

Inside Story

“Little wisps and threads of cloud”

In the spring of 1911, CTR Wilson made the first observation of particle tracks in a cloud chamber.

“My choice of a subject to work upon was not due to any forethought on my own part nor to any good advice received, but just to the fact that in the autumn of 1894 I spent a few weeks on a cloudy Scottish hill-top – the top of Ben Nevis. Morning after morning I saw the sun rise above a sea of clouds and the shadow of the hill on the clouds below surrounded by gorgeous coloured rings. The beauty of what I saw made me fall in love with clouds...”

This love of clouds was to lead Charles T R Wilson to receive the Nobel prize in Physics in December 1927, when he spoke these words at the Nobel banquet in Stockholm. However, he received the ultimate accolade for research not for studies in atmospheric physics but for his development of the cloud chamber as a device to make visible the tracks of charged subatomic particles.

The journey from the top of Ben Nevis to Stockholm had taken more than 30 years and in this time physics had seen some remarkable developments. In particular, a new world of subatomic physics had opened up after Ernest Rutherford, while at Manchester University, had discovered “what the atom looked like” (p20).

Rutherford published his findings on the nuclear atom in May 1911 in what was not only a good year for physics, but a good few weeks. On 8 April, Heike Kamerlingh Onnes and his staff at the Leiden Cryogenic Laboratory were the first to observe superconductivity (*CERN Courier* April 2011 p46) and in the same month Wilson, at the Cavendish Laboratory of Cambridge University, included some of his first “rough” photographs of tracks in a communication to the Royal Society in London. His paper was published on 9 June (Wilson 1911).

Nowadays, many a particle physicist seeking to engage non-specialists will remind them of how the passage of



Contrails – an analogy to cloud chamber tracks. (Image credit: Cardiae/Dreamstime.com.)

aeroplanes is made clearly visible, in the right atmospheric conditions, through the trails of condensation – contrails – associated with the exhaust of the engines. When Wilson talked in his Nobel speech of, “little wisps and threads of clouds”, he could easily have been referring to this phenomenon, but this was the 1920s. Instead, he was describing what he had seen in the first tests of his cloud chamber in the spring of 1911.

“I was delighted to see the cloud chamber filled with little wisps and threads of clouds – the tracks of electrons ejected by the action of the [X-] rays”, he said. He then explained that on introducing some radium inside the cloud chamber, “the very beautiful sight of the clouds condensed along the tracks of the α particles was seen for the first time”; the “long thread-like tracks of fast β particles were also seen” with a suitable source.

Even in 1895, when Wilson began to make his own clouds back at Cambridge in order to study the optical effects he had admired on Ben Nevis, he soon became absorbed in studying the formation of the droplets themselves in apparatus of the kind already used by the Scot John Aitken and Pierre-Jean Coulier in France to form clouds in moist air supersaturated by expansion. By the autumn of that year, following Wilhelm Röntgen’s announcement of the discovery of X-rays, Wilson (like Rutherford, who was also at the Cavendish Laboratory at the time) was following JJ Thomson’s lead in bringing the new radiation to bear on his research and he found that X-rays produced large numbers of the condensation nuclei in the cloud

chamber.

There followed a few years of studying the role of ionization in condensation, but from around 1900 Wilson did not continue this line of research until about 1910. By then, thanks in large measure to the work of Rutherford, the particle nature of the α and β radiation had become much more apparent. So Wilson began to pursue the idea of making the tracks visible, with notable results in 1911–1913. After the First World War, he resumed this work only in 1921, leading to the publication of two classic papers on investigations with the cloud chamber of X-rays and β rays (Wilson 1923).

By this time, Patrick Blackett at the Cavendish Laboratory had developed a cloud chamber that expanded automatically every 10–15 s and used cine film to record pictures. Among some 23 000 photographs of α particles shooting through nitrogen were a few that revealed the first visual evidence for nuclear transmutations. The α particles could occasionally penetrate the atomic nucleus that Rutherford had discovered in 1911. The frontier was about to change from subatomic to subnuclear – but that’s another story.

● Further reading

For Wilson speeches at the Nobel prize ceremony in 1927, see: http://nobelprize.org/nobel_prizes/physics/laureates/1927/wilson.html.

CTR Wilson 1911 *Proc. Roy. Soc. Lond.* **A 85** 285.

CTR Wilson 1911 *Proc. Roy. Soc. Lond.* **A 104** 1 and 195.

● Christine Sutton, CERN.

Single Photon Counting
No Noise
High Dynamic Range
Fast Frame Rate
Adjustable Energy Threshold

DECTRIS X-ray detector systems

DECTRIS offers a wide variety of detector systems for a broad range of applications

PILATUS 2-D detector systems

PILATUS detector systems are based on CMOS hybrid-pixel technology and deliver outstanding results in various applications. A wide range of models ensures that a suitable PILATUS detector can be chosen for every measurement.



