Physics prospects with taus

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Introduction

in this presentation: "proper" tau Physics topics

- tau properties (mass, lifetime, $g-2$, EDM, *CPV* ...)
- tau decays
  - EW precision measurements
  - $|V_{us}|$, low energy QCD
  - LFV in tau decays
- treated here a selection of most relevant ones for strategy, due to time constraints

not in this presentation: topics I believe belong to other Physics topics

- processes where the tau is a decay product
  - $e^+e^- \to Z \to \tau^+\tau^-$ (EW precision measurements)
  - $H, Z \to \tau^+\tau^-$ (EW)
  - $H, Z \to \mu^+\tau^-$ (LFV)
  - $W^- \to \tau^-\bar{\nu}_\tau$ (EW)
  - $B \to D^{(*)}\tau\nu$ (Heavy Flavour anomalies)
  - heavy flavour hadrons decays with LFV and that involve also tau leptons

Main “strategic” tau Physics topics (personal selection)

Searches for Lepton Flavour Violation in tau decays

- clean & effective search for “natural” NP processes extremely suppressed in SMν
- upper limits are effective constraints on NP models

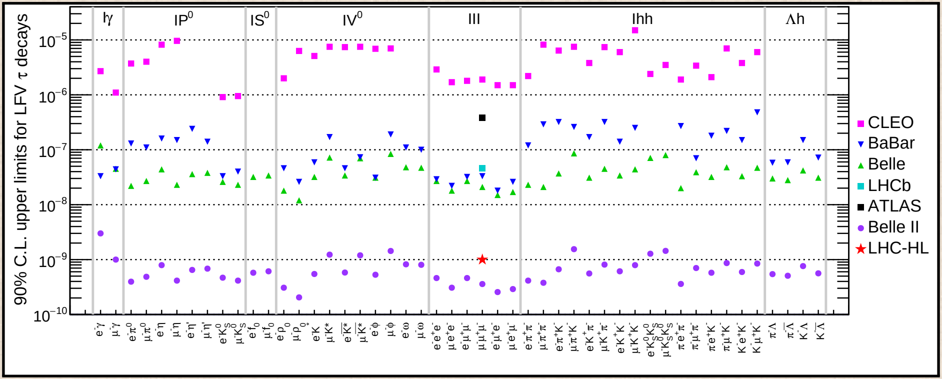
Lepton Universality tests

- EW precision tests
- effective constraints on NP models

$|V_{us}|$, $\alpha_s(m_\tau)$, low energy QCD

- $|V_{us}|$ measurement alternative to kaons and without lattice QCD inputs
- measure $\alpha_s(m_\tau)$ and test running of α_s from m_τ to m_Z
- alternative measurement of HVP contribution to muon $g-2$
- other low-energy-QCD measurements (specialized and active theorists' community)
- in practice: measure hadronic BRs and spectral functions

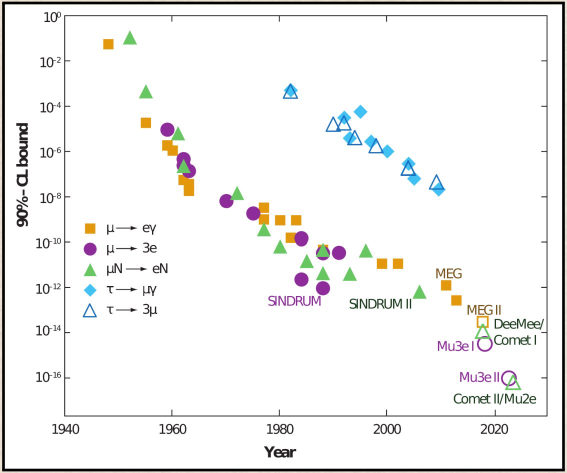
Tau LFV searches dominated by *B*-factories



HL-LHC and HE-LHC opportunities, arXiv:1812.07638 [hep-ph]

B factories expected to be the most powerful and versatile tool for tau LFV (but see later for more complete information on tau LFV prospects)

Tau/Muon LFV searches over time (and Muon LFV prospects)

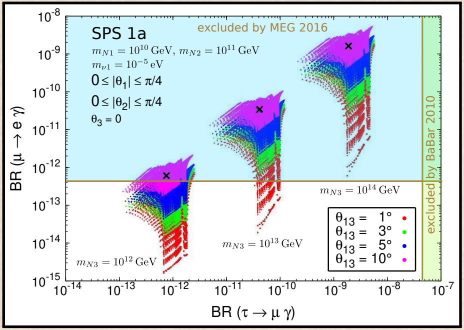


A. Signer, Tau 2018

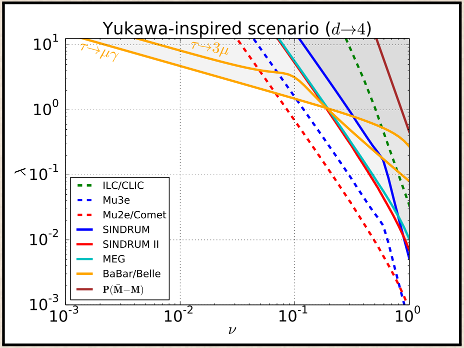
remarkable progress expected in near future on Muon LFV searches

