Physics at the LHC

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Presentation to the Board of Sponsors
CERN openlab

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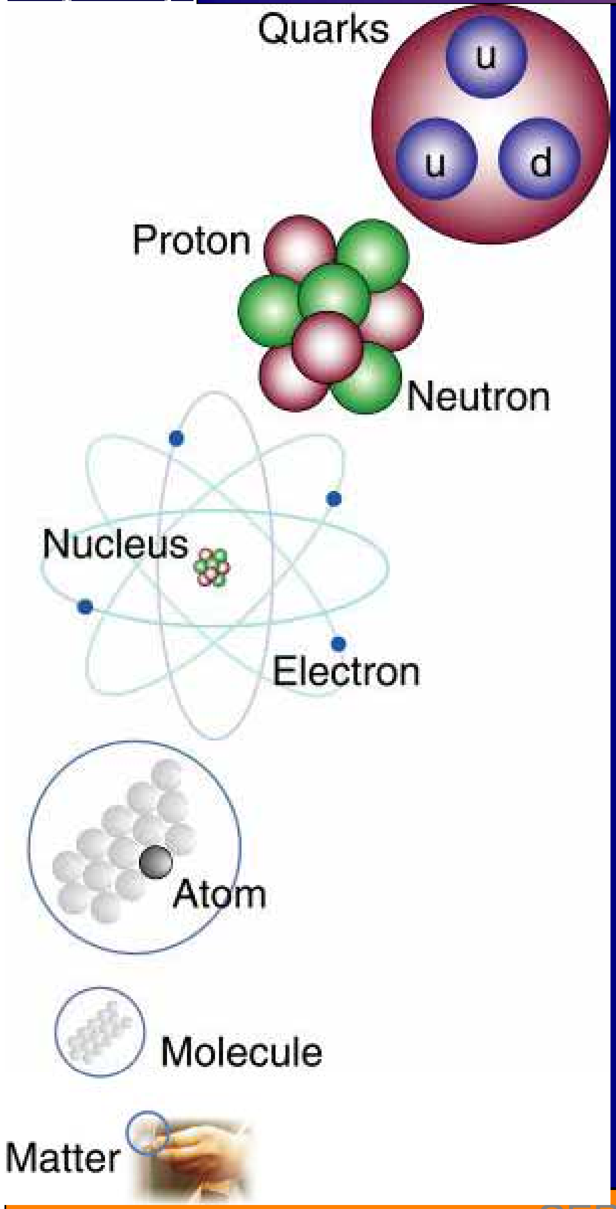
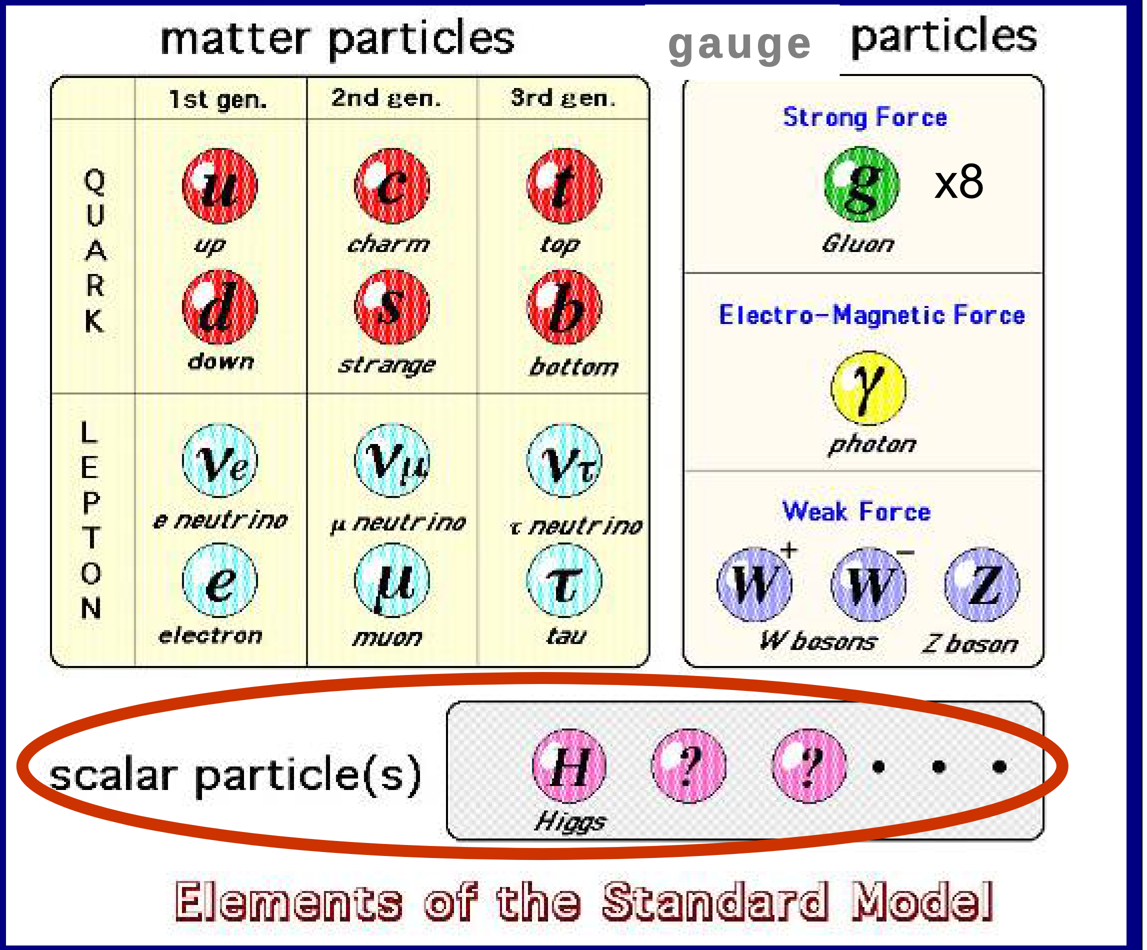
to remind us all of the exciting opportunities to be seized at the LHC, where we are very likely going to find a new, fundamental energy scale and cross the threshold giving access to new physics

Thanks: Fabiola Gianotti, Peter Jenni, Jim Virdee, Michel Della Negra, Wouter Verkerke, Tatsuya Nakada, Juergen Schukraft, Karsten Eggert and others

A cartoon





matter particles

	1st gen.	2nd gen.	3rd gen.
QUARK	u up	c charm	t top
	d down	s strange	b bottom
LEPTON	ν_e e neutrino	ν_μ μ neutrino	ν_τ τ neutrino
	e electron	μ muon	τ tau

gauge particles

Strong Force
g x8
Gluon

Electro-Magnetic Force
γ
photon

Weak Force
W^+ W^- Z
W bosons Z boson

scalar particle(s)
H ? ? · · ·
Higgs

Elements of the Standard Model

A formula

The full GSW Lagrangian, including the Higgs sector

$$L_{GSW} = L_0 + L_H + \sum_l \left\{ \frac{g}{2} \bar{L}_l \gamma_\mu \vec{\tau} L_l \vec{A}^\mu + g' \left[\bar{R}_l \gamma_\mu R_l + \frac{1}{2} \bar{L}_l \gamma_\mu L_l \right] B^\mu \right\} +$$

$$+ \frac{g}{2} \sum_q \bar{L}_q \gamma_\mu \vec{\tau} L_q \vec{A}^\mu +$$

$$+ g' \left\{ \frac{1}{6} \sum_q \left[\bar{L}_q \gamma_\mu L_q + 4 \bar{R}_q \gamma_\mu R_q \right] + \frac{1}{3} \sum_{q'} \bar{R}_{q'} \gamma_\mu R_{q'} \right\} B^\mu$$

SU(2)xU(1)

$$L_H = \frac{1}{2} (\partial_\mu H)^2 - m_H^2 H^2 - h\lambda H^3 - \frac{h}{4} H^4 +$$

$$+ \frac{g^2}{4} \left(W_\mu^+ W^\mu + \frac{1}{2\cos^2\theta_W} Z_\mu Z^\mu \right) (\lambda^2 + 2\lambda H + H^2) +$$

$$+ \sum_{l,q,q'} \left(\frac{m_l}{\lambda} \bar{l} l + \frac{m_q}{\lambda} \bar{q} q + \frac{m_{q'}}{\lambda} \bar{q}' q' \right) H$$

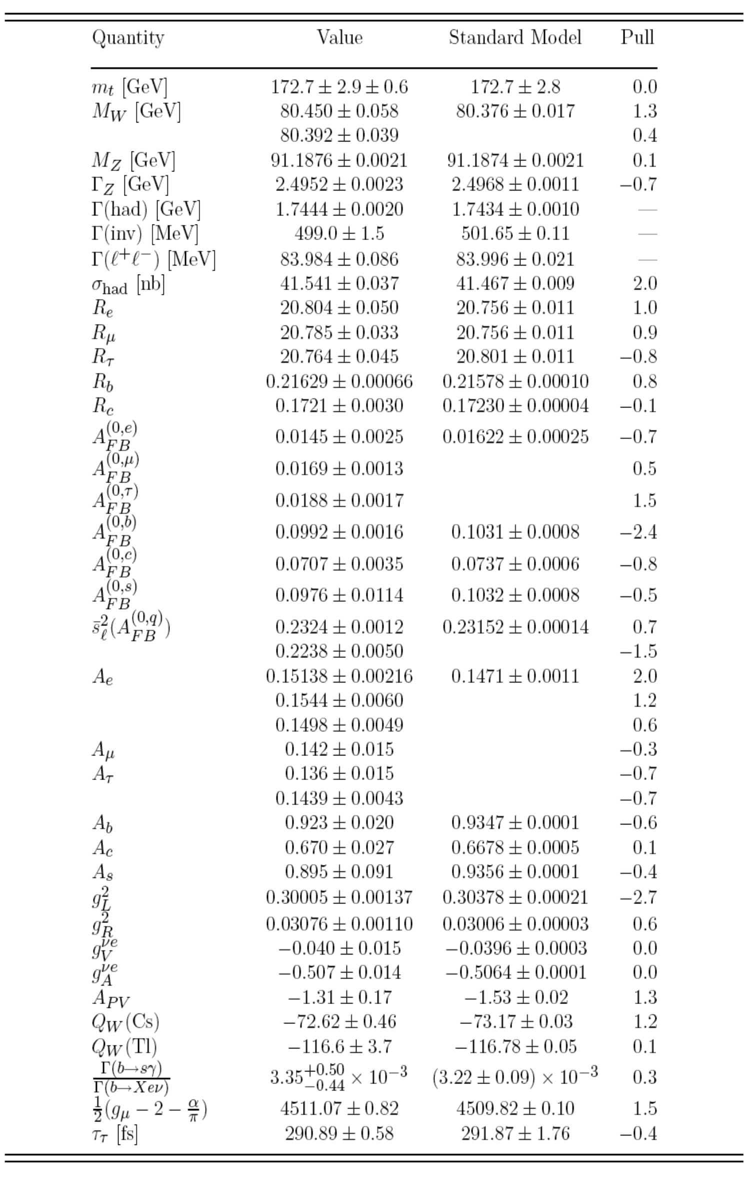
Makes theory gauge invariant
(renormalizable)
Also preserves unitarity

Mass terms !

Precision Measurement from LEP

The standard Model is a beautiful and one of the most precisely tested theories

Why then do we need to probe further ?



Quantity	Value	Standard Model	Pull
m_t [GeV]	$172.7 \pm 2.9 \pm 0.6$	172.7 ± 2.8	0.0
M_W [GeV]	80.450 ± 0.058	80.376 ± 0.017	1.3
	80.392 ± 0.039		0.4
M_Z [GeV]	91.1876 ± 0.0021	91.1874 ± 0.0021	0.1
Γ_Z [GeV]	2.4952 ± 0.0023	2.4968 ± 0.0011	−0.7
$\Gamma(\text{had})$ [GeV]	1.7444 ± 0.0020	1.7434 ± 0.0010	—
$\Gamma(\text{inv})$ [MeV]	499.0 ± 1.5	501.65 ± 0.11	—
$\Gamma(\ell^+\ell^-)$ [MeV]	83.984 ± 0.086	83.996 ± 0.021	—
σ_{had} [nb]	41.541 ± 0.037	41.467 ± 0.009	2.0
R_e	20.804 ± 0.050	20.756 ± 0.011	1.0
R_μ	20.785 ± 0.033	20.756 ± 0.011	0.9
R_τ	20.764 ± 0.045	20.801 ± 0.011	−0.8
R_b	0.21629 ± 0.00066	0.21578 ± 0.00010	0.8
R_c	0.1721 ± 0.0030	0.17230 ± 0.00004	−0.1
$A_{FB}^{(0,e)}$	0.0145 ± 0.0025	0.01622 ± 0.00025	−0.7
$A_{FB}^{(0,\mu)}$	0.0169 ± 0.0013		0.5
$A_{FB}^{(0,\tau)}$	0.0188 ± 0.0017		1.5
$A_{FB}^{(0,b)}$	0.0992 ± 0.0016	0.1031 ± 0.0008	−2.4
$A_{FB}^{(0,c)}$	0.0707 ± 0.0035	0.0737 ± 0.0006	−0.8
$A_{FB}^{(0,s)}$	0.0976 ± 0.0114	0.1032 ± 0.0008	−0.5
$\bar{s}_\ell^2(A_{FB}^{(0,q)})$	0.2324 ± 0.0012	0.23152 ± 0.00014	0.7
	0.2238 ± 0.0050		−1.5
A_e	0.15138 ± 0.00216	0.1471 ± 0.0011	2.0
	0.1544 ± 0.0060		1.2
	0.1498 ± 0.0049		0.6
A_μ	0.142 ± 0.015		−0.3
A_τ	0.136 ± 0.015		−0.7
	0.1439 ± 0.0043		−0.7
A_b	0.923 ± 0.020	0.9347 ± 0.0001	−0.6
A_c	0.670 ± 0.027	0.6678 ± 0.0005	0.1
A_s	0.895 ± 0.091	0.9356 ± 0.0001	−0.4
g_L^2	0.30005 ± 0.00137	0.30378 ± 0.00021	−2.7
g_R^2	0.03076 ± 0.00110	0.03006 ± 0.00003	0.6
$g_V^{\nu e}$	-0.040 ± 0.015	-0.0396 ± 0.0003	0.0
$g_A^{\nu e}$	-0.507 ± 0.014	-0.5064 ± 0.0001	0.0
A_{PV}	-1.31 ± 0.17	-1.53 ± 0.02	1.3
$Q_W(\text{Cs})$	-72.62 ± 0.46	-73.17 ± 0.03	1.2
$Q_W(\text{Tl})$	-116.6 ± 3.7	-116.78 ± 0.05	0.1
$\frac{\Gamma(b\rightarrow s\gamma)}{\Gamma(b\rightarrow Xe\nu)}$	$3.35^{+0.50}_{-0.44} \times 10^{-3}$	$(3.22 \pm 0.09) \times 10^{-3}$	0.3
$\frac{1}{2}(g_\mu - 2 - \frac{\alpha}{\pi})$	4511.07 ± 0.82	4509.82 ± 0.10	1.5
τ_τ [fs]	290.89 ± 0.58	291.87 ± 1.76	−0.4

What is Wrong with the Standard Model?

