REVIEW OF CURRENT SATURATION DECOMPRESSION PROCEDURES IN THE OFFSHORE INDUSTRY

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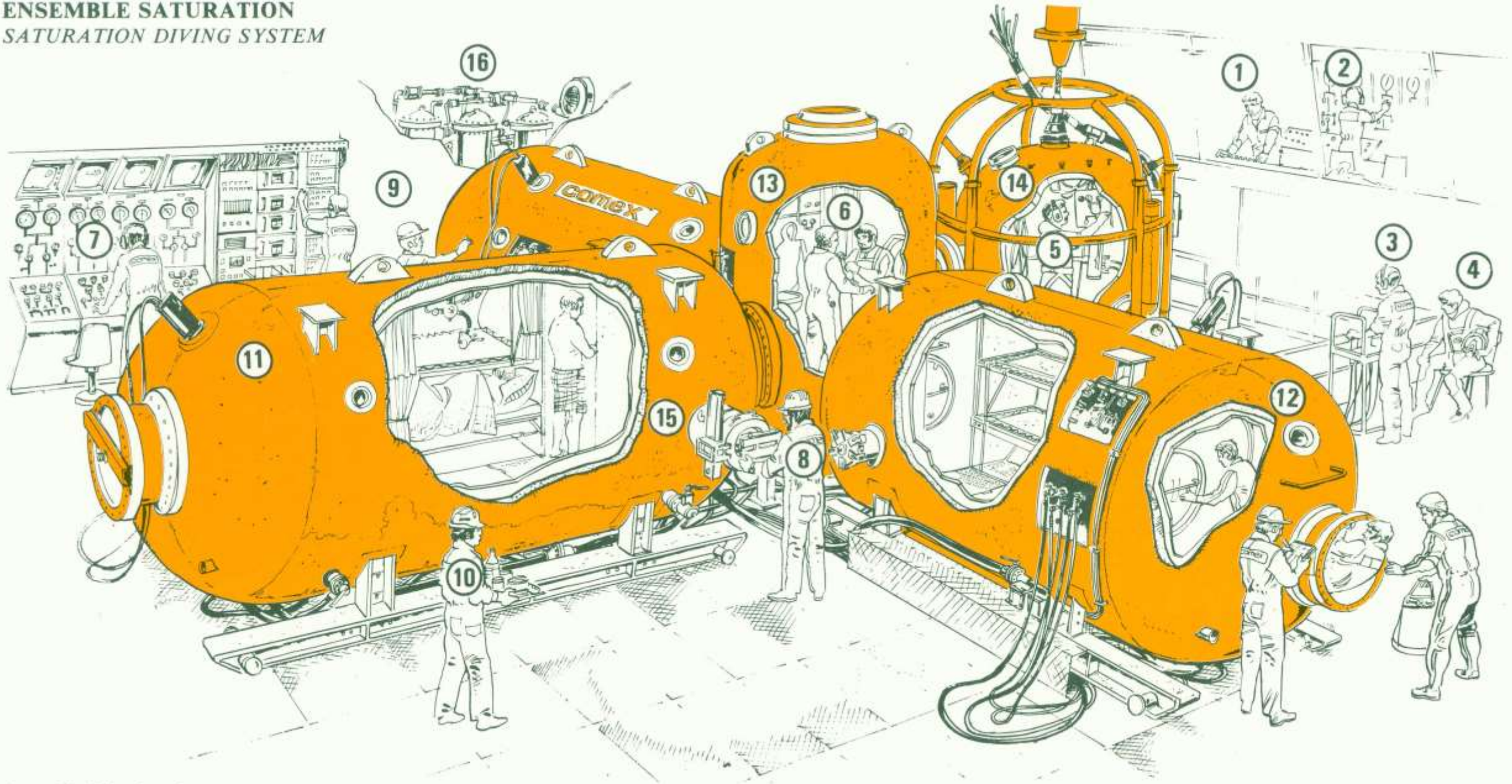
October 1970,
BP discovered oil in the UK sector, in 120 msw

1973
First oil crisis
Important effort of research

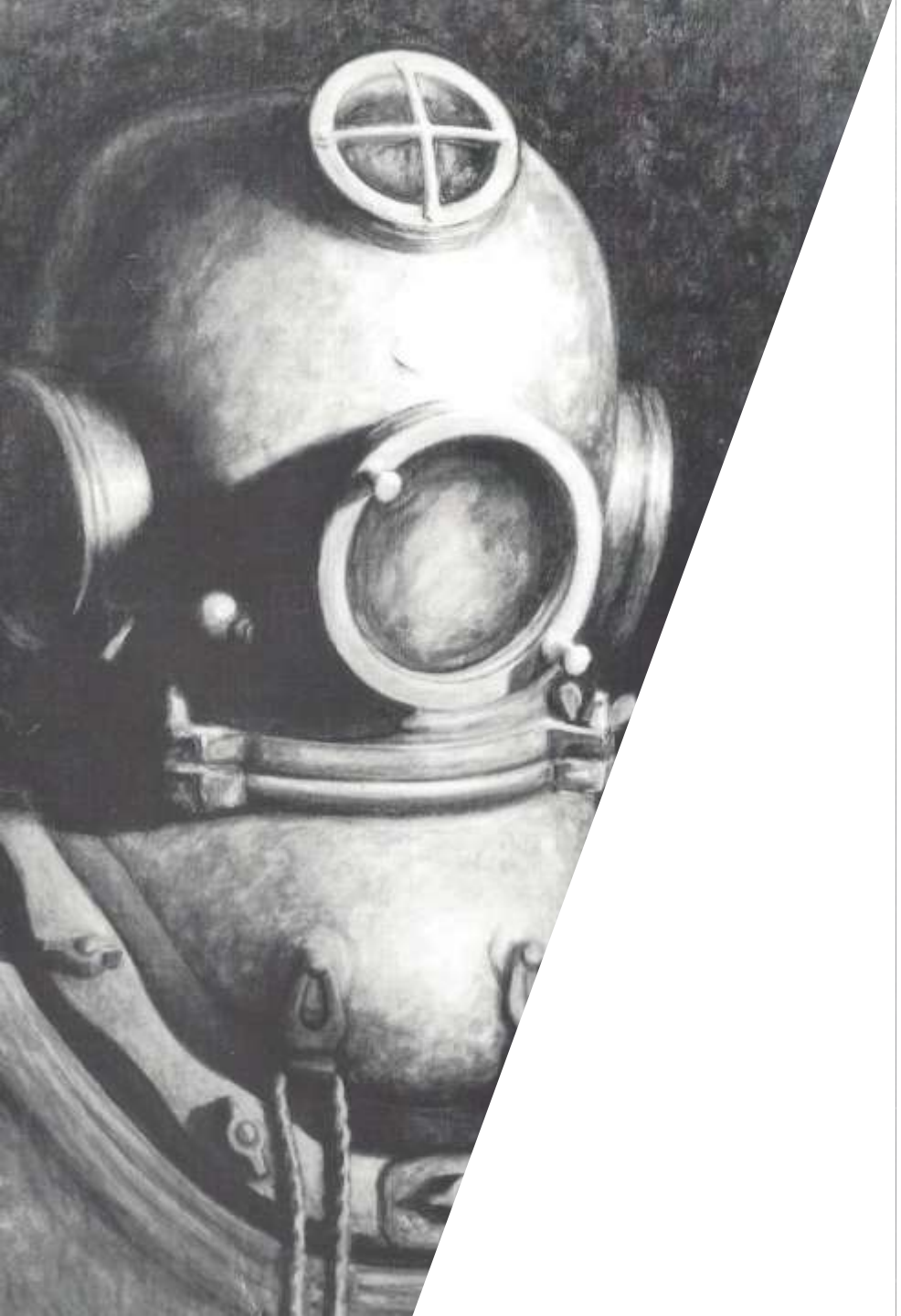
ENSEMBLE SATURATION
SATURATION DIVING SYSTEM



1 Chef de chantier

AODC, IMCA
DMAC
UKOOA, IOGP

The « North Sea Standards »

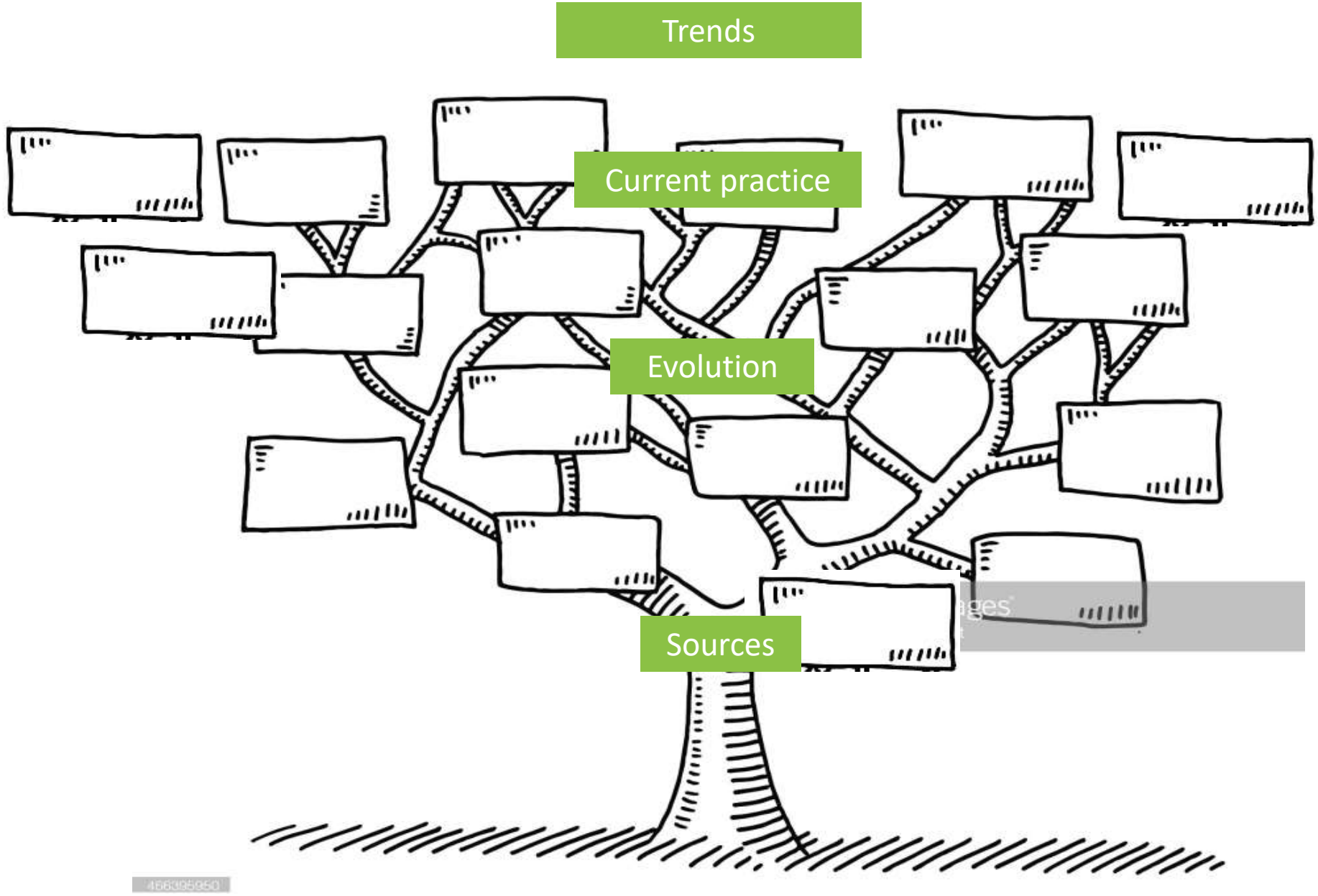


The project: Where do we stand 50 years later

(with focus on saturation decompression)

Objectives

Saturation procedures used in offshore commercial diving



Method

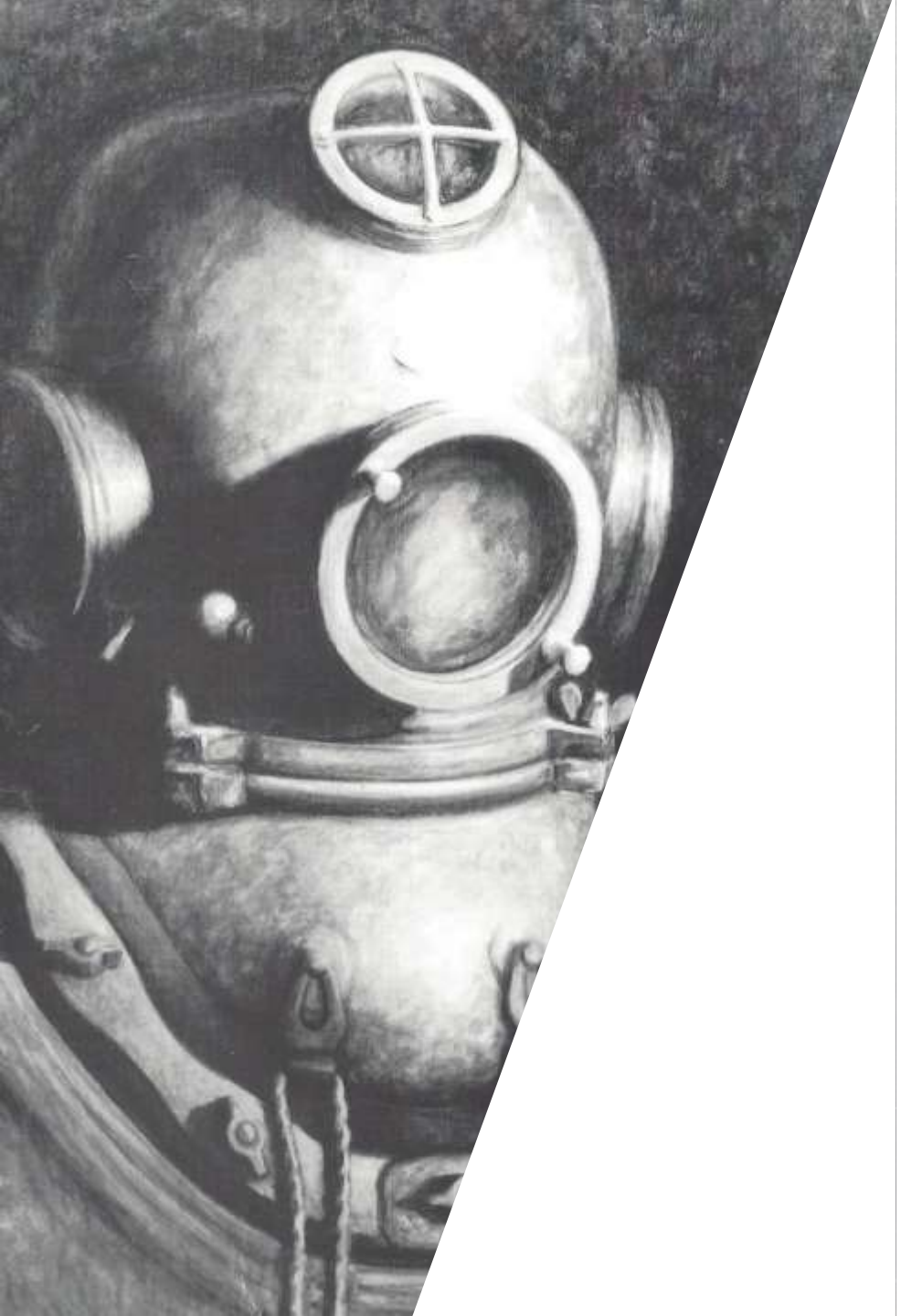
50 Diving companies registered in IMCA classified for “unrestricted diving”

