SSA + OSTIV 2018, Reno (NV)

AVOIDING MILD HYPOXIA

CONCEPT OF ZERO HYPOXIA IN FLIGHT

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&

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Dr. Heini Schaffner, during the experimentation of a special mask 24.11.2008

THE RULES TODAY:

USA:

- crew 30 min > 12,500 ft or >14,000 ft
- pax: > 15,000 ft
- any > 25,000 ft, a 10 min safety supply

EASA Sailpanes:

- crew 30 min > 10,000 ft or > 13,000 ft
- pax > 13,000 ft

FOLLOWING THIS RULE, THE GLIDER PILOT IS IN GREAT DANGER!

Even more in the US

Basic reminders of aviation medicine

- O_2 and glucose (fuel) >neurocellular metabolism >ATP

Basic reminders of aviation medicine

- ATP, the neurocellular fuel, has only few seconds storage, and can be depleted with even mild hypoxia.

Basic reminders of aviation medicine

- ATP must be produced continuously, any reduction in regeneration will cause **BRAIN MALFUNCTION**

Basic reminders of aviation medicine

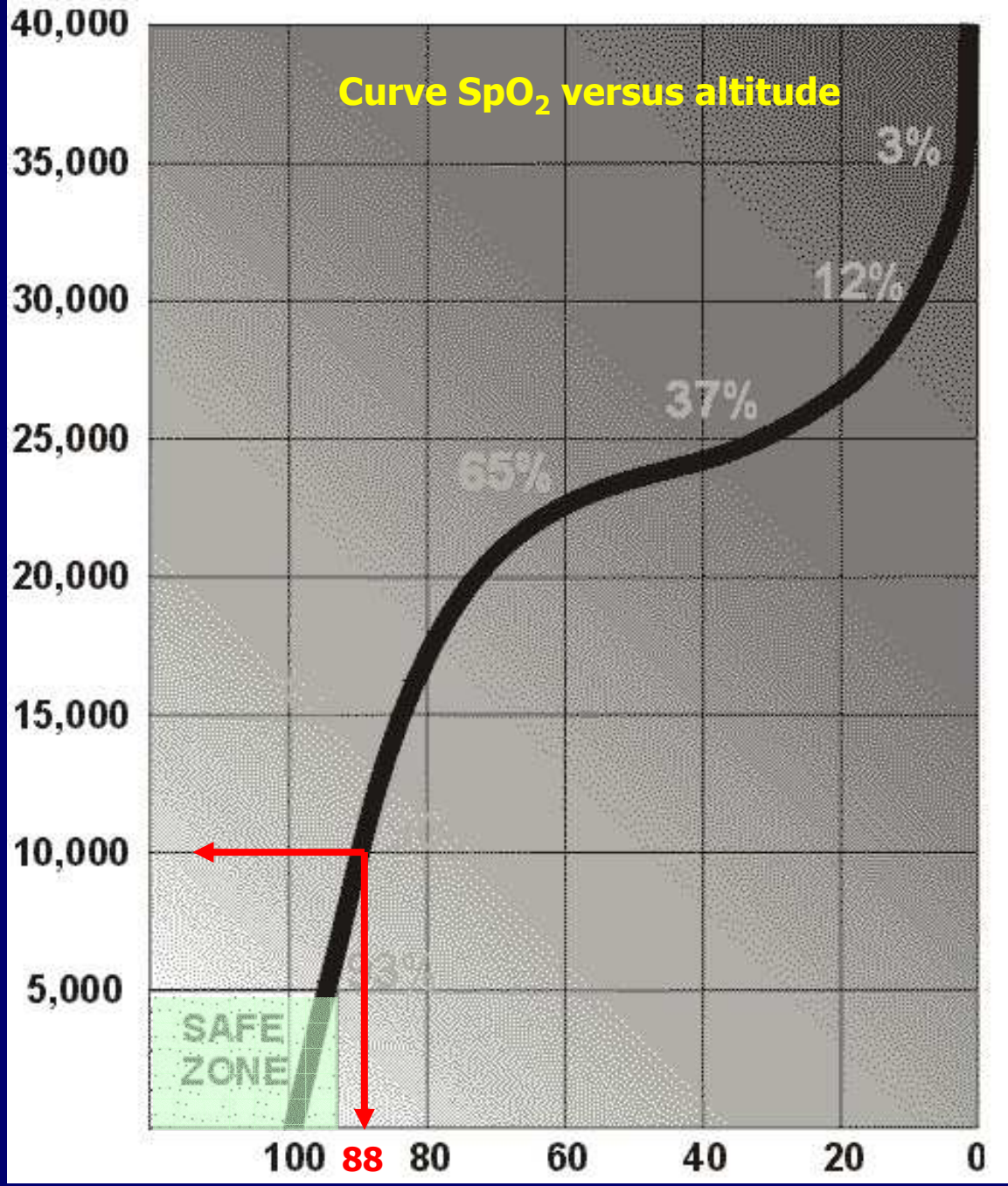
- Nerve cells deprived of ATP stop working in few seconds and **DIE WITHIN MINUTES**

Basic reminders of aviation medicine

- The SpO_2 measured on your finger is **NOT** representative of the O_2 present in your brain cells

(~ 2 hrs to reach cortex)

THIS MECHANISM IS IMPERCEPTIBLE



Typical SpO_2

Standard = 93%

(equivalent to 5,000 ft)

Safety > 90%

88% means Danger !

Degradation of cognitive functions

Warning:

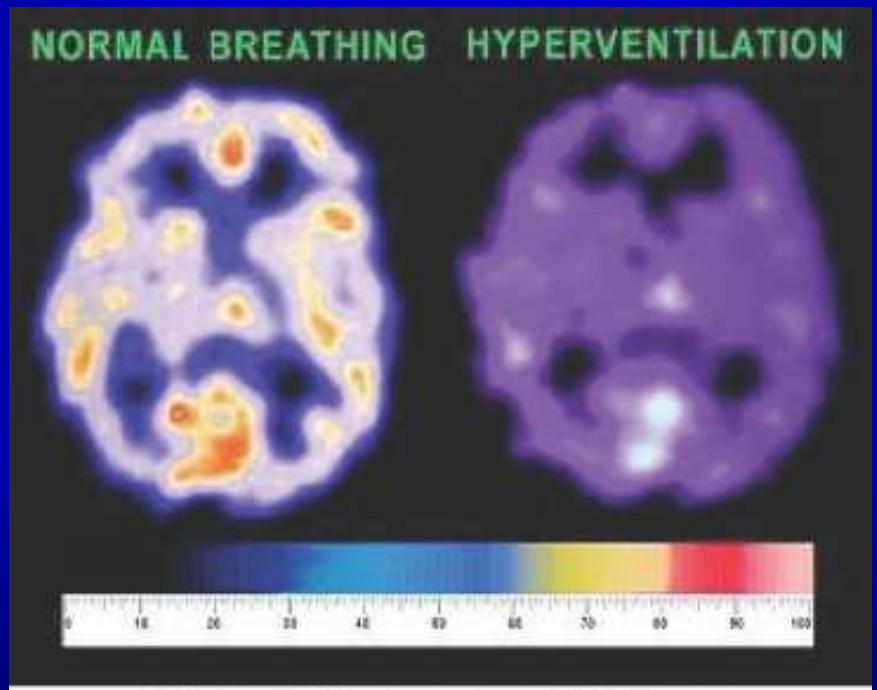
Lung function deteriorates with duration of the flight, but collapses during tight circling !

THE SYMPTOMS OF MILD HYPOXIA

Phase	Saturation	Altitude	POSSIBLE SYMPTOMS AND CLINICAL SIGNS
	SpO2	Ft	
Indifferent Insidious Danger	90-93 %	5,000 to 10,000	Reduction of vision in low light levels Hyperventilation Headache Reduction in capacity to accomplish new tasks or to manage an urgent situation
Compensatory Latent Danger!	80-90 %	10,000 to 15,000	Alteration of judgement, difficulties in mental calculation Decrease in coordination and writing Decreased effectiveness & performance, slowing of reflexes Tunnel Vision, fading colours, double vision Tingling Yawning Confusion, euphoria, sensation of well-being, followed by sleepiness

HYPERVENTILATION: AN INSIDIOUS ENEMY

- Happens to <u>everybody</u> around 8,000 ft (without extra O_2)
- Flushes away the CO_2 from the lungs and reduces cerebral perfusion >> immediately add O_2, or pursed lips breathe, or sing (Dr. Knüppel), try to control your bpm, or descend!



