PERFORMANCE EVALUATION OF AN AIR PURIFICATION SYSTEM IN AN ITALIAN "SAURO" CLASS SUBMARINE

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INDEX

- **ITALIAN SUBMARINES**
- **INTRODUCTION**
- **MATERIALS AND METHODS**
- **RESULTS**
- **CONCLUSIONS**

ITALIAN SUBMARINES

SAURO Class

ITALIAN SUBMARINES

SAURO Class

Characteristics

Weight surface: 1476 tons
Weight dive: 1662 tons

Lenght: 64,36 m
Beam 6,8 m

Propulsion: 3 diesel engine generators
1 propulsion electric engine
1 accumulator of 500 elements
Speed surface 11 kn
Speed dive 20 kn

Crew: 51

ITALIAN SUBAMARINES

TODARO Class (U212A)

S. TODARO

SCIRE'

INTRODUCTION

POLLUTION ON BOARD

- Gaseous
- Particulate (dust and particles)
- Microbiologic
- Electrical
- Electromagnetic waves

INTRODUCTION

The importance of particulate size

The more common mechanical filters used in Conditioning & Ventilation systems are able to capture particulate pollutant greater then 5 µm .

The PM10 dusts, have to be considered indicative to evaluate the air pollution because they are captured by the cyliar membrane of the respiratory tree and could produce important breathing pathology,

The PM2 dusts instead are able to cross the respiratory tree and to be adsorbed by the blood ;

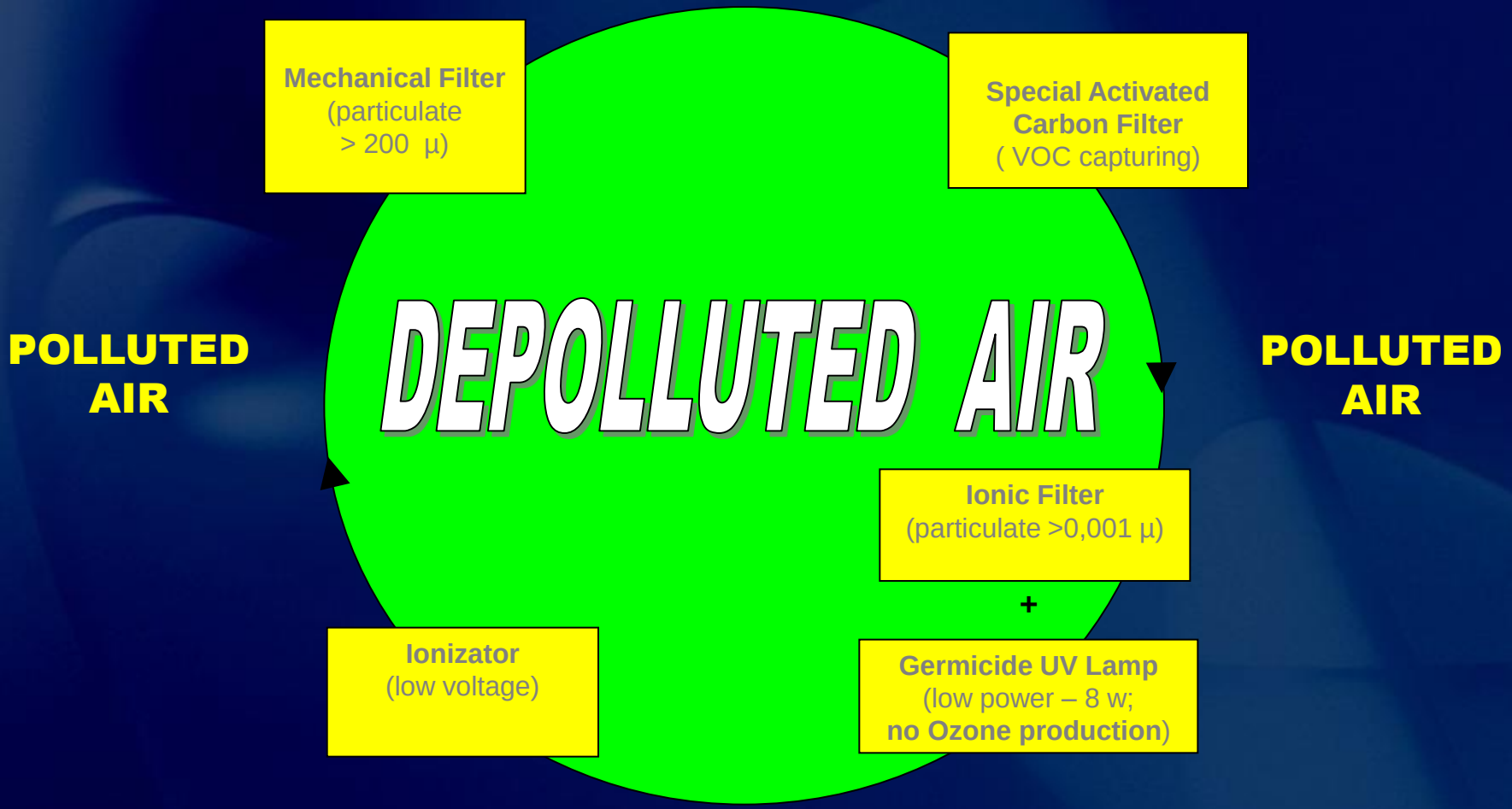
INTRODUCTION

Sinergy between various state of pollution

For example the dust sedimentation, facilitate micro-biologic and fungal transfer from the environment to the human body. The same kind of sub-micron dusts absorbs gases.

