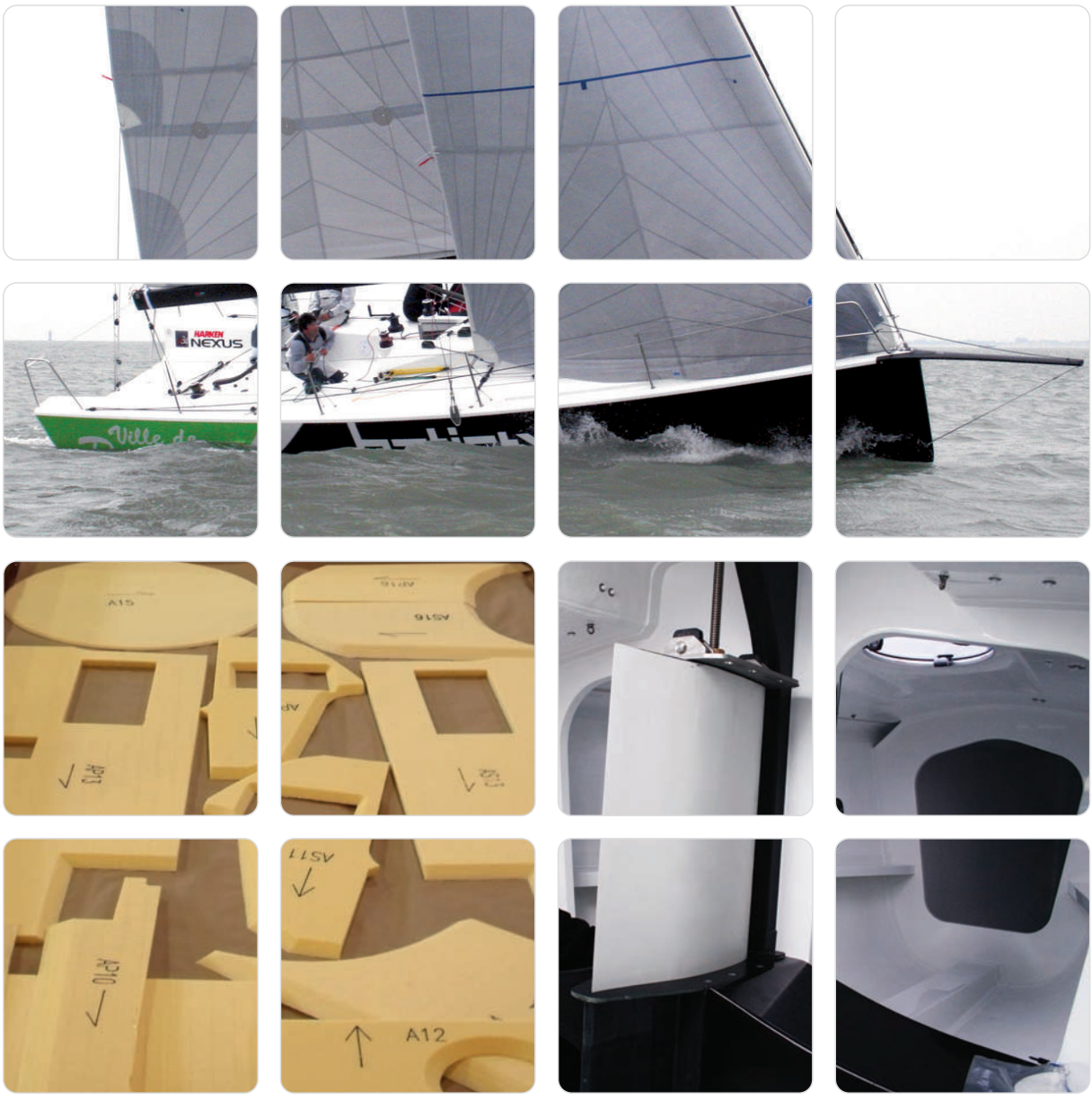
M34 Tour de France à la Voile

Structural Engineering, Composite Materials & Technology Transfer



www.tourvoile.fr / www.m34.eu

www.gurit.com/marine

About SP-High Modulus

Structural Engineering

SP-High Modulus, is the marine business of Gurit. The SP-High Modulus brand draws on the knowledge and expertise of the two most prolific and successful composite engineering consultancies in this market over the last 25 years. The range of projects worked on covers any large composite structural application including, Race Boats, Super Yachts, Production Boats, Commercial and Military Boats. The Engineering team offers services from the planning stage, much of which is carried out on proprietary software, plus a range of services that include loading analysis, material and laminate specification, engineering methodology and construction procedures.