Effects of 1 minute of voluntary hyperventilation on brain oxygen levels (vasoconstriction due to lack of CO2)

MRI of brain activity regions = level of oxygenation

THE EFFECTIVE PERFORMANCE TIME

Replaces the old concept of
Time of Useful Consciousness (TUC)

Altitude ft	EPT theoretical in hypo chambre min	EPT practical in a glider min
18.000	20-30	10-15
20.000	<10	<5-6
22.000	8-10	4-5
25.000	3-5	2-3
30.000	1-2	0,5-1

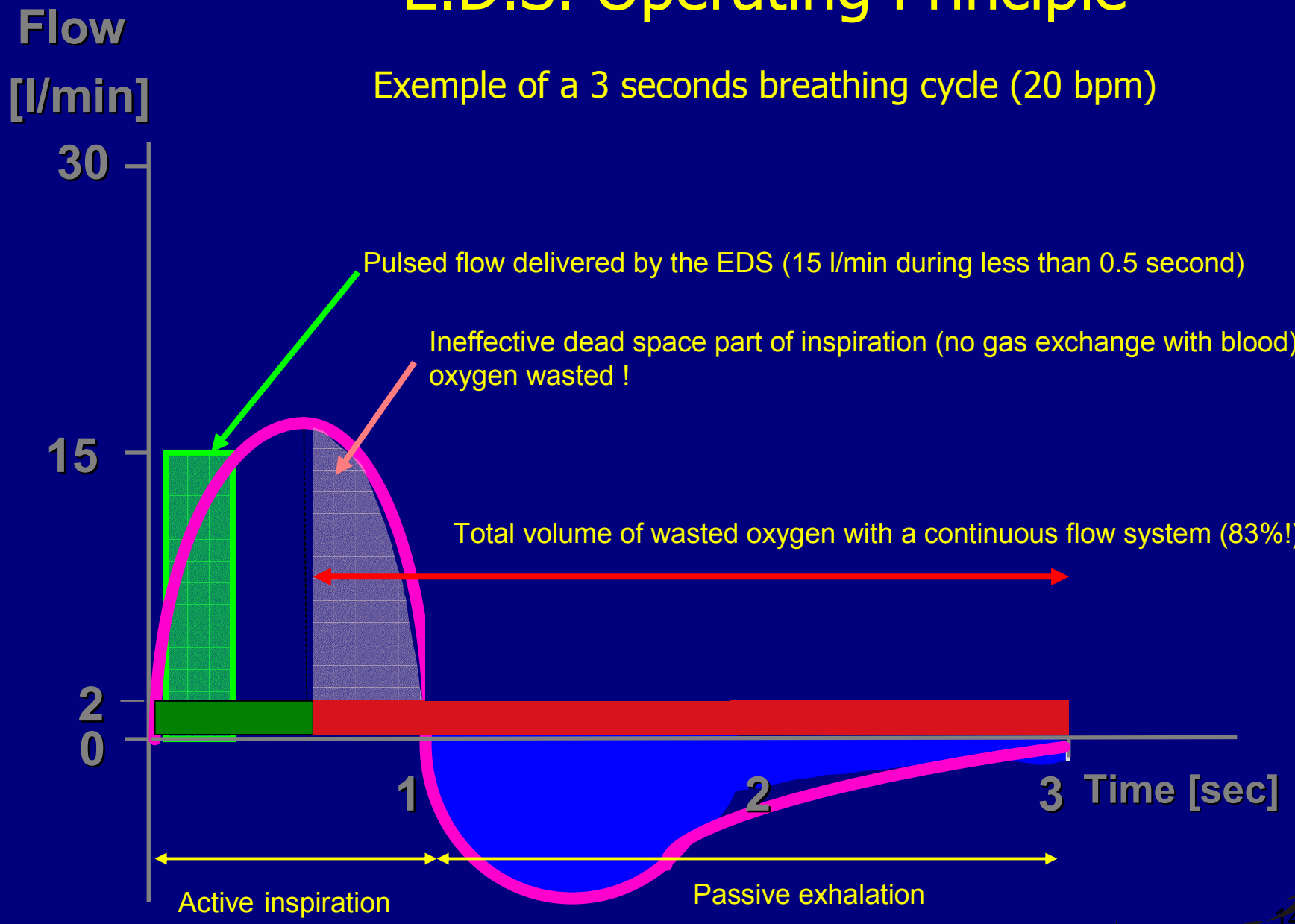
HOW DO WE BREATHE ?

and

HOW DOES THE E.D.S WORK?

E.D.S. Operating Principle

Exemple of a 3 seconds breathing cycle (20 bpm)

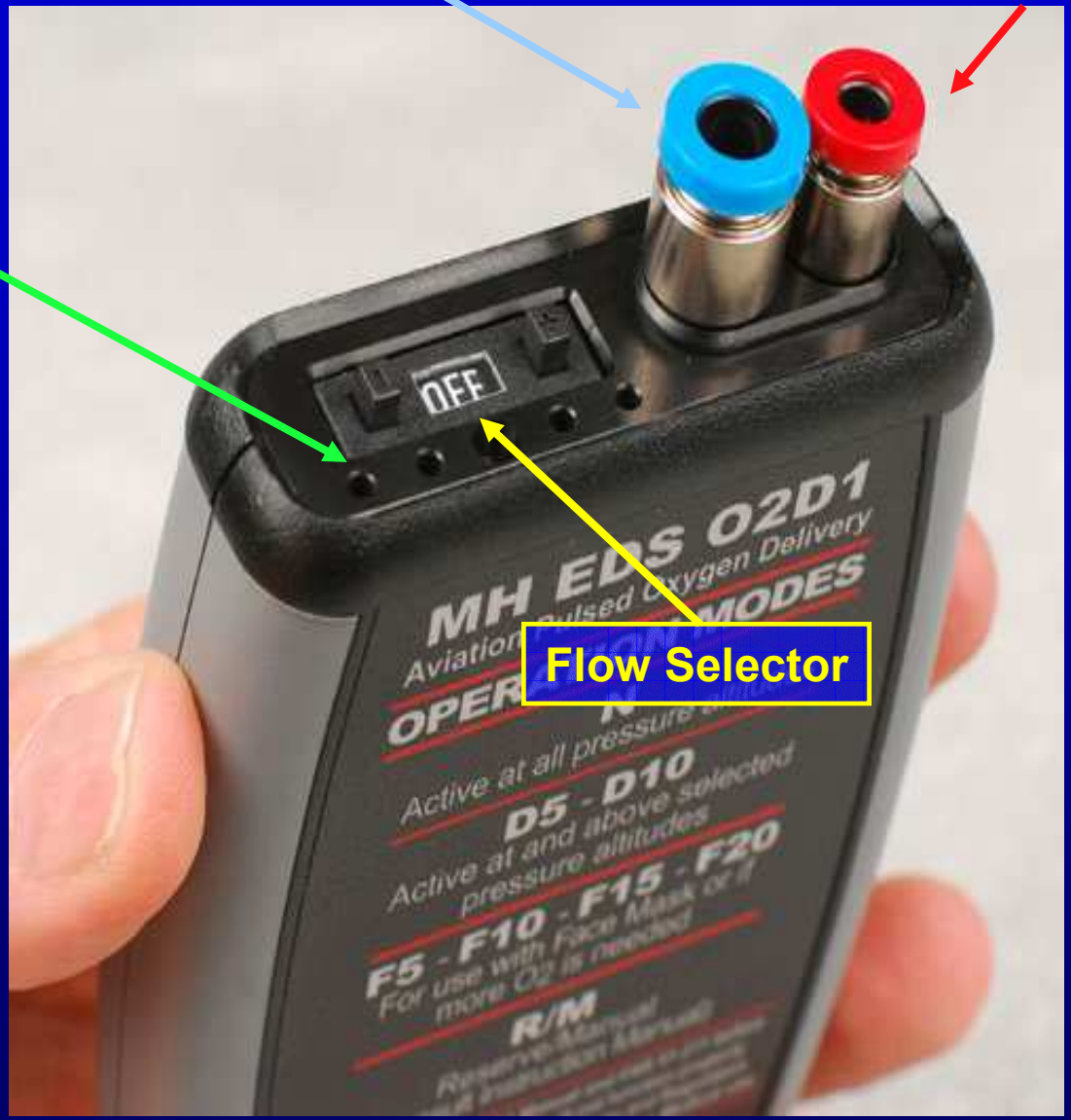


EDS-O2D1

Inlet > 1.4 bar (min 1 bar dynamic)
(20 psi min 14)

Output cannula

Control LED
Green/Red



THE EXPERIMENTATION IN THE LABORATORY

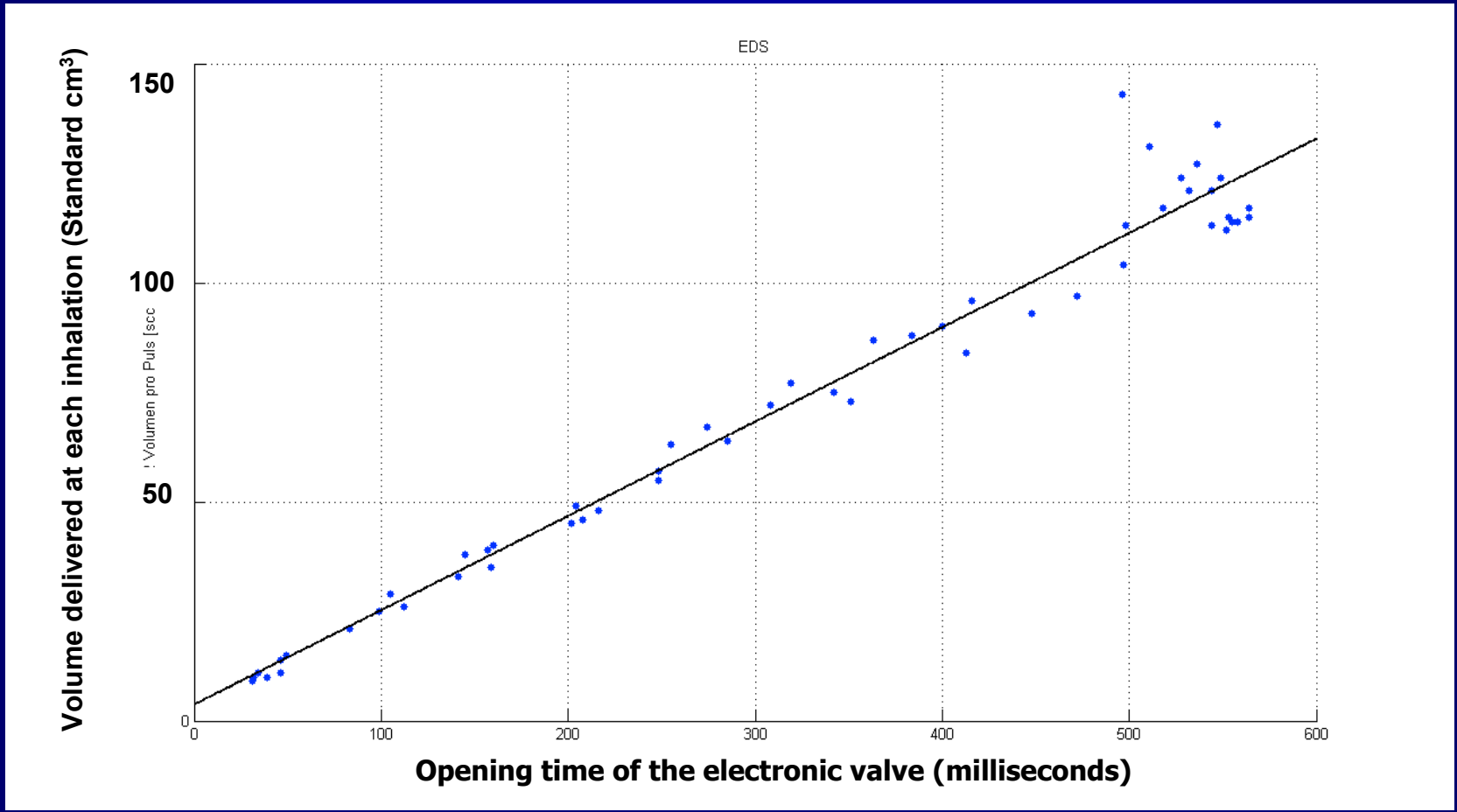
Of the Winterthur High School of Aviation Engineering

