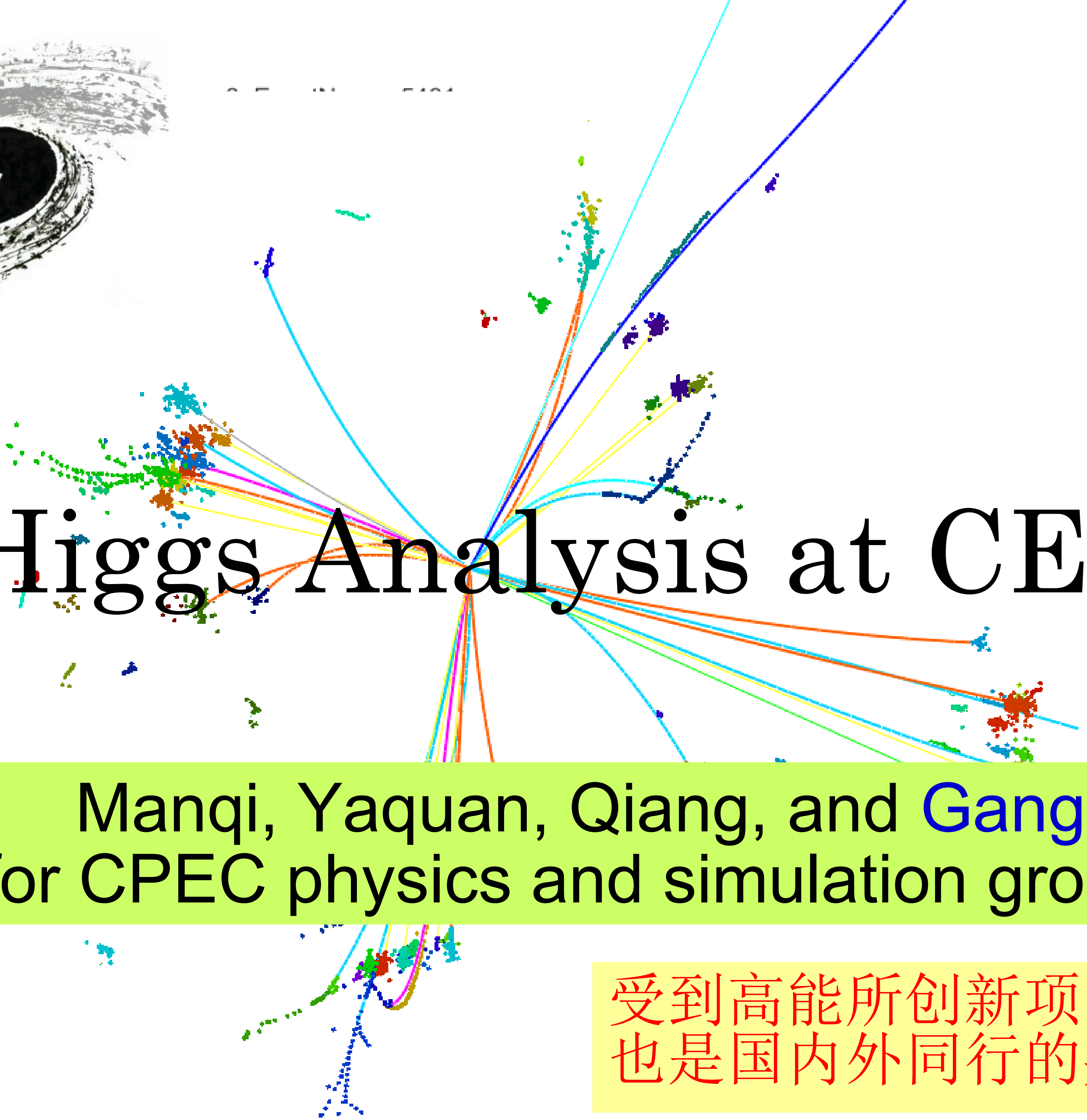


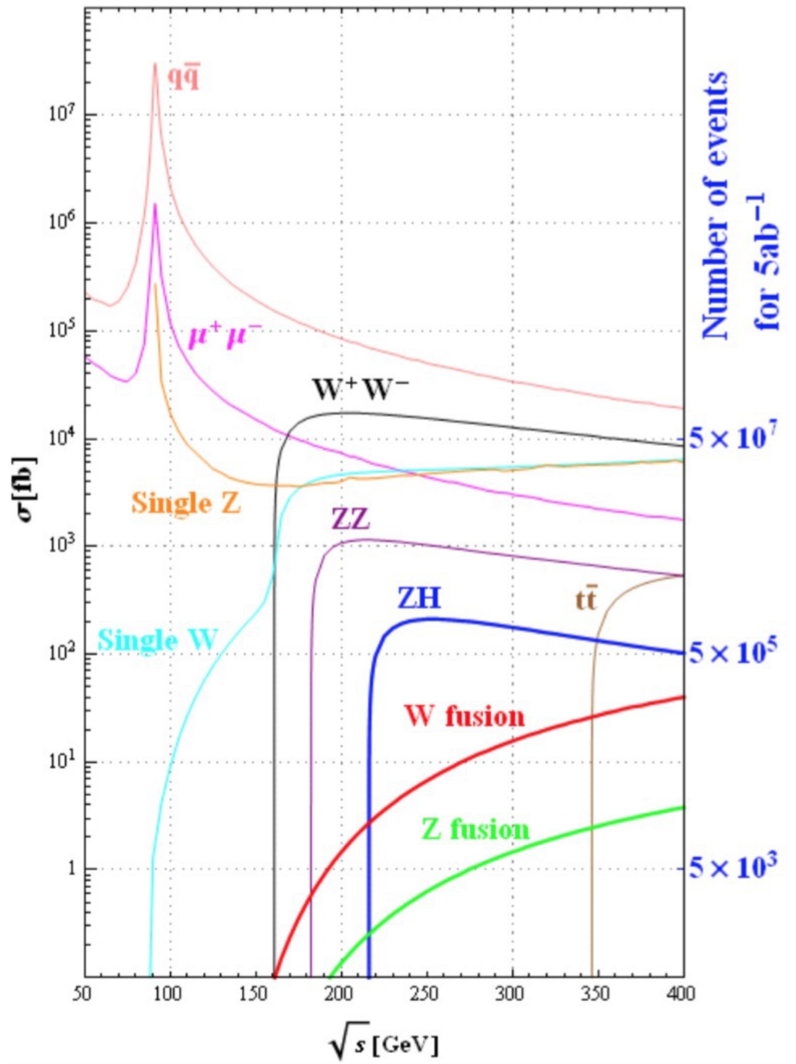
Higgs Analysis at CEPC

Manqi, Yaquan, Qiang, and Gang
for CPEC physics and simulation group

受到高能所创新项目的支持
也是国内外同行的共同努力

At CEPC

