2023年11月至2024年11月 年度绩效考核报告

吕峰

2024年11月14日

任务完成情况-1：

高能量前沿物理组： CEPC物理分析 + ATLAS 108室洁净间建设

1. CEPC物理分析： 360GeV slepton pair analysis

1.1 **重做stau pair物理分析**：发现该物理分析存在重大错误：10个本底道的归一化亮度是采用旧值2ab,而不是正确的1ab, 这样本底计算高估了一倍，对分析结果造成了重大影响。对SM本底设定1ab亮度后，重新做了全套分析，得到了显著改善的新结果：L+R，L/R 5σ上限提高为164、143GeV，比原来结果提高了4.8GeV 和16GeV。

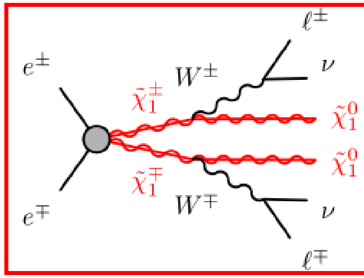
1.2 **对smu pair 5σ上限进行了精细化分析(增加了高端质量点），**使其5σ上限从174GeV 提高到 175GeV，提高了1GeV。

1.3 **根据内部评审第二、第三批反馈意见修改文章**，对所有的图形和表格都重做了，因为信号代表性质量点重新优化了。图表重新制备工作量很大，本底样本stack图反复修改了30多次：样本代表颜色全文中统一，样本叠加顺序为了更清晰都逐图调整

任务完成情况-2：

1.4 文章**<u>V50</u>**<u>版本经外国人帮助修改英文建议后进一步修改</u>，根据其30条（实际是refree水平的，并不是单纯修改英文）建议进行了逐条修改（4条坚持原样），形成**V52版**再次提交内部审查，再次修改后就可以对外投稿了

1.5 <u>编写**Bino C1N1**→**WW2LSP**→**2**μ**2**υ**+2LSP**末态**MC**产生子并完成产生级样本产</u>生，$M_{C1}=M_{N1}$=90-179GeV, W是on shell的，所以取$M_{C1}-M_{LSP}>M_{W}$，后面的事例模拟重建等待新CEPC MC版本发布，然后物理分析



2. <u>ATLAS硬件：完成HGTD 108室万级洁净间建设</u>

2.1<u>合同价格谈判</u>： 2024.03.25增加防静电地板新报价： 314782.38 元，而2023.07.05原价： 299200元 ，增加了**+15582.38**元，经我三轮谈判恢复了原价（防静电地板赠送）。后增加65米电源电缆，报价30.92万，砍价-1200元后确定了最终合同价30.8万。4月15日双方确定了正式合同版本，通过谈判协商合同节省了大约**-2.2万元**。4月26日组里正式批准了合同文本。

任务完成情况-3：

2.1 <u>开工前准备工作</u>： 所内采购审批、合同审批，6月12日合同电子签完成；申请借款15.4万支付工程50%首付款，6月20日汇款到拓展账，拓展开始空调系统定制订货；协助施工方办理安全责任书手续；落实108室灯具，吊顶拆除内容；40千瓦电增容协调落实；清空108室；物理楼门禁卡办理；停车票申请；装修物资和垃圾堆放地及安全管理落实；108工程施工交底：拓展工程师微信会，邀请安保办召集有关职能部门现场，和彭琪讨论108室消防方案：原喷淋烟感外延至新天花板外，需要新增一个消防排风口设计，AC间增加一个烟感。空调外管从窗户穿出，不得承重墙打孔；解决弱电连线问题；增加108室380V电源插座

2.2 <u>施工过程</u>

<u>2.1消防和总电源困境</u>： 工程施工一开始，乙方经理就怒气冲冲说消防和总电源改造不在他的施工范围之内，让我另找人做，我面对困局一方面安抚经理情绪，一方面积极寻求对策。找到高能所消防维保公司，价格从**1.2万**谈到**7500元**，然后让乙方和消防维保公司签订合同，积极配合维保公司协调各方完成施工，然后就消防工程价格与乙方谈判，达成我方仅承担**4000元**的协议（消防之重要是我签订合同时反复强调和确认的，结果拓展虽消防二级资质，却没有北京消防章，设计和施工双方严重脱节，违反了合同）

任务完成情况-3：

<u>2.2总电源100A总空开</u>： 我去经开大厦购买带消防脱口的100A空气开关，现场调研了4家经销商的2种空开，国际名牌施罗德报价550元，砍价到430元，国产名牌正泰质量可靠价格公道，报价190元，砍价175元拿下节省-255元。后组织物理楼停电，安装电源电缆和总电源空气开关。