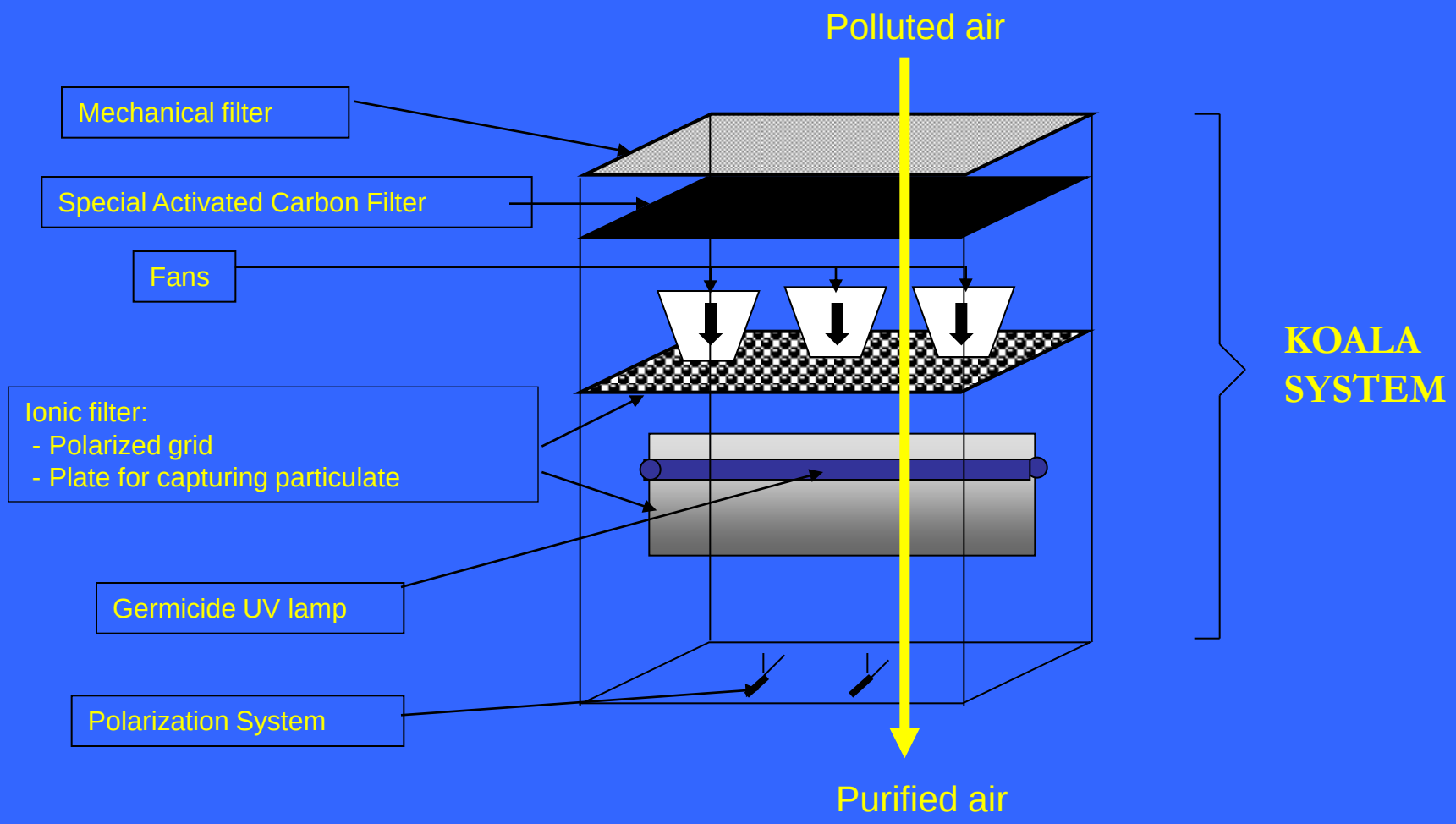
INTRODUCTION

Koala Sub – Application of clue



INTRODUCTION

Koala Sub - Functional technical scheme



INTRODUCTION

Ionic filter (non HEPA)

The system is formed by a stainless steel grid where the air is forced to go through and where it is charged with negative polarity . Following its way the air moves across electrically opposite-charged plate that capture all the polarized particulate. Its skill of capturing particulate arrives to the size of nanometer absolutely no-eliminable with traditional filtering

INTRODUCTION

External ionization system

There is a double ionizing points, positioned where the air flow came out; it's capable to associate to this quantity of air (can be seeted between 30÷60 m^3/h for each) a significant quantity of negative ions:

- avoid the fall of the remaining particulate
- force the particulate to remain in suspension in order to be captured in a further passage
- give to the outgoing air flow the special electric charge that seconds the natural exchange lungs

INTRODUCTION

Dimensions : 53 x 39 x 15 cm

INTRODUCTION

INTRODUCTION

SCENARIO

History of events on board

AM

8.00 - Start mission - Boat departure

8.55 - Doors Closed

9:15 - Dive

9.35 - Start baseline measures (Koala-Sub off)

