Extra Dimensions

R. Rückl, Sitges 99

Mass may be an artefact of extra dimensions

Example: 4+1 dimensions, extra coordinate z on circle of radius R

Probability conservation, e.g. for scalar field:

$$\partial_\mu j^\mu = 0 \qquad j_\mu = i\left(\Phi^* \partial_\mu \Phi - \Phi \partial_\mu \Phi^*\right)$$

requires all fields to be cyclic in z:

$$\Phi(x_\nu, z) = \Phi(x_\nu, z + 2\pi R) = \sum_k \Phi^k(x_\nu) e^{ikz/R}$$

Massless field in 4+1 dimensions with Klein-Gordon equation of motion:

$$\left(\partial_\mu \partial^\mu + \partial_z \partial^z\right) \Phi = 0$$

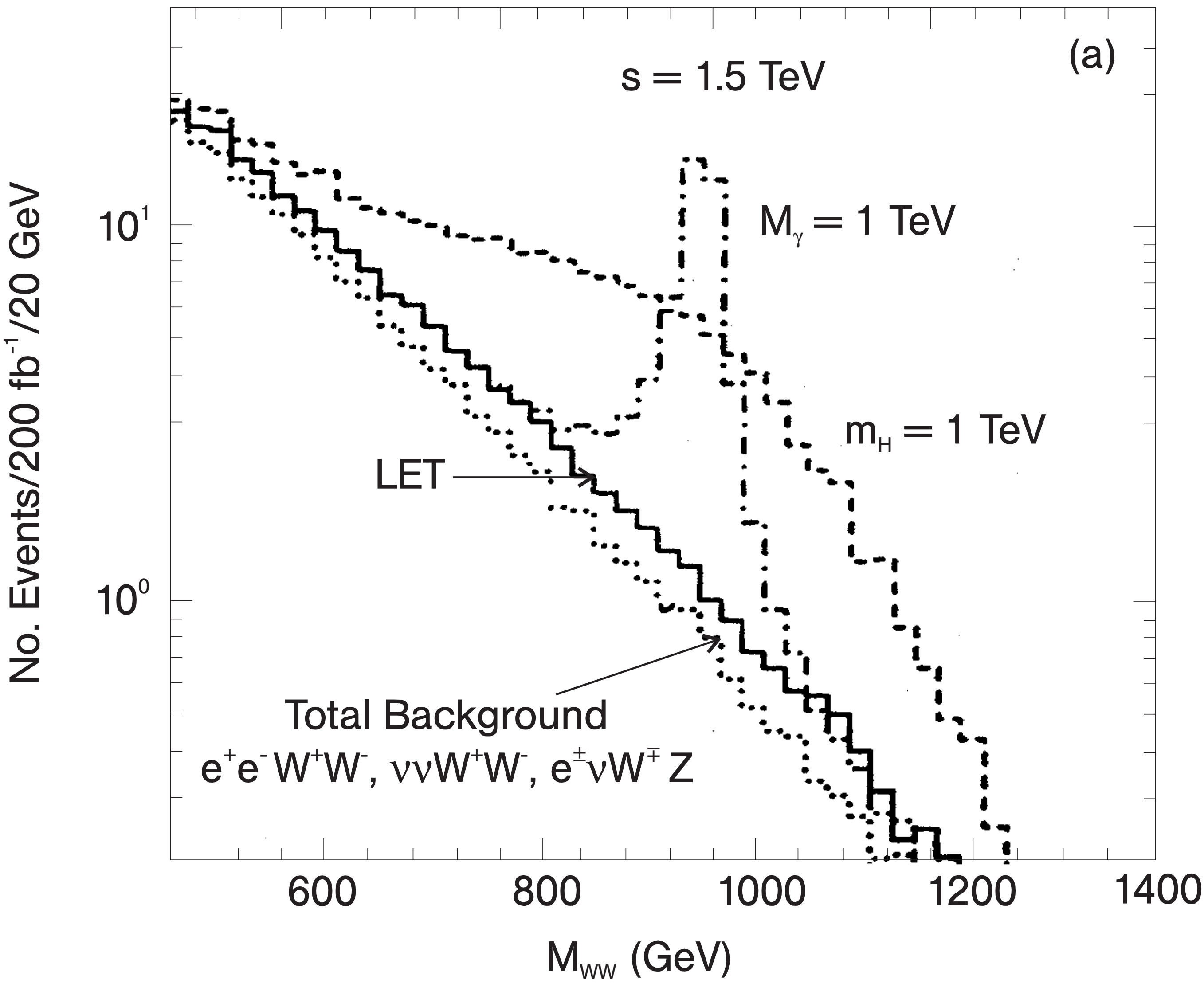
For each k:

