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Supersymmetry: Introduction to Experimental Searches

Outline

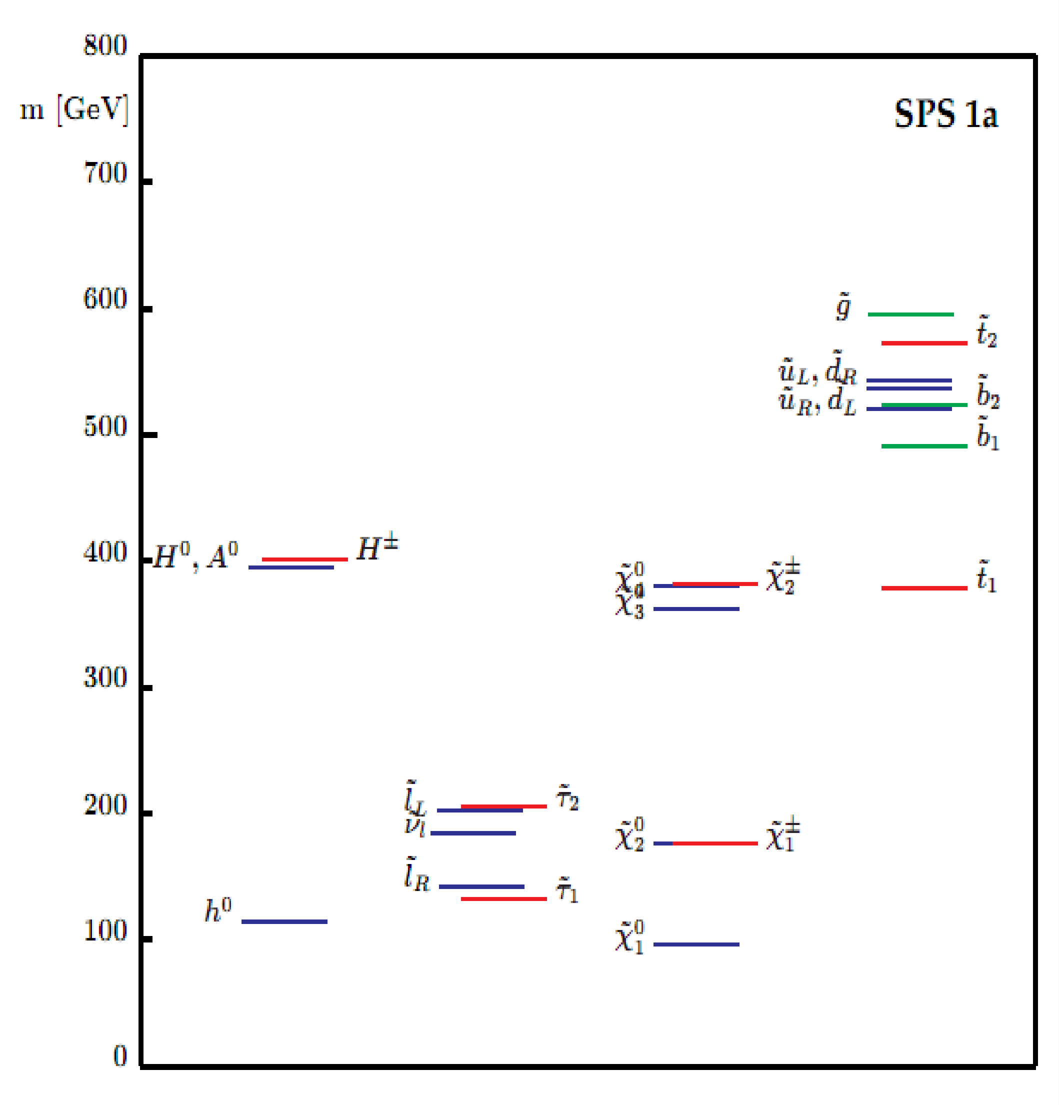
II. Basic Introduction to Experimental Searches for SUSY

1. Standard Steps for SUSY Searches at Colliders
2. One Example of Direct SUSY Search at a Collider
3. Complementarity between Hadron and Lepton Colliders
4. One Example of Indirect Search at a Collider
5. One Example of Non-Collider SUSY Search
6. Putting Together Constraints on SUSY

1. **Standard Steps for SUSY Searches at Colliders**

Setup Masses & Couplings

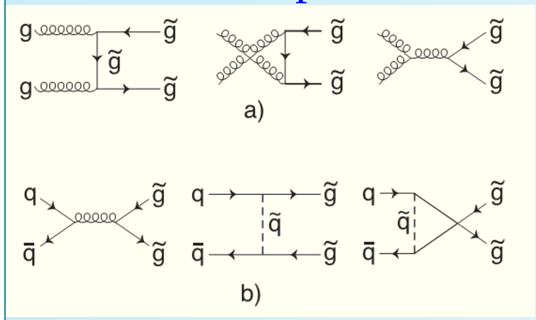
Example in Minimal Supergravity Model



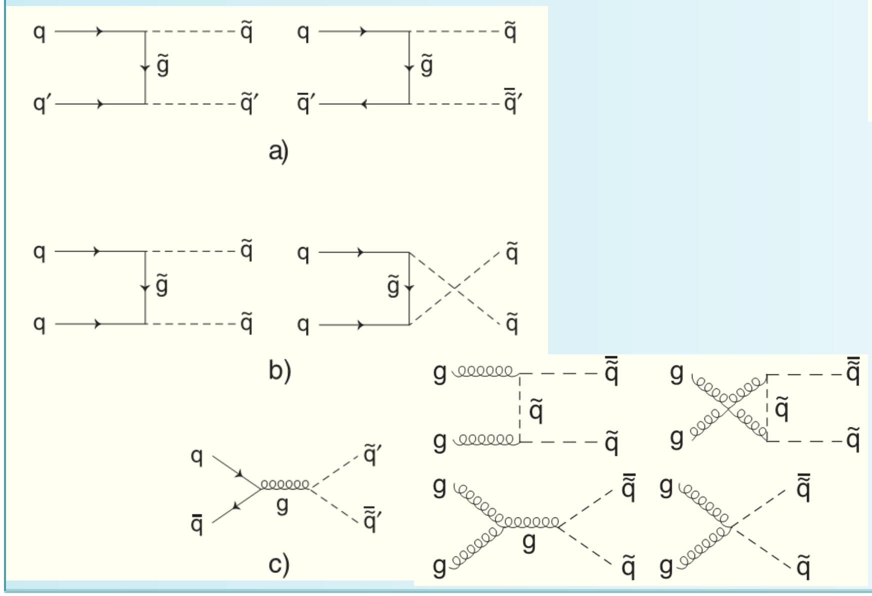
$$\begin{cases} m_0 = 100\text{GeV} \\ m_{1/2} = 250\text{GeV} \\ A_0 = -100\text{GeV} \\ \tan\beta = 10 \\ \mu > 0 \end{cases}$$

Production Mechanisms (1)

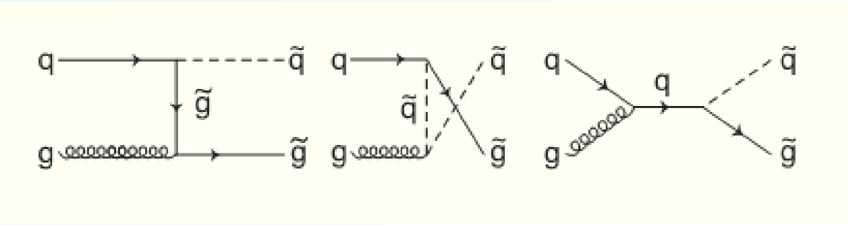
- How are these Sparticles produced?
  - Gluino pairs:



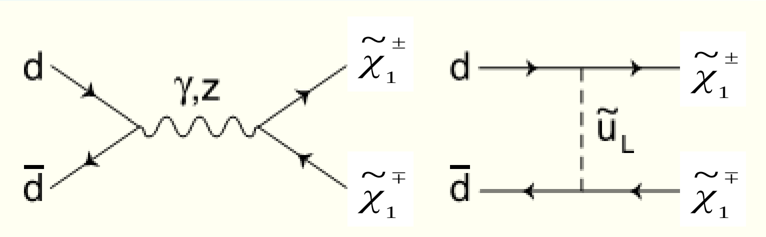
  - Squark pairs:



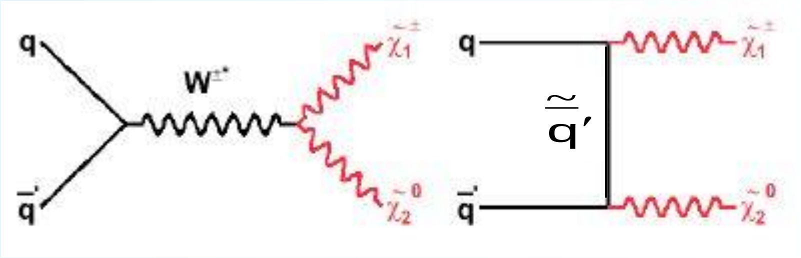
  - Gluino+Squark pairs:



  - Chargino pairs:

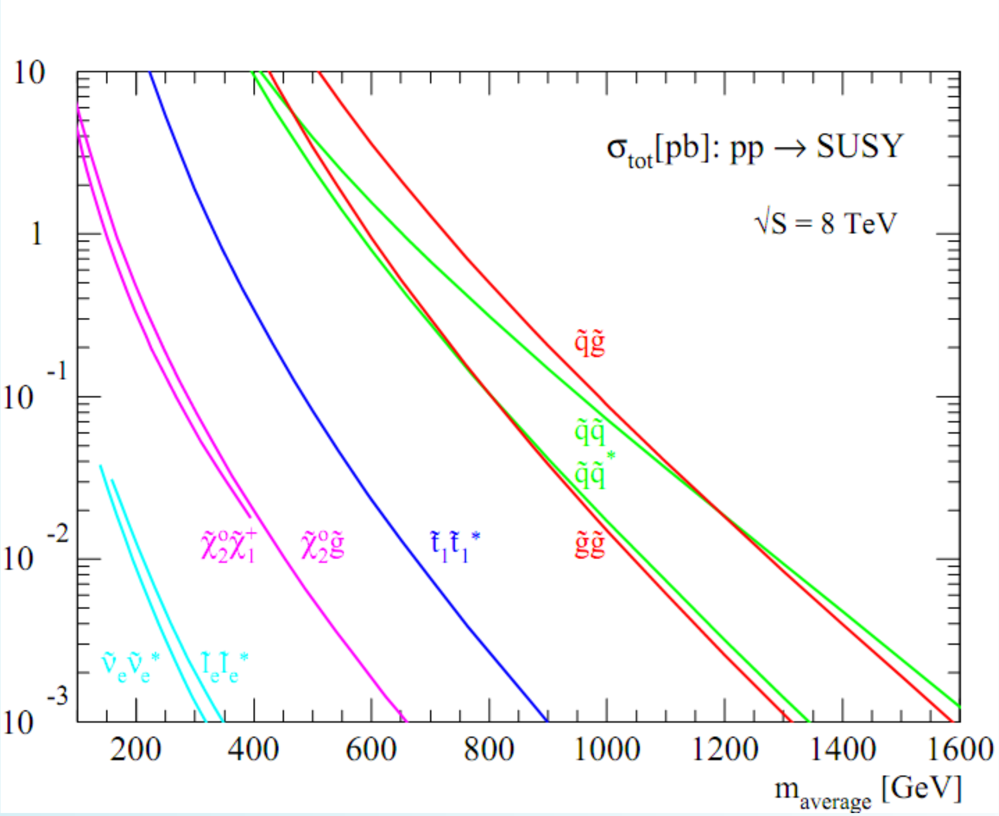


  - Chargino+Neutralino pairs:



Production Mechanisms (2)

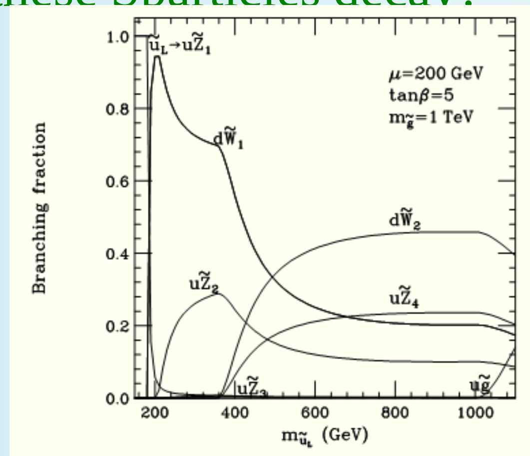
- What are the cross sections?

