

BIOKON
Bionik-Kompetenz-Netz

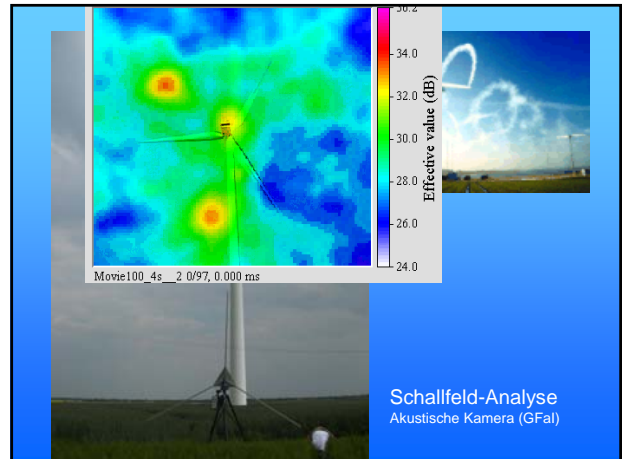
EvoLogics®

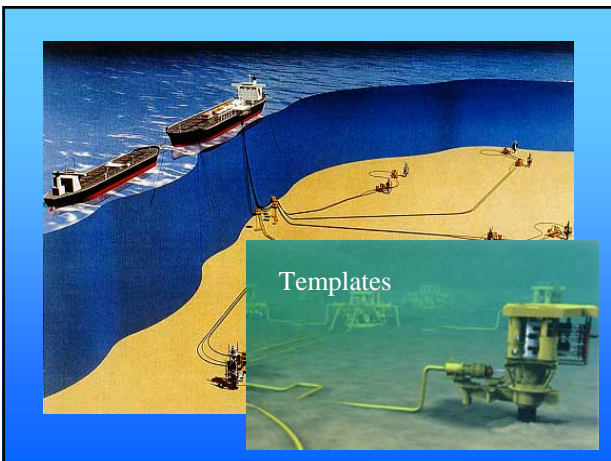
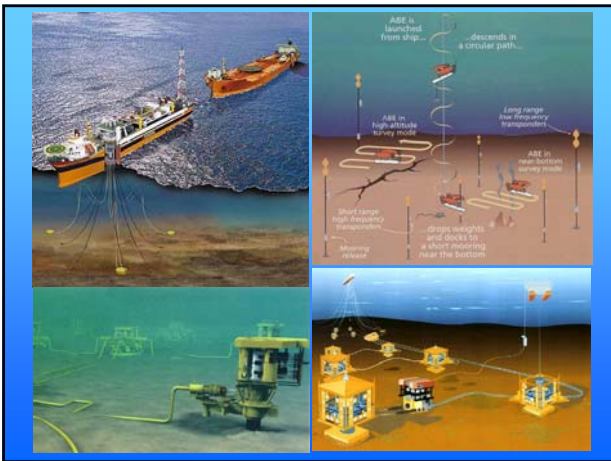
Dr. Rudolf Bannasch

**Acoustic UW Communication
3D-Positioning and
Object Recognition**

Based on Bionic Principles

Beamforming Conf. 22.11.2006



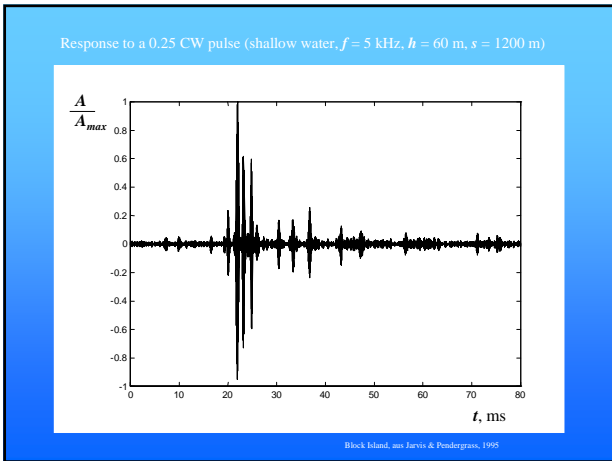




Main PROBLEM:

MULTIPATH PROPAGATION:

The transmitted signal takes numerous time varying paths to the receiver




STATE of the ART

Beamforming & Equalizing

STATE of the ART

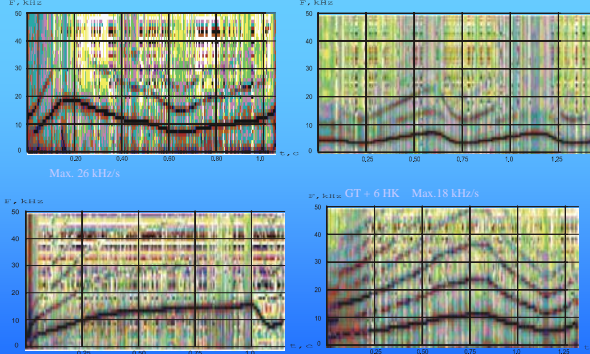
Frequency Hopping
+
Redundanz
+
Equalizing

