

考核报告

(2022年5月-2022年8月)

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实验物理中心

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简介

➤ 分析

➤ SS/3L EWK末态超对称粒子的寻找

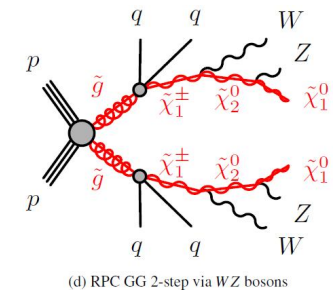
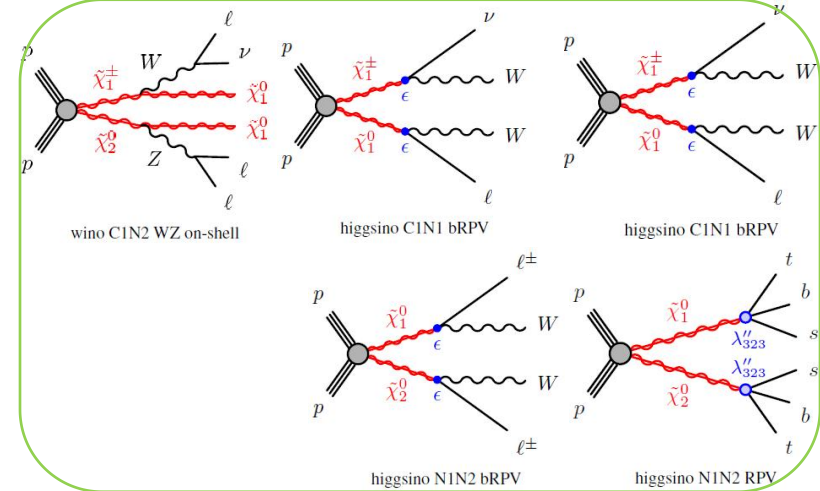
➤ 工作：理论误差估计；准备Hepdata；编辑support note

➤ SS/3L strong末态超对称粒子的寻找

➤ 工作：理论误差估计；GG2stepWZ信号的所有分析；编辑support note

➤ Tau ID 鉴别效率修正

➤ 未来计划



SS/3L EWK末态超对称粒子的寻找

理论误差和Hepdata

- 工作：理论误差所需样本的产生，理论误差计算；准备Hepdata
- 进展：该分析已通过PAM，在回答cds comments的阶段，计划年底发表论文。

理论误差

Region	radiation[%]	Merging scale varying xqcut[%]	QCD scale[%]
Rpv2L1bL	26.69/-28.7	16/-12.52	15.89/-9.78
Rpv2L1bM	21.37/-21.34	10.84/-19.3	10.49/-9.02
Rpv2L2bL	47.41/-37.33	13.45/-21.85	9.43/-10.54
Rpv2L2bM	40.38/-33.86	20.86/-26.48	13.29/-15.74
Rpv2L2bH	15.85/-18.15	6.22/-11.41	7.81/-5.18
Rpv2L3bL	22.97/-21.09	10.72/-13.86	10.5/-9.19
Rpv2L3bM	16.34/-19.03	7.77/-11.97	8.46/-8.99
Rpv2L3bH	11.86/-9.35	4.32/-10.3	6.3/-4.94

Region	radiation[%]	Merging scale varying xqcut[%]	QCD scale[%]
bRPV2L	+12.00/-11.23	+4.53/-5.43	+3.72/-4.20
bRPV3L	+5.87/-5.53	+1.96/-2.43	+2.23/-2.38

Region	radiation[%]	Merging scale varying xqcut[%]	QCD scale[%]
SRWZonshell1	+12.50/-12.52	+5.6/-8.61	+4.87/-6.17
SRWZonshell2	+18.01/-15.81	+7.69/-12.02	+8.38/-7.85

