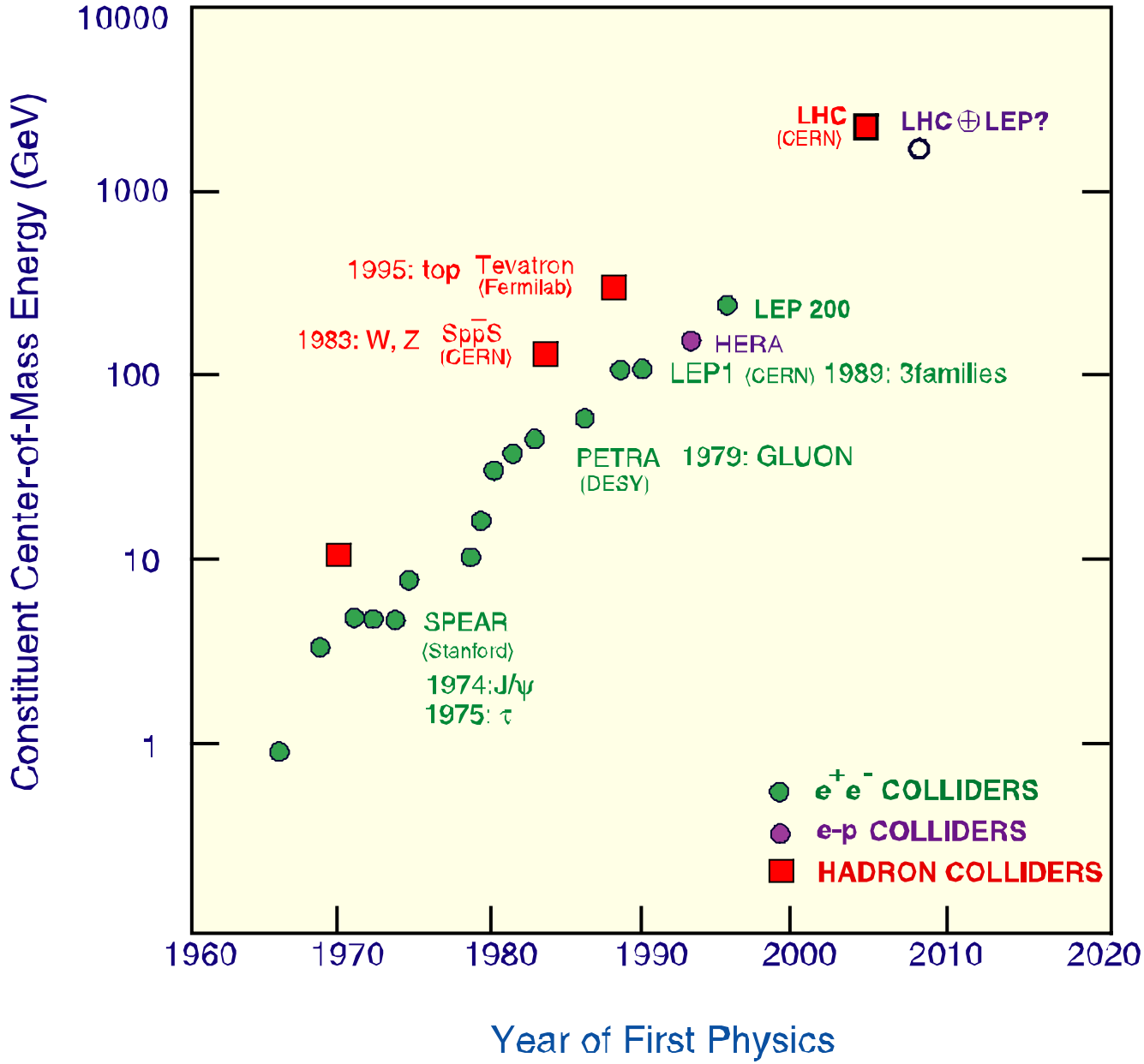

Constituent Center-of-Mass Energy (GeV)
10000
1000
100
10
1
1960
1970
1980
1990
2000
2010
2020
Year of First Physics
LHC
(CERN)
LHC ⊕ LEP?
1995: top Tevatron
(Fermilab)
LEP 200
1983: W, Z SppS
(CERN)
HERA
LEP1 (CERN) 1989: 3families
PETRA 1979: GLUON
(DESY)
SPEAR
(Stanford)
1974: J/ψ
1975: τ
e+e- COLLIDERS
e-p COLLIDERS
HADRON COLLIDERS

Fig.1

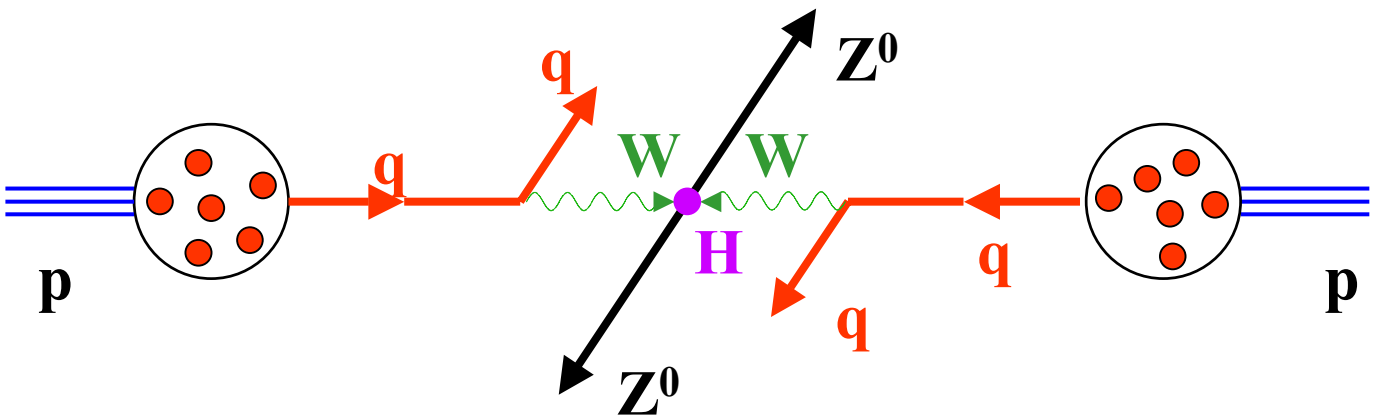


Fig.2

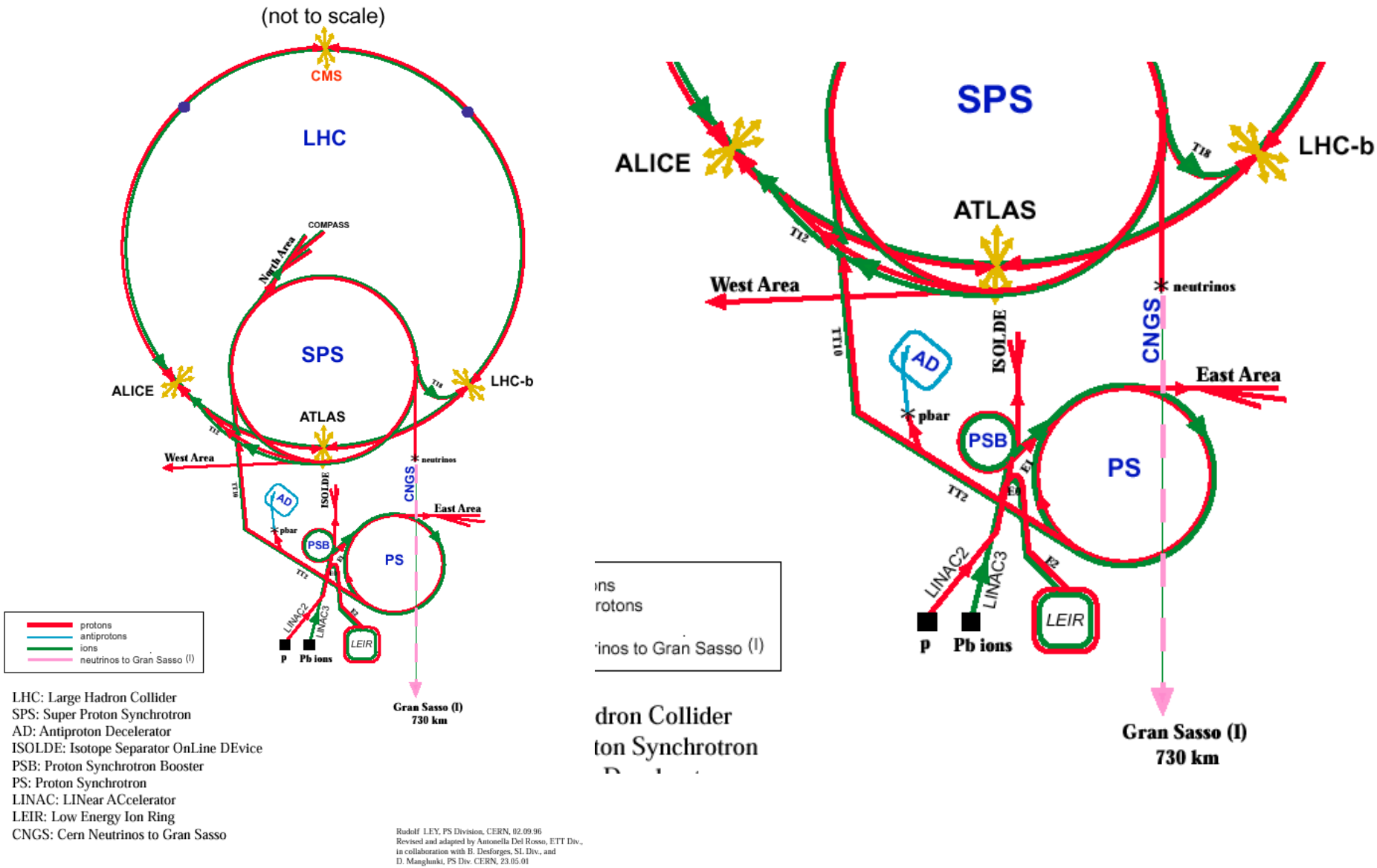

(not to scale)
CMS
LHC
COMPASS
North Area
SPS
ALICE
ATLAS
LHC-b
West Area
neutrinos
CNGS
ISOLDE
AD
pbar
East Area
PSB
PS
LINAC2
LINAC3
LEIR
p
Pb ions
Gran Sasso (I)
730 km
protons
antiprotons
ions
neutrinos to Gran Sasso (I)
LHC: Large Hadron Collider
SPS: Super Proton Synchrotron
AD: Antiproton Decelerator
ISOLDE: Isotope Separator OnLine DEvice
PSB: Proton Synchrotron Booster
PS: Proton Synchrotron
LINAC: LINear ACcelerator
LEIR: Low Energy Ion Ring
CNGS: Cern Neutrinos to Gran Sasso
Rudolf LEY, PS Division, CERN, 02.09.96
Revised and adapted by Antonella Del Rosso, ETT Div.,
in collaboration with B. Desforges, SL Div., and
D. Manglunki, PS Div. CERN, 23.05.01

Fig.3

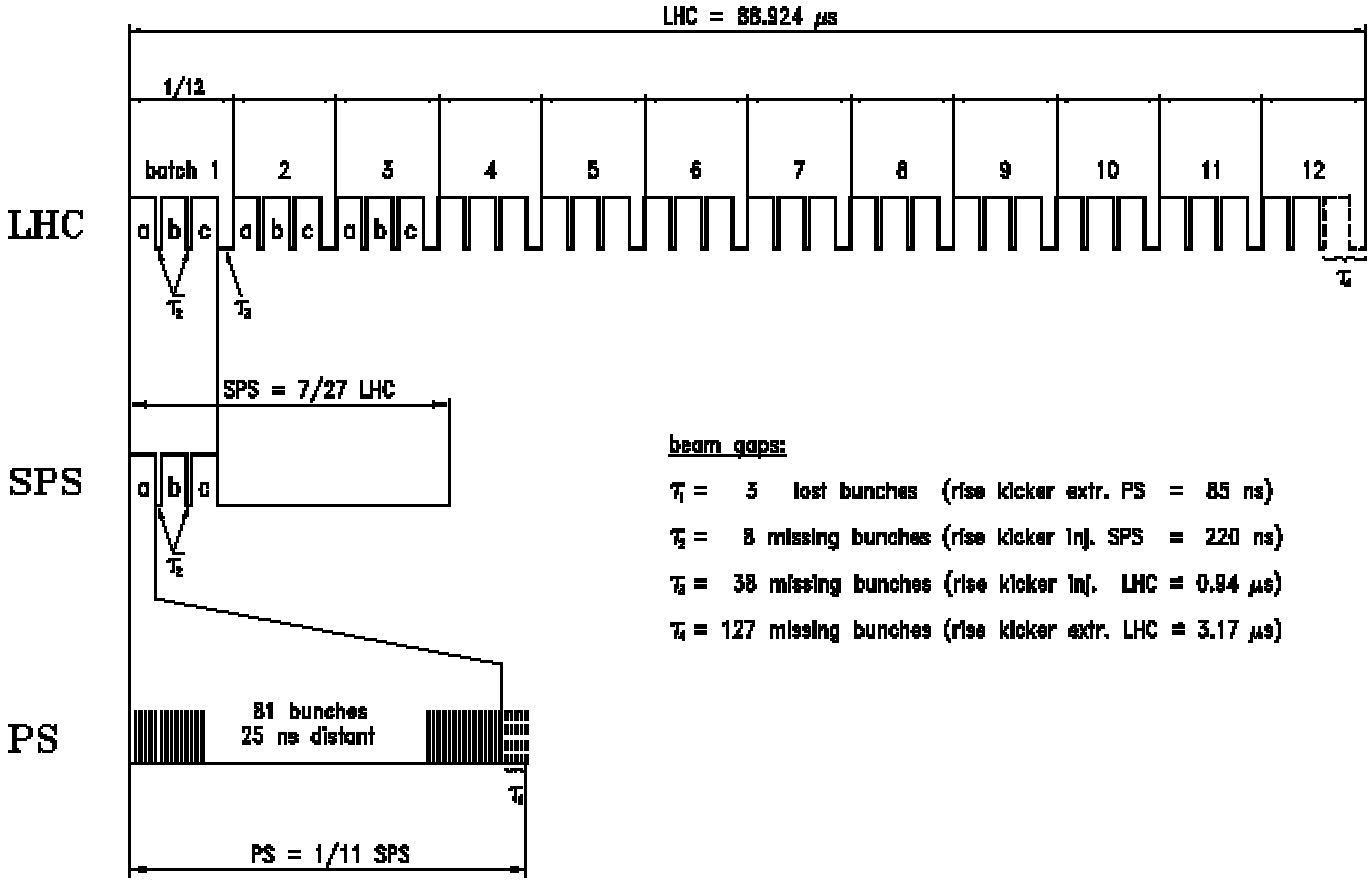

LHC = 88.924 μs
1/12
batch 1
2
3
4
5
6
7
8
9
10
11
12
LHC
a
b
c
SPS = 7/27 LHC
SPS
PS
81 bunches
25 ns distant
PS = 1/11 SPS
beam gaps:
τ1 = 5 lost bunches (rise kicker extr. PS = 85 ns)
τ2 = 8 missing bunches (rise kicker inj. SPS = 220 ns)
τ3 = 38 missing bunches (rise kicker inj. LHC = 0.94 μs)
τ4 = 127 missing bunches (rise kicker extr. LHC = 3.17 μs)

Fig.4

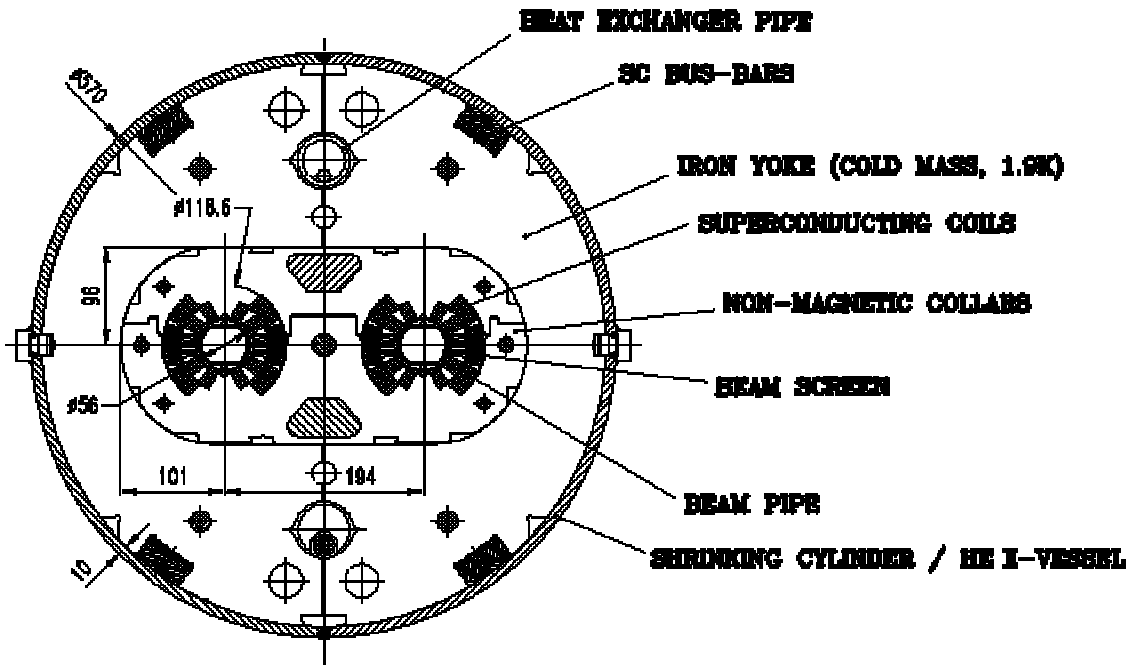

HEAT EXCHANGER PIPE
SC BUS-BARS
IRON YOKE (COLD MASS, 1.9K)
SUPERCONDUCTING COILS
NON-MAGNETIC COLLARS
BEAM SCREEN
BEAM PIPE
SHRINKING CYLINDER / HE I-VESSEL
ø370
ø118.6
96
ø56
101
194
19

Fig.5

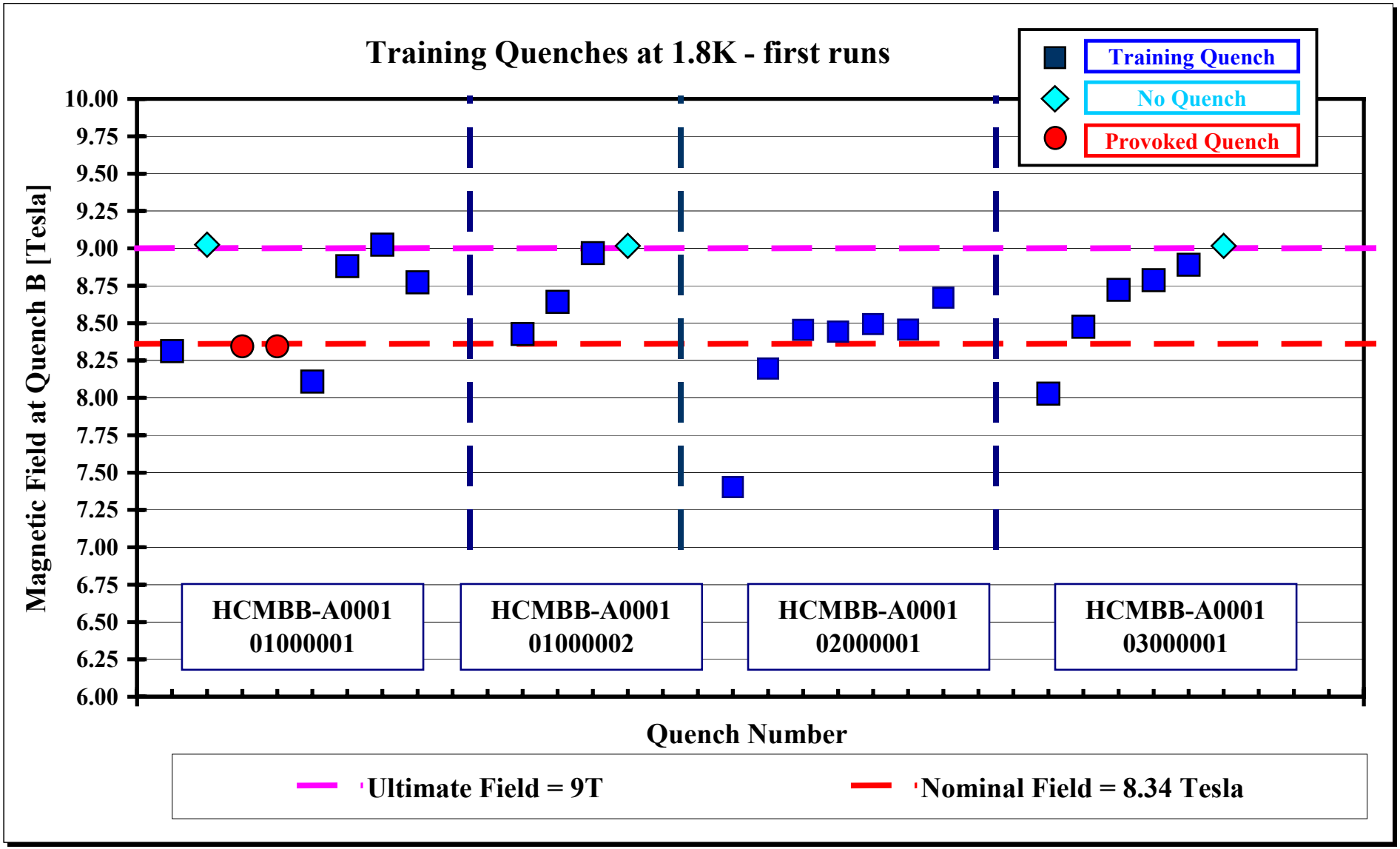

Training Quenches at 1.8K - first runs
Training Quench
No Quench
Provoked Quench
Magnetic Field at Quench B [Tesla]
10.00
9.75
9.50
9.25
9.00
8.75
8.50
8.25
8.00
7.75
7.50
7.25
7.00
6.75
6.50
6.25
6.00
HCMBB-A0001 01000001
HCMBB-A0001 01000002
HCMBB-A0001 02000001
HCMBB-A0001 03000001
Quench Number
Ultimate Field = 9T
Nominal Field = 8.34 Tesla

Fig.6

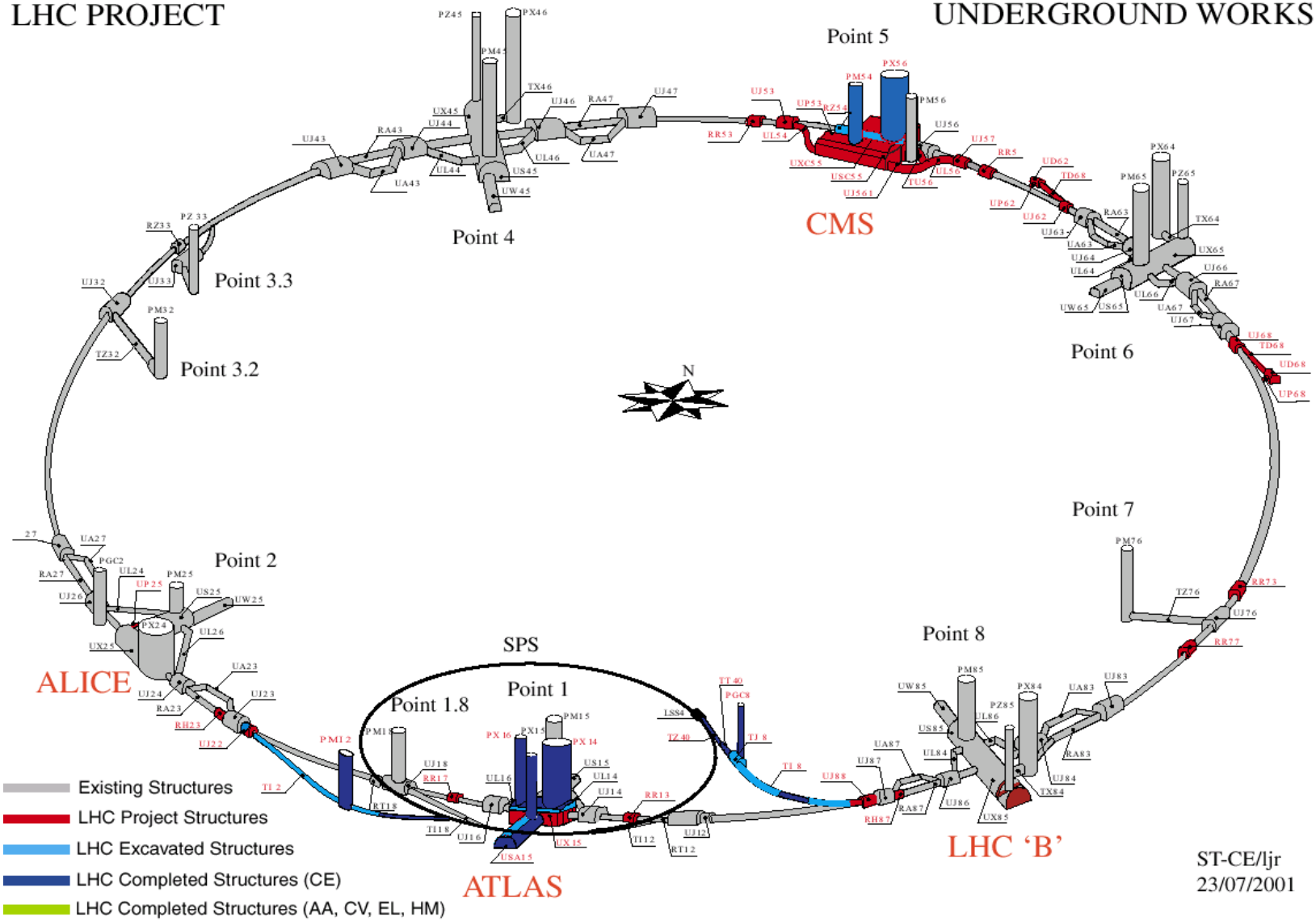
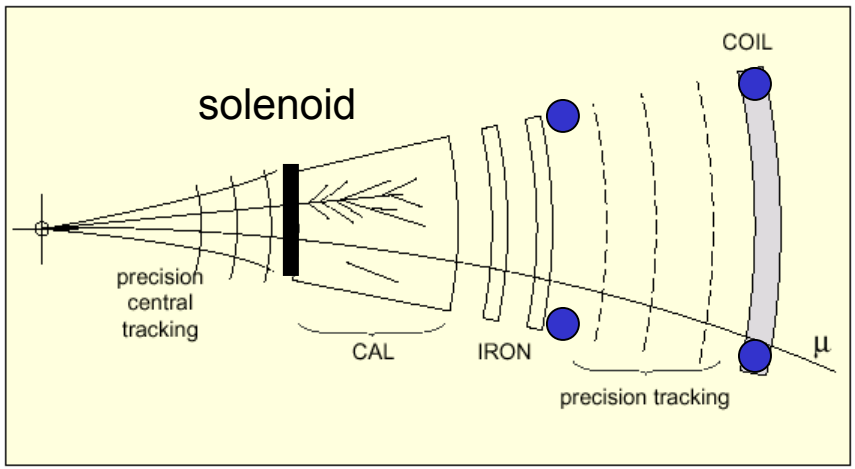
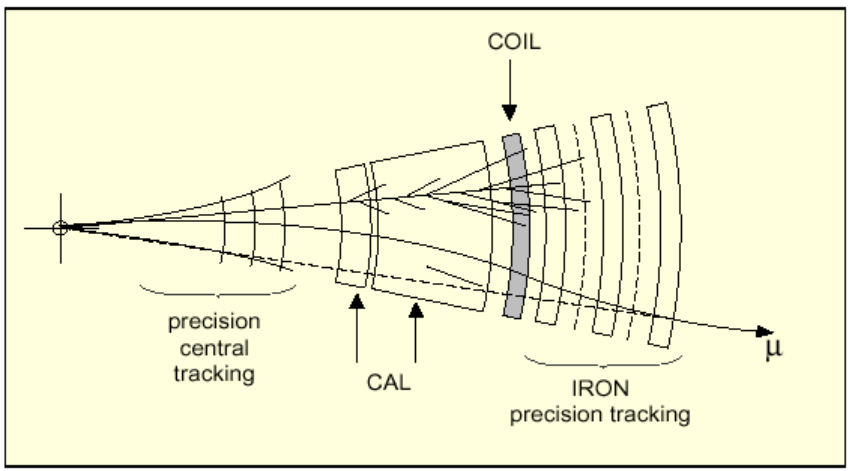

LHC PROJECT
UNDERGROUND WORKS
Point 5
CMS
Point 4
Point 3.3
Point 3.2
Point 6
Point 7
Point 8
Point 2
ALICE
SPS
Point 1
Point 1.8
ATLAS
LHC 'B'
N
Existing Structures
LHC Project Structures
LHC Excavated Structures
LHC Completed Structures (CE)
LHC Completed Structures (AA, CV, EL, HM)
ST-CE/ljr
23/07/2001

Fig.7



ATLAS



CMS

Fig.8

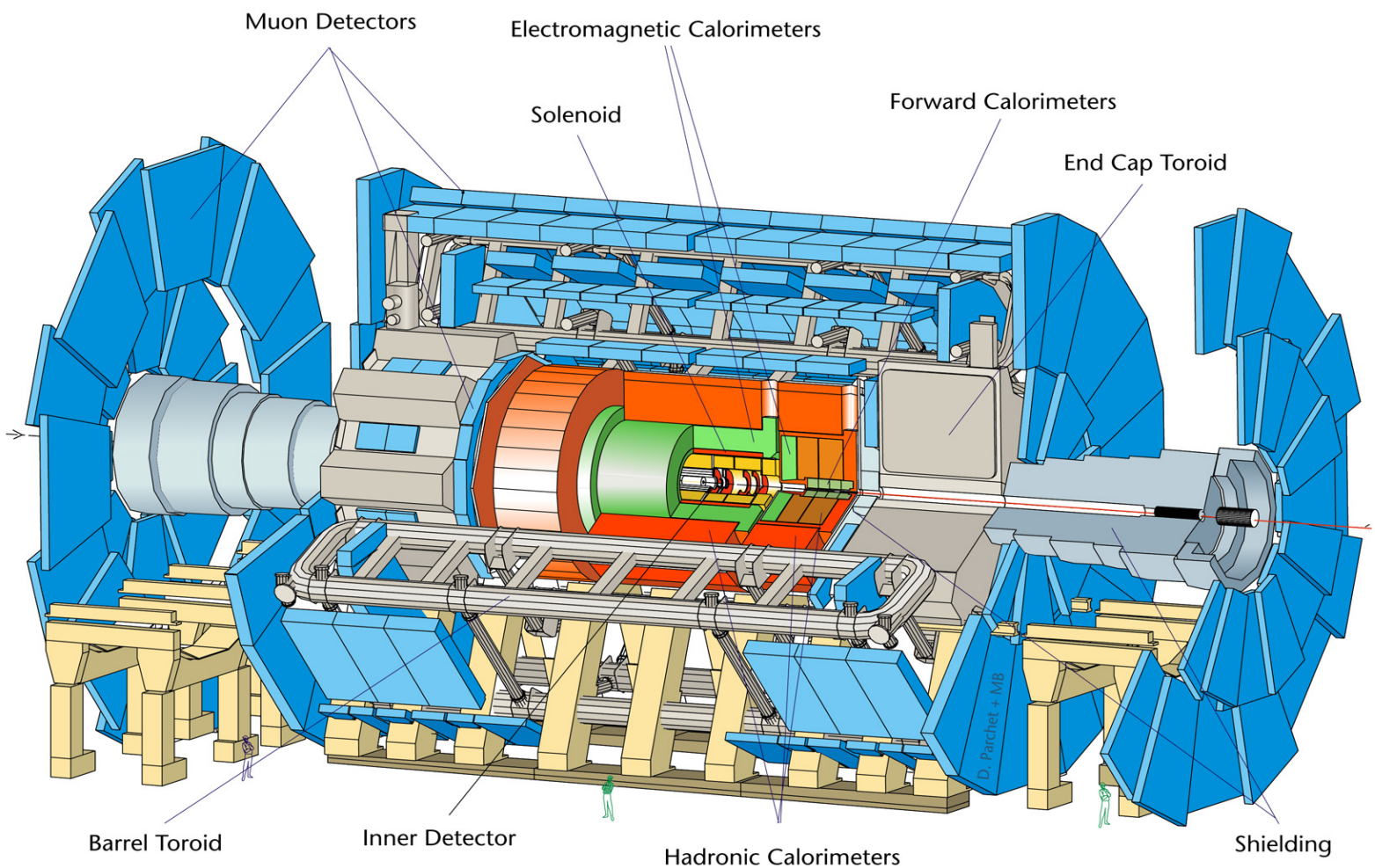

D712/mb-26/06/97
Muon Detectors
Electromagnetic Calorimeters
Solenoid
Forward Calorimeters
End Cap Toroid
Barrel Toroid
Inner Detector
Hadronic Calorimeters
Shielding
D. Parchet + MB

Fig.9

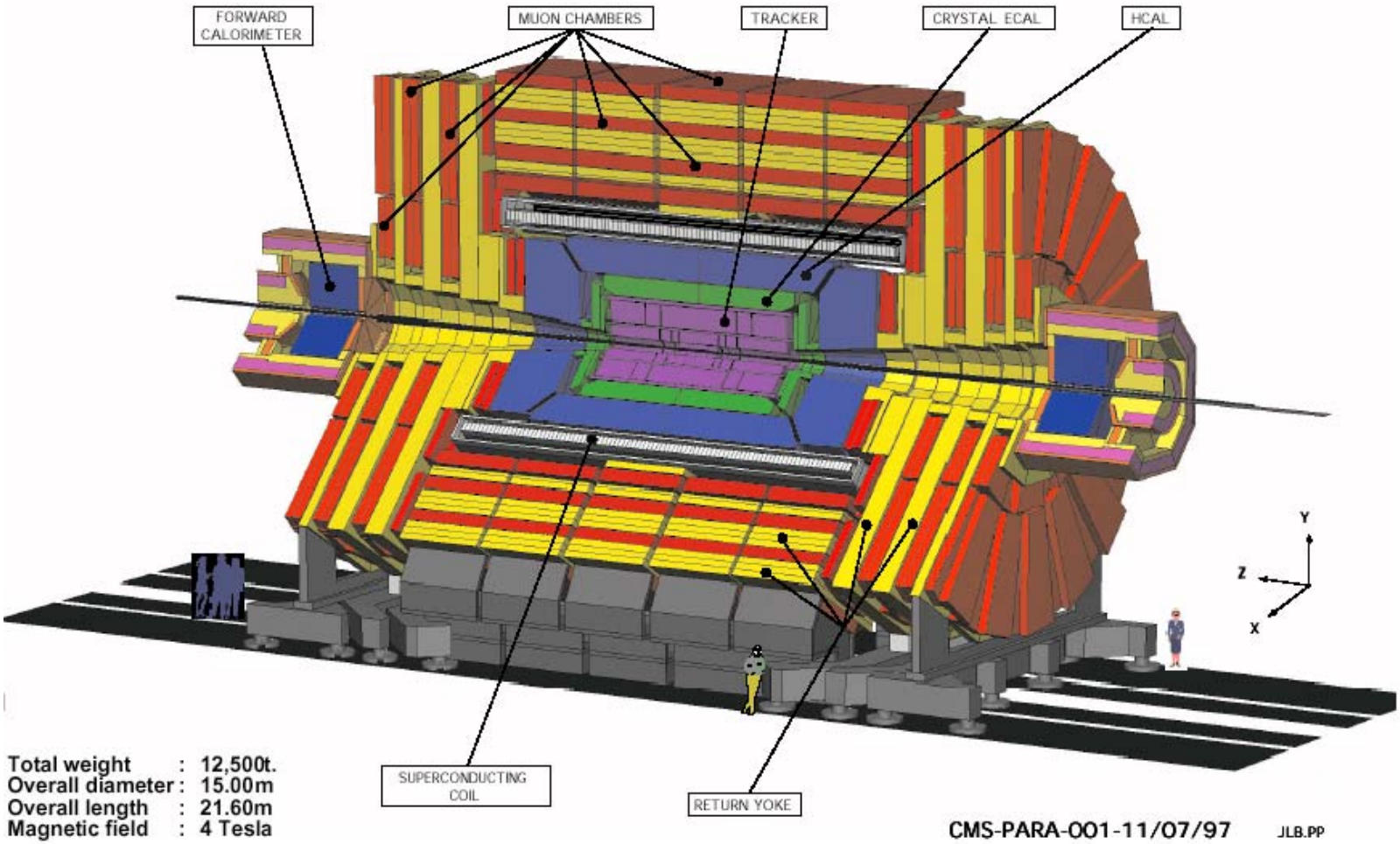

CMS
A Compact Solenoidal Detector for LHC
FORWARD CALORIMETER
MUON CHAMBERS
TRACKER
CRYSTAL ECAL
HCAL
Y
Z
X
Total weight : 12,500t.
Overall diameter : 15.00m
Overall length : 21.60m
Magnetic field : 4 Tesla
SUPERCONDUCTING COIL
RETURN YOKE
CMS-PARA-001-11/07/97
JLB.PP