SM contains too many apparently arbitrary features

SM has an unproven element – not some minor detail but a central element – namely the mechanism to generate observed masses of known particles
A solution is to invoke the Higgs mechanism

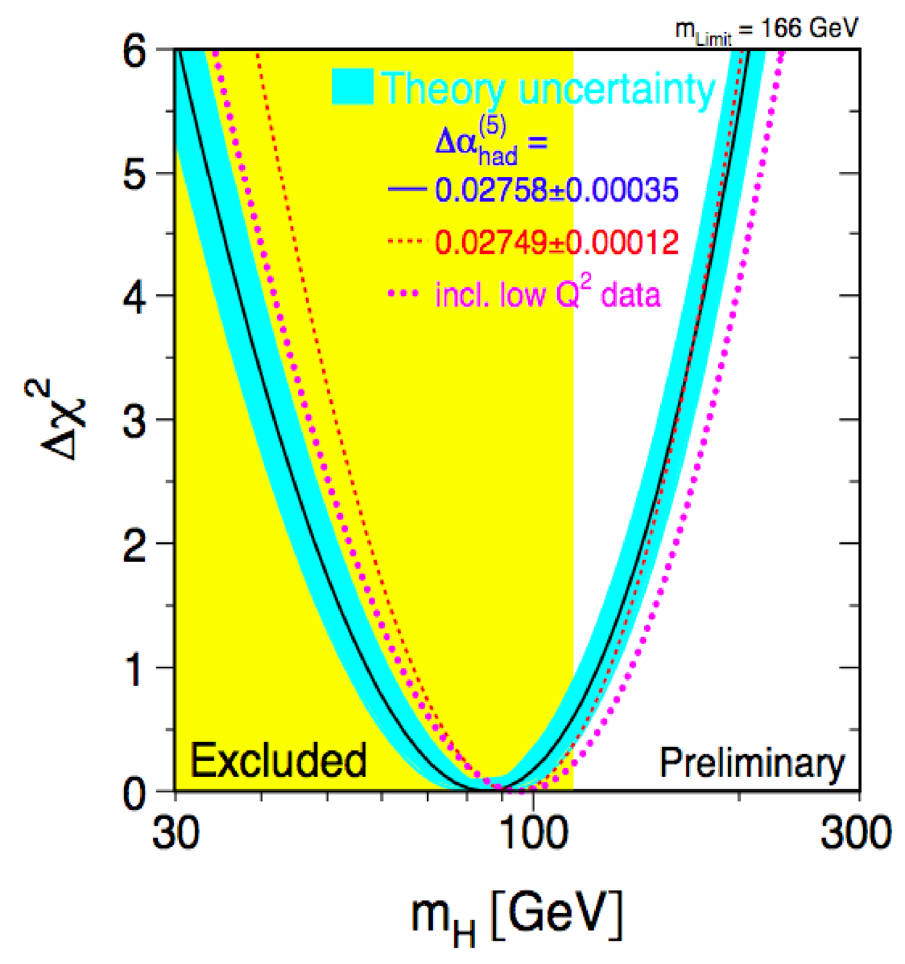
SM gives problems at high energies
At centre of mass energies > 1000 GeV the probability of W_LW_L scattering becomes greater than 1 !!
A solution is to introduce a Higgs boson exchange to cancel the bad high energy behaviour

SM is logically incomplete – does not incorporate gravity – build a Unified Theory
Is superstring theory the Unified Theory ?
Are there extra dimensions ?

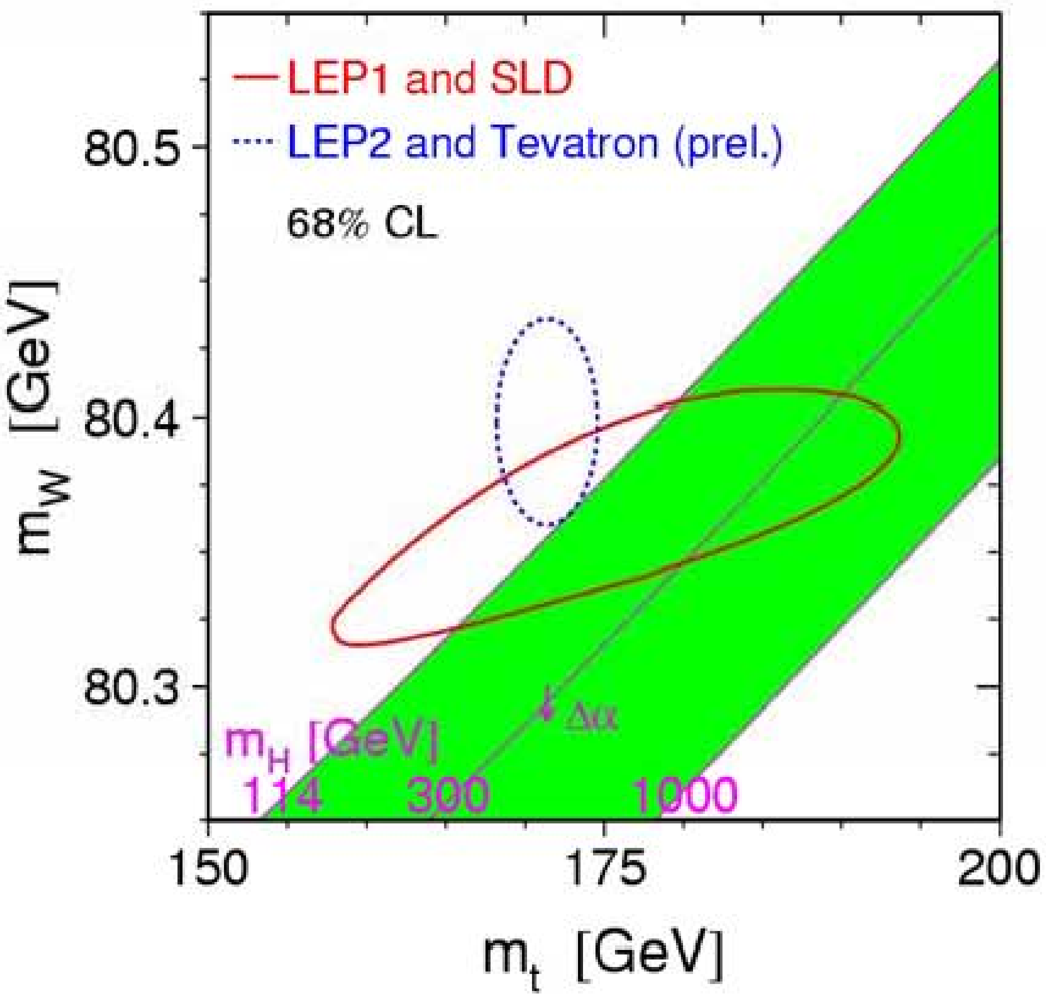
Experimentally: New particles/new symmetries/new forces? Higgs boson(s), Supersymmetry, Extra dimensions etc. ?

Experimental Limits on Mass of SM Higgs Boson

114.4 GeV < m_H < 194 GeV (95% CL)



Experimental Limits on Mass of SM Higgs Boson

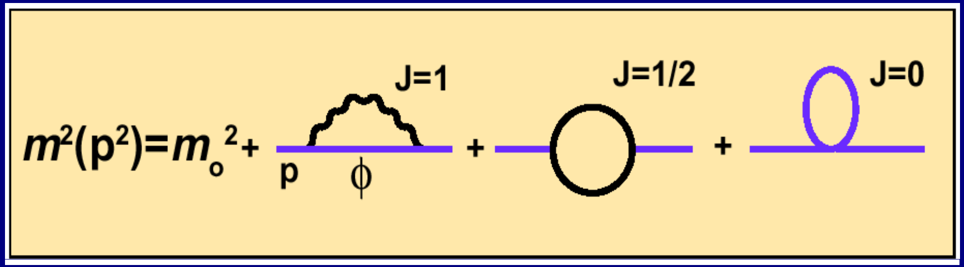


CDF
precision measurement of W mass very recently added (January 2007)

Naturalness

What happens if extend validity of SM to scales $\Lambda >> 1/\sqrt{G_F}$?

Radiative corrections to the Higgs boson mass



$$M_H^2 \rightarrow M_H^2\ (\text{bare}) + c\,\Lambda^2$$

Λ is the scale of the underlying theory (could be $M_{GUT} \sim 10^{15}$ GeV !)

Requires incredibly unnatural fine tuning to keep M_H small !!

What can be done ?

L_{SSB} does not contain an elementary Higgs boson

OR

Cancel quadratic divergences

Supersymmetry

Invoke additional symmetry (e.g. Supersymmetry) to cancel divergences

bosons have fermion superpartners
fermions have boson superpartners

SUSY is obviously broken

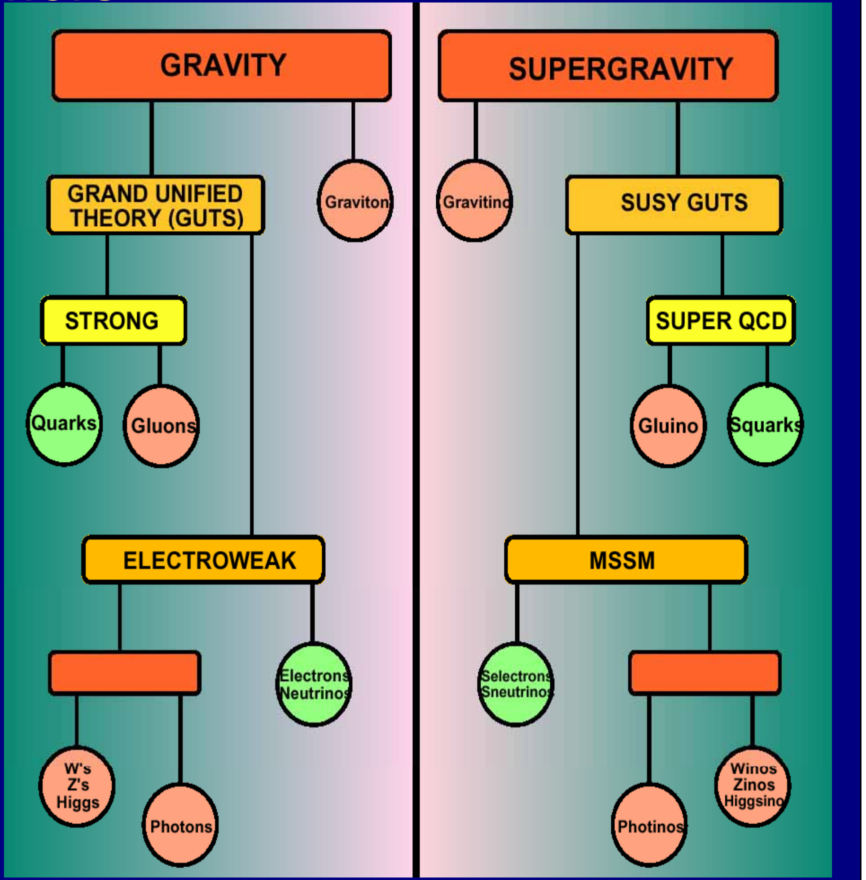
But if require SUSY to solve naturalness $|M^2_{spart} - M^2_{part}| < O\,(1\ \mathrm{TeV}^2)$

Minimal SUSY Model

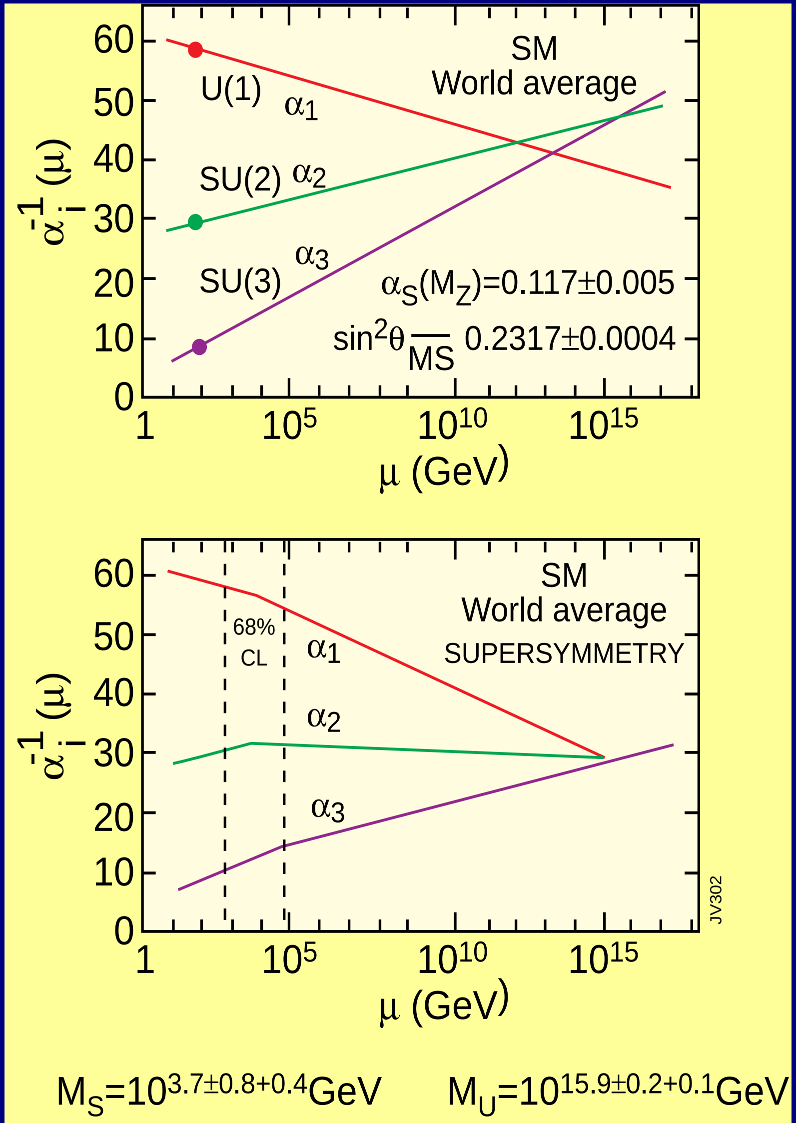
Gluinos, squark, sleptons
4 neutralinos, 2 charginos
Higgs sector: h^0, H^0, A^0, H±

R-parity conservation

Pair production of sparticles
LSP: stable and weakly interacting



Features of Supersymmetry

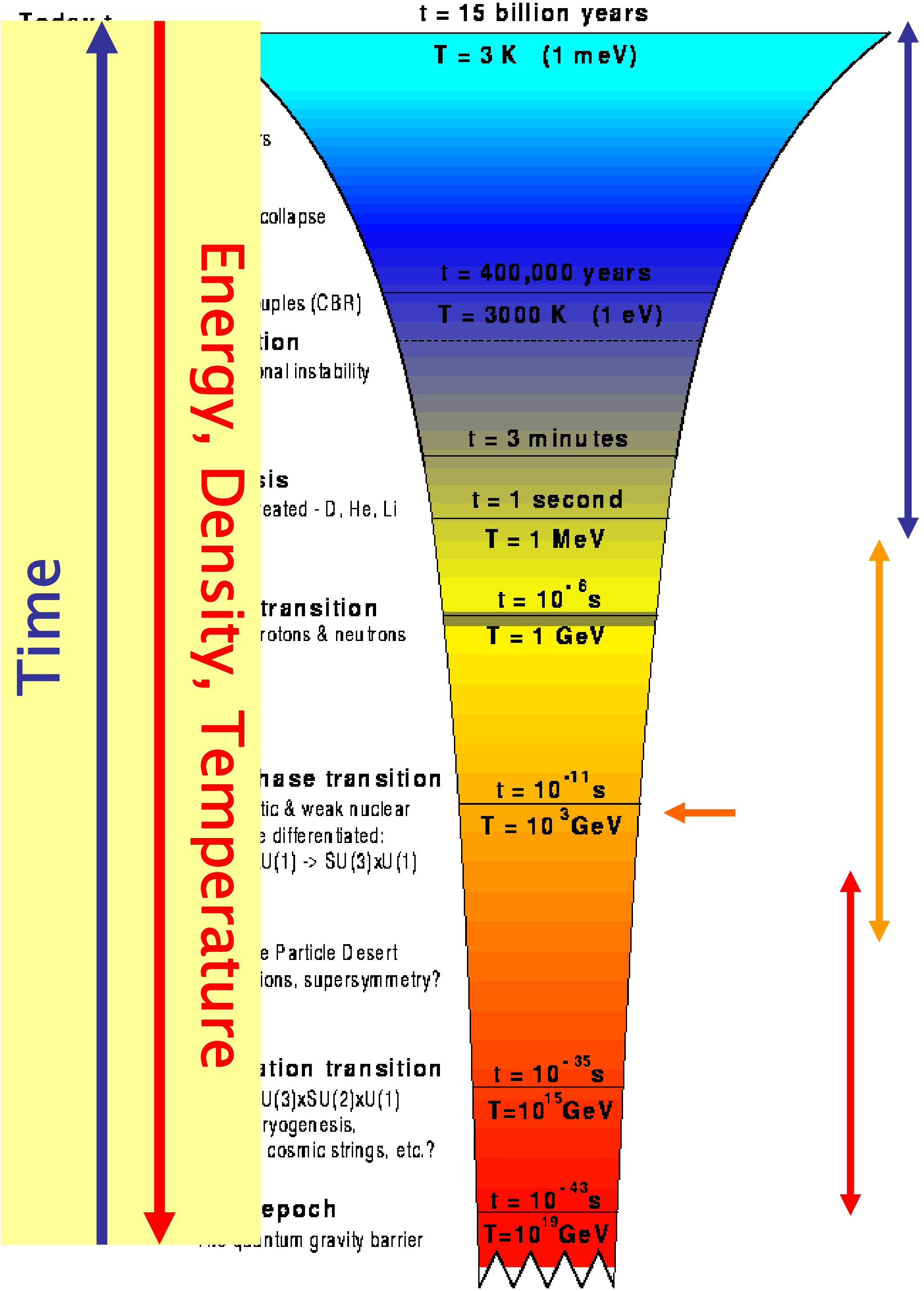


$M_S = 10^{3.7 \pm 0.8 + 0.4}$ GeV $M_U = 10^{15.9 \pm 0.2 + 0.1}$ GeV

Supersymmetry apparently plays an important role in:

- Naturalness problem i.e why is the Higgs mass so low ?
- Grand unification (strong + EW forces)
- Proton decay
- Lightest neutral sparticle – candidate for dark matter
–String theory requires supersymmetry (reconcile gravity and QM)

–No SUSY particle yet observed!
presumably massive –
Low energy SUSY will certainly be found at LHC



Standard Cosmology

Good model from 0.01 sec after Big Bang

Supported by considerable observational evidence

Elementary Particle Physics

From the Standard Model into the unknown: towards energies of 1 TeV and beyond: the **Terascale**

Towards Quantum Gravity

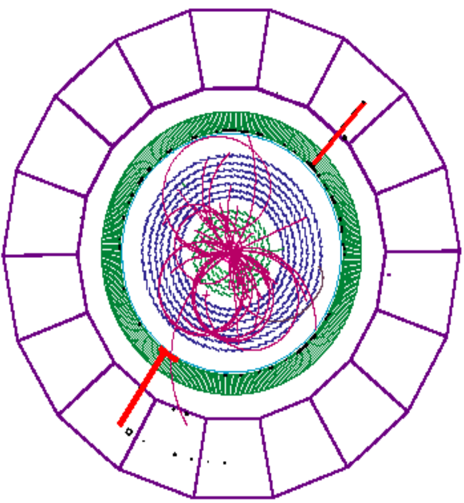
From the unknown into the unknown...

