Development of gas and RF system for the MuSEUM experiment

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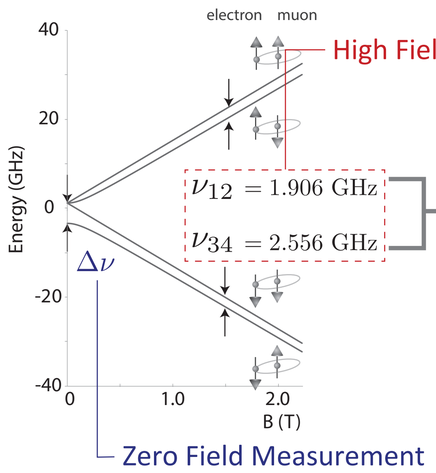
RIKEN's Programs for Junior Scientists

Background

measurement



Energy of muonium hyperfine splitting is obtained by sum of $\nu_{12} + \nu_{34}$.

Magnetic moment and mass of muon is calculated by ν_{12} and ν_{34} .

values

muonium HFS

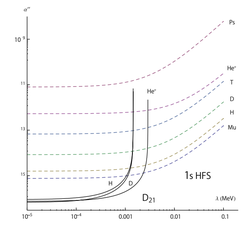
experimental	theory
ν_{HFS}(exp.)	ν_{HFS}(theory.)
$= 4\ 463.302\ 765(53)$ MHz [12 ppb]	$= 4\ 463.302\ 891(272)$ MHz [63 ppb]
W. Liu et al., PRL, 82, 711 (1999)	D. Nomura and T. Teubner, Nucl. Phys. B 867, 236 (2013)

magnetic moment $\frac{\mu_\mu}{\mu_p} = 3.183345107(84)$

mass $\frac{m_\mu}{m_e} = 206.7682823(52)$

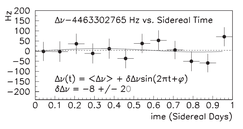
contributions

search for new particles
Suitable tool for new light particle search, inspired by proton radius puzzle (dark photon etc.).
PRL 104, 220406 (2010)



proton radius puzzle
Zemach radius can be obtained from muonium HFS.

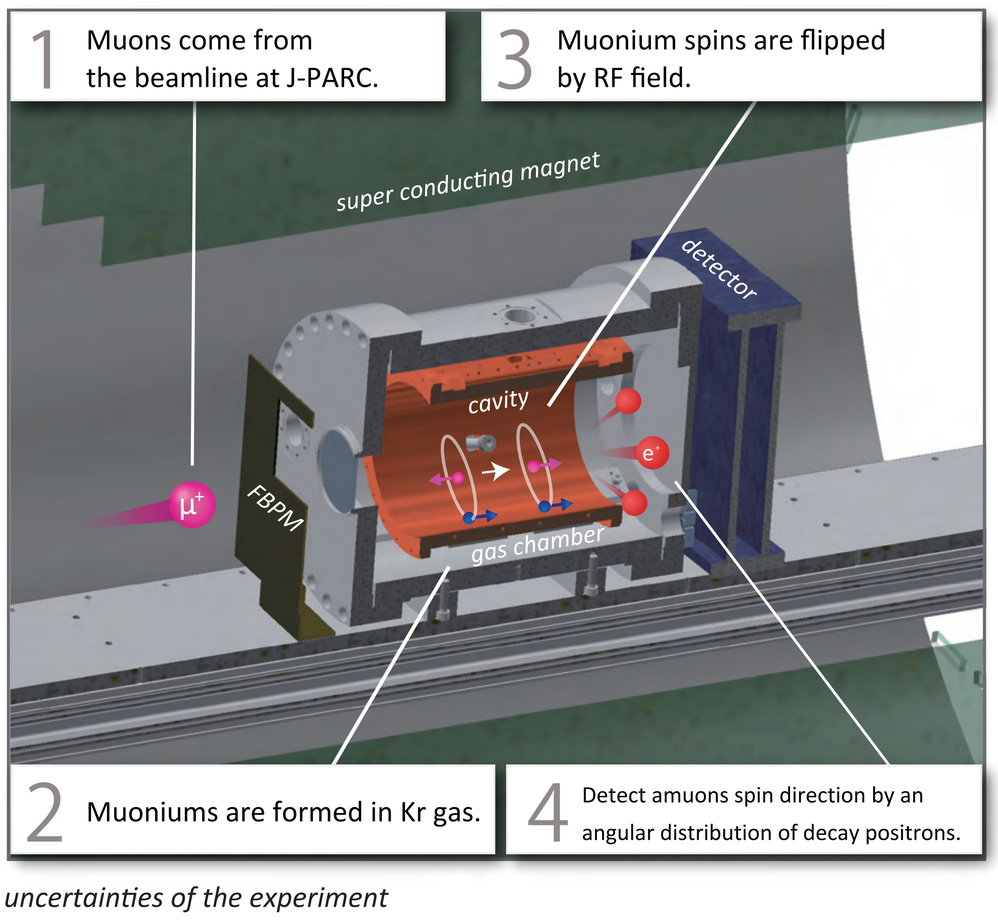
Test of CPT and Lorentz Invariance
Sidereal oscillation of transition frequency.
R. Bluhm, V. A. Kostelecký, and C. Da Lane, Phys. Rev. Lett. 84, 1098 (2000)
V.W. Hughes et al., Phys.Rev.Lett.87, 111804 (2001)



