



# Past and future muon EDM searches

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University of Washington

*Workshop on future muon EDM searches at Fermilab and worldwide*

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# How do we look for a muon EDM signal?

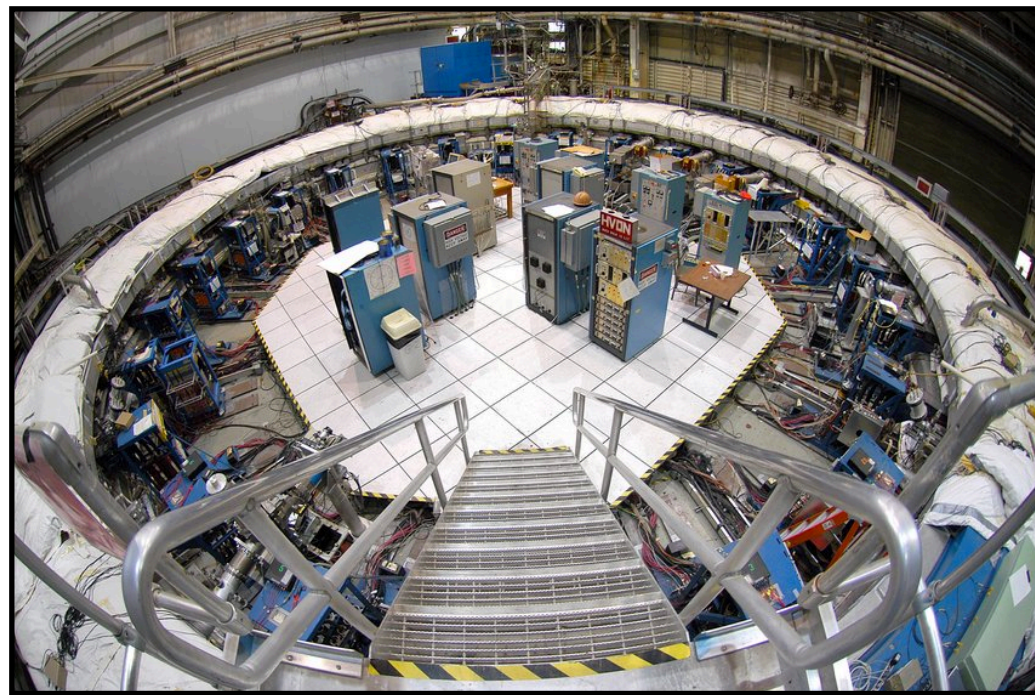




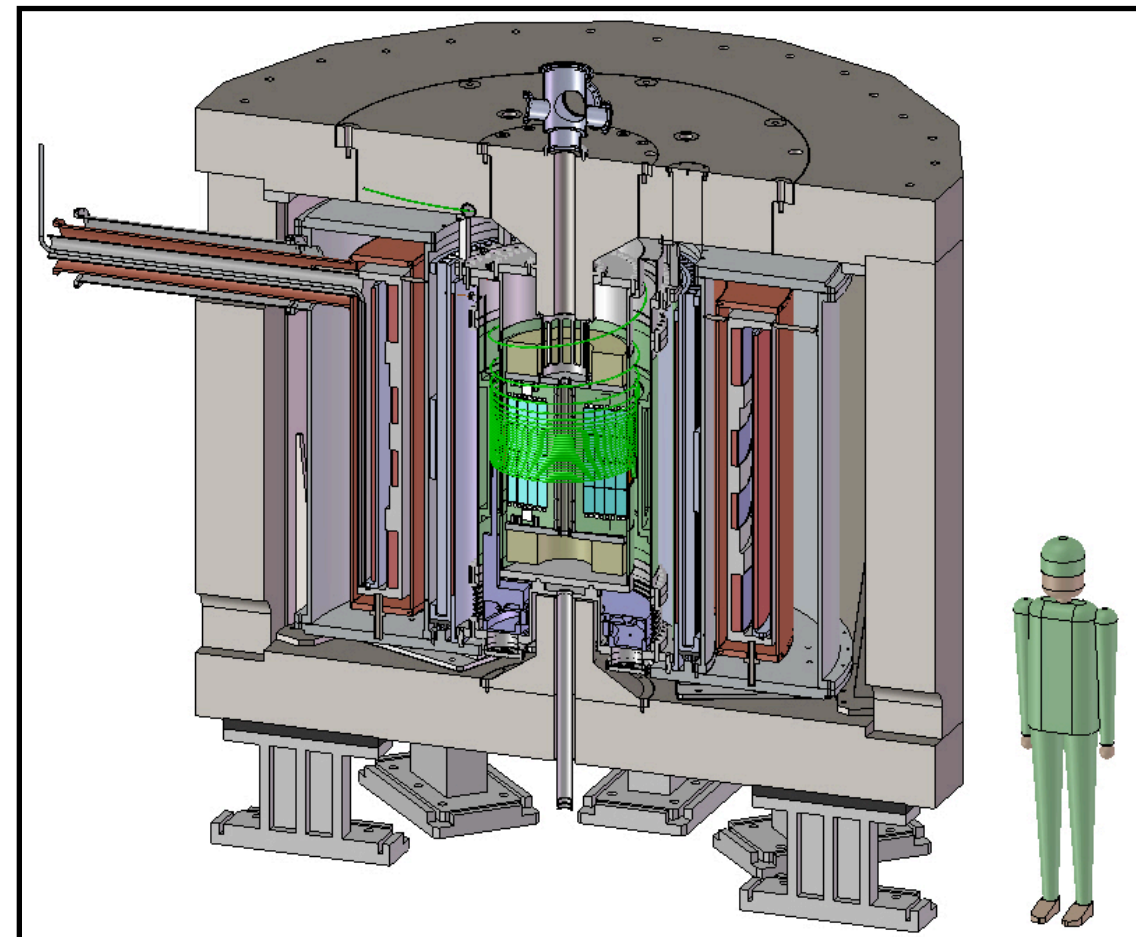
# How do we look for a muon EDM signal?

