Search for electroweak production of supersymmetric sleptons and charginos with the ATLAS detector

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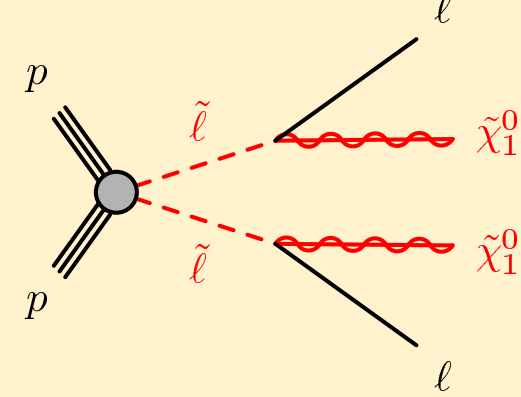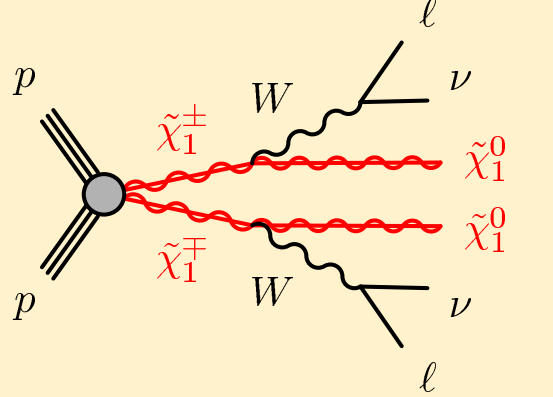on behalf of the ATLAS Collaboration
University and INFN, Milano (IT)

Introduction

New search [1] targeting supersymmetric models with 2 leptons, low hadronic activity and large E_T^{miss}:

Sleptons pair production

Charginos pair production

Challenging signatures due to **low production cross section** of supersymmetric signal and **very similar kinematics to WW Standard Model (SM) background**
- Dedicated search strategy for each considered model.

