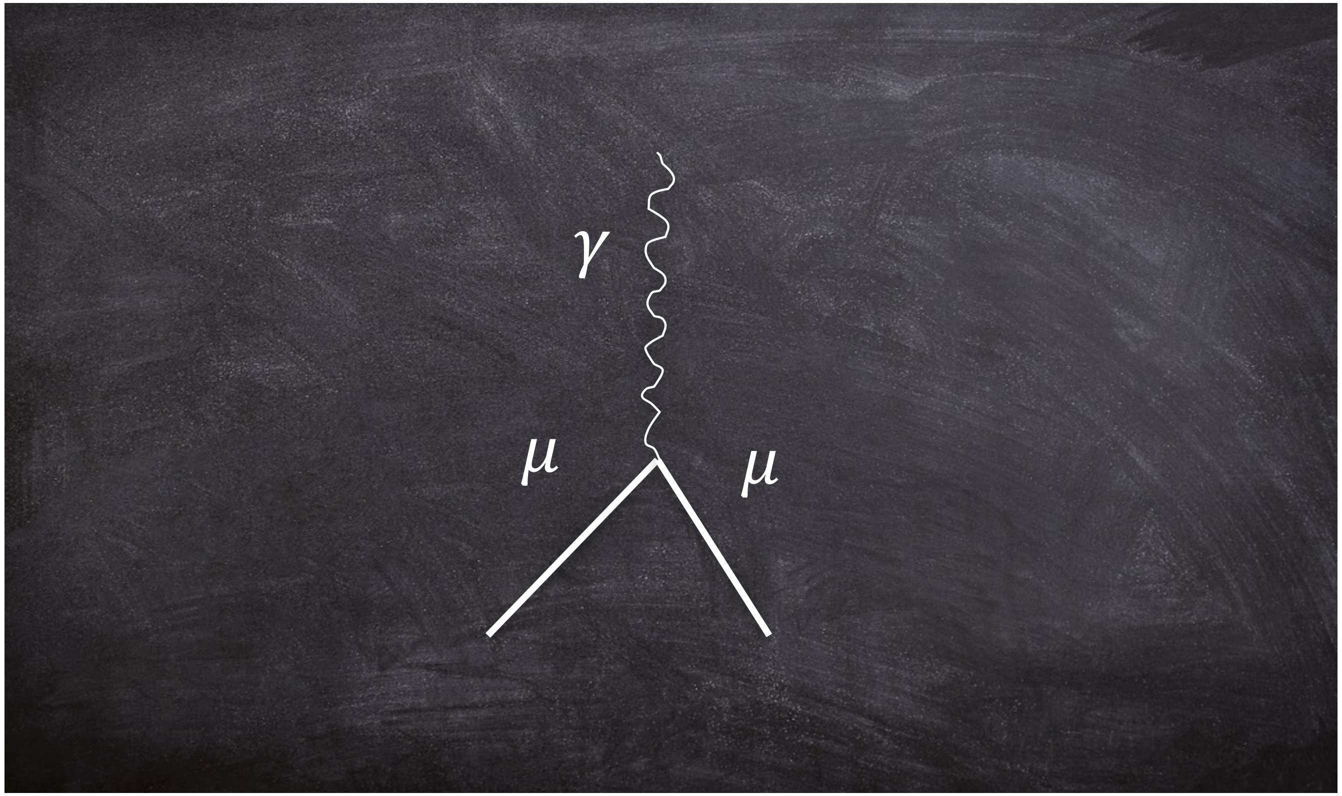
Measuring the leading hadronic contribution to the muon g-2 via $\mu - e$ scattering



