

Gain or Loss due to wind shifts

Tactical Sailing®

A Game Against the Wind

(Note: This document will be proofread soon.)

Introduction

Sailing – especially regatta sailing – is a fascinating sport that requires not only mental and physical training but also **a solid foundation in geometry** . The central element in sailing is always the wind, which moves the boat. The following section will focus specifically on sailing "upwind".

to illustrate to the skipper – graphically – the gains and losses as well as the "risk zones" by calculating "gained" and "lost" **boat lengths** , and **demonstrate the importance of carefully observing wind shifts** .

As an example, we will use "Opti" boats with a length of **2.30 m** and a turning angle of **45°** .



See the sketches and video clips below.

Summary

Boat **length** is the new standard here.

As a **result** of our analysis of **gain** or **loss** , there are two main reasons.

The **reduction** or **lengthening of the journey** is caused by:

- 
1. **Wind shifts**, such as from 360° to 345°, which shorten the journey,
 2. **Turning points**, that we miss  thus lengthening the journey.

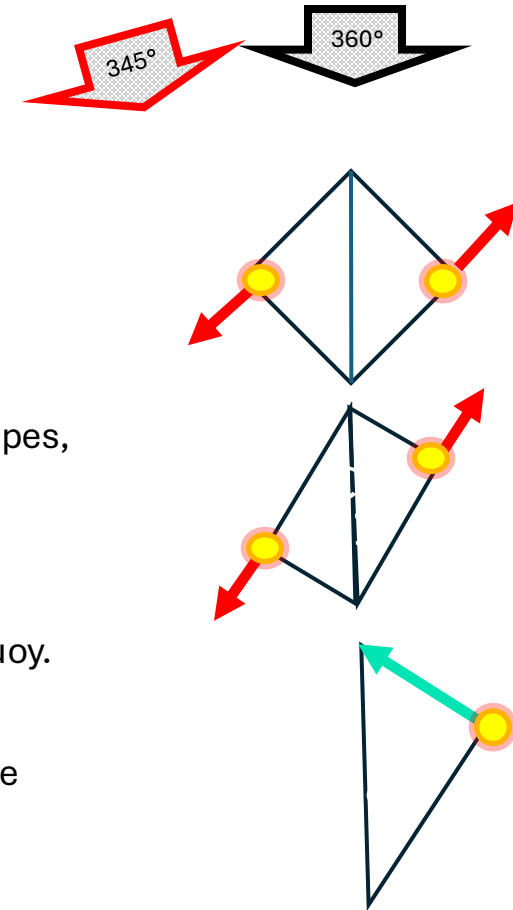
The basis for our considerations about gain or loss are familiar geometric regatta field shapes, namely **square** , **rhombus** and **triangle** .

The square is the longest course a boat must navigate. Wind shifts cause the square to become a rhombus or a triangle.

A quadrilateral, for example, has a distance of 400 m from the leeward to the windward buoy. Then the two "legs" of the course within the quadrilateral are $2 * 280 \text{ m} = 560 \text{ m}$. As an example, let's take a shortened/lengthened **course of 80 m** .

A **gain** then means shortening the course by 80 m, or in the case of **a loss** , lengthening the course by 80 m.

The **boat length of an Optimist is 2.30 m**; therefore, a gain or loss of 80 m results in a **difference of 34 boat lengths** !



Basics about gain and loss

The basis for **gain or loss** is a geometric structure of **stretch and hole bugs**.

A well-known rule states:

"Starboard tack before port tack!"

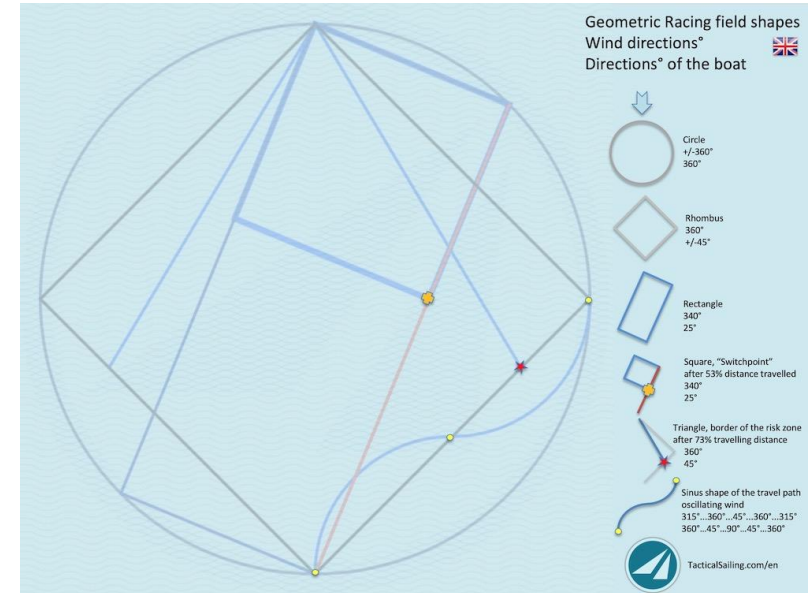
The following geometric rules apply to the regatta course shapes **quadrilateral**, **rhombus** and **triangle**:

A **draw** is always a **win – stretching bug**,

A **pusher button** always carries a **risk of loss - Holebug**.

