Wire chambers

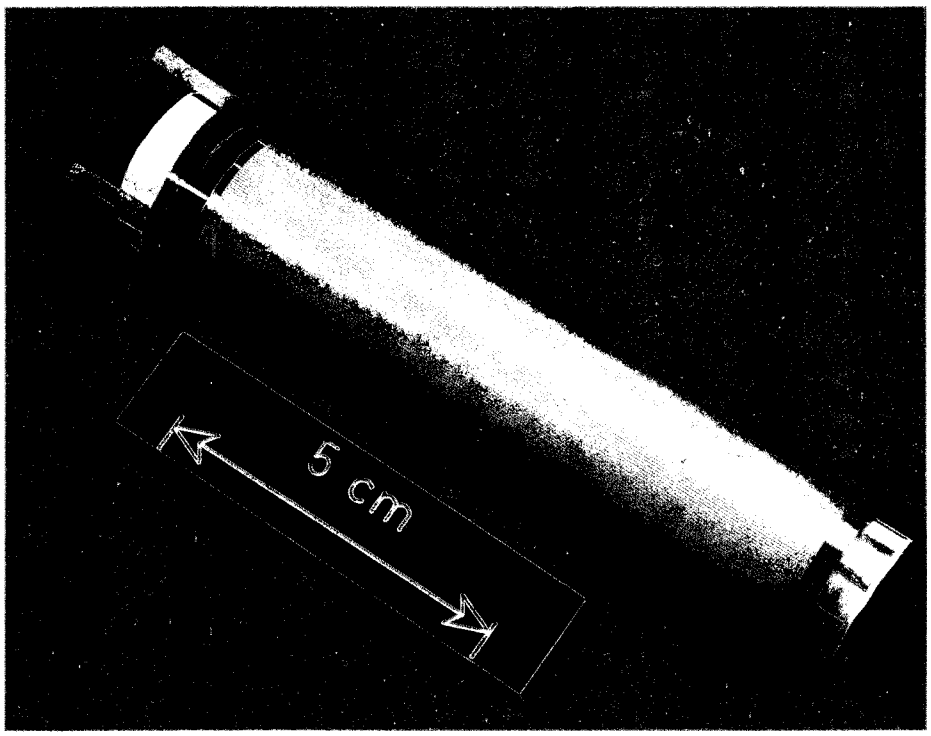
Trends and alternatives

The subtitle of this year's Vienna Wire Chamber Conference - 'Recent Trends and Alternative Techniques' - signalled that it covered a wide range of science and technology. While an opening Vienna talk by wire chamber pioneer Georges Charpak many years ago began 'Les funérailles des chambres à fils (the burial of wire chambers)', the contrary feeling this year was that wire chambers are very much alive!

At this year's conference, D. Imre began his summary talk by pointing out that although probably none of the participants had been born when the first (single) wire chamber came into operation in the 1920s, and that the meeting was attended by many young scientists who were born after the multiwire proportional chamber era began in the late 1960s, we are only just about beginning to really understand the fundamental aspects of gaseous detectors. Wire chambers are still essential in many particle detector domains and are enjoying a certain renaissance in the development work for the forthcoming SSC and LHC generation of big proton colliders.

Alternatives to wire chambers were reported mostly in the field of calorimetry, where T. Virdee reported on the impressive progress with warm and cold liquid calorimetry, mainly for electromagnetic calorimetry.

The field of semiconductor detectors was covered in an invited talk by R. Horisberger. The large variety of designs - strip detectors, pad detectors (both single and double-sided), drift detectors and pixel detectors - is remarkable. The future integration of front-end electronics (not only preamplifiers but some signal processing as well) will cope with the very high data rates expected at SSC and LHC, as long as the necessary radiation hardness and reliability is achieved. The limiting factor in precision will lie in the support structures, alignment and overall monitoring, although great progress has been made in these fields as well. Alternatives for wire chambers also emerge from work on fibre detectors.



