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Taipei, Taiwan, Republic of China

The Discovery of Top Quarks ROC Participation in the Process

In April of 1994, the CDF Experiment Group of the Fermi National Accelerator Laboratory in the United States announced direct experimental proof of the existence of top quarks. From then until now, more than twice as much new experimental data has been amassed at CDF and analyzed, not only confirming previous experimental results, but also proving the discovery of top quarks. Accordingly, the CDF Experiment Group along with another research group, DZero, announced at 1:30 P.M. (Chicago time) on MarcH 2, 1995, that it had found top quarks with a mass of 176 GeV/c^2, and a top quark/anti-top quark production cross section of 6.8 pb.

The greatest diffculty in analyzing the experimental data was how to distinguish between signals from real quarks and other ambiguous background signals. Therefore, experimental physicists must think of ways to eliminate all the possible background noise that can e produced in order to verify that the quarks they have discovered are the real event and not simply the result of background noise.

The CDF experimental group last year announced 12 top quark decay events, two of which were dilepton decay events. As of now, CDF has amassed 43 top quark decay events of which 6 are Dilepton decay events. Of these six, the only observed dimuon event was first discovered by Academia Sinica. The High-energy Physics Group of the Institute of Physics, Academia Sinica has played an important role in the highly detailed experimentation over the past year or so in search of proof. One half of the research funding for Academia Sinica and the CDF Experiment Group to search for top quarks has been underwritten by the National Science Council (NSC).

The High-energy Physics Group of the Institute of Physics, Academia Sinica has about twenty members, ten of which were among the authors of the monograph detailing the CDF discovery of top quarks. These ten researchers were Ping-Kun Teng, Ming-Jer Wang, Hsiao-Yin Chao, Ping Yeh, Mau-Tong Cheng, Chung-Hsiang Wang, Cheng-Nan Chieu, Rung-Sheng Guo, Jaroslav Antos, and Alexei Sumarokov.

The ROC's principal contributions included:

•Participation in the assembly and shakedown of the silicon vertex detector (SVX): Shi-Chen Wu (technician) and Ming-Jer Wang were the principal personnel in the SVX assembly and shakedown. The SVX played a crucial role in the CDF research task of proving the existence of top quarks.

•SVX alignment: Chung-Hsiang Wang was a primary member of the alignment group, and actually engaged in the task of monitoring the data to align the SVX detector to a peak measurement resolution of less than 10 microns.

•SVX computer simulation research: Ming-Jer Wang and Hsiao-Yin Chao were important members of the SVX computer simulation group. Their research increased the dependability of the SVX computer simulation programs.

•The SVX event display program: Cheng-Nan Chiou was in charge of writing this program which was very helpful in accurately locating the top quarks.

•Participation in b-jet tagging research: Ming-Jer Wang, Chung-Hsiang Wang and Cheng-Nan Chiou all took part in the work of this group. Upgrading the efficiency of b-jet tagging was the most important improvement in the CDF data analysis method used during this experiment and was a major development for the discovery of top quarks.

•Participation in data analysis: For example, CDF observed six top quark/ anti-top quark dilepton decay events, among which the only dimuon event was first discovered by Ping Yeh.

•Taking charge of initially processing all data: Ping Yeh was a primary member of this group. Initial processing of CDF data was done on an IBM work station cluster and a SGI work station cluster. Ping Yeh was in charge of the IBM workstation cluster.

The CDF experiment is present still collecting data, and will continue to do so until the end of this year. The next phase—a proton-antiproton collision so until the end of this year. The next phase—a proton-antiproton collision experiment—is scheduled to get under way in 1999. It will further explore the properties of top quarks and search for traces of another important basic particle, the Higgs particle. Prior to this next phase of the experiment, the CDF detector will undergo a major overhaul. A completely new SVX II will be fitting in place of the silicon vertex detector; and Taiwan will play an important role in the research and assembly of this detector. Academic Sinica and the Telecommunication Laboratory, Ministry of Transportation and Communications, and the Analog Chip Implementation Center run by Professor Chung-Yu Wu of Chiao-Tung University are jointly researching and building the high-density fiber-optic read-out system of the SVX II, and are in charge of the design, research and development of an advanced read-out chip for the SVX III. The High-energy Physics Group of the Institute of Physics, Academia Sinica will primarily be in charge of SVX II computer simulation research.

The approximately NT$15 million of operating costs this fiscal year for the High-energy Physics Group of the Institute of Physics, Academia Sinica were underwritten by the NSC. Because this group will be in charge of making the fiber-optic read-out system and data acquisition system for the SVX II starting this next fiscal year, annual operating expenditures required over each of the next three years will be approximately NT$30 million..

