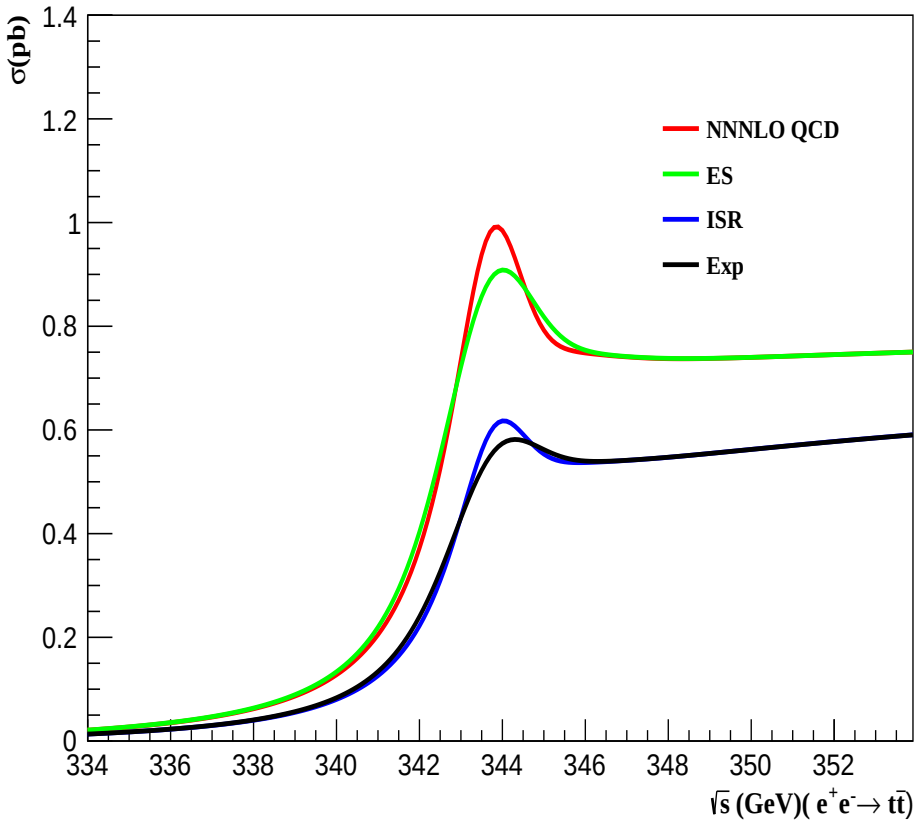
Top quark simulations near threshold at future CEPC

January 29, 2018

1. Minuit fitting:

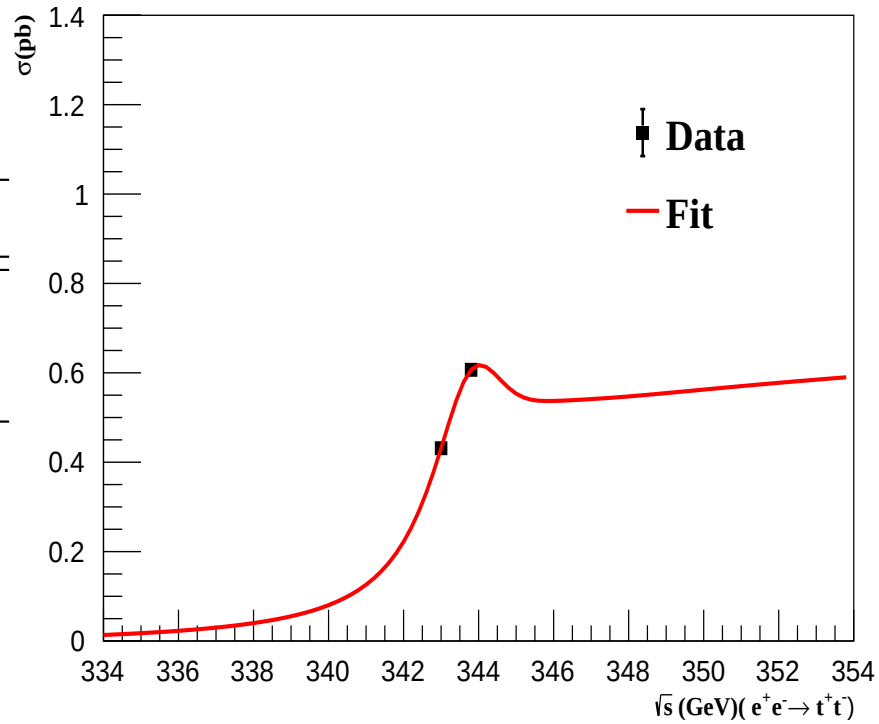
- The fitting is based on two parameters, top mass and top width.
- The changed point is the ISR, we use the new ISR function here.
- The Gaussian energy spread isn't included here.
- The initial values are taken: m_t=171.5 GeV, Γ_t=1.33GeV, α_s=0.1185.



the red line is xsection without ISR, the blue curve is xsection with ISR.

data(GeV)	luminosity(fb^{-1})
342.8	50.0
343.8	50.0

data-taken.