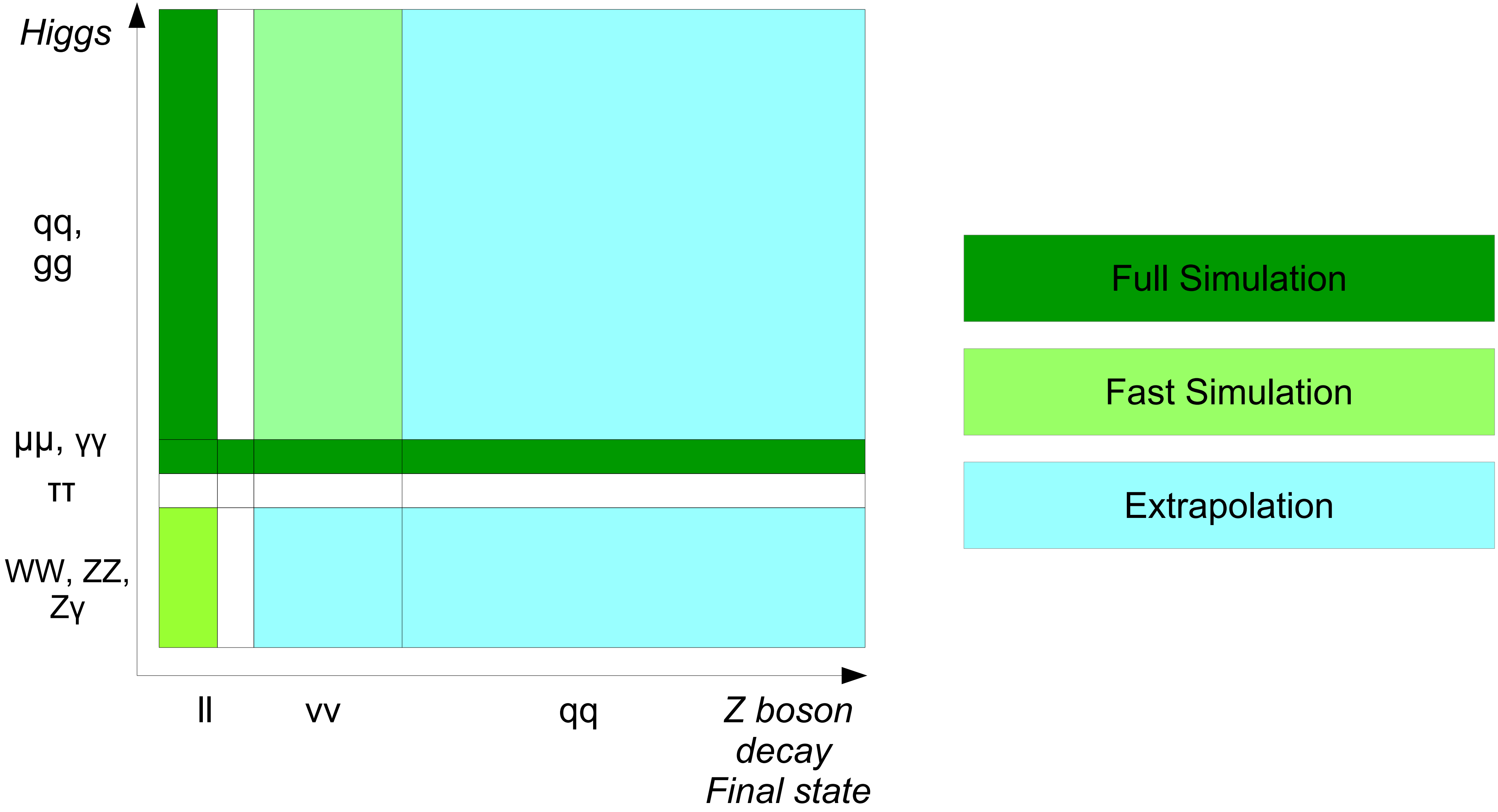
- Higgs Run: 10 years, 1 M Higgs boson in 1 B physics events
- Z Pole Runs: 10 Billion Z bosons (1 year)
- Perfect understanding of the nature of Higgs boson, precision EW measurements, and probe for NP...



