Searches for Supersymmetry at ATLAS

Alberto Cervelli, on Behalf of ATLAS collaboration INFN Sezione Bologna







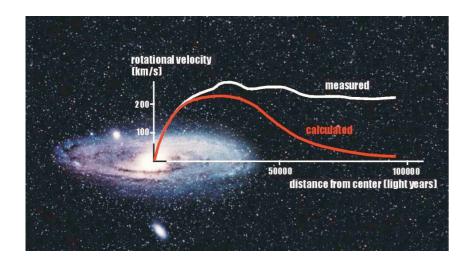


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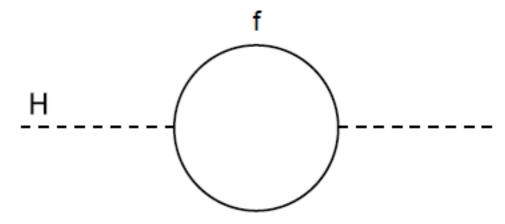
Why not the SM?

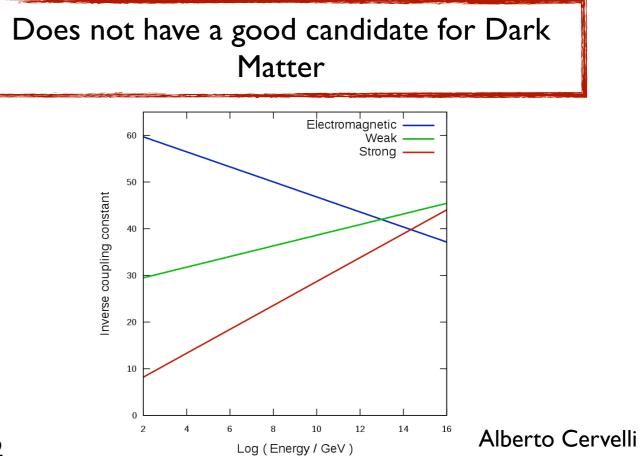
SM has been proven to be a very good model BUT..

Hierarchy problem: needs incredible fine tuning for Higgs mass stability



There is no unification of coupling constants at high energy scales





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Extending the SM

Why not supersymmetry? it is a framework, many possible phenomenologies

SUSY is a time-space symmetry linking a SM particle to a SUSY partner differing by 1/2 spin unit

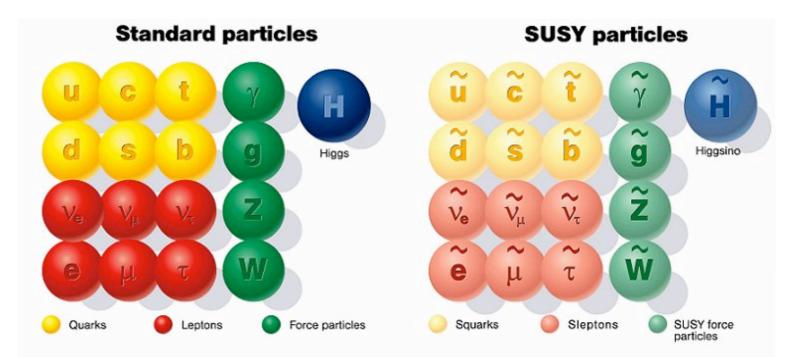
Not an exact symmetry: mass of particles ≠ mass of sparticles

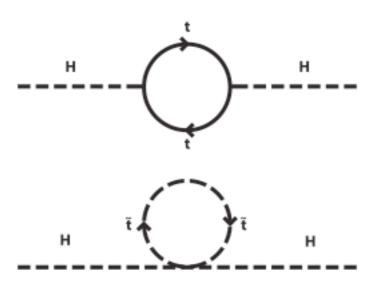
Loop corrections solve the quadratic divergence of Higgs boson mass

If R parity is conserved, SUSY LSP provide a natural Dark matter candidate

$$R : (-1)^{3(B-l)+2s}$$

+I For SM -I for SUSY









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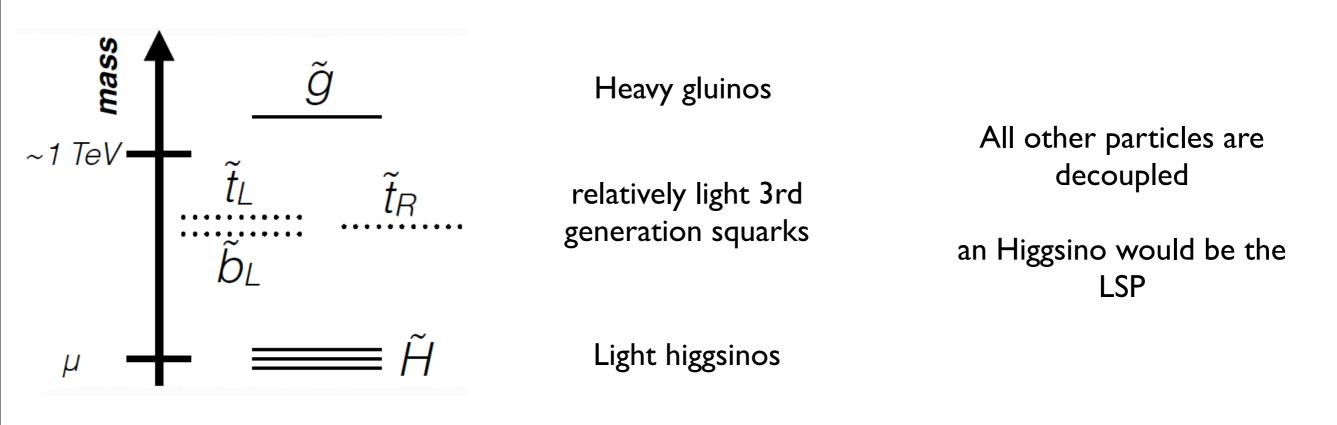
SUSY Naturalness

A possible phenomenology

Focus mainly on searches for Natural SUSY

Implication from both astronomic observation (dark matter relic density, cosmological constraints) and Particle physics (Higgs measurements)

Naturalness Phenomenology typically predict





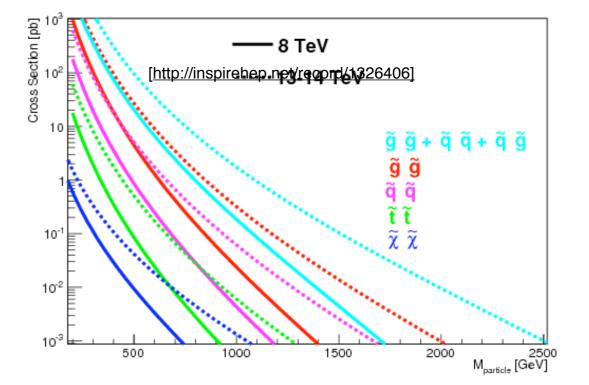
SUSY in

Increase of cross section at 13 TeV, more sizeable for higher SUSY masses:

early data will improve gluino and 1st-2nd generation production

after 10 fb⁻¹ improvement in 3rd generation and EWK production

Run 2



R-parity conservation

strong/EW pair production with cascade decay to LSP

many high P⊤ SM particles + ∉⊤ due to LSP escaping detection **R-parity Violation**

Multi Jet/Multi leptons from LSP decays

Displaced vertices due to late LSP decays

Long lived particles

Sparticles with long lifetimes due to mass degeneracy, small couplings

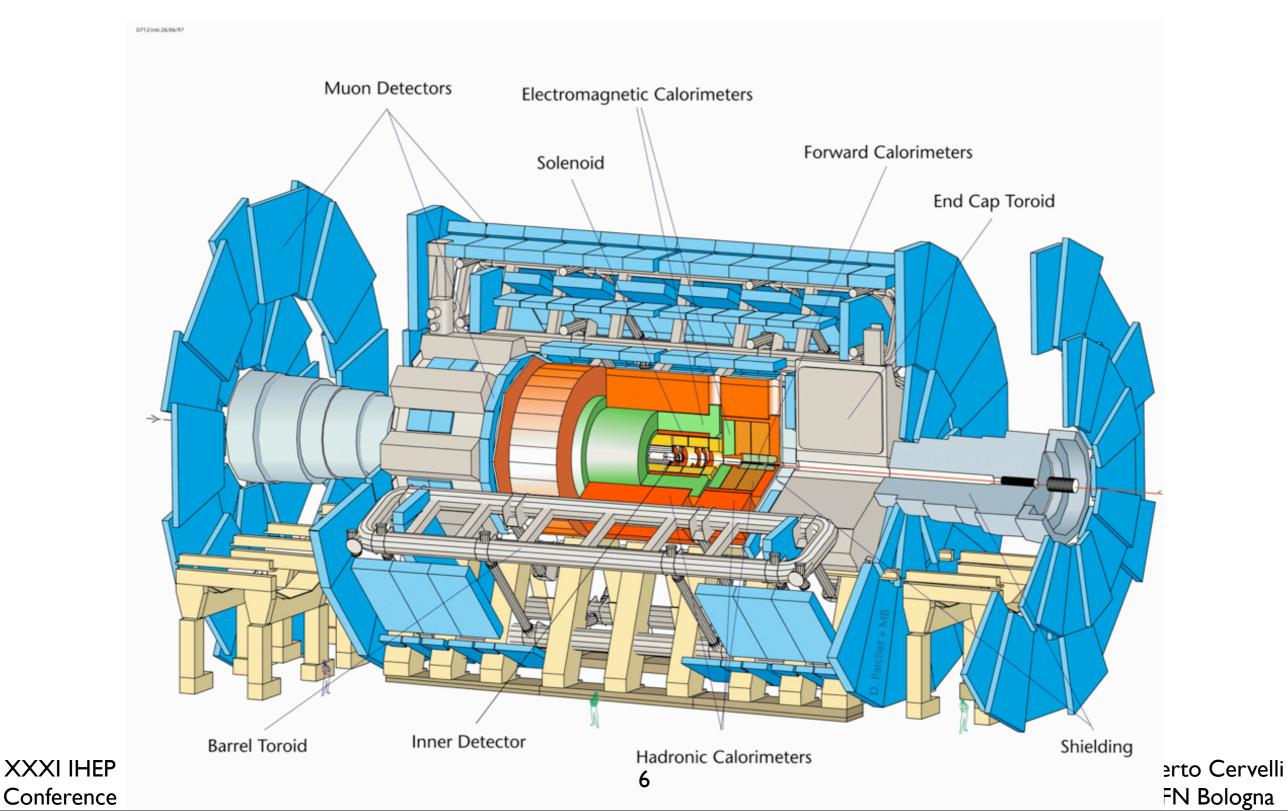
Secondary vertexes, mainly detector driven







