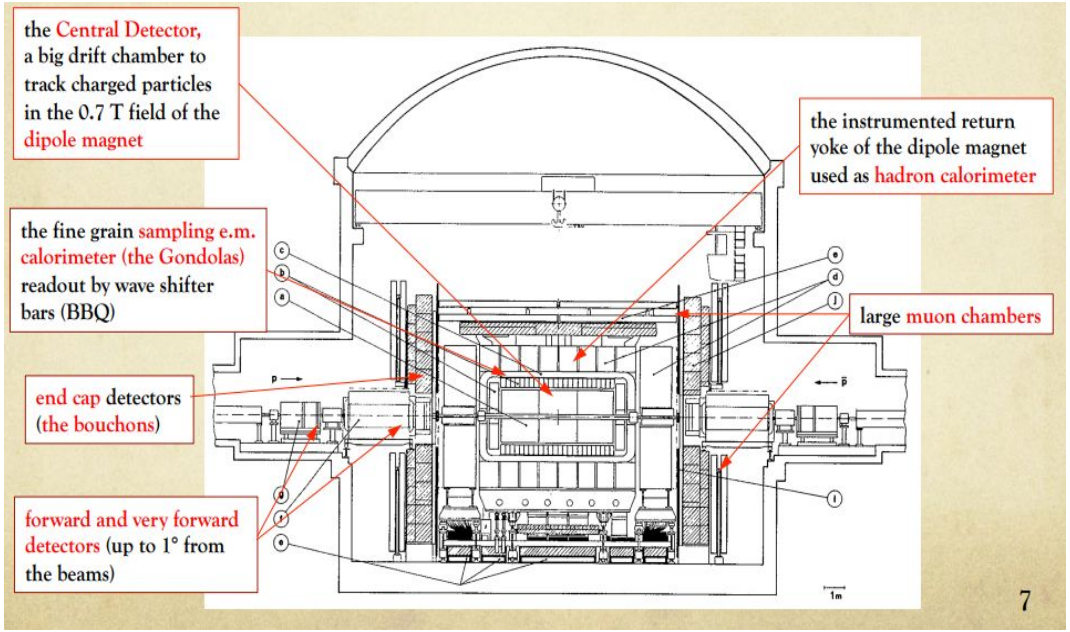
W Boson discovery : Experimental observation of isolated large transverse energy electrons with associated missing energy at $\sqrt{s}$ =540 GeV

$$p\bar{p} \rightarrow W^{\pm} \rightarrow e^{\pm} + \nu$$

What accelerator, is any ? What detector setup?

UA1 Detector



https://www.roma1.infn.it/~lacava/UA1_Experiment.pdf

Composition of UA1 Detector

- Central Detector : picture of each proton-antiproton interaction
- Central ElectroMagnetic calorimeter
- Hadron calorimeter
- Muon chamber

Constraints

- Need a quark interaction
- Find electrons and know its momentum and energy
- Calculate the missing energy and the direction

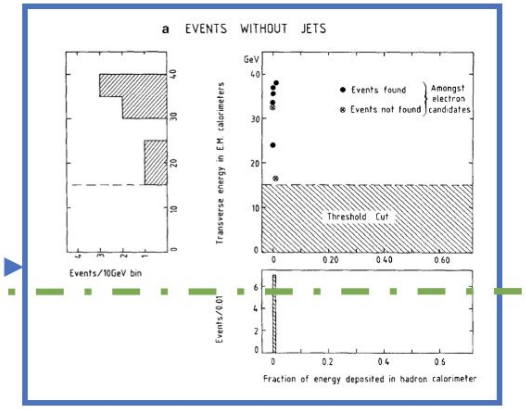
How was the signal identified?

