Project n° EVG1-CT-2000-00026 SESAME

European Commission – Research General Directorate

SESAME

Site EffectS assessment using AMbient Excitations

Third progress report

18th months Management report

1 May 2002 – 31 October 2002

SESAME Partnership

1	**UJF**	University Joseph Fourier	Grenoble
2	**Resonance**	Résonance Ingénieurs-Conseils SA	Geneva
3	**UP**	University of Potsdam -	Potsdam
4	**ULg**	University of Liège	Liège
5	**UiB**	University of Bergen	Bergen
6	**ETHZ**	Polytechnic School of Zürich	Zürich
7	**ITSAK**	Institute of Engineering Seismology and Earthquake Engineering	Thessaloniki
8	**ICTE/UL**	Institute of Earth and Space Sciences	Lisbon
9	**INGV**	National Institute of Geophysics and Volcanology	Roma
10	**CNR.GSAQ**	National Research Counsil	Milano
11	**GPISAS**	Geophysical Institute – Slovak Academy of Sciences	Bratislava
12	**CETE.Nice**	Center of Technical Studies	Nice
13	**CNRS**	National Center for Scientific Research	Grenoble
14	**LCPC**	Central Laboratory for Bridges and Roads	Paris

Co-ordinator: Pierre-Yves BARD - LGIT, Observatoire de Grenoble, BP 53 - 38041 Grenoble Cedex – France

Signature of the co-ordinator:

Content

Co-ordinator: **Pierre-Yves BARD**
LGIT, Observatoire de Grenoble
BP 53
F-38041 Grenoble Cedex
tel: +33 (0)4 76 82 80 61
fax: +33 (0)4 76 82 81 01
e-mail: bard@obs.ujf-grenoble.fr

Introduction

April 2001	***signature of the contract between the partners and the European Commission***	
1 May 2001	beginning of the contract	
May 2001		
June 2001	*First payment of the EC (40%)*	
26-27 June 2001	Kick-off meeting in Grenoble, France	
July 2001		**Work on the field and in the laboratories on the different Tasks**
August 2001		
29-30 August 2001	workshop for TaskC in Zurich, Switzerland	
September 2001		
October 2001		
22-26 October 2001	Instrument workshop (TaskA – WP02) in Bergen, Norway	
November 2001		
	A first progress report has been sent to the EC	
December 2001		
January 2002		
7-8 January 2002	Instrument workshop (Task A – WP02) in Postdam, Germany	**Work on the field and in the laboratories on the different Tasks**
9-11 January 2002	workshop (TaskA – WP03 & TaskB-WP06) in Postdam, Germany	
February 2002		
March 2002		
April 2002		
21-27 April 2002	TaskA meeting during the EGS in Nice, France	
May2002		
29-30 May 2002	TaskC meeting in Zurich, Switzerland	
	A second progress report including Cost statements (= D03.01) and two deliverables (D01.02, D02.09) have been sent to the EC.	
June2002		
July 2002		**Work on the field and in the laboratories on the different Tasks**
10 July 2002	Review meeting on seismic risk research in the European Union	
August 2002		
September 2002		
October 2002	*Second payment of the EC (37,99%)*	
22-24 October2002	Work-package meetings in Roma, Italy	
25-26 October2002	General SESAME meeting in Roma, Italy	
November 2002		
December 2002		
	a third progress report including four deliverables D04.04, D05.06, D05.05, D07.05 is sent to the EC.	

SESAME project rules

1. **All the data lent by one of the SESAME project partners can only be used within the framework of the project SESAME. If one partner wants to use the data for an other purpose, it is essential that he asks for an utilization agreement to the data owner.**
2. **Each time the SESAME project partners make a presentation concerning the project SESAME, they must inform the co-ordinator of the project and as much as possible send a copy of the presentation. Moreover, each presentation on the SESAME project have the mandatory obligation to acknowledge the EC funding and mention the grant identification.**

Progress of the Work

The following table shows the time table of the SESAME project. We have highlighted in yellow the work planned to be in progress – and effectively is - at the date of December 31, 2002. This report presents a summary of the work done during Year 2.

TABLE : Project planning and time table

Phases	WP	Tasks	*Year 1*	Year 2	Year 3	Deliverables
P01			xxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxxx	
	WP01		xxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxxxxxxxx	
		T01.01	xxxxxxxxxxxx			*D03.01**
		T02.01		xxxxxxxxxxxx		
		T03.01			xxxxxxxxxxxx	
P02			xxxxxxxxxxxx	xxxxxxxxxxxx	xxxxxx	
	WP02		xxxxxxxxxxxx	xxxxxx		
		T01.02	xxxxxxxxxxxx			*D01.02**
		T02.02		xxxxxxxxxxxx		D08.02 delayed
	WP03		xxxxxxxxx	xxxxxxxxx		
		T01.03	xxxxxxxxx			
		T02.03		xxxxxxxxx		
	WP04		xxxxxx	xxxxxxxxxxx	xxxxxx	
		T01.04	xxxxxx			
		T02.04		xxxxxxxxxxxx		**(D04.04)***
		T03.04			xxxxxx	
P03			xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxx	
	WP05		xxxxxxxxxxx	xxxxxx		
		T01.05	xxxxxxxxxxx			
		T02.05		xxxxxx		**(D06.05 & D07.05)***
	WP06		xxxxxxxxxxx	xxxxxxxxxxx	xxx	
		T01.06	xxxxxxxxxxx			
		T02.06		xxxxxxxxxxxx		**(D05.06)***
		T03.06			xxx	
	WP07		xxxxxxxxxxx	xxxxxxxxxxx	xxxxxxxx	
		T01.07	xxxxxxxxxxx			
		T02.07		xxxxxxxxxxxx		
		T03.07			xxxxxxxx	
P04			xxxxxxxxxxx	xxxxxxxxxxx	xxx	
	WP08		xxxxxxxxxxx	xxxxxxxxxxx		
		T01.08	xxxxxxxxxxx			
		T02.08		xxxxxxxxxxx		
	WP09		xxxxxxxxxxx	xxxxxxxxxxx		
		T01.09	xxxxxxxxxxx			*D02.09**
		T02.09		xxxxxxxxxxx		
	WP10			xxxxxxxxx	xxx	
		T01.10		xxxxxxxxx		
		T02.10			xxx	
P05					xxxxxxxxxxx	
	WP11				xxxxxxxxxxx	
		T01.11			xxxxxxxxxxx	
	WP12				xxxxxxxxxxx	
		T01.12			xxxxxxxxxxx	
	WP13				xxxxxxxxxxx	
		T01.13			xxxxxxxxxxx	

*, the Deliverables in italic have already been sent to the EC with the previous reports;
the Deliverables in brackets are sent to the EC with this report.

I WP01 – T02.01: co-ordination – year 2

The co-ordination is followed by two persons:

Pierre-Yves Bard for the scientific part and Laurence Bourjot for the administrative and financial part.

TABLE 1 : List of the persons working in the project from May to October 2002

Partners	Name of the person		Task or WP	Time spent
1	Sylvette Bonnefoy	*S*	WP08	6 M
1	Laurence Bourjot	*ACo*	WP01	1,2 M
1	Fabrice Cotton	*R*	WP08	0,6 M
1 (13)	Jean-Luc Chatelain	*R*	WP02	2,1 M
1 (13)	François Dunand	*S*	WP02	0,45 M
1 (13)	Bertrand Guillier	*R*	WP02	2,2 M
1 (13)	Jérôme Noir	*S*	WP02	0,85 M
1 (14)	Pierre-Yves Bard	*R*	WP01, Task A,C	2,2 M
1 (14)	Philippe Guéguen	*R*	WP01, WP02	1,5 M
2	Martin Koller	*R*	WP01, WP03	0,38 M
2	Corinne Lacave	*R*	WP01, WP03	0,02 M
3	Matthias Ohrnberger	*R*	TaskB	6 M
3	Andreas Koehler	*S*	Task B	-
3	Gudrun Richter	*R*	Task B	-
3	Frank Scherbaum	*R*	Task B	-
3	Daniel Vollmer	*T*	WP 02	-
3	Hans Havenith		Field work	-
4	Denis Jongmans	*R*	TaskB	-
4	Marc Wathelet	*S*	WP07	6 M
5	Kuvvet Atakan	*R*	Task A	-
5	Mathilde Bottger	*S*	WP 02	0,48 M
5	Jens Havskov	*R*	Task A	-
5	Bladimir Moreno	*S*	WP03	1,67 M
5	Eirik Tvedt	*S*	WP02, WP03	0,76 M
5	Terje Utheim	*T*	Task A	-
5	Jose Asheim Ojeda	*S*	WP02	0,1 M
5	Katharina Wolff	*S*	WP02	0,13 M
5	Gerardo Aguacil	*R*	Task A	-
6	Cécile Cornou	*R*	Task A, C	6 M
6	Donat Faeh	*R*	Task A, B, C	-
6	Fortunat Kind	*R*	WP03	6 M
6	Ivo Oprsal	*R*	Task C	-
6	Eva Spühler-Lanz	*R*	Task A, C	1,2
6	Jochen Woessner	*R*	Task A	-
6	Jörg Kirsch		Field work	-
7	Nikolaos Adam	*T*	WP04	-
7	Christos Papaioannou	*R*	WP04	2 M
7	Petros Dimitriu	*R*	WP04	2 M
7	Apostolos Marinos	*T*	WP04	-
7	Alekos Savvaidis	*R*	WP04	1 M
7	Areti Panou	*S*	WP04	2 M
7	Nikos Theodulidis	*R*	WP04	2 M
7	Eleftherios Vorias	*T*	WP04	-
7	Stratos Zacharopoulos	*T*	WP04	2 M
8	Antonio Borges	*S*	WP02,WP03	6 M
8	Pedro Roquette	*R*	WP03	1,35 M
8	Paula Teves-Costa	*R*	WP02, WP03	(1,5 M)
9	Catello Acerra	*T*	WP02	-
9	Riccardo Azzara	*R*	WP02	-
9	Roberto Basili	*R*	WP02	-
9	Paola Bordoni	*R*	WP02	-
9	Fabrizio Cara	*R*	WP04	6 M
9	Giovanna Cultrera	*R*	WP02, WP04	-
9	Giuseppe di Giulio	*R*	WP02, WP04	-
9	Fabrizio Marra	*R*	WP02	-
9	Sandro Rao	*T*	WP02	-
9	Antonio Rovelli	*R*	WP02, WP04	-
9	Mario La Rocca		Field work	-
9	Rosalba Maresca		Field work	-
9	Gilberto Saccoroti		Field work	-
10	Rosastella Daminelli	*T*	WP03, WP04	0,67 M
10	Roberto de Franco	*R*	WP03, WP04	0,35 M

10	Alberto Marcellini	*R*	WP03, WP04	0,69 M
10	Antonio Morrone	*T*	WP04	0,4 M
10	Marco Pagani	*R*	WP04	-
10	Alberto Tento	*T*	WP03, WP04	2,93 M
11	Lucia Fojtikova	*S*	Task C	0,2 M
11	Josef Kristek	*R*	WP09,WP10	2,65 M
11	Miriam Kristekova	*R*	WP09,WP10	1,69 M
11	Peter Moczo	*R*	Task C	2,4 M
12	Anne-Marie Duval	*R*	WP02,WP03	0,8 M
12	Etor Querendez	*R*	WP02	1 M
12	Sylvain Vidal	*T*	WP02	1,7 M

- *R = Researcher, S = Student, T = Technician, ACo = Assistant Coordinator*

Since the beginning of the second year of the project (May to October 2002), 68 persons have been involved in the project SESAME for a minimum of 85 man-months: 42 researchers or engineers, 13 students, 12 technicians and 1 assistant-coordinator (**Table 1**)

All these persons have met several times to exchange their work and also to do experiments together.

30-31 May 2002 – Task C meeting in Zürich (Switzerland):
- to define the parameters that will be used for noise computation for canonical models and real sites,
- to define the status of the time-frequency analysis
- to draw the work plan

10 July 2002 – Review meeting on seismic risk research in the European Union.
- Presentation of a synopsis of the project by the coordinator, Pierre-Yves Bard.

22 October 2002 – Task C meeting in Roma (Italy)
- to present the preliminary results of numerical simulation of seismic noise for a single layer over halfspace and the program package NOISE,
- to draw the work plan and in particular to update the plan of numerical simulations for canonical models.

23 October 2002 – WP04 Empirical evaluation meeting in Roma (Italy)
- to present the final data set on ambient noise and earthquake recordings,
- to prepare the deliverable D04.04.

23-24 October 2002 – WP02 meeting in Roma (Italy)
- to explain the modification of the planning (delay of the deliverable D08.02),
- to present the "WP02 data-base" and draw the work plan.

24 October 2002 – WP03 Software development meeting in Roma (Italy)
- to summarize the status of the work on the H/V software,
- to prepare the deliverable D09.03.

25-26 October 2002 – General SESAME mid-term meeting in Roma (Italy)
- to review the work done since the beginning of the project,
- to have a global view of the project for every partner,
- to have interactions between different tasks and WP,
- to exchange viewpoints about several issues and partial decisions,
- to recall the main objectives of each task and work packages,
- to prepare the future of the project.

The minutes of the meetings or workshops are presented at the end of this report and are available on the web site:
http://SESAME-FP5.obs.ujf-grenoble.fr

❷ Since May 2002, the partners, in parallel to their work on the project, have participated to different national or international meetings where they have presented a part of the scientific work done in the SESAME project.

III Coloquio sobre Microzonification Sismica in Caracas (Venezuela), 12-18 July 2002

1: Invited lecture by Pierre-Yves Bard

Bard P.-Y., 2002. H/V Nogoshi-Nakamura's technique: Theoretical background, applications, limitations, and more, *Invited lecture, III Coloquio sobre Microzonificacion Sismica, Pre-coloquio sobre aplicaciones recientes en sismologia, FUNVISIS, Caracas, 12-14 July 2002.*

2: Invited magistral talk by Pierre-Yves Bard

Bard P.-Y., 2002. Important parameters for dynamic soil response, Invited magistral talk, *III Coloquio sobre Microzonificacion Sismica, FUNVISIS, Caracas, 15-18 July, 2002.*

ESC in Genoa (Italy), 2-6 September 2002

3: Presentation of a Key-note lecture by Pierre-Yves Bard

Bard P.-Y., 2002. Site effects in urban areas, *Key-note lecture, XXVIII Assembly of the European Seismological Commission, Genova, September 2-6, 2002*.

4: Presentation of a poster by Bertrand Guillier

Guillier B., Atakan K., Duval A.-M. , Ohrnberger M., Azzara R., Cara F., Havskov J., Alguacil G., Teves-Costa P., Theodulidis N. and the SESAME Project WP02 Team, 2002. Influence of instruments on H/V spectra of ambien noise, *XXVIII Assembly of the European Seismological Commission, Genova, September 2-6, 2002.*

5: Oral presentation by Peter Malischewsky

Malischewsky P.G., and Scherbaum F., 2002. "Love's formula and H/V ratios", *XXVIII Assembly of the European Seismological Commission, Genova, September 2-6, 2002.*

6: Presentation of a poster by Matthias Ohrnberger

Ohrnberger M. and Scherbaum F, 2002. "Derivation of surface wave dispersion curves from array analysis of ambient vibrations", *XXVIII Assembly of the European Seismological Commission, Genova, September 2-6, 2002*.

7: Oral presentation by Frank Scherbaum

Scherbaum F., Hinzen K.-G. and Ohrnberger M., 2002. "Determination of shallow shear wave velocity profiles in the Cologne/Germany area using ambient vibration", *XXVIII Assembly of the European Seismological Commission, Genova, September 2-6, 2002*.

8: Presentation of a poster by Paula Teves-Costa

Teves-Costa P., Borges A., Vales D., Riedel C., Gaspar J.L. & Senos M.L., 2002. Investigation on H/V microtremor processing, *XXVIII Assembly of the European Seismological Commission, Genova, September 2-6, 2002*.

Forum Katastrophenvorsorge und Gefahrentag,7.-9. October, Telegrafenberg Potsdam (GFZ)

9: Presentation of a poster by Matthias Ohrnberger

Ohrnberger M., Scherbaum F., Krüger F., Pelzing R., and Reamer Sh.-K., 2002. "How good are the shear wave velocity models in the Lower Rhine Embayment obtained from inversion of ambient vibrations?".*Third Forum Katastrophenvorsorge und Gefahrentag, Telegrafenberg Potsdam (GFZ), 7.-9. October 2002.*

The summary of the different communications and posters are presented at the end of this report.

❸ Since the beginning of the project, five papers have already been accepted or submitted and one is in preparation

Kristek K., Moczo P. and Archuleta R., 2002. Efficient methods to simulate planar free surface in the 3D 4th –order staggered-grid finite-difference schemes. *Studia Geophys. Geod.*, **46**, 2002, 355-381.

Bard P.Y., Extracting information from ambient seismic noise: The SESAME project (Site EffectS assessment using AMbient Excitations) – *Synopsis of the first year project* (14 p.) submitted and accepted for the review to the EC.

Moczo P., Kristek J., Vavrycuk V., Archuleta R. and Halada L.3D Heterogeneous Staggered-grid Finite-difference Modeling with Volume Harmonic and Arithmetic Averaging of Elastic Moduli and Densities. *Bull. Seism. Soc. Am.* (in press).

Scherbaum F., Hinzen K.-G. and Ohrnberger M., "Determination of shallow shear wave velocity profiles in the Cologne/Germany area using ambient vibrations". *Geophys. Journ. Int.* (in press).

Fäh D., Kind F. and Giardini D., Inversion of local S-wave velocity structures from average H/V ratios, and their use for the estimation of site effects. *submitted to Journal of Seismology*, January 2002.

Kristek J., Moczo P. and Kristeková M.Finite-difference Simulation of Ambient Noise in 3D Surface Sedimentary Structures: Part 1 – Method (In preparation).

A copy of the papers can be asked to Pierre-Yves Bard

❹ At the end of December 2002, seven deliverables are available.

- D01.02 "***Controlled instrumental specifications***": a report of 34 pages + 5 appendices. The complete report will be available on a CD ROM. At this moment, it is on the anonymous ftp site of the University of Bergen at the following address: ftp://ftp.ifjf.uib.no/pub/sesame/REPORT/FINALREPORT
- D02.09 "***FD code to generate noise synthetics"***: in the form of a CD ROM with a report describing the flow chart of the software and canonical structural models.
- D03.01 "***First year progress report"***: a report of 41 pages + annexes on the financial aspect of the project.

The deliverables D01 to D03 have been sent to the EC with the first year progress report in June 2002

- D04.04 "***Homogeneous data set of noise and earthquake recording at many sites***": a draft report.
- D05.06 "***Quality control software for in-situ checks***": a report of 16 pages + 1 appendix.
- D06.05 "***Array data set for different sites***": a report of 33 pages + 1 appendix + 12 CD ROMs containing the data sets.
- D07.05 "***Optimum development strategy and quality measure for array layout in view of obtaining surface wave***": a report of 41 pages + 3 appendices. The complete report will be available on a CD Rom.

The deliverable D04 to D07 are sent to the EC with this progress report.
All these deliverables are available on the web site (except the 12 CD ROMs with the data):
http://SESAME-FP5.obs.ujf-grenoble.fr

II WP02 – T02.02: H/V technique – experimental conditions – year 2

Leader : Anne-Marie Duval (Partner 12 : CETEMED.LRE – Nice – France)

The aim of WP02 is to evaluate the influence of experimental parameters in stability and reproducibility of "H/V on ambient vibrations". This means that we have to test various types of parameters and to check the variations, both in frequency and in amplitude of the "H/V curves". One of the numerous parameters to test (the recording instrument in itself) has been evaluated separately during the first year under the main direction of UiB (Bergen, Norway) and a first deliverable has been produced D01.02 "Controlled instrumental specifications" in June 2002. All the very numerous other parameters are tested in a common and global survey performed simultaneously by all partners.

