

考核报告

(2023年1月 - 2023年3月)

报告人：蔡雨辰

导师：庄胥爱

实验物理中心

2023年4月23日

■ ATLAS实验物理分析

1. $\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp$ 与 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \tilde{\tau} \rightarrow \geq 2\tau + MET$ 过程
2. $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow Wh \rightarrow 2\tau + 1l + MET$ 过程
3. *pMSSM* Reinterpretation
4. *EWK 2-Tau* 分析的 RPC-to-RPV Reinterpretation

■ ATLAS实验，tau子的in-situ能量刻度

■ 测量FCC量能器光纤衰减系数

■ 未来计划

ATLAS实验 $\tilde{\chi}_1^\pm$ 与 $\tilde{\chi}_2^0$ 的寻找

ICHEP 2022: [ATLAS-CONF-2022-042](https://atlas.conf-2022-042)

1. $\tilde{\chi}_1^\pm \tilde{\chi}_1^\mp$ 与 $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow \tilde{\tau} \rightarrow \geq 2\tau + MET$ 过程
2. $\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow Wh \rightarrow 2\tau + 1l + MET$ 过程: **ATLAS首次研究**

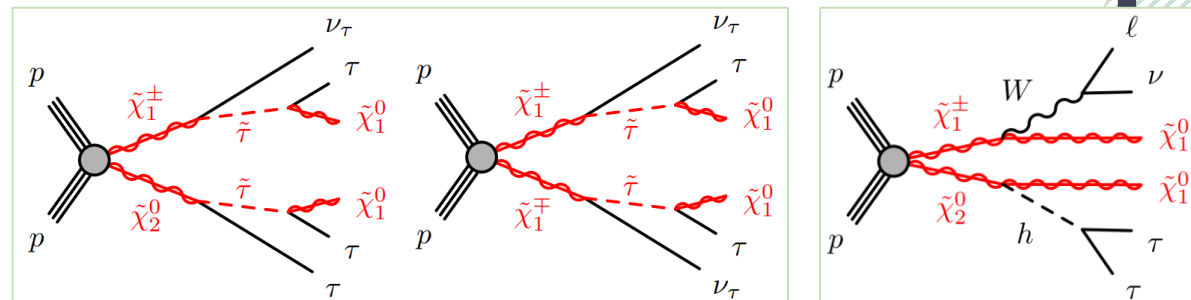
■ 工作: 全组样本产生工作、分析(1)的理论误差计算与最终结果, 分析(2)的全分析工作。担任Support note editor, 课题组SUSY3 derivation联系人、课题组EWK combination联系人, **ATLAS Approval Talk**。

■ 进展:

- 完成了1 与2 的HEPData中我负责的部分:
<https://www.hepdata.net/record/sandbox/1672820798>

■ 计划:

- 完成文章所需的收尾工作。



The screenshot shows the HEPData Sandbox interface. The top navigation bar includes the HEPData logo, a search bar, and links to Sandbox, About, Submission Help, File Formats, Dashboard, and Log out. The main content area is divided into several sections: Overview, Exclusion contours, and Papers. The Overview section provides a summary of the record, including the title, authors, and a list of data tables. The Exclusion contours section lists the various exclusion contours used in the analysis. The Papers section lists the papers associated with the record, including the ATLAS Collaboration paper and the SLHA paper.

Overview

----- Overview of HEPData Record -----

Exclusion contours:

- C1C1 exclusion contour (Obs.)
- C1C1 exclusion contour (Obs. Down)
- C1C1 exclusion contour (Obs. Up)
- C1C1 exclusion contour (Exp.)
- C1C1 exclusion contour (Exp. Down)
- C1C1 exclusion contour (Exp. Up)
- C1C1+C1N2(OS) exclusion contour (Obs.)
- C1C1+C1N2(OS) exclusion contour (Obs. Down)
- C1C1+C1N2(OS) exclusion contour (Obs. Up)
- C1C1+C1N2(OS) exclusion contour (Exp.)
- C1C1+C1N2(OS) exclusion contour (Exp. Down)
- C1C1+C1N2(OS) exclusion contour (Exp. Up)
- With exclusion contour (Obs.)