STEP 1:

UNDERSTAND THE E.D.S

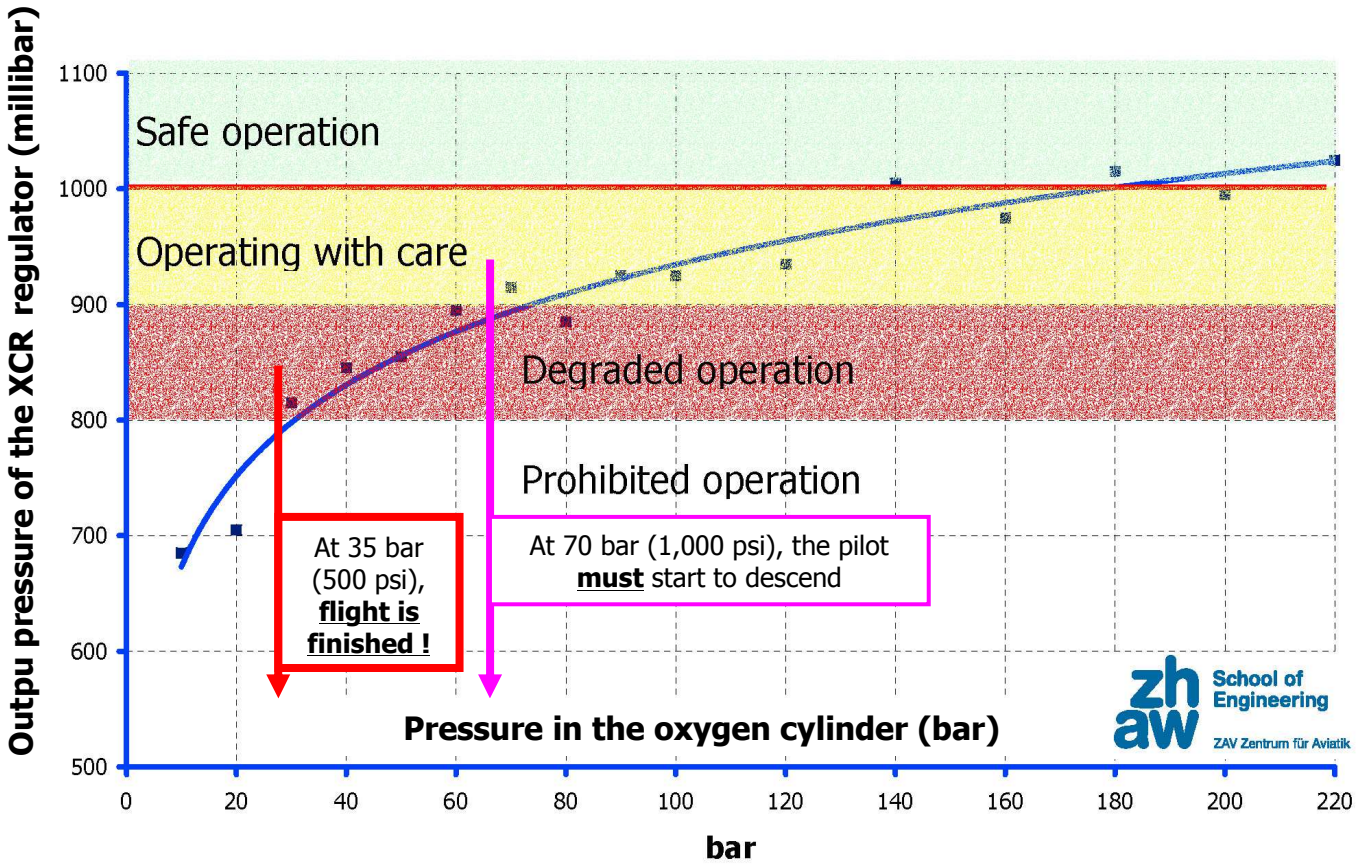
MEASUREMENT OF FLOW Vs (F) POSITIONS

THE QUANTITY OF O2 DELIVERED DEPENDS ON THE DURATION OF OPENING OF THE ELECTRONICALLY OPERATED VALVE ..... AND .....



School of Engineering
ZAV Zentrum für Aviatik

THE QUANTITY OF O2 DELIVERED DEPENDS ON THE PRESSURE AHEAD OF THE VALVE ..... AND .....



1st CONCLUSION:

THE SINGLE STAGE XCR "CHEAP" REDUCER

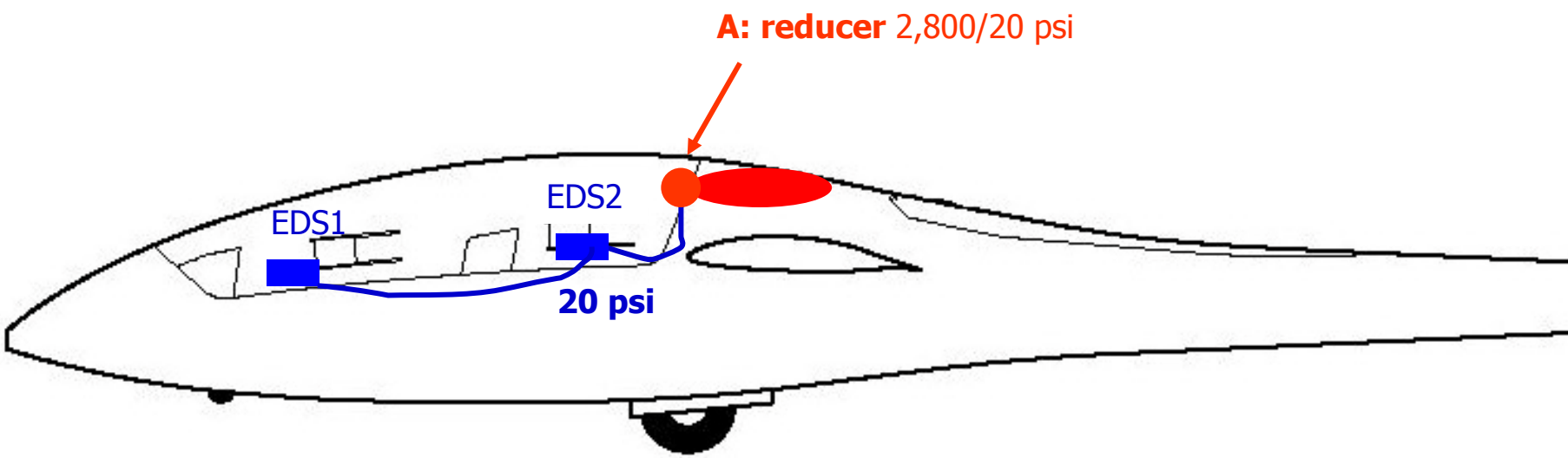
DOES NOT PERMIT FULL USE OF THE CYLINDER

SOLUTION: (2) REDUCERS IN SERIES

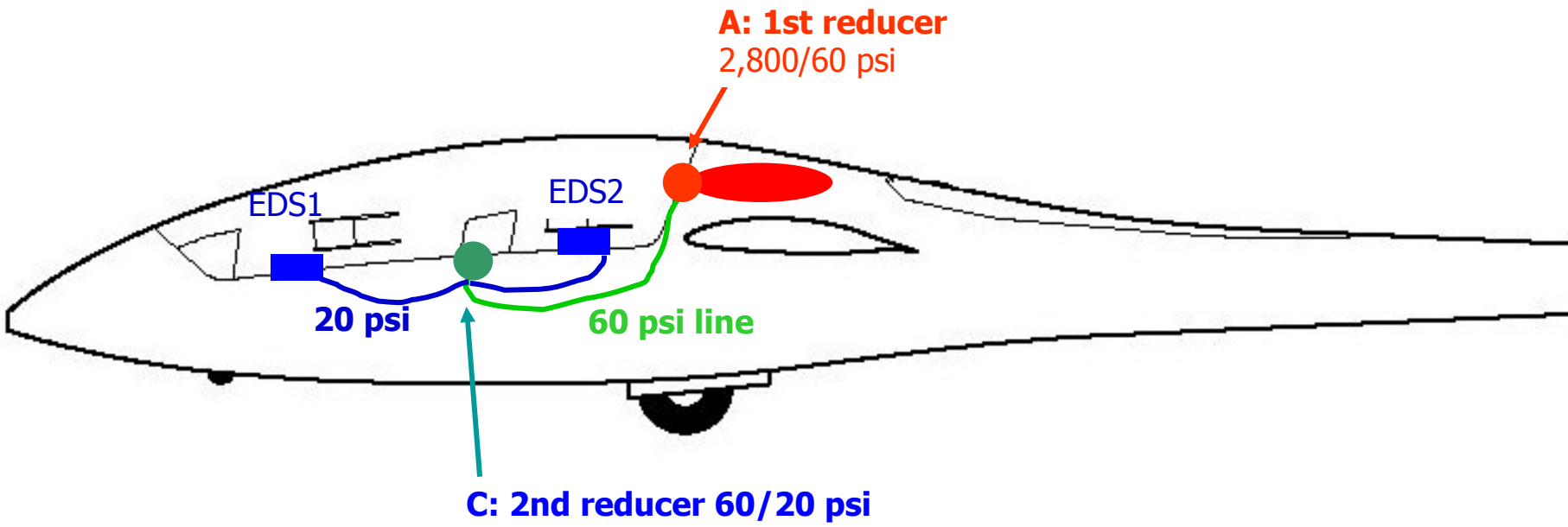
2,800/60 psi FOLLOWED BY 60/20 psi (200/4 bar and 4/1.5 bar)