From May 2001 to February 2002, partners had intensive exchanges to prepare an exhaustive list of experimental parameter to test, set common and rigorous experimental protocol, define common forms to be filled to build a common data base and share the instrumental work. Many documents were written and regularly updated to take into account new remarks, and in particular a table was established to summarize tests that had to be performed by each partner following a special procedure: each parameter should be tested separately at least by two teams and each test will be performed, changing only the tested parameter [whenever possible]. From February to August 2002, partners have performed the different tests with their own software and have defined a common data format SAF. In September-October, partners from Grenoble, Roma and Nice have tested the SESAME software v1.

😐 A first deliverable D01.02 "***Controlled instrumental specifications***" has been produced in June 2002 The second deliverable D08.02 "***Measurement guidelines***", corresponding to the final step of this work package is delayed for the reasons given in the paragraph below and will be finished for the second year report.

During the last meeting, in Roma (October 2002), the WP02 leader explained what has been done during the last months in this work package, and that it was not possible to follow the planning fixed during the meeting in Nice (April 2001) concerning the test to perform to check the influence of experimental parameters:

- even if records were performed, we couldn't process it with a common SESAME software during the summer as planned due to the fact that the final version of SAF format was delivered by the end of August 2002 instead of May 2002;
- then Nice and Roma teams had to write transformation in the software from local format to SAF format and to wait for the first version of SESAME H/V software and Windowing software;
- Roma, Nice and Grenoble teams had to test those softwares, to ask for modifications and to wait for new versions to realize a parametric survey proposing a default parameter file. F. Cara from INGV came in Nice during 15 days to work mainly on that topic. There F. Cara, E. Querendez and AM Duval summarized the individual reports written on that test by Grenoble, Nice and Roma teams (*see "Individual and common reports on software test WP03", sept 2002 – available on SESAME web site*);
- by the end of September, the SESAME software was available for WP02 teams together with the default parameter file fixed for WP02 and series of tests could be performed. The deliverable D08.02 "***Measurement guidelines***" will be finished in June 2003.

III WP03 – T02.03: H/V technique – data processing – year 2

Leader : Kuvvet Atakan (Partner 5: UIB.ISI – Bergen – Norway)

WP03 is devoted to investigations on the various data processing alternatives and produce a standard processing software based on the most robust alternative. The objective is to produce a processing software package which is optimal for empirical site response analysis with noise data.

The work already done since the beginning of the project is:

- the collection of existing algoritms for each processing step;
- the identification of the best (robustness-simplicity-resolution) solution based on comparisons with representative data sets;
- the design and implementation of the H/V Software divided in four modules (the Browsing module by UiB Bergen, the Window selection module by LGIT Grenoble, the Processing module by CNR Milano and ETHZ and the Display module by UL Lisbon);

- the testing of the processing module performed by three groups (CETE Nice, INGV Rome, IRD-LGIT Grenoble) taking into account the machine dependence and functionality. A specific parametric survey was conducted and some format conversion programs are developed.
- the implementation of the display modules;
- the distribution of the first version of the SESAME H/V software for evaluation (WP04) and review within consortium;
- the selection of a well-known data set for evaluation and testing of the SESAME H/V Software;
- the redaction of the deliverable D09.03 "***Multi-platform H/V processing software***" by January 2003;
- the co-ordination with WP02 (for experimental conditions);
- the co-ordination with WP04 (for data sets and field-experiments).

Further improvements and modifications: a final version of the software with user guidelines will be available during year 3 (WP12).

☺ Up to now the time table is respect and the work package will be finished for the second year report. The deliverable D09.03 "***Multi-platform H/V processing software***" is thus still foreseen for February 2003 and will be sent to the EC with the second year report.

IV WP04 – T02.04: H/V technique – empirical evaluation – year 2

Leader: Nikos Theodulidis (Partner 7 – IESEE – Thessaloniki – Greece)

At the Nice SESAME Meeting (April 22-27, 2002) it was decided that the presented Standard Information Sheets (SIS) for sites with Noise and Earthquake Recordings will be enriched and refined in the next few months to come. Noise measurements were performed in selected sites by all partners participating in WP04. Each partner prepared both the SIS – for about 200 sites - and the homogeneous dataset of noise and earthquake recordings according to the SESAME Ascii Format (SAF) released after the Nice Meeting. All these data were sent to the WP04 leader for homogeneity check and possible incorporation into a preliminary database. In Rome WP04 meeting (October 23, 2002) all available SIS were presented by each partner and the preliminary database by the WP04 leader. Comments/remarks made during the meeting are included in the relevant Minutes and will be fulfilled by the end of November 2002. It was also decided that the deliverable *"D04.04: Homogeneous Data Set of Noise and Earthquake Recordings at Many Sites"* will be submitted to EC by the end of December 2002.

😐 ☺ A first deliverable D04.04 "***Homogeneous data set of noise and earthquake recordings at many sites***" is sent with this report. The present version, however, is not the final one: some of the data are already gathered but could not be entered in the data bank with the proper format specifications and information sheets (see the reason of this delay below). A final version will be delivered and distributed with the progress report at the end of the 2nd year.

The main reasons for the delay are the following:
1. Possible seasonal variation of noise level, especially in low frequencies (f<1hz) forced some Partners to repeat noise measurements in certain sites. This fact was not foreseen from the beginning of the experimental stage.
2. Additional data, outside of Europe, are going to enrich the SESAME noise/earthquake recordings database.
3. The SESAME Ascii Format (SAF) of the homogeneous data set was finally adopted in July 2002. This in turn, caused a time shift in converting existing data set from various formats to SAF

V WP05 – T01.05: instrument layout for array measurements – year 2

Leader: Frank Scherbaum (Partner 3 – UPOTS.GEO – Postdam – Germany)

Within the context of this work package the dependence of the array performance (for phase velocity determination) on the experimental conditions (array geometry, aperture, number of sensors, sensor types, timing accuracy) shall be assessed. The input needed for this task are existing array measurement data sets from within the consortium, array measurements performed at well known test sites within the consortium, the

relative calibration of instruments with respect to a broadband sensor (phase response) and computer codes for the calculation of the array transfer functions.

In order to evaluate the dependence of the array performance for phase velocity determination on the experimental conditions, we have continued working on the following topics:

- forward calculation of synthetic waveforms for 1D-velocity models (modal summation code by Herrmann, 1987). The 1D-velocity models have been derived from geotechnical data available within the SESAME-consortium. Special focus has been put on sites Lefkas and LEP (Thessaloniki) in the preparatory phase of the field campaign in July and August 2002 (see below). After calculating a full set of synthetic waveforms, we have determined the dispersion curves for this data set for varying virtual array geometries and source receiver configurations. One part of this study has been presented as a poster at the ESC 2002 in Genoa (Ohrnberger and Scherbaum, 2002).
- evaluation of the array response function for multiple plane wave arrivals and varying geometries. Especially we have investigated as best case scenario a random station distribution with 100 sensors with 5 apertures from 0.2 km to 1.0 km in steps of 0.2 km. The results have been compared to a more realistic configuration with 13 stations, arranged as two hexagons surrounding a central station. The inner radius is a third of the second radius, with the second radius varying from 0.1 km to 0.5 km in steps of 0.1 km. As possible source configurations we have tested single plane wave or three plane wave arrival, either azimuthally distributed following a realistic dispersion relation, or assuming same arrival directions, but using different slowness values for all contributing modes for the relevant frequency range. The details of this study will be included in the deliverable D07.05.
- iIn a three week field campaign we have performed ambient vibration array measurements in Colfiorito (Italy) and several sites in Greece (Lefkas, Thessaloniki and Volvi graben) together with the SESAME partners INGV (Rome) and ITSAK (Thessaloniki). Field data acquisition has been finished within the scope of SESAME project. The acquired data has been archived and a quality control has been performed. The individual data sets will be made available as CD-ROM for SESAME partners together with deliverable D06.05.
- a huddle test for the 13 Lennartz 3D-5s sensors and the reference broadband sensor Geotech KS2000 has been performed installations of the Institute of Geosciences, University of Potsdam (IGUP). Difficulties have been encountered due to the relatively noisy performance of the broadband sensor for longer periods. The missing of a motorized automatic mass centering for the KS2000 in the first release of this sensor has shown, that this sensor cannot be used as a portable field instrument. For the purpose of recalibrating the LE3D-5s sensors of IGUP in the field, we have sent the KS2000 instrument for an update to Geotech in October 2002. The manufacturer has agreed to add a motorized mass centering facility to the sensor which shall allow the use of this sensor as a calibration sensor in the field in future. The cost for this update will be paid by IGUP.

☺ The time table is respected and this work package is now finished. Two deliverables, one on a tentative strategy for array deployment and performance evaluation D06.05 "***Array data set for different sites***", and a second on field survey D07.05 "***Optimum deployment strategy and quality measure for array layout in view of obtaining surface wave***" are sent with this report.

VI WP06 – T02.06: array measurements – derivation of dispersion curves – year 2

Leader: Frank Scherbaum (Partner 3 – UPOTS.GEO – Postdam – Germany)

Within the context of this work package a semi-automatic processing system for the array analysis of ambient vibrations shall be developed. The array processing has the final objective to derive the dispersion curve characteristics for the investigated site.

The implementation of standard array methods has been finished by now. The slantstack method for linear array configurations, however, has not been further considered within the newer version of the cap processing software (still available though in an older version of cap), as the reliability of slowness estimates for passive ambient vibration recordings have to be questioned from our experience (e.g. Ohrnberger et al., 2001). An additionally feature provided is the FK-processing of horizontal components (R and T) as has been described by Tokimatsu.

The software „cap“ is a simple command line tool which reads method specific parameters from a configuration file and additional information directly from the command line. A more detailed overview of cap's processing scheme, as well as the database connectivity to GIANT/PITSA processing system has been described previously in SESAME's 2nd progress report (May 2002). Cap has been tested now with a variety of synthetic datasets (derived by waveform calculation for 1D structures, compare SESAME's 2nd progress report) and array data sets acquired at various sites within the SESAME consortium (compare activity report, WP05). The output of cap are ascii metafiles, which allow the derivation of dispersion curves after specifying selection criteria. The criteria implemented so far are coherence and energy thresholds. Upon selected values the dispersion curves are derived by estimating the mean, standard deviation, median, lower and upper quartils and median deviation from the complete distribution of calculated results. From both synthetic and real data examples we have learned that a visual quality control is essential to prevent misinterpretation of results. One reasonable approach is to display the whole set of slowness estimates obtained from a longer time window as a histogram and then add the statistical parameters together with additional information (i.e. aliasing curves, noise spectrum and H/V spectra). This way of displaying the results allows to carefully select the allowable frequency range for the dispersion curve and has been presented in Ohrnberger and Scherbaum (2002). Currently we are performing a parameter study to derive a suitable set of wavefield parameters in order to allow on-the-fly hypothesis testing whether a signal window which is processed fulfills the assumption of plane wave arrival with Rayleigh wave characteristics. We are investigating polarization attributes as well as the eigenspectrum structure of the array covariance matrix to look for a single dominant surface wave component in the wavefield window under consideration. Furthermore we have calculated residual slowness maps to test the expected shape of the array transfer function with the observed one.

Ohrnberger, M., Scherbaum, F., Hinzen, k.-G., Reamer, Sh.-K., and Weber, B., 2001, *Vibrations on the Roll - MANA, a Roll Along Experiment to map Local Site Effects Across a Fault System*, Eos. Trans. AGU, Vol. 82, No. 42, Fall. Meet. Suppl., Abstract S21D-0606, 2001.
Ohrnberger, M. and Scherbaum, F., 2002, *Derivation of surface wave dispersion curves from array analysis of ambient vibrations*, presented as poster in Subcommission SCF-3 „Seismological Investigations of Site Conditions and Site Response“ at: XXVIII General Assembly of the European Seismological Commission (ESC), September 2nd-6th, 2002, Genoa, Italy.

☺ Up to now, the time table is respected. The deliverable D05.06 "***Quality control software for in-situ checks***" is sent with this report. This software is designed so that it can be used on a small workstation or a PC during field experiments as well as for post-processing. The next and final step of this work package is the deliverable D15.06 "Interface software" for April 2003.

VII WP07 – T02.07: array measurements – inversion of velocity profile – year 2

Leader: Denis Jongmans (Partner 4 – ULGG.DGO – Liège – Belgium)

During the period running from May 2002 and October 2002 we mainly focused on the two following topics: improvements of the forward calculations and test on synthetic dispersion curves.

Direct Problem or forward calculation

As stated in the last report various changes have been brought to the classical way of calculating the dispersion curves (Herrmann's code, St Louis, 1966). Due to problems arising on particular velocity profiles the proposed approach presented in the last report did not seam to achieve the best efficiency. Consequently the idea of identifying the limits between all modes before their computation with classical techniques has been abandoned, and we are now going back to a more systematic and classical search in the plane frequency-wave number.
This return to the classical method obliged us to develop a reliable set of tests in order to detect a possible mode jumping. They occur each time the search step is too large relative to the minimum distance between modes. The standard step size must be kept to a reasonable value to avoid an uncontrolled increase of the time consumption. When an error has been detected the whole search is restarted with a smaller step size until computing the curve for all desired frequencies without trouble.
Time consumption has been drastically reduced by modifying the way the roots to find are refined. The refinement was achieved using a conjunction of dichotomy and Neville polynomial fit. The polynomial fit was

not well used in the Herrmann's code. We optimised the choice of the left and right brackets of the root to exploit the Neville polynomial as best as possible.
The final result is an efficient algorithm able to calculate any dispersion curve for any velocity profile, provided however it does not present any velocityinversion at some depth. Test performs on Pentium 1.7 GHz for a three layers model shows that the computation takes between 3 and 4 times less time than Herrmann's code written in Fortran (between 2 and 3 ms compared to about 11 ms). This is valuable when we have to calculate more 25 000 models in a single inversion. Quality control made over each mode allows us to execute it relatively blindfold.

Inversion of synthetics dispersion curves
The fundamental dispersion curve is now inverted using the Neighbourhood algorithm described in the last report. Other sampling methods will be implemented in the future.
Up to now tests have been carried out on 2 layers and 3 layers models. The dispersion curve to fit is first calculated with our algorithm for a known layered model. When adding some uncertainties on the model parameters we used Monte Carlo's method to obtain the resulting standard deviation of the dispersion curve.
The first case is constituted by a soft sediment layer lying on bed-rock. It is possible to retrieve the thickness, the Vp and the Vs of the sediment layer, and the Vs of the bed-rock assuming a constant Poisson's ratio. A very good recovery is obtained in all cases even when introducing the uncertainties of the dispersion curve.
Unlike the former case, the 3 layers add some more degrees of freedom and the recovery is not as good. Except for the very first layer, the dispersion curve is not able to constrain the velocity profile in an acceptable way. One of the very badly reproduced parameter is the depth of the top of the half space.
At this stage it is obvious that it is impossible to get the complete solution in case of strong non uniqueness. It is thus mandatory to introduce a priori or other information in order to guide the inversion to the areas of the parameter space that correspond to other sources of geological information: refraction profiles, Cone Penetration Tests, H over V ratio, Cross-hole Vs measurements…
For this purpose it is now possible in our software to introduce an a priori Vp profile, first tests leaded to a very good recovery even on the 3 layers case. We also introduced the possibility of defining layers with properties (Vp, Vs, Density) increasing with depth by the mean of a power law.

Perspectives
We will be working during the next months on the introduction of the various a priori enumerated above. Before application to real cases we have to develop a flexible way of defining the parameterization of the layered model. As the inversion is performed by several runs of the same algorithm with different random seeds, the automatic estimation the global convergence is still under study.

☺ Up to now, the time table is respected. In 2003, a first deliverable D14.07 "***Report on the inversion of velocity profile and Version 0 on the inversion software***" will be produced and sent with the second year report.

VIII WP08 – T02.08: nature of noise wavefield – year 2

Leader: Pierre-Yves Bard (Partner 1 – UJF.LGIT – Grenoble – France)

After the literature survey, the next step was to start the noise simulation connected with WP09, since one of the conclusions of the survey is that the main questions to be solved require both new, high quality array data (Task B) and well controlled numerical simulations. In May 2002, we met the WP09 team (GPISAS and ETHZ) in Zurich, in order to learn how to use the Program Package Noise. It took some time to install the Program Package on the Grenoble platform because of the advanced fortran and of the multiple compiler options. Since the middle of September the program is available; it had, however, to undergo several slight modifications / improvements in order to improve the numerical stability

The first simulations were devoted to program testing, and checking the effects of different parameters (number and depth of sources, size modelling…). These tests emphasized the very heavy computational time requirements for the noise synthetics computation (around 4 weeks for 57 second of noise – model size equal 2 km, grid spacing 4 m), which, unfortunately, do not allow to run too many models, and therefore make parameter sensitivity studies rather difficult. We thus decided during the WP09 Roma meeting to compare the

noise synthetics obtained with the FD code with those obtained with another, faster code, which however can consider only 1D flat layered structures (Hisada / DWN code).

The work for the following months is:

- to write down a documented synthesis of the literature review;
- and to adapt the Hisada's DWN code to the RANSOURCE program.

☺ Up to now, the time table is respected. This work package will be finished by the end of the second year and the deliverable D13.08 "***Report on the nature of noise***" will summarize the work done.

IX WP09 – T02.09: numerical simulation of noise – year 2

Leader: Peter Moczo (Partner 11 – IGSAS.SD – Bratislava – Slovakia)

This work package is dedicated to the design of several representative canonical models, and to the achievement of noise simulations for comparison between the site information derived from noise synthetics and the actual model parameters.

In almost all numerical simulations of noise in canonical models using the program package NOISE, relatively early occurrence of artificial high frequency oscillations, i.e., instabilities, has been observed. 'Relatively early' means earlier than in simulations with one point source or plane-wave excitations. It was found, however, that it is possible to remove the high-frequency oscillations from simulated noise using a special filtration technique. The technique applies FIR (Finite Impulse Response) filter to field variables at certain time levels during the finite-difference calculation. The characteristics of the filter and times of its application may be determined on the basis of a trial simulation without application of any filter. Instructions for the filter-technique application have been written and supplied to users of the program package NOISE.
An important improvement in the finite-difference modelling of seismic motion (applicable also to the program package NOISE) has been achieved. A new definition of the anelastic functions, which now do not depend on the anelastic coefficients, and their new spatial distribution in the spatial staggered grid enable better account for material discontinuities in the viscoelastic medium. At the same time, the number of the anelastic functions has not increased compared to the original memory-efficient Day's (1998) coarse spatial graining. Numerical tests against the discrete wavenumber method and comparisons with the Day's (1998) and Day and Bradley's (2001) approach show that the new approach enables more accurate viscoelastic modelling than other approaches.

1. The initial model design (see the previous management reports) was further refined and/or modified in recent meetings, taking into account the constraints of the numerical model.

2. Various tests were performed with one of the canonical models (M2 single layer model) in order to determine the effects of the source distribution (density, time function, spatial location) on H/V ratios and on spatial correlations.

3. Another series of test was performed on the noise synthetics derived from these first simulations in order to establish a correct parameter set needed for the numerical modelling.

Tests on M2 model have shown that:

- surface sources provide results in agreement with what is usually observed using real noise;
- source time functions do not influence the shape of the H/V curves;
- density and location of sources plays a role in shaping the H/V curves. This is especially true for the depth of the sources.

Further tests are planned before the end of the year for assessing precisely the influence of very near source effects on H/V ratios and the influence of source distribution from the surface down to depth. These tests will help to establish source characteristics for real-sites noise modeling. Further tests and comparisons with other numerical techniques (Mode summation/ Hisada program) are planned during November and December in order to define the modeling uncertainty in finite difference program. A work meeting is planned in February 2003.

☺ Up to now, the time table is respected. A first deliverable D02.09 "***FD code to generate noise synthetics***" in the form of a CD ROM with a report describing the flow chart of the software and canonical structural models has been sent to the EC in June 2002. The next step will be to perform numerical simulations for the selected set

of canonical models. A next deliverable D12.09 "***Report on parameter studies***", initially foreseen for May 2003, will probably undergo some delay because of the very heavy computational time, which forced us to apply for computer time on specific high-performance computers in Switzerland.

