

magnets at Argonne. The group first built a 25cm bore magnet that pioneered many features that later became standard. In particular the windings used a cable made of niobium-titanium superconductor and copper, thus providing many parallel current paths, good stabilization and a twisted conductor. This magnet, designed by Charles Laverick, operated at 4.4T in 1964 and is now in the Smithsonian Institution, Washington D. C. .

Following this, it was natural to design a superconducting magnet for the 12 ft bubble chamber. The capital costs of a conventional or super-magnet were about the same, but the operating costs strongly favoured the latter. The decision was made in 1966 and the resulting magnet, with a 16ft diameter room temperature bore, proved the new technology on the largest scale. In the early 1980s the magnet was reused for the High Resolution Spectrometer at SLAC's PEP ring.

John Purcell, who led the 12ft bubble chamber magnet group, went on to build the coil for the Fermilab 15ft chamber. Other members of the group, notably Henri Desporte and Bert Wang, went on to apply this technology elsewhere. Large superconducting magnets are now a standard industrial product used in magnetic resonance imaging, in energy storage and in ore separation, amongst other applications.

A significant non-accelerator device, the Compound Parabolic Concentrator, a non-imaging concentrator of light, was reviewed by Earl Swallow. This was invented in 1965 by Roland Winston of the University of Chicago as a way of minimizing the number of phototubes needed in a Cherenkov counter array. "Winston Cones" have been used in many subsequent experiments in several

fields of science but they have also found major application in non-tracking solar concentrators. Concentrations as high as 84000 have been measured.

Perhaps the most dramatic incident at the meeting was when Swallow demonstrated a rear light assembly of a Ford Thunderbird car that uses a set of LEDs and associated CPCs - a remarkable spinoff from a high energy physics experiment!

Argonne high energy physicists have continued doing experiments at Fermilab, PEP, HERA and other accelerators. Many technical contributions have been made, notably in the calorimeters for HRS at PEP, CDF at Fermilab and ZEUS at HERA, as was reviewed by Brian Musgrave.

The interest in neutrino physics that started with the first study of neutrino interactions in hydrogen and deuterium using 1 GeV neutrinos from the ZGS has continued and is now focussed on electron-proton collisions in the ZEUS electron-proton collider at DESY, Hamburg.

Lower energy neutrinos are still under investigation at Argonne, the particles coming from cosmic ray interactions in the atmosphere and the detector being the Soudan nucleon decay detector in Minnesota.

A proposed future experiment with this detector involves directing a neutrino beam from the Fermilab main injector to Soudan, a distance of 730km, to search for neutrino oscillations.

Although at its peak the ZGS program represented about a quarter of Argonne's total activity, the Laboratory took the termination of the programme in its stride by initiating important new projects in related areas of research and technology, building on ZGS successes where possible. Much of this activity relied heavily on the skills and resilience of the people who had worked on the ZGS.

CHARM2000

The fourth quark, charm, may not hit the headlines these days as much as its heavier cousins, but it has still a lot of physics to give. From June 7-9 over 100 attendees heard 35 plenary talks at Fermilab on the Future of High-Sensitivity Charm

*How sensitive can one be to charm?
Participants at the Fermilab CHARM 2000
workshop look at a possible extrapolation.*



Experiments. Twelve working groups focused on the physics opportunities and technical challenges. Speakers representing the CLEO (Cornell), BES (Beijing), SLAC B-Factory, Fermilab E653, E687/831, E769/791, E781, and CERN WA82/92 and WA89 collaborations reviewed the current status and future prospects.

Exponential growth in charm sensitivity during the past decade, along with the rapid pace of advance in technology and computing, suggests the goal of 10^8 reconstructed decays (three orders of magnitude beyond current samples) for an experiment to run at the turn of the millenium.

This served as a unifying theme for the diverse areas of charm physics surveyed: spectroscopy, semileptonic decays, QCD tests, baryons, rare and forbidden decays, charm mixing and CP violation. In contrast with the fifth quark, beauty, for which the most exciting prospects are detailed tests of CP violation in the Standard Model, the grail for charm is physics beyond the Standard Model, for which the rates of flavour-changing neutral currents, mixing, and CP violation expected in the Standard Model present negligible backgrounds. Observable effects in one or more of these areas are expected in theories which make useful predictions about the fermion masses and mixings, such as supersymmetry, technicolour and left-right-symmetric, grand unified and multiple-Higgs theories.

Also discussed was progress in detector technology - pixel and diamond detectors, scintillating-fibre tracking, vertex triggers and other new techniques which make the promise of a 10^8 -charm experiment realistic. Organizers John Cumalat of Colorado, Dan Kaplan of Northern Illinois and Simon Kwan of Fermilab and attendees were enthusiastic



Lively discussions on electromagnetic physics at the Intersections Conference: from left to right Lawrence Cardman (CEBAF), Hans de Vries (NIKHEF-K) and Bernard Frois (CE-Saclay).

about the prospects for advancing the "programmatic" production, spectroscopy and decay physics by three orders of magnitude and achieving sensitivities of order 10^{-5} for mixing, 10^{-7} for rare decays, and 10^{-3} for CP asymmetries. A follow-up session is contemplated for the HQ94 heavy-quark workshop at Virginia, with ongoing work towards a technical proposal.

Particle-nuclear intersections

With the traditional distinctions between particle and nuclear physics becoming increasingly blurred, the Fifth Conference on the Intersections of Particle and Nuclear Physics, held from May 31 to June 6 in St. Petersburg, Florida, brought together particle and nuclear physicists to discuss common research efforts and

to define and plan a united approach.

The topics spanned an extremely large range (more than 15 decades in energy), from fundamental physics with ultracold neutrons to evidence for the top quark. Special emphasis was placed on testing the Standard Model at both the intensity and precision frontiers. The enormous range of energy is only one indication of the diversity of subject matter, which is underlined by a sample of the topics discussed (and the range of laboratories involved):

fundamental physics with cold and ultracold neutrons; parity violation and time-reversal invariance with epithermal neutrons; CP violation; conservation laws through rare and forbidden decays; nucleon form factors and spin structure functions with electromagnetic probes; particle physics aspects of relativistic heavy-ion collisions; physics of quantum chromodynamics and of quark and gluon distributions; search for exotics, hybrids and glueballs.