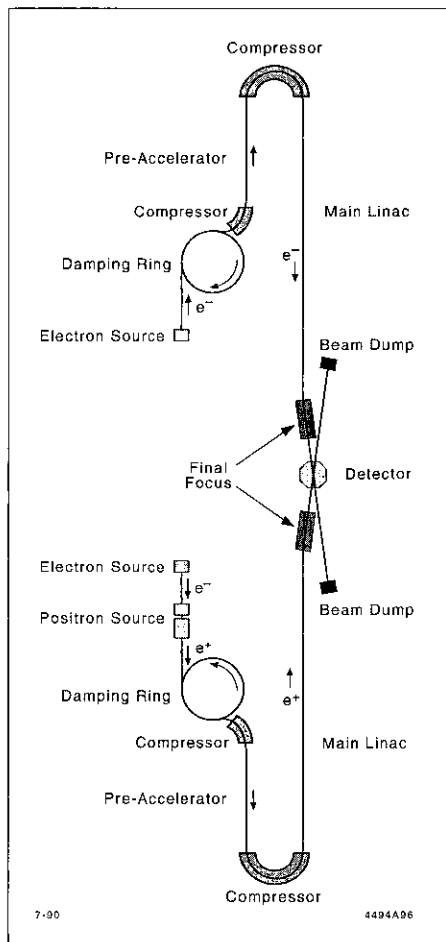


Possible layout of the Next Linear Collider (not to scale).



which will prototype the injectors and damping rings required for such a machine.

Another important international R&D project now being commissioned at SLAC is the Next Linear Collider Test Accelerator (NLCTA), whose purpose is to construct and reliably operate a fully engineered sector of a TeV machine. This 42 metre prototype now incorporates four 1.8 meter copper accelerating structures of slightly different design, powered by two 50 megawatt, 11.4 GHz klystrons built at SLAC. The microwave power from each klystron is first compressed by a factor of four using a SLED-II pulse compression system developed at

SLAC. The resulting pulse is then split and 100 MW is delivered to each of two accelerator structures.

The fabrication of three of these structures reflects the international character of the project. In each, some 200 copper cavities were machined to micron tolerances by KEK; assembly and bonding of these cavities was done at SLAC. The NLCTA has already achieved accelerating gradients averaging nearly 50 MV/m with acceptable dark currents of a few microamps, and 70 MV/m is expected in individual 1.8 m structures after two more klystrons have been added to allow the instantaneous power level to reach 200 MW. For comparison, the Stanford Linear Collider and the TESLA Test Facility have achieved accelerating gradients of about 17 MV/m (July/August 1997, p. 1).

In actual operation with a multibunched electron beam traversing these structures, the beam loads down the cavities, resulting in a lower gradient for the succeeding bunches in a given train. Physicists working on the NLCTA compensate for this transient beam-loading effect by selectively shaping the RF pulse fed to the structures. With a flat-top pulse, this effect leads to a 17 percent spread in the output electron energies, but this spread can be limited to a mere 0.3 percent by a suitably shaped RF pulse.

The NLCTA provides an ideal test bed to use in refining the design of a next-generation linear collider and addressing remaining unresolved issues. Initial plans call for two 0.9 m and four 1.8 m structures powered by four 50 MW klystrons, together capable of accelerating an electron beam to 450 MeV. A possible upgrade of two additional 1.8 m structures and a total of seven 75 MW klystrons would be able to generate a

1 GeV beam - corresponding to a gradient of 85 MV/m within the structures. This is approximately the accelerating gradient that will be required for a full-scale TeV linear collider.

