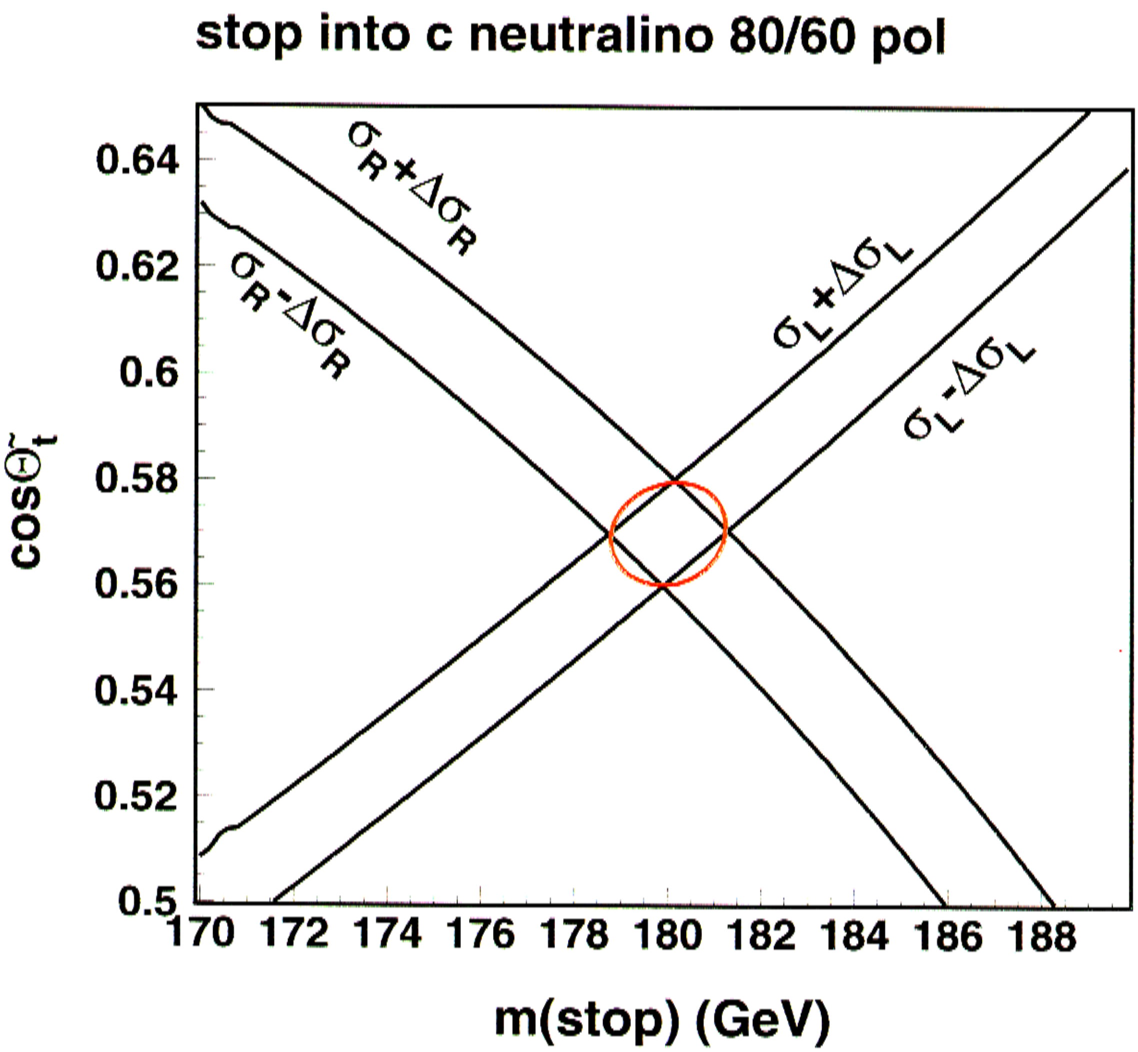
$e^+e^- \to \tilde{t}_1\tilde{t}_1$ at high luminosity LC:

80% pol. e^- beam, 60% pol. e^+ beam,
$\sqrt{s} = 500$ GeV, $\mathcal{L} = 500$ fb^{-1}

[R. Keränen, H. Nowak, A. Sopczak '00]



$\Rightarrow \Delta m_{\tilde{t}_1} = 1.1$ GeV and $\Delta \cos\theta_{\tilde{t}} = 0.01$

compared with case $P(e^-) = 80\%$, $P(e^+) = 0$:

$\Rightarrow$ Improvement by $\sim$ 20% if $P(e^+) \neq 0$

(S. Kraml et al.)

Summary: $P(e^+)$ is needed in

- **Higgs:** a) Better separation $H\bar{\nu}\nu \leftrightarrow HZ$ and $\frac{S}{\sqrt{B}}$

  b) Error reduction in HZV-coupling

- **Electroweak:** a) high $\sqrt{s}$: $WWZ \leftrightarrow WW\gamma$ coupling

  b) Giga Z: $\Delta \sin^2\theta^e_{eff} = 0.000013$!

- **TOP/QCD:** <u>First</u> study of PDF in polarised γ

- **Alternatives:** a) Enlarging Reach for W', Z', CI $\sim 40\%$

  b) ED: • Reach enlarged by $\sim 16\%$

  • $\frac{S}{\sqrt{B}}$ improved by ~ 5

- **SUSY:** a) New Signals by $e^-_L e^+_L$: $e^+e^- \to \tilde{\chi}_i \tilde{e}\, \nu_e$ (e.g.)

  b) Quick test if: $e^+e^- \to Z'$ or $e^+e^- \to \tilde{\nu}_e$

  c) $e^+e^- \to \tilde{\chi}^0_i \tilde{\chi}^0_j$: MSSM $\leftrightarrow$ Extended Models

  $\Rightarrow$ scaling factor needed for "survival"

$\Rightarrow$ For discovery and precision measurements in NP and SM: $P(e^+)$ is the key!

$\Rightarrow$ We should not miss this chance  $P(e^+)$

Use of Polarisation in LC Physics
The Gain of e^+ Polarisation

Gudrid Moortgat-Pick
DESY

LCWS 2000
Fermi National Accelerator Laboratory

October 24–28, 2000

First of all:

Special thanks to Herb Steiner!

Contents

One Remark before :

Measuring polarisation via

- Compton polarimeter

$\Rightarrow \delta(P) \sim 1\% - 0.5\%$! ($\leftrightarrow$ P. Schüler)

- Møller polarimeter

$\Rightarrow$ difficult due to $\vec{B}$

- Blondel Scheme

$\Rightarrow \delta(P) \sim$ ‰ , see GigaZ

Effects of $P(e^+)$ in Higgs

- Improve statistics

→ Separation of $H\nu\bar{\nu}$ und HZ channel

$$\frac{H\nu\bar{\nu}}{HZ} \to 0.2\Big|^{(+0)}_{80,0} \Longrightarrow 0.06\Big|^{(+-)}_{80,60}$$

→ Separation of Signal

$$(+0)\ \frac{S}{B} \sim 1.14 \Longrightarrow (+-)\ \frac{S}{B} \sim 1.2$$

! $$\frac{S}{\sqrt{B}} \sim 1.0 \Longrightarrow \frac{S}{\sqrt{B}} \sim 1.23 \Rightarrow \sim 20\%$$

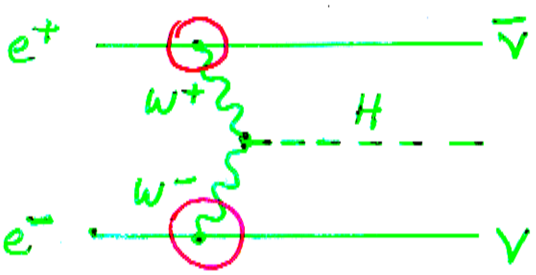
→ Suppression of $e^+e^- \to W^\pm e^\mp \nu$

- General HZV-coupling

→ Further reduction of errors up to $\sim 30\%$

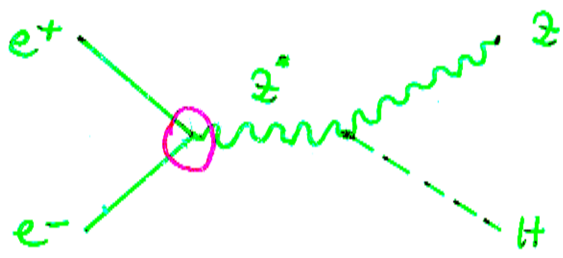
Higgs Sector

WW-Fusion



$e^+e^- \to H\nu\bar{\nu}$

Higgsstrahlung



$e^+e^- \to HZ, hA, HA, H^+H^-$

Scaling factors for $P_{e^-} = 80\%$ and $P_{e^+} = 60\%$:

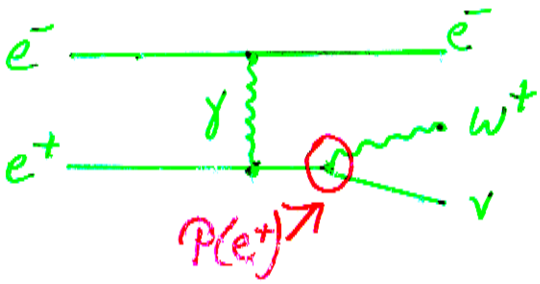
$P(e^-)$ $P(e^+)$	WW-Fusion	Higgsstrahlung
$(+\ 0)$	0.2	0.87
$(-\ 0)$	1.8	1.13
$(+\ -)$	0.08	1.26 *
$(-\ +)$	2.88	1.70

Desch, Obernai 99

Background

	• $e^+e^- \to WW$, $e^+e^- \to Z\nu\bar{\nu}$	• $e^+e^- \to ZZ$
$(+0)$	0.2 *	0.76
(-0)	1.8	1.25
$(+-)$	0.1 *	1.05
$(-+)$	2.85	1.91

• $e^+e^- \to W^{\pm} e^{\mp} \nu$



!

