MTV-G experiment

probing non-standard strong gravitational field at nuclear scale using geodetic precession.

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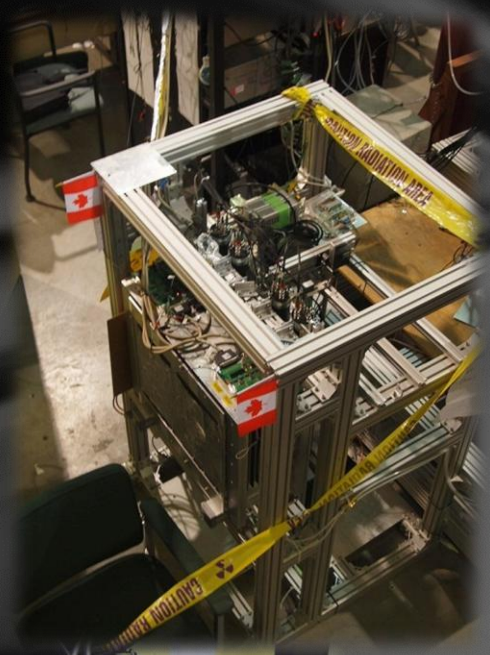
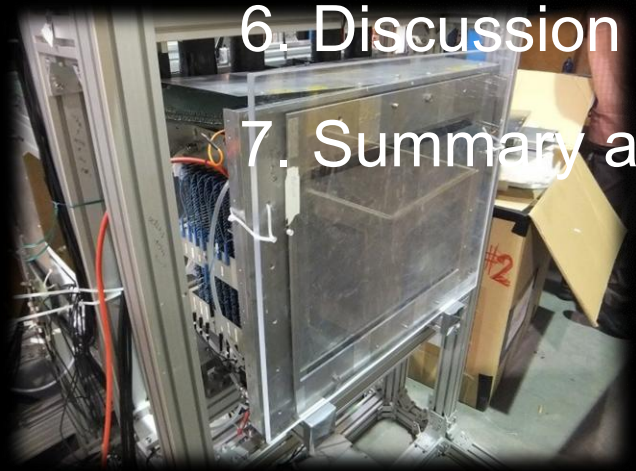
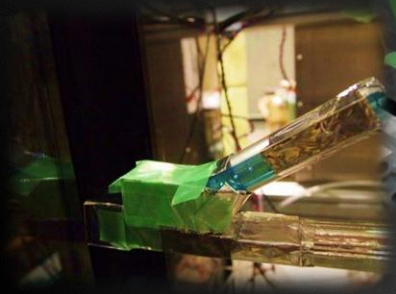






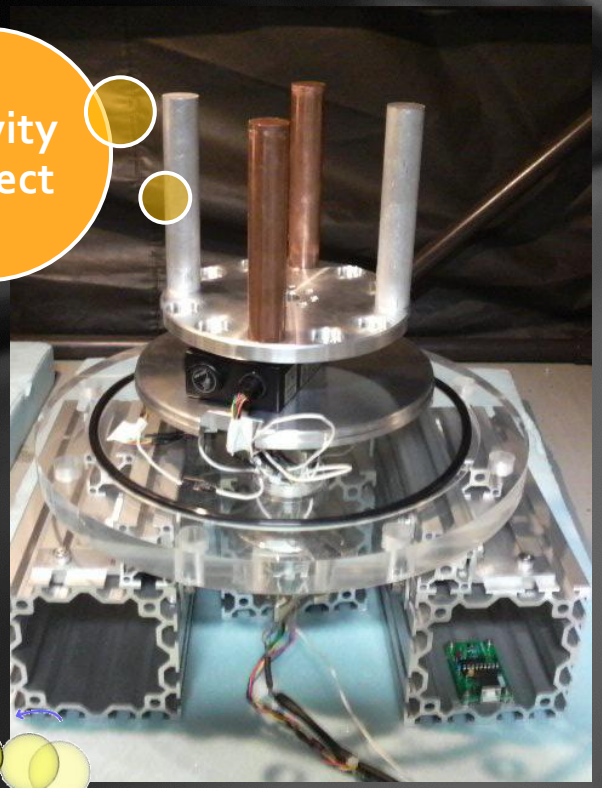
What's MTV-G ??

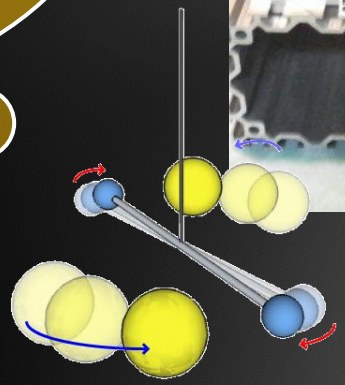
Short-range Gravity group **testing the gravitational inverse-square law** using **a torsion balance bar**

