Search for tau LFV with polarized beams

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Outline

- Introduction
- Data Sample Used & Models tested
- Longitudinal spin correlation results
- Future Plans and conclusions

Introduction

- BaBar selection focused on Kinematics for selection

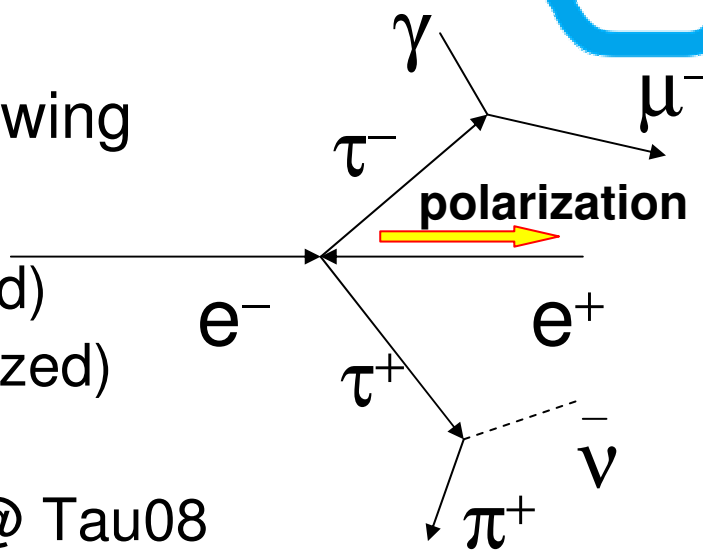
Decay modes	$< m_{EC} >$	$\sigma(m_{EC})$	$< \Delta E >$	$\sigma(\Delta E)$	2σ signal ellipse		ε	UL ($\times 10^{-8}$)	
	MeV/c^2	MeV/c^2	MeV	MeV	obs	exp	(%)	obs	exp
$\tau^{\pm} \to e^{\pm}\gamma$	1777.3	8.6	-21.4	42.1	0	1.6±0.4	3.9±0.3	3.3	9.8
$\tau^{\pm} \to \mu^{\pm}\gamma$	1777.4	8.3	-18.3	42.2	2	3.6±0.7	6.1±0.5	4.4	8.2

If scaled to SuperB 75 ab^{-1} O(100) events expected even if background reduced by factor 2 → L$^{1/2}$ scaling expected

- Polarization would give us access to dynamics as well with potential reduction of backgrounds to reasonable levels → UL scaling almost as Lumi

Data Sample

- Produced 500K events of the following
  - $\tau^- \rightarrow \mu^- \gamma$
    - BaBar-like spin matrix (polarized)
    - BaBar-like spin matrix (unpolarized)
    - $\pi^- \nu$–like spin correlation matrix
    - Spin matrix proposed by Was @ Tau08
  - $\tau^- \rightarrow \mu^- \nu\nu$
    - Polarized
    - Unpolarized