Materials Technology

Gurit's research and development team continues to develop new technology to deliver higher performance and more cost effective composite solutions. State of the art analytical and mechanical test equipment provides the fundamental information required for the design of new materials. This test capability is also at the disposal of the technical support functions to assist the customer in process optimisation and rapid root cause analysis.

Processing

The application and processing of composites provides a complex technical challenge. Materials as diverse as adhesives, prepregs, structural cores and coating systems, are all integrated as far as possible into a single process. To meet this challenge a team of committed technical service engineers provide industry-leading onsite technical support, delivering advice on production procedures and the optimal use of composite technology.

Bringing Global Composite Materials Expertise to the M34

SP-High Modulus teamed up with Bateaux Archambault, Joubert / Nivelt / Mercier and Isotop, and was integral to the M34 project from the start. All aspects of SP-High Modulus' expertise and capabilities were made available to the M34.

SP-High Modulus' structural engineering team worked in collaboration with the naval architects to create a light, but stiff and robust structure. This led to the development of custom materials that suited both the structural and manufacturing requirements.

SP-High Modulus' processing team provided regular onsite support for the transfer of technology to the yard and the B^3 SmartPac solution was introduced to the mix to offer improved production efficiencies and repeatability of build. SP-High Modulus' engineering team also worked closely with Isotop on the development of the carbon appendages.

"The scope of work was very clear: we had to help create a very high profile racing boat, within a tight financial envelope and at high rates of production. SP-High Modulus played various roles in creating a boat that met all of these requirements." Katia Merle, Gurit Design Engineer for the M34.

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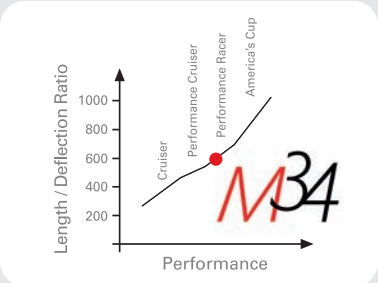
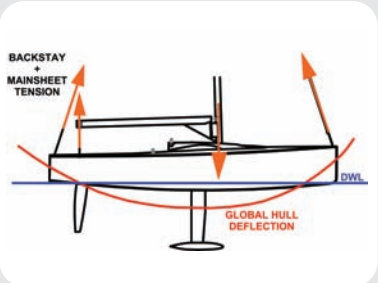
Stiffness

Hull and deck laminates were specifically optimised with the aim of achieving the best compromise between weight, cost and global stiffness. Global stiffness was a key performance factor as it gives the crew better control on forestay sag and allows maximum water-line length to be maintained while sailing upwind.

Cost targets were met by using epoxy infused E-Glass multi-axial fabrics in most areas of the hull and deck. Hybrid biaxial glass/unidirectional carbon plies were selectively applied in the side-decks and hull bottom for maximum added global stiffness (see "Material Development").

The same hybrid glass/carbon reinforcements were also added to the hull and deck in way of the keel structure to increase load carrying capability and minimise deflections under transverse keel loads.



