中国科学院高能物理研究所
Institute of High Energy Physics Chinese Academy of Sciences

Weekly report

Qiyu Sha

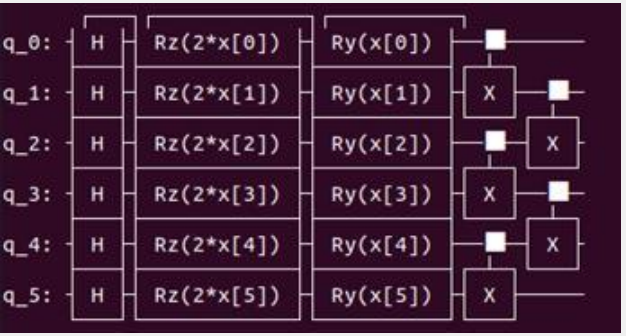
Quantum machine learning

IBM Machine: ibm_Nairobi
Simulator: use statevector.

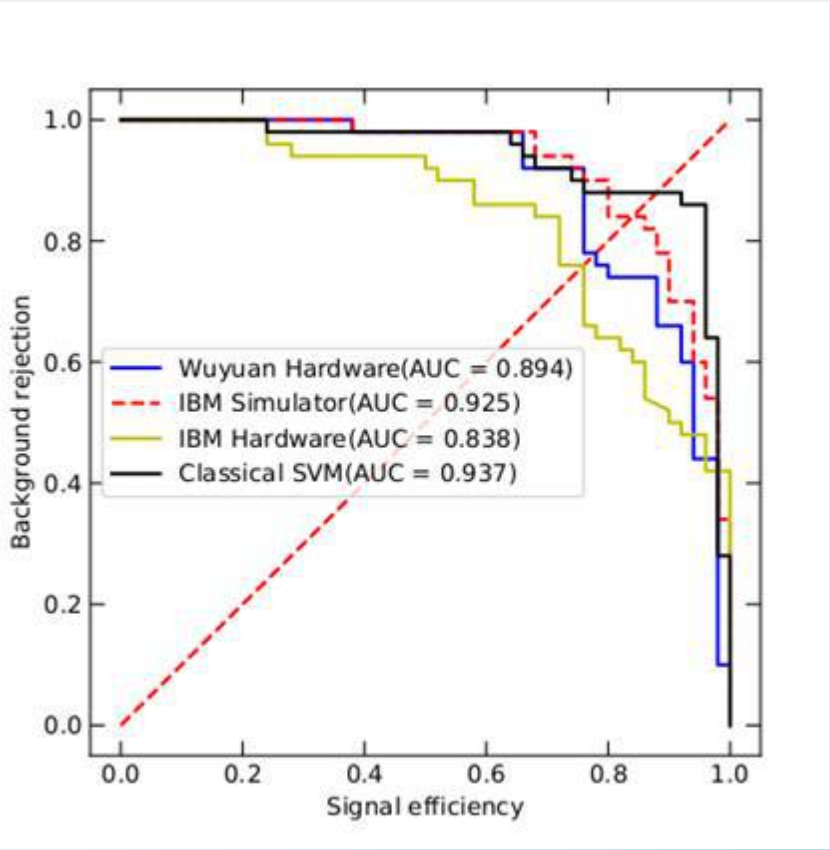
200 events(100 sig&100 bkg), 6 qubits(6 variables)

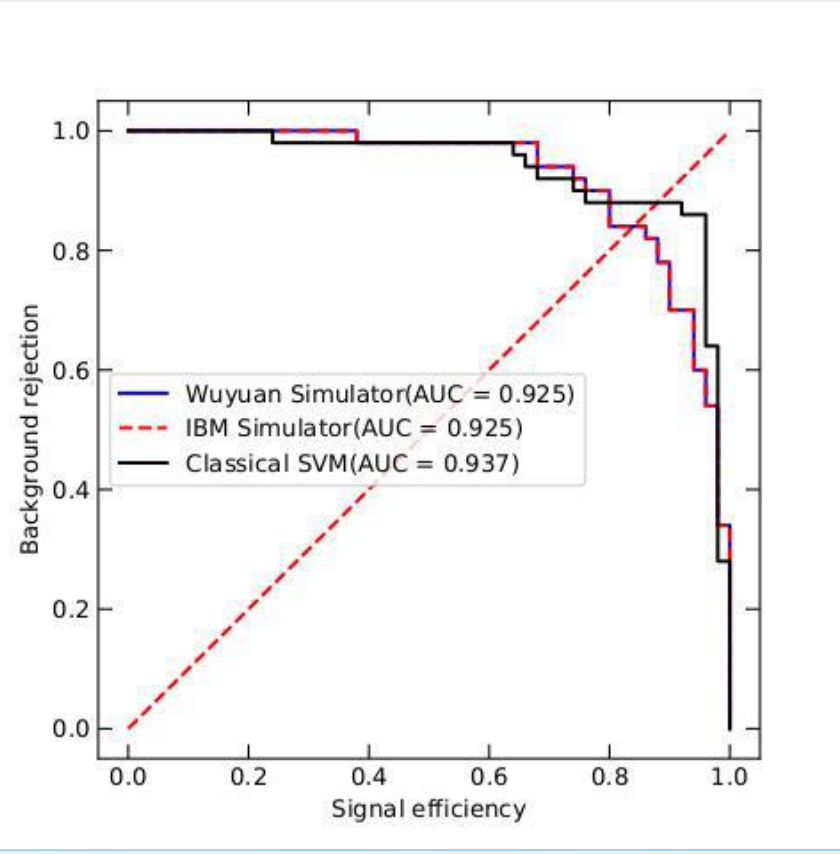
Svm&QSVM(IBM/wuyuan simulator/hardware) compare:

