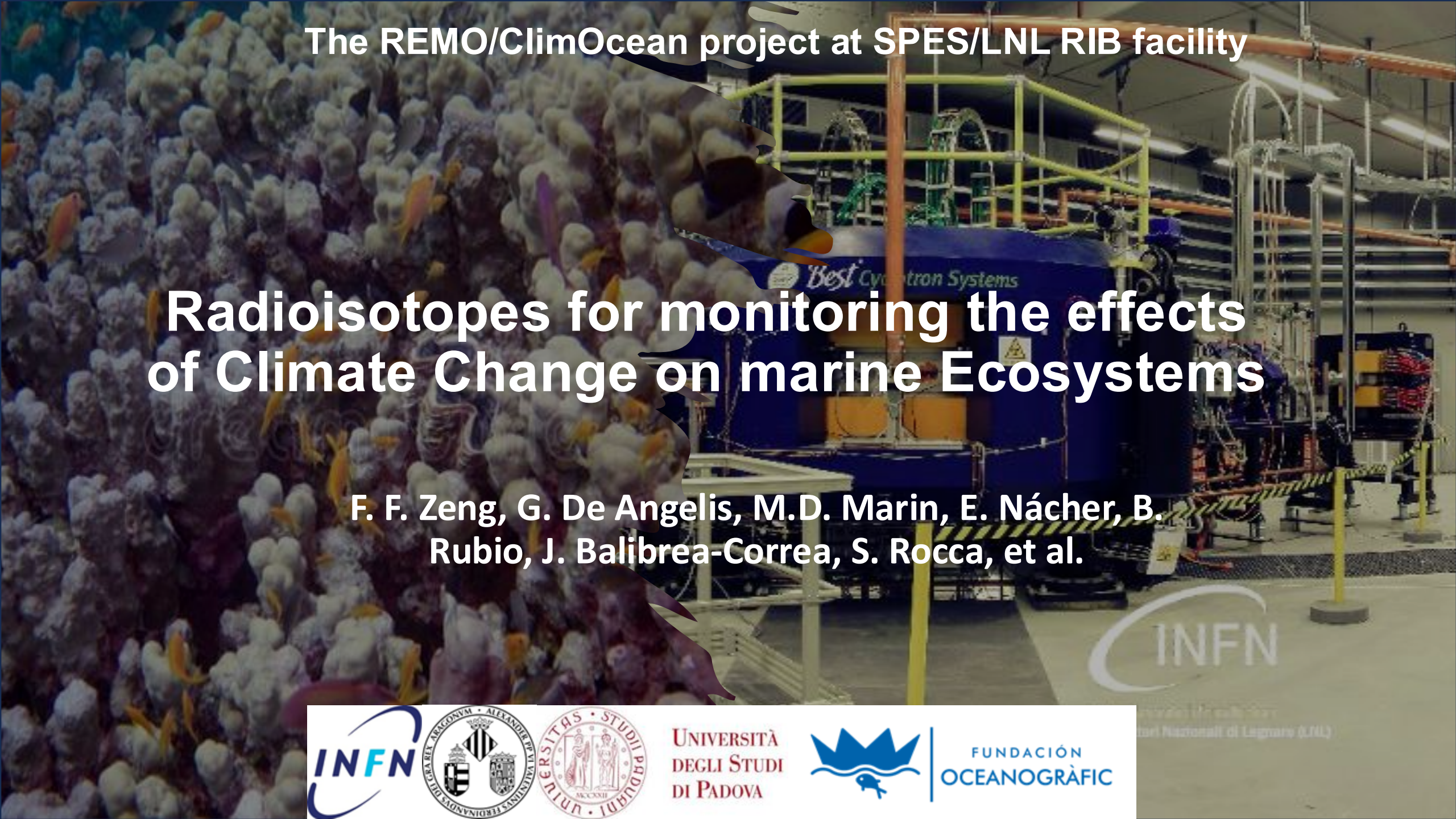
The REMO/ClimOcean project at SPES/LNL RIB facility

