

NEW SOLUTIONS FOR WATERSIDE SECURITY

TNO innovation
for life

TNO's SOBEK technology detects divers and small boats using passive sonar: smart listening without emitting any sound. This brings operational benefits: robust performance in challenging underwater port environments with technology that is covert and more cost-effective than existing products. SOBEK technology can be used stand-alone, but is also complementary to existing active sonar solutions. Using SOBEK in conjunction with other sensors makes for better waterside security solutions.

SOBEK is environmentally friendly: no sound is emitted, so no harm is done to underwater life. This makes it ideally suitable for application in natural underwater environments, monitoring e.g. coral reefs, underwater archaeological sites, or the habitat of endangered species (fish, marine mammals).

In March 2012, we hosted an event on Port Waterside Security, informing a broad audience of maritime port stakeholders on how innovation can contribute to better waterside security solutions. A prototype diver detection system was successfully demonstrated in the biggest operational port of Europe: Rotterdam, the Netherlands.

Whereas waterside security is now largely absent in commercial ports, SOBEK technology paves a way towards affordable and environmentally friendly solutions against waterside threats, to enhance the safety of the most important infrastructure hubs in modern society.

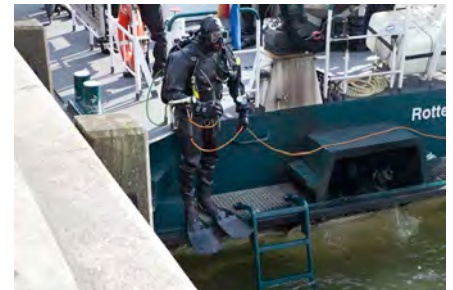
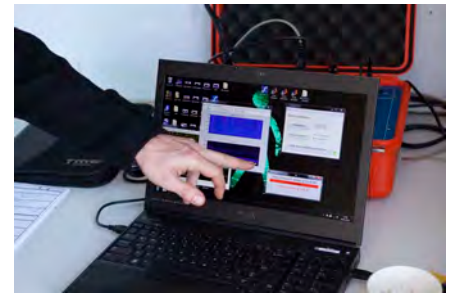
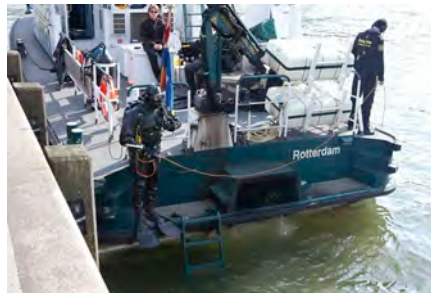


"Hoor, daar zwemt een drugsplukker"

De Volkskrant – 7 March 2012

Text: Elsbeth Stoker, de Volkskrant

Graphic: Erik d'Ailly, de Volkskrant



ACHILLES HEEL

Free transport of goods and persons has traditionally characterized most sea ports. After September 11, 2001 all this changed and legislation such as the International Ship and Port facility Security code (2004) was enforced.

Focus has been set on control procedures and enhancing security for assets on the landside in ports (quays, terrain, premises) – so-called landside security. Security measures for the waterside domain are largely absent and form today's Achilles' heel in ports. Waterside intruders can pose a terrorist threat or engage in theft or smuggling. The main threats come from small, fast boats or divers. Drugs attached to ships' hulls for instance are routinely removed by divers. But what does that tell us about the possibilities for terrorists to attach something to a ship's hull?

Port facilities, bridges, weirs, tunnels, cargo ships, ferries and cruise liners are potential targets. In the future EU legislation and important partners for international trade (such as the US) will demand more and more waterside security. There are many waterside security products on the market, but these are generally quite expensive. Furthermore, they often do not show

sufficient performance in confined port environments.

In 2010, TNO started research on alternative solutions.

SOBEK

TNO is working on new security solutions for the waterside based on passive sonar under the name SOBEK. The key aspect is smart listening to almost inaudible sounds of, amongst other things, divers. New technology that is promising. Robust performance, affordable and environmentally friendly.

BENEFITS

Performance

Contrary to current market solutions, SOBEK passive sonar technology aims at detecting waterside intruders without actively emitting sound. This approach is better tuned to a challenging port environment. Conversely, sound from active sonar reflects from the sea/river bottom and surface, quays and ship hulls, causing many false alarms.