$\Rightarrow$ e_L^+ needed ! $P(e^+)$ needed !

General $HZZ, HZ\gamma$

B. Kniehl, K. Hagiwara, S. Ishihara, J. Kamoshita

OPTIMAL OBSERVABLE METHOD

$\mathcal{L}_{eff} \sim \tilde{b}_V H Z_{\mu\nu} \tilde{V}^{\mu\nu} + \dots$

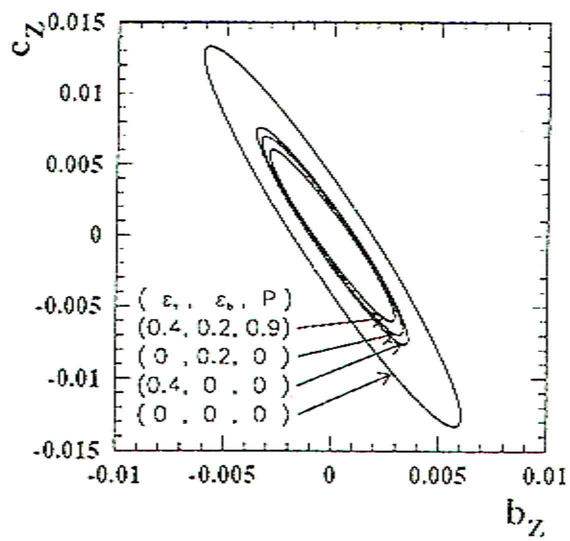
with $V = Z, \gamma$

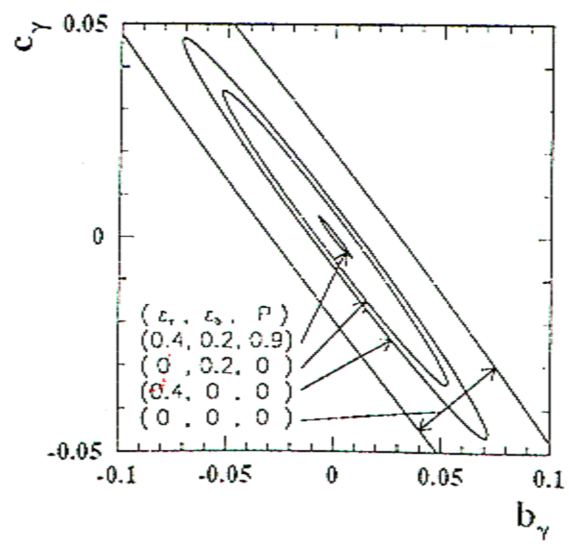
Further reduction of errors by $P(e^\pm)$:

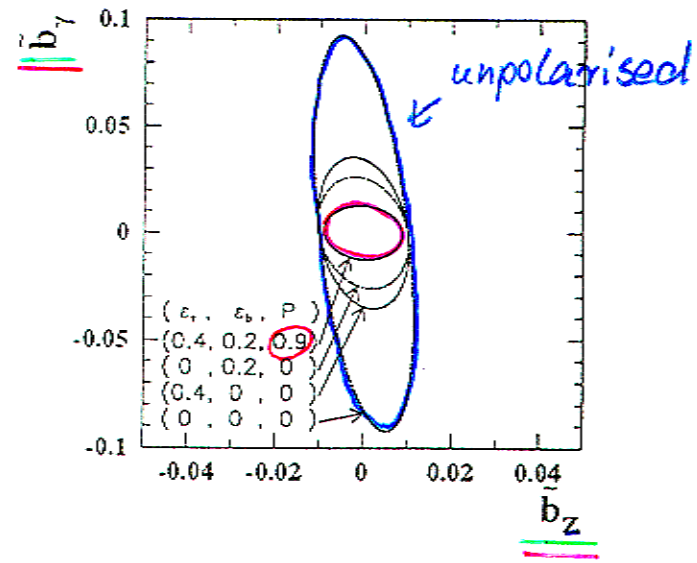
$\Rightarrow$ up to 30%

Table 1.1: Optimal errors on general $ZZ\Phi$ and $Z\gamma\Phi$ couplings.

	ϵ_τ	—	0.5	—	—	—	0.5
	ϵ_b	—	—	0.6	—	—	0.6
	$\lvert P_{e^-}\rvert$	—	—	—	0.8	0.8	0.8
	$\lvert P_{e^+}\rvert$	—	—	—	—	0.6	0.6
	$\mathrm{Re}(b_Z)$	0.00055	0.00038	0.00029	0.00028	0.00023	0.00022
	$\mathrm{Re}(c_Z)$	0.00065	0.00037	0.00017	0.00014	0.00011	0.00011
	$\mathrm{Re}(b_\gamma)$	0.01232	0.00665	0.00205	0.00052	0.00036	0.00034
	$\mathrm{Re}(c_\gamma)$	0.00542	0.00292	0.00090	0.00011	0.00008	0.00007
~ 20%	$\mathrm{Re}(\tilde{b}_Z)$	0.00104	0.00099	0.00097	0.00095	0.00078	0.00052
~ 30%	$\mathrm{Re}(\tilde{b}_\gamma)$	0.00618	0.00334	0.00105	0.00145	0.00101	0.00063
	$\mathrm{Im}(b_Z - c_Z)$	0.01055	0.00570	0.00176	0.00070	0.00049	0.00046
	$\mathrm{Im}(b_\gamma - c_\gamma)$	0.00206	0.00126	0.00077	0.00070	0.00057	0.00054
	$\mathrm{Im}(\tilde{b}_Z)$	0.00521	0.00281	0.00087	0.00032	0.00022	0.00022
	$\mathrm{Im}(\tilde{b}_\gamma)$	0.00101	0.00061	0.00035	0.00032	0.00026	0.00026

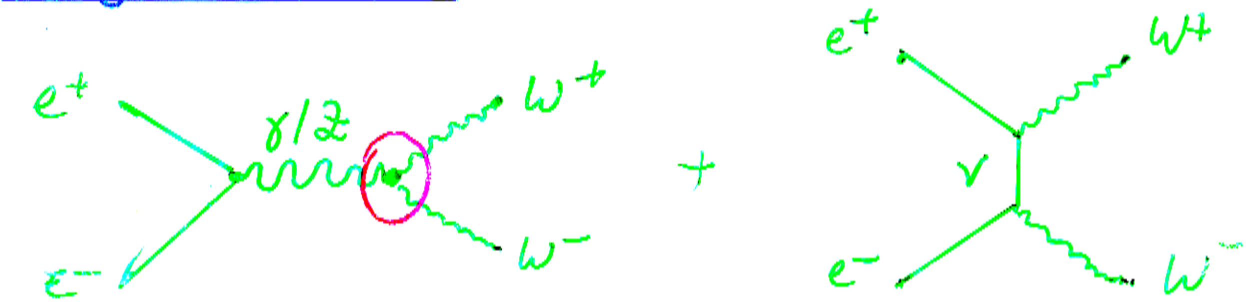






Effects of $P(e^+)$ for Electroweak

High $\sqrt{s}$:



- High precision : WWZ, $WW\gamma$ couplings

  $\Rightarrow \Delta(P_e) \sim ‰$ needed ($\rightarrow$ Blondel)

- Better statistics $\frac{S}{B}$, $\frac{S}{\sqrt{B}}$ as usual

  background (e.g.): $e^+e^- \rightarrow WZ\nu, WWZ, We\bar{e}$

GigaZ:

$e^+e^- \rightarrow Z \rightarrow f\bar{f}$: $A_{LR}(\sin\theta^{\ell}_{eff})$

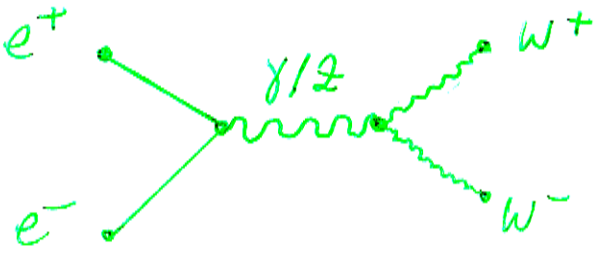
- High precision : $\sin\theta_{eff}$!

  $\Rightarrow \Delta P(e^-) \sim ‰$ needed ($\rightarrow$ Blondel)

  $\Delta A_{LR} \sim 10^{-5}$ possible !