Two-parameter fitting with ISR

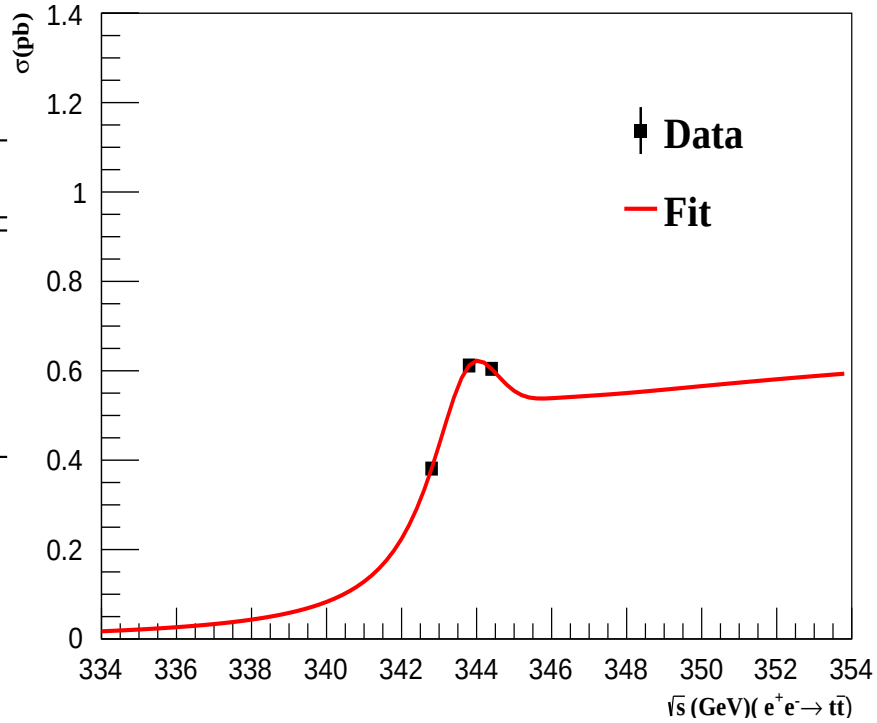
The results are:

cases	mt	width	δ_{mt}	δ_{width}
with ISR	171.500 GeV	1.308 GeV	5.3 MeV	12.9 MeV

- 3-parameters fitting:

data(GeV)	luminosity(fb^{-1})
342.8	33.33
343.8	33.33
344.4	33.33

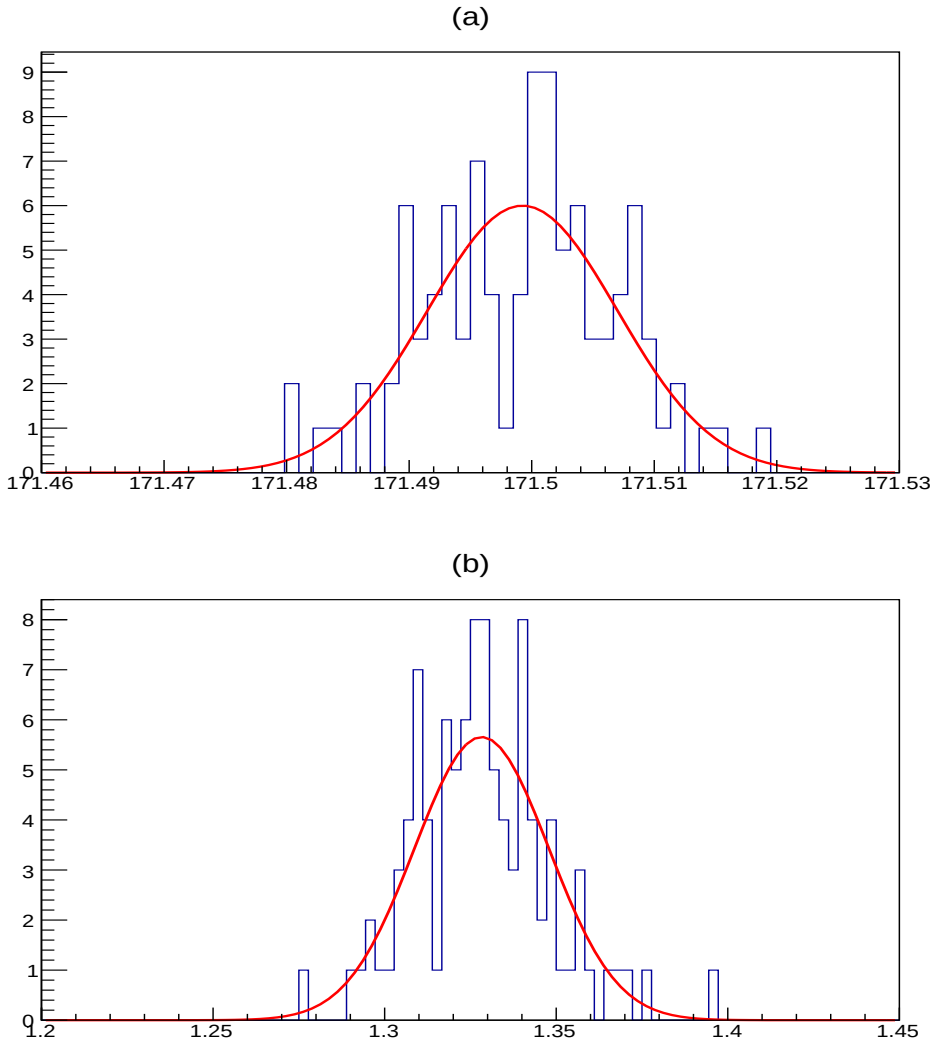
data-taken.



