Underwater lighting simulation

This software has been developed in collaboration with IFREMER (French Institute of Marine Research and Exploration) to help them in their oceanographical research. It has been validated by the company ECA in the field.

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1. Presentation

The software SPEOS enables the user to simulate the volumic diffusion of light in various environments, including under water.

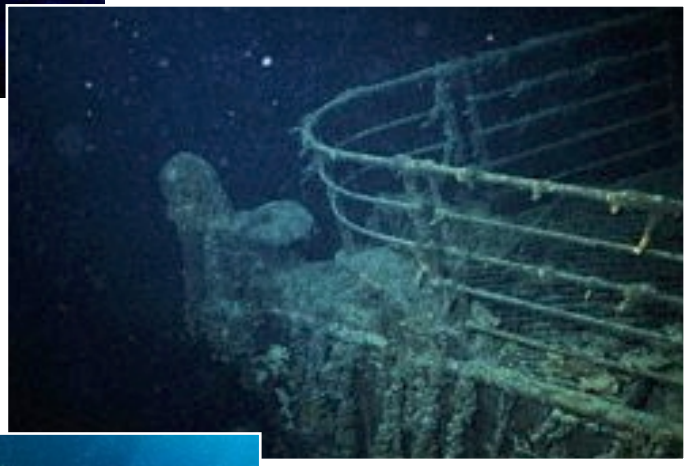
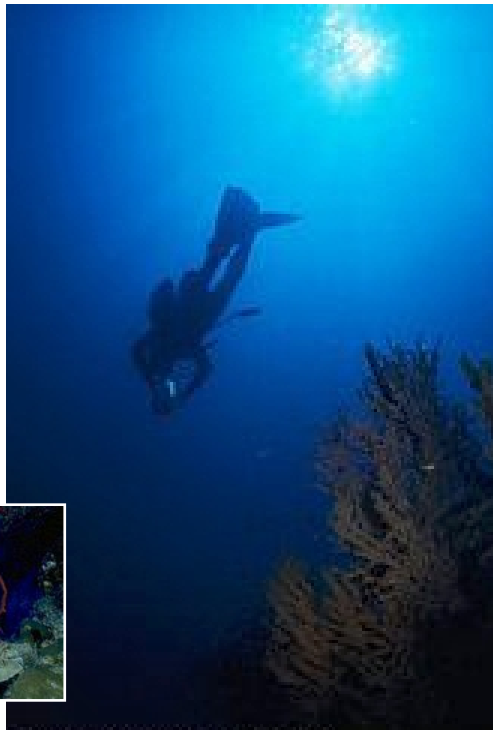
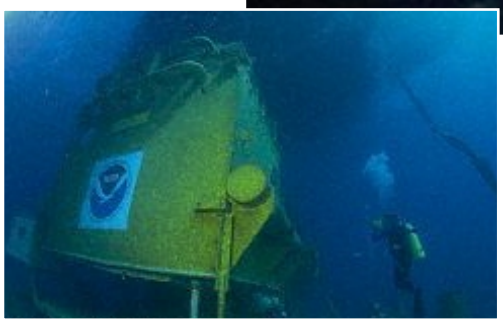
After having imported the scene to be lit, the user can define the properties of the different surfaces, the properties of water and finally position the projectors in the scene.

After having carried out a simulation, the user can either obtain photometric measurements such as illuminance and luminance, or study the image or video sequence of the lit scene.

2. Applications

The applications for this type of simulation are numerous :
- Evaluation of the efficiency of an underwater lighting system
- Optimisation of an underwater lighting system
- Help with the choice of characteristics of cameras (sensitivity)
- Creation of realistic images or video sequences
- Help with the design of mine detection systems by visible means (infra red lighting, visible, UV, different types of lamps or lighting etc)

