Tau Physics Summary

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SuperB Workshop VI

New Physics at the Super Flavour Factory SuperB

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Outline

♦ progress during the workshop

♦ physics reach of SuperB golden channels

♦ plans

Tau physics topics overview

LFV Decays

♦ safe conservative SuperB reach estimate

♦ how to estimate improvements

♦ improvements we have considered

CPV in tau decay

♦ no progress w.r.t. CDR

♦ needs tau spin effects simulation

Tau EDM

♦ more interesting than assumed in CDR

♦ needs tau spin effects simulation

Charged Current Universality Measurements

♦ no planned work (syst. limitations)

CPT test on tau lifetime

♦ no progress w.r.t. Tuesday

♦ 2nd priority vs. golden channels

CPT test on tau mass

♦ no planned work (syst. limitations)

Tau g-2

♦ exp. UL estimate: arXiv:0707.2496 [hep-ph]

♦ interesting - not mentioned in CDR

♦ needs tau spin effects simulation

LFV decays: $\tau \to \mu\gamma$

S.Banerjee presentation

♦ work to improve selection for *BABAR* analysis (not yet ready)

♦ cannot disclose details until the analysis is submitted (before summer?)

♦ no new information yet w.r.t. CDR

Conservative estimate

♦ start from last published B-Factories paper (*BABAR*, $232\,\text{fb}^{-1}$)

♦ $UL_{\text{EXP}}^{90} = \dfrac{\max(2.4,\, 1.6\,\sqrt{N_{\text{BGK}}})}{2 \cdot \mathcal{L} \cdot \sigma(e^+e^- \to \tau^+\tau^-) \cdot \epsilon}$ $N_{\text{BGK}} = 6.2 \cdot (\mathcal{L}/232\,\text{fb}^{-1})$ $\epsilon = 7.42\%$

♦ $\mathcal{L} = 75\,\text{ab}^{-1} \longrightarrow UL_{\text{EXP}}^{90} = 7{\cdot}10^{-9}$

♦ in order to get to $UL_{\text{EXP}}^{90} = 2{\cdot}10^{-9}$ (CDR):

  ▶ either suppress BKG ×12 at constant signal efficiency

  ▶ or increase efficiency ×3.5 at constant BKG

  ▶ or increase efficiency & BKG ×12

  ▶ no proof yet the above can be done

LFV decays: $\tau \rightarrow \mu\gamma$

Improvements that were considered

♦ kinematic $\mu\mu\gamma$ rejection: not yet conclusive

♦ *BABAR* analysys re-optimization, NN: in progress, not ready

♦ SuperB lower asymmetry, better geom. coverage: estimate *UL* better by 5%

♦ smaller beam-pipe, more precise d_0 reconstruction: to be investigated

♦ tau polarization from polarized beams

▶ (must assume how LFV interaction produces μ, γ momenta w.r.t. tau polarization)

▶ several useful discussions (Swagato, Marcello, Oscar, Tony, ...)

▶ progress done towards simulation with KK & Tauola

♦ veto muons in tag-side (minimal improvement)

♦ remove muon ID to increase efficiency (more work needed)

LFV decays: $\tau \to 3\ell$, $\tau \to \ell hh, \ell P^0, \ell V^0$

J.Portoles, $\tau \to \ell hh, \ell P^0, \ell V^0$ in constrained MSSM

- ◆ interesting talk (work by J.P, M.Herrero & E.Arganda) and interesting discussions

- ◆ predictions up to 10^{-7} for $\tau \to \mu\rho$, $\tau \to \mu\pi^+\pi^-$

- ◆ if in same model $\tau \to \mu\gamma$ is comparable, should promote the other one to golden channel

Plans

- ◆ will revise CDR limits with more conservative ones based on latest publications

- ◆ will investigate/ document how and how much ve can improve with SuperB

- ◆ aim at getting BF predictions at Snowmass points

T/CP-odd observables in tau decay in CDR

♦ no progress in these days

♦ work on tau spin effects simulation continues

♦ estimate experimental reach on simulated events or toy MC

Tau EDM

♦ intesting discussions with P.Bernabeu and O.Vives

♦ even in MSSM models, the tau EMD may increase better than $\propto m_\tau / m_e$

♦ there are models with $\propto m_\tau^3 / m_e^3$ dependence that may have tau EDM within SuperB reach

Tau (g-2)

♦ assuming SUSY explains $(g-2)_\mu$ exp. vs. theory discrepancy

➡ $\Delta_{\mathsf{SUSY}}[(g-2)_\tau] = m_\tau^2 / m_\mu^2 \cdot \Delta_{\mathsf{SUSY}}[(g-2)_\mu] \approx 1\%(g-2)_\tau$ (P.Paradisi, private comm.)

♦ from J.Bernabeu et al. paper

arXiv:0707.2496v1 [hep-ph] Tau anomalous magnetic moment form factor at Super B/Flavor factories

➡ SuperB resolution is comparable to $\Delta_{\mathsf{SUSY}}[(g-2)_\tau]$

♦ presentation by P.Bernabeu, and fruitful discussions

♦ A.Cervelli presentation on work in progress to study possible exp. systematic limitations.

♦ measurement can profit from beam polarization (simulation needed)

$$H \rightarrow \tau^+\tau^-$$

♦ interesting presentation by Miguel Angel Sanchis Lozano

♦ useful discussions on how to derive Higgs parity from tau spin measurement through tau decay

♦ also here need tau spin effects simulation

Plans

♦ simulate beam polarization and tau spin effects

♦ $\tau \to \mu\gamma$

  ▶ simulate / estimate use of beam polarization effects for selection

  ▶ continue exploring UL sensitivity improvements with SuperB

♦ understand if other cleaner channels could overperform $\tau \to \mu\gamma$ at SuperB

♦ study systematic errors on tau EDM, g-2

  ▶ g-2: continue study on tau angular distribution

  ▶ study other proposed measurement methods

♦ estimate SuperB resolution on CPV in tau decay

♦ collaborate with Matteo (Tools) to define realistic requirements on tools, esp. simulation