Impact of LEP2 and a glimpse to the future

LEP130 ➔ LEP172 ➔ LEP190 ➔ LEP206 $\not\Rightarrow$ LEP220 $\not\Rightarrow$ LEP240

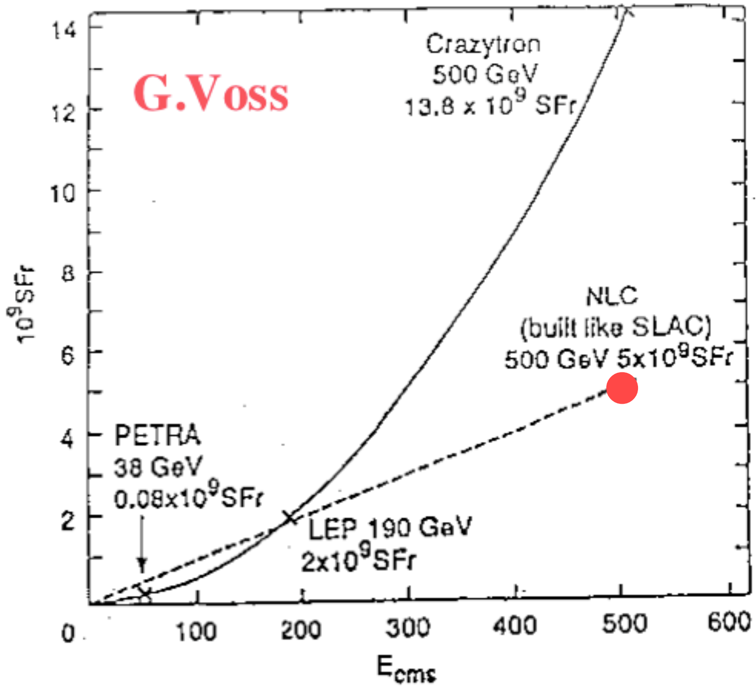
IMPACT

- success from the machine side
- success from the experimental side: generators, analyses, ADLO, LEP groups
- Higgs searches
- other searches: SUSY, compositeness, etc
- W physics: M_W , W couplings
- four-fermions
- fermion-antifermion
- electroweak constraints and consequences: the LEP paradox.

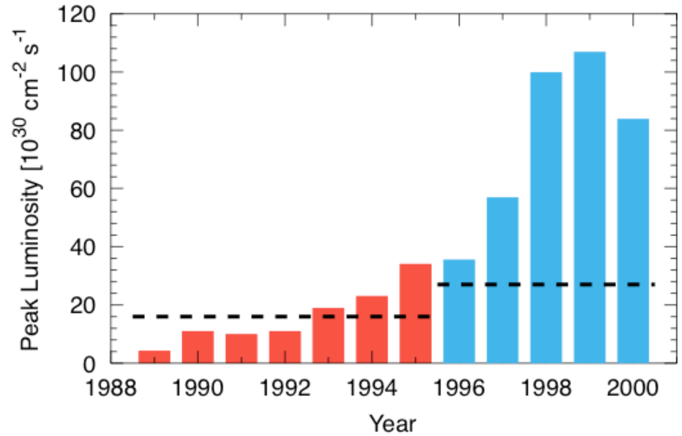
GLIMPSE

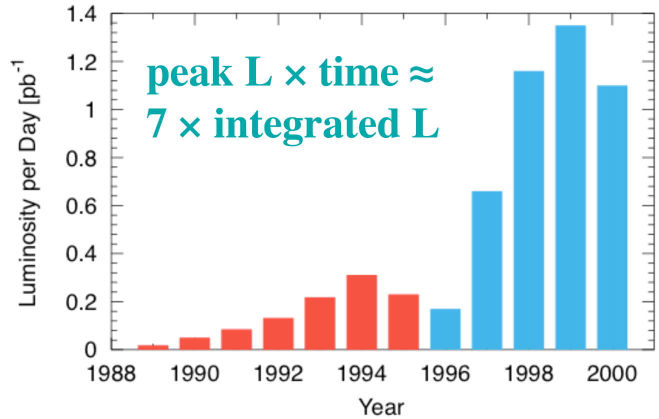
- status of speculations beyond the Standard Model (BSM):
  ambition, Lorentz framework, promises, accessibility at LHC
- How to proceed at LHC?

Hommage to the LEP machine



window of opportunity

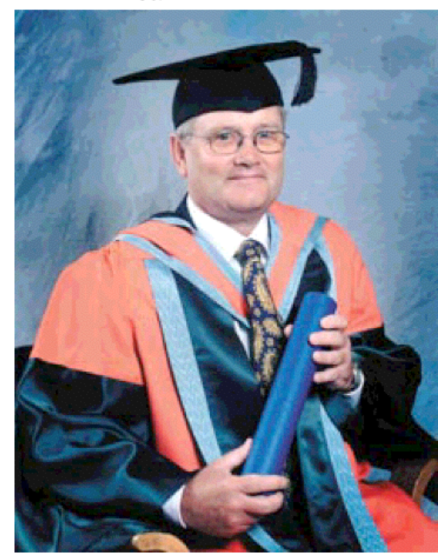




	Foreseen (55/95 GeV)	Achieved (46/98 GeV)
Current per bunch	0.75 mA	1.00 mA
Total current	6 mA	8.4 mA/6.2 mA
Beam-beam vertical parameter	0.03	0.045/0.083
Ratio of emittances	4.0	0.4 %
Maximal luminosity (10^{+30})	16/27 ↔	34/100
β_x^*	1.75 m	1.25 m
β_y^*	7 cm	4 cm

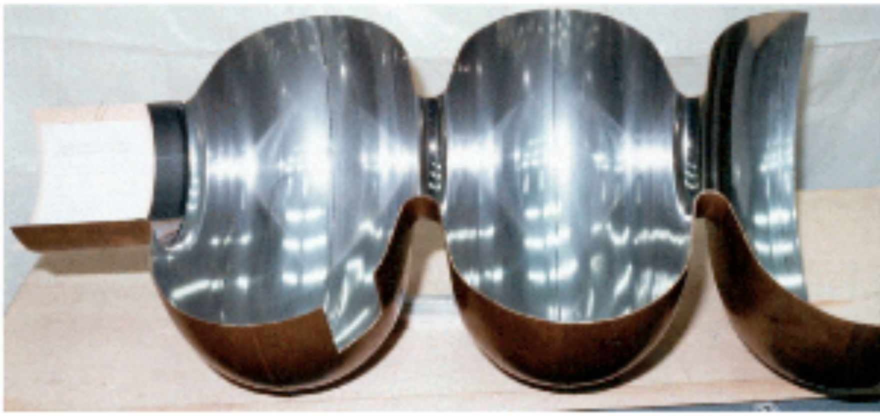
synchrotron studies, masks: P. Roudeau, G. von Holtey

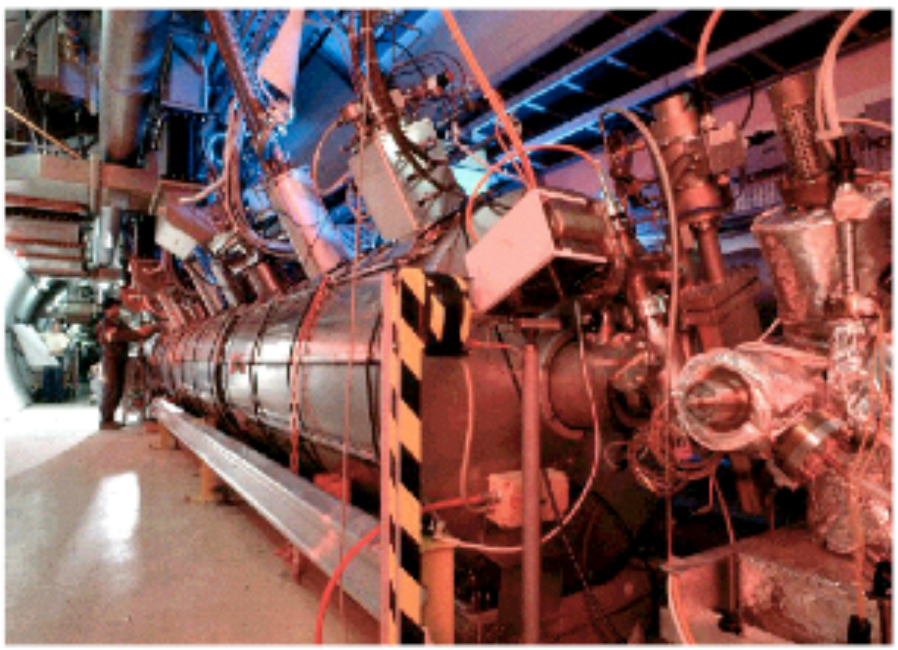
Steve

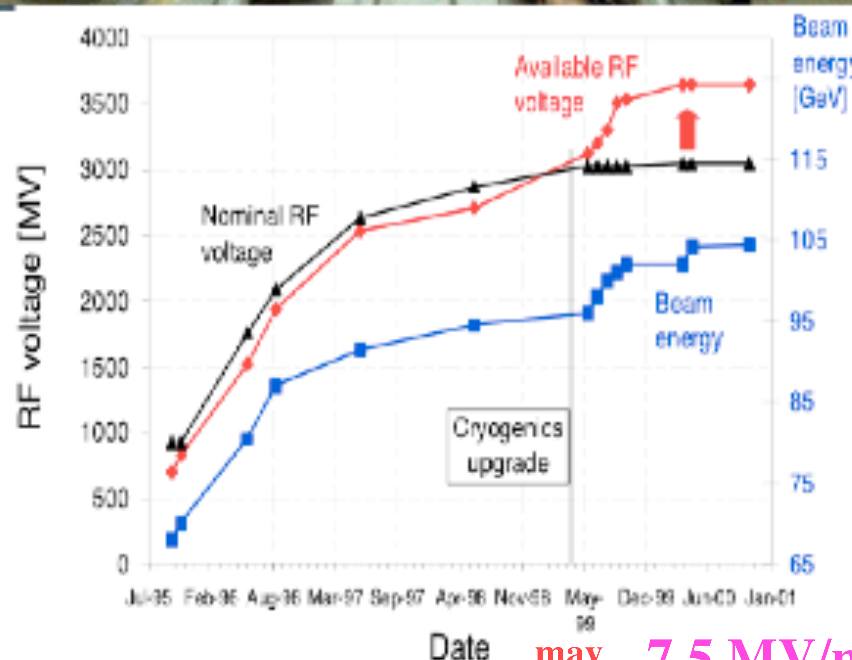


LEP SUPERCONDUCTING CAVITIES

C.Benvenuti

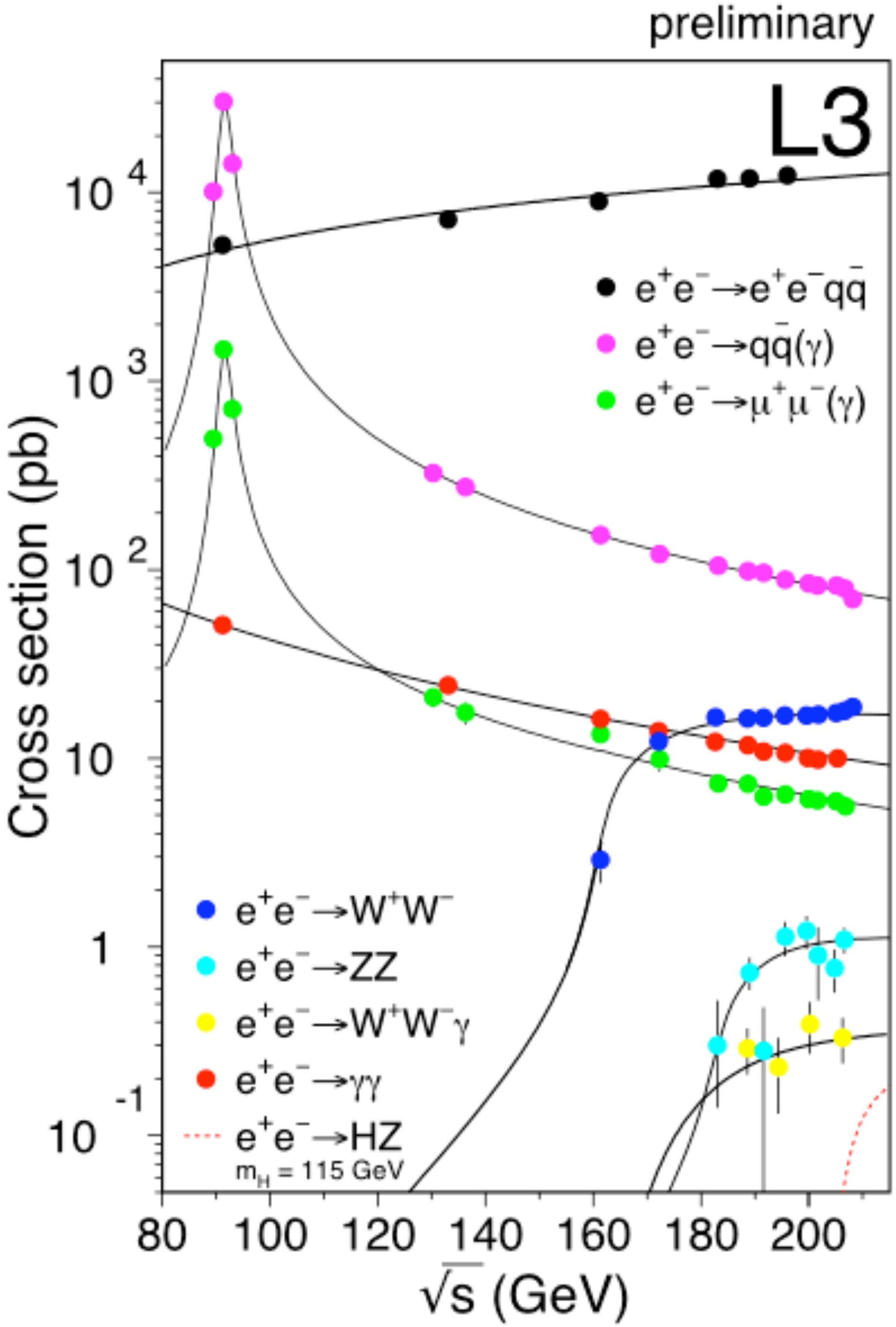




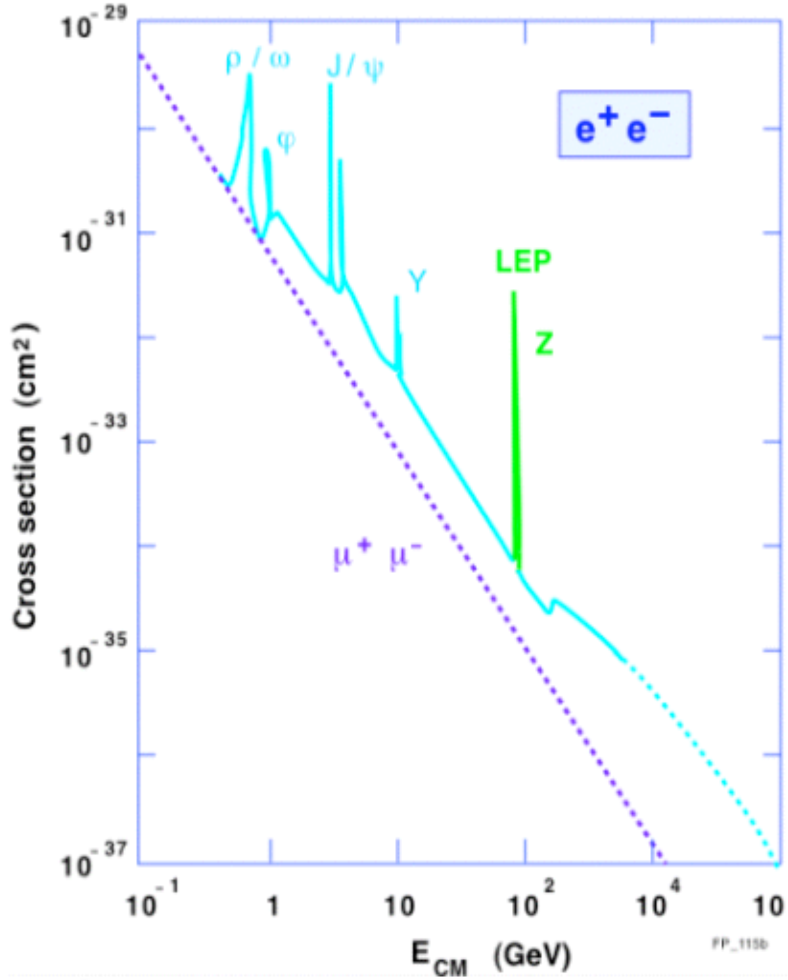


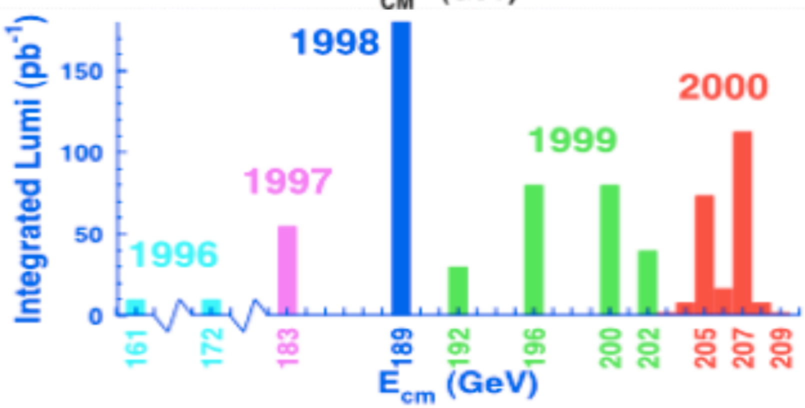
may 99

7.5 MV/m


preliminary
L3
Cross section (pb)
√s (GeV)
e+e−→e+e−qq̄
e+e−→qq̄(γ)
e+e−→μ+μ−(γ)
e+e−→W+W−
e+e−→ZZ
e+e−→W+W−γ
e+e−→γγ
e+e−→HZ
mH = 115 GeV

Ugo


ρ / ω
J / ψ
φ
Υ
LEP
Z
e+e−
μ+ μ−
1 μb
1 nb
1 pb
Cross section (cm²)
ECM (GeV)


Integrated Lumi (pb-1)
1996
1997
1998
1999
2000
161
172
183
189
192
196
200
202
205
207
209
Ecm (GeV)

HIGGS SEARCH

Aachen, 1986

And from the Workshop Summary:

"Clearly the 4 jet events are not useful if M_H= 80-90 GeV since there could be complete confusion with WW and ZZ production,..."

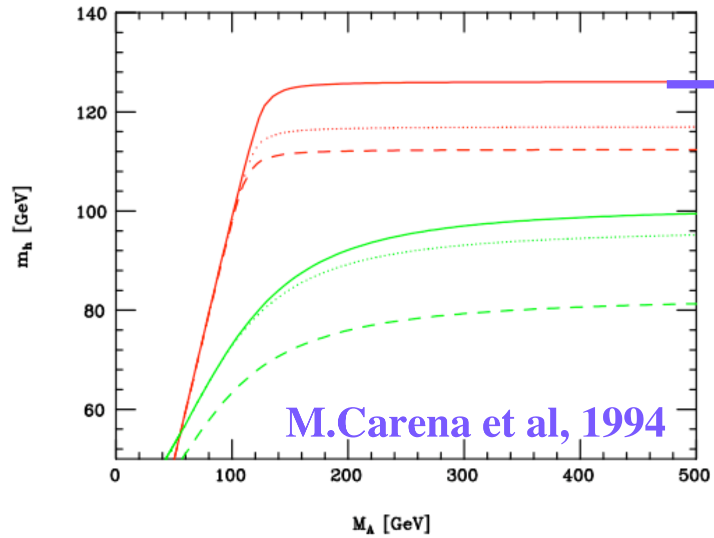
Similarly later:

"LEP200 should detect the Higgs if $40 \leq M_H \leq 80$ GeV, but it will be difficult. It is not at all clear that hadron colliders (of any energy) would be able to detect the Higgs at all."

