Royal Norwegian Council
for Scientific and Industrial Research
(NTNF)

NORSAR

NORSAR Scientific Report No. 1-89/90

Semiannual Technical Summary

1 April — 30 September 1989

Kjeller, December 1989

7.4 A new data acquisition system for FINESA

The FINESA array was installed in Finland in 1985 and comprised in its original version 10 SPZ seismometers. Results from data analysis using the FINESA array in its initial configuration are given in Ringdal *et al* (1987). In 1988, the geometry of the array was expanded by the addition of five elements, and the FINESA array geometry currently comprises 15 vertical only seismometers within an aperture of 2 km, as shown in Fig. 7.4.1. An evaluaion of the performance of the expanded array is offered by Mykkeltveit *et al* (1988).

Until this year (1989), the only way of acquiring FINESA data has been by on-site recording on magnetic tapes, and all analysis of FINESA data has been strictly off-line. With the development of the Intelligent Array processing System (IAS), it has become an objective, however, to provide the capability of transmitting data from FINESA in real time to the NORSAR data processing center. At the same time, it has been an objective to enable real time transmission of FINESA data to Helsinki, for the independent analysis of this data by the staff of the Institute of Seismology at the University of Helsinki. A new data acquisition system, meeting the above objectives, has been developed at NORSAR and put into operation. Short descriptions of the field system, the communications interface used, the data transmission lines that have been established, and the SUN-based data acquisition and processing systems installed at NORSAR and Helsinki, are the subjects of this contribution.

The field system

The field unit is a VME-based system manufactured by Force Computers. The software was developed in Norway by the company Data Respons A/S, under the guidance and supervision of NORSAR personnel. A detailed description of this field system is provided in a manual prepared by Data Respons A/S, entitled NORSAR Field, System Description Manual. This manual is available upon request.

The main functions of the field unit are:

- A/D conversion at a sampling rate of 40 Hz of up to 32 channels (15 channels currently in use)
- Synchronized sampling using a Kinemetrics clock feeding the system with GMT time
- Data buffering, reformatting and adding of header information
- SDLC communication.

The entire FINESA acquisition system is shown schematically in Fig. 7.4.2. The units located at the FINESA array site in Sysmä are shown in the upper left corner: The field unit (Force Computer with A/D cards), Kinemetrics clock, an RS232 to V.35 converter, and a modem.

Communications interface and data transmission lines

NORSAR has recently developed a communications system named BUSC-VME (*BU*ffered *S*DLC *C*ommunications system for SUN VME-based systems). Our major requirements for a new communications interface were:

- Low cost
- VME-based
- SDLC communication
- No hardware developments
- Easy and low cost maintenance.

The BUSC-VME system meets these requirements and is easily interfaced with a SUN VME-based system. The BUSC-VME system is based on commercially available cards for installation directly into a SUN system.

The BUSC-VME system is based on two VME cards (CPU and memory) installed in the SUN VME bus. There is no requirement for outside units. The SDLC stream is plugged directly into the CPU board. The CPU board is MC68020-based and handles two high speed SDLC links (array and HF-data in case of NORESS; array data only in the current FINESA implementation). Data received by the CPU card are stored in a cyclic buffer on a memory board. A 2 Mb board has buffer capacity for 10 minutes of array data. The buffer size may easily be changed. The transfer speed between SUN and the BUSC-VME system is only limited by the SUN VME bus and the activity on the SUN.

The software driver is very simple since the BUSC-VME memory is mapped into the SUN VME bus and there is no need for interrupt routines to communicate with the memory board. The driver simply reads data out of the buffer like a program fetches data from the regular SUN memory space. All handshaking is controlled on a VME hardware level and has no influence on the SUN itself.

Two spare cards are the only requirements for backup and an acceptable maintenance scheme for the communications system.

The BUSC-VME interface has been installed in the SUN computers at NORSAR and Helsinki to enable reception of FINESA data at these locations.

High speed (64 Kbit/s) digital land lines have been installed between the FINESA array site and Helsinki and between Helsinki and NORSAR. As shown in Fig. 7.4.2, the data stream is split in Helsinki, and forwarded to both NORSAR and the Seismological Institute of the University of Helsinki.

