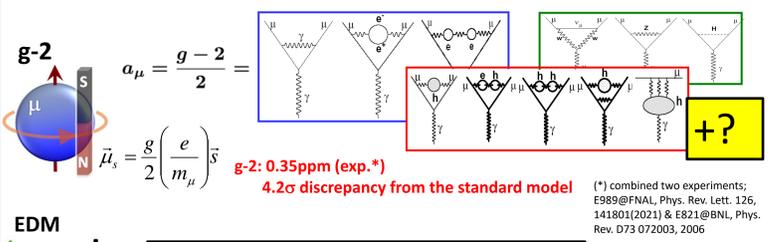


# Design of a strong X-Y coupling beam transport line for J-PARC muon g-2/EDM experiment

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## 1. Physics goal : Explore the beyond standard model



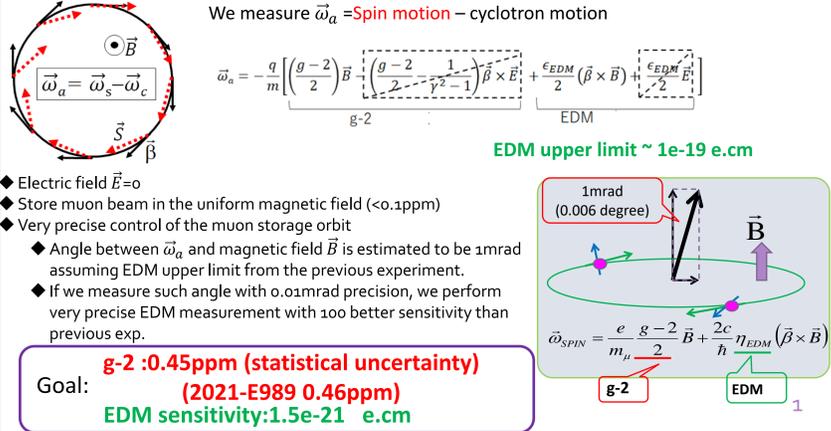
**Non-zero observation = new physics**

Standard Model expects  $\sim 2 \times 10^{-38} \text{ e}\cdot\text{cm}$

Upper limit (E821)  $< 1.9 \times 10^{-19} \text{ e}\cdot\text{cm}$  (90% CL)

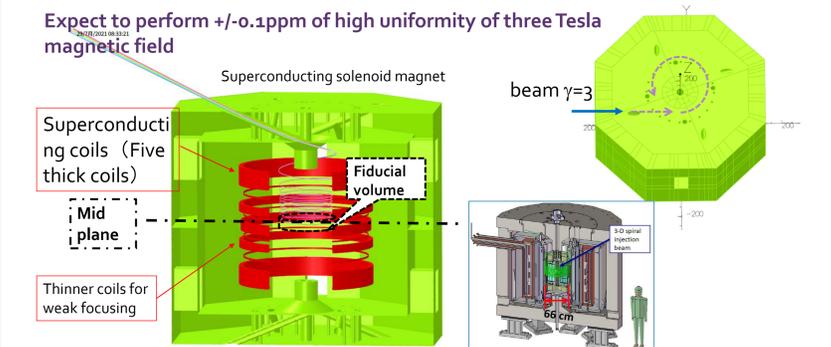
We aim sensitivity of  $\sigma(d_\mu) < 1 \times 10^{-21} \text{ e}\cdot\text{cm}$

