THE REMO-CLIMEOCEAN PROJECT @ LNL-INFN

DEVELOPMENT OF NOVEL RADIOTRACERS FOR CLIMATE CHANGE

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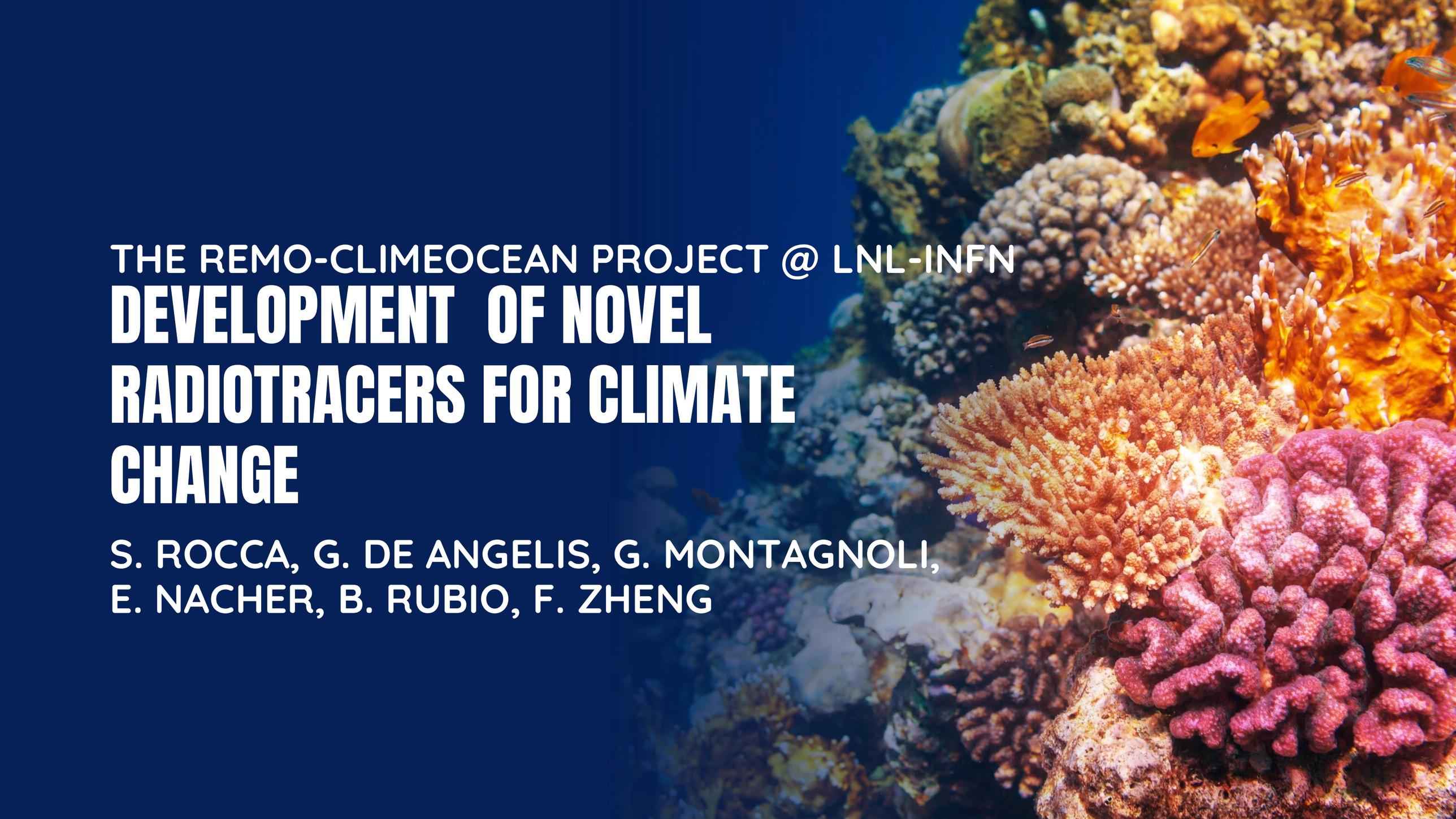
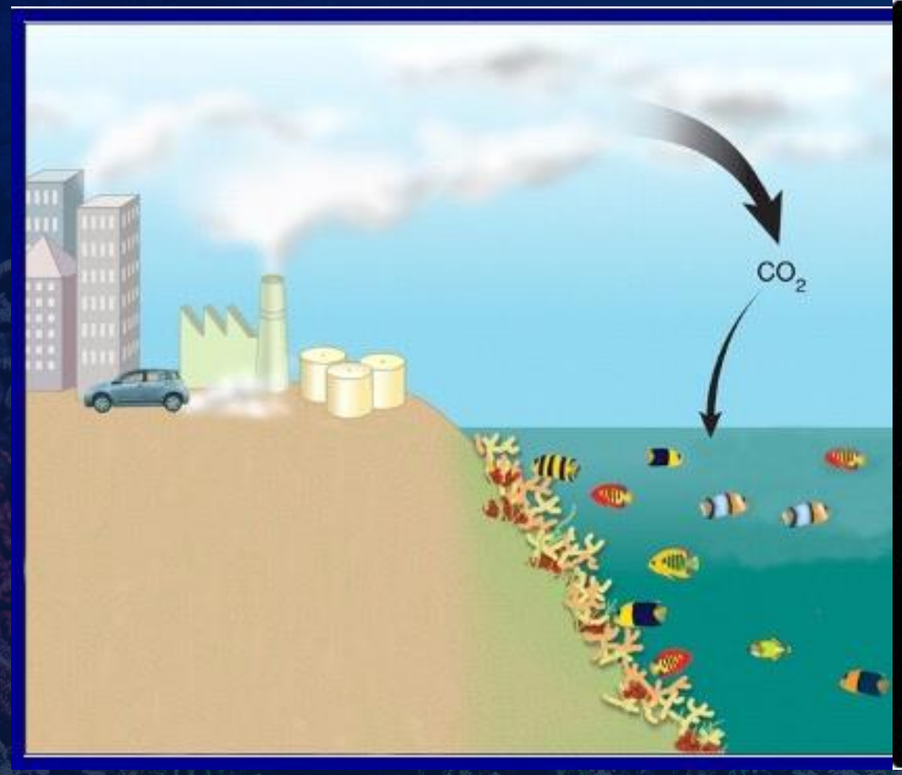
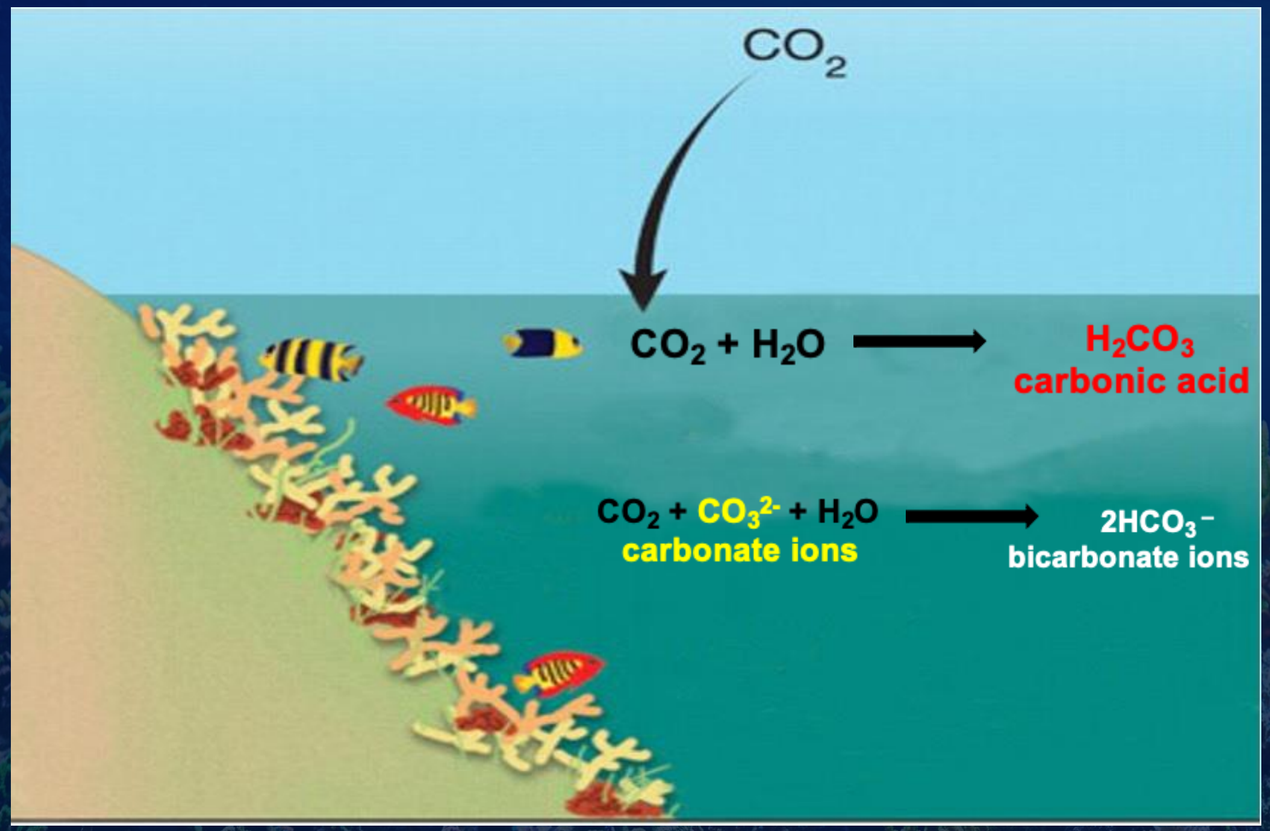
E. NACHER, B. RUBIO, F. ZHENG