ITALY

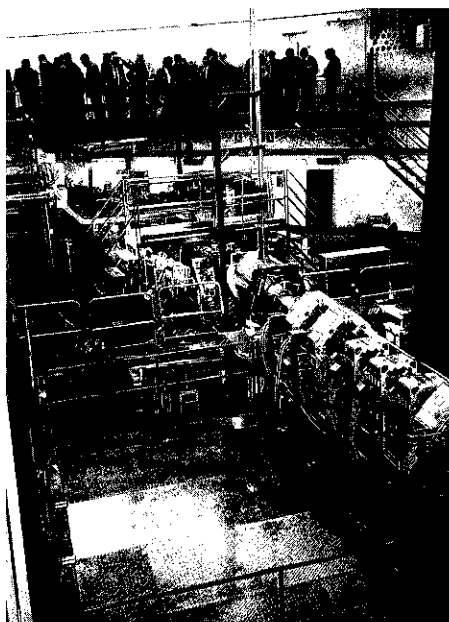
In its continual tour of CERN Member States, the European Committee for Future Accelerators (ECFA) had a major assignment in April when it visited the Frascati and Gran Sasso laboratories to learn about their work and about Italy's continuing impressive commitment to particle physics, at both national and international levels.

The continuing national effort was underlined at Frascati when committee members heard news of the first colliding beams at the new DAFNE electron-positron collider (April, page 24 - an earlier but more comprehensive DAFNE status report appeared in the December 1997 issue, page 12).

Nuclear and sub-nuclear research had a relatively late start in Italy compared to other major European countries. In the mid-1920s, Orso Mario Corbino, influential politician and chairman of Rome physics, pushed for an increased national effort in physics. The figurehead for this effort was Enrico Fermi, recently returned from Göttingen. This science burgeoned, in nuclear physics, in theoretical physics and in cosmic ray research.

After the difficult war years, Italian physics made a new start with the creation of the Centre for the Study of Nuclear Physics and Elementary Particles in 1945, followed by the INFN (National Institute for Nuclear

The European Committee for Future Accelerators (ECFA) visited the DAFNE installations at the Italian national laboratory at Frascati.



Physics) in 1951. In Italy, particle physics is now the major basic physics research effort, a situation unique in the Member States.

Italy benefits from a very high scientific return from CERN. From the very start, exemplified by Edoardo Amaldi, Italian physicists and engineers have played leading roles in the Organization.

All particle physics research is carried out within the framework of the INFN. At present no less than 2050 physicists are working under the general auspices of INFN although most are paid by the universities. This number includes 1450 permanent researchers and 600 postdocs and fellows. There are about 500 pre-doctoral students.

Among the 2050 physicists, 820 (40%) are particle experimentalists, of whom 600 are working on CERN programmes and 28% are theorists. About 14% of INFN physicists are

experimental nuclear physicists, but nuclear physics now also covers some of the CERN programme. The remainder (18%) are working on detector, accelerator and software development. Most postdoctoral researchers used to have a permanent position, but a considerable fraction now turn to industry.

Major commitment

Italian physicists participate in nearly all aspects of CERN's work. The considerable activity on LEP at CERN (mainly Aleph, Delphi and L3) corresponds to the equivalent of 212 full-time physicists, although the full roll of Italian members of the LEP collaborations numbers 284. The CERN fixed-target programme counts the equivalent of 217 full-time physicists, and 110 on R&D for CERN's LHC collider.

Besides the high level of activity at CERN, there is also a considerable effort at HERA at DESY (70 equivalent full-time researchers), at Fermilab (45) and at Frascati (60), at SLAC, Stanford (where the contin-

gent is increasing), and PSI in Switzerland (21). There is also considerable and increasing activity in non-accelerator experiments (84).

CERN's LHC will be a vital part of Italian particle physics. For the longer-term future, there is strong interest in the development of an electron-positron linear collider where there is collaboration in the Tesla superconducting test facility at DESY.

Of the physicists working on accelerators, 60% are working at CERN, 25% are working on US facilities and the remaining 15% are equally spread between DESY and Frascati.

With Italian research support staff generally not as numerous as in the other major European countries, Italy looks towards collaborations abroad.

Italy has a strong tradition of outstanding contributions to theoretical particle physics. At present some 500 theorists (including 120 graduate students) work at close to 30 major centres.

About half work in field theory and related domains, a third concentrate on phenomenology, and a sixth on mathematical physics. Besides the



ECFA Chairman Enrique Fernandez (right) with Frascati Director Paolo Laurelli.

After Frascati, the ECFA party continued their mission at the Gran Sasso underground laboratory. Director Alessandro Bettini explains.

500 engaged in particle physics research, 160 theorists work in nuclear physics, also supported by INFN.