ATLAS detector





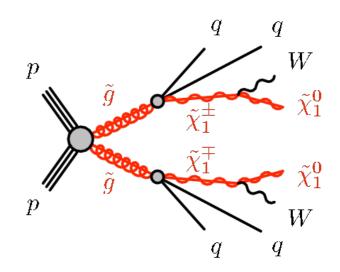


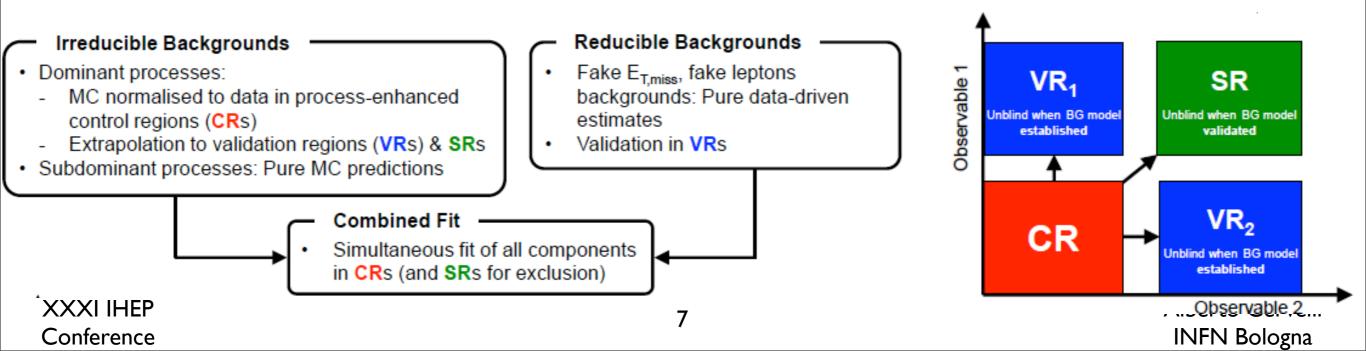
How we look for SUSY

Pick a signal model Typically use a simplified model for signal optimization: -assumes 100% BR along the decay cascade -limits the number of free parameters -easy to present results to the community lately reinterpretation for full models may be pursued

Search optimization:

Discovery: Typically inclusive cut and count analysis in SR Exclusion: more elaborate methods such as MVA, shape fits..







Discriminating Variables

Reconstructed object multiplicities, momenta, energies, e.g. N_{jet/b-tag/t/y}, p_T, E_{T,miss}, ...

Scale variables, e.g. m_{eff} = Σp_T + E_{T,miss},

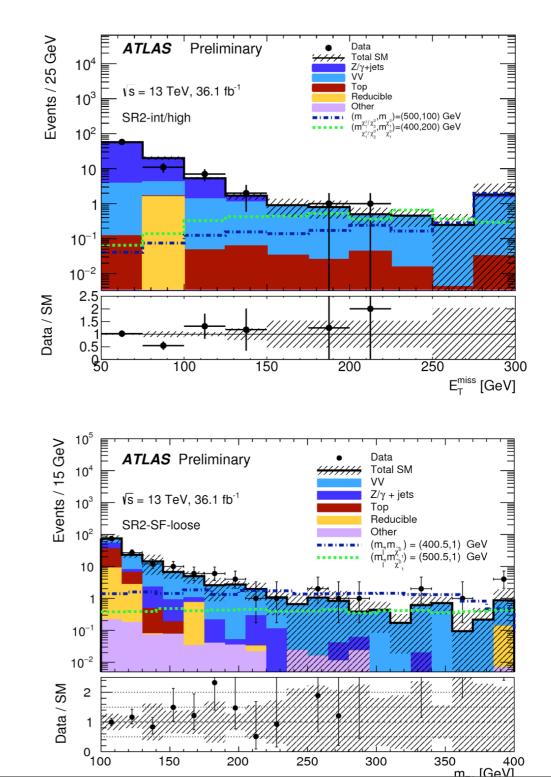
Angular variables, e.g. min ΔΦ(jet, E_{T,miss}), ...

Mass variables, e.g. m_μ, m_T^{b/ℓ/j}, Σm_{fat-jet}, ...

Event shape variables, e.g. Aplanarity, ...

Hypothesis-based event variables e.g. m_{T2}, ...

More complex methods, e.g. new recursive jigsaw reconstruction [arxiv:1607.08307], ...

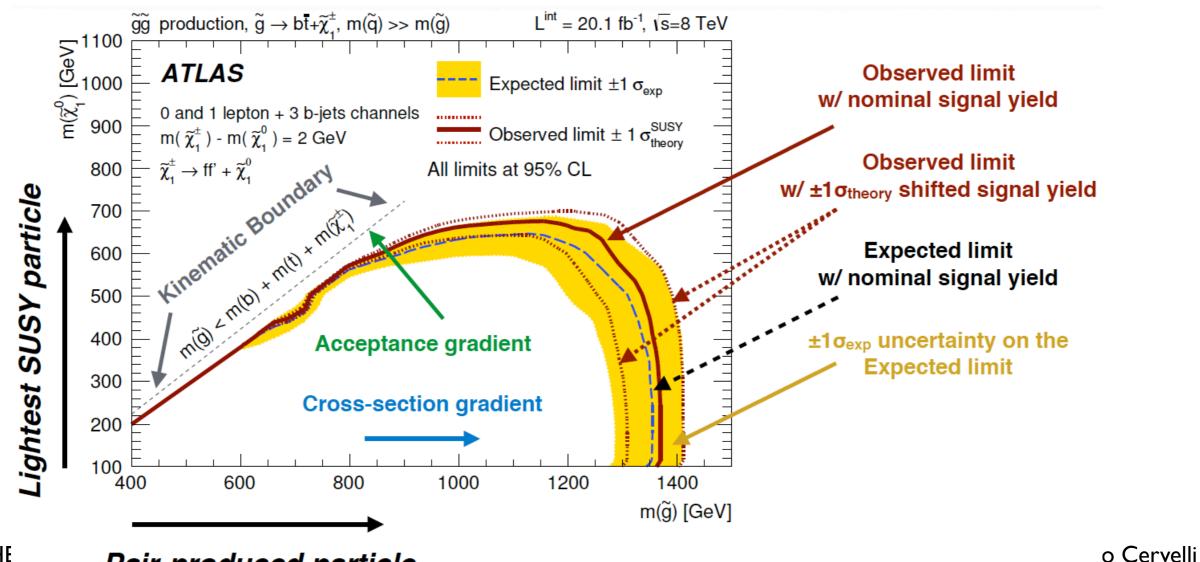


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complexity



Results typically presented in 2D slices of SUSY particle masses Consistency between signal and bkg is evaluated for the point of the plane as a p-value Model dependent limits are set on production cross sections



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Pair-produced particle





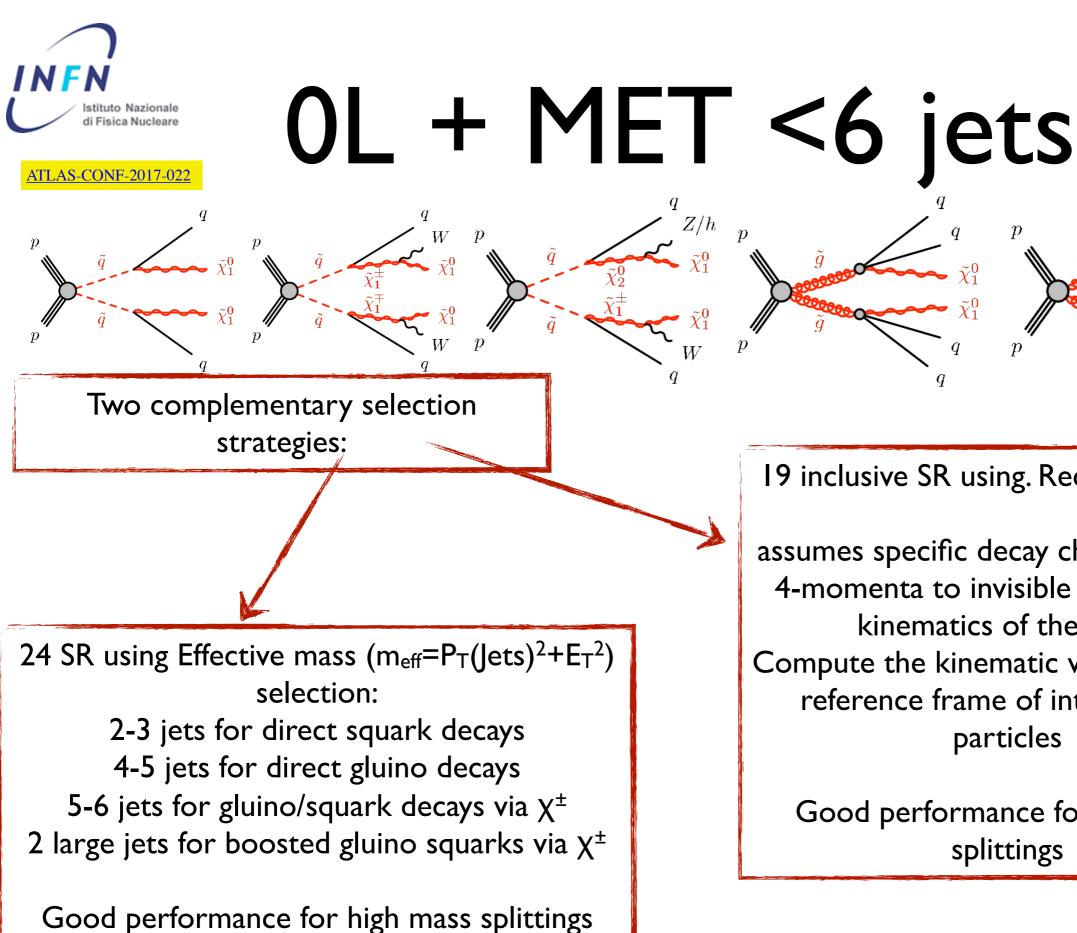
Results with full dataset

Inclusive searches OL 2-6Jets ATLAS-CONF-2017-022 OL 7-11 Jets ATLAS-CONF-2017-033 multi b-jets ATLAS-CONF-2017-021 SS/3L + jets arXiv:1706.03731 3rd Generation stop 0L <u>ATLAS-CONF-2017-020</u> stop 1L with DM+HF <u>ATLAS-CONF-2017-037</u> Stop 2L<u>ATLAS-CONF-2017-034</u> 2b+MET <u>ATLAS-CONF-2017-038</u> Stop in Z/h <u>arXiv:1706.03986</u>