Table 62: Theory uncertainties of WZ

Region	QSF[%]	CKKW[%]	CSSKIN[%]
CRWZ2j	3.67/-0.74	0.82/-1.22	1.15
VRTTV	27.97/-21.02	14.82/-21.44	20.57
VRWZ4j	12.79/-21.39	8.22/-3.22	1.86
VRWZ5j	17.12/-31.18	13.9/-2.91	1.48
bRPV2L	20.76/-38.86	10.7/-15.7	11.13
bRPV3L	2.26/-5.15	3.92/-16.99	6.88
Rpv2L1bL	47.64/-35.74	36.74/-61.68	72.57
Rpv2L1bM	45.37/-69.19	35.6/-100	101.24
Rpv2L2bL	100/-100	100/-100	100
Rpv2L2bM	100/-100	100/-100	100
Rpv2L2bH	25.02/-80.8	100/-100	100
Rpv2L3bL	100/-100	100/-100	100
Rpv2L3bM	100/-100	100/-100	86.52
Rpv2L3bH	100/-100	100/-100	100
SRWZonshell1	24.04/-12.4	18.5/-27.67	32.06
SRWZonshell2	1.56/-3.39	3.47/-2.06	1.25

Table 63: Theory uncertainties of WW

Region	QSF[%]	CKKW[%]	CSSKIN[%]
CRWZ2j	100/-100	100/-100	100
VRTTV	17.9/-6.98	18.79/-8.71	1.73
VRWZ4j	100/-100	100/-100	100
VRWZ5j	100/-100	100/-100	100
bRPV2L	0.09/-6.71	4.38/-5.97	6.19
bRPV3L	100/-100	100/-100	100
Rpv2L1bL	15.54/-11.96	44.98/-0.99	15.56
Rpv2L1bM	4.48/-18.57	16.53/-33.7	8.91
Rpv2L2bL	100/-100	100/-100	100
Rpv2L2bM	100/-100	100/-100	100
Rpv2L2bH	33.09/-25.64	10.79/-21.95	18.2
Rpv2L3bL	100/-100	100/-100	100
Rpv2L3bM	100/-83.41	100/-8.32	100
Rpv2L3bH	10.04/-65.07	44.98/-100	10.06
SRWZonshell1	21.4/-17.02	30.09/-12.62	12.45
SRWZonshell2	9.14/-3.96	8.01/-2.02	11.05

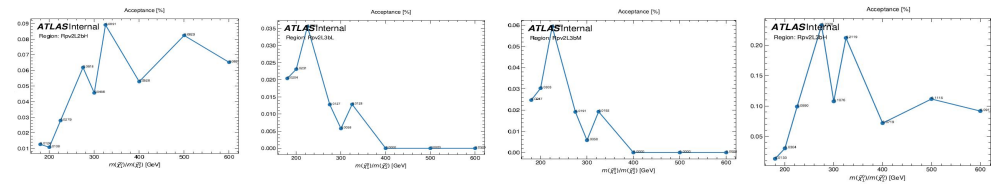
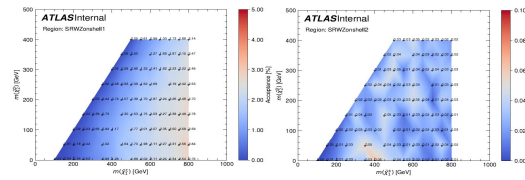
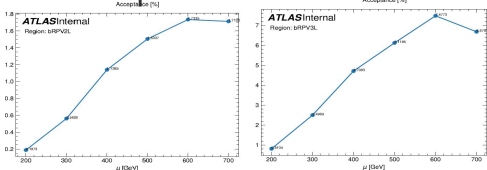
Table 64: Theory uncertainties of ttZ

