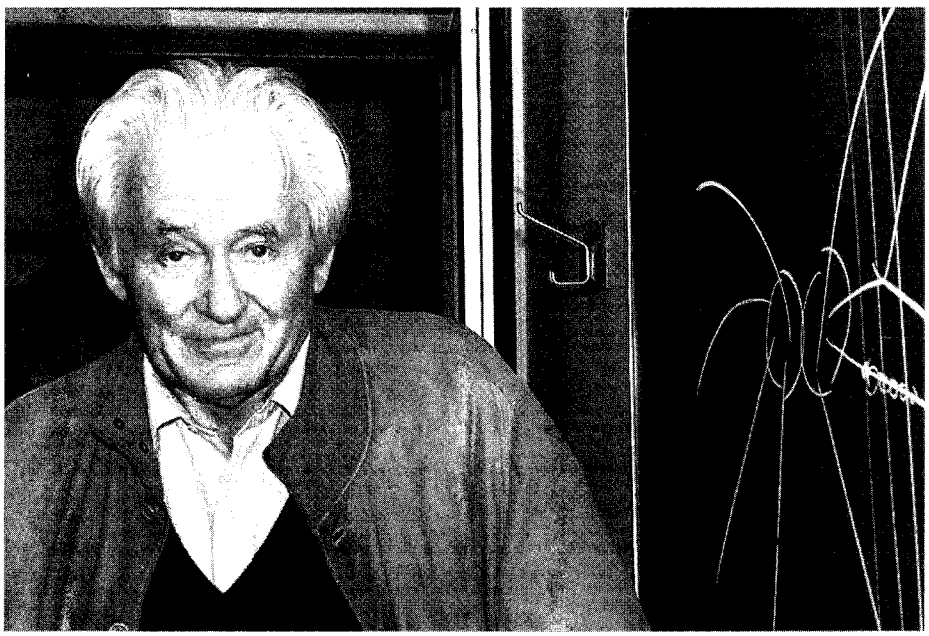
Georges Charpak
Nobel Physics Prize 1992



Georges Charpak at CERN just after hearing the Nobel news.

Wednesday 14 October looked like being a day like any other for detector specialist Georges Charpak. Except he had an unwelcome appointment with the dentist early that afternoon. Late that morning he was able to telephone to cancel the appointment. 'I have a small problem...', he explained.

The problem was the announcement that Georges Charpak receives 1992's most prestigious award for physics – 'for his invention and development of particle detectors, in particular the multiwire proportional chamber – a breakthrough in the technique for exploring the innermost parts of matter', reads the citation from the Royal Swedish Academy of Sciences.

A means of making the invisible become visible, Charpak's Nobel-winning contribution has an immediate appeal to the man in the street, who is often left in the dark about the significance of other major science awards, not that these are any less important for the development of their subject.

Physics is all about observation, and improved measuring techniques have always been at the forefront of new directions in science. Just as development of the microscope and the telescope did in the seventeenth century, so the new methods of the 20th century have lifted scientists' horizons.

Since its invention in 1968, Charpak's multiwire proportional chamber and his subsequent developments heralded the age of fully electronic particle detection. They revolutionized detection techniques and have become the principal tools of the particle physicist's trade, enabling them to handle high reaction rates and to preselect special types of interaction.

Charpak's Nobel is also the latest addition to a periodic Nobel physics theme of improved 'position sensitive detectors' – measurement techniques for telling physicists where particles have passed. In 1927 the award went to C.T.R. Wilson for his invention of the cloud chamber; in 1948 Patrick Blackett received the coveted prize for his further development and discoveries with cloud chambers; in 1950, Cecil Powell's prize was in recognition of his work with photographic emulsions and its physics outcome; in 1960 came Donald Glaser, for the bubble chamber, while Luis Alvarez was recognized in 1968 for his further development of this technique.

Georges Charpak has always been concerned about seeing things that are visually obscure but nevertheless important. Before joining CERN in 1959, at the Joliot-Curie Laboratory in Paris he had an introduction to particle detectors ('most of them didn't work', he later admitted) and pioneered new techniques in the then traditional method of photographing the sparks left in the wake of charged particles. At CERN, he initially worked on the first precision measurements of the anomalous magnetic moment of the muon (g-2), an experiment which turned out to be a training ground for some of the most gifted post-war European physicists.