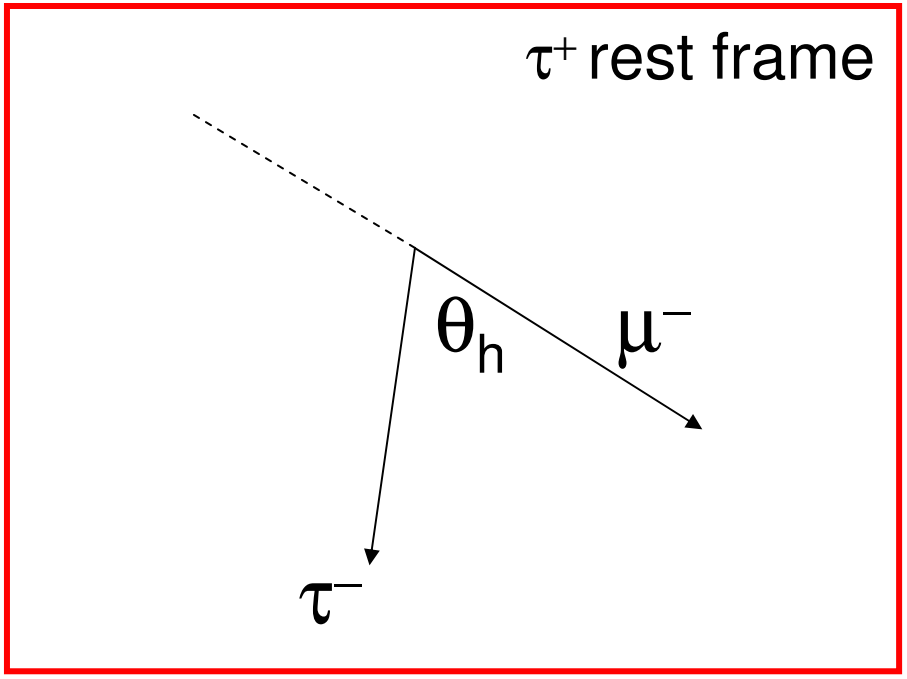


- All events were produced with Fast Sim 0.1.1, using Tauola+KK2f. All events had $\tau^+ \rightarrow \pi^+ \nu$ in the tag side

Longitudinal correlation

- The observable used to evaluate the spin correlation between the dcaying tau and its products is θ_h.
- All the analysis presented is made using MC truth values

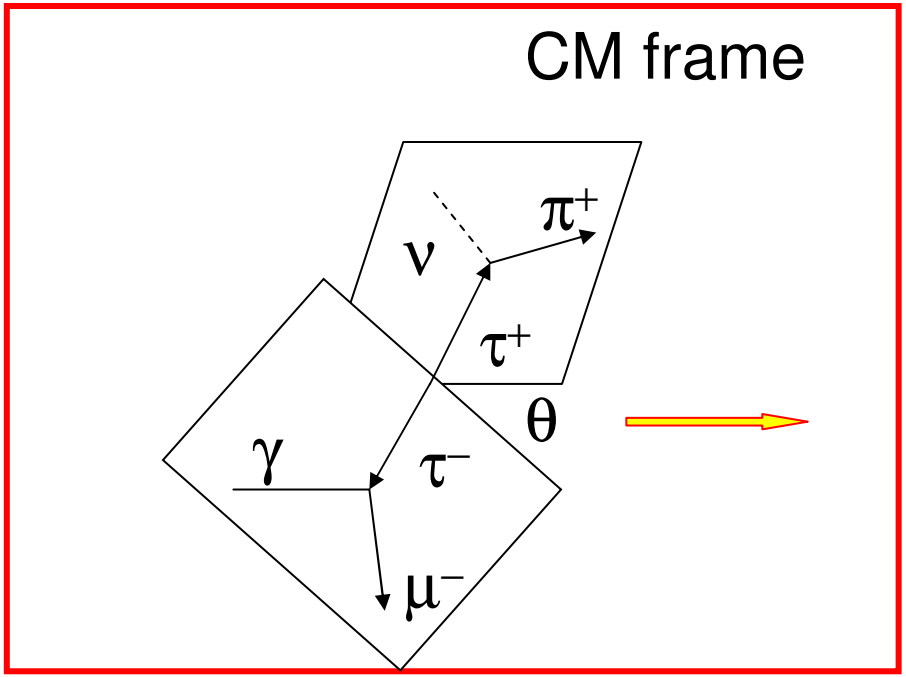
- τ produced along beam lines are longitudinnaly polarized
- Polarization has same direction and sign for the two τ's
- For LFV (V-A) models helicity angles for μ, π are positively correlated