Region	Radiation(up/down)[%]	Parton Shower[%]	Hard Scatter[%]
CRWZ2j	-13.29/-12.07	-14.35	-10.41
VRTTV	-9.87/-9.5	-13.21	-10.72
VRWZ4j	-6.95/-17.48	-17.97	-22.49
VRWZ5j	-3.09/-17.3	-8.56	-16.83
bRPV2L	5.61/-25.15	-20.52	-16.11
bRPV3L	-10.38/-12.28	-28.14	-20.9
Rpv2L1bL	-14.89/-32.41	-17.11	-39.03
Rpv2L1bM	15.36/13.97	-11.15	-10.22
Rpv2L2bL	-8.47/-6.23	-26.51	-11.35
Rpv2L2bM	-21.51/-5.54	8.17	3.59
Rpv2L2bH	8.71/-3.12	19.73	-15.33
Rpv2L3bL	26.11/68.28	44.95	23.73
Rpv2L3bM	39.64/25.03	9.47	22.57
Rpv2L3bH	-9.93/-5.41	-9.46	1.06
SRWZonshell1	-1.72/-27	-13.23	-21.1
SRWZonshell2	-5.72/3.37	12.27	-2.37

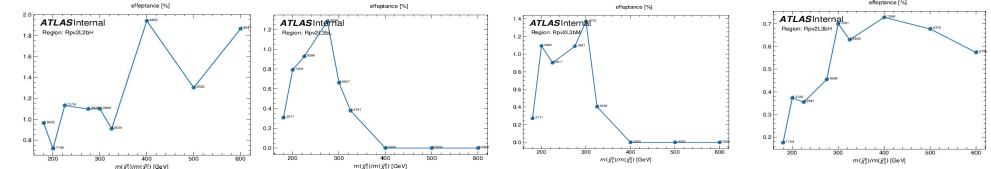
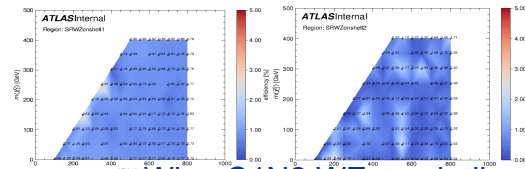
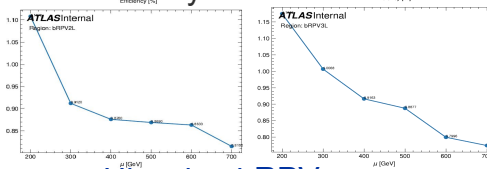
Table 65: Theory uncertainties of ttW

Region	Radiation[%]
CRWZ2j	-4.3/1.91
VRTTV	0.48/-0.79
VRWZ4j	29.27/50.06
VRWZ5j	53.62/53.85
bRPV2L	21.89/-9.62
bRPV3L	-1.03/2.52
Rpv2L1bL	-8.45/-14.13
Rpv2L1bM	5.17/0.6
Rpv2L2bL	4.39/-9.1
Rpv2L2bM	-9.7/-16.38
Rpv2L2bH	0.82/-6.57
Rpv2L3bL	-5.51/2.96
Rpv2L3bM	-4.15/8.11
Rpv2L3bH	-11.83/-2.6
SRWZonshell1	-5.07/20.13
SRWZonshell2	-0.52/1.18