10.30 - Koala-Sub activated in sequence

11.30 - Koala-Sub off in sequence

11.55 - Start continuous monitoring (baseline)

PM

01.05 - Koala Sub-activated

01.35 - Periscope depth

01.45 - Snorkel and engines on

03.45 - Snorkel and engines off

05.00 - Surface

05.05 - Doors Open (Koala-Sub off)

05.30 - End of the measures

08.00 - End mission – Boat at the pier

MATERIALS AND METHODS

Parameters investigated

-Particulate fractions

-Volatile organic compounds (VOCs), as ppm of CH_4

- Nitrogen oxides NOx

- Carbon monoxide CO

- Carbon dioxide CO_2

- Volatile organic compounds containing the SO bond (SOx)

MATERIALS AND METHODS

Analisys Instruments:

(Bruel-Kjaer infrared analyzer)

VOCs, CO2, CO, NOx, SOx compounds

MATERIALS AND METHODS

Analisys Instruments:

Particulates

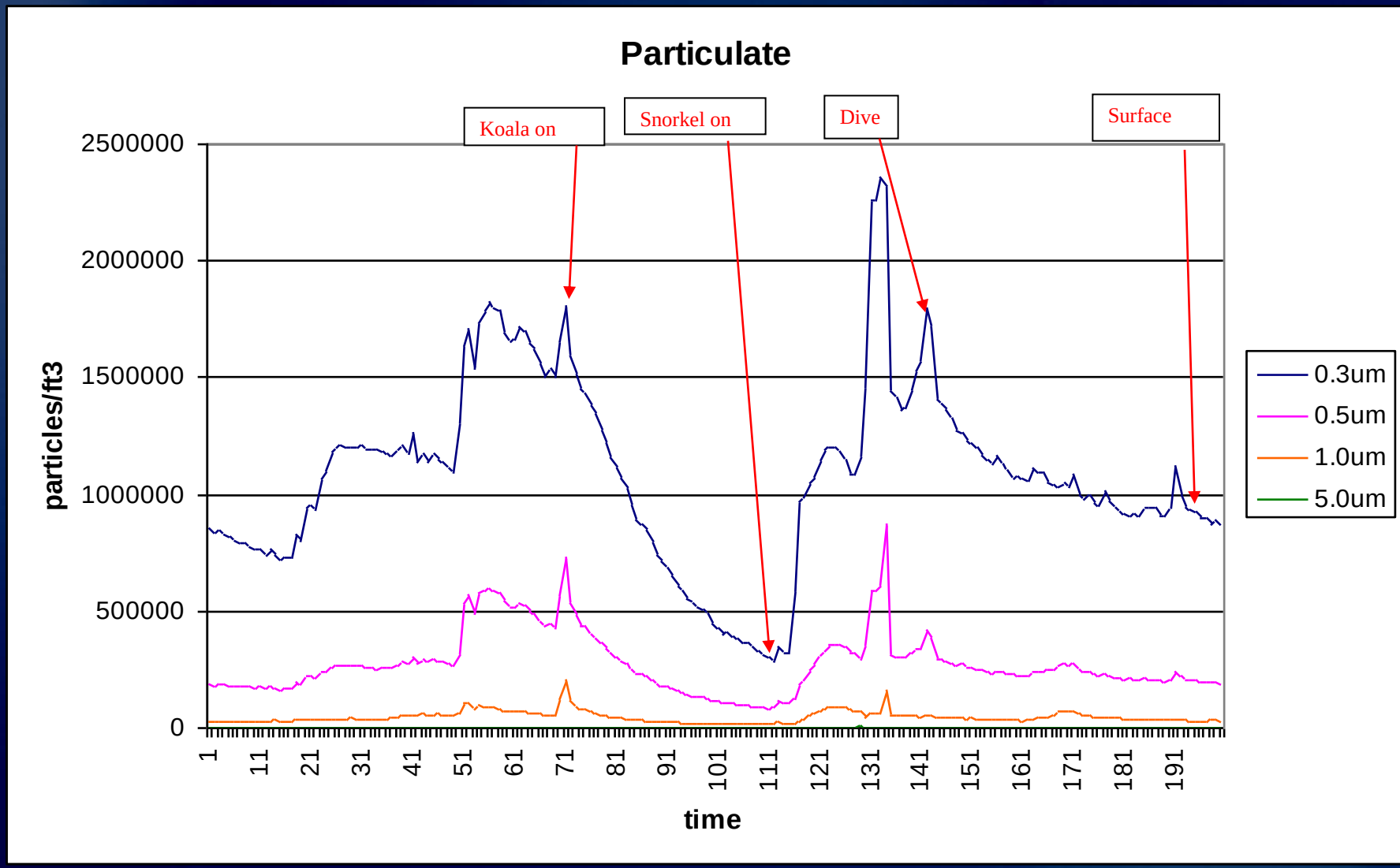
(Bio-Test Diagnostic laser counter)

(Aquaria-Microflow sampler)