X WP10 – T01.10: simulation of real sites – year 2

Leader: Donat Fäh (Partner 6 – ETHZ – Zürich – Switzerland)

This work package is dedicated to the noise simulations for real sites and final cross-checking between noise synthetics and actual noise simulations for a few well-known test-sites. However, these computations on real sites cannot start before

1. the simulation program is successfully tested on various canonical models, and the optimum computational parameters are derived from these tests,
2. the actual 3D structure of those real sites is detailed and encoded.

Besides the numerical tests described in WP09, the work during the third semester has first focused on the establishment of models for real sites. Two models are now ready for the 3D modeling; Basel and Grenoble. Partial information is available for Volvi, Colfiorito and Liege (canonical model 1D layer over half-space), but they are yet encoded

During the testing of the FD program, it has been recognized that the requirement in computation time is very high. For this reason, the Swiss Seismological Service has submitted a project to the Swiss Center for Scientific Computing (CSCS) in Manno. The answer to this request is expected by the end of December. Computation time will restrict the number of models that can be studied within the SESAME project.

A special task is concerned with the use of frequency-time analysis to compute H/V ratios. This method is suitable for the extraction of Rayleigh wavelets, and allows the computation of the ellipticity of these wavelets.
A wavelet transformation algorithm has been optimized and compared to classical H/V methods:the Fortran95 code for the time-frequency method of the H/V ratio computations with 2 different methods of time-frequency analysis, windowed Fourier transform (WFT) and continuous wavelet transform (CWT), has been written. Since the commonly used wavelets did not work well for this method of the H/V ratio computation, a proper modification of Morlet wavelet has been proposed. Based on the theory and the numerical tests, it has been found that CWT with a modified Morlet wavelet is more suitable for the determination of the H/V ratio based on the time-frequency analysis then the standard WFT. It has been also found that the technique based on the CWT better determines the minimum of the ellipticity curve for the fundamental mode of Rayleigh waves in wave motion composed of several modes of Rayleigh waves than the classical technique of the H/V computation. First tests have been performed with synthetic signals calculated for simple models with a single layer of soft sediments.

☺ This work package has started at the beginning of year 2 and up to now the time table is respected. However, due to the heavy computational requirements, some delay is anticipated in the first deliverable D11.10 "Set of noise synthetics for H/V and array studies from simulation of real sites".

XI Task D: short description

Task D is devoted to the dissemination and implementation of the scientific results. It will officially start only at the beginning of the 3rd year. It is composed of the following three work-packages:

– WP11: Scientific outcomes

– WP12: H/V user guidelines

– WP13: Recommendations for quality array measurements and processing

WP11: The scientific outcomes will be disseminated in three steps:

1. seven months before the end of the project, a three day workshop will be held in Smolenice, near Bratislava in September 2003 to exchange the results within the project team; a few observers not being involved in the project will be invited and asked to add constructive critics;

2. a special issue of an international journal or a monograph that presents the project achievements will be prepared;

3. a special theme session on the project outcomes will be organised at the 13th World Conference on Earthquake Engineering in Vancouver in August 2004, three months after the so far scheduled end of the project.

WP12: The H/V user guide will be kept simple so that it can be used by practitioners. It will contain general guidelines as well as the user manual for the H/V software developed by SESAME (WP03). A first draft will be reviewed by the work-package leaders. After revision of the guide, a second draft will be given to people not involved in the project for test applications. At least one of these test applications should be done by an European engineering consultant, and one by a third world institution. Final adjustments will be made based on this practical experience.

WP13: The recommendations for quality array measurements and processing will be written for scientists, since it is highly improbable that "ordinary" engineering consultants would perform array measurements. The reasons are that a very sophisticated measurement equipment as well as a very specialised theoretical knowledge are needed.

The core work of task D will only start with the Smolenice workshop (near Bratislava) since most of the scientific results will not yet be available before.

XII To conclude this mid-term report

As outlined in the sections describing each active work package, the project is progressing normally, according to the schedule, and there does not exist any major problem that jeopardize the chance of success of this project.

From a general viewpoint, the project is going nicely. The mid-term meeting in Roma clearly showed the dedication of all involved partners, as well as their enthusiasm. Work packages are all in progress and even when there are some delays, it is for good reasons. The general feeling is very good, the various groups are exchanging information.

The presentations made in various conferences and meetings did show the interest for the SESAME project, its preliminary results and its anticipated outcomes, especially in "third world countries". We think it would be a very good added value to invite some representative individuals as "observers" in the Smolenice workshop near Bratislava (see above task D), but we do not have any budget for that. We would appreciate any suggestion to help funding such invitations.

For the future, as discussed in the Rome meeting, the consortium would very much like to have a follow-up project ; several directions were proposed. Some of them may be included in the proposals presently under building under ongoing FP6 calls, but unfortunately, it is not possible to keep the same consortium under given the new FP6 structure, especially for "NoE". These "follow-up" issues will be of major importance in next general meetings, which will be the Bratislava scientific workshop, and the Nice end meeting in April 2004 (followed, hopefully, by the Special Session at 13WCEE, Vancouver, in August 2004).

SESAME important dates

	Months	Week 1	Week 2	Week 3	Week 4
1	*May 2001*				
2	*June 2001*				Kick-off Meeting-Grenoble
3	*July 2001*				
4	*Aug. 2001*				**Zürich – Aug 29-30** Task C meeting
5	*Sept. 2001*				
6	*Oct. 2001*				**Bergen – Oct 22-26** TaskA - WP02
7	***Nov. 2001***	**First progress report: 6th months report**			
8	*Dec. 2001*		(AGU)		
9	*Jan. 2002*	**Postdam – Jan 7-8** TaskA-WP02	**Postdam – Jan 9-11** TaskA-WP03 & TaskB-WP06		
10	*Feb. 2002*				
11	*March 2002*				
12	*April 2002*			**During the EGS – Nice – April 21-27** Task A- WP02- WP 03- WP 04 D1, D2 → sent with D3 in June 03	
13	*May 2002*			**Zürich** Task C meeting	D3: Progress report 1 (due on 30/06/02)
14	***June 2002***	**Second report: first year progress report + Deliverables D1, D2, & D3**			
15	*July 2002*				
16	*Aug. 2002*				
17	*Sept 2002*	(ECEE London) (ESC Genoa)			
18	*Oct. 2002*		**Roma – Oct 22-26** Oct 22-24: WP02, WP03, WP04, WP09-10 meetings Oct. 25-26: General SESAME meeting		D5, D6, D7 → sent with the third report
19	*Nov. 2002*				
20	*Dec. 2002*		(AGU)		D4 draft sent with the third report
20	***Dec. 2002***	**Third report: 18th months report + Deliverables D5, D6, D7 & a draft of D4**			
21	*Jan. 2003*				D9 ?
22	*Feb. 2003*	**Postdam– Feb. 3-14** WP05-WP06 meeting		**Bratislava– Feb. 20-21** Task C meeting	
23	*March 2003*				
24	*April 2003*		**During the EGS-AGU-EUG** **Nice – April 6-11** WP02 meeting		D8, D11, D12, D13, D14, D15
25	*May 2003*				D10: Progress report 2 (due on 30/06/03)
26	*June 2003*		**Thessaloniki– June 12-13** WP03-WP04 meeting		
27	*July 2003*				D16, D17, D18, D19
28	*Aug. 2003*				
29	*Sept. 2003*			**Smolenice – Sept 22-24** **Scientific Workshop**	
30	*Oct. 2003*				D20,D21
31	*Nov. 2003*				
32	*Dec. 2003*		(AGU)		
33	*Jan. 2004*				
34	*Feb. 2004*				EGS – Nice
35	*March 2004*				
36	*April 2004*			General Meeting - Nice	D22, D23, D24
37	*May 2004*				D25: Progress report 3
38	*June 2004*				D25; Final report

Adress of the web site is **http://SESAME-FP5.obs.ujf-grenoble.fr**

Minutes of the meetings or workshops

1. Task C meeting – Zürich (Switzerland) 2002

In the following, we give the minutes of the task C (WP08/09/10) discussions during the meeting in ETH-Zürich, 30-31 May 2002. The meeting was mainly focused on defining the parameters that will be used for noise computation for canonical models and real sites (source-receiver configuration, array configuration, local/distant sources, etc). These minutes end with the status of the time-frequency analysis and draw the work plan.

I Partners attending the meeting

Pierre-Yves Bard, Sylvette Bonnefoy	LGIT - Grenoble
Cécile Cornou, Donat Fäh, Ivo Oprsal	ETH – Zürich
Jozef Kristek, Miriam Kristekova, Peter Moczo	GPI SAS – Bratislava

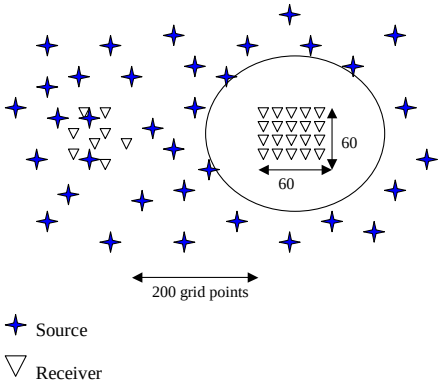
II Scientific matters

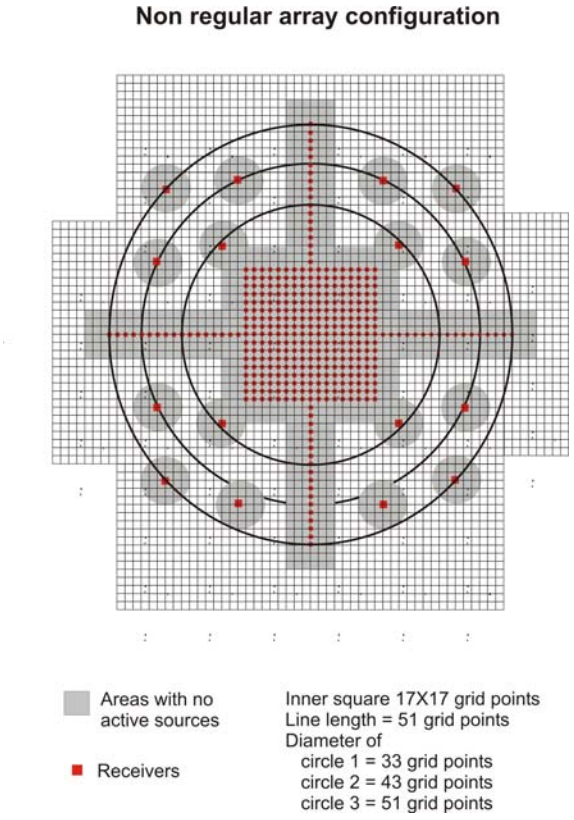
II.1 Noise computation

Because of large time computations, it was decided to skip some of the canonical models that were defined during the last meeting (Zürich, august 2001). The final models that will be considered in priority are presented in Appendix 1. Simulations will be performed in SAS GPI, ETHZ and LGIT. Noise pieces of 100 s will be computed on several receivers and then be gathered to get 10 minutes of noise recordings.

II.2 Canonical models: sources and source-receiver configuration

It was agreed to consider sources outside the array and possible sources inside the array as depicted in the following figures.





For the deep canonical models, local and long distant sources (incident Rayleigh waves) will be considered separately in a first step. Characteristics of long distance sources (frequency content, azimuth, location) are given hereafter for each deep model. The computation will first focus on local sources since the incorporation of long-distance sources in the code requires some slight adjustments by the SAS-GPI team.

II.3 Real sites

At the present time, only Grenoble and Basle models are enough well constrained to allow noise simulations. Grenoble model was prepared by Jozef Kristek and Basle model will be very soon available. Other sites will be considered after their improvement (Volvi and Colfiorito models expected next september/october). As for deep canonical models, long distance sources will be considered using a source excitation box. Besides, positions of receivers will fit as much as possible positions of experimental points used for H/V or array analysis purposes and completed by additive receivers.

II.4 Reliability of the 3D modelling

Simulation of noise was performed for the half-space model and reliability of simulated noise was checked through correlation and autocorrelation analysis between signals recorded at close receivers. Further check (ETHZ) will be performed through a comparison between the simulated spatial noise correlation decrease and the observed one for the Basle area.

II.5 Canonical models

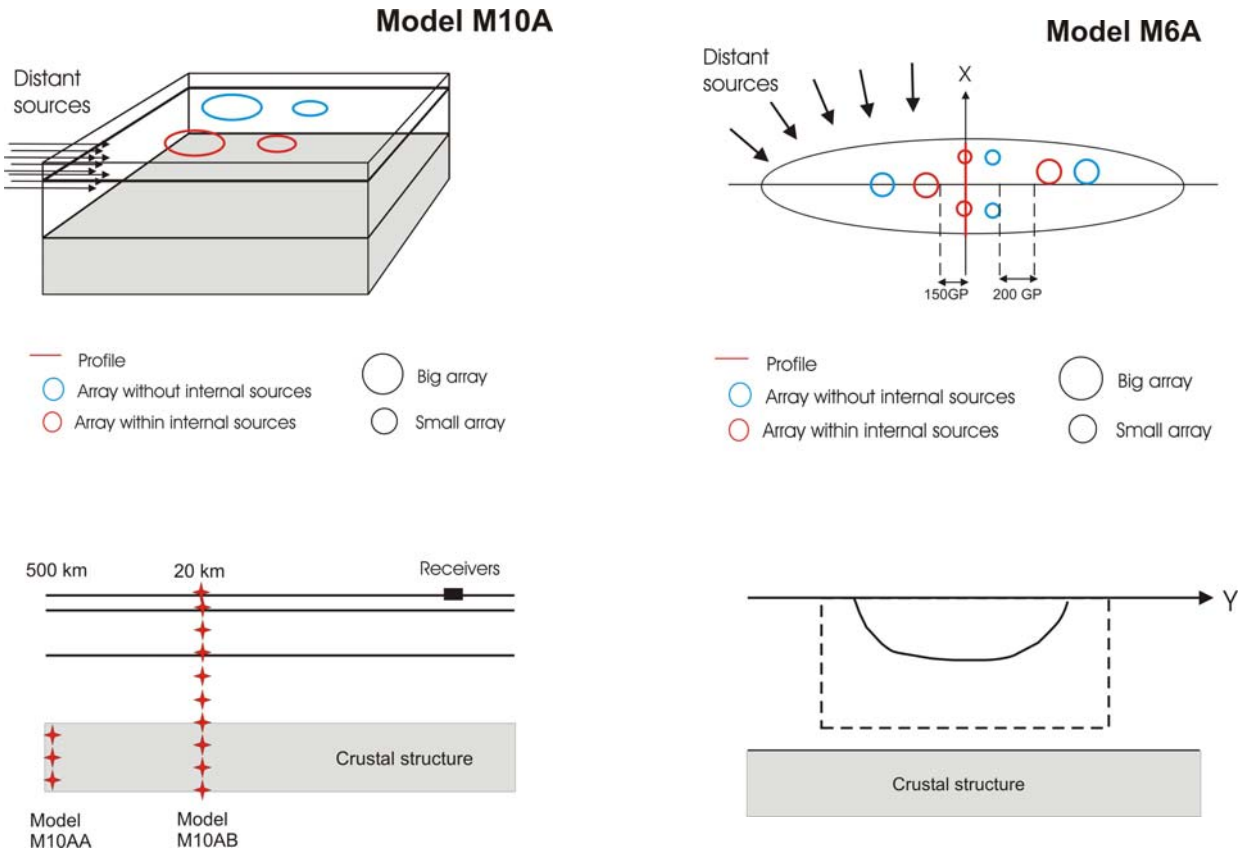
II.5.1 Shallow 1D model

Model #	Number of models	Computation grid spacing	Array grid spacing	Frequency Range	Institute
M2	4	4 m	4 m	0.1 – 10 Hz	GPI SAS
M10B	1	4 m	4 m	0.1 – 10 Hz	GPI SAS
M11	2	4 m	4 m	0.1 – 10 Hz	GPI SAS

For the M2 Liege model, five different depth intervals for source volume will be considered as defined in the previous meeting. Besides, it was agreed to test on that model the effects of various proportions of harmonic/pulses sources: 20-80%, 80-20% and 50-50% (ETHZ).

II.5.2 Deep models

Model #	Comp. grid spacing	Big array grid spacing	Small array grid spacing	Freq. Range (Hz)	Distant sources	Institute
M2 (Grenoble)	16 m	16 m	no	0.1-3	no	GPI SAS
M6A	4 m	16 m	4 m	0.1–10	Use of an excitation box Freq. content: 0.1 – 1 Hz	GPI SAS / ETHZ
M10AA M10AB	4 m	16 m	4 m	0.1–10	Single sources located either in the crustal structure (M10AA) either in the whole soil column (M10AB) Freq. content: 0.1 – 1 Hz Crustal model from Pegasos SP2 (mean crust model for swiss/germany area with a S-wave surface layer velocity of 2000 m/s) – see Appendix 2	GPI SAS / LGIT



II.6 Real sites

Grenoble site

- 10 km X 10 km model
- Local + long distant sources
- Frequency range for computation:0.1 – 1.5 Hz
- Time pieces of 120 s
- Grid spacing = 30 m
- 8 arrays within 100 receivers each
- receivers at the location of experimental H/V points completed with receivers located every 12 grid points (≈ 360 m)

Basle site

- 8 X 8 km model
- Local + long distant sources
- Time pieces of 120 s
- Frequency range for computation 0.1 – 3 Hz
- Grid spacing = 20 m
- 6 arrays
- receivers at the location of experimental H/V points completed with receivers located every 20 grid points (≈ 400 m)

II.7 Time-frequency analysis

Miriam Kristekova wrote the Fortran95 code for time-frequency method of H/V ratio computations (Fäh et al., 2001) with 2 different methods of time-frequency analysis: windowed Fourier transform and continual wavelet transform. Since the commonly used wavelets did not work well for this method of H/V ratio computation, she proposed a modification of Morlet wavelet. In the next, the method will be tested on the synthetic Rayleigh wave signals and on the synthetic/real noise signals.

III Work plan

The simulations are starting now for canonical and real sites (local sources only). Some first analysis using the WP03 software are expected before the 22th of October meeting in Roma. The next meeting is planned at the end of March 2003 in Grenoble.

2. Review meeting - Bruxelles (Belgium), 10 July 2002

Presentation of a state of art of the project SESAME and redaction of a paper.

Extracting information from ambient seismic noise: The SESAME project
(Site EffectS assessment using AMbient Excitations)

Pierre-Yves BARD
LGIT / LCPC, Grenoble Observatory, Joseph Fourier University, Grenoble

Content

A copy of the paper can be asked to Pierre-Yves Bard

3. Task C meeting - Rome (Italy), 22 October 2002

I Partners attending the meeting

Pierre-Yves Bard, Sylvette Bonnefoy	LGIT - Grenoble
Cécile Cornou, Donat Fäh	ETH – Zürich
Jozef Kristek, Miriam Kristekova, Peter Moczo	GPI SAS – Bratislava

II Scientific matters

II.1 Preliminary results of numerical simulation of seismic noise for a single layer over halfspace (H/V ratios and spatial correlation)

II.1.1 Spatial and density distribution in a horizontal plane

Density and location of sources seems to play a role in shaping the H/V curves. Further tests are planned before the end of the year for assessing precisely the influence of very near source effects on H/V ratios with sources at varying positions with respect to the receiver array. (Zürich team)

II.1.2 Spatial distribution in a vertical direction

Surface sources provide results in agreement with what is usually observed using real noise (unrealistic HF components for deep sources). Further checks are planned before the end of the year with sources from surface down to depth. (Zürich team)

II.1.3 Ratio of delta-like to pseudoharmonic source time functions

Source time functions do not influence the shape of the H/V curves: The ratio of delta-like to pseudoharmonic source time functions was finally choose to 50%.

II.1.4 Real sites

Two models are ready for the 3D modeling; these are the models for Basel and Grenoble. Information is available for Volvi, Colfiorito and Liege (canonical model 1D layer over half-space).

