Denis Perret-Gallix (1949-2018)

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Abstract. Denis Perret-Gallix was the founder of the AIHENP-ACAT workshop series in 1990 and has chaired its international advisory committee until June 2018. He passed away on June 28 during one of the mountain bike climbs he used to enjoy. He was a high energy experimental physicist affiliated to IN2P3-CNRS (research director). He worked at Rutherford Lab., SLAC (DELCO experiment), CERN (CHARM and L3 experiments) and KEK developing low temperature dark matter detectors and event generators for the collider (LEP, LHC, ILC) physics simulations. He was the director of the CNRS Tokyo office from 2000 to 2004 and played a leading role in the France-Japan Particle Physics Laboratory which was established in 2006.

1. Main research themes
I remember Denis as a man with a vision, but still very practical: “Let’s stop the dream here. How can we do it?” This sentence is actually recorded in a video of a talk he gave at the 2005 “War and Peace workshop” at Sokendai, where he discussed the role of global laboratories like ILC in knowledge for peace. This sentence expresses his approach to research challenges and his many creative ideas (at least one per day exaggerated one of his colleague!).

Just before becoming, in 1976, the first researcher nominated at the newly created Laboratoire d’Annecy de Physique des Particules (LAPP), an IN2P3 CNRS laboratory, Denis developed a beam profile analyzer. This was the subject of his PhD thesis at the Paris Sud University at Orsay, and appeared as a CERN NP internal report. As a CERN fellow, he completed his doctoral thesis on spin effects at CERN PS. He then joined the DELCO experiment at SLAC and, back at CERN, worked on neutrinos oscillations in the CHARM experiment. He was one of the first three French physicists who joined the L3 experiment at LEP. He designed a digital first level trigger for the BGO calorimeter and worked on electromagnetic shower pattern recognition. He has more than 350 publications and talks at international conferences, mostly related to analysis and interpretation of high energy physics experimental data.

Amongst his many achievements, I would like to stress two aspects of his research. First, his work on new low temperature detectors for dark matter, solar neutrinos and monopoles nowadays called astroparticles, with the development of the superconducting granules detector and the invention of the scintillating bolometers used now in CRESST and nuclear physics, for example. And second, the development of automated particle interaction computation systems, “Generator of event generator” in
the framework of an international cooperation with experimental and theoretical particle physicists that
he initiated in 1991 between France, Russia and Japan.

In both cases, Denis initiated international workshops to boost these research fields, the LTD (Low
Temperature Detector) and the AIHENP (Artificial Intelligence in High Energy and Nuclear Physics),
later ACAT (Advanced Computing and Analysis Techniques), series of which ACAT 2019 at Saas Fee
is the 19th edition.

2. New ideas in Low Temperature Detectors
Apart from his research in accelerator experiments, Denis had other fields of interest. In 1988, he co-
organized a workshop on “The hidden mass in the universe and the dark matter” [1]. He decided to
develop new low temperature detectors for dark matter, solar neutrinos and monopoles. He developed
the superconducting granules detector [2].

To detect dark matter or low energy neutrinos, he proposed dedicated scintillating crystals, where
the crystal acts both as target and as detector. To limit backgrounds, he pioneered scintillating
bolometers with simultaneous light and heat measurement [3]. This technique uses both the good energy
resolution obtained from the bolometric signal and the good timing obtained from the scintillating signal.
There is a strong discrimination between the signal (the nuclear recoil), and the background (photons or
cosmic rays), a low impact from possible surface contaminants because the volume is both the target
and the detector and a possibility to construct massive detectors of active target. This concept was later
used for live time measurement of natural Bi [4] or for dark matter search by ROSEBUD and CREST-
II. It has been used to study the neutrinoless double beta decay with crystals based on Cd or Mo [5].
First results [6] from CUPID-0 with Zn Se crystals [7] show an order of magnitude improvement with
this technique.

With K.Pretzl, Denis founded the LTD workshop series dedicated to Low Temperature Detectors. He
was a member of the scientific committee from LTD 1 to LTD 11 and organized LTD 2 in Annecy.
The cover of the LTD 2 proceedings shows his design of “cold crystals under the sun” at a time where
he envisaged InBO3 crystals as scintillating bolometers to detect solar neutrinos. He chaired the first
session of LTD 11 in Tokyo where he had the pleasure to see some of his ideas realized: for dark matter
detection by CRESST or applied to neutrinoless double beta decay searches.