Fig.10

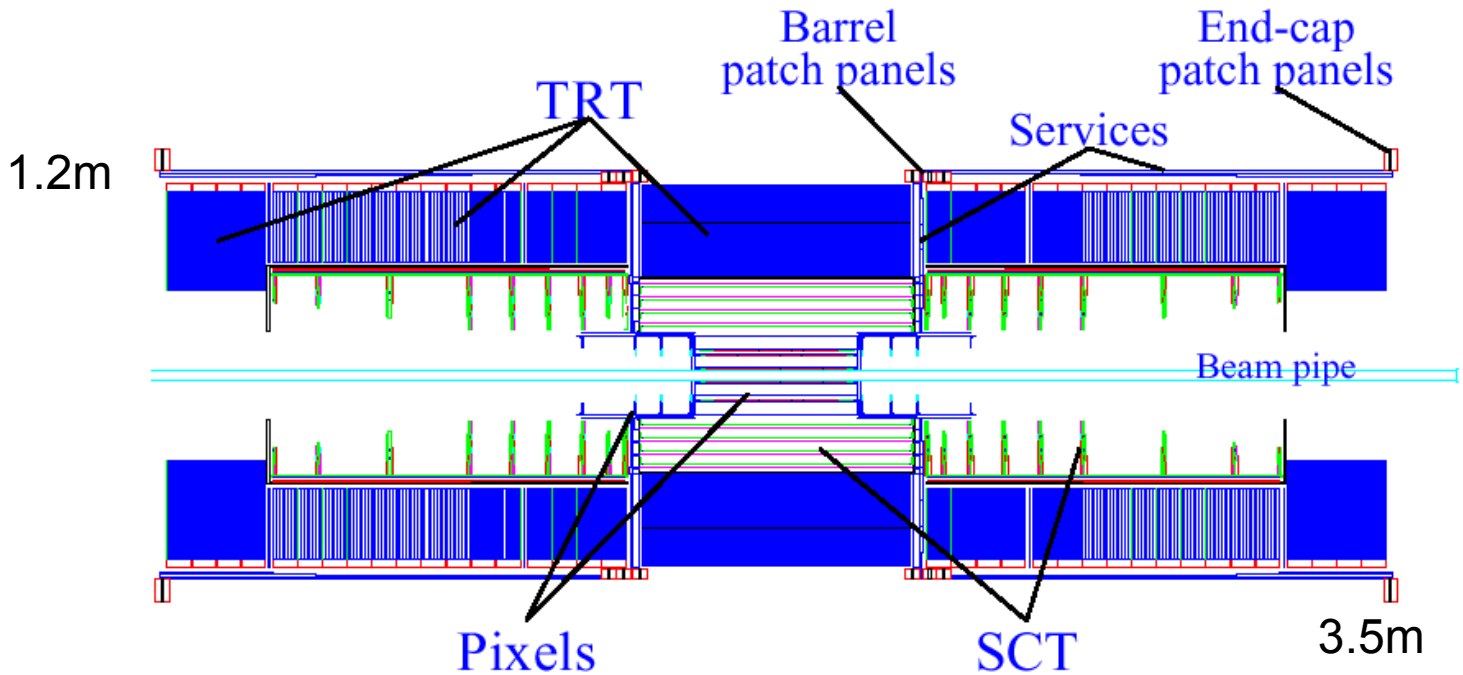

Barrel
patch panels
End-cap
patch panels
TRT
Services
1.2m
Beam pipe
Pixels
SCT
3.5m

Fig.11

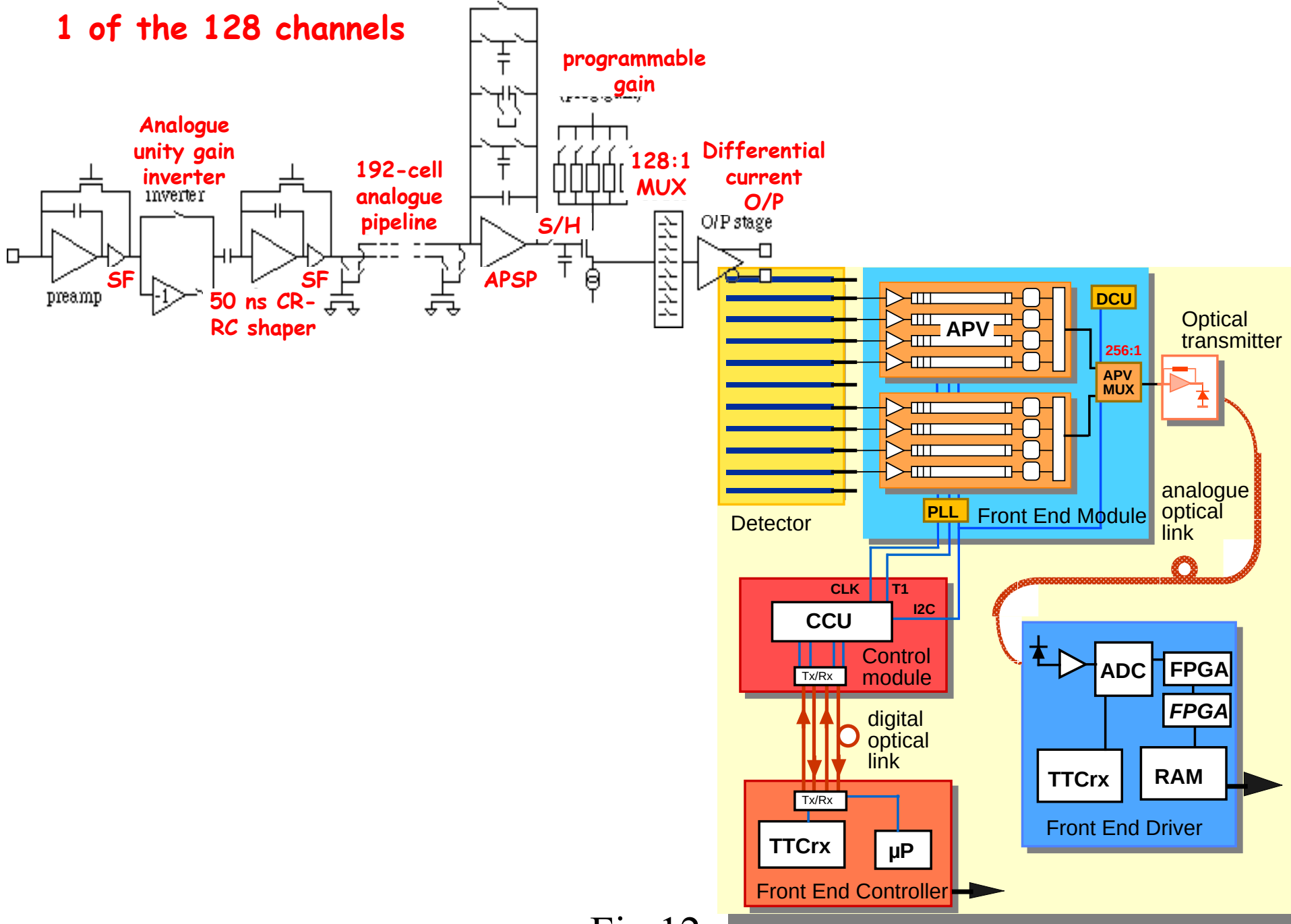
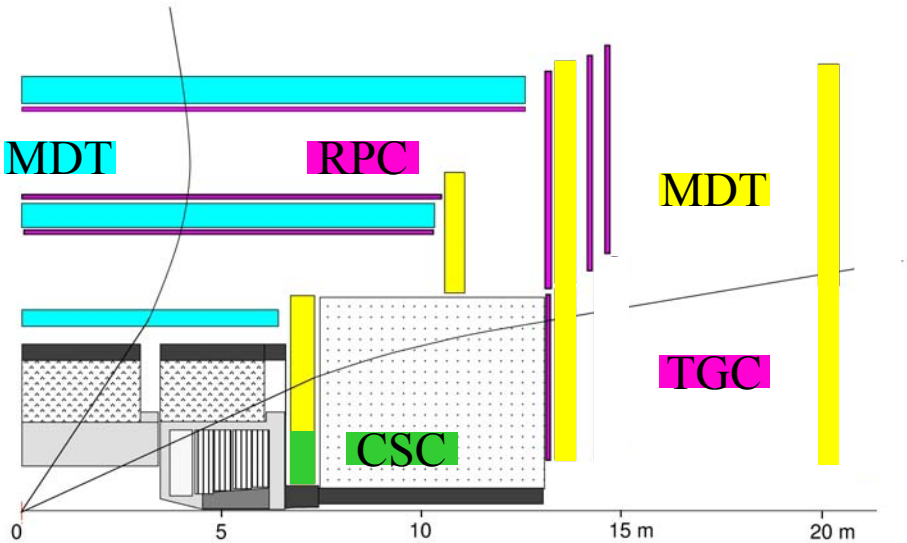

1 of the 128 channels
programmable gain
Analogue unity gain inverter
inverter
192-cell analogue pipeline
128:1 MUX
Differential current O/P
S/H
O/P stage
preamp
SF
-1
50 ns CR-RC shaper
SF
APSP
APV
DCU
256:1
APV MUX
Optical transmitter
Detector
PLL
Front End Module
analogue optical link
CLK
T1
I2C
CCU
Control module
Tx/Rx
digital optical link
ADC
FPGA
FPGA
TTCrx
RAM
Front End Driver
Tx/Rx
TTCrx
µP
Front End Controller

Fig.12



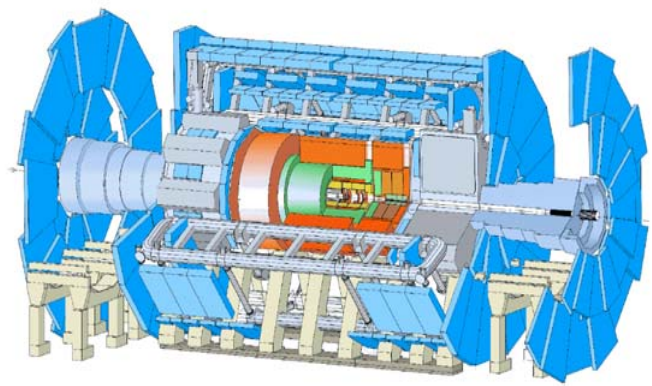
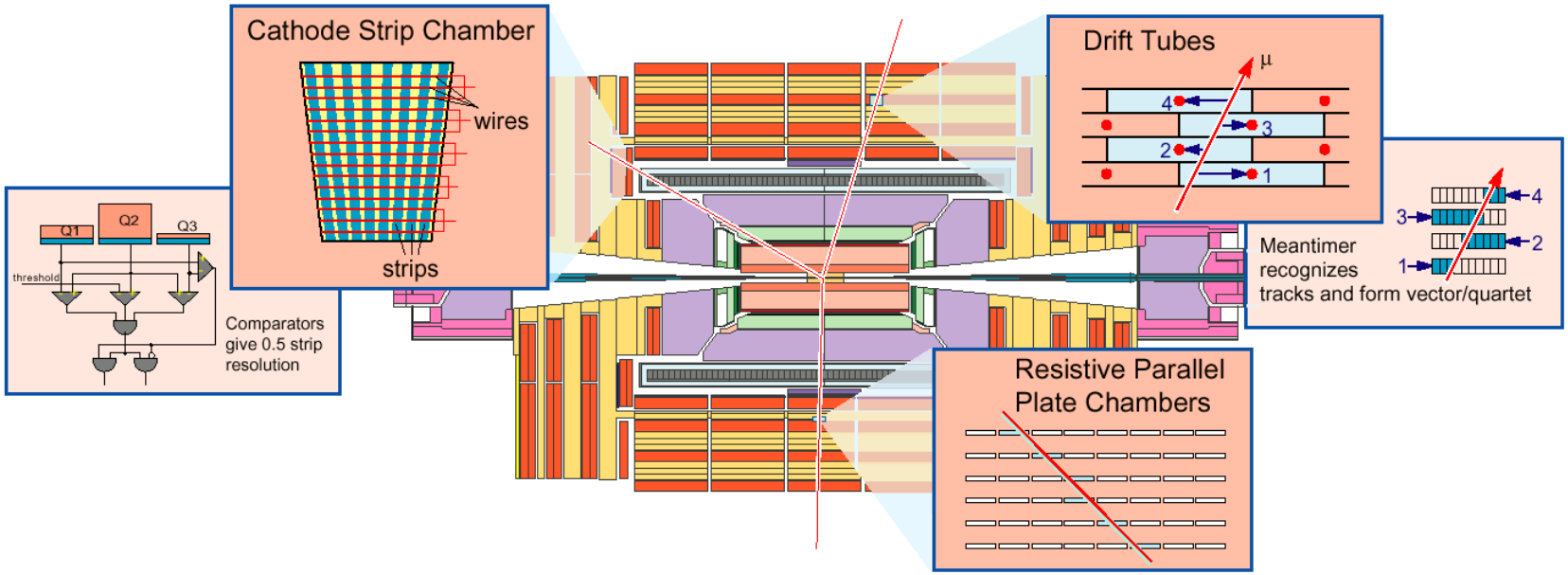
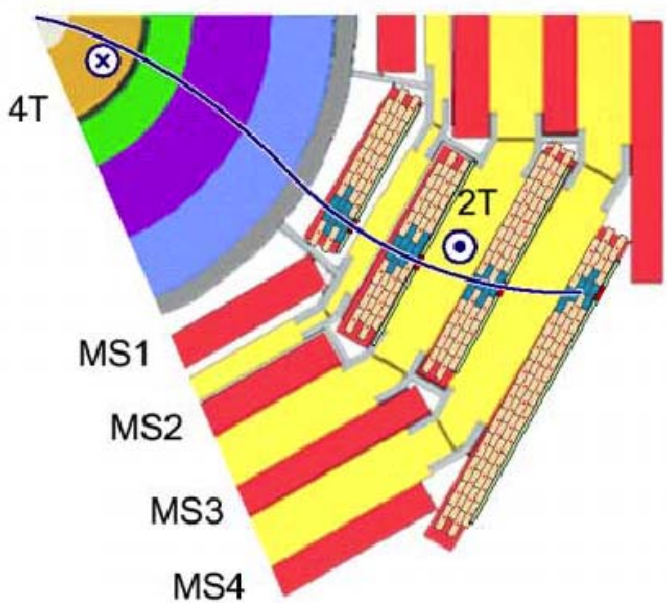


Fig.13





4 Muon Stations
redundancy
acceptance

Per Station
barrel – 12 measuring planes
endcap – 6 measuring planes

Measurement Accuracy
position 70 – 100 μm /station
direction ~ 1 mrad

Fig.14

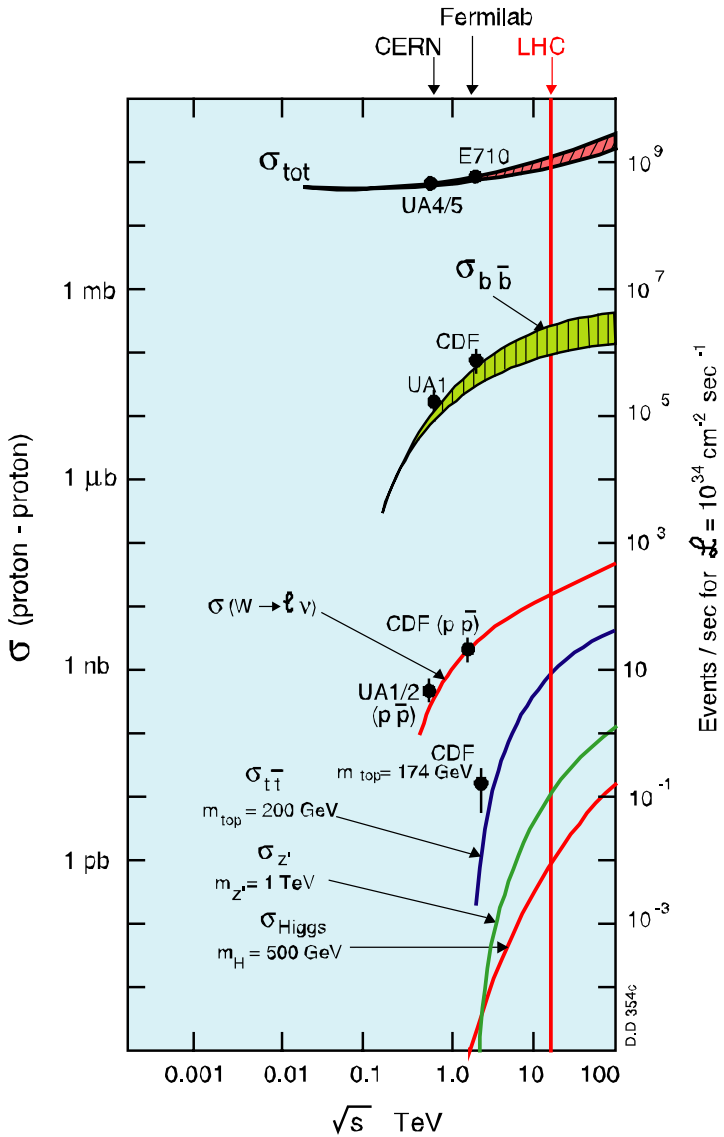
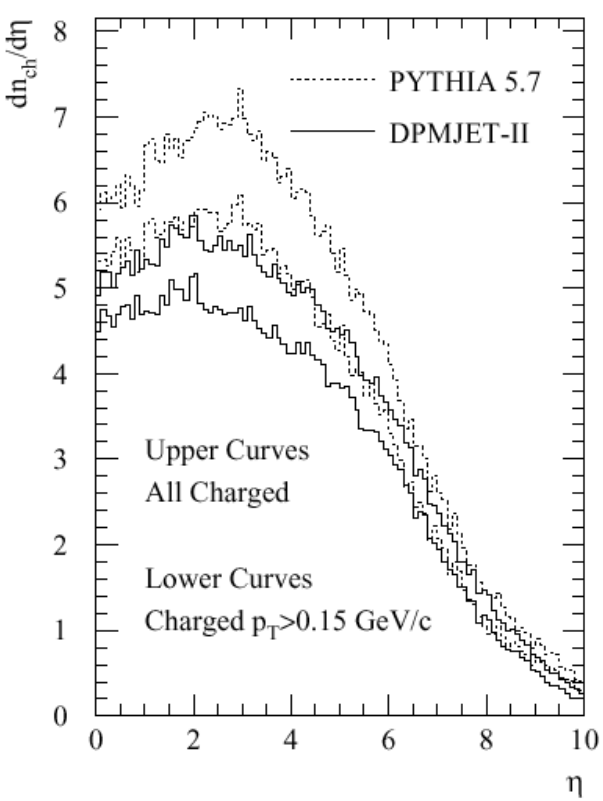
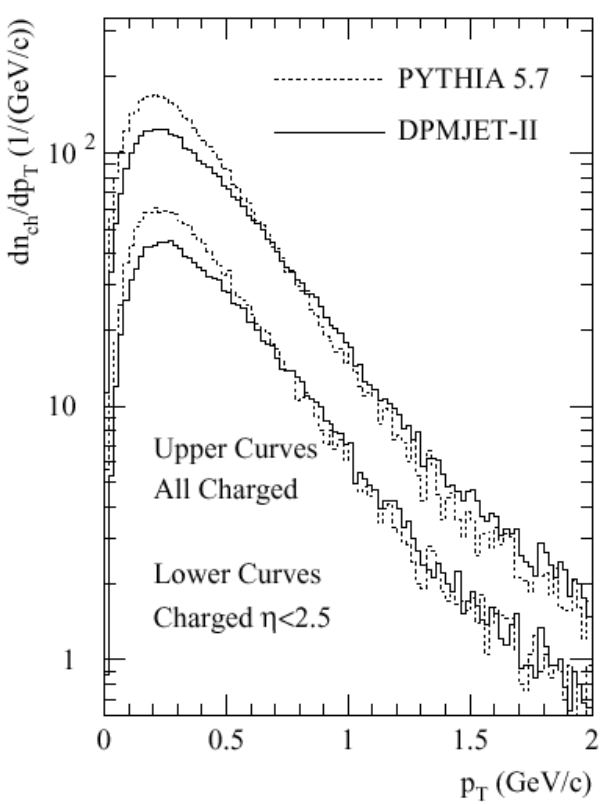

Fermilab
CERN
LHC
σ tot
E710
UA4/5
σ b b̄
CDF
UA1
σ (W → ℓ ν)
CDF (p p̄)
UA1/2
(p p̄)
σ t t̄
m top = 200 GeV
CDF
m top = 174 GeV
σ Z'
m Z' = 1 TeV
σ Higgs
m H = 500 GeV
1 mb
1 μb
1 nb
1 pb
σ (proton - proton)
10 9
10 7
10 5
10 3
10
10 -1
10 -3
Events / sec for ℒ = 10 34 cm -2 sec -1
0.001
0.01
0.1
1.0
10
100
√s TeV
D.D 3546

Fig.15


$dn_{ch}/d\eta$
PYTHIA 5.7
DPMJET-II
Upper Curves
All Charged
Lower Curves
Charged p_T>0.15 GeV/c
η


dn_{ch}/dp_T (1/(GeV/c))
PYTHIA 5.7
DPMJET-II
Upper Curves
All Charged
Lower Curves
Charged η<2.5
p_T (GeV/c)

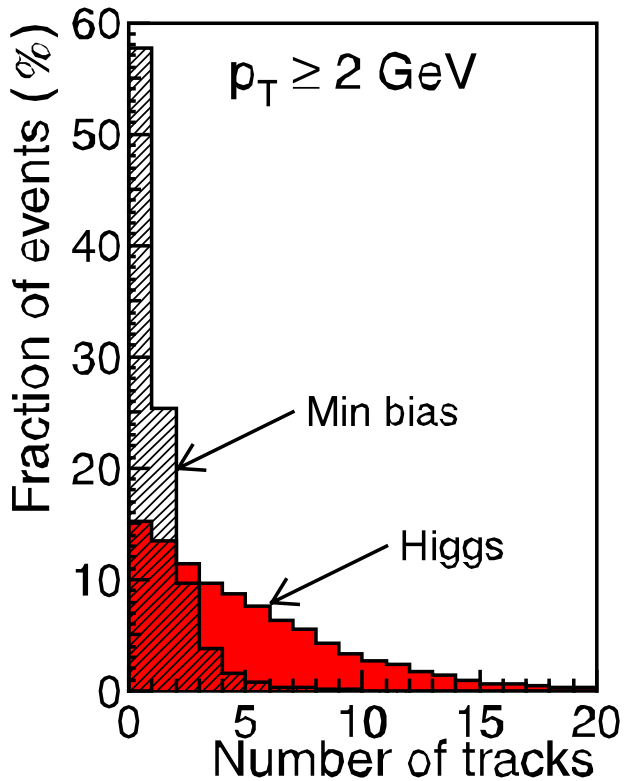

$p_T \geq 2$ GeV
Fraction of events (%)
Min bias
Higgs
Number of tracks

Fig.16

CMS: Transverse energy flow in $\Delta\eta x\Delta\phi$ ~ 0.1x0.1 at $L=10^{34}$ cm $^{-2}s^{-1}$

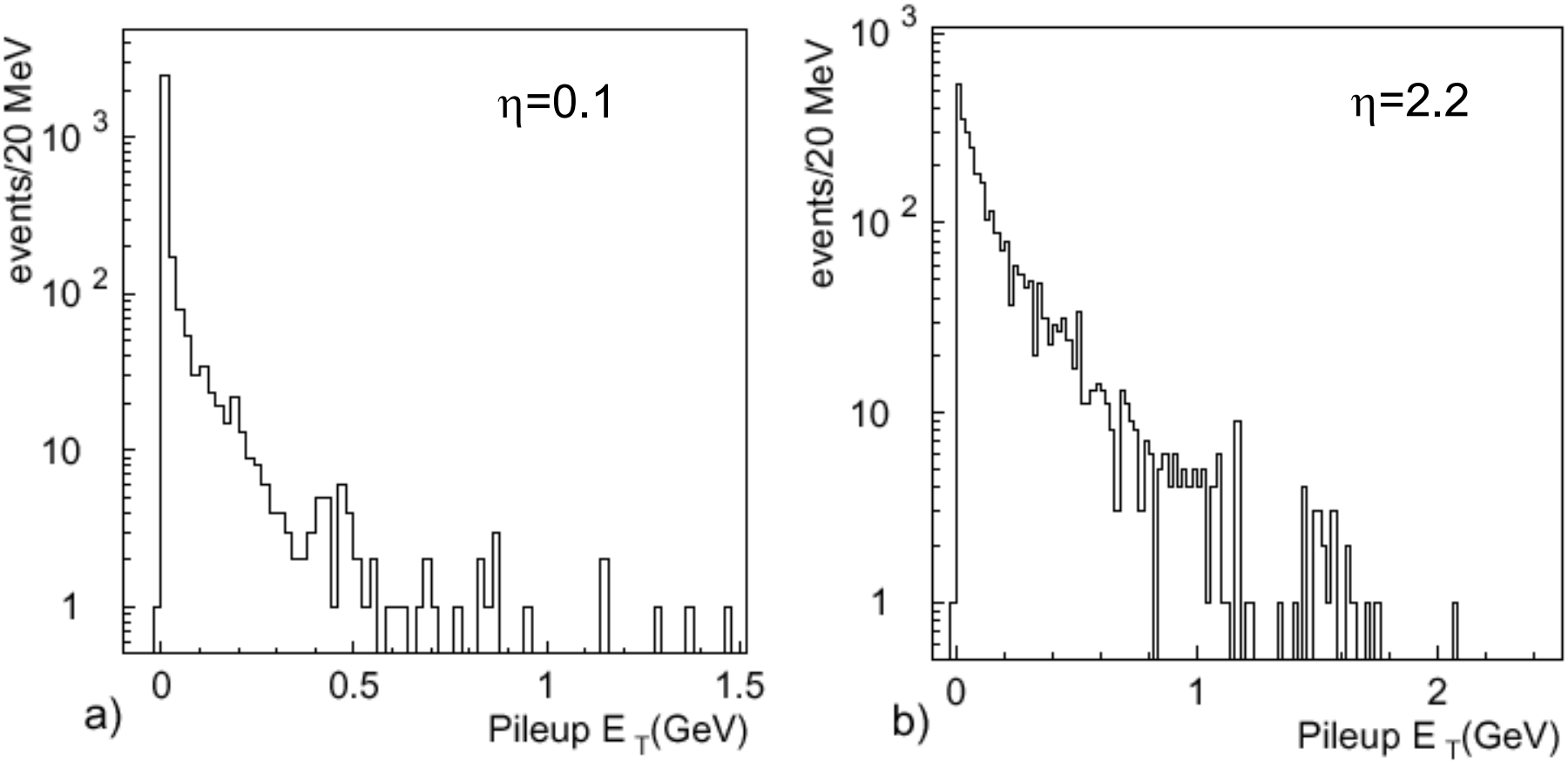
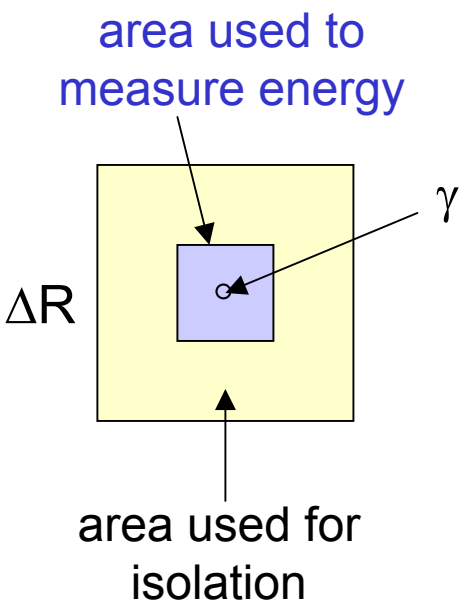
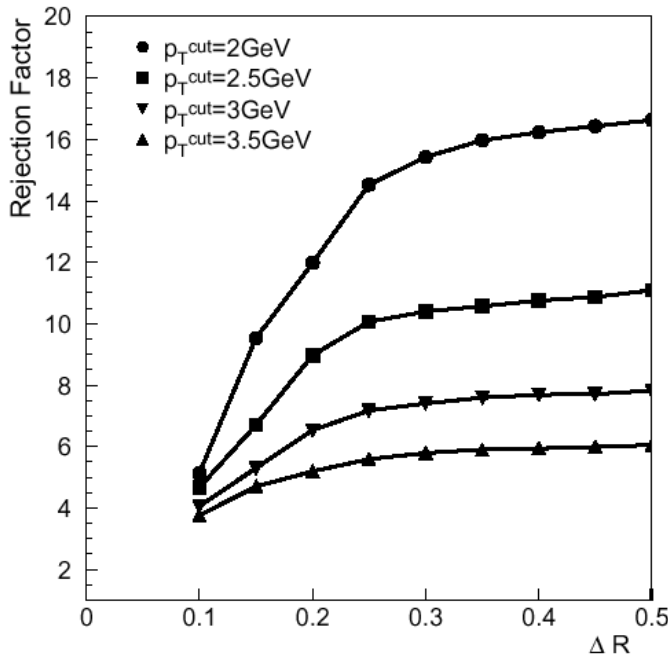


Fig.17



$\Delta R = \sqrt{(\Delta\phi^2 + \Delta\eta^2)}$

Rejection power against π^0s in jets



Loss of efficiency at Hi L for $H \rightarrow \gamma\gamma$

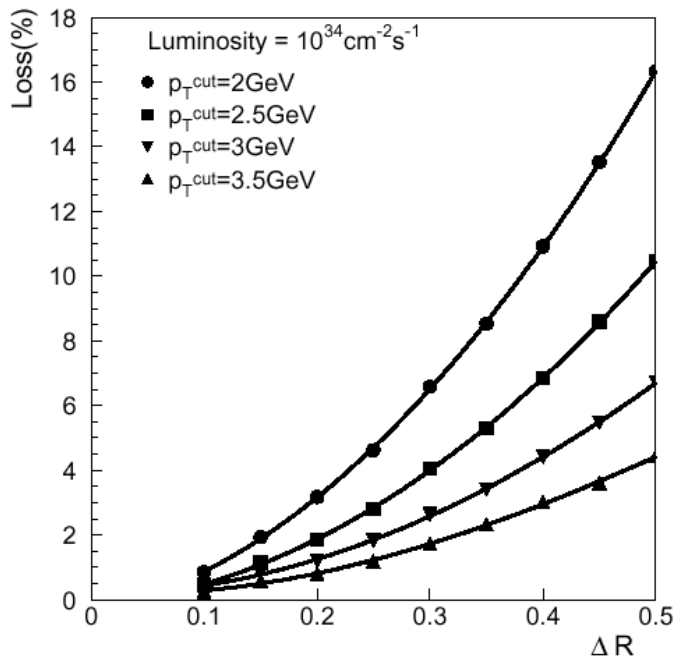


Fig.18

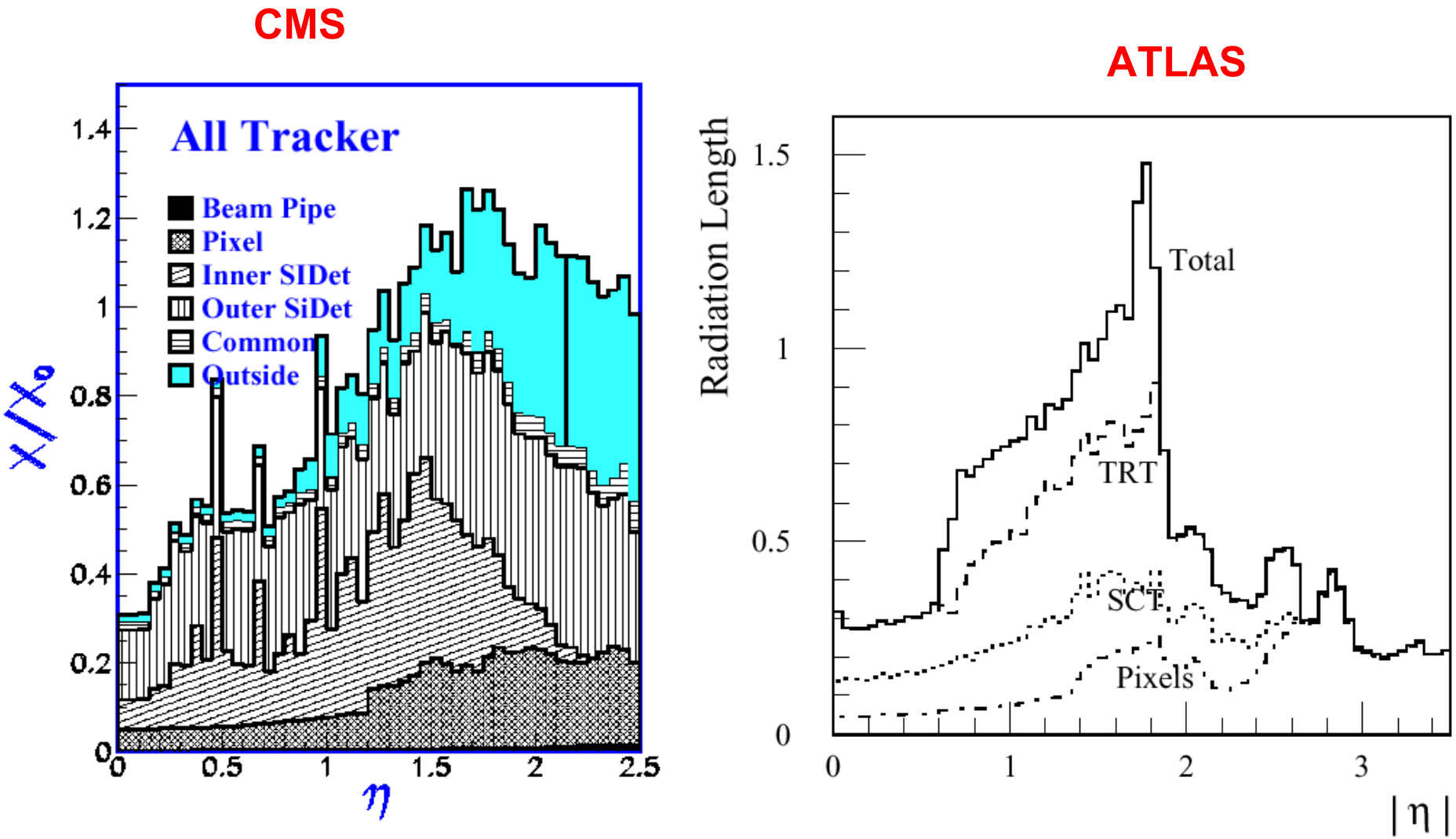

CMS
All Tracker
Beam Pipe
Pixel
Inner SIDet
Outer SiDet
Common
Outside
X/X0
η
ATLAS
Radiation Length
Total
TRT
SCT
Pixels
|η|