## 2. Muon spin precession probes g-2 and EDM...catch the new physics!



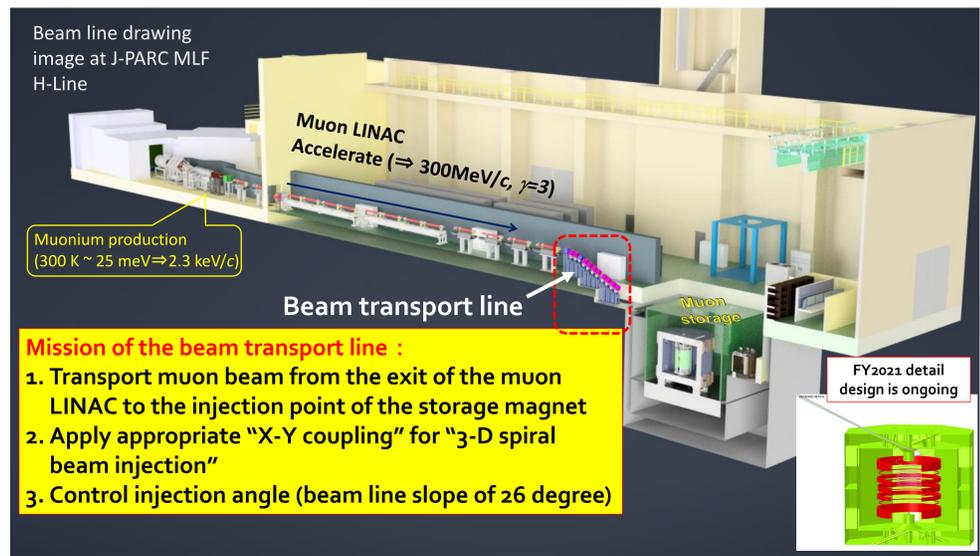
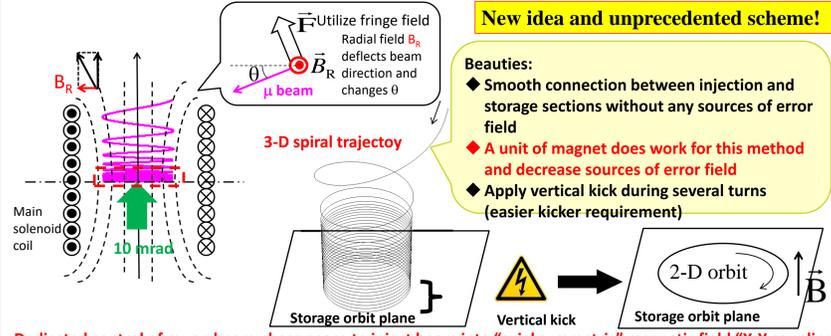
**Super precise adjustment for muon storage magnetic field is a KEY**

## 3. Apply medical MRI type superconducting magnet technology

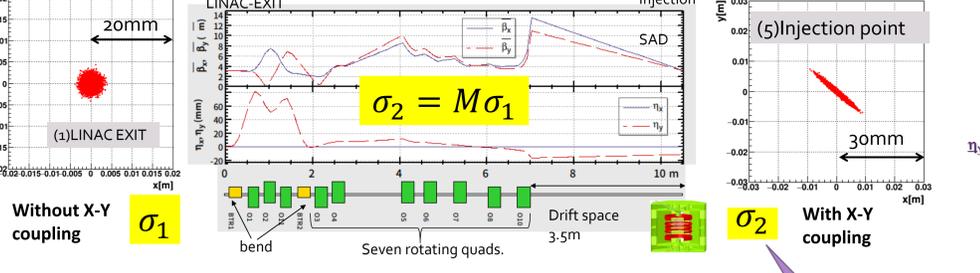


Diameter of storage orbit is only 0.66m. The smallest storage ring for relativistic energy beam in the world! How to inject the beam into MRI-sized compact storage magnet?

