One year after Miami meeting: (my) status of knowledge

F. Reseghetti (ENEA-ACS-Clim.Med)-Lerici (Italy)

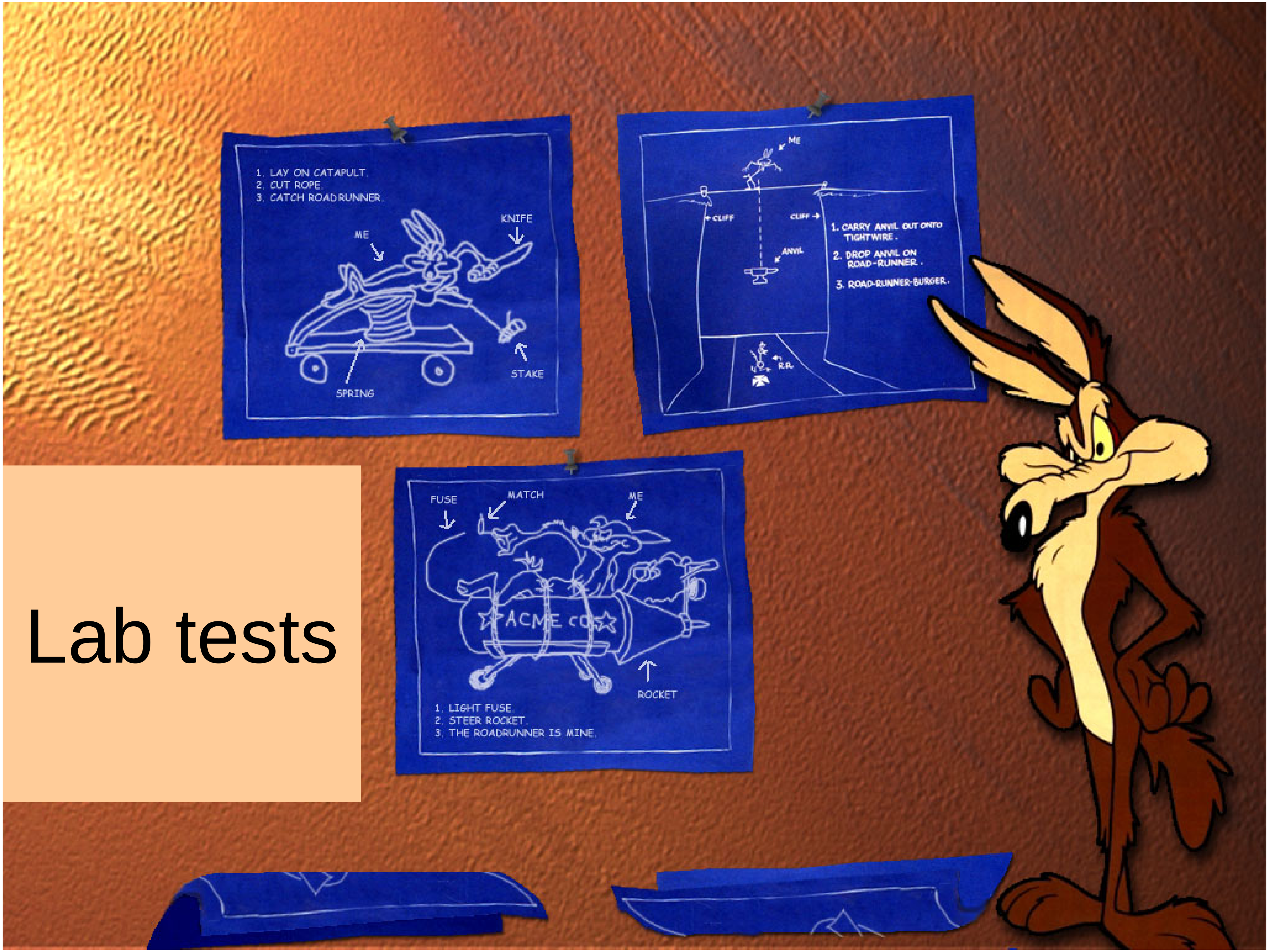
- Lab test
- Biblio test
- Field test

Geneve, SOT-V Meeting
18-22 May, 2009

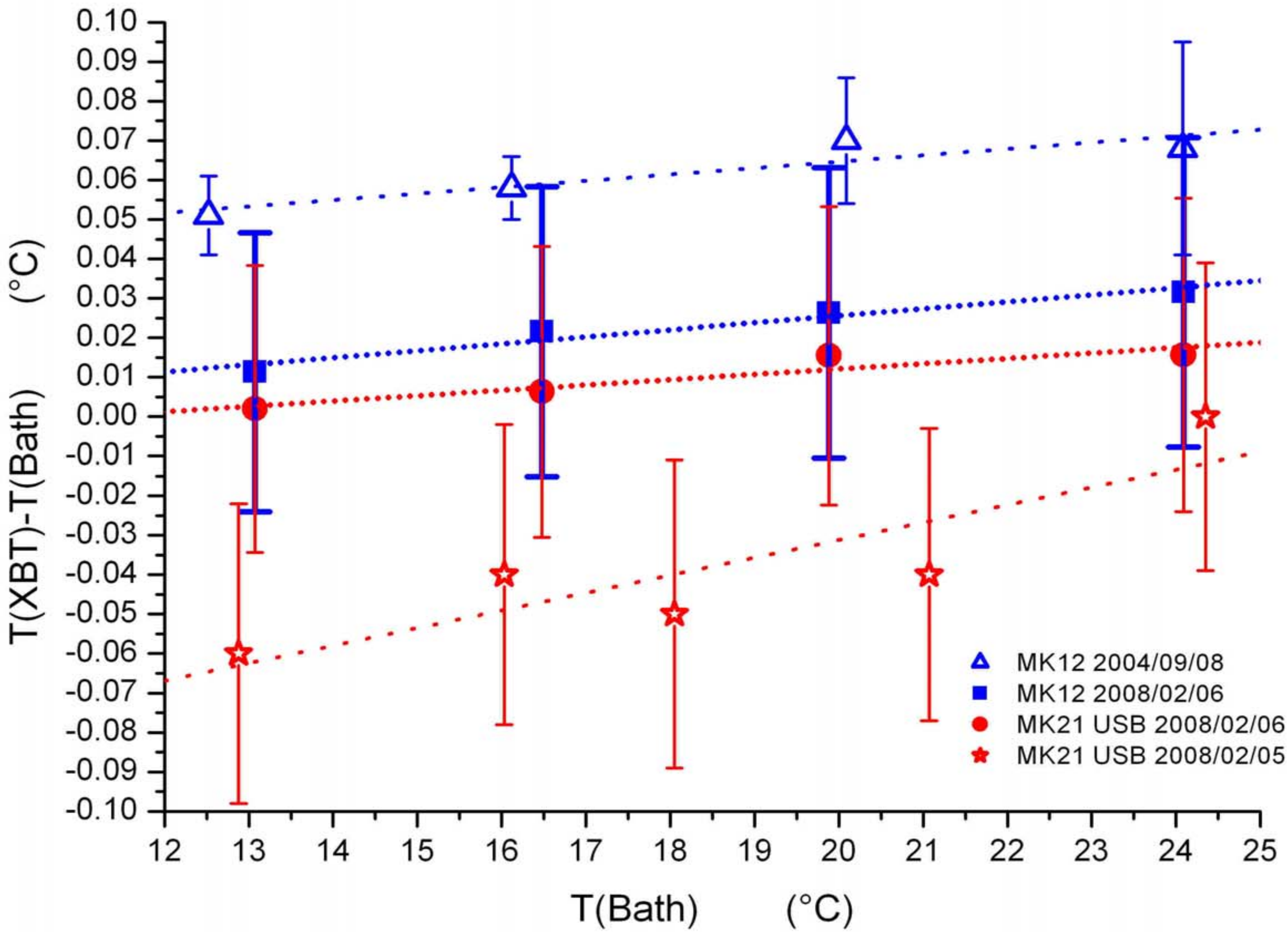
- Uncert
- Fall rat
- How re
- Propert ... ıot?
- Launch ... eed, wind…
- QC pro
- ...