Radioisotopes for monitoring the effects of Climate Change on marine Ecosystems

F. F. Zeng, G. De Angelis, M.D. Marin, E. Nácher, B. Rubio, J. Balibrea-Correa, S. Rocca, et al.

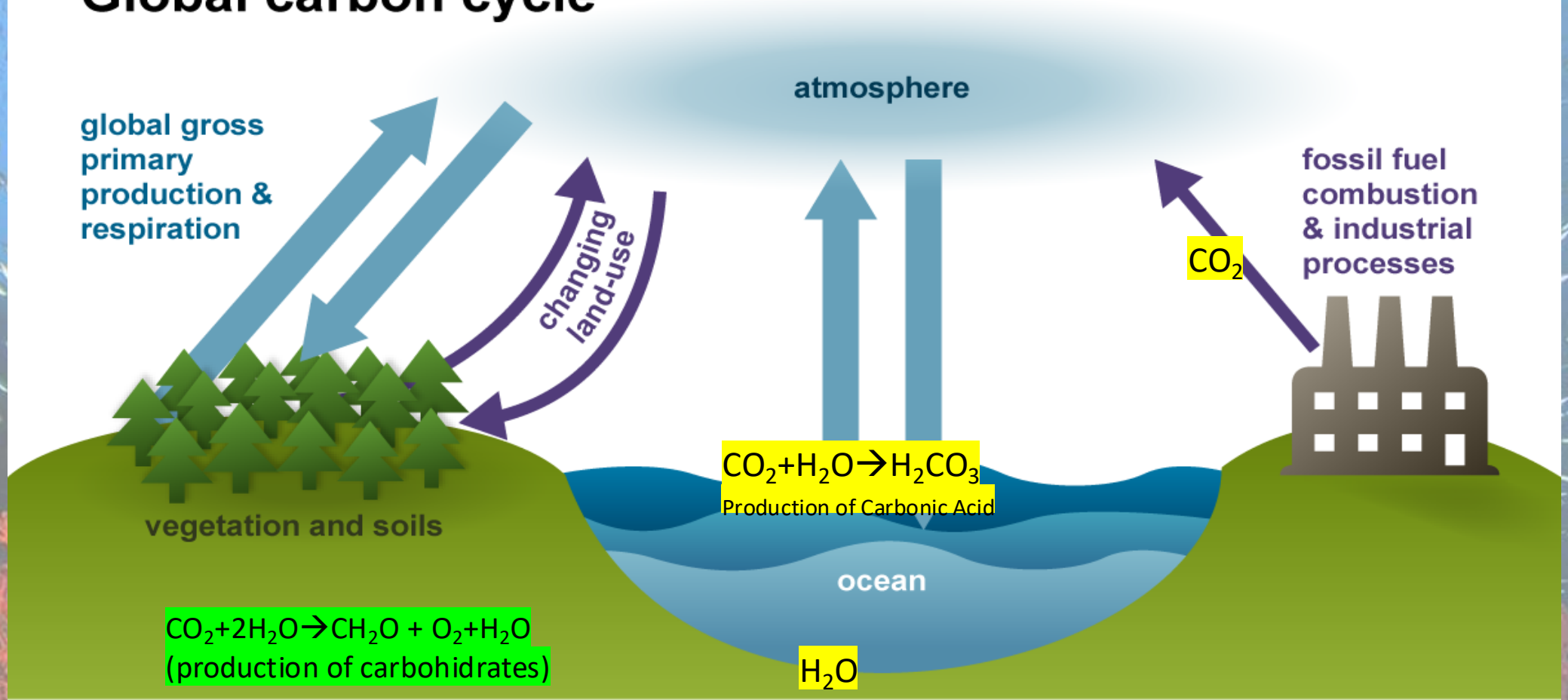


INFN

UNIVERSITÀ DEGLI STUDI DI PADOVA

FUNDACIÓN OCEANOGRÀFIC

Global carbon cycle

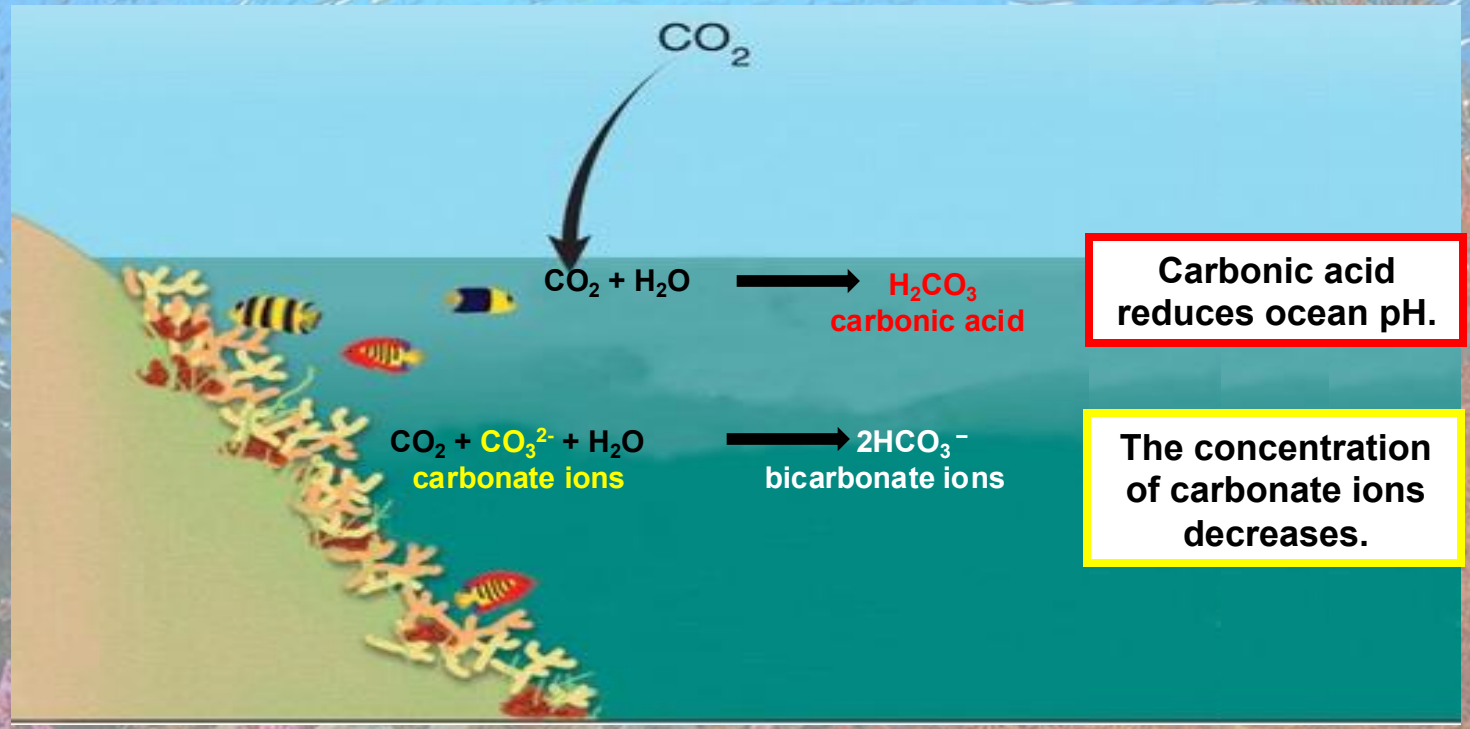


Source: adapted from Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis*, Figure 7.3 (U.K., 2007)

Ocean Acidification

Carbon dioxide dissolves in the ocean, where it causes a potentially more serious problem → ocean acidification.

Mechanisms of Ocean Acidification



Carbonic acid reduces ocean pH.

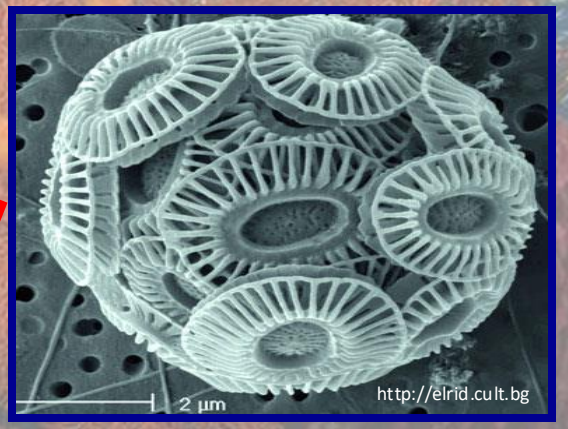
The concentration of carbonate ions decreases.


www.bigmoviezone.com


www.travel-vancouver-island.com


www.nceas.ucsb.edu


www.noaanews.noaa.gov


2 µm
http://elrid.cult.bg

Important and “Accessible” Species

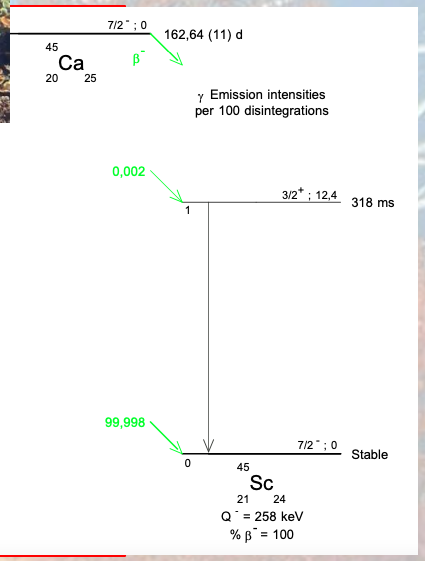
Coral reefs support more species per unit area than any other marine environment, including about 4,000 species of fish.

Bivalve mollusc are very important for the Economy of Mediterranean and Atlantic Countries like Spain: we eat them, export them.