30 Diving companies when eliminating multiple registrations

10 Diving companies accepted to participate to the survey

1. Boskalis, Aberdeen, UK
2. DOF Subsea, Perth, WA
3. Fugro, Singapore
4. Helix Wellops, Aberdeen, UK
5. Kreuz, Singapore
6. McDermott, Houston, Texas, USA
7. Mermaid Subsea Services, Bangkok, Thailand
8. Rever Offshore, Aberdeen, UK
9. Shelf Subsea, Perth, WA
10. TechnipFMC, Aberdeen, UK

Anonymized randomly into company A, B, C …



Identify the sources

Laboratories

IFEM
DUKE
RNPL

The US Navy Diving Manual

1977

Free

Exhaustive

Highly respected

Rev 7 2016

Increased chamber PO2

440-480 mbar

Diving companies

Comex
Oceaneering
Taylor Diving

1984-1990
Norway
NUTEC
Bergen

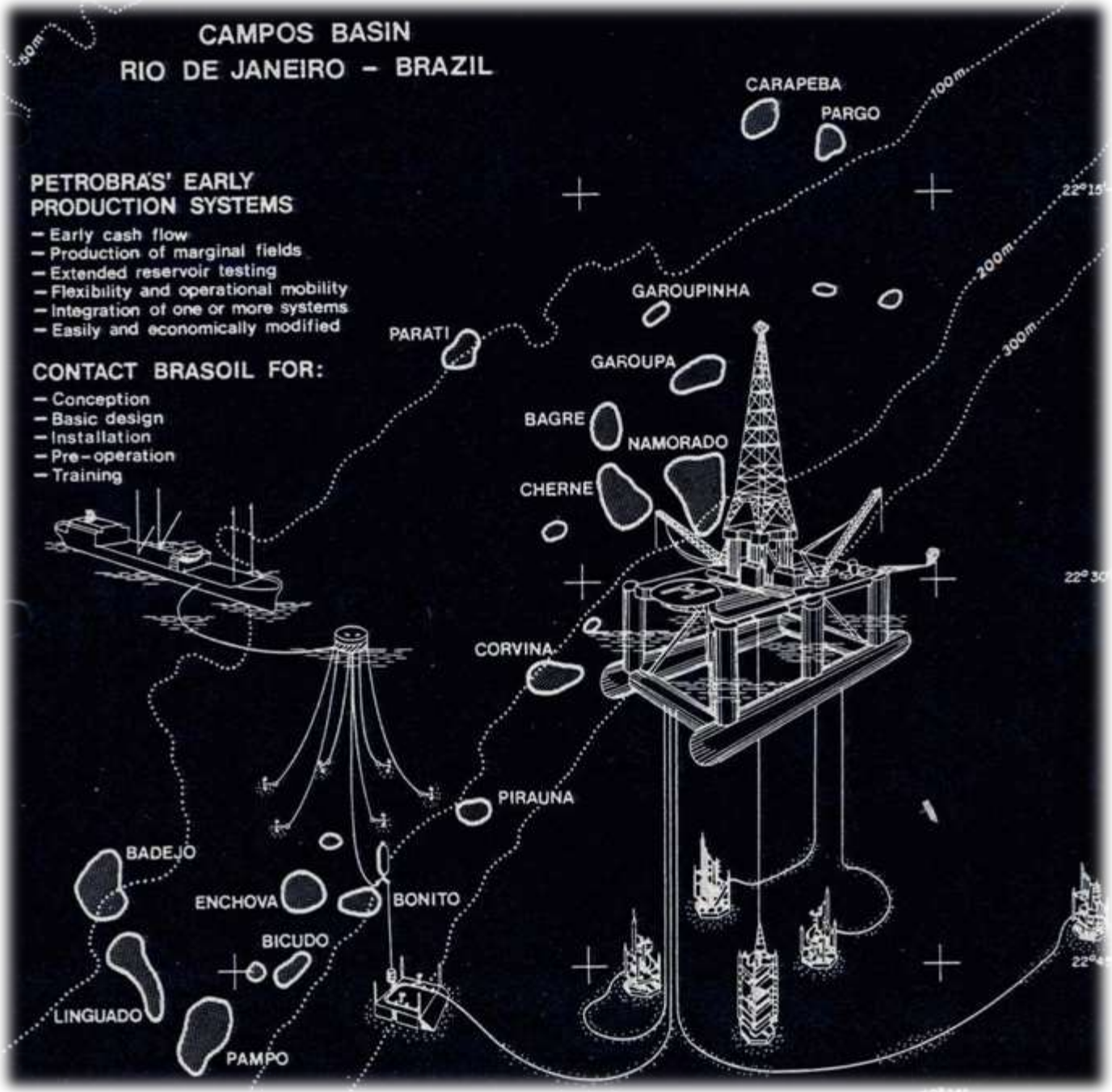
Norske Shell
Statoil 3DP
Norsk Hydro Oseberg
Deep diving projects