3-parameters fitting with ISR

results	mt	width	α_s
central value	171.526 GeV	1.371 GeV	0.1197
stat.err	16.2 MeV	37.2 MeV	0.0008

The sift of central value due to energy uncertainty(without ISR):



estimation of mass systematics,(a) is the top mass distribution and (b) is the top width distribution.

the results are:

parameters	mean(GeV)	sigma(MeV)
m_t	171.499	7.75857
Γ_t	1.32828	19.59

cross section

2. Btag cuts:

process	cross section(fb)	events
$E350.Ptt\_dtdtutdtutdt.e0.p0.whizard195$	43.252527	10000
$E350.Pzzz\_dddddd.e0.p0.whizard195$	0.040326517	100000
$E350.Pzzz\_uuuuuu.e0.p0.whizard195$	0.013213431	100000
$E350.Pzww\_utututdtutdt.e0.p0.whizard195$	1.4992257	5924

cross section

process	cross section(fb)	events
$E350.Ptt\_dtdtlvlv.e0.p0.whizard195$	11.656258	10000
$E350.Ptt\_dtdtutdtlv.e0.p0.whizard195$	45.566043	10000
$E350.Pzww\_lllvlv.e0.p0.whizard195$	0.58936780	100000
$E350.Pzww\_llutdtlv.e0.p0.whizard195$	2.2178931	100000
$E350.Pzww\_llutdtutdt.e0.p0.whizard195$	2.30305180	100000
$E350.Pzww\_ututlvlv.e0.p0.whizard195$	0.51962634	100000
$E350.Pzww\_utututdtlv.e0.p0.whizard195$	1.6540463	100000
$E350.Pzww\_vvlvlv.e0.p0.whizard195$	0.27943516	100000
$E350.Pzww\_vvutdtlv.e0.p0.whizard195$	1.0329543	100000
$E350.Pzww\_vvutdtutdt.e0.p0.whizard195$	1.0616599	100000
$E350.Pzzz\_ddddll.e0.p0.whizard195$	0.064563515	100000

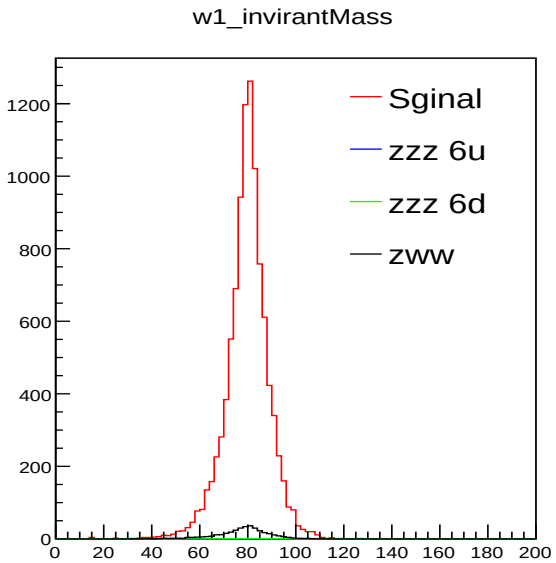
cross section

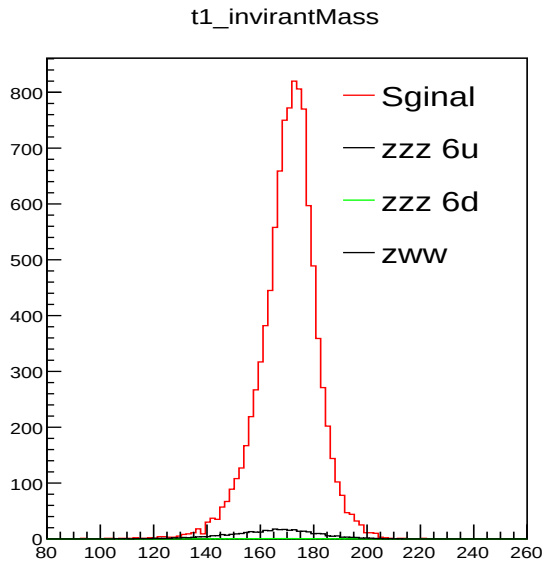
process	cross section(fb)	events
$E350.Pzzz\_ddddnn.e0.p0.whizard195$	0.06727436	100000
$E350.Pzzz\_ddllll.e0.p0.whizard195$	0.035538321	100000
$E350.Pzzz\_ddnnnn.e0.p0.whizard195$	0.034468349	100000
$E350.Pzzz\_llllll.e0.p0.whizard195$	0.011159665	100000
$E350.Pzzz\_nnnnnn.e0.p0.whizard195$	0.054654329	100000
$E350.Pzzz\_uullll.e0.p0.whizard195$	0.033171327	100000
$E350.Pzzz\_uunnnn.e0.p0.whizard195$	0.024068653	100000
$E350.Pzzz\_uuuull.e0.p0.whizard195$	0.035005353	100000
$E350.Pzzz\_uuuunn.e0.p0.whizard195$	0.031984135	100000