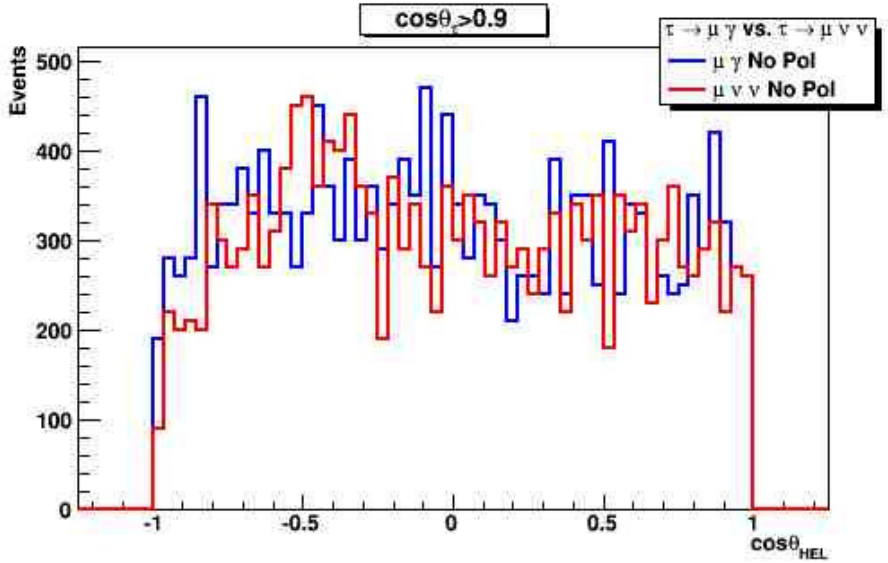
Transverse correlation

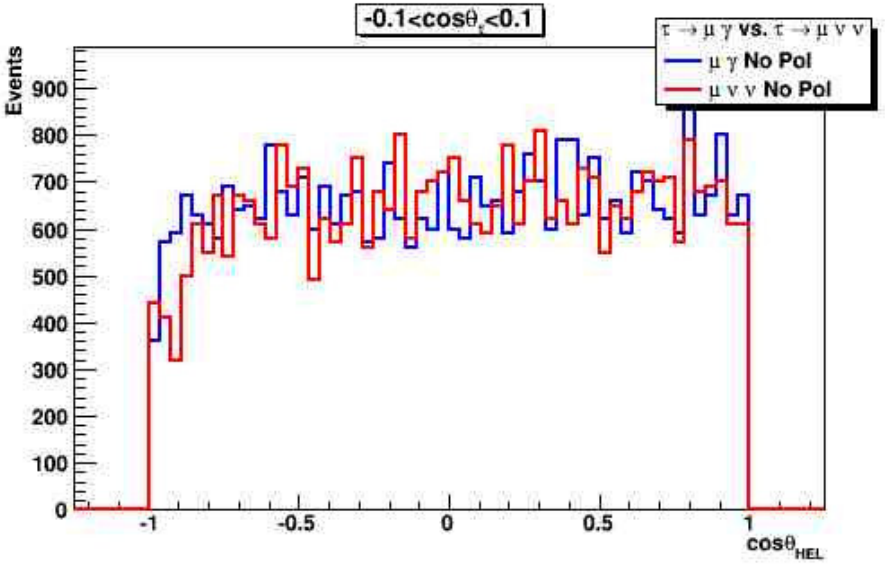
- When τ's are emitted at 90 degrees beam polarization can NOT be used to predict the τ spin direction