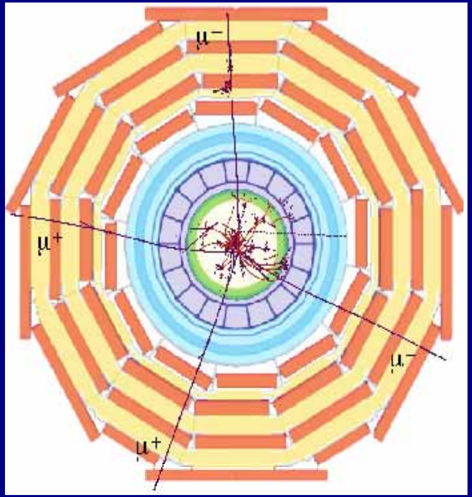
http://www.damtp.cam.ac.uk/user/gr/public/bb_history.html

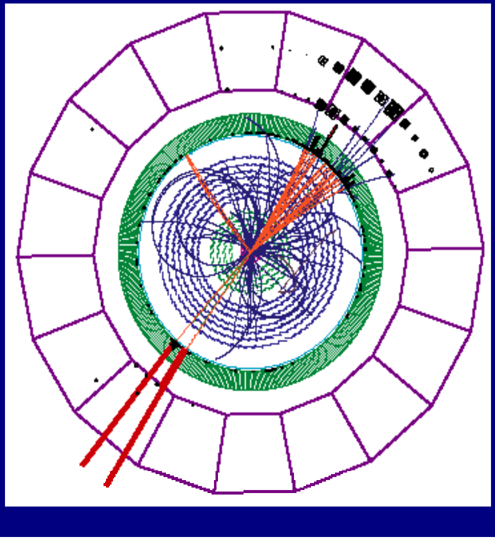
Summarizing………

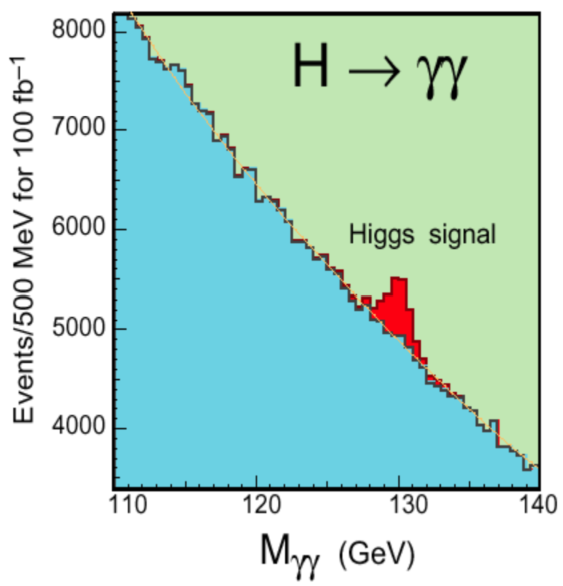
- LEP, SLC and the Tevatron: established that we really understand the physics at energies up to ~100 GeV
  - And any new particles have masses above 200–300 GeV – and in some cases TeV
- The Higgs itself can have a mass up to ~700–800 GeV;
  - if it's not there, something must be added by ~1.2 TeV, or WW scattering exceeds unitarity
- Even if the Higgs exists, all is not 100% well with the Standard Model alone: next question is "why is the (Higgs) mass so low"?
  - – The same mechanism that gives all masses would drive the Higgs mass to the Planck scale. If SUSY is the answer, it must show up at O(TeV)
  - – Recent: extra dimensions. Again, something must happen in the O(1–10) TeV scale if the above issues are to be addressed
- Conclusion: we need to study the TeV region

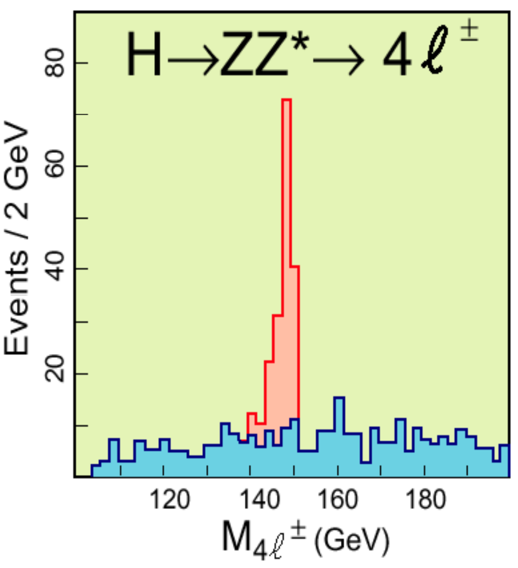
SM Higgs in CMS

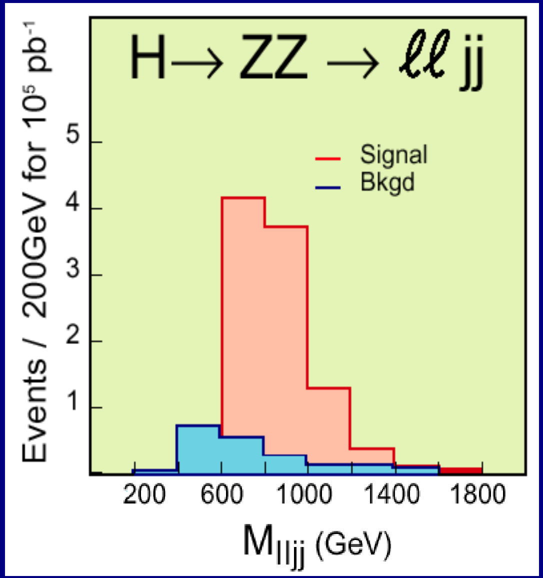












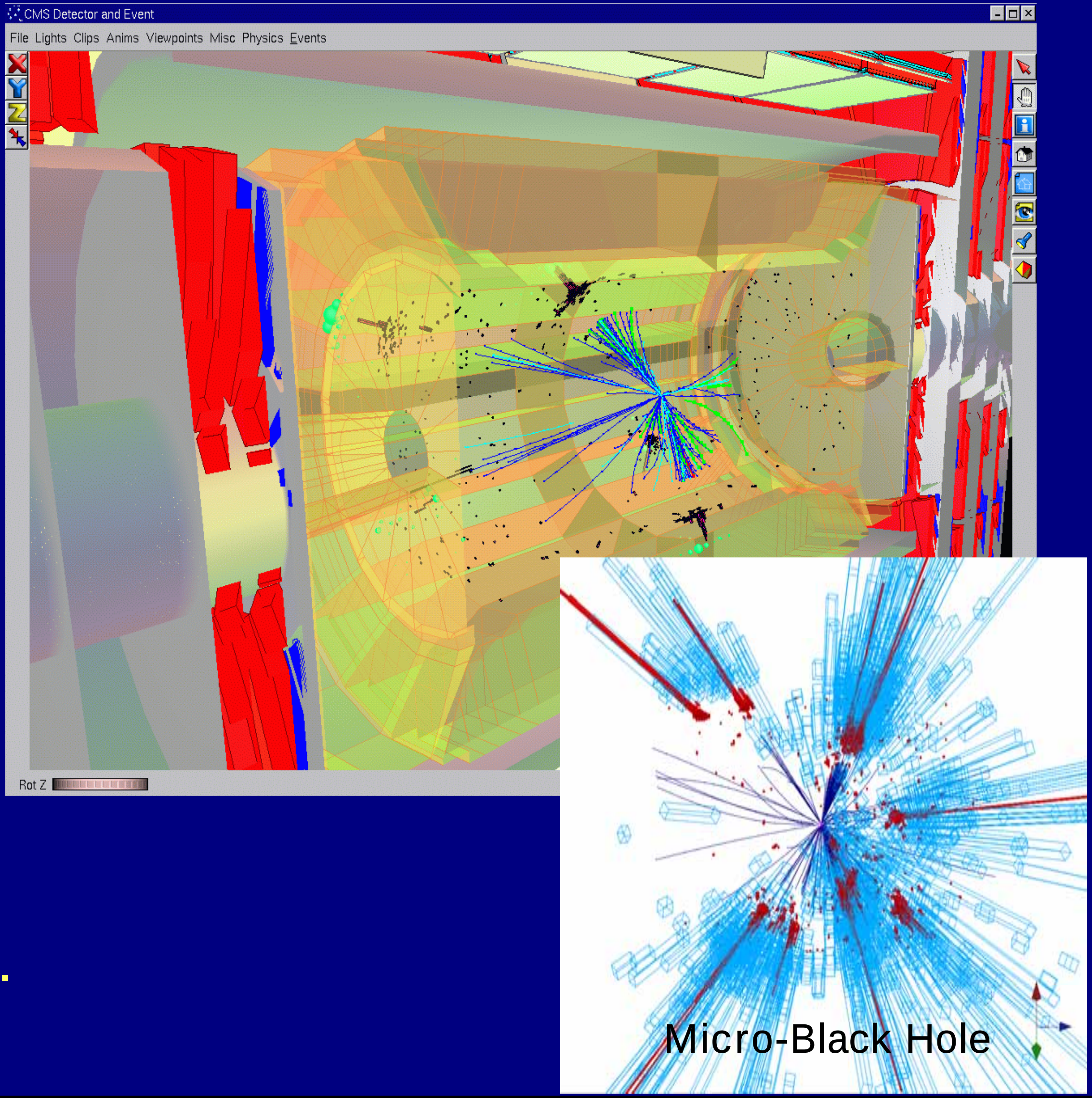
Extra Dimensions: Black Hole Production

In extra dimensions

Semi-classical argument: two partons approaching with impact parameter < Schwarzschild radius, R_S → black hole

Spectacular decays – democracy of SM particles – high multiplicity incl lots of charged leptons and photons at high p_T

Can determine Hawking Temperature, M_{BH}, n – no. of dimensions !



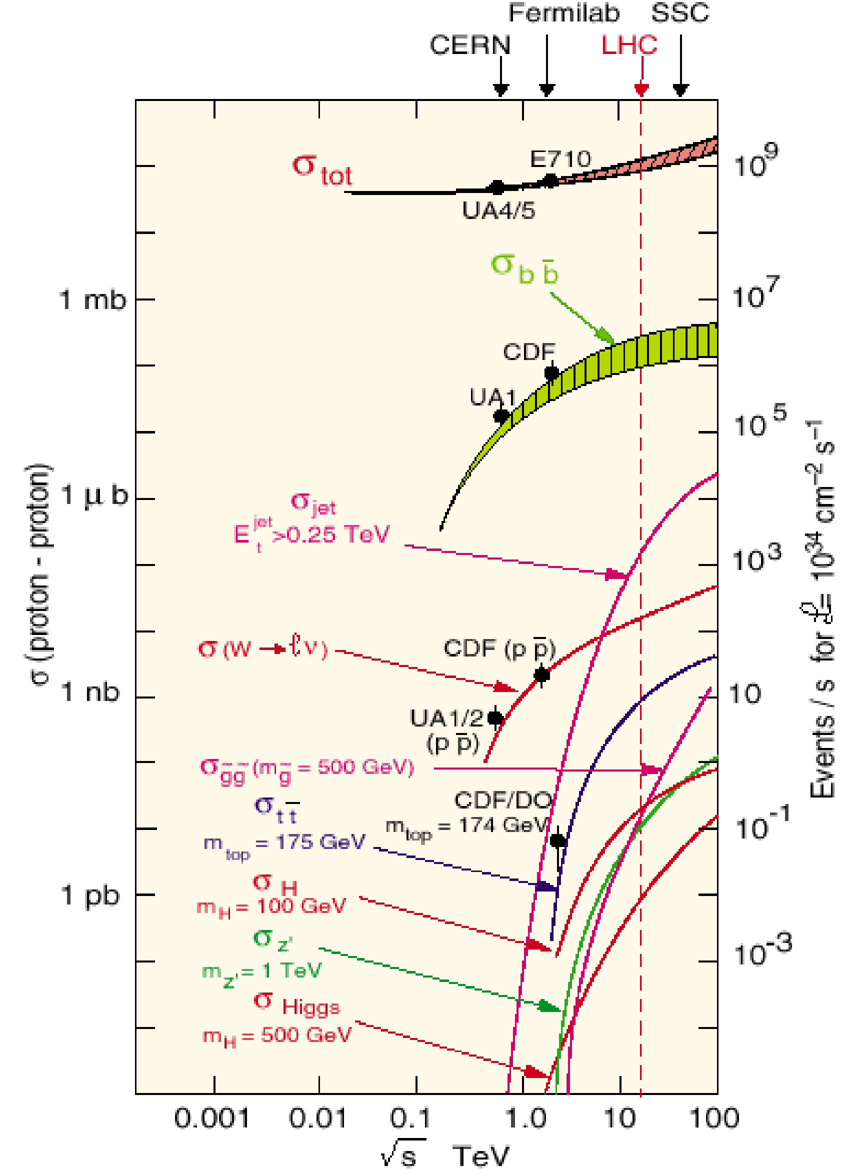
Selectivity - physics

Cross sections for various physics processes vary over many orders of magnitude

- Inelastic: 10^9 Hz
- $W \rightarrow l\,\nu$: 10^2 Hz
- t t production: 10 Hz
- Higgs (100 GeV/c^2): 0.1 Hz
- Higgs (600 GeV/c^2): 10^{-2} Hz

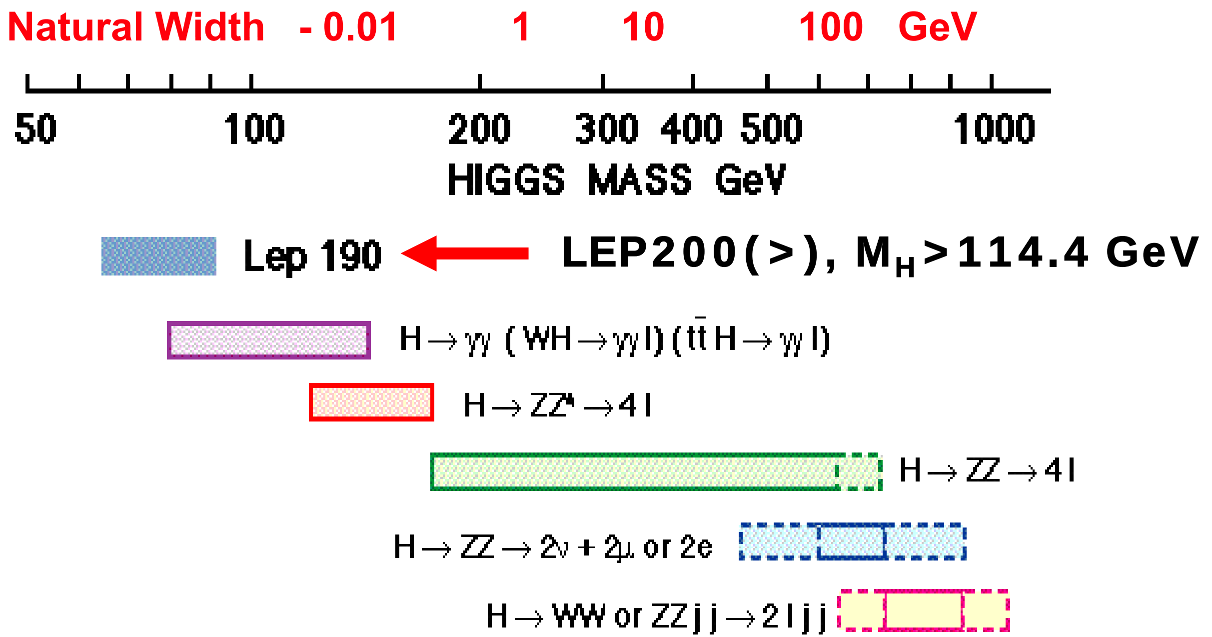
Selection needed: 1:10^{10-11}

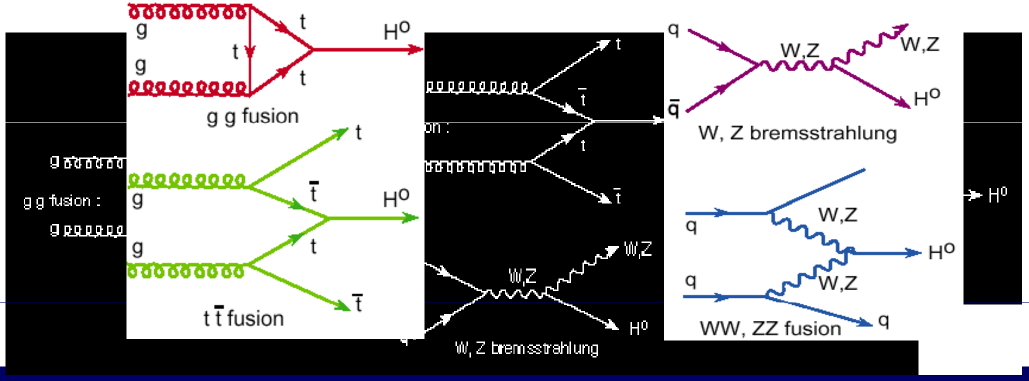
- Before branching fractions...