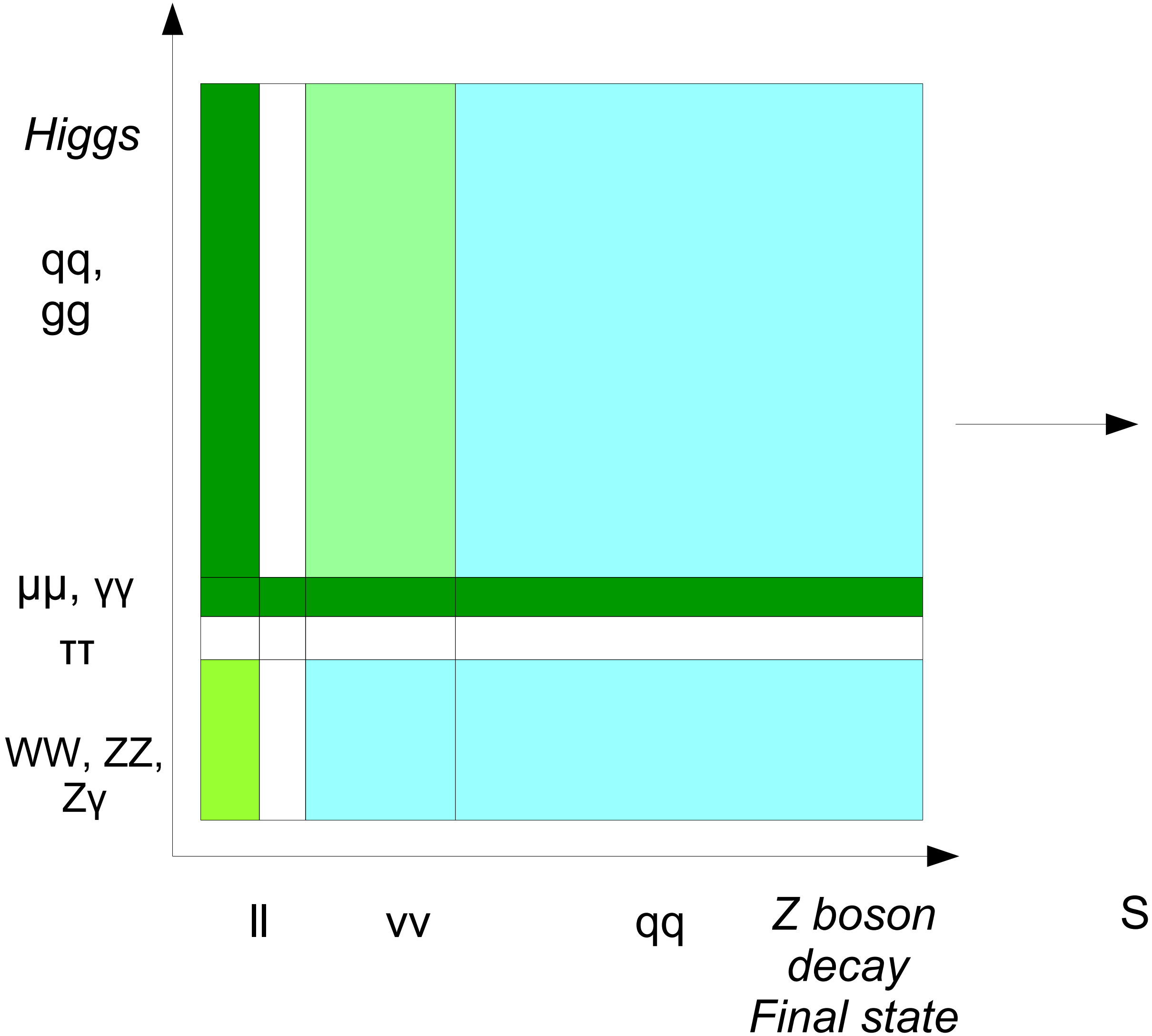
Higgs program at CEPC

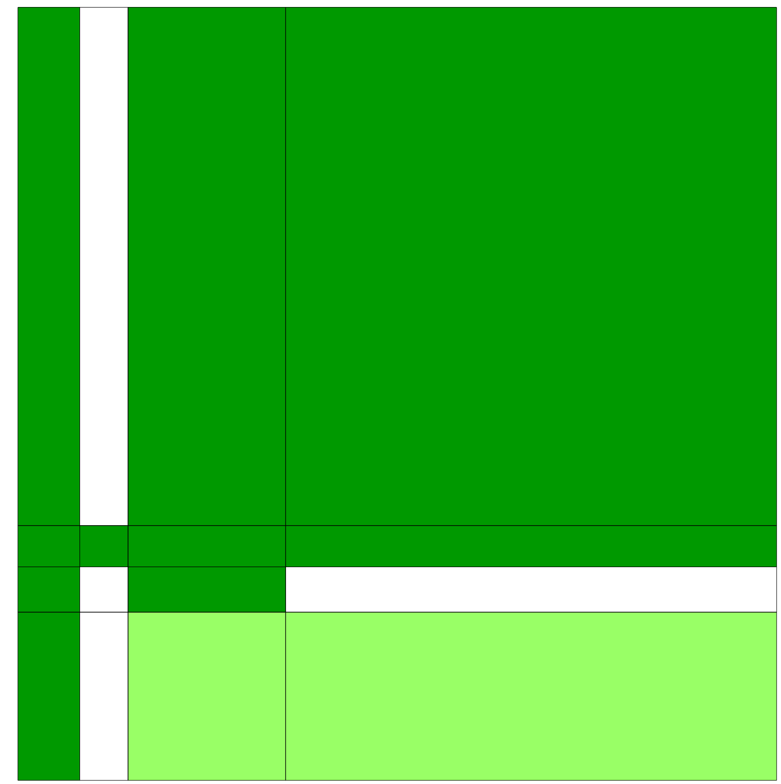
- **Absolute** Higgs measurements
- Benchmark measurements
  - sigma(ZH) determination
  - Higgs width measurement: Yuqian's talk
  - H->bb, cc, gg: see Baiyu's talk
  - Higgs exotic
    - Invisible
    - Hadronic state
    - Leptonic final state
- Next step:
  - Data driven method for sys. control? MC/theoretical uncertainties, ...
  - Differential distributions

Higgs analysis: Status at PreCDR



preCDR -> present





Significant progress had been made on
Br(H->bb, cc, gg)
Br(H->WW, ZZ)
Br(H->exotic)
Br(H->di tau, di muon)
Measurements

σ(ZH)*Br(H->bb, cc, gg)

- Strategy: Event selection + Template fit on the b-likeness Vs c-likeness plane
- 4 independent channels: Signal & Key background processed with Full Simulation

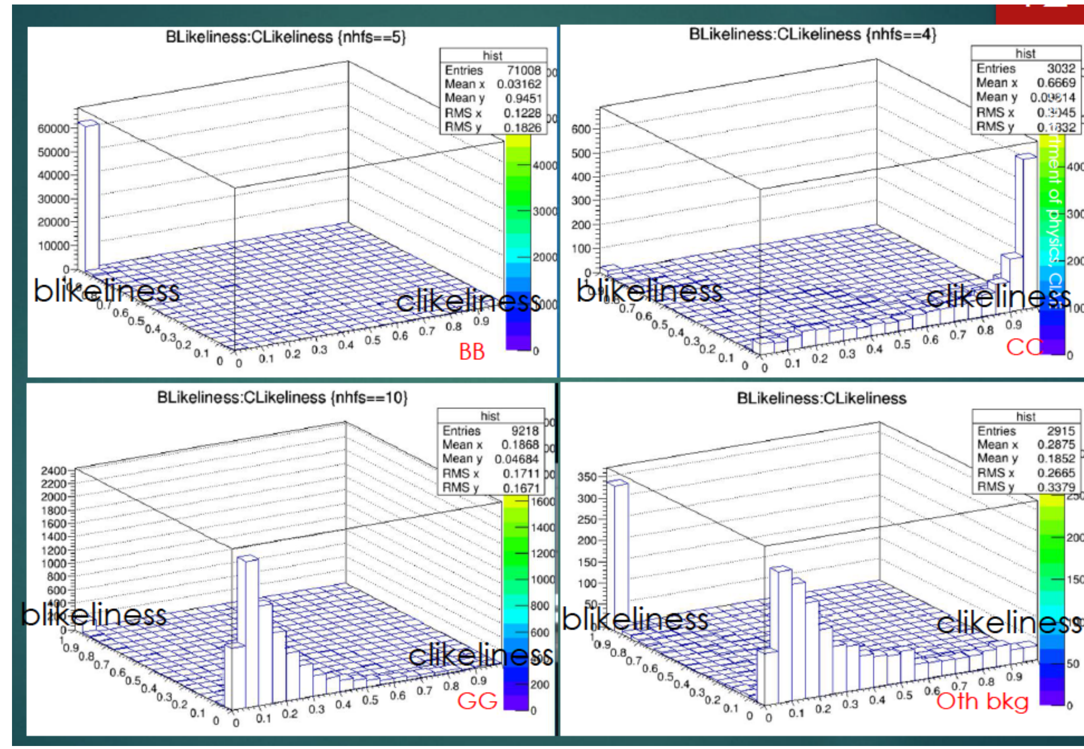
	Analyzer	bb	cc	gg	
mumuH	Zhenxing, etc	0.96%	13.5%	11.6%	
		0.96%	11.0%	8.73%	
eeH					
tautauH					
vvH	Lianghao, Yulei, Dikai	0.38%	3.5%	2.4%	Notes submitted
qqH	Baiyu, Boyang, etc	0.27%	4.4%	3.0%	Notes submitted
Comb. opti		0.21%	2.5%	1.7%	
Result at PreCDR		0.28%	2.2%	1.6%	