Feature map for QSVM:



Method	AUC value
SVM	0.937
IBM simulator	0.925
wuyuan simulator	0.925
IBM hardware	0.838
Wuyuan hardware	0.894



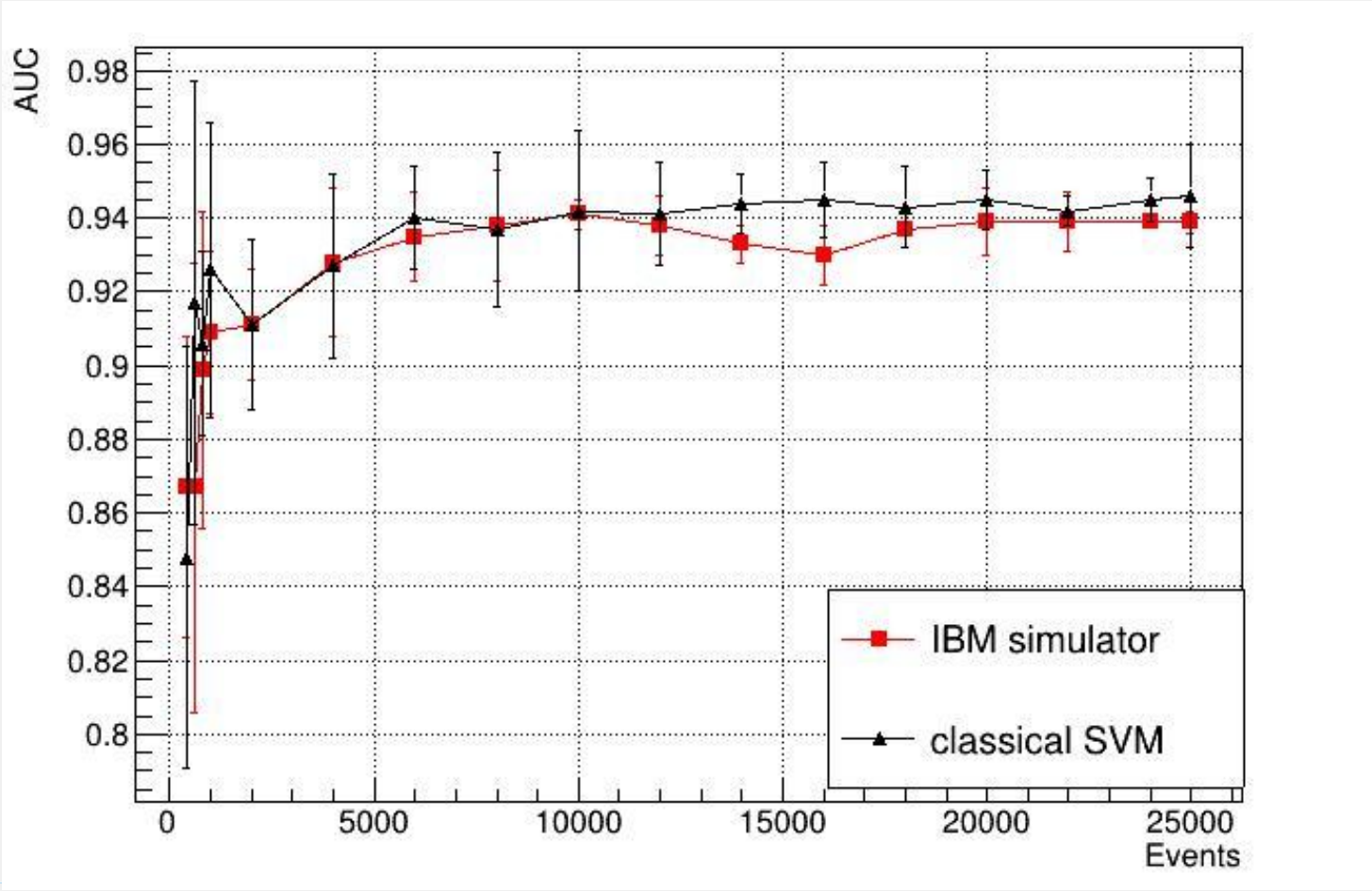


Quantum machine learning

Scan for best hyper parameters(use cross validation, 3 folds)