Tau LFV searches probe & constrain New Physics models

MSSM Seesaw
Antusch, Arganda, Herrero, Teixeira 2006



doubly charged scalar
Crivellin, Ghezzi, Panizzi, Pruna, Signer 2019



typical NP models

- $\mathcal{B}(\tau \to \mu\gamma) \sim 10\text{–}1000 \times \mathcal{B}(\mu \to e\gamma)$
- muon LFV searches more effective

specific models / parameter space regions

- tau LFV searches can be decisive

do not forget the second step: if LFV discovered on muons, studies on the many tau LFV modes are essential to investigate the underlying LFV mechanism and how it breaks down in μ vs. τ

Lepton universality tests (unofficial prelim. HFLAV)

$$\left(\frac{g_\tau}{g_\mu}\right) = \sqrt{\frac{\mathcal{B}_{\tau e}}{\mathcal{B}_{\mu e}} \frac{\tau_\mu m_\mu^5 f_{\mu e} R_\gamma^\mu R_W^\mu}{\tau_\tau m_\tau^5 f_{\tau e} R_\gamma^\tau R_W^\tau}} = 1.0010 \pm 0.0014 = \sqrt{\frac{\mathcal{B}_{\tau e}}{\mathcal{B}_{\tau e}^{\text{SM}}}}$$

$$\left(\frac{g_\tau}{g_e}\right) = \sqrt{\frac{\mathcal{B}_{\tau \mu}}{\mathcal{B}_{\mu e}} \frac{\tau_\mu m_\mu^5 f_{\mu e} R_\gamma^\mu R_W^\mu}{\tau_\tau m_\tau^5 f_{\tau \mu} R_\gamma^\tau R_W^\tau}} = 1.0029 \pm 0.0014 = \sqrt{\frac{\mathcal{B}_{\tau \mu}}{\mathcal{B}_{\tau \mu}^{\text{SM}}}}$$

$$\left(\frac{g_\mu}{g_e}\right) = \sqrt{\frac{\mathcal{B}_{\tau \mu}}{\mathcal{B}_{\tau e}} \frac{f_{\tau e}}{f_{\tau \mu}}} = 1.0018 \pm 0.0014$$

using Standard Model predictions for leptons λ, $\rho = e, \mu, \tau$ (Marciano 1988)

$$\Gamma[\lambda \to \nu_\lambda \rho \bar{\nu}_\rho(\gamma)] = \Gamma_{\lambda\rho} = \Gamma_\lambda \mathcal{B}_{\lambda\rho} = \frac{\mathcal{B}_{\lambda\rho}}{\tau_\lambda} = \frac{G_\lambda G_\rho m_\lambda^5}{192\pi^3} f\left(m_\rho^2/m_\lambda^2\right) R_W^\lambda R_\gamma^\lambda$$

$$G_\lambda = \frac{g_\lambda^2}{4\sqrt{2} M_W^2}\ ; \qquad f(x) = 1 - 8x + 8x^3 - x^4 - 12x^2 \ln x\ ; \qquad f_{\lambda\rho} = f\left(m_\rho^2/m_\lambda^2\right)$$

$$R_W^\lambda = 1 + \frac{3}{5}\frac{m_\lambda^2}{M_W^2} + \frac{9}{5}\frac{m_\rho^2}{M_W^2}\ ; \qquad R_\gamma^\lambda = 1 + \frac{\alpha(m_\lambda)}{2\pi}\left(\frac{25}{4} - \pi^2\right)\ ;$$

all statistics correlations included

Lepton universality tests with hadronic decays (unofficial prelim. HFLAV)

$$\left(\frac{g_\tau}{g_\mu}\right)_\pi = 0.9958 \pm 0.0026 \; , \qquad \left(\frac{g_\tau}{g_\mu}\right)_K = 0.9879 \pm 0.0063 \; .$$