THE OTHER CO2 PROBLEM



OCEAN ACIDIFICATION



Carbonic acid reduces ocean pH.

The concentration of carbonate ions decreases.

WHICH ANIMALS?

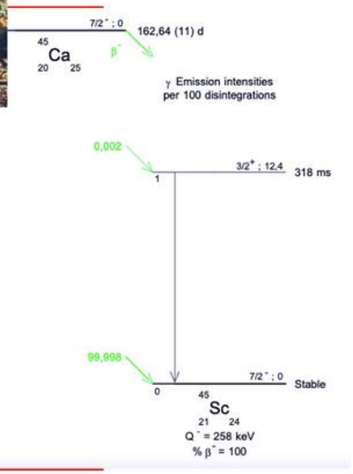
Bivalve mollusk: Very important for the Economy of Mediterranean and Atlantic Countries like Spain: we eat them, export them.

Coral: Reefs support more species per unit area than any other marine environment, including about 4000 species of fish.

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... $\beta\alpha$ 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
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

Collaborating institutes

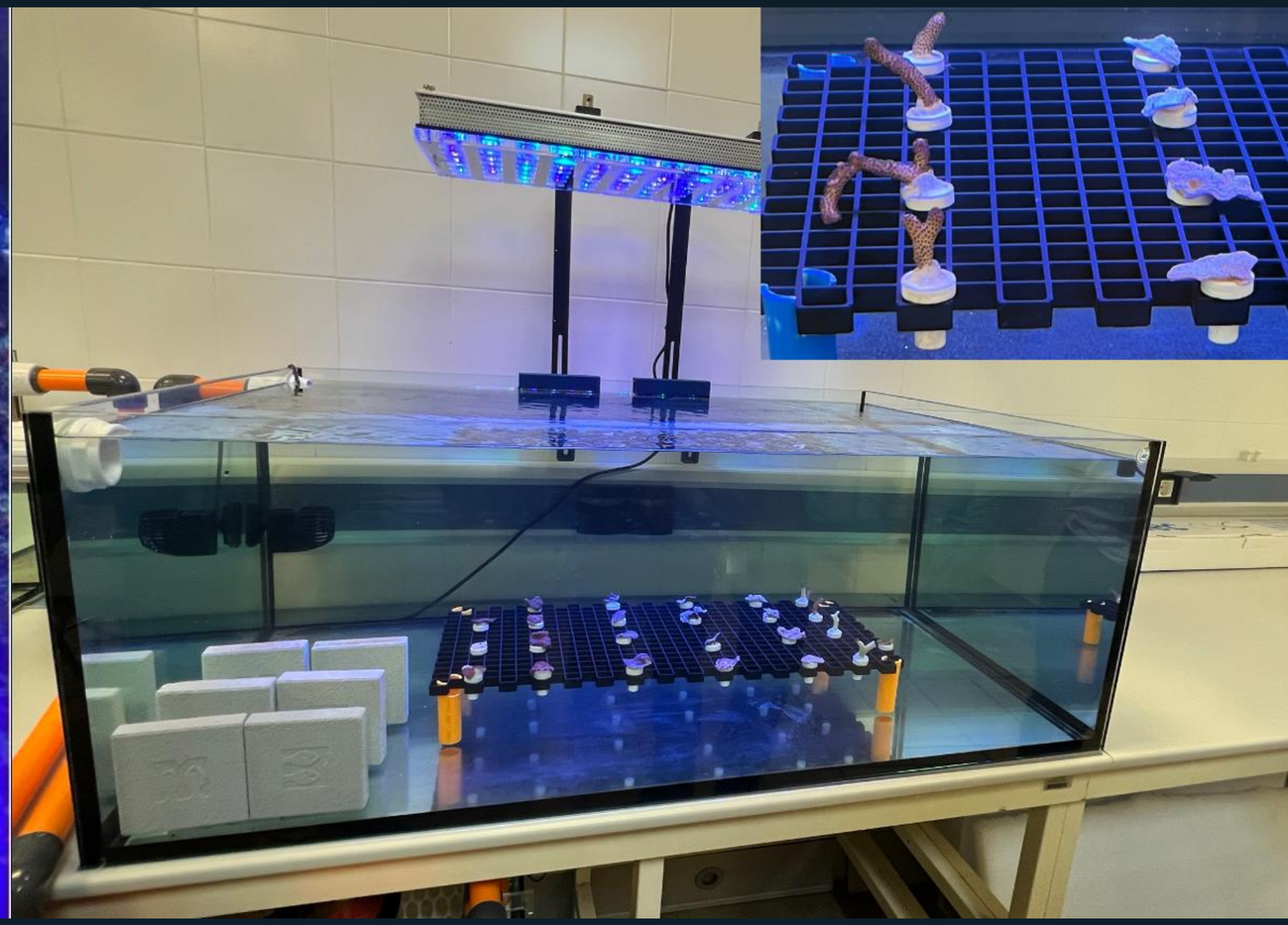
- INFN - LNL, Legnaro (PD), Italy.
- Department of Marine Biology of the University of Padova and Hydro-Biological Station of the University of Padova, Chioggia, Italy.
- IFIC-CSIC, University of Valencia, Spain,
- Oceanografic, Valencia, Spain.

