

Polarization White Paper

Gudi m-p

Write-Up: 'Beam Polarisation at a LC'

(Wed. Afternoon)

The 'Polarisation Write-up' should be addressed to our HEP community and should give a comprehensive overview about theoretical, experimental and machine issues of beam polarisation and should stress our physics case for the use of polarised beams at a LC. In particular it should summarise either the physics cases but also the technical issues – like generation, measurement and cost – of polarised positrons and should list the ongoing activities concerning beam polarisation at a future LC.

For each topic the contact persons of the editorial board are given and everybody who made a study with regard to beam polarisation should contact these people himself. It is planned to have a **draft in the end of June.**

PLEASE LET US KNOW ABOUT YOUR CONTRIBUTIONS!

Authorship of this document does not mean that you have to write yourself – but you can, of course – but it would be highly appreciated that you at least inform the contact persons about your study with key points, references and main results.

IN ORDER TO MAKE OUR WANTED LC AS EFFICIENT AS POSSIBLE, PLEASE, GIVE YOUR INPUT TO THE CONTACT PERSONS!

Proposal:

I. Introduction:

Theory: chirality \leftrightarrow helicity, definitions, conventions, history
Beam polarisation as an analyzer for the coupling structure
Expected degree of polarisation at a future LC

II. Physics with Polarisation:

Electron polarisation only: quite short, good summary and list of references
Update (e.g. CP-violation in tau sector, news)
SM \rightarrow New Physics

Contact: *Herb Steiner + Tac Hirase*

Electron+positron polarisation: Improved accuracy for effective polarisation

Table with background scaling factors for W and Z
(and S/B and S/sqrt(B))
Few examples from SM, Higgs,.....
Susy background studies,...

Contact: *Uriel Nauenberg + Achim Stahl*

Positron polarisation essential for: Update,
Susy studies (chiral quantum numbers of selectrons, e.g.)
Highest precision at GigaZ
'Preparation for new physics searches'
Try to make all studies more homogeneous

Contact: *Herb Steiner + Gudi*

Physics case for transverse polarisation: Sensitivity to longitudinal W-bosons ←
CP-violation phenomena
Effects in Susy and Extra dimension
Test of mixing matrices for Susy particles

Contact: *Tac Hirose + Tom Rizzo + Gudi*

III. Machine issues:

Remarks about machine operation of polarised sources: Loss of luminosity?
Machine time for running-in
Reduced intensity of positron beam?
Increased energy spread?
Order of magnitude of saved money?

Electron polarisation: History, results, short description of the hardware
New developments in gradient doping

Contact: *Tsutomu Nakanishi + John Sheppard + Mike Woods*

Positron polarisation: Description of the hardware, possible schemes
Order of magnitude of additional costs
Helical undulator from the very beginning
Design and operation characteristics of spin rotators
Number of spin rotators
Plans/results from Cornell
Plans/results from Daresbury
Expected polarisation degree (E-dependence?)
Impact on lumi and energy spread
Cost
Description of E166: short description

physics potential: what does it tests?
for what is it essential?

Contact: *Klaus Floettmann + Tsunehiko Omori + Rainer Pitthan + John Sheppard*

Transverse polarisation: short description of hardware
order of magnitude of additional costs
which R&D needed?
cost of spin rotators?

Contact: *Klaus Floettmann + John Sheppard*

IV. Polarisation Measurement:

History, results

Possibilities: Compton, Moeller, Bhabha
Technical potential
Pro's and Con's

Electron+positron polarisation: short description of the polarimeter
Polarimetry for transverse beam polarisations
Achievable precision
Polarisation transport and depolarisation in the IP
Polarimetry up- and/or downstream?
Technical possibilities at the LC designs
Cost
Polarimetry needed for E166

Contact: *Peter Schueler + Mike Woods*



Editorial Board: 'Polarisation dream team'

Physics: Tachishige Hirose, Uriel Nauenberg, Thomas Rizzo, Achim Stahl,
Herb Steiner and myself
Machine: Klaus Floettmann, Tsutomu Nakanishi, Tsunehiko Omori,
Rainer Pitthan, John Sheppard
Polarimetry: Peter Schueler, Mike Woods

Back to the [POWER homepage](#)

Last update of this page: 19-March-03

by *Gudi*

Discriminating graviton effects via centre-edge asymmetry

(hep-ph/0304123)

N. Paver
University of Trieste

Amsterdam, April 2003

- A Plethora of New Physics
- The centre-edge asymmetry A_{CE}
- Applications

(with P. Osland and A. Pankov)

- New technique for
Differentiation of Various Contact Int. Signatures ¹
- Moment method / transverse polarization
asymmetry (T&K)
JHEP 0210(1002)013
hep-ph/0211324

Various New Physics possibilities

- Composite models
- Heavy Z' exchanges
- Scalar and vector leptoquarks
- Sneutrino exchange
- Anomalous Gauge Couplings (AGC)
- Exchange of gauge boson KK towers
- Virtual KK graviton exchange (ADD) ← Spm-2

Many
Contact Int.
Sources

Framework of effective Lagrangians
(expansion in s/Λ^2)

Deviations of cross sections from SM
predictions

Study process ($f \neq e, t$)

$$e^+ + e^- \rightarrow f + \bar{f}$$

Contact interaction terminology

Helicity cross sections:

$$\frac{d\sigma}{dz} = \frac{1}{4} \left(\frac{d\sigma_{LL}}{dz} + \frac{d\sigma_{RR}}{dz} + \frac{d\sigma_{LR}}{dz} + \frac{d\sigma_{RL}}{dz} \right)$$

$$z \equiv \cos \theta$$

$$\frac{d\sigma_{\alpha\beta}}{dz} = N_C \frac{\pi \alpha_{e.m.}^2}{2s} |\mathcal{M}_{\alpha\beta}|^2 (1 \pm z)^2$$