The 3DP Contract
300 m Onarhein Fjord demonstration dive

1984 NPD initiative for standardisation de saturation procedures

1999 publication of the NORSOK U100 standards

Deep diving in Brazil 1990

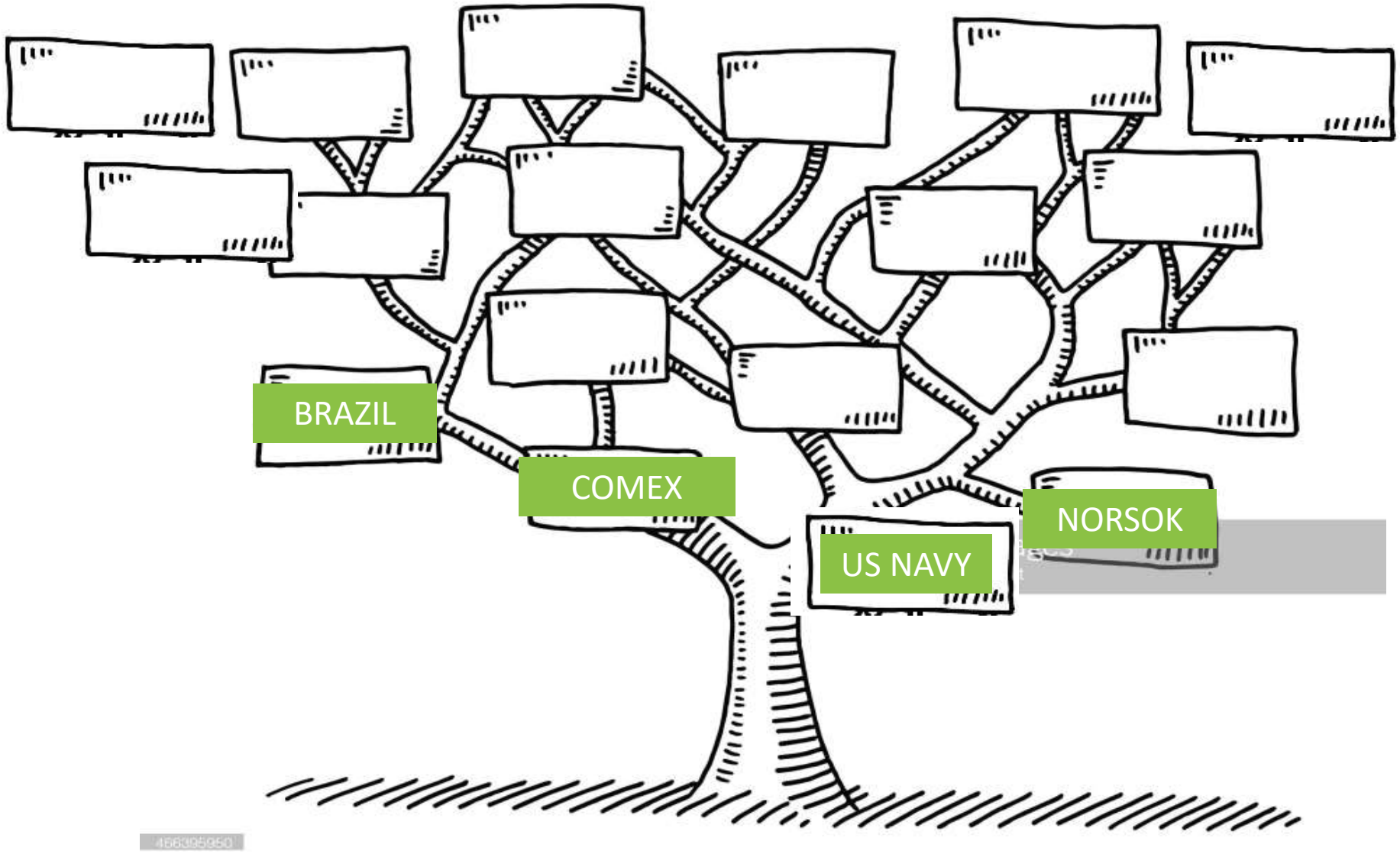


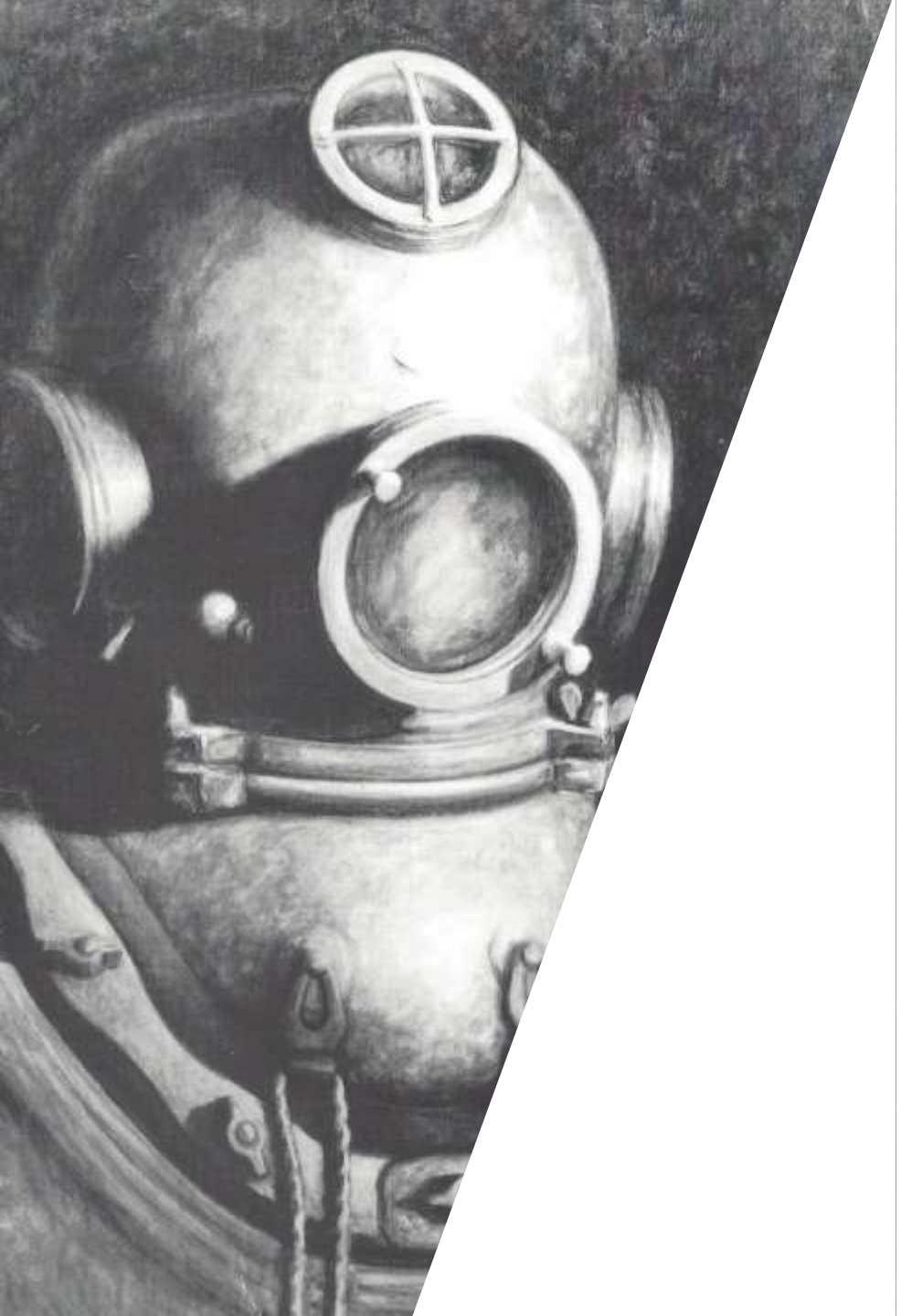
Two companies
Comex
Marsat

Comex Flex Services I
3 to 4 saturations to 240 – 280 msw per year

Brazil
1996 publication of the NORMAM 15
Saturation procedures

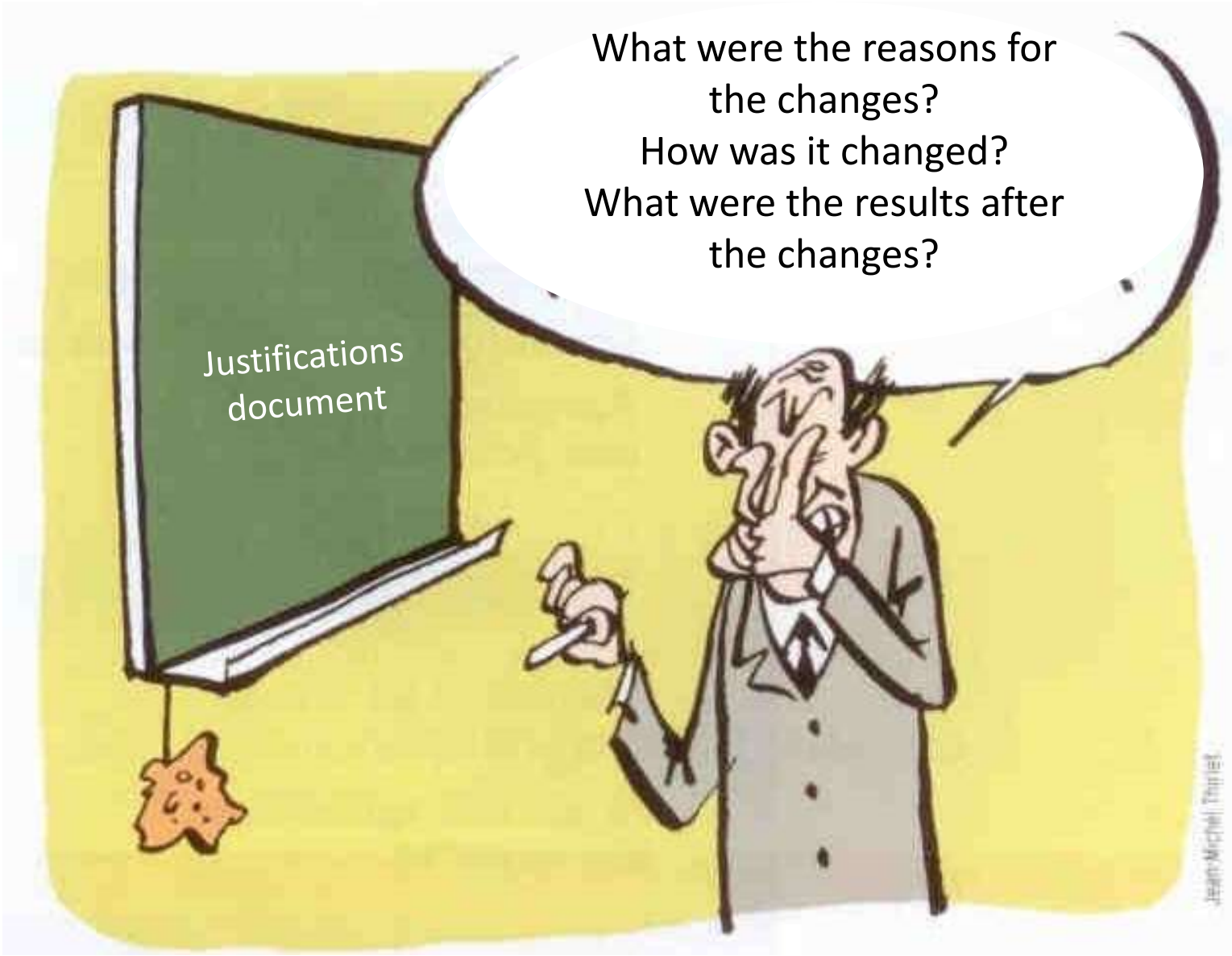
Sources





Track the evolution

Keep the Lessons learnt



History was lost most of the time
Only two companies were maintaining justification documents

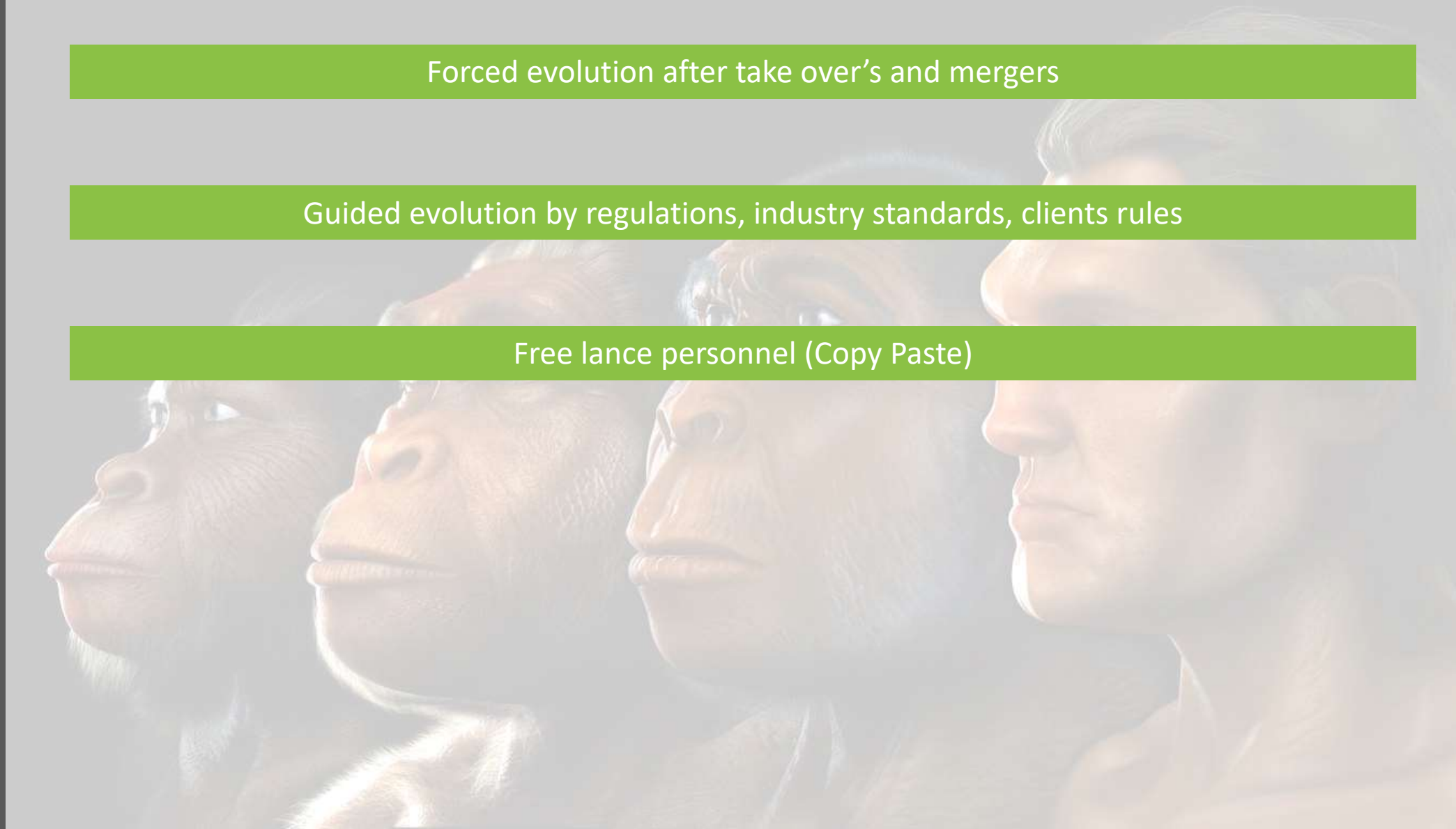
Survey results

No large scale research since the 90’s
Evolution based on empirical adjustments

Forced evolution after take over’s and mergers

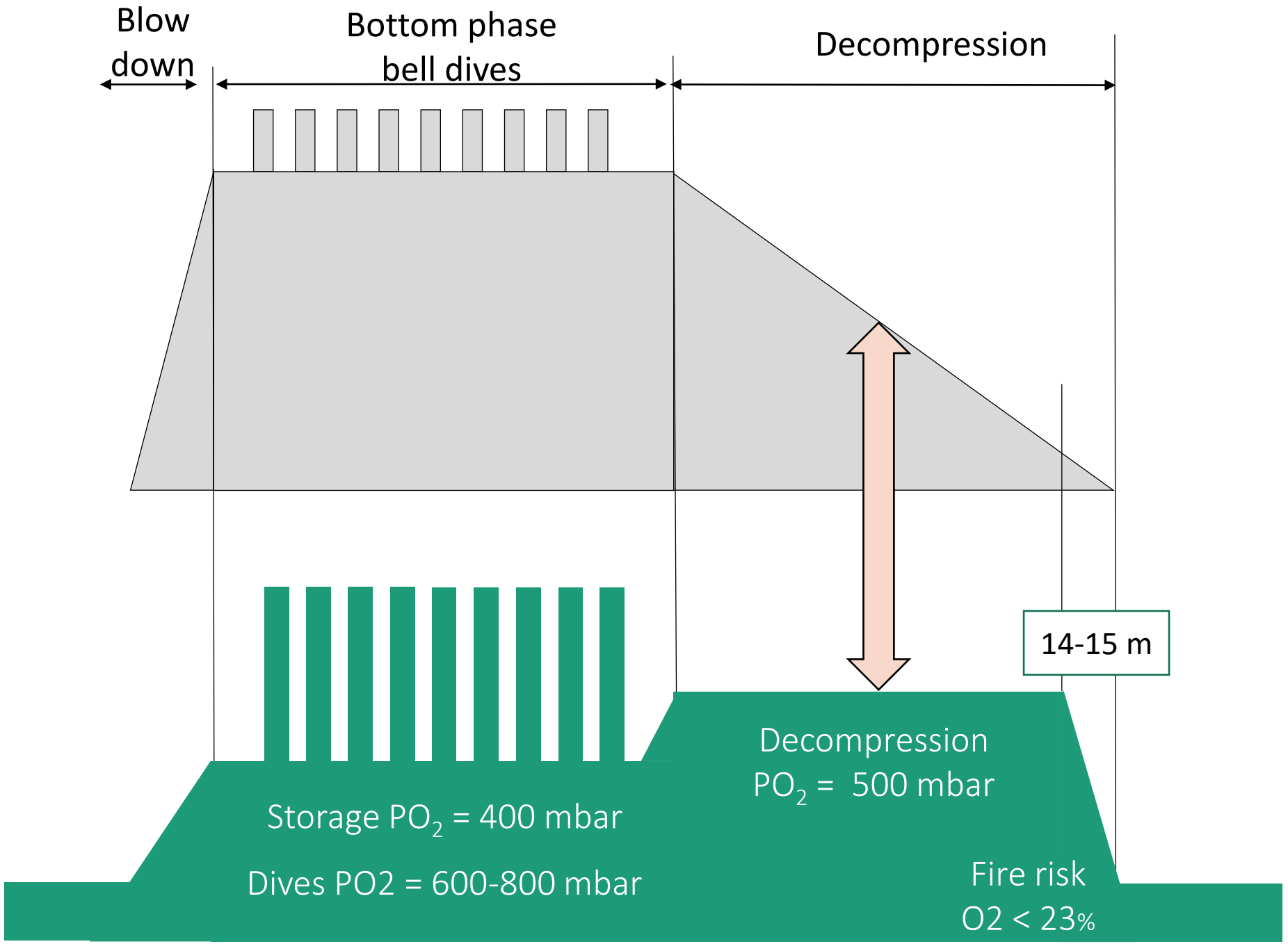
Guided evolution by regulations, industry standards, clients rules

Free lance personnel (Copy Paste)