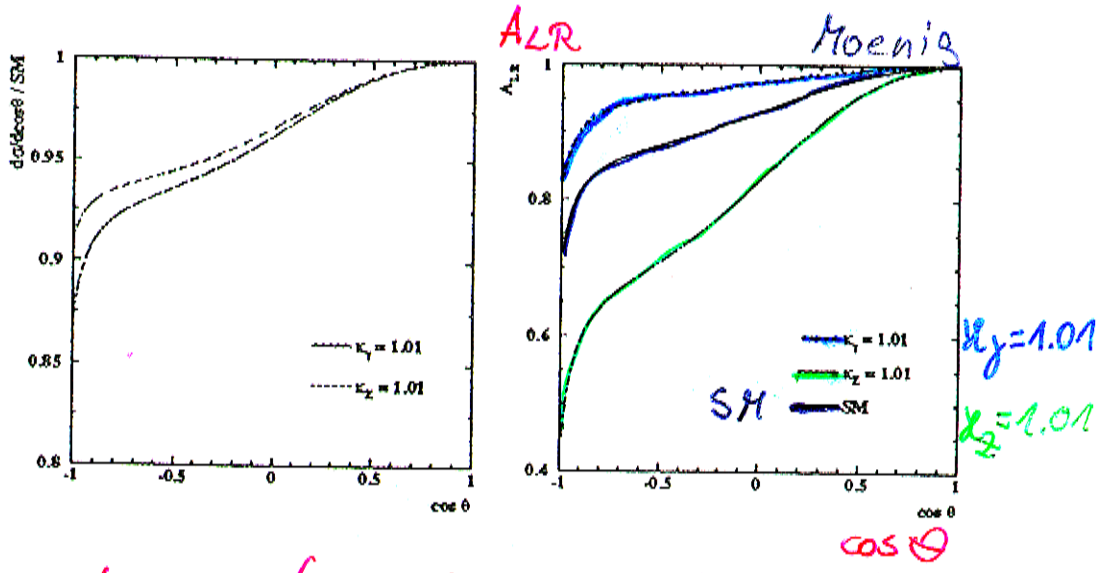
$\Longrightarrow$ $P(e^+)$ absolutely needed !

Electroweak – High $\sqrt{s}$



$\mathcal{L} \sim \underline{\kappa_V}\, W^+_\mu W^-_\nu V^{\mu\nu}$ with $V = \gamma, Z$

$(SM: \kappa_V \equiv 1)$



$\Longrightarrow$ A_{LR}: Separation of $WW\gamma \longleftrightarrow WWZ$

If $\Delta(P_{e^-}) \sim 1\% \Rightarrow \Delta\kappa_Z(\text{stat}) < \Delta\kappa_Z(\text{pol})$ ↯

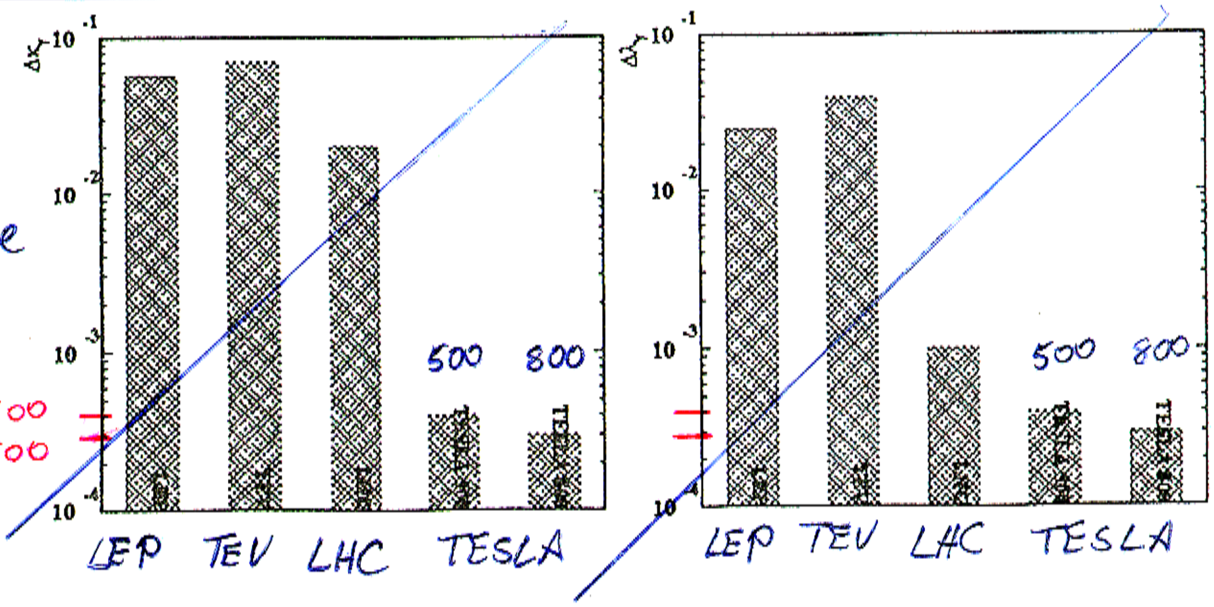
But $\Delta(P_{e^-}) < 1\% \Rightarrow$ Blondel-Scheme needed!

$\Rightarrow$ $\underline{P(e^+)}$ needed: $(-+), (+-)$ and $(--), (++)$

---

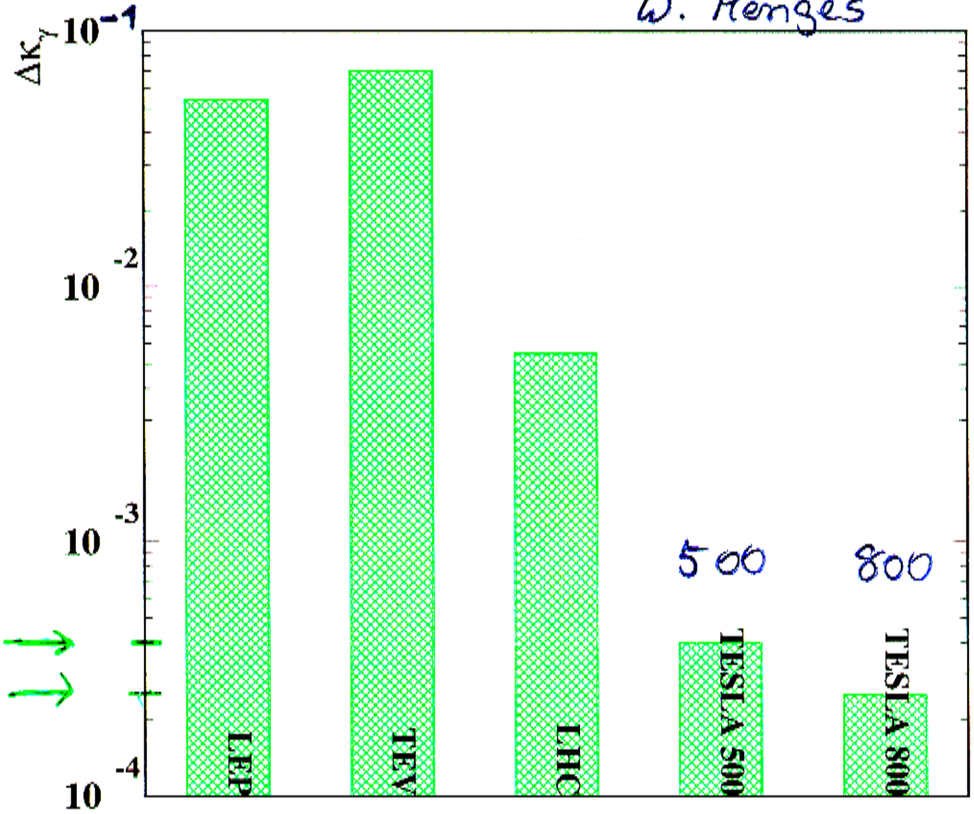
see plot
→ next page

TESLA: $\sqrt{s}$ = 500
800



W. Menges

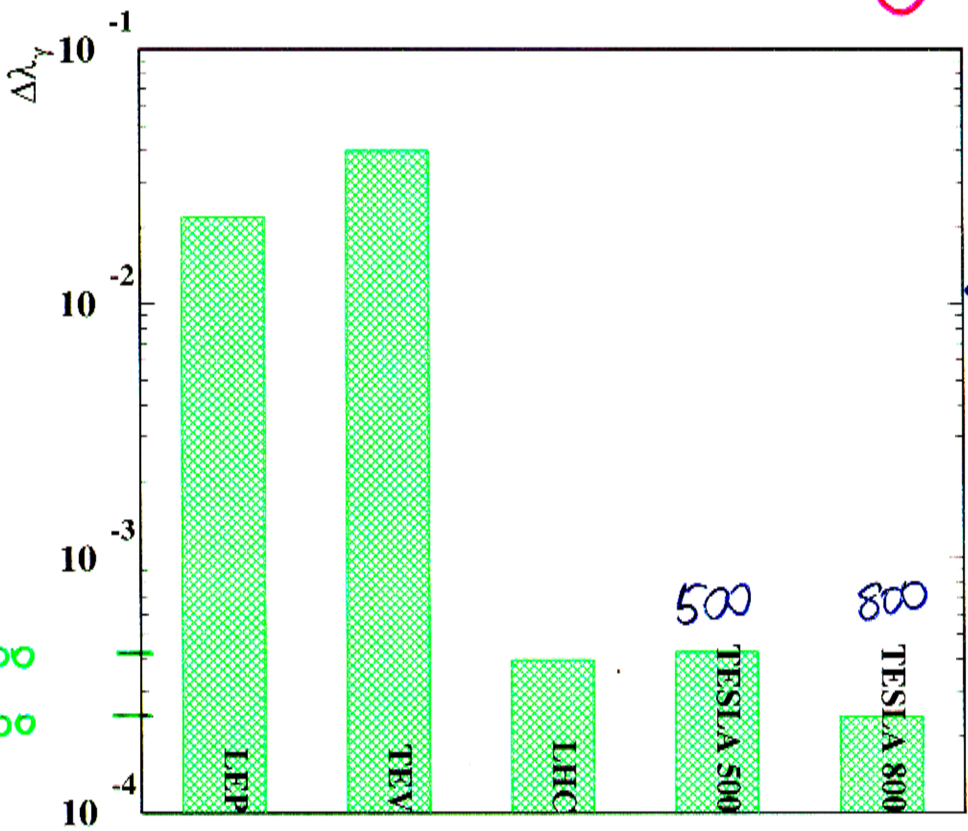
TESLA 500 →
TESLA 800 →



$\mathcal{L} \sim \varkappa_\gamma W^+_\mu W^-_\nu V^{\mu\nu}$

! If $P(e^-) = 80\%$, $P(e^+) = 50\%$: $\Delta\varkappa_\gamma \longrightarrow \frac{1}{2}\Delta\varkappa_\gamma$!!