Fig.19

ATLAS
Pattern
Recognition
>9 precision hits
+ 2 pixel hits
+ σ_d < 1mm

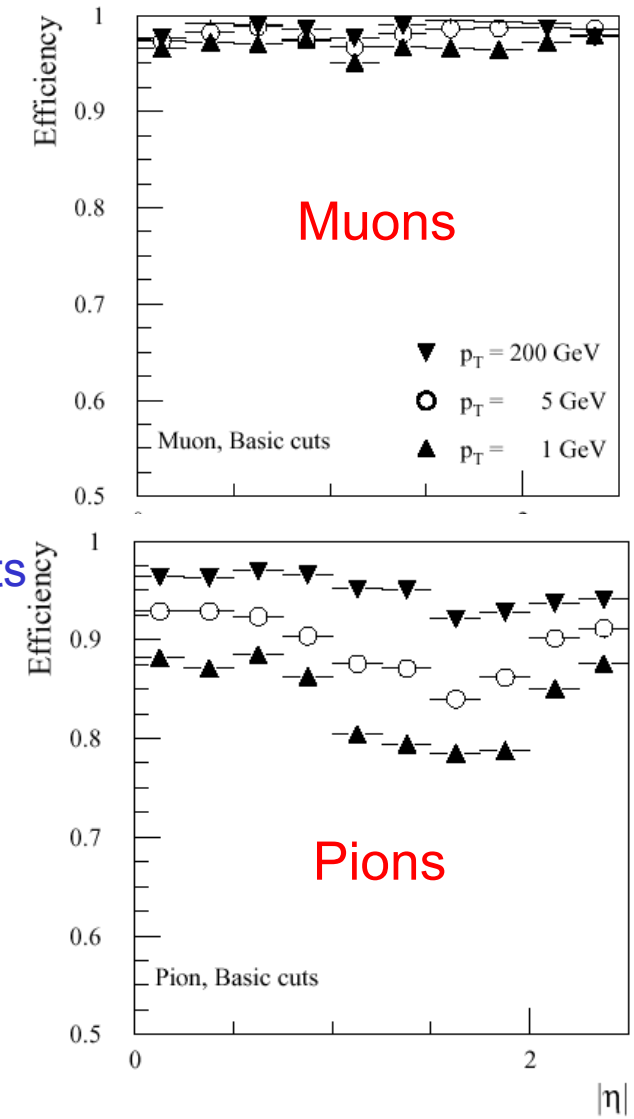


Fig.20

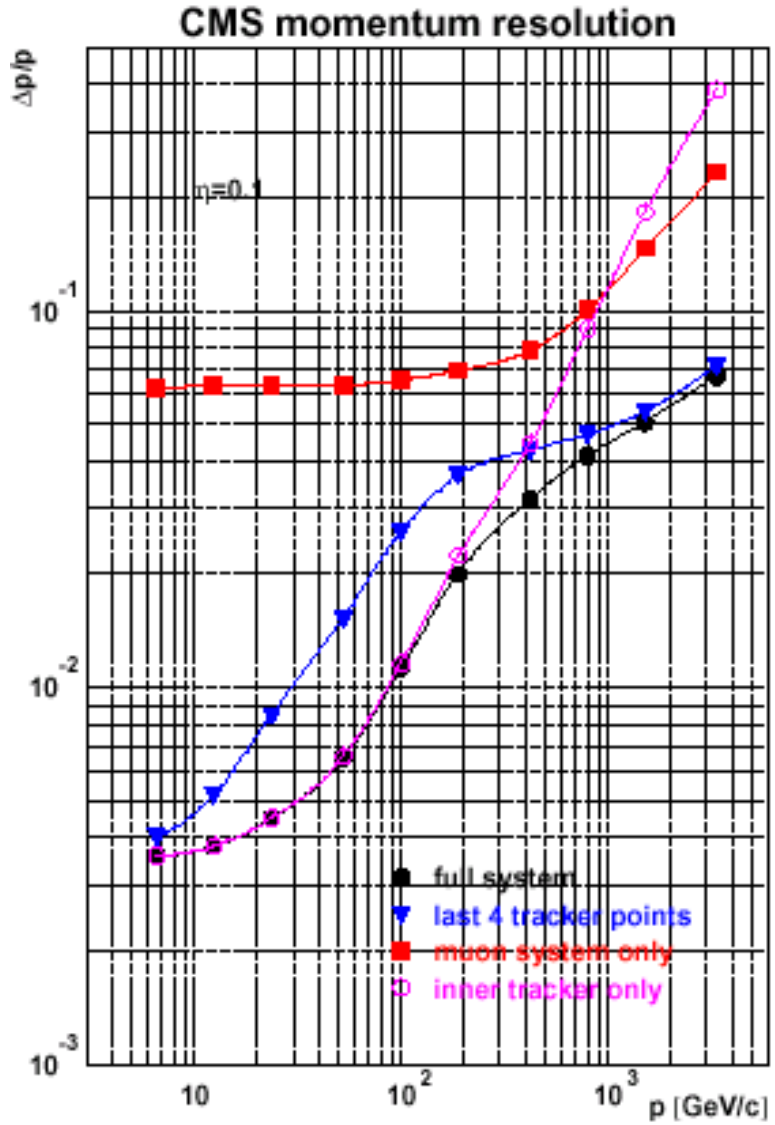

CMS momentum resolution
Δp/p
η=0.1
10^-1
10^-2
10^-3
10
10^2
10^3
p [GeV/c]
full system
last 4 tracker points
muon system only
inner tracker only

Fig.21

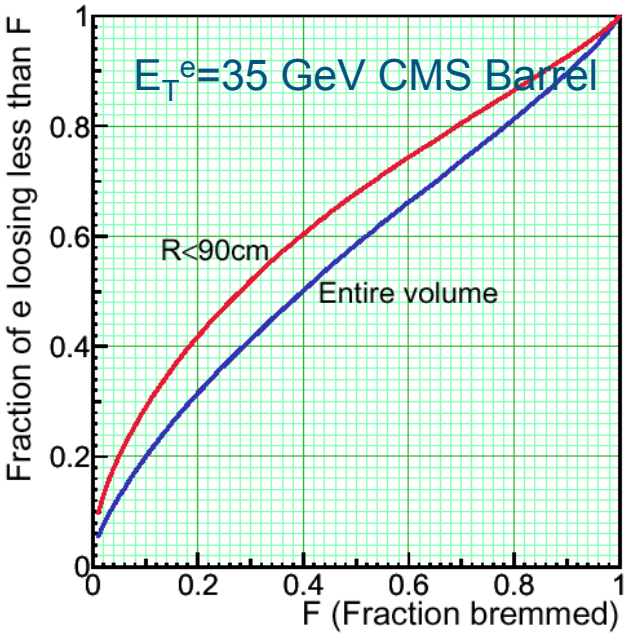
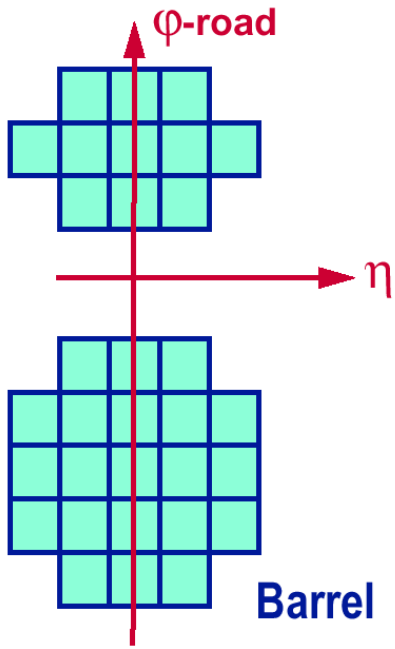


Fig.22a



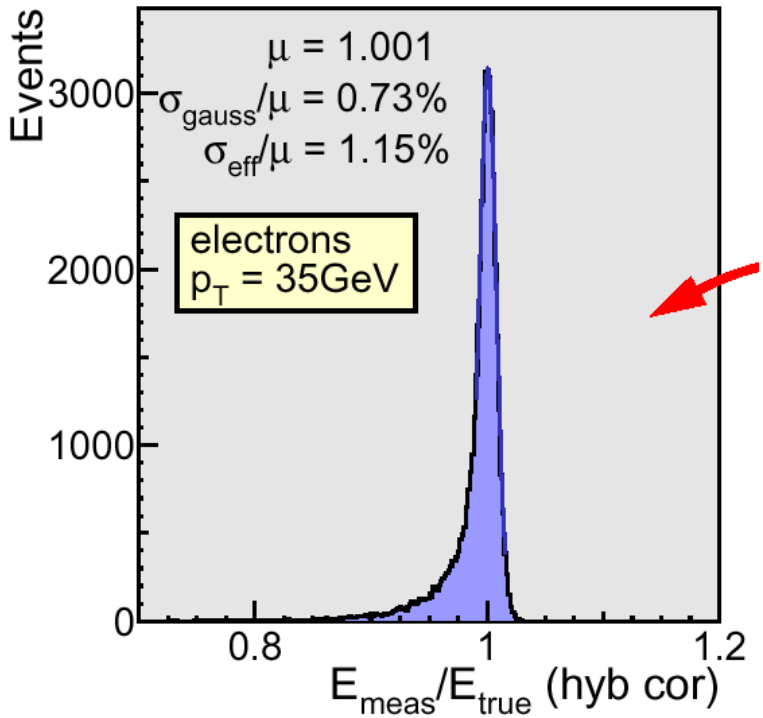
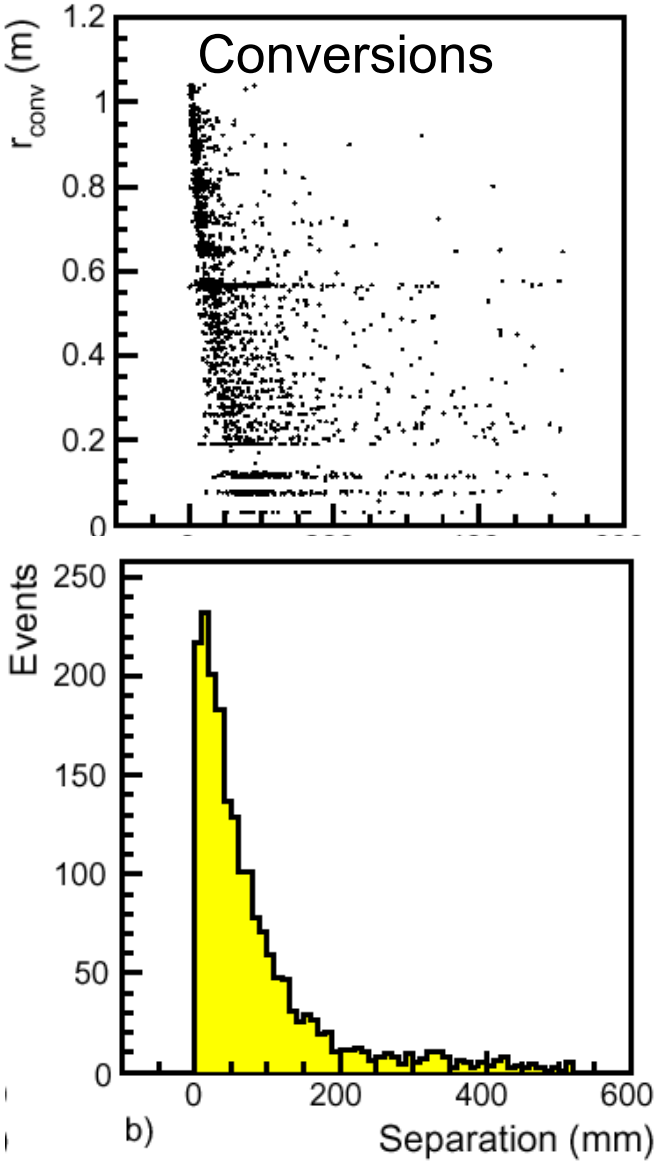


Fig.22b



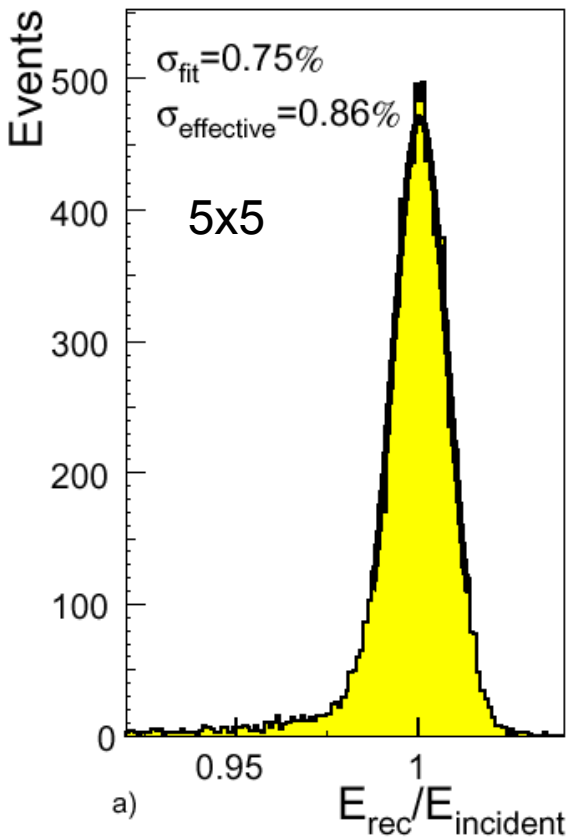
CMS Barrel

Higgs → γγ

ε_γ ~ **90%**

¼ of conversions cannot be reconstructed

Unconverted γs



Converted γs

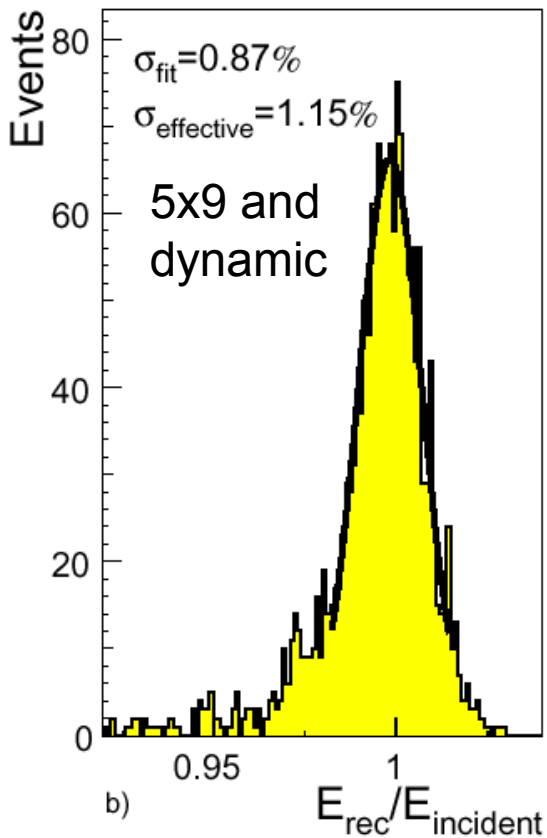
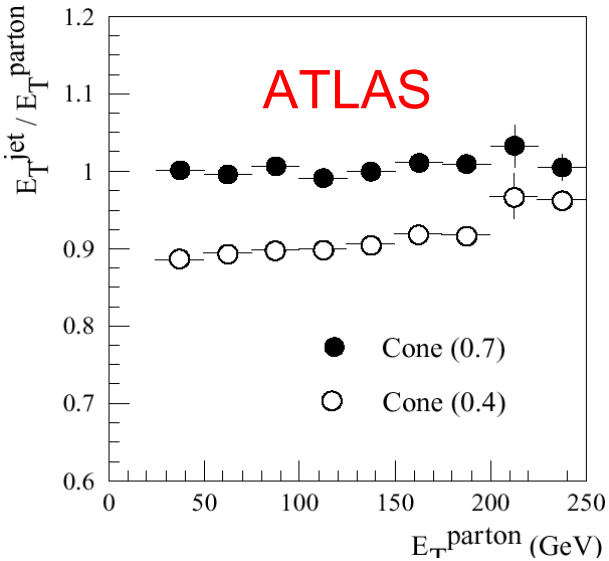
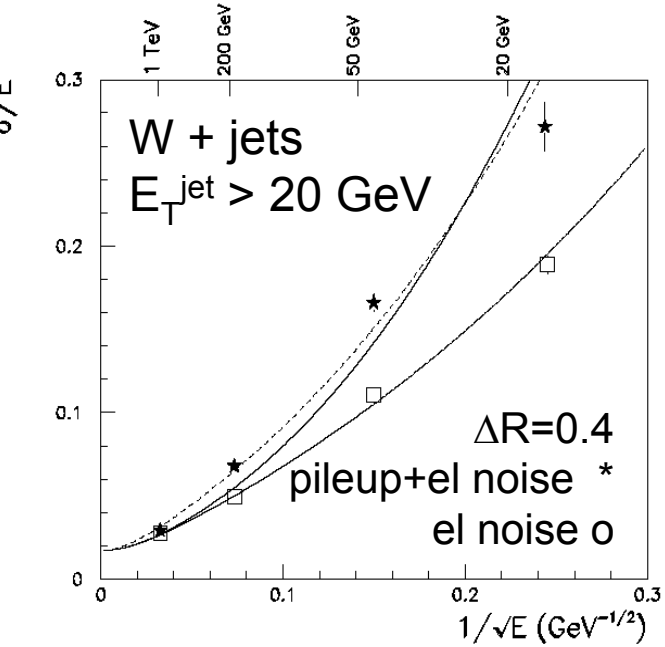


Fig.23





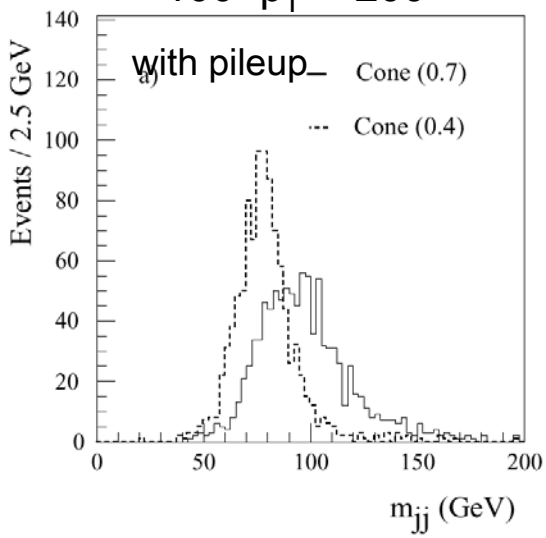
Classical 'cone' algorithm - jet built around a seed

- parameters: E_T^{seed} cut, cone opening radius ΔR

ATLAS: W → jet-jet mass resolution

p_T^W(GeV)	ΔR	σ_{LoL}	σ_{HiL} (GeV)
p_T<50	0.4	9.5	13.8
100<p_T<200	0.4	7.7	12.9
200<p_T<700	0.3	5.0	6.9

100<p_T^W<200



200<p_T^W<700

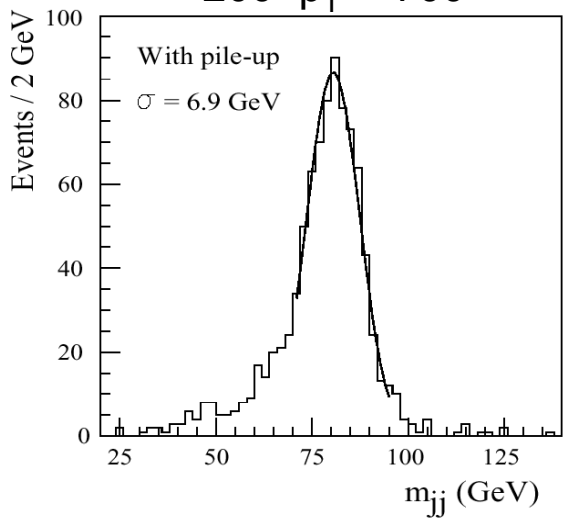


Fig.24

$A \rightarrow \tau\tau \quad m_A = 150$ GeV

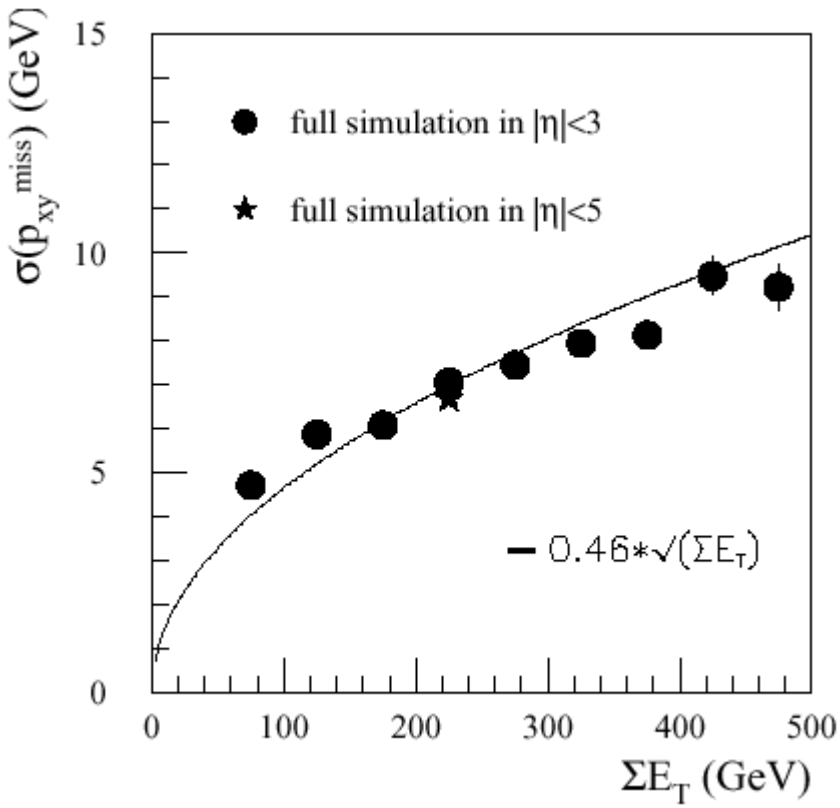


Fig.25

Cuts (ATLAS)

$E_{T\gamma 1}, E_{T\gamma 2}$ > 40, 25 GeV with $|\eta| < 2.5$

E_{H1}/E_{em}

$E_{em2}^{3x3}/ E_{em2}^{7x7}$

Shower width in η

Track Veto

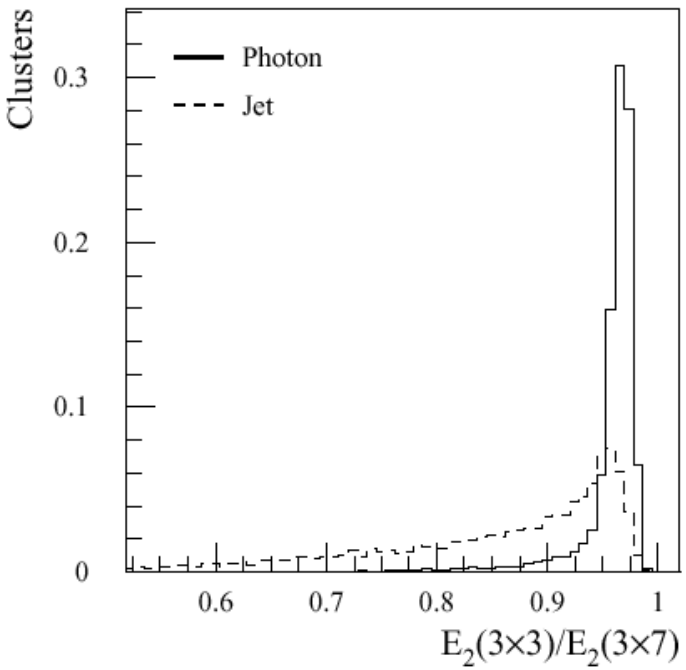
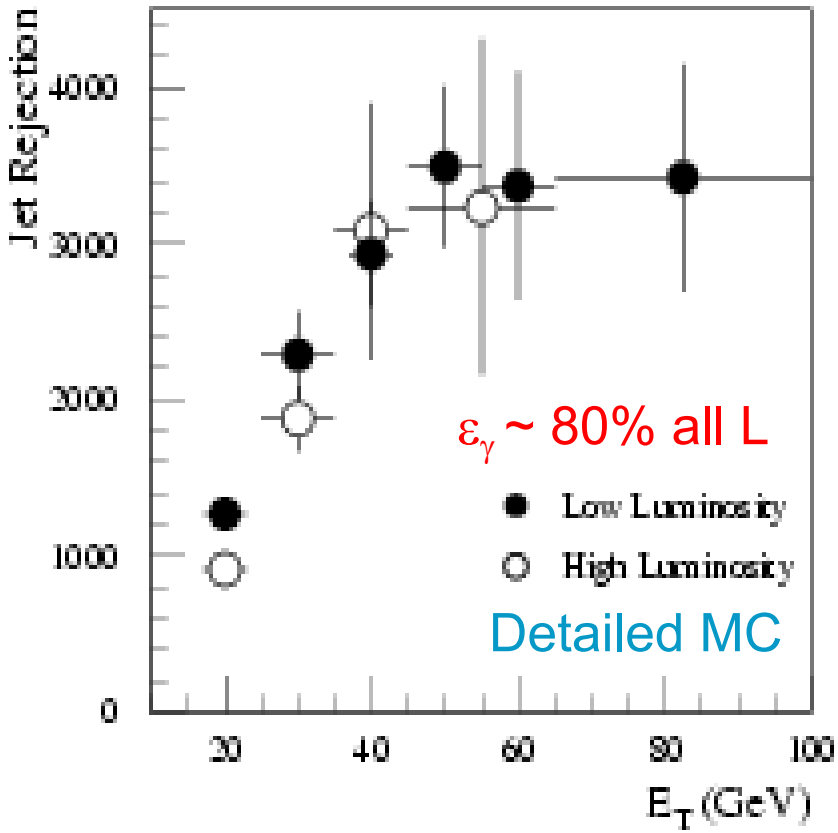


Fig.26a

ATLAS EM calorimeter

4 mm η-strips in first compartment

3 longitudinal segments



⇨ (γ–jet + jet-jet) < 40% $\gamma\gamma$

Fig.26b

Likelihood method

Form significance S_i for i-th trk in jet

Form $r_i = f_b(S_i)/f_u(S_i)$

Form Jet weight W = Slog r_i

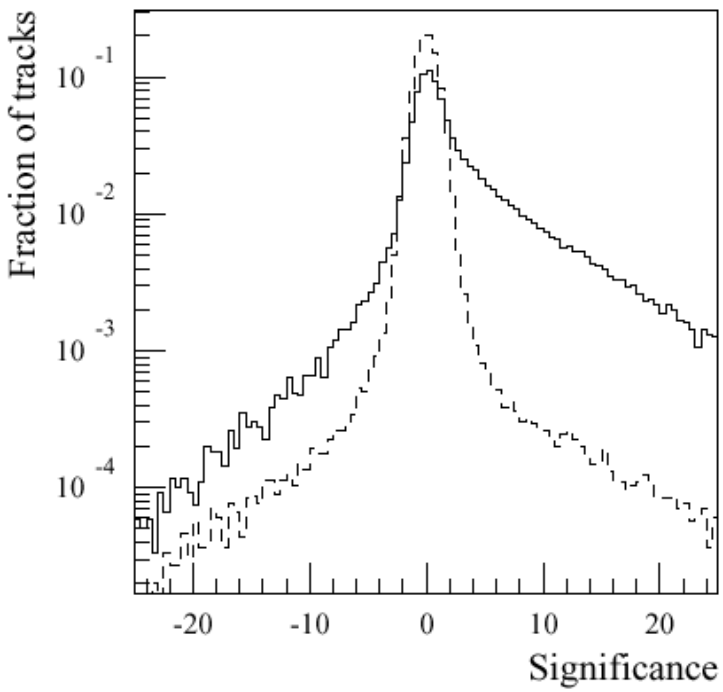


Fig.27a

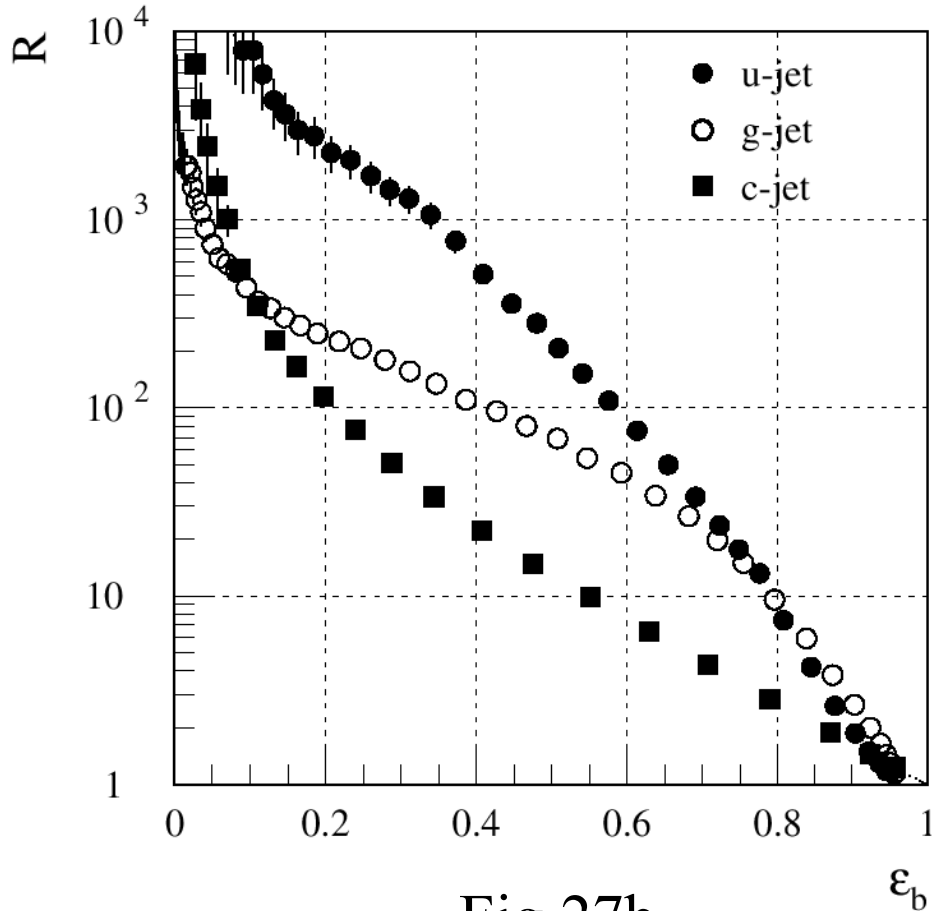


Fig.27b

ATLAS

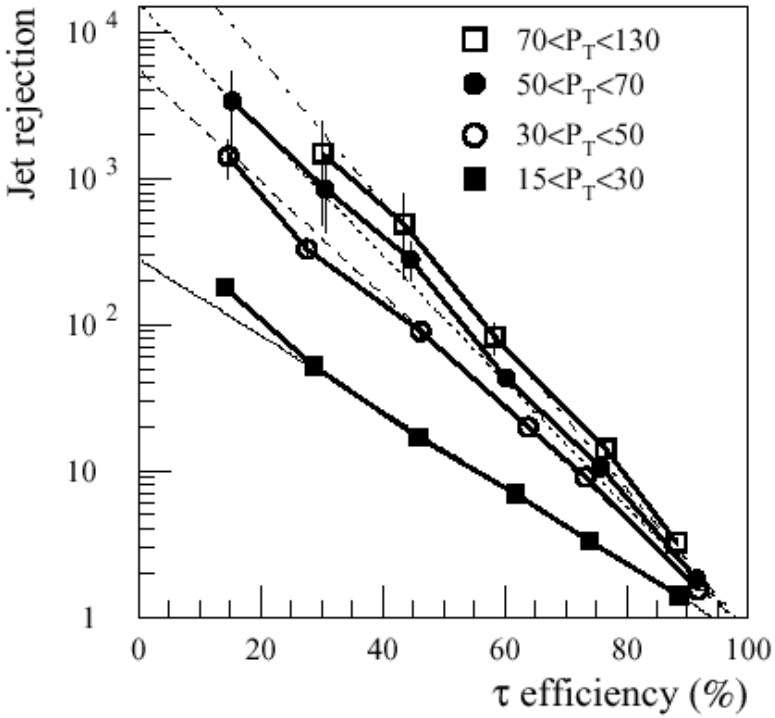


Fig.28a

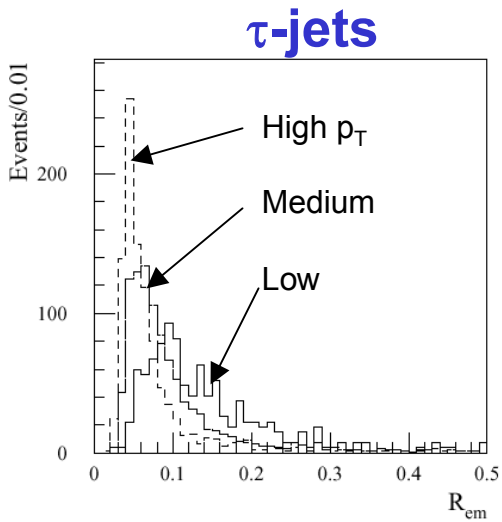


Fig.28b

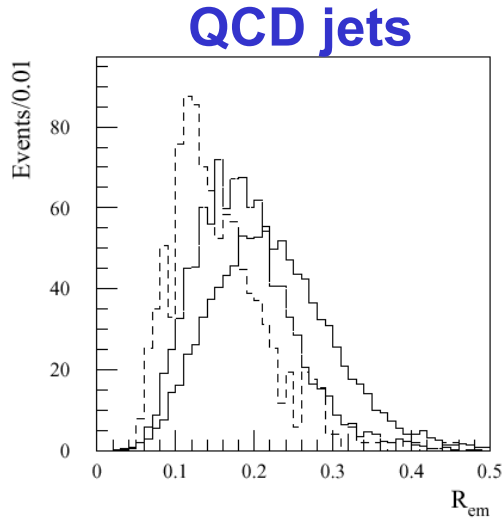
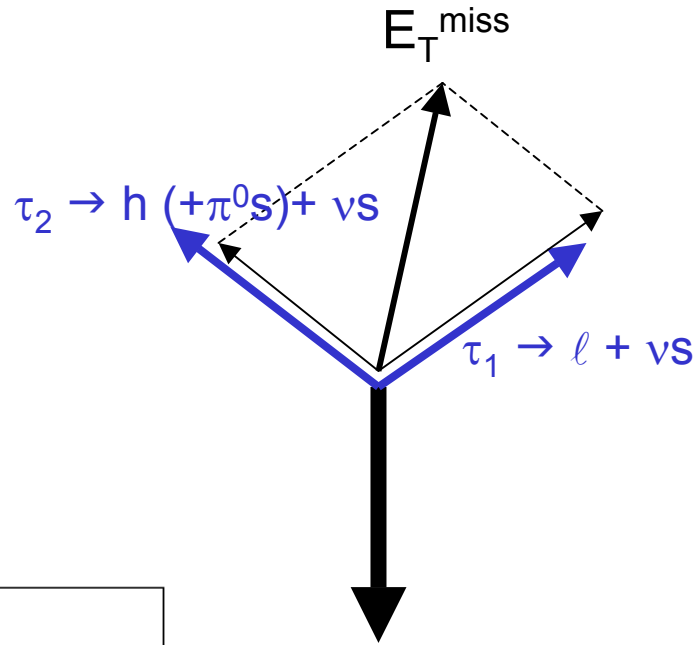


Fig.28c



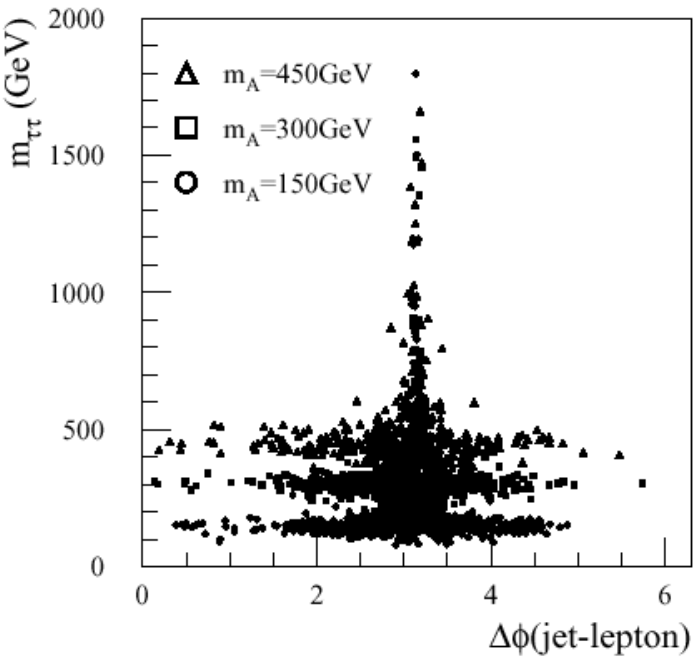
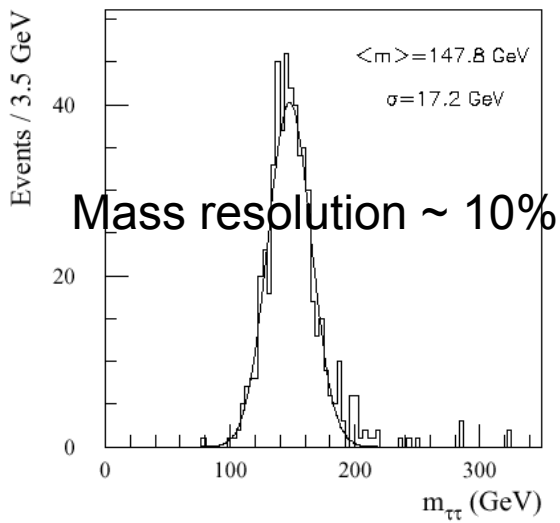