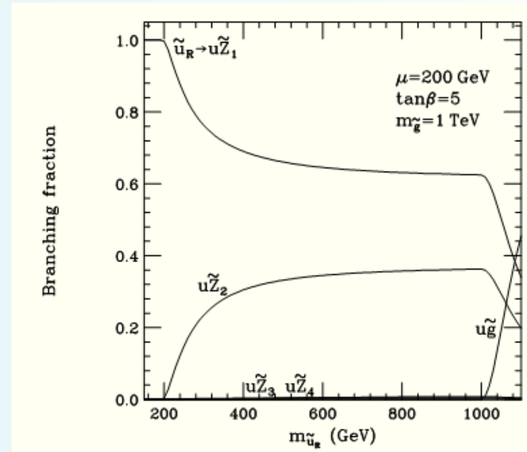


- Obtained with Prospino (include NLO-QCD corrections)
- They determine which Sparticles are accessible and the hierarchy in their search

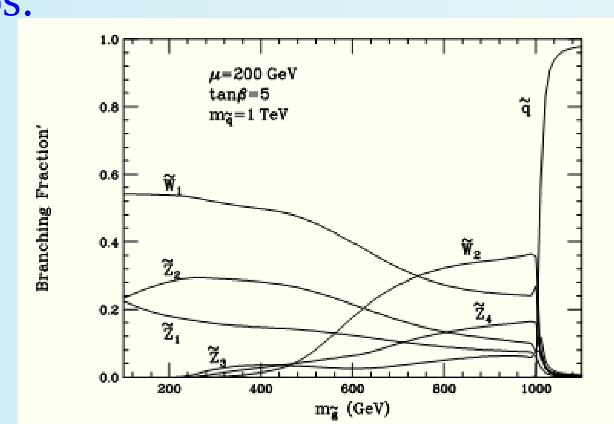
Decay Modes

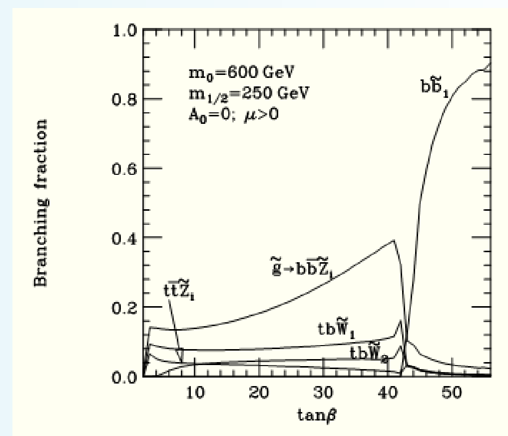
- How do these Sparticles decay?
- Squarks:





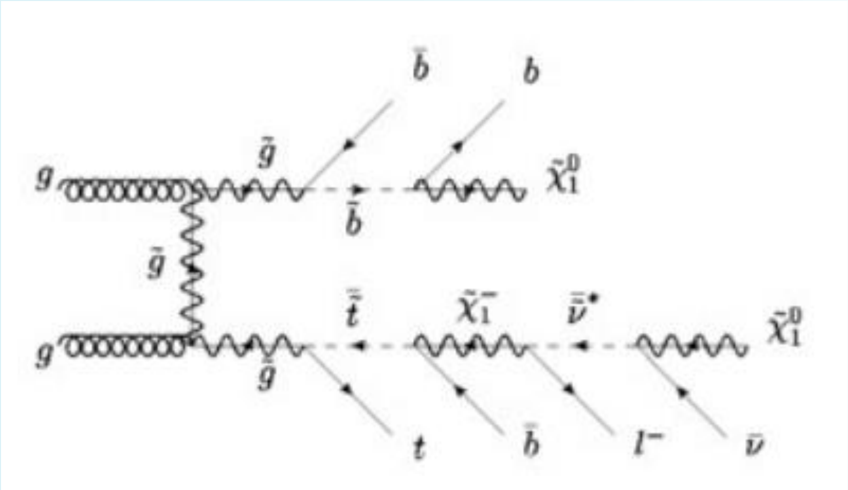
- Gluinos:



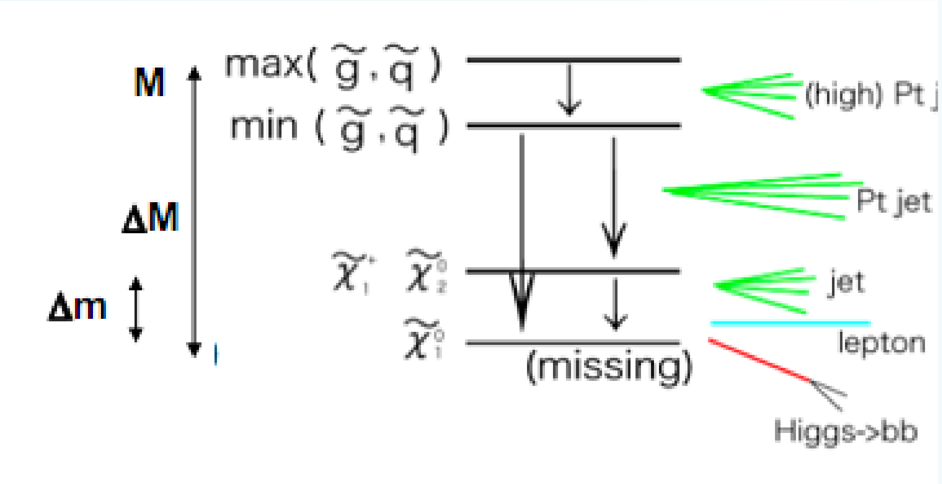


- Search topologies are chosen wrt to some decay chains
- In RPC searches the phase space is limited by a ΔM

- What are the search topologies?



multi-Jets + n leptons + E_T^{miss}



Useful Kinematic Variables

- Pseudo-rapidity: $\eta = -\mathrm{Log}\left(\tan\frac{\theta}{2}\right)$
- Angular distance in space: $\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\varphi)^2}$
- Missing Transverse Energy:

$$\begin{cases} -p_x^{miss} = \sum_{objects} p_x(\text{reco'd object}) + p_x(\text{non-associated cells}) \\ -p_y^{miss} = \sum_{objects} p_y(\text{reco'd object}) + p_y(\text{non-associated cells}) \end{cases}$$

$$\left|\vec{\not p}\right| = \not E_T = E_T^{miss} = \sqrt{(p_x^{miss})^2 + (p_y^{miss})^2}$$

- Total Transverse Energy & Effective Mass:

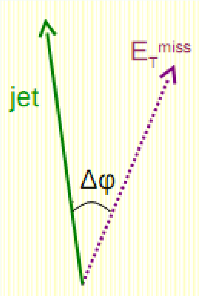
These are scalar sums, not vector sums

$$H_T = \sum_{i=1}^{N_{obj}} p_T^{(i)}$$

$$M_{eff} = H_T + \not E_T$$

- $\Delta\varphi(\text{Jets}, \not E_T)$:

Lower bound helps reduce E_T^{miss} from jets mis-measurements



2. <u>One Example of Direct SUSY Search at Collider</u>

Jets+mET Analysis (1)

$\sqrt{s} = 7\,\text{TeV}$

L=1.04 fb^{-1}

Dataset:

- 2011 p+p collisions

Trigger:

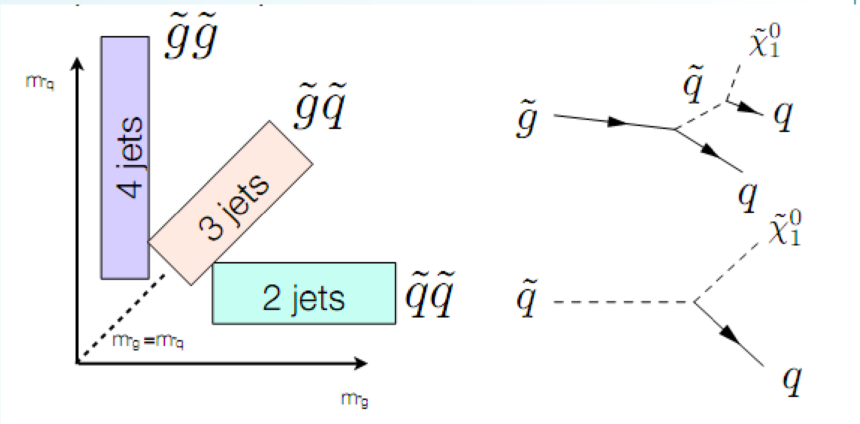
- LVL1: multijets
- HLT: 5j55 or 6j45
- Performance: ε=99%

Data Quality:

- Remove bad $\mathcal{L}$ blocks
- Remove evts w/ bad jets
- Reject evts w/ cosmics or noise

Object ID:

- Jets:
  - anti-k_T, ΔR=0.4
  - p_T > 20 GeV
  - |η|<2.5
- e: medium, p_T > 20 GeV, |η|<2.47
- e isolation: H_T(tracks) (ΔR=0.2)<10% p_T(e)
- μ: matched, p_T > 20 GeV, |η|<2.4
- μ isolation: H_T(tracks) (ΔR=0.2)<1.8GeV
- Veto isolated e or μ



Jets+mET Analysis (2)

Main Background Processes:

- Z+jets: especially $Z(\rightarrow \nu\nu)$+jets
- W+jets: especially $W(\rightarrow \tau\nu)$+jets or $W(\rightarrow e/\mu\nu)$+jets w/ missed e/μ
- QCD multijet

Background Estimation:

- Evaluate each process in a « Control Region » (5 CRs x 5 SRs)
- Extrapolate the CR to SR using transfer factors:

Estimate Signal Sensitivity:

- Profile log-likelihood fit (with correlated systematic uncertainties and CRs cross-contamination)

- NB:
  - SR: Signal Region. A region of phase space where the signal yield is large.
  - CR: Control Region (for a given background process). A region of phase space where largely dominated by the contribution of the considered background process.

Jets+mET Analysis (3)

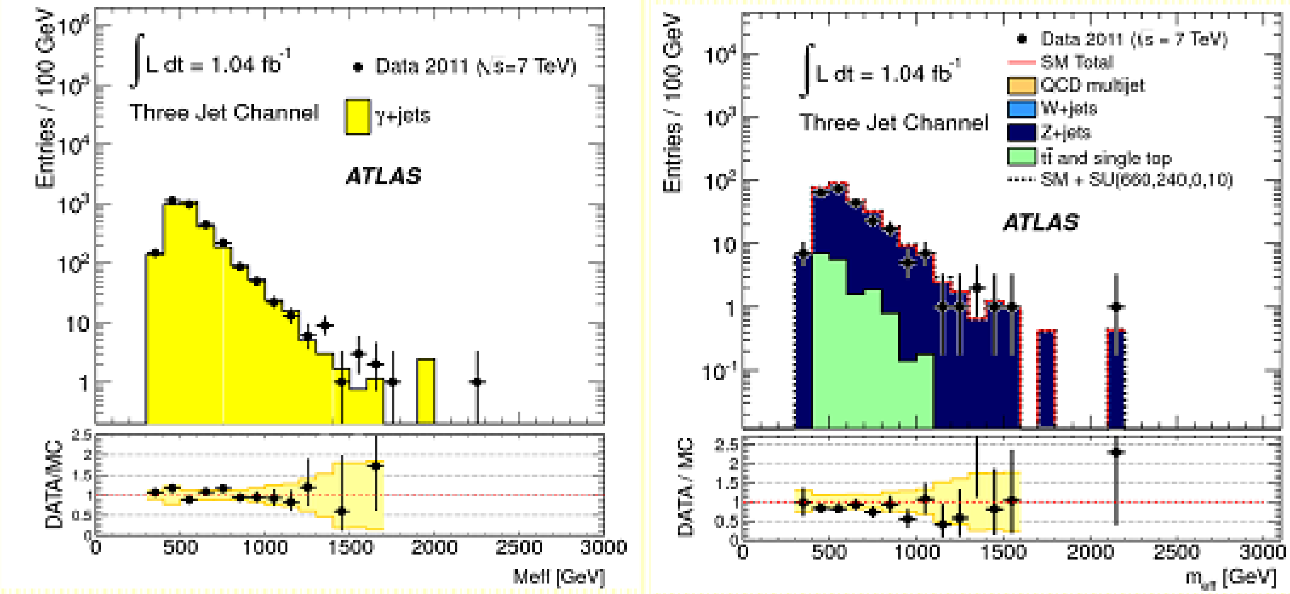
Signal Region	$\geq$ 2-jet	$\geq$ 3-jet	$\geq$ 4-jet	High mass
E_T^{miss}	> 130	> 130	> 130	> 130
Leading jet p_T	> 130	> 130	> 130	> 130
Second jet p_T	> 40	> 40	> 40	> 80
Third jet p_T	–	> 40	> 40	> 80
Fourth jet p_T	–	–	> 40	> 80
$\Delta\phi(\text{jet}, \vec{P}_T^{miss})_{min}$	> 0.4	> 0.4	> 0.4	> 0.4
E_T^{miss}/m_{eff}	> 0.3	> 0.25	> 0.25	> 0.2
m_{eff}	> 1000	> 1000	$> 500/1000$	> 1100

Trigger requirements

Reject the QCD BG

Optimize for SUSY

Z+jets BG

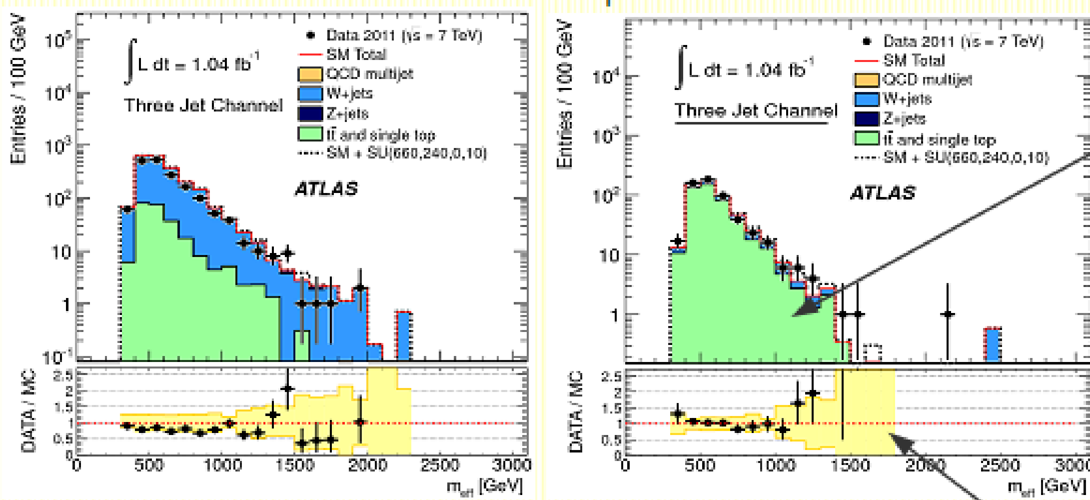


Two control regions are used:

- γ + jets, where the photon is added the the E_T^{miss}
- Z($\rightarrow$ ll)+jets, where the leptons are removed ($\rightarrow$ E_T^{miss})

W+jets and top BG

W CR | Top CR



MC normalized to luminosity

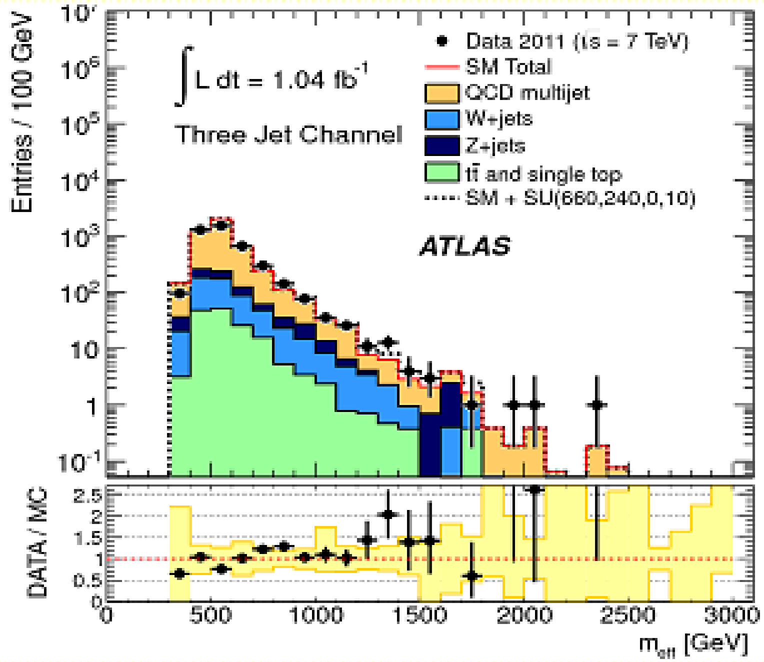
JES, JER, MC stat uncert.

