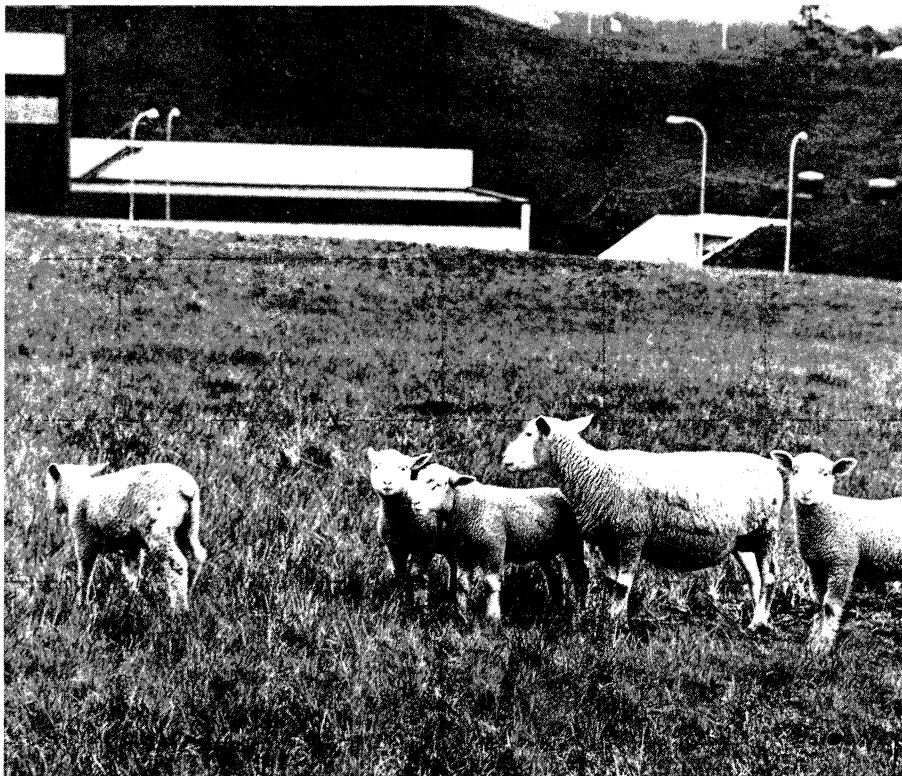




CERN 4.5.73

*All large organizations have their sheep and CERN is no exception. A herd was brought to work on the grass covered mounds of the ISR in May and provided a very pleasant Springtime diversion.*

## The big chambers

By the time this issue appears, if all goes to plan, the European bubble chamber, BEBC, will have started its first physics run.

Only two cameras were in action when the first pictures were taken in the chamber at the beginning of March and it was not possible during the test programme to determine all the optical parameters required for the geometrical reconstitution of the photographed tracks. This will therefore be the first task of the run. For the first experiment (being carried out by a Birmingham-CERN-Glasgow-Heidelberg-LPHE Paris collaboration) the chamber will be fed with a separated 9 GeV/c negative kaon beam to study kaon-proton interactions. At least half a million pictures will be taken.

Apart from the quickly repaired hydrogen leak that we mentioned in the March issue, no serious problems arose during the previous tests which is a very encouraging sign for the physics programme. The chamber now has to show its paces in the relentless running of normal experiments. It will operate with a metal piston until the Autumn when the permanent plastic piston will be installed.

While BEBC is entering the commissioning phase, the heavy-liquid bubble chamber, Gargamelle, has just resumed operation for a series of neutrino experiments using a freon filling.

The experiments scheduled for last December had to be postponed for safety reasons. Vibrations, caused by the enormous forces of the pressure cycles, had fractured some of the pipework and thorough surgery was necessary during the long shutdown of the proton synchrotron at the beginning of this year. The pressure system was completely dismantled. The trolley which carries the nitrogen

of 0.06 K). The necessary time to achieve polarization is very short — two to three minutes with a microwave power of 6 mW per cm<sup>3</sup> (this is about four times faster than butanol which in addition only reaches a polarization of 70 % as against 90 % for propanediol).

