ALVARO @ 80

- **1963 : Alvaro @ 19**
  Participating in an experiment at the CERN 600 MeV Synchro-cyclotron (SC)

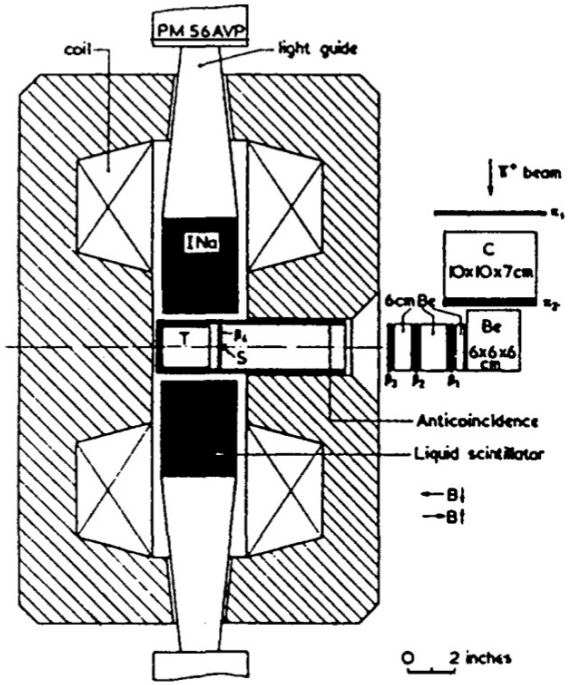
- **1985 : Alvaro giving the Concluding Talk at the High-Energy Physics Conference of the European Physical Society**

- **2014 : CERN Internal Lecture : The Dawn of the Standard Model Revolution**
  (in the framework of the CERN 60 Celebrations)

Luigi Di Lella
June 10th, 2024

1963: V – A crisis at the CERN 600 MeV synchro-cyclotron (SC)

A new method to measure the e^+ helicity from $\mu^+ \to e^+ \nu \bar{\nu}$ decay predicted to be 100% by V – A



- Bring positrons to rest in plastic scintillator where positronium can be formed
- The plastic scintillator is located in a 2 T magnetic field with direction along the expected positron helicity
- The magnetic field direction is reversed periodically
- The relative amounts of positronium singlet and triplet states depend on the relative direction of the positron helicity and magnetic field
- The amounts of positronium singlet and triplet states are measured by the different lifetimes of the annihilation process $e^+e^- \to \gamma\gamma$

The method was tested successfully using positrons from Na^{22} and B^8

Result of the measurement with positrons from muon decay:

Positron helicity = $(28 \pm 16)\%$

→ strong disagreement with V – A !

Summer 1963

Decision to measure the e^+ helicity from μ^+ decay in three independent experiments:

1. e^+ annihilation in a thin magnetized iron plate at 45^O to the average e^+ direction;

2. transmission through magnetized iron of the bremsstrahlung photons emitted by the e^+ in a thin Pb plate;

3. measure e^+e^- (Bhabha) scattering from a thin magnetized iron plate at 45^O to the average e^+ direction.

(Alvaro participated in this experiment)

In all these experiments the e^+ helicity was determined by measuring the event rate for the two opposite directions of iron magnetization.

Average result of the three experiment:

$$e^+ \text{ helicity} = (103 \pm 14)\%$$

(excellent agreement with V - A)

