The painstaking realignment of more than three miles of accelerator components had taken a month, being completed by late November. After that, alignment crews began working on the Mark II vertex detectors installed during the October shutdown. With this work finished by mid-December, an attempt was made to restart the SLC, but no collisions were obtained before Christmas.

Fortunately, SLAC Director Burton Richter had extended the Mark II run by a month to help compensate for the time lost due to the tremor, and by the middle of January a steady trickle of Zs began to appear inside Mark II, enabling physicists to begin checking out the VDS.

This system has two principal components – an inner silicon strip vertex detector (SSVD), surrounded by a drift-chamber vertex detector (DCVD). About the size of a beer can, the three-layer SSVD rests directly on the beam pipe, which has a radius of only 2.5 cm. A high-precision drift chamber operating at about two atmospheres, the DCVD extends out to a radius of 17 cm. The SSVD is designed to measure positions of charged particles very accurately, and the DCVD determines their angles precisely.

Together these two devices distinguish whether the tracks of charged particles emerged directly from the SLC interaction point (the primary vertex) or from a secondary vertex slightly offset from it. In the latter case, a Z boson must have given birth to a heavy particle – a tau lepton, or a hadron containing a charmed or bottom quark – that can travel several hundred microns before disintegrating in turn.

Another important SLC advance was the increase of the machine's rhythm to 120 Hz, twice last year's best pulse repetition rate. The transition went extremely smoothly, with no significant problems in beam monitoring or control, and the SLC began producing Z particles at its new cadence about a day later.

By the end of January the peak luminosity had almost returned to its best pre-quake level, despite problems with the positron beam. The two beams approached their best prior intensity levels, but physicists were unable to focus the positrons as well as before. This problem is being attacked during the current three-month shutdown, when a new high-power positron target, together with many other improvements and upgrades, is being installed. (see photo page 32)

FERMILAB Linac upgrade

The Fermilab linear accelerator (Linac) was conceived 20 years ago, produced its first 200 MeV proton beam on 30 November 1970 and has run without major interruption ever since. Demands have steadily increased through the added complexity of the downstream chain of accelerators and by the increased patient load of the Neutron Therapy Facility.

Major improvements have been the conversion from protons to negative hydrogen ion working, a new control system, and replacement of the radiofrequency control monitoring system.

Last year a revamp of the Linac got underway as the first stage of a major Laboratory upgrade (June 1989, page 15) to provide more protons and antiprotons.

The final four of the nine drift-tube tanks in the present Linac will be replaced with seven new accelerating modules operating at a higher frequency and higher accelerating fields to increase the final beam energy from 200 to 400 MeV.

The radiofrequency power to drive the new modules will be supplied by seven 12 MW 805 MHz klystrons installed in an expanded gallery. The higher energy will reduce the tune spread due to beam space-charge forces at injection in the 8 GeV Booster accelerator, thereby improving performance.

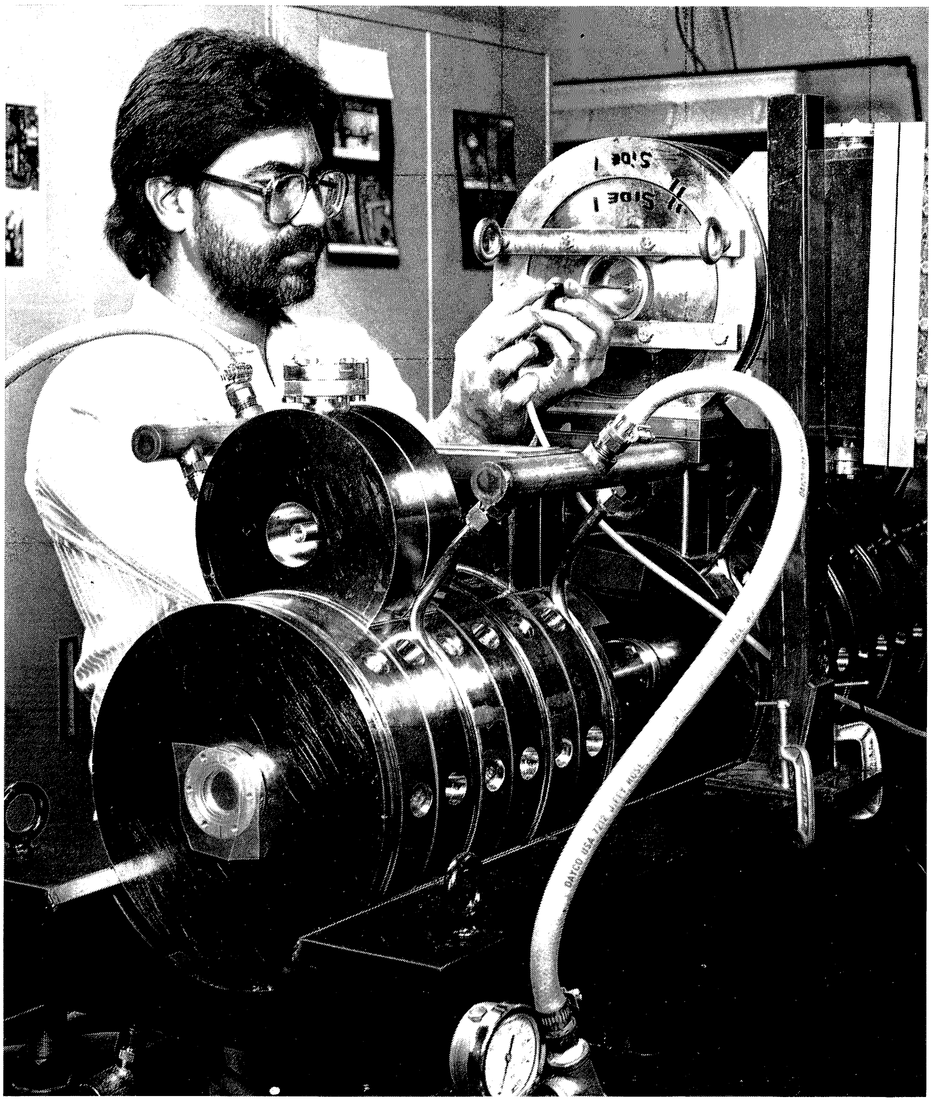
The past year saw an ambitious R&D effort take shape for the Linac upgrade. This will continue until the summer, when accelerator fabrication will commence, using the side-coupled cavity structure design originally used on the Los Alamos Meson Physics Facility (LAMPF) linac 20 years ago.

