

**The relative and absolute
performance
of 4 dive computers on a
controlled bounce dive (*) to
50 m @ air**

**(*) HBO center Stuttgart
02/08/2020**

**DOI:
10.13140/RG.2.2.34716.44160**

→ Relative Performance:
comparison of the
TTS / stop times (*)
of the 4 computers
relative to each other

→ Absolute Performance:
comparison of depth readings
with HAUX systems
and TTS / stop times with
well-tried air diving tables

(*) TTS = time-to-surface,
i.e.: sum of all stop times + (bottom depth / ascent rate)

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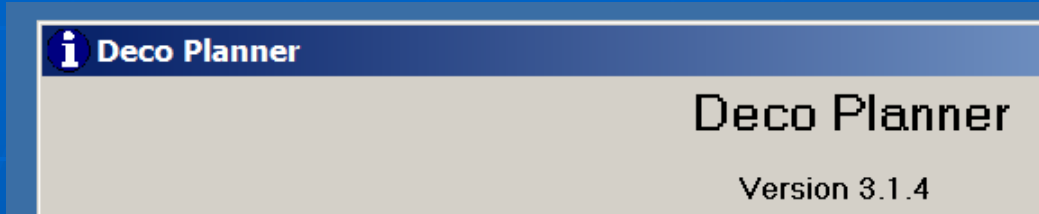


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Question:
do the advertised
conservatism settings
of the G2 & iX3MDeep
match any standard
procedures?
(say, for eg. with regular
Gradient Factors?)

Evaluated with: DecoPlanner 3.1.4



&

DIVE Version 3_07

```
*****
DIVE V 3_07 ist nicht abwaertskompatibel !
*****

DIVE Version 3_07      01/2020 FTN 77
Intel(R) Visual Fortran Intel(R) 64
Compiler Version 17.0.2.187 Build 20170213
copyright: 1991-2020 @ Dipl. Phys. "ALBI" A. Salm,
PADI Master Scuba Diver Trainer #33913
SSI Advanced & Technical Extended Range
Trimix Instructor #12653
& SubMarineConsulting: www.SMC-de.com
Jegliche Haftung, die aus dem Gebrauch oder den Ergebnissen
des Programms resultiert, ist hiermit ausgeschlossen ! ! !
```

older english version there:

https://www.divetable.info/DIVE_V3/V3e/index.htm

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Question:
do the advertised
conservatism settings
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Gradient factors?)

Standard Air Tables (for comparison with square / box profiles):

Question:
do the advertised
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of the G2 & iX3MDeep
match any standard
procedures?
(say, for eg. with regular
Gradient factors?)

- DCIEM Air Diving Tables;
Defence and Civil Institute of Environmental Medicine, c.e. 1992
DCIEM No. 86-R-35, page 1B-16
- Deco 2000; Dr. Max Hahn, c.e. 2000
- US Navy Diving Manual, Revision 3, 0927-LP-001-9010,
15 February 1993, page 9-60
- US Navy Diving Manual, Revision 7, 0910-LP-115-1921,
30 April 2018, page 9-81
- Dräger Austauschabelle #210, Dezember 1984, p. 9
(still used as MDv 450/1 in the german navy, p. A 6-7)

Bounce 50 m / 8' @ air

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The 4 computers:



Bounce 50 m / 8' @ air

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The 4 computers:

from left to right

- Scubapro Aladin TEC 2G
 - Software Version: 40 20 72 73 25
 - Setting: MicroBubble Level L0
- Scubapro Galileo G2
 - HW: 0.0
 - SW: 1.5
 - Setting: MicroBubble Level L1
- Cochran Undersea Technology EMC-20 H
 - Setting: Con = 50 (i.e. maximum conservatism)
- DiveSystem / RATIO iX3M Deep
 - Software: 4.0.70 / 014
 - Setting: PS = 1 (i.e.: GF Hi = 0.9, GF Lo = 0.9)



