AIRFOILS AND PLANKS

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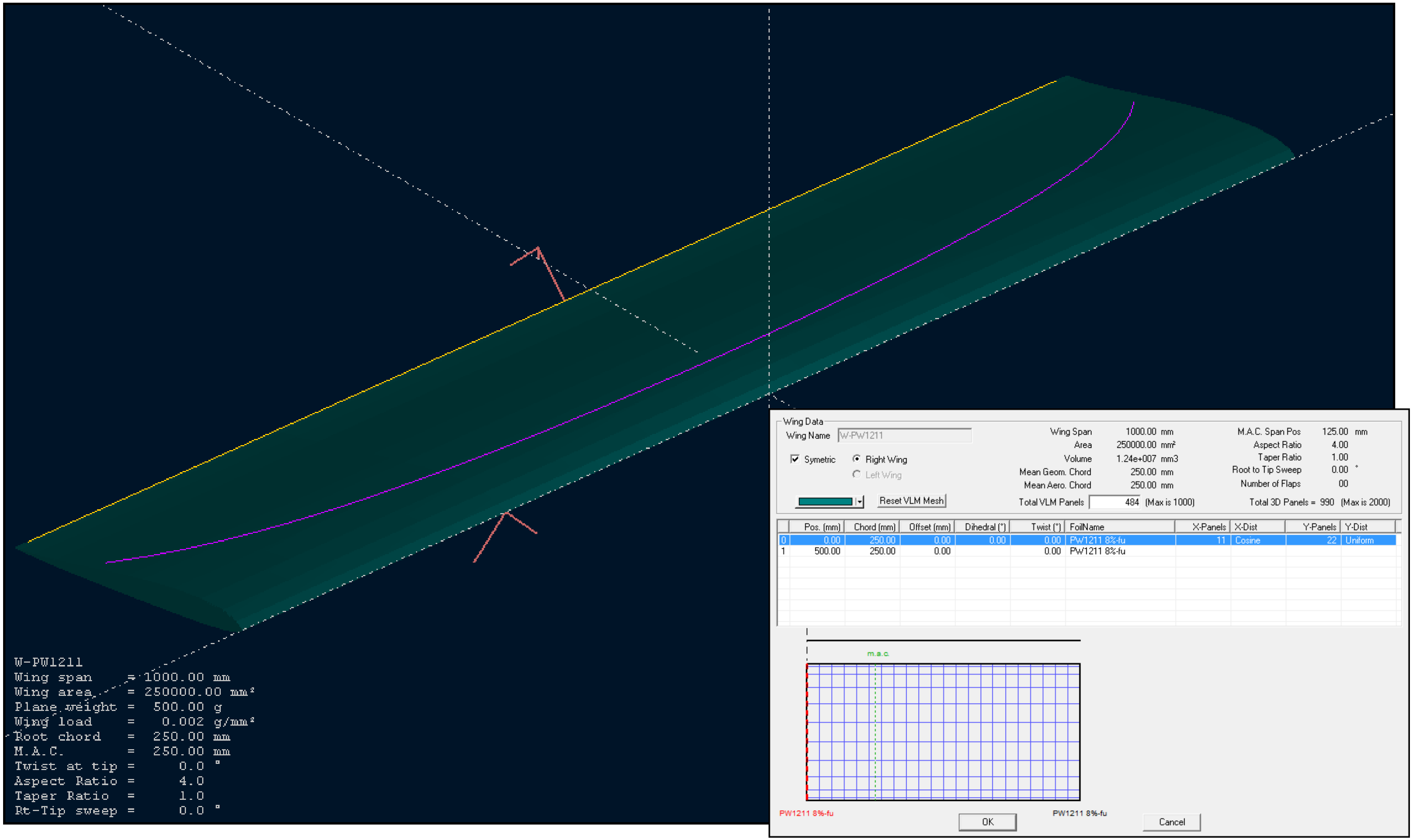
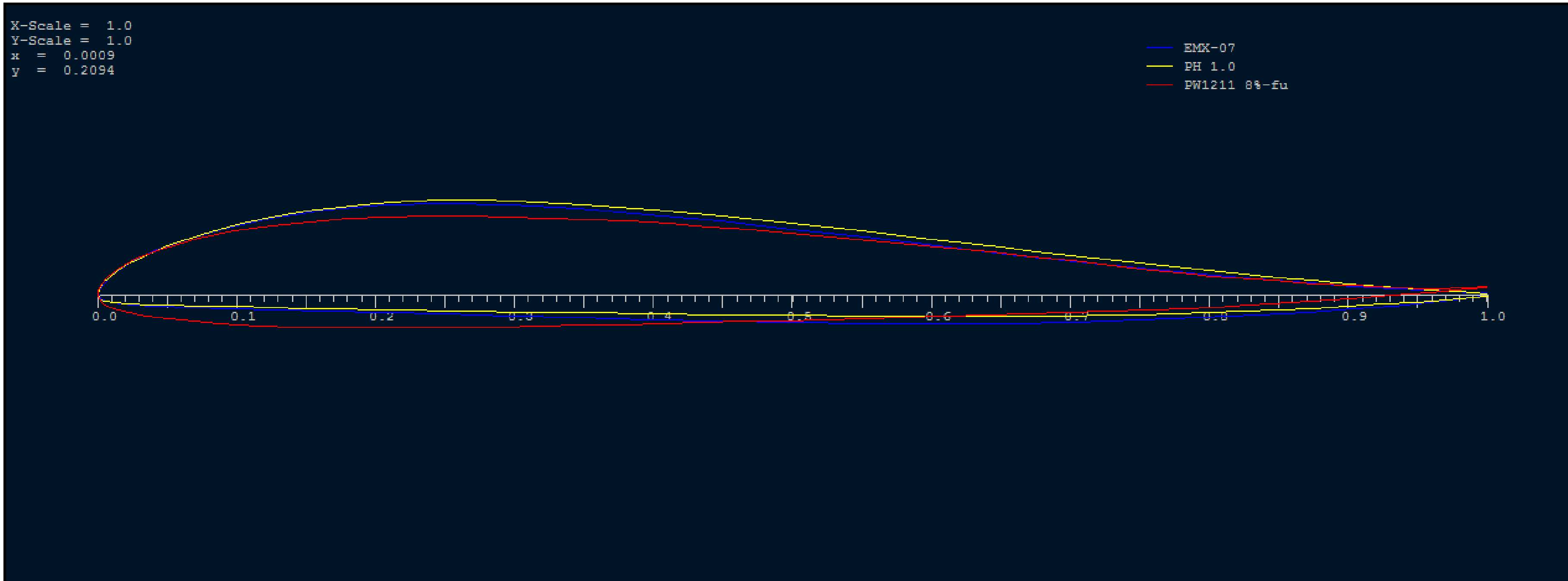
The Plank