Physics Requirements

At the LHC the SM Higgs provides a good benchmark to test the performance of a detector





Physics Requirements

Very good muon identification and momentum measurement

trigger efficiently and measure sign of a few TeV muons

High energy resolution electromagnetic calorimertry

~ 0.5% @ E_T~50 GeV

Powerful inner tracking systems

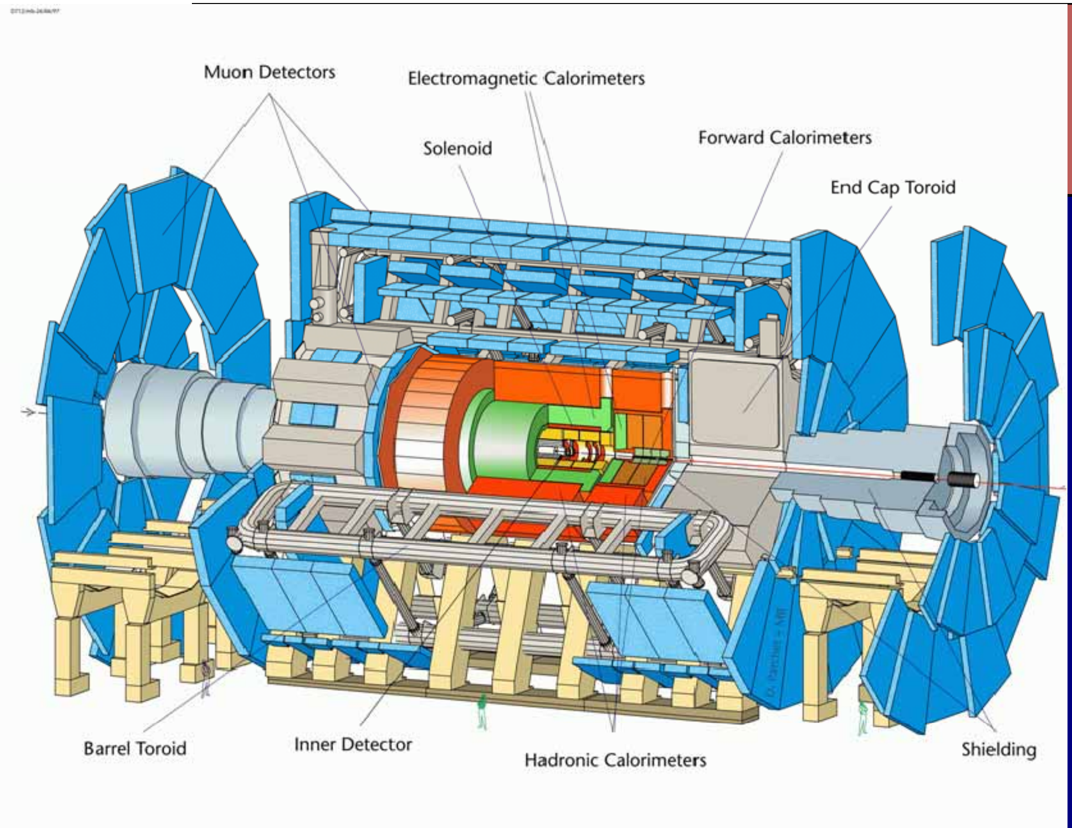
factor 10 better momentum resolution than at LEP

Hermetic calorimetry

good missing E_T resolution

(Affordable detector)

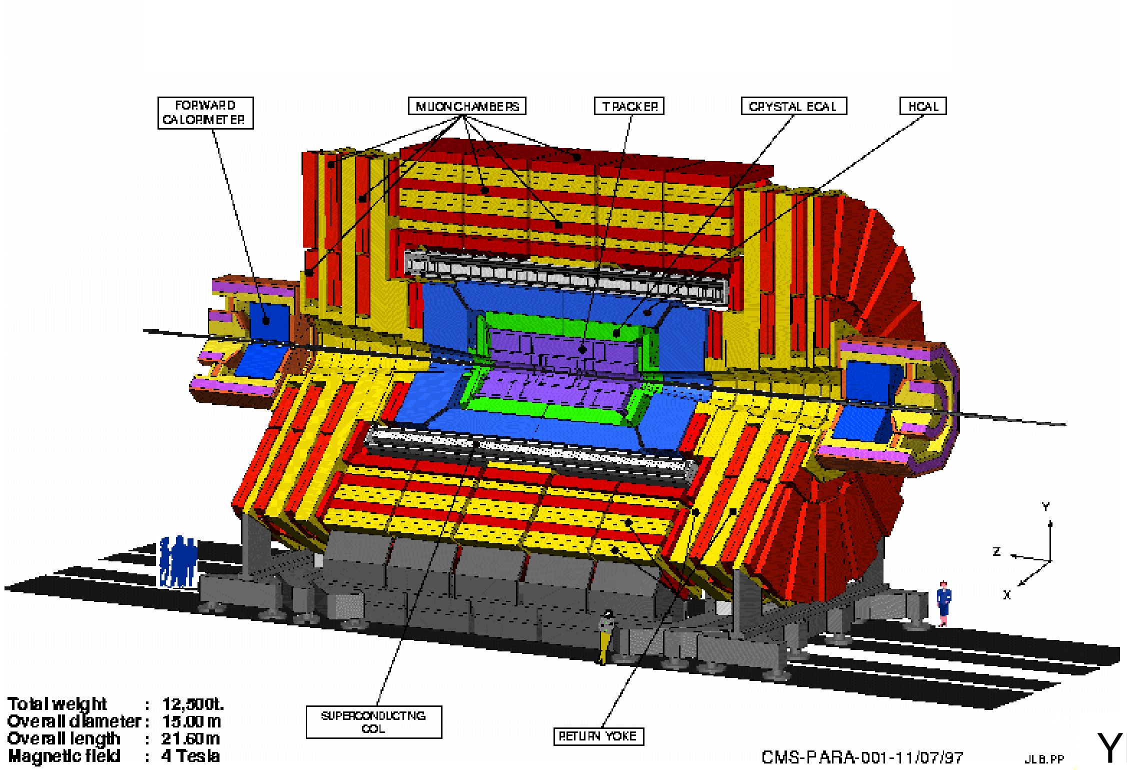
ATLAS



Length : ~45 m
Radius : ~12 m
Weight : ~ 7000 tons
Electronic channels : ~ 10^8
~ 3000 km of cables

- Tracking ($|\eta|<2.5$, B=2T) :
  -- Si pixels and strips
  -- Transition Radiation Detector (e/π separation)
- Calorimetry ($|\eta|<5$) :
  -- EM : Pb-LAr with Accordion shape
  -- HAD: Fe/scintillator (central), Cu/W-LAr (fwd)
- Muon Spectrometer ($|\eta|<2.7$) :
  air-core toroids with muon chambers

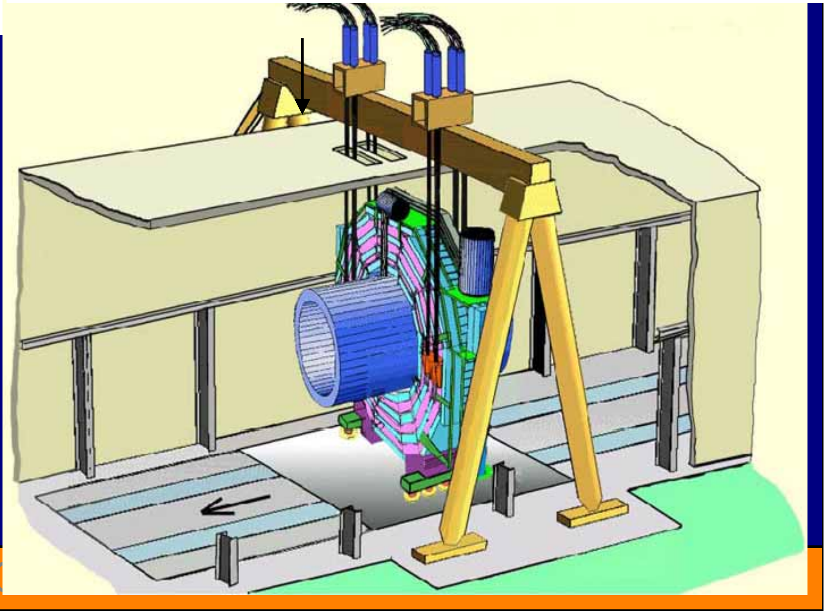
CMS



Length : ~22 m
Radius : ~7 m
Weight : ~ 12500 tons

Compact and modular: assembled at the surface and lowered in the cavern piece by piece

YB0 lowering (2000t)



- Tracking (|η|<2.5, B=4T) : Si pixels and strips
- Calorimetry (|η|<5) :
  -- EM : $PbWO_4$ crystals
  -- HAD: brass/scintillator (central+ end-cap), Fe/Quartz (fwd)
- Muon Spectrometer (|η|<2.5) : return yoke of solenoid instrumented with muon chambers

14 TeV Rates of Events

LHC is a factory for b, W,Z, top

1 fb^{-1} (100 pb^{-1}) ≡ 6 months at $L= 10^{32}\ cm^{-2}s^{-1}$
with 50% data-taking efficiency

Channels (<u>examples</u> …)	Events to tape for 100 pb^{-1} (per expt: ATLAS, CMS)	Total statistics from previous Colliders
$W \rightarrow \mu\ \nu$	~ 10^6	~ 10^4 LEP, ~ 10^6 Tevatron
$Z \rightarrow \mu\ \mu$	10^5	~ 10^6 LEP, ~ 10^5 Tevatron
tt $\rightarrow$ W b W b $\rightarrow \mu\ \nu$+X	~ 10^4	~ 10^4 Tevatron
QCD jets p_T > 1 TeV	> 10^3	---
$\tilde{g}\tilde{g}$ m = 1 TeV	~ 50	---

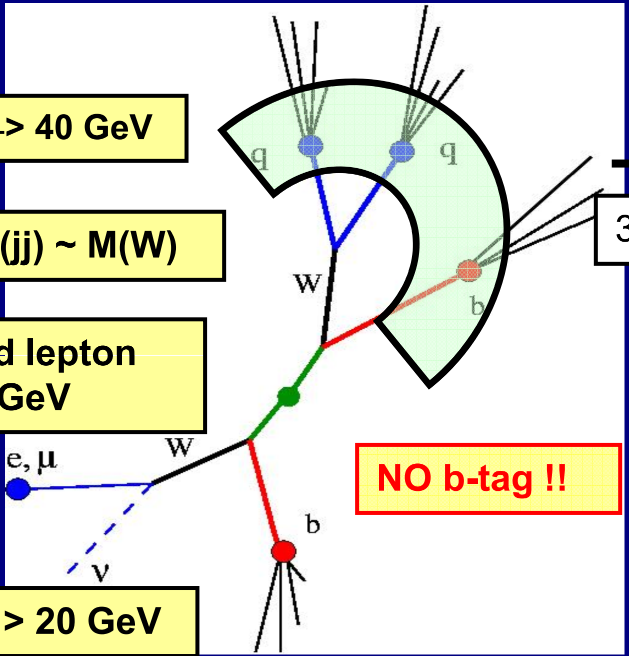
<u>With these data:</u>

- Understand and calibrate detectors <u>in situ using well-known physics samples</u>
  e.g. - $Z \rightarrow ee, \mu\mu$ tracker, ECAL, Muon chambers calibration and alignment, etc.
  - tt $\rightarrow$ blν bjj jet scale from $W \rightarrow jj$, b-tag performance, etc.

- Measure SM physics at $\sqrt{s}$ = 14 TeV : W, Z, tt, QCD jets …
  (also because omnipresent backgrounds to New Physics)

Example of initial measurement: understanding detector and physics with top events

$\sigma_{tt} \approx 250$ pb for $tt \to bW\ bW \to bl\nu\ bjj$



4 jets p_T> 40 GeV

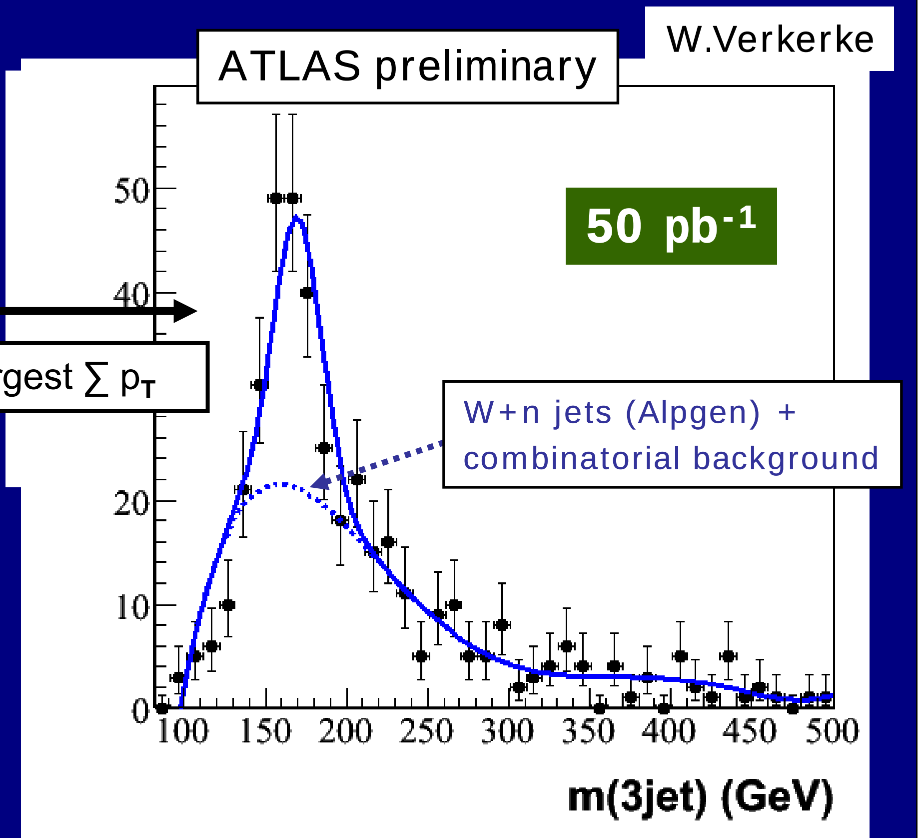
2 jets M(jj) ~ M(W)

Isolated lepton p_T> 20 GeV

E_T^{miss} > 20 GeV

NO b-tag !!