- Standa
  - Lab t
  - Lab t
  - Field
  - ...

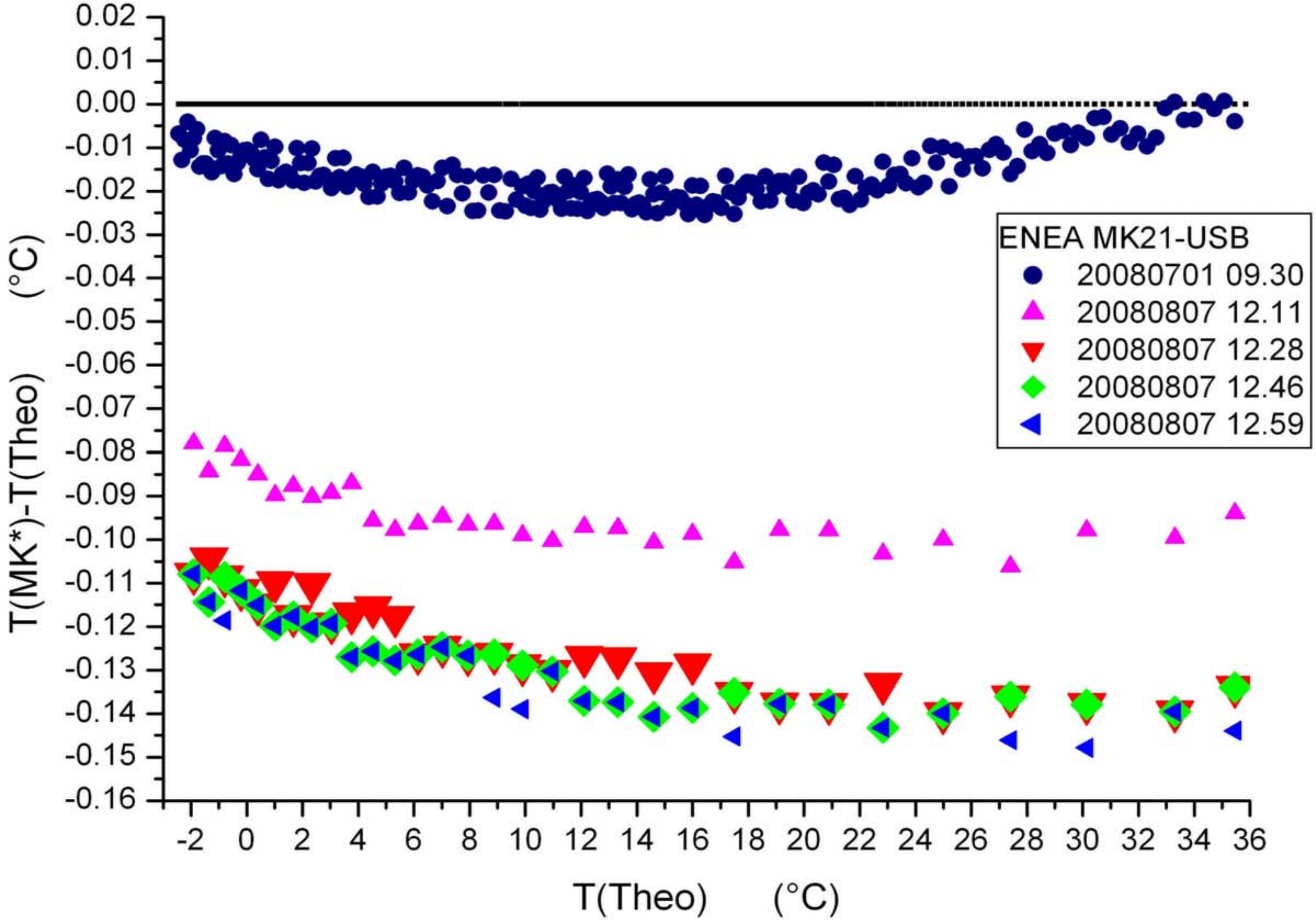
Lab tests


1. LAY ON CATAPULT.
2. CUT ROPE.
3. CATCH ROAD RUNNER.
KNIFE
ME
STAKE
SPRING
ME
CLIFF
CLIFF
ANVIL
R.R.
1. CARRY ANVIL OUT ONTO TIGHTWIRE.
2. DROP ANVIL ON ROAD-RUNNER.
3. ROAD-RUNNER-BURGER.
FUSE
MATCH
ME
ACME CO
ROCKET
1. LIGHT FUSE.
2. STEER ROCKET.
3. THE ROADRUNNER IS MINE.

2008/02/06: Bath Calibration



Recorders..



ENEA MK21-USB
20080701 09.30
20080807 12.11
20080807 12.28
20080807 12.46
20080807 12.59
T(MK*)-T(Theo) (°C)
T(Theo) (°C)
0.02
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
-0.10
-0.11
-0.12
-0.13
-0.14
-0.15
-0.16
-2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36

Probes dimensions

Type	S	eight
T7		
T4		728.5
T10		
DB		734.8
T4		
T4		
DB		729.5
PL-T4		731.5
T4		
T4		
T4		
T6		
T5		
??		
??		
DB		
T4		
T4		
T4		

TABLE 2. Theoretical XBT probe random errors.

