The discovery of weak neutral currents

Discovery at CERN in 1973 - 51th anniversary

Glashow, Salam, Weinberg ⇒ Gauge theory of electroweak interactions

- Introduction of 2 charged vector bosons $W^{+/-}$ and 1 **neutral Z**
- Veltman and t'Hooft ⇒ the theory is renormalizable
- Higgs mechanism ⇒ massive vector bosons

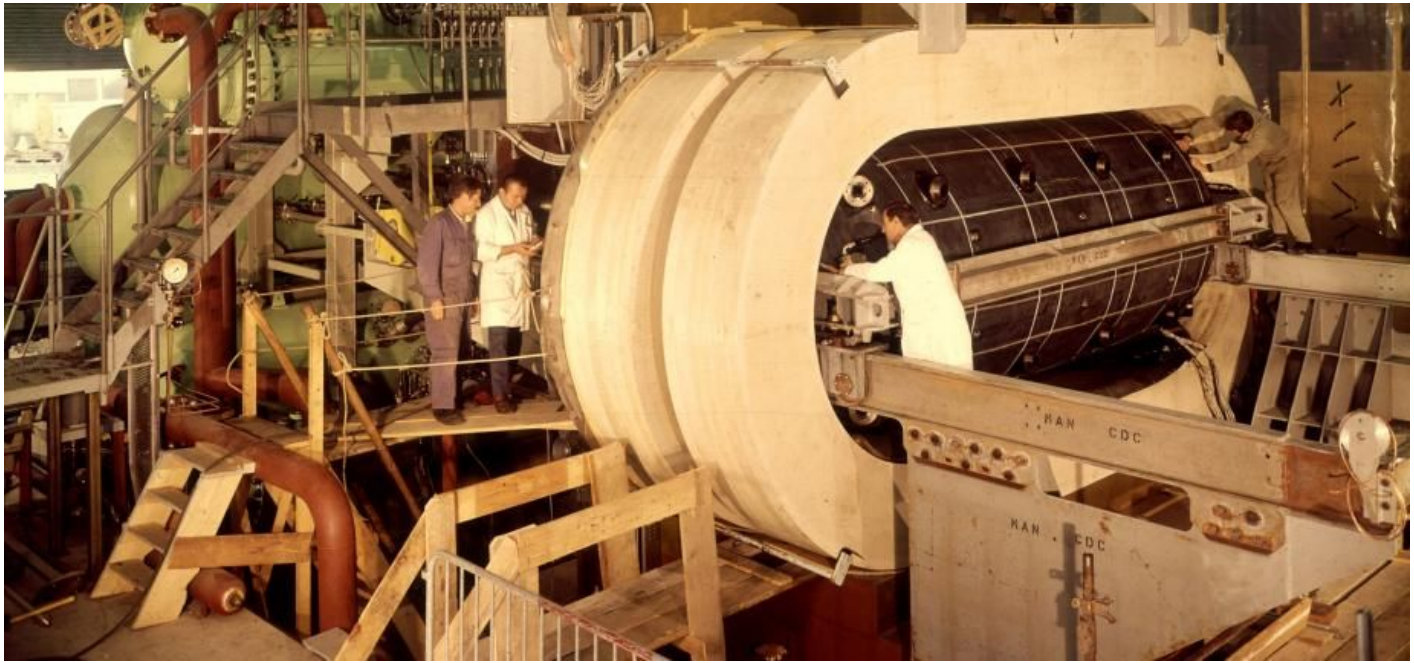
In 1971-1972 we had an electroweak theory predicting the existence of neutral currents → the ball was in the court of experimentalists !