The Executive Yuan's 1994 Outstanding Sci-tech Talent Awards

In order to recognize the R.O.C.'s outstanding scientific and technical workers, the National Science Council has undertaken to select talented sci-tech researchers the results of whose research has made a great contribution to the nation and society; at a set time every year, these individuals are honored with the Executive Yuan's Outstanding Sci-tech Talent Award. Each of the persons so honored receives a plaque and monetary prize of NT$400,000 (approximately US$16,000). These prize-winning individuals can be considered the R.O.C.'s most outstanding and respected sci-tech workers.

On February 9, 1995 Executive Yuan Premier Lien Chan issued the 1994 Outstanding Sci-tech Talent Awards to three individuals: S.N. Lee of Prime View International Co., Ltd., Professor Tien-yau Lu of the National Taiwan University Department of Chemistry, and Professor Yung-ho Ko of the National Taiwan University Department of Psychology. The following is a brief introduction to the achievements of these worthy individuals:

I. Mr. S.N. Lee

Reasons for Selection:

Mr. Lee has been a unique innovator in the field of amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) driver design and has been the recipient of U.S. patents. This invention not only brings the capability of amorphous silicon TFTs to the highest point of development, but also has great economic value. The a-Si TFT LCDs built utilizing this invention will have a lower cost, higher quality, and a higher acceptance rate than Japanese liquid crystal displays (LCD). In addition, these devices will increase the R.O.C.'s international competitive strength and insure that the approximately NT$200 billion of LCDs used annually in the R.O.C.'s electronics and information products will no longer be subject to Japanese control. Because of the great contribution it will make to the nation and society, this invention is truly praiseworthy.

Introduction to Achievement:

The production of TFT/LCDs exceeded a value of ¥200 billion (approximately NT$50 billion) in 1993, and this market is expected to experience rapid growth over the next few years. Following in the wake of the semiconductor industry, production of these devices will become the next star industry of the future. Of the current methods for manufacturing TFTs, amorphous silicon TFT technology is the most mature and offers the lowest costs. Nevertheless, due to restrictions in the supply of materials for amorphous silicon TFTs and the fact that their operation frequency and driving ability are relatively poor, it had been generally considered that this kind of TFT could not be utilized in integrated driver circuits. Mr. Lee employed conventional amorphous silicon TFTs in conjunction with ground-breaking circuit design methods to develop unique driver circuits that fully exploit the capabilities of amorphous silicon TFTs. The integrated amorphous silicon TFT/LCDs invented by Mr. Lee will enable a great reduction in the number of input leads; it will now be possible to accomplish the input of high-density TFT/LCDs employing an extremely small number of input leads. Besides greatly lowering costs, it will also be able to shake off the tight grip the Japanese hold on this technology. After performing a detailed evaluation of Mr. Lee's unique invention, the Yuen Foong Yu Paper Manufacturing Co., Ltd. has decided to invest the sum of over NT$10 billion in the mass fabrication of these devices. When the time comes, the finished products will be supplied to such display-using fields as the television and terminal industries, enabling them to shake off Japanese control. Because it is conservatively estimated that production of these devices will affect more than NT$200 billion of downstream industrial output, this invention is truly a great contribution.

II. Professor Tien-yau Luh

Professor Luh has excelled in the fundamental research of organic chemistry and in the development of useful processes for the production of specialty chemicals and pharmaceuticals. He received the Ph.D. degree from the University of Chicago. After spending two years as a posidoctoral associate at the University of Minnesota, he joined the Chinese University of Hong Kong in 1976 and returned to his alma mater in 1988, where he is currently Professor of Chemistry.

With respect to his basic research in organic chemistry, Professor Luh has published over one hundred scientific papers in internationally refereed journals including fifteen review articles and book chapters, and two *Organic Synthesis* procedures. His research interests include development of new synthetic methods using organometallic reagents, mechanistic organometallic chemistry and chemistry of materials. He has discovered several new synthetic reactions in organic synthesis. Using dithioacetal functional group, he uncovered three new types of transformations: olefination, geminal dimethylation and desulfurdimerization reactions. In particular, his chelation approach has led to the activation of the otherwise unactivated carbon-sulfur and carbon-oxygen bonds in aliphatic dithioacetals and acetals, respectively. This reaction has recently been applied to the synthesis of various monosaccharide derivatives. His contributions have been widely cited.