3 jets with largest $\sum p_T$

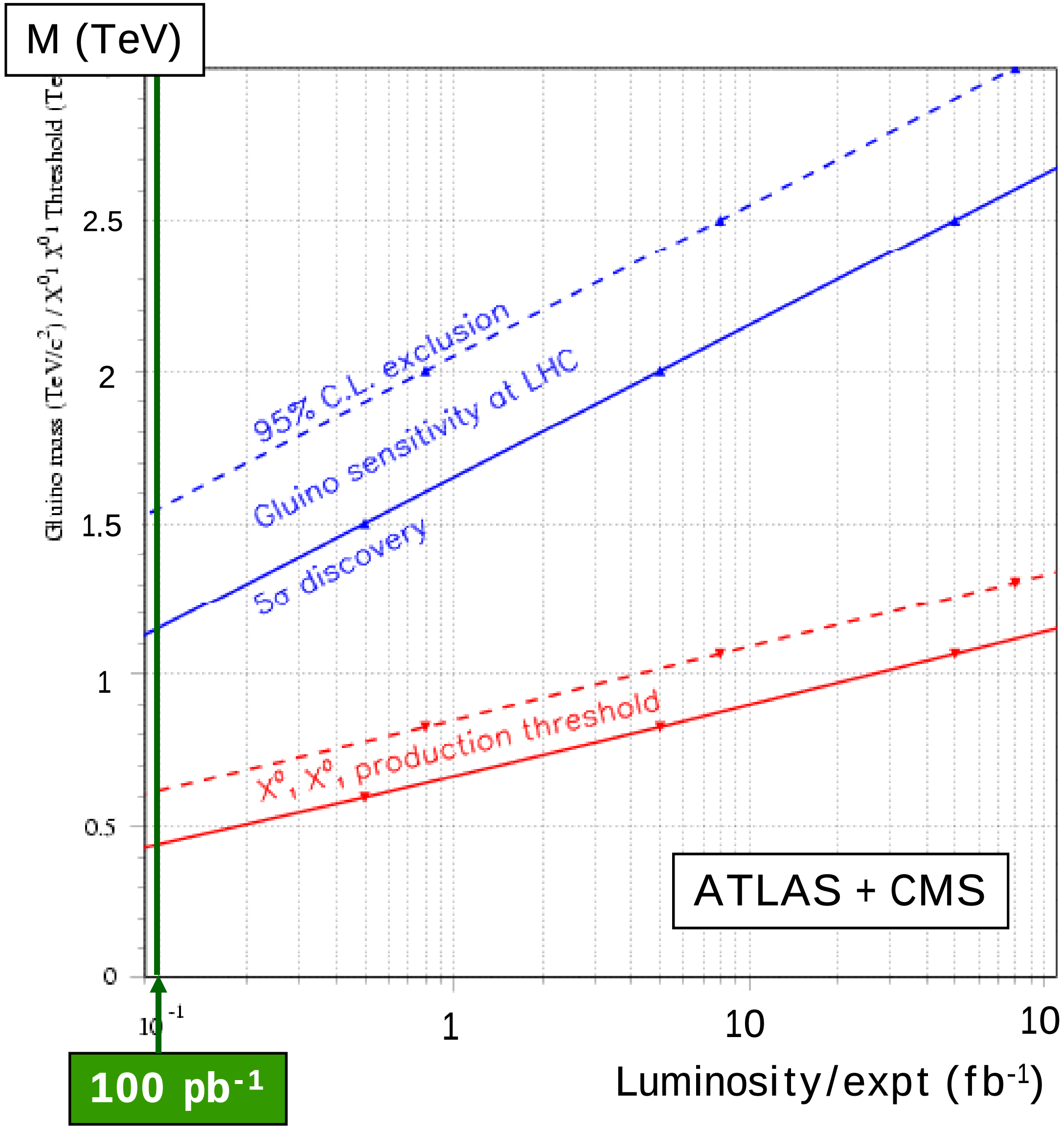


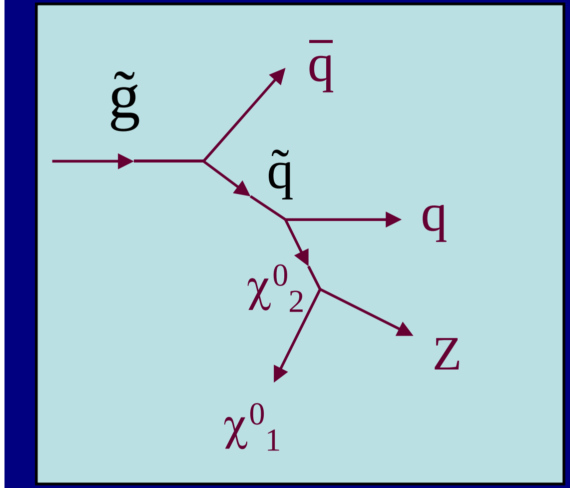
Top signal observable in early days with no b-tagging and simple analysis (100 ± 20 evts for 50 pb^{-1}) → measure σ_{tt} to 20%, m to 10 GeV with ~100 pb^{-1} ?

In addition, excellent sample to:

- **commission b-tagging, set jet E-scale using W → jj peak**
- **understand detector performance for e, μ, jets, b-jets, missing E_T, …**
- **understand / constrain theory and MC generators using e.g. p_T spectra**

Example of “early” discovery: Supersymmetry ?



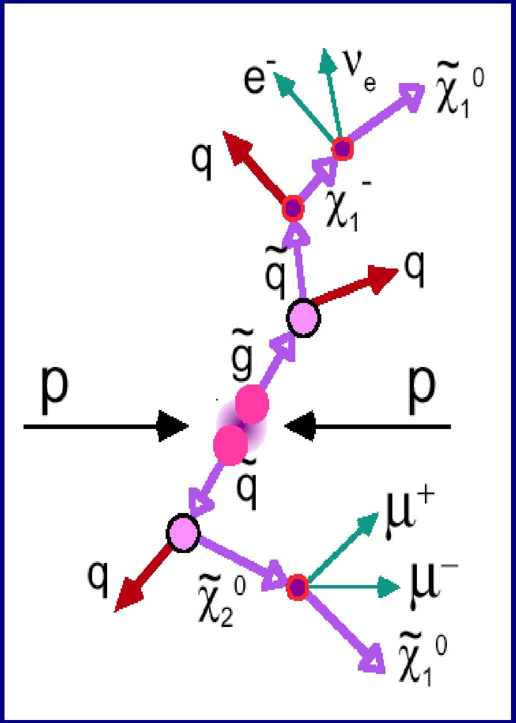


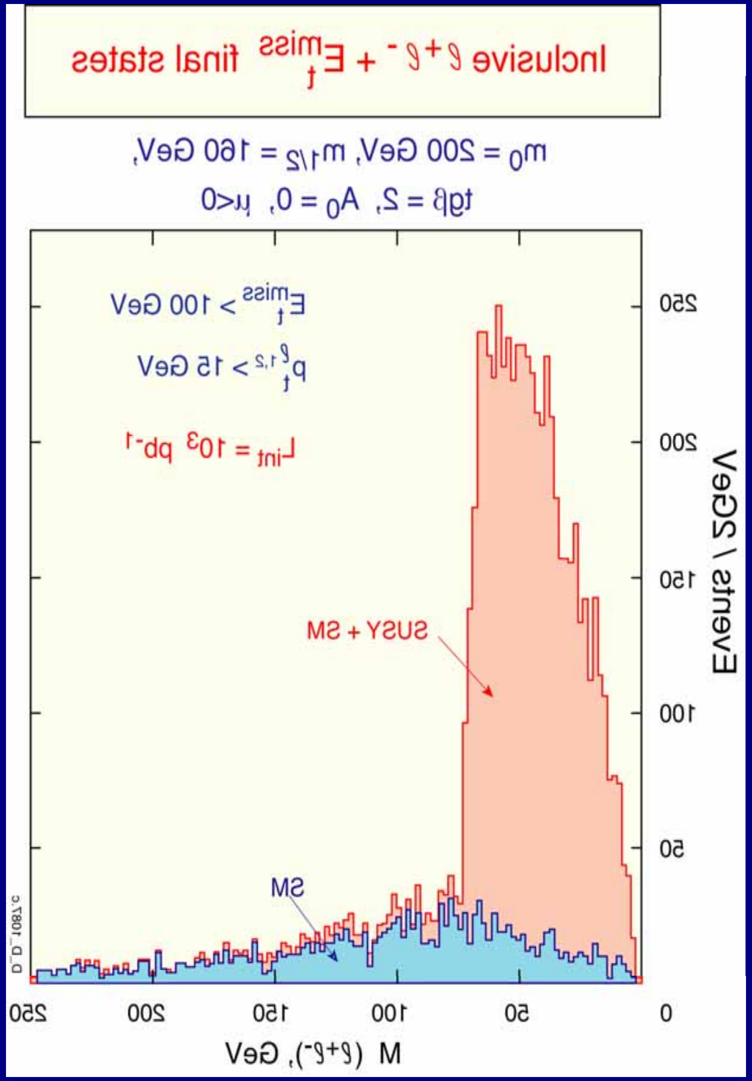
Our field, and planning for future facilities, will benefit a lot from quick determination of scale of New Physics. E.g. with 100 (good) pb^{-1} LHC could say if SUSY accessible to a $\leq$1 TeV ILC

BUT: understanding E_T^{miss} spectrum (and tails from instrumental effects) is one of the most crucial and difficult experimental issue for SUSY searches at hadron colliders.

Discovery Physics (SUSY)

Squarks & gluinos



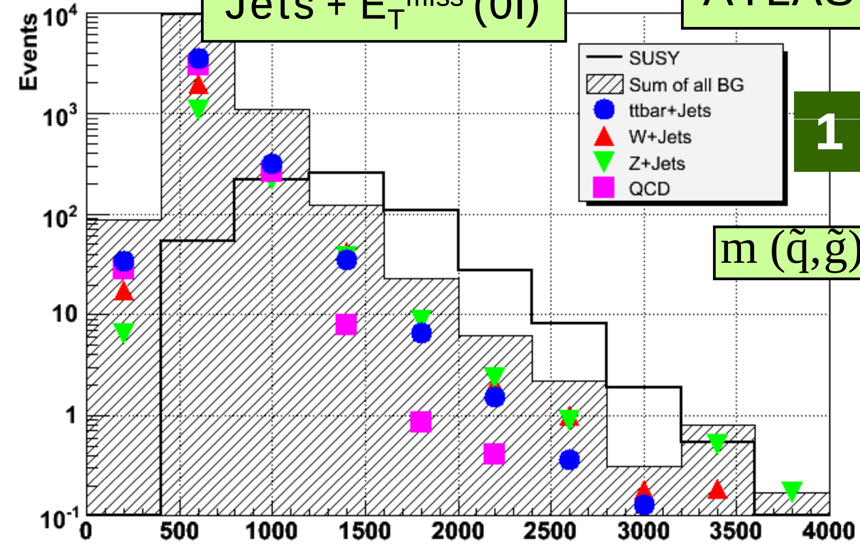


Low energy SUSY will be found quickly

ATLAS preliminary

S.Asai

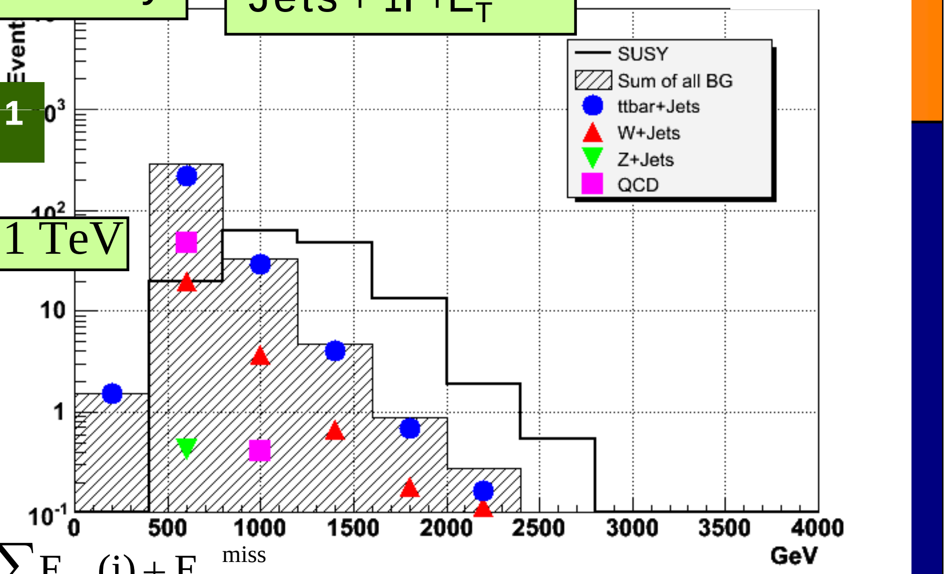
Jets + E_T^{miss} (0l)



1 fb^{-1}

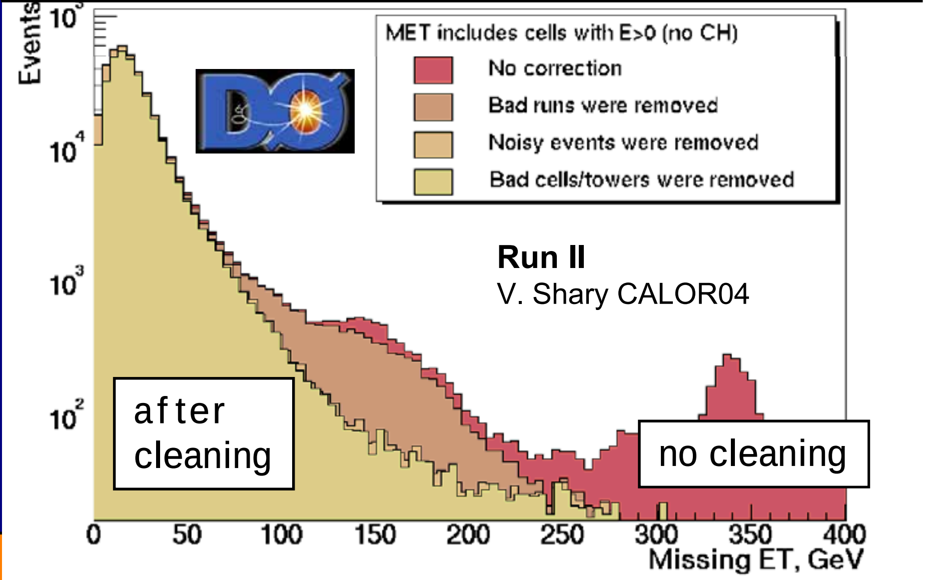
$m(\tilde{q},\tilde{g}) \sim 1$ TeV

Jets + 1l + E_T^{miss}



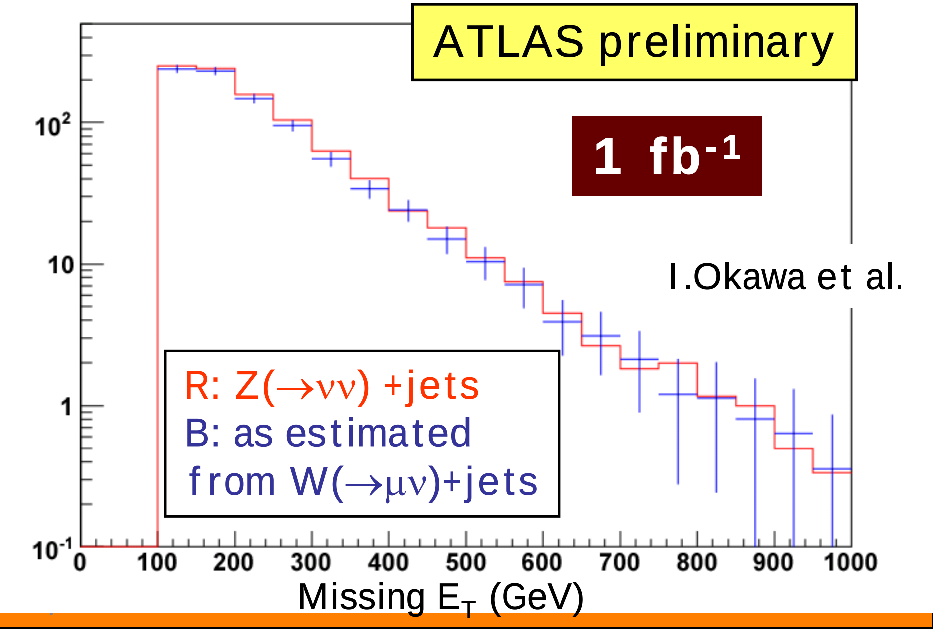
$$M_{eff}\ (\text{GeV}) = \sum_{i=1,4} E_T\ (i) + E_T^{miss}$$

E_T^{miss} spectrum contaminated by cosmics, beam-halo, machine/detector problems, etc.