$$\left[\partial_\mu \partial^\mu - \left(\frac{k}{R}\right)^2\right] \Phi^k(x_\nu)$$

Looks like a massive field in 4 dimensions

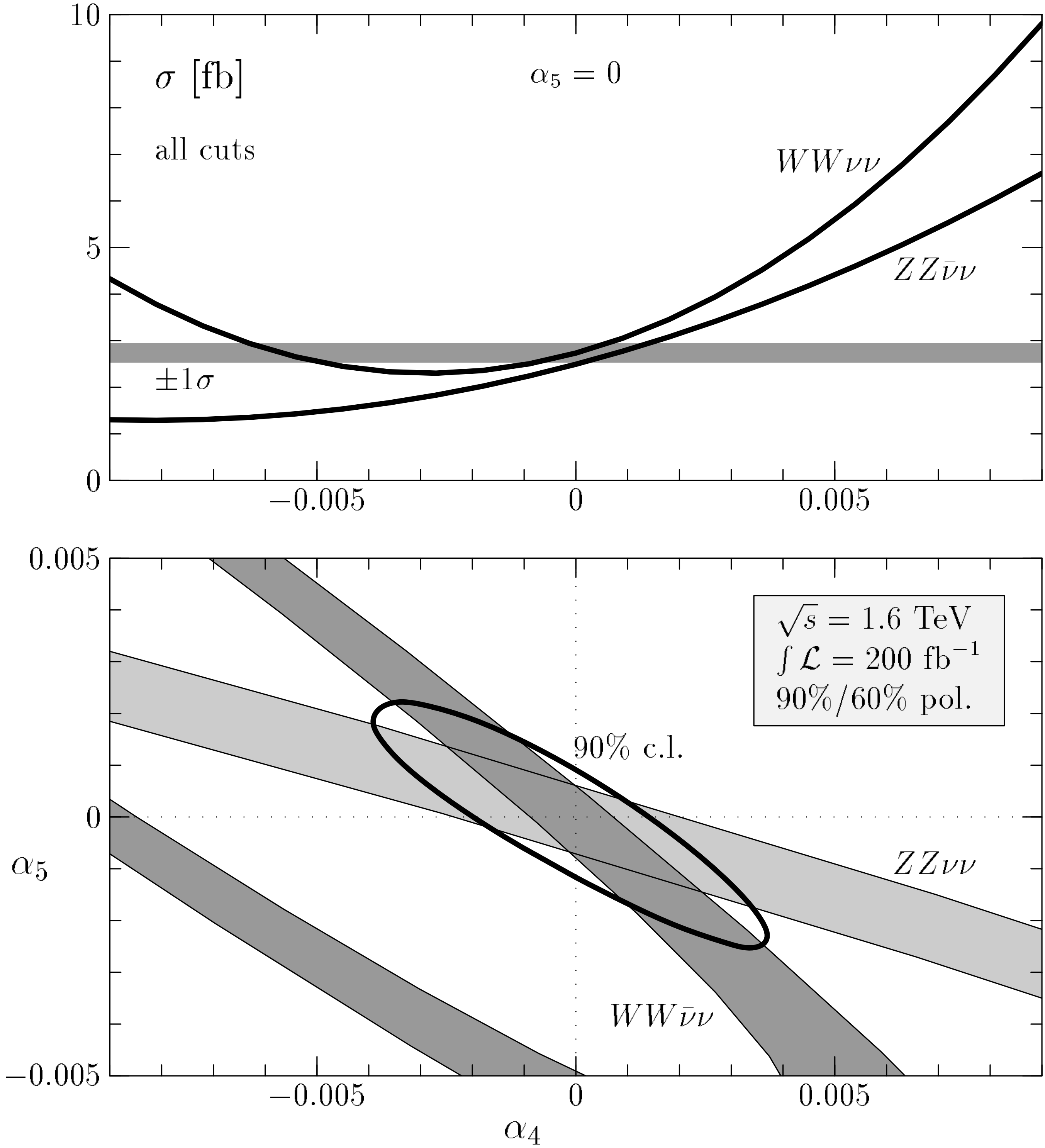