Microstrip gas chambers are a promising new detector development, offering good spatial resolution, and avoiding the instabilities which occur when the wires in conventional chamber designs are crammed together, and could go on to play a major role in the next generation of high energy collider experiments. The model shown here was developed at CERN to explore the possibility of mounting microstrips on a curved plastic substrate.

(Photo CERN IT 34.7.91)

Software methods were reviewed in a enlightening talk by G. Kellner, starting with an overview of the SSC/LHC challenge. He not only pointed out the aspects of extracting the rare signatures of interesting physics events from a very high background - like looking for a needle in a haystack - but also gave very important advice on aspects of professional management in software development, crucial for ongoing applications.

The first afternoon of the five-day conference is traditionally devoted to the application of wire chambers outside high energy physics. After an introduction by F. Sauli, the progress in precision and reliability of wire chambers in medical diagnostics (X-ray imaging devices), in Positron Emission Tomography (PET) in vivo, in solid-state physics and in cosmic ray studies was presented. Ring Imaging Cherenkov (RICH) detectors are now operational even for experiments in high altitude balloon flights.

Since Time Projection Chambers are now standard, and as large Transition Radiation Detectors are now well understood, the remainder of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this report concentrates on the increasing fundamental understanding of wire chambers and on novel detectors.

Great progress in the fundamental understanding of gaseous detectors has resulted from improved application of transport equations using the angular dependence of electron interactions with gas molecules, a more precise calculation of the Townsend coefficient as a function of the reduced electric field, and an impressive convergence of simulations and time development of chamber pulses.

Extensive chemical studies have led to a better theoretical understanding of aging, while wire breakage is also understood far better now. Attention to many sophisticated details will allow wire chambers to be used in the high energy domain as well as in particle 'factories'.

Special emphasis was put on gas studies for several purposes - breakdown studies in new combined detectors (see below), achieving desirable properties like low multiple scattering (helium), high density gases for photon detection (xenon) or fast gases with low diffusion (CF_4).

Microstrip Gas Chambers (MGC) look very promising. Detectors with two-dimensional or pixel readout (including ring structures) have been built on thin quartz layers of only 200 microns, and first MGC results from a full scale high energy experiment (NA 12 -'GAMS'- at CERN) were impressive: relative energy resolution 10% at 5.9 keV, and spatial resolution of 30 microns. Various plastic and resistive glass supports were tested to overcome the instability of gain due to space-charge effects. First progress was also reported in managing the ageing problem.

Coordinate gaseous detectors with solid photocathodes may significantly change detection techniques (V. Peskov). The report of T. Ypsilantis on gas detectors combined with a cesium iodide reflecting photodiode was also notable. This detector is fast, compact, has small quantum fluctuations and, last but not least, is quite cheap. Significant progress may be expected in realistic experimental environments before the next Wire Chamber Conference in 1995.

The field of electronics has seen substantial progress in building trigger and readout electronics. The increased computing capacity by new applications-specific (ASIC) chips and field programmable gate arrays (FPGA) will lead to better handling of data streams from the LHC and SSC experiments.

Application of logic cell arrays in the H1 experiment at DESY demonstrates new possibilities. The logic functions can be changed by software to adopt the best algorithm, to run calibration measurements, to get raw data from selected stages of the readout or trigger chain and to test parts of the system online without any additional hardware.

Many suggestions were made to conference organizers W. Bartl, G. Neuhofer, A. Taurok and M. Regler (Institute of High Energy Physics of the Austrian Academy of Sciences) on how the conference should develop in the future. They ranged from a general instrumentation conference via a fundamentalist meeting (gas studies, ageing, etc.) to a meeting covering a selected few topics. The inclusion of semiconductor detectors was proposed.

On the industrial front, the current economic recession has been felt, although there was a wide attendance at Vienna of scientists from Eastern Central Europe, representing a region undergoing a complete economic upheaval.

An unofficial peripheral topic was the reorganization of scientific collaborations in the region, including discussions on an international research centre for Central Europe (AUSTRON - December 1991, page 16). Another was a memorable Mozart concert given by the Vienna Chamber Orchestra in the Auersperg Palace, where Mozart himself had once conducted, long before the era of even single-wire chambers.

From Meinhard Regler