

A new experiment to measure the hadronic contribution to g-2

QCD@Work 9th edition

International Workshop on Quantum Chromodynamics Theory and Experiment

Matera (Italy), June 25 - 28, 2018 European Capital of Culture 2019



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Low energy and nonperturbative QCD - Advances in perturbative QCD Heavy quarks - QCD in extreme conditions of temperature and density Holographic methods

Luca Trentadue Università di Parma and INFN Milano-Bicocca

on behalf of the proponents of the project

June 27th 2018

C. M. Carloni Calame, M. Passera, L.Trentadue. and G. Venanzoni,

"A new approach to evaluate the leading hadronic corrections to the muon g-2", Phys. Lett. B 746 (2015) 325

G. Abbiendi, C.M. Carloni Calame, U. Marconi, C. Matteuzzi, G. Montagna,

O. Nicrosini M. Passera, F. Piccinini, R. Tenchini, L. Trentadue and G. Venanzoni,

"Measuring the leading hadronic contribution to the muon g-2 via mu-e scattering", Eur. Phys. J. C77 (2017) 3, 139. arXiv: 1609.08987 [hep-ex].



is a new experiment to measure the Hadronic Leading Order (HLO) contribution to the muon g-2 by using $\mu + e \rightarrow \mu + e$ elastic scattering

Outlook:

- Physics Motivations
- Tools to perform the measurement
- The first testbeam (CERN)
- Future plans and developments

L. Trentadue - QCD@Work 27 June 2018 Univ. Parma and INFN Milano Bicocca

Historical Aside

This talk is about how to measure the Vacuum (the hadronic contribution to)

Vacuum, since a long time (2500 years), constitutes an always present issue in Physics or, better, in Natural Sciences Philosophy

Parmenides, Democritos, Leucippos,.....Torricelli, von Guericke, Casimir, Schwinger, to mention only a few until nowadays



In Quantum Field Theory, in the perturbative phase, Vacuum is naturally represented by the vacuum polarization contribution

Vacuum Polarization makes α_{em} running assuming a well defined "effective" value at any scale



vacuum polarization and the "effective charge" are

$$e^2 \rightarrow e^2(q^2) = \frac{\text{defield by:}}{1 + (\Pi(q^2) - \Pi(0))} \qquad \alpha(q^2) = \frac{\alpha(0)}{1 - \Delta \alpha}; \quad \Delta \alpha = -\Re e \Big(\Pi(q^2) - \Pi(0) \Big)$$

 $\Delta \alpha$ takes contributions from leptonic and hadronic and gauge bosons elementary states

Among these the non-perturbative $\Delta \alpha_{had}$

$$\Delta \alpha = \Delta \alpha$$
 leptonic + $\Delta \alpha_{gb}$ + $\Delta \alpha_{had}$ + $\Delta \alpha$ top







$$a_{\mu} = \frac{g-2}{2}$$

The muon g-2 has been measured with high precision $a_{\mu}^{exp} = 116592089(63) \times 10^{-11}$

G.W. Bennet et al., Phys. Rev. D73(2006_072003

The Standard Model prediction gives:

$$a_{\mu}^{SM} = 116591783(35) \times 10^{-11}$$

F. Jegerlehner, MITP Workshop, 19-23 February 2018 Mainz

$$\Delta a_{\mu}(exp - SM) = 306 \pm 72$$

Systematics of the measurement ? Systematics of the theoretical prediction ? New Physics ?

Comparisons of the SM predictions with the measured g-2 value:

a_µ^{EXP} = 116592091 (63) x 10⁻¹¹

E821 – Final Report: PRD73 (2006) 072 with latest value of $\lambda = \mu_{\mu}/\mu_{p}$ from CODATA'10

$\Delta a_{\mu} = a_{\mu}^{\text{EXP}} - a_{\mu}^{\text{SM}}$	σ
$330~(85) \times 10^{-11}$	3.9[1]
273 (81) $\times 10^{-11}$	3.4[2]
$250~(86) \times 10^{-11}$	2.9[3]
	$\begin{aligned} \Delta a_{\mu} &= a_{\mu}^{\text{EXP}} - a_{\mu}^{\text{SM}} \\ 330 \ (85) \times 10^{-11} \\ 273 \ (81) \times 10^{-11} \\ 250 \ (86) \times 10^{-11} \end{aligned}$

with the recent "conservative" hadronic light-by-light $a_{\mu}^{HNLO}(IbI) = 102 (39) \times 10^{-11}$ of F. Jegerlehner arXiv:1511.04473, and the hadronic leading-order of:

- [1] Jegerlehner, arXiv:1511.04473.
- [2] Davier, arXiv:1612:02743.
- [3] Hagiwara et al, JPG38 (2011) 085003.

