GIB DEMONSTRATION TO MBARI

EVALUATION OF ACOUSTIC PROPAGATION CONDITIONS

Version 1.0

28/03/02

COMMERCIAL IN CONFIDENCE

A.C.S.A.
9 EUROPARC,
13590 - MEYREUIL
TEL.: 33 (0) 442 58 54 52
FAX: 33 (0) 442 58 65 46

PROJECT : GIB Demonstration to MBARI **PROJECT REF.: AFF-3043**	**CONTRACT REF. : DEMO** **CUSTOMER : MBARI**
DOCUMENT TITLE : Evaluation of Acoustic Propagation conditions **DOCUMENT REF. :** **FILE : 3043-RT-AC-CB-Simulation of Propagation V1.doc**	

ORIGIN	Prepared by	Reviewed by	Approved by
ACSA	Camille BECHAZ	Hubert THOMAS	Hubert THOMAS

Document classification:

☐ Non confidential ☑ Commercial in confidence ☐ Confidential Defence

Customer approval:

☐ Approval ☐ Without comment ☐ With comments

☐ Without object

References of customer answer:

Name: **Date:** **Visa:**

Diffusion

External:	**Company**	**Contact**	**Type**
	MBARI	Rob McEwen	I
Internal:			
	All		I

Precise: A = for action, I= for information

REVISIONS			
Rev.	Date	Pages affected	Modifications
1.00	28/03/02	All	Initial version

\\Serveur\ACSA\PROJETS\R&D\3043-MBARI\3043-RT-AC-CB-Simulation of Propagation V1.doc

File recorded on: 28/03/02 09:43

LIST OF CONTENT

Page

1. INTRODUCTION

This report present some simulations of acoustic propagation conditions in the Bay of Monterey, based on a sound velocity profile acquired by MBARI's ROV on November 9th, 2001. This work will help in preparing the demonstration of a GIB system to MBARI planned in September 2002.

2. ACOUSTIC PROPAGATION CONDITIONS

2.1 Maximum admissible propagation loss

The maximum admissible propagation loss for a GIB-STD system is estimated at the value of 100 dB:

- Source Level of acoustic pinger: 190 dB,
- Noise level: 75 dB

  NL = Bm + 10Log(Bandwith)

  Mean Noise level in tables: 45 dB re 1µPa @ 10 kHz - Sea state 4

  Bandwith: 500 Hz.

- Signal to Noise ratio: 15 dB.

2.2 Sound velocity measurements

The sound velocity profile was measured by MBARI's deep ROV on November 9th, 2001. September conditions are assumed not to be too different.

2.3 Acoustic propagation modelling using RAYSON software

RAYSON software is a very useful tool for acoustic propagation prediction based on ray model (See data sheet in Appendix).

With the RAYSON software we simulated the acoustic propagation in order to calculate the propagation loss in the following conditions:

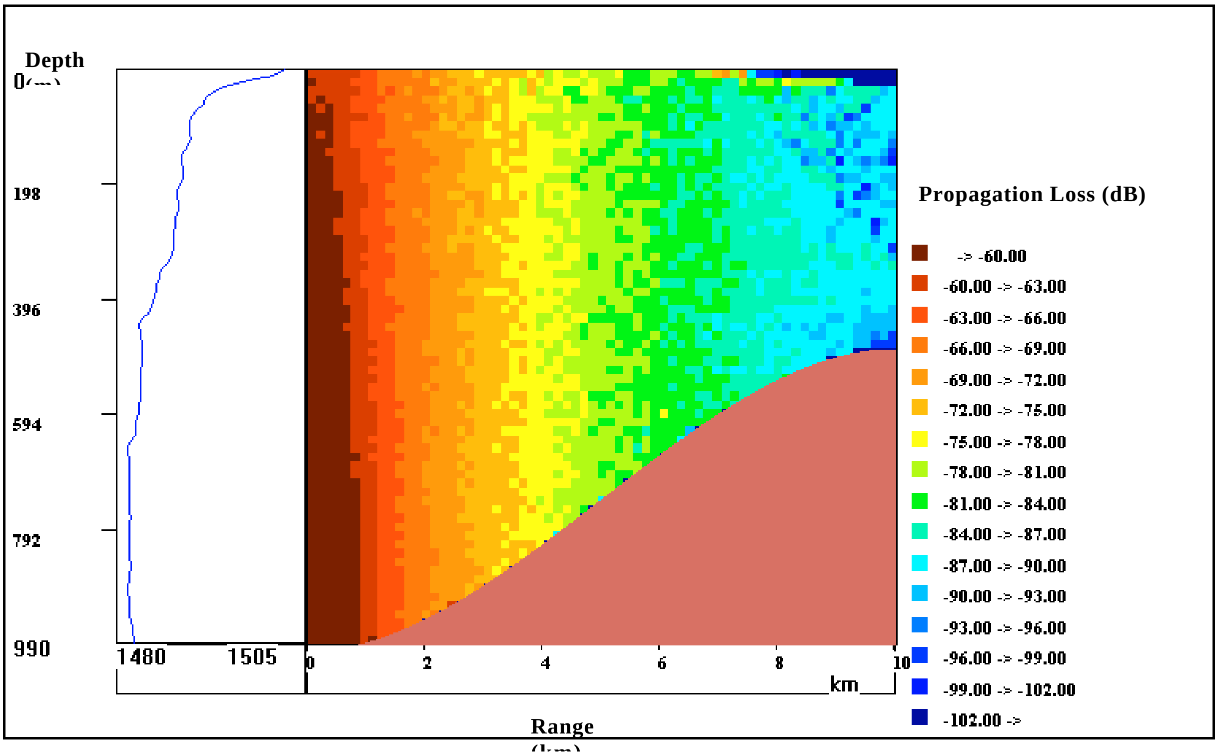
- Source's depth of 995 or 475 m corresponding to two different positions close to the bottom, taking into account the terrain slope,
- Sound velocity profile measured on the 9th of November 2001,
- Frequency of source: 10.5 kHz, corresponding to the GIB pinger,
- Source directivity: omnidirectional. This corresponds to the GIB pinger,
- Bottom: rock, with a typical slope simulating what could be encountered in the Monterey Bay canyon.

The modelling results are :

- Propagation Loss: picture composed of 2 graphs: the right-wing one is the sound propagation loss as a function of horizontal distance and vertical depth, and the left-wing graph is sound velocity profile. The vertical axis corresponds to depth, and horizontal axis corresponds to distance, colour scale: red (low propagation loss i.e. high energy) to blue (high propagation loss i.e. low energy), 6 dB per colour increment.