TESLA 500
TESLA 800



$\mathcal{L} \sim \frac{\lambda_\gamma}{m_W^2} \cdot V^{\mu\nu} W^{+\,s}_\nu W^-_{s\mu}$

⇒ If $P(e^-) = 80\%$ and $P(e^+) = 60\%$: also further improvements in $\Delta\lambda_\gamma$! (Factor up to 2)

Electroweak – GigaZ

$e^+e^- \to Z \to f\bar{f}$: $A_{LR} = \dfrac{2(1-4s^2\theta^l_{eff})}{1+(1-4s^2\theta^l_{eff})^2}$

$\Delta A_{LR}(\text{stat}) \sim 10^{-5} \ll \Delta A_{LR}(P_{e^-})$ ↯

Blondel-Scheme: $\Delta A_{LR}(\text{total}) \sim 4 \cdot 10^{-5}$ (no sys)

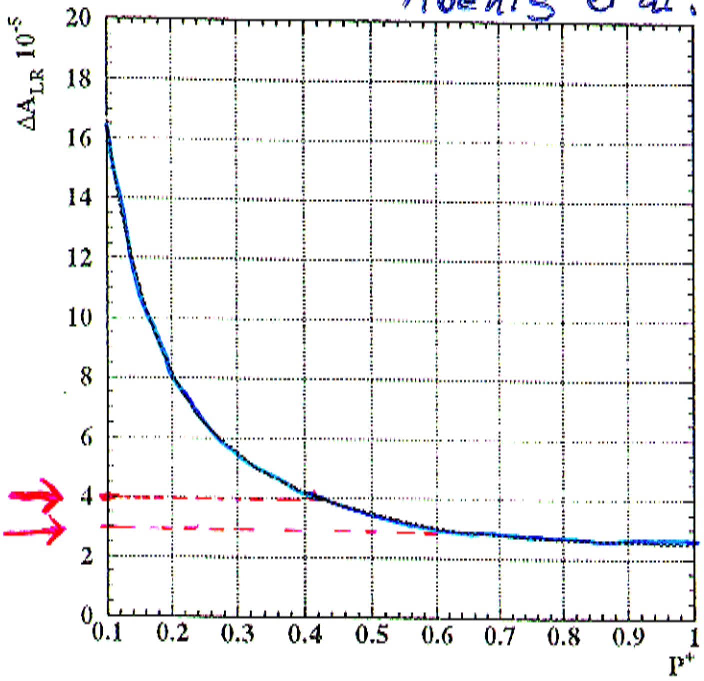
$\sim 10^{-4}$ (with sys)

$\Downarrow$

$\Delta \sin^2\theta^l_{eff} = 0{,}000013$!

Hoenig et al.

ΔA_{LR} $[10^{-5}]$



$P(e^+)$ =

40% ⇒

60% ⇒

$P(e^+)$

$$\sigma = \sigma_{unpol}\left[1 - P(e^+)P(e^-) + A_{LR}\left(P(e^+) - P(e^-)\right)\right]$$

$$\Rightarrow A_{LR} = \sqrt{\frac{(\sigma^{++}+\sigma^{+-}-\sigma^{-+}-\sigma^{--})(-\sigma^{++}+\sigma^{+-}-\sigma^{-+}+\sigma^{--})}{(\sigma^{++}+\sigma^{+-}+\sigma^{-+}+\sigma^{--})(-\sigma^{++}+\sigma^{+-}+\sigma^{-+}-\sigma^{--})}}$$

Problems: a) σ^{++}, σ^{--}

$\Downarrow$

10% $\mathcal{L}$ sufficient

(Observables: $\sigma^{-+}, \sigma^{++}, \sigma^{-0}, \sigma^{+0}$ doesn't solve problem b))

b) Sign flipping of $P(e^+)$

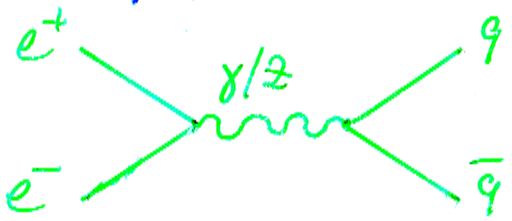
$\Rightarrow \Delta(\text{sys})$

$\Downarrow$

Challenge!

TOP / QCD – P(e⁺) effects

• $e^+e^- \to q\bar{q}$



For 'light' quarks: (Arnd Brandenburg)

$$\mathcal{X} = \frac{\sigma(P_{e^+},P_{e^-})}{\sigma(P_{e^+,e^-}=0)} = [1-P(e^+)P(e^-)]\cdot\left[1+0.46\,\frac{P(e^+)-P(e^-)}{1-P(e^+)P(e^-)}\right]$$

↑ at $\sqrt{s}=500$ GeV

$P(e^-)=80\%,\ P(e^+)=0$: (-0) $\mathcal{X}=1.37$ $(+0)$ $\mathcal{X}=0.63$

↓ ~50% ↓ ~30%

$P(e^-)=80\%,\ P(e^+)=60\%$: $(-+)$ $\mathcal{X}=2.12$ $(+-)$ $\mathcal{X}=0.83$

background $e^+e^-\to W^+W^-$: (-0) 1.8 $(+0)$ 0.2

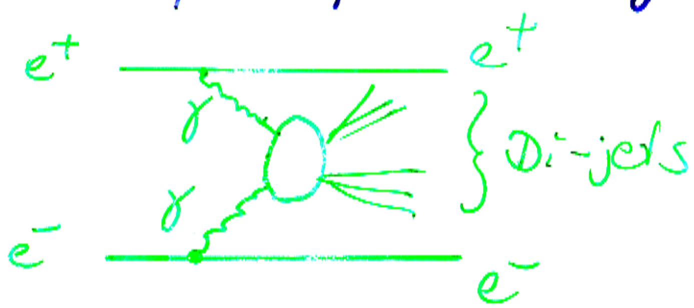
↓ ↓

$(-+)$ 2.8 $(+-)$ 0.1 !

⇒ $P(e^+)$ for better statistics $\frac{S}{B}$, $\frac{S}{\sqrt{B}}$ as usual

• $e^+e^- \to$ Di-jets $+e^+e^-$:

Study of polarized γ structure functions



Not as good as in $e\gamma$,

but better than nothing!

⇒ High $P(e^+)$ needed!