EWK production EWK 2/3L ATLAS-CONF-2017-039 EWK di-tau ATLAS-CONF-2017-035 RPV/Long lived particles stop B-L <u>ATLAS-CONF-2017-036</u> stop 2x2 <u>ATLAS-CONF-2017-025</u> displaced vertices +MET <u>ATLAS-CONF-2017-026</u> disappearing tracks <u>ATLAS-CONF-2017-017</u> RPV IL <u>arXiv:1706.03731</u>

In this talk only a sample for each category will be presented, highlighted in the list, togeteher with summary

The list of the latest ATLAS SUSY results can be found here <u>https://twiki.cern.ch/twiki/bin/view/AtlasPublic/SupersymmetryPublicResults</u>



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19 inclusive SR using. Recursive Jigsaw:

assumes specific decay chains to assign 4-momenta to invisible particles the kinematics of the event Compute the kinematic variables in the reference frame of intermediate particles

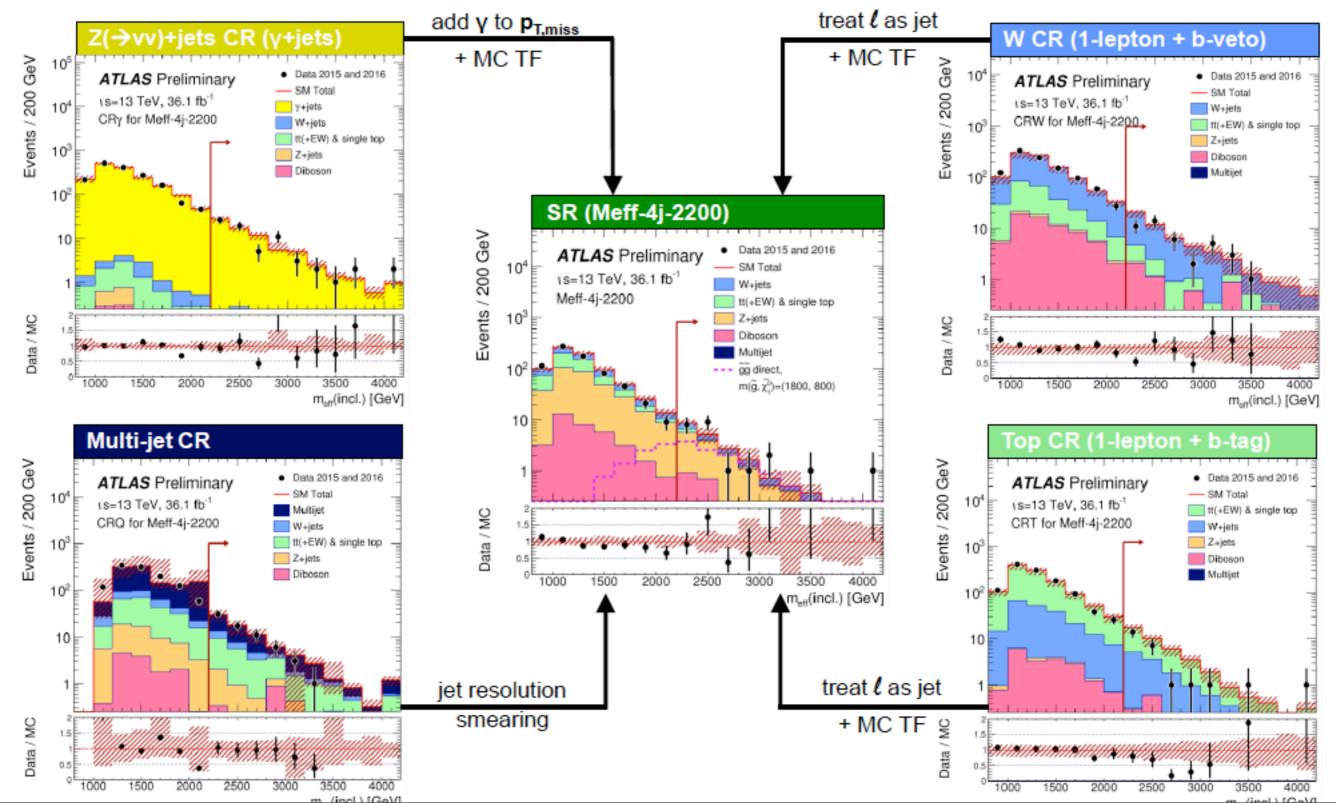
Good performance for low mass splittings

