Measurement of Standard Model Higgs boson decay to $\mu^+\mu^-$ at CEPC

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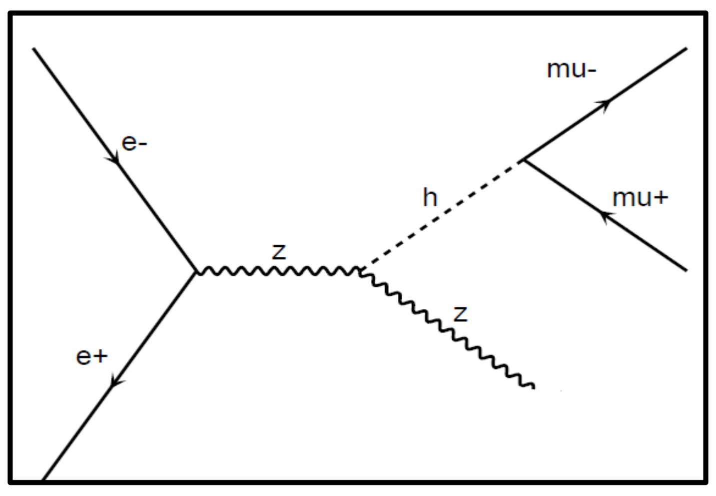
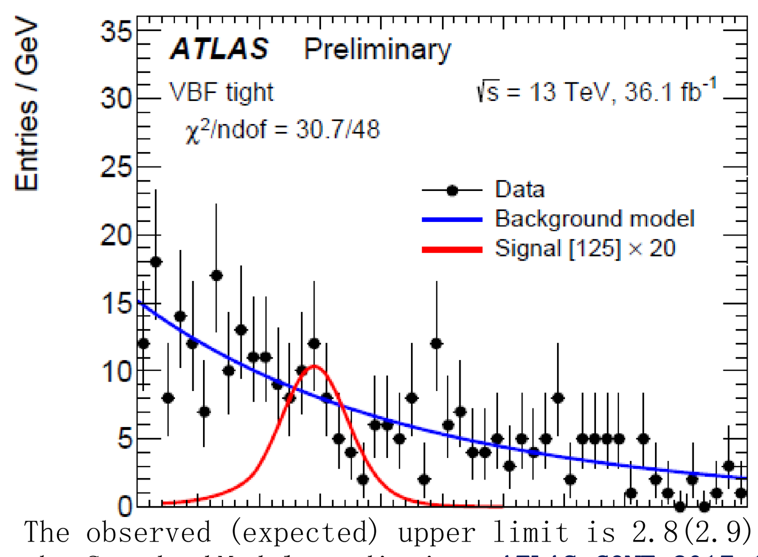
• Introduction

it is very difficult while quite interesting to measure Higgs coupling to second generation particles. The most updated direct probe on $H \to \mu^+\mu^-$ from ATLAS experiment set upper limit on the cross-section times the branching ratio as 2.8 times the Standard Model prediction. For the future experiments, the projects are as following:

Detector	Signal	luminosity(fb^{-1})	$\sqrt{s}$ (TeV)	Significance or Precision
ATLAS projection[1]	ggH+VBF+ VH+ttH	300	14	2.3
		3000	14	7
CMS projection[2]	0/1-jets(μμ) VBF(jj+μμ)	300	14	Uncertainty [40,42](%)
		3000	14	Uncertainty [20,24](%)
ILC[3,4]	vvH	500	1	2.75
	qqH	250	0.25	1.1
	vvH	250	0.25	1.8

1. ATL-PHYS-PUB-2013-014 2. CMS-NOTE-13-002 3. arXiv:1603.04718 4. SiD Letter of Intent，arXiv:0911.0006





The observed (expected) upper limit is 2.8(2.9) times the Standard Model prediction. ATLAS-CONF-2017-14

- The Circular Electron-Positron Collider (CEPC), proposed by the Chinese particle physics community, is one such possible facility. CEPC will operate at a center-of-mass energy of $\sqrt{s}\sim$ 250 GeV that maximizes the Higgs production cross section through the $e^+e^- \to ZH$ process. At the CEPC, in contrast to the LHC, Higgs candidate events can be identified through the **recoil** mass method without tagging its decays. Therefore, Higgs production can be disentangled from Higgs decay in a model-independent way. Moreover, the cleaner environment at a lepton collider allows much better exclusive measurement of Higgs decay channels. All of these give CEPC impressive reach in probing Higgs properties.