Dolphins, however, are able to communicate under nearly any circumstances

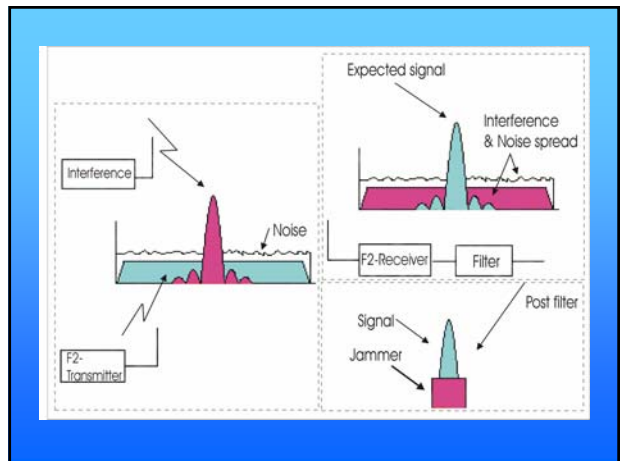
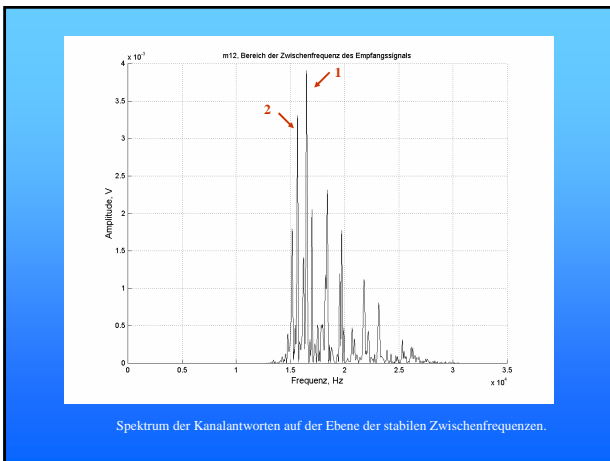
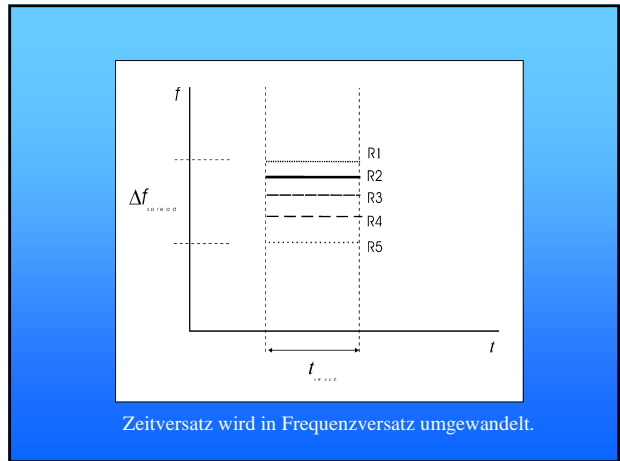
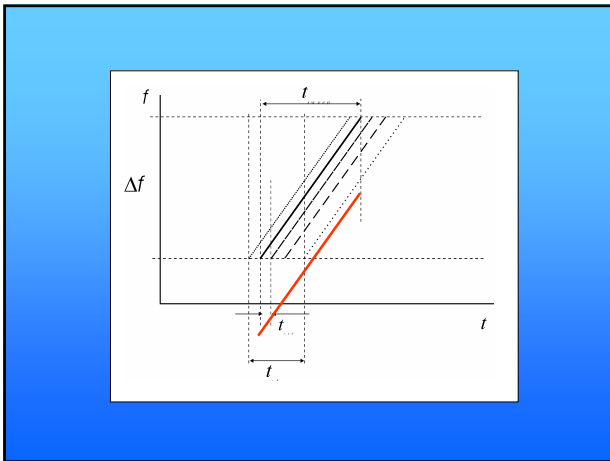


Colleagues in

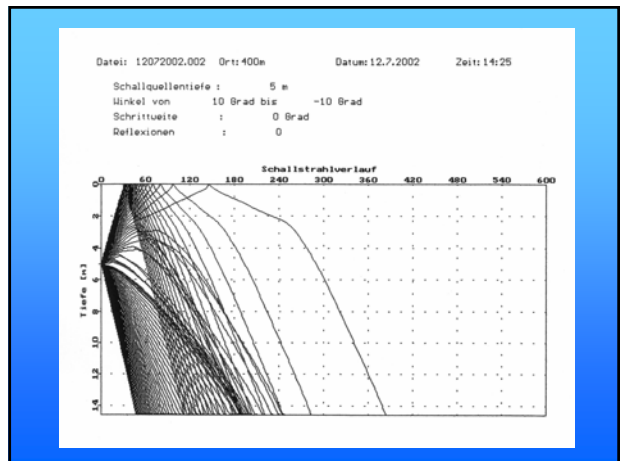
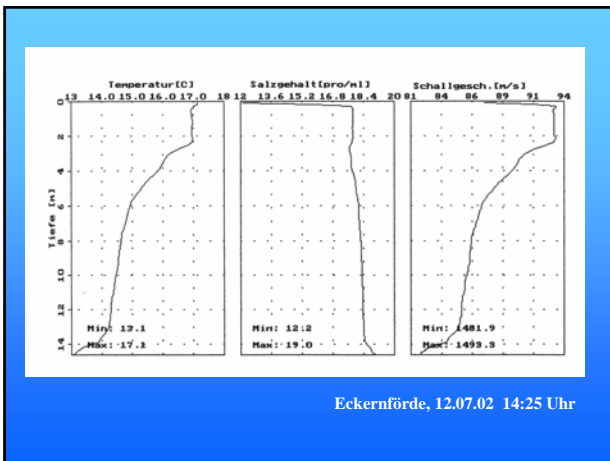
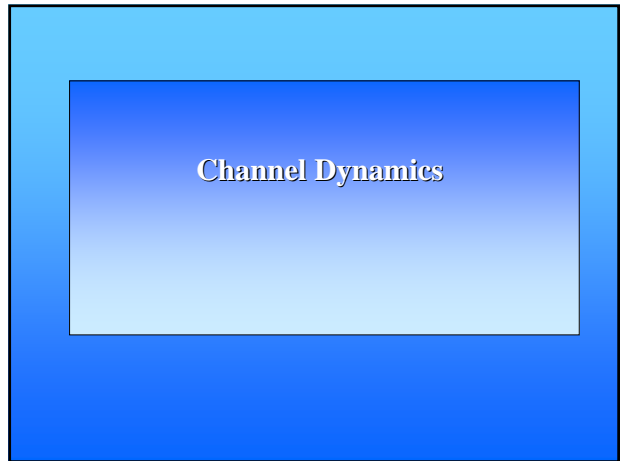
**BIONIC
RESEARCH**