In addition to his basic organic chemistry research, Professor Luh has contributed actively to the development projects by the local industries for pharmaceuticals and specialty chemicals. He echoed the governmental policy and participated in a joint effort among industry, government and academic institutions to upgrade the industrial productivity in Taiwan. In this regard, he and his colleagues in the Chemistry Department and the Biochemistry Institute of the National Taiwan University have established a Research Unit on Syntheric Chemistry and Analytical Technology in the Tjing Ling Industrial Research Institute at NTU to serve as a liason between the industry and the university. For the past five years Professor Luh has collaborated with the China Chemical Synthesis Industrial Co. Ltd., to establish the process for the synthesis of a diabetic control-release agent, glipizide, which is now on the market. In addition, he has finished the laboratory scale preparation of an antacid drug omeprazole and the extension to the industrial process is underway. In cooperation with San Fu Chemical Co. Ltd., the industrial scale syntheses of N-substituted maleimides, key industrial specialty chemicals for high performance polymers, have been developed.

III. Professor Yung-ho Ko

Reasons for Selection:

Mr. Ko is one of the R.O.C.'s most prominent experts on clinical psychology and mental health and has performed extensive psychotherapy, teaching, and research in these areas during the past 30 years. Mr. Ko has written over ten books and more than 100 articles in this field; his best-known work is "Ko's Mental Health Questionnaire." This questionnaire has become the R.O.C.'s most authoritative psychodiagnostic inventory and possesses diagnostic ability superior to the United States' MMPI. Apart from this, Mr. Ko's original theory of the "psychology of habit" ha sprovided a brand new direction for research in counseling psychology, mental health, and clinical psychology. Yung-ho Ko's research and writings have made a very clear and concrete contribution to health care and human welfare in the R.O.C.; his outstanding inventions are therefore truly praiseworthy.

Introduction to Achievement:

Mr. Ko spent almost 20 years emplying scientific methodology to compile and develop "Ko's Mental Health Questionnaire." After many more years of revisions and improvements, this work has become the R.O.C.'s most effective and widely used psychodiagnostic instrument. It is also the sole large-scale psychodiagnostic test to be independently developed in the R.O.C. over the last forty years, and has proved to be very useful in the diagnosis and prevention of mental illness, deviant behavior, and maladjustment to social change. This important diagnostic tool has been completed by tens of thousands of subjects and is in wide use by schools, factories, hospitals, prisons, reformatories, and community mental health counseling centers. Since society in the R.O.C. is undergoing extremely rapid transformations, and the number of people with such symptoms of mental illness as deviant behavior and maladjustment is also increasing rapidly, there is currently an urgent and growing need for psychological diagnosis and therapy. Thus even more people will take this questionnaire in the future. Professor Ko's research has unquestionably made an outstanding contribution to mental health and health care in society. His recent theory of the "Psychology of Habit" has been tested in many clinical diagnoses and has proved to be a successful and useful indicator of a subject's state of mental health. This theory has already had a revolutionary influence on the diagnosis and treatment of deviant behavior and mental illness, and this influence has been continuously increasing. Yung-ho Ko's contributions have indeed been very numerous.

R.O.C. Synchrotron Radiation Research Sets a New World Record

The First Successful Synchrotron Radiation Source Using Wigglers

The Preparatory and Construction Office of Synchrotron Radiation Research Center of the Executive Yuan, ROC, recently issued a bulletin stating that at approximately 4:00 PM on February 27, the first hard X-rays were successfully generated using the W20/SRRC wiggler magnet system that had been completely installed only a week earlier. This news implies that besides the vacuum ultraviolet (VUV) and soft X-ray facilities that are already in successful operation and open for use, from this point onward the Synchrotron Radiation Research Center will also be able to provide an even broader range of X-ray users with one of the world's best X-ray sources. This is the world's first successfully commissioned high magnetic field wiggler used in a third generation medium energy synchrotron radiation facility, and this development insures that the R.O.C. will continue be a world leader in the field of synchrotron research.

During this century, mankind's tools for observing the natural world have made the leap from lenses and the naked eye to X-ray machines and lasers. As we approach the end of the 20th century, synchrotron radiation sources have suddenly emerged to help lead mankind into the "sub-micron age" of the 21th century. As far as both quality and quantity are concerned, the great boost synchrotron radiation sources have given sci-tech research has greatly exceeded anything researchers in the past could imagine. In particular, the emergence of third generation synchrotron radiation sources has greatly increased the disparity in sci-tech research capability between different nations. In light of this situation, many nations have been investing large sums to boost synchrotron radiation research; the number of synchrotron radiation sources around the world is rapidly approaching the 100 mark.