•Samples

- Analysis based on full simulations at $\sqrt{s}$= 250 GeV CEPC
- Integrated luminosity in 10 years: 5000 fb-1

Signal: $e^-e^+ \to ZH,\ H \to \mu^+\mu^-$

Backgrounds:
2f(ee, $\mu\mu$, $\tau\tau$, qq)
4f(ZZ, WW, ZZorWW, SZ)

- Generator: WHIZARD v1.95 .
- Simulation: MOKKA with CEPC conceptual detector design, containing silicon vertex and tracking system, TPC tracker, ultra high granularity calorimeter system and a strong solenoidal magnetic field of 3.5 Tesla.
- Reconstruction: Arbor version3, an efficient particle flow algorithm

• Summary

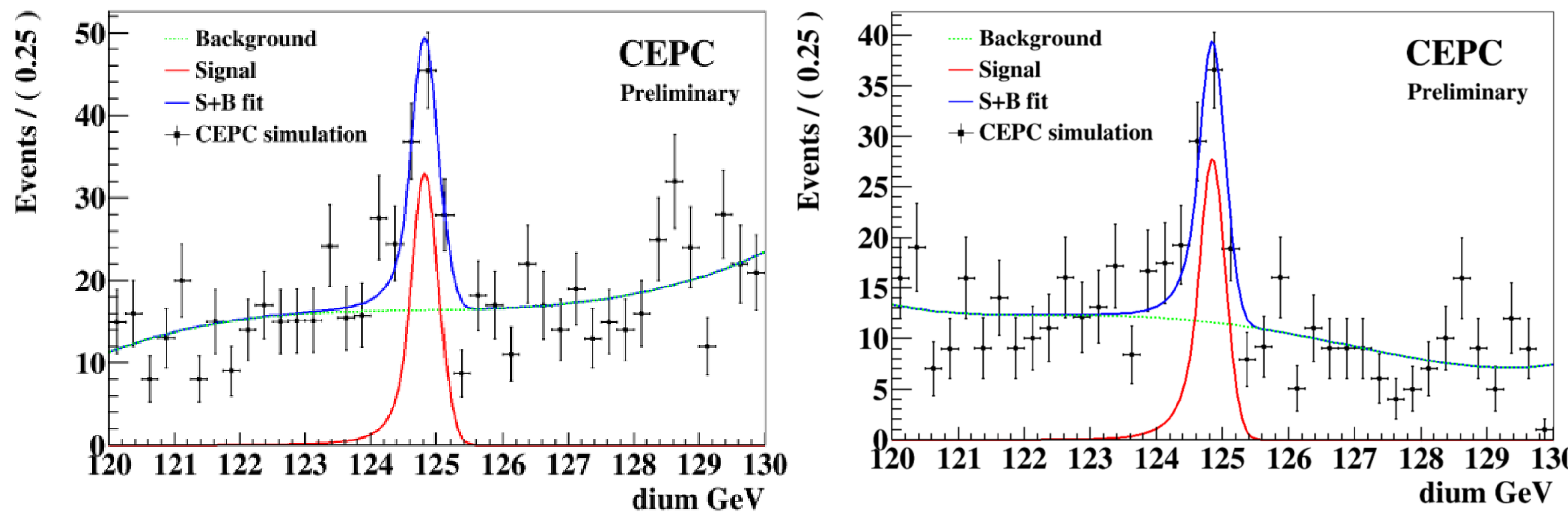
CEPC is expected to observe $H \to \mu^+\mu^-$ with a significance of 7.7σ with inclusive analysis, and 8.2σ in Z → qq channel. The couplings can be constrained within 10% level of SM predictions. Optimizations on magnetic field and Tracker are also provided.

