

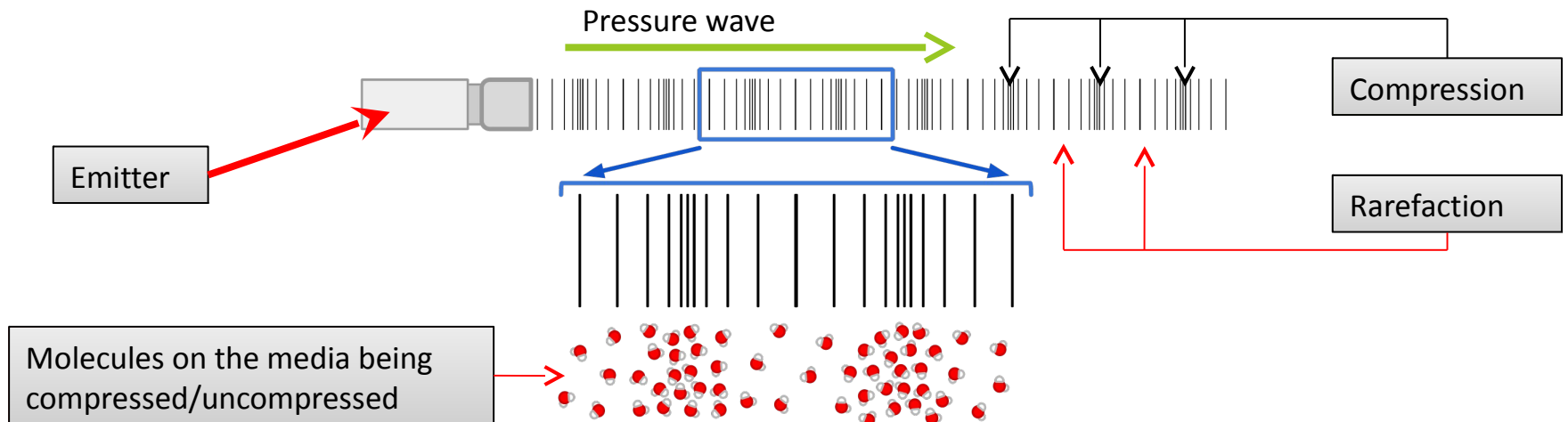
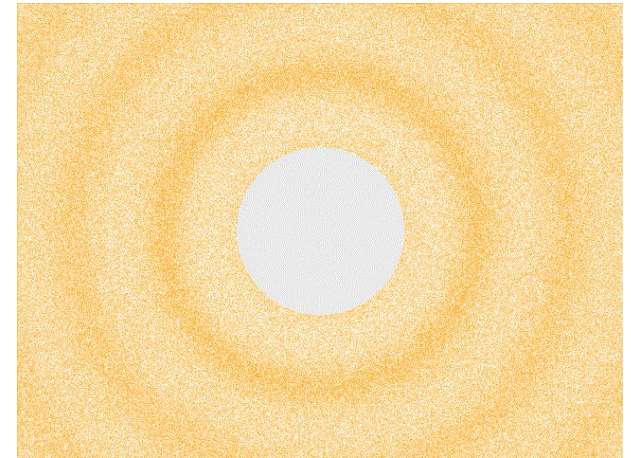


Ultrasonic treatment working principles & research

The sound: a pressure cyclic wave across the media

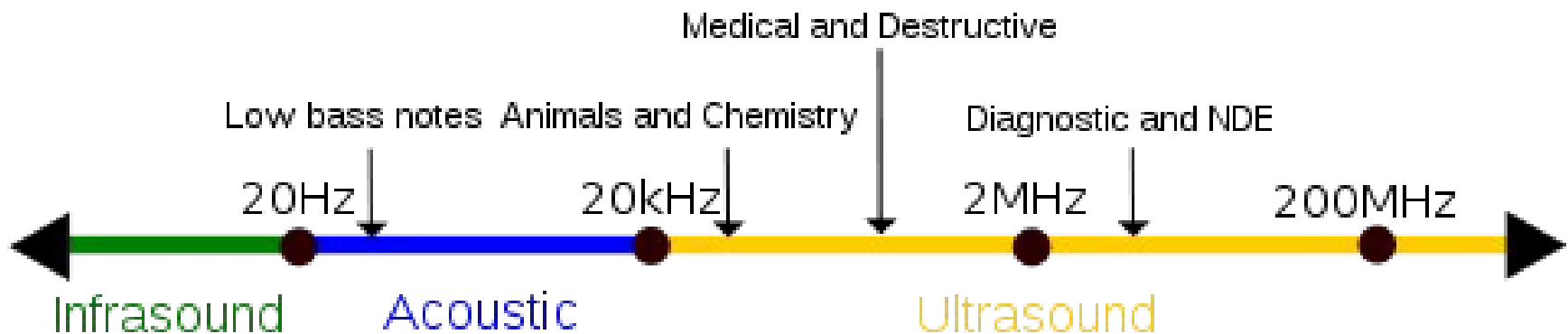
Sound is:

- A mechanical wave.
- A pressure oscillation through a solid, liquid, or gas.
- Composed of frequencies within the range of appreciation.