The muon g-2 - The Hadronic contribution



from M. Passera

Comparison between the SM predictions and the experimental determinations

Theory parametrizations DHMZ (M.Davier et al.), HLMNT (K. Hagiwara et al.) SMXX is the average of the two previous values

BNL-E821 04 average is the current experimental value of aµ

New (g-2) exp. is the same central value with a fourfold improved precision of future g-2 experiments at Fermilab and J-PARC.



.From T. Blum et. al., "The Muon g-2 Theory Value: Present and Future" arXiv:1311.2198 [hep-ph]

a fourfold gain

will this possibly change in the next few years ?

The present experimental error as from the BNL E821 is $\delta a_{\mu}^{Exp}\simeq 6.3\cdot 10^{-10}[0.54\ ppm]$

The new experiments in preparation at Fermilab and J-PARC are aiming to a precision of * $\delta a_{\mu}^{Exp-FL/J-PARC} \simeq 1.6 \cdot 10^{-10} [0.14 \text{ ppm}]$

(*assuming the same central value as today's one)

The question is how to cope with such an improvement from the theoretical side

$$a_{\mu} = \frac{g-2}{2}$$

$$\Delta a_{\mu}(Exp - SM) \simeq 28 \pm 8 \cdot 10^{-10}$$

Within the framework of low-energy high precision measurements the long-standing (~ $4\sigma)$

discrepancy between the experimental value of the muon anomalous magnetic moment and the Standard Model prediction

The accuracy of the SM prediction $5\cdot 10^{-10}$

is limited by strong interactions effects

The present error on the leading order hadronic

contribution to muon $\ g-2$

$$\delta a_{\mu}^{HLO} \simeq 4 \cdot 10^{-10}$$

It constitutes the main uncertainty of the SM predictions

In order to understand the discrepancy between the experimental measurement and the Standard Model prediction it is needed to reduce the theoretical uncertainty to have a more precise determination

The largest contribution to the theoretical uncertainty comes from the term $\Delta\alpha_{had}$ which can be measured experimentally

More theoretical work is necessary: Radiative corrections, Lattice evaluations, etc...

The Standard Dispersive Approach to the evaluation of the HLO contribution to the muon anomalous magnetic moment goes back to the '60

The Standard Dispersive Approach

$$a_{\mu}^{HLO} = \left(\frac{\alpha}{\pi^2}\right) \int_0^\infty \frac{ds}{s} K(s) \ Im\Pi_{had}(s+i\epsilon) \qquad \hat{K}(s) = \int_0^1 dx \frac{x^2(1-x)}{x^2+(1-x)\frac{s}{m_{\mu}^2}}$$



Optical Theorem

$$Im \ \hat{\Pi}_{had}(s) \to \sigma_{tot}^{had}(s)$$

$$a_{\mu}^{HLO} = \left(\frac{\alpha m_{\mu}}{3\pi}\right)^2 \int_{4m_{\pi}^2}^{\infty} ds \frac{\hat{K}(s) R_{had}(s)}{s^2}$$

$$R_{had}(s) = \frac{\sigma(e^+e^- \to hadrons)}{\sigma(e^+e^- \to \mu^+\mu^-)}$$



from F. Jegerlehner talk in Frascati March 23, 2016

Measurement of the running of lphaem

- A direct measurement of $\alpha_{em}(s/t)$ in space/ time-like regions can show the running of $\alpha_{em}(s/t)$
- It can provide a test of "duality" (far away from resonances)
- It has been done in past by few experiments at e⁺e⁻ colliders by comparing a "wellknown" QED process with some reference (obtained from data or MC)

$$\left(\frac{\alpha(q^2)}{\alpha(q_0^2)}\right)^2 \sim \frac{N_{signal}(q^2)}{N_{norm}(q_0^2)}$$

 N_{signal} can be any QED process, muon pairs, etc... N_{norm} can be Bhabha process, pure QED as $\gamma\gamma$ pair production, a well as theory, or any other reference process.



