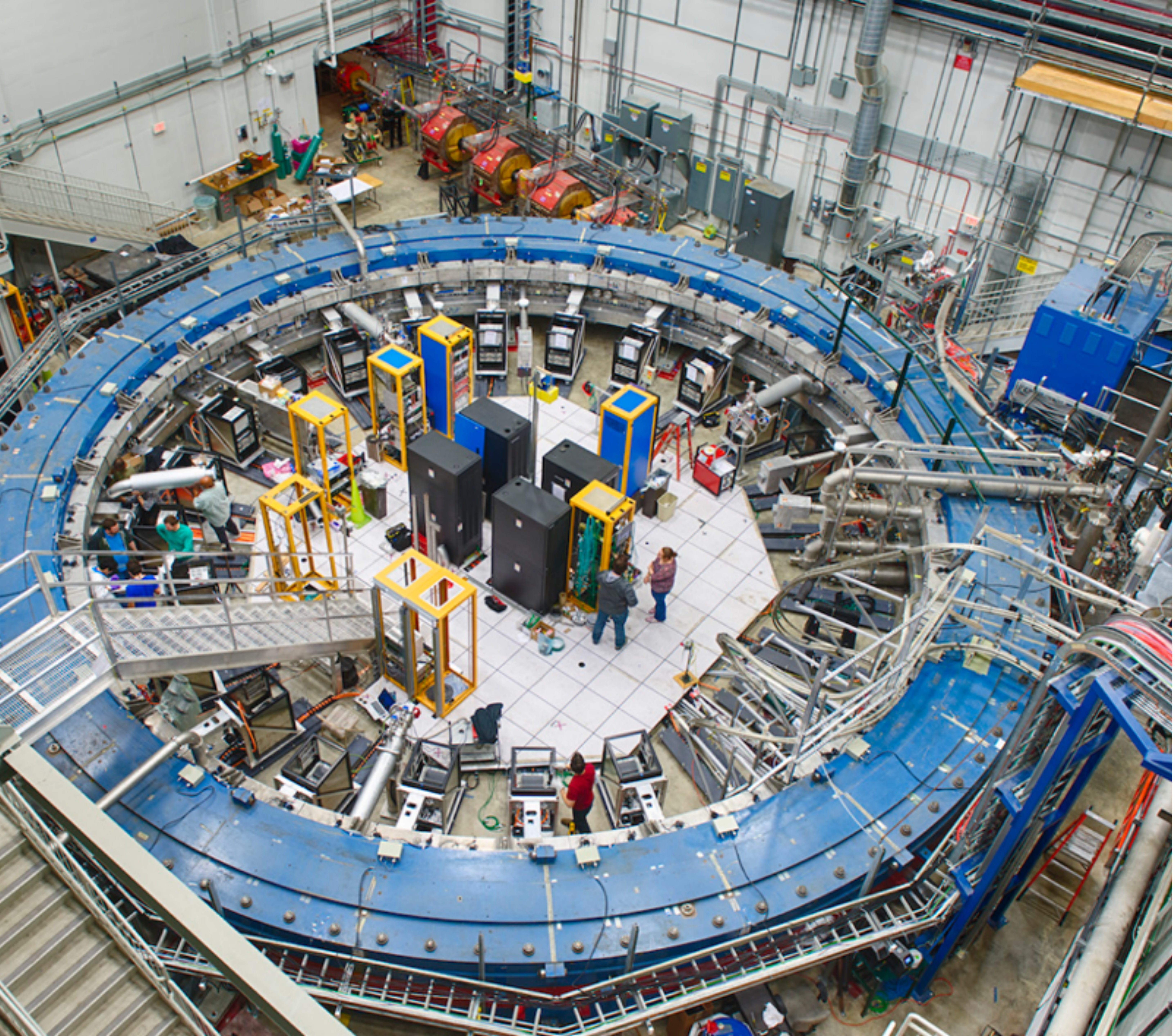

The first results of the Muon g-2 experiment at Fermilab

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CIPANP 2022

Orlando, FL, USA

August 30th, 2022

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Outline

The magnetic moment of a charged lepton

Muon g-2: Status of theory vs. experiment before April 7th, 2021

The Muon g-2 experiment at FNAL

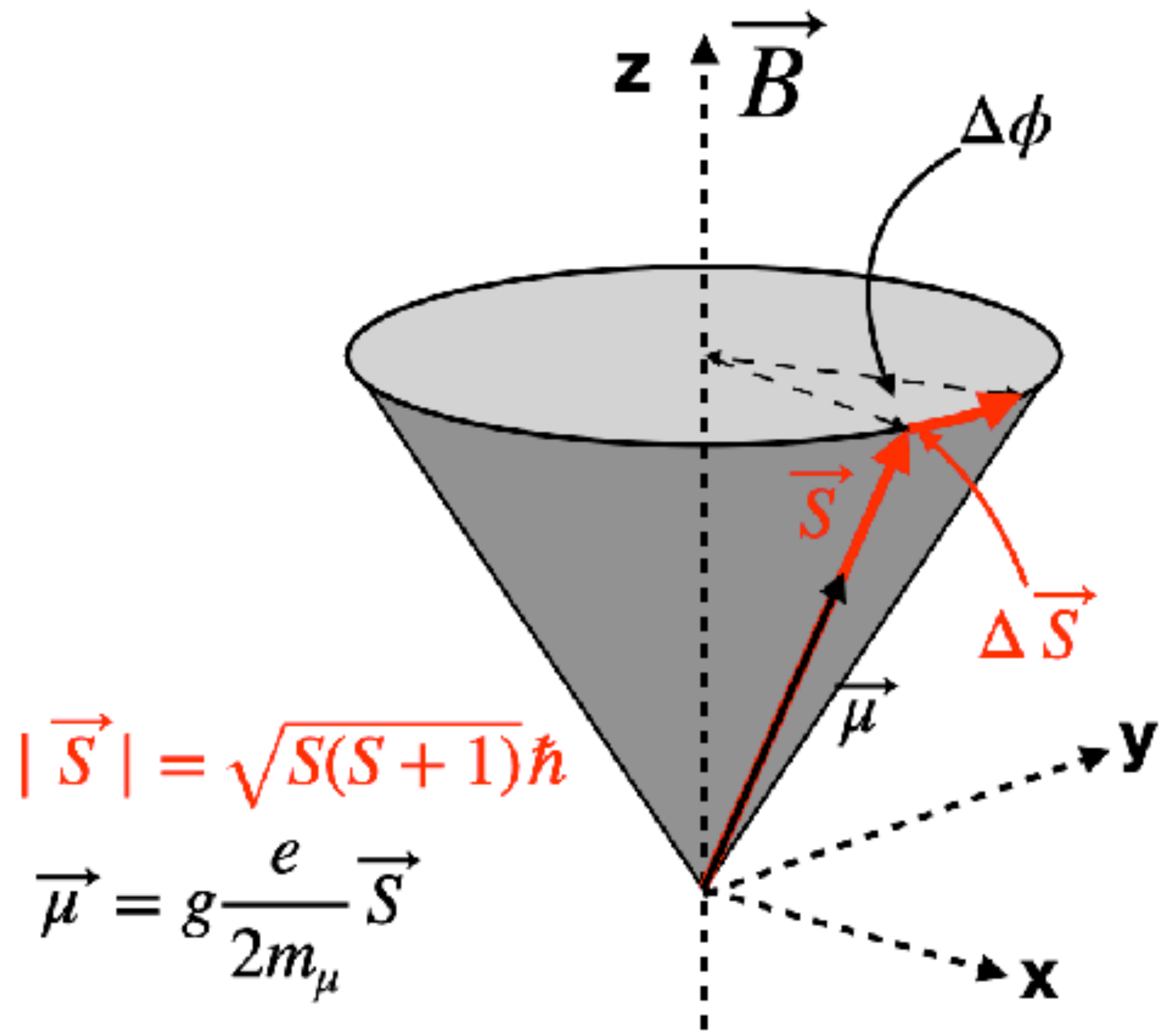
- The measurement principle
- The muon source
- The muon storage ring and its instrumentation

The data analysis chain

- The anomalous spin precession frequency and its corrections
- The precision magnetic field and its corrections

The current status of theory and experiment

The magnetic moment of a charged lepton



Particle with magnetic dipole moment and spin

$$\vec{\mu} = g\frac{q}{2m}\vec{s}$$

This differs from (1) by the two extra terms

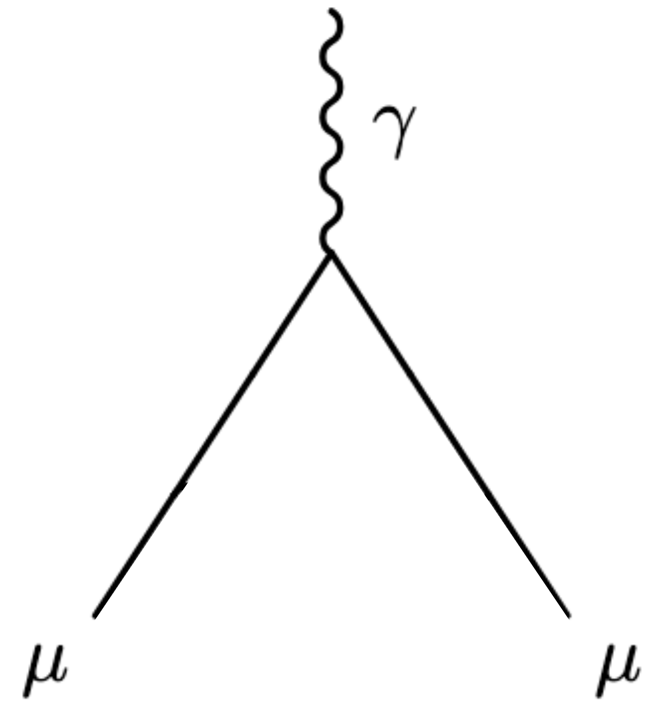
$$\frac{eh}{c}(\boldsymbol{\sigma}, \mathbf{H}) + \frac{ieh}{c}\rho_1(\boldsymbol{\sigma}, \mathbf{E})$$

in F. These two terms, when divided by the factor $2m$, can be regarded as the additional potential energy of the electron due to its new degree of freedom. The electron will therefore behave as though it has a magnetic moment $eh/2mc \,.\, \boldsymbol{\sigma}$ and an electric moment $ieh/2mc \,.\, \rho_1\boldsymbol{\sigma}$. This magnetic moment is just that assumed in the spinning electron model. The electric moment, being a pure imaginary, we should not expect to appear in the model. It is doubtful whether the electric moment has any physical meaning, since the Hamiltonian in (14) that we started from is real, and the imaginary part only appeared when we multiplied it up in an artificial way in order to make it resemble the Hamiltonian of previous theories.

SM contributions to the prediction of a_μ

A highest-precision prediction of the anomalous magnetic moment from within the SM is possible!

Modern representation of Dirac's g=2! (1928)



Anomalous magnetic moment is caused by "radiative corrections"

$$a_\mu = a_{\mathrm{QED}} + a_{\mathrm{weak}} + a_{\mathrm{had}}$$

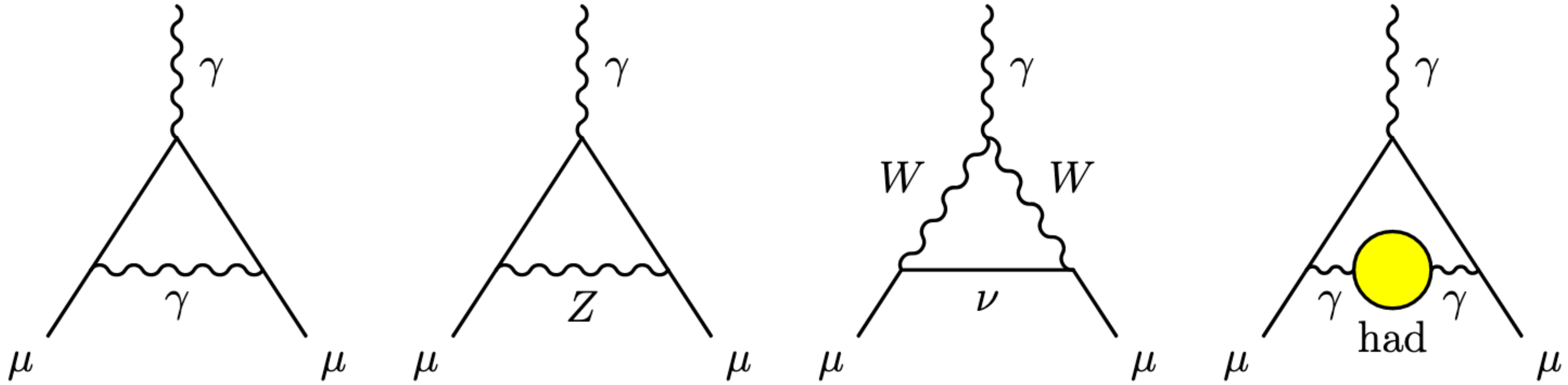


Figure: M. Tanabashi et al. (Particle Data Group), Phys. Rev. D98, 030001 (2018)

2020 evaluation of the SM prediction of a_μ

Units: xxx 10^{-11}

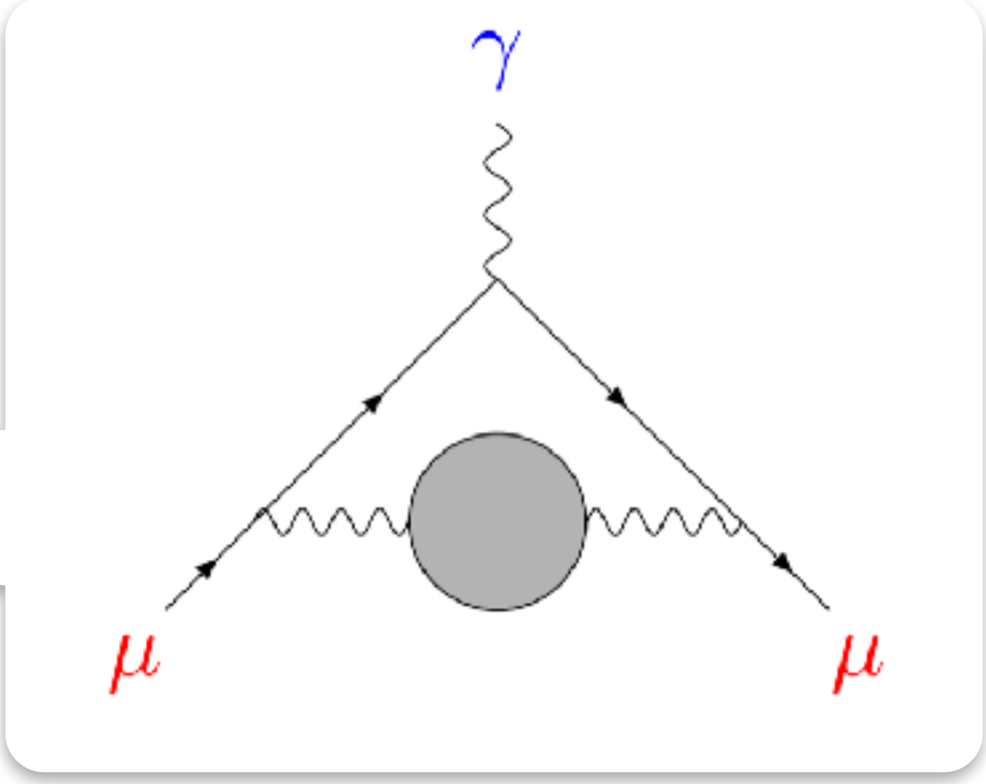
QED ($\mathcal{O}(\alpha^5)$, > 12000 digrams): 116584718.931 ± 0.104

Electroweak: 153.6 ± 1.0

LO hadronic vacuum polarization: 6931 ± 40

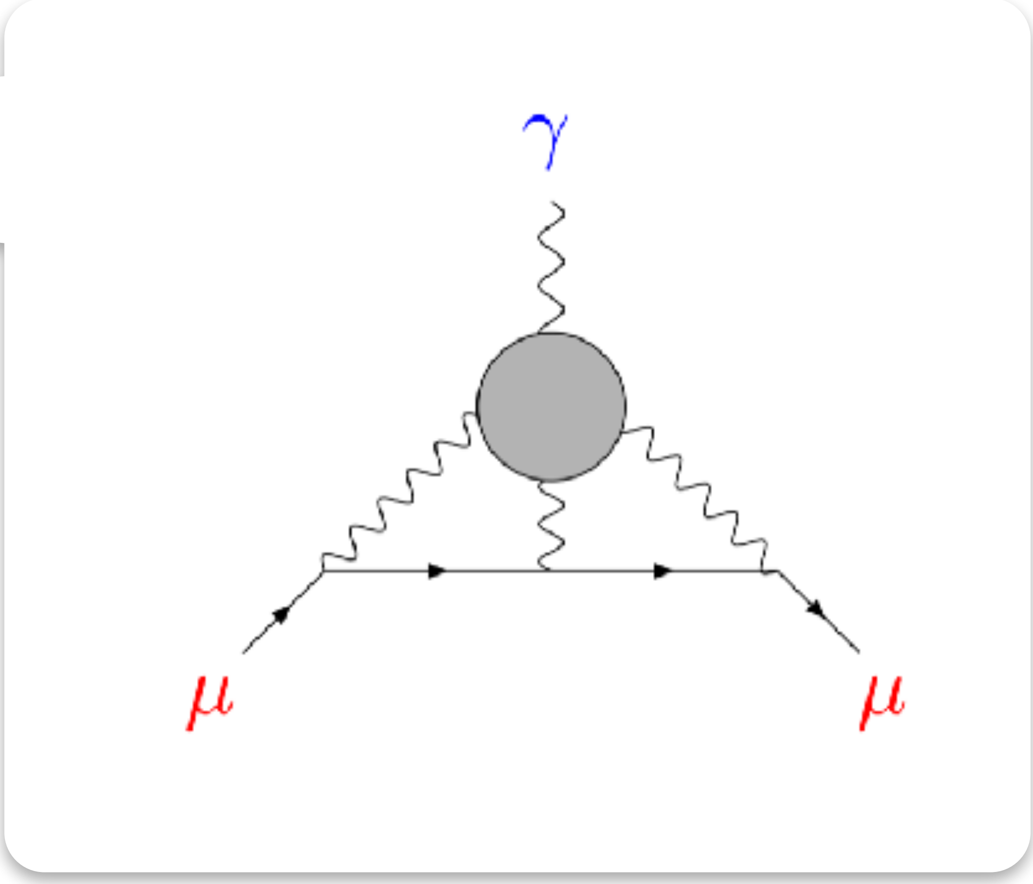
NLO HVP: -98.3 ± 0.7

NNLO HVP: 12.4 ± 0.1



LO hadronic light-by-light scattering: 92 ± 19

NLO hLbL scattering: 2 ± 1

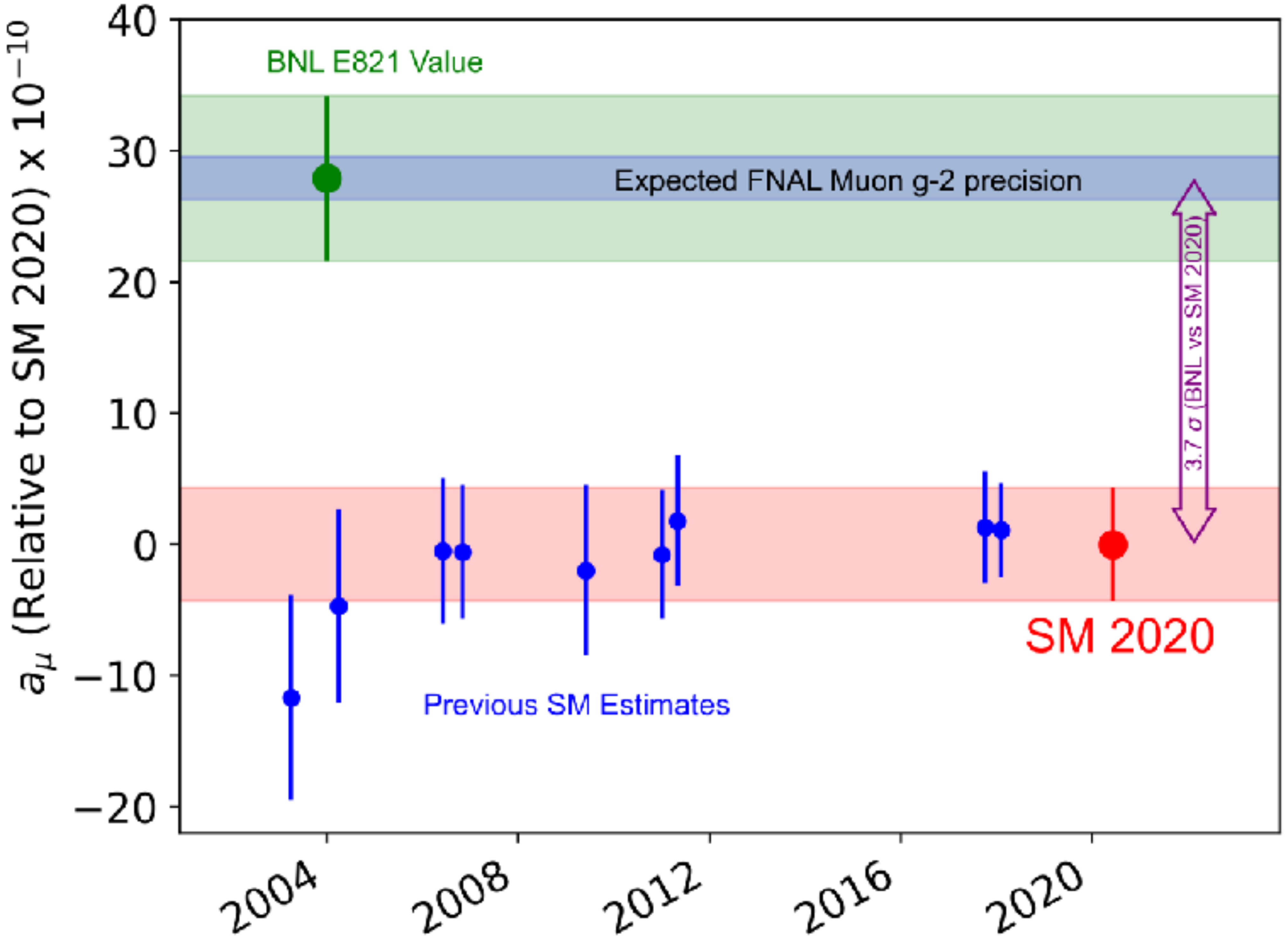


The largest uncertainty comes form hadronic physics contributions!

Total SM prediction: $a_\mu^{\mathrm{SM}} = 116591810 \pm 43$ (368 ppb)

Numbers taken from "Muon g-2 Theory Initiative White Paper": Phys. Rept. 887 (2020) 1-166

SM prediction meets the experiment



Experiment (BNL E821): $a_\mu^{\text{BNL}} = 116592089 \pm 63$ (540 ppb)

Discrepancy: $\Delta a_\mu = a_\mu^{\text{exp}} - a_\mu^{\text{SM}} = (279 \pm 76) \times 10^{-11}$

Total SM2020 prediction: $a_\mu^{\text{SM}} = 116591810 \pm 43$ (368 ppb)

3.7 σ deviation between SM2020 and BNL experiment!

Goal of the Muon g-2 experiment at Fermi National Laboratory
Reduction of experimental uncertainty
by a factor 4!

The two clocks of a free charged lepton

A *relativistic* charged lepton circulating in a homogenous magnetic field experiences two effects:

Cyclotron motion

Equilibrium between centrifugal and Lorentz force

Cyclotron frequency

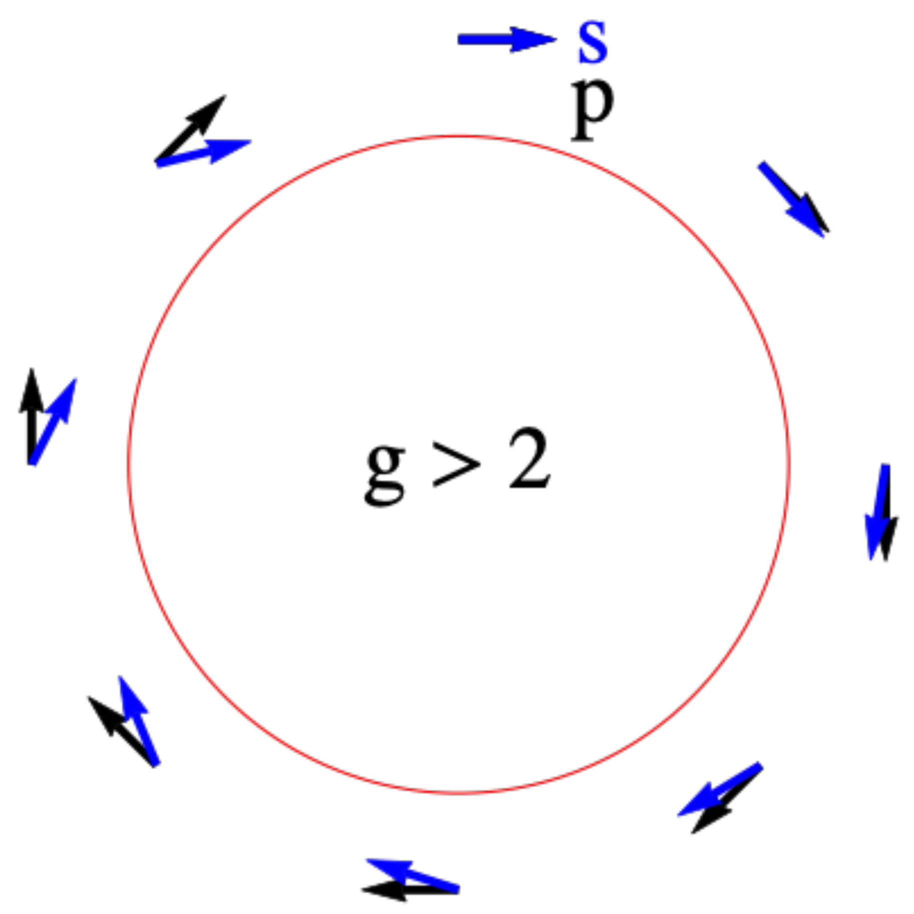
$$\vec{\omega}_{\mathrm{c}} = -\frac{Qe}{m\gamma}\vec{B}$$

Spin precession

Coupling of magnetic moment and field

Larmor frequency

$$\vec{\omega}_{\mathrm{s}} = -\left(\frac{g-2}{2} + \frac{1}{\gamma}\right)\frac{Qe}{m}\vec{B}$$



Anomalous spin precession frequency

$$\vec{\omega}_{\mathrm{a}} = \vec{\omega}_{\mathrm{s}} - \vec{\omega}_{\mathrm{c}} = -\left(\frac{g-2}{2}\right)\frac{Qe}{m}\vec{B} = -a\frac{Qe}{m}\vec{B}$$

Independent of particle momentum!

Clock frequency shifts for muons in motion

Evolution of muon's longitudinal polarization in a superposition of electric and magnetic fields

$$\frac{d}{dt}P_{\mathrm{L}} = \frac{d}{dt}\left(\hat{\beta}\cdot\vec{s}\right) = -\frac{e}{m}\vec{s}_{\perp}\cdot\left[a_{\mu}\hat{\beta}\times\vec{B} + \left(a_{\mu} - \frac{1}{\gamma^2-1}\right)\beta\vec{E}\right]$$

Spin component perpendicular to velocity

Non-relativistic and circular motion limit

Relativistically generated magnetic fields
"electric field correction"
"pitch correction"

Magnetic field maps and temporal interpolation

Reconstruction of complex beam dynamics

FNAL E989: $E \neq 0$ suppressed at $\gamma = 29.3$ "magic momentum"

Extracting a_μ - the external ingredients

External measurements to anchor B and e to other high-precision measurements and calculations

$\frac{\mu'_p(T_r)}{\mu_e(H)}$ 10.5 ppb uncertainty at T_r = 34.7°C

Metrologia 13, 179 (1977)

$\frac{\mu_e(H)}{\mu_e}$ Bound state QED calculation exact

Rev. Mod. Phys. 88, 035009 (2016)

$$a_\mu = \frac{\omega_a}{\tilde{B}'}\frac{m_\mu}{e} = \frac{\omega_a}{\tilde{\omega}'_p(T_r)}\frac{\mu'_p(T_r)}{\mu_e(H)}\frac{\mu_e(H)}{\mu_e}\frac{m_\mu}{m_e}\frac{g_e}{2}$$

Total uncertainty from external quantities: 25 ppb

$\frac{m_\mu}{m_e}$ Muonium hyperfine splitting 22 ppb uncertainty

Phys. Rev. Lett. 82, 11 (1999)

$\frac{g_e}{2}$ Measurement with 0.28 ppt uncertainty

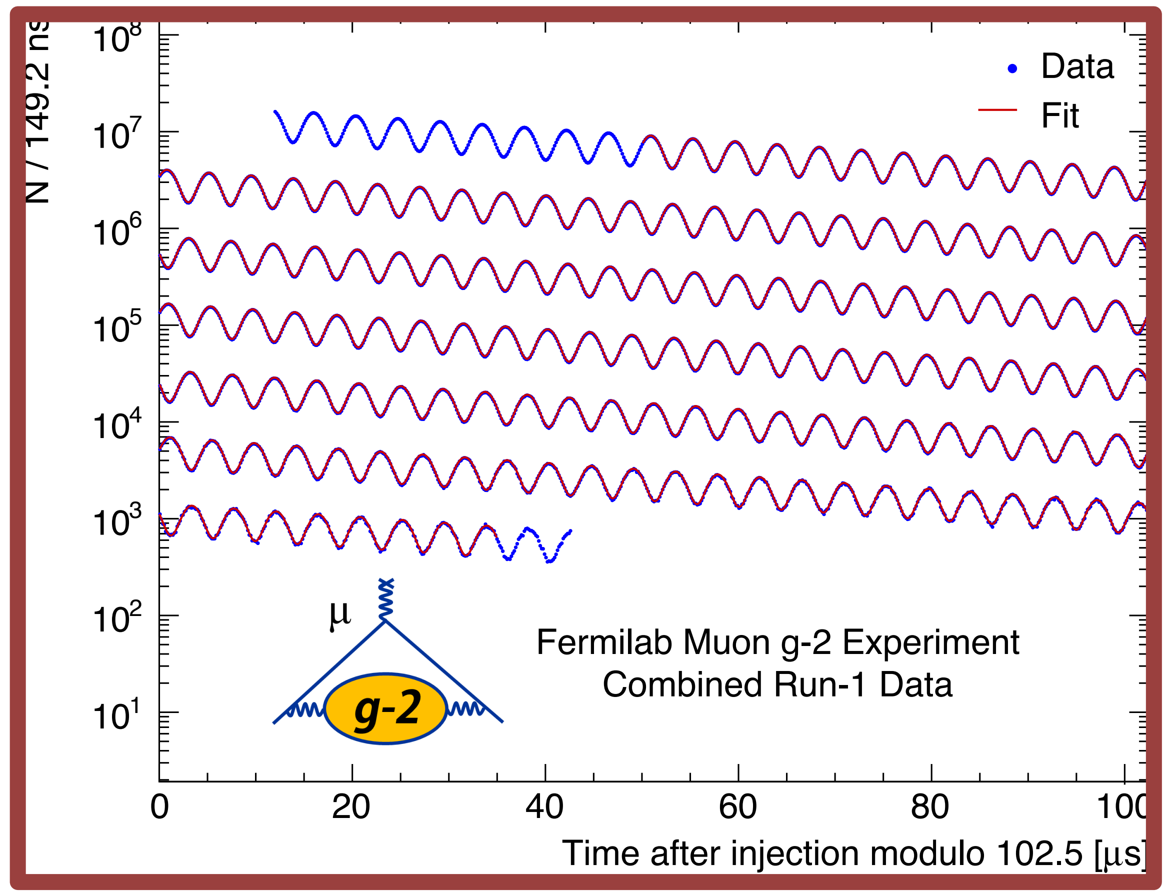
Phys. Rev. A 83, 052122 (2011)

Extracting a_μ - our challenge

$$R' = \frac{\omega_a}{\tilde{\omega}'_p} = \frac{f_{clock}\,\omega_a^{meas}\left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{calib}\left\langle M\left(x,y,\phi\right)\omega_p\left(x,y,\phi\right)\right\rangle\left(1 + B_k + B_q\right)}$$

