Tau physics summary

A.Lusiani – Pisa

Super*B* Workshop IX – Perugia, June 16-20, 2009

Outline

- summary of Super*B* Physics Workshop – Warwick, 14th-17th April 2009
- progress since then

Warwick Workshop

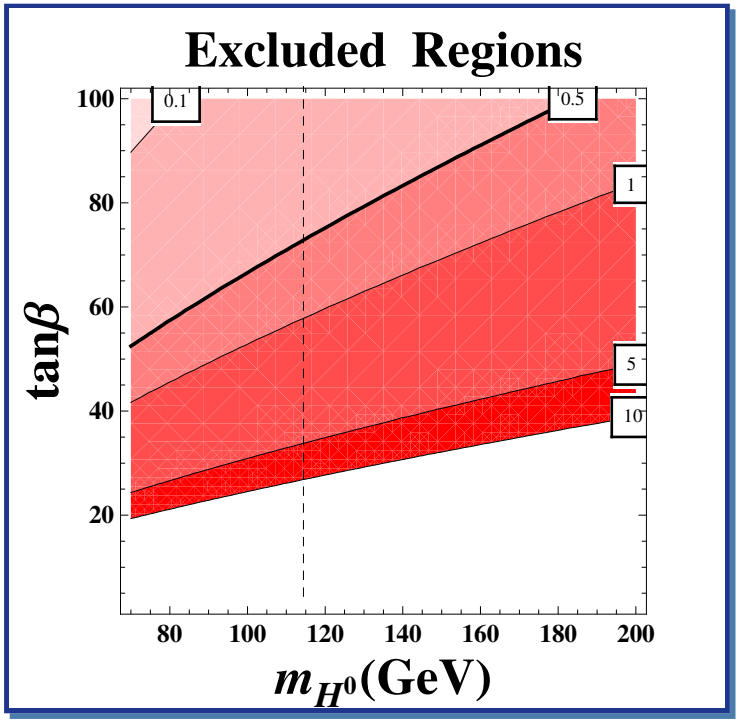
- www: http://www2.warwick.ac.uk/fac/sci/physics/research/epp/meetings/superb2009/
- agenda: http://agenda.infn.it/conferenceDisplay.py?confId=1118
- theory (phenomenology) talks
  - Ana María Rodríguez Sánchez, LFV in tau -> l f0(980) in constrained MSSM
  - Oscar Vives, Flavour and CP in general MSSM: implications for tau physics
  - P. Paradisi, Tau LFV in SUSY see-saw models and SUSY GUTs
  - Gabriel Gonzalez-Sprinberg, Tau EDM and g-2 observables for tau pairs produced with polarized beams
  - Björn Duling, LHT model presentation with predictions for tau LFV decays
  - Oscar Vives, SUSY CP phases at colliders (summary on behalf of the Bartl group)
- 1 experimental talk (A.L.) reporting progress and plans for sensitivity studies and tools
- useful interaction with FastSim developments (tau events generation, LFV backgrounds)

LFV in tau -> l f0(980) in constrained MSSM

by Ana María Rodríguez Sánchez

- new study w.r.t. Valencia report, **arXiv:0903.5151 [hep-ph]** (M.Herrero group)
- LFV semi-hadronic tau decays are good exp. probe for NUHM models