Climate change effects studied using unstable tracers:

$1.03\ 10^5$ y $^{41\text{-}45}$Ca radioactive 163 d

Sc 40	Sc 41	Sc 42	Sc 43	Sc 44	Sc 45		
183 ms β⁺ 5.7, 9.6... γ 3737, 755... βp 1.09, 1.00... βα 3.31, 3.75...	596 ms β⁺ 5.5... γ (2575, 2959)	61 s / 0.68 s β⁺ 2.8 γ 438 1525 1227 β⁺ 5.4... γ (1525...)	3.89 h β⁺ 1.2... γ 373...	58.61 h / 3.92 h Iγ 271 ε γ (1002 1261 1157) β⁺ 1.5... γ 1157...	100 σ 10 + 17	Iγ 142 γ 1121 889... σ 5.0	β⁻ 0.4, 0.6 γ 159
Ca 39	**Ca 40**	**Ca 41**	**Ca 42**	**Ca 43**	**Ca 44**	**Ca 45**	**Ca 46**
860.7 ms β⁺ 5.5... γ (2522)	96.941 σ 0.41 $\sigma_{n,\alpha}$ 0.00013	$1.03 \cdot 10^5$ a ε, no γ σ ~4 $\sigma_{n,\alpha}$ 0.18 $\sigma_{n,p}$ 0.007	0.647 σ 0.65	0.135 σ 6	2.086 σ 0.8	163 d β⁻ 0.3... γ (12), e⁻ σ ~15	0.004 σ 0.70
K 38	**K 39**	**K 40**	**K 41**	**K 42**	**K 43**	**K 44**	**K 45**
924.6 ms / 7.6 m β⁺ 5.0 β⁺ 2.7... γ 2168...	93.2581 σ 2.1 $\sigma_{n,\alpha}$ 0.0043 $\sigma_{n,p}$ < 0.00005	0.0117 $1.248 \cdot 10^9$ a β⁻ 1.3, ε, β⁺... γ 1461; σ 30 $\sigma_{n,\alpha}$ 0.39, $\sigma_{n,p}$ 4.4	6.7302 σ 1.46	12.36 h β⁻ 3.5... γ 1525...	22.2 h β⁻ 0.8, 1.8... γ 373, 618...	22.13 m β⁻ 5.7... γ 1157, 2151...	17.8 m β⁻ 2.3, 4.2... γ 174, 1706...



Monitoring the adaptation of species to climate change through $^{41\text{-}45}$Ca uptake

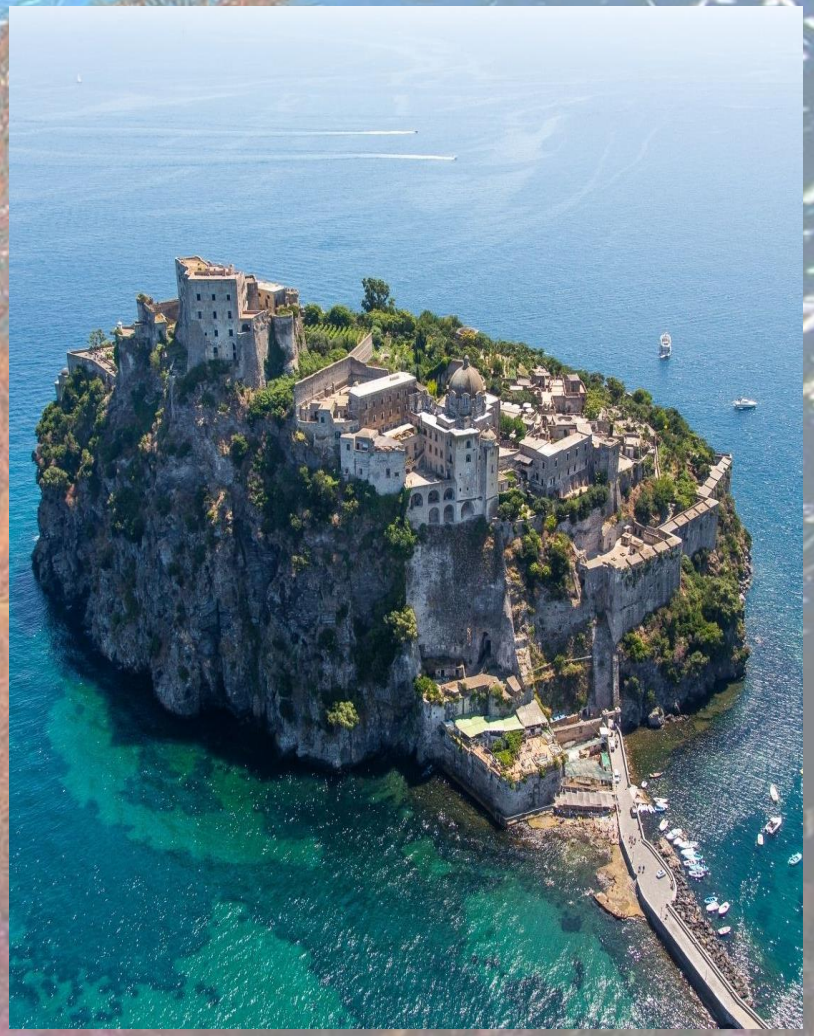
Collabrating Institutes

- INFN - LNL, Legnaro (PD), Italy.
- Department of Marine Biology of the University of Padova and Hydro-Biological Station of the University of Padova, Chioggia, Italy.
- IFIC-CSIC, University of Valencia, Spain.
- Oceanografic, Valencia, Spain.

Valencia, Spain

Chioggia (PD), Italy

Ischia (NP), Italy



Radiotracer ^{45}Ca: a global problem due to the war, to the inflaction and to the handling of radiactive materials

Through good international contacts (E. Nácher) and after several months of negotiations…

^{44}Ca (stable), neutron irradiation at the high flux reactor in Grenoble

^{45}Ca and other isotopes are analised and calibrated at PSI (CH). A primary separation is performed

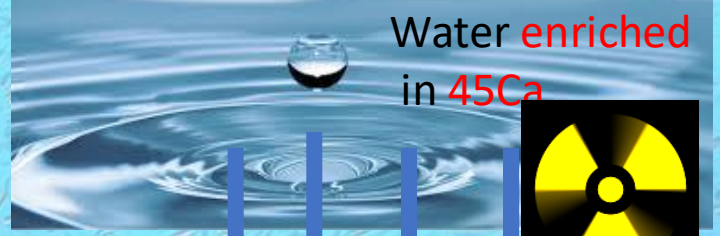
9,5 k€

CIEMAT (Madrid) does a purification process with dissolution in water at low concentration (allowing use in uncontrolled areas) (costs in nature: 45Ca)

^{45}Ca arrives at IFIC Valencia (E) the 13th of May 2024

How?

The aquarium Ecosystems will be intalled at Oceanographic In Valencia



Water enriched in 45Ca

PH 8,1(present)