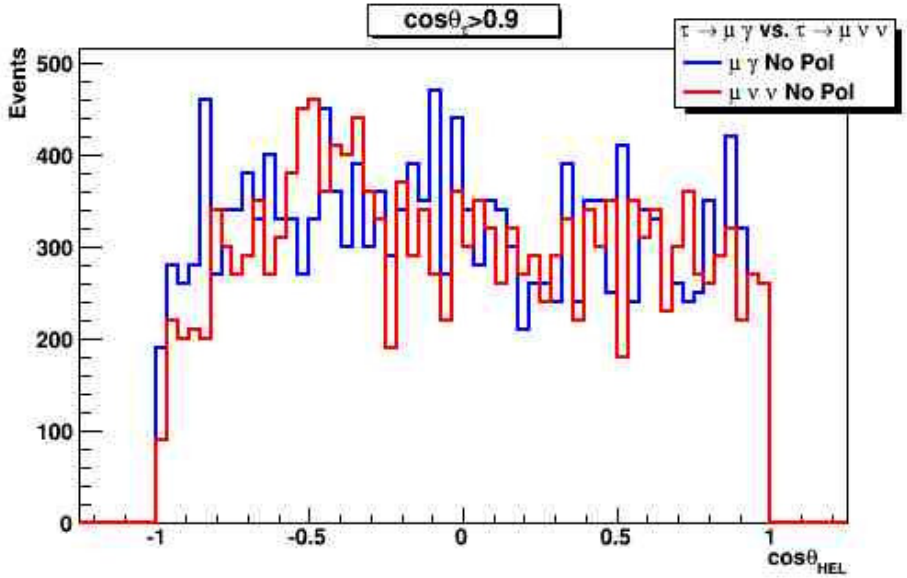
- Looking for other possible observables
- At this time no information on dynamics available
- Will investigate effects of transverse beam polarization
- Work ongoing



$\tau \rightarrow \mu\nu\nu$ decays Vs $\tau \rightarrow \mu\gamma$ (no Pol)