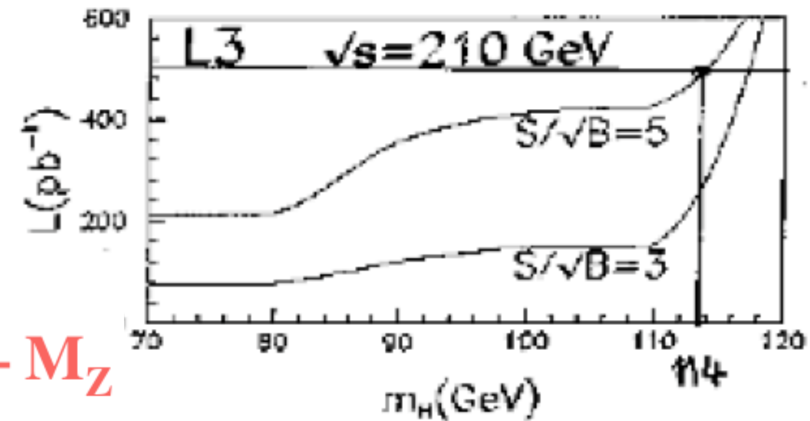
What we knew when LEP2 started....

discovery limit at LEP

mass limit in MSSM

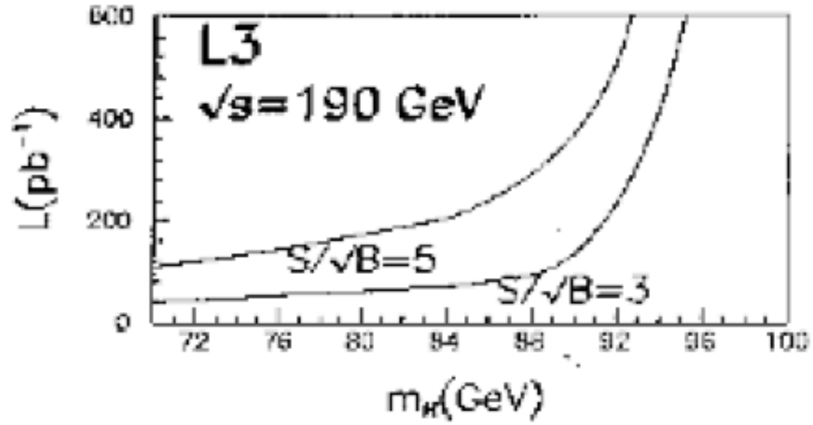


→ 126 GeV

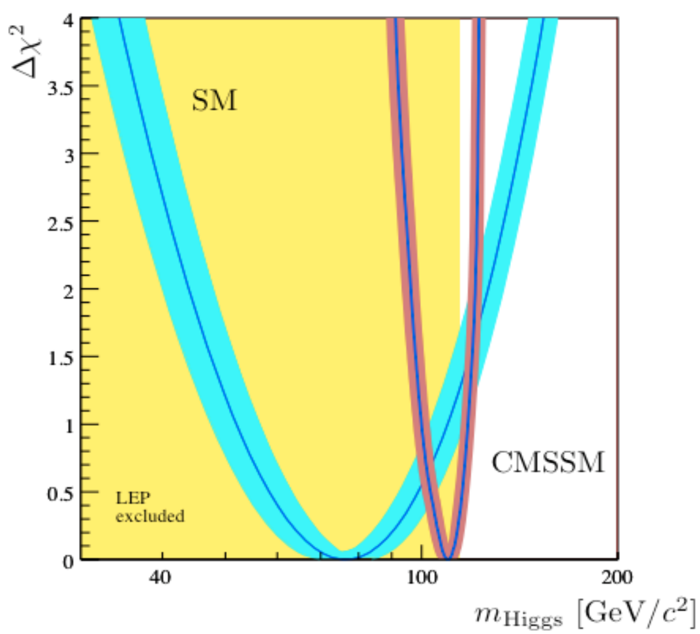


$\sqrt{s} - M_Z$

1993



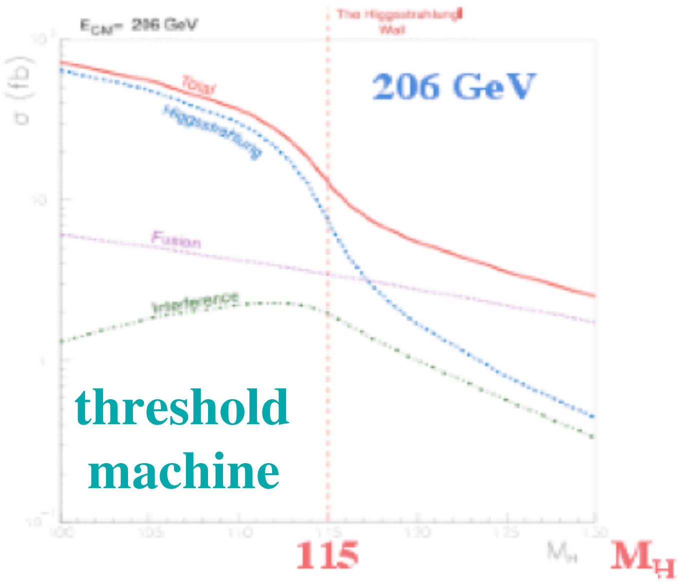
now: $m_h^{\mathrm{CMSSM}} = 110^{+8}_{-10}\ (\mathrm{exp.}) \pm 3\ (\mathrm{theo.})\ \mathrm{GeV}/c^2$

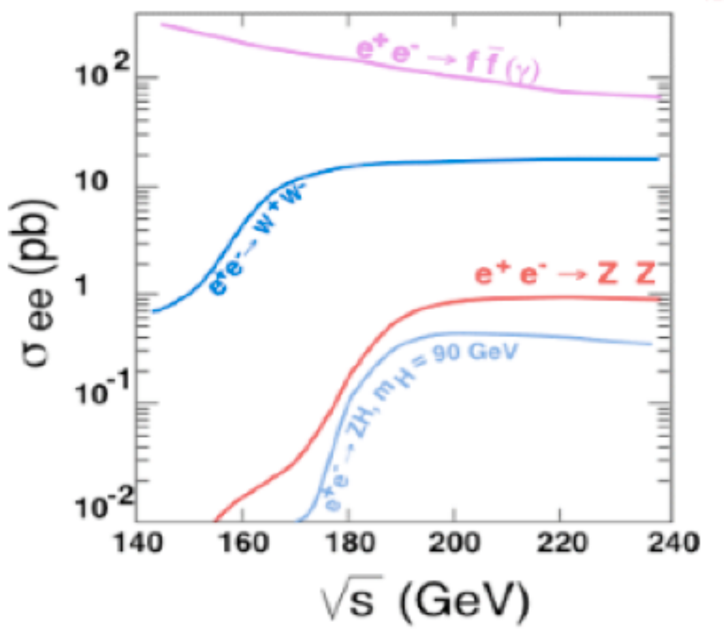


" The CM energy required to do so (i.e. complete the exploration of the MSSM "plane", tgβ - M_A) would be $\sqrt{s} \sim 210$ GeV (220 GeV) for $M_{top} \leq 150$ GeV (170 GeV)."

PPE/94-114, Rep.Prog.Phys. 57(1994)1137

in the last year, crash against the higgsstrahlung barrier for $M_H = \sqrt{s} - M_Z$, namely 115 GeV

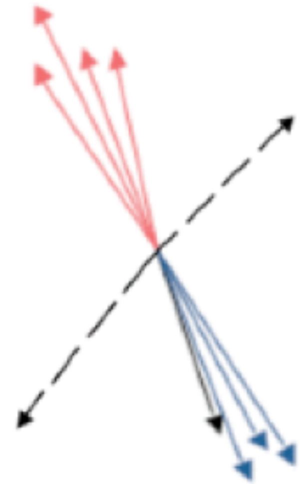


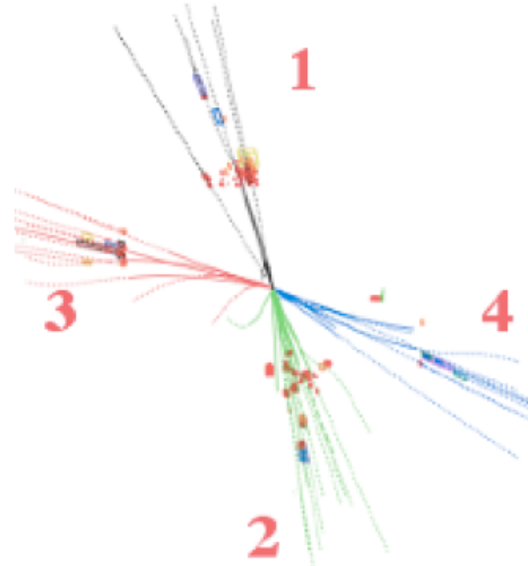


we rediscovered the existence of backgrounds

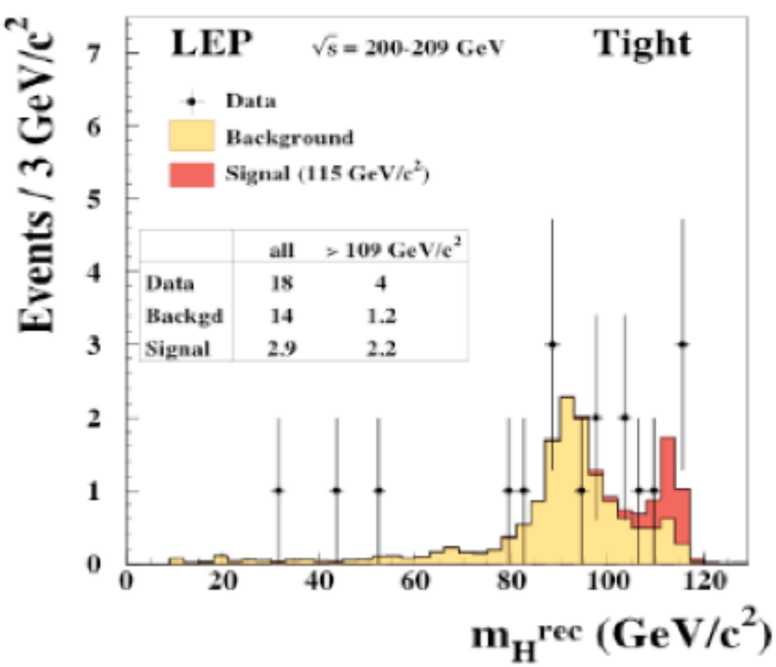
HZ with $Z \to \nu\nu$

two-jet at rest: automatically rescaled at 115 GeV!..



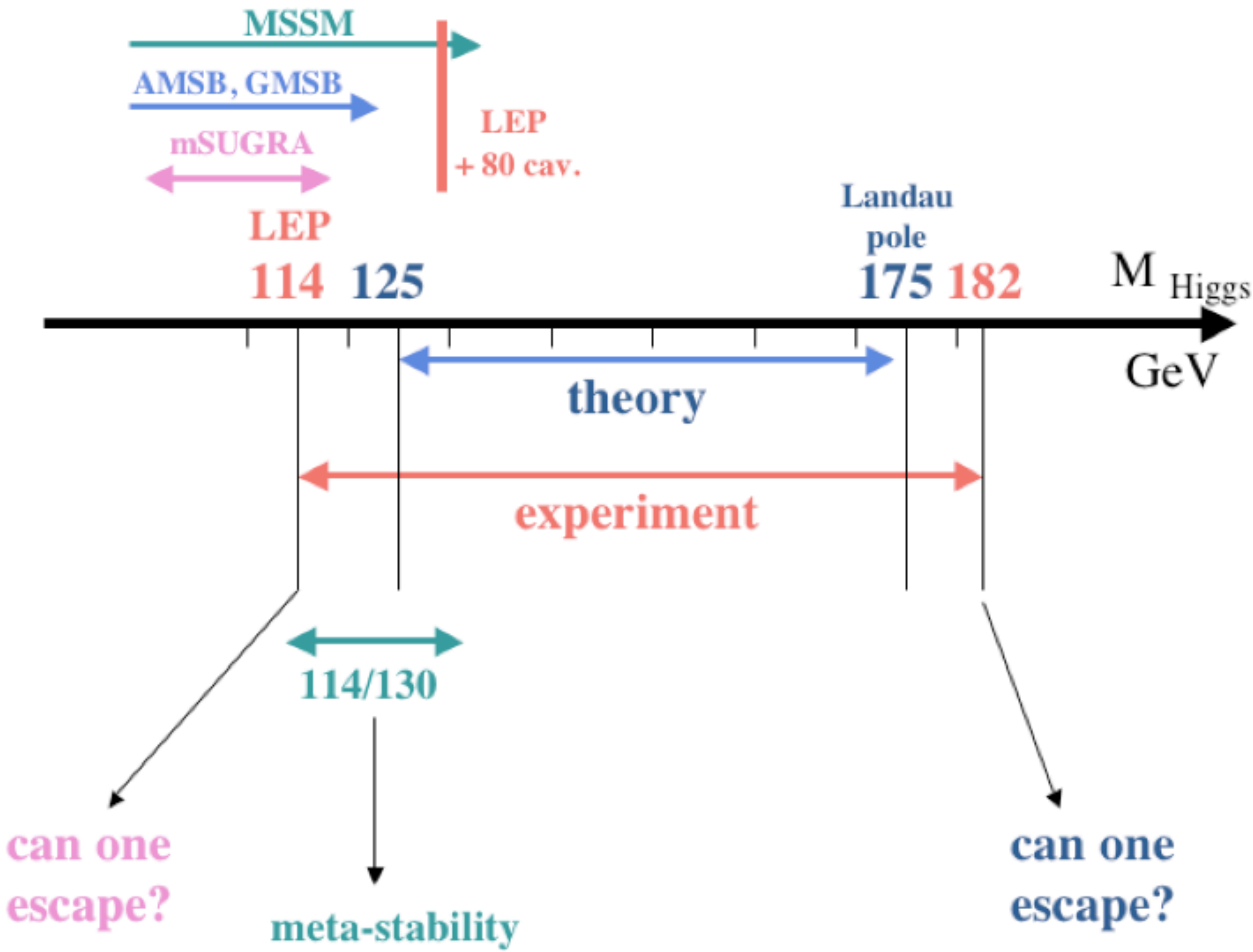


HZ with $Z \to q\bar{q}$?



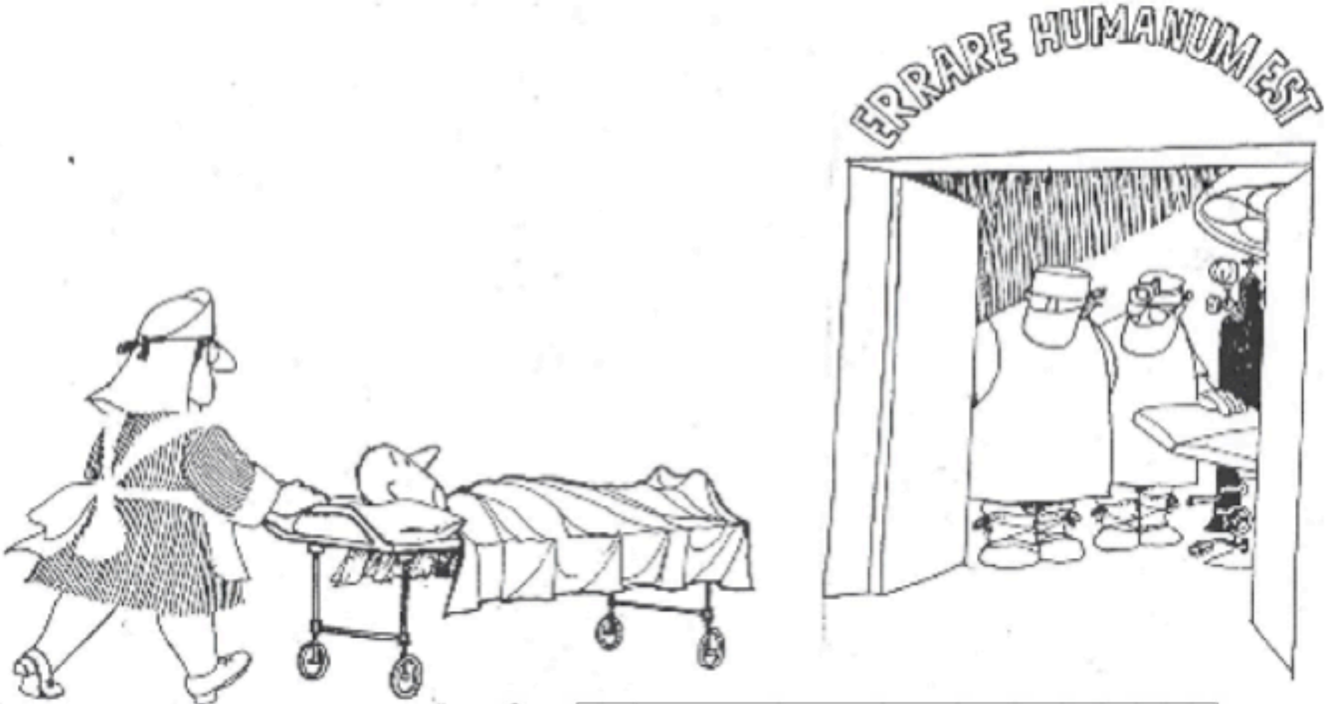
12 – 34 : 91 – 115
13 – 24 : 68 – 68
14 – 23 : 80 – 81

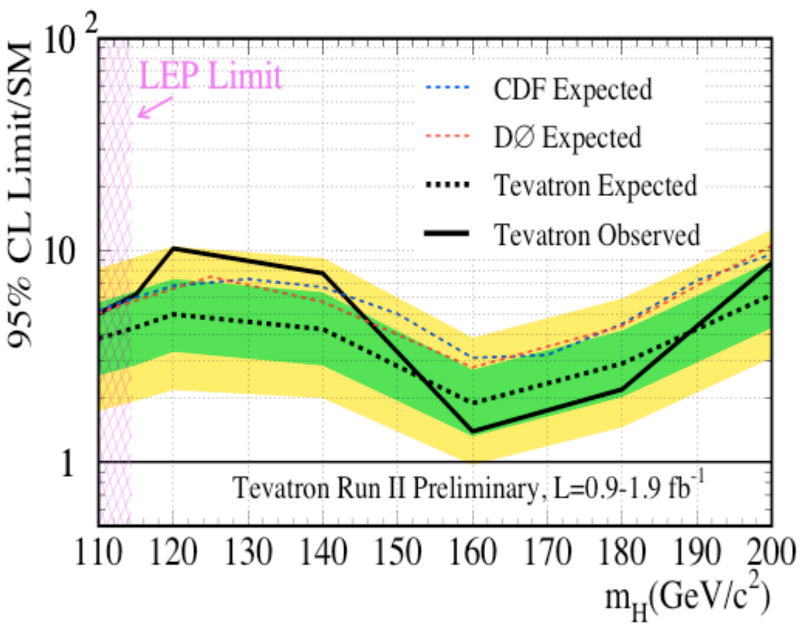
and ended in confusion...

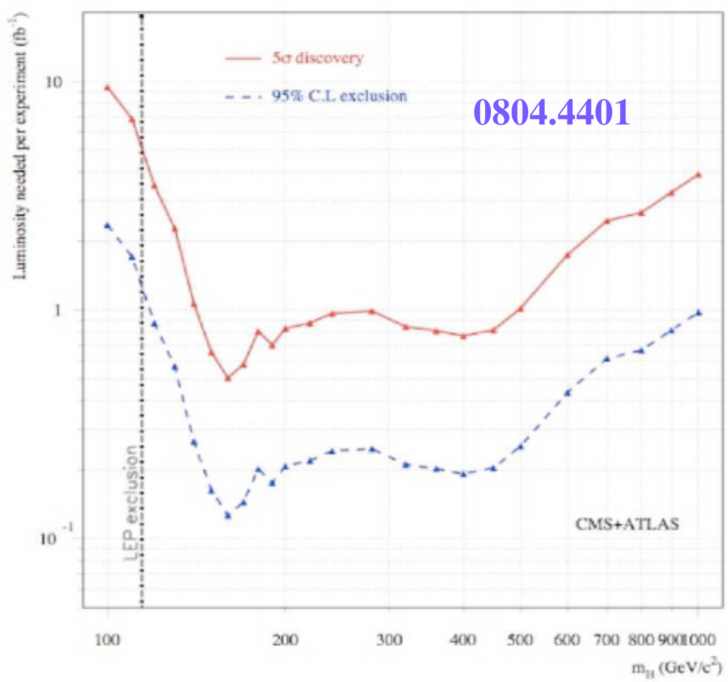

MSSM
AMSB, GMSB
mSUGRA
LEP
+ 80 cav.
LEP
Landau
pole
114
125
175
182
M Higgs
GeV
theory
experiment
114/130
can one
escape?
meta-stability
can one
escape?

MSSM either correct,
and we missed it,
or incorrect, and we
are wrong to spend
most of our activity
on this scenario

S.Myers-C.Wyss
CERN-96-0, p40
384 SCC (100 more)
in equipped zones
(111 GeV/beam, K.Hubner)







$$(1 - \frac{m_W^2}{m_Z^2})\frac{m_W^2}{m_Z^2} = \frac{\pi\alpha(m_Z)}{\sqrt{2}G_F m_Z^2(1 - \Delta r_W)}$$

$$g_A = -\frac{\sqrt{\rho}}{2} \sim -\frac{1}{2}(1 + \frac{\Delta\rho}{2}),$$

$$x = \frac{g_V}{g_A} = 1 - 4\sin^2\theta_{eff} = 1 - 4(1 + \Delta k)s_0^2.$$

$$\begin{aligned} \epsilon_1 &= \Delta\rho, \\ \epsilon_2 &= c_0^2\Delta\rho + \frac{s_0^2\Delta r_W}{c_0^2 - s_0^2} - 2s_0^2\Delta k, \\ \epsilon_3 &= c_0^2\Delta\rho + (c_0^2 - s_0^2)\Delta k. \end{aligned}$$

$$\begin{aligned} \frac{m_W^2}{m_Z^2} &= \frac{m_W^2}{m_Z^2}|_B(1 + 1.43\epsilon_1 - 1.00\epsilon_2 - 0.86\epsilon_3) \\ \Gamma_l &= \Gamma_l|_B(1 + 1.20\epsilon_1 - 0.26\epsilon_3), \\ A_l^{FB} &= A_l^{FB}|_B(1 + 34.72\epsilon_1 - 45.15\epsilon_3), \\ \Gamma_b &= \Gamma_b|_B(1 + 1.42\epsilon_1 - 0.54\epsilon_3 + 2.29\epsilon_b). \end{aligned}$$

$$\begin{aligned} \epsilon_1 &= \frac{3G_F m_t^2}{8\pi^2\sqrt{2}} - \frac{3G_F m_W^2}{4\pi^2\sqrt{2}}\tan^2\theta_W \ln\frac{m_H}{m_Z} + \ldots, \\ \epsilon_2 &= -\frac{G_F m_W^2}{2\pi^2\sqrt{2}}\ln\frac{m_t}{m_Z} + \ldots., \\ \epsilon_3 &= \frac{G_F m_W^2}{12\pi^2\sqrt{2}}\ln\frac{m_H}{m_Z} - \frac{G_F m_W^2}{6\pi^2\sqrt{2}}\ln\frac{m_t}{m_Z}\ldots., \\ \epsilon_b &= -\frac{G_F m_t^2}{4\pi^2\sqrt{2}} + \ldots. \end{aligned}$$

$$3\epsilon_3 - \epsilon_2 \propto \ln\frac{m_h}{m_Z} = -0.002 \pm 0.004$$

$$2\epsilon_1 + 3\epsilon_b \propto \ln\frac{m_h}{m_Z} = -0.004 \pm 0.005$$

LEP results, J.Lykken

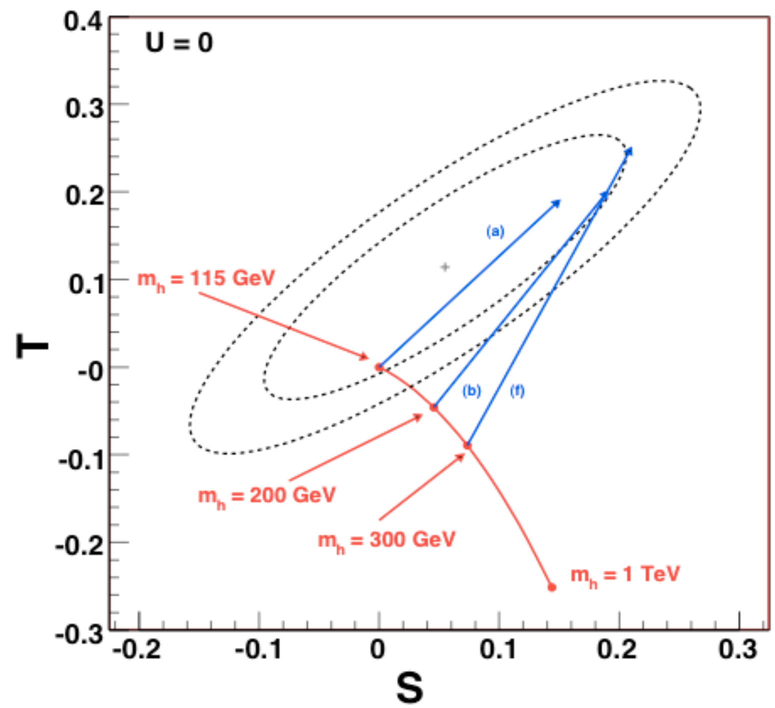
custodial symmetry

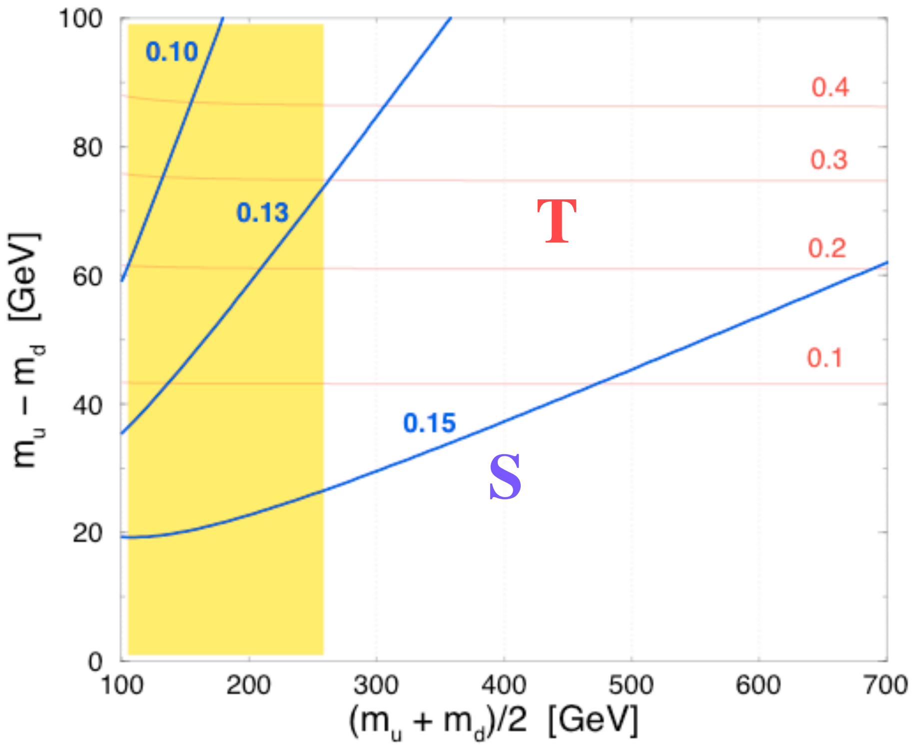
Thus the statement that the precision data favors a light Higgs, as opposed to no Higgs at all, relies upon some theoretical baggage. This baggage **•••**

