

Chapter 5

Role of Bruno Touschek in the Realization of the Particle-Antiparticle Colliders



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Abstract Recollections about meeting and collaborating with Bruno Touschek.

I have met for the first time Bruno when I was a student at the Scuola Normale di Pisa. Luigi Radicati had succeeded in convincing Bruno to come periodically to Pisa by train from Roma and to give some lectures on subjects of his choice.

Parity violation had just been discovered and the question of the true nature of the neutrino fascinated and obsessed Bruno. But he was even more fascinated by the role in Nature of fundamental symmetries like C, P, and T. The originality and uniqueness of his personality and of his ideas, even his strange accent, and, most of all, the enthusiasm and the drive with which he was literally aggressing subjects in his lectures and in the subsequent long discussions, made a deep impression on all of us, then young students.

On my return to Italy after a period spent in the United States, I moved to the University of Roma, where I met then again Bruno. He had not changed, not even a bit. At that time he was in his full creative effort on electron positron colliding beams. I was extremely surprised that he could be talking about such “practical” devices, like those needed to accumulate particles, since I had known him only as a “champion of the Majorana neutrino”.

Then I understood that in his mind electron–positron collisions were nothing else than the way of realizing in practice the idea of symmetry between matter and antimatter, in the deep sense of the Dirac equation.

I still remember him saying with a very loud voice, resonating in the corridors, “the positron and the electron must collide because of the CPT theorem”. His boundless enthusiasm for particle-antiparticle collisions was dominated by a sense of perfect and intellectual aesthetics, rivalled only by his contempt for the other and more

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mundane alternatives of collisions of electrons or of protons, being explored at that time for instance by Jerry O'Neill, Andy Sessler and others.

One must recognize that talking about practical collisions between particles and antiparticles was at that time perfectly and totally crazy in the views of most of the so-called “reasonable” scientists, since neither the accelerator technology, nor the vacuum, —without mentioning the problem of accumulating realistic amounts of positron current—were known at the time.

Norman Ramsey told me later that returning in those days from a trip to Europe and the Soviet Union he got as an answer: “there will never be enough luminosity to do any physics”.

It was however evident that all these concerns had absolutely no influence on Bruno and that he was only attracted by the perfection and the beauty of a machine capable of producing “an excited vacuum”. I remember him explaining that in this way “all possible (charged) particle states must be produced, the “ultimate and definitive spectroscopy”.

Later, when I met Budker, I realized how similar his and Bruno mental attitudes were. I met Budker in the United States, where he had come for a short visit in California, at a dinner with Wheeler at the O'Neill home.

At that time proton-antiproton collisions had become the next “unthinkable idea”. Shortly afterwards, Budker visited CERN with Skrijnsky, since he was very curious to see the progress on the ISR, which was being started at that time. However he was not very respected by the CERN accelerator community, much too conservative and attached to formalisms to fully appreciate the genius of the man. So I had to take personally a significant role in the visit, showing him around CERN.

In order to smooth further the harshness of the reception at CERN and also in order to have a further chance “to pick at his brain”, I decided to accompany both Budker and Skrijnsky in their visit to Roma and to Frascati, where instead he was received very warmly and with an immense enthusiasm.

On the next day—which was some kind of a holiday—we were all invited for lunch in Bruno's home. Of course, the “lunch” lasted a major fraction of the afternoon. This has been for me the occasion of witnessing the interesting interactions between Bruno and Budker, at the same time so similar and so different. While Budker tended to jump constantly from one subject to the other in a continuous firework of ideas, Touschek was saying much less and concentrating stubbornly on the same idea.