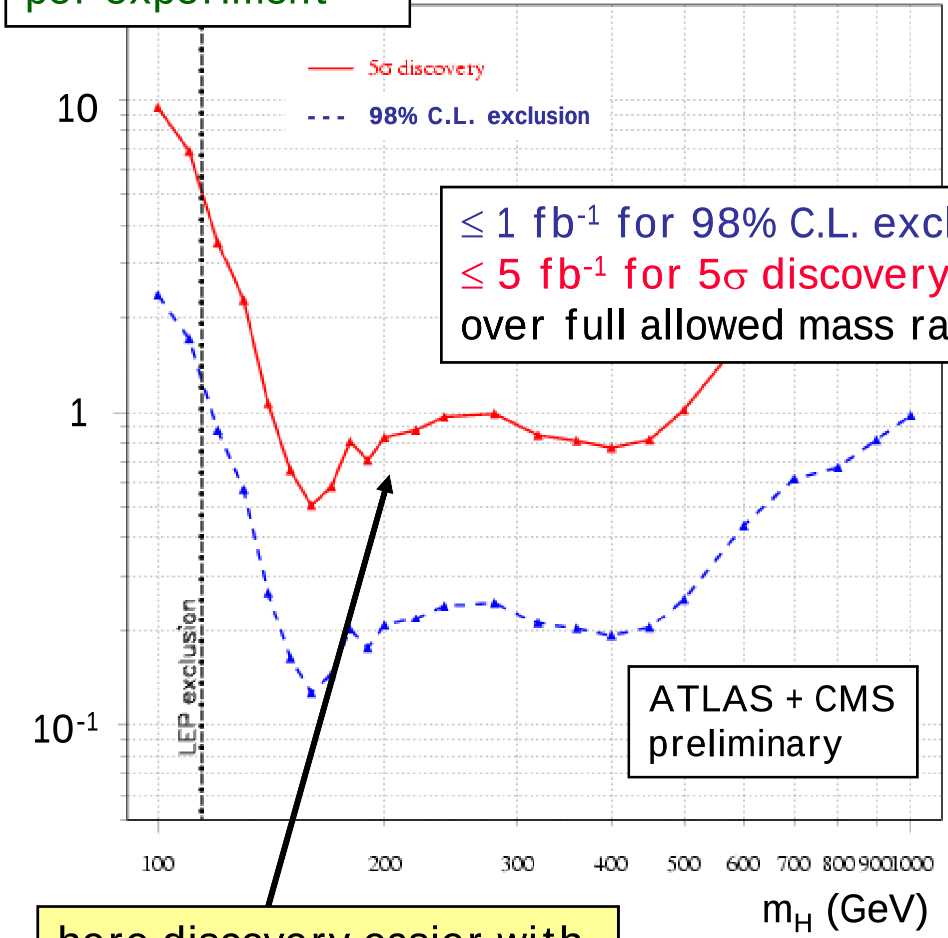
Estimate physics backgrounds using <u>data (control samples)</u>

ATLAS preliminary



What about the SM Higgs boson ?

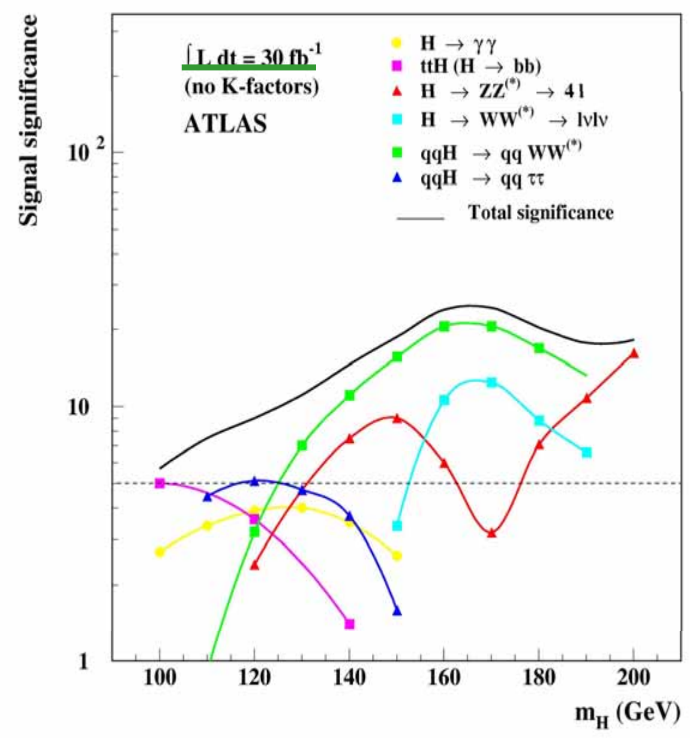
Needed ∫Ldt (fb^{-1})
per experiment



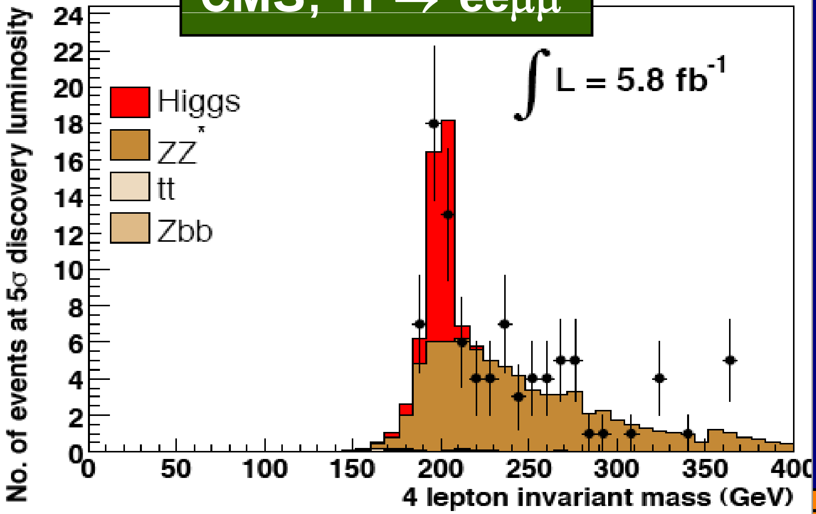
≤ 1 fb^{-1} for 98% C.L. exclusion
≤ 5 fb^{-1} for 5σ discovery
over full allowed mass range

ATLAS + CMS
preliminary

here discovery easier with
gold-plated H → ZZ → 4l
→ **by end 2008 ?**



CMS, H → eeμμ

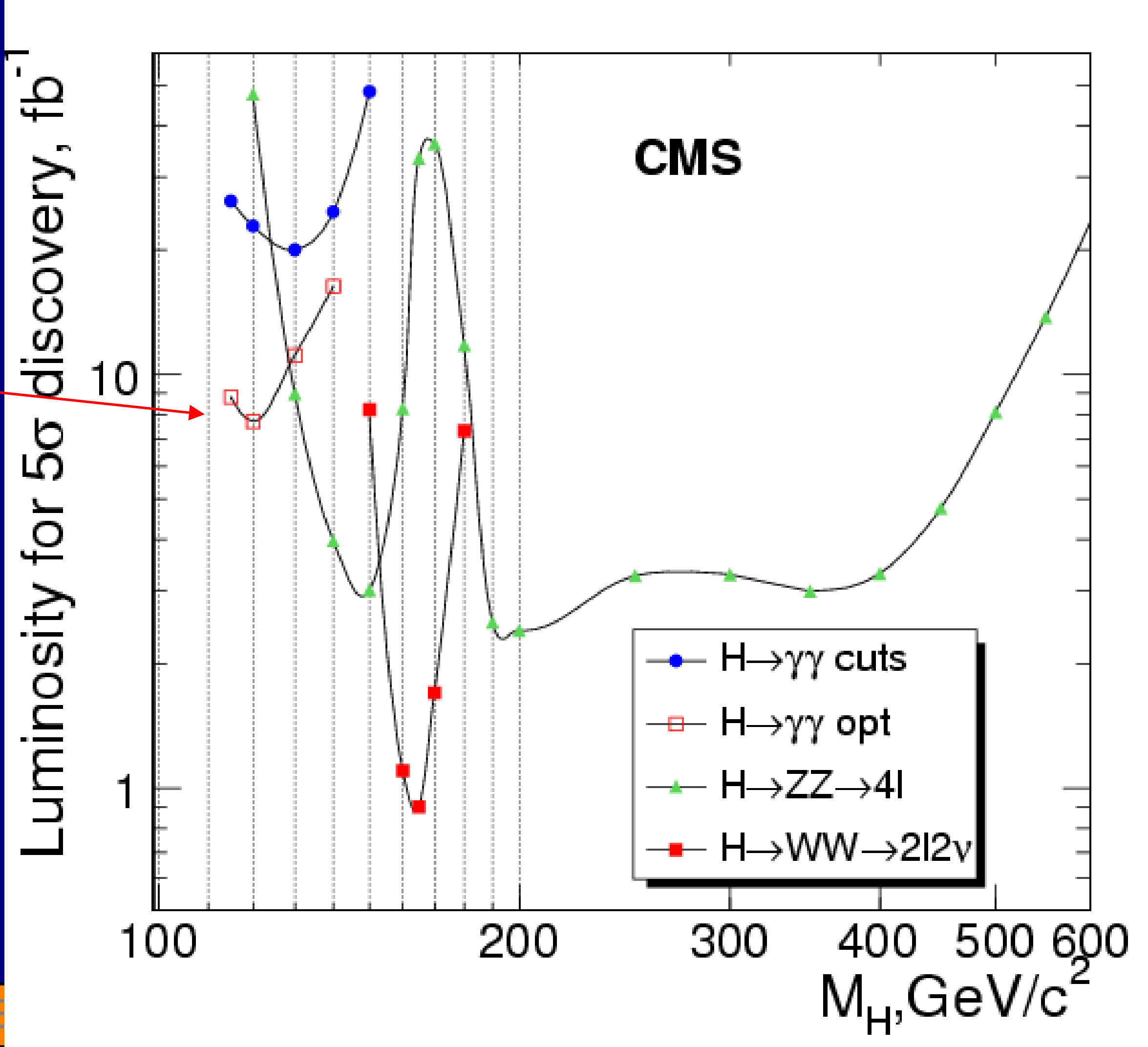


H → 4l : narrow mass peak, small background
H → WW → lνlν (dominant at the Tevatron):
counting channel (no mass peak)

Discovery Physics (SM Higgs)

The Physics Reach of CMS has been re-evaluated in 2006

The low mass Higgs in the two photon mode can be discovered in CMS alone with 10 fb^{-1}

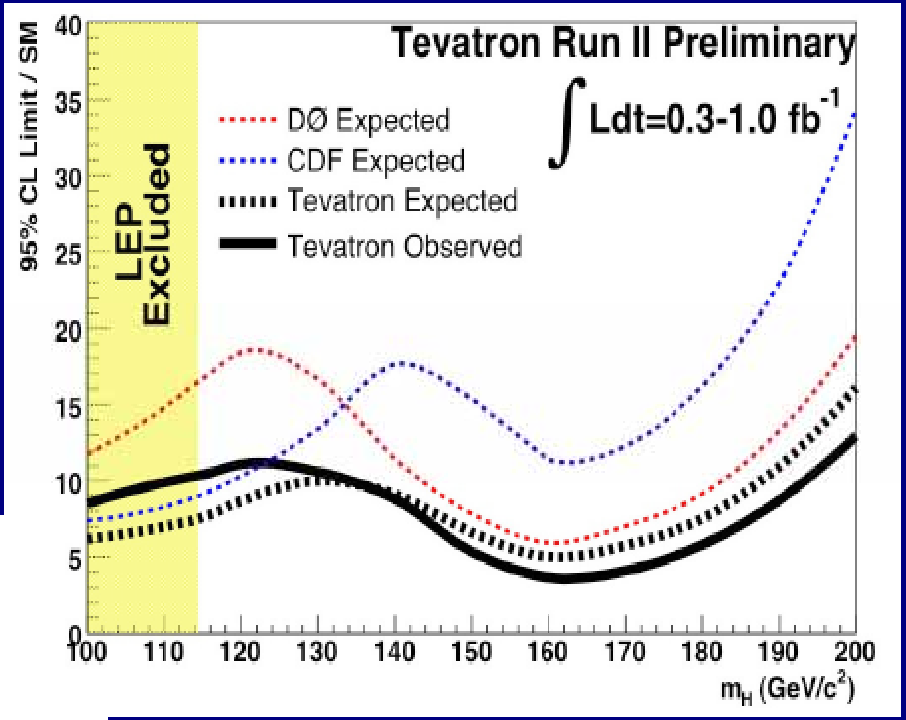


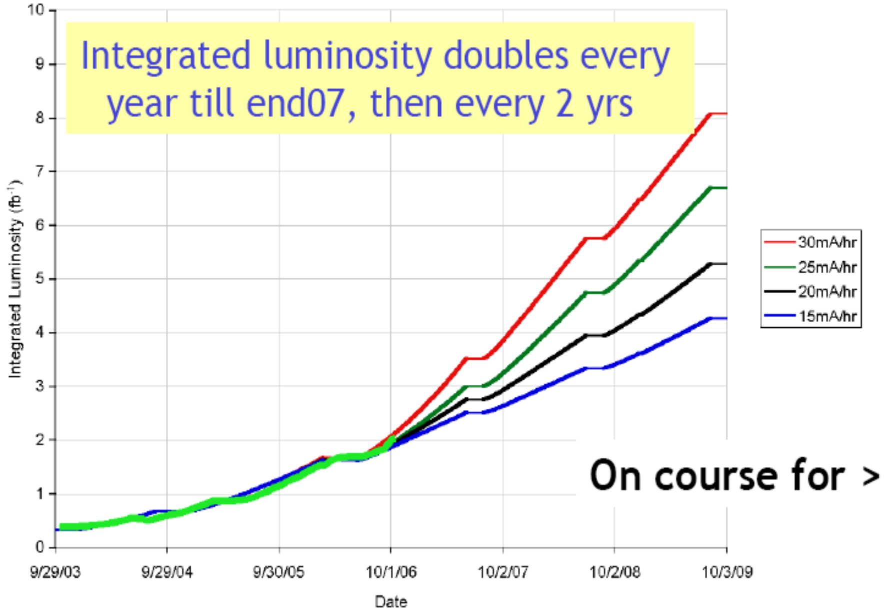
Meanwhile across the Ocean ...