W-PW1211
Wing span = 1000.00 mm
Wing area = 250000.00 mm²
Plane weight = 500.00 g
Wing load = 0.002 g/mm²
Root chord = 250.00 mm
M.A.C. = 250.00 mm
Twist at tip = 0.0 °
Aspect Ratio = 4.0
Taper Ratio = 1.0
Rt-Tip sweep = 0.0 °
Wing Data
Wing Name W-PW1211
Symetric
Right Wing
Left Wing
Reset VLM Mesh
Wing Span 1000.00 mm
Area 250000.00 mm²
Volume 1.24e+007 mm3
Mean Geom. Chord 250.00 mm
Mean Aero. Chord 250.00 mm
Total VLM Panels 484 (Max is 1000)
M.A.C. Span Pos 125.00 mm
Aspect Ratio 4.00
Taper Ratio 1.00
Root to Tip Sweep 0.00 °
Number of Flaps 00
Total 3D Panels = 990 (Max is 2000)
Pos. (mm) Chord (mm) Offset (mm) Dihedral (°) Twist (°) FoilName X-Panels X-Dist Y-Panels Y-Dist
0 0.00 250.00 0.00 0.00 0.00 PW1211 8%-fu 11 Cosine 22 Uniform
1 500.00 250.00 0.00 0.00 PW1211 8%-fu
m.a.c.
PW1211 8%-fu
PW1211 8%-fu
OK
Cancel

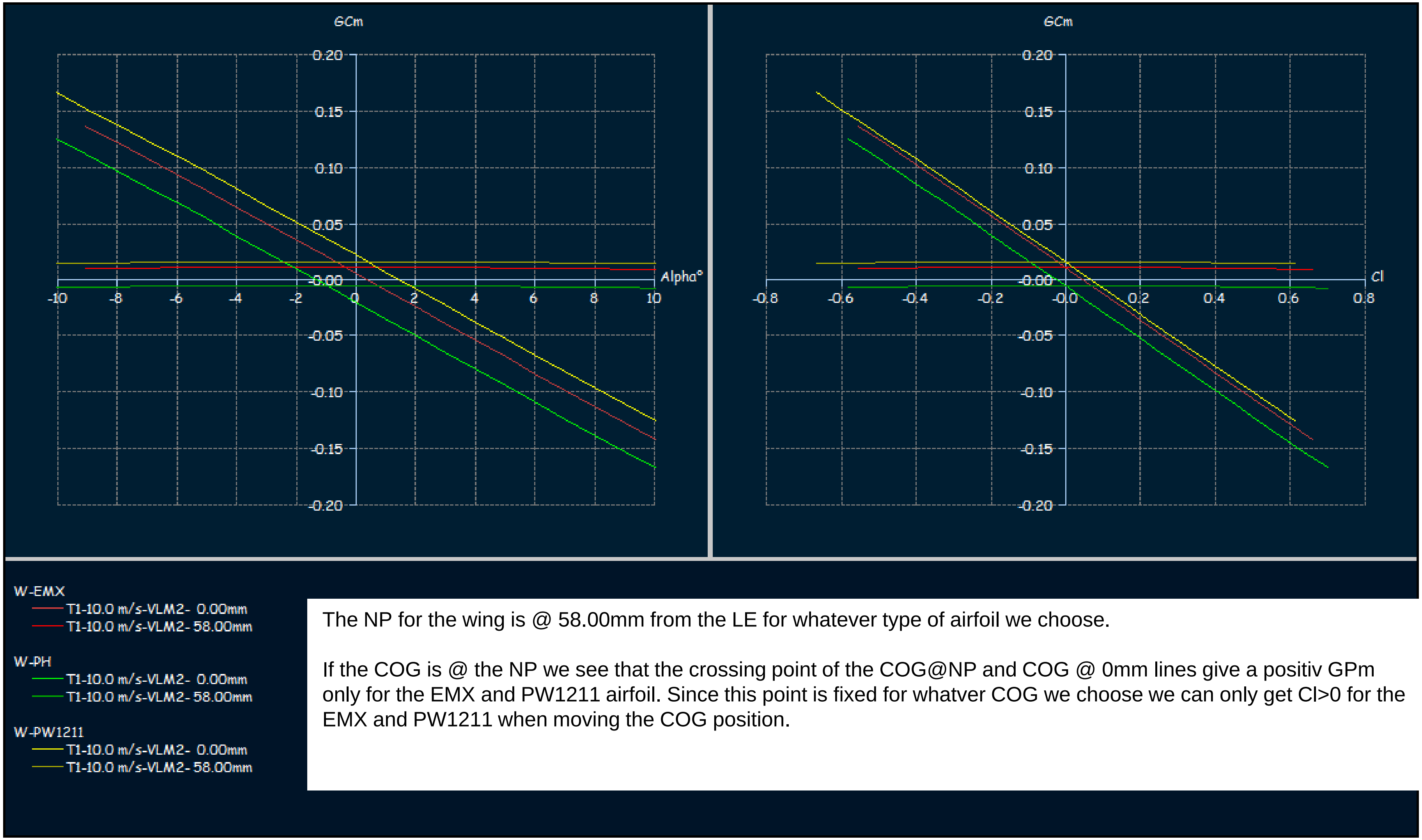
The airfoils



Foil Name	Thickness	At	Camber	At	Points	TE Flap Angle	TE XHinge	TE YHinge
Spline Points Foil	9.13%	29.3%	1.72%	36.4%	105			
EMX-07	7.99%	29.6%	2.58%	20.7%	61			
PH 1.0	8.00%	27.5%	2.80%	25.0%	88			
PW1211 8%-fu	8.00%	23.8%	1.64%	26.7%	84			

