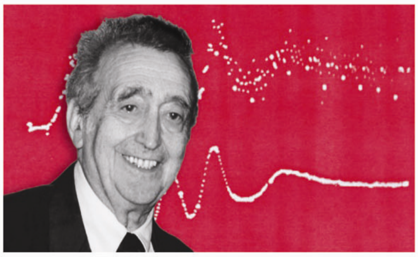
Emilio Gatti (1922–2016)

Remembering Prof. Emilio Gatti with any single invention of his, such as the sliding-scale analog-to-digital converter (ADC)[1], or the charge sensitive amplifier, will be gross injustice to the talent and genius of this legendary scientist. Universally acclaimed as the 'father of nuclear electronics', Gatti was also a brilliant teacher with unbeatable clarity. Gatti's inventions and numerous contributions to experimental nuclear physics reflect his deep understanding of solid state physics, quantum mechanics, not to exclude classical theories and electronics engineering. He loved mathematics and had outstanding skills in the mapping of physical processes into mathematical models.

Gatti passed away on 9 July 2016, at his residence in Milan, Italy. He was 94 and was ailing for some time. Until recently, he was active and deeply involved with research projects at the Politecnico di Milano and at the University of Milan, guiding young students in modern topics like MEMS, silicon lithium drift detectors (geometry profiling to achieve higher sensitivity), robotics, lasers, etc. His last patented invention, jointly with (Late) Pavel Rehak (Brookhaven National Laboratory (BNL), USA) on silicon drift detectors made monumental contribution in modern particle physics research[2]. Their concept was that a large, very thin sheet of silicon (e.g. of n type with p+ doping on each face) can be depleted of free carriers (electrons in this case) from a tiny n+ contact (an anode about 100 μm in diameter) anywhere at the edge of the sheet. The remaining fixed positive charges create a parabolic potential distribution, with a maximum in the median plane of the sheet. Electrons created by an ionizing particle gather at this potential maximum, and can be channelized to drift along the sheet by applying an electric field in the desired drift direction to the strip electrodes formed on the surfaces of the silicon sheet. From this basic concept, various geometrical configurations emerged. A large cylindrical drift detector (10 cm in diameter) with radial drift to readout anodes around the periphery was developed for an experiment at CERN (Figure 1). A large drift detector system was built for the STAR experiment at the Relativistic Heavy Ion Collider (RHIC) at BNL. It is one of the detector technologies included in ALICE (A Large Ion Collider Experiment) at the Large Hadron Collider at CERN[3].

The concept of depletion of large areas and charge collection over long distances by a small anode has made possible other types of devices for different applications. One is the fully depleted charge coupled device. Such a device has been developed as an efficient X-ray detector for astrophysics experiments at the Max-Planck-Institute in Munich, Germany. It



is one of the principal detectors on the X-ray Multi Mirror Mission (Figure 2). Another application has been in silicon detectors for X-ray spectrometry. These are now widespread in industry for trace element analysis, which today is used not only in high-energy physics, but also in countless fields of application from medical diagnostics to preservation of antiques and artifacts of cultural heritage and in environmental monitoring[4].

Gatti was born in Turin and had his early education in Venice. He wanted to study physics while his father and Bruno Rossi (the great cosmic ray physicist, who was a family friend) advised him to take up engineering since it had better job prospects. He graduated in electrical engineering in 1946 from University of Padua, and obtained his doctorate in 1948 from Galileo Ferrari's institute in Torino. Gatti started his career in 1948 at the Centro Informazioni per Studi e'Esperienze (CISE) Lab which he virtually built from scratch. He started teaching as a Visiting Professor at Politecnico di Milano in 1951 and became a full professor in 1957, where he taught until 1997. He became a Professor Emeritus in 1998 for his services rendered to science and academics in Italy. In between, for few years he was also Pro Rettore (equivalent of a Vice Chancellor in India) of the Politecnico.

Gatti was a regular Visiting Scientist at BNL for over 30 years. Working with Veljko Radeka and Rehak, Gatti played a major role in laying the foundations of nuclear radiation detection and instrumentation techniques. He always remembered his Brookhaven association with admiration and nostalgia. During his days at the Brookhaven Lab, Gatti invented the basic design of the low-noise charge-sensitive pre-amplifier which revolutionized detection of particles in ionization chambers and later adopted to solid state detectors.

His other inventions include the sliding-scale principle (Box 1) to improve the differential nonlinearity of the ADC and other equally valuable contributions in filter theory, development of lasers using diverse organic compounds, statistical theory of communication, and the theory of photo-multipliers.

