考核报告

(2023年1月 – 2023年3月)

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实验物理中心

2023年4月23日

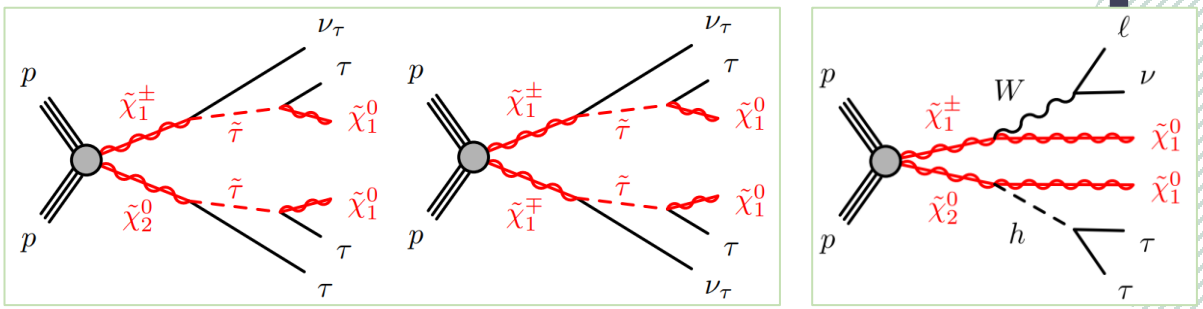
简介

- ATLAS实验物理分析
  1. $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ 与 $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \to \tilde{\tau} \to \geq 2\tau + MET$ 过程
  2. $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0} \to Wh \to 2\tau + 1l + MET$ 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

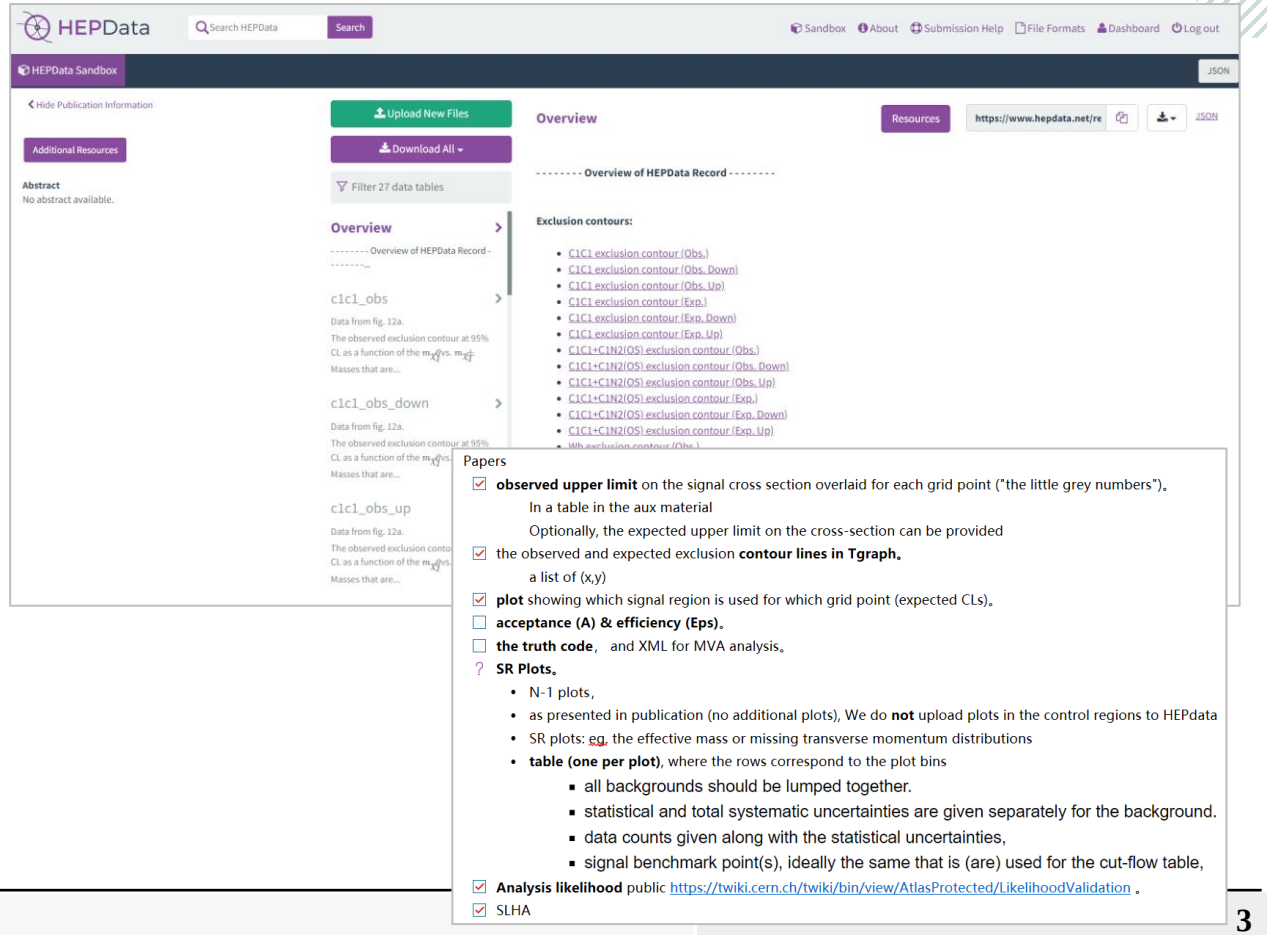
1. $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}$ 与 $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to \tilde{\tau} \to \geq 2\tau + MET$ 过程
2. $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to Wh \to 2\tau + 1l + MET$ 过程：ATLAS首次研究