- [x] Show Foil
- [ ] Show Points
- [ ] Show Centerline

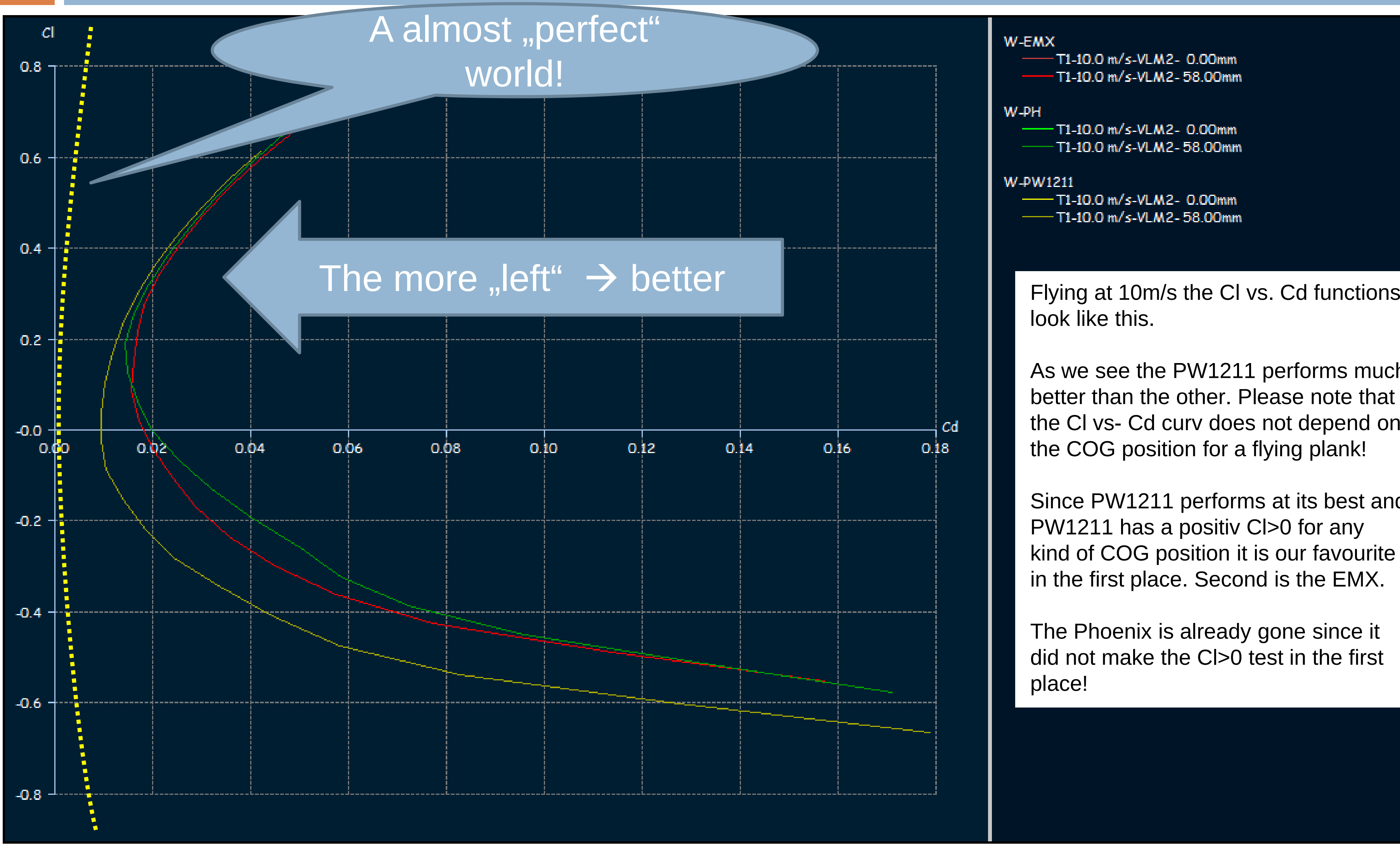
NP Calculations



The NP for the wing is @ 58.00mm from the LE for whatever type of airfoil we choose.

If the COG is @ the NP we see that the crossing point of the COG@NP and COG @ 0mm lines give a positiv GPm only for the EMX and PW1211 airfoil. Since this point is fixed for whatver COG we choose we can only get Cl>0 for the EMX and PW1211 when moving the COG position.

Cl vs. Cd @ 10m/s



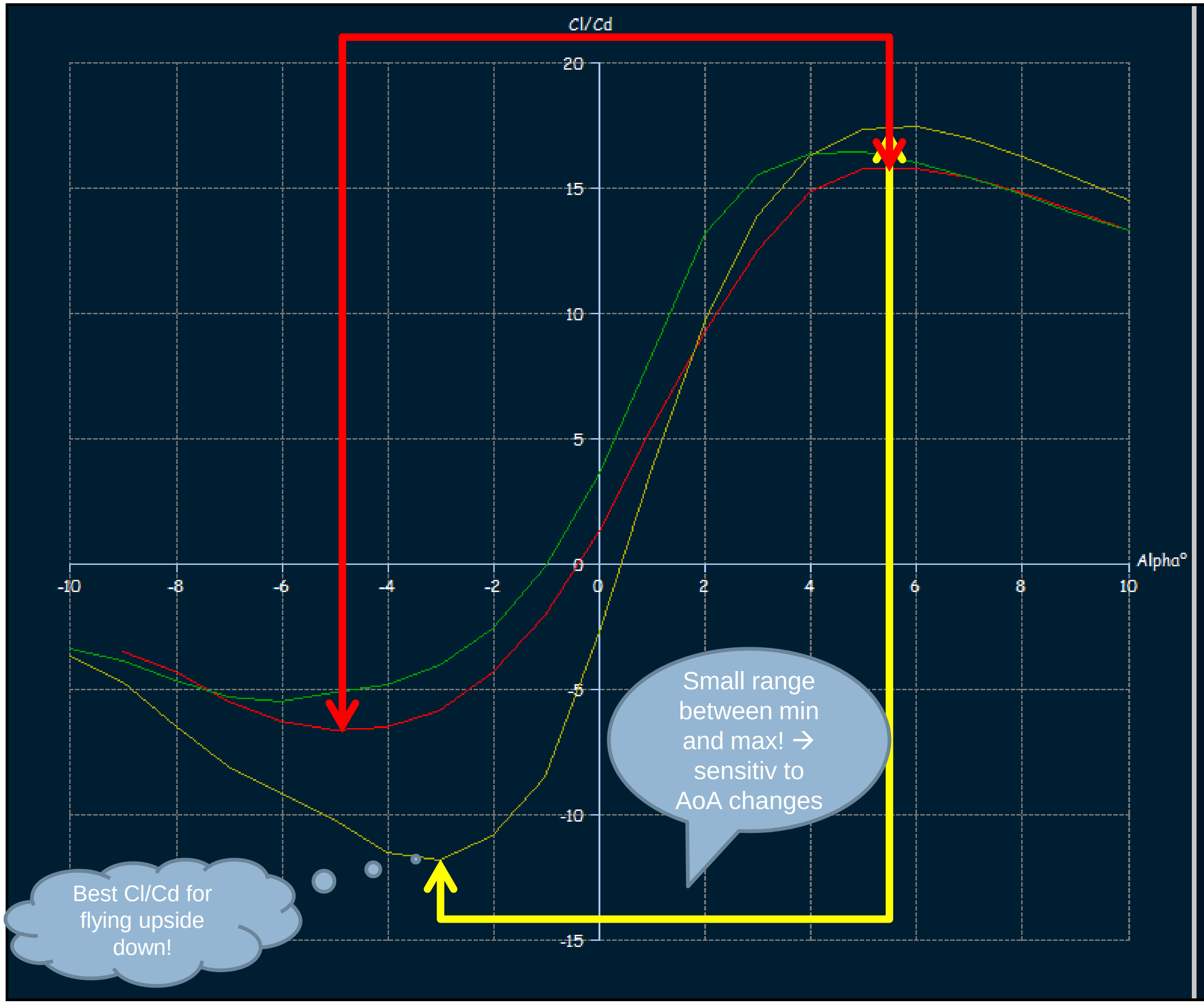
Flying at 10m/s the Cl vs. Cd functions look like this.

As we see the PW1211 performs much better than the other. Please note that the Cl vs- Cd curv does not depend on the COG position for a flying plank!

Since PW1211 performs at its best and PW1211 has a positiv Cl>0 for any kind of COG position it is our favourite in the first place. Second is the EMX.

The Phoenix is already gone since it did not make the Cl>0 test in the first place!

Cl/Cd vs. alpha @ 10m/s



The Cl/Cd vs. Alpha is quite interessting. Since we fly at a fixed speed of 10m/s we now change the AoA (alpha) and search for the best Cl/Cd ratio. Again, this curve does not depend on the COG positions!

The results show that the best Cl/Cd is between 4°-6° for all airfoils.

The minimum Cl/Cd varies very strong with the type of airfoils.