Regions with large slepton and chargino mass already excluded by previous searches [2]:
- **Challenging gaps** remain uncovered in the exclusion contours.
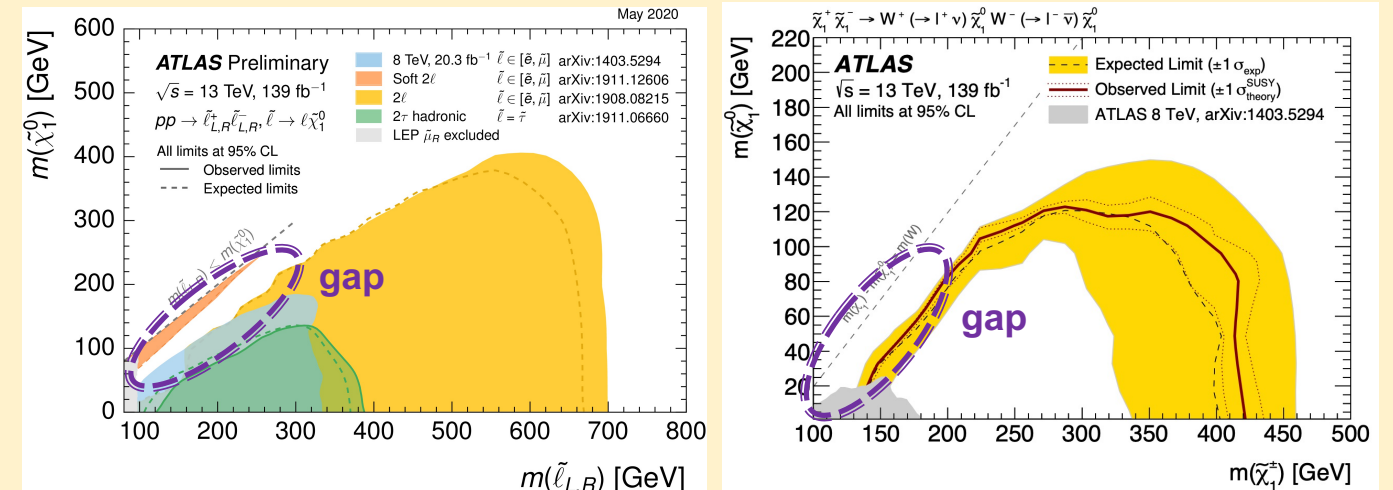
- New search focusing on phase space regions with slepton-neutralino and chargino-neutralino **mass differences of the order of W boson mass.**
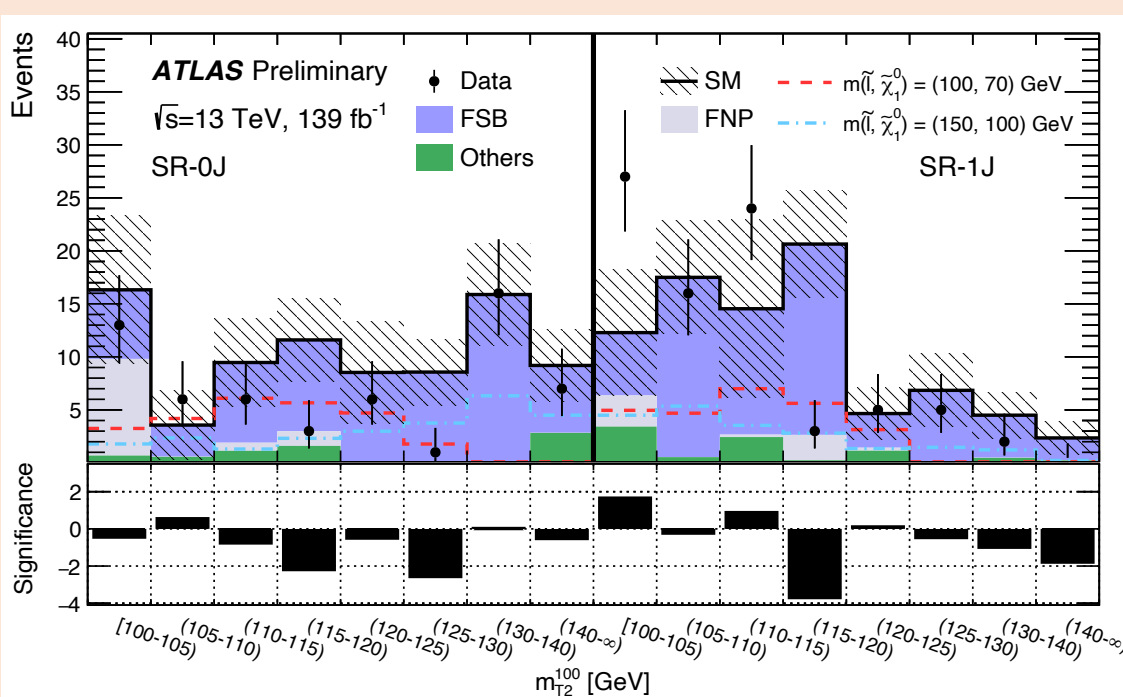
Slepton analysis

Search strategy

- **Data-driven background estimate**
  - Flavour Symmetric Background (FSB) composition of Same Flavour (SF) events ($ee/\mu\mu$) in the Signal Region (SR) by looking to Different Flavour (DF) events ($e\mu$) in data and reweighting them by detector efficiencies.

