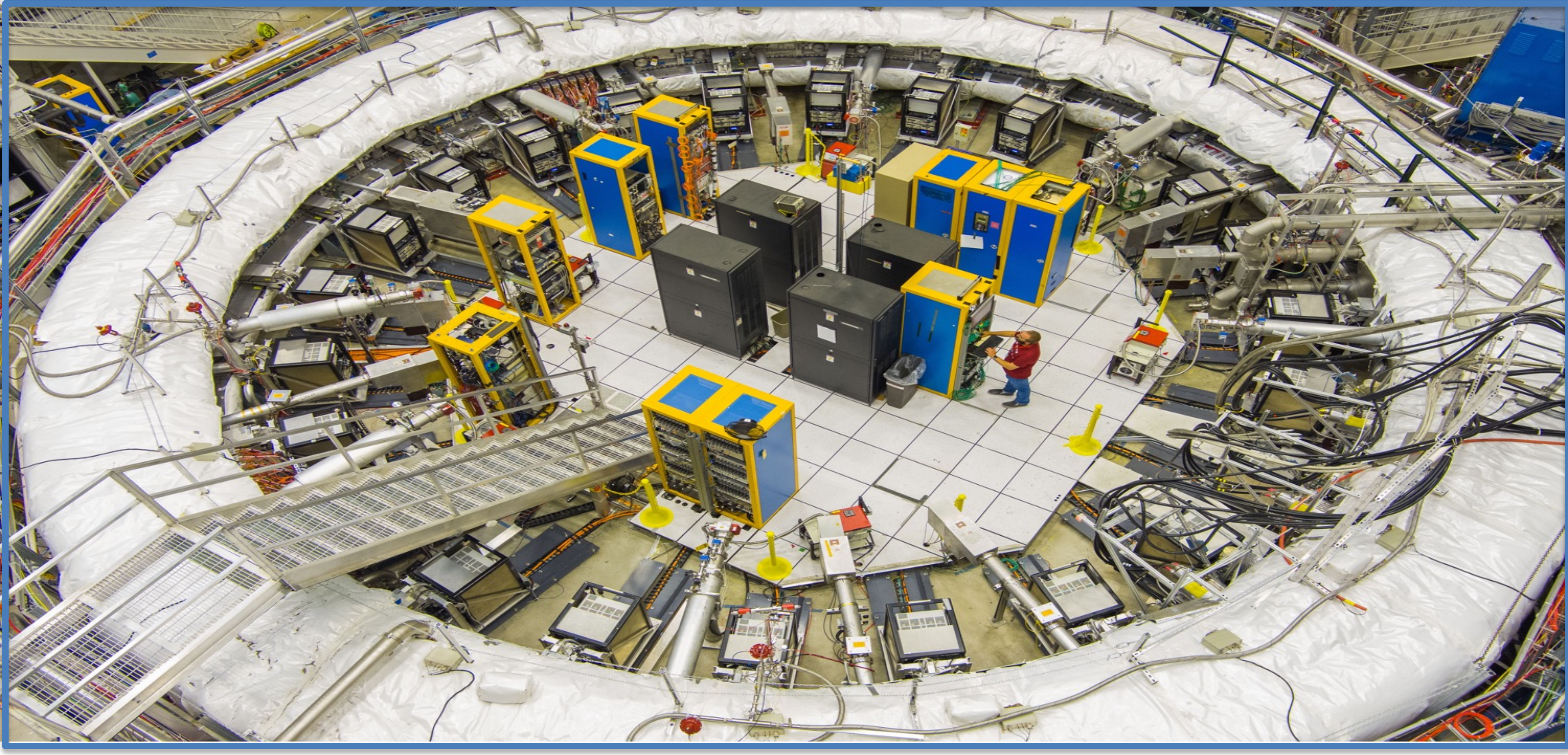


New results from the Muon g-2 Experiment

Graziano Venanzoni
University of Liverpool and Sezione INFN Pisa

on behalf of the Muon g-2 Collaboration

EPS-HEP2023 Conference, Hamburg, 22 August 2023

Muon g-2 Collaboration

Muon g-2

USA
- Boston
- Cornell
- Illinois
- James Madison
- Kentucky
- Massachusetts
- Michigan
- Michigan State
- Mississippi
- North Central
- Northern Illinois
- Regis
- Virginia
- Washington

USA National Labs
- Argonne
- Brookhaven
- Fermilab

181 collaborators
33 Institutions
7 countries

China
- Shanghai Jiao Tong

Germany
- Dresden
- Mainz

Italy
- Frascati
- Molise
- Naples
- Pisa
- Roma Tor Vergata
- Trieste
- Udine

Korea
- CAPP/IBS
- KAIST

Ru
- Budker/Novosibirsk
- JINR Dubna

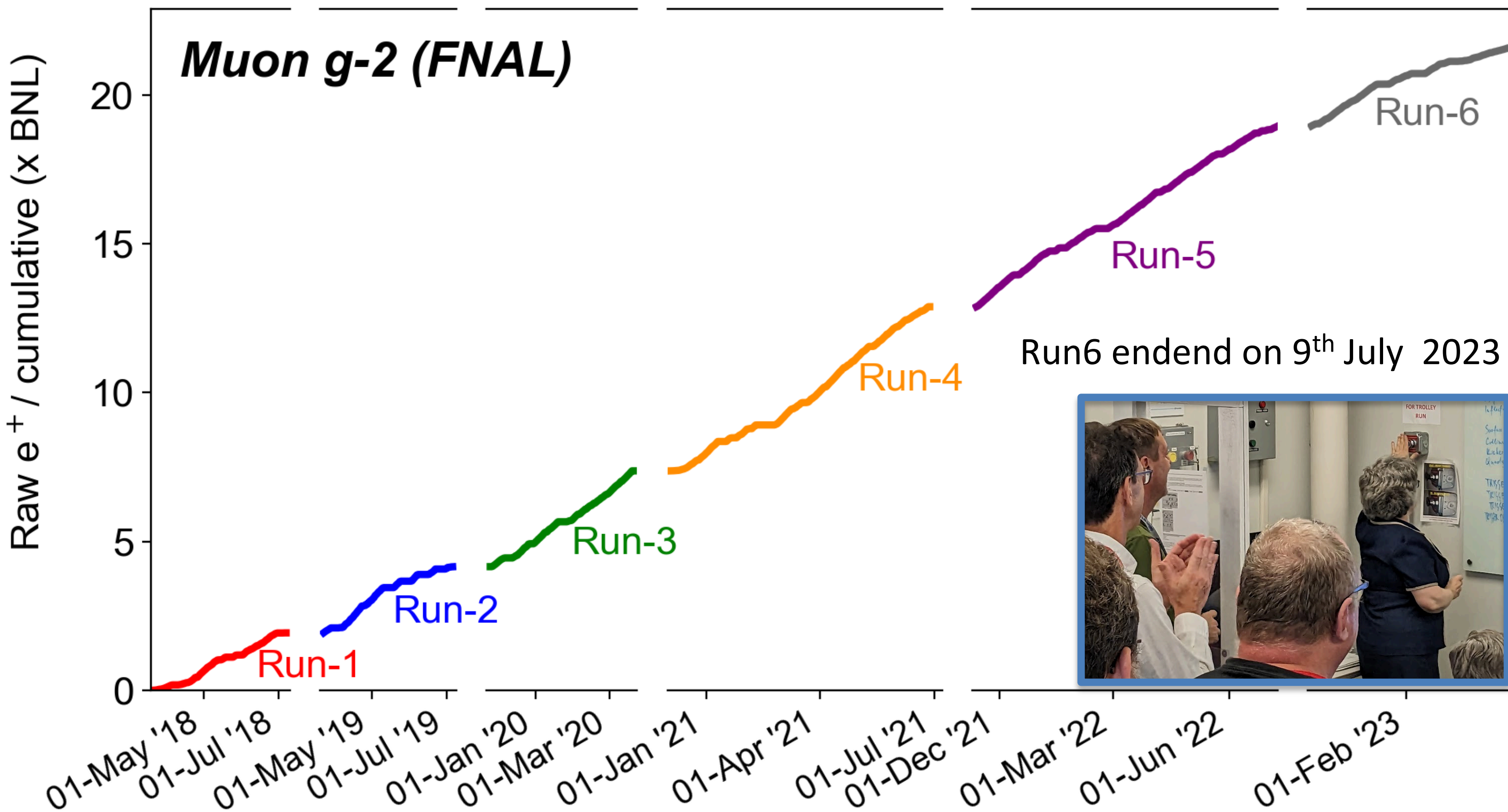
United Kingdom
- Lancaster/Cockcroft
- Liverpool
- Manchester
- University College London

Muon g-2 Collaboration Meeting @ Elba, May 2019

Muon g-2 Collaboration (2023)

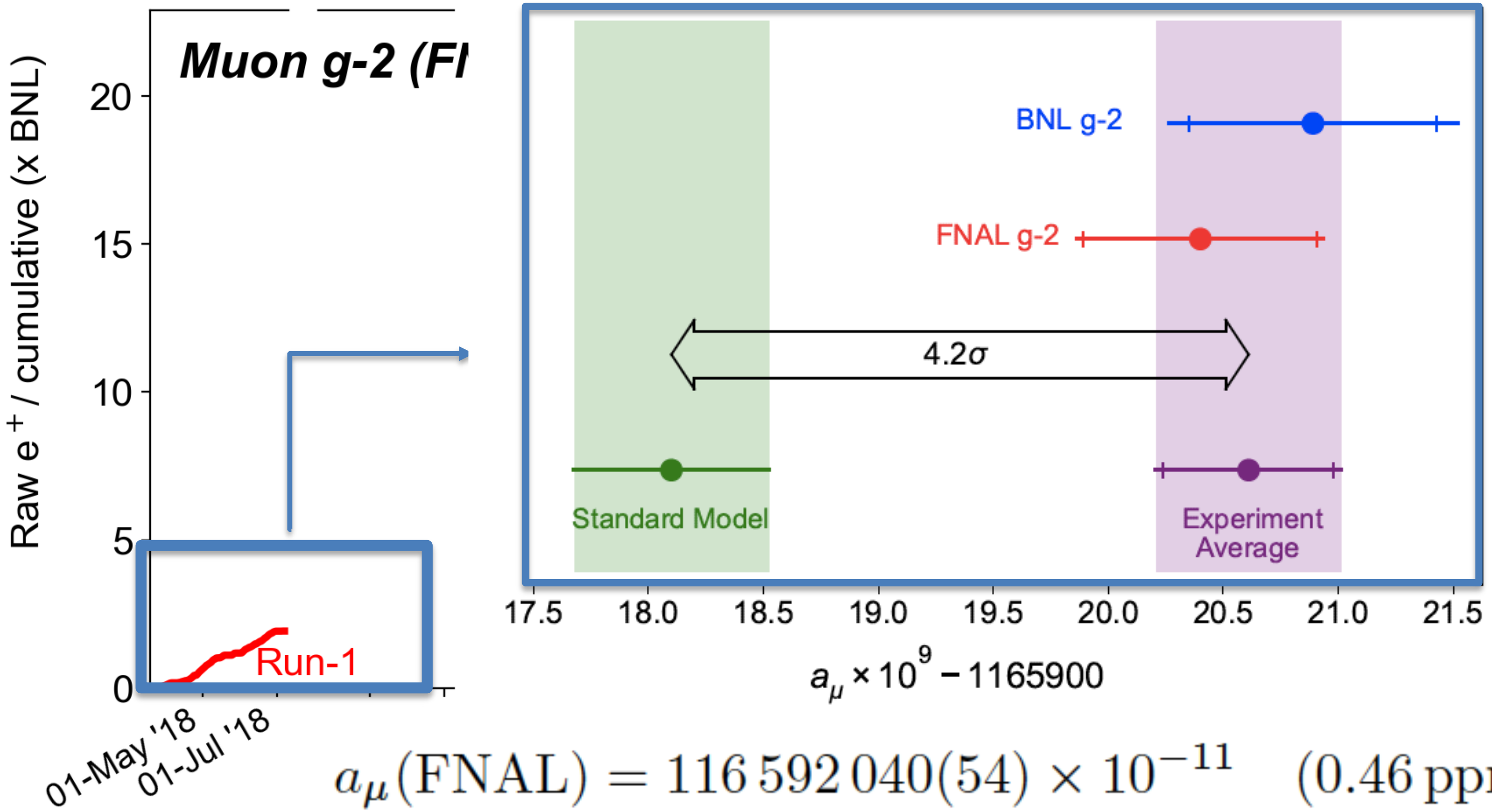
Collected statistics from Muon g-2: x21.9 BNL datasets

On 27 February 2023: proposal Goal of x21 BNL datasets!