The R.O.C. completed Asia's first third generation synchrotron radiation source in October 1993. At that time, the only other modern third generation research tools comparable to this facility were at the European Synchrotron Radiation Facility (ESRF) and the U.S.A.'s Advanced Light Source (ALS). But in little over a year, not only have Italy's Trieste facility and Korea's Pohang Light Source successfully been commissioned, America's Advanced Photon Source (APS), Japan's Spring-8, Germany's BESSY II, and Switzerland's MAX II have also been completed. Even more synchrotron radiation projects are in the review stage. It can be said that international sci-tech competition in the field of synchrotron radiation has lately reached a fever pitch.

In so-called third generation synchrotron radiation sources, the storage ring holding charged particles from the accelerator is equipped with many straight sections. These straight sections can accommodate the installation of such insertion devices as wigglers and undulators, thereby allowing increased brightness, purer monochromatic light, a broader range of useable radiation wavelengths, and even the generation of various types of polarized radiation. Therefore storage ring design must accommodate these insertion devices and as a result its specifications are more than ten times as stringent as those of second generation machines. The brightness of such a device is consequently up to a million times greater than conventional laboratory radiation sources. Such a bright radiance will be able lay bare the fine structure of any substance and biological structure, thus providing untold benefits for human civilization.

Because of such factors as budgetary constraints, when the R.O.C. first began planning this synchrotron facility, it was decided to construct a machine operating in the long wavelength range (other machines operating in this energy range include America's ALS, Italy's Trieste, Korea's Pohang, Germany's BESSY II, and Switzerland's MAX II). It was expected that this device would provide domestic users with high-quality vacuum ultraviolet and soft X-ray radiation—thereby greatly advancing understanding of the chemistry and physical characteristics of solids and gasses. Since this facility opened in October of last year (1993), several dozen foreign and domestic scientists have set up end station experiments on the four beam lines that have been opened for use. Among the pleasantly astonishing results these workers obtained was the use of synchrotron radiation to itch a micron hole set for the fundamental parts of micromachining. Looking at a related aspect, the R.O.C. currently has an even greater number of hard X-ray specialists in its industrial and basic research sectors; topics of interest to these workers include biology, materials science, crystallography, and surface and interface science. Thus the installation of wiggler magnets in order to generate high-quality, high-brightness short wavelength radiation satisfying the needs of these hard X-ray specialists has been an important task for the Synchrotron Radiation Research Center over the last several years.

The principle behind the wiggler system consists of placing high field strength magnets with differing polarizations in a periodic arrangement. When an electron bean passes through the magnets, it will bend sharply and continuously under the influence of the magnetic field distribution, simultaneously emitting short wavelength electromagnetic radiation. Since all the bends of the electron beam are located on the same long straight section, the accumulation of emitted X-rays allows a greater brightness to be attained.

When bidding for the enormous wiggler magnet system was conducted three years ago, the Synchrotron Radiation Research Center was in the midst of gathering manpower to complete the final construction, installation, and commissioning of the storage ring. Construction of the first wiggler system was therefore entrusted to the American firm STI. Beginning last year, the Center selected talented individuals from among storage ring operation and maintenance teams and the user's group to participate in wiggler system planning and help complete design revision and quality control for the world's most precise insertion device.

The working magnetic field of the code-named W20/SRRC wiggler system will attain a strength of 1.8 teslas (over 40,000 times the strength of the earth's magnetic field), and there will be 29 abrupt bends in the magnetic beam's orbit as it passes through this section. Maintaining control over the electron beam as it passes through these sharp bends and avoiding interference with highquality radiation in the storage ring's other beamlines are both extremely tough challenges for every high-energy accelerator in the world. After more than a year of nearly constant work, the wiggler system has been finished, accepted, installed, and commissioned two months ahead of the anticipated completion date. Once again the Synchrotron Radiation Research Center has shown its team spirit and put on a virtuoso performance.

In conjunction with the above efforts, the three beamlines conveying X-rays emitted in the W20/SRRC wiggler are in the midst of construction and installation by the Center's X-ray and beamline groups. It is anticipated that commissioning will be conducted by the summer of this year. Tail section experiment stations are already in the preparatory stage. By the end of this year the Synchrotron Radiation Research Center will be able to provide domestic users from all sectors eight beamlines of different wavelength radiation.

發行人：胡錦標
發行所：行政院國家科學委員會
台北市和平東路二段一〇六號
印刷廠：百杰電腦排版印刷有限公司
台北市復興南路二段二九三－三號十二樓之二
行政院新聞局出版事業登記證局版台誌字第〇九三三號
中華郵政北台字第一一六五號執照登記爲新聞紙類（雜誌）交寄