

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW

## HOW DID IT HAPPENED?



*Marian Mięśowicz (1907 – 1992), PhD in physics.*

After successful work on liquid crystals got a grant from Fundusz Kultury Narodowej and joined the group of prof. L. Ornstein in Utrecht in 1936.

*... Leave your liquid crystals. They have no future (!).  
Switch to nuclear physics. Build with us  
a  $\beta$ -spectrometer ...*

Utrecht Uni was at that time totally reoriented on nuclear physics. Here worked also G.E. Uhlenbeck, who in 1925 introduced, together with S.A. Goudsmit, concept of spin.

# ***HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW***

## ***HOW DID IT HAPPENED?***

***Na następujących przeźroczach korzystam szeroko z tekstów wybranych z "Notatki Autobiograficzne Fizyka" autorstwa Mariana Mięśowicza zamieszczonych w Kwartalniku Historii Nauki i Techniki 32/3-4 545-600 1987.***

***On the following transparencies I extensively use texts selected from "Notatki Autobiograficzne Fizyka" by Marian Mięśowicz published in the Kwartalnik Historii Nauki i Techniki 32/3-4 545-600 1987.***

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW

## HOW WAS "ATOMISTICS" IN 1935?

1. Around 1910, considered one of the most beautiful experiments in physics: scattering of a particles on golden foil, resulted in the discovery of the proton;
2. this experiment outlined the only way to study the structure of matter in the projectile-target pattern, which is still in use today! (R. Feynman's ever-current sarcasm);
3. 1912 - discovery ("accidental") of cosmic rays (V.F. Hess, Austria. Nobel in 1936 );
4. 1932 - discovery of positron ( $e^+$ ) in cosmic radiation. Electron known since 1897, discovered in ionized gases;
5. 1936 - muon ( $\mu$ ), "heavy electron", observed in cosmic rays. Carl Anderson. Rabi: "Who ordered it?" ;
6. neutron (n), discovered in 1932, James Chadwick.
7. The pion ( $\pi$ ) will be finally discovered in 1947 in cosmic rays. C. F. Powell.

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW

## 1938, back in Kraków



In 1937, a project was created to organize a Polish balloon flight into the stratosphere. The goal was to record an altitude, but funding required a scientific program. It was agreed that the subject of research during the flight would be the measurement of the altitude distribution of cosmic radiation.

The main part was supposed to be counter "telescope", counters cutting out a specific spatial angle through coincidences of the number of counters specified for a given purpose. Our counter telescope with 30 counters was an ambitious undertaking for its time. An essential role Stanisław Wojtow, a long-time mechanic of mine, played a role in the creation of this equipment.

The balloon burned down during take-off, but the equipment remained undamaged.

# *HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW*

## *1939-1945*

**During the war, professors Zakrzewski, Wertenstein and Weysenhoff stayed in Krakow. We maintained constant scientific contact.**

**We discussed, to my great advantage, the problems of our further work on cosmic rays. We discussed the ideas of the works in Wieliczka, suggested by Auger.**

**I received German literature from one of my "secret" students, who worked as a messenger in a German bookstore and brought me books.**