It is usually believed that the idea of transforming a conventional accelerator into a proton-antiproton collider was developed by me and collaborators in the late seventies and in order to observe the production of intermediate vector bosons. Actually the idea is to be traced far back in time and to Italy. About ten years before, Giorgio Salvini—at that time President of INFN—had asked a number of physicists, including myself, to meet in Pisa under Stoppini as a “coach” in order to come up with a recommendation for the next step in accelerators in Italy. At that time the SPS was not yet accepted and many people thought that one should have launched the “next step” on a national basis, and why not, also in Italy. I must say that hopes were not riding very high, if one considers that the name with which the project was unofficially labeled was

Macchina Acceleratrice Italiana Protosincrotrone Inter Universitario—MAI-PIU' (Never Again).

At that time, we had two alternatives: one was a conventional 80 GeV proton synchrotron, the other a proton-antiproton collider, based on Budker's electron cooling, in the same tunnel and 160 GeV in the centre of mass.

I remember I had a long discussion with Bruno on what one should do next. He had no doubt that the colliding beam solution was the correct line to follow. Clearly in his and in our mind at the time the proton antiproton option was the logical continuation of the ADA-Adone line.

Bruno's enthusiasm was—as usual—very contagious and Ghigo and myself started to work out in detail a possible and “least unrealistic” scheme. We concluded that the first step was the one of testing the idea of electron cooling experimentally. To that effect, we had planned to borrow from CERN the “electron analogue” of the ISR, at that time left unused in the Adam's Hall at CERN. We spent in fact several days at CERN and found that all components for cooling experiment were easily at hand at that time. What was lacking—and that we were prepared to provide—was the real interest in proceeding with the studies and the courage to take these things seriously.

Unfortunately, the end of that summer coincided with the end of our dreams, shortly followed by the tragic and sudden death of Ghigo. The whole matter was set to rest, since it was decided by the scientific community at large to concentrate all European efforts toward the political consensus needed for construction of the SPS.

The Italian initiative for a collider-accelerator, as well as the projects in France and Germany for conventional medium energy accelerators were in the way of the larger CERN machine and had to be sacrificed. In a way this has not been all bad, since the MAI-PIU' option would never had the energy to reach W and Z thresholds!

Ten years later the fire of the proton-antiproton collision was still burning in the back of my mind, and I must say that so it was in the mind of Bruno. (The third person would—no doubt—have been Ghigo, if still alive!). As soon as he knew that the proton-antiproton collision adventure at last was actually going to start—although already terribly affected by his illness—Bruno decided to move immediately to CERN.

I remember having long discussions with him first at CERN and then, toward the end, at the nearby Hospital de La Tour, where he was periodically admitted for intensive care. Although the body was clearly weakening, his mind was as sharp and lucid as ever.

He was trying to assess for his own mind the relative merits between the electron cooling of his old friend Budker and the more modern stochastic cooling being worked by Simon Van Der Meer, Lars Thorndhal and Frank Sacherer (also tragically deceased soon after).

His approach was very indicative of the way in which his mind worked, totally polarized and almost uninterested of the way in which the problem was being tackled by others. His last paper—posthumously published by one of his then young disciples at Frascati—has been on stochastic cooling. Although it is clearly an unfinished job and it does not contribute significantly to the practical realization of the new device,

it has all the flavours of his unique way of observing the world through the eyes of a true theoretical physicist.

It has been often pointed out that the contributions of Bruno in the field of antiproton cooling have been negligible. It is very likely so especially if one looks at the impact of such a last, notebook paper.

However there are ways of contributing to a field of science which cannot be quantized in terms of published papers and identifiable contributions.

So it has been for instance the case of Niels Bohr who, in comparison with other top scientists of his time, has produced almost nothing—there is no Bohr equation, no Bohr effect, no Bohr constant, no Bohr discovery. As yet, without Bohr, today there will be no quantum mechanics. Likewise without Touschek's and Budker's contributions today there will be no colliding beams of matter–antimatter. At the end, Bruno returned to his native Austria accompanied all along by my CERN driver Willy Aigner also from Austria. He died at age 57 in Innsbruck on 25 May 1978.

I have learned from Bruno to love matter–antimatter reactions. Without this fact, my own scientific career would certainly have been very different. So I believe it has been the case also for many other of us.

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