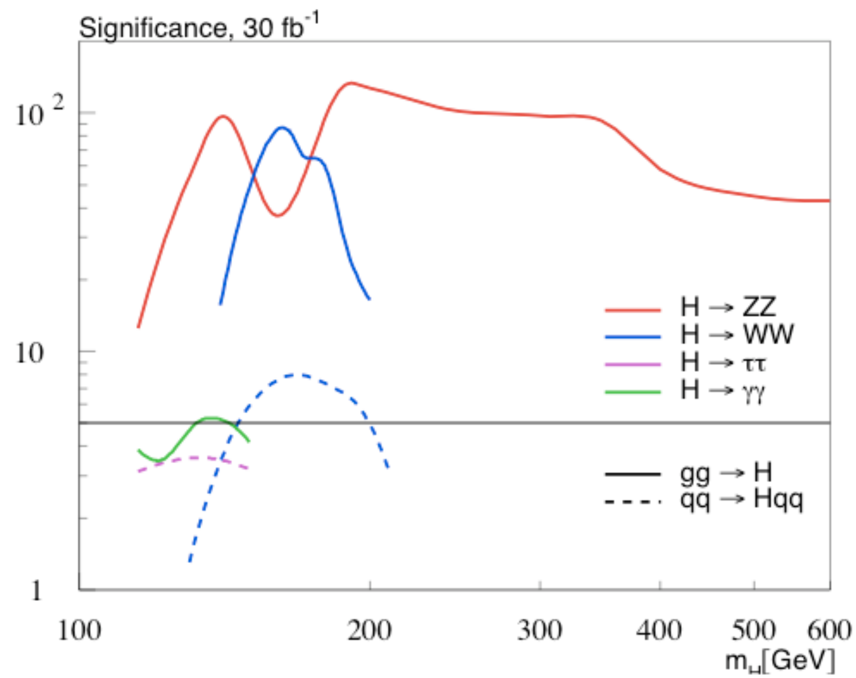
J.Lykken

Many possibilities of conspirations with new physics, allowing for a heavier Higgs: Peskin-Wells.

Example: a 4th generation, with heavy ν
arXiv:0706.3718







Other limits on Higgs bosons (in GeV):

MSSM, small m_A

CP conserving for m_h–max, m_t=174.3 → $m_h > 92.8$, $m_A > 93.4$

charged → 76.6 –78.6

doubly charged → 95.5

Vanina, ..

fermiophobic → 109.7

invisible →114.4

flavour independent →112.9

....

"stealthy", coupled to phions, limit on coupling (OPAL)

etc, etc

But some searches missing (or not ADLO)

ex. h → aa → 4τ

possible in NMSSM, even MSSM?

h would be the "97 GeV" bump,

the next boson would be the "115"

hZ or hA with h → AA cascade				
91	Z → $q\bar{q}$	< 0.21	16.2	no
91	(AA → V^0V^0) (Z → any but $\tau^+\tau^-$)	< 0.21	9.7	no
91	(AA → $\gamma\gamma$) (Z → any or A → $\gamma\gamma$)	< 0.21	12.5	no
91	(AA → 4 prongs) (Z → any or A → 2 prongs)	> 0.21	12.9	no
91	(AA → hadrons) (Z → $\nu\bar{\nu}$ or A → hadrons)	> 0.21	15.1	no
91	(AA → $\tau^+\tau^-\tau^+\tau^-$) (Z → $\nu\bar{\nu}$ or A → $\tau^+\tau^-$)	> 3.5	15.1	no
161,172	(AA → any) (Z → $q\bar{q}$, $\nu\bar{\nu}$ or A → any)	> 20.	20.0	1d
183	(AA → $b\bar{b}b\bar{b}$) (Z → $q\bar{q}$)	> 12.	54.0	1d
192-208	(AA → $b\bar{b}b\bar{b}$, $b\bar{b}c\bar{c}$, $c\bar{c}c\bar{c}$) (Z → $q\bar{q}$)	> 12.	452.4	2d
192-208	(AA → $c\bar{c}c\bar{c}$) (Z → $q\bar{q}$)	> 4.	452.4	2d
189-208	(AA → $b\bar{b}b\bar{b}$) (Z → $q\bar{q}$ or A → $b\bar{b}$)	> 12.	610.2	no

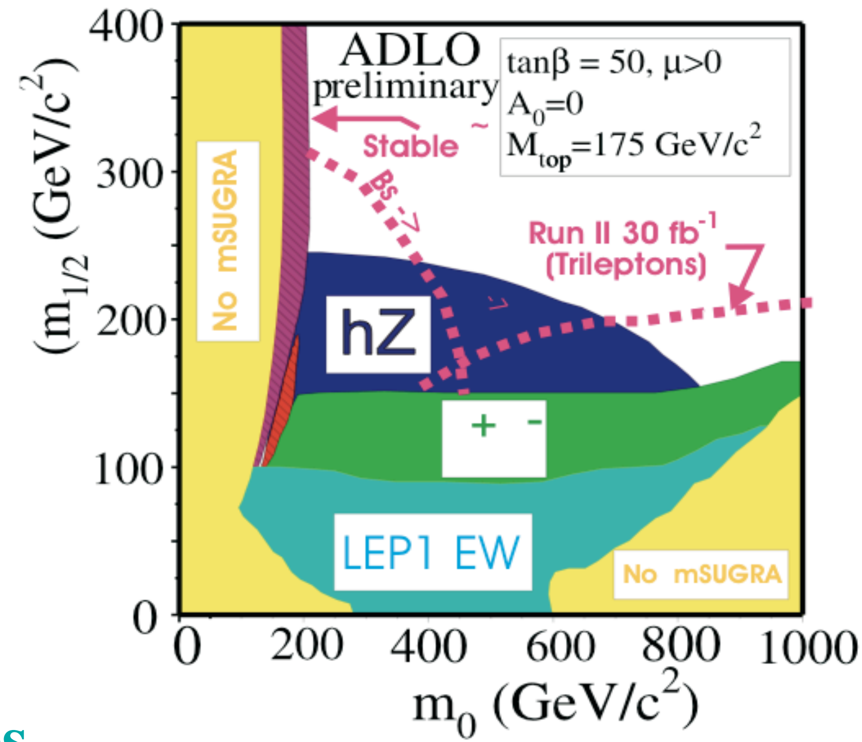
Other searches

SUSY, etc

Some limits

Luc, ..

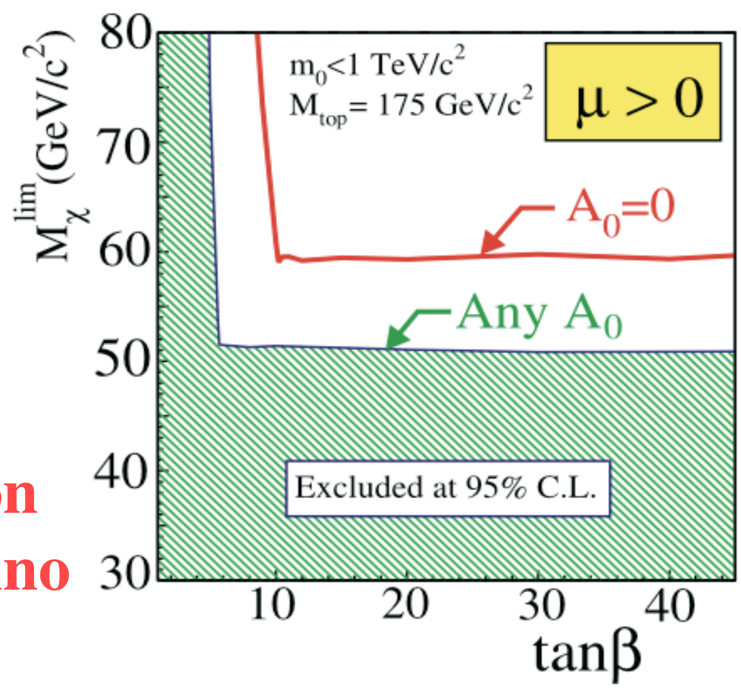
Channel	$m(\tilde{l}) >$	ΔM	
$\tilde{\nu}$, E.W. measurements	43.7 GeV	-	ADLO
$\tilde{e} \rightarrow e\chi_1^0$	99 GeV	10 GeV	ADLO
$\tilde{\mu} \rightarrow \mu\chi_1^0$	95 GeV	10 GeV	ADLO
$\tilde{\tau} \rightarrow \tau\chi_1^0$	85 GeV	10 GeV	ADLO
$stop \rightarrow c\chi_1^0$	95 GeV	20 GeV	ADLO
$stop \rightarrow bl\ \tilde{\nu}$	96 GeV	20 GeV	ALO
$sbot \rightarrow c\chi_1^0$	94 GeV	20 GeV	ADLO
$\tilde{g} \rightarrow jets + E_T^m$	195 GeV	-	CDF
$\chi_1^\pm \rightarrow W\chi_1^0$	103.5 GeV	large m_0	ADLO
$\chi_1^\pm \rightarrow W\chi_1^0$	92.4 GeV	small ΔM	ADLO



$\gamma\nu$	$\chi_1^\pm$, GMSB
$e\nu$	$\tilde{l}^+\tilde{l}^-$
$l^+l^-\nu$	$\tilde{l}^+\tilde{l}^-, \chi_1^\pm$
$\gamma\gamma\nu$	GMSB
l^+l^- (quasi-stable)	$\chi_1^\pm$
$l^+l^-\nu$	$\tilde{l}^+\tilde{l}^-$
$l^+l^-\gamma\nu$	$\tilde{l}^+\tilde{l}^-$
l, 2-jets, ν	$\chi_1^\pm$
$l^+l^-\gamma\gamma\nu$	$\tilde{l}^+\tilde{l}^-$
$l^+l^-l^+l^-\nu$	$\tilde{l}^+\tilde{l}^-$
l^+l^- jet–jet	squarks
4-jets, ν	$\chi_1^\pm$
6-leptons, ν	RPV
multi-jets + leptons	RPV

topologies explored

Limit on neutralino

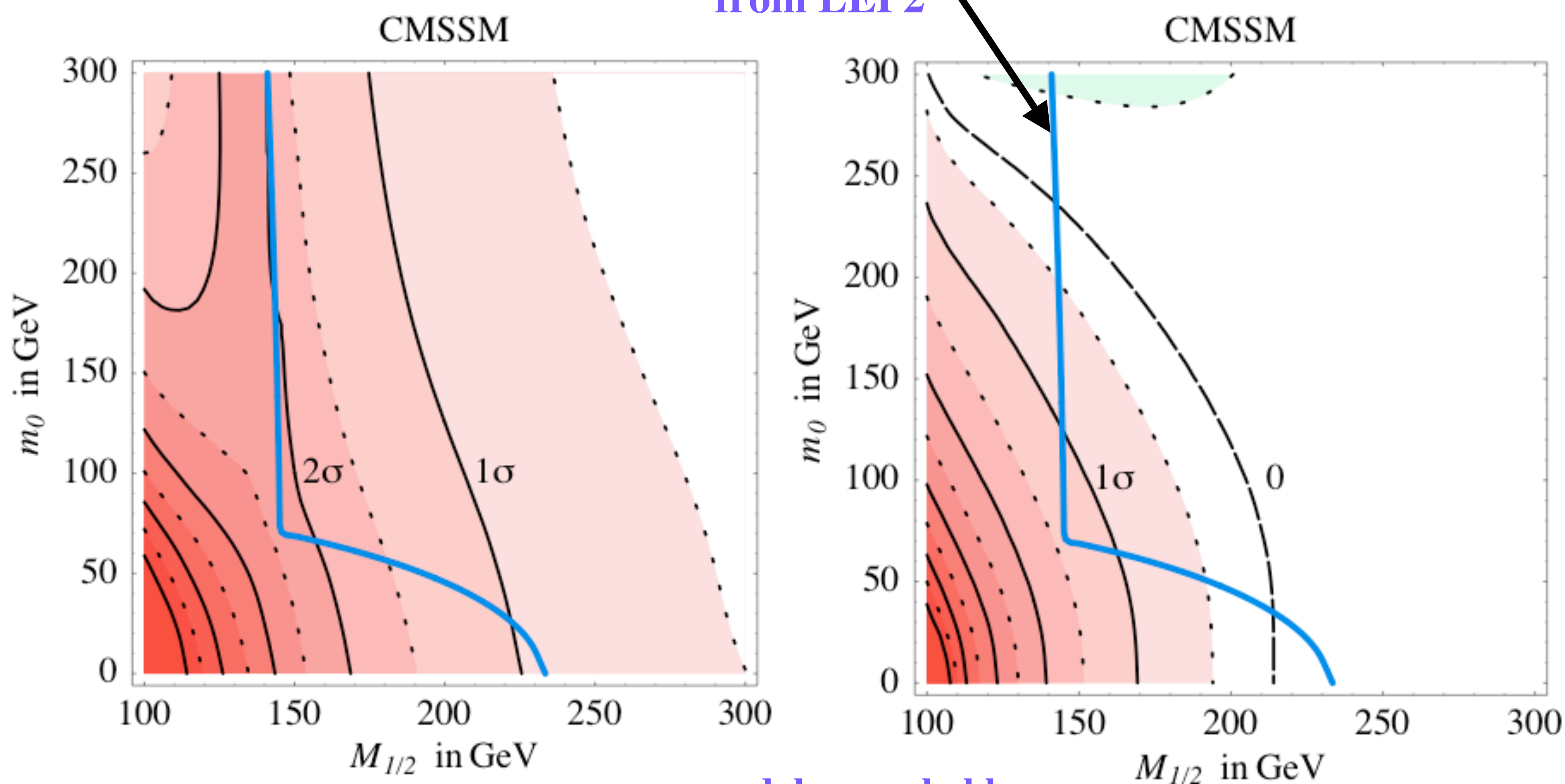


SUSY after LEP2 hep-ph/0502095

with LEP2 electroweak

direct limit from LEP2

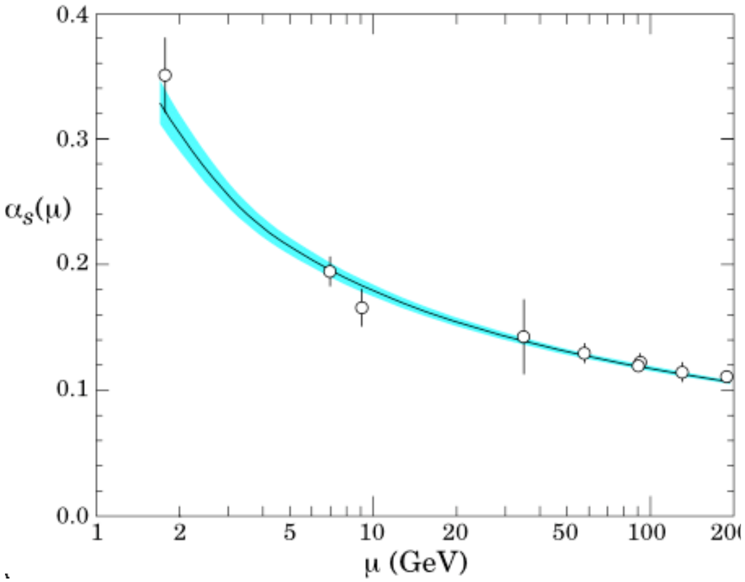
without LEP2 electroweak

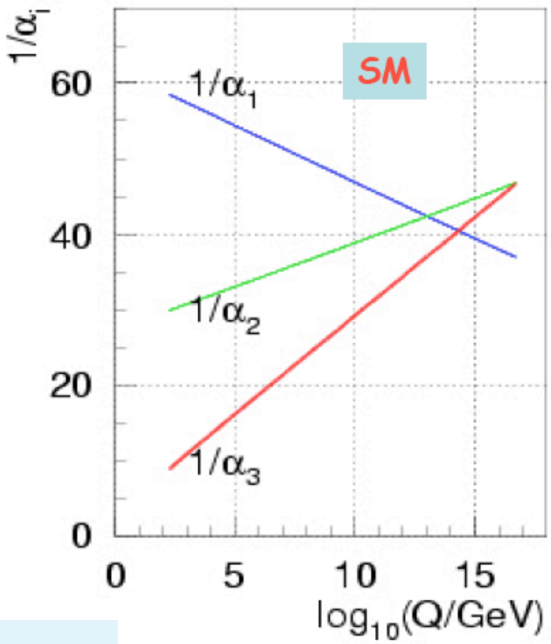


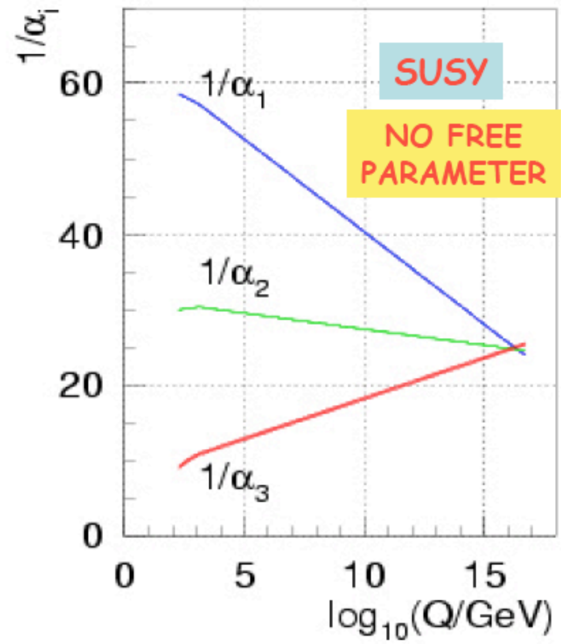
more red, less probable,...

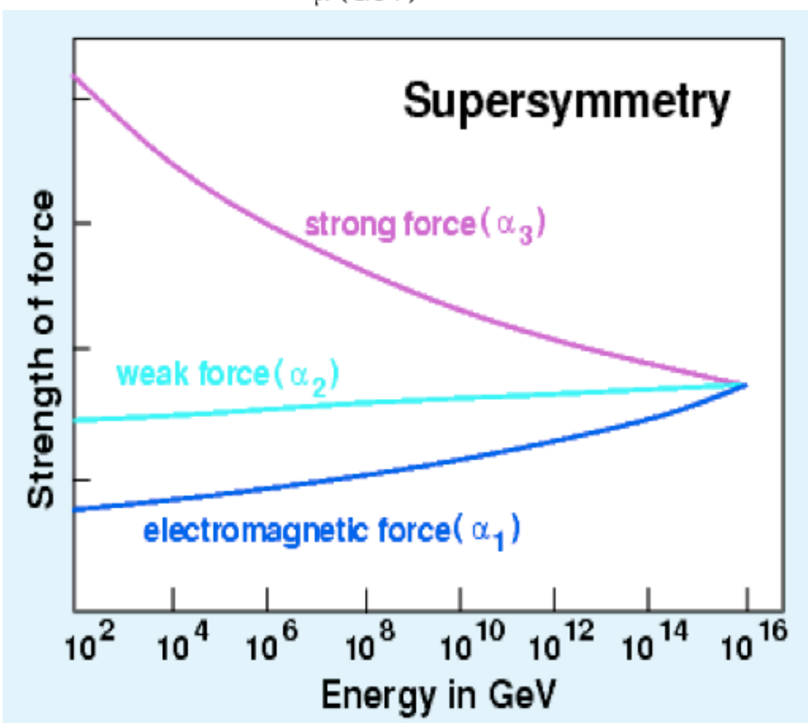
quasi perfect convergence of coupling strengths at 10^{16} GeV in low mass SUSY