WW Resonances

Provide cut-off for trilinear couplings if there is no Higgs



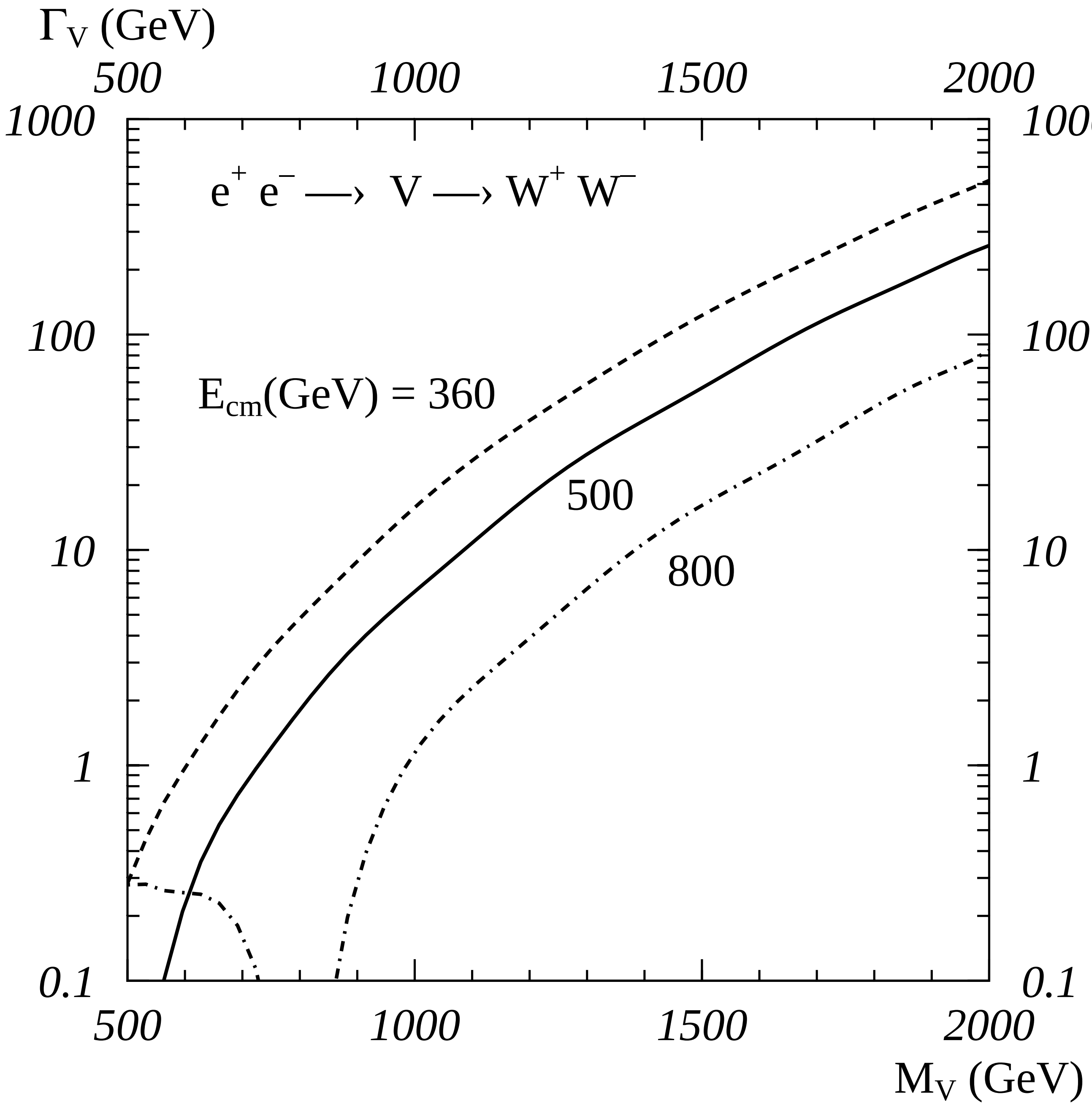
Scalar (Higgs-like) or vector resonances