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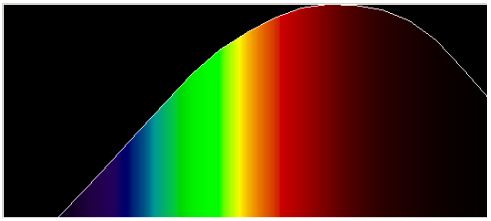
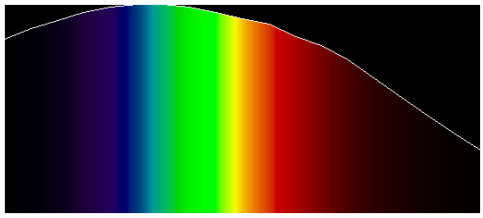
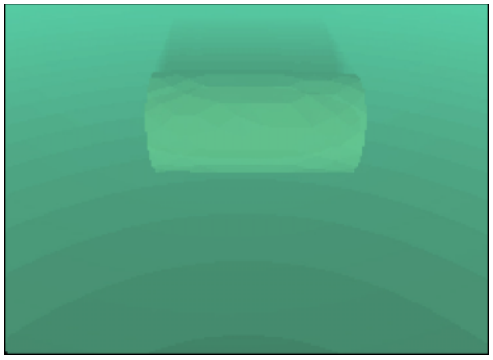
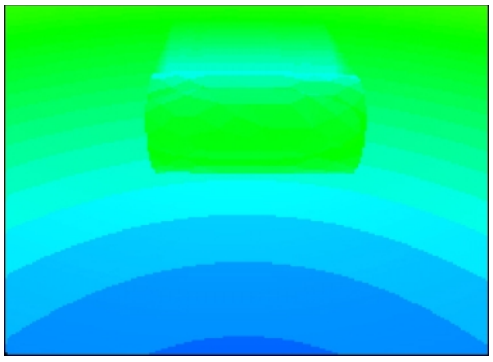
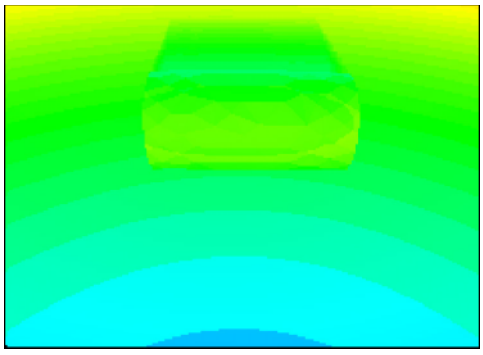
3. Example : Comparaison of 2 types of lamps

3.1 Presentation

In this example we compare the efficiency of two types of lamps (Halogen and HMI) for underwater use.
We have kept the flux and the same intensity diagram for both lamps.

3.2 Simulations

Lamp	Halogen	HMI
Spectrum		
Display in real color		
Display in false color		
Luminance	Luminance = 1.99 cd	Luminance = 2.30 cd

3.3 Conclusion

The spectrum of the lamps is very different. The absorption of the water depends mainly on the spectrum. Using an HMI lamp enables us to increase the contrast as can be seen on the images in real color.
The images in false color are even more representative of the importance of the choice of the lamp because they show the levels of illuminance.
This is confirmed by the simulation of luminance which shows an increase of 15%.

This simulation highlights the fundamental role played by the choice of lamps in the definition of an underwater lighting system.