2000

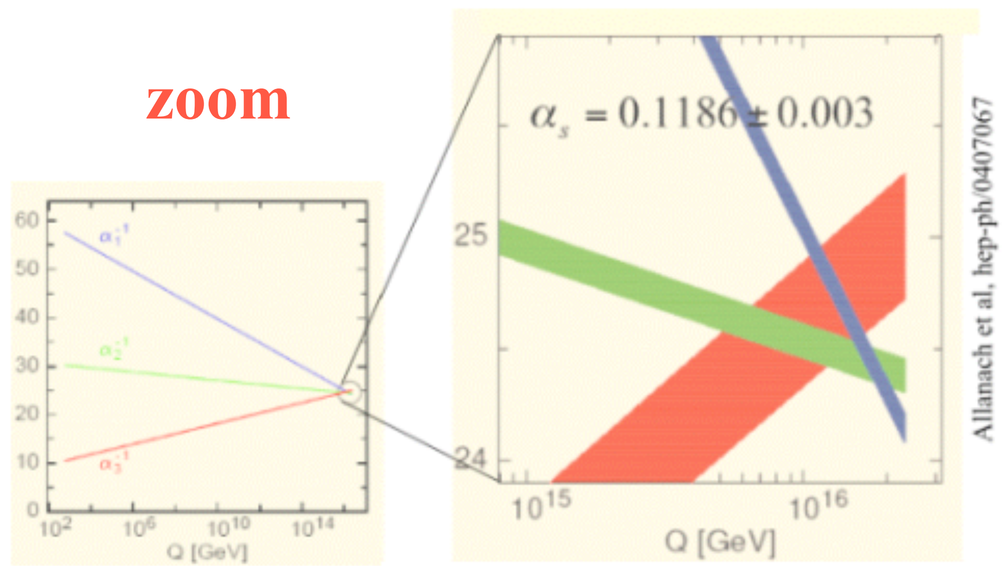




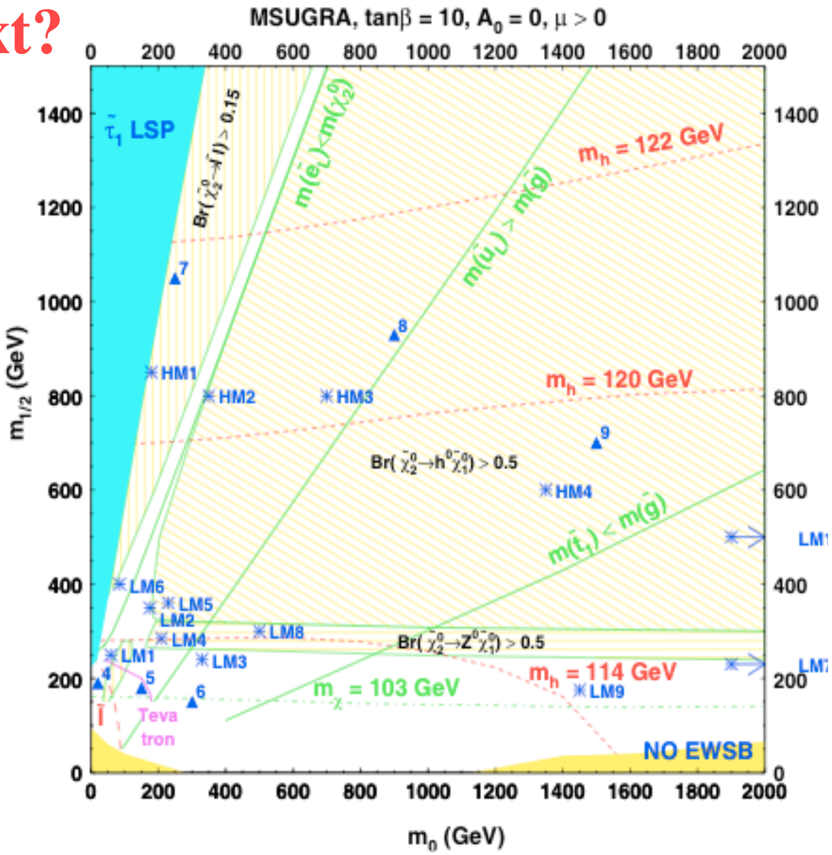


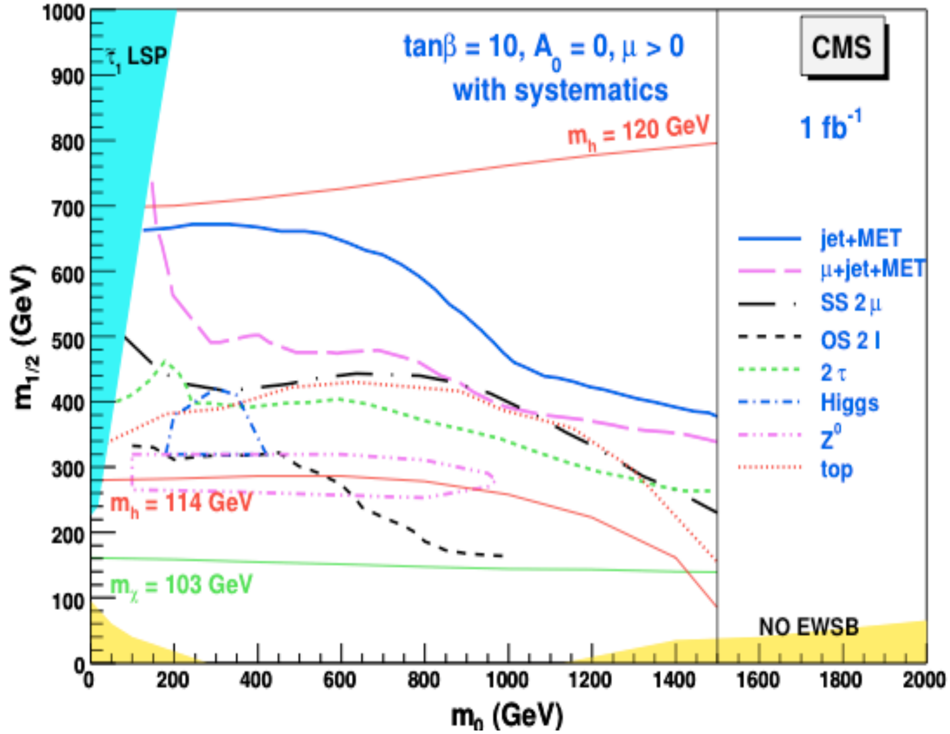


zoom

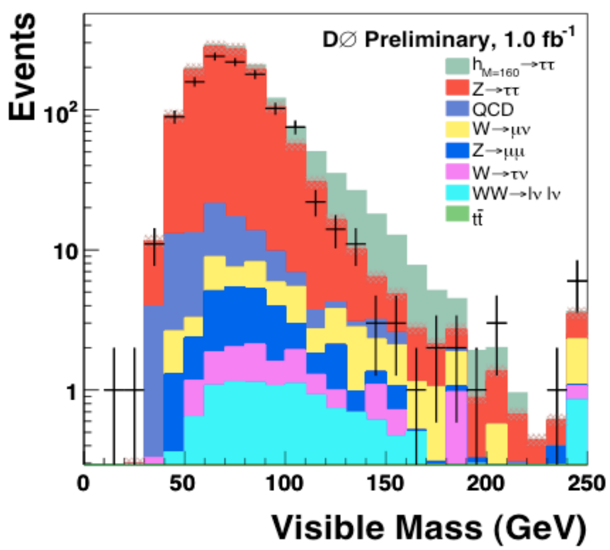


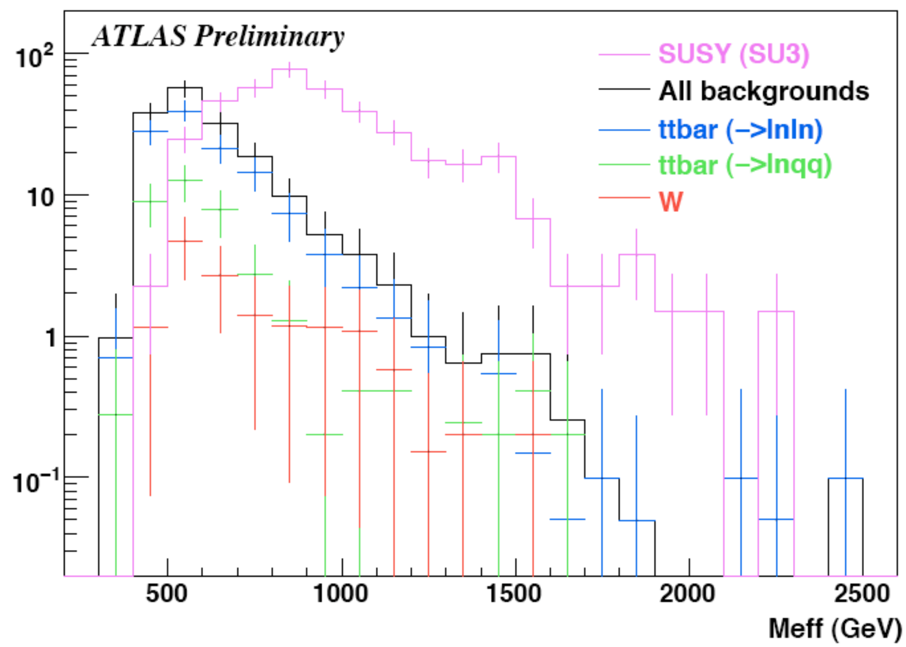
Next?



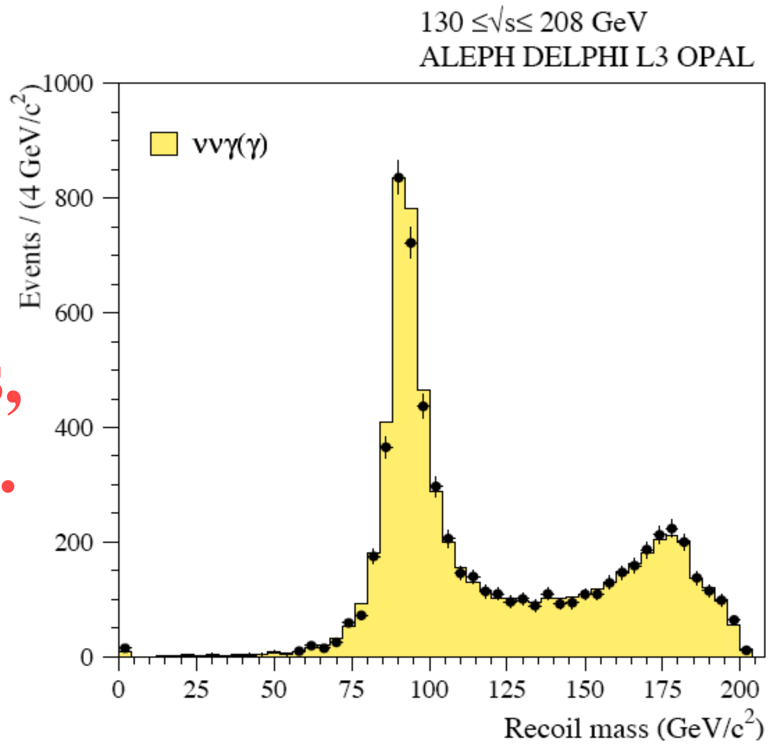


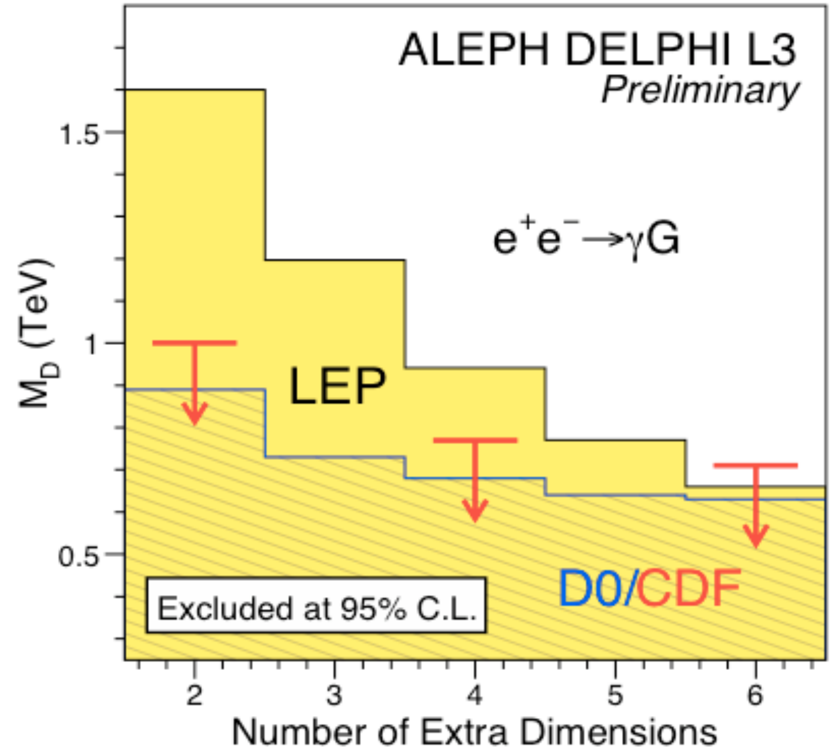
Tevatron?



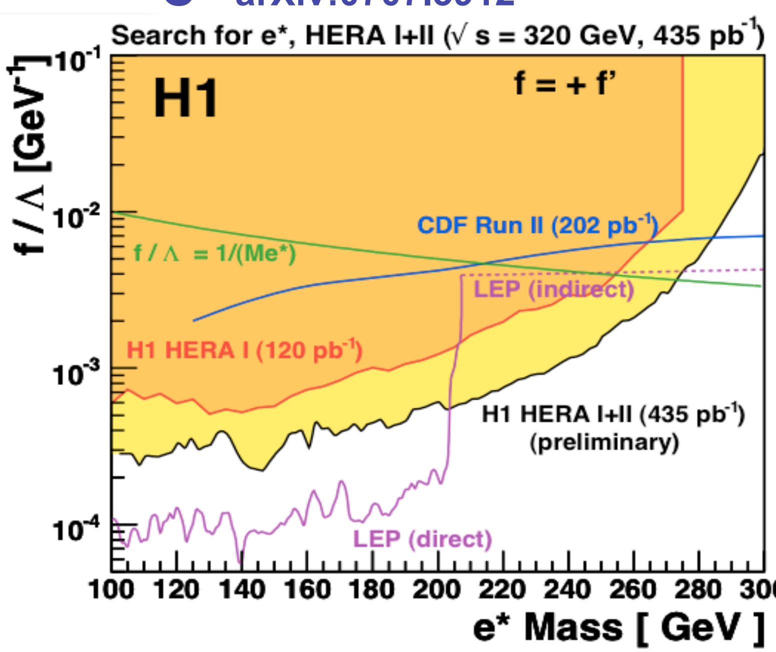


Limits, limits..

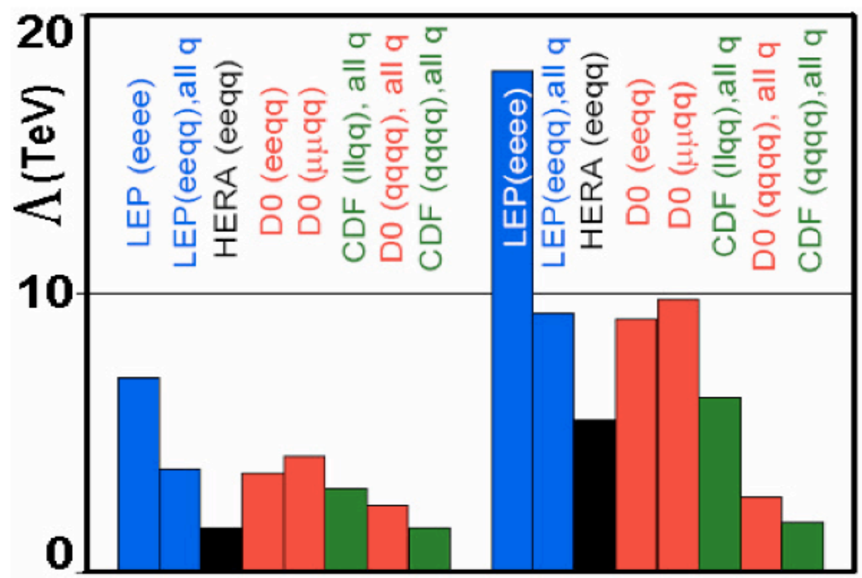




e* arXiv:0707.3912



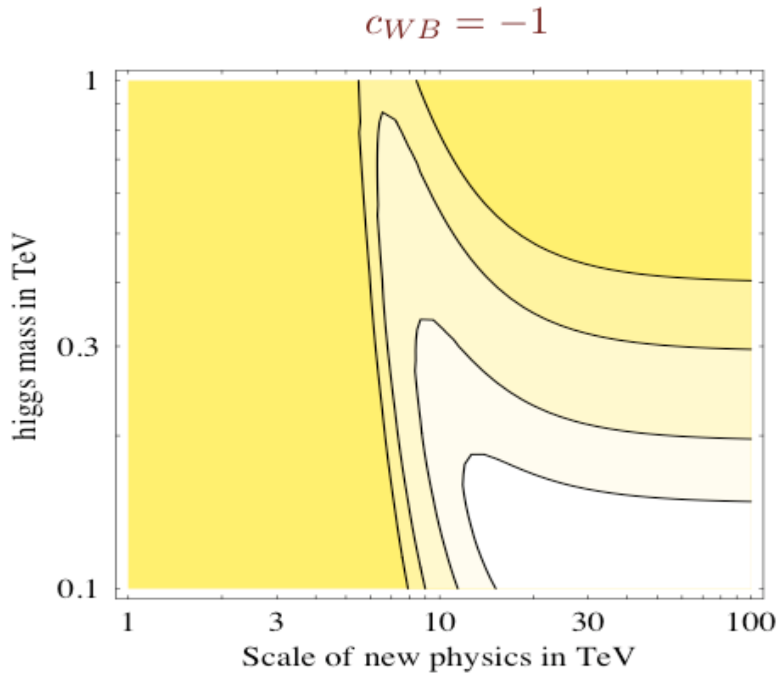
Compositeness, hep-ex/0512006



LEP paradox hep-ph/0007265

$$\mathcal{L}_{\rm eff}(E<\Lambda) = \mathcal{L}_{\rm SM} + \sum_{i,p} \frac{c_i}{\Lambda^p}\mathcal{O}_i^{(4+p)}$$

dim≥5



does not apply to SUSY

$$\frac{4\pi}{\Lambda^2}(\bar{e}\gamma_\mu e)(\bar{f}\gamma_\mu f) \quad \Lambda \approx \sqrt{\frac{sN^{1/2}}{\alpha}} \approx 10\,\text{TeV}$$

$$4\pi/\Lambda^2 \sim g^4/(4\pi m_{\rm SUSY})^2$$

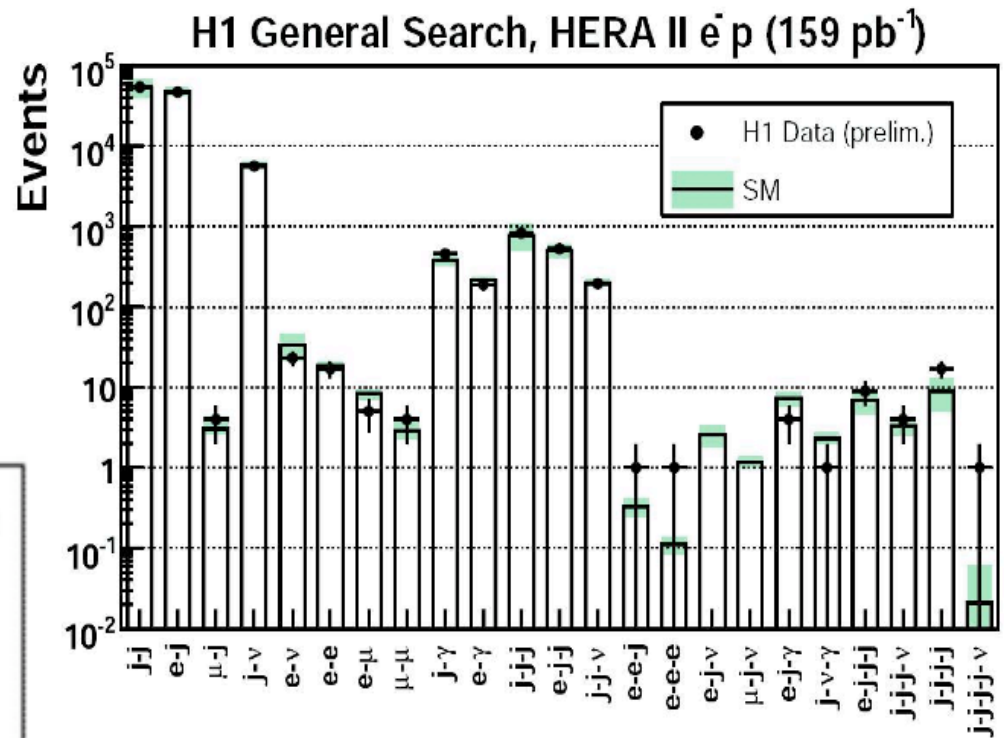
$$m_{\rm SUSY} \gtrsim g^2\Lambda/(4\pi)^{3/2} \approx 100\,\text{GeV}$$

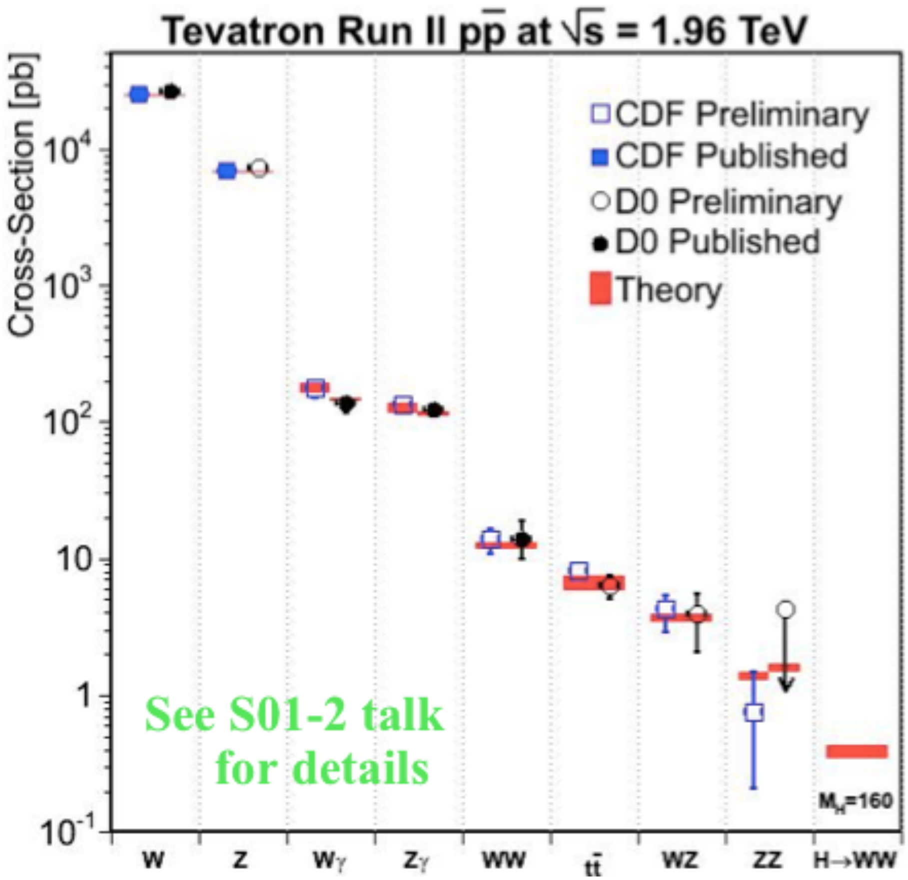
95% lower bounds

Dimensions six operators	$m_h = 115$ GeV $c_i=-1$	$m_h = 115$ GeV $c_i=+1$	$m_h = 300$ GeV $c_i=-1$	$m_h = 300$ GeV $c_i=+1$	$m_h = 800$ GeV $c_i=-1$	$m_h = 800$ GeV $c_i=+1$
$\mathcal{O}_{WB} = (H^\dagger\tau^a H)W^a_{\mu\nu}B_{\mu\nu}$	9.7	10	7.5	—	—	—
$\mathcal{O}_H = \|H^\dagger D_\mu H\|^2$	4.6	5.6	3.4	—	2.8	—
$\mathcal{O}_{LL} = \frac{1}{2}(\bar{L}\gamma_\mu\tau^a L)^2$	7.9	6.1	—	—	—	—
$\mathcal{O}'_{HL} = i(H^\dagger D_\mu\tau^a H)(\bar{L}\gamma_\mu\tau^a L)$	8.4	8.8	7.5	—	—	—
$\mathcal{O}'_{HQ} = i(H^\dagger D_\mu\tau^a H)(\bar{Q}\gamma_\mu\tau^a Q)$	6.6	6.8	—	—	—	—
$\mathcal{O}_{HL} = i(H^\dagger D_\mu H)(\bar{L}\gamma_\mu L)$	7.3	9.2	—	—	—	—
$\mathcal{O}_{HQ} = i(H^\dagger D_\mu H)(\bar{Q}\gamma_\mu Q)$	5.8	3.4	—	—	—	—
$\mathcal{O}_{HE} = i(H^\dagger D_\mu H)(\bar{E}\gamma_\mu E)$	8.2	7.7	—	—	—	—
$\mathcal{O}_{HU} = i(H^\dagger D_\mu H)(\bar{U}\gamma_\mu U)$	2.4	3.3	—	—	—	—
$\mathcal{O}_{HD} = i(H^\dagger D_\mu H)(\bar{D}\gamma_\mu D)$	2.1	2.5	—	—	—	—