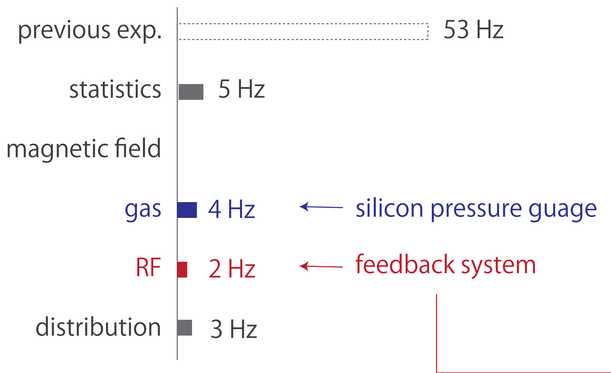
g-2 experiment
MuHFS is one-half of the experimental input

$$g - 2 = \frac{R}{\lambda - R}$$
$$\lambda \equiv \frac{\mu_\mu}{\mu_p}$$

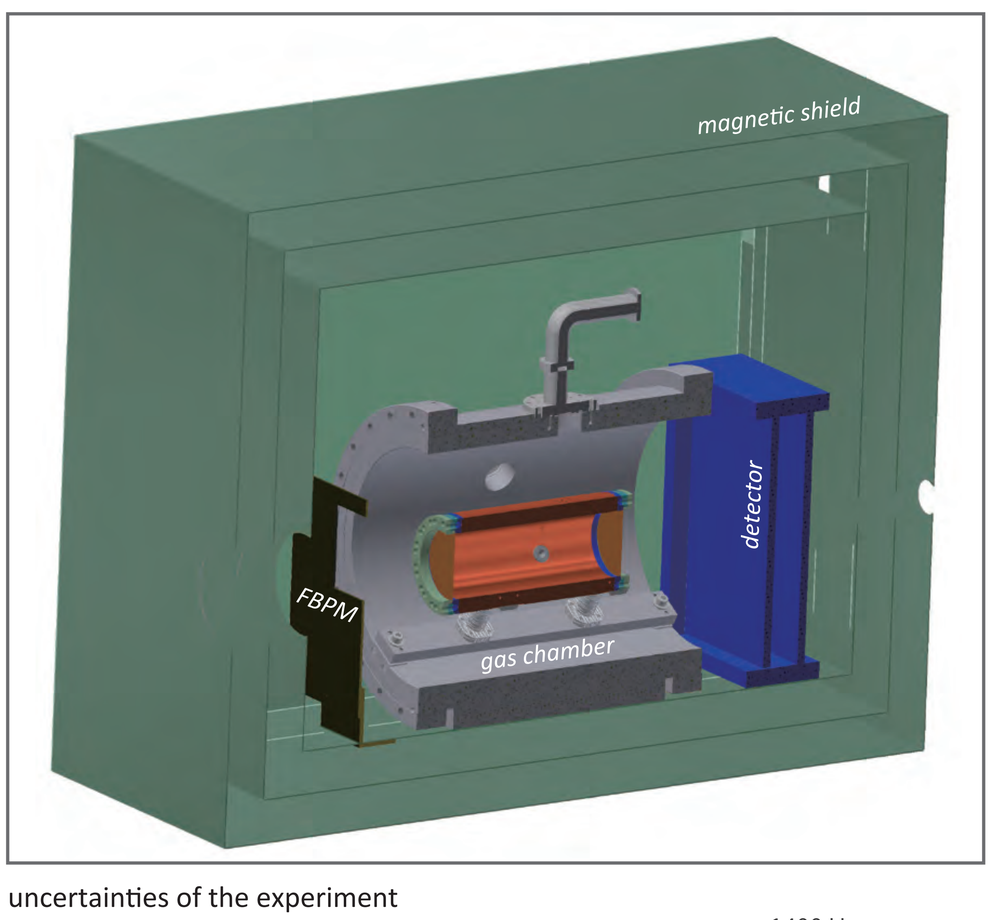
High Field Measurement



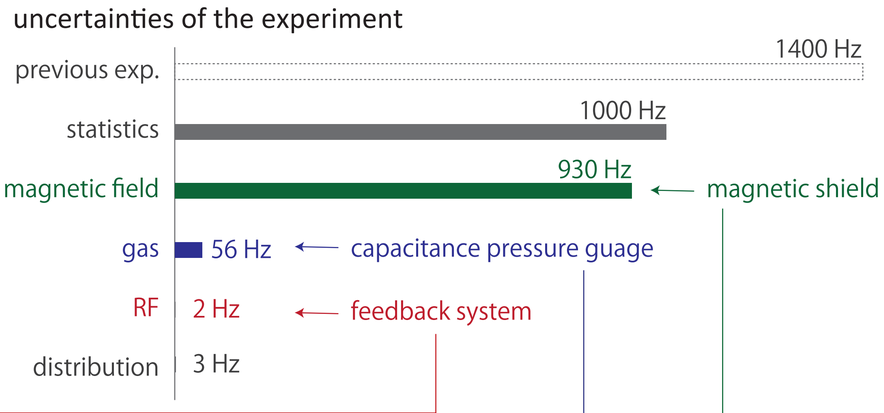
uncertainties of the experiment



Zero Field Measurement

