

In 1996, France signed the Comprehensive Nuclear Test Ban Treaty (CTBT) after having completed in 1995 a final and resounding nuclear test campaign in the Pacific. Now, France has to find other ways to guarantee the performance of its thermonuclear weapons.

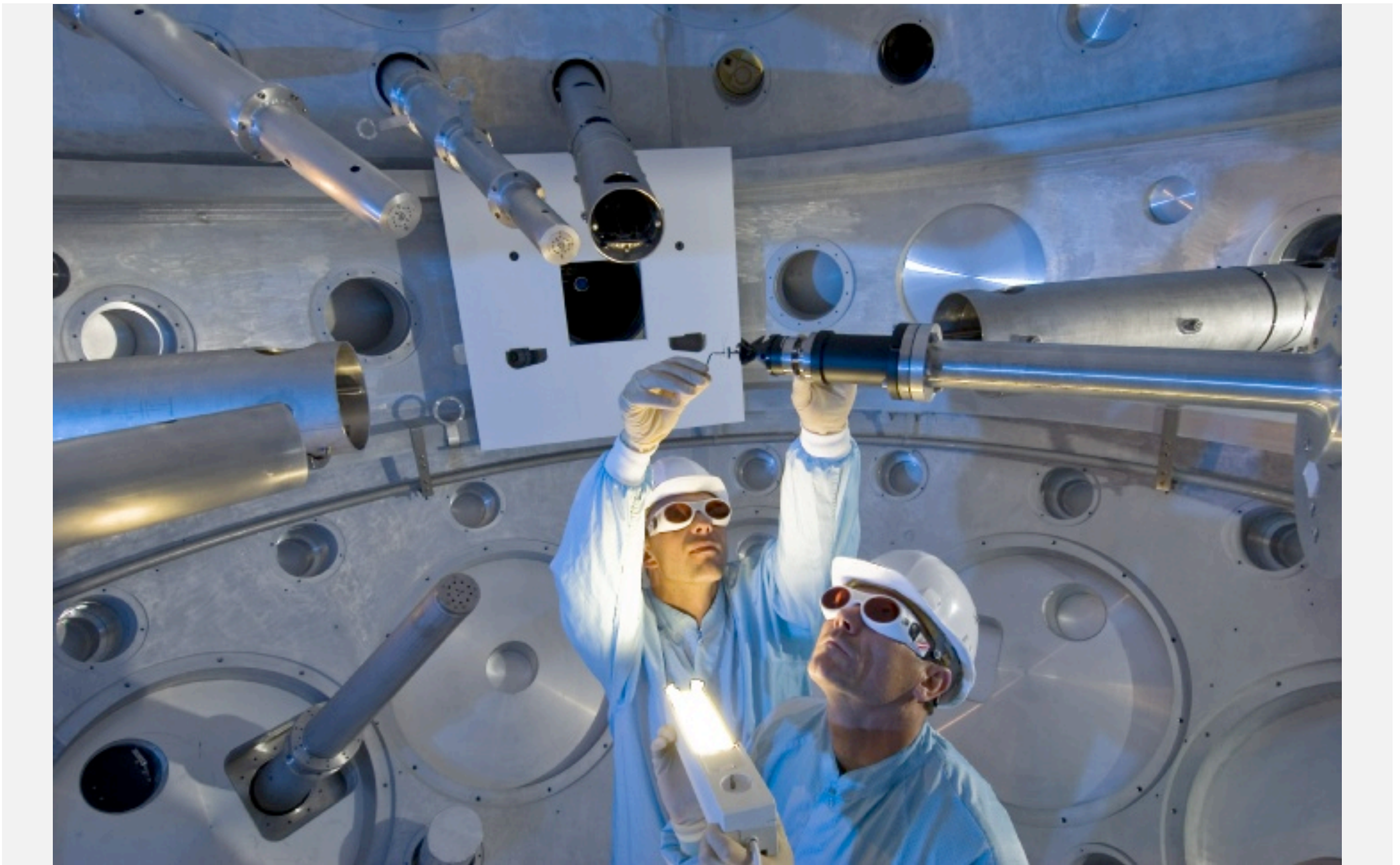
To maintain a convincing strike force, without resorting to other nuclear tests, France created an ambitious Simulation programme whose aim is to put in an equation the physical phenomena involved in the ignition of a thermonuclear weapon.

A laboratory for the H-bomb.

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1217-05: Bordeaux. CEA's CESTA center. LIL. Simulation programme. The Laser Integration Line (LIL) is a scale 1 prototype facility of one of the future laser chains of the Megajoule Laser (LMJ). It is mainly used to validate the technological choices selected for the LMJ. The LIL is made of an elementary LMJ laser chain composed of eight identical beams. As the future LMJ, the LIL is equipped with a vacuum experimental chamber around the target and supporting many measuring or diagnostic tools. Here, the arm of the target holder in the centre of the LIL experimental chamber is being examined during maintenance. /// Bordeaux. CEA. Site du Megajoule Laser. LIL. Programme Simulation. La ligne d'intégration laser (LIL) est une installation prototype à échelle 1 d'une des futures chaînes laser du Laser Mégajoule. Elle est en partie destinée à valider les choix technologiques retenus pour le LMJ (Laser mégajoule). La LIL est constituée d'une chaîne laser élémentaire du LMJ comportant huit faisceaux identiques. Comme le futur LMJ, la LIL est équipée d'une chambre d'expériences, sous vide, abritant la cible et supportant de nombreux instruments de mesures ou diagnostics. Ici, examen du bras porte-cible au centre de la sphère d'expérience de la LIL lors d'une maintenance.



