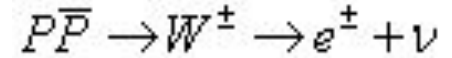
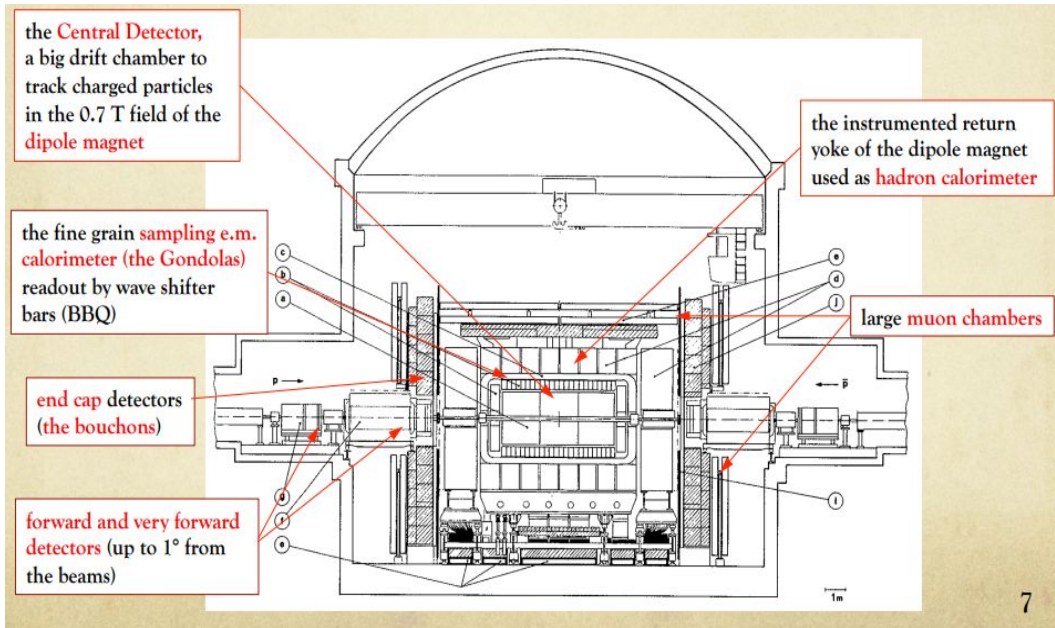


W Boson discovery : Experimental observation of isolated large transverse energy electrons with associated missing energy at $\sqrt{s}=540$ GeV



What accelerator, is any ? What detector setup?

UA1 Detector



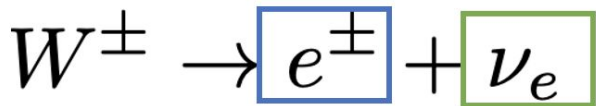
Composition of UA1 Detector

- 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?



Electromagnetic showers:

- Transition curve
- Lack of penetration in the hadron calorimeter

Emission 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

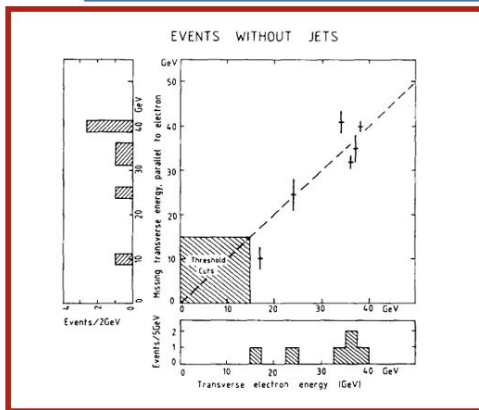
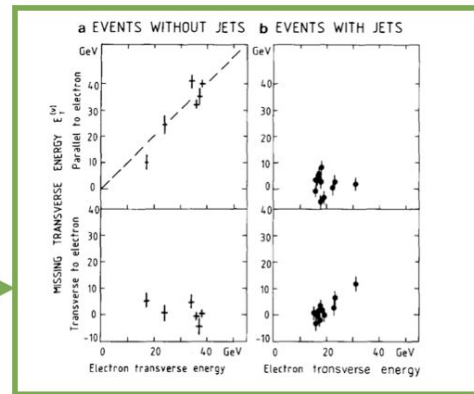
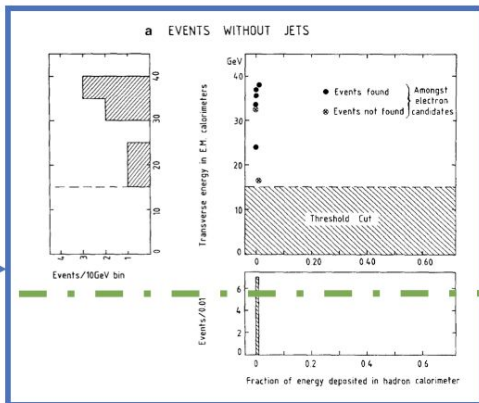
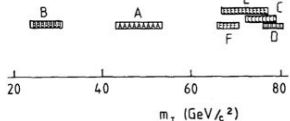
4