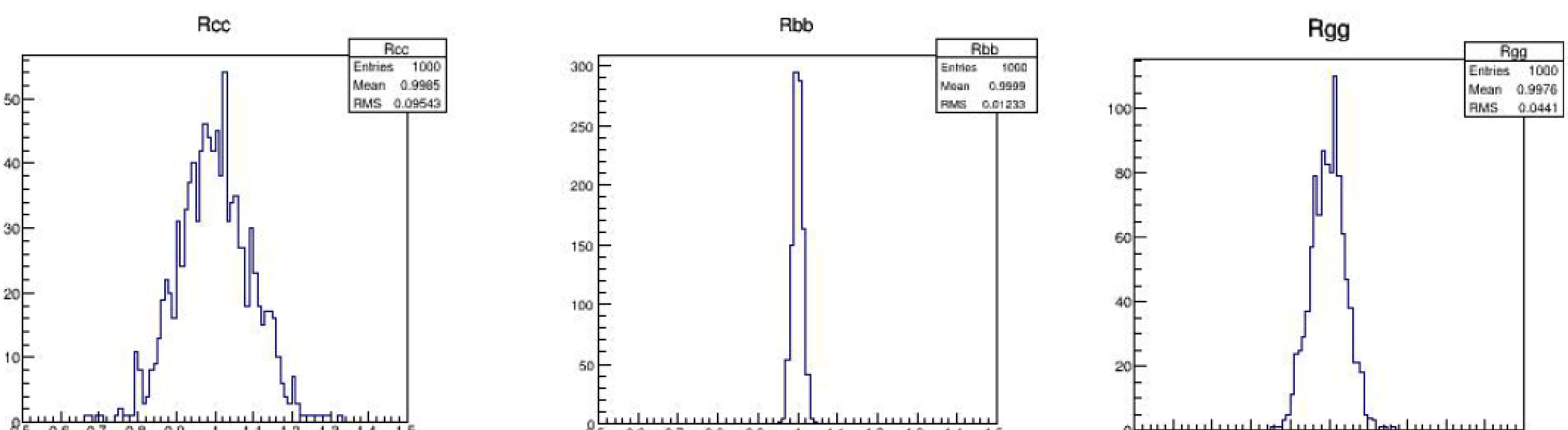
σ(ZH)*Br(H->bb, cc, gg)

- Key points
  - uuH: different template fit technologies to be compared and understood
  - qqH:
    - Complex analysis:
      - Jet clustering algorithm,
      - Hard gluon emission & jet correlation
      - Matching
      - Systematic control
  - eeH & tautauH: to be covered
  - All channels: distinguish between H->gg and H->WW/ZZ->4 jets still challenging!

vvH

Cut Definition	*Sig.*	*qq*	*qqnn*	*qqln*	*nnh*
Generated	16260	25M	183K	3681K	
FSClasser output	16768	25M	183K	3681K	7485
$N_{\mathrm{PFO}(E>0.4\mathrm{GeV})} > 20$	16748	23M	163K	3439K	4889
$110 < E_{\mathrm{total}} < 150$	14689	10M	126K	705K	3311
$P_T > 19$	13687	34K	116K	627K	3101
Isolation lepton veto	13429	33775	115K	327K	2537
$100 < M_{\mathrm{inv}} < 135$	12827	9506	10420	162K	2269
$70 < M_{\mathrm{rec}} < 125$	12166	7521	10045	110K	2260
$0.15 < y_{12} < 1$	12093	7405	9702	101K	2211
$y_{23} < 0.06$	10902	6644	8456	69313	1220
$y_{34} < 0.008$	10377	6504	7878	58532	519
$-0.98 < \cos(\theta^{(2\mathrm{jets})}_{\mathrm{included}}) < -0.4$	10284	5766	5454	34823	485
$BDT > 0.04$	8705	381	465	267	230
Significance	**84.92**				
Efficiency	**53.5%**				





Fitting result over truth for cc, bb, gg respectively

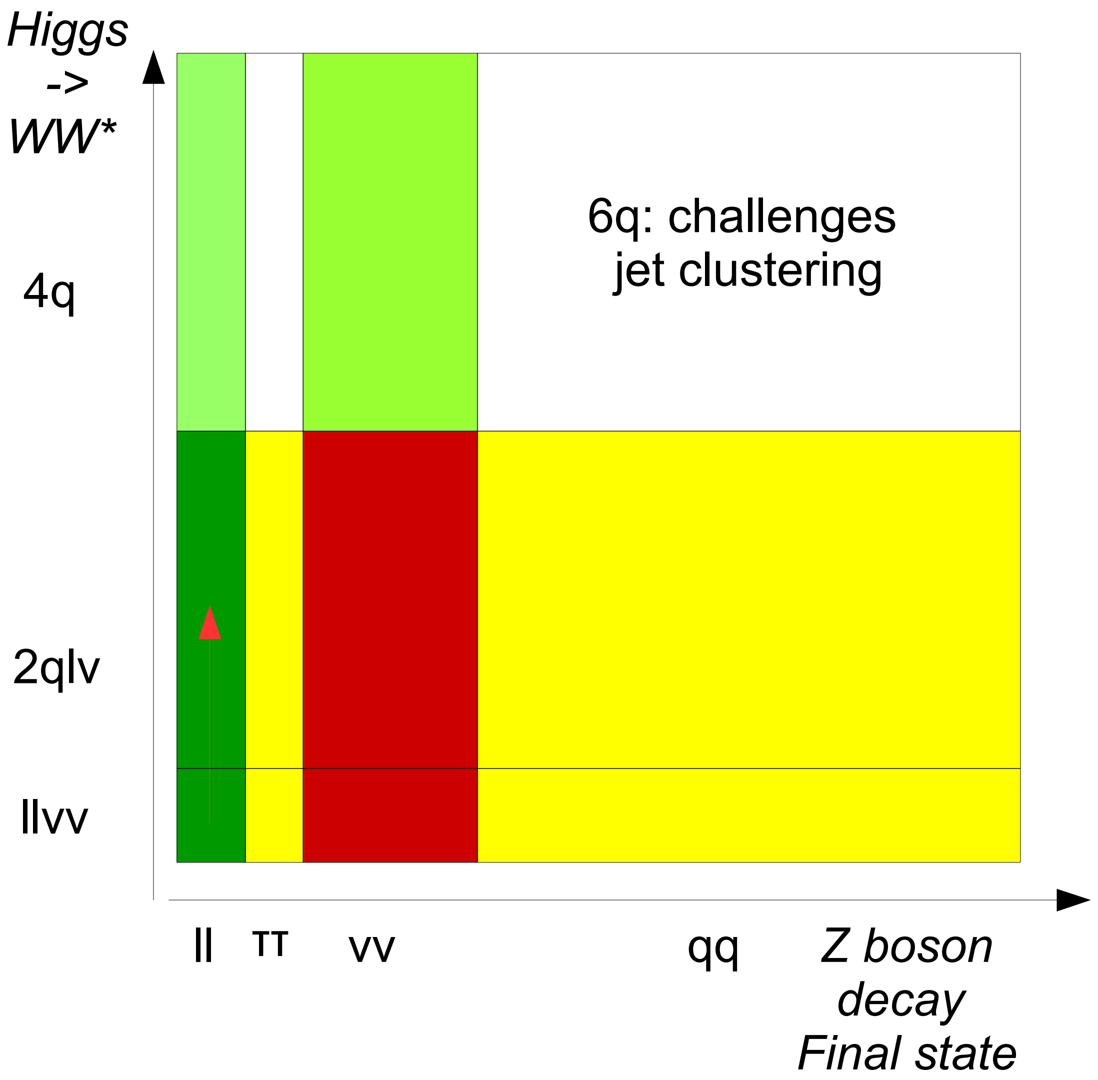
H -> WW* && H->ZZ*

- Various Final States! Combinations of leptons, missing E/P, jets...
- Processed with Full Simulation:
  - Final states with at most 2 jets
  - Lepton ID&Isolation and total E/P resolutions: key ingredients for these analysis
- WW*
  - Dedicated Isolation lepton finding algorithm has been developed & tuned
- ZZ*
  - Tau related background could be largely suppressed once tau finder is more mature