II.2 Program package NOISE

II.2.1 High-frequency instabilities

In almost all numerical simulations of noise in canonical models using the program package NOISE, relatively early occurrence of artificial high frequency oscillations, i.e., instabilities, has been observed. Relatively early means earlier than in simulations with one point source or plane-wave excitations. Intuitive opinion that early occurrence of instabilities is due to a very large number of randomly acting point sources in relatively short time window has to be verified. Therefore, WP09 group will perform special tests for a homogeneous halfspace. Tests should reveal dependence (or independence) of an occurrence time on the increasing number of acting point sources.

It is, however, possible to remove the high-frequency oscillations from simulated noise using a special filtration technique developed in WP09. The technique applies FIR (Finite Impulse Response) filter to field variables at certain time levels during the finite-difference calculation. The characteristics of the filter and times of its application may be determined on the basis of a trial simulation without application of any filter. The users of the program package NOISE received instructions how to apply the filter.

II.2.2 Additional tests and comparisons

A requirement of special additional tests of the NOISE calculations has been raised. One set of tests should check a possible negative effect of the FIR filter application on the synthetics by comparing NOISE synthetics with those calculated by Hisada's version of the AXITRA code based on the discrete-wavenumber (DWN) method. The calculated configuration should include single source and 1D multilayer models. The other set of

tests should check a possible negative effect of the applied finite-difference representation of the material discontinuity (layer–halfspace interface). WP09 team thinks that the latter tests are not necessary because the accuracy of the modeling was checked against the DWN method for a series of canonical models.

II.2.3 Excitation box

The FDSIM code of the program package NOISE should be supplemented with an option of application of the so-called excitation box for simulating distant sources. This type of excitation will be used to simulate noise in closed surface sedimentary bodies and also in the single–layer model. It is expected, in both cases, that surface waves will be dominant in the excitation wavefield. The principle of the excitation box is known, however, its encoding requires time especially in the 3D case.

II.3 Update of plan of numerical simulations for canonical models

The experience learned from so far performed numerical calculations led to conclusion that the original plan and extent of numerical simulations for canonical models should be modified. A long and detailed discussion was concluded with a modified table of numerical simulations – see Table 1. The table does not include simulations with the excitation box.

II.4 Application of the time frequency analysis to determination of the H/V ratios

Based on the theory and the numerical tests, it has been found that the continuous wavelet transform (CWT) with a modified Morlet wavelet is more suitable for the determination of the H/V ratio based on the time-frequency analysis then the standard windowed Fourier transform. It has been also found that the technique based on the CWT better determines the minimum of the ellipticity curve for the fundamental mode of Rayleigh waves in wave motion composed of several modes of Rayleigh waves than the classical technique of the H/V computation.
Additional tests for more complex wave fields (containing, e.g., also Love waves) will be performed.

II.5 Future meetings of TASK C

The next meeting of *WP08*, *WP09* and *WP10* is planned for the third week of February 2003 in Bratislava.

4. WP04 Empirical evaluation meeting - Rome (Italy), 23 October 2002

This meeting mainly focused on Data Compilation and deliverable D04.04. The aims of the WP04 Meeting in Rome are:

- the presentation of the Final Standard Information Sheet (SIS) for Ambient Noise & Earthquake Recordings and SAF dataset
- the establishment /adoption of a SIS – DATABASE
- the submission of D04.04 – New Date

The aforementioned issues were discussed and resolutions were taken as presented in the minutes.

I Partners attending the meeting

INGV (Roma), CSGAQ-CNR (Milan), LGIT (Grenoble), ITSAK (Thessaloniki), ETHZ (Zürich)

II Scientific matters

II.1 Presentation of the Final Standard Information Sheet (SIS) for Ambient Noise & Earthquake Recordings and SAF dataset

The initial SIS was as follows:

SITE INFORMATION SHEET (SIS) FOR EARTHQUAKE & NOISE RECORDINGS	Information	Remarks/Notes
Site		
Name	Almiros/Greece	
Code (up to 6 characters)	alm1	
Latitude (xxx.xxxx degrees) North(+)South(-)		
Longitude (xxx.xxxx degrees) East(+)West(-)		
Noise Recordings		
Available		Continuous
Exctracted for SESAME (min)		
Earthquake Recordings		
Weak Motion (velocity) - No. Records		
Reference Site Code (up to 6 characters)	alm9	
Reference Site - No. Records		
Weak Motion (acceleration) - No. Records		
Reference Site Code (up to 6 characters)	alm9	
Reference Site - No. Records		
Strong Motion (PGA >0.1g) - No Records		
Reference Site Code (up to 6 characters)	alm9	
Reference Site - No. Records		
Magnitude minimum (Mw)		
Magnitude maximum (Mw)		
Epicentral Distance minimum (km)		
Epicentral Distance maximum (km)		
Geological Data		
Surface Geology (Rock/Stiff/Soft)	STIFF	
Stratigraphy & Lithology [Y/N]	Y	
Bedrock Depth (m)	15	
Geotechnical - Geophysical Data		
SPT-values [Y/N]	Y	
CPT-values [Y/N]	N	
Vp (m/sec) [Y/N]	Y	
Vs (m/sec) [Y/N]	Y	

Q	[Y/N]	Y	
ρ (gr/cm**3)	[Y/N]	Y	
Basin Geometry			
Shape			
fo (Hz)		1,5	Ranging from 1,3 to 1
Width (km)			
Depth (km)			
Length (km)			
Closest Distance from Edge (km)			
Surface Topography			
Surface (Flat,Mountaineous, etc.)		Flat	
Site Description			
Area (Urban, Industrial, Agricultural, etc.)		Urban	
Ground Coupling			
Earthquake Recording Sensor		Ciment	
Noise Recording Sensor		Ground	
Information on Noise Recordings			
Recorder Type		CityShark	A/D 24bits
Sensor Type		Lennartz/3D-5sec	
Sampling Frequency (Hz)			
Gain		1024	
Data Format (saf or gse)		saf	converted from Citysh
Recording Period from (European format)			
Recording Period to (European format)			
Information on Earthquake Recordings			
Recorder Type		SMA-1	
Sensor Type		FBA	
Sampling Frequency (Hz)			
Gain			
Data Format		saf	converted from Kinem
Recording Period from (European format)			
Recording Period to (European format)			
GPS time [Y/N]		N	
Contact Information			
Institute		ITSAK	
Person		N. Theodulidis	

After discussion it was decided:

- All available SIS and the corresponding earthquake or/and noise recordings have to be sent to the WP04 leader by the end of November.
- For earthquake recordings, where possible, at least one minute (1min) pre-event noise should be kept in SAF files.
- In the Comments for Geotechnical - Geophysical data it must be noted whether Array Noise Measurements were performed and they are available.
- All fields of the second column (Information) that show the number of earthquake or/and noise recordings have to be completed, even in case there is no record (put 0). In addition, in case of cells where [Y/N] is required it is obligatory to write Y or N.
- The Partner [CSGAQ-CNR: Alberto Marcellini] asked and agreed to participate in the deliverable D20.04 as well as to fulfil the corresponding SIS, using data from Fabriano site.
- In this WP04 dataset of earthquake and noise recordings no instrument response will be provided. Hence, in a first stage only uncorrected data will be given and corresponding correction factors will be asked from the owner of the data (responsible Institute). However, it must be mentioned in the SIS comments column whether data are corrected or not. It will be examined in the future whether dataset will be converted to corrected SAF data.
- The SIS row "GPS time [Y/N]" will be replaced by "Absolute time [Y/N]".
- All contributors of data sets to WP04 must provide maps showing their stations.

The data (headings, SAF or GSE) of ambient noise & earthquake recordings was also discussed. In the following example of a SAF file it was decided that:

- Rows with red colour are MANDATORY for the input of the code "HV_PROC".
- Rows with green colour are MANDATORY comments useful to users of SAF files.
- Rows with black colour are NOT MANDATORY comments and data provider may put as many as she/he wishes.
- The hush # symbol in the beginning of the row means comment row. To separate headings from data four #### hushes have to be set (MANDATORY in SAF format).
- Example of finally suggested SAF file

```
SESAME ASCII data format (saf) v. 1
#Noise Recording [or Earthquake Recording]
#[If earthquake recording] Source Coordinates & Magnitude
#
# Station Coordinates =30.4531N 23.2536E
STA_CODE = arc1
START_TIME = 2001 09 23 23 59 58.4
SAMP_FREQ = 62
NDAT = 112501
CH0_ID = Z
CH1_ID = N
CH2_ID = E
UNITS = (e.g. microvolts)
#
#North Rotation (if needed)
NORTH_ROT = 50.
#East Rotation (if needed)
#VANG (Polarity if needed)
#
# Original file name: 012662359t.arc1
#Data Conversion Factor (e.g. from units --> SI units)
#Digitiser Type & Sensor Type (e.g. City Shark &Le5s)
####----------------------------------------
-348.5   338.5   101.25
-352.5   266.75   87.
-342.5   256.75   37.
```

The final number of SIS to be provided is as following:

"FINAL" number of sites with earthquake & noise recordings

CR7	[ITSAK]	80
CR9	[INGV]	36
AC10.9	[CSGAQ-CNR]	~40
CR6	[ETHZ]	22
AC12.1	[CETE]	
CR14	[LCPC]	~60
Total		~238

II.2 Establishment / Adoption of a SIS – DATABASE

After the presentation of a demo of SESAME database by the WP04 leader, the following comments/remarks were decided to be incorporated as well:

- Since for the majority of SIS sites there is no velocity profile information site characterization by ROCK/STIFF/SOFT is mainly based on surface geology and judgment. However, in case that the

provider has more information about site characterization (e.g. category A, B, C, D, E according to NEHRP) it must be mentioned in the corresponding column of Remarks/Notes.

- Resonant frequency row f_o (Hz) should be set as selection criterion within a certain range, for instance, $1.2Hz \leq f_o \leq 1.8Hz$.
- In Site Selection Criteria the Site Code Name should be added as a criterion.
- Magnitude should be set instead of Moment Magnitude.
- Absolute Time should be set instead of GPS Time.
- A table should be given by each Partner that connects each earthquake with the corresponding recording Site Codes, as in the following example:

Earthquake Origin Time	Lat. - Long.	Depth (km)	M	Site Code	Recording Start Time
19860210121530.5	42.2330 15.3561	12.0	6.3	Arc1 Rov1 Rov2	19860210121552.3 19860210121600.5 19860210111602.0
19980623141612.6	40.3450 22.5434	8.0	5.8	Lef1 Agr1 Vas1 Pre1 Igm1	19980623141630.4 19980623141642.2 19980623141645.6 19980623141655.1 19980623141702.5
……	……	…	…	….. ….. …..	…….. …….. ……..

II.3 Submission of D04.04 – New Date

After discussion it was decided that:

- A four (4) months submission delay of the D04.04 will be asked (by the Coordinator) from the EC-Brussels, that is, this deliverable will be sent to Brussels by the end of Dec. 2002.
- The general form/contents of the D04.04 Report will be as following:

Deliverable D04.04
Homogeneous Data Set of Noise and Earthquake Recordings at Many Sites
SESAME WP04 - H/V Technique: Empirical Evaluation

1. Introduction - Aim of the D04.04 - Partners
2. Standard Information Sheets (SIS) per Partner
  2.1 Discussion / Remarks
3. SIS Database Presentation
  3.1 Selected Data Base - Reports
  3.2 Discussion / Remarks

5. WP02 meeting - Rome (Italy), 23-24 October 2002

The aim of this meeting was to review all the work done and to prepare the final tests to be done to conclude this workpackage.

I Partners attending the meeting

K. Atakan, J.-L. Chatelain B. Guillier, P. Teves-Costa, D. Faeh, R. Azzara, F. Carra, G. Cultrera, P.-Y. Bard and A-M Duval.

II Scientific matters

II.1 Explanations about modification of planning

First WP02 leader explained what has been done during the last months: as a matter of fact, we couldn't follow the planning fixed during Nice meeting concerning test to perform to check the influence of experimental parameters:

- Even if records were performed, we couldn't process it with a common SESAME software during the summer as planned.
- This is due to the fact that the final version of SAF format was delivered by the end of August 2002 instead of May as planned
- Then Nice and Roma team had to write transformation software from local format to SAF format.
- Then we had to wait for the first version of SESAME H/V software and also for the first version of Windowing soft.
- Roma, Nice and Grenoble teams had to test those software and proposed modification
- wait for new version of software and made a parametric survey to propose a default parameter file (**Appendix A**). F. Cara from INGV came in Nice to work during 15 days mainly on that topic. There F. Cara, E. Querendez and AM Duval summarized the individual reports written on that test by Grenoble, Nice and Roma teams (***see individual and common reports on software test WP03, sept 2002***).
- by the end of September SESAME software was available for WP02 teams together with the default parameter file fixed for WP02.
- This explain the delay in progress of WP02 and the request for delay for deliverable D08.02. This delay is accepted by SESAME coordinator.

II.2 State of each team "WP02 data-base"

Table 1: number of records used in each database.

Total = 1 896		878	50 ?

Each team explains what was done until now and how is its data base. These information are reported in **Appendix C**.

The table of tested parameters (in **Appendix B**), already updated in 2002 April (Nice) is also partially updated in Roma.

During this Roma meeting, we had no time to check each of the test or to drawn any conclusion on the effect of any parameter. The only thing that can be surely said is that there is some variation due to experimental condition.

II.3 Decisions

We all agreed that comparison between all our results must take place as soon as possible. But this meeting in Roma is not the right place to check the precise conditions of each of the very numerous tests. These comparisons will mainly take time for Grenoble and Nice teams which have performed the more numerous test.

To be able to compare our result test by test and to argue on the conclusion, we need to present the result in the same format. For this reason we decide the following:

- the records should be processed with SESAME HVproc soft (including automatic windowing SESAME) with the default parameter file (soft and default file joined to this mail).
- remark : in the default parameter file, the computation of the standard deviation is : log
- Definition of graphs to perform: see **Appendix D**
- **As soon as possible and in any case before January the 15th 2003**, e**ach team (ITSAK, INGV, UiB, LGIT, CETE, UTH) will send** to Nice team:

  a word document containing for each test
  - the name of the test
  - some comments on the experiment conditions
  - some comments on the process (windowing)
  - the required plots (**Appendix D**)
  - the conclusion of the team for each test

  data:
  - the records in SAF format
  - the output files from SESAME soft
  - the organization of the database should follow the one described by Nice team in appendices C of these minutes.
- Nice team will make a rough compilation of these 6 documents (sort by parameter number) and send it back in February.

Nice meeting April. 7-11th 2003:

- Nice and Grenoble team will meet in Nice during few days to have a deep review of the overall results.
- P. Teves-Costa is in charge of an international bibliographic review on the subject of influence of experimental. She will join Grenoble and Nice team in April the 11 at least.
- Other participants (M. Koller, D. Faeh) may be invited in 2002 April the 11, in Nice to conclude on the tests.
- The synthesis and conclusions should be oriented toward the different use made of H/V: only Fo or Ao or peak thickness, or rate of slope. For each use, the rate of difference in H/V induced by one parameter as to be quantified. D Faeh and F. Scherbaum already proposed some computation and categories to apply to our future results. D. Faeh proposed to write a matlab routine to fill these tables by test. He will send it to Nice team in December 2002. Nice team will try to apply it to the more representative test.
- These tables will be discussed during next meeting (2002, April the 11, in CETE Nice).
- During this meeting we will also design the final report « user guideline » and share the work. The final report will be produced for the end of may 2003.

Instrument influence, Bergen WS:

- We should write a paper as soon as possible. Each person responsible for one task (design during Potsdam meeting Janv 2002, see minutes) should write his part. B. Guillier proposed to gather all the part. After large discussion, we decided:

  not to identify the instrument but to give their specification,

  to clearly indicate the limit of our experiment,

to propose a more complete protocol to test instrument;

- this paper would be devoted to highlight the need of common calibration protocol for all seismological instrument.

III Appendixes

III.1 Appendix A: default parameter file for HVproc

```
#PARAMETER FILE
### section processing

## possible options for frequency spacing
# syntax: freq_spacing:<type>:<arg1>:<arg2>[:<arg3>]
#
#      type   arg1   arg2   arg3
#      fft    -      -      -
#      fft_red       f_min  f_max  -
#      linear f_min  f_max  # points
#      log    f_min  f_max  # points
freq_spacing:fft

## possible options for offset removal
# syntax
# offset_rem:<type>[:<arg>]
# type:
# no
# r_mean
# high-pass: frequency
offset_rem:r_mean

## tapering
# syntax:
# taper:<type>:[<arg1>]
#
#      type   arg1   arg2   arg3
#      boxcar -      -      -
#      cos    percentage -  -percentage of the window that is affected by the
#                                 tapering on both ends
#
taper:cos:5

## instrument correction
# syntax:
# instrument_resp:<arg>
#
# where arg is either 'yes' or 'no'
#
instrument_resp:no

## smoothing section
# syntax:
# smooth:<type>:[<arg1>[:<arg2>]]
#
# type arg1   arg2
# none -      -
# linear     bandwidth   box     linear smoothing with constant weight in the interval [f-
bw/2 f+bw/2]
# linear     bandwidth   tri     linear smoothing with triangular weight in the interval [f-
bw/2 f+bw/2]
# log percentage  box     smoothing  with  constant  weight  in  an  interval  [f/(1+p/100)
f*(1+p/100)]
# log percentage  tri     smoothing  with  triangular  weight  in  an  interval  [f/(1+p/100)
f*(1+p/100)]
# konno-ohmachi bandwidth   -    bandwith for the smoothing window
#
smooth:konno-ohmachi:40
```

```
## merging of horizontal components
# syntax:
# merge_type:<type>
#
# type
# arithmetic (H_ew+H_ns)/2
# geometric  sqrt(H_ew*H_ns)
# quadratic  sqrt(H_ew^2+H_ns^2)
#
merge_type:quadratic

## output of single components
# syntax:
# single_component:<arg>
#
# arg: 'yes' or 'no'
single_component:no

## average of horizontal components
# syntax:
# average_type:<type>
#
# type
# linear
# log
average_type:log

## output of single window information]
# syntax:
# single_win_out:<arg>
#
# arg is either 'yes' or 'no'
single_win_out:no

### end processing
```

III.2 Appendix B: tested parameters

The table on the tested parameters **has been updated** on the 26th October2002 in Roma for Nice, Roma and Lisbon teams only

Parameter:	Grenoble	Roma	Nice	Bergen	Thessaloniki	Lisbon	Zurich
P1-1	♠					♠	
P1-2	X •					♠	
P1-3		♠	♠				
P1-4	♠	♠	♠			♠	
P1-5	♠	♠	♠				
P1-6	X ♠		♠				
P1-7	♠		♠				• synthetic
P1-8	♠		♠				
P2-1	♠•	♠	♠			♠ •	
P2-2	♠		♠				♠
P2-3			♠			•	
P2-4	♠•	♠	♠♠			♠•	♠
P2-5				♠			
P3-1	♠•		♠♠			♠	♠
P3-2	♠		♠	X			♠
P3-3	♠		♠			• no	
P3-4	♠		♠				
P3-5	♠		♠				
P4-1			♠			♠	
P4-2	X •		♠		•	•no	
P5-1	•					♠	
P5-2	X		♠			• no	
P6-1	•		♠				
P6-2	•		♠				
P6-3							
P6-4	X				X	♠	
P7-1	X •				X		
P7-2			♠				
P8-1		♠	♠		X	X ♠	
P8-2	X•	X	♠		X		♠ X
P8-3		♠	♠				X
P8-4				•			

P9-1-1	X	X	♠			•no	
P9-1-2			♠			•no	
P9-1-3			♠			•no	
P9-1-4	♠		♠				
P9-2			♠			♠	

♠: record already performed •: record to be performed X: old data to integrate

III.3 Appendix C: data base of each team

III.3.1 Grenoble/IRD-LGIT team

Processed all its about 100 tests (several records per test) with its own software and prepared graphs for the meeting. Graphs included average H/V and standard deviation for both reference and test, plus a graph of comparison featuring the difference between reference and test H/V divided by H/V of the reference.