SM Higgs Boson at FNAL

Current Limits: 5-10 times SM cross-section

Anticipation: reach SM sensitivities





Integrated luminosity doubles every year till end07, then every 2 yrs

On course for > 5fb^{-1}

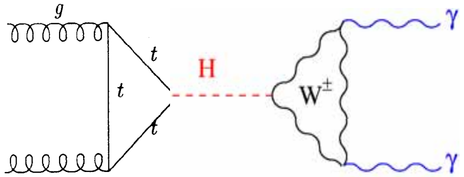
Light Higgs : more difficult ....

m_H ~ 115 GeV 10 fb^{-1} : $S/\sqrt{B} \approx 4$ ATLAS

K-factors $\equiv \sigma(NLO)/\sigma(LO) \approx 2$
for $H \rightarrow \gamma\gamma$ NOT included (conservative)

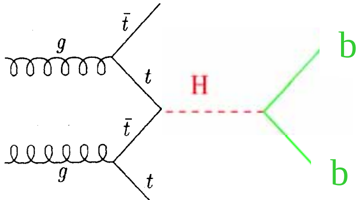
3 (complementary) channels with similar (small) significances:

$H \rightarrow \gamma\gamma$



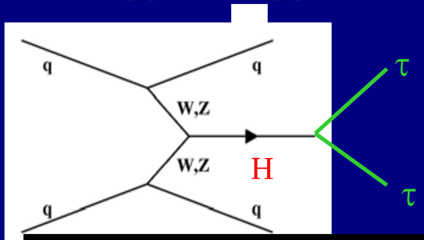
$S=130, B=4300, S/\sqrt{B}=2$

$ttH \rightarrow ttbb \rightarrow bl\nu bjjbb$



$S=15, B=45, S/\sqrt{B}=2.2$

$qqH \rightarrow qq\tau\tau$



$S=10, B=10, S/\sqrt{B}=2.7$

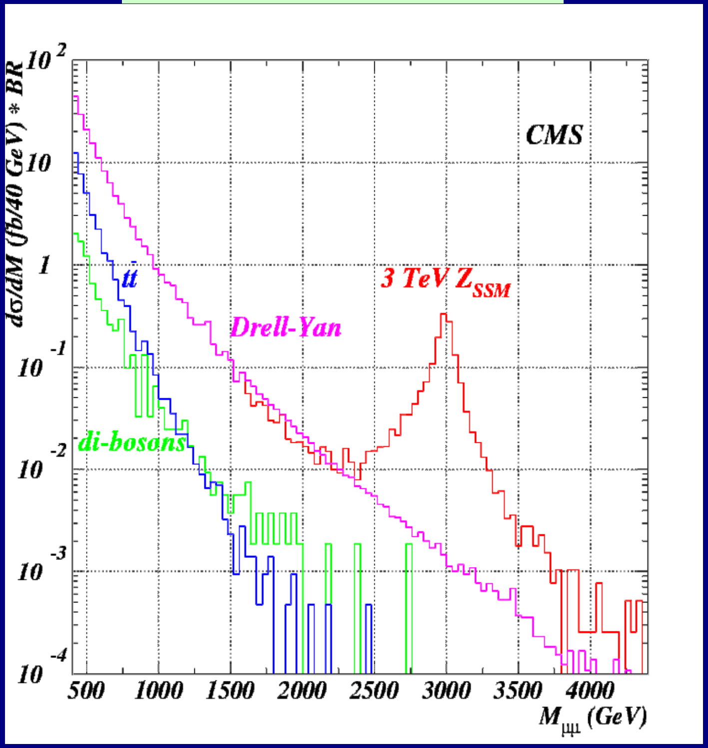
- different production and decay modes
- different backgrounds
- different detector/performance requirements:
  - -- ECAL crucial for $H \rightarrow \gamma\gamma$ (in particular response uniformity) : σ/m ~ 1% needed
  - -- b-tagging crucial for ttH : 4 b-tagged jets needed to reduce combinatorics
  - -- efficient jet reconstruction over $|\eta| < 5$ crucial for $qqH \rightarrow qq\tau\tau$: forward jet tag and central jet veto needed against background

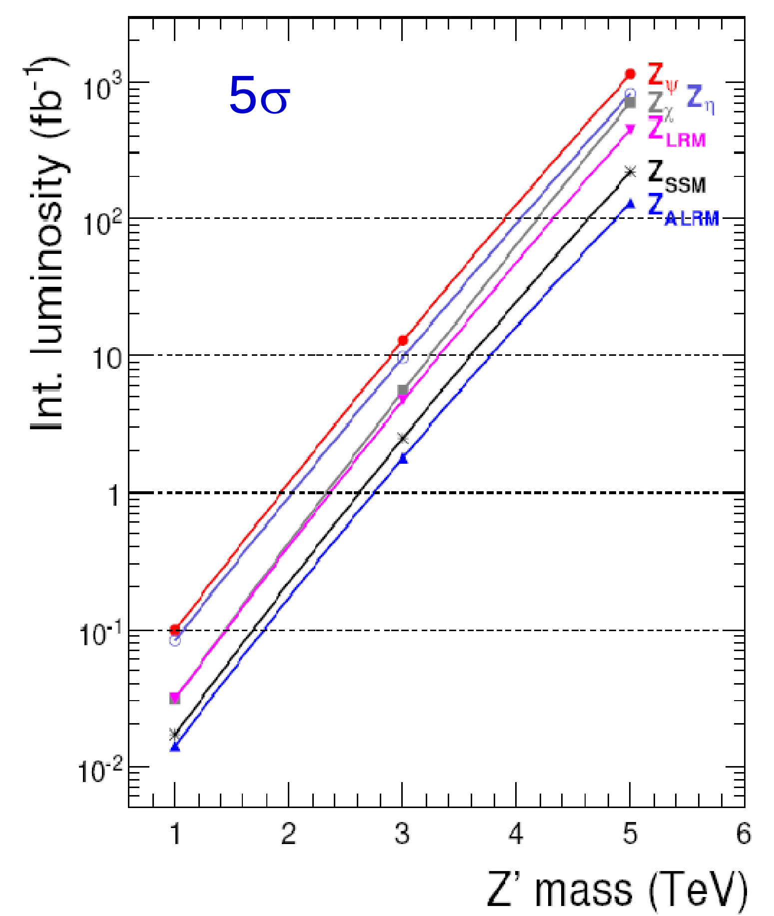
All three channels require very good understanding of detector performance and background control to 1-10% → convincing evidence likely to come later than 2008 ...

Note: $WH \rightarrow l\nu bb$ (dominant at the Tevatron) provides less sensitivity than ttH at LHC

Discovery Physics (Z')

Z'→μμ production





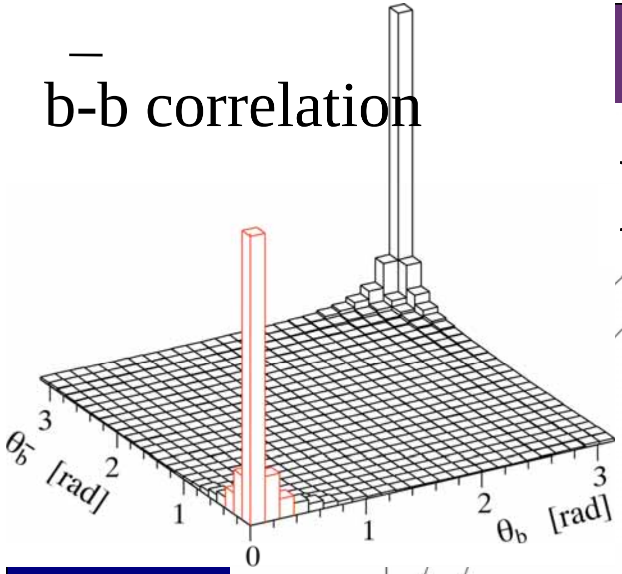
Low lumi 0.1 fb^{-1} : discovery of 1-1.6 TeV possible, beyond Tevatron II
High lumi 100 fb^{-1}: extend range to 3.4-4.3 TeV

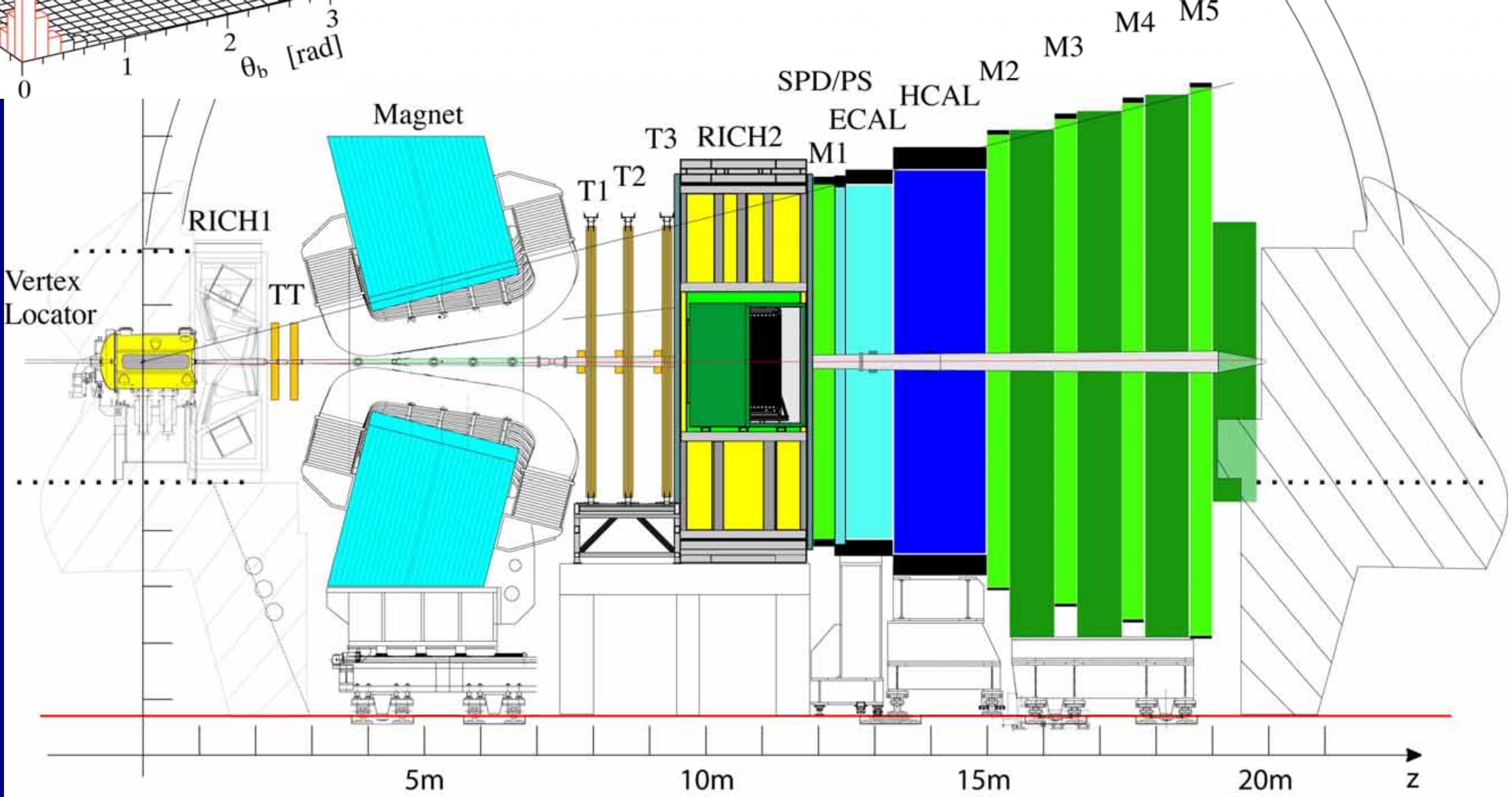
‘Dedicated’ experiments:

ALICE, LHCb, TOTEM, (LHCf)

To the conclusions:

LHCb detector at IP8


$\bar{b}$-b correlation



A possible scenario for 2008

Let us assume 0.5 fb^{-1} of physics data with LHCb

1/4 of the “nominal” year with $\langle L \rangle = 2\times10^{32}\mathrm{cm}^{-2}\mathrm{s}^{-1}$

= less than 10% of a calendar year

With this data, first check some established results, e.g.

$\sigma_{\Delta m_s} = 0.014\ \mathrm{ps}^{-1}$ cf. 0.10 ps^{-1} by CDF now

$\sigma_{\sin 2\beta} = 0.04$ cf. 0.03 current world average

lifetimes

⇒ understanding of trigger, momentum scale, σ_τ, tagging performance, detector acceptance etc.

Then proceed to exclude (or discover!) not yet excluded (relatively) large New Physics effects

e.g.

CP violation in B_s, $B_s \to J/\psi\phi$ measuring $\phi_s = -2 \arg V_{ts}$

ϕ_s: B_s–B_s oscillation phase (respect to that of V_{cb})

$\sigma_{\phi s} = 0.04$ rad, SM prediction $\phi_s \approx -0.04$ rad

cf. current D0 result: $\sigma_{\phi s} = -0.56(+0.44-0.41)$ rad @1 fb^{-1}

Search for very rare $B_s \to \mu^+\mu^-$ decays

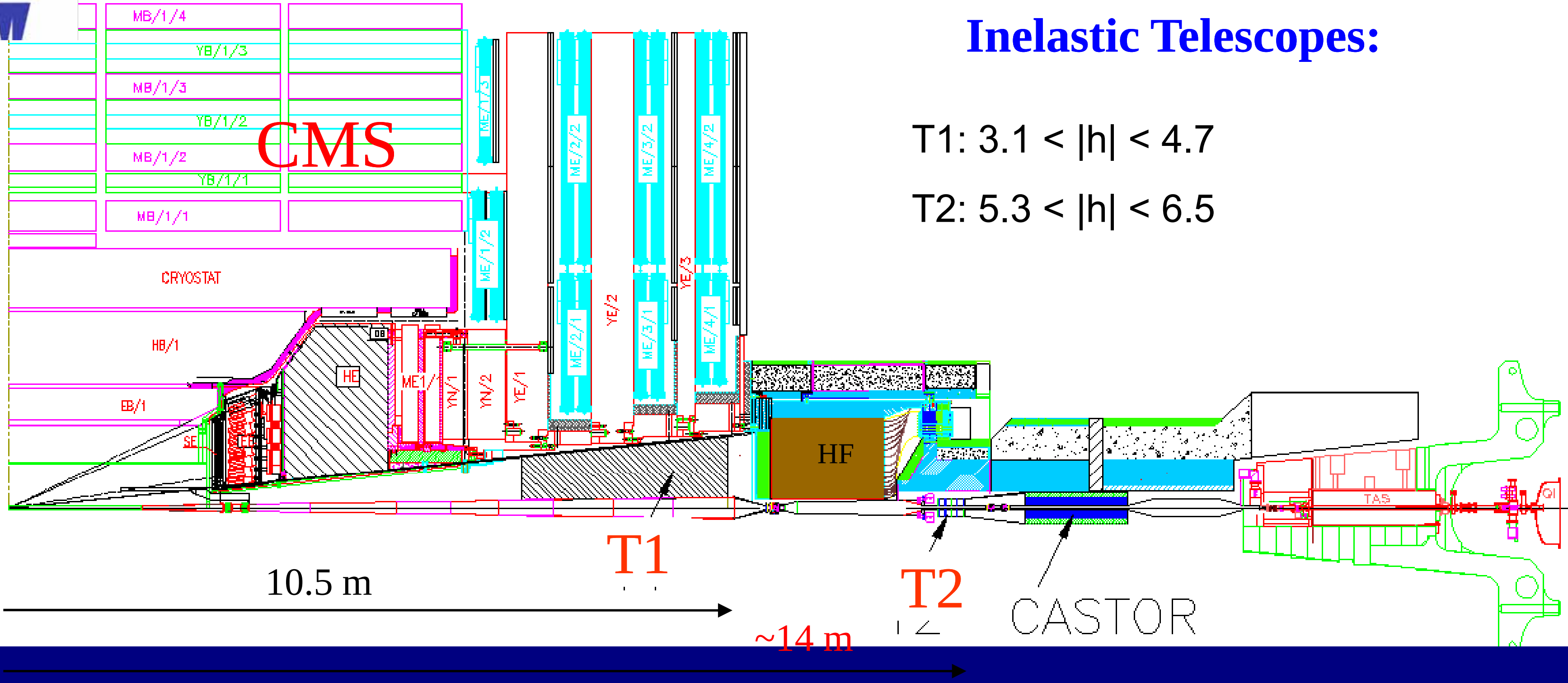
$Br(B_s \to \mu^+\mu^-) <$ SM-Br (90% CL) SM-Br~3×10^{-9}

cf current CDF result $<0.8\times10^{-7}$ (90% CL) @780 pb^{-1}

cf current D0 results $<1.9\times10^{-7}$ (90% CL) @700 pb^{-1}

i.e. With 2008 LHCb data, we should be able to reach the Standard Model level of sensitivities

TOTEM

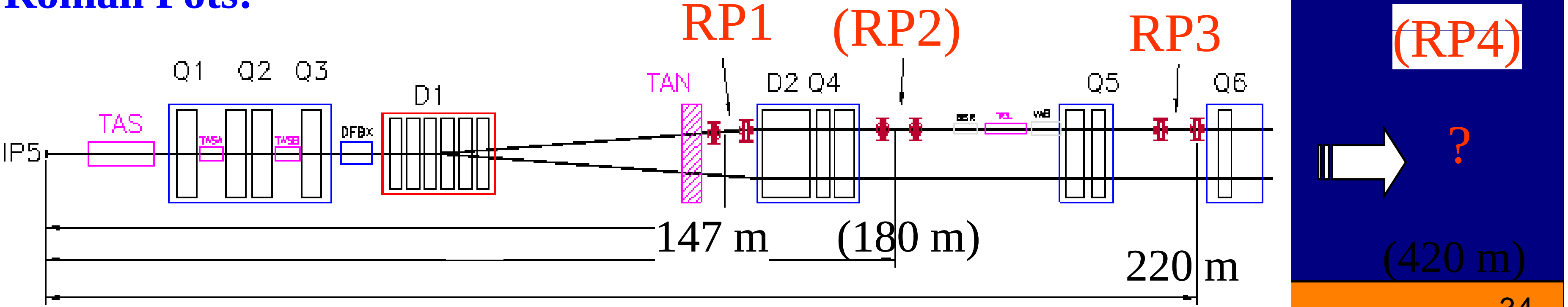


Inelastic Telescopes:

T1: 3.1 < |h| < 4.7

T2: 5.3 < |h| < 6.5

Roman Pots:



TOTEM Physics:
Total p-p Cross-Section

- Current models predict for 14 TeV: 90 – 130 mb
- Aim of TOTEM: ~ 1% accuracy
- **Luminosity independent method**:

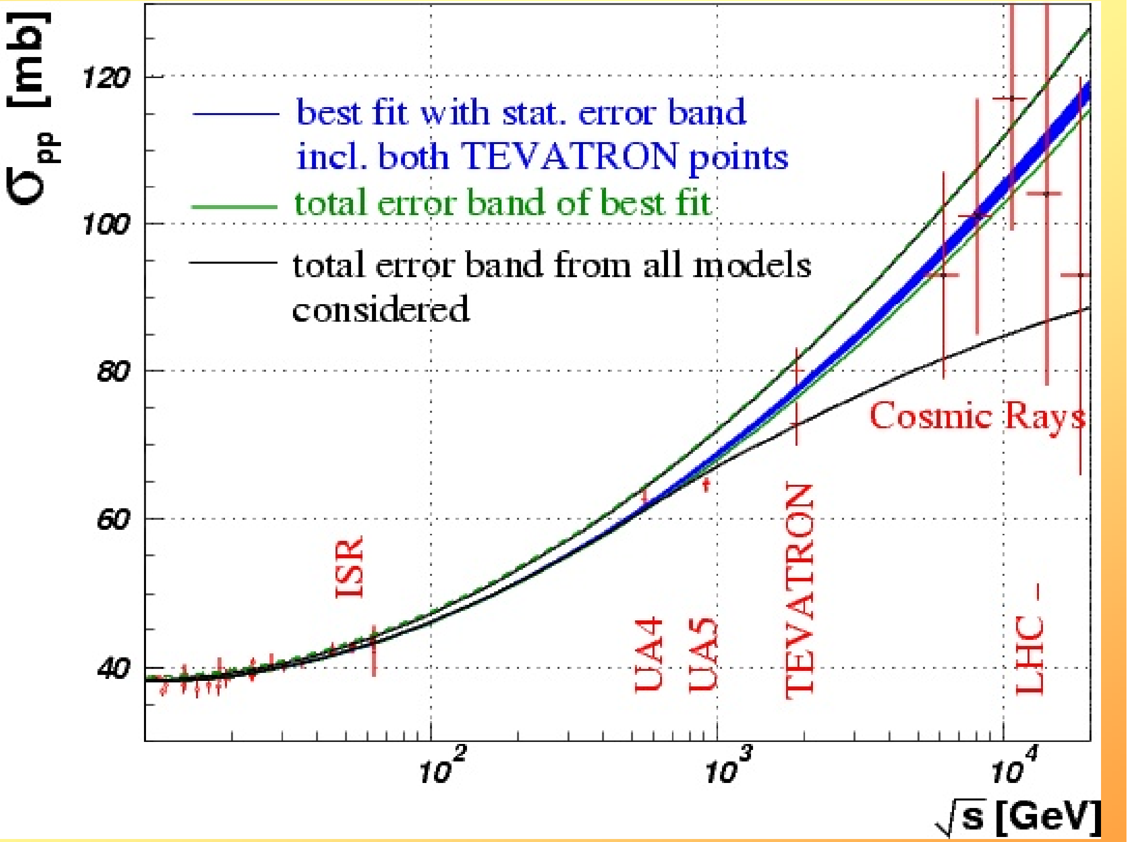
Optical Theorem
$$L\,\sigma_{tot}^2 = \frac{16\pi}{1+\rho^2} \times \left.\frac{dN}{dt}\right|_{t=0}$$

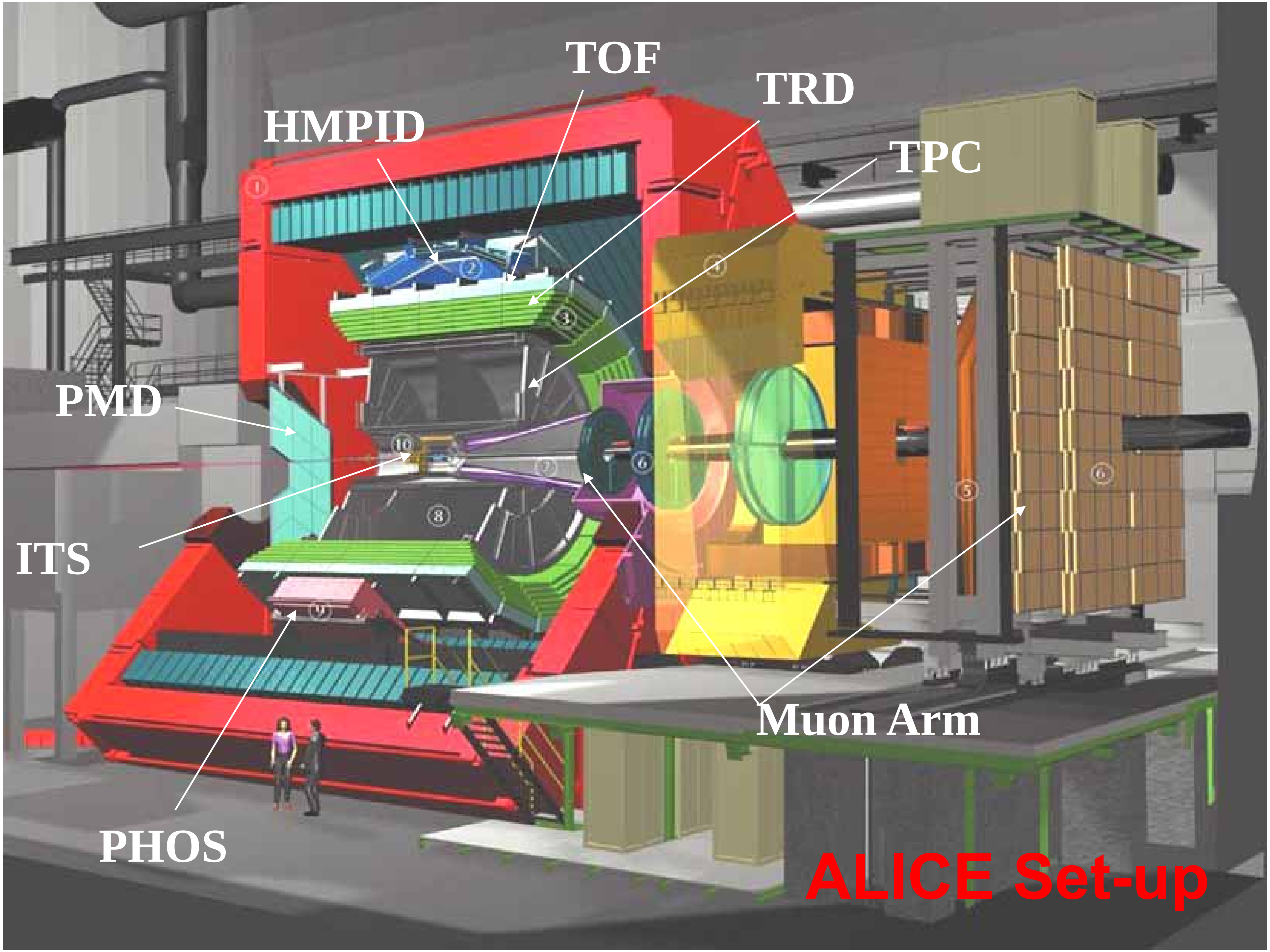
$$L\,\sigma_{tot} = N_{elastic} + N_{inelastic}$$

⇓

$$\sigma_{tot} = \frac{16\pi}{1+\rho^2} \times \frac{\left.(dN/dt)\right|_{t=0}}{N_{el}+N_{inel}}$$

COMPETE Collaboration:





ALICE Set-up

Hard Processes at the LHC

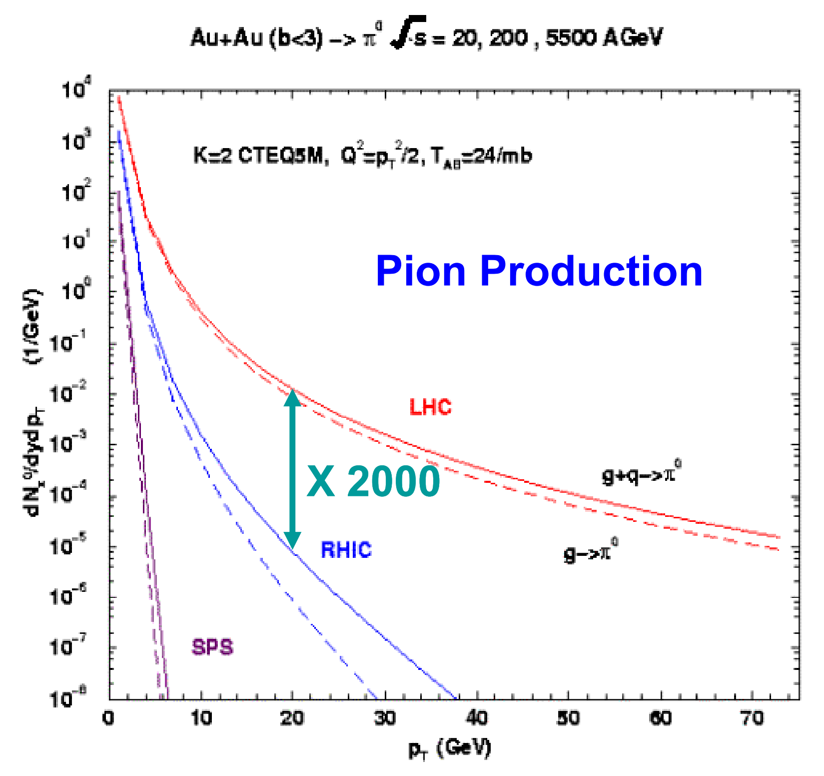
Main novelty of the LHC: large hard cross section

$\sigma^{hard}(p_T > 2GeV; y=0)/\sigma^{tot}$
~2% at SPS
~50% at RHIC
~98% at LHC

Hard processes are extremely useful tools

- *probe matter at very early times (QGP) !!!*
- *hard processes can be calculated by pQCD -> precision measurements*

Reasonable jet rates up to E_T > 200 GeV



Pb Pb jet rates |η| < 0.5:

p_t jet > (GeV/c)	jets / event (10% central)	jets / 0.5 nb-1
5	>200	
20	**2**	**2 10^9**
50	5 10^{-2}	5 10^5
100	2.5 10^{-3}	2.5 10^6
200	**10^{-4}**	**10^5**

Heavy Quarks & Quarkonia

copious heavy quark production

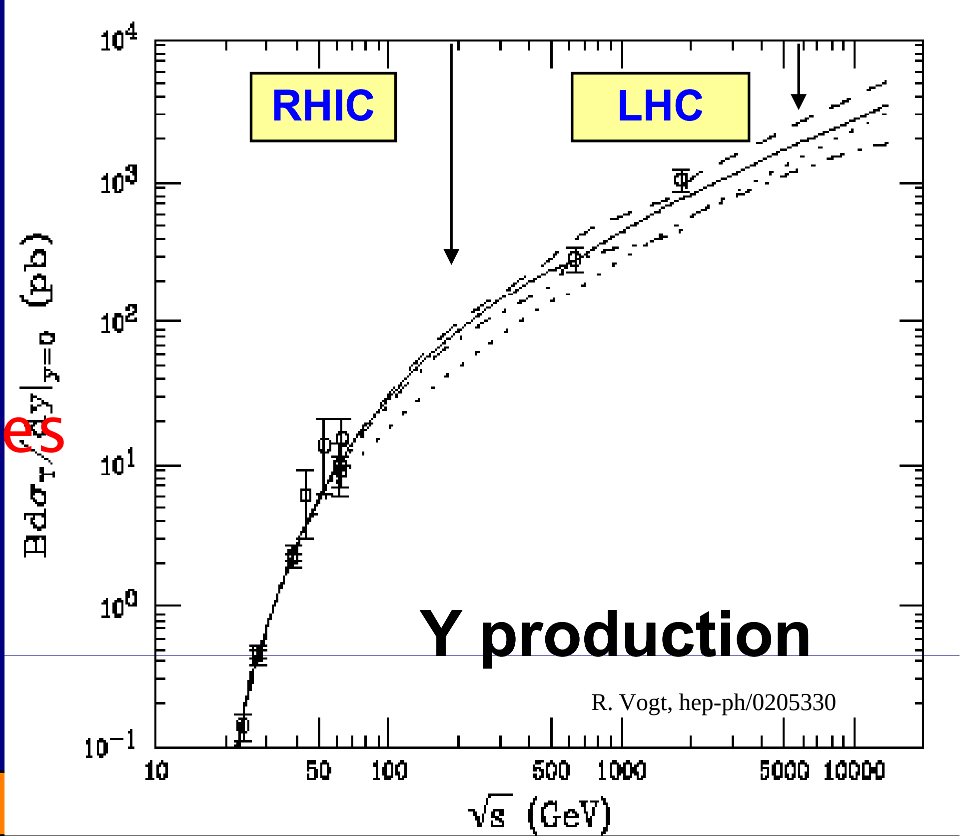
- charm @ LHC ~ strange @ SPS
  - statistical hardonization picture ?
  - jet-quenching with heavy quarks

N(qq̄) per central AA (b=0)

	SPS	RHIC	LHC
charm	0.2	10	200
bottom	---	0.05	6

Y ds/dy LHC ~ 20 x RHIC

- full set of quarkonia states
  - J/Y, Y', Y, Y', Y''



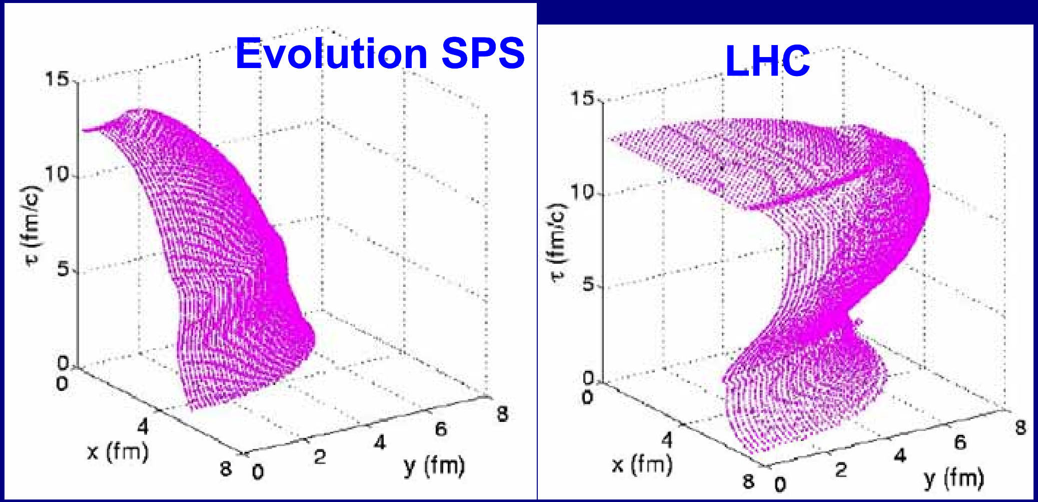
Y production

R. Vogt, hep-ph/0205330

Soft Physics

Important changes compared to lower energies are expected

- very different evolution with time
  much larger volume & longer lifetime
- Is the QGP a ‘perfect liquid’ ?
  - large flow (v_2) discovered at RHIC
  - theory predicts it will saturate with energy
  - extrapolation of data suggests continued rise ?



Conclusions

With the first collision data (1-100 pb^{-1}) at 14 TeV

Understand detector performance in situ in the LHC environment,
and perform first physics measurements:

- Measure particle multiplicity in minimum bias (a few hours of data taking ...)
- Measure QCD jet cross-section to ~ 30% ?
  (Expect $>10^3$ events with E_T (j) > 1 TeV with 100 pb^{-1})
- Measure W, Z cross-sections to 10% with 100 pb^{-1}?
- Observe a top signal with ~ 30 pb^{-1}
- Measure tt cross-section to 20% and m(top) to 7-10 GeV with 100 pb^{-1} ?
- Improve knowledge of PDF (low-x gluons !) with W/Z with O(100) pb^{-1} ?
- First tuning of MC (minimum-bias, underlying event, tt, W/Z+jets, QCD jets,...)

And, more ambitiously:

- Discover SUSY up to gluino masses of ~ 1.3 TeV ?
- Discover a Z‘ up to masses of ~ 1.3 TeV ?
- Surprises ?

Conclusions

And, later on ....

The LHC will explore in detail the highly-motivated TeV-scale with a direct discovery potential up to m ≈ 5-6 TeV

→ if New Physics is there, the LHC will find it

→ it will say the final word about the SM Higgs mechanism and many TeV-scale predictions

→ it may add crucial pieces to our knowledge of fundamental physics → impact also on astroparticle physics and cosmology

→ most importantly: it will likely tell us which are the right questions to ask, and how to go on