The Beam Line

Stanford Linear Accelerator Center

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An Operator's View

Hybrid Bubble Chambers

by Gordon Bowden

Over the past year progress has been made at SLAC in the synthesis of bubble chambers and spark chambers into a new experimental technique called the Hybrid Experiment. This method uses spark chambers and electronic counters to guide the bubble chamber in its picture-taking and add supplementary data to that of the photograph. The approach is most valuable in the study of the details of very rare events where indiscriminate picture taking would produce a huge number of pictures containing only a few examples of the event.

In August, 1972, the SLAC 40-inch bubble chamber completed its second hybrid experiment, BC-42. This experiment, done by members of Experimental Groups A and B, studied inelastic scattering of muons from protons. It is the first bubble chamber experiment ever to photograph high energy muon scattering and the most ambitious hybrid experiment so far done anywhere.

Muon scattering is of intense current interest because it is similar to electron scattering which SLAC physicists have used to study the internal structure of the proton. So far, counter and spark chamber experiments have indicated that the proton possibly contains a point-like structure. This bubble chamber experiment is one of the first to show the number and character of the particles produced by collision with this structure.

Inelastic muon scattering is a particularly difficult subject for bubble chambers because it occurs so rarely. On the average only one muon in 360,000 will scatter on its way through the hydrogen of the 40-inch B.C. The experimental group found they could put 100 tracks through the chamber and still untangle the event out of the dense mass of beam tracks. This raised the event rate to one in 3600.

One might think that with an electronic detector sitting behind the bubble chamber controlling its camera, the bubble chamber could rest quietly until required to photograph the detected event. Unfortunately, this is not so. The bubble chamber must pulse and form tracks every time particles arrive whether an event will occur or not. If the bubble chamber waits until an event is detected, the heat left along the particle track will have dissipated before the pressure falls low enough to form bubbles. Quantitatively, it takes the chamber about 7 thousandths of a second to reach minimum pressure, but the track heat dissipation time is only one hundred billionth of a second. Thus, the bubble chamber must start an expansion before each and every beam burst in order to reach track-formation conditions at the same instant the particles pass through the chamber. To photograph one muon event, the chamber had to pulse 3,600 times.

The only way to capture enough muon events during available running time was to pulse the chamber as fast as possible. The experiment took seven months during which time 80 days were spent running. The chamber pulsed 38 million times, which is twice the number it had done in its entire five-year life, and this probably represented the largest number of expansions ever devoted to a single experiment. The results were compressed into 100,000 pictures, which contain about 5,000 inelastic events. All difficulties included, the chamber averaged over one-half million expansions per day and ran at a rate of 10 expansions per second.

There are problems associated with running a bubble chamber at 10 pps (pulses per second). After each expansion the bubble chamber must wait at high pressure until all the bubbles have recondensed back into liquid. If you try to expand the chamber before this is complete, the remaining bubbles will grow from the beginning of the new pulse. They will grow bigger with each succeeding expansion. At 10 pps it takes only a matter of seconds for these bubbles to raise the pressure and heat up the chamber beyond control. If this happens, pulsing must be stopped and the chamber allowed to cool. Throughout the experiment the bubble chamber was pulsed as fast as this boiling and recondensation would permit. Sometimes the chamber would heat up in a matter of seconds without warning, making the operators very nervous. We call it "boiling over".

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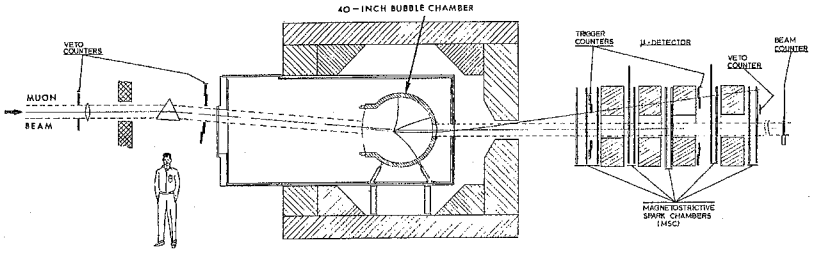

BC-42 apparatus diagram, showing the 40-inch chamber followed by the spark chambers which, with the help of a PDP-8 computer, decide whether an event has occurred which would warrant a picture being taken by the chamber.