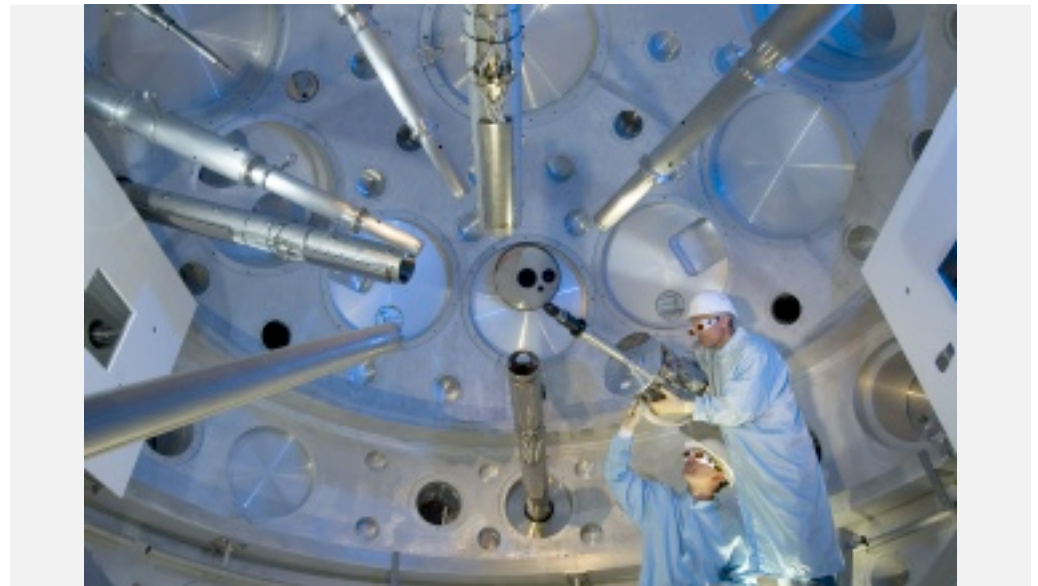
1217-01: Bordeaux. CEA's CESTA center. The Megajoule Laser's experimental chamber with its concrete shield. This sphere 10m in diameter and 10cm in width weighs 140 tons. 240 laser beams will converge on



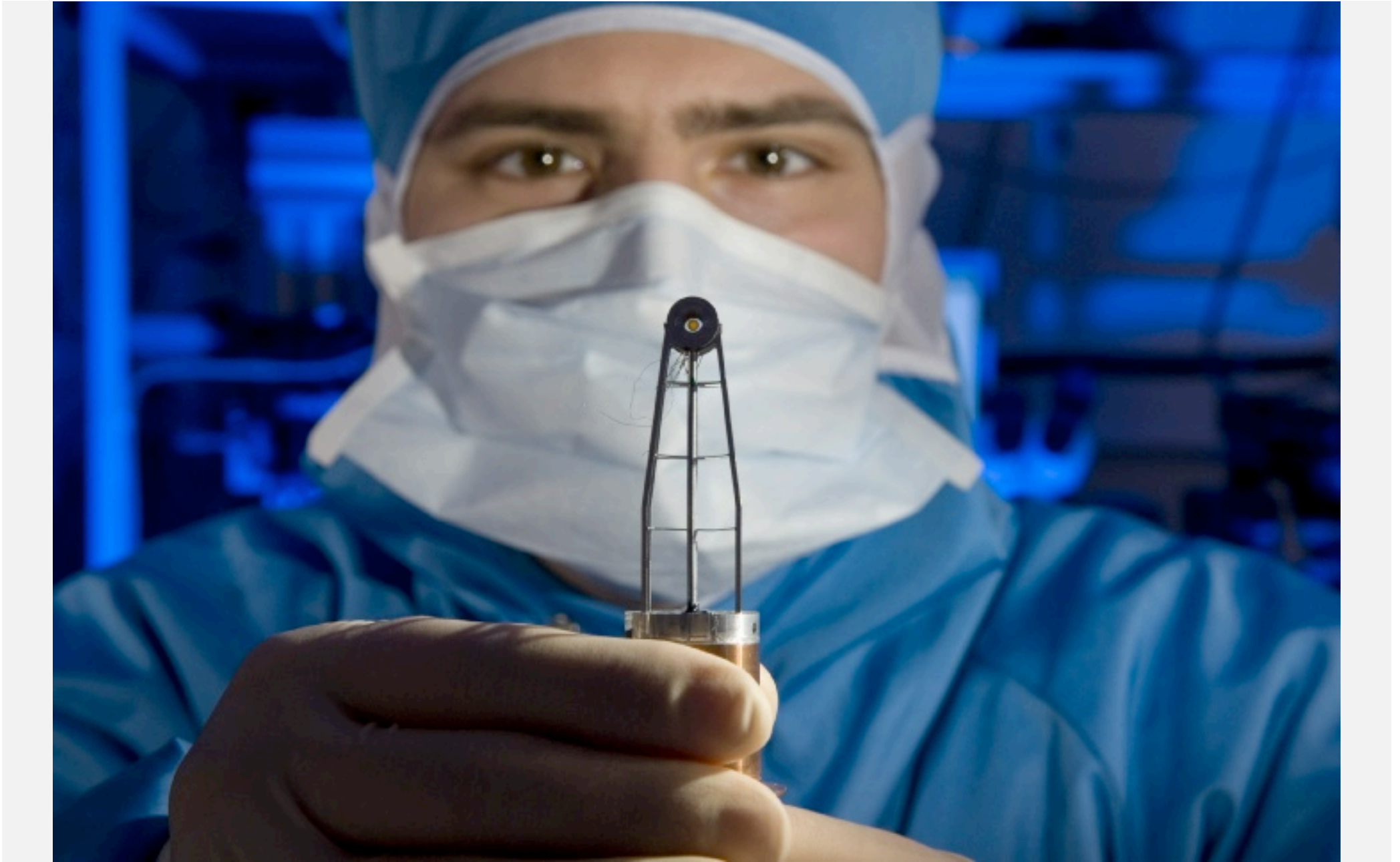
1217-02: Bordeaux. CEA's CESTA center. The Megajoule Laser's experimental chamber with its concrete shield. This sphere 10m in diameter and 10cm in width weighs 140 tons. 240 laser beams will converge