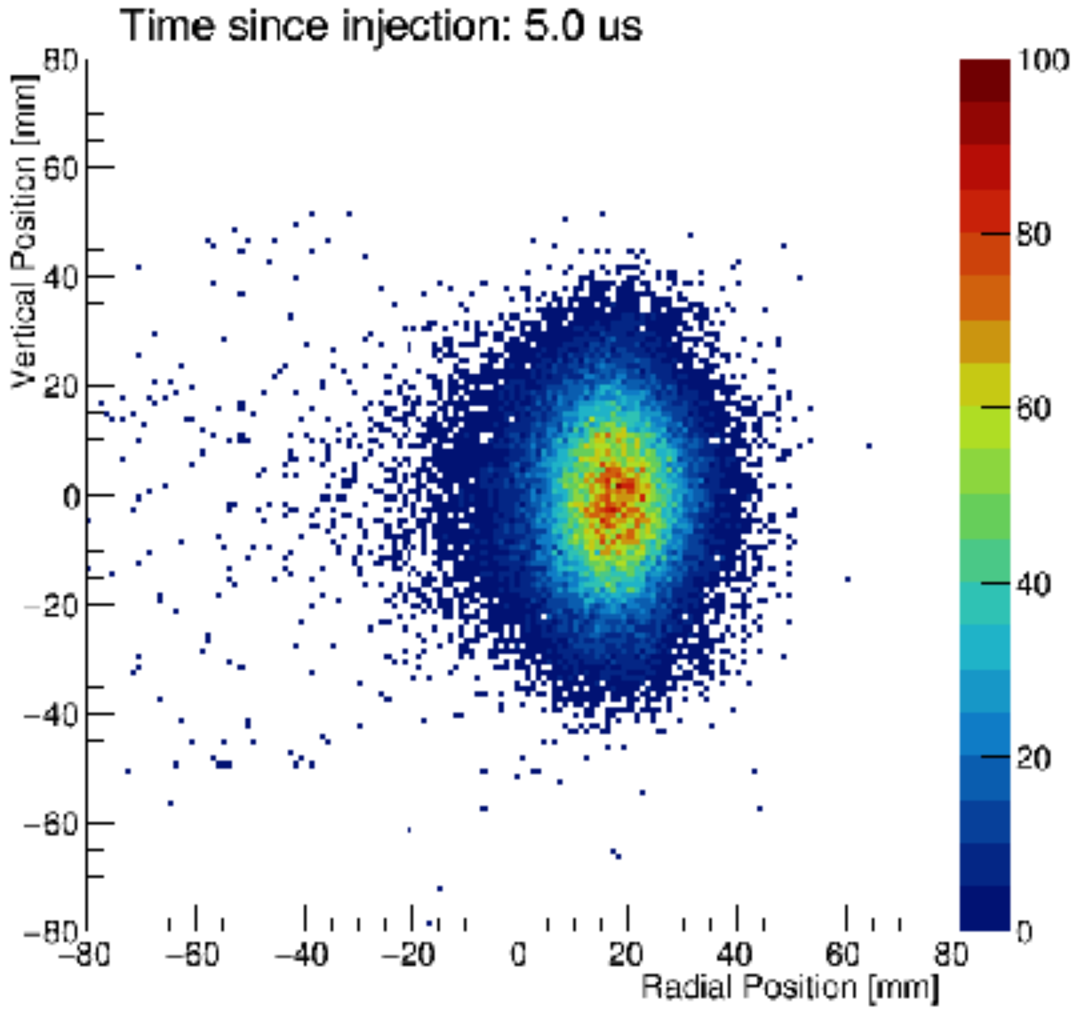
$$a_\mu = \frac{\omega_a}{\tilde{B}'}\frac{m_\mu}{e} = \frac{\omega_a}{\tilde{\omega}'_p\left(T_r\right)}\frac{\mu'_p\left(T_r\right)}{\mu_e(H)}\frac{\mu_e(H)}{\mu_e}\frac{m_\mu}{m_e}\frac{g_e}{2}$$

Extracting a_μ - our tools



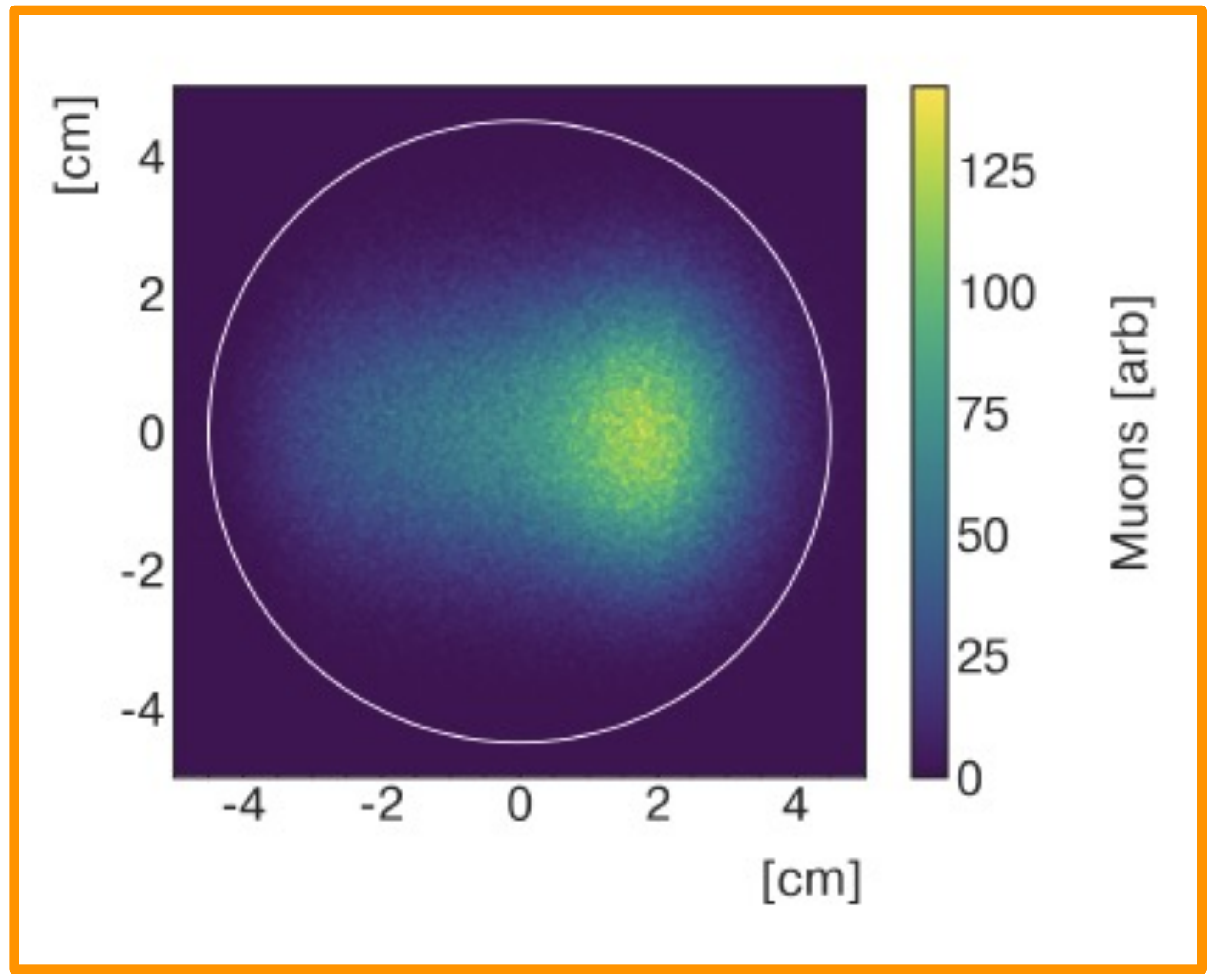
Anomalous spin precession frequency

Muon beam dynamics corrections



Clock blinding

$$R' = \frac{\omega_a}{\tilde{\omega}'_p} = \frac{f_{\text{clock}}\,\omega_a^{\text{meas}}\left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{\text{calib}}\left\langle M(x,y,\phi)\,\omega'_p(x,y,\phi)\right\rangle\left(1 + B_k + B_q\right)}$$

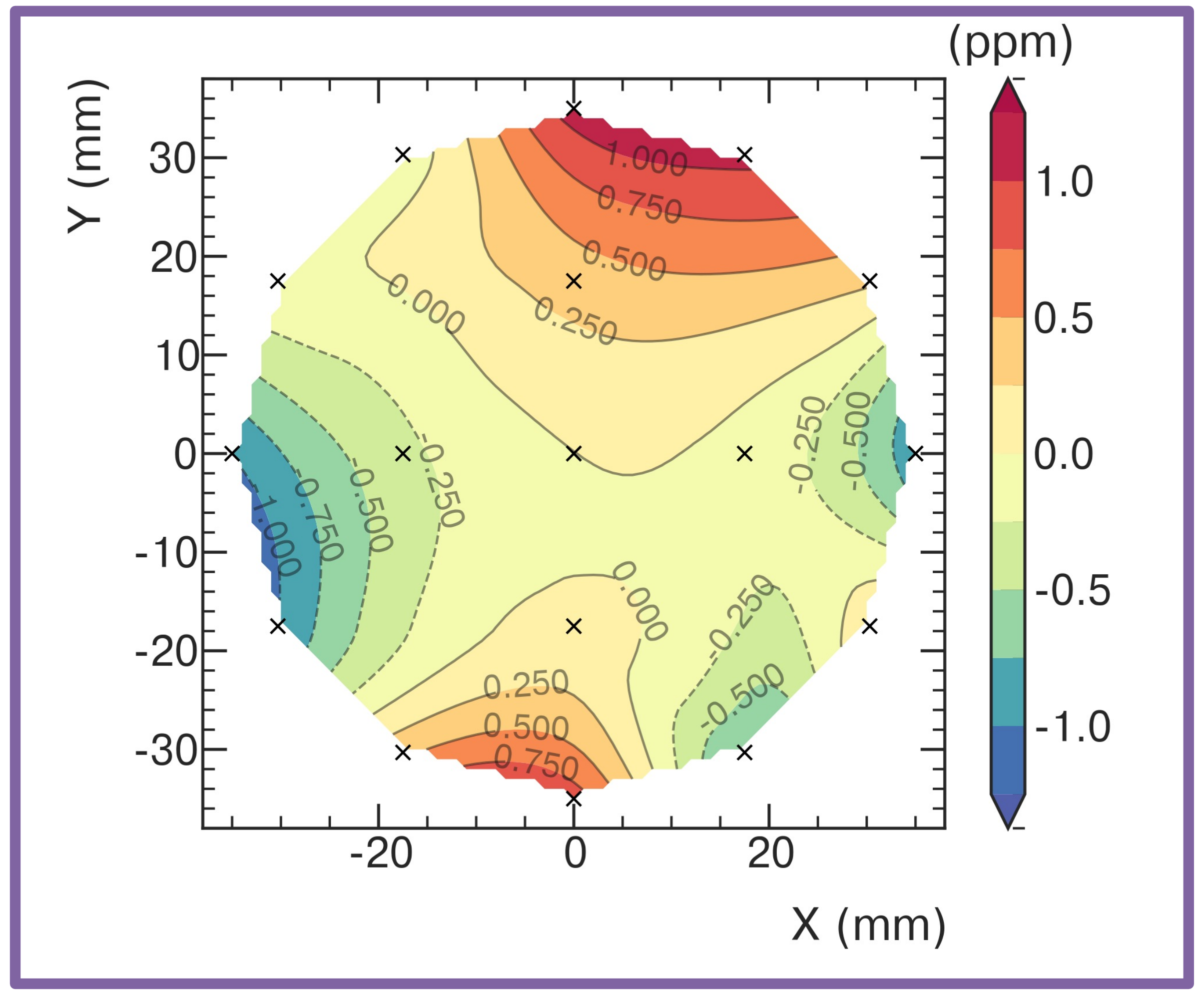


Spatial muon distribution

Spatial distribution of magnetic field

Transient magnetic fields

Calibration



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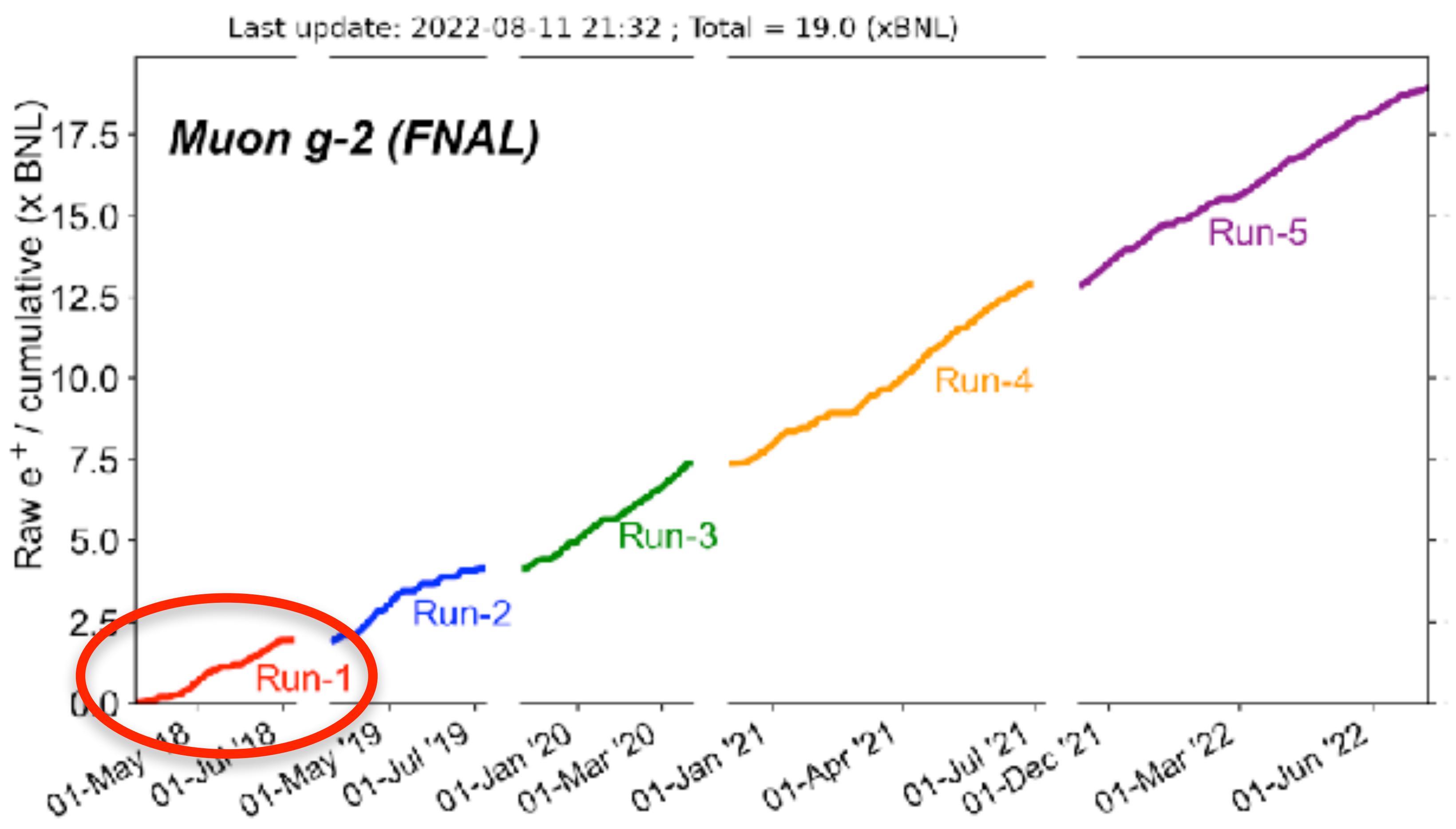
The statistics and the uncertainty table for Run 1



Dataset	Date	Field index n ESQ HV [kV]	Kicker HV [kV]	Number of positrons
1a	Apr 22, 2018 - Apr 25, 2018	0.108 18.3	130	0.9×10^9
1b	Apr 26, 2018 - May 02, 2018	0.120 20.4	137	1.3×10^9
1c	May 04, 2018 - May 12, 2018	0.120 20.4	132	2.0×10^9
1d	Jun 06, 2018- Jun 29, 2018	0.108 18.3	125	4.0×10^9

Quantity	Correction Terms (ppb)	Uncertainty (ppb)
ω_a^m (statistical)	–	434
ω_a^m (systematic)	–	56
C_e	489	53
C_p	180	13
C_{ml}	-11	5
C_{pa}	-158	75
$f_{\text{calib}}\langle\omega_p(x,y,\phi) \times M(x,y,\phi)\rangle$	–	56
B_k	-27	37
B_q	-17	92
$\mu'_p(34.7^\circ)/\mu_e$	–	10
m_μ/m_e	–	22
$g_e/2$	–	0
Total systematic	–	157
Total fundamental factors	–	25
Totals	544	462

Uncertainty dominated by statistics!

The Fermilab muon campus

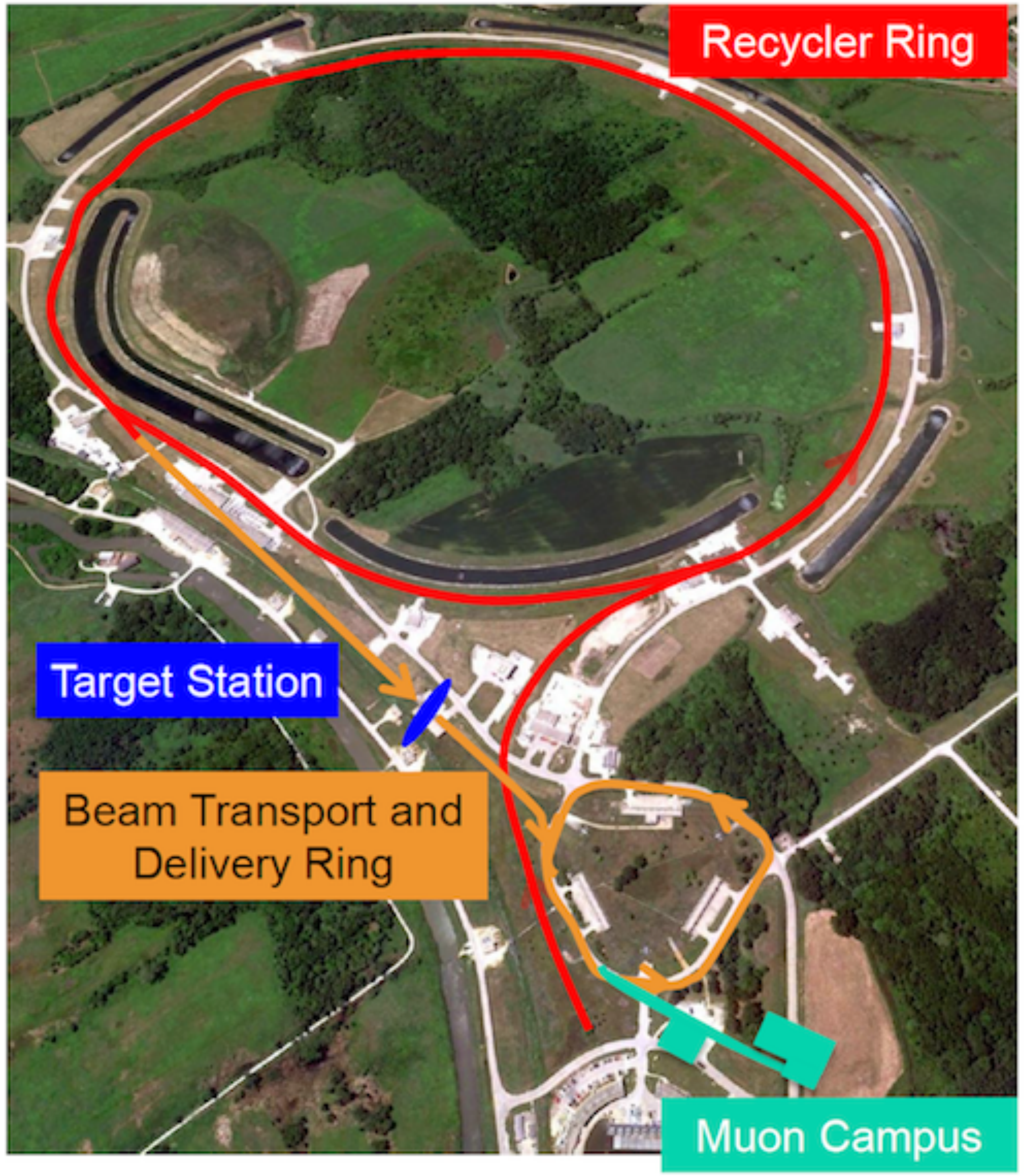


Figure courtesy: M. Convery

A bright source of pulsed polarized muons is needed!

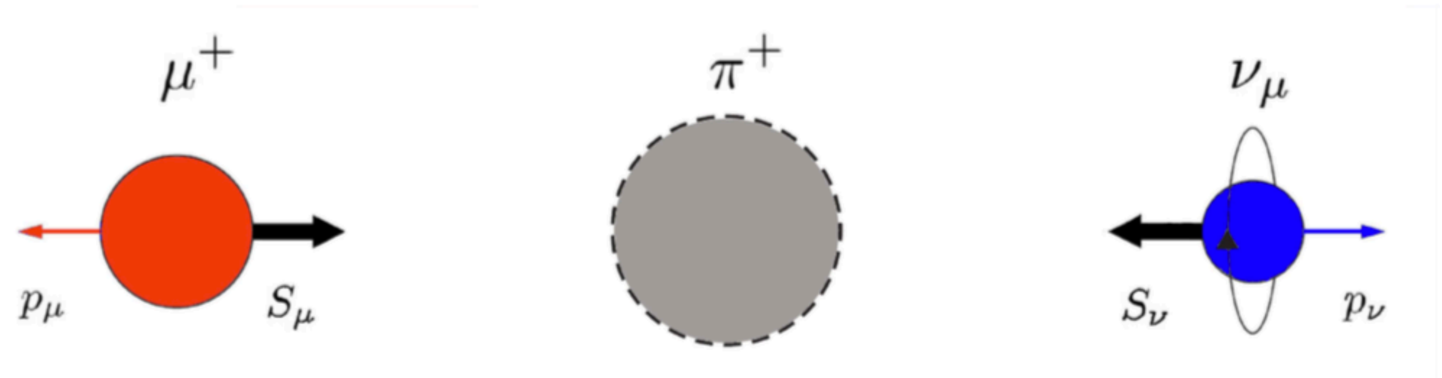
8 GeV p^+ strike target, 120 ns bunch length

8 bunches spaced by 10 ms, second bunch train 200 ms later

Pion production in the target:

$$p^+ + p^+ \rightarrow p^+ + n + \pi^+$$

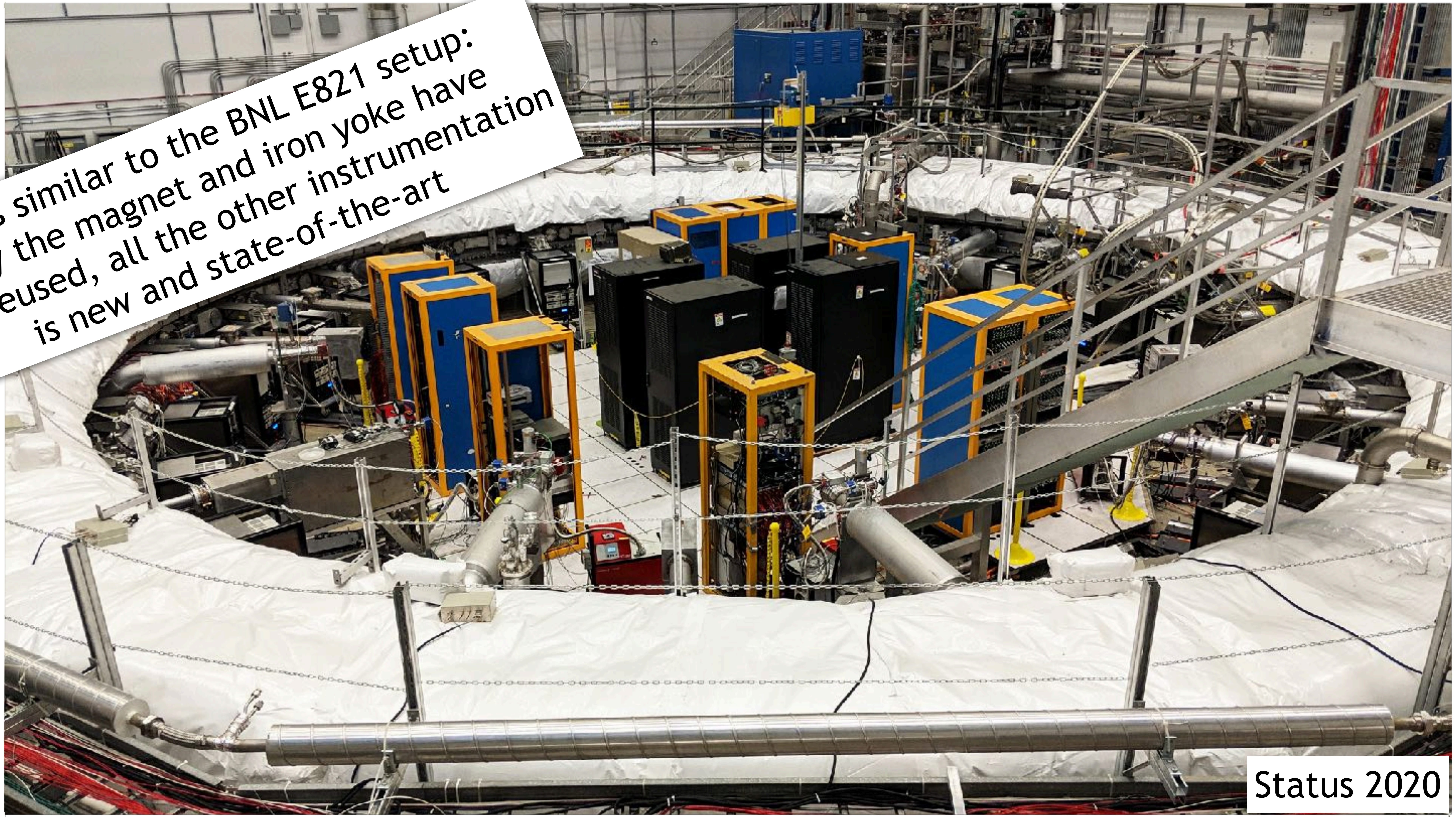
Focus the "debris" into a momentum selective beam line



ν_μ must be left-handed → μ^+ also left-handed!

Figures: K.S. Khaw, PhD thesis, ETH Zürich, 2015

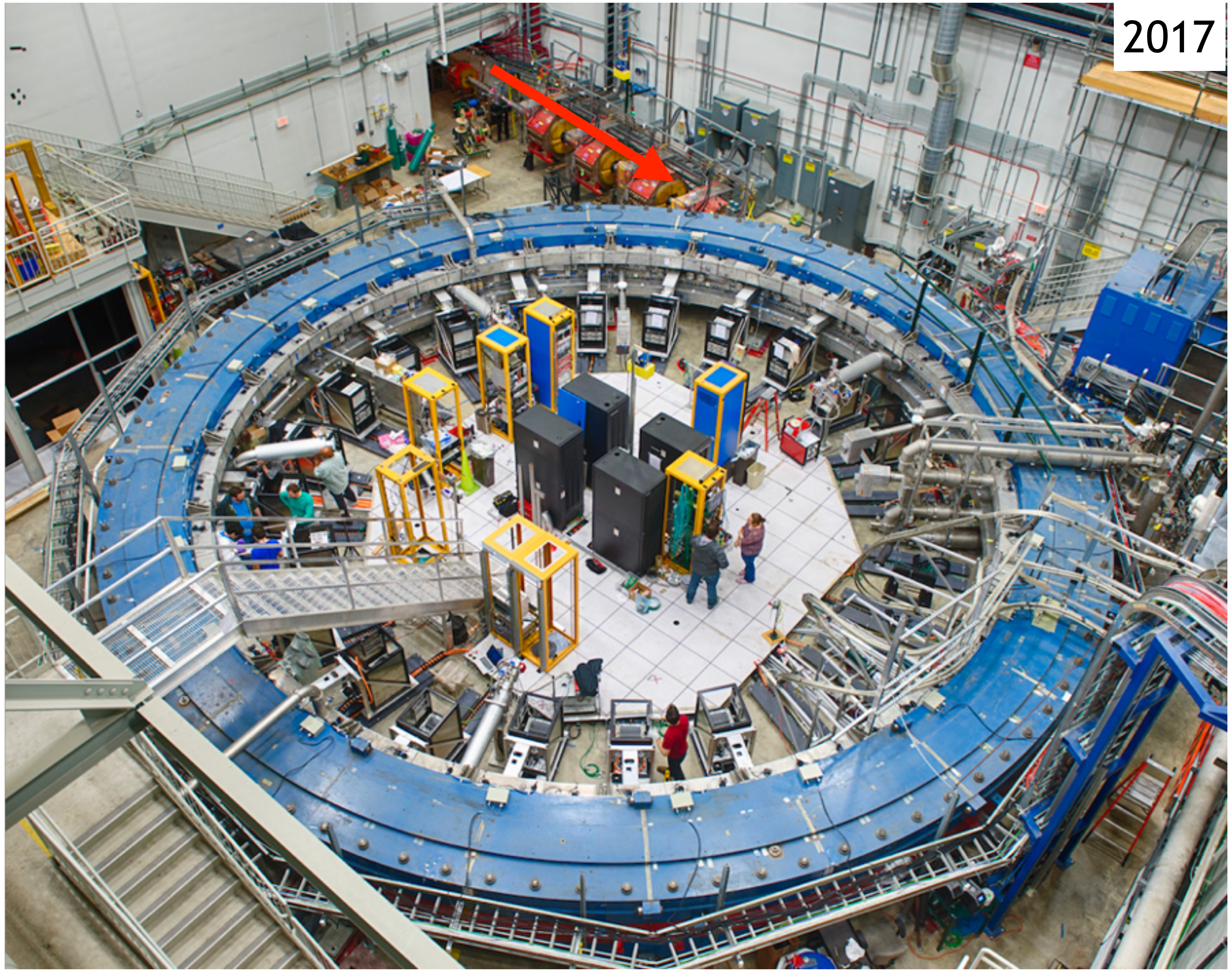
The muon g-2 experiment at Fermilab



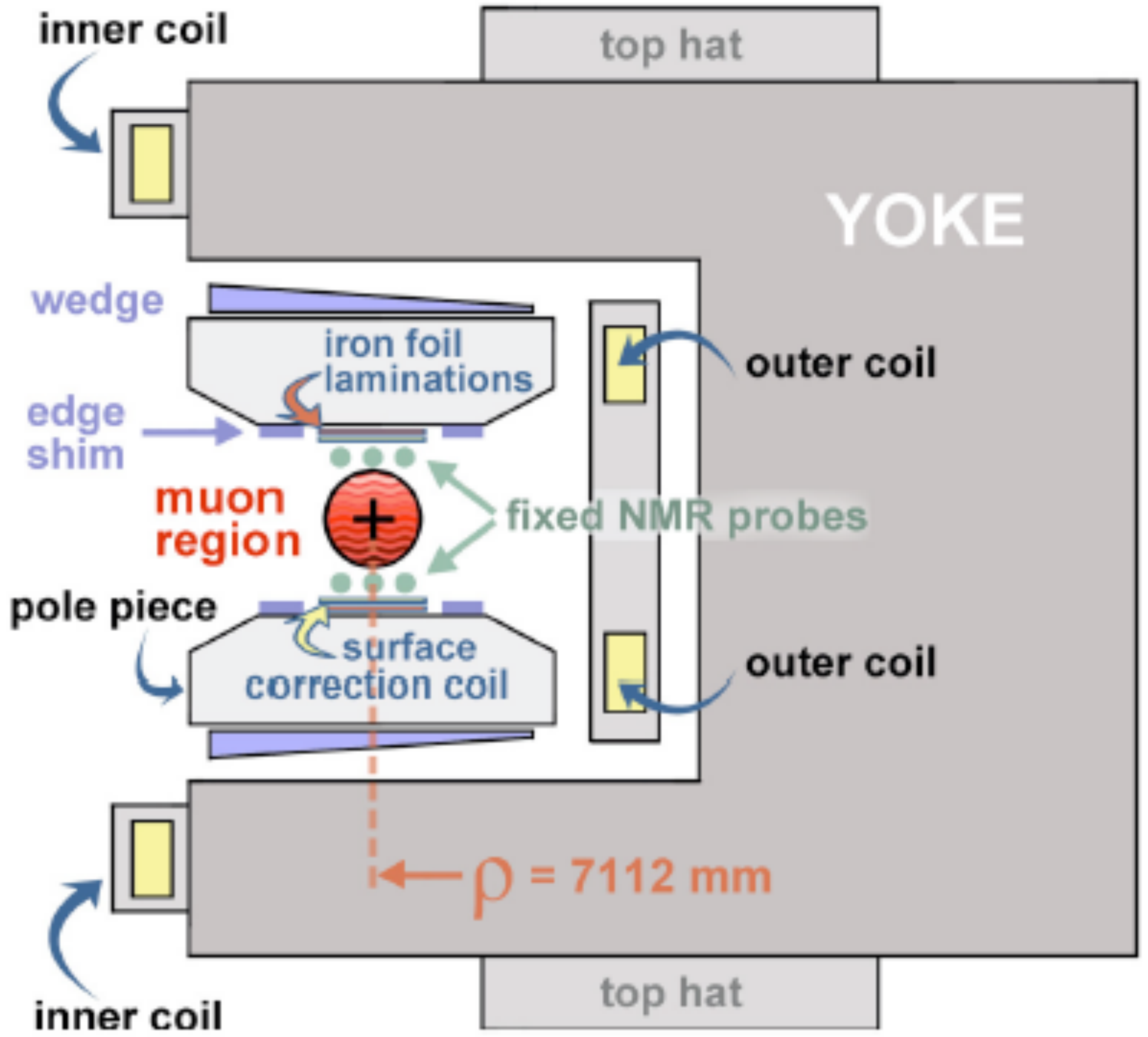
Looks similar to the BNL E821 setup:
Only the magnet and iron yoke have been reused, all the other instrumentation is new and state-of-the-art

