Tau Tagging for the ILC

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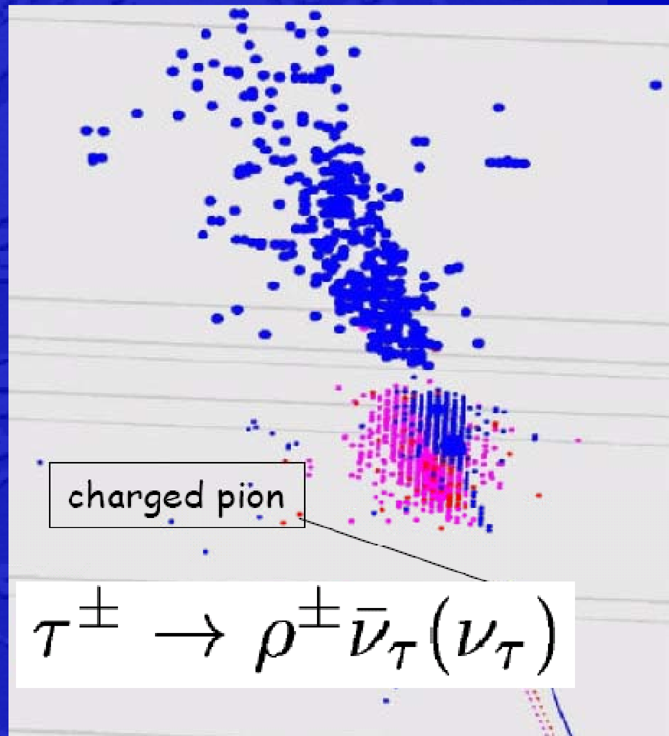
Tau tagging should exploit characteristic "jet" topology, mass and impact parameter; Use of calorimetric information has also been successful both for tagging and for identifying τ decay mode for polarization studies;

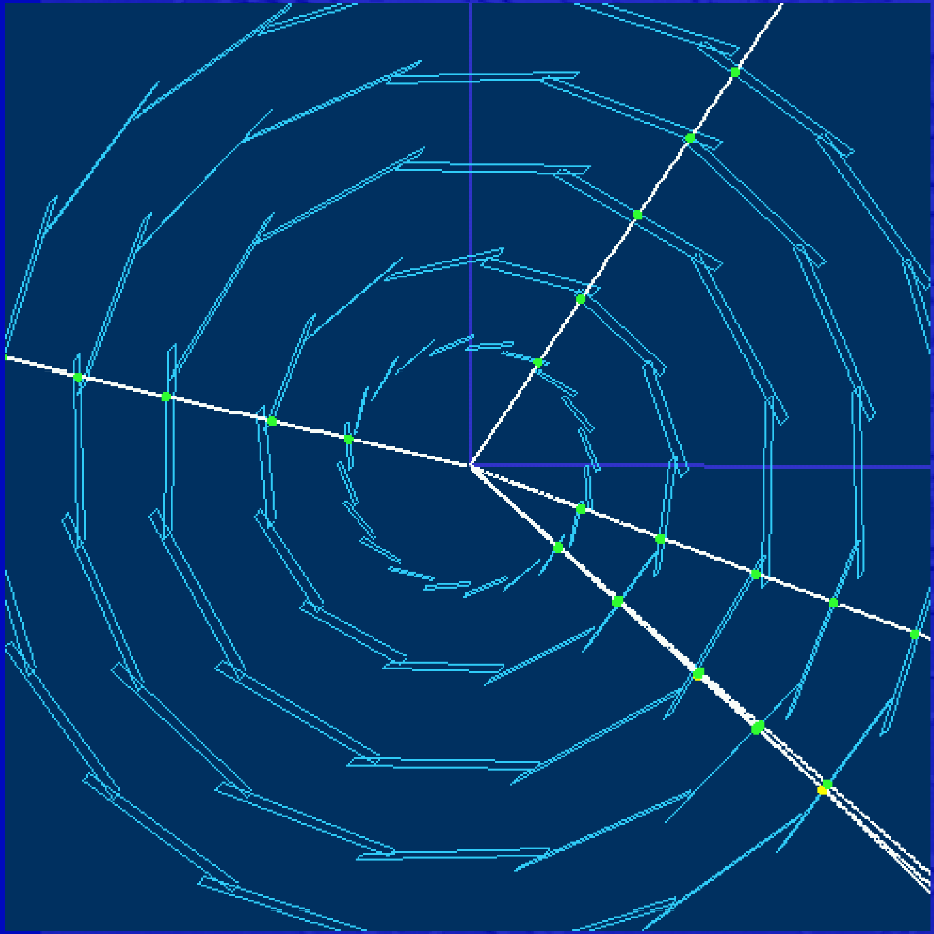


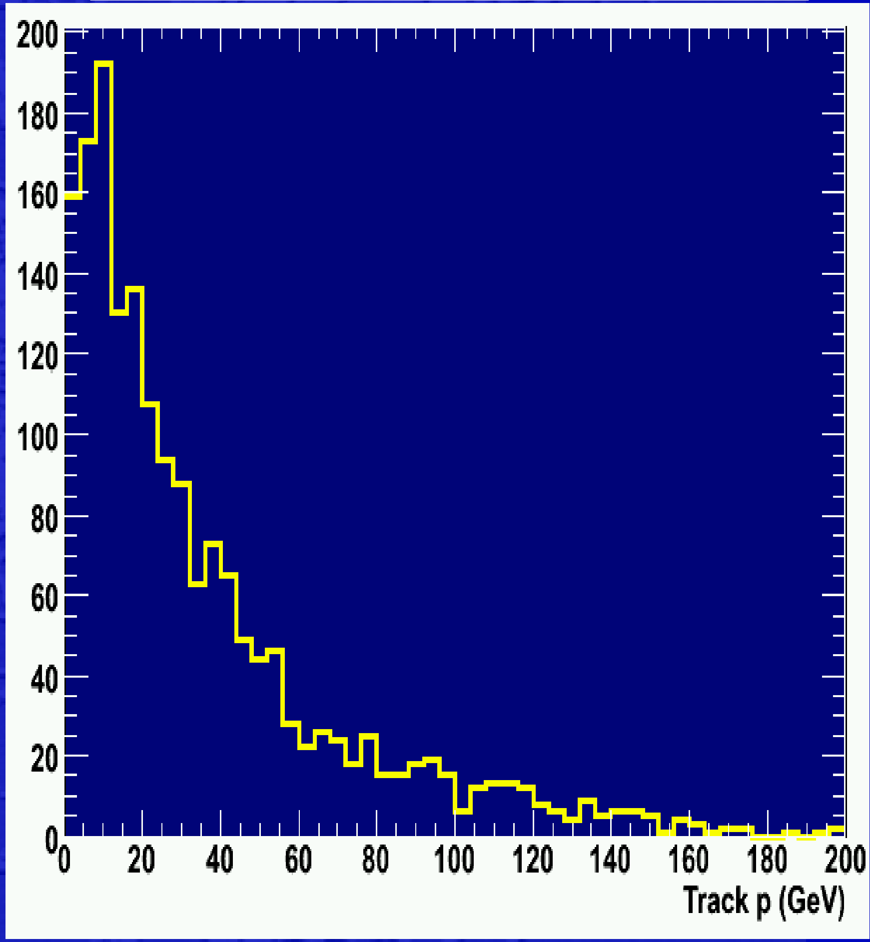
$\tau \to 1$ prong	BR = 0.85
$\tau \to l\nu\nu$	BR = 0.35
$\tau \to 3$ prongs	BR = 0.15
$\tau \to 5$ prongs	BR = 0.001