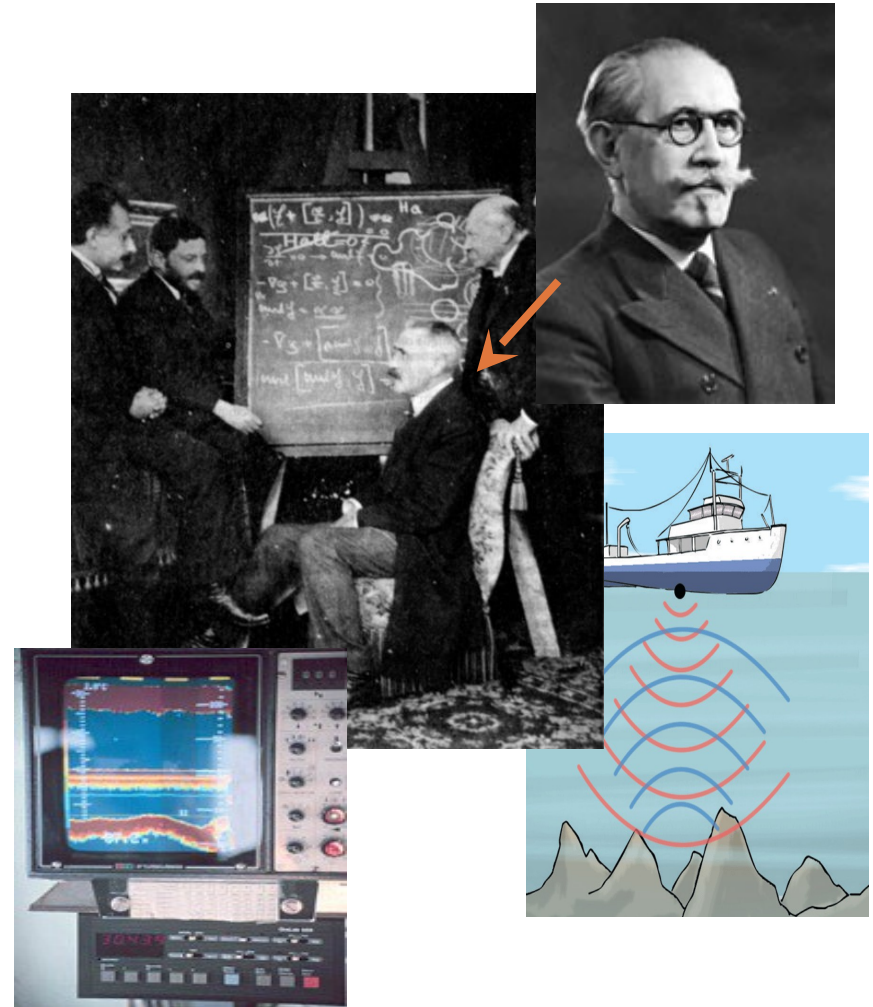
Ultrasound: what does it mean?

- Ultrasound is a cyclic sound pressure wave.
- Its frequency greater than the upper limit of human hearing (between 20Hz and 20,500Hz).
- Beyond this frequency we talk about ultrasound range (freq>20kHz).

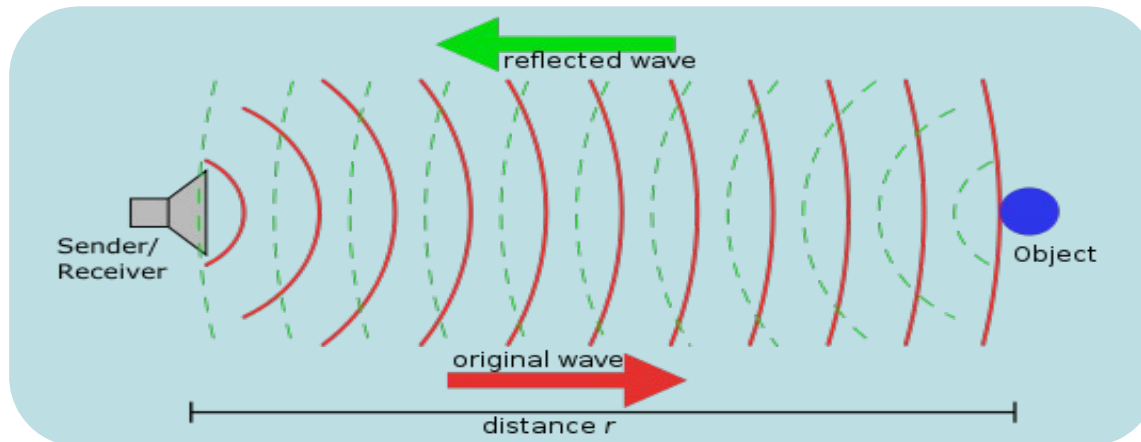


Algae and ultrasound

- In 1916 and 1917 Paul Langevin and Chilowski filed two US patents disclosing the first ultrasonic submarine detector using an electrostatic method (singing condenser) for one patent, and thin quartz crystals for the other.
- The amount of time taken by the signal to travel to the enemy submarine and echo back to the ship on which the device was mounted was used to calculate the distance under water.



- While developing the sonar system he observed that the algae in the experimental set doesn't grow and biofilm gets reduced.