Bounce 50 m / 8' @ air

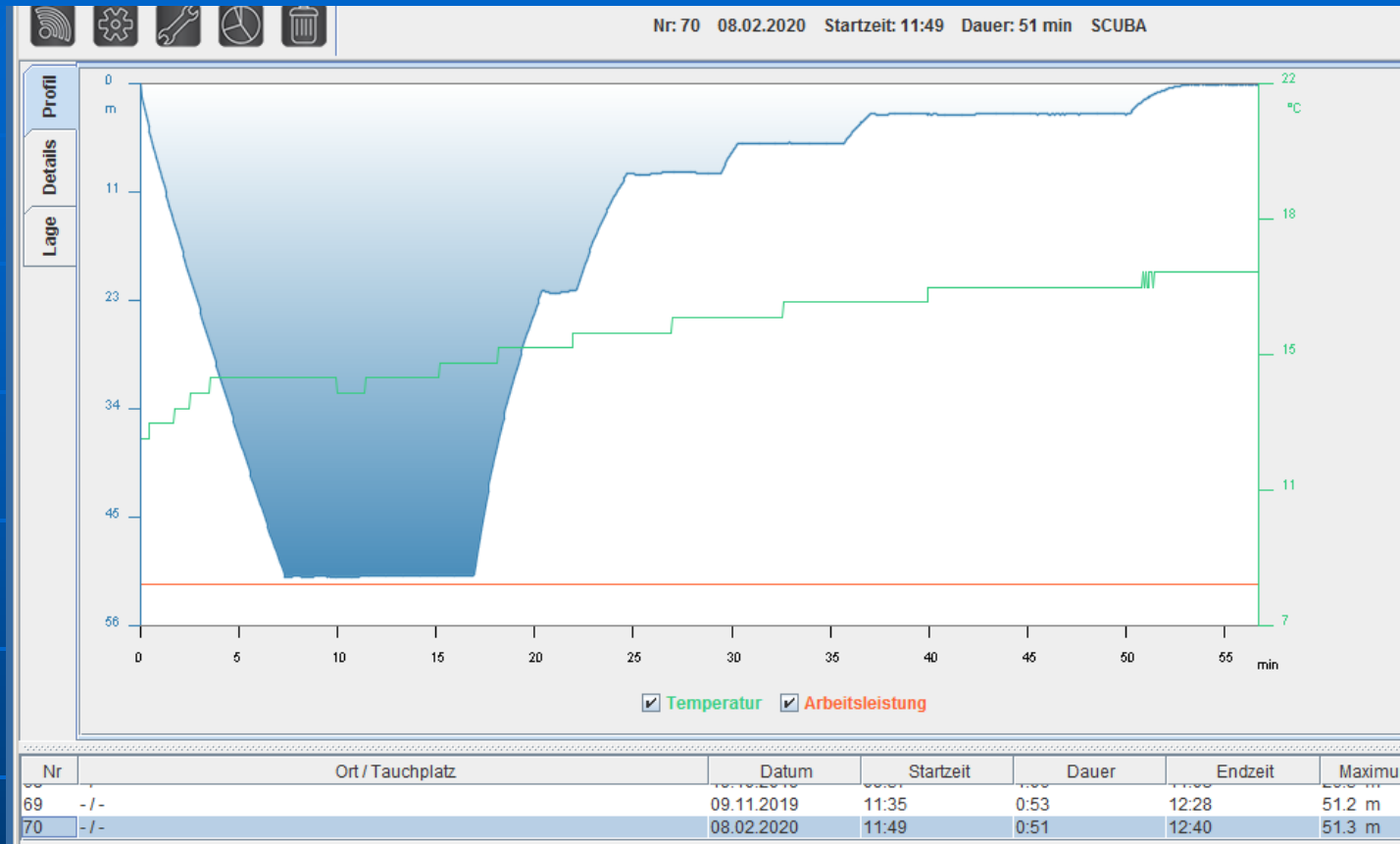
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The profile: G2 in log book mode

Bounce 50 m / 8' @ air

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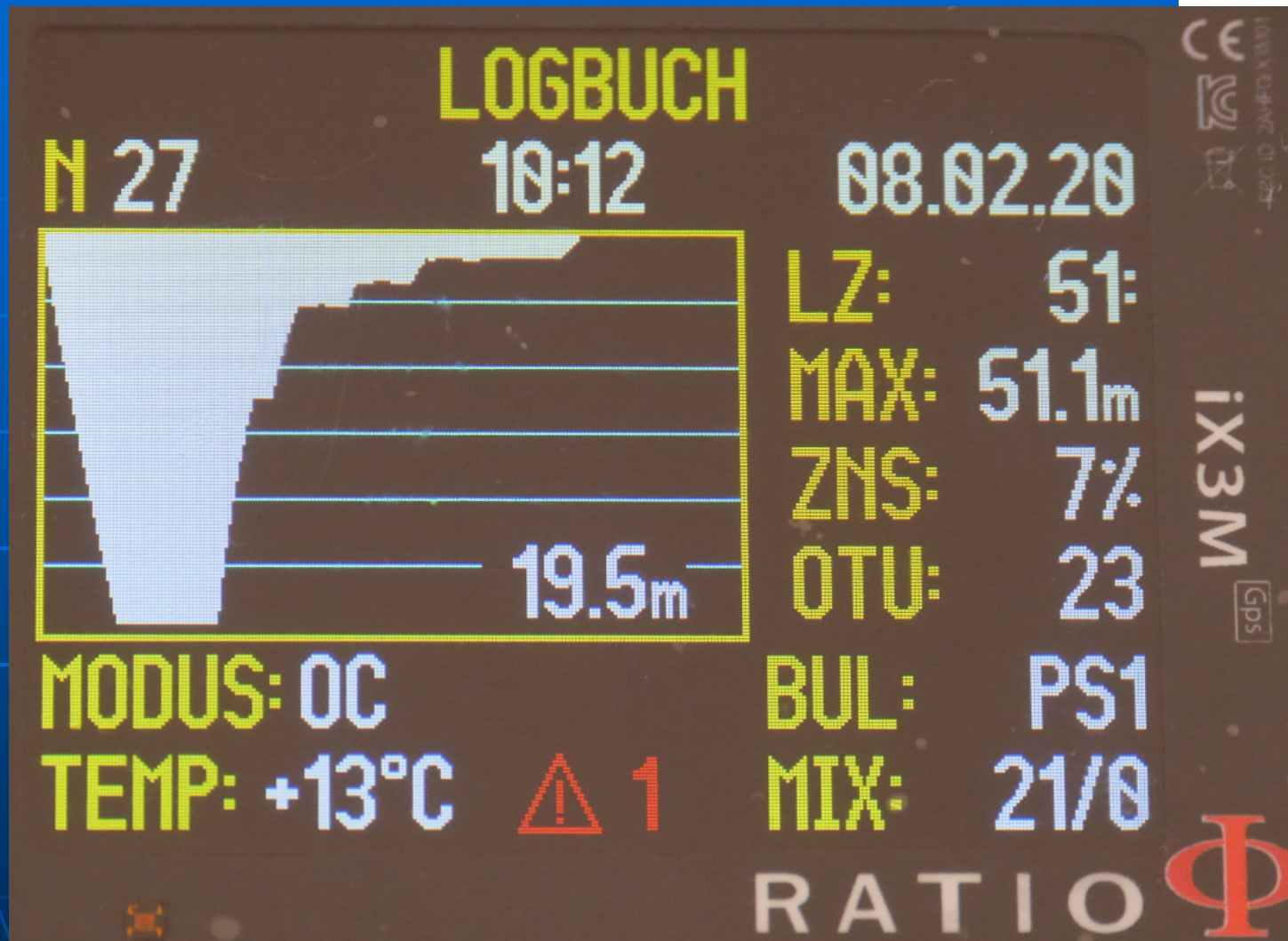