STANDARD CONFIGURATION OF A TANDEM TWO-SEATER

- The medium pressure line goes first to back seat, then to front seat
- Small dia. (4 mm) pipe means high friction losses, pressure drop
- When inspirations are synchronized, the front seat pressure is too low



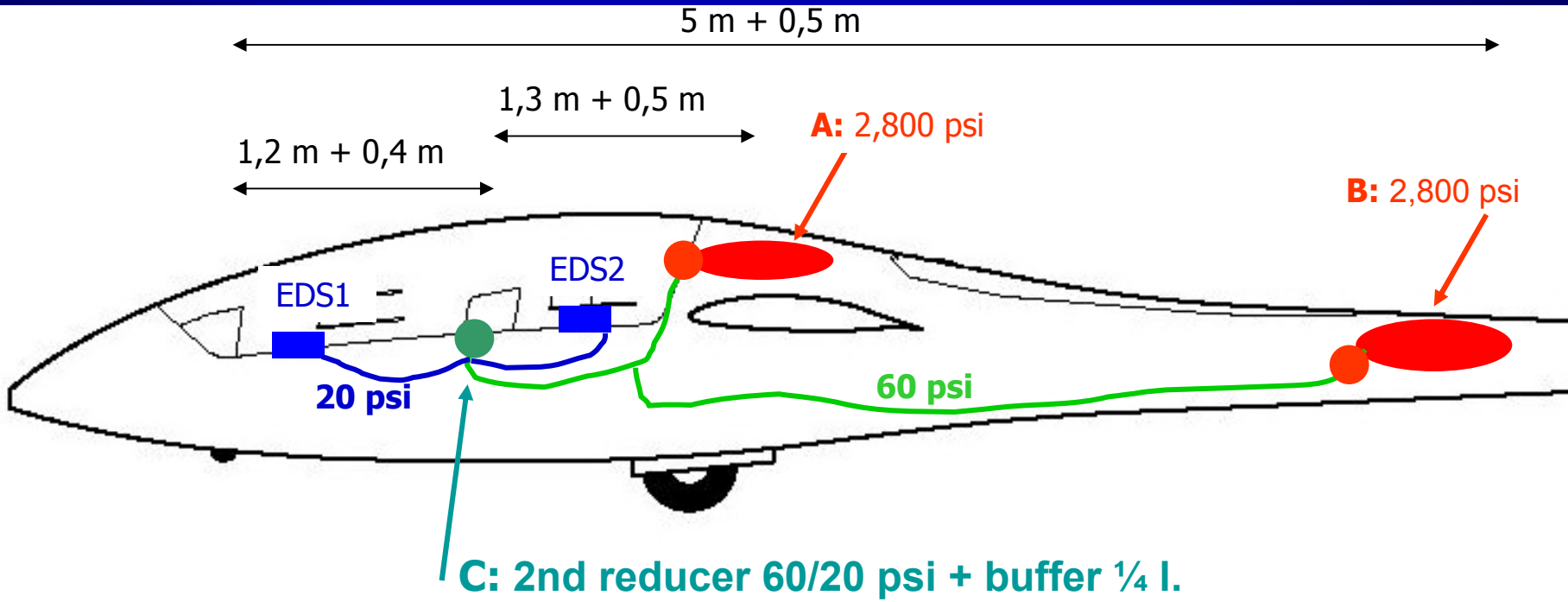
RECOMMENDED CONFIGURATION FOR A TANDEM TWO-SEATER



THE QUANTITY OF O2 DELIVERED DEPENDS ON

THE LENGTH OF THE LINES ….. AND …..

In a tandem two-seater, lines must be balanced and L<1,5 m



A & B : main cylinder(s)

C : when possible, install a small capacity (ex. vario thermos)

CHECKING THE PRESSURE DURING EXPERIMENTATION IN THE GLIDER

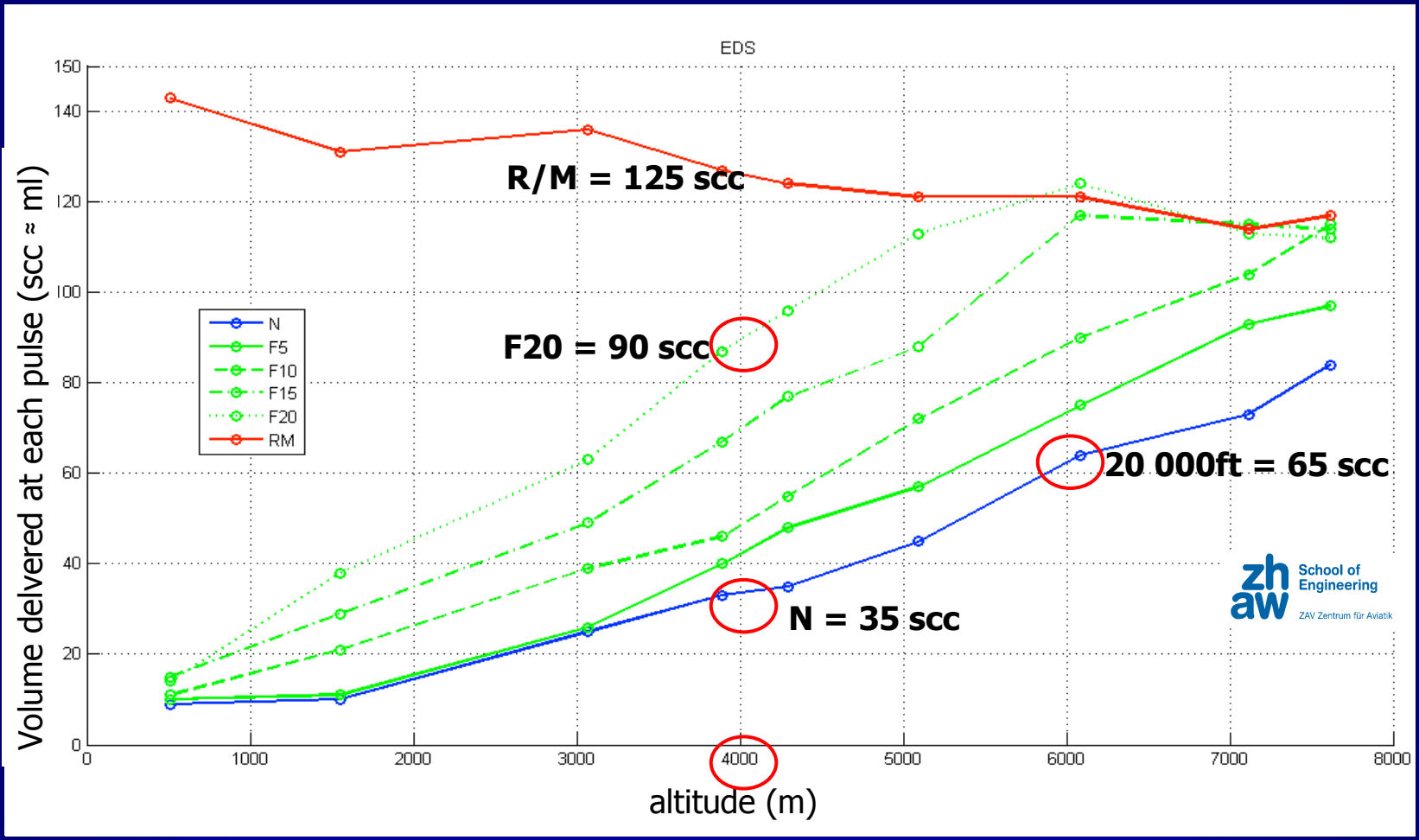
THE QUANTITY OF O2 DELIVERED DEPENDS ON

THE POSITION OF THE (F) SELECTOR

The amount of O_2 is not the one we expected!

Positions (F) The value F (x 1 000 ft) is supposed to be added to the actual altitude

Only F10 & F20 are useful (+R/M in emergency or doubt)



- Example: at 4 000 m and F20, flow should be 35+65=100 scc. It is in fact 90 scc
- F5 gives 10% more than N/F15 are of no interest.
- F20 = R/M above 5 000m, No further increase above 6 000m !
- F10 = +50%, F20= +100%

THE QUANTITY OF O_2 DELIVERED DEPENDS ON

- the pilot's respiratory frequency (bpm):
  - 75% of bolus from 20 to 30 bpm
  - 50% of bolus from 30 to 40 bpm (pathological tachypnea).

OK for saving O_2, very bad for the pilot (HVR)!