Two approaches so far .....

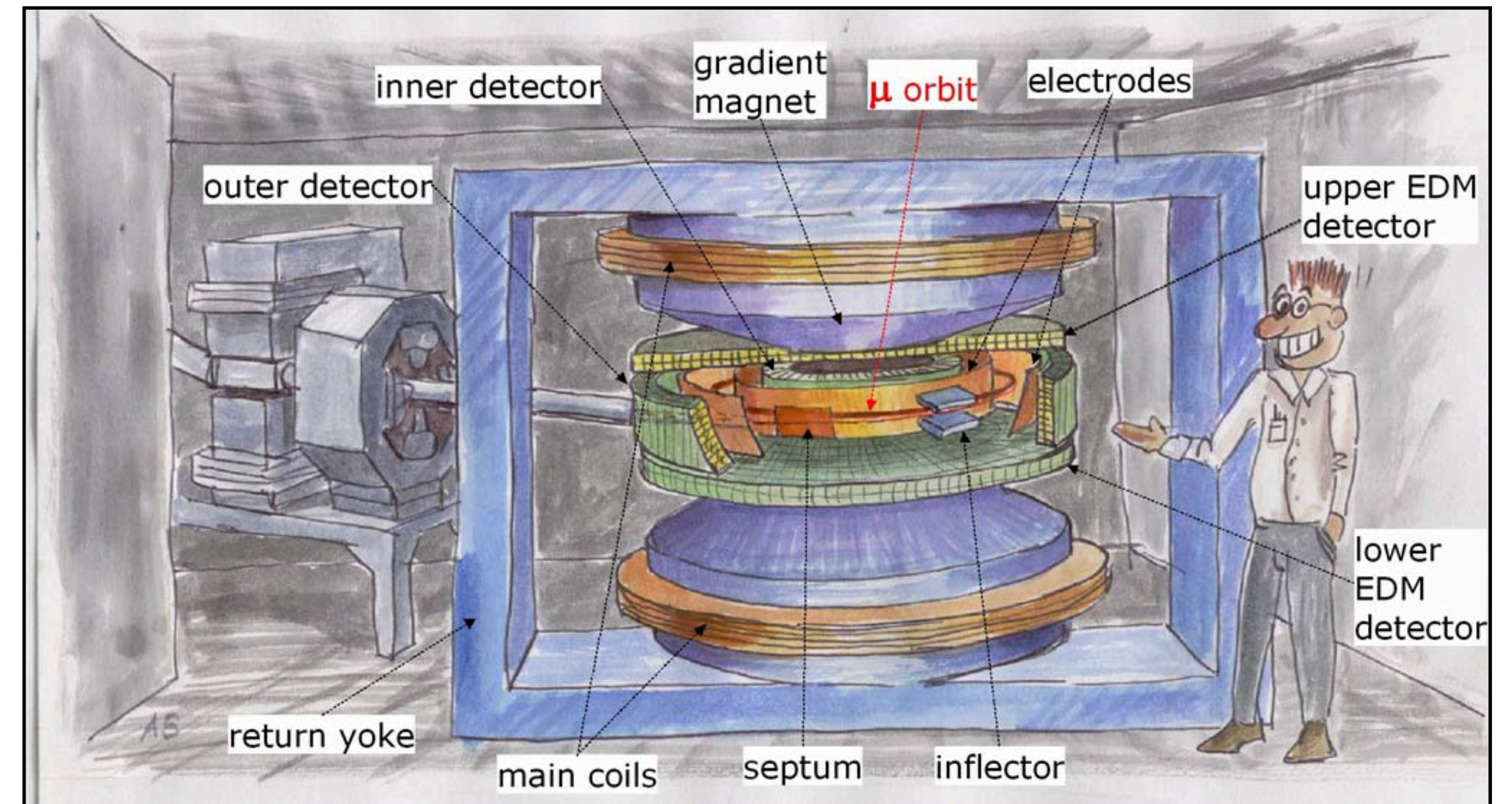
Oct 01, R. Chislett



Oct 12, T. Mibe



Oct 12, P. Schmidt-Wellenburg



Oct 01, J. Price

**The “parasitic” approach with g-2**  
(performed or proposed at BNL, FNAL and J-PARC)

**The “frozen-spin” approach**  
(proposed at J-PARC, PSI)



# Muon spin precession in B and E field

$$\vec{\omega} = -\frac{e}{m} \left\{ \underbrace{a\vec{B} + \left( \frac{1}{1-\gamma^2} - a \right) \frac{\vec{\beta} \times \vec{E}}{c}}_{\omega_a : \text{AMM}} + \underbrace{\frac{\eta}{2} \left( \frac{\vec{E}}{c} + \vec{\beta} \times \vec{B} \right)}_{\omega_\eta : \text{EDM}} \right\}$$

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$\omega_a$  : AMM  $\omega_\eta$  : EDM