Water sonar tank experimental set

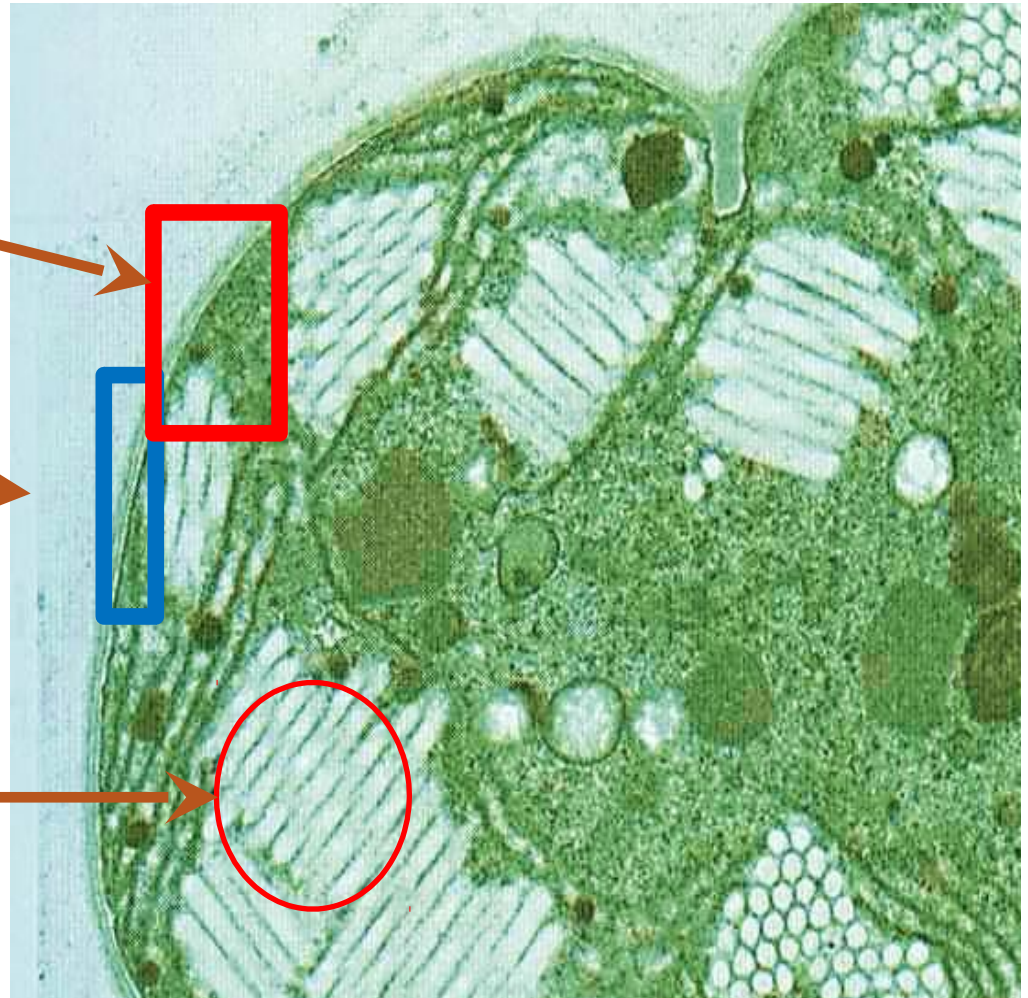
Biological activity reduced
Less algae
Less biofilm

- He saw that micro-biological organisms exposed to ultrasound waves died.
- Ultrasound in water can kill the algae growing, that is a fact but, how this happen?

Algae and ultrasound: preliminary biology concepts

Cell parts:

- Membrane: controls the movement of substances in and out of cells.
- Cell wall: provides the cells with structural support and protection.
- Gas vesicles: provides buoyancy to these cells by decreasing their overall cell density.



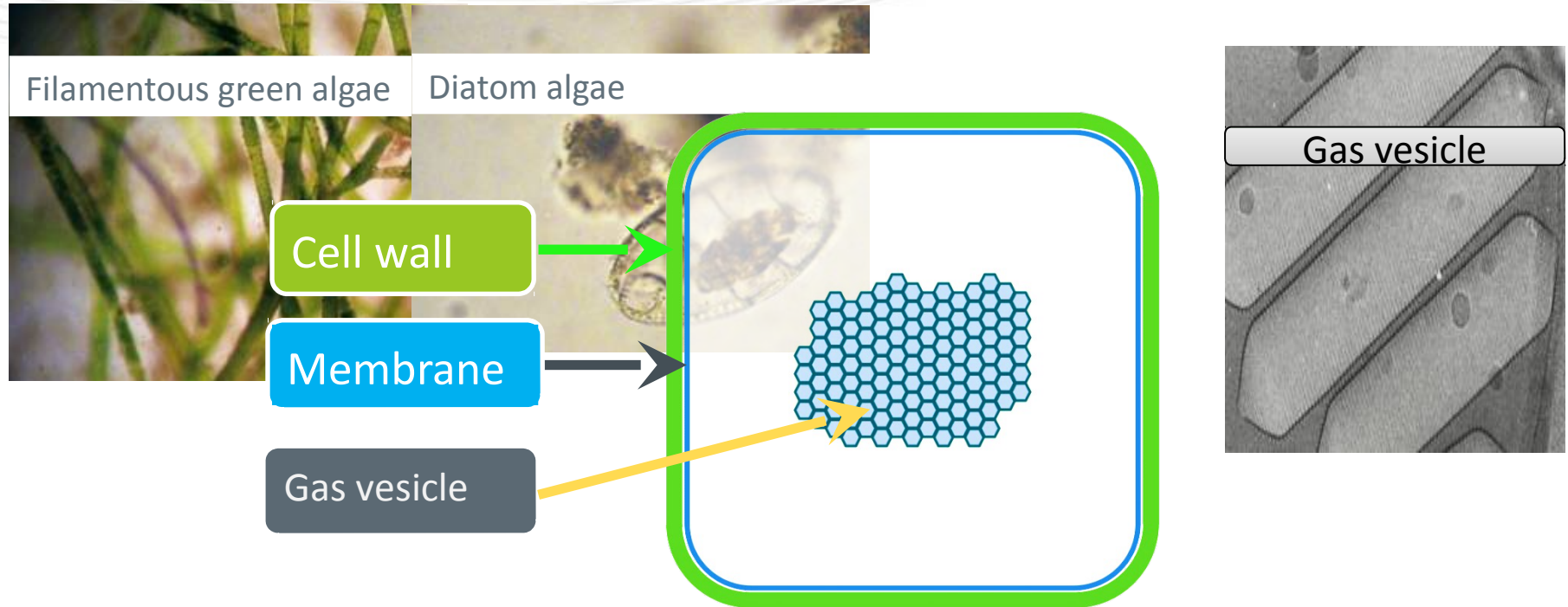
Algae and ultrasound:

What happens with the ultrasound?

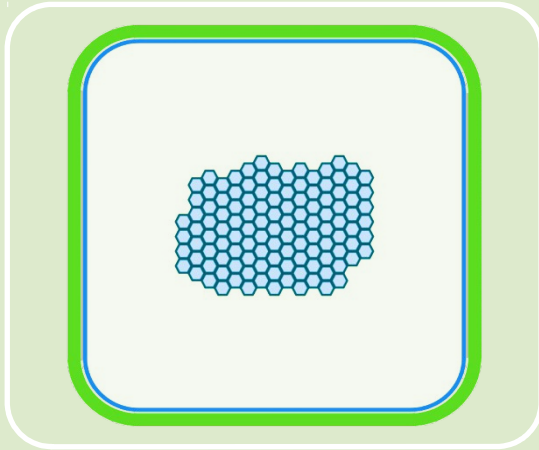
- Liquids such as water are considered resistant to compression, but not the gas inside the algae cell.
- The gas inside the gas vesicle is compressible, affecting to the gas volume depending on the pressure experimented.
- The sound in a media (e.g., water) is a pressure wave.
- So, if the algae is formed by liquid substances (such as cytoplasm), solid matter (Golgi apparatus, ribosomes, cytoskeleton, etc.) and gas vesicles susceptible to compression:

Micrograph by H.
S. Pankratz.
Magnification
x31,500

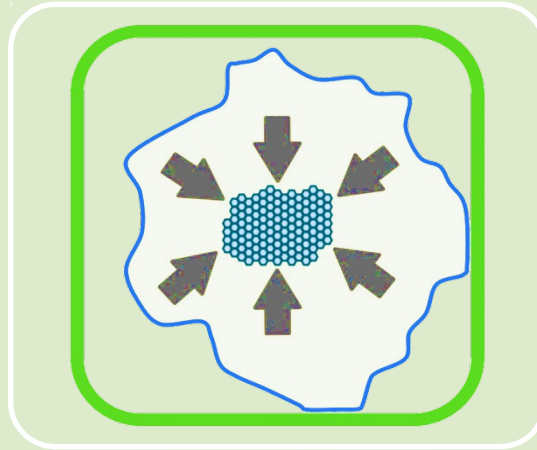
What happens when pressure sound waves affects the volume of the gas vesicle but not the surrounding organs inside the algae?



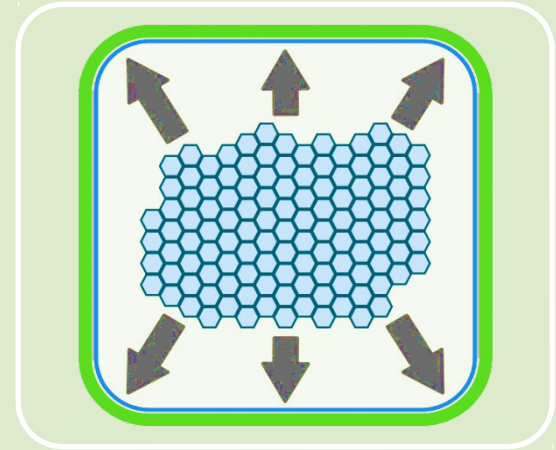
- The gas vesicle volume varies depending on the pressure while the cell wall, which is rigid, remains structurally stable.
- The membrane is flexible, so any variation in the internal structure of the cell affects this, but not the cell wall.
- Then, the change in volume of gas vesicles may fragment the union between the cell wall and plasma membrane.



At normal pressure the union between the cell wall and the membrane remains stable.