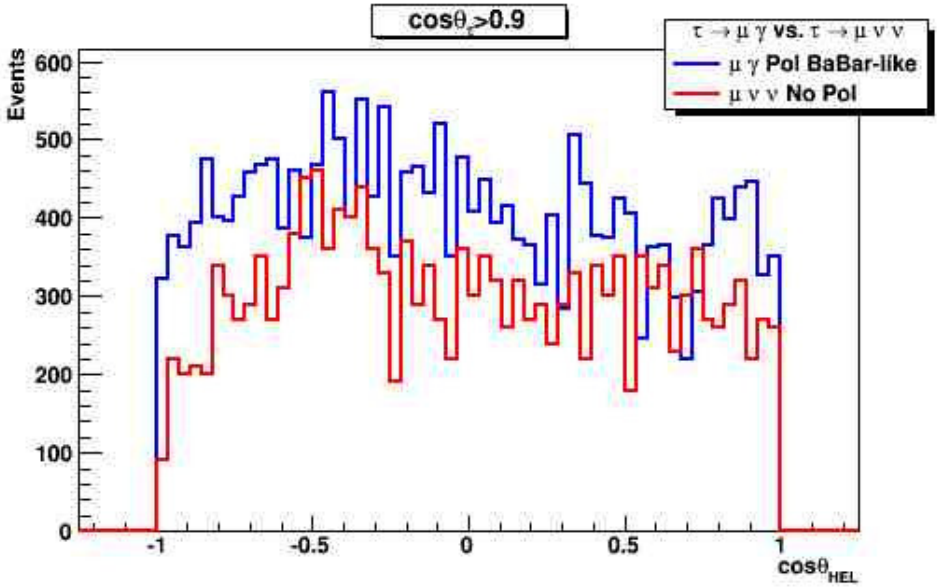


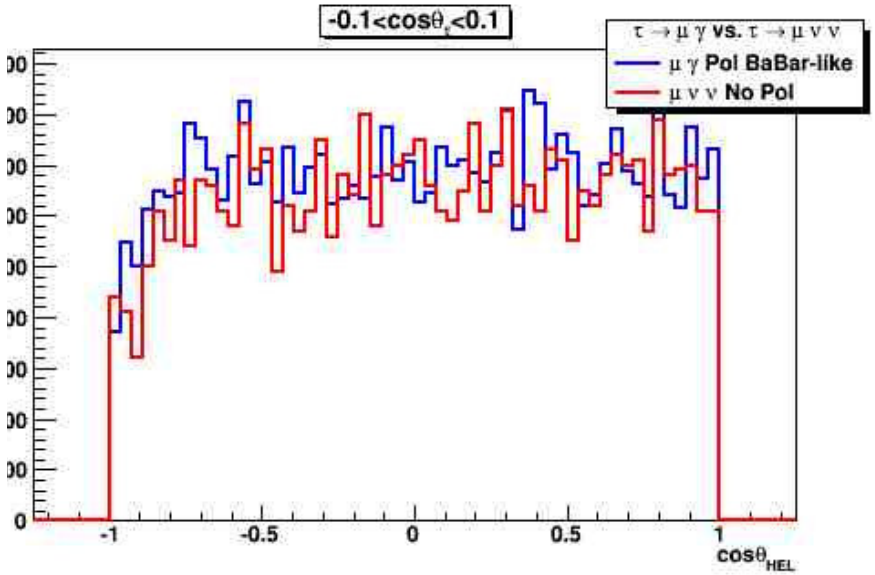


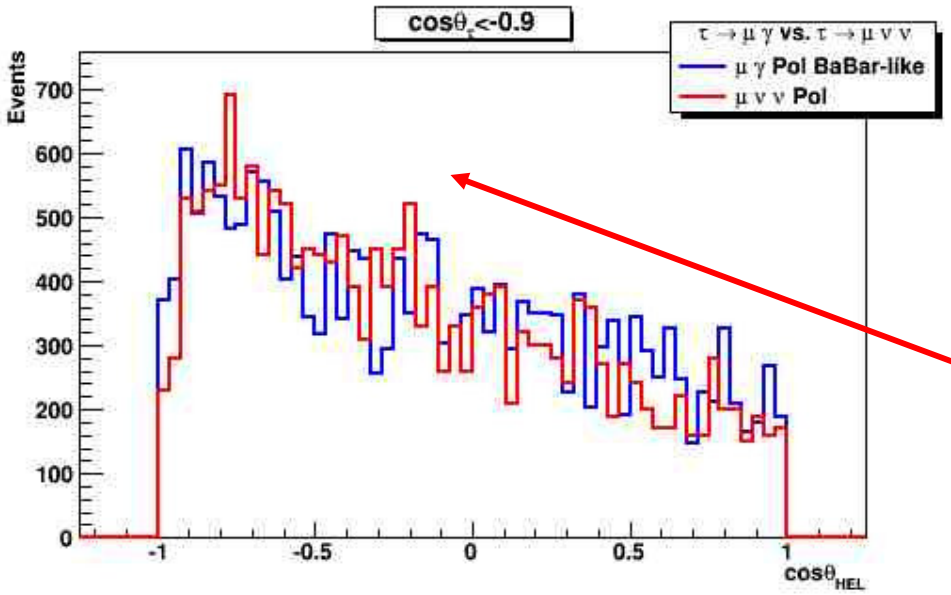
As expected when no polarization is present θ_h distribution is the same for signal and background distributions

No improvement wrt BaBar analysis

$\tau \rightarrow \mu\nu\nu$ decays Vs $\tau \rightarrow \mu\gamma$ (BaBar-like)