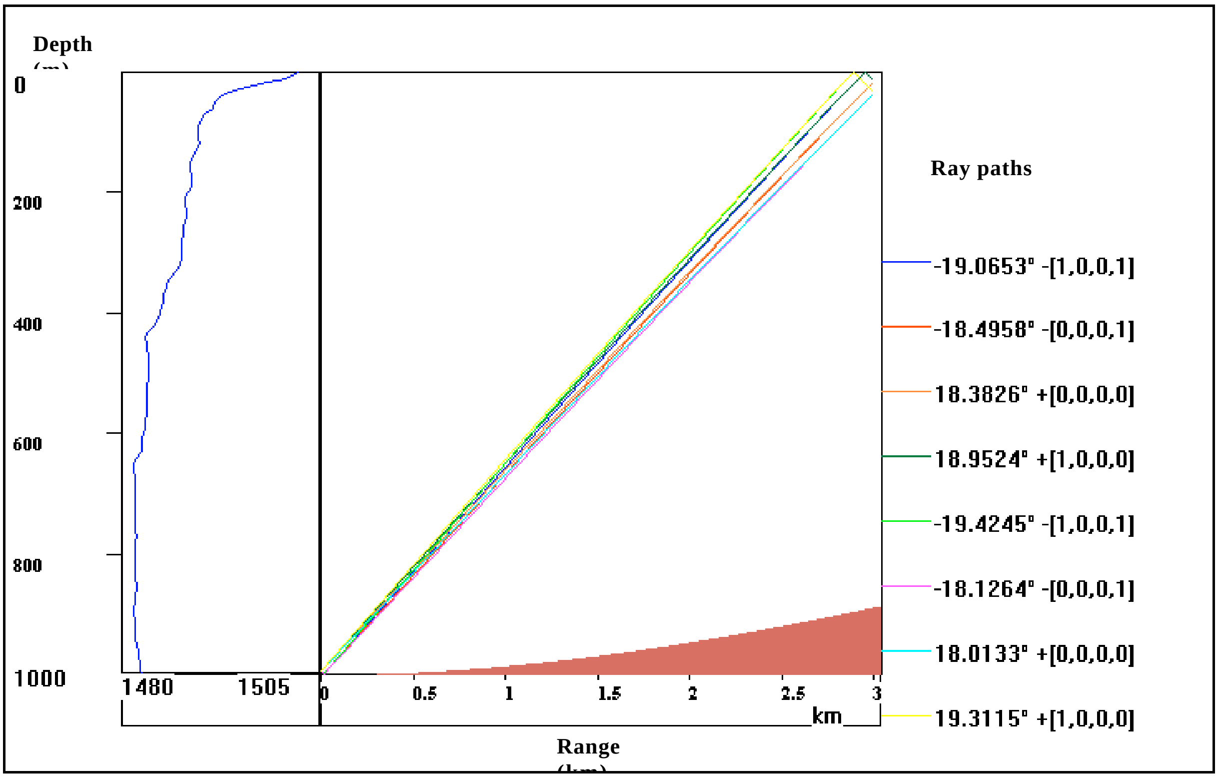
- Ray diagram: picture composed of 2 graphs: the right-wing one is the ray plot as a function of horizontal distance and vertical depth, and the left-wing graph is sound velocity profile.

Like all prediction the RAYSON results must be interpreted with care. As a matter of fact, the medium is approximate as it is represented by only 1 sound velocity profile, with rocky bottom. Nevertheless the results give a correct view of the acoustic propagation conditions and are very helpful for understanding some of the real phenomena that could be observed during the future trials.



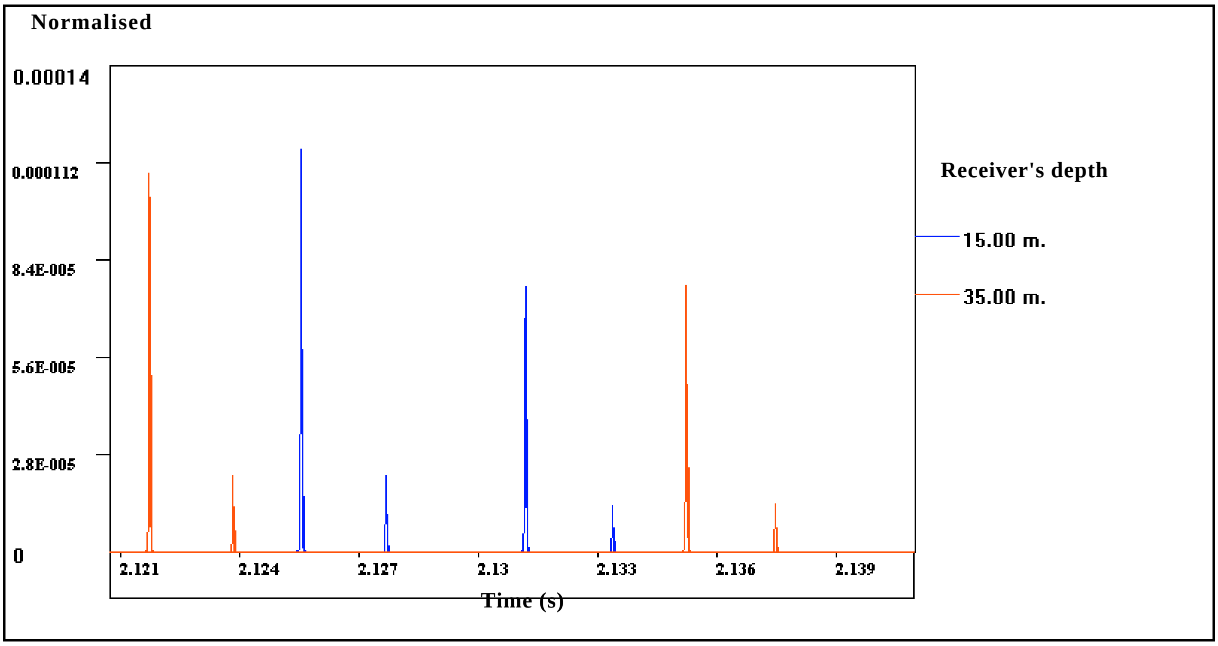
Picture 1: Propagation Loss - Source depth: 995 m