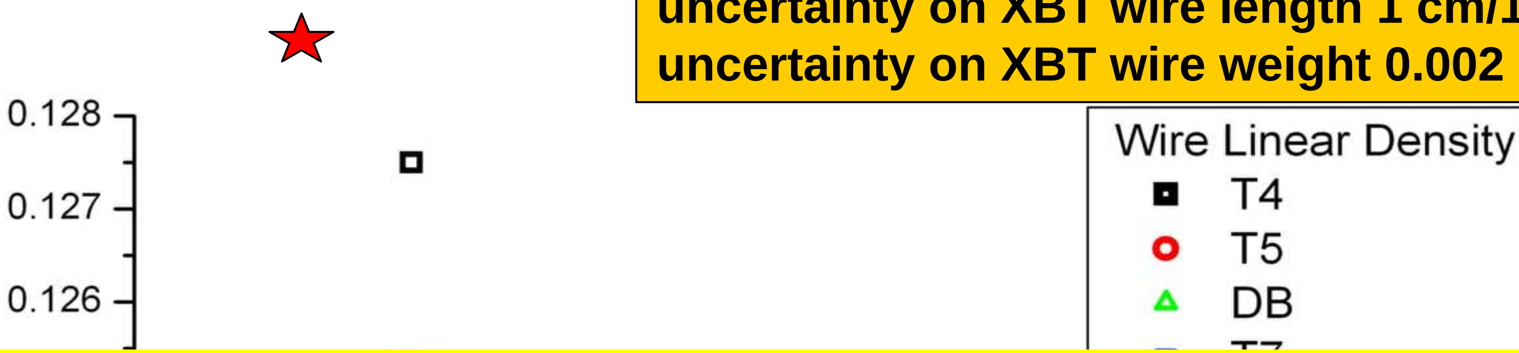
Cause	Maximum depth error (m)	Maximum temperature error (°C)	Maximum $\sigma(\Delta D')$ (m)
Probe nose roughness	7.0 at 700		4.6
Probe nose and/or wire weight variations			
0.36%	1.6		1.1
2.0%	8.8 at 750		6.2
Thermistor variability	5 (18°C water)	0.025	3.5
	25 (4°C water)	0.025	17.7

$$\sigma_{max} = \left[\frac{2N(\Delta D')^2}{N}\right]^{1/2}$$

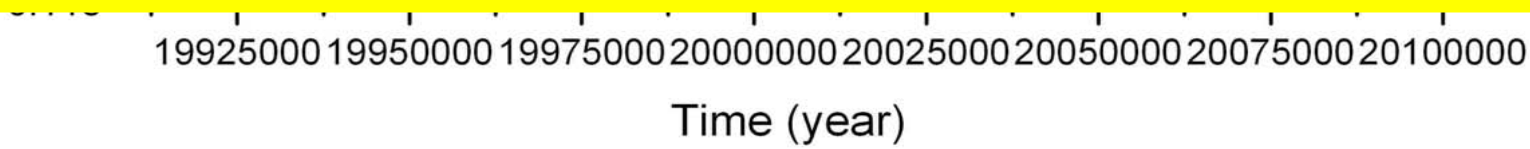
Seaver and Kuleshov, 1982

Wire linear density

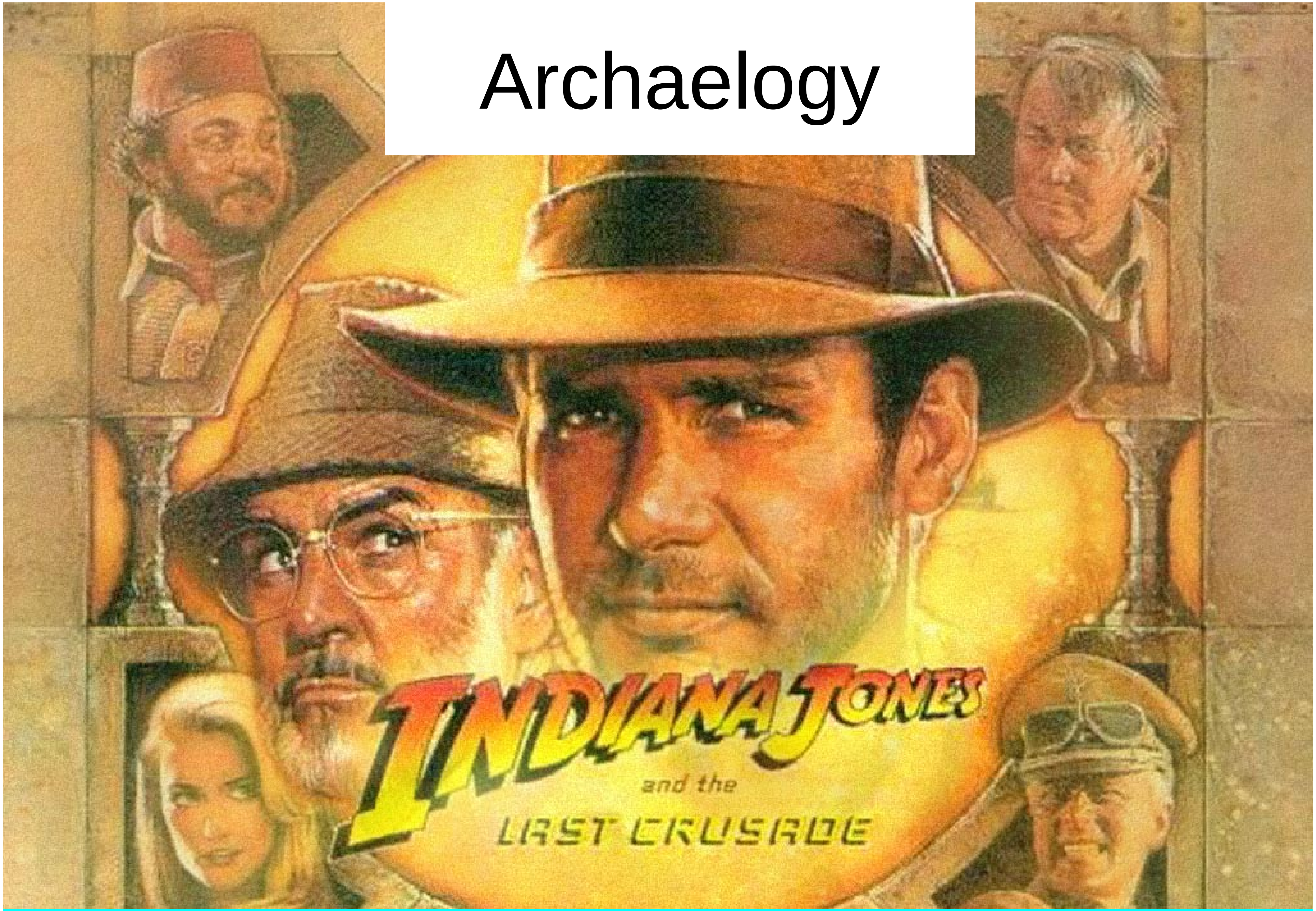
uncertainty on XBT wire length 1 cm/10 m
uncertainty on XBT wire weight 0.002 g/10m