Fig.29a



Mass resolution ~ 10%

Fig.29b

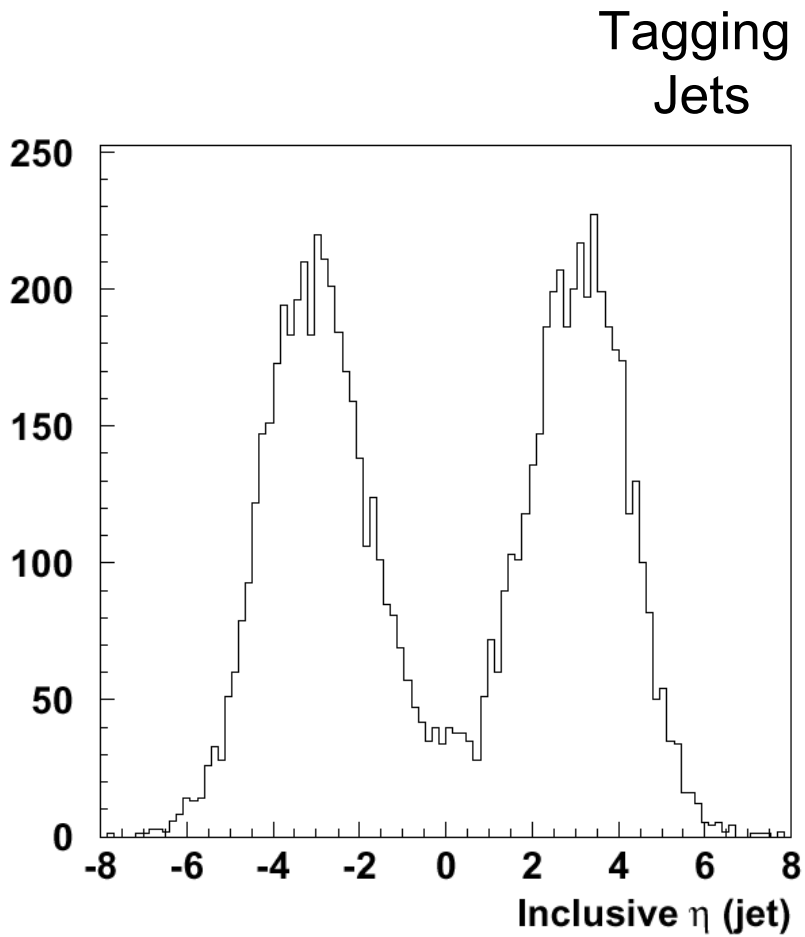


Fig.30

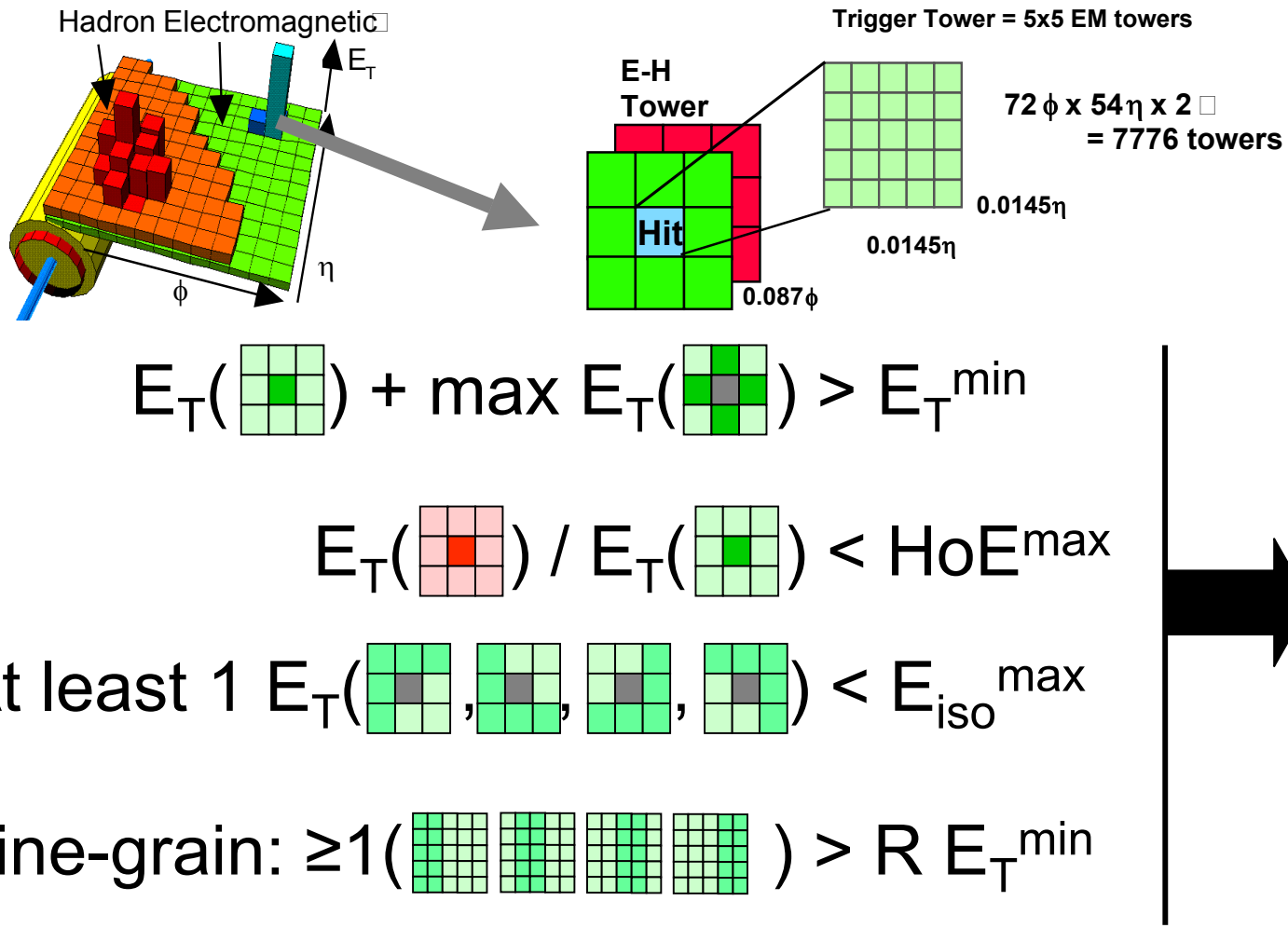

Hadron Electromagnetic
E_T
η
ϕ
Trigger Tower = 5x5 EM towers
E-H Tower
Hit
0.087ϕ
0.0145η
0.0145η
72 ϕ x 54 η x 2
= 7776 towers
E_T( ) + max E_T( ) > E_T^{min}
E_T( ) / E_T( ) < HoE^{max}
At least 1 E_T(, , ,) < E_{iso}^{max}
Fine-grain: ≥1( ) > R E_T^{min}
Isolated
"e/γ"

Fig.31

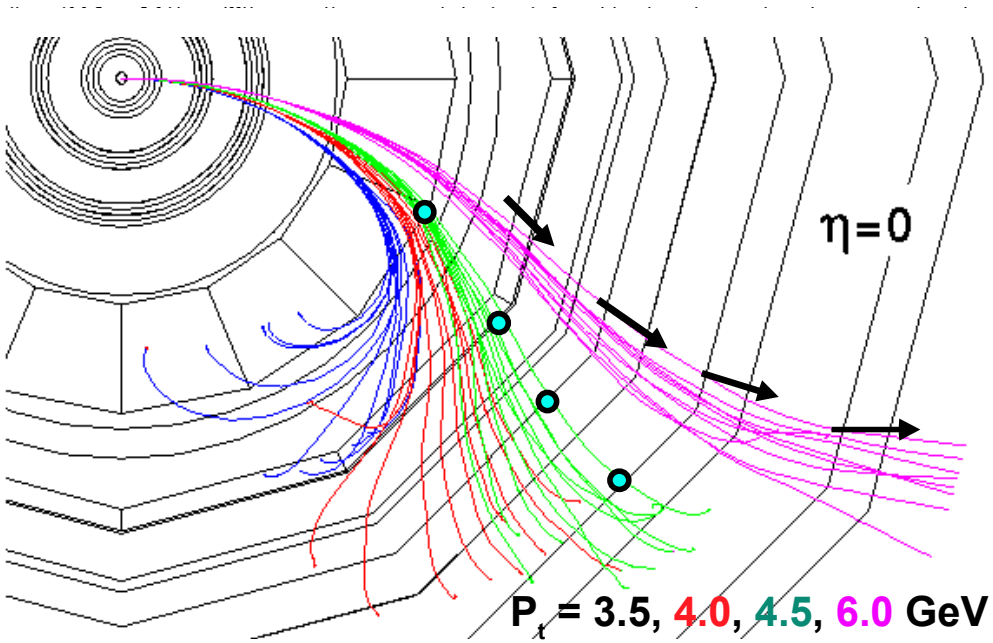
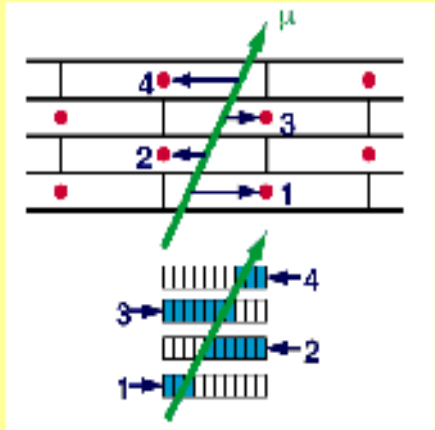
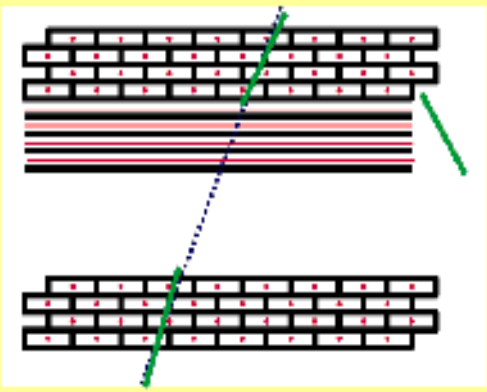


Fig.32

Drift Tubes

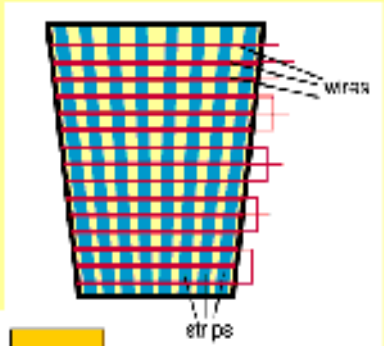


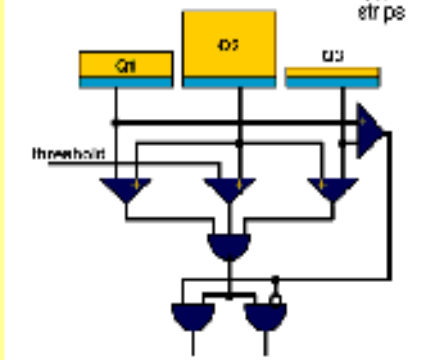
Meantimers recognize tracks and form vector / quartet.



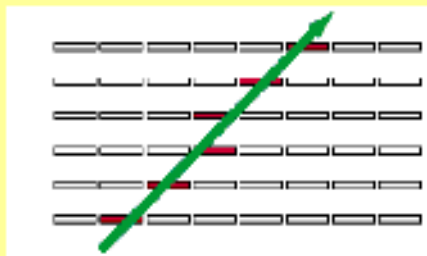
Correlator combines them into one vector / station.

CSC



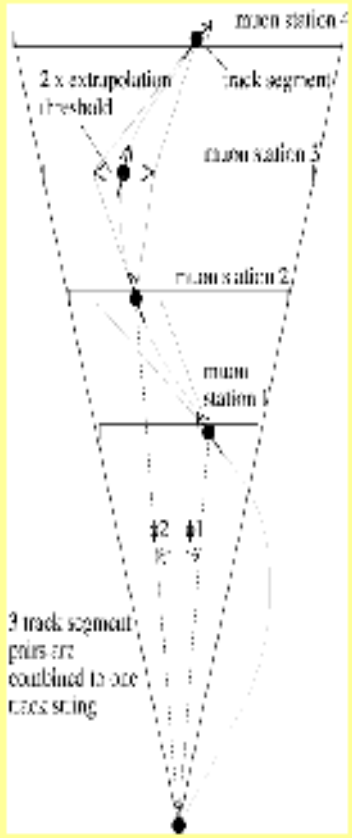


Comparators give 1/2strip resol.



Hit strips of 6 layers form a vector.

Track Finder



combines vectors, forms a track, assigns p_t value.

Fig.33

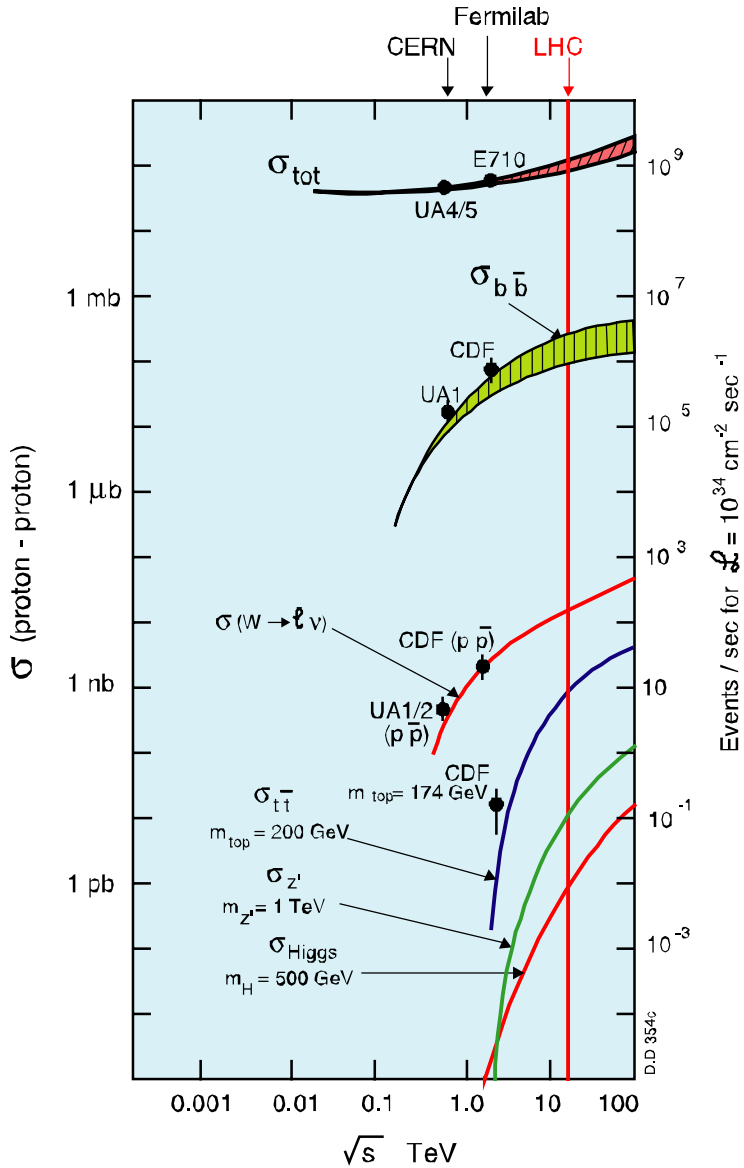
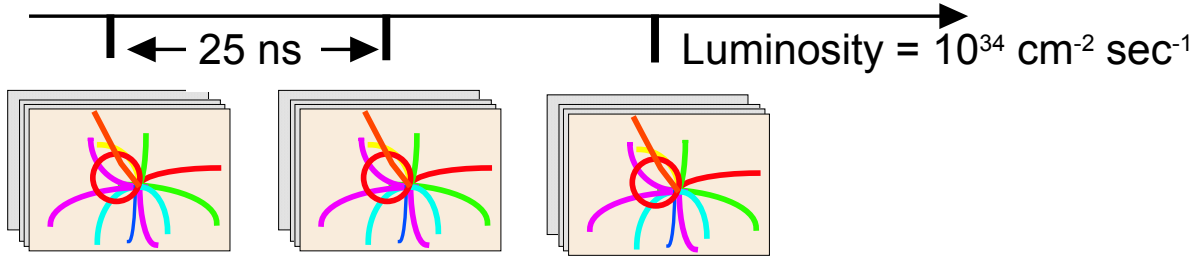

Fermilab
CERN
LHC
σ tot
E710
UA4/5
σ b b̄
CDF
UA1
σ (W → ℓ ν)
CDF (p p̄)
UA1/2
(p p̄)
σ t t̄
m top = 200 GeV
CDF
m top= 174 GeV
σ Z'
m Z'= 1 TeV
σ Higgs
m H = 500 GeV
σ (proton - proton)
1 mb
1 μb
1 nb
1 pb
Events / sec for ℒ = 10^34 cm^-2 sec^-1
10^9
10^7
10^5
10^3
10
10^-1
10^-3
0.001
0.01
0.1
1.0
10
100
√s TeV
D.D 354c

Fig.34

- 30 Collisions/25ns
(10^{9} event/sec)

10^{7} channels
(10^{16} bit/sec)



Multilevel trigger and readout systems

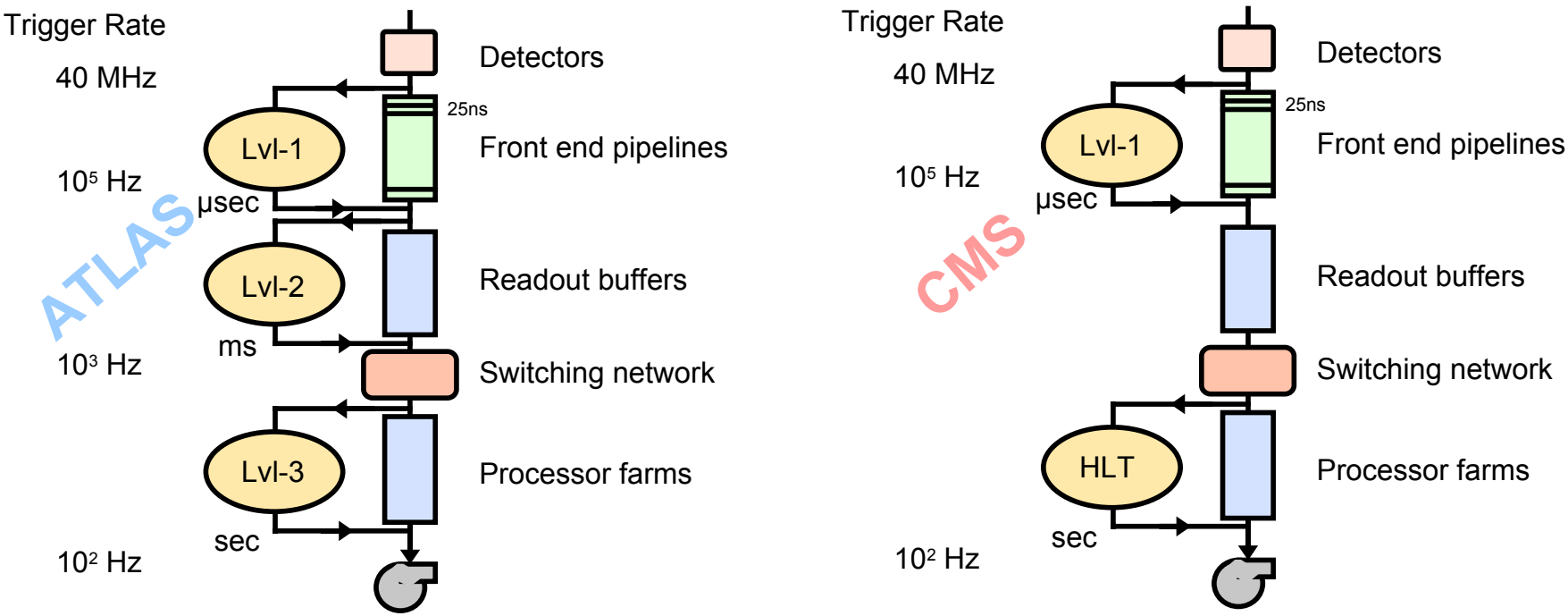
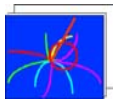


Fig.35



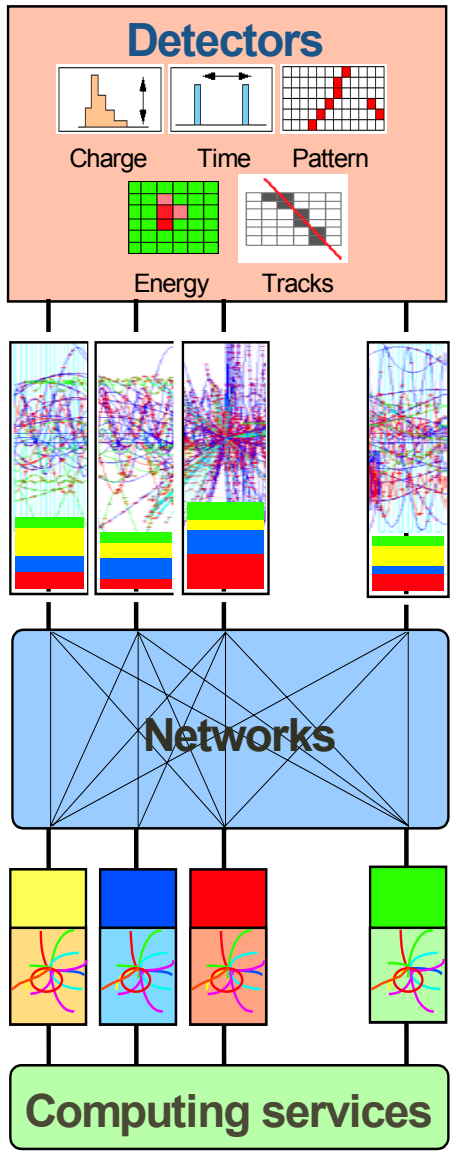
40 MHz
COLLISION RATE

100 kHz
LEVEL-1 TRIGGER

1 Terabit/s
(50000 DATA CHANNELS)

500 Gigabit/s

Gigabit/s SERVICE LAN



16 Million channels
3 Gigacell buffers

1 Megabyte EVENT DATA

200 Gigabyte BUFFERS
500 Readout memories

EVENT BUILDER. A large switching network (512+512 ports) with a total throughput of approximately 500 Gbit/s forms the interconnection between the sources (Readout Dual Port Memory) and the destinations (switch to Farm Interface). The Event Manager collects the status and request of event filters and distributes event building commands (read/clear) to RDPMs

5 TeraIPS

EVENT FILTER. It consists of a set of high performance commercial processors organized into many farms convenient for on-line and off-line applications. The farm architecture is such that a single CPU processes one event

Petabyte ARCHIVE

Fig.36

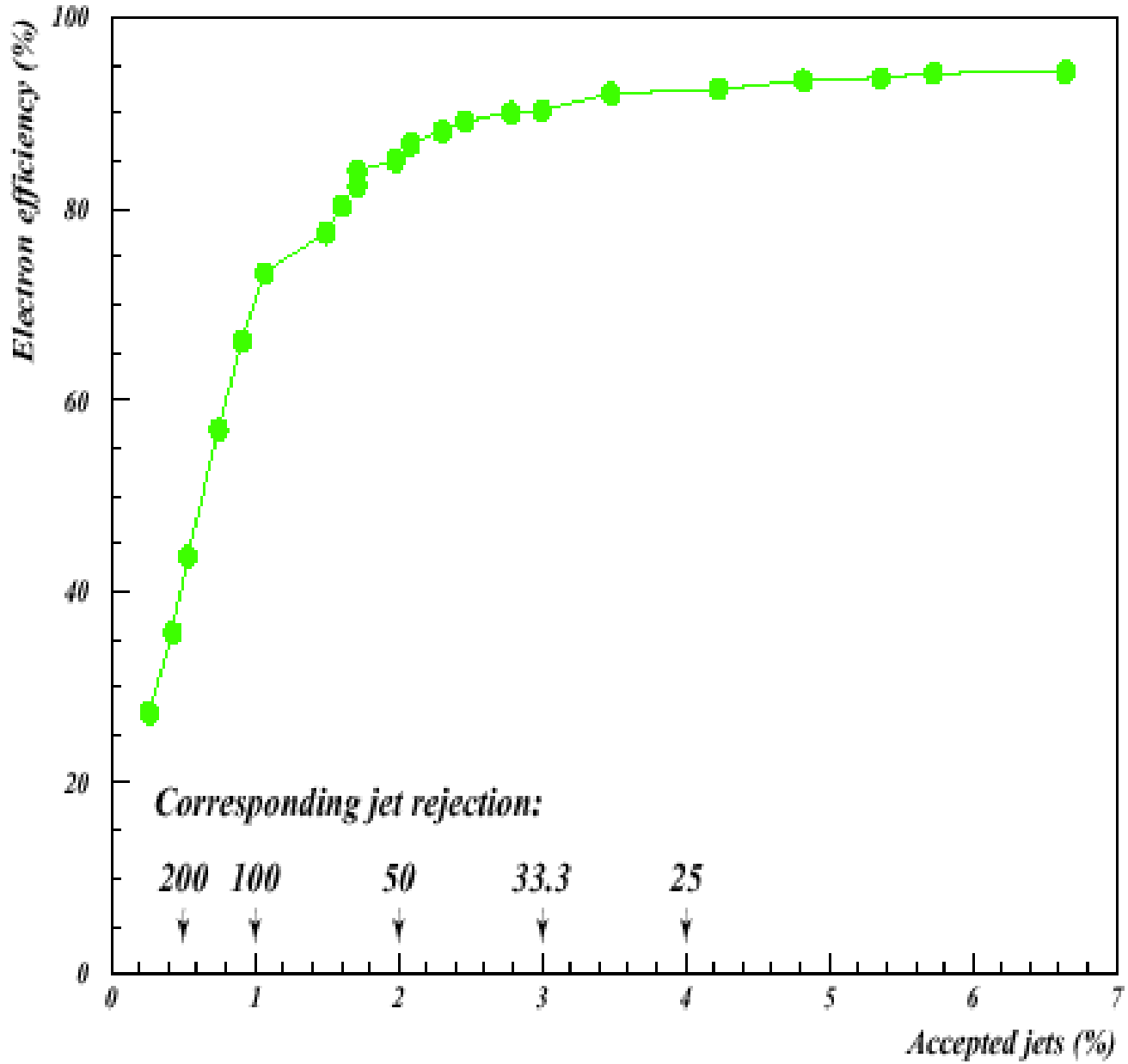

Electron efficiency (%)
100
80
60
40
20
0
Corresponding jet rejection:
200
100
50
33.3
25
0
1
2
3
4
5
6
7
Accepted jets (%)

Fig.37

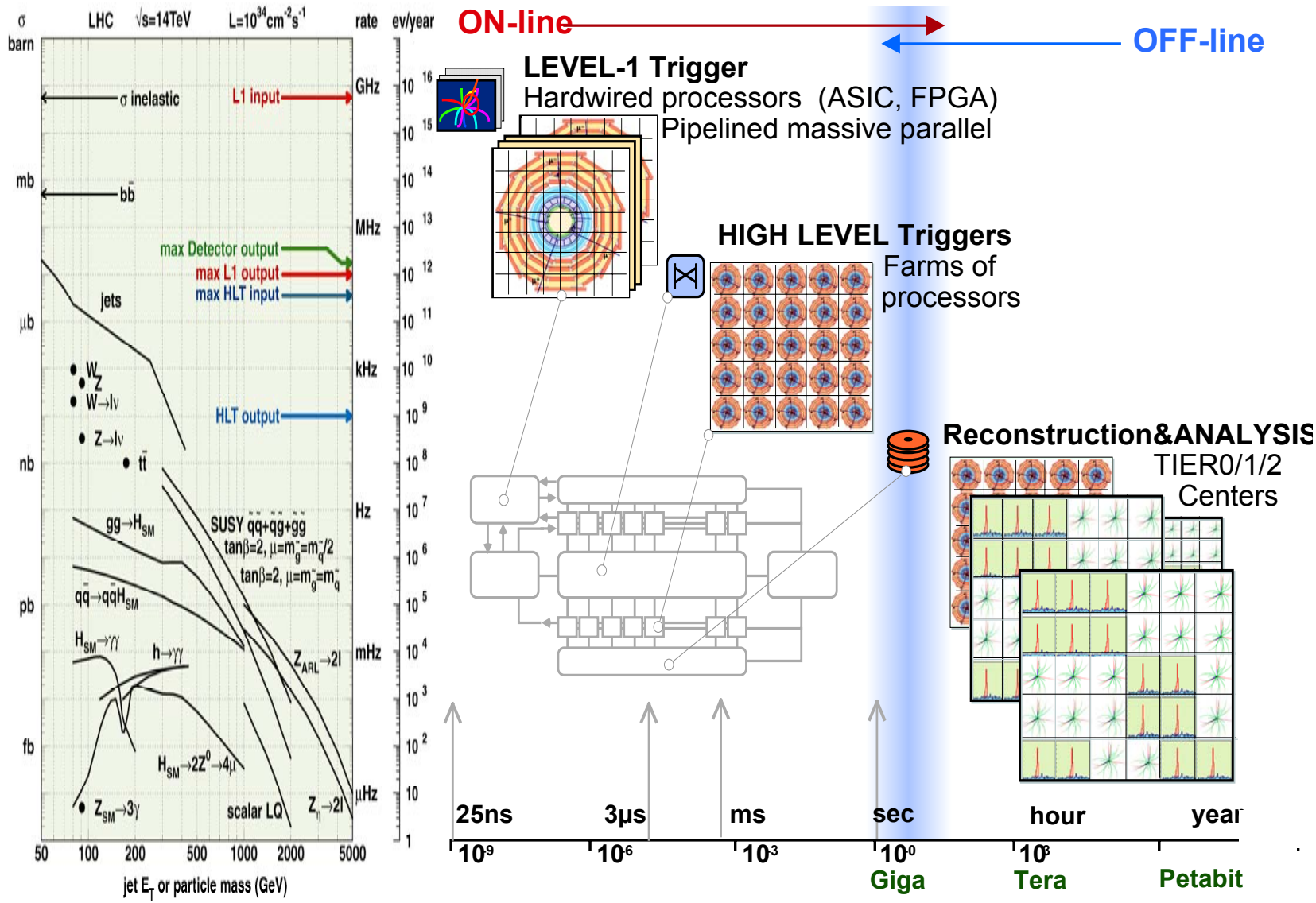

σ
LHC √s=14TeV L=10^34cm^-2s^-1
rate ev/year
barn
mb
μb
nb
pb
fb
σ inelastic
L1 input
bb̄
max Detector output
max L1 output
max HLT input
jets
W
Z
W→lν
HLT output
Z→lν
tt̄
gg→H_SM
SUSY qq̃+qg̃+g̃g̃
tanβ=2, μ=m_g̃=m_q̃/2
tanβ=2, μ=m_g̃=m_q̃
qq̄→qq̄H_SM
H_SM→γγ
h→γγ
Z_ARL→2l
H_SM→2Z^0→4μ
Z_SM→3γ
scalar LQ
Z_η→2l
GHz
MHz
kHz
Hz
mHz
μHz
50 100 200 500 1000 2000 5000
jet E_T or particle mass (GeV)
ON-line
OFF-line
LEVEL-1 Trigger
Hardwired processors (ASIC, FPGA)
Pipelined massive parallel
HIGH LEVEL Triggers
Farms of processors
Reconstruction&ANALYSIS
TIER0/1/2 Centers
25ns
3μs
ms
sec
hour
year
10^9
10^6
10^3
10^0
10^3
Giga
Tera
Petabit

Fig.38

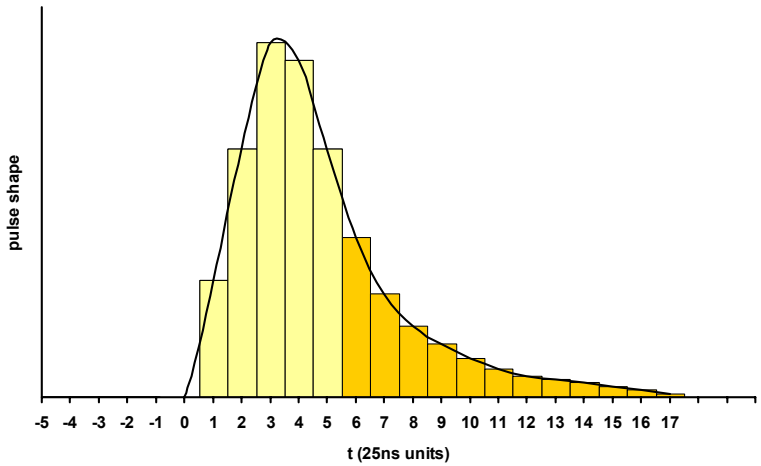


Fig.39a

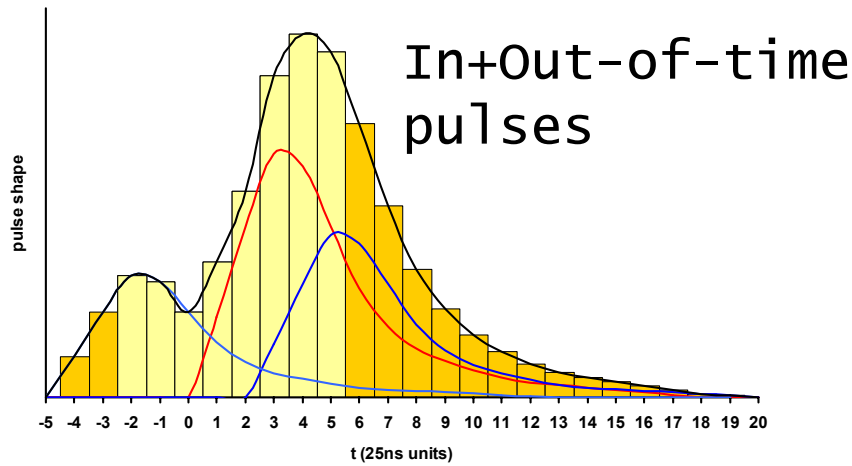
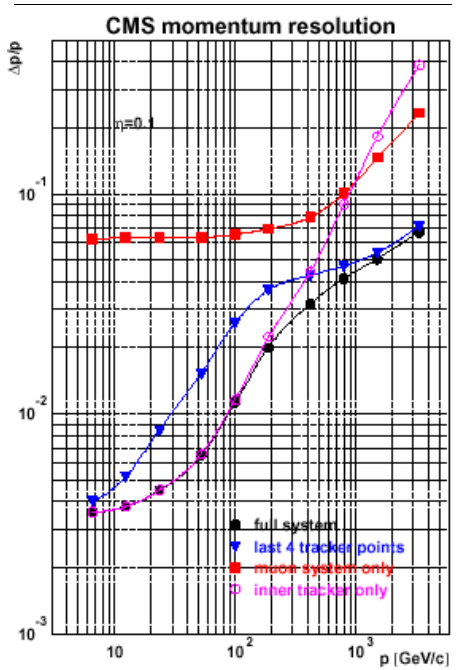


Fig.39b

Muon Momentum Resolution

Spatial resolution
Š 100 μm/station

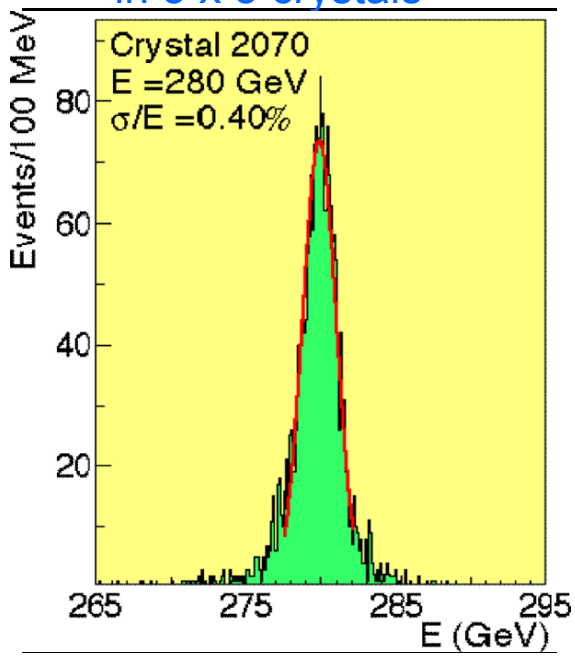


$\delta p_t/p_t$ - 10%
at p_t=500 GeV at η=2

Fig.40a

$PbWO_4$ CRYSTAL ELECTROMAGNETIC CALORIMETER

Energy reconstructed
in 3 x 3 crystals



σ / E - 2.7% / ¦ E ⊕ 0.5% ⊕ 20%/E
(E in GeV)

)