After g-2 he returned to his major preoccupation – particle detectors. Any particle physics detection scheme uses ionization – the atomic havoc of charged particles left in the wake of a subatomic projectile. In 1968 Charpak was looking for ways of localizing spark signals without having to take photographs. To achieve this he realized he had to understand the details of what happens when a gas is ionized between two high voltage electrodes, to chart the different ways that electron chain reactions caused signals to grow into sparks, the role of photons, and the effect of localized high electric field gradients on the drift of electrons and ions and on the way the signal is formed. When his work was done, not only did he understand better what happened between high voltage

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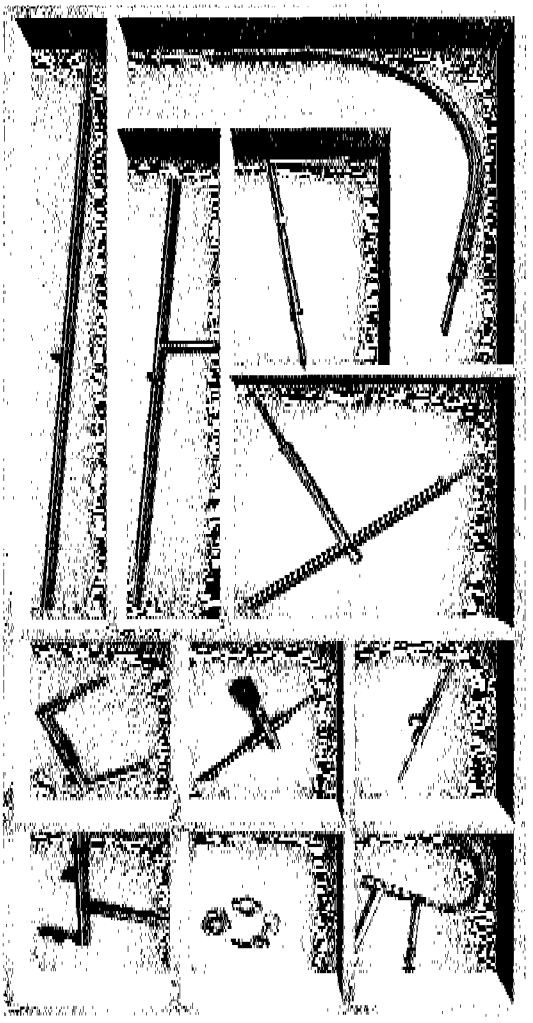

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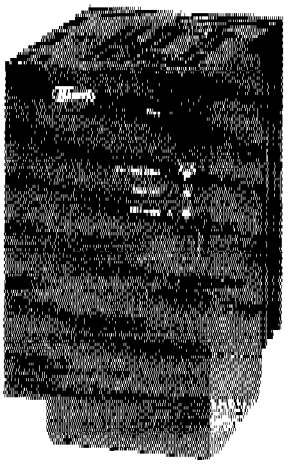

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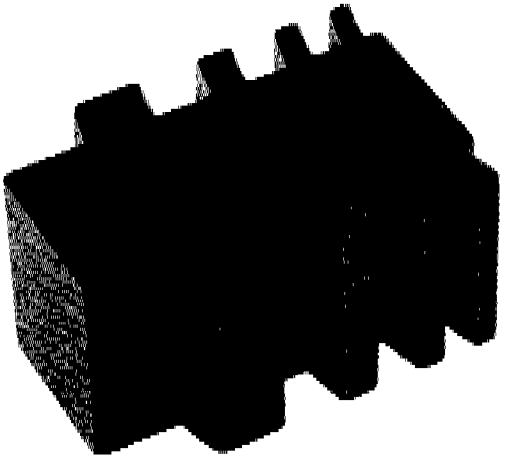