Best Wishes

Vi Smoyer — Jim Smoyer

Vi Smoyer, secretary for the Low Temperature Materials Research Group, will retire at the end of January after ten years of working for SLAC. She began working in the Quality Control group on campus in an "old tin building" and later transferred to Mechanical Design and Fabrication in M1, still on campus, working with Jack Gunn. Her next move was to the SLAC site where she worked with Jean Oster in an MDF subgroup. She worked for a short time with the Reports Office here, and then transferred to her present position in LTMR, first with Habibo Brechna, and subsequently with Ed Garwin and Steve St. Lorant. Vi loves to read and plans to catch up on some of her favorite books after leaving SLAC as well as pursue her other interests such as gardening, sewing -- and grandchildren! As she puts it, "Time won't hang heavy on my hands!"

Jim Smoyer will retire at the end of January after nearly eleven years of working for SLAC, having begun on campus in Plant Engineering working with Ken Johnson. His next transfer was to the SLAC site in Fred Hall's group (still PE). Presently he is on loan to Instrumentation and Control with Joe Fish and coordinates drafting with the engineers there. Jim has had a long interest in operating ham radios and has operated the ham radio station here at SLAC in CCR. After retiring he plans to travel all around the world via his new-found time for ham radios!

Best wishes to husband and wife, Jim and Vi Smoyer, for their upcoming "free days" after their long service with SLAC.

User's Conference to be Held

The Eighth Annual SLAC User's Conference will be held in the SLAC Auditorium on Friday and Saturday, February 23-24.

As in previous years, the Conference is intended to bring current and prospective SLAC users up to date on facilities that are being built or planned. The agenda includes reports on the early operation, schedule, and plans for SPEAR; on the large-aperture solenoid spectrometer (LASS) now being built; on plans for the recirculating linear accelerator project (RLA) and on SLAC's bubble chambers. There will also be several talks, a review of the experimental program and schedule, and a general discussion of the laboratory's plans in view of the present budgetary problems.

The final agenda for the conference will be printed in the next issue of the Beam Line.

All employees are welcome for any or all sessions, subject to supervisors' approval.

The Fantastic Tape Winding Device

Although SLAC's purpose is "impractical" in that the laboratory exists to unearth the mysteries of the subnuclear world, a great deal of solid practical work is necessary to built and maintain the apparatus to enable the impractical research to go on.

A prime example is the invention of a machine for taking bare conducting metal used in magnet coils and giving the metal two layers of tape for insulation. This tape winding machine, as it has come to be called, was devised back in 1966 by a collaboration including Cliff Rasmussen, Fabrications Shops; Don Fuller, Fab. Shops; and Dan Nevius, Mechanical Engineering.

A number of more recent incarnations of the device have been made. People involved with the newer models include Stan Butler, Ron MacCampbell, and Wayne Shetler, all of the Fabrications Shops.

The device solves the problem of quickly and efficiently wrapping two layers of tape on bare conducting wire. This is done so that the two layers are of opposite pitch - one wind is left-handed while the other is right-handed.

Two more or less conventional wrapping heads are located at either end of the device. A conveyor belt feeds the conductor (typically, rectangular and fairly thick) from one wrapping head to the other.

The novel feature of the device as it has been developed at SLAC is that the same motor (a drill motor) runs both the conveyor and the wrapping heads in synchronization. The speed of the device is variable.

Prior techniques for conductor insulation involved either hand-wrapping the conductor, a tedious and inefficient chore, or hand-wrapping via a single wrapping head.

The technique devised by Mr. Rasmussen and collaborators can be used whenever a conductor is to be tape-insulated. The various winding machines built at SLAC have, among other things, been used on all the SPEAR magnet coils.

Although a somewhat similar technique is used by Pacific Telephone for winding cables, the present device is the first of its type to be used in the area of magnet coil conductor insulation.