1217-03: CEA. Valduc nuclear center. Nuclear weapons simulation programme. This micro-target will contain a mixture of deuterium and tritium. It will be placed in the centre of the Megajoule Laser's



1217-04: Bordeaux. CEA's CESTA center. LIL. Simulation programme. The Laser Integration Line (LIL) is a scale 1 prototype facility of one of the future laser chains of the Megajoule Laser (LMJ). It is mainly used



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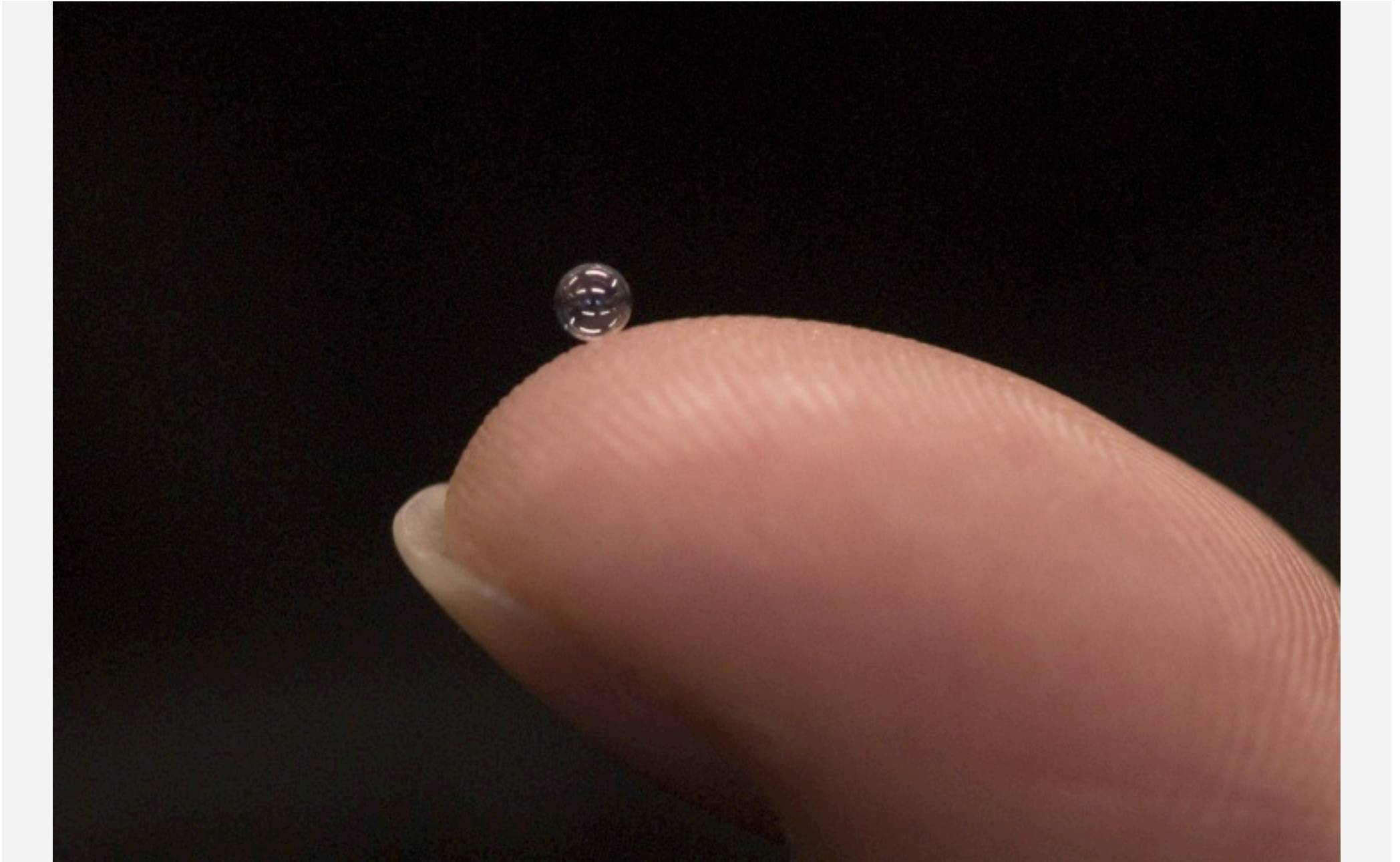
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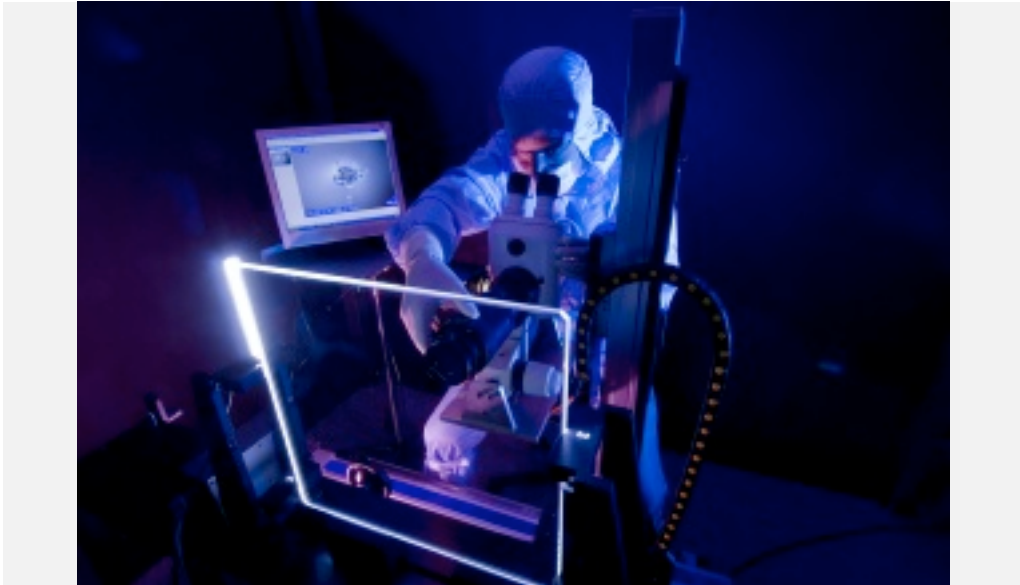
1217-07: Bordeaux. CEA's CESTA center. LIL. Nuclear weapons simulation programme. The Laser Integration Line (LIL) is a scale 1 prototype facility of one of the 30 chains of the Megajoule Laser (LMJ).