<u>2.3空调室外机位置</u>： 乙方按照空调厂家建议未经我允许把空调室外机安装在窗外雨棚前地面上了，这是违背所园区委员会指定安装在雨棚下地沟里的决定的。考虑到这样对空调性能和维护更好，我积极三次向行政处申请安装地面上，争取弥补措施，但未获批准。最终还是按照原方案把空调机放于地沟里，采取了措施尽量减少对空调性能的影响。移机费用3000元，经过协商，我方承担1500元 （乙方有错在先）

<u>2.4工程资料归档和检验通过</u>： 9.21日 施工完毕，9.24自检完毕，9.25日提交档案室所有工程档案，同日行政处组织的所内验收通过。其后组内又提出电气和气路增项，10.27日全部施工完成。通过协商，谈妥所有合同外增项价格。乙方初始报价：消防7500元，空调室外机移机费3000元，电气增项3864，气体增项15869元，气体补充增项：7120元。经友好协商，达成甲方最终支付价：消防4000元，空调室外机移机费1500元，电气增项3300，气体增项13000元，气体补充增项：5860元。节省了**-9693元**

任务完成情况-4：

<u>2.5启动结算审计</u>：9.24日选定审计公司，确定审计合同，10.8通过所内采购申请，合同申请，10.9日和审计公司签订正式审计书面合同，准备提供结算书，就结算书格式和审计公司沟通，拓展公司项目部出具结算书的效率极低，反复催促，11.3日才快递得到到拓展正式审计书，但我发现有几个重要数据错误，退回修改，11.13日收到更正后的结算书并快递给审计公司。11.14日审计公司收到结算书正式开始审计。

整个工程办理我兢兢业业、争分夺秒，没有在我手里耽误过半天时间。 但是每件事都很不顺利，需要极大的耐心和智慧来推进工程，每天都亲临施工现场检查工程质量，看看存在什么问题，及时加以解决。在工程结算上认真负责，一丝不苟，细致研究每一项价格，据理力争，节省了大约-4万元， 最终支付拓展公司：30.8 合同+2.766增项+0.47首年维保= 34.04万元，

节省了-11.8%费用， 工程质量超过预定的洁净度指标，其他项目全部达标

Slepton pair analysis with CEPC@360 GeV 1ab^{-1}

Potential search for direct slepton pair in $\sqrt{s}$ = 360 GeV at CEPC

Feng Lyu[a,1] Jiarong Yuan[1,2], Huajie Cheng[1,3], Xuai Zhuang[a,1]

[1]Institute of High Energy Physics, Chinese Academy of Sciences, Yuquan Road 19B, Shijingshan District, Beijing 100049, China
[2]University of the Chinese Academy of Sciences, Yuquan Road 19A, Shijingshan District, Beijing 100049, China
[3]Department of Applied Physics, Naval University of Engineering, Jiefang Blvd 717, Qiaokou District, Wuhan 430033, China

文章修改已完成

Abstract The center-of-mass energy of Circular Electron Positron Collider (CEPC) could be upgrade to 360 GeV after its ten-year running at 240GeV as a Higgs factory which can provides better opportunities for new physics searches besides SM precision measurements. This paper presents the sensitivity study of direct stau and smuon pair production at CEPC with $\sqrt{s}$ = 360 GeV by full Monte Carlo (MC) simulation. With 1.0 ab^{-1} integrated luminosity and the assumption of flat 5% systematic uncertainty, the CEPC@360GeV has the potential to discover the production of combined left-handed and right-handed stau up to 162 GeV if exists, or up to 150 GeV for the production of pure left-handed or right-handed stau; the discovery potential of direct smuon reaches up to 173 GeV with the same assumption. Given the similar nature of the facilities and detectors, the results can be a good reference for similar slepton pair searches in other electron positron colliders with the same center-of-mass energies and target luminosities, such as Future Circular Collider e^+e^- (FCC-ee) and the International Linear Collider (ILC).

Declarations

Funding

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Availability of data and material

The data used in this study won't be deposited, because this study is a simulation study without any experiment data.