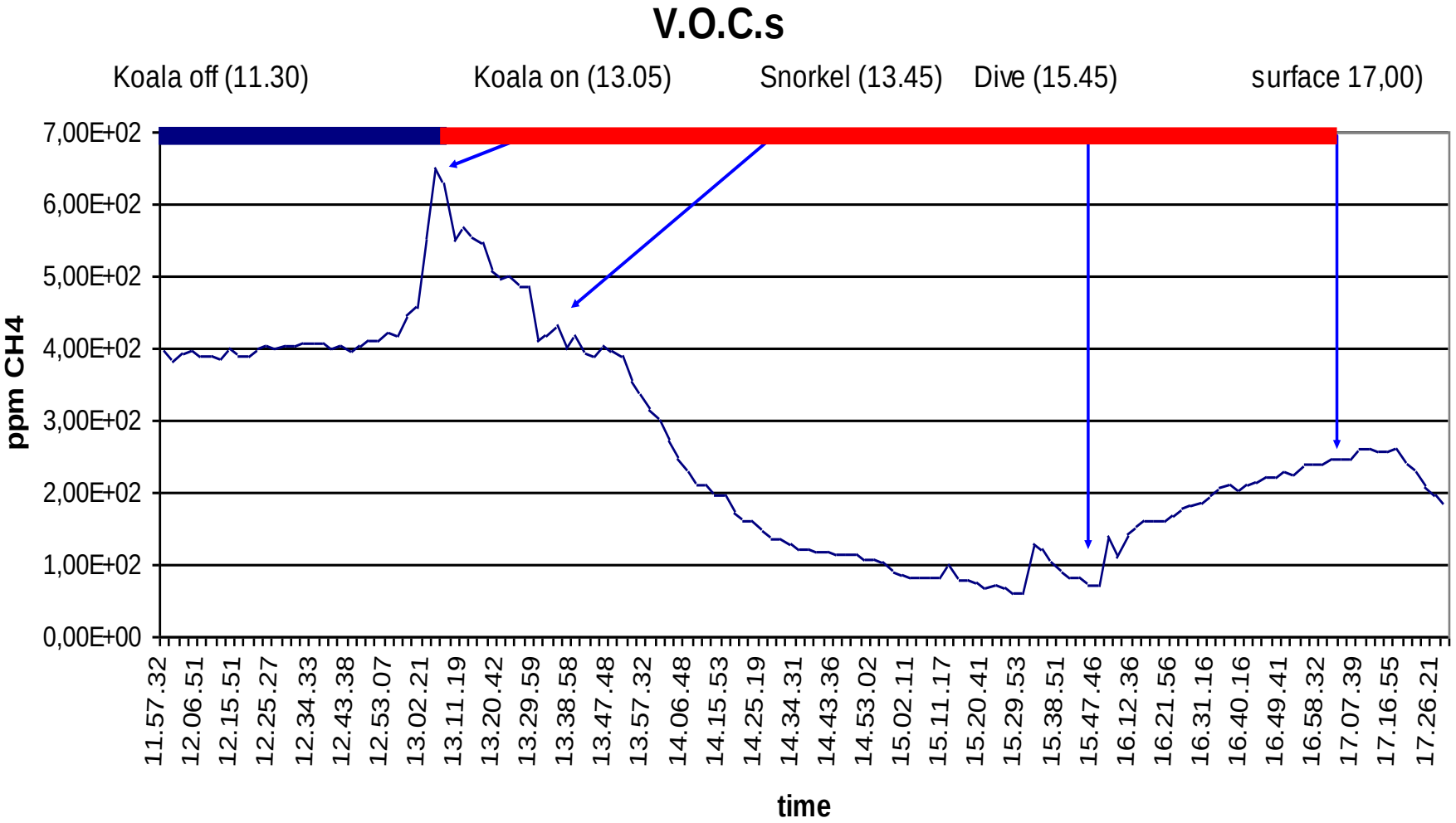
Microorganisms

(Merck Rodac Culture plates)