- 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)的全部分析工作。担任Support note editor，课题组SUSY3 derivation联系人、课题组EWK combination联系人，ATLAS Approval Talk。

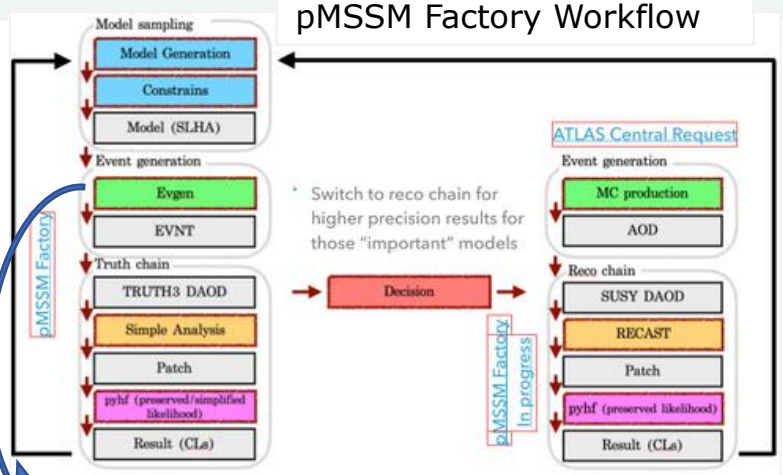
- 进展：
  - 完成了*1* 与*2* 的HEPData中我负责的部分：https://www.hepdata.net/record/sandbox/1672820798