[a]e-mail: luf@ihep.ac.cn,zhuangxa@ihep.ac.cn (corresponding author)

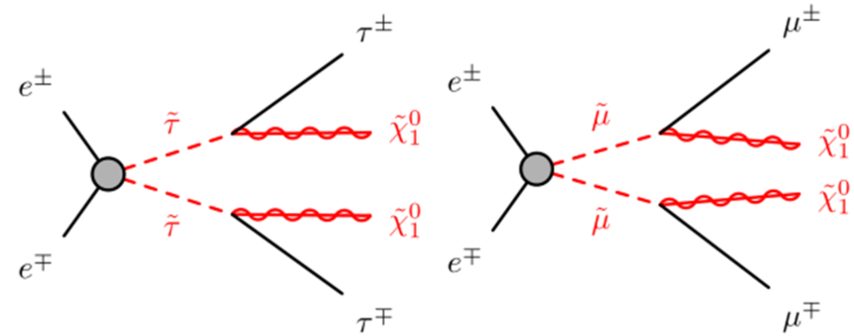
1 Introduction

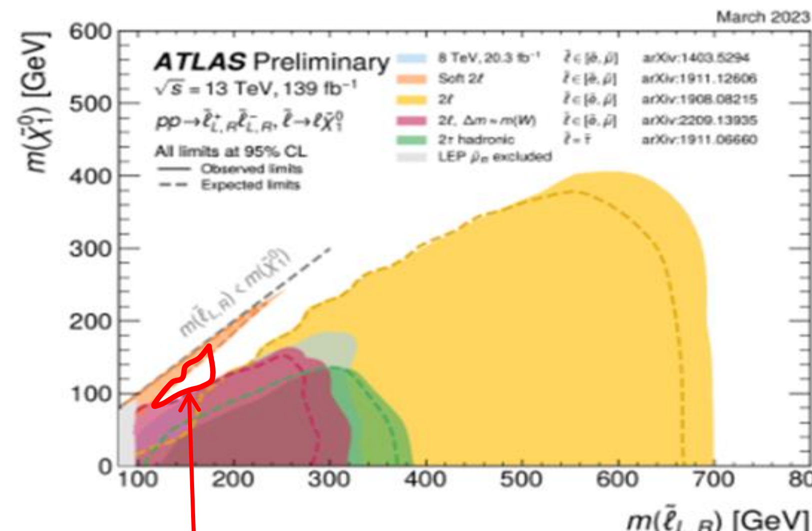
Supersymmetry (SUSY) [1–7] assumes that each Standard Model (SM) particle has its own superpartner, named as sparticle, which has related spin is different by a half from the corresponding SM particle. If R-parity [8] conservation assumption is valid, then all SUSY particles are produced in pairs and further decay to other SUSY and SM partiles, only the lightest supersymmetric particle (LSP) is stable, which is a good candidate for the dark matter [9, 10].

Among SUSY particles, two charginos (charged mass eigenstates) and four neutralinos (neutral mass eigenstates) are created by the linear superpositions of charged and neutral Higgs bosons and electroweak gauge bosons. Chirality of the superpartner of a lepton (slepton) under SUSY system is the same as the SM lepton's chirality, and superpositions of left-handed sleptons and right-handed sleptons form slepton mass eigenstates

Models with light sleptons are consistent with the dark matter relic density measurements [11]. Further more, light sleptons can take part in the coannihilation of neutralinos [12, 13]. Models with light smuons can provide some explanations of $(g-2)_\mu$ excess [14]. In gauge-mediated [15–17] and anomaly-mediated [18, 19] SUSY breaking models, the mass of sleptons are favor to be around 100 GeV level.

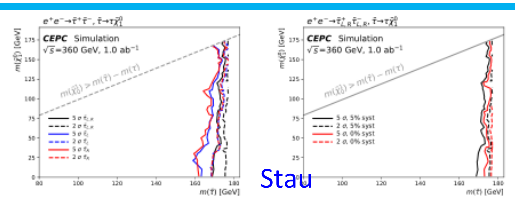
Direct slepton pair production were previously performed at the Large Electron-Positron Collider (LEP) and the Large Hadron Collider (LHC). Stau (smuon) masses below 86 - 96 (95 - 99) GeV are excluded by LEP when mass splitting between stau (smuon) and LSP is larger than 7 (4) GeV [20–25]. The slepton mass up to 700 GeV has been excluded by ATLAS experiment with massless LSP ($\tilde{\chi}_1^0$) [26], while the constrain is a bit weaker for the compressed slepton, which only excluded up to 251 GeV for a mass splitting around 10 GeV [27]. The similar results are set by CMS experiment [28], and using 137 fb^{-1} data, new CMS result [29] updated slepton excluded masses up to 700 GeV for a mass-





5% sys. 下5σ发现slepton的质量上限:
LR stau（L/R）道达到 164 GeV (143 GeV)
smu 道达到174GeV，分别比之前世界记录（LEP）提高78（79）GeV