Mediterranean

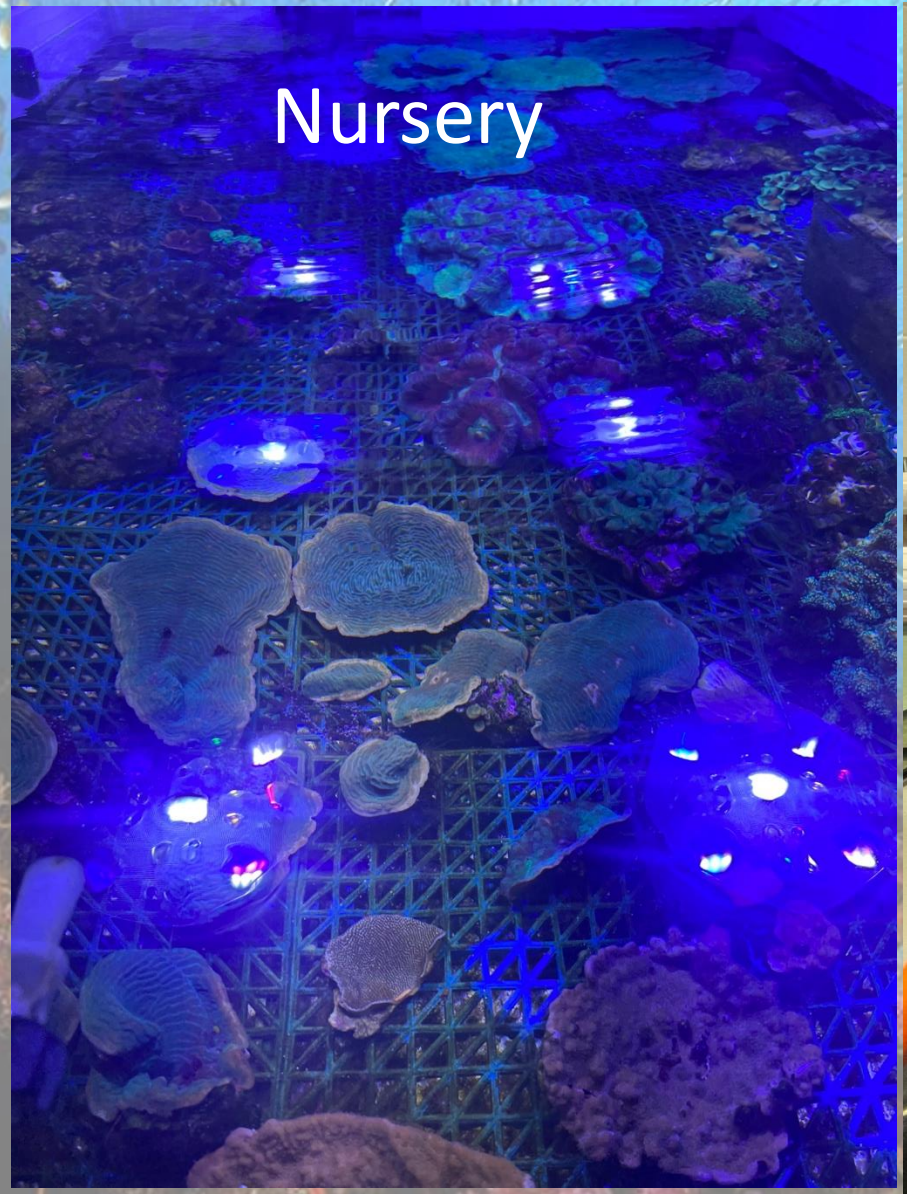
PH 7,5 (year 2100, if we do nothing!!)

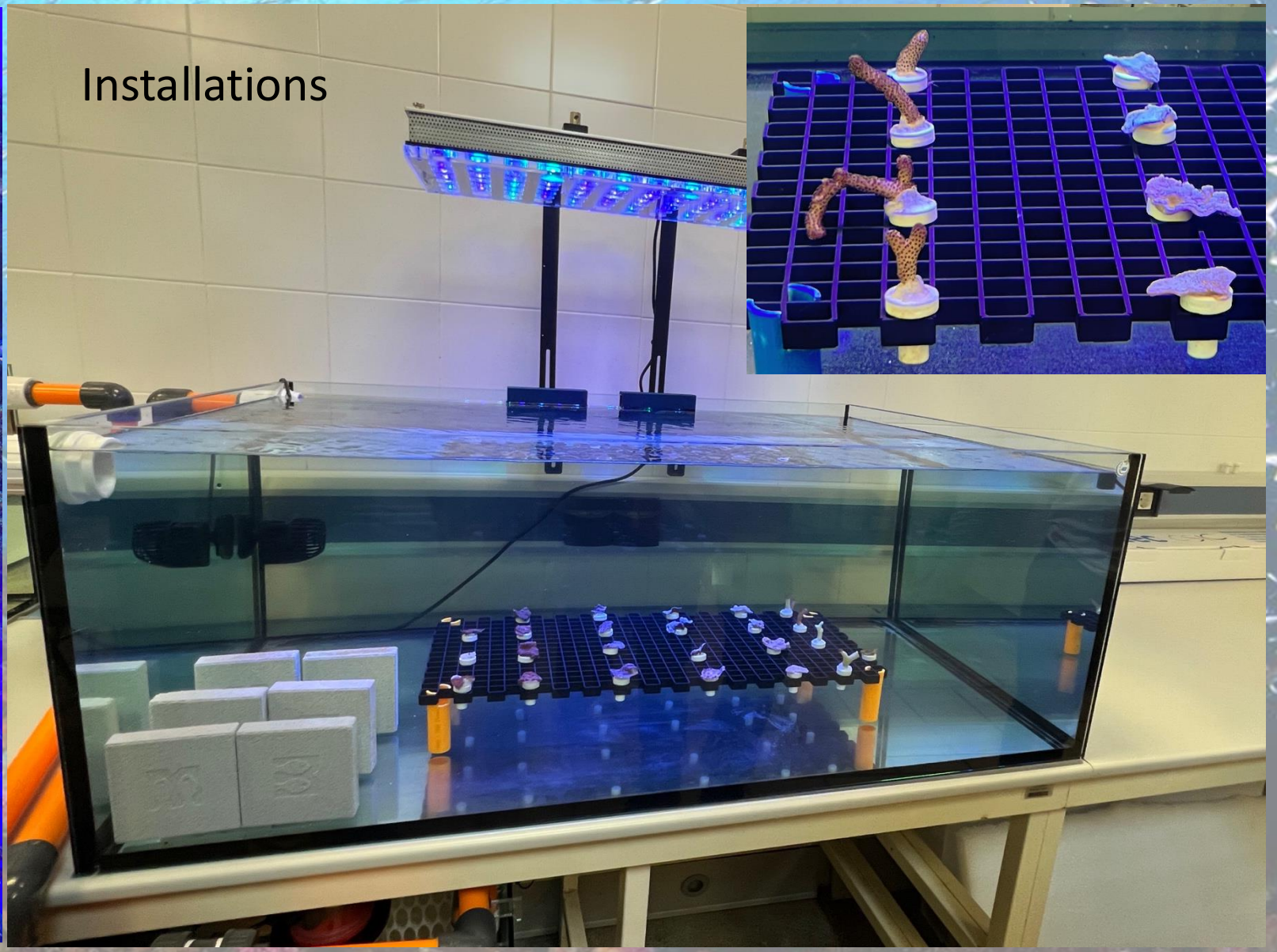
PH 8,1(present)