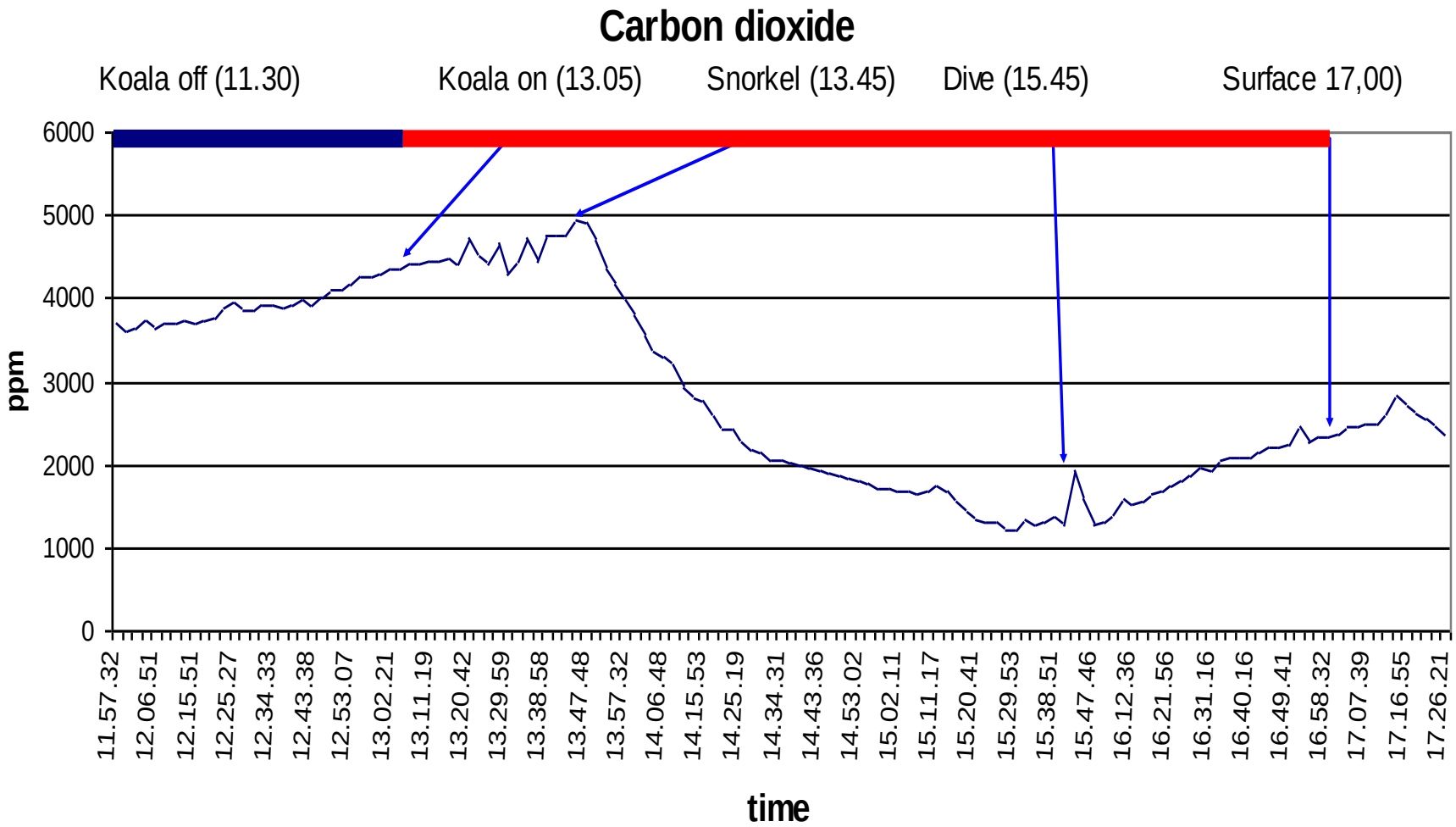
RESULTS


Particulate
Koala on
Snorkel on
Dive
Surface
2500000
2000000
1500000
1000000
500000
0
particles/ft3
1
11
21
31
41
51
61
71
81
91
101
111
121
131
141
151
161
171
181
191
time
0.3um
0.5um
1.0um
5.0um