Helicity amplitudes:

$$\mathcal{M}_{\alpha\beta} = \mathcal{M}_{\alpha\beta}^{SM} + \Delta_{\alpha\beta} = \underbrace{Q_e Q_f}_{\gamma} + \underbrace{g_\alpha^e g_\beta^f}_{Z} \chi_Z + \underbrace{\Delta_{\alpha\beta}}_{\text{extra}}$$

Bsm pieces (with arrows pointing to $\Delta_{\alpha\beta}$ and $\Delta_{\alpha\beta}$)

$$\chi_Z = s / (s - M_Z^2 + iM_Z \Gamma_Z) \approx s / (s - M_Z^2)$$

$$g_L^f = (I_{3L}^f - Q_f s_W^2) / s_W c_W$$

$$g_R^f = -Q_f s_W / c_W$$

$$s_W^2 = 1 - c_W^2 \equiv \sin^2 \theta_W$$

Parametrization of the $\Delta_{\alpha\beta}$ functions in different models ($\alpha, \beta = L, R$)

Model	$\Delta_{\alpha\beta}$
composite fermions	$\pm \frac{s}{\alpha_{em} \Lambda_{\alpha\beta}^2}$
extra gauge boson Z'	$g_\alpha^c g_\beta^f \chi Z$
AGC ($f = \ell$)	$\Delta_{LL} = s \left(\frac{f_{DW}}{2s_W^2} + \frac{2f_{DB}}{c_W^2} \right)$ $\frac{\Delta_{RR}}{2} = \Delta_{LR} = \Delta_{RL} = s \frac{4f_{DB}}{c_W^2}$
TeV-scale extra dim.	$(Q_f Q_f + g_\alpha^c g_\beta^f) \frac{\pi^2}{3 M_C^2}$
ADD model	$\Delta_{LL} = \Delta_{RR} = f_G (1 - 2z)$ $\Delta_{LR} = \Delta_{RL} = -f_G (1 + 2z)$

all these are $CP \otimes$ independent

Spin-2

- $\bar{f} = f/m_f^2$ (f_{DW} and f_{DB} parametrize new-physics effects associated with the SU(2) and hypercharge currents)
- M_C is the compactification scale
- $f_G = \lambda s^2 / (4\pi\alpha_{em} M_{Pl}^2)$ parametrizes strength associated with massive graviton exchange

Centre Edge Asymmetry



$$A_{CE} = \frac{\sigma_{CE}}{\sigma}$$

$$\sigma_{CE} = \left[\int_{-z^*}^{z^*} - \left(\int_{-1}^{-z^*} + \int_{z^*}^1 \right) \right] \frac{d\sigma}{dz} dz$$

$$\sigma = \int_{-1}^1 \frac{d\sigma}{dz} dz$$

Decompose cross section:

$$\sigma = \sigma^{SM} + \sigma^{INT} + \sigma^{NP}$$

"SM", "INT" and "NP" refer to "Standard Model", "Interference" and (pure) "New Physics" contributions.

$$A_{CE} = \frac{\sigma_{CE}^{SM} + \sigma_{CE}^{INT} + \sigma_{CE}^{NP}}{\sigma^{SM} + \sigma^{INT} + \sigma^{NP}}$$

Explicitly:

$$\sigma_{CE}^{SM} = \sigma_0 \frac{1}{4} [(\mathcal{M}_{LL}^{SM})^2 + (\mathcal{M}_{RR}^{SM})^2 + (\mathcal{M}_{LR}^{SM})^2 + (\mathcal{M}_{RL}^{SM})^2] \\ \times \frac{4}{3} [z^*(z^{*2} + 3) - 2],$$

$$\sigma_{CE}^{INT} = \sigma_0 2 f_G \frac{1}{4} [\mathcal{M}_{LL}^{SM} + \mathcal{M}_{RR}^{SM} - \mathcal{M}_{LR}^{SM} - \mathcal{M}_{RL}^{SM}] 4z^*(1 - z^{*2}),$$

$$\sigma_{CE}^{NP} = \sigma_0 f_G^2 \frac{4}{5} [4z^{*5} + 5z^*(1 - z^{*2}) - 2]$$

$$\sigma_0 = N_c \frac{\pi \alpha_{em}^2}{2s}$$

$$\sigma^{SM} = \sigma_0 \frac{1}{4} [(\mathcal{M}_{LL}^{SM})^2 + (\mathcal{M}_{RR}^{SM})^2 + (\mathcal{M}_{LR}^{SM})^2 + (\mathcal{M}_{RL}^{SM})^2] \frac{8}{3},$$

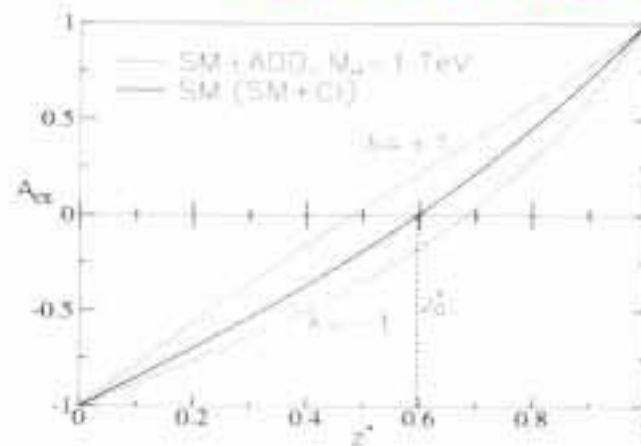
$$\sigma^{INT} = 0, \quad \sigma^{NP} = \sigma_0 f_G^2 \frac{8}{5}$$

Note that, at $z^* = 0$ and 1 , $\sigma_{CE} = \mp \sigma$, respectively.