- 计划：
  - 完成文章所需的收尾工作。



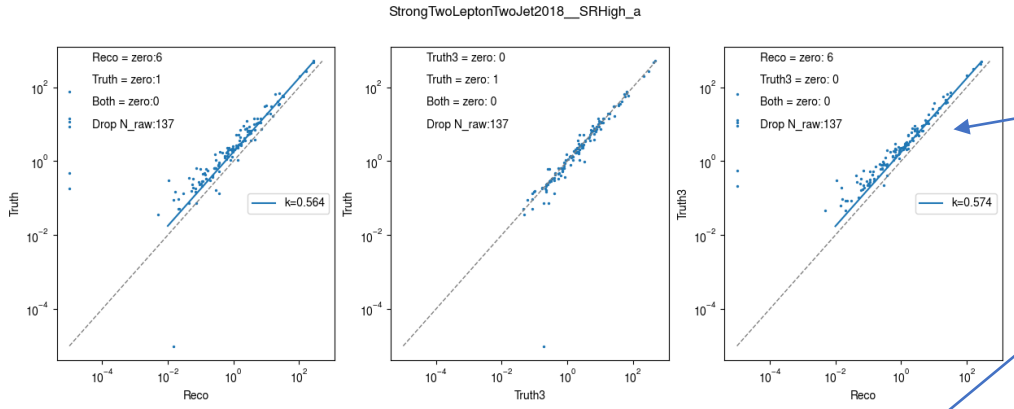
pMSSM Reinterpretation

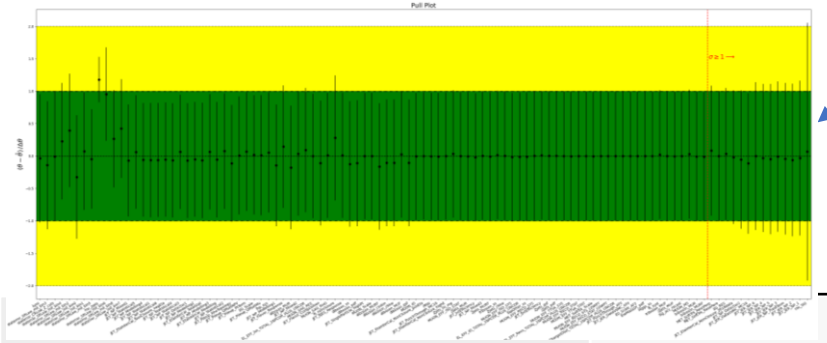
pMSSM Factory Workflow

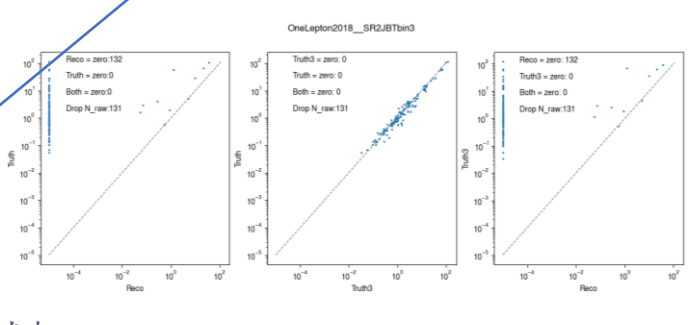


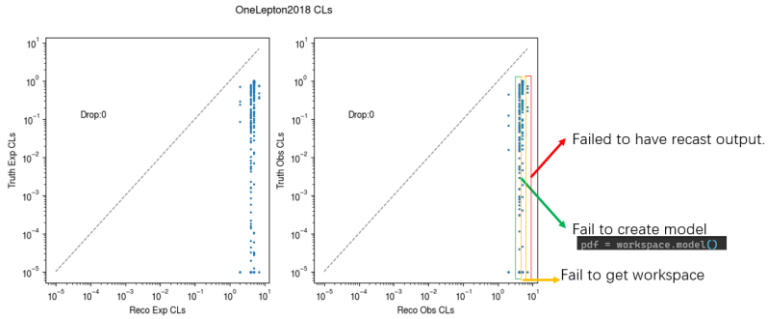
Add a new step to calculate constraints

- 目的：目前ATLAS SUSY组主要使用SUSY简化模型的作为信号模型，并没有考虑超对称粒子间的关联，所以我们计划使用所有Run-2的分析定义的信号区限制pMSSM模型的参数，得到更真实的排除限。
  - 帮助搭建pMSSM workflow
  - 计算非直接寻找SUSY的实验对pMSSM参数的约束
  - SUSY Strong production 的扫描工作（General pMSSM scan）
- 进展
  - 对Strong分析的truth和full reconstruction的yields与CLs进行修正
    - 2L2J strong:
      - 拟合线性关系得到Truth和full reconstruction的修正
      - 检查recast的拟合步骤在pMSSM信号上是否有异常
    - Strong-1L:发现分析组提供的recast有问题，联系了相关人员处理





