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A „deep stop“ table for recreational dives on air: Debunked!

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Depth (m)	BT (min)	Deep and all other Stops (metres/minutes). Rise-times (min).					Exit RG
9	135	-	-	-	-	3/2 3.0	G
12	125	-	-	-	-	6/2 3.0	G
15	77	-	-	-	9/1 2.0	6/1 3.0	G
	85	-	-	-	9/1 2.0	6/5 7.0	G
	90	-	-	-	9/1 2.0	6/8 10.0	G
18	52	-	-	12/1 2.0	9/1 3.0	6/1 4.0	F
	65	-	-	12/1 2.0	9/1 3.0	6/10 13.0	G
	70	-	-	12/1 2.0	9/1 3.0	6/14 17.0	G
21	35	-	-	12/1 2.0	9/1 3.0	6/1 5.0	F
	50	-	-	12/1 2.0	9/1 3.0	6/11 15.0	G
	55	-	-	12/1 2.0	9/1 3.0	6/16 20.0	G
24	27	-	-	12/1 2.0	9/1 4.0	6/1 5.0	E
	35	-	-	12/1 2.0	9/1 4.0	6/6 10.0	F
	40	-	-	12/1 2.0	9/1 4.0	6/10 14.0	F
	45	-	-	12/1 2.0	9/1 4.0	6/17 21.0	G
27	22	-	-	15/1 2.0	9/1 4.0	6/2 6.0	E
	30	-	-	15/1 2.0	9/1 4.0	6/8 12.0	F
	35	-	-	15/1 2.0	9/1 4.0	6/13 17.0	F
	40	-	-	15/1	9/1	6/21	G

Depth (m)	BT (min)	Deep and all other Stops (metres/minutes). Rise-times (min).					Exit RG
33	15	-	18/1 3.0	12/1 4.0	9/1 6.0	6/1 7.0	E
	20	-	18/1 3.0	12/1 4.0	9/1 6.0	6/6 12.0	F
	25	-	18/1 3.0	12/1 4.0	9/1 6.0	6/11 17.0	F
	30	-	18/1 3.0	12/1 4.0	9/1 6.0	6/21 27.0	G
36	12	-	18/1 3.0	12/1 5.0	9/1 6.0	6/1 7.0	D
	15	-	18/1 3.0	12/1 5.0	9/1 6.0	6/3 9.0	E
	20	-	18/1 3.0	12/1 5.0	9/1 6.0	6/9 15.0	F
	25	-	18/1 3.0	12/1 5.0	9/1 6.0	6/17 23.0	G
39	11	-	21/1 3.0	12/1 5.0	9/1 6.0	6/1 7.0	D
	15	-	21/1 3.0	12/1 5.0	9/1 6.0	6/6 12.0	E
	20	-	21/1 3.0	12/1 5.0	9/1 6.0	6/13 19.0	F
	25	-	21/1 3.0	15/1 5.0	9/1 6.0	6/25 31.0	G
42	9	-	21/1 3.0	12/1 5.0	9/1 6.0	6/1 8.0	D
	15	-	21/1 3.0	12/1 5.0	9/1 6.0	6/9 16.0	F
	20	-	21/1 3.0	12/1 5.0	9/1 6.0	6/17 24.0	F
45	8	-	24/1 3.0	15/1 5.0	9/1 7.0	6/1 8.0	D
	15	-	24/1 3.0	15/1 5.0	9/1 7.0	6/11 18.0	F
	20	24/1 3.0	15/1 5.0	12/1 6.0	9/1 7.0	6/23 31.0	G
48	7	-	24/1 4.0	15/1 5.0	9/1 7.0	6/1 8.0	D
	10	-	24/1 4.0	15/1 5.0	9/1 7.0	6/5 12.0	E
			27/1	18/1	12/1	9/1	6/14

excerpt from the air-table in question

However:

a graphical analysis of the air-table (pls. cf. slide #2) reveals the following pattern for this particular deep stops:

Bottom depths 18, 21 & 24 m:
deep stops @ half bottom depth of 24 (24/2 = 12 m) + 1 min stop at 9 m