**This is how I obtained Heisenberg's book Kosmische Strahlung, which helped me a lot in my later work.**

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1947 --

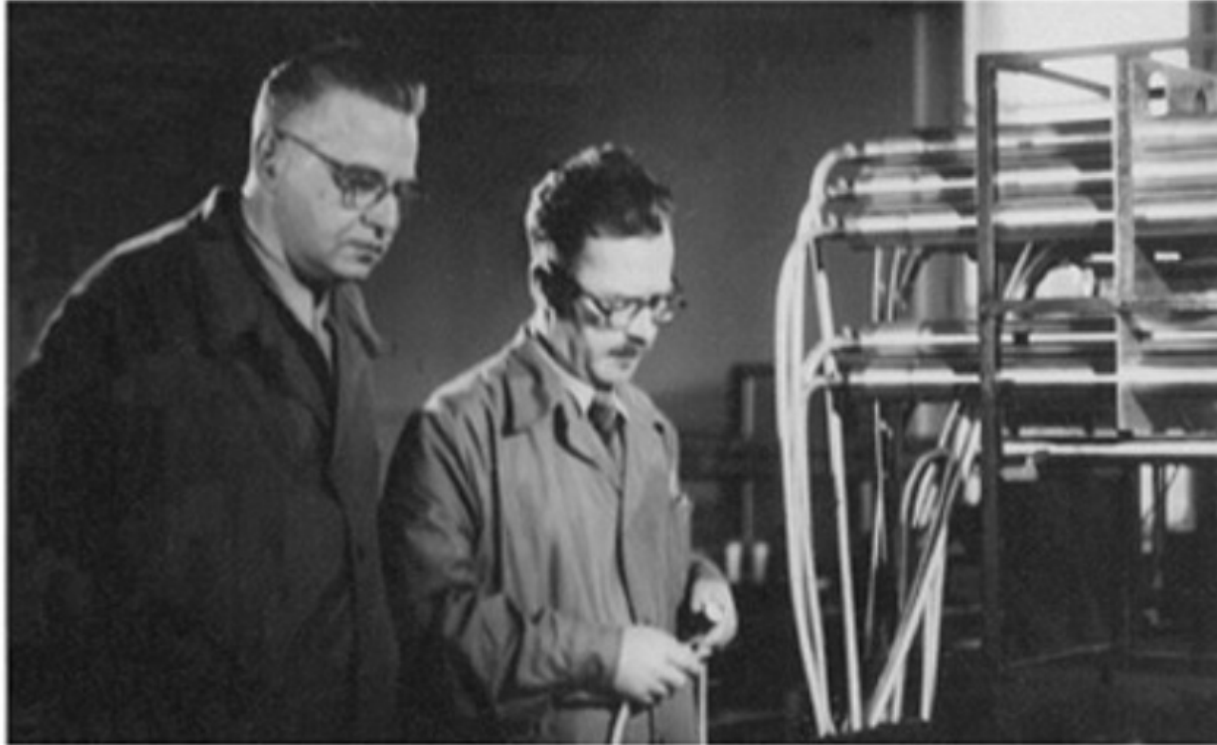
In 1947 an event occurred that contributed greatly for the future development in Krakow of research on cosmic rays, which later moved on to the issue of high-energy interactions and elementary particles.



Standing from the left: P.Blacket, J.Blaton, J.A.Wheeler, W.Heitler

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW

## 1947 --



During the conference, our studio at A.G. producing large counters and equipment that we prepared for research in Wieliczka, was frequently visited by foreign guests. The work of this studio met with general acclaim. Especially prof. G. Bernardini from Rome was interested in the construction of our large counters, which Wojtow and I produced with our own hands.

Who were “we” ?

3-4 persons:  
M.Miesowicz, L. Jurkiewicz,  
M.Massalski and S. Wojtow.

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1947 --



**At that time, I didn't even expect that the contact with prof. Bernardini and later with prof. Eduardo Amaldi, will have repercussions for decades our later work with CERN, and also that forty years later, Krakow physicists will work closely with Ugo Amaldi (Eduard's son) on the great DELPHI experiment in Cern.**



# *HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW*

## *1948 --*

**Prof. Bernardini invited me to Rome, to his studio, having in mind primarily our cooperation in equipment. This trip stayed realized already in 1948 as one of the results of the wonderful Krakow conference.**

**From Czech friends, on my way back from Italy, I received a cylinder of argon for filling counters. But her transport to Krakow was adventurous. The steel cylinder with argon seemed suspicious to the customs officers in Zebrzydowice.**

**After all, I was travelling as an "atomic physicist". The news spread on the train that one of...  
passengers is carrying an atomic bomb! I was detained with my luggage and the train left. A few hours of explanations and calls to various institutions... finally worked.**