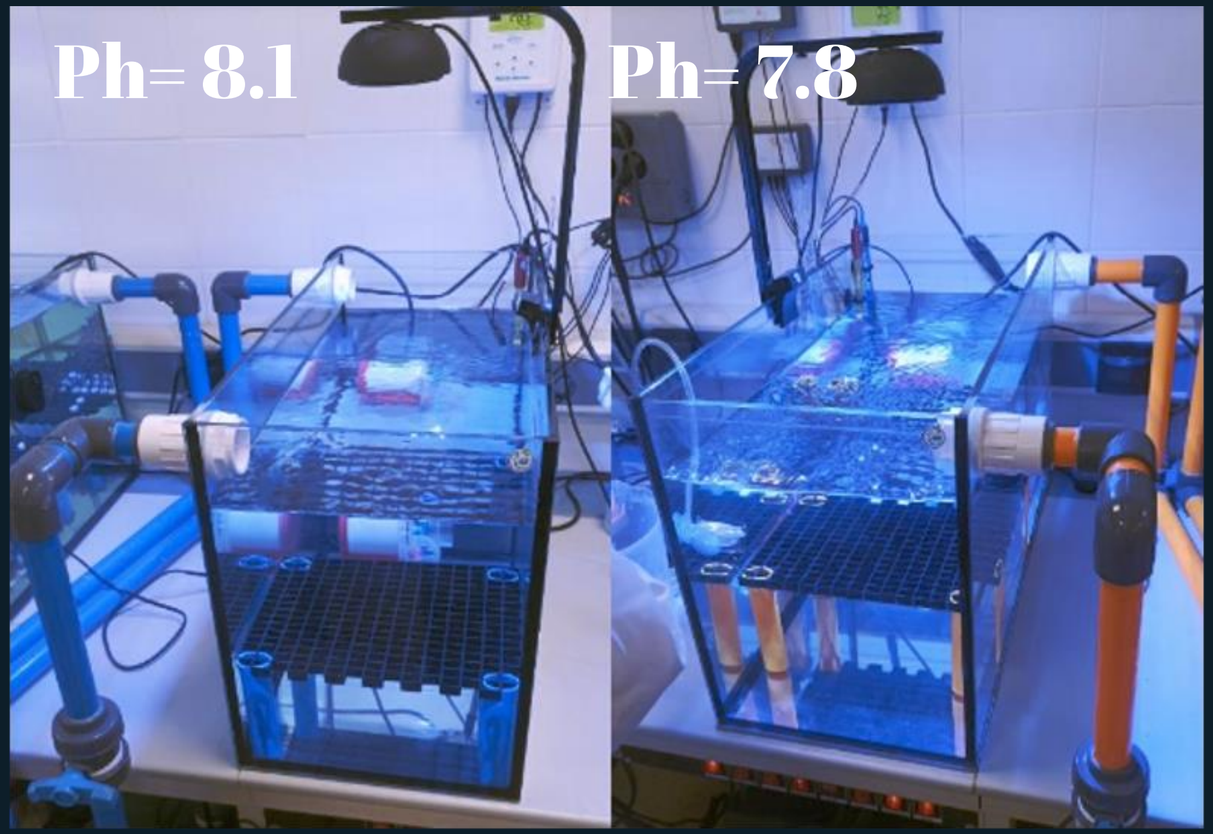
Valencia, Spain

Chioggia, Italy

Ischia Island, Italy

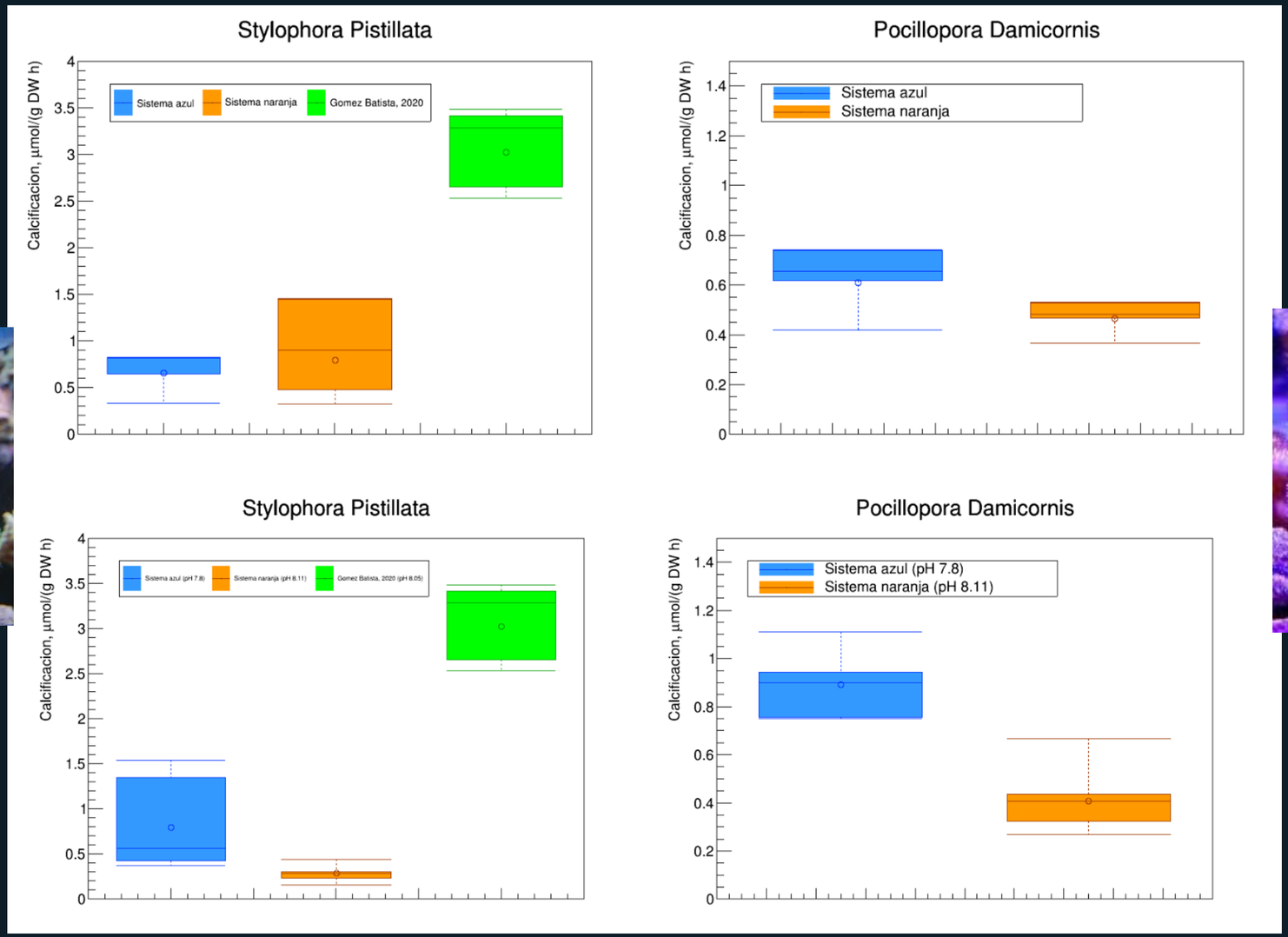
Installation at the Oceanographic





Valencia Experiment

The first results at Valencia

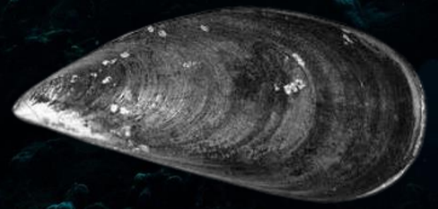


PRIN 2022 -LNL-INFN-PD.Univ-Padova

Use of stable & unstable isotopes (13C, 41Ca) for
Monitoring the growth in Mollusks and Echinoderms
Institute of marin biology of the University of Padova.