Ron MacCampbell, Fab Shops, holding a piece of rectangular conductor. The tape winding machine is shown "riding" the conductor.

Job Openings

Heating, Ventilating and Air-Conditioning Mechanic - Maintenance: Plant Office has two day shift openings for Heating, Ventilating and Air-Conditioning Mechanic - Maintenance --- to work in the assembly, installation, repair and overhaul of reciprocating and centrifugal refrigeration equipment. Duties will include preventive maintenance and repair on large chillers, refrigeration, window air-conditioning units, damper controls and motors, thermostats, and ice machines; repairs and adjustments on thermostats and controls; trouble shooting inoperative systems. Applicants must be skilled in the use of the tools, materials and equipment of the heating, ventilating, and air-conditioning trade. He or she must have sufficient experience to qualify as a Journeyman Mechanic. The positions offer an opportunity for independent application of judgement in performing the above duties. The salary range at the Journeyman level is $930 to $1024 per month.

In addition to the above positions available at SLAC, a complete listing of 125 open positions on the Stanford campus and the Stanford Hospital are posted outside of the Employee Relations Office, Room 238, A&E Building.

Contact the Employee Relations Office (phone extension 2355) if you are interested in any of these positions.

SLAC - Emergency

2313. Recognize that number? It usually stares silently at you from the cradle of every SLAC telephone you pass by or use -- but dialing it can save a life, and has.

The Stanford Fire Department at SLAC (SFD), under Assistant Chief H.W. Lund, responds to a variety of emergency calls on site when anyone dials 2313. The majority of calls are for first aid in cases of electrical shock, heart attack, or industrial accident of any sort. The firemen on duty are trained in giving first aid on such "resuscitator calls," sometimes giving closed chest cardiac massage or mouth-to-mouth resuscitation. Bomb scares are also routed through the SFD, giving sufficient reason for many firemen to fully relish the excitement of their job on such days. Auto crashes on site or even electric carts which have flipped over can also require emergency procedures from firemen.

Classes Given by Fire Department for SLAC Employees

First Aid -- If you can get together 8 to 12 people from your department (with supervisor's approval) who wish to have training in first aid, a class can be scheduled two weeks in advance and started for those who are interested. A "standard" first aid card can be obtained after 10 hours of training (optimum class time is 10 a.m. to 12 noon for five successive work days) and an "advanced" card can be obtained after 18 hours of training. For the first-aid classes a young lady named Resusci Anne is the subject for practicing resuscitation techniques -- she lives quietly in a box about 3 ft. long by 1 foot wide and is kept in a cabinet at the Fire Department. Firemen get along well with her because they say she is the only woman who doesn't give them any trouble -- Anne is quite literally a perfect plastic girl.

In addition, classes are given in (1) Fire Extinguishers and Use, (2) Fire Orientation (preventive course), and (3) Heart-Lung Resuscitation.

Also, Don Busick (Health Physics) will be starting a class in late February on "Radiological Monitoring" -- how to read geiger counters, dosimeters, and ion chambers, all of which are tools for measuring dosages of radiation.

(Ed. note: This article will be continued in the next issue of the BEAM LINE, beginning with a description of the Fire Department Communication System in conjunction with emergency resources from outside communities.)

SLAC at Foothill Museum

SLAC is one of the initial contributors to the just-opened Foothill Electronic Museum at Foothill College. Other participants include Varian Associates, Pacific Telephone, and Pacific Gas and Electric Company.

SLAC is exhibiting "The Modern Klystron" which consists of a mockup of a 30 MW SLAC klystron, a real subbooster klystron and a large graphic cutaway of the large klystron. R. Stringall of the Klystron Group and Walter Zawojski, SLAC Graphic Artist, organized the display.

In addition, the museum features two priceless collections. These are several thousand irreplaceable artifacts of the late Douglas Perham, Peninsula electronics pioneer, and the Lee de Forest Collection of some 2500 properties given the museum by Marie de Forest whose late husband is known as the father of radio for his invention of the triode, or audion tube.

No musty repository for relics, the facility is designed to be a "living" museum in which "hands-on" exhibits will predominate and visitors may touch, handle, and activate many artifacts, plus audio-visual devices.