The acoustic detection range is compatible with GIB tracking system in such conditions.



Picture 2: Ray path diagram between source and receiver- Source depth: 995 m - Receiver depths: 15 and 35 m.

There is a direct path between source and receiver.



Picture 3: Impulse response - source depth: 475m - Receiver depth: 15 m (blue) and 35 m (red).

For both depths receiver, the first ray is the direct path. Then we detect a path with one reflection on the bottom, but very attenuated (more than 10 dB), and next, with only 3 dB difference, we detect a path with one reflection on the surface.

<u>Receiver depth: 15m</u>

Attenuation of 1st path: 73.5 dB

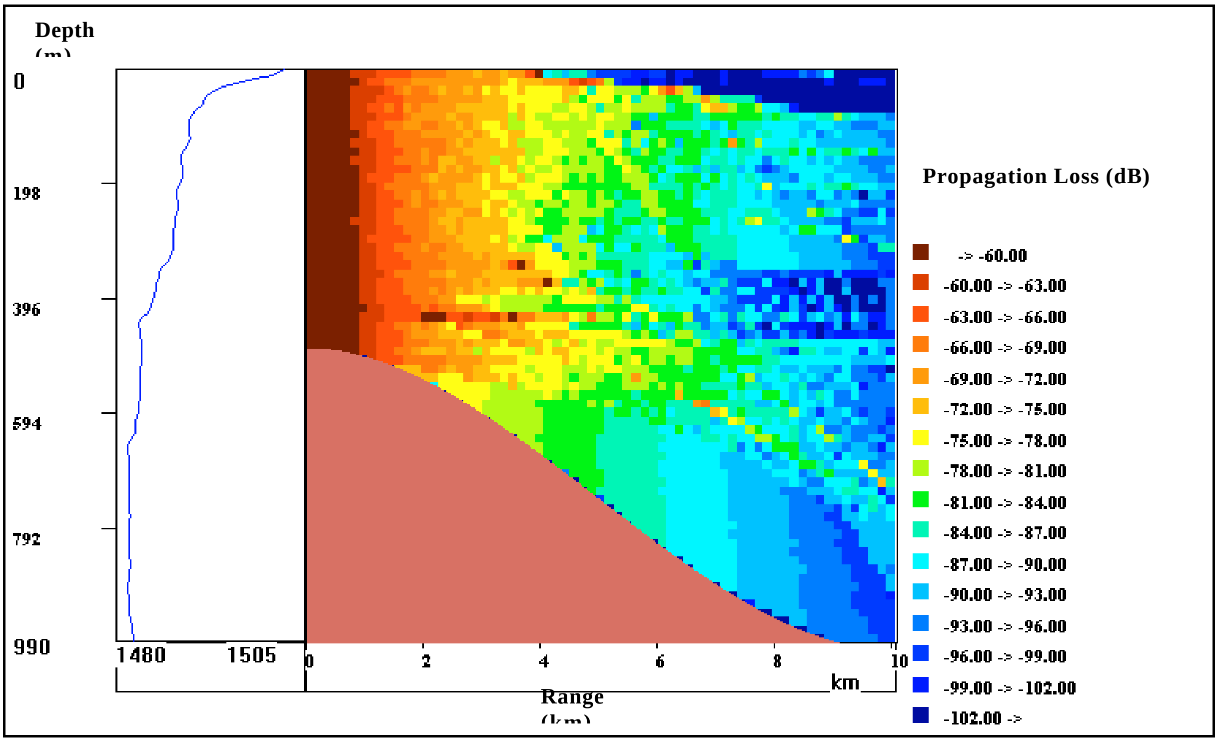
5 ms between two main paths (3 dB difference).