$c\tau = 87\ \mu m$

$e^+e^- \rightarrow HZ \rightarrow \tau\tau\mu\mu$ at 0.5 TeV

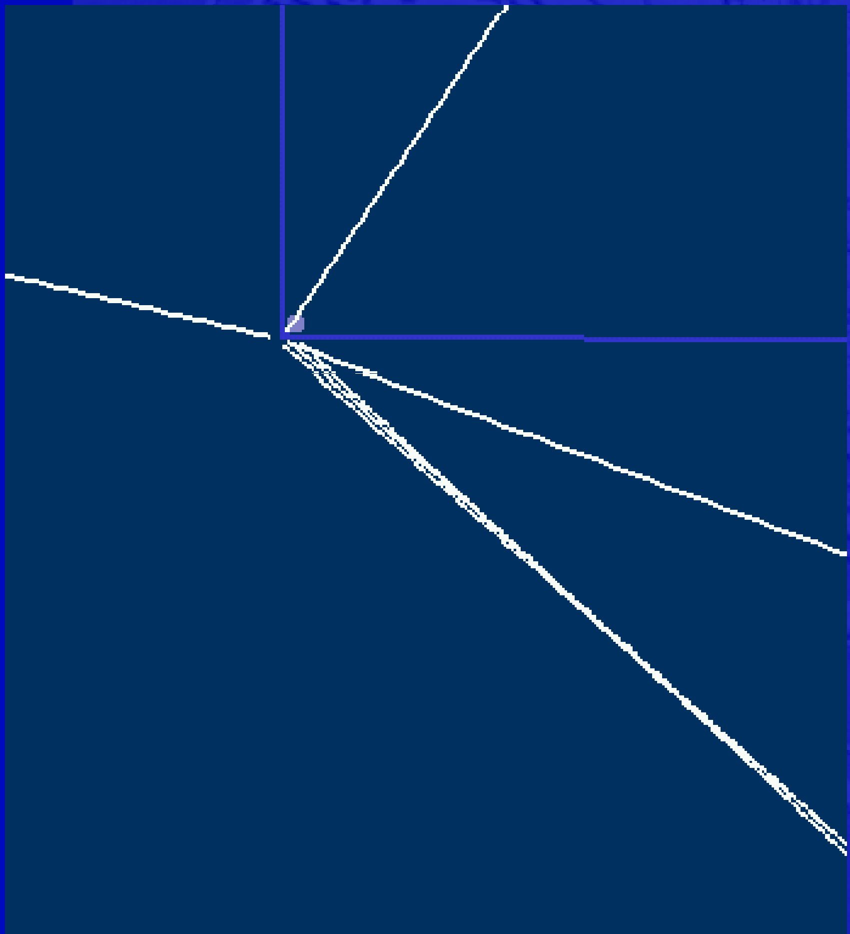
τ Decay Product Momentum

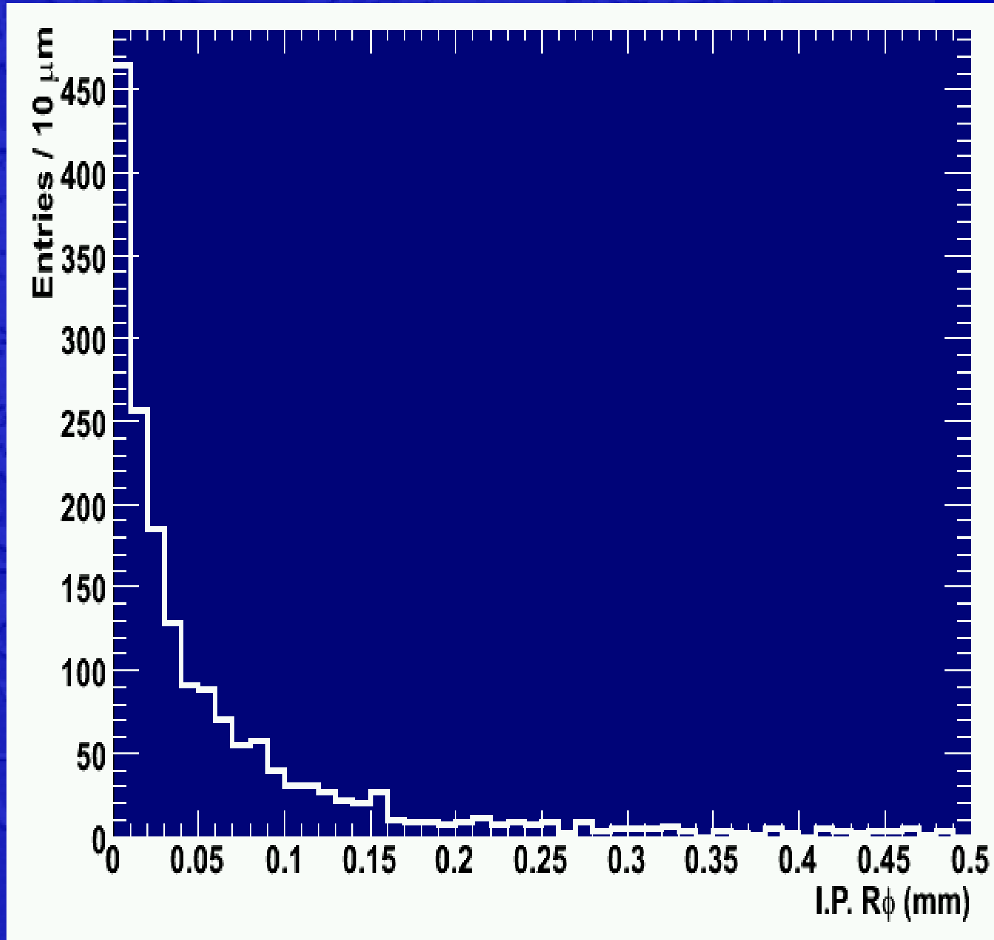




$e^+e^- \to HZ \to \tau\tau\mu\mu$ at 0.5 TeV

τ Decay Product Impact Parameter Rϕ

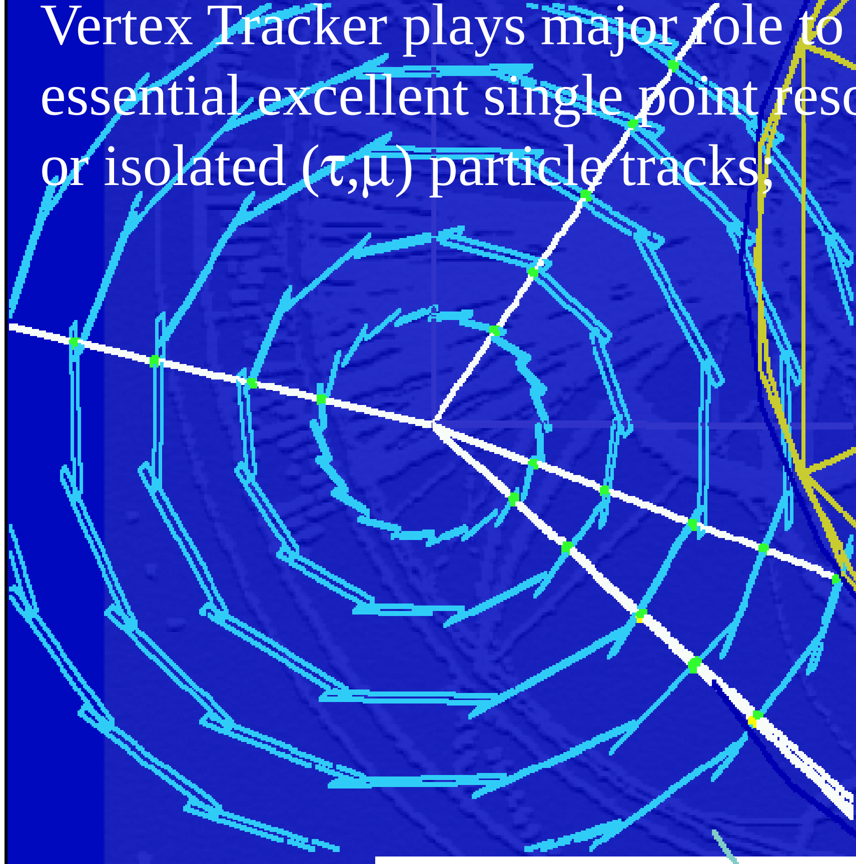


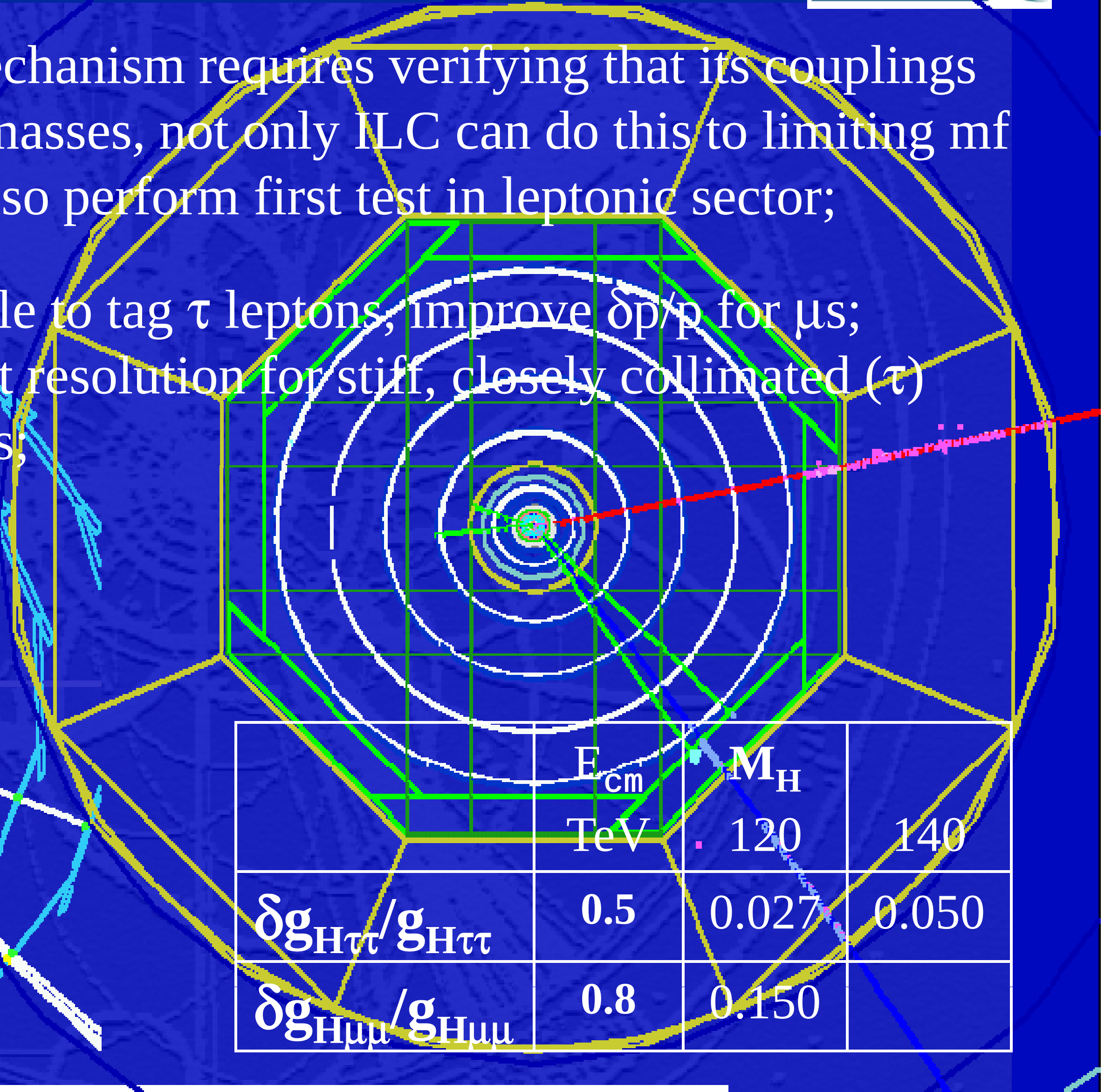