# *HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW*

## *1949 --*

**The experiment in Wieliczka was a success.**

**Prof. Barnothy and Forro presented their work at the Krakow conference, claiming that at great depths underground, apart from the muon component, they also observe another type of radiation, namely very weakly ionizing radiation, perhaps neutrinos.**

**We have confirmed the existence of weakly ionizing radiation. We served it however, a completely different interpretation. Namely, we found that the effect comes from the natural radioactivity of the environment, and there are double coincidences caused by the double-registered Compton effect.**

**This interpretation was later generally accepted.**

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1949 --

**The experiment in Wieliczka was a success.**

**Prof. Kenneth Greisen of Cornell University (...) responded the fastest. On August 20, 1949, he wrote: (...) I gave my consent and our work was published in "Physical Review" on February 1, 1950 as: M. Mięśowicz, L. Jurkiewicz and J.M. Massalski - *On Some Low Ionizing Radiation Observed by Measurements of Cosmic Radiation at Great Depths.***

**The work has been cited many times**

# *HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW*

## *1950 --*

**The field of research in high energy physics, still based on cosmic rays, developed enormously in the 1950s.**

**Several employees of our team continued to work with counter technology. This group under the supervision of prof. Jerzy Massalski and doc. Zdzisława Buji performed counter experiments in mountain laboratories of the USSR, in close cooperation with Soviet physicists.**

**We decided to switch to working with the photographic emulsion technique to study particles in high-energy collisions. This method has gained great importance from the works of C.F. Povell.**

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1950 --

Thanks prof. Danysz and my personal contacts with prof. Powell, we received a small block of emulsion, exposed in one of the flights organized by Bristol, where we started working. We made a lot of use of Warsaw's microscopic experiments.

A emulsion group was created, which I led for many years.

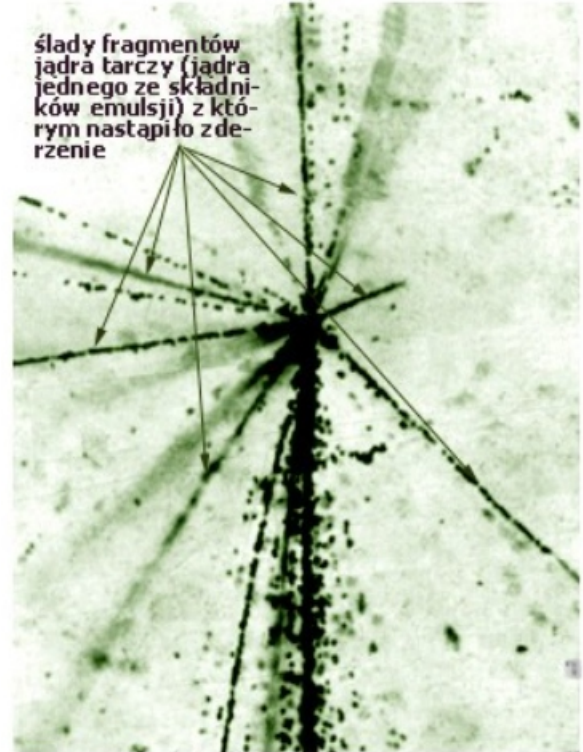
The first employees of this group were Władek Wolter and Olena Błażonowa, and later Mirek Coghen, Alina Jurakówna, Roman Hołyński, Zofia Czachowska, Krzysztof Rybicki and Jan Babecki.

In 1957 joined us Jerzy Gierula, who was the leader of this group until his premature death (1975).