BNL, FNAL: use  $\gamma = 29.3$

J-PARC: no E-field focusing

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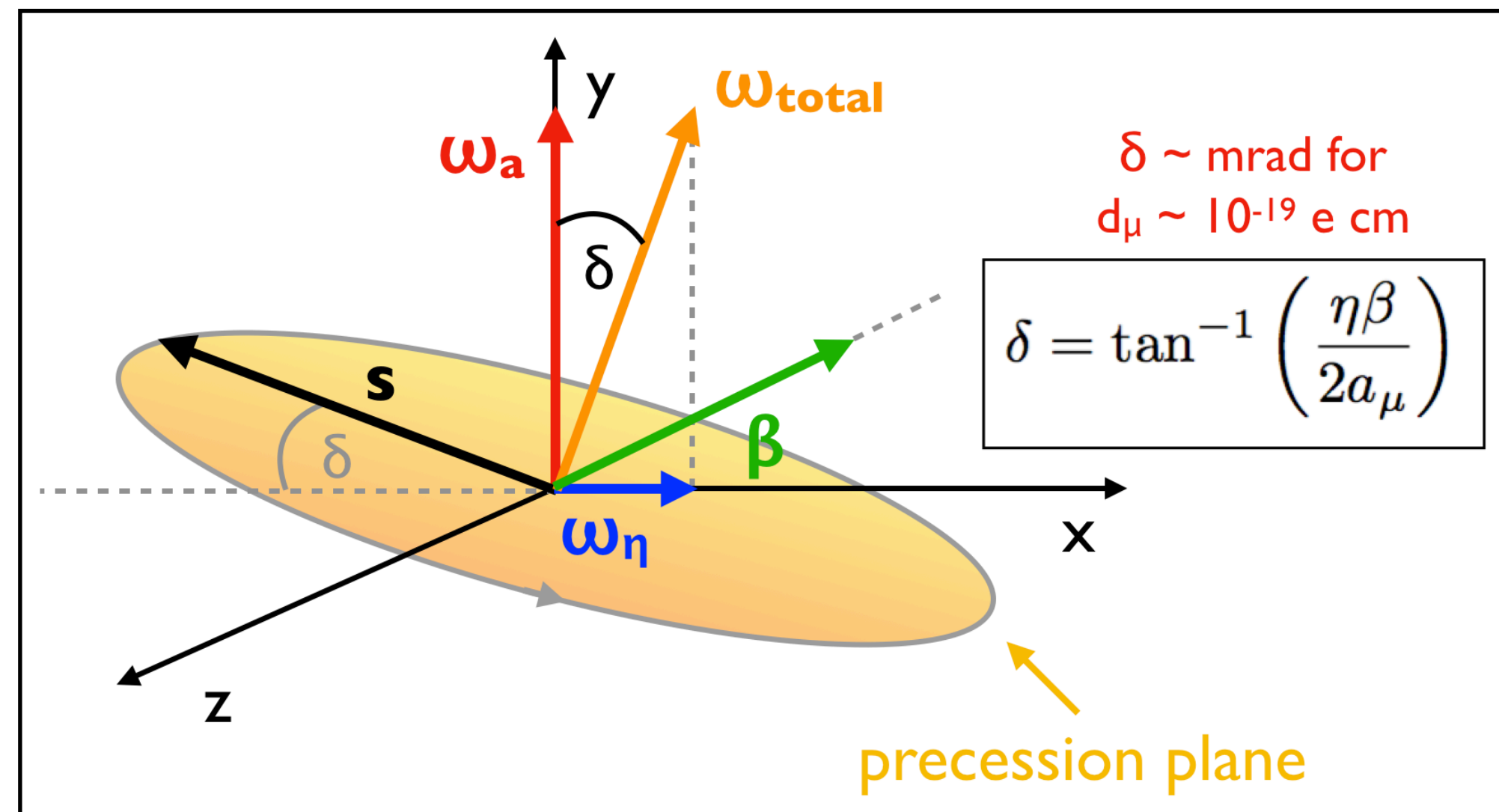