Bottom depths: 27 & 30 m: deep stop @ 30/2 = 15 m + 1 min stop at 9 m

Bottom depths: 33 & 36 m: deep stop @ 36/2 = 18 m + stops at 12 & 9 m

Bottom depths: 39 & 42 m: deep stop @ 42/2 = 21 m + stops at 12 & 9 m

Bottom depths: 45 & 48 m: deep stop @ 48/2 = 24 m + stops at 15 & 9 m

This follows basically the empirical rule from DAN:
1 min @ bottom depth / 2

i.e.: *not controlled via an algorithm*

However:

the shallow stops (@ 6 & 9 m) are simply extracted from an *unmodified Bühlmann ZH-L 16 C* with the following boundary conditions:

- → **ascent rate = 10 m / min**
- → **last stop depth = 6 m**
- → **Bühlmann correction / safety factor used, i.e.:**
- → **bottom depth * 1.03 + 1.00 m**

As an example we take bottom depth 42 m, bottom time 20 min. This yields (pls. cf. slide #2):

- → **42/2 = 21 m / 1 min, 12 m / 1 min, 9 m / 1 min, 6 m / 17 min**

9 m / 1 min & 6 m / 17 min is the *standard ZH-L16C* with the above boundary conditions:

```
 Deko Prognose:
 9m Stopp Prognose Dekozeit:      1.0   Komp.#:   2
 6m Stopp Prognose Dekozeit:     17.0   Komp.#:   6
TTS =      22.0
```

Further claims from the authors:

stemming their growth. Furthermore, the nitrogen tension, or decompression stress, on the first four to five tissue compartment is reduced compared with Bühlmann's standard ZHL 16B Tables and the leading tissue compartments move marginally to the right, away from the central nervous system (CNS) region.

and:

Finally, through the guidance of CMAS they have received supplementary micro-bubble control

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However;

an in-depth analysis of the calculated N_2 compartment pressures reveals the following from the above example:

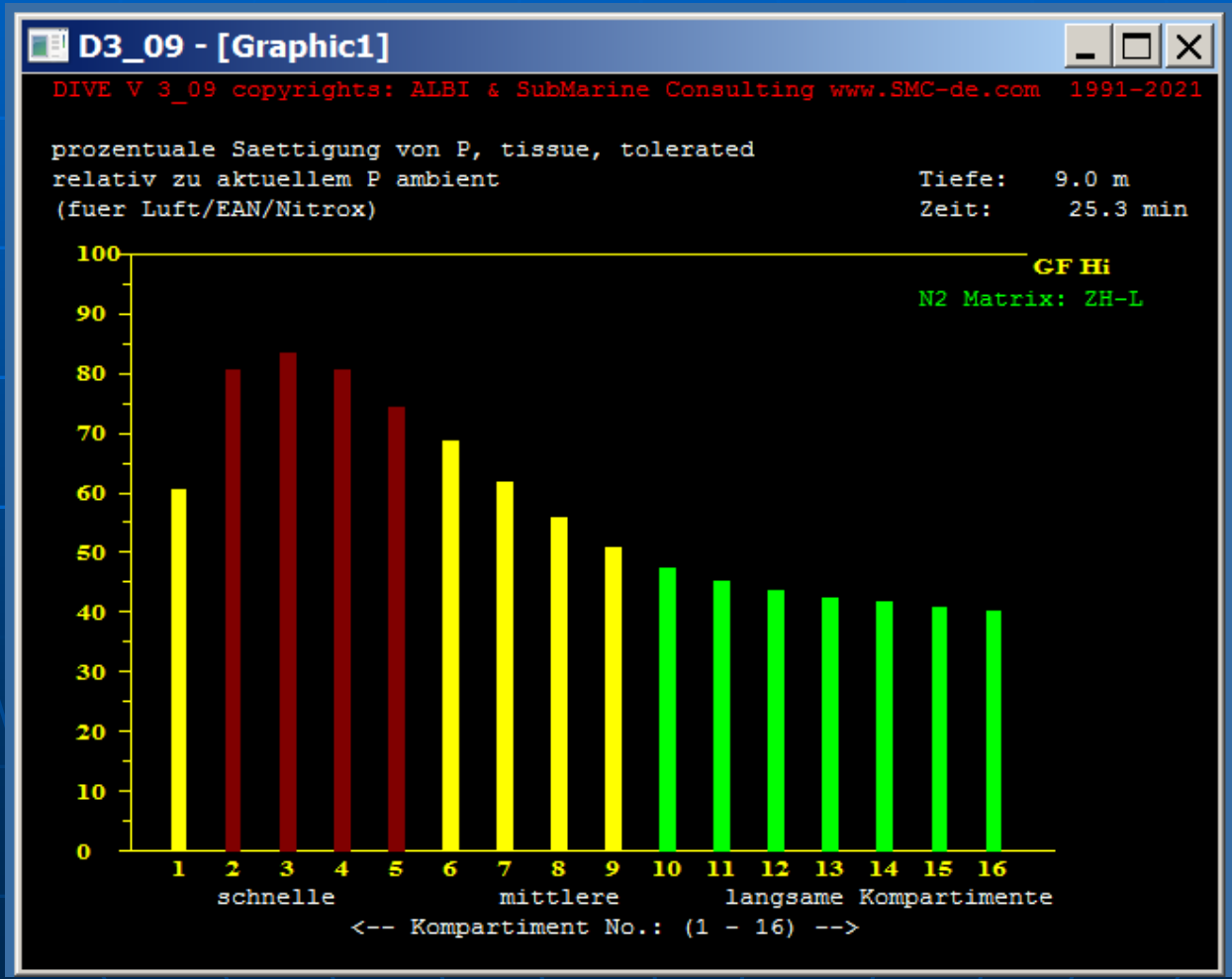
@9 m, after the stops at 21 m & 12 m, i.e.: run time 25.3:

```
Tiefe:    9.00    Zeit:       0.3 max. Tiefe=  42.00 ges. Tauchzeit=     25.3
  berechnete Kompartimentwerte mit N2 Matrix: ZH-L      He Matrix: ZH-L
 Nr.:  1 3.0262 P N2 0.0000 P HE Sum.=  3.0262 Ceil. m=  0.00 Putol:  0.892
 Nr.:  2 3.1499 P N2 0.0000 P HE Sum.=  3.1499 Ceil. m=  3.96 Putol:  1.400
 Nr.:  3 2.9046 P N2 0.0000 P HE Sum.=  2.9046 Ceil. m=  4.72 Putol:  1.475
 Nr.:  4 2.5586 P N2 0.0000 P HE Sum.=  2.5586 Ceil. m=  4.06 Putol:  1.410
 Nr.:  5 2.1958 P N2 0.0000 P HE Sum.=  2.1958 Ceil. m=  2.73 Putol:  1.281
 Nr.:  6 1.8850 P N2 0.0000 P HE Sum.=  1.8850 Ceil. m=  1.55 Putol:  1.165
 Nr.:  7 1.6211 P N2 0.0000 P HE Sum.=  1.6211 Ceil. m=  0.13 Putol:  1.026
 Nr.:  8 1.4090 P N2 0.0000 P HE Sum.=  1.4090 Ceil. m=  0.00 Putol:  0.899
 Nr.:  9 1.2460 P N2 0.0000 P HE Sum.=  1.2460 Ceil. m=  0.00 Putol:  0.792
 Nr.: 10 1.1404 P N2 0.0000 P HE Sum.=  1.1404 Ceil. m=  0.00 Putol:  0.729
 Nr.: 11 1.0697 P N2 0.0000 P HE Sum.=  1.0697 Ceil. m=  0.00 Putol:  0.690
 Nr.: 12 1.0134 P N2 0.0000 P HE Sum.=  1.0134 Ceil. m=  0.00 Putol:  0.665
 Nr.: 13 0.9687 P N2 0.0000 P HE Sum.=  0.9687 Ceil. m=  0.00 Putol:  0.649
 Nr.: 14 0.9329 P N2 0.0000 P HE Sum.=  0.9329 Ceil. m=  0.00 Putol:  0.641
 Nr.: 15 0.9047 P N2 0.0000 P HE Sum.=  0.9047 Ceil. m=  0.00 Putol:  0.631
 Nr.: 16 0.8825 P N2 0.0000 P HE Sum.=  0.8825 Ceil. m=  0.00 Putol:  0.627
```

However;

an in-depth analysis of the calculated N_2 compartment pressures reveals the following from the above example:

@9 m, after the stops at 21 m & 12 m, i.e.: run time 25.3:



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However;

an in-depth analysis of the calculated N_2 compartment pressures reveals the following from the above example:

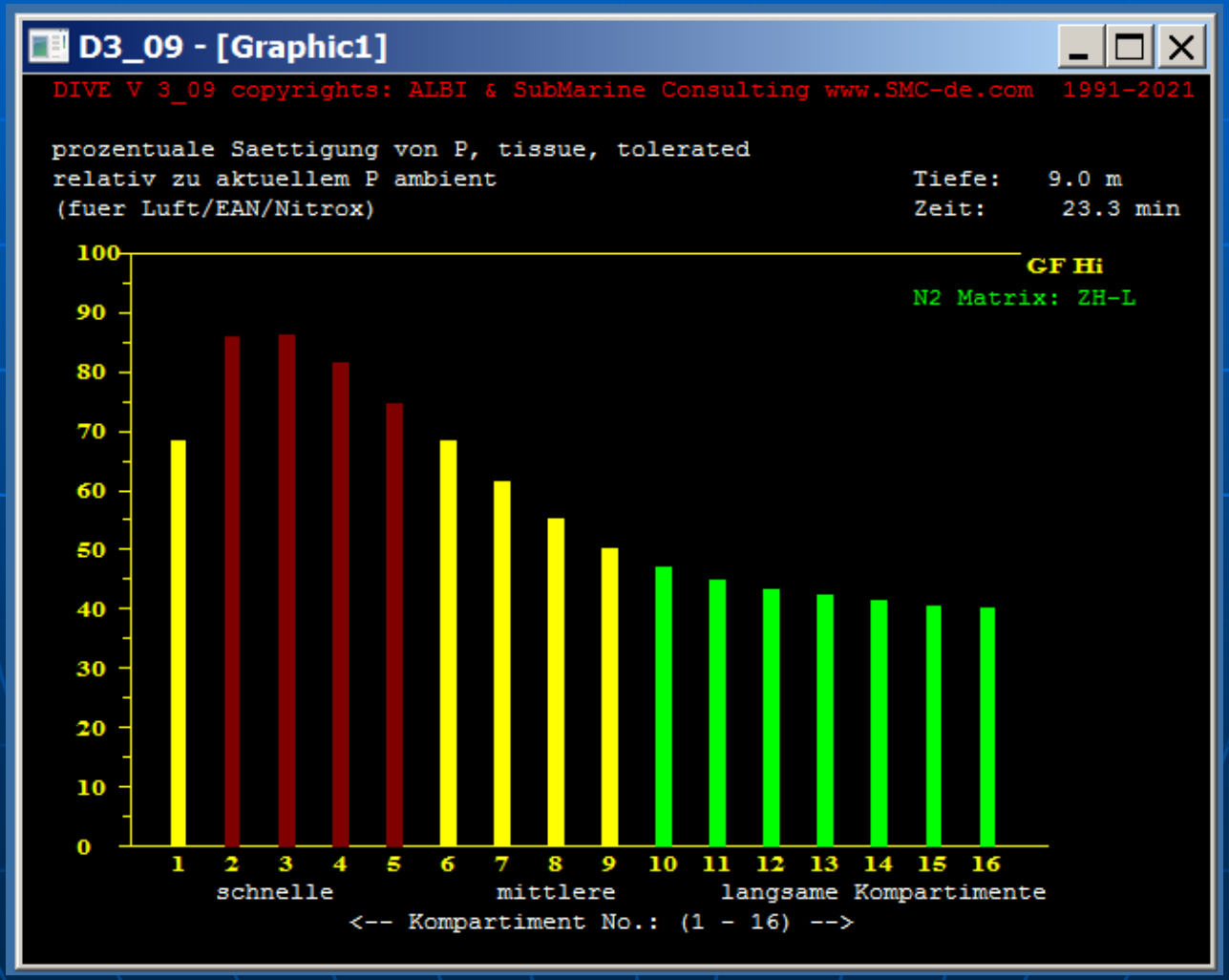
@9 m, prior to first regular stop, i.e. run time 23.3:

```
Eingabe der Austauchstufe in Metern & cm:(m.cm): 9.
 Austauchstufe:  9.00  Aufstiegszeit:      3.3  P insp N2:  3.998  P insp He:  0.000
 Nr.:  1 3.4293 P N2 0.0000 P HE Sum.=  3.4293 Ceil. m=  0.84   Putol:  1.096
 Nr.:  2 3.3494 P N2 0.0000 P HE Sum.=  3.3494 Ceil. m=  5.29   Putol:  1.530
 Nr.:  3 2.9976 P N2 0.0000 P HE Sum.=  2.9976 Ceil. m=  5.41   Putol:  1.542
 Nr.:  4 2.5926 P N2 0.0000 P HE Sum.=  2.5926 Ceil. m=  4.33   Putol:  1.437
 Nr.:  5 2.1994 P N2 0.0000 P HE Sum.=  2.1994 Ceil. m=  2.76   Putol:  1.283
 Nr.:  6 1.8759 P N2 0.0000 P HE Sum.=  1.8759 Ceil. m=  1.47   Putol:  1.157
 Nr.:  7 1.6078 P N2 0.0000 P HE Sum.=  1.6078 Ceil. m=  0.01   Putol:  1.014
 Nr.:  8 1.3958 P N2 0.0000 P HE Sum.=  1.3958 Ceil. m=  0.00   Putol:  0.887
 Nr.:  9 1.2346 P N2 0.0000 P HE Sum.=  1.2346 Ceil. m=  0.00   Putol:  0.782
 Nr.: 10 1.1309 P N2 0.0000 P HE Sum.=  1.1309 Ceil. m=  0.00   Putol:  0.720
 Nr.: 11 1.0617 P N2 0.0000 P HE Sum.=  1.0617 Ceil. m=  0.00   Putol:  0.682
 Nr.: 12 1.0068 P N2 0.0000 P HE Sum.=  1.0068 Ceil. m=  0.00   Putol:  0.659
 Nr.: 13 0.9634 P N2 0.0000 P HE Sum.=  0.9634 Ceil. m=  0.00   Putol:  0.644
 Nr.: 14 0.9286 P N2 0.0000 P HE Sum.=  0.9286 Ceil. m=  0.00   Putol:  0.637
 Nr.: 15 0.9013 P N2 0.0000 P HE Sum.=  0.9013 Ceil. m=  0.00   Putol:  0.627
 Nr.: 16 0.8798 P N2 0.0000 P HE Sum.=  0.8798 Ceil. m=  0.00   Putol:  0.625
 Deko Prognose:
 6m Stopp Prognose Dekozeit:    17.0  Komp.#:  6
TTS =     17.0
```