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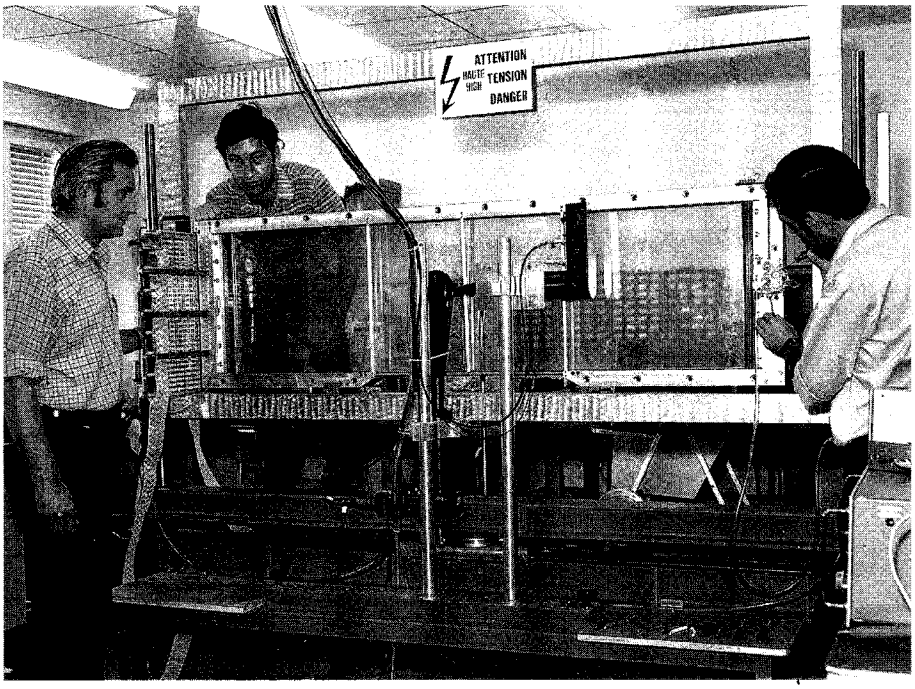
The first large multiwire proportional chamber built at CERN. Left to right, Georges Charpak, Fabio Sauli and Jean-Claude Santiard. (Photo CERN x8.8.70)



electrodes, but the spinoff was virtually immediate.

Fortunately, a high energy charged particle passing through matter is the proverbial bull in a china shop, scattering and breaking whatever atomic material is in its path. However this trail of subatomic destruction needs some method of amplification to make it visible, when and where it happens.

Some techniques already existed – ion chambers; proportional tubes; and the famous Geiger counter – but they all had limitations. The classic proportional tube uses a thin anode wire along the axis of a cylindrical cathode filled with a suitable gas. As a charged particle passes through, liberated electrons are pulled towards the wire anode, producing more electrons in their wake. An electron 'avalanche' is formed.

The resultant signal shows that a charged particle has passed through, but with a tube of radius one centimetre, no real precision is given. It is impractical to build large detecting surfaces of such modules, and the irregular time response (up to a microsecond), makes precision measurements difficult.

Charpak's brilliant idea was to use a plane of anode wires a few millimetres apart stretched between two cathode planes. This improved geometry and higher field of the multiwire proportional chamber (MWPC) make the ionization electrons move faster and more uniformly, so that the time resolution improves to, say, 25 nanoseconds.

At first it was feared that the large mutual capacitance between neighbouring wires would spread the signal throughout the mesh, frustrating any attempt to localize tracks. However Nature lent a hand in the form of an opposite and almost equal signal induced by positive ions in the avalanche in all wires but the one directly concerned. Understanding this helpful signal, Charpak realized it could be exploited to greatly improve localization in the MWPC – a set of wires of strips in the cathode plane would pick up this induction, providing a powerful means of localizing ionization away from an anode direction. This two-dimensional localization allowed detection of X-rays and opened up MWPC applications in medicine and biology.

By adding suitable additional ingredients to the gas in the chamber, secondary by-products are quickly absorbed so that one avalanche does not trigger another and the initial ionization is quickly confined. The technique can be extended to cover large areas, with each wire read out into appropriate electronics. For the first time, high volumes of data became available on line.

A further Charpak development, the 'drift chamber', measures the time it takes for the electrons to get to the anode. This time then gives a fix on where the initial ionization took place, and requires less closely spaced detection and readout channels.

Describing those early days, Charpak says his first attempts at building proportional tube were so clumsy that when the time came to prototype the MWPC, his team took such care that it worked first time!

Charpak also pays tribute to the facilities at CERN and the team spirit. 'If you ask someone to do something difficult, you're sure to get good response,' he says. An ideas man, he stands aside and lets others get on with mass-production and nitty-gritty applications problems, again an area where CERN excels.

In more recent years his interest has turned to applications of physics instrumentation in other areas, particularly biology and medicine. Here the improved accuracy and response of modern electronic detectors promise faster scanning and lower radiation doses.

