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A Real **Mega Project**

A research facility is currently being set up in the south of France near Bordeaux that is heralding in a new era in laser technology. Schott is supplying the laser glass and other important optical components.

The amount of energy supplied by a million power stations all at once. That is what the French Laser Mégajoule (LMJ) will require – for a few billionths of a second – when it goes into service for the first time in 2008. Together with a comparable facility in the USA, the LMJ will be the most powerful laser in the world.

The project carries its name because of the energy of almost two megajoules that the laser will deliver to a so-called pellet. This tiny ball of about 2 millimeters contains a mixture of deuterium and tritium, both heavier relatives of hydrogen. Under the impact of the 0,35 micron laser radiation, a fusion reaction will take place producing excess energy, about ten times as much as the laser energy needed to ignite the fuel. It creates conditions similar to those in the interior of the sun for a few fractions of a second – long enough to give researchers a rich field of operation.

Gigantic Dimensions

But not only the laser energy is in the "mega" range. The LMJ building will be 300 meters long and 150 meters wide. Each of the 240 beams is produced using 18 slabs of laser glass, requiring a total of 4,320 pieces, each measuring 45 by 80 centimeters. Thus, an enormous amount of material has to be manufactured and processed. That makes 150 tonnes of laser glass altogether. Equally imposing are 35 tonnes of fused silica and 66 tonnes of glass for mirrors plus the 4,000 square meters of flat glass surfaces that have to be polished.

Even though 2008 seems to be a distant future, the project is proceeding full force. Already by the end of this year, a first test facility will begin operating. The LIL (Ligne d'integration laser – integrated laser line) contains a package of eight laser beams and puts all materials to the test. "A crucial step towards the LMJ", say Evelyne Le Page and Michel Le Guennec, "which is very important for us". The small team of Schott France has been with the LMJ project since its conception in 1996. They work on the outskirts of Paris and are in constant contact with the customer, the CEA (Commissariat à l'énergie atomique – the French atomic energy authority). "This involves supplying more than the laser glass," comments Le Page, naming the first transport mirror as an example. "Also we offer interesting alternatives all along the beam route with our filter lenses and absorption and reflector glass. If there should be any tests where other Schott products could provide a solution we will be ready and willing to give our advice and support."