- stress, fear, fatigue → deep and rapid breath

Here is the result of our experimentation

THE HYPOBARIC CHAMBER OF THE ZHAW

Dr. Schaffner, 2 students and safety doctor

Up to 24,600 ft by increments of 3,000 ft

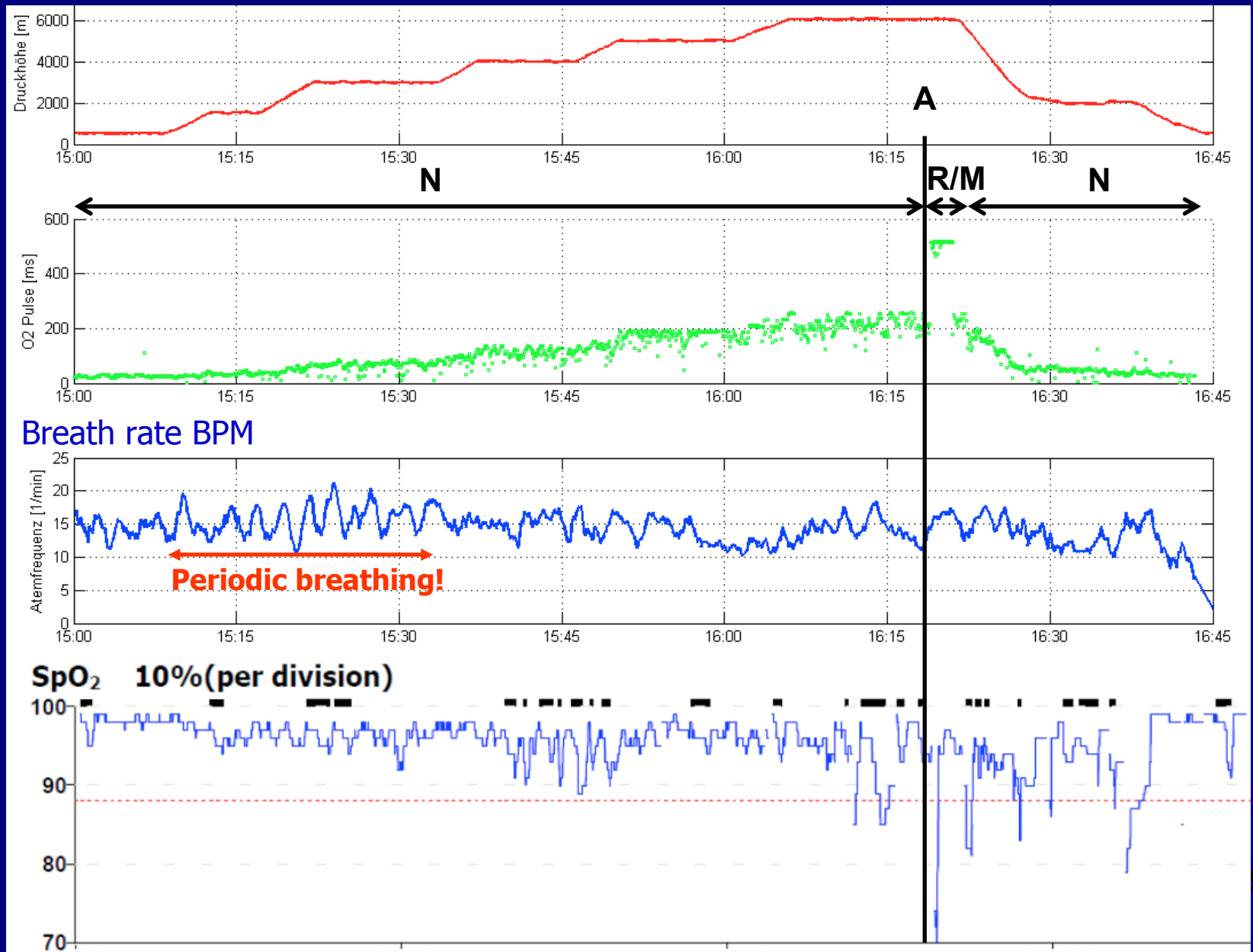
THE GUINEA PIGS IN THE PC 6 (all glider pilots)

Up to 20,000 ft by increments of 3,000 ft in 1h20 min

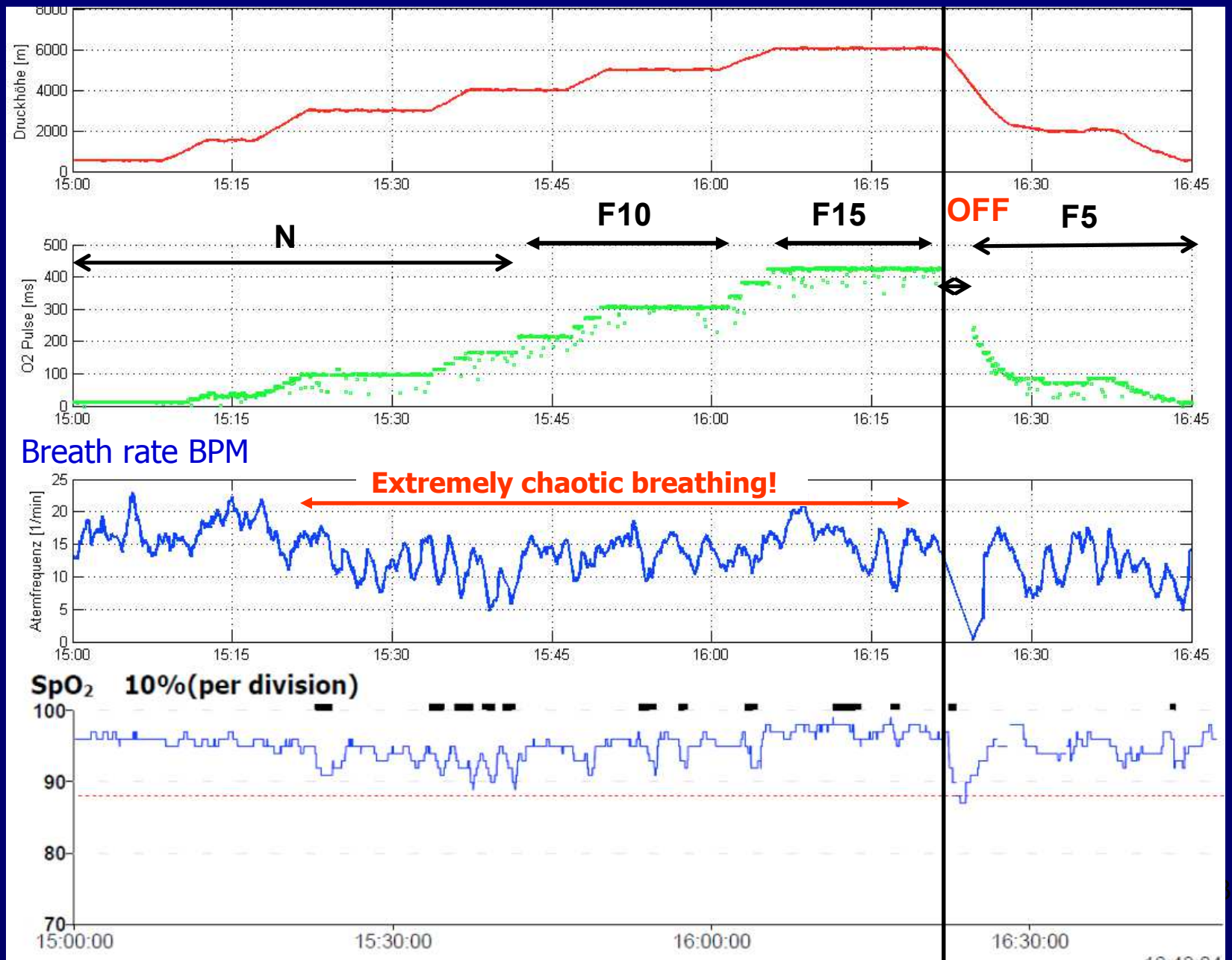
♀ 23, BMI 20.4, non smoker - ♂ 38, BMI 31.4, Smok. (15/d)

♂ 69, BMI 26.3, non smoker - ♂ 36, BMI 25.4, Smok. (20/d)