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my record track

I BCD ISHEP 2015 HL-LHC → FUNDED

Teacher at the time of HL-LHC

Muon g-2 anomaly

A charged elementary particle with half-integer intrinsic spin has a magnetic dipole $\vec{\mu}$ aligned with its spin $\vec{s}$

$$\vec{\mu} = g_s \left(\frac{q\hbar}{2mc}\right) \vec{s}$$

g_s is the Landé g-factor for the muon is s slightly greater than 2

It was predicted by Dirac equation to be exactly uqual to 2

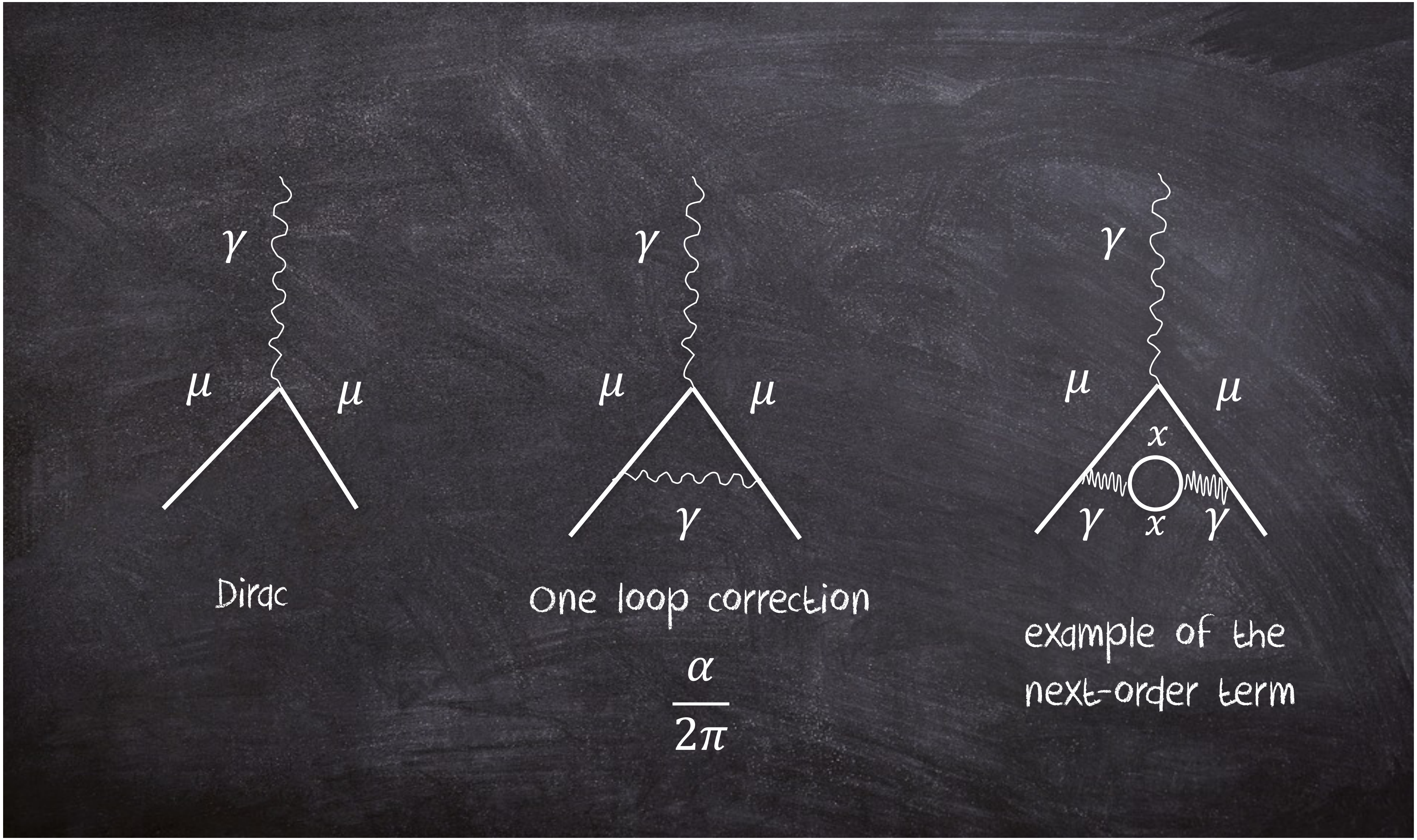
Theoretically it is useful to break the magnetic moment into two pieces

$$\vec{\mu} = 2\left(1 + a_\mu\right) \frac{e\hbar}{2m_\mu} \vec{s} \quad \text{where}$$

