DHV-Safetytest LTF A- und B- Paragliders, Part 8

This report extends the work publicised in DHV Info 174 which can also be found under www.dhv.de. Details on how we have classified the gliders, the relevance of different manoeuvres to accident statistics, German airworthiness requirements (LTF certification) and other details can be found there. The DHV safety and technical department tested the following gliders in the 8th round of its ongoing safety test program:

Glider	LTF Test number	Weight range
LTF A		
BGD Adam M	EAPR-GS-0148/14	70-95 kg
LTF B		
Skywalk Tequila 4 S	DHV GS-01-2077-13	70-95 kg
Icaro Instinct TE M	DHV GS-01-2086-13	85-110 kg
EN B		
Ozone Rush 4 ML	AIRT_PG_0805.2013	85-105 kg

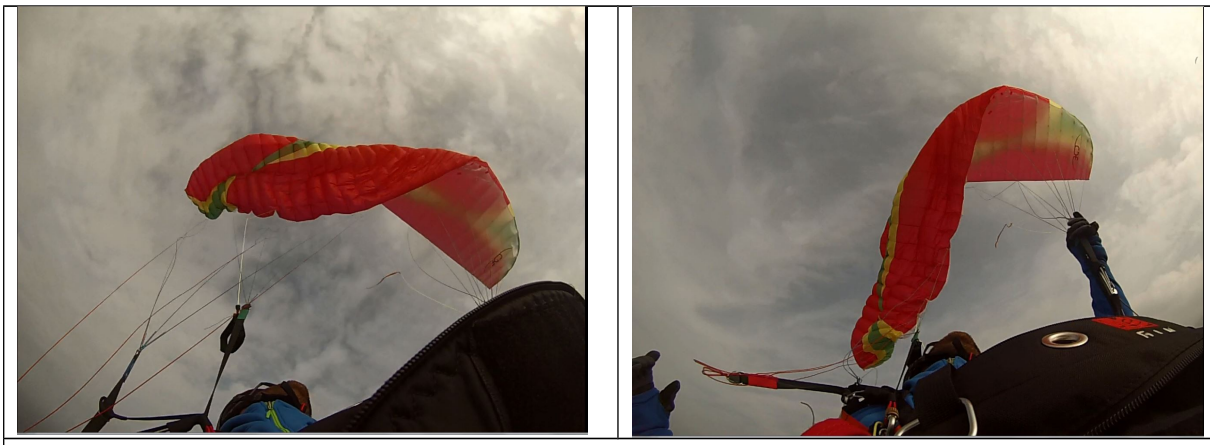
Test manoeuvres / recovery from instability
All test manoeuvres were filmed with on-board GoPro cameras, ground cameras and documented with the DHV's data loggers. Test manoeuvres were performed by the DHV test pilots Simon Winkler and Jürgen Kraus at the top third of the weight range.

Asymmetric Collapses
The responsive **Adam from Bruce Goldsmith Design (BGD)** was the only A class glider tested here and demonstrated honest and reproducible collapse behaviour. Regarding dynamics, the glider is at the top end of the A scale, but pitching was notably better than the other gliders tested here.
The glider collapses steeply and turns rapidly through 90-180°, following this the rotation slows markedly but continues for another 180° before normal flight is regained.
On massive collapses an occasional further rotation of 90° was noted. Forward pitching remained under 60°. It was possible to collapse the glider over the maximum defined in the EN/LTF tests, but even then the glider reacted moderately.