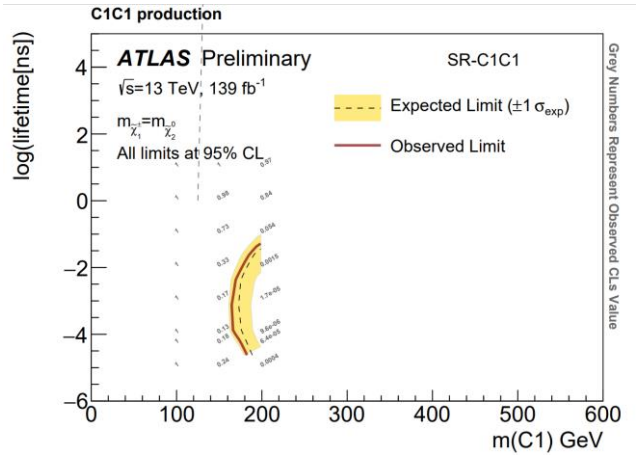


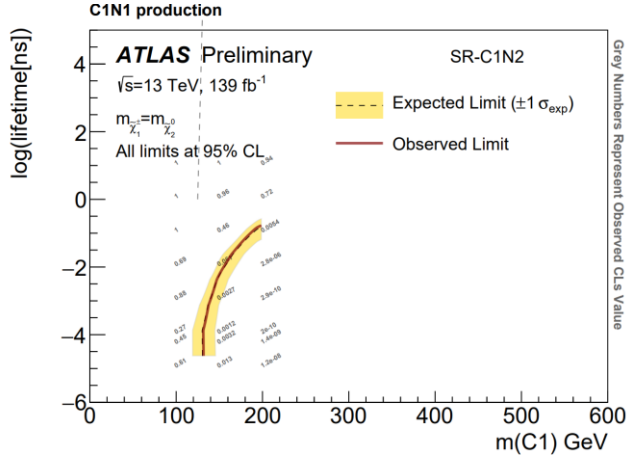


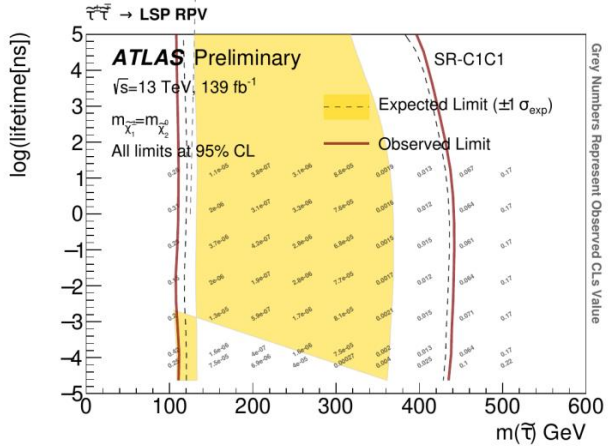
- 计划
  - 完成General pMSSM scan的后续工作

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 $\tilde{\chi}_1^{\pm}\tilde{\chi}_1^{\mp}/\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to \tilde{\tau}/Wh \to \geq 2\tau(+1l) + MET$ 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：