The Electronics Museum completes Foothill Space Science Center on the west side of the campus.

The museum, which opened February 2, is open from 9 a.m. to 5 p.m. Wednesdays and Thursdays; from 9 a.m. to 10 p.m. Fridays, and from noon to 5 p.m. on Saturdays, Sundays and most holidays.

Gaxiola Advises Personnel Dept.

Ralph Gaxiola of the Central Laboratory Machine Shop has accepted an invitation extended him by Dr. Panofsky and Doug Dupen to take on the task of advising the Personnel Director when assistance is needed in contacts with Spanish-surnamed and Chicano members of the staff.

MWC Request

The Minority and Women's Committee is concerned about the problems encountered in employment at SLAC by women and members of minority groups. There are people at SLAC who exhibit a special appreciation of these problems and we would like to know more about them. We think these people should be commended and their efforts made known. So we ask BEAM LINE readers to help us recognize such persons and if you know of someone whom you think fits this description, send the name and your comment on why to M. A. Fisherkeller, Bin 88.

NATO Journalists Visit

A group of 14 journalists from 12 NATO countries visited SLAC on the afternoon of February 2. The group is touring the United States under the joint sponsorship of the White House, State Department, and the U.S. Information Agency.

Senior editors from Holland, Turkey, Greece, Germany, Belgium, Finland, England, Spain, Norway, France, Iceland, and Italy were in attendance.

On the day they visited SLAC, the group was also hosted by Hewlett-Packard, Stanford, and SRI.

This group is representative of the 10,000 people each year who visit the Center as a result of SLAC's open door policy for groups of all kinds.

Hybrid Chamber

(continued from front page)

A number of changes were made to shorten the recondensation time and extend the pulse rate. Pressures were raised to cause more rapid condensation. Heat exchangers were positioned to promote convection and prevent bubbles from collecting in pockets. Cracks and crevices, the most copious producers of bubbles, were eliminated wherever possible. There are no longer any bolted joints inside the chamber. Everything has been welded. The main glass window seal, a major source of bubbles, now has a special cast and machined indium sealing surface which is far superior to the conventional indium wire seal.

A second problem is to produce accurate and uniform expansions with the hydraulic actuator. The piston must move with a precision of a few thousandths of an inch in space with an accuracy of one ten thousandth of a second in time. The hydraulic system must produce this motion against a three-quarter ton force ten times per second.

When everything is in good working order, the expansion system, originally developed by the operations group for the 82-inch bubble chamber, works admirably well at 10 pps. There are some difficulties, though. At ten pps mechanical vibrations do not die out between pulses but build up to such a level that parts break from fatigue. In spite of a continuous program of strengthening, a large number of bolts were broken during the experiment. Repairs were often made to the machine while pulsing in order to keep going. Ten expansions per second require 30 gallons of hydraulic oil per minute under 3000 pounds per square inch of pressure. During the early part of the experiment there were numerous failures of the hydraulic plumbing. With this quantity of high-pressure oil flowing, the leaks were often spectacular.

Once the chamber began to run regularly at 10 pps, the pictures began to show that some tracks were disappearing in parts of the chamber and reappearing in other parts. At first it was thought that this was due to incorrect temperatures in some parts of the chamber which prevented the bubbles from growing. This had to be discounted when it was found that the trackless areas varied from pulse to pulse. Furthermore the problem went away if the chamber was pulsed slowly. The difficulty was finally uncovered in the hydraulic system. At high pulse rates, oil in the exhaust pipe would resonate like air in an organ pipe. A pocket of gas would collect inside the actuator. Each time the chamber pulsed, this gas pocket collapsed causing a vibration that was transmitted to the main piston inside the chamber. The pressure variations in the hydrogen from this piston vibration caused the track bubbles not to form in some parts of the chamber. Once the oil pipe was pressurized to prevent the gas pocket, the vibration disappeared and tracks were visible throughout the chamber.

The entire experiment was done with one scothlite reflector. The chamber stayed clean for the whole experiment and the optical quality of the pictures was always good. This experiment would have been impractical in any chamber which became dirty from pulsing.