Papers

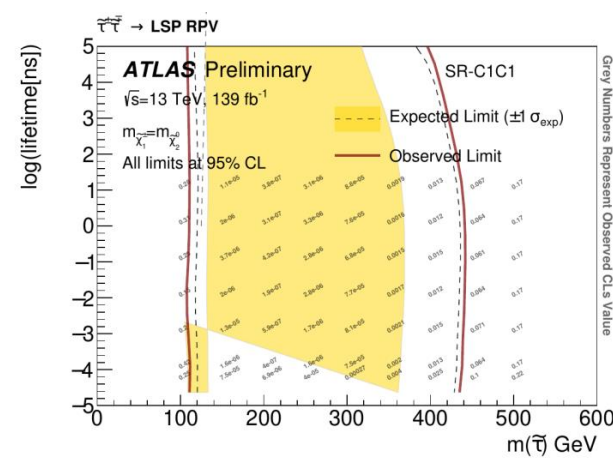
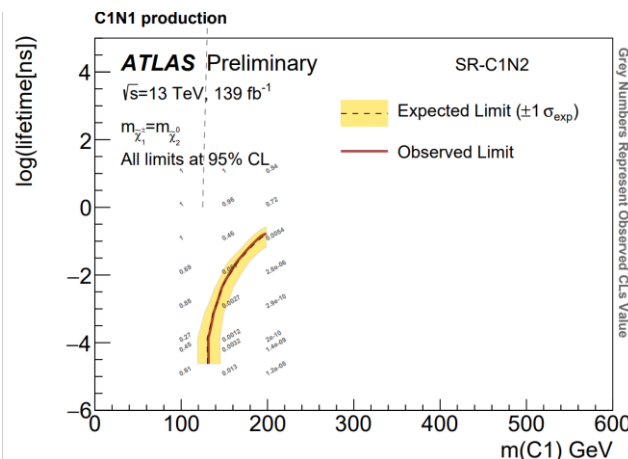
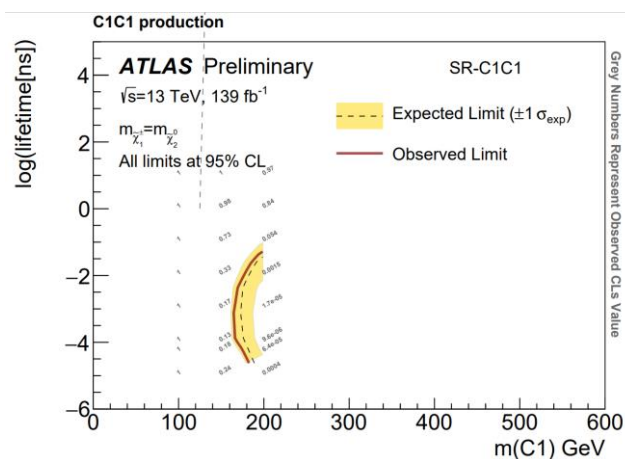
- ☒ **observed upper limit** on the signal cross section overlaid for each grid point ("the little grey numbers"). In a table in the aux material. Optionally, the expected upper limit on the cross-section can be provided
- ☒ the observed and expected exclusion **contour lines** in **Tgraph**, a list of (x,y)
- ☒ **plot** showing which signal region is used for which grid point (expected CLs).
- ☐ **acceptance (A) & efficiency (Eps)**.
- ☐ the **truth code**, and XML for MVA analysis.
- ☐ **SR Plots**.
 - N-1 plots,
 - as presented in publication (no additional plots), We do **not** upload plots in the control regions to HEPdata
 - SR plots: **eg**, the effective mass or missing transverse momentum distributions
 - **table (one per plot)**, where the rows correspond to the plot bins
 - all backgrounds should be lumped together.
 - statistical and total systematic uncertainties are given separately for the background.
 - data counts given along with the statistical uncertainties,
 - signal benchmark point(s), ideally the same that is (are) used for the cut-flow table,
- ☒ **Analysis likelihood** public <https://twiki.cern.ch/twiki/bin/view/AtlasProtected/LikelihoodValidation>.
- ☒ SLHA

RPC-to-RPV reinterpretation

- 目的: SUSY模型中可以存在破坏重子数或轻子数守恒的项, 通过人为引入R宇称并要求R宇称守恒 (RPC) 可以使得重子数与轻子数的守恒。此研究的目的是使用RPC $\tilde{\chi}_1^+ \tilde{\chi}_1^- / \tilde{\chi}_1^+ \tilde{\chi}_2^0 \rightarrow \tilde{\tau} / Wh \rightarrow \geq 2\tau (+1l) + MET$ 过程的信号区对RPV过程进行约束, 这是首次对Higgsino λ_{i33} 衰变进行研究。