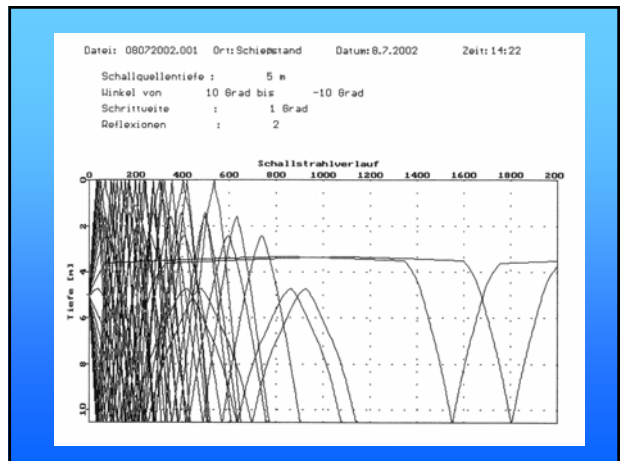
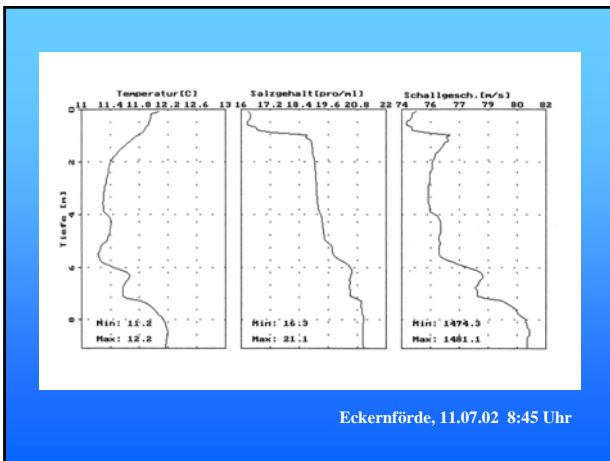
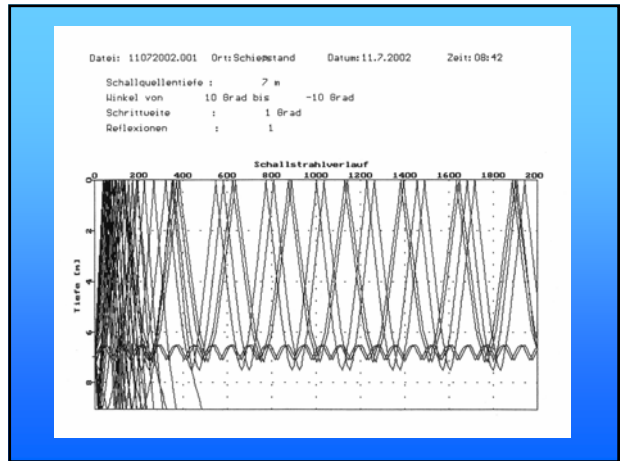
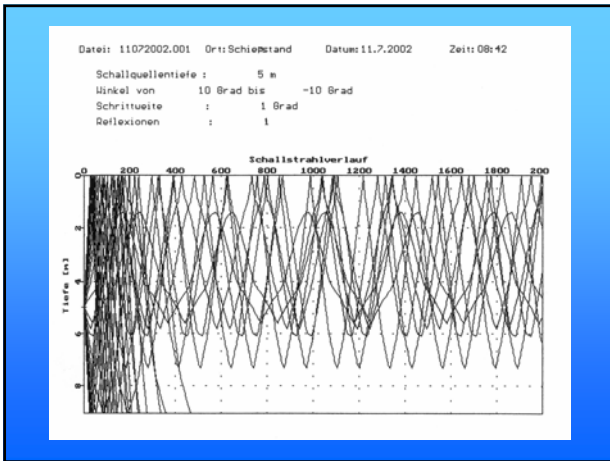
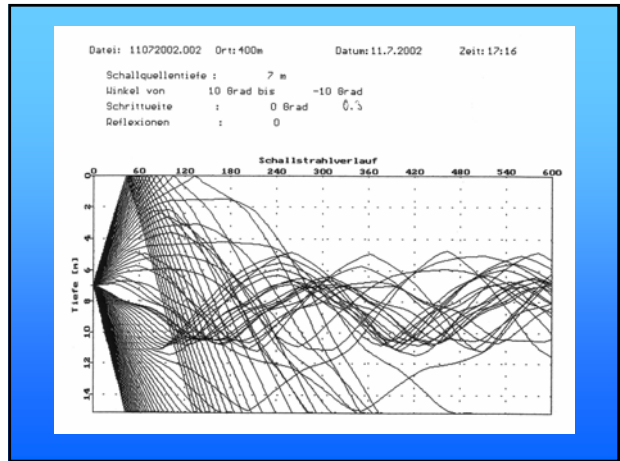
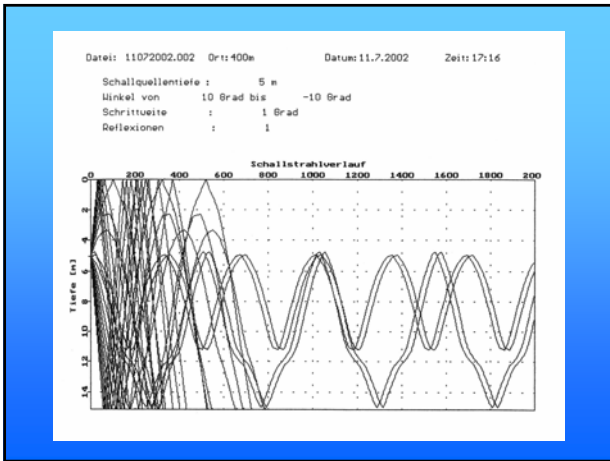