Averaging the three g_τ/g_μ ratios:

$$\left(\frac{g_\tau}{g_\mu}\right)_{\tau+\pi+K} = 0.9999 \pm 0.0014 \; .$$

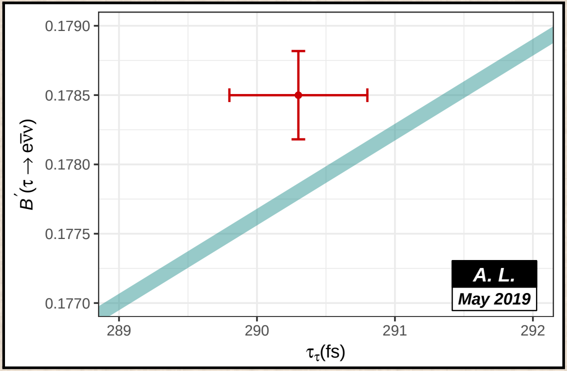
using Standard Model predictions

$$\left(\frac{g_\tau}{g_\mu}\right)^2 = \frac{\mathcal{B}(\tau \to h\nu_\tau)}{\mathcal{B}(h \to \mu\bar{\nu}_\mu)} \frac{2m_h m_\mu^2 \tau_h}{(1+\delta_h) m_\tau^3 \tau_\tau} \left(\frac{1 - m_\mu^2/m_h^2}{1 - m_h^2/m_\tau^2}\right)^2 \qquad (h = \pi \text{ or } K)$$

rad. corr. $\delta_\pi = (0.16 \pm 0.14)\%$, $\delta_K = (0.90 \pm 0.22)\%$ (Decker 1994)

note: electron tests less precise because $h \to e\nu$ decays are helicity-suppressed

Canonical tau lepton universality test plot (unofficial prelim. HFLAV)



$(g_\tau/g_{e\mu}) = 1.0020 \pm 0.0013$
$[g_{e\mu} = g_e = g_\mu$ assuming $g_e = g_\mu]$

$\Delta(g_\tau/g_{e\mu})$ contributions

input	Δinput	$\Delta(g_\tau/g_{e\mu})$
$\mathcal{B}'_{\tau\to e}$	0.178%	0.089%
τ_τ	0.172%	0.086%
m_τ	0.007%	0.017%
total		0.125%

best measurements

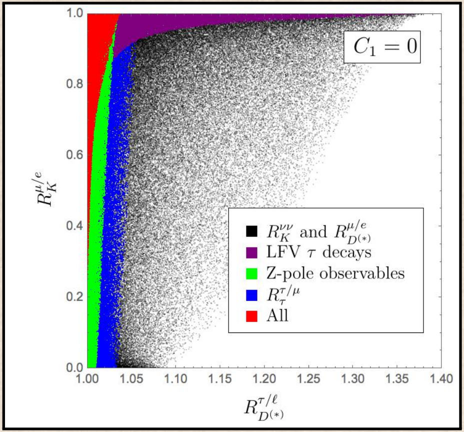
$\mathcal{B}'_{\tau\to e}$	ALEPH
τ_τ	Belle
m_τ	BES III

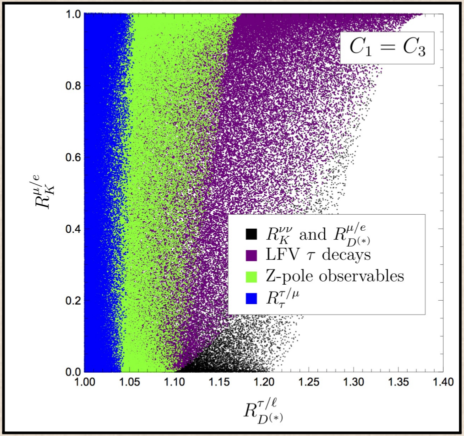
- $\mathcal{B}'(\tau \to e\bar{\nu}\nu)$ = average of $\begin{cases} \mathcal{B}(\tau \to e\bar{\nu}\nu) \\ \mathcal{B}(\tau \to \mu\bar{\nu}\nu)\cdot f_{\tau e}/f_{\tau\mu} \end{cases}$
- $\dfrac{\mathcal{B}'(\tau \to e\bar{\nu}\nu)\tau_\mu}{\mathcal{B}(\mu \to e\bar{\nu}\nu)\tau_\tau} = \dfrac{g_\tau^2}{g_{e\mu}^2}\,\dfrac{m_\tau^5 f_{\tau e} R_\gamma^\tau R_W^\tau}{m_\mu^5 f_{\mu e} R_\gamma^\mu R_W^\mu}$
- $\left(\dfrac{g_\tau}{g_{e\mu}}\right)^2 = \dfrac{\mathcal{B}'(\tau \to e\bar{\nu}\nu)}{\mathcal{B}(\mu \to e\bar{\nu}\nu)}\,\dfrac{\tau_\mu}{\tau_\tau}\,\dfrac{m_\mu^5}{m_\tau^5}\,\dfrac{f_{\mu e} R_\gamma^\mu R_W^\mu}{f_{\tau e} R_\gamma^\tau R_W^\tau}$