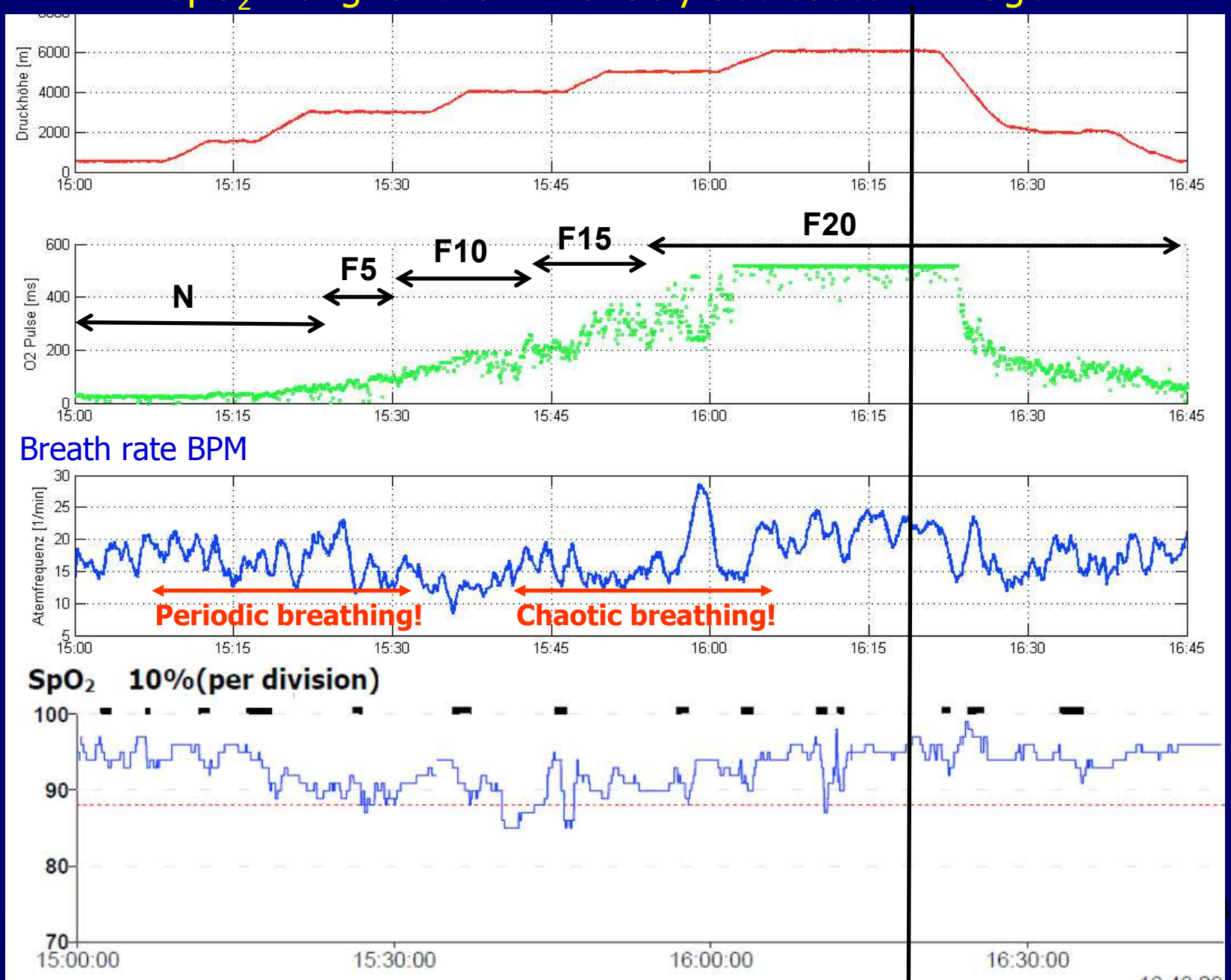
The young fit lady non smoker: excellent response, position N gave 90% minimum ave. Periodic breathing unvoidable



The young male (36), smoking 20 cig./d, needs 20% more O_2 above 13,000 ft. Lung function not yet much deteriorated, but coming soon!



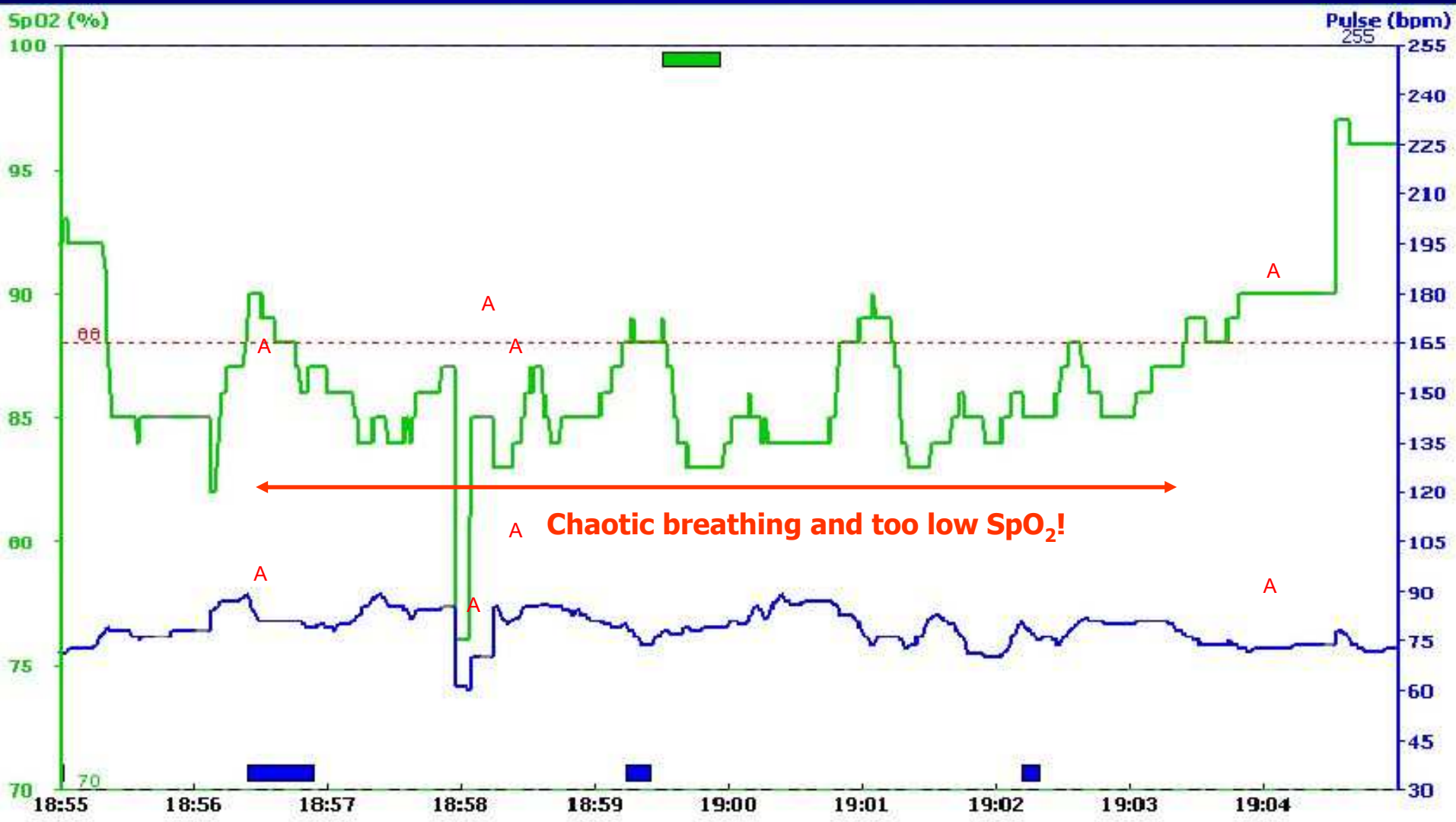
The fit senior (69), n.s., requires 100% more O_2 than the youngs for the same SpO_2. Lung function invariably decreases with age!



IN-FLIGHT STUDY OF REAL HYPOXIC INCIDENTS

- To chat or to be hypoxic: you must decide!

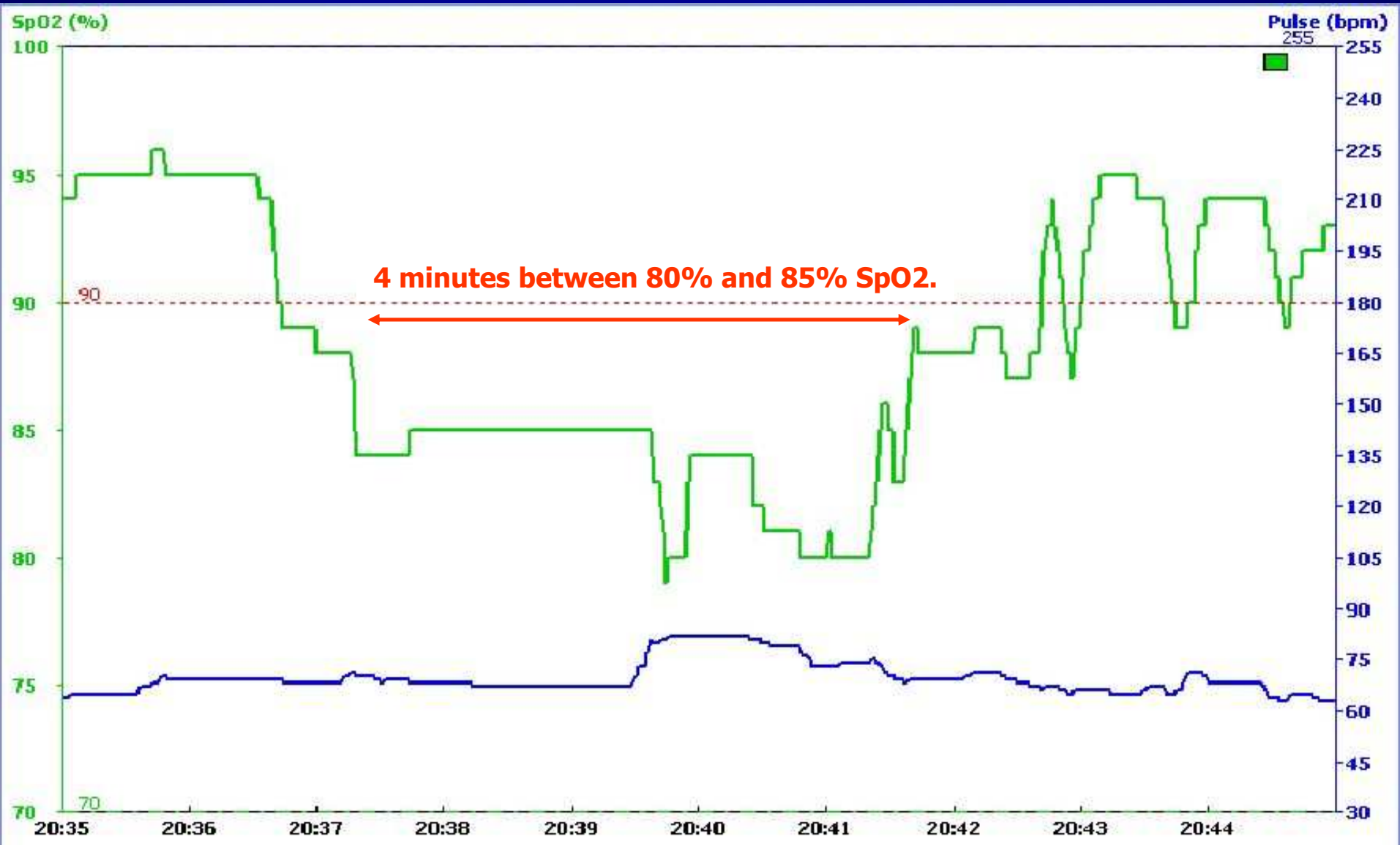
Young man, athletic, healthy, non smoker. 5 minutes chat between pilots, SpO2 falls between 85% and 88%. Very dangerous in a single seater!