WW and ZZ Resonances



WW Resonances

From differential Xsection for WW and W polarisation,
$\mathcal{L} = 10\text{fb}^{-1}$, no direct coupling to fermions



90% CL upper limits on resonance width

Leptoquark Production

Baryon and lepton number not protected by gauge symmetry

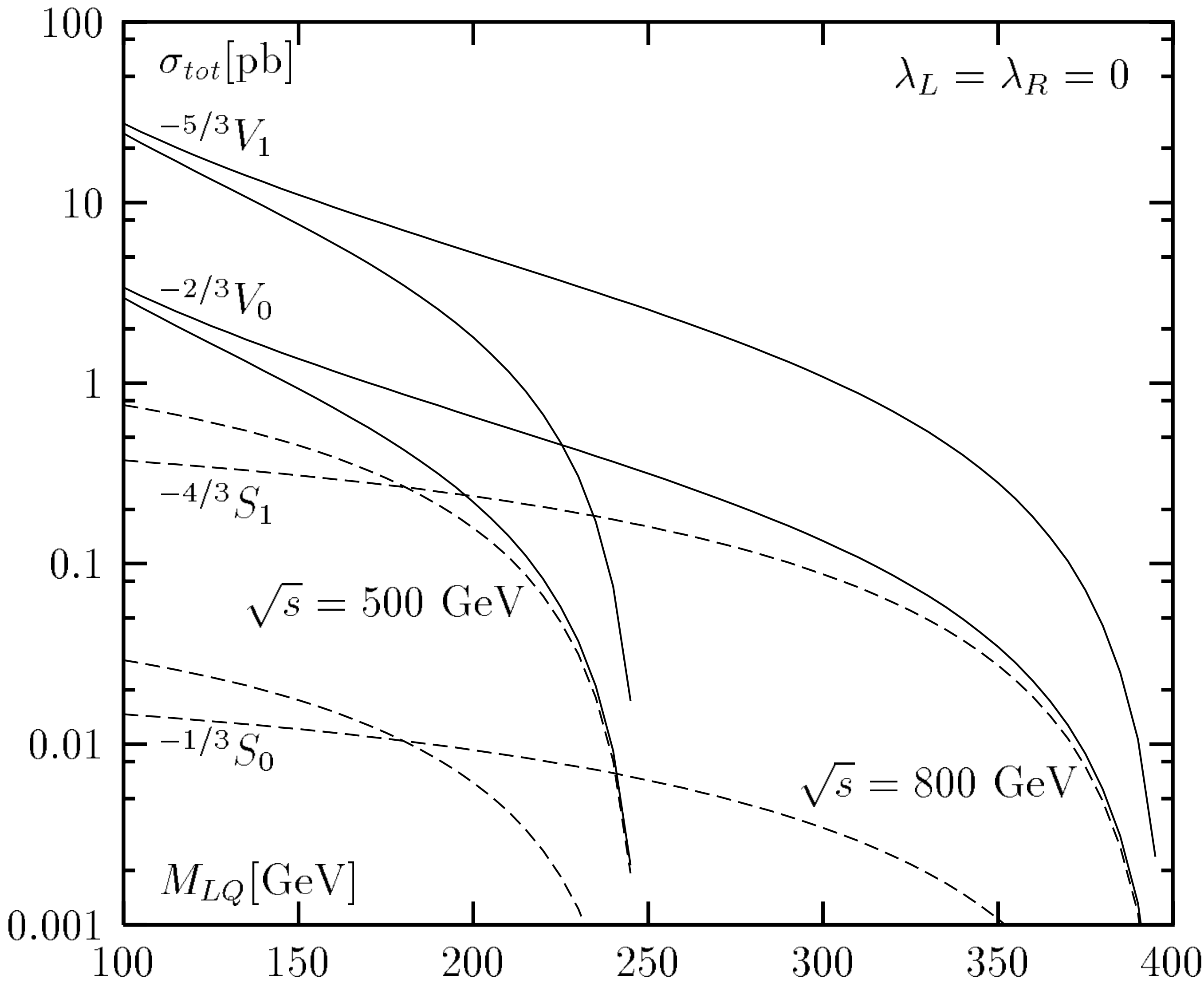
Type $^{Q}\overline{LQ}_T$	Decay	$\sigma_{tot}(s)$[fb]
$^{-1/3}S_0$	$e_L^- u_L$ $e_R^- u_R$ $\nu_e d_L$	6
$^{-4/3}\tilde{S}_0$	$e_R^- d_R$	98
$^{+2/3}S_1$ $^{-1/3}S_1$ $^{-4/3}S_1$	$\nu_e u_L$ $\nu_e d_L$ $e_L^- u_L$ $e_L^- d_L$	110 6 158
$^{-2/3}S_{1/2}$ $^{-5/3}S_{1/2}$	$\nu_e \bar{u}_L$ $e_R^- \bar{d}_R$ $e_L^- \bar{u}_L$ $e_R^- \bar{u}_R$	65 149
$^{+1/3}\tilde{S}_{1/2}$ $^{-2/3}\tilde{S}_{1/2}$	$\nu_e \bar{d}_L$ $e_L^- \bar{d}_L$	27 39