- **S.Kizu (personal communication) is preparing a paper detailing his comparison between LM Sippican DB and TSK T7 (vs. CTD).**
- **The probes are very similar but not equal (length/weight/shape/dimension + hole/weight/roughness of the nose)**
- **In situ test: the motion is not the same.**



Archaelogy



how to re-discover previously discovered results

The chart paper records horizontally from 28F to 96F in 7.0 inches, or about 0.103 of an inch of chart paper per 1.0F. Table II shows the resolution capabilities of the paper using different recording intervals.

TABLE II

Chart Spacing (inches)	Resolution Temperature (F)	Resolution Depth (ft)
0.01	0.0971	3.690
0.005	0.0476	1.045
0.001	0.0097	.369

The response time for the thermistor is 110 milliseconds nominal and 130 milliseconds maximum [Choate, 1970 and Demeo, 1968]. A time constant-temperature change plot shows that 98.2 percent of a temperature change has been recorded in 10.4 feet of fall, 83 percent recorded in 5.2 feet of fall, 68 percent in two feet of fall and 35 percent in one foot of fall (Figure 24).

The thermistor, because of its finite size, has thermal inertia which causes it to act as a low pass filter. As a result, fine structure is lost or at best smoothed out. The original trace could be reconstructed if the filtering characteristics (of both phase and amplitude) of the thermistor were known. These could be obtained experimentally.

ps' specifications [Danner, 1966]

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I

?8F to 96F
± 0.4F
0 to 1000 ft
± 2% or 15 ft, whichever is greater
± 63% of a temperature step after 3 ft depth change

obe currently used has a
obe is connected electrically
which pay out from both the
in the launcher is connected
no splices in the wire. The
determining its fall-rate.
thin ± 3 gms both with and
e deviation was from 0.3% to
.) The observed average fall-
t/sec. A probe, with its
velocity of 19.9 ± 0.7 ft/sec.
± 0.5 ft [Gouzie, Sanders and

t recorder is a Mark 2A model
ording the thermal profile. The
at a rate of 3.25 in/min. In one
will have reached a depth of 1200
3.25 inches of chart paper, or
ed for every foot of fall.

SUMMARY

During six acoustic experiments conducted between 1971 and 1975, a total of 1978 XBT temperature profiles were acquired – 26 by means of 1830-m XBT systems and 1961 by means of 460-m systems. Included were special sets of measurements that provided data bases for absolute and relative accuracy studies. The measurements were made on eleven 460-m and two 1830-m systems from four ships and two research platforms. In addition, independent temperatures were measured by using hydrocasts, STD/SV, thermistor chain, surface towed thermistors, and bucket thermometers.

It is common practice to read XBT analog records visually with a temperature accuracy of ±0.2°C and a depth accuracy of ±2 m. In this study, all XBT records were read with a Hewlett-Packard 9864A Digitizer that has a temperature resolution of ±0.05°C and a depth resolution of ±0.94 m.

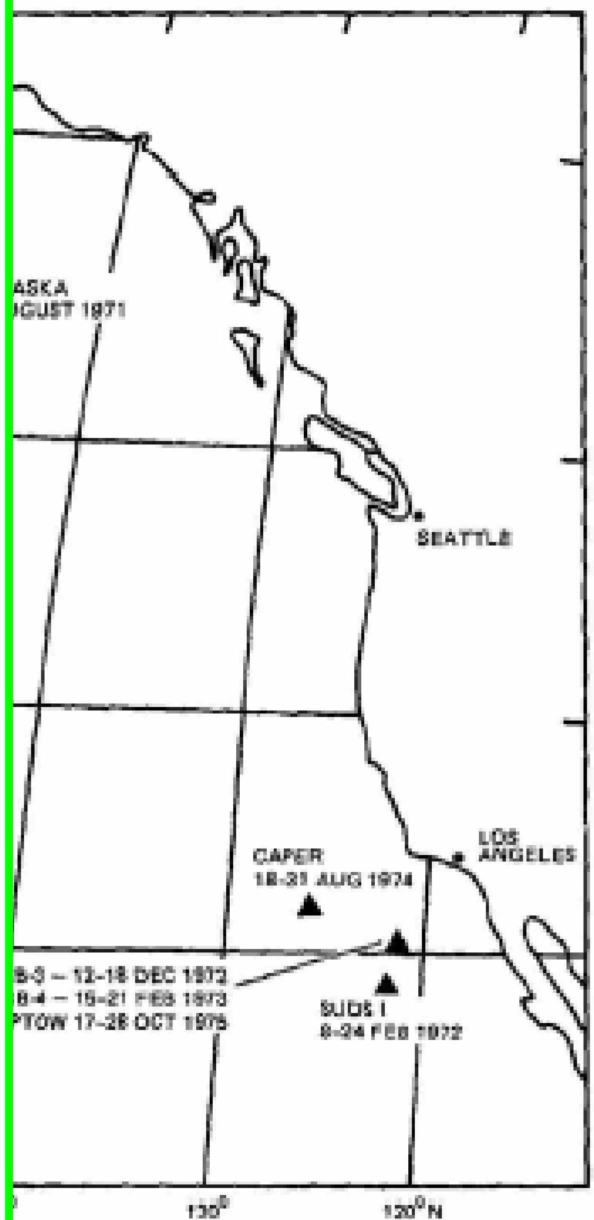
XBT PERFORMANCE

The following is a summary of the performance of the XBT systems used to provide the data for this study.

	460 m		1830 m	
Profiles attempted	1961	100.0%	26	100.0%
Catastrophic failures	126	6.4%	8	30.8%
Miscellaneous failures	52	2.7%	0	0.0%
Partial successes	212	10.8%	8	30.8%
Successes	1571	80.1%	10	38.4%
Visually acceptable	1783	90.9%	18	69.2%

where the above categories are defined as follows:

- Catastrophic failure – No usable measurements for depths greater than 50 m.
- Miscellaneous failure – Failed because of operator error, wire blowing against ship, etc.
- Partial success – Visually acceptable to a depth greater than 50 m but less than the maximum depth.
- Success – Visually acceptable to maximum depth.
- Visually acceptable – The sum of the successes and partial successes. No basis for rejecting as incorrect based on a visual inspection of the analog record.



ocation of XBT measurements.

