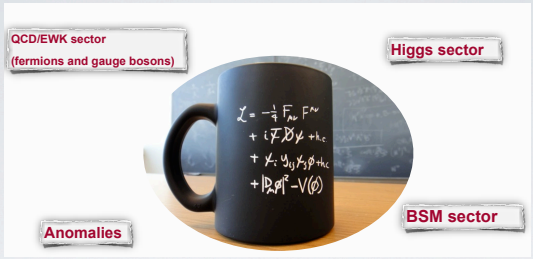


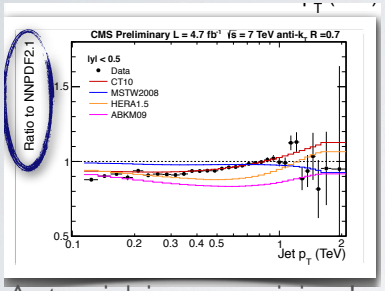
THE HIGH ENERGY FRONTIER

Review of discussions at Krakow
(+ a little on specific ATLAS plans)

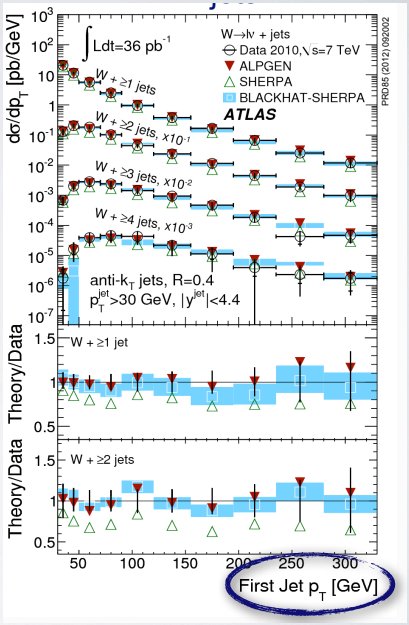
P. Hansen

centre for particle physics
Discovery

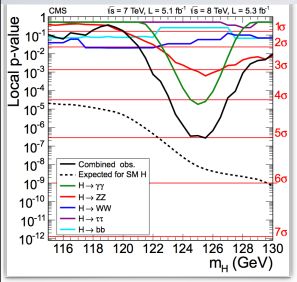
G. Dissertori on <u>where we are</u>:

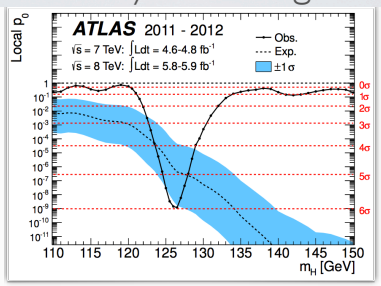


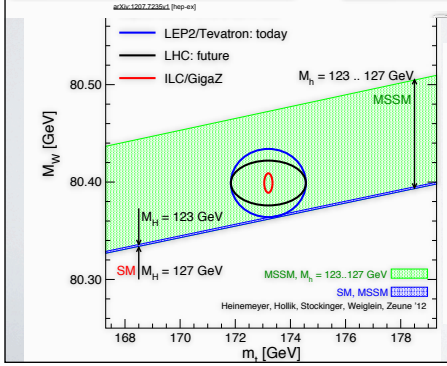
Astonishing precision!
Note that data is now constraining pdf's and amp's.
(note prominence of NNPDF2 and BLACKHAT).
<->an argument for LHeC..