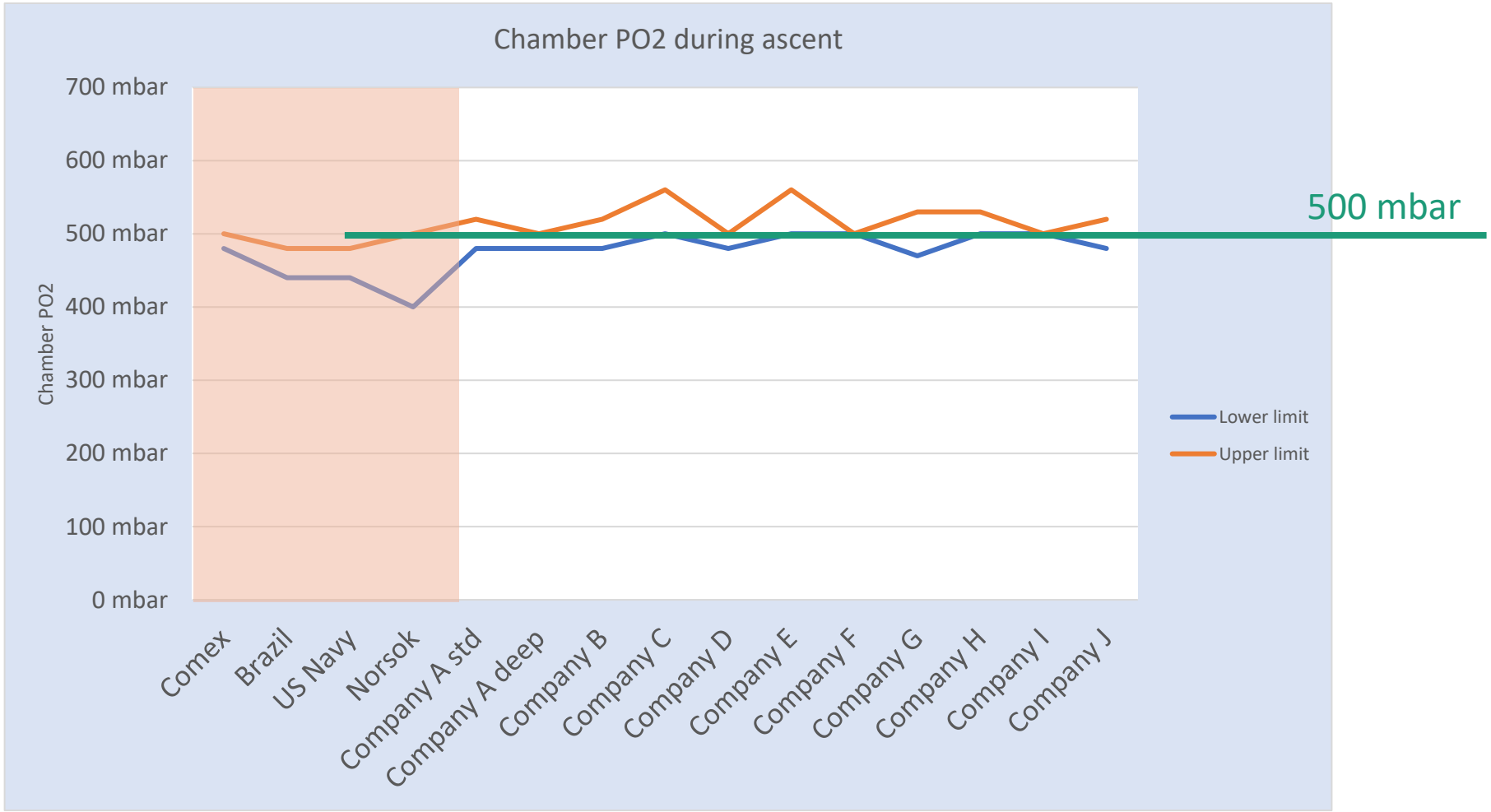
Define
the current practice

Saturation profile and PO2 profile



Survey

Chamber PO2 during ascent > 15 msw



Survey

Ascent rates

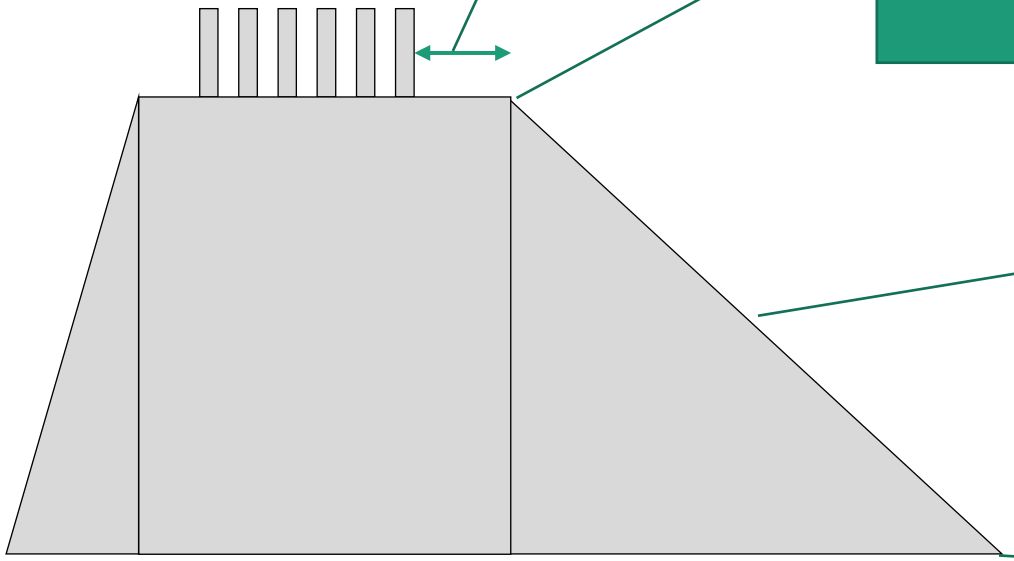
(expressed in distance travelled per day)

Survey

Ascent rates In distance travelled per day

Survey

Other decompression issues



Decompression hold

7 companies systematically require 6 to 8 hrs
2 companies only after a downward excursion
1 company defines none

Initial pull up
(start with an upward excursion)

Now forbidden by all companies

Decompression night stops

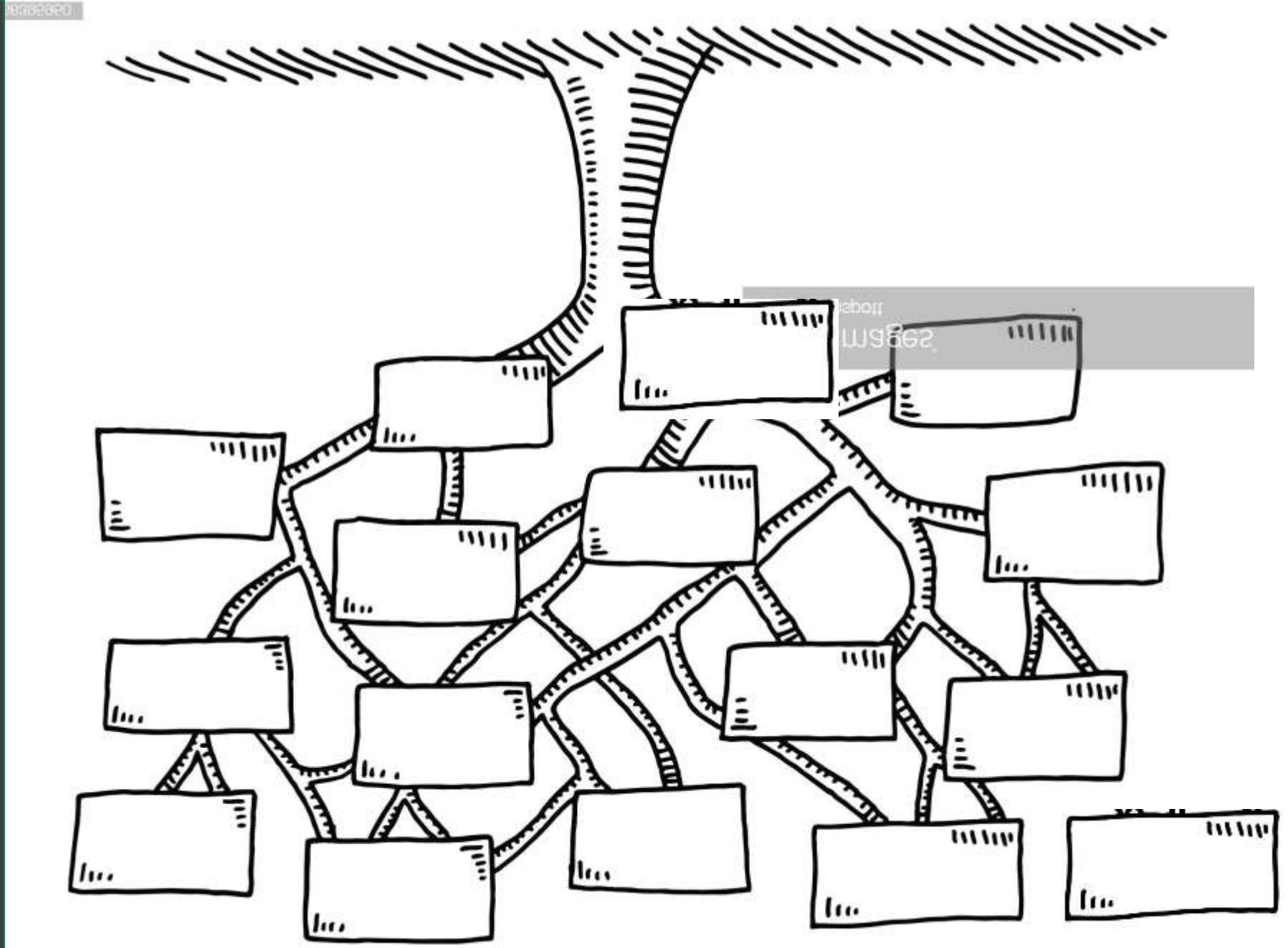
8 companies use stops (4 to 8 hours)
2 companies use continuous ascent