Lepton universality from tau constrains New Physics models

Feruglio, Paradisi, Pattori JHEP 09 (2017) 061:

tau lepton universality (blue points) severely bounds NP models for B $R^{\tau/\ell}_{D^{(*)}}$ - $R^{\mu/e}_{K}$ anomalies

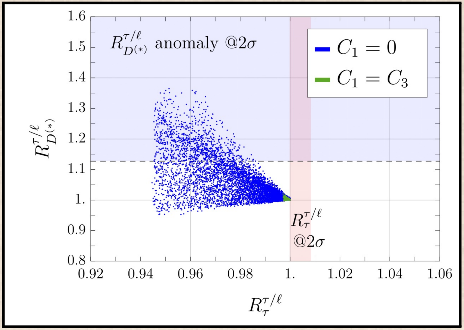




Lepton universality from tau constrains New Physics models

Feruglio, Paradisi, Pattori JHEP 09 (2017) 061:

blue points are NP model predictions for tau LU parameter and $R^{\tau/\ell}_{D^{(*)}}$



Lepton universality from tau: experimental measurements

- $\mathcal{B}_{\tau\to\ell\bar{\nu}\nu}$, $\mathcal{B}_{\tau\to h\nu}$
  - best experimental inputs: ALEPH, then other LEP experiments
  - what mattered and what matters to improve
    - e^+e^-, hermeticity, tau decays statistics, PID systematics
    - e^+e^- at Z peak much more effective if statistics is the same
- τ_τ
  - best experimental inputs: Belle, then LEP experiments
  - what mattered and what matters to improve
    - e^+e^-, hermeticity, tau decays statistics, vertex detectors
    - e^+e^- at Z peak more effective if statistics is the same
- m_τ
  - best experimental inputs: BES III then KEDR i.e. e^+e^- at $\tau^+\tau^-$ threshold, then B-factories
  - what mattered and what matters to improve
    - e^+e^- at tau production threshold
    - e^+e^- at higher energies contribute, but with higher systematics

"$\tau \to X_s \nu$ inclusive" $|V_{us}|$ determination

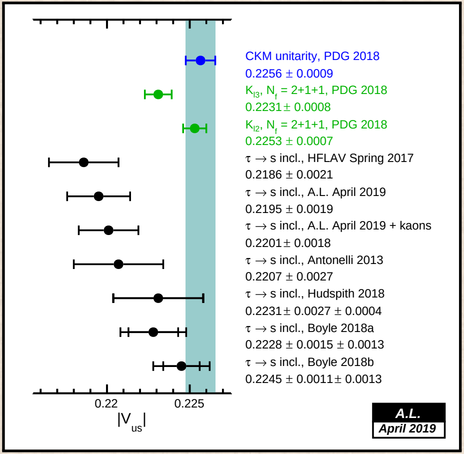
$$|V_{us}|_{\tau s} = \sqrt{R_s / \left[\frac{R_{VA}}{|V_{ud}|^2} - \delta R_{\text{theory}} \right]} \;, \text{ where}$$

$$\begin{cases} R_s = \mathcal{B}(\tau \to X_s \nu)/\mathcal{B}(\tau \to e\bar{\nu}\nu) \\ R_{VA} = \mathcal{B}(\tau \to X_d \nu)/\mathcal{B}(\tau \to e\bar{\nu}\nu) \\ \delta R_{\text{theory}} = SU(3)\text{-breaking correction} \end{cases}$$

Gamiz, Jamin, Pich, Prades, Schwab 2003/2005
does not require form factors from lattice QCD
unlike $|V_{us}|$ from kaons
$\Rightarrow$ independent theory systematics

- also alternative procedures used: use other inputs, tau spectral functions, lattice QCD techniques (also exploiting work done for the muon $g-2$ hadronic contribution)

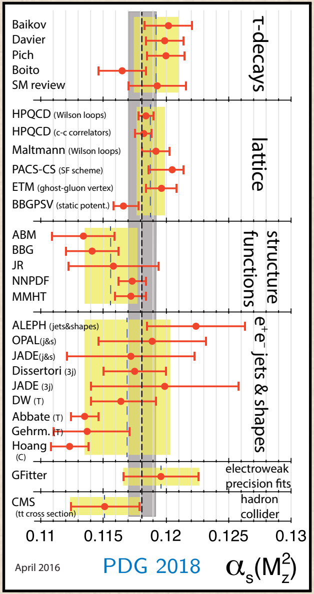
- precision limited by Cabibbo-suppressed tau BRs (improved by B-factories)
- large Cabibbo-favoured BRs best measured at LEP (ALEPH)