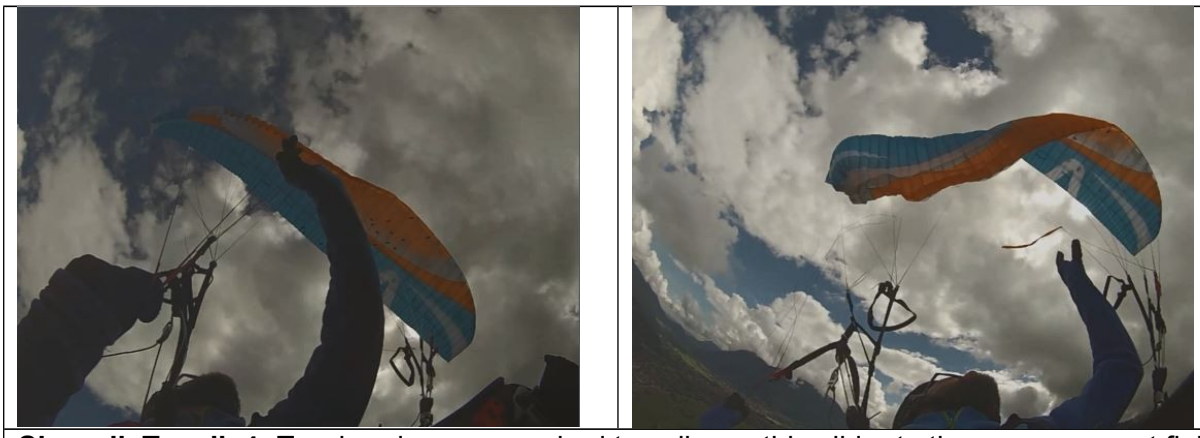
Asymmetric collapses within the EN/LTF test field markers were very difficult to produce on **Skywalk's Tequila4**. Test pilots needed on occasion both hands to collapse the glider, after which the glider rotates minimally, but pitches forward quite markedly. This, in combination with impulsive re-inflation often resulted in a further deformation or collapse on the opposing wingtip.

Testing **Icaro's Instinct TE** reminded our test pilots of collapsing a tandem glider. Pulling an A-riser causes the entire wing on this side to deform before it finally collapses steeply. The glider can be flown over a wide pitch range and is extremely collapse resistant, but this produces high dynamics when the wing finally collapses. The outer edge of the wing tip (stabiliser) tends to re-inflate on its own, often before the rest of the wing, which can lead to cravats. As with the Tequila4, the Instinct rotates minimally but pitches markedly on a collapse.

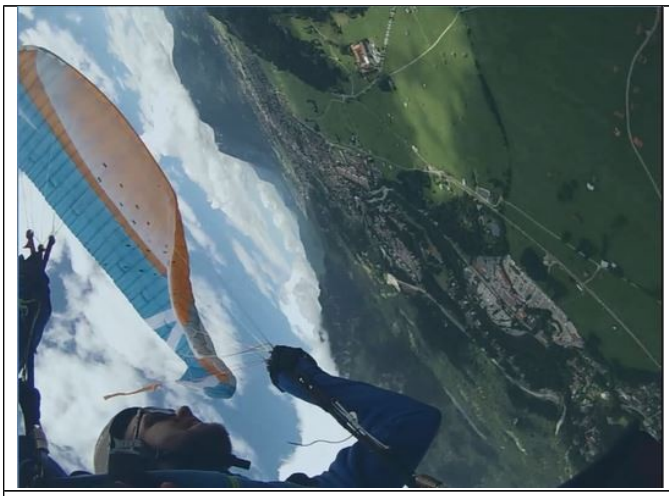
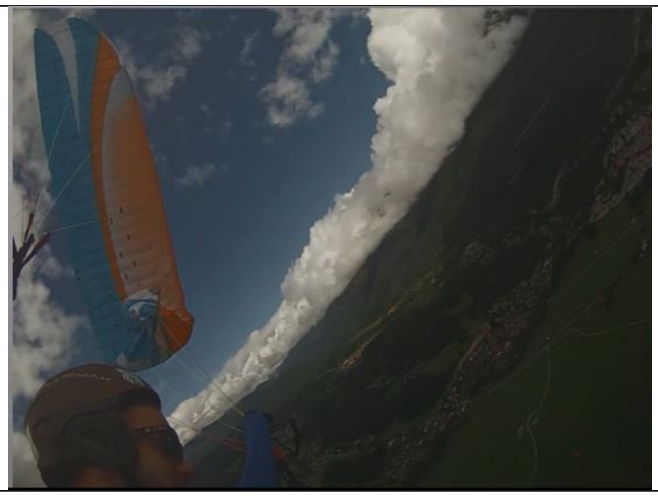
Ozone's Rush4 reacts surprisingly well to trim-speed collapses at the lower limit of the test field. Rotation is usually less than 90°, forward pitching less than 45°. If deformations are induced at the upper end of the test field, then reactions are more dynamic with impulsive re-inflation, collapses on the opposite wing tip, cravats and course changes. Forward pitching can then markedly exceed 60°. Collapse resistance is very high, and a lot of force is required to induce a collapse in the measurement field. Collapses are correspondingly steep, in particular when the glider is flown accelerated. Here the impulsive re-inflation may again create collapses on the opposite wing tip and cravats. All cravats could be easily recovered from via brake or stabiliser line input.