Centre Edge Asymmetry in SM

$$A_{CE}^{SM} = \frac{\sigma_{CE}^{SM}}{\sigma_{SM}} = \frac{1}{2} z^* (z^{*2} + 3) - 1.$$

Same for all massless fermions if no spin-2



← zero shift due to spin-2

Independent of s , flavour, longitudinal polarization

Zero of $A_{CE}^{SM}(z^*)$:

$$z_0^* = (\sqrt{2} + 1)^{1/3} - (\sqrt{2} - 1)^{1/3} = 0.596$$

$\theta = 53.4^\circ$ (solid curve in Fig.)

8

location of Asymmetry zero indep. of new physics UNLESS spin-2

Centre Edge Asymmetry for CI

$$A_{CE}^{SM+CI} = \frac{\sigma_{CE}^{SM+CI}}{\sigma^{SM+CI}}$$

with

$$\sigma_{CE}^{SM+CI} = \sigma_0 \frac{1}{4} [(M_{LL})^2 + (M_{RR})^2 + (M_{LR})^2 + (M_{RL})^2] \\ \times \frac{4}{3} [z^*(z^{*2} + 3) - 2]$$

$$\sigma^{SM+CI} = \sigma_0 \frac{1}{4} [(M_{LL})^2 + (M_{RR})^2 + (M_{LR})^2 + (M_{RL})^2] \frac{8}{3}$$

$$A_{CE}^{SM+CI} = \frac{1}{2} z^*(z^{*2} + 3) - 1$$

THIS IS THE SAME RESULT AS IN SM

Reason: Vector couplings

Conventional "contact-like" interactions
"filtered" out

Graviton Exchange

Graviton exchange in the ADD model:

$$\Delta A_{CE} = A_{CE} - A_{CE}^{SM}$$

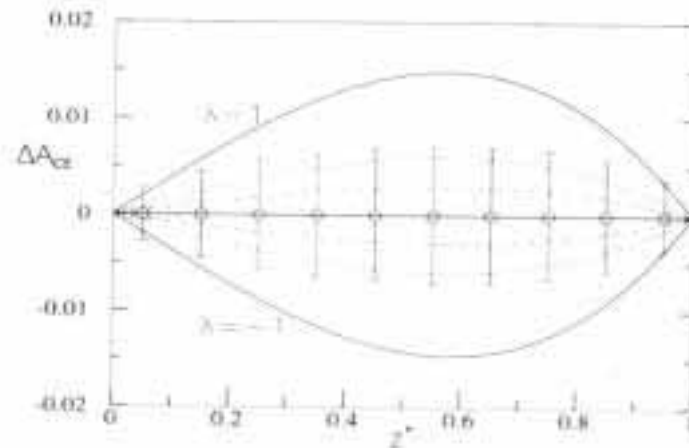
σ_{CE}^{INT} produces largest deviation

Interference terms only:

$$\Delta A_{CE} \simeq f_f \frac{\mathcal{M}_{LL}^{SM} + \mathcal{M}_{RR}^{SM} - \mathcal{M}_{LR}^{SM} - \mathcal{M}_{RL}^{SM}}{[(\mathcal{M}_{LL}^{SM})^2 + (\mathcal{M}_{RR}^{SM})^2 + (\mathcal{M}_{LR}^{SM})^2 + (\mathcal{M}_{RL}^{SM})^2]} \times 3z^*(1-z^{*2})$$

Depends on flavour of final state f

Working at point z^* where SM contribution vanishes, this effect of graviton exchange can be isolated.



quite
sensitive
to
 M_H finite

$M_H = 2$ (solid), 2.5 (dotted)

3 TeV (dash-dotted)

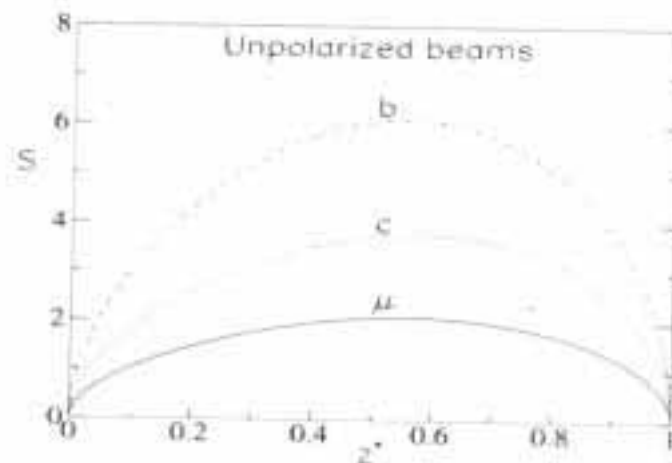
$\lambda = \pm 1$ and $\sqrt{s} = 0.5$ TeV

$\mathcal{L}_{\text{int}} = 50 \text{ fb}^{-1}$

At the point z_0^* where $A_{\text{CE}}^{\text{SM}}$ vanishes, the effect is maximal

Sensitivity

$$S = \frac{|\Delta A_{CE}|}{\delta A_{CE}}$$



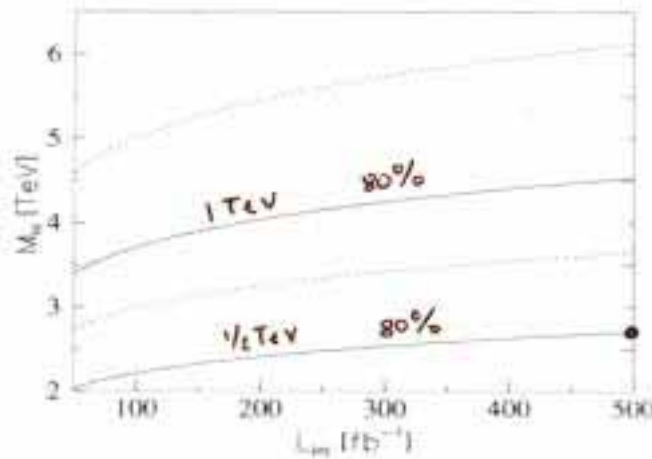
$M_H = 2 \text{ TeV}$, $\mathcal{L}_{\text{int}} = 50 \text{ fb}^{-1}$, $\lambda = 1$,
 $\sqrt{s} = 500 \text{ GeV}$.