Fig.40b

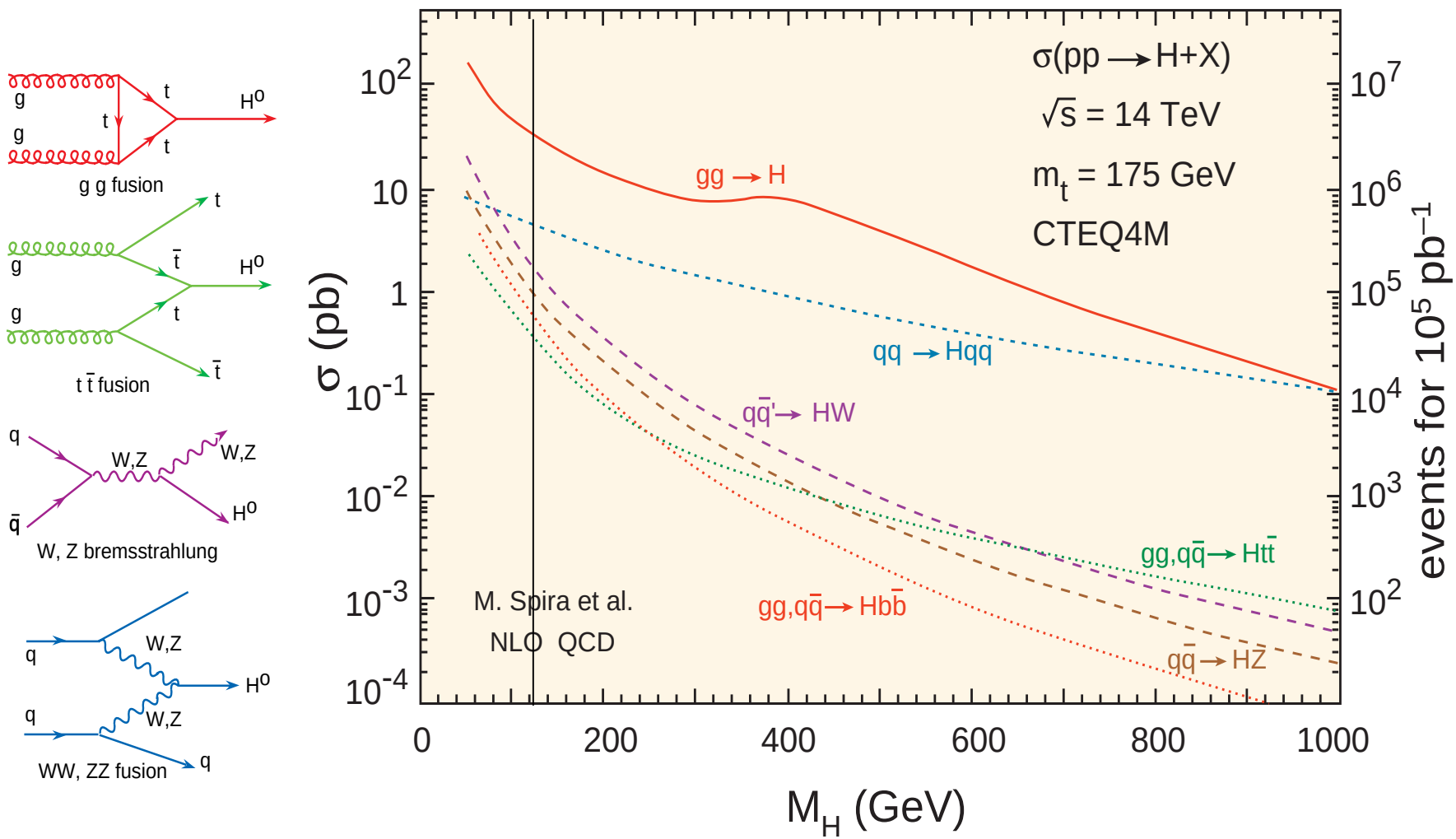

g
g
t
t
t
H⁰
g g fusion
g
g
t
t̄
t
t̄
H⁰
t t̄ fusion
q
q̄
W,Z
W,Z
H⁰
W, Z bremsstrahlung
q
q
W,Z
W,Z
H⁰
q
WW, ZZ fusion
σ(pp → H+X)
√s = 14 TeV
m_t = 175 GeV
CTEQ4M
gg → H
qq → Hqq
qq̄' → HW
gg,qq̄ → Htt̄
gg,qq̄ → Hbb̄
qq̄ → HZ
M. Spira et al.
NLO QCD
σ (pb)
events for 10^5 pb^-1
M_H (GeV)
10^2
10
1
10^-1
10^-2
10^-3
10^-4
10^7
10^6
10^5
10^4
10^3
10^2
0
200
400
600
800
1000

Fig.41

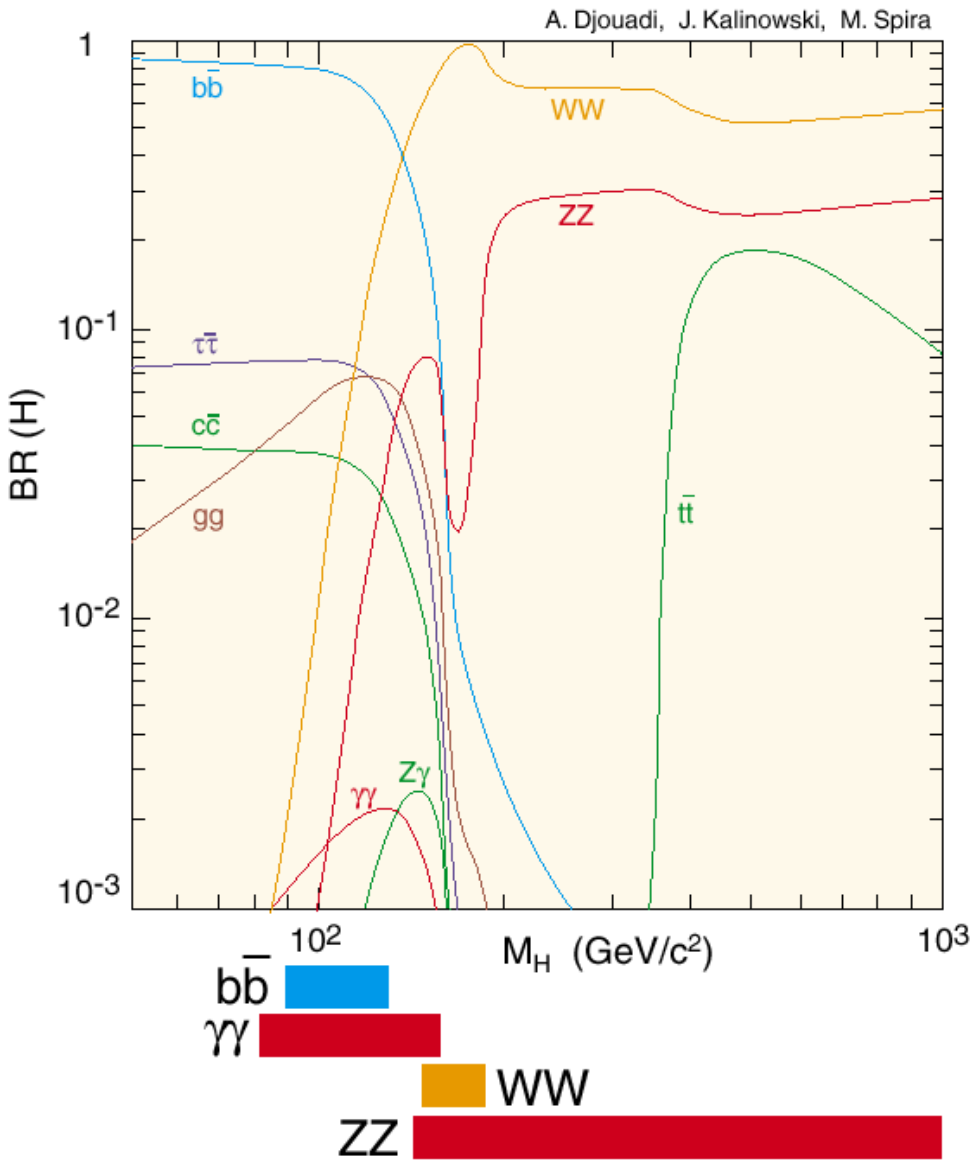

A. Djouadi, J. Kalinowski, M. Spira
1
10^{-1}
10^{-2}
10^{-3}
BR (H)
$b\bar{b}$
WW
ZZ
$\tau\bar{\tau}$
$c\bar{c}$
gg
$t\bar{t}$
$\gamma\gamma$
$Z\gamma$
10^2
M_H (GeV/c^2)
10^3
$b\bar{b}$
$\gamma\gamma$
WW
ZZ

Fig.42

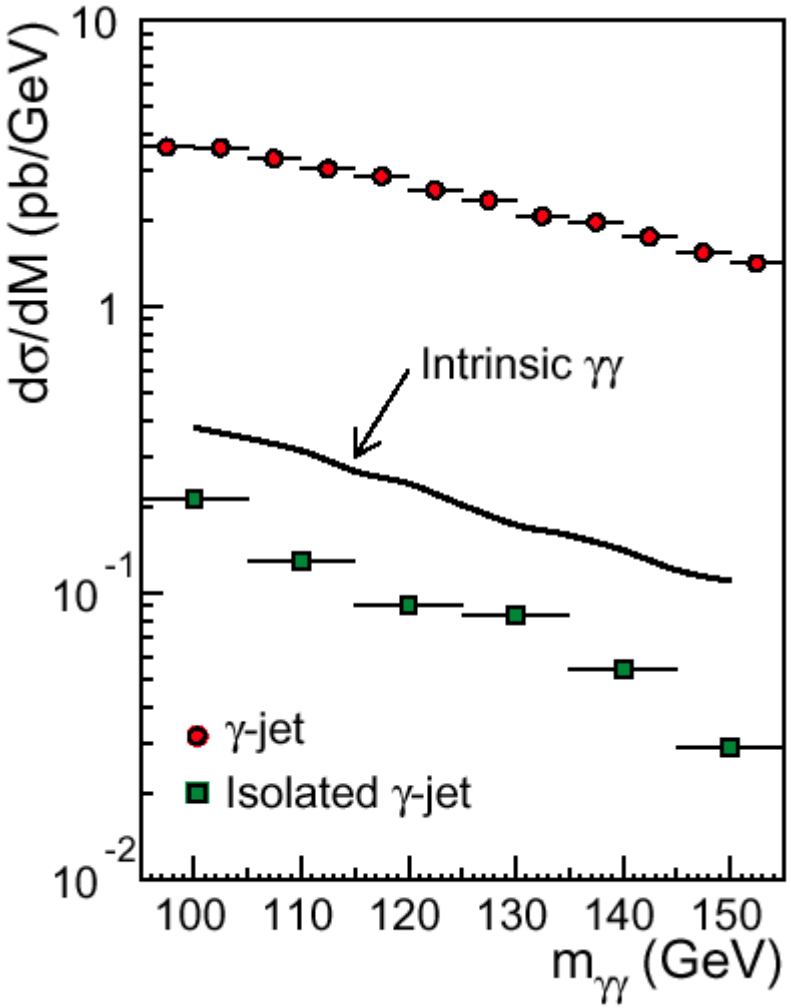


Fig.43a

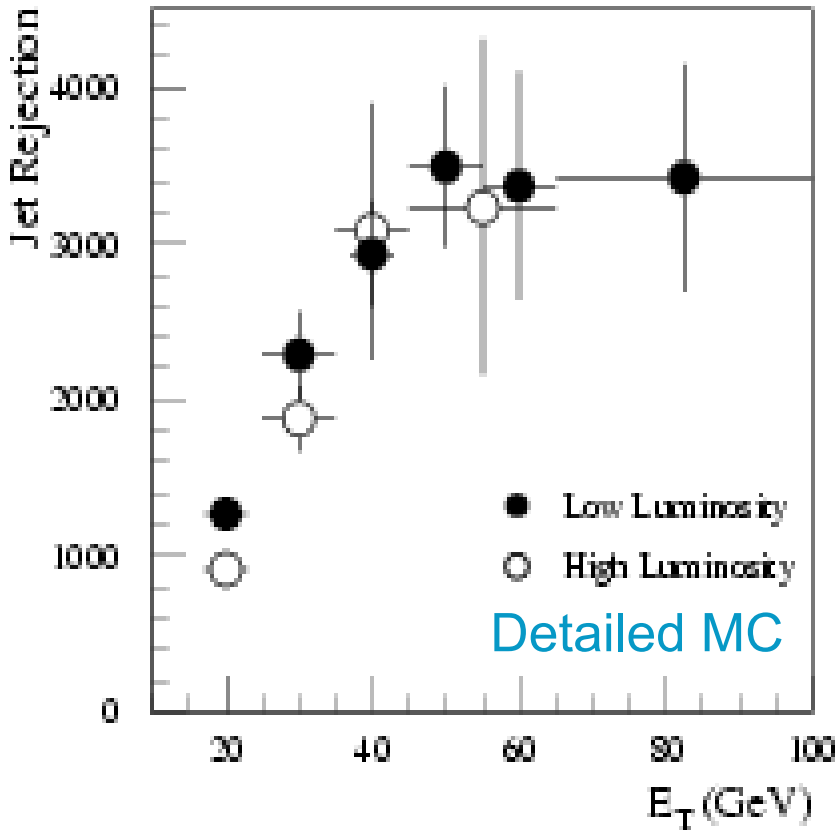


Fig.43b

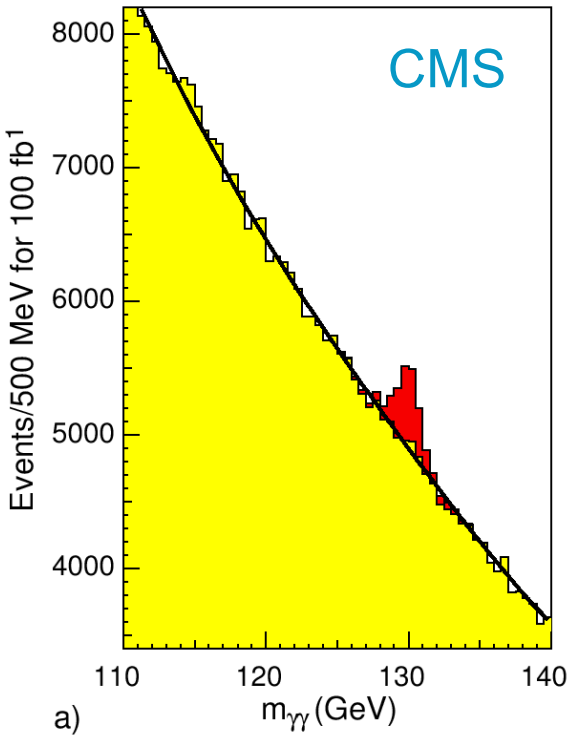


Fig.44a

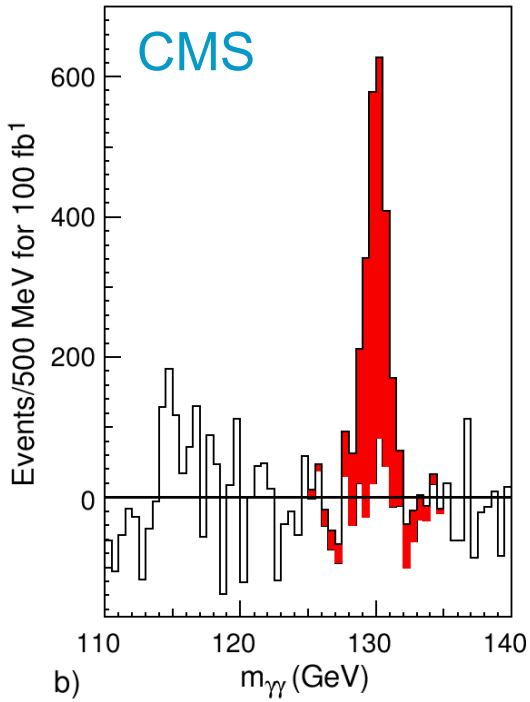


Fig.44b

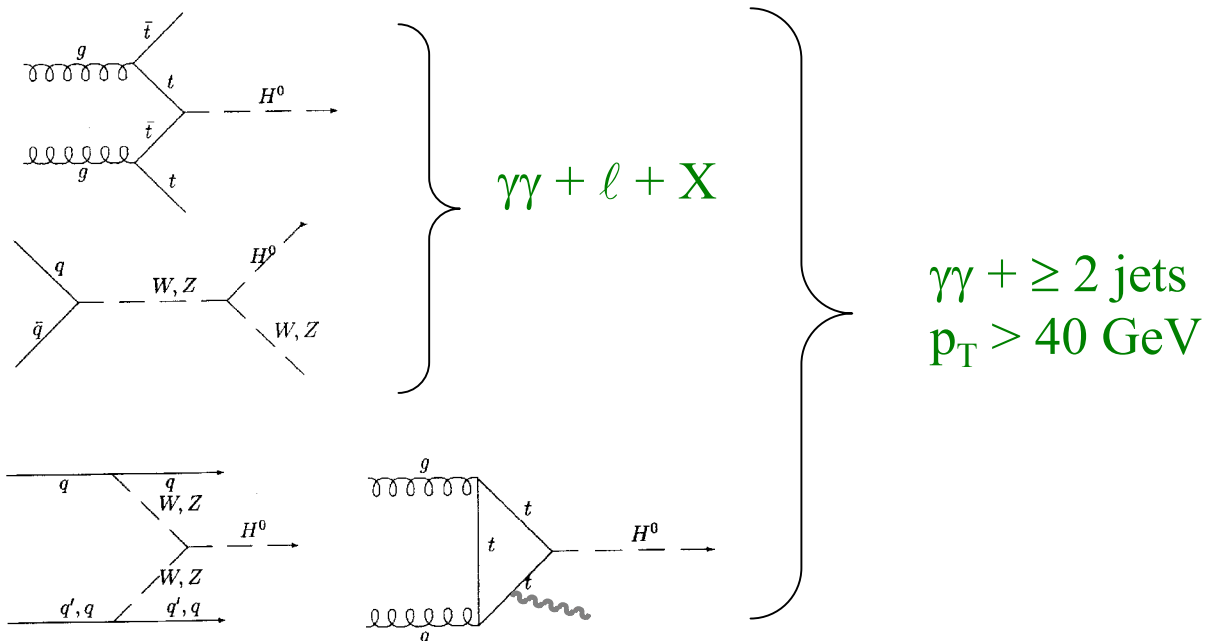

g
t̄
t
H⁰
g
t̄
t
q
q̄
W, Z
H⁰
W, Z
q
q
W, Z
H⁰
W, Z
q′, q
q′, q
g
t
t
t
H⁰
g
γγ + ℓ + X
γγ + ≥ 2 jets
p_T > 40 GeV

Fig.45

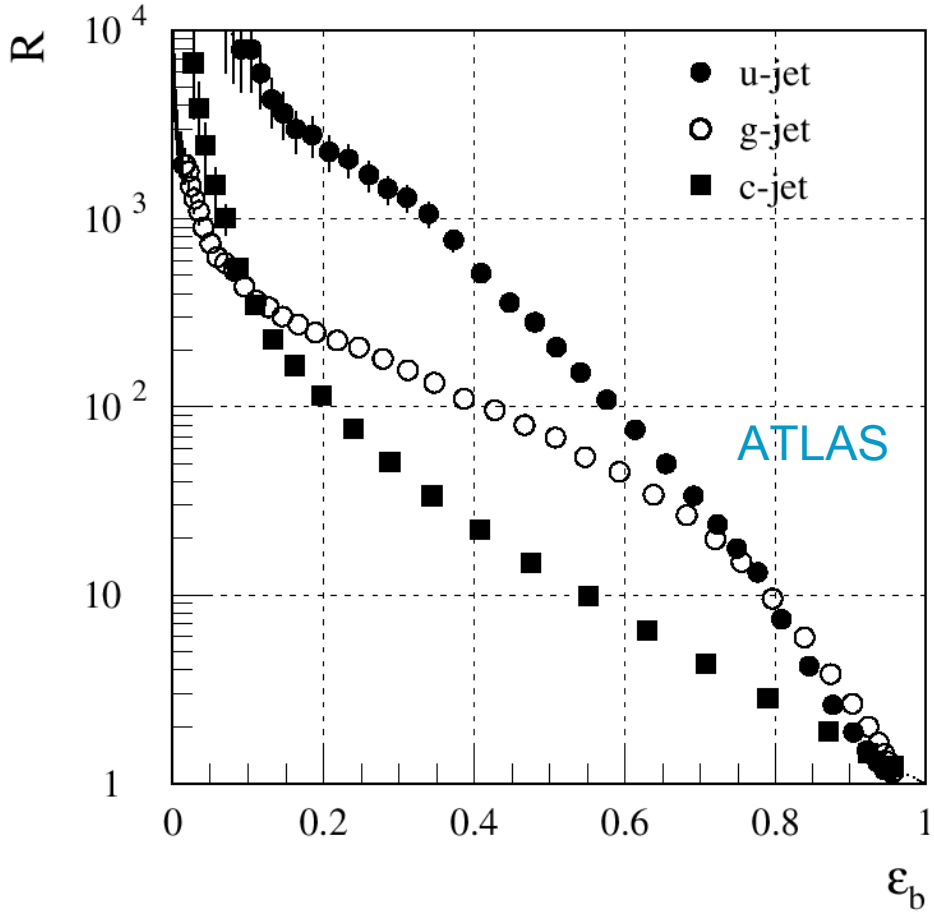

R
10^4
10^3
10^2
10
1
0
0.2
0.4
0.6
0.8
1
ε_b
u-jet
g-jet
c-jet
ATLAS

Fig.46

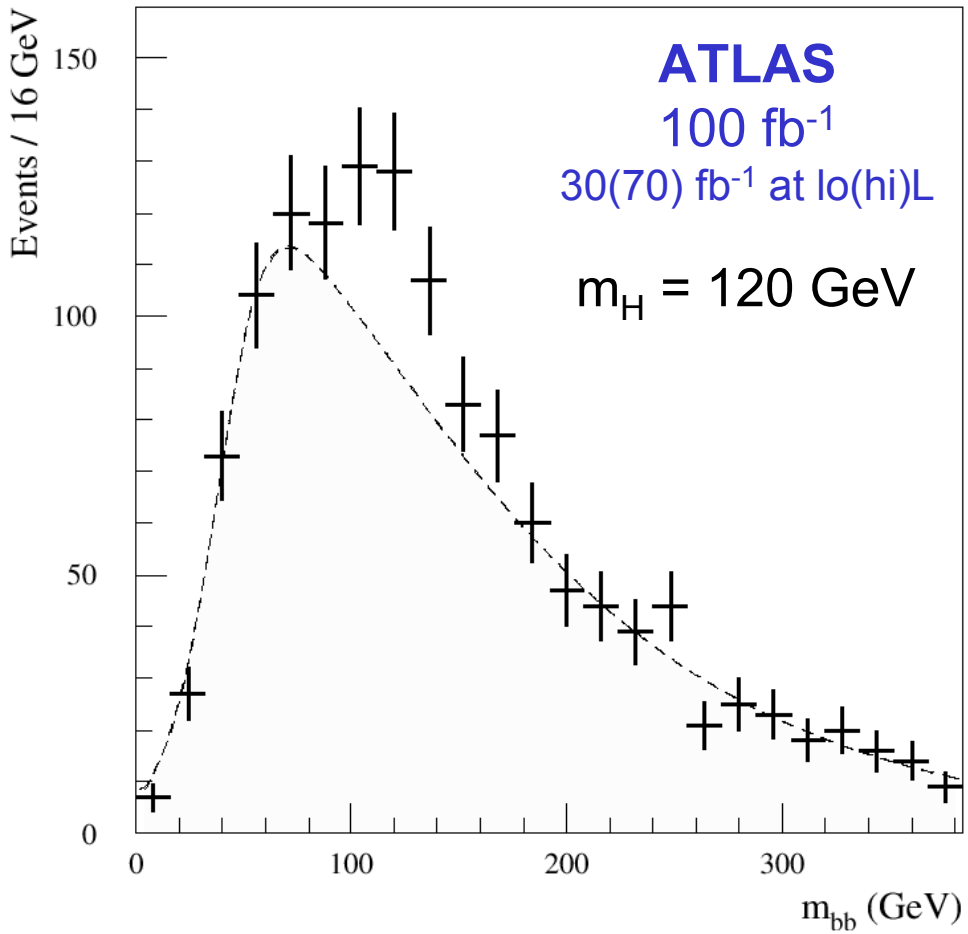

ATLAS
100 fb-1
30(70) fb-1 at lo(hi)L
mH = 120 GeV
Events / 16 GeV
150
100
50
0
0
100
200
300
mbb (GeV)

Fig.47

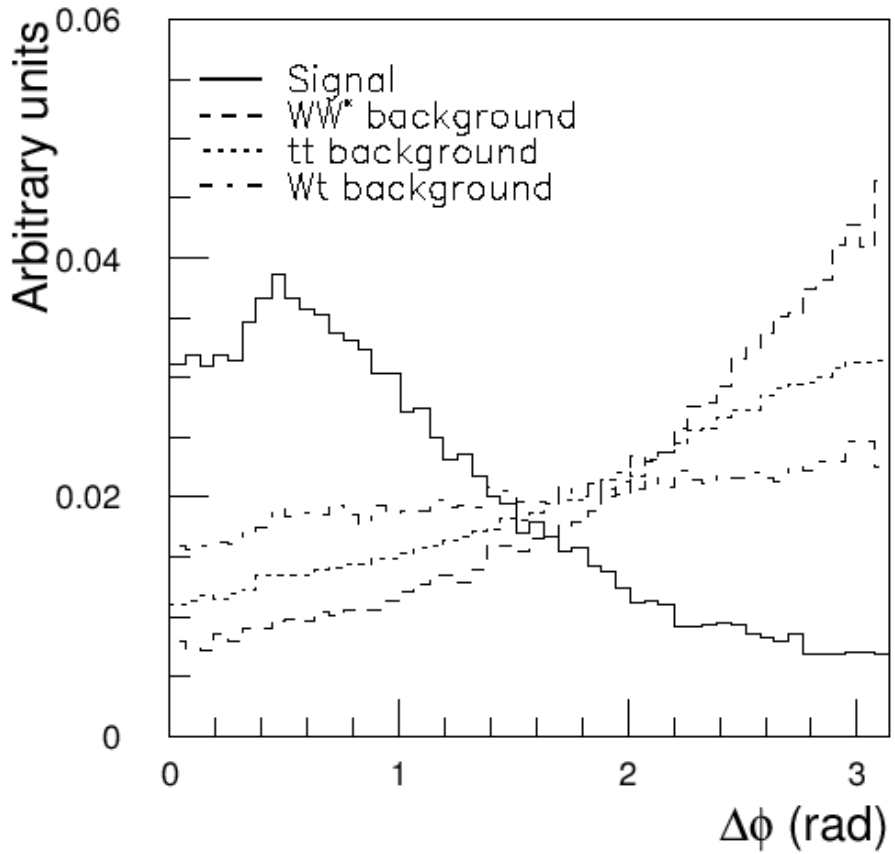

Arbitrary units
0.06
0.04
0.02
0
Signal
WW* background
tt background
Wt background
0
1
2
3
Δϕ (rad)

Fig.48

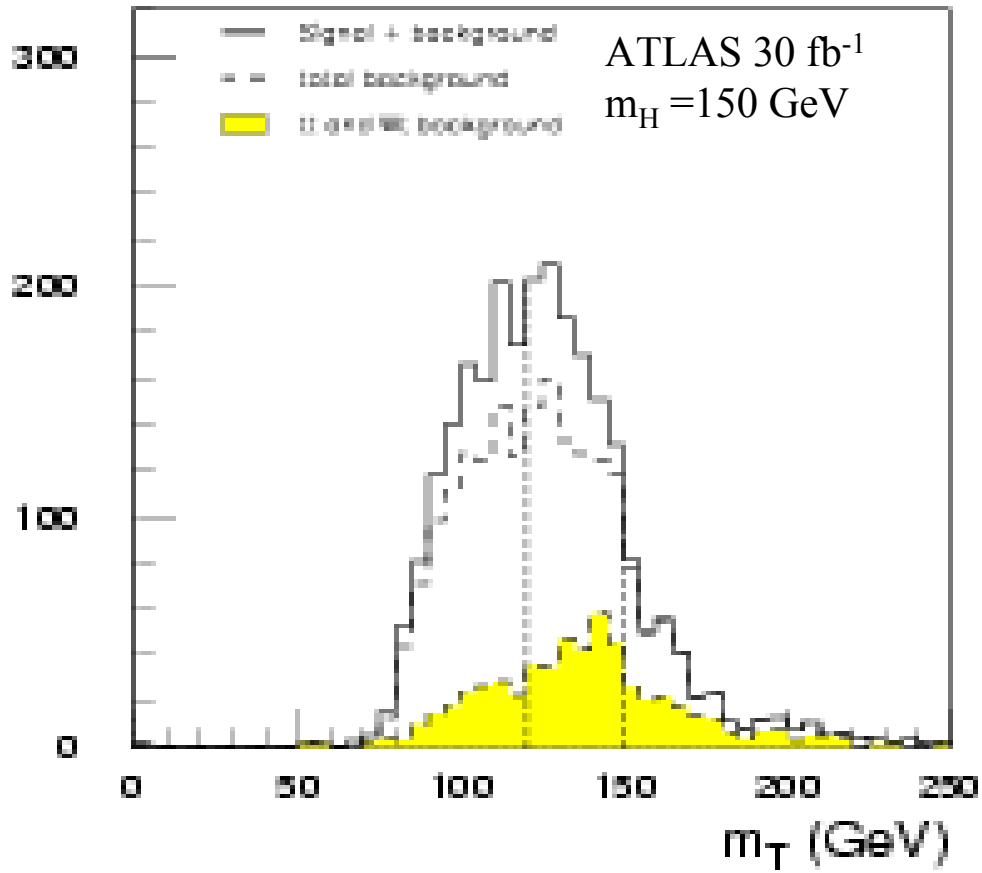

Signal + background
total background
ATLAS 30 fb-1
mH =150 GeV
300
200
100
0
0
50
100
150
200
250
mT (GeV)

Fig.49

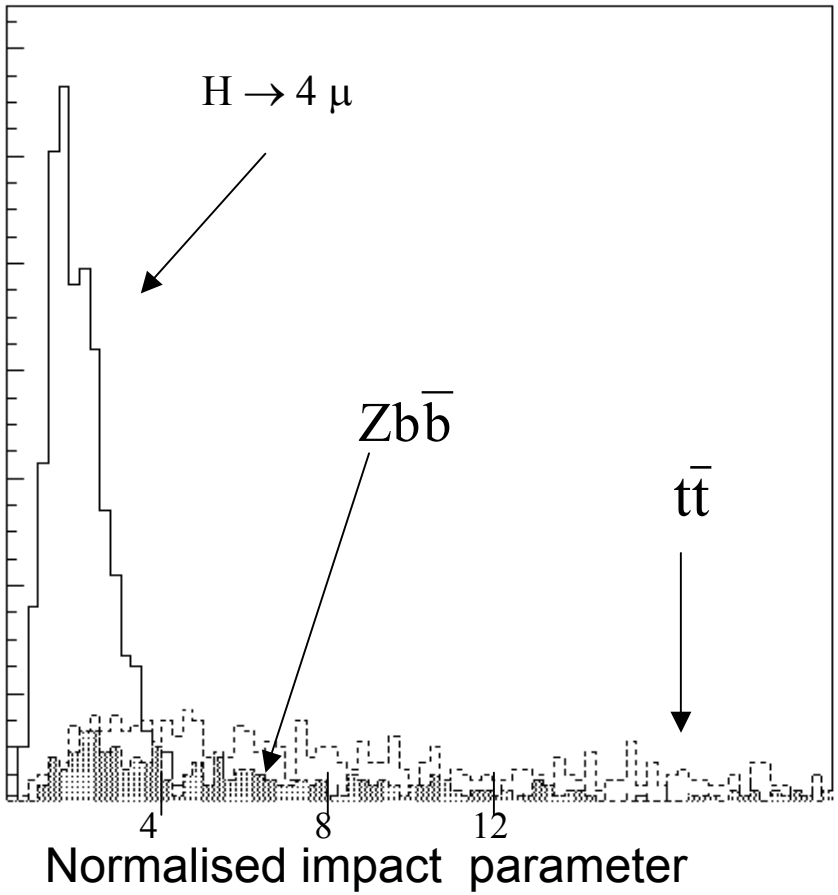


Fig.50

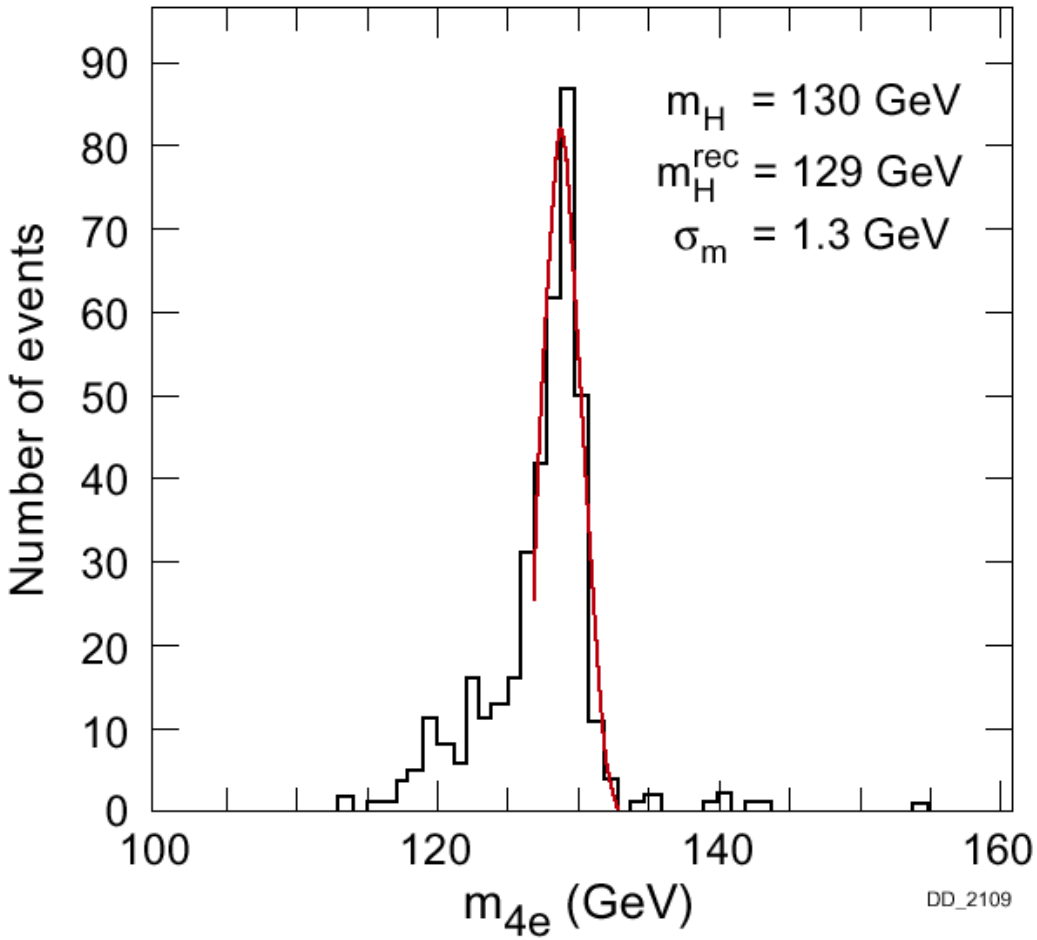

m_H = 130 GeV
m_H^{rec} = 129 GeV
σ_m = 1.3 GeV
Number of events
m_{4e} (GeV)
DD_2109

Fig.51

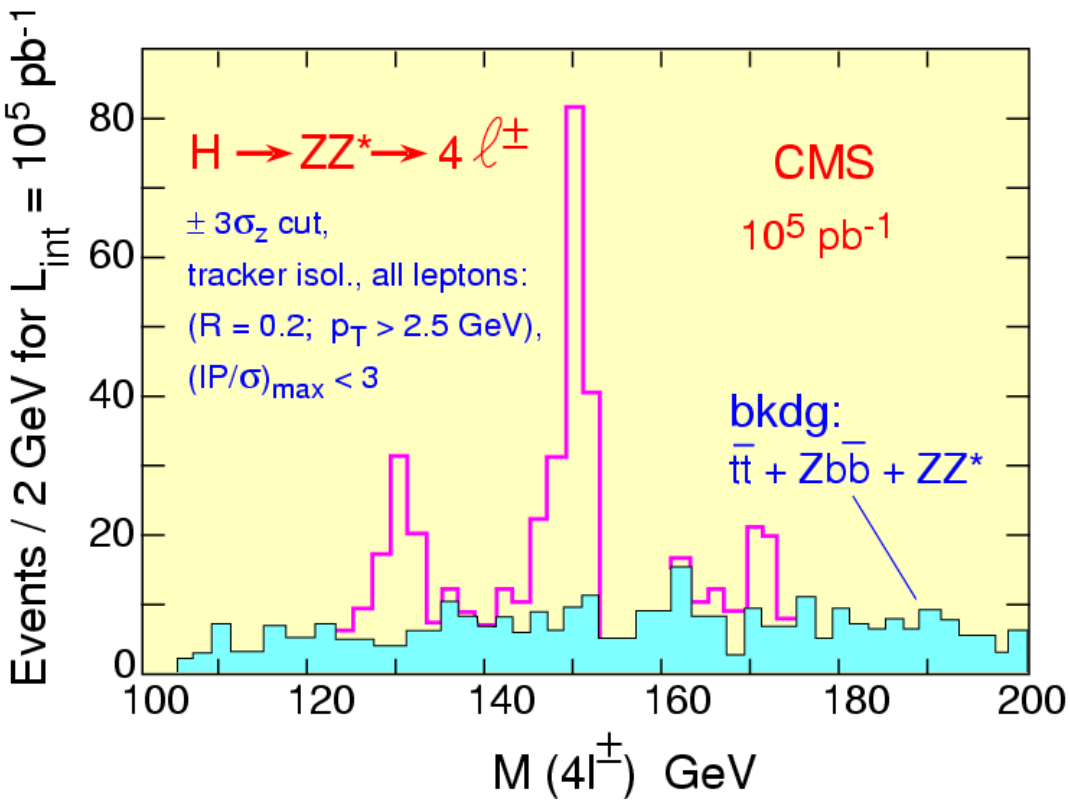

Events / 2 GeV for $L_{int} = 10^5$ pb^{-1}
80
60
40
20
0
100
120
140
160
180
200
M ($4l^{\pm}$) GeV
$H \rightarrow ZZ^* \rightarrow 4\,\ell^{\pm}$
$\pm 3\sigma_z$ cut,
tracker isol., all leptons:
($R = 0.2$; $p_T > 2.5$ GeV),
$(IP/\sigma)_{max} < 3$
CMS
10^5 pb^{-1}
bkdg:
$\bar{t}\bar{t} + Z\bar{b}\bar{b} + ZZ^*$