Searches at HERA and Tevatron

topological approach 0710.2378





CDF Run II preliminary (927 pb⁻¹)

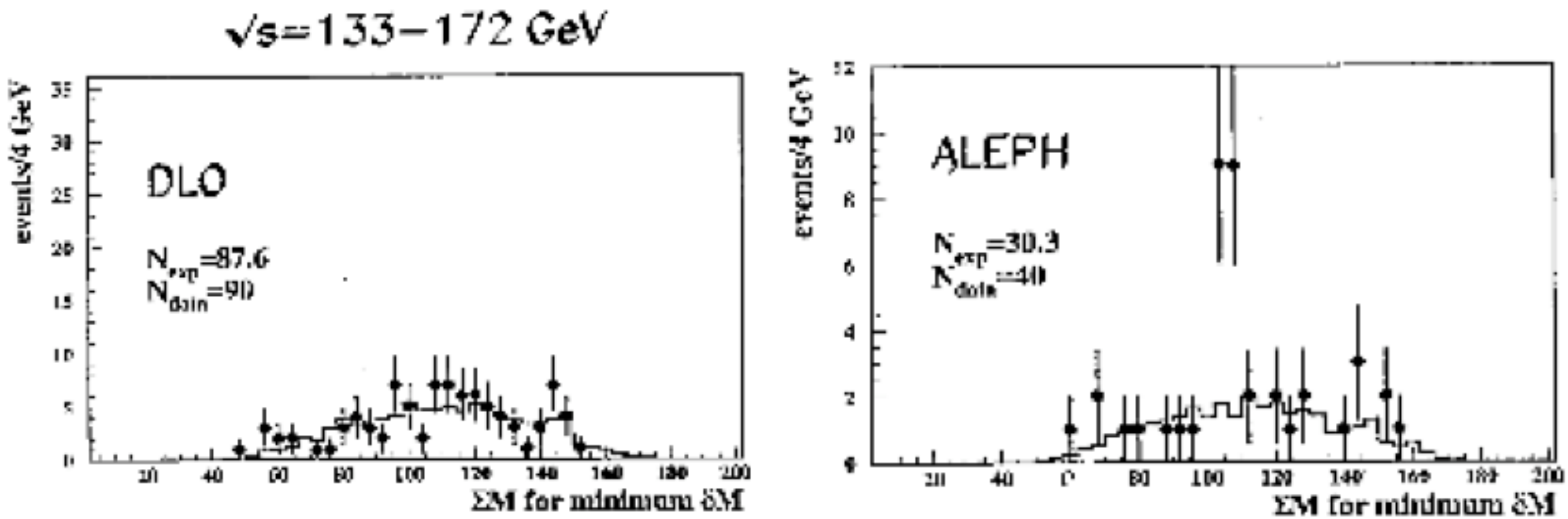
Sleuth@CDFIIa result

(top 5)

SLEUTH Final State	$\mathcal{P}$
$b\bar{b}$	0.0055
$j\,\not{p}$	0.0092
$\ell^+\ell'^+\not{p}jj$	0.011
$\ell^+\ell'^+\not{p}$	0.016
$\tau\,\not{p}$	0.016

$$\tilde{\mathcal{P}} = 0.46$$

- Sleuth finds no significant excess in 1fb⁻¹ of CDF Run II high-p_T data
- 46% of pseudo experiments are expected to be as interesting
- This does not prove there is no new physics present

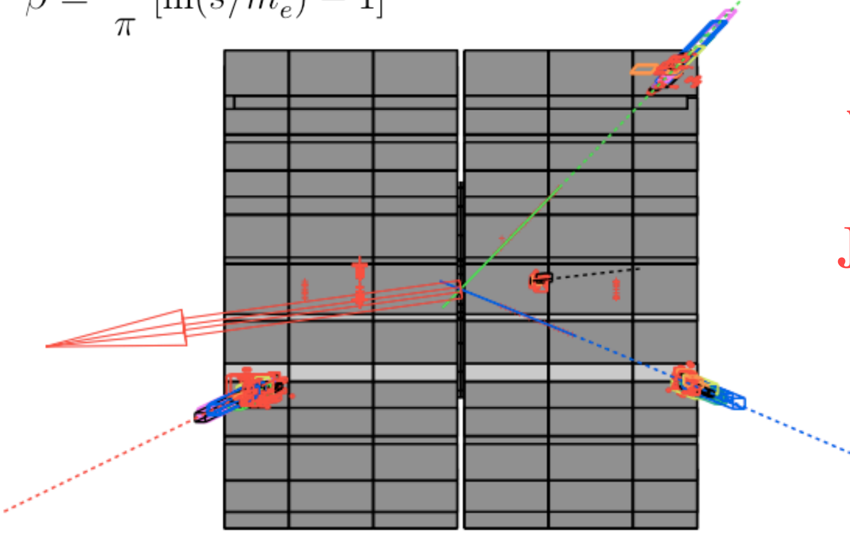


only two experiments (or a single one) may lead to tricky situations..

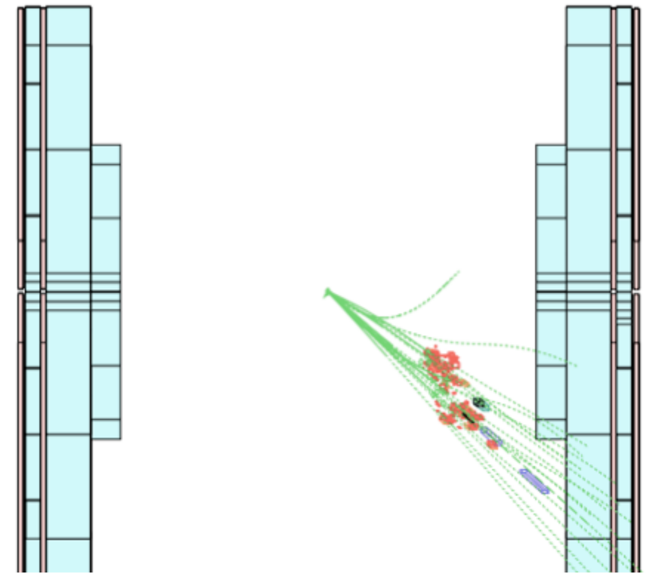
$$R_{ISR}(x_\gamma) = \beta x_\gamma^{(\beta-1)}$$

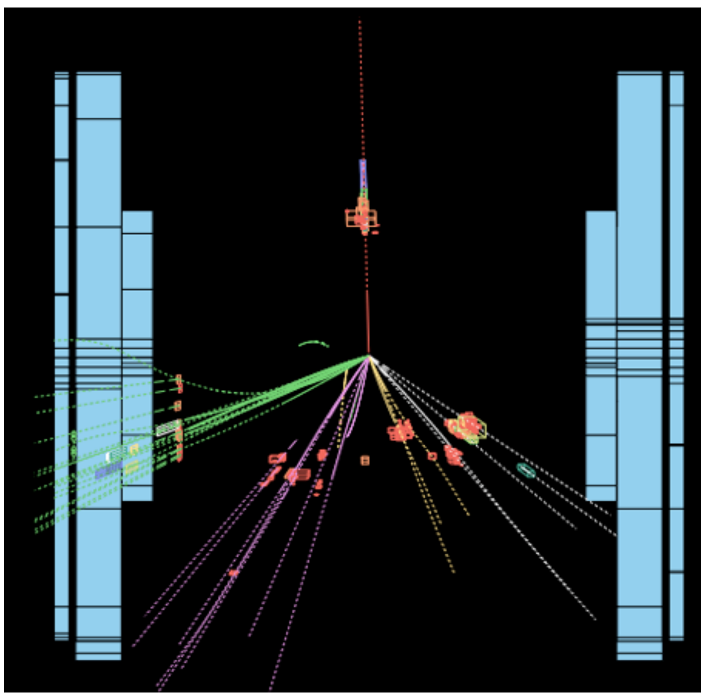
$$\beta = \frac{2\alpha}{\pi}[\ln(s/m_e^2) - 1]$$

Happy time!...

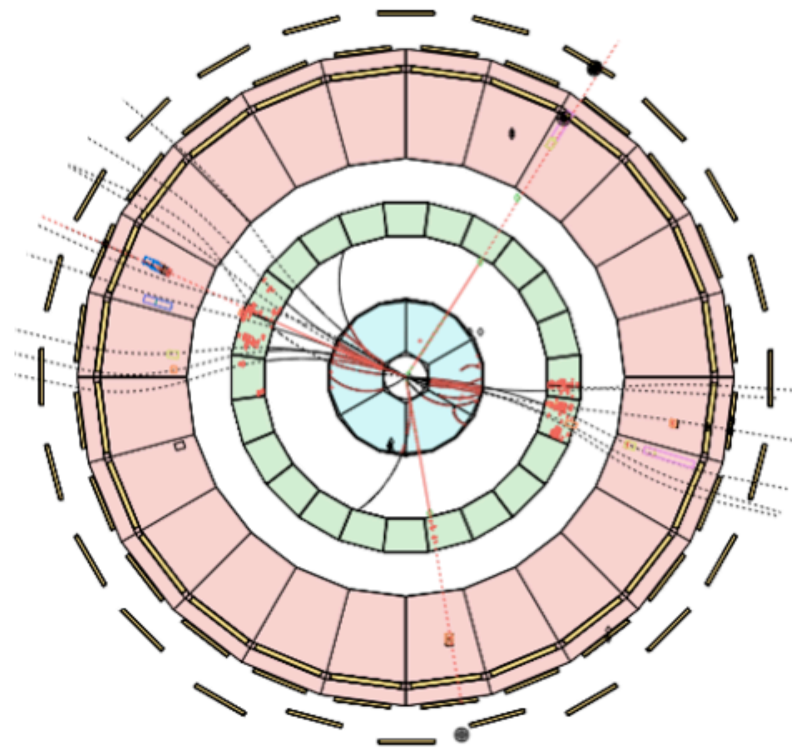


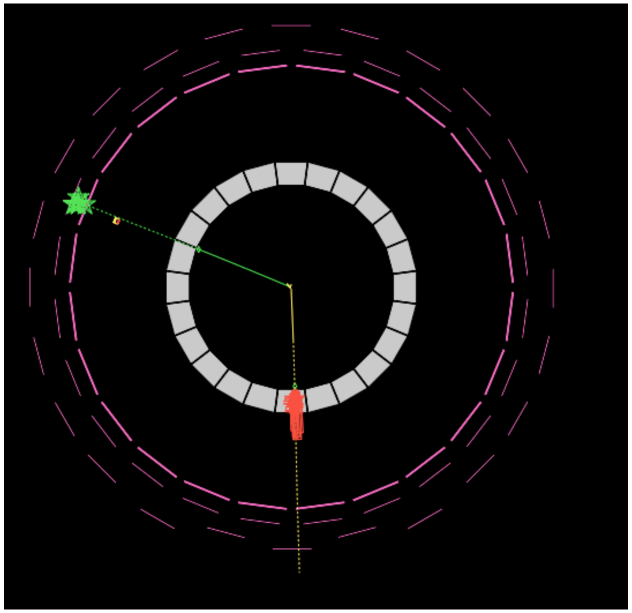
visualisation
Luc,
Jean-Claude,
Franco

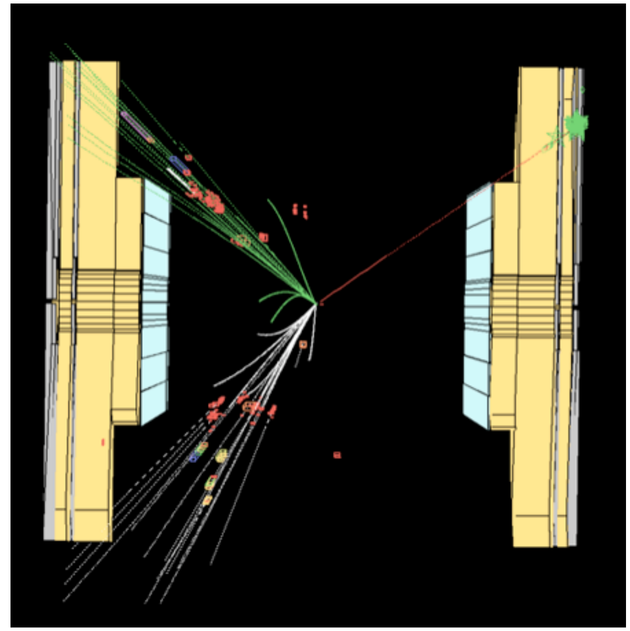


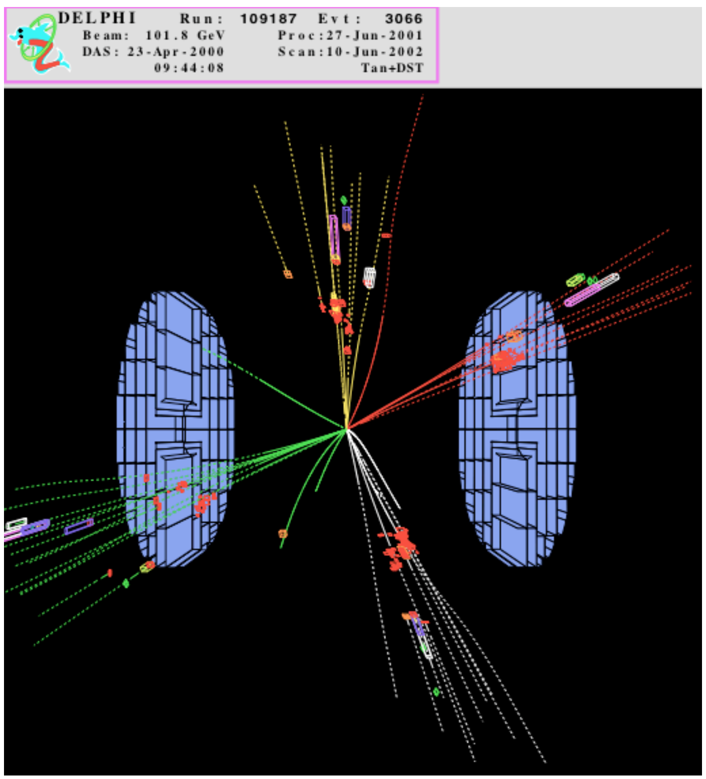


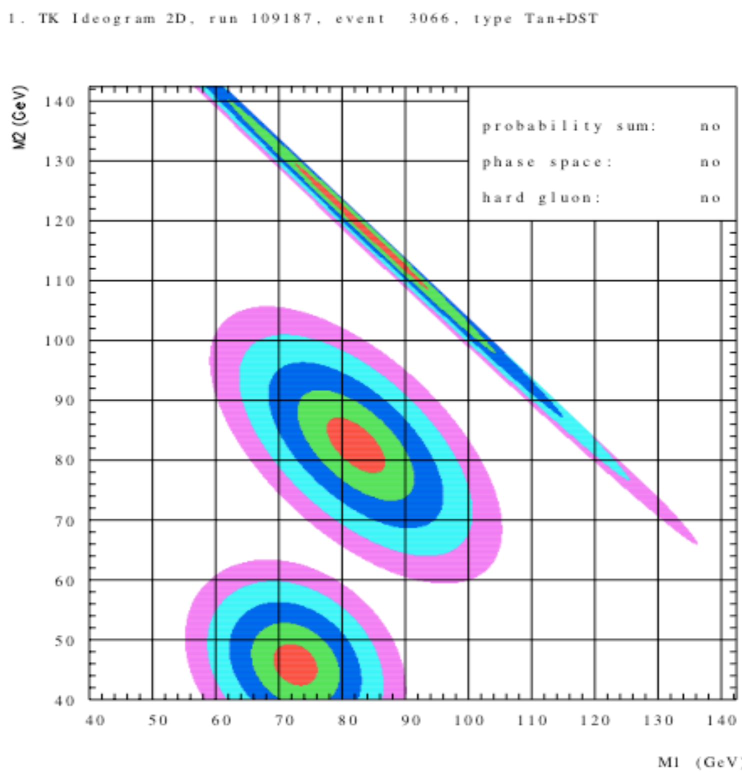
scanning:
Niels,..





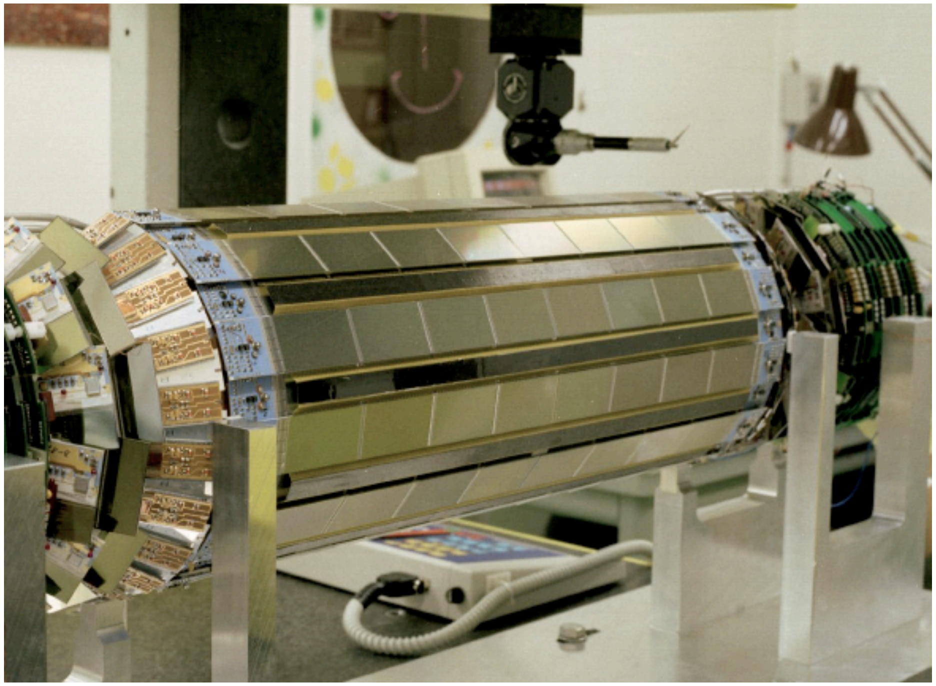


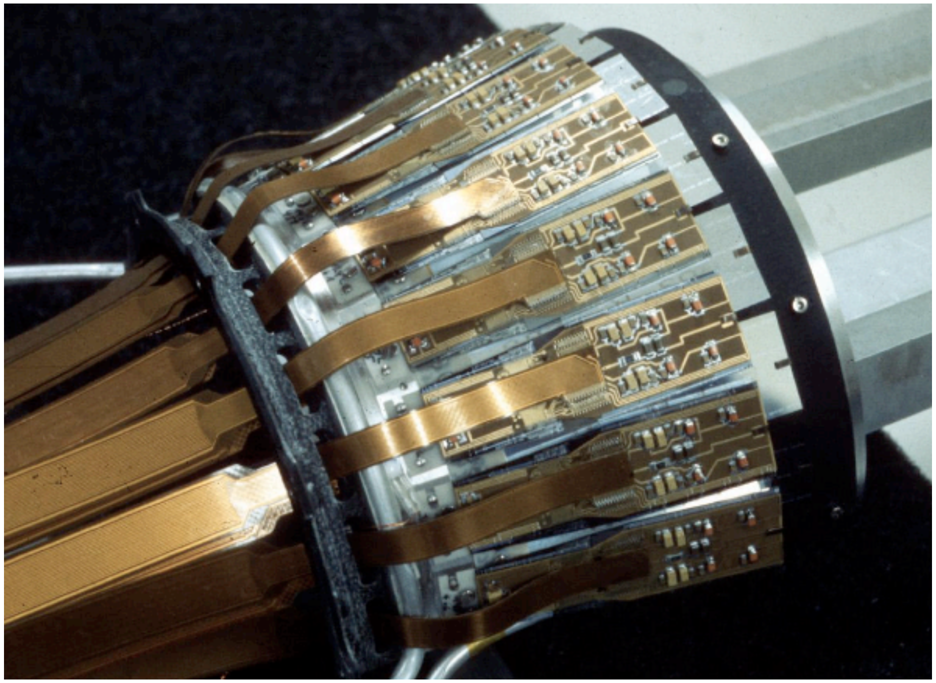




Ideogram: Niels, Martijn

DELPHI 97-55





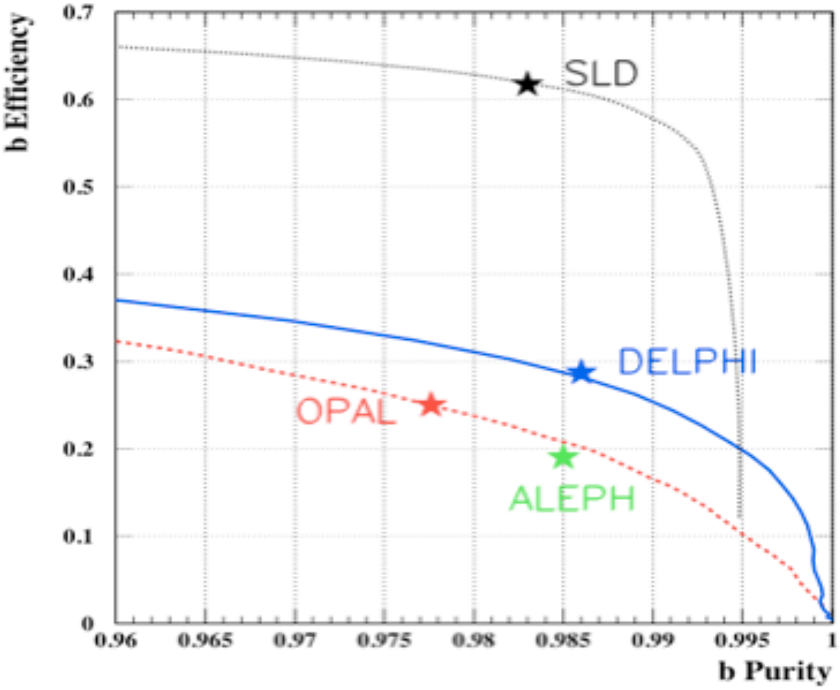
Very Forward Tracker: improved tracking forward

tracking: 11° to 169° coverage

John, Maria-E, Markus, etc

one sector of TPC out for 1/4 of 2000 data, but enough redundancy to cope with the problem