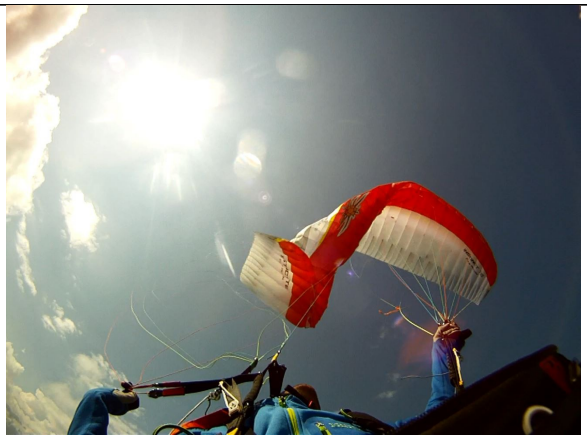
BGD Adam M: Accelerated collapses (right picture) are markedly steeper, but glider dynamics are only slightly increased. Surprisingly, the maximum descent rate never exceeded 9 m/s.



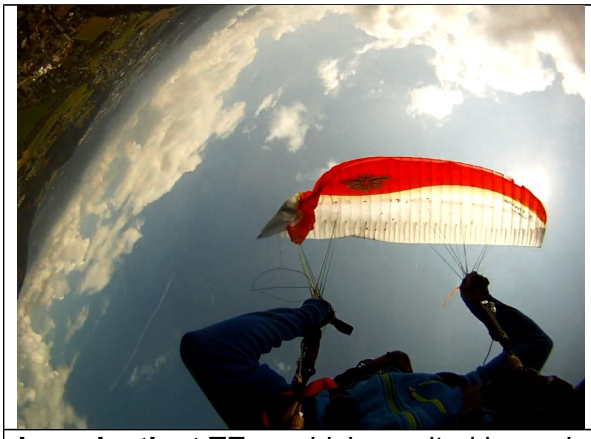
Skywalk Tequila4: Two hands were required to collapse this glider to the measurement field maximum. Skywalk's Mescal4 (LTF A) has a similar high collapse resistance.

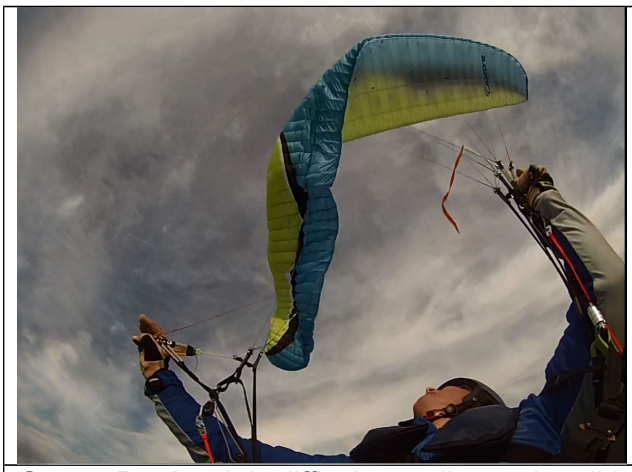
Skywalk Tequila4: Minimal rotation but marked pitching forwards. Deformations on the opposite wingtip may result from this, with occasional cravats (right picture).

