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Precision Instruments for over 30 years

A look into the future of direct comparison ambient temperature salinometry

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Salinometer FAQ

With my AutoSal™, can I:

1.	Use it on a small boat?	NO
2.	Transport it in my suitcase?	NO
3.	Characterize different seawaters over temperature?	NO
4.	Test the salinity of Guacamole?	NO
5.	Run it off of a car battery?	NO
6.	Set it up and use within 1 hour?	NO

Outline

- Why Salinometry?
- Standard Methods of Salinometry
- Basic limitations
- The future of Salinometry
- Conclusion/Discussion

Why Salinometry?

Salinity is a key property of seawater from which density and sound speed may be derived; these are fundamental to ocean science and climatology.

Salinometers provide a reference to the widely accepted Practical Salinity Scale.

Standard Method

CTD & Water Samples → AutoSAL

Practical Salinity Scale (1978)

$$R = C(S,t,p)/C(35,15,0) = C(S,t,p)/42.914$$

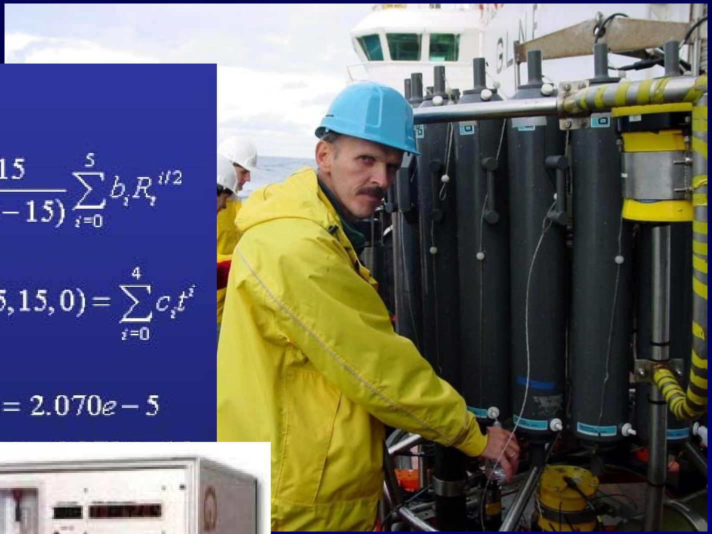
$$R_t = R / r_t R_p$$

$$R_p = C(S,t,p)/C(S,t,0) = 1 + \frac{p(e_1 + e_2 p + e_3 p^2)}{1 + d_1 t + d_2 t^2 + (d_3 + d_4 t)R}$$

$$S = \sum_{i=0}^{5} a_i R_t^{i/2} + \frac{t-15}{1+k(t-15)} \sum_{i=0}^{5} b_i R_t^{i/2}$$

$$r_t = C(35,t,0)/C(35,15,0) = \sum_{i=0}^{4} c_i t^i$$

$a_0 = 0.0080$	$b_0 = 0.0005$	$c_0 = 0.6766097$	$d_1 = 3.426e-2$	$e_1 = 2.070e-5$
$a_1 = -0.1692$	$b_1 = -0.0056$	$c_1 = 2.00564e-2$	$d_2 = 4.464e-4$	
$a_2 = 25.3851$	$b_2 = -0.0066$	$c_2 = 1.104259e-4$	$d_3 = 4.215e-1$	
$a_3 = 14.0941$	$b_3 = -0.0375$	$c_3 = -6.9698e-7$	$d_4 = -3.107e-3$	
$a_4 = -7.0261$	$b_4 = 0.0636$	$c_4 = 1.0031e-9$		
$a_5 = 2.7081$	$b_5 = -0.0144$			
	$k = 0.0162$			



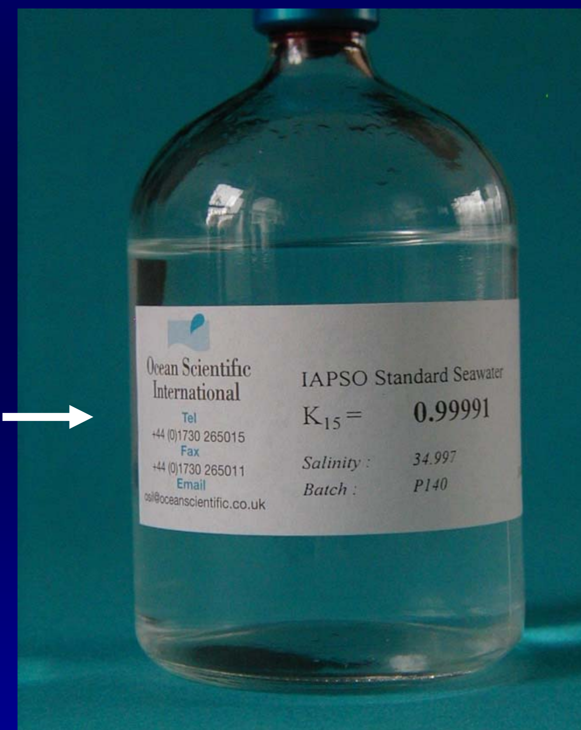
Standard Method - Standardization

Salinometer

referenced to

Standard Seawater

sequential samples



Limitations

- Temperature stabilized environment
- Sequential standardization
- Skilled staff
- SSW is expensive
- Warming samples may change apparent salinity