Tropical

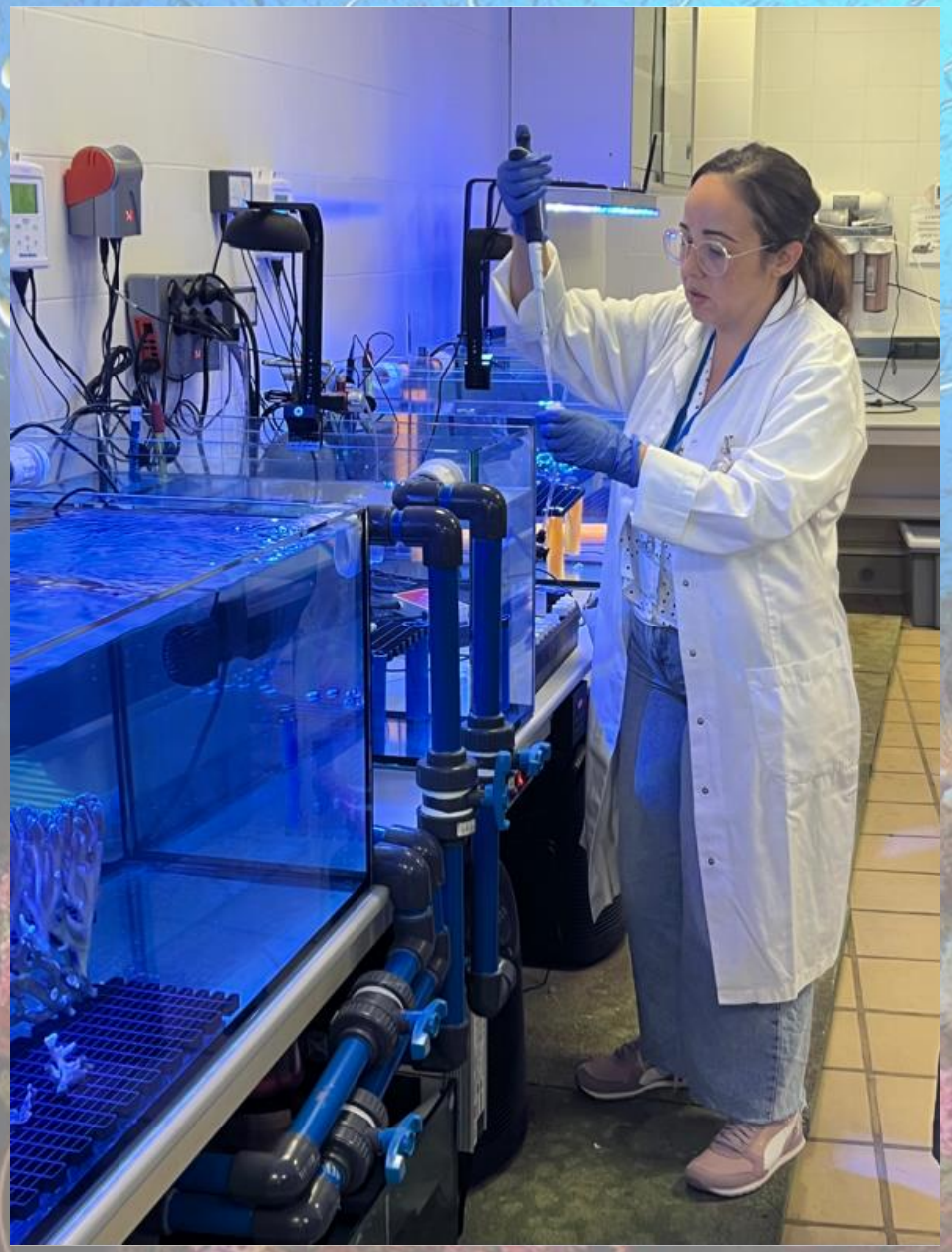
PH 7,5 (year 2100, if we do nothing!!)