- comparison with CKM unitarity determination of $|V_{us}|$ is equivalent to testing the unitarity of the first row of the CKM matrix

α_s from tau decay measurements

- $\alpha_s(m_\tau)$ from
  - $R_{VA} = \mathcal{B}(\tau \to X_d \nu)/\mathcal{B}(\tau \to e\bar{\nu}\nu)$
  - tau spectral functions
- tau data competitive
- $\alpha_s(m_\tau)$ confirms running of α_s
- best experimental inputs e^+e^- facilities at the Z peak
  - modest experimental progress since LEP times
  - statistics, clean data, non-trivial analysis needed
  - non-trivial exp. and theory systematics



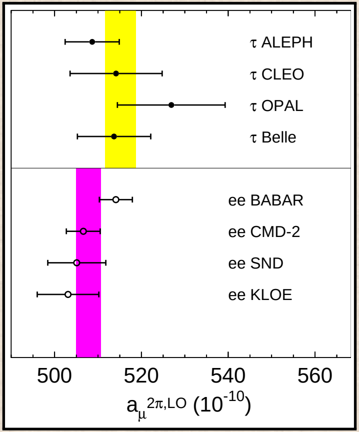
Recent discussions

- different groups get somewhat inconsistent results
  disagreements on non-pert. effects, duality violations
- Pich 2019
  Boito, Golterman, Maltman, Peris 2019
  Pich, Rojo, Sommer, Vairo 2018
  Boito, Golterman, Maltman, Peris 2017
  Pich, Rodríguez-Sánchez 2016
- additional data welcome

Muon $g-2$ hadronic contribution from tau

- $\alpha_\mu^{2\pi,\mathrm{LO}}$ from
  - $\tau \to \pi\pi^0\nu$ spectral function
  - normalization could come from $\mathcal{B}(\tau \to \pi\pi^0\nu)$, τ_τ
  - isospin rotation (associated theory systematics)
- best experimental inputs e^+e^- facilities at the Z peak
  - modest experimental progress since LEP times
  - statistics, clean data, non-trivial analysis needed
- tau data $\Rightarrow$ reduced discrepancy with exp.
- presently e^+e^- data more precise and complete

Davier 2013



Tau Physics plans of relevant facilities

Belle II

- The Belle II experiment at SuperKEKB: input to the European Particle Physics Strategy
- The Belle II Physics Book arXiv:1808.10567 [hep-ex]
- $50\,\text{ab}^{-1}$, improved detector w.r.t. Belle/BaBar, $50\times$ Belle statistics, $9 \cdot 10^{10}$ tau decays
- *B*-factories scored well on LFV, less well on precision measurements and spectral functions
- $\mathcal{B}(\tau \to \mu\gamma) < \sim 1 \cdot 10^{-9}$ 90% CL detailed study with BelleII sample, may be optimistic
- $\mathcal{B}(\tau \to 3\mu) < 3.3 \cdot 10^{-10}$ 90% CL extrap. from Belle assuming selection remains bkg-free
- similar improvements on many other tau LFV modes
- $\Delta m_\tau = \pm 0.10 - 0.15\,\text{MeV}$ "very optimistically" (BESIII $\pm 0.17\,\text{MeV}$)
- my personal statistics-only-driven estimate $\Delta\tau_\tau = 0.026\%$ (Belle 0.21%)
- improvements w.r.t. today WA expected on $\mathcal{B}(\tau \to \ell\bar{\nu}\nu)$ and τ_τ but non-trivial & non-assured
- significant improvements on Cabibbo-suppressed BRs and spectral functions, but non-trivial
- significant advances possible on many more measurements:
  Michel parameters, spectral functions, *CPV*, radiative decays, $g-2$, EDM...
- Belle III: luminosity upgrade of Belle II would advance the reach of the LFV searches

Tau Physics plans of relevant facilities

HL-LHC and HE-LHC

- inputs to the European Particle Physics Strategy
- Opportunities in Flavour Physics at the HL-LHC and HE-LHC, arXiv:1812.07638 [hep-ph]
- $\mathcal{B}(\tau \to 3\mu)$ 90% CL

Table 23: Actual and expected limits on BR($\tau \to 3\mu$) for different experiments and facilities. The ATLAS projections are given for the medium background scenario, see main text for further details.