The basic unit for the new linac is a set of coupled resonant cavities brazed together into a 16-cavity section. Four such sections are connected in series to form a module powered by one klystron. There will be a total of 448 cavities, each providing an energy gain of about 600 keV.

Because of the high electric fields (7.5 MV/m), a special six-cavity test model was built in a collaboration between Fermilab and Los Alamos to test sparking and X-ray production. Power tests at Fermilab last year indicated that voltage conditioning with 6 million r.f. pulses (5 days of conditioning at 15 Hz) would bring the sparking rate down to less than one spark per hundred pulses in the new linac. Continued voltage conditioning leads to a steady reduction in sparking.

A second six-cavity model was fabricated at Fermilab to explore

Technician Rene Padilla making adjustments in a full-scale prototype side-coupled accelerating structure fabricated by Fermilab for the Linac upgrade.



improved machining and tuning techniques and power tested in February. After 20 million r.f. pulses, the sparking rate extrapolated to a full linac was less than one spark per thousand pulses.

Fabrication also began last year of a complete prototype accelerator module, mechanically and electrically equivalent to the first of the seven needed for the new linac. This module is scheduled for completion by July and will be power tested using a 12 MW prototype r.f. system, the modulator portion of which was fabricated in the Fermilab linac gallery during 1989 and successfully operated into a diode load at full power and the specified 15 Hz repetition rate. The prototype klystron comes from Litton Industries.

The 400 MeV linac is scheduled for operation by the fall of 1992. Its total estimated cost is $22.8 million, opening up a further 20 years of reliable operation.

From Robert J. Noble

GANIL New beams and facilities

Last year, the French GANIL National Laboratory in Caen successfully completed an energy upgrade to consolidate its position in the forefront of heavy ion research in the medium energy domain (20-100 MeV/nucleon).

Main modifications included installation of a new electron cyclotron resonance (ECR) source (Caprice 2B at 10 GHz), a recasting of the injector cyclotron and of the buncher in the low energy line, a change in the ion stripping ratio (from 3.5 down to 2.5) between the two separated sector cyclotrons, and replacement of injection elements in the second SSC.

This upgrade now allows not only a substantial gain in intensity for the previously available beams to 1.4 x 10^{11} for krypton and xenon, but also a significant increase in beam energies (to 60 MeV/nucleon for krypton, 44 MeV/nucleon for xenon). Beams up to uranium are now available at interesting energies – a 29 MeV/nucleon lead beam (intensity 4 x 10^9) was delivered to an experiment in December.

In parallel, two major new experimental facilities have been designed and built. An electrostatic separator has been added downstream of the existing doubly achromatic LISE spectrometer. This new set-up, LISE3, can select a given mass and charge from the products of a heavy ion interaction, useful for experiments with secondary beams as well as studies using exotic nuclei up to the limits of stability.

The second new facility is TAPS – Two Arm Photon Spectrometer