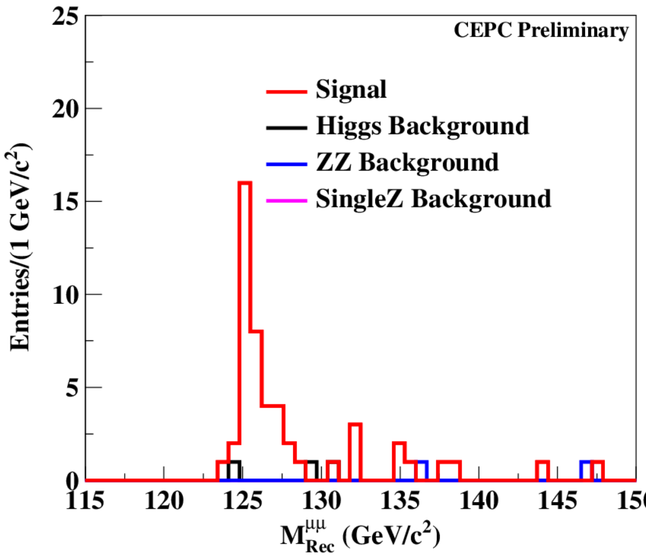
H -> WW* && H->ZZ*

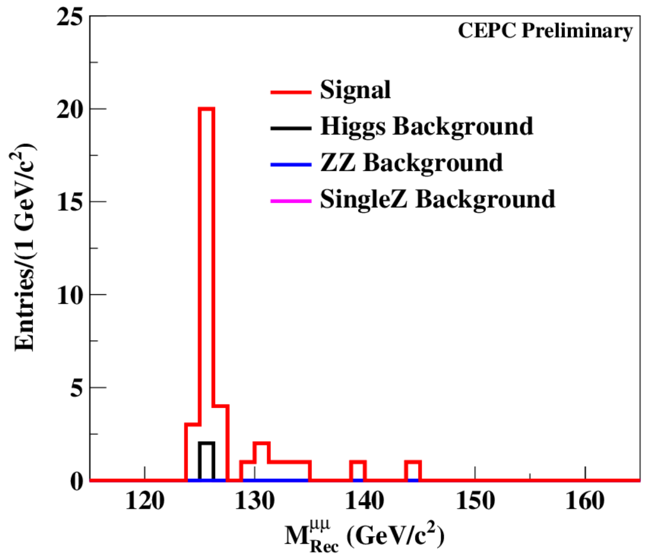
- Various Final States! Any combination of leptons, missing E/P, jets...
- Key measurement for achieving Higgs width
- Processed with Full Simulation:
  - Final states with leptons
    - Lepton ID & Detector coverage: intrinsic requirements
    - Isolation condition for letpons: compromise between Signal Efficiency & Bkgrd rejection rate
  - Libo, responsible for general isolation framework design & H->WW analysis
  - Yuqian will talk on ZZ* analysis

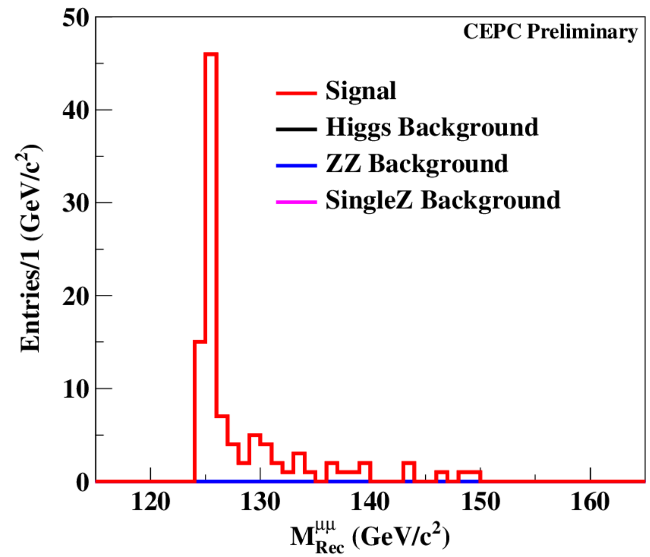
H -> WW*


Higgs
->
WW*
4q
2qlv
llvv
6q: challenges
jet clustering
ll
ττ
vv
qq
Z boson
decay
Final state

H -> WW*->lvlv







Category	Signal	ZH	ZZ	Single Z
Total	348	34624	5499688	7788916
$N_{ZPole} = 2; N_{Isolep} = 2; l = \mu$	77	129	5309	0
80 GeV $< M^{\mu^+\mu^-}_{Inv} <$ 100 GeV	73	124	4143	0
120 GeV $< M^{\mu^+\mu^-}_{Rec} <$ 150 GeV	66	118	2548	0
$N_{Remain} < 3$	66	56	2442	0
10 GeV $< M^{\mu^+\mu^-}_{Inv} <$ 65 GeV	58	46	411	0
40 GeV $< E_{Missing} <$ 100 GeV	55	26	231	0
$\sqrt{(\frac{D0}{sigD0})^2 + (\frac{Z0}{sigZ0})^2} < 5$	54	7	226	0
Total $P_T >$ 20 GeV	52	3	3	0

Table 2: Cut chain of $\mu\mu$ final state

Category	Signal	ZH	ZZ	Single Z
Total	348	34624	5499688	7788916
$N_{ZPole} = 2; N_{Isolep} = 2; l = e$	61	114	4	1807
80 GeV $< M^{\mu^+\mu^-}_{Inv} <$ 100 GeV	53	105	2	1165
120 GeV $< M^{\mu^+\mu^-}_{Rec} <$ 150 GeV	52	101	1	726
$N_{Remain} < 3$	51	60	0	692
10 GeV $< M^{e^+e^-}_{Inv} <$ 65 GeV	49	47	0	49
35 GeV $< E_{Missing} <$ 100 GeV	49	27	0	31
$\sqrt{(\frac{D0}{sigD0})^2 + (\frac{Z0}{sigZ0})^2} < 6$	39	4	0	24
Total $P_T >$ 20 GeV	36	4	0	0

Table 3: Cut chain of ee final state

Category	Signal	ZH	ZZ	Single Z
Total	348	34624	5499688	7788916
$N_{ZPole} = 2; N_{Isolep} = 2; l_1 = e, l_2 = \mu$	147	136	32	1
80 GeV $< M^{\mu^+\mu^-}_{Inv} <$ 100 GeV	134	119	21	0
120 GeV $< M^{\mu^+\mu^-}_{Rec} <$ 150 GeV	130	117	15	0
$N_{Remain} < 3$	130	89	3	0
10 GeV $< M^{e\mu}_{Inv} <$ 65 GeV	123	79	3	0
35 GeV $< E_{Missing} <$ 110 GeV	123	68	2	0
$\sqrt{(\frac{D0}{sigD0})^2 + (\frac{Z0}{sigZ0})^2} < 4$	105	0	0	0