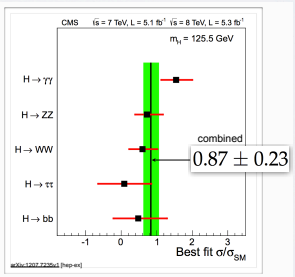


Standard EW+QCD theory strikes again:









Tevatron:

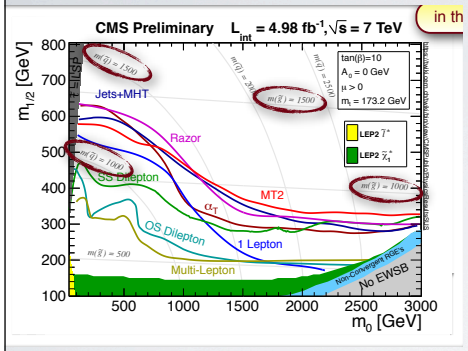
- 3sigma excess
- New M_W, M_t

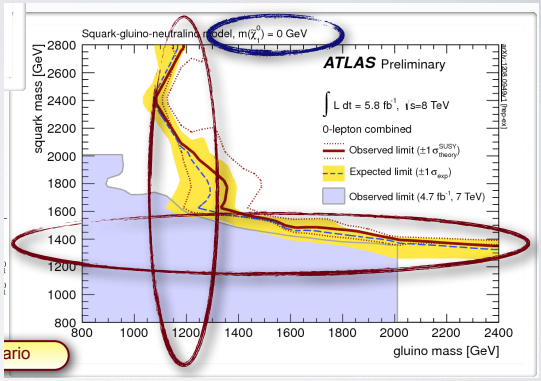
Next from LHC:

- J^P (by end 2012)
- BR's (uncertain +-20% at LHC14)

seen in a talk by R. Erbacher at SUSY2012

No SUSY signal yet

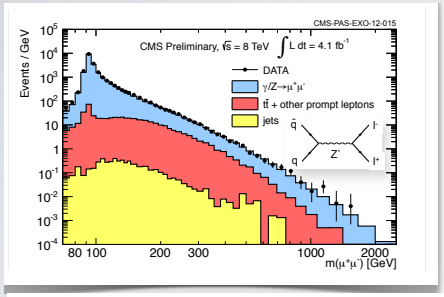


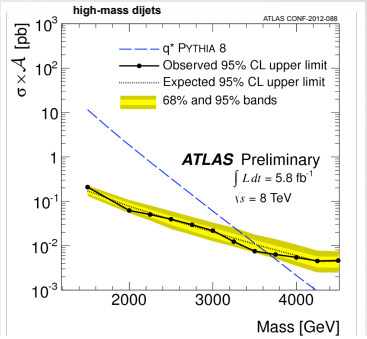


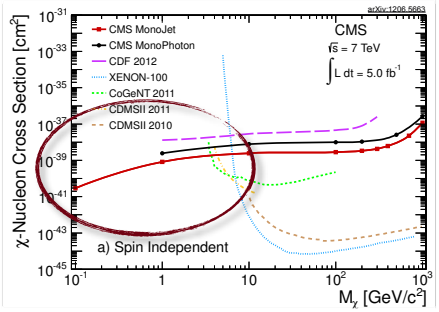
In simplest MMSM version, m(squark)=m(gluino)>1500GeV

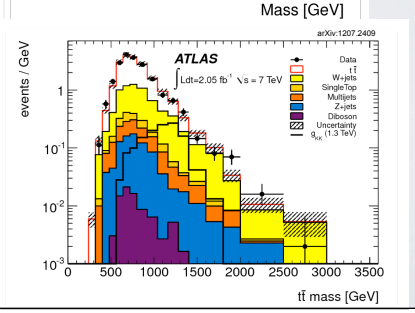
Focus is then on third generation squarks.
Only a region around 300-500 GeV is excluded
for M(LSP)<120 GeV. (G. Dissertori)

Indeed no BSM hint, at all. Some examples (G. Dissertori):