- Select 1-lepton events with $30 < m_T < 100$ GeV

- Split the top from W by asking for no b-tagged jet (W) or at least one b-tagged jet (top)

- Treat the lepton as a jet (for MET calculations, Meff, jet cuts...)

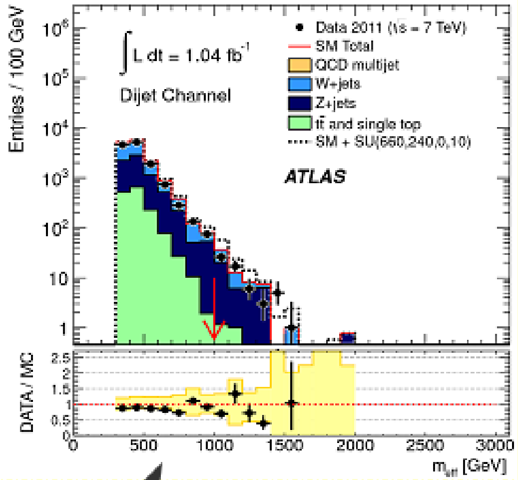
QCD BG

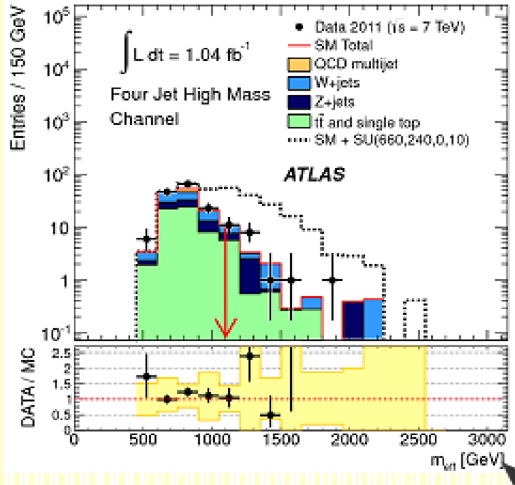


Data-driven background estimation:

- Reverse and tighten the cut: $\Delta\varphi(\text{jet}, E_T^{miss})_{min} < 0.2$
- Transfer factor computed using pseudo-events obtained by smearing low-E_T^{miss} events with the jet response function

Jets+mET Analysis (7)



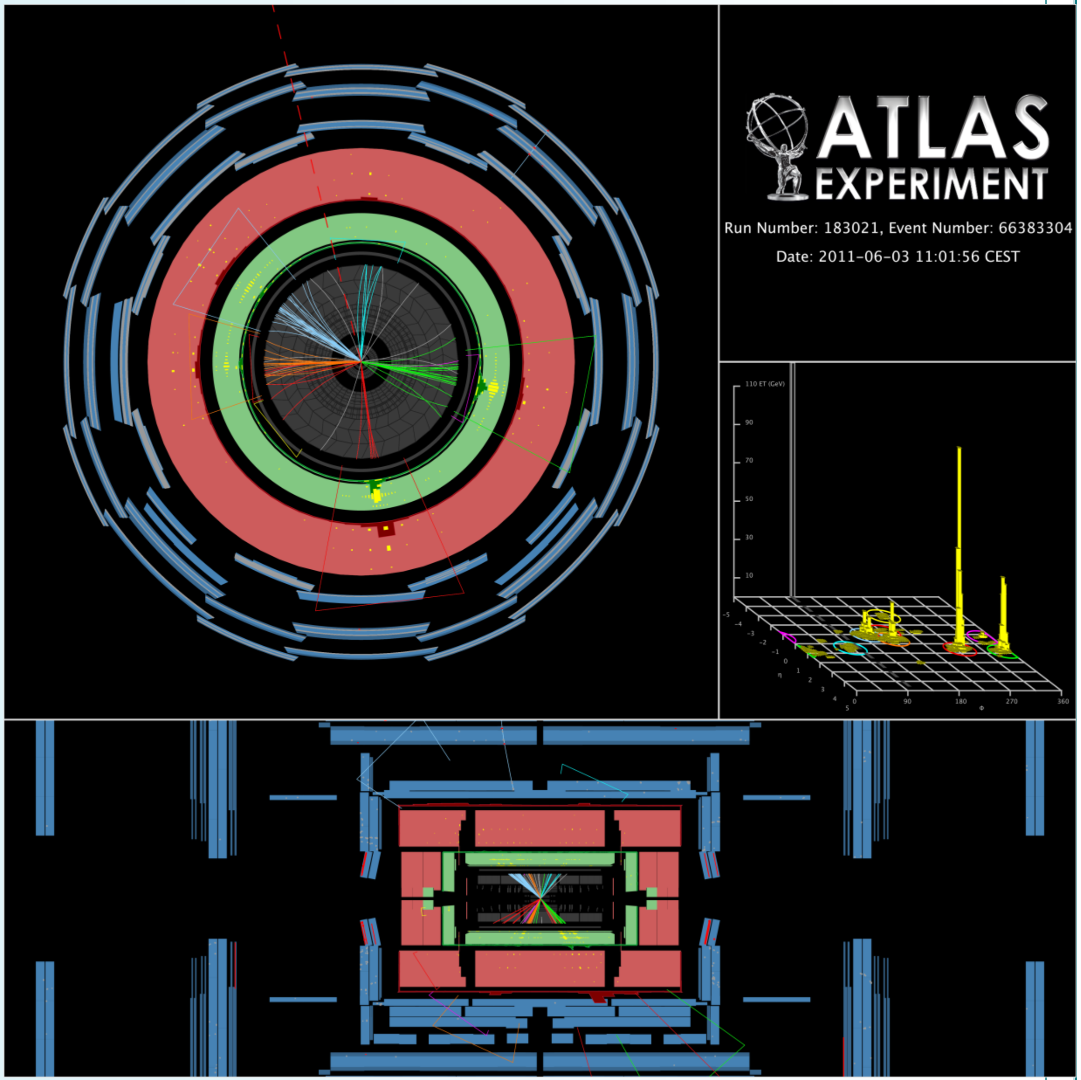


Process	Signal Region				
	$\geq$ 2-jet	$\geq$ 3-jet	$\geq$ 4-jet, $m_{\text{eff}} > 500$ GeV	$\geq$ 4-jet, $m_{\text{eff}} > 1000$ GeV	High mass
Z/γ+jets	32.3 ± 2.6 ± 6.9	25.5 ± 2.6 ± 4.9	209 ± 9 ± 38	16.2 ± 2.2 ± 3.7	3.3 ± 1.0 ± 1.3
W+jets	26.4 ± 4.0 ± 6.7	22.6 ± 3.5 ± 5.6	349 ± 30 ± 122	13.0 ± 2.2 ± 4.7	2.1 ± 0.8 ± 1.1
$t\bar{t}$+ single top	3.4 ± 1.6 ± 1.6	5.9 ± 2.0 ± 2.2	425 ± 39 ± 84	4.0 ± 1.3 ± 2.0	5.7 ± 1.8 ± 1.9
QCD multi-jet	0.22 ± 0.06 ± 0.24	0.92 ± 0.12 ± 0.46	34 ± 2 ± 29	0.73 ± 0.14 ± 0.50	2.10 ± 0.37 ± 0.82
Total	62.4 ± 4.4 ± 9.3	54.9 ± 3.9 ± 7.1	1015 ± 41 ± 144	33.9 ± 2.9 ± 6.2	13.1 ± 1.9 ± 2.5
Data	58	59	1118	40	18

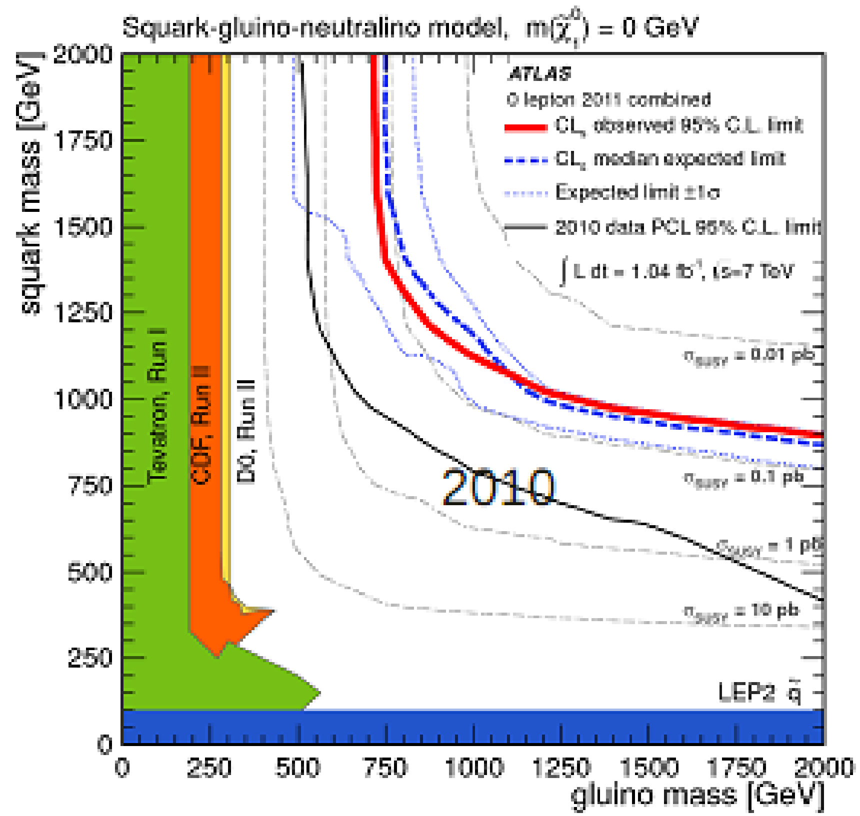
95% CL limits on cross section · acceptance · efficiency:
22 fb, 25 fb, 429 fb, 27 fb and 17 fb

Jets+mET Analysis (8)

Event w/ highest M_{eff} found
5 jets with pt > 40 GeV:
pT = 528, 418, 233, 171, 42 GeV
mET = 460 GeV
M_{eff} =1810 GeV (4 leading jets)



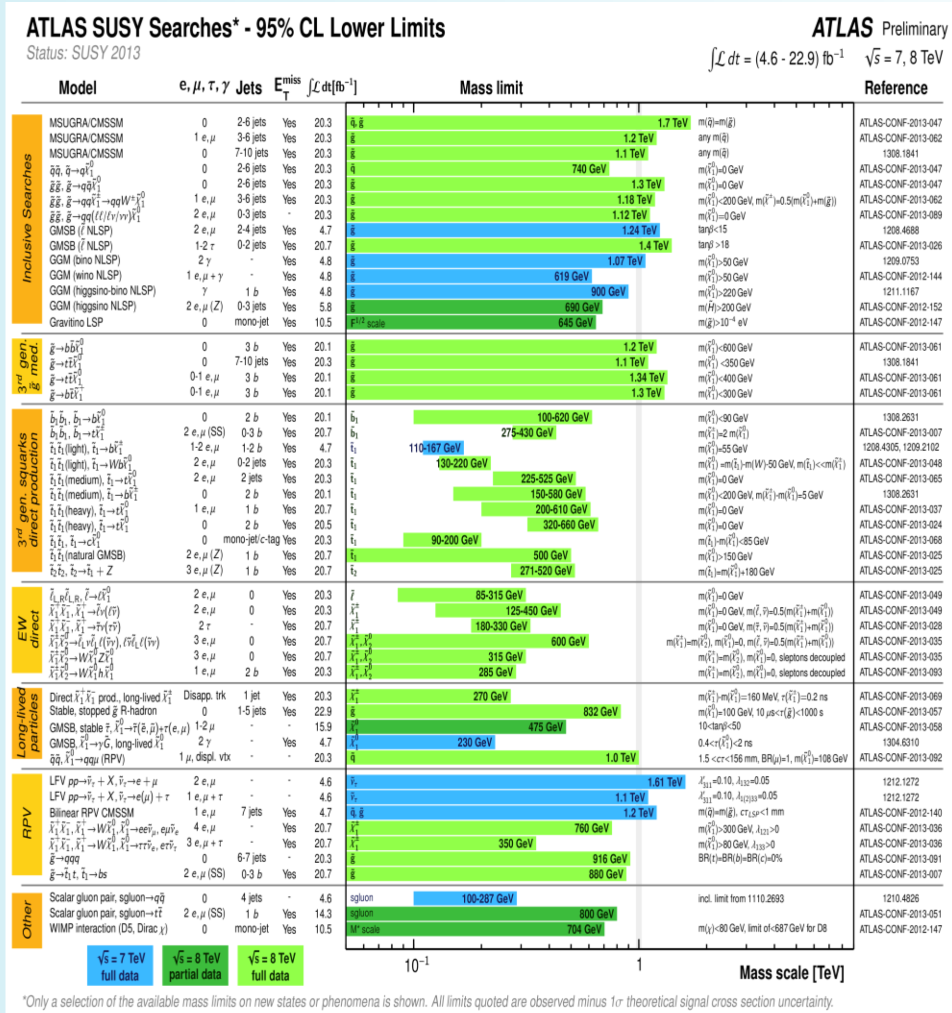
Jets+mET Analysis (9)