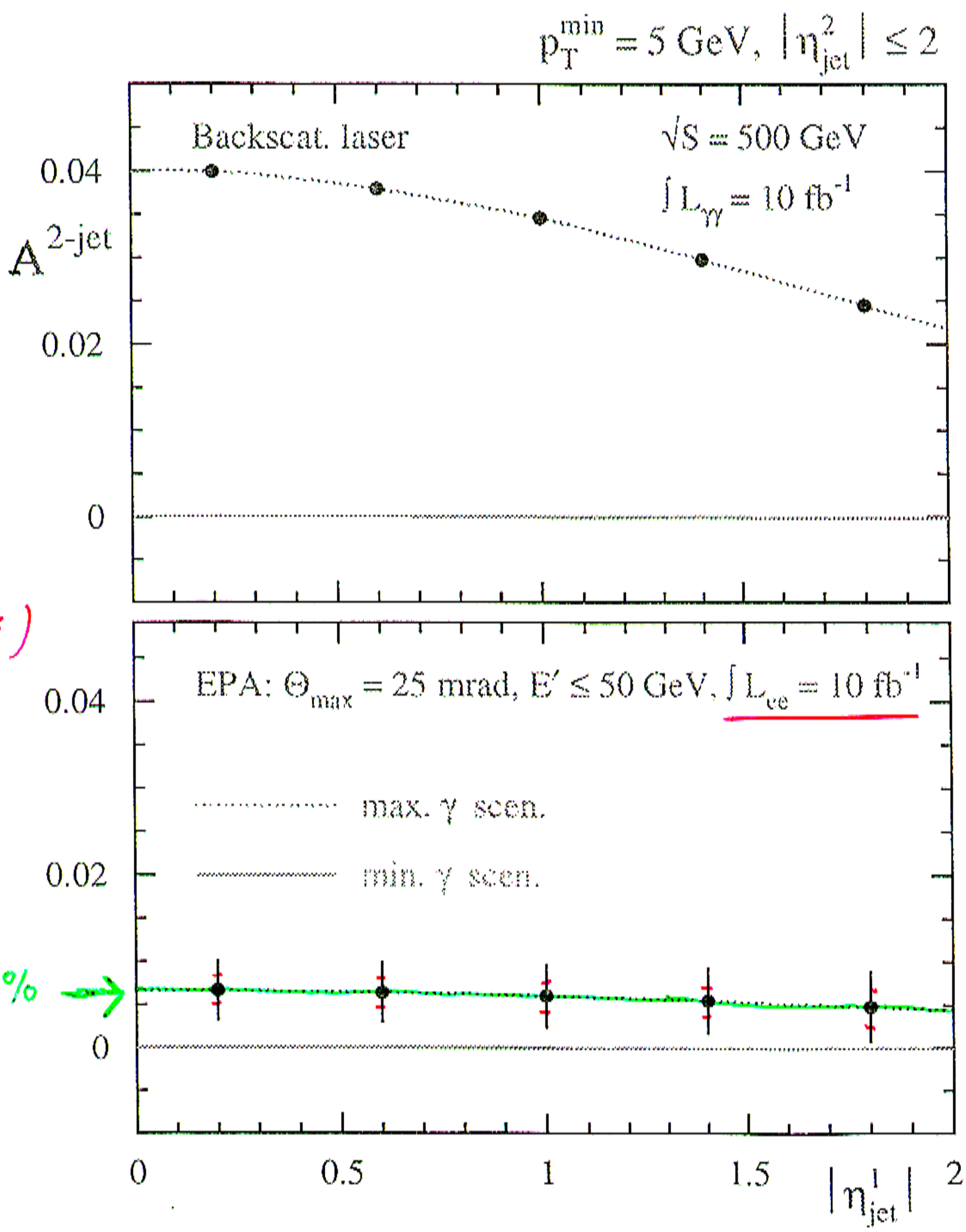
Top / QCD

- Up to now: nothing known about PDF

e^+e^- could show, that PDF in polarised γ exist!

Marco Stratmann

$P(e^-) = P(e^+) = 70\%$



(*)

< 1% →

if $\int \mathcal{L}_{ee} = 100\ fb^{-1}$

↓

smaller errors ~ 1/3

⇒ High $P(e^+)$ needed for PDF in pol. γ!

Alternatives – Effects of $P(e^+)$

• Reach for Z', W'

e.g. lower bound for $M_{Z'}$:

$\mathcal{L} = 500\ fb^{-1}$	$M_{Z'}$ in E_6	$M_{Z'}$ in LR	(S. Riemann)
$\lvert P(e^-)\rvert = 80\%$, $\lvert P(e^+)\rvert = 0$	4.4 TeV	4.0 TeV	
	$\downarrow \sim 10\%$	$\downarrow \sim 20\%$	
$\lvert P(e^-)\rvert = 80\%$, $\lvert P(e^+)\rvert = 60\%$	4.9 TeV	6.0 TeV	

e.g. lower bound for $M_{W'}$ (sys. errors included):

$\mathcal{L} = 1\ ab^{-1}$	$M_{W'}$ in SSM	$M_{W'}$ in LR	$M_{W'}$ in KK	(Godfrey et al.)
unpolarised beams	1.7 TeV	0.9 TeV	1.8 TeV	
	$\downarrow$	$\downarrow$	$\downarrow$	
$\lvert P(e^-)\rvert = 80\%$, $\lvert P(e^+)\rvert = 0$	2.2 TeV	1.2 TeV	2.3 TeV	

$$(80,0): P_{eff} = 80\% \xrightarrow{+20\%} (80,60): P_{eff} = \frac{P(e^-) - P(e^+)}{1 - P(e^-)P(e^+)} = 95\%$$

$\Rightarrow$ With $P(e^+) = 60\%$: Reach for $M_{Z'}$, $M_{W'}$ increases by 10 – 20% !

• Contact Interactions, e.g.: $e^+e^- \to b\bar{b}$

$\Rightarrow$ With $P(e^+) = 40\%$: Sensitivity enlarged by up to 40%

• Extra Dimensions: $e^+e^- \to \gamma G$

$\Rightarrow$ Reach for M_D enlarged by 20% and $\frac{S}{\sqrt{B}}$ improved by ~ 2.3

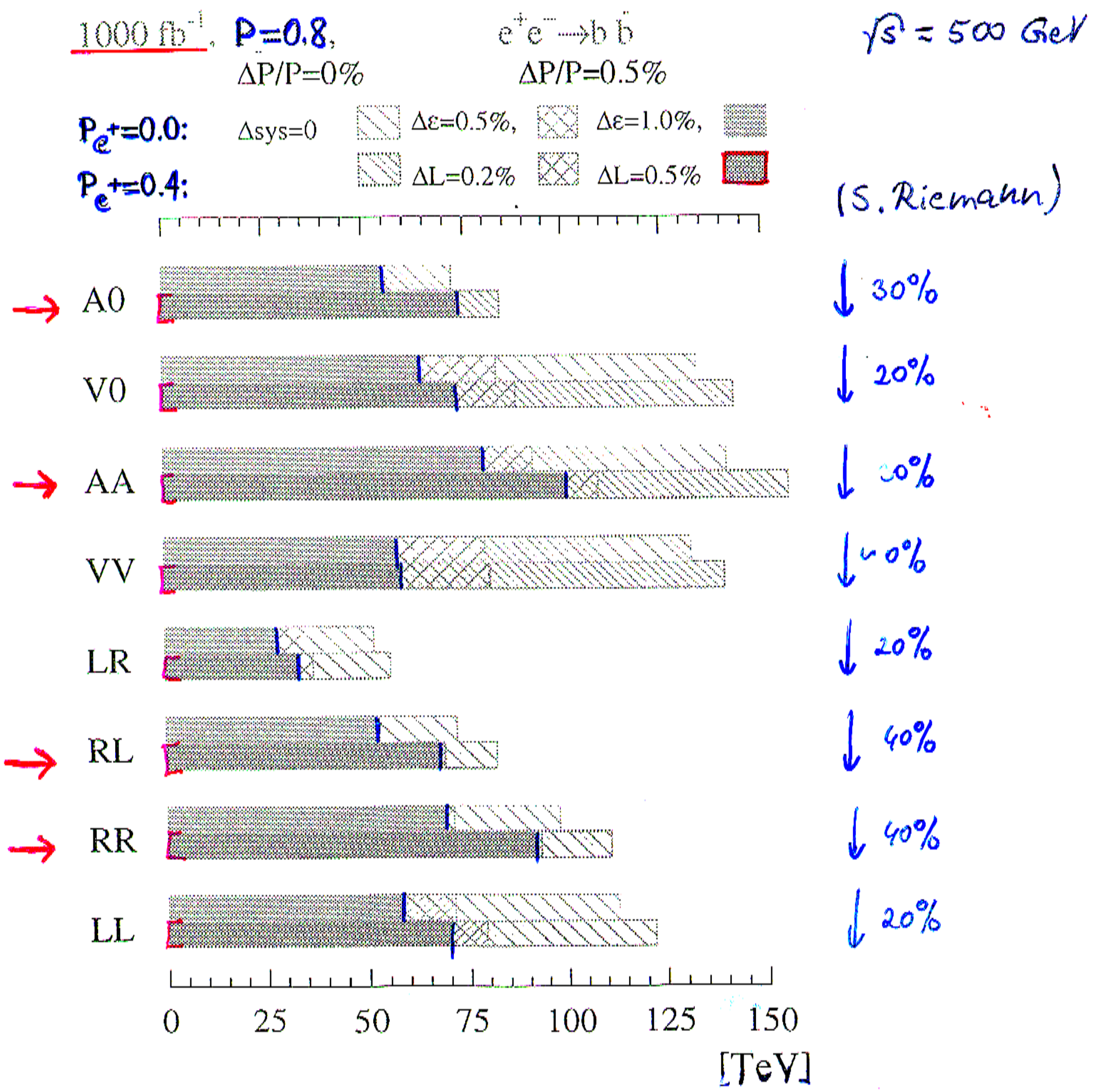
$\Rightarrow$ $P(e^+)$ especially helpful for Alternatives!!

Expected Sensitivity from $e^+e^- \to b\bar{b}$

With $P(e^+)=40\%$ ($\hat{=}$ no lost in e^+ intensity!):

$\Rightarrow$ Reach further enlarged by

up to 40% !



Extra Dimensions

Signal: $e^+e^- \to \gamma G$

Background: $e^+e^- \to \nu\bar{\nu}\gamma$

Compared with case $P(e^-)=80\%$ and $P(e^+)=0$:

$\Rightarrow$ With $P(e^-)=80\%$, $P(e^+)=60\%$: we gain up to 16%!