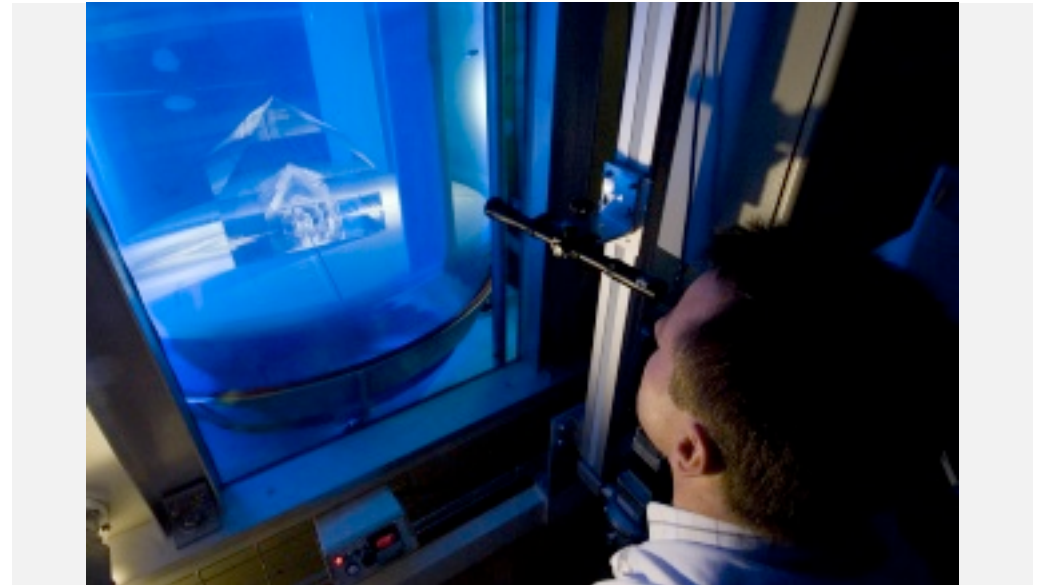
1217-08: Bordeaux. CEA's CESTA center. LIL. Nuclear weapons simulation programme. The Laser Integration Line (LIL) is a scale 1 prototype facility of one of the 30 chains of the Megajoule Laser (LMJ).



1217-13: CEA. Valduc nuclear center. Nuclear weapons simulation programme. This micro-target will contain a mixture of deuterium and tritium. It will be placed in the centre of the Megajoule Laser's experimental chamber and the 240 laser beams will trigger the nuclear fusion. /// CEA. Site de Valduc. Programme de simulation de l'arme nucléaire. Ce micro-ballon contiendra le mélange de deutérium et de Tritium. Il sera placé au centre de la chambre d'expérience du LMJ, et fusionnera sous l'action des 240 lasers.



1217-17: CEA's Bruyères-le-Château complex. Nuclear weapons simulation programme. The supercomputer Tera 10, developed by the French company Bull, is able to treat 50,000 billion operations



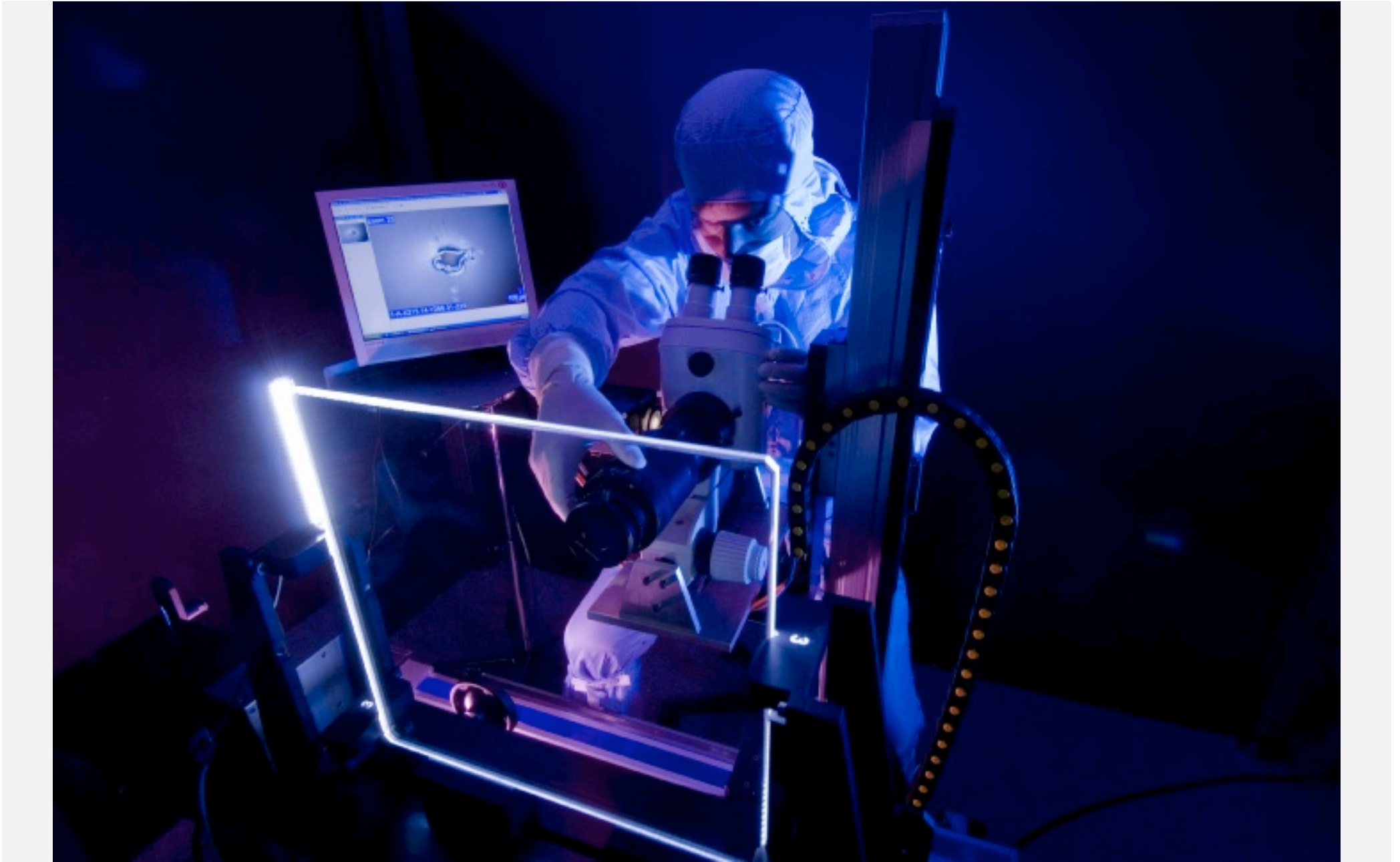
1217-10: Nemours, St Gobain. The company St Gobain synthesizes for the CEA "KDP" crystals used to modify the length of the laser waves, from infrared to ultraviolet, just before they strike the micro-target



