JOINT EUROPEAN RESEARCH INFRASTRUCTURE NETWORK FOR COASTAL OBSERVATORIES

DISSOLVED OXYGEN SENSORS CALIBRATION

Best Practices

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There is not a single way to practice calibration

Protocol definition

Simpliest ***Most complete***

Calibration uncertainty

Biggest ***Faintest***

Determination of uncertainty to achieve

Protocol adapted to the uncertainty to achieve

Uncertainty

+

Simple

Protocol adapted to using conditions

→ **Definition of calibration method**

+

Definition of calibration facilities

+

Definition of calibration data processing

→ **Definition of using conditions**

Aanderaa DO sensors

GENERAL INFORMATION

Using conditions

Sensor power supply

7V

Measuring frequency

> 10sec

Sensor surroundings

Stirred water

Measurement data processing

Sensor immersion

Using range / Using points

…

Using range / Using points

Points

Dynamic to reach a level

Extreme points of the range

+

intermediate points equally positioned in the range (number of points depends on the sensor response: linear, …)

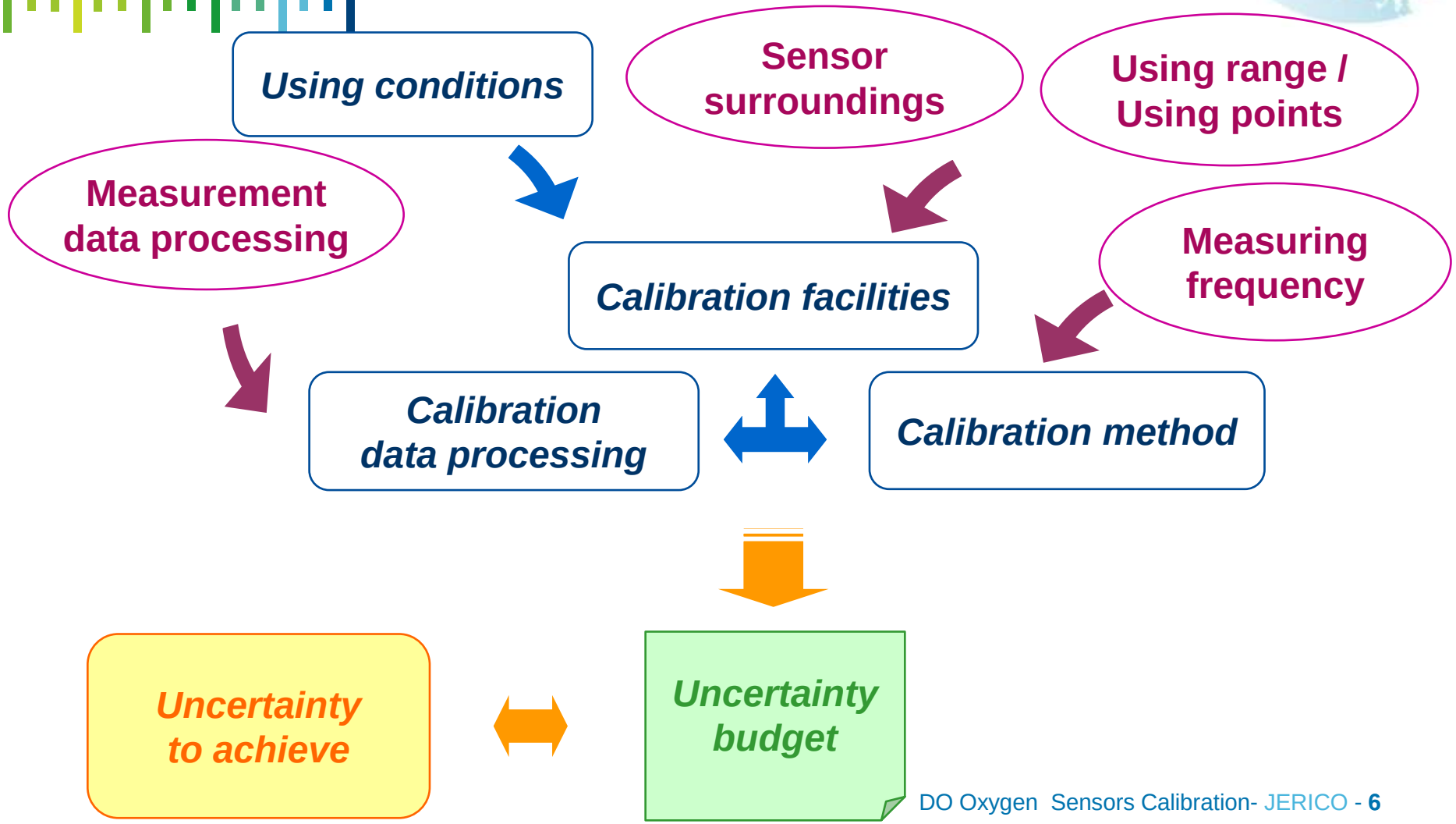
General protocol

+

additional points to control influence parameter (temperature: self-heating, zero correction, …)

Specific protocol fitted to sensor technology

GENERAL INFORMATION



Dissolved oxygen calibration:

Protocol definition