Dirac moment — anomalous (Pauli) moment

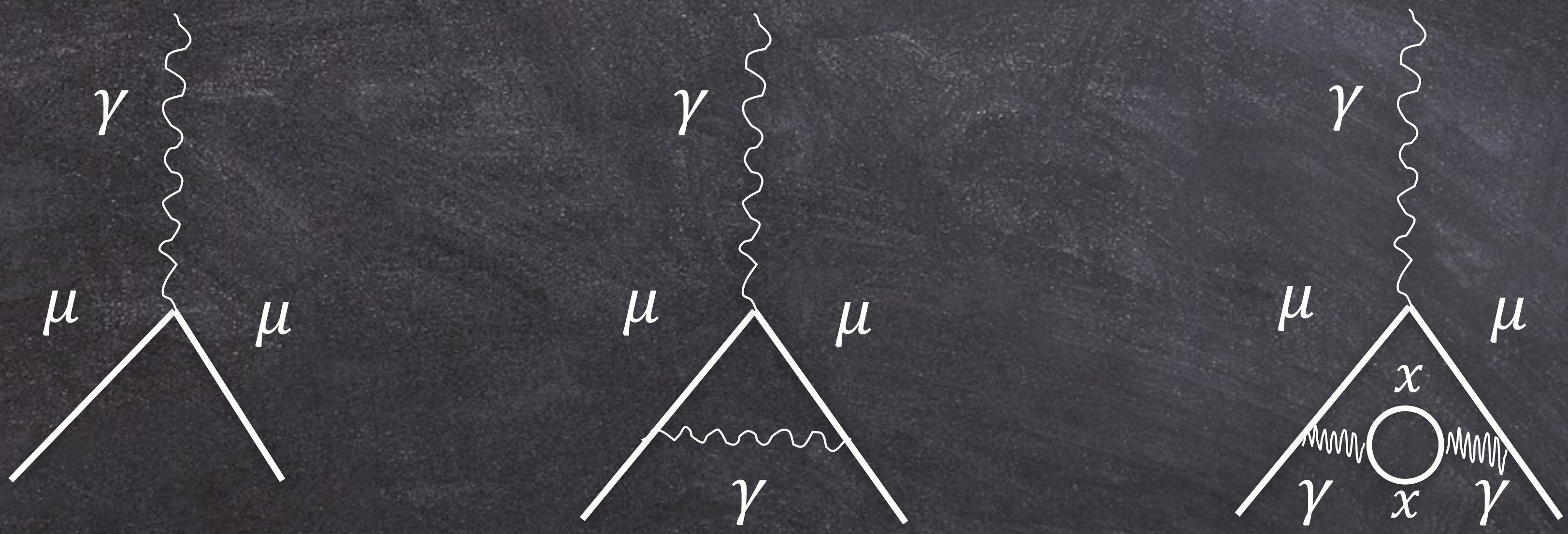
lowest-order radiative correction to the Dirac moment