$e^+e^- \rightarrow H^0Z^0$, $H^0\nu\nu$; $H^0 \rightarrow \tau^+\tau^-$, $\mu^+\mu^-$

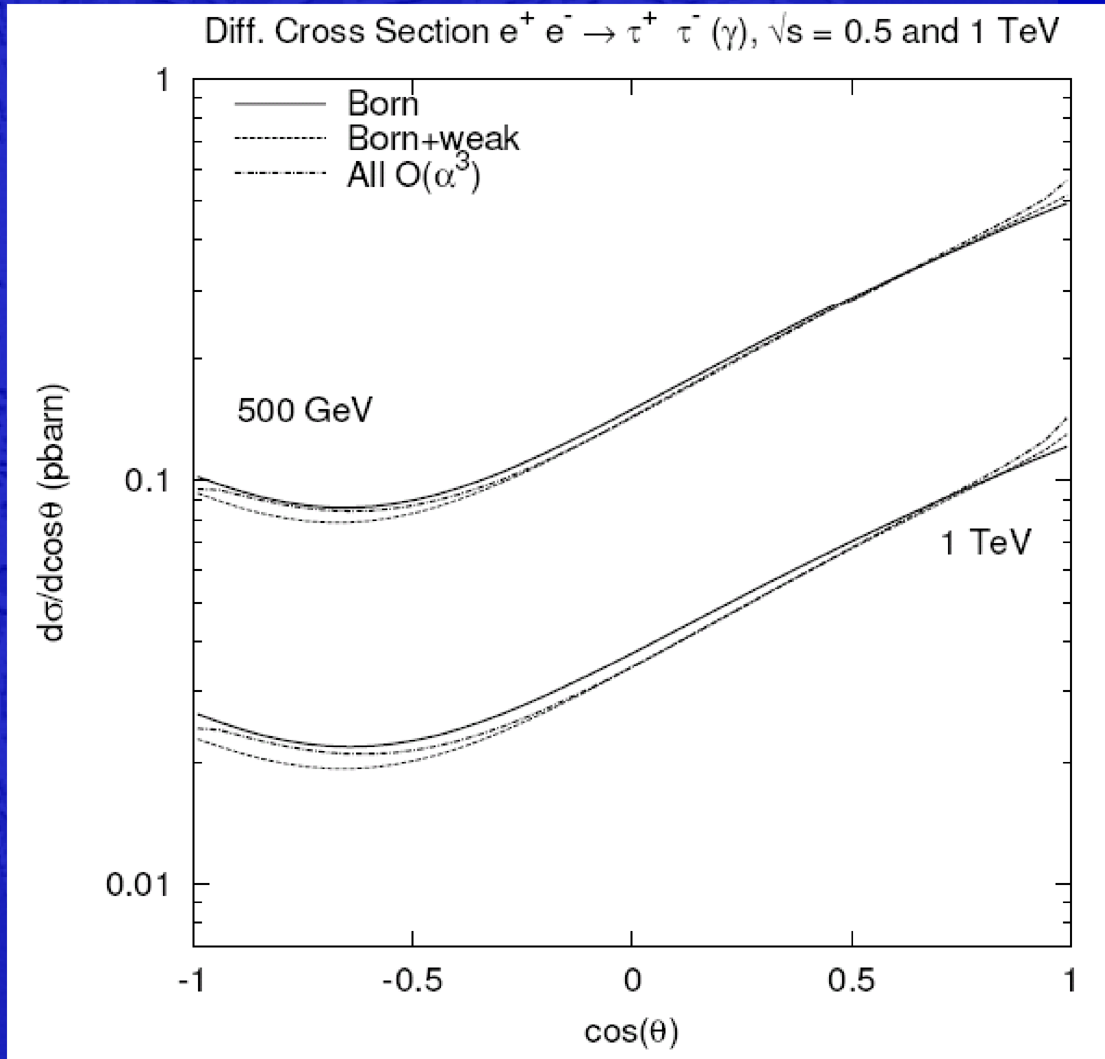
Fundamental test of Higgs mechanism requires verifying that its couplings to fermions scale as fermion masses, not only ILC can do this to limiting mf accuracy for quarks but can also perform first test in leptonic sector;

