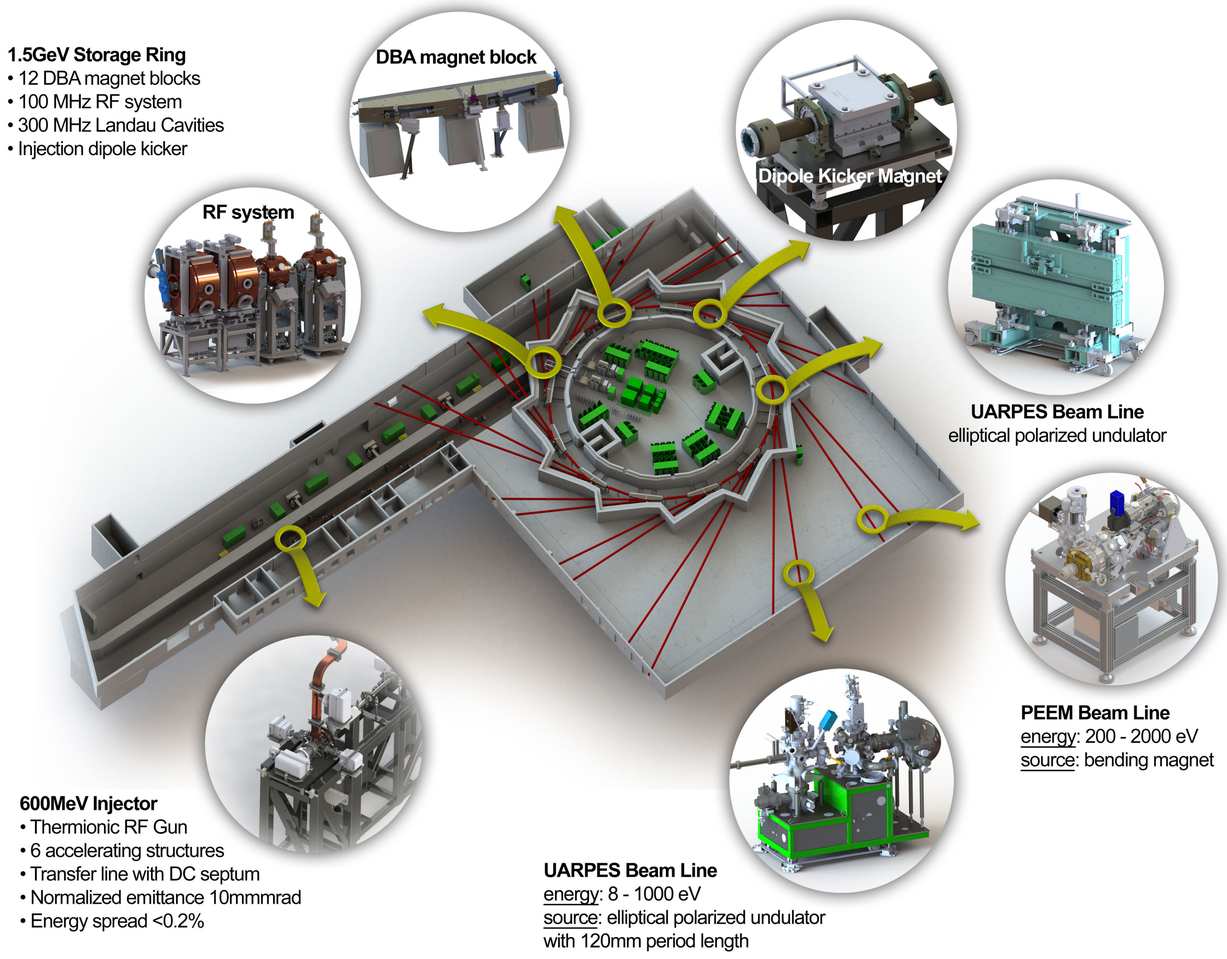
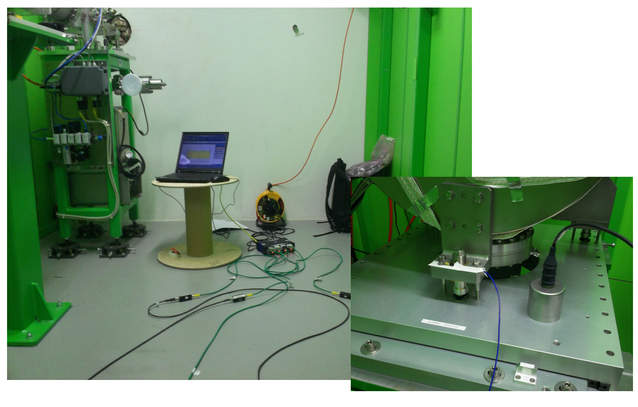
SOLARIS OVERVIEW