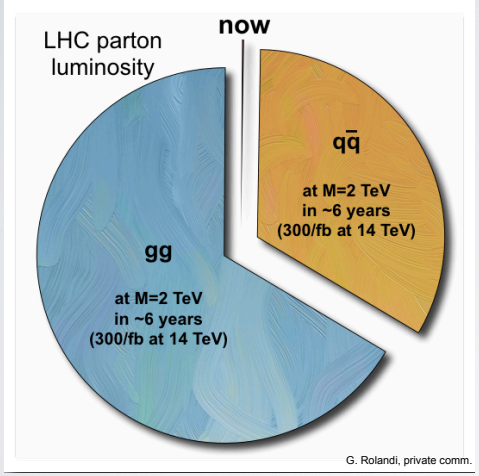


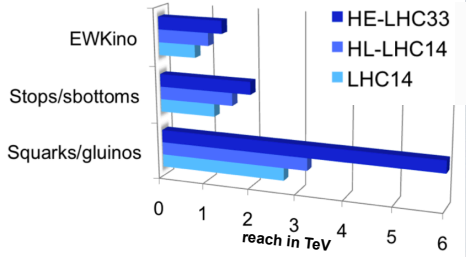






But LHC has only started scratching the surface:





model	300 fb^{-1}	1000 fb^{-1}	3000 fb^{-1}
g_{KK}	4.3 (4.0)	5.6 (4.9)	6.7 (5.6)
$Z'_{\text{Topcolour}}$	3.3 (1.8)	4.5 (2.6)	5.5 (3.2)
$Z'_{SSM} \to ee$	6.5	7.2	7.8
$Z'_{SSM} \to \mu\mu$	6.4	7.1	7.6

Very few "BSM hints" at this point (G. Dissertori):

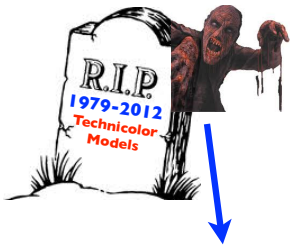
- Top A_{FB} at Tevatron (2-3 sigma)
- W+b x-section slightly high
- Di-boson x-section slightly high
- Tension between bb and l+l- A_{FB}'s in Z decay

A theorists view (A. Pomeral, at ICHEP Melbourne):
Things are far from perfect

Specially for fans of **Higgsless models:**

But

It is *not unconceivable* that a light dilaton appears in Higgsless theories



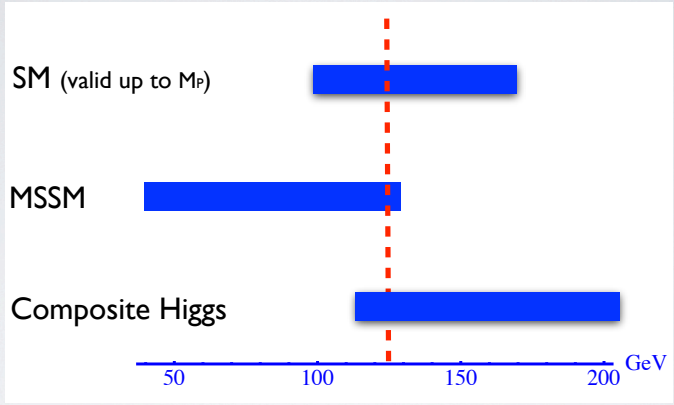
Dilaton

(Goldstone of the spontaneous breaking of scale invariance)

Couples as a Higgs up to an overall scale → **A Higgs impostor**

A composite Higgs can also still be squeezed into 125 GeV

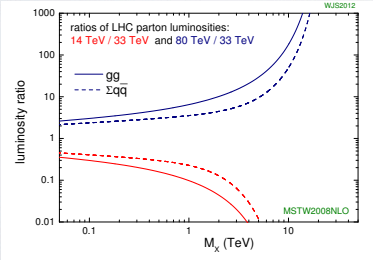
A theorists view (A. Pomaral)

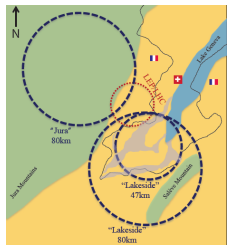


All possibilities still open!