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Background estimation

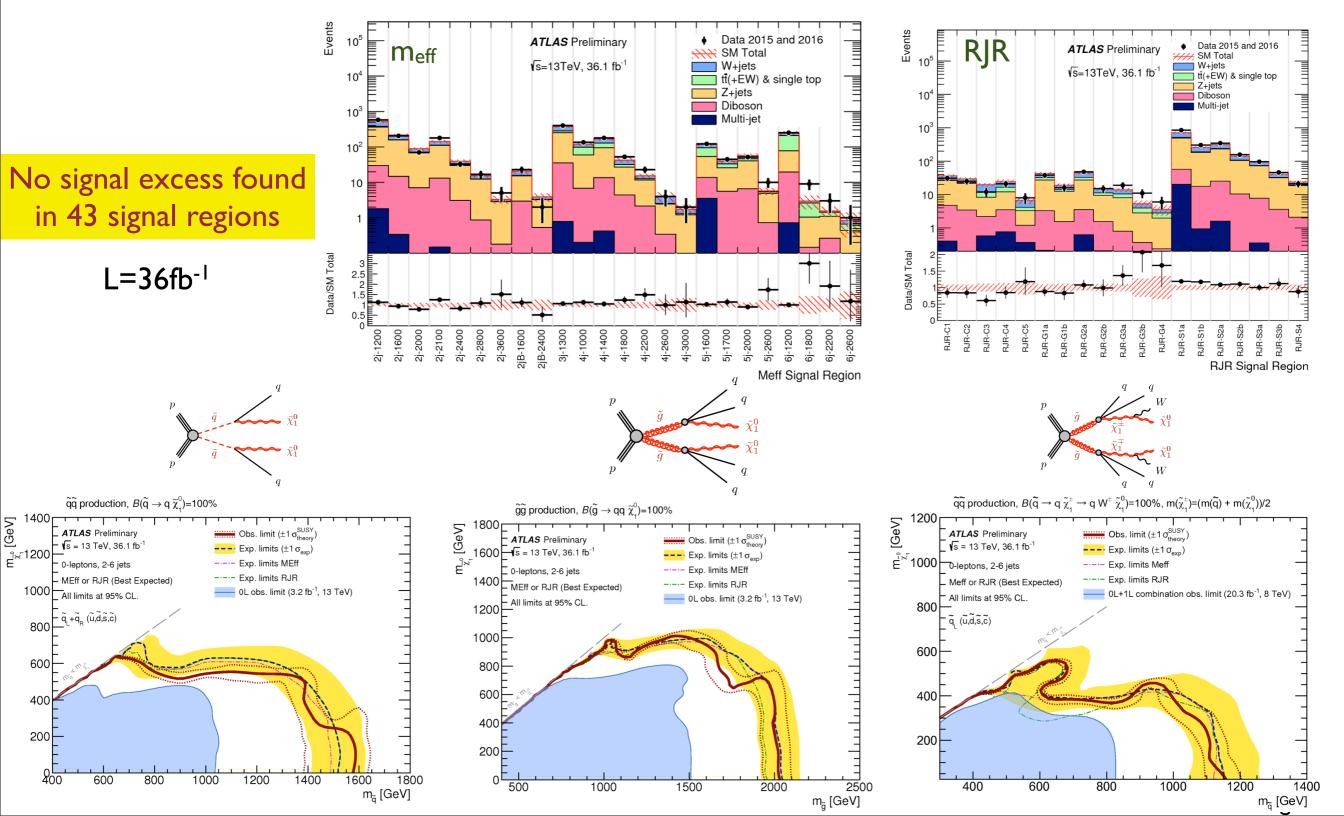
INFN

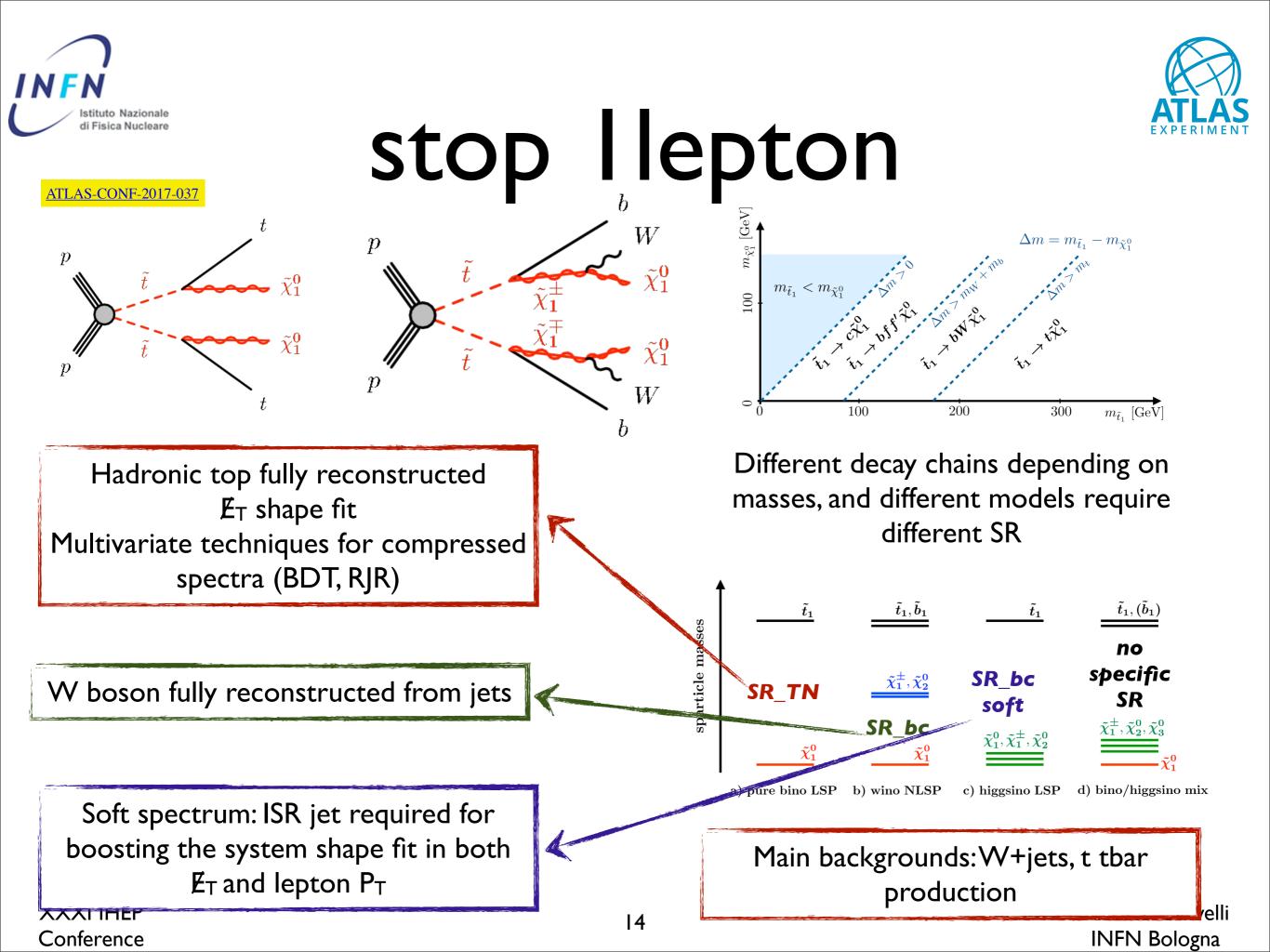




ATLAS-CONF-2017-022









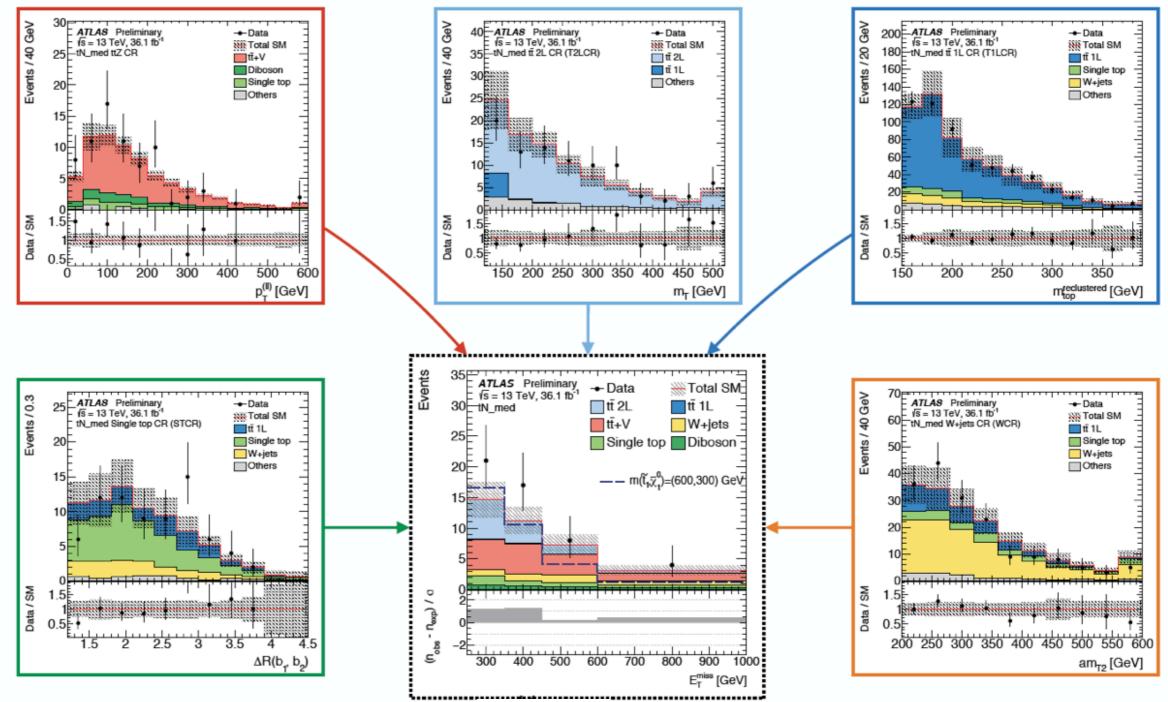
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stop I lepton



I 6 SR: main discriminants m_T , E_T , p_T^W Background estimated in up to 5 CR and validated in VR for each SR