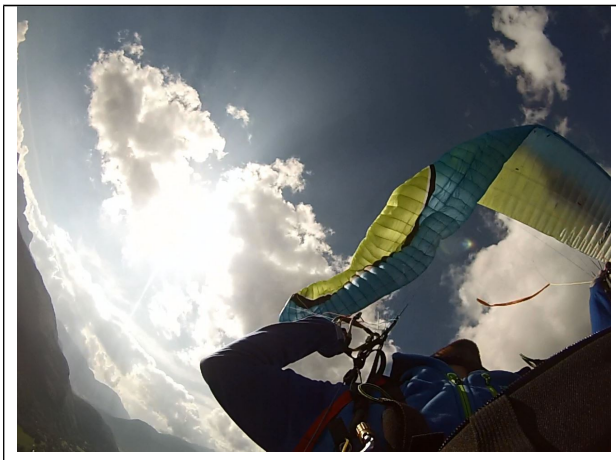
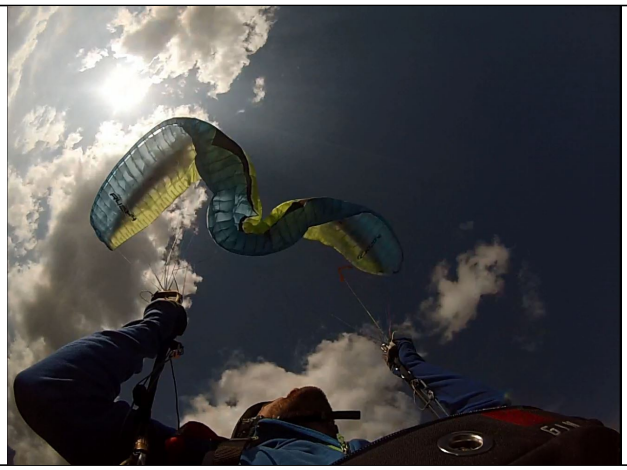
Icaro Instinct TE: In the left picture the high pitch range of the glider can be clearly seen: the A-riser has been pulled down as far as it can go, but the wing remains largely intact. The wingtip remains inflated (right picture) and has a life of its own...




Icaro Instinct TE: ...which resulted in marked cravats (left picture). Special collapse techniques needed to be used to create class-conform collapses as in the right picture.




Ozone Rush4: It is difficult to collapse the glider to the outer limit of the measurement field (left picture). Recovery was indifferent: on occasion cell by cell, then impulsive on the next collapse. This was often accompanied by small collapses on the opposite wing tip which help reduce rotation dynamics (right picture).

Ozone Rush4: Fully accelerated collapses usually lead to impulsive re-inflation followed by further deformations and collapses on the other wing tip.

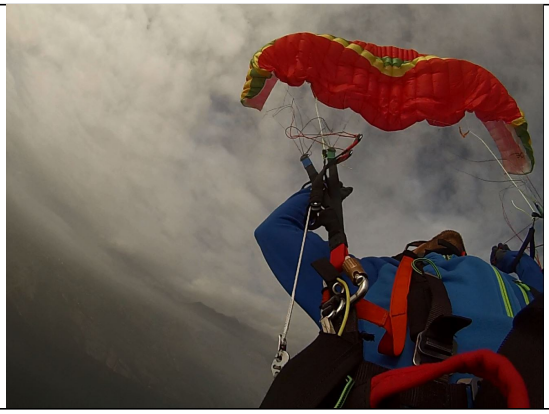
Asymmetric Collapses							
Glider	**Height-loss in m**	**Pitch-angle in °**	**Pitch change rate in °/sec**	**G-Force in G**	**Course-change angle in °**	**V/sink maximum in m/s**	**Notes**
LTF A							
BGD Adam	30-39 m	-60°	-75°	2,6 G	180° 180-270°	<10 m/s	Moderate rotation and pitch dynamics. Forward diving up to 60°. Accelerated massive steep collapses result in course changes of up to 270°. Very low maximum sink rate.
LTF B							
Skywalk Tequila4	40-49 m	-75°	>75°	2,9 G	180-270°	10-14 m/s	Difficult to collapse to measurement field limits. Marked rotation with dive angles of up to 75° for large collapses. Opposing collapses observed with occasional cravats and course changes.
Icaro Instinct TE	40-49 m	-75°	>75°	2,9 G	180-270°	10-14 m/s	Without using special collapse techniques the wing collapses very steeply and has high rotation and pitching dynamics, resulting in opposing collapses and cravats on both wingtips.
EN B							
Ozone Rush4	50-59 m	-75°	-75°	-3,9 G	90°-180°[2] 270°-360°[1]	10-14 m/s	Difficult to collapse to measurement field limits. Collapses to lower limit are unspectacular with low rotation and pitching dynamics. Accelerated collapses to the measurement field maximum demonstrate reactions typical for high-end B gliders. Recovery characteristics are not reproducable – slow cell by cell[1], or fast and impulsive[2]. Impulsive re-inflations are accompanied by opposing collapses, course changes and cravats.