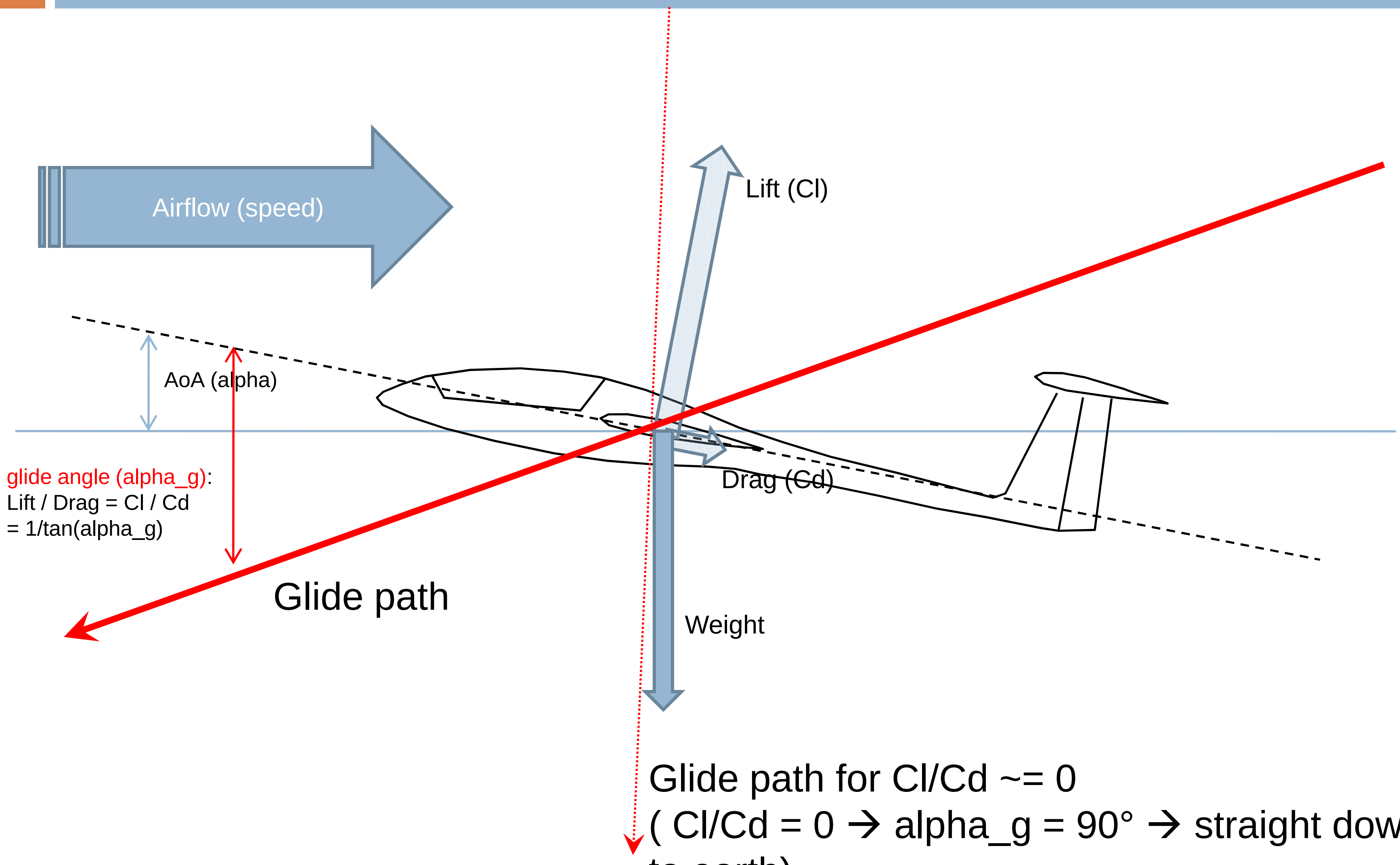
Max Cl/Cd means going as far as possible.
Min Cl/Cd means going as short as possible.

Example: max Cl/Cd = 17 @ 5.5° @ 10m/s, min Cl/Cd = -12 @ -3° @ 10m/s.

From a hight of 1m we can fly 17m if we choose 5.5° and 10m/s (glide angle ~3.3°)

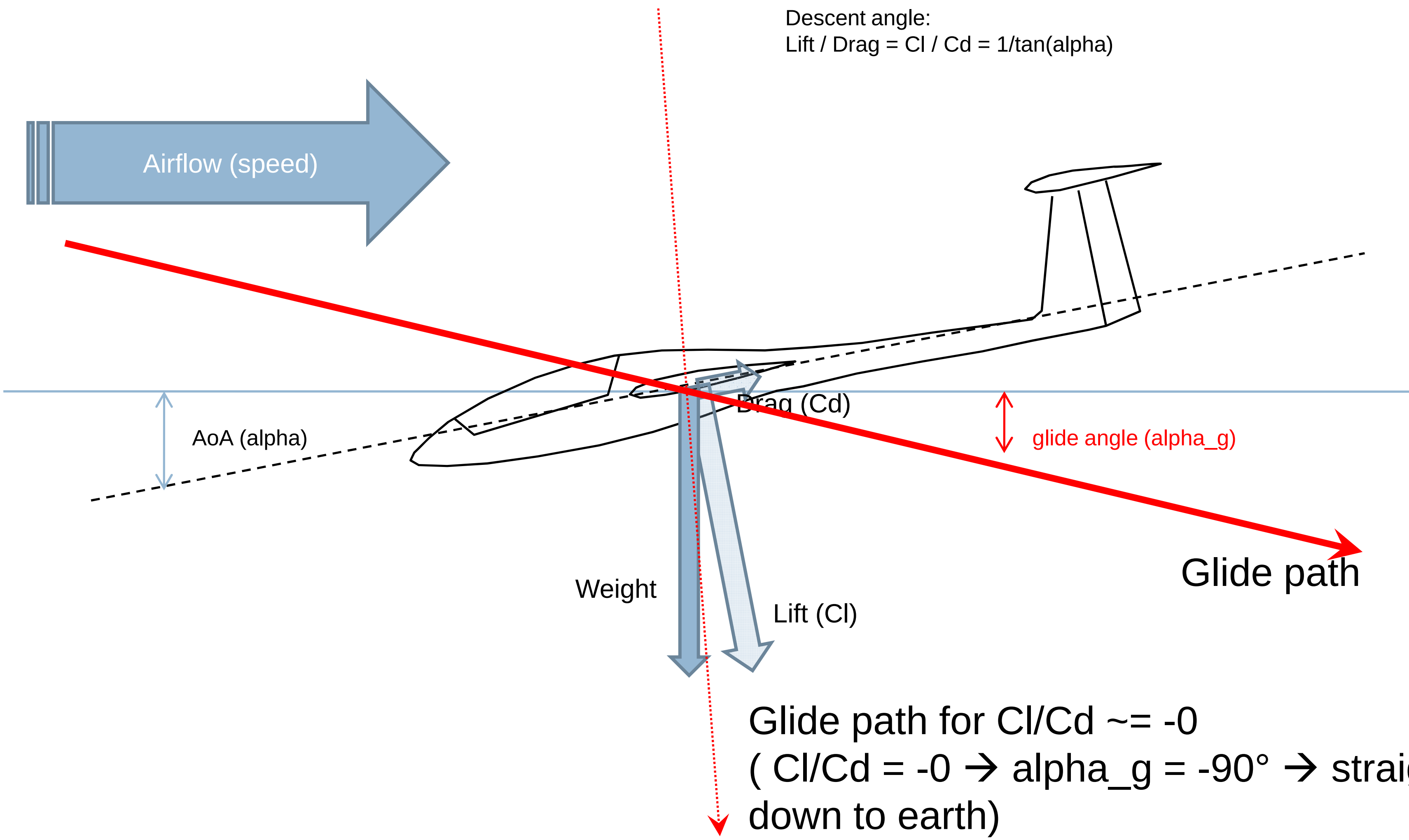
From a hight of 1m we can fly -12m if we choose -3° and 10m/s ??? STRANGE !!!