•Inclusive analysis

- Cut-based

Category	signal	ZZ	WW	ZZorWW	SingleZ	2f
Preselection	207.3	311312	129869	501590	63658	1740371
120<dium<130	189.7	5479	17126	57405	1868	52525
90.8<recoilu<93.4	118.4	1207	868	2115	164	1157
25<diupt<62.4	109.5	951	697	1675	121	439
-55.2<diupz<55.2	107.1	897	647	1613	112	391
cosum<0.28	69.7	480	55	277	55	164
cosup>-0.28	58.3	348	29	142	44	116
puu>-0.996	58.0	346	27	142	43	70
efficiency	28.0%					

- MVA(BDTG) :muon momentum and angles



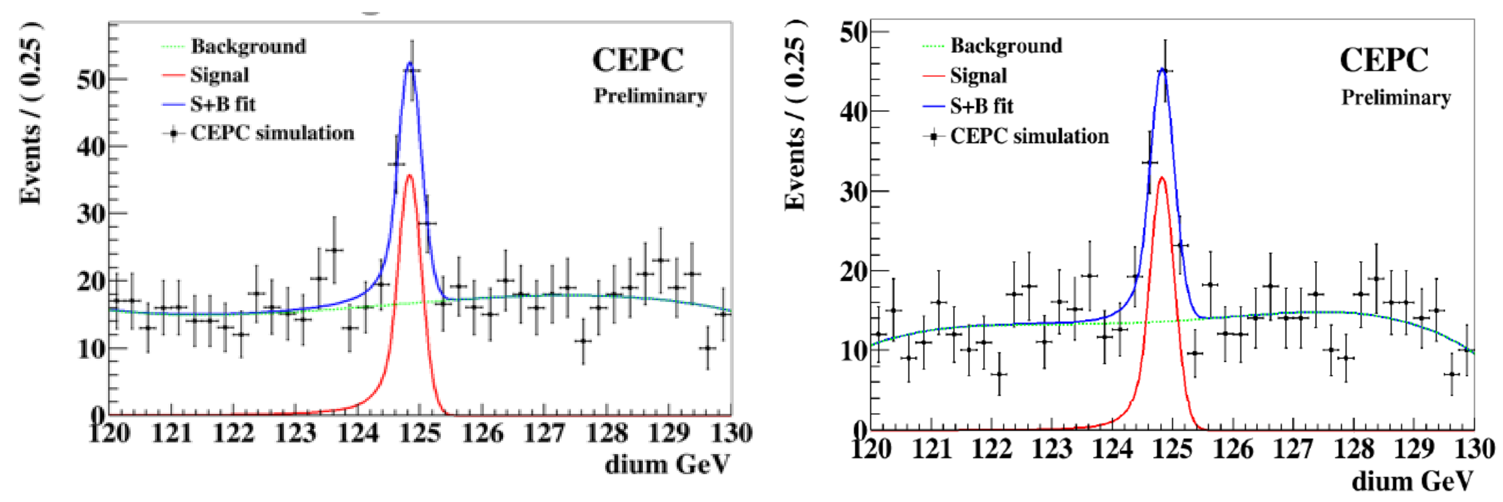
Fit result with cut-based(left) and MVA(right)

•ZqqHuu analysis

- Cut-based

Category	signal	ZZ	WW	ZZorWW	SingleZ	2f
Preselection	207.3	390775	183751	463361	101164	0
120<invariant mass<130	141.6	3786	181	227	244	0
jet1m<4.2 jet2m<2.8	133.0	3216	111	0	9	0
dijm>76.0	127.5	2917	2	0	8	0
90.9<recoilu<93.5	78.7	893	0	0	0	0
20<diupt<62.3	74.9	743	0	0	0	0
-58<diupz<58	74.2	714	0	0	0	0
cosup>-0.94	73.0	691	0	0	0	0
cosum<0.94	71.6	665	0	0	0	0
efficiency	50.6%					