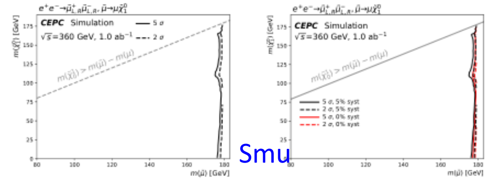
Slepton pair with CEPC@360 GeV 1ab^{-1} V52版



Stau

(a) systematic uncertainty = 5% (b) comparison between systematic uncertainty = 0% and 5 %

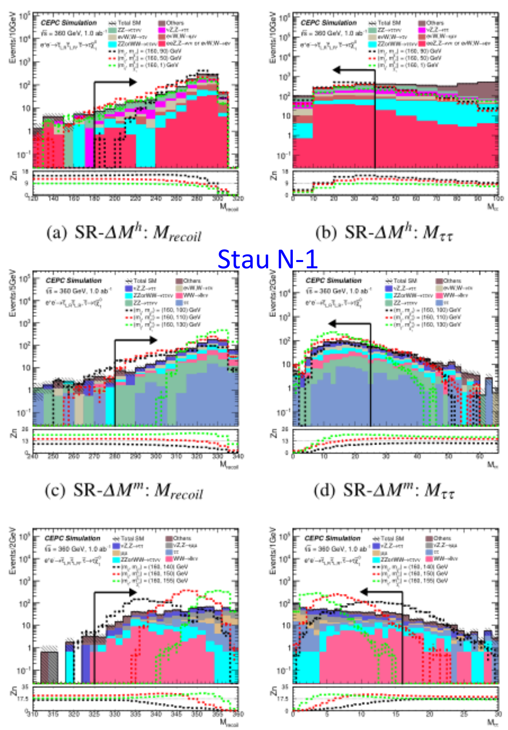
Fig. 5 The expected sensitivities as function of $\tilde{\tau}$ mass and $\tilde{\chi}_1^0$ mass for direct $\tilde{\tau}$ production with systematic uncertainty of 0% and 5% assumption



Smu

(a) systematic uncertainty = 5% (b) comparison between systematic uncertainty = 0% and 5%

Fig. 8 The expected sensitivities as function of $\tilde{\mu}$ mass and $\tilde{\chi}_1^0$ mass for direct smuon production signal regions with systematic uncertainty of 0% and 5% assumption



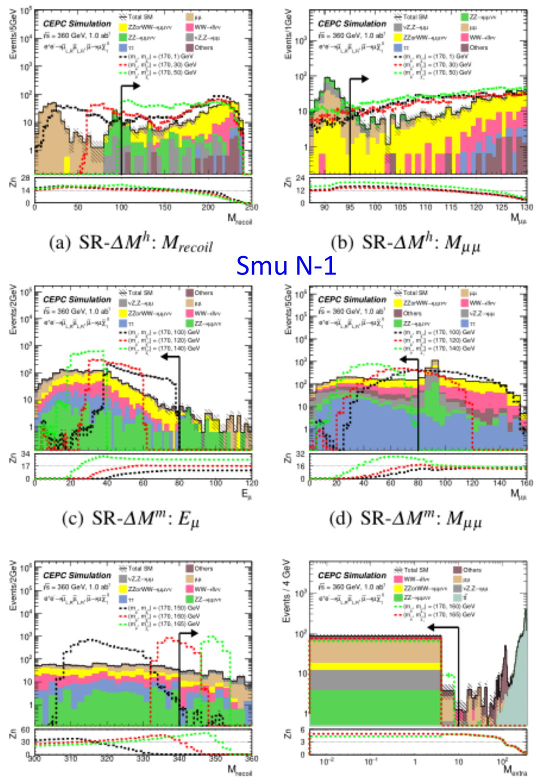
(a) SR-ΔM^h: M_{recoil} (b) SR-ΔM^h: $M_{\tau\tau}$

Stau N-1

(c) SR-ΔM^m: M_{recoil} (d) SR-ΔM^m: $M_{\tau\tau}$

(e) SR-ΔM^l: M_{recoil} (f) SR-ΔM^l: $M_{\tau\tau}$

Fig. 4 "N-1" distributions after signal region requirements for the direct stau pair production. All signal region requirements are applied except on the variable shown. The stacked histograms show the expected SM backgrounds. To illustrate, the distributions from SUSY reference