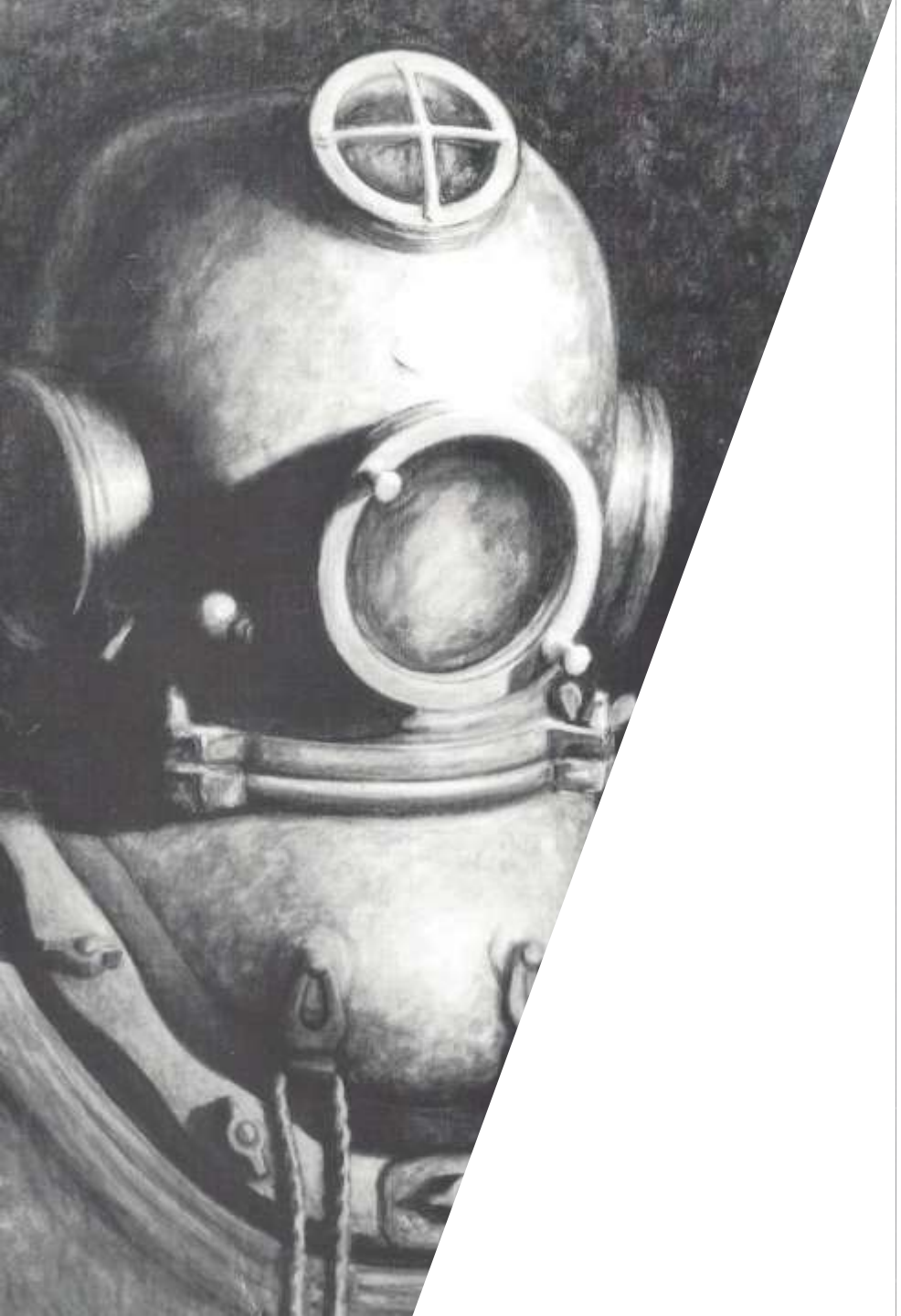
DCS incidence
One case every 5-10 years

Observed continuous harmonization of procedures

Because of the international dimension of the market

the influence of industry guidelines





Identify the trends

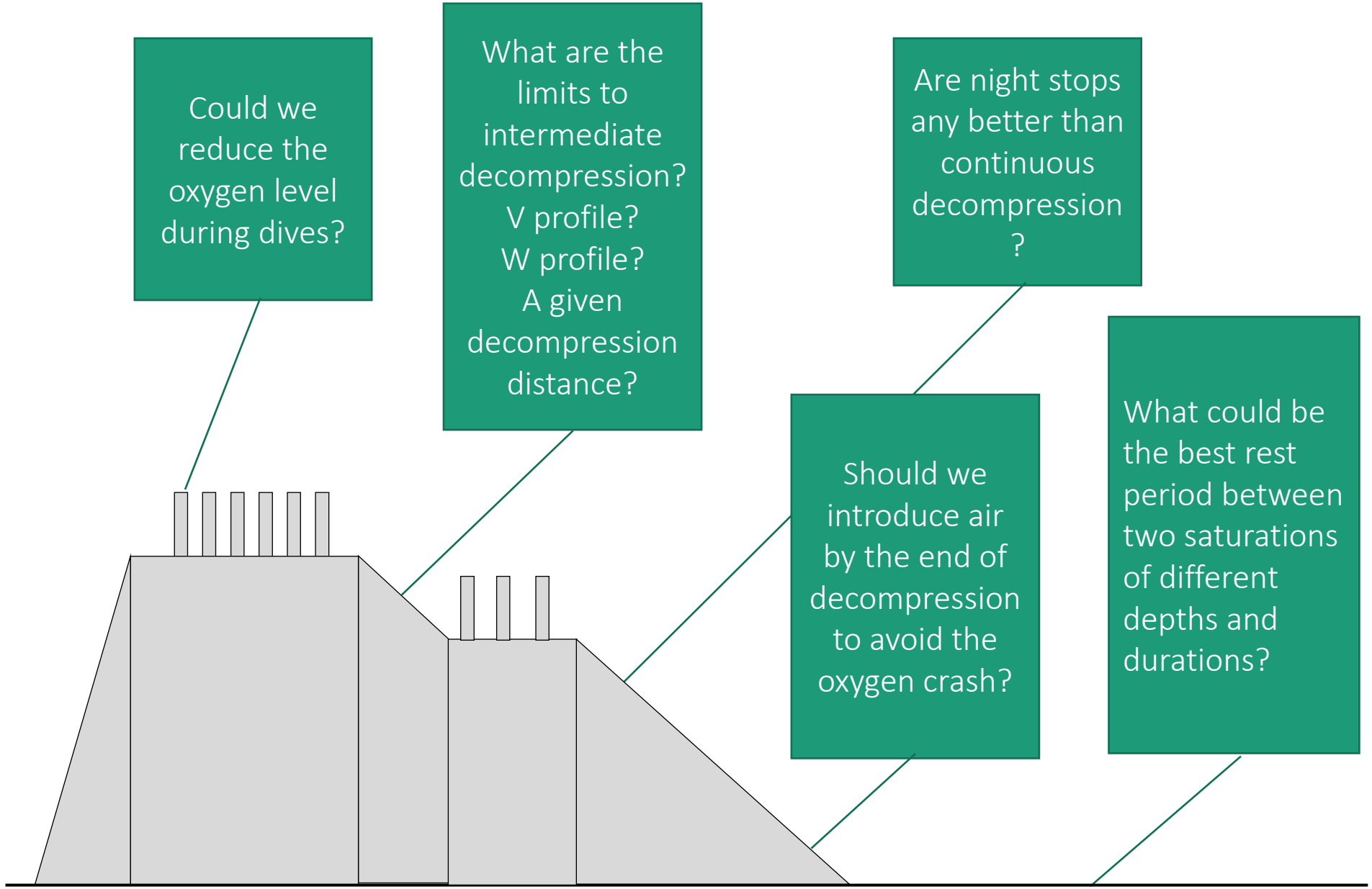
Managing a modern DSV:

Crew changes and surface intervals for 80 divers

Multi project missions with multiple storage depths

At a daily rate of 200k€

Pending Questions

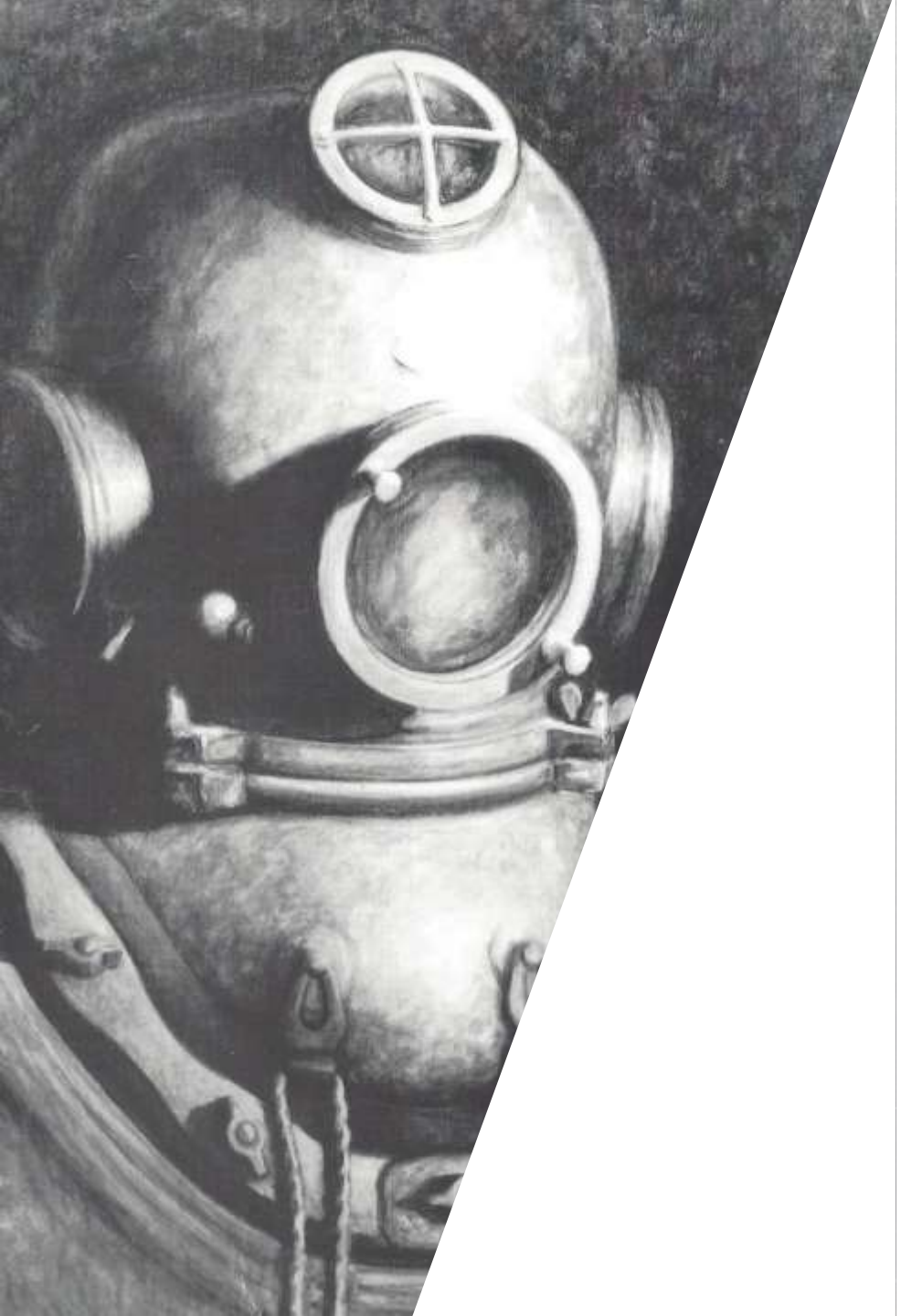


Moving shallow

- What should be the interval after a saturation before an air dive ?
- Could we extend sat instructions to 10 msw working depth?
- Could we use 600 mbar chamber PO2 for shallow saturation decompression?

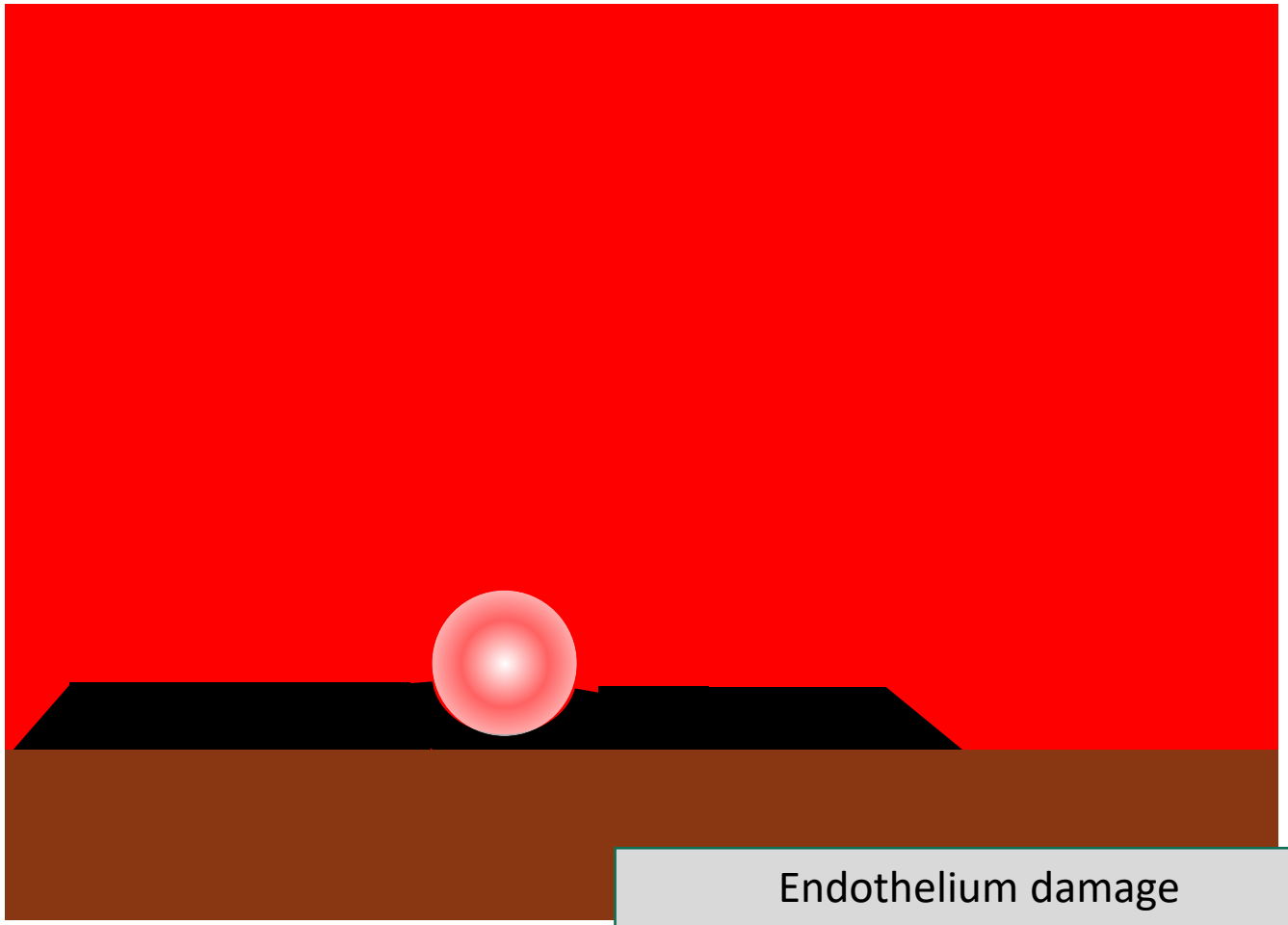
Pending Questions

- Is thi  ther?



Organizing our knowledge

2017
Dr Ran Arieli:
"A venous bubble, on detachment from the endothelium, tears off part of the membrane"



Endothelium damage
Micro particles
Oxidative stress
Inflammation

Dr Ran Arieli: October 2021

Arieli R (2021) Endothelial Injury in Diving: Atomic Force-, Electronic-,
and Light-Microscopy Study of the
Ovine Decompressed Blood Vessels.
Front. Physiol. 12:767435.
doi: 10.3389/fphys.2021.767435