b-tag

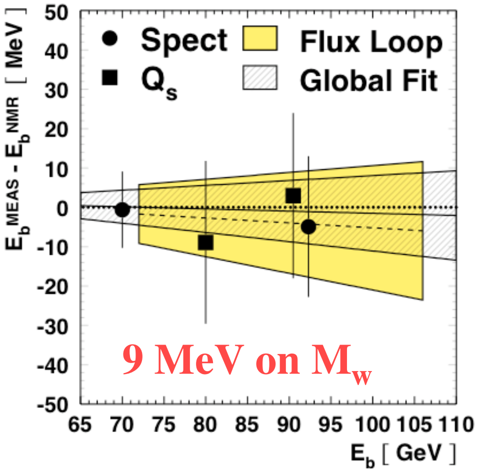


LEP2 measurements

M_W at LEP

hep-ex/060501

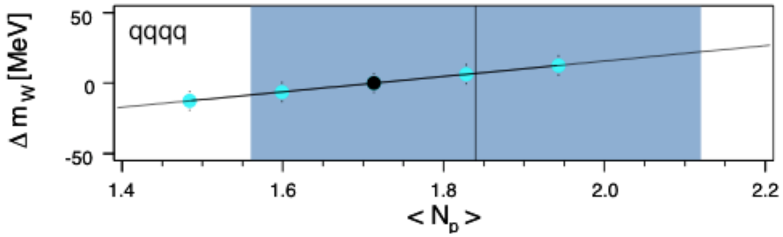
beam energy

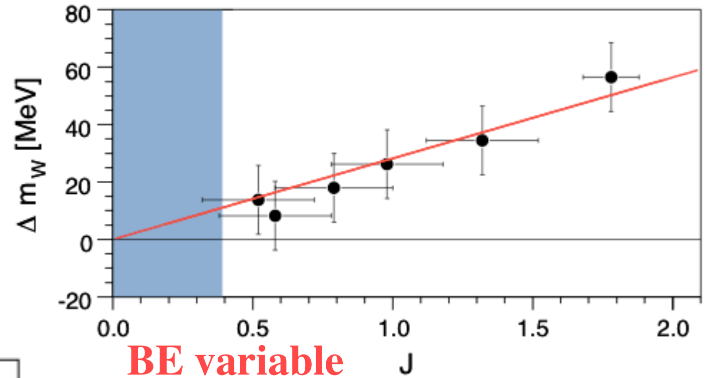


9 MeV on M_w

$$\Delta E_{cm} = +0.073 \pm 0.094(Stat.) \pm 0.065(Syst.)\ \text{GeV}$$

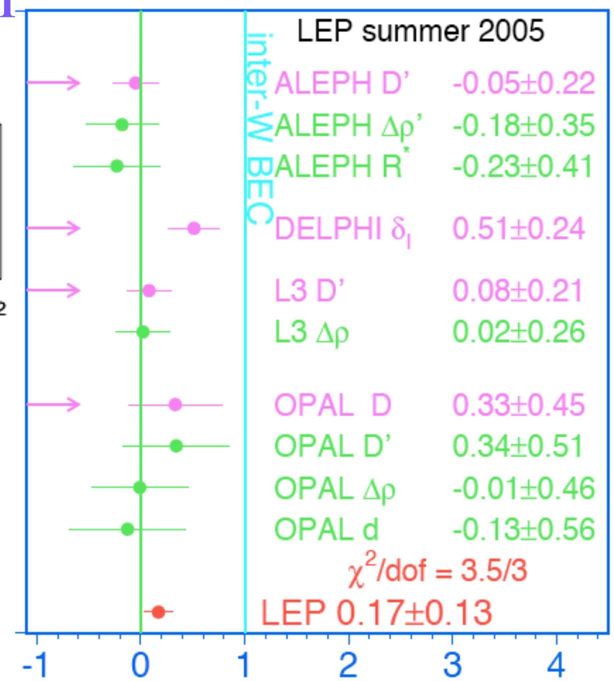
hadronization: proton multiplicity





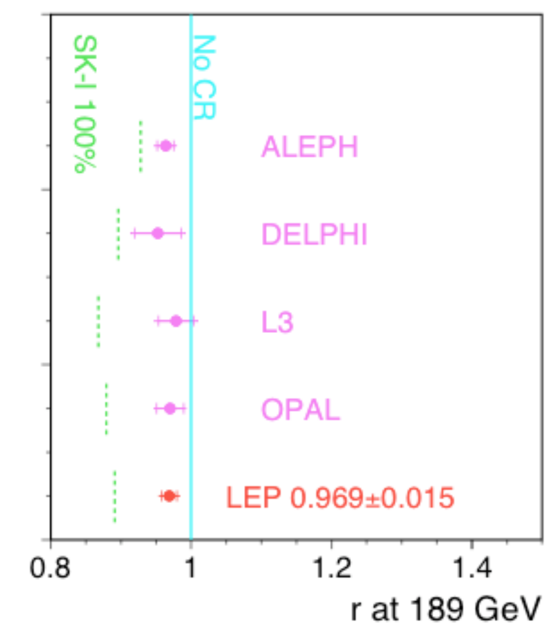
BE variable

Bose-Einstein



fraction of LUBOEI model

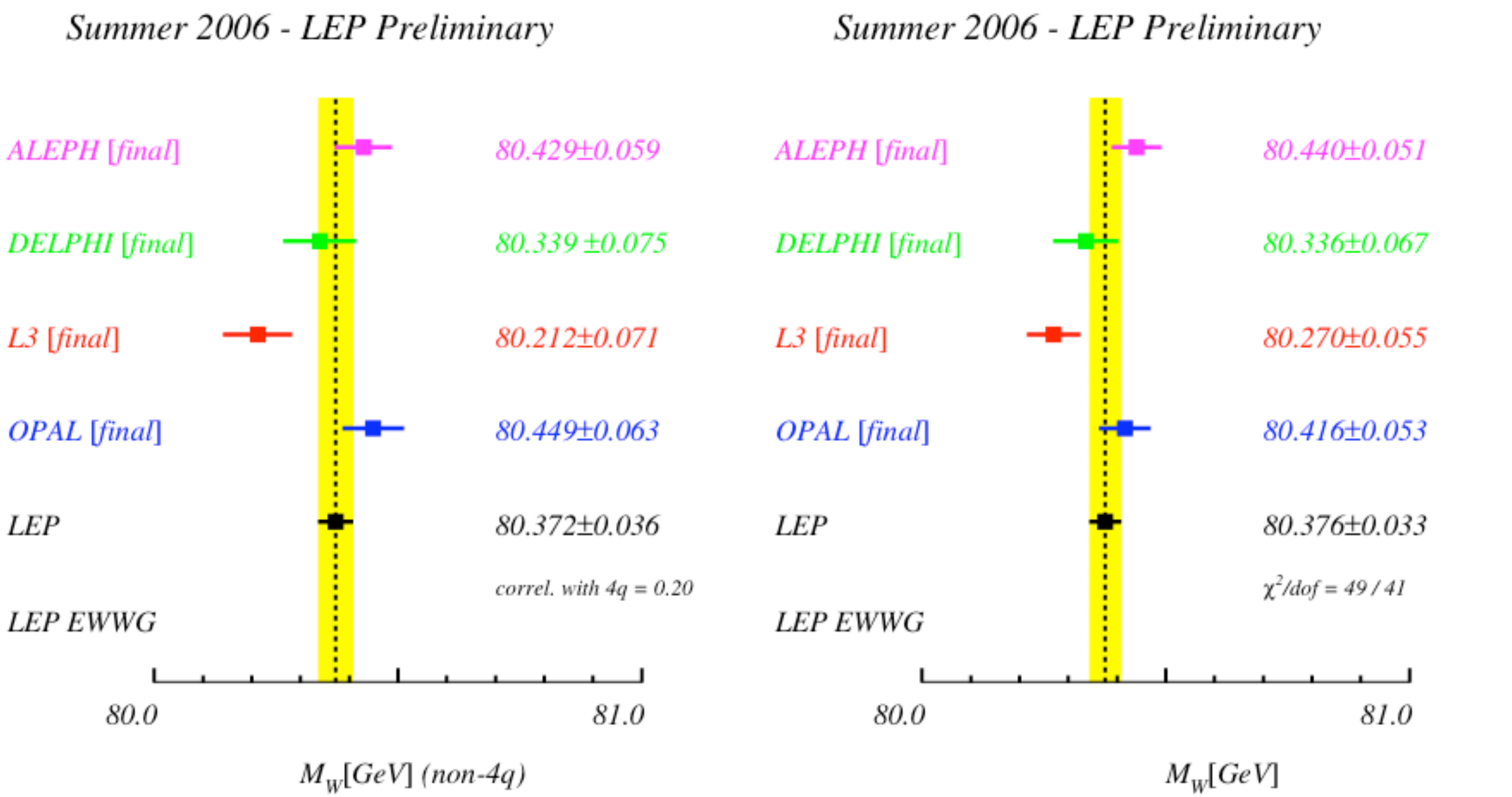
color reconnection



Sjostrand-Khose: full c.r.

r = p.f. intra-W over p.f. inter-W

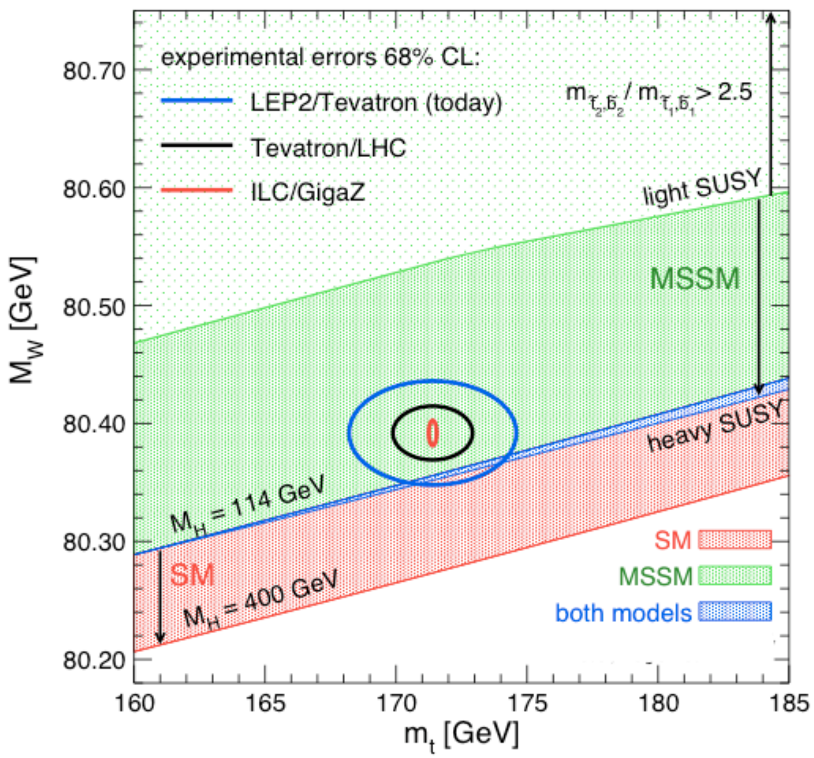
	ΔM_W (MeV)			$\Delta\Gamma_W$ (MeV)
Systematics source	$qq\ell\nu$	qqqq	$qq\ell\nu$ + qqqq	qqqq + $qq\ell\nu$
Hadronization	17	18	17	34
Color Reconnection	-	49	7	14
Bose-Einstein Cor.	-	22	3	25
Detector	14	8	13	31
ISR/FSR	10	9	10	14
LEP Beam Energy	14	11	13	5
Others	4	5	4	19
Total Systematics	28	62	28	59
Statistical	31	48	27	65
Total Uncertainty	42	79	39	88

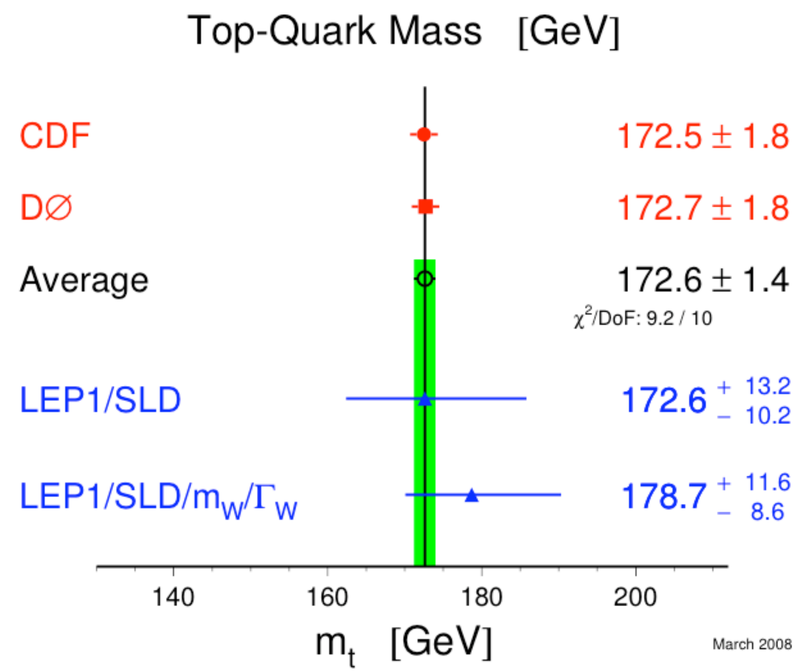


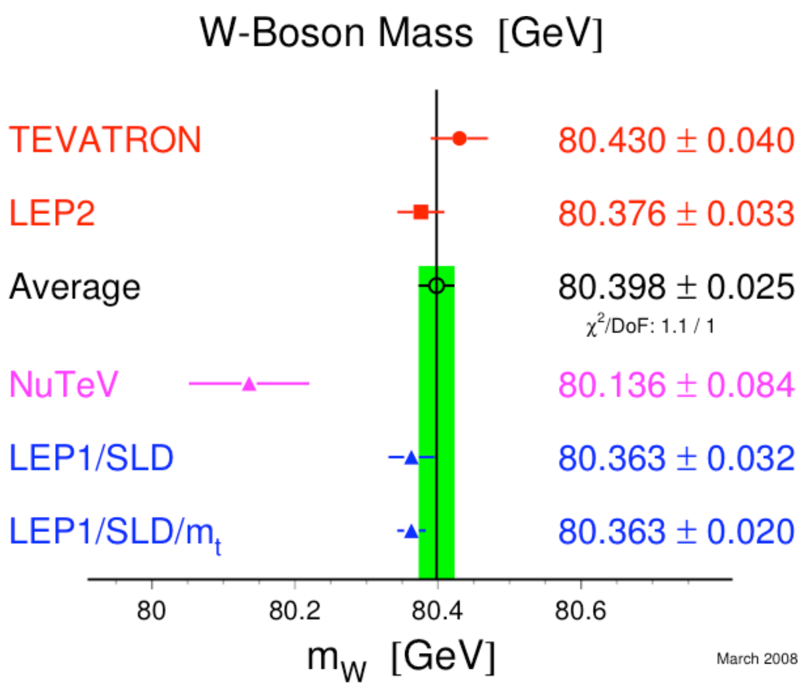
LEP 80.376±0.033 GeV

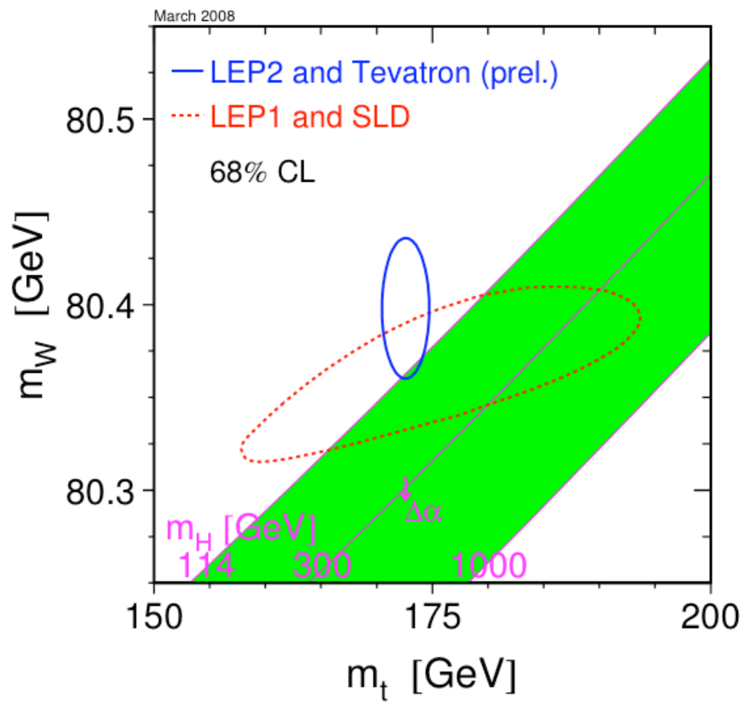
P.Roudeau, Aachen, 1986

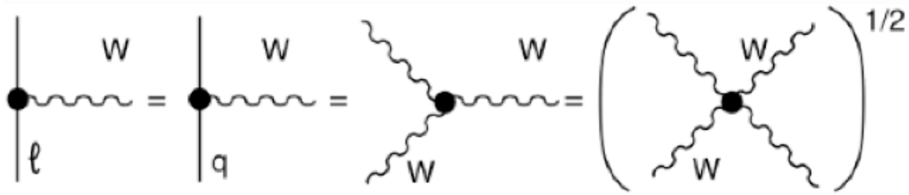
"Each of the four LEP experiments can measure in at least three ways the mass of the W boson at LEP200 with an accuracy of the order of 100 MeV or better. The integrated luminosity of 500pb^{-1} used in this study provides a better statistical accuracy (50–60 MeV) but it appears difficult to control the systematical uncertainties at such a level."


experimental errors 68% CL:
LEP2/Tevatron (today)
Tevatron/LHC
ILC/GigaZ
$m_{\tilde{t}_2,\tilde{b}_2} / m_{\tilde{t}_1,\tilde{b}_1} > 2.5$
light SUSY
MSSM
heavy SUSY
$M_H = 114$ GeV
$M_H = 400$ GeV
SM
SM
MSSM
both models
80.70
80.60
80.50
80.40
80.30
80.20
M_W [GeV]
160
165
170
175
180
185
m_t [GeV]


Top-Quark Mass [GeV]
CDF 172.5 ± 1.8
DØ 172.7 ± 1.8
Average 172.6 ± 1.4
χ^2/DoF: 9.2 / 10
LEP1/SLD 172.6 + 13.2 − 10.2
LEP1/SLD/m_W/Γ_W 178.7 + 11.6 − 8.6
140
160
180
200
m_t [GeV]
March 2008

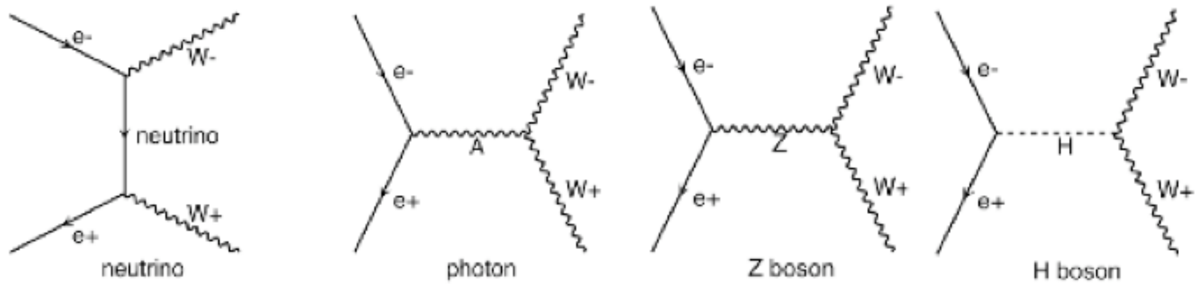

W-Boson Mass [GeV]
TEVATRON 80.430 ± 0.040
LEP2 80.376 ± 0.033
Average 80.398 ± 0.025
χ^2/DoF: 1.1 / 1
NuTeV 80.136 ± 0.084
LEP1/SLD 80.363 ± 0.032
LEP1/SLD/m_t 80.363 ± 0.020
80
80.2
80.4
80.6
m_W [GeV]
March 2008

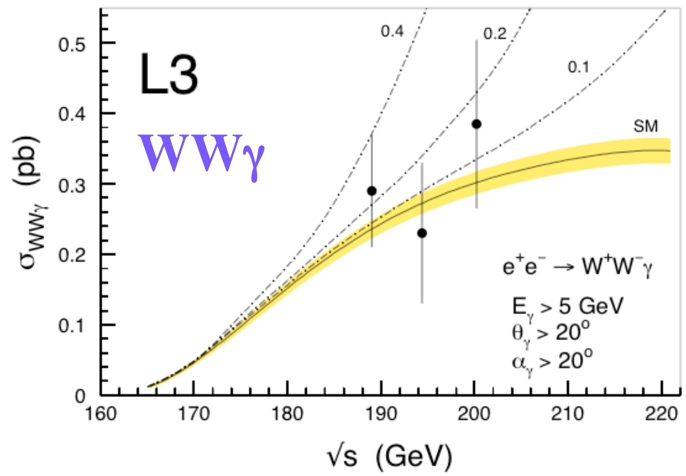

March 2008
LEP2 and Tevatron (prel.)
LEP1 and SLD
68% CL
80.5
80.4
80.3
m_W [GeV]
$\Delta\alpha$
m_H [GeV]
114
300
1000
150
175
200
m_t [GeV]