- https://www.radiofrance.fr/franceculture/podcasts/sciences-chrono/cern-gargamelle-au-pays-des-particules-6919704
- https://cds.cern.ch/record/1740863/files/vol44-issue8-p021-f.pdf
- https://www.in2p3.cnrs.fr/fr/cnrsinfo/gargamelle-de-sa-conception-aux-courants-neutres-une-histoire-rebondissements
- https://teshep.lal.in2p3.fr/teschool18/wp-content/uploads/sites/9/2018/07/neutral-currents-Ukraine-Summer2018.pdf

~1963 : André Lagarrigue, André Rousset and Paul Musset

- Proposal to build a large bubble chamber with dense liquid (Freon) for a neutrino experiment

Collaboration around Orsay - École Polytechnique and Nuclear Physics Apparatus division at CERN - 7 European labs + Japan and Russia



Gargamelle

4.8 x 2 m

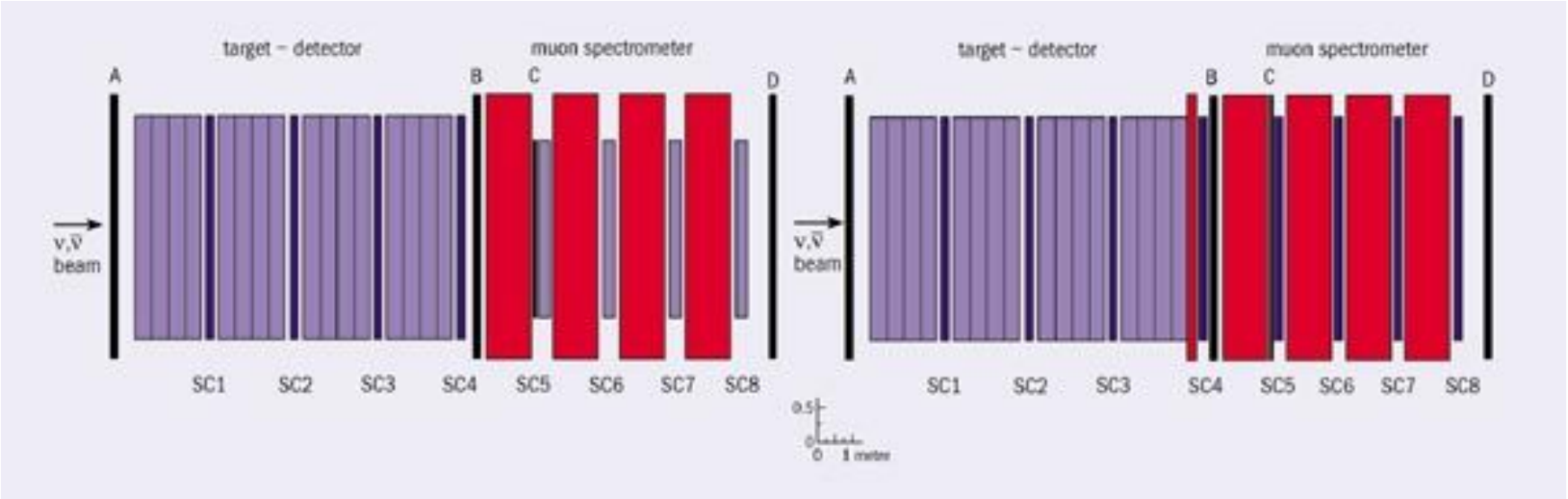
12 m^3 of CF_3Br

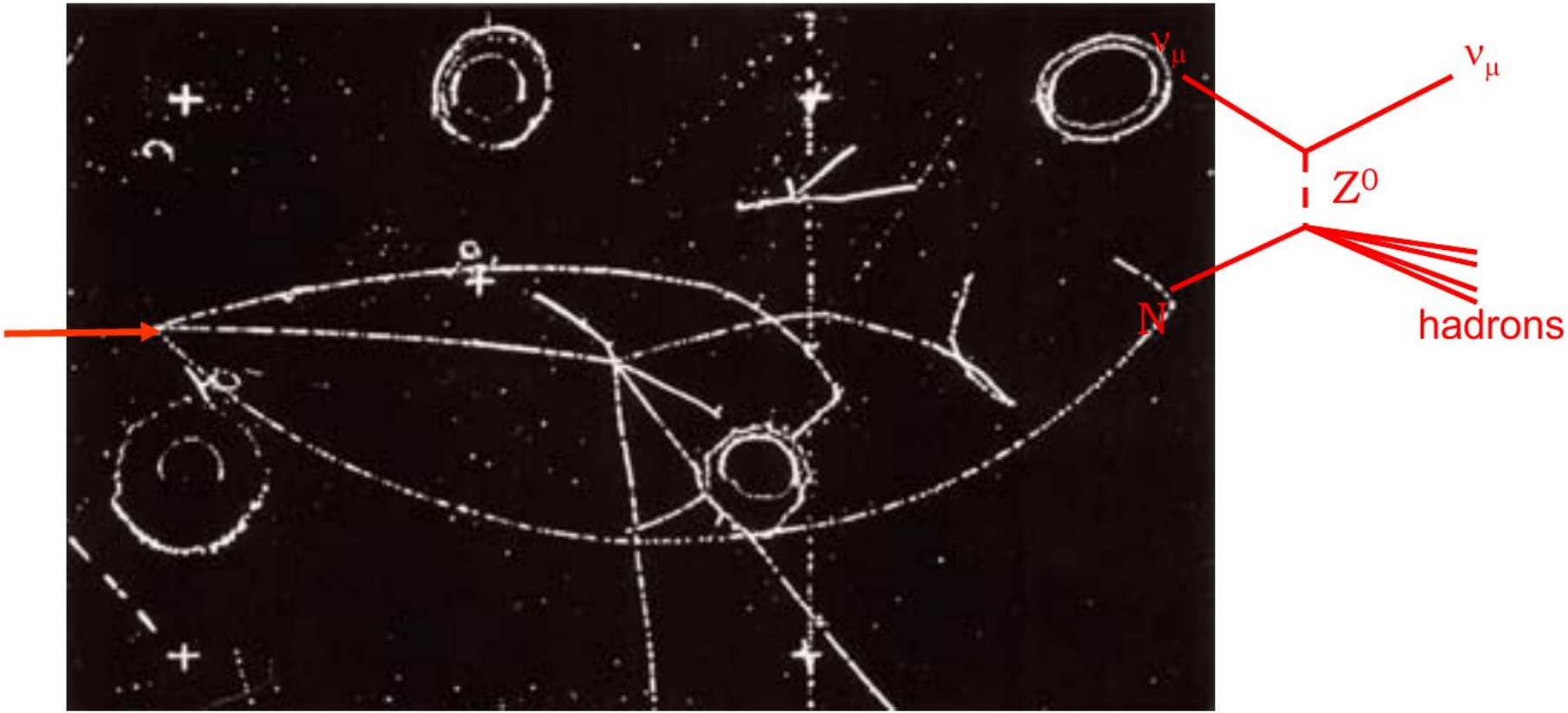
B = 2T

1000 t

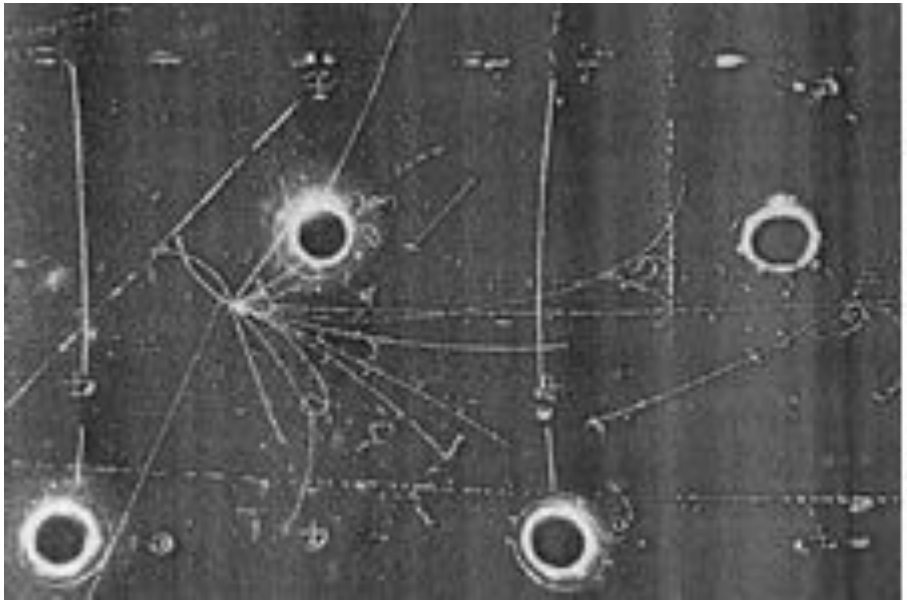
Competition with HPWF (Harvard, Pennsylvania, Wisconsin, Fermilab) at Fermilab