acceptance



efficiency



Higgsino bRPV

Wino C1N2 WZ on-shell

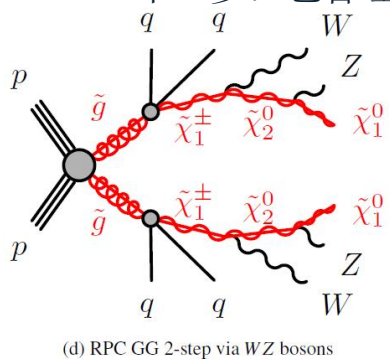
Higgsino N1N2 RPV



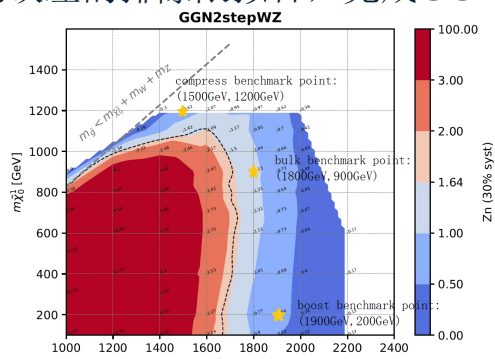
SS/3L strong末态超对称粒子的寻找

■ GG2stepWZ模型的信号区优化和排除限拟合

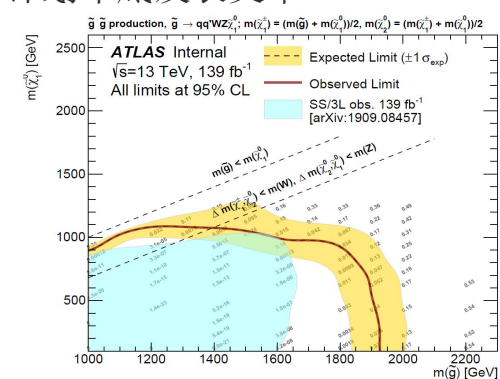
- 目的: SS/3L末态因低本底, 高散射截面的特点有利于SUSY粒子的寻找, 本次分析对GG2stepWZ模型进行更细致的研究, 增大信号显著性。
- 工作: 完成GG2stepWZ模型的信号区定义, 用multi-bin fit提高排除能力; 考虑实验误差, 将理论误差设为30%用HistFitter进行排除限拟合; 编辑support note。
- 进展: 本人在今年的高能物理分会报告了这个研究, 该分析已通过FAR approval。
- 策略: 在boost, bulk, compress区域分别选取一个信号点作为参考, 用cut-and-count方法结合N-1图优化信号区; 对bulk信号区, 用meff做multi-bin fit提高排除能力。对每个信号点, 选3个信号区CL值的最小值作为CL值, 得到最终的排除限。
- 结论: 相比于1 wave分析, 新信号区拓展了bulk, compress区域的排除限, gluino质量排除限从1600GeV提高到1950GeV。
- 下一步: 包含理论误差的排除限拟合, 完成GG2stepWZ模型的分析, 计划年底发表文章。



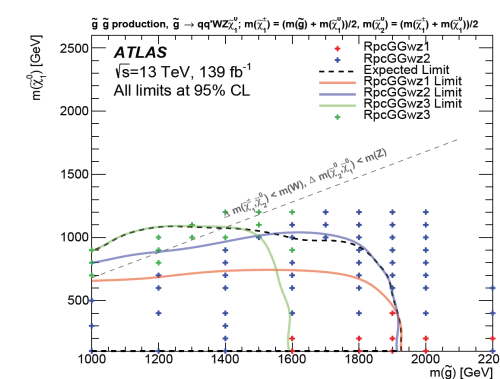
(a)信号模型



(b)参考点在1 wave分析排除线的位置



(c)综合3个信号区的CL得到的最大排除限



(d)3个新信号区的排除限与最大排除限

信号区定义	nSigLep	nBJets20	nBaseLep	n jets	Jet Pt	met	限 meff	dPhiLLmet	met_Sig	meff/ht_lep	multi-bin fit
boost	>=2	=0	-	>=6	40 GeV	>150 GeV	>2100GeV	-	-	-	-
bulk	>=2	=0	-	>=6	40 GeV	>190 GeV	>1300GeV	>0.8	-	-	meff binning in [1300 GeV, 2300 GeV]
compress	>=2	=0	>= 3	>=6	25 GeV	>200 GeV	-	>0.2	>6	>8	-