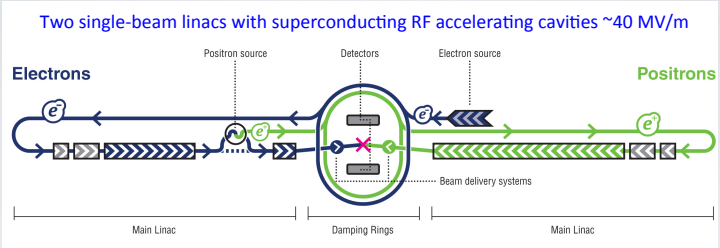
Future proton-proton machines (Terry Wyatt)

Facility	Years	Ecm [TeV]	Luminosity [10^{34} cm^{-2}s^{-2}]	int Luminosity [fb^{-1}]	Comments
nominal LHC	2014-2021	14	1-2	300	
HL-LHC	2023-2030	14	5	3000	luminosity levelling
HE-LHC	>2035	26-33	>2	100-300 / yr	dipole fields 16-20 T
V-LHC		42-100			new 80 km tunnel



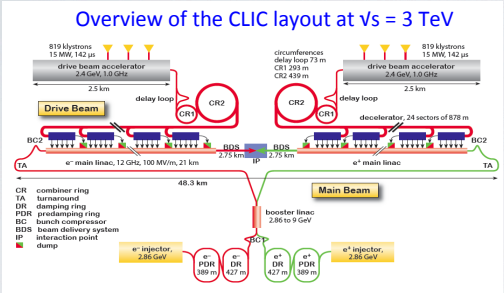


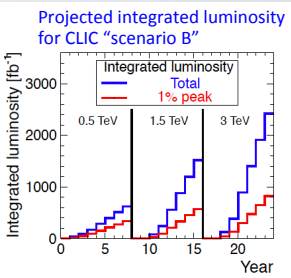
A logical next step: ILC



- Industrial production of SC cavities well established.
- L=30 km for E=500 GeV.
- Japanese statement of interest of being host (40% of cost)

CLIC: A longer term option





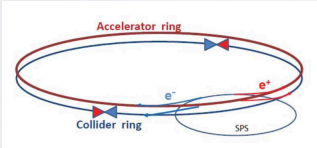
- Two high current drive-beams giving 100MV/m
- Scenario A has 2x luminosity at low energy but needs to replace cavities for 3 TeV

Circular e+e- collider:

o LEP3: Double 240 GeV e+e- accelerator in the LEP tunnel (lifetime is 16min - need replenishing of beam)

o SuperTristan is the same proposal in Japan

o TLEP in a 80km superLHC tunnel (E=350 GeV to reach nunuWW and top pair).

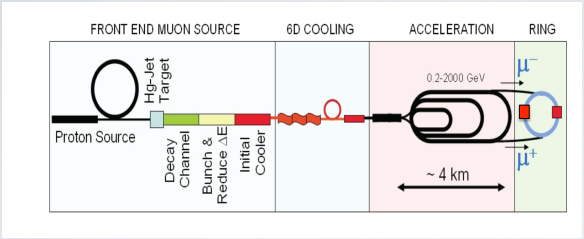


e+e- summary (Terry Wyatt)

	ILC	ILC	ILC	CLIC	CLIC	CLIC	LEP3
√s [GeV]	250	500	1000	500	1500	3000	240
Luminosity [10^{34} $cm^{-1}s^{-1}$]	0.75	1.8	4.9	1.3	3.7	5.9	1 per IP
>0.99 √s fraction	87%	58%	45%	54%	38%	34%	100%
polarization e^-	80%	80%	80%	80%	80%	80%	-
polarization e^+	30%	30%	20%	>50%?	>50%?	>50%?	-
beam size σ_x [nm]	729	474	335	100	60	40	71000
beam size σ_y [nm]	7.7	5.9	2.7	2.6	1.5	1	320
Power [MW]	128	162	300	235	364	589	200

All with a GigaZ mode to pin down $\sin\theta_W$ and other Z couplings and an intermediate mode to measure M_W and M_t.