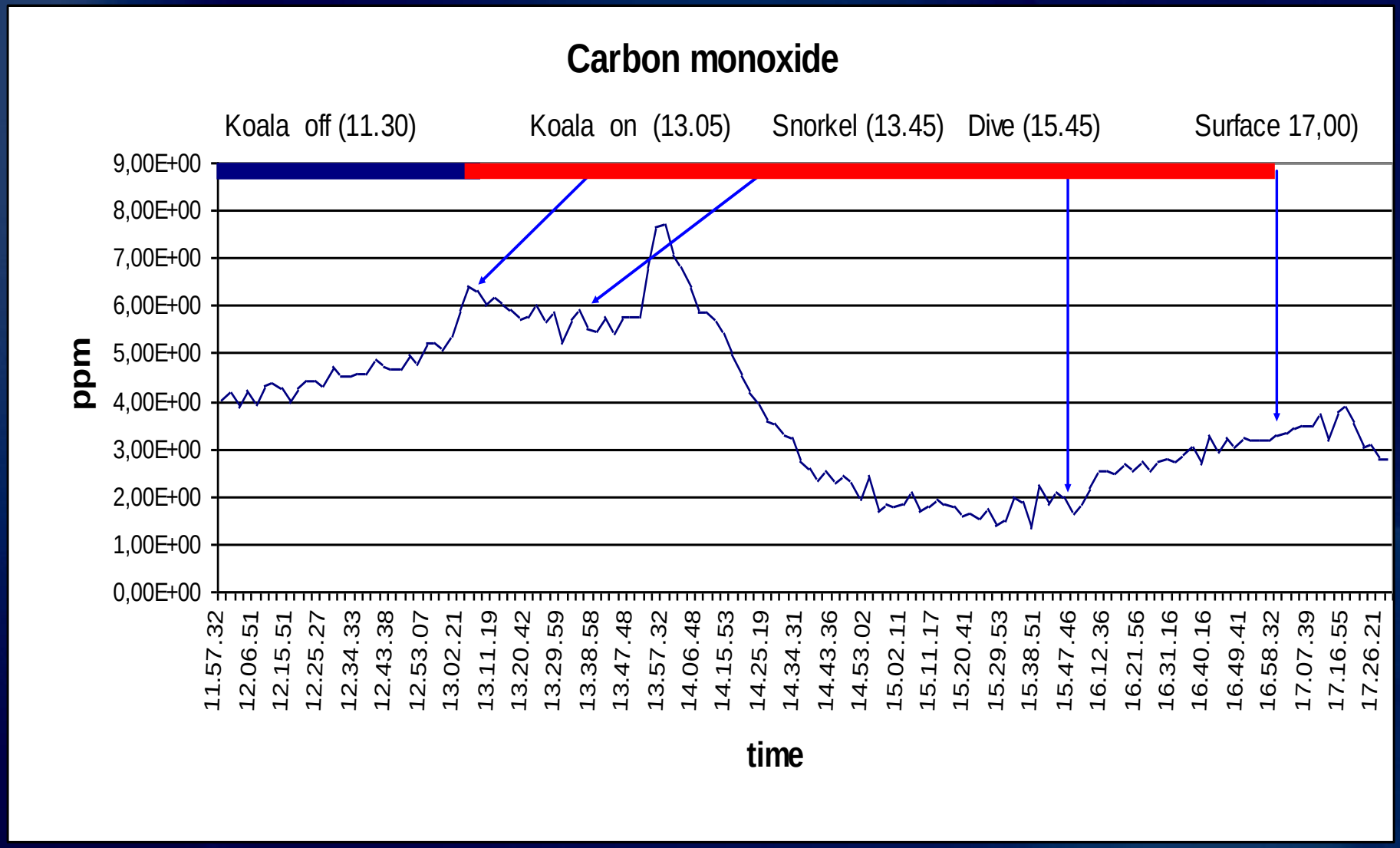
RESULTS


V.O.C.s
Koala off (11.30)
Koala on (13.05)
Snorkel (13.45)
Dive (15.45)
surface 17,00)
ppm CH4
7,00E+02
6,00E+02
5,00E+02
4,00E+02
3,00E+02
2,00E+02
1,00E+02
0,00E+00
11.57.32
12.06.51
12.15.51
12.25.27
12.34.33
12.43.38
12.53.07
13.02.21
13.11.19
13.20.42
13.29.59
13.38.58
13.47.48
13.57.32
14.06.48
14.15.53
14.25.19
14.34.31
14.43.36
14.53.02
15.02.11
15.11.17
15.20.41
15.29.53
15.38.51
15.47.46
16.12.36
16.21.56
16.31.16
16.40.16
16.49.41
16.58.32
17.07.39
17.16.55
17.26.21
time

RESULTS


Carbon dioxide
Koala off (11.30)
Koala on (13.05)
Snorkel (13.45)
Dive (15.45)
Surface 17,00)
6000
5000
4000
3000
2000
1000
0
ppm
11.57.32
12.06.51
12.15.51
12.25.27
12.34.33
12.43.38
12.53.07
13.02.21
13.11.19
13.20.42
13.29.59
13.38.58
13.47.48
13.57.32
14.06.48
14.15.53
14.25.19
14.34.31
14.43.36
14.53.02
15.02.11
15.11.17
15.20.41
15.29.53
15.38.51
15.47.46
16.12.36
16.21.56
16.31.16
16.40.16
16.49.41
16.58.32
17.07.39
17.16.55
17.26.21
time