The superconducting magnet in MC1

Particles from delivery ring

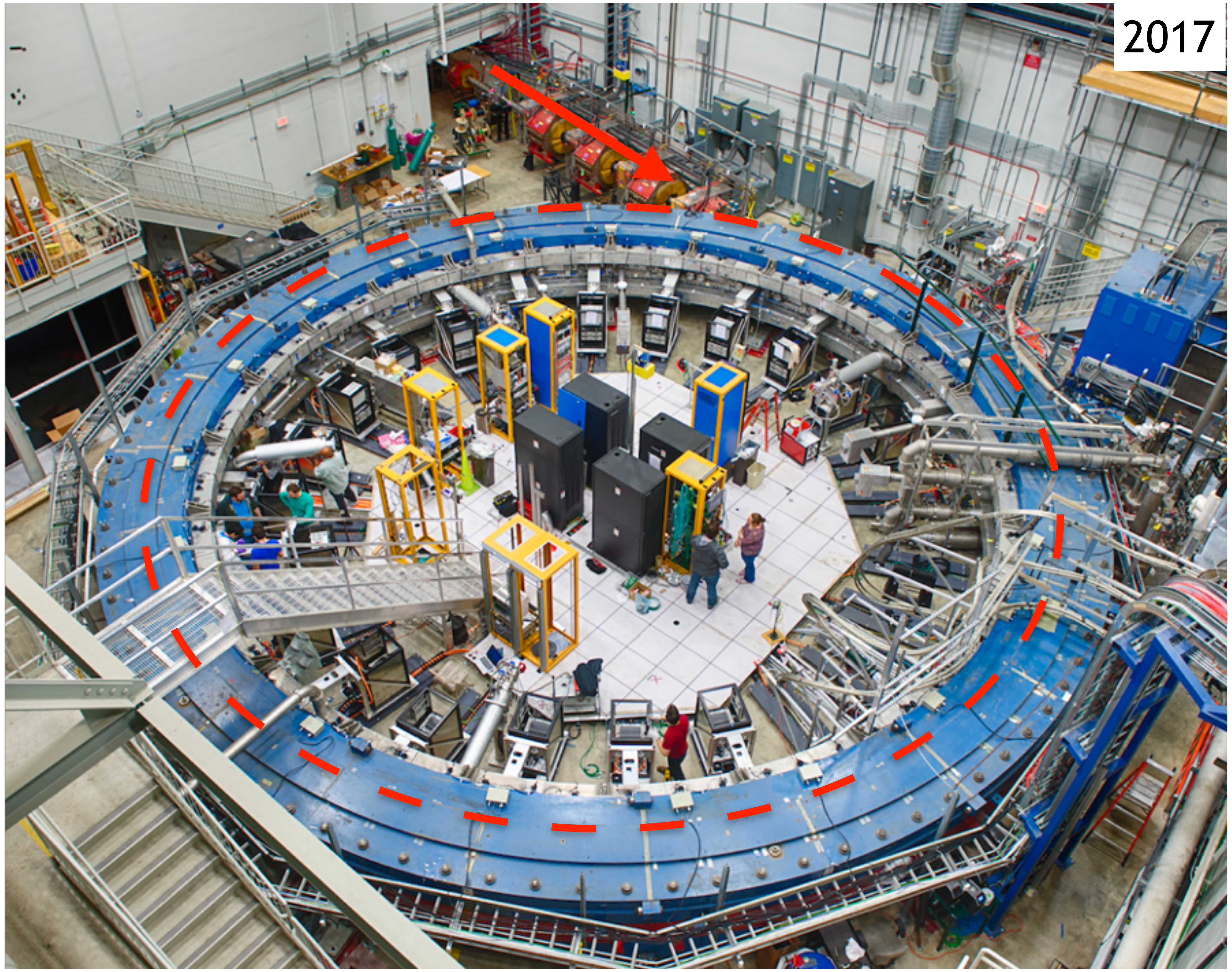


Magic momentum: $p_{\mu}^{\text{magic}} = 3.094\,\text{GeV/c} \pm 0.5\,\%$

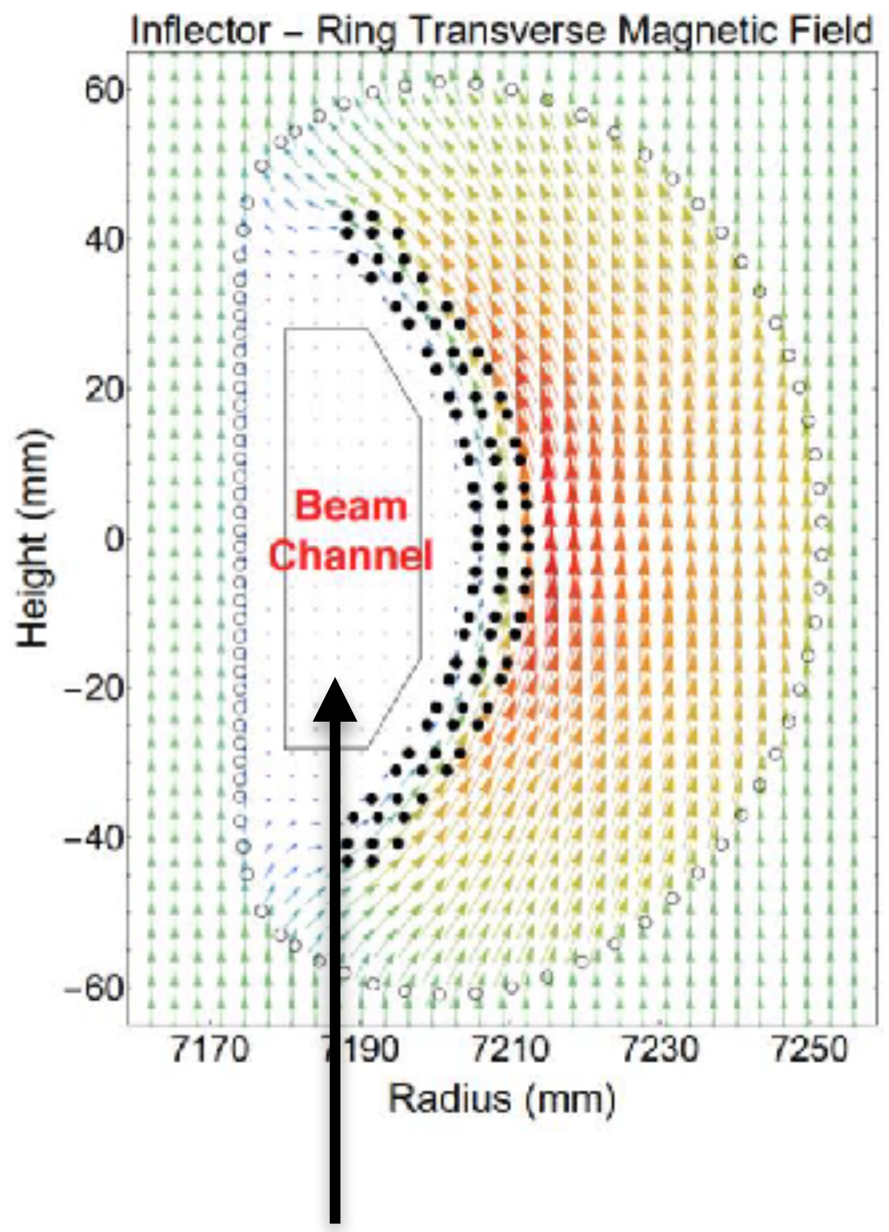


The muon inflector magnet

Particles from delivery ring

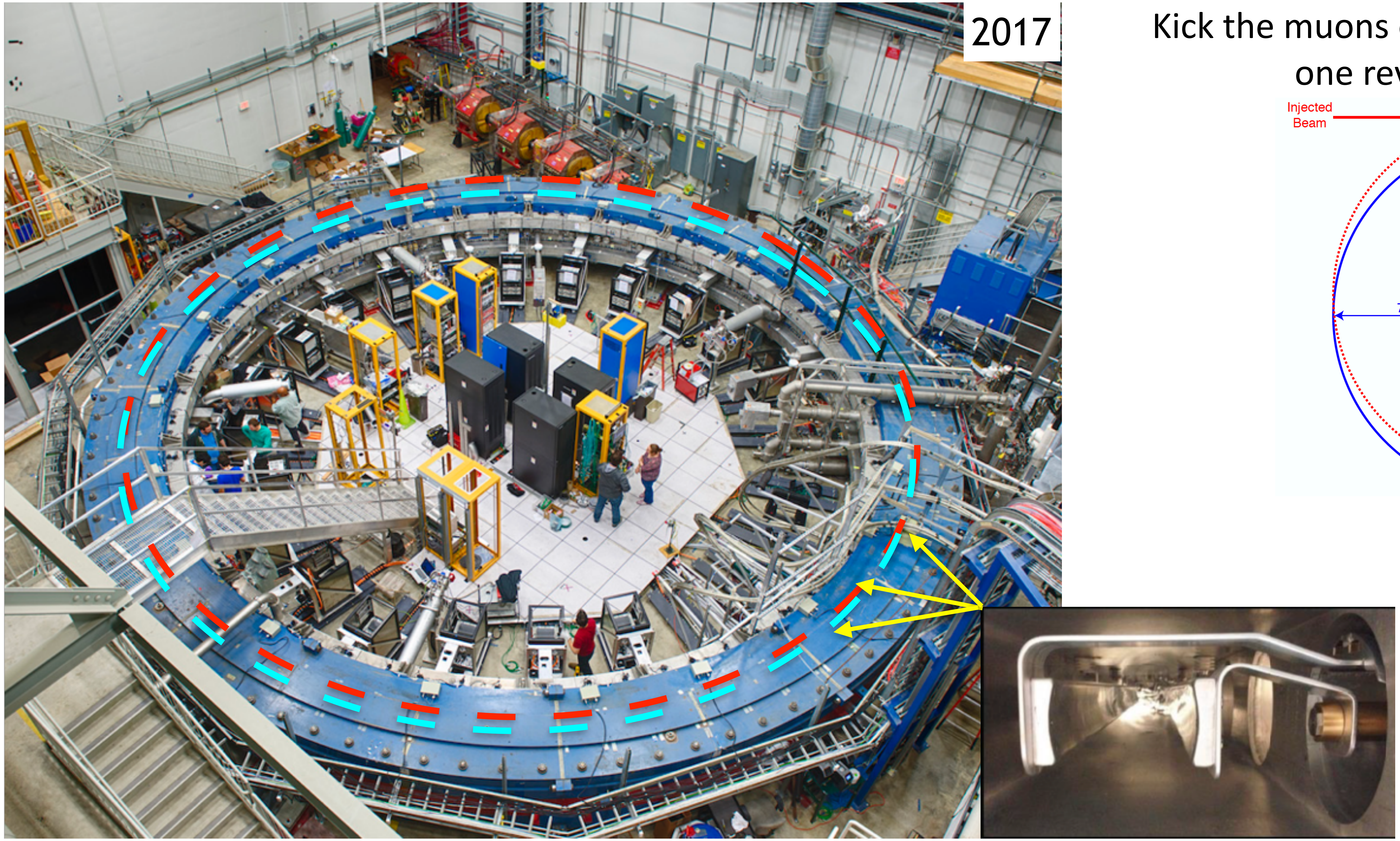


Superconducting inflector magnet cancels return B field in iron yoke to make muon travel straight!

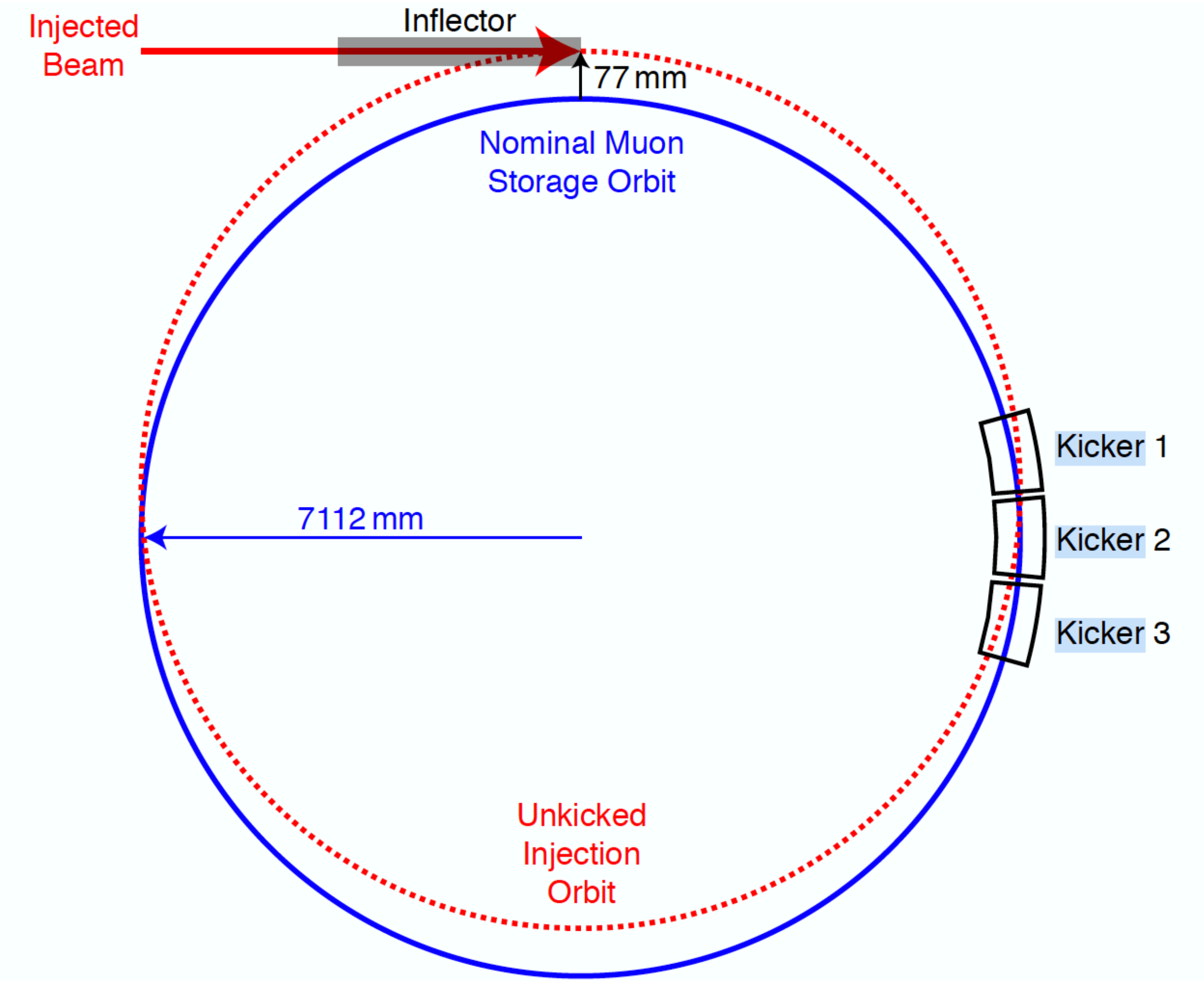


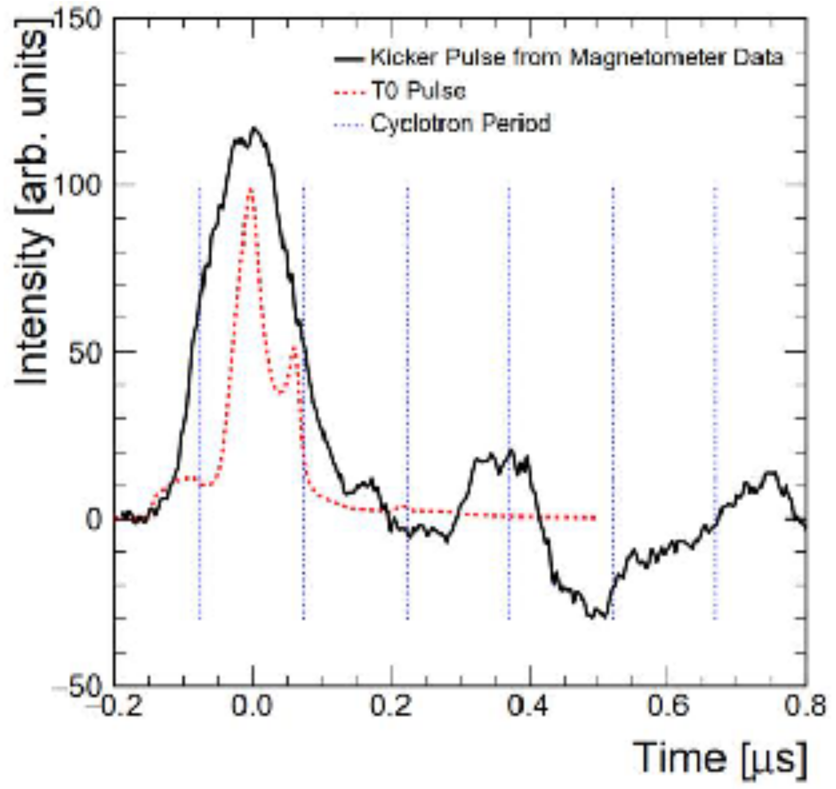
Field free region

The fast kicker

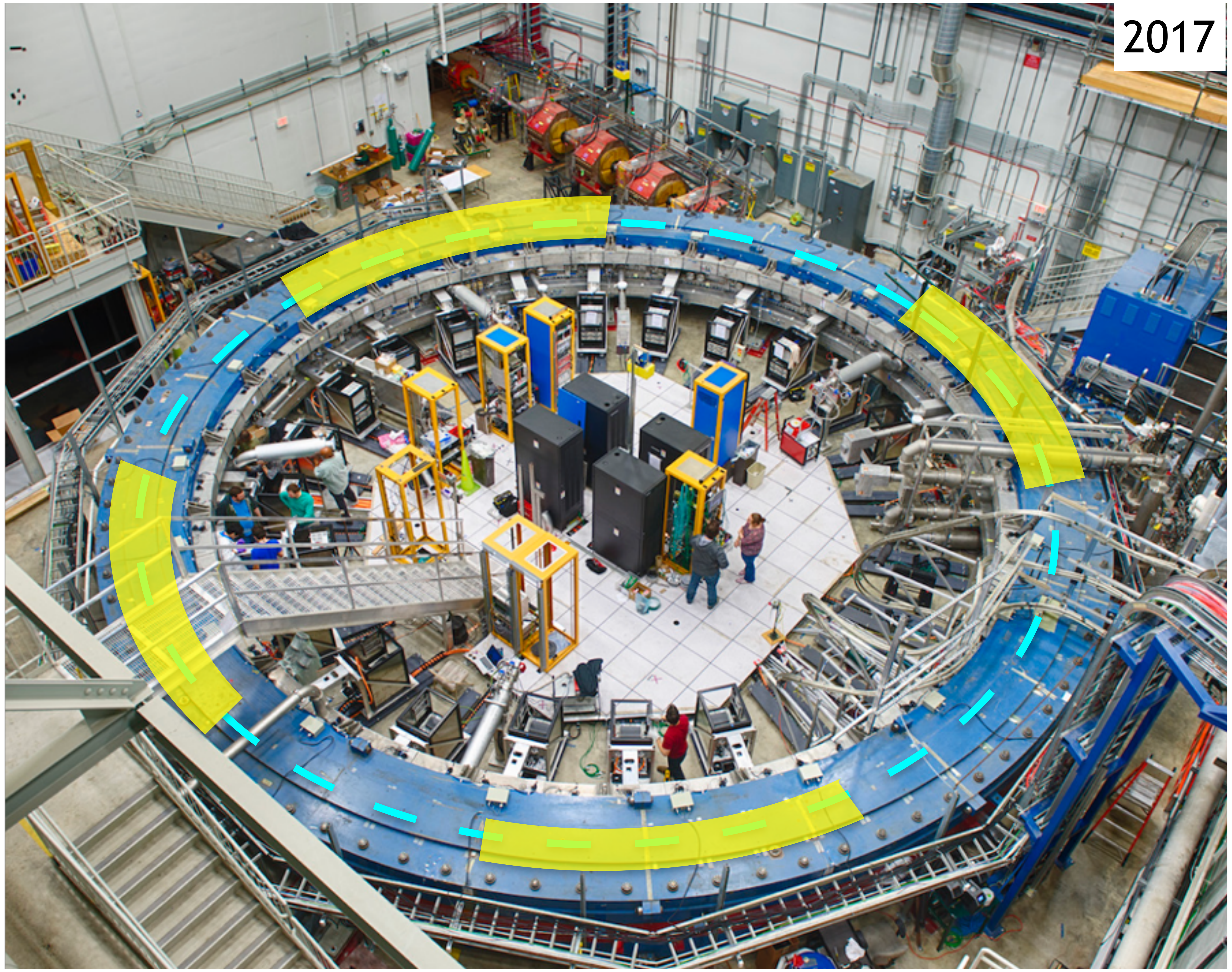


Kick the muons on their storage orbit within one revolution (≈ 150 ns)





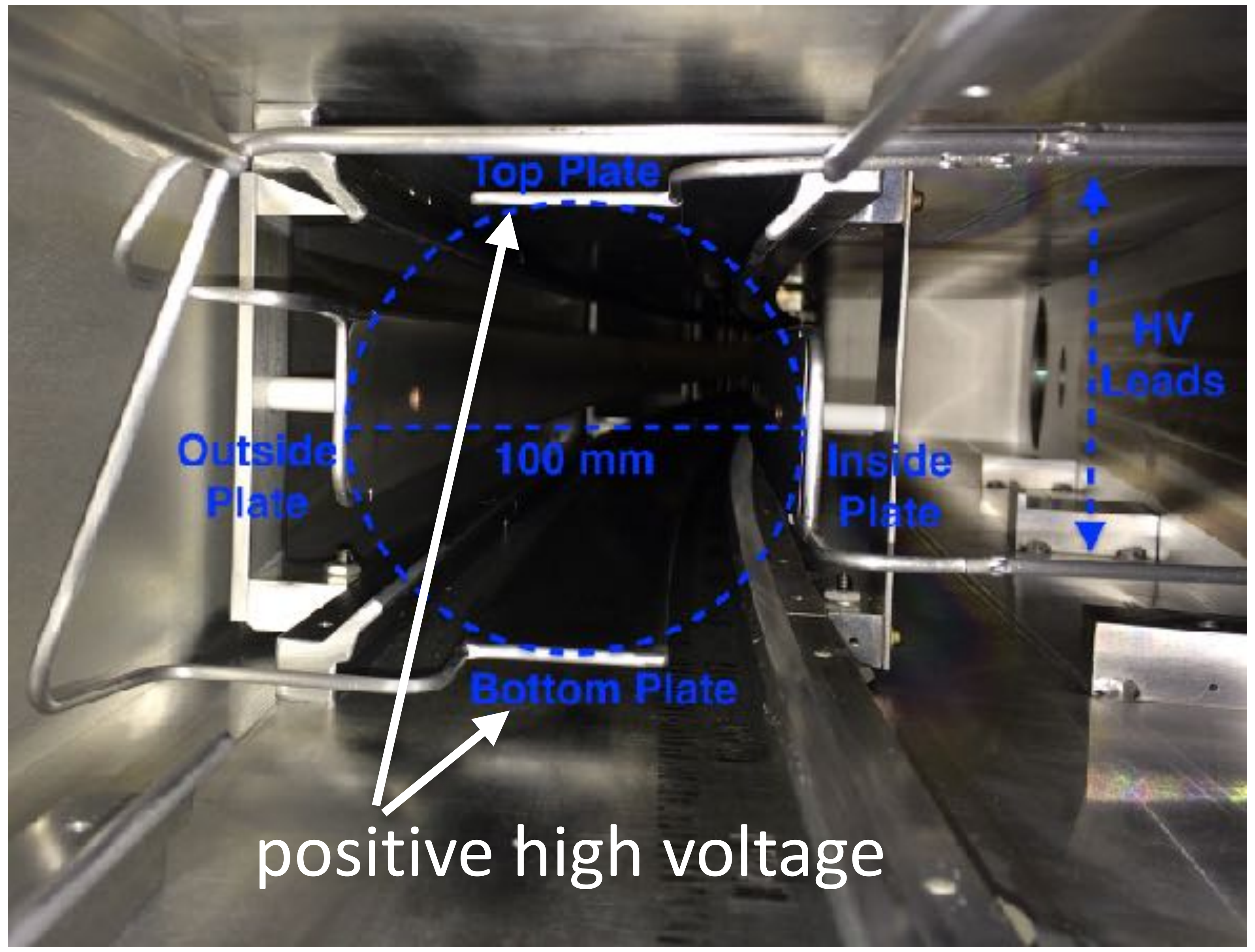
The electrostatic quadrupoles



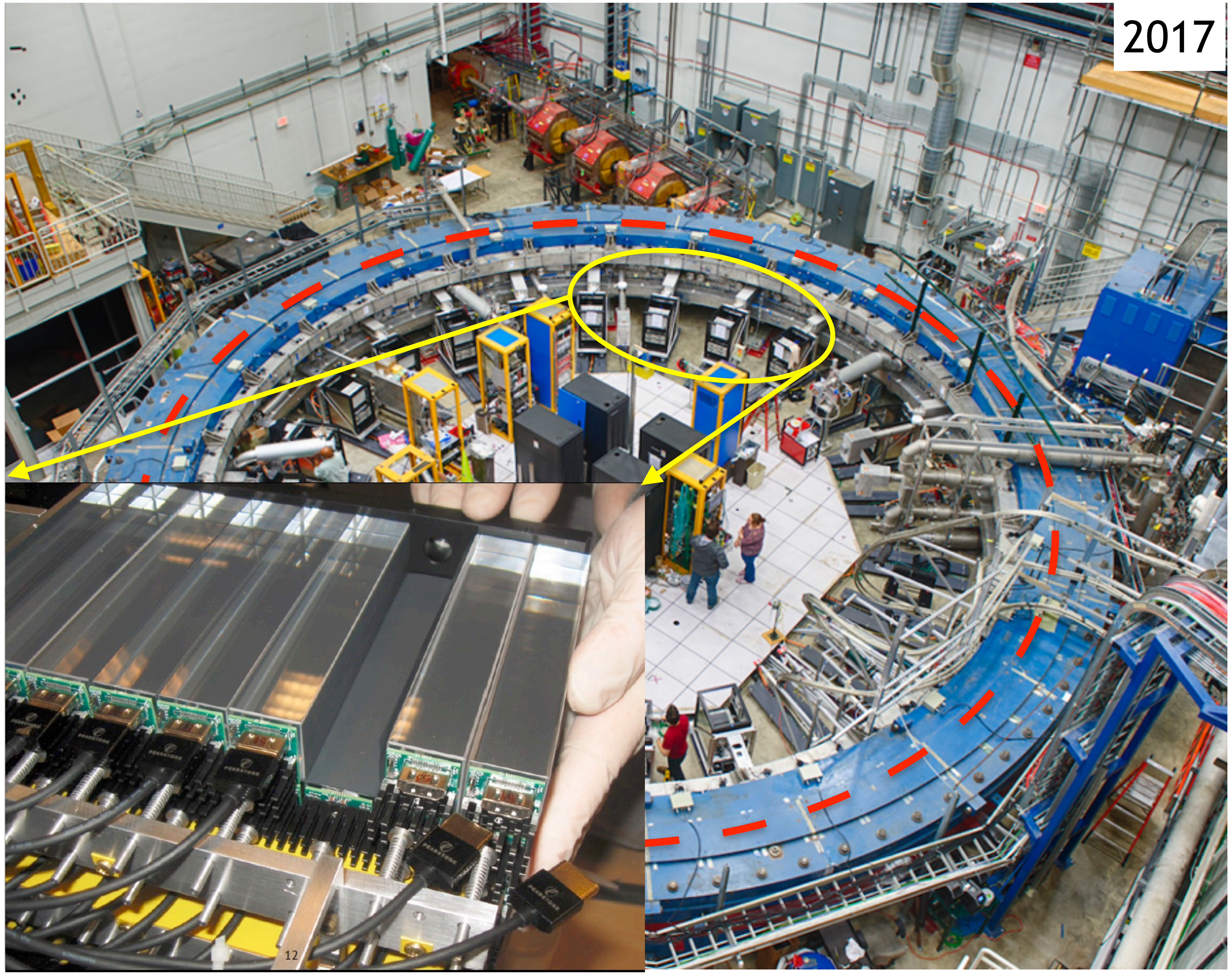
Pulsed "electrostatic" quadrupoles

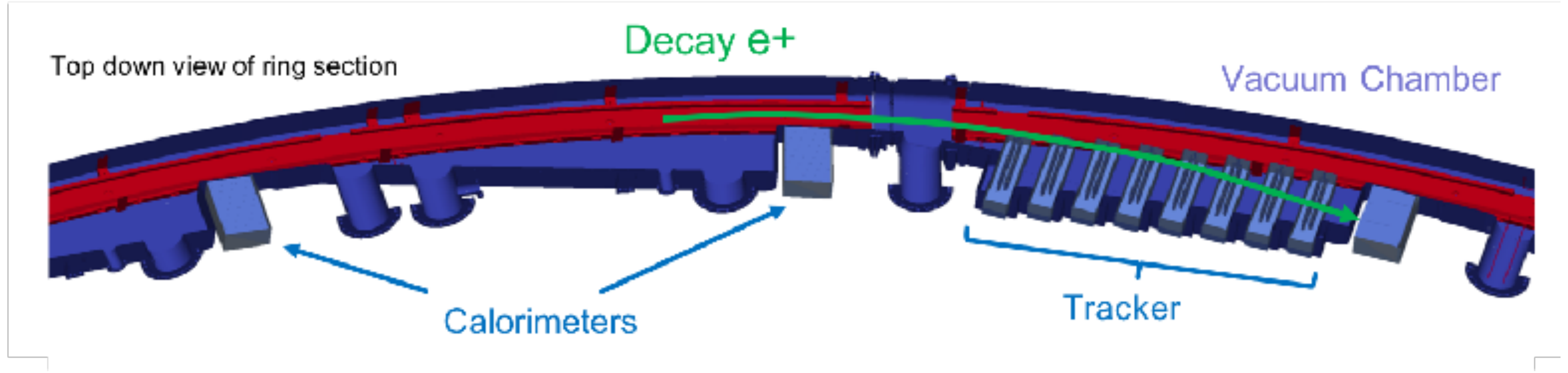
Vertical focusing and confinement of positive muon beam

Quasi-penning trap cover 43% of the ring



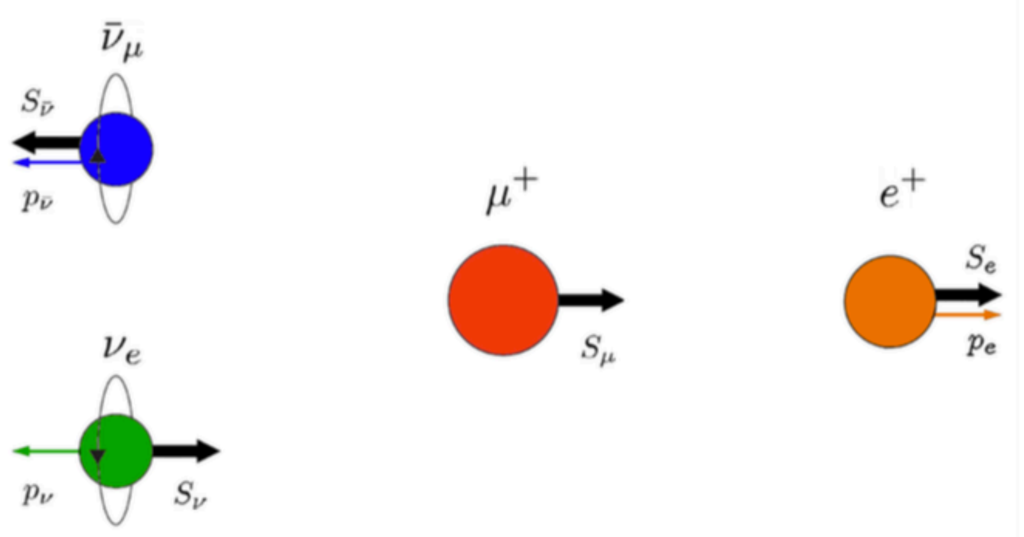
The positron calorimeter system

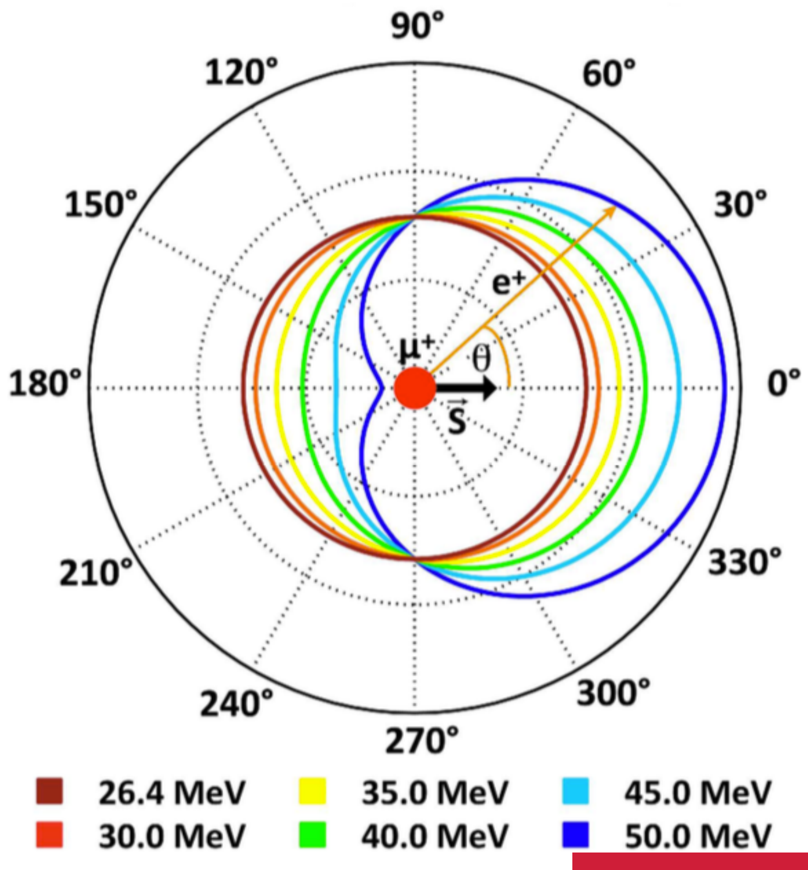




24 calorimeter stations to detect the decay positrons
9 x 6 arrays of PbF_2 crystals (Cherenkov detectors!)