Vertex Tracker plays major role to tag τ leptons, improve δp/p for μs; essential excellent single point resolution for stiff, closely collimated (τ) or isolated (τ,μ) particle tracks;





	E_{cm} TeV	M_H 120	140
$\delta g_{H\tau\tau}/g_{H\tau\tau}$	**0.5**	0.027	0.050
$\delta g_{H\mu\mu}/g_{H\mu\mu}$	**0.8**	0.150	



Hahn et al.,
LC-TH-2003-083

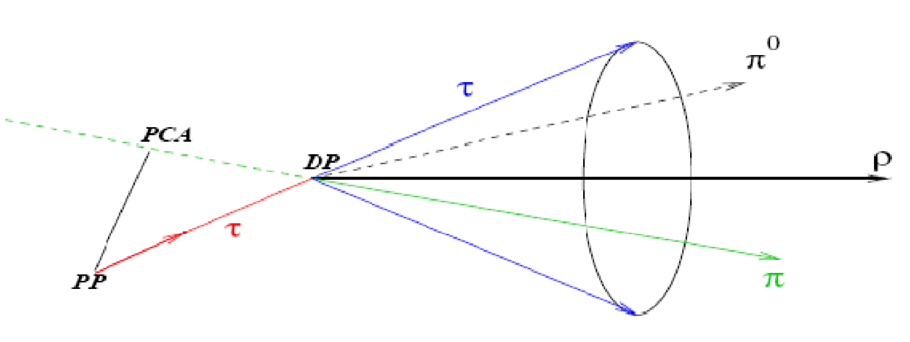
Higgs Boson Parity in $H(A)\rightarrow\tau^+\tau^-$