Muon g-2 anomaly : the diagram



Muon g-2 anomaly : the diagram

Both the QED and electroweak contributions can be calculated to high precision



X= QED
Leptons and photons

X= Hadronic

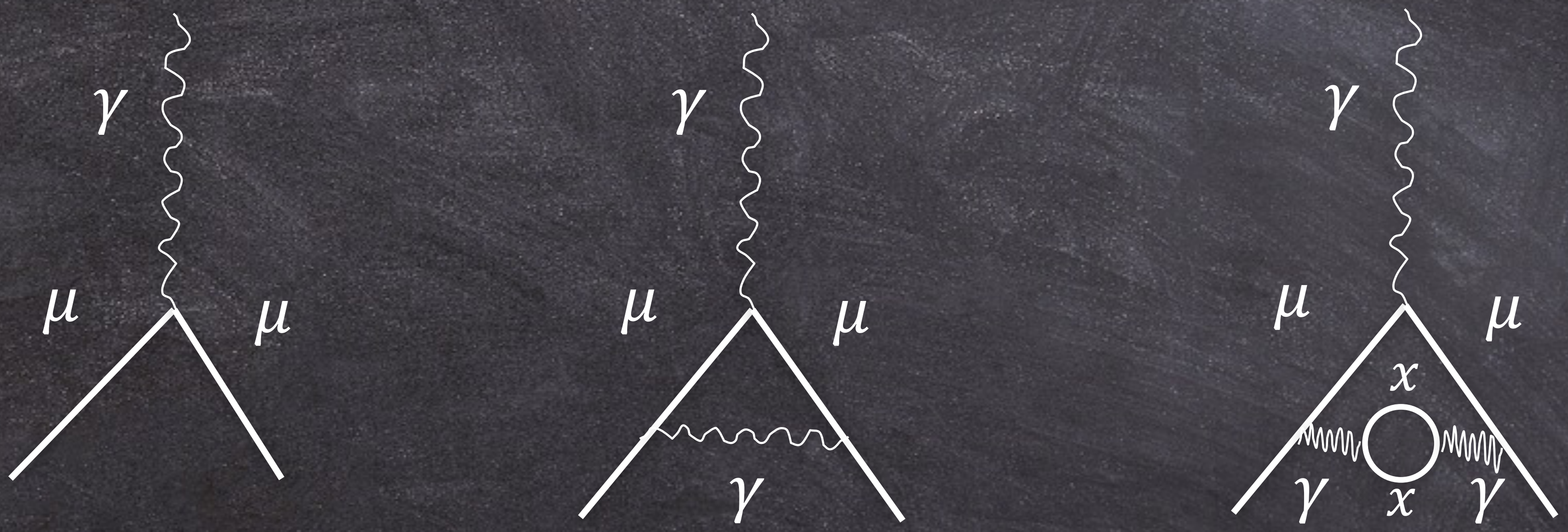
X= Week
Z, W, h

$$a_\mu^{SM} = a_\mu^{QED} + a_\mu^{WEEK} + a_\mu^{HAD}$$

Muon g-2 anomaly : the diagram

Hadronic contribution are complicated to be calculate

They contributes the dominant theoretical uncertainty on the SM prediction



X= QED

Leptons and photons

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$$a_\mu^{SM} = a_\mu^{QED} + a_\mu^{WEEK} + a_\mu^{HAD}$$

Current status: experimental and SM

Experimental measurement: E821 experiment at BNL

$$a_\mu^{E821} = (11659208.9 \pm 6.3)\times 10^{-10}$$

$$0.54\, ppm$$

The SM predicDon:

$$a_\mu^{SM} = (11659180.2 \pm 4.9)\times 10^{-10}$$

$$0.42\, ppm$$

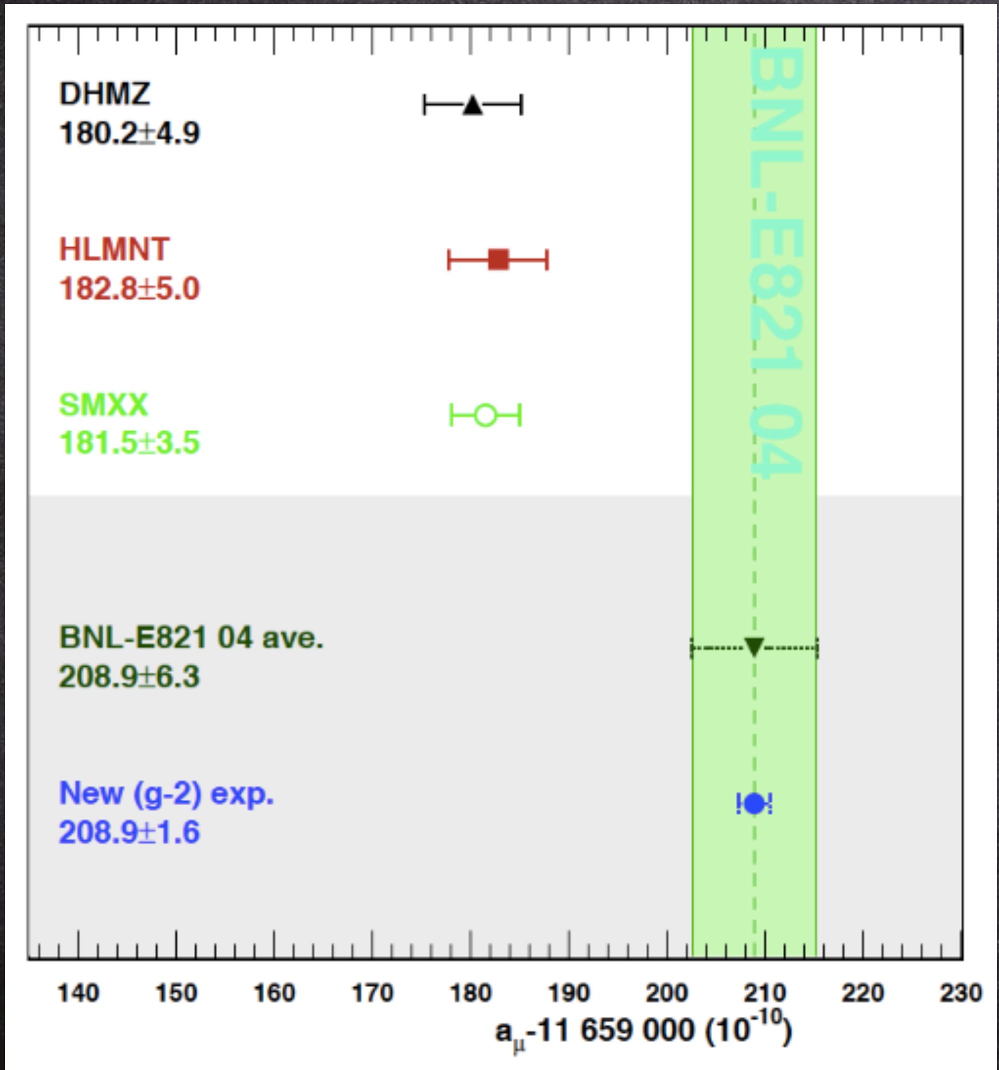
SM test: 3.5 standard deviation sigma difference