- **Cut-and-count approach for the SR**
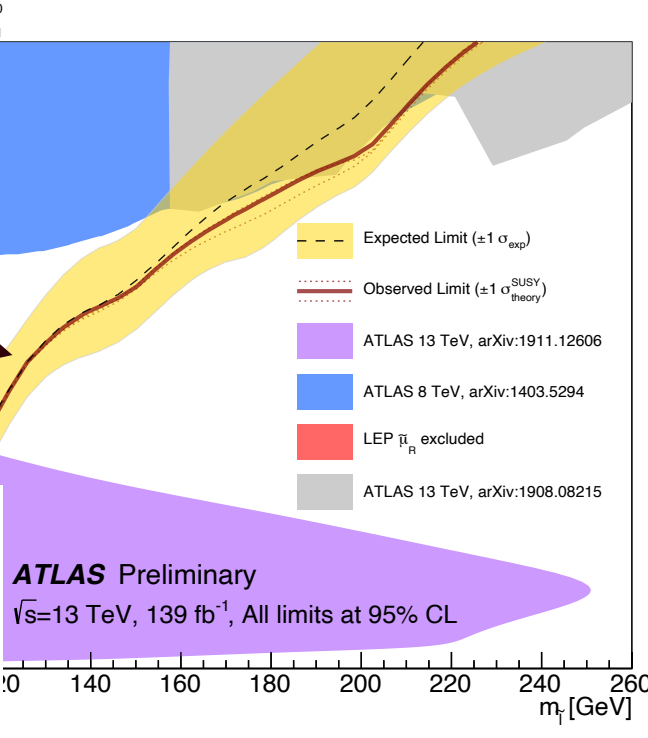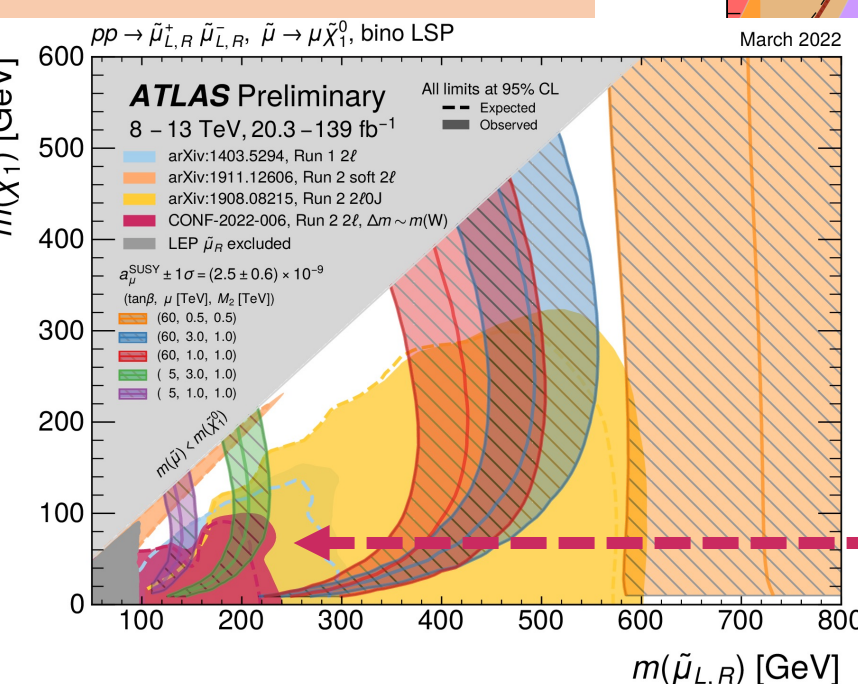

- SR with both 0-jet and 1-jet channels.

- Shape fit in m_{T2}^{100} [1] bins to target different slepton masses.

- No significant deviations from the SM observed in SR bins.