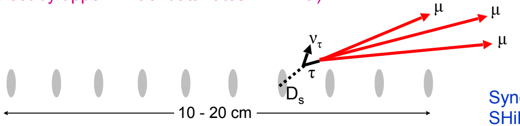
BR($\tau \to 3\mu$) (90% CL limit)	Ref.	Comments
3.8×10^{-7}	ATLAS [429]	Actual limit (Run 1)
4.6×10^{-8}	LHCb [428]	Actual limit (Run 1)
3.3×10^{-8}	BaBar [417]	Actual limit
2.1×10^{-8}	Belle [423]	Actual limit
3.7×10^{-9}	CMS HF-channel at HL-LHC	Expected limit (3000 fb^{-1})
6×10^{-9}	ATLAS W-channel at HL-LHC	Expected limit (3000 fb^{-1})
2.3×10^{-9}	ATLAS HF-channel at HL-LHC	Expected limit (3000 fb^{-1})
$\mathcal{O}(10^{-9})$	LHCb at HL-LHC	Expected limit (300 fb^{-1})
3.3×10^{-10}	Belle-II [196]	Expected limit (50 ab^{-1})
7.9×10^{-9}	LHCb	M.Chrząszcz priv.comm. (50 fb^{-1})

Tau Physics plans of relevant facilities

TauFV, project, SPS protons on fixed-targed, dedicated to tau LFV searches

- inputs to the European Particle Physics Strategy

Instead, design dedicated experiment upstream of SHiP, with thin, distributed targets, to bleed off ~2% of the beam intended for SHiP → 2 mm of tungsten (this value also set by upper limit of data rates in VELO).



Synergetic with SHiP operation !

- leverages on LHCb expertise, success and upgrade-related R&D, synergic with SHiP
- n. of tau decays: 900×BelleII, 60×LHCb(50 fb^{-1}), 10×LHCb(300 fb^{-1})
- target and detector optimized for tau LFV searches
- earliest date 2026-2027
- $\mathcal{B}(\tau \to 3\mu)$ 90% CL UL "down to 10^{-10}"
- also sensitive to other $\mathcal{B}(\tau \to \ell_1 \ell_2 \ell_3)$, one less order of magnitude for $e^+\mu^-\mu^-$
- promising enterprise, could match and improve on BelleII for $\mathcal{B}(\tau \to 3\mu)$

Tau Physics plans of relevant facilities

Super Charm-Tau Factories: SCT (BINP, Novosibirsk) and STCF/HIEPA (China)

- SCT/Russia inputs to the European Particle Physics Strategy
- STCF/China Haiping Peng, priv.comm., $\tau \to \mu\gamma$ study arXiv:1511.07228 [hep-ex]
- very similar projects, common description
- $E = 2{-}6$ or $2{-}7\,\text{GeV}$, $\mathcal{L} = 10^{35}\,\text{cm}^{-2}\text{s}^{-1}$, polarized e^- beam
- begin datataking 2029-2030
- max $\tau^+\tau^-$ cross-section at 4.25 GeV (3.5 nb), unknown how many years at that CM energy
  - I rescaled estimates to 2 years at 4.25 GeV (each year $2 \cdot 10^7$ s and $7 \cdot 10^9$ tau pairs)
- Δm_τ from ± 0.166 MeV (BESIII) to ± 0.012 MeV [10× better systematic uncertainty]
- $\mathcal{B}(\tau \to \mu\gamma) < 5 \cdot 10^{-9}$ 90% CL
  - extrapolated from $3\,\text{fb}^{-1}$assuming search bkg free (my understanding)
  - note that background is significantly less than at B-factories energies
- $\mathcal{B}(\tau \to 3\mu) < 3.5 \cdot 10^{-10}$ 90% CL   sensitive also to all other $\mathcal{B}(\tau \to \ell_1\ell_2\ell_3)$
- many LFV modes and other tau measurements possible, but little guiding past experience
  - both projects actively investigating/planning many tau Physics measurements

Tau Physics plans of relevant facilities

CEPC at the Z peak

- inputs to the European Particle Physics Strategy
- The CEPC Conceptual Design Report, Vol II: Physics and Detector, arXiv:1811.10545 [hep-ex]
- could be approved in 2022!
- $1 \cdot 10^{12}$ Z, $3 \cdot 10^{10}$ tau pairs (comparable to $4.5 \cdot 10^{10}$ of BelleII)
- expect tau LFV sensitivities similar to BelleII
  - but historic LEP LFV limits are much better than B-factories, for the same number of tau
- stat. uncertainties $\mathcal{O}(450)\times$ better than LEP $\Rightarrow$ must estimate reasonable limiting systematics
- expect $\Delta\mathcal{B}(\tau \to \ell\bar{\nu}\nu) \sim 0.02\%$ (by improving $10\times$ ALEPH systematics 0.2%)
- expect $\Delta\tau_\tau \sim 0.02\%$ (by improving $10\times$ w.r.t. Belle total uncertainty of 0.2%)
- significant advances possible on about all measurements and LFV limits
- Z peak offers by far best conditions for about all tau Physics measurements