Wind changes don't only occur at the starting line or the leeward buoy, but also **at any point in the middle** of the racecourse. The so-called "**switch point**," described by Tilo Schnekenburger*, is one such point for **tactical decisions**, for gain or loss.

* See notes on Tilo Schnekenburger in the appendix.



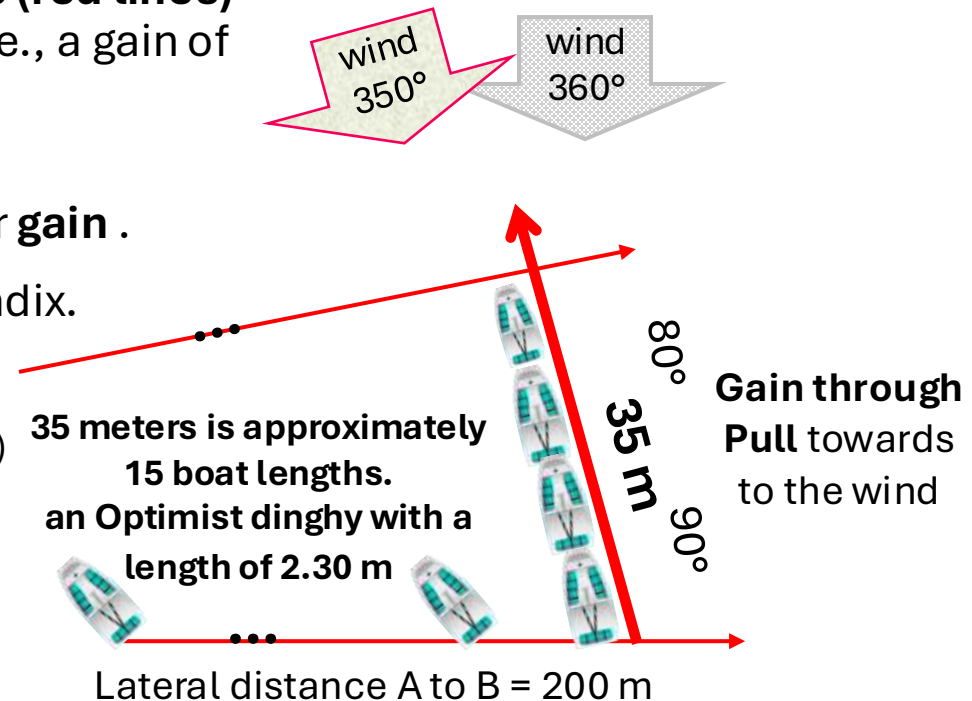
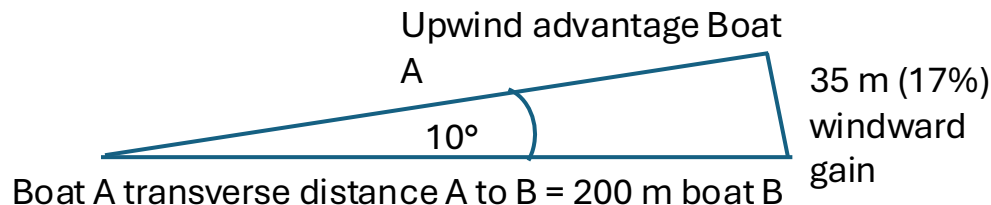
Geometric regatta field shapes: **square**, **rhombus** and **triangle**.

Gain in "boat lengths"

A wind shift of **-10°** caused by a "pull" and a transverse distance of **200 m** creates an "advantage", for example at a starting line. The **resulting upwind advantage** of **35 m** then **corresponds to approximately 15 boat lengths (red lines)** for an Optimist dinghy with a length of 2.30 m, i.e., a gain of approximately **17%**.

The so-called "**10:17 rule**", described by Tilo Schnekenburger*, is an important calculation for **gain**.

* See notes on Tilo Schnekenburger in the appendix.