SS/3L strong末态超对称粒子的寻找

理论误差

- 进展：完成了所有理论误差计算所需样本的产生，完成了所有需考虑的本底（WZ, WW_{ss}, ttW, ttZ）和部分信号的理论误差计算，编辑 support note 的理论误差部分。
- 本底理论误差来源：
 - multi-boson: Scale variations, matching scale variations, resummation scale variations, recoil scheme uncertainty
 - ttbar+x: Scale variations, Parton Shower uncertainties, Radiation uncertainties, PDF uncertainties, Hard Scatter uncertainty
- 本底理论误差计算策略：用 SimpleAnalysis 计算 nominal sample 和各 variation sample 的在对应信号区，控制区和验证区的 yields，通过放松信号区筛选条件解决一些信号区 yields 统计量低的问题，对于事例数太少导致计算所得误差特别大的，取 50% 为理论误差。
- SUSY 信号理论误差来源：factorization and renormalization scale (scup and scdw), merging scale varying xqcut (qcup and qcdw), radiation:(py1up,py1dw,py2up,py2dw,py3aup,py3adw,py3bup,py3bdw,py3cup,py3cdw)
- SUSY 信号理论误差计算策略：事例产生，Truth Derivation，用 SimpleAnalysis 计算 nominal sample 和各 variation sample 的在对应信号区的 signal yields，计算每个信号点的理论误差，对每个模型取该模型所有信号点理论误差的加权平均值为该模型所有信号点的理论误差，通过放松信号区筛选条件解决一些信号区 yields 统计量低的问题。

uncertainty[%]	QS(up/down)	CKK(up/down)	CSSKIN
CRWZ2j	-4.39/10.82	-2.74/4.14	-0.69
VRTTV	-0.09/11.8	-0.78/-24.28	38.12
VRWZ4j	-3.64/0.74	-8.55/1.9	-5.63
VRWZ6j	-19.95/-15.85	-21.7/-4.03	-14.83
VRTTW	-4.47/7.57	-13.66/21.88	-30.16
VRTTW3j	0.22/28.92	-10.23/50	1.72
RpcGGwz1	-26.76/-18.4	-18.48/-24.81	-33.22
RpcGGwz2	-16.02/-24.39	-12.6/-51.81	-51.04
RpcGGwz3	-21.91/34.49	13.99/48.31	-3.26
RpcGgslep1	-19.17/27.03	1.76/-9.99	3.74
RpcGgslep2	-22.45/1.24	6.91/52.3	-14.95
RpcGgslep3	4.16/-1.1	-22.13/8.15	-18.95
RpvUDD1b	-8.71/50	-21.59/-50	-30.7
RpvUDD2b	-50/-50	-50/-52	-8.94
RpvUDDge2b	-50/-50	-50/28.93	24.54
RpvUDDge3b	-50/-50	-50/-50	-50
RpvLQD	-3.1/-24.68	-14.71/-30.66	10.86
RpcSSslep1	-25.12/7.9	13.49/-11.08	-13.3
RpcSSslep2	-23.78/-7.84	7.41/0.48	-17.08
RpcSSslep3	16.09/2.77	18.74/-18.08	7.22
RpcSSslep4	16.2/2.62	18.85/-18	7.33

Table 153: WZ uncertainty in CR/VR/SR

uncertainty[%]	QS(up/down)	CKK(up/down)	CSSKIN
CRWZ2j	-	-	-
VRTTV	2.39/-1.8	2.16/0.52	10.31
VRWZ4j	-	-	-
VRWZ6j	-	-	-
VRTTW	3.62/1.72	-7.25/10.78	-9.74
VRTTW3j	-0.58/20.68	-17.92/-6.79	-1.23
RpcGGwz1	15.25/-10.86	-12.66/-16.61	0.35
RpcGGwz2	-0.42/1.95	-24.4/-8.08	12.71
RpcGGwz3	-	-	-
RpcGgslep1	-	-	-
RpcGgslep2	-	-	-
RpcGgslep3	-	-	-
RpvUDD1b	6.52/-5.77	-3.88/19.27	-50
RpvUDD2b	-16.09/4.43	35.75/-37.61	-19.02
RpvUDDge2b	-32.65/-17.61	6.72/-50	6.96
RpvUDDge3b	-50/-50	-50/-50	43.13
RpvLQD	8.23/-0.37	0.87/-8.43	0.03
RpcSSslep1	-	-	-
RpcSSslep2	-	-	-
RpcSSslep3	-	-	-
RpcSSslep4	-	-	-