The Future...now

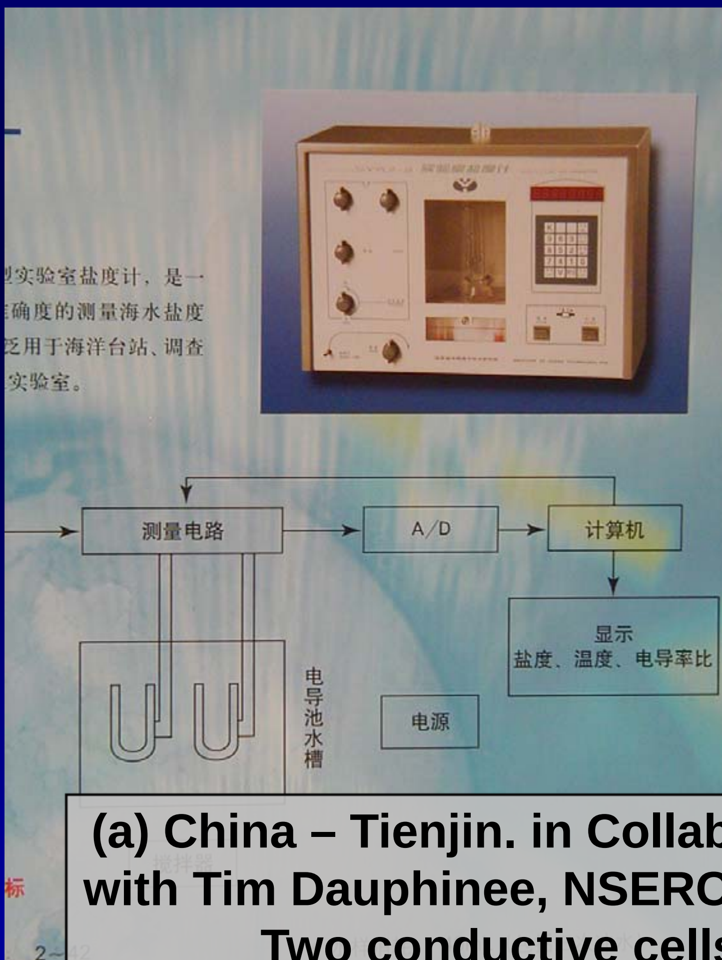
- High Performance
- Easy to Use
- Operates at *in situ* temperatures
- Small size

Concepts of the Small Salinometer:

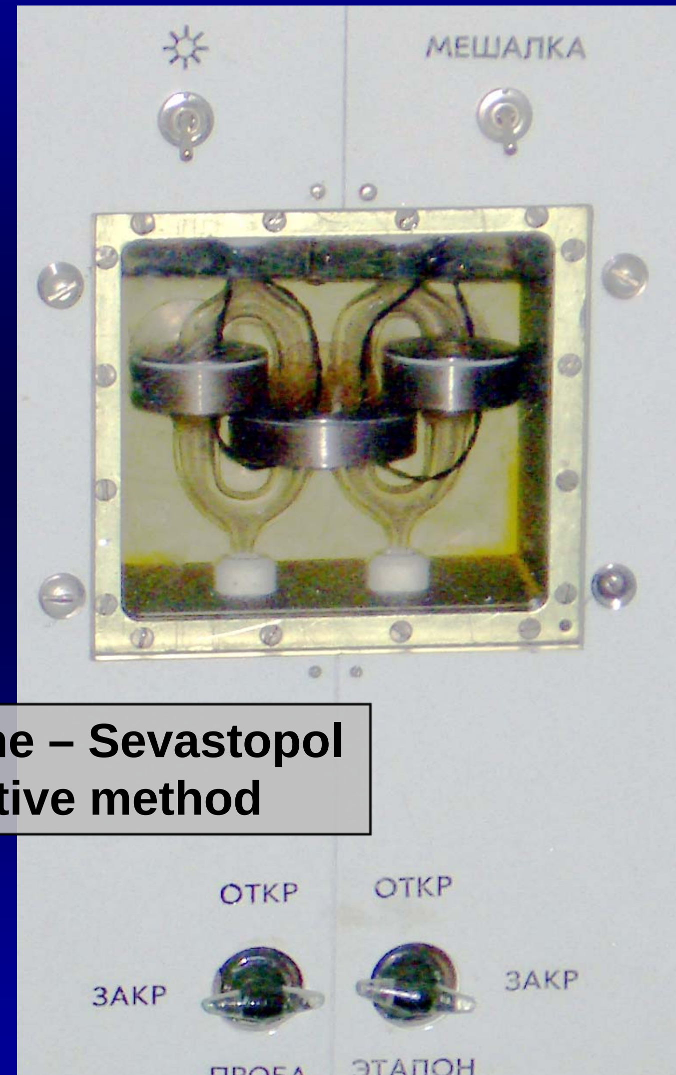
1. **Direct comparison of conductivity of sample and standard**

2. Direct reading of R_t over wide temperature range

Previous works



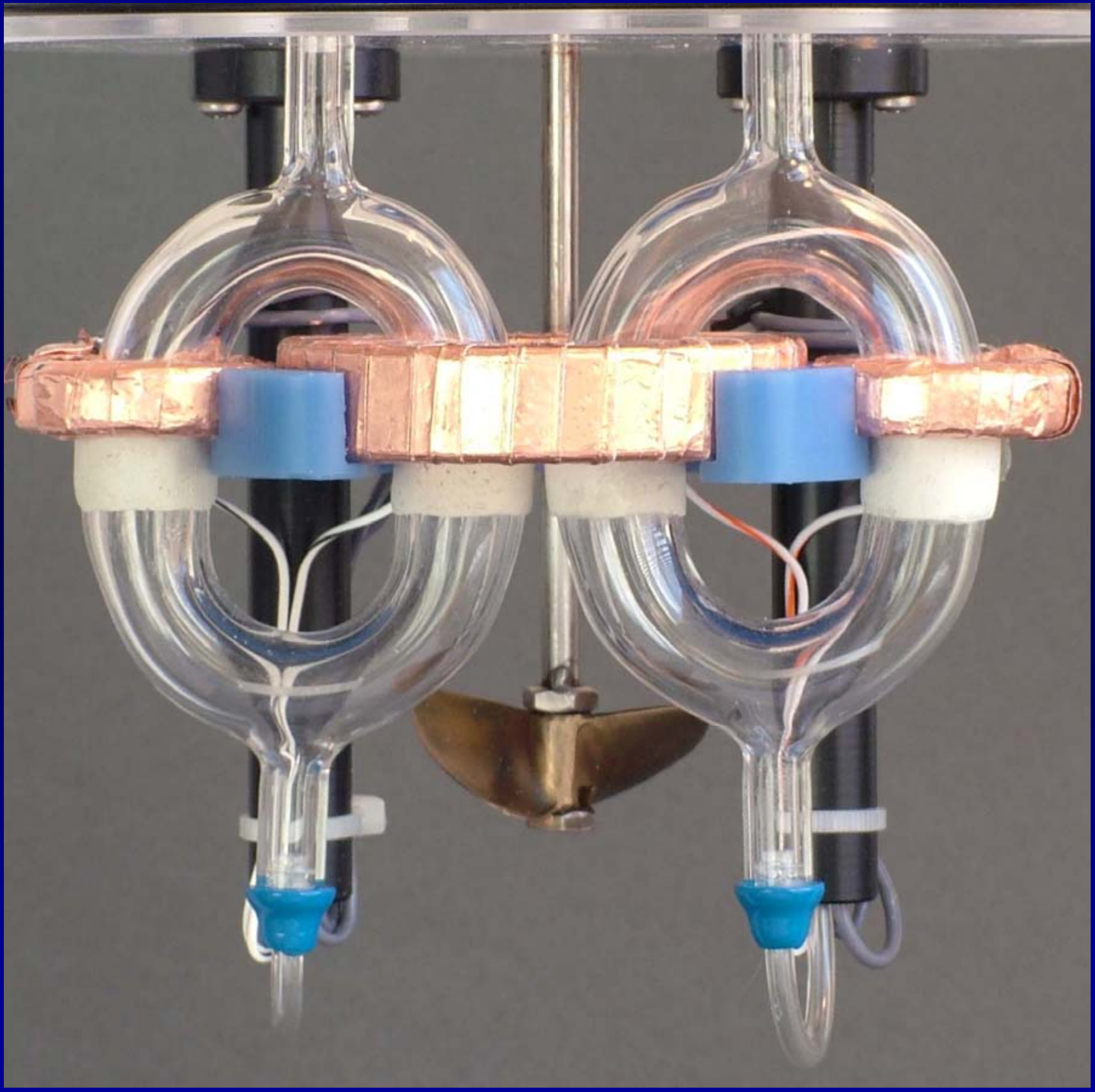
(a) China – Tienjin. in Collaboration with Tim Dauphinee, NSERC Canada
Two conductive cells