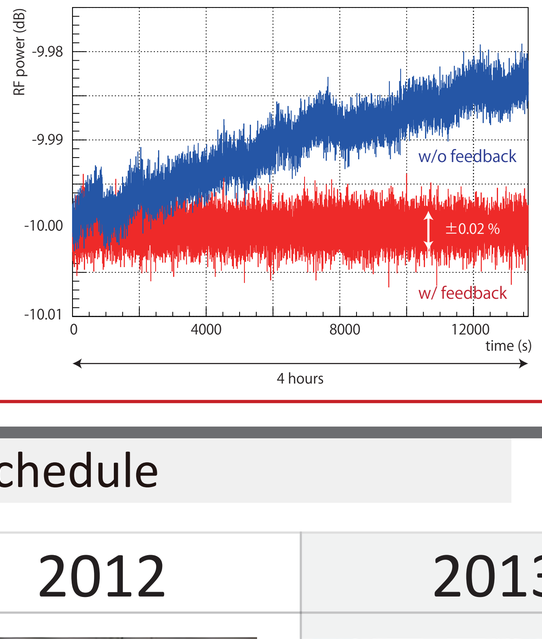


uncertainties of the experiment



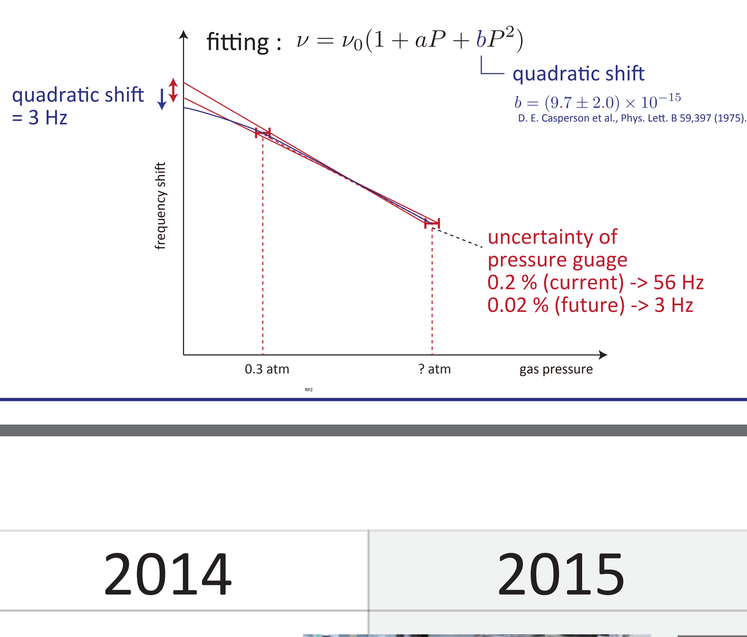
RF feedback system

RF power input to the cavity is stabilized by RF feed back system at the level of 0.2 %.



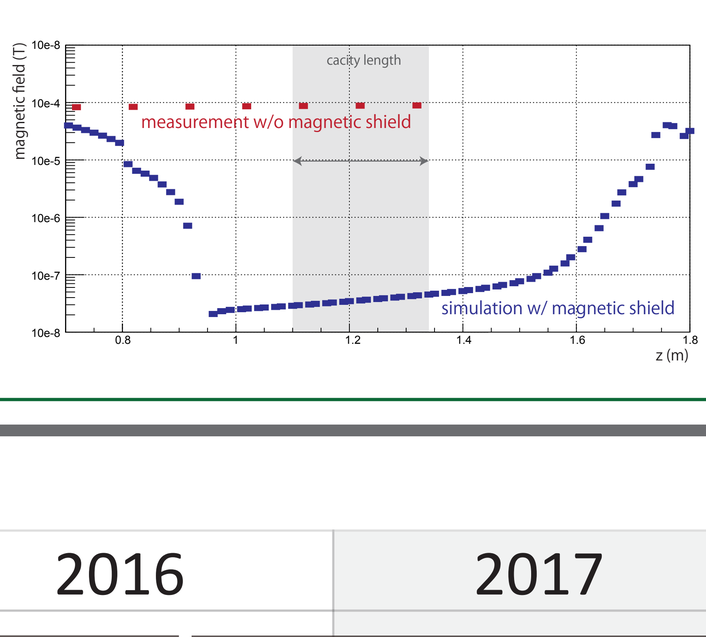
Gas System

Systematic uncertainty from the precision of pressure guage can be neglected by using a silicon pressure guage (0.02 % relative precision).



Magnetic Shield

For homogeneous (~mG) zero magnetic field, we are preparing the magnetic shield to suppress leakage field.



Schedule

2012	2013	2014	2015	2016	2017
cavity test	detector test	TBPM test	shimming test	Zero Field exp -1st phase 1400 Hz -> ~1000 Hz	High Field exp 53 Hz -> ~5 Hz -2nd phase 1000 Hz -> ~100 Hz