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EPS HISTORIC SITES

The LAL-LURE accelerator complex,

a new EPS historic site

The '*Laboratoire de l'Accélérateur Linéaire*' (LAL), CNRS-IN2P3 and Université Paris-Sud, was set up at Orsay in 1956 to build and operate a state-of-the-art linear accelerator ('linac') that would provide high intensity electron and positron beams of 1 GeV or more. Later on, in the early 70's, the '*Laboratoire pour l'Utilisation du Rayonnement Electromagnétique*' (LURE) was set up in close technical connection to LAL to make full use of the synchrotron light available at the *Anneau de Collisions d'Orsay* (ACO) storage ring built by LAL in 1962-65, and to develop a wide research programme including such fields as materials science, chemistry or structural biology.

The linac operation started in 1959 and ended 44 years later. In the meantime, many upgrades were performed to improve its performance and major facilities were added, ranging from lepton colliders to synchrotron light sources.

In 1962, the AdA collider, designed and built in Frascati under the leadership of Bruno Touschek, was brought to Orsay as the LAL linac allowed a higher particle injection rate. A year and a half later, the first ever electron-positron collisions were observed and the machine studies performed with AdA opened an entirely new field in accelerator science. In particular, the so-called Touschek effect, which is still limiting the performances of today's low energy and high current accelerators as well as synchrotron light sources, was discovered and understood while AdA was running at LAL.

The ACO stored its first beam in 1965. ACO, built by the LAL in collaboration with a team from CEA-Saclay, was an electron-positron collider of 1100 MeV total center-of-mass energy which lead to important discoveries in accelerator physics and to many pioneering measurements of vector meson properties. Until 1975, six particle detectors were operated in turn at ACO, in particular the first detector that ever featured a longitudinal magnetic field.

Following an idea of Orsay Professor Yvette Cauchois a first synchrotron light beam was turned on at ACO in 1973, making it the first storage ring in

▲ The unveiling of the EPS "Historic site" plate in front of the ACO collider. From left to right, on the front row: A. Stocchi, LAL director; G. Senzacqua, Frascati deputy mayor; S. di Tommaso, Frascati mayor; D. Ros, Orsay mayor; J. Dudley, president of the European Physical Society; M. Ducloy, a former EPS and SFP president. Two such plates are on display on site: one at the LAL main entrance, the other in the 'Pierre Marin' experimental hall that hosts the Science ACO museum.

Europe available to synchrotron light users. In June 1983, a free-electron laser was successfully operated at ACO; the second in the world, it was the first one in the visible bandwidth and the first at a storage ring.

Until the mid-80's, particle physics and synchrotron light experiments ran in parallel on site, all were making use of the LAL linac either as an accelerator or as an injector. The former field was driven by the DCI collider where three detectors operated between 1976 and 1984. Close to nine million J/ψ particles were collected – the world largest sample at the time. Then, DCI was fully dedicated to hard X-ray production, while the successor of ACO, Super ACO, specifically designed as a synchrotron source started operating in 1987. Both were using positron beams.

Super-ACO provided twenty light beams to a large international user community working in atomic and molecular physics, solid state and surface physics, protein structure studies, among others. It featured six ondulators and a free electron laser that produced a coherent beam in the visible-300 nm range.

Finally, in 1991, the CLIO free electron laser was commissioned. This facility, still in use today, allows one to investigate non-linear phenomena and ultra-fast processes in the infrared domain.

These achievements, covering five decades of basic science, have motivated the European Physical Society to award its "Historic Label" to the LAL-LURE accelerator complex, making it the 8th such site in Europe and the second in France after the 'Observatoire des Cosmiques' in the Chamonix valley. The ceremony took place on September 13, 2013, in the 'Pierre Marin' experimental hall which hosts ACO, now registered French historical monument and one of the main attractions of the 'Science ACO light and matter' museum. This presentation was part of a series of events organized that day and the following weekend – on the occasion of the European Heritage Days – to celebrate the 50th anniversary of the collisions observed at AdA and to cement the LAL collaboration with the INFN Frascati laboratory (LNF), as well as a scientific twinning between the Orsay and Frascati cities.

LURE has given birth to SOLEIL, the French third generation synchrotron located a few kilometers away from Orsay, on the Saclay plateau. LAL is still a major laboratory whose research activities range from the infinitely small to the infinitely large, from the LHC to the Planck satellite. Its accelerator department is presently involved in many projects: the local and state-of-the-art PHIL photo-injector and the THOMX compact X-ray source; international projects like XFEL in DESY (Germany) and ELI-NP in Romania; or basic science developments at CERN, KEK, *etc.* ■

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EUROPEAN PHYSICAL SOCIETY – EPS HISTORIC SITE
THE LAL-LURE ACCELERATOR COMPLEX

THE "LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE" (LAL, CNRS/IN2P3 AND PARIS-SUD UNIVERSITY) WAS SET UP IN 1956 TO OPERATE AN ELECTRON "LINAC" DESIGNED FOR NUCLEAR PHYSICS AND PARTICLE PHYSICS EXPERIMENTS. FROM 1958 TO 2003, THIS LINAC WAS THE HEART OF A COMPLEX OF STATE-OF-THE-ART FACILITIES INCLUDING: AN ELECTRON-POSITRON CONVERTER, SPECTROMETERS, COLLIDERS AND STORAGE RINGS FOR SYNCHROTRON LIGHT. PART OF THESE FACILITIES WERE SHARED WITH THE "LABORATOIRE POUR L'UTILISATION DU RAYONNEMENT ELECTROMAGNÉTIQUE (LURE)" WHICH WAS SET UP IN 1973.

MAJOR ACHIEVEMENTS AT LAL-LURE WERE:

- 1962-1964: FIRST OBSERVATION EVER OF ELECTRON-POSITRON COLLISIONS WITH THE AdA RING (BUILT IN FRASCATI) AND DISCOVERY OF THE TOUSCHEK EFFET.
- 1965: COMMISSIONING OF THE ACO ELECTRON-POSITRON COLLIDER WHERE PIONEERING MEASUREMENTS IN ACCELERATOR PHYSICS AND IN VECTOR MESON PHYSICS WERE PERFORMED.
- 1973: OPENING AT ACO OF A SYNCHROTRON BEAMLINE, THE FIRST EVER TO BE FED BY A STOCKAGE RING.
- 1983: FIRST LIGHT AMPLIFICATION EVER OBTAINED WITH A FREE ELECTRON LASER FED BY A STORAGE RING BEAMLINE (ACO).
- 1979-1984: RECORD PRODUCTION OF 9 MILLION J/Ψ BY THE DCI ELECTRON-POSITRON COLLIDER, LATER CONVERTED INTO A HARD X-RAY SOURCE.
- 1987: SUPER-ACO SUPERSEDING ACO (SUPER-ACO WAS PHASED OUT IN 2003, SOLEIL TOOK OVER IN 2006).
- 1991: COMMISSIONING OF THE CLIO FREE ELECTRON LASER TO EXTEND IN THE INFRARED RANGE THE SPECTRUM PROVIDED BY THE ORSAY LIGHT SOURCES.

ORSAY, 13 SEPTEMBER 2013