Table 154: WW uncertainty in CR/VR/SR

uncertainty[%]	radiation(up/down)	parton shower	hard scatter
CRWZ2j	-11.53/7.72	-4.25	5.13
VRTTV	-6.06/2.14	-6.44	4.97
VRWZ4j	-3.46/-8.02	-7.28	-11.36
VRWZ6j	8.17/-2.23	8.89	9.38
VRTTW	-1.48/-2.72	1.54	7.02
VRTTW3j	2.05/0.85	-0.24	7.27
boostSR	50/50	-30.61	27.66
bulkSR	50/50	-14.98	17.53
compressSR	11.58/4.81	-13.86	-17.94
RpcGgslep1	-15.02/22.39	-40.59	-26.65
RpcGgslep2	6.52/-5.47	-23.62	-16.32
RpcGgslep3	-50/-50	-6.29	33.13
RpvUDD1b	-50/-50	-26.83	-20.36
RpvUDD2b	-50/0.98	-29.66	-14.61
RpvUDDge2b	-50/6.38	-33.46	-19.16
RpvUDDge3b	-36.07/-16.81	-33.6	19.74
RpvLQD	-4.63/45.06	-17.38	10.67
RpcSSslep1	0.05/14.31	-50	-26.09
RpcSSslep2	50/50	1.01	0.62
RpcSSslep3	-32.88/-50	-50	-25.15
RpcSSslep4	41.55/-6.21	-24.49	-14.74

Table 155: ttWZ uncertainty in CR/VR/SR

uncertainty[%]	radiation(up/down)
CRWZ2j	20.24/-4.81
VRTTV	-0.01/-0.45
VRWZ4j	50.00/25.11
VRWZ6j	-6.64/23.96
VRTTW	0.98/2.34
VRTTW3j	0.86/0.48
RpcGGwz1	36.49/11.79
RpcGGwz2	50.00/-14.78
RpcGGwz3	50.00/50.00
RpcGgslep1	50.00/-44.03
RpcGgslep2	17.62/-4.32
RpcGgslep3	-49.28/18.66
RpvUDD1b	-11.45/-8.04
RpvUDD2b	23.72/15.64
RpvUDDge2b	3.73/-2.81
RpvUDDge3b	13.65/-6.59
RpvLQD	13.41/3.29
RpcSSslep1	50.00/50.00
RpcSSslep2	16.24/2.59
RpcSSslep3	-50.00/-50.00
RpcSSslep4	21.74/36.10

Table 156: ttW uncertainty in CR/VR/SR

uncertainty[%]	radiation(up/down)	Merging scale varying xqcut(up/down)	QCD scale(up/down)
RpcGGwz1	+12.05/-12.70	+5.48/-5.56	+5.28/-5.24
RpcGGwz2	+9.65/-9.54	+4.31/-3.85	+3.82/-3.65
RpcGGwz3	+23.52/-22.35	+10.77/-10.99	+9.47/-8.96

Table 157: Signal theory uncertainty of RPC GG 2-step via WZ model			
uncertainty[%]	radiation(up/down)	Merging scale varying xqcut(up/down)	QCD scale(up/down)
RpvUDD1b	+38.91/-39.68	+15.67/-16.10	+16.20/-18.68
RpvUDD2b	+17.38/-19.16	+8.12/-7.93	+7.66/-7.53
RpvUDDge2b	+7.18/-6.44	+3.13/-2.85	+2.92/-2.70
RpvUDDge3b	+10.82/-11.03	+5.04/-4.85	+4.13/-4.14