Rec. efficiency: $\epsilon_{\mu, \tau} = 100\%$; $\epsilon_c = 60\%$;
 $\epsilon_b = 80\%$

Max of S at $z_{\text{max}}^* \approx 1/\sqrt{3} = 0.577$ ($\theta = 54.7^\circ$),
close to $z_0^* = 0.596$ ($\theta = 53.4^\circ$)

Smooth behaviour around z_0^*

5 σ Reach on M_H (summed over μ, τ, b, c):



Spin-2
ID to
 $\approx 5-6\sqrt{s}$

Solid: unpolarized

Dashed: $P = 0.8, \bar{P} = -0.6$

$\delta\mathcal{L}_{\text{int}}/\mathcal{L}_{\text{int}} = \delta P/P = \delta\bar{P}/\bar{P} = 0.5\%$

$z_{\text{cut}} = 0.985 (10^0) [-z_{\text{cut}} \leq z \leq z_{\text{cut}}]$

Top down: $\sqrt{s} = 1 \text{ TeV}, 0.5 \text{ TeV}$

This is
quite
comparable
to the
Legendre poly
method...

HUNTING RANDALL-SUNDRUM RADIONS IN e^+e^- COLLISION

the Randall-Sundrum

What is the reach for a radion production
at LC ?

Anindya Datta
Helsinki Institute of Physics

in collaboration with
K. Huitu, HIP

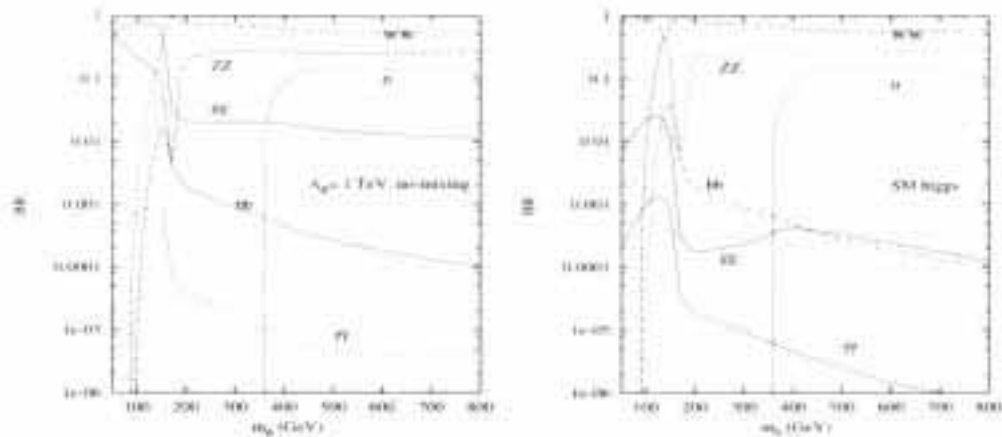
- Radion couples to matter/SM fields via T_μ^μ

$$\mathcal{L} = \frac{1}{\Lambda_\phi} \phi T_\mu^\mu \quad \leftarrow \text{Stress-energy tensor trace}$$

$\Lambda_\phi \approx \text{TeV}$

$$T_\mu^\mu = \sum m_f \bar{f} f + m_V^2 V_\mu V^\mu + \frac{\beta(g_s)}{2g_s} G^{\mu\nu} G_{\mu\nu} + \frac{\beta(e)}{2e} F^{\mu\nu} F_{\mu\nu} + (2m_h^2 h^2 - \partial_\mu h \partial^\mu h)$$

- Couplings are very similar to the SM higgs



Gluon Gluon decay branching ratio is drastically enhanced w.r.t the SM higgs !

- + At LHC, enhanced coupling to gg was exploited:

$$pp(gg) \rightarrow \phi \rightarrow \gamma\gamma, ZZ, WW$$

- Apart from this... **Radion-Higgs mixing:**

$$S = -\xi \int d^4x \sqrt{-g_{vis}} R(g_{vis}) H^\dagger H$$

$R(g_{vis}) \rightarrow$ Ricci scalar on SM brane..with metric g_{vis}

$$\langle H \rangle = v, \quad \langle \phi \rangle = \Lambda_\phi, \quad \text{with} \quad \gamma \equiv \frac{v}{\Lambda_\phi} \lesssim 0.1-0.2$$

- Kinetic Mixing between Higgs and Radion.....

$$\begin{pmatrix} \phi \\ H \end{pmatrix} \rightarrow \begin{pmatrix} \phi' \\ H' \end{pmatrix} \equiv Z_R \mathcal{M}^{-1} \begin{pmatrix} \phi \\ H \end{pmatrix}$$

$$\mathcal{M} = \begin{pmatrix} \cos \theta & -\sin \theta \\ Z_R \sin \theta - 6\xi\gamma \cos \theta & Z_R \cos \theta + 6\xi\gamma \sin \theta \end{pmatrix}$$

where

$$Z_R^2 = 1 - 6\xi\gamma^2(1 + 6\xi) \quad \tan 2\theta = \frac{12\xi\gamma Z_R m_h^2}{m_H^2(Z_R^2 - 36\xi^2\gamma^2) - m_\phi^2}$$

$$m_\phi^2 = (\mathcal{M}_{21}^2 m_h^2 + \mathcal{M}_{11}^2 m_\phi^2) / Z_R^2 \quad m_h^2 = (\mathcal{M}_{22}^2 m_h^2 + \mathcal{M}_{12}^2 m_\phi^2) / Z_R^2$$

- Kinetic terms must be **positive**...