Fig.52

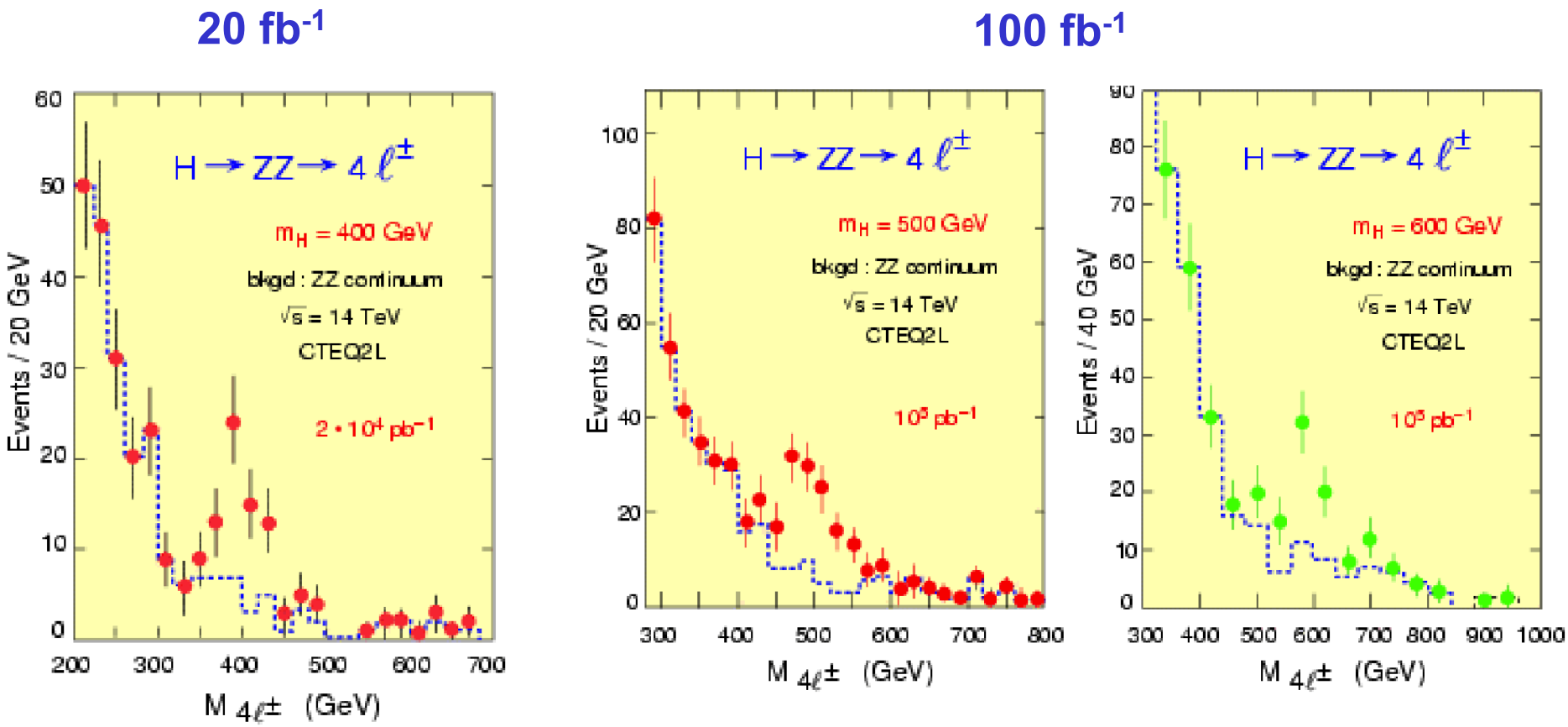

20 fb-1
100 fb-1
H → ZZ → 4 ℓ±
mH = 400 GeV
bkgd : ZZ continuum
√s = 14 TeV
CTEQ2L
2 • 10⁴ pb⁻¹
Events / 20 GeV
M 4ℓ± (GeV)
H → ZZ → 4 ℓ±
mH = 500 GeV
bkgd : ZZ continuum
√s = 14 TeV
CTEQ2L
10⁵ pb⁻¹
Events / 20 GeV
M 4ℓ± (GeV)
H → ZZ → 4 ℓ±
mH = 600 GeV
bkgd : ZZ continuum
√s = 14 TeV
CTEQ2L
10⁵ pb⁻¹
Events / 40 GeV
M 4ℓ± (GeV)

Fig.53

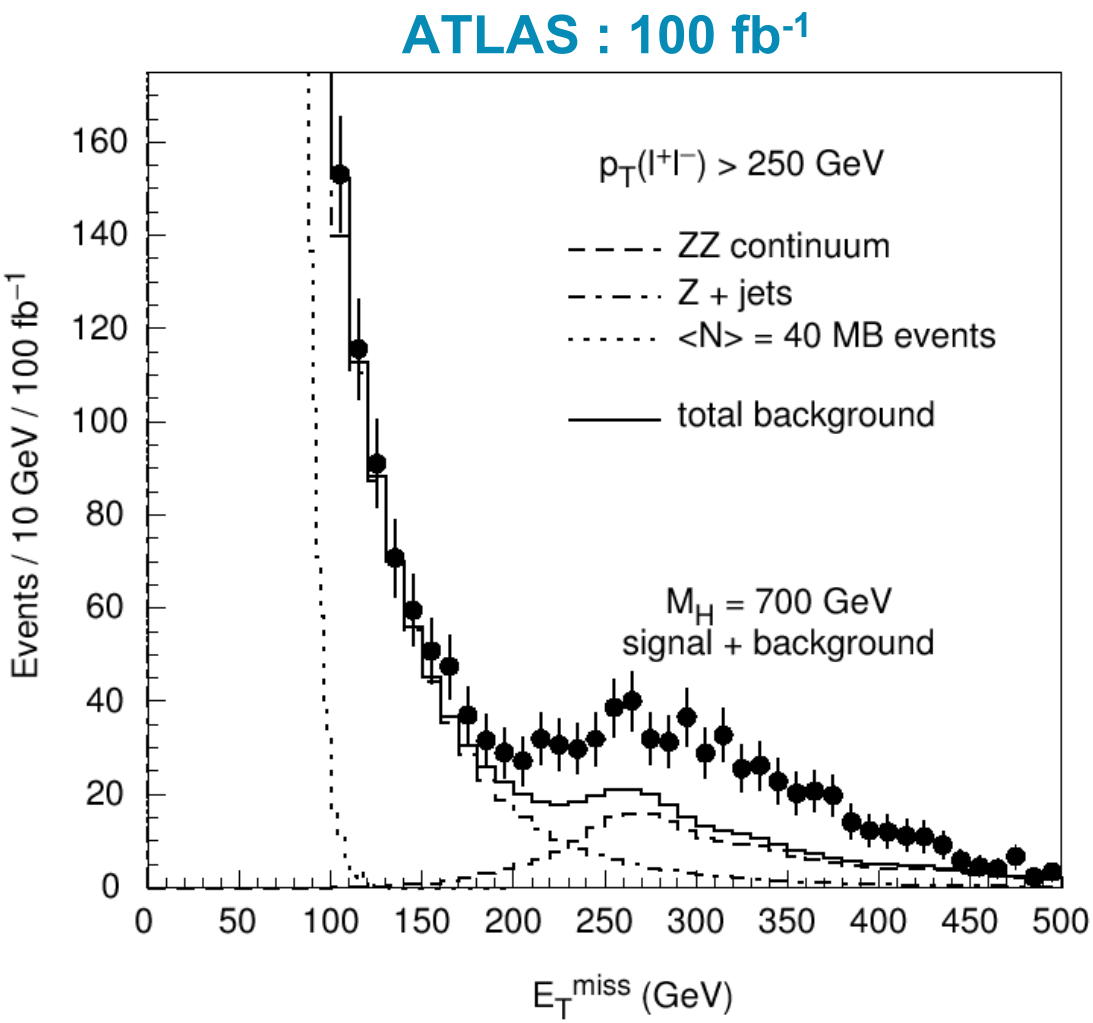
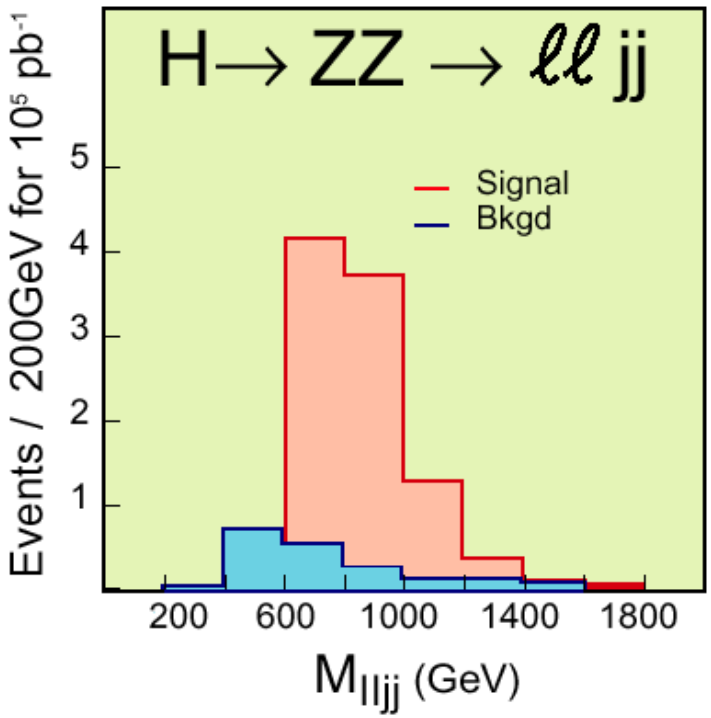

ATLAS : 100 fb-1
pT(l+l−) > 250 GeV
ZZ continuum
Z + jets
<N> = 40 MB events
total background
MH = 700 GeV
signal + background
Events / 10 GeV / 100 fb−1
ETmiss (GeV)
0
20
40
60
80
100
120
140
160
0
50
100
150
200
250
300
350
400
450
500

Fig.54


H→ ZZ → ℓℓ jj
Signal
Bkgd
Events / 200GeV for 10⁵ pb⁻¹
1
2
3
4
5
200
600
1000
1400
1800
M_lljj (GeV)

CMS

Fig.55

ATLAS

m_H = 1TeV, 30fb^{-1}

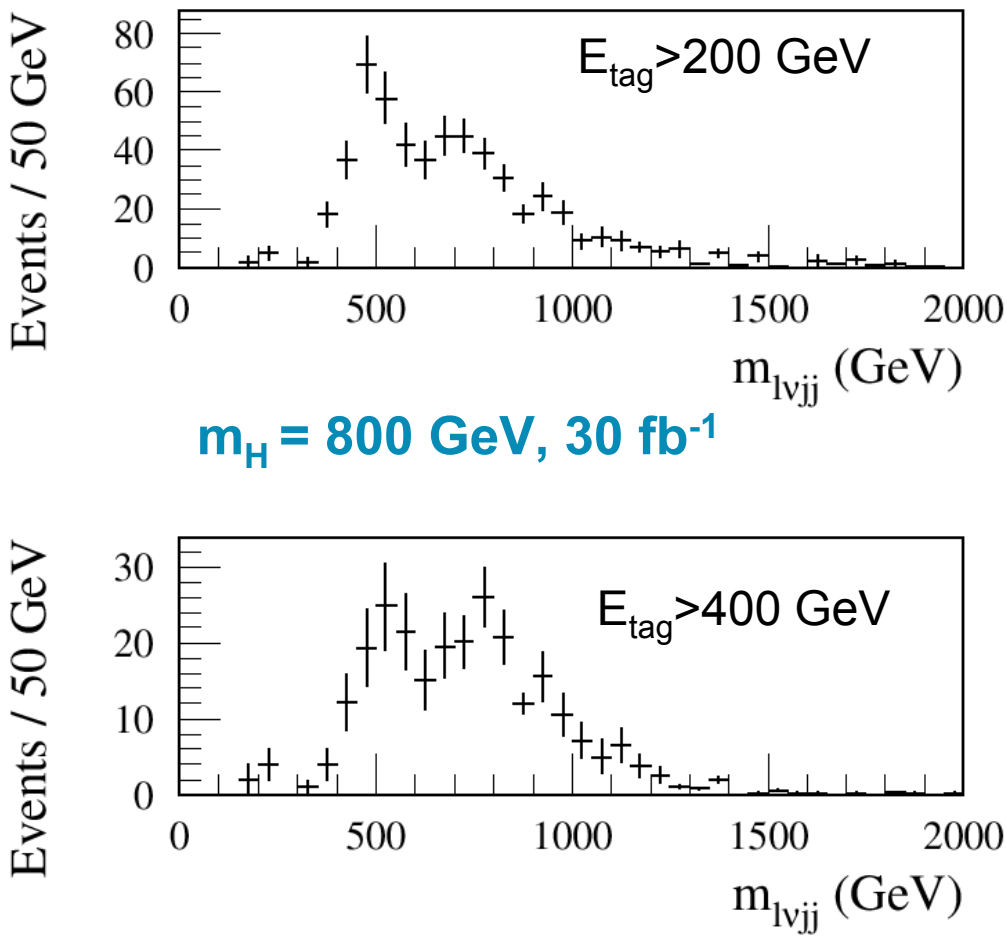


Fig.56

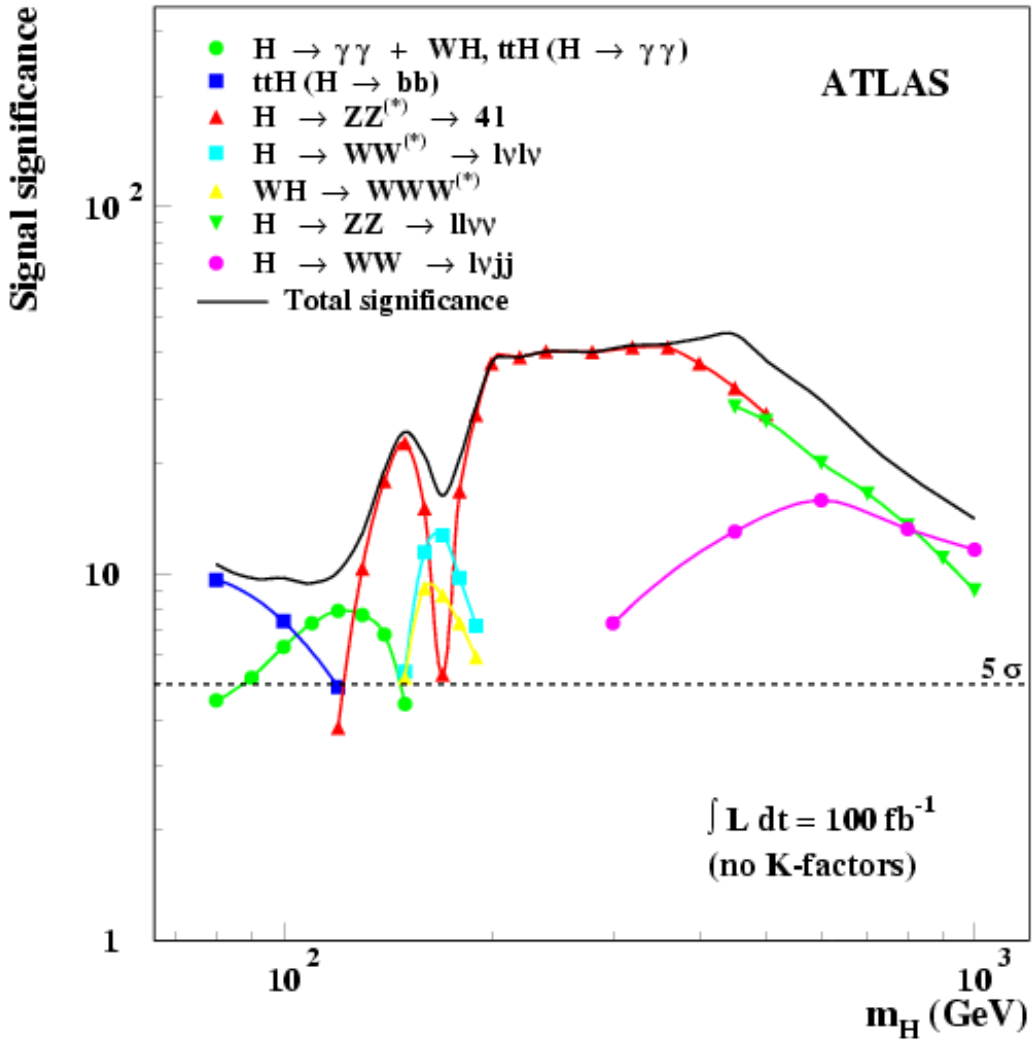

Signal significance
10^2
10
1
10^2
10^3
m_H (GeV)
$H \rightarrow \gamma\gamma$ + WH, ttH ($H \rightarrow \gamma\gamma$)
ttH ($H \rightarrow bb$)
$H \rightarrow ZZ^{(*)} \rightarrow 4l$
$H \rightarrow WW^{(*)} \rightarrow l\nu l\nu$
$WH \rightarrow WWW^{(*)}$
$H \rightarrow ZZ \rightarrow ll\nu\nu$
$H \rightarrow WW \rightarrow l\nu jj$
Total significance
ATLAS
5 σ
$\int L\,dt = 100\ fb^{-1}$
(no K-factors)

Fig.57

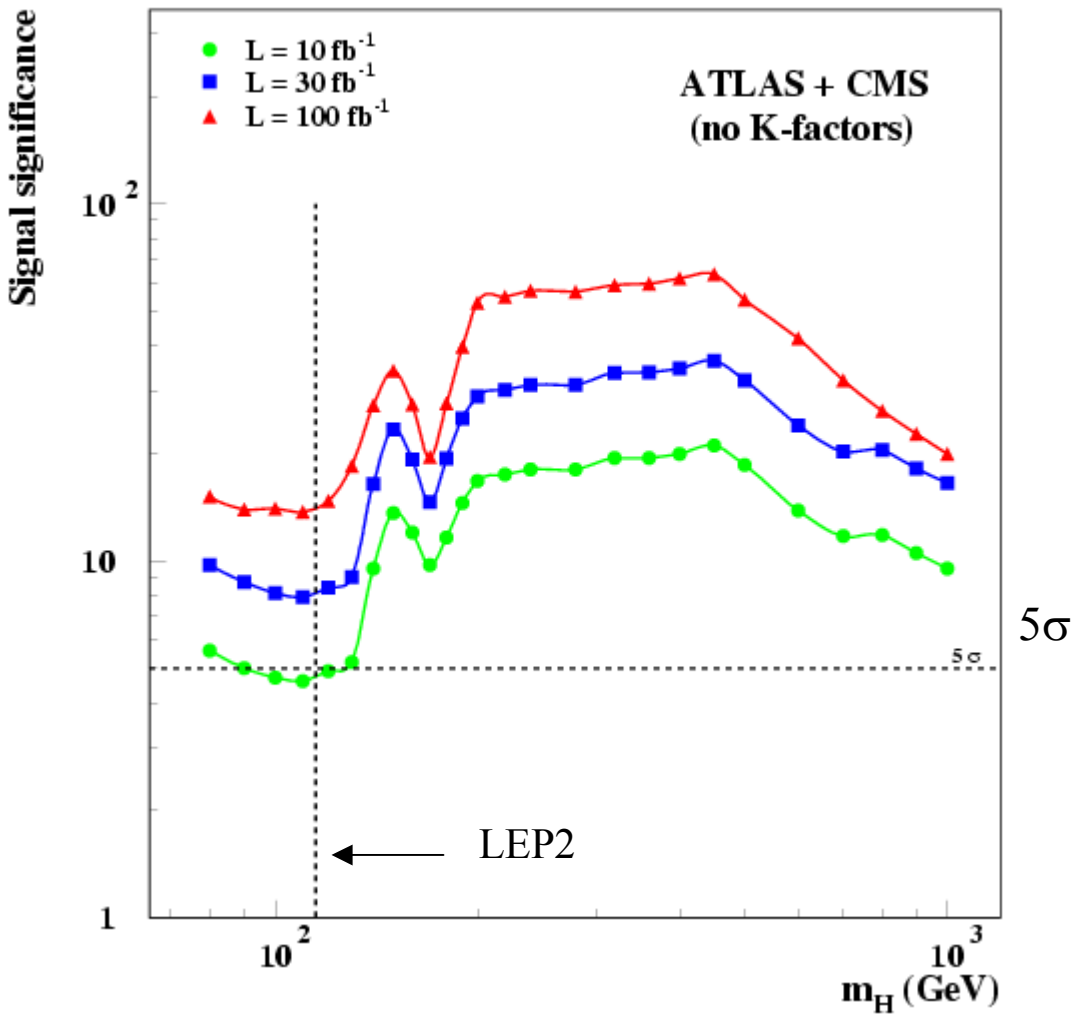

Signal significance
L = 10 fb-1
L = 30 fb-1
L = 100 fb-1
ATLAS + CMS
(no K-factors)
10 2
10
1
5σ
LEP2
10 2
10 3
mH (GeV)

Fig.58

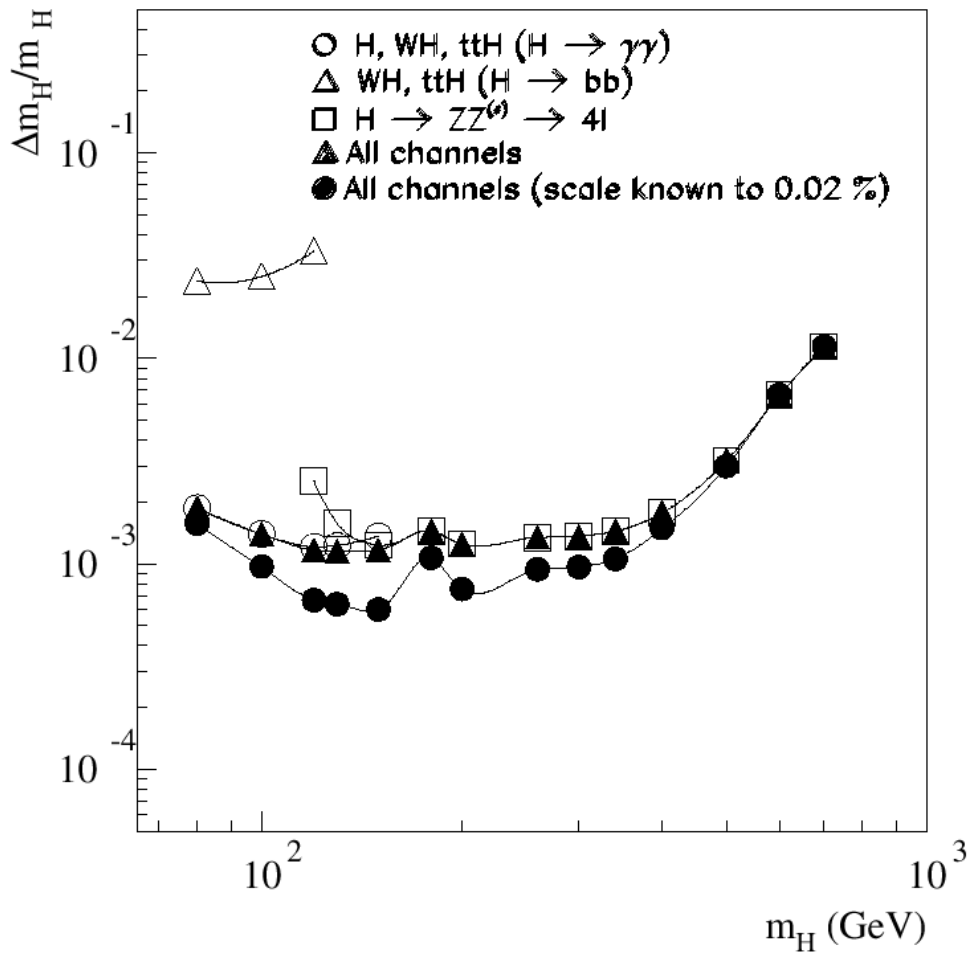

H, WH, ttH (H → γγ)
WH, ttH (H → bb)
H → ZZ(*) → 4l
All channels
All channels (scale known to 0.02 %)
Δm_H/m_H
10^-1
10^-2
10^-3
10^-4
10^2
10^3
m_H (GeV)

Fig.59

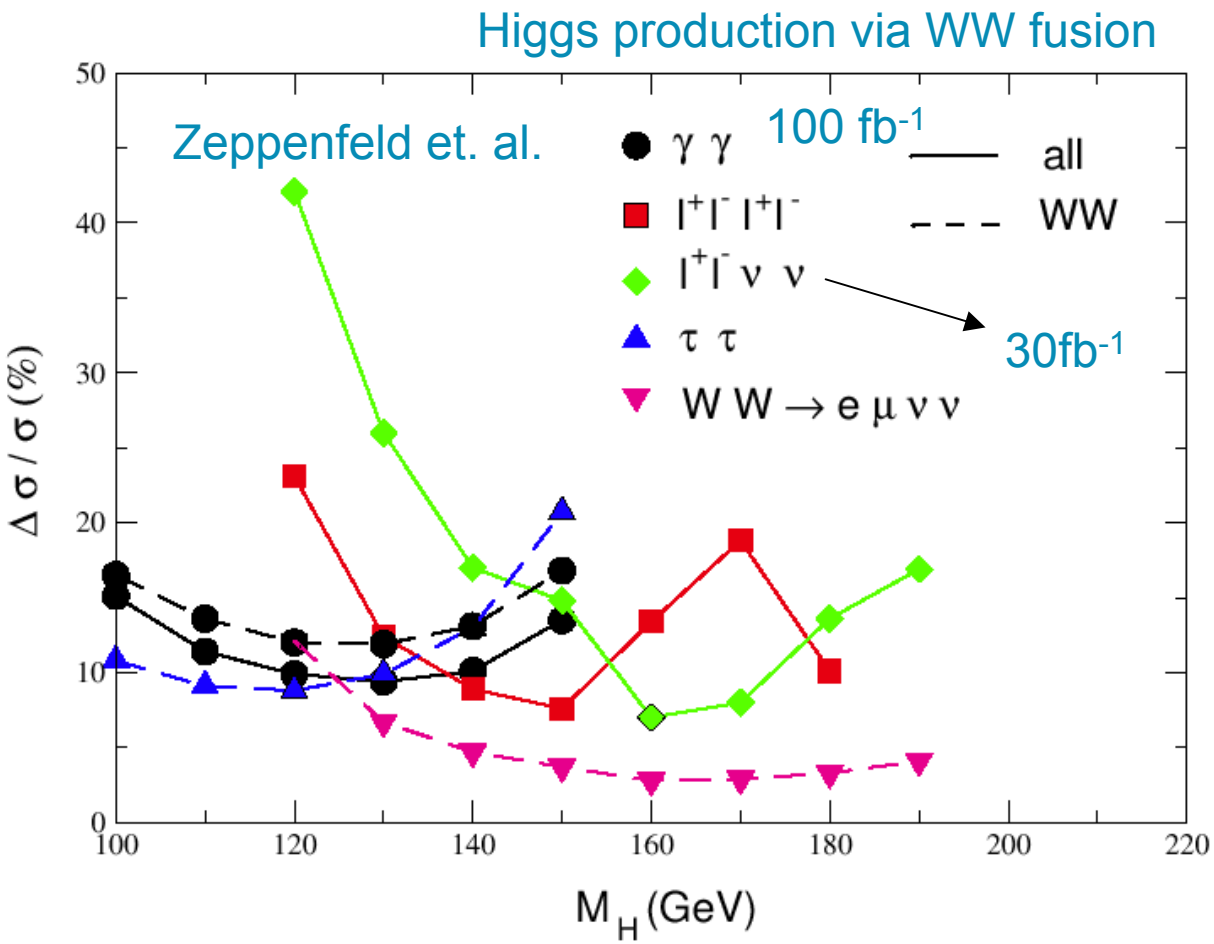
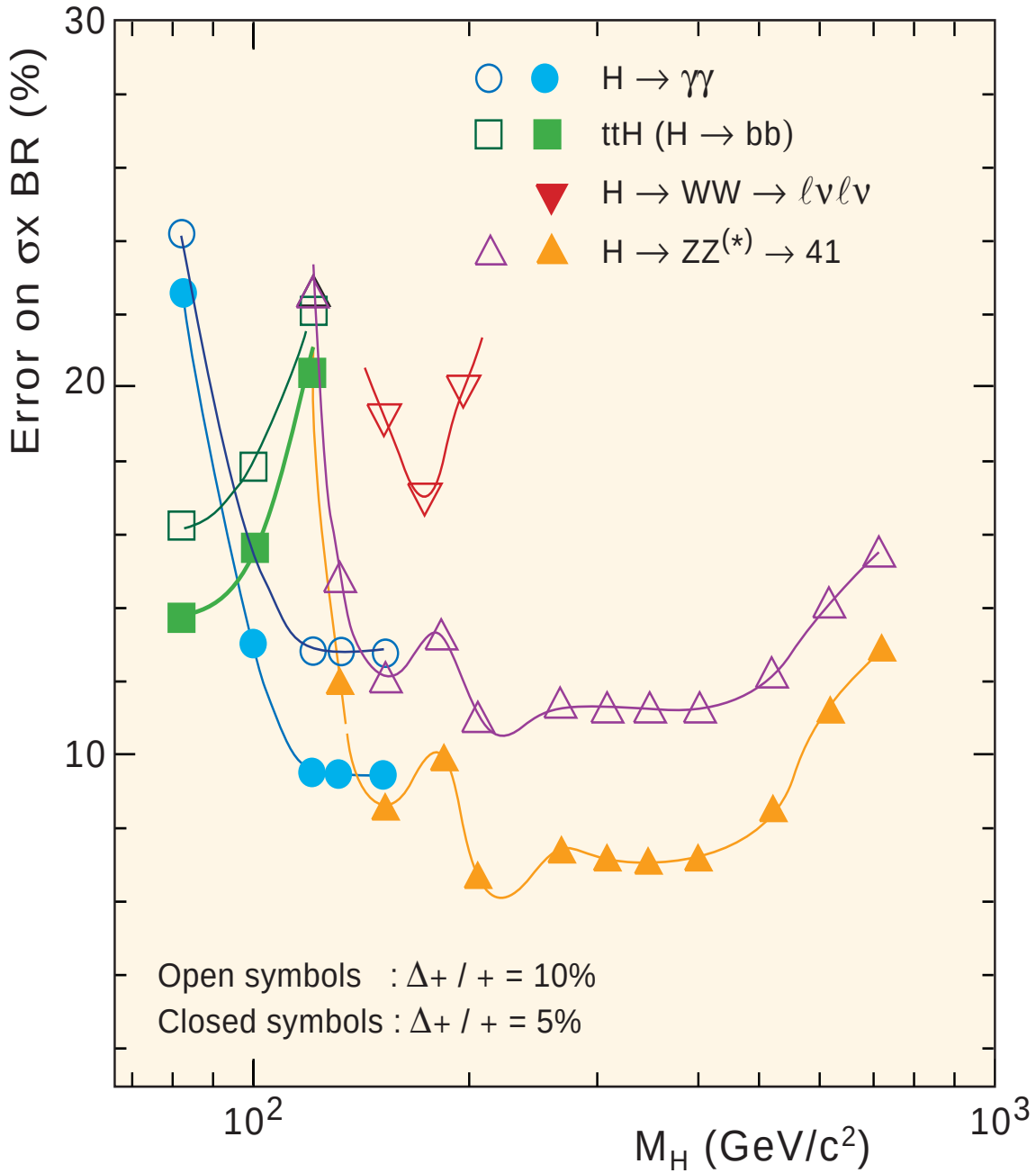

Higgs production via WW fusion
Zeppenfeld et. al.
100 fb-1
γ γ
all
l+l- l+l-
WW
l+l- ν ν
30fb-1
τ τ
W W → e μ ν ν
Δ σ / σ (%)
M H (GeV)
0
10
20
30
40
50
100
120
140
160
180
200
220

Fig.60

Fig.61


Error on σx BR (%)
30
20
10
10^2
10^3
M_H (GeV/c^2)
H → γγ
ttH (H → bb)
H → WW → ℓνℓν
H → ZZ(*) → 41
Open symbols : Δ+ / + = 10%
Closed symbols : Δ+ / + = 5%