3. Generator of event generator
Joining in 1986, for the LEP 200 ECFA workshop, the working group on “Electroweak radiative
corrections”, Denis got interested in the problem of automatic calculation of Feynman diagrams for a
given physics process. To tackle this problem, he initiated an international cooperation CPP
(Computational Particle Physics) between France, Russia and Japan. In this framework, he worked on
the development of automatic packages from the automated calculation of process matrix element to the
construction of event generators. This allows to go from the theory to the simulated experimental data.
He coordinated the EU-INTAS program “Physics at the upcoming colliders and new calculation
techniques” (INTAS-93-1180) and the CERN_INTAS program “Automatic calculation of LHC
processes: From Lagrangian to event generators” (INTAS-1999-00377). He also initiated the first
international collaboration between France, Japan and Russia as a Program for International
Collaboration in Science of CNRS (PICS 397) “Automated calculations of Feynman diagrams: event
generator”.

In a talk at CPP 2016 with the title “Science vision: the matrix revolutions”, Denis explained how
computational physics went from vision to reality. Computers have transformed all physics research:
from the slide rule, graph paper and counter printer to LHC/ILC data grid; from theorist hand
calculations to automatic packages; from mere geometric acceptance hand calculation to full-fledged simulation; from Ernest Stueckelberg and Richard Feynman to the symbolic language developers A.C. Hearn (REDUCE), T. Veltman (SCHOONSHIP), S. Wolfram (Mathematica) and J. Vermaseren (Form); from Grace and CompHep [8] to the billions events simulated in the LHC worldwide GRID. Very few people believed back in the 80-90 that automatic calculations would have any practical use besides a learning tool for students. Today we have an automatic calculation “industry” and no experiment can be designed, analyzed or interpreted without simulation, the matrix element generator being the first link in the simulation chain.

In 1996, Grc4f [9] became probably the first event generator using an automatic calculated matrix element. It was extensively used in LEP analysis. An example of the integration of Grace and CompHEp is quartic couplings at LEP2 [10] used in L3 analysis [11]. Denis gave two reviews [12] at CCP 2001 and at CCP 2012 summarizing the use of CPP for event generation and analysis.

4. Denis and the AIHENP-ACAT workshop series
In 1990, Denis started the AIHENP workshop series [13] dedicated to Artificial Intelligence in High Energy and Nuclear Physics. The name was a little provocative: what benefits is artificial intelligence bringing to physics research? The initial motivations were to explore computing beyond number crunching in three domains: 1) Software development, 2) Data analysis: neural nets, evolution/genetic algorithms, expert systems, 3) Theoretical computations: symbolic algebraic manipulation, automatic calculation. Bridging disciplines, namely theory, experiment and computing, was at the heart of the project. Denis would go on to be the editor of nine of the proceedings of the AIHENP-ACAT series.

The 1990 Lyon workshop turned out also to be the first meeting of the HEP symbolic/automatic calculation community. The La-Londe-Les-Maures workshop, in January 1992, featured one of the first WWW demo [14]. At the Oberammergau workshop (Oct. 1993), the academician Dmitrij V. Shirkov (1928-2016) chaired the session where M. Veltman presented his view on symbolic manipulation [15] and T. Kinoshita his numerical approach of higher order radiative corrections in QED [16]. This edition was a festival of multi-loops. Pisa (1995) saw an important number of contributions about neural networks ranging from electron identification, search for Higgs, heavy quark tagging to trigger applications. Denis presented his view on complete automatic computation of Feynman diagrams [17]. Presented at the 1996 Lausanne workshop, the object-oriented data analysis framework ROOT [18] will become a top cited analysis tool (more than 1800). Beyond particle physics, it has found applications in astrophysics, nuclear physics, lasers, satellite monitoring, solar energy and, even, for financial forecasting. LANHEP [19], also presented there, generates automatically the Feynman rules from the Lagrangian. Parallel and distributed computing were highlighted. Dmitrij V. Shirkov attended also the 1999 Heraklion edition (see Figure 1). In 2000, at the Fermilab edition, the series was renamed ACAT (Advanced Computing and Analysis Techniques) to broaden the scientific scope to new topics like distributed computing and a more extended data analysis coverage [20]. The highlights were large scale simulations in HEP and astrophysics as well as world-wide computing.