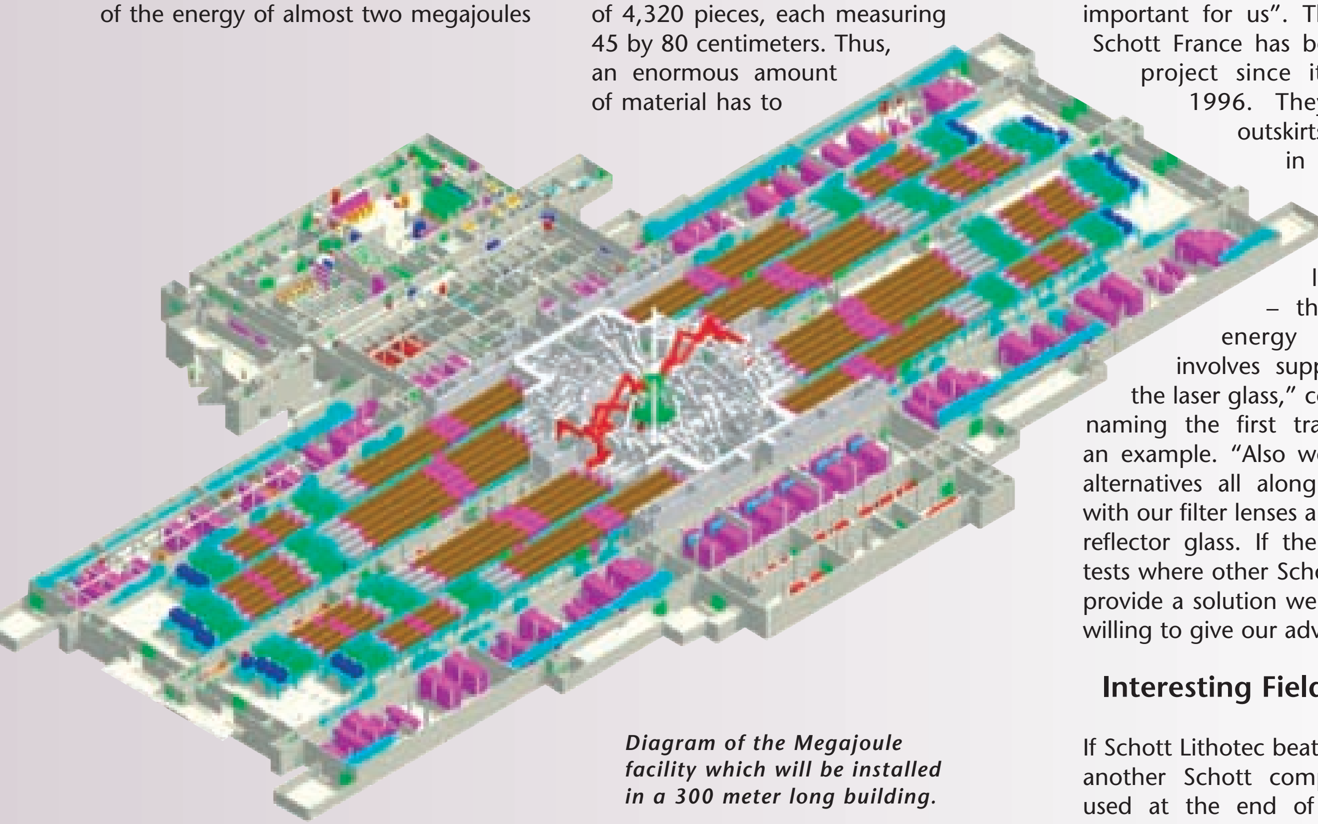
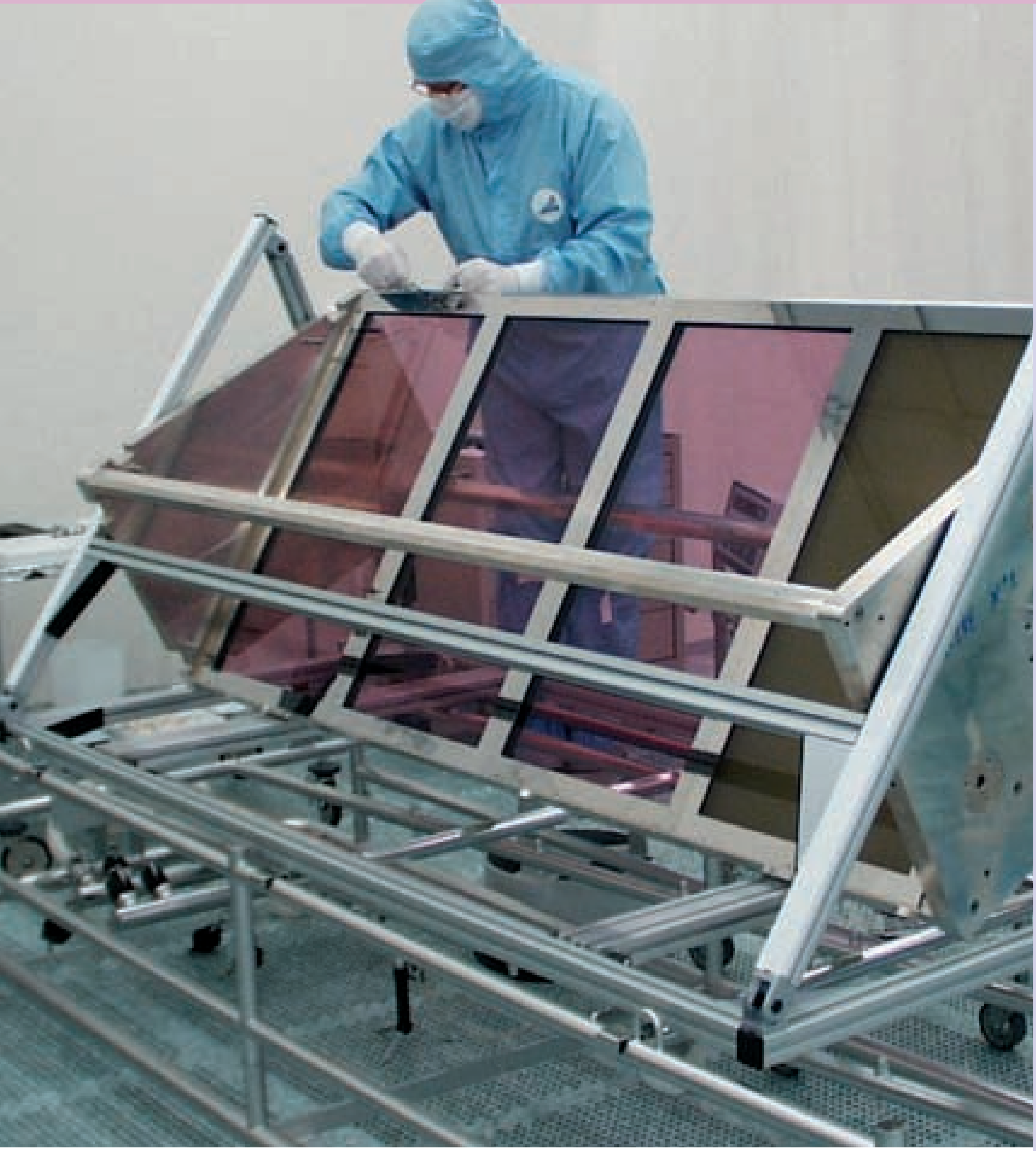


Diagram of the Megajoule facility which will be installed in a 300 meter long building.