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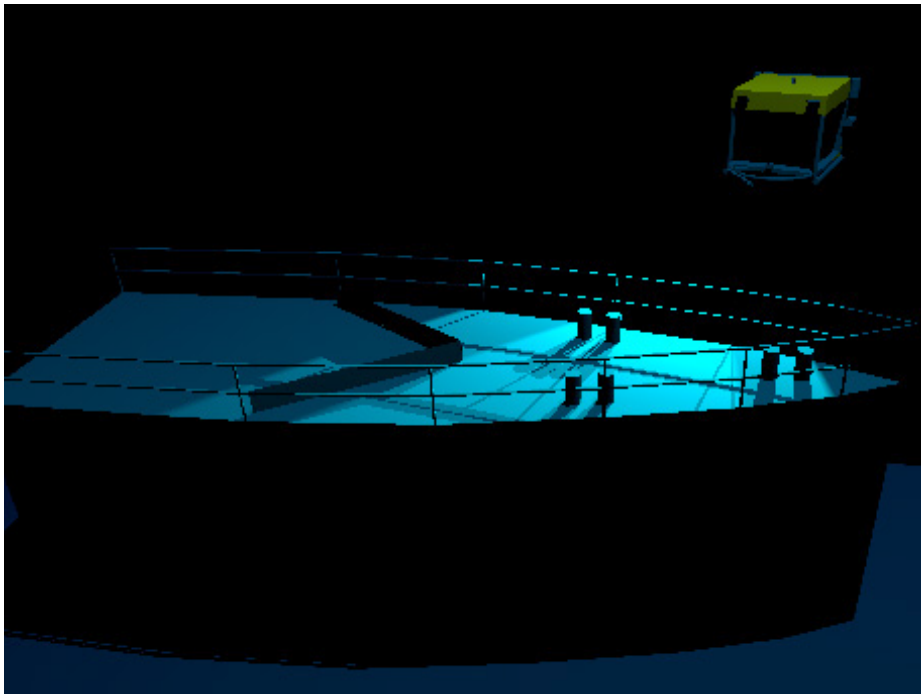
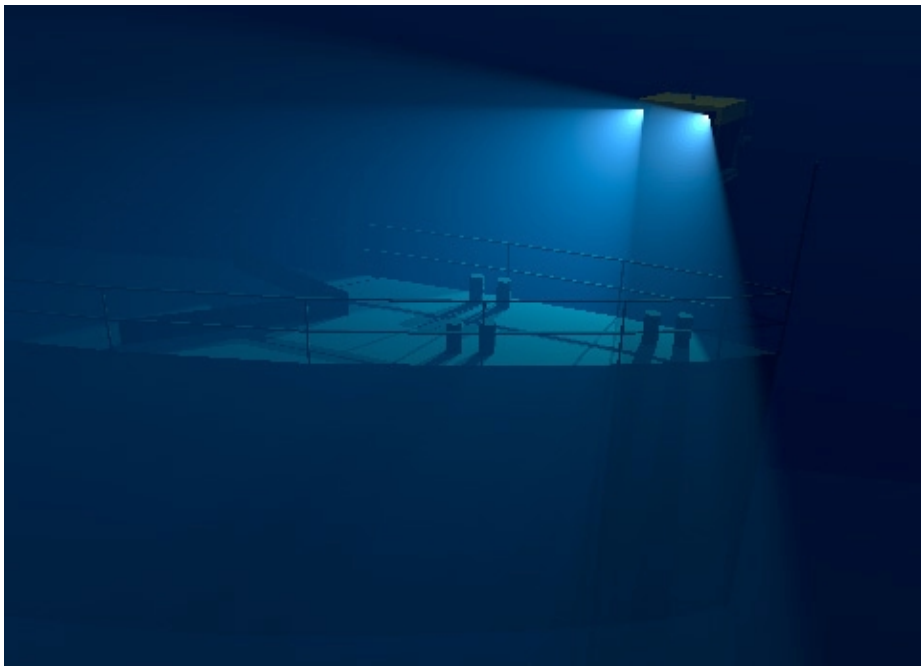
4. Example : Importance of volumic diffusion in underwater lighting

To demonstrate the importance of volumic diffusion in underwater lighting we have carried out a simulation of the same scene with and without volumic diffusion.

Scene without volumic diffusion



Scene with volumic diffusion



Not only does volumic diffusion play an essential role in the realism of the rendering of the lit scenes, the performances of an underwater lighting system depend directly on the properties of the water.

In the case of very choppy water, the quantities of light diffused can be much greater than the quantities of light reflected. It is thus essential to take into account the phenomenon of volumic diffusion.