<u>Receiver depth: 35m</u>

Attenuation of 1st path: 73.5 dB

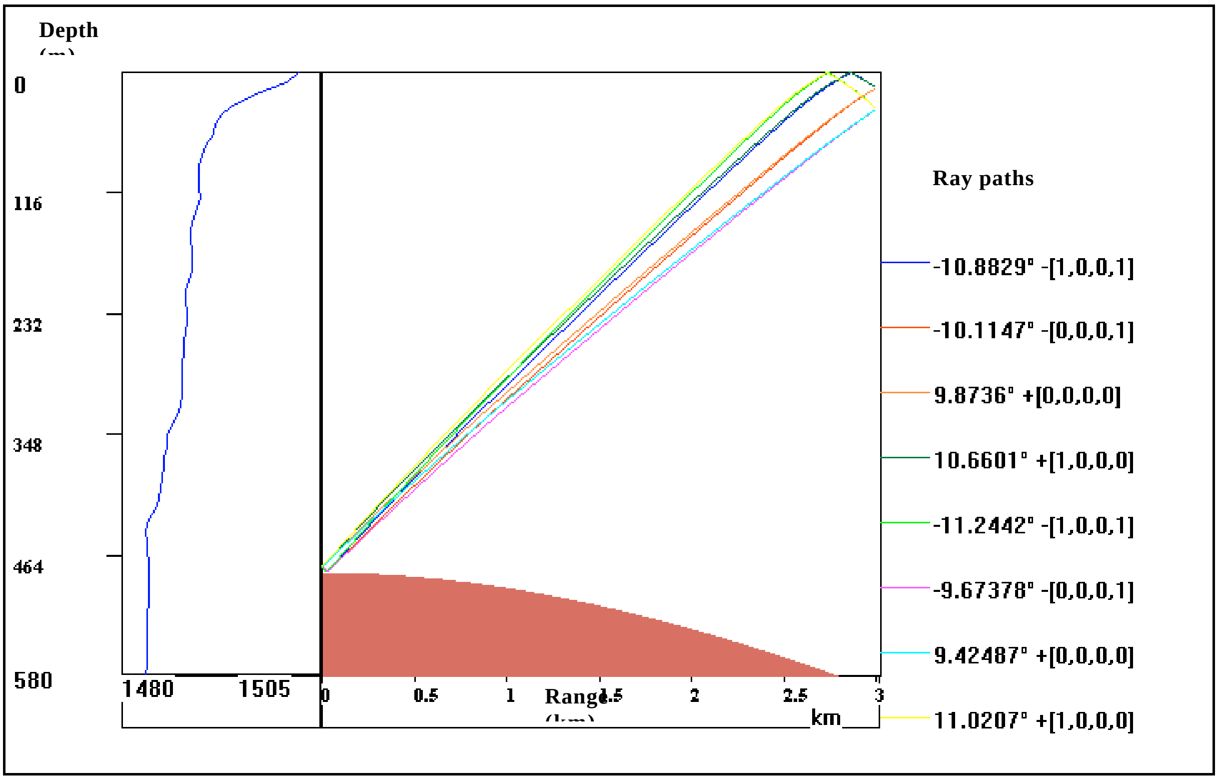
13 ms between two main paths (3 dB difference).

The hydrophone should perform better at a depth of 35 m. As the GIB pulse length is 10 millisec., at such depth, direct path and surface reflected path will not interfere.