Table 1: Cut chain of $e\mu$ final state

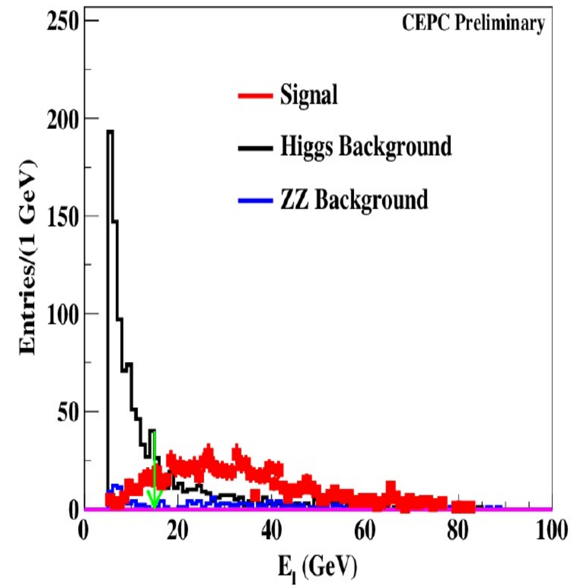
Obj Eff = 90%
Sig Eff = 60%

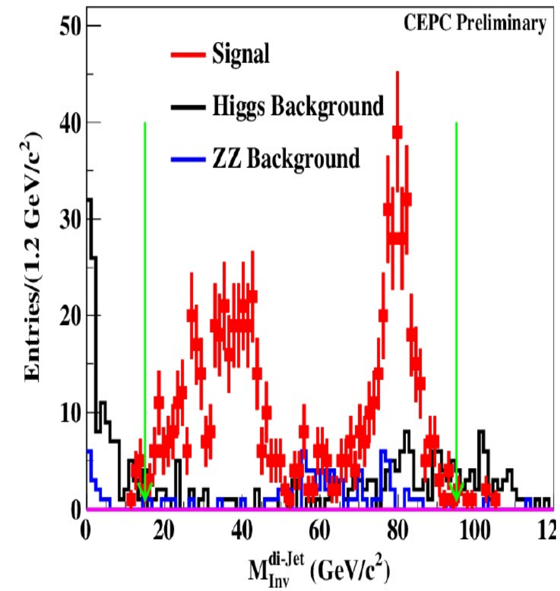
Obj Eff = 70%
Sig Eff = 41%

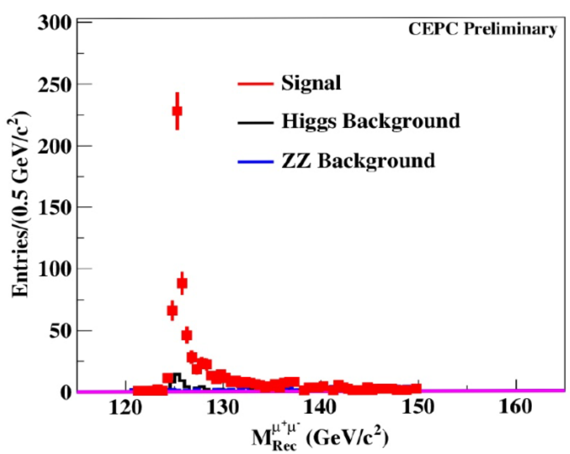
Obj Eff = 85%
Sig Eff = 60%

7% accuracy achieved with counting: improved by a factor of 2 to pre-CDR

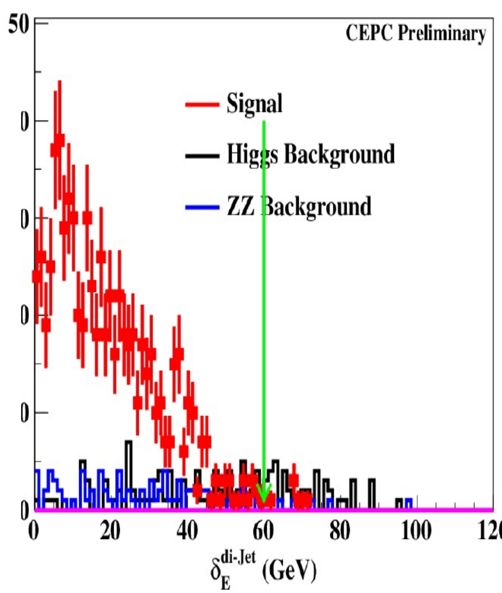
H -> WW*







$H \rightarrow WW^* \rightarrow \mu\nu qq$

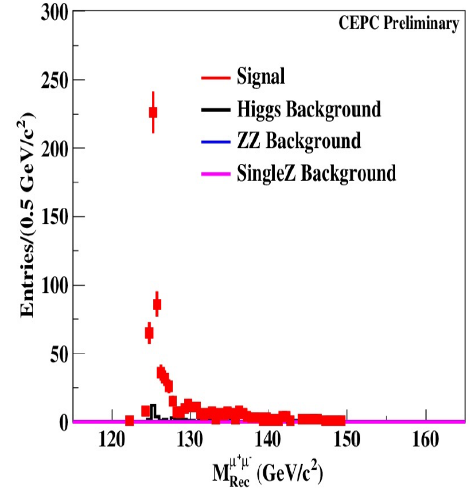


Category	Signal	ZH	ZZ	Single Z
Total	2112	32291	5499688	7788916
$N_{ZPole} = 2; N_{Isolep} = 1; N_{Jets} = 2; l = \mu$	988	1667	508	0
$80\ \text{GeV}/c^2 < M_{Inv}^{\mu^+\mu^-} < 100\ \text{GeV}/c^2$	879	1455	296	0
$120\ \text{GeV}/c^2 < M_{Rec}^{\mu^+\mu^-} < 150\ \text{GeV}/c^2$	853	1412	170	0
$-1000\ \text{GeV}^2/c^4 < M_{Missing}^2 < 2000\ \text{GeV}^2/c^4$	837	1070	141	0
$E_\mu > 15$ GeV	741	291	92	0
$15\ \text{GeV}/c^2 < M_{Rec}^{di-Jet} < 95\ \text{GeV}/c^2$	724	129	77	0
$\lvert\delta E_{Jets}\rvert < 50$ GeV	717	86	72	0

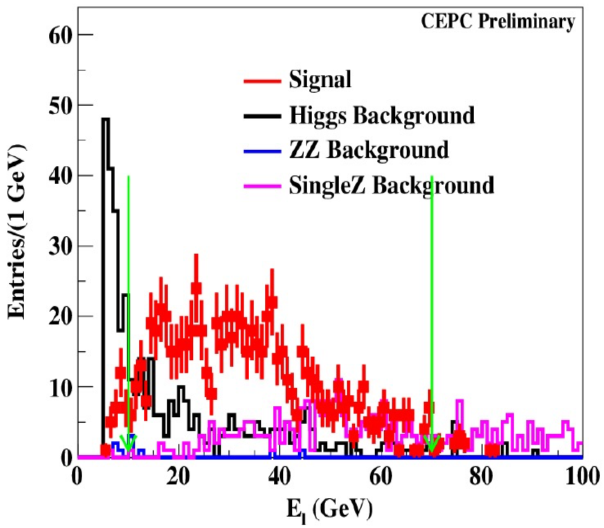
Table 5: Cut chain of semi leptonic decay of $H \rightarrow WW^* \rightarrow \mu\nu qq$

