



**SAAB**



**CEROS 200**

**Fire control director**



## Excellent defence against any modern threat

*CEROS 200 stealth version onboard stealth corvette Visby.*

### References

CEROS 200 is installed on over 230 ships worldwide, including:

- Visby-class corvettes
- ANZAC frigates
- Skjold-class fast patrol boats
- Al Bushra-class fast patrol boats
- Iver Huitfeldt and Absalon frigates
- Halifax-class frigates
- Naresuan-class frigates

CEROS 200 is a radar and optronic tracking system designed for use on naval ships. When interfaced to semi-active missile or gun systems it provides excellent defence against any modern threat including advanced sea skimming missiles or asymmetric surface threats in littoral environments.

### Open architecture

CEROS 200 is part of the 9LV modular suite of solutions for Command and Control (C2) in naval environments. The 9LV modules are well aligned with open architecture standards for Combat Management Systems (CMS).

The modularity of the 9LV system allows CEROS 200 to be provided not only as an optimally integrated part of the 9LV CMS, but also as a stand alone product or in combination with other 9LV parts.

The flexibility of the CEROS 200 and the 9LV modular open architecture provide advantages for design of modern naval ships as well as for upgrades of existing systems.

### Human machine interface

The optional 9LV Human Machine Interface (HMI) that provides full control of all CEROS features will run on any modern multi function console.

### Defence coordination

CEROS 200 can also be combined with the 9LV gun fire control and SAM modules that provide precision control for any naval gun or SAM missile system. Several CEROS 200, EOS 500 electro optical tracking systems, gun fire control

and missile control modules can be combined in a 9LV weapon control subsystem where the operators dynamically allocate any combination of tracker and weapon for flexible handling of surrounding threats.

For best performance the 9LV defence coordination suite is available for performance based engagement optimisation of incoming threats.

CEROS 200 is available in a Continuous Wave Illumination (CWI) configuration with the 9LV ESSM missile control module. This version has been delivered to Australia, New Zealand, Denmark, Canada and Thailand, and provides an X-band channel for CW illumination of a target for guidance of the semi-active Surface-to-Air Missile (SAM).

### Advantages

For the operators the advantages of CEROS 200 are found in the world class performance in terms of acquisition speed and tracking precision combined with the ability to track any target in any weather situation.

The versatile CEROS 200 tracks supersonic missiles and surface targets extremely well, even close to the ship. This gives the advantage of full performance against any threat, including asymmetric threats in littoral environments.



*CEROS 200 CWI version.*



## CEROS 200 advanced solutions

### Radar design

The coherent radar transmitter provides reliable performance even in poor weather. Depending on the clutter situation and Electronic Countermeasures (ECM) threat the radar selects its frequency agility pattern between: 32-pulse bursts and pulse doppler signal processing, 4-pulse bursts and moving target indication processing, or pulse-to-pulse agility. The pulse repetitive frequency and pulse width are selected depending on the range to the target.

The new digital receiver in combination with the improved signal processing enables a higher degree of flexibility of e.g. pulselength and waveform for adaptation to new threats.

The transmitted pulses are frequency coded and pulse compression in the receiver ensures a high range resolution in all modes.

The radar design incorporates many Electronic Counter-Countermeasures (ECCM) features:

- Very low antenna side lobes
- Very wide bandwidth
- A large number of transmit frequencies
- Random selection of frequency
- Lock on jam, track on jam

### Video tracker

The CEROS 200 has an advanced video tracker to enhance the passive modes; passive search, detection and tracking. It includes sensor fusion, i.e. simultaneous TV and IR tracking, correlation tracking and background suppression.

Up to four simultaneous targets are automatically detected during acquisition and tracking within the field-of-view. This allows the operator to easily acquire and change target within fractions of a second.

### Advanced tracking filters

CEROS 200 uses advanced multi hypothesis Interacting Multiple Model (IMM) filters to provide optimal tracking of any target.

### Stealth technology

The stealth version is specially designed for ships optimised for low radar cross section. It uses a combination of techniques: flat, inclined metallic surfaces, a frequency selective surface in front of the antenna, and radar absorbing material.

The result is a very low radar cross section over a multi-octave frequency band. This enables the fire control director to be mounted above deck even on board the most extreme stealth vessels.