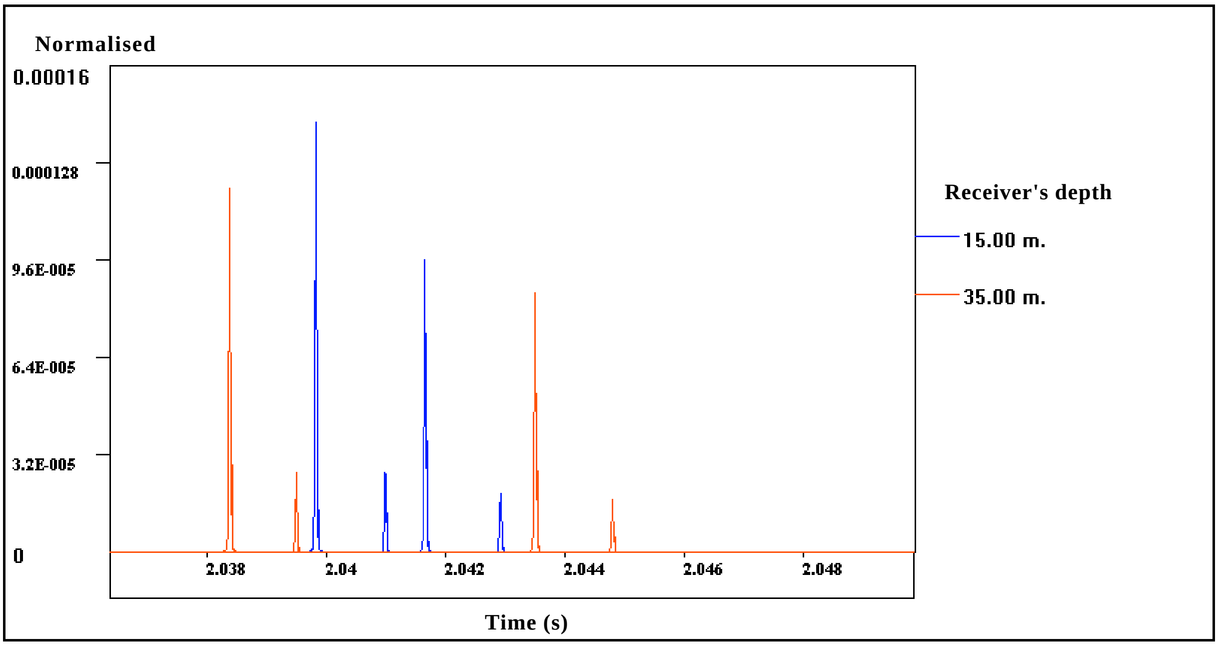
Picture 4: Propagation Loss - Source depth: 475 m

The acoustic detection range is compatible with GIB tracking system in such conditions.



Picture 5: Ray path diagram between source and receiver- Source depth: 475 m - Receiver depths: 15 or 35 m.

What ever the hydrophone depth is, there is a direct path between the source and the receiver.



Picture 6: Impulse response - source depth: 475m - Receiver depth: 15 m (blue) or 35 m (red).

For both depths receiver, the first ray is the direct path. Then we detect a path with one reflection on the bottom, but very attenuated (more than 10 dB), and next, with only 3 dB difference, we detect a path with one reflection on the surface.

Receiver depth: 15m

Attenuation of 1st path: 72 dB

1.8 ms between two main paths (3 dB difference).

Receiver depth: 35m

Attenuation of 1st path: 73 dB

5 ms between two main paths (3 dB difference).

The hydrophone should better be at a depth of 35 m.

3. CONCLUSION

This study demonstrates that the acoustic propagation conditions encountered in November were correct for a nominal use of a GIB system in the Monterey Bay Canyon.