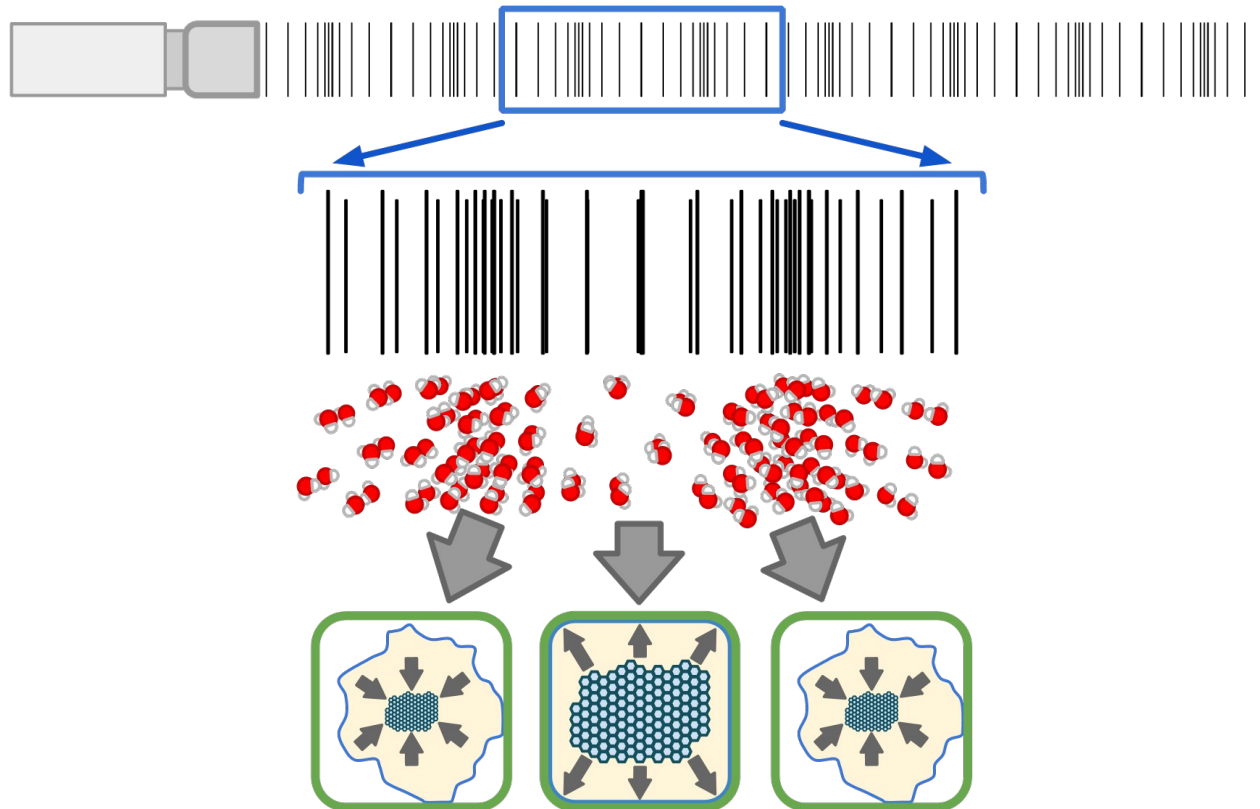


When the pressure goes up the volume of the gas vesicle gets reduced. That breaks the union between the rigid cell wall and the membrane.



When the pressure goes up the gas vesicle gets expanded so the membrane over fits the cell wall.

- This rupture between the membrane and cell wall prevents the leakage of nutrients into the cell getting as a final result the cell death.
- This phenomena affects to the cell structure on the algae and bacteria (biofilm) but the effect of ultrasound on different cell structures is likewise not representative because of the absence of the gas vesicle.

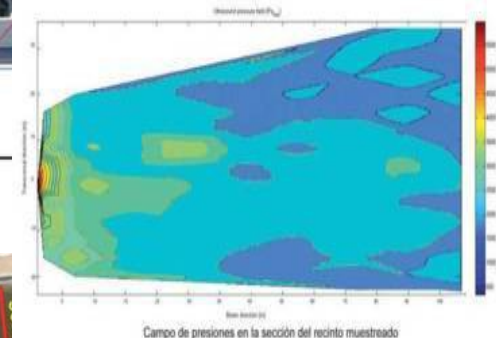


DUMO ultrasonic devices: Algacleaner

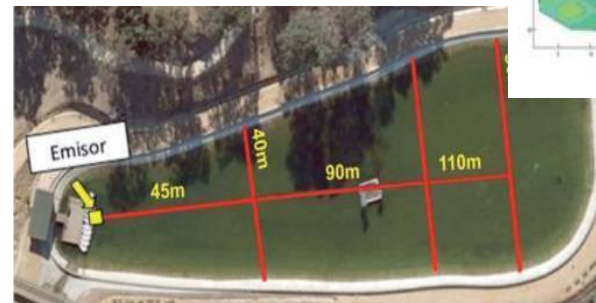
- Based on this phenomena, Toscano started to develop their own ultrasonic device for algae control.
- Toscano is an electronic manufacturer of water control equipment. As an expert in this area Toscano wants to gets a remedy to algae bloom which affects the water pumps, irrigation systems and other environmental problems. Under this circumstances.



Sonda móvil y sus componentes.



Campo de presiones en la sección del recinto muestreado



DUMO ultrasonic devices: research & engineering

- Cooperation agreements with European and local universities.
- New DUMO Algacleaner has been developed, supported and verified by different Physics and Biological authorities.