MTV project

MTV-G
gravity test
with
MTV detector

Gravity project



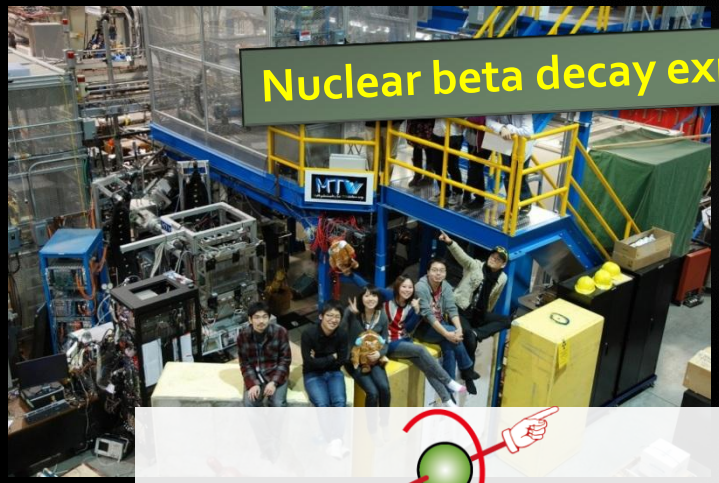


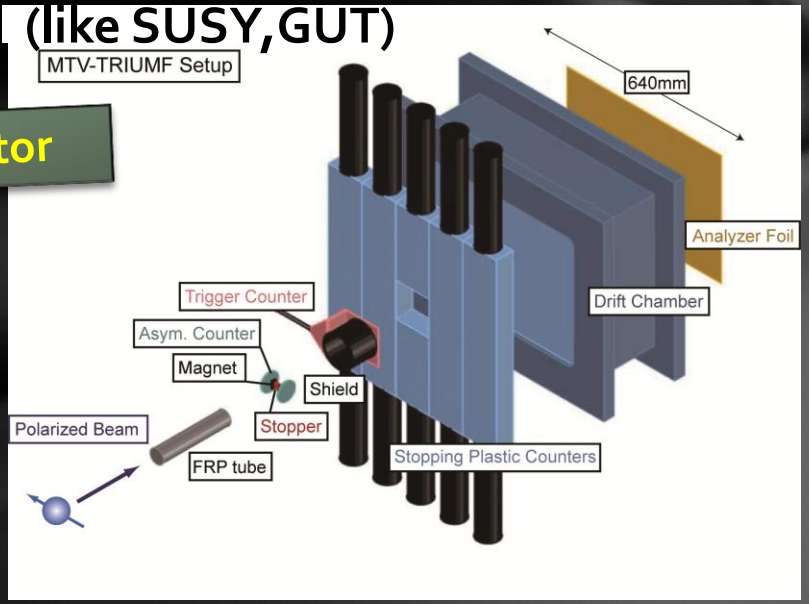
MTV group **searching T-violation** in **an accelerator experiment**

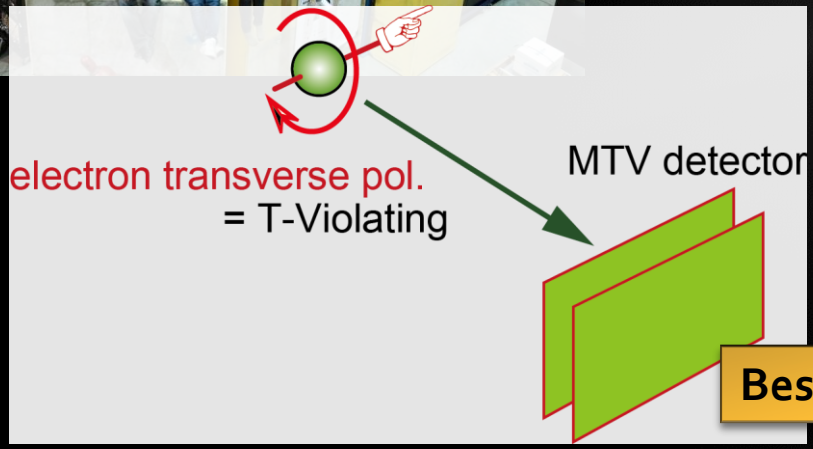
MTV experiment

MTV : *M*ott polarimetry for *T*-*V*iolation experiment

… search for T-violation (Time Reversal Symmetry Violation) probing New Physics Beyond the Standard Model (like SUSY,GUT)







T-Violating

Electron **Transverse Polarization** < 10^{-3}

competitive to LHC !

Best Limit for Time Reversal Symmetry Test !

MTV experiment

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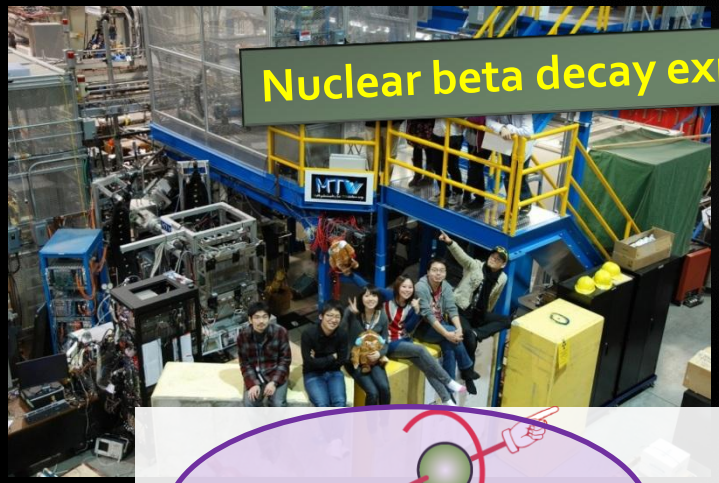