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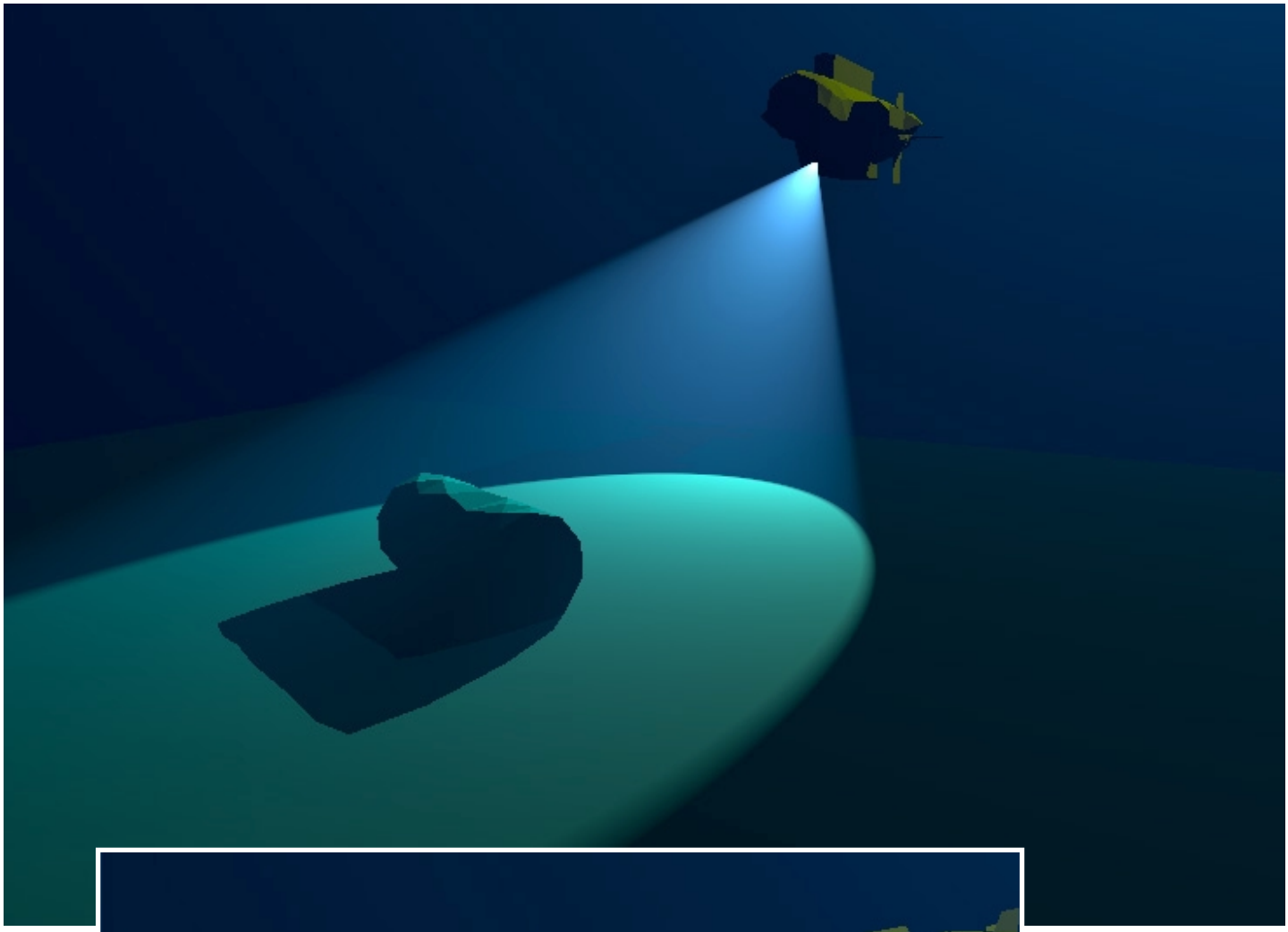
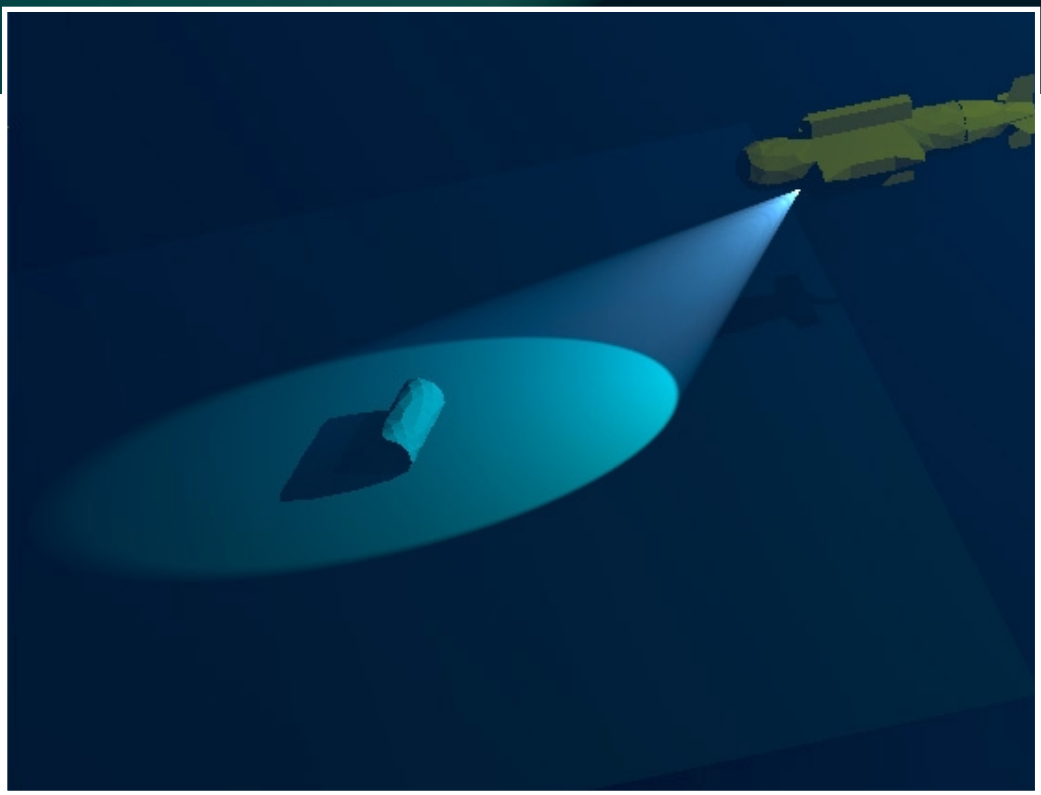
5. Example : the lighting of an obstacle from 2 angles