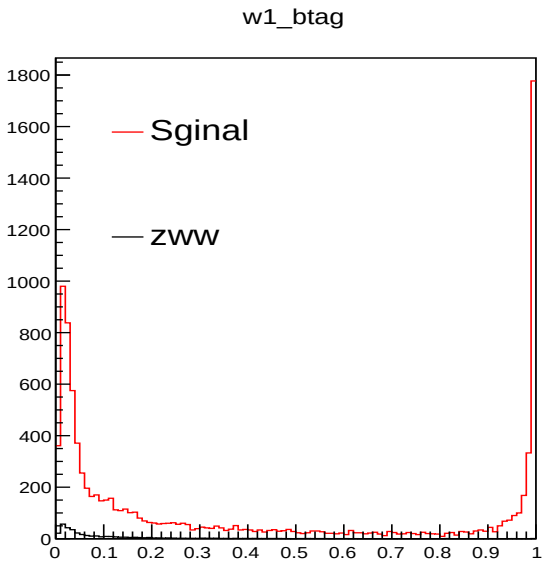
cross section

The normalization rule:(L is the luminosity and N donates the events number)

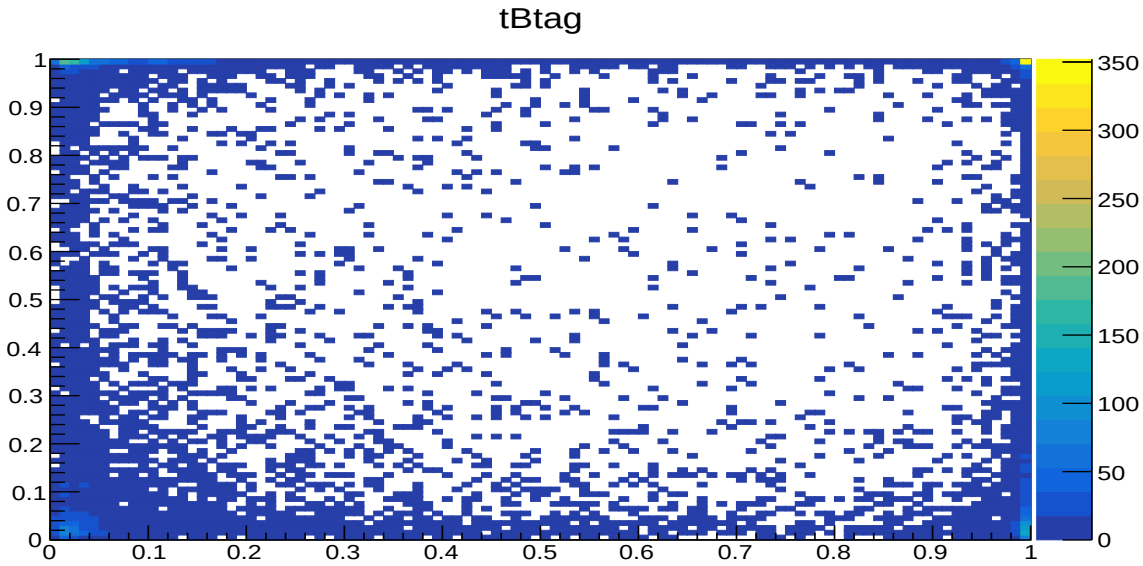
$$\frac{N_{signal}}{\sigma_{signal} \times L_{signal}} = \frac{scale \times N_{backgrounds}}{\sigma_{backgrounds} \times L_{backrounds}}$$