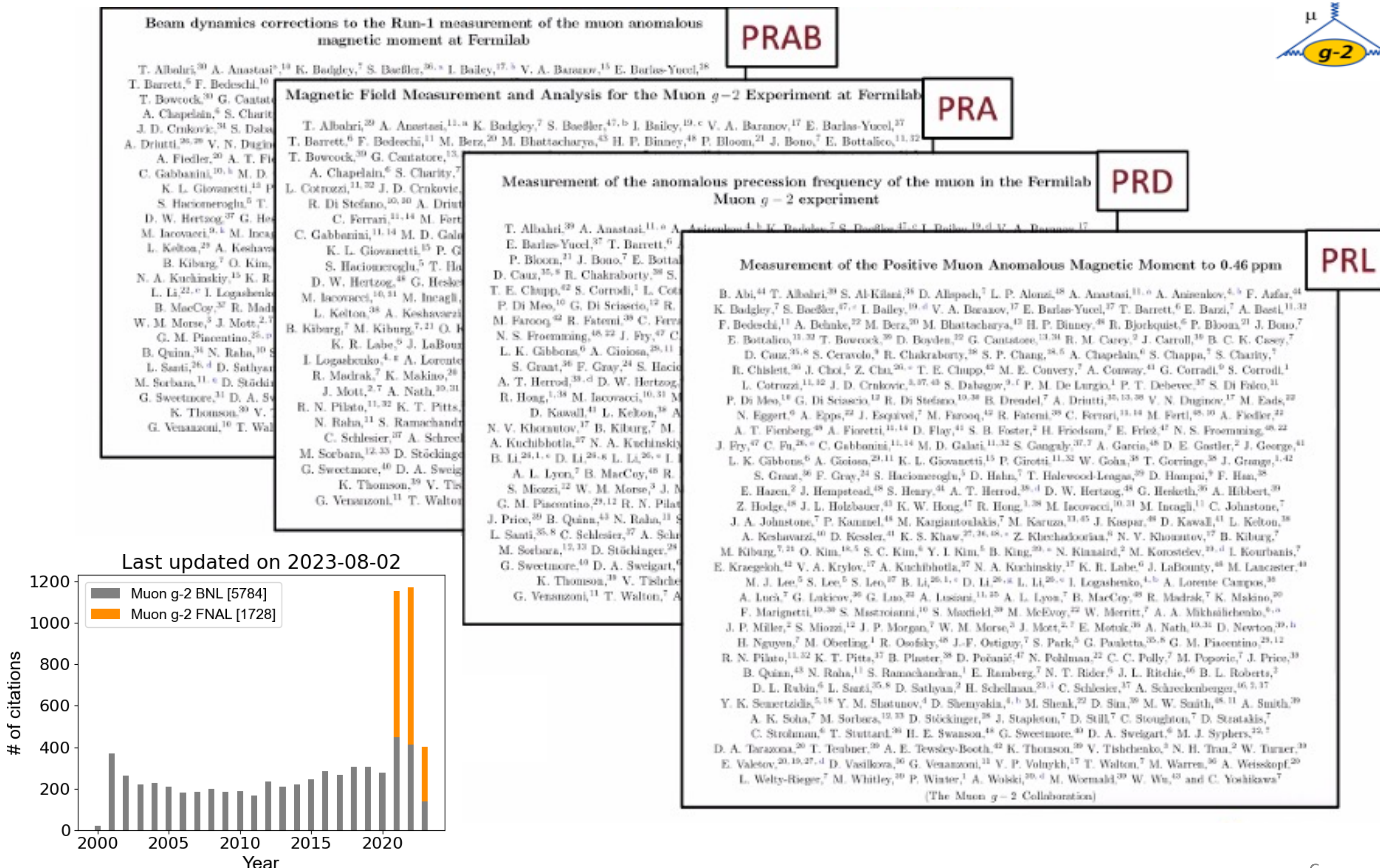
Run6 endend on 9th July 2023

7 April 2021: We released our first result

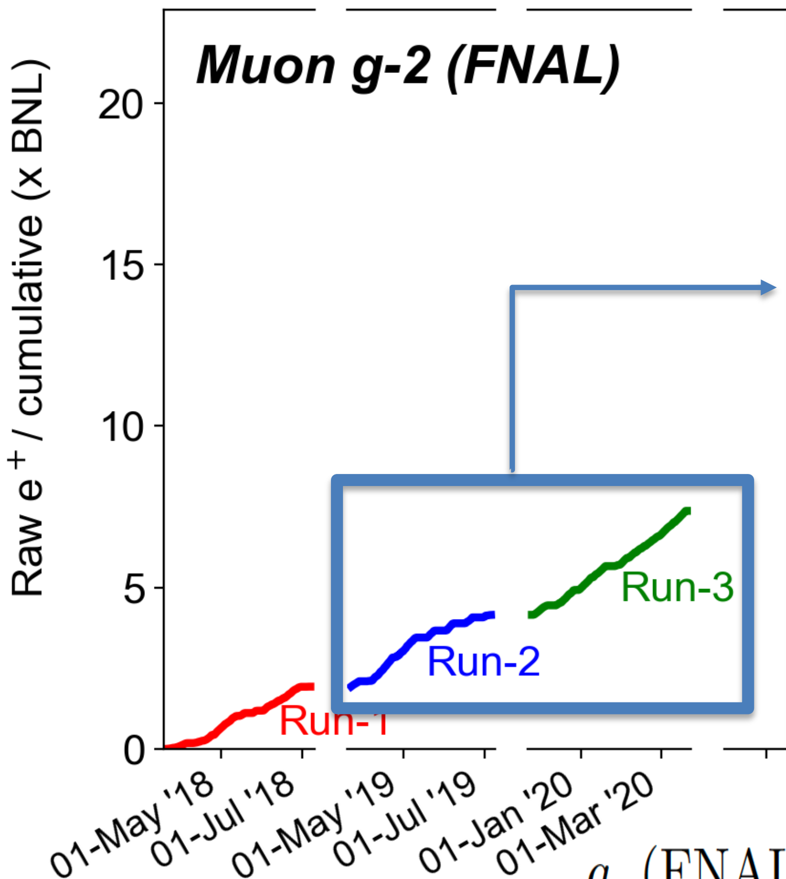


$$a_\mu(\mathrm{FNAL}) = 116\,592\,040(54) \times 10^{-11} \quad (0.46\,\mathrm{ppm})$$

4 Phys Rev journals on April 2021(>1700 citations)



10 August 2023: We released our new result



$$a_\mu(\mathrm{FNAL}) = 116\,592\,055(24) \times 10^{-11} \quad (0.20 \ \mathrm{ppm})$$

submitted to PRL on 10 August 2023

https://arxiv.org/pdf/2308.06230.pdf

Measurement of the Positive Muon Anomalous Magnetic Moment to 0.20 ppm

D. P. Aguillard,[33] T. Albahri,[30] D. Allspach,[7] A. Anisenkov,[4,a] K. Badgley,[7] S. Baeßler,[35,b] I. Bailey,[17,c] L. Bailey,[27] V. A. Baranov,[15,d] E. Barlas-Yucel,[28] T. Barrett,[6] E. Barzi,[7] F. Bedeschi,[10] M. Berz,[18] M. Bhattacharya,[7] H. P. Binney,[36] P. Bloom,[19] J. Bono,[7] E. Bottalico,[30] T. Bowcock,[30] S. Braun,[36] M. Bressler,[32] G. Cantatore,[12,e] R. M. Carey,[2] B. C. K. Casey,[7] D. Cauz,[26,f] R. Chakraborty,[29] A. Chapelain,[6] S. Chappa,[7] S. Charity,[30] C. Chen,[23,22] M. Cheng,[28] R. Chislett,[27] Z. Chu,[22,g] T. E. Chupp,[33] C. Claessens,[36] M. E. Convery,[7] S. Corrodi,[1] L. Cotrozzi,[10,h] J. D. Crnkovic,[7] S. Dabagov,[8,i] P. T. Debevec,[28] S. Di Falco,[10] G. Di Sciascio,[11] B. Drendel,[7] A. Driutti,[10,h] V. N. Duginov,[15,d] M. Eads,[20] A. Edmonds,[2] J. Esquivel,[7] M. Farooq,[33] R. Fatemi,[29] C. Ferrari,[10,j] M. Fertl,[14] A. T. Fienberg,[36] A. Fioretti,[10,j] D. Flay,[32] S. B. Foster,[2] H. Friedsam,[7] N. S. Froemming,[20] C. Gabbanini,[10,j] I. Gaines,[7] M. D. Galati,[10,h] S. Ganguly,[7] A. Garcia,[36] J. George,[32,k] L. K. Gibbons,[6] A. Gioiosa,[25,l] K. L. Giovanetti,[13] P. Girotti,[10] W. Gohn,[29] L. Goodenough,[7] T. Gorringe,[29] J. Grange,[33] S. Grant,[1,27] F. Gray,[21] S. Haciomeroglu,[5,m] T. Halewood-Leagas,[30] D. Hampai,[8] F. Han,[29] J. Hempstead,[36] D. W. Hertzog,[36] G. Hesketh,[27] E. Hess,[10] A. Hibbert,[30] Z. Hodge,[36] K. W. Hong,[35] R. Hong,[29] T. Hu,[23,22] Y. Hu,[22,g] M. Iacovacci,[9,n] M. Incagli,[10] P. Kammel,[36] M. Kargiantoulakis,[7] M. Karuza,[12,o] J. Kaspar,[36] D. Kawall,[32] L. Kelton,[29] A. Keshavarzi,[31] D. S. Kessler,[32] K. S. Khaw,[23,22] Z. Khechadoorian,[6] N. V. Khomutov,[15] B. Kiburg,[7] M. Kiburg,[7,19] O. Kim,[34] N. Kinnaird,[2] E. Kraegeloh,[33] V. A. Krylov,[15] N. A. Kuchinskiy,[15] K. R. Labe,[6] J. LaBounty,[36] M. Lancaster,[31] S. Lee,[5] B. Li,[22,1,p] D. Li,[22,q] L. Li,[22,g] I. Logashenko,[4,a] A. Lorente Campos,[29] Z. Lu,[22,g] A. Lucà,[7] G. Lukicov,[27] A. Lusiani,[10,r] A. L. Lyon,[7] B. MacCoy,[36] R. Madrak,[7] K. Makino,[18] S. Mastroianni,[9] J. P. Miller,[2] S. Miozzi,[11] B. Mitra,[34] J. P. Morgan,[7] W. M. Morse,[3] J. Mott,[7,2] A. Nath,[9,n] J. K. Ng,[23,22] H. Nguyen,[7] Y. Oksuzian,[1] Z. Omarov,[16,5] R. Osofsky,[36] S. Park,[5] G. Pauletta,[26,s] G. M. Piacentino,[25,t] R. N. Pilato,[30] K. T. Pitts,[28,u] B. Plaster,[29] D. Počanić,[35] N. Pohlman,[20] C. C. Polly,[7] J. Price,[30] B. Quinn,[34] M. U. H. Qureshi,[14] S. Ramachandran,[1,k] E. Ramberg,[7] R. Reimann,[14] B. L. Roberts,[2] D. L. Rubin,[6] L. Santi,[26,f] C. Schlesier,[28,v] A. Schreckenberger,[7] Y. K. Semertzidis,[5,16] D. Shemyakin,[4,a] M. Sorbara,[11,w] D. Stöckinger,[24] J. Stapleton,[7] D. Still,[7] C. Stoughton,[7] D. Stratakis,[7] H. E. Swanson,[36] G. Sweetmore,[31] D. A. Sweigart,[6] M. J. Syphers,[20] D. A. Tarazona,[6,30,18] T. Teubner,[30] A. E. Tewsley-Booth,[29,33] V. Tishchenko,[3] N. H. Tran,[2,x] W. Turner,[30] E. Valetov,[18] D. Vasilkova,[27,30] G. Venanzoni,[30,l] V. P. Volnykh,[15] T. Walton,[7] A. Weisskopf,[18] L. Welty-Rieger,[7] P. Winter,[1] Y. Wu,[1] B. Yu,[34] M. Yucel,[7] Y. Zeng,[23,22] and C. Zhang[30]

(The Muon $g-2$ Collaboration)

Wide coverage!

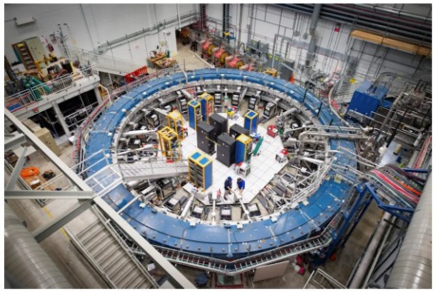
Muon g-2

The New York Times

Physicists Move One Step Closer to a Theoretical Showdown

The deviance of a tiny particle called the muon might prove that one of the most well-tested theories in physics is incomplete.

Share full article 480



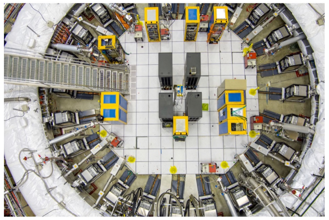
The Muon g-2 ring at the Fermilab particle accelerator complex in Batavia, Ill. Reidar Hahn/Fermilab, via US Department of Energy

By Katrina Miller
Katrina Miller, a science reporter, recently earned a Ph.D. in particle physics from the University of Chicago.