Muon Collider



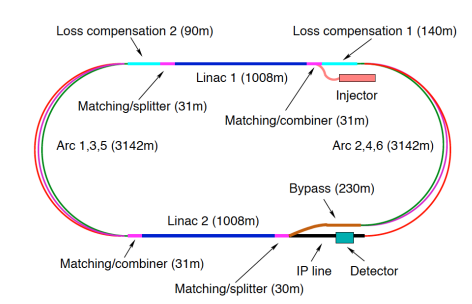
Advantages:

- Polarization, size, energy-spread
- Synergy with nu-factory

Disadvantages:

- Proton source, target, cooling, insane radiation

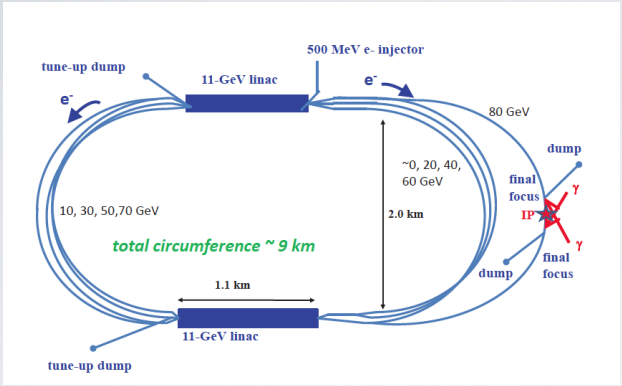
LHeC: Linear e+- accelerator for ep (eN) @ LHC



60 GeV, $Q^2<1\,TeV^2$, $L=10^{33}$
both e+ and e-, P=90%,
Energy recovery

Main HEF interest:
o Precise pdf's and alphaS

Photon-photon collider



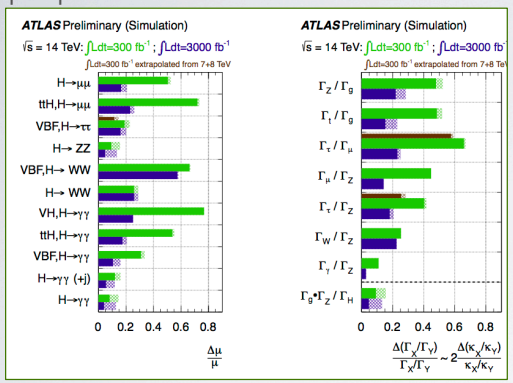
$\gamma\gamma \rightarrow H \rightarrow anything$

Advantages: Low energy, no e+ source
Only a Higgs (or continuum) produced

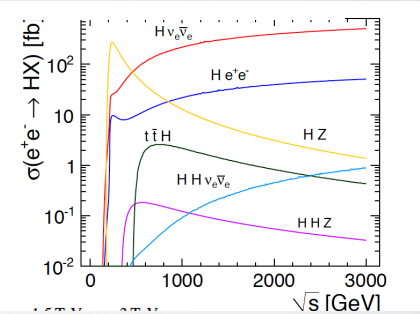
Disadvantages: Needs R&D, No extensions

Higgs couplings potential:

p+p



e+e- x-section
(multiply by L~=1000)



An e+e- machine would be better than LHC.

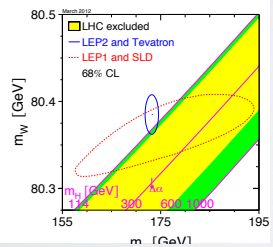
- 50MeV on mass, 5% on widths, CP information.
- LHC can only do relative widths to O(20%).
- Self-couplings hard at any machine

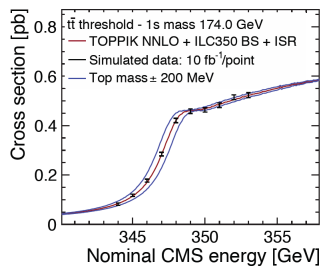
Vector Boson scattering potentials:
LHC:
Anomalous couplings in WW+jj : ~3% level
e+e- collider:
Due to fantastic calorimeter (WW->4j) and beam polarization: 1% on each term in the Lagrangian

$$e^+e^- \to \nu\bar{\nu}W^+W^-$$
$$e^+e^- \to \nu\bar{\nu}ZZ,$$

Bonus measurements at e+e- (Terry Wyatt):

- o M_W, weak angle etc (factor 10 improvements)
- o M_t to 20 MeV (+-100 MeV theory), width to 30MeV
- o Such measurements give indirect access to new physics at the10TeV scale.