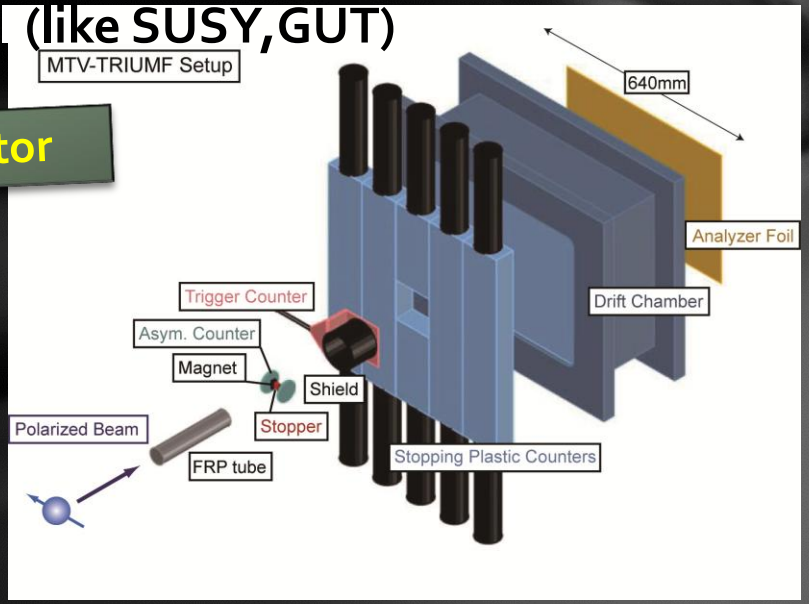

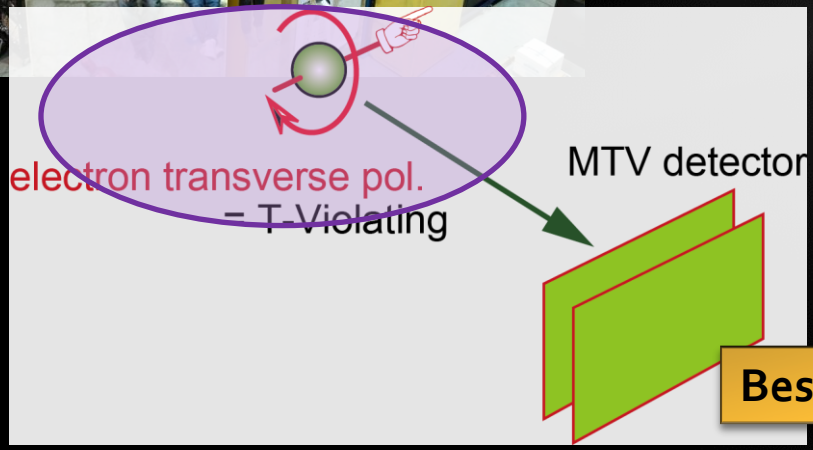

T-Violating

Electron **Transverse Polarization** < 10^{-3}

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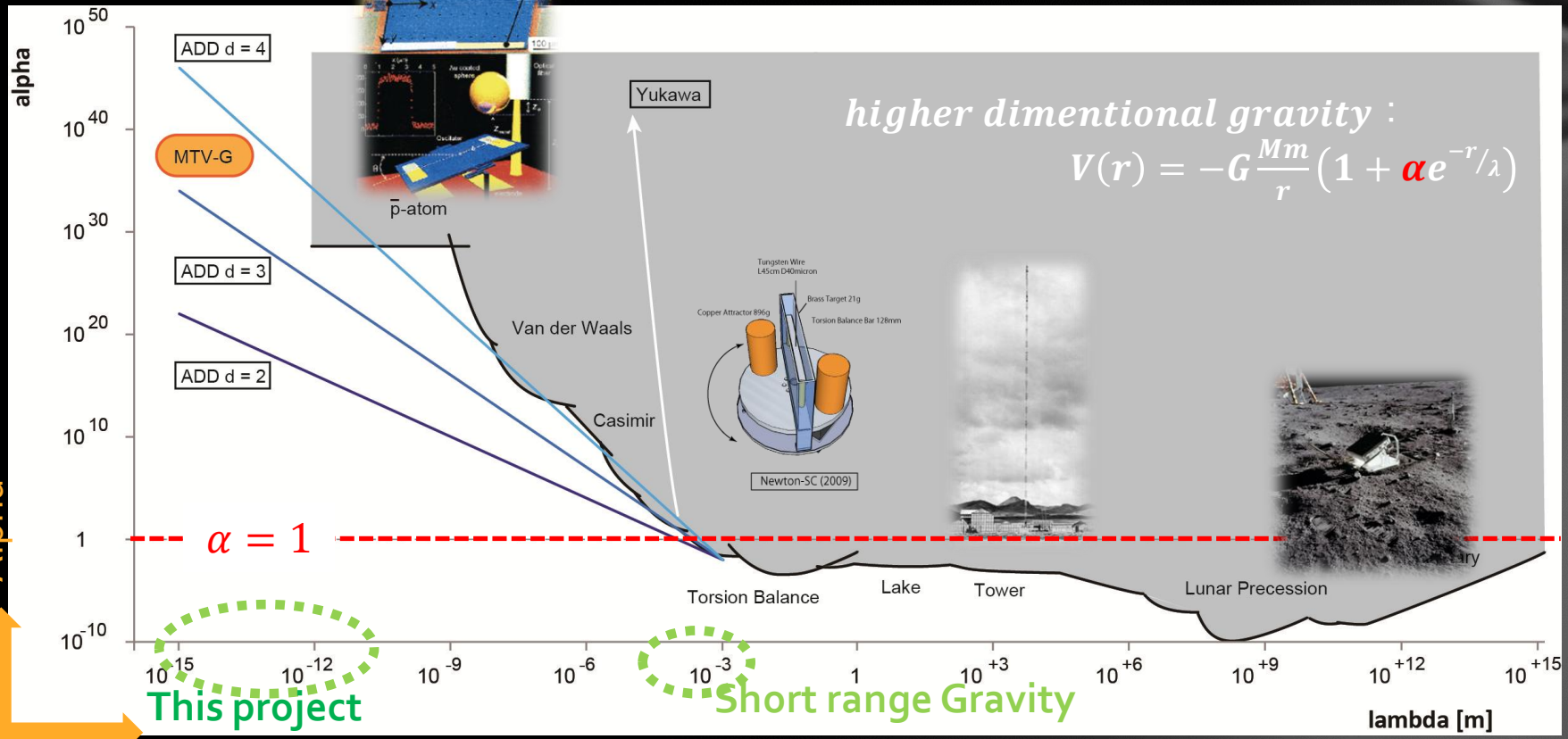