APPENDIX: RAYSON DATA SHEET

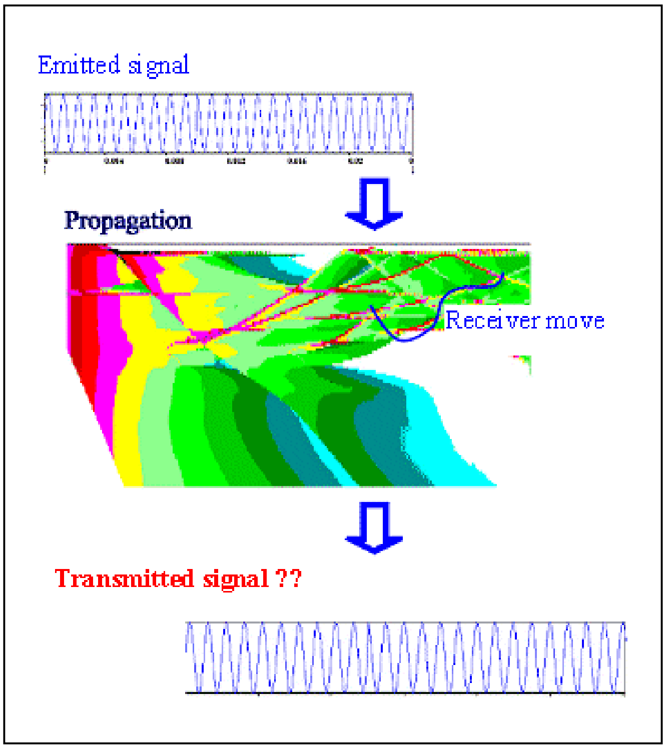
Refer to attached file : "GIB Module Rayson n° 21 V1.10.pdf"

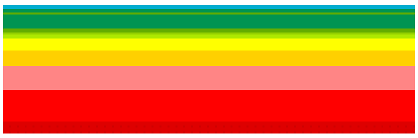
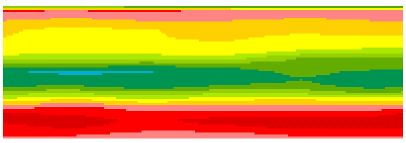
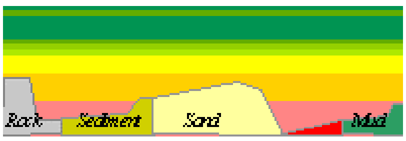
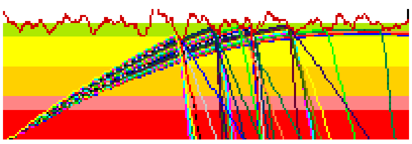
GIB MODULE RAYSON

Ray Tracing Model

Predicts acoustic field using a ray method based on a simplification of Helmholtz equation.
Valid in areas of high frequencies.
Differential equation defines the trajectory of a ray taking into account local values of sound velocity and its gradients.

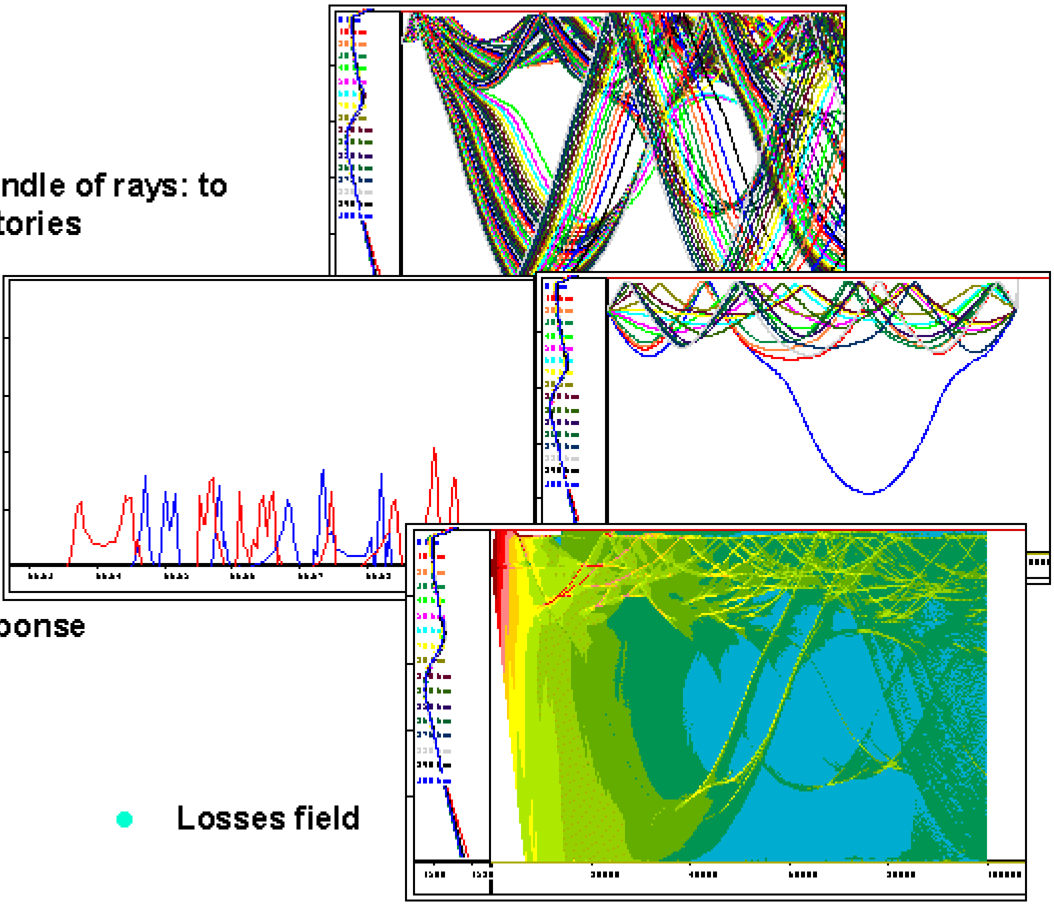
- Range independent medium: analytical solutions which are parts of circles.
- Range dependent medium: rays equation is solved numerically with a Runge-Kutta scheme of the order 4
- Program realized in C++