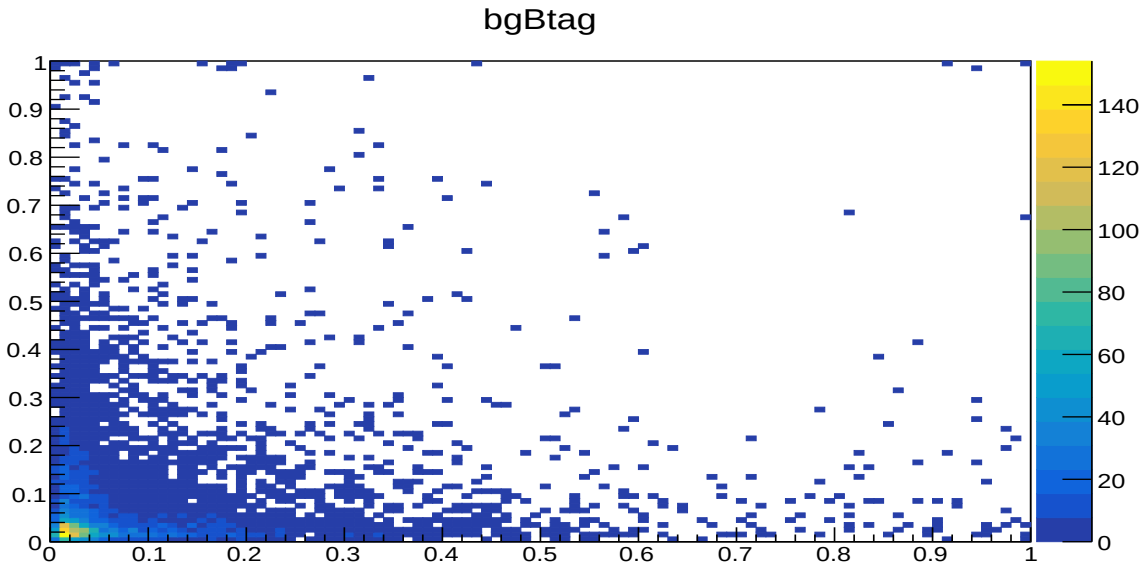






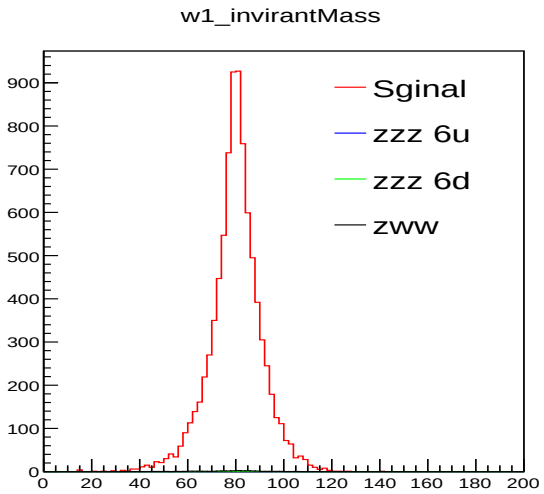
without cut, only zww channel(dominative)

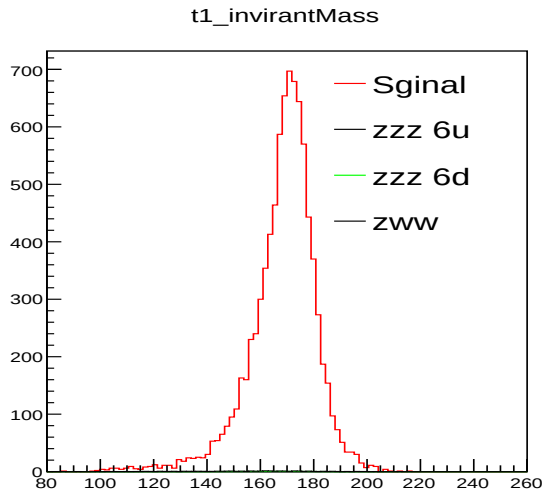


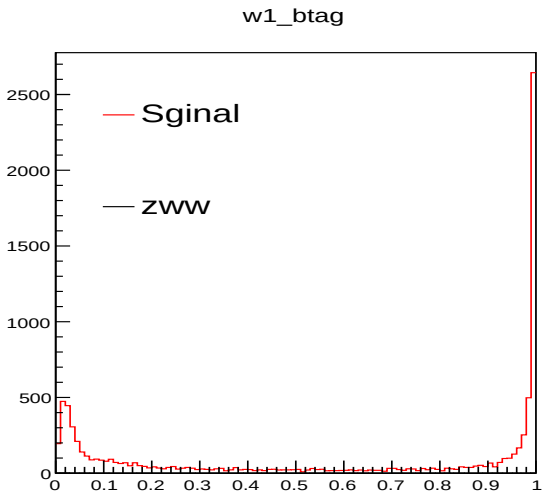


without cut, only zww channel(dominative)

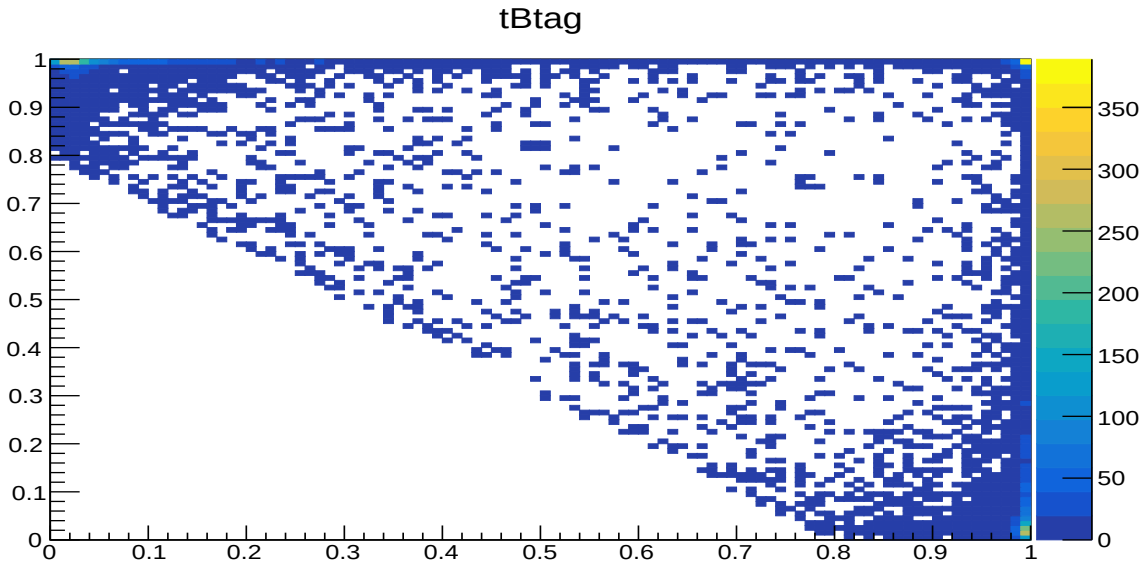
After cutting:

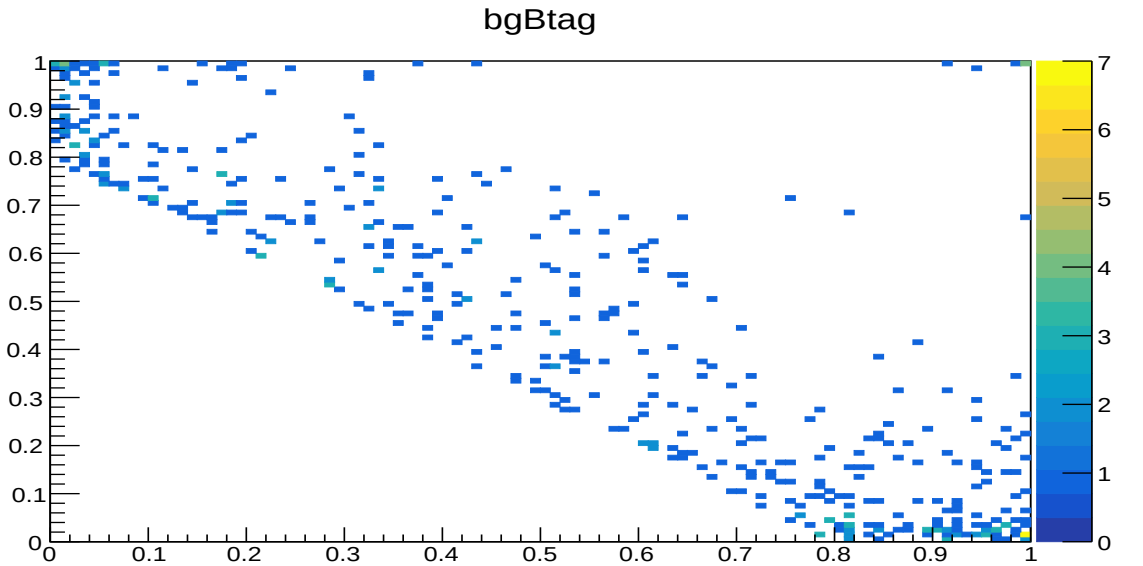






$$btag1 + btag2 \geq 0.8$$





$$btag1 + btag2 \geq 0.8$$

The results of 2-dimensions btag cutting:

cuts	signal	zww	6u	6d	Significance	Purity
none	10000	347	3	9	98.252	0.965345
$btag1 + btag2 \geq 0.8$	8684	29	0	6	93.0017	0.996006

3. Cross sections check

In Standard model:

ECM	eewwbb	eewwbb(ISR)	6-quarks	6-jets
350 GeV	222.702 fb	148.541 fb	43.252527 fb	112.099 fb

A difference of 36.442 fb, tree level, ISR considered!

It is understandable!

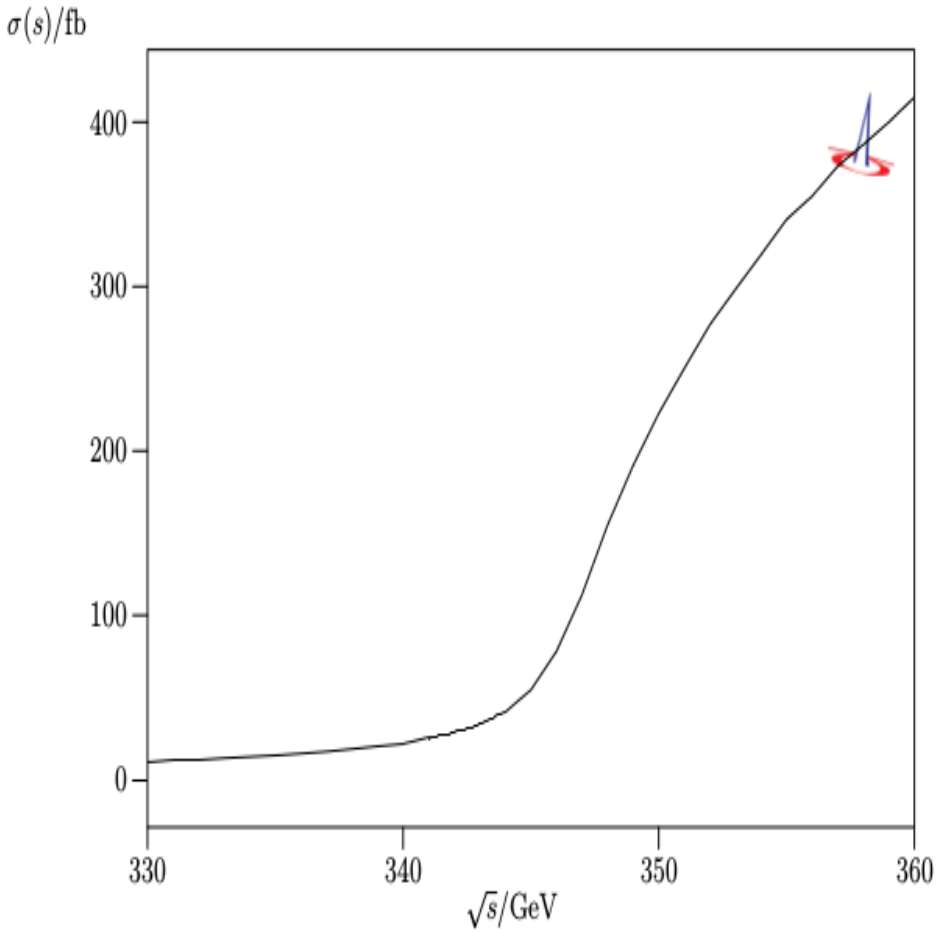
Comparison of parameters:(the width effects of top,Z,W can not be dropped)