REMO-ClimOcean Installations at the Oceanografic

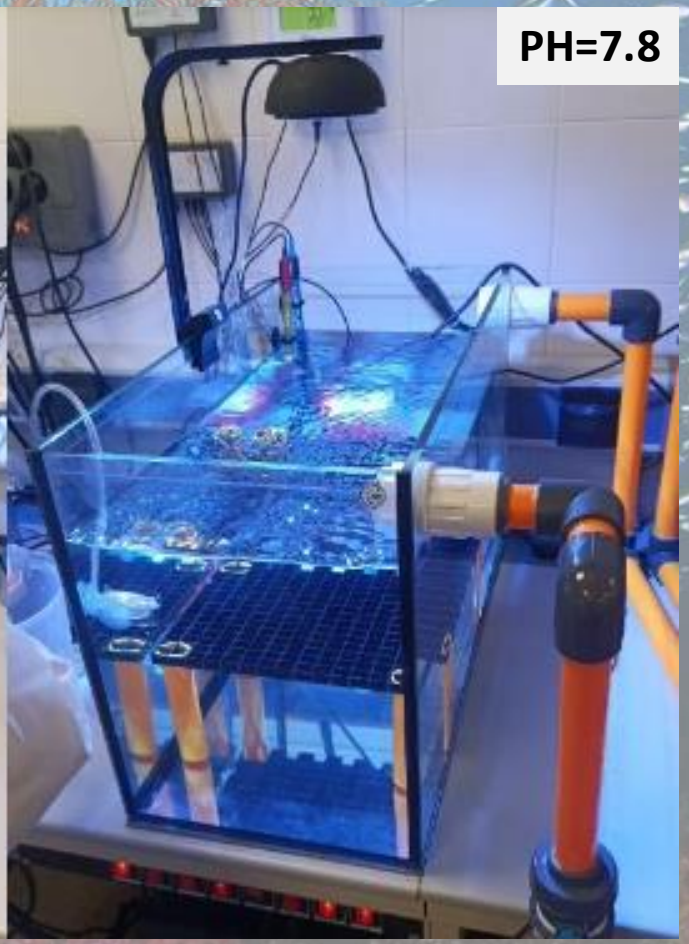




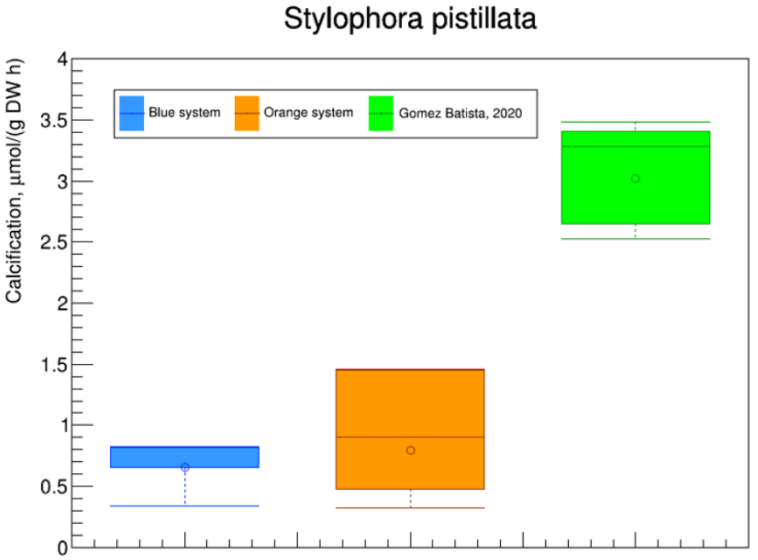
Valencia Experiment

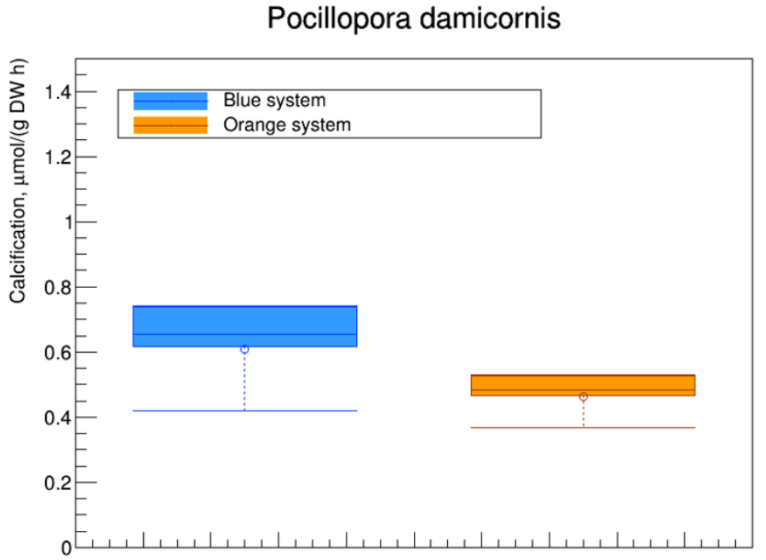


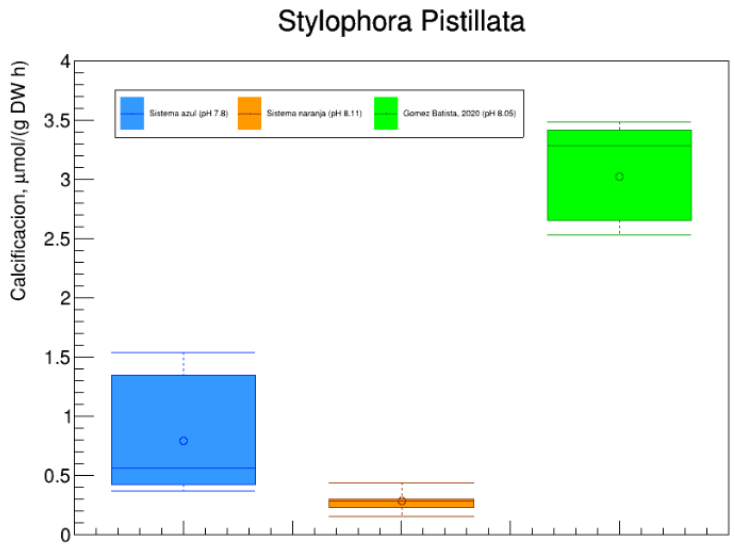
First measurement at the Oceanografic Valencia 16 July 2024

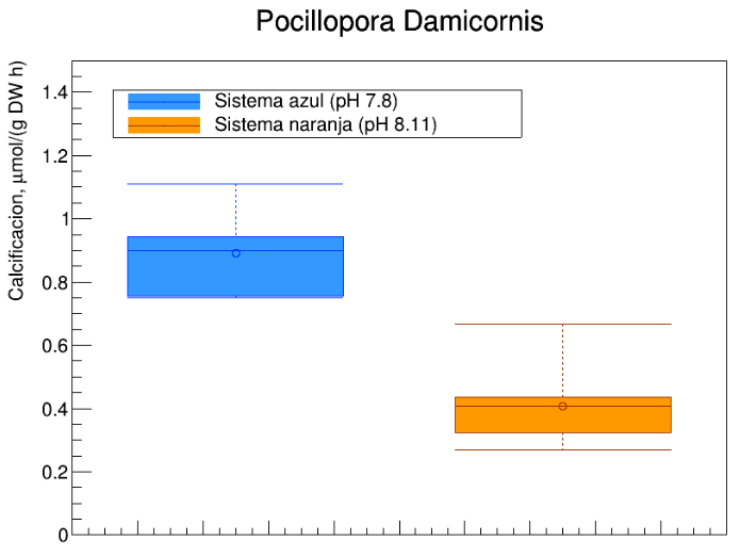


Results of the first measurement









Light problems affecting the growth of the symbiotic algoe

PRIN 2022 - LNL-INFN-PD-Univ-Padova

Use of stable & unstable isotopes (^{13}C ^{41}Ca) for Monitoring the growth in Mollusks and Echinoderms

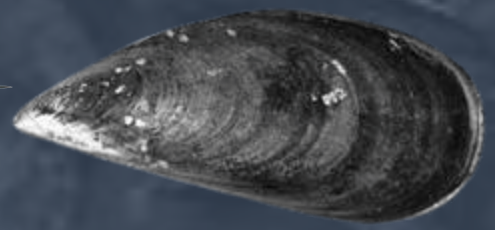
Institute of marin biology of the University of Padova