Results

Exclusion limits at 95% Confidence Level (CL) set on the slepton pair production model.
- **New results extend LEP sensitivity and cover the gap between previous results.**

Exclusion limits at 95% CL are also set separately on the smuon pair production.
- **New results exclude portions of the phase space favoured to explain the $(g-2)\mu$ anomaly!**
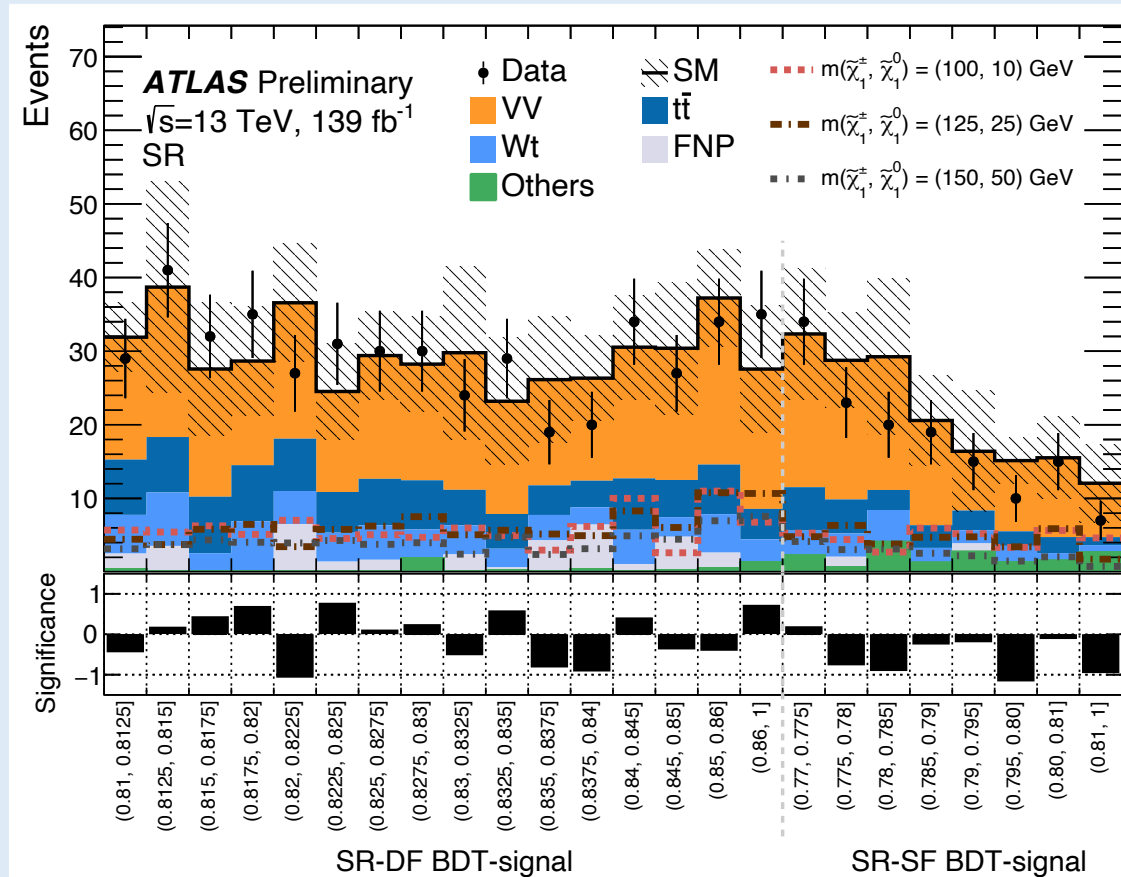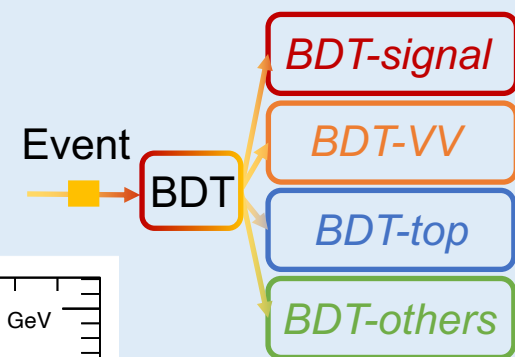
Chargino analysis

Search strategy

- **Semi data-driven background estimate**
  - Main backgrounds (VV and top) normalized in Control Regions (CRs).