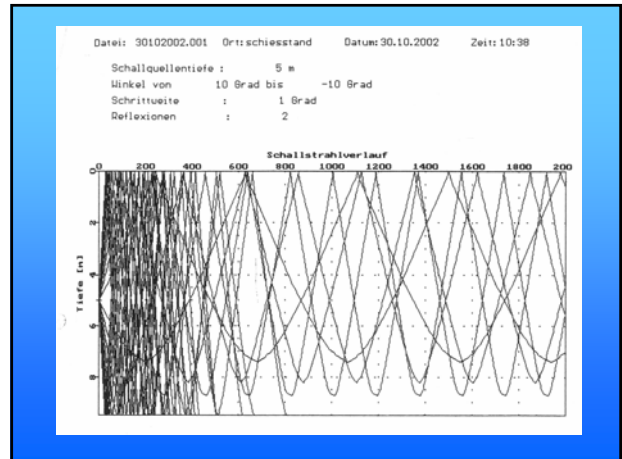
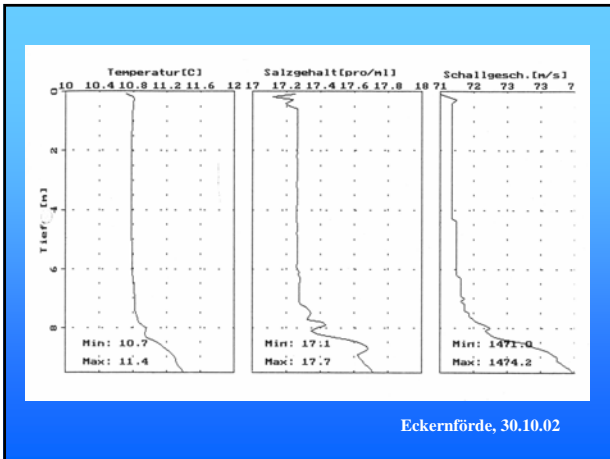
Besonderheit: Delfine verwenden keine konstanten Töne, sie singen !



<p>Conventional carrier</p> $s(t) = \text{Re}[g(t) \exp(2\pi i f_c t)]$ <p style="text-align: center;">Stationary</p> $z(t) = \sum_n \alpha_n(t) \exp[-2\pi i f_c(t) t - \tau_n(t)]$ <p style="text-align: center;">Influence of Doppler</p> $z(t) = \sum_n \alpha_n(t) \exp[-2\pi i (f_c + f_{dn}) t - \tau_n(t)]$	<p>Sweep spread carrier</p> $s(t) = \text{Re}\{g(t) \exp[i(2\pi f_c t + m t^2)]\}$ $z(t) = \sum_n \alpha_n(t) \exp[i(-2\pi \Delta f_n t + \phi_n)] g[t - \tau_n(t)]$ $z(t) = \alpha_n(t) g(t)$ $z(t) = \sum_n \alpha_n(t) g[t - \tau_n(t)] \exp[2\pi i f_{dn}(t) t] \exp[-2\pi i f_c t + \phi_n]$ <p style="text-align: center;">if $\Delta f_n \gg f_{dn}(t)$</p> $z(t) = \alpha_n(t) g(t) \exp[2\pi i f_{dn}(t) t]$
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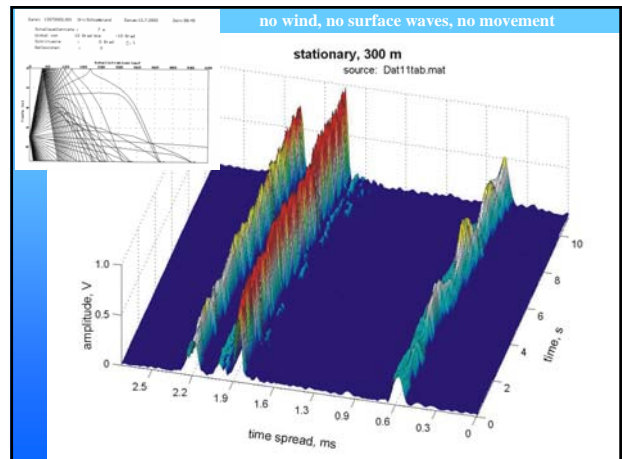
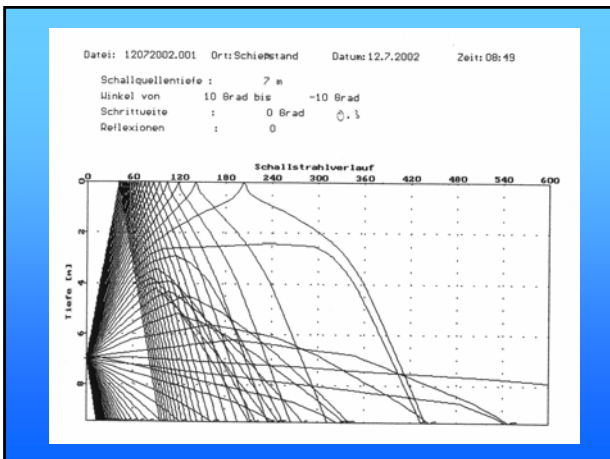
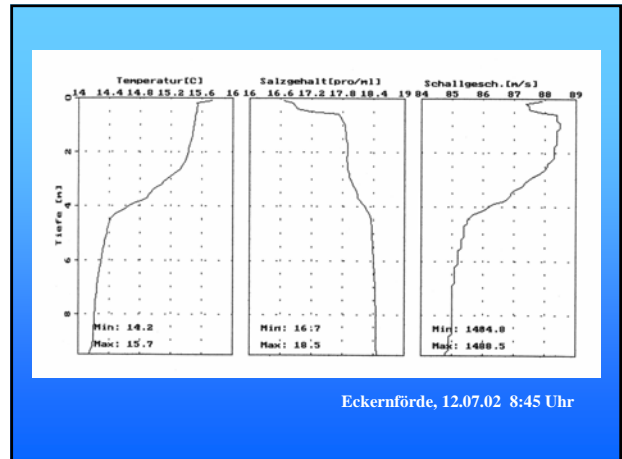