$$a_\mu^{E821} - a_\mu^{SM} = (28 \pm 8)\times 10^{-10}$$

SM model estimation dominated by hadronic uncertainty 0.6%

$$a_\mu^{HLO} = (692.3 \pm 4.2)\times 10^{-10}$$

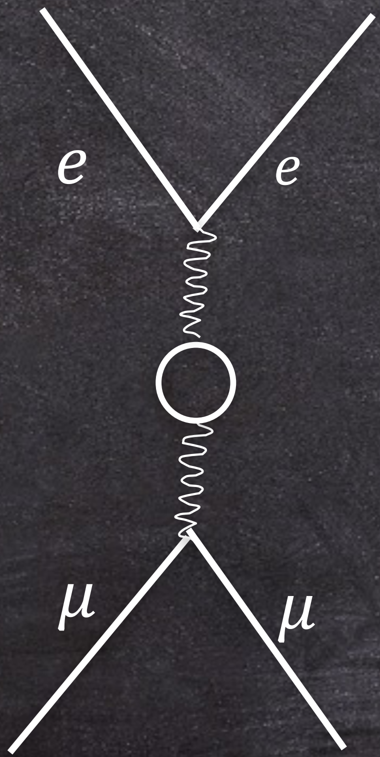
Current status: experimental and SM



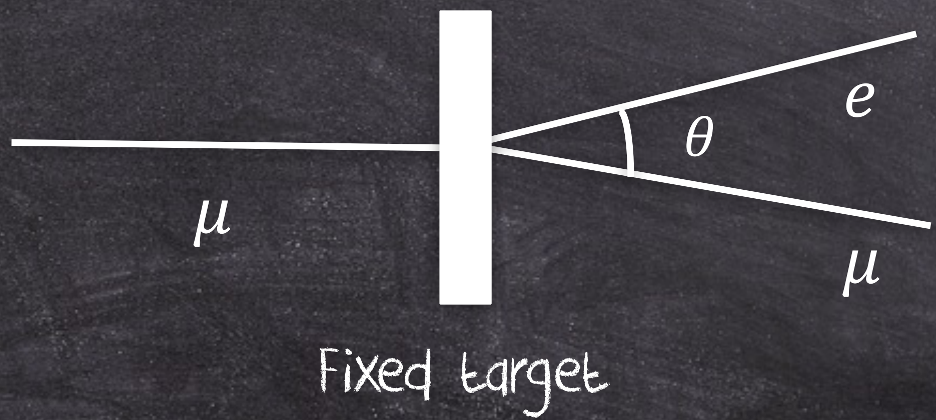
Near future:
new experiments at Fermilab and J-PARC, aiming at measuring the muon g-2 to a precision of 1.6×10^{-10} (0.14 ppm)

Proposal

a_μ^{HLO} can be determined unambiguously measuring the running of α through the t-channel $\mu - e$ elastic scattering process.



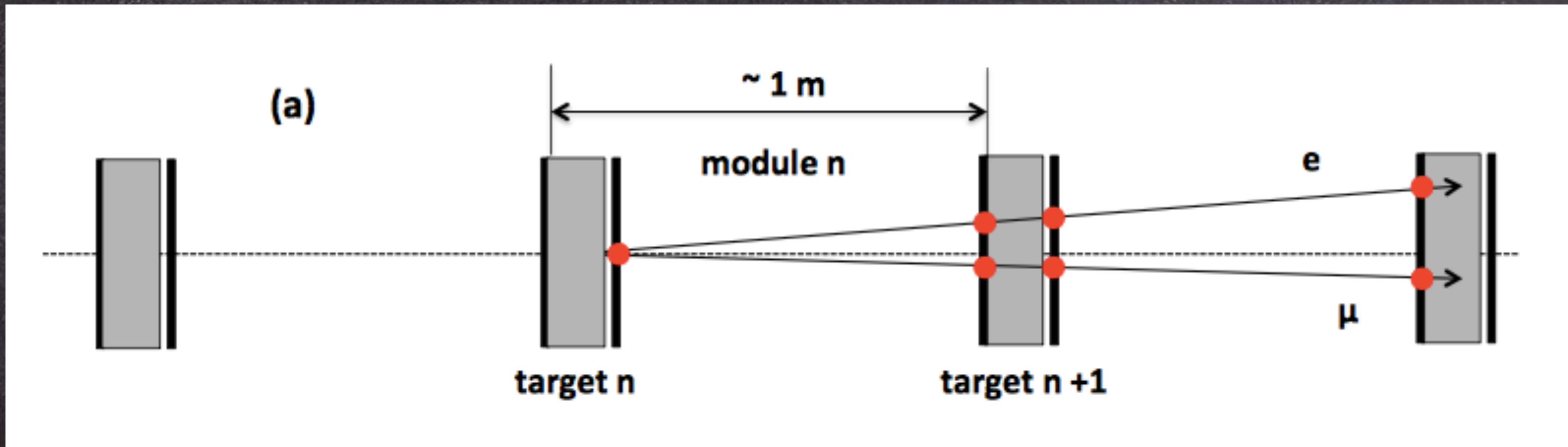
The proposal is to measure the scattering of a muon beam of 150 GeV on electron at rest on a fixed target



Detection technique

Modular apparatus covering the full angular acceptance with high uniformity.