NEWS INFN

10 AGOSTO 2023

MUON g-2 RADDOPPIA LA PRECISIONE E SI PREPARA AL CONFRONTO FINALE CON LA TEORIA

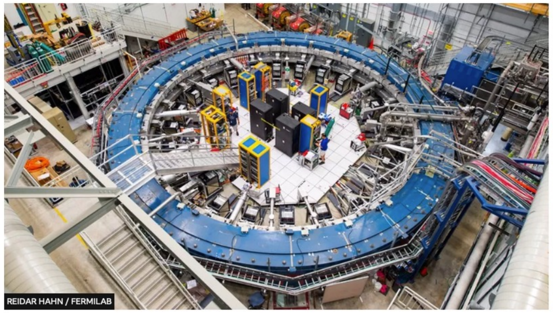


Una nuova e ancora più precisa misura di una particolare proprietà magnetica del muone, il cosiddetto *momento magnetico anomalo* (indicato con la lettera g), è stata presentata oggi, 10 agosto, nel corso di un seminario, dalla Collaborazione scientifica dell'esperimento Muon g-2 del Fermi National Accelerator Laboratory (FermiLab) di Batavia, vicino Chicago, Stati Uniti. La nuova

Scientists at Fermilab close in on fifth force of nature

4 days ago

BBC



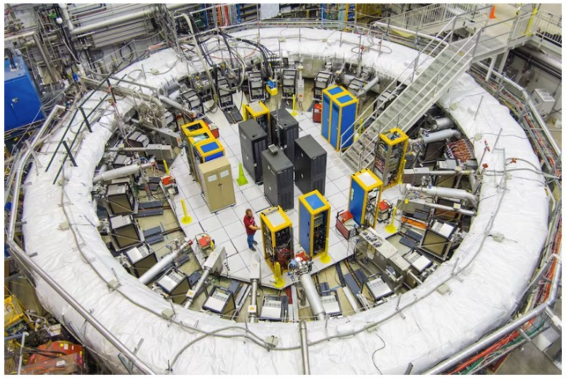
The findings come from the US muon g-2 experiment

By Pallab Ghosh

The Washington Post
Democracy Dies in Darkness

New measurements of a tiny particle deepen a big mystery in physics

By Michael Greshko
August 10, 2023 at 11:43 a.m. EDT

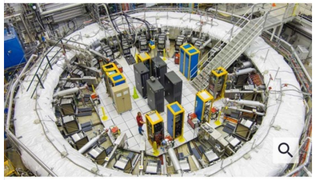


Scientists at Fermilab in Illinois took the most precise measurements yet of the way the muon subatomic particle behaves. (Fermilab)

Süddeutsche Zeitung

Das Myon im Quantenschaum

10. August 2023, 17:31 Uhr | Lesezeit: 3 min



Der Speicherring des Muon-g-2-Experiments am Fermilab bei Chicago. (Foto: FNAL)

Ein internationales Team hat das magnetische Moment des Myon-Teilchens neu vermessen. Das Ergebnis passt nicht zur Vorhersage. Ist die Theorie falsch oder nur die Rechnung?

Von Marlene Weiß

Anhören Merken Teilen Feedback

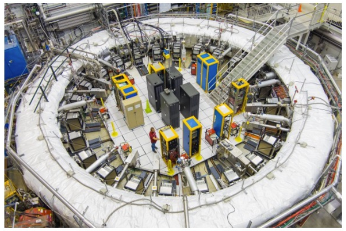
동아사이언스

과학

기본입자 '뮤온'의 일탈 재확인…흔들리는 물리학 '표준모형'

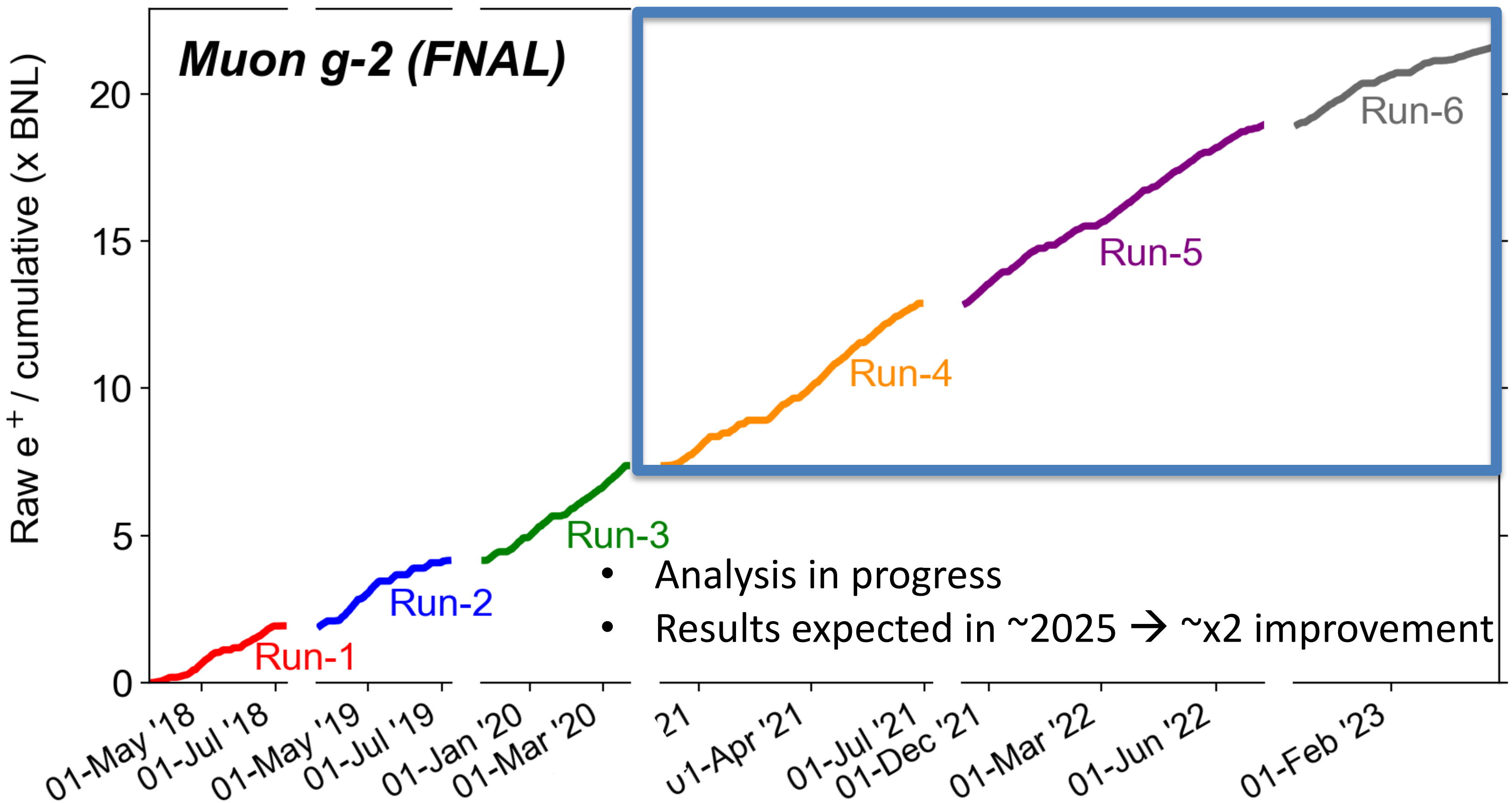
2023.08.11 16:10

| 미국 페르미국립연구소



두 번째 뮤온 실험에서 표준모형이 예측한 g값과 미세하게 벗어나는 값이 측정됐다. Fermilab 제공

Run-4/5/6: more than x3 Run-1/2/3 data



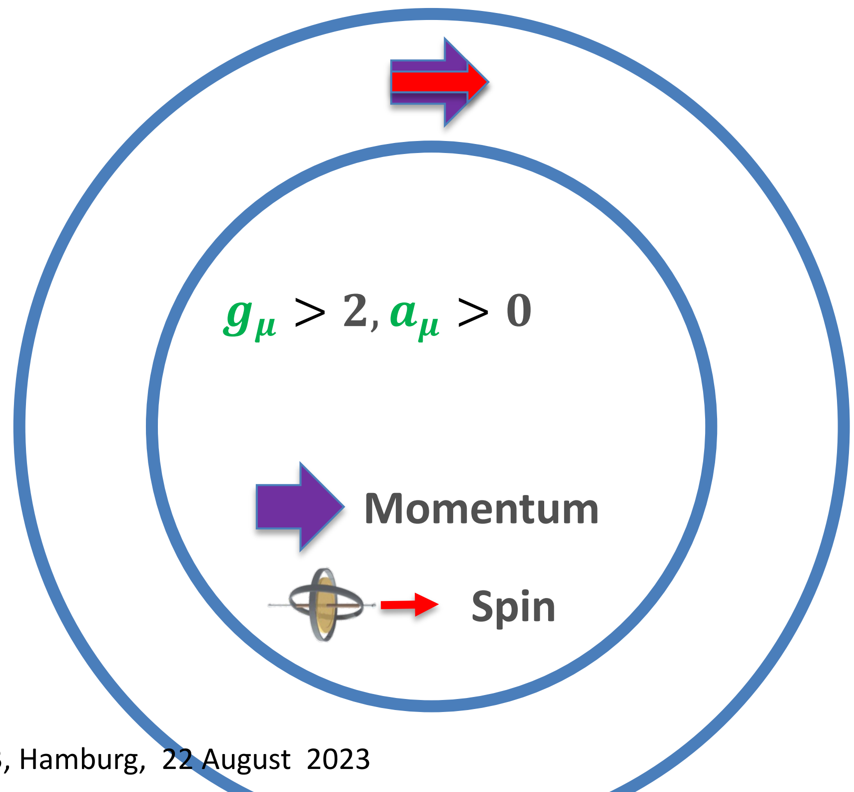
- Analysis in progress
- Results expected in ~2025 → ~x2 improvement

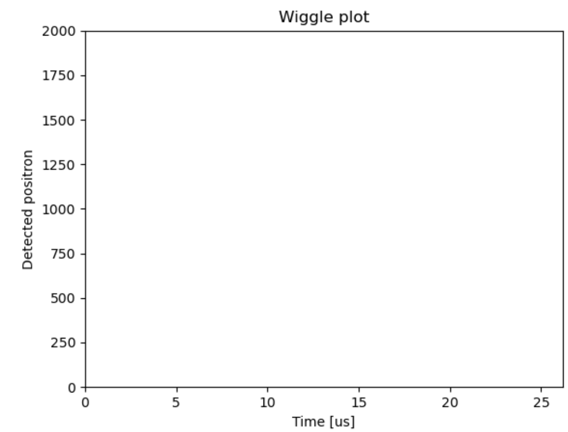
How to measure a_μ =(g-2)/2…

- The frequency with which the spin moves ahead of the momentum in a magnetic field B (anomalous precession frequency ω_a) is:

$$\omega_a = \omega_s - \omega_c = a\frac{eB}{m}$$

- If g>2 (a>0) spin advances respect to the momentum



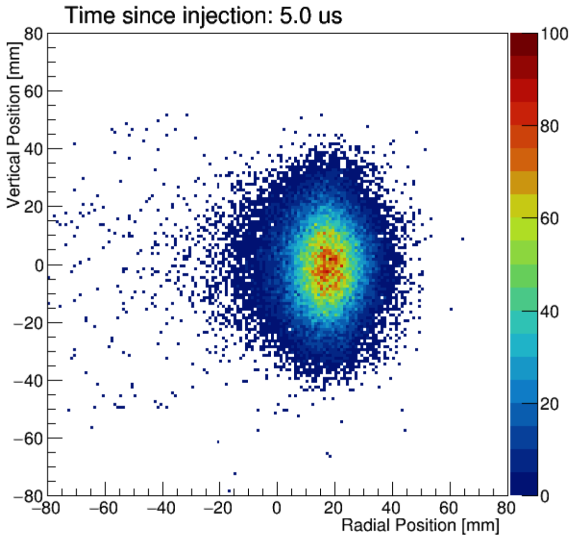


By measuring directly a_μ x800 more sensitive than an experiment which measures g

Current experiments δa_μ < 1ppm

However there are beam dynamics effects

- The muon beam oscillates and breathes as a whole
- The full equation is more complex and corrections due to radial (x) and vertical (y) beam motion are needed



$$\vec{\omega}_a = \vec{\omega}_s - \vec{\omega}_c = = -\frac{e}{mc}\left[a_\mu \vec{B} - \left(a_\mu - \frac{1}{\gamma^2 - 1}\right)\vec{\beta}\times\vec{E} - a_\mu\left(\frac{\gamma}{\gamma+1}\right)(\vec{\beta}\cdot\vec{B})\vec{\beta}\right]$$

- Running at γ_{magic}=29.3 (p=3.094 GeV/c) this coefficient is null
- Because of momentum spread (<0.2%)→ **E-field Correction**

- Vertical beam oscillation → **Pitch correction**

Extracting a_μ

Muon g-2

Corrections due to beam dynamics

$$\frac{\omega_a}{\omega_p} = \frac{\omega_a^m}{\omega_p^m} \frac{1 + C_e + C_p + C_{pa} + C_{dd} + C_{ml}}{1 + B_k + B_q}$$

Measured Values

Corrections due to transient magnetic fields

$$a_\mu = \boxed{\frac{\omega_a}{\omega_p}} \times \frac{\mu_p'(T_r)}{\mu_e(H)} \frac{\mu_e(H)}{\mu_e} \frac{m_\mu}{m_e} \frac{g_e}{2}$$

All these quantities have been evaluated throughout in the analysis of Run2/3 data: Total correction is **622 ppb**, dominated by **E-field & Pitch**

If you want to know more…

Muon g-2

Sean's talk | **On's talk**

$$\frac{\omega_a}{\omega_p} = \frac{\omega_a^m}{\omega_p^m}\frac{1 + C_e + C_p + C_{pa} + C_{dd} + C_{ml}}{1 + B_k + B_q}$$

Saskia's talk

599. Measurement of the muon anomalous precession frequency ω_a in the Fermilab $g-2$ experiment
Sean Foster
8/21/23, 4:45 PM
Flavour Physics and CP... | Parallel session talk | T08 Flavour Physics an...