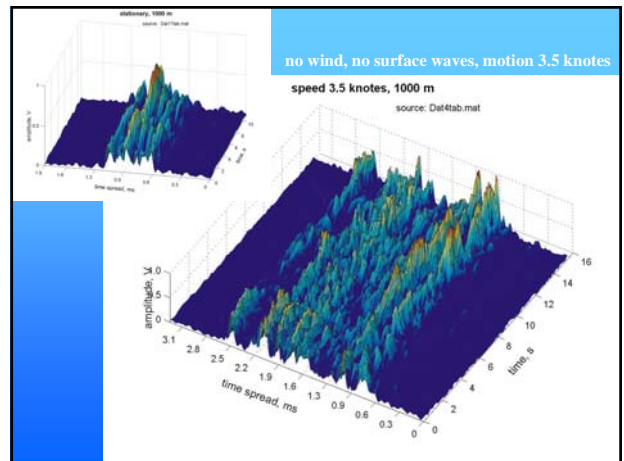
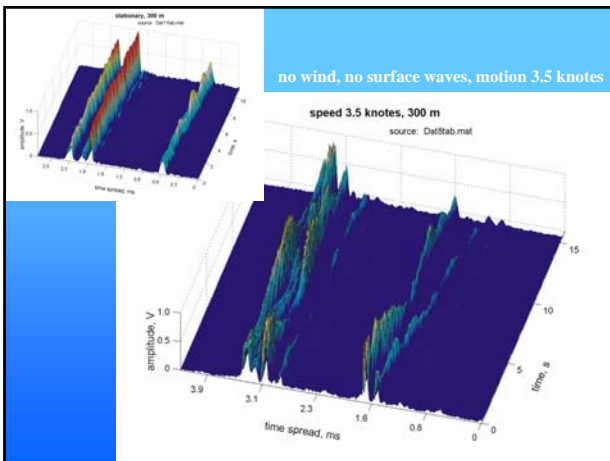
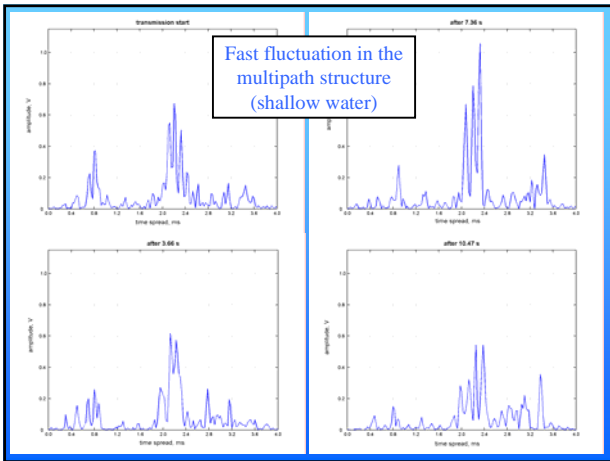
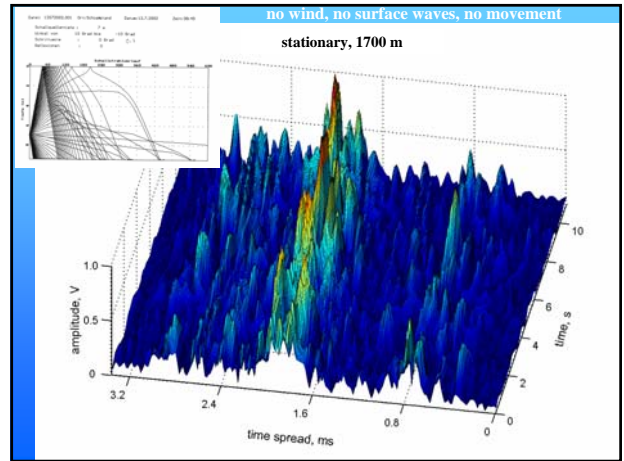
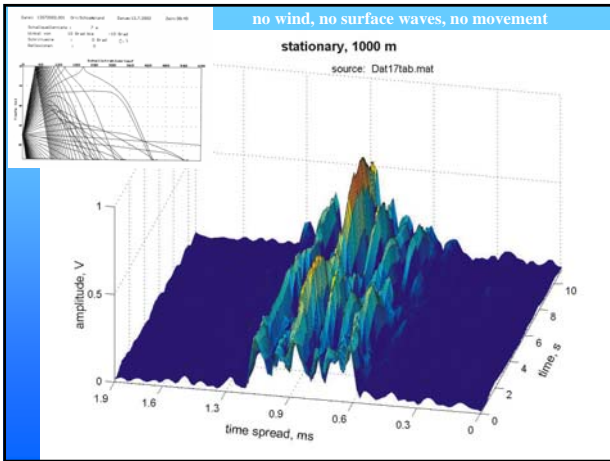