Background evaluation

5

Event analysis

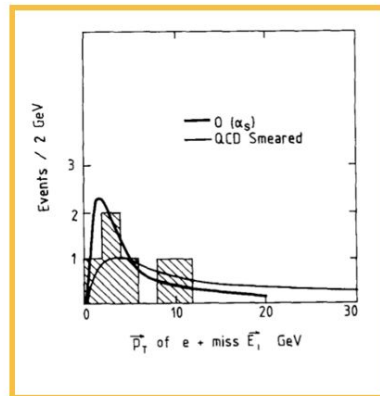
Simultaneous presence of an electron and neutrino of approximately equal and opposite moment in the transverse direction suggests the presence of a two-body decay.



6

Comparison between events and expectations

$$m_W = (81 \pm 5) \text{ GeV}/c^2$$



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

Standard Model of Elementary Particles

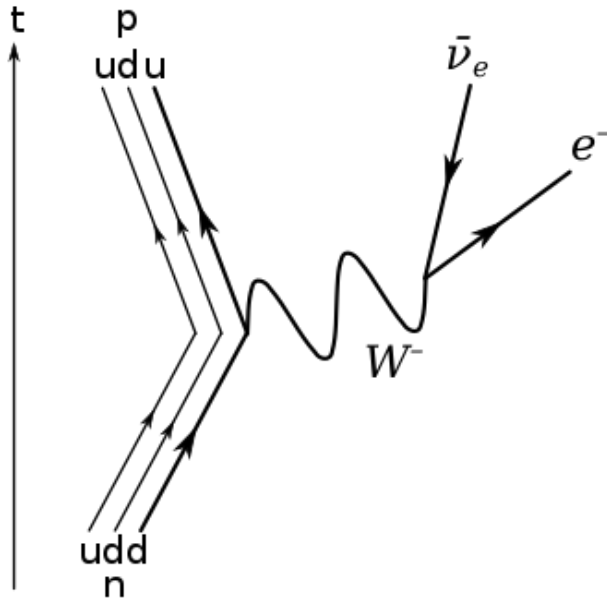
	three generations of matter (fermions)			interactions / force carriers (bosons)	
	I	II	III		
mass	$\approx 2.2 \text{ MeV}/c^2$	$\approx 1.28 \text{ GeV}/c^2$	$\approx 173.1 \text{ GeV}/c^2$	0	$\approx 124.97 \text{ GeV}/c^2$
charge	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0	0
spins	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	0	0
	u up	c charm	t top	g gluon	H higgs
	d down	s strange	b bottom	γ photon	
	e electron	μ muon	τ tau	Z Z boson	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	
	$\approx 0.511 \text{ MeV}/c^2$	$\approx 105.66 \text{ MeV}/c^2$	$\approx 1.7768 \text{ GeV}/c^2$	$\approx 81.18 \text{ GeV}/c^2$	
	-1	-1	-1	0	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	
	ν_e	ν_μ	ν_τ	W	
	$\approx 1.0 \text{ eV}/c^2$	$\approx 0.17 \text{ MeV}/c^2$	$\approx 18.2 \text{ MeV}/c^2$	$\approx 80.39 \text{ GeV}/c^2$	
	0	0	0	1	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	

QUARKS

LEPTONS

GAUGE BOSONS
VECTOR BOSONS

SCALAR BOSONS



- 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 !