$$\frac{-1}{12} \left(1 + \sqrt{1 + 4/\gamma^2} \right) \leq \xi \leq \frac{1}{12} \left(\sqrt{1 + 4/\gamma^2} - 1 \right)$$

$$\Lambda = 1 \text{ TeV} \rightarrow -0.75 < \xi < 0.59$$

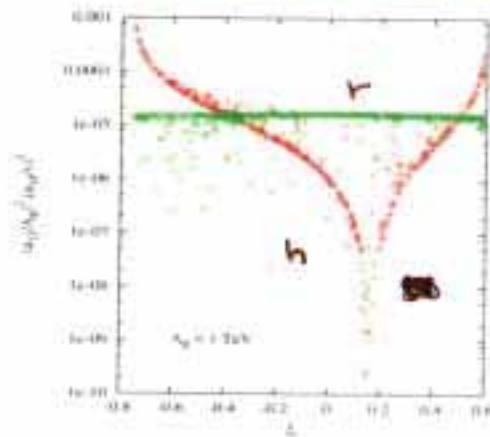
$$\Lambda = 10 \text{ TeV} \rightarrow -6.7 < \xi < 6.6$$

Unitarity in $W_L W_L$ scattering amplitudes constrain ξ , Λ_ϕ

Effects of Higgs-Radion mixing on the couplings

$$\mathcal{L} = -\frac{1}{\Lambda_\phi} (m_{ij} \bar{\psi}_i \psi_j - M_V^2 V_{A\mu} V_A^\mu) \left[a_{34} \frac{\Lambda_\phi}{v} h + a_{12} \phi \right]$$

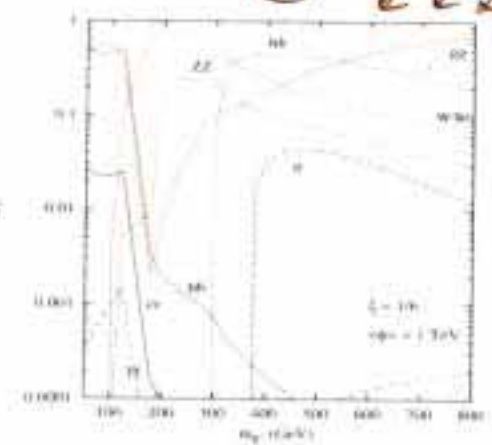
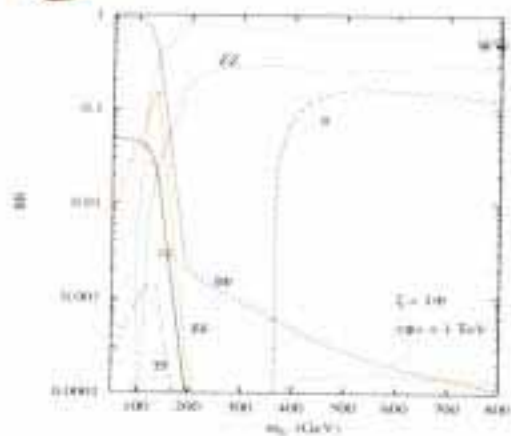
also non-trivial effect on gg coupling



$\xi = 1/6$

(H)

(\gamma)



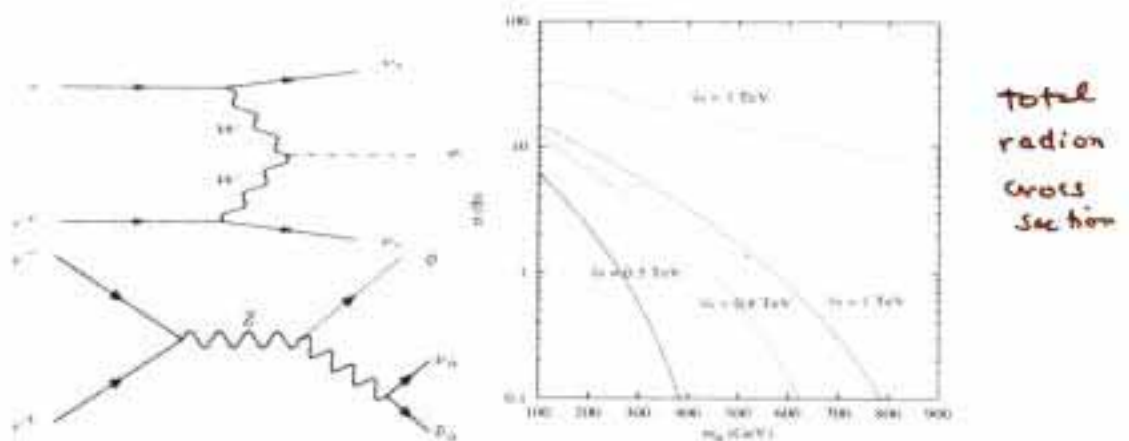
around $\xi = \frac{1}{6}$, gg branching ratio is close to 1 for heavy radions also..due to smallness of ϕ coupling to $V, f...$ (soon see it is a no-lose situation for us..!!)

- What can we say at the Linear e^+e^- colliders ?

Important: Can we also differentiate it from SM higgs ?

Should use some production/decay mode which is different from SM higgs ? $\gamma\gamma$ or gg .

For $\sqrt{s_{ee}} > 500$ GeV $e^+e^- \rightarrow \nu\bar{\nu}\phi$ is the dominant production mode.



ϕ production at $\Lambda_\phi = 1$ TeV: suppressed w.r.t h_{SM} production by a factor of 16 ($\sim \frac{\lambda}{\Lambda_\phi^2}$) $\xi = 1/6$

Consider Heavy neutrinos

Choose a decay mode to compensate this suppression...

We propose to investigate $e^+e^- \rightarrow \nu\bar{\nu}(\phi \rightarrow)gg$

At an e^+e^- collider gg final state is not difficult to handle !