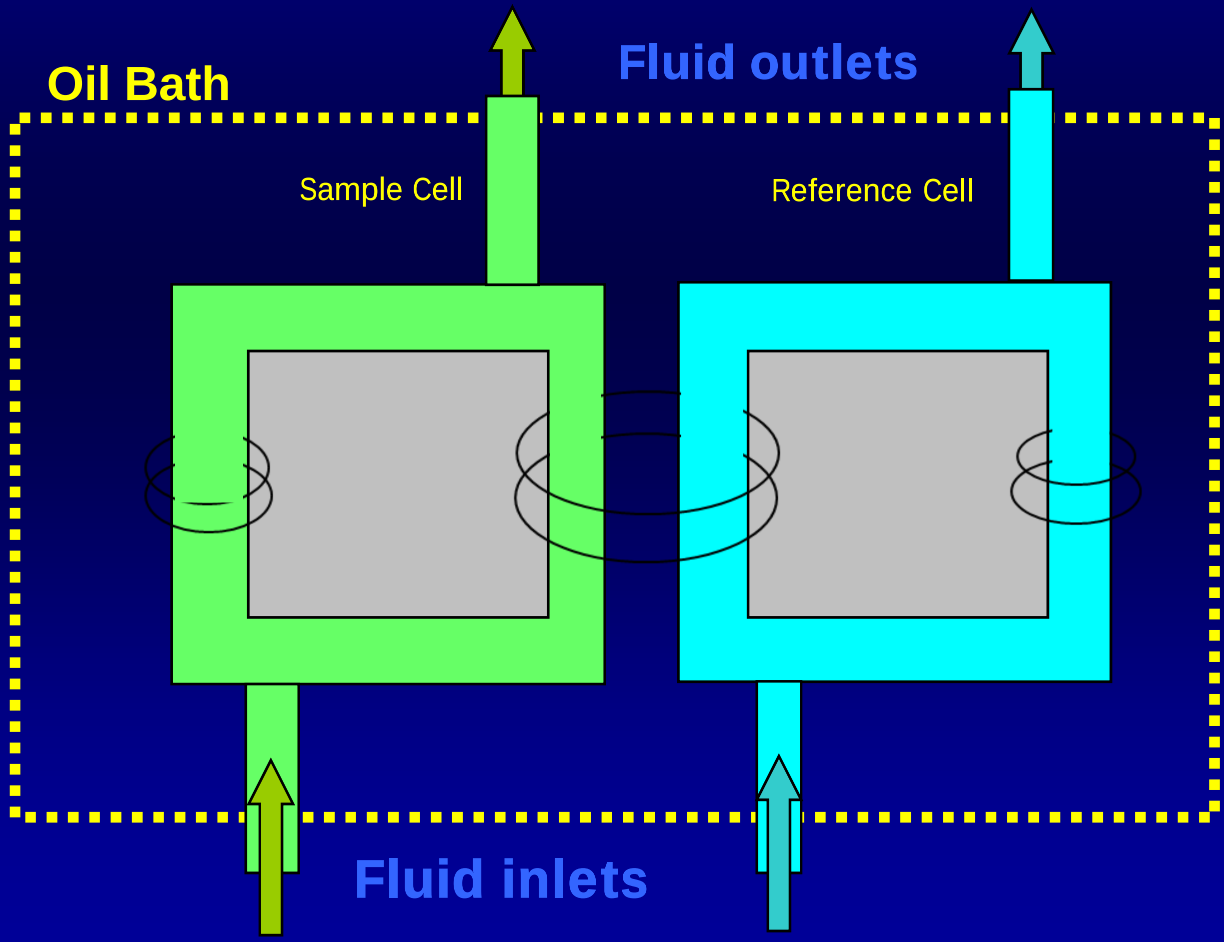
(b) Ukraine – Sevastopol
Inductive method

Dual chamber Inductive system

Based on standard RBR technology



Dual Chamber principle



Concepts of the Small Salinometer:

1. Direct comparison of conductivity of sample and standard

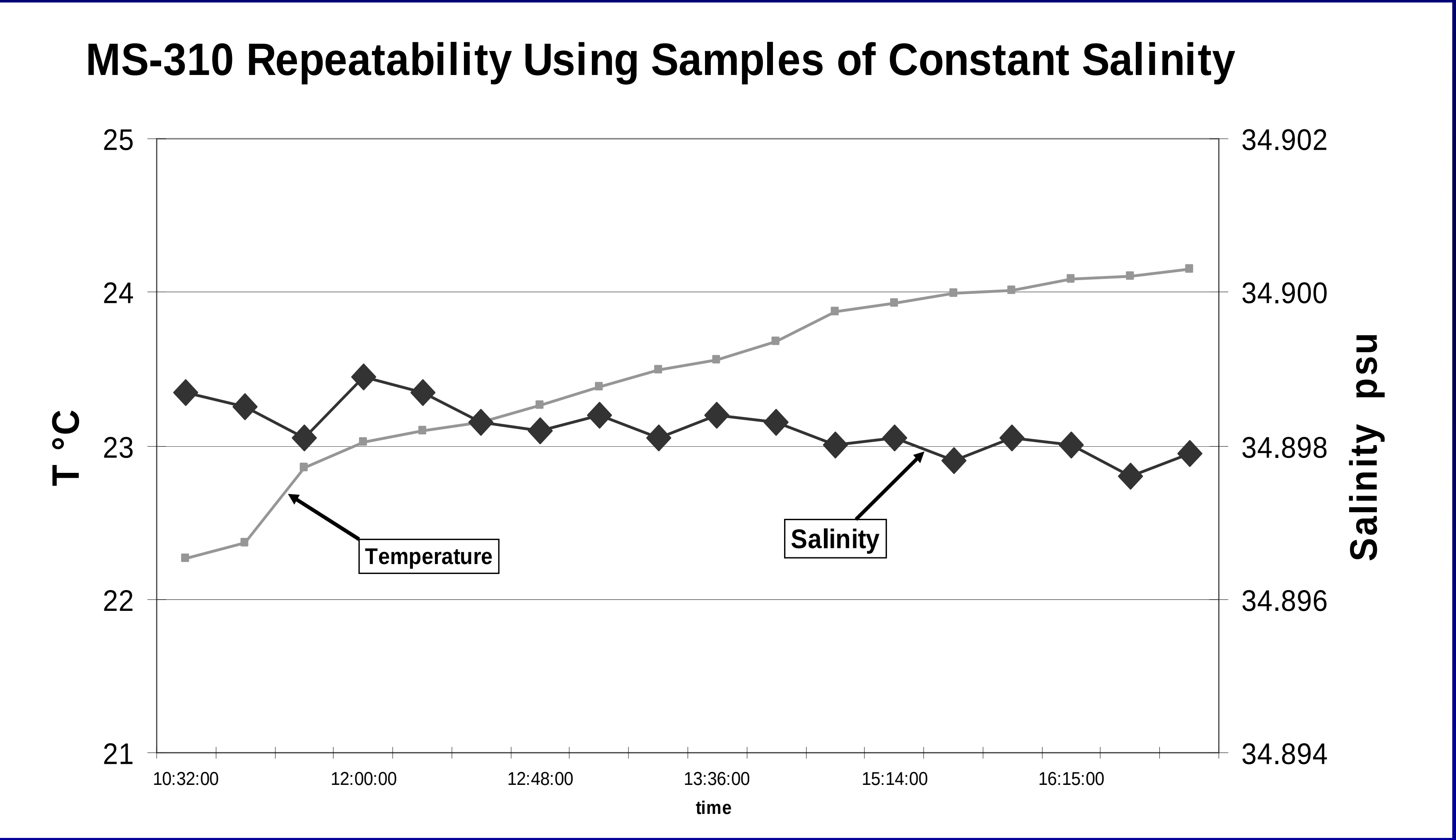
2. Direct reading of R_t over wide temperature range

Salinometers measure R_t

$$S = a_0 + a_1 R_t^{\frac{1}{2}} + a_2 R_t + a_3 R_t^{\frac{3}{2}} + a_4 R_t^2 + a_5 R_t^{\frac{5}{2}} + \\ + \frac{T-15}{1+k(T-15)}\left(b_0 + b_1 R_t^{\frac{1}{2}} + b_2 R_t + b_3 R_t^{\frac{3}{2}} + b_4 R_t^2 + b_5 R_t^{\frac{5}{2}}\right)$$