The data-base organized as follows:

- a directory for each task
- inside this directory, a sub-directory for each sub-task
- inside the subdirectories :
  - a sub-sub directory containing the row data in CityShark format
  - a sub-sub directory containing the data used for grphics, in Macintosh format
  - a Macintosh file containing description of data acquisition
  - files with the graphs

III.3.2 Nice/CETE team

Build a data base containing:

- around 150 tests (several records by test). (about 145 Nice tests + swiss tests: 4)
- one directory by test
- for each test: one directory containing the original data files
- for each test: one directory containing the photographies (referenced in excel shet by records)
- for each record : fill the excel file containing information on experimental parameters during the record. for each test: one directory contains these files

Although almost all Nice data were already processed with a local software during June and July 2002, from the end of 2002 September, all those data were:

- transform in SAF format
- processed again with the common SESAME soft
- for some experiments, we didn't use automatic windowing soft but we had to select window manually (effect of sources)

Then for each test, the data base was completed:

- for each test: one directory containing the SAF data files, these directories also contains parameter files used and window limit files for each records.
- for each test: one directory contains the output files for each record.

For each test, graphs were prepared by superimpositon of H/V of individual records.

- for each test: one word document is elaborated that contains:
  - a graph, a comment and the header of the SAF file
- for some test, the time history and the window selection.
- a synthetic word document was elaborated that gathered all those previous document for each test.
- table 1 is elaborated with the following parameters (one line = one record=333 lines):
- Date, Site Géographique, Precise measurement location, name of original ascii file, name of SAF file, comments
- table 2 is elaborated to related a number of map to locate precisely point location
- table 3: header of each original files
- table 4: header of each SAF file
- several map and plan were gathered that explain the different experiments

III.3.3 Rome/INGV team

Build a data base containing:

- 15 tests (several records by test) concerning 8 parameters
- one directory by parameter
- for each parameter:
  - one directory containing the original data files, divided by number of test and when possible by record. Sometimes the original files were cut to be processed; in this case there is another directory with the cut files

when available one directory containing the photographies (referenced in excel sheet by records) referred to the tests about the single parameter

- for each record : fill the excel file containing information on experimental parameters during the record. for each parameter: the directory referred to that parameter contains the excel file

Although almost all Rome data were already processed with a local software during March 2002, from the end of 2002 September, all those data were:

- transform in SAF format
- processed again with the common SESAME soft
- for some experiments, we didn't use automatic windowing soft but we had to select window manually (for example for the stabilization of the sensors)

Then for each test, the data base was completed for each parameter: one directory:

- containing the SAF data files (from the whole original files and from the cut files, as explained before).
- one directory containing the analysis that have been carried out, divided by tests and when possible by record. For each test (and record): one directory containing the window files used for the processing, one directory containing the output files from the Sesame software (sometimes we asked to have the output for each window processed; in this case another subdirectory is present); we add similar directory where the results are given in SAC format and in ASCII-1 column format, useful for the visualization of the results; a directory containing the pictures that have been carried out for a preliminary interpretation of the results: graphs were prepared by superimpositon of H/V of individual records.

A very synthetic word document was elaborated in order to summarizied the main conclusions and comments about the single test.

Two of the tested parameters with several tests performed by Nice team were processed by Rome team (stabilization of the sensor and artificial source effects); as above some graphs have been prepared.

III.3.4 Lisbon/ICTE team

Build a data base containing:

- about 12 tests (two or more records by test) concerning 8 parameters
- one directory by parameter
- Inside this, subdirectories containing *(i)* the original data files; *(ii)* the saf files; *(iii)* the excel sheets; *(iv)* the photos (if available, as referenced in the excel sheets) and/or drawn scheme showing the location of the sensors

Although all data were already processed with a local software, during June to September 2002, some of the tests were processed with the SESAME software (always with manual window selection, accordingly to the previous analysis) bilization of the sensors)

- for each processed test the data base was completed with:
- results obtained with the local software (graphs with mean H/V)
- results obtained with the SESAME software (graphs with mean H/V± standard deviation)

III.4 Appendix D: definition of graph to perform

For each record: plot 1 graphs (graph 1) + For each test : plot 2 graphs (graph 2 and graph 3)

All graphs should be:

- x-axis: log plot from 0.2 to 20 Hz
- y-axis: linear plot amplitude: from 0 to 10 (20 or more if necessary)

The output file of SESAME software contains:

- the frequency (*freq*)
- the mean H/V ratio (*M=av_HV*, geometric mean)
- the standard deviation (*std_M=10^std_logHV*, where *std_logHV* is the standard deviation of log(H/V))

let's call: $A = M_{reference\ record}$ and $B = M_{tested\ record}$

graph 1) For each record: plot of the average (*M*) with standard deviation (3 curves):

M
*M * Std_M*
M / Std_M

graph 2) For each test: superimposition of the averages (*M=A,B*) for all records concerning the test with different color (reference A in red)

graph 3) For each test: superimposition of C for the different records:
($C = (A-B)/A =$
$= [(M_{reference\ record} - M_{tested\ record}) / M_{reference\ record}]$) for all records concerning the test.

6. WP03 Software development meeting - Rome (Italy), 23-24 October 2002

In the following, we summarize the status of the WP03 on the H/V software and give the minutes of the discussions during the meeting at INGV-Rome, 24 October 2002. List of participants is given in the Appendix.

I Partners attending the meeting

Kuvvet Atakan & Bladimir Moreno	UiB-Bergen
Ricardo Azzara, Fabrizio Cara Giovanna, Cultrera & Antonio Rovelli	INGV-Rome
Pierre-Yves Bard & Sylvette Bonnefoy	LGIT-Grenoble
Jean-Luc Chatelain & Bertrand Guillier	UJF/IRD-Grenoble
Cécile Cornou &Donat Fäh	ETHZ-Zurich
Anne-Marie Duval	CETE-Nice
Jozef Kristek, Miriam Kristekova & Peter Moczo	GPISAS-Bratislava
Martin Koller	RESONANCE-Geneva
Alberto Marcellin & Alberto Tento	CNR-Milano
Matthias Ohrnberger	UP-Potsdam
Pedro Roquette & Paula Teves	Costa ICTE/UL-Lisbon
Nikos Theodulidis	ITSAK-Thessaloniki

II Scientific synopsis

There were major developments on all four modules of the H/V software, which are: (i) Browsing Module, (ii) Window Selection Module, (iii) Main Processing Module and, (iv) Display Module.

The work regarding the first, was organized and performed by the UiB-Bergen group also in coordination with ICTE/UL-Lisbon group. The second module was developed by the LGIT-Grenoble group. The third was organized and performed by the ETHZ-Zurich and CNR-Milano groups, whereas the last module was developed by the ICTE/UL-Lisbon group.

The browsing module is already integrated with the window-selection and the main processing modules and there is work in progress to integrate also the display module. This latter work is envisaged to be completed within three weeks time.

The deliverable deadline is in January 2003 and the first version of the software together with a report will be delivered according to the original plan and we do not expect any delays. There has also been additional work performed by the WP02 group, where the processing module was tested and compared with the existing processing routines. Three separate groups (CETE-Nice, INGV-Rome and IRD-Grenoble) have performed this analysis and prepared individual reports and a summary report was prepared in the workshop in Nice during September 2002.

In general, the progress is satisfactory and further actions are scheduled for the work to be done until January 2003. The suggested changes to the different modules will be implemented if feasible within the limitations of the January 2003 deadline. Those suggestions that require significant additional work will be implemented later, after the deliverable deadline. The developers of the four modules will write their individual reports summarizing each module and will send them to Bergen (latest mid-November 2002) for integration into the deliverable report.

The action points are as follows:

- Complete changes on the browsing module (B. Moreno)
- Complete changes on the window selection module (P-Y. Bard)
- Complete changes on the processing modules (A. Tento)
- Complete changes on the display module (P. Roquette)
- Integrate the display modules to the software (B. Moreno and P. Roquette)

- Send the individual reports to Bergen for each module (by each responsible of module latest in mid-Nov.2002)
- Integrate the report (K.Atakan)
- Prepare the CD for the software distribution together with installation procedure and instructions for installation (P. Roquette)

After the January 2003 deliverable deadline, there will be additional work which will be performed. These are:

- Extensive testing of the entire software
- Final modifications (if necessary), following the test results and recommendations of the users (also including the on-line help functions)
- Preparation of the user manual
- Dissemination of the software (WP12)

III Browsing Module

The main functionalities of the browsing module was discussed and agreed upon during the Nice Workshop. Following this, B. Moreno from the UiB-Bergen, has developed the preliminary version of the browsing module and the main graphical user interface (GUI). A dedicated effort was made in Lisbon, in September 2002, when B. Moreno and T. Utheim from UiB-Bergen worked together with P. Roquette from ICTE/UL-Lisbon.

During the meeting in Rome the main graphical interface and the browsing module, together with the window processing and the main processing modules were demonstrated followed by a discussion.
Several suggestions were made and these are outlined below which will be implemented following the priority list of the developers:

- In the general parameter-setting dialog window add the choice of indicating where all the output files should reside.
- Overwriting of a file-name should have a confirmation prompt.
- Give warning to the user when automatic and manual selected windows are mixed for processing together.
- Give warning to the user when several files for a site are processed together if one or more files does not contain any automatic or manually selected windows.
- Option to activate or de-activate all the warnings in the general parameter-setting dialog window.
- Add availability of tracking the time when the main processing module is executed in the GUI.
- Add filtering possibilities in the browsing module.
- Add options for saturation check and low frequency transient removal in the parameter-setting dialog window for window selection module.
- Fix the number of windows to process for each file for a site in order to have the same number for windows for each file. Should be set equal to the minimum number of windows that are automatically selected by the window selection module among all the selected files for a site.

In the following, the main graphical user interface and the functionalities of the browsing module is shown by a series of screen snap-shots:

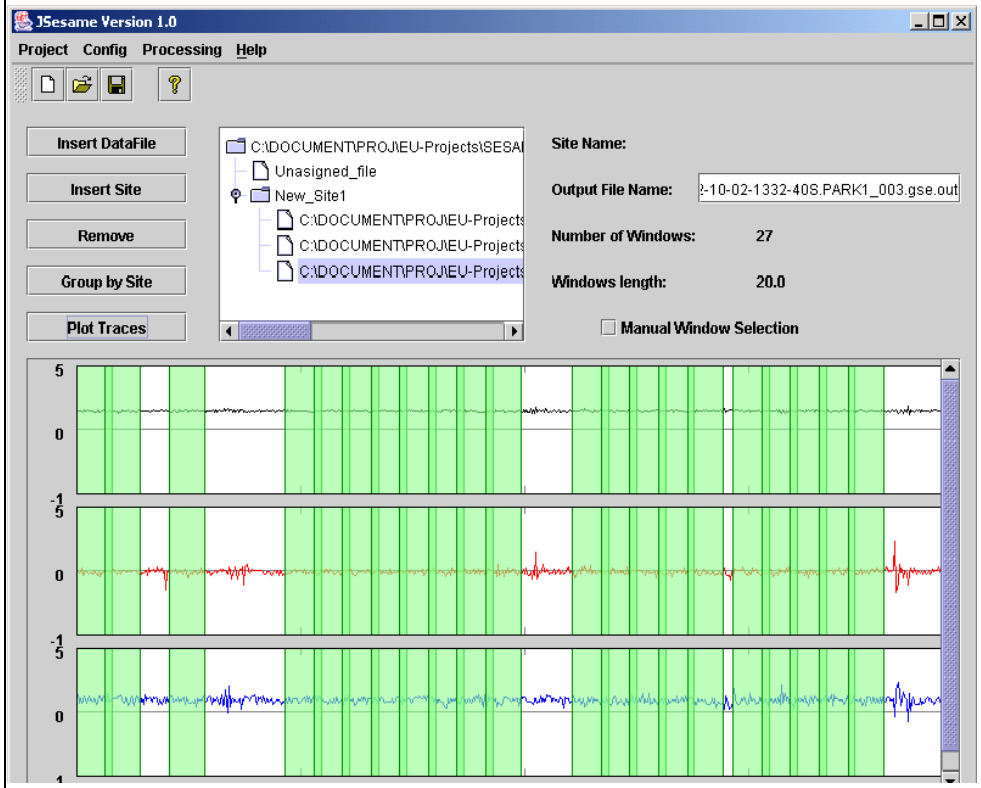


Figure 1-1. The general layout of the Graphical User Interface (GUI) and the Browsing Module.

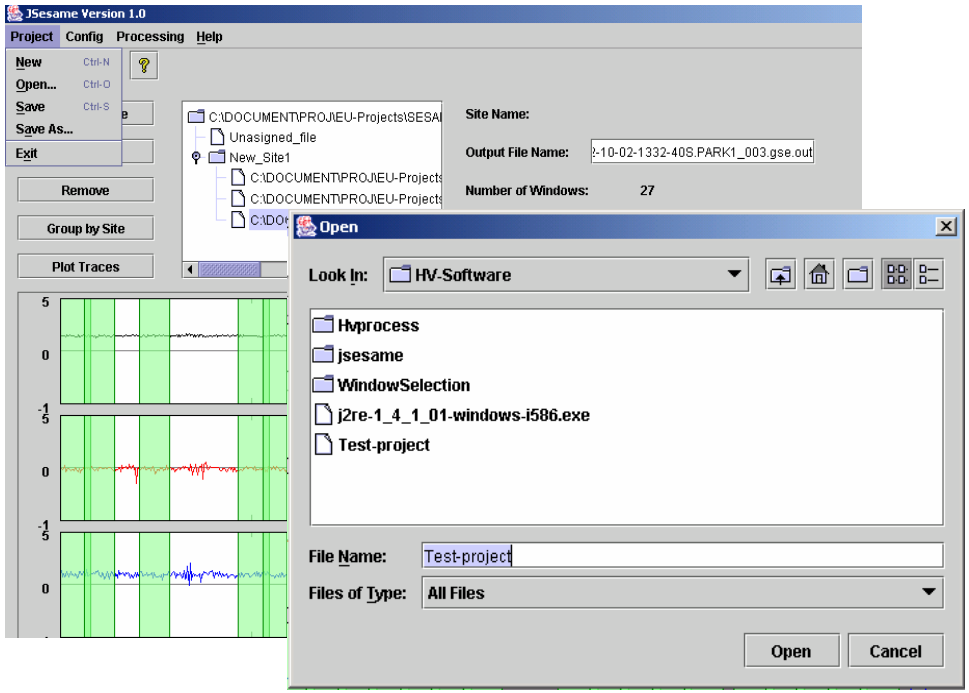


Figure 1-2. Creating a new project or opening an existing project is performed through a dialog box.

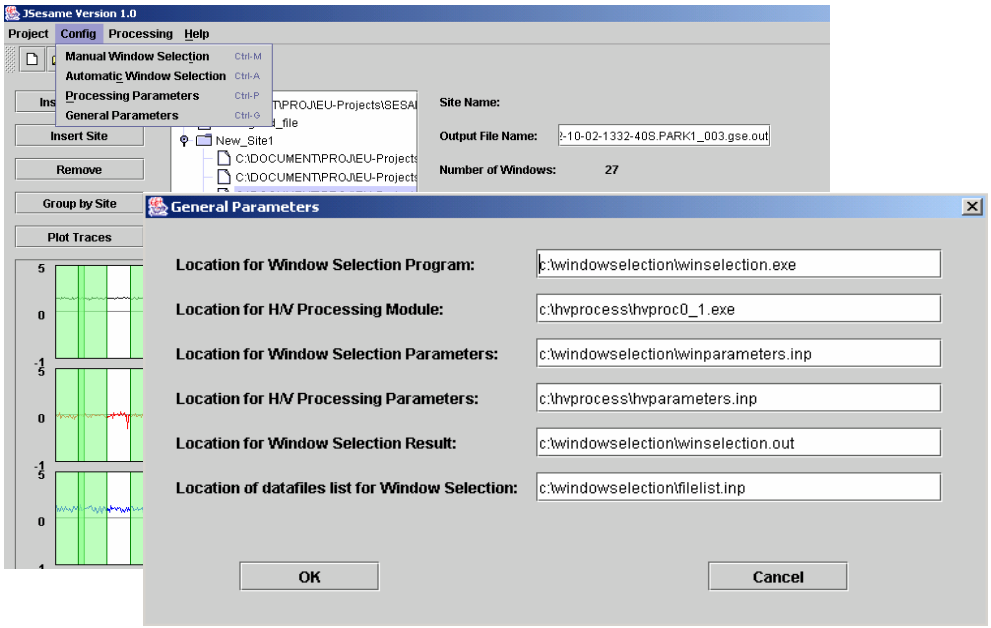


Figure 1-3. General parameter settings are performed through a dialog window, where the location of the input parameters and the executable programs are given.

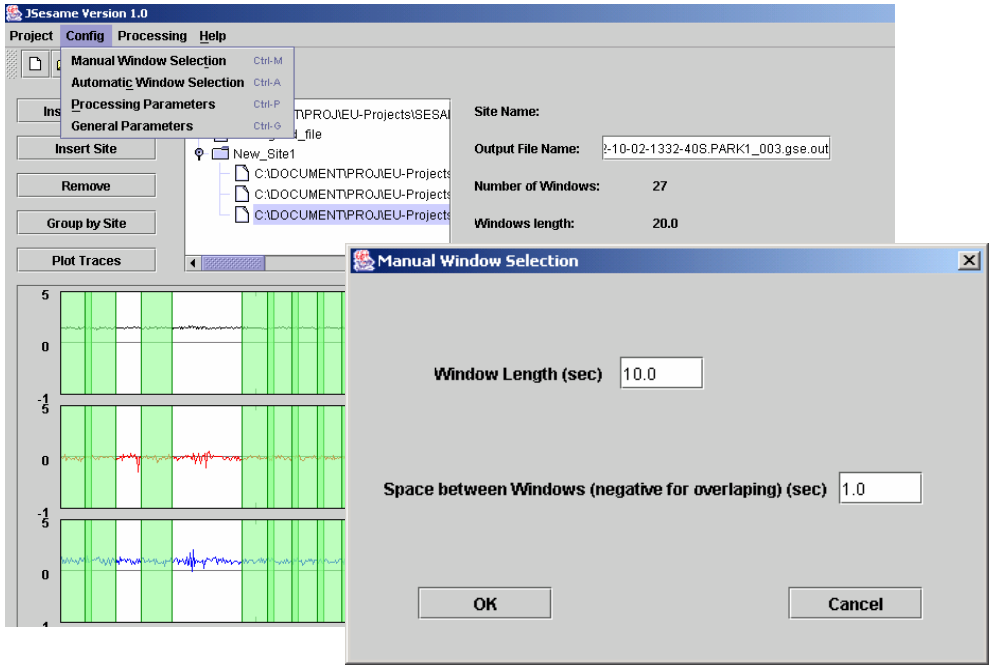


Figure 1-4. Dialog window for parameter setting of the manual window selection routine.

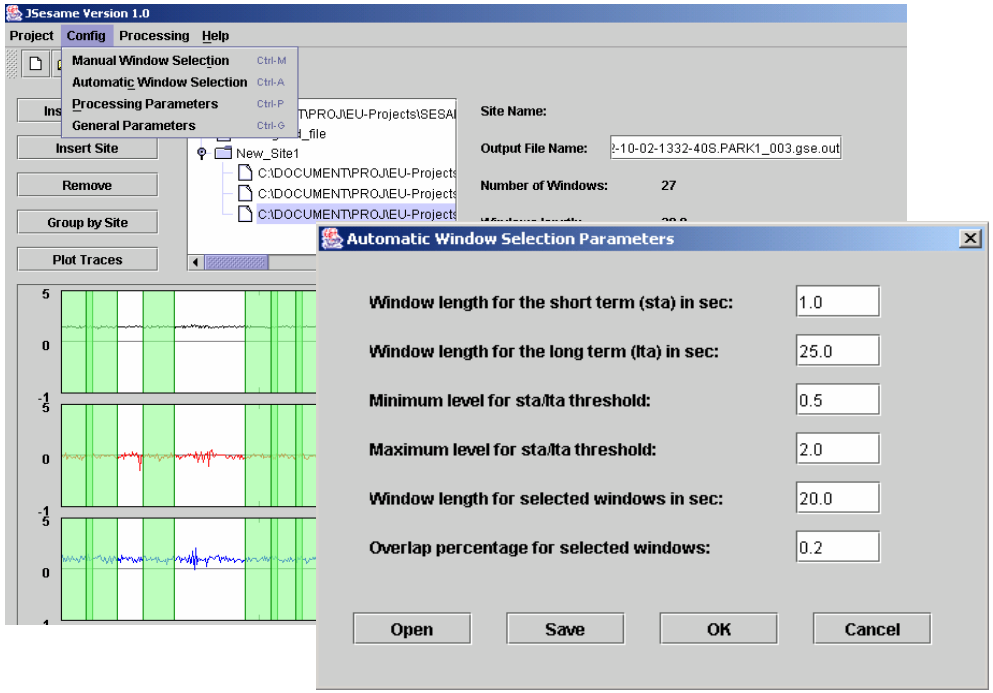


Figure 1-5. Dialog window for the parameter setting of the automatic window selection routine.

