

CERN Courier Archive: 1973

A LOOK BACK TO CERN COURIER VOL. 13, MARCH 1973, COMPILED BY PEGGIE RIMMER

LABORATORY II

Telling the mole in the hole where to go

February 19 was the second anniversary of the authorisation of construction of the Super Proton Synchrotron (SPS). It was celebrated by the start of tunnel boring by the "mole". This conventional Robbins boring machine, built in Seattle, came by sea from the US Pacific Coast, through the Panama Canal to Rotterdam, up the Rhine to Basel, and then by lorry to Geneva. It arrived at the end of last year.

The SPS tunnel will be 4.8 m in diameter with a circumference of 6.9 km. A tunnelling scheme was selected (rather than the "cut-and-fill" method) to avoid changing the character of the countryside in a major way so that agricultural and forestry activities can continue much as previously. A second reason is the variation in altitude over the site. To retain a minimum Earth shield of 20 m for radiation protection, the tunnel will be 65 m below the highest point on the surface at an average depth of 40 m. A final point is that the molasse bedrock is solid enough to allow the tunnel to be bored reasonably easily.

Survey problems at the SPS are different to those encountered in building the PS or the Batavia accelerator in trenches in open flat land. The problems at Laboratory II are:

- installation of the magnet ring in an underground tunnel;
- links with existing installations at Laboratory I, mainly using the PS as injector;
- about 45 m difference in surface altitude around the circumference of the ring;
- wooded land which interferes with the line-of-sight in survey measurements.

To solve these problems, the surveyors had to resort to triangulation (angular measurement) and trilateration (distance measurement). Datum points are located on high buildings (ISR Laboratory, Laboratory 5, SB Building, etc). It was impossible to use the top of the ISR water tower, the highest point at CERN, because it is subject to movements of up to 2 cm. Other points [monuments], some beyond the site, have been set in the ground at a height of about 1.5 m, one at a height of 8 m. The baseline is provided by two PS survey points. The results give an accuracy of 2 mm between all points.

In subterranean surveying, one of the most difficult problems is the dropping of a perpendicular line within a shaft to transfer surface co-ordinates to the tunnel level. Various methods were used for this operation,



The mole being installed underground at the point where boring is beginning. Its 7 km journey around the ring is expected to be completed by autumn 1974. The machine, 80 m in length, comprises the 4.8 m diameter head, shown here, pressure and supporting pads, an operator's cabin, electrical equipment, conveyor belts, tunnel-lining system, skip changer and spoil-removal train.

giving results to better than 0.5 mm for depths of 60 m. It is amusing to note that the curvature of the Earth requires a correction of about 8 mm for the deepest shafts, to ensure that the SPS has the same diameter underground as that calculated at the surface.

The first underground survey consisted in laying out the line of the tunnel between two shafts (PGC and PPI), some 200 m apart. After the tunnel had been pierced, metal brackets with reference sockets containing an automatic centring system were fitted to the walls. Distances were measured with invar



Geodetic measurements are often taken under an umbrella to shelter the surveyors from the Sun, but here a gyro-theodolite and its operator are being protected from water seeping in at the bottom of the PPI shaft, some 40 m below the surface.

wire and directions with a gyro-theodolite. This underground alignment was accurate to a very satisfactory 2.4 mm compared with the surface alignment.

The first survey monument in the tunnel, with its reference socket and support for the laser used to guide the boring machine, is already in place. Monuments will be built every 32 m as the mole progresses. The survey team has considerable confidence that the mole will arrive back where it is starting from.

- Compiled from texts on pp70–72.

Compiler's Note



CERN's next impressive civil-engineering programme was even more challenging. Started in 1985, the 27 km underground ring for the Large Electron-Positron Collider (LEP) was Europe's largest tunnelling project, prior to the Channel Tunnel. It was excavated by three moles burrowing for three years. The ring had to link with the SPS as an injector and was given a 1.4% tilt to minimise the depth and cost of the access shafts under the Jura. The depth of the ring varies from 175 m on the Jura side to 50 m on the lake side, with an average of 100 m. Since 2007, it has housed the LHC.