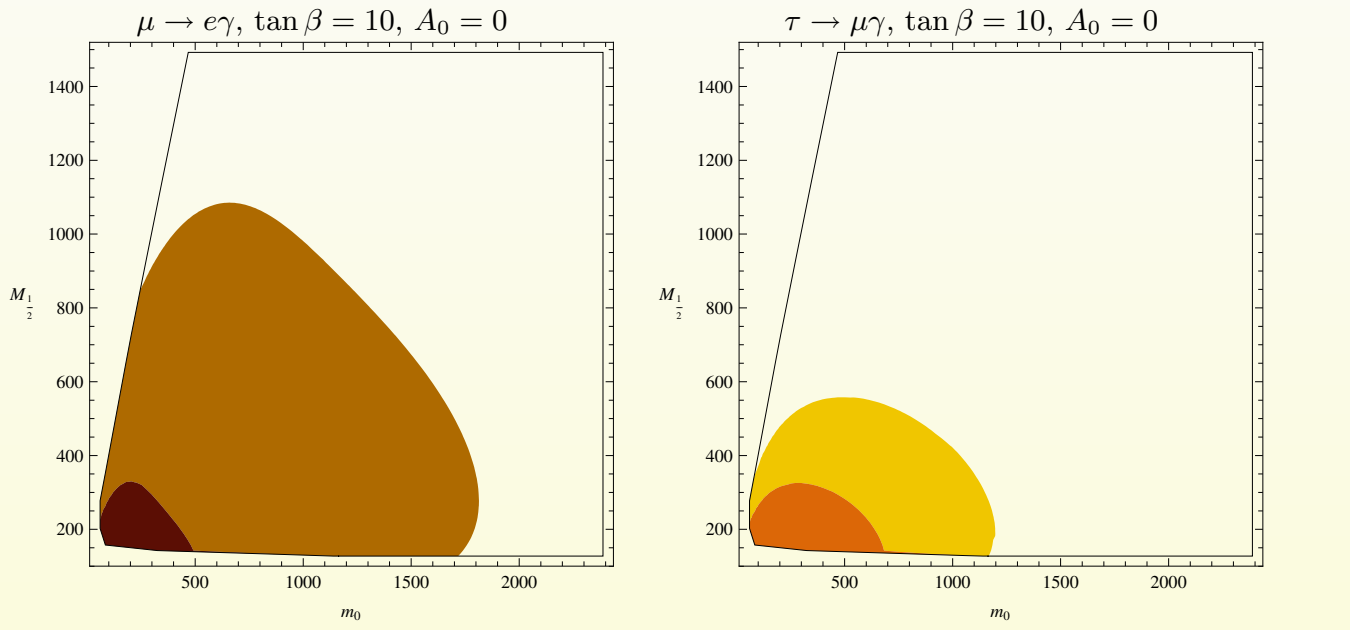
  (already stressed in Valencia report)



constraints from the present Belle limit,
for several δ_{23} values
("natural" value of δ_{23} is 1)

Oscar Vives, Flavour and CP in general MSSM: implications for tau physics

- follows on previous studies like e.g. arXiv:0710.3705v1 [hep-ph]
- theory model for prediction of Yukawa couplings (hadron and lepton masses and mixing)
  → related to SUSY symmetry breaking
- if such relation exists → correlation between LFV in $\mu \to e\gamma$ and $\tau \to \mu\gamma$



Brown (clear): Present (fut.) $\mu \to e\gamma$ bounds, Orange: Present (fut.) $\tau \to \mu\gamma$ bounds.

G.Gonzalez-Sprinberg, Tau EDM and g-2 observables for tau pairs produced with polarized beams

3. Conclusions

EDM

- Linear polarization and correlation CP-odd observables at super B factories can lower the Tau-EDM bound by 2-3 orders of magnitude.
- Tau-EDM bounds may become competitive with other EDM bounds for "mass dependent" models.
- Polarized beam observables have the best sensitivity and are independent from other low and high energy observables already investigated.

36 Tau EDM and g-2 at Super B Factories with polarized beams

G.Gonzalez-Sprinberg, Tau EDM and g-2 observables for tau pairs produced with polarized beams

3. Conclusions

MDM

- The Tau-MDM form factor can be *measured* for the first time in asymmetries at Super B factories.
- At least two SM/QED figures can be obtained.
- Both unpolarized and polarized beam observables allow to do so.
- Linear observables for MDM:
  real part polarization beam needed
  imaginary part unpolarized beam

Paride Paradisi, Tau LFV in SUSY see-saw models and SUSY GUTs

- overview SUSY predictions on tau LFV
- correlation between $g-2$ and tau LFV
- $\mu \to e\gamma$ has two amplitudes, A_{FB} in $\mu \to e\gamma$ is correlated with $\tau \to \mu\gamma$

SUSY CP phases at colliders, Oscar Vives for Bartl group

- SUSY introduces CP violation effects through complex couplings
- however, no effect appears to be detectable in Super*B* tau physics

LHT predictions vs. MSSM on tau LFV

- as known, LHT predicts different ratios of BR for different channels
  specifically $\tau \to 3\ell$ comparable or even larger that $\tau \to \ell\gamma$

