



SOKENDAI KEK Tsukuba/J-PARC Summer Student Program

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International and Inter-institution
Network for Accelerator Science
to Next Generation, IINAS-NX



JENNIFER2 a HORIZON2020
MSCA-RISE project, g.a. 822070

Summer Student Program Joint Event



About Me

Name: Sibtain Ali

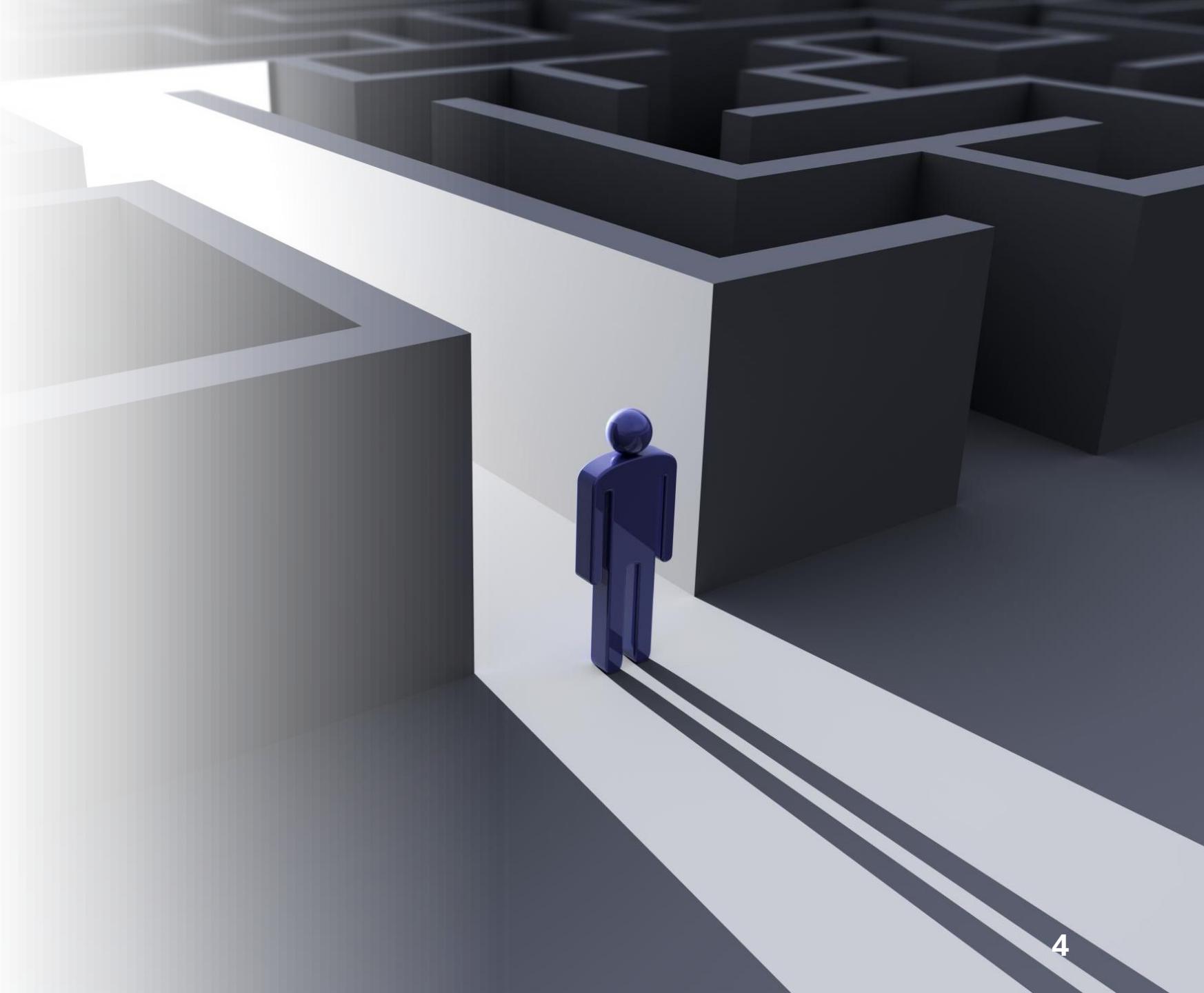
Country: Pakistan

Affiliation: COMSATS Islamabad
(BS Physics)



Charge-Parity Violation and Matter-Antimatter Asymmetry: A Theoretical Study

WHY DO WE EXIST!