IN-FLIGHT STUDY OF REAL HYPOXIC INCIDENTS

- Urinating with difficulty

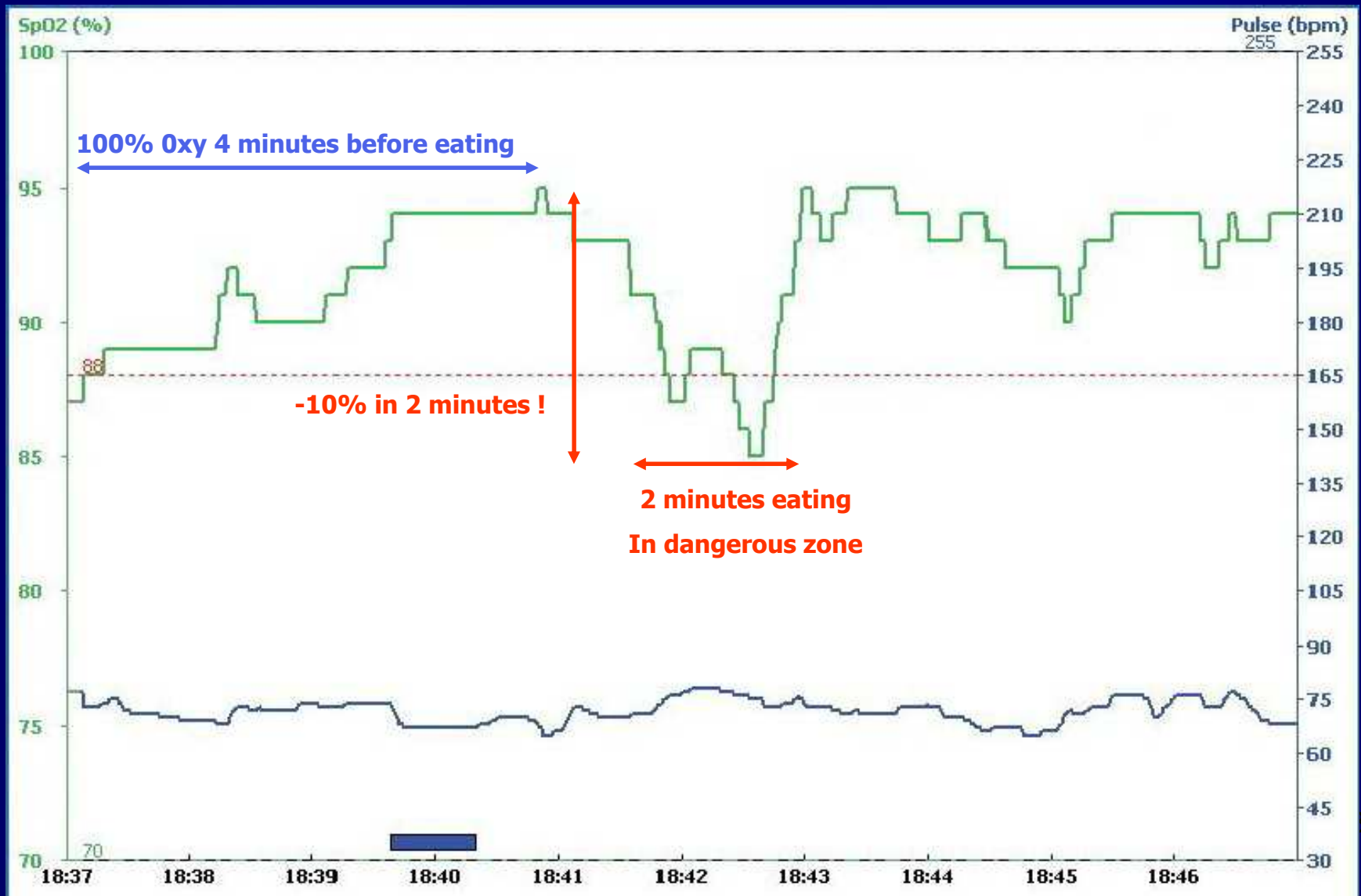
At 21,000 ft, with EDS on R/M (100%) as an anticipation of this effort apnoea, the pax (70, healthy, non smk.) remained 4 minutes at 80% - 85% SpO2. Equivalent to stay at 15,000 ft without oxygen



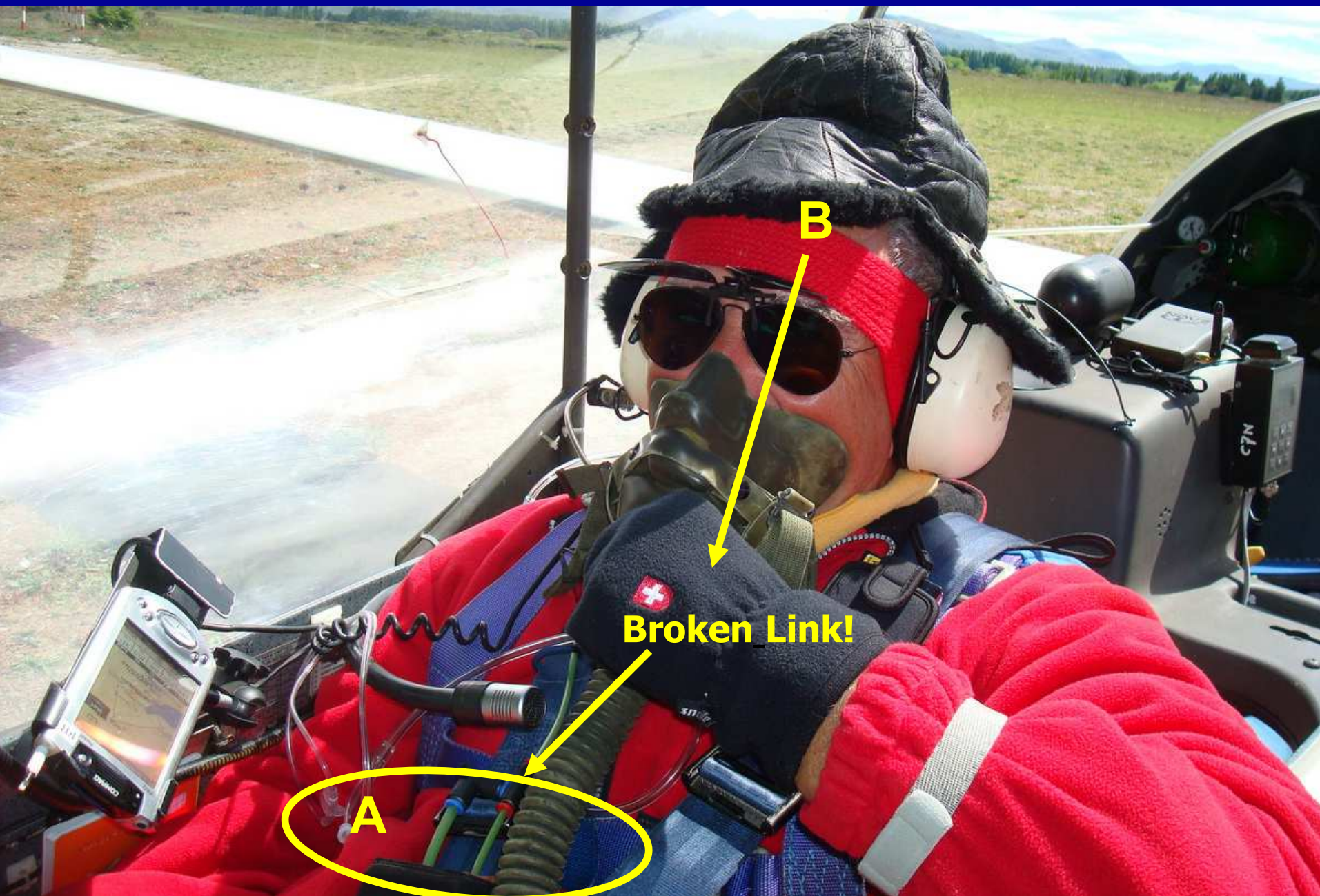
IN-FLIGHT STUDY OF REAL HYPOXIC INCIDENTS

- Eating a sandwich

At 20,000 ft, pilot (30, very healthy) changes EDS to R/M (100%) as an anticipation of this strongly hypoxic activity. SpO2 goes up to 93% then collapses by 10 points during eating.



At 20,000 ft, during a cough crisis, Dr Schaffner could fuzzily see the EDS (A) but his brain (B) could not order his hand to increase the setting.



IN-FLIGHT STUDY OF REAL HYPOXIC INCIDENTS

- To cough or not to cough, that is the question ....