In 1973, Gatti was elected Fellow of the Institute of Electrical and Electronics Engineers (IEEE). He was awarded the IEEE Centennial Medal in 1988 and Life Time Achievement Award in 2004 for his outstanding contribution to nuclear radiation instrumentation. In 1983, he

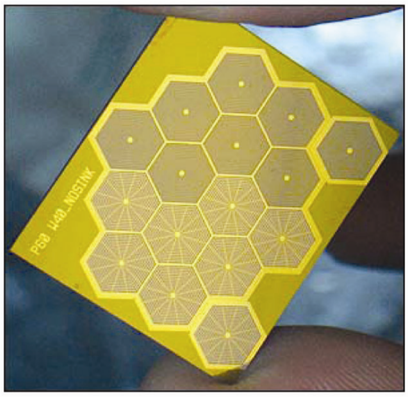


Figure 1. Silicon drift detector droplet SD^3.

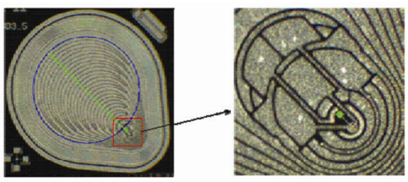


Figure 2. Silicon drift detector with integrated FET input stage.

Box 1.

In the mid 60s, Gatti's paper on the sliding-scale principle[1] stirred considerable debate in the nuclear spectroscopy and the electronics community. This principle propounded an averaging scheme in which the reference base line was shifted randomly with the help of a digital-to-analog converter (DAC). Thus the zero of the scale was different for every other estimate of the particle energy. The shifted datum was restored by subtracting the numerical value given to the DAC from the value of the each conversion to get the corrected value. The scheme eliminated differential nonlinearity errors and resulted in clean–smooth nuclear spectra with enhanced resolution. However many of us, groomed to think in a deterministic world, found Gatti's scheme uncomfortable to accept. Using his skills with probability theory, Gatti brilliantly justified that his scheme works equally well for a single particle estimation as well. This was also published in *Nuclear Instruments and Methods* as a sequel to his paper[1]. However, this paper (the sequel) is not traceable now.

–Author

was elected as a member of the Accademia Nazionale dei Lincei (Italy). In 1986, the Italian National Academy honoured him by awarding the prestigious Feltrinelli Prize.

Gatti was an avid mountaineer and an adept skier. He was a sensitive and compassionate person. It was common sight to see him deeply engrossed in academic discussions with his students at the CISE Lab and at the Politecnico. He had the uncanny insight of going straight to the weakest point in a research paper under preparation or a research proposal under discussion, and was always kind enough to suggest amendments to make a paper acceptable for publication in a journal. Needless to say, that the journals gratefully accepted papers referred by him.

Let me recount an incident without which this tribute to Emilio Gatti will be incomplete.

Date 22 August 1968. Those were the days when scientists loved to get invited to foreign countries for lectures, seminars or similar assignments. Gatti was invited by the Hungarian Academy of Sciences to deliver lectures in Budapest. A fortnight prior to his scheduled departure, Gatti had planned a vacation with his family at their mountain resort in the Alps at Champoluc, Val d'Aosta, near the Swiss border. He invited me and my wife to stay at the resort. At that time Gatti was nominated as a Rapporteur for IAEA's Nuclear Electronics Conference scheduled later at Versailles, Paris. I was assisting Gatti in his job as the Rapporteur. We combined work with vacation at the Champoluc resort, spending late nights in whetting various papers submitted for the conference. After almost a week in isolation at the resort, we decided to go to the nearby Rail head Chatillon Saint Vincent to pick up a newspaper and groceries. Driving back from Chatillon to Champoluc, Gatti opened the newspaper and went into grim silence. After a minute, which appeared too long a time, he uttered *Non ci vado, Non ci vado*... (I shall not go, I shall not go…). The news was about the Warsaw Pact Army's invasion of Czechoslovakia to crush the ongoing Prague spring movement. Truly he felt distressed at the happening and could not wish it aside. He did not go. This was Emilio Gatti, a remarkable scientist, teacher and a great human being. May his soul rest in peace.

He is survived by his wife, two sons and two daughters.

1. Cottini, C., Gatti, E. and Svelto, V., *Nucl. Instrum. Methods*, 1963, **24**, 241–242.
2. Radeka Veljko, Obituary, Proceedings of the Seminar held on 9 November 2010 in memory of Dr Pavel Rehak on his first death anniversary at Brookhaven National Laboratory, NJ, USA, 9 November 2010.
3. Gatti, E. and Rehak, P., *Nucl. Instrum. Methods A*, 1984, **225**, 608–614.
4. Struder, L. *et al.*, *Mikrochim. Acta Suppl.*, 1998, **15**, 11–19.

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