SENSORS AND ACQUISITION SYSTEM

The acquisition system used was the QuantumX made by HBM. The QuantumXI system is a universal amplifier and compact data acquisition system. It contains 8 input channels for each channel with a sampling frequency up to 19,2 [kHz]. 24–bit A/D converter per channel
for synchronous, parallel measurements.



Parameters	Value
Sampling frequency	512
Frequency Lines	12801
Block size	32768
Frequency resolution	0.015625[Hz]
Block duration	64[s]
Windowing	Hanning
Averaging	Linear
Overlap	66.7[%]
Number of averages	50
Length of entire block	1108.29 [s]

SUMMARY

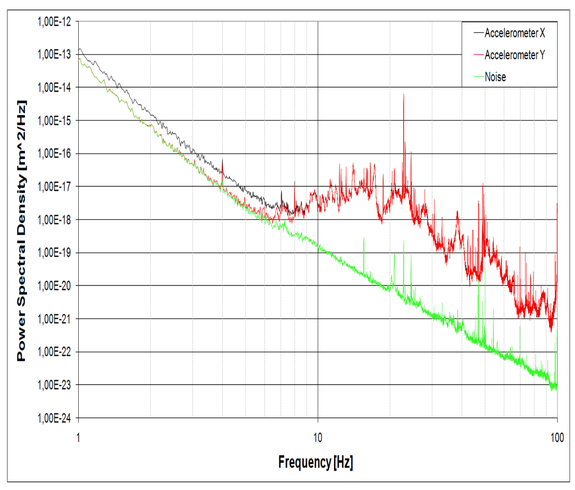
- Methods and parameters have been established on how to perform ground vibration measurements in the sub nanometre range.
- For some locations of interest, the ground motion has been measured and calculated. The integrated RMS at 1 Hz are shown in the table below:
- The frequency spectrum showing an integrated RMS value above 1 nm can be reduced if some effort is given to remove vibration sources from the environment (services, pumps, etc.) and from the mechanical interfaces between the ground and the magnet.
- In general the Signal-to-Noise ratio for the seismometers used seems to be satisfactory for the SOLARIS stabilisation and work activities.
- The most critical places are the SOLARIS tunnel and the experimental hall where the signal-to-noise ratio is about 2 at 1 Hz.
- A system was developed by the SOLARIS mechanical team for ground motions measurement in a single degree and three degree of freedom. This system includes a seismic accelerometer and the QuantumX data acquisition system. The performance of this system was measured in parallel by a second acquisition system.

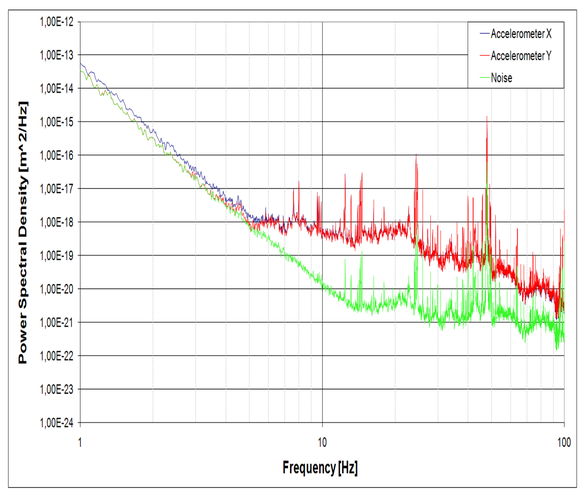
REFERENCES

[1] **Collette, C, Artoos, K, Kuzmin, A, Sylte, M, Guinchard, M and Hauviller, C**. *Active control of quadrupole motion for future linear particle colliders. Geneva (Switzerland)*: CERN, 2009.
[2] **Artoos, K, Capatina, O, Collette, C, Guinchard, M, Hauviller, C and Sylte, M**. *Ground vibration and coherence length measurements for the CLIC Nano-Stabilisation studies*. Vancouver (Canada): PAC09, June 2009.
[3] **Artoos, K, Capatina, O, Collette, C, Guinchard, M, Hauviller, C, Lackner, F, Pfingstner, J, Schmickler, H, Sylte, M, Fontaine, M, Coe, P, Urner, D, Bolzon, B, Brunetti, L, Deleglise G, Geffroy, N and Jeremie, A.** Study of the stabilisation to the nanometre level of mechanical vibrations of the CLIC main beam quadrupole. Vancouver (Canada) : PAC09, June 2009.