Front collapses

Past tests have indicated that reactions to front collapses in the EN/LTF B class can be particularly challenging to deal with. This is however not the case for the current set of paragliders tested here. **BGD's Adam** showed the best behaviour, even in response to large front collapses. The glider's construction means the wing tips do not readily fully collapse, but the glider shows no tendency to go into a front horseshoe. **Skywalk's Teqila4** was again rather collapse resistant and it is very difficult to perform a massive front collapse on the glider. Recovery characteristics are somewhat random; on occasion re-inflation was rapid and the glider dived moderately, at other times the wingtips stay folded and delay recovery. **Icaro's Instinct TE** collapses massively after the high resistance forces are overcome. Re-

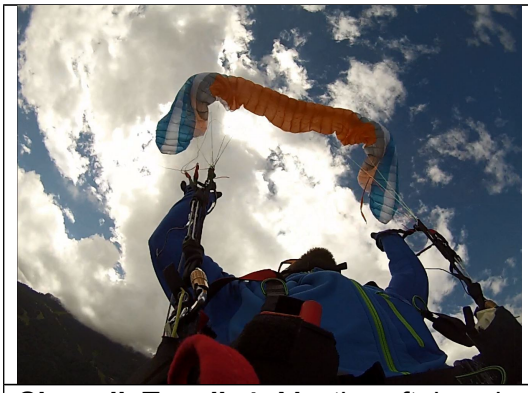
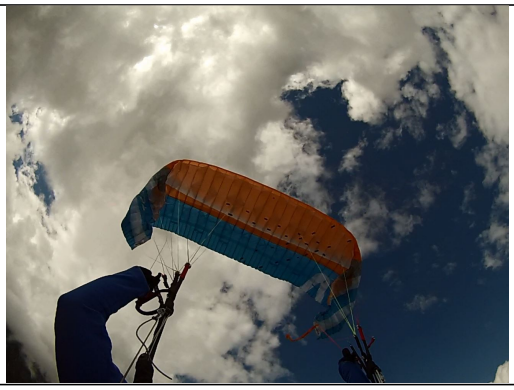
inflation is generally rapid and on occasion impulsive. As the wing tips often open rapidly, the glider often enters a front horseshoe which then self-recovers but markedly delays the entire recovery. **Ozone's Rush4** was remarkably well behaved in spite of its high aspect ratio. Collapses usually open progressively from the middle outwards. Occasionally an impulsive re-inflation of the entire canopy lead to marked forward pitching with following asymmetric collapses which also cravatted.

Front Collapse						
Glider	**Height-loss in m**	**Pitch-back angle in °**	**Pitch forward angle in °**	**Rotation, G-Force in G**	**V/sink maximum in m/s**	**Notes**
LTF A						
BGD Adam						
40% collapse	20-29 m	-30°	-30°	No	-7 m/s	Low pitch back, low pitch forward. Rapid soft self recovery, no course change.
Maximum collapse presented by construction	20-29 m	45-60°	45-60°	No	< 10 m/s	Marked pitch back and forward due to massive collapse. Rapid self recovery, no course change.
LTF B						
Skywalk Tequila4						
40% collapse	40-49 m	30-45°	-30°	No	10-15 m/s	Moderate pitch back. Both rapid and delayed recoveries noted. On delayed recovery, wing tips remain collapsed, low pitch forward, no course change
Maximum collapse presented by construction	30-39 m	45-60°	30-45°	No	<10 m/s	Marked pitch back, moderate pitch forward. Mostly rapid recovery with low Vsink.
Icaro Instinct TE						
Maximum collapse presented by construction	>50 m	45-60°	30-45°	Yes, 90-180° due to front horseshoe	<10 m/s	Glider always collapses massively. Strong tendency to enter front horseshoe, which self-recovers but results in increased height loss.
EN B						
Ozone Rush4						
40% collapse	30-39 m	45-60°	30-45°	No	<8 m/s	Soft recovery when the glider is back above the pilot.
Maximum collapse presented by construction	40-49 m	45-60°	45-60°	Yes, due to cravat; 3,4 G	10-14 m/s	Impulsive re-inflation followed by high dynamics and marked pitch forward, tendency to cravat if the glider collapses again.