20 layers of low Z material (Be or C) paired to Si strip planes



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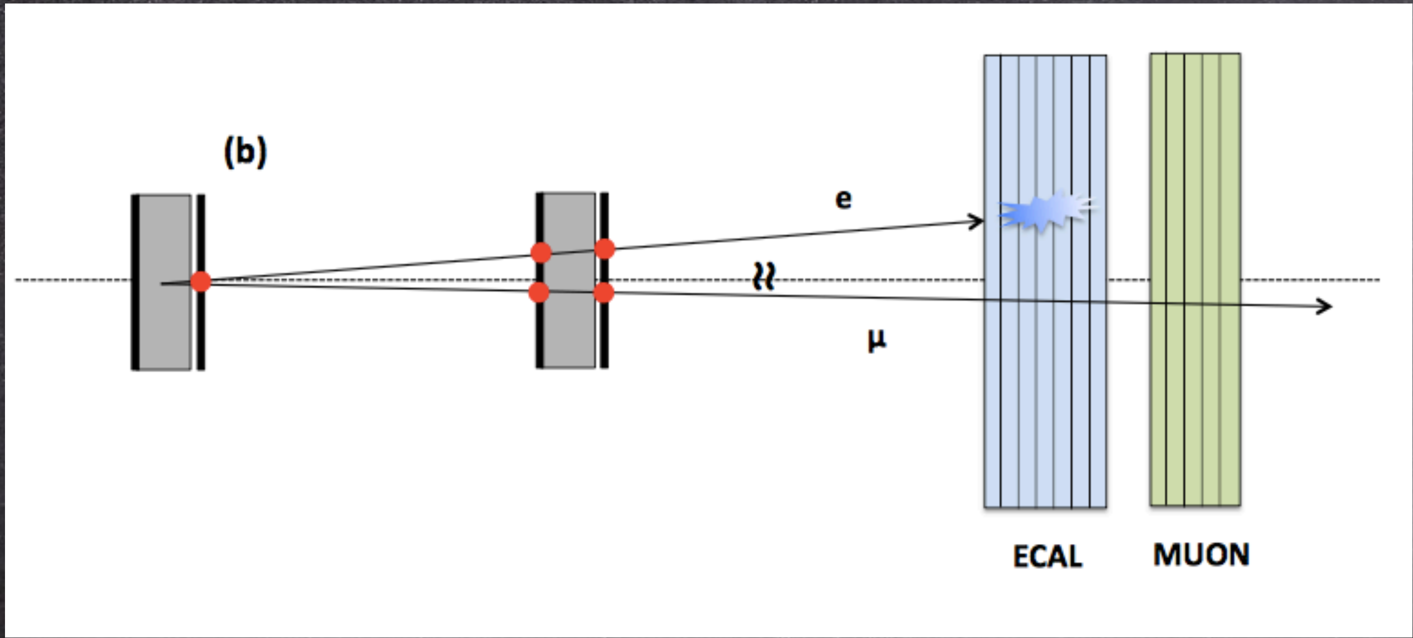


Measuring angles with high angular resolu2on ~ 0.02 mrad

Luminosity and statistical error

With the CERN 150 GeV muon beam, which has an average intensity of $1.3\times10^{7}\ \mu/s$
incident on 20 Be layers, each 3 cm thick,
2 years of data taking running per 2×10^{7} s/yr,