We propose an alternative approach

The alternative approach of using a space-like formula for the vacuum polarization

$$a_{\mu}^{HLO} = \frac{\alpha}{\pi} \int_0^1 dx \ (1-x)\bar{\Pi}_{had}(t(x)) = \frac{\alpha}{\pi} \int_0^1 dx \ (1-x) \ \Delta\alpha_{had}(t(x))$$

$$a_{\mu}^{HLO} = \left(\frac{\alpha}{\pi}\right) \int_{-\infty}^{0} \frac{dt}{\beta t} \left(\frac{1-\beta}{1+\beta}\right)^2 \bar{\Pi}_{had}(t) = -\left(\frac{\alpha}{\pi}\right) \int_{-\infty}^{0} \frac{dt}{\beta t} \left(\frac{1-\beta}{1+\beta}\right)^2 \Delta \alpha_{had}(t(x))$$

$$\beta = \sqrt{1-\frac{4m_{\mu}^2}{t}} \qquad t(x) = -\frac{x^2 m_{\mu}^2}{1-x} \qquad \alpha(t) = \frac{\alpha(0)}{1-\Delta\alpha(t)}$$

$$\Delta \alpha_{had}(t) \text{ is the hadronic contribution to the running of } \alpha$$

$$t = -|q|^2 \qquad \Delta \alpha_{had}(t) = \Delta \alpha(t) - \Delta \alpha_{lep}(t)$$
This may be obtained by using Bhabha scattering

$\Delta \alpha_i(t(x))$



 \boldsymbol{x}



2. Theoretical framework

The leading-order hadronic contribution to the muon g-2 is given by the well-known formula [4,15]

$$a_{\mu}^{\text{HLO}} = \frac{\alpha}{\pi^2} \int_{0}^{\infty} \frac{ds}{s} K(s) \, \text{Im}\Pi_{\text{had}}(s+i\epsilon), \tag{1}$$

where $\Pi_{had}(s)$ is the hadronic part of the photon vacuum polarization, $\epsilon > 0$,

$$K(s) = \int_{0}^{1} dx \frac{x^{2}(1-x)}{x^{2} + (1-x)(s/m_{\mu}^{2})}$$

is a positive kernel function, and m_{μ} is the muon mass. As the total cross section for hadron production in low-energy e^+e^- annihilations is related to the imaginary part of $\Pi_{had}(s)$ via the optical theorem, the dispersion integral in Eq. (1) is computed integrating experimental time-like (s > 0) data up to a certain value of s [2,18,19]. The high-energy tail of the integral is calculated using perturbative QCD [20].

Alternatively, if we exchange the x and s integrations in Eq. (1) we obtain [21]

$$a_{\mu}^{\text{HLO}} = \frac{\alpha}{\pi} \int_{0}^{1} dx \, (x-1) \,\overline{\Pi}_{\text{had}}[t(x)],$$

(3)

(2)

where $\overline{\Pi}_{had}(t) = \Pi_{had}(t) - \Pi_{had}(0)$ and

$$t(x) = \frac{x^2 m_\mu^2}{x-1} < 0$$

The space-like kinematics allows a direct comparison with the lattice evaluations

is a space-like squared four-momentum. If we invert Eq. (4), we get $x = (1 - \beta) (t/2m_{\mu}^2)$, with $\beta = (1 - 4m_{\mu}^2/t)^{1/2}$, and from Eq. (3) we obtain

$$a_{\mu}^{\text{HLO}} = \frac{\alpha}{\pi} \int_{-\infty}^{0} \overline{\Pi}_{\text{had}}(t) \left(\frac{\beta - 1}{\beta + 1}\right)^{2} \frac{dt}{t\beta}.$$

(5)

Eq. (5) has been used for lattice QCD calculations of a_{μ}^{HLO} [22]; while the results are not yet competitive with those obtained with the dispersive approach via time-like data, their errors are expected to decrease significantly in the next few years [23].

- [22] C. Aubin, T. Blum, Phys. Rev. D 75 (2007) 114502;
 P. Boyle et al., Phys. Rev. D 85 (2012) 074504;
 X. Feng et al., Phys. Rev. Lett. 107 (2011) 081802;
 M. Della Morte et al., J. High Energy Phys. 1203 (2012) 055.
- [23] T. Blum et al., PoS LATTICE 2012 (2012) 022.