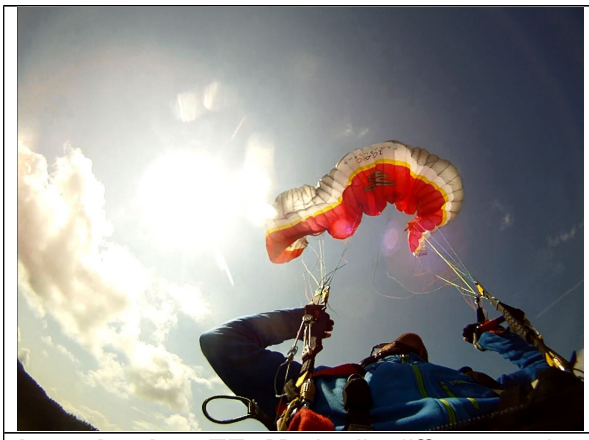


BGD Adam: At trim-speed front collapses of only 50% were possible. 100% collapses are

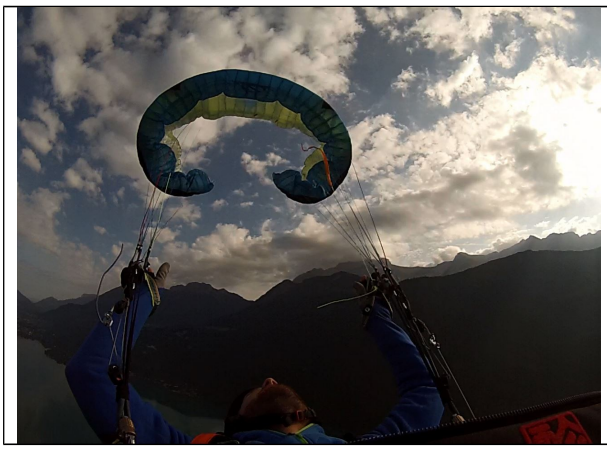
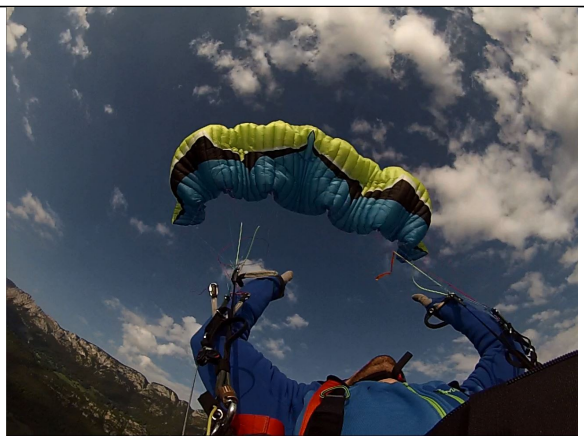
only possible when flown fully accelerated.

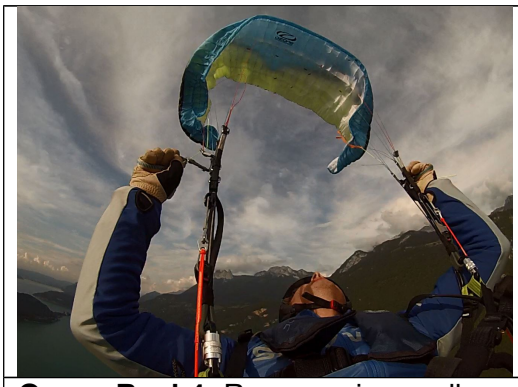
Skywalk Tequila4: Mostly soft, low dynamic reactions to front collapses with rapid self recovery. Occasionally the wing tips remain collapsed and result in increased height loss.