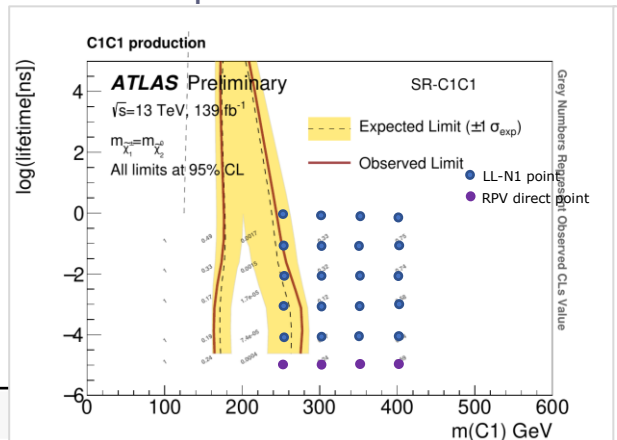


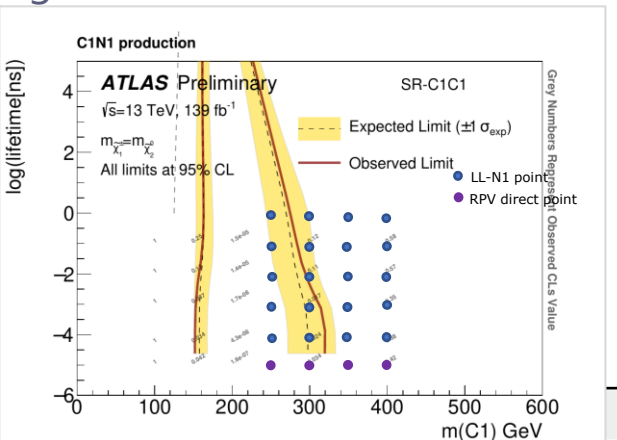




  - 目前，我们基于初步结果申请了更多的信号点。解决了Job option与control file的bug，正在产生新的信号点

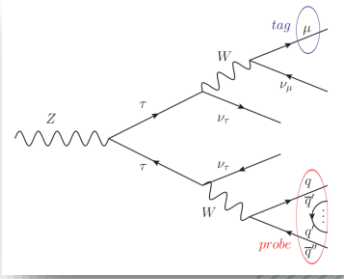
- 计划：
  - 在信号点产生完毕后，得到完整的排除限。

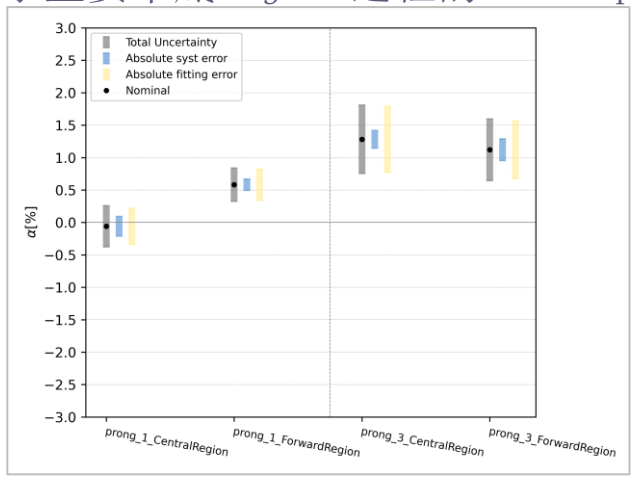


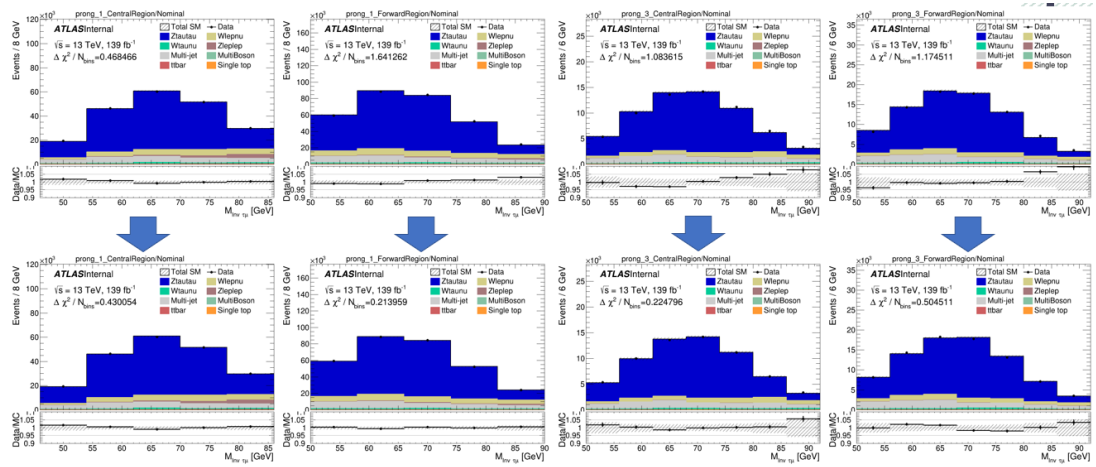


ATLAS实验中tau子的in-situ能量刻度（in-situ TES）

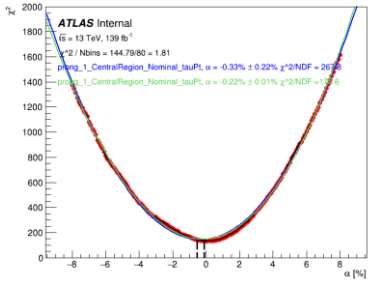
- 目的：使用tag-and-probe方法对 τ 子四动量修正以使蒙卡模拟更接近真实的实验数据，作为R22的tau recommendation
- 进展：
  - 完成了R22的Pre recommendation结果［TauRecommendationsR22］