Background

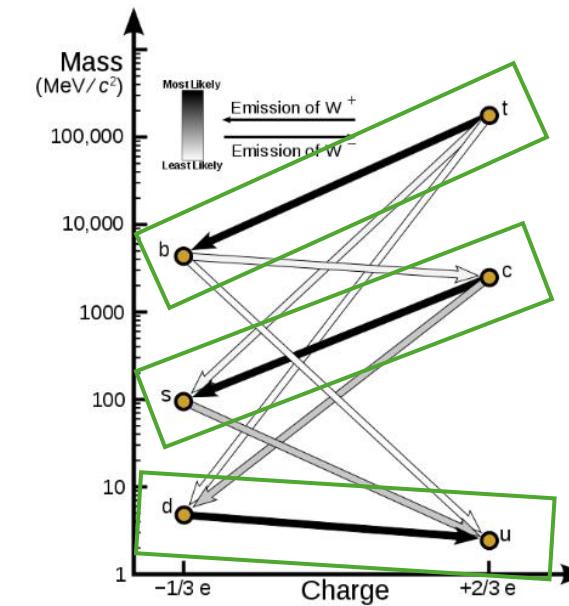
- 1928: Antimatter Prediction by Dirac (-ve energy solutions)
- 1956: Parity Violation in “Cobalt-60 decay” Wu’s Experiment
- 1964: CP Violation in “ K^0 Decay” at BNL $\epsilon = 10^{-4}$
- 1967: Sakharov Three Conditions for BAU
- 1973: CKM $e^{i\delta}$ (δ = CPV Phase)

Cabibbo-Kobayashi-Maskawa Matrix

$$V_{CKM} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} c_1 & -s_1 c_3 & -s_1 s_3 \\ s_1 c_2 & c_1 c_2 c_3 - s_2 s_3 e^{i\delta} & c_1 c_2 s_3 + s_2 c_3 e^{i\delta} \\ s_1 s_2 & c_1 s_2 c_3 + c_2 s_3 e^{i\delta} & c_2 s_2 s_3 - c_2 c_3 e^{i\delta} \end{pmatrix}$$

where each $V_{ij} \equiv$ Transition Amplitude $q_i \rightarrow q_j$

 [Cabibbo, N. \(1963\) Physical Review Letters, 10, 531](#)
[Cabibbo–Kobayashi–Maskawa matrix - Wikipedia](#)



The Jarlskog's Invariant

VOLUME 55, NUMBER 10

PHYSICAL REVIEW LETTERS

2 SEPTEMBER 1985

Commutator of the Quark Mass Matrices in the Standard Electroweak Model and a Measure of Maximal *CP* Nonconservation

C. Jarlskog

Department of Physics, University of Bergen, Bergen, Norway, and Department of Physics, University of Stockholm,
S-11349 Stockholm, Sweden
(Received 20 June 1985)

The structure of the quark mass matrices in the standard electroweak model is investigated. The commutator of the quark mass matrices is found to provide a convention-independent measure of *CP* nonconservation. The question of maximal *CP* nonconservation is discussed. The present experimental data indicate that nowhere is *CP* nonconservation maximal.