Although the T-5 mean experimental error is satisfactorily explained by the theory, this is not so clear in the case of the T-7 probe. The T-5 also comes closest to the absolute fall rate predicted by theory for the flat plate. This idealized streamlined body with no pressure drag falls at 122% of the T-5 rate and 147% of the T-7 rate (Schlichting, 1955). This contrast, along with the smoother curve of the T-5 mean experimental error near the surface, suggests that the weight and shape of the T-5 give it a more stable configuration than that of the T-7 and that this results in reduced pressure drag, particularly at the beginning of the fall. Also, the spin stability of the T-7 might be slower to develop; the T-7 has been observed to have a helical trajectory in a 10 m drop tank. The above factors suggest that if the T-5 weight and shape were adopted for the T-7 probe, the theory would more adequately describe the T-7 mean error.

Some of the preceding theoretical considerations can be applied to the random as well as the mean fall-rate error. A depth error from a constant fall-rate error would be a monotonically increasing function of depth from (6); the T-7 probe results show a 6 m increase in the standard deviation between the seasonal and the main thermocline, where the effects of temperature errors are minimized. This is shown

As previous investigators have suggested that the mean XBT error derives from ballast and unreeling factors, these have been investigated both theoretically and experimentally. The manufacturer corrects for the loss of weight and decrease in fall rate due to the unreeling of the wire by increasing the chart-paper grid size with increasing time of descent. He has developed these empirical descent equations from laboratory tests in 10 and 30 m drop tanks and from field tests in waters and mine shafts of known depth. These tests were conducted in the early 1960's (Sippican, 1973). Using the preceding theory, and recent experimental results by Seaver to determine the ballast errors and true wire-weight ratios, the error in Sippican's empirical unreeling correction was found to be generally less than 0.2%, a surprising result. We conclude that, although the wire weight is reduced by 12% from the entrapment and release of air, the effect on the mean fall rate from wire pull, and ballast and unreeling factors is negligible.

Seaver and Kuleshov 1982

RESULTS

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Table 1 First expendable probe drop test on Sunday

Probe ID	Type/Mod	Wire (Y/N)	Weight (gm)	C of G inches	Start seconds	Stop seconds	Spin RPM	Drop Rate meters/sec
H	no video							4 probes
S	no video							are
16	no video							on
13	no video							bottom
12	XBT-5	Y	980	2.85	no flash	7.59	360	
15	XBT-5	N	720	2.19	19.37	23.35	360	4.84
14	XBT-5/M2	N	716	2.19	33.19 ?	37.24	360	4.70
2	XOTD/M1	Y	784	3.40	46.36 ?	51.46	N/A	3.72
17	XBT-5	N	717	2.18	57.45 ?	64.26	214	2.87
4	XBT-4	Y	719	1.90	83.10	missed		
18	XBT-4/M1	Y	719	2.05	no flash	90.01	360	
6	XBT-4	N	608	1.65	97.17	missed		
19	XBT-4/M2	Y	715	2.00	no flash	104.28		
8	XBT-7	Y	717	2.10	no flash	109.29		
9	XBT-7	Y	719	2.10	118.31	121.52	450	5.73
5	XBT-4	Y	715	2.05	131.16	134.25	400	6.10
22	AXBT	N	702	0.75	144.23	157.52	N/A	1.42
20	AXBT	Y	839	1.03	no flash	168.12	N/A	
23	AXBT	N	699	0.77	no flash	181.50	N/A	
21	AXBT	Y	845	1.05	no flash	197.56	N/A	

The second test went much better, video is missing for only two probe deployments.

Table 2 Second expendable probe drop test on Sunday

Probe ID	Type/Mod	Wire (Y/N)	Weight (gm)	C of G inches	Start seconds	Stop seconds	Spin RPM	Drop Rate meters/sec
S	XCTD. Fin				no flash	282.23	675	
1	XOTD/M1	N	677	2.6	291.13	296.08	N/A	3.91
H	H-C Fin	N	?	?	306.08	311.27	N/A	3.61
15	XBT-5	N	720	2.19	317.56	321.41	360	5.12
2	XOTD	Y	784	3.40	342.12	347.05	N/A	3.93
16	XBT-5/M1	N	727	2.2	359.48 ?	365.02	N/A	3.67
1?	?	?	?	?	380.22	383.38	450	5.88
D	?	?	?	?	393.41	missed		
14	XBT-5	N	716	2.19	407.17	410.50	360	5.41
12	XBT-5	Y	980	2.85	427.59	431.28	450	5.51
13	XBT-5	Y	981	2.90	520.23	523.38	450	5.91

The tow tests
probe. Included
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XOTD probe
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when the
Extremely

Field results

Physics (and Physical Oceanography) is an experimental science…

Last News

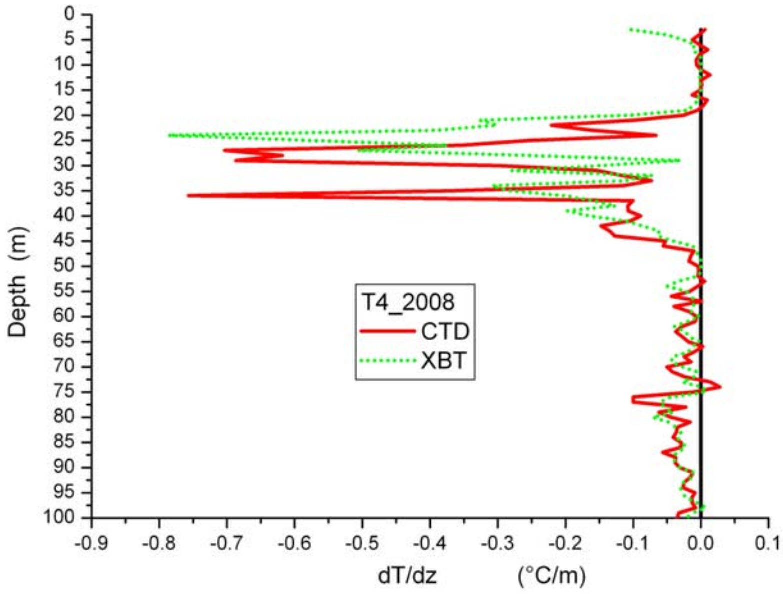
- DiNezio-Goni (submitted): XBT vs. ARGO
- Tim and Gopal have described XBT vs. CTD in Indian Ocean (Tim and Gopal)
- Kizu et al. (submitted): (LMSippican XBT vs. TSK XBT) vs. CTD