	**Stratified Medium**: horizontally homogeneous: determination and discretization of analytical solutions
	**Range dependent medium :** Runge Kutta scheme. The number of celerity profiles is just limited by the processor memory
	**Range dependent shape and nature bottom** allowing to take into account sediment, sand, mud, rocks, fluid bottom, bottom with constant losses (devoted to calibration)
	**Sea surface varying in space and time**

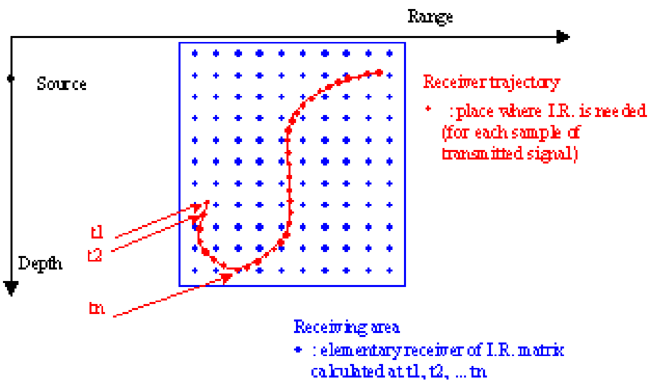
ACSA © 9, Europarc Ste Victoire – 13590 Meyreuil – France
Tel : +33 (0) 4 4258 5452 – Fax : +33 (0) 4 4258 6546 – Web site : www.underwater-gps.com

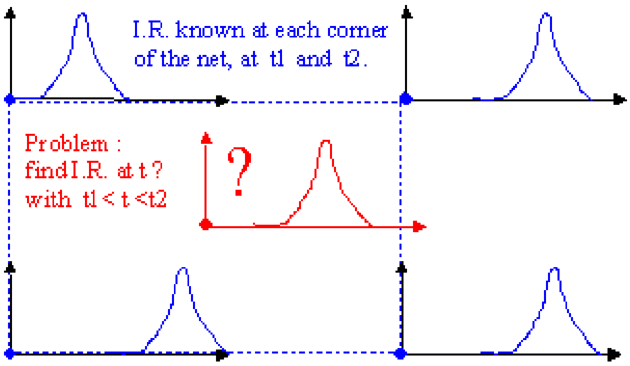
- Shot of a bundle of rays: to study trajectories



- Impulse response
- Losses field

- **Take into account**
  - Source / receiver directivity
  - Receiver trajectory





- **Interpolate impulse response** for each receiver place