parameters	SM	SM_CKM
m_t	173.2 GeV	174 GeV
Γ_t	1.523GeV GeV	1.523 GeV
m_z	91.1876 GeV	91.1882 GeV
Γ_z	2.4430 GeV	2.5060 GeV
m_w	80.385 GeV	80.419 GeV
Γ_w	2.0978 GeV	2.049 GeV
m_b	4.2 GeV	0 GeV
G_f	1.16639×10^{-5}	1.16639×10^{-5}

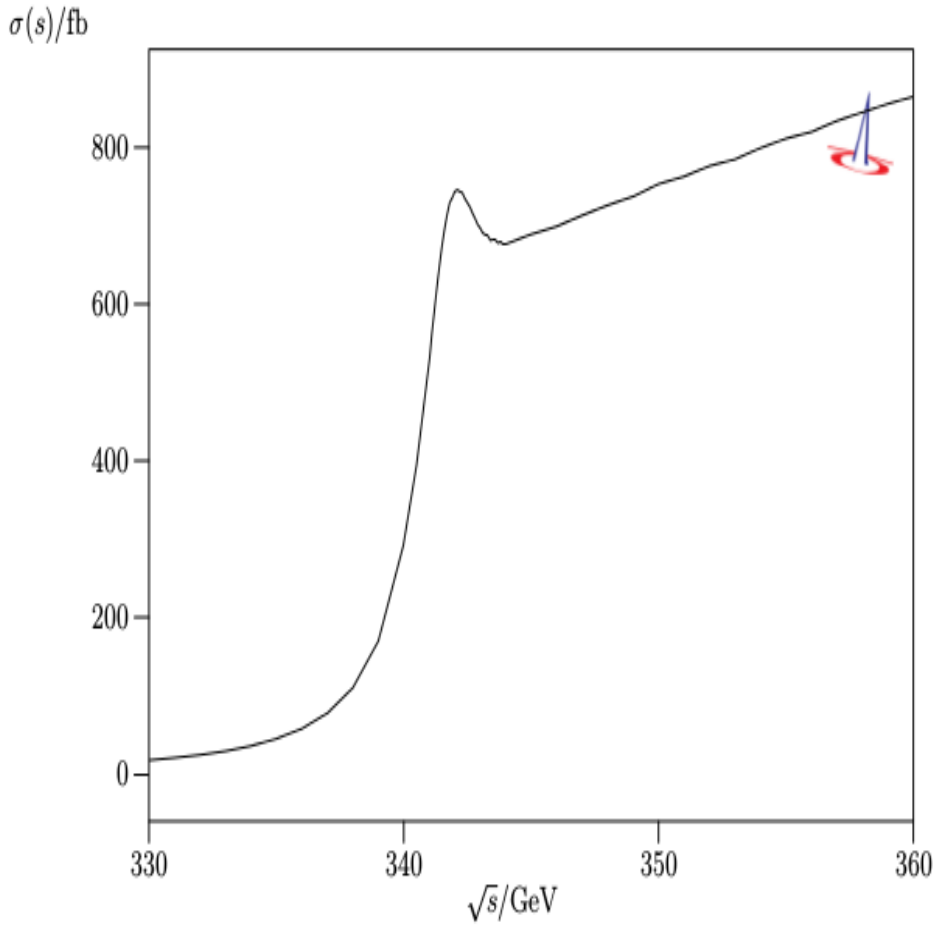
In addition, we find:(generated by MadGraph5)

Model	SM	SM_CKM
feynman diagrams	61	126

The difference between Stand Model and top pair threshold model:

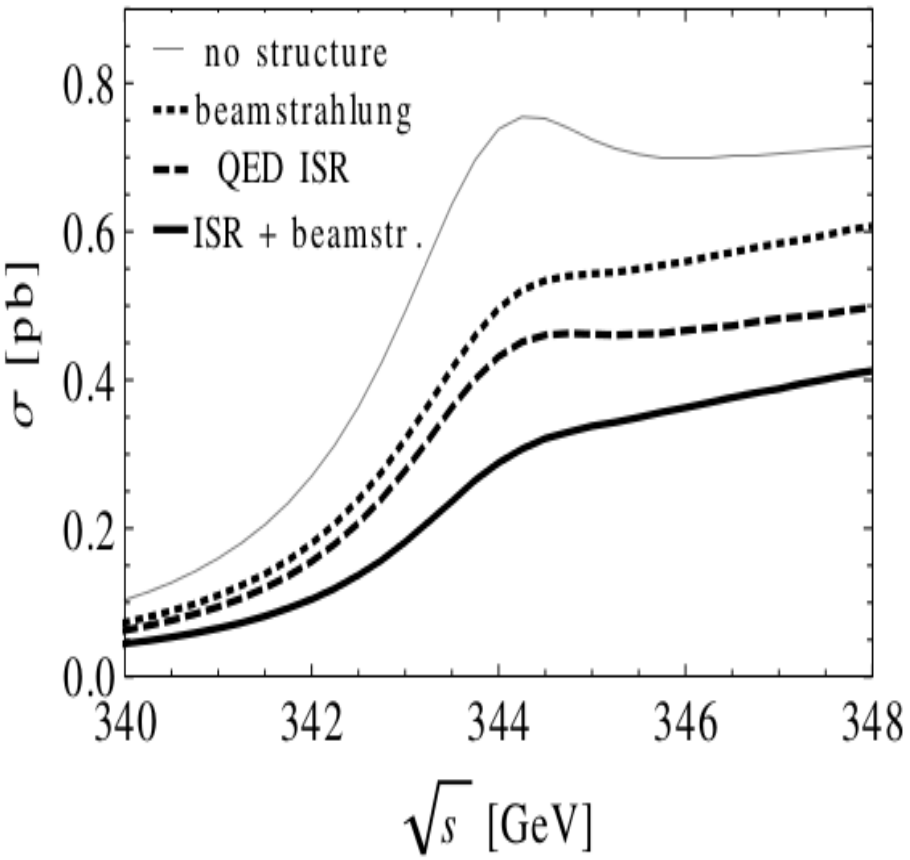


SM results

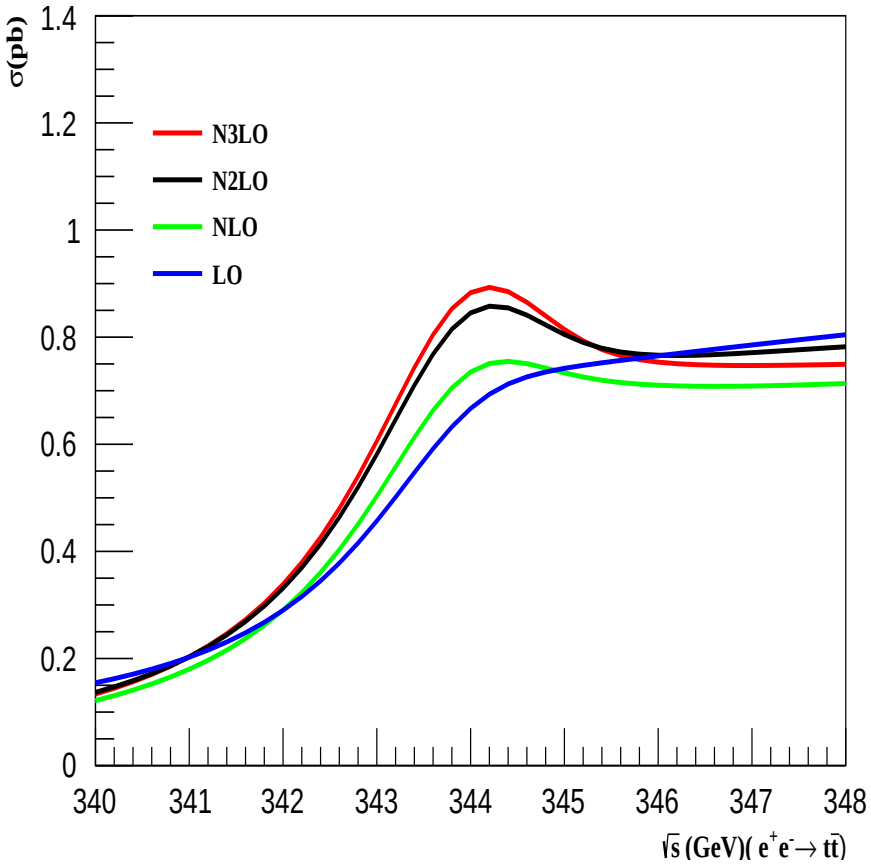


top pair threshold model

Whizard vs QQbar_threshold code:



Whizard xsection at NLO QCD, arXiv:1411.7318v2[hep-ph]



QQbar_threshold code

Summary:

- More than 90% backgrounds are rejected.
- QQbar_threshold code coincides with Whizard in top pair threshold model.
- In Whizard, the cross section of top pair threshold model is larger than SM at tree level.