- 进展:

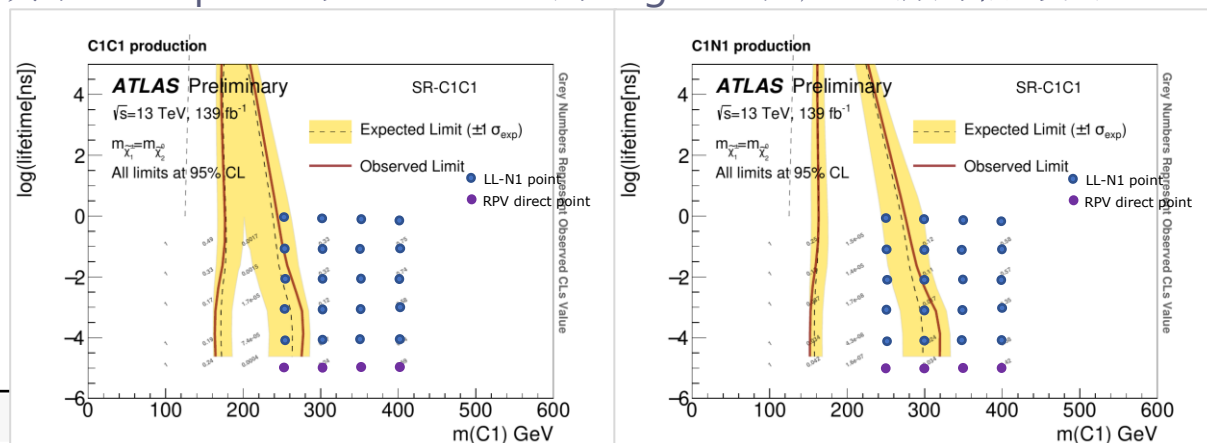
- 完成了信号点申请, 得到了初步结果:



- 目前, 我们基于初步结果申请了更多的信号点。解决了Job option与控制文件的bug, 正在产生新的信号点

- 计划:

- 在信号点产生完毕后, 得到完整的排除限。



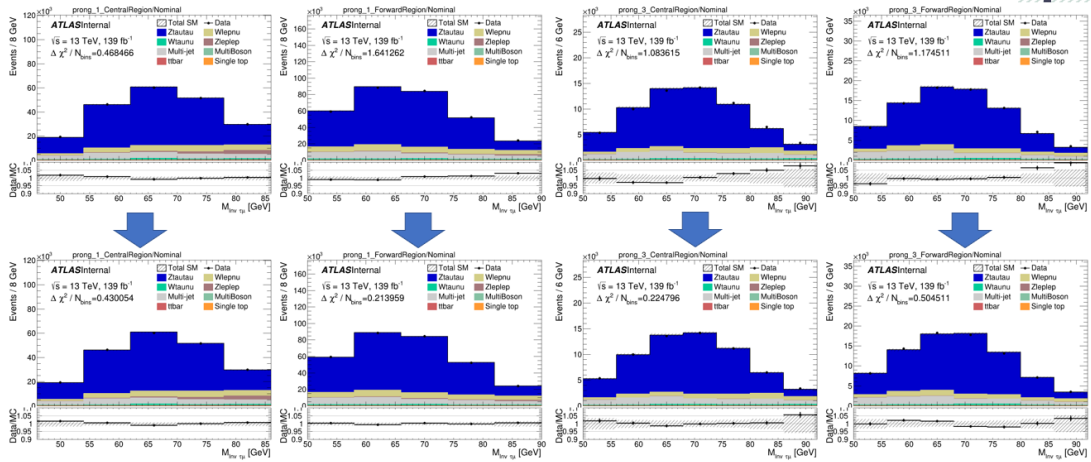
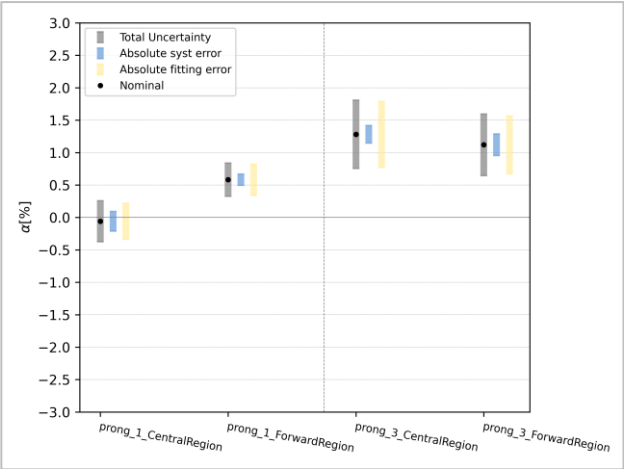
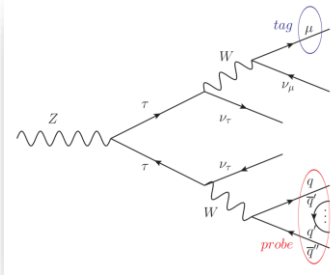
ATLAS实验中tau子的in-situ能量刻度 (in-situ TES)