Eight year series – three physics Nobels enjoy the CERN Charpak party entertainment. Left to right CERN Director General Carlo Rubbia (1984), Sam Ting (1976) and Georges Charpak (1992).
(Photo CERN HI84.10.92)

Using a wire chamber viewed by an image-intensified CCD camera, a CERN/Geneva Cantonal Hospital team obtained a radiograph of a rat kidney a hundred times faster than conventional methods. 'This rat kidney changed my life,' says Charpak.

For the future, the quest for 'Dark Matter' – the missing material that makes up most of the Universe – will continue to challenge detector builders. 'The detector research and development work being done for the LHC will also provide valuable spinoffs,' claims Charpak. 'When people ask "what use is this work", these are the things to point to'.

Charpak admits to having been surprised by the Nobel news. 'But CERN wasn't surprised,' retorted CERN Director General Carlo Rubbia. 'It underlines that physics instrumentation is just as important as accelerators. The prize is also a great honour for CERN, and underlines its preeminent position in the forefront of particle physics.'

Born in Poland in 1924, Georges Charpak was educated in France, the country whose nationality he now holds. After an introduction to research at the Collège de France, Paris, he joined CERN in 1959. He passed a formal 65th birthday career milestone in 1989, but is still very active with his driving ambition to apply frontier detection ideas.

While ideas in physics are quickly incorporated into ongoing research, convincing the medical community of the value of new techniques needs a special effort, he says. Charpak has made a considerable personal investment in this research and development work, to the extent of making personal sacrifices. 'Now I can buy some new shoes,' he joked after hearing the Nobel news.

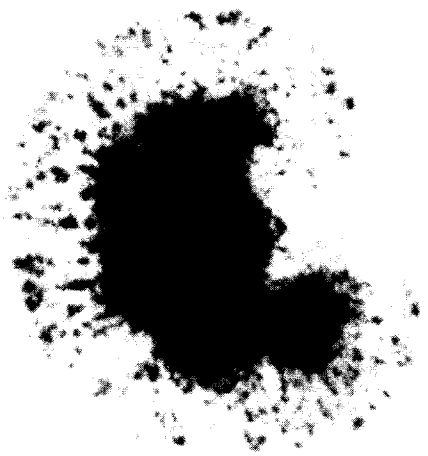
Charpak is popular and widely admired at CERN. On hearing the Nobel news on the car radio, a CERN acquaintance was moved to tears. Charpak inspires loyalty – he has worked with three skilled and dedicated specialists – Roger Bouclier, Gilbert Million and Jean-Claude Santiard – for practically the whole of his CERN career. At CERN, he was soon joined by Fabio Sauli, who has continually shared in a long series of new developments, and who now formally heads the unit at CERN. At Charpak's 65th birthday celebrations at CERN, Sauli declared that the name 'Charpak Group' will continue to be used.

Another aspect of Charpak's personality is his continual concern for less privileged colleagues. He was a driving force in the late 70s and early 80s in the action by physicists that eventually led to the release of Yuri Orlov and Andrei Sakharov.

With his fame previously restricted to physics circles, Charpak became a celebrity overnight after the Nobel announcement. With last year's physics prize won by Frenchman Pierre-Gilles de Gennes, the news had special impact in France.

Charpak's numerous contributions

This wire chamber radiograph of a rat kidney was obtained about a hundred times faster than using conventional means. 'This rat kidney was a turning point in my life,' says Georges Charpak.



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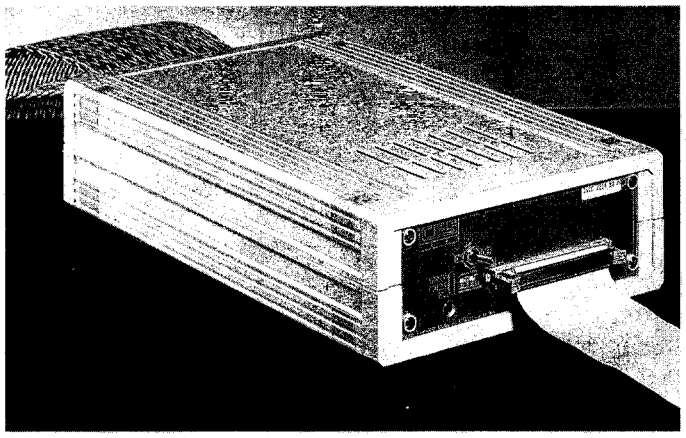