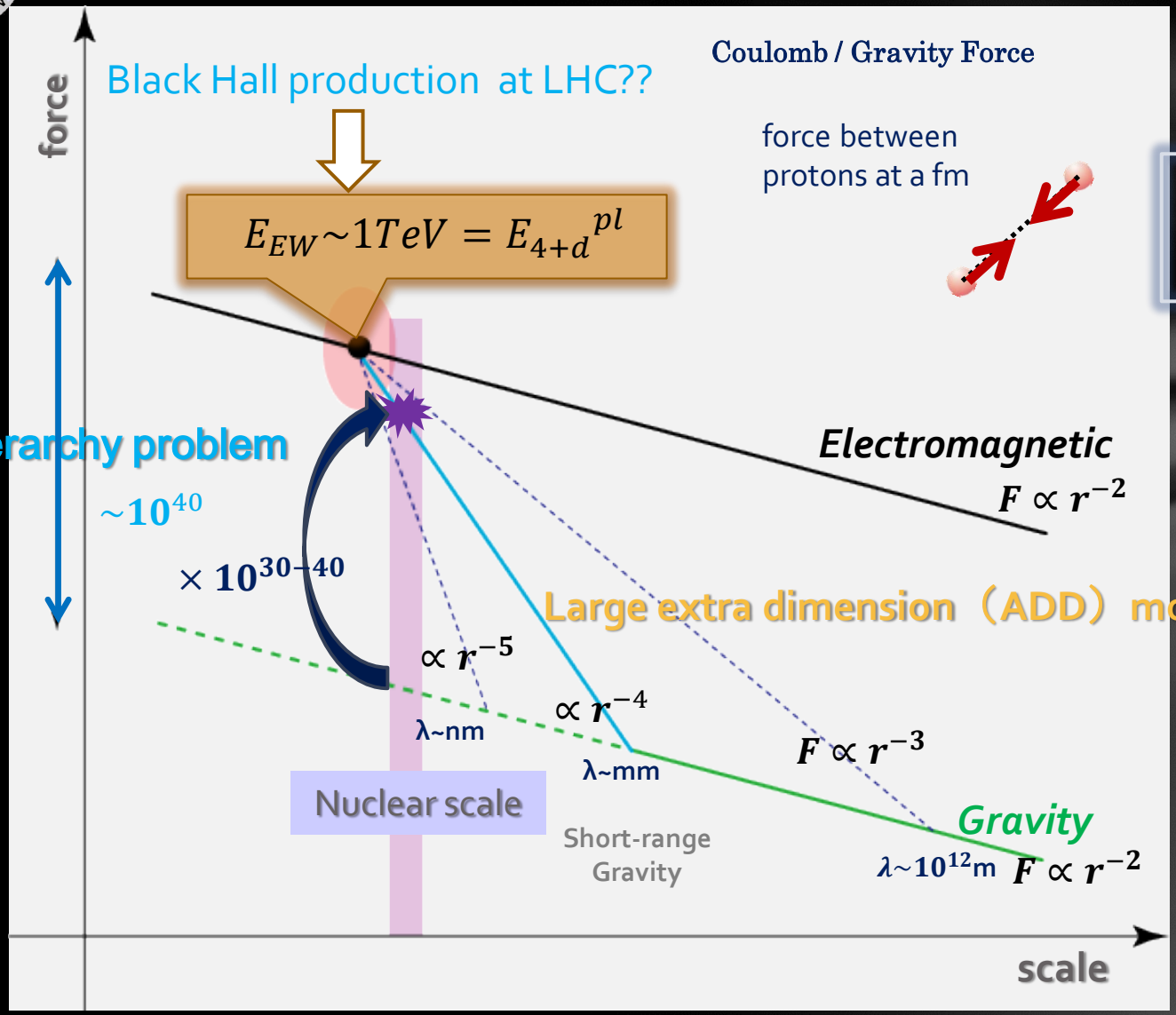
Best Limit for Time Reversal Symmetry Test !

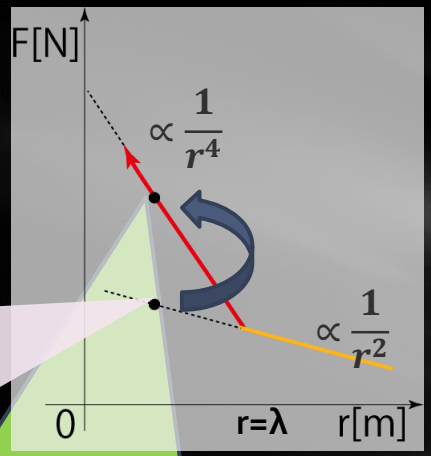
Motivation

we don't know whether the gravity exists or not, at sub-0.1mm scale experimentally !!




