EXPLORING MATTER BY THE LIGHT OF SOLEIL SYNCHROTRON

SOLEIL IS DEDICATED TO FUNDAMENTAL AND APPLIED RESEARCH, FOR EXAMPLE IN THE FIELDS OF BIOLOGY, PHARMACY AND MEDICINE, CHEMISTRY AND PETROCHEMICALS, THE ENVIRONMENT, NANOTECHNOLOGY, MICROMECHANICS AND MICROELECTRONICS, THE AUTOMOTIVE INDUSTRY, ETC.

1 LINAC: the electron 'launching ramp'

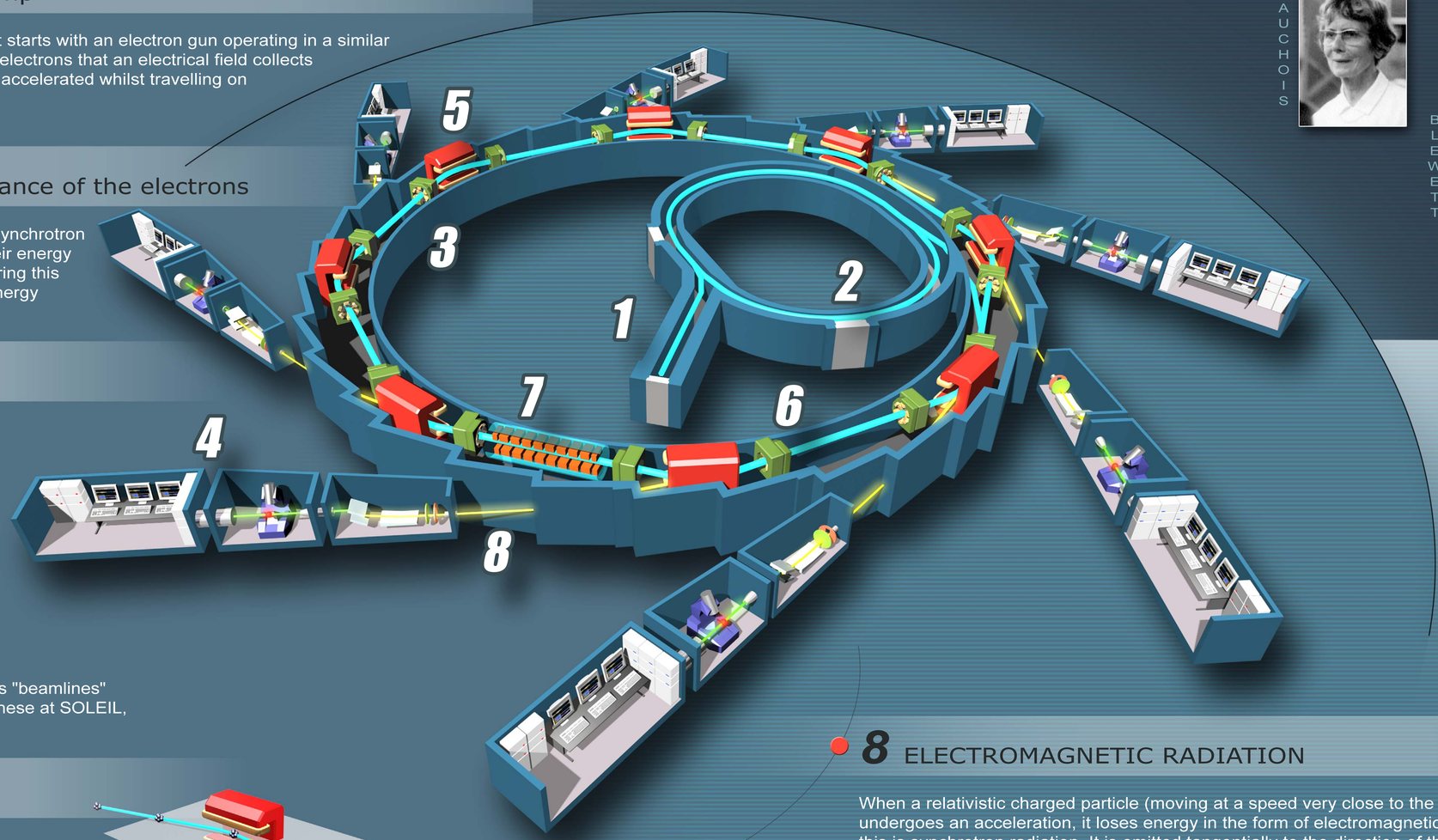
LINAC, the linear accelerator, is the first link in the chain. It starts with an electron gun operating in a similar way to that of a television set. A heated element produces electrons that an electrical field collects in bunches the size of a hair. The electron bunches will be accelerated whilst travelling on an electromagnetic wave like a surfer on an ocean wave.

