

## 'ALINGHI' 12M LAKE LEMAN RACING CATAMARAN

Lake Leman multihulls are a class of extreme, state-of-the-art racing machine capable of sailing at twice the speed of the wind, with ten times the power to weight ratio of an America's Cup yacht. Ernesto Bertarelli, a young Swiss businessman, wanted a new boat to replace his existing trimaran 'Alinghi'. He approached designers Jo Richards and Sebastien Schmidt for a radical design to be significantly faster than other yachts.

The big Swiss race is the Bol d'Or, a mad scramble for 400 yachts along the length of Lake Leman and back again. Winning this race was the new boat's main objective. On the day, Alinghi won by 17 minutes after 6 hours 15 minutes, sailing nearly 5% faster than the next boat.

The Lake Leman rule limits the length of the boat and the height of the mast and little else, so the yachts are a mixture of catamarans and trimarans. Catamarans are fundamentally faster because, having one less hull, they are lighter and have less drag. However in the past it has been difficult to build a catamaran strong and stiff enough to take the enormous loads applied by the giant rigs and water ballast.

To meet these challenges Alinghi's hull, appendages and rig were entirely built with SE 84 carbon prepregs using intermediate and higher modulus carbon over a Nomex honeycomb core, by Decision SA, of Morges, Switzerland. The boat that came third in the Bol d'Or (a catamaran called Ylliam,



built in 1995) also had materials and engineering by Gurit.

### Alinghi Structural Design

The platform structure and rig of Alinghi were heavily influenced by the overlapping headsails sailplan, and a decision was taken early on to accept significant structural difficulties and risk to achieve the highest power-to-weight ratio.

The unusual 'star-shaped' structural configuration of Alinghi is a development of the space-frame structure of the earlier Lake Leman catamaran Ylliam (originally Khamsin). Ylliam was designed by Jo Richards and engineered by Gurit and in the four years since then had twice been winner of the Bol d'Or. Ylliam was the first boat sporting a full carbon truss/tie rod structure on the centreline, looking somewhat like one side of a rig. This takes the place of a trimaran's main

hull to carry the very high fore-and-aft loads generated by the forestay, mast and mainsheet, but with only a fraction of the weight and drag of the trimaran's extra hull. Ylliam was 600-700kg lighter than the lightest trimarans on the lake when she was launched.

On Alinghi the concept was taken an important step further. Ylliam's aft longitudinal spar, which carries the mainsheet loads, was divided into two separate members, meeting at the mast step and spaced about 4m apart at the stern. Thus a 'Y' shape is formed by the two aft spars and the bowsprit. This completely solves the 'Achilles heel' of catamarans which is torsional deformation of the platform. By careful optimisation of the aft diagonal tubes and their associated tie-rods underneath, platform twist was reduced to a third of that seen with the 1996 layout of Ylliam.

Alinghi's windward hull trims down by less than one degree compared to the leeward hull at maximum load. Thus the windward hull lifts out parallel to the water, losing its drag earlier. The impulse from a gust or change of sail trim is transmitted directly into forward thrust as less energy is wasted in distorting the hull platform. A consequence of the stiffer platform is that accelerations and dynamic shock loading are increased. Obsessive weight saving is the best way to reduce forces under these loading conditions, and it also means less drag. Attention to detail kept the overall weight down to 1350kg ready-to-sail, with the hull shells weighing in at just 114kg each. The boom was under 25kg, compared with 60kg on previous designs. Finite element analysis and a specially-written truss-analysis program were used to calculate the loads on every structural member and optimise their stretch behaviour under all conceivable loading conditions. As some of these loads can reach 40 tonnes, it is important that they are known accurately so that nothing is under-strength or over-weight.

Alinghi also benefitted greatly from the developments in materials, construction and engineering technology accessible with a high budget. The most suitable fibre stiffness was chosen for each area depending on whether stiffness or strength was the critical factor, with little cost compromise.

Significant aerodynamic gains were made with the mast compared to standard solutions. A much finer section was used, requiring less rotation to fair into the mainsail, cutting down on drag. The overlapping headsails meant the diamond layout for the rigging, as used on Ylliam, could not be used. The current layout, involving a lower shroud and free-swinging diamonds, is very demanding on the sailors but has less windage and weight, and most importantly allows the headsails to be sheeted very close to the mast. Time constraints also limited the rig design, and further development is planned in this area to extract its full potential.

The radical structural layout used on Alinghi certainly worked for the Bol d'Or. However, in the future it is possible that this same concept could also bring new levels of performance to the current state-of-the-art 60ft Grand Prix trimarans.