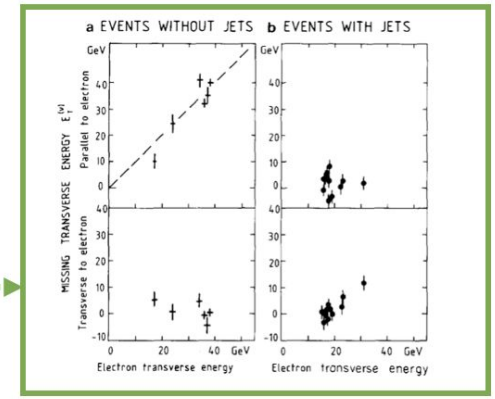
$$W^{\pm} \rightarrow e^{\pm} + \nu_e$$

Electromagnetic showers:
- Transition curve
- Lack of penetration in the hadron calorimeter

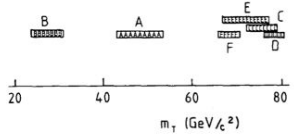
Emision of neutrinos
- Apparent visible energy imbalance of the event (missing energy)

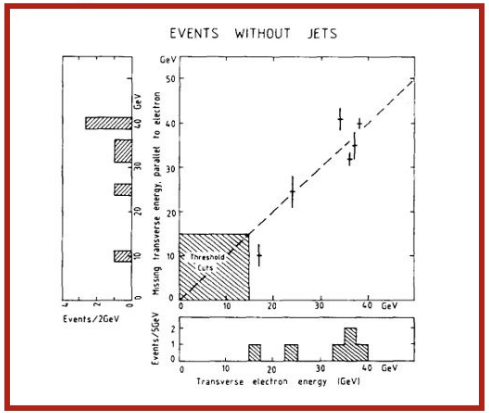
1. **Beam-beam collision**
2. **Data filtering** (energy deposition, trigger, momentum)
3. **Event Selection**
4. **Background evaluation**
5. **Event analysis**





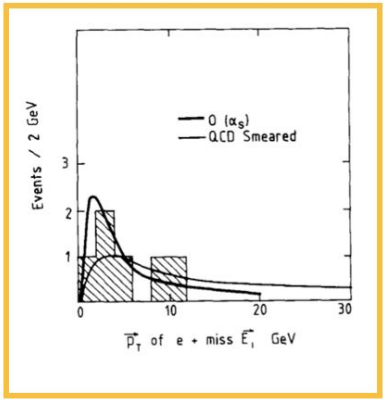
Simultaneous presence of an electron and neutrino of approximately equal and opposite moment in the transerve direction suggests the presence of a two-body decay.



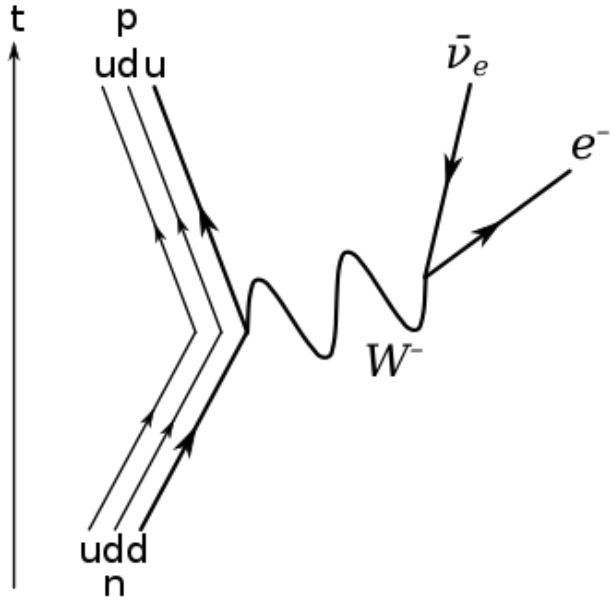


6. **Comparison between events and expectations**

$$m_W = (81^{+5}_{-5})\ \mathrm{GeV}/c^2$$



What were the major experimental challenges? How were they solved?



1) Interaction proton-proton
   - Majority of interactions gluons gluons
   - Select experiments leading to quark interactions
2) Find interactions with an emission of electron
3) Neutrino is invisible
   - Calculate energy and momentum of the electron-neutrino
4) If momentum are equal but in opposite direction : 2 body decay
5) Transverse motion of W drives to a underestimated mass
   - Compensation with the transverse energy

After the evaluation of the mass:

- Evaluation of the background
  - Discovery !