$\sqrt{s}=800$ GeV $\qquad \mathcal{L}=1000\,fb^{-1}$

(A. Vest)

Anzahl der Extra-Dimensionen	Polarisation	M_D in TeV für $\frac{\Delta f_N}{f_N}=1\%$	M_D in TeV für $\frac{\Delta f_N}{f_N}=0.1\%$
$\delta=2$	$P_{e^-}=0,\ P_{e^+}=0$	6.5	7.0
	$P_{e^-}=0.8,\ P_{e^+}=0$	7.9	9.1
	$P_{e^-}=0.8,\ P_{e^+}=0.45$	16% 8.7	14% 10.0
	$P_{e^-}=0.8,\ P_{e^+}=0.6$	9.2	10.4
$\delta=3$	$P_{e^-}=0,\ P_{e^+}=0$	4.8	5.1
	$P_{e^-}=0.8,\ P_{e^+}=0$	5.6	6.2
	$P_{e^-}=0.8,\ P_{e^+}=0.45$	6.0	6.8
	$P_{e^-}=0.8,\ P_{e^+}=0.6$	6.3	6.9
$\delta=4$	$P_{e^-}=0,\ P_{e^+}=0$	3.7	3.9
	$P_{e^-}=0.8,\ P_{e^+}=0$	4.3	4.7
	$P_{e^-}=0.8,\ P_{e^+}=0.45$	4.6	5.0
	$P_{e^-}=0.8,\ P_{e^+}=0.6$	4.7	5.1
$\delta=5$	$P_{e^-}=0,\ P_{e^+}=0$	3.1	3.2
	$P_{e^-}=0.8,\ P_{e^+}=0$	3.4	3.7
	$P_{e^-}=0.8,\ P_{e^+}=0.45$	3.6	3.9
	$P_{e^-}=0.8,\ P_{e^+}=0.6$	3.8	4.0
$\delta=6$	$P_{e^-}=0,\ P_{e^+}=0$	2.6	2.7
	$P_{e^-}=0.8,\ P_{e^+}=0$	2.9	3.1
	$P_{e^-}=0.8,\ P_{e^+}=0.45$	3.1	3.3
	$P_{e^-}=0.8,\ P_{e^+}=0.6$	3.1	3.3
$\delta=7$	$P_{e^-}=0,\ P_{e^+}=0$	2.0	2.1
	$P_{e^-}=0.8,\ P_{e^+}=0$	2.2	2.3
	$P_{e^-}=0.8,\ P_{e^+}=0.45$	2.3	2.4
	$P_{e^-}=0.8,\ P_{e^+}=0.6$	2.4	2.5

④

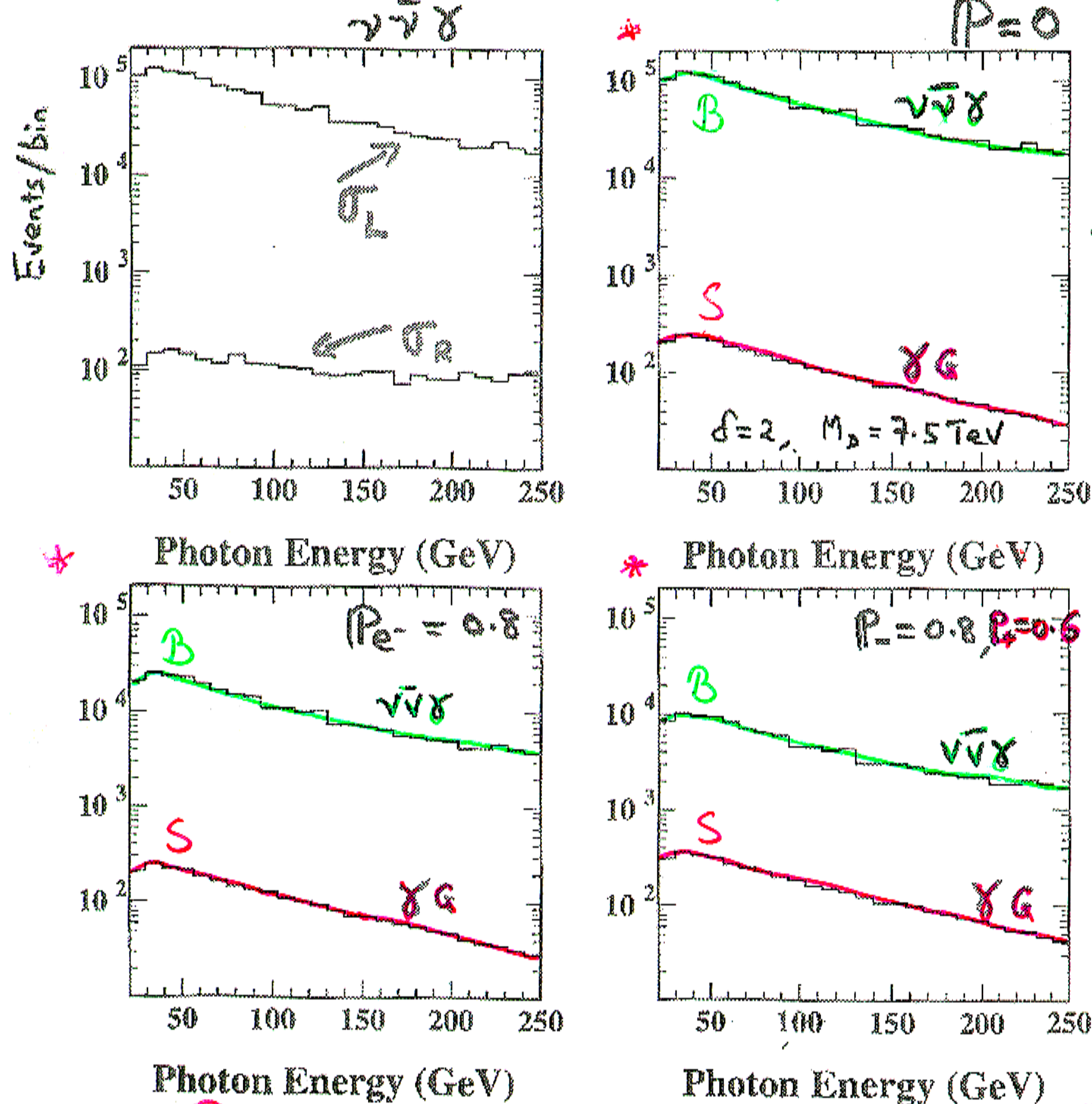
POLARISATION is THE KEY!

Background: $e^+e^- \to \nu\bar{\nu}\gamma$

$\sqrt{s} = 800$ GeV

$\mathcal{L} = 1\,ab^{-1}$

(G. Wilson)



$\nu\bar{\nu}\gamma$ BKG LOOK JUST LIKE THE SIGN

- The $\frac{S}{\sqrt{B}}$ significance improves by 2.2 and by 5.0
- equivalent* to lumi upgrades of $\times 5$ and $\times 25$

...

$P_{e^-} \leftrightarrow P_{e^-}$ AND P_{e^+}

Direct observation:see further talks at this workshopT

Indirect limits:see also J. Hewett
for $\sqrt{s}$ =500 GeV, L_{int} =1000 fb^{-1}, $ee \to ff$:

$$M_S \geq 5.3TeV$$

Specifics:

- angular distribution: charge identification of bb, cc final states reduces statistics
- polarisation error is ~~not~~ so important:P_{e^+} improves the limits slightly , up to 8% .

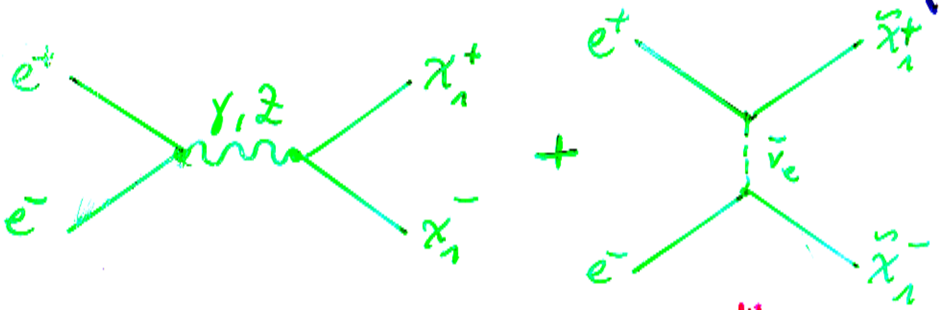
	M_S [TeV]		
	$P_{e^+} = 0.4$		$P_{e^+} = 0.0$
ee$\to \mu\mu$	4.05	$\xleftarrow{+7\%}$	3.78
ee$\to$ bb	4.74	$\xleftarrow{+7\%}$	4.42
ee$\to$ cc	4.73	$\xleftarrow{+8\%}$	4.38
combined	5.34	$\xleftarrow{+8\%}$	4.96

$\Rightarrow$ In indirect search: gain "only" up to 8% with P(e+)

Parameter Determination

$e^+e^- \to \tilde{\chi}_i^+ \tilde{\chi}_j^-$: $M_2, \mu, \tan\beta, (\phi_\mu)$

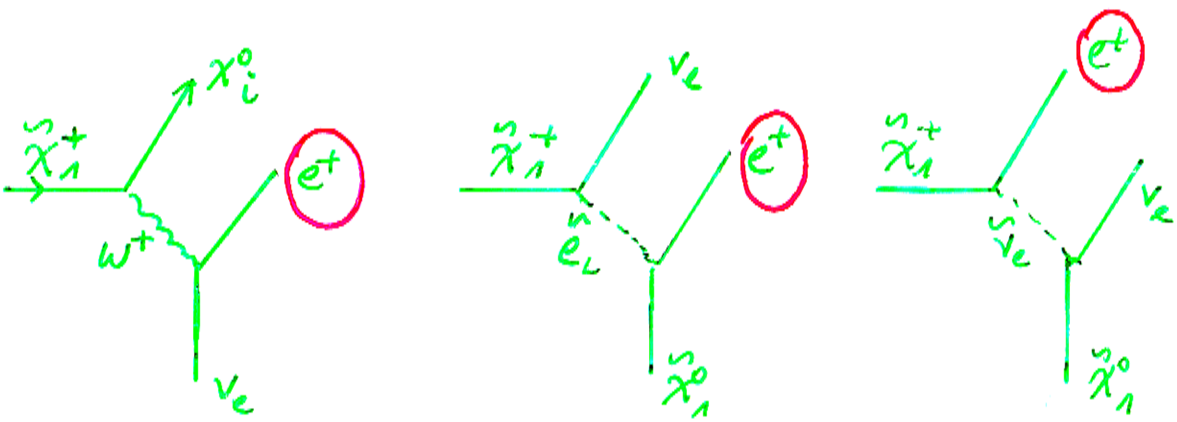
(→ see talk Kalinowski)



$\Downarrow$

Constraining $m_{\tilde{\nu}}$?