Environmentally friendly

SOBEK is also environmentally friendly since sounds are not emitted. Power consumption is low and marine life does not suffer from the impact of sound

emission. This is very relevant as worldwide restrictions on the use of man-generated underwater sound (including active sonar) are becoming a serious limitation for many applications.

Affordable

Passive sonar technology makes use of components that cost substantially less than those used in active sonar products. Future SOBEK solutions can therefore be considerably cheaper than those currently offered on the market.

Covert

Passive sonar does not emit sound. Therefore, a SOBEK based system does not betray itself. A small boat or diver can be detected without the detection system revealing its presence. That also has a deterrent effect on intruders - the system even 'works' when it is absent.

HOW DOES IT WORK?

The underwater domain in a port is a very noisy environment. Nevertheless, smart listening to almost inaudible sounds of, for instance, divers proves to be successful. Scuba divers emit high frequency signals when they inhale air, whereas the ambient underwater noise is mainly low frequency. All these sounds are picked up by hydrophones (underwater microphones).



Using signal processing developed at TNO, we can distinguish between the diver signals and all other underwater sounds. Using a pair of hydrophones, the direction of the diver can also be determined. Even if the diver is behind a boat. Boats can also be detected, also if they are small. And by using more hydrophone nodes at different locations, we can determine the exact location of the intruder.

“WHAT IS NEW?”

PASSIVE SONAR TECHNOLOGY ITSELF IS NOT NEW. BUT USING IT AS THE SOLE METHOD TO DETECT DIVERS IN AN OPERATIONAL PORT ENVIRONMENT CERTAINLY IS. TNO CURRENTLY TAKES A WORLDWIDE LEAD IN THIS RESEARCH FIELD. OUR AMBITION IS TO MAKE THE BENEFITS OF SOBEK TECHNOLOGY AVAILABLE FOR WATERSIDE SECURITY SOLUTIONS.

DEMONSTRATION OF A FIRST PROTOTYPE SYSTEM

TNO has developed, together with AVIC, a prototype system for diver detection. The aim was to enhance the safety of the customs divers. The system allows them to assess whether or not a potentially non-friendly diver is present in the water, before they themselves enter the water to inspect ship hulls for drugs. This allows them to reduce the risk of undesired and

dangerous encounters in the water and to perform their inspections with safety and confidence.

The prototype system detects divers in an operational port environment. We have also shown that the system can detect small and big boats. All this information is made available in the Avision environment, developed by AVIC. The diver and boat presence is overlaid in a Google maps environment on a smart phone or tablet. A real-time and secure connection ensures that the security information is made available to stakeholders as soon as possible, and serves a basis for counter measures.

WHAT CAN A BASIC SOBEK SYSTEM DO FOR YOU?

For port facilities, the added value is in monitoring the underwater domain remotely and continuously. Thieves can now enter port facility terminals from the freely accessible waterside.

Do I need waterside security?

What are the risks for your port facility? Is there a threat related to theft or smuggling? Are there potential threats to critical waterside infrastructure?

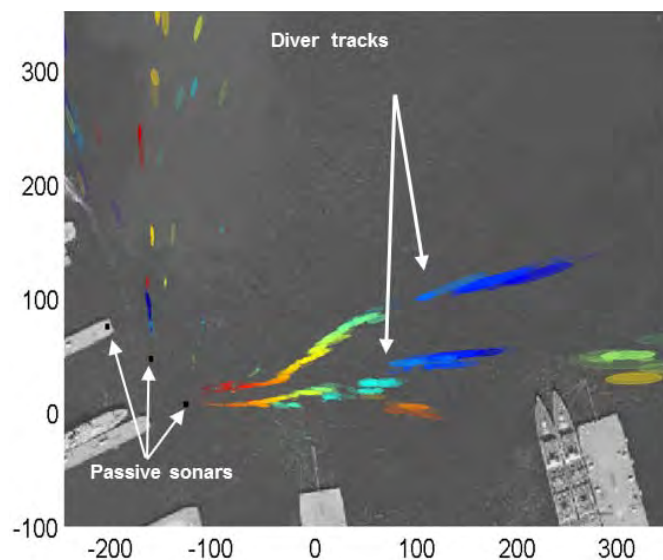
TNO offers a two-step approach:

1. Waterside security check: with the basic

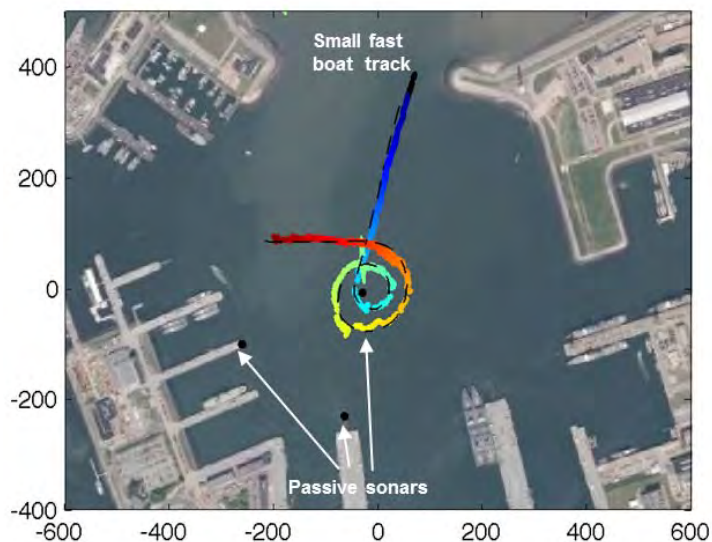
SOBEK system, the waterside area around your port facility is monitored 24/7 during several weeks. Any presence of small boats and divers is recorded and post-analyzed by TNO. This helps to reveal unexpected or unwanted presence of waterside intruders. You gather valuable information for your risk assessment.

2. (Semi-)permanent monitoring. Should the analysis point towards a need for more waterside security, SOBEK can permanently monitor the water domain around your port facility. In case an intruder is present, a direct warning is sent to for instance security personnel.