- A Convention-Independent measure of CP Violation \rightarrow Amount of Asymmetry

$$J \equiv \det[M_u, M_d]$$

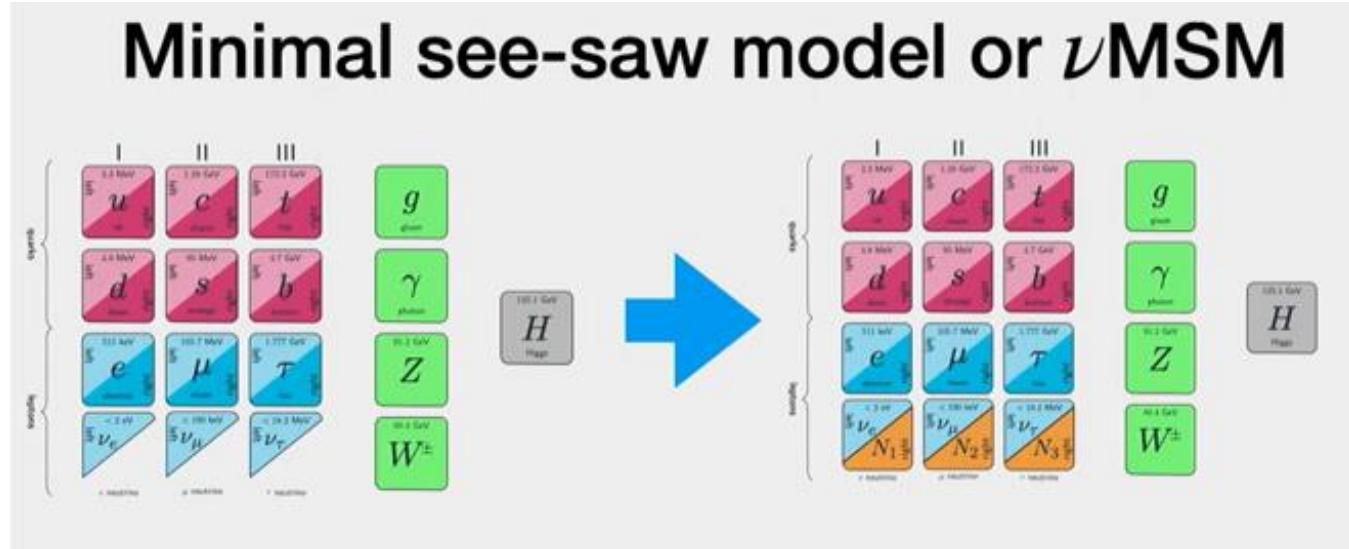
$$\begin{aligned} J &= (m_t^2 - m_c^2)(m_t^2 - m_u^2)(m_c^2 - m_u^2) \\ &\quad (m_b^2 - m_s^2)(m_b^2 - m_d^2)(m_s^2 - m_d^2) J_{\text{eff}} \\ \text{where } & J_{\text{eff}} = s_1^2 s_2 s_3 c_1 c_2 c_3 \sin\delta \\ \text{or } & = \text{Im} V_{ii} V_{jj} V_{ij}^* V_{ji}^*, \text{ for } i \neq j \end{aligned}$$

[Jarlskog_PhysRevLett.55.1039.pdf](#)

$$\frac{J}{(100 \text{ GeV})^{12}} \sim 10^{-20}$$

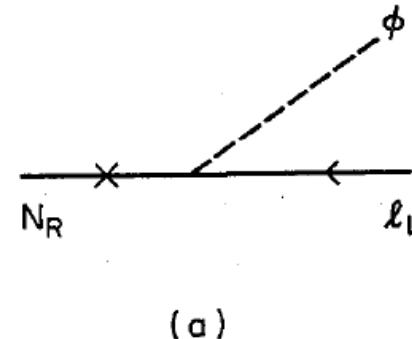
BEYOND THE STANDARD MODEL (BSM)