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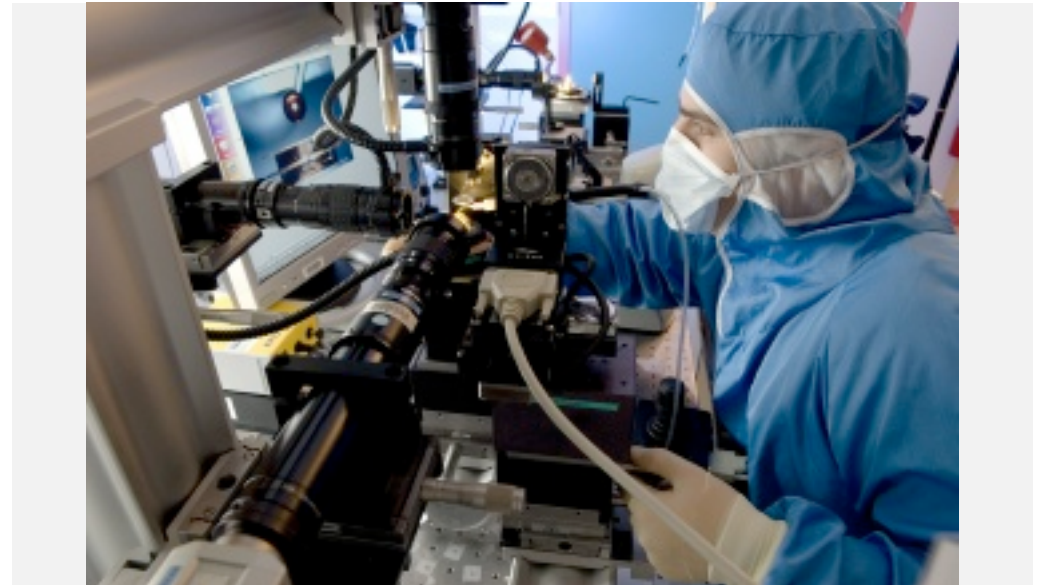
1217-12: Bordeaux. CEA's CESTA center. Nuclear weapons simulation programme. The Megajoule Laser. Optical bench test. The erosion marks or impacts on glass optics after several laser shots are being



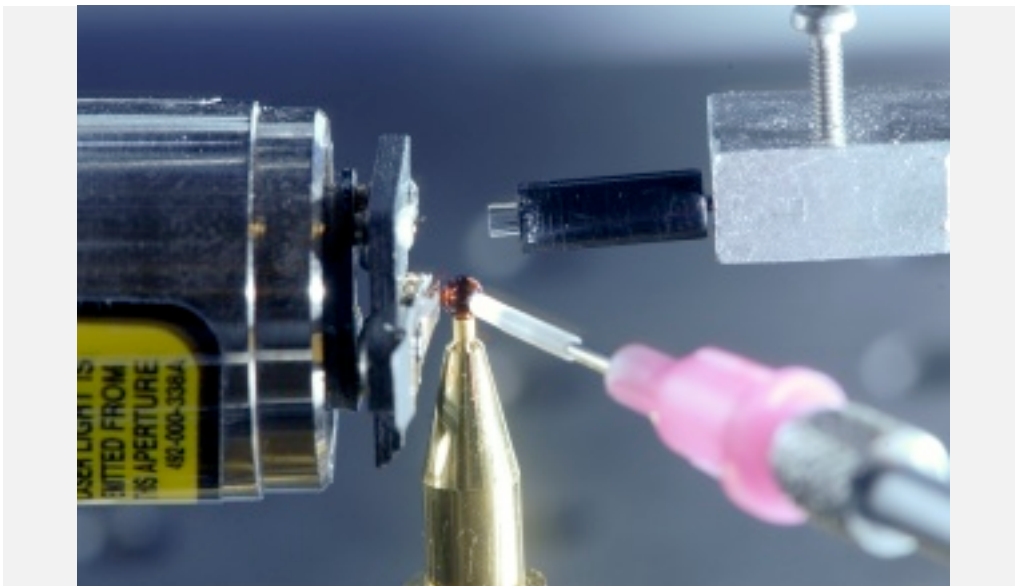
1217-09: Bordeaux. CEA's CESTA center. Nuclear weapons simulation programme. The Megajoule Laser. Here, a glass mirror used to transmit laser beams is inspected and any impacts or flaws recorded are software analysed. /// Bordeaux. CEA. site du CESTA. Programme de simulation de l'arme nucléaire. Laser Méga-joule. Ici, inspection d'un miroir en verre servant au transport des faisceaux lasers et analyse par logiciel des impacts ou défauts constatés.