## CEROS 200 versions



BASELINE



CWI



STEALTH

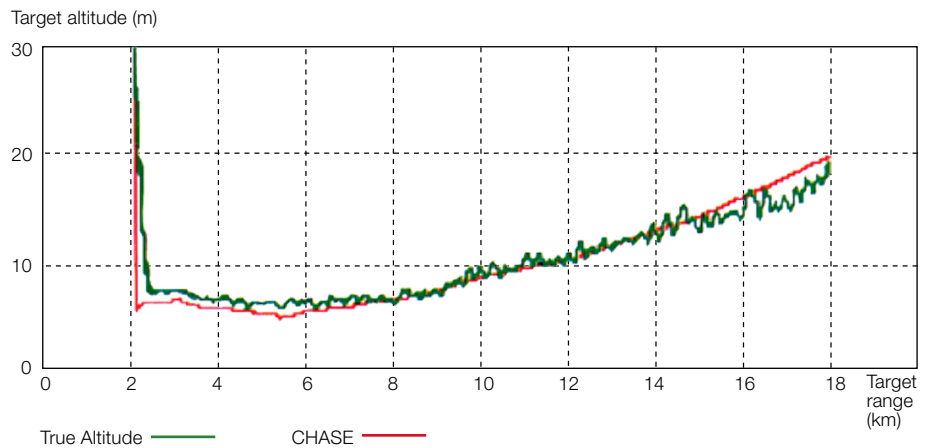


LIGHT-WEIGHT

## Sea skimmer radar tracking

The CEROS 200 incorporates CHASE, which is a patented method for processing of the complex radar target return signal from a very low flying target, such as sea skimming missiles, to eliminate multipath effects. A prerequisite for the CHASE algorithm is the very wide RF-bandwidth of the tracking radar on the CEROS 200.

The CHASE algorithm has been thoroughly tested in a wide range of sea states against a missile-like towed target with a built-in altimeter to allow controlled flight at altitudes between 6 and 50 metres. The result of a typical test run is shown in the plot. CHASE radar tracking is the red curve and true altitude is the green. The extensive testing proves that the radar tracking accuracy of the CHASE method against sea skimming targets is better than 0.2 mrad in calm sea and better than 0.4 mrad in rough sea.



## Gun fire control accuracy

The CEROS 200 provides unparalleled accuracy for gun engagements. The figure to the right illustrates firing results obtained by the Royal Swedish Navy during sea acceptance tests of the 'Göteborg' class corvettes.

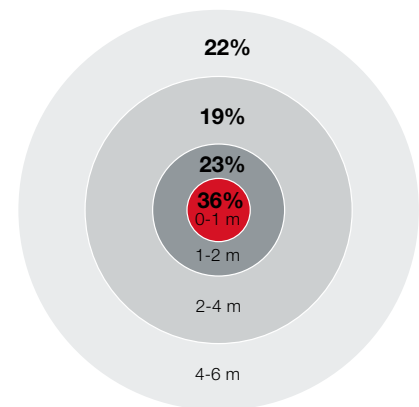
A total of some 200 rounds were fired at ranges between 1800 and 3000 m. Both Bofors guns, the forward 57 mm Mk2 and the aft 40 mm L/70, were controlled by both CEROS Directors in all combinations.

The tests were conducted in all types of weather and in sea states from 0 to 4/5 against targets at various aspects.

Analysis of the results indicate that 100% of fired rounds passed within 6 m of the target and more than 50% within 2 m. With the proximity fused ammunition this leads to very effective target engagements

Translated to angular dispersion this means an overall polar dispersion of approx. 1 mrad (which includes all contributions to accuracy such as tracking, prediction, gun laying, and ammunition influences). Similar results have been reported by other Navies using different guns.

*Results courtesy of FMV, the Swedish Defence Material Administration, Ship's Electronics Division.*



## Technical data

### Stabilised platform

The new generation of the CEROS 200 is based on the experience from deliveries of more than 200 fire control systems to navies world-wide and successful operation in all waters from arctic to tropical. The CEROS 200 has been thoroughly tested against the toughest naval MIL-specifications for shock, vibration, electromagnetic interference and electromagnetic compatibility.

### Tracking radar

Frequency range: Ku-band, 2 GHz  
Pulse compression: Frequency coded  
Very wide radar bandwidth (12%) which enables high tracking accuracy, long detection ranges and ECCM.

### Antenna

Type: Cassegrain with multimode feed, 1 m antenna dish, beam width: 1.5°

### Transmitter

Number of frequencies: More than 100  
Transmit patterns: (pulse doppler: 32-pulse batches), (moving target indication: 4-pulse batches), (frequency agility: pulse-to-pulse frequency agility)

### Receiver

Type: 3-channel amplitude monopulse digital processing.  
Compressed pulse width: 0.2 µs in all modes

### TV-camera

Type: CCD sensor  
Output: Colour or B/W  
Field-of-view: 1 to 2 fixed FOV's

### IR thermal imager

Type: 4th generation  
Wavelength band: 3-5 µm or 8-12 µm

### Laser rangefinder

Wavelength: Eye-safe region  
From single shot to high pulse repetitive frequency, necessary against manoeuvring targets.

### Stabilised platform

Type: 2-axis, elevation over azimuth  
Angular speed: 2.5 rad/s  
Angular acceleration: Azimuth 7.4 rad/s<sup>2</sup>, elevation 10.5 rad/s<sup>2</sup>

### Dimensions and weight

Height above deck: approx. 2 metres  
Diameter: approx. 1.6 metres  
Weight: 625-750 kg depending on version

### Additional equipment

Hydraulic Pump Unit, Dry Air Unit  
Military specification 19-inch cabinet

Specifications subject to change without notice.  
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