Angular distribution of t decay products distinguish a scalar boson (H) from a pseudoscalar (A);

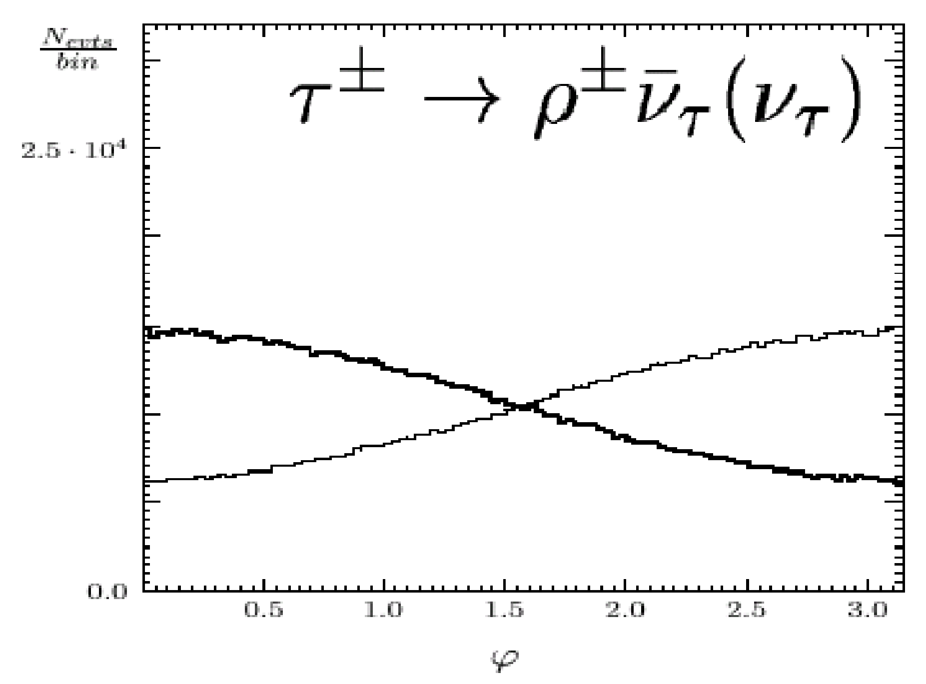
Due to νs the τ kinematic cannot be fully reconstructed and a two-fold ambiguity remains;

Reconstructing the t impact parameter this ambiguity can be removed and the full sensitivity to the Higgs parity recovered;

this requires accurate measurement of the single prong particle.



Acoplanarity angle of the $\rho^+\rho^-$ system



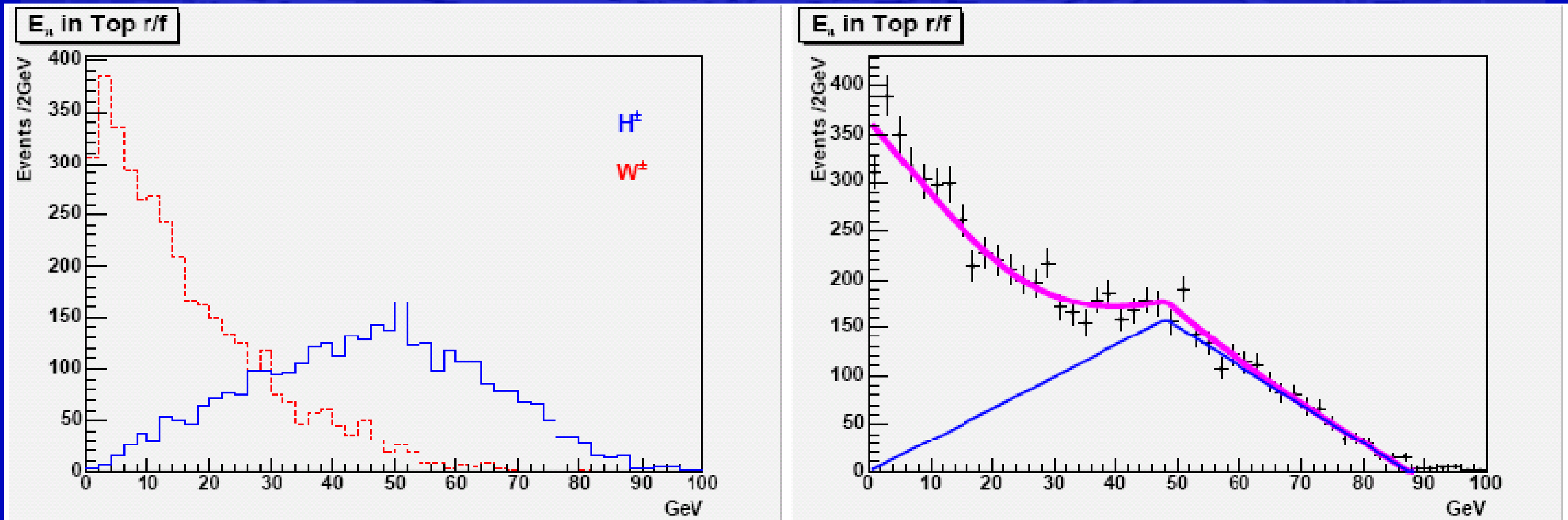
Desch et al.
LC-PHSM-2003-003

Identify Light H^- in large tan β SUSY

SUSY scenarios with light charged Higgs bosons and large tan β bring $H^- \to \tau\nu$ signature which can be distinguished from $W^- \to \tau\nu$ using τ polarization (RH vs. LH τs);

If $m_{H^-} < m_{top}$, study can be performed in recoil of hadronic top and experimental challeng is to tell $\tau \to \pi$ decay over broad momentum range;