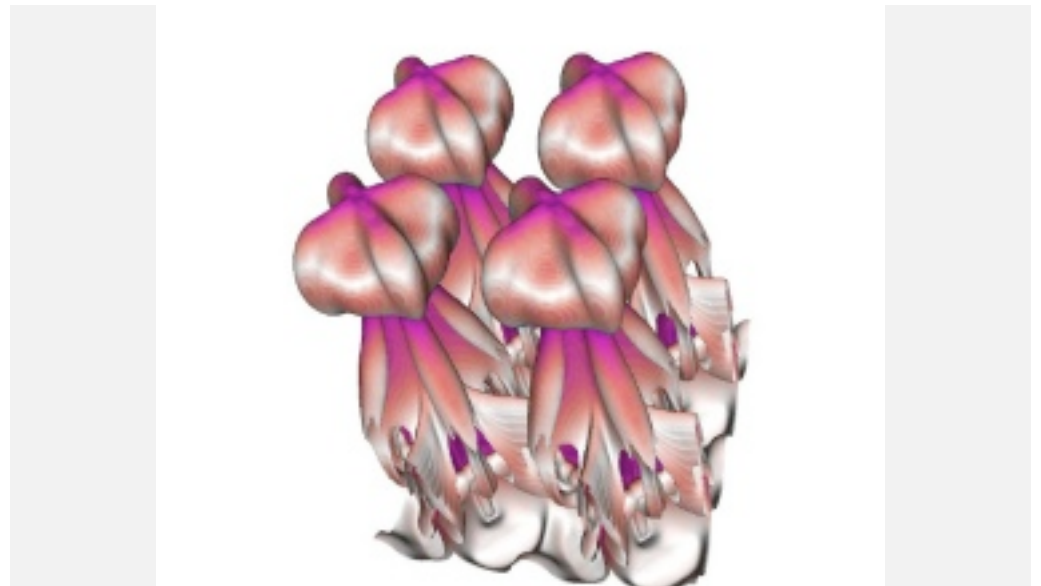
1217-13: CEA. Valduc nuclear center. Nuclear weapons simulation programme. This micro-target will contain a mixture of deuterium and tritium. It will be placed in the centre of the Megajoule Laser's



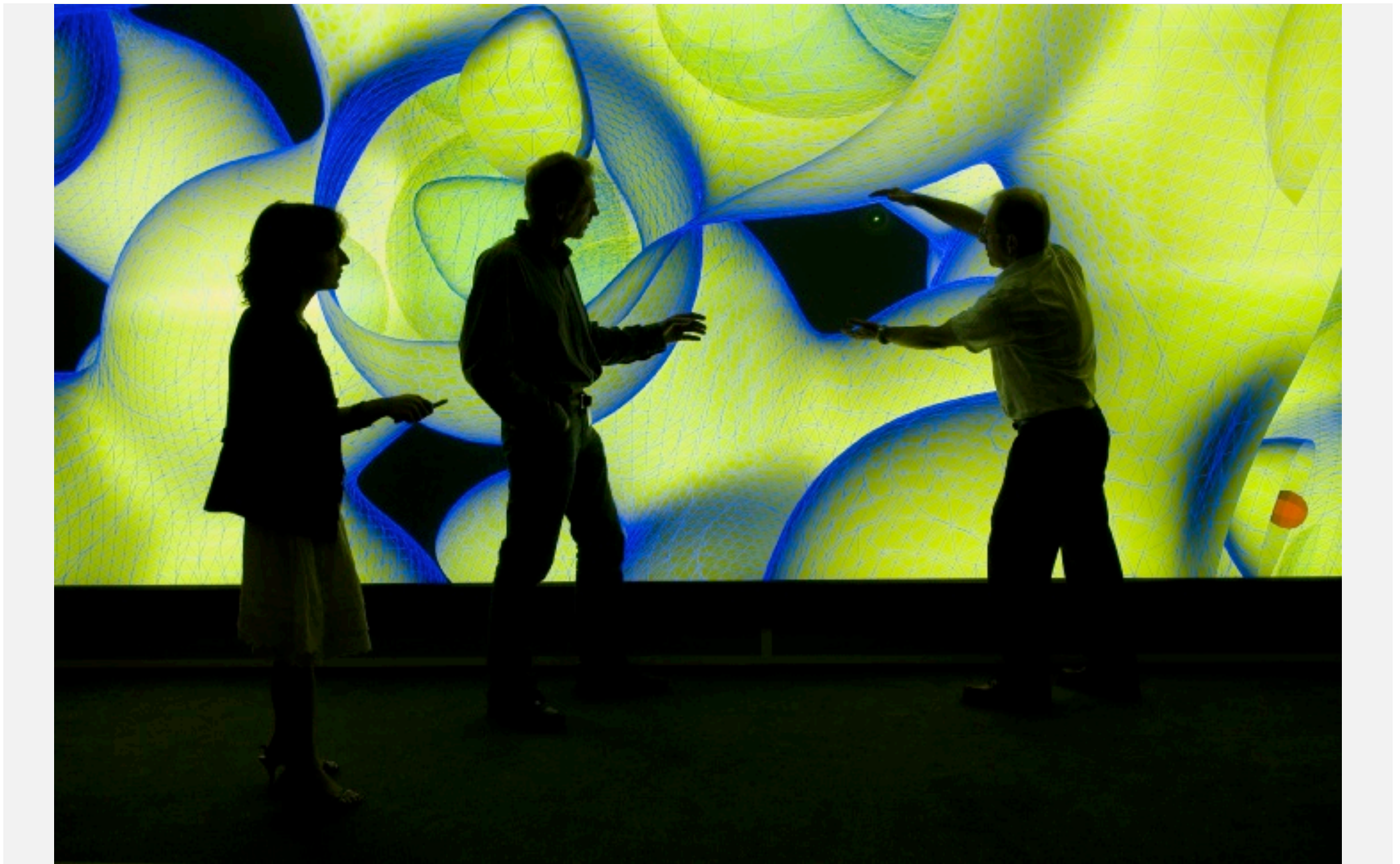
1217-14: CEA. Valduc nuclear center. Nuclear weapons simulation programme. Micro-assembly of the elements which will support the micro-target containing the mixture of deuterium and tritium. The target