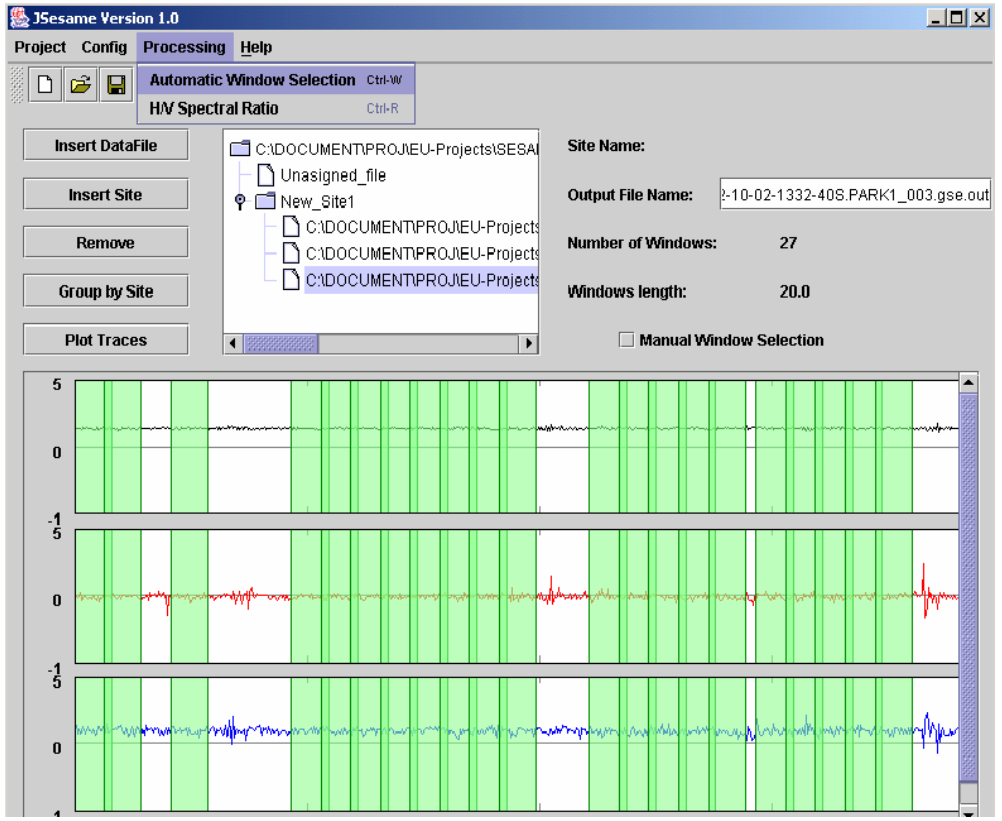


Figure 1-6. General layout of the browsing module, where individual time series can be viewed and the selected windows can be inspected.

IV Window Selection Module

Window selection program seems to work efficiently and is already integrated to the browsing module. There were basically two additional suggestions to be added, these concern the saturation of signals and the removal of long-period transients. Details are described below:

IV.1 Window selection program (winselect_3)

Antitrigger algorithm

Constructs $s(t) = [v^2(t) + h_1^2(t) + h_2^2(t)]^{0.5}$

Computes running averages sta(t) and lta(t)

Tsta = 0.5 to 2.0 s ; tlta = 15 to 50 s

Computes the ratio rsta (t) = sta(t) / lta(t)

Compares it with given thresholds

Csmin = 0.1 to 0.5 ; csmax = 1.5 to 2 s

("seuilmin", seuilmax")

Computes two indexes ind1 and ind2

ind1(t) = rsta / csmin (should be ≥ 1)

ind2(t) = csmax / rsta (should be ≥ 1)

Anti-saturation condition

Constructs $smax = Max_t [|v(t)|, |h_1(t)|, |h_2(t)|]$

Avoids windows where the maximum value of any component exceeds 0.995. smax

Computes another index ind3

ind3(t) = 0.995 smax / Max [|v(t)|, |h₁(t)|, |h₂(t)|]

(should be ≥ 1)

Avoiding too noisy windows

Computes maximum and minimum values of lta (ltamax, ltamin)

Computes ltamoy=0.8*ltamax + 0.2*ltamin

Computes index ind4

ind4(t) = ltamoy/lta (should be ≥ 1)

V Main Processing Module

The main processing module is developed by the ETHZ-Zurich and CNR-Milano groups in a coordinated effort. Two meetings were held in Milano during the 14-15 March and 18-19 April 2002 for the coordination of the work. Otherwise the work was performed individually by each group and information is exchanged electronically. Following the Nice workshop in April 2002, a concentrated effort was done to finish a working version of the module for testing and use in WP02 experimental conditions. This was accomplished and the first version was made available in the first week of July 2002. The module was used and tested by three groups (CETE-Nice, INGV-Rome and IRD-Grenoble) and individual reports were prepared. In addition a summary report was given in September 2002 (these reports will be part of the deliverable in January 2003). Further development taking into account the test results as well as the discussions during the Rome meeting, will continue until the deliverable deadline. This will also be in coordination with the UiB-Bergen with regard to integration to the browsing module. It will be possible to make corrections and improvements after the deliverable deadline, however, the possible changes will have to be given a priority have comments, suggestions and the report of possible bugs until mid-September 2002.

The HVPROC program is developed in Fortran90 and runs with the following command line call:

```
> hvproc0_1 winfile parfile outfile
```

- window.file : list of time histories and selected time window for the analysis
- parameters.file : file with a section containing the parameters needed for the analysis
- out.file : main output
- defaults.file: file with a section containing the default setting of the parameters needed for the analysis (this file is found to be redundant and will not be included, instead the default parameters will be hardwired in to the code)

In the Appendix A-D the different files (window file, parameter file and the output files) are given separately.

```
C:\Sesame\Data> hvproc0_1 wind parameter.file output defaults.file
 window file not found !
wind

>>>>>>>>>      CONTROLLED ERROR EXIT      <<<<<<<<<
>>>>>>>>>      CONTROLLED ERROR EXIT      <<<<<<<<<
>>>>>>>>>      CONTROLLED ERROR EXIT      <<<<<<<<<
>>>>>>>>>      CONTROLLED ERROR EXIT      <<<<<<<<<
```

```
C:\Sesame\Data> hvproc0_1 window.file parameter.file output.file defaults.file
 WARNING
 output file already  exists: it will be overwritten
output.file

 WARNING : NO instrument correction provided in the current software version
>>>>>>>>> WARNING MESSAGES HAVE BEEN ISSUED <<<<<<<<<
>>>>>>>>> WARNING MESSAGES HAVE BEEN ISSUED <<<<<<<<<
>>>>>>>>> WARNING MESSAGES HAVE BEEN ISSUED <<<<<<<<<
>>>>>>>>> WARNING MESSAGES HAVE BEEN ISSUED <<<<<<<<<
```

```
C:\Sesame\Data> hvproc0_1 window.file parameter.file output.file defaults.file
>>>>>>>>>          O.K.          <<<<<<<<<
>>>>>>>>>          O.K.          <<<<<<<<<
>>>>>>>>>          O.K.          <<<<<<<<<
>>>>>>>>>          O.K.          <<<<<<<<<
```

→ Problem with Macintosh about reading the command line arguments

V.1.1 Platform

- 2 routines (up to now) are machine or compiler dependent
- successfully compiled and run on :
  - Windows with Compaq Visual Fortran compiler and Microsoft PowerStation compiler (but this compilers are already compatible)
  - Linux g77
  - Sun → INGV
  - Digital (Digital Fortran compiler)
  - No HP
- Some minor problems with Macintosh

V.1.2 To be implemented

- Conform the program to the decided standard
- Dimensioning : now
  - Max. time history number of samples

- Max. time window number of samples
- Max. number of windows

Then → *dynamical* dimension

- Uniform coding and improve efficiency
- Handbook (user manual)
- Some routines are taken from public domain software (i.e. FFT, GSE driver)

V.1.3 Options of the HVPROC

,,,

possible options for frequency spacing are:

```
syntax: freq_spacing:<type>[:<arg1>:<arg2>:<arg3>]
      type     arg1      arg2  arg3
      fft        -  -      -      (1)
      fft_red  f_min   f_max     -
      linear   f_min   f_max    # points (2)
      log      f_min   f_max    # points (2)
```

(1) FFT does not require 2^N points in order to always have df=1/window_length
(2) IF f_min < df : f_min = df

```
IF f_max > F_Nyquist : f_max = F_Nyquist
```

,,,

possible options for offset removal are:

```
syntax: offset_rem:<type>[:<arg>]
# type:
# no
# r_mean all [win]
# high-pass: frequency
# band-pass: f1 f2
#
# offset_rem:r_mean:all
# offset_rem:r_mean:win
offset_rem:band-pass:1:10
```

- Offset removal, high pass filter and band pass filtering is performed on the entire record.
- Here it is decided that there will be one more option (mean only on the all windows separately)

,,,

tapering

```
syntax:
 taper:<type>:[<arg1>]
      type   arg1
      boxcar -
      cos    percentage : percentage of the window that is affected by the tapering on both
ends
```

- Hanning (hann)

,,,

instrument correction

```
syntax:
 instrument_resp:<arg>
 where arg is either 'yes' or 'no'
```

- instrument correction cannot be performed (this is due to the fact that the decision on the SAF format excluded this possibility) and therefore this option will not be implemented.

,,,

merging of horizontal components

```
syntax:
 merge_type:<type>

 type
 arithmetic  (H_ew+H_ns)/2
```

```
 geometric   sqrt(H_ew*H_ns)
 quadratic   sqrt((H_ew^2+H_ns^2)/2)
```

- complex merging to be added later

,,

output of single components

```
syntax:
 single_component:<arg>

 arg: 'yes' or 'no'
```

- If yes is selected, the output file will contain the columns frequency, average H/V, error, average H_ns/V, error, average H_ew/V, error
- If no is selected, the output file will contain only the columns frequency, average H/V, error

This option was proposed with the purpose of having a simpler and smaller output files, but we have decided not to implement this.

,,

average of the H/V ratios of the single windows

```
syntax:
 average_type:<type>
 type: log
```

No options here, only log

,,

output of single window information

```
syntax:
 single_win_out:<arg>

 arg is either 'yes' or 'no'
```

In case of 'yes', for each time window a separate output file is created. The name of the file is the base output file name extended by '_win_###', ### indicating the number of the time window in the sequence of file#2. Each file contains the following columns:

frequency, merged H/V, H/V ns, H/V ew, spectrum vertical, spectrum NS, spectrum EW

,,

smoothing section

```
syntax:
 smooth:<type>:[<arg1>[:<arg2>]]

type    arg1     arg2
none      -        -
linear bandwidth box : linear smoothing with constant weight in the interval  [f-bw/2 f+bw/2]
linear bandwidth tri : linear smoothing with triangular weight in the interval [f-bw/2 f+bw/2]
log percentage   box   : smoothing with constant weight in an interval [f/(1+p/100) f*(1+p/100)]
log percentage   tri   : smoothing with triangular weight in an interval [f/(1+p/100) f*(1+p/100)]
konno-ohmachi bandwidth : bandwidth for the smoothing window (see reference)
```

- As pointed out by the tester, I did not properly considered the case when the smoothing bandwidth is shorter than df. (results are unstable or the program even crashes)
- When smooth:none and freq_spacing is not fft, the spectrum values are linearly interpolated.
- When the smoothing window requires values of the raw spectrum outside the range 0-F_Nyquist, then the smoothed spectrum will be restricted to the significant frequency interval.
- The smoothed spectrum is not *normalised*

,,

VI Display Module

The status of the 'Display Module' was summarized by the ICTE/UL Lisbon group. During the preparations interactions were made with groups working on the main processing module to coordinate the data input and output. The preliminary version of the display modules were developed as agreed on the Potsdam meeting and presented. The developments were done in Java code. In the following, summary of the suggestions made during the meeting, as well as the snapshots of the different graphical displays are given. In addition, a preliminary version of the user guidelines is given in the Appendix E.

Summary of the implementations that are either done or will be done before the January 2003 deadline:

- In the output window (1a) the title used will be the name of the output file
- In the output window (1a) we should show all processing parameters present in the parameter file
- In the time series window (2) we should include the start time
- Place a button in all of the windows to open the HTML version of the manual (will be in the browser, will be a general HTML)
- Possibility (by pressing a button) to show the header of the input file (will be implemented in the browser)
- Show a legend with the meaning of each of the curves
- It should be possible to change the settings of each chart. The settings include:
  - The colours
  - The line patterns and thickness
  - Showing (or not) the chart gridlines
  - Showing (or not) box axis
  - The font properties of the various fonts
  - Which curves to show
- The windows should be resizable
- Double click the axis to define the interval, the max and the min values

Options that are being implemented:

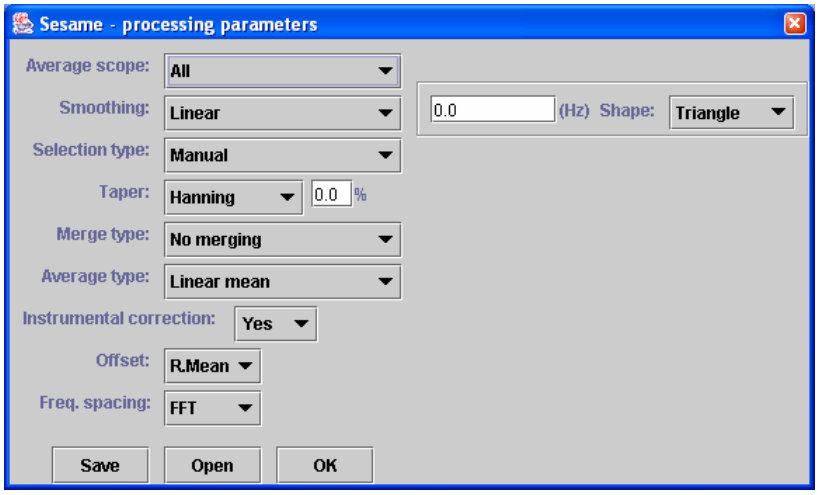
- User option to change between logarithmic and linear scales. The user will also be able to change the limits in the scale
- Possibility to show the wave graphics using a common vertical scale or one scale for each component (2). This will be accomplished using a check box which will link/unlink the scales

New suggestions in Rome:

- Save all graphical print-outs in 'jpeg' and 'postscript' formats
- Select the series that you want to represent in each graph
- Optional choices of graph displays among the three standard windows
- Modification on the Plot window #2 (see figure 1b below): add a third plot showing the mean-H/V curve together with the NS/V and EW/V curves without the st.dev.
- Option of displaying the absolute amplitude spectra of a single entire time series (one component of a waveform file) in the browser.
- Possibility of selecting two independent points on a given H/V curve and finding the difference between these points in terms of both the frequency and the amplitude [i.e. freq.(point #1 – point #2) and amp.(point #1 – point #2)]
- Set up program and installation instructions
- The three standard

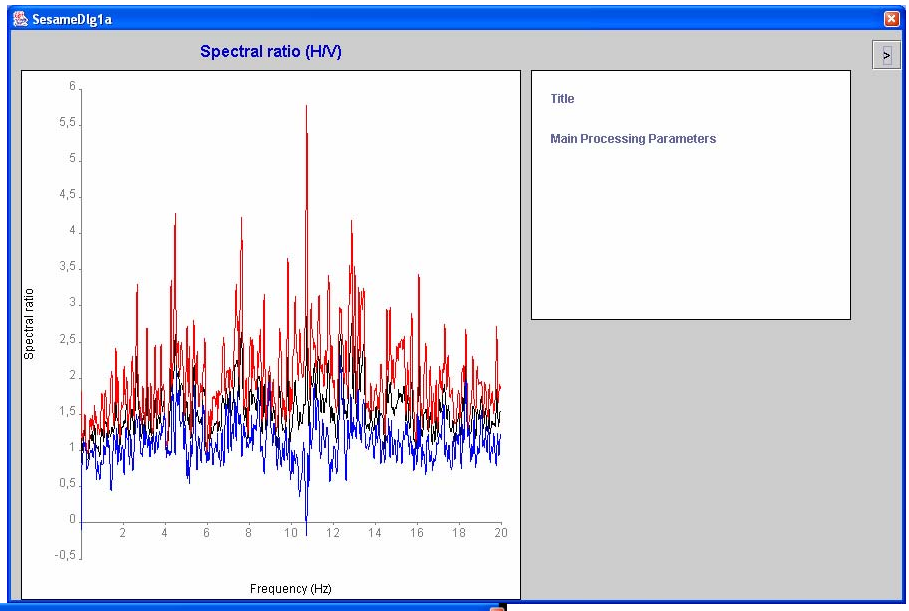
VI.1 Snapshots of the Display Module:

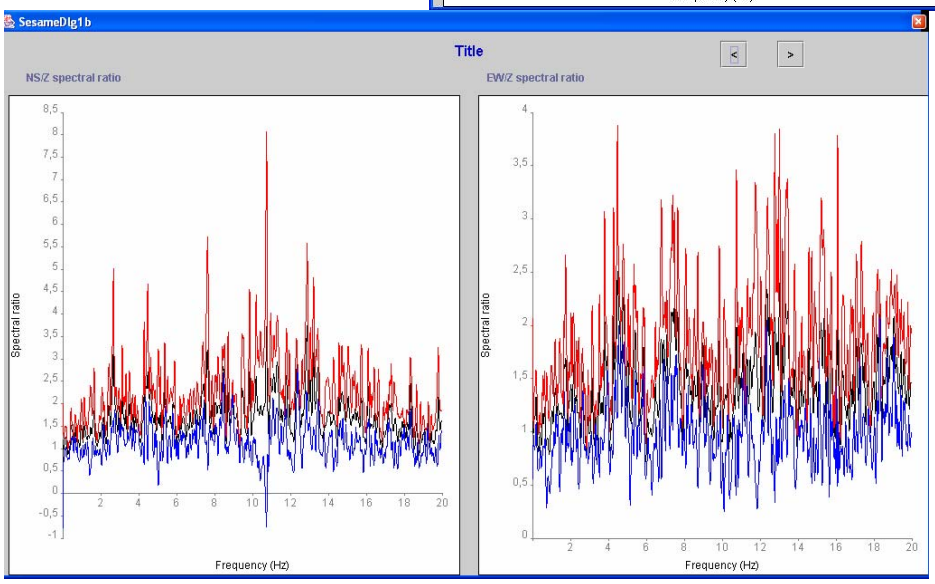
Parameters window

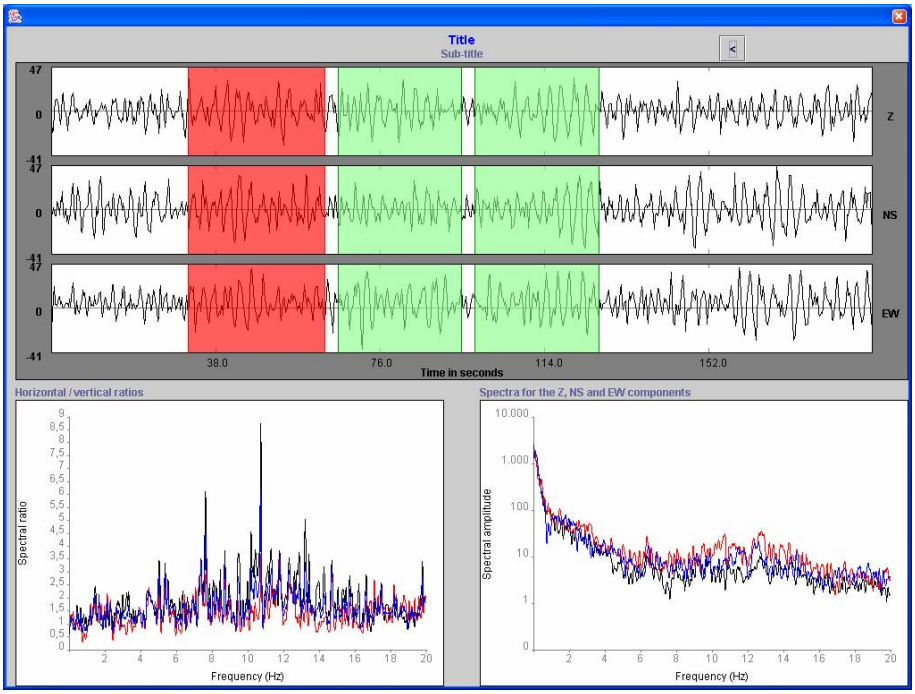


This window is being discussed by the three development teams as to which parameters should be used, the default values to be used in each case, as well as the limits of each parameter.