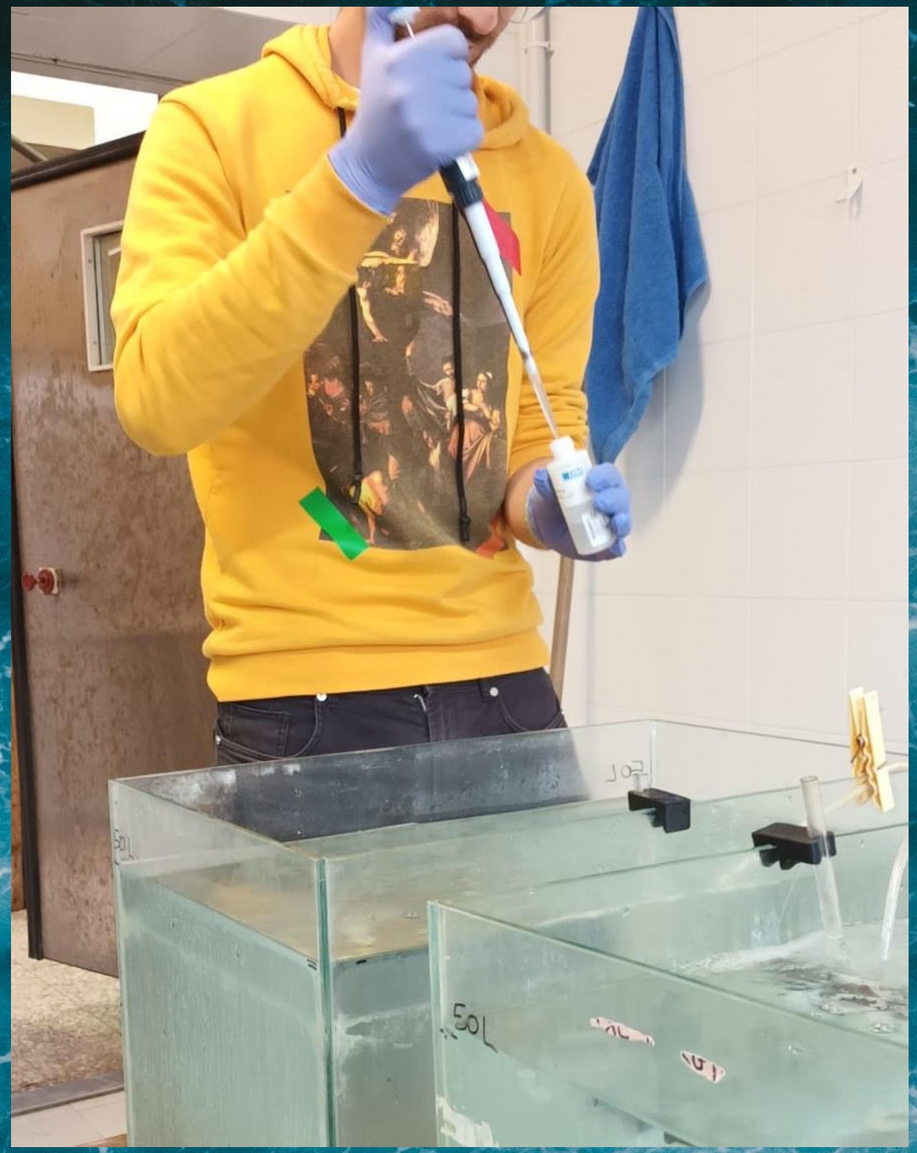
Chioggia Experiment

Paracentrotus lividus



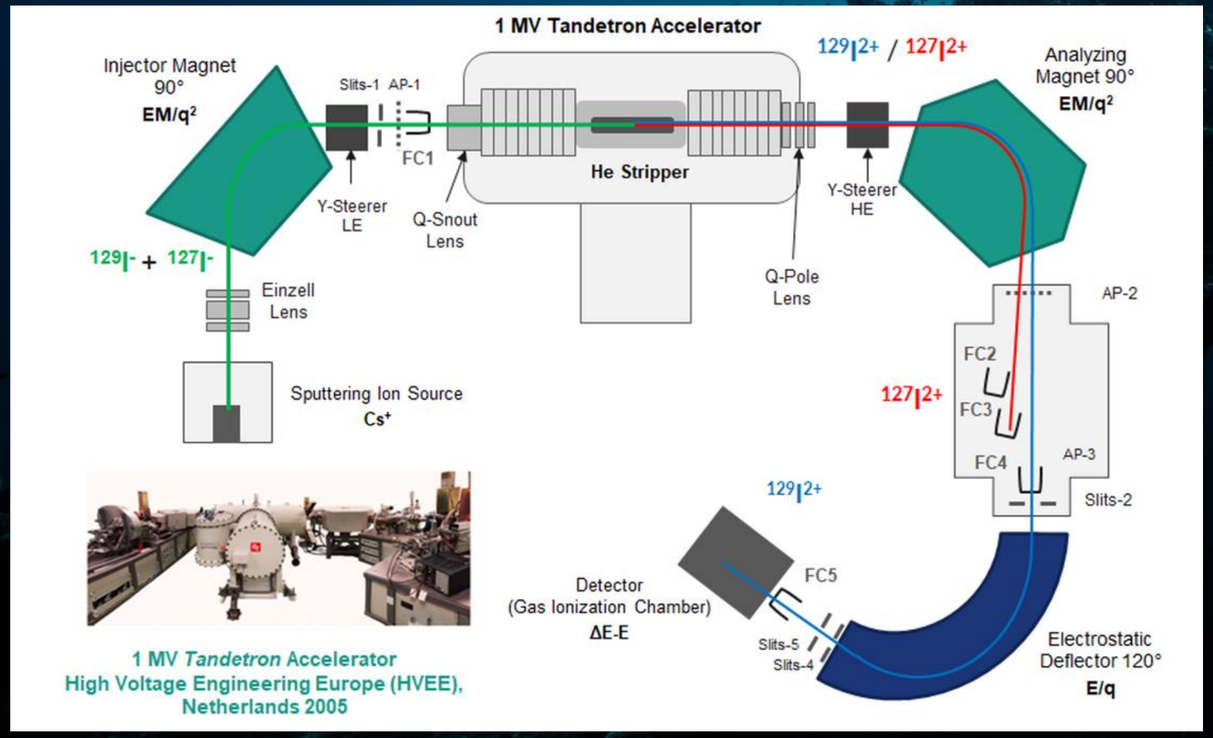
Mytilus galloprovincialis (12 mm)

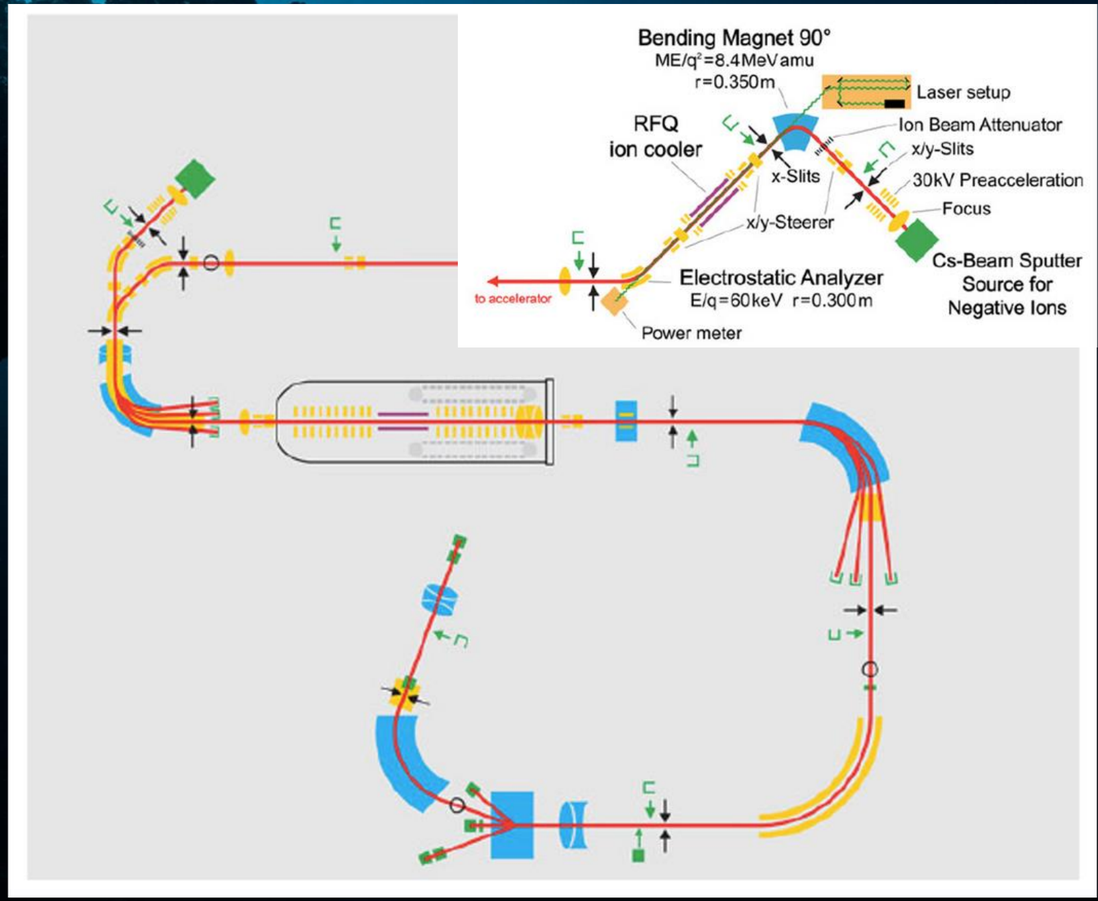
Chamelea Gallina (8 mm)