Similar final state can arise in SM from

$$e^+e^- \rightarrow (\gamma^*, Z^*/Z) \nu\bar{\nu} jj$$

$$e^+e^- \rightarrow \nu\bar{\nu}(\gamma^*, Z^*/Z, WW) jj: \text{ same topology with signal...}$$

difficult topology at LHC

Discriminating features:

1. Invariant mass of the jets....

for signal it is coming from ϕ , peaked around m_ϕ

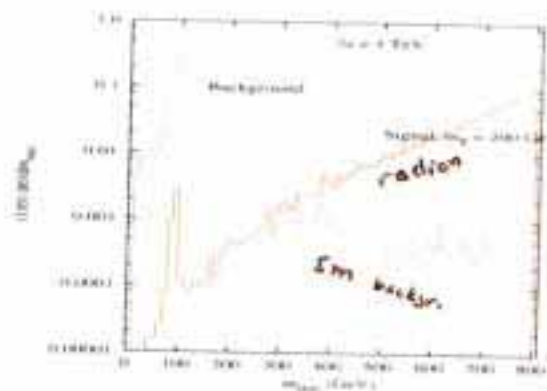
a dominant part of background also comes from Z ...

around Z mass our channel is not efficient....

2. Mass of the system recoiling against the jets...

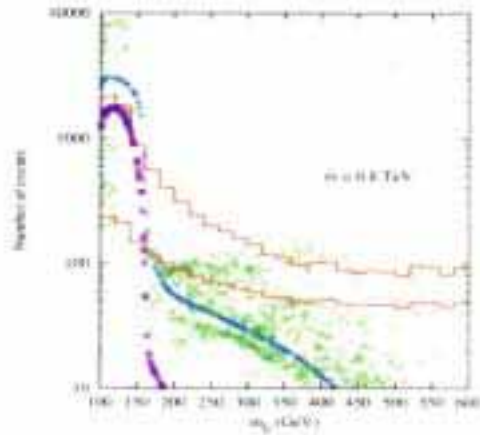
has a sharp edge for signal $\sim (\sqrt{s} - m_\phi)$

has a peak $\sim m_Z$ for background...

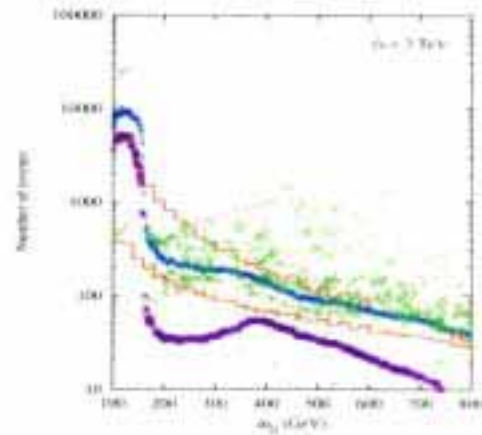
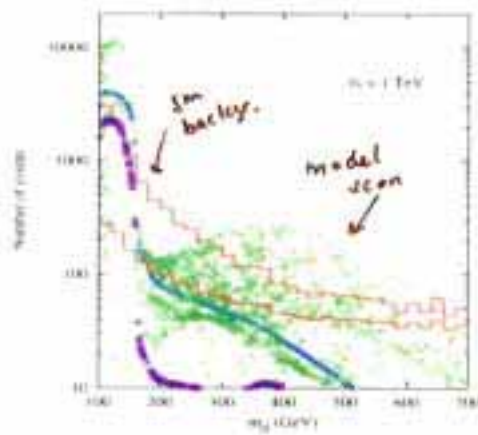


Apart from selection cuts... E_j, η etc... use $m_{jj} > 120$ GeV
then compare the invariant mass of the jet-pair for signal and background..

Let us look at some numbers....



promising
signature if
 $\sqrt{s} \geq 0.8$ TeV
+
 $m_{\text{real}} \geq 300$ GeV



Used some simple selection cuts like
 $E_j > 15$ GeV, $p > 15$ GeV, $|\eta| < 2.5$

1 TeV and 3 TeV cases are promising !!

Reconstruction of
Supersymmetric Theories
New results

Werner Porod

Amsterdam '03

in collaboration with
G. Blair, G. Polesello and P. Zerwas

- Procedure
- numerical results for mSUGRA, GMSB
- analytical proof that spectrum is sufficient to distinguish between mSUGRA and GMSB
- generate a choice of high scale parameters + run them down to weak scale \rightarrow masses + couplings
- generate 'data', cross sections etc + try to extract parameters from them
- combine + run back up - does it work?

Procedure*

- Input at m_Z : $g_1, g_2, g_3, h_l, h_d, h_u, \tan \beta$ in \overline{DR} scheme
- Using 2-loop RGEs to get the above parameters at the high scale: M_{GUT} (in mSUGRA defined via $g_1 = g_2$) or M_M (in GMSB)
- Evaluating mass parameters down to electroweak scale using 2-loop RGEs[†], including threshold effects**
- radiative electroweak symmetry breaking

$$\Rightarrow |\mu|^2 = \frac{m_{H_2}^2 \sin^2 \beta - m_{H_1}^2 \cos^2 \beta}{\cos 2\beta} - \frac{m_Z^2}{2} + \text{rad. corr.}$$

*for details see G. Blair, W. Porod, P. Zerwas, Phys. Rev. **D63** (2001) 017703; hep-ph/0210058; W. Porod, hep-ph/0301101

[†]S. Martin and M. Vaughn, Phys. Rev. **D50**, 2282 (1994); Y. Yamada, Phys. Rev. **D50**, 3537 (1994); I. Jack, D.R.T. Jones, Phys. Lett. **B333**, 372 (1994)

J. Bagger, K. Matchev, D. Pierce, and R. Zhang, Nucl. Phys. **B491, 3 (1997)

- Calculate SUSY masses at the electroweak scale. Attach experimental errors to the masses.
- Calculation of production cross sections for $\tilde{l}_{1,2}$, $\tilde{b}_{1,2}$, $\tilde{\tau}_{1,2}$ with polarized e^- and e^+ beams.
- Fit the masses and production cross sections within given experimental errors by varying the low energy parameters: M_{E_k} , M_{L_k} , M_{D_k} , M_{Q_k} , M_{U_k} , A_τ , A_b , A_t , M_{H_1} , M_{H_2} , M_i , $\tan \beta$, $k = 1, 3$, $i = 1, 2, 3$
- use again RGEs to get high scale parameters within the errors.