Svm: rbf kernel. Best C and value: (Half of events for training, and then apply these best parameters in the test dataset.)

scan	cv=3	
	SVM	
	C	gamma
100	9	0.1
200	5	0.1
400	24	0.1
600	3	0.1
800	8	0.05
1000	18	0.1
2000	36	0.1
4000	6	0.1
6000	4	0.1
8000	18	0.1
10000	9	0.1
12000	6	0.1
14000	8	0.1
16000	16	0.1
18000	22	0.1
20000	6	0.1
22000	24	0.1
24000	18	0.1
25000	14	0.1

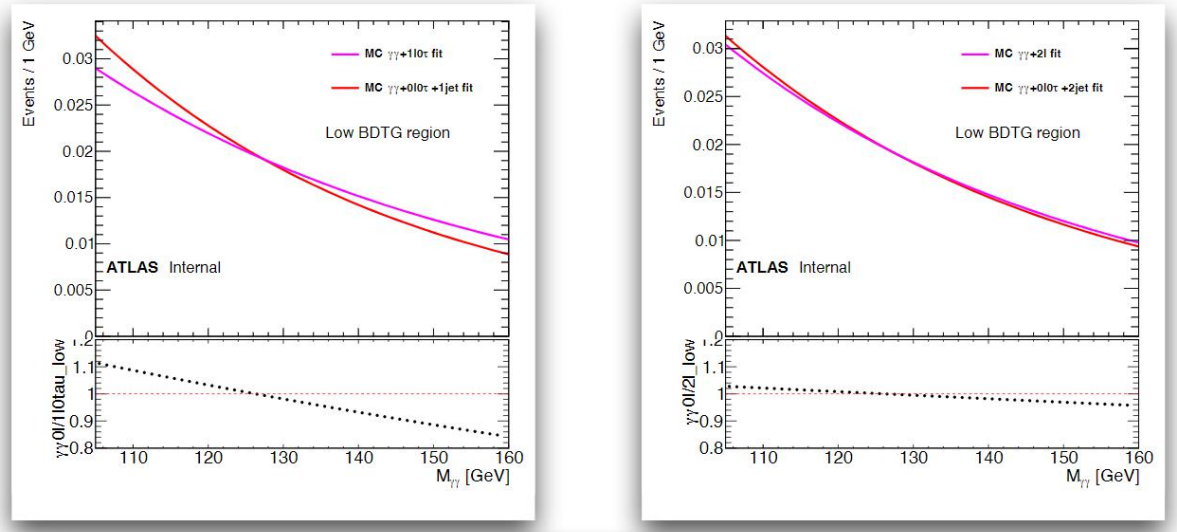


SVM finish the scan.
Working with QSVM scan now.