(Editor's note: Our thanks to G. Bowden of the Bubble Chamber Operations Group for providing this operator's view of the experiment. In our next issue the physics results of the experiment will be discussed.)

Beyond Our Physics

"SLAC is a temple of the 20th Century -- a holy place -- a probing into the very depths of existence" remarked Professor Jeffery J. Smith in a program at SLAC January 17 titled "Parapsychology: Its Implications for Science." Professor Smith is a Stanford Professor Emeritus in Humanities and Philosophy, and President of a planned Emeritus University. A short summary of his talk follows:

If phenomena such as psychokinesis, telepathy, clairvoyance and precognition are valid, what are their implications for science? Do they give us only glimpses of a larger pattern in existence not yet fully recognized by us?

Open-minded skepticism

In examining these phenomena we ask ourselves, what is the evidence for their existence, what explanations can be offered, and what is their significance or value? If we genuinely strive to further our knowledge of scientific, objective facts, we should always be prepared for surprise, for current ideas are not final. Gullibility in any area of inquiry must be avoided by testing and doubting everything yet at the same time retaining the essential open mind of a sincere investigator desiring to progress in his understanding.

Precognition?

One publicly recorded incident of precognition is the prediction of a psychic of the order in which the National League baseball teams placed at the finish of the season some years ago. Out of eight teams, he predicted their finishing order exactly except for inverting the 5th and 6th teams, and predicted against 20-1 odds that the Dodgers would place first, which they did. The most notable aspects of his prediction were that it was publicly recorded in print, it was not self-fulfilling for the psychic himself, and it was intrinsically dramatic as well as statistically measureable.

New time concepts?

Precognition forces us to radically reevaluate our concept of time. If an event can be known before it happens, does not our entire notion of time, already radically modified by relativity, call for even more radical re-thinking?

Reevaluation of present-day science

Ignoring these phenomena, which exist primarily beyond the range of our present understanding of them, does not erase their existence. What is needed is much deeper investigation and incorporation of the resultant findings into the main body of science so that the now-scattered bits of information are integrated by verifiable evidence into a cohesive new picture. Just as Einstein gave unity to the scattered phenomena that brought Newtonian physics into question, so we need scientists to integrate the scattered phenomena of parapsychology that render present physics inadequate.

Interrelationship of thought and matter

Descartes, a proponent of the sharp distinction between thought and matter, has greatly influenced our thinking up till now. However, present day knowledge suggests that thought and matter are profoundly linked in ways yet to be discovered by us. For example, there is a man living today who by the power of his mind can project a picture of what he is thinking onto film so that his thoughts are recorded in the manner of a photograph. His mind in some way affects the molecular structure of the film so that if he thinks of a particular picture, be it building or scenic view, that picture has been observed to appear on the film.

We are just beginning to discover the deep relationship between the mechanical world around us and our intentions and wishes. Our inner self, our values and purposes do affect the "matter world" within which we move.

St. Francis of Assisi wrote of "My brother the sun, my brother the stream..." Today ecology teaches us in a demonstrable, scientific way the interrelationship between all living things and the havoc which is wreaked when the intricacies of such relationships are abused.

Telekinesis

In telekinesis the relationship between thought and matter is clear -- objects which can be made to move without apparent physical aid by persons at a distance are acting under laws outside the realm of what most of us presently understand. An object can be made not only to move but also to simply disappear.

It is the effort of present research in parapsychology to move away from the questionable aspects of observed phenomena into a stage of dedicated verification through investigation and experimentation. Those psychic persons who agree to participate in experimentation must above all be given a chance to enhance their abilities through experiments which are an enjoyable and life-giving experience involving the whole person. They must not be made to feel any weight of intense scientific scrutiny which can altogether smother the very capabilities desirous of being studied.

New Approach

A new approach must be taken through science to loosen the strictures surrounding the form we know as man in order that he may proceed to higher levels of understanding about his own unfathomed nature, and fit in harmoniously with the laws we comprehend today as physics in a universe of objective truth.

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