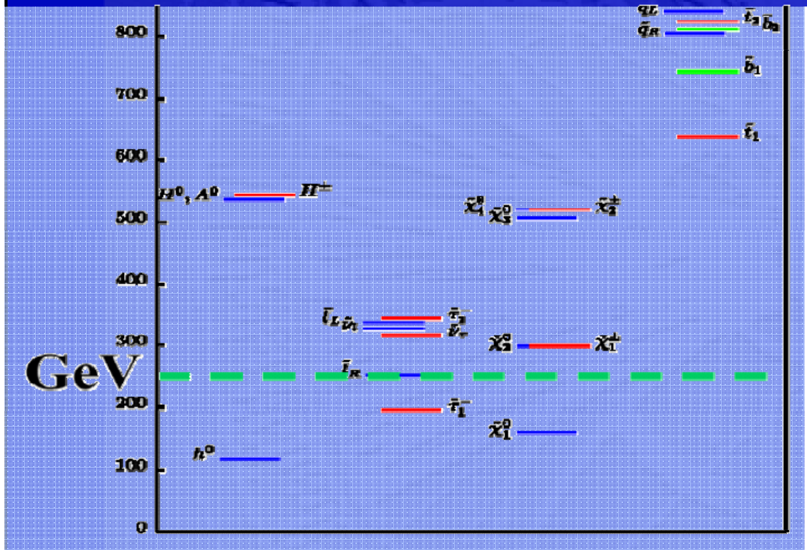
Vertex Tracker must identify single-prong τ at moderate to large momenta;



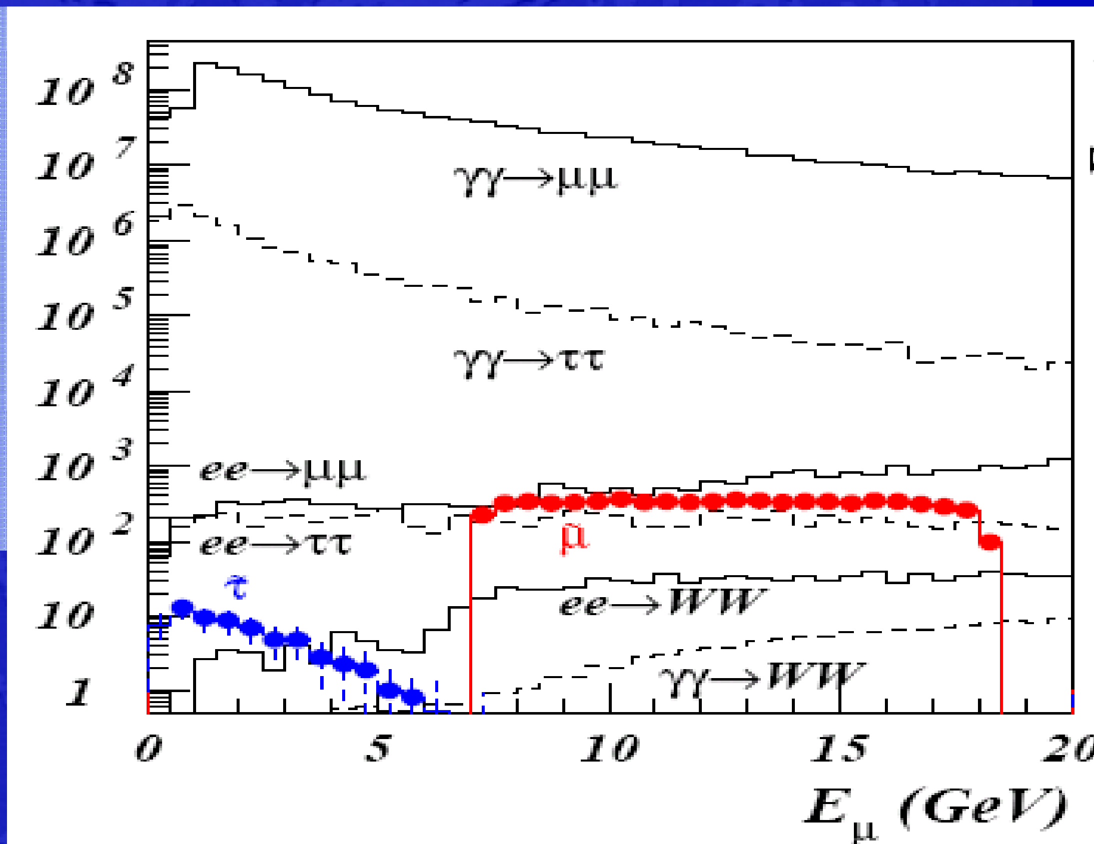
Boos, Carena, Wagner, hep-ph/0507100

$e^+e^- \to \tau_1\tau_1 \to \tau^+\tau^-\chi^0\chi^0$ in DM-motivated SUSY

In co-Annihilation SUSY scenarios DM density controlled by stau-LSP mass splitting: sensitivity to small ΔM depends on $\gamma\gamma$ background rejection:

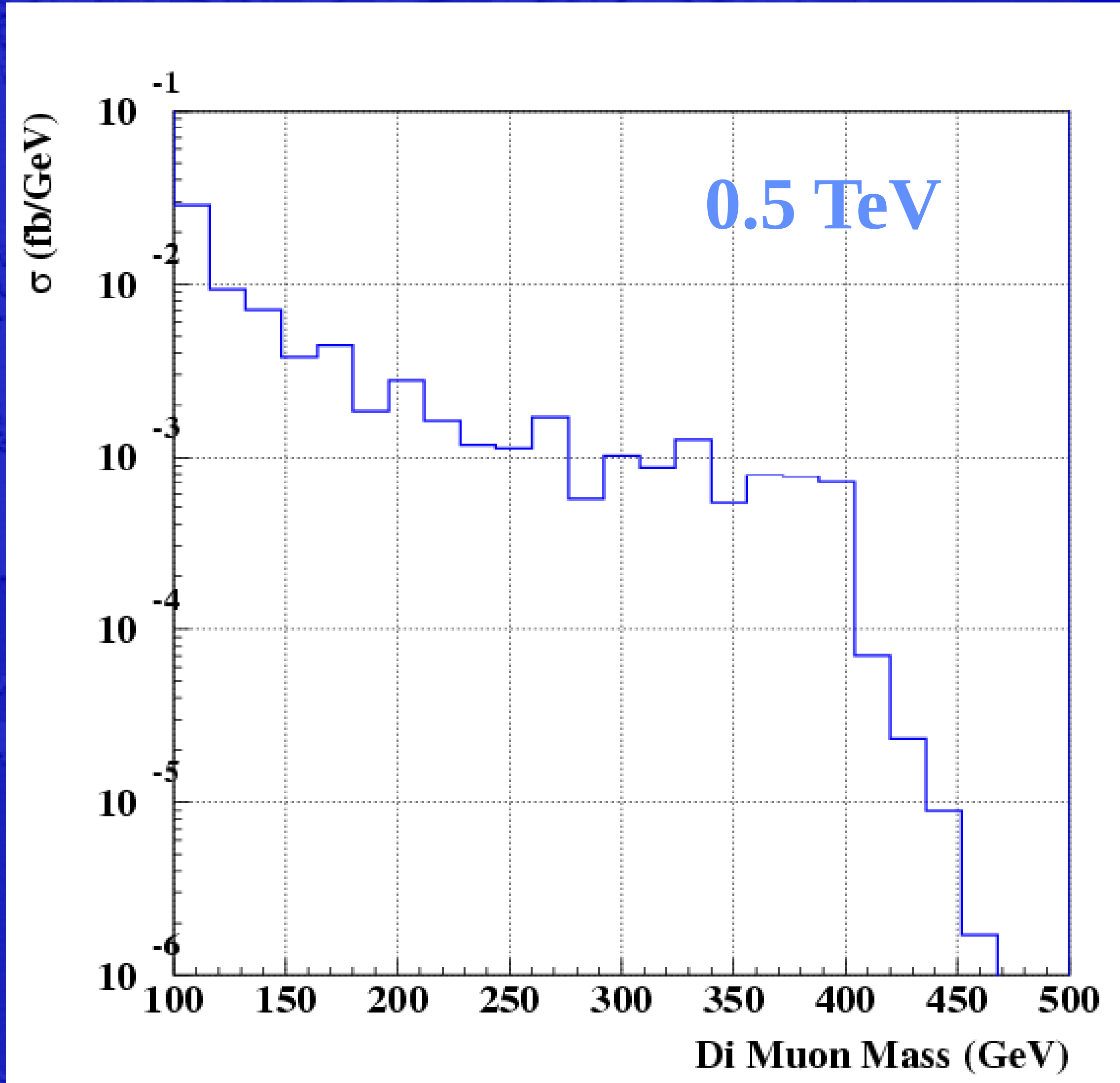


Essential to reject $\gamma\gamma$ bkg $ee \to ee\tau\tau$ by low angle electron tagging and $ee\tau\tau$, $ee\mu\mu$ also by i.p. tag:



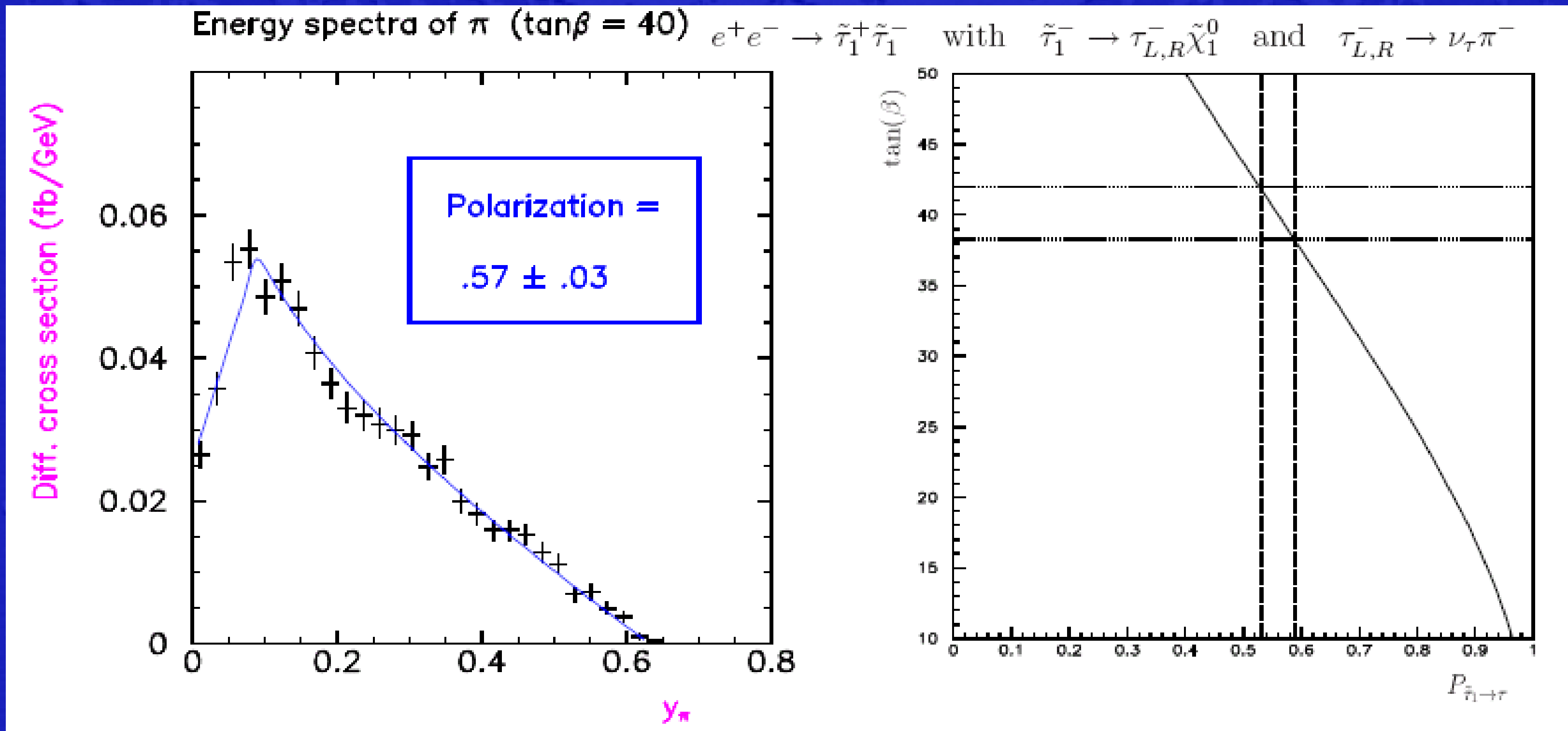
Bambade et al. LCWS04

SM μμνν yield is sizeable and τ tagging is highly beneficial in SUSY channels with τ final states