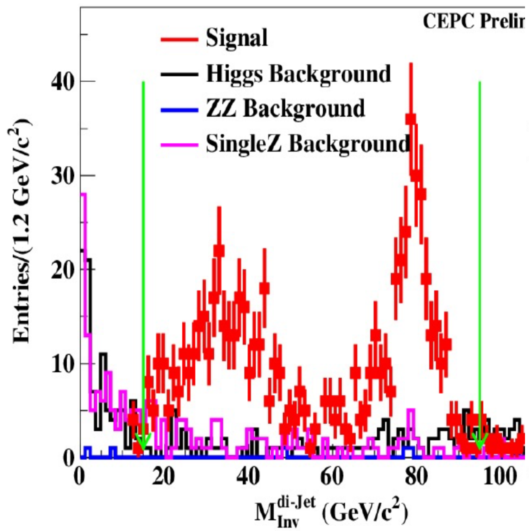
H -> WW*

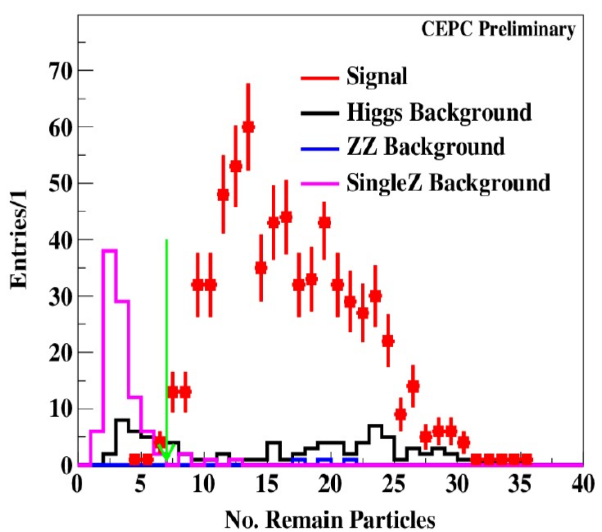
$H \to WW^{*} \to e\nu qq$

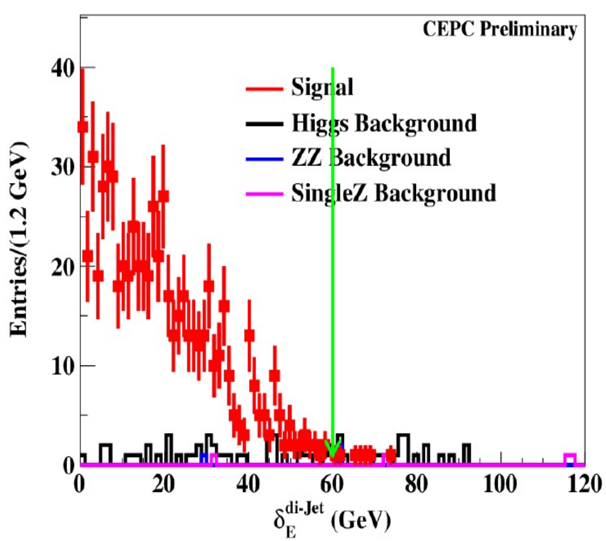


Category	Signal	ZH	ZZ	Single Z
Total	2112	32291	5499688	7788916
$N_{ZPole} = 2; N_{Isolep} = 1; N_{Jets} = 2; l = e$	864	881	83	824
$80\ GeV/c^2 < M_{Inv}^{\mu^+\mu^-} < 100\ GeV/c^2$	774	738	52	472
$120\ GeV/c^2 < M_{Rec}^{\mu^+\mu^-} < 150\ GeV/c^2$	755	717	31	314
$-1000\ GeV^2/c^4 < M_{Missing}^2 < 2000\ GeV^2/c^4$	743	402	11	299
$10\ GeV < E_e < 70\ GeV$	699	225	6	203
$15\ GeV/c^2 < M_{Rec}^{di-Jet} < 95\ GeV/c^2$	676	90	3	97
$N_{Remain} > 6$	670	65	3	4
$\lvert\delta E_{Jets}\rvert < 50\ GeV$	663	43	1	1