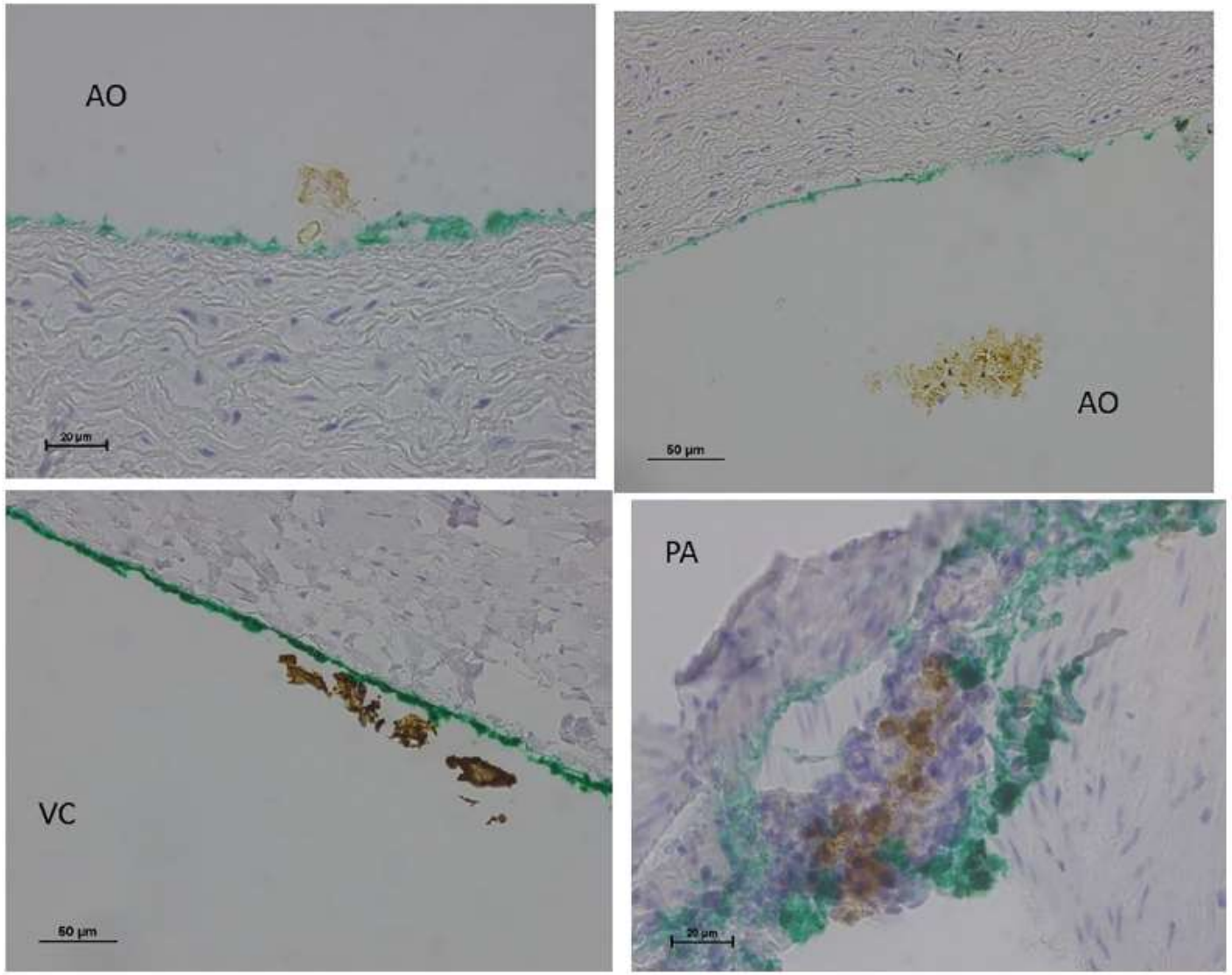
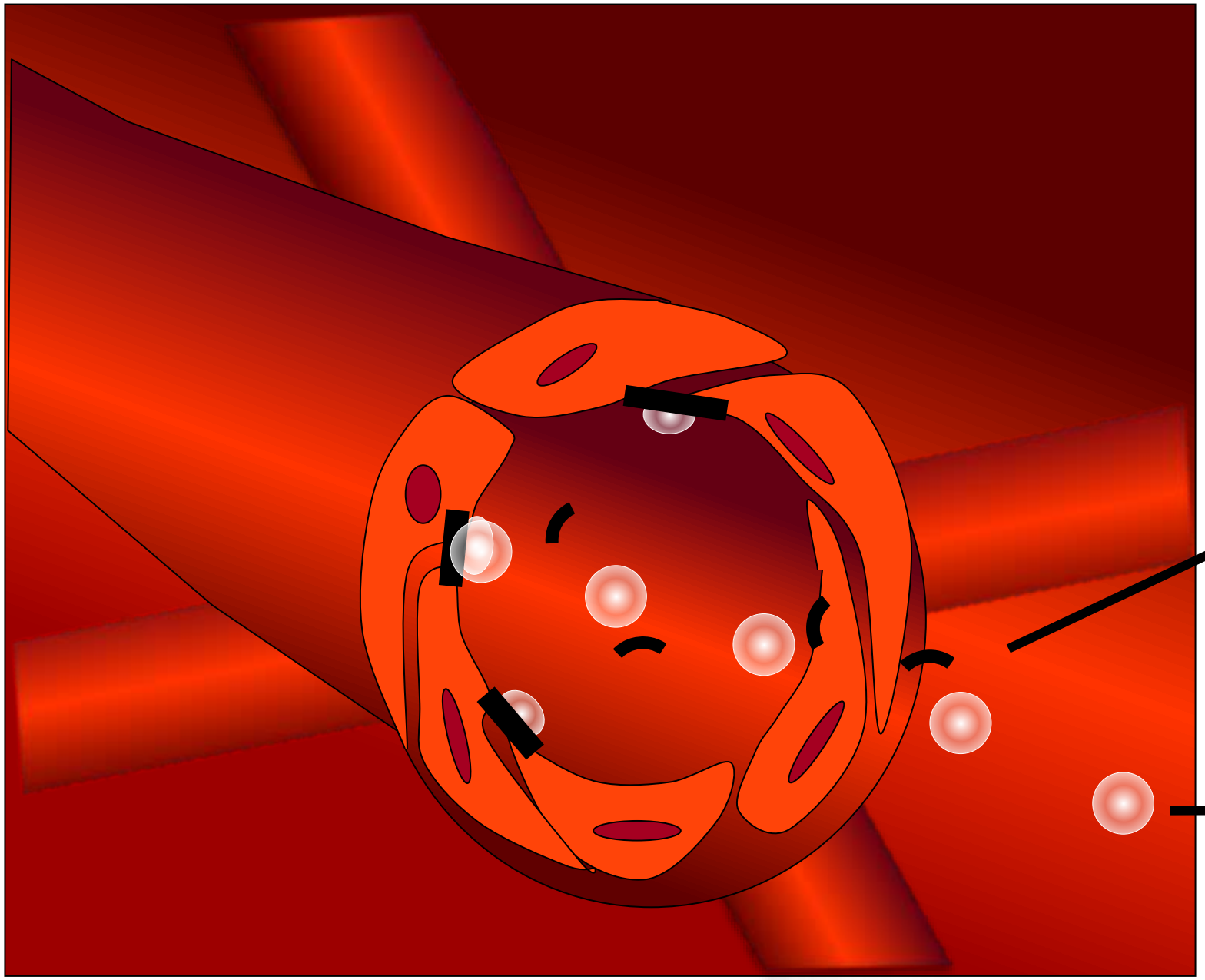
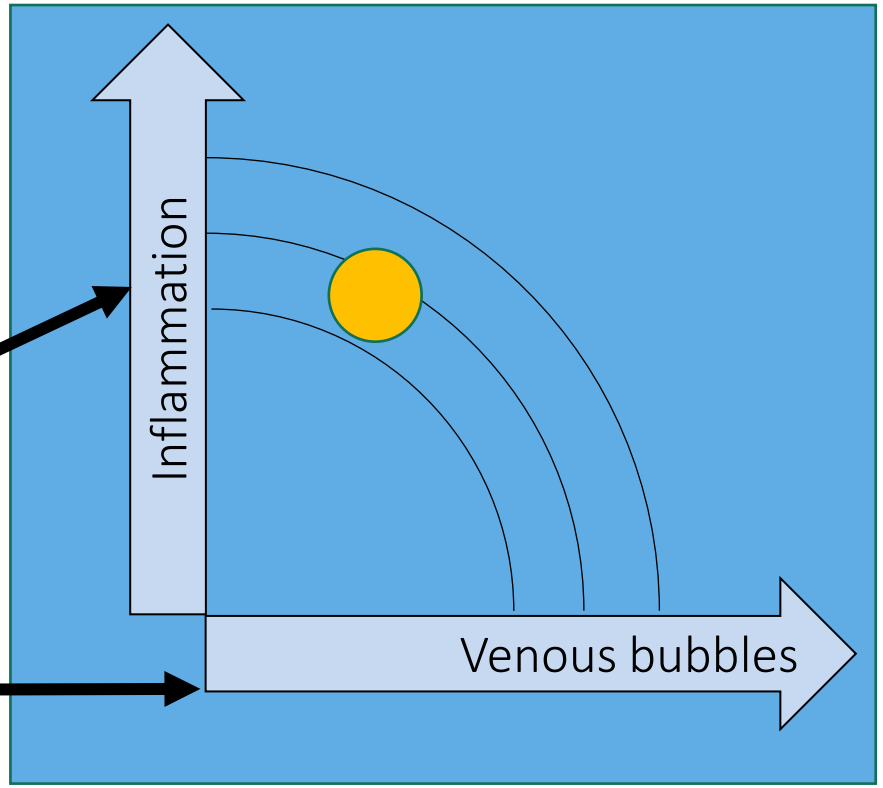


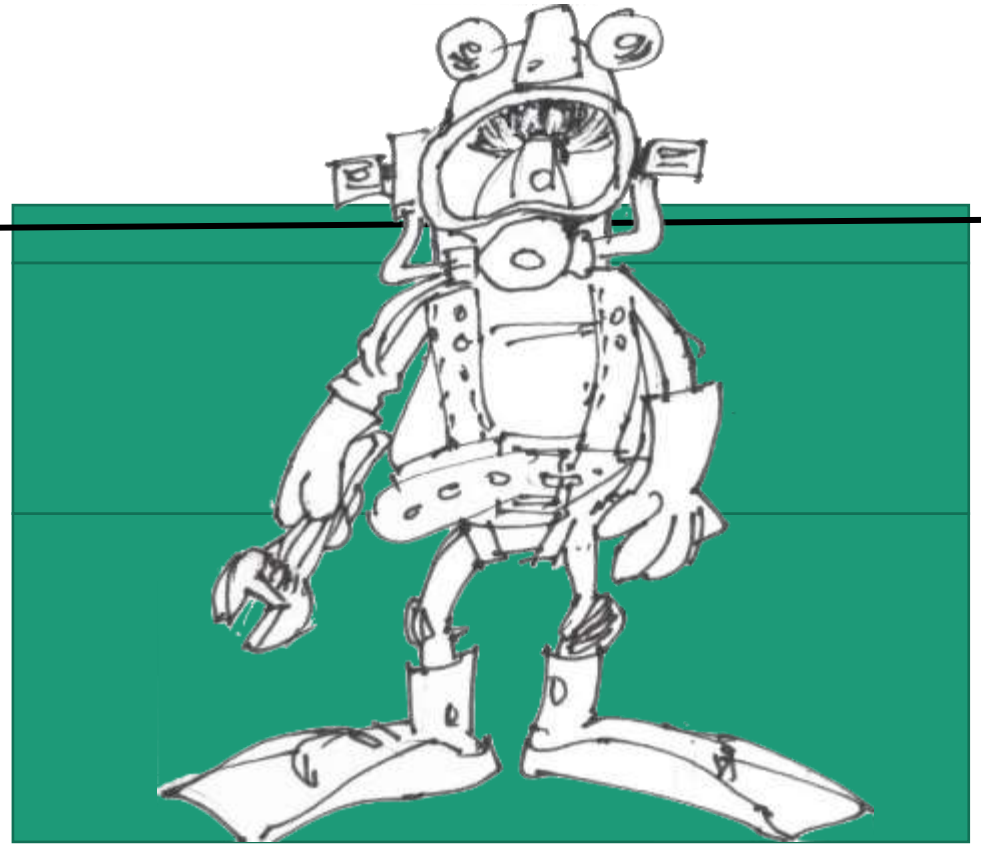
FIGURE 5 | Light microscopy view of the luminal aspect of the blood vessels: aorta-AO, superior vena cava-VC, and pulmonary artery-PA at the AHS. Green line denotes the luminal aspect. There is debris or detached cluster of the endothelial cells (brown color).