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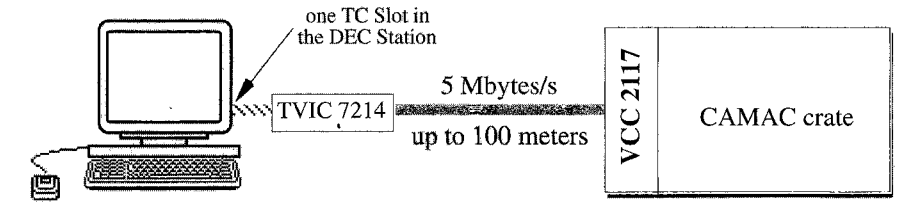

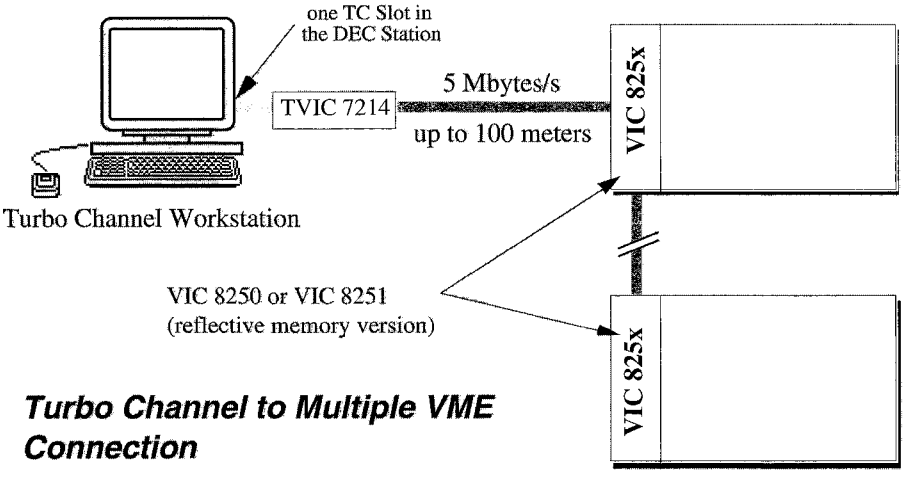

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Physics in the street

to science have earned him a series of distinguished awards in recent years, including the European Physical Society's High Energy and Particle Physics prize in 1989. The Nobel comes as the well-deserved culmination.

Culmination of CERN's involvement in the Expo 92 World Fair fiesta in Seville came on 30 September with in 'CERN Day' – the only day devoted to science in the whole six-month Expo 92 programme. A cast of nearly 500 scientists from all CERN's 18 Member States brought Cinderella Science out of its dusty laboratory seclusion, dressed it up, and took it to the ball.

CERN's permanent exhibition in Expo 92's Pavilion of the Universe, including a 27 metre long section of LEP 'tunnel', had already attracted one and a half million people, but for the CERN Day a carnival had been planned months in advance. With 'discovery' the central theme of Expo 92, the special CERN event stressed how scientists are the explorers of our age, having embarked on the greatest voyage of all – back to the creation of the Universe.

The event began conventionally enough with the official greeting of the CERN delegation, led by Director General Carlo Rubbia and Council President Sir William Mitchell, by Expo Commissioner-General Emilio Cassinello. The official business continued with the opening ceremony at the central 'Palenque' with short speeches by the CERN Director General, Commissioner Cassinello, and Spain's Secretary of State for Universities and Research Elias Fereres.

Then came the awards for "The Young Scientist of the Future", a specially-arranged pan-European competition. (The winners were: Austria – Christoph Simon; Belgium – Stefan Rummens; Czech and Slovak Federal Republic – Jiri Vanicek; Denmark – Morten B. Pedersen; Finland – Ville Voipio; France – Frédérick Jeske; Germany – Robert Nitzschmann; Greece- Marcallos Rallidis; Italy – Alberto De Fanis; Netherlands- Martijn Leisink; Norway – Joakim Bergli; Poland – Barbara Smalska; Portugal – Orlando Moreira; Spain – Ana Colorado-

CERN Director General Carlo Rubbia enjoys the action at 'CERN Day', the culmination on 30 September of CERN's involvement in the Expo 92 World Fair fiesta in Seville.