MEASUREMENT OF THE e^+ POLARISATION IN MUON DECAY BY MEANS OF BHABHA SCATTERING

J. DUCLOS *, J. HEINTZE, A. DE RUJULA ** and V. SOERGEL
CERN, Geneva, Switzerland

Received 12 February 1964

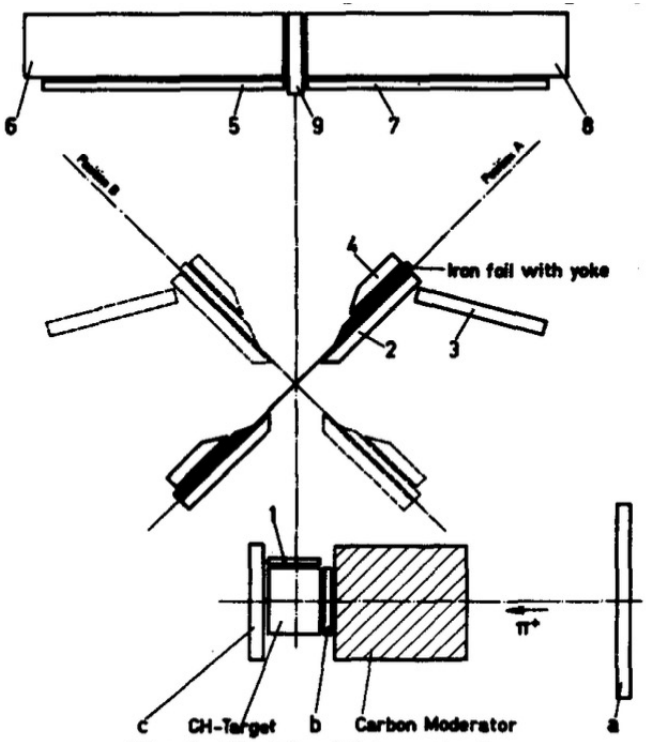


Fig. 1. Sketch of the apparatus.

Note: the thin Iron plate and associated counters can be rotated by 90^O to remove spurious instrumental effects

Final result:

Positron helicity = (104 $\pm$ 18) %

* On leave from Centre d'Etudes Nucléaires de Grenoble.
** Visiting scientist from the University of Madrid, Spain.

Summer 1985 : EPS High-Energy Physics Conference

SNAPSHOTS OF THE 1985 HIGH ENERGY PHYSICS PANORAMA

A. De Rújula
CERN -- Geneva

Concluding Talk at the High Energy Physics Conference
of the European Physical Society
Bari (Italy) - July 1985

OBITUARY

During the past year, it must be admitted, we have seen about a dozen wonderful, revolutionary discoveries ... die. The experimental side of this conference would have been extraordinarily more optimistic a few months earlier. On the side of theoretical theory, the opposite is true.

Among the ''dead'' discoveries:

- **Mono-jet events at the CERN $\bar{p}\,p$ Collider:**
  single, high p_T hadronic jets with large missing p_T
  first seen as evidence for production of SUSY particles,
  then explained as a ''cocktail'' of Standard Model events
  (Altarelli cocktail, Workshop on $\bar{p}p$ Physics, February 1985)

- **A 17 keV neutrino**
  from a large statistical fluctuation of a $\beta-$ spectrum

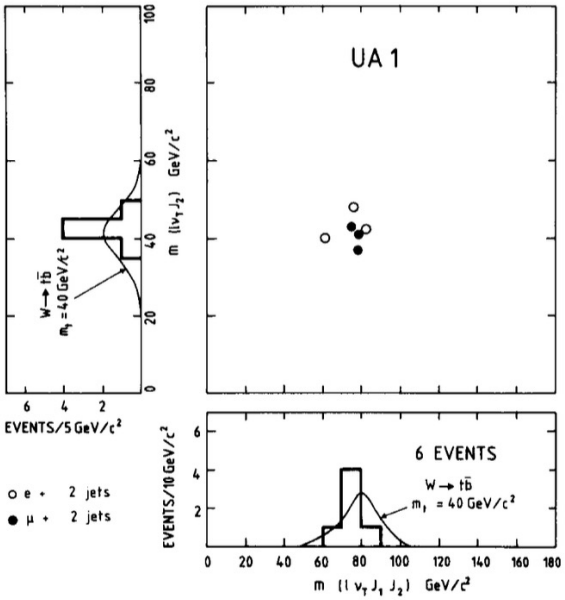
- **A new scalar resonance, ζ , with a mass of 8.3 GeV, observed in the missing-mass spectrum of the decay $\Upsilon(1S) \rightarrow \gamma + X$**
  (again, from a large statistical fluctuation)