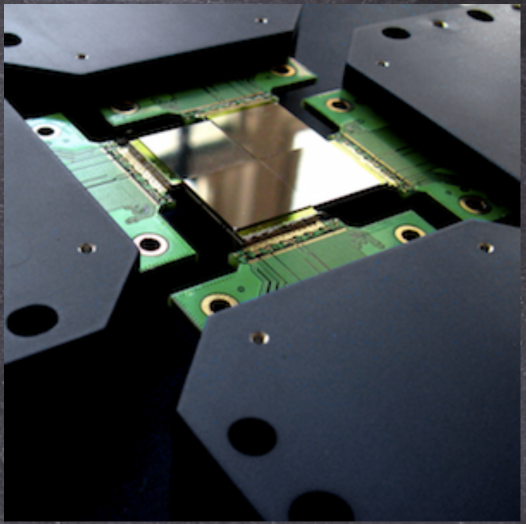
$$\mathcal{L} \sim 1.5\times10^{7}\ \text{nb}^{-1} \longrightarrow \delta a_{\mu}^{HLO} \sim 2\times10^{-10}$$

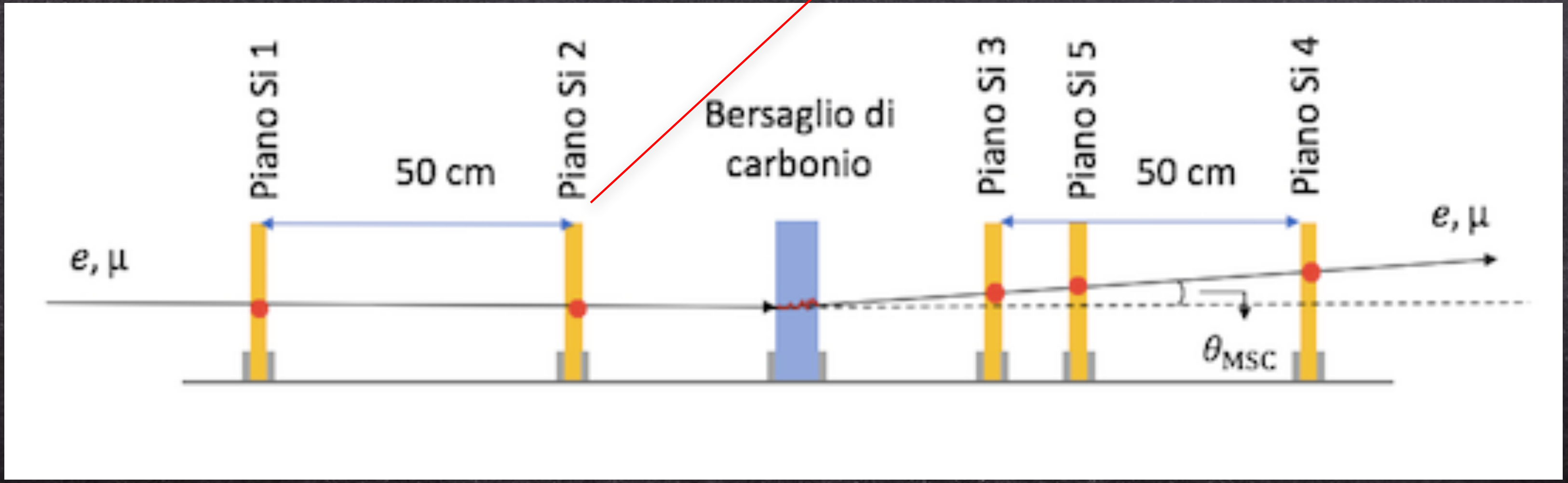
Multiple scattering plays an important rule you need a very accurate model, better what GEANT4 has

Main systematic error

DAQ with usb on PC

Total cost of this system 10k euro





Why fund me?

The project is cheap not more than 1M euro

It is experimentally very simple, when precise multiple scattering is measured

Small collaboration -> more fun

And the most important thing:

Theorists need help from experimentalists (as usual…), why don't give them a help?

vote for project #2 it has the