To summarize

$$a_{\mu}^{HLO} = -\frac{\alpha}{\pi} \int_{0}^{1} (1-x) \Pi_{had} \left(-\frac{x^{2}}{1-x}m_{\mu}^{2}\right) dx$$

$$t = \frac{x^2 m_{\mu}^2}{x - 1} \quad 0 \le -t < +\infty \qquad a_{\mu} = (g - 2)/2$$
$$x = \frac{t}{2m_{\mu}^2} (1 - \sqrt{1 - \frac{4m_{\mu}^2}{t}}); \quad 0 \le x < 1;$$
$$t = -s \sin^2(\frac{\vartheta}{2})$$

$$\Delta \alpha_{had}(t) = -\Pi_{had}(t) \quad for \ t < 0$$

with the "t" $a_{\mu}^{HLO} = -\frac{\alpha}{\pi} \int_{0}^{1} (1-x)\Delta\alpha_{had} (-\frac{x^2}{1-x}m_{\mu}^2)dx$



A.Arbuzov, D.Haidt, C.Matteuzzi, M.Paganoni, L.T. Eur. Phys. J. C 34 (2004) 267

AN EXAMPLE OF A SPACE-LIKE APPROACH

arXiv:hep-ph/0402211v1 19 Feb 2004



The running of the electromagnetic coupling α in small-angle Bhabha scattering

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Abstract

A method to determine the running of α from a measurement of small-angle Bhabha scattering is proposed and worked out. The method is suited to high statistics experiments at e^+e^- colliders, which are equipped with luminometers in the appropriate angular region. A new simulation code predicting small-angle Bhabha scattering is also presented.

A. Arbuzov, D. Haidt, C. Matteuzzi, M. Paganoni and L.T., Eur. Phys. J. C 34 (2004) 267

The method to measure the running of α exploits the fact that the cross section for the process $e^+e^- \rightarrow e^+e^-$ can be conveniently decomposed into three factors :

$$\frac{\mathrm{d}\sigma}{\mathrm{d}t} = \frac{\mathrm{d}\sigma^0}{\mathrm{d}t} \left(\frac{\alpha(t)}{\alpha(0)}\right)^2 \left(1 + \Delta r(t)\right) \tag{3}$$

each one of them known with an accuracy of at least 0.1%

lst factor

$$\frac{\mathrm{d}\sigma^0}{\mathrm{d}t} = \frac{\mathrm{d}\sigma^B}{\mathrm{d}t} \left(\frac{\alpha(0)}{\alpha(t)}\right)^2.$$

The Born cross section contains all the soft and virtual corrections

Bhabha is a pure QED process Quarks enter only in loops

$$\frac{\mathrm{d}\sigma^B}{\mathrm{d}t} = \frac{\pi\alpha_0^2}{2s^2} \mathrm{Re}\{B_t + B_s + B_i\},\,$$

$$\begin{split} B_t &= \left(\frac{s}{t}\right)^2 \bigg\{ \frac{5+2c+c^2}{(1-\Pi(t))^2} + \xi \frac{2(g_v^2+g_a^2)(5+2c+c^2)}{(1-\Pi(t))} \\ &+ \xi^2 \bigg(4(g_v^2+g_a^2)^2 + (1+c)^2(g_v^4+g_a^4+6g_v^2g_a^2) \bigg) \bigg\} \\ B_s &= \frac{2(1+c^2)}{|1-\Pi(s)|^2} + 2\chi \frac{(1-c)^2(g_v^2-g_a^2) + (1+c)^2(g_v^2+g_a^2)}{1-\Pi(s)} \\ &+ \chi^2 \big[(1-c)^2(g_v^2-g_a^2)^2 + (1+c)^2(g_v^4+g_a^4+6g_v^2g_a^2) \big] \\ B_i &= 2\frac{s}{t}(1+c)^2 \bigg\{ \frac{1}{(1-\Pi(t))(1-\Pi(s))} \\ &+ (g_v^2+g_a^2) \bigg(\frac{\xi}{1-\Pi(s)} + \frac{\chi}{1-\Pi(t)} \bigg) \\ &+ (g_v^4+6g_v^2g_a^2+g_a^4)\xi\chi \bigg\} \end{split}$$





Vacuum polarization effects gives the running of alpha





with all the real and virtual effects not incorporated in the running of alpha

$$\alpha(q^2) = \frac{\alpha(0)}{1 - \Delta \alpha(q^2)},$$

lpha(0) is the Sommerfeld fine structure constant measured with a precision of

 $O(10^{-9})$

 $\Delta lpha(q^2)$ from loop contributions to the photon propagator

Feb 2006 23 arXiv:hep-ex/0505072v3

EUROPEAN ORGANISATION FOR NUCLEAR RESEARCH

CERN-PH-EP/2005-014 21 February 2005 Revised 28 June 2005

Measurement of the running of the QED coupling in small-angle Bhabha scattering at LEP