→ gluino and squark masses below 700 GeV and 875 GeV are excluded (for squark or gluino masses below 2 TeV)

→ limit at 1075 GeV for equal mass squarks and gluinos

SUSY Searches: ATLAS Summary

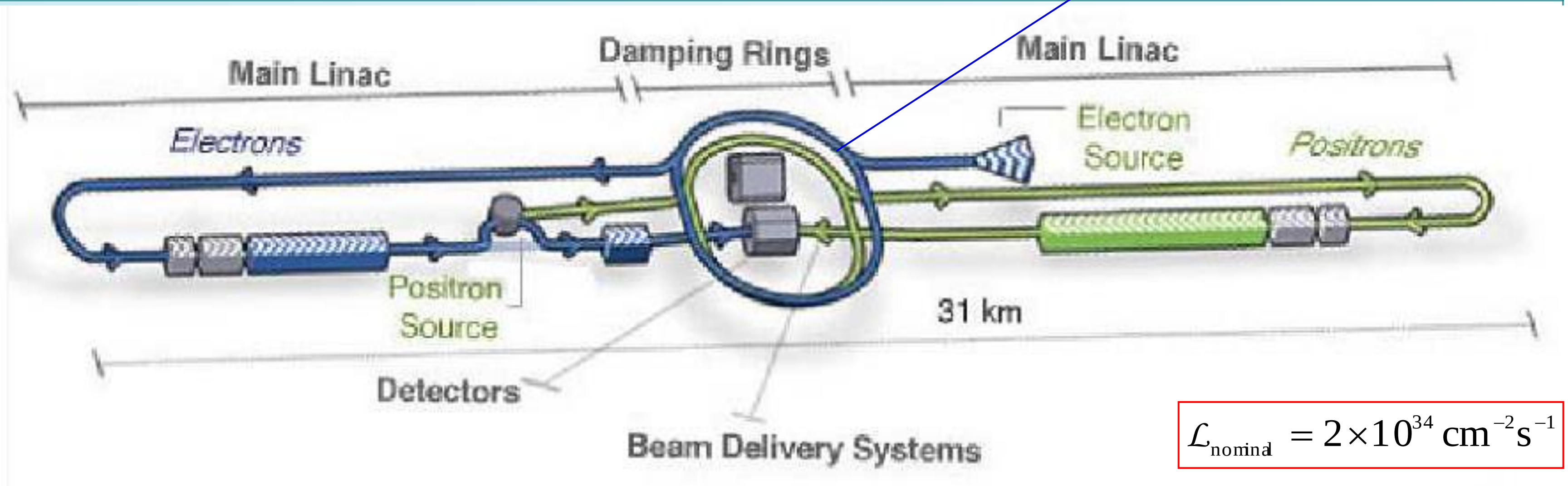


$$\begin{cases} M_{\tilde{q}} > 1.7\,\text{TeV}\ (M_{\tilde{g}} = M_{\tilde{q}}, \text{light } \tilde{\chi}_1^0) \\ M_{\tilde{g}} > 1.18\,\text{TeV}\ (M_{\tilde{q}} < 2\,\text{TeV}, \text{light } \tilde{\chi}_1^0) \end{cases}$$

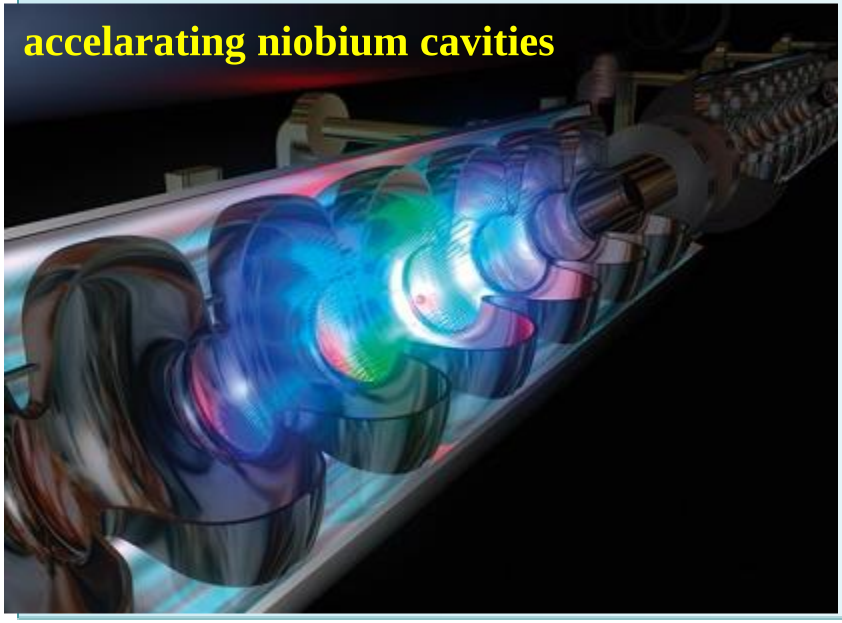
3. Complementarity between Hadron and Lepton Colliders

Main Features

structures the beam bunches



$\mathcal{L}_{\text{nominal}} = 2\times10^{34}\ \text{cm}^{-2}\text{s}^{-1}$



Advantages:

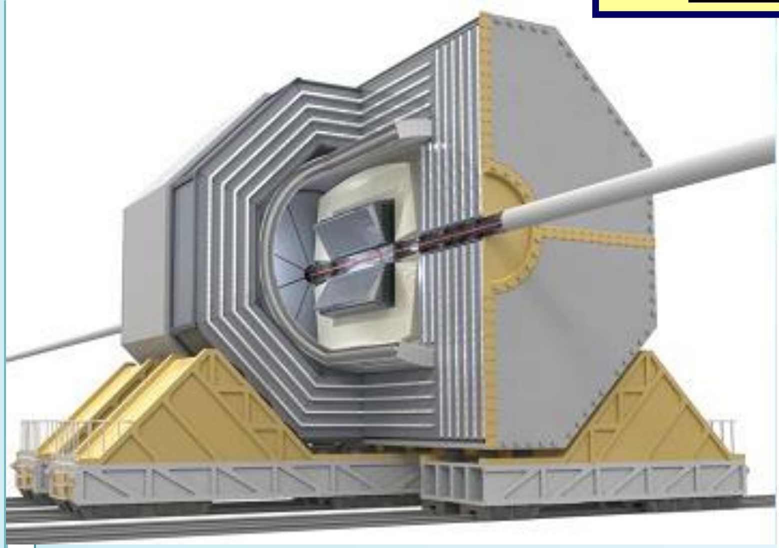
Very clean and flexible environment:

- tuneable E: $M_Z \le \sqrt{s} \le 500\ GeV$ (Phase I: ~500 fb^{-1})
  $M_Z \le \sqrt{s} \le 1\,TeV$ (Upgrade → Phase II)
- polarized beams: $P(e^-) \le 80\%$
  $P(e^+) \le 50\%$
- low rate: 15-30 kHz
- sensitivity to virtual effects

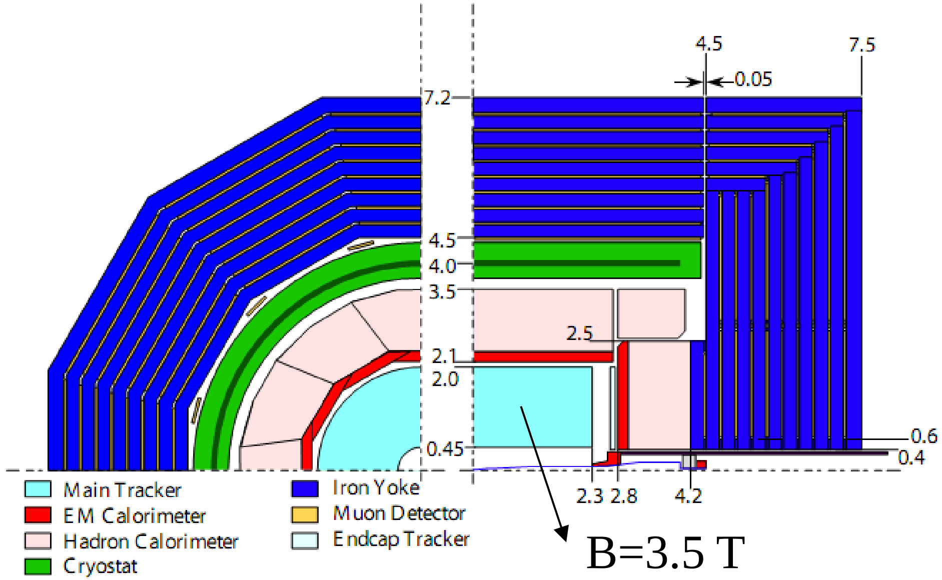
Drawbacks:

- large γγ background (0.1 evt / bunch X)
  - 10% evts w/ $\sqrt{s'} < \sqrt{s}$
  - monitor accolinearity of Bhabha's to estimate $\sqrt{s'}$

Detector Concepts



Global Detector Concept



<u>« Triggerless Mode » Collider:</u>

•Low rate enables:

- No hardware trigger
- Just a software-based trigger for loose filtering

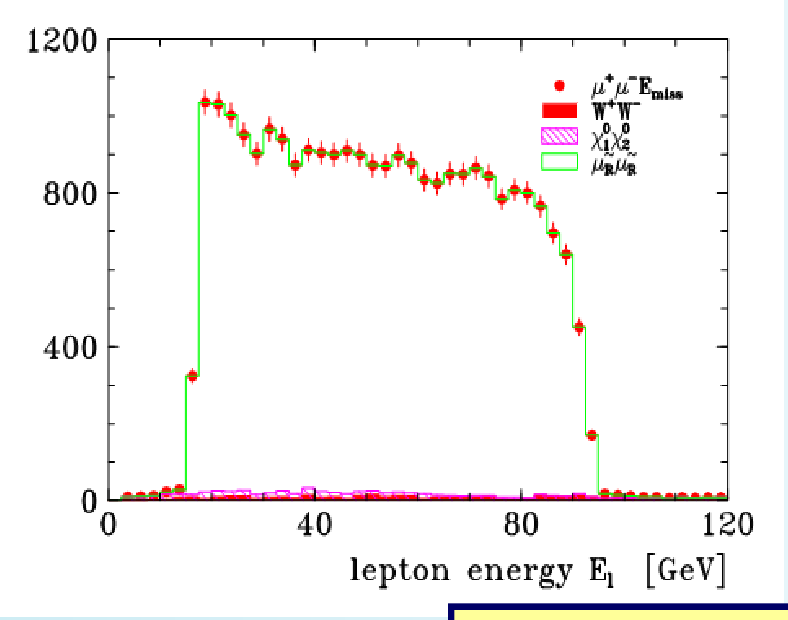
<u>Typical Requirements:</u>

- Inner Tracking:
  - Vertex Detector: $\sigma\left(1/p_T \right) \leq 5 \times 10^{-5}\, p_T$
  - Outer Tracking: $\sigma_{IP} = 5 \mu m \oplus 10\, \mu m \cdot \sin^{3/2} \theta$
- Calorimetry:
  - EM: $\frac{\sigma_E}{E} = \frac{17\%}{\sqrt{E}}$
  - Jets: $\frac{\sigma_E}{E} = \frac{30\%}{\sqrt{E}}$

SUSY Measurements

	m [GeV]	Δm [GeV]	Comments
$\tilde{\chi}_1^\pm$	176.4	0.55	simulation threshold scan , 100 fb^{-1}
$\tilde{\chi}_2^\pm$	378.2	3	estimate $\tilde{\chi}_1^\pm \tilde{\chi}_2^\mp$, spectra $\tilde{\chi}_2^\pm \to Z\tilde{\chi}_1^\pm$, $W\tilde{\chi}_1^0$
$\tilde{\chi}_1^0$	96.1	0.05	combination of all methods
$\tilde{\chi}_2^0$	176.8	1.2	simulation threshold scan $\tilde{\chi}_2^0\tilde{\chi}_2^0$, 100 fb^{-1}
$\tilde{\chi}_3^0$	358.8	3 – 5	spectra $\tilde{\chi}_3^0 \to Z\tilde{\chi}_{1,2}^0$, $\tilde{\chi}_2^0\tilde{\chi}_3^0$, $\tilde{\chi}_3^0\tilde{\chi}_4^0$, 750 GeV, > 1000 fb^{-1}
$\tilde{\chi}_4^0$	377.8	3 – 5	spectra $\tilde{\chi}_4^0 \to W\tilde{\chi}_1^\pm$, $\tilde{\chi}_2^0\tilde{\chi}_4^0$, $\tilde{\chi}_3^0\tilde{\chi}_4^0$, 750 GeV, > 1000 fb^{-1}
$\tilde{e}_R$	143.0	0.05	e^-e^- threshold scan, 10 fb^{-1}
$\tilde{e}_L$	202.1	0.2	e^-e^- threshold scan 20 fb^{-1}
$\tilde{\nu}_e$	186.0	1.2	simulation energy spectrum, 500 GeV, 500 fb^{-1}
$\tilde{\mu}_R$	143.0	0.2	simulation energy spectrum, 400 GeV, 200 fb^{-1}
$\tilde{\mu}_L$	202.1	0.5	estimate threshold scan, 100 fb^{-1} [24]
$\tilde{\tau}_1$	133.2	0.3	simulation energy spectra, 400 GeV, 200 fb^{-1}
$\tilde{\tau}_2$	206.1	1.1	estimate threshold scan, 60 fb^{-1} [24]
$\tilde{t}_1$	379.1	2	estimate b-jet spectrum, $m_{\min}(\tilde{t})$, 1TeV, 1000 fb^{-1}

