Prestigious Discoveries at CERN

1973 Neutral Currents
1983 W & Z Bosons

With 114 Figures, Including 88 in Color
1973: Neutral Currents
1983: W\(^\pm\) & Z\(^0\) Bosons

The anniversary of CERN's discoveries and a look into the future

Tuesday, September 16, 2003 at 9 am
Main Auditorium

- Welcome: Luciano Maiani
- The making of the Standard Model: Steven Weinberg
- CERN's contribution to accelerators and beams: Giorgio Brianti
- The discovery of neutral currents: Dieter Haidt
- The discovery of the W & Z, a personal recollection: Pierre Darriulat
- W & Z Physics at LEP: Peter Zerwas
- Physics at the LHC: John Ellis
- Challenges of the LHC:
  - The accelerator challenge of the LHC: Lyn Evans
  - The detector challenge of the LHC: Jos Engelen
  - The computing challenge of the LHC: Paul Messina
- Particle detectors and society: Georges Charpak
- Closing of the Symposium: The future for CERN: Luciano Maiani

Panel discussion: Future of Particle Physics
With the participation of: Robert Aymar, Georges Charpak, Pierre Darriulat, Luciano Maiani, Simon van der Meer, Lev B. Okun, Donald Perkins, Carlo Rubbia, Martinus Veltman, Steven Weinberg

Organizers: Roger Cashmore and Jean-Pierre Revol

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will be assisting at the end of DESY as a high-energy laboratory, a bit like Brookhaven National Laboratory in the USA. That's a serious question that we also should worry about: you cannot see that away from CERN, as CERN is not an entity in itself. I feel very strongly that CERN belongs to Europe. So, if something goes around in Europe I feel entirely free to say to CERN you have to do this or you have to do that. The only trouble is that usually that kind of thing doesn't happen and if anything moves, it usually has to come out of CERN itself. I really have very little else to say at this time.

**Lev Okun**

**Statement**

I hope that you don't expect from me the prediction of the future of physics. I thought about predecessors of this panel, the people who really made prophecies in physics, and chose three names: Glanvill, Klein, Budker. Concerning the future of CERN, I will mention Higgs, vacuum and CLIC.

**Roots of the future (Glanvill, Klein, Budker)**

One of the most impressive examples of prophecy I know was published by Joseph Glanvill (1636–1680), a founder member of Britain's Royal Society (1660), in his book "Vanity of dogmatizing" (1661).

The full title is: "The vanity of dogmatizing: or, confidence in opinions. Manifested in a discourse of the shortness and uncertainty of our knowledge and its causes; with some reflections on peripateticism; and an apology for philosophy."; London: printed by E. C. for Henry Eversden at the Grey-Hound in St Paul's Church-Yard, 1661.

I learned about Glanvill from my friend Igor Kobzarev (1932–1991). The original text was kindly provided to me by Rupert Baker, Library Manager of the Royal Society, and Tullio Basaglia, CERN Librarian. The relevant quotation is from pages 181–182:

"And I doubt not but posterity will find many things that are now but Rumours, verified into practical Realities. It may be some Ages hence, a voyage to the Southern unknown Tracts, yea possibly the Moon, will not be more strange than one to America. To them, that come after us, it may be as ordinary to buy a pair of wings to fly into remotest Regions; as now a pair of Boots to ride a Journey. And to confer at the distance of the Indies by Sympathetick conveyances [resonance transmission in modern terms, radio, WWW, LBO], may be as usual to future times, as to us in a literary correspondence. The restauration of gray hairs to Juvenility, and renewing the exhausted marrow, may at length be effected without a miracle: And the turning of the now comparatively desert world into a Paradise, may not improbably be expected from late Agriculture."

The last three problems have turned out to be too difficult to solve so far.

Oscar Klein (1894–1977) presented a gauge theory of W, Z bosons and photons at the Conference "New Theories of Physics", Warsaw, 1938. It was a prophetic talk, even the magnetic moment of the W was correct.
Strangely enough in all his subsequent publications O. Klein never mentioned this remarkable contribution of his, though he was active during the period of creation of the Standard Model (he was a member of the Nobel Committee from 1953 to 1965).

Girsh Budker (1918–1977) had direct relation to the discoveries we are celebrating today. He used to say that the accelerators and especially the colliders of our age are like the cathedrals of the Middle Ages. He founded the famous Institute in Novosibirsk.

In 1965, the first $e^- e^-$ collider produced physics results at Novosibirsk. In the same year Budker invented the process of electron cooling of protons.

In 1966, the work on the $p\bar{p}$ collider was started in Novosibirsk.

In 1967, their first $e^+ e^-$ collider produced physics.
In 1968, the election of Sasha Skrinsky to the Soviet Academy took place. Budker said: “His only drawback is young age, but with time it will diminish”. Sasha was then 32 years old.

Budker’s team created accelerators for practical purposes: to treat sewage, insects in grain, to develop various applications in industry, medicine, etc. This gave a certain financial independence to the Institute in the field of fundamental science.

Starting from 1974 Carlo Rubbia paid regular visits to Novosibirsk to see proton cooling in operation, before switching from electron cooling to stochastic cooling for the CERN $p\bar{p}$ collider.

Sasha Skrinsky is still playing a crucial role in the Russia–CERN collaboration, especially for the LHC.

The future of particle physics is unthinkable without intense international collaboration.

**On the future of CERN**

It is impossible to cover briefly even a few directions in particle physics in five minutes and also it is needless after the talks we heard today. I will stress only the importance of the discovery of the Higgs at LHC and R&D on CLIC.

Higgs is a bridge to the vacuum. The breaking of the vacuum symmetry is responsible for the masses of all the elementary particles. This is closely related to the most unusual property of vacuum ("dark energy") observed by astrophysicists.

Luciano Maiani yesterday at the Scientific Policy Committee said that it would be impossible for CERN to start building CLIC immediately after getting LHC working. I fully agree with him. To build one collider after another is unreasonable: we need ample time for physics on LHC. But there is a difference between construction and R&D.

It seems to me that R&D on CLIC should be intensified (and must be additionally funded) to get the decisive answer on the feasibility of the machine as soon as possible. This would drastically change the landscape of the future of particle physics in the world.