(a) SR-ΔM^h: M_{recoil} (b) SR-ΔM^h: $M_{\mu\mu}$

Smu N-1

(c) SR-ΔM^m: E_μ (d) SR-ΔM^m: $M_{\mu\mu}$

(e) SR-ΔM^l: M_{recoil} (f) SR-ΔM^l: M_{extra}

ig. 7 "N-1" distributions after signal region requirements for the direct smuon pair production. All signal region requirements are applied except on the variable shown. The stacked histograms show the ex-

Selections & yields

Table 1 Summary of selection requirements for the direct stau production signal region. ΔM means difference of mass between $\tilde{\tau}$ and LSP

SR-ΔM^h	SR-ΔM^m	SR-ΔM^l
$E_{\tau^\pm}$ <40 GeV	$E_{\tau^\pm}$ <15 GeV	
sumP_T >50 GeV	sumP_T >20 GeV	-
2.55 <$\|\Delta\phi(\tau,recoil)\|$ <3.1	$\|\Delta\phi(\tau,recoil)\|$ <3.1	$\|\Delta\phi(\tau,recoil)\|$ >2.3
-	0.45<$\Delta R(\tau,\tau)$ <1.7	$\Delta R(\tau,\tau)$ >0.45
$\Delta R(\tau,recoil)$ <3.2	$\Delta R(\tau,recoil)$ <3.15	$\Delta R(\tau,recoil)$ <2.9
$M_{\tau\tau}$ <40 GeV	$M_{\tau\tau}$ <25 GeV	$M_{\tau\tau}$ <16 GeV
M_{recoil} >180 GeV	M_{recoil} >280 GeV	M_{recoil} >325 GeV

stau

Table 2 The number of events in the signal regions for signal and SM backgrounds with statistical uncertainty for direct stau production

Process	SR-ΔM^h	SR-ΔM^m	SR-ΔM^l
ZZ or $WW \to \tau\tau\nu\nu$	79±7	111±8	59±6
$\tau\tau$	16±4	55±7	91±9
$\nu Z, Z \to \tau\tau$	169±10	173±10	170±10
$ZZ \to \tau\tau\nu\nu$	246±11	97±7	42±5
$WW \to \ell\ell\nu\nu$	75±7	91±7	52±6
$\nu Z, Z \to \mu\mu$	30±4	34±5	163±10
$\mu\mu$	-	14±3	81±7
ZZ or $WW \to \mu\mu\nu\nu$	37±5	5.9±1.9	8.2±2.2
$ZZ \to \mu\mu\nu\nu$	10±3	4.4±1.7	22±4
$e\nu W, W \to \tau\nu$	118±9	112±8	41±5
$e\nu W, W \to \mu\nu$	115±9	20±4	11±3
$eeZ, Z \to \nu\nu$ or $e\nu W, W \to e\nu$	104±8	25±4	15±3
$eeZ, Z \to \nu\nu$	4.6±1.3	0.4±0.4	-
$\nu\nu H, H \to$ anything	51±6	18±3	6.5±2.0
Total SM	1053±25	760±22	761±22
m($\tilde{\tau}$,$\tilde{\chi}_1^0$) = (160,50) GeV	1028±21	157±8	9.4±2.0
m($\tilde{\tau}$,$\tilde{\chi}_1^0$) = (160,110) GeV	984±21	1053±22	151±8
m($\tilde{\tau}$,$\tilde{\chi}_1^0$) = (160,150) GeV	-	3.1±1.2	1690±27

Table 3 Summary of selection requirements for the direct smuon production signal region. ΔM means difference of mass between $\tilde{\mu}$ and LSP

SR-ΔM^h	SR-ΔM^m	SR-ΔM^l
E_μ > 60 GeV	E_μ < 80 GeV	-
$\Delta R(\mu,recoil)$ < 2.8	1.9 < $\Delta R(\mu,recoil)$ <2.9	
$M_{\mu\mu}$ <87 GeV || GeV 95 < $M_{\mu\mu}$ < 130 GeV	$M_{\mu\mu}$ < 80 GeV	-
M_{recoil} > 100 GeV	-	M_{recoil} > 340 GeV
M_{extra} <15 GeV	M_{extra} <10 GeV	M_{extra} <10 GeV

Table 4 The number of events in the signal regions for signal and SM backgrounds with statistical uncertainty for direct smuon production