In the muon rest frame



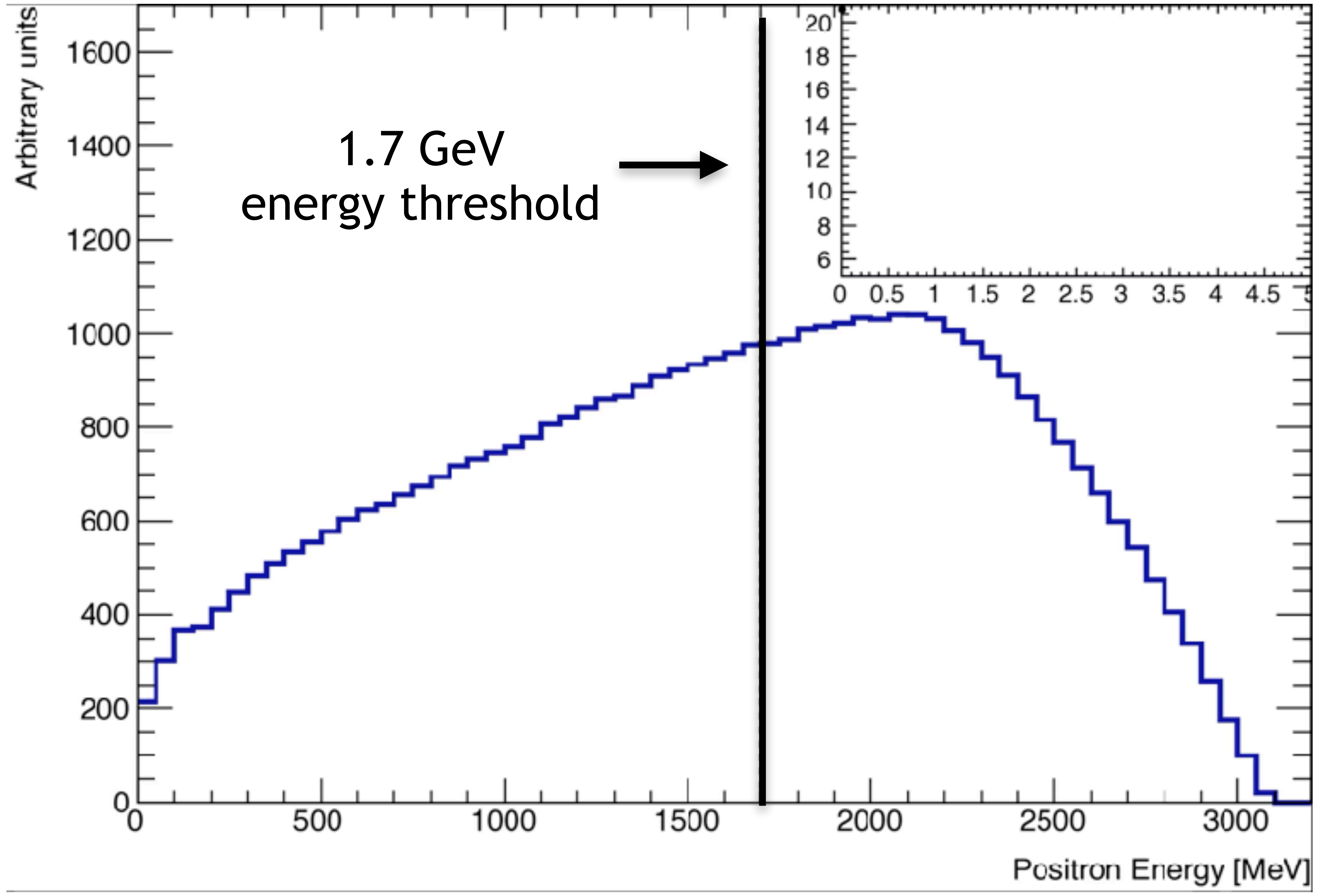


Wiggle plot basics and laser calibration system

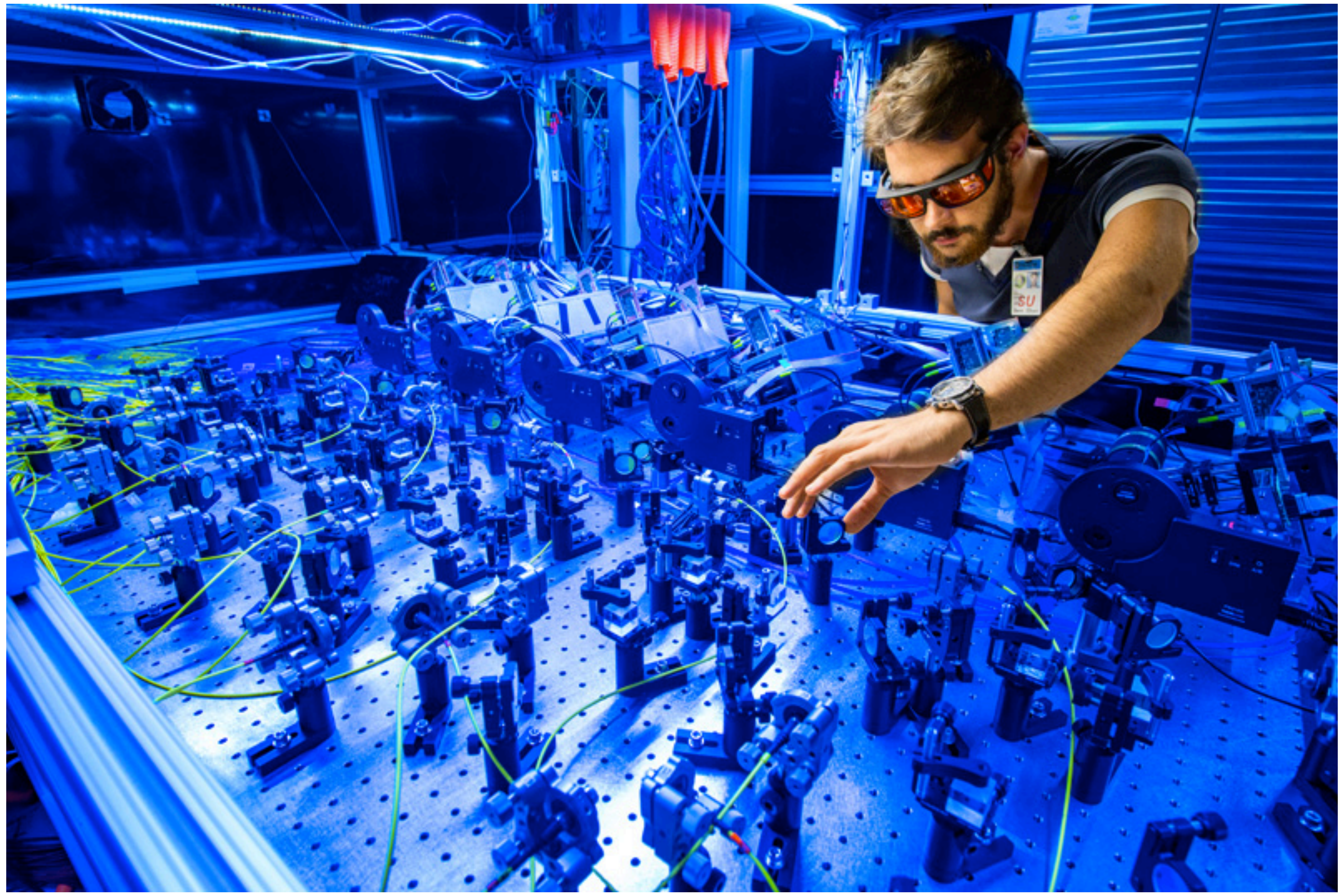
Spin precession in muon rest frame

transforms to

above-energy-threshold count rate modulation in laboratory frame



Dedicated laser calibration system to ensure energy calibration of calorimeter system



Extracting a_μ: the anomalous spin precession frequency

$$R' = \frac{\omega_a}{\omega'_p} = \frac{f_{\mathrm{clock}} \boxed{\omega_a^{\mathrm{meas}}} \left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{\mathrm{calib}} \left\langle M(x,y,\phi)\, \omega'_p(x,y,\phi) \right\rangle \left(1 + B_k + B_q\right)}$$

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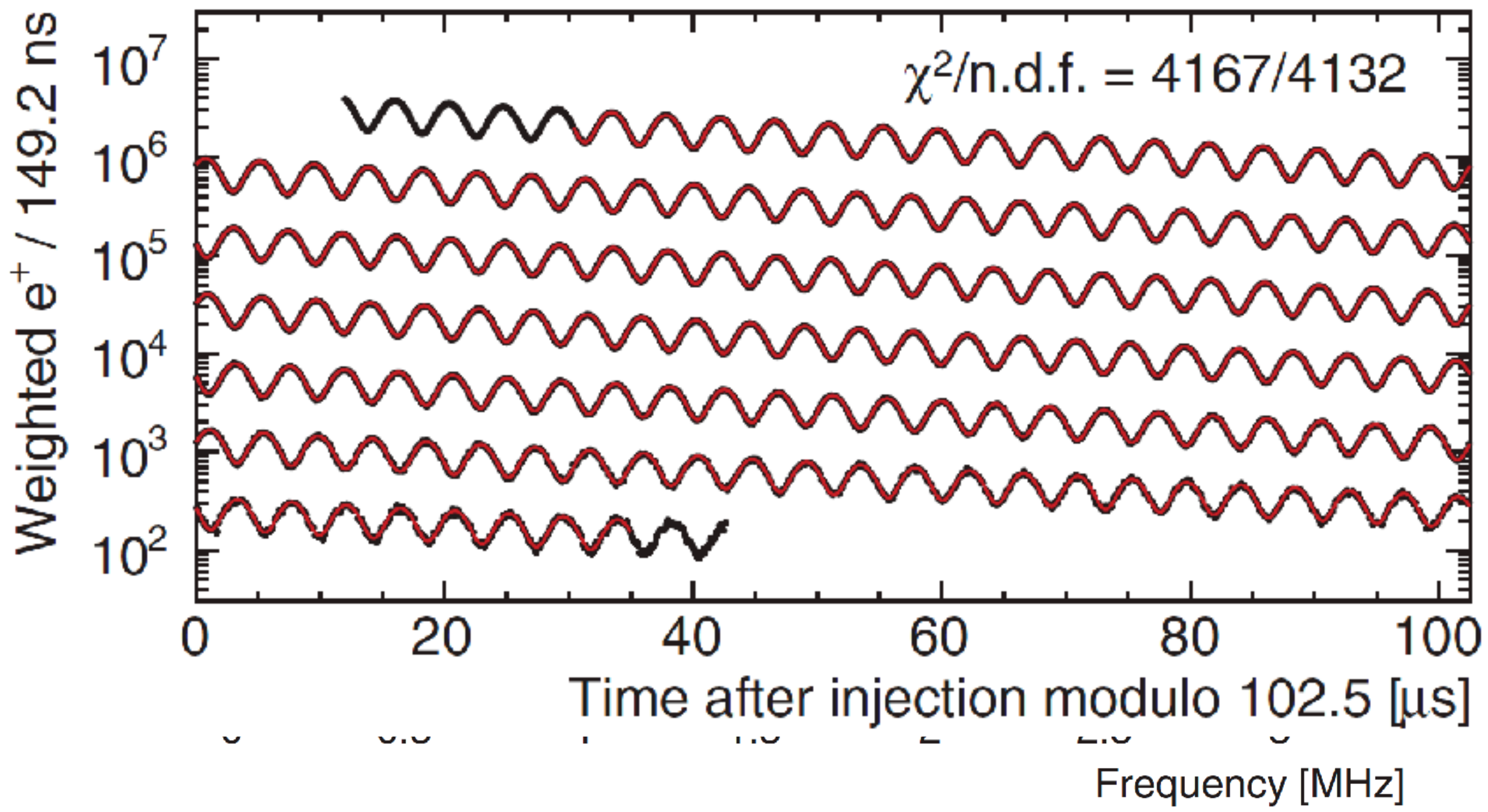
Extract ω_a^{meas} from the wiggle plot

Histogram of decay e⁺ arrival times (wiggle plot)

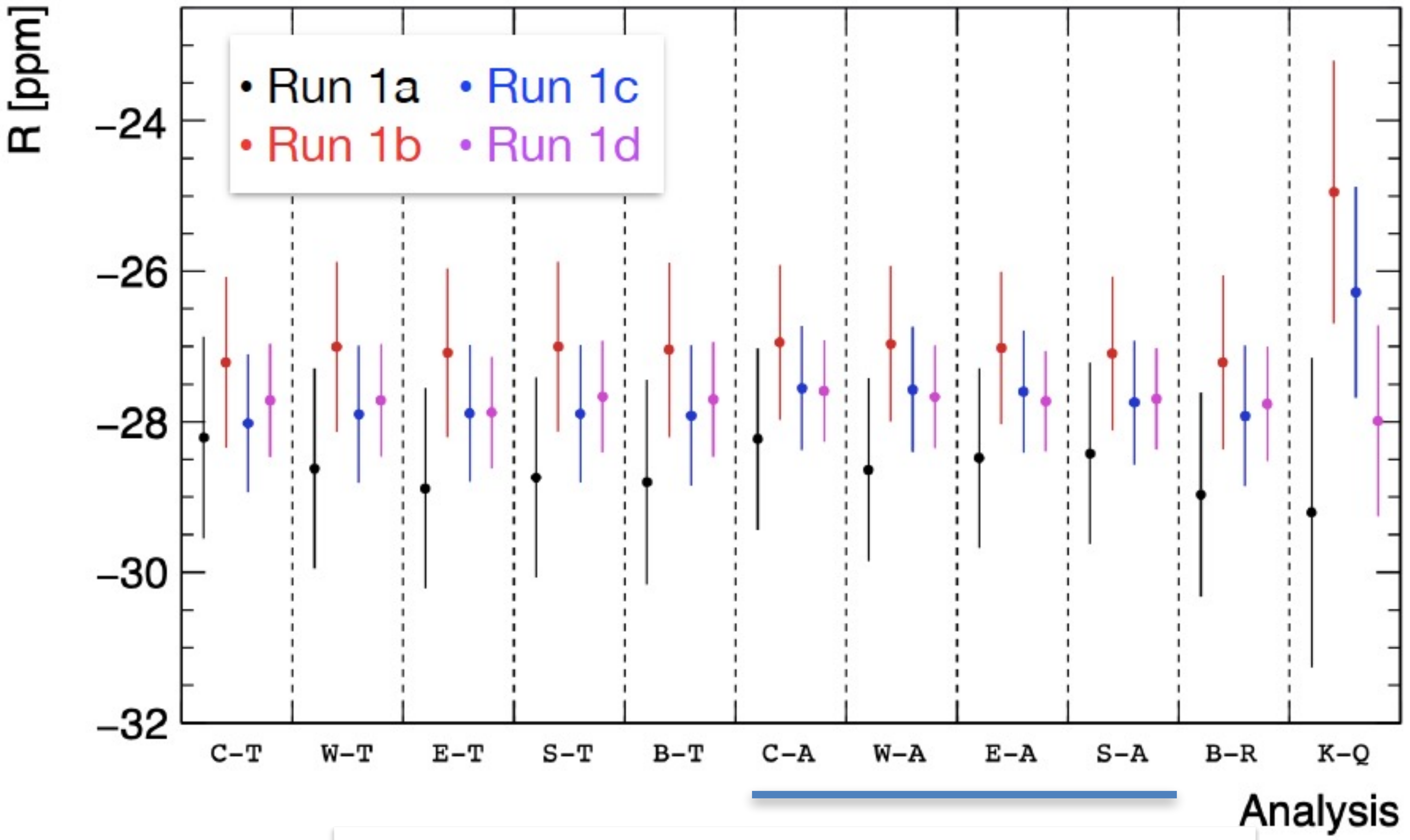


3 independent event reconstruction schemes
11 different and independent analyses
6 independent groups

Complex beam dynamics encoded in wiggle plot

Separate analyses for Runs 1a-1d

Extensive systematic checks passed:
→ "Software" unblinding to check consistency, hardware blinding still in place



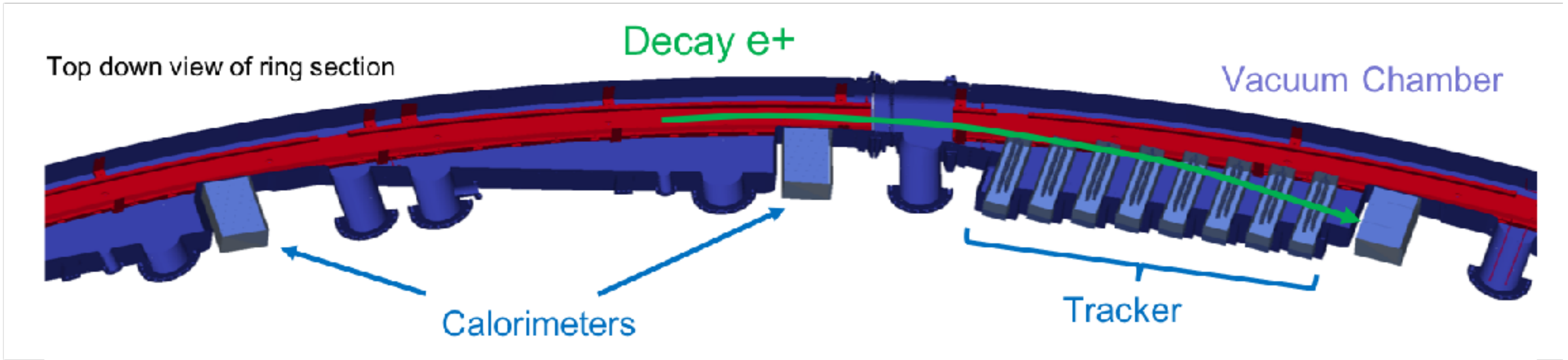
- **434 ppb** statistical uncertainty
- **56 ppb** systematic uncertainty

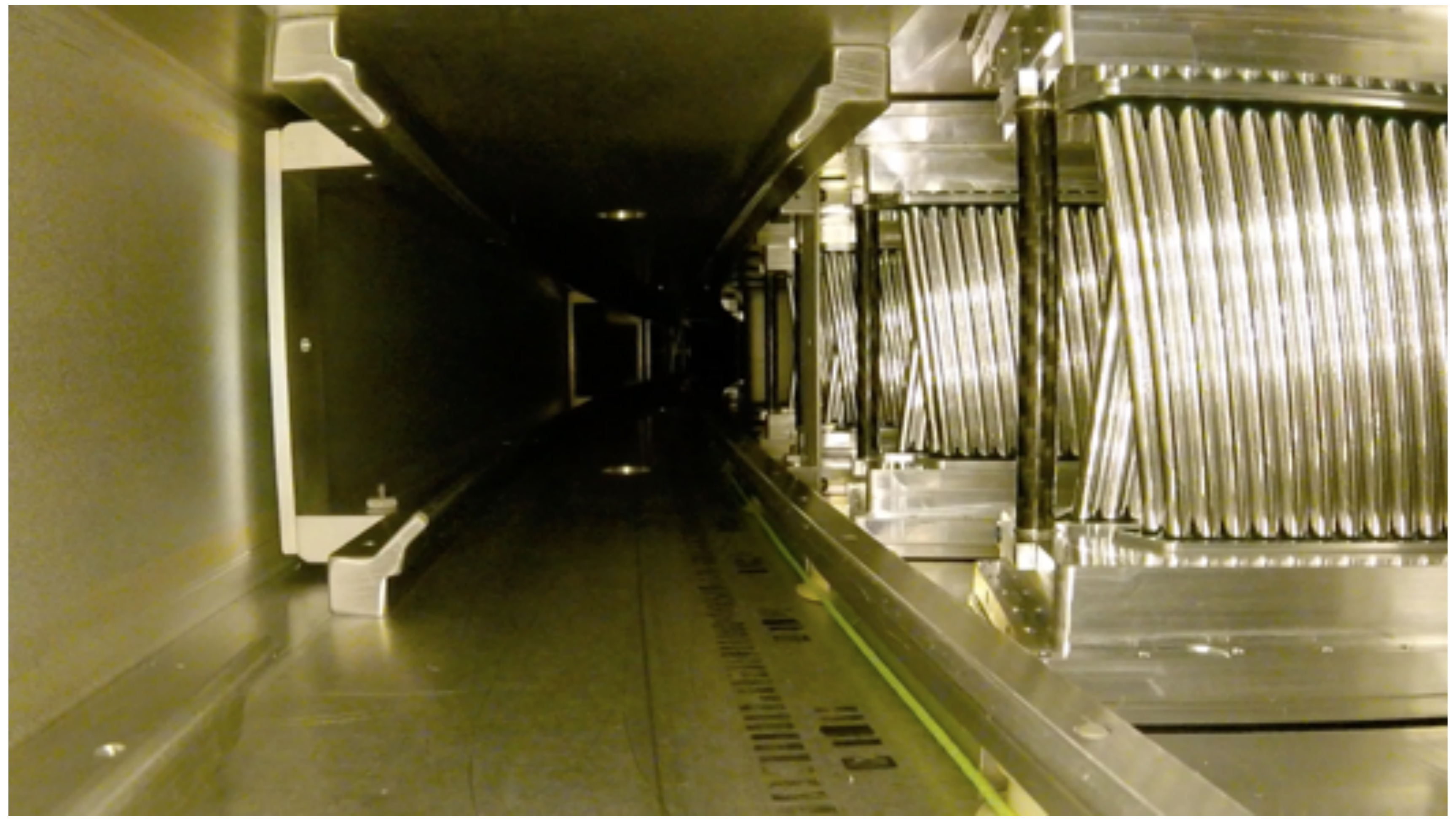
JG|U

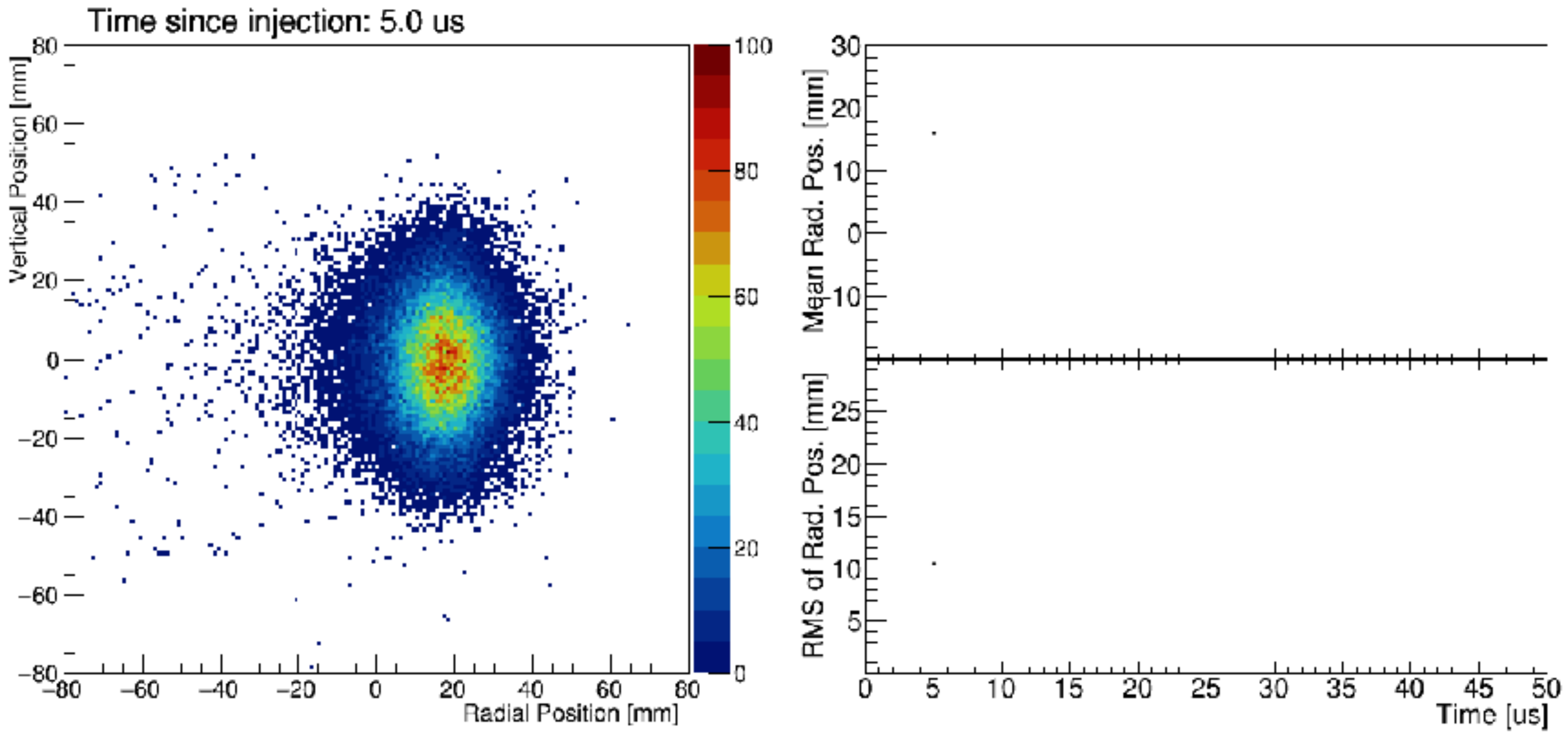
Extracting a_μ: the muon beam dynamics corrections

$$R' = \frac{\omega_a}{\omega'_p} = \frac{f_{\text{clock}}\, \omega_a^{\text{meas}} \left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{\text{calib}} \left\langle M(x,y,\phi)\, \omega'_p(x,y,\phi) \right\rangle \left(1 + B_k + B_q\right)}$$

The straw tracker stations





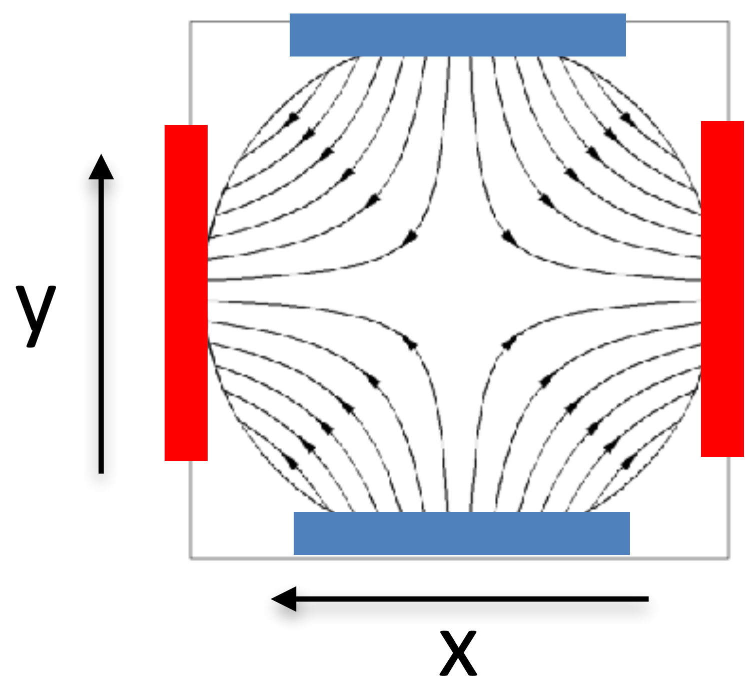


Determine e⁺ trajectory to decay position and extrapolate to find muon beam distribution!
Input for beam dynamics simulations and magnetic field averaging

The long-known corrections: E-field and pitch correction

$$\frac{d}{dt}P_{\mathrm{L}} = \frac{d}{dt}\left(\hat{\beta}\cdot\vec{s}\right) = -\frac{e}{m}\vec{s}_{\perp}\cdot\left[a_{\mu}\hat{\beta}\times\vec{B} + \left(a_{\mu} - \frac{1}{\gamma^2-1}\right)\beta\vec{E}\right]$$

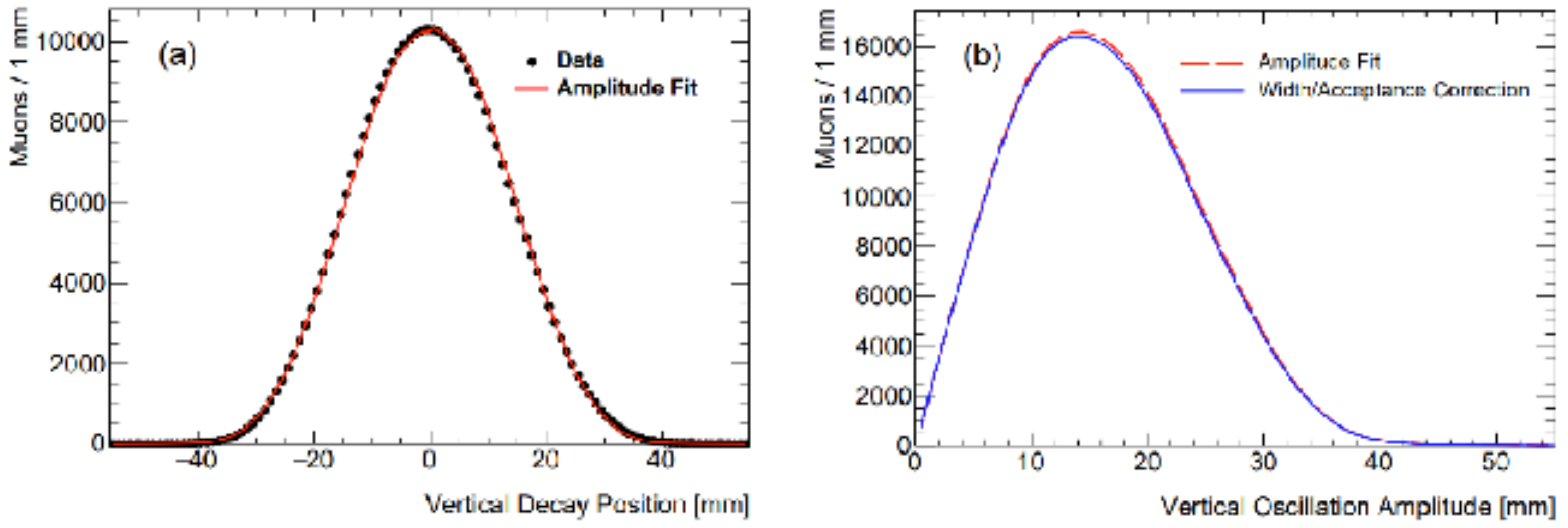
Pitch correction



Electrostatic focusing → spin precession due to E_x and vertical harmonic motion in quadratic E field!