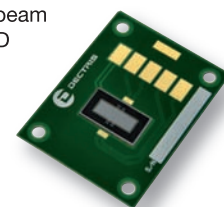
MYTHEN 1-D detector systems

MYTHEN is a one dimensional silicon strip detector system, which can be combined to form multi-detector arrays covering large angles (MYTHEN 6K).



XBPM Beam Position Monitors

XBPM4 is a 4-quadrant x-ray beam position monitor based on CVD diamond technology, suitable for hard x-ray synchrotron beam lines.



Waveform Digitizers Family



742 Switched Capacitor Digitizer series

VME/V1742 (32ch), Desktop/DT5742 (16ch), NIM/N6742 (16ch)

12 bit resolution 5 GS/s

- This units are an excellent mix of performance and high density (32/16 ch) of Data Acquisition Channels in one single board.
- Based on the PSI (Paul Scherrer Institute) switched capacitor array “DRS4-Domino”
- The analog input signals are continuously sampled by the DRS4s in a circular analog memory buffer; 1024 storage cells per channel (200 ns recorded time per event @ 5GSample/s)
- Programmable sampling frequency is **5GS/s, 2.5GS/s and 1GS/s**

761 Interleaved Digitizer series

VME/V1761 (2ch), Desktop/DT5761 (1ch), NIM/N6761 (1ch)

10 bit 4 GS/s Waveform Digitizer

- Clock In/Out, Triggers and 16 GPIOs available on the Front panel for multi-board synchronisation
- Memory buffer: 7.2 or 57.6 MSample/channel divided in 1 to 1024 independent read/write buffers

Available in VME, NIM and Desktop Form Factors

- Innovative and revolutionary daisy chainable Optical Link :
 - One PCI card A2818 (1 Optical Link) can control up to 8 ADC boards (e.g. 256 channels of model 742)
 - One PCIe card A3818 (4 Optical Links) can control up to 32 ADC boards (e.g. 1024 channels of model 742)
- USB2.0 port for NIM and Desktop boards
- Drivers, Libraries (C and LabView), Demos and Software tools for Windows and Linux

Digitizers Selection Table

Model ⁽¹⁾	Form Factor	N. of ch. ⁽⁴⁾	Max. Sampling Frequency (MS/s)	N. of Bits	Input Dynamic Range (Vpp) ⁽⁴⁾	Single Ended / Differential Input	Bandwidth (MHz)	Memory (MS/ch) ⁽⁴⁾	DPP firmware ⁽⁵⁾
x724	VME	8	100	14	0.5 / 2.25 / 10	SE / D	40	0.5 / 4	TF
	Desktop/NIM	4 / 2				SE			
	PCle	2				SE			
x720	VME	8	250	12	2	SE / D	125	1.25 / 10	CI, NG
	Desktop/NIM	4 / 2				SE			
	PCle	2				SE			
x721	VME	8	500	8	2	SE / D	250	2	no
x731	VME	8 - 4	500 - 1000	8	2	SE / D	250/500	2/4	no
	PCle	2				SE			
x751	VME	8 - 4	1000 - 2000	10	1	SE / D	500	1.8 / 14.4 - 3.6 / 28.8	NG
	Desktop/NIM	4 - 2				SE			
x761	VME	2	4000	10	1	SE / D	TBD	7.2 / 57.6	no
	Desktop/NIM	1				SE			
x740	VME	64	65	12	2 / 10	SE	30	0.19 / 1.5	no
	Desktop/NIM	32							
x742	VME	32+2	5000 ⁽²⁾	12	1	SE	500	0.128 ⁽³⁾	no
	Desktop/NIM	16+1							

(1) The x in the model name is V1 for VME, VX1 for VME64X, DT5 for Desktop and N6 for NIM

(2) Sampling frequency of the analog memory (switched capacitor array); A/D conversion takes place at lower speed (dead-time)

(3) The memory size for the x742 is 128/1024 events of 1024 samples each

(4) The indication “size 1/ size 2” denotes different options

(5) DPP-TF: Pulse Height analysis (Trapezoidal Filters), DPP-CI: Charge Integration (digital QDC), DPP-NG: γ-n Discrimination

www.caen.it

Small details 
Great differences

Meet us at the following events:

DIPAC2011 - 10th European Workshop on Beam Diagnostics and Instrumentation for Particle Accelerators

May 16 - 18, 2011

NSTAR2011 - The 8th International Workshop on the Physics of Excited Nucleons

May 17 - 20, 2011

RICAP2011 - 3rd Roma International Conference on Astro-Particle physics

May 25 - 27, 2011

GLA2011 - 2nd International Workshop towards the Giant Liquid Argon Charge Imaging Experiment

June 05 - 10, 2011

ANIMMA 2011 - Advancements in Nuclear Instrumentation, Measurement Methods and their Applications

June 06 - 09, 2011