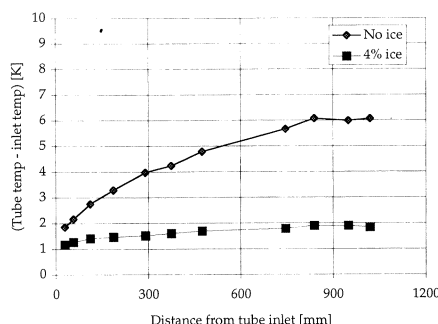


To cool the Semiconductor Tracker of the inner detector for the ATLAS detector at CERN's LHC proton collider to a temperature of around -10°C, the cooling system will have to remove about 24 kW of heat. To accomplish this, a novel system has been developed at the UK Rutherford Appleton Laboratory (RAL) which uses 'Binary-ice' - a suspension of ice crystals in an aqueous medium containing a freezing point depressant. The graph shows the benefits of binary-ice over conventional cooling.



magnet was spotted that summer and, with initial evidence for top quarks already in the can, the collision rate doubled. Tevatron collider running has been almost exclusively with 900 on 900 GeV beams.

Run II of the Tevatron collider will use the new Main Injector instead of the original Fermilab Main Ring.

RUTHERFORD APPLETON Binary ice

The Semiconductor Tracker (SCT) of the inner detector for the ATLAS detector at CERN's LHC proton collider will contain approximately 6.1 million channels of electronics coupled to the 16000 silicon wafers in the barrel and forward regions. The whole assembly must operate at a temperature of around -10°C and the cooling system must remove about 24 kW of heat. To accomplish this, a novel system has been developed at the UK Rutherford Appleton Laboratory (RAL) which uses 'Binary-ice' cooling. The term refers to a suspension of ice crystals of sizes ranging from 50 to 500 microns in an aqueous medium containing a freezing point depressant. Almost all the heat applied to a bath of binary-ice fluid is absorbed by the latent heat of melting and thus results in near isothermal behaviour, in contrast to conventional cooling systems which operate with a substantial temperature gradient between inlet and outlet.

The binary-ice fluid is produced in commercially available generators, supplied by Integral Technologie

GmbH. For the last two years, a 1.7kW machine has been operated at RAL. From the results of these tests, binary-ice cooling has recently been chosen as the baseline option for the SCT. In the current design, a mixture of 80% water and 20% methanol is used to provide the -10°C operating temperature. The obvious benefits of binary-ice cooling over conventional cooling can be seen in the accompanying graph which shows the increase in temperature relative to the inlet temperature for liquid and Binary-Ice coolants.

The fluid flows along a uniformly heated 3 mm diameter pipe. The flow rate is about 5.5 ml/s and the total heat load is 48.5 W. In each case, the alcohol/water mixture is identical.

Binary-ice has a much higher effective heat capacity and a significantly better heat transfer coefficient than water but still benefits from the low density and long radiation length of that fluid. It is also able to cope with the intense radiation of the LHC intersection regions. Although the viscosity of the fluid is increased by the presence of ice crystals, any pressure drop increase is easily overcome by a small reduction in flow velocity. For ATLAS, the pipework inside the inner detector will be operated as a leakless cooling system, using a design developed at CERN.

To prepare for the design of the final ATLAS system, a team of scientists and engineers from RAL and the University of Oslo are studying the kinematic properties of these fluids, developing flow and ice concentration monitors and writing slow control and data acquisition software.

Greece

Continuing its survey of physics in its member states, the European Committee for Future Accelerators (ECFA) met in Greece in March, at the Demokritos Institute and the University of Athens.

No CERN member state has such a long and distinguished history in fundamental physics. In the 5th and 4th centuries BC Democritus, Leucipidus, Anaximander and Anaxagoras laid the foundations of the atomic picture of matter. 25 centuries later, Greece was one of the founding members of CERN, and particle physics is currently a key element in Greece's programme of basic research.

Thanks to CERN, Greek physicists are numerous and active despite limited home funding, but are dispersed in independent small groups over many experiments. There is as yet no national coordination, although Manolis Floratos, the new Director of the Demokritos Institute and CERN Council delegate, plans to improve the coordination of Greek experimental physics at CERN.

However sizable collaborations have formed for the Atlas and CMS detectors at CERN's future LHC proton-proton collider, where Greek

groups hope, with EU support, to contribute significantly to the development and construction of the detectors.

The NESTOR underwater neutrino project led by Leo Resvanis in Athens has developed into a major international collaboration and hopes to avoid the funding hiccups which have hindered the progress of underwater projects elsewhere. Funding for phase 1 is now complete, and further international collaboration is sought to extend the detector. NESTOR, like the Italian Gran Sasso underground laboratory, could later act as one distant station for a CERN neutrino beam, providing useful 'long baseline' data in the continuing search for neutrino oscillations.

About 50 experimental high energy physicists are currently working in Greece, with some 25 graduate students. They are affiliated with the University of Athens, the National Technical University in Athens, the Demokritos Institute, the University of Thessaloniki, the University of Crete, the University of Ioánnina and the University of Patra. Most of the experimental activity is related to work at CERN, with, over the past ten years, a significant contribution to detector component building in Greece, in particular in connection with the aptly named Delphi experiment at LEP. This has been helped by the development of companies with high-tech expertise. Greek experimentalists have long played a prominent role in research at CERN, in particular the discovery of prompt photons by an Athens/Brookhaven/CERN/Syracuse collaboration at the Intersecting Storage Rings in 1979.