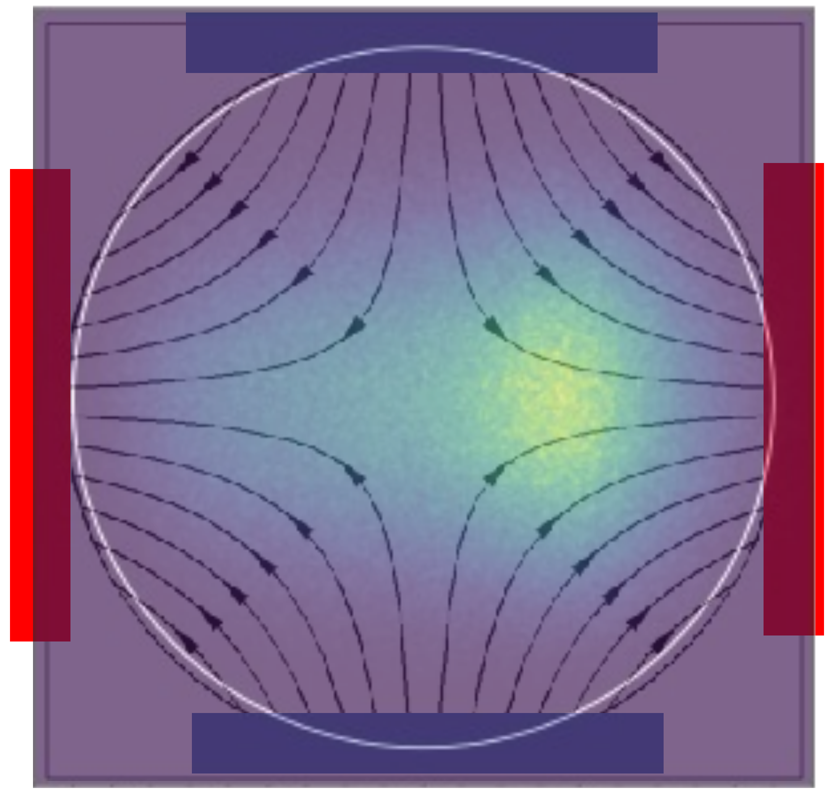
$$C_{\mathrm{p}} = \frac{n}{4R_0^2}\langle A^2\rangle$$

Trackers measure vertical oscillation amplitude

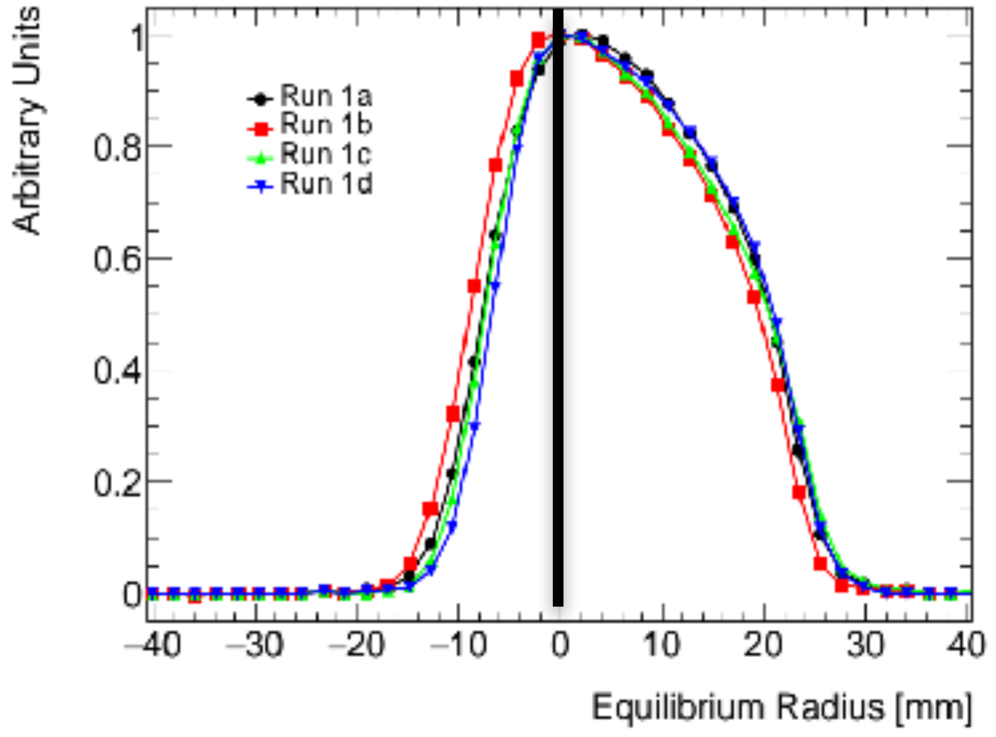


Correction: 180 ppb, Uncertainty: 13 ppb

Electric field correction



"Fast rotation analysis"

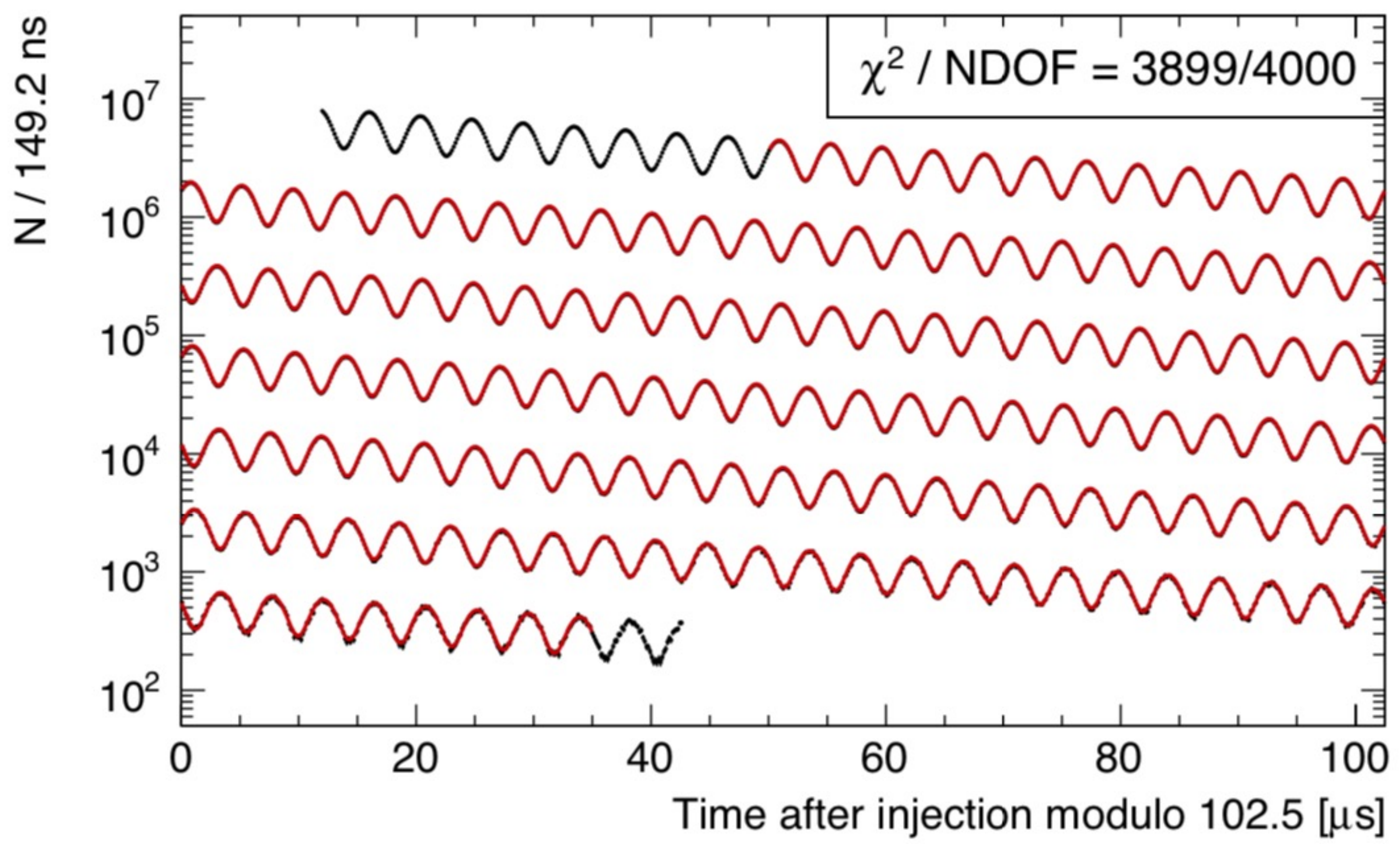


Run 1 muon distribution
Muons were not centered!

$$C_e = -2n(1-n)\beta^2\frac{\langle x_e^2\rangle}{R_0^2}$$

Correction: 489 ppb, Uncertainty: 53 ppb

Phase acceptance correction



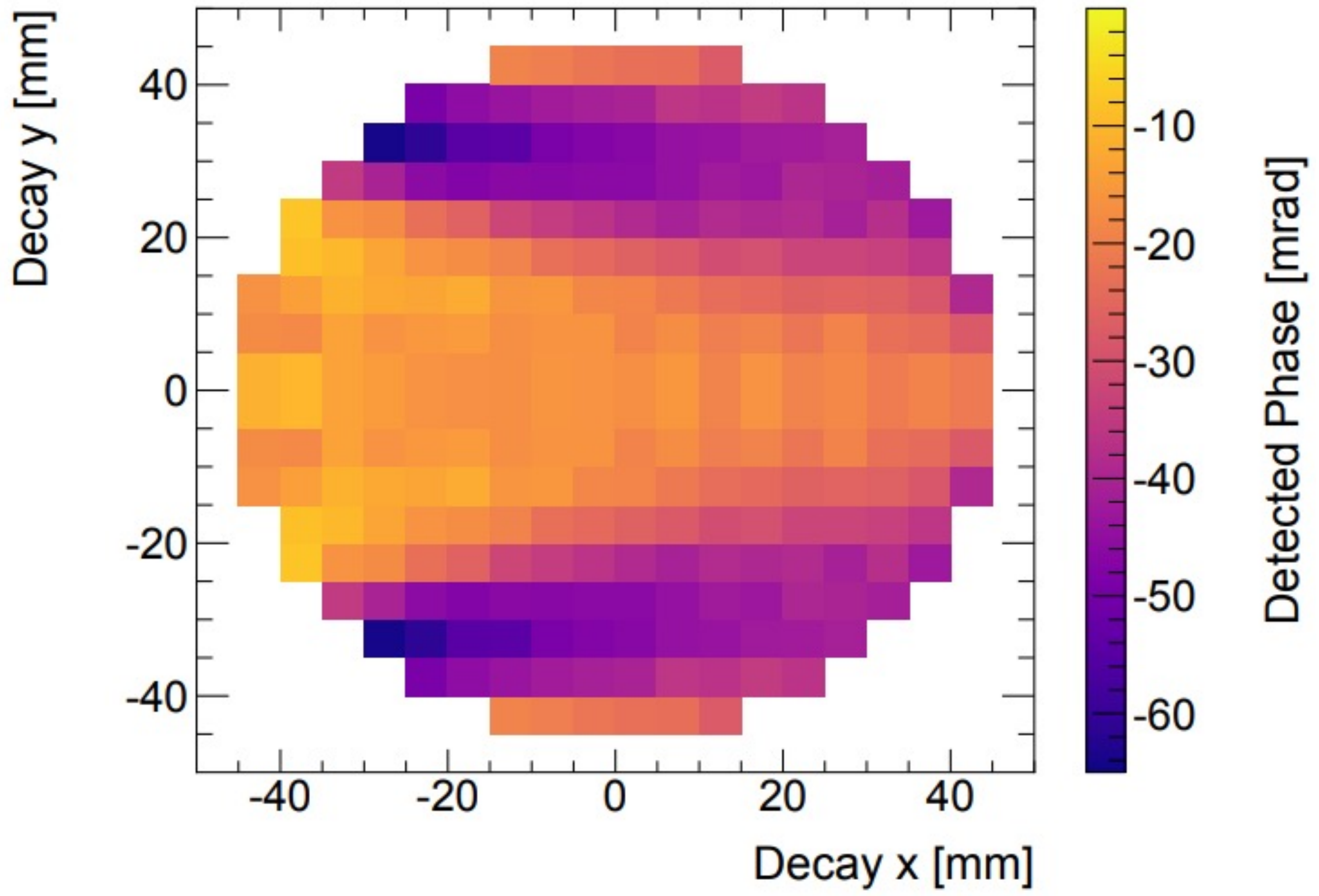
$$N(t) \approx N_0 e^{-\lambda t}\left[1 + A\cos\left(\omega_a t + \phi\right)\right]$$

If the phase of the muon ... is not stable, then:

$$\cos\left(\omega_a t + \phi_0 + \ldots\right) = \cos\left((\omega_a + \phi')t + \phi_0 + \ldots\right)$$

A possible frequency shift of ϕ'

early-to-late effects

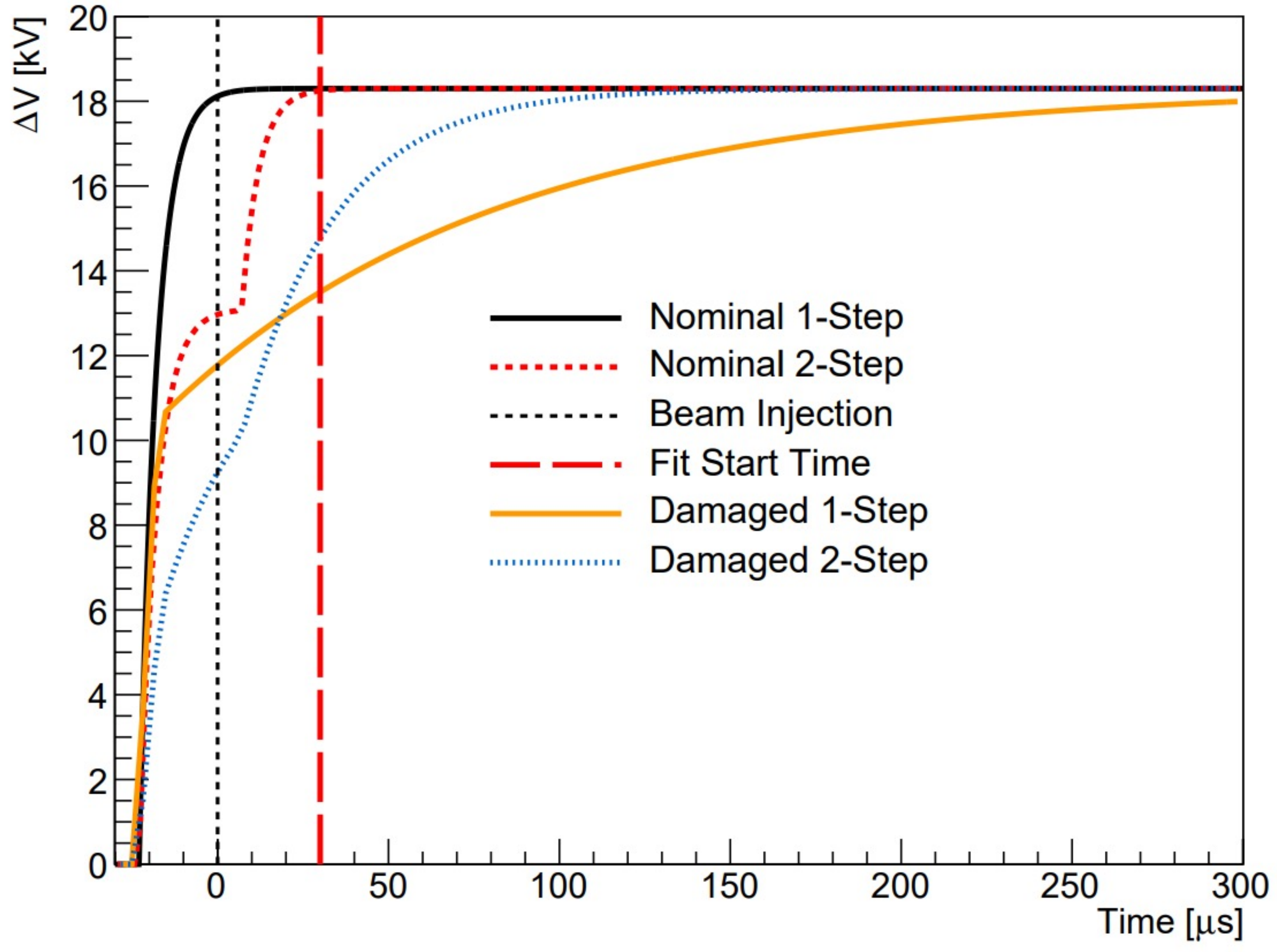


- The decay positrons encode a particular phase
- This phase depends on
  - Muon decay position
  - Decay positron energy

Extensive simulation campaign

- Not a problem if muon distribution is stable in time, but…

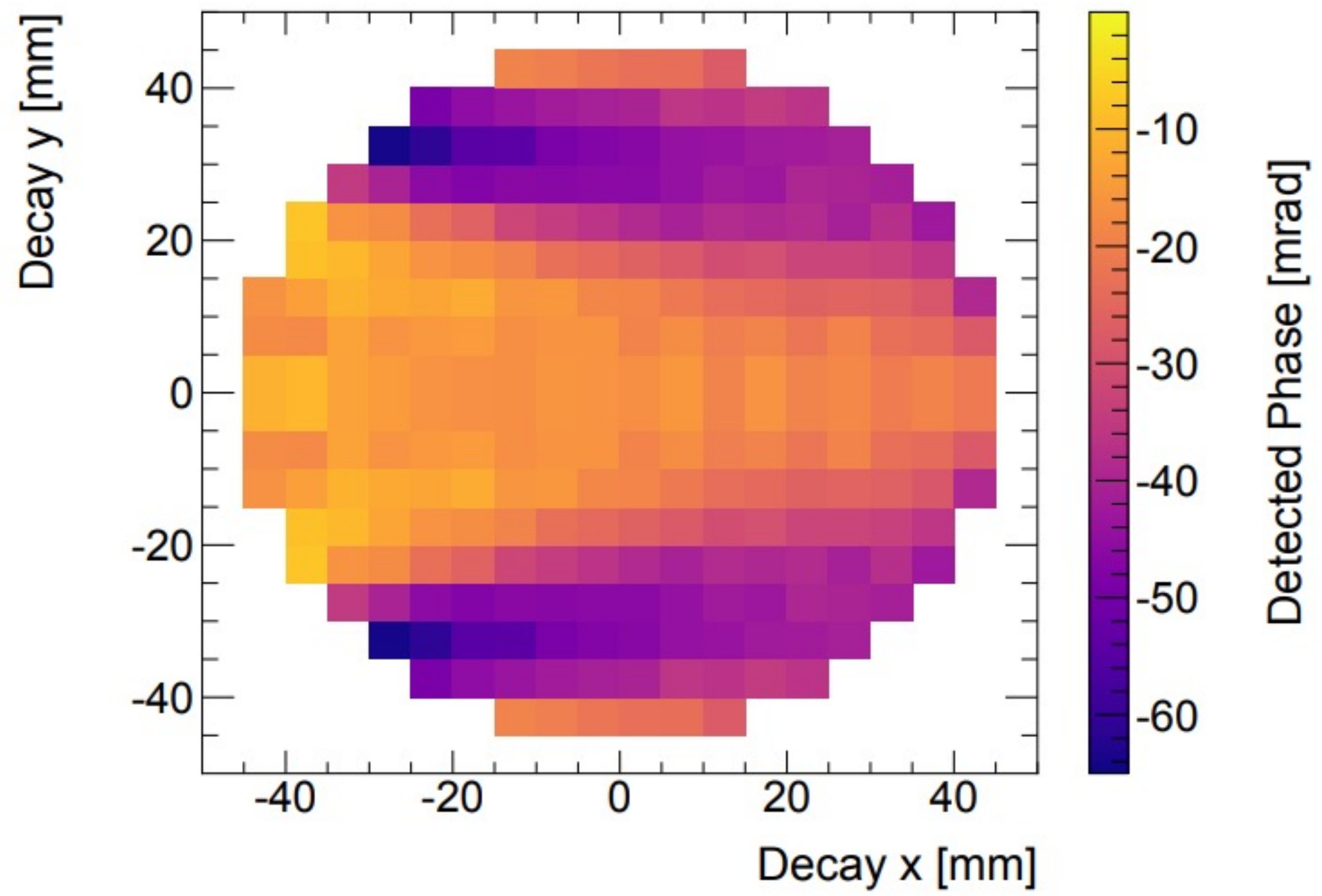
Phase acceptance correction: The voltage on the ESQs

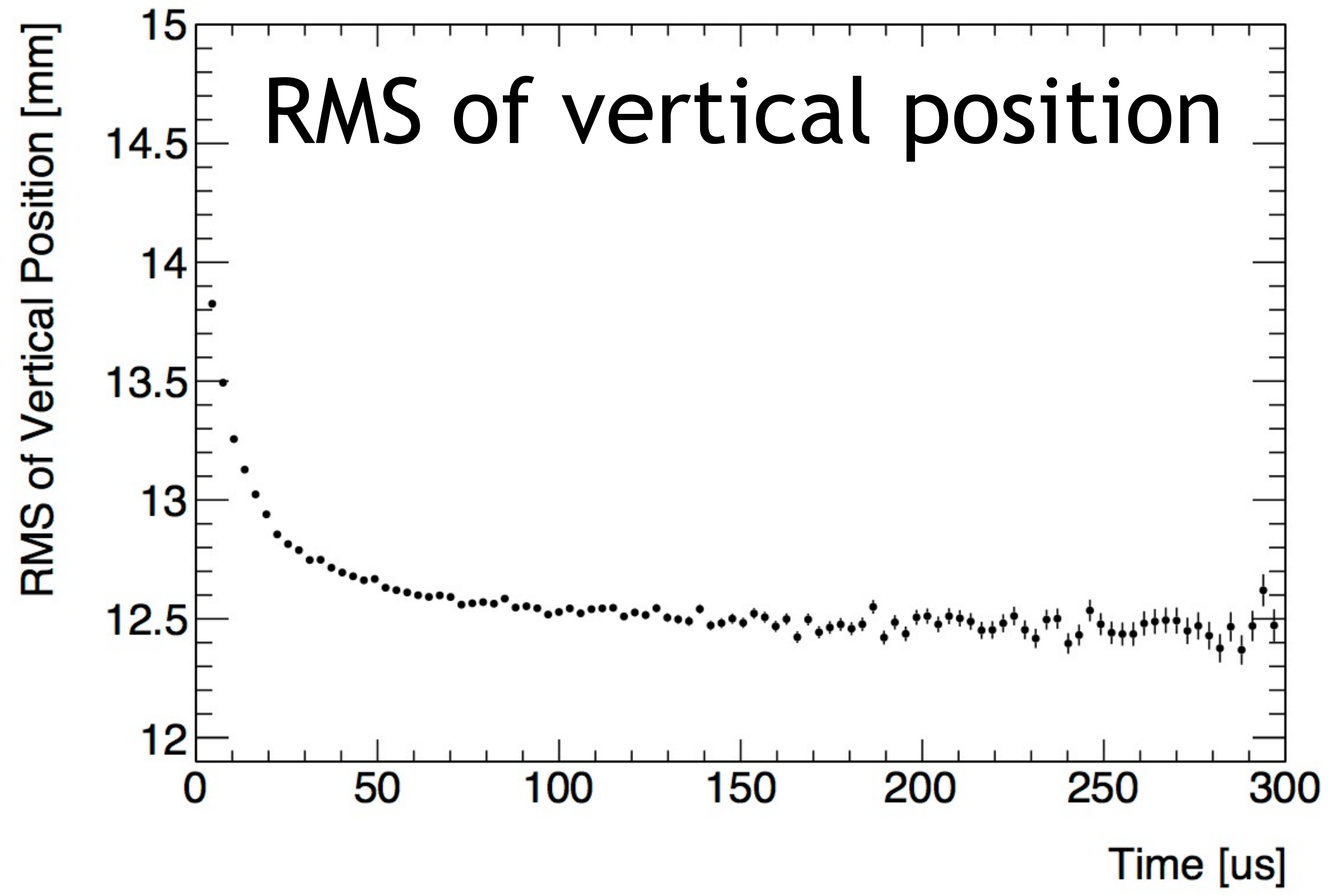


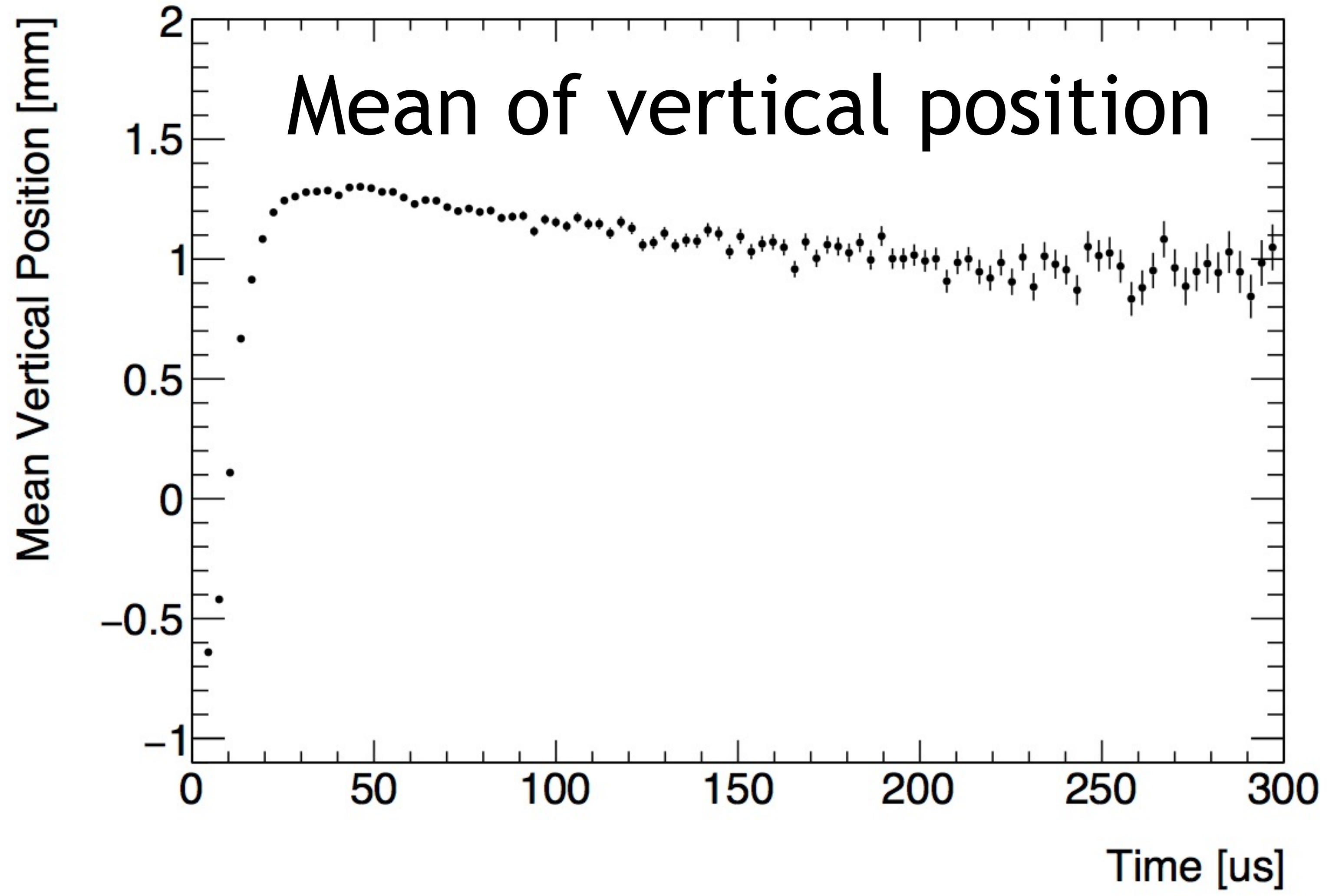
Systematic effect unique for Run 1 data (hardware fixed for run 2 and beyond):

- 2 high-voltage isolators for ESQ failed
- Time-dependent E-Field of on 2 ESQ plates
  → Change of vertical beam position and width

Correction: -158 ppb, Uncertainty: 75 ppb







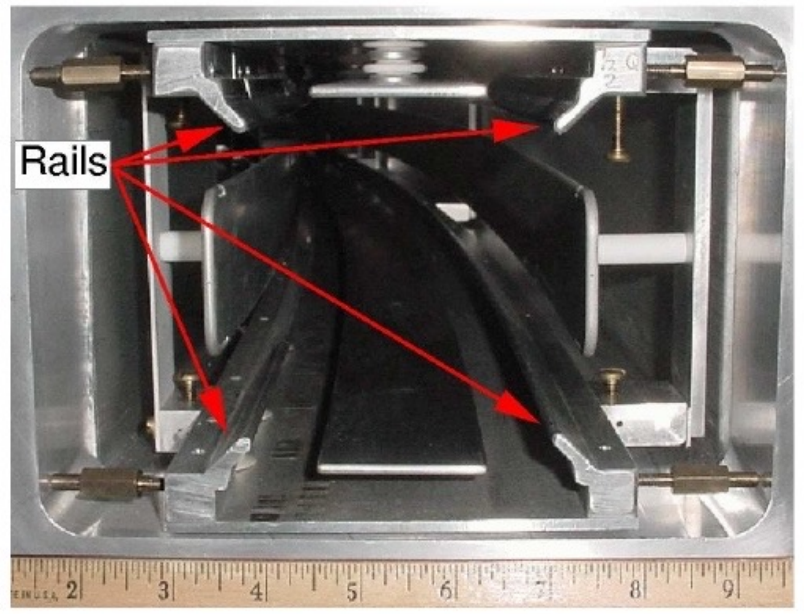
Extracting a_μ: the magnetic field distribution and calibration

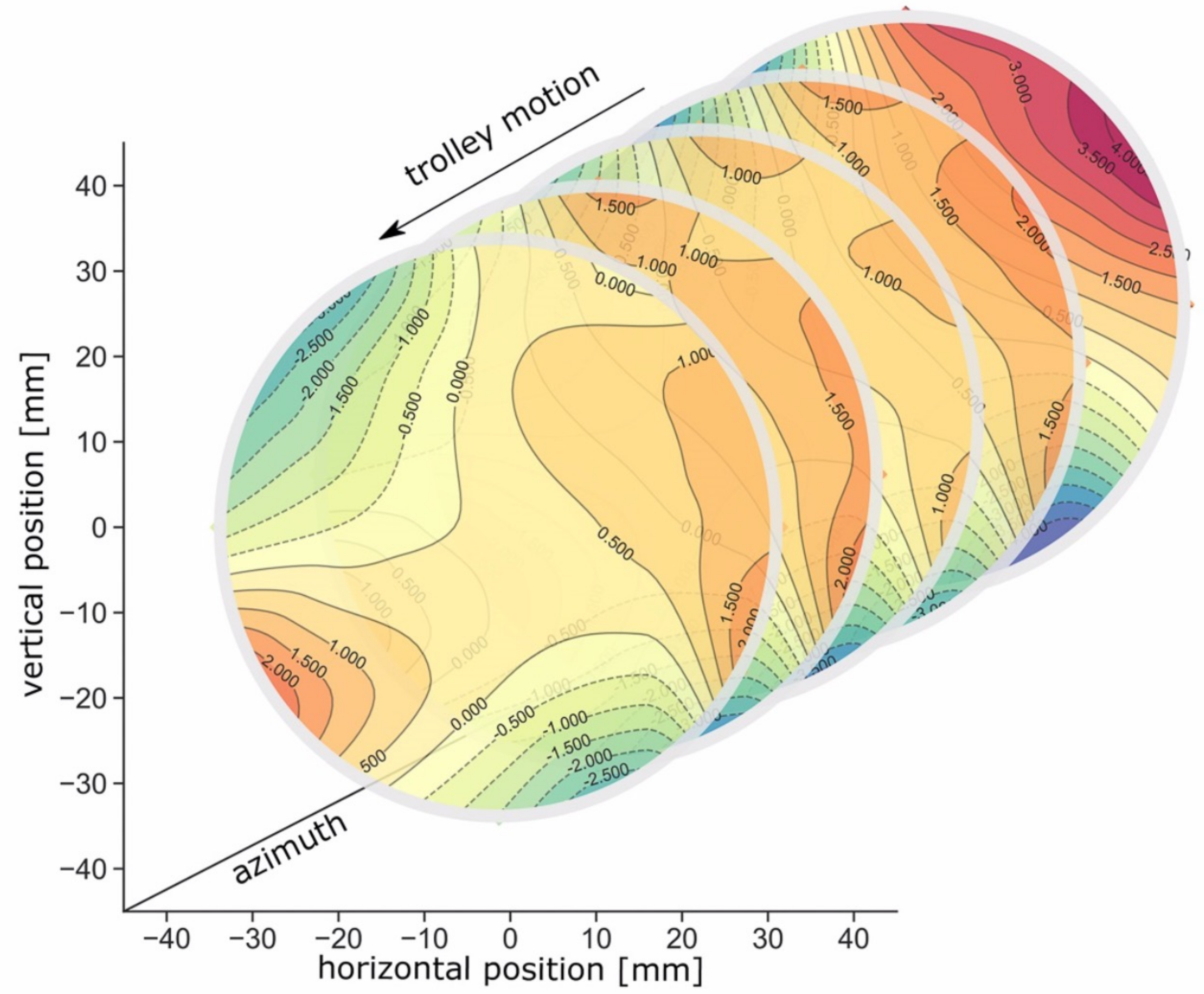
$$R' = \frac{\omega_a}{\omega'_p} = \frac{f_{\text{clock}}\, \omega_a^{\text{meas}} \left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{\boxed{f_{\text{calib}}} \left\langle M(x, y, \phi) \boxed{\omega'_p(x, y, \phi)} \right\rangle \left(1 + B_k + B_q\right)}$$

The magnetic field calibration chain

"The trolley"