Cl/Cd definition – glide angle with Cl/Cd >0



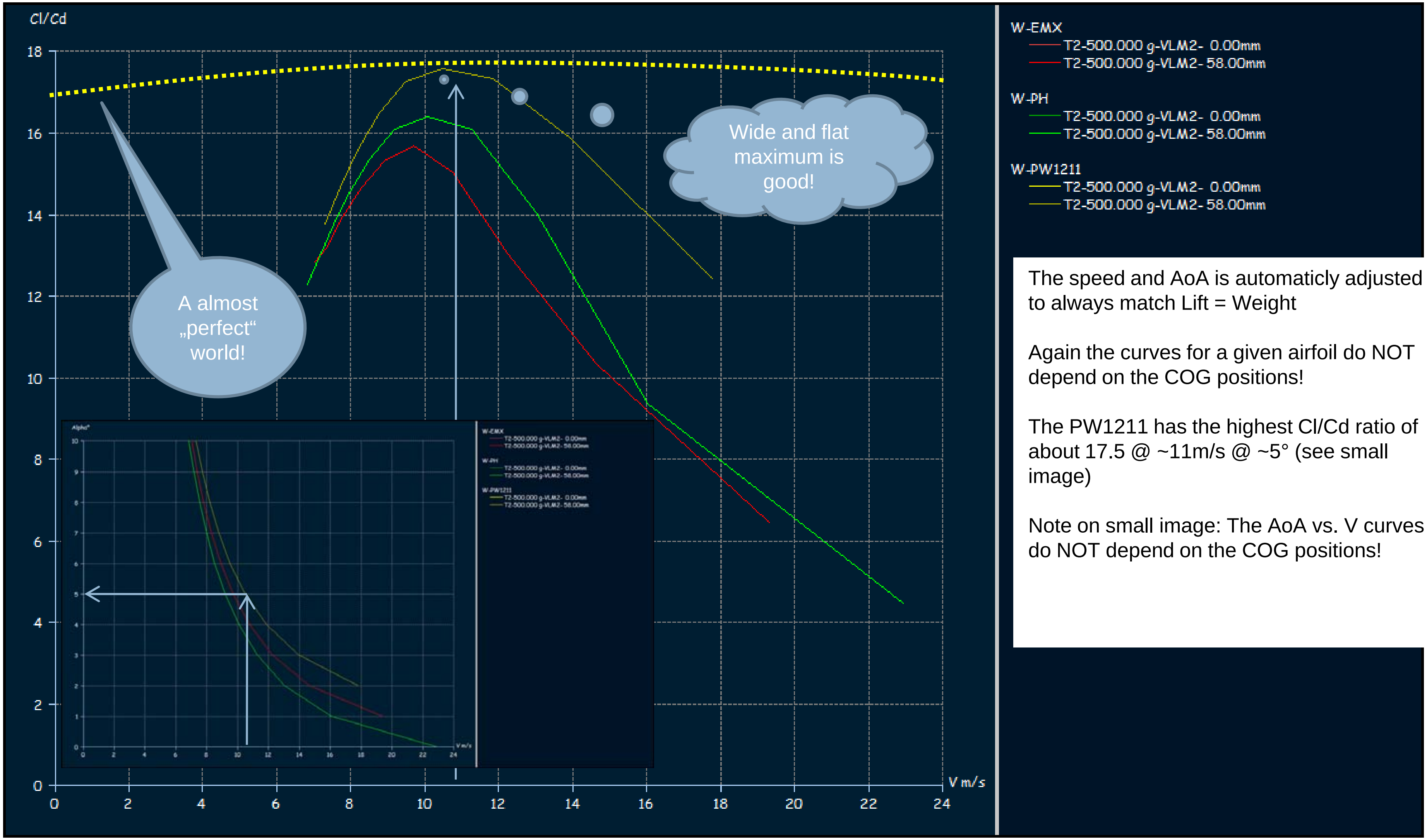
Glide path for Cl/Cd ~= 0
(Cl/Cd = 0 → alpha_g = 90° → straight down to earth)

Cl/Cd definition – glide angle with Cl/Cd <0



Glide path for Cl/Cd ~= -0
(Cl/Cd = -0 → alpha_g = -90° → straight down to earth)

Cl/Cd @ Lift = Weight



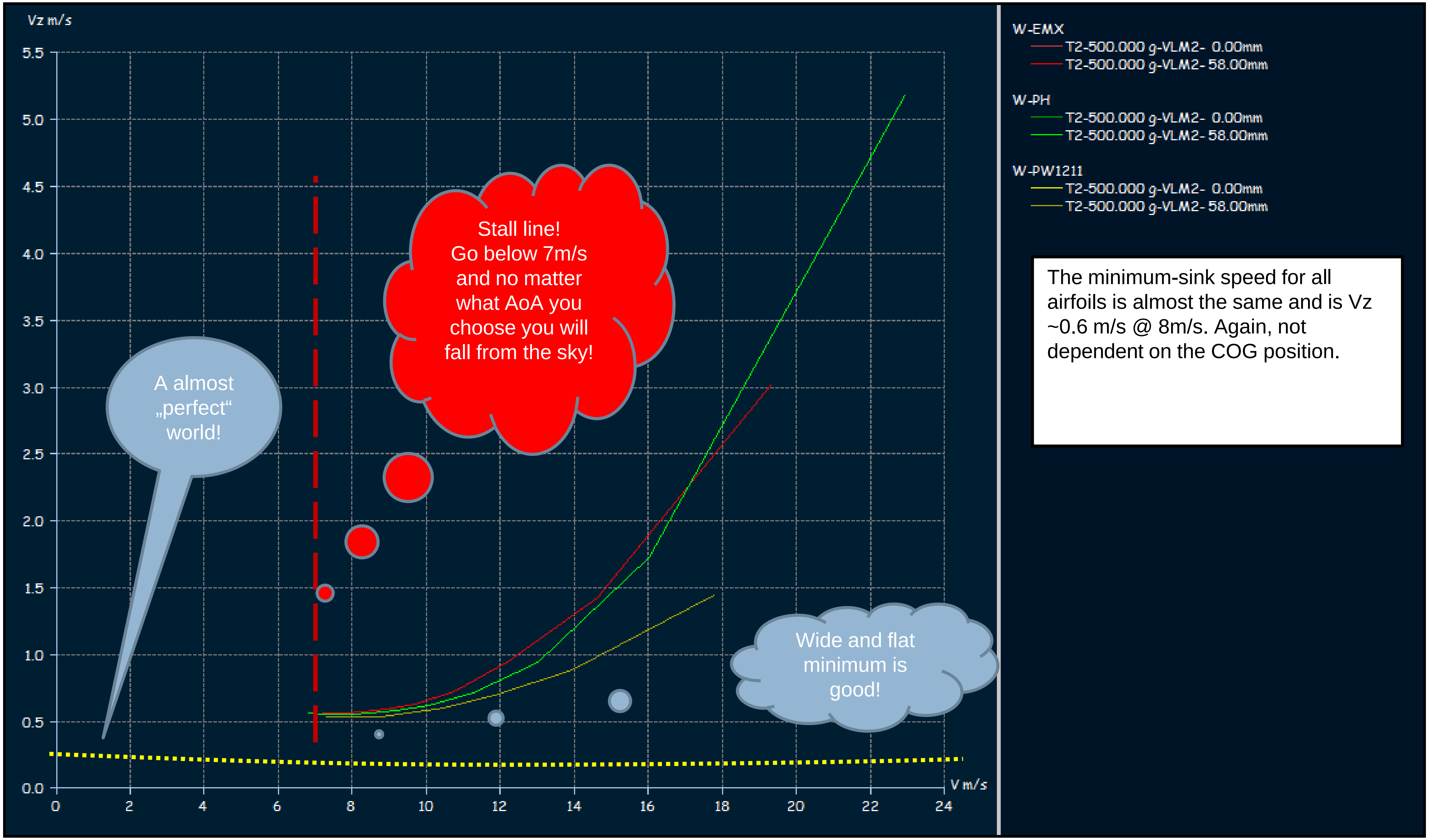
The speed and AoA is automaticly adjusted to always match Lift = Weight