+ $\chi_1^+ \to \chi_1^0 e^+ \nu$:



Observable: A_{FB} of decay e^-

⇒ Production ⊗ Decay

Spin correlations!

(GMP '99)

Determining $m_{\tilde{\nu}} > \sqrt{s}/2$?

$e^+e^- \to \tilde{\chi}_1^+ \tilde{\chi}_1^- \to \tilde{\chi}_1^+ \tilde{\chi}_1^0 \bar{\nu} e^-$ (spin correlations!)

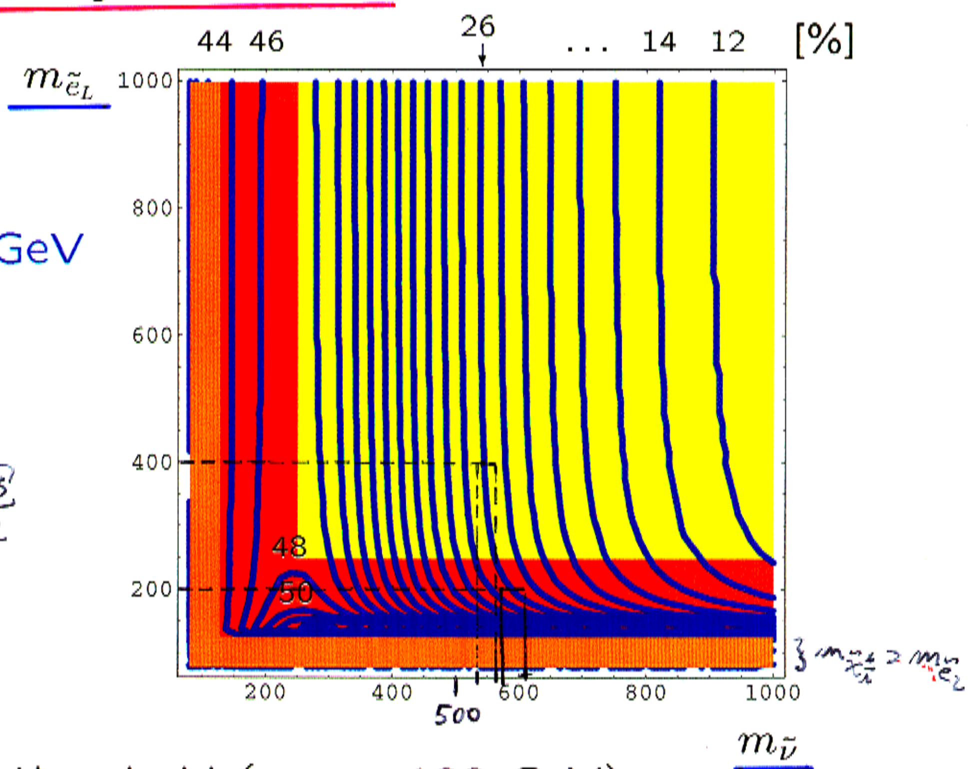
polarized beams: $P_{e^-} = -85\%$, $P_{e^+} = +60\%$ M.-P. et al. '00

$\Longrightarrow$ highest cross section!

A_{FB} of decay electron:

$\sqrt{s} = 500$ GeV

$= m_{\tilde{e}_L}, m_{\tilde{\nu}} < \frac{\sqrt{s}}{2}$



Since $\sqrt{s} \gg$threshold ($m_{\tilde{\chi}_1^\pm} = 128$ GeV):

$\to$ high values of A_{FB}

$\to$ very sensitive to $m_{\tilde{\nu}}$, even for large $m_{\tilde{\nu}}$!

$\to$ only weakly dependent on $m_{\tilde{e}_L}$

Measured: $A_{FB} = 26\% \pm 0.5\%$ ($\mathcal{L} = 500$ fb^{-1})

if $m_{\tilde{e}_L} = 200$ GeV $\Rightarrow$ 590 GeV$< m_{\tilde{\nu}} <$610 GeV

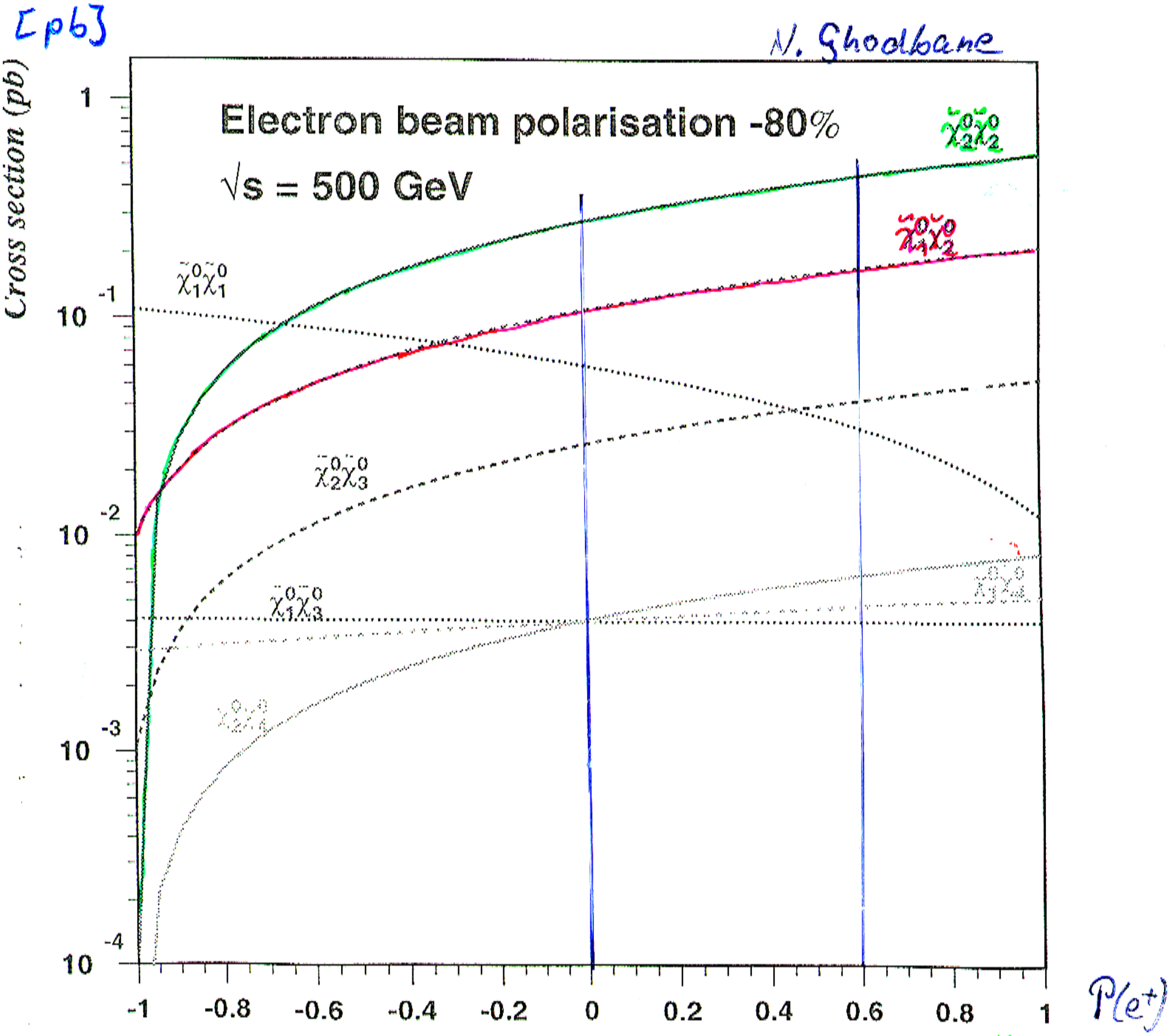
if $m_{\tilde{e}_L} > 250$ GeV $\Rightarrow$ 540 GeV$< m_{\tilde{\nu}} <$580 GeV

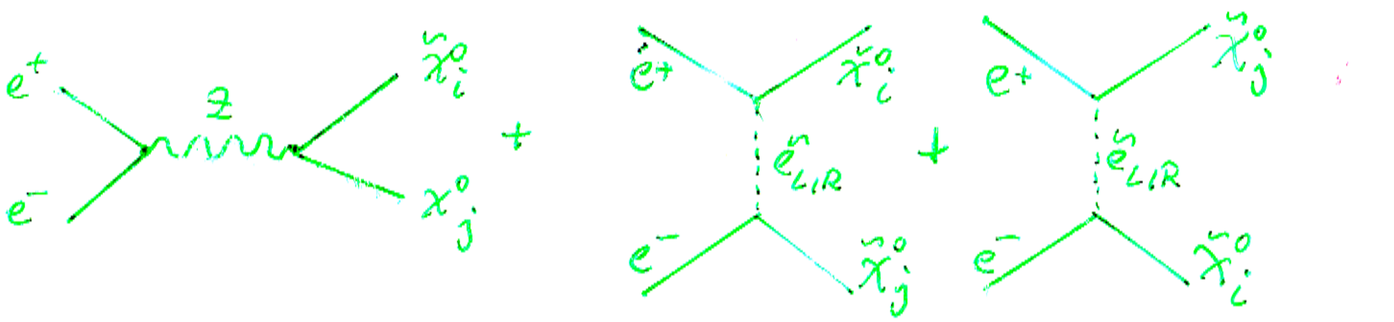
Prediction possible even if $m_{\tilde{\nu}} > \sqrt{s}/2$ (high $\mathcal{L}$)!