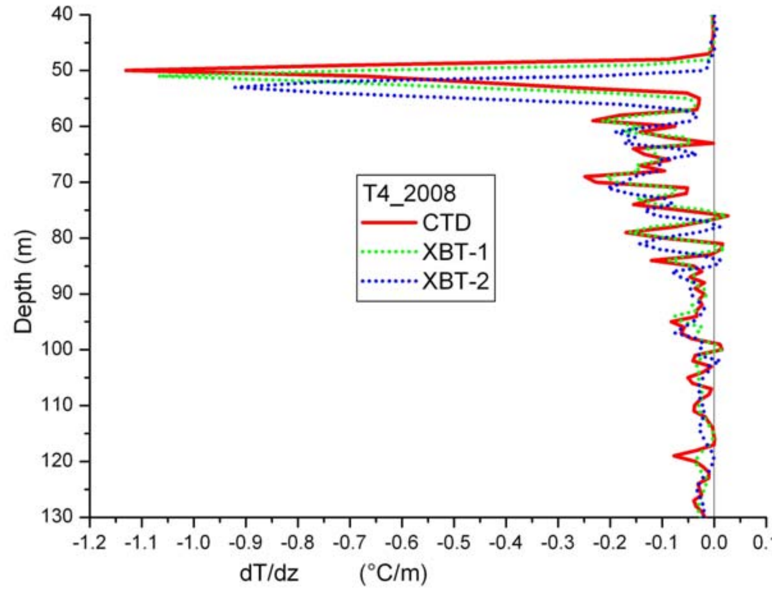
Correction schemes for archived data have realised and announced by some groups.

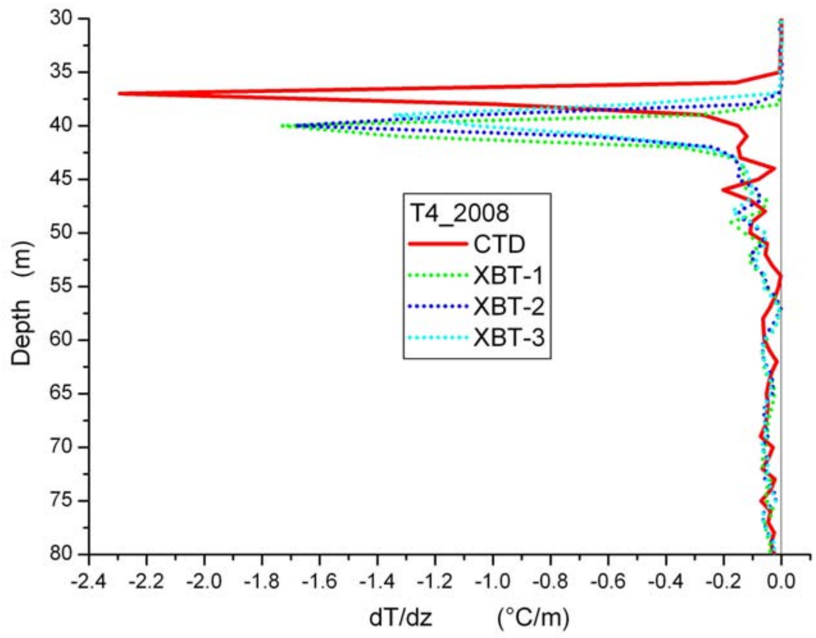
Gouretski-Reseghetti (submitted) proposal.

After WEB researches, several reports quoting small XBT vs. CTD comparisons (since 70s). (Hard job for Tim!!)

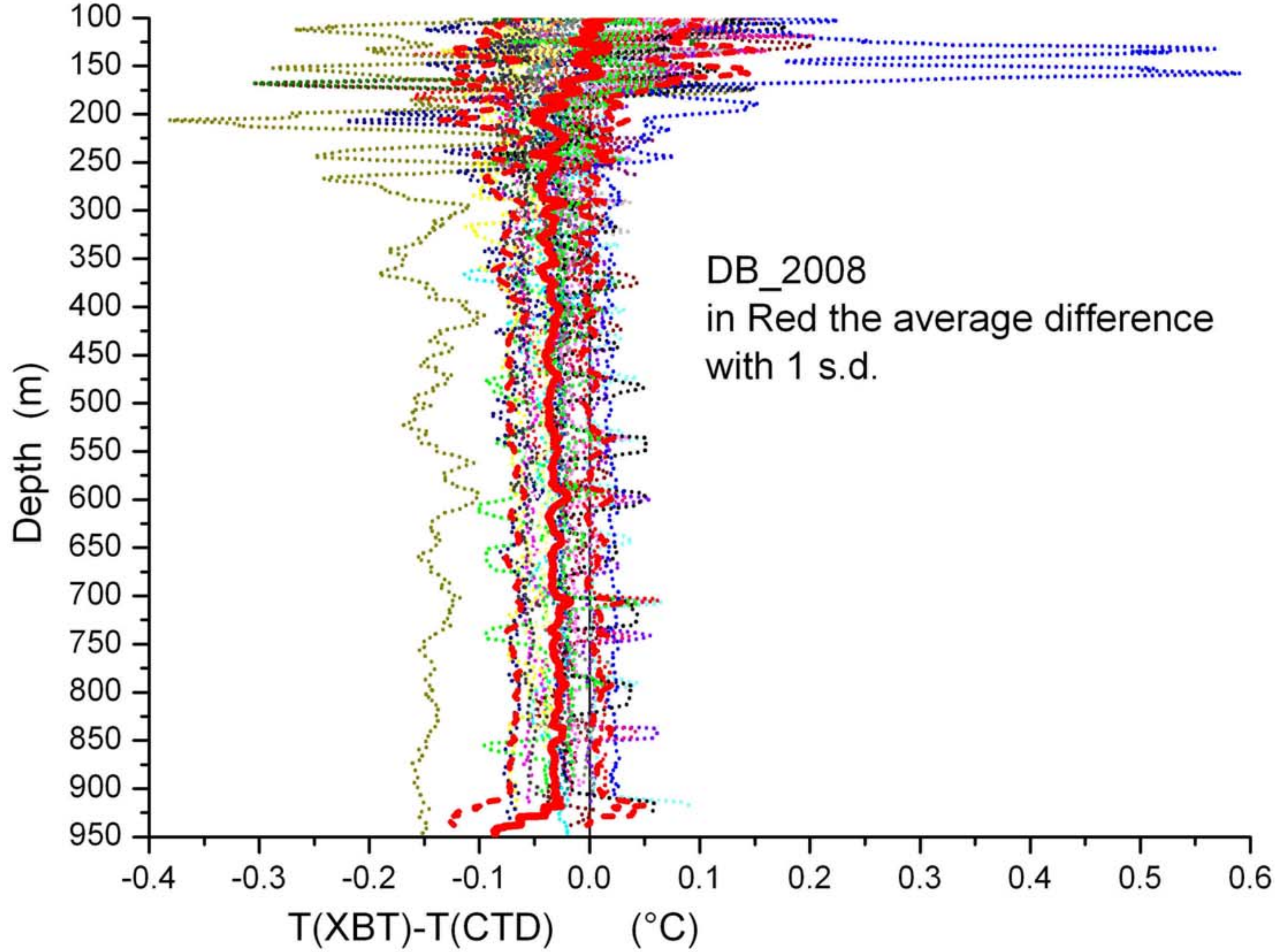
Further details from Nov. 2008 test in Med.Sea