1217-15: CEA. Valduc nuclear center. Nuclear weapons simulation programme. Micro-assembly of the target elements to create a complete structure. This structure will support the micro-target which will



1217-22: Bruyères-le-Châtel. CEA's Military Applications Division. The supercomputer Tera 10 can simulate complex phenomena in 3D. Here, the instability development of the interface between heavy and



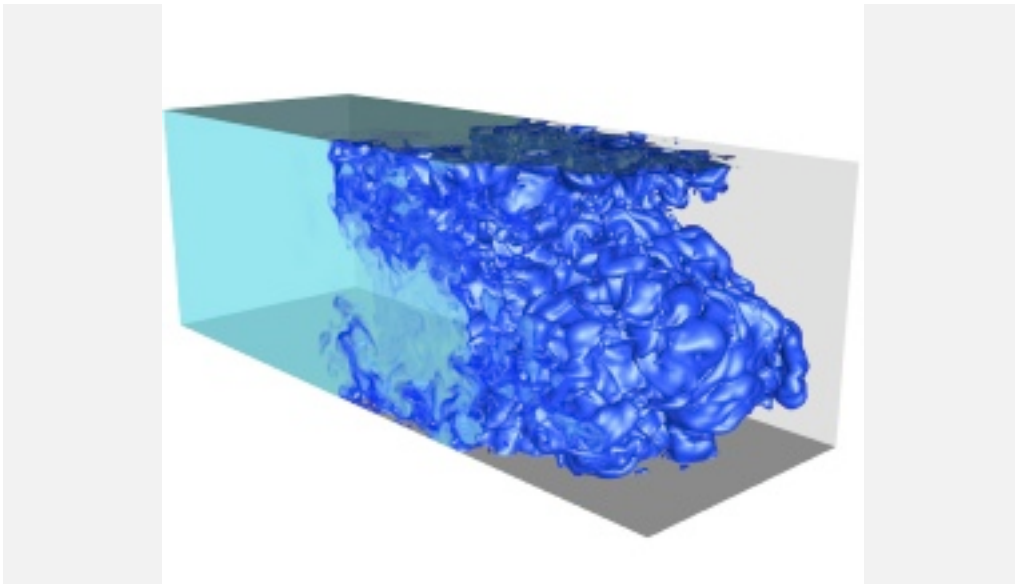
1217-19: Bruyères-le-Châtel. CEA's Military Applications Division, Ile de France. The supercomputer Tera 10 can simulate complex phenomena in 3D such as the modelling of materials' properties. Here, by compressing a sample of silica, the optical properties are modified. It becomes more and more reflective depending on the pressure exerted. This property could be leveraged to accurately measure the pressure inside the Megajoule Laser targets. /// CEA Direction des applications militaires, Centre DAM - Ile de France. Le super calculateur Tera 10 permet de modéliser des objets complexes notamment pour la simulation des expériences réalisées au Laser Mégajoule. Ici on voit une modélisation représentant les faisceaux des lasers convergeant vers la cible. Les étapes suivantes de la simulation numérique reproduisent l'implosion de la cible, la compression et le chauffage du mélange de deutérium et tritium jusqu'à l'amorçage des réactions de fusion nucléaire.



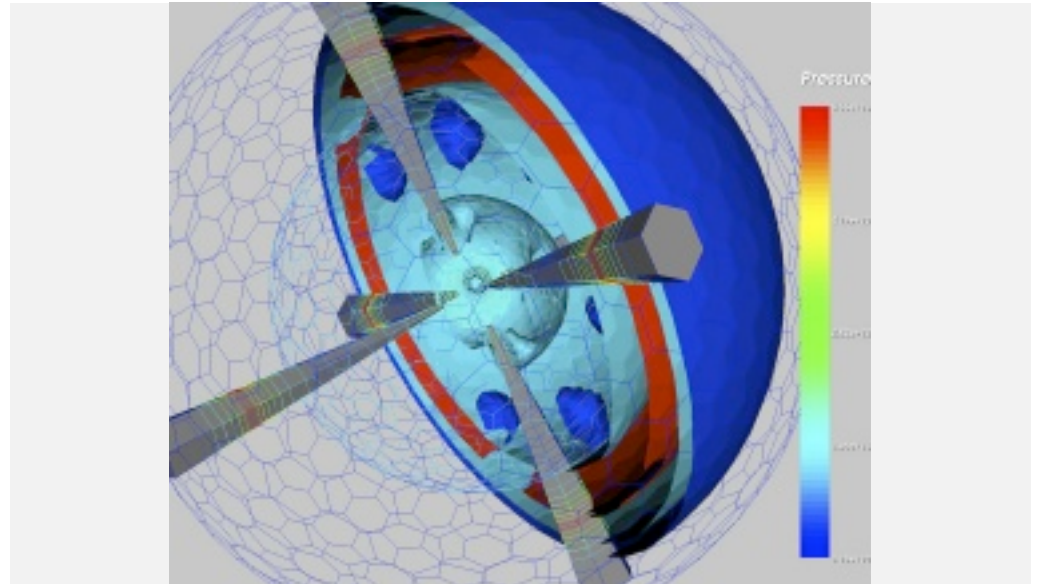
1217-17: CEA's Bruyères-le-Châtel complex. Nuclear weapons simulation programme. The supercomputer Tera 10, developed by the French company Bull, is able to treat 50,000 billion operations