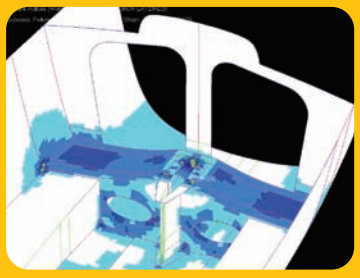


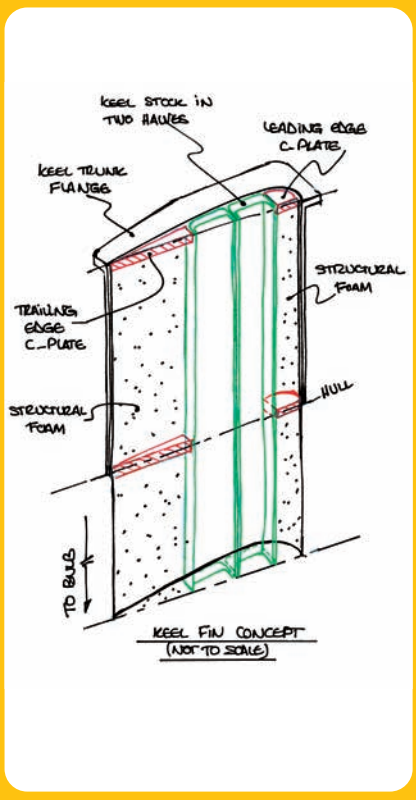
Keel

The keel fin and its supporting structure were analysed for a load case equivalent to 3g transverse acceleration (knock-down case), and a 2.35g grounding longitudinal acceleration. The top keel bolts transfer the load from the stainless steel top plate to the composite structure. Due to the complexity of the load path from the keel box into the hull, SP-High Modulus used Finite Element Analysis to optimise the structure.

Archambault were able to achieve optimum and repeatable alignment of the keel trunk by building a mating flange pre-moulded into the hull.

Benefitting from Isotop expertise with high profile appendages, the stock was built as two hollow sections bonded together inside the shell. This efficient solution stabilises the stock capping, provides the necessary shear strength and stiffness, and minimises manufacturing time. The longevity of the part is increased by including solid carbon inserts at key locations along the leading and the trailing edge, where the load transfers from the keel to the trunk.





Material Development

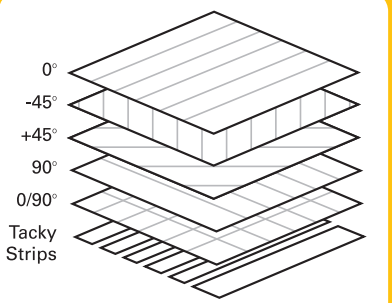
Two custom fabrics were specifically made for the M34 project. The multiaxial E-glass fabric used in most parts of the hull and deck combines an 800g/m² quadriaxial layer (QE800) with a 300g/m² woven biaxial (RE300) laid at 0/90°.

The hybrid (YEC750) fabric used for stiffness in key areas of the hull and deck features 315g/m² at 0° unidirectional carbon fibres sandwiched between two layers of 270g/m² glass unidirectional laid respectively at +45° and -45°.

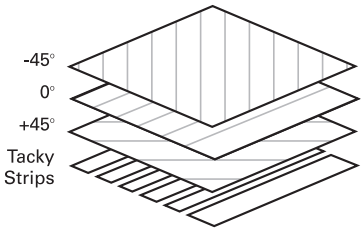
Both custom fabrics were stitched into one single ply to reduce laying-up time. A further improvement in the production process was achieved by adding tacky strips to the fabrics that promoted adhesion to the mould during the lamination. Finally, the fibres and the stitching pattern were customised for best drapability and optimum resin flow during the infusion process.

M34 Key Materials:

- PRIME™ 27 Epoxy Infusion Resin for hull and deck
- **Core**cell™ M80 SAN foam core in all sandwich laminates
- Spabond 540 high elongation adhesive
- SE 84LV high elongation carbon/epoxy prepreg for the keel, rudder and bowsprit
- F230 foaming epoxy for keel construction



QE800 / RE300



YEC750

B³ SmartPac

Significant gains in production efficiencies were made by the use of the B³ SmartPac. The core and fabric materials were supplied pre-cut to the size and shape for the build, and were accompanied with a schematic and written construction booklet. The use of the SmartPac resulted in the yard reducing its preparation and lamination time by half.

The B³ SmartPac:

- Pre-cut and pre-labeled reinforcement and core materials
- Packed in the order to be used, accompanied with a comprehensive construction manual
- Integral quality control processes

Integral to the B³ SmartPac solution is the quality control process and construction documentation.

