The Rare and Forbidden: Testing Physics beyond the SM with the Mu3e

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Mu3e Experiment (Phase I)

- Background-free search for $\mu \rightarrow eee$
- Observe some $10^{15}$ muon decays
- Precise tracking of $e^+/e^-$ and large acceptance

... more details in A. Bravar's talk
\( \mu \to eee \) in Effective Theories

• Dipole operator: \( \epsilon = 11\% \)  
  \( \Rightarrow \) \( \text{BR} \geq 8.5 \cdot 10^{-15} \) at 90\% CL

• Vector operator: \( \epsilon = 17\% \)  
  \( \Rightarrow \) \( \text{BR} \geq 4.6 \cdot 10^{-15} \) at 90\% CL
Dark Photon Searches

- $e^+e^-$ resonances in $\mu \rightarrow eee\nu\nu$
- Same data set as for $\mu \rightarrow eee$ searches

\[ A' \rightarrow e^+e^- \]

\[ m_{A'} = 10^{-8} \text{ to } 10^{-2} \text{ GeV} \]

\[ (g-2)_{\mu} = 4\sigma \]

Mu3e: Work in progress adapted from 1705.04265

A. Perrevoort (NIKHEF)
Familon Searches

$\mu \rightarrow eX$: narrow peak on $p_e$ spectrum

![Graph showing the Michel spectrum (leading order) and the $\mu \rightarrow eX$ signal ($m_X=60$ MeV).]
BSM Searches with Mu3e

- Characteristic decay distributions of \( \mu \rightarrow eee \) can reveal type of BSM interaction (... in case of discovery)

- Can search for more than \( \mu \rightarrow eee \)
  - Dark photons in \( \mu \rightarrow eee\nu\nu \)
  - Familons in \( \mu \rightarrow eX \)

⇒ Significant improvements in all these channels expected