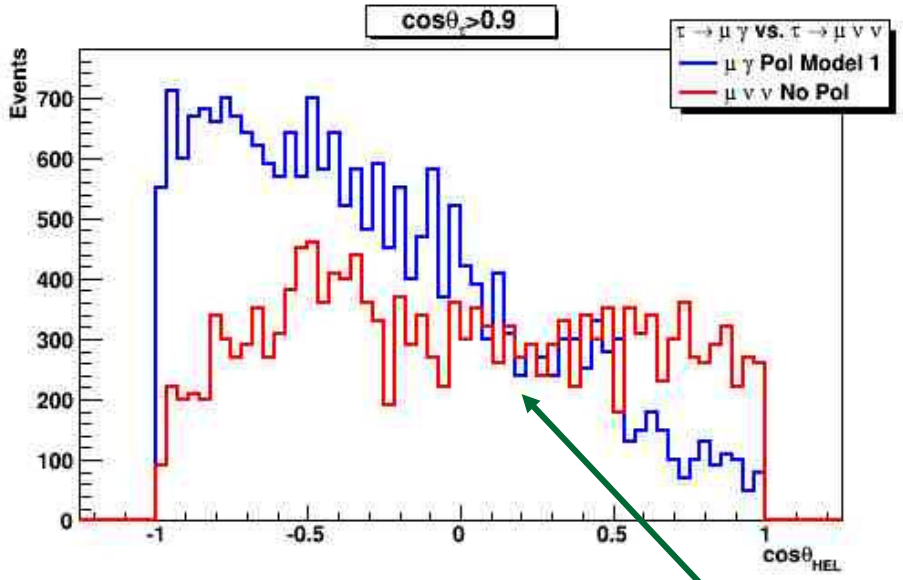


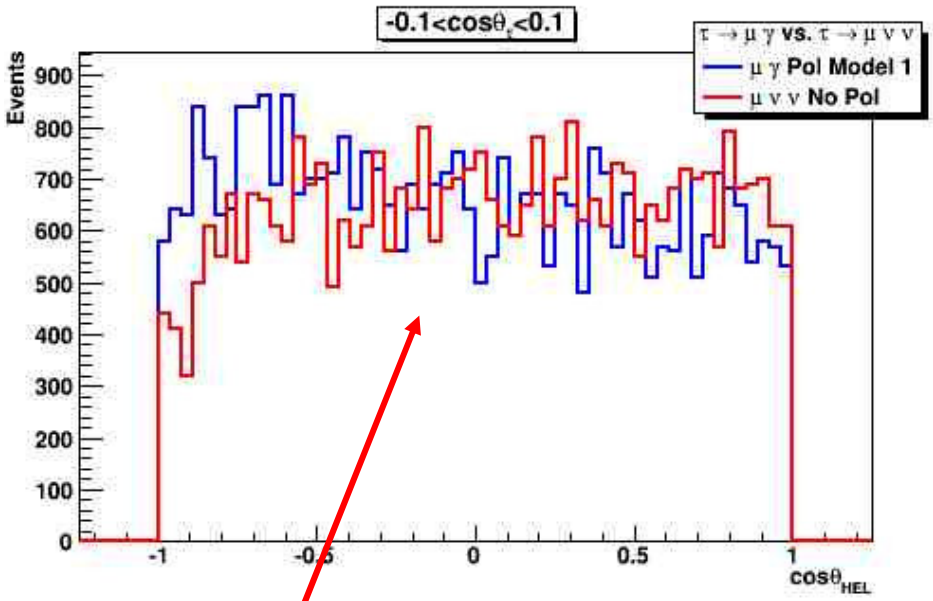


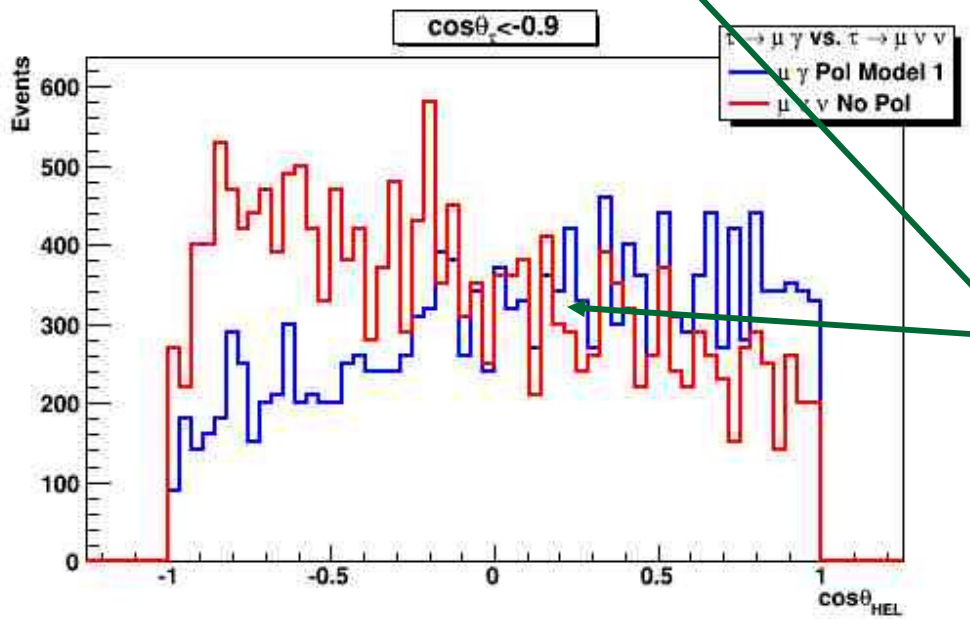
By-Product of this study: BaBar used a flat spin correlation matrix, no spin dynamics implemented in BaBar code

Taus going backwards show a small correlation even for $\tau \rightarrow \mu\nu\nu$

$\tau \rightarrow \mu\nu\nu$ decays Vs $\tau \rightarrow \mu\gamma$ ($\pi\nu$-like)