However;

an in-depth analysis of the calculated N_2 compartment pressures reveals the following from the above example:

@9 m, prior to first regular stop, i.e. run time 23.3:



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Final example:

As a final example we take
bottom depth 24 m, bottom time 40 min.
This yields (pls. cf. slide #2):

→ 24/2 = 12 m / 1 min, 9 m / 1 min, 6 m / 10 min

6 m / 10 min is the ***standard ZH-L16C*** with the above boundary conditions (from slide # 4):

```
 Deko Prognose:
 6m Stopp Prognose Dekozeit:    10.0  Komp.#:  6
TTS =     12.0
```

The next 2 slides feature the pN_2 analysis and the heatmaps
with the deep stops @ 12 & 9 m (LHS)
and without these stops (RHS),
prior to the first regular stop @ 6 m,
i.e. after the run-times of ***43.8 resp. 41.8*** min:

Final example,
bottom depth 24 m, bottom time 40 min.
analysis of calculated pN_2 per compartment

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LHS: with deep stops, run time 43.8 min

```
Luftdruck:  1.013 AMV: 25.0 RQ:  1.000 O2:   0.210 He:   0.000 N2:   0.790
 CNS:     7.0 OTU:    19.2 AR =  10.00 VO2 =  0.25 Latency: N   K_A =   1.0
 NUM FLAG: OFF   Wassertemp.:   20.00  Wasserdichte:  998.203   PRT=  29.7
Korrektur: Y GFHI=   1.00 GFLO=   1.00 LAST STOP=  6.0 m First Stop =  3.0 m
Tiefe:   6.00    Zeit:      0.3 max. Tiefe=  24.00 ges. Tauchzeit=     43.8
  berechnete Kompartimentwerte mit N2 Matrix: ZH-L      He Matrix: ZH-L
 Nr.:  1 2.2504 P N2 0.0000 P HE Sum.=  2.2504 Ceil. m=  0.00 Putol:  0.500
 Nr.:  2 2.4194 P N2 0.0000 P HE Sum.=  2.4194 Ceil. m=  0.00 Putol:  0.925
 Nr.:  3 2.3831 P N2 0.0000 P HE Sum.=  2.3831 Ceil. m=  0.88 Putol:  1.099
 Nr.:  4 2.2350 P N2 0.0000 P HE Sum.=  2.2350 Ceil. m=  1.47 Putol:  1.157
 Nr.:  5 2.0197 P N2 0.0000 P HE Sum.=  2.0197 Ceil. m=  1.27 Putol:  1.137
 Nr.:  6 1.7977 P N2 0.0000 P HE Sum.=  1.7977 Ceil. m=  0.80 Putol:  1.091
 Nr.:  7 1.5852 P N2 0.0000 P HE Sum.=  1.5852 Ceil. m=  0.00 Putol:  0.995
 Nr.:  8 1.3998 P N2 0.0000 P HE Sum.=  1.3998 Ceil. m=  0.00 Putol:  0.891
 Nr.:  9 1.2488 P N2 0.0000 P HE Sum.=  1.2488 Ceil. m=  0.00 Putol:  0.794
 Nr.: 10 1.1472 P N2 0.0000 P HE Sum.=  1.1472 Ceil. m=  0.00 Putol:  0.735
 Nr.: 11 1.0775 P N2 0.0000 P HE Sum.=  1.0775 Ceil. m=  0.00 Putol:  0.697
 Nr.: 12 1.0211 P N2 0.0000 P HE Sum.=  1.0211 Ceil. m=  0.00 Putol:  0.672
 Nr.: 13 0.9758 P N2 0.0000 P HE Sum.=  0.9758 Ceil. m=  0.00 Putol:  0.656