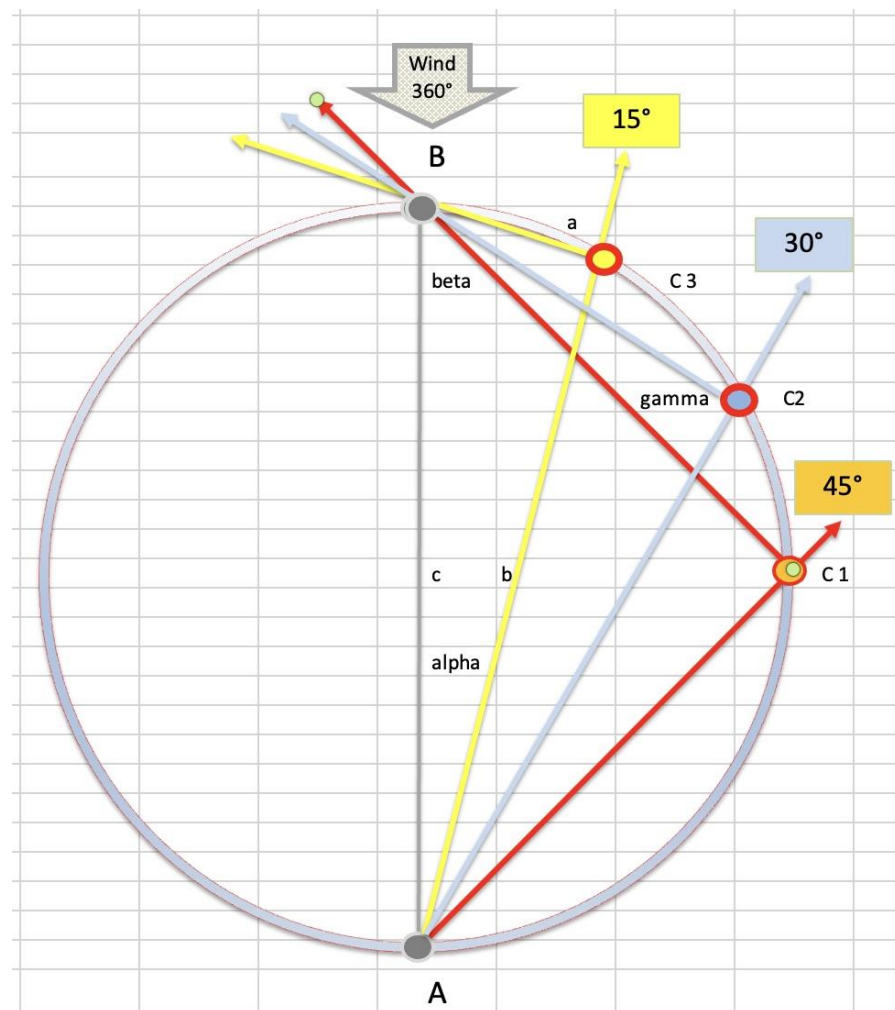
Pull and gain through wind shift in the direction of travel from 45° to 30° and 15°

The wind shifts caused by a "**puller**" of 15° each result in directions of travel of 30° and 15°, which bring a boat ever closer to the windward mark (B).

The colored lines of varying lengths show the "**gain**" achieved by shortening the "distances" of 22 m and 78 m to the windward mark (B).

The **gain** then corresponds to an Optimist dinghy with a height of 2.30 m. Length provides an advantage of approximately **10 or 34 boat lengths!**

See the calculations in the appendix.



Push and loss due to wind shift in the direction of travel from 315° to 300° and 285°

The wind shifts caused by a "**push**" of 15° each result in the sailing directions 300° and 285°, which always bring a boat "further away" from the windward buoy (B).

The three colored lines of varying lengths initially show **no extension** along the "course" from the leeward buoy (A) on the "**holebow**" in the direction of 315°, 300°, or 285°. The courses correspond to the regatta course shape of a "**rhombus**".

The extension in the example with 285° is **100 m**.

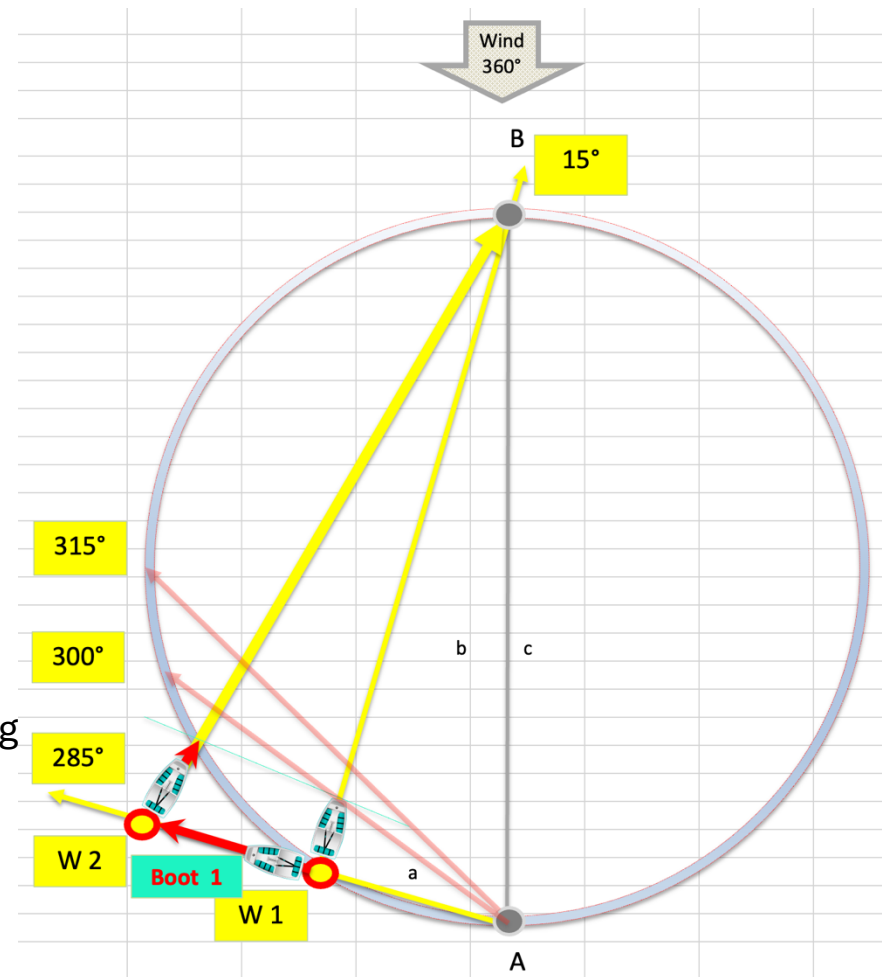
Reason: Boat 1 makes a **serious mistake** and misses the turn at **W1**; it continues towards **285°** and only turns at **W2**!