HH yy+multilepton-bkg modeling

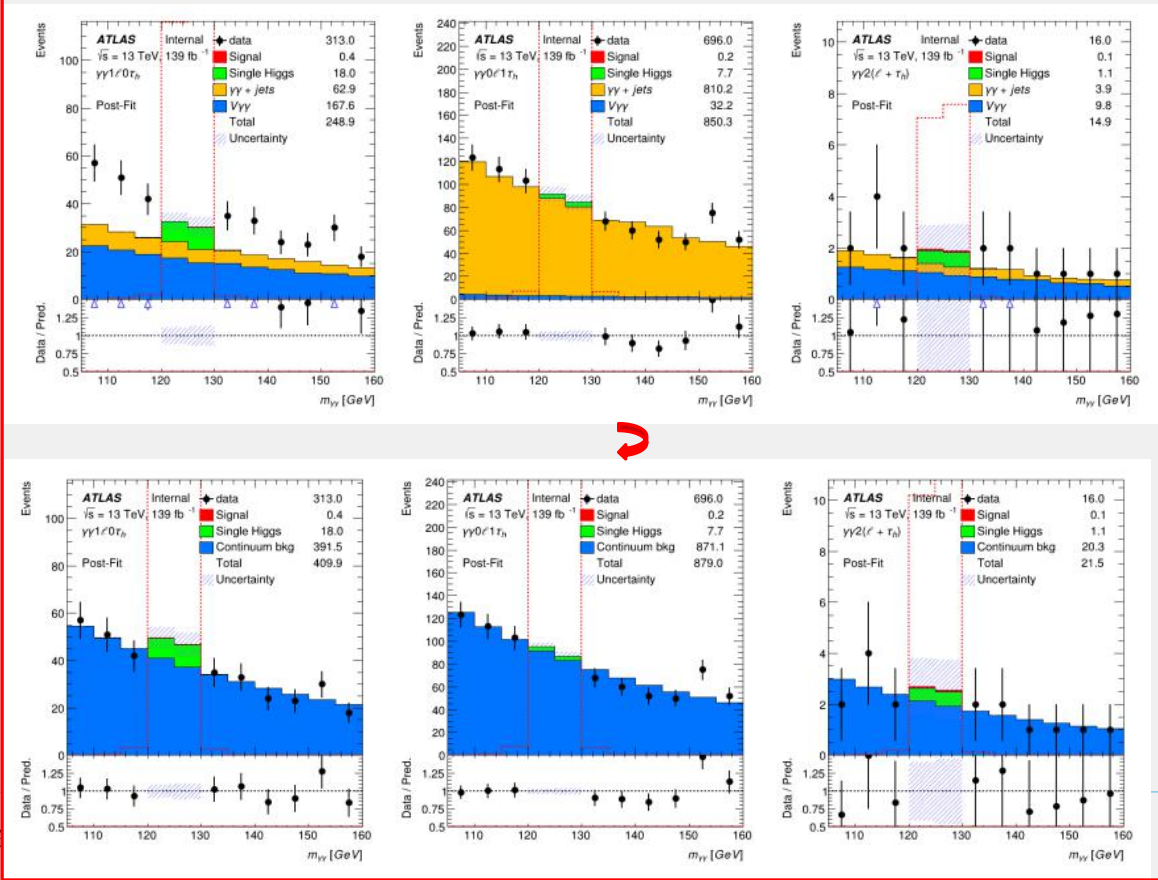
Use yy0l0tau+1/2 jets shape as yy1l/yy2l continue background (The exponential function with a 2th polynomial function is chosen).

The shape different as a systematic uncerntainty.



Channel	Low BDTG region	Medium BDTG region	Tight BDTG region
$\gamma\gamma$+1ℓ0τ_{had}	±2.34%	±2.76%	±2.09%
$\gamma\gamma$+0ℓ1τ_{had}	±1.83%	±2.77%	±2.34%
$\gamma\gamma$+2L	±1.74%	±2.55%	±2.68%

Before bkg modeling & After bkg modeling:



HH yy+multilepton-spurious signal

- Use signal+background model to fit a background only sample.
- Use histpdf to get the signal model and use a exponential function with a second-order polynomial as the background model.
- This fit can get the S_{spur}. Then do the test which shows below.

- $S_{spur} < 10\% N_{s,exp}$ where $N_{s,exp}$ is the expected number of signal events within the SM in cateogry ($\mu_{sp} = S_{spur}/N_{s,exp}$),
- $S_{spur} < 20\% \sigma_{bkg}$, where σ_{bkg} is the statistical uncertainty on the fitted number of signal events, when fitting the signal+background model to a background only Asimov dataset ($Z_{sp} = S_{spur}/\sigma_{bkg}$).

Qiyu Sha shaqiyu@ihep.ac.cn 5

HH yy+multilepton

	Function	Ndof	μ_{sp}[%]	Z_{sp}[%]	P(chi2) [%]	Result
1l0tau low	ExpPoly2	2	0.44	1.76	27.67%	pass
1l0tau medium	ExpPoly2	2	0.34	0.93	51.17%	pass
1l0tau tight	ExpPoly2	2	0.54	1.36	49.91%	pass

	Function	Ndof	μ_{sp}[%]	Z_{sp}[%]	P(chi2) [%]	Result
0l1tau low	ExpPoly2	2	1.75	8.30	15.80%	pass
0l1tau medium	ExpPoly2	2	0.47	1.27	39.06%	pass
0l1tau tight	ExpPoly2	2	0.17	0.39	41.27%	pass

	Function	Ndof	μ_{sp}[%]	Z_{sp}[%]	P(chi2) [%]	Result
2l low	ExpPoly2	2	0.037	0.078	97.18%	pass
2l medium	ExpPoly2	2	0.004	0.007	96.08%	pass
2l tight	ExpPoly2	2	0.045	0.037	97.12%	pass

Qiyu Sha shaqiyu@ihep.ac.cn

To do

- Scan best parameters for QSVM.
- Working with theory uncertainty.
- Try to use function to fit the signal shape(Use Hgam core and then redo the spurious signal.) (no urgent.)