Chioggia experiment

Predicting Climate Change Impacts

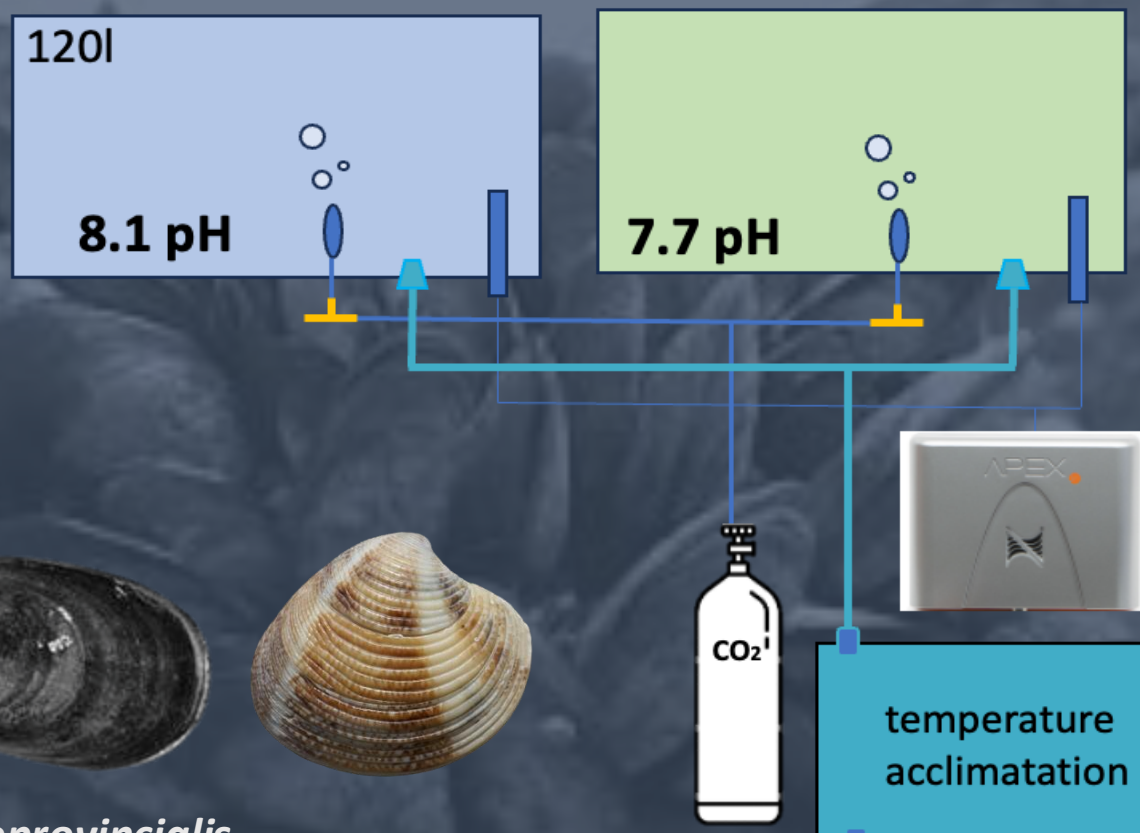
Laboratory experiments

Sea Urchin

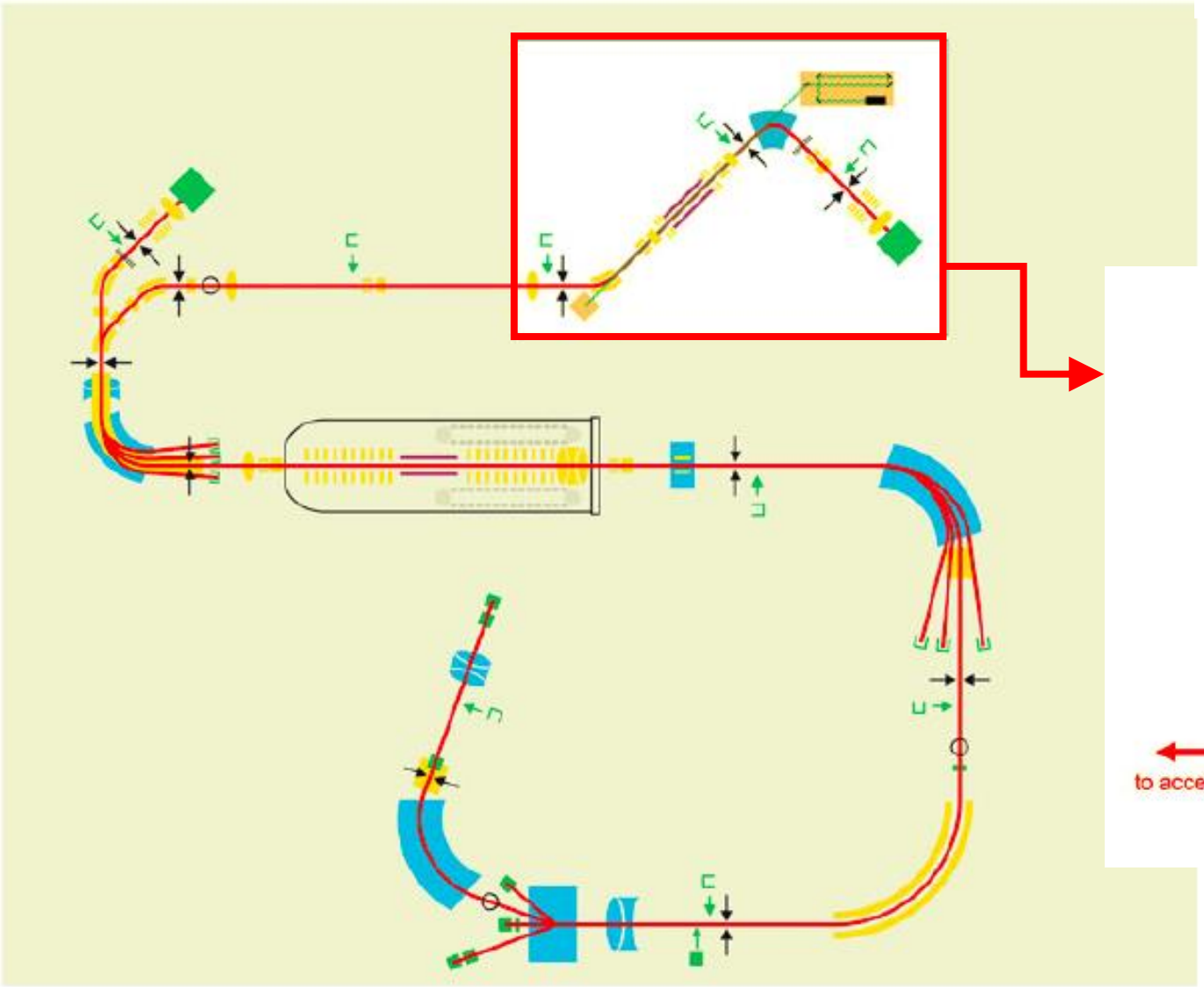


Mytilus galloprovincialis (12 mm)

Chamelea Gallina (8 mm)



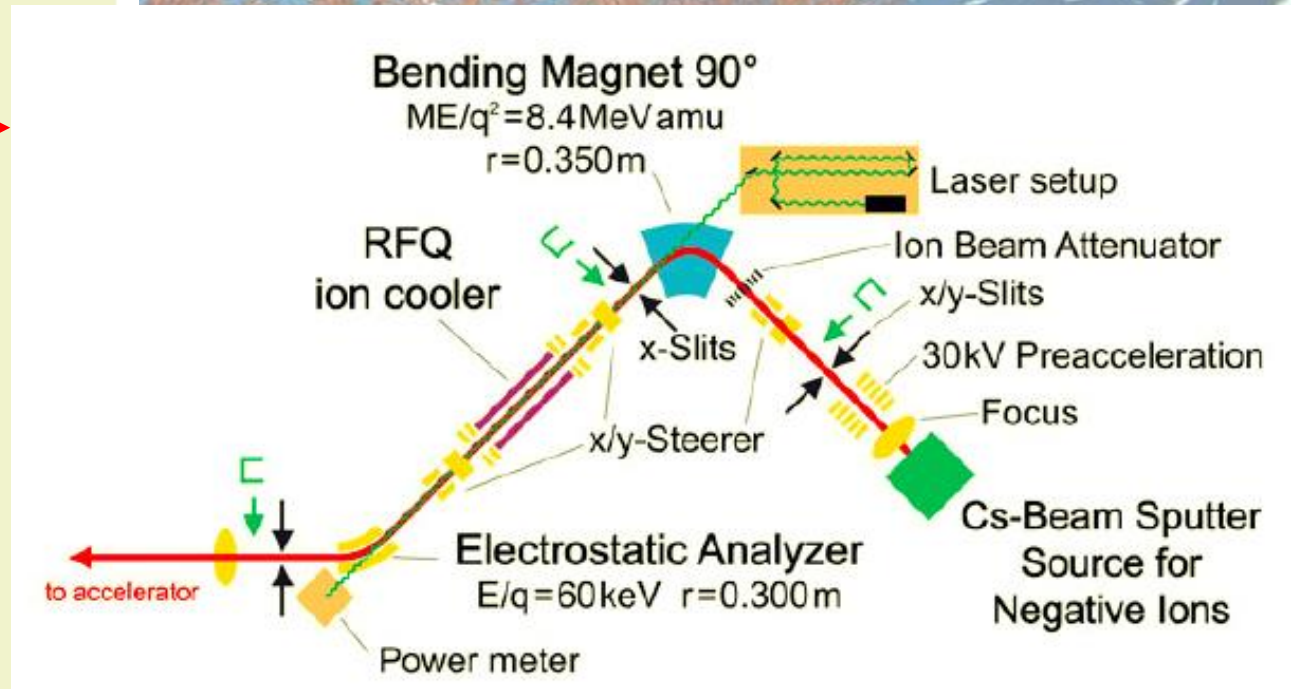
$^{41}Ca/^{40}Ca$ Isotopic ratio by ILAMS @ Vienna