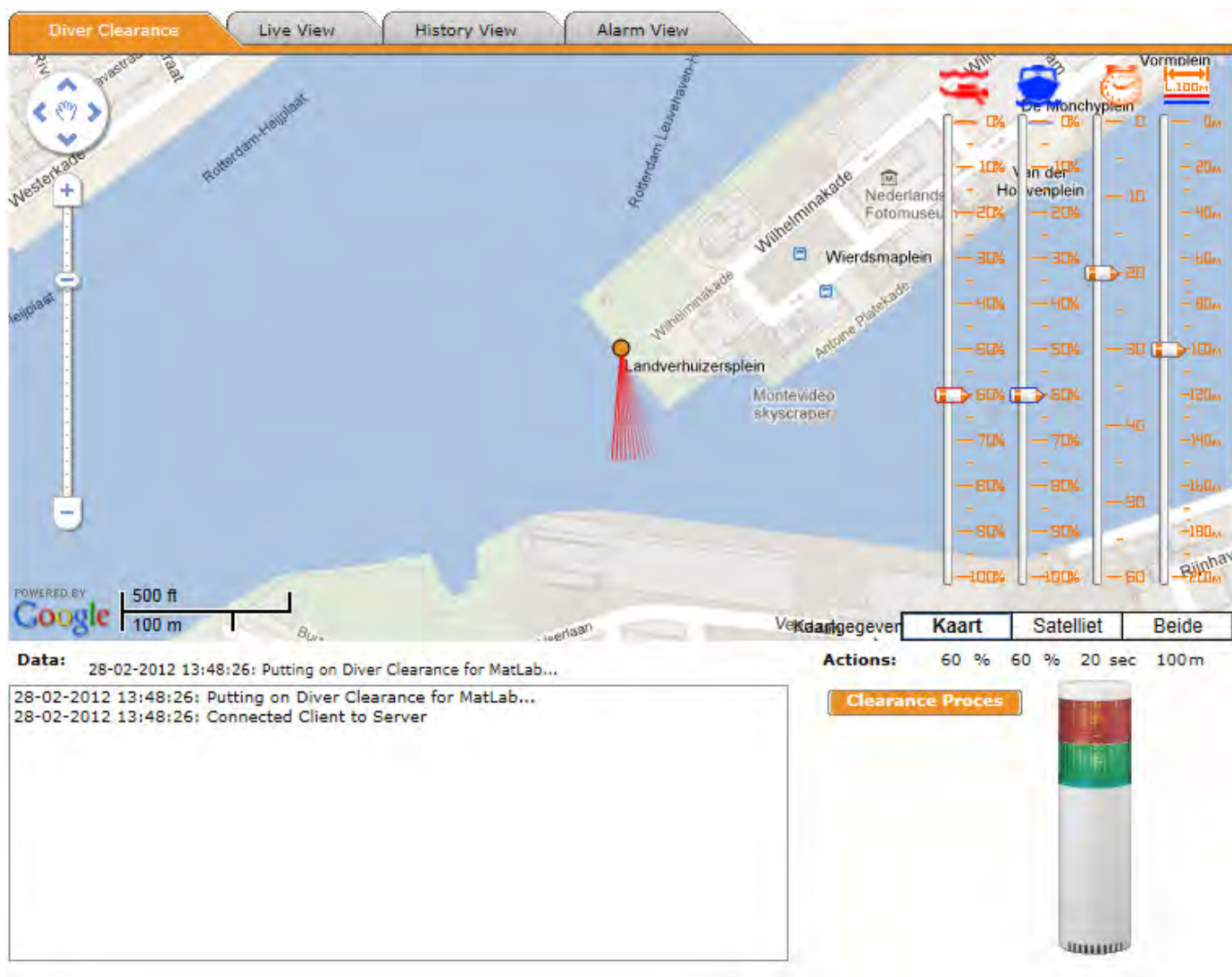




Tracking results for two divers in an operational port environment.
Time progress is from blue to red.



Tracking results for a small, fast (30 knots) boat in an operational port environment.





“WHAT ARE CURRENT DETECTION RANGES WITH SOBEK TECHNOLOGY?”

**IN AN OPERATIONAL PORT ENVIRONMENT:
UP TO 400 M FOR DIVERS
MORE THAN 1 KM FOR SMALL FAST BOATS**

WHAT MORE CAN SOBEK TECHNOLOGY DO FOR YOU?

The first prototype diver detection system can find widespread application. Monitoring

divers is useful for both professional and recreational diving activities. The natural underwater environment can be monitored, to protect the habitat of endangered species (fish, marine mammals) or coral reefs. Wreck diving can be policed, and archaeological underwater sites can be guarded. Yachting or sailing marinas can benefit from an early warning system against thieves approaching from the waterside. Critical waterside infrastructure, such as tunnels, weirs and (nuclear) power plants can be monitored 24/7.

Because of the lower costs of passive sonar technology, wide area surveillance using a network of sensor nodes becomes more economically feasible. That can not only be useful for the protection of coastal areas, but also means added value for vessel tracking systems in shipping lanes. In the military context, passive sonar nodes quickly deployed around, for instance, a frigate can offer waterside security in hostile waters. A navy port can benefit from waterside security, either for a large water area, or for choke point monitoring at a port entrance. In April 2012, we will start working on a worldwide new concept for semi-permanent protection of the waterside.

“WHAT IF THERE IS AN UNFRIENDLY DIVER IN THE WATER?”

THERE ARE DIFFERENT OPTIONS FOR COUNTER MEASURES, DEPENDING ON THE ‘RULES OF ENGAGEMENT’. WE CAN ADVISE ON THESE OPTIONS. FOR INSTANCE, UNDERWATER LOUDHAILERS CAN BE USED TO SEND COMPREHENSIBLE WARNING MESSAGES TO THE DIVER OVER LONGER DISTANCES, PROVIDED THESE ARE PROPERLY USED. TNO HAS PERFORMED RESEARCH ON THE MOST EFFECTIVE USAGE OF THESE DEVICES.

BOOMS AND SENSORS: A NEW DETECTION CONCEPT

Booms are lines of floats used to make a physical barrier on the water surface. They can be used to limit the access to a harbor or to part of it, or to create an exclusion perimeter around a moored vessel. They constitute the waterside counterpart of fences and barriers and share with them a common drawback: unless they are equipped with further instrumentation, booms and fences cannot report if somebody is tampering with them or trying to pass under or over it.