Mass spectra for M_{SUSY}>1TeV

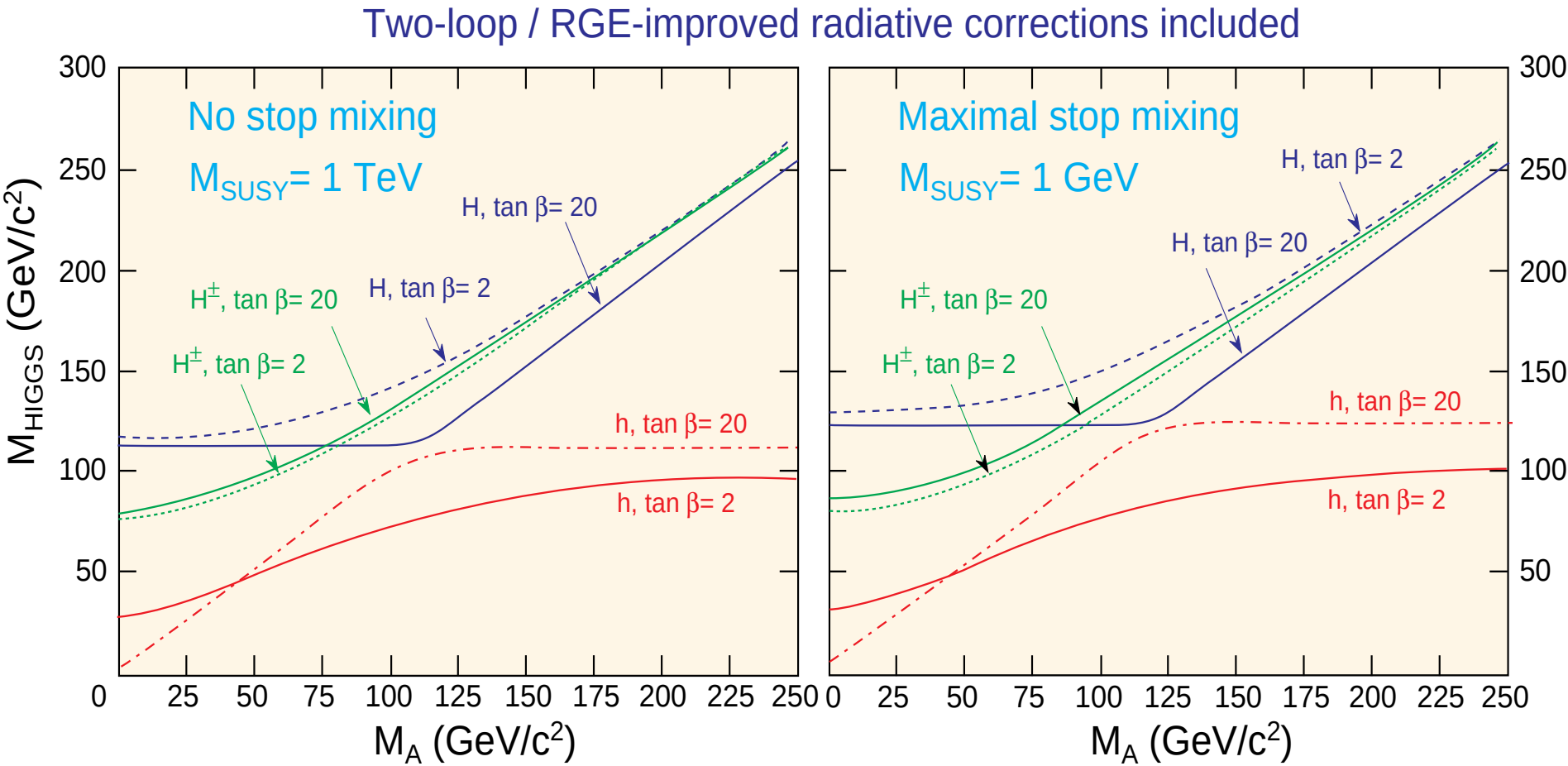


Fig.62

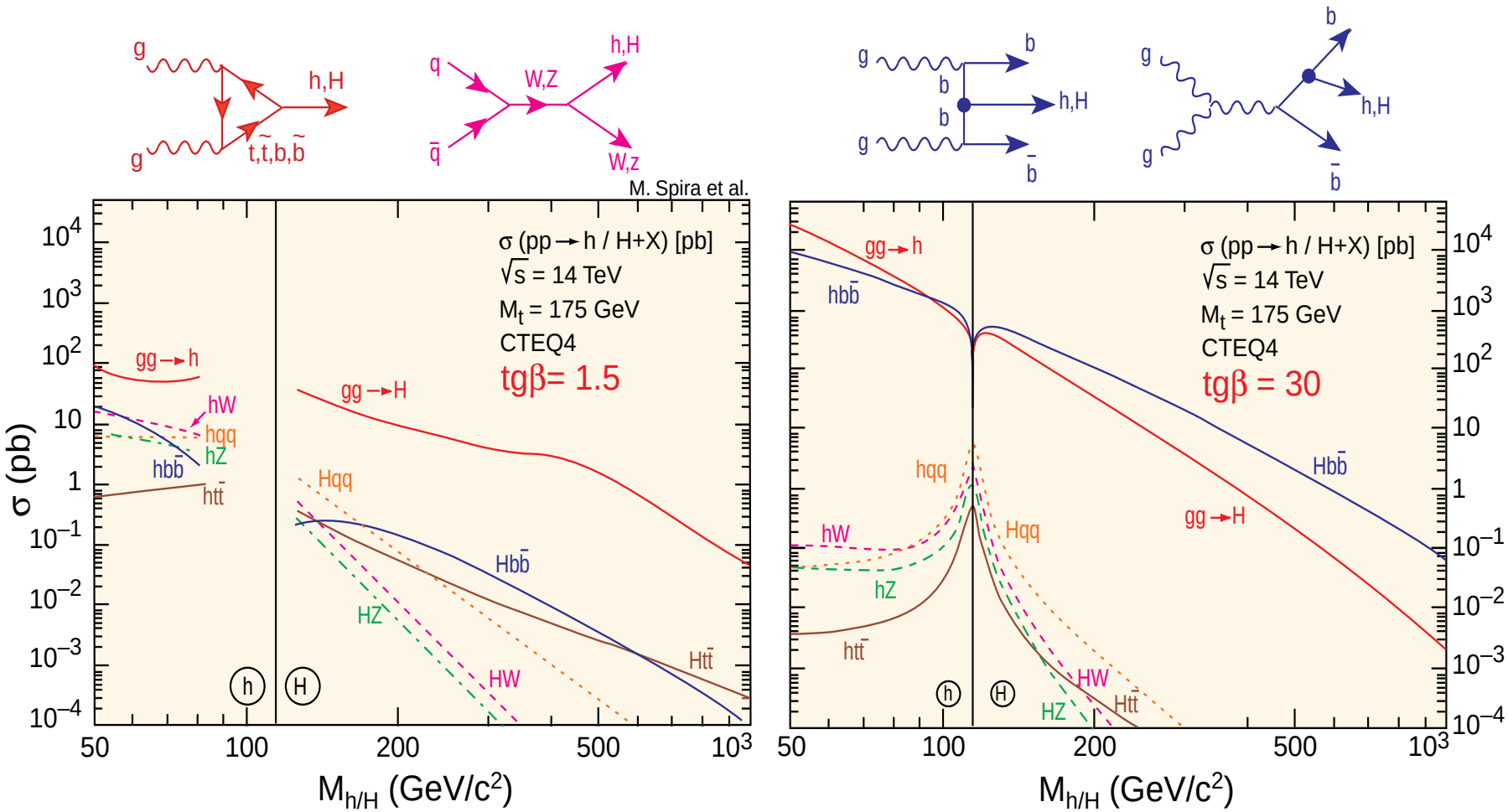
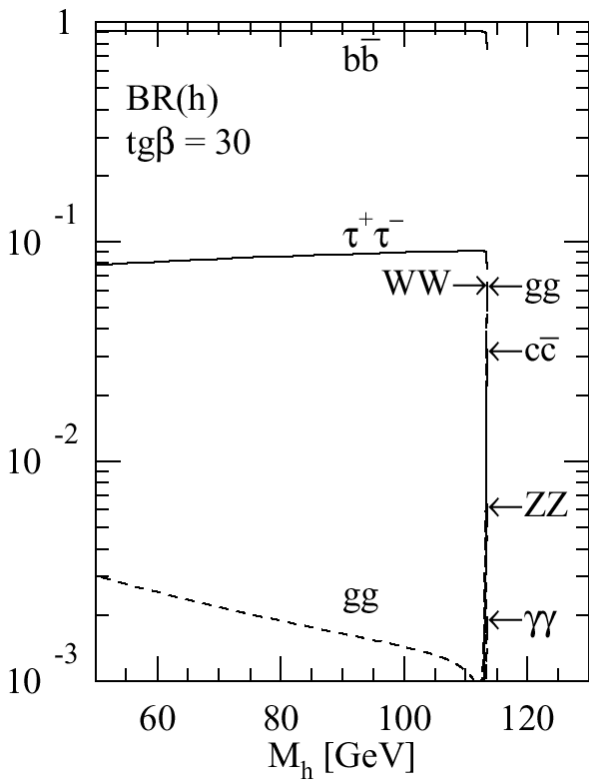
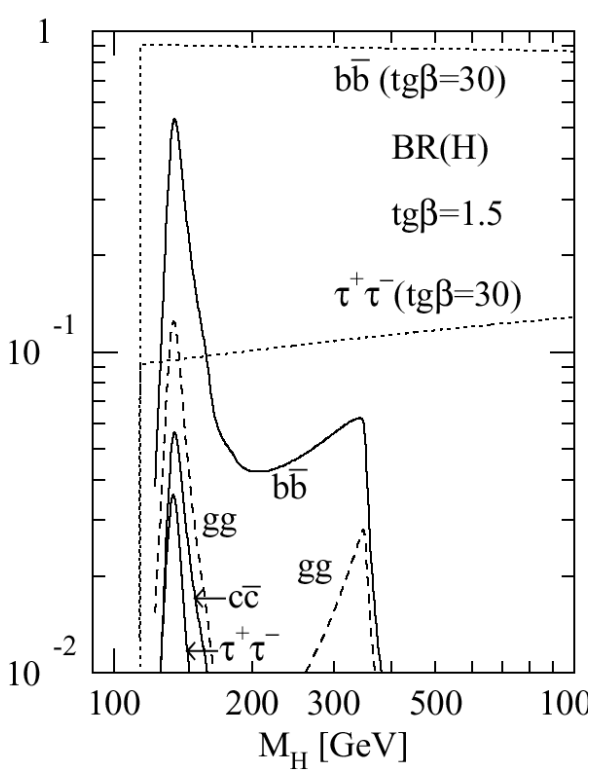

g
g
h,H
t,t̃,b,b̃
q
q̄
W,Z
h,H
W,z
M. Spira et al.
σ (pp → h / H+X) [pb]
√s = 14 TeV
M_t = 175 GeV
CTEQ4
tgβ= 1.5
gg → h
hW
hqq
hZ
hbb̄
htt̄
gg → H
Hqq
Hbb̄
HZ
HW
Htt̄
h
H
σ (pb)
M_h/H (GeV/c²)
b
b
b̄
b̄
σ (pp → h / H+X) [pb]
√s = 14 TeV
M_t = 175 GeV
CTEQ4
tgβ = 30
gg → h
hbb̄
hqq
hW
hZ
htt̄
gg → H
Hbb̄
Hqq
HW
HZ
Htt̄
M_h/H (GeV/c²)

Fig.63

No mixing, M_S=1TeV





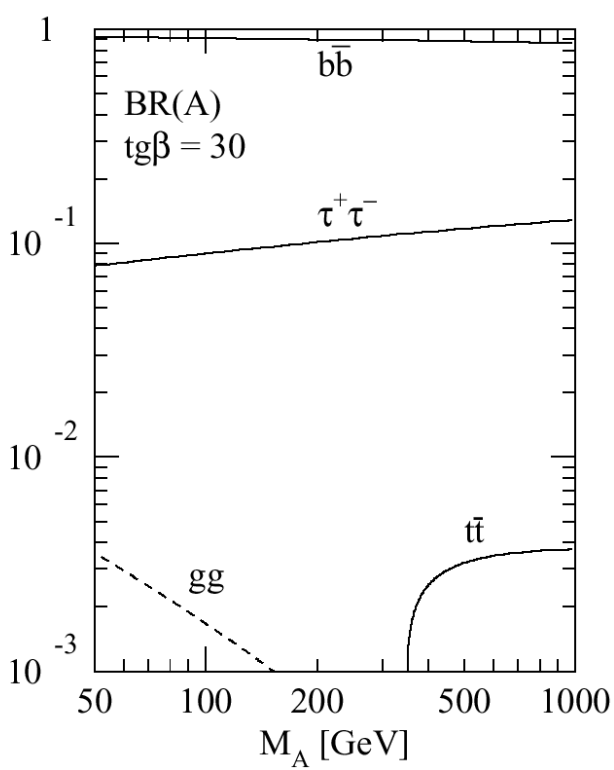


Fig.64

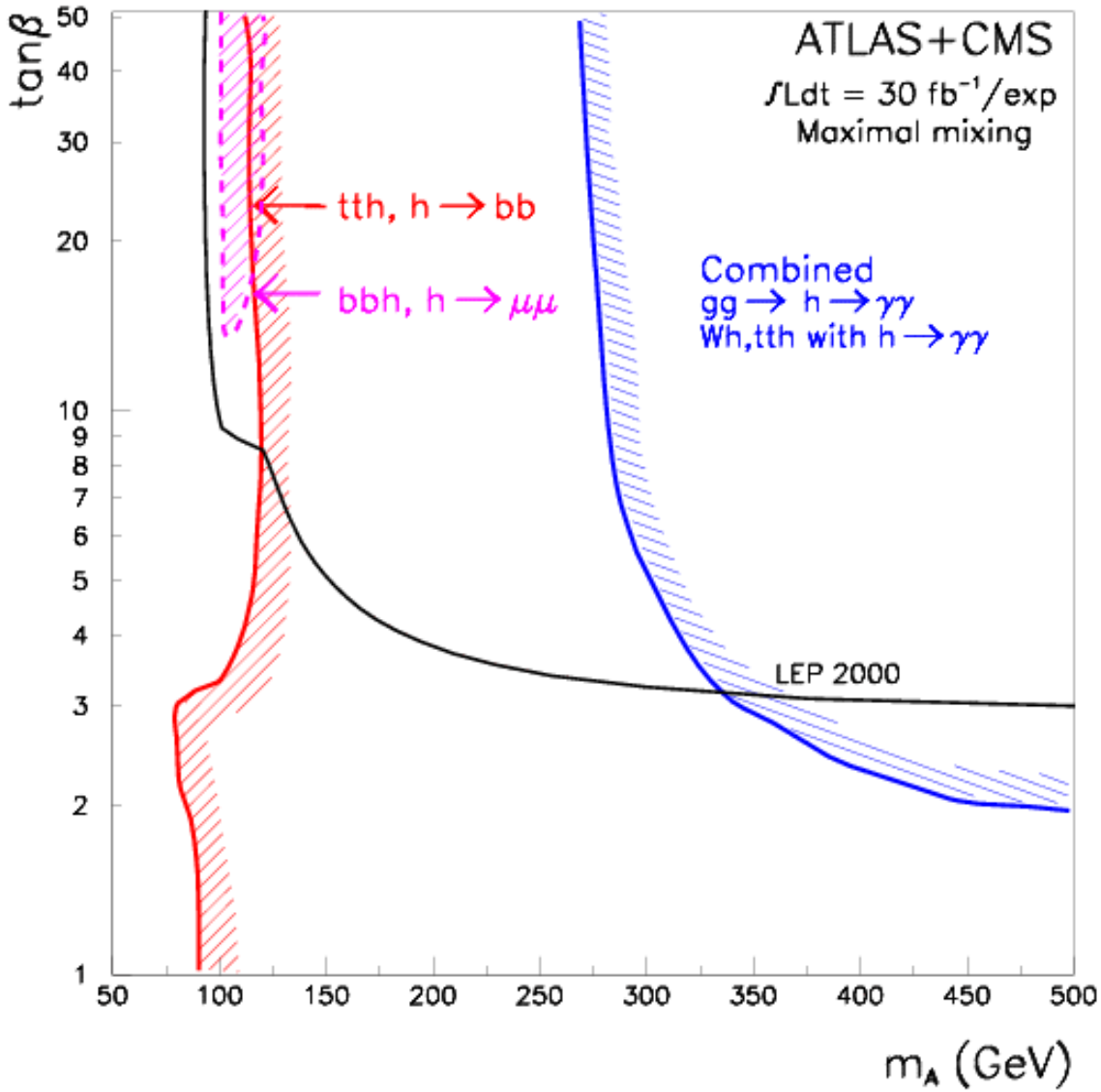

ATLAS+CMS
∫Ldt = 30 fb⁻¹/exp
Maximal mixing
tth, h → bb
bbh, h → μμ
Combined
gg → h → γγ
Wh,tth with h → γγ
LEP 2000
tanβ
m_A (GeV)
50
40
30
20
10
9
8
7
6
5
4
3
2
1
50
100
150
200
250
300
350
400
450
500

Fig.65

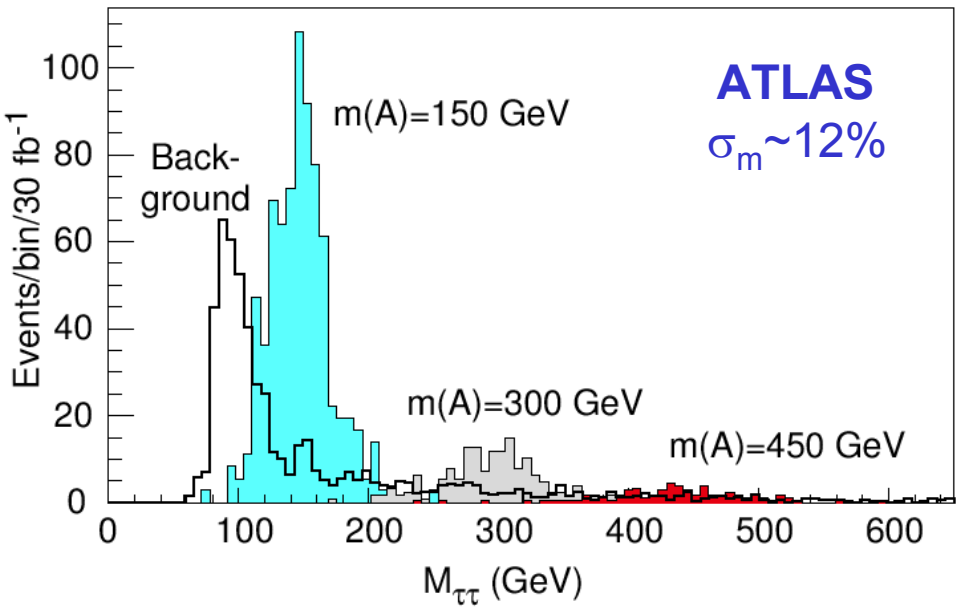


Fig.66a

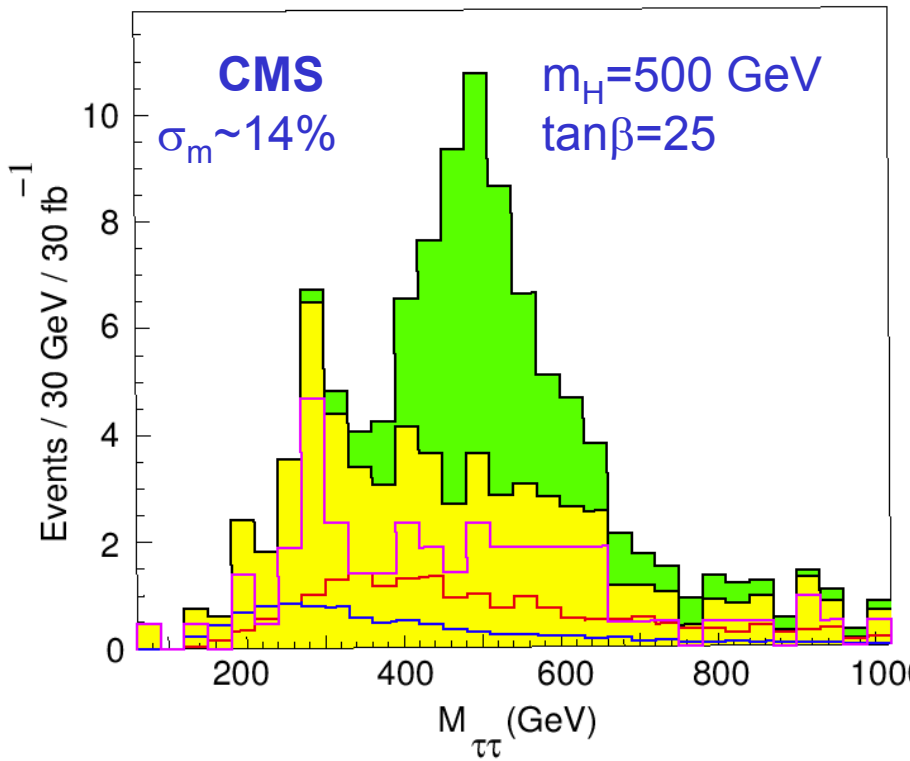


Fig.66b

CMS 30 fb^{-1}

Fig.67a

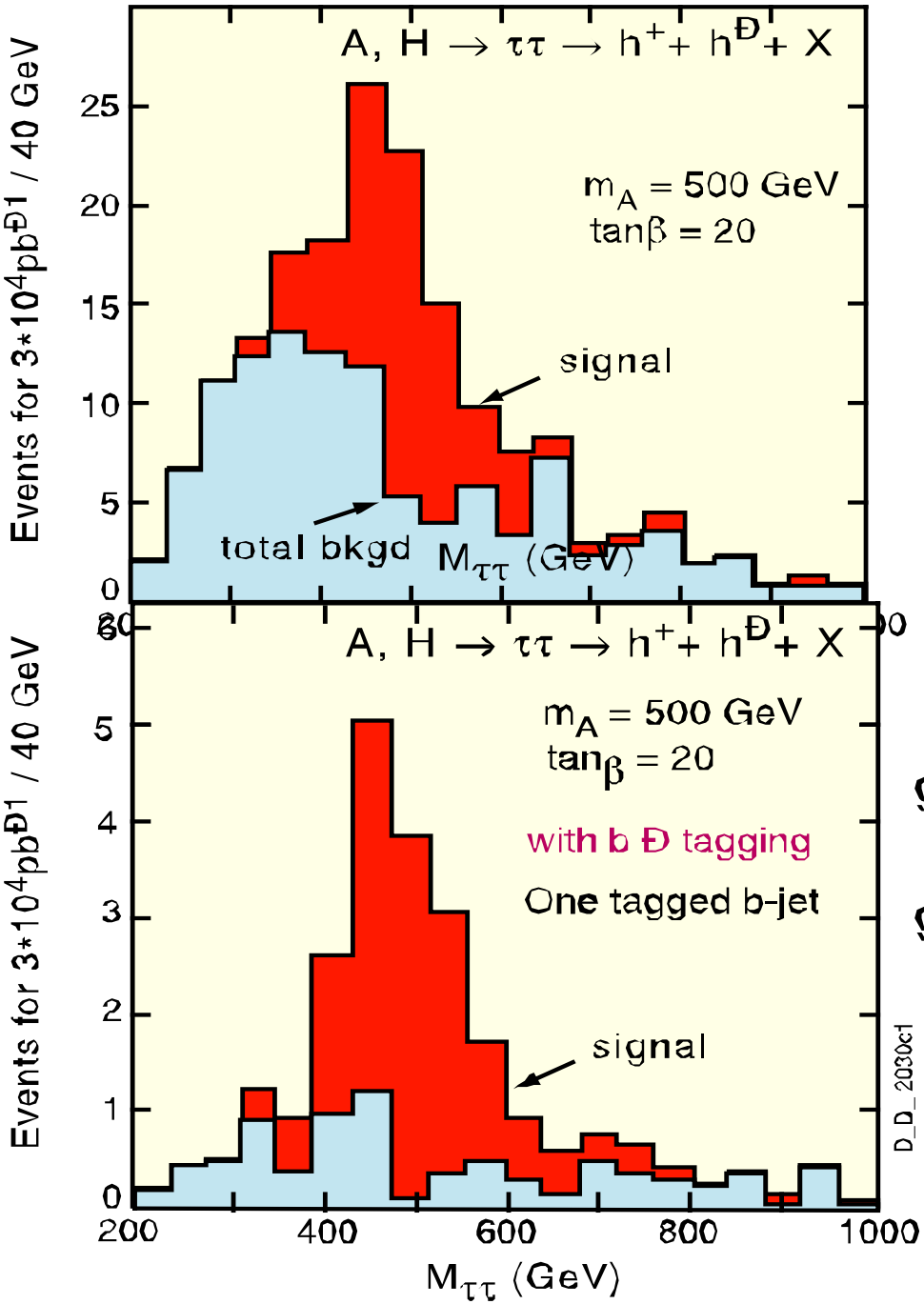


Fig.67b

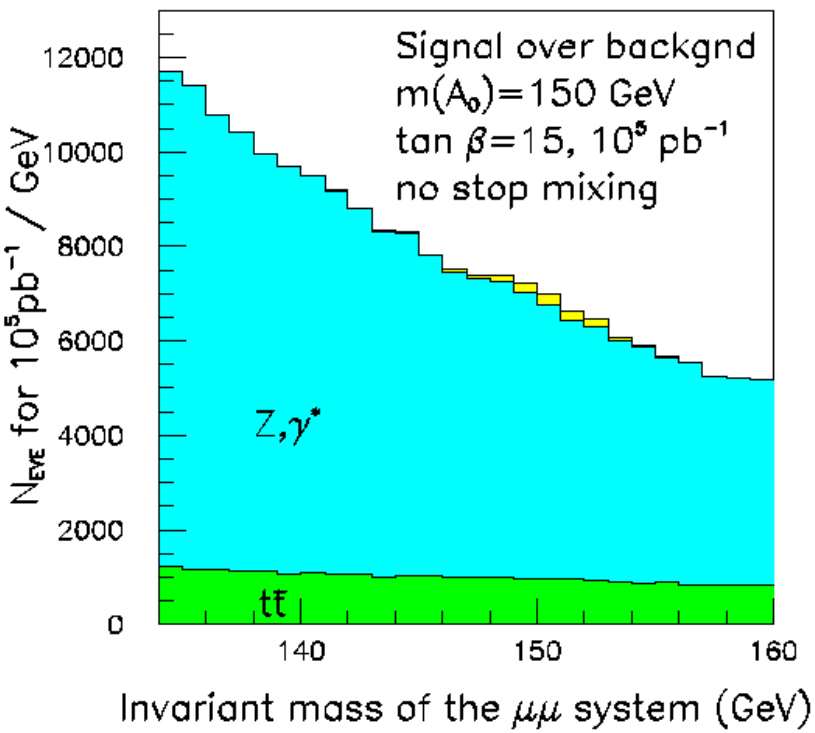


Fig.68a

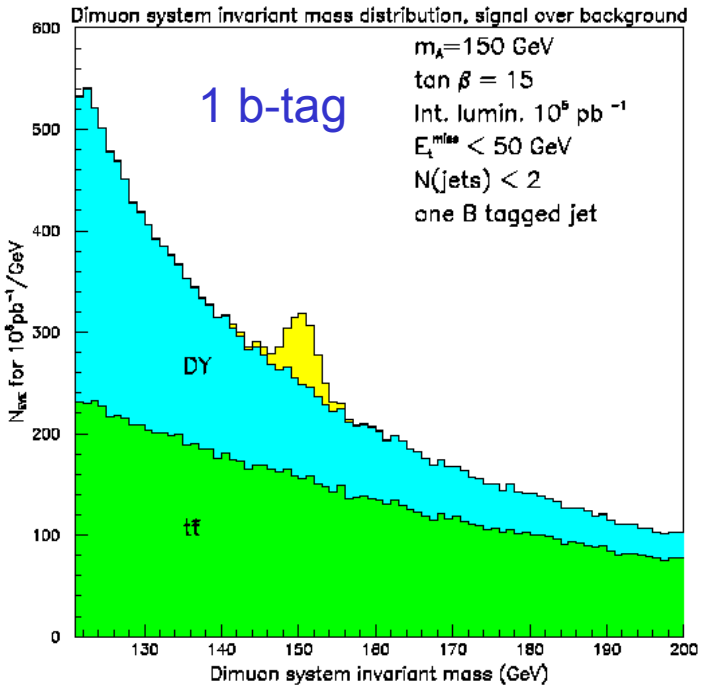


Fig.68b

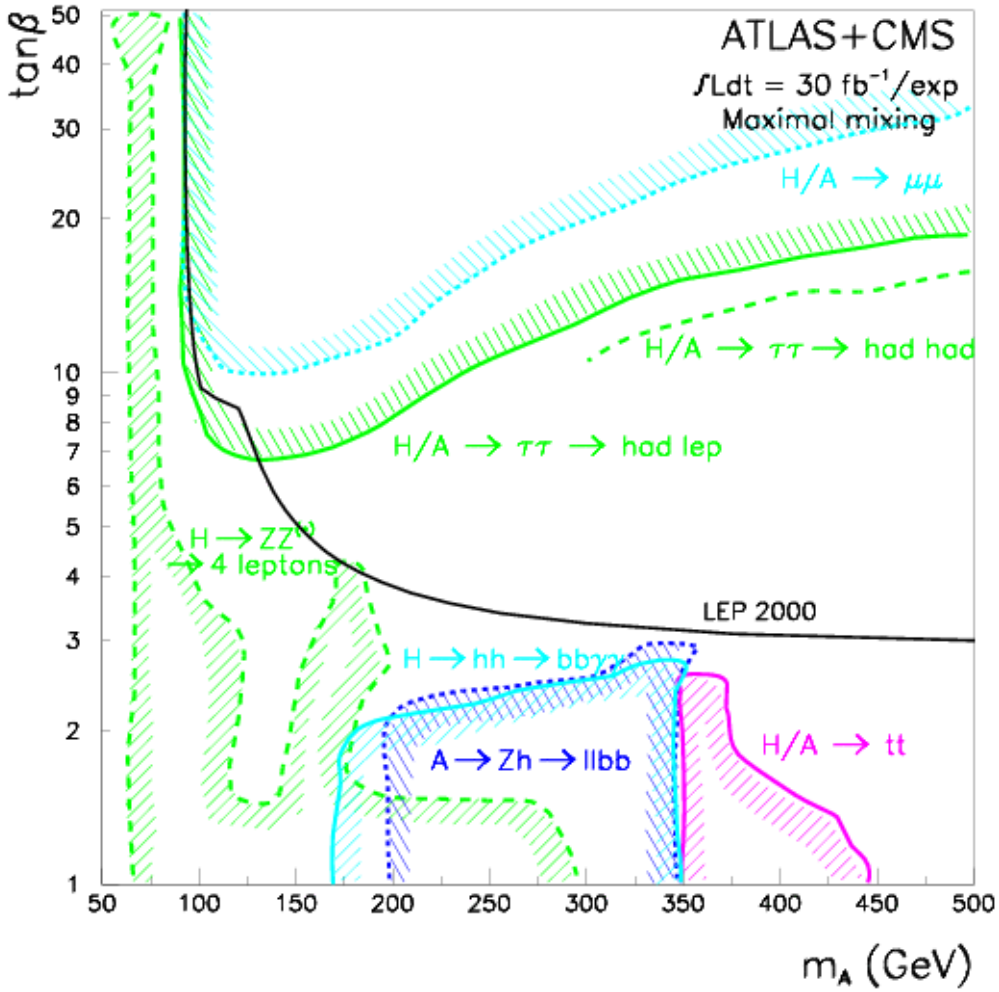

ATLAS+CMS
∫Ldt = 30 fb⁻¹/exp
Maximal mixing
H/A → μμ
H/A → ττ → had had
H/A → ττ → had lep
H → ZZ(*) → 4 leptons
LEP 2000
H → hh → bbγγ
A → Zh → llbb
H/A → tt
tanβ
m_A (GeV)

Fig.69

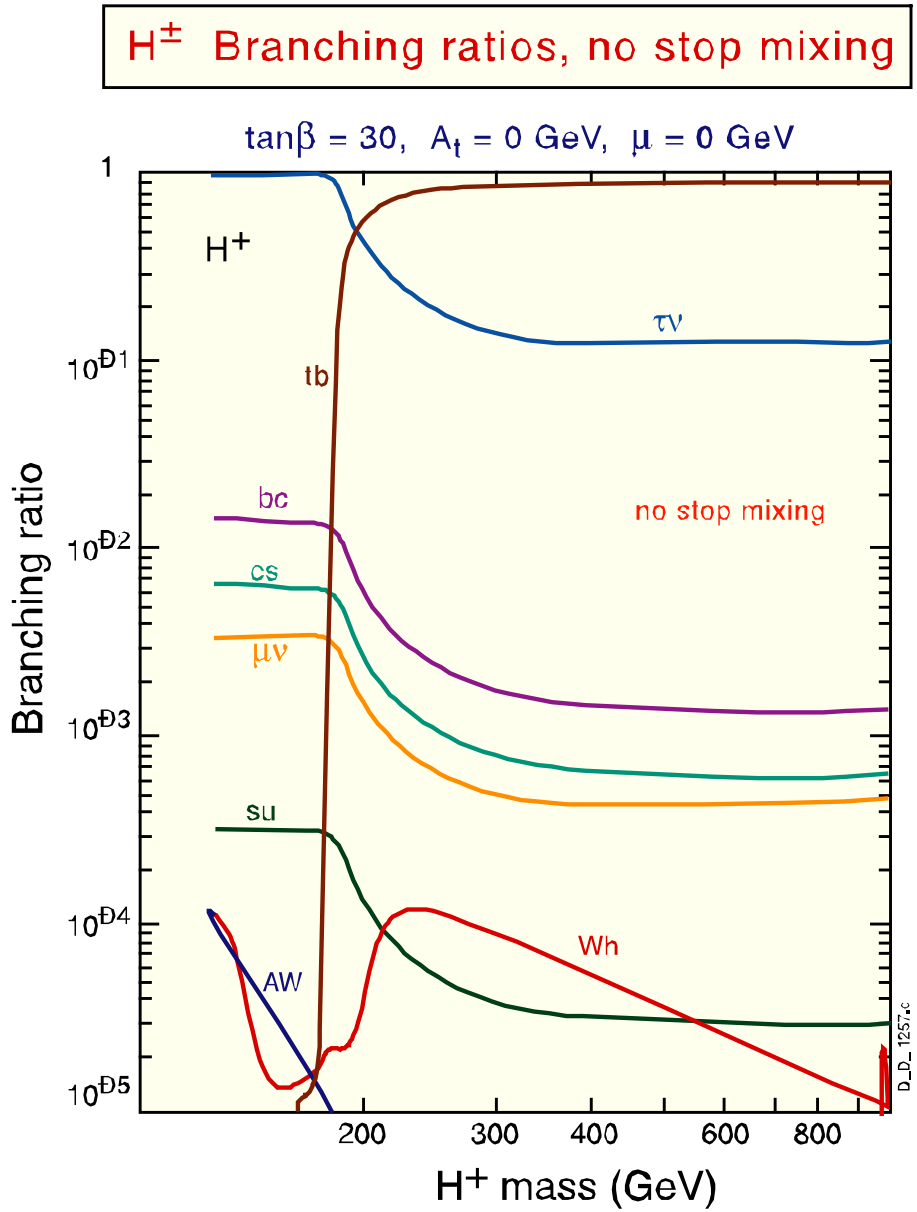

H± Branching ratios, no stop mixing
tanβ = 30, A_t = 0 GeV, μ = 0 GeV
H+
τν
tb
bc
cs
μν
su
AW
Wh
no stop mixing
Branching ratio
1
10Đ1
10Đ2
10Đ3
10Đ4
10Đ5
200
300
400
600
800
H+ mass (GeV)
D_D_1257.c

Fig.70

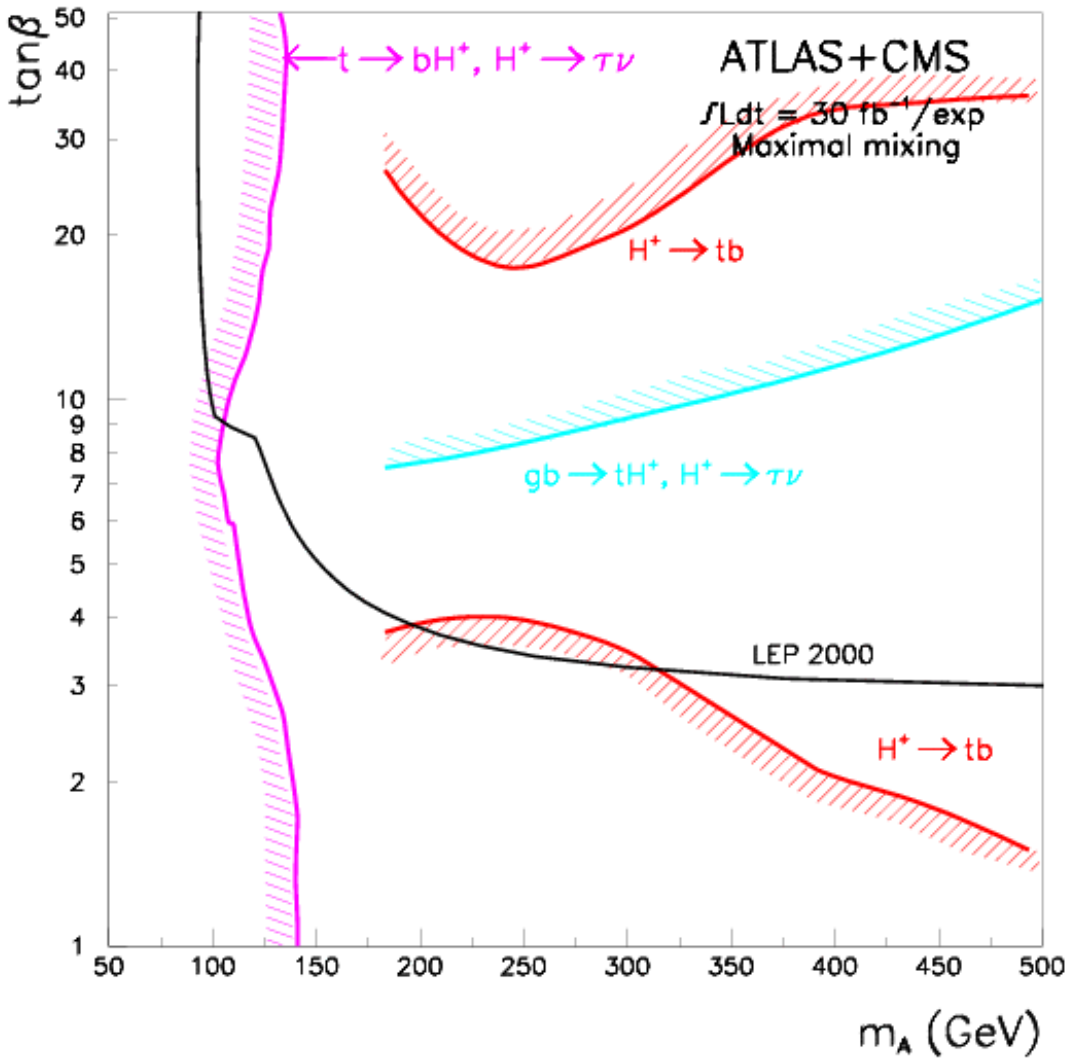
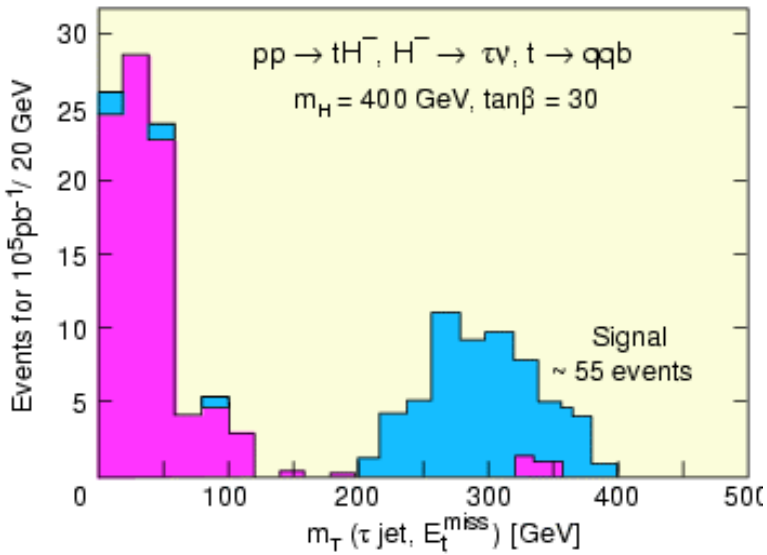

tanβ
50
40
30
20
10
9
8
7
6
5
4
3
2
1
50
100
150
200
250
300
350
400
450
500
m_A (GeV)
t → bH⁺, H⁺ → τν
ATLAS+CMS
∫Ldt = 30 fb⁻¹/exp
Maximal mixing
H⁺ → tb
gb → tH⁺, H⁺ → τν
LEP 2000
H⁺ → tb