Simpliest

Calibration at:

- 0% (sodium sulphite)
- 100% (stirred water)

Reference: Winkler

Most complete

Calibration at:

- Several DO concentrations (whatever method is used)
- Several temperatures (?)
- Several salinities (?)
- Several pressures (?)

Reference: Winkler

Winkler literrature:

Standard:

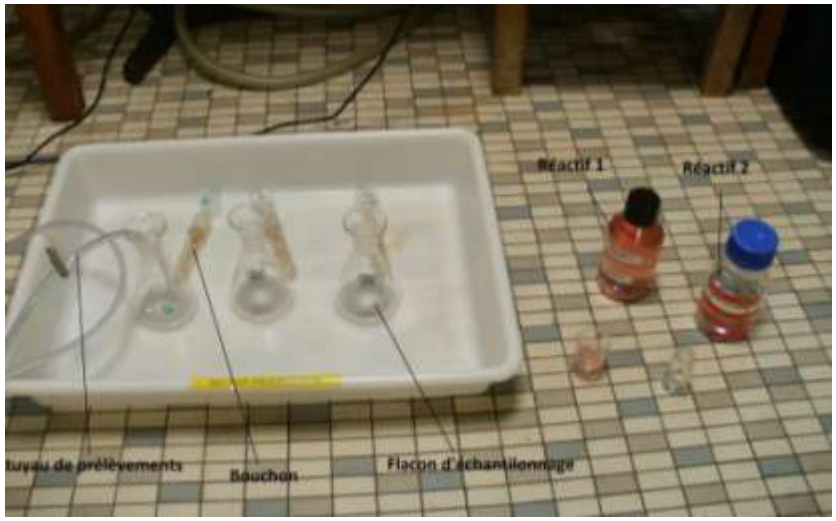
- NF EN 25813 / ISO 5813 Standard

Sampling description

Oceanographic recognized references:

- World Ocean Circulation Experiment recommendations (1990-1998)
- French reference literature: “Hydrologie des écosystèmes marin. Paramètres et analyses” - Editions Ifremer

Winkler description:



- KIO_3 solution: $Na_2S_2O_3$ calibration
- $Na_2S_2O_3$ solution: I_2 titration

- Reagent 1: $MnCl_2$
- Reagent 2: NaOH / NaI
- Reagent 3: H_2SO_4

Winkler: main issues

- Winkler analysis: Waiting and storage… … Still many practices

  - Waiting time: 2 to 4 hours before analysis
  - Storage:

    condition: distilled water around the stopper

    time: analysis within one day

- Substance matrix: seawater

(Winkler's method overestimates dissolved oxygen in seawater: Iodate interference and its oceanographic implication. George T.F. Wong and Kuo-Yuan Li, Marine Chemistry, 2009, vol.115, n°1-2, pp.86,91)

Surface and deep open ocean, overestimation = 0.52 ± 0.15 and 0.63±0.05 µmol kg^{-1} respectively.