Data acquisition and processing

Data from FINESA are received continuously in real time both at NORSAR and in Helsinki, as shown in Fig. 7.4.2. The data acquisition and processing systems are based on SUN 3/2xx computers. Both systems are equipped with local disk, and the SUN system at NORSAR also has an Exabyte tape drive for data archiving.

The data received are written on to a cyclic diskloop, and only available disk space limits the size of this loop. For the NORSAR installation, the disk drive installed permits a loop containing approximately 70 hours of data, which matches the length of the disk loops implemented for the NORESS and ARCESS data acquisition systems.

The detection processing (DP) and event processor (EP) program packages described by Fyen (1989) have been installed on the acquisition computers both at NORSAR and in Helsinki. The beam deployment chosen was designed from the NORESS/ARCESS experience and adapted to the FINESA array geometry. An example of an event automatically detected and located (after an association of a P and an Lg phase) by the DP/EP packages is shown in Figs. 7.4.3–7.4.5. The event is a small mining explosion in Estonia. The format of the plots and the information contained therein are as explained in Fyen (1989).

In the future, data from FINESA will be processed jointly with NORESS and ARCESS data (as well as GERESS data, when available) in the IAS.

R. Paulsen
J. Fyen
P.W. Larsen
S. Mykkeltveit

References

Fyen, J. (1989): Event processor program package, *Semiann. Tech. Summ., 1 October 1988 - 31 March 1989*, NORSAR Sci. Rep. No. 2-88/89, Kjeller, Norway.

Mykkeltveit, S., J. Fyen, T. Kværna and M. Uski (1988): Analysis of regional seismic events using the NORESS/ARCESS/FINESA arrays, *Semiann. Tech. Summ., 1 April - 30 September 1988*, NORSAR Sci. Rep. No. 1-88/89, Kjeller, Norway.

Ringdal, F., S. Mykkeltveit, T. Kværna, R. Paulsen, H. Korhonen, S. Pirhonen (1987): Initial results from data analysis using the FINESA experimental small aperture array, *Semiann. Tech. Summ., 1 October 1986 - 31 March 1987*, NORSAR Sci. Rep. No. 2-86/87, Kjeller, Norway.