The profile:
G2 with software LogTRAK 1.7.0.1



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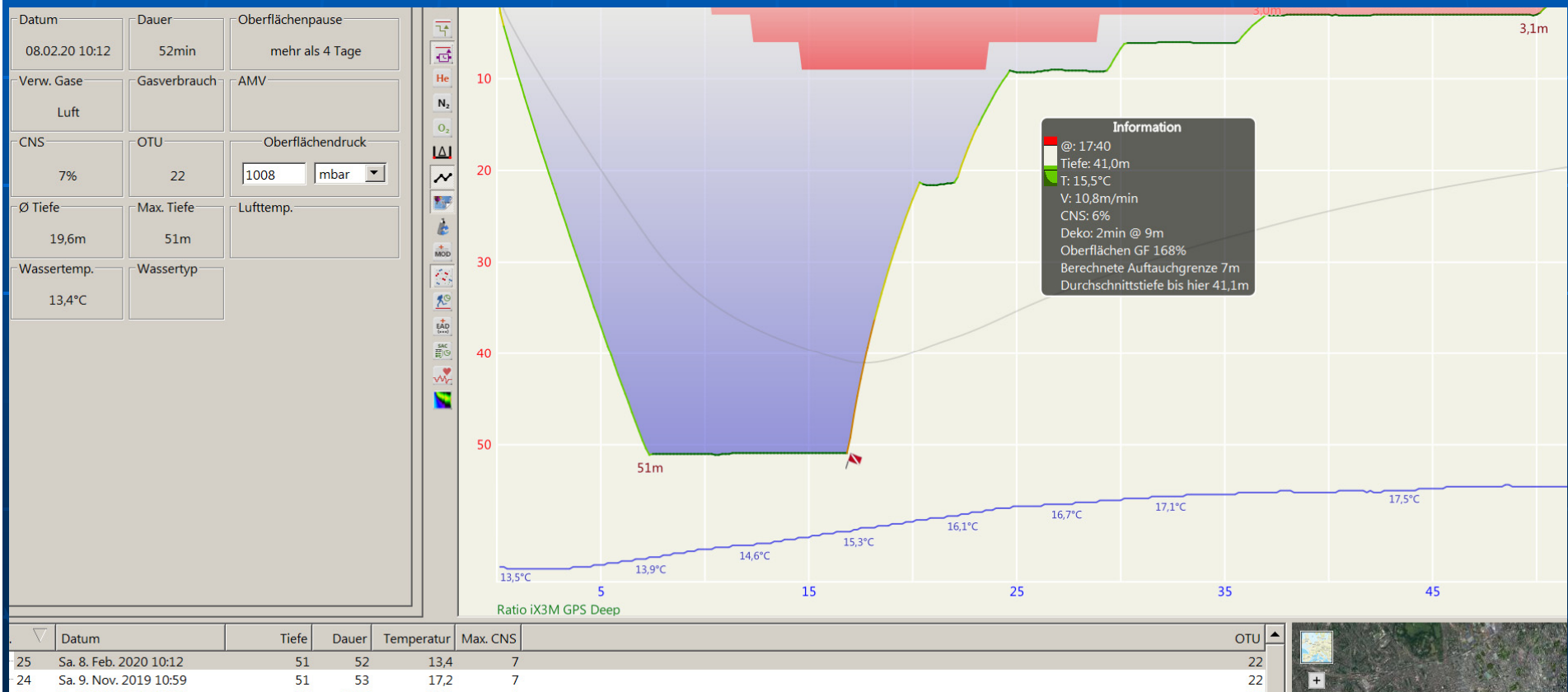
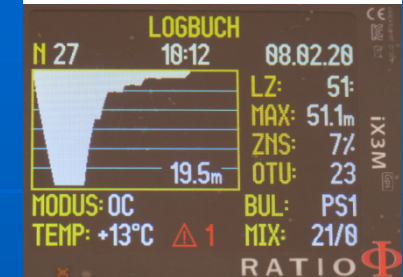
The profile: Ratio iX3M in log book mode