 Nr.: 14 0.9390 P N2 0.0000 P HE Sum.=  0.9390 Ceil. m=  0.00 Putol:  0.647
 Nr.: 15 0.9099 P N2 0.0000 P HE Sum.=  0.9099 Ceil. m=  0.00 Putol:  0.636
 Nr.: 16 0.8868 P N2 0.0000 P HE Sum.=  0.8868 Ceil. m=  0.00 Putol:  0.631
 was jetzt?a
maximale Ceiling:  1.47
Eingabe der Austauchstufe in Metern & cm:(m.cm):
         Austauchstufe ist zu hoch:
         niedriger wie Ceiling waehlen!
 Deko Prognose:
 6m Stopp Prognose Dekozeit:     7.0  Komp.#:  6
TTS =      7.0
```

RHS: ZH-L16 C, run time 41.8 min

```
Luftdruck:  1.013 AMV: 25.0 RQ:  1.000 O2:   0.210 He:   0.000 N2:   0.790
 CNS:     7.0 OTU:    19.2 AR =  10.00 VO2 =  0.25 Latency: N   K_A =   1.0
 NUM FLAG: OFF   Wassertemp.:   20.00  Wasserdichte:  998.203   PRT=  23.4
Korrektur: Y GFHI=   1.00 GFLO=   1.00 LAST STOP=  6.0 m First Stop =  3.0 m
Tiefe:   6.00    Zeit:      1.8 max. Tiefe=  24.00 ges. Tauchzeit=     41.8
  berechnete Kompartimentwerte mit N2 Matrix: ZH-L      He Matrix: ZH-L
 Nr.:  1 2.5063 P N2 0.0000 P HE Sum.=  2.5063 Ceil. m=  0.00 Putol:  0.629
 Nr.:  2 2.5653 P N2 0.0000 P HE Sum.=  2.5653 Ceil. m=  0.07 Putol:  1.020
 Nr.:  3 2.4687 P N2 0.0000 P HE Sum.=  2.4687 Ceil. m=  1.51 Putol:  1.160
 Nr.:  4 2.2799 P N2 0.0000 P HE Sum.=  2.2799 Ceil. m=  1.83 Putol:  1.192
 Nr.:  5 2.0387 P N2 0.0000 P HE Sum.=  2.0387 Ceil. m=  1.43 Putol:  1.153
 Nr.:  6 1.8027 P N2 0.0000 P HE Sum.=  1.8027 Ceil. m=  0.84 Putol:  1.095
 Nr.:  7 1.5833 P N2 0.0000 P HE Sum.=  1.5833 Ceil. m=  0.00 Putol:  0.993
 Nr.:  8 1.3950 P N2 0.0000 P HE Sum.=  1.3950 Ceil. m=  0.00 Putol:  0.887
 Nr.:  9 1.2435 P N2 0.0000 P HE Sum.=  1.2435 Ceil. m=  0.00 Putol:  0.790
 Nr.: 10 1.1423 P N2 0.0000 P HE Sum.=  1.1423 Ceil. m=  0.00 Putol:  0.731
 Nr.: 11 1.0731 P N2 0.0000 P HE Sum.=  1.0731 Ceil. m=  0.00 Putol:  0.693
 Nr.: 12 1.0174 P N2 0.0000 P HE Sum.=  1.0174 Ceil. m=  0.00 Putol:  0.668
 Nr.: 13 0.9726 P N2 0.0000 P HE Sum.=  0.9726 Ceil. m=  0.00 Putol:  0.653
 Nr.: 14 0.9365 P N2 0.0000 P HE Sum.=  0.9365 Ceil. m=  0.00 Putol:  0.645
 Nr.: 15 0.9078 P N2 0.0000 P HE Sum.=  0.9078 Ceil. m=  0.00 Putol:  0.634
 Nr.: 16 0.8851 P N2 0.0000 P HE Sum.=  0.8851 Ceil. m=  0.00 Putol:  0.630
 was jetzt?a
maximale Ceiling:  1.83
Eingabe der Austauchstufe in Metern & cm:(m.cm):
         Austauchstufe ist zu hoch:
         niedriger wie Ceiling waehlen!
 Deko Prognose:
 6m Stopp Prognose Dekozeit:     8.0  Komp.#:  6
TTS =      8.0
```