- **Machine learning techniques**
  - Training of BDTs combining signal samples with $\Delta m(\tilde{\chi}_1^\pm, \tilde{\chi}_1^0) = 90$ or 100 GeV.
  - Multiclass classification with 4 BDT outputs.

Event → BDT → BDT-signal / BDT-VV / BDT-top / BDT-others

- SR with both SF and DF channels. Only 0-jet channels considered.

- Shape-fit in *BDT-signal* bins.

- No significant deviations from the SM observed in SR bins.

Results

Exclusion limits at 95% CL set on the chargino pair production model:
- **New results supersede the ATLAS 8 TeV results and extend the previous ATLAS 13 TeV results.**

- **Exclusion in particularly interesting regions where the charginos could have hidden behind the looking-alike WW background.**
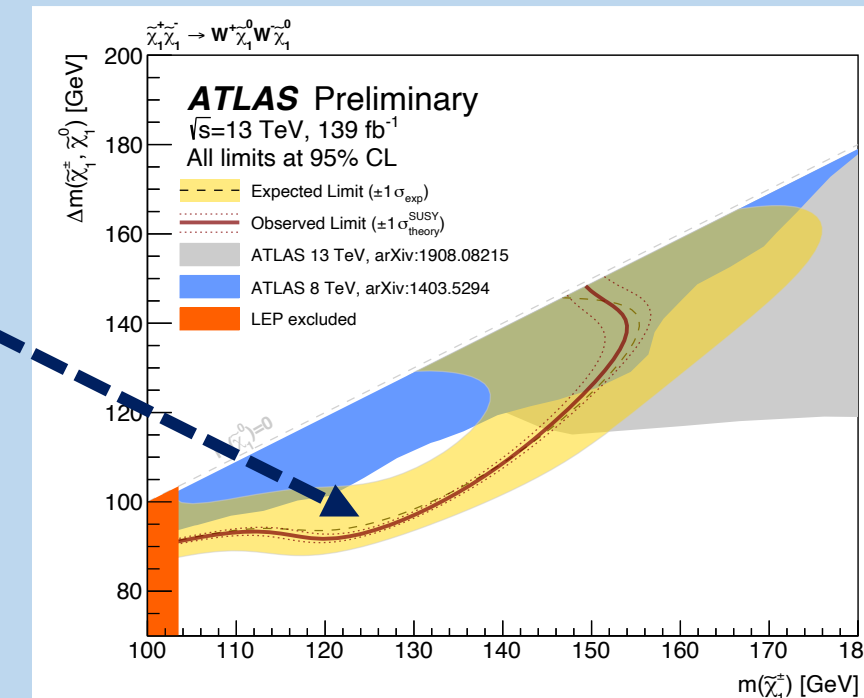
Conclusions

New search [1] targeting the slepton and chargino pair productions using pp collisions collected by the ATLAS detector during Run 2 (2015-2018).
- Dedicated and **improved analysis strategies** adopted for each search.
- **Unprecedented sensitivity** reached for both searches.

The SM has survived our new ATLAS searches. However challenging "gaps" in the exclusion contours still remain uncovered.
- Larger datasets, improved data analysis techniques or even dedicated new searches will pave the way to explore these gaps.
- **Run 3 is due to start this year** – stay tuned to future discoveries!

References

[1] ATLAS Collaboration, "*Search for direct pair production of sleptons and charginos decaying to two leptons and neutralinos with mass splittings near the W boson mass in 13 TeV pp collisions with the ATLAS detector*", ATLAS-CONF-2022-006.

[2] ATLAS Collaboration, "*Search for electroweak production of charginos and sleptons decaying into final states with two leptons and missing transverse momentum in $\sqrt{s} = 13$ TeV pp collisions using the ATLAS detector*", arXiV:1908.08215.