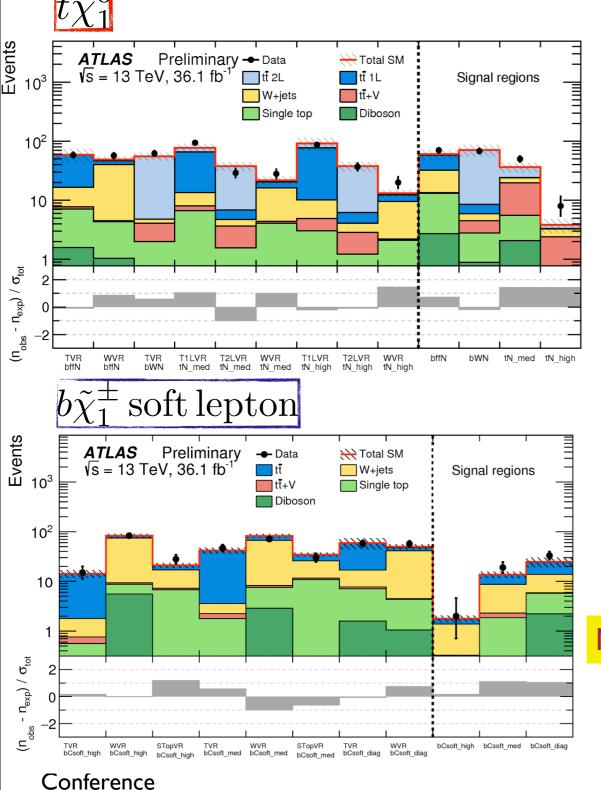
zna

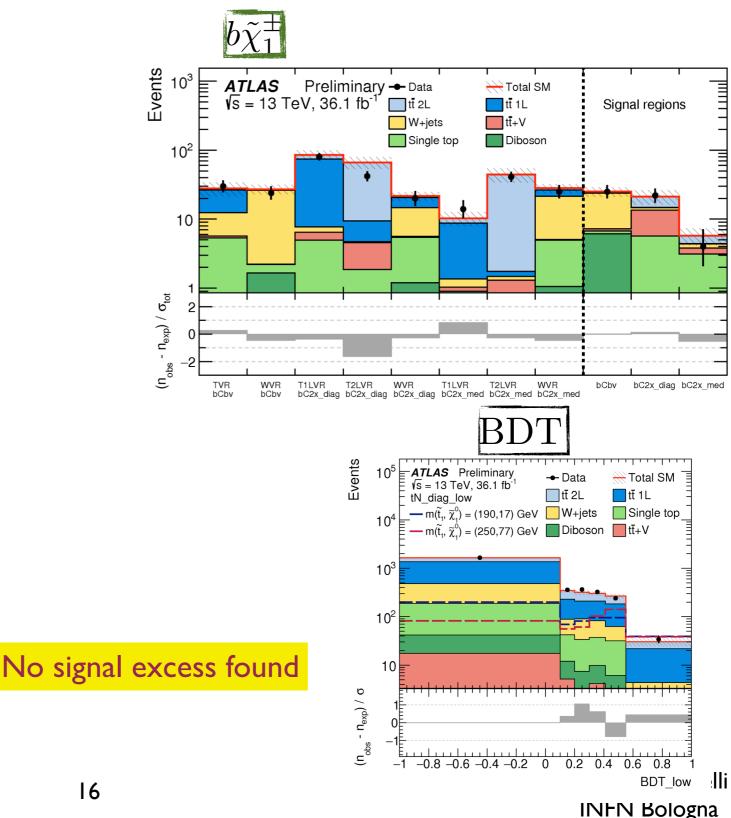
velli





Stop II: results





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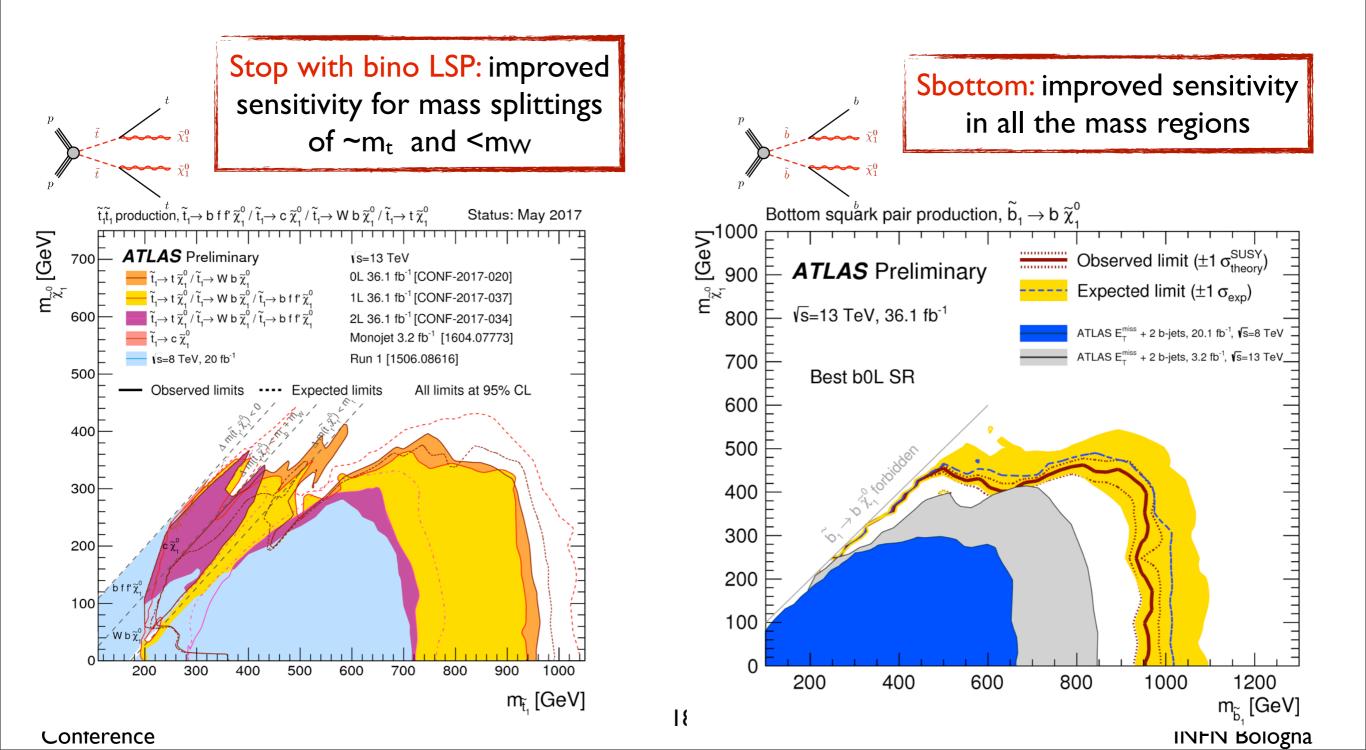
Stop II: interpretation

I N F N

ATLAS-CONF-2017-037 $\text{Wino NLSP model: } \widetilde{t_1}\widetilde{t_1}, \ \widetilde{b_1}\widetilde{b_1} \text{ production}, \\ m_{\widetilde{\chi}_1^\pm} \approx m_{\widetilde{\chi}_2^\circ} \approx 2 \times m_{\widetilde{\chi}_1^\circ} (M_2 = 2 \times M_1) \\$ Pure Bino LSP model: $\tilde{t}_1\tilde{t}_1$ production, $\tilde{t}_1 \rightarrow bff \tilde{\chi}_1^0, \tilde{t}_1 \rightarrow Wb \tilde{\chi}_1^0, \tilde{t}_1 \rightarrow t \tilde{\chi}_1^0$ $m_{\widetilde{\chi}_1^0} \, [\text{GeV}]$ $\rightarrow b \widetilde{\chi}_{1}^{\pm}, t \widetilde{\chi}_{1}$ $m_{\widetilde{\chi}_1^0} \, [\text{GeV}]$ 700 ATLAS Preliminary $\sqrt{s} = 13 \text{ TeV}, 36.1 \text{ fb}^{-1}$ Cobserved limit (±1 σ_{exp}) Expected limit (±1 σ_{exp}) | _<u>_</u>___ ATLAS Preliminary $\sqrt{s} = 13$ TeV, 36.1 fb⁻¹ 600 $\rightarrow t \tilde{\chi}_{1}^{\pm}, b \tilde{\chi}_{1}^{0}$ Expected limit (±1σ_{exp}) Limit at 95% CL 600 Limit at 95% CL ATLAS t1L 13 TeV, 3.2 fb⁻¹ $\rightarrow Z \widetilde{\chi}^{0}_{1}, h \widetilde{\chi}^{0}_{1}$ 500 Observed limit u>0: χ̃ \rightarrow h $\tilde{\chi}^{0}_{i}$ (dominant), Z $\tilde{\chi}^{0}_{i}$ ATLAS 8 TeV, 20.3 fb 500E --- Expected limit $(\pm 1\sigma_{exp})$ 400 **400**E **300**E 300 200 200 100E100 U 1200 200 400 600 800 1000 550 600 650 700 750 800 850 900 950 $m_{\tilde{t}}$ [GeV] $m_{\tilde{t}}$ [GeV] **ATLAS** Preliminary $\sqrt{s} = 13 \text{ TeV}, 36.1 \text{ fb}^{-1}$ $\tilde{t}_1 \rightarrow b \, \tilde{\chi}_1^{\pm}, t \, \tilde{\chi}_1^0$ $\widetilde{\chi}_{_{1}}^{_{\pm}} \rightarrow W \ \widetilde{\chi}_{_{1}}^{_{0}} \quad \widetilde{\chi}_{_{2}}^{_{0}} \rightarrow h \ \widetilde{\chi}_{_{1}}^{_{0}}, Z \ \widetilde{\chi}_{_{1}}^{_{0}}$ Limit at 95% CL $BR(t\tilde{\chi}_{a}^{0}, b\tilde{\chi}_{a}^{\pm}, t\tilde{\chi}_{a}^{0}) \approx$ Observed limit , small tanβ: (45, 10, 45)% Expected limit $(\pm 1\sigma_{exp})$ t̃,, large tanβ: (33, 33, 33)% $ilde{t}_1$ $ilde{t}_1,(b_1)$ $-\tilde{t}_1 \approx \tilde{t}_1 - \tilde{t}_1 \approx \tilde{t}_1$ (large tan β) $-\tilde{t}_1 \approx \tilde{t}_B$ t̃_a: (25, 50, 25)% sparticle masses Higgsino LSP model: \tilde{t}, \tilde{t} , production, $m_{\tilde{\chi}^{\pm}} = m_{\tilde{\chi}^{0}} + 5 \text{ GeV}, m_{\tilde{\chi}^{0}} = m_{\tilde{\chi}^{0}} + 10 \text{ GeV}$ $m_{\widetilde{\chi}_1^0} \, [\text{GeV}]$ 400 $ilde{\chi}^{\pm}_{1}, ilde{\chi}^{0}_{2}$ 350 300 250 200 150 e bino LSP d) bino/higgsino mix b) wino NLSP c) higgsino LSP 100 800 700 900 500 600 1000 400 Alberto Cervelli 17 $m_{\tilde{t}.}$ [GeV] **INFN Bologna**



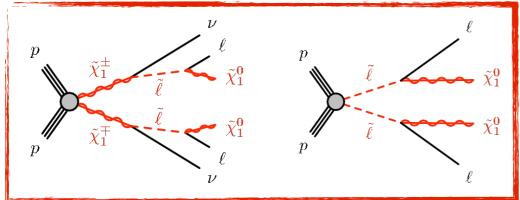
Istituto Nazionale di Fisica Nucleare Summary of 3rd Gen

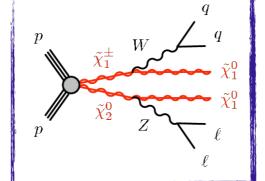


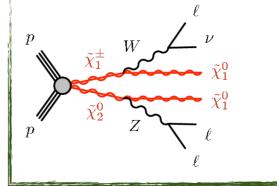
ATLAS-CONF-2017-039 Istituto Nazionale di Fisica Nucleare

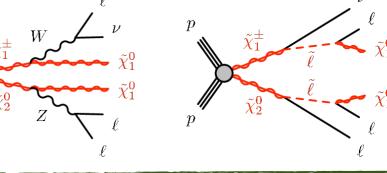
2/3 leptons











Electro Weak production: Gaugino or slepton production, decaying via leptons or bosons 3 different channels/Signal regions. All channels have a large missing E_T

2l+0jets: targets chargino pair production, decaying via sleptons

Main discriminating variables: M_{T2} , invariant mass of dilepton pair.

21+Jets: target charginoneutralino production, decaying via gauge bosons

Look for 2 leptons, both opposite and same sign.

3 leptons: targets charginoneutralino decaying both trough gauginos or sleptons

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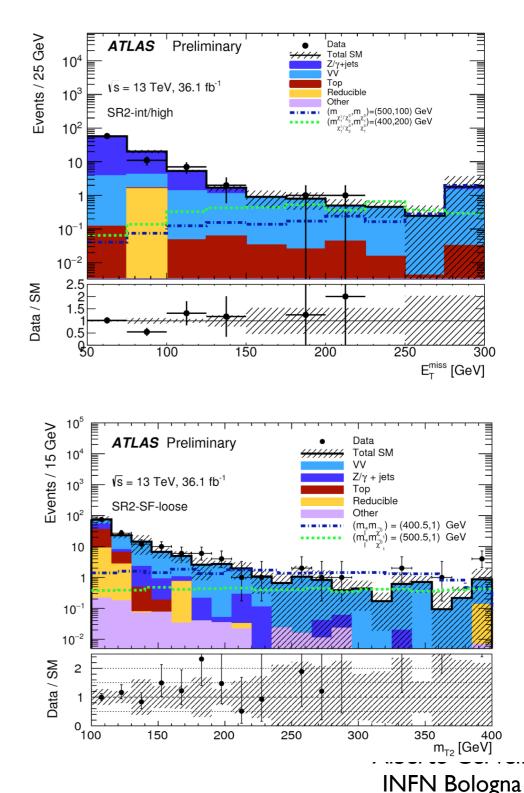
2/3 L: backgrounds

Different backgrounds and CR for different channels.