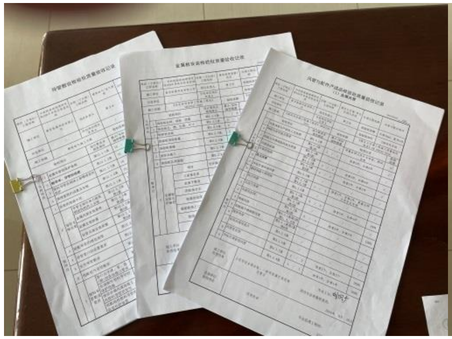
Process	SR-ΔM^h	SR-ΔM^m	SR-ΔM^l
$ZZorWW \to \mu\mu\nu\nu$	333±14	869±23	19.4±3.4
$\mu\mu$	64±6	441±17	78±7
$\nu Z, Z \to \mu\mu$	19±4	204±11	48±6
$ZZ \to \mu\mu\nu\nu$	44±5	104±8	8.8±2.3
$WW \to \ell\ell\nu\nu$	64±6	444±17	22±4
$\tau\tau$	11.0±2.8	209±12	12±3
$ZZorWW \to \tau\tau\nu\nu$	7.6±2.2	98±8	3.8±1.6
$ZZ \to \tau\tau\nu\nu$	1.0±0.7	41±5	6.0±1.7
$\nu Z, Z \to \tau\tau$	-	67±7	12.5±2.8
$\nu\nu H, H \to$ anything	1.7±1.2	25±5	-
ttbar	0.07±0.07	0.14±0.10	-
$e\nu W, W \to \mu\nu$	-	-	-
$e\nu W, W \to \tau\nu$	-	-	-
$eeZ, Z \to \nu\nu$	-	-	-
$eeZ, Z \to \nu\nu$ or $e\nu W, W \to e\nu$	-	-	-
Total SM	524±18	2503±39	210±12
m($\tilde{\mu}$,$\tilde{\chi}_1^0$) = (170,30) GeV	775±11	82±4	7.4±1.1
m($\tilde{\mu}$,$\tilde{\chi}_1^0$) = (170,100) GeV	1111±14	1927±18	2.5±0.6
m($\tilde{\mu}$,$\tilde{\chi}_1^0$) = (170,165) GeV	-	2310±20	2310±20