A recent development in computational physics is the new APE 100 Gflop machine (November 1996, page 4). APE-100 is now available commercially and in use in Italy and Germany. INFN APE funding for 1997 was at the level of 4 million Swiss francs.

Italy is also host to the Abdus Salam International Centre for Theoretical Physics in Trieste and to the European Centre for Theoretical (nuclear) physics in Trento. In both cases Italy provides a large fraction of the funding. Italian theorists have always played a prominent role at CERN.

The Italian contribution to CERN (126.6 million Swiss francs in 1997) comes through the Foreign Ministry, while the Ministry of Universities and Research supervises INFN.

With the exception of university salaries, the INFN is the only source of funds for research in nuclear and sub-nuclear physics within Italy. Its present annual budget (therefore excluding the CERN contribution) amounts to almost 440 million Swiss francs. The particle physics effort is shared between accelerator-based physics at CERN and elsewhere, investment in experiments at CERN, HERA and Fermilab, and personnel and travel costs. Considerable funding is earmarked for the LHC detectors (ATLAS, CMS and ALICE).

INFN (Istituto Nazionale di Fisica Nucleare)

The INFN, a public body financed by Parliament, serves to promote, coordinate and finance Italian research in nuclear and sub-nuclear



physics. The INFN 's decentralized structure is based on 19 research units or sections (sezioni) in leading Italian universities, together with smaller units (gruppi collegati), each associated with a section.

The 19 sections are at Torino, Milano, Pavia, Genova, Padova, Trieste, Bologna, Ferrara, Firenze, Pisa, Perugia, Roma-1, Roma-2, Napoli, Cagliari, Bari, Lecce and Catania and at Roma-Sanita (which now becomes Roma-3). All sections cover both experimental and theoretical particle physics. "Gruppi collegati" with activities in particle physics are in Trento, Parma, Udine, Cosenza and L'Aquila. The INFN also operates four national laboratories - Frascati and Gran Sasso, and the nuclear physics laboratories of Legnaro (near Padova) and del Sud (near Catania).

The INFN works in close collaboration with the universities and supports university staff besides its own. The research scientists working with the INFN include 950 university physicists in addition to 500 INFN employees. Technical and

administrative personnel number 1300.

The INFN has joint programmes with other public organizations, mainly the CNR (National Research Council), the ENEA (energy and environmental research) and the INFN (condensed matter). In terms of spending power it ranks fourth among the Italian research organizations after the CNR.

Under the Ministry of Universities and Research and, to a lesser extent, the Ministry of Industry, the INFN has its own Council of 37 members (34 being active scientists). The president (and acting director) is currently Luciano Maiani, who will become CERN Director General next January. He will be succeeded as INFN president by Enzo Iarocci (see page 31).

INFN's Council is advised by five national committees formed by representatives from each of the sections and which provide a sense of unity to an institution with widely distributed activities.

At present the chairman of the committee for sub-nuclear physics with accelerators is M. Calvetti, the committee for sub-nuclear physics without accelerators is chaired by F. Bobisut and the committee for theoretical research by C. Becchi. The two other committees, covering nuclear physics and technological research, are chaired by A. Bertin and C. Sciacca, respectively.

Proposals which eventually define the research programmes originate from the community of researchers and are evaluated by the national committees and INFN management, which shapes general strategy.

The INFN traditionally has close relations with CERN. Its long-time "Minister for Foreign affairs", M. Gigliarelli-Fiumi, served in many key capacities at CERN, including

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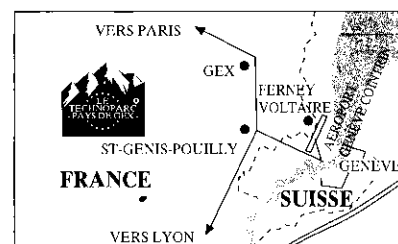
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The MACRO installations at Gran Sasso

chairman of the Finance Committee. He has now retired, and is replaced by Roberto Pellegrini.

INFN programmes cover five-year period, the present one spanning 1994 - 98. The first version, presented in 1992, had to be revised lower in view of economic difficulties and a new version approved by the National Council for Science and Technology in June 1993 includes rescheduling for some of the investments. The approved version increased by almost 40% over the period 1994 - 8.