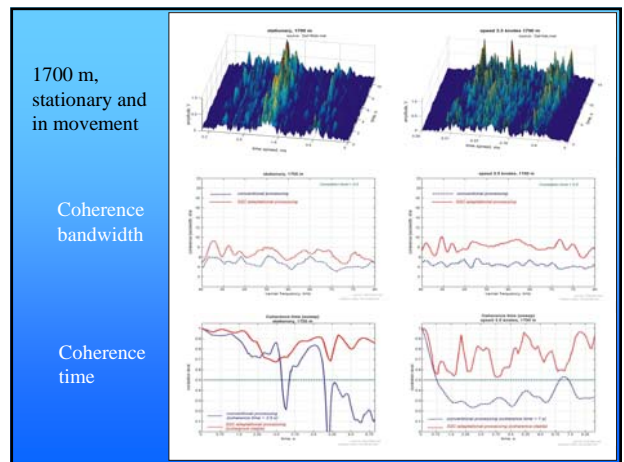
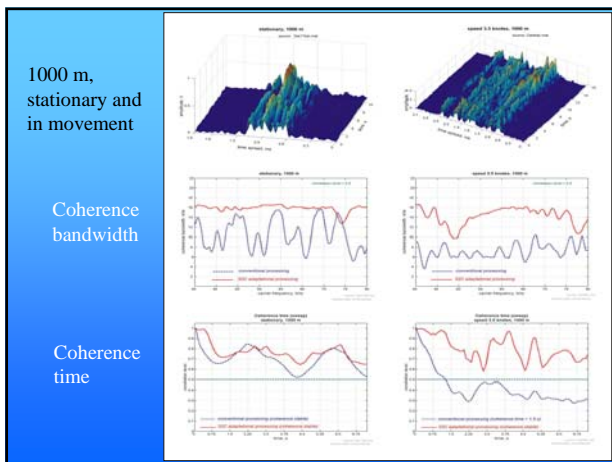
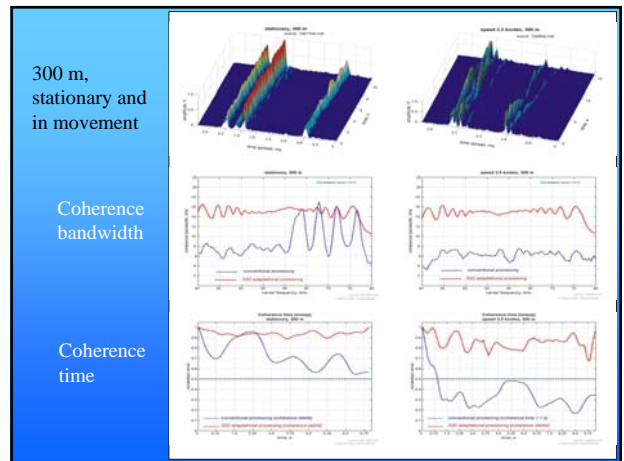
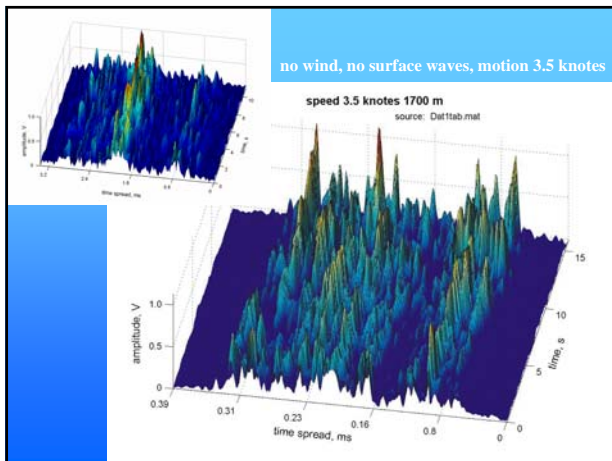


**Kurzzeitige Fluktuationen
 in der Multipath-Struktur**

**Notwendigkeit der
 S2C-SYSTEM-ADAPTIVITÄT**

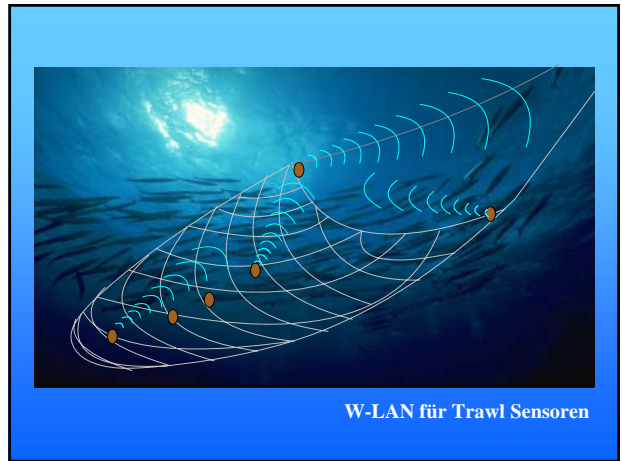
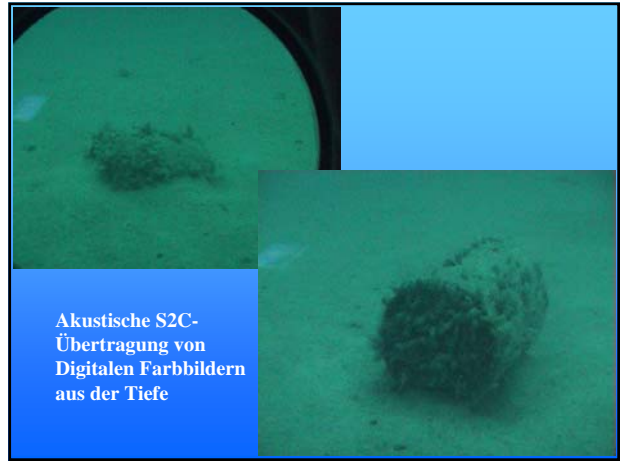
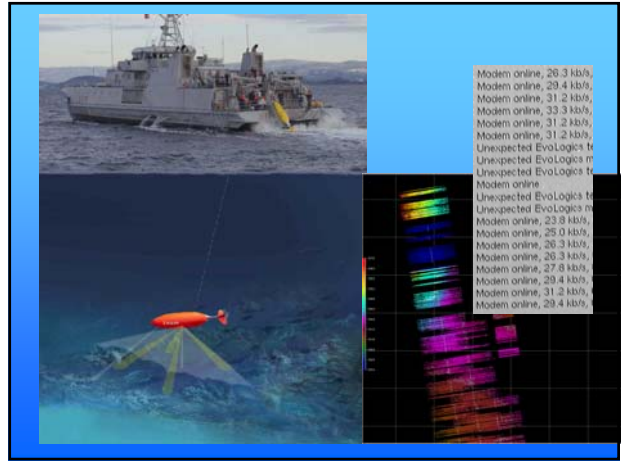