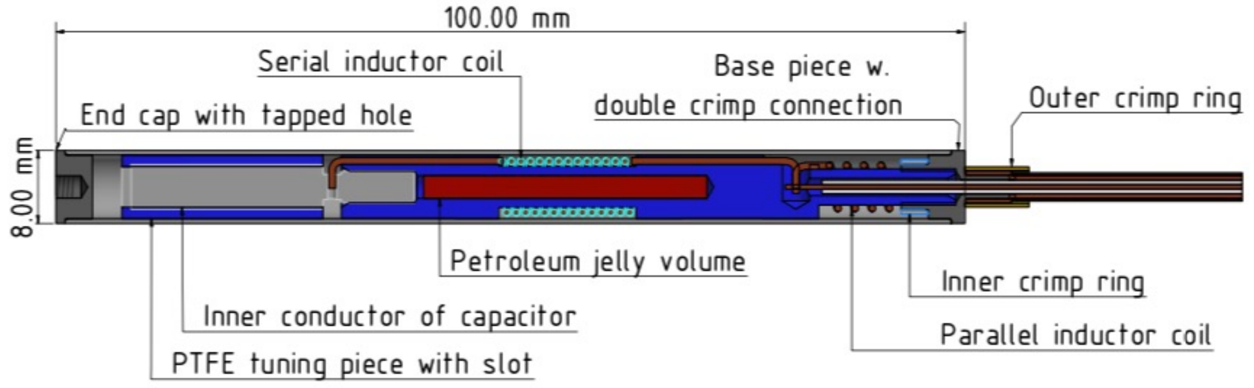
17 NMR probes, 3-day interval

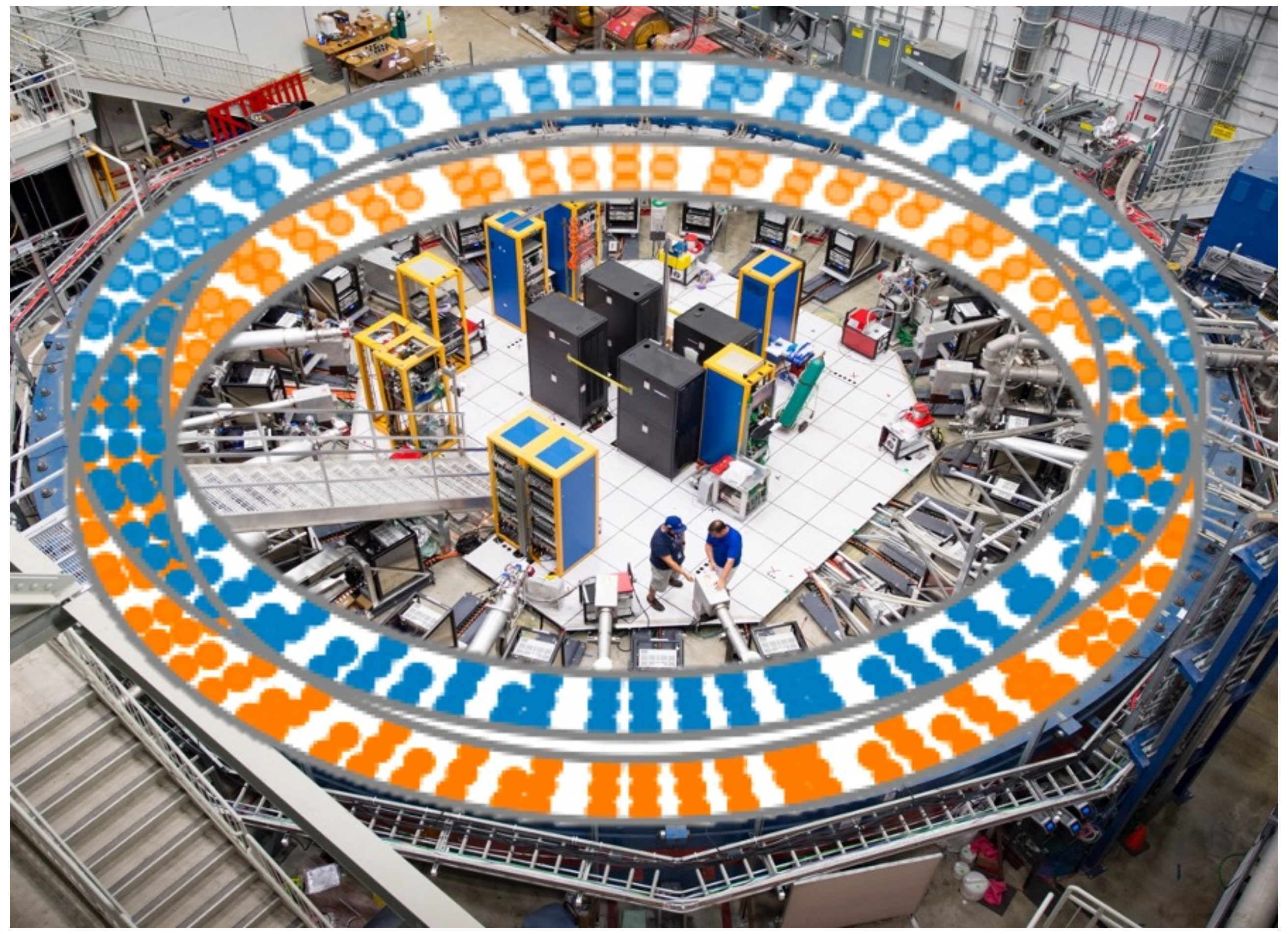




"The fixed probe array"

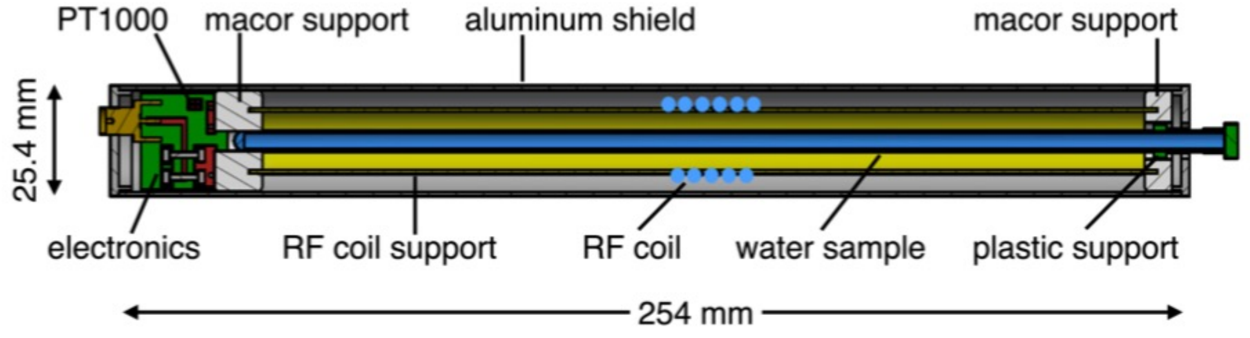
378 pulsed nuclear magnetic resonance probes measure 24/7 around μ beam

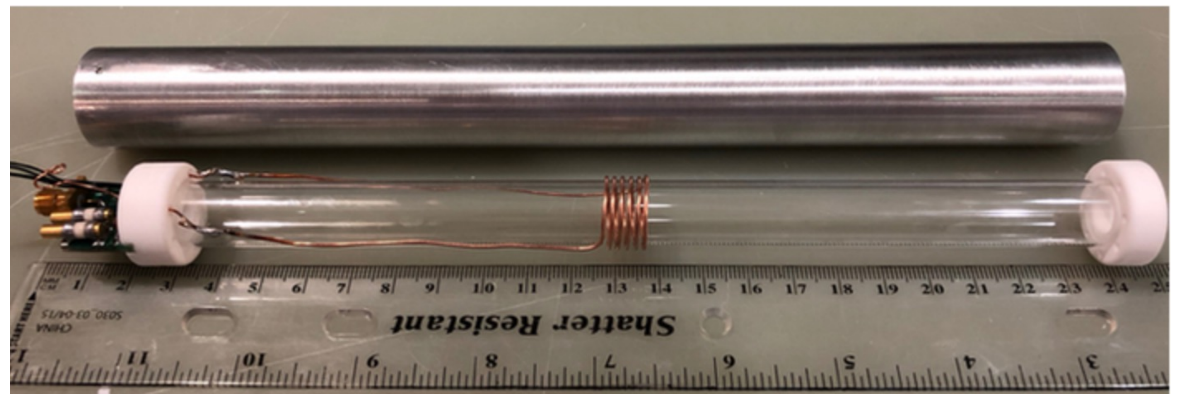




"The calibration"

"Plunging probe" to transfer absolute calibration to trolley probes

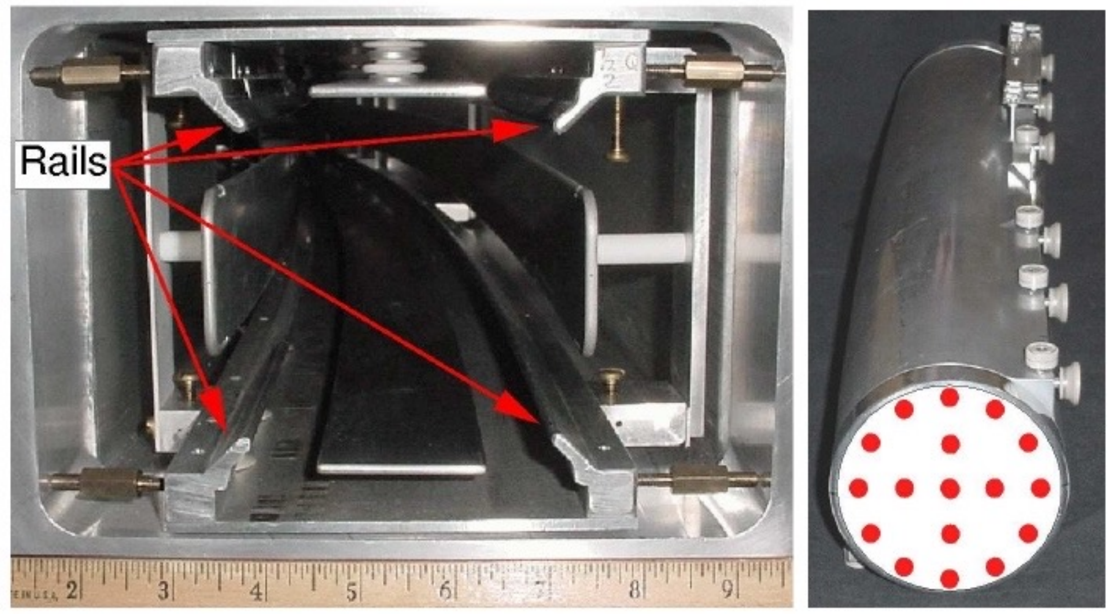


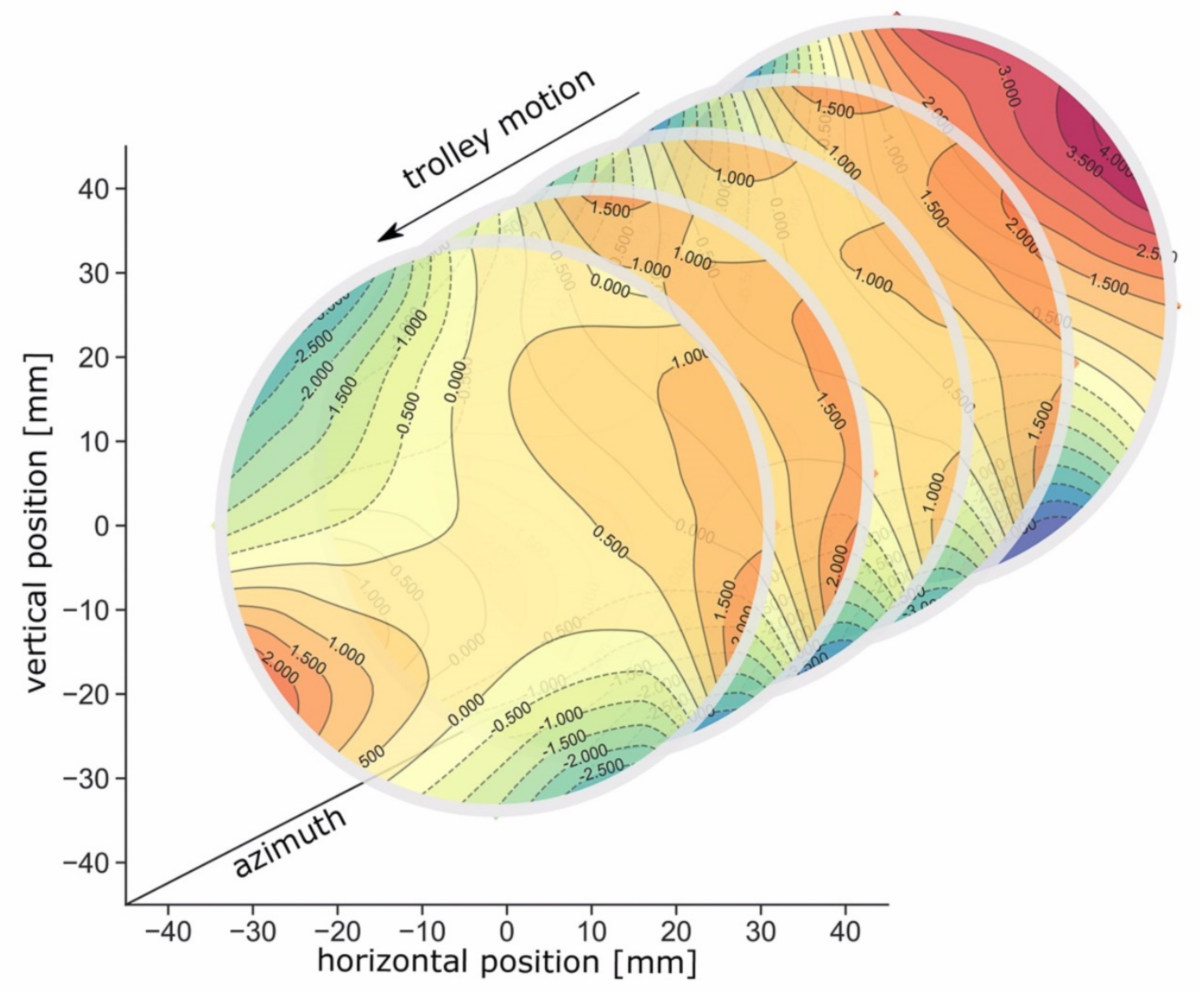


The precision magnetic field: spatial mapping

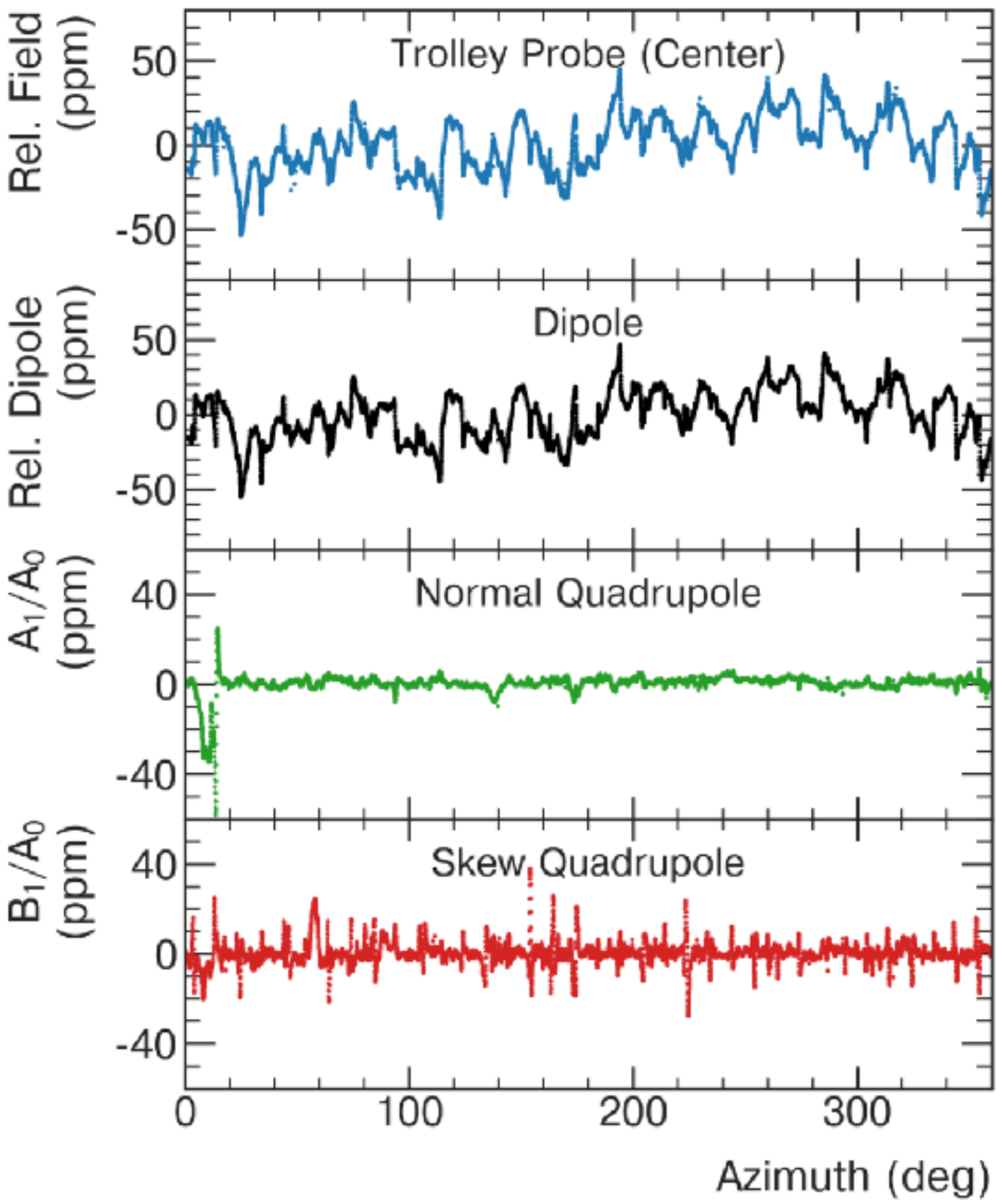
"The trolley"

17 NMR probes, 3-day interval

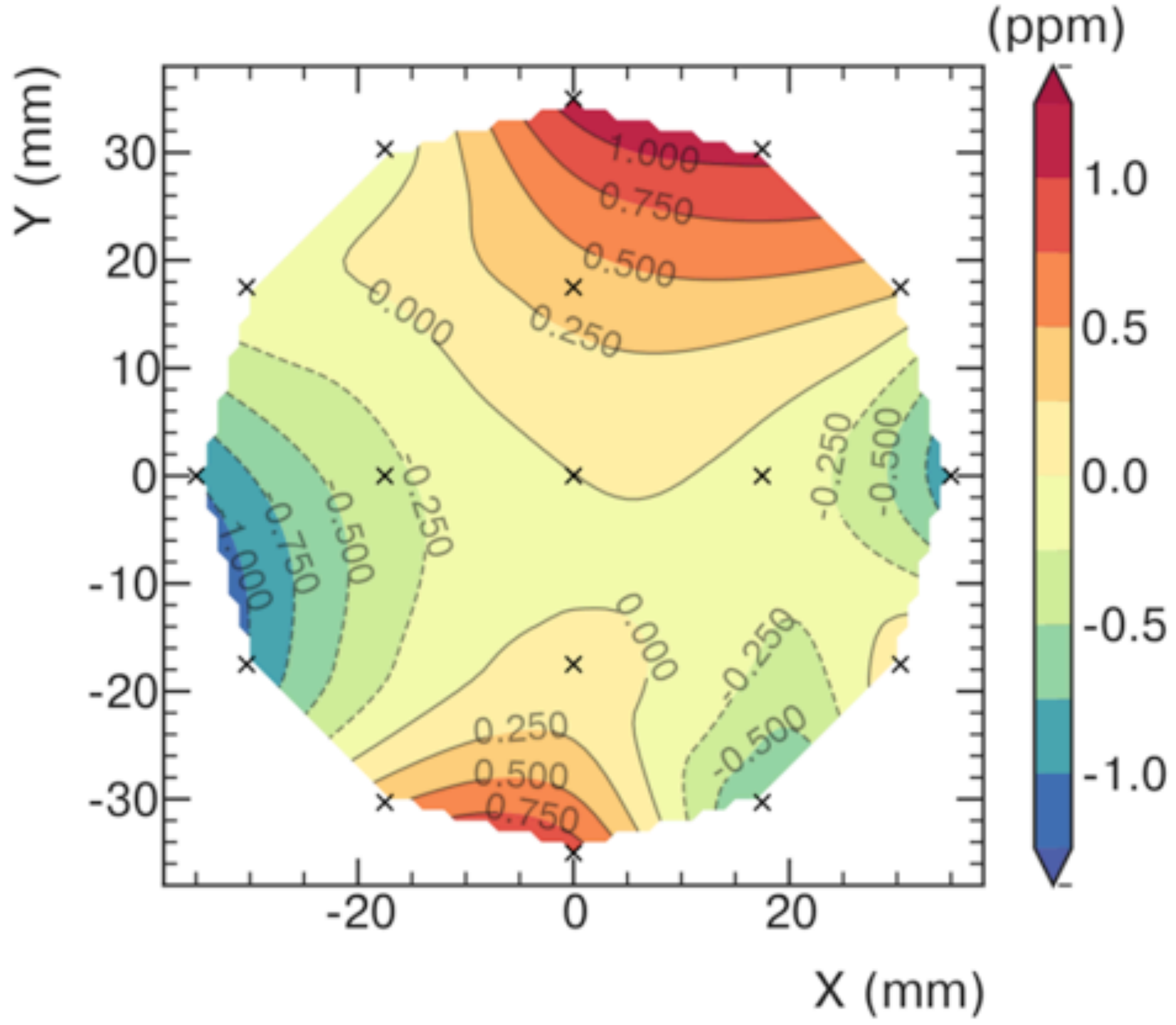




About 9000 azimuthal positions to make a field decomposition into 2D spatial multipoles



A typical azimuthally averaged magnetic field map



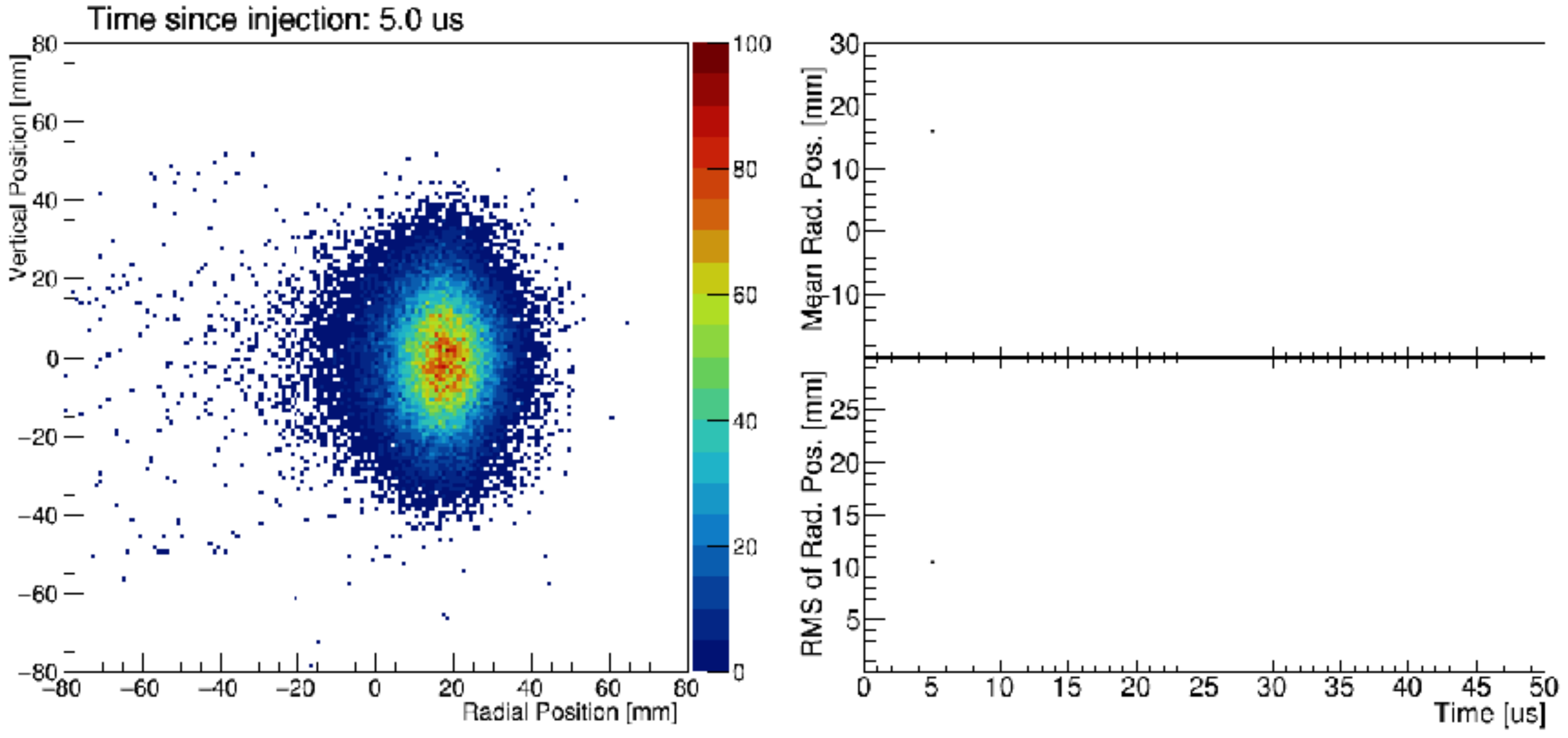
For more details listen to

K.W. Hong
Aug 30th, 2022, 3:30 PM
Today!

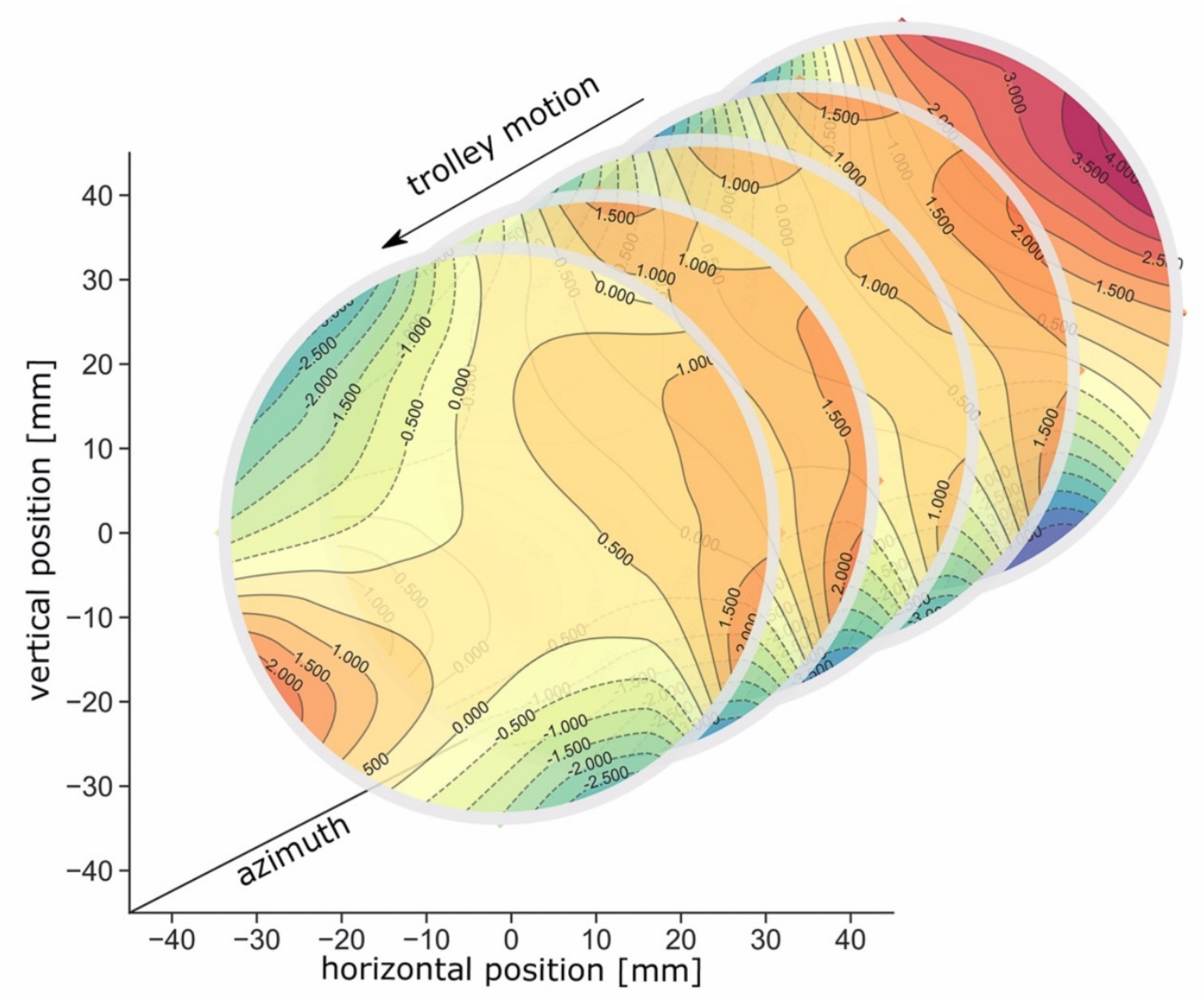
Extracting a_μ: the muon weighted average magnetic field

$$R' = \frac{\omega_a}{\omega_p'} = \frac{f_{\mathrm{clock}}\,\omega_a^{\mathrm{meas}}\left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{\mathrm{calib}}\left\langle M(x,y,\phi)\,\omega_p'(x,y,\phi)\right\rangle\left(1 + B_k + B_q\right)}$$

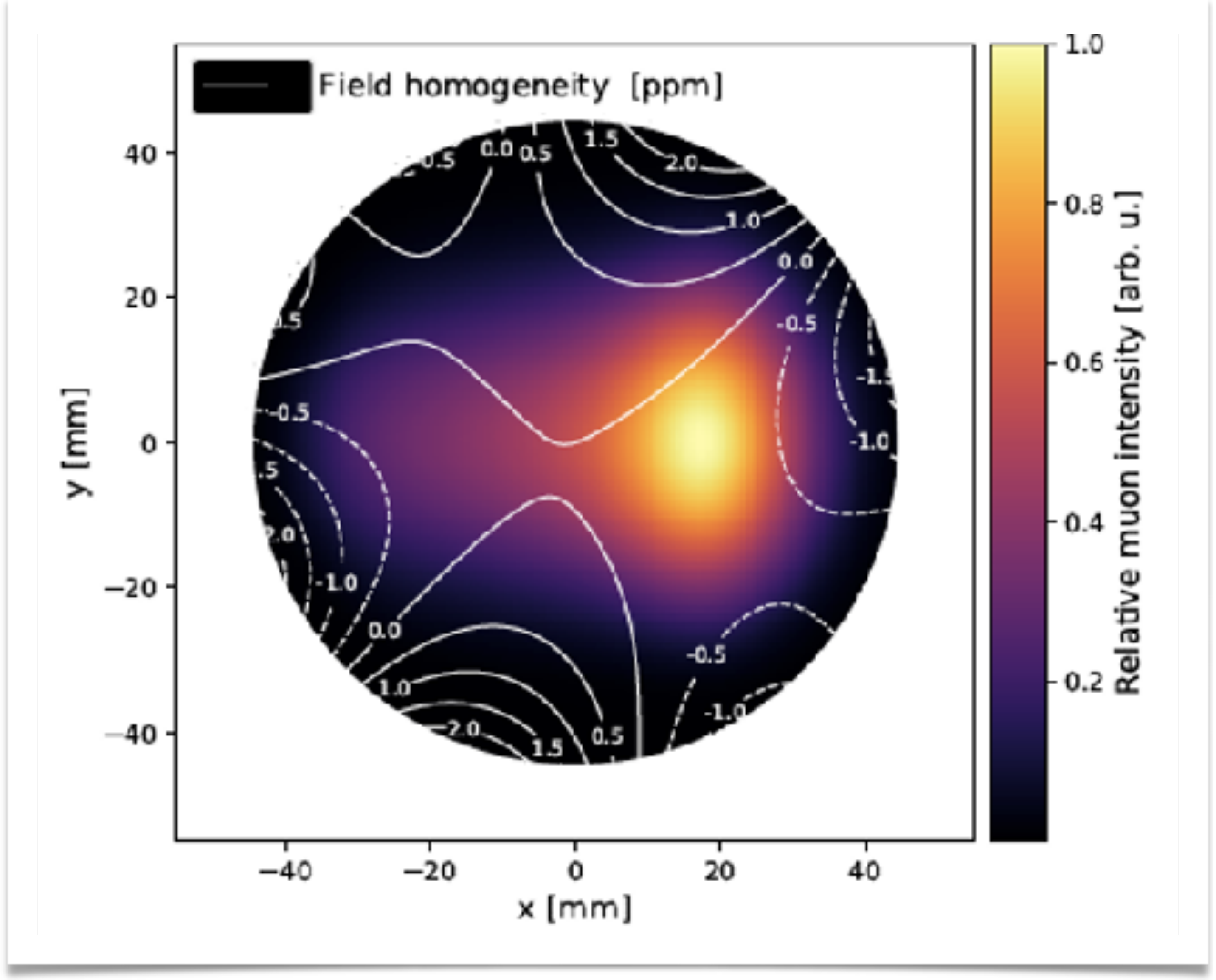
The muon weighted average magnetic field