50L


V1
V2
50L

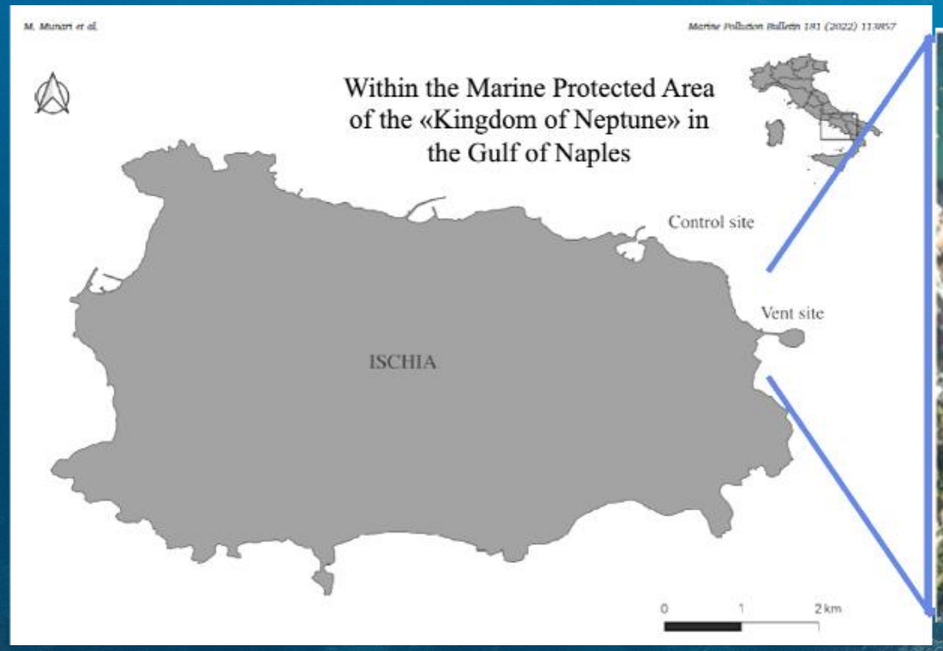
AMS measurement

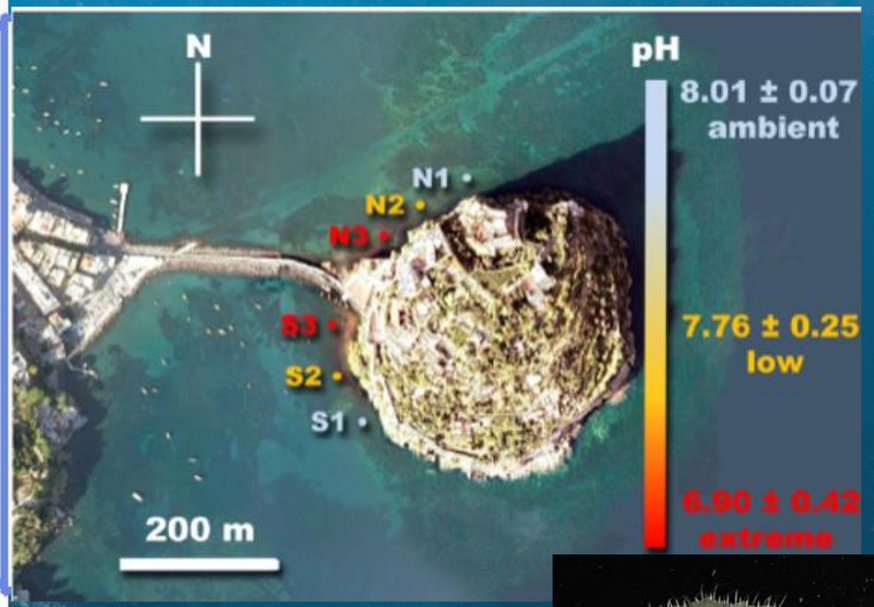


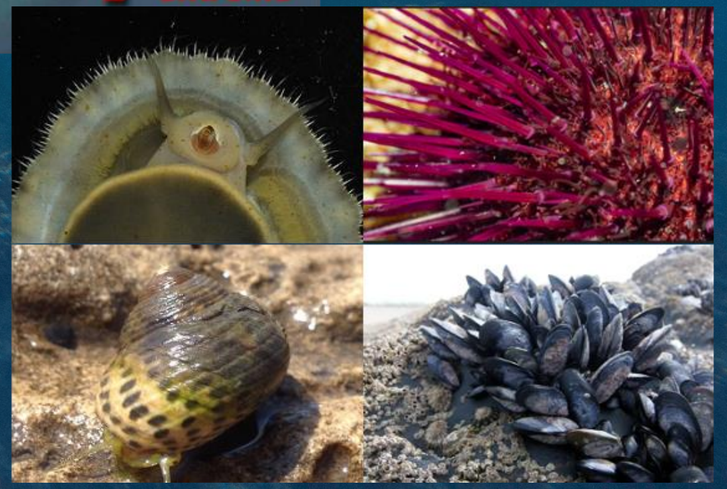


Predicting Climate Change Impacts

From the lab to the field

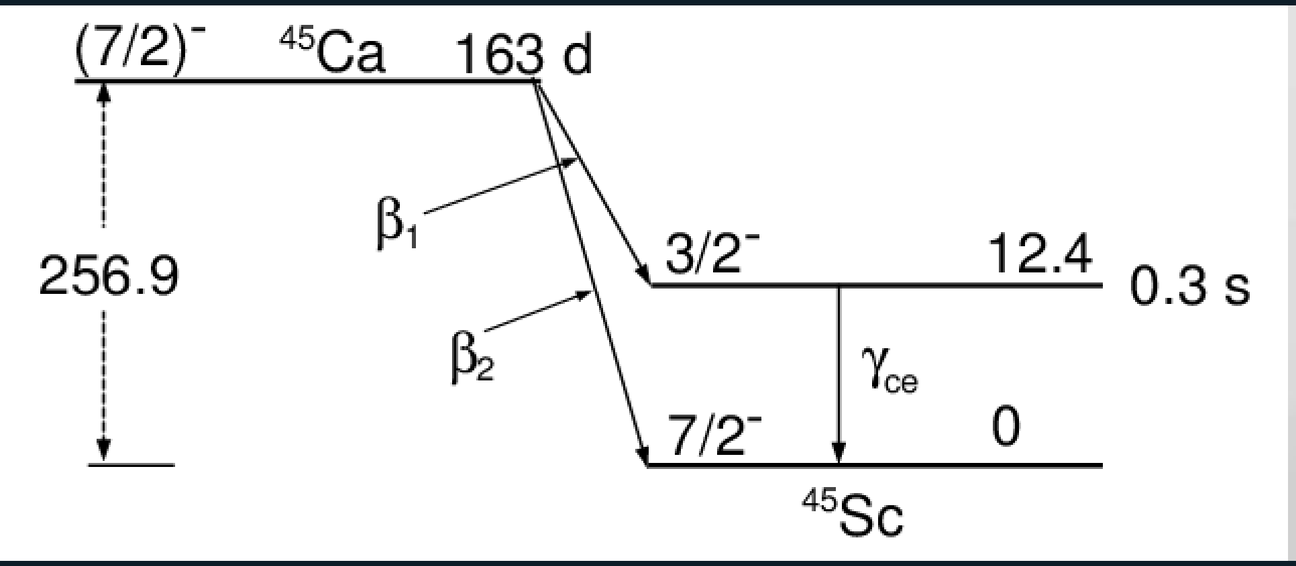


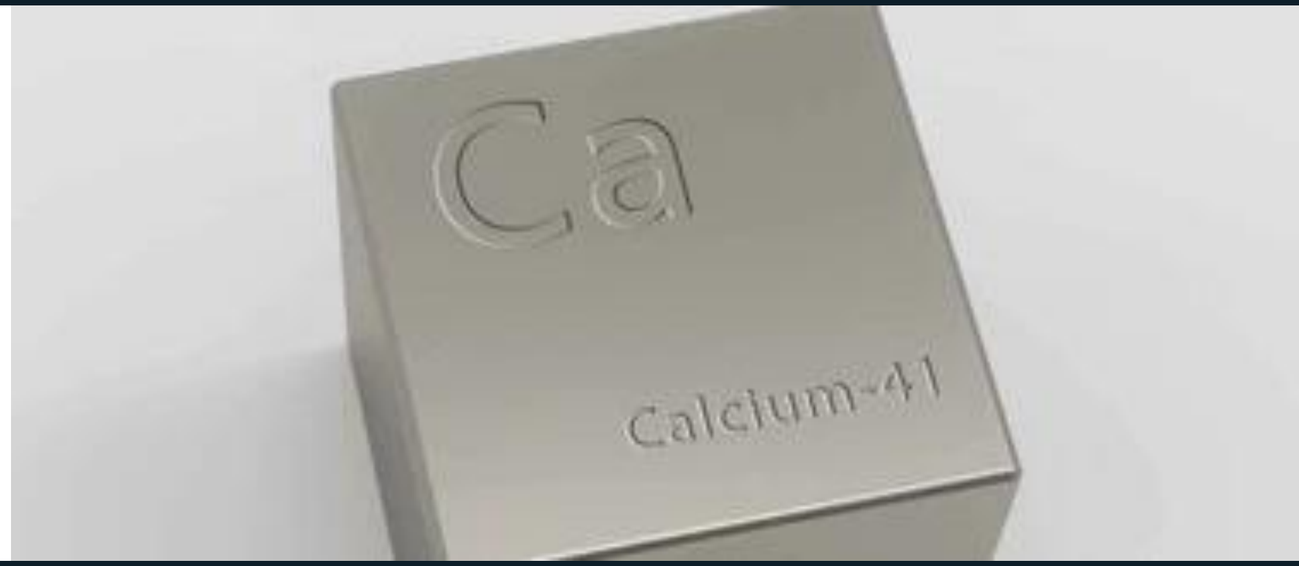




Castello Aragonese vent systems (Ischia Island, Italy)

The problem of Calcium





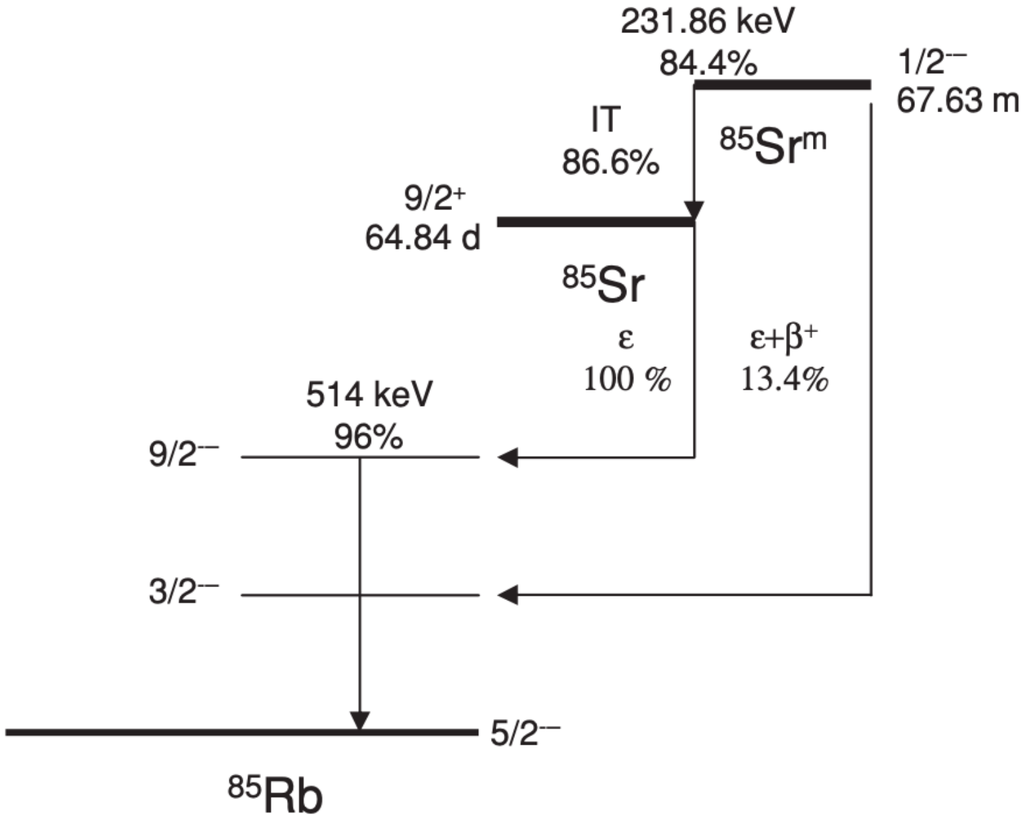