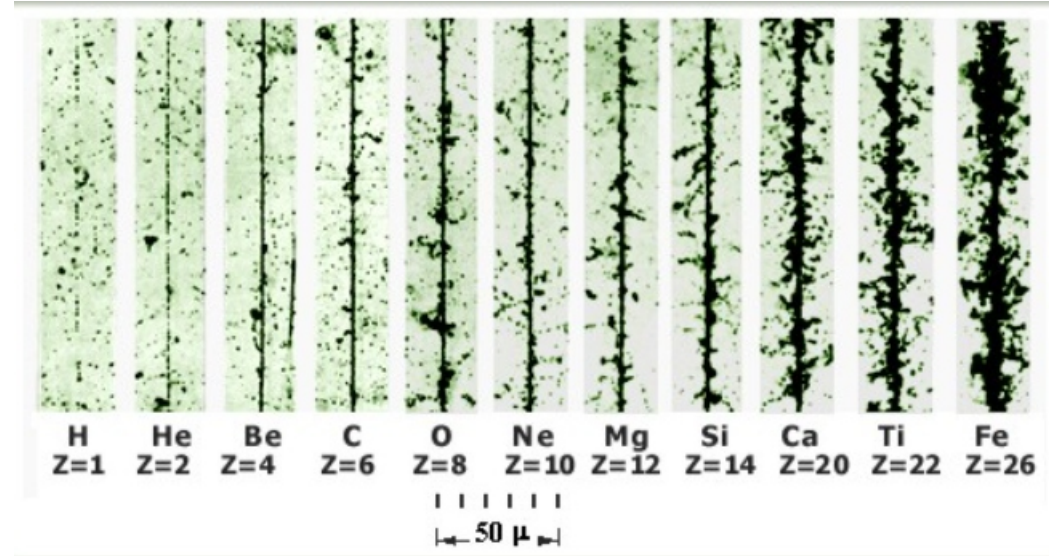
The attractiveness of this research attracted many young physicists: Barbara Wilczyńska, Henryk Wilczyński, Grażyna Nowak, ...Barbara Wosiek

śląd pozostawiony przez cząstkę pierwotną, (w tym wypadku jądro He o energii 30 TeV), która zderzyła się z jednym z jąder atomów w emulsji

ślady fragmentów jądra tarczy (jądra jednego ze składników emulsji) z którym nastąpiło zderzenie



# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1955 – 57



*The Krakow group "specialized" in research on the multivariate production of particles in high-energy collisions.*

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW

## 1955 – 60

*In the 1950s, the process of creating many particles in one interaction, the so-called the process of multi-particle production was described by the then widely accepted theories of Fermi, Heisenberg and, perhaps most predictably, Landau's theory. All of them were of a statistical nature, assuming the mutual independence of the generated secondary particles.*

*This issue was undertaken by our group in systematic studies of observed jets with energies of  $10^{12}$  eV. In the examined angular distributions, we found groups of particles correlated against the background of a Gaussian distribution. In the case of high anisotropy of distributions, we often found two groups of correlated particles. These "clusters" of particles had a mass of about 2-4 GeV.*

# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1955 – 60



*For the first time, a different effect of very high energy was observed in our group. This was an effect predicted by the Soviet physicist Chudakov. This effect consists in decreasing ionization at the very beginning of the tracks  $e^+e^-$  pairs produced by the "materialization" of a high-energy photon. At the very beginning of the pair charges  $e^+$  and  $e^-$  compensate each other, we observe a decrease ionization. At energies of  $10^{12}eV$  this effect is measurable. Władek Wolter observed this effect for the first time in our country.*