FINESA

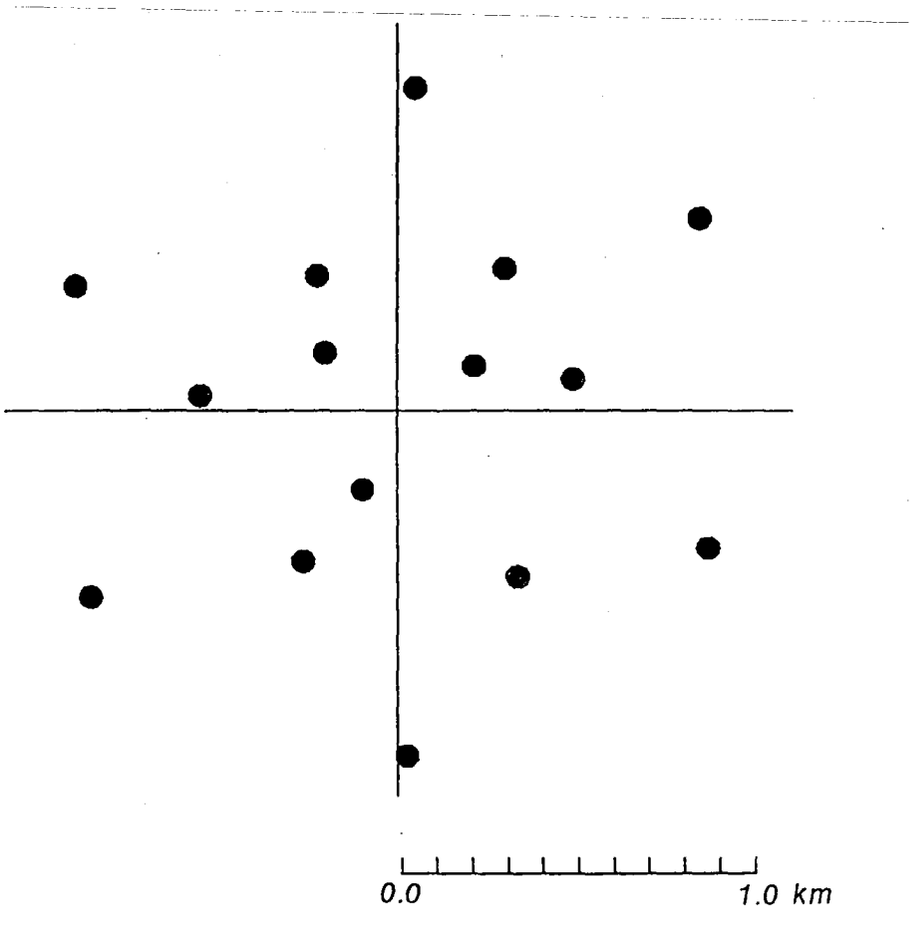
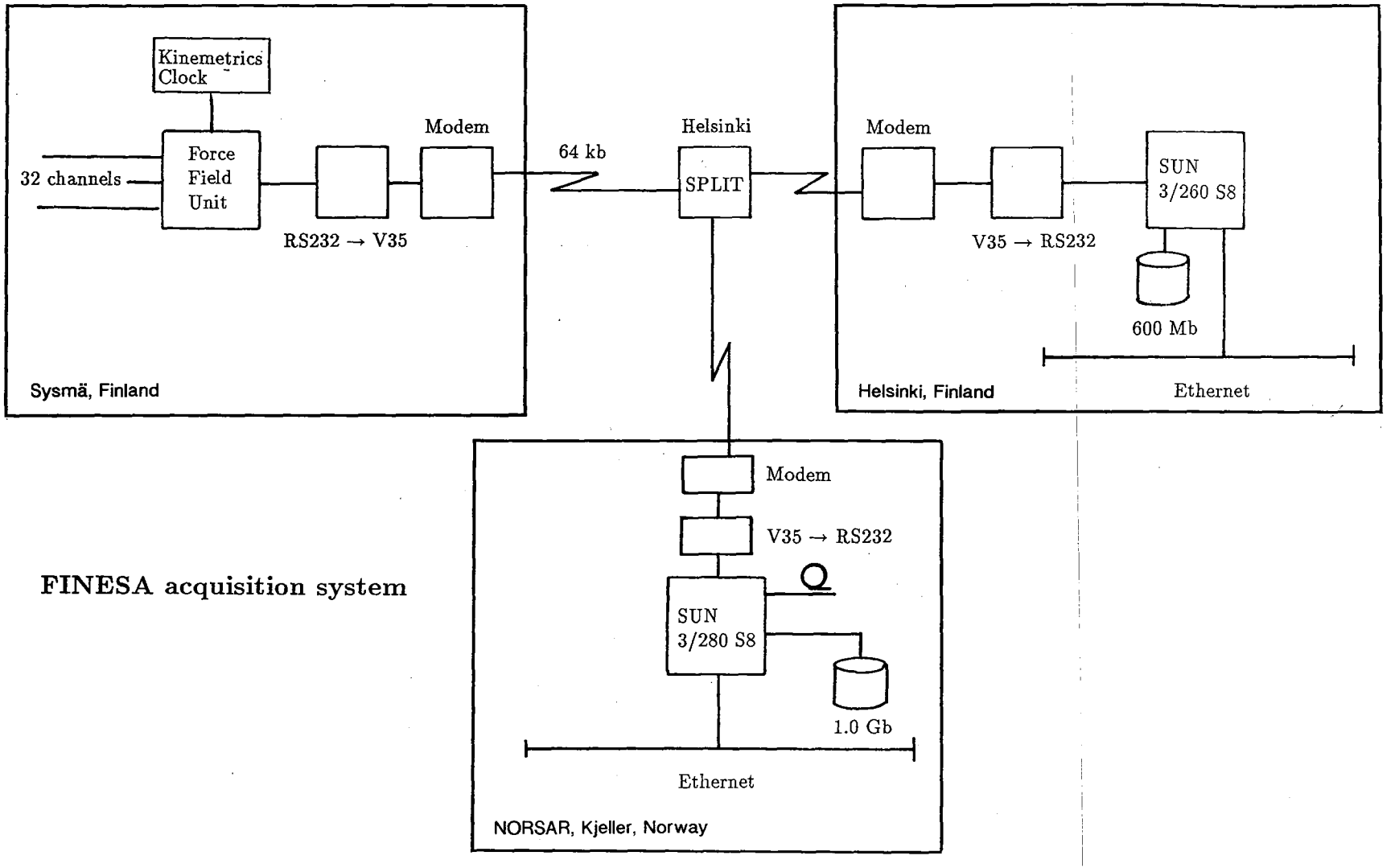


Fig. 7.4.1 Configuration of the FINESA array in Sysmä, Finland, after the expansion of the array geometry in 1988.