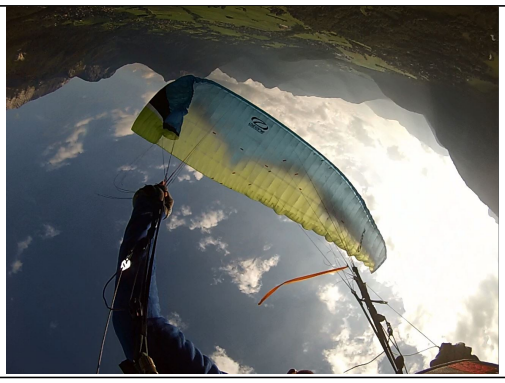



Icaro Instinct TE: Markedly different to the other gliders in this test: both at trim-speed and fully accelerated the Instinct TE collapses massively. It was very difficult to collapse the glider to a lesser degree. Front horseshoes on recovery were normal, but these self-recovered and resulted only in increased height loss.

Ozone Rush4: At trim-speed it was difficult to achieve collapses >60% (picture left). Fully accelerated, the glider collapses massively. Reactions were class conform in both cases.





Ozone Rush4: Recovery is usually progressive from the canopy middle outwards. The collapsed wing tips help reduce forward pitching. Should the canopy re-inflate impulsively over the entire span, follow-on collapses may result with marked cravat tendencies (right picture).

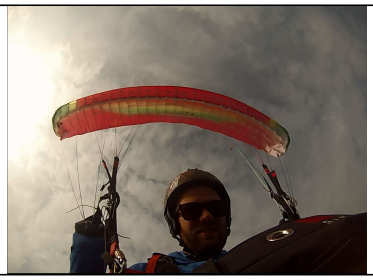
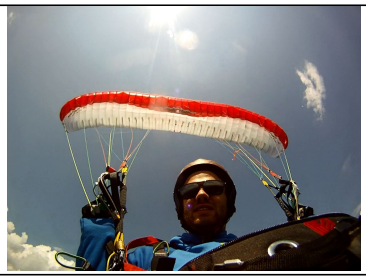
Spiral dives

The agile handling of **BGD's Adam** makes entering a spiral particularly easy. Sink velocities increase rapidly, but are moderate at their maximum. Recovery on exiting is rapid with only little course change. The behaviour of the other gliders was more dynamic, as to be expected in the EN/LTF B class. **Skywalk's Tequila4** (low end LTF B class) rapidly attains a high sink velocity and continues to turn on exiting once the brakes have been released while maintaining a sink velocity of 18-19 m/s. Should the pilots harness be set up for minimal weight shifting, the glider shows tendencies to enter a stable spiral dive. **Icaro's Instinct TE** recovers according to the expectations for the LTF B class. During the spiral dive, marked G-forces of around 5 G were noted. **Ozone's Rush4** (high end EN B) recovers excellently for its class, and shows only a tendency to remain for a little longer in the turn on exiting.

Spiral dives							
Glider	**Vsink after 360°, 720°, max.**	**G-Force after 360°, 720°, max.**	**Height loss after 360°, 720°, max.**	**Height loss from brake release to regaining normal flight**	**Time to 360° 720°**	**Action after brake release**	**Notes**
LTF A							
BGD Adam	6 m/s 12 m/s 17 m/s	2,2 G 3,7 G 4 G	20 m 55 m	50 m	0-6 s 7-10 s	Short acceleration from 12 to 17 m/s for <180°, then exit and self recovery within the next 180°	Relatively dynamic for its class, but generally well behaved. Moderate increase in sink velocity during entry phase, transition to spiral phase moderately dynamic. No sudden increase in sink velocity, progressive transition from spiral to exit on recovery.
LTF B							
Skywalk Tequila4	8 m/s 21 m/s 24 m/s	1,7 G 2,7 G 4,5 G	25 m 70 m	140 m	0-6 s 7-10 s	Acceleration from 21 to 24 m/s and then constant sink rate of >17 m/s for 540°. Then exit and self recovery within the next 180°	On brake release the glider remains in the turn with a sink velocity of 18-19 m/s. Active recovery is recommended to exit from the spiral. Tendency for remaining in a stable spiral when combined with low weight-shift harness. With the correct spiral technique the manoeuvre is easy and controllable.
Icaro Instinct TE	8 m/s 16 m/s 21 m/s	2,7 G 3,9 G 5 G	30 m 65 m	60 m	0-7 s 8-11 s	Acceleration from 16 to 21 m/s and then constant sink rate of >17 m/s for 270°. Then exit and self recovery within the next 180°	Relatively high G-forces and dynamics for its class. Easy exit and recovery.
EN B							
Ozone Rush4	9 m/s 16 m/s 19 m/s	1,9 G 3,6 G 4 G	40 m 60 m	60 m	0-6 s 7-10 s	Acceleration from 16 to 19 m/s and then constant sink rate of <15 m/s for 360°. Then exit and self recovery within the next 180°	Relatively easy exit and recovery for its class.