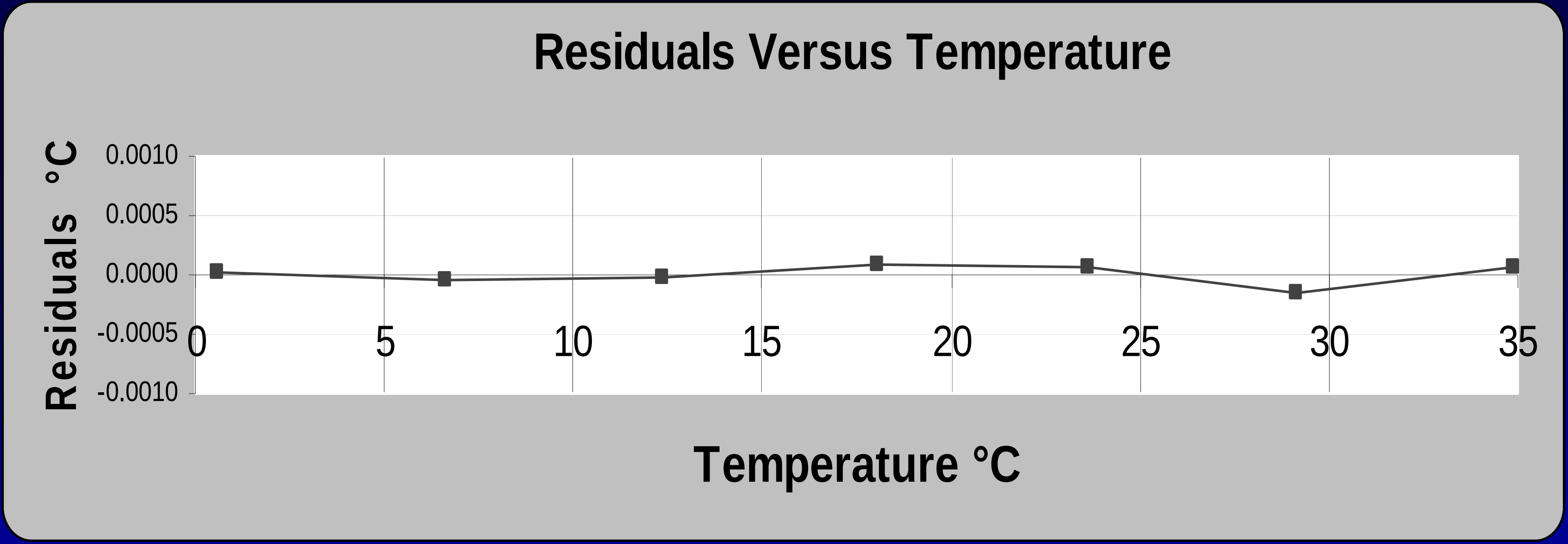
Practical Salinity Scale - 1978

Test Results



Test Results

Calibration of Temperature Sensor



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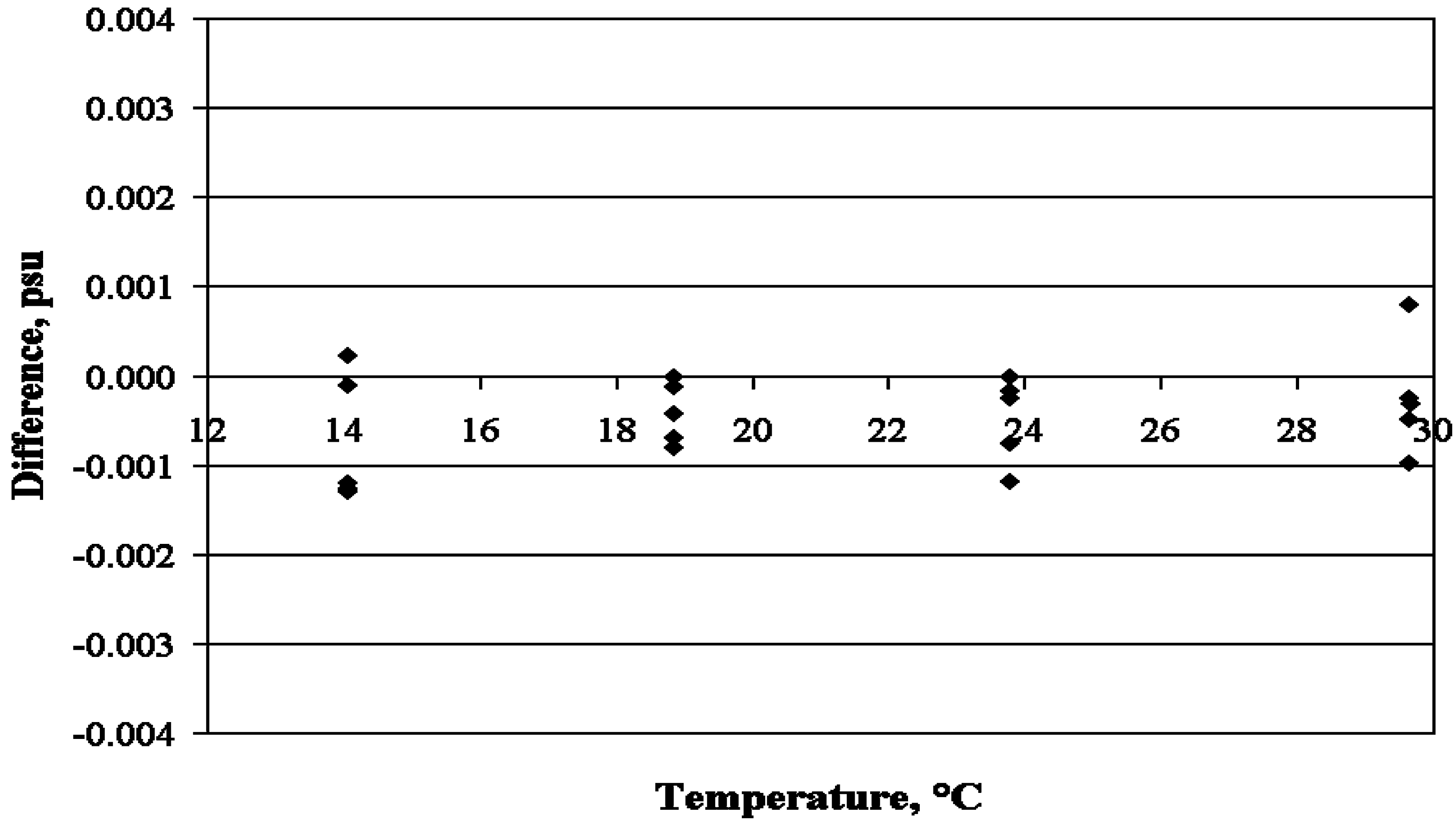
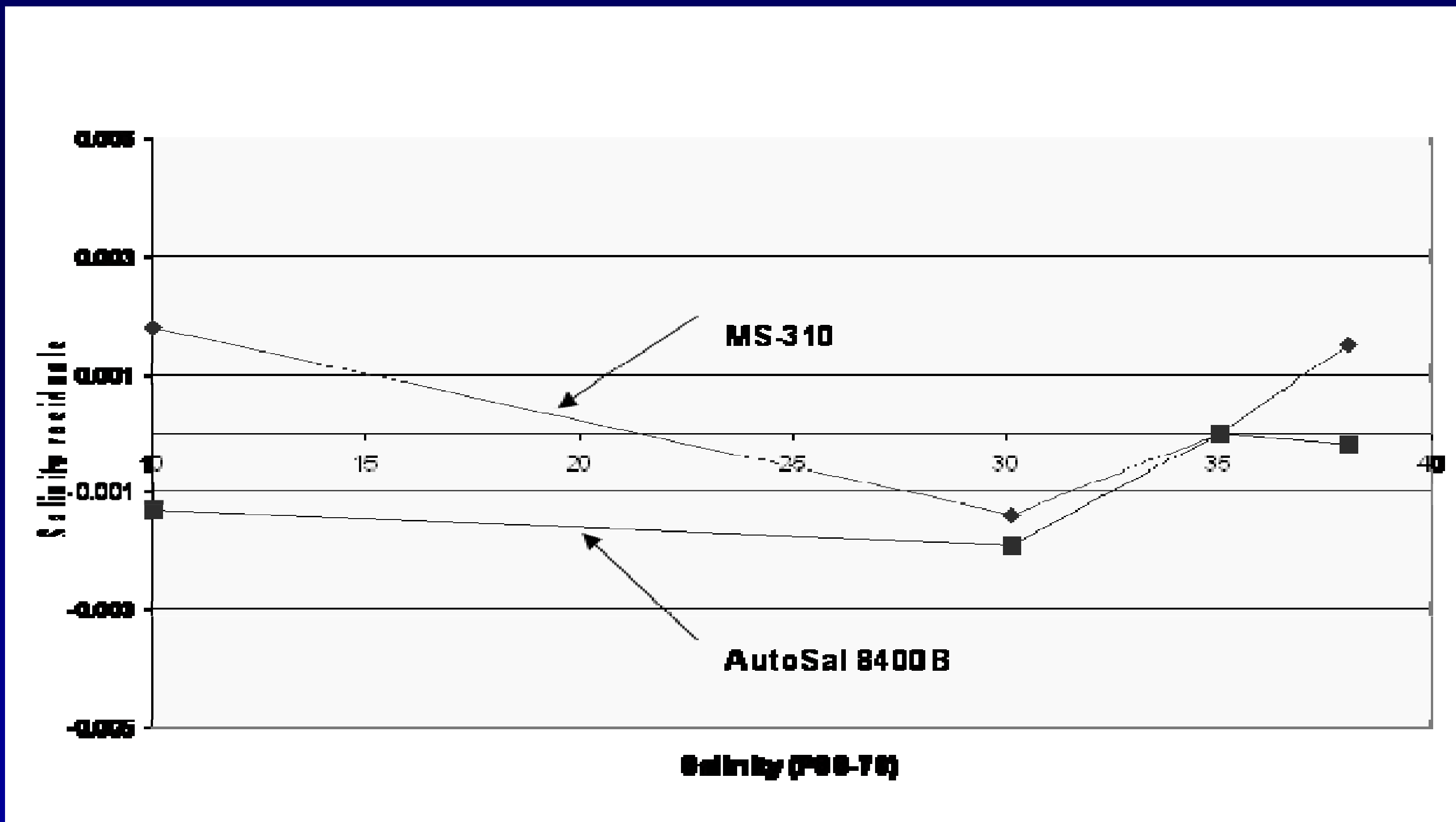
Test Results