This is a pure bottom-up approach!

Assumptions for the Fits*

1. $\mathcal{L} = 100 \text{ fb}^{-1}$ for each scanned point
2. $\mathcal{L} = 500 \text{ fb}^{-1}$ for each polarized cross-section measurement
3. $\Delta m_{\tilde{q}} = 10 \text{ GeV}$ from LHC†
4. The errors $\Delta\sigma$ on the cross sections σ are statistical only: $\Delta\sigma = \sqrt{\frac{\sigma}{\mathcal{L}\epsilon}}$, where ϵ ($\approx 80\%$) is the efficiency and \mathcal{L} the integrated luminosity
5. Error on squark masses $\Delta m_{\tilde{q}}$ as given by simulation* for LHC [$\mathcal{O}(10 \text{ GeV})$] including correlations between the errors on different masses (\tilde{q} , $\tilde{\chi}^0$, \tilde{t}_R)

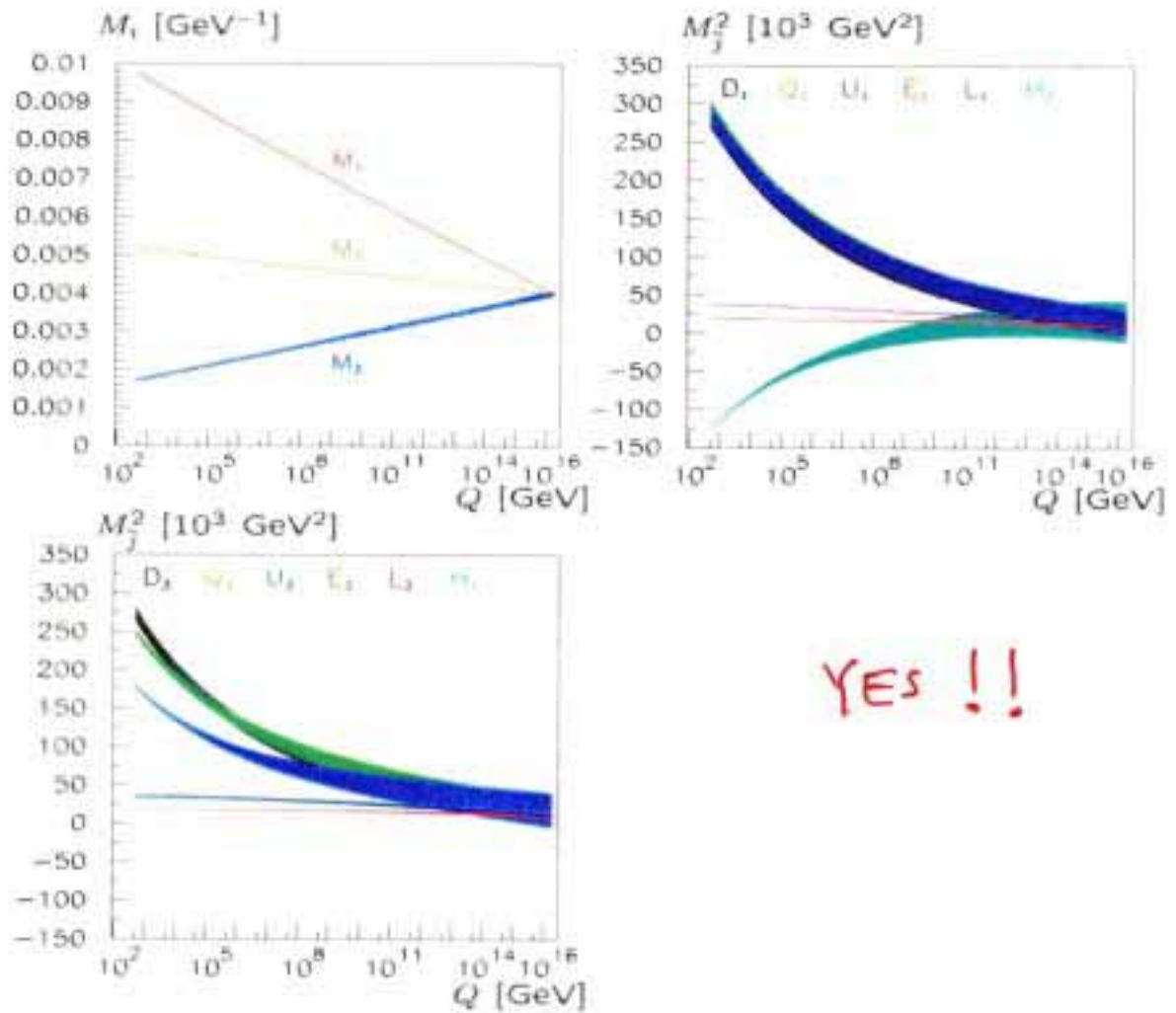
*for details see e.g. G.A. Blair and U. Martyn
hep-ph/9910416

†ATLAS TDR, CERN/LHCC/99-15
A.de Roeck, talk given in St. Malo

*G. Polesello, talk given at LHC/LC meeting at CERN,
14 Feb. 2003

mSUGRA

$\tan \beta = 10$, $M_0 = 100$ GeV, $M_{1/2} = 250$ GeV,
 $A_0 = -100$, $\text{sign}(\mu) = 1$ (SPS1a)