Winkler: results

Acquisition du thiosulfate	
Etalonnage du thio ml	
1	5.089
2	5.088
3	5.092
4	5.089
5	5.094
Moyenne	5.0905

Acquisition du thio échantillonnage		Acquisition temp, salinité	
N° Flacon	Vthio echant. (ml)	T°	Sal
13	11.477	10.0	0
14	11.324	10.0	0
15	11.311	10.0	0
19	11.168	10.0	0
11	8.381	15.0	0
12	8.233	15.0	0

Résultats thio échantillonnage				Résultats de t et S		Résultats complémentaires			
Flacon	O2 µmol/l	O2mg/l	O2 ml/l	température °C	Salinité	O2 Sat µmol/l	O2 Sat mg/l	O2 Sat ml/l	% sat
flacon 13	353.40	11.31	7.91	10.0	0.0	352.80	11.29	7.90	100.2
flacon 14	353.82	11.32	7.92	10.0	0.0	352.80	11.29	7.90	100.3
flacon 15	354.20	11.33	7.93	10.0	0.0	352.80	11.29	7.90	100.4
flacon 19	353.96	11.33	7.93	10.0	0.0	352.80	11.29	7.90	100.3
flacon 11	258.32	8.27	5.78	15.0	0.0	315.04	10.08	7.05	82.0
flacon 12	257.69	8.25	5.77	15.0	0.0	315.04	10.08	7.05	81.8

Winkler: uncertainties

U = +/- 2 µmol/L

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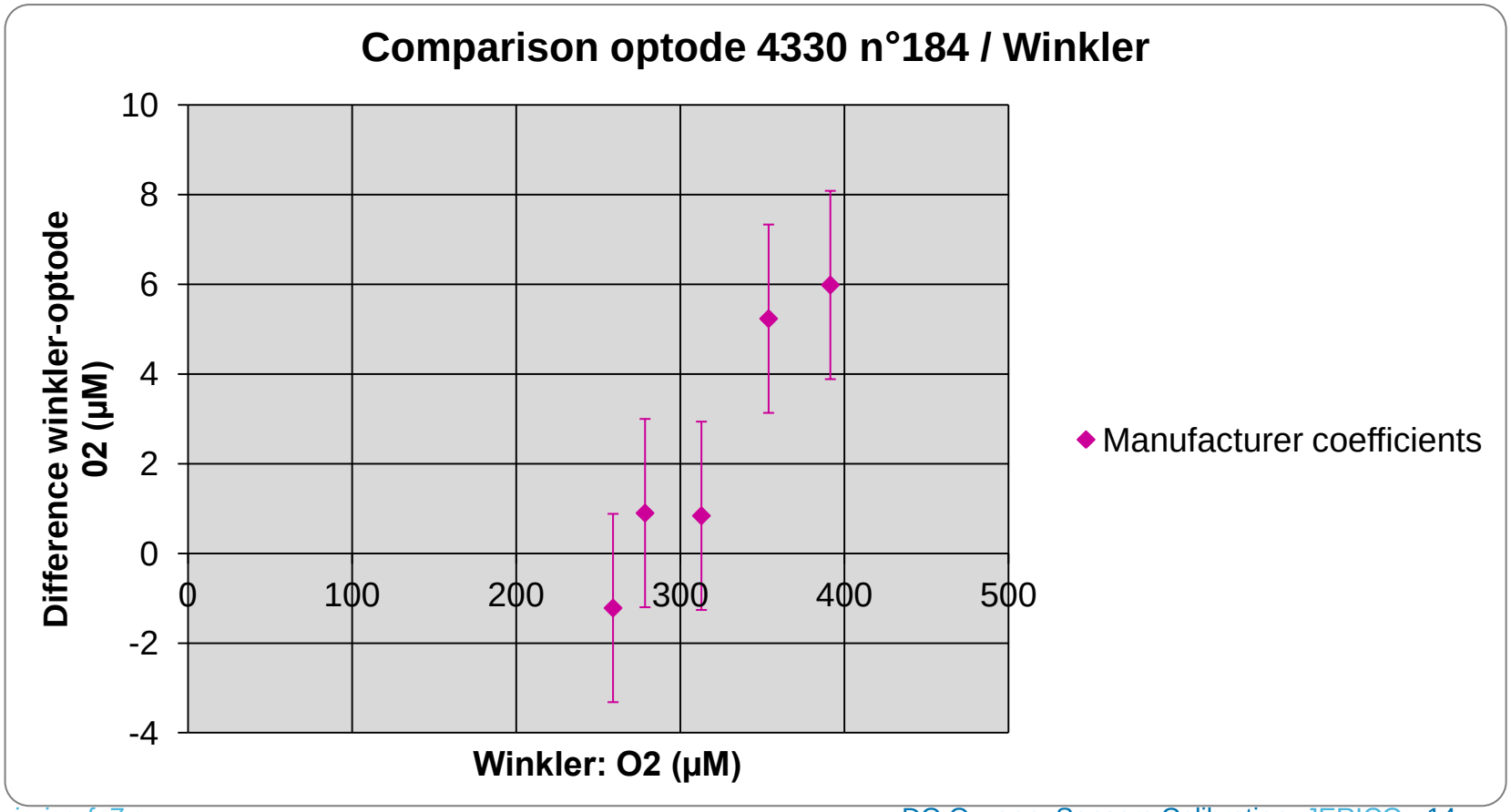
Dissolved oxygen calibration:

Several temperatures and pressure ?

Uchida H., T. Kawano, I. Kaneko and M. Fukasawa, 2008: In situ calibration of optode-based oxygen sensors, J. Atm. Ocean. Tech., 2271-2281, doi: 10.1175/2008JTECHO549.1

Calibration in bath at different temperatures and air equilibrium:



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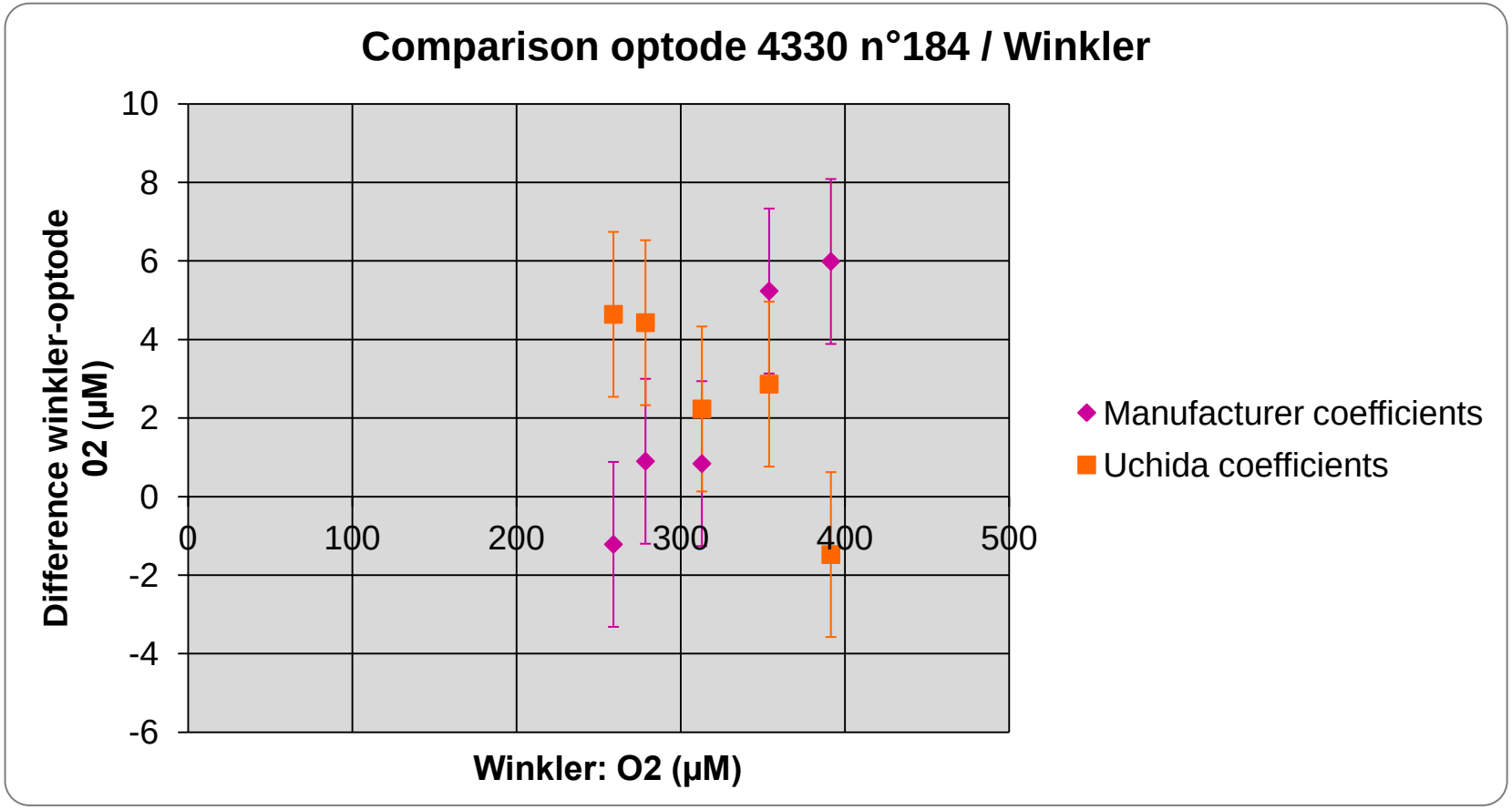
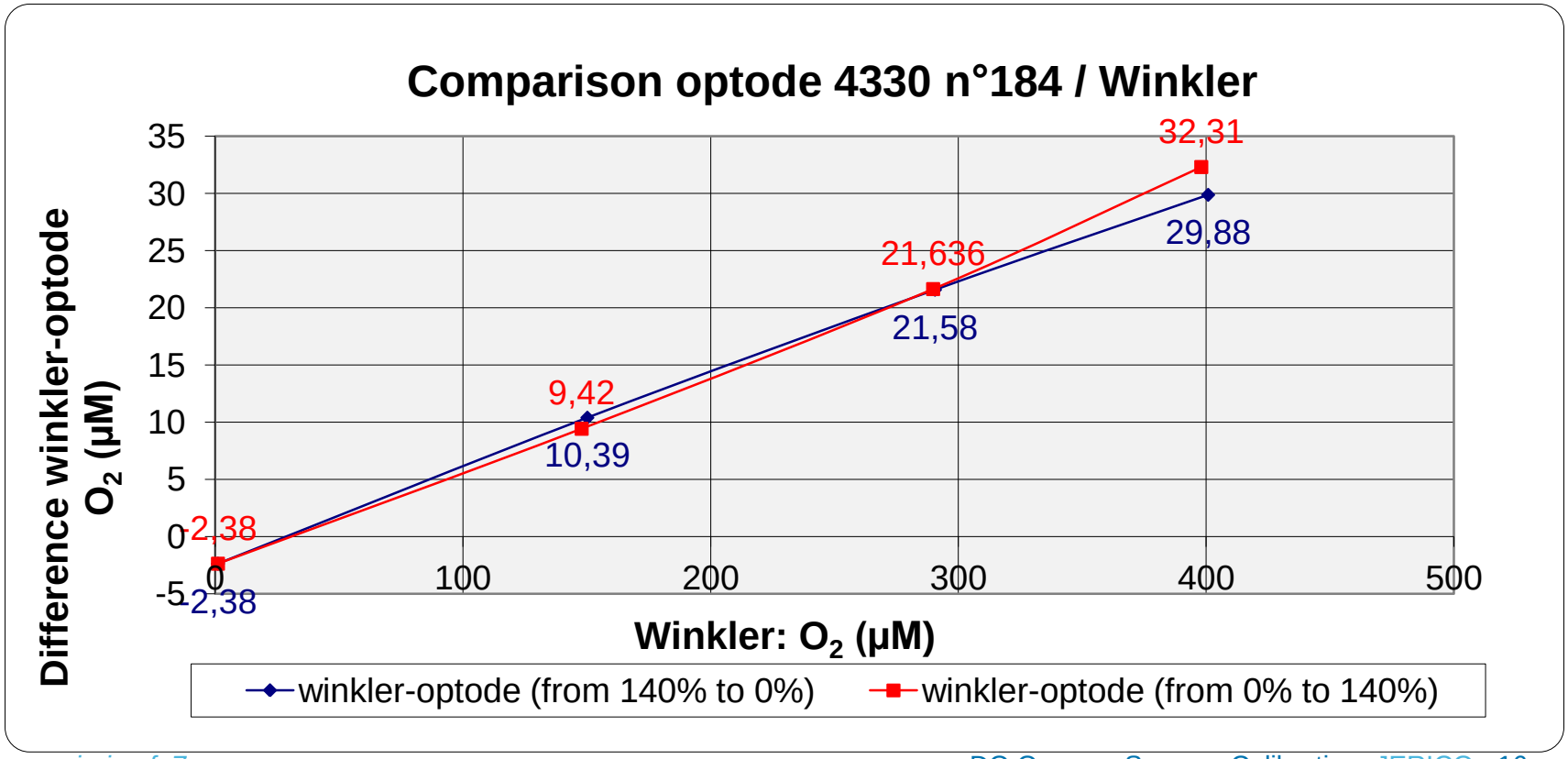