Sean Foster: Anomalous precession frequency

601. Measurement of the precision magnetic field in the Fermilab Muon g−2 experiment
Saskia Charity (FNAL)
8/21/23, 5:02 PM
Flavour Physics and CP... | Parallel session talk | T08 Flavour Physics an...

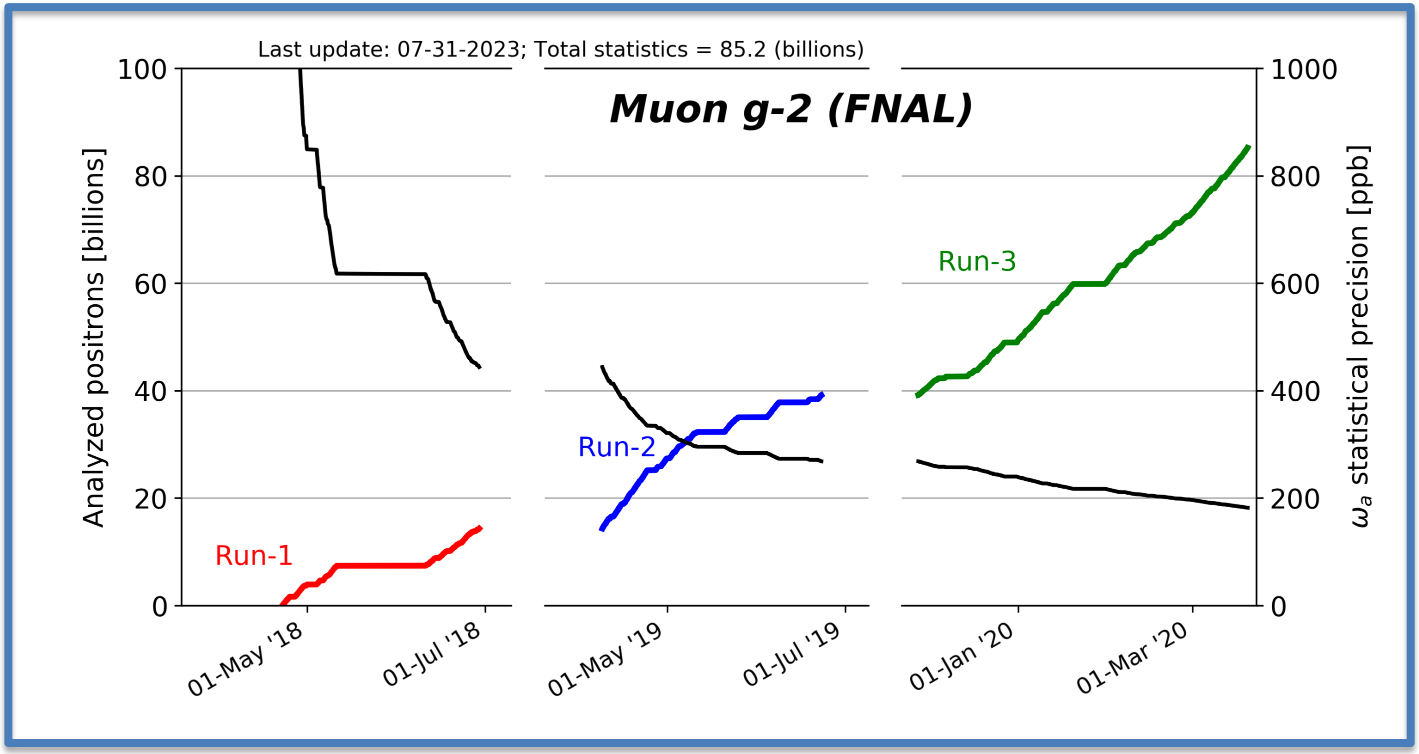
Saskia Charity: Magnetic field

603. Beam dynamics corrections to measurements of the muon anomalous magnetic moment
On Kim
8/21/23, 5:19 PM
Flavour Physics and CP... | Parallel session talk | T08 Flavour Physics an...