Final example,
bottom depth 24 m, bottom time 40 min.
heat map pN_2

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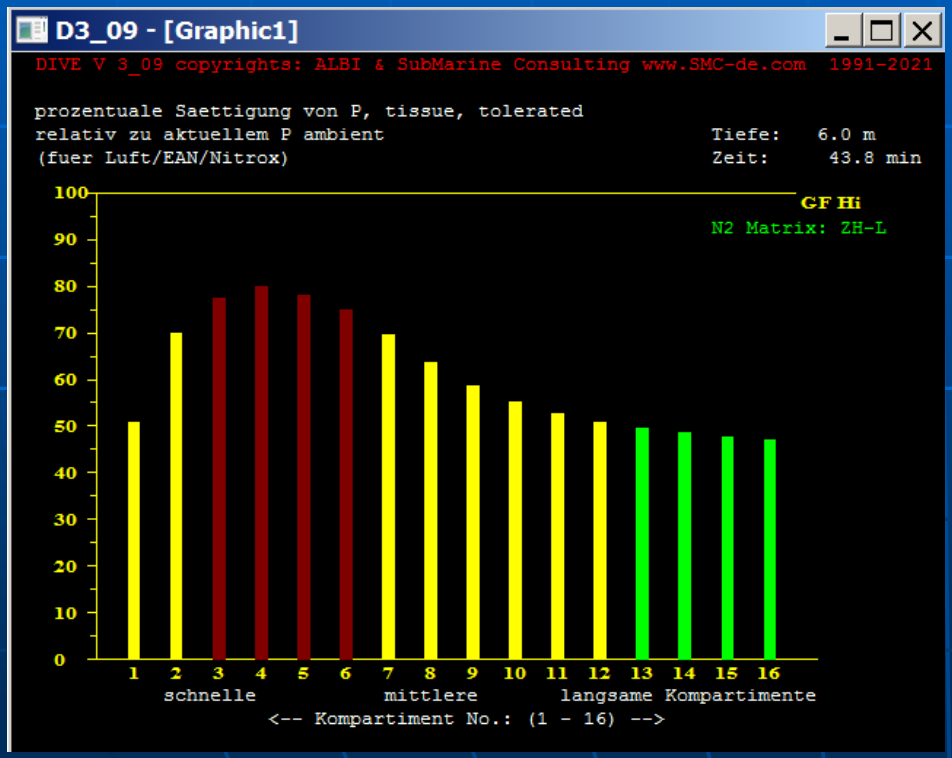
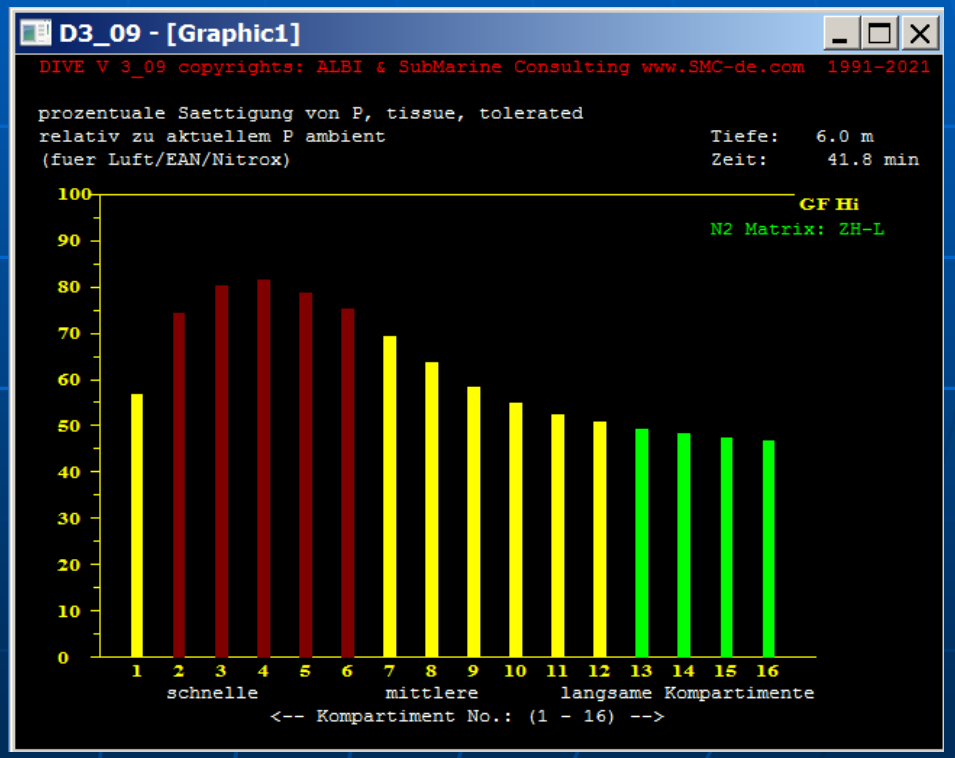
LHS: with deep stops, run time 43.8 min