R_t variation with temperature for samples of Standard Seawater

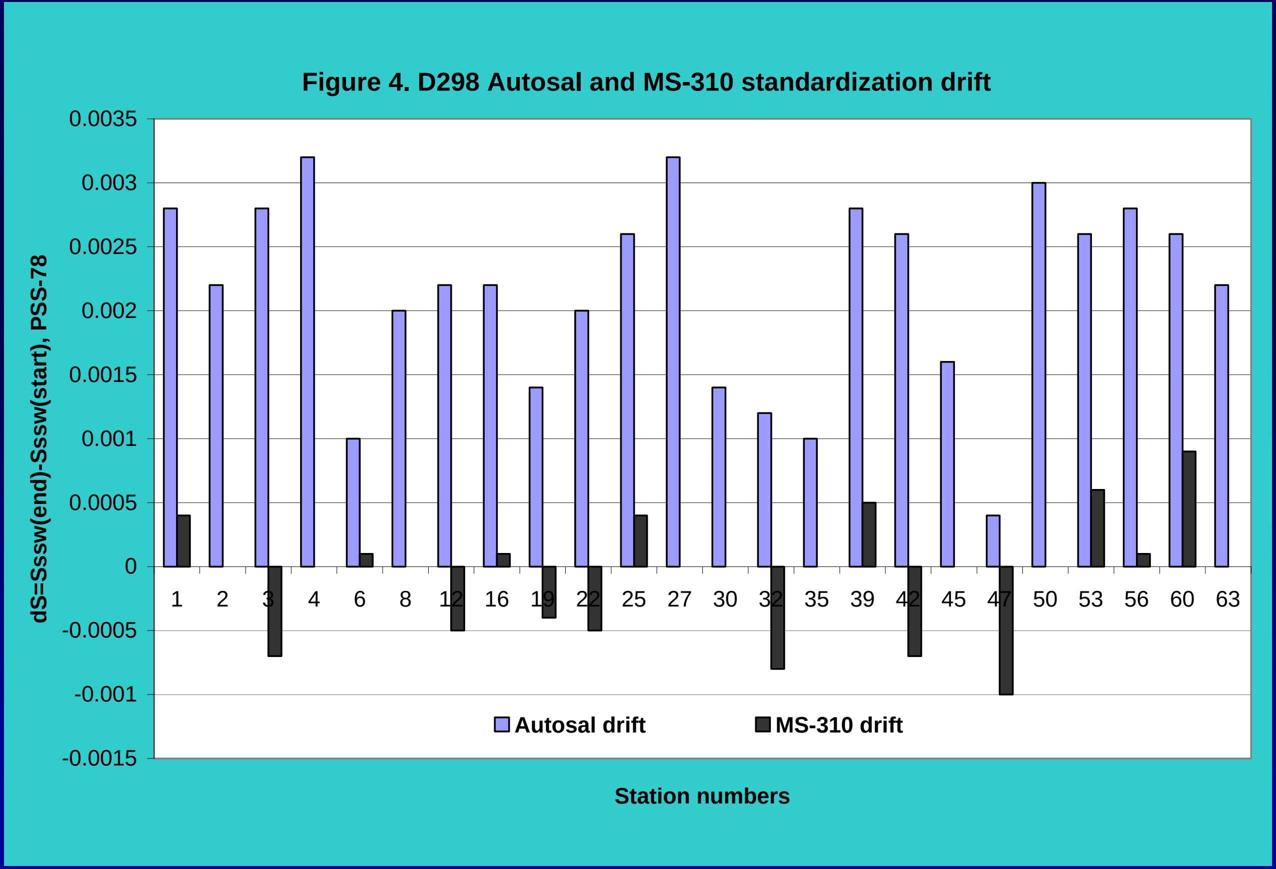


Test Results

MS-310 and AutoSal 8400B against OSIL Linearity pack (1 trial)



Salinometer Drift Comparison



Performance data compared with PortaSal and AutoSal

	AutoSal 8400B	PortaSal 8410A	MicroSal MS-310	
Range	0.0001 to 1.15	0.0001 to 1.15	**0.0001 to 2.00**	Rt
Accuracy	0.002	0.003	**0.002**	psu
Resolution	0.0002	0.0003	**0.0002**	Psu
Room Temp	+0°; -2°	+0°; -2°	**15° to 30°**	C
Bath	16.8	9	**2**	Litres
Weight	70	29	**5**	kg
Power	400	200	**10**	watts
Supply Voltage	110/220 AC	110/220 AC	**12 DC**	volts