EVALUATION OF ACELEROMETERS

In addition to seismometers, seismic accelerometers can be a suitable motion transducer for the SOLARIS measurement. The noise of two different seismic accelerometers has been evaluated. These are PCB393831 and Endevco Model 86. The signal and noise for these transducers are plotted below.





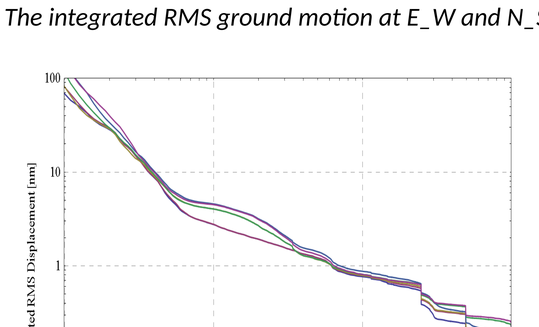
Two curves show that all accelerometers tested are able to measure above 7 Hz according to the signal to noise ratio. For the SOLARIS measurement this is not sufficient. The motion should be measured down to 1 Hz. However, seismic accelerometers can be used as a supplement to seismometers at high frequencies.

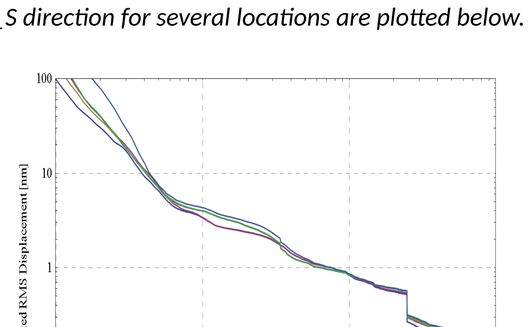
INTEGRATED RMS VALUES

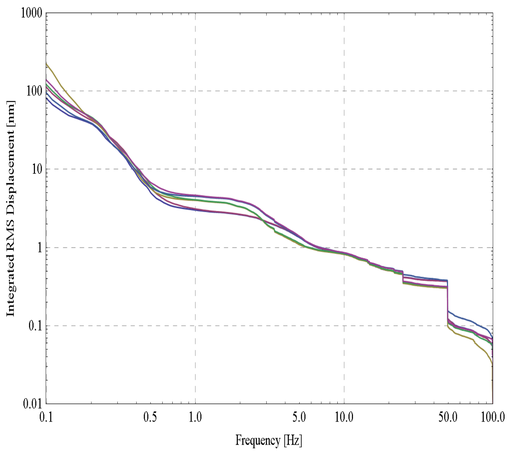
Integrated RMS is used to sum up the total vibration in a spectrum. As the name indicates it give the RMS (Root Mean Square) value of the total vibration. The integrated RMS is defined by:

$$\sigma_w(\nu) = \sqrt{\sum_{k1}^{k2} \Phi_w(\nu) d\nu}$$

Integrated RMS is a function of k, the frequency, k_1 is the lower value for the summation and k_2 is the upper value for summation. It is usual to plot the integrated RMS as a graph where k_2 is a fixed upper value and k_1 is gradually reduced while the integrated RMS is plotted for each value of k_1. Then it is possible to see the total summation of vibrations from a frequency and down to every lower frequency.
The integrated RMS ground motion at E_W and N_S direction for several locations are plotted below.







The integrated RMS ground motion in vertical direction for several locations are plotted on the left.

Location	1 Hz [nm]	10Hz [nm]
SOLARIS	5,1	0,9
CLEX experiment (Bld.2013)	13,3	11,6
AEGIS experiment (Bld.193)	13,0	12,4
PSI particle accelerator	11,8	11,0
CERN surface	11,7	10,1
CMS experiment	6,8	1,5
CesrTA particle accelerator	3,8	3,0
TT1 tunnel (ISR)	2,3	1,1
LHC tunnel (DCUM584)	1,9	0,5

Table show the value Integrated RMS value at 1 and 10 Hz.

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