45-Ca

- **Self absorption**: The betas are absorbed by the shell and so is difficult to measure (Needs Monte Carlo Simulation).
- **Production**: Difficult to produce and at High cost.

41-Ca

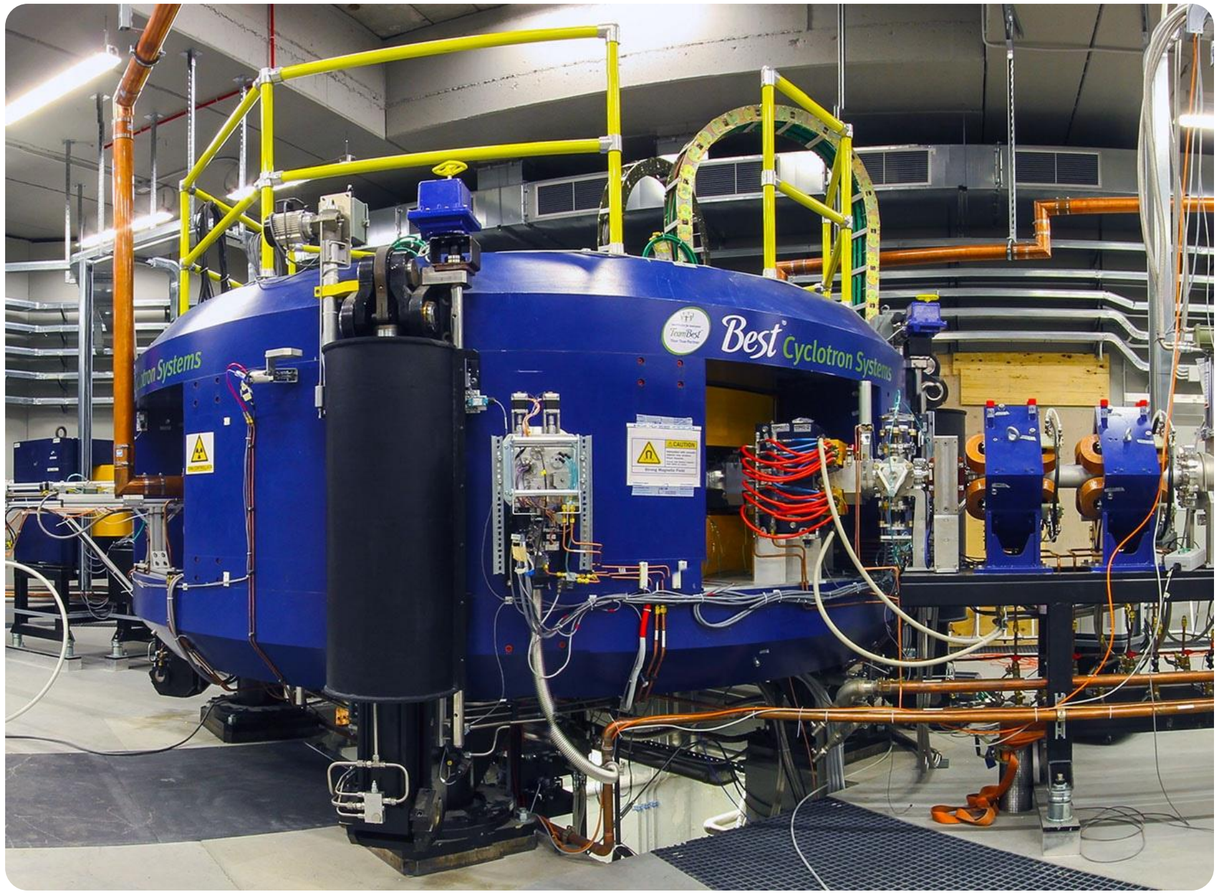
- **Long Half Life**: Impossible to do a normal spectrometry (AMS needed).
- **Position dependent**: The piece of shell has to be taken very precise.
- **Destructive**: The animal die.