On Kim: Beam dynamics corrections

Run-2/3 Improvement: Statistics

Number of e+ with E > 1 GeV t > 30 μs

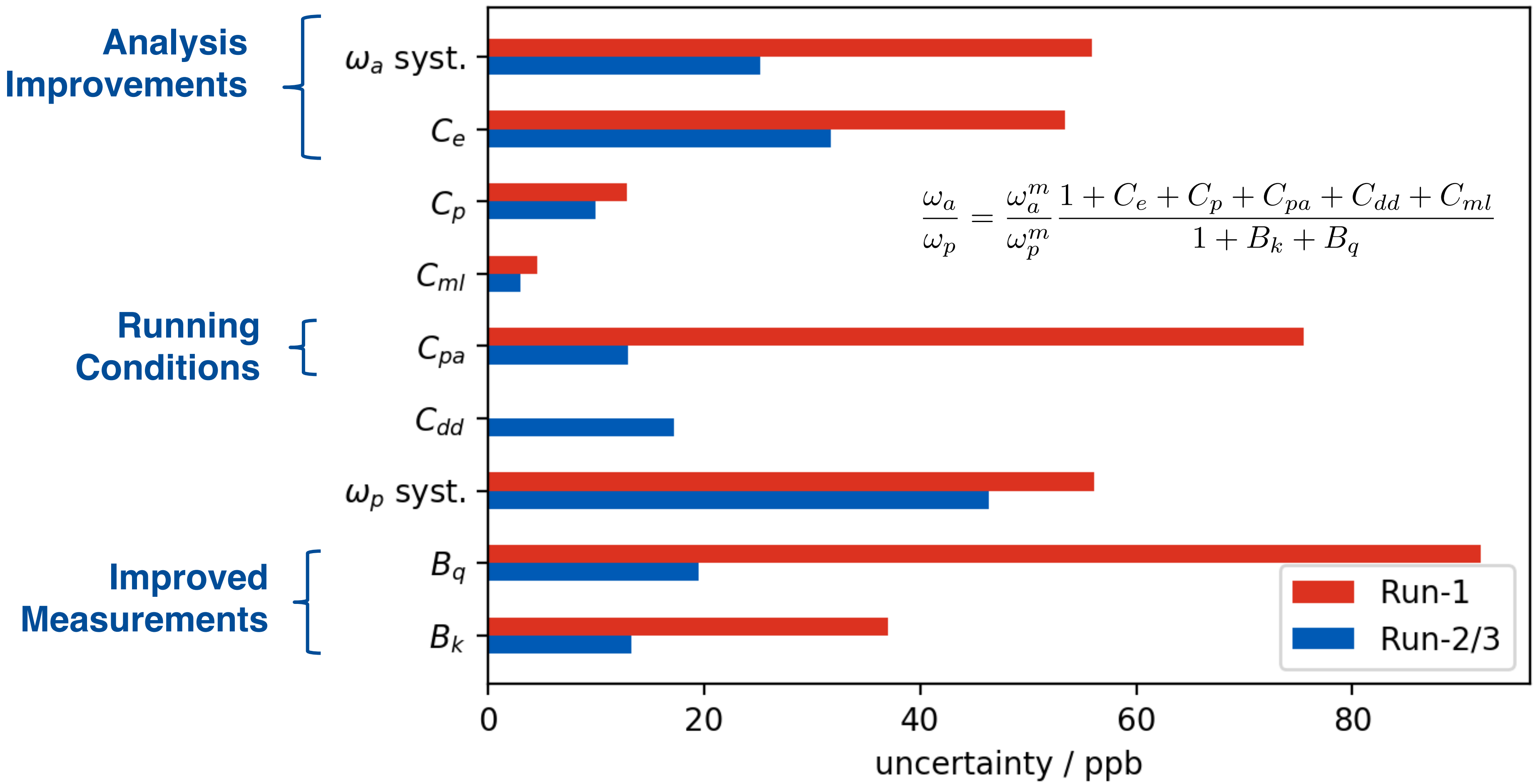


- Factor 4.7 more data in Run-2/3 than Run-1

Dataset	Statistical Error [ppb]
Run-1	434
Run-2/3	201
Run-1 + Run-2/3	185

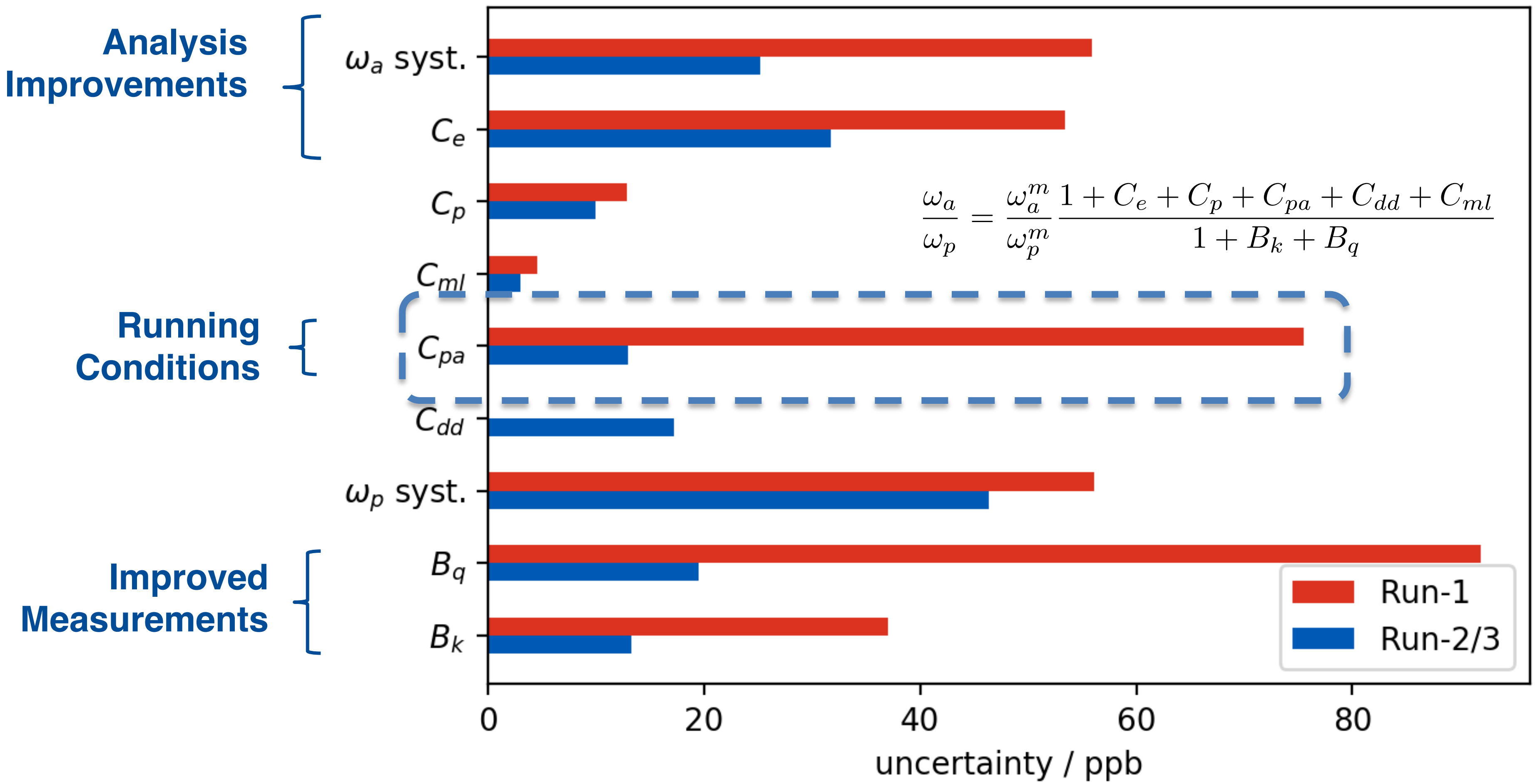
Run-2/3 Improvement: Systematics

- Systematic improvements in **all parameters**



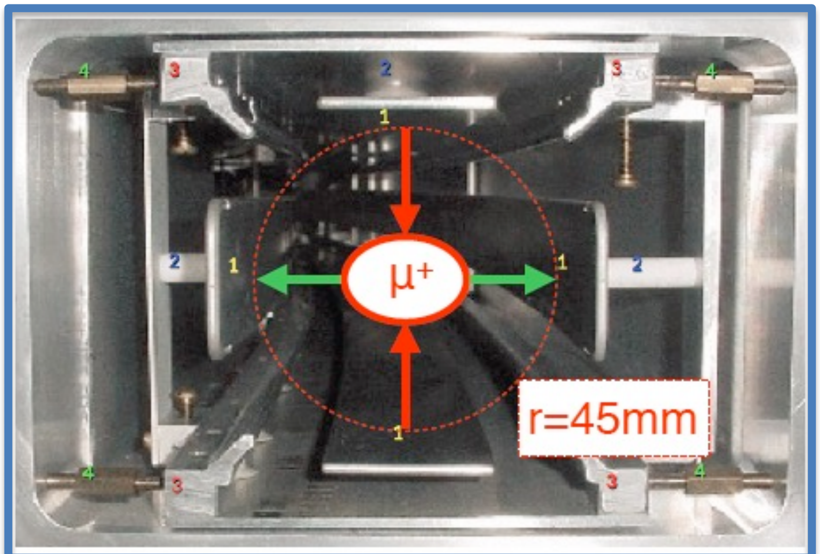
Run-2/3 Improvement: Systematics

- Systematic improvements in **all parameters**

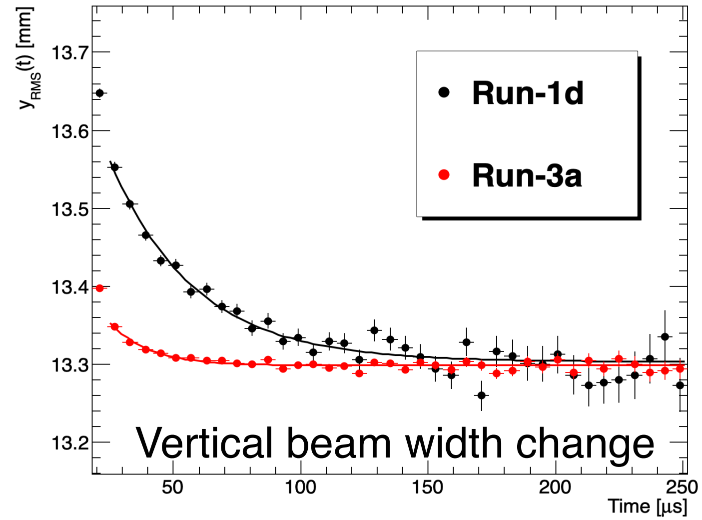


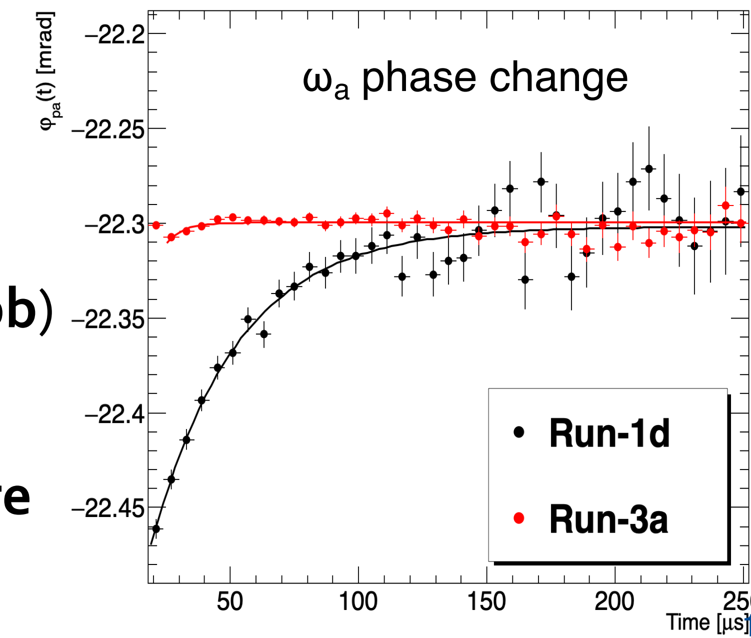
Running Conditions: Damaged Quad Resistors

- Run-1 had **damaged resistors** in 2/32 quad plates leading to **unstable beam storage**
- Resistors **replaced before Run-2**



- C_{pa} uncertainty is reduced (**75 ppb** $\longrightarrow$ **13 ppb**) thanks to a more stable beam
- Beam **oscillation frequencies** are also **more stable**





Other systematic improvements

Muon g-2

- **Running conditions:**
  - Improved cooling of the hall and added insulation of the magnet which made the magnetic field more stable
  - Improved kicker strength which made the orbit more centered and reduced the E-field correction
- **Improved measurements:**
  - Extensive measurement of vibration the quadrupoles in multiple locations around the ring
  - Reduced vibration noise for kicker transient field measurement
- **Analysis improvements:**
  - Improved treatment of the pileup for ω_a analysis
  - Improved analysis of E-field correction including correlations between momentum & time of injection.

Run-2/3 Uncertainties

Quantity	Correction [ppb]	Uncertainty [ppb]
ω_a^m (statistical)	–	201
ω_a^m (systematic)	–	25
C_e	451	32
C_p	170	10
C_{pa}	-27	13
C_{dd}	-15	17
C_{ml}	0	3
$f_{\text{calib}} \langle \omega'_p(\vec{r}) \times M(\vec{r}) \rangle$	–	46
B_k	-21	13
B_q	-21	20
$\mu'_p(34.7^\circ)/\mu_e$	–	11
m_μ/m_e	–	22
$g_e/2$	–	0
Total systematic	–	70
Total external parameters	–	25
Totals	622	215

- Total uncertainty is **215 ppb**

[ppb]	Run-1	Run-2/3	Ratio
Stat.	434	**201**	2.2
Syst.	157	**70**	2.2

- Near-equal improvement: We're still **statistically dominated**

Systematic uncertainty of 70 ppb surpasses our proposal goal of 100 ppb!

July 24th 2023: Unblinding

Muon g-2

- Muon g-2 analysis has **software & hardware blinding**
- Unblinding meeting in Liverpool:

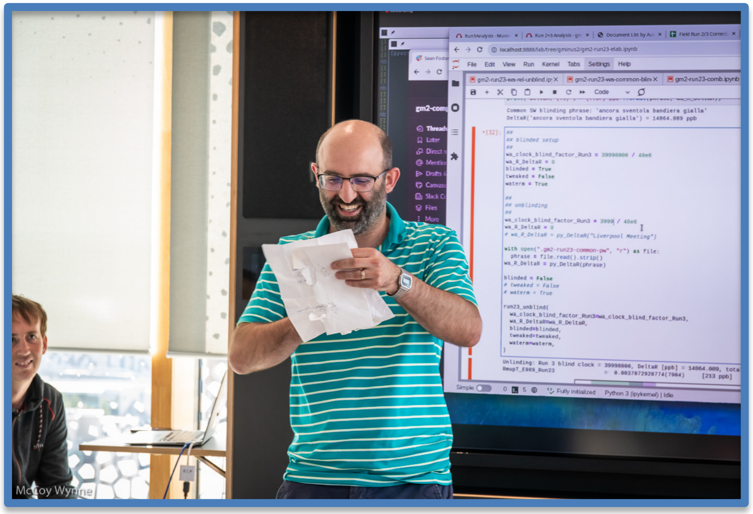
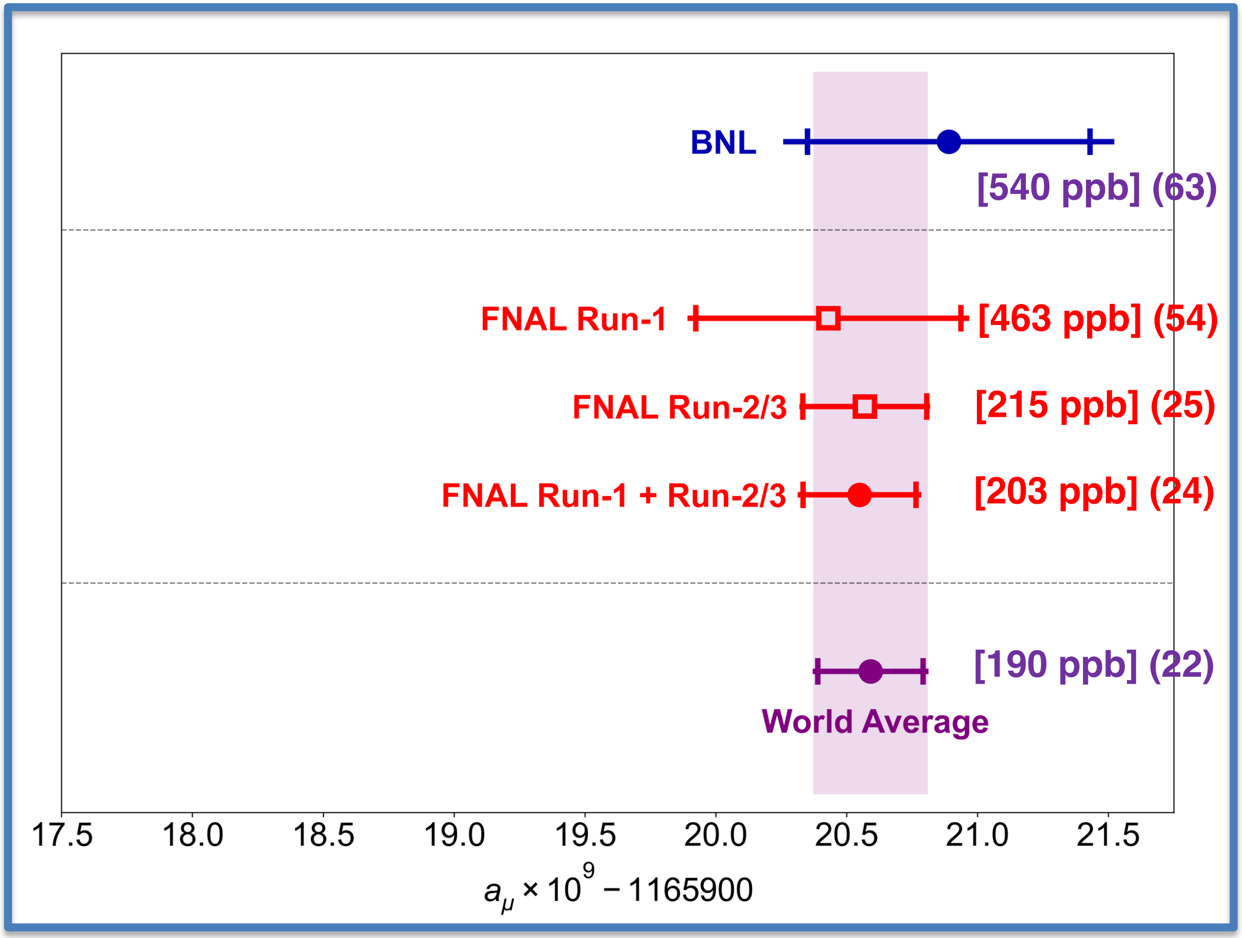


Photo credits: McCoy Wynne

- Unanimous vote from all collaborators to unblind!
- Secret envelopes were finally opened to reveal the hidden clock frequencies and the result…

Run-2/3 Result: FNAL + BNL Combination

$a_\mu(\text{FNAL}) = 116\ 592\ 055(24) \times 10^{-11}$ [203 ppb]

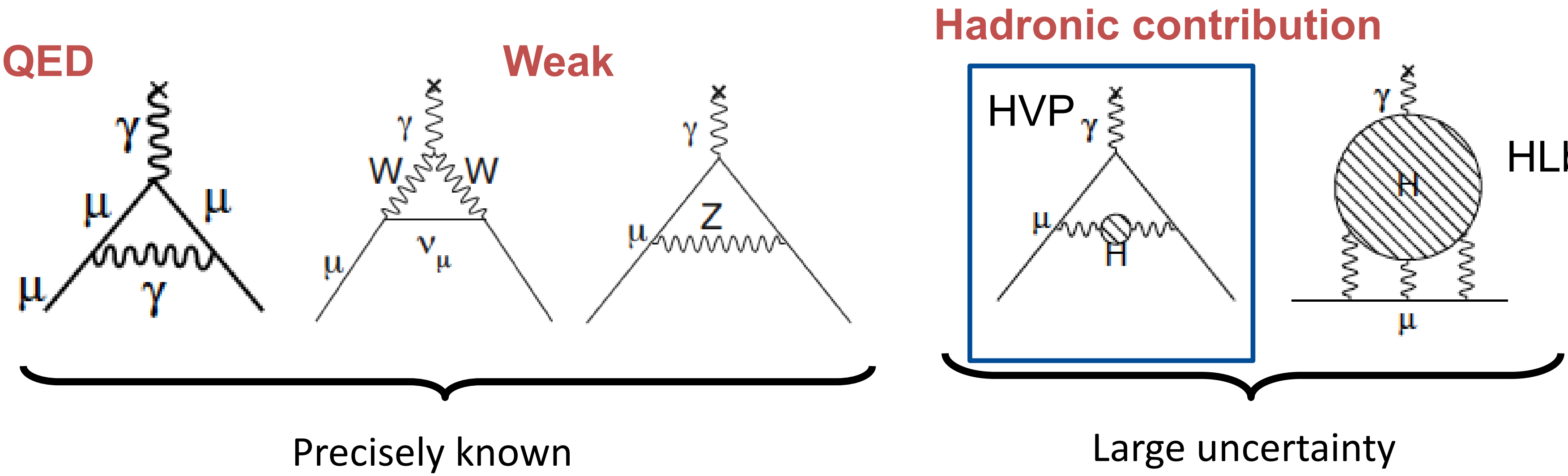


- FNAL combination: **203 ppb** uncertainty
- Both FNAL and BNL dominated by statistical error
- Combined world average **dominated by FNAL** values.