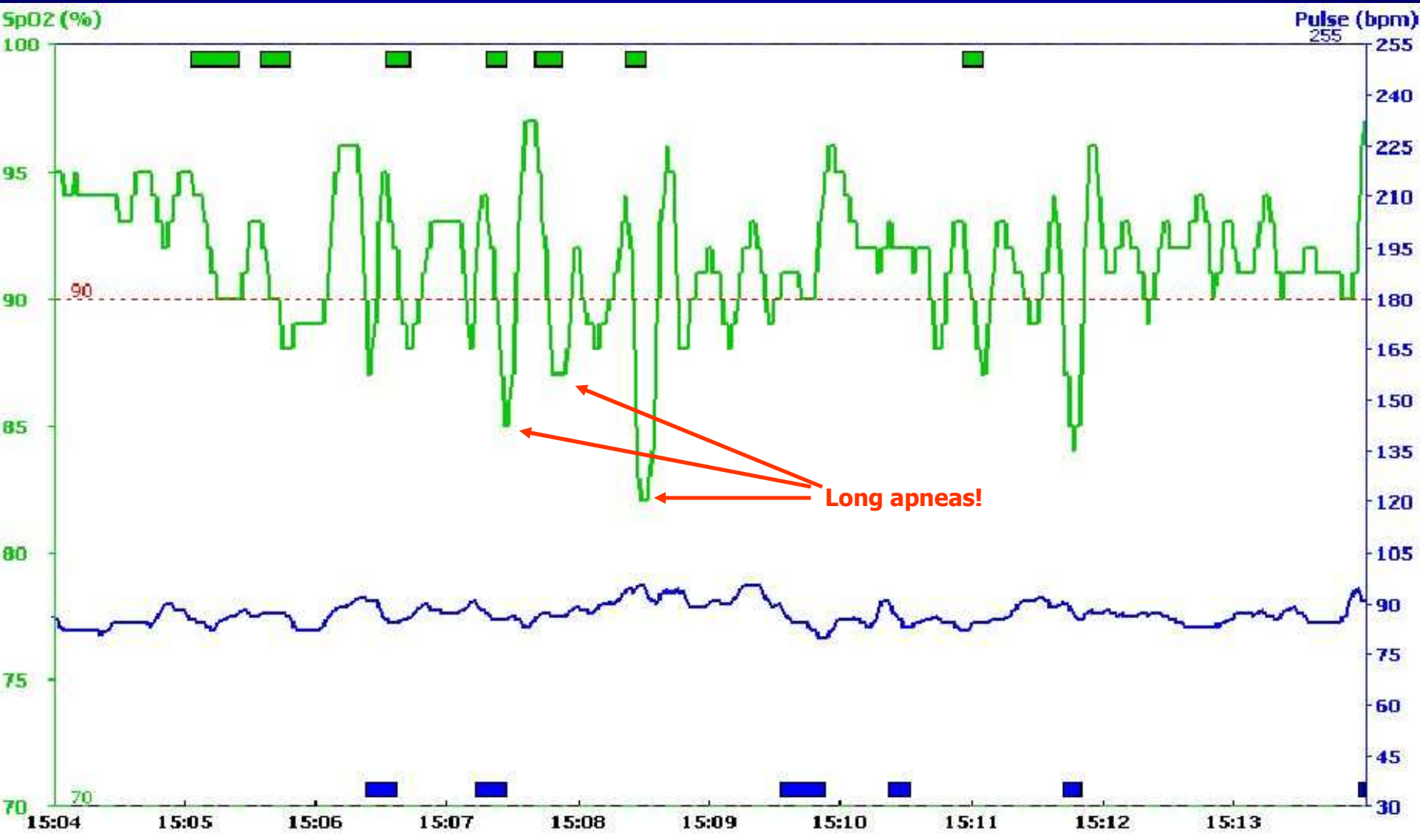
«For whatever reason, I started coughing, an incessant light coughing, dry. I realized then that I had to change the EDS to R/M position to increase my chances of recovery, but I saw already the selector fuzzily and I had not been able to verify the setting, my field of vision tapers to tunnel vision, I felt that I was no longer myself. .... I was totally unable to act effectively or fly the glider, a real stupor (inability to act but with open eyes) .... If I had been in a single seater, I would have probably lost the wings and would not be here to talk about it. »

Dr. Schaffner, p. 294 "Dancing With the Wind"

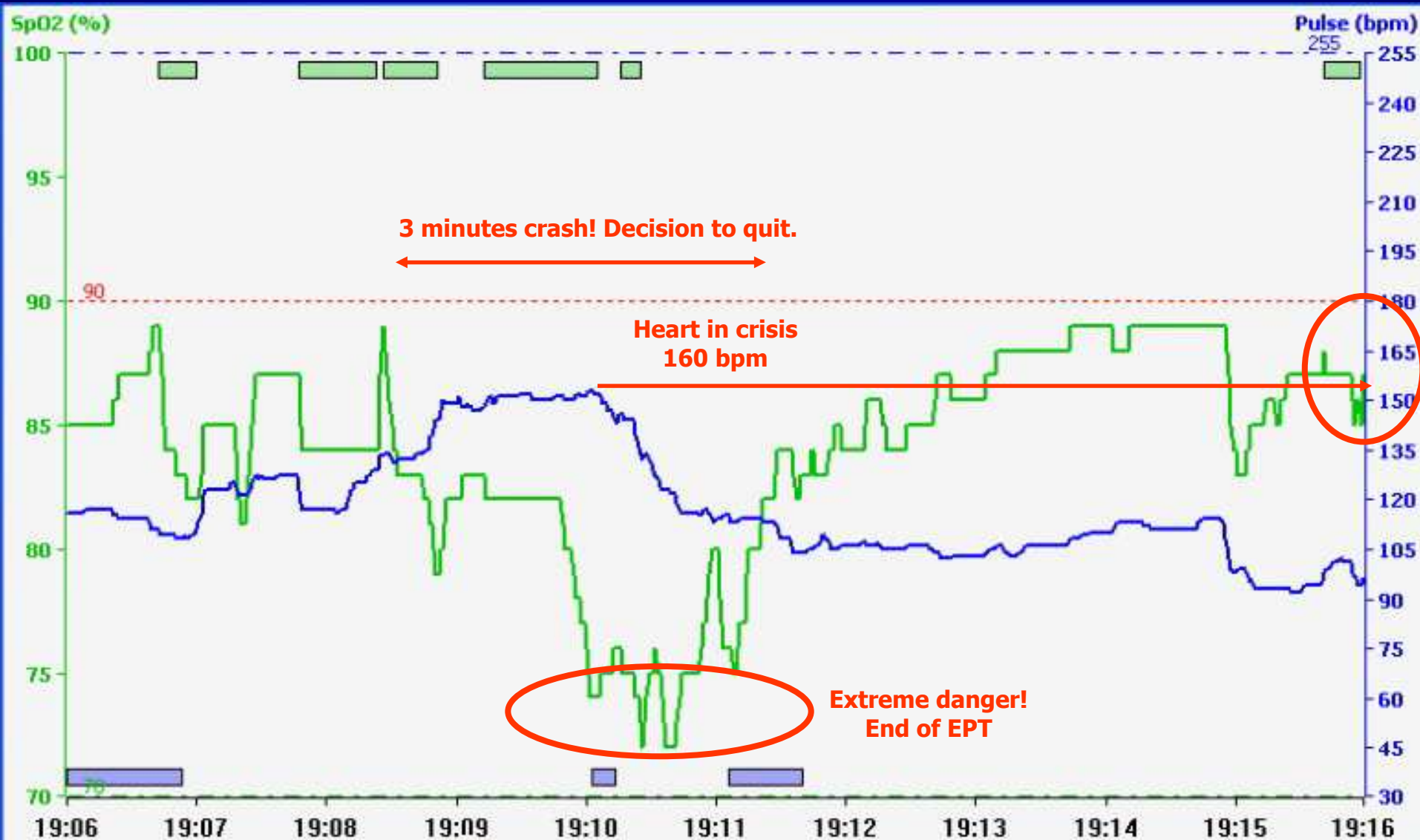
IN-FLIGHT STUDY OF REAL HYPOXIC INCIDENTS

- Non hypoxic hyperventilation: stress, fear, anxiety, over concentration, phobia.

~ 20,000 ft, periodic and episodic hyperventilatory breathing (Cheyne-Stockes).
The high initial saturation (95%) made this episode passed unnoticed.
Not a big problem as long as enough O2 is supplied



~ 21,000 ft, hypoxic "crash" caused by chaotic and uncoordinated breathing. After 40 min of hard battle in migratory rotors, partly in IMC, tension, fatigue, frustration, high physical efforts, **high "g's" (compression of pulmonary alveoli)** Pilot was a young, very healthy and trained, multiple world champion.



AVOID HYPOXIC INCIDENTS

- Cannula on your nose and EDS "on" before take-off in order to avoid slow, insidious, ATP depletion

AVOID HYPOXIC INCIDENTS

- Pilots >50, smoker or user of βblocker :

F10 at take-off, F15 (or F20) @ FL150

AVOID HYPOXIC INCIDENTS

- Any “unusual feeling, uncomfort”: switch to R/M for 5 min.

If the symptoms disappear, switch permanently to F10 or F20.

AVOID HYPOXIC INCIDENTS

- Flying > FL200: EDS is not sufficient! Only very young and healthy people may climb to FL 250 with caution and a pulse oximeter.
- Train and apply pursed lips expiration.
- Alternatively: use a 2nd EDS in parallel.

AVOID HYPOXIC INCIDENTS

- Pre-oxygenate 5 min on R/M before any foreseeable effort.

Very efficient, it costs nothing!

MAINTAIN ZERO HYPOXIA

THE RULES MAY BE SUFFICIENT FOR PHYSICAL SURVIVAL

BUT NOT FOR FLYING A GLIDER FOR HOURS!

P.I.C: GOOD & RESPONSIBLE OXYGEN MANAGEMENT

Everything

and

much more

in this book

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THANK YOU FOR
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