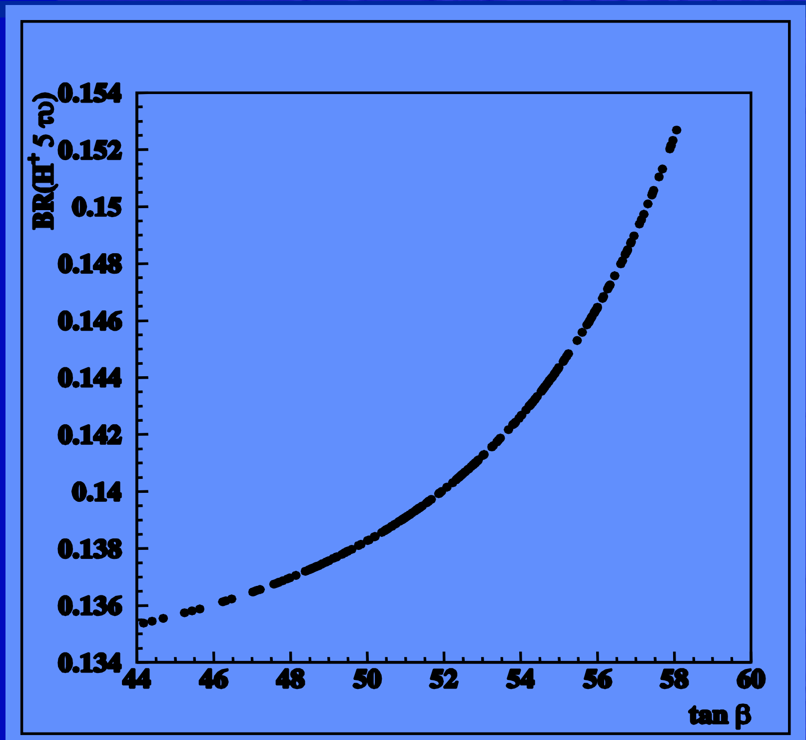
Tau Polarization, tan β and A_{tau}

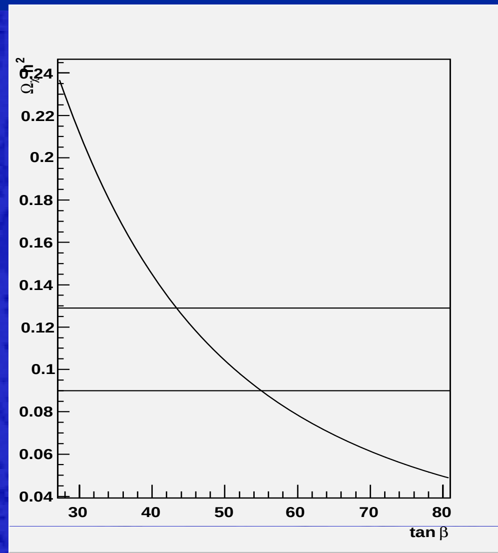
Stau mixing angles can be measured through polarised rates and in the polarisation of stau decays;
Relate polarization of $\tau_1 \rightarrow \tau$ to tan β while $\tau_2 \rightarrow \tau$ would measure Atau:

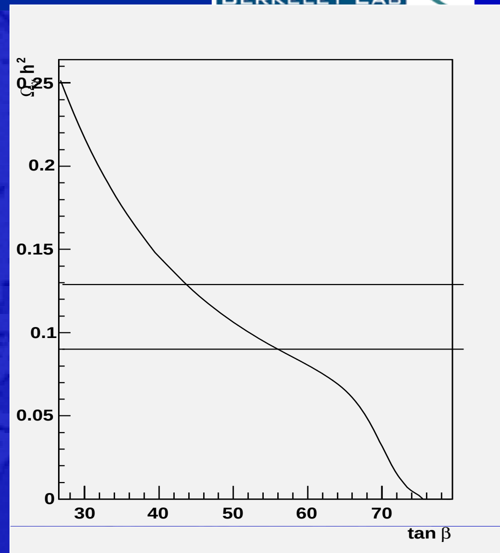


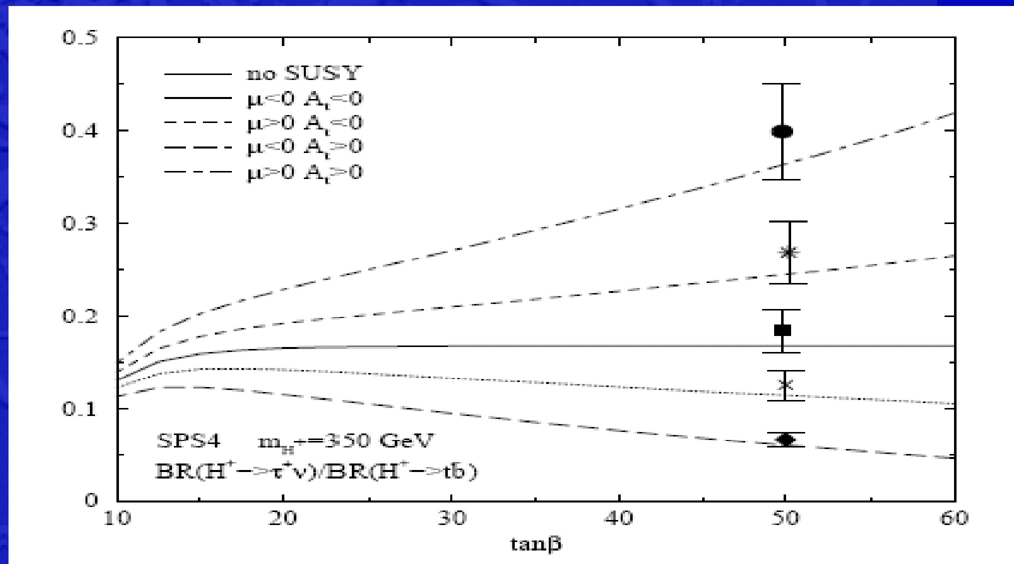
Boos et al., hep-ph/0211040

Tau tagging, Charged Higgs decays and tan β









$H^- \rightarrow \tau\nu$ sensitive to tan β and may offer one of few techniques to constrain this fundamental SUSY parameter;

More generally $\tau\nu$ channel sensitive to distinguish Higgs models;

Assamagan et al, hep-ph/0409189

- Need to develop combined tau tagging package based on topology, calorimeter response and vertexing;

- Several benchmark processes are available with emphasis on both τ/hadron and τ/μ separation;

- Interesting area of activity to benchmark specific detector properties such as calorimeter response to close-by charged and neutral energy deposits and vertex tracker single track impact parameter and vertexing for almost collinear tracks.