$\sigma(e^+e^- \to \tilde{\chi}^0_i \tilde{\chi}^0_j)$ in MSSM

LC-Scenario for $\tan\beta = 3$: $M_2 = 152\,\mathrm{GeV}$, $\mu = 316\,\mathrm{GeV}$

e.g. $P(e^-) = -80\%$: $\sigma_L(\chi^0_1\chi^0_2) \xrightarrow{P(e^+)=60\%} \underline{1.6}\, \sigma_L(\chi^0_1\chi^0_2)$





Beam Polarization ⇒ 'Weighting–Factors' W_{pol}

(including P_{e^-}, P_{e^+} and lepton couplings L_ℓ, R_ℓ)

Cross Section:

$$\sigma_P(e^+e^- \to \tilde{\chi}^0_1\tilde{\chi}^0_2)$$
$$= \sigma_P(Z) + \sigma_P(\tilde{e}_L) + \sigma_P(\tilde{e}_R) + \sigma_P(Z\tilde{e}_L) + \sigma_P(Z\tilde{e}_R)$$
$$= W_{pol}(Z)\tilde{\sigma}_P(Z) + \underbrace{W_{pol}(\tilde{e}_L)}_{=(1-P_{e^-})(1+P_{e^+})}\tilde{\sigma}_P(\tilde{e}_L) + \underbrace{W_{pol}(\tilde{e}_R)}_{=(1+P_{e^-})(1-P_{e^+})}\tilde{\sigma}_P(\tilde{e}_R) + \text{int.t.}$$

P_{e^-} (P_{e^+}): longitudinal e^- (e^+) polarization

Ordering of $\sigma_P^{(sgnP_{e^-},sgnP_{e^+})}$ important:

a) Pure higgsinos:
$\sigma_P^{-+} > \underline{\sigma_P^{+-}} > \sigma_P^{-0} > \sigma_P^{00} > \sigma_P^{+0} > \sigma_P^{--} > \sigma_P^{++}$

b) Pure gauginos and $m_{\tilde{e}_L} \gg m_{\tilde{e}_R}$:
$\sigma_P^{+-} > \sigma_P^{+0} > \sigma_P^{00} > \sigma_P^{++} > \sigma_P^{--} > \sigma_P^{-0} > \sigma_P^{-+}$

c) Pure gauginos and $m_{\tilde{e}_L} \ll m_{\tilde{e}_R}$:
$\sigma_P^{-+} > \sigma_P^{-0} > \sigma_P^{00} > \sigma_P^{--} > \sigma_P^{++} > \sigma_P^{+0} > \underline{\sigma_P^{+-}}$

3f $P(e^+)=0$

a) = c)

Polarizing both beams: Information about mixing character and/or $m_{\tilde{e}_L}$, $m_{\tilde{e}_R}$

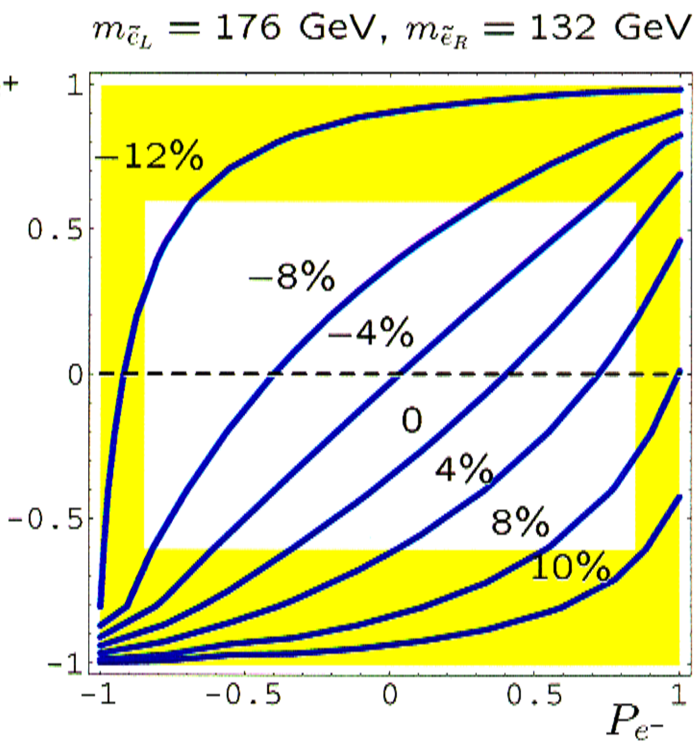
Constraining $m_{\tilde{e}_L}, m_{\tilde{e}_R} > \sqrt{s}/2$?

$e^+e^- \to \tilde{\chi}^0_1\tilde{\chi}^0_2 \to \tilde{\chi}^0_1\tilde{\chi}^0_1 e^+e^-$ (spin correlations!)

spin correlations! (← if neglected: $A_{FB} \equiv 0$, "Majorana")

A_{FB} of decay electron:

$\sqrt{s} = 230$ GeV



Beam Polarization of both beams

⇒ enhances A_{FB} !

⇒ enhances σ_e !

- if $\sqrt{s} \geq m_{\tilde{\chi}^0_1} + m_{\tilde{\chi}^0_2}$: large A_{FB} up to ±12% possible
- if $\sqrt{s} \gg m_{\tilde{\chi}^0_1} + m_{\tilde{\chi}^0_2}$: $A_{FB} \approx 0$ (Majorana)!!!

Constraining $m_{\tilde{e}_L}, m_{\tilde{e}_R} > \sqrt{s}/2$?

$e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_2^0 \to \tilde{\chi}_1^0\tilde{\chi}_1^0 e^+e^-$ (spin correlations!)

polarized beams: $P_{e^-} = -85\%$, $P_{e^+} = +60\%$

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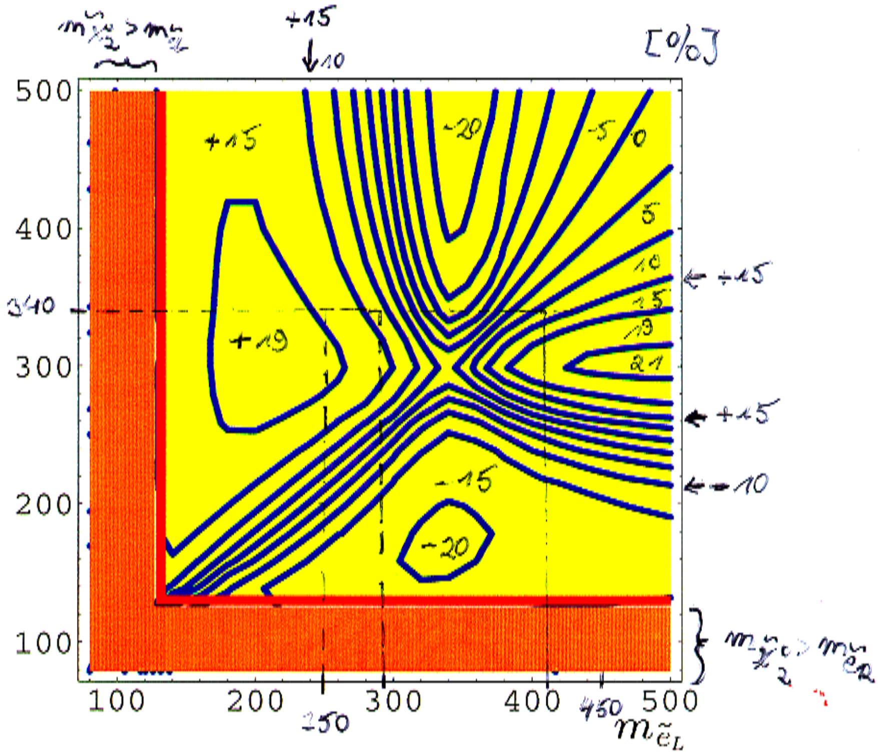
$\rightarrow$ highest cross section!

A_{FB} of decay electron:

$\sqrt{s} = 230$ GeV

$= m_{\tilde{e}_L}, m_{\tilde{e}_R} < \frac{\sqrt{s}}{2}$



Since $\sqrt{s} = m_{\tilde{\chi}_1^0} + m_{\tilde{\chi}_2^0} + 30$ GeV:

$\rightarrow$ very sensitive to $m_{\tilde{e}_L}$ and to $m_{\tilde{e}_R}$!

Example: $m_{\tilde{e}_R} = 340$ GeV

high $\mathcal{L} = 500$ fb^{-1}: measured $A_{FB} = 15\% \pm 3\%$

$\Rightarrow$ 250 GeV< $m_{\tilde{e}_L}^{exp}$ <300 GeV $\rightarrow$ direct production

or $\Rightarrow$ 410 GeV< $m_{\tilde{e}_L}^{exp}$ <600 GeV

Constraining possible if $m_{\tilde{e}_L} > \sqrt{s}/2$

$e^+e^- \to \tilde{\chi}^0_1 \tilde{\chi}^0_2$: "E6"

- similar behaviour as NMSSM
- very small σ : any scaling factor needed!

$\Rightarrow$ $P(e^+)$ can be important for "survival".