The same conditions apply to directions of travel 315° and 300°.

For an Optimist dinghy measuring 2.30 m in length and sailing a distance of approximately 22 m to 30 m, this **loss equates to 10 to 13 boat lengths!**

See the calculations in the appendix.

A detailed explanation of this example is provided on the following slide.



Example: Loss on the hole bug due to wind shift

Boat 1 must first sail a **320° push** by shifting the wind on the holebow .

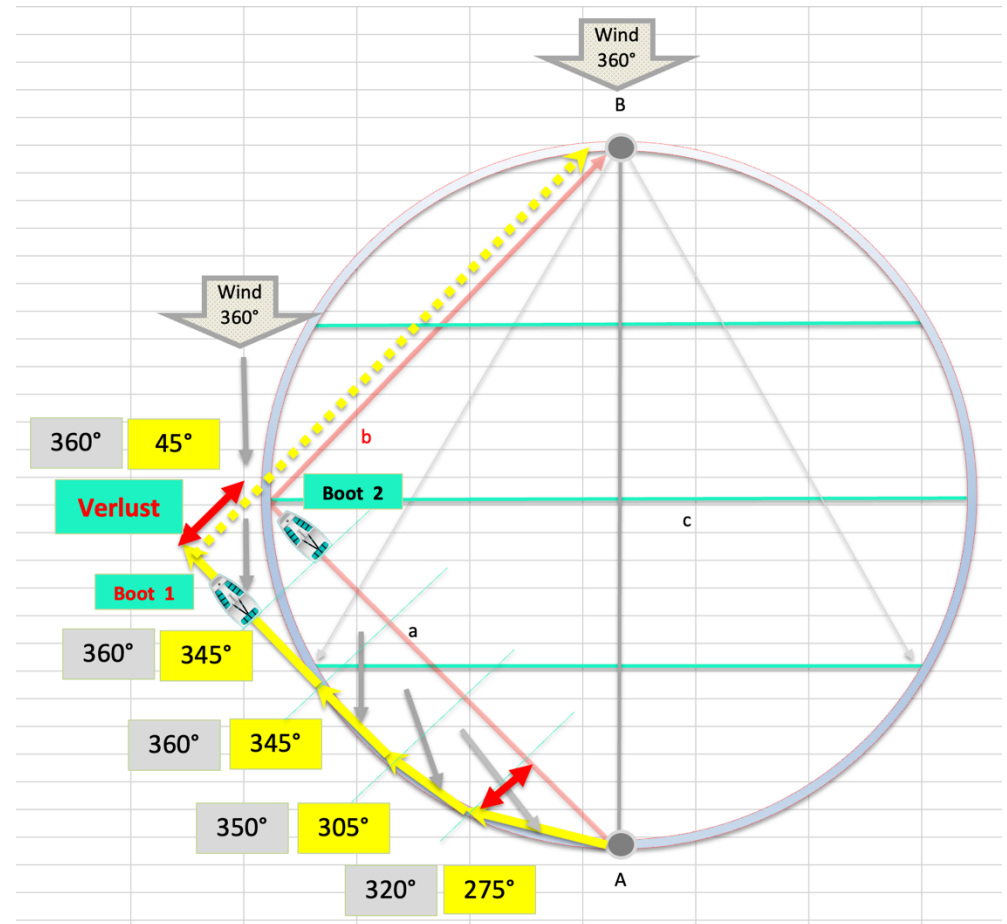
Then there is a sustained, gradual change in wind direction from 320° to 350° and then to 360° .

This corresponds to a change in course from 275° to 305° and then to 345° .

The wind then remains constant at 360°, and Boat 1 enters the " **risk zone*** " (grey line). It soon turns onto a course of 45°, having **lost** approximately 30 meters by that point .

The **loss** for **boat 1** corresponds to an Optimist with a hull length of 2.30 m. Length approximately **13 boat lengths!**

* Risk zones are shown on the following page.