FINESA acquisition system

Fig. 7.4.2 The new FINESA data acquisition system, comprising the field unit with clock, RS232-V.35 converter and modem (upper left), data transmission lines, and data acquisition and processing systems in Helsinki (upper right) and NORSAR (lower middle).

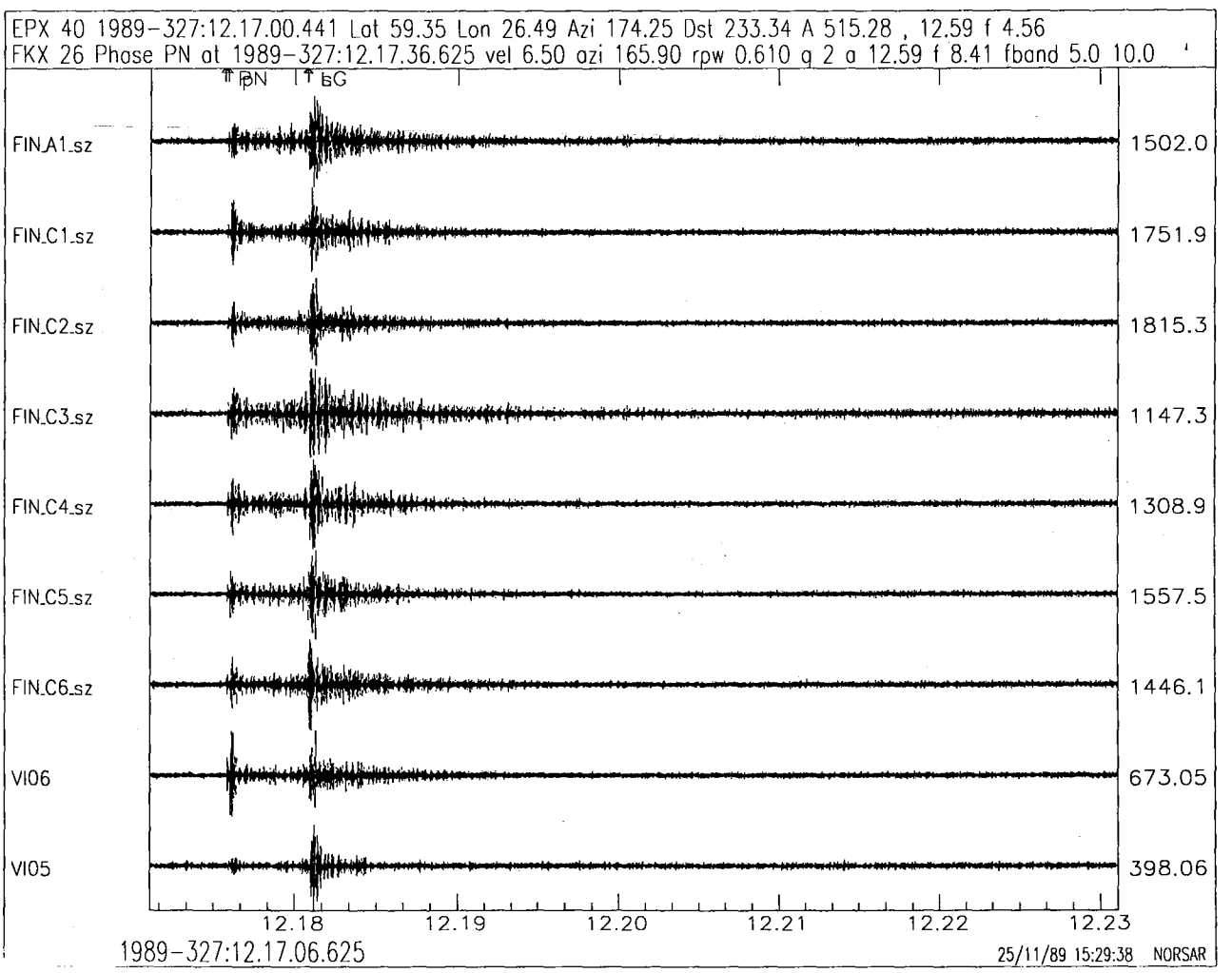


Fig. 7.4.3 Six-minute plot of a regional event located by FINESA. "Best" P and S beams (VI06 and VI05, respectively; for explanation, see the caption of Fig. 7.4.4) are displayed as the two bottom traces.