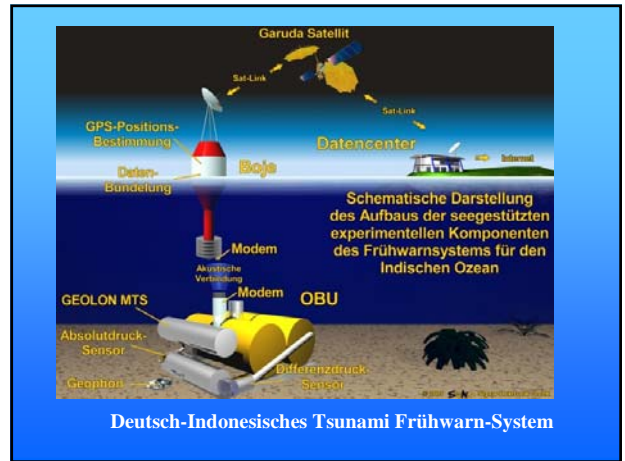
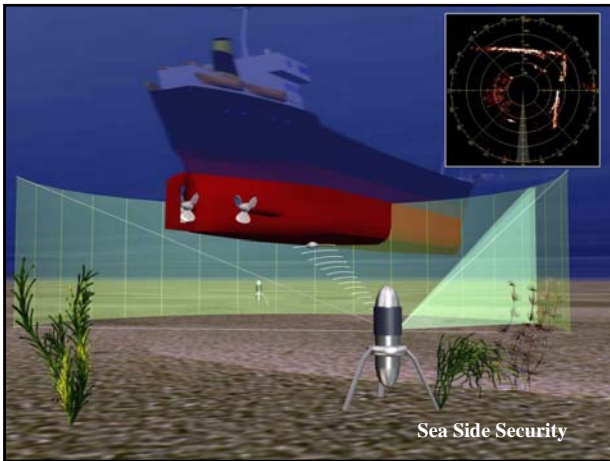


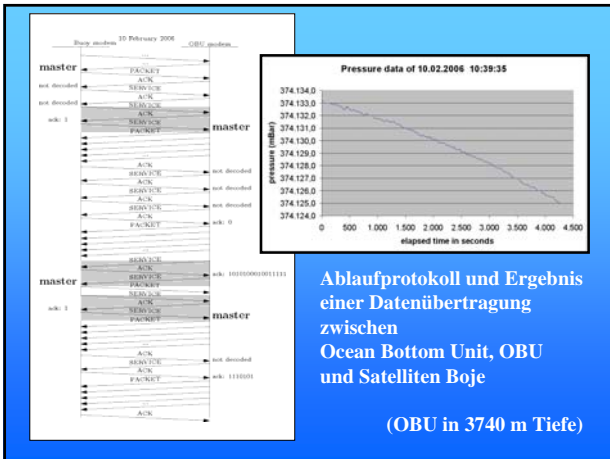


Anwendungen



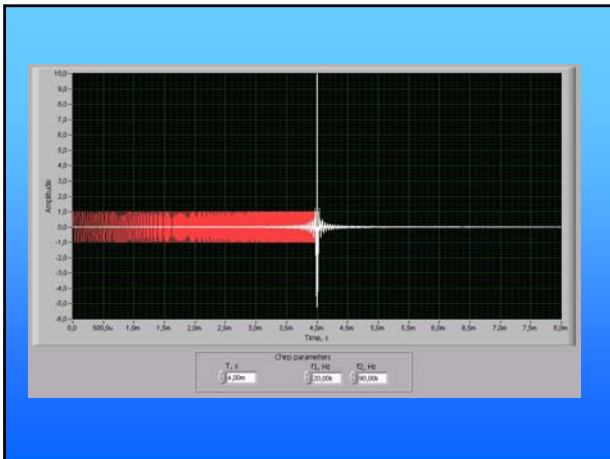






SATCOM solutions

Your Access to the Depth of the Ocean - simply via Internet



Räumliche Wahrnehmung

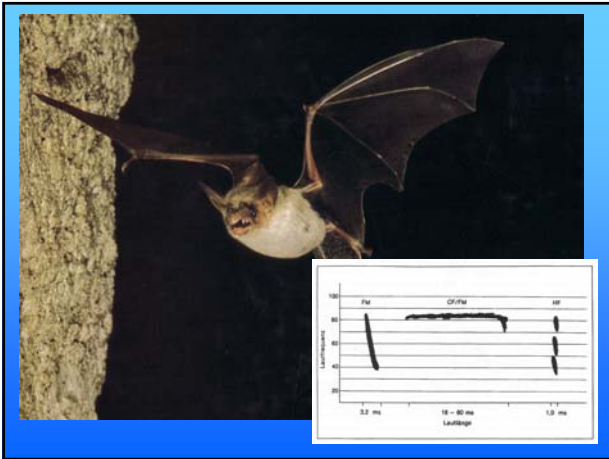
Wellensignale,
Richtungsbestimmung

Fotografie:

Lochkamera (Camera obscura)
Linse (Fokus)

⇒ Winkelzuordnung der Bildpunkte

Akustische Ortung (passiv)