While this is encouraging, budgeted funds and allocated funds are now showing some significant differences - funds available in 1997 were about 5% lower than in 1996.

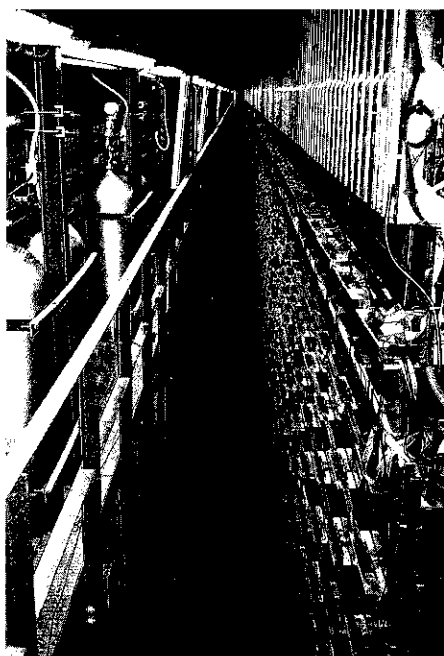
The five-year INFN plan

The 1994 - 98 five-year plan seeks a budget increase of about 8% per year (probably 2% in real terms). The sub-nuclear physics areas targeted are:

- The continuation of the LEP experiments;
- Fixed-target physics at the Tevatron (Fermilab) and Babar (SLAC);
- Preparation for LHC experiments;
- Exploitation of HERA (DESY);
- Completion and exploitation of DAFNE (Frascati);
- Development of the experimental programme at Gran Sasso;
- Detection of gravitational waves, in particular Virgo (see below).

Relativistic heavy ion collisions at CERN is considered under nuclear physics.

The new plan (1999-2004), now in the approval stage, will show a slight decrease. It includes completion of Babar at SLAC and Borexino at Gran Sasso. There will be an effort toward a neutrino beam from CERN to Gran



Sasso, using the Icarus experiment.

The INFN has already significantly extended its activities to include astroparticle physics. The substantial involvement in the detection of gravitational waves reflects its desire to cover fully all basic interactions. Two important bar detectors using 100 mK technology, Auriga, at Legnaro, and Nautilus, at Frascati, are nearing completion. These follow Explorer, at CERN, using 2.5 K technology. The two new detectors should reach a sensitivity of 10^{-19} at 103 Hz. The Virgo interferometer, built in Pisa as a Franco-Italian project, should eventually reach 4 orders of magnitude lower.

The INFN submitted itself to an international review last year. The review panel consisted of B. Richter (chair), P. Kienle and V. Soergel, with G. Ross as consultant for theory. The report was very positive but expressed concerns about the lack of mobility of researchers within Italy and about the small number of postdoc positions which hinders the mobility of younger researchers.

CERN and Italian industry

Italian industry is involved with high-tech equipment at CERN, and in particular, with the assistance of the INFN, in the development of superconducting radiofrequency cavities for LEP and LHC superconducting dipole magnets. Italy has a well-developed and diversified industrial base with major companies (Ansaldo, Olivetti) and dynamic small ones involved in work for CERN. This is also the case for major international companies established in Italy. Particle physics has opened a market for nuclear instrumentation companies.

Gran Sasso

The Gran Sasso underground laboratory represents a major research effort. At present the laboratory serves 500 users from 10 nations (half the users are Italian).

In 1997 ECFA invited the Director of the Laboratory to become, together with the directors of CERN and DESY, an ex-officio member of Restricted ECFA, reflecting ECFA's interest in non-accelerator based particle physics.

The Laboratory, near the town of L'Aquila, 120 km North-East of Rome, is alongside a 10 km road tunnel through the Gran Sasso range in central Italy. It has of 3 large underground experimental halls, about 100 m. in length and 20 m. in height.

Construction was approved in 1982 after a proposal of then INFN president Antonino Zichichi in 1979. Civil engineering was completed in 1987 and Gallex obtained its first result on the solar neutrino flux in 1992.

The annual budget (excluding salaries) is of the order of 12 million