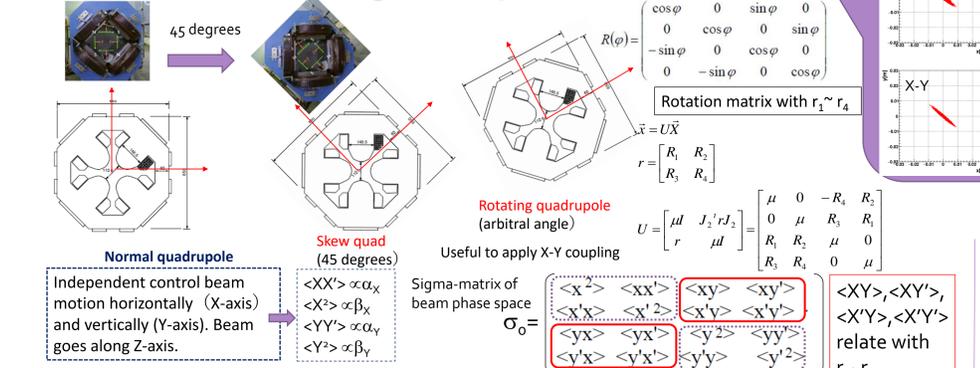
## 4. Newly develop 3-D spiral injection



## 7. Design beam transport line by use of SAD(\*)

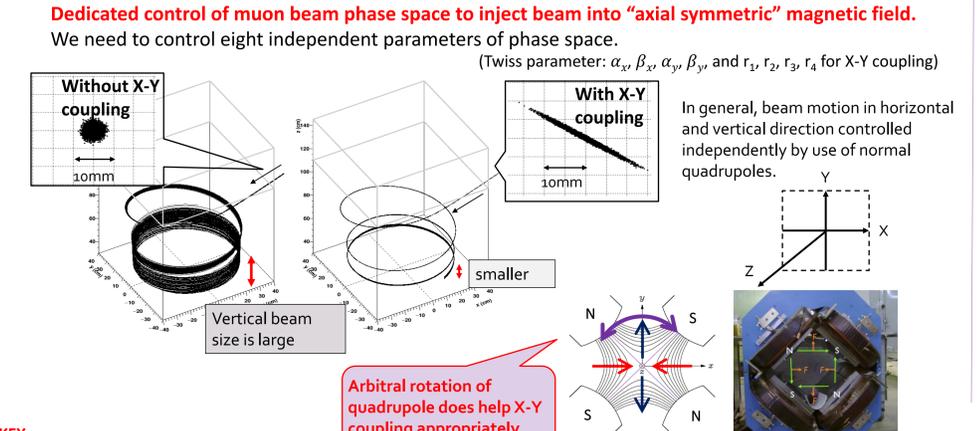


## 6. How to control eight twiss parameters with rotating Quadrupoles?

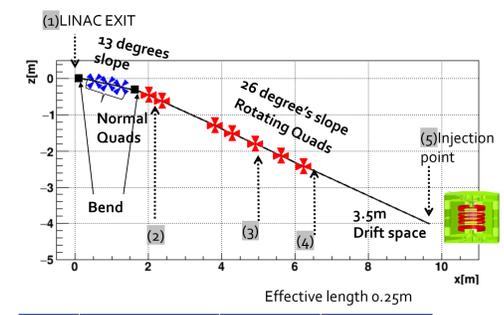


Twiss parameter:  $\alpha_x, \beta_x, \alpha_y, \beta_y$ , and  $r_1 \sim r_4$  for X-Y coupling: **Eight independent parameters.**

## 5. A key technology for 3-D spiral injection scheme: "X-Y coupling"?



## 8. Beam Line components estimated by SAD



Bore radius [mm]	K[T/m]	AT	Angle (deg)	
Q3	10	-20.2	-805	-30.6
Q4	10	3.7	-147.5	38.7

