The network of the International Monitoring System with its associated communications infrastructure and the International Data Centre was designed by a Group of Scientific Experts at the Conference on Disarmament in Geneva to be fully capable of monitoring compliance with the Treaty. New research and improved communications technology continuously strengthens and refines the detection capabilities of the IMS. This column introduces some of the latest developments in the field of verification science.

Evaluating infrasound station performance

The IMS infrasound network of 60 stations uses acoustic pressure sensors to dectect very low-frequency sound waves in the atmosphere produced by natural and man-made events. Many of the IMS infrasound stations have four-element arrays, based on network performance simulation studies carried out during the Treaty negotiations in Geneva. According to these studies, the detection threshold will be significantly less than one kiloton over most of the continental areas.

In 2002, Working Group B recommended that a number of tests be carried out in order to evaluate the performance of the IMS infrasound station network. At that time, about 60% of the infrasound network was in contract negotiation, under construction or already built. Experts from various scientific institutions were approached by the Provisional Technical Secretariat (PTS) to review the capabilities of several types of stations and to analyze the data from newly built and existing stations. The outcome of the review was discussed with PTS representatives in two workshops in March and in October 2003 in Vienna, Austria, and in La Jolla, United States, respectively.

The results of the expert study indicated that the four-element array stations are not robust enough. If one or two of the elements fail due to high noise or malfunction, the triangulation accuracy will be reduced. Another source of concern is the large spacing between the array elements which ranges between one and three kilometres. This may result in a poor directional performance of an array for higher-frequency sound waves.[1] This effect is often referred to as spatial aliasing (see Fig.1 and Fig.2). Eight-element arrays are less vulnerable to performance degradation. If an element or two are lost due to damage or malfunction, the increase in source parameter estimation error is still less than the error introduced by atmospheric variations. Furthermore, eight-element arrays perform equally well in detecting low- and high-frequency infrasonic waves. The expert group therefore recommended that stations be installed with more than four elements.

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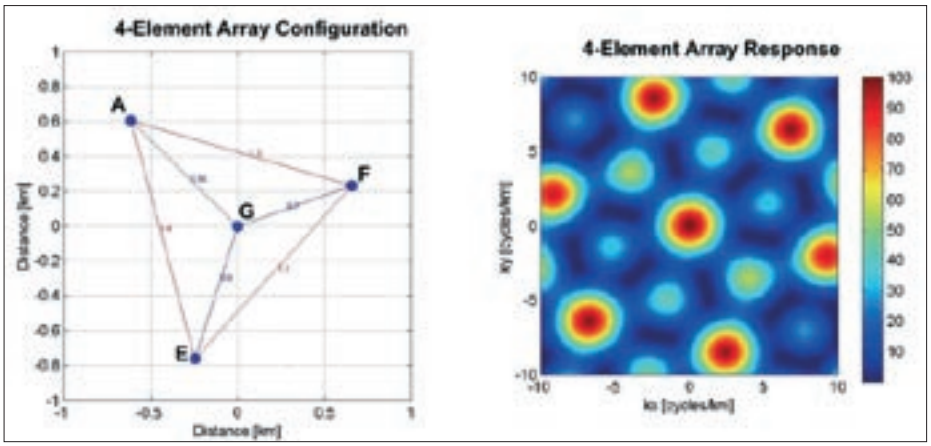

FIG. 1: SPATIAL ALIASING OF A 4-ELEMENT ARRAY IS VISUALIZED BY MULTIPLE RED-COLORED SPOTS IN ITS ARRAY RESPONSE PLOT. THE RESULT IS THAT THE DIRECTION OF THE INCOMING INFRASOUND MAY NOT BE UNIQUELY IDENTIFIED.

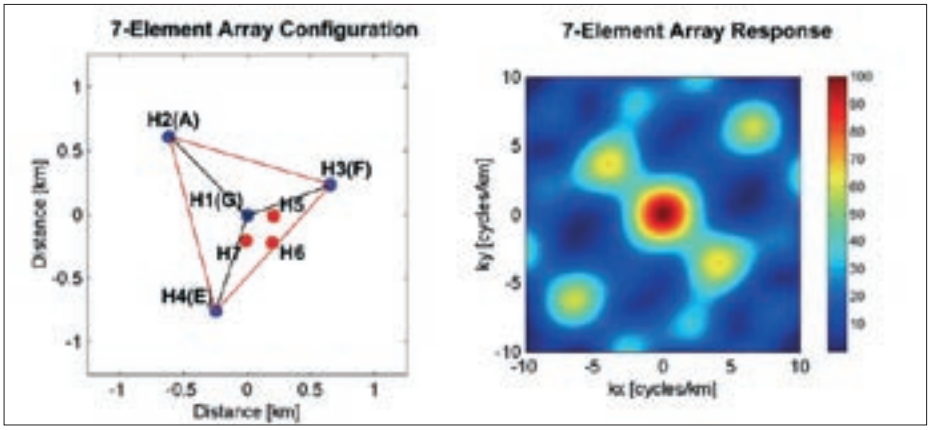

FIG. 2: THE ADDITION OF 3 CLOSELY SPACED ARRAY ELEMENTS (H5-H7) TO THE ORIGINAL 4-ELEMENT CONFIGURATION ELIMINATES ALL BUT ONE RED COLORED SPOT. THE DIRECTION OF THE INCOMING INFRASOUND IS NOW UNIQUELY IDENTIFIED.

[1] Recent studies of infrasound generated by small nuclear explosions suggest that the primary frequency band of interest for the detection of low-yield nuclear explosions is in the higher frequency range from about 0.4 Hz to 4 Hz. The frequency band specified during the Treaty negotiations covers a band from 0.02 Hz to 4 Hz.

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Evaluating infrasound station performance

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The expert group also recommended an irregular arrangement of the elements in the array and to adjust the number of elements and the size and type of the noise reducing system, according to the local meteorological conditions. The more recently built IMS stations have already implemented these recommendations.

Infrasound technology and analysis of infrasound signals is still developing. It is not as mature as the other verification technologies due to its comparatively short history. It has, however, a unique position within the verification system since it is capable of detecting explosions and many other natural phenomena in the atmosphere that cannot be detected by other IMS monitoring technologies. Further development and refinement of the infrasound network could therefore benefit the entire IMS. ■

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Calendar of Meetings 2004

Preparatory Commission:
22nd Session 22 – 25 June 2004
23rd Session 15 – 19 November 2004

Working Group A:
25th Session 7 – 11 June 2004
26th Session 4 – 8 October 2004

Working Group B:
22nd Session 9 – 27 February 2004
23rd Session I 24 May – 4 June 2004
23rd Session II 30 August – 10 Sept. 2004

Advisory Group:
22nd Session I 19 – 23 April 2004
22nd Session II 17 – 21 May 2004
23rd Session 13 – 17 Sept. 2004

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