There are solutions to that drawback for fences but not yet for booms. Moreover, booms suppliers see an increasing amount of requests for options to monitor the waterside area and specifically the underwater domain against intruders.

We decided to work together with supplier Bolina Booms, entering into a research partnership. TNO devised a concept to instrument booms with acoustic sensors in order to detect intrusions, for instance of divers passing under the boom. The same sensor can also be used to detect and monitor the surface traffic in the vicinity of

the boom, possibly sending alerts if suspicious or unusual behavior is observed.

This concept is under investigation and the first tests conducted in December 2011 and April 2012 demonstrated the feasibility of the concept.

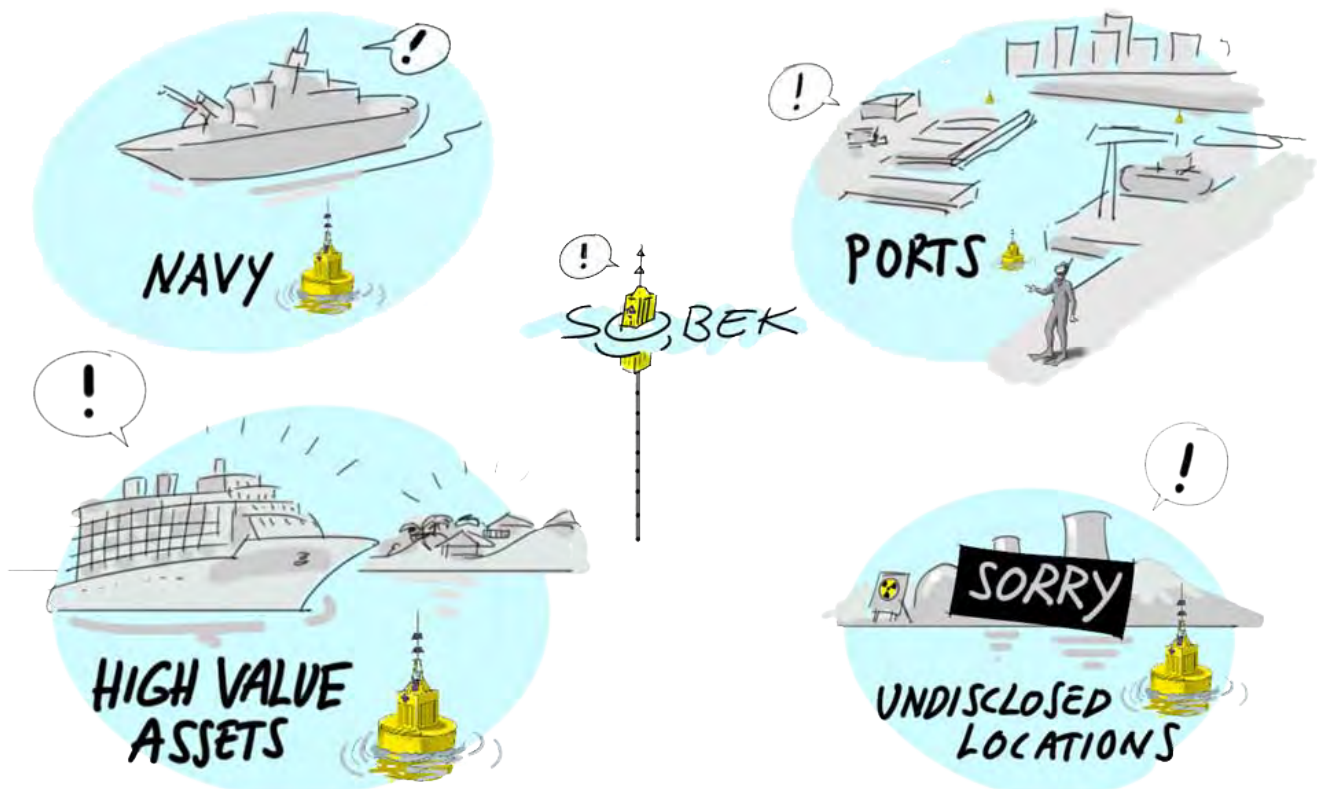
Research on this new concept is supported by Port of Rotterdam.