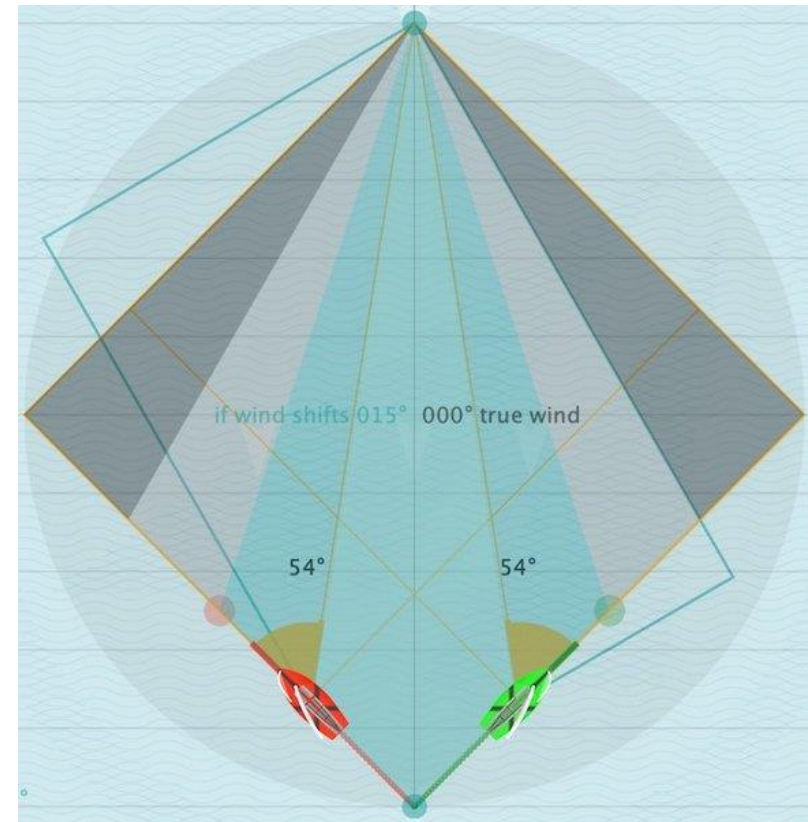
Risk zones

The risk-reward zones

The color-coded "risk-opportunity zones" in the image represent **tactical "decision areas"** whose boundaries should not be crossed or should be observed on the port and starboard sides. These zones depend on the turning angle of a boat. For practical reasons, the drawings assume a boat with a 90° turning angle (e.g., Optimist, 470) and a **wind direction** of 360° that **can vary by +/- 15°**.

Different segments and boundary lines are distinguished by different colors:

- dark gray areas mark the **absolute loss zone** at a distance of 75% to 100% from the center line,
- light gray areas mark the **high Risk zone** and simultaneously **high opportunity zone** at a distance of 50% to 75% from the center line.
- Turquoise areas mark the zone with **medium risk** and/or **medium opportunity** at a distance of 25% to 50% from the center line.
- Light turquoise areas mark the zone with **minimal risk** and/or **minimal opportunity** at a distance of 0 to 25% from the center line.



Wind shifts across the entire regatta course

Wind shifts can come on the regatta course in **small** steps. The wind direction can change **gradually**, for example by $\pm 5^\circ$ when approaching the shore. A **sudden change** in wind direction can be caused by a gust, for example by $\pm 15^\circ$.

Wind changes don't only occur at the starting line or the leeward buoy, but also **at any point** of the race course. The so-called "**switch point**," described by Tilo Schnekenburger**, is one such point for **tactical decisions**, for gain or loss.

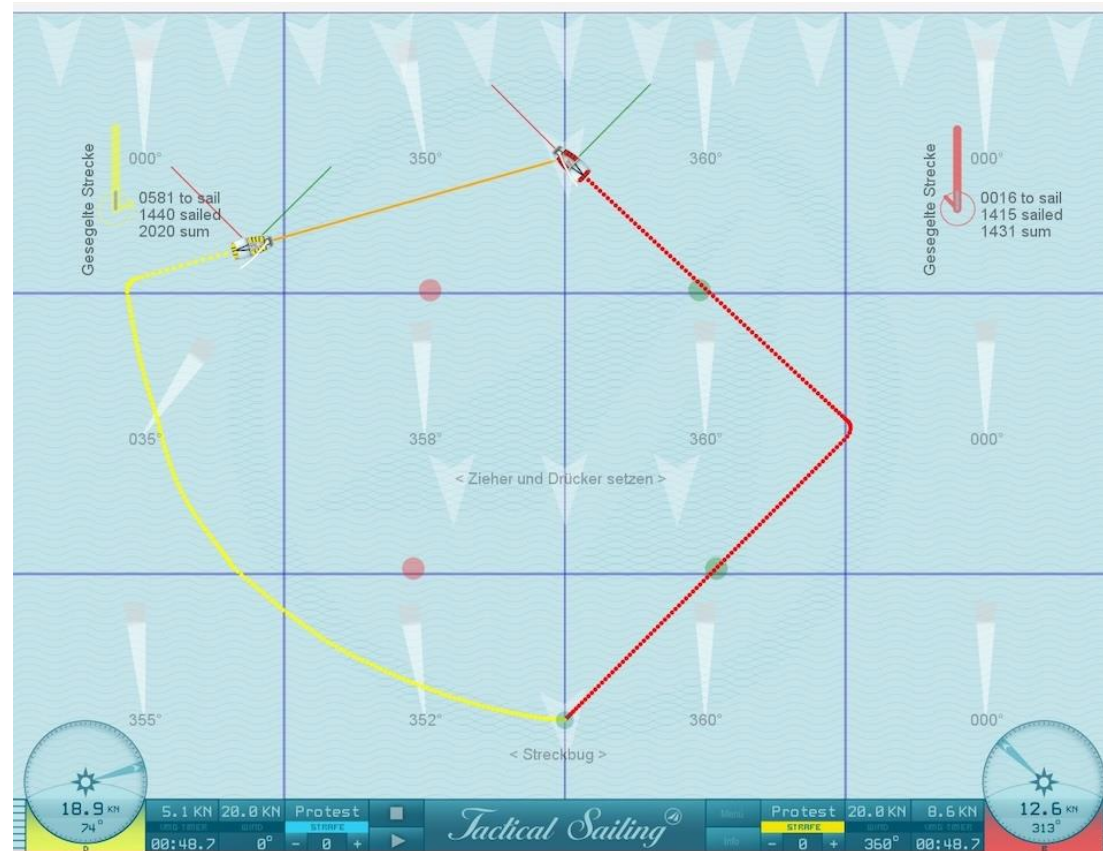
The Tactical Sailing program simulates a regatta course with wind conditions in 12 zones that change in both **direction** and **strength**. These can be constant or follow rhythmic lines*.