smu

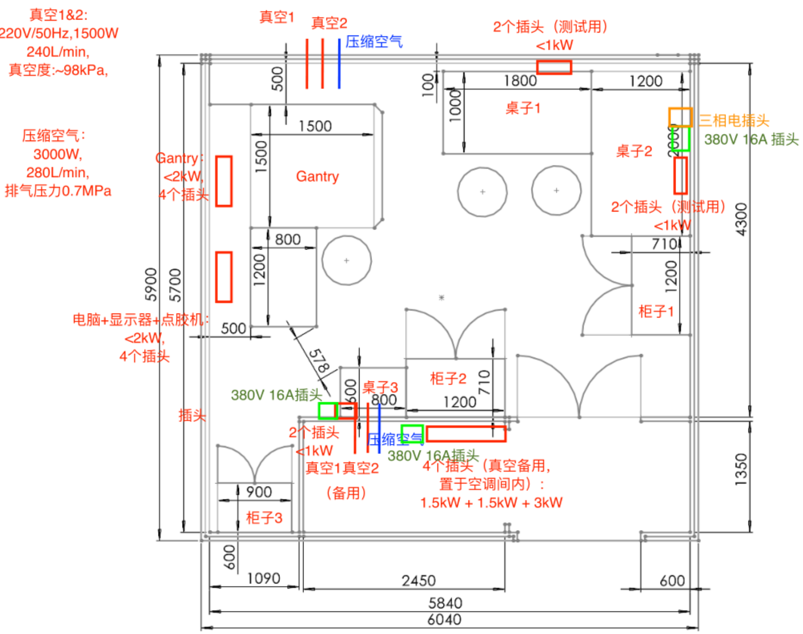
108室洁净间典型图片

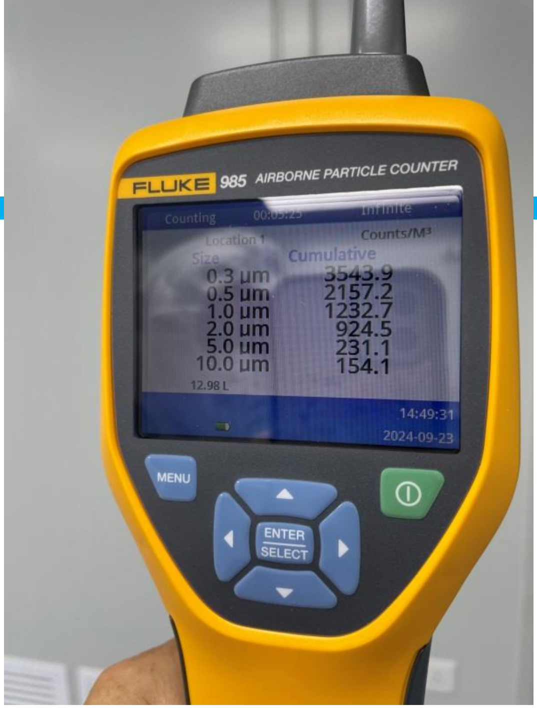


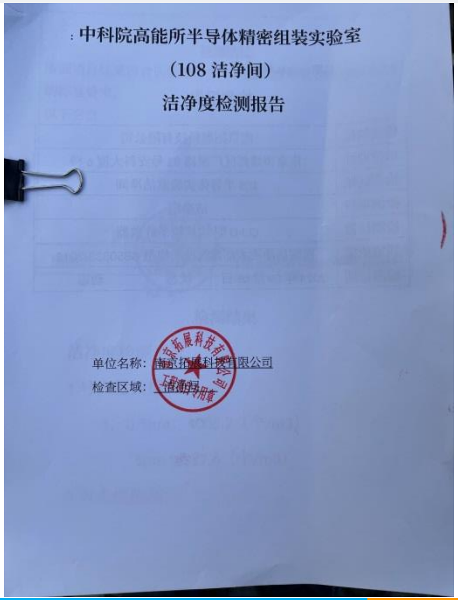




108室洁净间典型图片

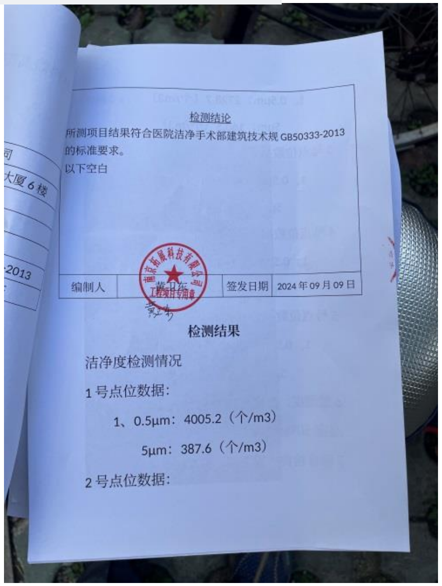





中科院高能所半导体精密组装实验室

（108 洁净间）

洁净度检测报告


检测结论

所测项目结果符合医院洁净手术部建筑技术规 GB50333-2013 的标准要求。

以下空白

编制人　　签发日期　2024 年 09 月 09 日

检测结果

洁净度检测情况

1 号点位数据：

1、0.5μm：4005.2（个/m3）

5μm：387.6（个/m3）

2 号点位数据：

万级标准：0.5μm：35.2万个/m²，5μm：2930个/m²

颗粒尺寸	108洁净间	108洁净间过道	108外面楼道
0.5μm (5点值）	4005, 2729 4503, 2148 3840	10.3万	50万
5μm (5点值）	388, 161, 795, 222, 996	2700	15万
是否达标？	合格！远优于万级标准！接近达到千级水平！	过道都能合格！	参考环境

千级标准：0.5μm：3.52万个/m²，5μm：293个/m²

学术发展、学术交流、论文

1. 在8月第十四届全国高能物理大会TeV新物理分会上做了《Prospect on slepton search at CEPC@360 GeV》报告
2. 完成CEPC 360GeV slepton pair analysis的文章修改稿，是**第一作者和通讯作 者**。文章正在内部最后评审中，准备投稿。
3. 对**CEPC新物理白皮书**SUSY章节作出重要贡献，提供了360GeV slepton研究结果。新物理白皮书在内部审查中，计划年底投稿，**本人是白皮书作者之一**。
4. 参与CEPC Ref-TDR中关于muon性能的研究。利用已有的smuon分析研究Ref-detector的muon和met性能的提升。

Potential search for direct slepton pair in $\sqrt{s}$ = 360 GeV at CEPC

Feng Lyu[a,1], Jiarong Yuan[1,2], Huajie Cheng[1,3], Xuai Zhuang[a,1]

[1]Institute of High Energy Physics, Chinese Academy of Sciences, Yuquan Road 19B, Shijingshan District, Beijing 100049, China
[2]University of the Chinese Academy of Sciences, Yuquan Road 19A, Shijingshan District, Beijing 100049, China
[3]Department of Applied Physics, Naval University of Engineering, Jiefang Blvd 717, Qiaokou District, Wuhan 430033, China