Calibration in bath at different temperatures and concentrations (bubbling system):



Dissolved oxygen calibration:

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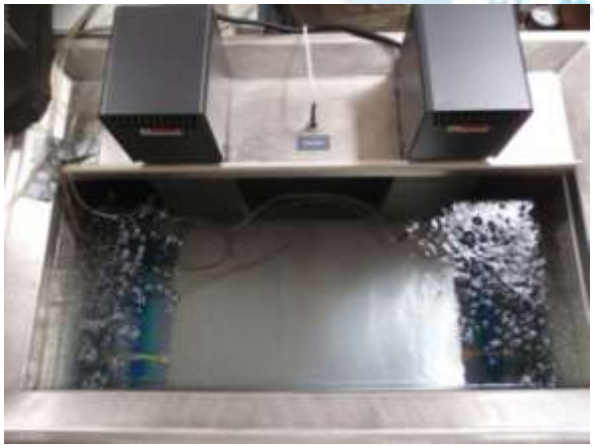
Calibration at:

- Several DO concentrations (whatever method is used)
- Several temperatures (YES)
- Several salinities (?)
- Several pressures (?)

Reference: Winkler

Reference device to perform stable stages



Whatever instrument is used to perform stable DO concentrations, you must check that it is STABLE and HOMOGENEOUS in

- DO

But also:

- Temperature
- All influence parameters (pressure, salinity ?, …)

Storage:

Always keep foil wet (to avoid 1 to 2 days drift when immersed) and dark.

"In situ calibration":

If possible, when deploying (and regularly if possible), perform comparisons with *in situ* winkler.

Fouling:

At sea, try to prevent from bio-fouling.

In lab, calibrate (or check) before and after cleaning.

THANKS FOR YOR ATTENTION