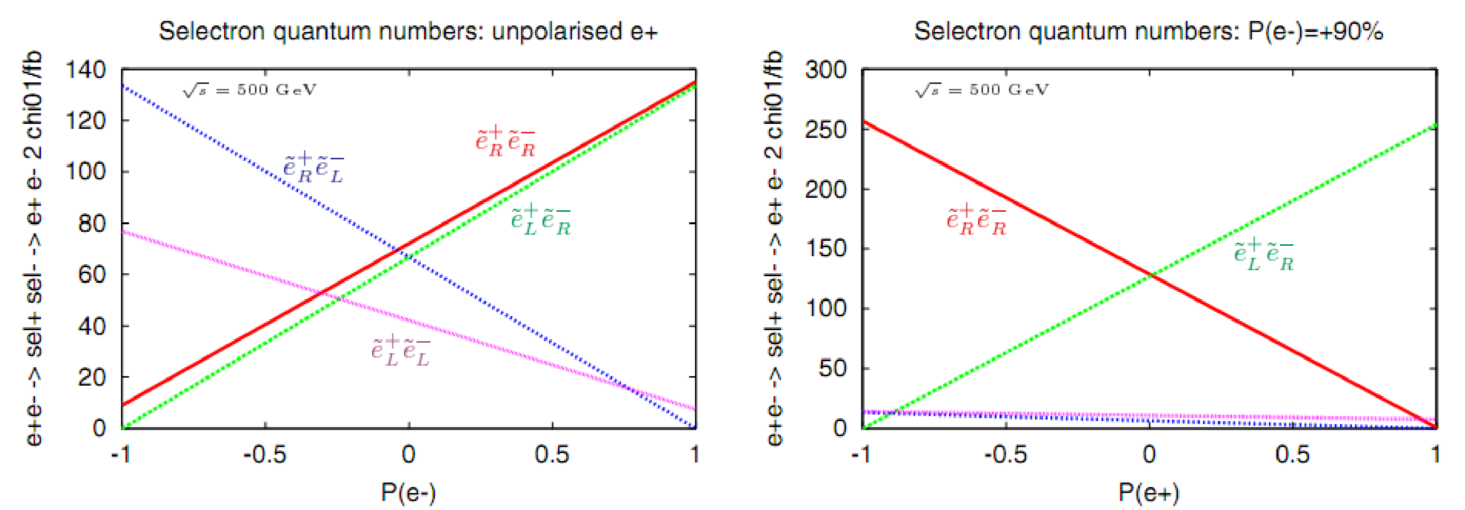
Thresholds & Edges Measurements



$e^-_R e^+_L \to \tilde{\mu}^+_R \tilde{\mu}^-_L \to \mu^+ \mu^- \tilde{\chi}^0_1 \tilde{\chi}^0_1$

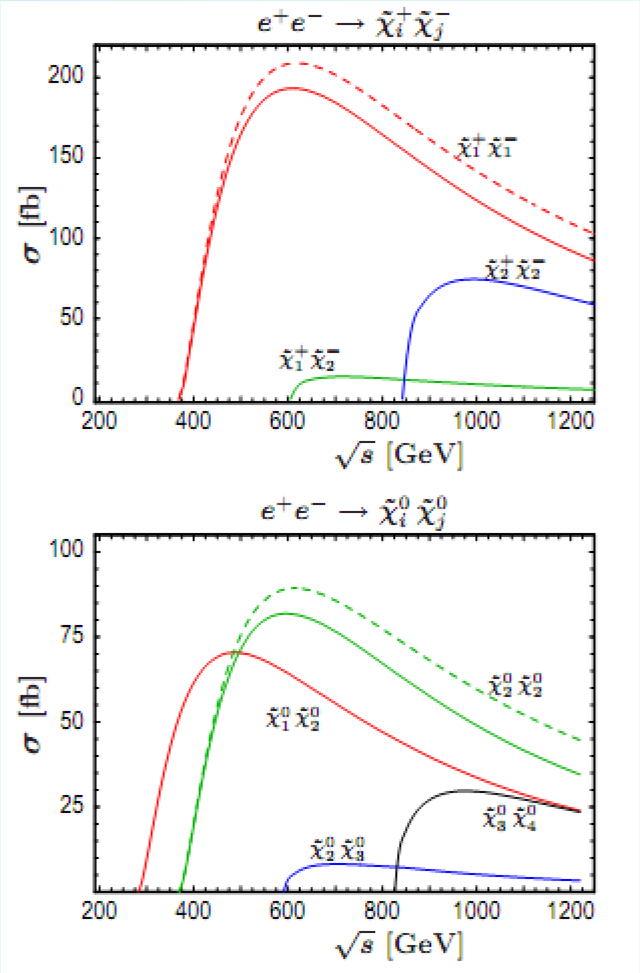
L=200 fb^{-1}

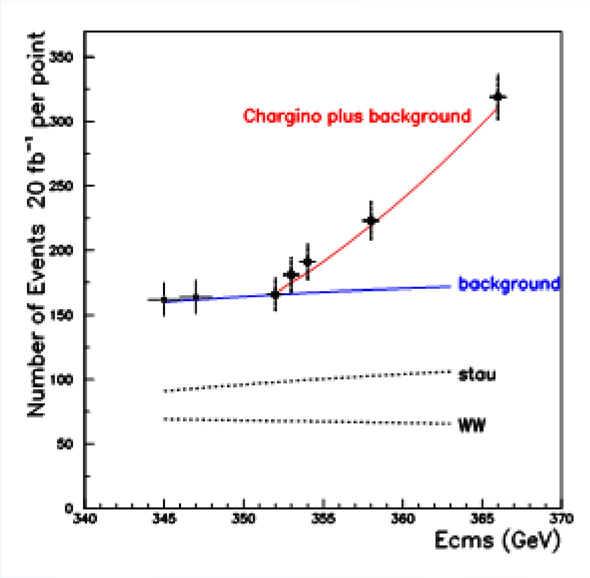
Beam Polarization



Threshold Scans

Sharp production thresholds => E scan gives good sensitivity M(FS)





$$e_R^+ e_L^- \to \tilde{\chi}_1^\pm \tilde{\chi}_1^\mp \to \tau^+ \tau^- \nu_\tau \bar{\nu}_\tau \tilde{\chi}_1^0 \tilde{\chi}_1^0$$

L=100 fb^{-1}

mSUGRA Fit

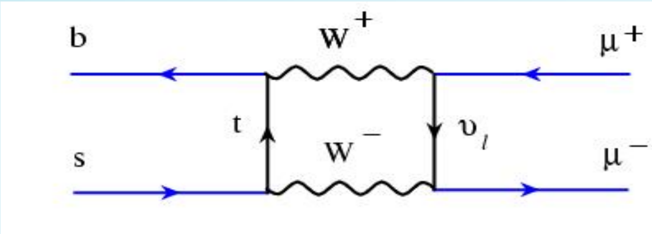
SFitter

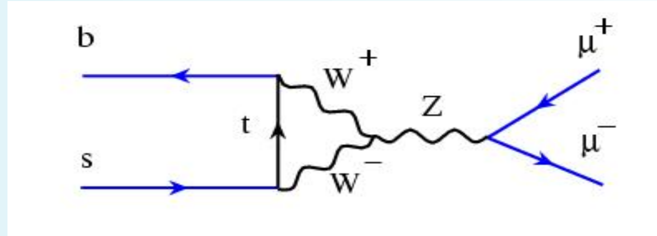
	m_{SPS1a}	LHC	LC	LHC+LC		m_{SPS1a}	LHC	LC	LHC+LC
h	111.6	0.25	0.05	0.05	H	399.6		1.5	1.5
A	399.1		1.5	1.5	$H+$	407.1		1.5	1.5
χ_1^0	97.03	4.8	0.05	0.05	χ_2^0	182.9	4.7	1.2	0.08
χ_3^0	349.2		4.0	4.0	χ_4^0	370.3	5.1	4.0	2.3
$\chi_1^\pm$	182.3		0.55	0.55	$\chi_2^\pm$	370.6		3.0	3.0
$\tilde{g}$	615.7	8.0		6.5					
$\tilde{t}_1$	411.8		2.0	2.0					
$\tilde{b}_1$	520.8	7.5		5.7	$\tilde{b}_2$	550.4	7.9		6.2
$\tilde{u}_1$	551.0	19.0		16.0	$\tilde{u}_2$	570.8	17.4		9.8
$\tilde{d}_1$	549.9	19.0		16.0	$\tilde{d}_2$	576.4	17.4		9.8
$\tilde{s}_1$	549.9	19.0		16.0	$\tilde{s}_2$	576.4	17.4		9.8
$\tilde{c}_1$	551.0	19.0		16.0	$\tilde{c}_2$	570.8	17.4		9.8
$\tilde{e}_1$	144.9	4.8	0.05	0.05	$\tilde{e}_2$	204.2	5.0	0.2	0.2
$\tilde{\mu}_1$	144.9	4.8	0.2	0.2	$\tilde{\mu}_2$	204.2	5.0	0.5	0.5
$\tilde{\tau}_1$	135.5	6.5	0.3	0.3	$\tilde{\tau}_2$	207.9		1.1	1.1
$\tilde{\nu}_e$	188.2		1.2	1.2					

	SPS1a	StartFit	LHC	Δ_{LHC}	LC	Δ_{LC}	LHC+LC	Δ_{LHC+LC}
m_0	100	500	100.03	4.0	100.03	0.09	100.04	0.08
$m_{1/2}$	250	500	249.95	1.8	250.02	0.13	250.01	0.11
$\tan\beta$	10	50	9.87	1.3	9.98	0.14	9.98	0.14
A_0	-100	0	-99.29	31.8	-98.26	4.43	-98.25	4.13

4. One Example of Indirect SUSY Search at Collider

$B_s \rightarrow \mu^+\mu^-$ (1)



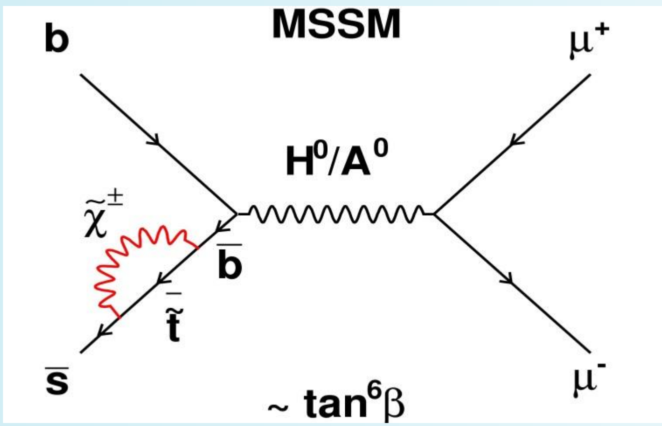


- In SM $B_s \rightarrow \mu^+\mu^-$ is suppressed (need FCNC)

SM predicts $BR(B_s \rightarrow \mu^+\mu^-) = (3.35 \pm 0.32) \times 10^{-9}$

Ref: M. Blanke et al., JHEP 0610 (2006) 003

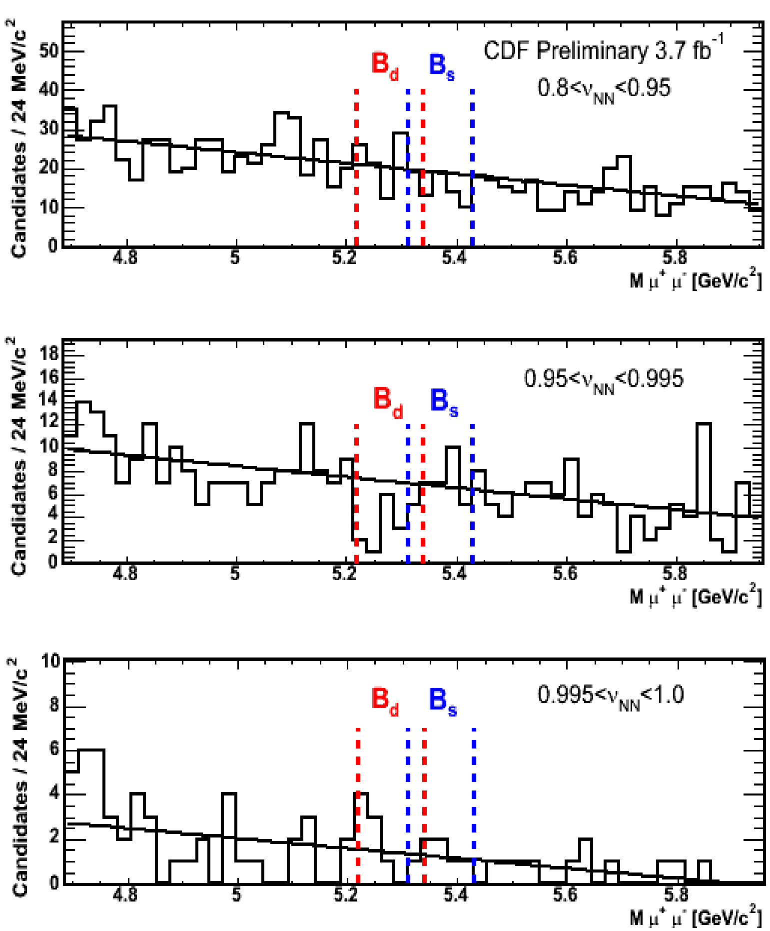
- SUSY can enhance BR by 1 order of magnitude



$$i\mathcal{M} \propto \frac{M_\mu}{M^2_{A^0}} \tan^3\beta$$

A key early measurement for LHC

$B_s \to \mu^+\mu^-$ (2)



CDF Result: No excess seen

L=3.7 fb^{-1}

$$\begin{cases} BR(B_s \to \mu^+\mu^-) < 4.3 \times 10^{-8}\ (95\%CL) \\ BR(B_d \to \mu^+\mu^-) < 7.6 \times 10^{-9}\ (95\%CL) \end{cases}$$