B-Stall
None of the test pilots found any safety relevant problems with B-stalls on the tested gliders. The Adam and Tequila4 require somewhat more force to enter the B-stall than the other gliders. When large deformations are induced on the Tequila4 the glider begins to oscillate a little, indicating it would like to exit.

B-Leinen-Stall				
LTF A				
Glider	**Sink rate in stable B-stall. Deformation tendencies Rotation**	**Pitch back on entry / pitch forward on exit**	**Height loss on exit**	**Notes**
BGD Adam	9,5 m/s no no	15°-30° -15°	20-30 m	Very stable sink phase, low pitching back and forward.
LTF B				
Skywalk Tequila4	9,5 m/s slight no	30-45° 30-45°	<20 m	Difficult to hold, especially for high sink rates. Glider wants to self exit.
Icaro Instinct TE	8 m/s no no	-15° -15°	<20 m	Stable sink phase, low pitching back and forward.
EN B				
Ozone Rush4	8 m/s no no	15-30° 30-45°	-30-40 m	Very stable sink phase, low pitching back and moderate pitching forward.


All three gliders were easy to handle in a B-stall. The BGD Adam requires a little more force to enter the stall.

The Tequila4 is built to fly and is difficult to hold in a B-Stall. High sink rates require a lot of force.

Big Ears

This manoeuvre is simple on three of the gliders tested here. Only the Tequila4 is difficult to keep in big ears. When flown accelerated with large big ears the wing tips want to self re-inflate and flap badly, making the manoeuvre very difficult. Less accelerator and less collapsed area make the manoeuvre progressively easier.

Big Ears					
Glider	**Entry**	**Exit**	**Vsink (trim) Vsink (full)**	**Speed difference trim - full**	**Notes**
LTF A					
BGD Adam	High entry force required	Automatic, rapid	3,5 m/s 4 m/s	Approx.0-3 km/h less than trim speed Approx. 5-8 km/h more than trim speed	Very easy, wingtips stable, no flapping
LTF B					
Skywalk Tequila4	High entry force required	Automatic, very rapid	4 m/s 4 m/s	Approx.3-5 km/h less than trim speed Approx. 5-8 km/h more than trim speed	High forces require to keep wingtips collapsed, Glider has a strong tendency to self exit.
Icaro Instinct TE	Easy	Automatic, rapid	3 m/s 4 m/s	Approx.0-3 km/h less than trim speed Approx. 5-8 km/h more than trim speed	Very easy, wingtips stable, no flapping
EN B					
Ozone Rush4	High entry force required	Automatic, markedly delayed	3 m/s 4 m/s	Approx.0-3 km/h less than trim speed Approx. 3 km/h more than trim speed	High entry forces required, no flapping, marked delayed recovery

Conclusions:

With exception of the BGD Adam, all gliders tested in part 8 of this series required relatively high forces to deform their canopies on test manoeuvre entry. This results, particularly for asymmetric collapses, in steep collapse angles and correspondingly dynamic recovery reactions. We also observe increased dynamic reactions during normal flying, should such a glider collapse. Asymmetric collapses are still the most common accident source in paraglider flying. The high collapse resistance of gliders tested here was a contributing factor to the degraded overall safety class rating awarded to these gliders.