Fig.71

a


pp → tH⁻, H⁻ → τν, t → qqb
m_H = 400 GeV, tanβ = 30
Signal
~ 55 events
Events for 10^5 pb^-1 / 20 GeV
m_T (τ jet, E_t^miss) [GeV]

b

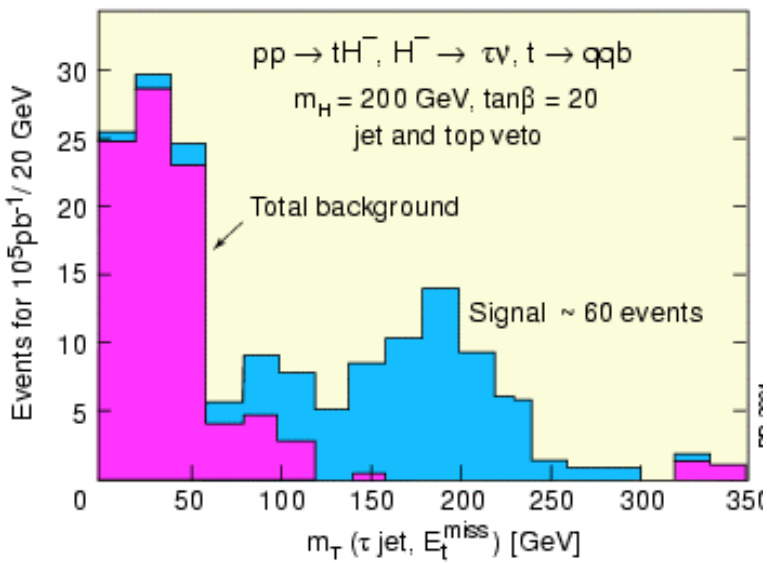
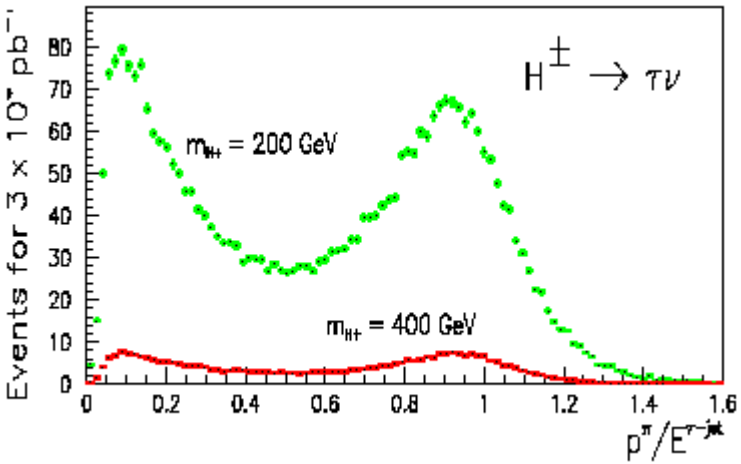
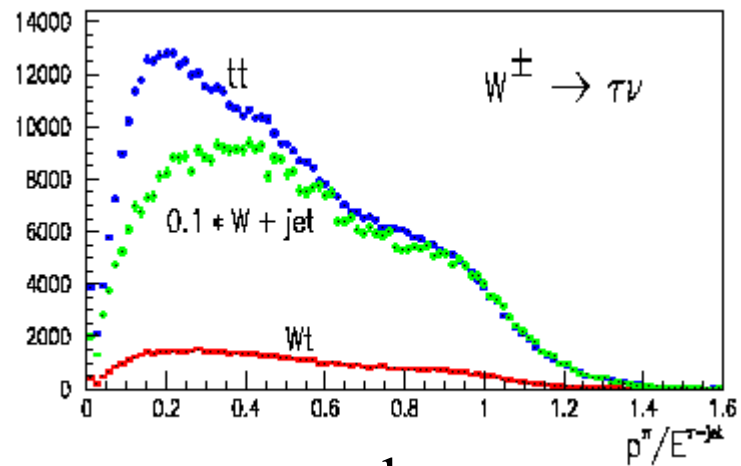

pp → tH⁻, H⁻ → τν, t → qqb
m_H = 200 GeV, tanβ = 20
jet and top veto
Total background
Signal ~ 60 events
Events for 10^5 pb^-1 / 20 GeV
m_T (τ jet, E_t^miss) [GeV]

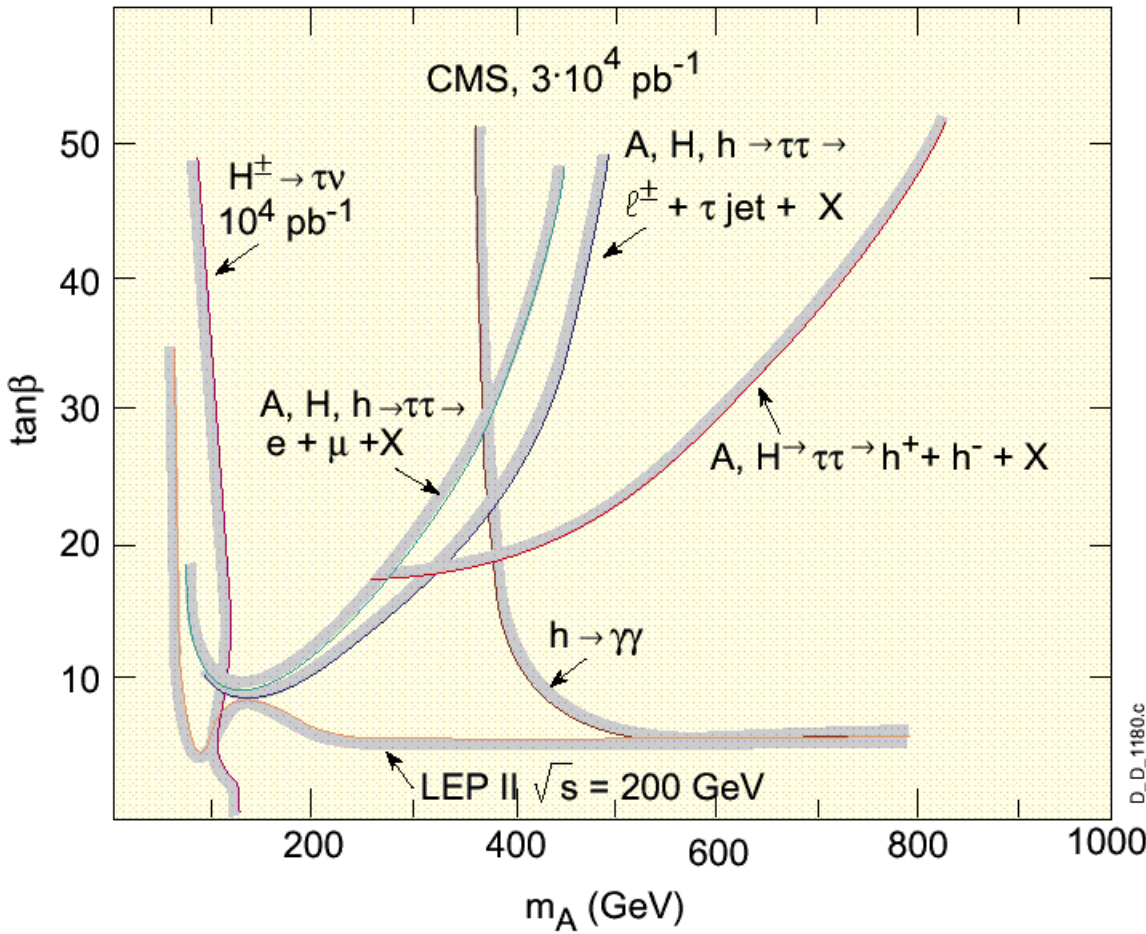
Fig.72

a


Events for 3 x 10⁷ pb⁻¹
H± → τν
m_H+ = 200 GeV
m_H+ = 400 GeV
p^π/E^τ-jet


tt
W± → τν
0.1 * W + jet
Wt
p^π/E^τ-jet

b


CMS, 3·10⁴ pb⁻¹
H± → τν
10⁴ pb⁻¹
A, H, h → ττ →
ℓ± + τ jet + X
A, H, h → ττ →
e + μ +X
A, H → ττ → h⁺ + h⁻ + X
h → γγ
LEP II √s = 200 GeV
tanβ
m_A (GeV)
D_D_1180.c

c

Fig.73

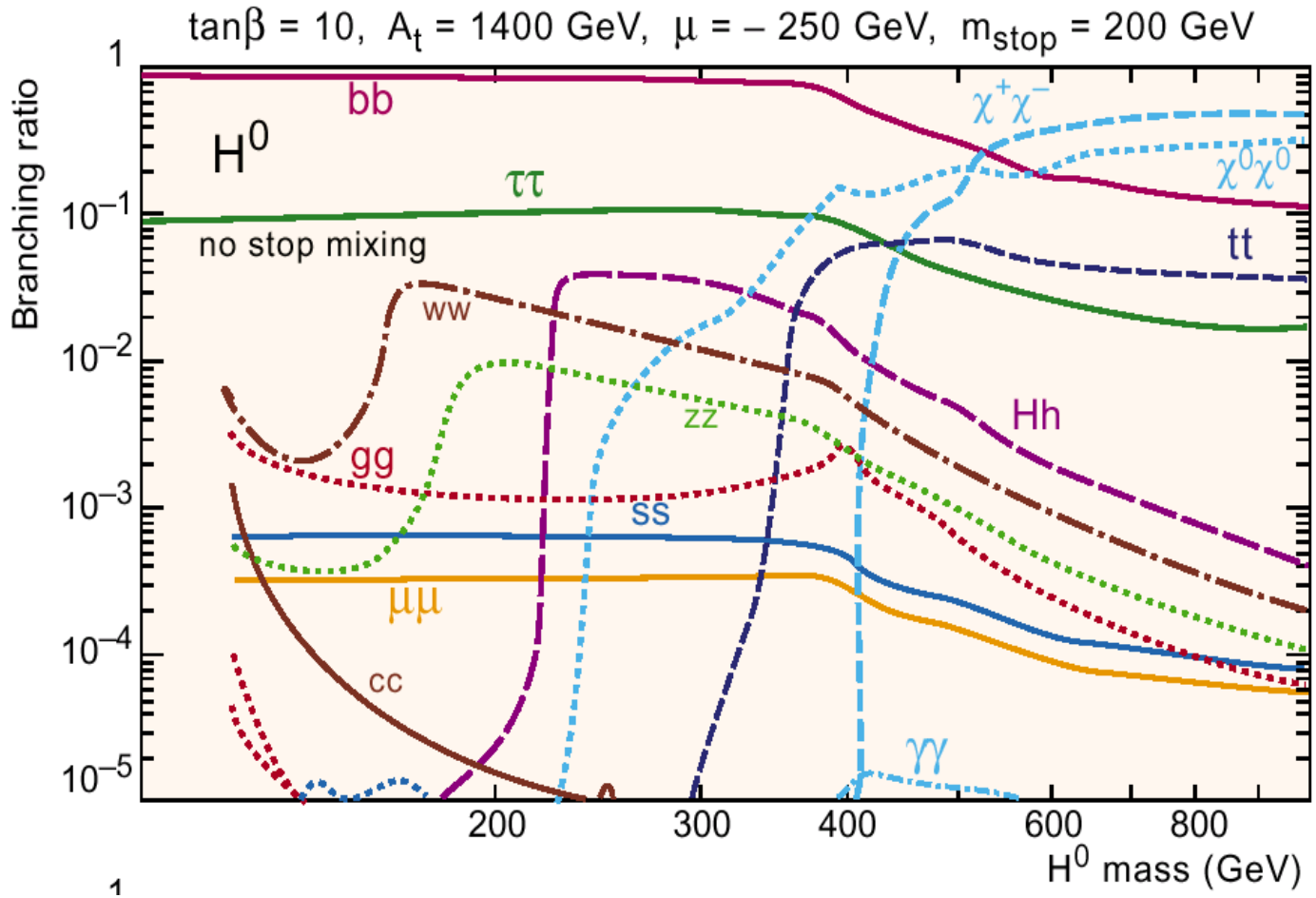
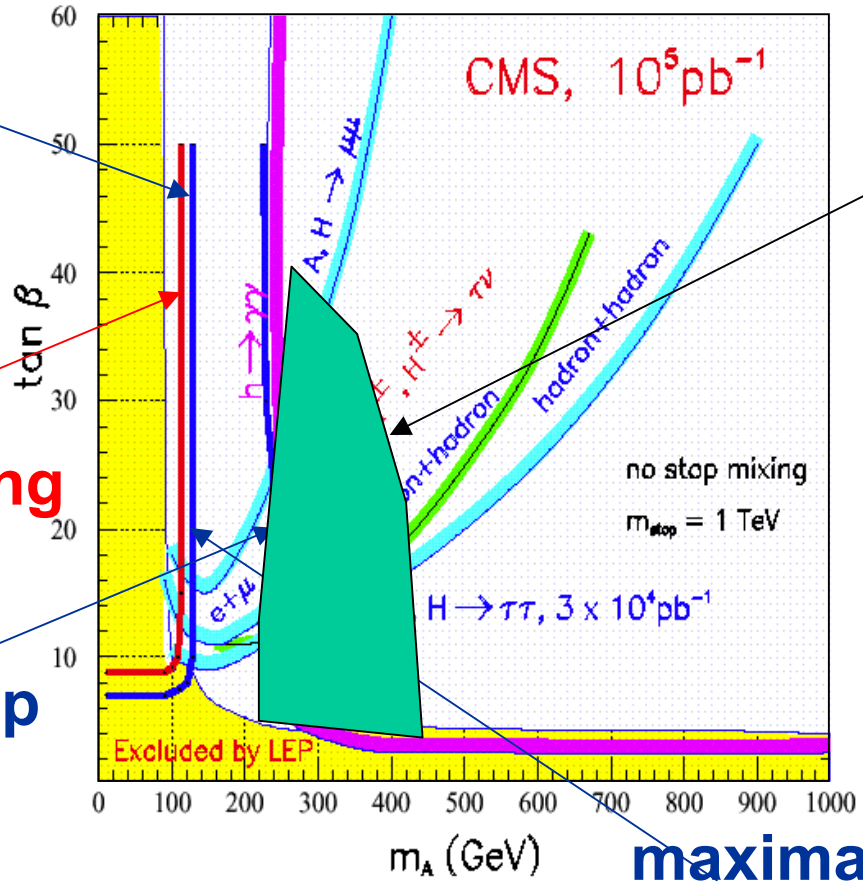

tanβ = 10, A_t = 1400 GeV, μ = – 250 GeV, m_{stop} = 200 GeV
Branching ratio
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
H^0
bb
ττ
no stop mixing
ww
gg
zz
ss
μμ
cc
$\chi^+\chi^-$
$\chi^0\chi^0$
tt
Hh
γγ
200
300
400
600
800
H^0 mass (GeV)

Fig.74

Adding $b\bar{b}$ on the τ modes can "close" the plane

Wh

$(e/\mu)\nu$ $b\bar{b}$



Area covered by $H^0 \to \tilde{\chi}^0_2 \tilde{\chi}^0_2$, $\to 4\ell$eptons 100 fb^{-1}

No stop mixing

maximal stop mixing with 30 fb^{-1}

maximal stop mixing with 300 fb^{-1}

Fig.75

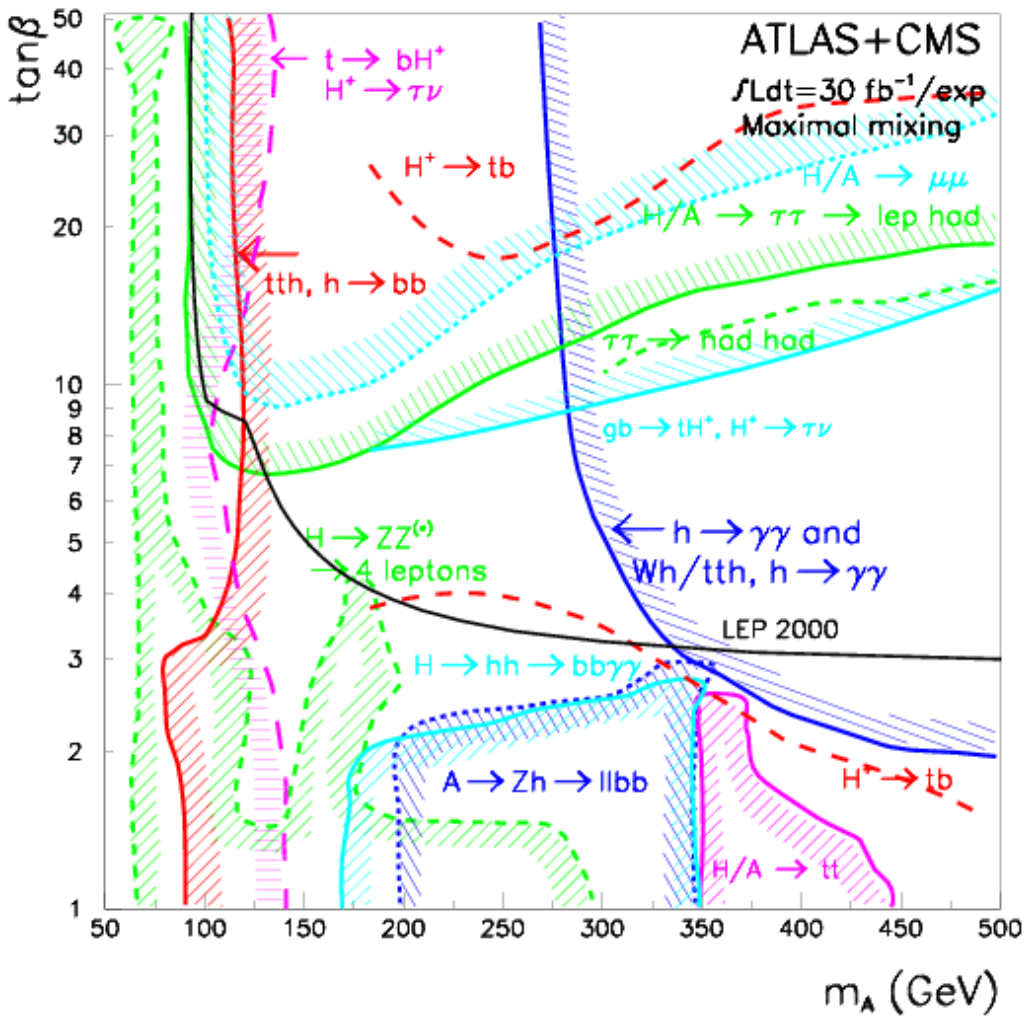
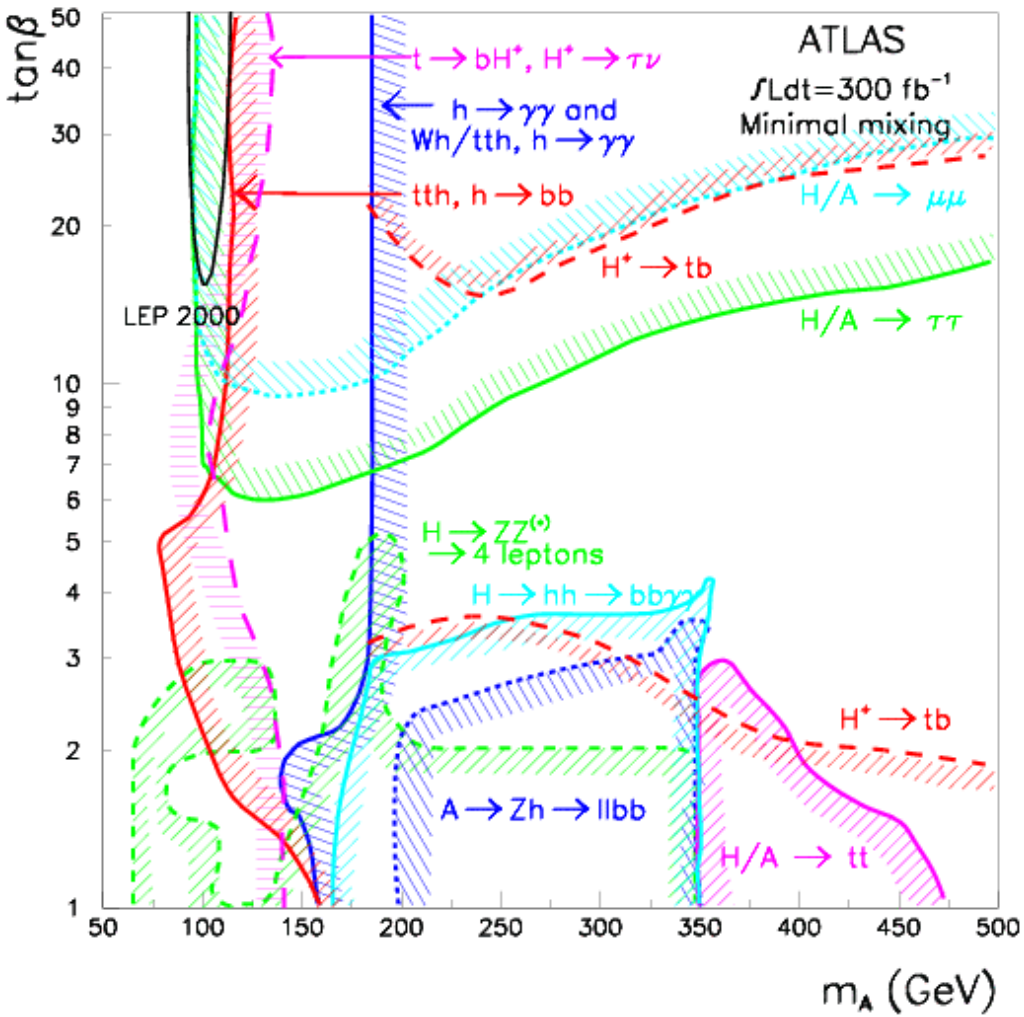

ATLAS+CMS
∫Ldt=30 fb⁻¹/exp
Maximal mixing
tanβ
m_A (GeV)
t → bH⁺
H⁺ → τν
H⁺ → tb
H/A → μμ
H/A → ττ → lep had
tth, h → bb
ττ → had had
gb → tH⁺, H⁺ → τν
H → ZZ⁽*⁾ → 4 leptons
h → γγ and Wh/tth, h → γγ
LEP 2000
H → hh → bbγγ
A → Zh → llbb
H⁺ → tb
H/A → tt

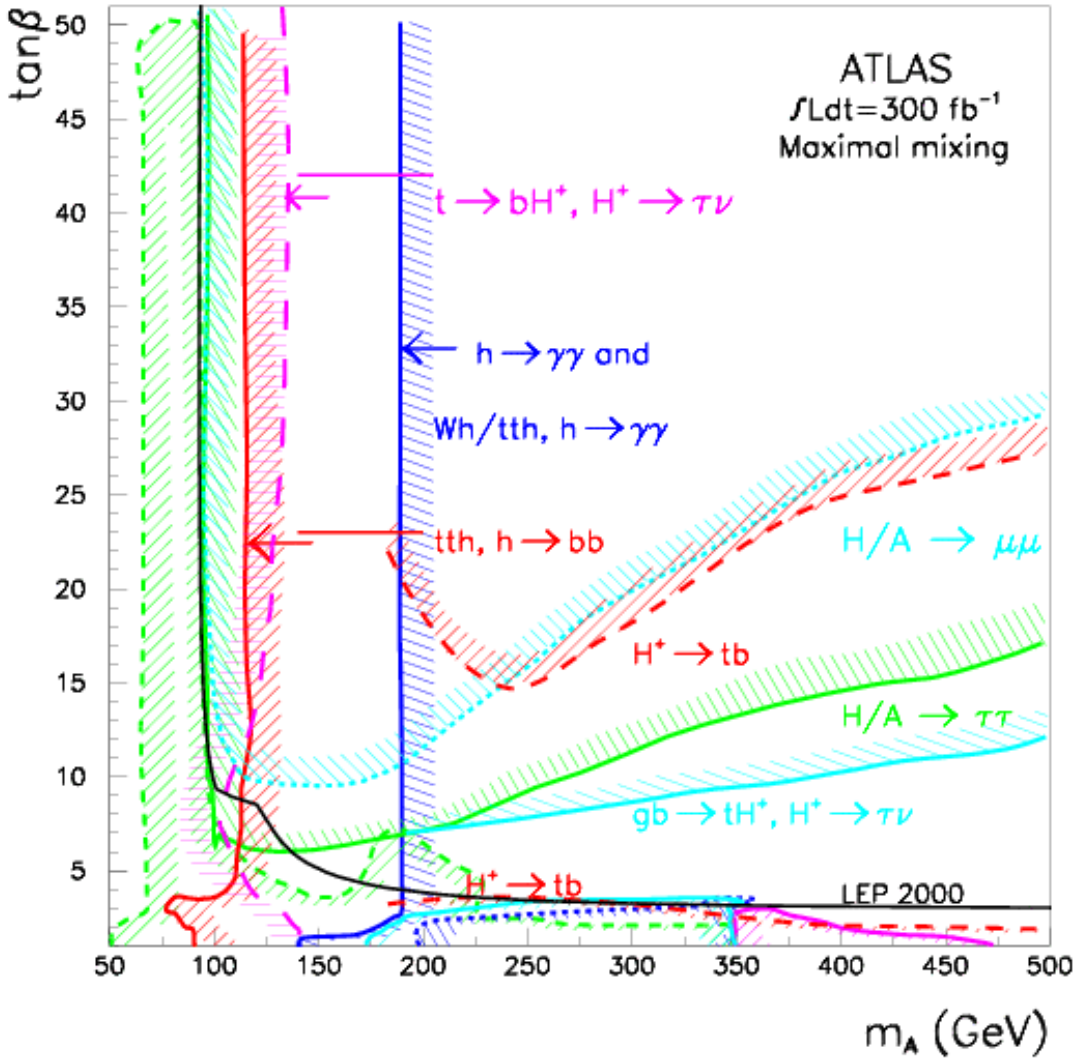
Fig.76



Minimal mixing
(m_h < 115.5 GeV)
NB: log scale

Caveat: coverage depends strongly on exact upper bound on m_h

Fig.77

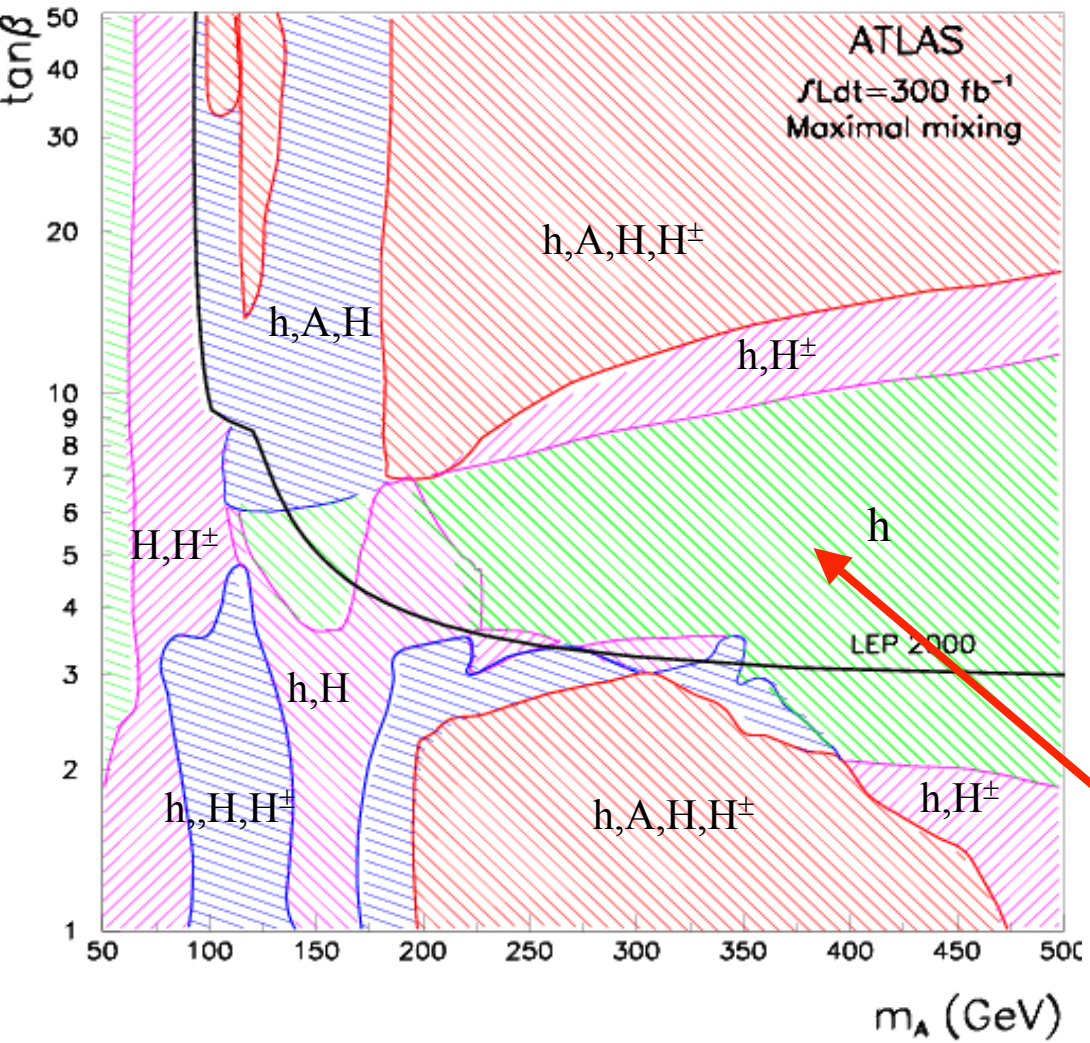


Maximal mixing
(m_h < 130 GeV)
NB: linear scale

Caveat: possible suppression of e.g. bbH coupling could affect significantly H observation at LHC

Fig.78

MSSM Higgs bosons



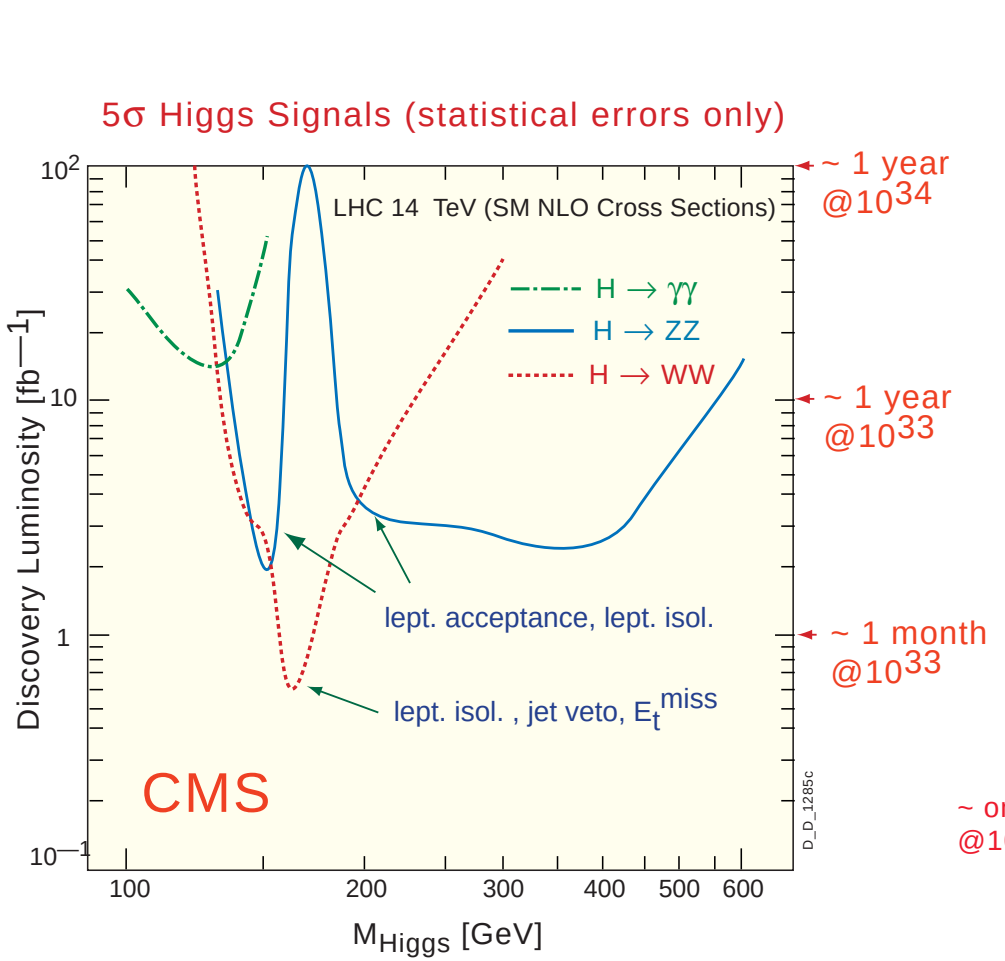
4 Higgs observable
3 Higgs observable
2 Higgs observable
1 Higgs observable

5σ contours

Assuming decays to SM particles only

In this region only h observable (h ≈ SM Higgs)
→ disentangle SM /MSSM ?

Fig.79


5σ Higgs Signals (statistical errors only)
LHC 14 TeV (SM NLO Cross Sections)
H → γγ
H → ZZ
H → WW
lept. acceptance, lept. isol.
lept. isol. , jet veto, E_t^miss
CMS
Discovery Luminosity [fb⁻¹]
M_Higgs [GeV]
~ 1 year @10^34
~ 1 year @10^33
~ 1 month @10^33
D_D_1285c

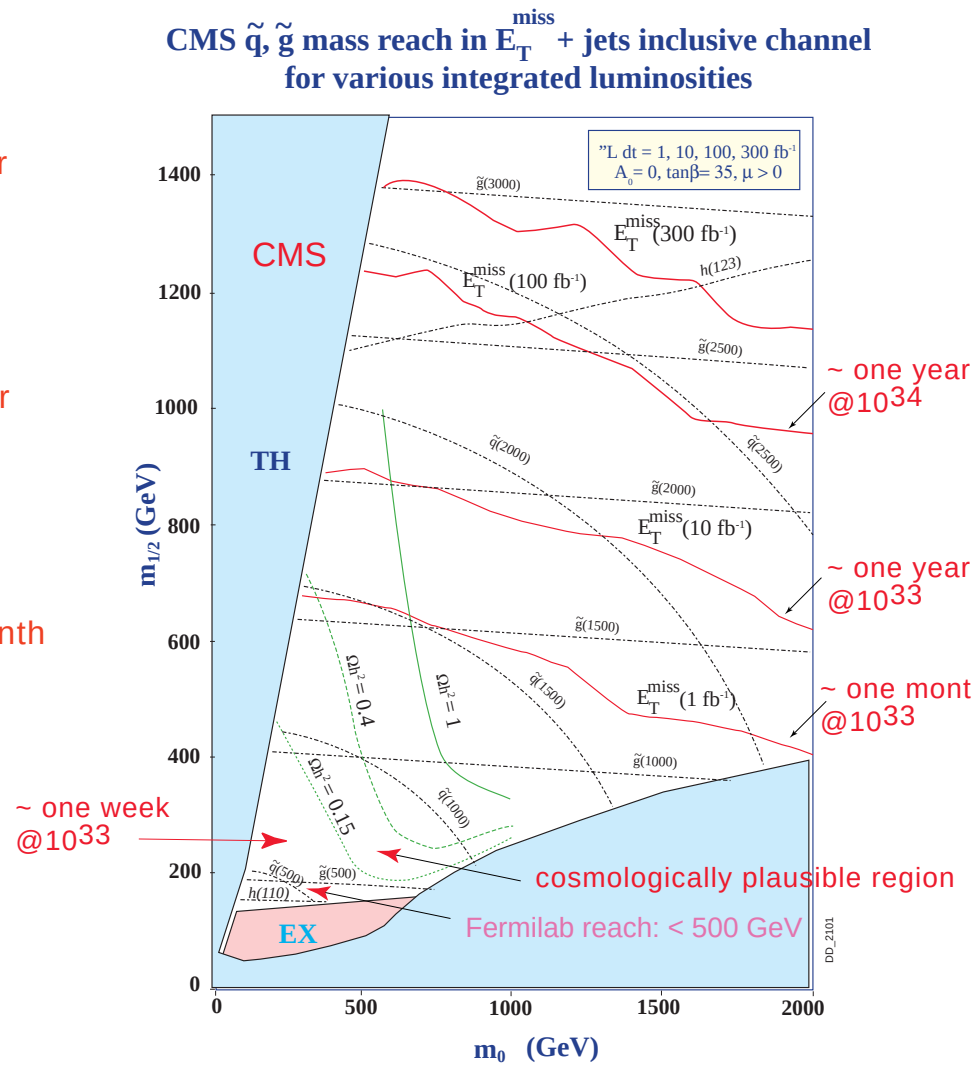

CMS q̃, g̃ mass reach in E_T^miss + jets inclusive channel
for various integrated luminosities
"L dt = 1, 10, 100, 300 fb⁻¹
A_0 = 0, tanβ= 35, μ > 0
CMS
TH
EX
E_T^miss (300 fb⁻¹)
E_T^miss (100 fb⁻¹)
E_T^miss (10 fb⁻¹)
E_T^miss (1 fb⁻¹)
Ωh² = 0.4
Ωh² = 1
Ωh² = 0.15
cosmologically plausible region
Fermilab reach: < 500 GeV
~ one week @10^33
~ one year @10^34
~ one year @10^33
~ one mont @10^33
m_1/2 (GeV)
m_0 (GeV)
DD_2101

Fig.80