$a_\mu(\text{Exp}) = 116\ 592\ 059(22) \times 10^{-11}$ [190 ppb]

SM prediction: $a_\mu^{SM} = a_\mu^{QED} + a_\mu^{Had} + a_\mu^{Weak}$

Muon g-2

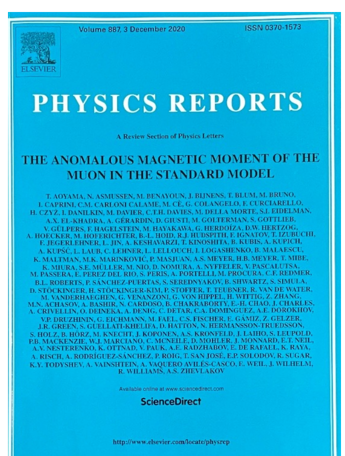


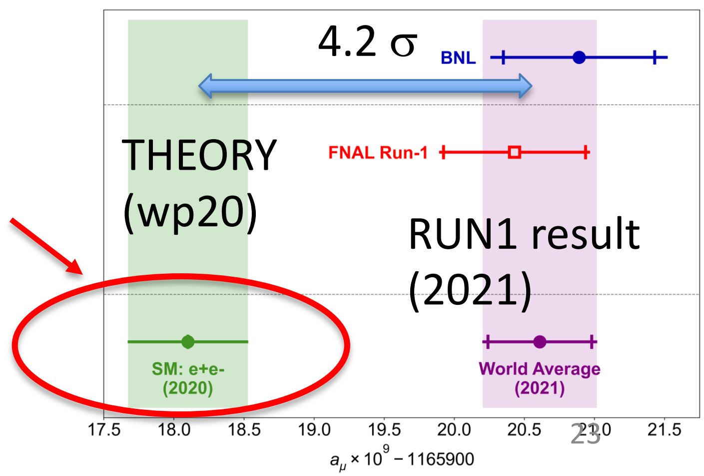
$$a_\mu(\mathrm{SM}) = 116\,591\,810(43) \times 10^{-11} \;\; (0.37\;\mathrm{ppm})$$

SM Prediction in 2020

Theory Initiative **(wp20):**
T. Aoyama et al. Phys. Rept. 887 (2020)

HVP based on e+e- hadronic cross section data

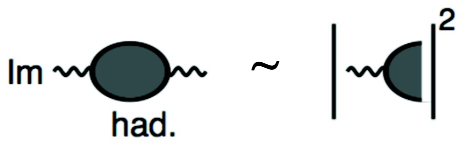




HVP Calculation: Dispersive (e^+e^-) Method

Muon g-2

- Calculated from data for $\sigma(e^+e^- \to \text{hadrons})$



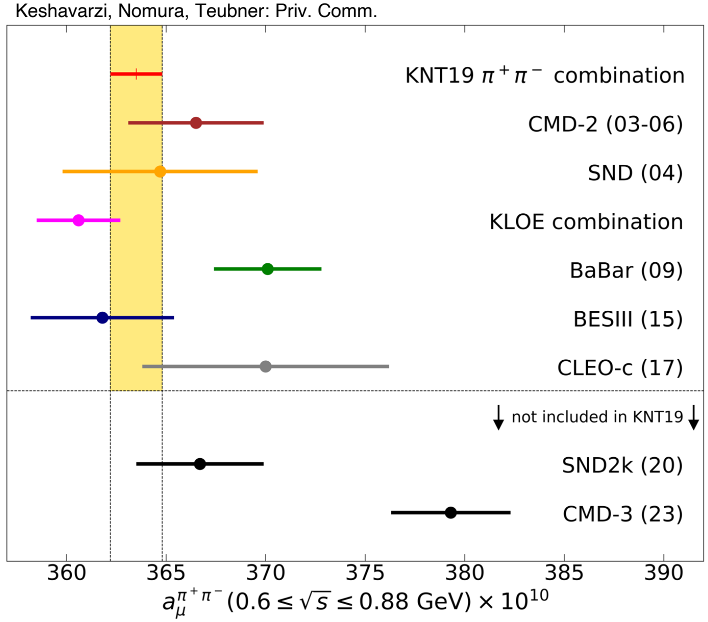
Analyticity & Unitarity

$$a_\mu^{\mathrm{HVP,LO}} = \frac{\alpha^2}{3\pi^2}\int_{s_{th}}^{\infty}\frac{K(s)}{s}R(s)\,ds$$

Hadronic R-ratio (Data Driven)

- Uses **data** from different experiments from **20+ years**
- 1/s weights low energy strongly: 73% from **$\pi^+\pi^-$ channel**

Keshavarzi, Nomura, Teubner: Priv. Comm.



inc. in wp20

NOT inc. in wp20

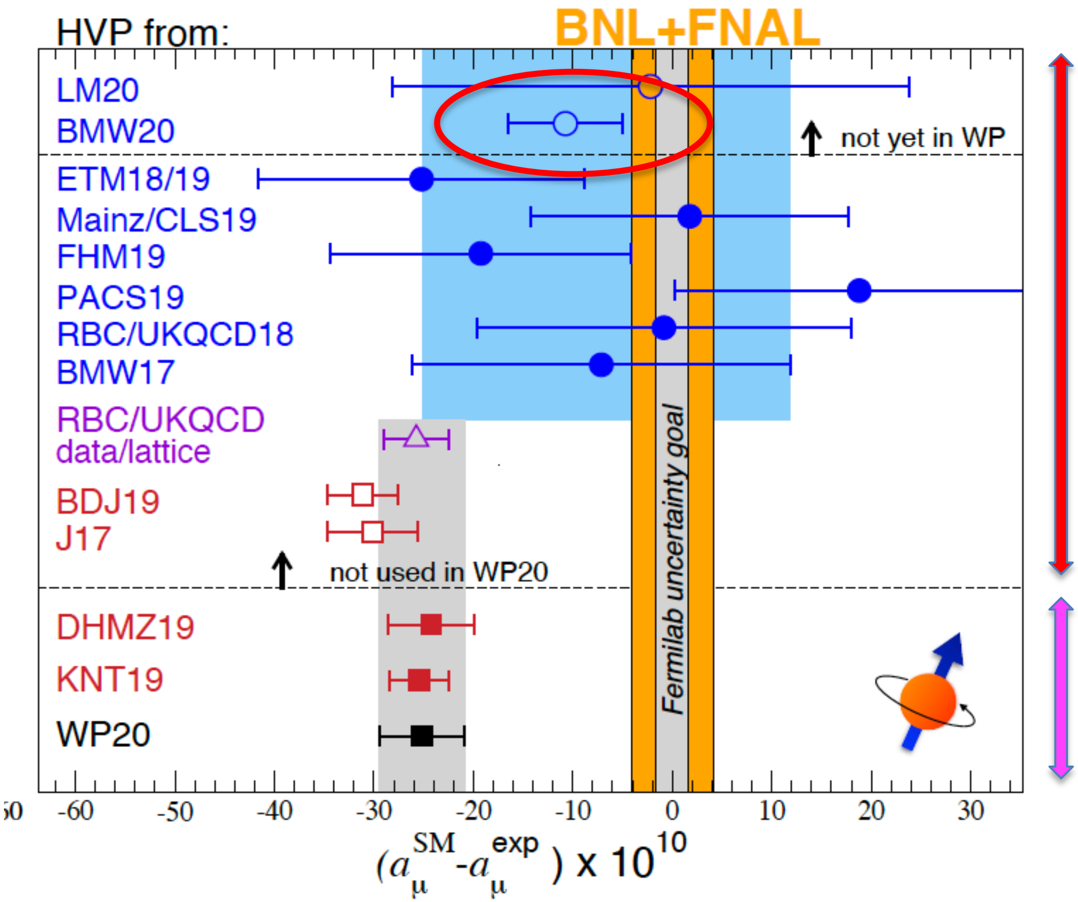
- Data from **CMD-2, SND, KLOE, BaBar, BESIII** and **CLEO-C** were included in wp20
- New results from **SND2k** and **CMD-3** after wp20
- **CMD-3 is different from all the other data**

HVP Calculation: Lattice QCD Method

Muon g-2

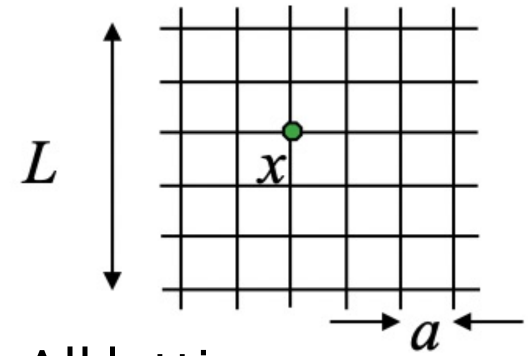
- ***Ab-initio*** calculation of HVP on lattice

G. Colangelo et al.
https://arxiv.org/pdf/2203.15810.pdf



NOT inc. in wp20

inc. in wp20



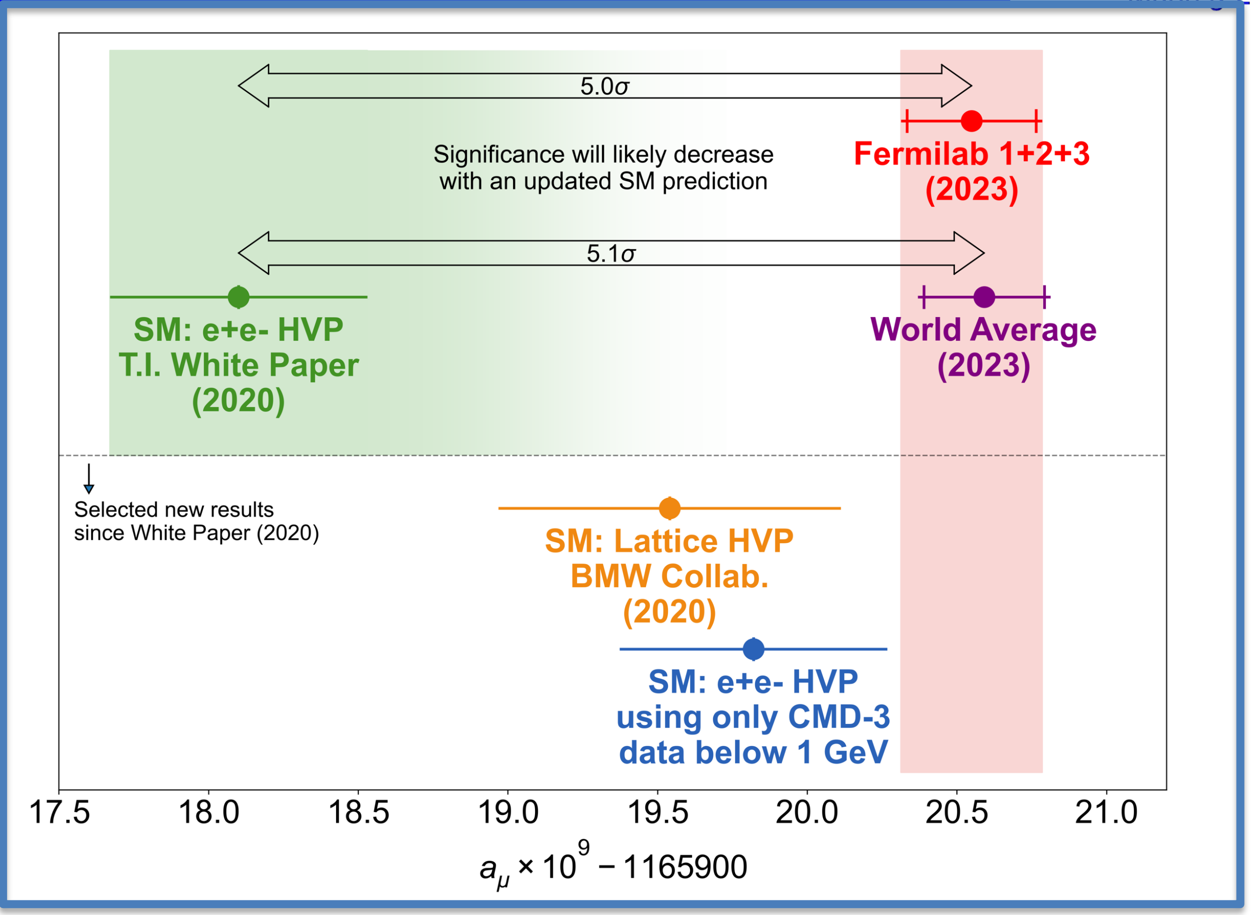
- All lattice calculations were not included in wp20
- **BMW** is only high precision calculation: closer to exp. Result

Comparison with SM prediction (2023)

Comparison with wp20

New results after 2020

Disclaimer: prediction from Lattice taken from Lattice 2023 talk; prediction from CMD3 based on our specific assumption

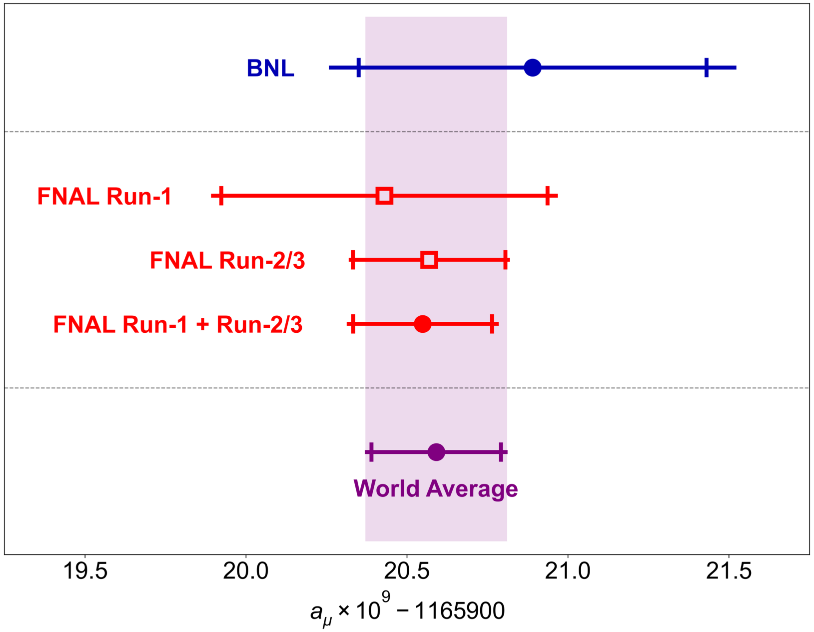


- Comparison of FNAL Run1-3 result with the Theory Initiative's calculation **wp20** is at **5 sigma**

- Waiting for a clarification of the theory

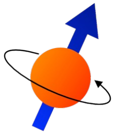
Conclusions

- We've measured a_μ to an unprecedented **203 ppb** precision



- New result is in **excellent agreement** with **Run-1 & BNL** → new **world average** has an uncertainty of **190 ppb**
- More than **halved the total uncertainty** from Run-1
- **Went beyond our design goal** with systematic uncertainty of **70 ppb**.