RHS: ZH-L16 C, run time 41.8 min





This demonstrates, that the claims (pls. cf. slide #5) of:

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- → pN_2 reduction is not in „four to five“ compartments, instead
- → marginally, only in the first, the fastest compartment #1;
- → here from ca. 70 to 60 % (resp. ca. 55 to 50%)
- → And, negligible, in #2 & 3 from ca. 85 to 80 %
- → thus, the „micro-bubble control“ restricts to these two (to three) 1 min stops
- → And, as well:
- → the leading compartment did not change at all

- → ***i.e.: the claims can not be verified seriously,***
- → ***these deep stops are added not via a documented algorithm,***
- → ***but just manually to an***
- → ***unmodified version of a Bühlmann ZH-L 16***
- → ***That is: the „reduction in decompression stress“ is, compared to a Bühlmann ZH-86 table, if at all, negligible!***
- → ***And so maybe the offered „extra safety“.***

Bonus Material: Source for DIVE Version 3_09

Download free of charge:

→ DIVE V 3_09 (https://www.divetable.info/DIVE_V3/index.htm)

→ and the german manual
https://www.divetable.info/DIVE_V3/DOXV3_0.pdf

The release train for
→ the english version (V3_04) is somewhat slower …

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

Fine tuning of DIVE:

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Fine tuning could be done via the commands:

→ ascent rate („**AR**“)
→ ambient atmospheric pressure at start („**L**“)
→ the respiratory coefficient („**R**“)
→ the ambient (water)-temperature („**te**“)
→ the water density („**di**“)
→ Buehlmann Safety Factor („**B**“)
→ last stop depth („**LS**“)

And with: „**a**“ we recieve the complete decompression prognosis;
i.e.: the stop times in min per stage, modulo 3 m
and the **responsible leading compartment & the rounded up TTS** in min. The latest DIVE Version for beta testing is always staged there:

https://www.divetable.info/beta/index.htm

along with information on production date, size in bytes, new features and the checksums for verifying the download.

Handling of DIVE:

The first paradigm from above via the commands,
the input of commands and parameters are in the quotes: „ “

→ (ZH-L 16 C is the default coeffcients matrix)
→ „b“ (setting of the Bühlmann correction/safety factor)
→ „ar“ „10.“ (setting the ascent rate to 10 m / min)
→ „ls“ „6.“ (setting the depth of the last stop to 6 m)
→ „d“ (simulation of a box profile with these parameters:)
→ „42.“ (bottom depth)
→ „20.“ (bottom time)
→ „a“ „“ (yields this decompression prognosis):

```
 Deko Prognose:
 9m Stopp Prognose Dekozeit:      1.0   Komp.#:   2
 6m Stopp Prognose Dekozeit:     17.0   Komp.#:   6
TTS =      22.0
```

→ the heat maps (pls. cf. slides # 7, 9 & 12) are created via: „%p“