2I+0jets: top pair and VV estimated from dedicated CR
2I+Jets: Z+jets obtained from data using orthogonal γ+jets
3 leptons: top pair, VV, and single top from dedicated CR, Z+jets obtained from Data

Non prompt background estimated from data

Error on background estimation ~20-50%





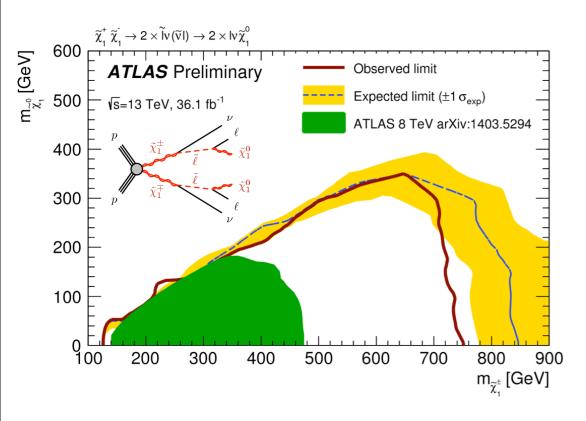
2/3 leptons No signal excess found

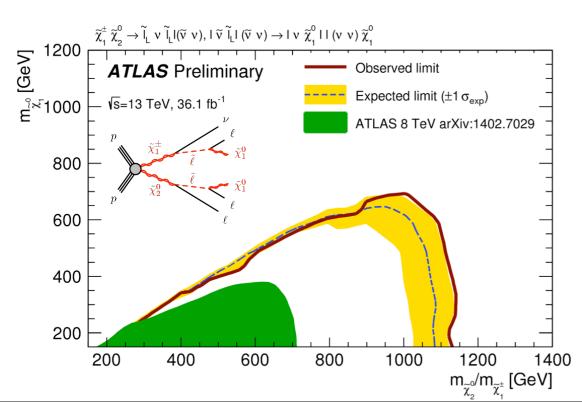
L=36fb⁻¹

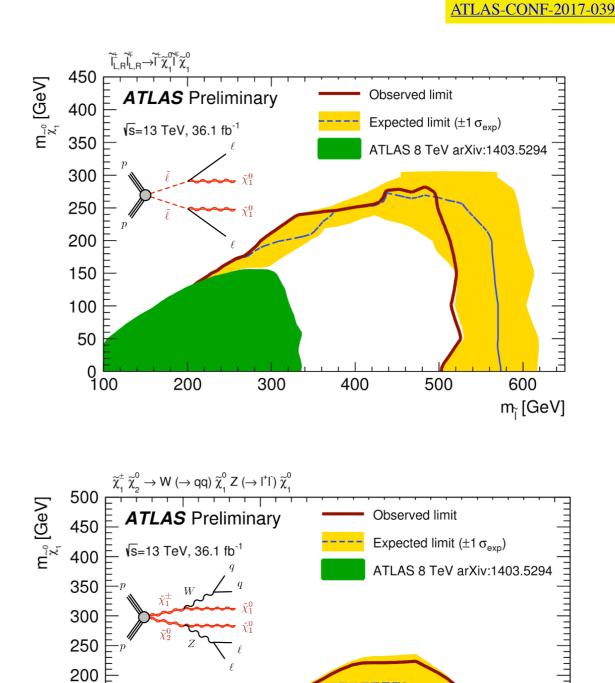


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 $m_{\tilde{\chi}_{2}^{0}}/m_{\tilde{\chi}_{1}^{\pm}}$ [GeV]







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Summary of EWK

May 2017

 $\widetilde{\chi}_1^+ \widetilde{\chi}_1^-$

200

150

100

50

22

too

150

200

250

Decays via sleptons: Sensitivity exceeding ITeV for chargino and heavier neutralinos

Decays via W/Z/h bosons: sensitivity up to 600 GeV for chargino and heavier neutralinos

via WW 2I, arXiv:1403.5294

via WZ 2I+3I, 8 TeV, arXiv:1403.5294

W/Z/h

300

350

400

WZ 2I+3I, 13 TeV, ATLAS-CONF-2017-039

lbb+lγγ+l[±]l[±]+3l, arXiv:1501.07110

ATLAS Preliminary Vs=8,13 TeV, 20.3-36.1 fb⁻¹

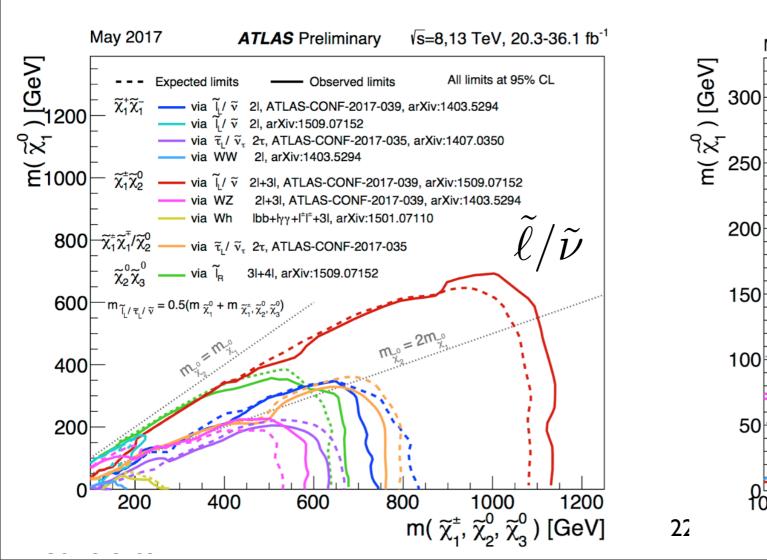
 Expected limits **Observed limits**

All limits at 95% CL

450 500 550

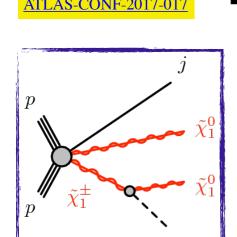
m($\widetilde{\chi}_{1}^{\pm}, \widetilde{\chi}_{2}^{0}$) [GeV]

600



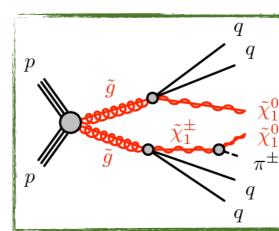


Disappearing Tracks



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Detector driven analysis.

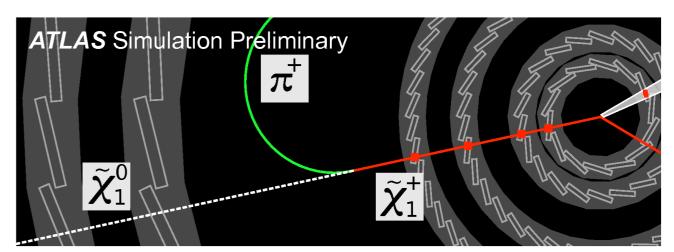
Targets models where chargino and neutralino are almost degenerate, pion not reconstructed

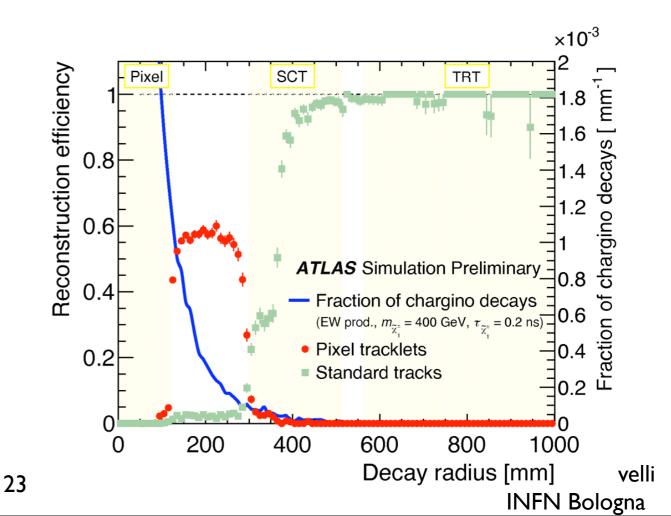
Two different signatures and productions: EWK: ISR jet+ET+disappearing strong: multi jets+ET+disappearing

Low mass (160 MeV) LSP may have cT~6cm

Run 2 sensitivity improved thanks to IBL

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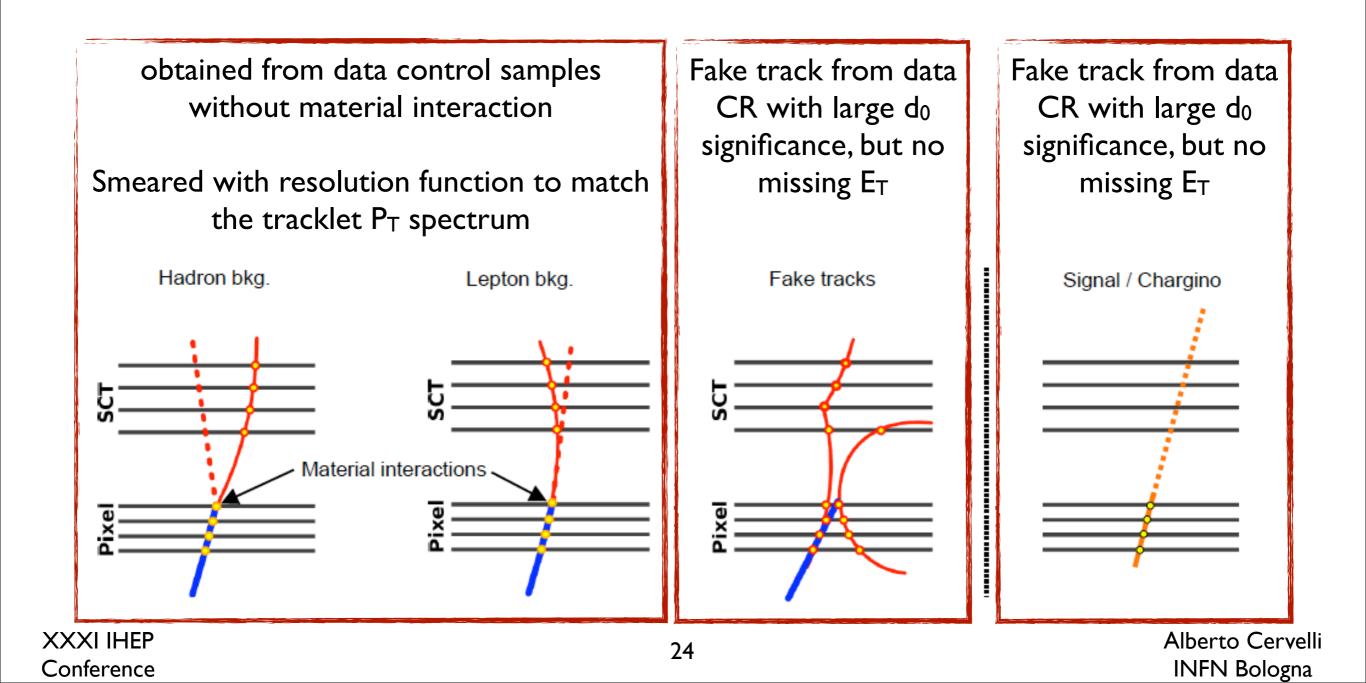