These simulations demonstrate the influence of the position of the lighting system in the detection of an object.

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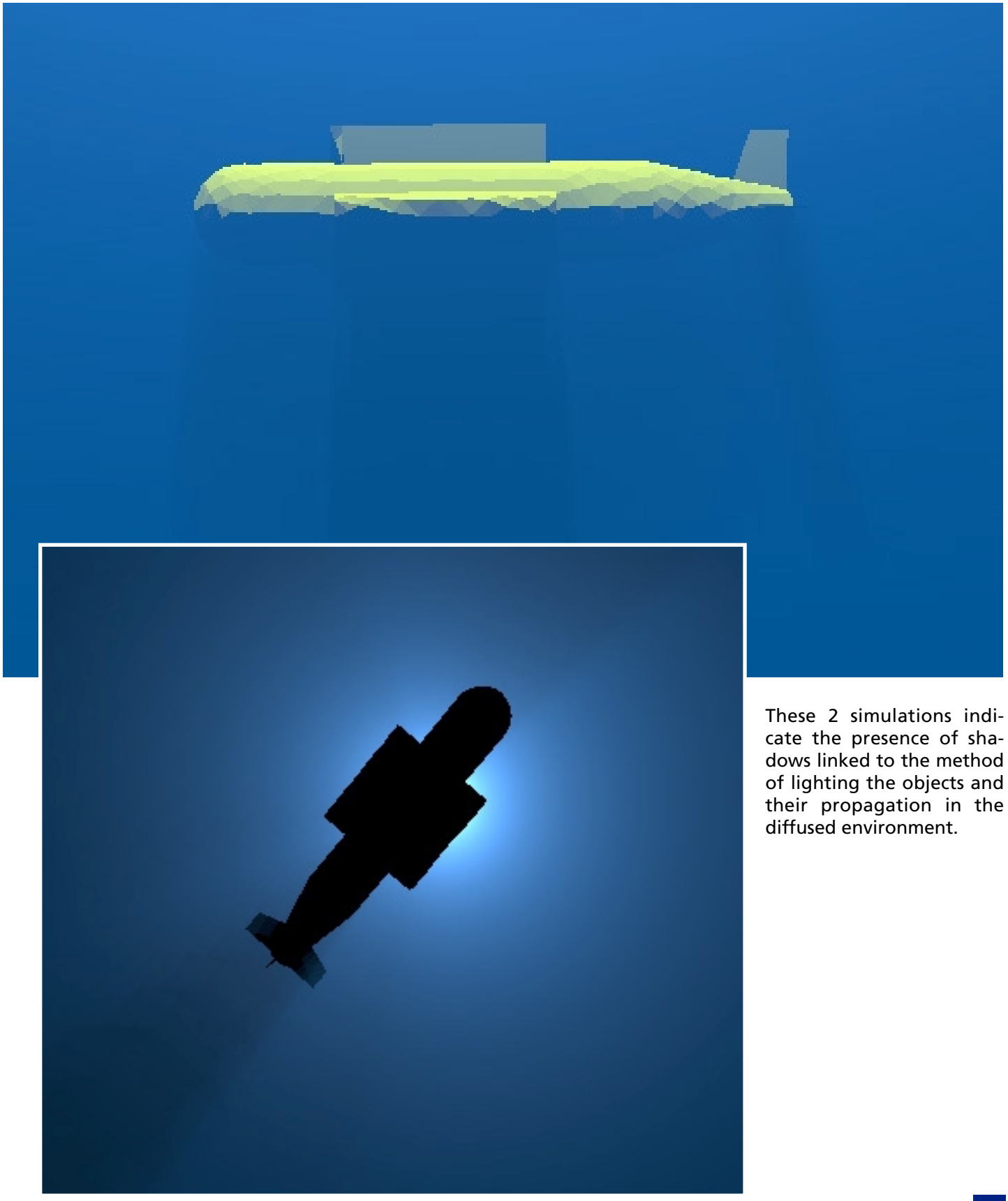
6. Example : The influence of shadows