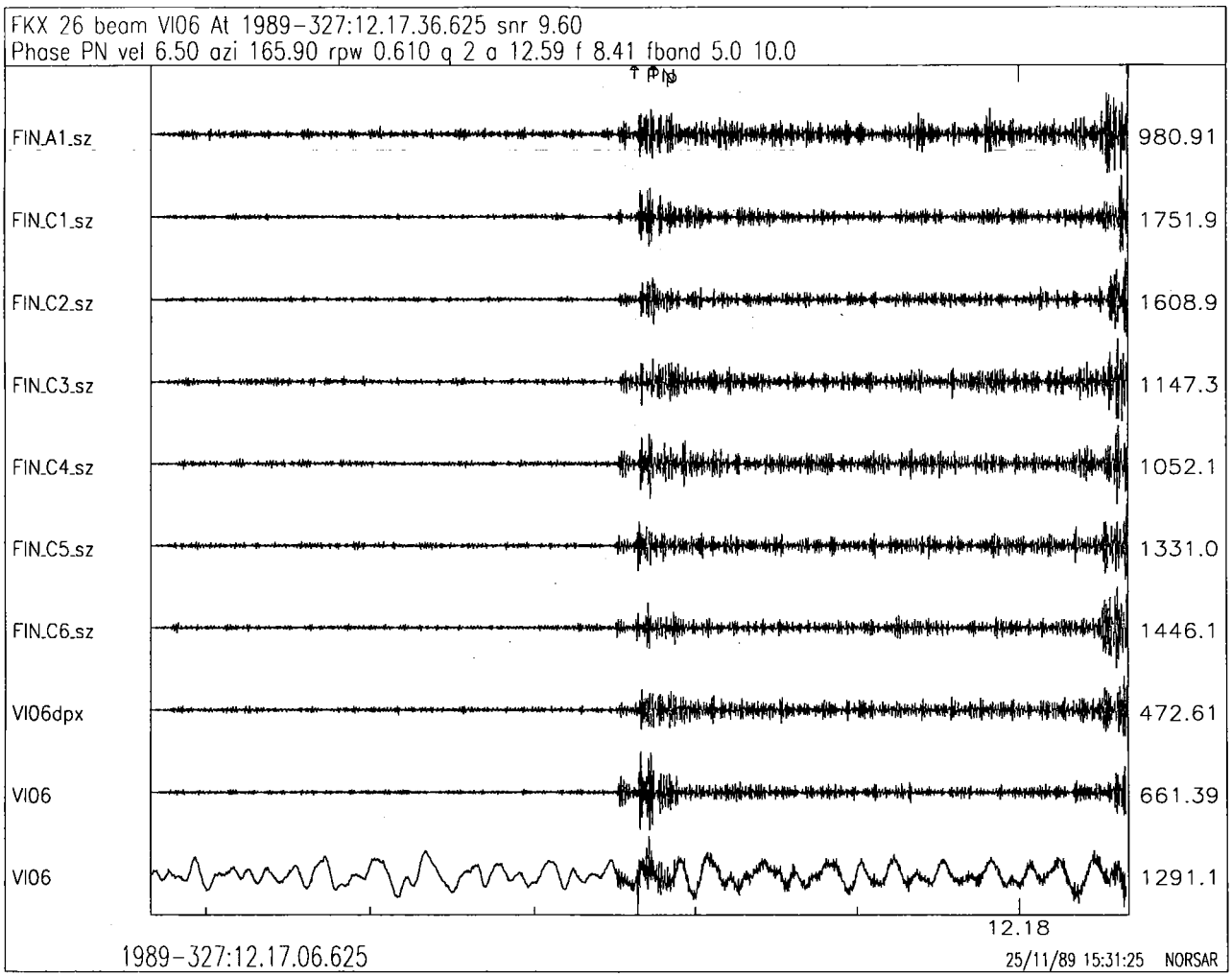


Fig. 7.4.4 Expanded display of the P-phase for the event of Fig. 7.4.3. VI06dpx is the detecting beam that gives the best SNR for this phase. This is an incoherent beam with infinite velocity, but plotted here as a coherent beam, using the same steering parameters. VI06 (shown both filtered and unfiltered) is the coherent beam using the same configuration, and steered according to the f-k estimate (here: phase velocity 6.50 km/s; azimuth 165.90°).