2 THE BOOSTER: the frenzied whirling dance of the electrons

Upon leaving the LINAC, the electrons enter the BOOSTER, a synchrotron with a circumference of 157 m. In just a fraction of a second, their energy will be increased from 100 MeV to 2750 MeV (or 2.75 GeV). During this energy rise, the beam characteristics such as bunch size and energy scattering will be fine-tuned.

3 THE STORAGE RING: the 'electron trail'

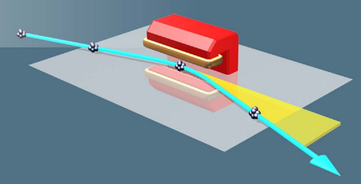
The electrons are transferred to the storage ring where they circle for several hours very close to the speed of light. The ring is a closed tube roughly 5 cm in diameter with a series of straight and curved segments. In the dipoles and insertion elements, the electrons undergo accelerations and lose energy in the form of electromagnetic radiation, known as 'synchrotron radiation'.



4 BEAMLINES

The light emitted by the electrons is guided towards outlets known as "beamlines" Each line is a laboratory in its own right. In 2010 there will be 25 of these at SOLEIL, with the possibility of 43 in the future.

5 BENDING MAGNETS



Dipoles (or bending magnets) generate the magnetic field to bend the trajectory of the electrons into an arc. They then lose energy in the form of light. The dipoles are both a source of light and an electron beam guidance element. There are 36 of them in the booster and 32 in the ring.

6 MAGNETIC GUIDANCE AND FOCUSING ELEMENTS

From the LINAC to the storage ring and even the booster, there are dozens of magnetic elements to guide the beam of particles: dipoles (or bending magnets) to make them turn, quadrupoles and sextupoles which are magnetic lenses to concentrate the bunches of particles to preserve their qualities.

THEY DISCOVERED THE SECRETS OF LIGHT

James Clerk Maxwell (1831-1879): Scottish physicist. His fundamental work changed the notions of electromagnetism and introduced the bases of field theory.

Alfred-Marie Liénard (1869-1958): French professor and research scientist. He was the first to show that a charged particle in motion produces electrical and magnetic fields.

Yvette Cauchois (1908-1999): Pioneer in the field of x-rays and the use of synchrotron radiation by French laboratories.

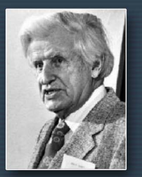
John Paul Blewett (1910-2000): Canadian physicist. He was the first to calculate electron energy loss by synchrotron radiation.

MAXWELL

LIÉNARD

CAUCHOIS

BLEWETT



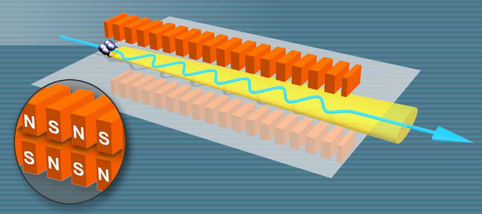
8 ELECTROMAGNETIC RADIATION

When a relativistic charged particle (moving at a speed very close to the speed of light) undergoes an acceleration, it loses energy in the form of electromagnetic radiation: this is synchrotron radiation. It is emitted tangentially to the direction of the particles.

7 MAGNETIC INSERTION ELEMENTS

(undulator and wiggler)

These are magnetic devices placed in the straight segments of the ring. They consist of small juxtaposed magnets to make the electrons follow an undulating path, a little bit like a skier slaloming. With each wave, the electron undergoes an acceleration and emits light. Thus, the magnetic insertion elements make the beams more intense than those emitted by the dipoles.



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