Activity at Genova

Laura Perasso
I.N.F.N. - Via Dodecaneso 33 - 16146 Genova
E-mail: `perasso@ge.infn.it`

Abstract

I will recall here the main physics activity of Prof. Giordano Diambrini-Palazzi in his first years at the *Università di Genova*, where I was one of his students when he held the Chair in *Physics II* and, later, was my Thesis advisor.

We did not make any experiment together - he did not participate to the "dimuon production" experiment at the ISR he wrote the proposal for - but we kept in touch for all these years and he was always very curious to know what I was doing and always asking me - every time we had the chance to meet at various Congresses or at "La Sapienza" University in Rome - how his other "pupils in Genova" were doing: in fact, one aspect of Diambrini's activity at the Università di Genova which cannot be neglected is the number of students he supervised and who remained in the field.

Diambrini arrived as full professor at the *Università di Genova* in 1963 from Frascati, after his successful experiments on high energy coherent bremsstrahlung and electron production in thin crystals [1].

As it was customary in Italy in those years, he came with three young fellows - Ivo Giannini, Alberto Santroni and Giuseppe Sette - and together they formed the core of a new group (*Gruppo Alte Energie)*, the first one, in Genova, devoted to the recently born "accelerator" physics, in addition to the already present nuclear and cosmic ray physics groups.

With them, and the new group members Francesco Grianti and Pasquale Ottonello, Diambrini studied the π pair photoproduction below 850 MeV at Frascati ([6] and [7]). For this experiment they built the spark chamber and counter detectors and this gave the opportunity to the staff at the Genova I.N.F.N. Laboratory to become familiar with these detection techniques, all new at those times. This expertise on frontier detectors has always been kept up-to-date since then and it is still flourishing today: one of its latest achievement being the construction of the pixel detector in the ATLAS experiment at LHC.

At the end of the '60s Diambrini went "on leave" from the *Università di Genova* at the Cornell University. There, at the Cornell electron synchrotron, he had the opportunity to obtain linearly polarized photons via coherent bremsstrahlung produced by 9.7 GeV electrons striking a diamond crystal, as predicted in one of his previous papers [2]. With this beam he studied the photoproduction of ρ^0 ([3] and [4]) and ϕ^0 [5] mesons.

After Frascati, the group - with Guido De Zorzi as new entry - decided to move to CERN to study the small-angle proton-proton elastic scattering [8] and total cross section [9]: these measurements were quite interesting, since the ISR was providing the highest center of mass energy, and they have been the first of a series of small-angle elastic scattering (and total cross section) measurements made by Genova teams which continued at all the other colliders built at CERN: at the SPS [12] , and at the LHC [13]. When Diambrini was back from Cornell, he joined this experiment [10] and with part of the group stayed at the ISR where they also measured the angular distribution of charged particles around 90 degrees [11].

In 1973 Diambrini co-signed a Proposal [14] with S. Ting to search for the neutral boson Z^0 at the highest energy available: again at the ISR of CERN. But then, even if the proposal has been accepted and the experiment was setup and completed - the final result was no hint of the Z^0 but a Drell-Yan dimuon production study - Diambrini never took part in it: what happened? What made him change his mind?

The answer is simple: the discovery of the J/ψ in november 1974, which marked the beginning of a new line of research for Diambrini: the study of the new charmed particles using photon beams.

The J/ψ discovery, confirming the Standard Model, implied also the existence of charmed hadrons. It was then essential to produce them and to study their properties.

Even if the first charmed barions, charmed mesons and strange charmed mesons had been detected the statistics was low and - more important - the vertex detector space resolution was not enough to measure the new particle lifetime, whose upper limit was estimated to be 10^{-12} seconds: this value required vertex detector with a spatial resolution of the order of 10 *micron*.

While in many Laboratories new high resolution detector were under study, some physicists thought about an obsolete detector: nuclear emulsions, which did have the necessary space resolution, but required very long scanning time, since it was still done manually. It was mandatory to drastically reduce the number of events to be scanned: one solution could have been increasing the ratio (R_c) between the charm particle production cross section and the total cross section and to couple the vertex emulsion with an outside spectrometer apt to select events with "charmed particle decay" characteristics.

Moreover, the outside spectrometer could offer two other important advantages: provide good kinematic information of the decay - not provided by the simple and precise measurement in the emulsion - and reduce the scanning volume by selecting the decay vertex region from the reconstructed tracks.

Diambrini had the necessary confidence with photon beams to know that a 100 GeV photon beam was providing an R_c 10 times higher than a regular hadron beam and thought that the Omega spectrometer, at CERN, could provide a well suited external trigger system. This idea, fully developed at Genova, was quickly - even before INFN approval - presented at CERN as a Proposal on november 11, 1976 [15], to study charmed particles photoproduced in emulsion plates tagged by the Omega apparatus triggers. It is worth noting here that this proposal marks the union of two experimental groups in Genova: the group of Diambrini and the group of Prof. Giavanna Tomasini, pioneer and great expert in the emulsion techniques.

In spite of the fact that the proposal was signed by only eight physicists, too few to do anything, it was enthusiastically accepted by the CERN management, who approved it, in january 1977, as test exposure (WA34 experiment inside the *Electron-Photon-Collaboration*) to demonstrate the validity of this new experimental method.

It was not an easy task: the Omega tracking system had to be improved and the first 40 kg Ilford emulsions presented unrecoverable problems; it was only thanks to Diambrini's stubbornness that new good emulsions (from a collaboration with Moskow's Lebedev Institute) were found and a new proposal to CERN could be written in which it is stated: "however, no clear cut case of charmed particle decay has been observed within the lifetime range $10^{-14} - 10^{-12}$. Possible cases of decays corresponding to lifetimes of the order of 10^{-15} sec had been suspected. Better statistics were clearly required." [16].