Aug 2009

D0 Result: No excess seen

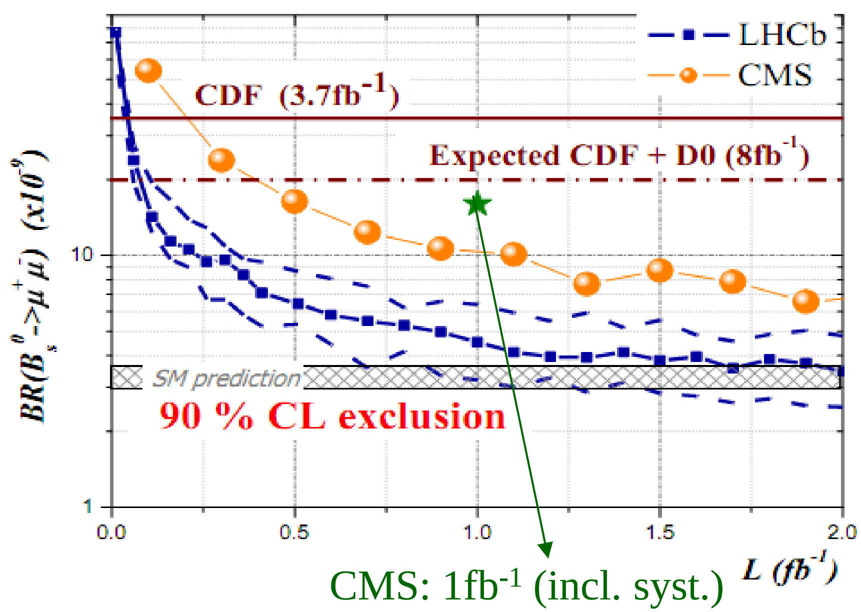
L=6.1 fb^{-1}

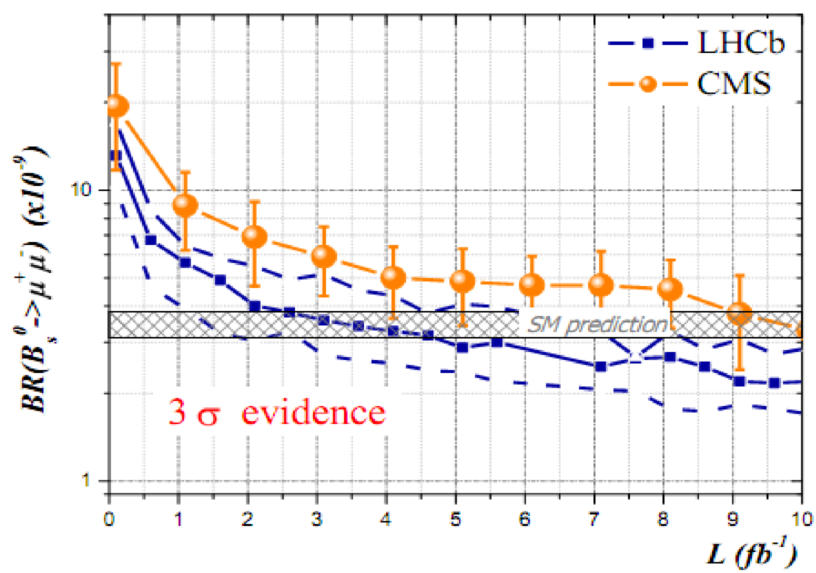
$$BR(B_s \to \mu^+\mu^-) < 5.1 \times 10^{-8}\ (95\%CL)$$

Jun 2010

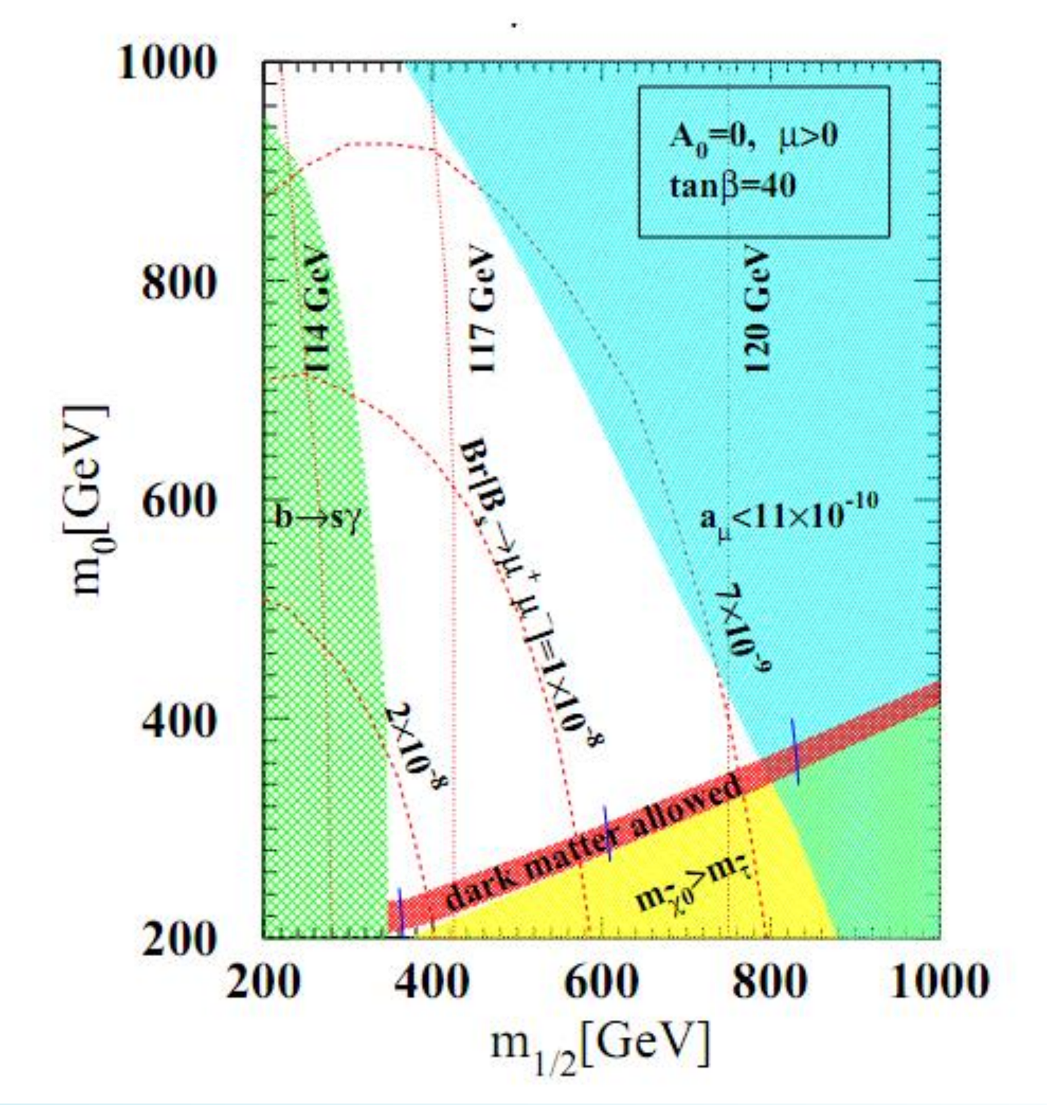
$B_s \to \mu^+\mu^-$ (3)

- ATLAS & CMS:
  - $|\eta_\mu|<2.5$, $\mathcal{L}=10^{32\text{-}33}$ $cm^{-2}s^{-1}$
  - Single & di-muon triggers
- LHCb:
  - $1.9<|\eta_\mu|<2.5$, $\mathcal{L}=2x10^{32}$ $cm^{-2}s^{-1}$
  - Low p_T trigger (sensitivity to σ_{bb} 2.3 larger than ATLAS & CMS)
- Evt Selection:
  - based upon several variables, including $M_{\mu\mu}$
  - mass resolutions: 90 MeV (ATLAS), 53 MeV (CMS), 22 MeV (LHCb)



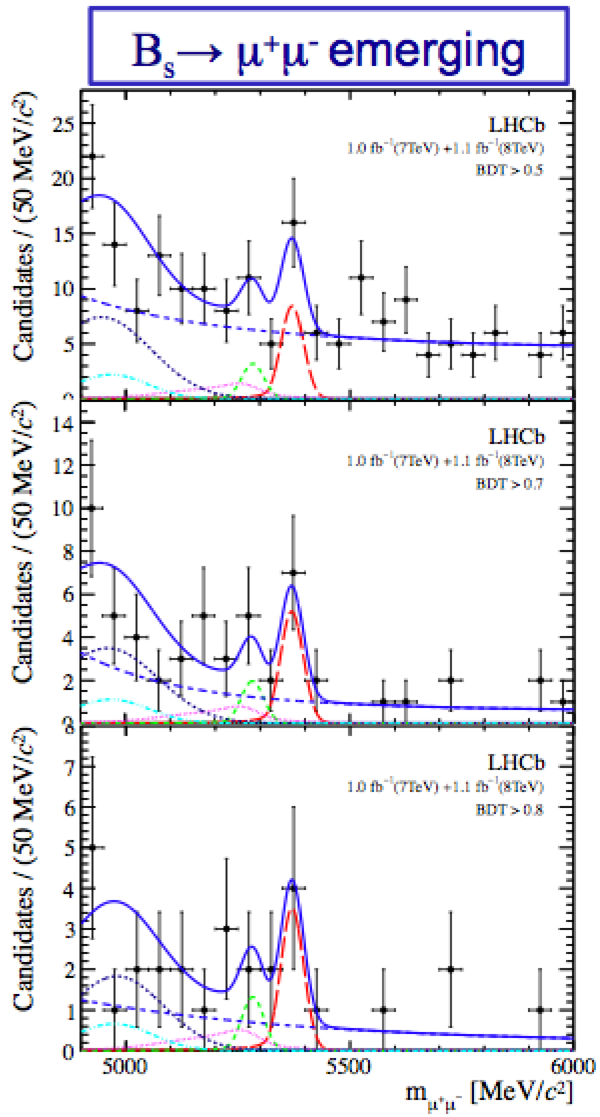


$B_s \to \mu^+\mu^-$ (4)



A_0=0, μ>0
tanβ=40
114 GeV
117 GeV
120 GeV
b→sγ
Br[$B_s \to \mu^+\mu^-$]=1×10^{-8}
2×10^{-8}
7×10^{-9}
a_μ<11×10^{-10}
dark matter allowed
$m_{\tilde{\chi}^0} > m_{\tilde{\tau}}$
m_0[GeV]
$m_{1/2}$[GeV]
200
400
600
800
1000

$B_s \rightarrow \mu^+\mu^-$ (5)
- Epilogue -



- LHCb: Finally observed this rare DK mode!
  - 2011 & 2012 Datasets:
    - resp. 1.0 & 1.1 fb^{-1}
    - resp. 7 TeV & 8 TeV

$$BR(B_S \rightarrow \mu^+\mu^-) = (3.2^{+1.5}_{-1.2})x\,10^{-9}$$

- Fittino:

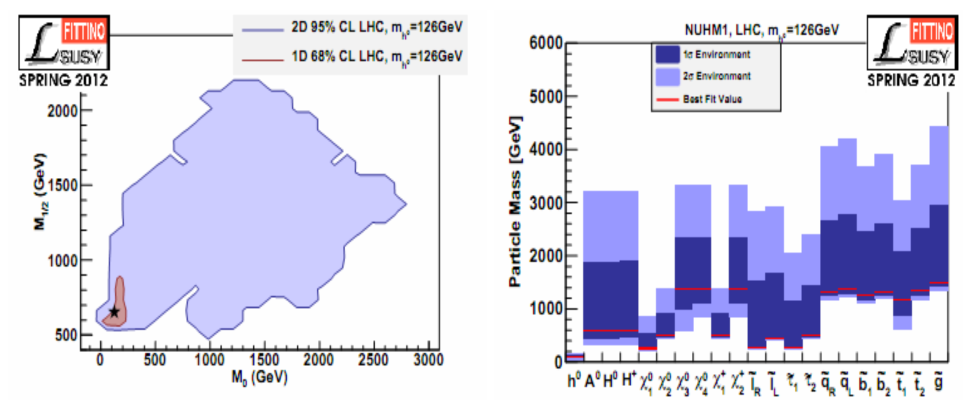


Figure 6: Left: Parameter distributions for the LHC+m_h fit of the NUHM1 with the 1-dimensional 1σ in red and the 2-dimensional 2σ in blue, and the best fit point marked by a star. Right: predicted distribution of sparticle and Higgs boson masses from the LHC + m_h fit of the NUHM1.