The geometric analysis of these situations is **very complex** if one also considers any position of the boats (left/right side, top/bottom) as well as their **lateral distance** on the regatta field.

If the wind shifts continuously beyond 360° , the **sailing route** can easily become a so-called "**banana**," resulting in a significant loss of time and distance.

* See PC simulations with the Tactical Sailing program on YouTube.

** See notes on Tilo Schnekenburger in the appendix.



The yellow route becomes a so-called "**banana**"

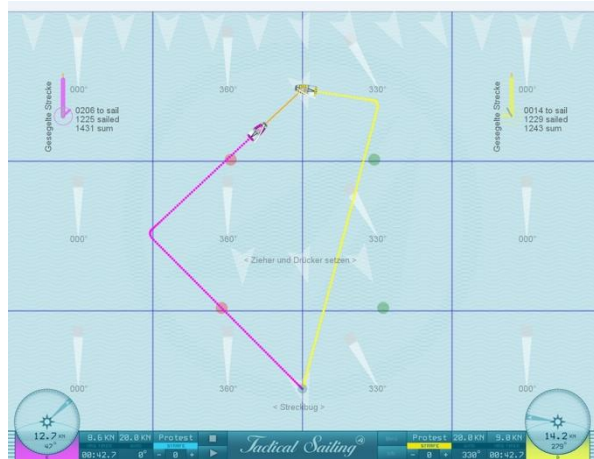
Simulations with the Tactical Sailing (TS) program. See video clips on YouTube.

- Risk at the turning point – the “Switch Point”
<https://www.youtube.com/watch?v=u2tRKjDODGc>
- Advantage of the 10:17 rule
<https://www.youtube.com/watch?v=5Sn4d4e7LQ4>
- Pull and push winds in a migrating gust
<https://www.youtube.com/watch?v=QAzmLElzZic>
- Boat to boat - leverage with risk
<https://www.youtube.com/watch?v=Rr3wW-sgqoE>
- Starting line with decision for left or right side
<https://www.youtube.com/watch?v=u2tRKjDODGc>
- Avoid risk zones
<https://www.youtube.com/watch?v=4PdM06uuaCw>
- Download the **Tactical Sailing program with Coach's Toolbox** from the TS website:
<https://www.tacticalsailing.com/en/coachs-toolbox>

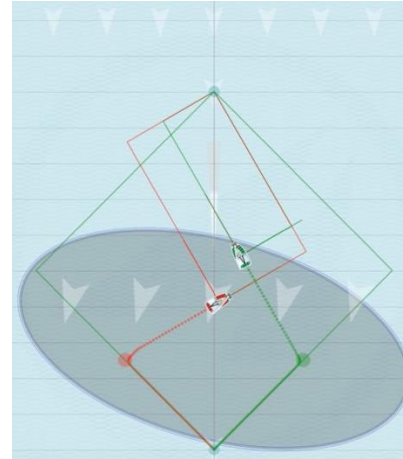


Gain through "pulling" in the direction of travel
15° (yellow) is simulated by the Tactical Sailing
program.