In 1984, from the analysis of the 1982-83 data, the UA1 collaboration had published a paper reporting a possible discovery:

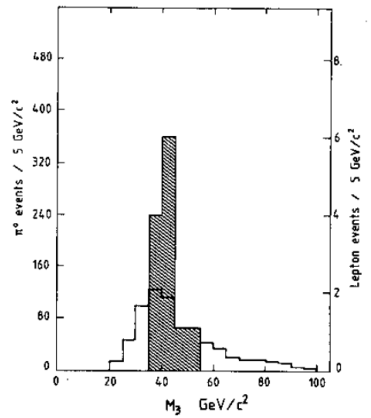
ASSOCIATED PRODUCTION OF AN ISOLATED, LARGE-TRANSVERSE-MOMENTUM LEPTON (ELECTRON OR MUON), AND TWO JETS AT THE CERN $p\bar{p}$ COLLIDER

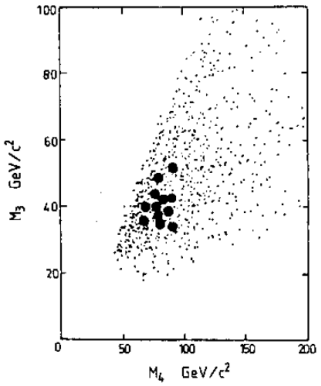
UA1 Collaboration, CERN, Geneva, Switzerland

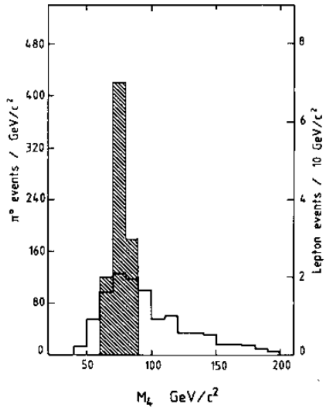
A clear signal is observed for the production of an isolated large-transverse-momentum lepton in association with two or three centrally produced jets. The two-jet events cluster around the $W^{\pm}$ mass, indicating a novel decay of the Intermediate Vector Boson. The rate and features of these events are not consistent with expectations of known quark decays (charm, bottom). They are, however, in agreement with the process $W \to t\bar{b}$ followed by $t \to b\ell\nu$, where t is the sixth quark (top) of the weak Cabibbo current. If this is indeed so, the bounds on the mass of the top quark are $30\ \mathrm{GeV}/c^2 < m_t < 50\ \mathrm{GeV}/c^2$.



In 1985, the data taken in 1984 were analyzed and 6 more events containing an electron and two jets were found
(the analysis of the events with a muon was still in progress at that time)







Shaded area: the 12 events with a lepton and two jets, superimposed to a sample of background events obtained by replacing the lepton with a high-p_T π^0

The analysis of the additional data seemed to confirm the earlier observation

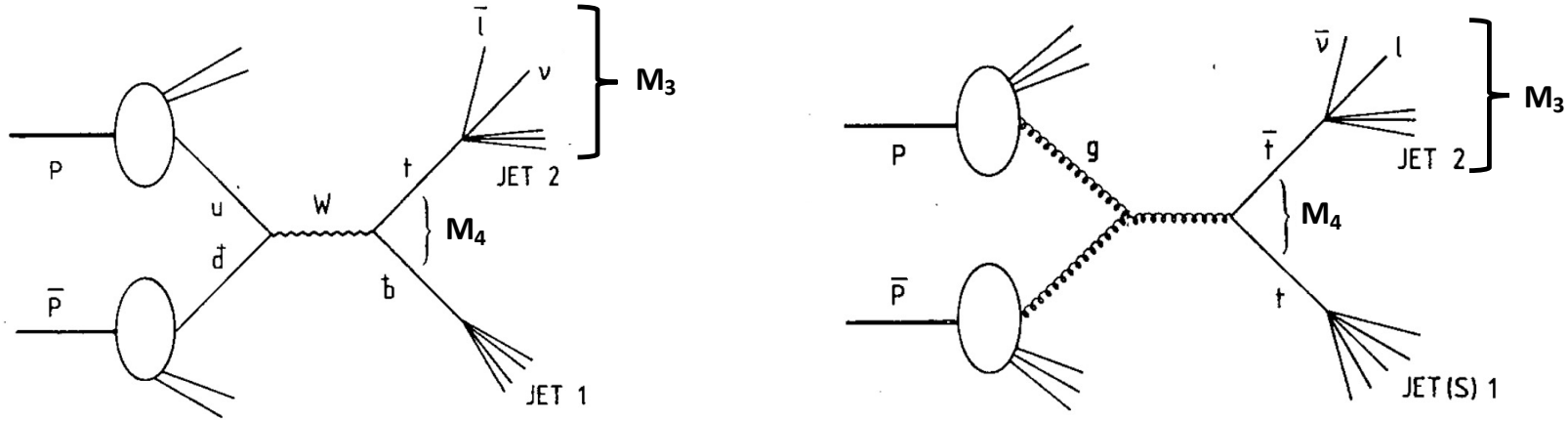
However, UA1 and UA2 had measured the W production cross-section with an uncertainty of ~10%.