Coulomb / Gravity Force
force between protons at a fm
$F_C \sim 230N$
$F_G \sim 2 \times 10^{-34} N$
force
Black Hall production at LHC??
$E_{EW} \sim 1TeV = E_{4+d}{}^{pl}$
hierarchy problem
$\sim 10^{40}$
$\times 10^{30-40}$
Electromagnetic
$F \propto r^{-2}$
Large extra dimension（ADD）model
$\propto r^{-5}$
λ~nm
$\propto r^{-4}$
λ~mm
$F \propto r^{-3}$
Nuclear scale
Short-range Gravity
Gravity
$\lambda \sim 10^{12}$m
$F \propto r^{-2}$
scale

Principle



Coulomb Scattering with Weak Gravitational Field

spinning particle

Electromagnetic Thomas Precession

Nuclei

Newton Gravity

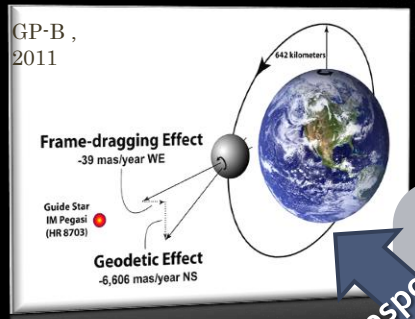
Strong Gravitational Field
=Warped Spacetime

spinning particle

Large Geodetic Precession
(+ Thomas Precession)

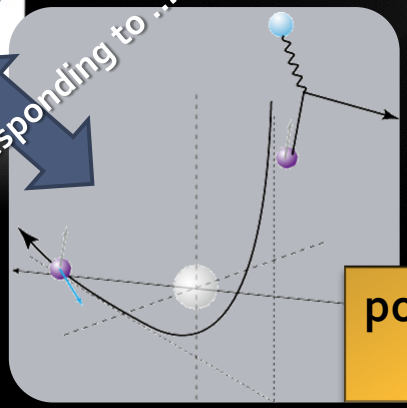
Nuclei

ADD-model



← GP-B (NASA)

Corresponding to ...



Principle of
this experiment →

polarized electron-nuclei scattering
(satellite) (the Earth)

Set up

precession angle measurement

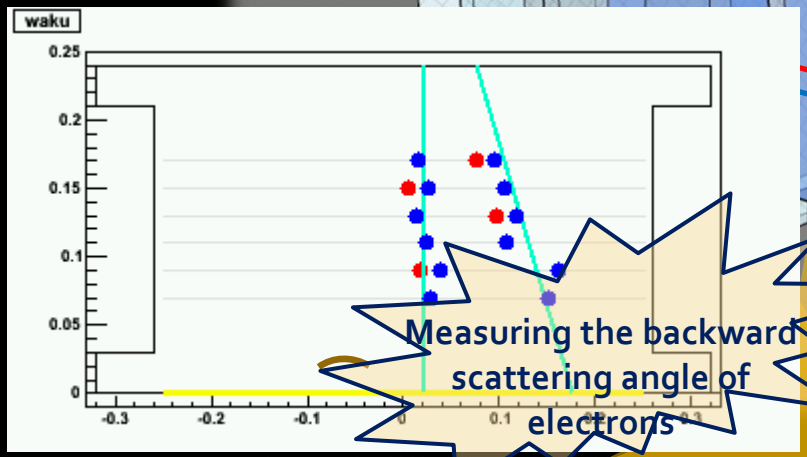
Measuring Scattering Asymmetry utilizing Analyzing power of Mott scattering (secondary scattering)

Longitudinally polarized electrons emission

Plastic Scintillator + PMT

Foil

Auto-NS



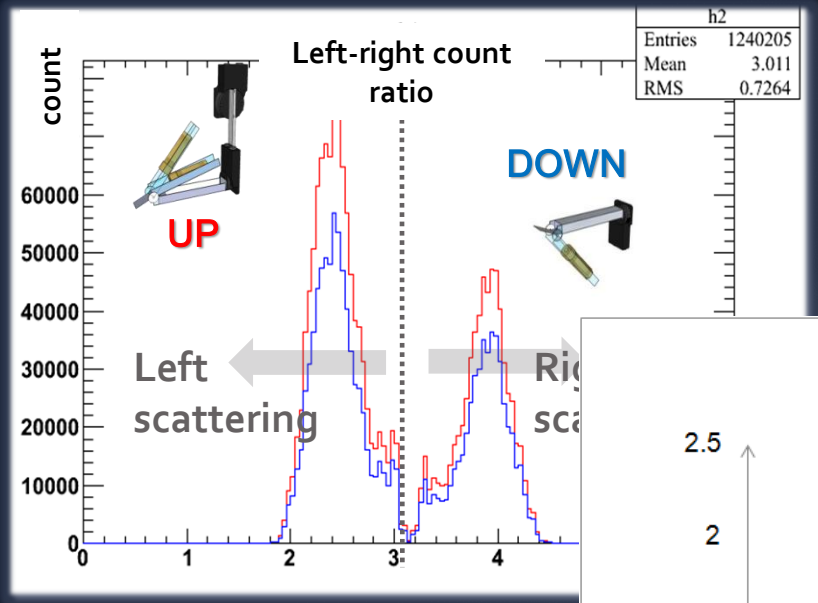
Measuring the backward scattering angle of electrons

Determining Transverse polarization of electrons by MWDC

Coulomb scattering by lead foil (primary scattering)