■ 目的：使用tag-and-probe方法对 τ 子四动量修正以使蒙卡模拟更接近真实的实验数据，作为R22的tau recommendation

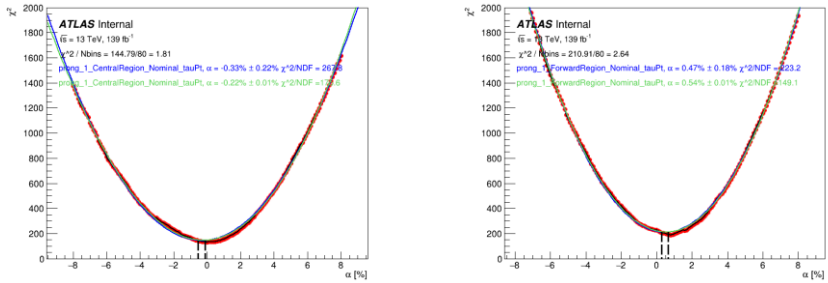
■ 进展：

- 完成了R22的Pre recommendation结果 [TauRecommendationsR22]
- 在2023 Tau & HL Workshop上进行了报告 [tau-energy-scale](#)
- 基本完成了full recommendation的结果

◦ 解决了主要本底W+jets过程的 muon pT modelling 的问题: $p_{T;\mu}$ bin: [20, 30, 35, 40, 45, 55, > 55] GeV



◦ 使用了 $(m_{vis}, p_{T;\tau})$ 二维拟合，以验证只使用 m_{vis} 拟合是否受muon pT modelling的影响



	2D [%] (Stat-uncertainty only)	Baseline [%]
1P Central	-0.325 ± 0.216	-0.059 ± 0.316
3P Central	0.471 ± 0.181	0.581 ± 0.256
1P Forward	0.969 ± 0.339	1.282 ± 0.527
3P Forward	1.014 ± 0.318	1.121 ± 0.475