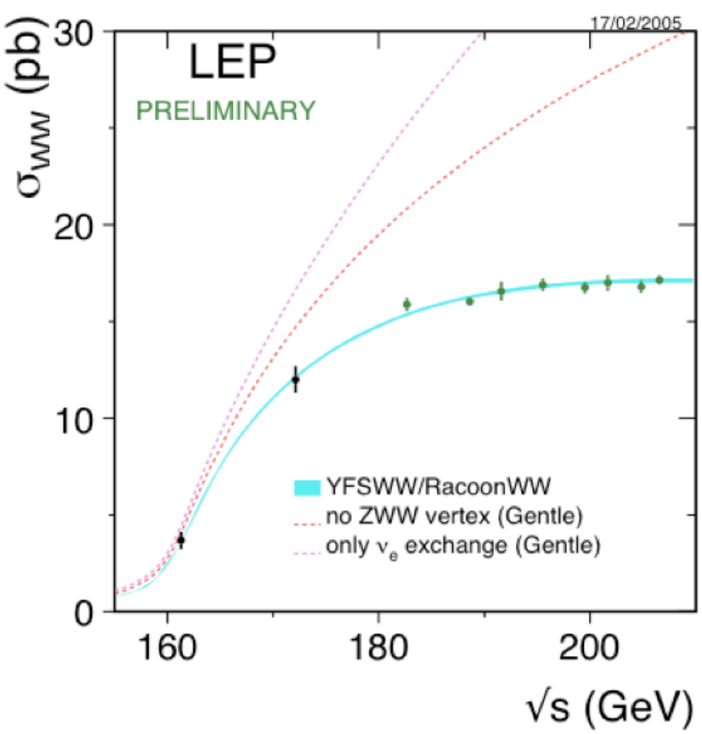
SM W couplings

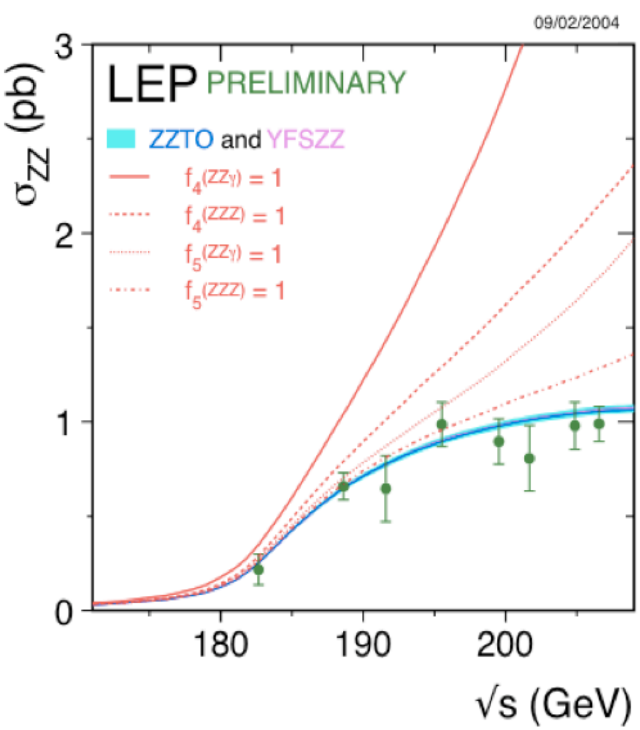
quartic



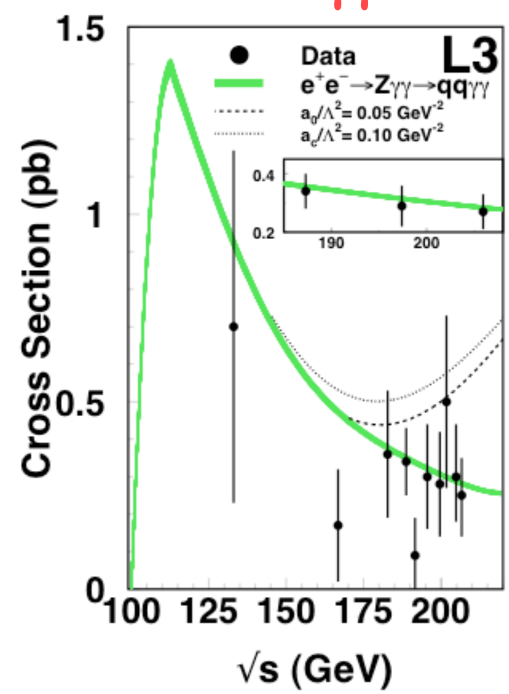


physical process	measurement / prediction	theoretical precision
$e^+e^- \to WW$	$0.997 \pm 0.007(stat) \pm 0.009(syst)$	0.005
$e^+e^- \to ZZ$	$0.969 \pm 0.047(stat) \pm 0.028(syst)$	0.02
$e^+e^- \to eeZ/\gamma^*$	$0.951 \pm 0.068(stat) \pm 0.048(syst)$	0.05
$e^+e^- \to e\nu_e W$	$0.949 \pm 0.067(stat) \pm 0.040(syst)$	0.05





Zγγ



Triple Gauge Couplings $\Delta g_1^Z, \Delta\kappa_\gamma, \lambda_\gamma$ and $g_4^Z, \tilde{\kappa}_Z$ and $\tilde{\lambda}_Z$

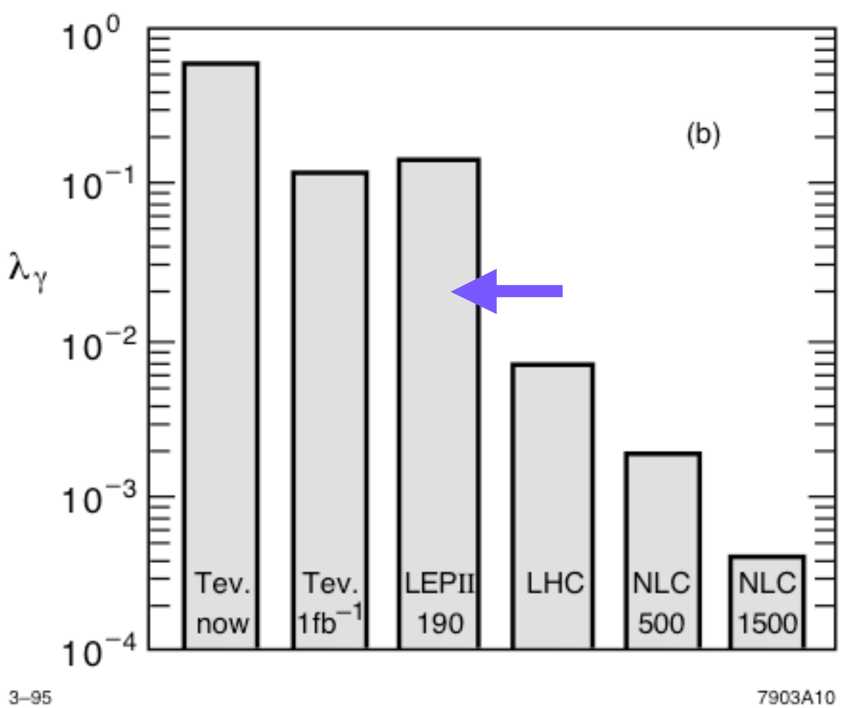
$$\kappa_\gamma = 0.984^{+0.042}_{-0.047}$$
$$\lambda_\gamma = -0.016^{+0.021}_{-0.023}$$
$$g_1^Z = 0.991^{+0.022}_{-0.021}$$

$$g_4^Z = -0.39^{+0.19}_{-0.20}$$
$$\tilde{\kappa}_Z = -0.09^{+0.08}_{-0.05}$$
$$\tilde{\lambda}_Z = -0.08 \pm 0.07$$

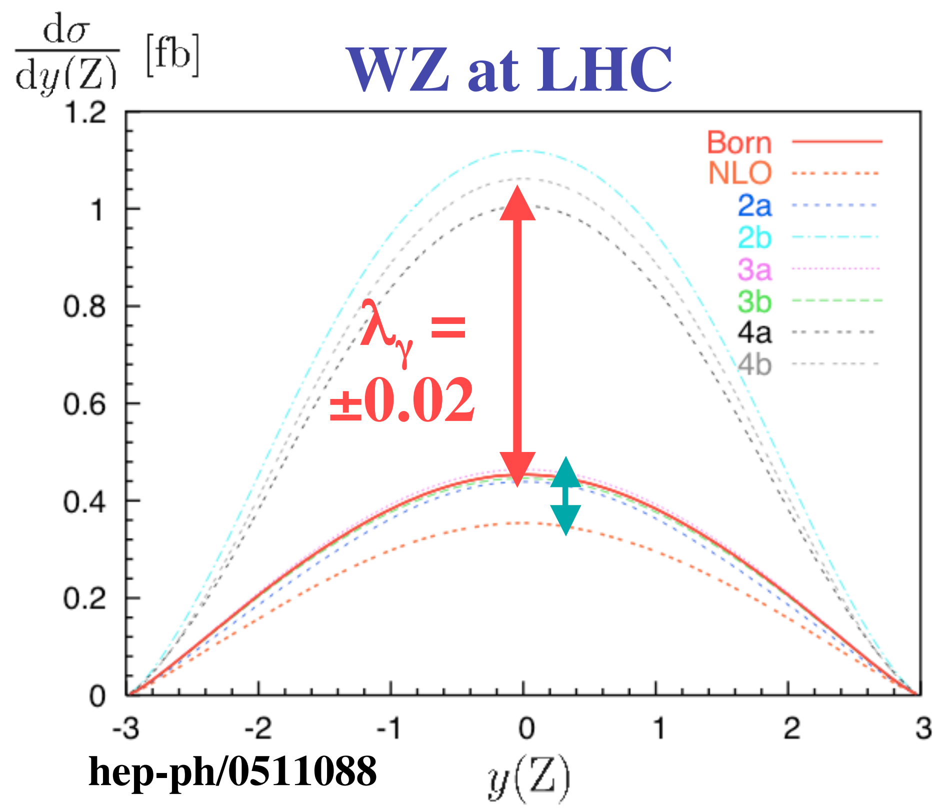
AQGC are compatible with zero as expected

not enough to probe SM loop effects (0.003)

expected to be depressed by m_W^2/Λ^2

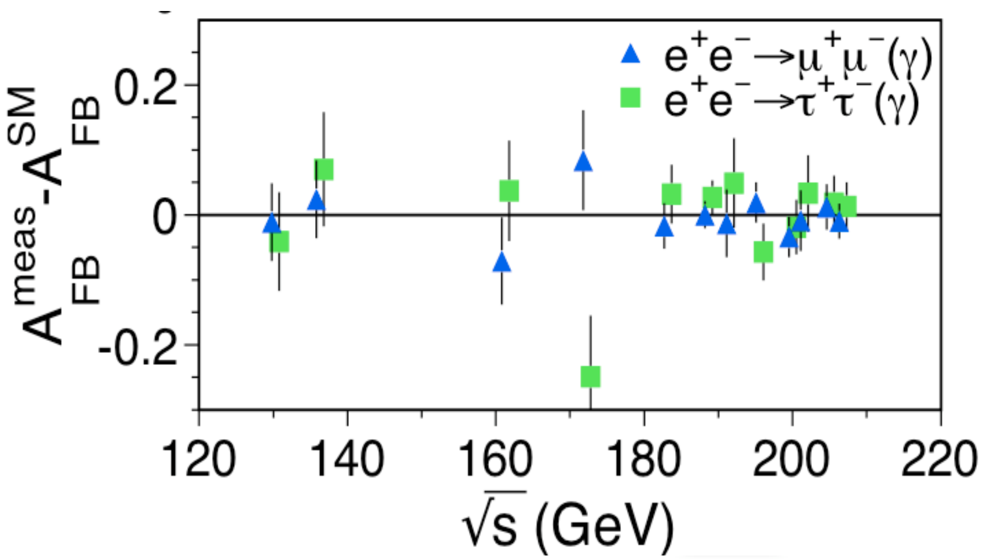


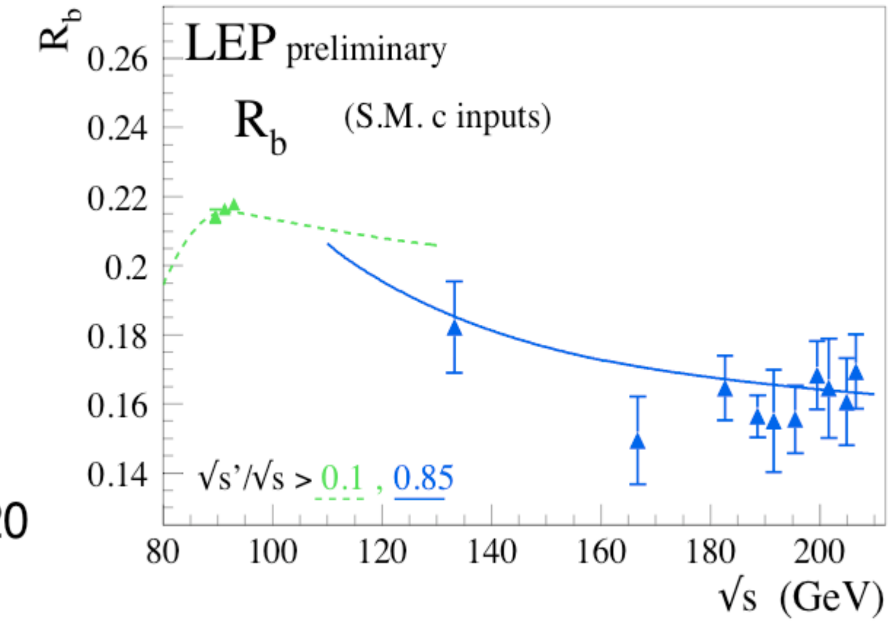
WZ at LHC

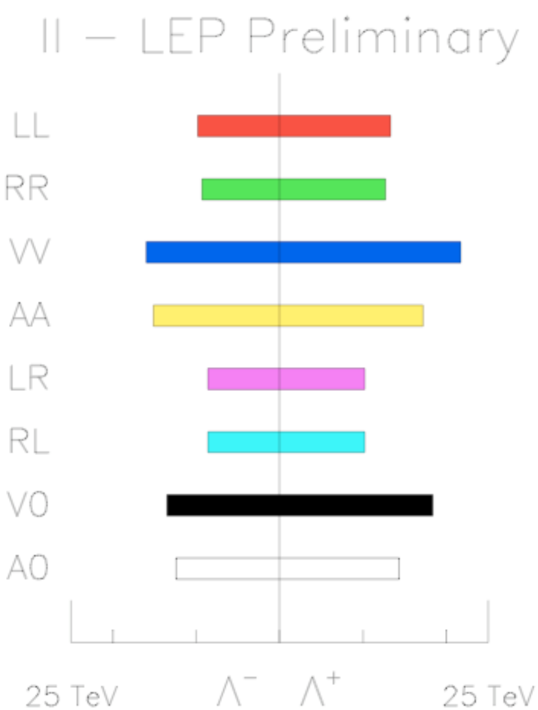


hep-ph/0511088

Fermion-antifermion LEP2FF/03-01







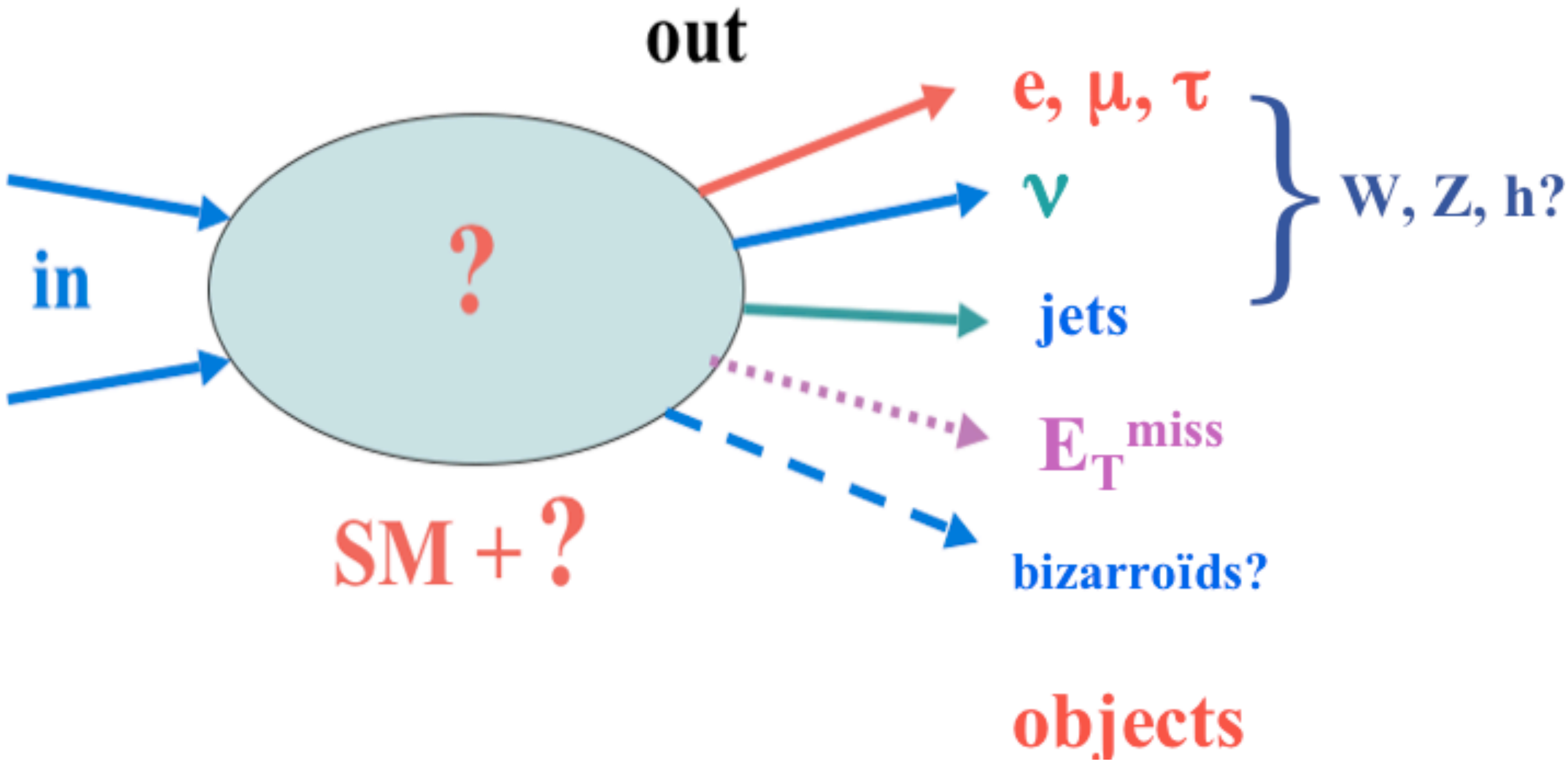
Model	leptons: $\mu^+\mu^-$ Λ_-	$\mu^+\mu^-$ Λ_+	$\tau^+\tau^-$ Λ_-	$\tau^+\tau^-$ Λ_+
LL	8.5	12.5	9.1	8.6
RR	8.1	11.9	8.7	8.2
VV	14.3	19.7	14.2	14.5
AA	12.7	16.4	14.0	11.3
LR	7.9	8.9	2.2	7.9
RL	7.9	8.9	2.2	7.9
V0	11.7	17.2	12.7	11.8
A0	11.5	12.4	9.8	10.8

compositeness

Z’

Z' model	χ	ψ	η	L-R	SSM
$M_{Z'}^{limit}$ (GeV/c^2)	673	481	434	804	1787

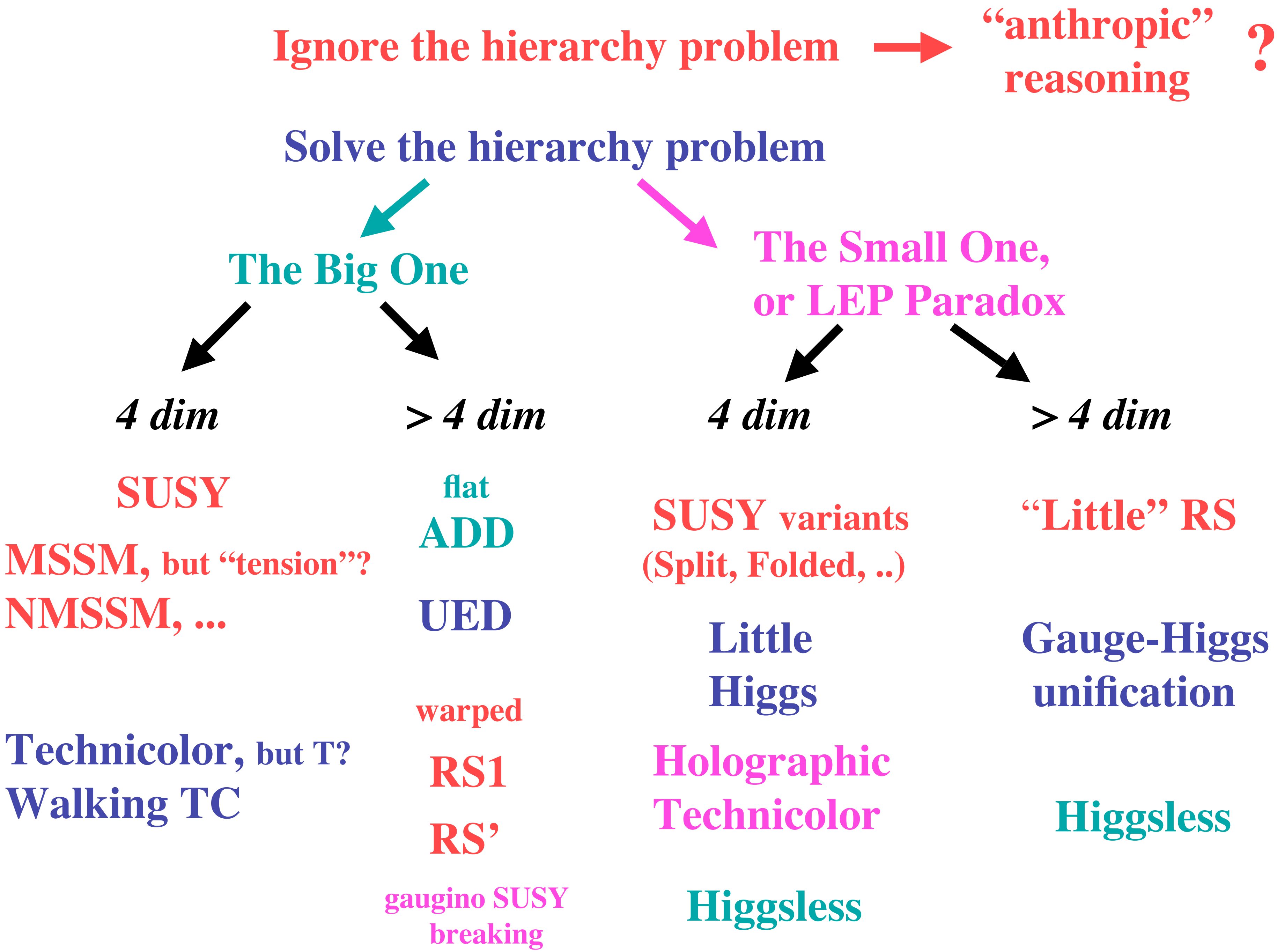
GLIMPSE AT LHC PHYSICS



1/ re-discover the SM

2/ establish the existence of signals BSM, if any

3/ find out what they are: the LHC "inverse problem"



Ignore the hierarchy problem
"anthropic" reasoning ?
Solve the hierarchy problem
The Big One
The Small One, or LEP Paradox
4 dim
> 4 dim
4 dim
> 4 dim
SUSY
MSSM, but "tension"?
NMSSM, ...
Technicolor, but T?
Walking TC
flat
ADD
UED
warped
RS1
RS'
gaugino SUSY breaking
SUSY variants
(Split, Folded, ..)
Little Higgs
Holographic Technicolor
Higgsless
"Little" RS
Gauge-Higgs unification
Higgsless

SUSY

→ great merits from the theoretical side

→ relatively abundantly produced

→ mostly MSSM, even SUGRA, are studied

- $m_h > 114$ GeV → "tension", O(1%) fine tuning
  ways to escape:

? we missed a non SM-like light Higgs: e.g. h (97) → aa → 4 τ (arXiv:0801.4554)

? consider hidden sectors: "Hidden Valleys", etc (arXiv:0712.2041)

? move to NMSSM: proposed benchmarks (arXiv:0801.4321)

? ignore the tension: Split SUSY → long-lived gluino, R-hadrons

(hep-ph/0612161, hep-ph/0611040)

- R-parity? proton stability, LSP dark matter, missing E_T
  but wishful thinking?

  proposed benchmarks (arXiv:0710.2287)

- missing E_T + ... as a privileged handle
  but try also "positive" identification (arXiv:0801.3799)

	no light vector resonance	light vector resonances
no light Higgs	Chiral lagrangians	LSTC Higgsless (D)BESS
light Higgs	SM, Strongly Interacting Light Higgs (SILH)	Warped/composite-Holographic-, Little-Gaugephobic-, Twin-Higgs LDBESS, Gauge-Higgs