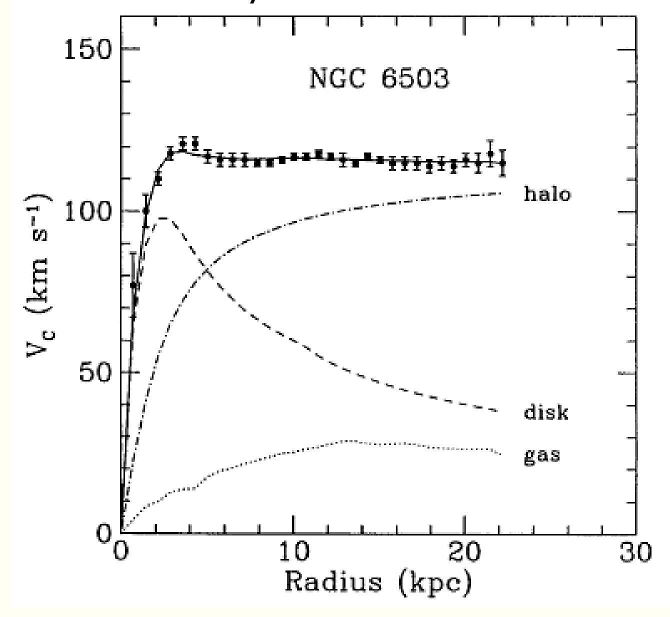
5. One Example of Non-Collider SUSY Search

Evidence for Dark Matter

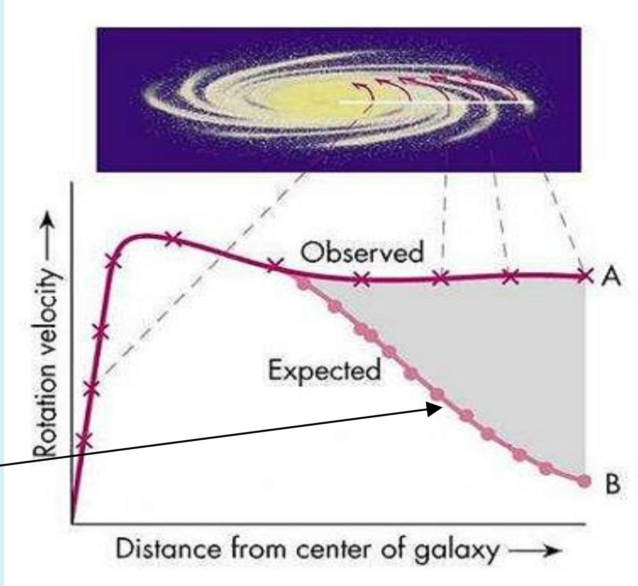
- Spiral galaxy rotation curves are incompatible w/ only visible matter contributions

Ref: F. Zwicky, Helv Phys Acta 6(2) (1933) 110-127

Galaxy Rotaion Curve



$$v = \sqrt{\frac{GM(r)}{r}}$$



- Other indications:
  - Clusters and Super-Clusters (gravitational lensing, X-rays,…)
  - Large Scale Structures (formation)
  - …

Main Properties of Dark Matter

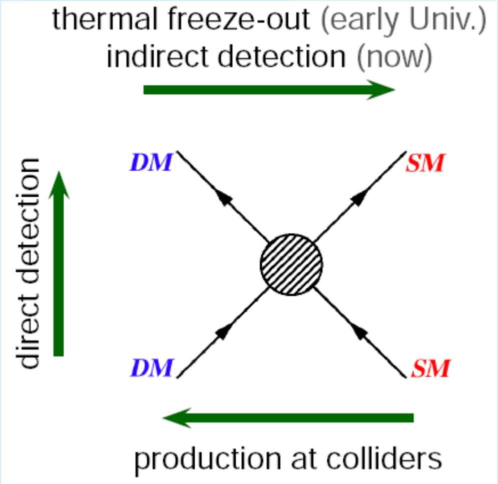
- Its composition cannot be explained by SM particles
- Features of the « Usual Suspect »:
  - Massive: compatible w/ measured Ω_m, « Cold Dark Matter »: $\beta < 0.1$
  - No electric charge (Dark)
  - No color charge (no bound states found in exotic nuclei or atoms)
  - Only interactions: Weak & Gravitational
  - So-called WIMP: « Weakly Interacting Massive Particle »

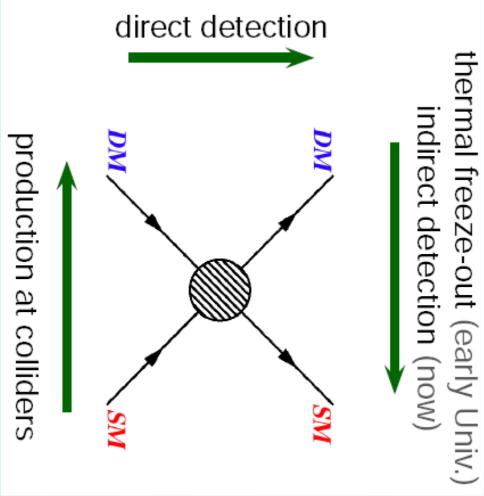
- SM Particles:
  - Neutrinos:
    - Hot Dark Matter (β>0.95): not suitable to explain properties of galaxies
- SUSY Particles:
  - Gravitino: when LSP: in general too light => Hot Dark Matter
  - Sneutrino: large annihilation σ (=> mass > 500 GeV), too σ_{el}(sneutrino+N)~O(fb)
  - Lightest Neutralino: ideal candidate
  - or even Axion, Axino (SO(10)-inspired)
- Other BSM candidates:
  - LKP (ED), LTP (LH), branons, black holes,…

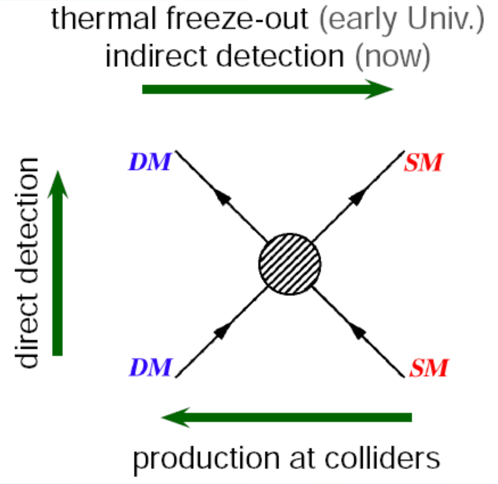
Dark Matter Searches: Two Methods

• Direct Detection:
Look for DM+N interactions => nuclear recoil

• Indirect Detection:
Look for SM particles (e^-, e^+, γ-rays, ν, p) produced through DM annihilation processes



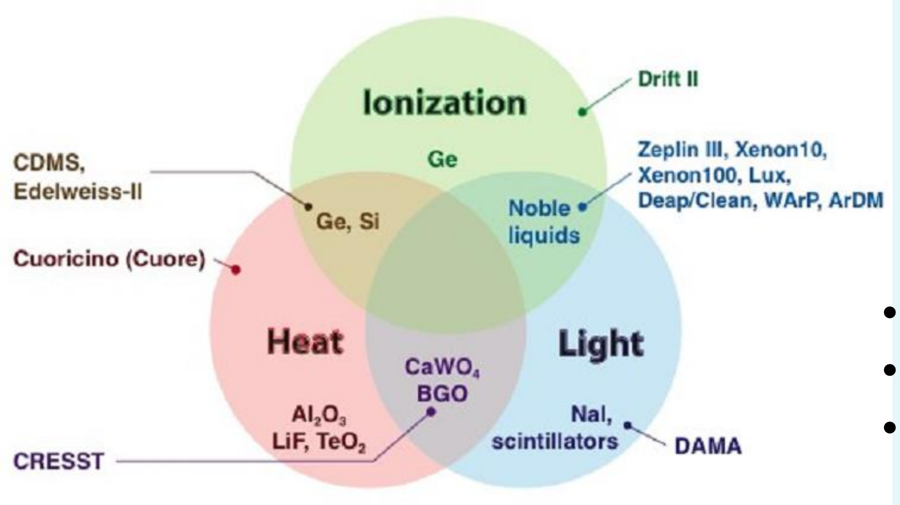




Dark Matter Searches: Direct Detection (1)

Search Hypotheses

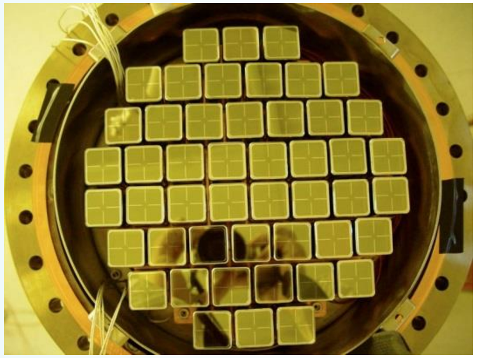
1. DM forms a static halo in the galactic rest frame
   - The sun rotates at 230 km/s around the galactic center
   - The earth rotates at (230+/-15) km/s => annual modulation
2. DM elastically scatters on ordinary matter
3. 10 GeV < m(WIMP) < 10 TeV
   => nuclear recoil E: 1-100 keV



- Heat: phonons in crystaline lattice structure
- Ionization: free electrons in materials
- Light: scintillation in materials

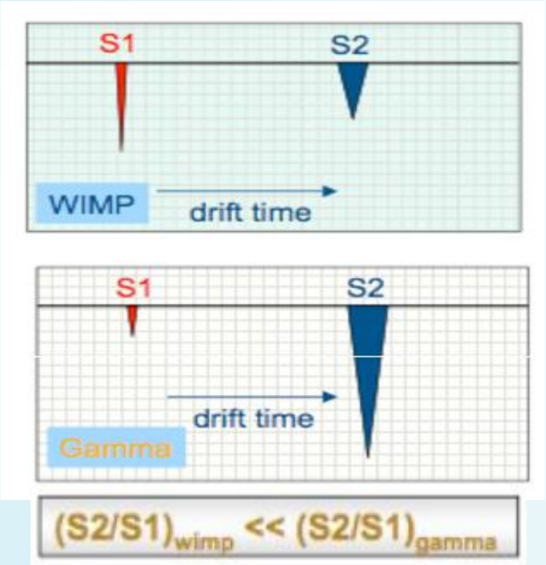
Dark Matter Searches: Direct Detection (2)

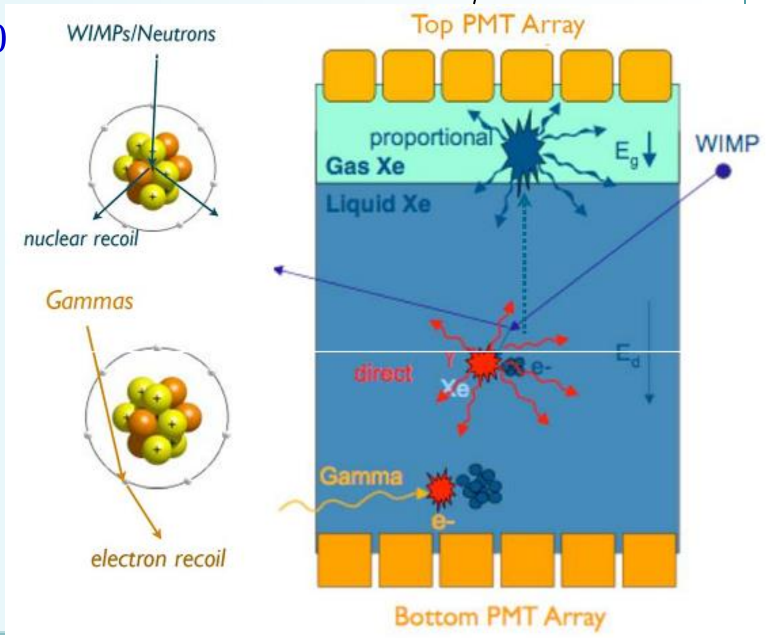
XENON-100 Experiment



- Location:
  - LN Gran Sasso

- Detection Technique:
  - dual phase Xe detector + PMTs
  - prompt scintillation in liquid
  - ionization => proportional scintillation in gas
  - Phase I (05-07): 10 kg target mass
  - Phase II (08-10): 100 kg target mass, bkgd/100



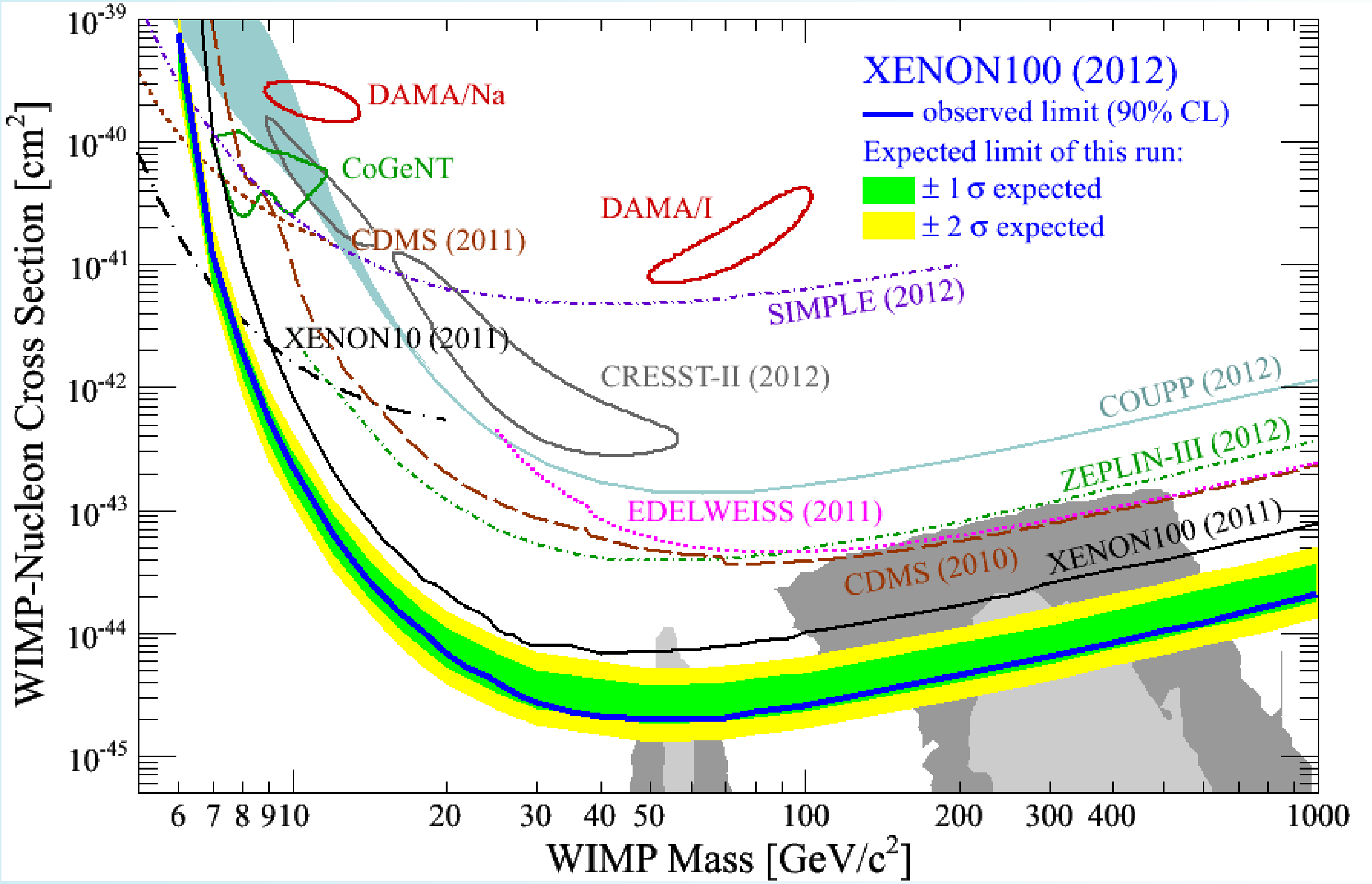


- Data samples:
  - 190.4 kg-day

- S1: scintillation in LXe (bottom)
- S2: top ionization in GXe (top)

Dark Matter Searches: Direct Detection (3)

XENON-100 Results



6. Putting Together Constraints on SUSY

SUSY Global Fits (1)

• Versions of SUSY filts that include the non-accelerator constraints

Indirect constraints on M_{SUSY} from existing data?