Benefits of B³ SmartPac:

- Reduced overall costs
- Repeatable process - known costs, known quality
- Improved overall quality

Basic Deck Laminate

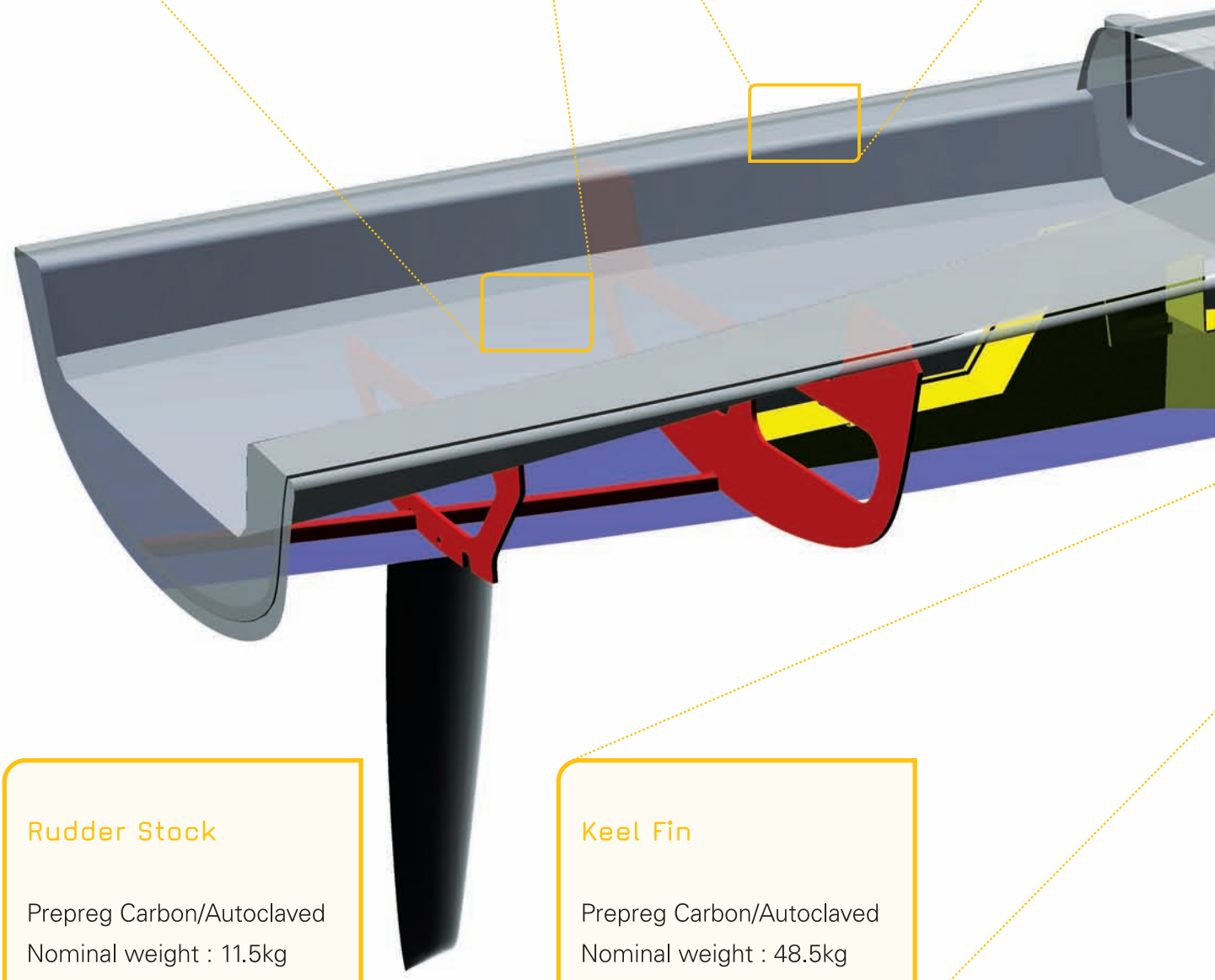
Female moulded epoxy infused sandwich

- 1100g/m² Glass multiaxial
- 15mm thick **Core**cell™ M80
- 1100g/m² Glass multiaxial

Side Decks

- 750g/m² Hybrid Carbon/Glass Triaxial
- 15mm thick **Core**cell™ M80
- 750g/m² Hybrid Carbon/Glass Triaxial

"See Stiffness"