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The profile: iX3M with
software
Subsurface 4.9.3



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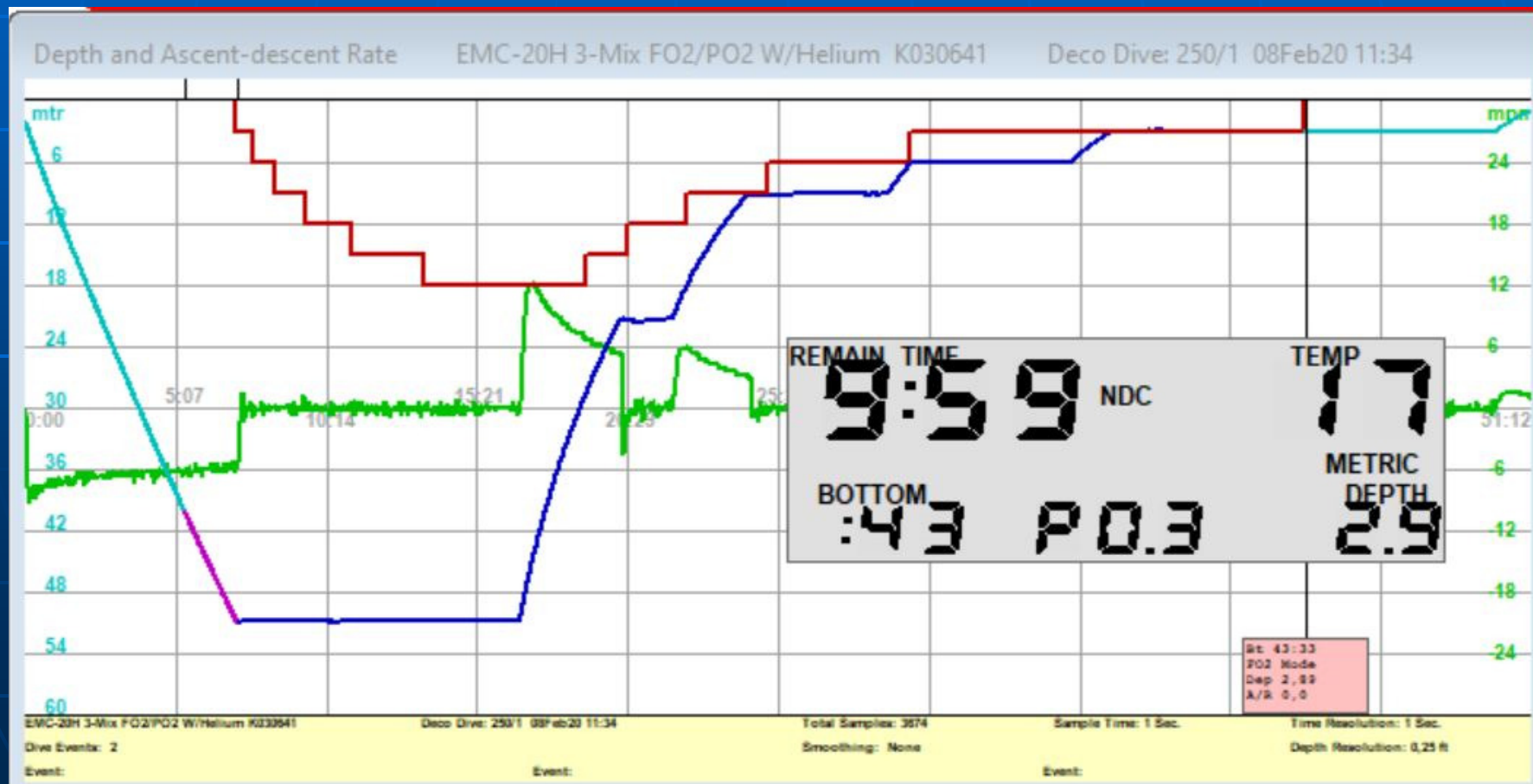
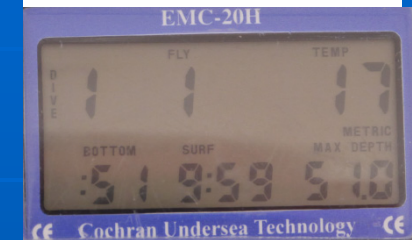


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The profile: EMC-20 H with
Software
Dive Analyst 4.02a pro



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Bounce 50 m / 8' @ air

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The protocol from the deco chamber dive:

Meßprotokoll Druckkammerfahrt vom: 08.02.2020

OFP = ' , Tauchzeit: 50 m / 50 min (= ') mit Luft

Tiefe [m] / Geplante Zeit [min.]	Scubapro Galileo G2 V 1.05 L1 (1)	DiveSystems RATIO iX3M Deep 4.0.70/014 PS 1 (2)	EMC 20 H 50 % (3)	Aladin TEC 2G L0	Benchmark: DIVE V 3_07	Benchmark: DIVE V 3_07
TTS = 34'	Tiefe / TTS	Tiefe / TTS	Tiefe / TTS	TTS	TTS GF 100 / 100	TTS GF 90 / 90
0 → 50 / 6'	51,2 / 8'	50,9 / 3' NDL	50,8 / -	51,2 / 3' NDL		
50 / 8'	51,2 / 15'	50,9 / 15'	51,1 / 11	51,1 / 14'	6 m / 2' 3 m / 6' TTS = 14	6 m / 3' 3 m / 7' TTS = 17
50 → 21 / 4'	21,7	21,3		21,5		
21 / 2'	21,7 / 29'	21,3 / 16'	21,5 / 16'	21,6 / 17'	6 m / 2' 3 m / 6' TTS = 10	6 m / 3' 3 m / 7' TTS = 13
21 → 9 / 3'	9,3	9,2		9,4		
9 / 5'	9,3 / 25'	9,2 / 12'	9,2 / 15'	9,4 / 14'	TTS = 5	TTS = 9
6 / 5'	6,3 / 23'	6,1 / 8'	6,0 / 11'	6,2 / 11'	TTS = 4	TTS = 8
3 / 15'	3,2 / 17' nach ca. 15': L1 → L0	3,0 / 2' NDL ab RT 40'	3,0 / 6' NDL ab RT 44'	3,0 / 10' NDL ab RT 45'	NDL ab RT 34	NDL ab RT 38

Alte DRÄGER Tabelle 51 m / 20': 5 / 5 / 15

NDL = No Decompression Limit

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C:\home\Bilder\Museum\2020\HBO\02\Bounce_50.docx; Stand: 08.02.2020

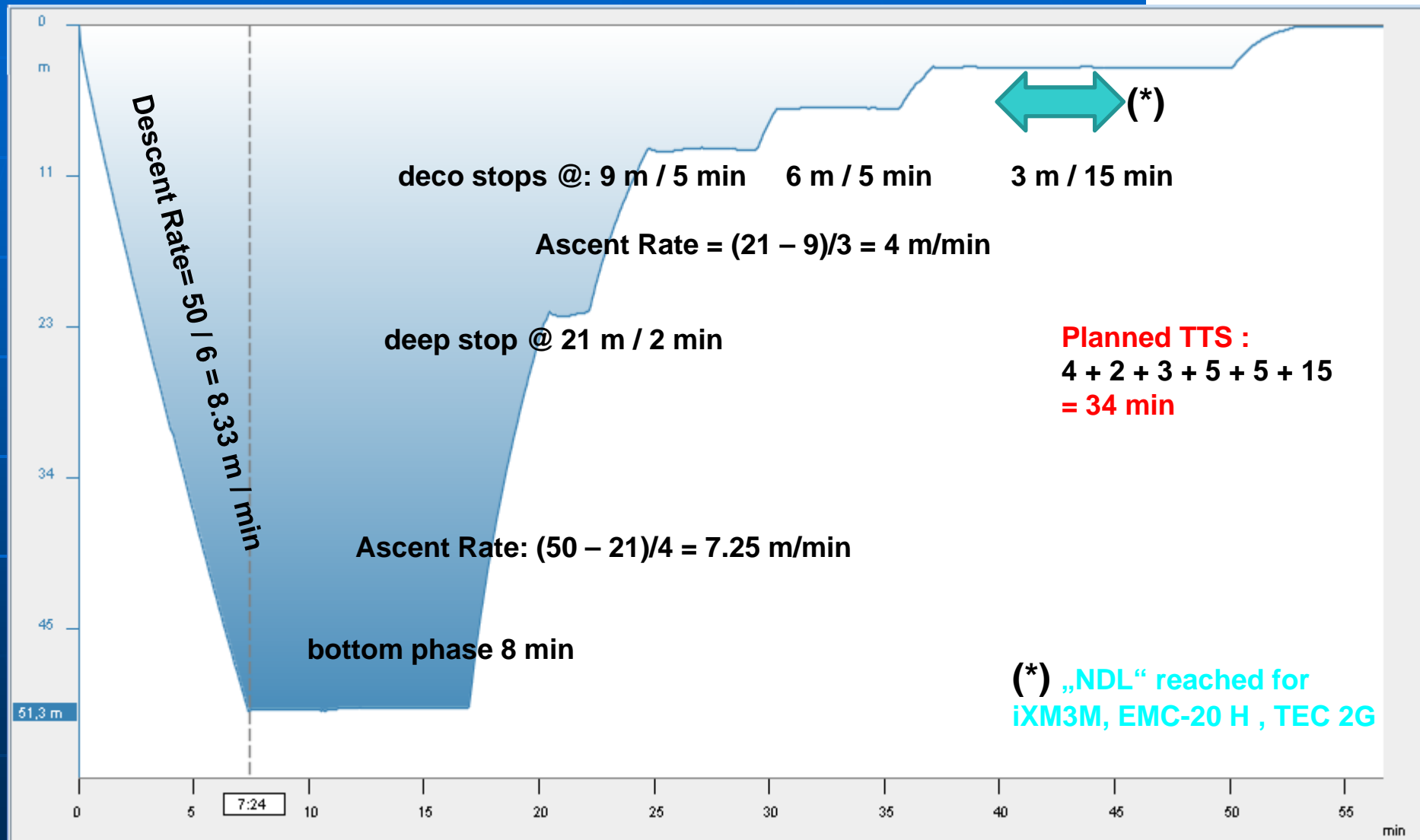
(1): MicroBubble Level L1; (2): PS1 → GF Hi = 0.90/ GF Lo = 0.90