RESULTS


Carbon monoxide
Koala off (11.30)
Koala on (13.05)
Snorkel (13.45)
Dive (15.45)
Surface 17,00)
ppm
9,00E+00
8,00E+00
7,00E+00
6,00E+00
5,00E+00
4,00E+00
3,00E+00
2,00E+00
1,00E+00
0,00E+00
11.57.32
12.06.51
12.15.51
12.25.27
12.34.33
12.43.38
12.53.07
13.02.21
13.11.19
13.20.42
13.29.59
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13.47.48
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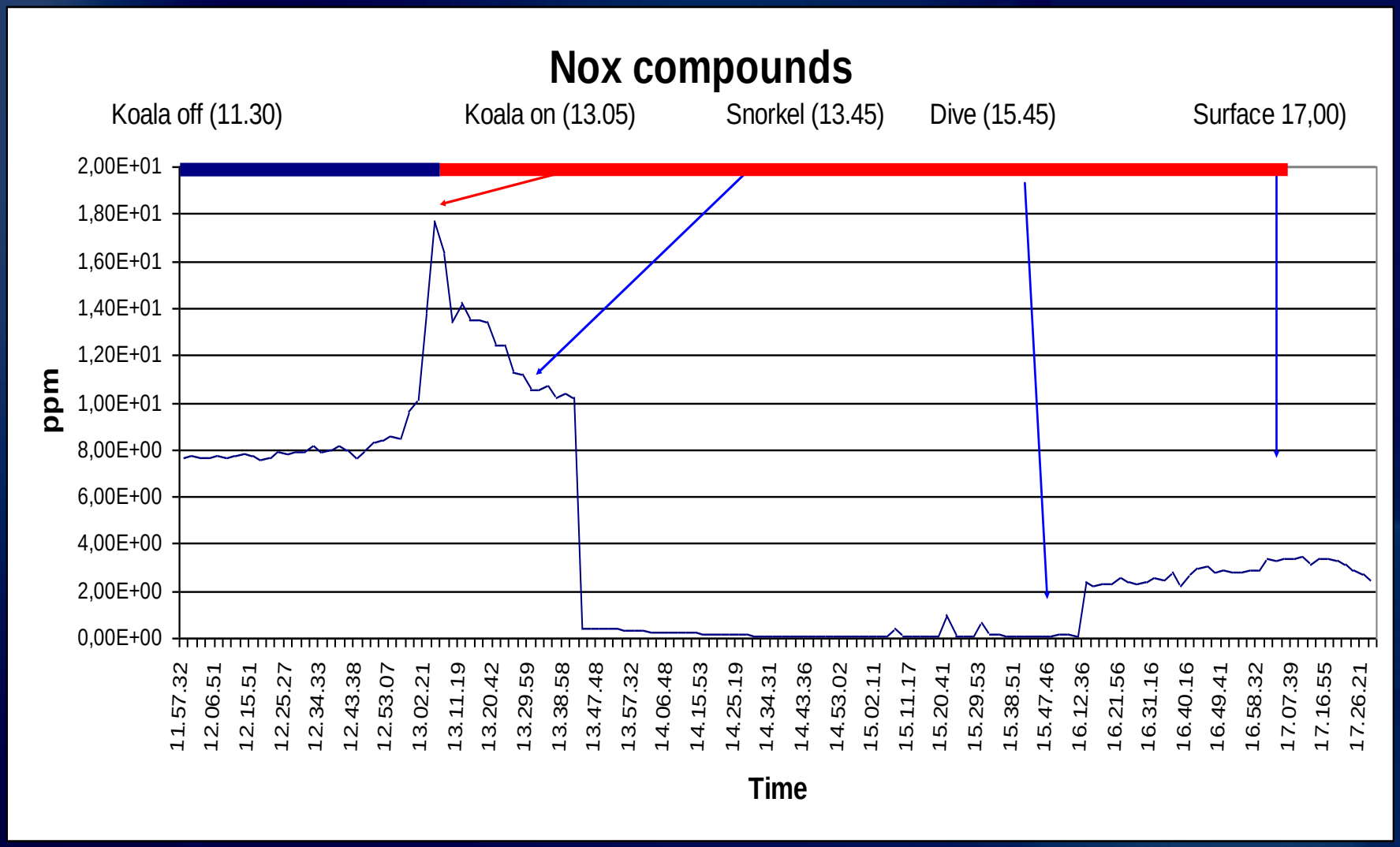
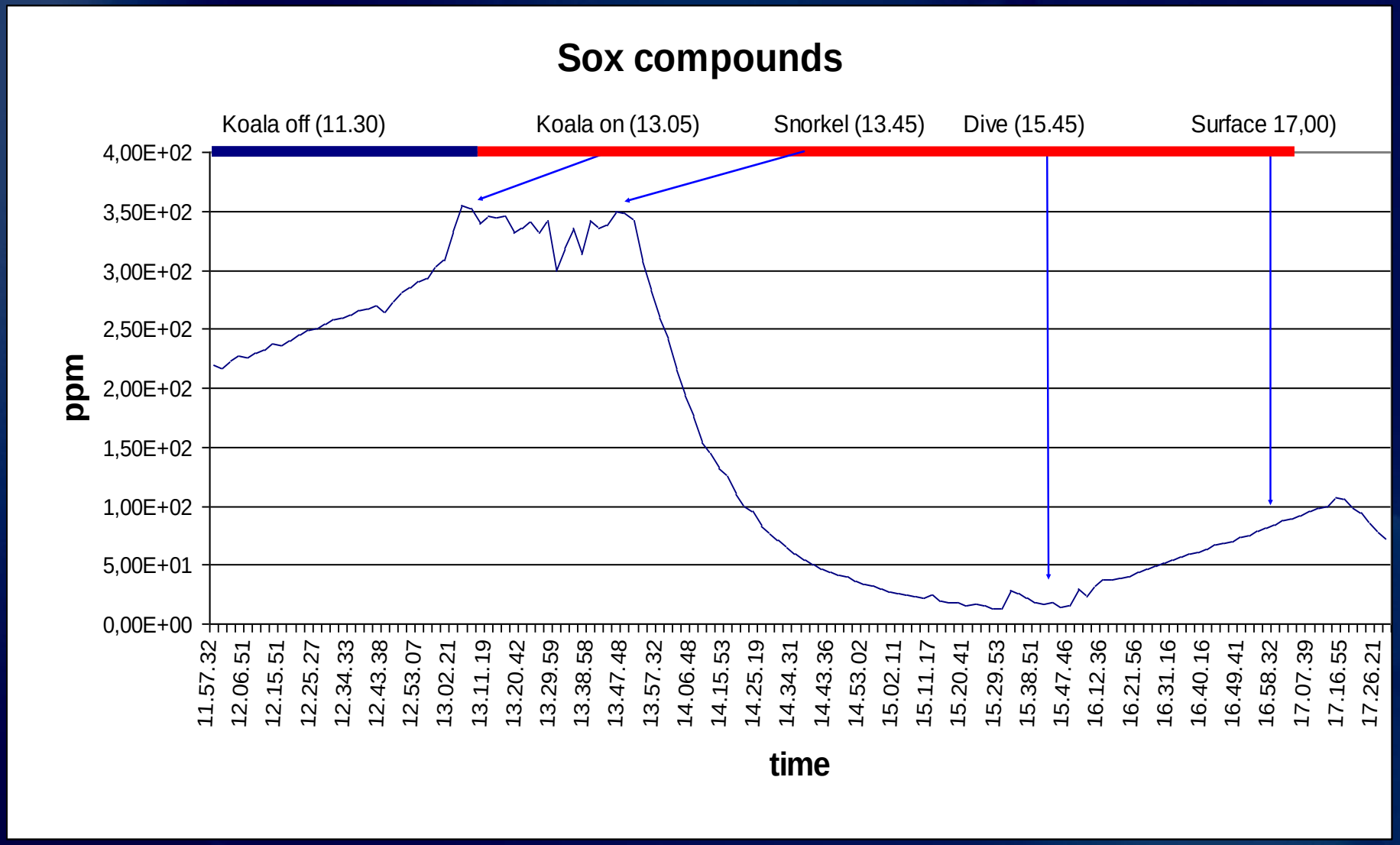
16.12.36
16.21.56
16.31.16
16.40.16
16.49.41
16.58.32
17.07.39
17.16.55
17.26.21
time