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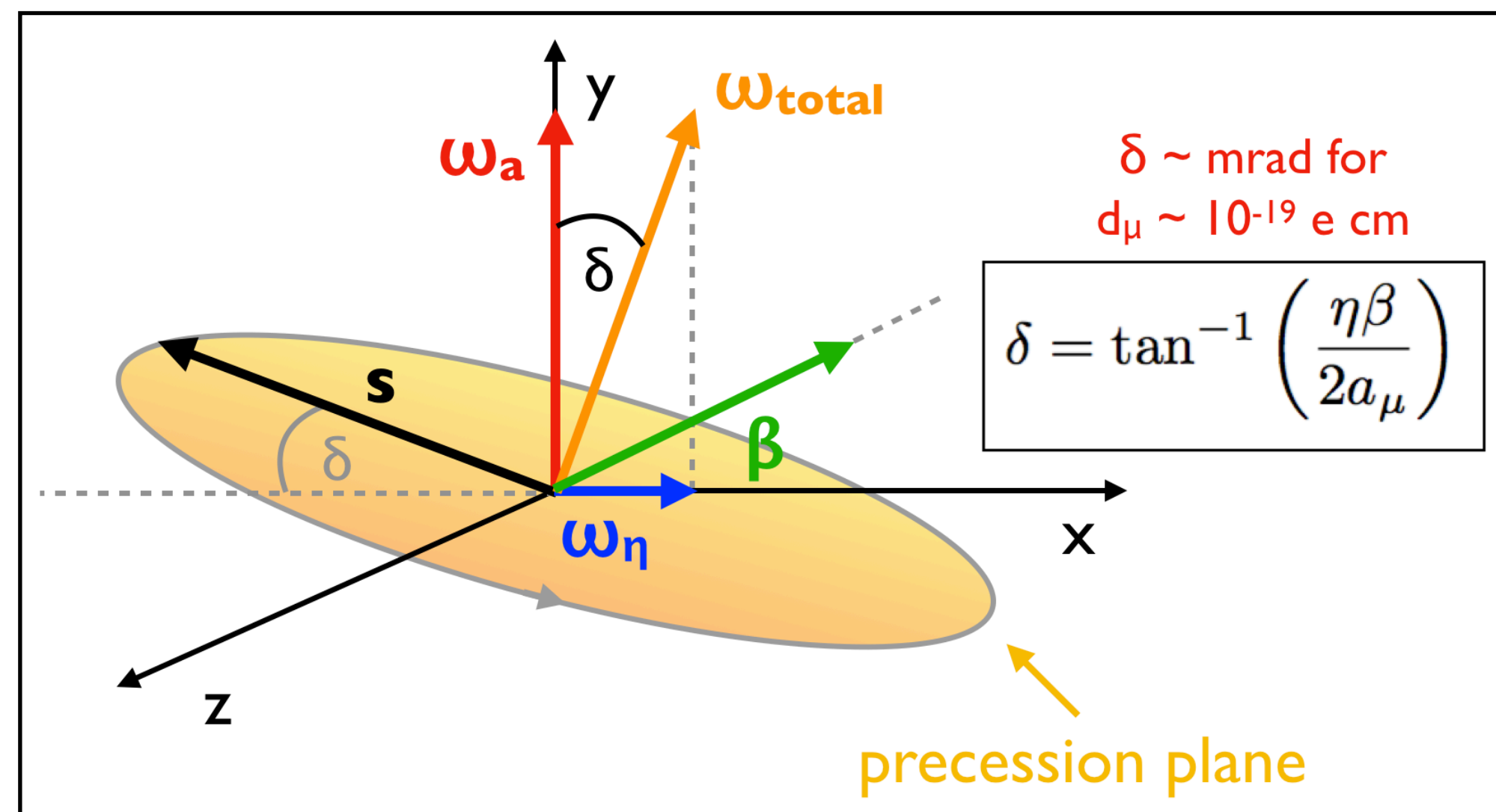
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J-PARC, PSI:  $E \sim aBc\beta\gamma^2$