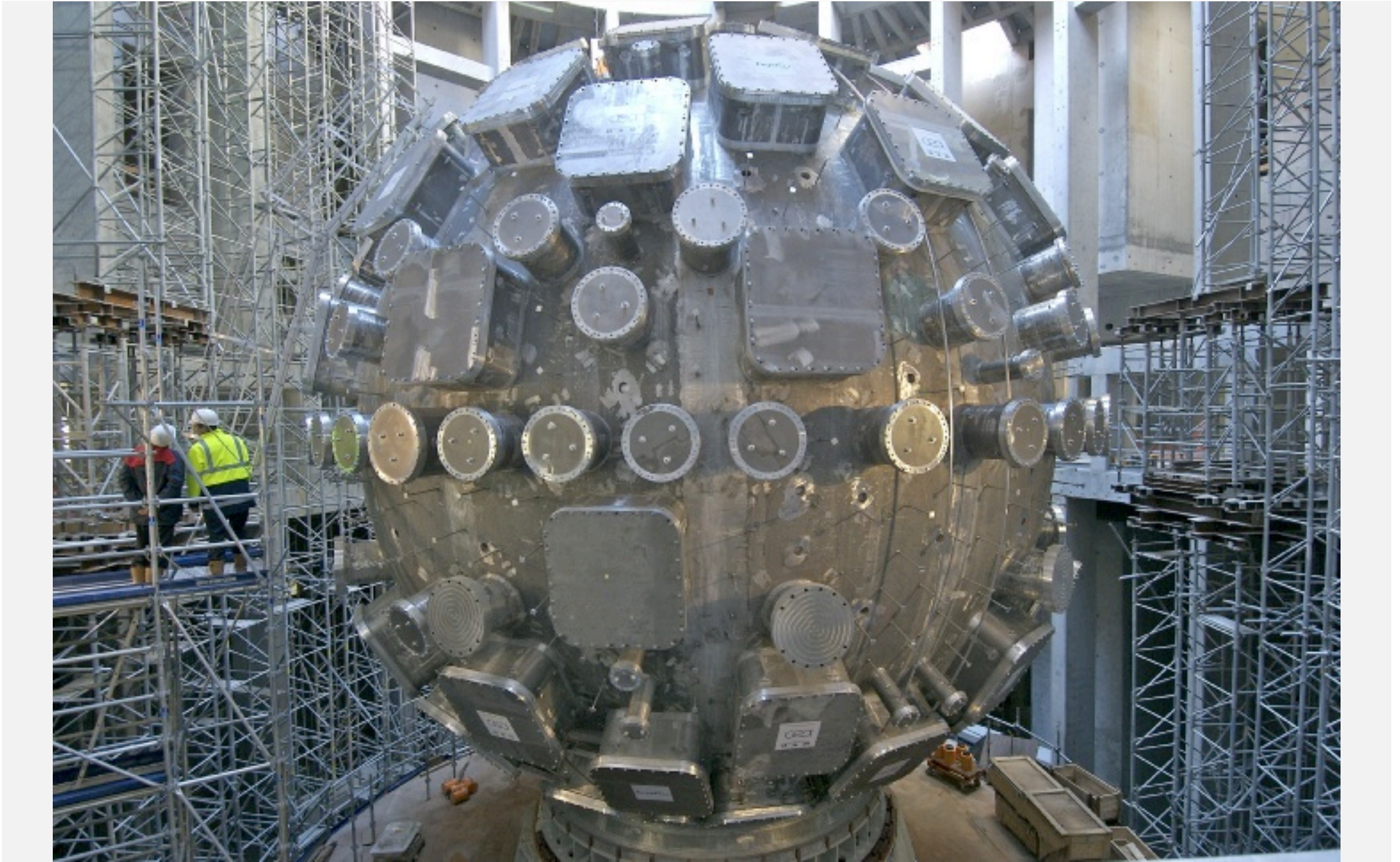
1217-18: Bruyères-le-Châtel. CEA's Military Applications Division, Ile de France. The supercomputer Tera 10 can model complex objects, especially to simulate experiments carried out with the help of the



1217-21: Bruyères-le-Châtel. CEA's Military Applications Division. The supercomputer Tera 10 can simulate complex phenomena in 3D. Here, the instability development of the interface between heavy and



1217-20: Bruyères-le-Châtel. CEA's Military Applications Division. The supercomputer Tera 10 can model complex objects in 3D, especially to simulate experiments carried out with the help of the Megajoule



1217-02: Bordeaux. CEA's CESTA center. The Megajoule Laser's experimental chamber with its concrete shield. This sphere 10m in diameter and 10cm in width weighs 140 tons. 240 laser beams will converge on it to trigger nuclear fusion experiments on tiny quantities of deuterium and tritium. The square windows are designed for laser beam access and the round windows, for diagnostic tool access. The Megajoule Laser or MLJ is used in the CEA's Simulation programme to guarantee the reliability and the safety of nuclear weapons, without resorting to nuclear tests which France decided to stop in 1996. //Bordeaux. CEA. Site du CESTA. Programme Simulation. La ligne d'intégration laser (LIL) est une installation prototype à échelle 1 d'une des futures chaînes laser du Laser Mégajoule. Elle est en partie destinée à valider les choix technologiques pour le LMJ (Laser mégajoule). La LIL est constituée d'une chaîne laser élémentaire du LMJ comportant huit faisceaux identiques. Comme le futur LMJ, la LIL est équipée d'une chambre d'expériences, sous vide, abritant la cible et supportant de nombreux instruments de mesures ou diagnostics. Ici, examen du bras porte-cible au centre de la sphère d'expérience de la LIL lors d'une maintenance.



1217-16: CEA's Bruyères-le-Châtel complex. Nuclear weapons simulation programme. The supercomputer Tera 10, developed by the French company Bull, is able to treat 50,000 billion operations per second and to predict, with a 0.5mm precision, what is happening inside the nuclear weapon during its combustion which only lasts one millionth of a second. // CEA. Site de Bruyère le Chatel. Programme de simulation de l'arme nucléaire. le super-ordinateur Tera10. Mis au point par la société Bull il est capable de traiter 50 000 milliards d'opérations par seconde et de prédire avec une précision de 0,5 mm ce qui se passe dans l'arme nucléaire pendant sa mise à feu et sa combustion qui ne dure qu'un millionième de seconde.