These 2 simulations indicate the presence of shadows linked to the method of lighting the objects and their propagation in the diffused environment.

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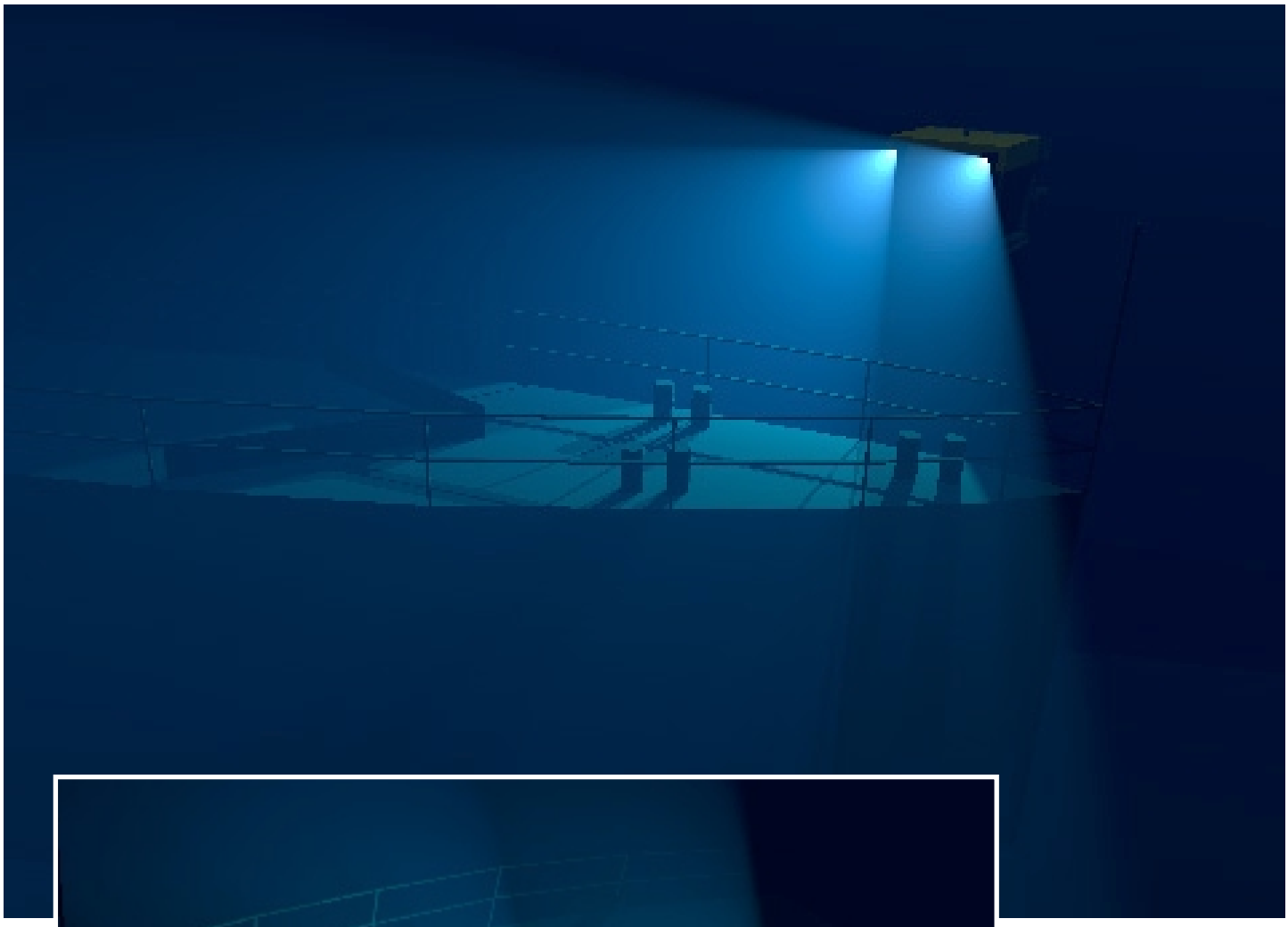
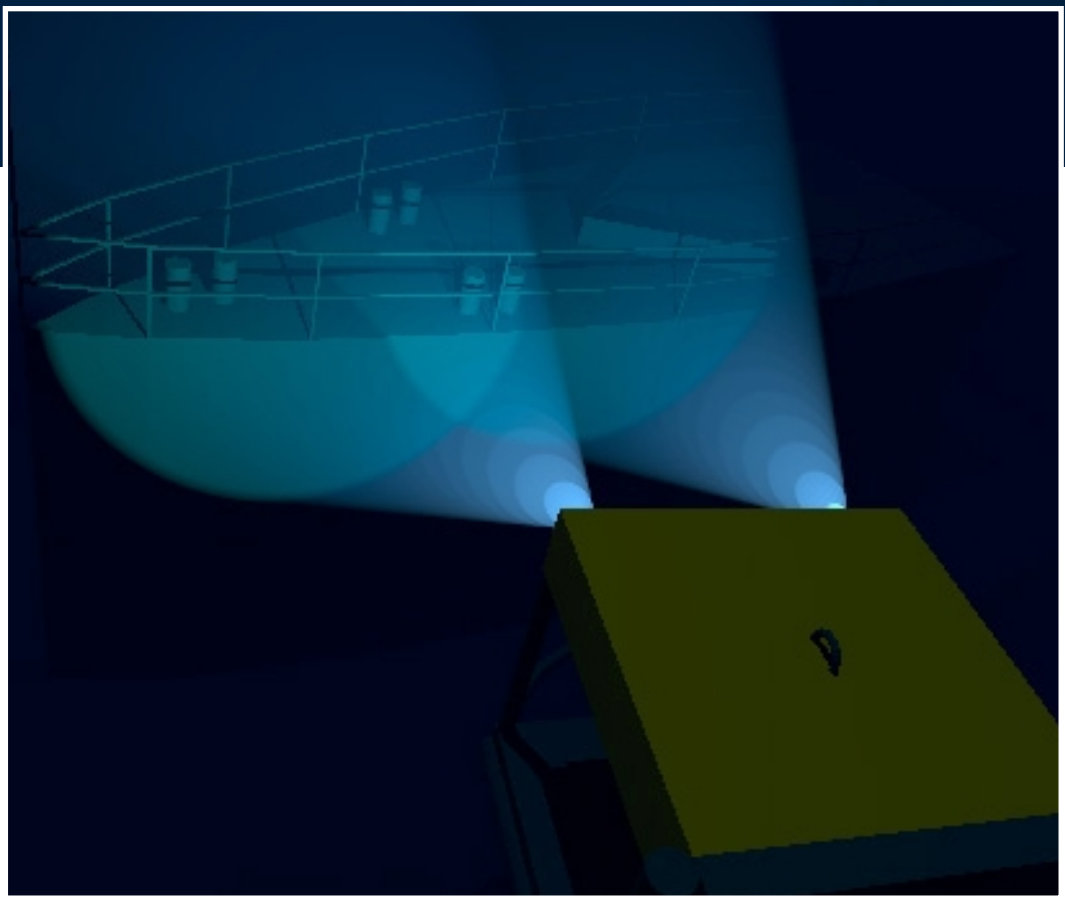
7. Example : Taking into account details





These 2 simulations show that a high level of detail can be taken into account in the simulation but that the highlighting of these details also depends a lot on the diffusion of light and on the way in which the scene is lit.

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8. Possibilities of the software

Photometric calculations
- Calculation of illuminance
- Calculation of luminance
- Calculation of colorimetry (XYZ, xyY, Lab, Luv)
- Control of radiometric and photometric measurements

Lighting
- Compatible with photometric data formats of IESNA LM-63 and Eulumdat
- Taking into account of natural light

Modelling
- Surface diffusion
- Volumic diffusion
- Spectral modelling (light sources, surface, surrounding environment, results)
- Camera (sensibility, spectral response, optical characteristics)

Import
- DXF (AutoCAD)
- IGES
- STEP
- VRML

Export
- Export of images in BMP format
- Export of videos in AVI format

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