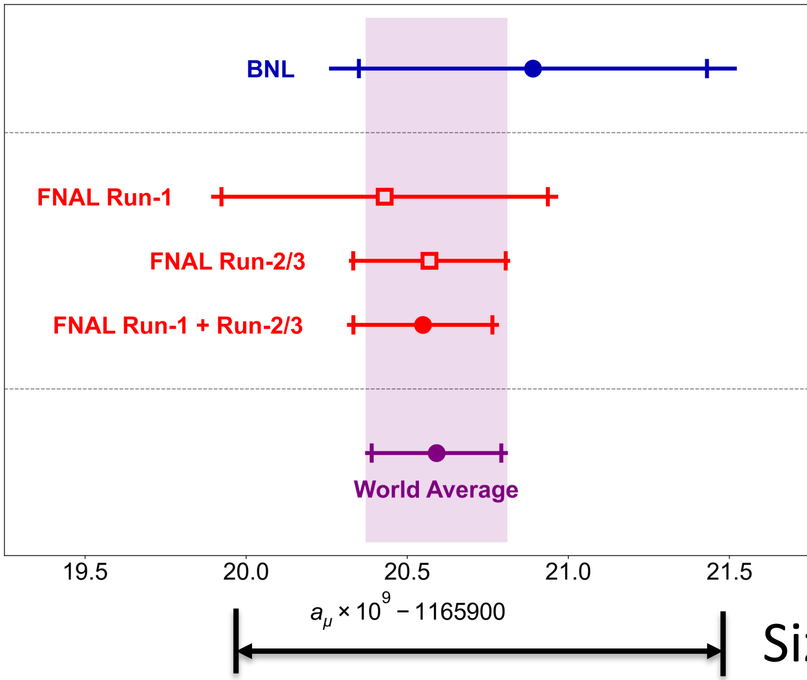
- A factor ~ x 3 **data** from Run4-6 with a projected twofold improvement on the uncertainty (analysis should be completed by 2025)
- Expect **theory improvement** on a similar timescale (https://muon-gm2-theory.illinois.edu/)
- Look out for other analyses too: **EDM, CPT/LV** and **Dark Matter** searches.



Conclusions

Muon g-2

- We've measured a_μ to an unprecedented **203 ppb** precision



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- More than **halved the total uncertainty** from Run-1
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Size of $a_\mu^{EW} = 153.6(1.0) \times 10^{-11}$

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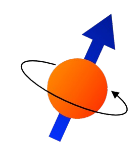
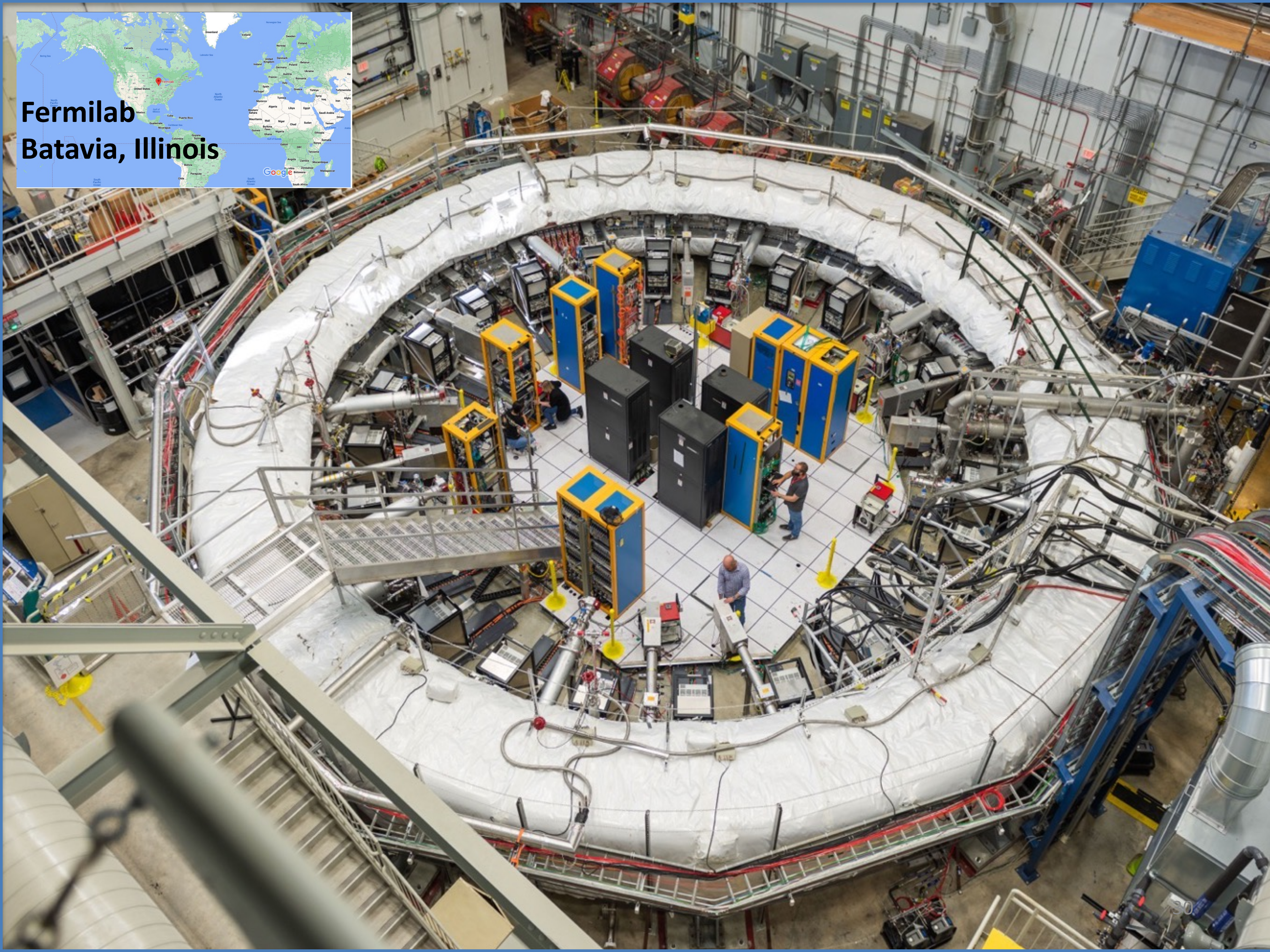


Acknowledgements

Muon g-2

- Department of Energy (USA),
- National Science Foundation (USA),
- Istituto Nazionale di Fisica Nucleare (Italy),
- Science and Technology Facilities Council (UK),
- Royal Society (UK),
- Leverhulme Trust (UK),
- European Union's Horizon 2020,
- Strong 2020 (EU),
- German Research Foundation (DFG),
- National Natural Science Foundation of China,
- MSIP, NRF and IBS-R017-D1 (Republic of Korea)


Fermilab
Batavia, Illinois

END

t [μs]

SM prediction

Muon g-2

Contribution	Section	Equation	Value $\times 10^{11}$	References
Experiment (E821)		Eq. (8.13)	116 592 089(63)	Ref. [1]
HVP LO (e^+e^-)	Sec. 2.3.7	Eq. (2.33)	6931(40)	Refs. [2–7]
HVP NLO (e^+e^-)	Sec. 2.3.8	Eq. (2.34)	−98.3(7)	Ref. [7]
HVP NNLO (e^+e^-)	Sec. 2.3.8	Eq. (2.35)	12.4(1)	Ref. [8]
HVP LO (lattice, *udsc*)	Sec. 3.5.1	Eq. (3.49)	7116(184)	Refs. [9–17]
HLbL (phenomenology)	Sec. 4.9.4	Eq. (4.92)	92(19)	Refs. [18–30]
HLbL NLO (phenomenology)	Sec. 4.8	Eq. (4.91)	2(1)	Ref. [31]
HLbL (lattice, *uds*)	Sec. 5.7	Eq. (5.49)	79(35)	Ref. [32]
HLbL (phenomenology + lattice)	Sec. 8	Eq. (8.10)	90(17)	Refs. [18–30, 32]
QED	Sec. 6.5	Eq. (6.30)	116 584 718.931(104)	Refs. [33, 34]
Electroweak	Sec. 7.4	Eq. (7.16)	153.6(1.0)	Refs. [35, 36]
HVP (e^+e^-, LO + NLO + NNLO)	Sec. 8	Eq. (8.5)	6845(40)	Refs. [2–8]
HLbL (phenomenology + lattice + NLO)	Sec. 8	Eq. (8.11)	92(18)	Refs. [18–32]
Total SM Value	Sec. 8	Eq. (8.12)	116 591 810(43)	Refs. [2–8, 18–24, 31–36]
Difference: $\Delta a_\mu := a_\mu^{\mathrm{exp}} - a_\mu^{\mathrm{SM}}$	Sec. 8	Eq. (8.14)	279(76)	

History of muon g-2 experiments (1960-2000)

Muon g-2

- The storage ring method was developed at CERN and improved at BNL through a series of experiments with increasing precision which allowed to test the SM at the level of strong (CERN) and EW (BNL) effects

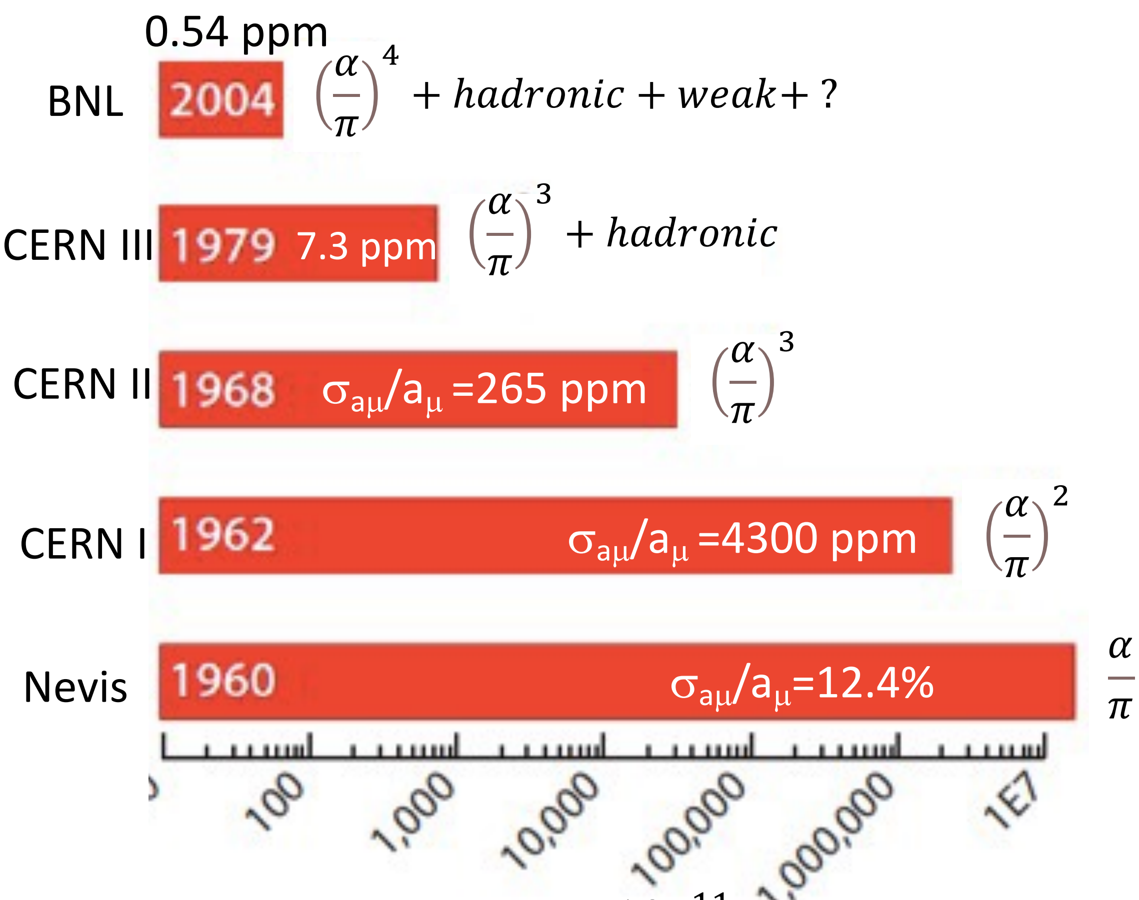
$\pm$	Measurement	σ_{a_μ}/a_μ	Sensitivity	Reference
μ^+	$g = 2.00 \pm 0.10$		$g = 2$	Garwin *et al*[30], Nevis (1957)
μ^+	$0.001\,13^{+0.00016}_{-0.00012}$	12.4%	$\frac{\alpha}{\pi}$	Garwin *et al*[33], Nevis (1959)
μ^+	0.001 145(22)	1.9%	$\frac{\alpha}{\pi}$	Charpak *et al*[34] CERN 1 (SC) (1961)
μ^+	0.001 162(5)	0.43%	$(\frac{\alpha}{\pi})^2$	Charpak *et al*[35] CERN 1 (SC) (1962)
$\mu^\pm$	0.001 166 16(31)	265 ppm	$(\frac{\alpha}{\pi})^3$	Bailey *et al*[36] CERN 2 (PS) (1968)
μ^+	0.001 060(67)	5.8%	$\frac{\alpha}{\pi}$	Henry*et al*[46] solenoid (1969)
$\mu^\pm$	0.001 165 895(27)	23 ppm	$(\frac{\alpha}{\pi})^3$ + Hadronic	Bailey *et al*[37] CERN 3 (PS) (1975)
$\mu^\pm$	0.001 165 911(11)	7.3 ppm	$(\frac{\alpha}{\pi})^3$ + Hadronic	Bailey *et al*[38] CERN 3 (PS) (1979)
μ^+	0.001 165 919 1(59)	5 ppm	$(\frac{\alpha}{\pi})^3$ + Hadronic	Brown *et al*[48] BNL (2000)
μ^+	0.001 165 920 2(16)	1.3 ppm	$(\frac{\alpha}{\pi})^4$ + Weak	Brown *et al*[49] BNL (2001)
μ^+	0.001 165 920 3(8)	0.7 ppm	$(\frac{\alpha}{\pi})^4$ + Weak + ?	Bennett *et al*[50] BNL (2002)
μ^-	0.001 165 921 4(8)(3)	0.7 ppm	$(\frac{\alpha}{\pi})^4$ + Weak + ?	Bennett *et al*[51] BNL (2004)
$\mu^\pm$	0.001 165 920 80(63)	0.54 ppm	$(\frac{\alpha}{\pi})^4$ + Weak + ?	Bennett *et al*[51, 26] BNL WA (2004)