Again the curves for a given airfoil do NOT depend on the COG positions!

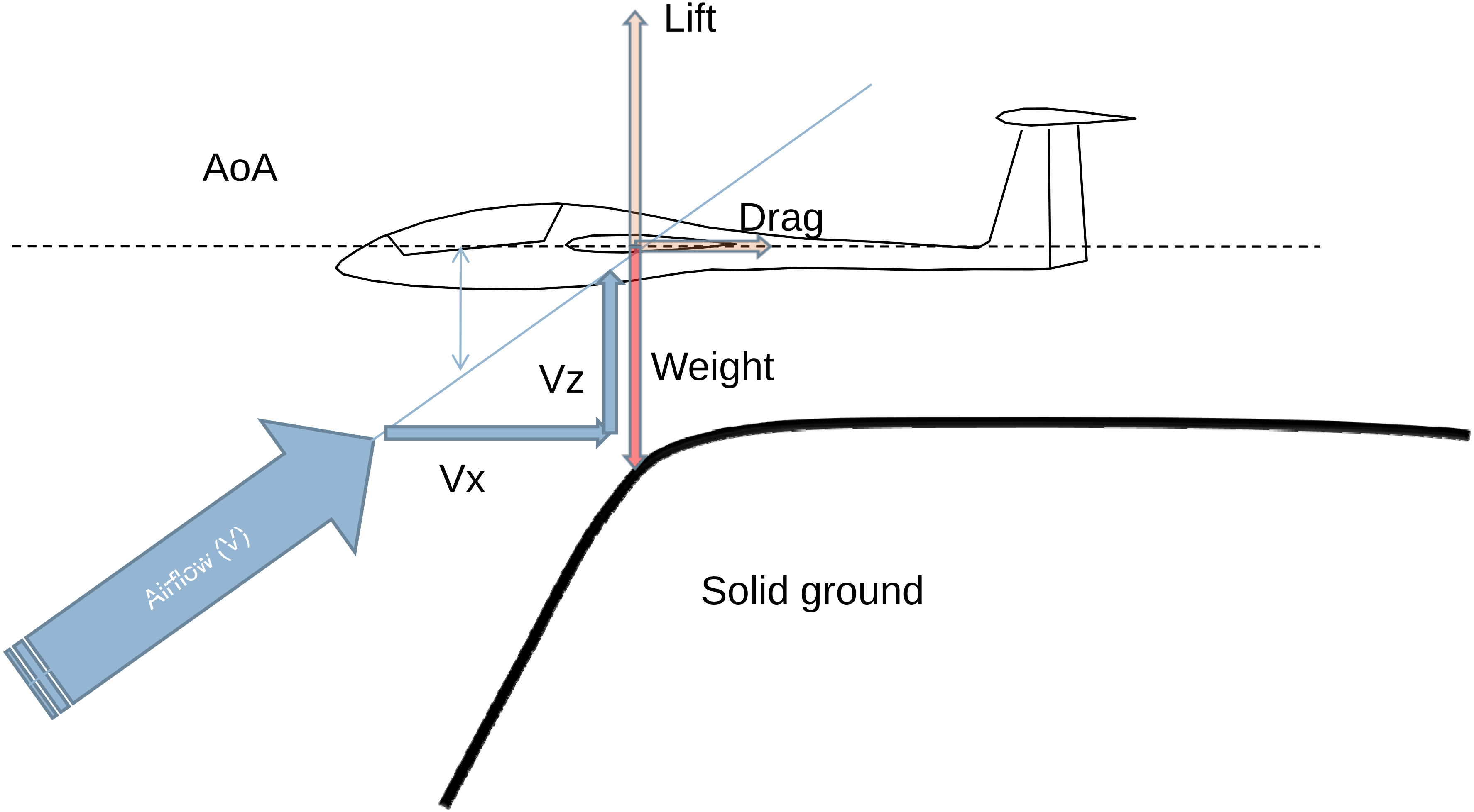
The PW1211 has the highest Cl/Cd ratio of about 17.5 @ ~11m/s @ ~5° (see small image)

Note on small image: The AoA vs. V curves do NOT depend on the COG positions!