(3): maximal conservatism (=50); RT = run time

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Analysis of the deco chamber profile:



worst case scenario: $6 + 8 + 4 + 2 = 20 \text{ min}$ bottom time for conservative table planning (box profile)

realistic scenario: $6/2 + 8 + 4/2 + 2 = 15 \text{ min}$ bottom time for liberal table planning (box profile)

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Comparison with DP 3 at 50 m:

GF 100/100

50	8	21	0
6	2	21	0
3	7	21	0
0			

GF 0.9 / 0.9

50	8	21	0
6	4	21	0
3	8	21	0
0			

Comparison with DIVE V 3_07 at 50 m:

GF 100/100

```
Deko Prognose:  
6m Stopp Prognose Dekozeit: 2.0 Komp. #: 2  
3m Stopp Prognose Dekozeit: 6.0 Komp. #: 4  
TTS = 14.0
```

GF 0.9 / 0.9

```
Deko Prognose mit Gradientenfaktoren: GFHI= 0.90 GFLO= 0.90  
6m Stopp Prognose Dekozeit: 3.0 GF = 0.90 Komp. #: 2  
3m Stopp Prognose Dekozeit: 7.0 GF = 0.90 Komp. #: 4  
TTS = 17.0
```

The delta t between DP3, DIVE and the G2 stems from a different ascent rate: DP3 can use only **one** full integer, whereas DIVE and the test profile in the HAUX chamber used **2 ascent rates**: 7.25 and 4.0 m/min; G2 uses 6.85 m/min in planning mode.

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Comparison with DP 3 after deep stop 21 m 2 min:

GF 100/100

50	8	21	0	6	14
21	4	21	0	17	21
21	2	21	0	21	20
6	1	21	0	21	23
3	8	21	0	23	31
Dive Time: 32 mins				Deco Time: 10	

GF 0.9 / 0.9

50	8	21	0	6	14
21	4	21	0	17	21
21	2	21	0	21	20
6	3	21	0	23	25
3	10	21	0	25	35
Dive Time: 36 mins				Deco Time: 14	

Comparison with DIVE V 3_07 after deep stop at 21 m / 2 min:

GF 100/100

```

Deko Prognose:
6m Stopp Prognose Dekozeit: 2.0 Komp. #: 3
3m Stopp Prognose Dekozeit: 6.0 Komp. #: 4
TTS = 10.0
    
```

GF 0.9 / 0.9

```

Deko Prognose mit Gradientenfaktoren: GFHI= 0.90 GFLO= 0.90
6m Stopp Prognose Dekozeit: 3.0 GF = 0.90 Komp. #: 3
3m Stopp Prognose Dekozeit: 7.0 GF = 0.90 Komp. #: 5
TTS = 13.0
    
```

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Comparison with other tables / worst case scenario:

Table Name	Parameters	Stoptime @ 12 m [min]	Stoptime @ 9 m [min]	Stoptime @ 6 m [min]	Stoptime @ 3 m [min]	TTS [min]
DRÄGER	51 m 20 min	-	5	5	15	30
DCIEM	51 m 20 min	5	5	8	20	43
Deco 2000	51 m 18 min	2	4	7	14	32
USN old	51,8 m 20 min		-	4	15	25
USN new	170 feet 20 min		3	6	24	38

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Comparison with other tables / realistic scenario:

Table Name	Parameters	Stoptime @ 9 m [min]	Stoptime @ 6 m [min]	Stoptime @ 3 m [min]	TTS [min]
DRÄGER	51 m 15 min	-	5	10	20
DCIEM	51 m 15 min	5	7	10	27
Deco 2000	51 m 14 min	3	4	9	21
USN old	51,8 m 15 min	-	2	5	13
USN new	170 feet 15 min	-	3	13	22

Bounce 50 m / 8' @ air

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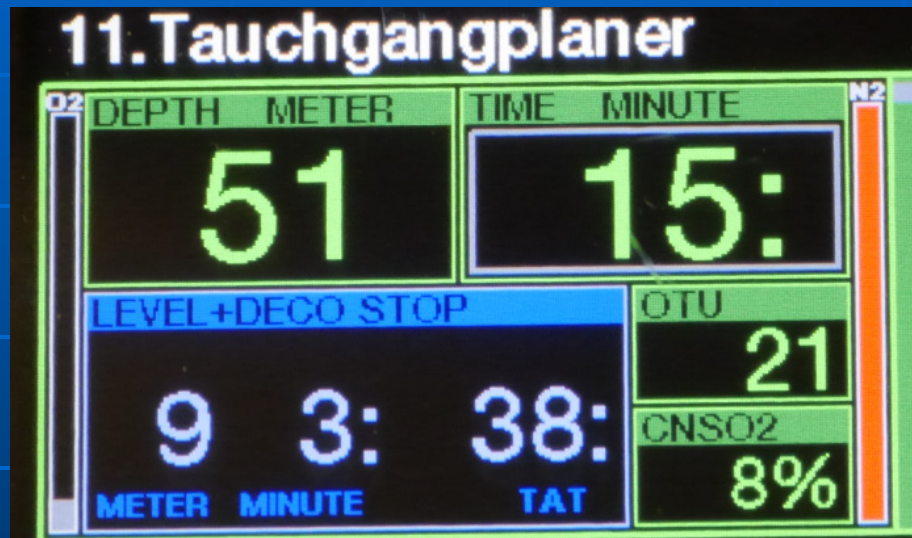
Comparison realistic scenario:

G2 @ L1 planner fits box profile with:

→ Bühlmann Table correction factor

→ GF Hi = GF Lo = 0.85

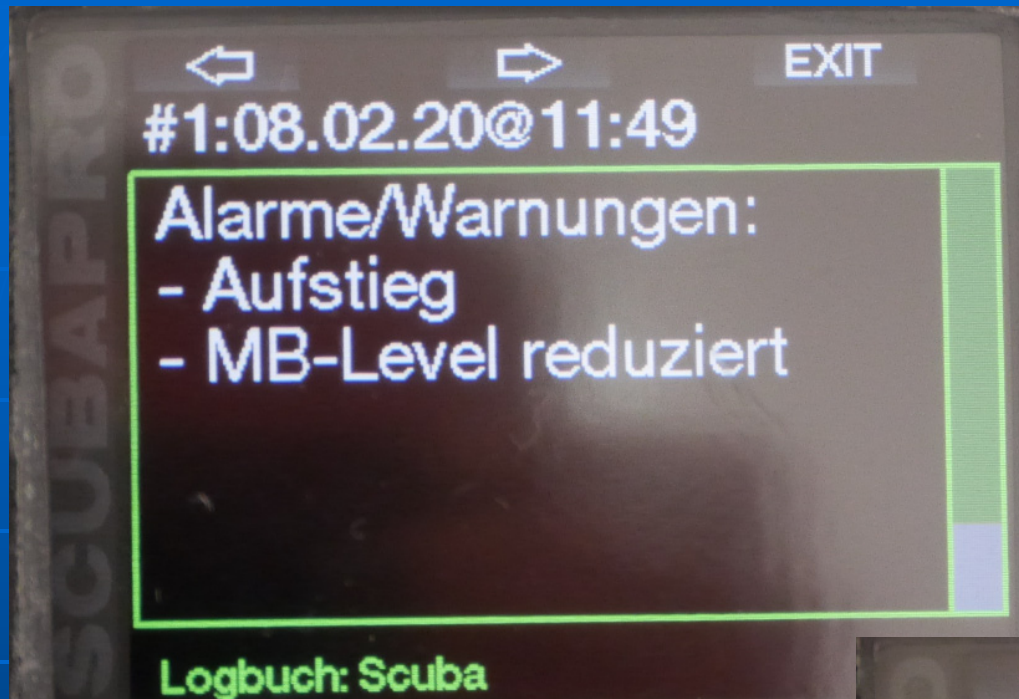
→ and Aladin @ L0; i.e.: GF Hi = GF Lo = 1.0



```
Deko Prognose:
9m Stopp Prognose Dekozeit: 3.0 Komp. #: 2
6m Stopp Prognose Dekozeit: 4.0 Komp. #: 4
3m Stopp Prognose Dekozeit: 13.0 Komp. #: 6
TTS = 27.0
Deko Prognose mit Gradientenfaktoren: GFHI= 0.85 GFLO= 0.85
12m Stopp Prognose Dekozeit: 2.0 GF = 0.85 Komp. #: 2
9m Stopp Prognose Dekozeit: 3.0 GF = 0.85 Komp. #: 3
6m Stopp Prognose Dekozeit: 7.0 GF = 0.85 Komp. #: 4
3m Stopp Prognose Dekozeit: 18.0 GF = 0.85 Komp. #: 6
TTS = 38.0
```

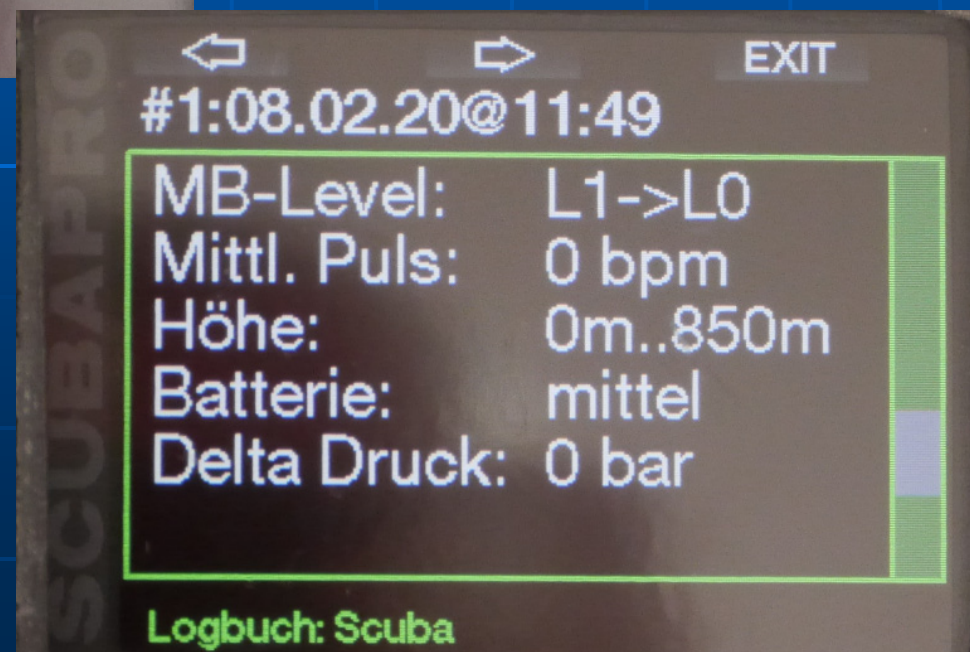
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G2 warnings:

→ Ascent Rate exceeded
→ MicroBubble Level
reduced from L1 to L0
due to the missing 2 min stop
@ 3m
(heart rate monitor
& tank pressure not used)



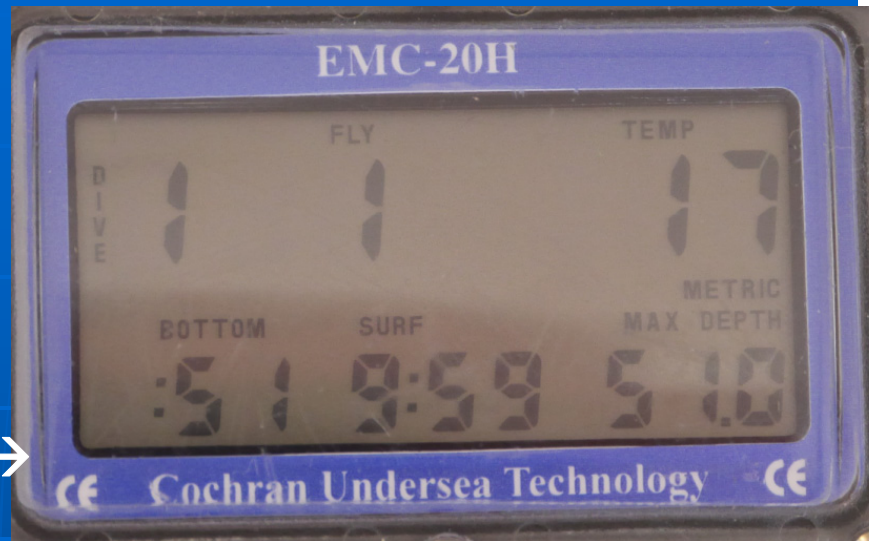
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The others:



EMC-20H Log Book →



Aladin Log Book →



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Synopsis:

- The errors in the depth-reading range from ca. 2.5 to 6 % which is regularly more than the specifications from the dive computers handbooks.
- The EMC-20 H (with Con = 50) matches, just by accident, the Aladin TEC / L0, which is funny, since neither the intended user-groups (pro vs. rec) nor the used deco models (modified USN with 20 compartment vs. modified Bühlmann ZH-L with 8 compartments) match.
- Aladin TEC / L0 matches pretty much the benchmarks with the claimed Gradient Factors = 1.0, i.e.:
100 % ZH-L „x“C with Bühlmann Table correction factor.
- The Ratio iX3M with PS =1 matches pretty much a standard conservatism with the claimed Gradient Factors of 0.9 for a ZH-L16 C
- The G2 with L1 matches pretty much with a standard GF for ZH-L 16C of GF Hi = 0.85 & GF Lo = 0.85, but only in the „Dive Planner“ mode for a square / box-profile.

Bounce 50 m / 8' @ air

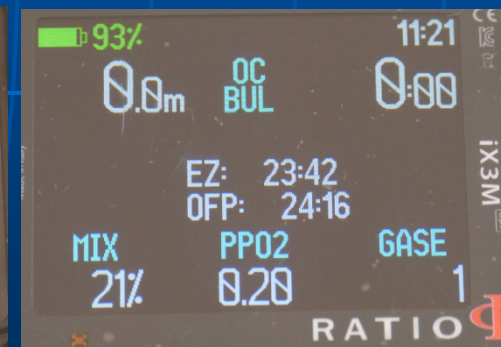
Synopsis, G2 continued:

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→ During diving it doesn't match at all:
there is an added conservatism through a hidden / unpublished
parameter / procedure, which presents itself to the diver
during ascent as an unsymmetrical de-saturation, i.e. prolonged stop times.

This may not stem from the heart rate nor the air consumption
or temperature adaptations in the modified ZH-L implementation,
since these features have not been used during the test dive.
But the de-sat times during surface interval match again then with other
computers:

SI ca. 24 h



This asymmetry in de-saturation reveals itself only if MB Level > 0, i.e.:
L1 or higher. With L0 this asymmetry is not seen (page 4):
https://www.divetable.info/skripte/HBO_Stgt_250519.pdf