Beam tracker station data
and beam dynamics simulations



Magnetic field measurement
Temporal drift correction
Probe calibration



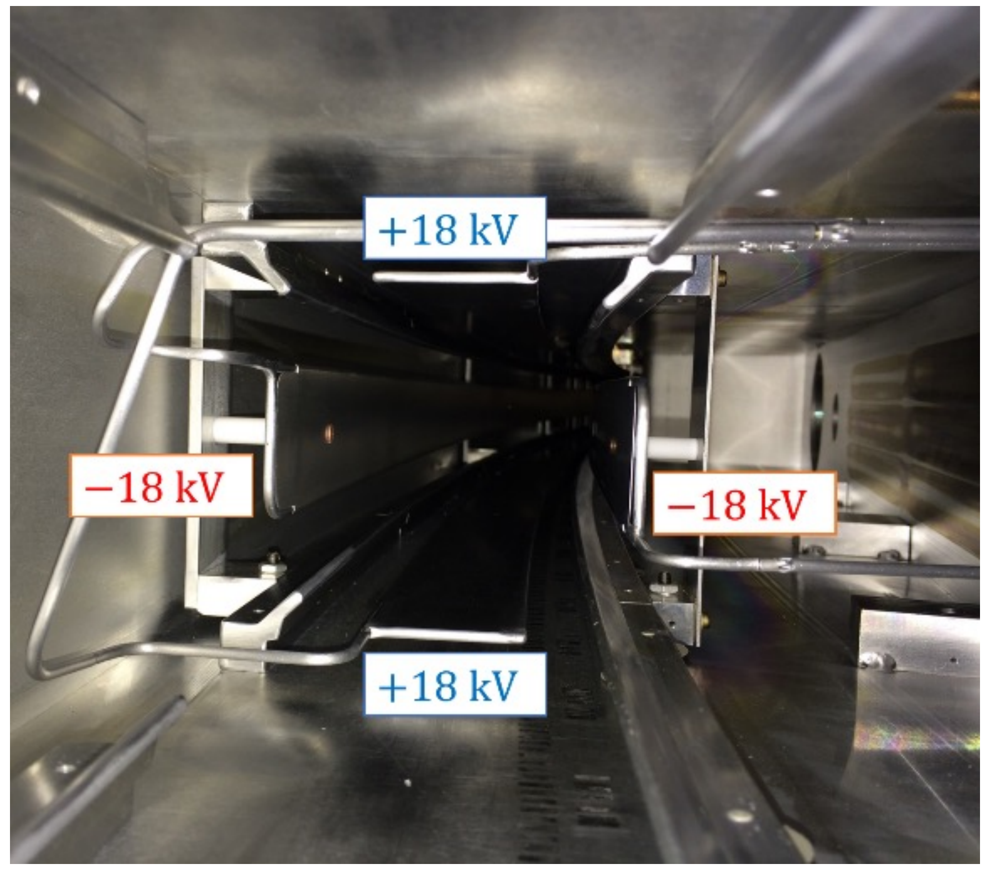
Total uncertainty
of convoluted field map:
56 ppb

Extracting a_μ: transients from ESQ

$$R' = \frac{\omega_a}{\omega'_p} = \frac{f_{\mathrm{clock}}\, \omega_a^{\mathrm{meas}} \left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{\mathrm{calib}} \left\langle M(x,y,\phi)\, \omega'_p(x,y,\phi) \right\rangle \left(1 + B_k + \boxed{B_q}\right)}$$

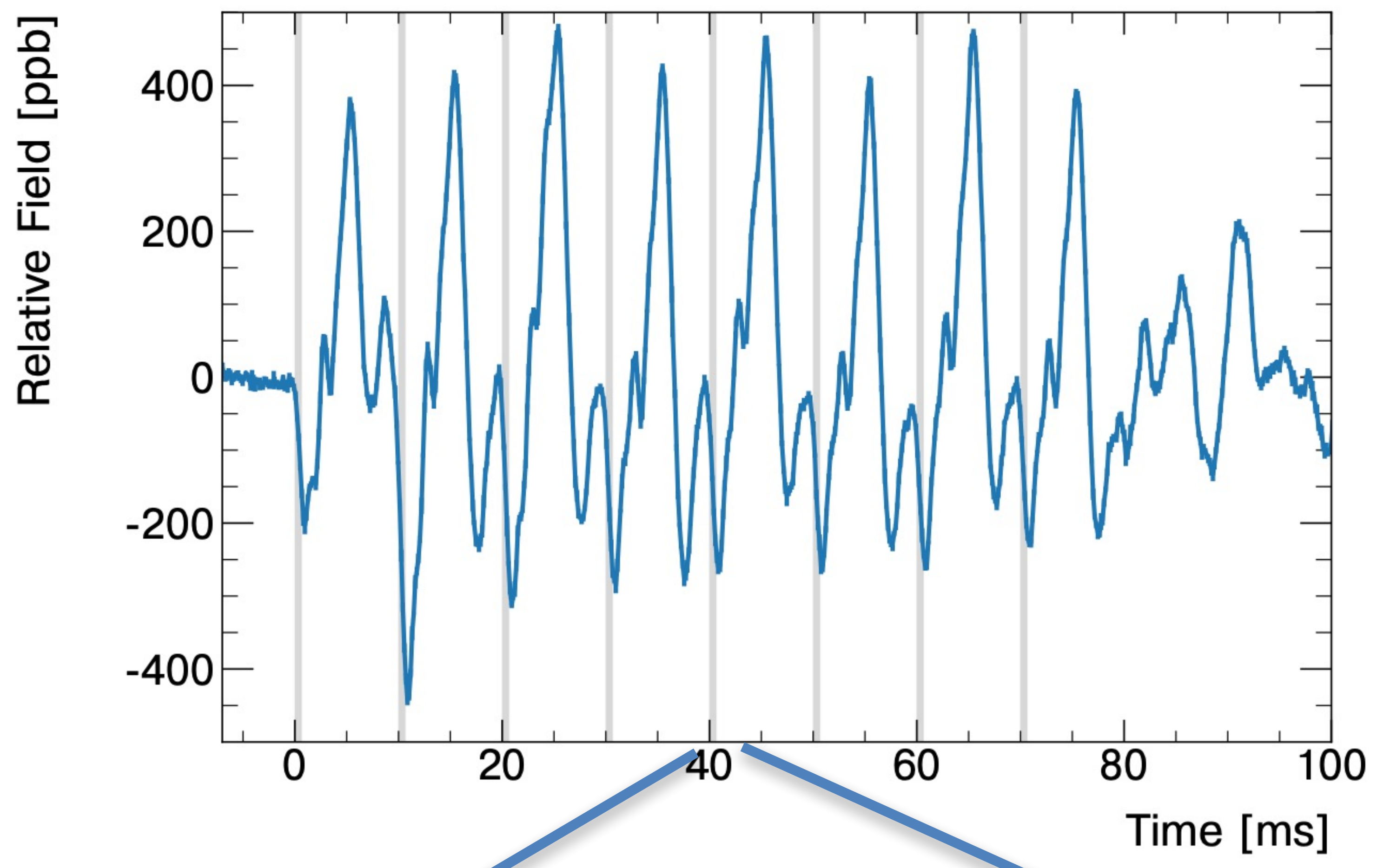
Transients from electrostatic quadrupoles (ESQ)

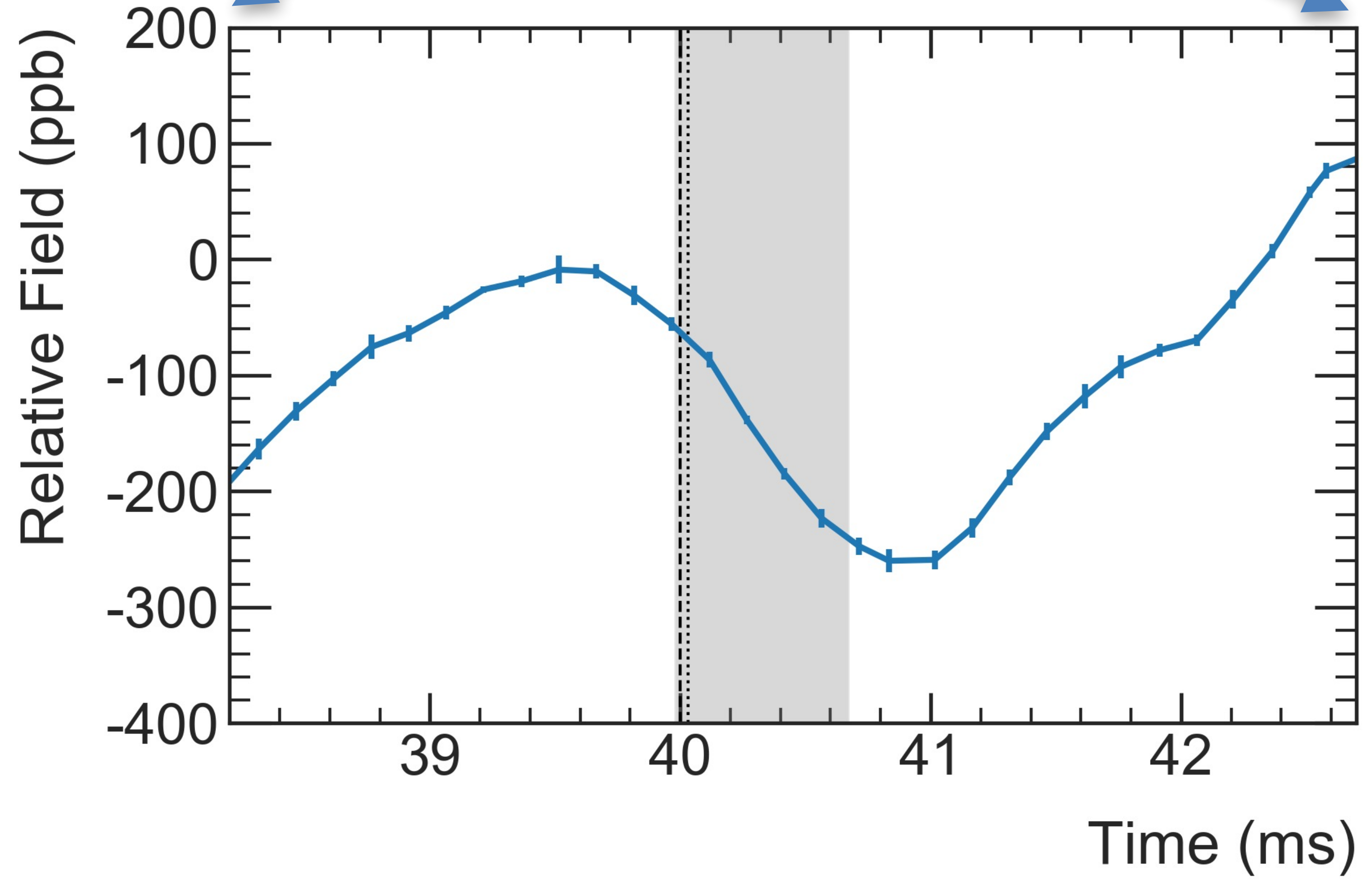
ESQ only static on the time scale of an muon beam bunch injection:



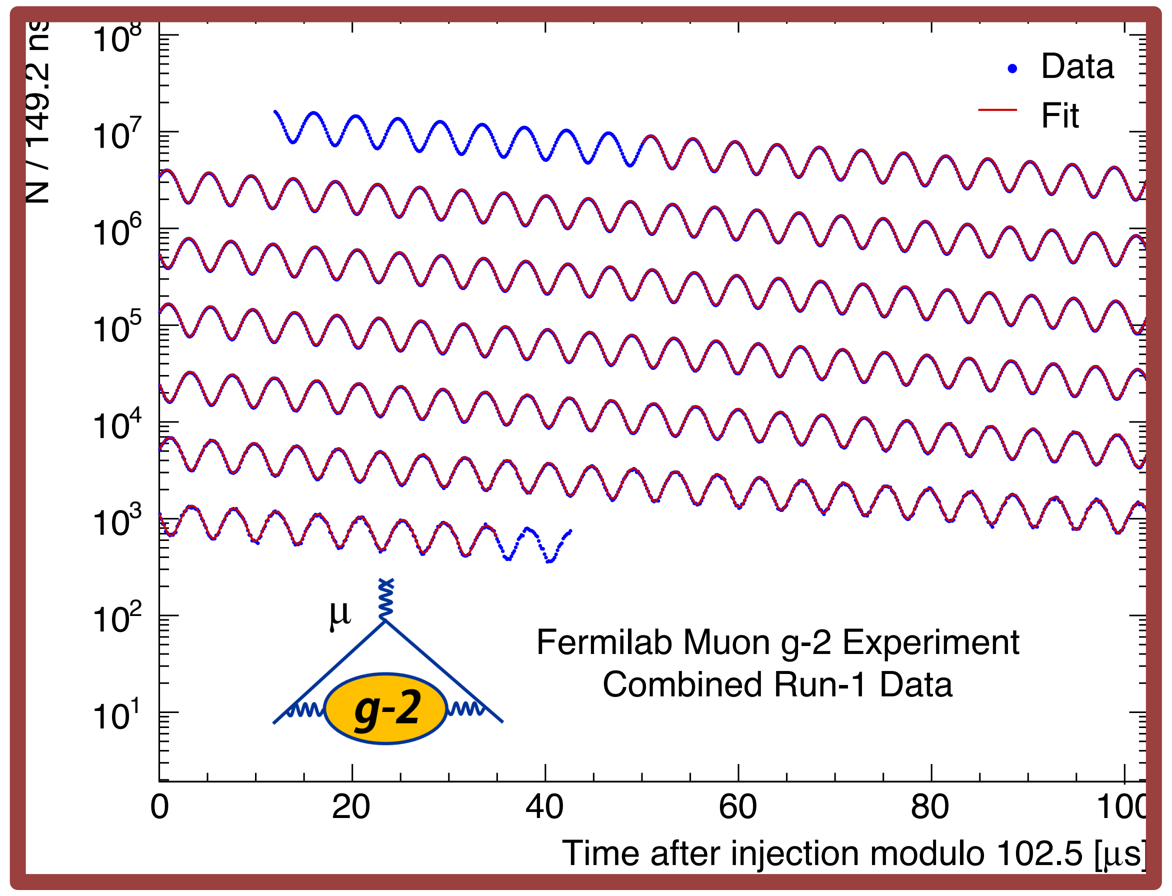
- Pulsing with high-voltage:
  - → mechanical vibrations of electric conductors
  - → perturbation of B field

Correction: 17 ppb
Uncertainty: 92 ppb



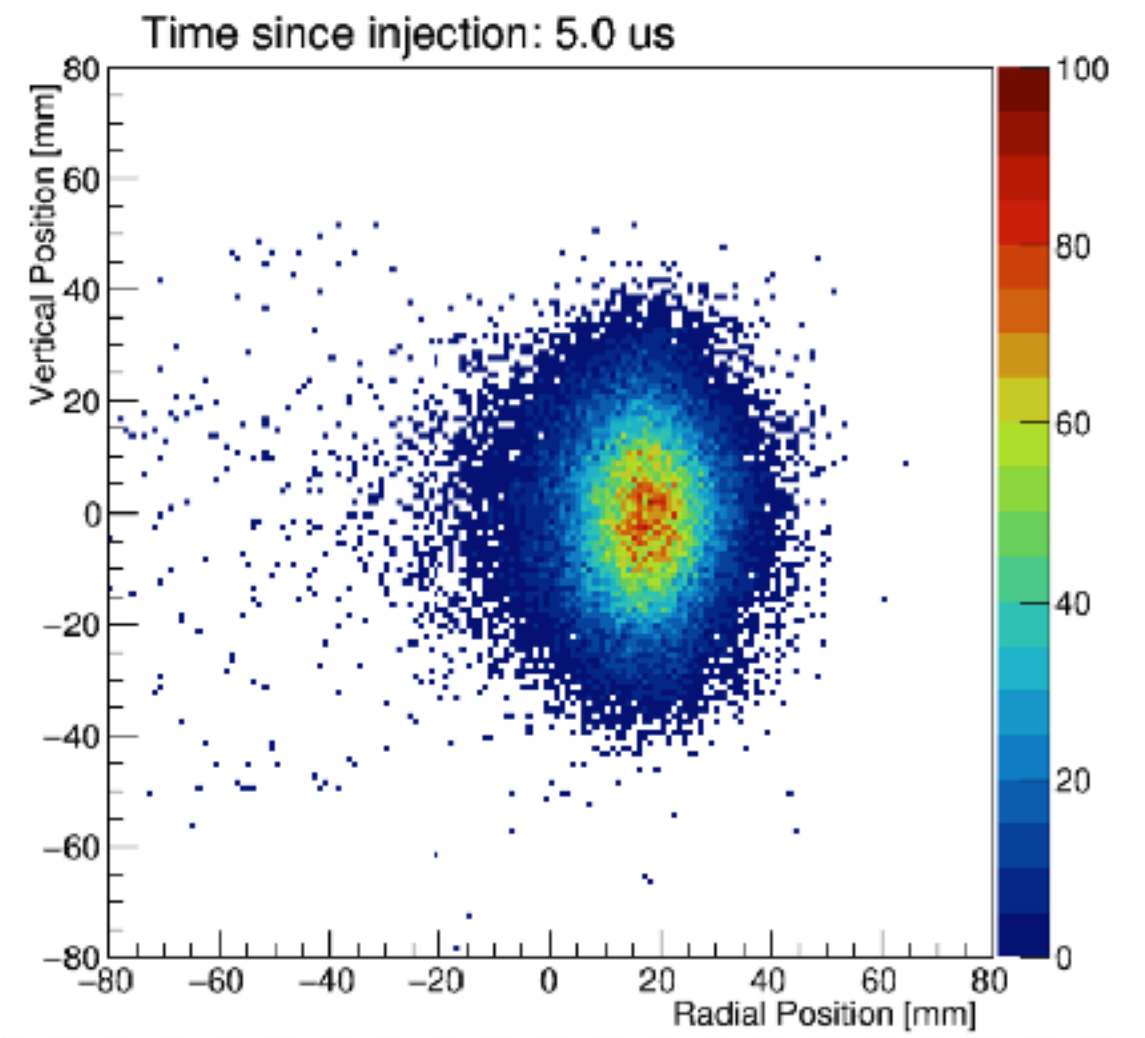


Extracting a_μ - our tools



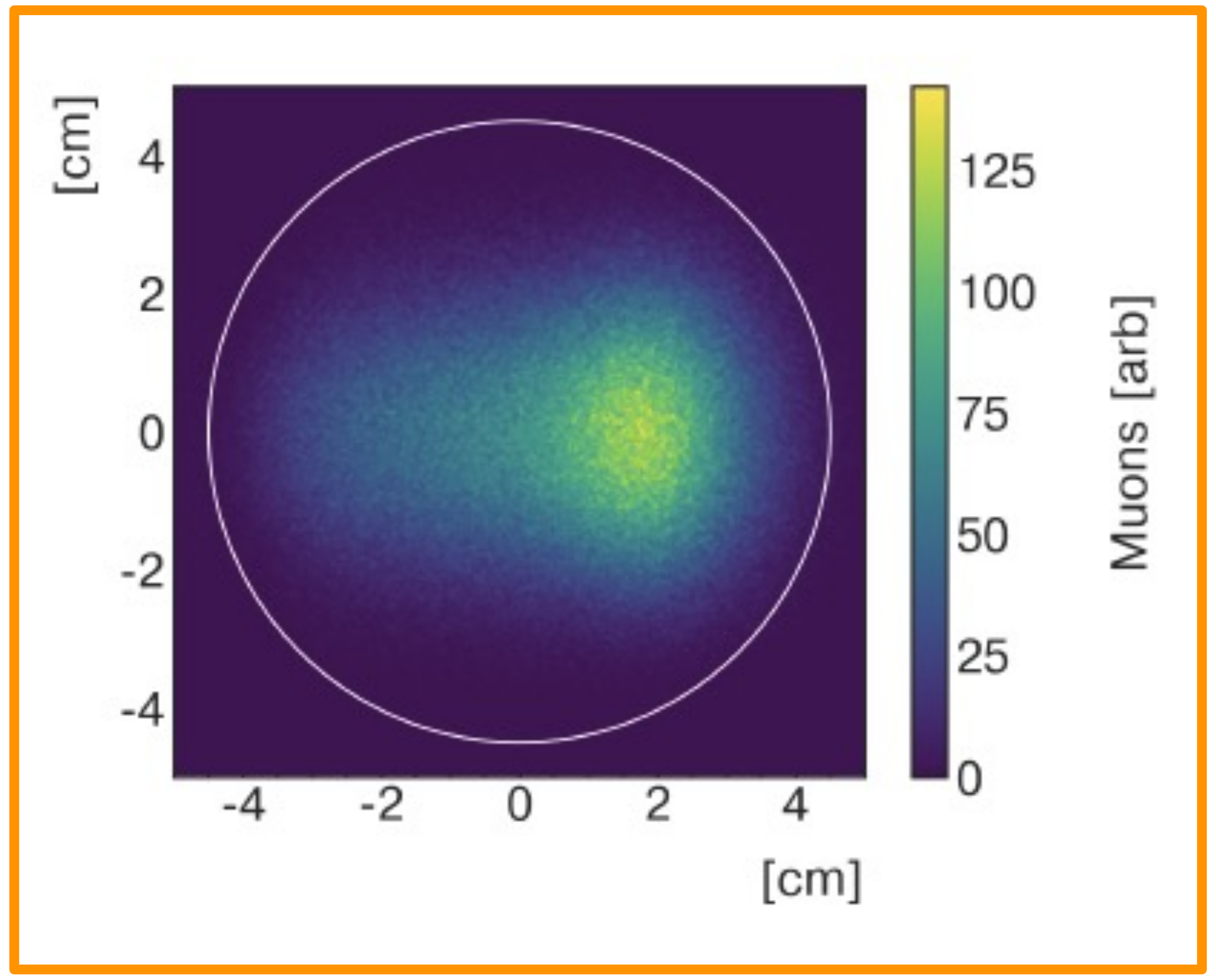
Anomalous spin precession frequency

Muon beam dynamics corrections



Clock blinding

$$R' = \frac{\omega_a}{\tilde{\omega}'_p} = \frac{f_{\mathrm{clock}}\,\omega_a^{\mathrm{meas}}\left(1 + C_e + C_p + C_{ml} + C_{pa}\right)}{f_{\mathrm{calib}}\left\langle M(x,y,\phi)\,\omega'_p(x,y,\phi)\right\rangle\left(1 + B_k + B_q\right)}$$

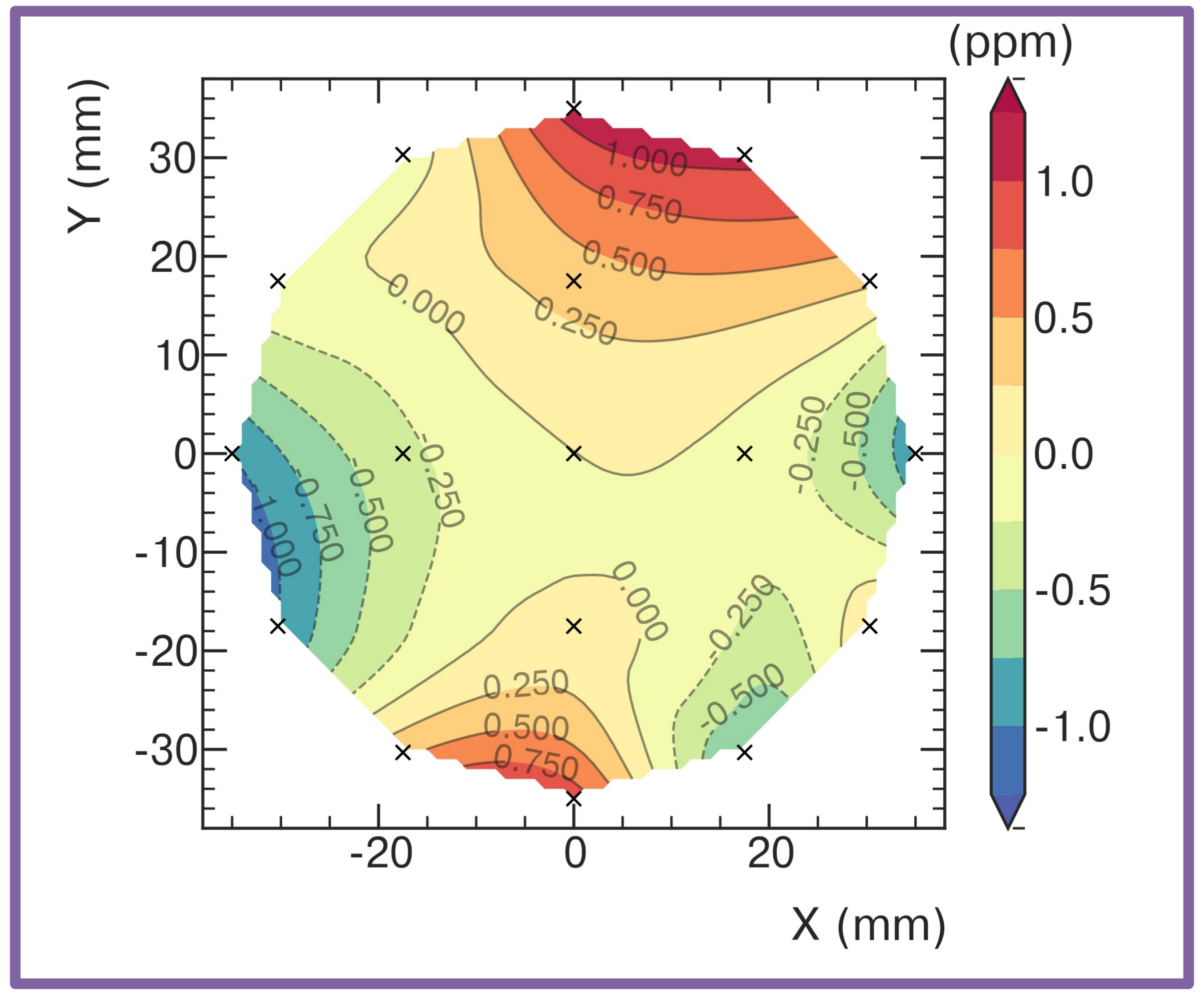


Spatial muon distribution

Spatial distribution of magnetic field

Transient magnetic fields

Calibration



All the analysis is available for you to look at in detail

PHYSICAL REVIEW ACCELERATORS AND BEAMS **24**, 044002 (2021)

Beam dynamics corrections to the Run-1 measurement of the muon anomalous magnetic moment at Fermilab

T. Albahri,

Beam dynamics

PHYSICAL REVIEW D **103**, 072002 (2021)

Editors' Suggestion | Featured in Physics

Measurement of the anomalous precession frequency of the muon in the Fermilab Muon $g-2$ Experiment

T. Albahri,

Muon spin precession

PHYSICAL REVIEW A **103**, 042208 (2021)

Featured in Physics

Magnetic-field measurement and analysis for the Muon $g-2$ Experiment at Fermilab

T. Albahri,[39]

Magnetic field

PHYSICAL REVIEW LETTERS **126**, 141801 (2021)

Editors' Suggestion | Featured in Physics

Measurement of the Positive Muon Anomalous Magnetic Moment to 0.46 ppm

B. Abi,[44] T. Albahri,[39] S. Al-Kilani,[36] D. Allspach,[7] L. P. Alonzi,[48] A. Anastasi,[11,a] A. Anisenkov,[4,b] F. Azfar,[44] K. Badgley,[7] S. Baeßler,[47,c] I. Bailey,[19,d] V. A. Baranov,[17] E. Barlas-Yucel,[37] T. Barrett,[6] E. Barzi,[7] A. Basti,[11,32] F. Bedeschi,[11] A. Behnke,[22] M. Berz,[20] M. Bhattacharya,[43] H. P. Binney,[48] R. Bjorkquist,[6] P. Bloom,[21] J. Bono,[7] E. Bottalico,[11,32] T. Bowcock,[39] D. Boyden,[22] G. Cantatore,[13,34] R. M. Carey,[2] J. Carroll,[39] B. C. K. Casey,[7] D. Cauz,[35,8] S. Ceravolo,[9] R. Chakraborty,[38] S. P. Chang,[18,5] A. Chapelain,[6] S. Chappa,[7] S. Charity,[7] R. Chislett,[36] J. Choi,[5] Z. Chu,[26,e] T. E. Chupp,[42] M. E. Convery,[7] A. Conway,[41] G. Corradi,[9] S. Corrodi,[1] L. Cotrozzi,[11,32] J. D. Crnkovic,[3,37,43] S. Dabagov,[9,f] P. M. De Lurgio,[1] P. T. Debevec,[37] S. Di Falco,[11] P. Di Meo,[10] G. Di Sciascio,[12] R. Di Stefano,[10,30] B. Drendel,[7] A. Driutti,[35,13,38] V. N. Duginov,[17] M. Eads,[22] N. Eggert,[6] A. Epps,[22] J. Esquivel,[7] M. Farooq,[42] R. Fatemi,[38] C. Ferrari,[11,14] M. Fertl,[48,16] A. Fiedler,[22] A. T. Fienberg,[48] A. Fioretti,[11,14] D. Flay,[41] S. B. Foster,[2] H. Friedsam,[7] E. Frlež,[47] N. S. Froemming,[48,22] J. Fry,[47] C. Fu,[26,e] C. Gabbanini,[11,14] M. D. Galati,[11,32] S. Ganguly,[37,7] A. Garcia,[48] D. E. Gastler,[2] J. George,[41] L. K. Gibbons,[6] A. Gioiosa,[29,11] K. L. Giovanetti,[15] P. Girotti,[11,32] W. Gohn,[38] T. Gorringe,[38] J. Grange,[1,42] S. Grant,[36] F. Gray,[24] S. Haciomeroglu,[5] D. Hahn,[7] T. Halewood-Leagas,[39] D. Hampai,[9] F. Han,[38] E. Hazen,[2]

The result

The Muon g-2 collaboration

Domestic Universities
- Boston
- Cornell
- Illinois
- James Madison
- Kentucky
- Massachusetts
- Michigan
- Michigan State
- Mississippi
- Northern Illinois
- Regis
- UT Austin
- Virginia
- Washington

National Labs
- Argonne
- Brookhaven
- Fermilab

China
- Shanghai Jao Tong University

United Kingdom
- Lancaster
- Liverpool
- University College London

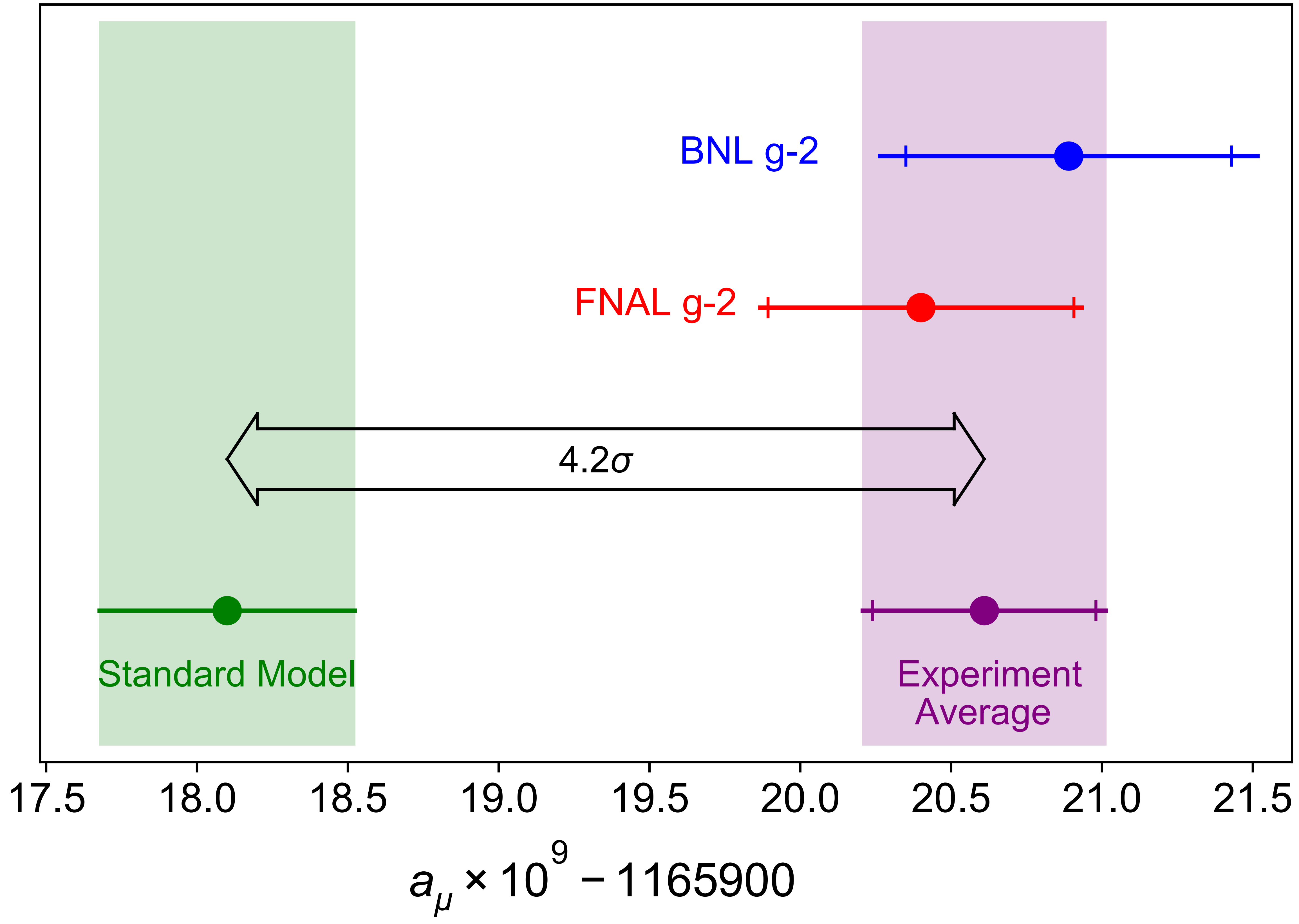
Italy
- Frascati
- Molise
- Naples
- Pisa
- Roma 2
- Trieste
- Udine