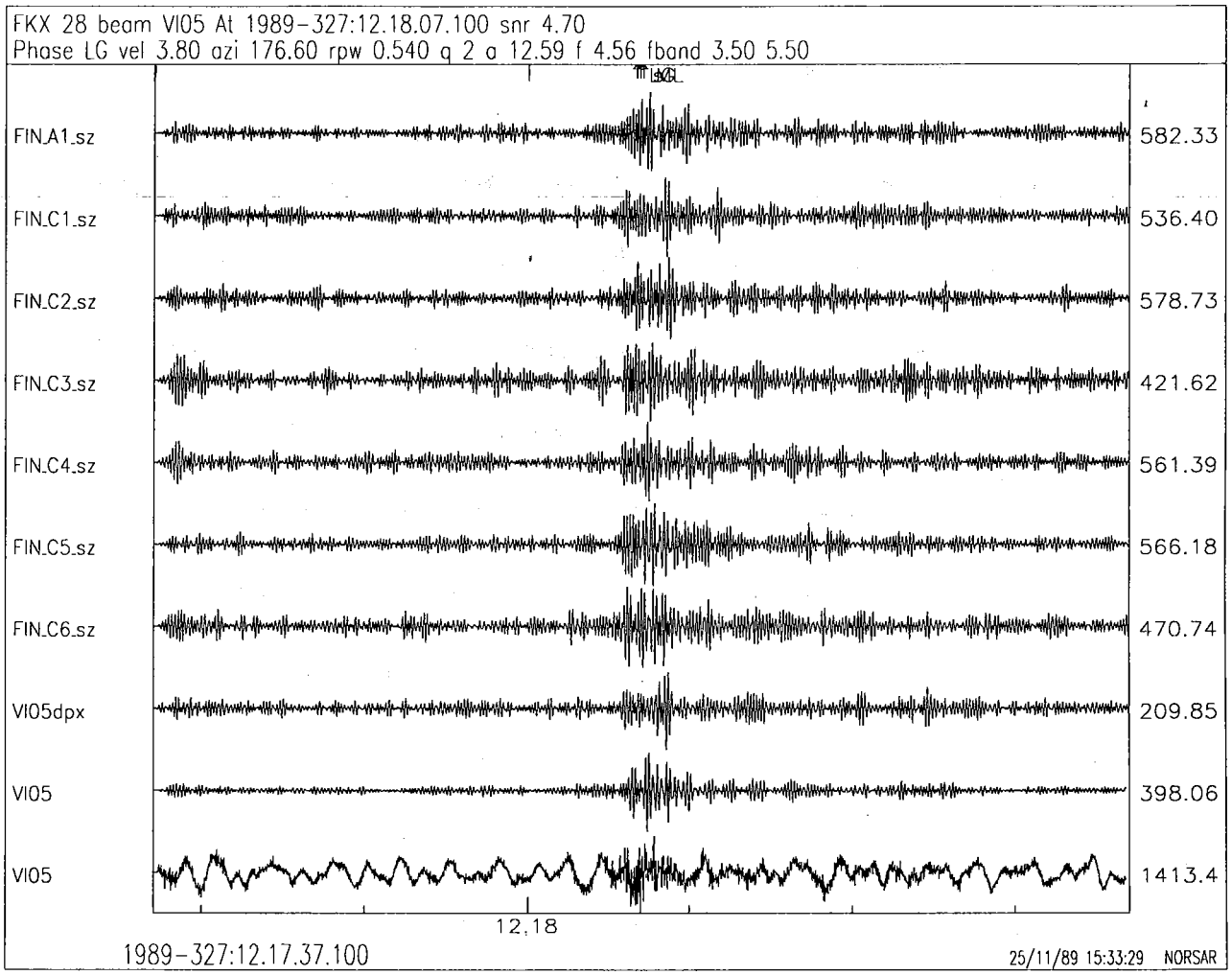


Fig. 7.4.5 Same as Fig. 7.4.4, but corresponding to the Lg phase.