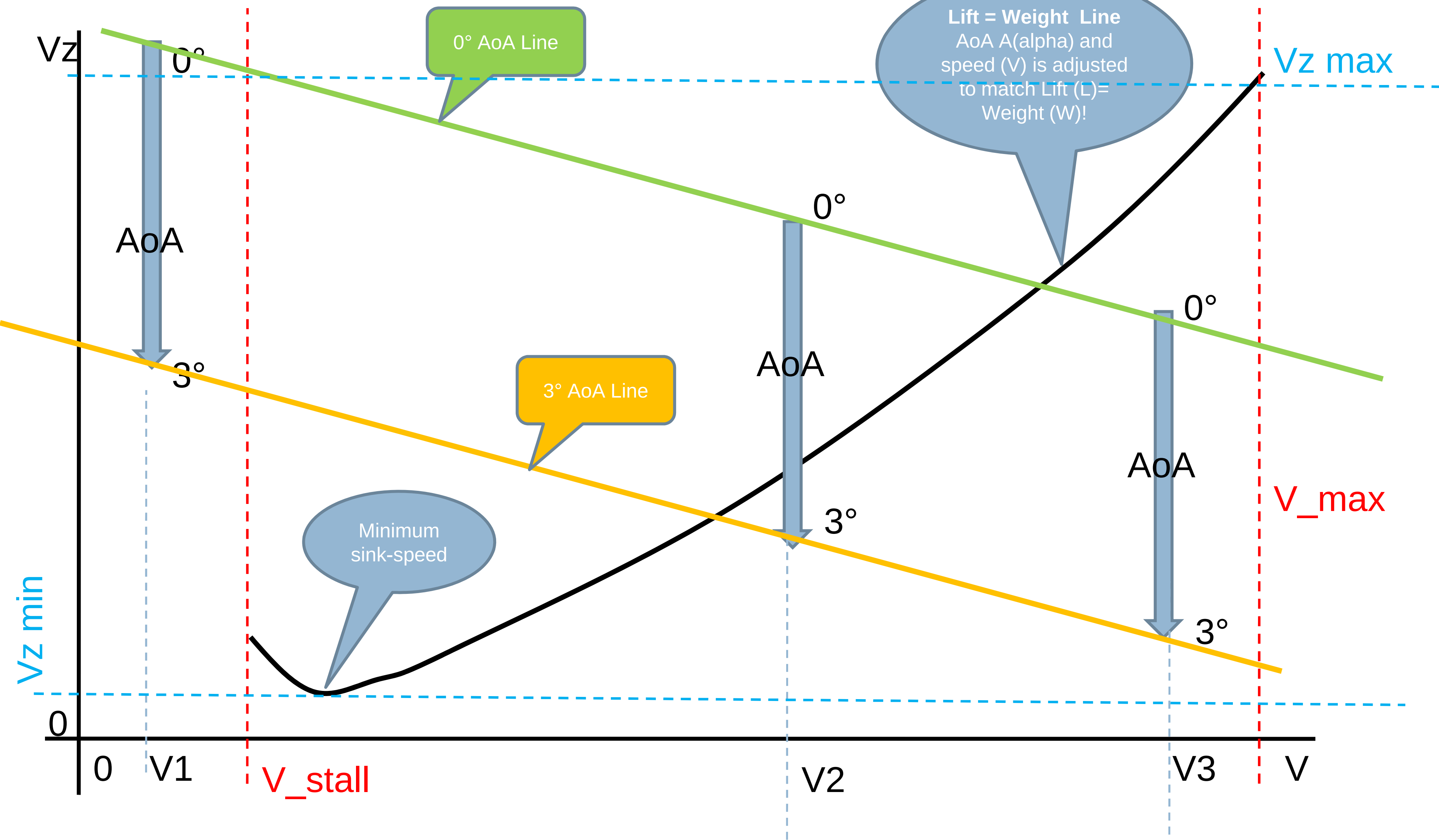
Sink-Rate @ Lift = Weight



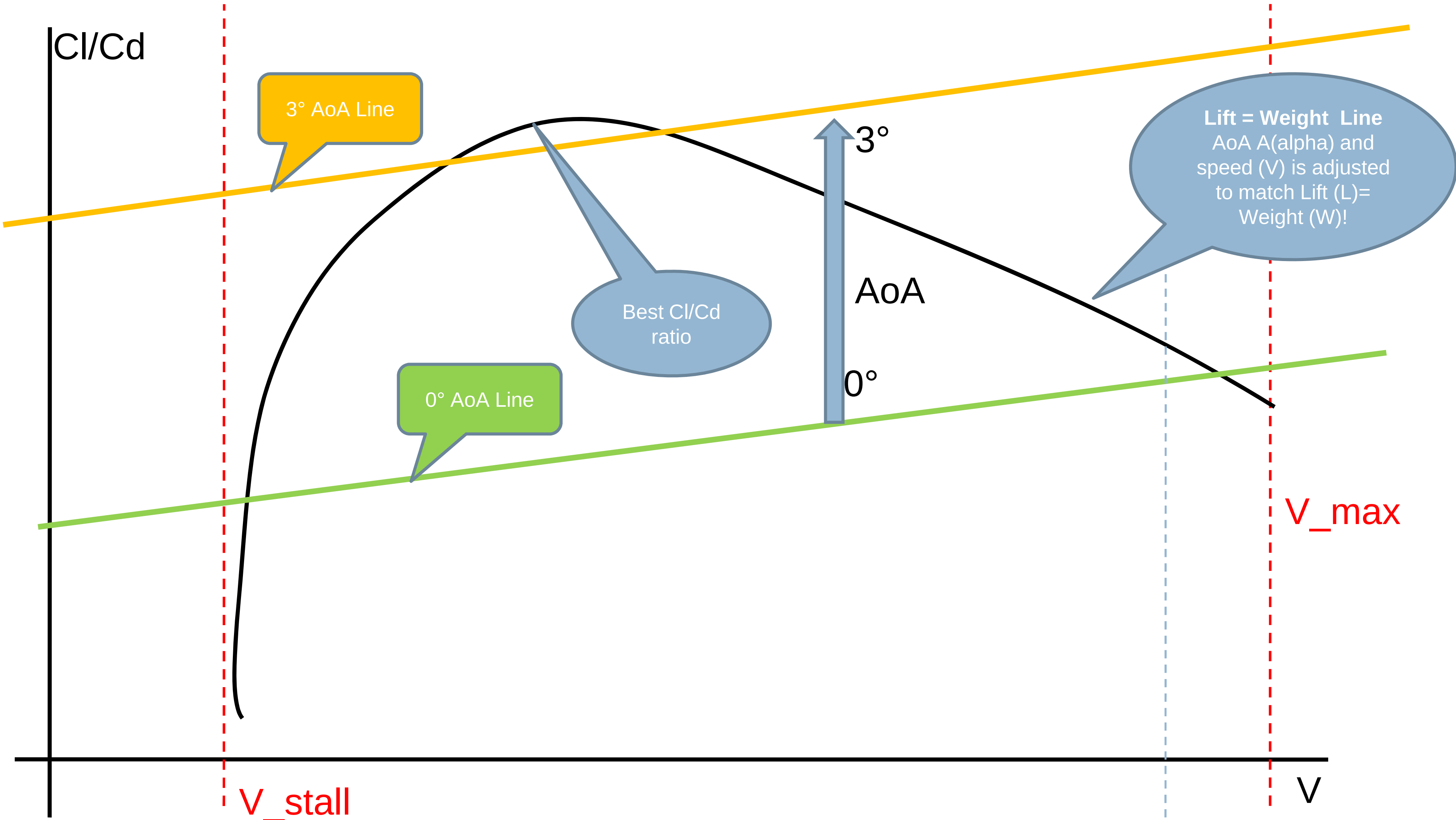
Riding the slope



Lift, Weight, Sink,... → simple

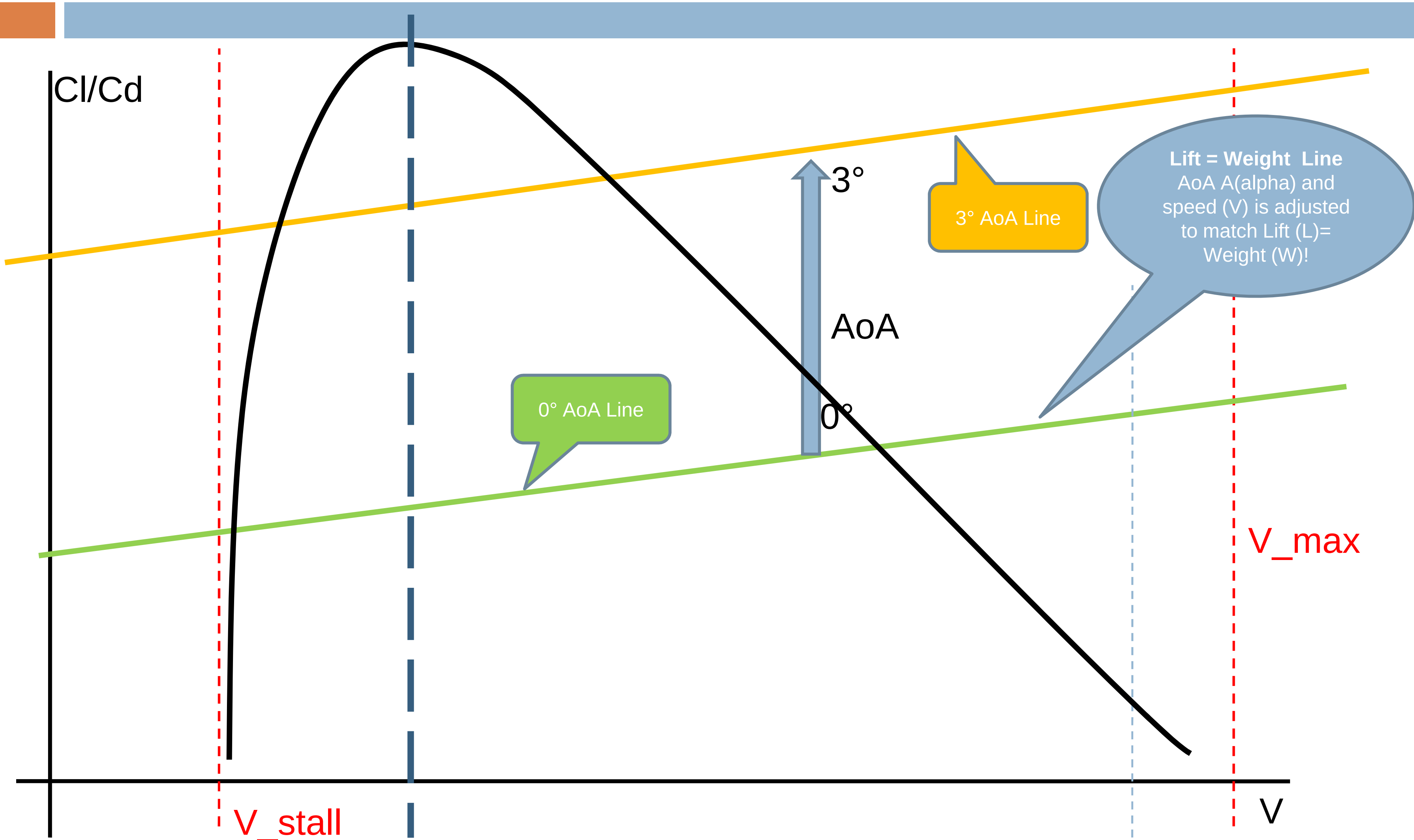


Cl/Cd → simple

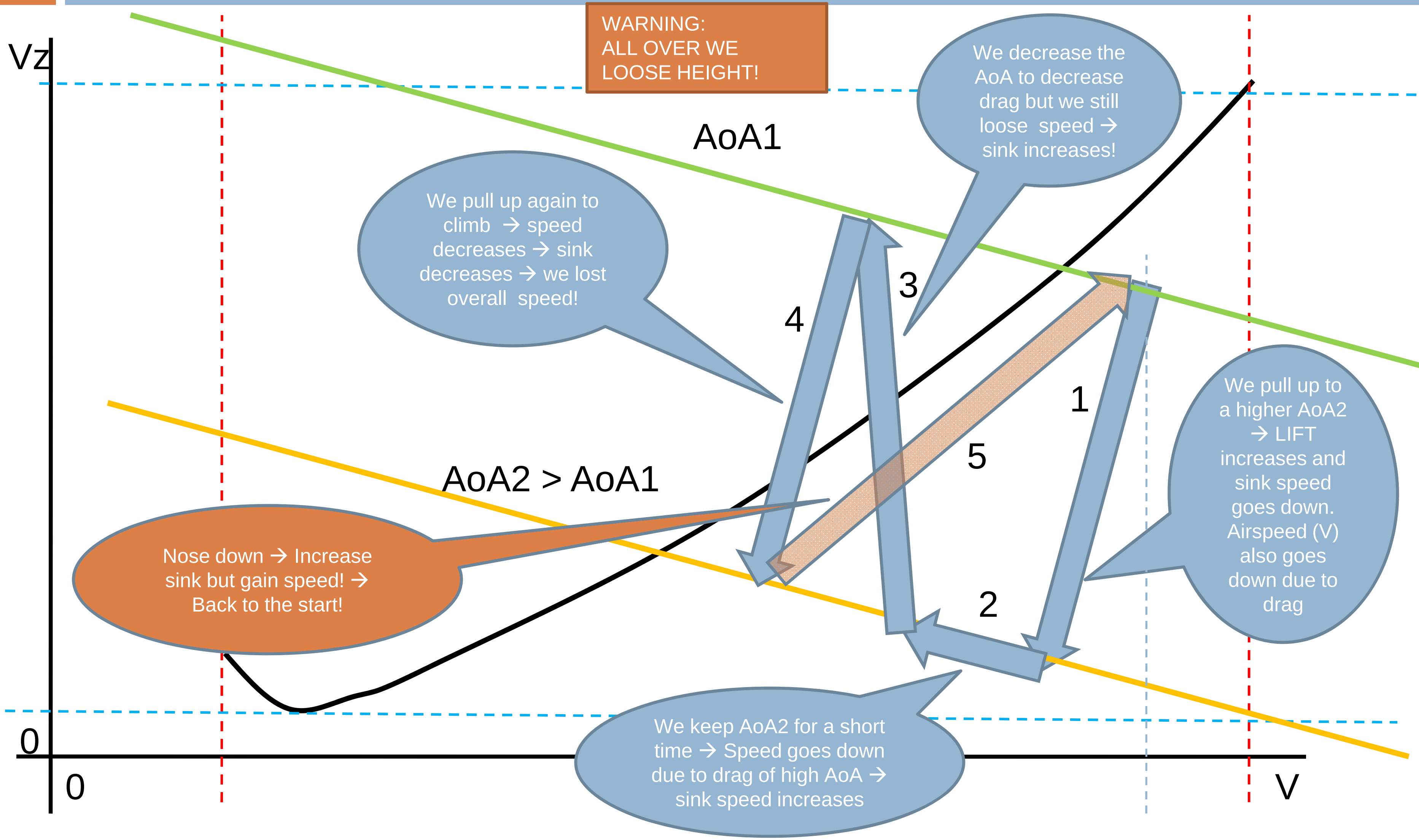


Cl/Cd
3° AoA Line
Lift = Weight Line
AoA A(alpha) and speed (V) is adjusted to match Lift (L)= Weight (W)!
3°
AoA
0°
Best Cl/Cd ratio
0° AoA Line
V_max
V_stall
V

Cl^(3/2)/Cd vs V – power factor



Up and down...


WARNING:
ALL OVER WE
LOOSE HEIGHT!
Vz
0
0
V
AoA1
AoA2 > AoA1
1
2
3
4
5
We decrease the AoA to decrease drag but we still loose speed → sink increases!
We pull up again to climb → speed decreases → sink decreases → we lost overall speed!
We pull up to a higher AoA2 → LIFT increases and sink speed goes down. Airspeed (V) also goes down due to drag
Nose down → Increase sink but gain speed! → Back to the start!
We keep AoA2 for a short time → Speed goes down due to drag of high AoA → sink speed increases

In depth analysis

- For a given V1, V2, V3 we can change the AoA. In the case of V1, whatever AoA we choose we never get into the „Lift Area“
- For V2 we get Lift>Weight (climb) if we choose an AoA close to 3°
- For V3 we always get Lift>Weight for whatever AoA between 0° and 3° we choose
- ➔ Changeing the AoA for a given airspeed reduces the sink-rate (Vz) in the first place.