The 8th edition in Moscow, organized by MSU and JINR in 2002, showed a strong participation from young researchers thanks to sponsorship. The most cited work presented at the 2003 workshop at Tsukuba was CompHEP [21] with automatic computation from Lagrangian to events. Denis stressed once more that the goals of AIHENP-ACAT were to present, promote, discuss and confront new ideas, approaches, algorithms or implementations using computers to provide “intelligence” to basic research activities building a community between computer science, experimental research and theory. The NeuroBayes [22] neural network package was presented at ACAT 2005 at DESY-Zeuthen. Possible applications of quantum computing to physics research were reviewed and the state of the art covered in a talk “Quantum computing in physics research” from B. Georgeot (CNRS) [23]. In his concluding
remarks, Denis discussed, among emerging topics, the impact of floating-point accuracy on intensive numerical calculations [24].

At Amsterdam, for ACAT 2007, TMVA, a toolkit for multivariate analysis, which will be used in the LHC analysis discovering the Higgs, was presented [25]. At ACAT 2008 at Erice, we learned that the future is many-core. Denis chaired a session with a presentation dedicated to intellectual property in software development as well as patents and licensing What computing brings to neural science research was discussed by a software expert from Blue Brain. Cloud computing was a highlight in Jaipur at ACAT 2010. The Roostats project [26], an advanced statistical tool, which will be used in the LHC analysis discovering the Higgs, was presented. For ACAT 2011 at Uxbridge, Denis gave the outlook talk. There is an NLO revolution with automatic tools for 2→6 processes becoming a reality! He foresaw that GPU (Graphic Processor Unit) were going to take the central stage with, for example, quadruple precision or acceleration by a factor 50 to 60 for Monte Carlo integration achieved at KEK [27] or a factor 10 for track finding in ATLAS. He discussed also cognitive computing namely what neural science brings to computing, for example the IBM neurosynaptic chips. Earth science and astrophysics were featured at the 15th edition of the workshop held in Beijing in 2013. Here the latest developments of four major QCD NLO programs were presented: BlackHat [28] NJet [29], GoSam [30] and OpenLoops [31]. For ACAT 2014 in Prague, Denis opened the workshop with the “bridging disciplines” motto. During a round table he elaborated on cross-fertilization between HEP computing and other fields. Symbolic algebraic manipulation languages mostly originally crafted by HEP physicists for their own needs are now of widespread use. Integration packages developed by mathematicians for statistical studies or financial applications in computational finance are now used in Feynman diagram loop integration. At Seattle, the ACAT 2017 workshop remembered its origin back in 1990 when it was called AIHENP with a strong emphasis put on AI again. The focus was machine learning featuring its role in event reconstruction and classification, fast simulation of detector response, measurement of particle properties and AlphaGo inspired calculations of Feynman loop integrals.

Denis was enthusiastic at the perspective to have the workshop in Saas-Fee, from where we climbed to the Mischabel hut (see Figure 2). In the ACAT blog entry of March 28th 2018, he writes: “ACAT 2019 is foreseen to be a landmark in the series as we stand at a dramatic moment in the history of computing and physics research. At a time where the advances in AI, deep learning, quantum computing, high performance computing as well as dedicated chips (GPU, tensor processing units, neuromorphic), separately as well as in combination, will change drastically the way physics research is done.”

5. Denis and Japan
International cooperation played a major role in Denis activities. He spend two years in California, four years in Tsukuba and most of his experimental work was at CERN. An interview of Denis in Japan was published in the November 2008 issue of the French “Science et Avenir”.

5.1 Director of the CNRS Tokyo office 2000-2004
In 2000, Denis becomes director of the CNRS Tokyo office (and scientific attaché, for fundamental research, at the French embassy). Some of his activities were still connected to HEP, like being a member of the consultative group of high energy physics for the report to the Global Science Forum of OECD (June 2002), which stresses the importance of a linear collider. He was also a member of the global linear collider network committee and of the super computer evaluation committee at KEK.