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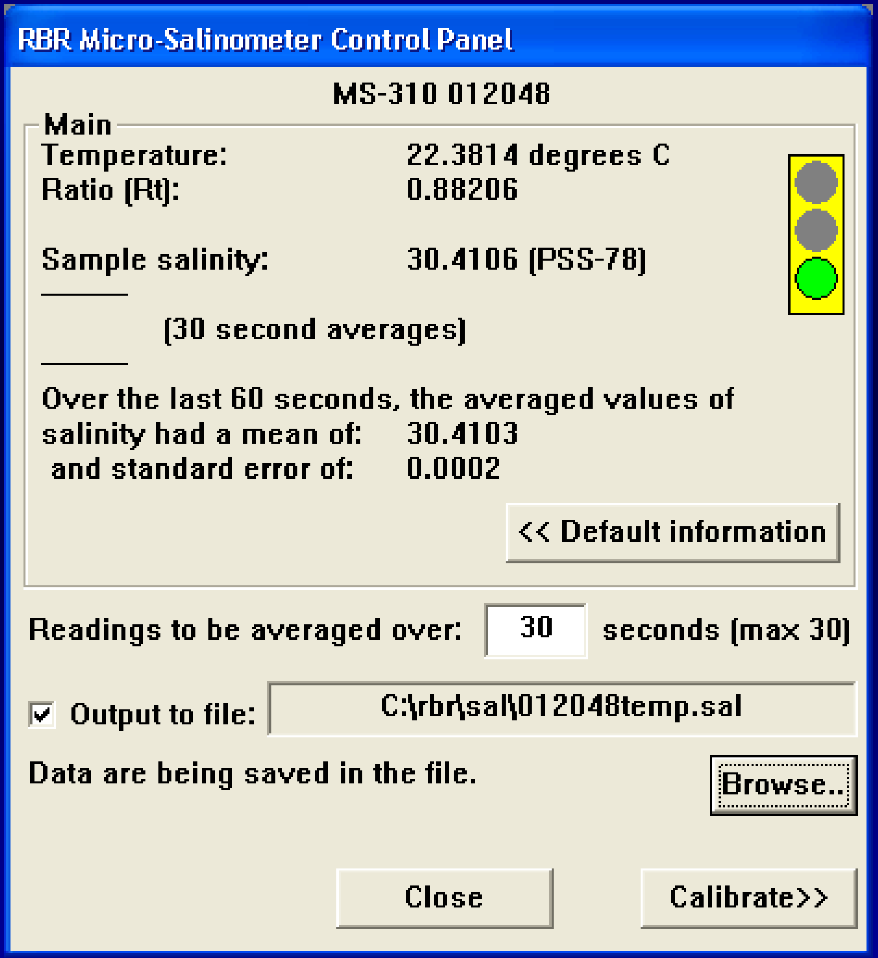
Easy to use

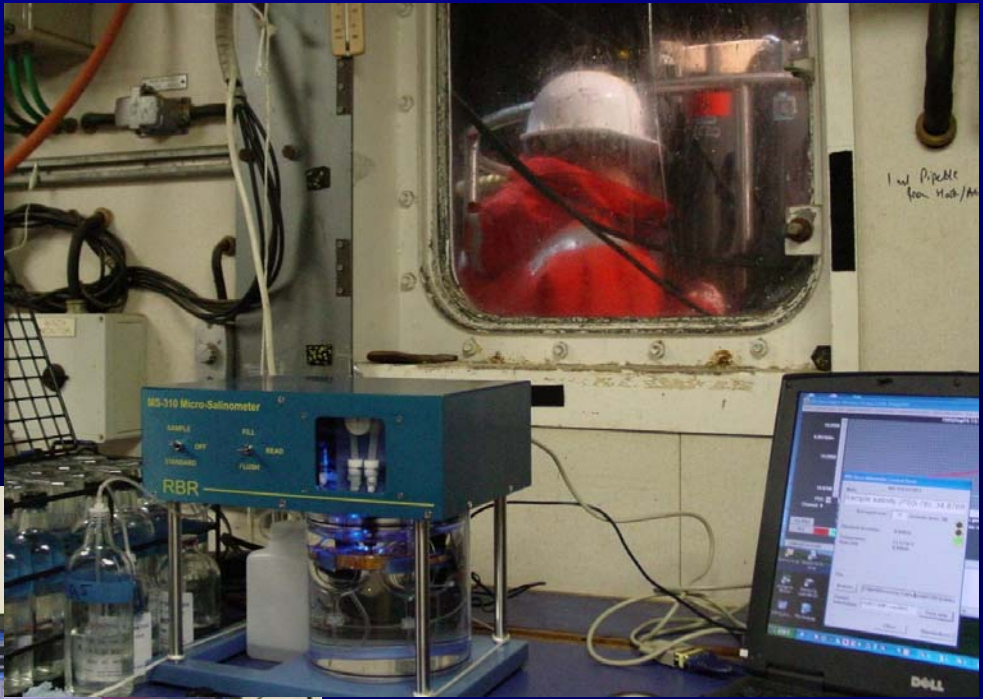
MS-310 User Interface

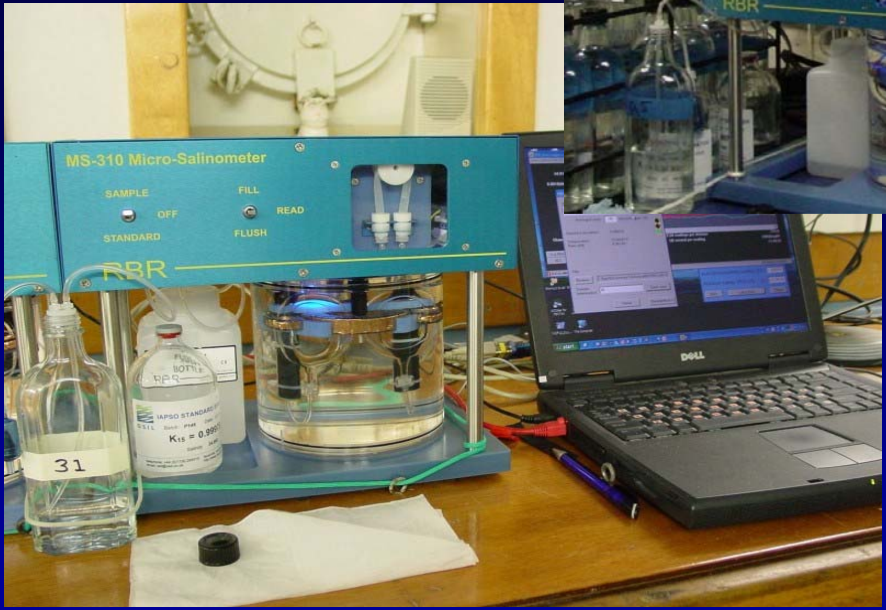
Windows®-based
control panel streamlines
And simplifies operation