Interesting Field of Research

If Schott Lithotec beats the competition, another Schott component could be used at the end of the beam path,



Fitting one of a total of 4,320 laser glass plates in a support. The high purity Schott material facilitates the release of the enormous amounts of energy required for nuclear fusion.

namely a deflection and focusing system comprised of fused silica grids. "The CEA has chosen a new approach here for directing the beam to the target", explains Le Guennec. "While the American design favors lenses, the LMJ prefers to keep grids." These do two things at the same time. They focus the beam from its original 40 by 40 centimeter size down to fractions of a millimeter. At the same time they aim it at the tiny pellet that is positioned with an accuracy of a twentieth of a millimeter – in a target chamber some ten meters in diameter. The same precision is called for here as in microlithography. Grids are in fact normally used there to deflect short-wave radiation. This produces tiny structures on silicon chips to make computers faster and faster.

For a 1.3 billion euro price tag, people justifiably want to know what the purpose of the facility is. The purposes are at least as manifold as the number of

Extra Performance with Glass

High performance lasers like the LMJ use special glass as the laser medium rather than gas or diodes. It is the only material capable of producing the enormous energy at exactly the wavelength required for fusion experiments. Schott has been one of the world's leading manufacturers for more than 30 years. The glass for the LMJ is doped with small quantities of the chemical element neodymium that transmits the laser radiation. Formerly the laser glass was produced in the form of cylinders, but large sheets are also possible now. Amplification of the beam, known as laser pumping, is in consequence more uniform and more effective. The Schott laser glass of the 21st century complies with the highest requirements as regards precision and purity. Because of the large amounts of energy involved, no residual particles of platinum, which are normally present from the production process, are permitted in the glass. They would heat up and destroy the glass. The significant breakthrough from the financial point of view came with the introduction of a continuous melting process for the manufacture of laser glass. The costs for over 4,000 glass plates would otherwise have been unrealistic right from the start.

scientific experiments scheduled to be carried out there. More than a hundred a year are planned. They are expected to provide insight into thermonuclear plasmas so that the behavior of stars can be better understood. The dream of fusion as a virtually inexhaustible source of energy is getting a good deal closer to reality. And, furthermore thanks to the LMJ, France will be able to do without atomic weapon tests in the future without adverse effects on the safety and maintenance of existing stocks.

Schott is devoting a large part of its activities in France to the LMJ. Quite apart from laser technology, initial spin-offs in such areas as coating technology and satellite optics have been formed. Still, several hurdles have to be taken before the first laser pulses are emitted. But that is not surprising with this mega project ■

The heart of the Megalaser: the target chamber where all the beams meet on the fuel capsule known as a "pellet".

Hope for Great Innovations

Michel André is managing the LMJ project within the CEA. The French physicist is a pioneer of laser technology. He has been working in this field for nearly 30 years, in particular on the plasma physics aspects.

France already has a very powerful laser at its disposal with PHEBUS. So what is an even bigger plant required for?
André: In this case it really is a question of size! The physics prescribes certain parameters for our experiments. There is no existing plant that can come up to these figures, but the LMJ will.

That means that you are entering unknown scientific territory. How can you be sure that the LMJ will work?
André: Firstly, we have been planning the LMJ for many years very thoroughly. Secondly, we have chosen partners in research and industry who apply the same high standards that we do. And thirdly, we have the possibility with the LIL to further refine and improve the concept.

Does that mean that the final design is not yet decided?
André: Yes and no. The most important components such as the laser glass have been settled. Others now have to be tested. We expect our suppliers to provide solutions above and beyond the current state-of-the-art. If Schott for example were to offer new highly promising technologies we would be more than happy to look at them.

Is there something like a vision for the LMJ?
André: To start with I am looking forward to technological, scientific and economic progress. In addition to that I firmly believe that the LMJ will bring further innovations. When the laser was developed in 1960, nobody suspected for a moment that it would be an established part of our daily lives today.