5 YEARS OF ION-LASER INTERACTION MASS SPECTROMETRY—STATUS AND PROSPECTS OF ISOBAR SUPPRESSION IN AMS BY LASERS

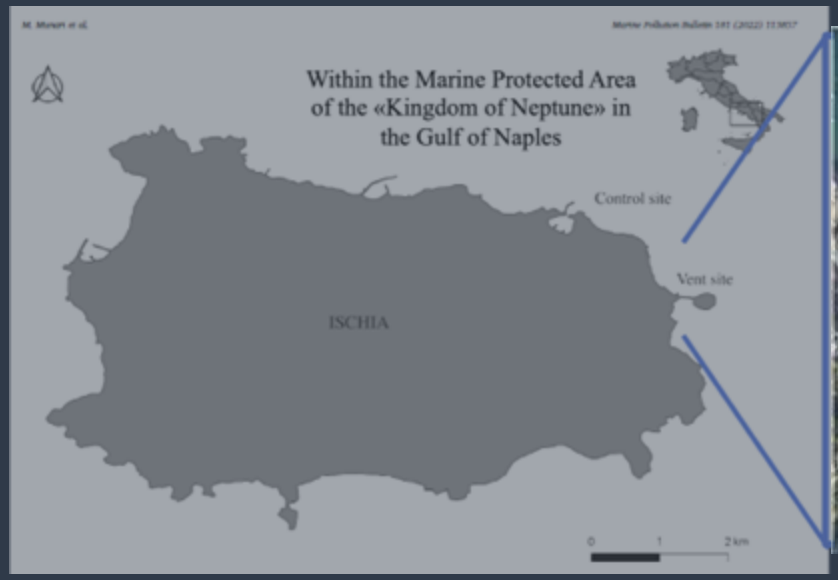
Martin Martschini* • Johannes Lachner • Karin Hain • Michael Kern • Oscar Marchhart • Johanna Pitters • Alfred Priller • Peter Steier • Andreas Wiederin • Alexander Wieser • Robin Golser

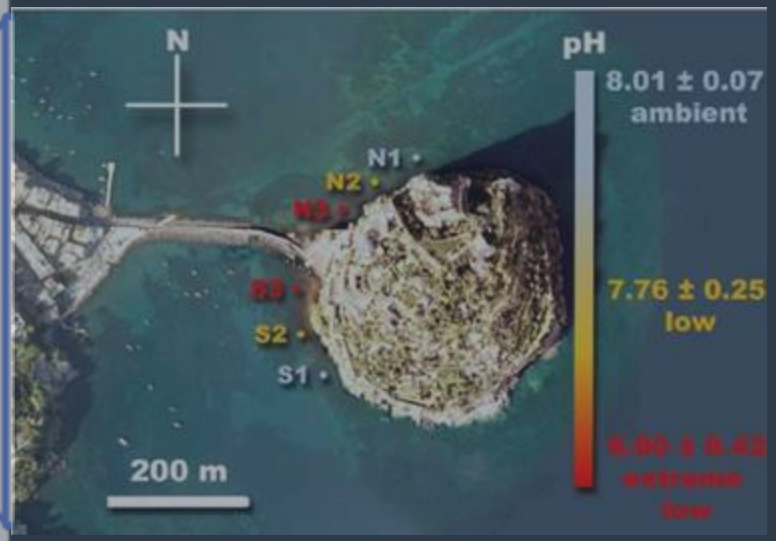
University of Vienna, Faculty of Physics – Isotope Physics, Waehringer Strasse 17, A-1090 Vienna, Austria



Predicting Climate Change Impacts

From the lab to the field





Castello Aragonese vent systems (Ischia Island, Italy)

Production of ^{45}Ca

^{44}Ca enriched in ^{44}Ca (stable)

^{45}Ca, ^{41}Ca and other isotopes

^{45}Ca

Neutron irradiation

centrifugal separation, mass spectrometers

…

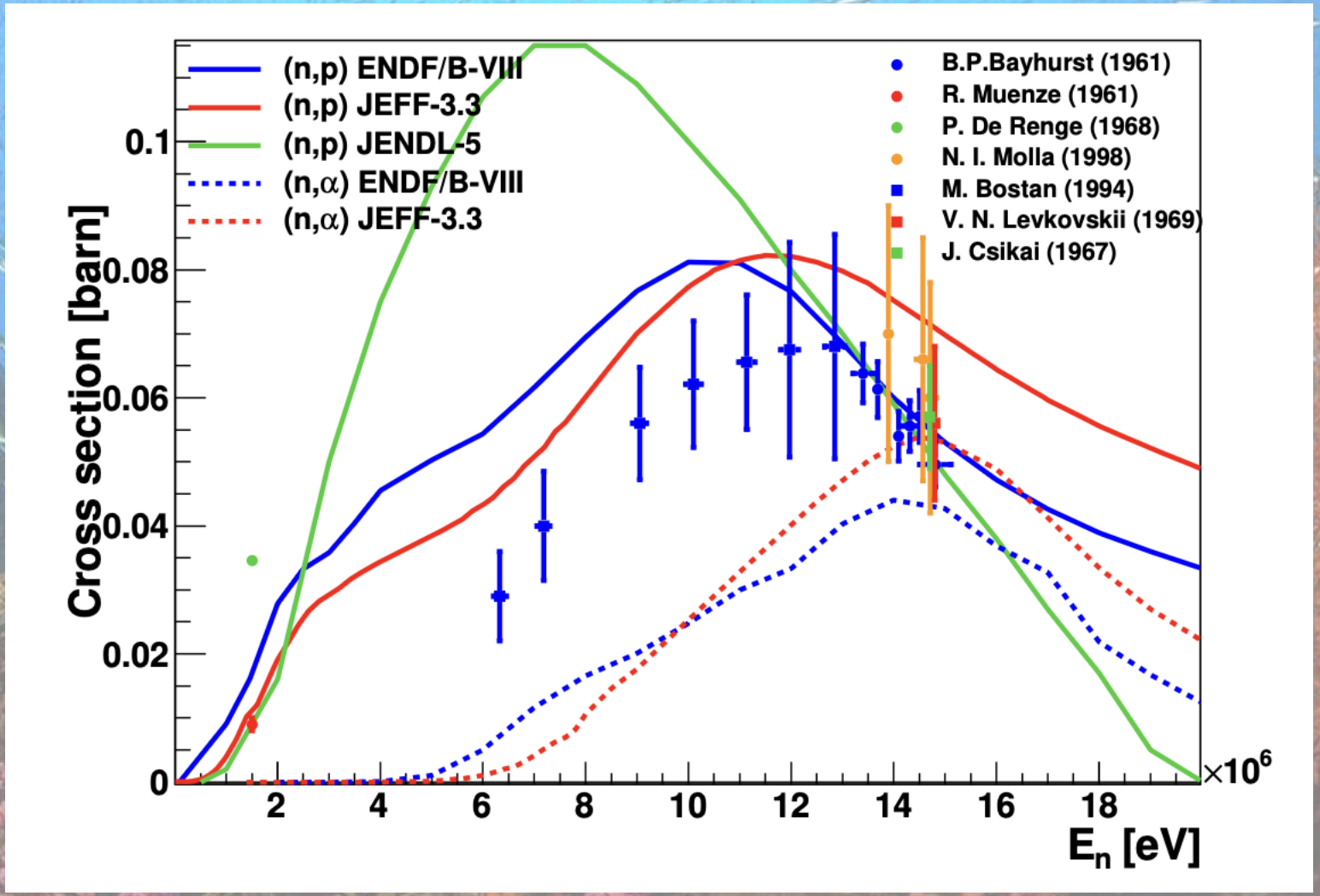
It's difficult and expensive to separate from the unstable isotope ^{41}Ca

$^{45}Sc(n,p)^{45}Ca$ reaction: A new concept to produce the radiotracer

Sc target placed inside or near the target area at Radioactive Ion Beam Facilities, leveraging the (n,p) nuclear reaction for isotopic production

- ✓ **Only stable Ca isotope created except ^{45}Ca**
- ✓ **chemically separate isotopes with different Z**

Cross section of $^{45}Sc(n,p)^{45}Ca$



Measurement of the ^{45}Sc (n,p)^{45}Ca cross section

Thanks for Attention

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