Baryogenesis via
Leptogenesis in Seesaw
Type-I Mechanism

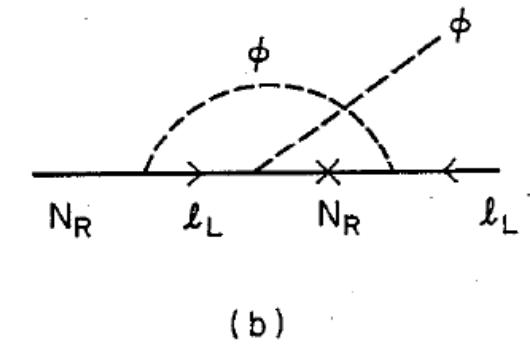


Leptogenesis via Seesaw Mechanism

$$N_R \rightarrow \ell_L + \bar{\phi} \quad (a)$$



$$N_R \rightarrow \bar{\ell}_L + \phi \quad (b)$$



- Lepton number non-conservation: $0 \rightarrow \pm 1$

$$\epsilon \approx 10^{-6}$$

- Lepton asymmetry number

• Lepton asymmetry



Baryon asymmetry



*Sphaleron
Interactions*

$$k \frac{\Delta B}{s} \sim 10^{-10}$$

Conclusion

We all are the children of
broken symmetry



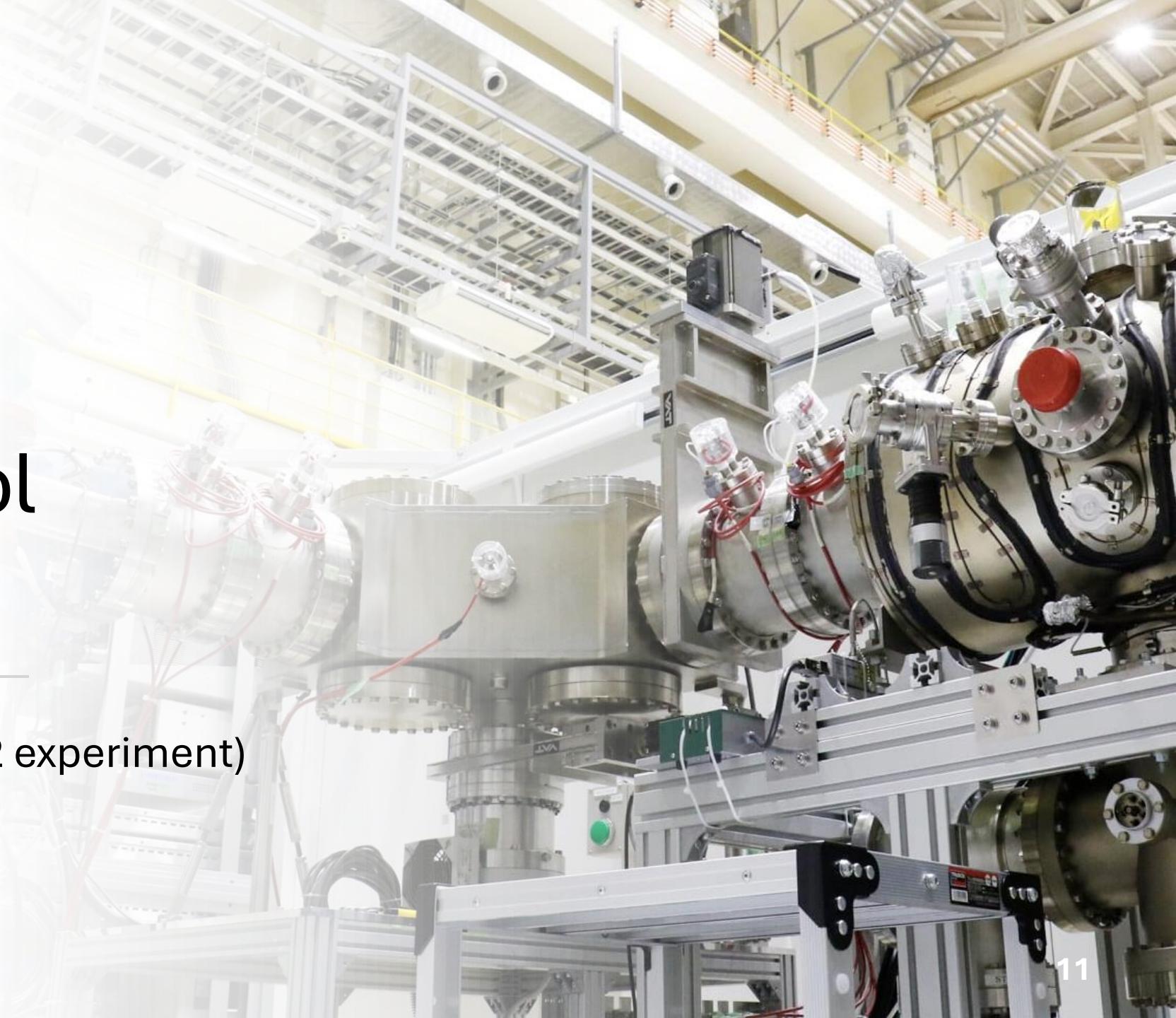


Summer School Program

Group: E34 (*muon g-2 experiment*)

Supervisors: Prof. Mibe

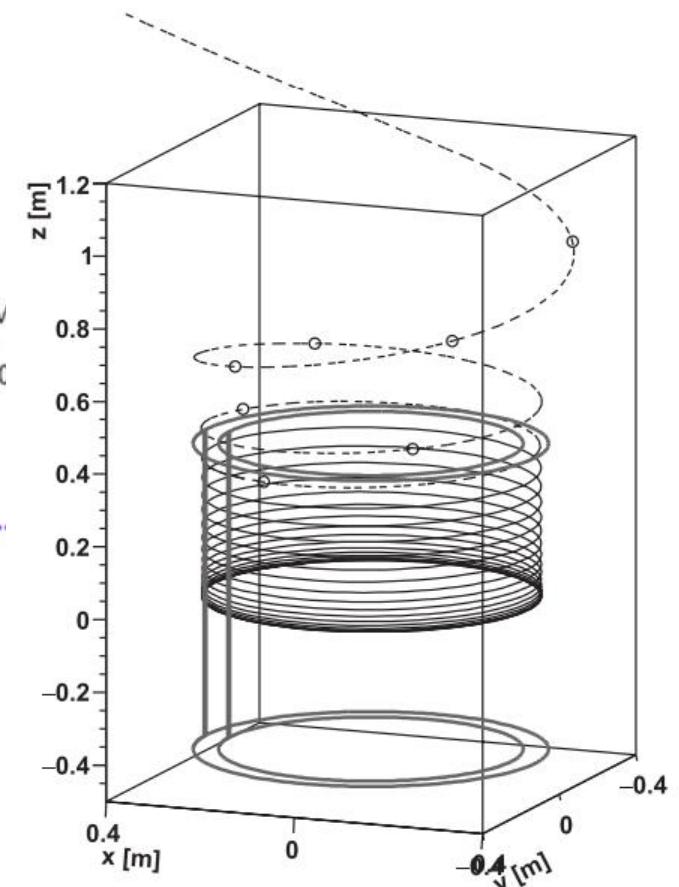
Prof. Shinji



Preliminary Studies: Motion of Stored Muons

My Goal: Motion of Stored Muons

- Approach:
- Equation of Motion
 - Vertical Betatron Oscillation
 - Simulate Muon Motion (C++ Root)
 - Predict muons position and momentum at any time
-
- The diagram illustrates the Muon LINAC process. It starts with a 'Surface muon (H-line)' source at the bottom left. Red arrows point from this source to a 'Room temperature muon source' (represented by a green rectangle). From there, blue dashed arrows labeled μ^+ and $\text{Mu}^{(+e)}$ enter a 'Thermal muonium production target'. A green arrow points from this target to 'Initial accelerating electrodes (SOA)'. Above the SOA, a green box labeled 'Resonant Laser ionization' is shown. Dashed arrows then lead to three stages of acceleration: '1st stage RFQ IH-DTL', '2nd stage Disk-And-Washer structure', and '3rd stage Disk-loaded structure'. Each stage is represented by a stack of rectangular components. Final parameters are listed: Energy (4 MeV), Emittance ($\pi \text{ mm} \cdot \text{ mrad}$) (1,000), Intensity (per sec) (3×10^8), and a value of 212 N. The final energy is 40 MeV.



Outline of the 3D injection scheme

DOI: 10.1093/ptep/ptz030

Gantt Chart



About Japan



Thank you