  - 在2023 Tau & HL Workshop上进行了报告 tau-energy-scale
  - 基本完成了full recommendation的结果
    - 解决了主要本底W+jets过程的 muon pT modelling 的问题：$p_{T;\mu}$ bin: [20, 30, 35, 40, 45, 55, > 55] GeV

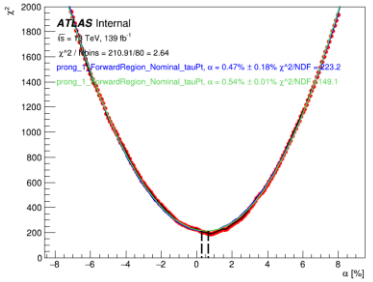






- 使用了 $(m_{vis}, p_{T;\tau})$ 二维拟合，以验证只使用m_{vis}拟合是否受muon pT modelling的影响



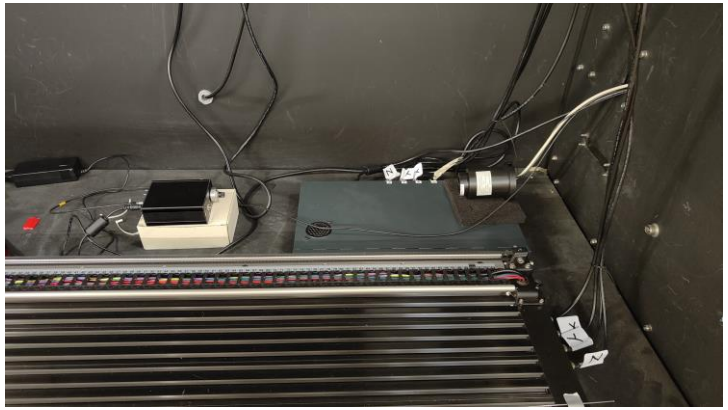


	2D [%] (Stat-uncertainty only)	Baseline [%]
1P Central	-0.325 ± 0.216	-0.059 ± 0.316
3P Central	0.471 ± 0.181	0.581 ± 0.256
1P Forward	0.969 ± 0.339	1.282 ± 0.527
3P Forward	1.014 ± 0.318	1.121 ± 0.475