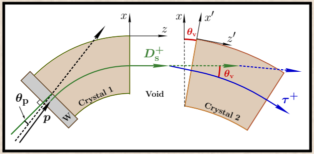
Tau Physics plans of relevant facilities

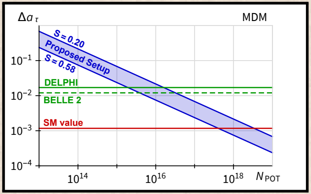
FCC-ee at the Z peak

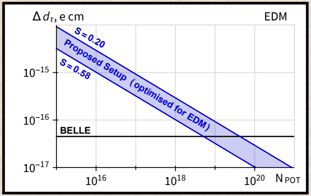
- inputs to the European Particle Physics Strategy
- Future Circular Collider, Vol. 1 : Physics opportunities (December 2018)
- Dam 2019 (Tau 2018 proc.)
- 8y preparation, 10y construction, 15y operation
- Z peak phase delivers $5 \cdot 10^{12}$ Zs, $15 \cdot 10^{10}$ tau pairs (BelleII $4.5 \cdot 10^{10}$)
- stat. uncertainties $\mathcal{O}(1000)\times$ better than LEP $\Rightarrow$ must estimate reasonable limiting systematics
- expect $\Delta\mathcal{B}(\tau \to \ell\bar{\nu}\nu) \sim 0.02\%$ (by improving 10× ALEPH systematics 0.2%)
- expect $\Delta\tau_\tau \sim 0.01\%$ (by improving 9× w.r.t. Belle detector alignment systematics of 0.1%)
- expect $\Delta m_\tau \sim 0.07\,\text{MeV}$ (by calibrating on m_{D^+}, PDG 2018 WA $\pm 0.12\,\text{MeV}$)
- $\mathcal{B}(\tau \to \mu\gamma) < 2 \cdot 10^{-9}$ 90% CL Monte Carlo study on 2% of full FCC-ee statistics
- $\mathcal{B}(\tau \to 3\mu) < [1{-}0.1] \cdot 10^{-10}$ 90% CL guestimate
- significant advances possible on about all measurements and LFV limits
- Z peak offers by far best conditions for about all tau Physics measurements

Digression on tau $g-2$ and EDM with bent crystals

Fomin, Korchin, Stocchi, Barsuk, Robbe 2018



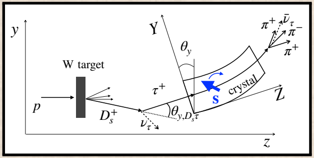


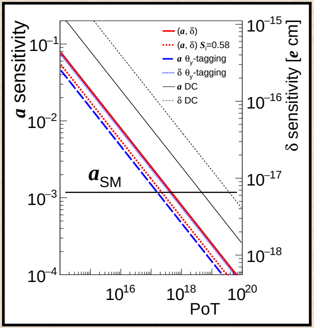


BelleII prospects on tau $g-2$ and EDM

- Chen, Wu 2018, simulation of just statistical errors
- $\Delta|d_\tau^{\mathbf{NP}}| = 2.04\cdot10^{-19}$ e cm, $\Delta|a_\tau^{\mathbf{NP}}| = 1.75\cdot10^{-5}$ (beware: here one actually measures NP pointlike contributions)

Fu, Giorgi, Henry, Marangotto, Martínez Vidal, Merli, Neri, Ruiz Vidal 2019





Additional notes

- best facilities for $\mathcal{B}(\tau \to \ell\bar{\nu}\nu)$ and τ_τ are best ones for most tau Physics, e.g.,
  - $|V_{us}|$ from tau, $\alpha_s(m_\tau)$, muon $g-2$ HVP and spectral functions
  - tau $g-2$ and EDM
  - *CPV* in tau decay and production
  - Michel parameters, radiative decays
- e^+e^- machines with hermetic detectors are best for most tau Physics
- tau decays at the Z peak offer much more favourable conditions than at lower energies

Additional notes on LFV searches

e^+e^- machines

- proven record
- OK for many tau LFV modes
- limited by accelerator luminosity

hadronic tau production

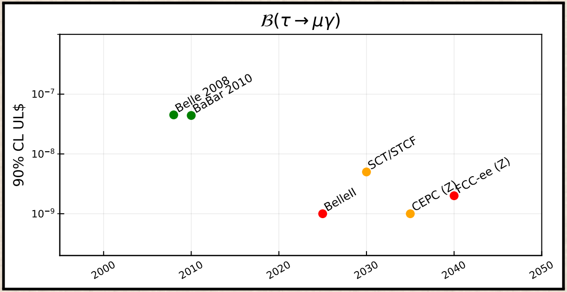
- can produce many more tau's
  but experimental conditions much worse
  and seems only competitive for $\tau \to 3\mu$
- limited by detector ingenuity
- optimized experiments like TauFV
  may match or do better than e^+e^-
  machines for $\tau \to 3\mu$