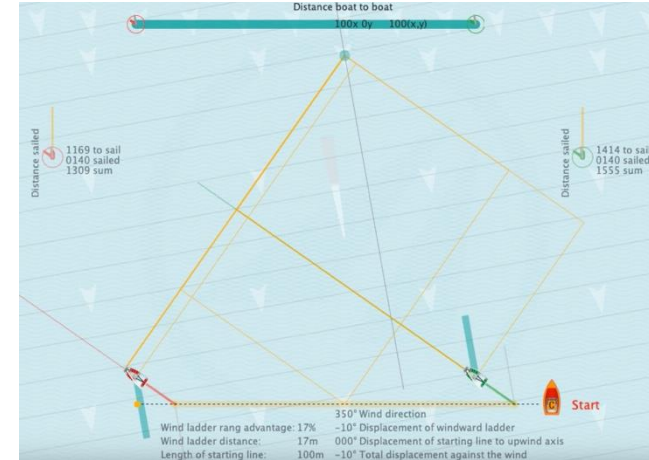
Attachment: Examples of Tactical Sailing Program Scenes



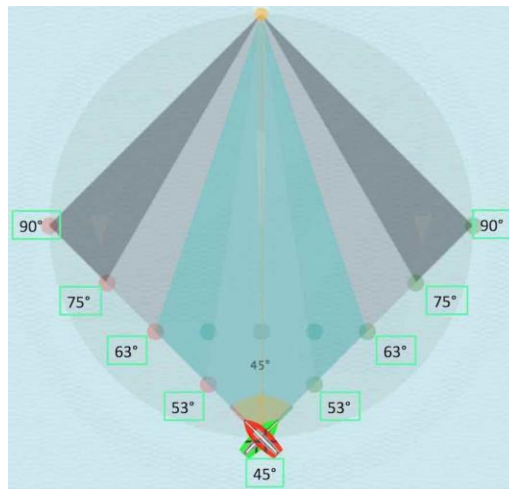
12 wind zones, lift (yellow)



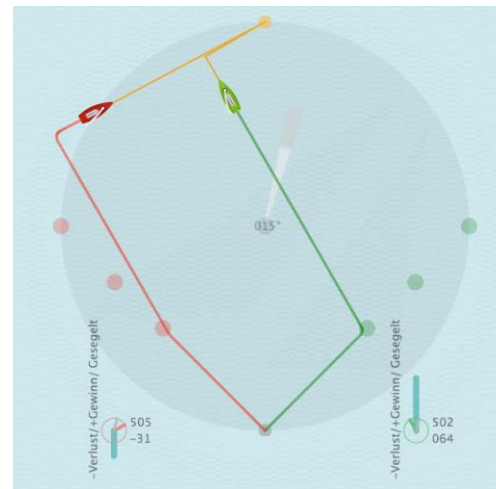
Wind gust



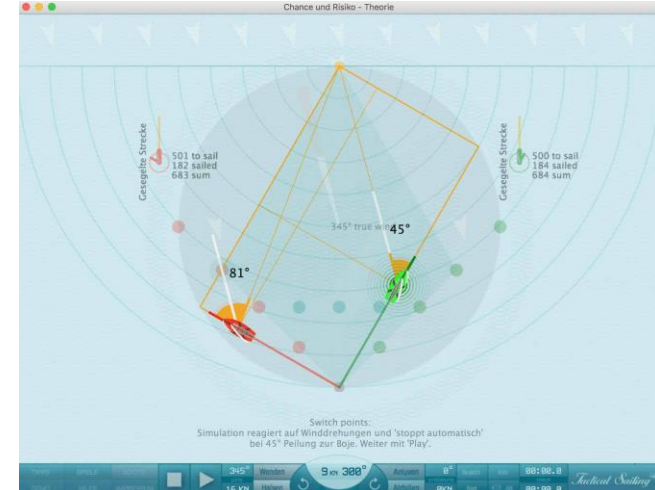
10:17 rule



Risk zones



Gain/Loss Calculation



Switch Point

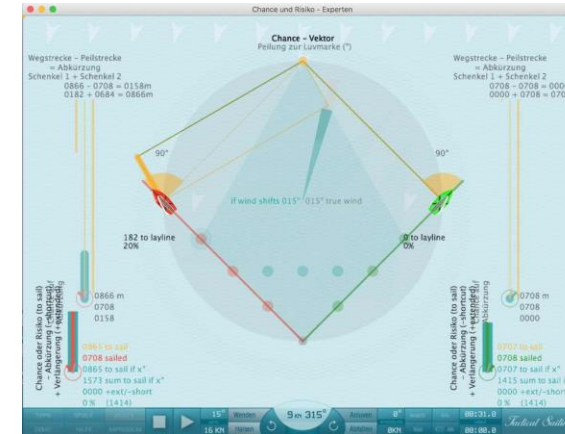
Attachment: Examples of Tactical Sailing Program Scenes