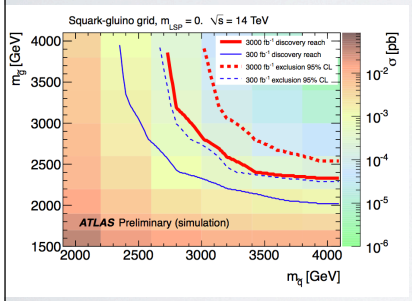


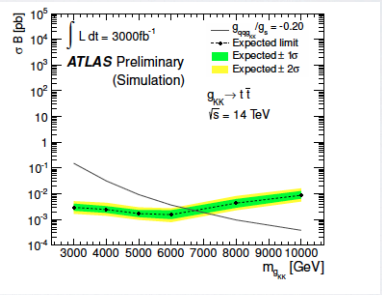


Discovery physics:

LHC is better than ILC for direct searches:

- From top resonances mKK limits can be set at ~6TeV
- From l+l- resonances SSM limits can be set at ~7TeV
- Spartners to light quarks and gluons up to 3 TeV
- Spartners to top and bottom up to ~1.5 TeV





My conclusions for the "short term":

o It is inconceivable that Europe will stop LHC in 2020. The US is also committed to exploiting the full LHC potential.

o ILC (or LEP3) would be a logical and hugely interesting supplement, but only South East Asia has muscle to do it now.

o LHeC would be a very nice supplement, but is difficult/unlikely on the proposed timescale.

o The SM triumphed, but no guidance from theory on extensions - no more predictions of things "around the corner" - and from the real world, the only hint is dark matter.

ATLAS plans

LS1 2013-14	Prepare machine for ~14TeV and L=10^{34}/cm^2/s Insertable B-Layer, new Si services, shielding+++
Phase 0 2015-17	Run 2 nominal machine (FDL ~100fb^{-1})
LS2 2018-19	Machine upgrades to 2 x FDL new Muon Small Wheels, new Triggers, AFP
Phase 1 2020-22	Run 3 (100fb^{-1}/year)
LS3	New inner triplets, CRAB waist for HL with leveling new ID, calorimeter and mu upgrades, LVL1 track-trig
Phase 2	Run4 up to 3000 fb^{-1}

The detector upgrades are necessary to maintain physics coverage with the increasing radiation and particle density

Phase 1 upgrade plans and organization

#	Project	Letter of Intent presented and approved by LHCC *	Initial Design Review	Kick-off meeting	CB approval	TDR due	LHCC approval session	I-MOU needed	MOU-due for signature (RRB)
1	FTK	21-Mar-12	2-Dec-10	3-Dec-10	24-Jun-11	30-Apr-13	11-Jun-13	yes	15-Oct-13
2	nSW	21-Mar-12	29-Aug-12	31-Aug-12	5-Oct-12	31-May-13	11-Jun-13	not clear	15-Oct-13
3	LAr + Tiles	21-Mar-12	9-Jan-13	11-Jan-13	8-Feb-13	15-Sep-13	24-Sep-13	not clear	15-Oct-13
4	TDAQ	21-Mar-12	21-Jan-13	22-Jan-13	8-Feb-13	15-Sep-13	24-Sep-13	not clear	15-Oct-13
5	AFP	21-Mar-12	17-Sep-12	19-Sep-12	2014	2014	2014	yes	15-Oct-14

* equivalent to the first level review for most funding agencies, necessary for allocation of pre-development funds

Total cost: 34MCHF
DK contribution: 200kCHF, hereof ~100kCHF in kind
Central Trigger Processor board
MoU: Next October. No detailed plans for funding and physics yet for us. We should also remember the TRT.