Small Size

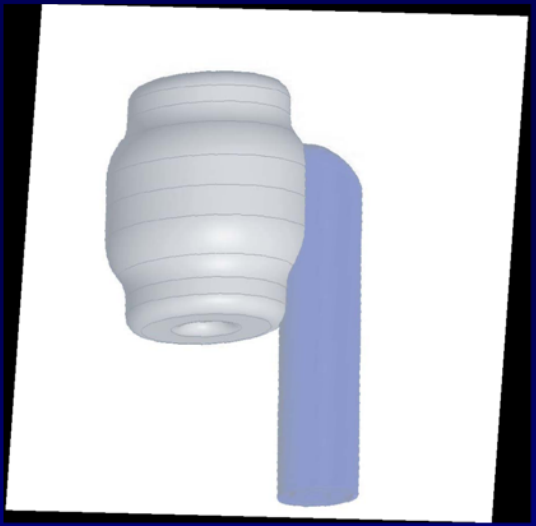
- 280mm x 280mm x 180mm
- 5kg
- 12VDC



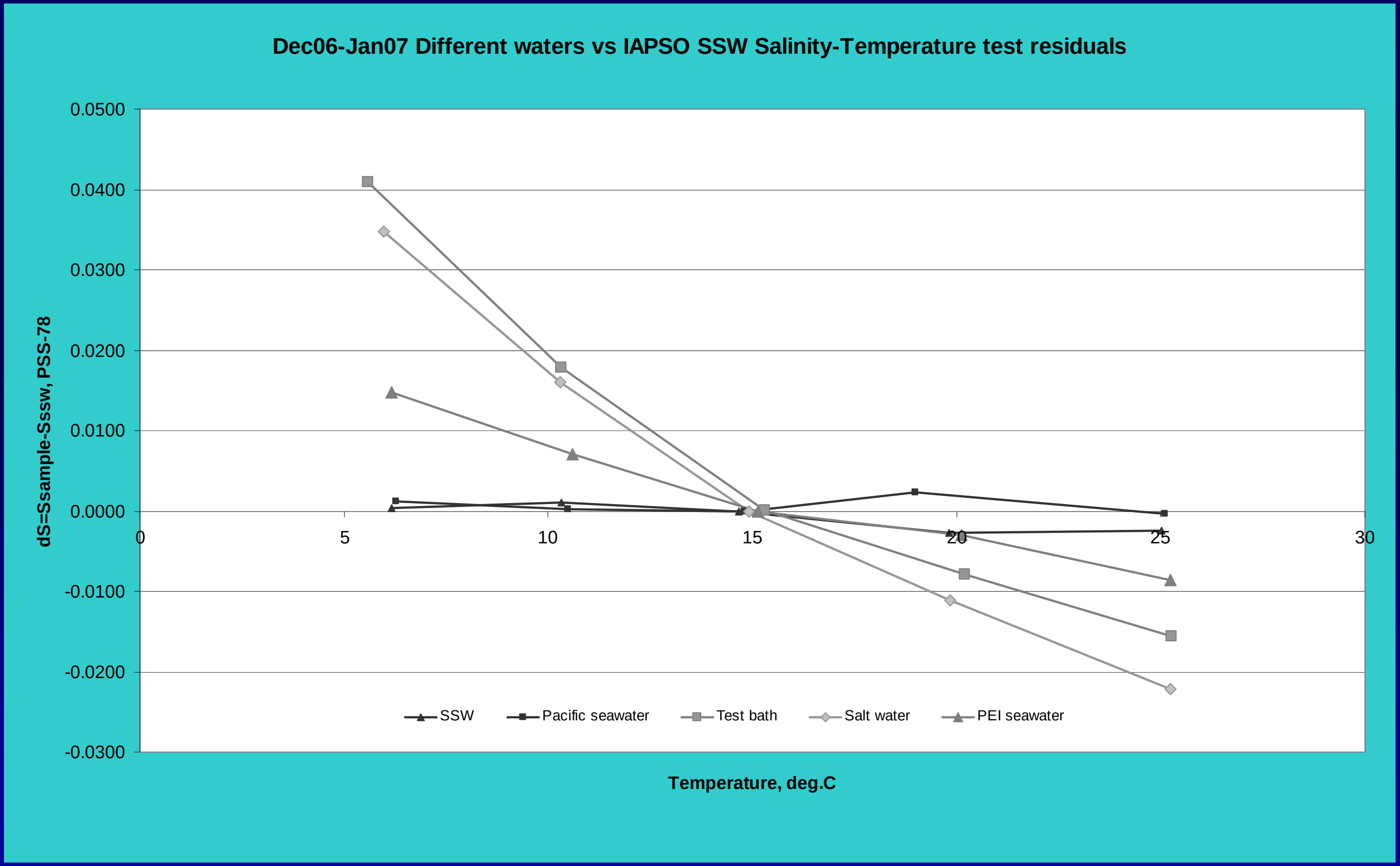


What else can I do with the MS-310?

- Thermosalinograph
- Measure other fluids (guacamole?)
- Immerse in bath for direct calibration of CTDs
- Autosamplers
- Submersible ocean salinometer (ZEFICC)
- Investigate behaviour of seawater types



Characterization of various seawater types over temperature range



Conclusions

The MS-310 represents the future of scientific salinity measurement, allowing measurement of salinity samples directly after CTD retrieval, outside the lab; the nearest thing to *in situ* salinometry.

This offers a new perspective for understanding the nature of the conductivity measurements of seawater and opens doors beyond the PSS-78.

Water samples should not have to be adjusted to a salinometer's comfort conditions, rather the salinometer should adjust to the CTD measurement conditions – this is the future of salinity technology