After these fine results had been achieved, research with this substance continued at lower temperatures. It has proved possible with the helium 3/helium 4 dilution cryostat (see vol. 11, page 353) to obtain a positive polarization of about 98 % and a negative polarization near 100 % at a cryostat temperature of 0.16 K and a magnetic field of 2.5 T. The temperature of the propanediol remained at 0.37 K as a result of the heating effect of the microwave power.

The research then extended to deuterized materials which make it possible to obtain polarized deuterons. It is more difficult to polarize deuterons than protons because of their lower magnetic moment (six times smaller than that of the proton). With the same magnetic field, thermal agitation more readily disorients the spins of deuterons than of protons.

During the first tests, partially deuterized 1.2 ethanediol, which has similar properties to 1.2 propanediol, gave a polarization of 37 % for deuterons while the residual protons in the target were polarized to 97 %. The significance of these results becomes

more obvious when it is realized that these values correspond to the same spin temperature (0.0012 K) for both protons and deuterons.

The advantage of dynamic polarization using microwave power, as opposed to the static (or 'brute force') method using only high field and low temperature, is very obvious. By the static method, even if it were easy to reach a temperature of 0.0012 K, months or possibly years would be needed before thermal equilibrium was reached between the cryostat and the nuclei of the target and thus before these polarization rates could be attained.

It was intriguing that the different nuclei of the ethanediol target assumed the same spin temperature and the CERN group has been studying the way in which this coupling took place. It seems that the phenomenon is brought about via the free electrons of the substance which, by their interactions, generate a reservoir of energy called a spin-spin interaction reservoir. The different kinds of nuclei couple thermally to the reservoir and this is thought to be the mechanism whereby such high polarization rates are obtained. The microwave power cools the reservoir and, via the thermal coupling, the nuclei are cooled to the same temperature and are highly polarized since there is a direct relationship between temperature and polarization.

*View inside the heavily shielded room where measurements on rare isotopes of lithium and sodium were carried out. 3.4 m of concrete and iron hide the detectors from the target region and, in addition, the room is lined with cadmium to cut down the background of neutrons.*

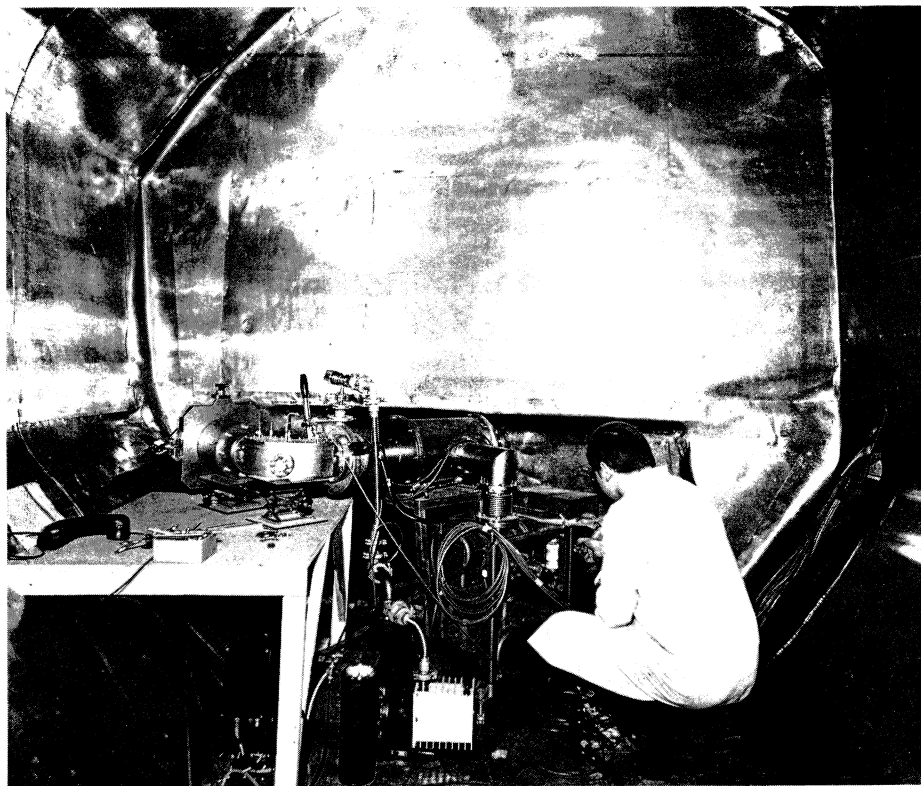
reservoirs (having a capacity of over 50 m<sup>3</sup>) was rebuilt. The framework was reconstructed using tougher girders in a close triangular pattern and, to improve rigidity, the wheels were replaced by piles set firmly in the ground. Struts bearing on the sides of the pit were also added in order to absorb static and dynamic reactions.