Exp. Tau Physics summary, ongoing work and plans

tau LFV

- improve sensitivity studies
  - $\tau \to 3\ell$ preliminary results in Pisa
  - N.Neri (Pisa): Super*B* can use i.p. to select $\tau \to \mu\gamma$
  - a student of A.Bevan, Cedric, has started working
  - a student of D.Hitlin will also work in this topic
- exploit beam polarization
  - S.Banerjee has added two models of $\tau \to \mu\gamma$ production (SUSY production with full beam polarizazion and spin correlation)
  - R.Cenci (Pisa) started working in this topic

tau $g-2$, EDM (lower priority: manpower is quite limited)

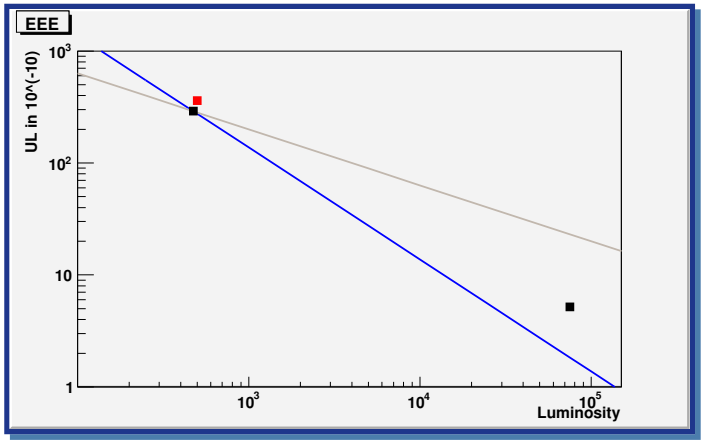
- improve $g-2$ sensitivity estimates, generator improvements

Exp. Tau Physics summary, ongoing work and plans, 2

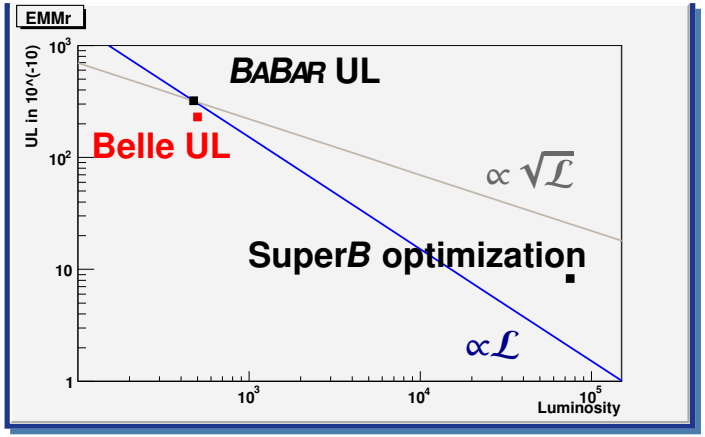
Tools

- tau generation in FastSim (A.L., PacTauUser, documentation)
  - lately M.Sokoloff fixed the simulation of decay in flight for tau events
  - will exploit FastSim facilities for bkg pre-selection to speed-up MC production

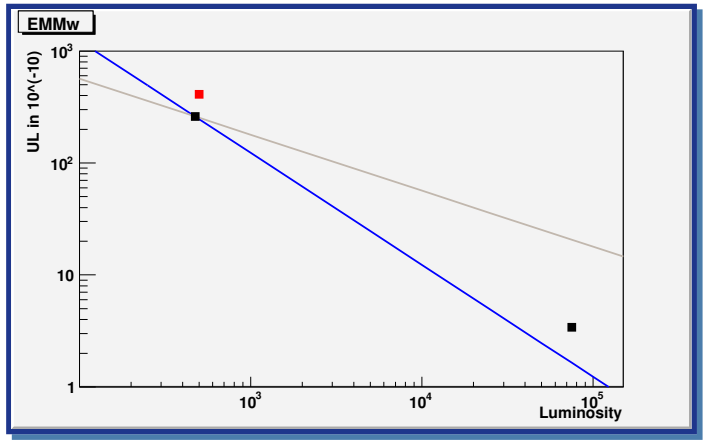
$\tau \to 3\ell$ optimization for Super*B*