OPAL Collaboration

Running of $lpha_{ ext{em}}$







 $\mu e
ightarrow \mu e$ $1.3 imes 10^7 \mu/s$

- High intensity muon beam available in the CERN North Area E = 150 GeV
- pure t-channel process

$$\frac{d\sigma}{dt} = \frac{d\sigma_0}{dt} |\frac{\alpha(t)}{\alpha(0)}|^2$$

 $s \simeq 0.16 \ GeV^2 - 0.14 \le t \le 0 \ GeV^2 - 0 \le x \le 0.93$

- the $2 \rightarrow 2$ kinematics reads



Same process can be used for signal and normalization





Muon and electron scattering angles are correlated This very important constraint may be used to select elastic events, reject background from radiative events and minimize systematics



Electron scattering angle (mrad)



- Electromagnetic calorimeter needed to:
 - Perform the PID: muon/electron discrimination.
 - PID capabilities also reconstructing the electromagnetic shower in the tracking system.
 - Triggering : (muon in) AND (ECAL $E > E_{th}$)
 - There is an alternative trigger condition: (muon in) AND (2 prongs into a given module)
- Establish how to measure E_e in order to get rid of events with electron energy below 1 GeV



i) Initial muons have to be tagged with their direction and momentum
 ii) 60 Be (C) layers interfaced with Si planes spaced by 1m air gap modularly spaced
 iii) The use of a low Z material in order to reduce multiple scattering and background
 iv) A final EM calorimeter to discriminate e/mu at small angles (2-3 mrad)

 $\mu \ beam \quad 1.3 \times 10^7 \mu/s \quad for \quad 2 \times 10^7 s/yr \\ 2 \times 10^{12} \ events/yr \quad \longrightarrow \quad \begin{array}{c} \text{statistical precision} \\ \textbf{0.3\% in 2 yrs running} \end{array}$

Systematics

many effects have to be under control: efficiencies (uniformity, acceptance, tracking, trigger, PID) alignment of the Si planes, uncertainties in vertex location, incoming muon momentum, effect of multiple scattering (different in "control" and "signal" regions)(many others, can be studied with data themselves).

Theory

Electroweak radiative corrections (including subleading logaritmic and mass contributions) have to be under control at the NNLO accuracy

This idea has been proposed in 2016 at the "Physics Beyond Collider Workshop" at CERN

- The idea has been presented in 2016 to the "Physics Beyond Collider Study Group"
- C. Matteuzzi and G. Venanzoni are members of the board as the experiment representatives.
- Physics Beyond Collider Study Group will select in fall 2018 experiments aiming to:
- Enrich and diversify the CERN scientific program: Exploit the unique opportunities offered by CERN's accelerator complex and scientific infrastructure Complement the laboratory's collider programme (LHC, HL-LHC and possible future colliders). The scientific findings will be collected in a report to be delivered by the end of 2018.

This document will also serve as input to the next update of the European Strategy for Particle Physics.

Also proposed to the INFN NSCI in 2017 and 2018

Theory

Our final TH goal: a running MC for the ratio of the SM cross sections in the signal and normalization regions below, at the level, of 10ppm

Theory (2)

μe

1st MUonE theory workshop: Padova - Sep 2017

Muon-electron scattering: Theory kickoff workshop

4-5 September 2017

https://agenda.infn.it/internalPage.py?pageId=0&confId=13774

The aim of the workshop is to explore the opportunities offered by a recent proposal for a new experiment at CERN to measure the scattering of high-energy muons on atomic electrons of a low-Z target through the process pa-ue. The focus will be on the theoretical predictions necessary for this scattering process, its possible sensitivity to new physics signals, and the development of new high-precision Monte Carlo tools. This sickoff workshop is intended to stimulate new ideas for this prefer.

It is organized and hosted by INFN Padova and the Physi University.

Organizing Committee

Carlo Carloni Calame - INFN Pavia Prepaolo Mastrolia - U. Padeva Guido Montagna - U. Pavia Oreste Nicrosiai - INFN Pavia Paride Paradisi - U. Padova Massimo Pasaera - INFN Padova (Chair) Pulvio Piccinini - INFN Pavia Luca Trentadue - U. Parna

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2nd MUonE theory workshop: Mainz - Feb 2018

μe

Next theory workshop in Zurich - Feb 2019

Just a few days ago !