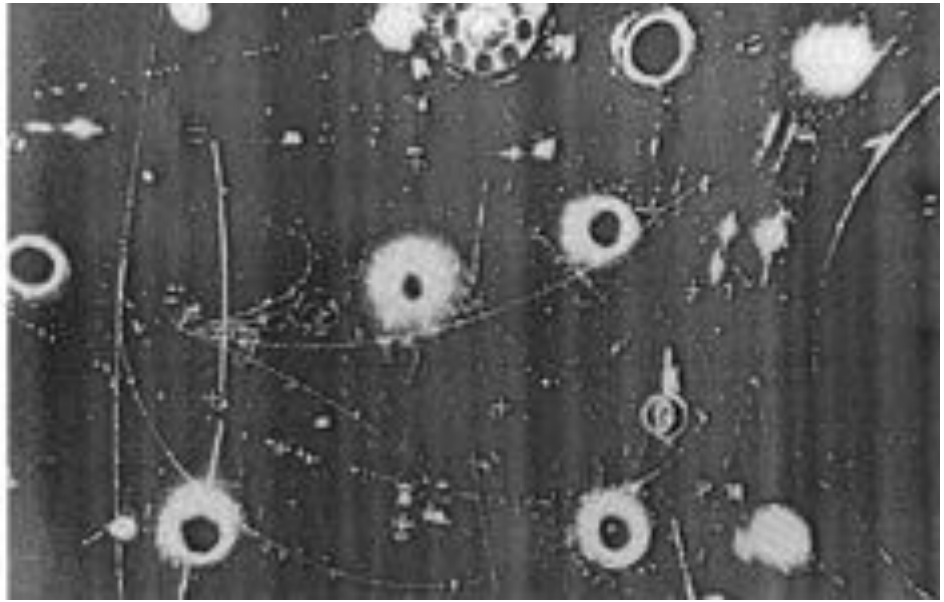
- "Counter" experiment





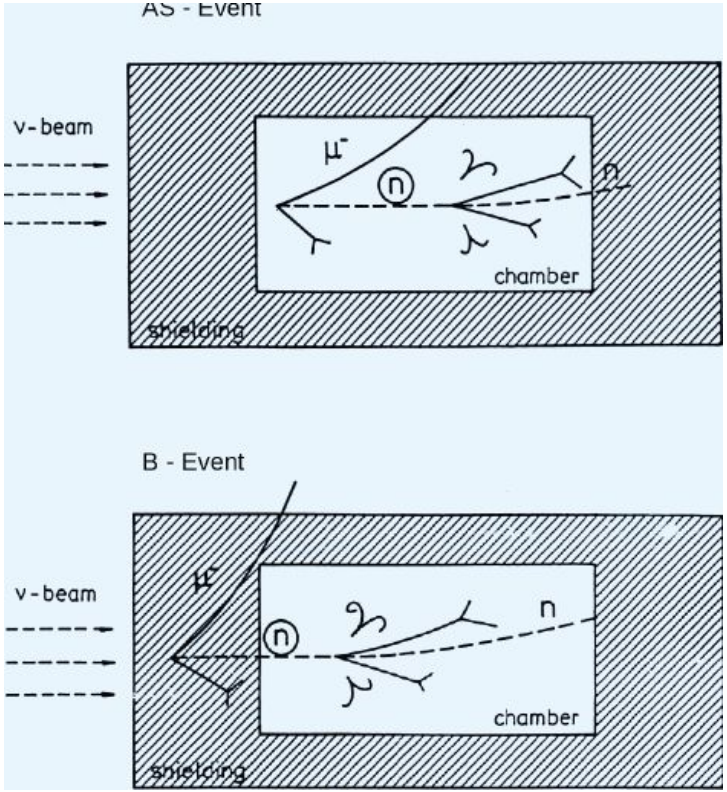
Taken from:
https://teshep.lal.in2p3.fr/teschool18/wp-content/uploads/sites/9/2018/07/neutral-currents-Ukraine-Summer2018.pdf





Controversy due to the possibility of contamination from neutrons