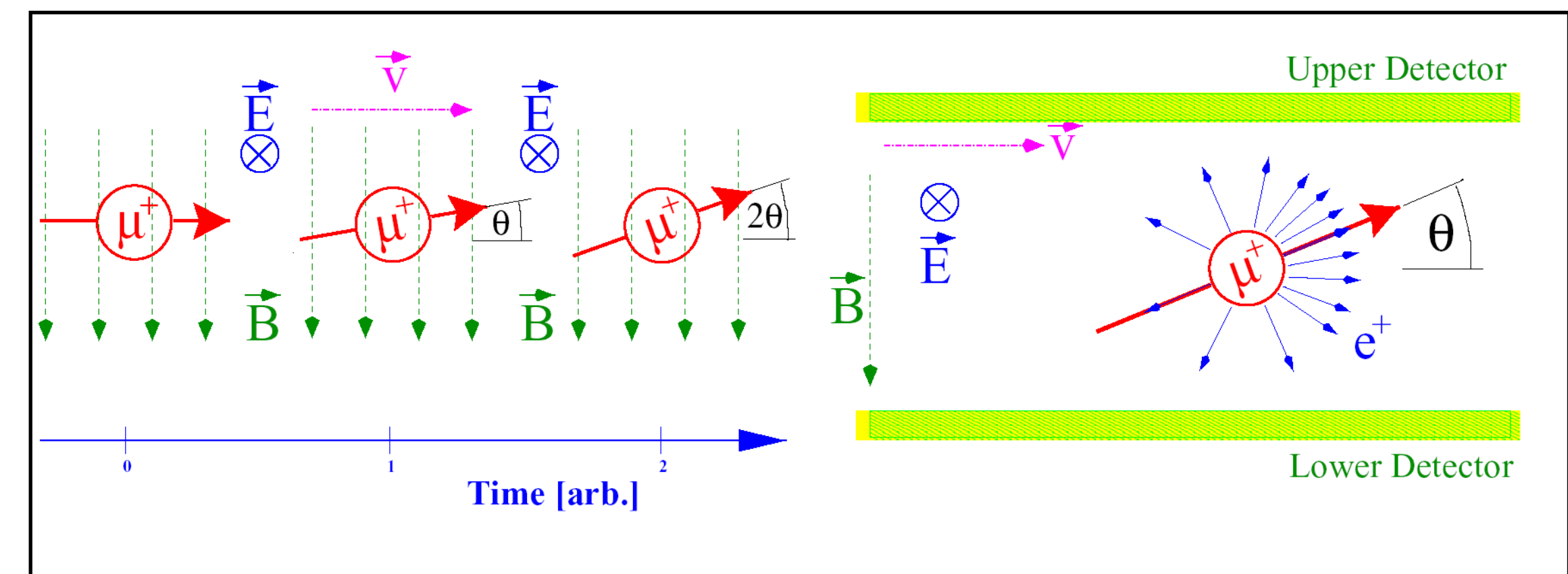
J-PARC: storage ring lattice,  $\langle R \rangle \sim 11$  m