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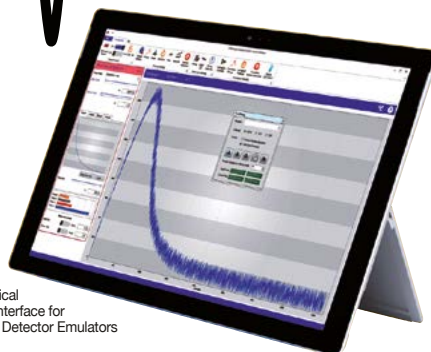
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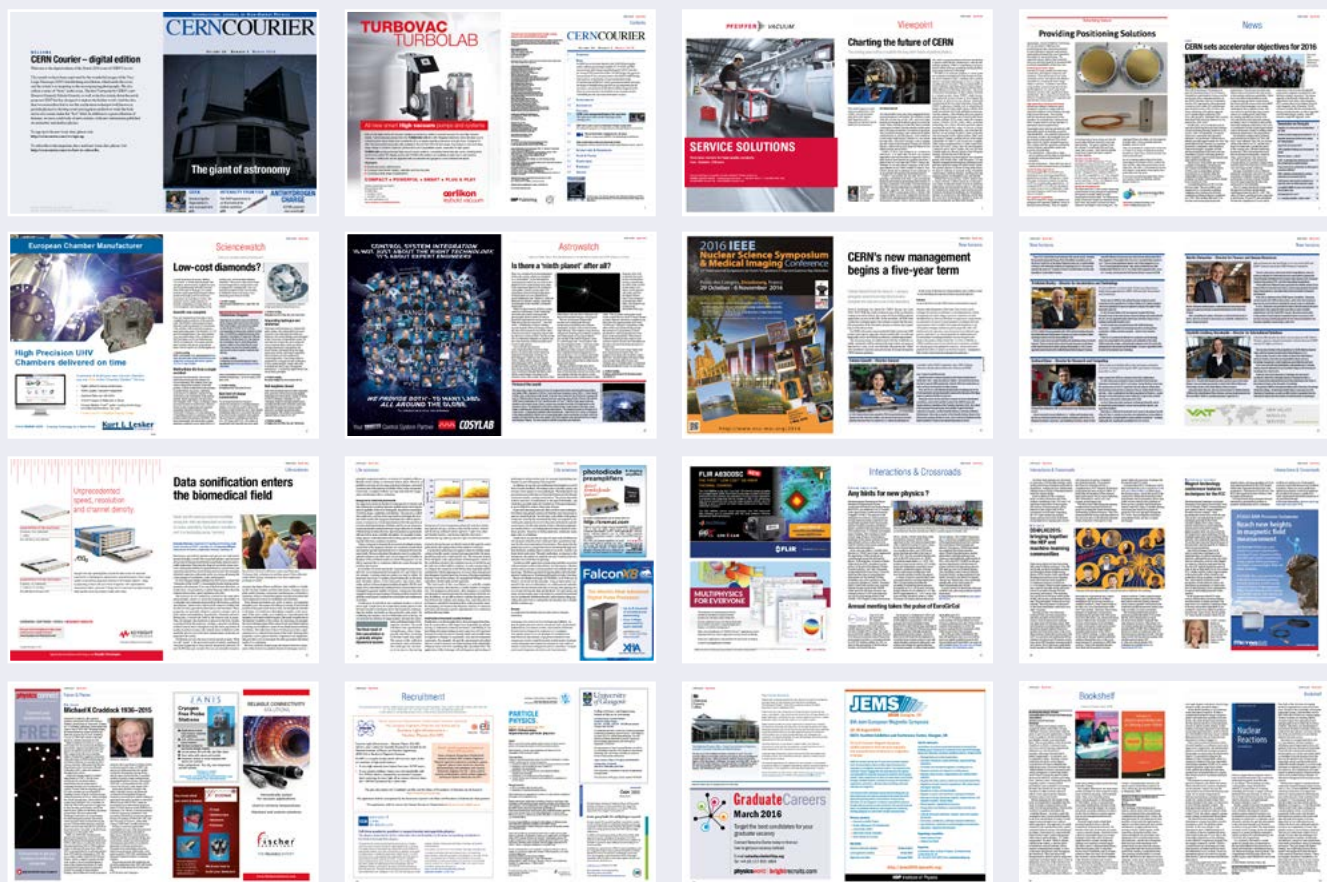
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WELCOME

CERN Courier – digital edition

Welcome to the digital edition of the March 2016 issue of *CERN Courier*.

This month we have been captivated by the wonderful images of the Very Large Telescope, ESO's breathtaking installation, which made the cover, and the article is as inspiring as the accompanying photographs. We also collect a series of “firsts” in this issue. The first Viewpoint by CERN's new Director-General, Fabiola Gianotti, as well as the first article about the newly proposed SHiP facility, designed to explore the hidden world. And the idea that two researchers had to use the sonification technique (well known in particle physics) to develop novel investigation methods to study the body motor also comes under the “first” label. In addition to a great collection of features, we have a rich body of news articles, with new information published on antimatter and nuclear physics.

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