Entfernungsauflösung: $\Delta R_{min} = \frac{1}{2} \tau_p c_o$

τ_p - Pulsdauer
 c_o - Ausbreitungsgeschwindigkeit

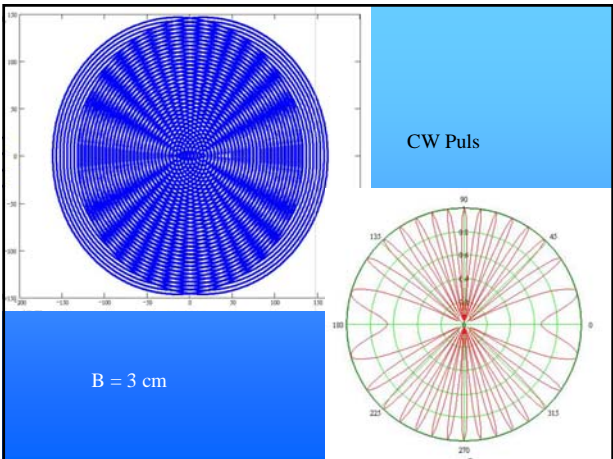
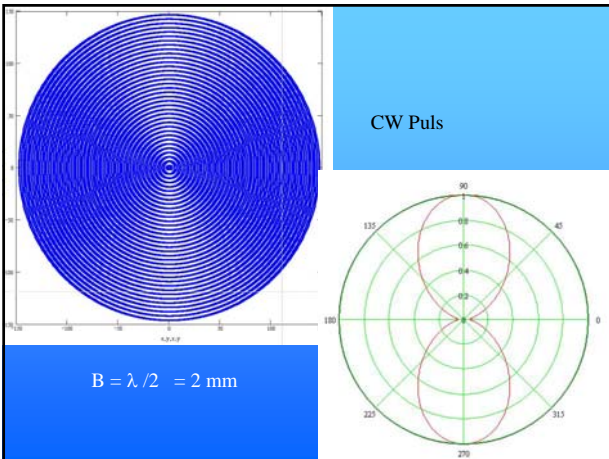
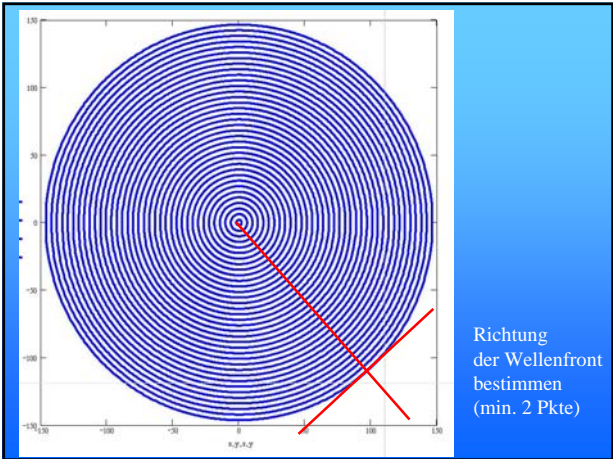
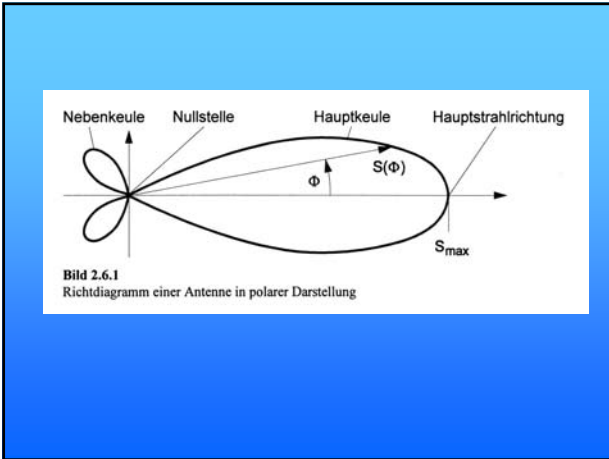
Winkelauflösung: $\theta_a \text{ (Bogenmaß)} = \lambda / D_a$

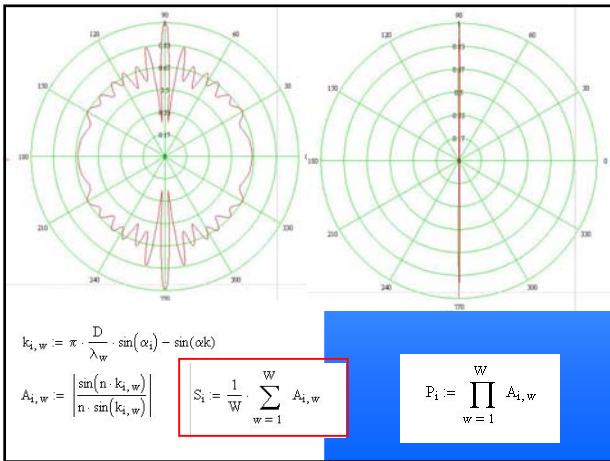
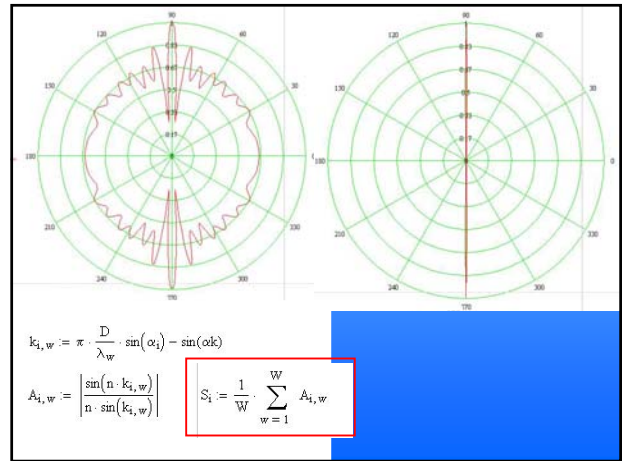
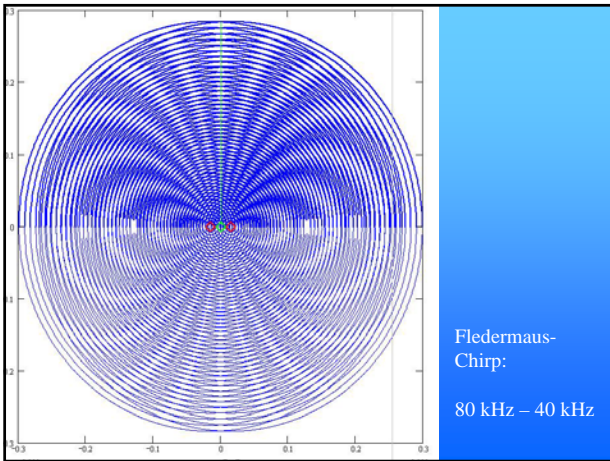
θ_a - 3 dB Breite der Hauptkeule
 λ - Wellenlänge
 D_a - Antennenlänge

Schall:
 c Luft = 330 m/s
 c Wasser = 1500 m/s

Querauflösung: $L_q = \theta_a R_z$

R_z - Zielabstand





Entfernungsauflösung:

$$\Delta R_{\min \text{ Puls}} = \frac{1}{2} \tau_p c_0$$

$$\Delta R_{\min \text{ FMCW}} = c_0 / 2 \Delta f$$

Bandbreite:

$$B_{\text{Puls}} = 1 / \tau_p$$

$$B_{\text{FMCW}} = \Delta f$$

Entfernungsauflösung allgemein:

$$\Delta R_{\min} = c_0 / 2B$$