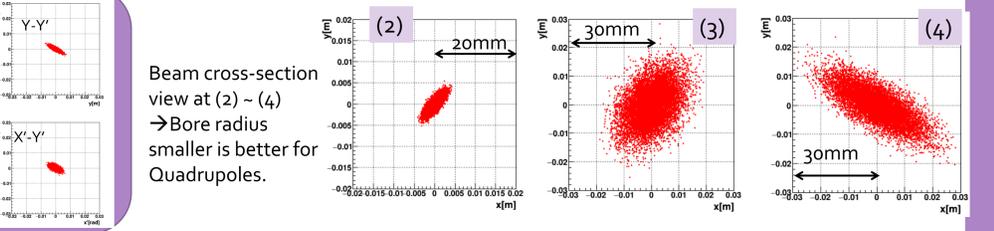
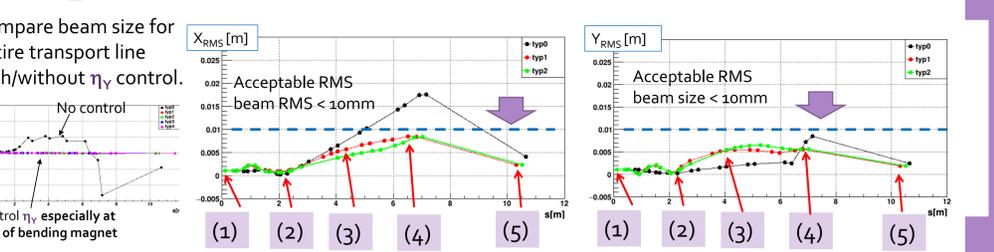
Effective length 0.29m

Bore radius[mm]	K[T/m]	AT	
Q1	10	-18.1	-720
Q2	10	17.4	691
Q11	10	-17.6	-702

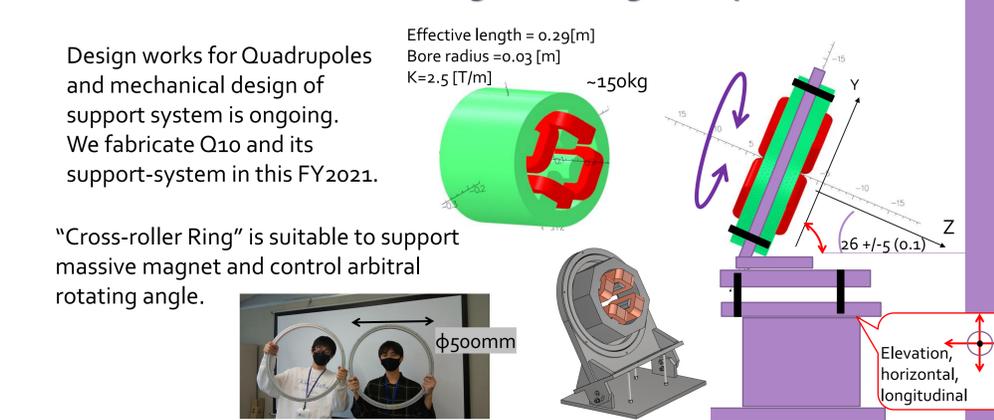
Bore radius [mm]	K[T/m]	AT	Angle (deg)	
Q5	30	0.71	-252.8	28.4
Q6	30	0.64	-229.6	32.8
Q7	30	1.04	-372.0	28.9
Q8	30	-0.64	-230.8	-36.8
Q10	30	-2.31	+828.3	31.8

Effective length 0.29m

## 9. $\eta_y$ control is a key to control reasonable beam size



## 10. How to control rotation angel at 26 degree slope beam line?



## 11. Summary and Next

- Preparation for new muon g-2/EDM experiment at J-PARC is ongoing.
- Muon g-2 and EDM probe new physics beyond the Standard Model.
- Discrepancy between experiment and theory  $> 4.2\sigma$ .
- Design work for the transport line (LINAC EXIT - injection point) is ongoing.
- X-Y coupling for the injection beam is important for 3-D spiral injection scheme.
- Set of rotating quadrupole magnets control appropriate X-Y coupling.
- Beam injection point is below 4m with respect to the beam line height of LINAC, and transport line need to treat 26 degrees slope.
- Mechanical design work for quads' base (right pict.) is ongoing.
- We will have a muon beam  $\sim$  FY2026.