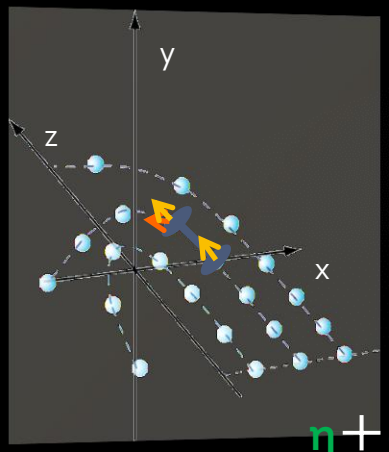
polarized electron-nuclei scattering

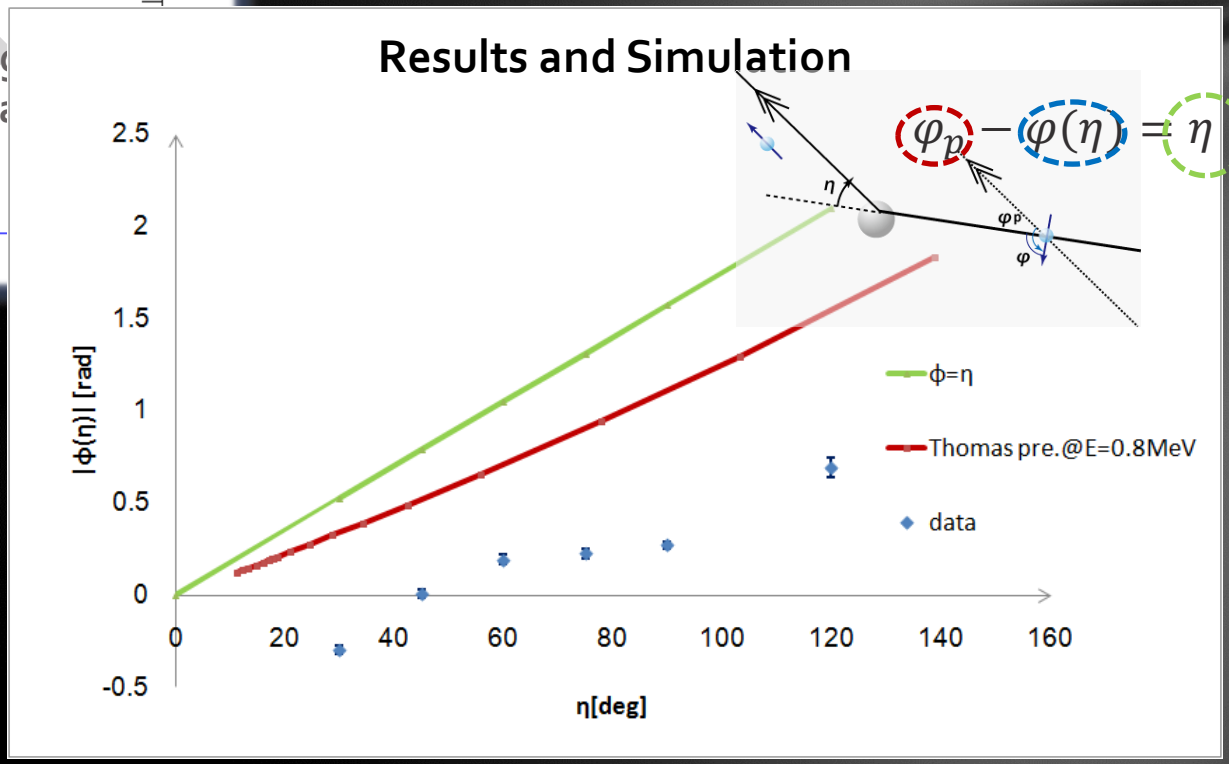
Experimental Result



AUTOMATIC data taking for 2 weeks.

We calculated
the Thomas and Geodetic Precession angle in a Simulation.