Particle physics contributed significantly to the revival of physics interest in Greece and a good number of university physics



positions are occupied by particle physicists. Particle physics is bound to remain a very important and is certain to remain highly oriented towards international collaborations. Greece is increasingly acting as a scientific focus for the whole Balkan and Eastern Mediterranean region, a role which should be encouraged.

Numerically, there is significant participation in Delphi (20 physicists from Athens (University, Technical University and the Demokritos Institute) and CP-LEAR (13 physicists from Athens, Ioánnina and Thessaloniki), and at a smaller level in Aleph (5 physicists from Demokritos). The University of Athens collaborates in a number of CERN heavy ion studies. There is a strong commitment to CERN's future LHC with direct involvement in Atlas (Athens Tech., Athens and Thessaloniki) and in CMS (Demokritos, Ioánnina and Athens).

Continuing the illustrious traditions of Democritus, Leucippus, Anaximander and Anaxagoras, there are about 45 well-known Greek theorists, of whom about 30% prefer to work overseas. There are at present 26 graduate students. Greek theorists have long used CERN as a base for advanced training and

research. Many important papers by Greek theorists have been written at CERN and the healthy development of Greek theoretical physics has profited from CERN's fellowship and associates programme. The Theory Division long welcomed and supported many Greek visitors in the framework of an agreement with the Demokritos Institute.

There are theorists in all Greek centres involved in experimental research. Some work goes on in phenomenology and there are also important groups in field theory (Crete, Thessaloniki, Ioánnina and Athens Tech.).

While there is an important inflow of undergraduate students, many of them prefer to go to the US or Western Europe for their graduate studies, partly because of lack of financial support. In the past, a good fraction of these students did return, often after a stay at CERN.

Funding comes from two ministries, the Ministry of Industry, Energy and Technology and the Ministry of Foreign Affairs. The latter covers part of the Greek contribution to CERN (at present 3.75 million Swiss francs) in its support for international organizations. As happens periodically in many countries in these cost-con-

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scious times, the visibility of particle physics and its funding is looked at with envy in some sectors. National material support is at the level of only 1 million Swiss francs per year, insufficient to meet the needs of Greek CERN users. Special projects like NESTOR are financed by the Ministry of Education as well as benefiting from EU funding.

Greek industry is beginning to benefit from CERN contracts, with the industrial return factor having increased tenfold recently. This trend should continue with a new committee formed by the Chamber of Industry and Technology, and an Industrial Liaison Officer appointed at Demokritos.

The creation of the Institute for Accelerator Systems and Applications in Athens could be a focus for specialized small enterprises also supplying CERN. Its director is C. Papanicolas. The institute's microtron accelerator should be completed in five years.

Greece has long benefited from a special agreement under which its CERN contribution was only 40% of the nominal value (at present 0.4% of the budget of the Organization). However according to recent CERN Council decisions, the Greek contribution should increase progressively to its full value between 1997 and 2002.

Dark Matter in the spotlight

The mysterious 'dark matter' which could make up most of the Universe continues to intrigue scientists. The status of the search for an understanding of this enigmatic stuff was highlighted at the 2nd Symposium on Dark Matter in the Universe, organized by UCLA, held in Santa Monica, California, from 14-16 February with 100 participants. It was an exciting meeting, not only because of the new observations presented, but also because of the expectations of major clarification of the nature of the Universe in the near future.

The Symposium began with an overview of the current status of the Hubble Constant by Virginia Trimble (Maryland) and the Age of the Universe by B. Chaboyer (Toronto). The Hubble constant relates the velocity of recession of galaxies to their distance - the further away a galaxy is, the faster it appears to recede. The Hubble constant also gives a handle on the age of the Universe - the faster the expansion, the less time has passed since the Big Bang. While the Hubble constant is still highly uncertain, the age of the Universe seems to be at least 12 billion years. The Universe can live with this, and contrary to recent press reports, there is no real "age crisis" yet.

One of the most exciting results was the announcement by S. Perlmutter (Berkeley Laboratory) of the observation of seven very distant type-Ia supernovae (with a total of 11 more to be analysed) by the Berkeley-led collaboration. There is a real possibility of measuring the deceleration parameter (the

deviation of the Hubble law from simple linearity) of the Universe, and to determine basic cosmological parameters using this technique. On the same note, the future detailed study of the cosmic background radiation angular fluctuations with a new generation of detectors on new satellites can also give these parameters. This was reviewed by A. Lange (Caltech) and E. Wright (UCLA).

An excellent, lucid review of the underlying theory was provided by Joseph Silk (Berkeley). Following the pioneering work of the COBE satellite, the inhomogeneity in the cosmic background radiation has now been measured at the 1-degree angle scale. New data is already providing important clues to the cosmological parameters of the Universe.

The discovery of a Brown Dwarf and more evidence for MACHOs (massive astrophysical compact halo objects) indicate at least two concrete sources of dark matter in our Galaxy. Both topics were represented at the meeting by S. Kulkarni (Caltech), who presented the brown dwarf discovery, while D. Bennett (Livermore) and other members of the MACHO team discussed the MACHO search status. They reported a total of eight events over two years of observation. The masses of the MACHO candidates are from 1/4 to 1/2 that of the Sun, leading to the obvious question of whether these are stars, white dwarfs, or what!

On the large scale, the use of gravitational lensing to measure the total mass of galactic clusters is now becoming a reality. In this technique, images of distant objects are distorted by intervening matter that is otherwise invisible. R. Blanford (Caltech) presented an overview of