He presented numerous seminars about CNRS, for example “CNRS at the service of mankind” at the new National Institute of Advanced Industrial Science & Technology where he also discussed the different time scales and management needs between science, where the aim is to increase knowledge, and technology, where the aim is to increase wealth (starting from a famous graph of Leo Esaki). This talk, as well as “Science policy: the French case”, was published in a Japanese translation. He
contributed to articles in the French press on the earth simulator or the robotics. He was a member of the Science and Technology Diplomat Circle.

5.2 French director of the Toshiko Yuasa Laboratory (TYL) 2006-2014
In 2006, Denis became the first French co-director of the French Japanese Particle Physics Laboratory (FJPPL) which was later renamed TYL to honor the first Japanese woman nuclear physicist (see Figure 3). He was also in charge of the IN2P3 cooperation with Asia, setting up the FCPPL with China and the FKPPPL with Korea. He organized ACGRID (Advanced Computing and GRID technologies for research) school series in Vietnam (2007, 2009, 2011) and Malaysia (2009). He was president of the France-Asia Particle Physics School and member of the E=MC2 French project to invite US and Japan researchers at LHC. On August 12, 2013, at Quy Nhon, for the ICISE center inauguration, he gave a seminar “Development of national high-performance computing infrastructure for research and education” chaired by the Science and Technology Minister.

5.3 Asia Europe Physics Summit
In 2010, he initiated and co-chaired the first Asia Europe Physics Summit at Tsukuba [32]. A joint declaration of the European Physical Society and the Asia Pacific Physical Societies was issued, strengthening the collaboration between Asia and Europe. The third summit, held in 2013 in Chiba, centered on international strategic planning for large research facilities.

In the Basic REsearch in a GLObal World (bareglow) blog [33], Denis used to express his personal view on issues like global research laboratories and international relations.

6. Green ILC and sustainable colliders
The high precision foreseen at ILC as well as the world-wide nature of the project, had attracted Denis’ attention since a long time. The Green ILC project deals with the numerous issues related to energy consumption, energy saving and recycling as well as the use of renewable energy in the running of ILC. For example, liquid nitrogen used as a primary coolant for cryogenics system can also be used for energy storage. Denis, who coined the name “green ILC” and created its web site [34], has presented this project to many international conferences on linear colliders as well as to industrial partners within the Advanced Accelerators Association. His last presentation on May 28, 2018 at the Asian Linear Collider Workshop in Fukuoka, “Green ILC Plasma wakefield and beam dump”, was related to his ongoing development of the simulation to study ILC beam dump by plasma-wakefield deceleration. He was a member of the ICFA panel on sustainable colliders/accelerators.

In a video of the series “I want the ILC”, Denis said “… But I am more interested on the challenges of the ILC as a technology and more precisely on the energy issue: any progress we will do for the energy consumption of the ILC will be progress for the humanity.” In an entry to bareglow, he explained why he thinks that meeting the energy challenge can have substantial impacts on the society. “Often when basic research meets technological difficulties, innovation is at the corner. The daunting management of documentation at CERN sparked the World-Wide-Web; filtering micro black hole fussy signals gave birth to algorithms which are at core of WIFI transmission; the annoying synchrotron radiations hampering the reach to higher electron energies ended up being a major tool to analyze materials and biological samples, and the list is long. With more than 30,000 accelerators in industry and hospitals, no doubt that energy efficiency will reduce the price tag for products and medical treatments. But what is even more important is that the gathering of multidisciplinary expertise from high-energy physics, energy R&D and industry in an international and open research framework may provide the best way to boost innovation in energy and may give light to new disruptive energy technologies. This is what the "ILC Energy Center", at the heart of a "global science city" as discussed in Japan, could modestly initiate and contribute to.”
Figure 1: Prof. Shirkov with Dr Perret-Gallix during the cultural excursion at AIHENP Heraklion

Figure 2: Denis Perret-Gallix in front of the Mischabel hut above Saas-Fee
Figure 3: Part of the TYL logo designed by Denis

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