THE SOLUTION



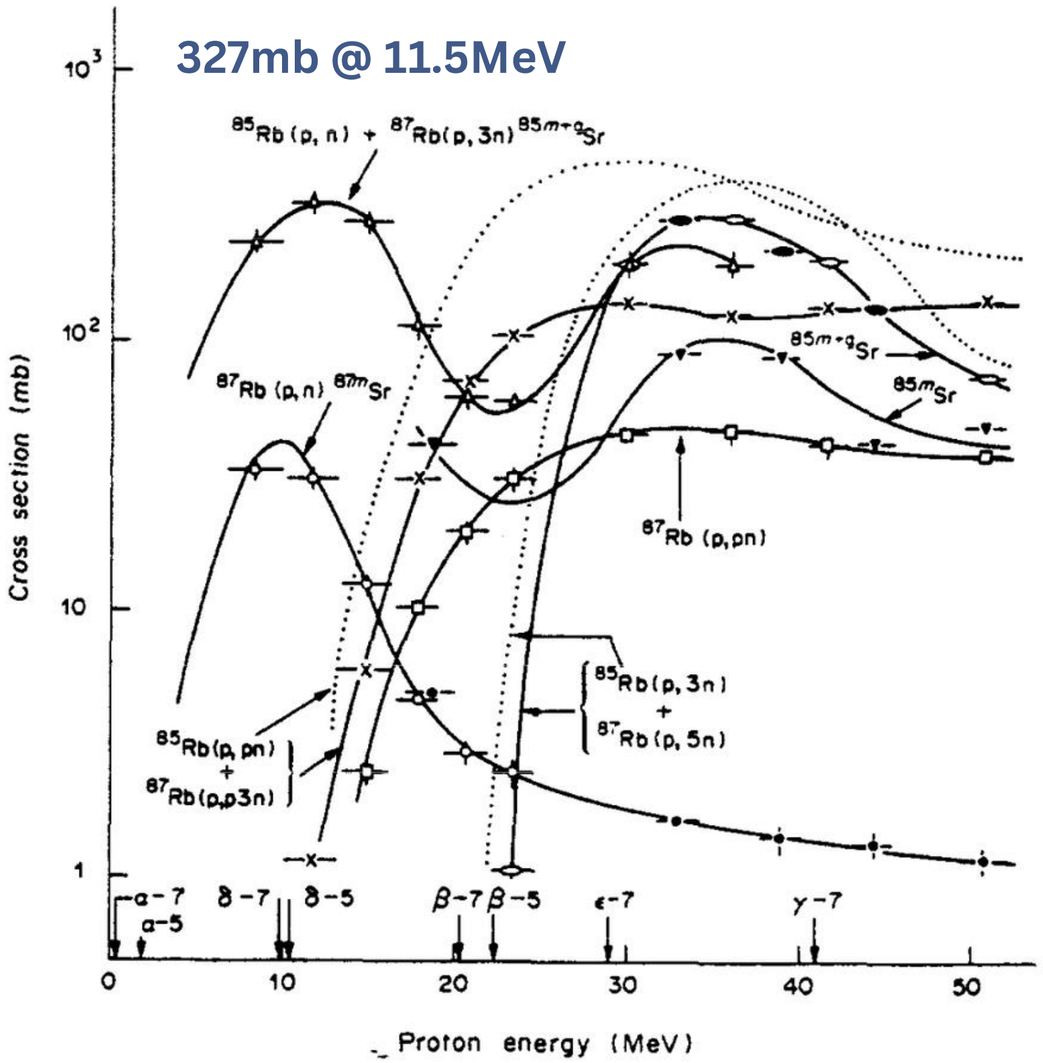
- **Gamma Emitter**: No Monte Carlo calculation needed.
- **Production**: It can be "easily" produced directly in the laboratory.
- **Not so long Half-Life time**: It is high enough to be produced and used later.
- **No destructive:** The animal can be keeped alive.