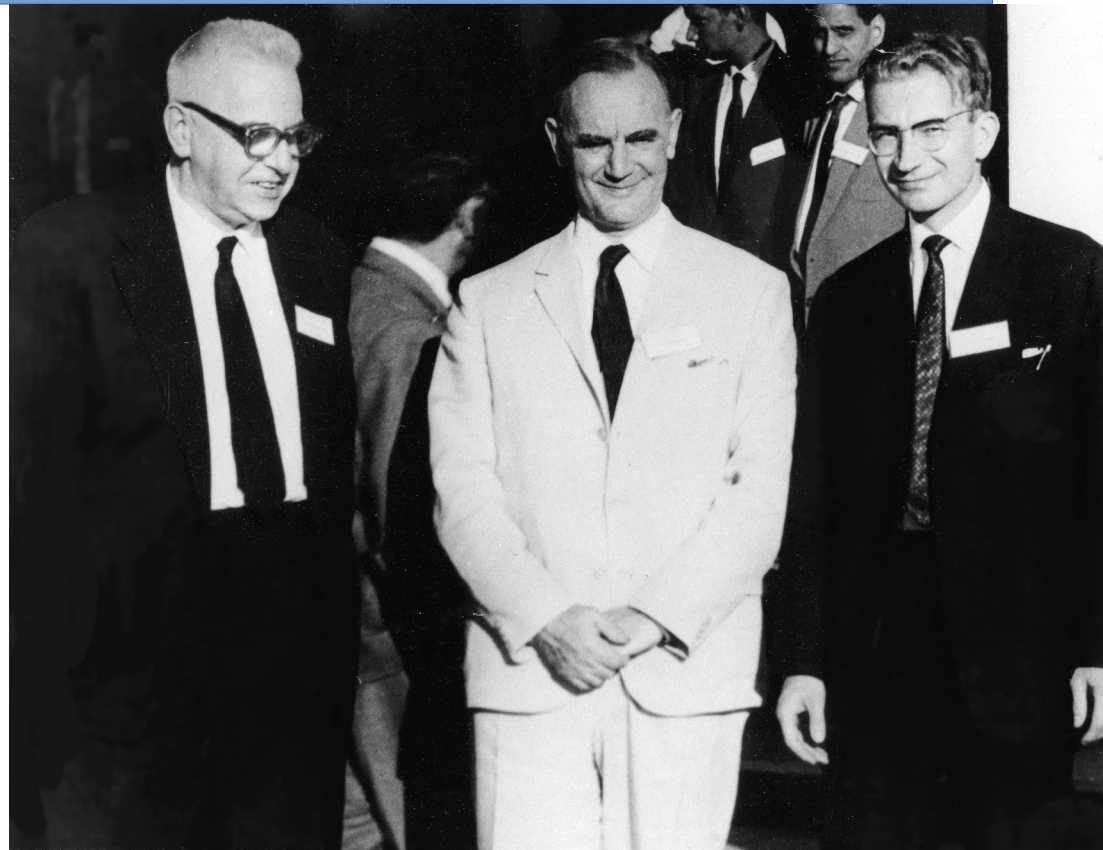


# HIGH ENERGY PARTICLE PHYSICS IN KRAKÓW 1960 --

*The Krakow Nuclear Emulsions Group has significantly expanded the scope of its work in recent years collaborating with Fermi-Lab. Batavia USA and taking an active part in USA-Kraków-Japan (JACEE) experiment.*

*But MM realized that the new generation of particle accelerators and fast developing technique of bubble chambers are potential tools for studying the interactions of elementary particles.*

*Oleg Czyzewski was the first organizer of the group of bubble chambers in ur laboratory.*



M.M.

C.F. Powell

O. Czyzewski

# Droga Polski do CERN



- 1959 r. – profesorowie **Marian Mięśowicz** (Kraków) i **Marian Danysz** (Warszawa) wystarali się o kilka indywidualnych stypendiów dla młodych fizyków na staże w CERN. Te indywidualne kontakty przekształciły się w intensywną współpracę naukową.
- 1963 r. – z inicjatywy prof. M. Danysza i dyrektora CERN V.Veisskopfa, Polska, jako jedyny kraj z „bloku wschodniego”, uzyskała status państwa-observatora w Radzie CERN (bez prawa głosowania). Próby przyznania Polsce statusu członkowskiego napotkały na opór Związku Radzieckiego.
- 1991 r. – Polska, jako pierwszy kraj „bloku wschodniego”, zostaje członkiem CERN. Podstawą prawną była umowa podpisana między rządem RP i CERN, ratyfikowana następnie przez Prezydenta RP.