TNO AND PORT SECURITY

At TNO, we do other research on port security that may be relevant to you. We have expertise on the impact of explosions

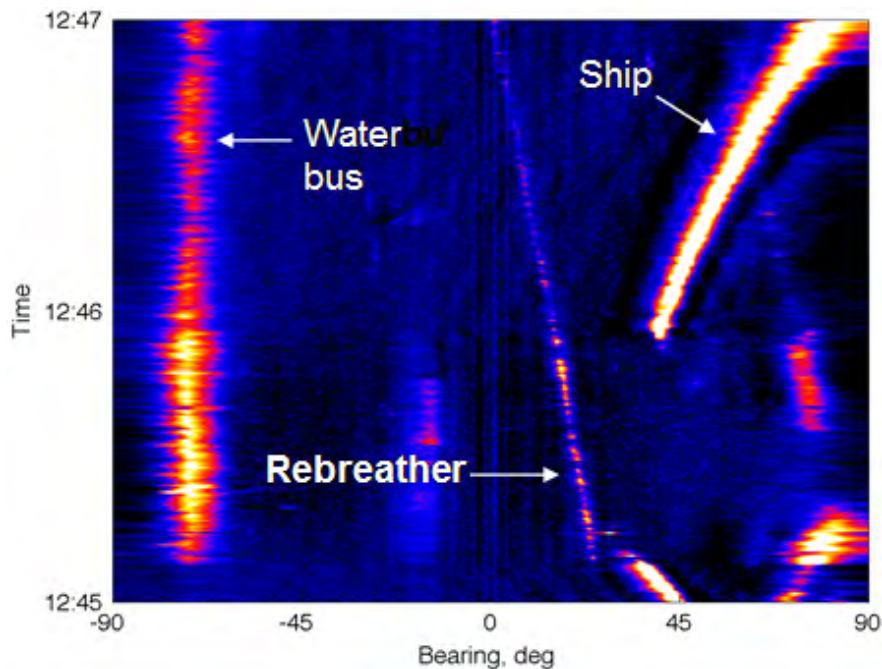
on ships, port infrastructure and premises, relevant to safety and security plans, including response measures. We have in-depth knowledge on both the scientific and operational aspects of several observation technologies such as sonar, radar, electro-optic and camera surveillance. We know how to design, develop and maintain safety and security concepts. We are in close contact with stakeholders in the domain of port security.

TNO strives to apply all this knowledge to enhance the safety of the most important infrastructure hubs in modern society.





SOBEK is environmentally friendly as no sound is emitted that can harm underwater life. This makes it ideally suitable for protecting natural underwater environments – for instance the monitoring of coral reefs, underwater archaeological sites, or maintaining non-diving zones for the habitat of endangered species (fish or marine mammals).



First proof of passive sonar tracking of the a rebreather diver (at 120 m distance) in an operational port environment.

WHAT ABOUT REBREATHING DIVERS?

Some intruders are more difficult to find than others.

In principle, SOBEK technology offers a cost-effective way to detect any intruder that emits sounds signals that are sufficiently audible.

It all depends on how well you can distinguish between the intruder sounds and all other underwater sounds.

In making this distinction, the knowledge of the intruder sound and the sensors used for detection are critical. Although this applies to some extent to any passive detection approach, it is especially important for the detection of rebreathers.

Rebreathers are underwater breathing apparatus optimized to recycle the gas breathed and to limit the acoustic emission. At TNO, we have made careful acoustic characterization of many models of rebreather in order to understand what kind of sounds they produce and how their acoustic emission differ from apparatus to apparatus. This knowledge is used to develop sensor and signal processing approaches suited to the detection of rebreathers.

The research is in progress and, following a recent experiment conducted in April 2012, we are proud to report our first passive detection of a rebreather in a harbor environment. More steps are necessary to turn this research into practical applications, but this encouraging result is a promising first step in the good direction.

ACKNOWLEDGEMENT

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Ministerie van Defensie



Douane
Belastingdienst

AVIC

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TNO is an independent innovation organisation. TNO connects people and knowledge to create innovations that sustainably boost the competitive strength of industry and the welfare of society.

TNO focuses its efforts on seven themes including defence, Safety and Security: Tno works on a safe and secure society by creating innovations for people working in defence organisations, the police, emergency services and industry.

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