After the final WA34 success, the new proposal was accepted and there were all the other WAs experiments, which were able to measure the charmed particle lifetimes, of the order of 10^{-13} s, as covered elsewhere in these proceedings [17].

The author would like to thank Marco Bozzo, Pasquale Ottonello, Leonardo Rossi and Alberto Santroni for fruitful discussions and for reading this paper and Mauro Dameri for many insight on the very beginning of the Genova-Omega collaboration.

References

[1] G. Barbiellini, G. Bologna, G. Diambrini and G. P. Murtas, *Measurement Of The Polarization Of The Frascati 1 - Gev Electron Synchrotron Gamma Ray Beam From A Diamond Crystal Radiator*, LNF-62-87; Phys.Rev.Lett. 8, 112, 454 (1962)

[2] Giordano Diambrini-Palazzi, *High-Energy Bremsstrahlung and Electron Pair Production in Thin Crystals*, Rev. of Mod. Phys. **40** , 3 - 1968, 611.

[3] G. Mcclellan, N. B. Mistry, P. Mostek, H. Ogren, A. Osborne, A. Silverman, J. Swartz and R. Talman *et al.*, *Incoherent photoproduction of rho-neutral mesons from complex nuclei and comparison with vector-dominance predictions*, Phys. Rev. Lett. **23** (1969) 554.

[4] G. Diambrini-Palazzi, G. Mcclellan, N. B. Mistry, P. Mostek, H. Ogren, J. Swartz and R. Talman, *Photoproduction of rho mesons from hydrogen and carbon by linearly polarized photons*, Phys. Rev. Lett. **25** 1970, 478.

[5] G. Mcclellan, N. B. Mistry, P. Mostek, H. Ogren, A. Osborne, J. Swartz, R. Talman and G. Diambrini-Palazzi, *Photoproduction of ϕ^0 mesons from hydrogen, deuterium, and complex nuclei*, Phys. Rev. Lett. **26** (1971) 1593.

[6] G. Diambrini-Palazzi, G. Sette, I. Giannini, F. Grianti, A. Santroni, 1968 *Pi-pair photoproduction below 850 MeV* (Phys. Rev. Lett. 21, 20 - 1463)

[7] G. Diambrini-Palazzi, I. Giannini, F. Grianti, P. Ottonello, A. Santroni and G. Sette, 1971 *Double pion photoproduction below 1 gev - experimental results*, (Lett. Nuovo Cim. **1S2** 267 [Lett. Nuovo Cim. **1** 267]).

[8] M. Holder, E. Radermacher, A. Staude, G. Barbiellini, P. Darriulat, M. Hansroul, S. Orito and P. Palazzi *et al.*, *Observation of small angle proton proton elastic scattering at 30 gev and 45 gev center-of-mass energies*, Phys. Lett. B **35** (1971) 355.

[9] M. Holder, E. Radermacher, A. Staude, G. Barbiellini, P. Darriulat, M. Hansroul, S. Orito and P. Palazzi *et al.*, *Determination of the proton proton elastic cross-section at 30-GeV center-of-mass energy*, Phys. Lett. B **35** (1971) 361.

[10] G. Barbiellini, M. Bozzo, P. Darriulat, G. Diambrini Palazzi, G. De Zorzi, a. Fainberg, M. I. Ferrero and M. Holder *et al.*, *Small angle proton proton elastic scattering at very high-energies (460-GeV^2 $<$ s $<$ 2900-GeV^2)*, Phys. Lett. B **39** (1972) 663.

[11] G. Barbiellini, M. Bozzo, P. Darriulat, G. Diambrini-Palazzi, G. De Zorzi, M. Holder, A. Mcfarland and G. Maderni *et al.*, *Experimental observation of the angular distribution of charged particles around 90 degrees in the centre of mass produced by proton proton collisions at very high energies*, Phys. Lett. B **39** (1972) 294.

[12] R. Battiston *et al.* [UA4 Collaboration], *Measurement Of The Proton - Anti-proton Elastic And Total Cross-section At A Center-of-mass Energy Of 540-GeV* Phys. Lett. B **117** (1982) 126.

[13] G. Antchev, P. Aspell, I. Atanassov, V. Avati, J. Baechler, V. Berardi, M. Berretti and E. Bossini *et al.*, *First measurement of the total proton-proton cross section at the LHC energy of* $\sqrt{s}$ *=7 TeV*, Europhys. Lett. **96** (2011) 21002 [arXiv:1110.1395 [hep-ex]].

[14] G. Diambrini-Palazzi, U. J. Becker, P. J. Biggs, A. Cook, G. Everhart, P. Goldagen, R. Little, K. Strauch and S. C. C. Ting, 1973, *Proposal to study electromagnetic properties of protons in the time-like region and to search for the neutral boson* Z^0, (CERN/ISRC 73-28)

[15] M. G. Dagliana, G. Diambrini-Palazzi, G. Di Caporiacco, A. .M. Cartacci, F. Richard, M. Sannino, G. Tomasini, D. Treille *Study of Charmed Particle photoproduced in Emulsion Plates Tagged by the Omega Apparatus Triggers*, (CERN/SPSC/76-96 SPSC/p. 78 November 11, 1976)

[16] M. Adamovich et al. *New Proposal to Measure the Lifetime of Charmed Particles in Nuclear Emulsion Exposed to 80 GeV Bremsstrahlung beam in Conjunction with the* Ω*' Spectrometer*, (CERN/SPSC/78-145 SPSC/p. 122, November 1978)

[17] see Mario Sannino and Sergio Petrera contributions to these proceedings.