DUMO ultrasonic devices: the algae problem



Algae bloom

Adverse effects

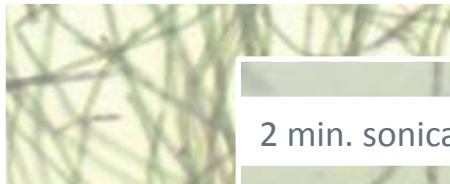
- Many facilities are severely compromised (pumps, pipes, sprinklers, etc).
- Odours occur because of bacteria.
- The resulting decrease in dissolved oxygen in water increases the mortality of fish and insects.
- Some types of algae produce neurotoxins, a very harmful biological impact on the environment.
- Health problems in swimming-pools, contaminated cooling towers, etc.

DUMO ultrasonic devices: Toscano labs

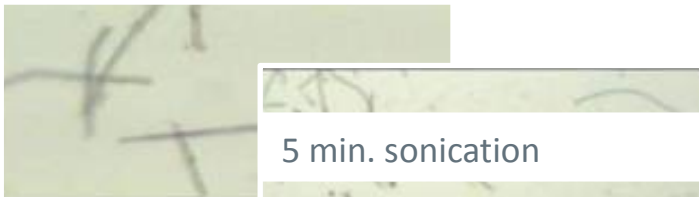
Tests shown by Toscano research and according to the reports from the Bioindication Group of the University of Seville, the breaking of filaments and the destruction of algae cells.



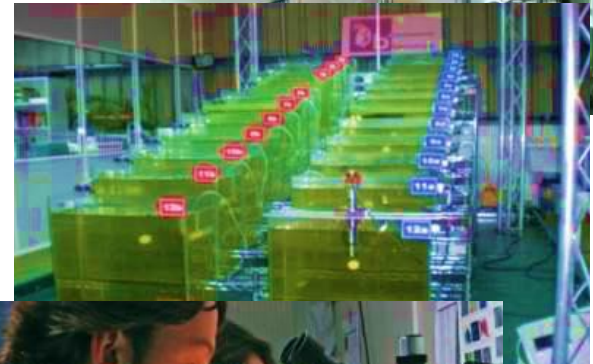
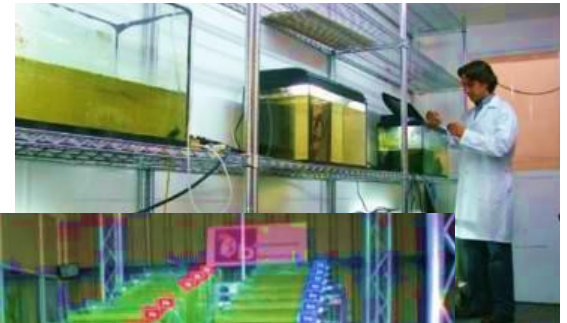
No ultrasound



2 min. sonication



5 min. sonication



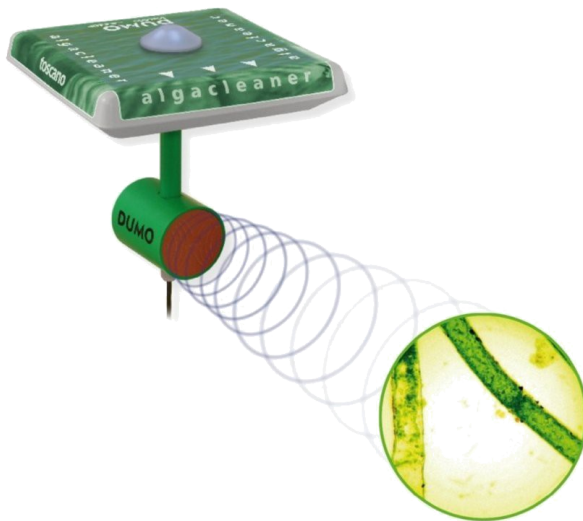
DUMO ultrasonic devices: Toscano labs



DUMO ultrasonic devices: R&D success



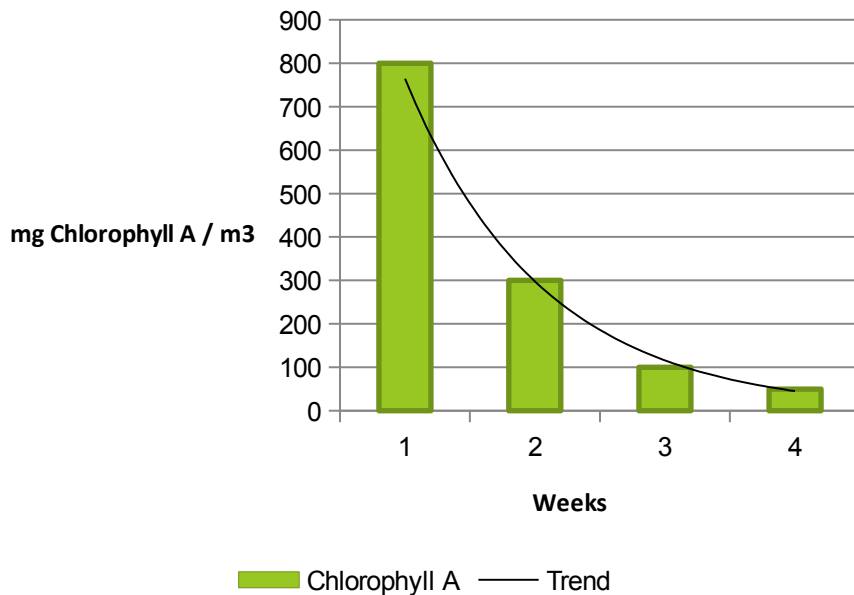
As a final result of Toscano R&D team, investigating the ultrasonic science and the biological algae and bacterial nature, we got...