The repair of the pressure system went without incident and the chamber was tested again in mid-May. The desired results were achieved — the vibrations which had caused trouble with the previous structure are now damped out and experiments can safely continue.

## New measurements on rare isotopes

A team from the Laboratoire René Bernas at Orsay completed a series of experiments at the proton synchrotron in May which has given new information on rare isotopes of lithium and sodium. They have measured the mass of lithium 11 to an accuracy of one part in 10<sup>5</sup> (i.e. to 150 keV) and have more precise data (masses to within 100 to 800 keV) on sodium isotopes from sodium 27 to 32. Measurements with this precision are not exceptional for stable masses but are a considerable achievement for isotopes so far from stability.

The Orsay work supplements the research at the isotope separator ISOLDE at the synchro-cyclotron (see for example vol. 10, page 4) where refined measurements on heavier elements of the periodic table are carried out. Orsay have concentrated on the light exotic nuclei which need GeV energy protons to be produced and live milliseconds (rather than seconds or minutes for the nuclei studied at ISOLDE). Very little is known about these nuclei and there are a number of interesting questions to be answered.



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The stability of lithium II for example has posed an interesting puzzle ever since it was discovered by a group at Berkeley in 1966. Most theoretical calculations predict it to be unbound and to give off two neutrons instantaneously. The precise mass measurement by the Orsay group shows that it is marginally bound (by some 200 keV only) and this can probably be reconciled with current theories.

The measurements performed on a sequence of sodium isotopes are interesting because there are terms in the mass formulas that diverge rapidly when the number of neutrons is increased, giving predictions that can differ by tens of MeV. The few hundred keV precision of the PS experiment can thus select clearly between the models.

The experiment sat along the neutrino beam-line from the PS where it could receive protons ejected at an energy of 25 GeV. The protons were directed onto a special target consisting of thin foils of uranium and graphite interleaved. Collisions with the uranium nuclei ejected nuclear fragments into the graphite which was heated. Alkalies diffuse rapidly through graphite and emerge as ions from the surface. Electric fields then pull them through a mass spectrometer which sorts out the different isotopes. They are detected in an electron multiplier which counts ion impacts. The masses are measured by a modification of the well-known isotopic doublet method.

A significant feature about the latest measurements, which has yielded the greater precision, has been much better shielding between the target region and the detector region. The isotope signals can be lost in the flood of neutrons from the target region and, to reduce this dramatically, the detector is placed in a shielded box lined with cadmium (which has a very high cross-section for catching neutrons). On the target side there is a wall of concrete and iron 3.4 m thick. With this arrangement the isotope signals soar out of the neutron background. Typical counting rates were 30 counts per PS pulse for lithium 11 and 1 count per 20 PS pulses for sodium 32 (which is a very exotic isotope).

In addition to the mass measurements the isotopes could be studied using a neutron detector and a beta detector. The phenomenon of delayed neutron decay is well documented for heavy elements but much less so for light nuclei. The measurements on lithium and sodium more than doubled the number of known light delayed neutron emitters. Sodium iodide detectors were used to obtain new spectroscopic information on the excited states of the isotopes by observing the gammas emitted as they decayed to more stable states.

The Orsay group enjoyed the collaboration of physicists from Berkeley and Darmstadt.