Graphics windows







VII Appendixes

VII.1 Appendix A: window file

\Data\12311021.cts 80001 84000 3
..\Data\12311021.cts 81001 85000 3
.\Data\12311021.cts 82001 86000 3

..\Data\12311021.saf 104001 108000 2
..\Data\12311021.saf 105001 109000 2
..\Data\12311021.saf 106001 110000 2
..\Data\12311021.saf 107001 111000 2
..\Data\12311021.saf 108001 112000 2

..\Data\12311021.gse 130001 134000 1 EHZ EHN EHE TST
..\Data\12311021.gse 131001 135000 1 EHZ EHN EHE TST
..\Data\12311021.gse 132001 136000 1 EHZ EHN EHE TST

- time histories must have the same sampling rate (otherwise → controlled exit)
- window length is allowed to be variable (it is not recommended), the actual window length for FFT is set to the max. (shorter windows are padded)
- uncorrected specified window limits cause a controlled exit of the program

- window limits in seconds
- file with only one horizontal component → duplication of the available horizontal component by the user is required
- instrument correction cannot be performed (no information in SAF file)
- Cityshark header could change

VII.2 Appendix B: Parameters file

```
Beginning of the file

Anything
# lines starting with # character are comments
# KEWORD:type:value_1:value_2

### section processing

freq_spacing:log:0.1:25:800
```

```
offset_rem:high-pass:0.02

taper:cos:5

# instrument correction is not available
instrument_resp:no

smooth:konno-ohmachi:20

merge_type: geometric

single_component:no

average_type:log

single_win_out:no

### end processing
```

Outside the ### some further options not related to the processing may be added.

VII.3 Appendix C: Output file

```
### data used in the H/V ratio processing:
 # ../Data/12311021.cts          80001        84000
 # ../Data/12311021.cts          81001        85000
 # ../Data/12311021.cts          82001        86000
 # ../Data/12311021.cts          83001        87000
 # ../Data/12311021.cts          84001        88000
 # ../Data/12311021.cts          85001        89000
 #
 # parameters actually used in the processing
 ### section processing
 # freq_spacing:log:0.1:25:800
 # offset_rem:high-pass:0.02
 # taper:cos:5
 # instrument_resp:no
 # smooth:konno-ohmachi:20
 # merge_type: geometric
 # single_component:no
 # average_type:log
 # single_win_out:no
 ### end processing
 #------------------------------
 # n_windows:     67
 # n_freq_samples:    800
#  freq   av_HV   ns_HV   ew_HV  av_HV_logstd  ns_HV_logstd ew_HV_logstd
0.1000000   2.166863  2.156196 2.177583 1.825516      1.930187     1.985633
0.1006934   2.156689  2.144270 2.169179 1.811655      1.915399     1.969796
```

- Columns separated will not be separated by <tab>

VII.4 Appendix D: Output.file_win_xxx

```
### window used in the H/V ratio processing:
 # ..\Data\12311021.gse        129001       133000 EHZ EHN EHE
 #
 # parameters actually used in the processing:
 ### section processing
 # freq_spacing:log:0.1:25:800
 # offset_rem:high-pass:0.02
 # taper:cos:5
 # instrument_resp:no
```

```
# smooth:konno-ohmachi:20
# merge_type: geometric
# single_component:no
# average_type:log
# single_win_out:yes
### end processing
#------------------------------
# n_freq_samples:    800
#   freq : specvert :  spec-ns :  spec-ew : mergedHV :    ns_HV :    ew_H
0.1000000  5468.083    2964.309   6106.855  0.7781001    0.5421113   1.116818
0.1006934  5508.878    2938.143   6141.929  0.7711266
```

- Meaning of spec-xx (no instrument correction). Please remember that the time-series is not corrected

VII.5 Appendix E: SESAME H/V Software Display Module User Guideline

In the following document a brief (preliminary) explanation is given about the help functions and the guideline of the 'Display Module' of the SESAME H/V Software. The complete documentation of the guidelines will be provided when the development is finalized.

Zoom In
To zoom in on a spectrum representation you should press the left mouse button and drag it to select the area that you want. When you release the mouse button the chart will represent the area you selected.

If there are multiple linked charts – for example, the spectra for the NS, EW and Z components – all charts will zoom to the same region at the same time.

Zoom Out
When you want to view the entire spectrum in the chart window just click the left mouse button on the chart. The chart will represent the entire spectrum.

Selecting a window
Windows are represented as light green rectangles. When they are selected they change to dark pink rectangles.
To select a window just click the right mouse button over it.

Picking sample points
To know the value of a point just click over it with the center mouse button. The point will be marked with a yellow circle, and its coordinates are on the right.
If the point isn't the one you where trying to select use the arrow keys (left and right) to scroll the circle to the point you are looking for.
When you have selected the point you want you can record it's coordinates by pressing the enter key. When you close (or change) the window you will be prompted for the file name where you want your sample points stored.

7. General SESAME mid-project meeting

Rome (Italy), 25-26 October 2002

In addition to "get-together" of all partners at mid-project, the objectives were:

- to review the work done since the beginning of the project,
- to have a global view of the project for every partner,
- to have interactions between different tasks and WP,
- to exchange viewpoints about several issues and partial decisions,
- to recall the main objectives of each task and work packages,
- to prepare the future of the project.

The present minutes can not keep track of the richness of all the discussions that occurred during the meeting; their aim is basically to indicate all the decisions that were taken and are to be implemented by the corresponding task leaders, work package leaders and partners.

I Partners attending the meeting

All partners were present to the meeting (**Table 1)**.

TABLE 1 : List of the persons attending the mid-plenary meeting in Rome

Partners	Name of the person
1	Pierre-Yves Bard
1	Sylvette Bonnefoy
1	Laurence Bourjot
1	Fabrice Cotton
1	Jean-Luc Chatelain
1	Bertrand Guillier
2	Martin Koller
3	Matthias Ohrnberger
3	Frank Scherbaum
4	Denis Jongmans
4	Marc Wathelet
5	Kuvvet Atakan
5	Bladimir Moreno
6	Cécile Cornou
6	Donat Faeh
7	Nikos Theodulidis
8	Pedro Roquette
8	Paula Teves-Costa
9	Riccardo Azzara
9	Fabrizio Cara
9	Giovanna Cultrera
9	Giuseppe di Giulio
9	Antonio Rovelli
	Rosalba Maresca *
10	Alberto Marcellini
10	Marco Pagani
10	Alberto Tento
11	Josef Kristek
11	Miriam Kristekova
11	Peter Moczo
12	Anne-Marie Duval

* from the Università del Sannio-Benevento - Italy

II Schedule of the meeting

See appended file "Rome schedule"

III Scientific matters

III.1 Task A – H/V Technique

The whole morning was dedicated to Task A - H/V technique. It started with an overview presentation by K. Atakan, which was followed by more detailed presentations of each work package by A.-M. Duval (WP02: Experimental aspects, measurements and stability), K. Atakan (WP03: Data processing) and N. Theodulidis (WP04: Experimental evaluation).

III.1.1 WP02 (Experimental conditions : A-M Duval)

This workpackage is dedicated to investigations on the required experimental conditions for warranting the stability and reproduction of measurements. The work is divided in two parts.

1. **Instrumental specification:** instrument calibration and, testing and comparisons of the instruments that are used in the project were completed following the workshop in Bergen in October 2001. A report on "Controlled instrumental specifications" corresponding to Deliverable D01.02 has been written. These results are useful for the calibration of instruments and they have to be published but we first have to answer the following question: "Can the instruments tested be named or not in the paper?".
2. **Experimental conditions**: assessment of the effects on the experimental conditions is ongoing and a large number of tests are already performed. For different reasons explained in the minutes of the "WP04 Rome meeting", the work has taken more time than foreseen and there is some delay in the progress of WP02. The deliverable D08.02 "Measurement guidelines" will not be finished for month 18 as foreseen and Anne-Marie asked for an extension of six months to finish this work package.

The following decisions were taken, and several issues were identified to be thought about:

- ***Instrumental specification:***

A first draft of a paper will be written without naming the instruments but detailing their specifications. Pierre-Yves will ask for advices to the EC, and with Kuvvet, they will prepare a letter to be sent to the manufacturers giving the results of the tests for their instruments.

- ***Experimental conditions****:*

In the third progress report sent to the EC at the beginning of December, we will inform Brussels about a 6 months delay for the deliverable D08.02. (for month 24 – April 2003).
The next work meeting is scheduled in Nice ***(April 7-11th,2003)****, during the EGS meeting.*
Reminde*r → think about the end user of H/V (f0, amplitude, ellipticity…) whenever possible, while writing the conclusions of this work.*

WP02 with D08.02 **will be finished for April 2003**

III.1.2 WP03 (Data processing, K. Atakan)

This WP is devoted to investigations on the various data processing alternatives and is intended to produce a standard processing software based on the most robust alternative.

- Existing algorithms for each processing step were collected.
- The best (robustness-simplicity-resolution) solution for processing has been found based on comparisons with representative data sets
- The design and implementation of the software has been done by a dedicated sub-group (UiB, Bergen).
- Now, the software is distributed for evaluation (WP04) and review within the consortium.
- A final version of the software with user guidelines will be available at the end of the project (WP12).

The following decisions were taken, and several issues were identified to be thought about::

- *The deliverable D09.03 "multi-platform H/V processing software" will be finished on time (month 21-Jannuary 2003). A first working version will be available within 3 weeks.* ***No further change will be done/accepted in the software after the Rome meeting for the January version.***
- *On a later version of the software, it will be possible to consider improvements, and in particular on the aspect of filtering on raw time histories.*
- *The next work meeting (with WP04) is scheduled in Thessaloniki (****June 12-13th,2003****).*
- *Within Task D, a detailed user manual will be written for this software. Also, within report D09.03, there will be only a short description of the various modules.*

WP03 with D09.03 **will be finished for April 2003**

III.1.3 WP04 (Empirical evaluation, N. Theodulidis)

This WP is intended to evaluate and compare (using the software developed in WP03) the H/V ratios with other more reliable estimates (reference site). It will also compare H/V results with observed damage on recent earthquakes. The work is carried out in different stages:

- **Data set**: - existing data sets (earthquake and noise) have already been collected, but additional data (outside of Europe) are going to enrich the database, and experimental measurements and processing of ambient vibrations at a few selected sites have been performed, but possible seasonal variation of noise level forced some partners to repeat noise measurements in certain sites. For these reasons, the work tookmore time than foreseen and there is some delay for the deliverable D04.04 "Homogeneous data set of noise and earthquake recordings at many site". Nikos asked for an extension of four months to finish the deliverable.
- Systematic comparisons of standardized H/V noise ratio with weak- and strong-motion data as well as damage distribution in urban areas is in progress. The comparison with macroseimic data will be performed for the cities of Kalamata, Thessaloniki, Roma, Palermo, Fabriano, and possibly the Azores (Horta-Angra).
- Comparing experimentally and theoretically estimated transfer functions with H/V ratios on very well constrained sites has still to be done.

The following decisions were taken, and several issues were identified to be thought about::

- ***Data set***

In the third progress report sent to the EC, we will inform Brussels about ***a 4 months delay for the deliverable D04.04. (for month 20 – December 2002).***
ITSAK has proposed to organize the whole ***data base*** *(this was not included in the contract, which was only considering a* ***data set****). In that objective, all teams are asked to send, in addition to the actual data, a summary table of events with their localization and an indication on which stations have recorded those events.*
The whole data base will be delivered as several CD-ROM's, which will be fully available for all project partners, but not yet delivered outside the consortium.

- ***Data Processing and Overall comparison***

  - H/V on noise vs Site/reference spectral ratios on Earthquake recording : each team is asked to process his own noise data set with the SESAME H/V software, and with the standard parameters; the homogeneized processing of earthquake recordings and derivation of site to reference spectral ratios will be performed at LGIT by a PhD student, E. Haghshenas.
  - Noise H/V vs Damage observations: each team is asked to process his own noise data set with the SESAME H/V software, and with the standard parameters; each team wil also perform a preliminary comparison with damage data as he feels it: there is not yet any standardized procedure for such a comparison; which will have to be discussed in the next WP04 meeting.

- *The next work meeting (with WP03) is scheduled in Thessaloniki (****June 12-13th,2003****).*

The deliverable D04.04 will be finished in January 2003

III.2 Task B – Array measurement techniques

F. Scherbaum presented first an overview of Task B (Array measurement techniques). It was followed by more detailed presentations of each work package by M. Ohrnberger (WP05: Instrumental layout for array measurements; and WP06; Derivation of dispersion curves) and M. Wathelet (WP07: Inversion of velocity profile).

III.2.1 WP05 (Instrumental layout) and WP06 (Derivation of dispersion curves) – M Ohrnberger

Within the context of WP05 the dependence of the array performance (for phase velocity determination) on the experimental conditions (array geometry, aperture, number of sensors, sensor types, timing accuracy) shall be assessed. The input needed for this task are:

- existing array measurement data sets from within the consortium,
- array measurements performed at well known test sites within the consortium,

- the relative calibration of instruments with respect to a broadband sensor (phase response)
- computer codes for the calculation of the array transfer functions.

WP06 aims at developing a semi-automatic processing system for array analysis of ambient vibrations, based on frequency-wave number and spatial auto-correlation methods. Besides providing all the necessary facilities to obtain dispersion curves, the system should allow for rapid in-situ quality control of the array performance.

The discussions emphasized several issues:

- there is an essential need for both pre processing and post processing of the data. Wavelet extraction techniques, as well as MUSIC like techniques coupled with polarization analysis, should be tried in order to help the selection of the windows to be analysed.
- It is also essential to look for any way to extend the upper period limit on estimated dispersion curves. This limit is not only controlled by the array aperture and/or instrumental limitations, but may also be partially controlled by the generation mechanism of surface waves (which implies some tight connections with Task C / Noise simulation). This also emphasizes the need for including as soon as possible the processing of Horizontal components.

The following decisions were taken:

- *The next work meeting is scheduled in Postdam (**February 3-14th, 2003**).*
- *There is no problem with the deadlines and the deliverables will be finished on time.*

WP 05 with D06.05 and D07.05 **will be finished for April 2003**

The deliverable D05.06 and D15.06 will be finished for April 2003

III.2.2 WP07 (Inversion of velocity profile – M. Wathelet)

The objective of this WP is the development of a flexible software allowing to retrieve the Vp and Vs velocity profiles from the dispersion curves in an easy and reliable way. A particular attention will be paid to the introduction of a priori information which can greatly help to constrain the model during the inversion process.

Up to now, the work mainly focused on the two following topics: improvements of the forward calculations and test on synthetic dispersion curves. During the next months, they will work on the introduction of the various a priori Vp profile. Before application to real cases they have to develop a flexible way of defining the parameters of the layered model. As the inversion is performed by several runs of the same algorithm with different random seeds, the automatic estimation the global convergence is still under study.

The discussions emphasized the following points:

- It is recommended to investigate the sensitivity of the inversion process and of the results reliability on the upper period limit of the dispersion curve
- Amongst the "a priori information" to help constraining the inversion, the fundamental frequency, the ellipticity (i.e., H/V ratio) should be paid special attention.
- the variability of the inverted velocity profiles should be considered together with the resulting variability on the corresponding transfer functions.

The following decisions were taken:

- *There is no problem with the deadlines and the deliverables will be finished on time.*

The deliverable D14.07 will be finished for April 2003

The perspective regarding the interrelationship between the different WPs in Task B has considerably changed over the course of the project. Within the proposal, the links between the individual Wps were rather weak. One important lesson which we have already learned and which deserves to be mentioned is that there is not a single best deployment strategy which only depends on one single aspect, e. g. the array geometry or parture. As a consequence, the issues in the individual Wps become much more dependent on each other. For this reason, the work done in work packages 5 and 6 are so closely connected, that it is nearly impossible to allow separate work. It is the same with WP07 and also between Task B and Task C.

There must be more interactions between Task B and Task C

III.3 Task C – Physical background and noise simulation

At first, P.Y Bard gave a rapid overview of Task C. It was followed by more detailed presentation by S. Bonnefoy (WP08: Nature of noise wavefield), P. Moczo (WP09: Numerical simulation of seismic noise) and D. Faëh (WP10: Simulation for real sites)

III.3.1 WP08 [Nature of noise wavefield, P.-Y. Bard]

Its basic objective is to clarify – and as much as possible to improve - our knowledge about the physical nature of a noise wavefield, with special emphasis on urban areas.

Up to now, the work focused on the literature survey and the next step will be to analyse array data from test sites in the light of numerical modelling and tests in Task B.

The following decisions were taken, and several issues were identified to be thought about::

- *The literature survey has to be completed by Russian papers as already outlined during the kick-off meeting. Sylvette has to see this point with Pierre-Yves and Peter.*
- *A compilation of the whole list of references uses in the literature survey, followed by a synthesis has to be done for the beginning of year 2003.*
- *there is a need to look for borehole data (INGV + Ferrara, if possible; Netherlands; Lennartz; see also the ICC data from Barcelona boreholes)*
- *There is no problem with the deadlines and the deliverable will be finished on time (D13.08 – "Report on the nature of noise" for April 2003)*
- *The next work meeting (general Task C meeting) is scheduled in Bratislava (January 7-8 or 9-11^{h},* ***2003- postponed for February 20-21****).*

WP08 with D13.08 **will be finished for April 2003**

III.3.2 WP09 [Numerical simulation of seismic noise, P. Moczo]

This WP focuses on the development and validation of numerical models producing realistic noise synthetics. It will mainly use Finite-Difference techniques (FD) with spatially and temporally random surface sources, and include parameter studies to investigate the ability of H/V and array techniques, applied on synthetics, to recover the information on the structure.

Decisions/issues took for this work package are presented together with WP10.

III.3.3 WP10 [Simulation for real sites, D. Faëh]

This WP is an extension of the previous one to real sites, where, in addition to the good knowledge of the structure, field measurements are already or will be available. It will thus allow a final cross-checking between actual noise observations, noise synthetics from numerical simulations, and the known geological structure and local site effects.
The discussion focused on several issues:

- ? May the velocity profile smoothing included in the FD modelling induce some bias in the H/V curve ? In order to check that issue, Donat will compute ellipticity curves for "equivalent FD" velocity profiles.
- What is the origin of the numerical instabilities in FD code ? It might be due to the large number of close sources, but it is not sure. In order to check that issue, it was agreed to perform simulations with 3 different computer codes (Dinite Difference, Modal Summation, and Discrete WaveNumber / Hisada version, for an M2 like model to be chosen by Peter and Donat, and 2 source configurations (1 single source, and many simultaneous sources).
- What is the recommended choice of source characteristics?
    - The depth appears as a very important parameter. Surface sources (located between surface and h/4 depth) provide better simulation results as unrealistic High Frequency components appear

on the simulated H/V curves for deeper sources). This issue will be once more checked by Cécile with additional computations on M2 model, with sources from the surface down to large depth.