Disappearing tracks

Simultaneus fit of tracklet P_T for the 3 backgrounds (+ signal)



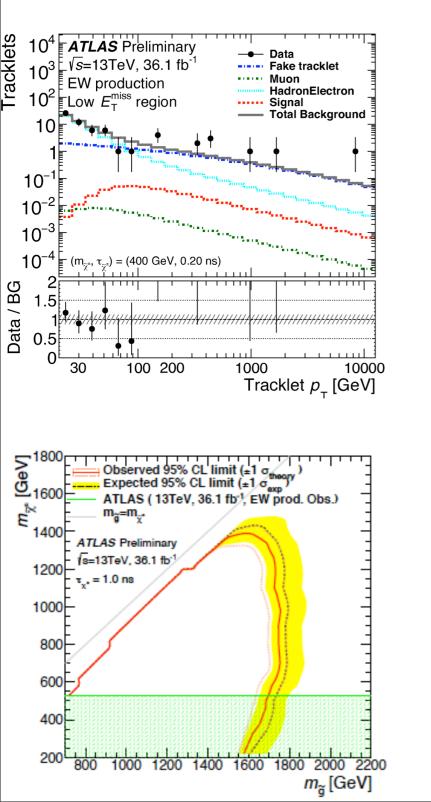


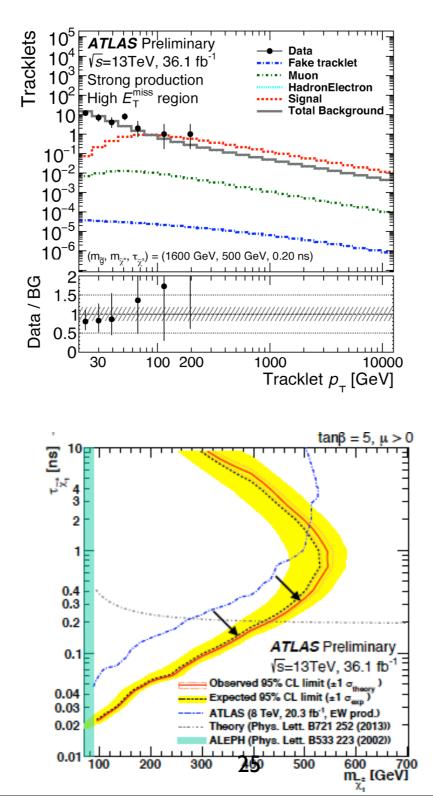
Disappearing tracks

ATLAS-CONF-2017-017

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No signal excess found

For weak production large increase w.r.t Run I

Starting to be as sensitive as direct higgsino searches

Strong production excludes up to 1.6 TeV for lifetimes under 1.1 ns

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ATLAS SUSY Searches* - 95% CL Lower Limits