➡ **it was possible to predict the expected number of W $\rightarrow t\bar{b}$ decays from the expected decay branching ratio as a function of the top mass.**

Expected number of events with an electron: 1.5 to 3 events (depending on m_{top})

Observed number : 9

To explain this difference, it was assumed that about 2/3 of the events were due to QCD production of $t\bar{t}$ pairs, followed by the semileptonic decay of the $t(\bar{t})$ – quark. In this case the accumulation of events at a total mass of ~ 80 GeV would be explained at the combined effect of $t\bar{t}$ threshold and the decrease of the $t\bar{t}$ production cross-section with increasing values of the $t\bar{t}$ invariant mass.



(graphs from Alvaro's concluding talk)

At the 1985 HEP Conference I gave the talk summarizing the physics from the $p\bar{p}$ Collider. On the evidence for a top-quark with a mass of ~ 40 GeV I said:

A *t*-quark in the mass range 30 – 50 GeV represents a possible explanation for the UA1 events. However, in my opinion, its existence is not established at present. The need for $t\bar{t}$ production weakens the previous evidence because it adds a contribution from events of complicated topologies which involve multi-jet final states. A full understanding of such events requires QCD-inspired simulation programs whose reliability in describing $t\bar{t}$ final states has not yet been demonstrated.

……

Further progress is expected by adding a high-precision vertex detector to the apparatus, capable of identifying the final-state *b*-quark by separating the decay vertex of the outgoing *b*-hadron from the $\bar{p} - p$ collision point.

At the conference, I had been asked by a member of the CERN Directorate not to cast doubt on the "UA1 top-quark discovery". However, in his concluding talk, Alvaro supported the doubts that I had mentioned in my talk. He said:

…..But the observed events tightly gather around a "total mass" M_W, not the expectation if the strong production channel is twice as copious as the weak one. Confronted with this conundrum Di Lella concluded [19] that the existence of the top quark is not yet proven. The 1984 results in the muon channel are not yet available. These results, the expected threefold increase in statistics in 1985/86, and a new UA1 microvertex detector (able to see b decays) could hopefully soon resolve the top quark issue.

The top quark was finally discovered at the Fermilab Tevatron $\bar{p}p$ Collider in 1995. Its mass is 172.7 GeV.