Rudder Stock

Prepreg Carbon/Autoclaved
Nominal weight : 11.5kg

Keel Fin

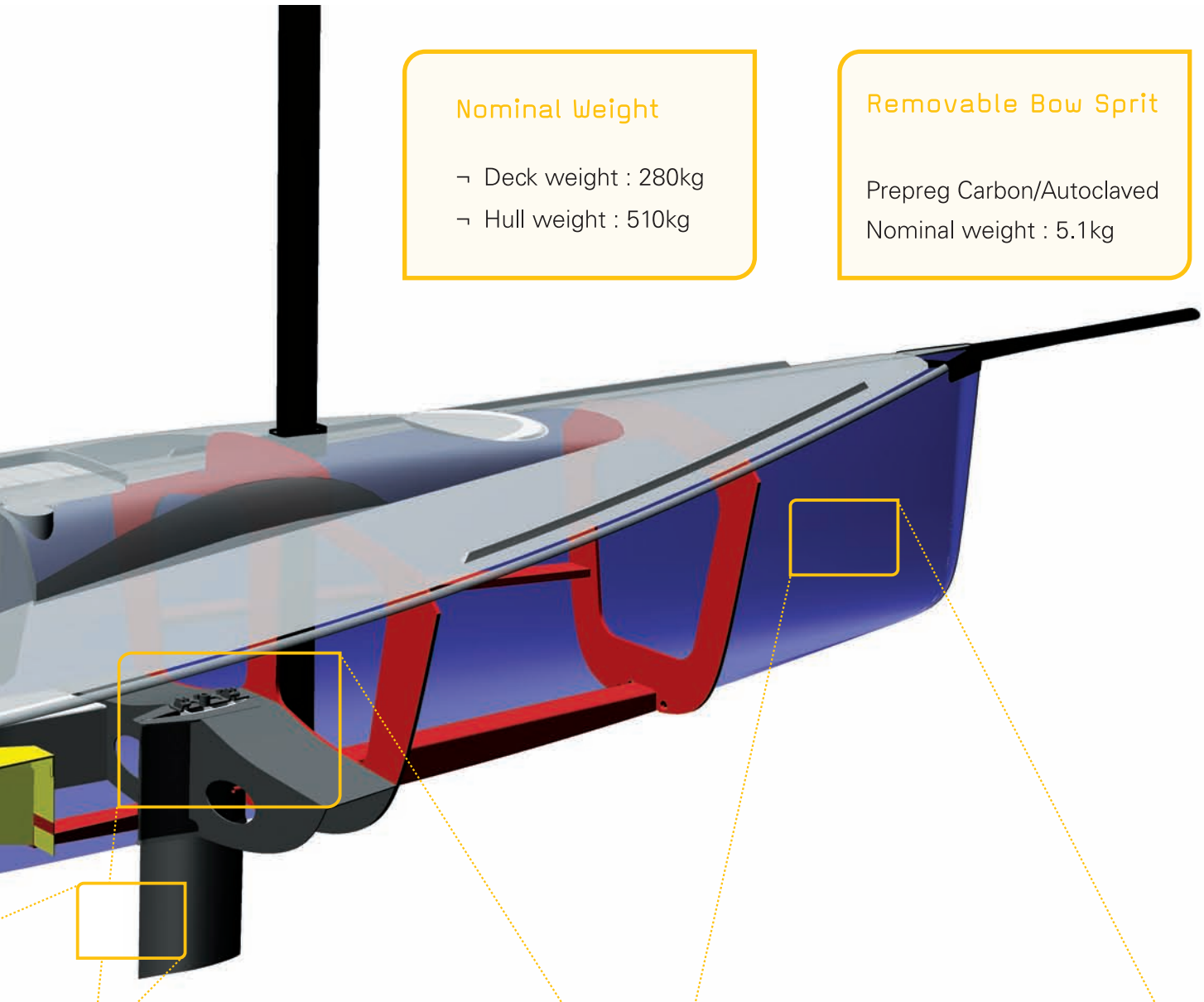
Prepreg Carbon/Autoclaved
Nominal weight : 48.5kg

Nominal Weight

- Deck weight : 280kg
- Hull weight : 510kg

Removable Bow Sprit

Prepreg Carbon/Autoclaved
Nominal weight : 5.1kg



Keel Box

Hybrid Glass/carbon
Female moulded epoxy infused sandwich
Nominal weight : 27kg

"See keel"

Basic Hull Laminate

Female moulded epoxy infused sandwich

- 1100g/m² Glass multiaxial
- 20mm thick **Core**cell™ M80
- 1100g/m² Glass multiaxial

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