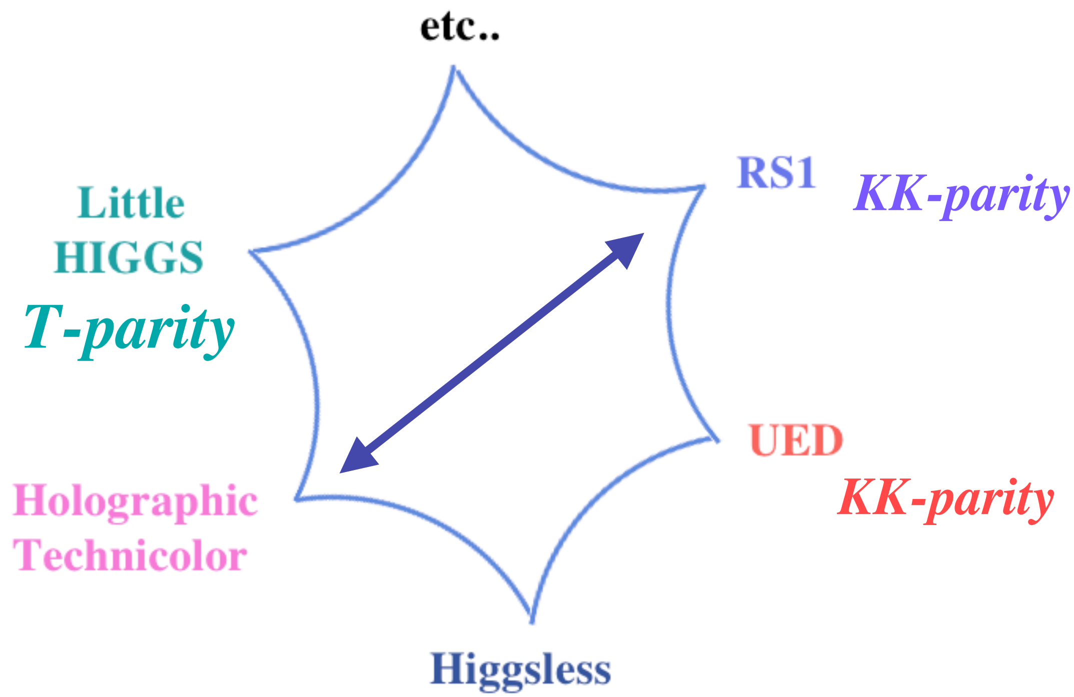
from C.Grojean

Custodial symmetry plus **Custodial parity**

to satisfy e.w. constraints

to allow for lighter objects, for a DM candidate, to satisfy e.g. R_b

then all models look somewhat alike... and like SUSY with R-parity.
They however differ in spin, in the number of recurrences.
The LHC "inverse problem"



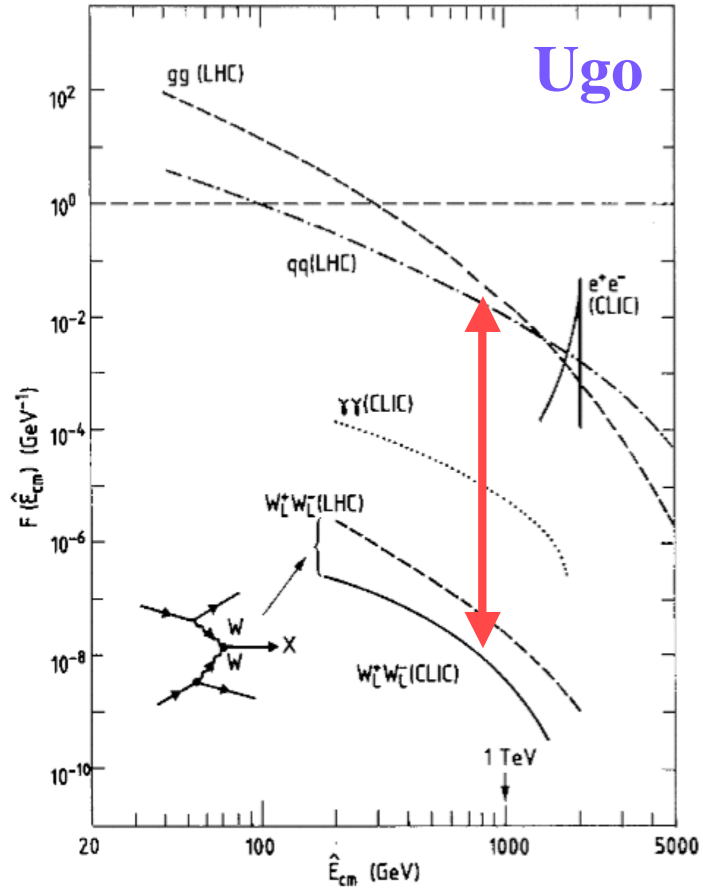
The AdS/CFT correspondance links 5D (RS) and 4D (Technicolor)

5th dimension ⟷ energy scale

deconstruction,
5th dimension on a lattice, etc

A critical question is whether new objects are coupled or not to SM projectiles

i.e. is the Drell-Yan mode open or should one rely on Vector Boson Fusion

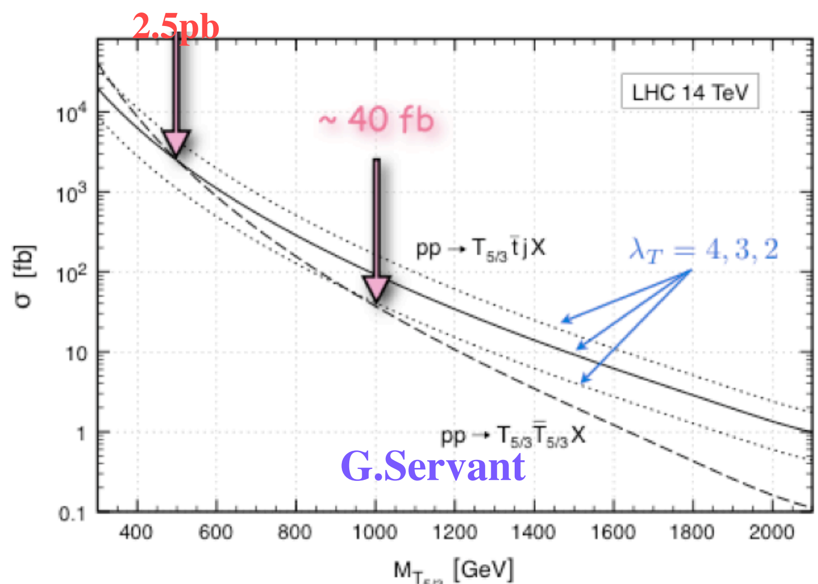


ex. SUSY versus "Folded SUSY"

Folded SUSY has no squark/gluino strong production

ex. fourth generation

ex. top partners

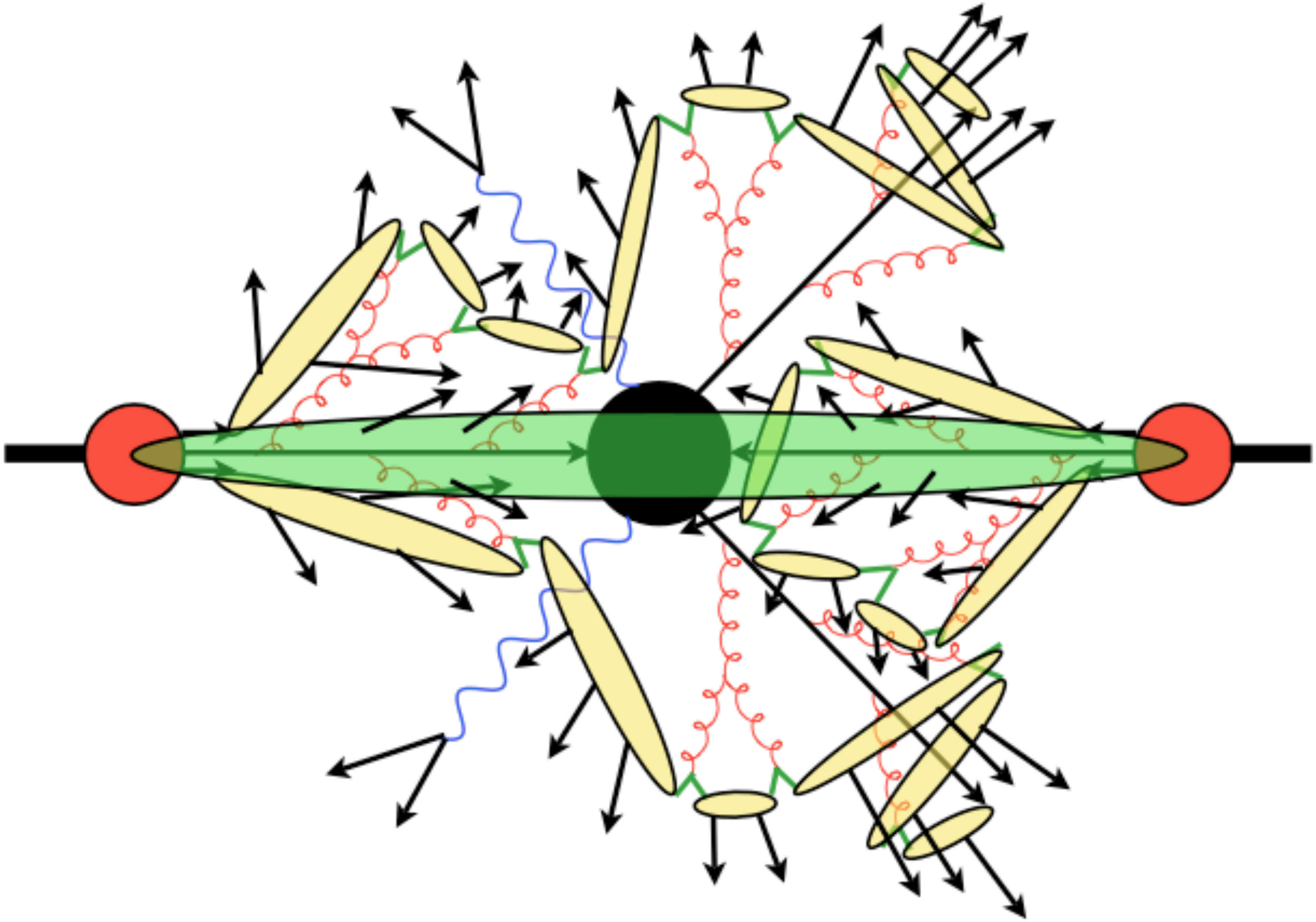


ex. benchmarks for strong e.w. breaking

arXiv:0712.3783

Signal	$\ell_1(\mathrm{TeV}^{-1})$	o_V	o_A	g_{ffV}/g_2
HTC 1	6.3	-10	0	0.1
HTC2	8	-22.5	0	0.05
	size of ED	departure from rescaled QCD		coupling to fermions

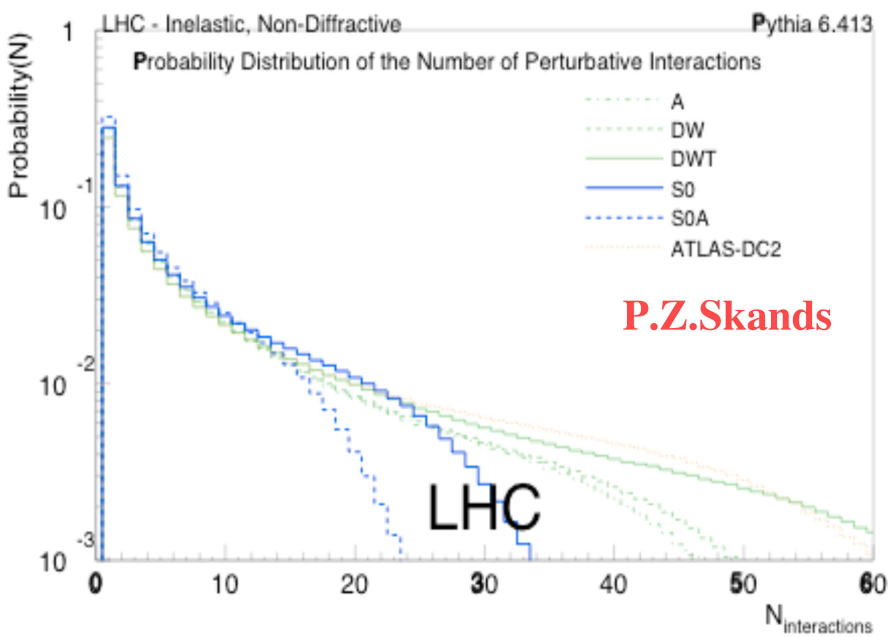
LHC Event Simulation

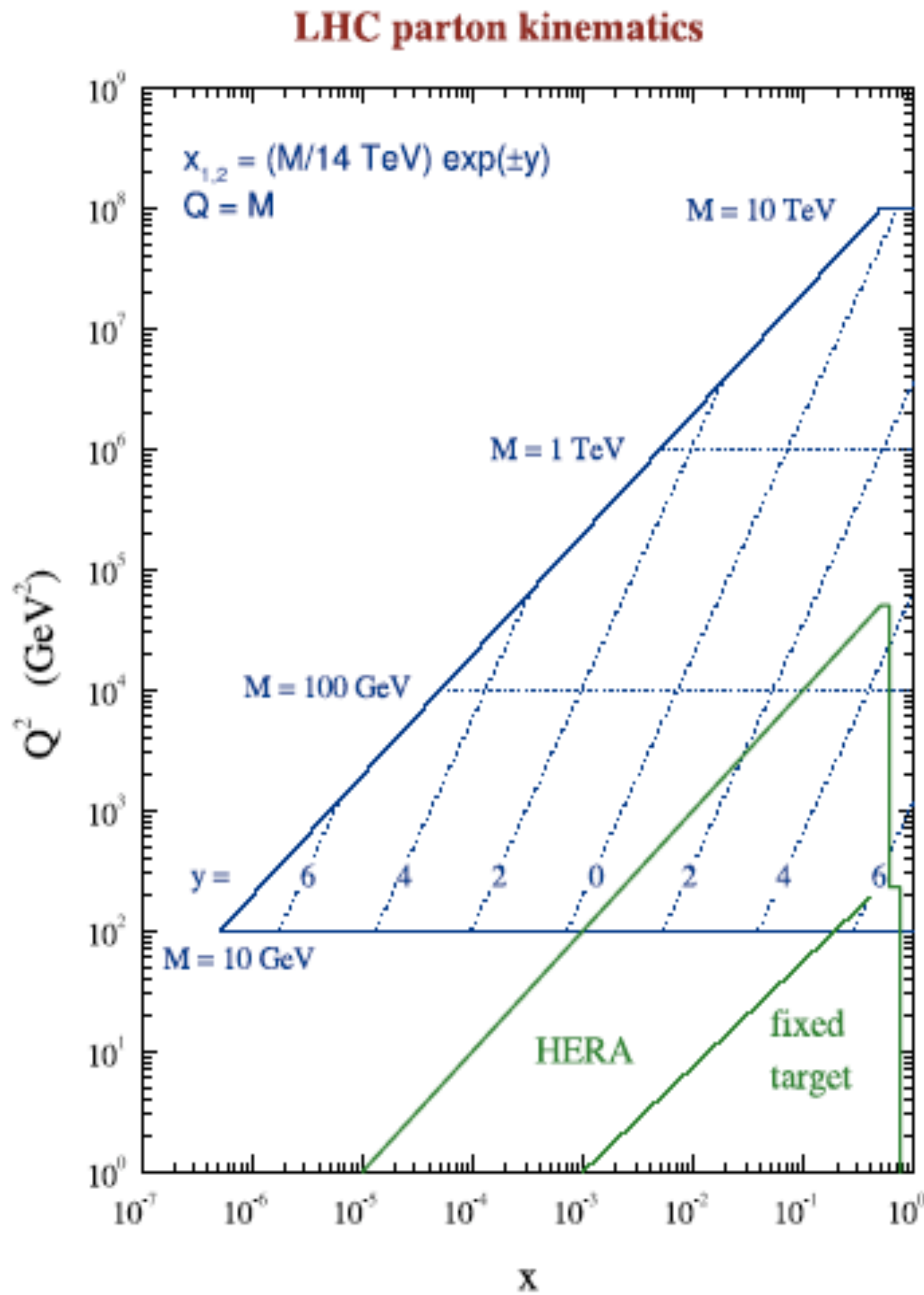


At LHC you must:

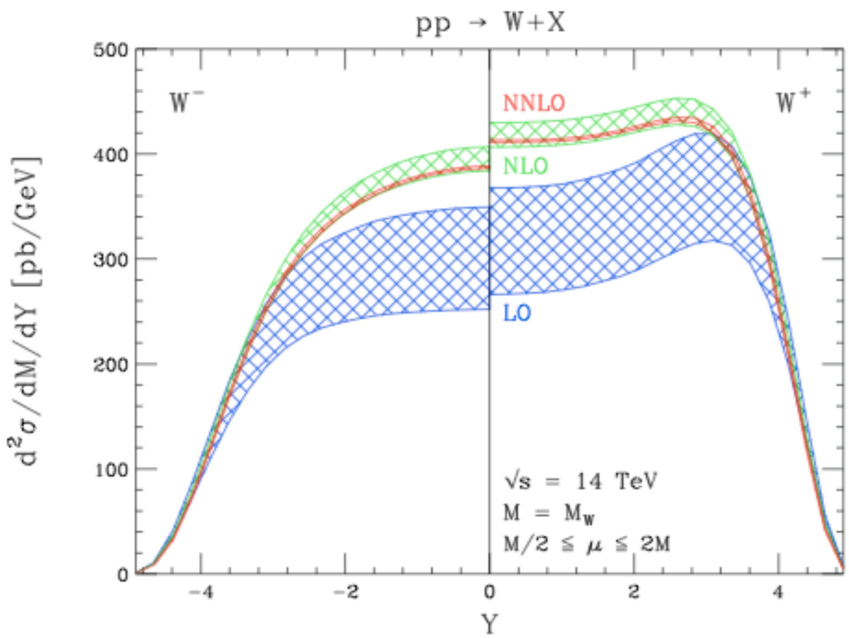
- know what you collide, i.e. master the PDF in the relevant regions at the order needed

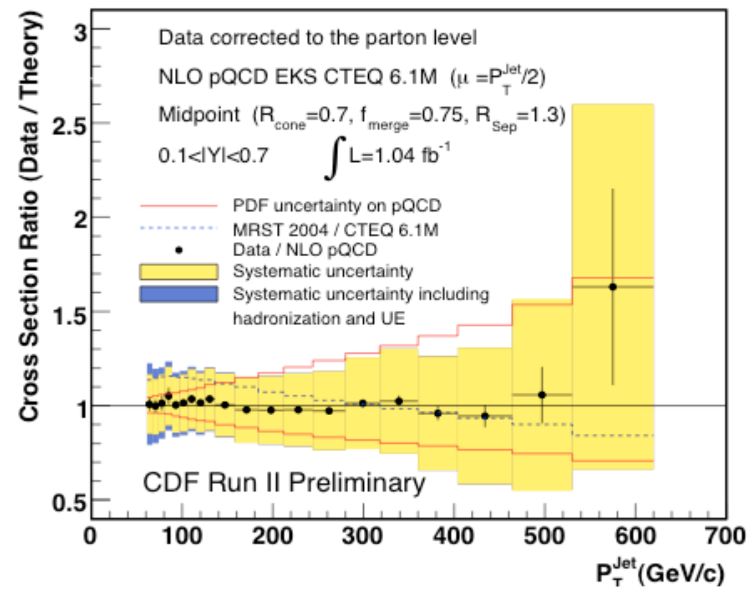
- master the underlying event

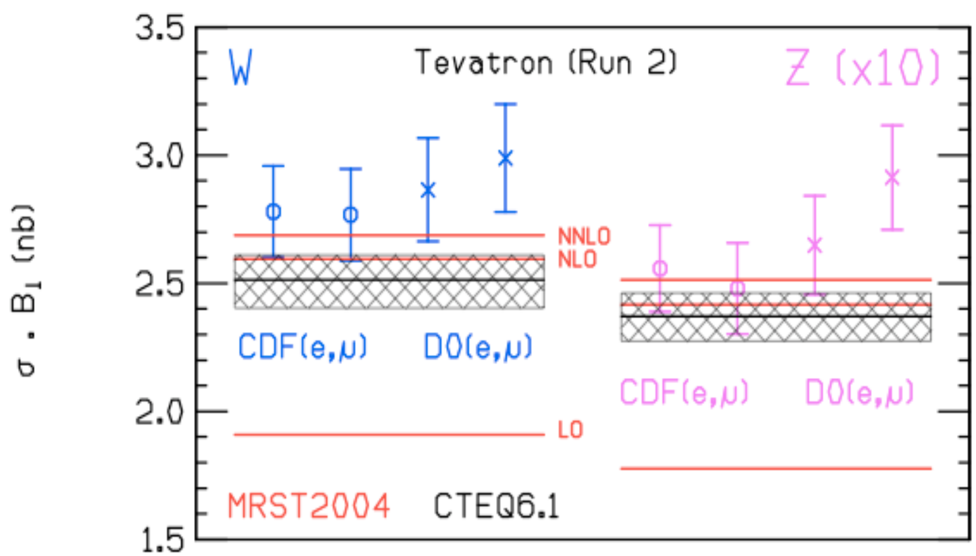


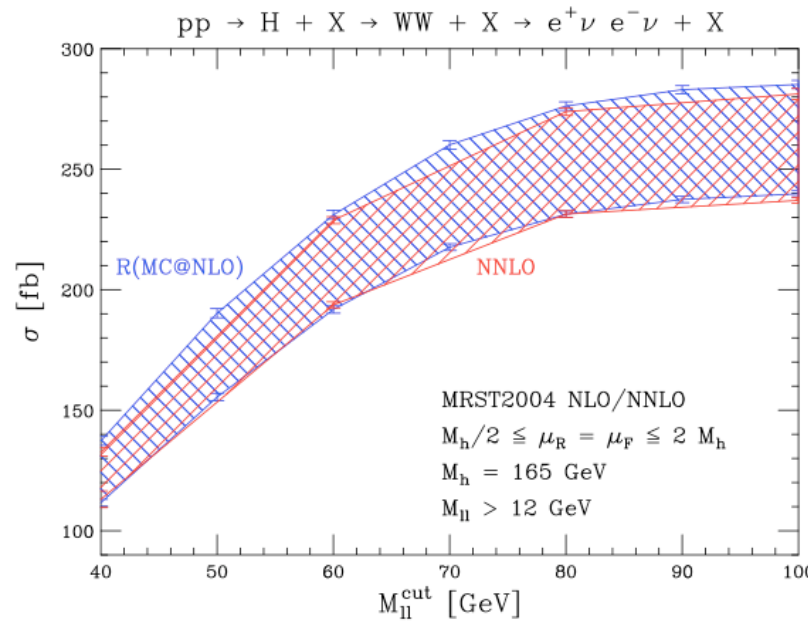


● master the "SM background" at the order needed









● Master the detection and analysis chain, statistics and systematics

- **Rather than on physics scenarios (of which at most one is correct) one should focus on all accessible topologies (i.e. instrumentally manageable and for which the SM "background" is mastered)**

  n leptons + m photons + p jets (+ E_T^{miss})

- **Re-discover the SM**
  first benchmarks are ratios (W/Z, jets "in"/jets "out", etc
  check e/μ universality

- **Promising search channels are:**

  di-leptons ("Drell-Yan")
  di-jets
  di-bosons, e.g. WZ
  top-antitop

and peculiar signatures: heavy stables, displaced vertices