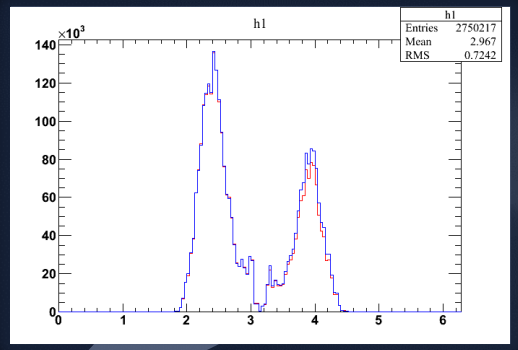


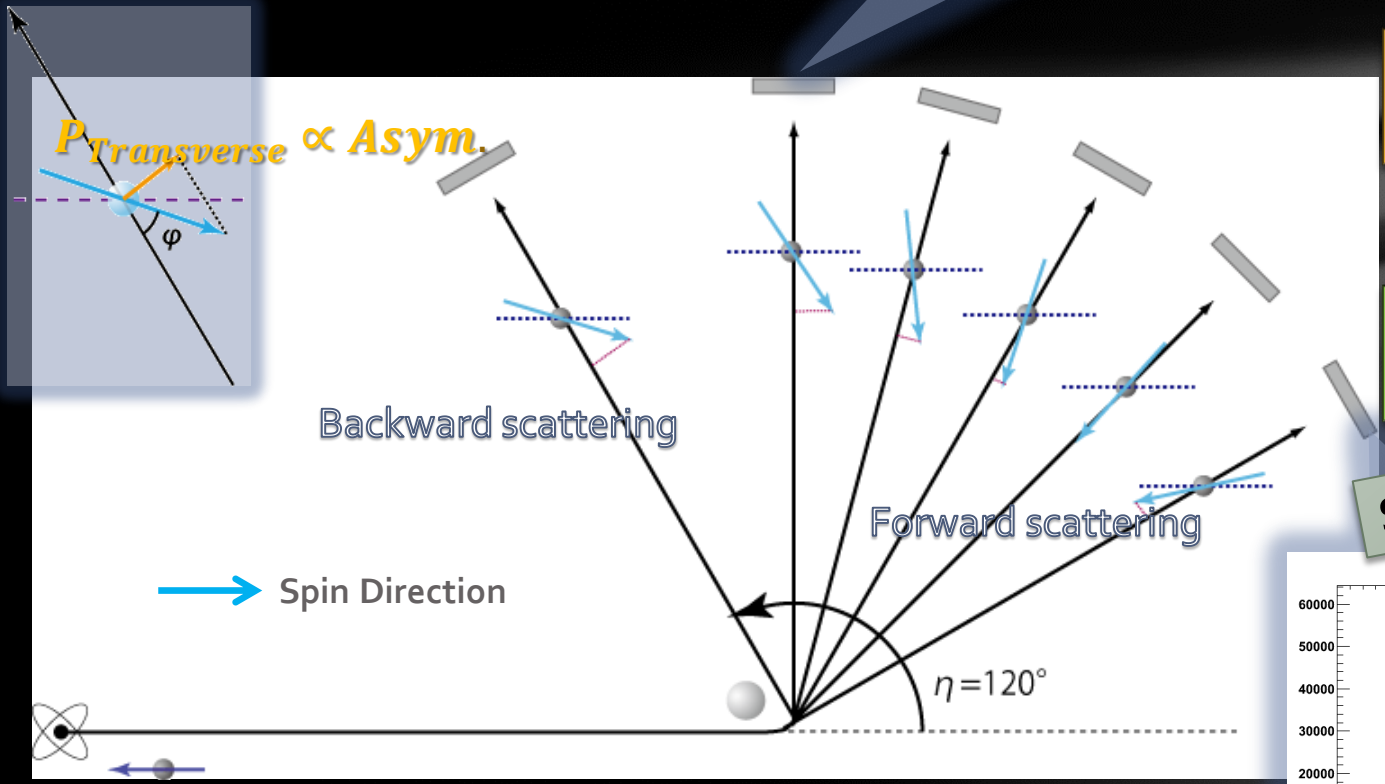


η + experimental data = Thomas Precession + Geodetic Precession??

Discussion

Spin direction changing is observed,
interpreted from the experimental results.
This may include the Geodetic pre. effect!!



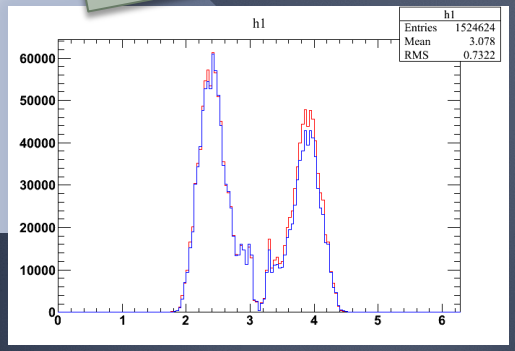


Thomas pre.
(Electromagnetic)

+ ?

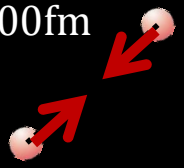
Geodetic pre.
(Strong Gravity)

Setting Upper Limit !