J. Miller, E. De Rafael, L. Roberts, Rept. Prog. Phys. 70 (2007) 795

History of muon g-2 experiments (1960-2000)

0.54×10^{-6}

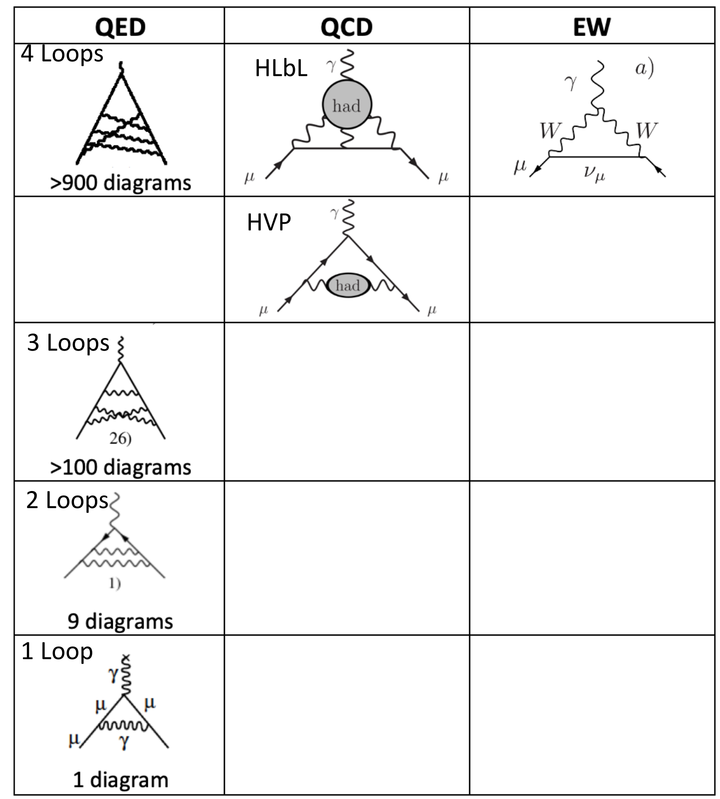
$$a_\mu^{BNL} = 116\,592\,089\,(63) \times 10^{-11}\ (2001)$$



Uncertainty on $a_\mu \times 10^{-11}$

contribution to $a_\mu\ (\times 10^{-11})$:

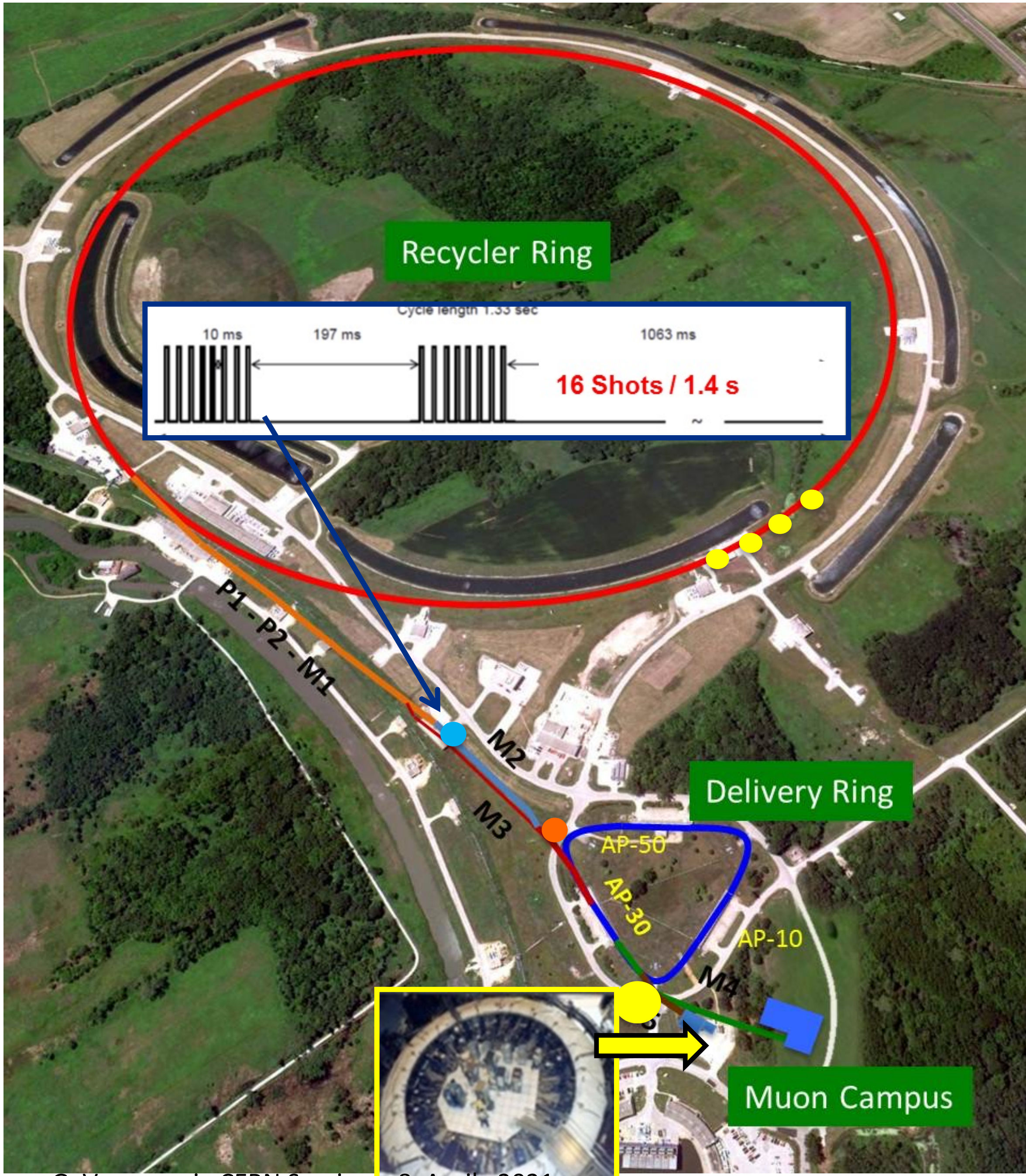
116 584 712…	*6937 (44)*	*153.6(1)*
(0.9999…)	(5.9×10^{-5})	(1.3×10^{-6})



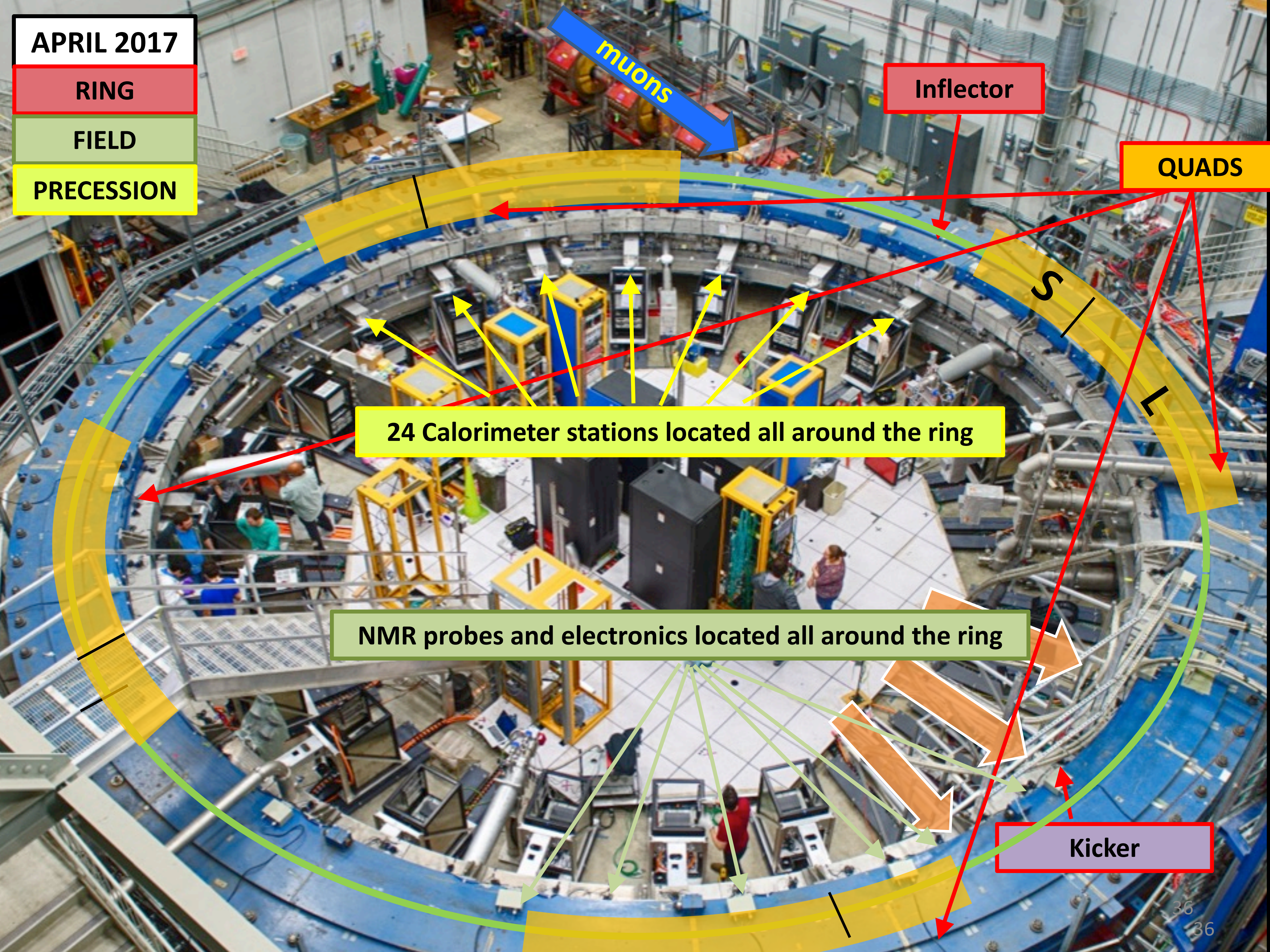
More in Martin's talk

Creating the Muon Beam for g-2

Muon g-2



- 8 GeV p batch into Recycler
- Split into 4 bunches
- Extract 1 by 1 to strike target
- Long FODO channel to collect $\pi \rightarrow \mu\nu$
- $p/\pi/\mu$ beam enters DR; protons kicked out; π decay away
- μ enter storage ring


APRIL 2017
RING
FIELD
PRECESSION
muons
Inflector
QUADS
S
L
24 Calorimeter stations located all around the ring
NMR probes and electronics located all around the ring
Kicker