PSI: compact storage ring,  $\langle R \rangle \sim 0.3$  m



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dominant term  $\sim$  GV/m

$\omega_a$  : AMM

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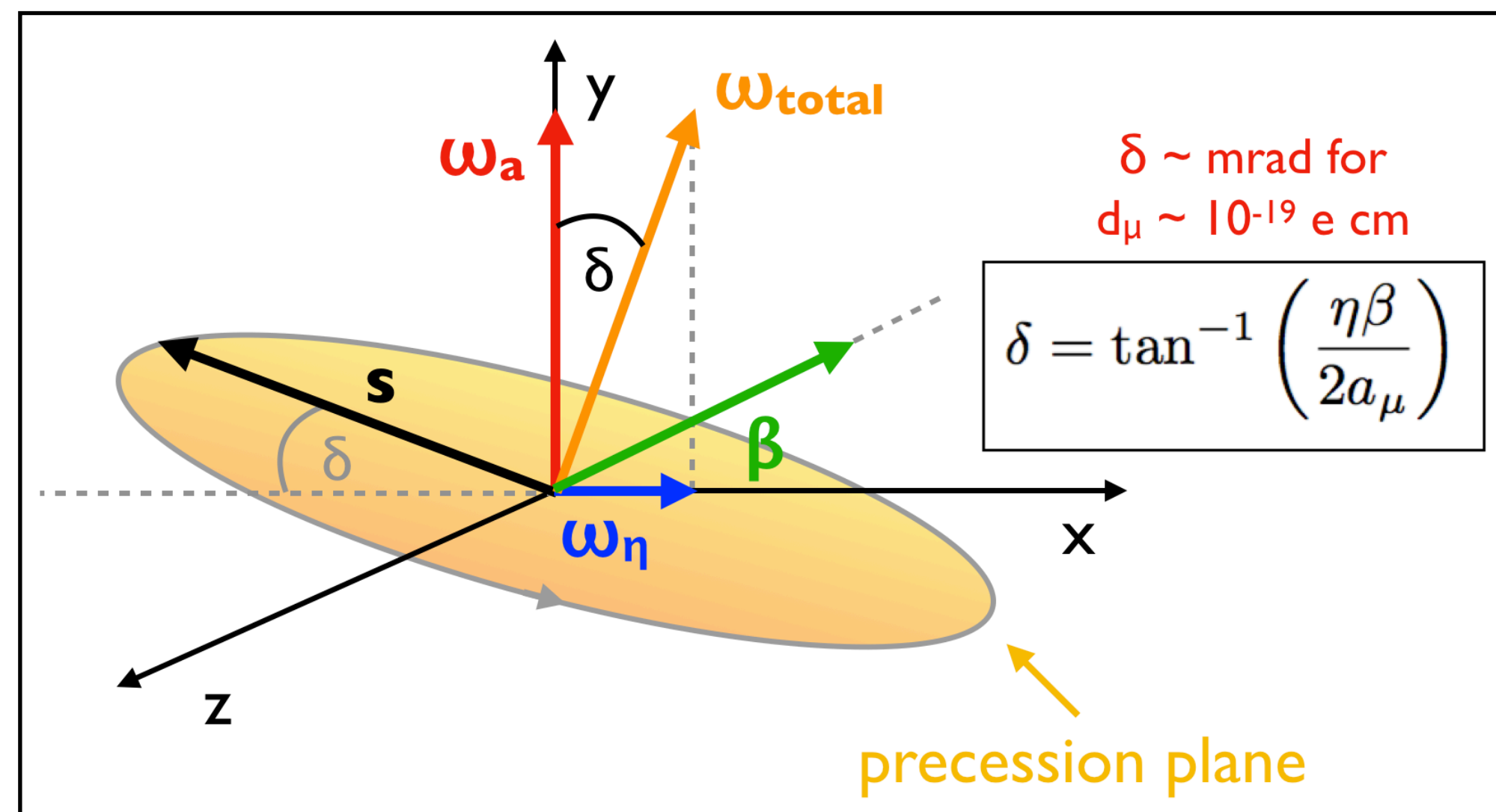
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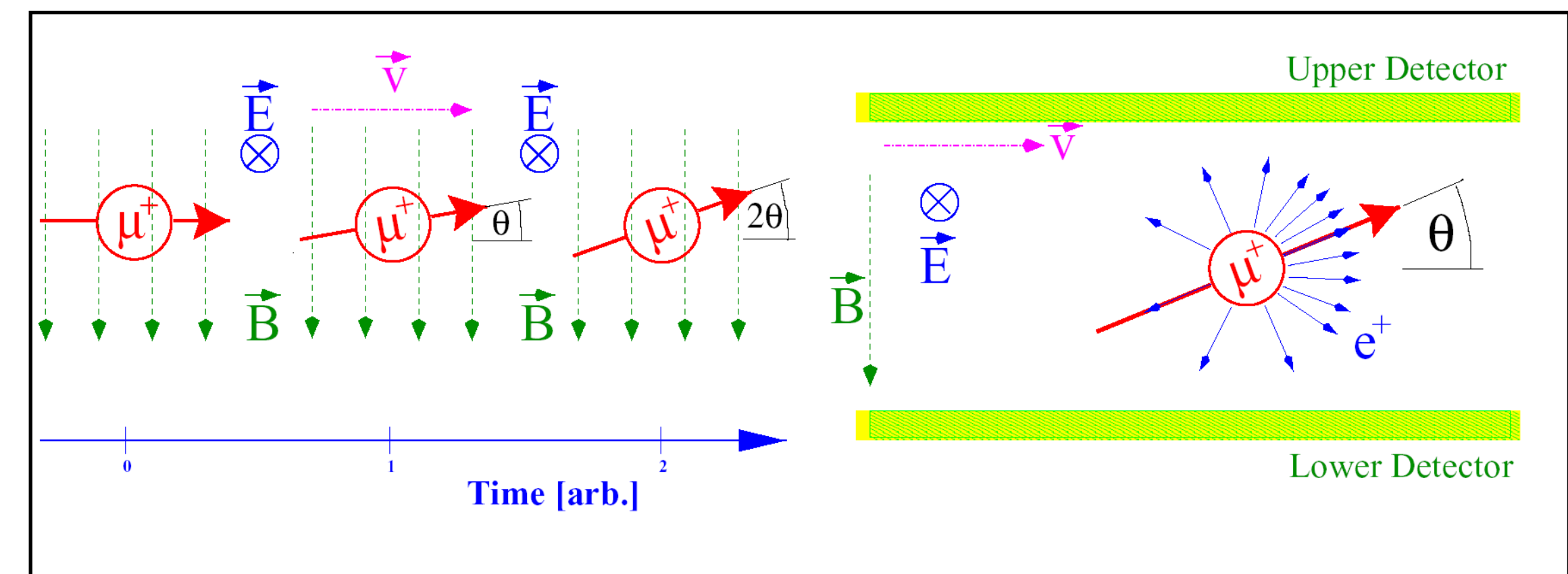
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# Status of recent muon EDM searches