■ 计划：按组内讨论的结果更新图片，完成完整的recommendation

FCC量能器光纤衰减系数

- 目的：搭建一个平台进行自动化的FCC双读出量能器的光纤衰减长度的测量

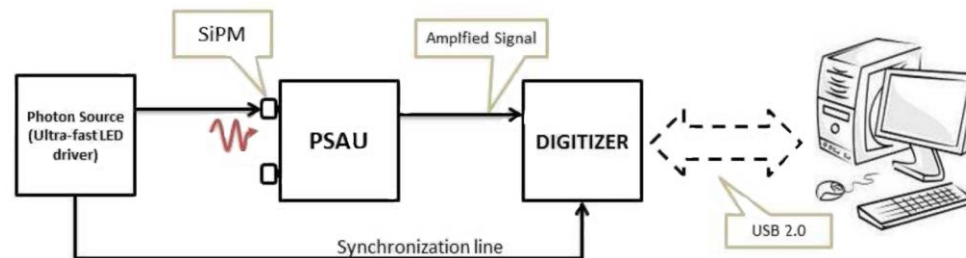
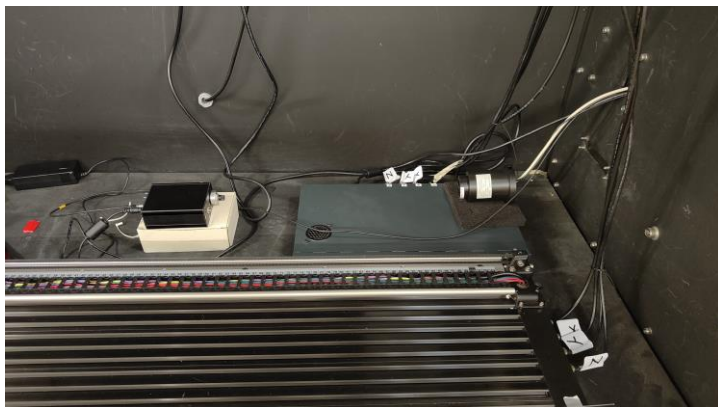
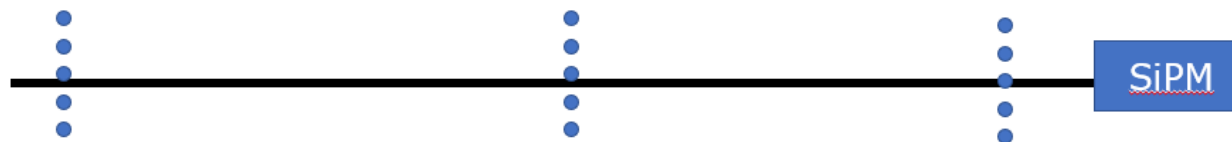


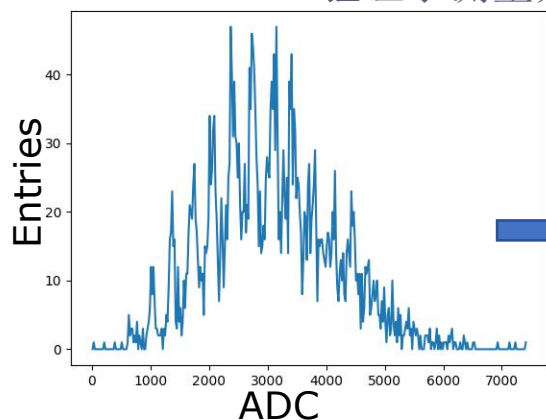
Fig. 4: Schematic layout of the experimental set-up.

进展

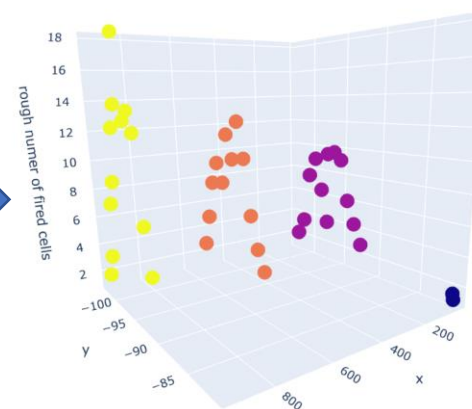
- 完成了实验平台的硬件搭建
- 验证了测量方法的可行性：



黑色：光纤
蓝色点：LED光源



$$N_{\text{number of fired cells}} = \frac{\Sigma N_{\text{photon}} \cdot y_{\text{peak}}}{\Sigma y_{\text{peak}} \cdot \Delta_{\text{ADC}}^{\text{peak to peak}}}$$



计划：

- 完成软件的自动化：光源移动: G-code + Computer Numerical Control (CNC) machine ; SiPM 读出: CAEN library ; 触发: Arduino

未来计划

- Di-tau末态的electroweakino与stau的寻找：
 - 完成收尾工作，计划今年发表一篇文章
- Tau performance
 - 完善R22 Full Run2 recommendation，计划今年完成note。
- pMSSM reinterpretation:
 - 继续研究，得到General pMSSM scan的结果，计划年中完成public note。
- RPC to RPV reinterpretation:
 - 尽快进行后续的研究，计划今年发表一篇文章。
- FCC量能器
 - 计划夏天进行Testbeam的研究