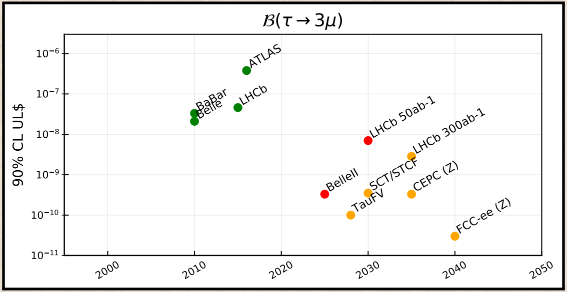
Some benchmarks

Introduction and cautions

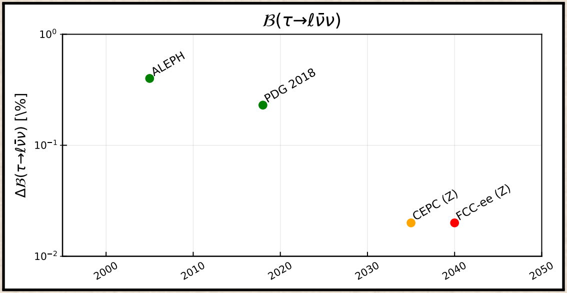
- in the next pages, future facilities are compared for their experimental reach
- Red is used when estimates of experimental sensitivity
  - are based on dedicated studies
  - similar past facilities have an extablished record of performance from which to extrapolate
- Orange is used when estimates of experimental sensitivity
  - have a less solid foundation
  - there are novel features for which it is difficult to extrapolate from past experience
- all estimates, including the ones in Red, are indicative
  - unfeasible to do studies close enough to the final analysis on simulated events
  - realization and operation of future, especially non-approved, projects is uncertain
  - extrapolations are not necessarily done in an equivalent way for different projects (I have tried to select and adapt the estimates to be comparable, but I almost always opted to report the original numbers)
- dates of estimated results are indicative and reflect my limited knowledge of future schedules
- benchmarks compare just an incomplete subset of features and are not an executive summary

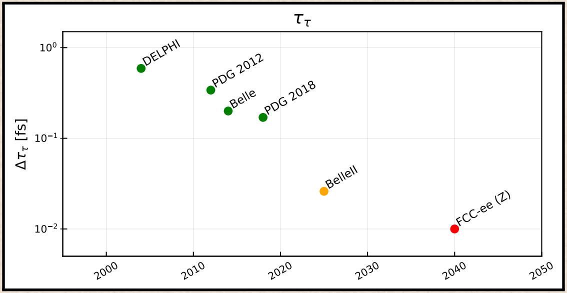
Benchmark of LFV searches $\tau \to \mu\gamma$, $\tau \to 3\mu$



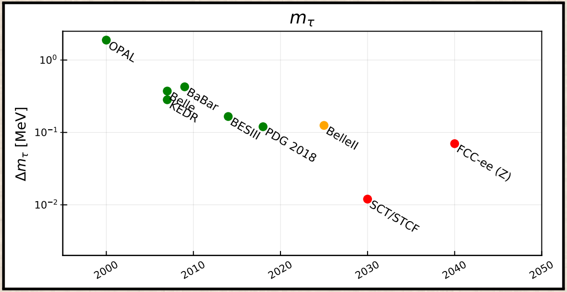


Benchmark of $\mathcal{B}(\tau \to \ell\bar{\nu}\nu)$ and τ_τ





Benchmark of m_τ



Conclusions

- BelleII will
  - effectively search for LFV tau decays
  - do precision tau Physics
    - on statistically-limited measurements
    - on other measurements if dedicated efforts will reduce typical B-factory systematics
- TauFV may match or even improve the search for $\tau \to 3\mu$ in the near future
  - other hadron facilities can search for $\tau \to 3\mu$ but quite less effectively
- SCT and STCF are essential to improve the precision on m_τ
  - may be very good on tau LFV searches and precision tau Physics, despite lack of past track record, sensitivity studies are progressing and encouraging
- CEPC and FCC-ee at the Z peak are best facilities for about all aspects of tau Physics

Which future facility is scientifically the best one for your flavour topic?

FCC-ee with $5 \cdot 10^{12}\, Z$'s is the best for tau Physics

Thanks for your attention!