DUMO Algacleaner

DUMO ultrasonic devices: results of Algacleaner

Destruction Release of chlorophyll A

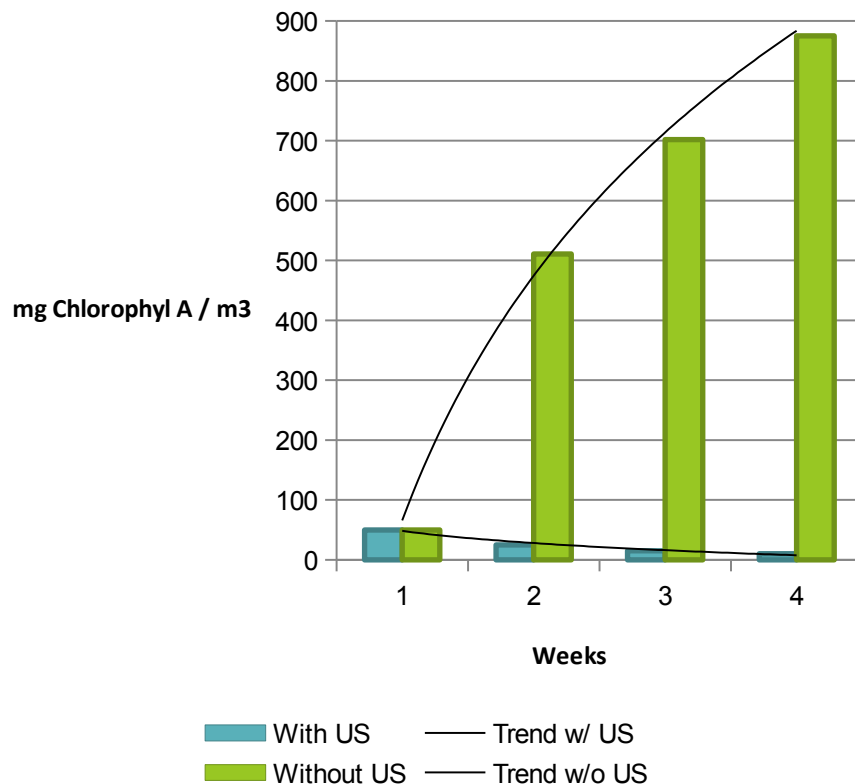


- The destruction of the cells causes the release of chlorophyll to the medium.
- The analysis shows a decrease in mg of chlorophyll A, and in the number of cells.



DUMO ultrasonic devices: results of Algacleaner

Inhibition Release of chlorophyll A



- Chlorophyll A naturally increases without the application of US.
- When DUMO Algacleaner is applied to, chlorophyll A density not only maintains but reduces in medium volume.

DUMO ultrasonic devices: Algacleaner benefits

- Controls and prevents the emergence and growth of algae and biofilm.
- Avoid chemical biocides
- Low power consumption. Solar-powered available.
- Application of several ultrasonic frequencies for different algae species.
- Easy installation and maintenance.
- Safe for humans, animals and plants.

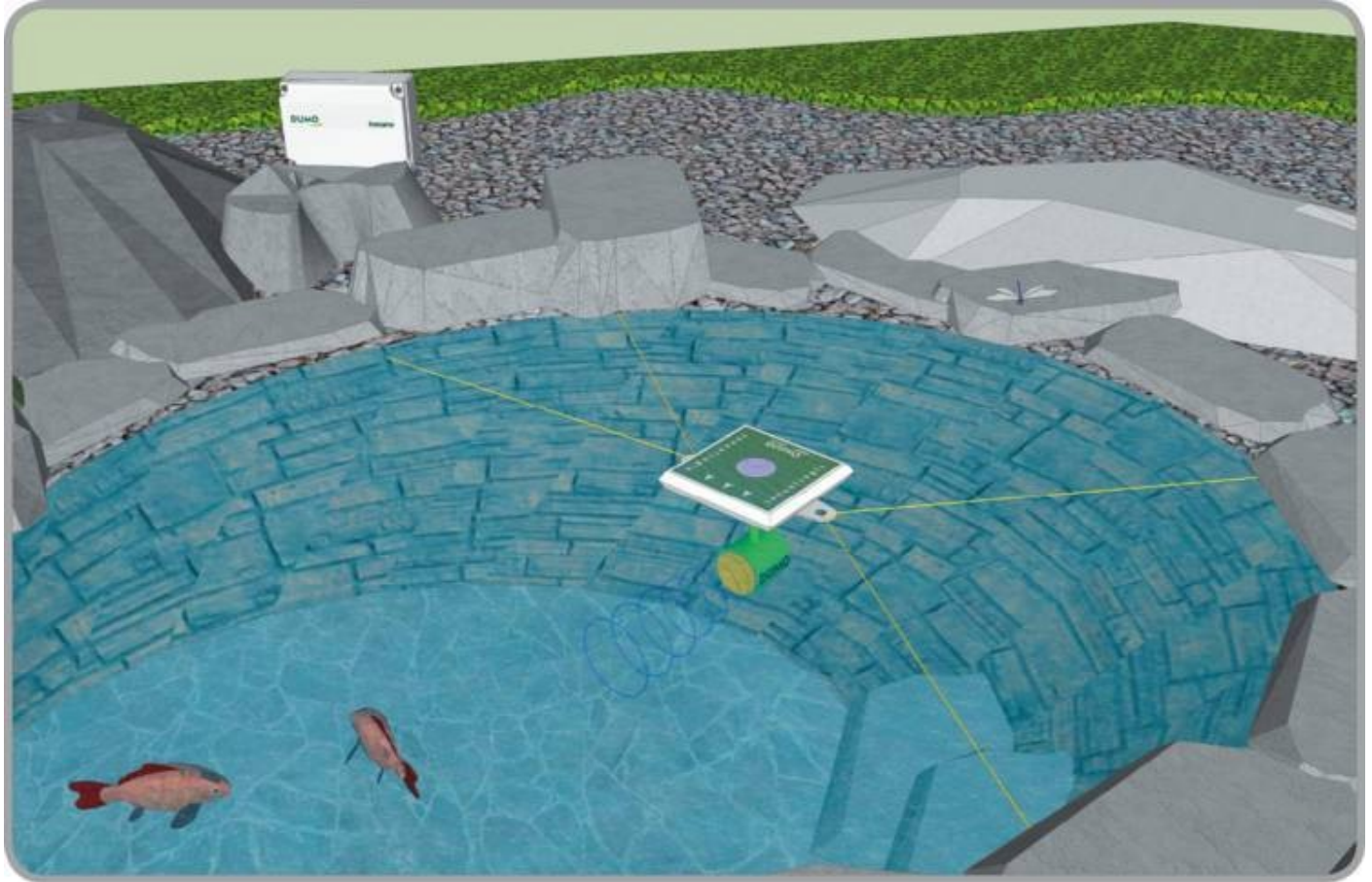
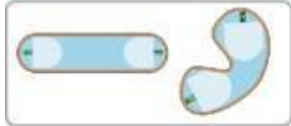