Table 158: Signal theory uncertainty of RPV UDD model



Tau ID 鉴别效率修正研究

- 目的：对tau ID鉴别效率进行修正以使蒙卡模拟更接近真实实验数据，作为tau recommendation.
- 工作：使用pre-run3的ntuple，提取Z->tau tau衰变道的tau ID鉴别效率修正因子
- 进展：分别用data减本底估计和最大似然法拟合两种方法提取tau ID鉴别效率修正因子。
- 初步结果：

$$\text{scale factor} = \frac{eff_{data}}{eff_{MC}} \quad \text{eff} = \frac{\text{true } \tau_{\text{pass the ID}}}{\text{true } \tau_{\text{all ID}}}$$

data减本底估计的tau ID鉴别效率修正因子

tau ID SF	e1p	e3p	mu1p	mu3p
Loose	1.02+-0.04	2.74+-0.78	1.24+-0.05	1.13+-0.11
Medium	0.98+-0.04	2.97+-0.84	1.23+-0.05	1.14+-0.11
Tight	0.98+-0.04	3.17+-0.90	1.26+-0.05	1.21+-0.12

最大似然法拟合得tau ID鉴别效率修正因子

tau ID SF	e1p	e3p	mu1p	mu3p	1p	3p
Loose	0.97+-0.03	1.31+-0.01	1.19+-0.02	1.14+-0.10	1.10+-0.02	1.31+-0.01
Medium	0.93+-0.03	1.37+-0.04	1.19+-0.02	1.16+-0.10	1.08+-0.02	1.34+-0.02
Tight	0.93+-0.03	1.47+-0.05	1.20+-0.02	1.20+-0.10	1.09+-0.02	1.41+-0.02

- 下一步：优化拟合方法，提高tau ID鉴别效率修正因子估计的稳定性；提取Run3的tau ID鉴别效率修正因子作为Run3的tau recommendation。

➤ 未来计划

- SS/3L EWK末态超对称粒子的寻找：完成Hepdata，年底发表论文。
- SS/3L (strong)末态超对称粒子的寻找：完成理论误差分析，完成GG2stepWZ模型的分析，计划年底发表文章。
- 研究Run3的Tau ID 鉴别效率修正

➤ 报告链接

- 2022 中国物理学会高能物理分会：<https://indico.ihep.ac.cn/event/16065/contributions/114856/attachments/62089/71615/LiangShiyiposter.pdf>
- SS/3L (EWK)末态超对称粒子的寻找：
 - <https://indico.cern.ch/event/1166239/contributions/4901827/attachments/2453295/4204204/EWK0531.pdf>
 - <https://indico.cern.ch/event/1169672/contributions/4921671/attachments/2461796/4220897/0614.pdf>
- SS/3L (strong)末态超对称粒子的寻找：
 - <https://indico.cern.ch/event/1193827/contributions/5017750/attachments/2497704/4289849/strong0826uncer.pdf>
 - <https://indico.cern.ch/event/1191765/contributions/5009733/attachments/2494839/4284709/0817.pdf>
 - <https://indico.cern.ch/event/1189629/contributions/5000284/attachments/2492320/4280091/strong0812.pdf>
 - <https://indico.cern.ch/event/1185846/contributions/4982482/attachments/2487245/4270810/0729.pdf>
 - <https://indico.cern.ch/event/1182072/contributions/4966083/attachments/2480645/4258338/0715.pdf>
 - <https://indico.cern.ch/event/1177398/contributions/4945464/attachments/2473742/4244403/0701.pdf>
 - <https://indico.cern.ch/event/1172365/contributions/4923680/attachments/2464566/4226054/0617.pdf>
 - <https://indico.cern.ch/event/1167293/contributions/4902122/attachments/2455644/4208902/SSstrong-0603.pdf>
 - <https://indico.cern.ch/event/1162779/contributions/4883885/attachments/2447976/4194826/SSstrong-0520.pdf>
 - https://indico.cern.ch/event/1160204/contributions/4872446/attachments/2443596/4186832/0513bkg_uncertainty.pdf
- Tau Measurement and Calibration Subgroup Meeting：
 - <https://indico.cern.ch/event/1194623/contributions/5022622/attachments/2498413/4291066/tauID-scale-factor-0829.pdf>
 - <https://indico.cern.ch/event/1186512/contributions/4988282/attachments/2487855/4272047/0801.pdf>
 - <https://indico.cern.ch/event/1163079/contributions/4889316/attachments/2448731/4196249/tauID-scale-factor-0523.pdf>

谢谢！