- Finally solved thanks to simulation + special validation runs with protons

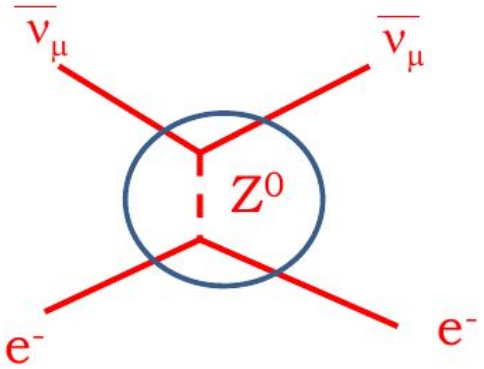


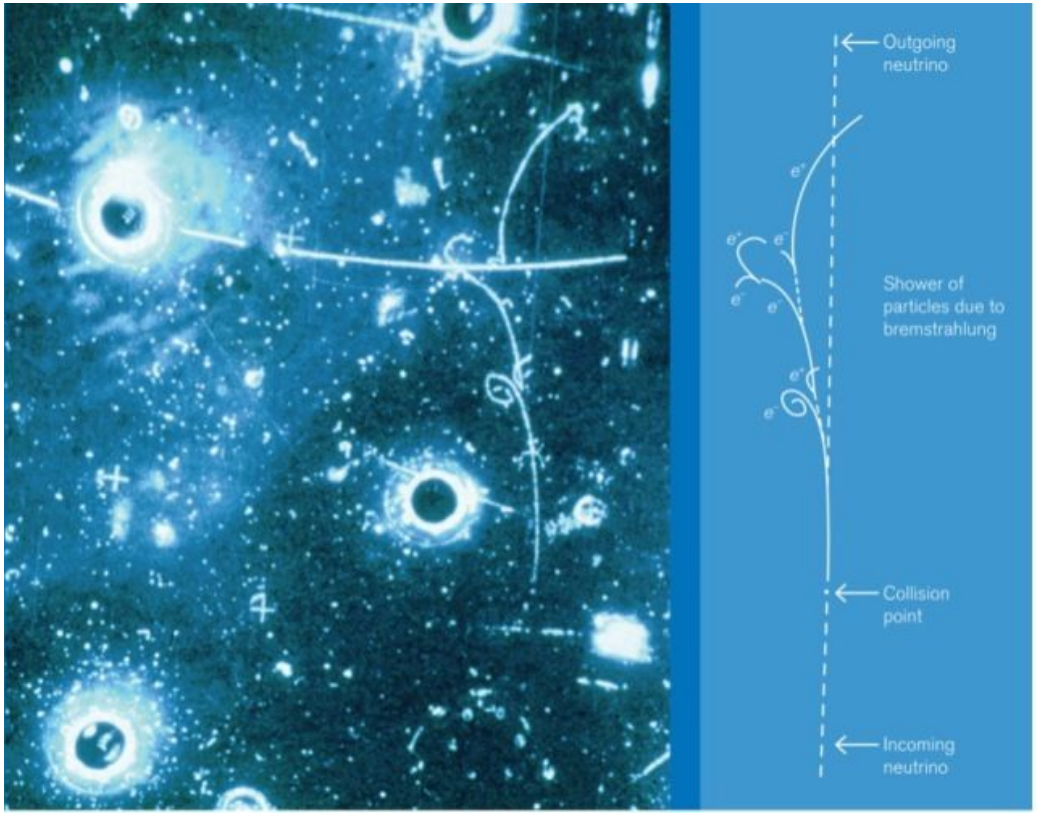
In a first time HPWF confirmed the observation then modified its apparatus and didn't see neutral current anymore before finally finding them again !