CERN, Parasitic, J. Phys. G 4, 345 (1978)

Proposed location	Proposed technique	Proposed year	Commissioned?	Data taken?	Result published?
BNL	Parasitic	1985 (proposed for g-2) 1995 [ <a href="#">TDR for E821</a> ]	Yes	Yes, R97-01	PRD 80, 052008 (2009)
J-PARC	Frozen spin	2003 (LOI) [ <a href="#">J-PARC L22</a> ]	-	-	-
PSI	Frozen spin	2006 (no LOI) [J. Phys. G 37, 085001 (2010)]	-	-	-
Fermilab	Parasitic	2009 (proposed for g-2) [FERMILAB-PROPOSAL-0989]	Yes	Yes for FY18	-
J-PARC	Parasitic	2009 (LOI) [KEK_J-PARC-PAC2009-06]	-	-	-
Fermilab	Parasitic	2-3 years after this workshop??	-	-	-
PSI	Frozen spin	2018 (no LOI) [arXiv:1807.11484]	-	-	-

# Summary

- Two approaches but various configurations for muon EDM searches
- Results only from parasitic measurements so far
- Two strategies
  - Exploit the running Muon g-2 experiment at Fermilab  
(more trackers, better control of the field, clever analysis techniques,.....)
  - Revisit the frozen-spin technique  
(new technology, better control of the field, renewed physics motivation,.....)