报告链接

- **Tau&HL WS:** <https://indico.cern.ch/event/1228109/timetable/#58-tau-energy-scale>
- **SUSY EWK-2tau Working group**
 - [https://indico.cern.ch/event/1257534/contributions/5281514/attachments/2597779/4484870/23_02_22%20\(Di-tau\).pdf](https://indico.cern.ch/event/1257534/contributions/5281514/attachments/2597779/4484870/23_02_22%20(Di-tau).pdf)
 - [https://indico.cern.ch/event/1238787/contributions/5209344/attachments/2573873/4438079/23_01_11%20\(Di-tau\).pdf](https://indico.cern.ch/event/1238787/contributions/5209344/attachments/2573873/4438079/23_01_11%20(Di-tau).pdf)
- **General pMSSM meeting**
 - https://indico.cern.ch/event/1269489/contributions/5332108/attachments/2622211/4534044/230331_Yuchen_RecastCheck.pdf
 - https://indico.cern.ch/event/1278742/contributions/5371895/attachments/2632464/4554574/230421_Recast.pdf
- **RPV-meets-RPC**
 - https://indico.cern.ch/event/1274363/contributions/5351922/attachments/2625730/4541647/RPV_DiTau_20230406_SignalRequest_Yuchen.pdf
 - https://indico.cern.ch/event/1266670/contributions/5319017/attachments/2613028/4515250/RPV_DiTau_20230316_N1issueSolved.pdf
 - https://indico.cern.ch/event/1260366/contributions/5294262/attachments/2610946/4511000/RPV_DiTau_20230314_N1issue.pdf
 - https://indico.cern.ch/event/1258210/contributions/5285046/attachments/2599018/4487241/RPV_DiTau_20230223_GridExtension.pdf
 - https://indico.cern.ch/event/1236737/contributions/5203079/attachments/2575012/4440019/RPV_DiTau_230112.pdf
- **Tau Sub group meeting**
 - https://indico.cern.ch/event/1275796/contributions/5364563/attachments/2629742/4548229/Checks_2023_04_17.pdf
 - https://indico.cern.ch/event/1271422/contributions/5345242/attachments/2622756/4535200/23_04_03.pdf
 - https://indico.cern.ch/event/1263810/contributions/5313628/attachments/2609812/4513834/23_03_13.pdf
 - https://indico.cern.ch/event/1251506/contributions/5258711/attachments/2587965/4465272/23_02_06_FinalFullRun2Measurement.pdf
 - https://indico.cern.ch/event/1239148/contributions/5215470/attachments/2575979/4441902/23_01_16_FinalFullRun2Measurement.pdf

谢谢！

Parameter	Min value	Max value	Note
$m_{\tilde{L}_1} (= m_{\tilde{L}_2})$	90 GeV	4 TeV	Left-handed slepton (first two gens.) mass
$m_{\tilde{e}_1} (= m_{\tilde{e}_2})$	90 GeV	4 TeV	Right-handed slepton (first two gens.) mass
$m_{\tilde{L}_3}$	90 GeV	4 TeV	Left-handed stau doublet mass
$m_{\tilde{e}_3}$	90 GeV	4 TeV	Right-handed stau mass
$m_{\tilde{Q}_1} (= m_{\tilde{Q}_2})$	200 GeV	4 TeV	Left-handed squark (first two gens.) mass
$m_{\tilde{u}_1} (= m_{\tilde{u}_2})$	200 GeV	4 TeV	Right-handed up-type squark (first two gens.) mass
$m_{\tilde{d}_1} (= m_{\tilde{d}_2})$	200 GeV	4 TeV	Right-handed down-type squark (first two gens.) mass
$m_{\tilde{Q}_3}$	100 GeV	4 TeV	Left-handed squark (third gen.) mass
$m_{\tilde{u}_3}$	100 GeV	4 TeV	Right-handed top squark mass
$m_{\tilde{d}_3}$	100 GeV	4 TeV	Right-handed bottom squark mass
$ M_1 $	0 GeV	4 TeV	Bino mass parameter
$ M_2 $	70 GeV	4 TeV	Wino mass parameter
$ \mu $	80 GeV	4 TeV	Bilinear Higgs mass parameter
M_3	200 GeV	4 TeV	Gluino mass parameter
$ A_t $	0 GeV	8 TeV	Trilinear top coupling
$ A_b $	0 GeV	4 TeV	Trilinear bottom coupling
$ A_\tau $	0 GeV	4 TeV	Trilinear τ lepton coupling
M_A	100 GeV	4 TeV	Pseudoscalar Higgs boson mass
$\tan\beta$	1	60	Ratio of the Higgs vacuum expectation values