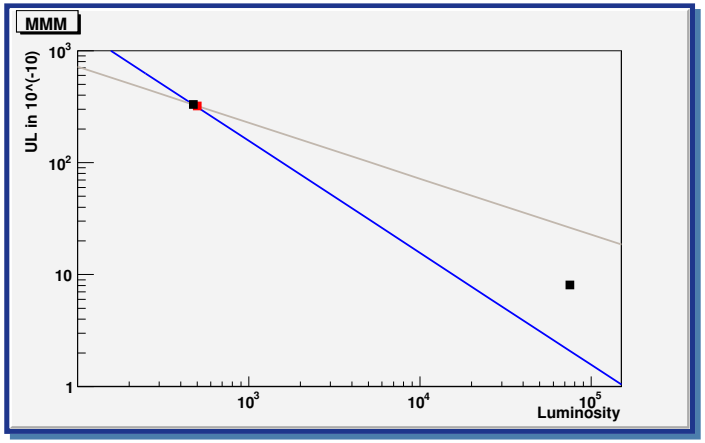
$\tau \to eee$



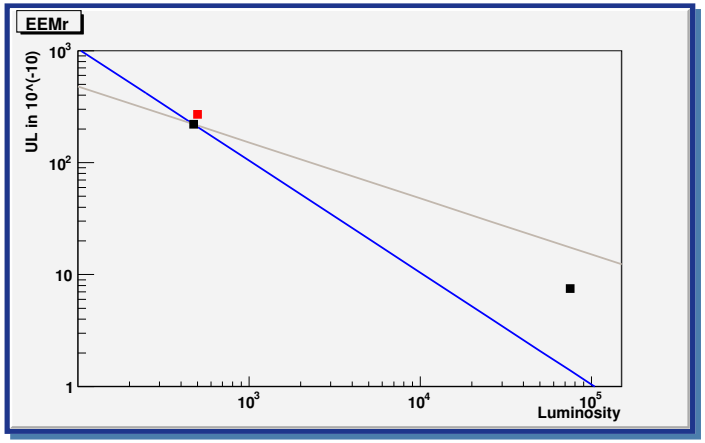
$\tau \to e\mu+\mu-$



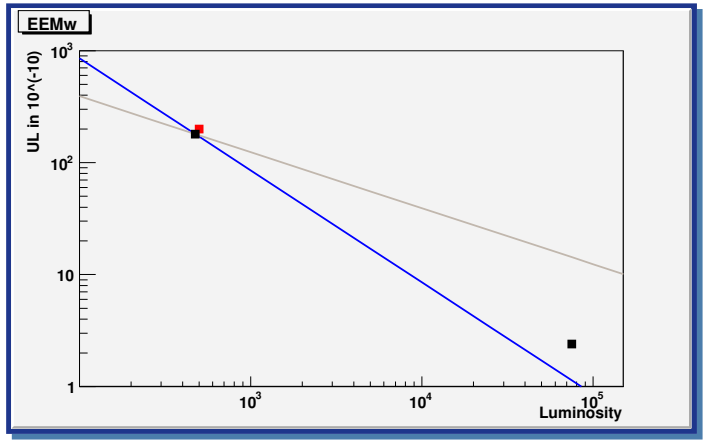
$\tau- \to e+\mu-\mu-$



$\tau \to \mu\mu\mu$



$\tau \to \mu e+e-$



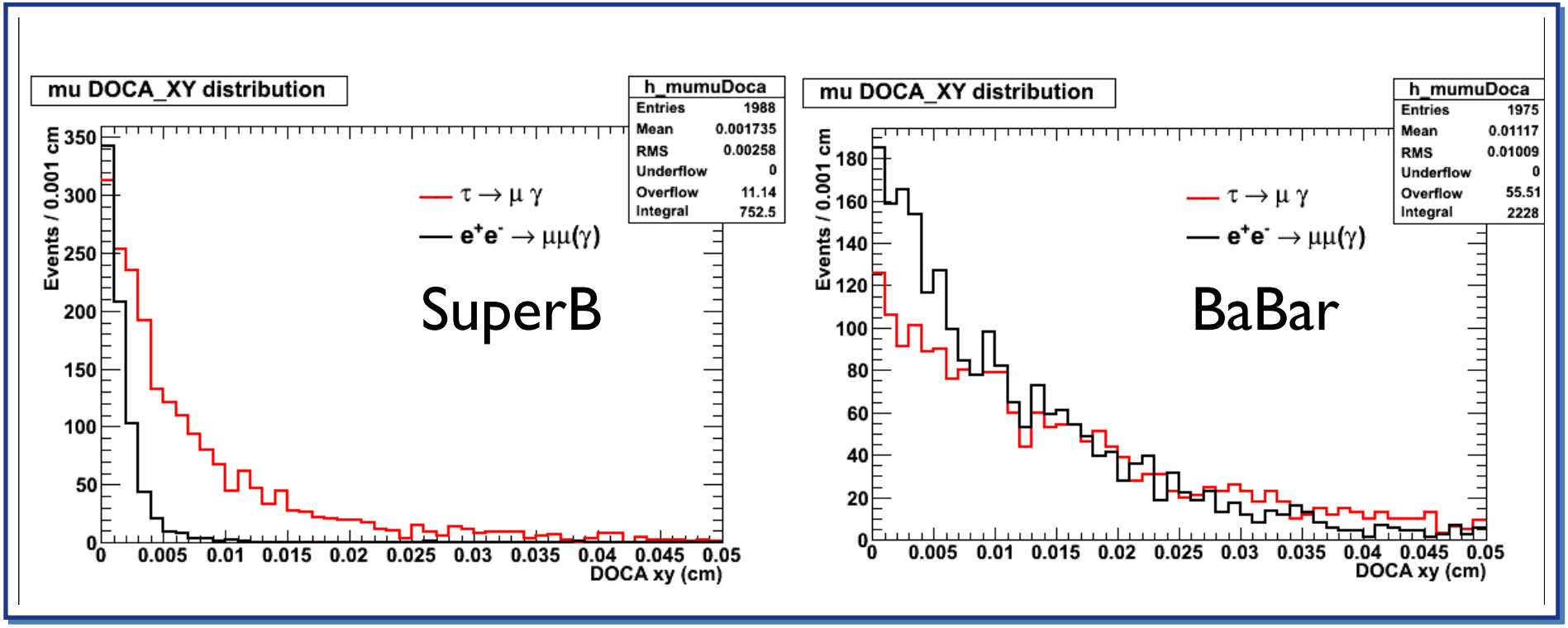
$\tau- \to \mu+e-e-$

Expected 90% CL upper limits for $\tau \to 3\ell$ at Super*B*@75 ab^{-1} (preliminary)

Channel	Efficiency (%)	exp.bkg	90% CL UL (10^{-10})
$e^+e^-e^+$	5.2 ± 0.5	1.7 ± 0.6	5.1
$e^+e^-\mu^+$	2.3 ± 0.2	0.16 ± 0.05	7.5
$e^+e^+\mu^-$	8.6 ± 0.9	0.3 ± 0.1	2.4
$\mu^+\mu^-e^+$	4.2 ± 0.4	3.8 ± 1.3	8.3
$\mu^+\mu^+e^-$	6.5 ± 0.6	0.8 ± 0.3	3.4
$\mu^+\mu^-\mu^+$	4.1 ± 0.4	3.3 ± 1.0	8.1

- to be compared with $2{\cdot}10^{-10}$ in the Valencia report

Select $\tau \to \mu\gamma$ w.r.t. $e^+e^- \to \mu^+\mu^-\gamma$ using the muon i.p. (N.Neri)



Recent progress on generators

- beam polarization effects on $\tau \to \mu\gamma$
  - LFV NP model dependent, ”standard” NP predicts factor $\left(1 \pm P_\tau \cos\theta_{\tau\mu}\right)$ (hep-ph/9604296)
  - *BABAR* simulated events have **P_τ-independent** $\tau \to \mu\gamma$ decay angular distributions
  - ”standard” NP dependence implemented in KK2f by S.Banerjee (as user option)
  - additional NP models P_τ dependencies can be implemented if desired
- preliminary investigations with Z.Was regarding tau EDM and $g-2$ simulation (A.L.)
  - the relevant code is (probably) present in KK2f, but needs validation to do

Status and Plans

- Valencia report still valid and confirmed
  - $\tau \to \mu\gamma$ remains the Super*B* tau golden channel
  - gained more information on physics reach of other observables
  - phenomenology studies confirm the importance of tau physics at Super*B*
- focus moving to Super*B* sensitivity studies and estimates of beam polarization benefits
  - **ongoing**, first prelim. results ready, progress will depend also on available manpower