- Density and location of sources (inside / outside the receiver arrays): although preliminary computations seem to show it is not so important and that one choice might be a constant number of acting sources, Donat prefers to allocate some time for further checks, considering in particular the shape of H/V for very close acting sources: Cécile will perform 4 additional tests with sources at varying positions with respect to the receiver array.
- The time function does not seem very important; the recommended proportion between pulse-like and monochromatic-like sources is 50% - 50%.
- How to decide whether a simulated noise is acceptable or not? The best criteria seem to be a) the shape of the H/V curve (single peak, low frequency only…), and b) the correlation map as a function of distance and frequency: it is therefore recommended to look at these maps for the 5 sites instrumented with arrays by Frank and Matthias.

See the Minutes of the specialized Task C meeting for more details.

The following decisions were taken:

- *There is some concern about the deadlines for deliverables (D12.09 and D11.10) to be finished, in principle, for April 2003: the origin of that concern is the very heavy computational time required.*
- *The next work meeting (general Task C meeting) is scheduled in Bratislava (the date January 7-8 or 9-11^{h}, 2003 has been later postponed to **February 20-21, 2003**).*

WP09 with D12.09 **might have to be extended beyond April 2003**

The deliverable D11.10 will probably not be finished for April 2003

III.4 Task D – Practical implementation and guidelines (M. Koller and D. Jongmans)

Task D is devoted to the dissemination and implementation of the scientific results. It is composed of the following three work-packages:

– WP11: Scientific outcomes,

– WP12: H/V user guidelines,

– WP 13: Recommendations for quality array measurements and processing.

The scientific outcomes will be disseminated in three steps.

- First, seven months before the end of the project, a three day workshop will be held in Smolenice, near Bratislava in September 2003 to exchange the results within the project team; a few observers not being involved in the project will be invited and asked to add constructive critics.
- Second, a special issue of an international journal or a monograph will be prepared that presents the project achievements.
- Finally, a special theme session on the project outcomes will be organised at the 13th World Conference on Earthquake Engineering in Vancouver in August 2004, three months after the so far scheduled end of the project.

This WP has already began with the different papers and presentations done by all the partners since the beginning of the project, but every partner has to keep in mind that this Task D can only be performed if the others Tasks are finished.

One has also to think about the idea proposed by Martin in the kick-off meeting, i.e., to agree on a "glossary of words and expressions to be used, so as to also "standardize" the vocabulary and better understand each other. It should be discussed in the Smolenice (near Bratislava) internal workshop.

IV Administrative and Financial Matters

IV.1 Financial follow-up

A first financial report with all the cost statements was sent to the EC in June 2002, on time.
The EC started the procedure for the second payment, only at the end of September and the University of Joseph Fourier received the money during our meeting in Rome.
The University have done the payments to each partner on Friday 25th October.

The next financial report is for May 2003. Laurence will ask each partner to complete their expenses table at the end of January 2003 and then at the end of April 2003. Thank you to be on time

IV.2 Time sheet follow-up

Just to remind you: each person working on the project SESAME has to be registered.
Please when a new person (student, technician, researcher…) is working on the project SESAME, do not forget to inform Laurence, even if this person is not paid by the project.

IV.3 Progress and/or management reports

On 6-monthly intervals from the project's starting date, the project provide the Commission services with a short management report, outlining the practical information of the project in accordance with the time schedule indicated in the project proposal.
A first management report was sent to the EC in November 2001, a second one in June 2002 (with the first annual report) and a third one will be sent at the end of December 2002.

The next progress/management report is for May 2003. It will be the second annual report. This report will include:
- a financial report (as mentioned in point IV.1),
- a scientific report describing in details the scientific progress and results of each work package,
- the following deliverables (D08.02, D09.03, D11.10, D12.09, D13.08, D14.07, D15.03),
- a management report.

Laurence will inform each partner, at the beginning of April 2003, on what they have to do for this report.

IV.4 Logo

Attention: some of you don't use the right logo on their presentation. See the first page of the minutes to have a look on the SESAME logo chosen by the partners.

IV.5 Website

Laurence, with Philippe, will put all the last reports, presentations, deliverables on the Website.

IV.6 Miscellaneous

The **table,** page 17 is a summary of all the important Dates (Task meeting, General meeting, Workshop,...)

V Other important points

V.1 Smolenice workshop (near Bratislava)

The workshop in Smolenice is maintained on the first date: **22-24 September 2003**

At the beginning, it was decided that this workshop would be open to persons not working in the project. After a general discussion, all the partners agreed with the fact that in September 2003, the scientific results of the

project will not be enough analysed, discussed, in between the partners of the project, to be presented to exterior people. Furthermore, a workshop open to everyone could be a barrier for a productive discussion.

It was decided that only few observers, not being involved in the project, will be invited and asked to add constructive critics. In particular, persons who will be able to use the H/V techniques process in the project, have to participate to this workshop in order to make some tests.

It is asked to all partners to propose few names of observers and of potential users (from developing countries, if possible) and to sent their proposition to Laurence. Also everyone is strongly invited to look for some additional funding to invite those persons.

V.2 FP6 and SESAME continuation

The presentations made in various conferences and meetings did show the interest for the SESAME project, its preliminary results and its anticipated outcomes, especially in "third world countries". We think a continuation would be very welcome in 2004: the consortium would very much like to have a follow-up project.
Several directions were proposed, amongst which quasi-real time in-situ array analysis, investigations on urban noise and ambient vibrations in any environment (soil / structure), strong motion observations at well investigated sites, practical use for microzonation, NL behavior. Some of them may be included in the proposals presently under building under ongoing FP6 calls, but unfortunately, it is not possible to keep the same consortium given the new FP6 structure, especially for "NoE". These "follow-up" issues will be of major importance in next general meetings, which will be the Smolenice (near Bratislava) scientific workshop, and the Nice end meeting in April 2004 (followed, hopefully, by the Special Session at 13WCEE, Vancouver, in August 2004)

Communications to International conferences

1. III Coloquio sobre Microzonification Sismica in Caracas (Venezuela), July 2002

For the two talks gave by Pierre-Yves Bard during this conferences, no abstract is available, but the presentations itself can be asked to P.-Y. Bard.

2. *European Seismological Commission* in Genova (Italy), September 2002

SITE EFFECTS IN URBAN AREAS

P.-Y. Bard

LGIT/LCPC, BP 53, 38041 Grenoble Cedex - France

The XXth century, and especially its second half, has been characterized by an unprecedented urbanization process, not always well controlled. Unfortunately, good sites for settlements and dense urbanization (with easy communication and transportation facilities) are often not as good as to their seismic response: they are often located along river valleys, along the coast, or within flat sedimentary basins. As a consequence, the risk is increasing in urban areas, and the damage is partially (sometimes totally) controlled by site conditions, as repeatedly illustrated in almost all recent destructive earthquakes. The presentation will therefore focus on two issues : a) how to estimate site effects in urban areas ? b) are there specific "urban" site effects ?

Estimating site effects in urban areas faces two specific difficulties: while there often exist a significant amount of shallow geotechnical information, it is still rarely well archived and available, and direct S-wave velocity measurements are very rare, and often impossible for thick sediment sites (use of explosives is generally forbidden, oil-industry type exploration methods using trucks exceed the available budgets): site response computations are therefore based on very fuzzy information and their results are highly uncertain. On the other side, obtaining direct site-specific earthquake recordings is hampered by the high-noise level, especially in moderate seismicity areas. The recent results that will be presented try to overcome these difficulties and provide a better control on numerical computations:

- on one hand, ambient seismic noise itself can be used to derive some information on the site conditions and/or directly on response. It may also be misused or overused ! The latest results obtained within the framework of the EC SESAME project, addressing both the H/V "Nogoshi – Nakamura's" technique, and the noise array measurements, will be discussed.
- on the other hand, despite the heavy trend to rely more and more on computations, some recent examples from Grenoble and Tehran, will be given to illustrate how interesting, meaningful, and sometimes unexpecetd results may be obtained even in moderate/low seismicity areas with long seismological experiments.

Then, the issue about the existence of specific urban effects will then be (partially) answered with results from a series of field and centrifuge experiments, and numerical modelling as well, showing that the seismic wavefield may be very significantly modified by dense urbanization in some specific conditions. The basic phenomenon leading to such modifications is a combination of wave radiation from buildings due to soil-structure interaction, and wave trapping due to shallow impedance contrast. The ground motion amplitude resulting from this "secondary" diffracted wave field may be comparable to the direct "free-field" one, when the building and soils have comparable resonant frequencies. Such situations are found in Mexico City, but also in more common cities such as Nice, or possibly Grenoble, and might be one explanation for the frequent observations of apparently erratic damage in groups of similar buildings.

INFLUENCE OF INSTRUMENTS ON H/V SPECTRA OF AMBIENT NOISE

B. Guillier (1), K. Atakan (2), A-M. Duval (3), M. Ohrnberger (4), R. Azzara (5), F. Cara (5), J. Havskov (2), G. Alguacil (6), P. Teves-Costa (7), Nikos Theodulidis (8) and the SESAME Project WP02-Team.

(1) LGIT, Observatoire de Grenoble, BP 53 – 38041 Grenoble Cedex - France, Bertrand.Guillier@bondy.ird.fr (2) UiB, Bergen, Norway, (3) CETE, Nice, France, (4) IGUP, Potsdam, Germany, (5) INGV, Rome, Italy, (6) UG, Granada, Spain, (7) CGUL, Lisbon, Portugal, (8) ITSAK, Thessaloniki, Greece.

Microtremor measurements are commonly used in microzonation studies for hazard assessment and engineering purposes. In this respect a very widely used methodology in recent years is the computation of H/V spectral ratio of ambient excitations. SESAME project aims to investigate the reliability of this technique, both from the experimental and theoretical point of view. The first step is to check the stability and reproducibility of the measurements. Before testing the experimental conditions that may influence the H/V ratio, a workshop was devoted to perform a set of tests in order to compare the performance of different equipments currently used (13 digitizers and 15 sensors). All data collected for instrument tests were converted into a common format and processed using a common software for homogeneity. The first set of tests was devoted to analyse the physical

properties of the digitizers (internal noise, time stability, sensitivity, channel consistency) and the minimum noise value able to be recorded for different gains and with different sensors. The second set of tests was dedicated to the sensor analysis. We check the performance of each sensor connected to the same digitizer. The last set of tests consisted of simultaneous measurements of noise by all the systems (digitizer-sensor combinations), performed on a concrete pier coupled directly with the bedrock in the laboratory, as well as outside in the free-field, in two different ground coupling conditions (grass and concrete). The preliminary results indicate that significant differences may occur between the different systems, depending upon the digitizer-sensor combinations. In general, the digitizer tests showed consistency with the manufacturers specifications. However, the combination with different sensors yielded variable results, indicating the importance of the system performance as a whole and the level of sensitivity required for the type of data collected. The sensor tests revealed the importance of the sensitivity required by the input ambient excitations at frequency levels down to 0.1 Hz. Broad-band sensors gave higher resolution at lower frequencies, but they are difficult to implement in a microtremor experiment, due to stability and portability problems. In general, sensors with 1-5 sec period are more suitable for microtremor measurements. The H/V spectral ratios performed on the simultaneous measurements, showed clear limitations on some of the sensor-digitizer combinations.

LOVE'S FORMULA AND H/V RATIOS

P.G. Malischewsky (1) and F. Scherbaum (2)

(1) Institute of Geosciences, Friedrich-Schiller University Jena, Burgweg 11, 07749 Jena, Germany. (2) Institute of Geosciences, University Potsdam, POB 6014415, 14415 Potsdam, Germany.

The analysis of horizontal to vertical component spectral ratios of ambient vibrations (H/V method) is currently one of the most popular methods to study local site effects. These spectral ratios commonly exhibit a distinct peak which is often empirically found to coincide with the fundamental quarter wavelength "resonance frequency" of the transmission response. However, since ambient vibrations consist mostly of surface waves, the relationship between the spectral ratio (ellipticity) peak frequencies and layer parameters is not straightforward. This is true even for a single layer over halfspace. Therefore, approximative formula for such simple situations would be most helpful. In order to get more insight into this kind of problems, the ellipticity of Rayleigh waves is investigated for simple situations with increasing complexity: homogeneous halfspace with stress-free surface, halfspace with impedance surface and layer over halfspace. It is well-known, that only in the first case the ellipticity is independent of frequency, while the other two cases already yield a complicated frequency behaviour. But it is less known that Love (1911) found a very simple approximation for H/V for an incompressible layer over an incompressible halfspace. We have generalized this fascinating simple formula for compressible media and discuss the quality and range of applicability in a wider context.

DERIVATION OF SURFACE WAVE DISPERSION CURVES FROM ARRAY ANALYSIS OF AMBIENT VIBRATIONS

M. Ohrnberger, and F. Scherbaum

Institut für Geowissenschaften, Universität Potsdam, Karl-Liebknecht-Str. 24, 14476 Golm, contact: mao@geo.uni-potsdam.de

The use of ambient vibration measurements for site effect assessment promises to be a low-cost alternative compared to borehole drilling. In recent years, several authors (e.g. Tokimatsu, 1997, Louie, 2001, Kind et al., 2001) have used ambient vibration data recorded with micro-array settings in order to determine the frequency dependence of the phase velocity of surface waves (mostly Rayleigh waves) within the ambient noise wavefield.
In this study we show a comparison of the performance of different array techniques applied to ambient vibration data with special focus on the automatic extraction of dispersion curves in a postprocessing stage. Tests on synthetic data sets are presented in order to demonstrate the capabilities and limitations of standard f-k algorithms (e.g. Kvaerna & Ringdahl, 1986, Capon, 1969) and the SPAC algorithm (Aki, 1957). For algorithms making use of the assumption of a plane wave arrival we find that a preselection of analyzed time windows according to the assumptions made, i.e. the existence of a dominant surface type wave, as well as the incorporation of the narrow-band array transfer function shape are essential for the reliability of the automatically obtained dispersion curves. The performance for real data has been tested for ambient vibration array measurements obtained at several sites in the Lower Rhine Embayment (LRE - Northwestern Germany) where shear wave velocity information has been available from borehole data.

DETERMINATION OF SHALLOW SHEAR WAVE VELOCITY MODELS IN THE LOWER RHINE EMBAYMENT OBTAINED FROM INVERSION OF AMBIENT VIBRATIONS

F. Scherbaum (1), K.-G. Hinzen (2) and M. Ohrnberger (1)

(1) Institut für Geowissenschaften der Universität Potsdam, POB 601553, D-14415 Potsdam, Germany. (2) Abt. für Erdbebengeologie der Universität zu Köln, Vinzenz-Palotti-Str. 26, D-51429 Bergisch Gladbach

We have used both single station and array methods to determine shallow shear velocity site profiles in the vicinity of the city of Cologne/Germany from ambient vibration records. Based on fk-analysis we assume that fundamental mode Rayleigh waves dominate the analysed wavefield in the frequency range of 0.7 - 2.2 Hz. Based on tests with synthetic data believed to represent a

typical situation in the Lower Rhine Embayment, in this frequency range dispersion curves were found to provide stronger constraints towards the absolute values of the velocity-depth model than the H/V spectral ratios (HVSR) interpreted as Rayleigh wave ellipticities. The shape of the HVSR was found to be subject to a strong tradeoff between layer thickness and average layer velocity. We have made use of this observation by combining the inversion schemes for dispersion curves and ellipticities such that the velocity-depth dependence is essentially constrained by the dispersion curves while the layer thickness is constrained by the HVSR. To test this method in practice, we have used array recordings of ambient vibrations from three sites where the subsurface geology is fairly well known and geotechnical information is at least partially available. In order to keep the parameter space as simple as possible we attempted to fit only a single layer over halfspace model. However, owing to earlier studies from the region (Budny, 1984), we assume a power law depth dependence for sediment velocities. For all three sites investigated, the inversion resulted in models for which the shear wave velocity within the sediment layer both in absolute value at the surface and in depth dependence are found to be remarkably similar to the results obtained by Budny (1984) from downhole measurements.

INVESTIGATION ON H/V MICROTREMOR PROCESSING

P. Teves-Costa,[(1)], A. Borges [(1)], D. Vales [(2)], C. Riedel[(3)], J.L. Gaspar [(4),] M.L. Senos[(2)]

[(1)] Centro de Geofísica da Universidade de Lisboa & DF-FCUL, Campo Grande, Edifício C8 – 6º Piso, 1749-016 Lisboa, Portugal; [(2)] Instituto Instituto de Meteorologia, Lisboa, Portugal; [(3)] Institut für Geowissenschaften, Kiel, Germany; [(4)] Centro de Vulcanologia e Avaliação de Riscos Geológicos, Universidade dos Açores, Ponta Delgada, Portugal

The Azores Islands is the Portuguese region which presents larger seismic activity and, consequently, exhibits high seismic risk. About 30 earthquakes, occurred in the last six centuries, produced social and economical important damages. For some selected earthquakes, the analysis of the damage distribution shows an irregular pattern suggesting the existence of site effects. As an attempt to understand the initial cause of these effects, a test-study was performed in a small region of the S. Miguel Island. Microtremor records were collected in 303 points, according to a grid of 50 meters wide, covering three different zones. In each point, a microtremor record was performed, during 5 minutes and with a sampling rate of 8 ms, using a Marslite seismic station with a 3-component Lennartz 1 Hz seismometer. Three different teams participated in this test-study: one from Lisbon University, other from Azores University (which included the collaboration of a researcher from the Kiel University), and the third one from the Institute of Meteorology.
In order to test the reliability of the results the three teams decided to process the data independently but in the same way, in order to estimate the H/V ratio defined according to the Nakamura methodology. The different processing routines gave different results, which forced us to revise all the procedures and to identify the main factors that caused it. These results will contribute for the discussion on the suitable software to be used and developed for microtremor analysis, which will be performed in the aim of the SESAME project (EVG1-CT-2000-00026) that partially financed this test-study.

3. *Forum Katastrophenvorsoge und Gefahrentag* in Postdam (Germany), October 2002

HOW GOOD ARE THE SHEAR WAVE VELOCITY MODELS IN THE LOWER RHINE EMBAYMENT OBTAINED FROM INVERSION OF AMBIENT VIBRATIONS?

Ohrnberger M.[1],F. Scherbaum[1], F. Krüger[1], R. Pelzing[2] and Sh.-K. Reamer[3]

1. Institut für Geowissenschaften, Universität Potsdam, Karl-Liebknecht-Str. 24, D-14476 Golm b. Potsdam. 2. Geologisches Landesamt Nordrhein-Westfalen, De-Greiff-Str. 195, D-47803 Krefeld. 3. Abt. für Erdbebengeologie der Universität zu Köln, Vinzenz-Palotti-Str. 26, D-51429 Bergisch Gladbach. contact: mao@geo.uni-potsdam.de

In a recent study, we have proposed a method to determine shallow shear wave velocity profiles in the Lower Rhine embayment by combined inversion of single station and array measurements of ambient vibrations (Scherbaum et al., 2001, 2002). In order to validate the resulting models, we have performed several tests.
First, we have applied the technique to several sites which have been analyzed by Budny (1984)using an active source. The comparison of the models obtained by inversion of ambient vibrations show a good agreement with the results obtained by Budny (1984).
Furthermore, between fall of 2000 and spring of 2002 we have operated a 5 sec seismometer simultaneously to the borehole recording at station PLH of the Geological Survey of NRW to obtain wide band recordings of earthquakes from the region. The largest recorded event (Ml=4.1) enabled us to calculate a full moment tensor solution to constrain the source parameters. This made it possible to test how well the ground motion at station PLH can be explained by the regional optimum 1D crustal model combined with the site model obtained from ambient vibrations. The main features of the seismogram are matched surprisingly well. However, the overall signal duration of the observed signal is larger than predicted from the 1-D model.
As a third test, we have used 9 surface and downhole records of local earthquakes at station PLH to compare observed plane wave site amplification functions to those computed for the site models obtained from the analysis of ambient vibrations. The frequencies for the fundamental resonance peaks were found to be in good agreement. Amplification factors, however, could not be determined robustly due to the large S-wave coda.