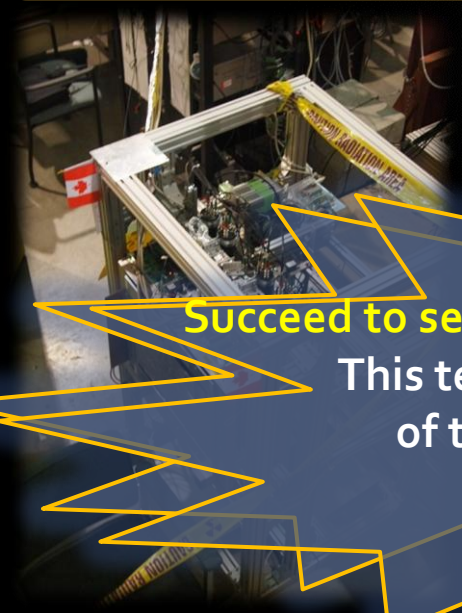


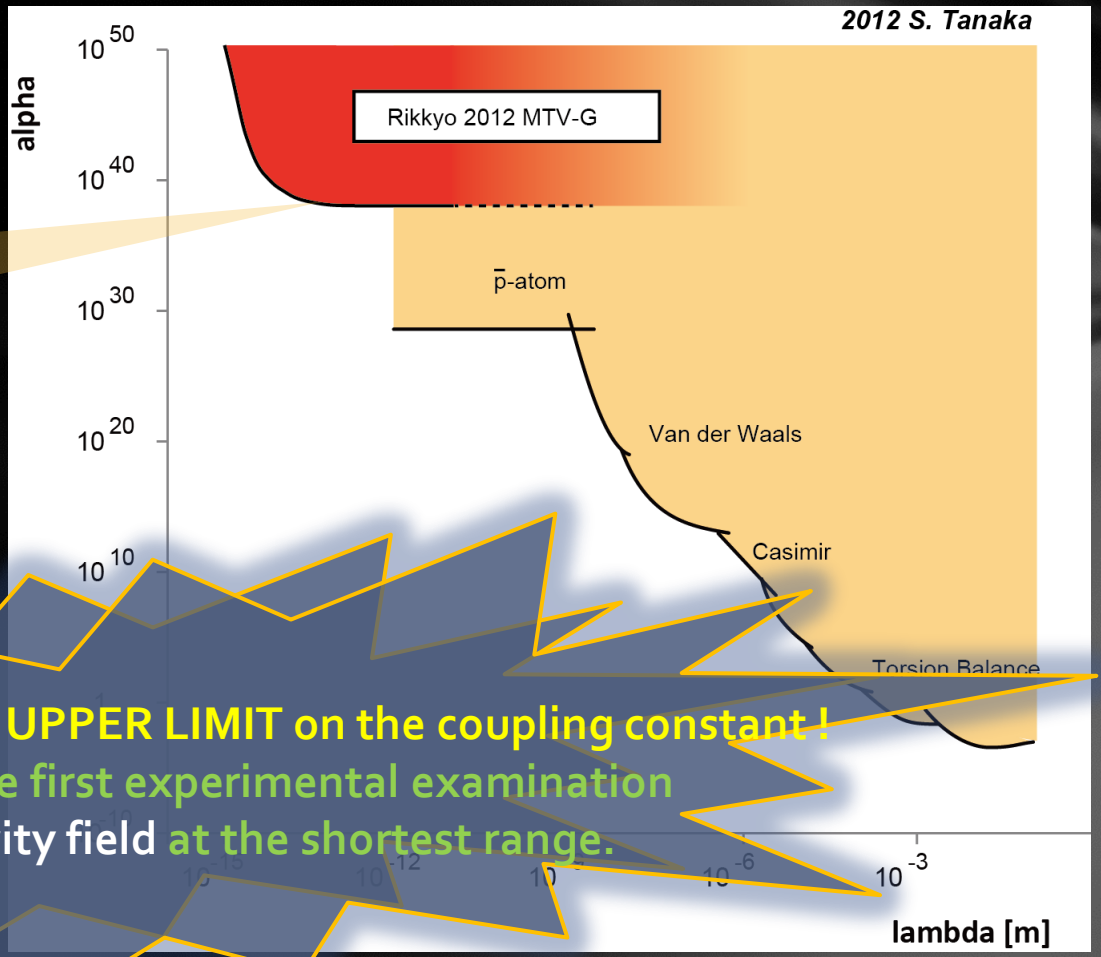
Final Result @alpha-lambda

Scattering scale : r~100fm



Parameter in this area
Conflicts with
our experiment data

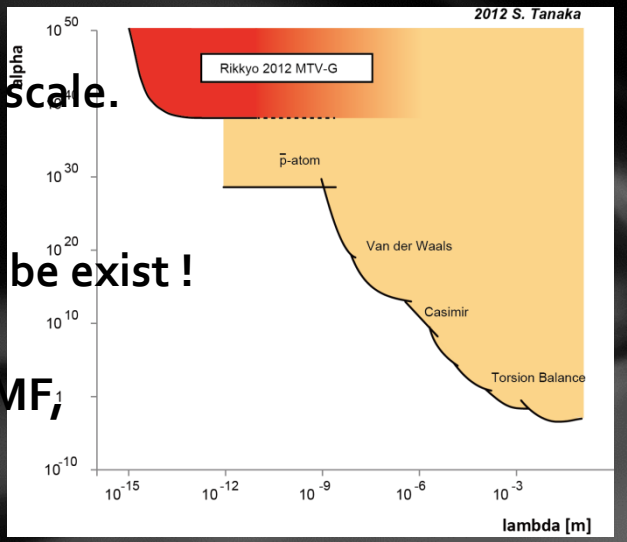


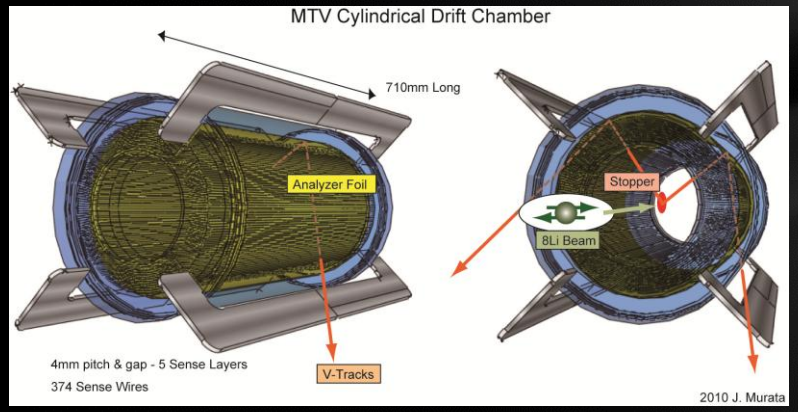


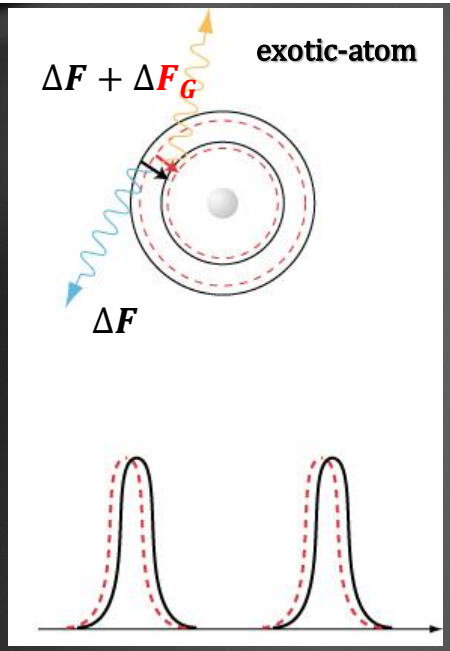
Succeed to set a new UPPER LIMIT on the coupling constant !
This test is the first experimental examination
of the gravity field at the shortest range.

Summary and Future plan

- We've tried to measure the effect of Gravity at nuclear scale.
  It's the first trial in the world!!
  We succeeded to set
  a newly excluded area where strong gravity cannot be exist !
- We'll continue this experiment with MWDC in Japan,
  and will try to start new experiment with CDC at TRIUMF,
  especially aiming to reduce systematic errors.







- We'll also try to explore wide area of physics
  in a gravitational point of view.
  ex) analyzing the spectroscopic data of exotic atoms

Murata Lab.

TRIUMF

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THANK you for Listening…