Abstract The center-of-mass energy of Circular Electron Positron Collider (CEPC) could be upgrade to 360 GeV after its ten-year running at 240GeV as a Higgs factory which can provides better opportunities for new physics searches besides SM precision measurements. This paper presents the sensitivity study of direct stau and smuon pair production at CEPC with $\sqrt{s}$ = 360 GeV by full Monte Carlo (MC) simulation. With 1.0 ab^{-1} integrated luminosity and the assumption of flat 5% systematic uncertainty, the CEPC@360GeV has the potential to discover the production of combined left-handed and right-handed stau up to 162 GeV if exists, or up to 150 GeV for the production of pure left-handed or right-handed stau; the discovery potential of direct smuon reaches up to 173 GeV with the same assumption. Given the similar nature of the facilities and detectors, the results can be a good reference for similar slepton pair searches in other electron positron colliders with the same center-of-mass energies and target luminosities, such as Future Circular Collider e^+e^- (FCC-ee) and the International Linear Collider (ILC).

Declarations

Funding

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Availability of data and material

The data used in this study won't be deposited, because this study is a simulation study without any experiment data.

*e-mail: luf@ihep.ac.cn,zhuangxa@ihep.ac.cn (corresponding author)

1 Introduction

Supersymmetry (SUSY) [1–7] assumes that each Standard Model (SM) particle has its own superpartner, named as sparticle, which has related spin is different by a half from the corresponding SM particle. If R-parity [8] conservation assumption is valid, then all SUSY particles are produced in pairs and further decay to other SUSY and SM partiles, only the lightest supersymmetric particle (LSP) is stable, which is a good candidate for the dark matter [9, 10].

Among SUSY particles, two charginos (charged mass eigenstates) and four neutralinos (neutral mass eigenstates) are created by the linear superpositions of charged and neutral Higgs bosons and electroweak gauge bosons. Chirality of the superpartner of a lepton (slepton) under SUSY system is the same as the SM lepton's chirality, and superpositions of left-handed sleptons and right-handed sleptons form slepton mass eigenstates

Models with light sleptons are consistent with the dark matter relic density measurements [11]. Further more, light sleptons can take part in the coannihilation of neutralinos [12, 13]. Models with light smuons can provide some explainations of $(g-2)_\mu$ excess [14]. In gauge-mediated [15–17] and anomaly-mediated [18, 19] SUSY breaking models, the mass of sleptons are favor to be around 100 GeV level.

Direct slepton pair production were previously performed at the Large Electron-Positron Collider (LEP) and the Large Hadron Collider (LHC). Stau (smuon) masses below 86 - 96 (95 - 99) GeV are excluded by LEP when mass splitting between stau (smuon) and LSP is larger than 7 (4) GeV [20–25]. The slepton mass up to 700 GeV has been excluded by ATLAS experiment with massless LSP ($\tilde{\chi}_1^0$) [26], while the constrain is a bit weaker for the compressed slepton, which only excluded up to 251 GeV for a mass splitting around 10 GeV [27]. The similar results are set by CMS experiment [28], and using 137 fb^{-1} data, new CMS result [29] updated slepton excluded masses up to 700 GeV for a mass-

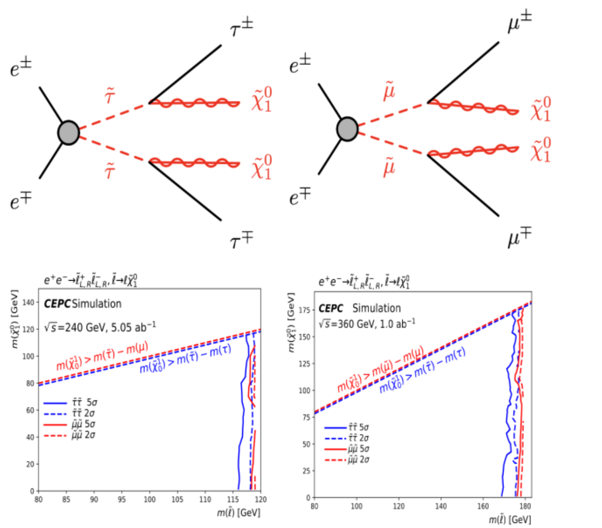

FIG. 60: *Top*: representative diagram illustrating the pair production of charged staus (smuons) and subsequent decay into a two-tau (two-muon) final state. *Bottom*: The 5σ discovery contour (solid line) and 2σ exclusion contour (dashed line) for the direct stau production and direct smuon production with 5% flat systematic uncertainty. Left (Right) plot presents the center-of-mass energy of 240 (360) GeV.

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