The two dimensions of the decompression stress





Our current understanding
A cumulative effect of sat diving and stress



Clinical inflammation

Unfit/old diver
Additional stress/anxiety

Longer recovery

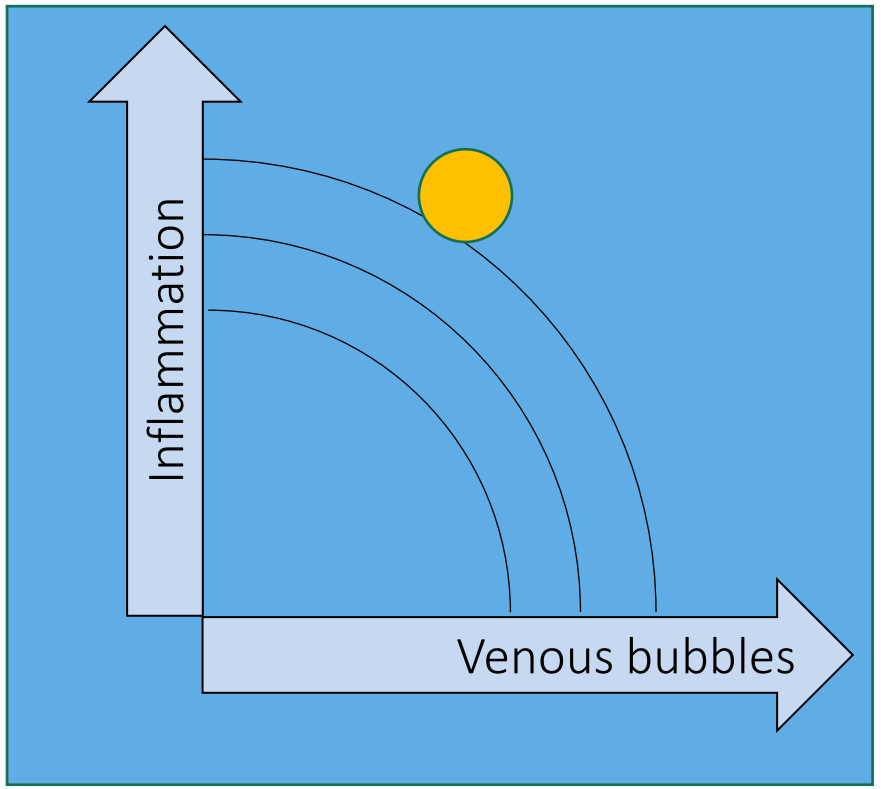
Fit/young diver
Experienced diver

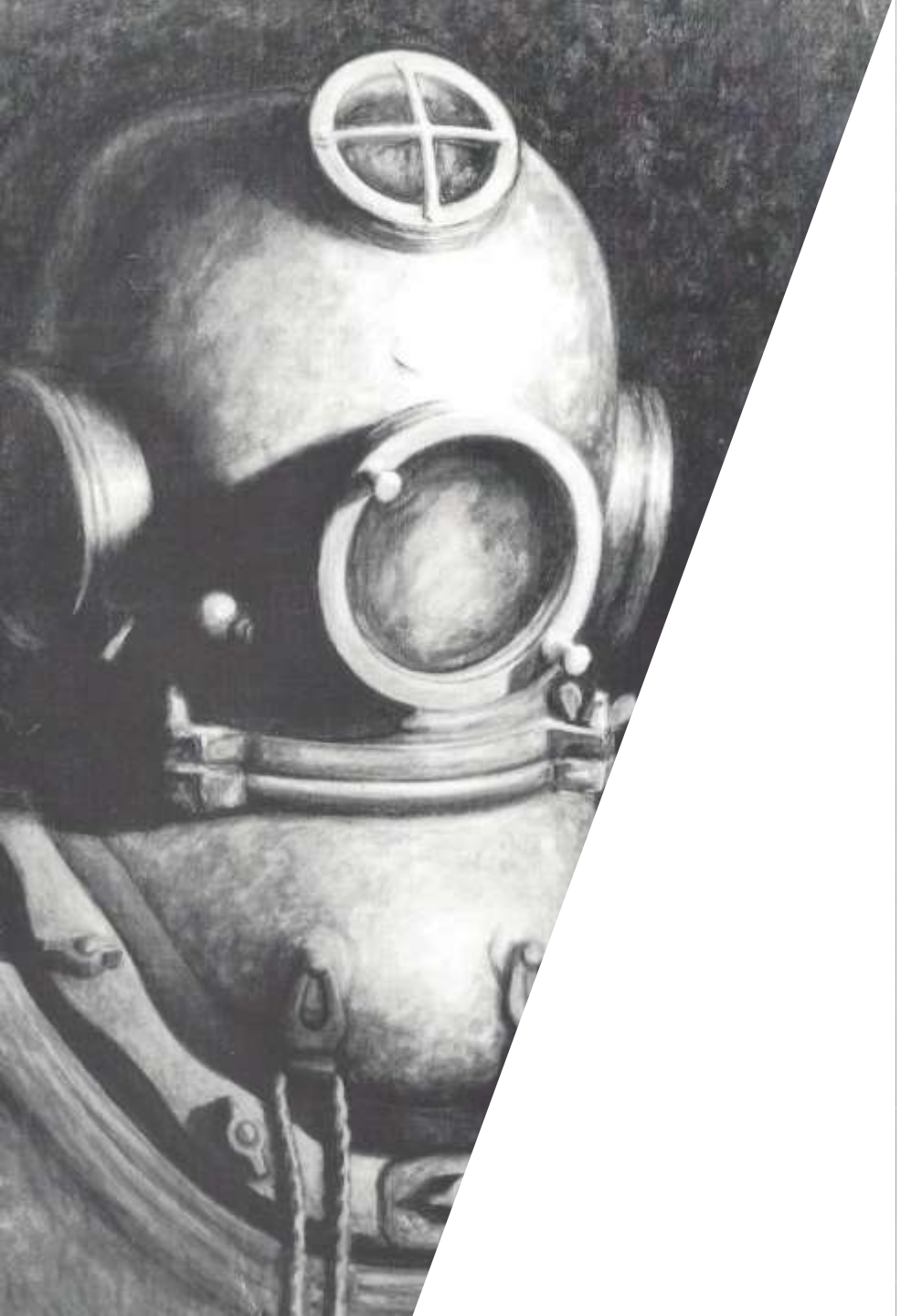
Sub clinical inflammation
Recovery

Strategy

Minimize the decompression stresses

Switch from measuring
DCS incidence rates
to
Decompression stress





Measuring the decompression stress

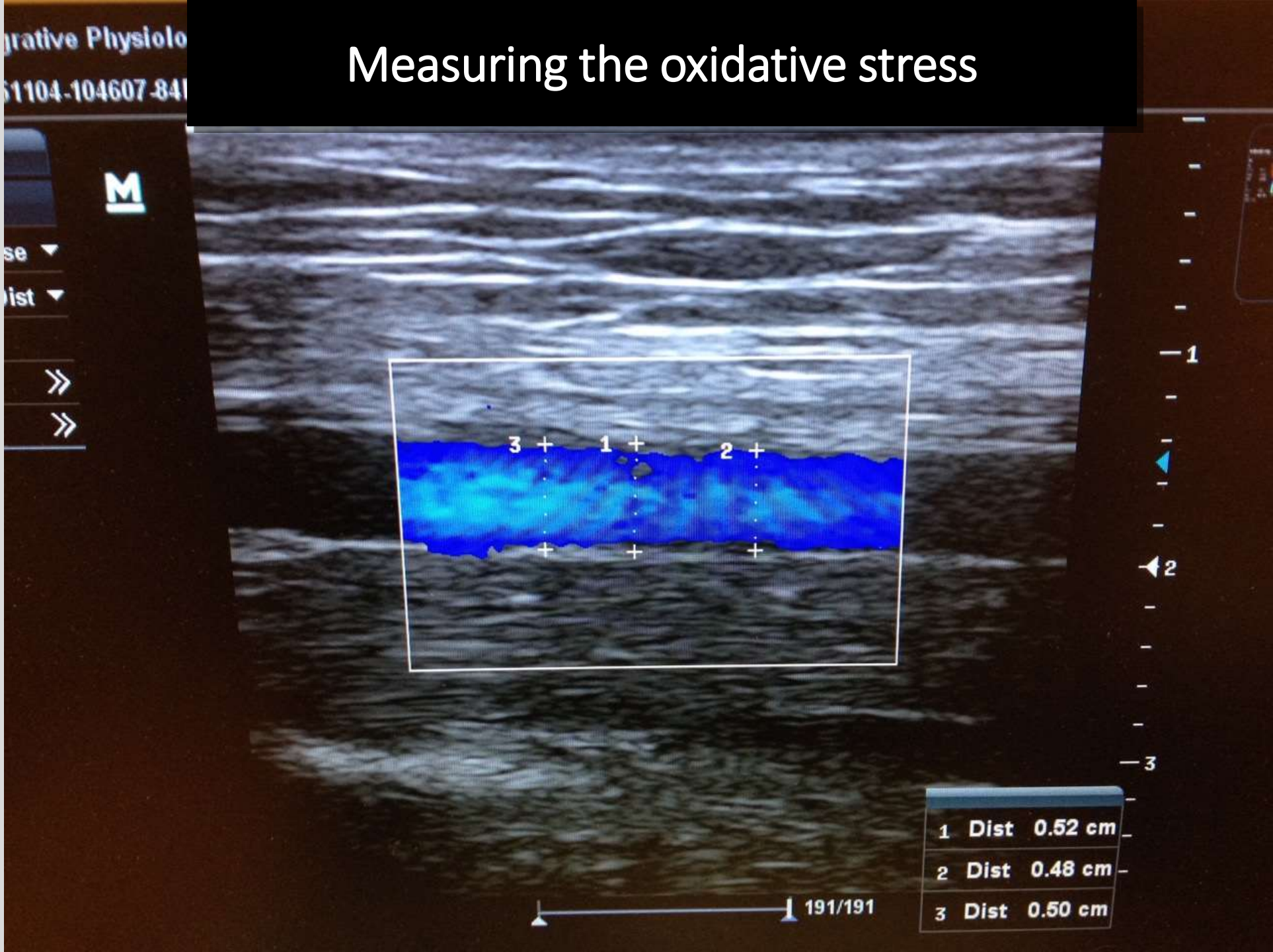
2017
DSV Arctic

Oxidative stress monitoring by FMD (Flow Mediated Dilatation)

Measuring the oxidative stress

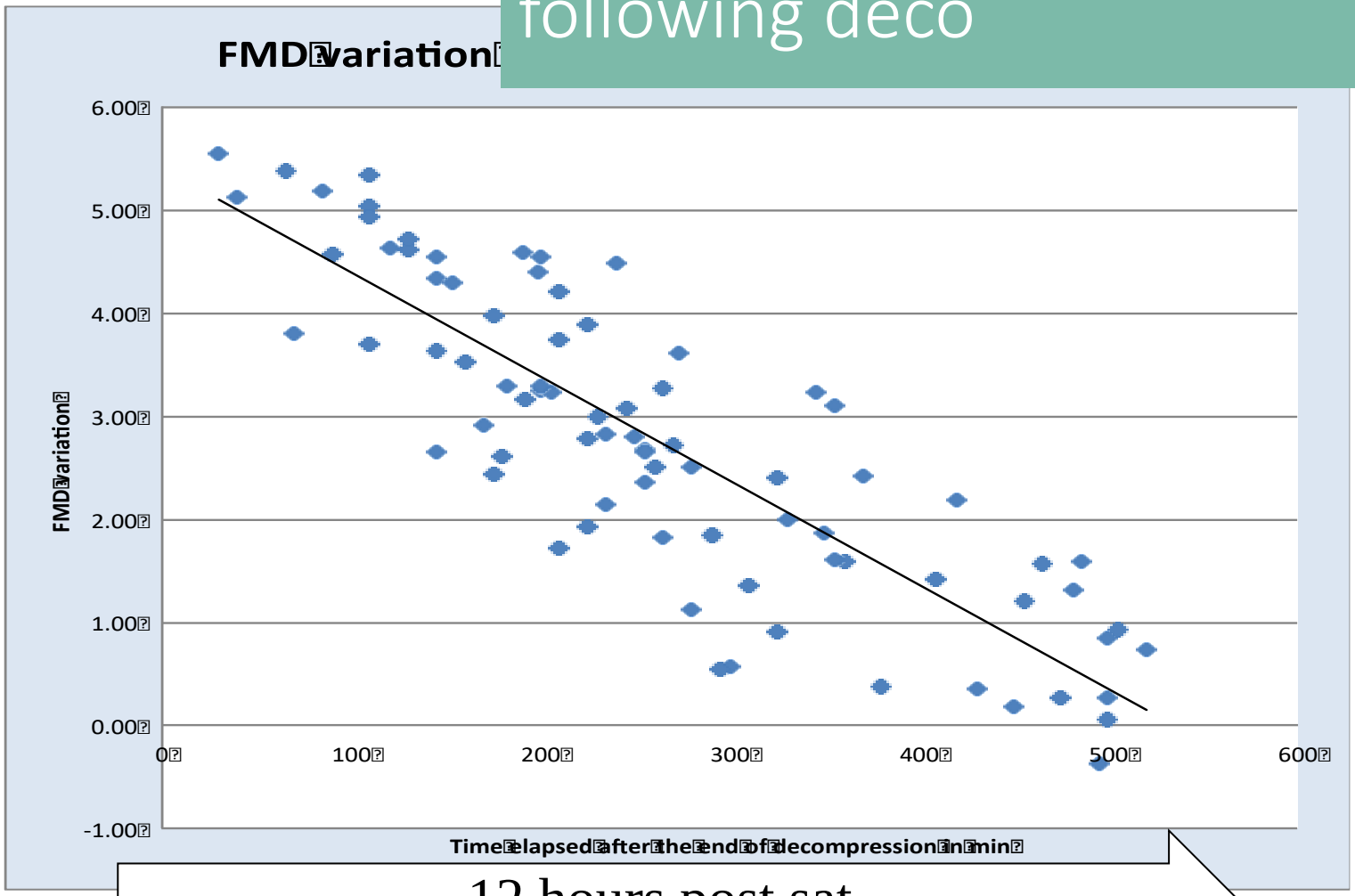
56 divers monitored during North Sea saturations