- 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



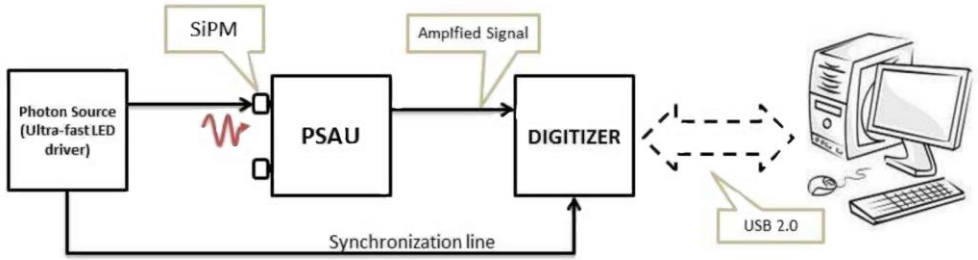
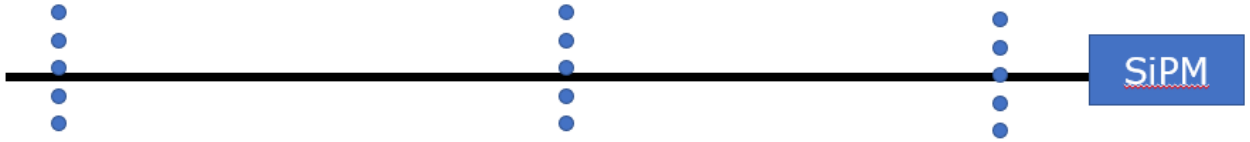
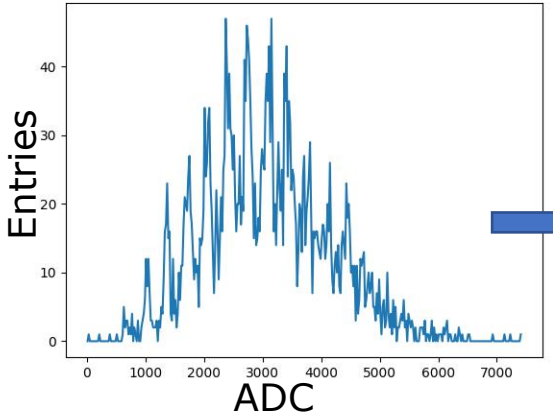


Fig. 4: Schematic layout of the experimental set-up.

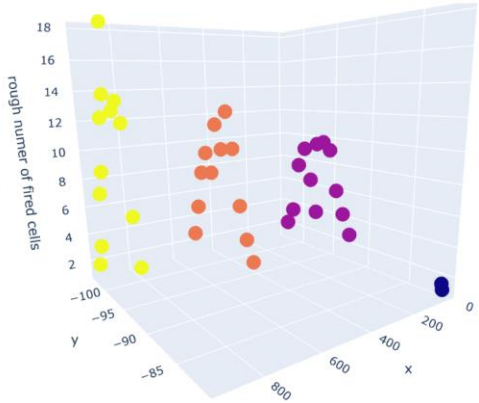
- 进展
  - 完成了实验平台的硬件搭建
  - 验证了测量方法的可行性：



黑色：光纤
蓝色点：LED光源



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



- 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/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_Yuche n.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
$\lvert M_1\rvert$	0 GeV	4 TeV	Bino mass parameter
$\lvert M_2\rvert$	70 GeV	4 TeV	Wino mass parameter
$\lvert\mu\rvert$	80 GeV	4 TeV	Bilinear Higgs mass parameter
M_3	200 GeV	4 TeV	Gluino mass parameter
$\lvert A_t\rvert$	0 GeV	8 TeV	Trilinear top coupling
$\lvert A_b\rvert$	0 GeV	4 TeV	Trilinear bottom coupling
$\lvert A_\tau\rvert$	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