Master integrals for the NNLO virtual corrections to μe scattering in QED: the non-planar graphs

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ABSTRACT: We evaluate the master integrals for the two-loop non-planar box-diagrams contributing to the elastic scattering of muons and electrons at next-to-next-to-leading order in QED. We adopt the method of differential equations and the Magnus exponential to determine a canonical set of integrals, finally expressed as a Taylor series around four space-time dimensions, with coefficients written as combination of generalised polylogarithms. The electron is treated as massless, while we retain full dependence on the muon mass. The considered integrals are also relevant for crossing-related processes, such as di-muon production at e^+e^- colliders, as well as for the QCD corrections to top-pair production at hadron colliders. In particular our results, together with the planar master integrals recently computed, represent the complete set of functions needed for the evaluation of the two-loop virtual next-to-next-to-leading order QED corrections to $e\mu \rightarrow e\mu$ and $e^+e^- \rightarrow \mu^+\mu^-$.

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ABSTRACT: We evaluate the master integrals for the two-loop non-planar box-diagrams contributing to the elastic scattering of muons and electrons at next-to-next-to-leading order in QED. We adopt the method of differential equations and the Magnus exponential to determine a canonical set of integrals, finally expressed as a Taylor series around four space-time dimensions, with coefficients written as combination of generalised polylogarithms. The electron is treated as massless, while we retain full dependence on the muon mass. The considered integrals are also relevant for crossing-related processes, such as di-muon production at e^+e^- colliders, as well as for the QCD corrections to top-pair production at hadron colliders. In particular our results, together with the planar master integrals recently computed, represent the complete set of functions needed for the evaluation of the two-loop virtual next-to-next-to-leading order QED corrections to $e\mu \rightarrow e\mu$ and $e^+e^- \rightarrow \mu^+\mu^-$.

arXiv:1806.08241v1 [hep-ph]

TEST Beams 2017/2018 at CERN

2017 Test Beam Goals

- Measure the effect of low Z materials on high energy electrons and check GEANT4 simulations.
- Carbon targets of various thickness: 4 to 20 mm
- Electron beams of 12 GeV and 20 GeV
- Detector response measured directly (by taking data removing the target)
- Detector alignment with high-energy pions and muons
- Run with muon beam to possibly detect elastic scattering events.

Test Beam 2017: the setup

- We used the UA9 tracking system to record scattering data
- Alignment, tracking, pattern recognition done by ourselves starting from scratch
- Geant4 simulation is an evolving subject: again developed from scratch

UA9 detector

2017 Test Beam setup and target

Thanks to the UA9 Collaboration (particularly M. Garattini, R. Iaconageli, M. Pesaresi), J. Bernhard

2017 Test Beam Result

Evidence of the elastic scattering

Golden selection: single track in and two tracks out

8mm, 20 GeV

Test Beam 2018

- COMPASS uses hadron beams. Muon beams are used for alignment and calibration once per 1 - 2 weeks
- We can use both muons beams and muons from pion decays.
 - This implies being able to run from April to October.

Main objectives

- Select elastic events
- Effects of the muon beam momentum mean and resolution
- Measure the tracking efficiency uniformity versus the scattering angle.
- Measure the relation angle-energy of the scattered electrons.

Setup located in the North Area behind COMPASS detector

Test Beam 2018

EHN2 Test Beams 2018

- MUonE: Measure µe scattering on 2 target modules with Silicon instrumentation + 1 EM calorimeter. Total length ~ 3m.
- Compass TPC: Measure µp scattering in high pressure TPC + Silicon telescope

Tentative timeline of the project

- Studies with Geant4 (underway)
- Detector geometry, number of planes, thickness, calorimeter for pid,...
- Test beam 2018 (muons) 2019 (electrons)
- Assemble the detector -> 2020
- Start to collect data 2021

Conclusions

- We propose to measure muon electron scattering by using the muon beam in the CERN North Area (150 GeV) to extract the space-like quark vacuum polarization
- This measurement will allow to obtain the leading hadronic contribution to the g-2 in a new independent way and will constitute a crosscheck with previous time-like determinations and with the lattice results
- The goal is to determine the origin of the presently observed discrepancy between experiments and Standard Model predictions of the g-2 and the origin if within SM or if it could be attributed to BSM physics