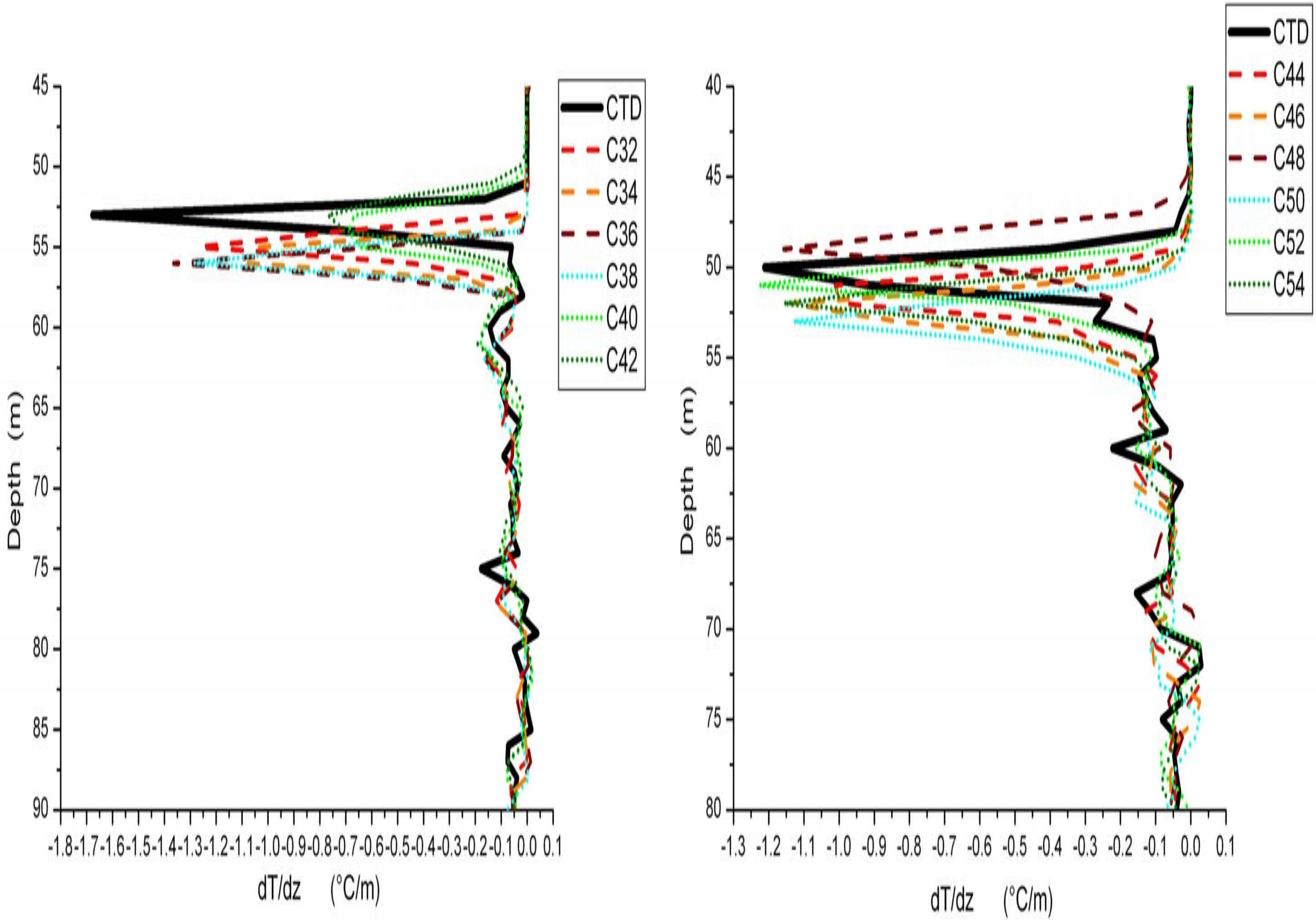






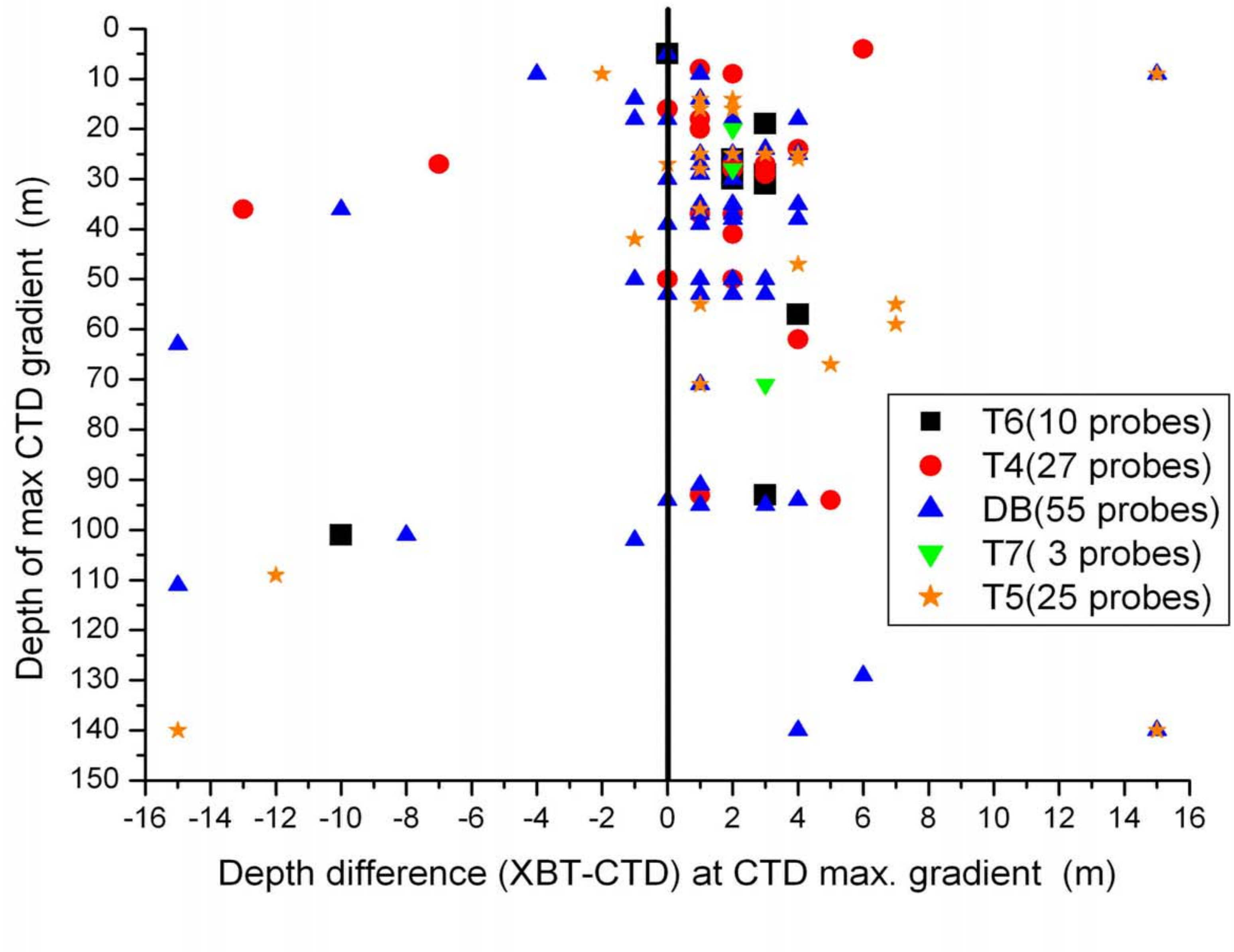
six T4 manufactured 1992 → 1995


100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
Depth (m)
-0.4
-0.3
-0.2
-0.1
0.0
0.1
0.2
0.3
0.4
0.5
0.6
T(XBT)-T(CTD) (°C)
DB_2008
in Red the average difference
with 1 s.d.

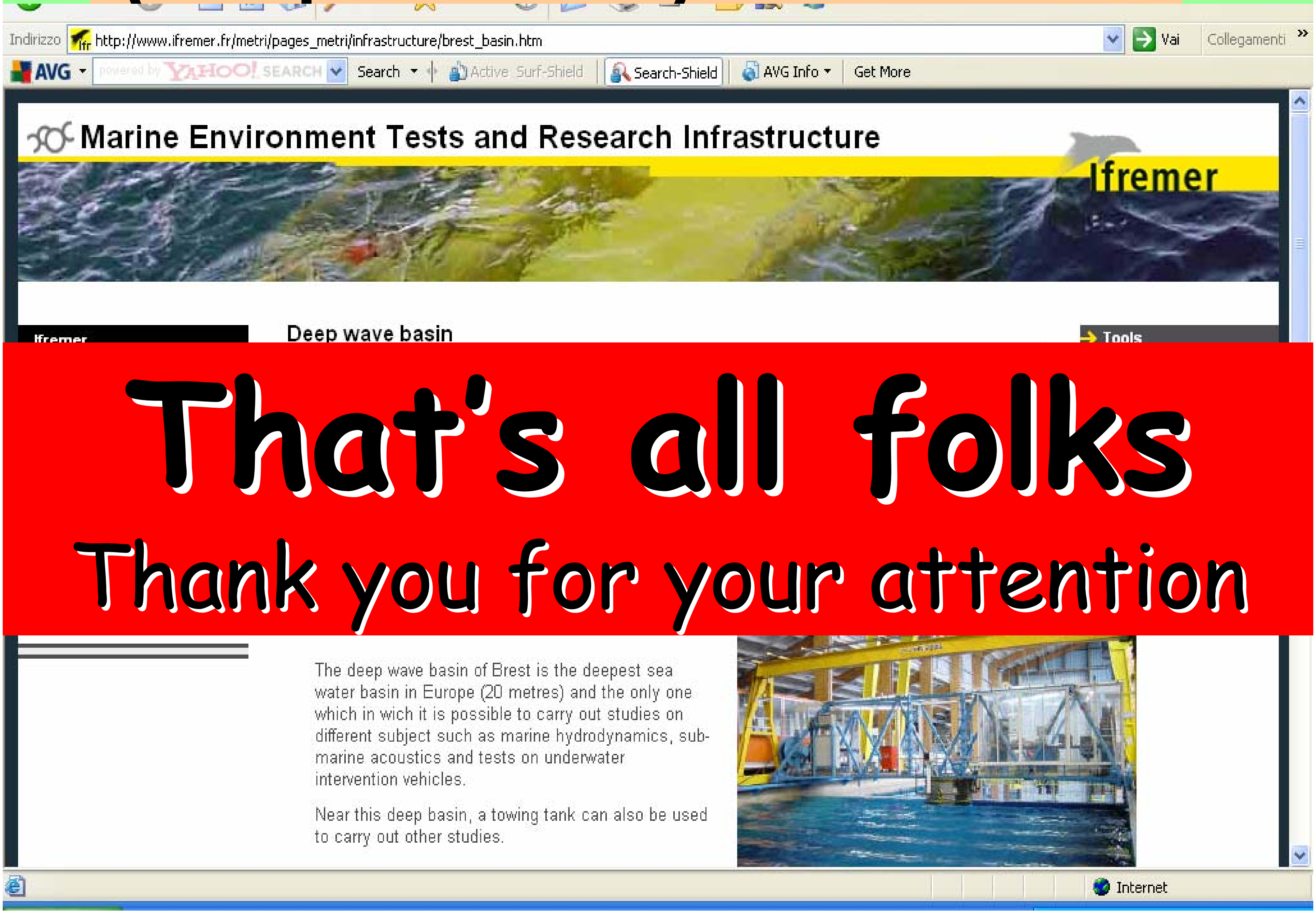


Depth (m)
dT/dz (°C/m)
CTD
C32
C34
C36
C38
C40
C42
-1.8 -1.7 -1.6 -1.5 -1.4 -1.3 -1.2 -1.1 -1.0 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1
45 50 55 60 65 70 75 80 85 90
CTD
C44
C46
C48
C50
C52
C54
-1.3 -1.2 -1.1 -1.0 -0.9 -0.8 -0.7 -0.6 -0.5 -0.4 -0.3 -0.2 -0.1 0.0 0.1
40 45 50 55 60 65 70 75 80

Depth difference vs. CTD $(dT/dz)_{max}$ depth



(Temporaneous) Conclusions



That's all folks

Thank you for your attention