⇒ Alternative neutral current :-)

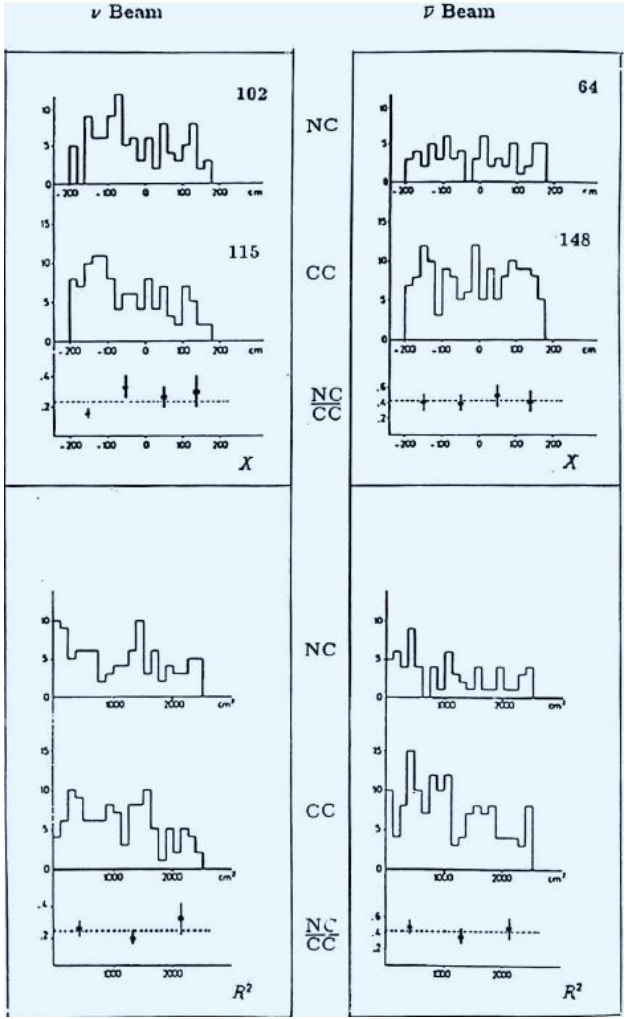
Observation of "gold plated" neutral current events on top of hadronic NC events

$$\nu_\mu e^- \rightarrow \nu_\mu e^-$$





1.4 million pictures (2 years) → 3 events !


ν Beam
ν̄ Beam
102
64
NC
115
148
CC
NC/CC
X
X
NC
CC
NC/CC
R²
R²

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Observation of neutrino-like interactions without muon or electron in the gargamelle neutrino experiment

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Magnetic horn - S. van der Meer

Scanning apparatus

To know more on the history around the electroweak force:

http://www.experience-cern360.fr/forcesfaibles.html

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