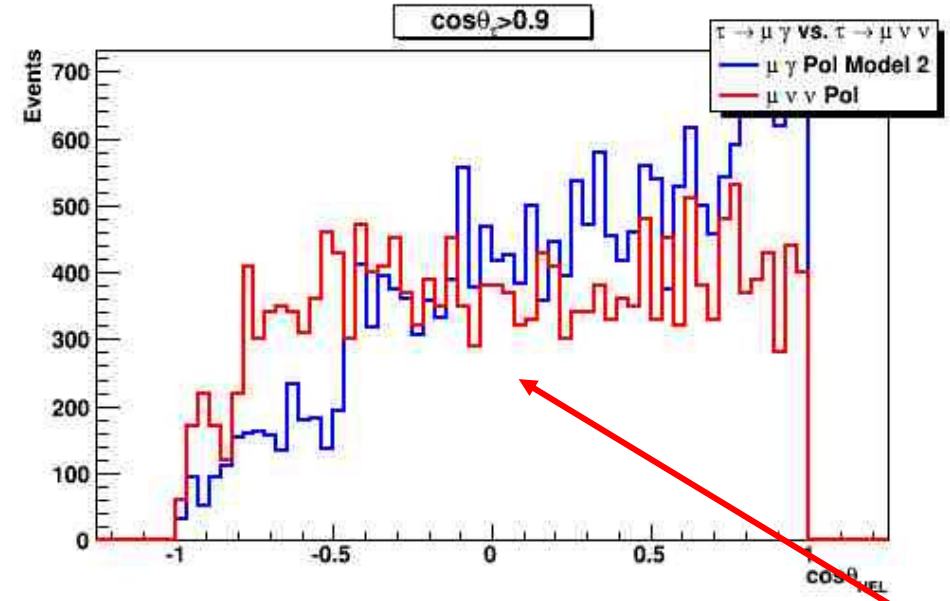


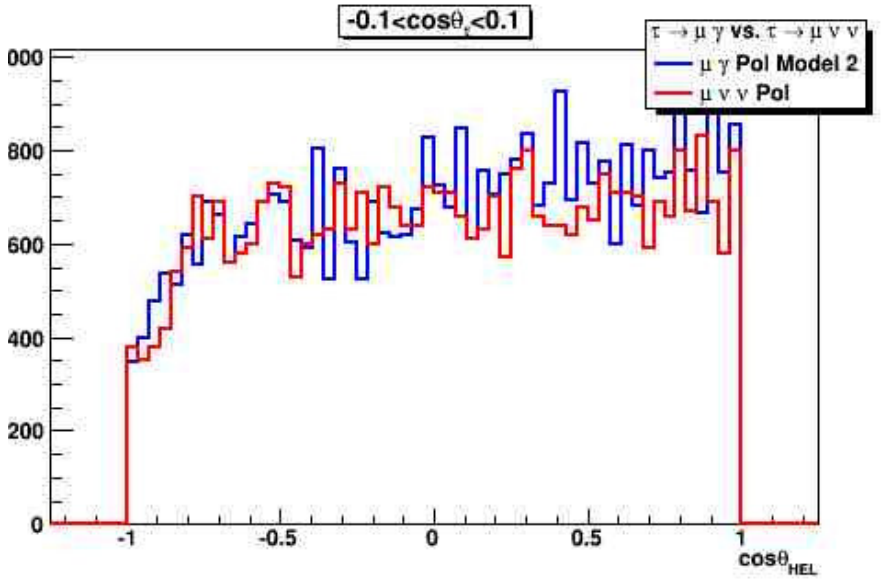


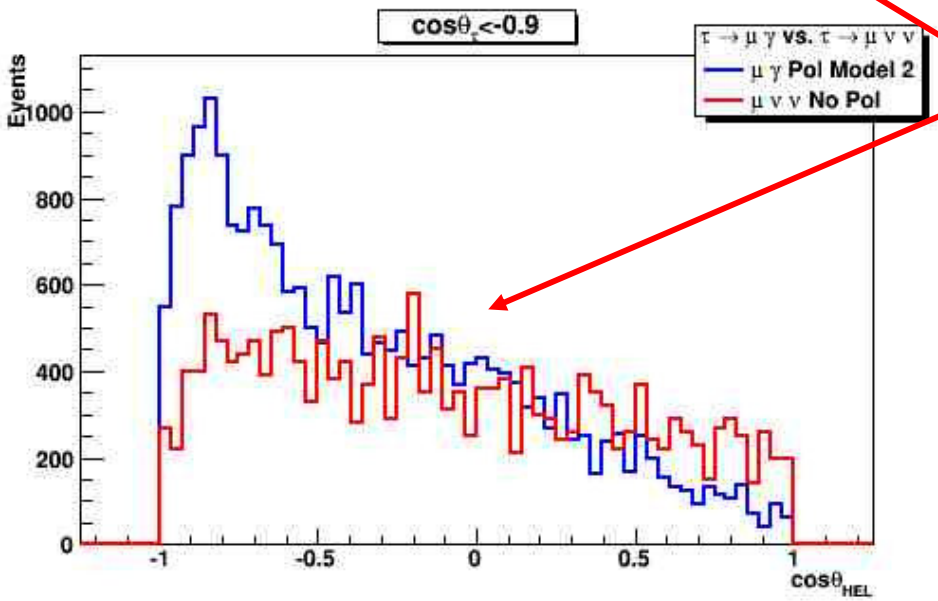
When emitted at large angles no distinction between sig and bkg: polarization information lost

When emitted along beam lines all polarization information mantained →sig/bkg separation

$\tau \rightarrow \mu\nu\nu$ decays Vs $\tau \rightarrow \mu\gamma$ (Was-like)







Even with different modelization difference between signal and MC is clear

Distribution between different models are much different → possible to study LFV dynamics

Conclusion

- MC spin matrix elements understood
- Clear improvement in background reduction is expected with polarization
- With reconstructed quantities sig-bkg separation expected to improve

- But... polarization along beam axis is not optimal
- Resolution on photon direction and energy may be crucial for tau reconstruction
- Need to go to full sim as soon as possible

Future Plans

- Move to reconstructed quantities using fast sim setup
- Prepare an analysis framework to evaluate differences w.r.t. Babar analysis, focusing on cut based selection

- Move to production after elba meeting