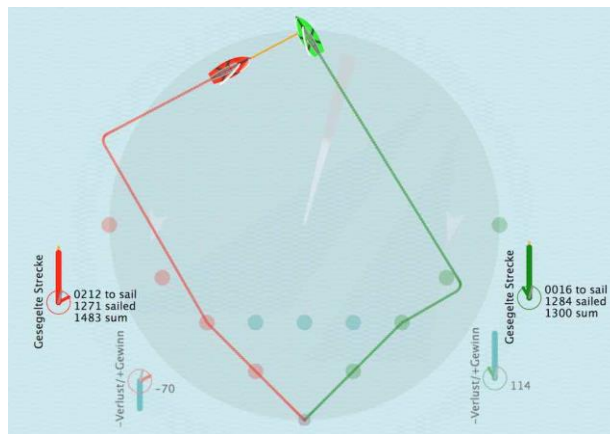
Distance circles - boat to boat



Diamond: gain - Loss



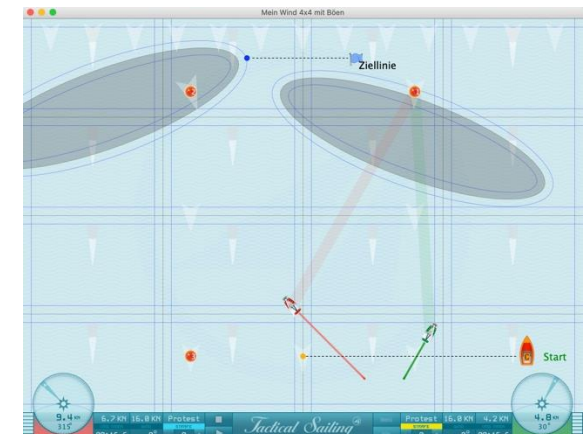
Values of the calculations



Display of gain and loss



My regatta; 4 boats, 16 wind fields



2 gusts in 16 wind fields

Attachment: Gain and Loss Calculations

Gain

Wind richtung °	Seiten (m)			Fahr richtung °	Fahr strecke(m)	Gewinn(m)	Anzahl Boote
	a	b	c	α °			2,3
360°	284	284	400	45	568	0	0
345°	200	346	400	30	546	22	10
330°	104	386	400	15	490	78	34

Loss

Wind richtung °	Seiten (m)			Fahr richtung °	Fahr strecke (m)	Verlust(m)	Anzahl Boote
	a	b	c	α °			2,3
330°	100	373	386	285	590	22	10

Loss and risk zones %

Fahr richtung °	Wind °	Schenkel länge b m	Verrlust Verlänge rung m Boot 1	Anzahl Boote	Risikozonen Faktor %
				2,3	
45	360	282.8	29,5	13	0
345	360	282.8	29,5	13	75-100
345	360	282.8	29,5	13	50-75
305	350	282.8	25,8	11	25-50
275	320	282.8	22	10	0 - 25

The basis for the calculations in the right-angled triangle are:

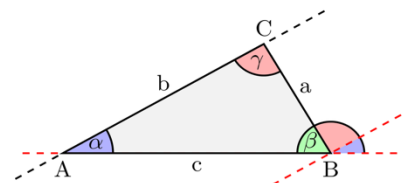
- the diameter of the circle, the side "c" (leeward to windward) is 400m,
- the formula of the "Pythagoras": $a^2 = b^2 + c^2$, and the "sine rule":
- $a : b : c = \sin(\alpha) : \sin(\beta) : \sin(\gamma)$.

See the article in the topic area. "Rule of Three Calculator" – www.Smart-Rechner.de

Recommendation: **A very good, flexible tool** for calculating triangles can be found here:

<https://www.smart-rechner.de/dreieck/rechner.php>

Publisher: Expert on calculating triangles, see: [Michael Mühl](#)

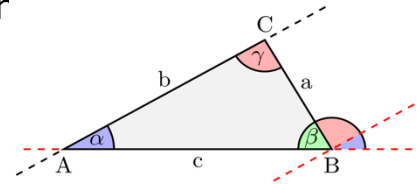


Attachments: Sources

Calculations:

The calculated distances in meters (boat lengths) are only exemplary values to illustrate the geometric relationships. The following principles apply:

- Calculations are performed within a right-angled triangle,
- the distance from leeward to windward, side "c", is set to 400 m for the calculations,
- constant boat and wind speeds are assumed,
- Optimist dinghies with a length of 2.30 m and a turning angle of 45° are used.



"The Geometry of Regatta Sailing"

Die Geometrie des Regattasegelns" (German language, 3rd edition 2024). Geometric tools for strategy and tactics in regatta sailing. ISBN: 97 83 75 83 70 700. See the website:

www.schnekenburger.click.

Contact: schnekenburger@segelverband-bw.de



The "Tactical Sailing Program (TS)"

simulates wind shifts and gusts, including gains and losses, pulls and pushes, wind speed changes, and gusts. Equipped with a "Coach' Toolbox," the TS offers flexible learning and training options for optimally utilizing wind shifts.

Parameters such as wind speed changes, tacking points, boat selection speeds, and the display of calculated routes can be customized.

Download the program from:

<http://www.tacticalsailing.com/en>. A detailed description is available in the documentation:

"Coach' Toolbox": <https://www.tacticalsailing.com/en/downloads/documentation/coachs-toolbox>,

Documentation:

https://www.tacticalsailing.com/fileadmin/files/downloads/documents/en/TS_Toolbox_en.pdf

See video clips on YouTube: <https://www.youtube.com/@TacticalSailing>

Contact: office@TacticalSailing.de .