More from Alvaro's concluding talk at the 1985 HEP Conference

Alvaro's introduction to Grand-Unification

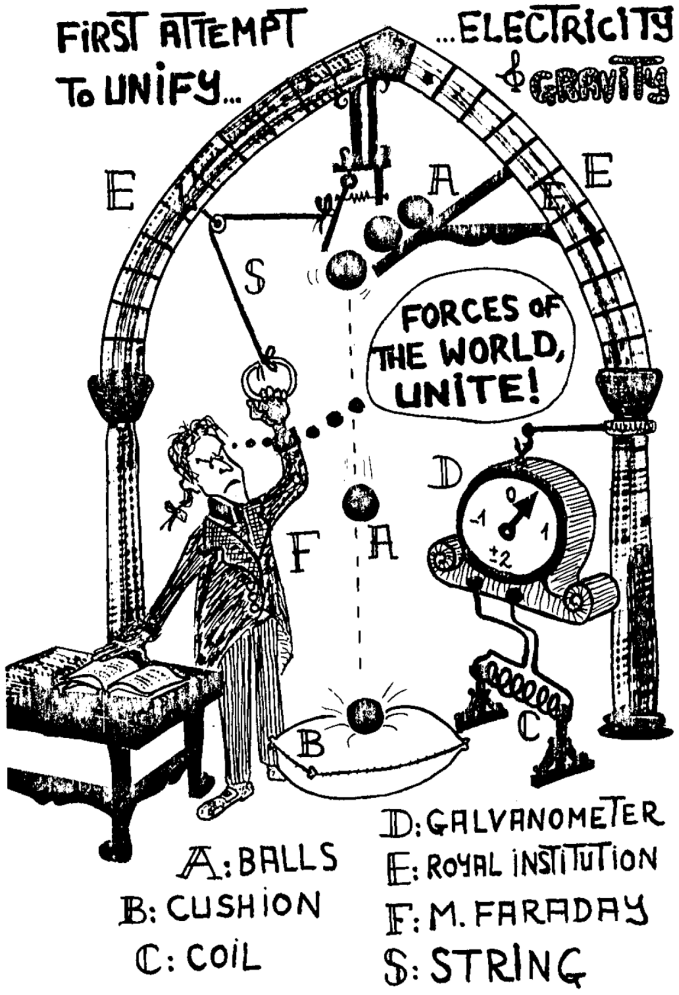
The first serious attempts to unify gravity and electricity were made by none less than Michael Faraday.

After his monumental work of the 1830's, the exhausted or perhaps chemically poisoned Faraday suffered a mental breakdown. Apparently having fully recovered in the early 50's, he dedicated the rest of his professional life to experiments on the induction of electricity by accelerating bodies.

Confronted with negative results, he did neither lose faith nor shy from admitting them. He [73] concluded: "Here end my trials for the present. The results are negative. They do not shake my strong feeling of the existence of a relation between gravity and electricity, though they give no proof that such a relation exists".

[73] M. Faraday, The Bakerian Lecture, Philosophical Transactions (1851).

Alvaro's cartoon describing Faraday's experiment to demonstrate that falling bodies produce electricity



Alvaro's figure caption:

One of the first of Faraday's experiments on the induction of electricity by accelerating bodies. Notice the premonitory use of a string.

2014:
CERN 60 years celebrations

INTERNAL LECTURE: THE DAWN OF THE STANDARD MODEL'S REVOLUTION | 6 JUNE | MAIN AUDITORIUM

"The dawn of the Standard Model's revolution", by Luigi di Lella and Alvaro de Rujula.

Alvaro de Rujula.

15:30 - 16:20: Lecture by Alvaro de Rujula (followed by 20 minutes of questions)

Abstract
In the few years around November 1974, particle physics changed very significantly and at a frantic pace. Practitioners began to get accustomed to the successful predictions of the Standard Model, which did not have many believers at that time. I shall recall the main experimental and theoretical advances, concerning in particular quarks as partons, the asymptotic freedom of QCD, charmonia and the first openly charmed particles.

17:00 - 17:50: Lecture by Luigi di Lella: Experiments at CERN in the decade 1964-1974 (followed by 20 minutes of questions)

Luigi di Lella.

Abstract
I will present the most significant physics results obtained by CERN experiments in the decade 1964-1974. These include the discovery of neutral current neutrino interactions, studies of CP violation, searches for new hadronic states, studies of two-body processes at high energies with and without polarized proton targets, and the results obtained in the first years of operation of the CERN Intersecting Storage Rings (ISR), which was the first hadron collider ever built. The precise measurements of the muon anomalous magnetic moment in three consecutive experiments will also be reviewed.

Dear Alvaro,

Best wishes for many more healthy, enjoyable and productive years !