# Dokument ratyfikacji

W imieniu Rzeczypospolitej Polskiej  
PREZYDENT  
Rzeczypospolitej Polskiej  
podaje do powszechnej wiadomości:

W dniu 1 lipca 1953 roku została sporządzona w Paryżu a następnie poprawiona Konwencja o utworzeniu Europejskiej Organizacji Badań Jądrowych oraz Protokół Finansowy stanowiący jej załącznik.

Po zaznajomieniu się z powyższą konwencją oraz Protokołem Finansowym, w imieniu Rzeczypospolitej Polskiej oświadczam, że:

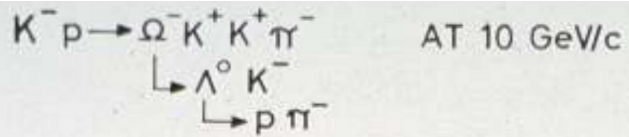
- zostały one uznane za słuszne zarówno w całości jak i każde z postanowień w nich zawartych,
- Rzeczpospolita Polska postanowiła przystąpić do powyższej Konwencji i Protokołu Finansowego,
- Będą one niezmiennie zachowywane.

Na dowód czego wydany został Akt niniejszy opatrzony pieczęcią Rzeczypospolitej Polskiej.

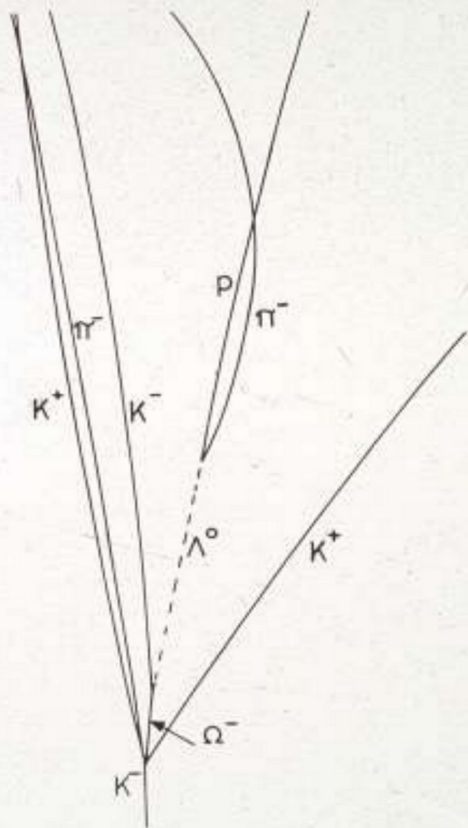
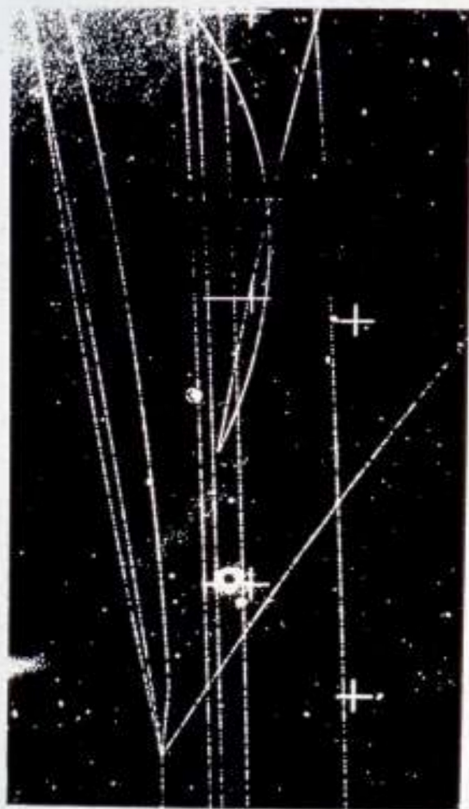
Dano w Warszawie, dnia *13 maja* 1991 roku

PREZYDENT  
RZECZYPOSPOLITEJ POLSKIEJ

Lech Wałęsa



AT 10 GeV/c



*The 70s and 80s of the last century  
GOLDEN era of bubble chambers*

## Produkcja i rozpad cząstki $\Omega^-$