Germany
- JGU Mainz
- TU Dresden

Russia
- JINR/Dubna
- Novosibirsk

South Korea
- CAPP/IBS
- KAIST

Result from combined Run 1 datasets



a_μ(BNL) = 0.00116592089(63) → 540 ppb

a_μ(FNAL, R1) = 0.00116592040(54) → 463 ppb

Both experiments uncertainty dominated by statistics:

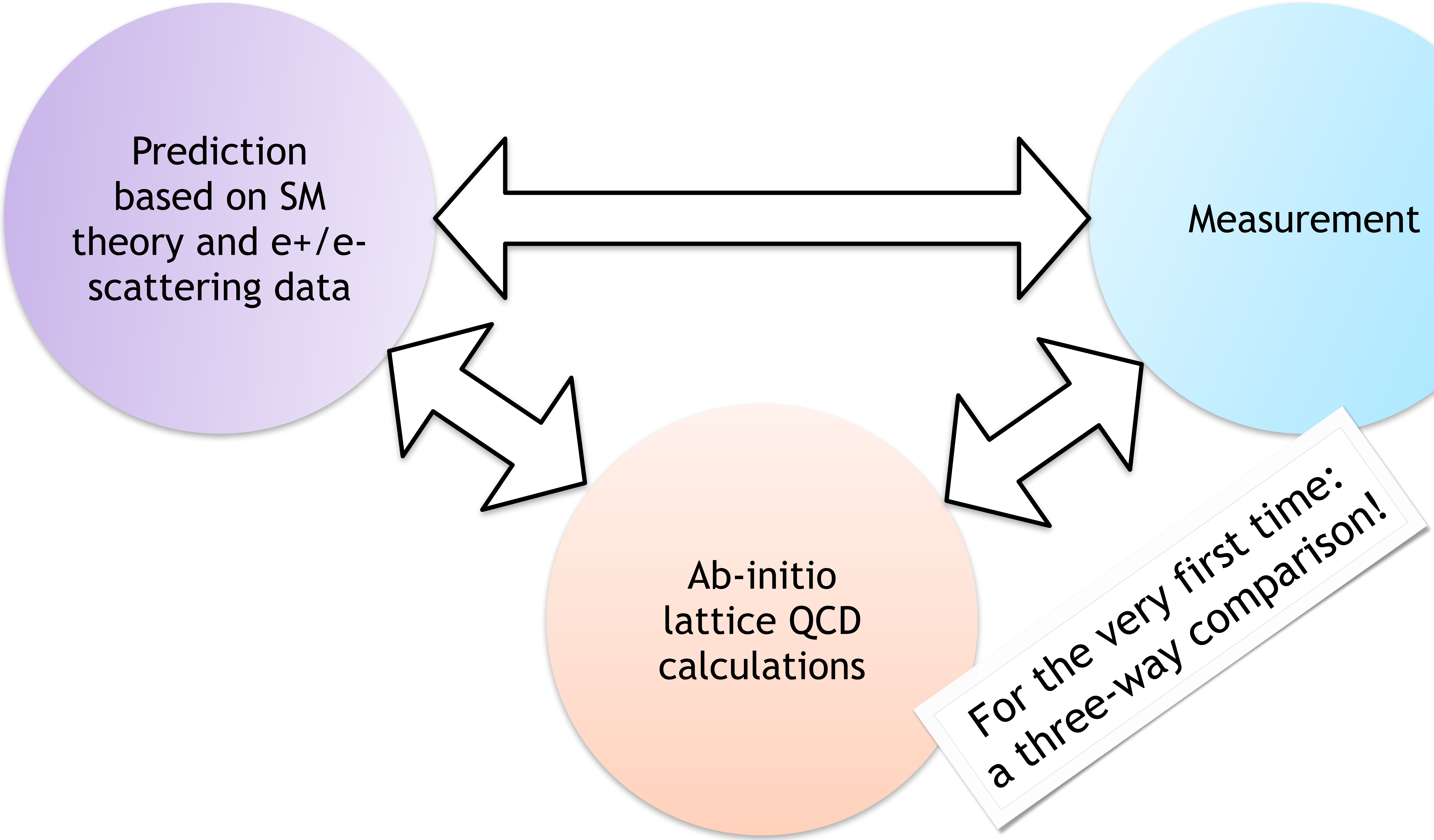
a_μ(Exp) = 0.00116592061(41) → 350 ppb

a_μ(SM2020) = 0.00116591810(43) → 350 ppb

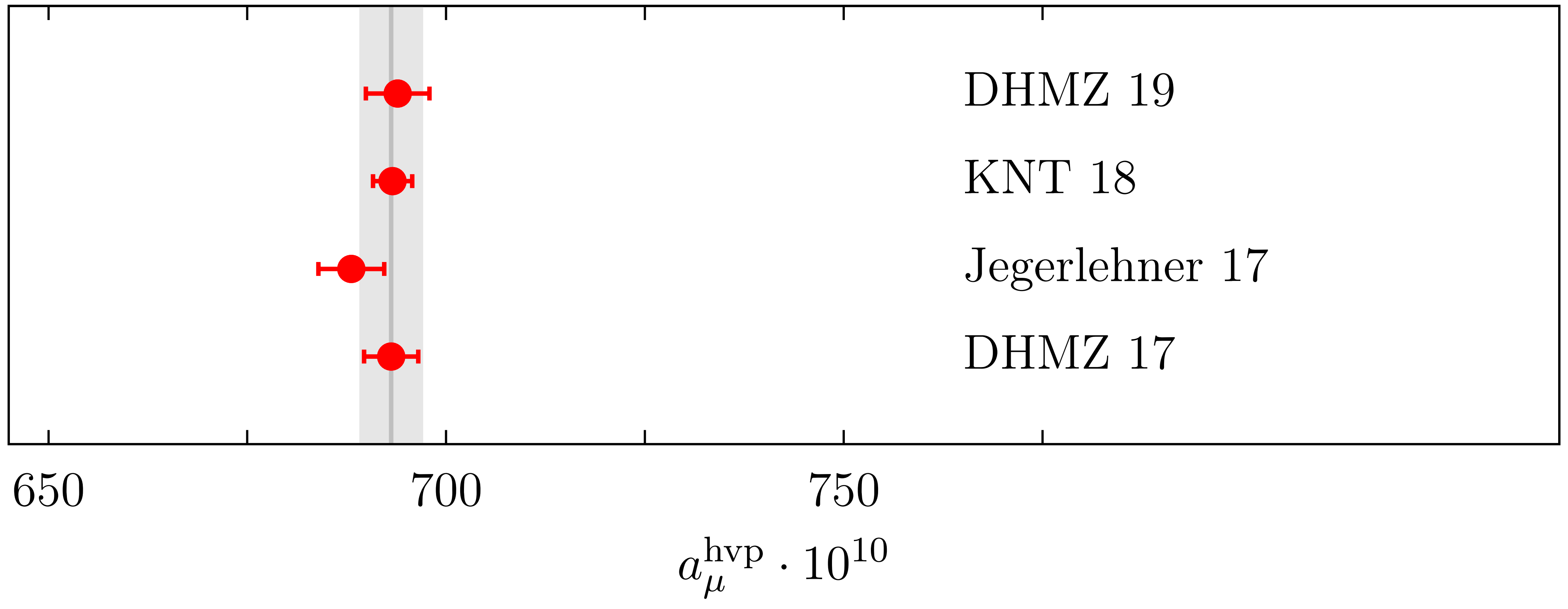
4.2 σ discrepancy between experiment and community approved SM2020 prediction

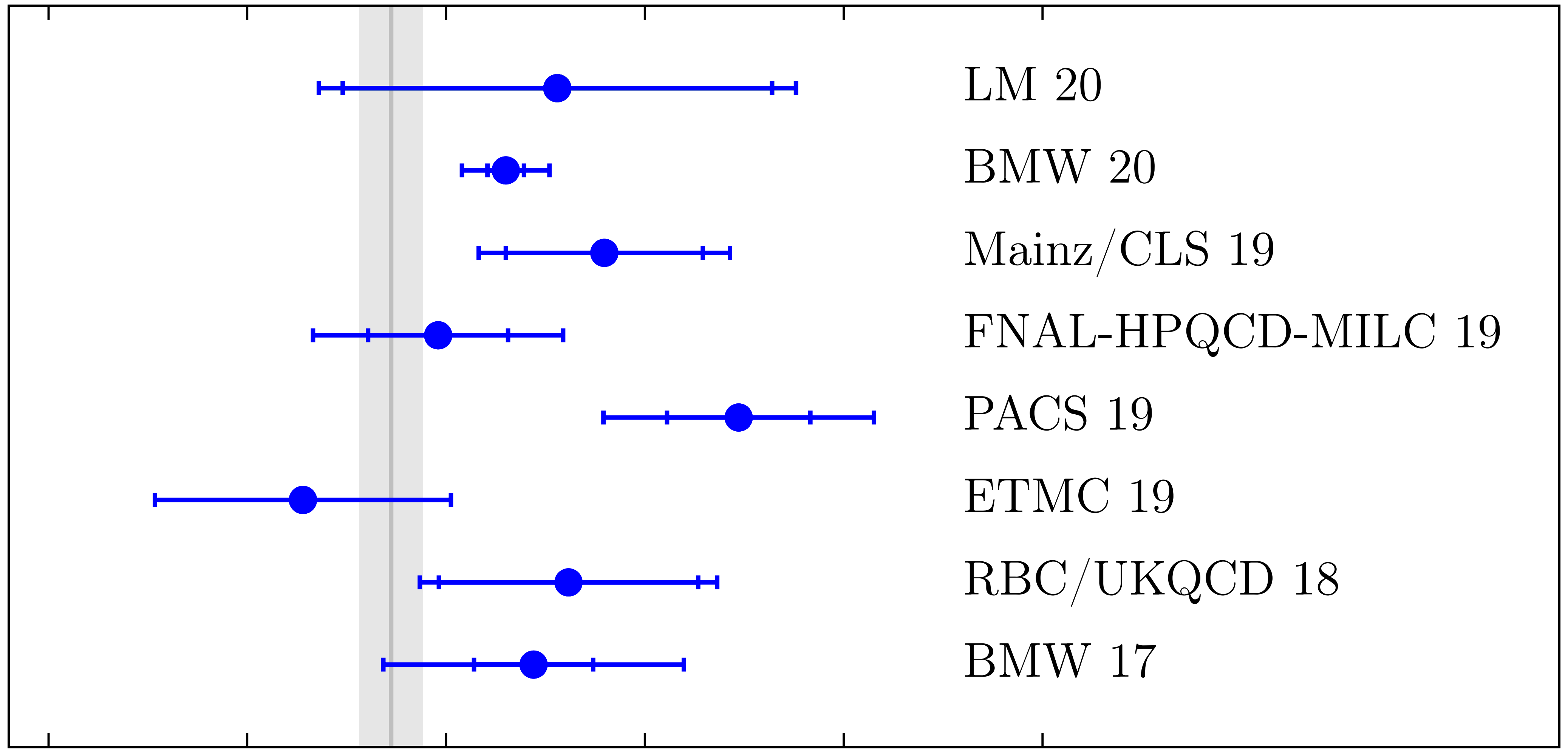
BUT: the very recent results from lQCD for HVP reduce the tension!

A new era of a_μ comparisons



Hadronic vacuum polarization: data-driven vs ab initio





$$\Delta a_\mu = a_\mu^{\mathrm{exp}} - a_\mu^{\mathrm{SM}} = (25.1 \pm 5.9) \times 10^{-10}$$

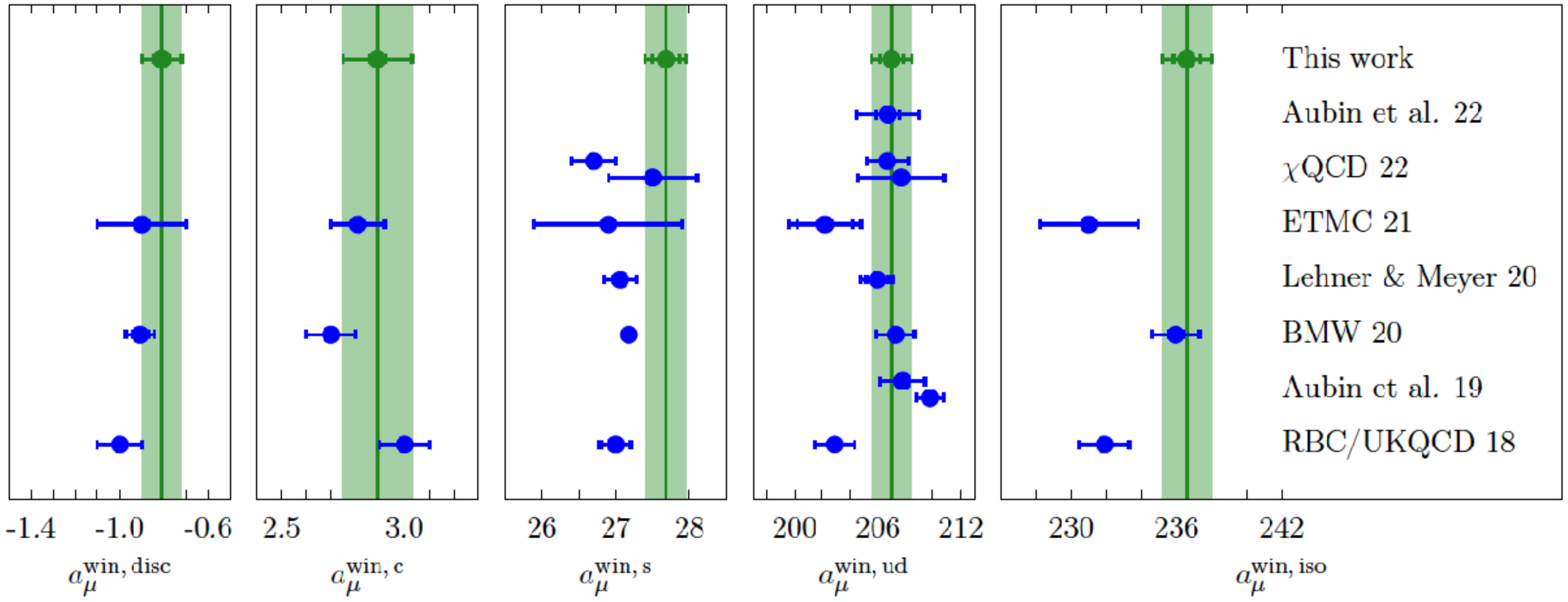
White paper, "Muon g-2 Theory Initiative"

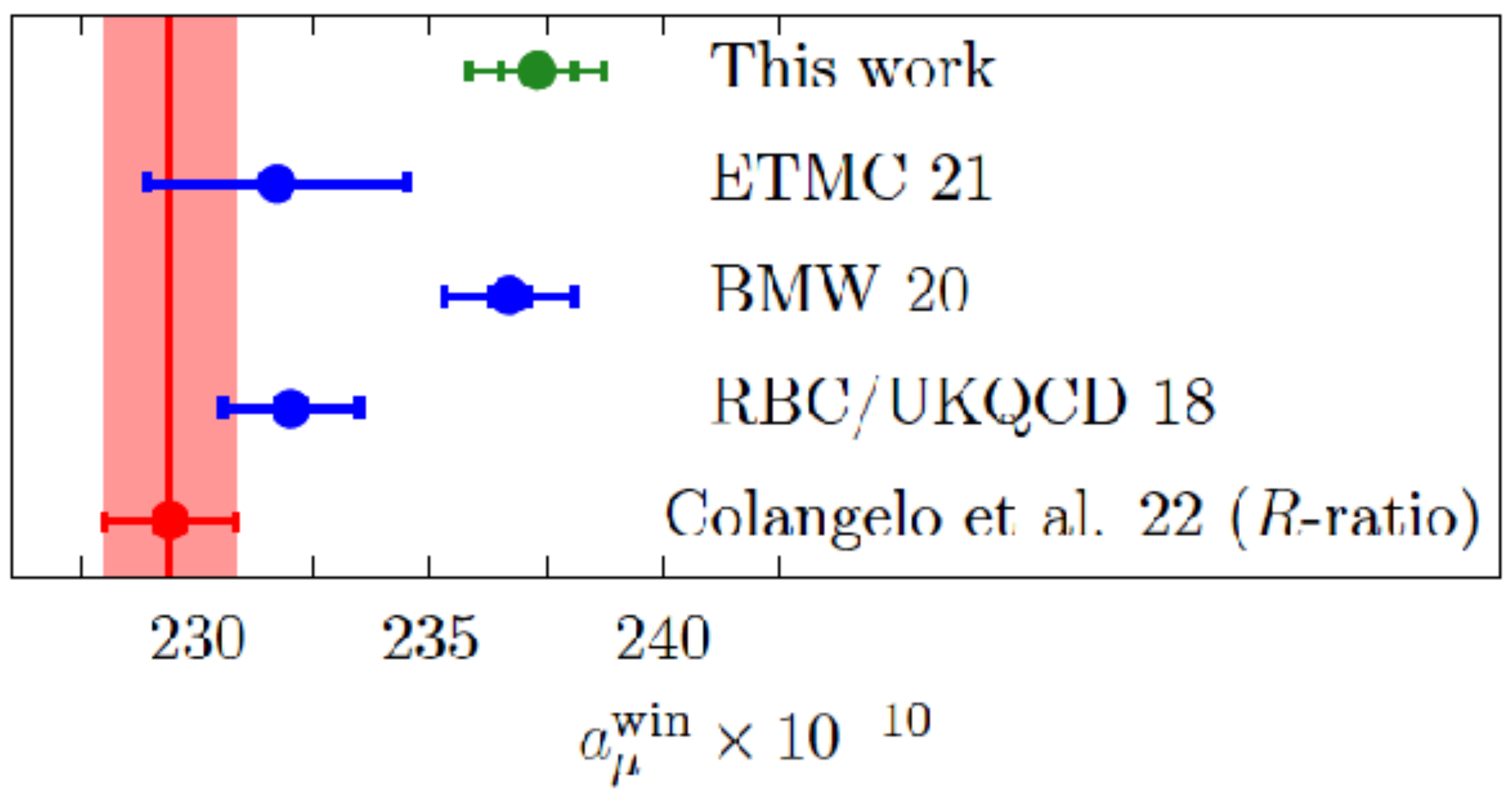
R-ratio: $a_\mu^{\mathrm{hvp,\,LO}} = (693.1 \pm 4.0) \cdot 10^{-10}$

[Aoyama et al., Physics Reports 887 (2020) and arXiv:2006.04822]

Hadronic vacuum polarization: data-driven vs ab initio

Intense scrutiny of the various contributions by several groups: window observables





Reference added after my talk:
Kalman Szabo, today, 4:30 PM

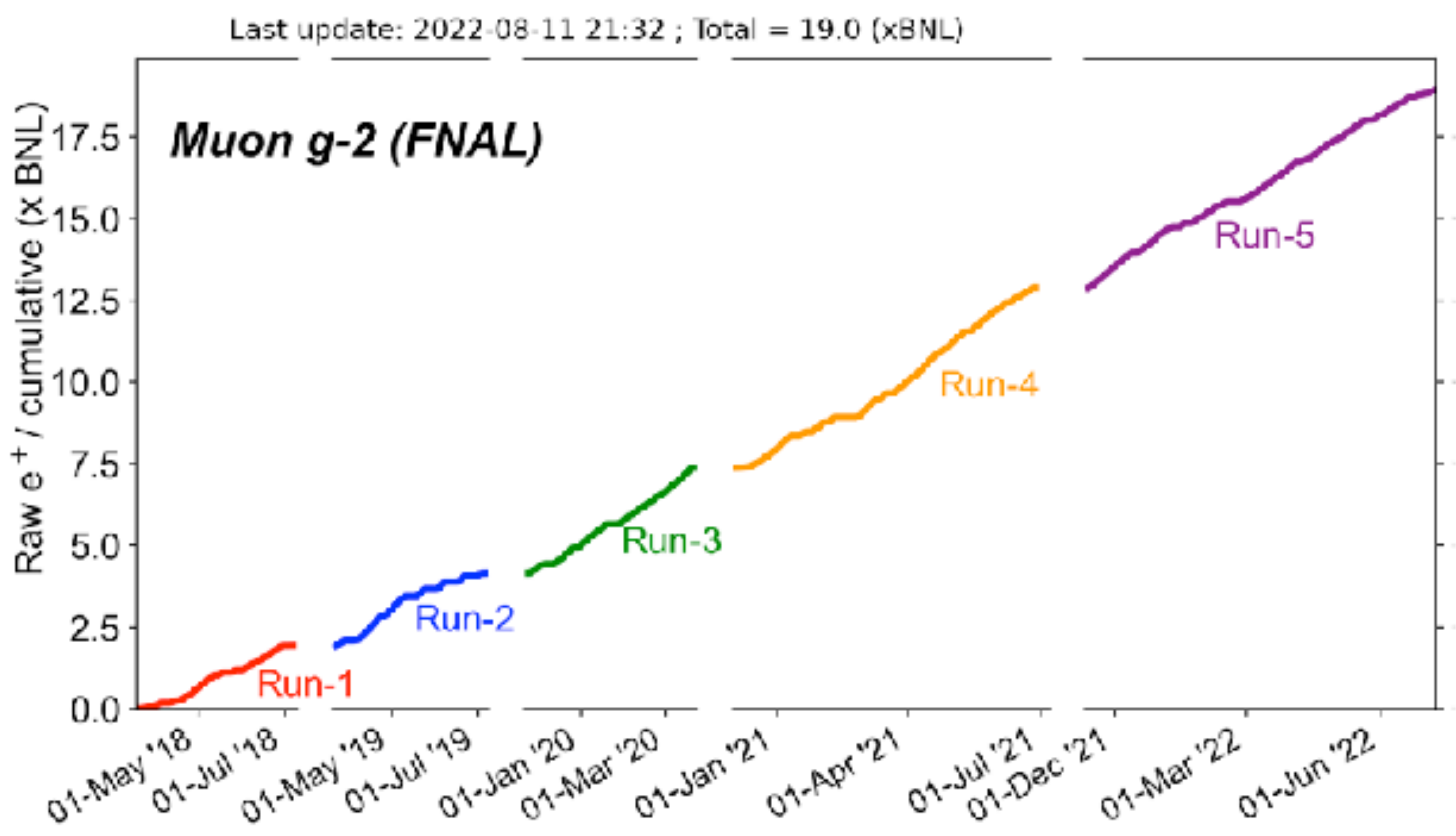
This work: M.Ce et al, arXiv:2206.06582v1
ETMC 21: D. Giusti and S. Simula, arXiv:2111.15329
BMW 20: S. Borsanyi et al., arXiv:2002.12347

RBC/UKQCD 18: RBC, UKQCD collaboration, arXiv:1801.07224
Colangelo et al. 22, arXiv:2205.12963

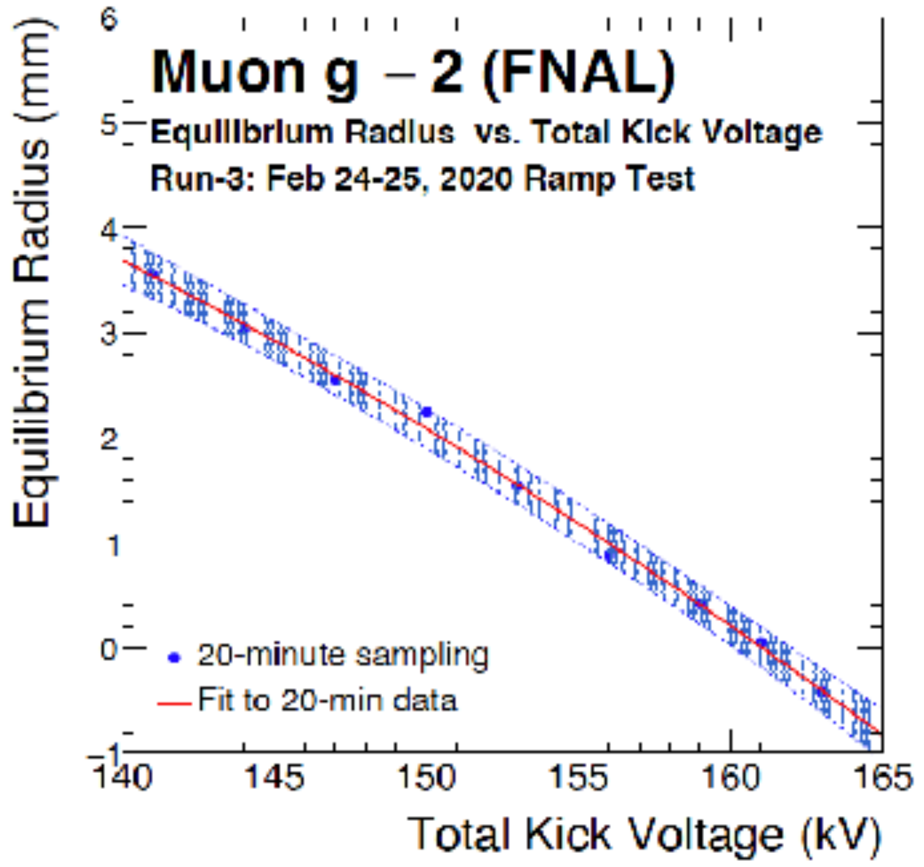
Fifth Plenary Workshop of the Muon g-2 Theory Initiative to "discuss recent progress on the theoretical calculations and prepare an update of the Standard Model prediction for Muon g-2" (starting 09/05/22)

Predictions are hard to make if they concern the future but, we…

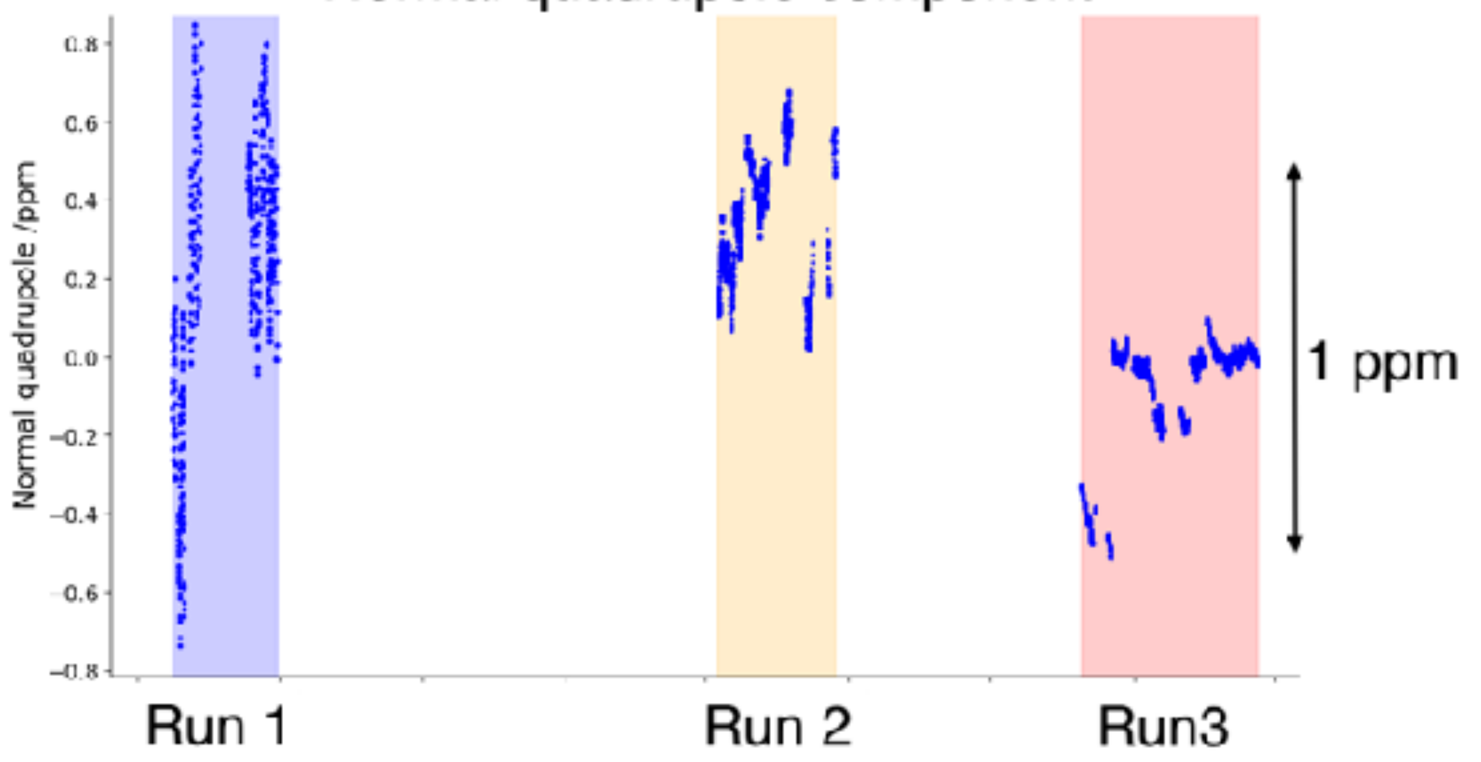
- … have accumulated 19 x BNL raw statistics through Run 5. Run 6 with μ^+ to reduce systematic uncertainties
- … have vastly improved running conditions after Run 3: reduced systematic uncertainties!



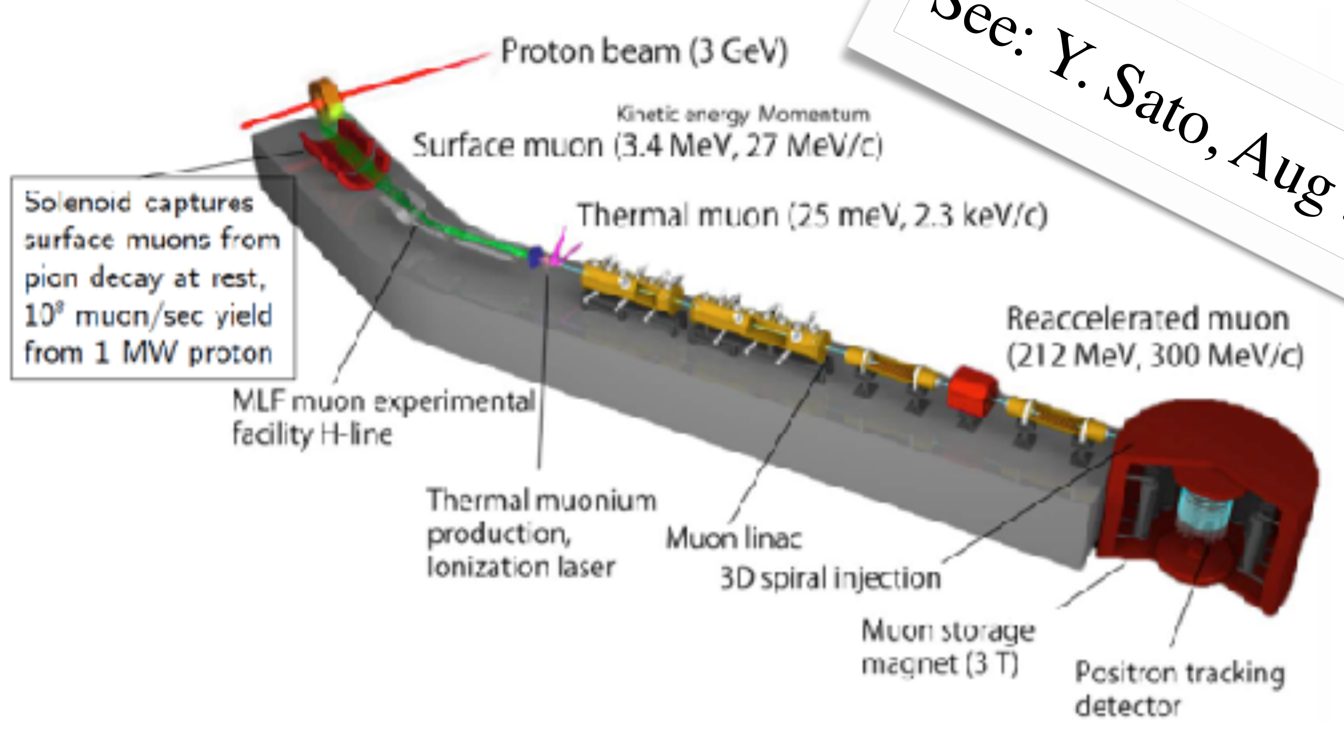
Nominal kicker strength



Better temperature stability



- … look forward to the J-PARC experiment using ultra-cold muons!



See: Y. Sato, Aug 30th, 2022, 16:00

- … wait for complementary data to e+/e- annihilation data from the MUonE experiment proposed at CERN

- … look forward to the update of the SM prediction!