Type $^{Q}\overline{LQ}_T$	Decay	$\sigma_{tot}(s)$[fb]
$^{-1/3}V_{1/2}$ $^{-4/3}V_{1/2}$	$\nu_e d_R$ $e_R^- u_L$ $e_L^- d_R$ $e_R^- d_L$	365 895
$^{+2/3}\tilde{V}_{1/2}$ $^{-1/3}\tilde{V}_{1/2}$	$\nu_e u_R$ $e_L^- u_R$	353 247
$^{-2/3}V_0$	$e_L^- \bar{d}_R$ $e_R^- \bar{d}_L$ $\nu_e \bar{u}_R$	222
$^{-5/3}\tilde{V}_0$	$e_R^- \bar{u}_L$	1370
$^{+1/3}V_1$ $^{-2/3}V_1$ $^{-5/3}V_1$	$\nu_e \bar{d}_R$ $e_L^- \bar{d}_R$ $\nu_e \bar{u}_R$ $e_L^- \bar{u}_R$	942 222 1790

Large cross section for leptoquarks

Leptoquark Production

If worst comes to worst...



Leptoquark spectroscopy

Conclusions

Rôle of accelerator generations:

- LEP: established current effective theory, Standard Model
- LHC: to show limits of validity of SM and outline next effective theory
- LC: establish next effective theory

After almost 10 years of study:

- Linear electron positron collider is likely to be the right machine for high energy physics after LHC.
- TESLA is a machine design that is both feasible and will fulfil the physics requirements.
- An excellent detector for TESLA can be built with reasonable extrapolations of todays technologies.

outlook

Schedule:

- Conceptual Design Report: Published DESY 1997-48
- Optimisation of machine and detector has started
- Technical Design Report: Costed proposal in 2000/2001
- In depth discussion in context of similar proposals elsewhere
- Approval 2003, first beams by 2008?