UK and Norwegian sector



Post deco monitoring

Oxidative stress measured during the next 12 hours following deco



12 hours post sat

Making monitoring simpler

Bio impedance 4 electrodes multi frequencies

2021

New divers monitoring package

Mental and physical fatigue

PhysioPad tablet
+ Flicker test

+

Oxidative stress

+

Bubble stress

2021
Gombessa 6 Project

3 weeks sat at
120 msw
on
rebreather

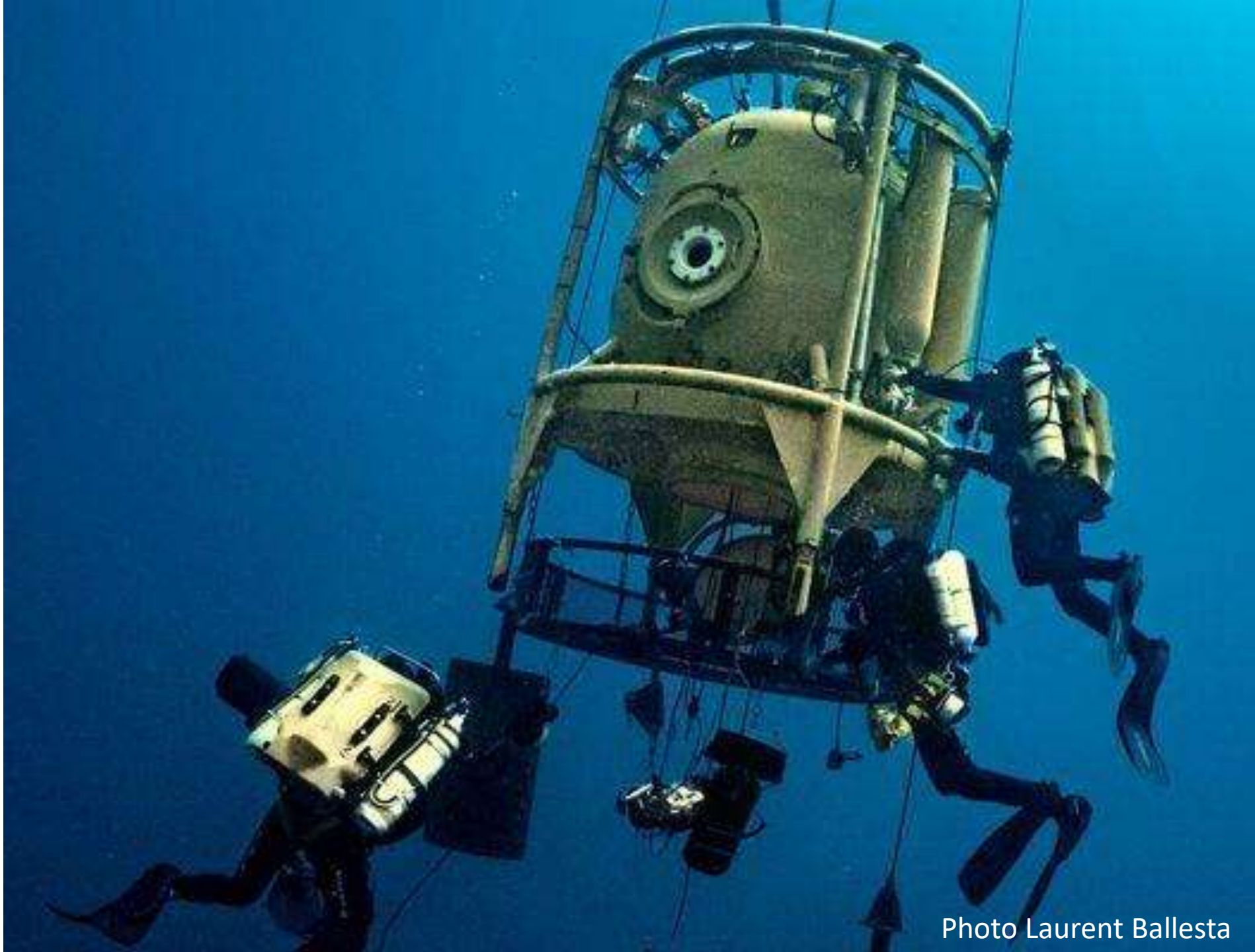
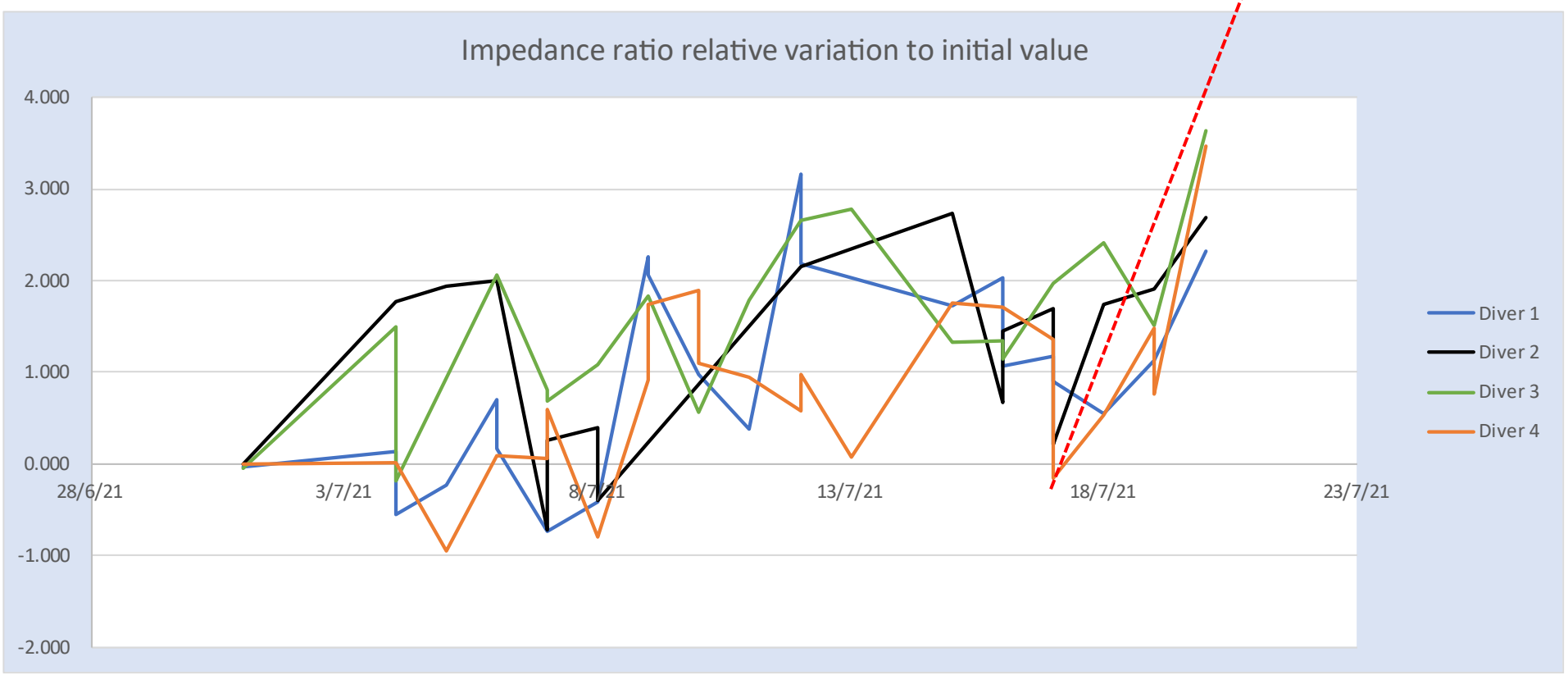


Photo Laurent Ballesta

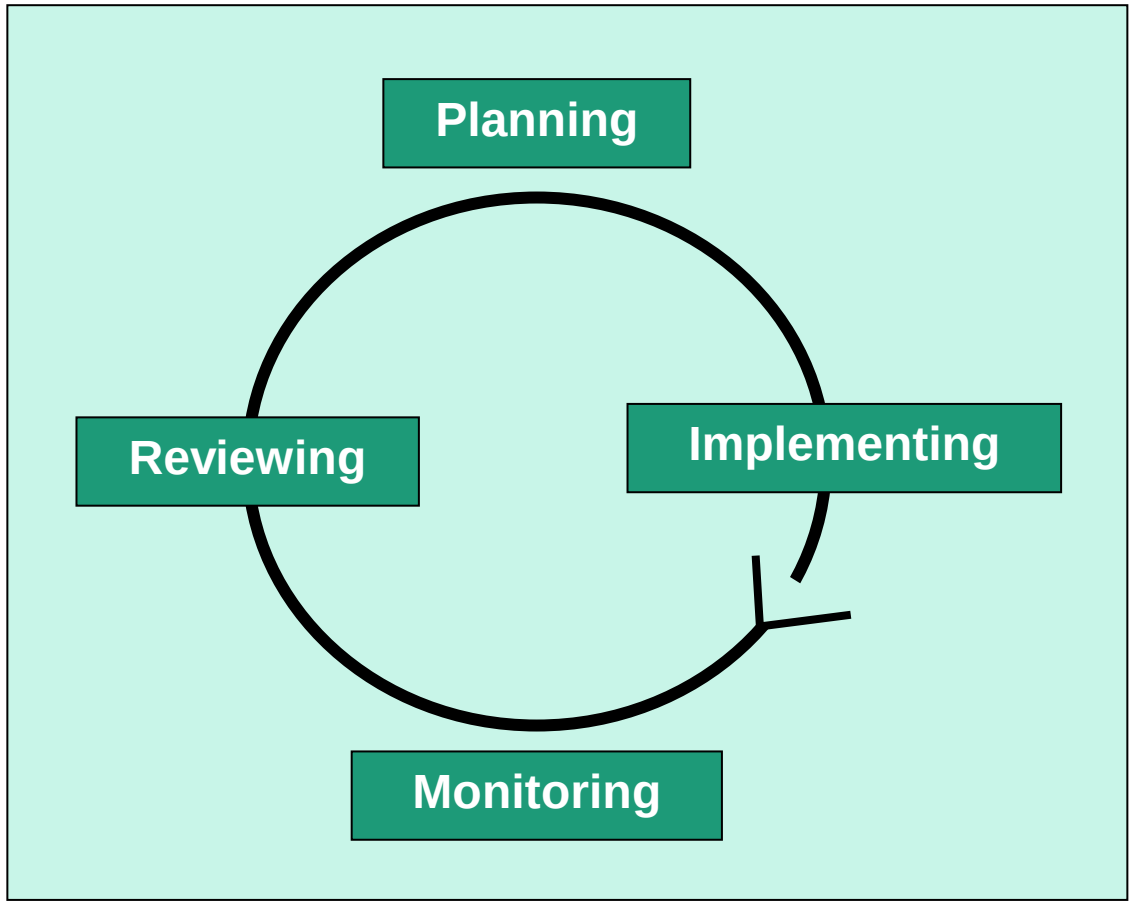
Photo Laurent Ballesta

Gombessa 6 Measurement of the oxidative stress



At a company scale

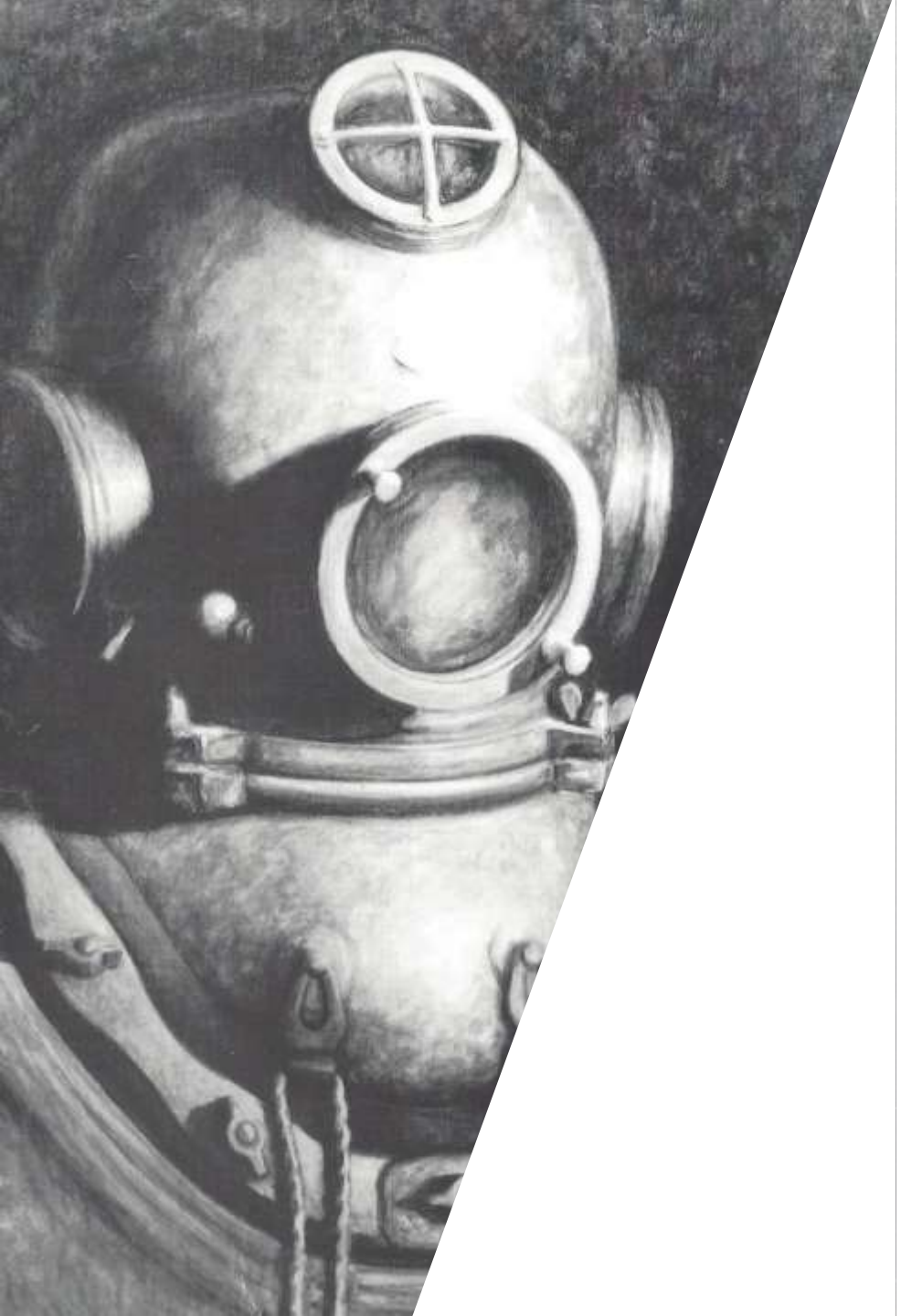
a simple scientific project
can be based on management of changes



At a company scale

Monitoring is
non invasive

It is not research
It is just
health monitoring



Conclusions

The diving industry has developed reasonable procedures

and

it is slowly moving towards harmonisation

Standardization of procedures by regulations would be a mistake

Saturation procedures should not be cast in concrete

The companies need more flexibility for their operations and want A lesser deco stress for their divers

Sciences provides answers

Companies should get acquainted with scientific teams

Data

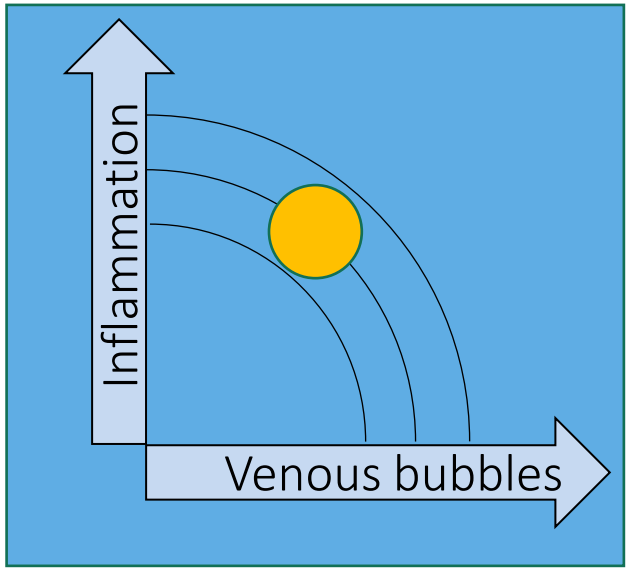
Information

Knowledge

Decision

We have a new vision to structure the problem

We have a way to quantify it



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