

## Monitoring Culturally Significant Buildings

### Güralp strong motion accelerometers monitor historic mosque in Turkey

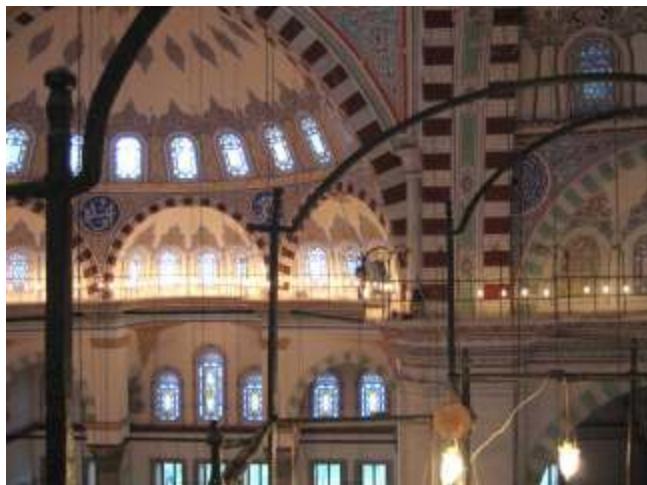
#### Summary

The city of Istanbul in Turkey lies in a very seismically active region due to the nearby North Anatolian Fault, which is potentially one of Earth's most dangerous continental fault zones. Studies have shown that the next large earthquake along the North Anatolian Fault may occur close to Istanbul.

Güralp was commissioned to set up a seismic monitoring system inside one of Istanbul's largest and oldest mosques. 13 5TD digital strong motion accelerometers were installed at different levels in the Mosque to record the response of the structure to ground movements. This data can be used to determine which parts of the structure may be susceptible to damage during a large earthquake. Real time data from these sensors was set-up as a real-time stream to city engineers.

The data obtained by the instruments has been used to analyse the vibrational modes of the building, which allow engineers to determine which parts of the building need to be strengthened to prepare for a future earthquake.

#### Fatih Sultan Mehmet Mosque, Istanbul



The Fatih Sultan Mehmet Mosque in Istanbul was built in honour of Fatih Mehmet II's conquest of the city in 1453. One of Turkey's largest mosque complexes, the site includes extensive precincts and madrasas (religious academies) as well as the central sanctuary.

Istanbul lies in an area of high seismicity, directly on the North Anatolian Fault, and small earthquakes are common. In 1509, forty years after construction was finished, an earthquake badly damaged the mosque buildings. A second earthquake, in 1766, caused the central dome to

collapse; this time, the complex was rebuilt entirely, with only the mihrab, portal and a portion of each minaret surviving.

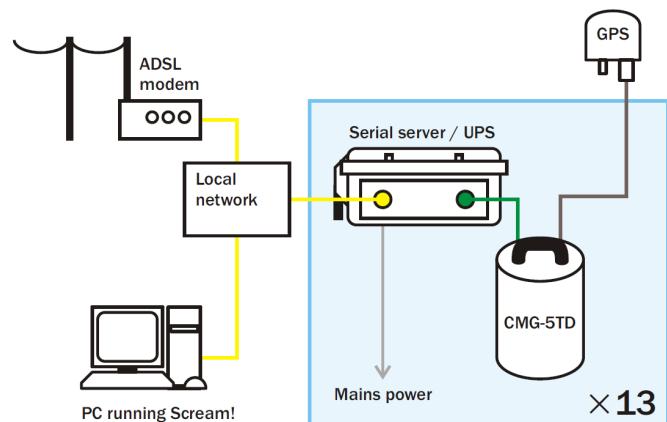
Recent scientific studies warn that a major earthquake is likely to hit Istanbul in the near future. According to one, the probability of such an event occurring in the next 30 years is  $62 \pm 12\%$ . Institutions across the city are working to make sure buildings will be able to withstand the earthquake when it happens.

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## Guralp Solution

Guralp were commissioned to set up a strong-motion experiment in the mosque, to record the response of the structure to ground movements and identify areas which will be susceptible to damage.

13 5TD triaxial digital accelerometers have been installed at locations around the mosque.



*System configuration*

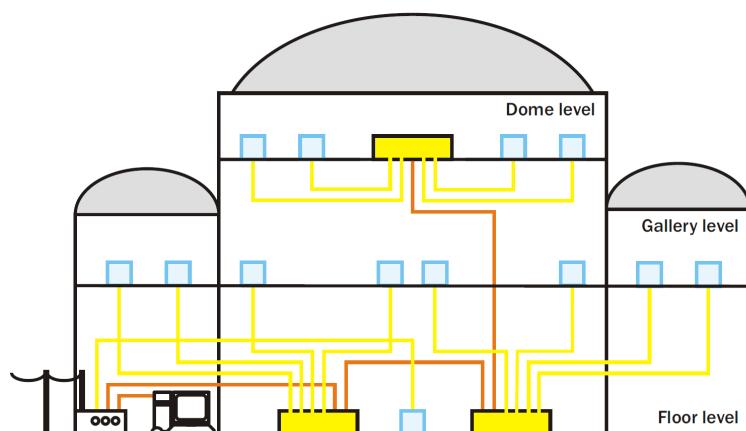
- > 4 instruments are located at equal spacing around the dome.
- > 8 further sensors are spaced about the gallery level.
- > A final 5TD placed on the stone floor provides an approximation to the free field.

Each instrument is connected to a Guralp Systems serial server / UPS module, which provides constant power and provides a TCP/IP connection for data streams to a central PC running Scream!. An ADSL modem using NAT provides internet access for the array equipment and forwards requests for GCF data to the PC's Scream! server.

## Outcome

With this setup, small earthquakes can be detected at the 5TD on the floor and compared with the motion of the sensor on the higher levels.

Differences between the traces can be analysed to provide information about the vibrational modes of the building, which are used to decide which areas are in need of strengthening before a large earthquake occurs.



*System configuration of strong motion accelerometers within the Mosque.*