THE REACTION

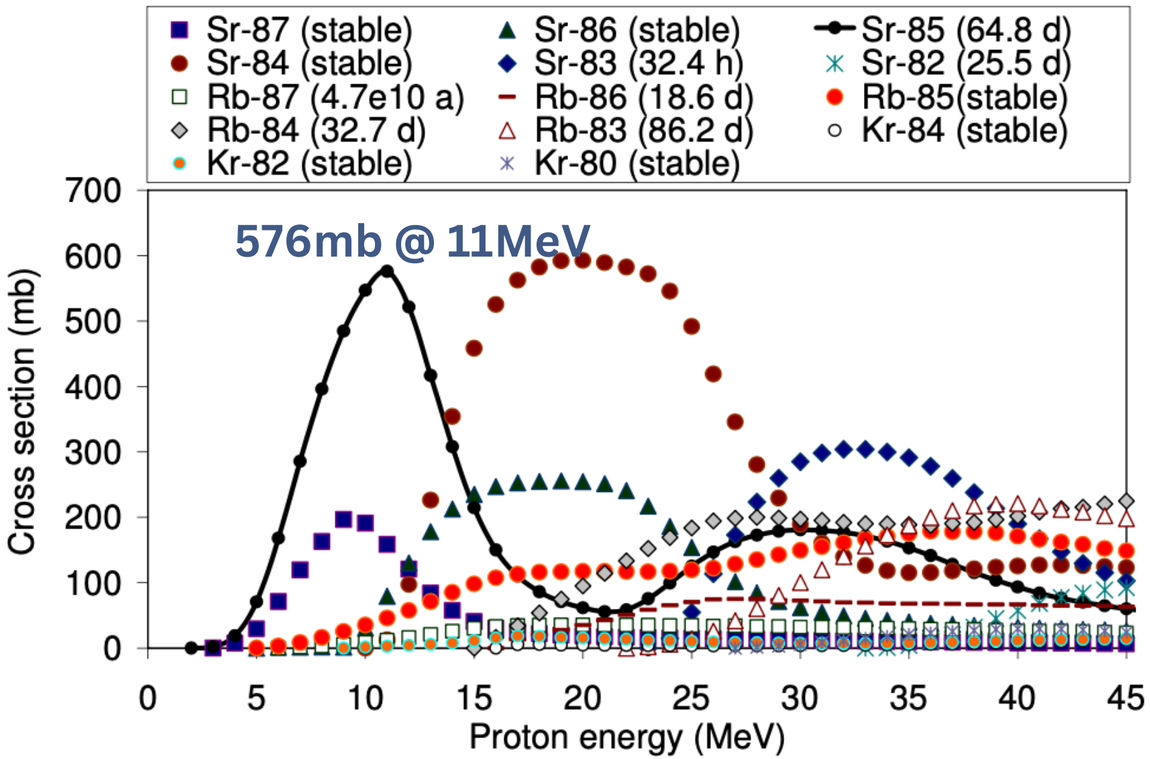


$$^{\mathrm{nat}}\mathrm{Rb}(p,x)^{85}\mathrm{Sr}$$

CROSS SECTION

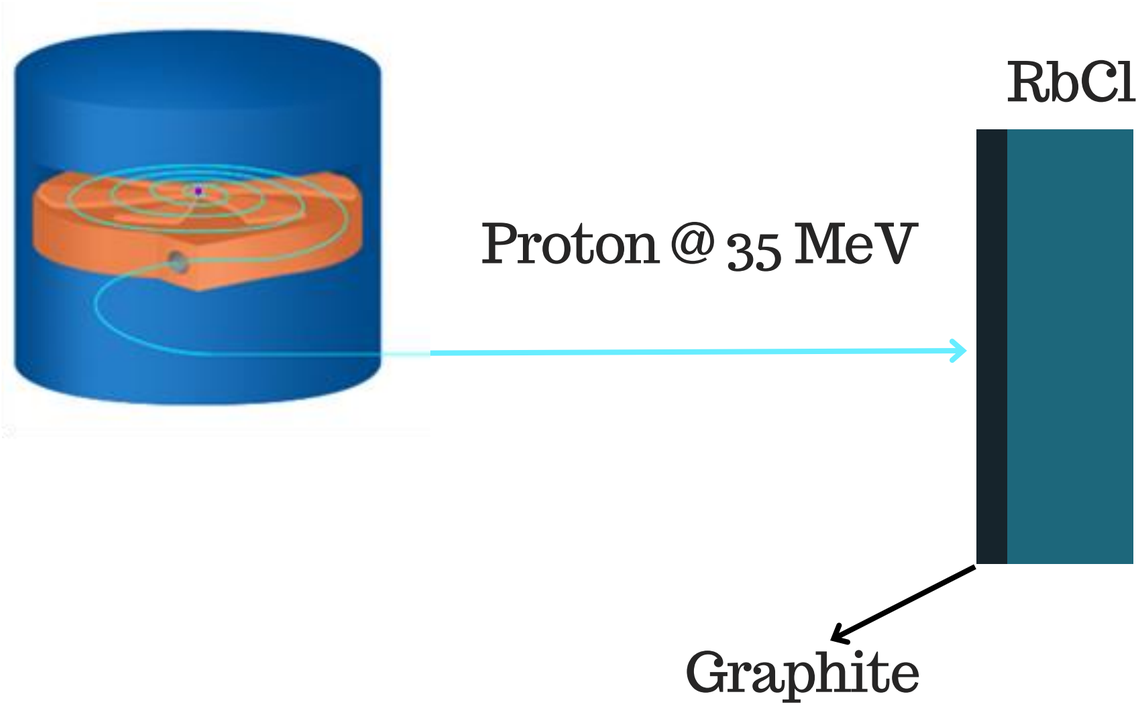


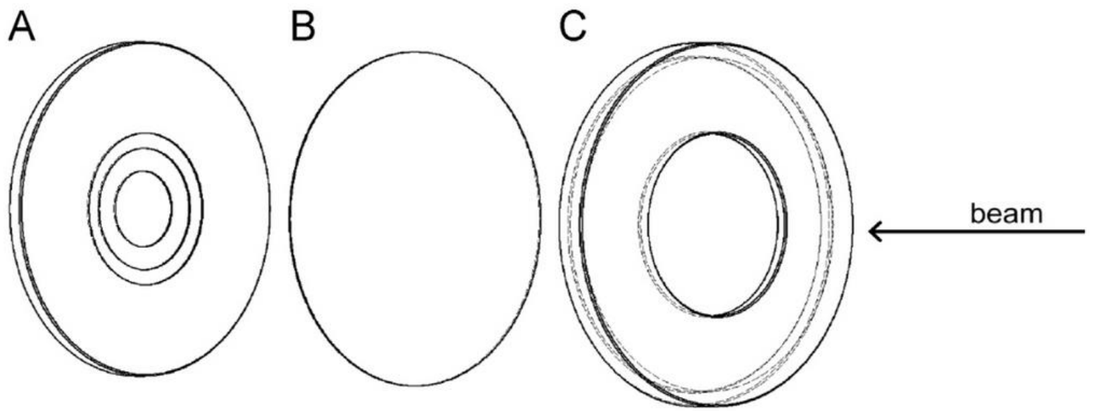
Sakamoto K. et al. (1995)



Sadeghi M. et al. “85Sr Poduction via proton induced on various targets usingTALYS 1.0 code” (2009)

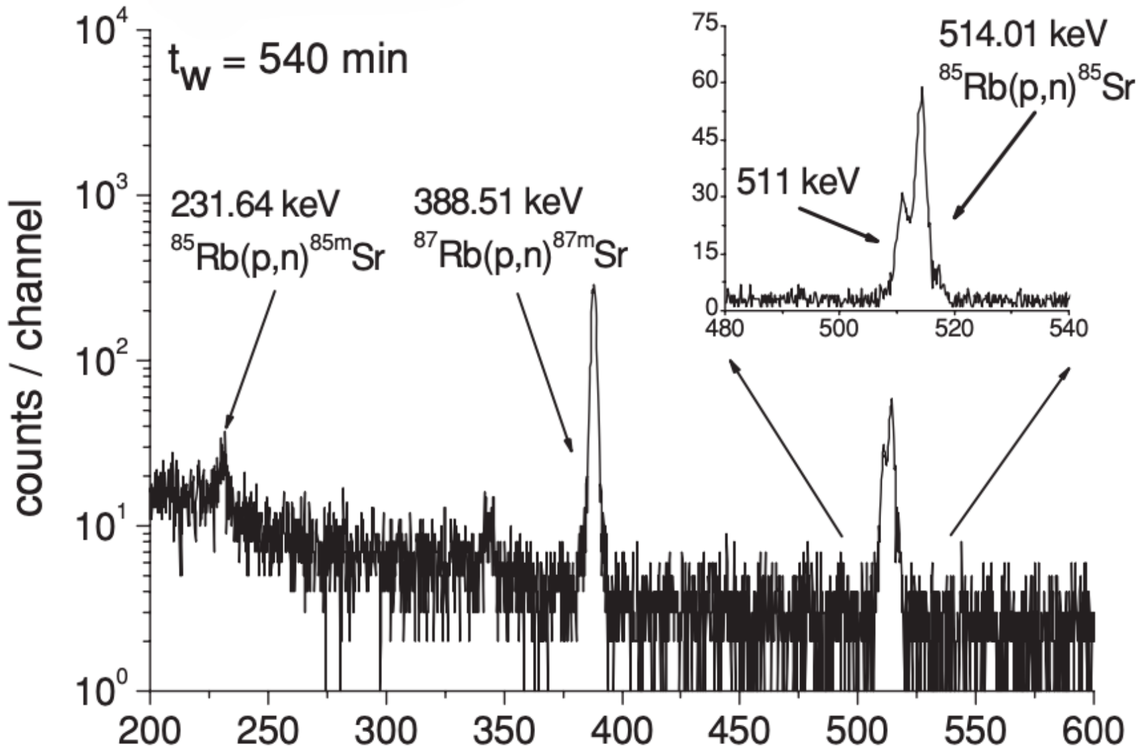
THE TYPE OF TARGET





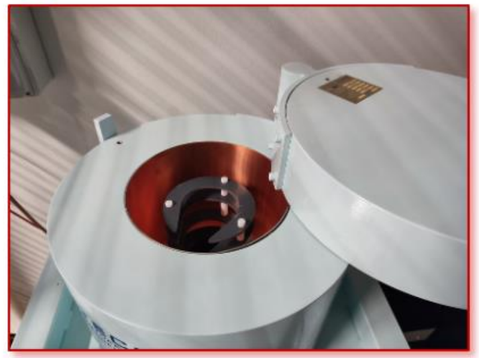
Mansel A. et al. “Production of 85Sr at 18 MeV-cyclotron and purification for geochemical investigations” (2014)

GAMMA SPECTROMETRY



- Low Background Lead Shields
- Carbon Fiber Endcap
- Integrated Cryocooling System

AMETEK®



Performance specifications	Warranted (Measured) RIV1	Warranted (Measured) RIV2
(Nominal) Efficiency at 1.33 MeV, ^{60}Co	20 (25.73) %	20 (29.91) %
Resolution (FWHM) at 1.33 MeV, ^{60}Co	1.9 (1.65) keV	1.9 (1.6) keV

Rauscher T. et al. "Suppression of the stellar enhancement factor and the reaction 85Rb(p,n)85Sr" (2009)

WHAT WE ASK

Produced ^{85}Sr activities A (MBq) depending on irradiation time (electric charge E_c, μAh).

E_c	$\pm \delta E_c$	A	$\pm \delta A$
0.20	0.05	0.04	0.01
5.00	0.05	3.90	0.18
5.60	0.05	6.59	0.32

Mansel A. et al. "Production of 85Sr at 18 MeV-cyclotron and purification for geochemical investigations" (2014)

- **Current**: 5 μA
- **Beam Energy**: 35 MeV
- **Beam Time**: 2-3 h maximum
- **Cooling system:** water

Thank You

For Your Attention