- Electroweak precision observables (EWPO) ?
- B physics observables (BPO) ?
- Cold dark matter (CDM) ?

$\Rightarrow$ combination of EWPO, BPO, CDM ?

EWPO M_W : information on $m_{\tilde{t}}$, $m_{\tilde{b}}$ or M_A, $\tan\beta$ or . . .

EWPO $(g-2)_\mu$: information on $\tan\beta$ and/or $m_{\tilde{\chi}^0}$, $m_{\tilde{\chi}^\pm}$ and/or $m_{\tilde{\mu}}$, $m_{\tilde{\nu}_\mu}$

BPO $\text{BR}(b \to s\gamma)$: information on $\tan\beta$ and/or $M_{H^\pm}$ and/or $m_{\tilde{t}}$, $m_{\tilde{\chi}^\pm}$

CDM (LSP gives CDM) : information on $m_{\tilde{\chi}_1^0}$ and $m_{\tilde{\tau}}$ or M_A or . . .

$\Rightarrow$ combination makes only sense if all parameters are connected!

$\Rightarrow$ GUT based models, . . .

SUSY Global Fits (2)

χ^2 calculation:

$\rightarrow$ global χ^2 likelihood function
combines all theoretical predictions with experimental constraints:

$$\chi^2 = \sum_i^N \frac{(C_i - P_i)^2}{\sigma(C_i)^2 + \sigma(P_i)^2} + \sum_i^M \frac{(f_{\mathrm{SM}_i}^{\mathrm{obs}} - f_{\mathrm{SM}_i}^{\mathrm{fit}})^2}{\sigma(f_{\mathrm{SM}_i})^2}$$

N: number of observables studied
M: SM parameters: $\Delta\alpha_{\mathrm{had}}, m_t, M_Z$
C_i: experimentally measured value (constraint)
P_i: MSSM parameter-dependent prediction for the corresponding constraint

Assumption: measurements are uncorrelated - fulfilled to a high degree

SUSY Global Fits (3)

• Tools: http://www.cern.ch/matsercode

Status of the "MasterCode":

– one model: (MFV) MSSM (see below)

– tools included:
  - B-physics observables [*SuFla*]
  - more B-physics observables [*SuperIso*]
  - Higgs related observables, $(g-2)_\mu$ [*FeynHiggs*]
  - Electroweak precision observables [*FeynWZ*]
  - Dark Matter observables [*MicrOMEGAs, DarkSUSY*]
  - for GUT scale models: RGE running [*SoftSusy*]

⇒ all most-up-to-date codes on the market!

– added: χ^2 analysis code [*Minuit*]

– currently being implemented:
  - Higgs constraints (for χ^2 contributions . . .) [*HiggsBounds*]

SUSY Global Fits (4)

Best-fit points:

CMSSM:

$m_{1/2} = 310$ GeV, $m_0 = 60$ GeV, $A_0 = 130$ GeV,

$\tan\beta = 11$, $\mu = 400$ GeV, $M_A = 450$ GeV

$\chi^2/N_{\rm dof} = 20.6/19$ (36 % probability)

$\Rightarrow$ very similar to SPS 1a :-)

NUHM1:

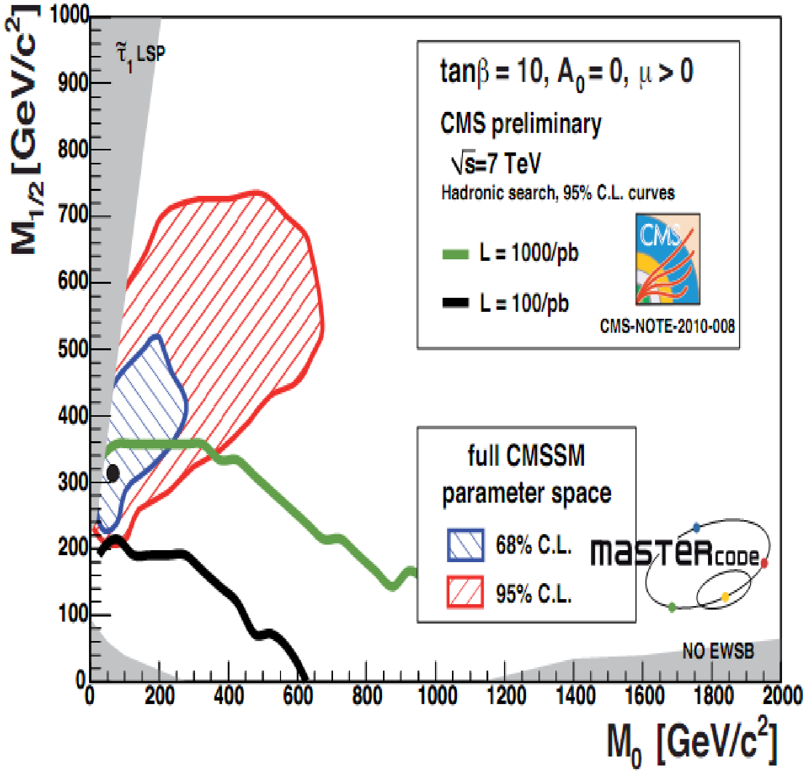
$m_{1/2} = 270$ GeV, $m_0 = 150$ GeV, $A_0 = -1300$ GeV,

$\tan\beta = 11$, $\mu = 1140$ GeV, $M_A = 310$ GeV

(similar probability)

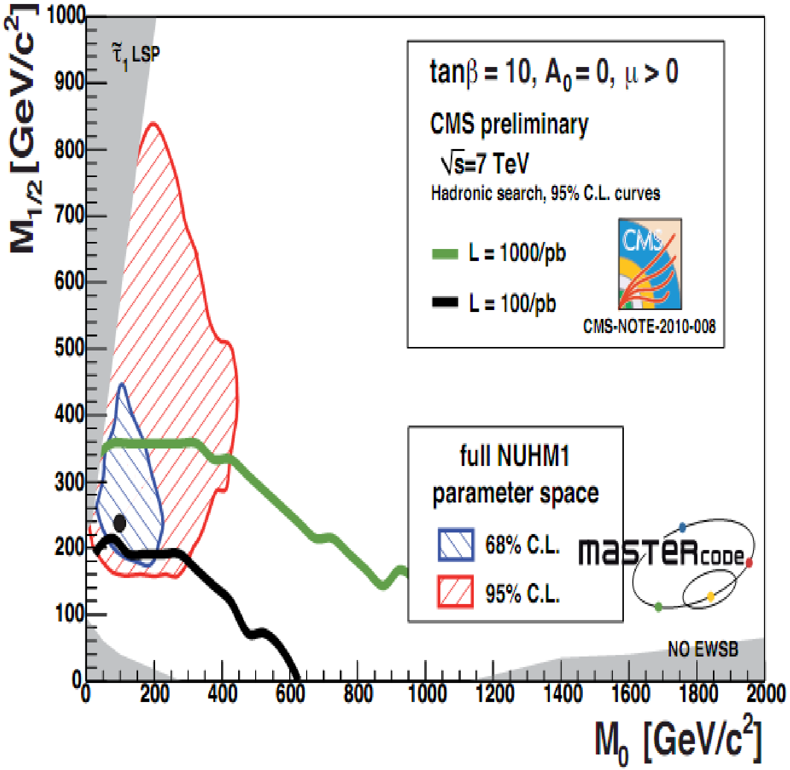
SUSY Global Fits (5)

LHC (CMS) ⊕ CMSSM analysis:



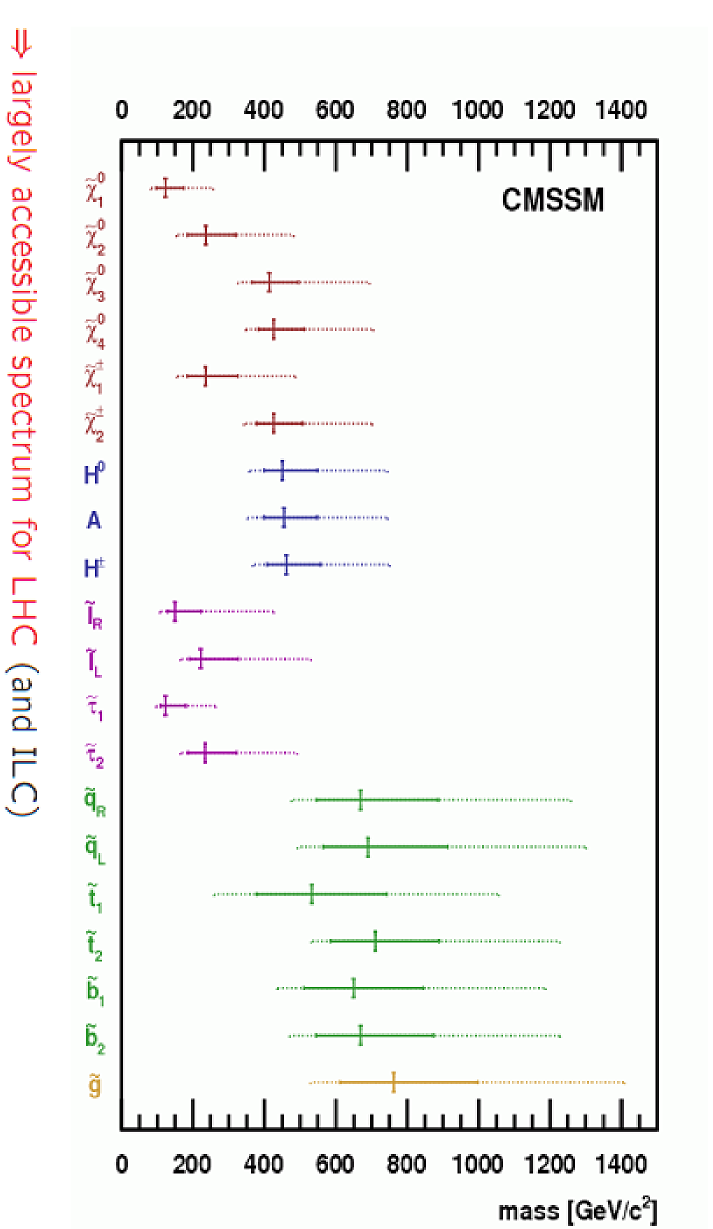
⇒ best-fit point and part of 68% C.L. are can be tested in 2011

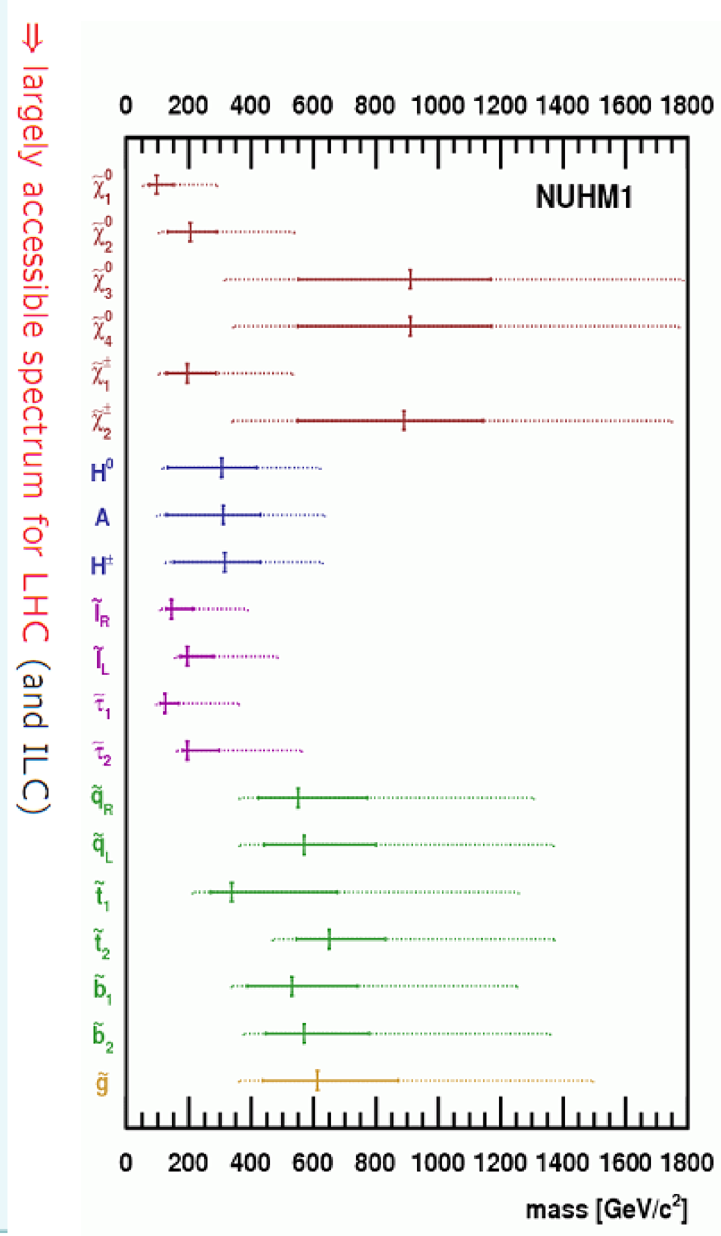
LHC (CMS) ⊕ NUHM1 analysis:



⇒ best-fit point and part of 68% C.L. are can be tested in 2011

SUSY Global Fits (6)





BACK-UP