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	arches - 95% CL LU			AILAS
May 2017				$\sqrt{s} = 7, 8, 13 \text{ TeV}$
Model	e, μ, τ, γ Jets $E_{\rm T}^{\rm miss} \int \mathcal{L} dt$	b ⁻¹] Mass limit	$\sqrt{s} = 7, 8 \text{ TeV}$ $\sqrt{s} = 13 \text{ TeV}$	Reference
$\begin{array}{c} \mbox{MSUGRA/CMSSM} \\ \bar{q}\bar{q}, \bar{q} \rightarrow q \tilde{k}_{1}^{0} \\ \bar{q}\bar{q}, \bar{q} \rightarrow q \tilde{k}_{1}^{0} \\ \bar{q}\bar{q}, \bar{q} \rightarrow q \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}, \bar{g} \rightarrow q \bar{q} \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}, \bar{g} \rightarrow q \bar{q} \tilde{k}_{1}^{0} \rightarrow q q W^{\pm} \tilde{\chi}_{1}^{0} \\ \bar{g}\bar{g}, \bar{g} \rightarrow q q \tilde{k}_{1}^{\pm} \rightarrow q q W^{\pm} \tilde{\chi}_{1}^{0} \\ \bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}\bar{g}, \bar{g} \rightarrow q q W Z \tilde{k}_{1}^{0} \\ \bar{g}\bar{g}\bar{g}\bar{g}\bar{g}\bar{g}\bar{g}\bar{g}\bar{g}\bar{g}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	ž ž 900 GeV	$\begin{array}{c c} \textbf{1.85 TeV} & m(\tilde{q}) = m(\tilde{g}) \\ \hline \textbf{1.57 TeV} & m(\tilde{k}_1^n) < 200 \ \text{GeV}, \ m(1^u \ \text{gen.} \tilde{q}) = m(2^{nd} \ \text{gen.} \tilde{q}) \\ & m(\tilde{k}_1^n) < 5 \ \text{GeV} \\ \hline \textbf{2.01 TeV} & m(\tilde{k}_1^n) < 200 \ \text{GeV}, \ m(\tilde{k}^n) = 0.5(m(\tilde{k}_1^n) + m(\tilde{g})) \\ \hline \textbf{1.825 TeV} & m(\tilde{k}_1^n) < 200 \ \text{GeV}, \ m(\tilde{k}^n) = 0.5(m(\tilde{k}_1^n) + m(\tilde{g})) \\ \hline \textbf{1.8 TeV} & m(\tilde{k}_1^n) < 400 \ \text{GeV} \\ \hline \textbf{2.0 TeV} \\ \hline \textbf{1.65 TeV} & rr(\text{NLSP}) < 0.1 \ \text{mm}, \ \mu < 0 \\ \hline \textbf{1.8 TeV} & m(\tilde{k}_1^n) < 950 \ \text{GeV}, \ rr(\text{NLSP}) < 0.1 \ \text{mm}, \ \mu > 0 \\ \hline \textbf{m}(\text{NLSP}) > 430 \ \text{GeV} \\ \hline \end{array}$	1507.05525 ATLAS-CONF-2017-022 1604.07773 ATLAS-CONF-2017-022 ATLAS-CONF-2017-022 ATLAS-CONF-2017-030 ATLAS-CONF-2017-033 1607.05979 1606.09150 1507.05493 ATLAS-CONF-2016-066 1503.03290
Gravitino LSP $\vec{k} \vec{k}, \vec{k} \rightarrow b \vec{b} \vec{k}_{1}^{0}$ $\vec{k} \vec{k}, \vec{k} \rightarrow b \vec{k} \vec{k}_{1}^{0}$ $\vec{k} \vec{k}, \vec{k} \rightarrow t \vec{k} \vec{k}_{1}^{0}$ $\vec{k} \vec{k}, \vec{k} \rightarrow t \vec{k} \vec{k}_{1}^{0}$	0 mono-jet Yes 20.3 0 3 b Yes 36.1 0-1 e,μ 3 b Yes 36.1 0-1 e,μ 3 b Yes 20.1	F ^{1/2} scale 865 GeV R	m(\tilde{c})>1.8 × 10 ⁻⁴ eV, m(\tilde{g})=m(\tilde{q})=1.5 TeV 1.92 TeV m(\tilde{c}_1^0)<600 GeV	1502.01518 ATLAS-CONF-2017-021 ATLAS-CONF-2017-021 1407.0600
$\begin{array}{c} \tilde{b}_{1}\tilde{b}_{1}, \tilde{b}_{1} \rightarrow b\tilde{x}_{1}^{0} \\ \tilde{b}_{1}\tilde{b}_{1}, \tilde{b}_{1} \rightarrow t\tilde{x}_{1}^{0} \\ \tilde{b}_{1}\tilde{b}_{1}, \tilde{b}_{1} \rightarrow t\tilde{x}_{1}^{0} \\ \tilde{b}_{1}\tilde{b}_{1}, \tilde{b}_{1} \rightarrow t\tilde{x}_{1}^{0} \\ \tilde{b}_{1}\tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\tilde{x}_{1}^{0} \\ \tilde{t}_{1}\tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\tilde{x}_{1}^{0} \\ \tilde{t}_{1}\tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\tilde{x}_{1}^{0} \\ \tilde{t}_{1}\tilde{t}_{1}(natural GMSB) \\ \tilde{t}_{2}\tilde{t}_{2}, \tilde{t}_{2} \rightarrow \tilde{t}_{1} + Z \\ \tilde{t}_{2}\tilde{t}_{2}, \tilde{t}_{2} \rightarrow \tilde{t}_{1} + h \end{array}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c} m(\bar{\xi}_{1}^{0}){<}420~\text{GeV} \\ m(\bar{\xi}_{1}^{0}){<}200~\text{GeV}, m(\bar{\xi}_{1}^{1}){=}~m(\bar{\xi}_{1}^{0}){+}100~\text{GeV} \\ m(\bar{\xi}_{1}^{2}){=}~2m(\bar{\xi}_{1}^{0}), m(\bar{\xi}_{1}^{0}){=}55~\text{GeV} \\ m(\bar{\xi}_{1}^{0}){=}1~\text{GeV} \\ m(\bar{t}_{1}){-}m(\bar{\xi}_{1}^{0}){=}5~\text{GeV} \\ m(\bar{\xi}_{1}^{0}){=}150~\text{GeV} \\ m(\bar{\xi}_{1}^{0}){=}0~\text{GeV} \\ m(\bar{\xi}_{1}^{0}){=}0~\text{GeV} \\ m(\bar{\xi}_{1}^{0}){=}0~\text{GeV} \end{array}$	ATLAS-CONF-2017-038 ATLAS-CONF-2017-030 1209.2102, ATLAS-CONF-2016-077 1506.08616, ATLAS-CONF-2017-020 1604.07773 1403.5222 ATLAS-CONF-2017-019 ATLAS-CONF-2017-019
$\begin{array}{c} \overbrace{\xi_{L,R}}^{\widetilde{\ell}_{L,R}}, \overbrace{\ell \to \ell} \widetilde{\chi}_{1}^{0} \\ \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}}, \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}} \to \overline{\ell} \nu(\ell \overline{\nu}) \\ \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}} \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}}, \overbrace{\chi_{2}}^{\widetilde{\tau}_{1}} \to \overline{\ell} \nu(\ell \overline{\nu}) \\ \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}} \overbrace{\chi_{2}}^{\widetilde{\tau}_{1}}, \overbrace{\chi_{2}}^{\widetilde{\tau}_{1}} \to \overline{\ell} \nu(\ell \overline{\nu}) \\ \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}} \overbrace{\chi_{2}}^{\widetilde{\tau}_{2}} \to W \widetilde{\chi}_{L}^{0} \ell(\overline{\nu}\nu) \\ \overbrace{\chi_{1}}^{\widetilde{\tau}_{1}} \overbrace{\chi_{2}}^{\widetilde{\tau}_{2}} \to W \widetilde{\chi}_{1}^{0} h \widetilde{\chi}_{1}^{0}, h \to b \overline{b} / W W / \tau \tau / \gamma \gamma \\ \overbrace{\chi_{2}}^{\widetilde{\tau}_{2}} \overbrace{\chi_{2}}^{\widetilde{\tau}_{2}} \to \overline{\ell}_{R} \ell \\ GGM (wino NLSP) weak prod., \widetilde{\chi}_{1}^{0} \\ GGM (bino NLSP) weak prod., \widetilde{\chi}_{1}^{0} \end{array}$	$4 e, \mu = 0$ Yes 20.3 $\rightarrow \gamma \tilde{G} = 1 e, \mu + \gamma = \gamma$ Yes 20.3	$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{split} \mathfrak{m}(\tilde{\xi}_{1}^{0}) = 0 & \mathfrak{m}(\tilde{\xi}_{1}^{0}) = 0, \mathfrak{m}(\tilde{\xi}, \tilde{v}) = 0.5(\mathfrak{m}(\tilde{\xi}_{1}^{+}) + \mathfrak{m}(\tilde{\xi}_{1}^{0})) & \mathfrak{m}(\xi_{1}^{0}) = 0, \mathfrak{m}(\tilde{\tau}, \tilde{v}) = 0.5(\mathfrak{m}(\tilde{\xi}_{1}^{+}) + \mathfrak{m}(\tilde{\xi}_{1}^{0})) & \mathfrak{m}(\tilde{\xi}_{1}^{0}) = 0, \mathfrak{m}(\tilde{\tau}, \tilde{v}) = 0.5(\mathfrak{m}(\tilde{\xi}_{1}^{+}) + \mathfrak{m}(\tilde{\xi}_{1}^{0})) & \mathfrak{m}(\tilde{\xi}_{1}^{+}) = \mathfrak{m}(\tilde{\xi}_{2}^{0}), \mathfrak{m}(\tilde{\xi}_{1}^{0}) = 0, \mathfrak{m}(\tilde{\xi}, \tilde{v}) = 0.5(\mathfrak{m}(\tilde{\xi}_{1}^{+}) + \mathfrak{m}(\tilde{\xi}_{1}^{0})) & \mathfrak{m}(\tilde{\xi}_{1}^{+}) = \mathfrak{m}(\tilde{\xi}_{2}^{0}), \mathfrak{m}(\tilde{\xi}_{1}^{0}) = 0, \tilde{\varepsilon} \text{ decoupled} & \mathfrak{m}(\tilde{\xi}_{2}^{0}) = \mathfrak{m}(\tilde{\xi}_{1}^{0}), \mathfrak{m}(\tilde{\xi}_{1}^{0}) = 0, \mathfrak{m}(\tilde{\tau}, \tilde{v}) = 0.5(\mathfrak{m}(\tilde{\xi}_{2}^{0}) + \mathfrak{m}(\tilde{\xi}_{1}^{0})) & \varepsilon_{\tau} < 1 \text{ mm} & \varepsilon_{\tau} < 1 mm$	ATLAS-CONF-2017-039 ATLAS-CONF-2017-039 ATLAS-CONF-2017-035 ATLAS-CONF-2017-039 ATLAS-CONF-2017-039 1501.07110 1405.5086 1507.05493 1507.05493
$\begin{array}{c} \text{Direct}\tilde{\chi}_{1}^{+}\tilde{\chi}_{1}^{-}\text{prod., long-lived}\tilde{\chi}_{1}^{\pm}\\ \text{Direct}\tilde{\chi}_{1}^{+}\tilde{\chi}_{1}^{-}\text{prod., long-lived}\tilde{\chi}_{1}^{\pm}\\ \text{Stable, stopped}\tilde{g}\text{R-hadron}\\ \text{Stable}\tilde{g}\text{R-hadron}\\ \text{Metastable}\tilde{g}\text{R-hadron}\\ \text{GMSB, stable}\tilde{\tau},\tilde{\chi}_{1}^{0} {\rightarrow} \tilde{\tau}(\tilde{e},\tilde{\mu}) {+} \tau(e,\mu)\\ \text{GMSB},\tilde{\chi}_{1}^{0} {\rightarrow} \gamma \tilde{G},\text{long-lived}\tilde{\chi}_{1}^{0}\\ \tilde{g}\bar{g},\tilde{\chi}_{1}^{0} {\rightarrow} eev/e\mu\nu/\mu\mu\nu\\ \text{GGM}\tilde{g}\bar{g},\tilde{\chi}_{1}^{0} {\rightarrow} Z\tilde{G} \end{array}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	\tilde{x}_1^{\pm} 430 GeV \tilde{x}_1^{\pm} 495 GeV \tilde{x} 850 GeV \tilde{x} 850 GeV \tilde{x} 9 \tilde{x}_1^0 537 GeV \tilde{x}_1^0 1.0 TeV \tilde{x}_1^0 1.0 TeV		ATLAS-CONF-2017-017 1506.05332 1310.6584 1606.05129 1604.04520 1411.6795 1409.5542 1504.05162
$\begin{array}{c} \textbf{LFV} pp \rightarrow \tilde{v}_{\tau} + X, \tilde{v}_{\tau} \rightarrow e\mu/e\tau/\mu\tau\\ \textbf{Bilinear RPV CMSSM}\\ \tilde{X}_{1}^{\dagger}\tilde{X}_{1}^{-}, \tilde{X}_{1}^{+} \rightarrow W\tilde{X}_{1}^{0}, \tilde{X}_{1}^{0} \rightarrow eev, e\mu\nu, \mu\mu\nu\\ \tilde{X}_{1}^{\dagger}\tilde{X}_{1}^{-}, \tilde{X}_{1}^{+} \rightarrow W\tilde{X}_{1}^{0}, \tilde{X}_{1}^{0} \rightarrow \tau\tau\nu_{e}, e\tau\nu_{\tau}\\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow \bar{g}qq\\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow \bar{q}\bar{q}\tilde{Y}_{1}^{0}, \tilde{X}_{1}^{0} \rightarrow qqq\\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{X}_{1}^{0}, \tilde{X}_{1}^{0} \rightarrow qqq\\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{X}_{1}^{0}, \tilde{t}^{0} \rightarrow qqq\\ \tilde{g}\tilde{g}, \tilde{g} \rightarrow t\tilde{t}\tilde{t}_{1}^{0}, \tilde{t}^{0} \rightarrow bs\\ \tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow bs\\ \tilde{t}_{1}\tilde{t}_{1}, \tilde{t}_{1} \rightarrow b\ell \end{array}$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	\$\vec{v}_r\$ \$\vec{v}_r\$ \$\vec{v}_r\$ \$\vec{v}_r\$ \$\vec{x}_1^*\$ 1.14 \$\vec{x}_1^*\$ 450 GeV \$\vec{v}_r\$ 1.08 Te \$\vec{v}_r\$ 1.08 Te	1.9 TeV λ'_{311} =0.11, $\lambda_{132/133/233}$ =0.07 1.45 TeV m(\tilde{q})=m(\tilde{g}), cr_{LSP} <1 mm TeV m($\tilde{\xi}_1^0$)>400GeV, $\lambda_{12k} \neq 0$ ($k = 1, 2$) m($\tilde{\xi}_1^0$)>0.2×m($\tilde{\xi}_1^0$), $\lambda_{133} \neq 0$	1607.08079 1404.2500 ATLAS-CONF-2016-075 1405.5086 ATLAS-CONF-2016-057 ATLAS-CONF-2016-057 ATLAS-CONF-2017-013 ATLAS-CONF-2017-013 ATLAS-CONF-2016-022, ATLAS-CONF-2016-084 ATLAS-CONF-2017-036
Other Scalar charm, $\tilde{c} \rightarrow c \tilde{x}_1^0$ *Only a selection of the available mapping phenomena is shown. Many of the simplified models, c.f. refs. for the	e limits are based on	² 510 GeV	m(₹1)<200 GeV 1 Mass scale [TeV]	1501.01325 erto ,FN B

ATLAS Preliminary





Conclusions

- SUSY searches in ATLAS represent a broad spectrum of different searches and approaches, 13 results are now public with full Run2 dataset
 - Different Physics: strong production, weak production, long lived particles
 - Different techniques: multivariate, kinematic variables, detector driven approaches
- We did not see anything yet
 - Final Run2 dataset will provide more insight on SUSY, and tools are getting better and better
 - Will be able to target lower cross-sections and problematic kinematic regions for SUSY decay chains