
Fully differential NLO predictions for rare and radiative lepton decays

Yannick Ulrich

Paul Scherrer Institut / Universität Zürich

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Based on 1611.03617 and 1705.03782

Motivation

The radiative decay

The rare decay

Conclusion

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Conclusion

... a SM process

- G_F is measured through the muon decay
- 3.5σ discrepancy between BaBar measurement of $\tau \rightarrow e\nu\bar{\nu}\gamma$ and branching ratio calculation [[Fael, Mercolli, Passera 2015](#)]
- Radiative ($\mu \rightarrow e\nu\bar{\nu}\gamma$) and rare ($\mu \rightarrow e\nu\bar{\nu}e^+e^-$) decays are important backgrounds to searches for LFV

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... a clean QED toy process to study

- Efficient ways of IR subtraction
- Regularisation scheme dependencies
- γ^5 schemes

Motivation

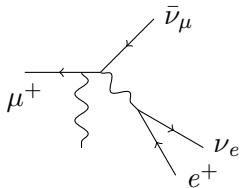
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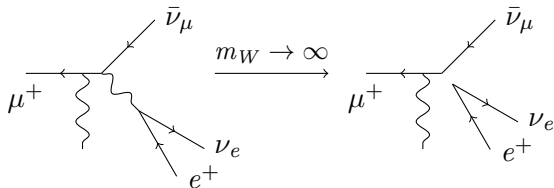
- 4-Fermi interaction, fierzed at the Lagrangian

$$\mathcal{L} = \mathcal{L}_{\text{QED}} + \frac{G_F}{\sqrt{2}} j_{V-A}(\mu, e) \cdot j_{V-A}(\nu_\mu, \nu_e)$$



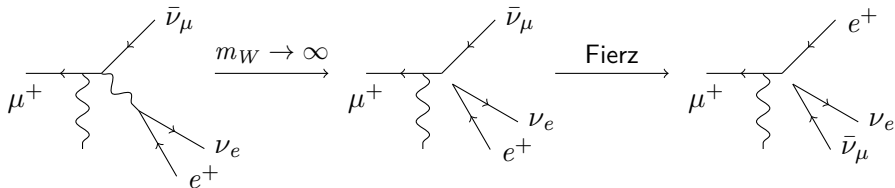
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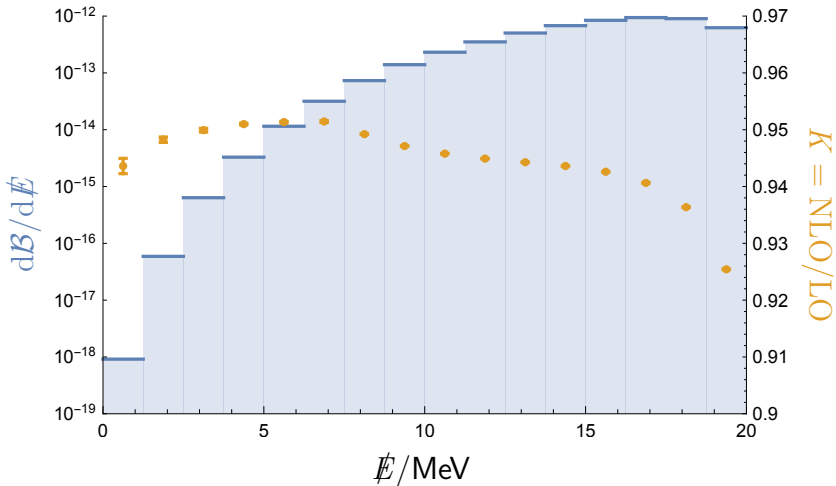
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- GoSam or FeynArts [Cullen, van Deurzen, Greiner, Heinrich, Luisoni, et al. 2014; Hahn 2001] → FKS subtraction [Frixione, Kunszt, Signer 1996] → VEGAS [Lepage 1980]
- Can create arbitrary distribution with arbitrary cuts

$$+2\Re \left(\begin{array}{c} \text{Diagram 1} \\ \text{Diagram 2} \end{array} \right) + \left| \begin{array}{c} \text{Diagram 3} \end{array} \right|^2$$

Invisible energy spectrum at MEG

- Using theorist's MEG cuts



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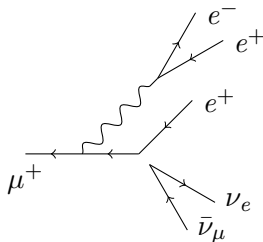
- Experimental cuts are very restrictive and unfolding of acceptance is not trivial
 - Correct fiducial acceptance by simulating full cuts of boosted system
 - Effect is large! Reduces discrepancy to 1.2σ
 - We **do not** claim that this is the full solution
- ⇒ Fully differential NLO corrections are very important!

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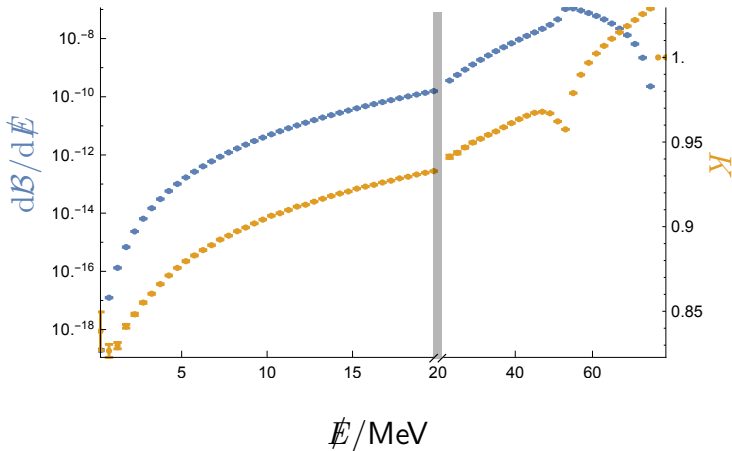
The rare decay

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- $4_{\text{Born}} + 40_{\text{1-loop}} + 20_{\text{real}}$ diagrams up to pentagons
- Use same approach (GoSam, FKS, VEGAS)
- Good parametrisation of phase space very important
- Mu3e cuts $E_{e^\pm} > 10 \text{ MeV}$, $|\cos \angle(\mathbf{p}_{e^\pm}, \mathbf{P}_\mu)| < 0.8$

Invisible energy spectrum at Mu3e



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- Proposal for resolution of discrepancy in radiative τ decay