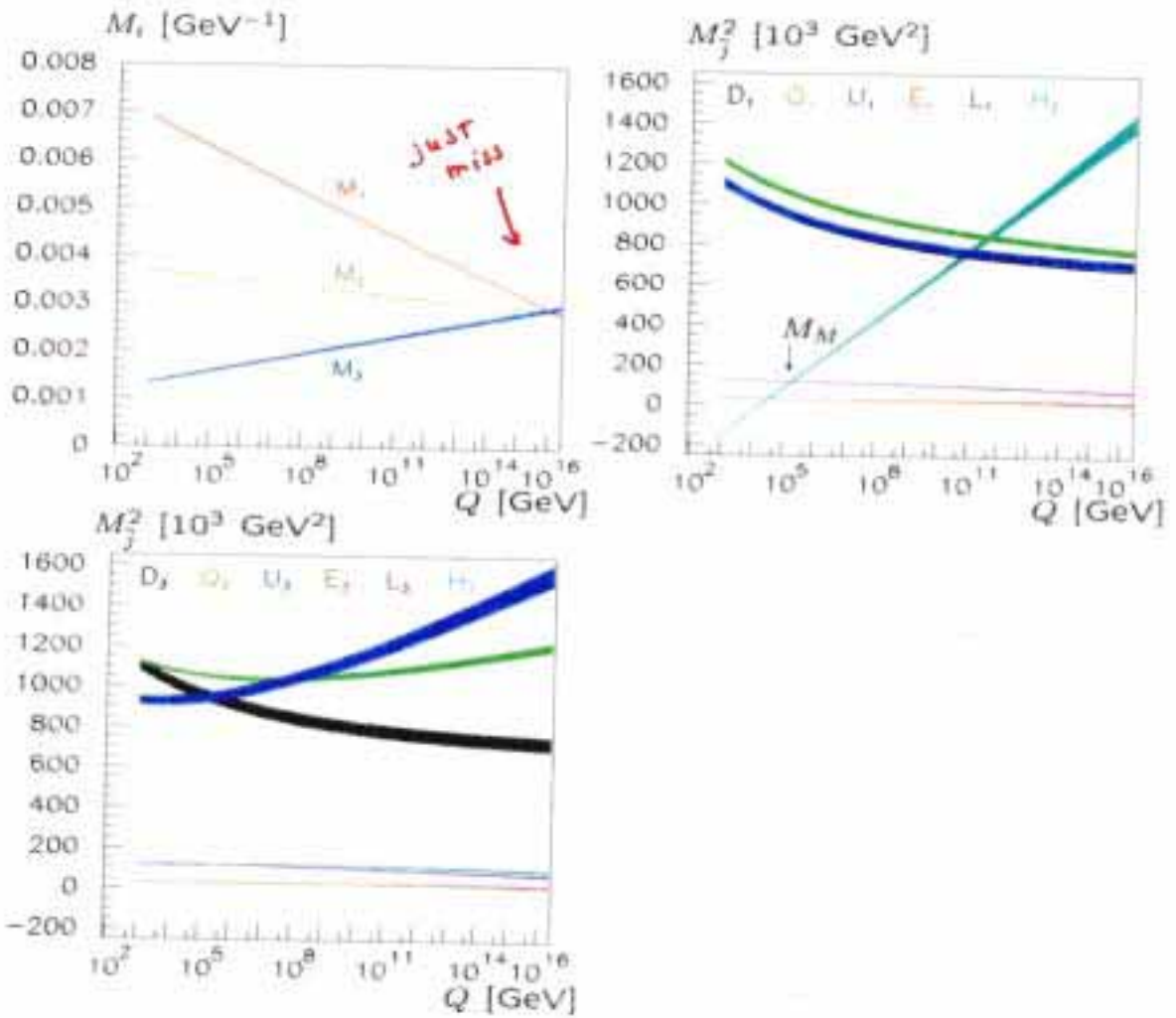


YES !!

1 σ error bands

GMSB

$\tan \beta = 15$, $\Lambda = 10^5$ GeV, $M_M = 2 \cdot 10^5$ GeV,
 $\text{sign}(\mu) = 1$ (SPS8)



1 σ error bands

**Can mSUGRA be confused
with GMSB?**

Examples before and various numerical studies by J. Bagger et al. (Phys. Rev. D 1997), S. Dimopoulos et al. (Nucl. Phys. B 1997), A. Strumia (Phys. Lett. B 1997) indicate that both models cannot be confused.

Using exact solutions of the 1-loop RGEs we show:

Complete mSUGRA spectrum of squarks and sleptons cannot be confused with a complete GMSB spectrum of squarks and sleptons if at the same time the gaugino parameters coincide for both models.

Tree and one-loop tests

of the minimal LR-symmetric model

Basic issue of the talk, also important for fitting New Physics Models in high energies (e.g. using TESLA)

- Tree level processes: restoration of the results of the Standard Model for $M_{\text{heavy,NS}} \rightarrow \infty$
- One-loop (and beyond) processes: is the same true there?

Muon decay, SM:

$$\frac{G_F}{\sqrt{2}} = \frac{\pi\alpha}{2s_W^2 M_W^2} (1 + \Delta r_{SM}).$$

Muon decay, LR:

1-loop
corrected LRM

$$\frac{G_F}{\sqrt{2}} = \frac{\pi\alpha}{2s_W^2 M_W^2} (1 + \Delta r_{LR}),$$

$$\Delta r_{LR} \stackrel{?}{=} \Delta r_{SM} + \text{"subleading effects from h.o.c."}$$

Extra "Δr" pieces cannot be neglected

4. Conclusions and Outlook: how to fit [some] beyond SM

LRM can be fitted to muon decay width, however:

- heavy neutrino masses and Higgs masses must be very tuned to get proper Δr
- corrections coming from SM particles within LR model do not constitute a structure equivalent to their SM structure, e.g. top quark and $\Delta\rho$, the lightest Higgs;

$$\Delta r_{LR} \neq \Delta r_{SM} + \text{"subleading effects from h.o.c."}$$

Also dramatic consequences for [some] NPM at high energy processes:

Czakon, Gluza, Jegerlehner, Zralek, EPJ, C13, 275 (2000),
see also: Lynn & Nardi, NPB381, 1992, ...