DUMO Algacleaner: certified production

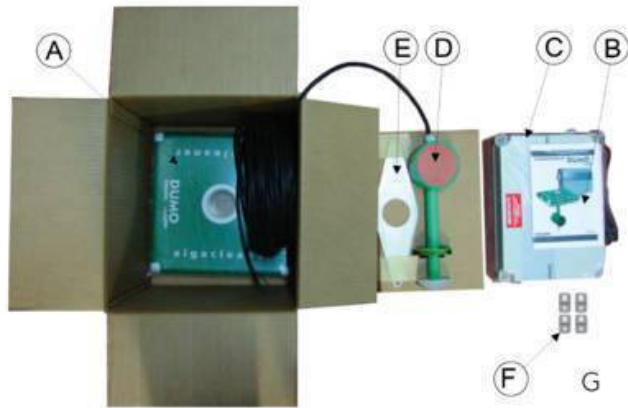
The manufacturing process of DUMO Algacleaner is performed under environmental and quality standards (ISO14001 and ISO9001).



DUMO Algacleaner: installation



DUMO Algacleaner: specifications



- A) Float
- B) User manual
- C) Control box
- D) Transducer and cable
- E) Stainless steel anchorage
- F) Fixing clamps

	AC 180	AC 60
Power AC	110-230VAC / 24VDC	110-230VAC / 24VDC
Power voltage frequency	50 / 60 Hz	50 / 60 Hz
Power consumption	Average: 80 W Max.:130 W	Average: 60 W Max.: 90 W
Operation temperature range	-10° to +70° C (14° to 158° F)	-10° to +70° C (14° to 158° F)
Average reach	180m	60m
Operation basis (double core)	Multi-frequency (automatic)	Multi-frequency (automatic)
Overvoltage protection	YES	YES
Operation indicator	LEDs in float and control box	LEDs in float and control box
Programmable timer ON / OF	YES (by default)	YES (by default)
Preset programs	YES (by default)	YES (by default)
Operation periods configuration	YES (by default)	YES (by default)
Control box protections	YES	YES
Cable protections	YES	YES
Sensor protections	YES	YES
Emission angle	168°	168°
Environmental protection	IP55 (box)	IP55 (box)
CE approval	61000-6-3	61000-6-3
Weight	7.3 kg	7.2 kg

DUMO Algacleaner: highlights



Effectiveness against algae.

- Our equipments emit different frequencies, harmonic among them, creating waves of different length. This effect generates effective wavefronts against algae.



Water coupling (matching).

- Our transducer incorporates a special elastomer that adapts the transmitter to the water density, resulting in a more effective penetration of ultrasonic waves (reaches longer distance and more powerful).



Power released to the medium (acoustic pressure).

- Power is important because not only the pulses go further, but because they come strongly enough to damage and inhibit algae growth.
- A proof of our effectiveness is microcavitation on the precise threshold, that pulses achieve to penetrate the water.



Electric power.

- Mean maximal peak. Because it is a system emitter of pulses, the effective average power is four times smaller.

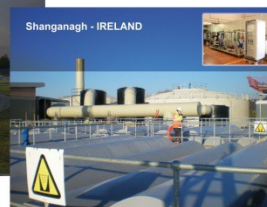


DUMO Algacleaner

- This is the system with the best balance among these parameters (Signal / Coupling / Pressure / Power) in the market.

DUMO ultrasonic technology

More solutions for water and biosolids.
A full range of OEM product references.





Any questions?