RESULTS


Nox compounds
Koala off (11.30)
Koala on (13.05)
Snorkel (13.45)
Dive (15.45)
Surface 17,00)
ppm
2,00E+01
1,80E+01
1,60E+01
1,40E+01
1,20E+01
1,00E+01
8,00E+00
6,00E+00
4,00E+00
2,00E+00
0,00E+00
11.57.32
12.06.51
12.15.51
12.25.27
12.34.33
12.43.38
12.53.07
13.02.21
13.11.19
13.20.42
13.29.59
13.38.58
13.47.48
13.57.32
14.06.48
14.15.53
14.25.19
14.34.31
14.43.36
14.53.02
15.02.11
15.11.17
15.20.41
15.29.53
15.38.51
15.47.46
16.12.36
16.21.56
16.31.16
16.40.16
16.49.41
16.58.32
17.07.39
17.16.55
17.26.21
Time

RESULTS


Sox compounds
Koala off (11.30)
Koala on (13.05)
Snorkel (13.45)
Dive (15.45)
Surface 17,00)
4,00E+02
3,50E+02
3,00E+02
2,50E+02
2,00E+02
1,50E+02
1,00E+02
5,00E+01
0,00E+00
ppm
11.57.32
12.06.51
12.15.51
12.25.27
12.34.33
12.43.38
12.53.07
13.02.21
13.11.19
13.20.42
13.29.59
13.38.58
13.47.48
13.57.32
14.06.48
14.15.53
14.25.19
14.34.31
14.43.36
14.53.02
15.02.11
15.11.17
15.20.41
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16.12.36
16.21.56
16.31.16
16.40.16
16.49.41
16.58.32
17.07.39
17.16.55
17.26.21
time

RESULTS

Microbiological

	KOALA-SUB off	KOALA-SUB on
Room	Units for colony.	Units for colony
	C.F.U.	C.F.U.
Torpedo room	800	300
CIC deck - A	60	40
CIC dech - B	110	42
Mess room	41	29
Electric board room	36	19
Engine room	220	105
Sleeping room	300	4
average	223.8	77
Percent Reduction average		-65%

CONCLUSIONS

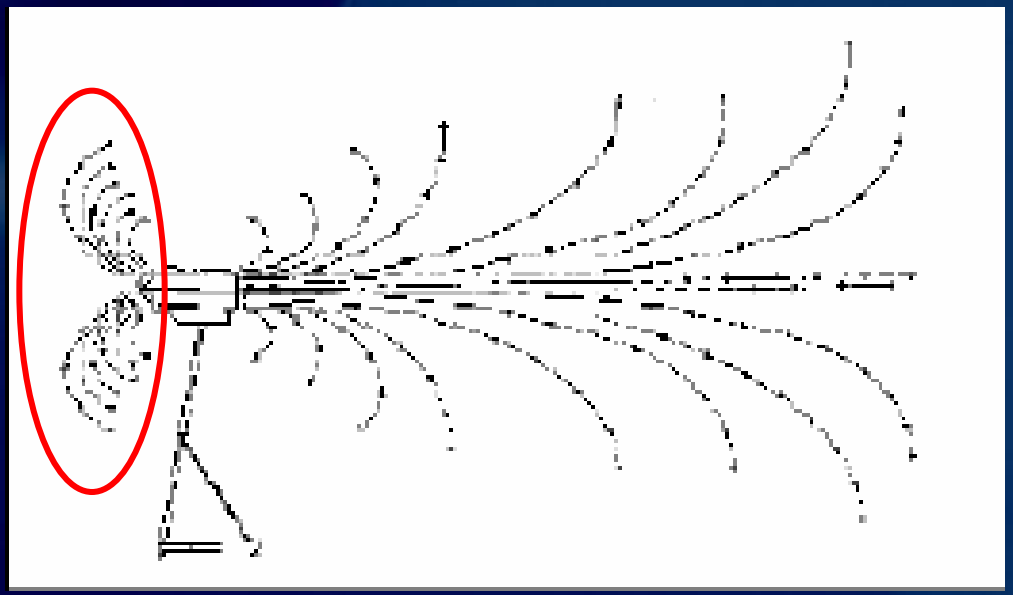
Koala Sistem is good system
to purify the air by

particulate
microrganism
VOCs

CONCLUSIONS

Best result in closed environments.

Close to the Koala there is an increase of air effective replacement



CONCLUSIONS

Why Italian Navy chose it

Compact
Integrated
Easy manuntenibile (and cheap)
Easy cleanable
Very low energy absorbtion

Submarine Air Monitoring
Air Purification Conference

Thanks for attention

Oct 19-22, 2009
San Diego
USA