- TMVA step1 (MLP): jet1m,jet2m,dijm,recoilj
  step2 (BDTG): cosum, cosup, upZ, umZ, diupz,dijpz, j1H, j2H, cosj1,cosj2

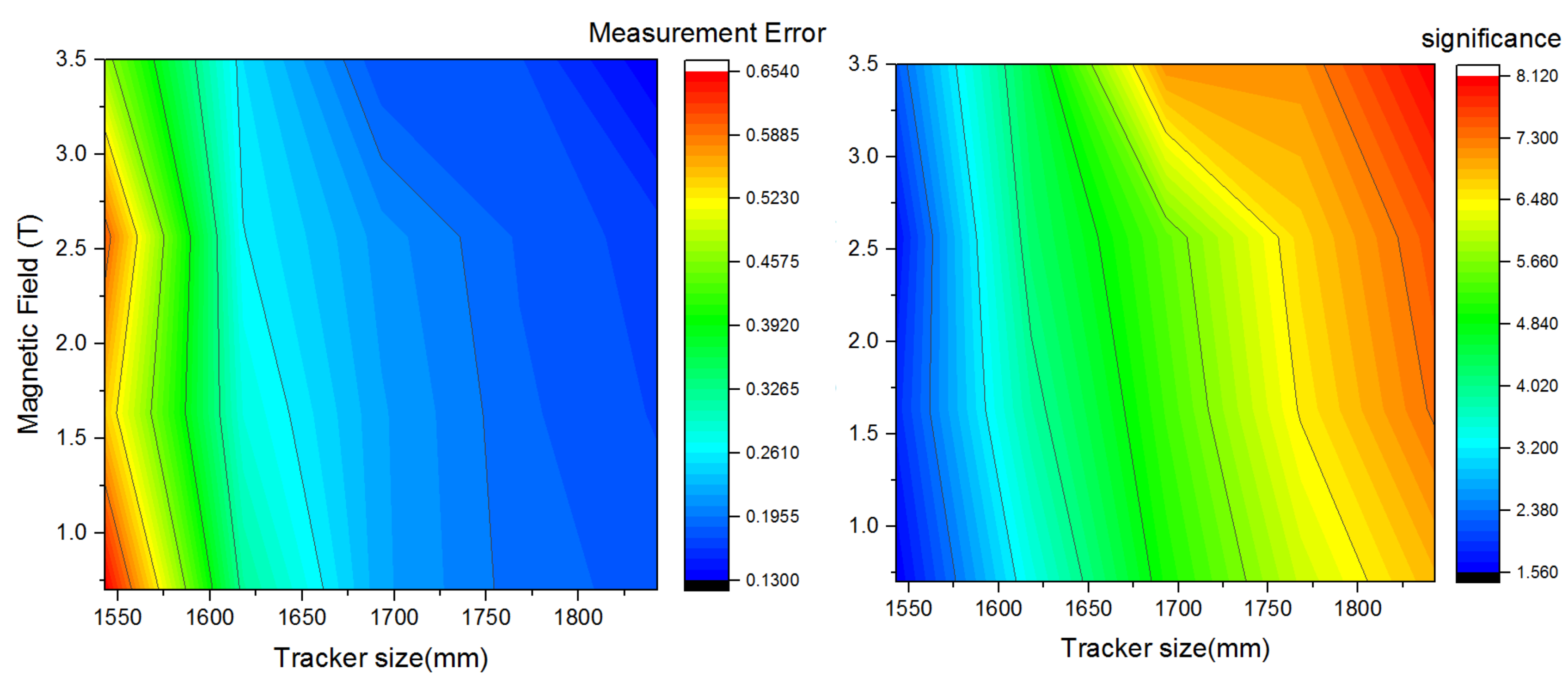


Fit result of cut-based (left) and MVA(right)

Significance	Inclusive	Z → qq	Z → vv
MVA	7.37	8.17	2.62
Cut	7.67	8.12	1.91

Signal: CBShape, BKG: Chebyshev

• Optimization on Magnetic Field Strength and Tracker size (Z → qq channel)



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