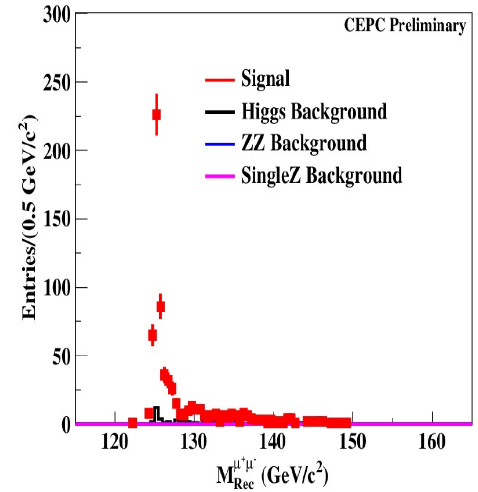


P

Z Decay / W Decay	ll	vv	tau tau	qq
lvlv				
lvqq				
qqqq				
Tau+X				

Green: undone
Yellow: 25%
Orange: 50%

$H \to WW^* \to e\nu qq$



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$15\ \mathrm{GeV}/c^2 < M_{Rec}^{di-Jet} < 95\ \mathrm{GeV}/c^2$	676	90	3	97
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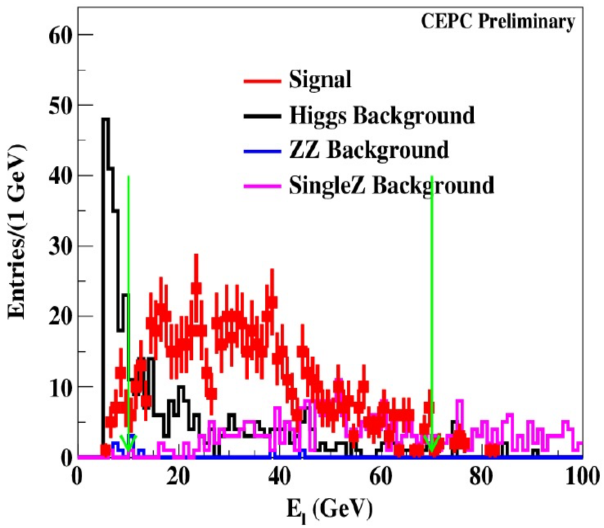
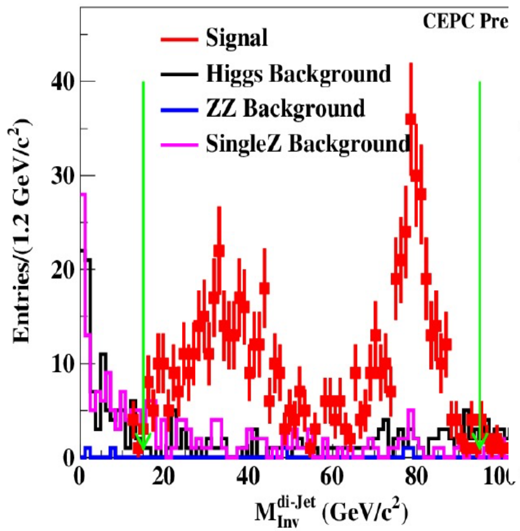
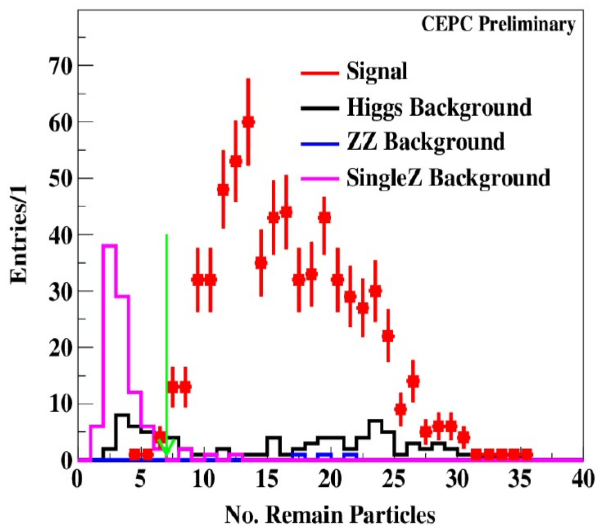
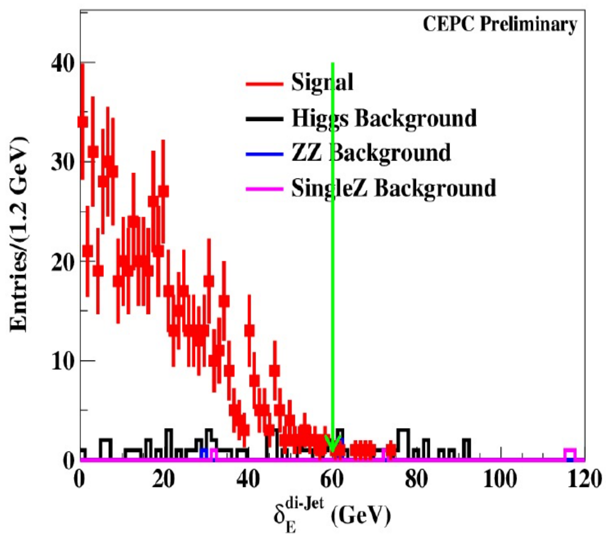
$\lvert\delta E_{Jets}\rvert < 50\ \mathrm{GeV}$	663	43	1	1







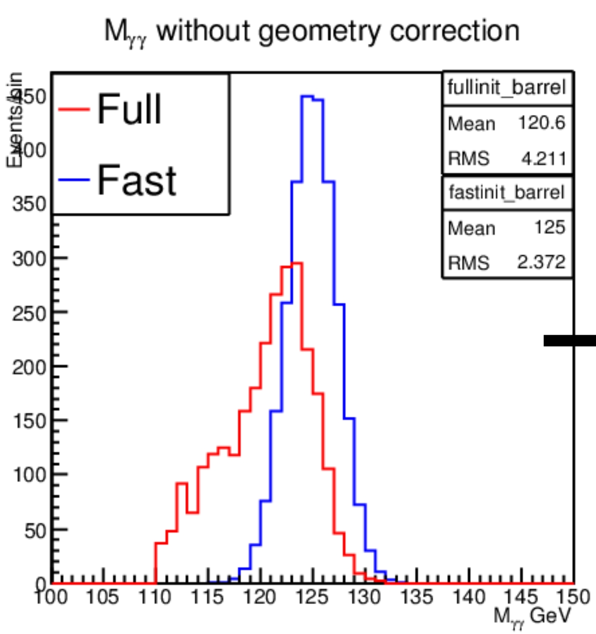


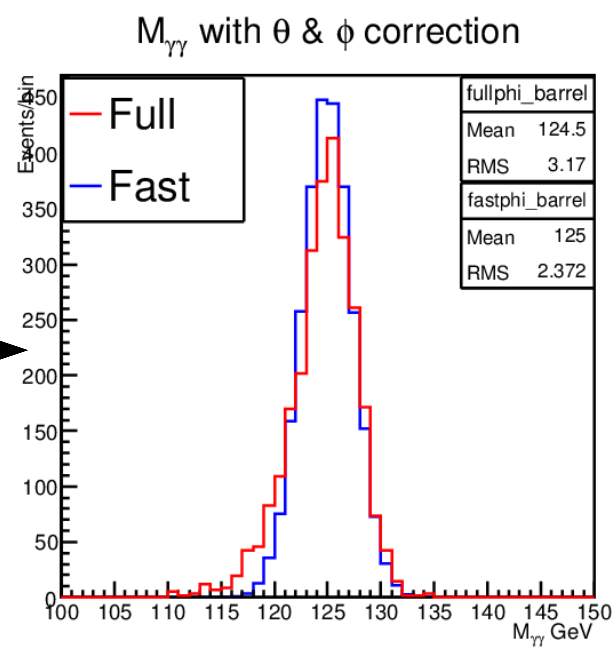
P

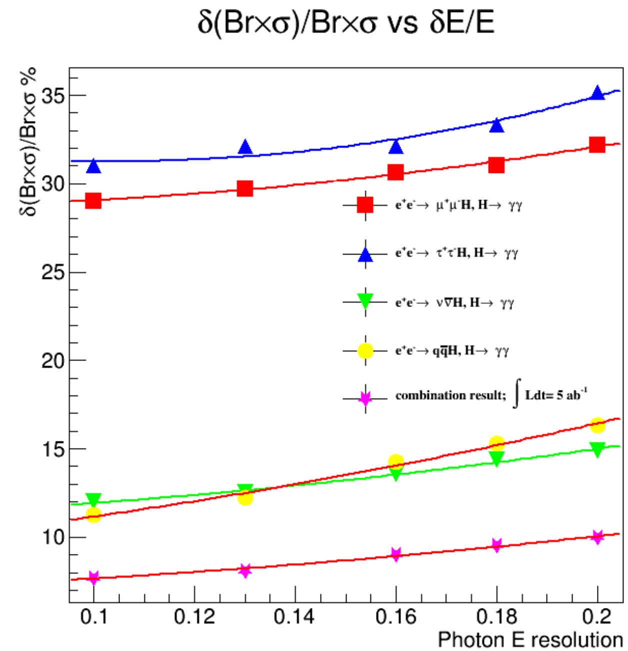
Z Decay / W Decay	ll	vv	tau tau	qq
lvlv				
lvqq				
qqqq				
Tau+X				

Green: undone
Yellow: 25%
Orange: 50%

H->di photon







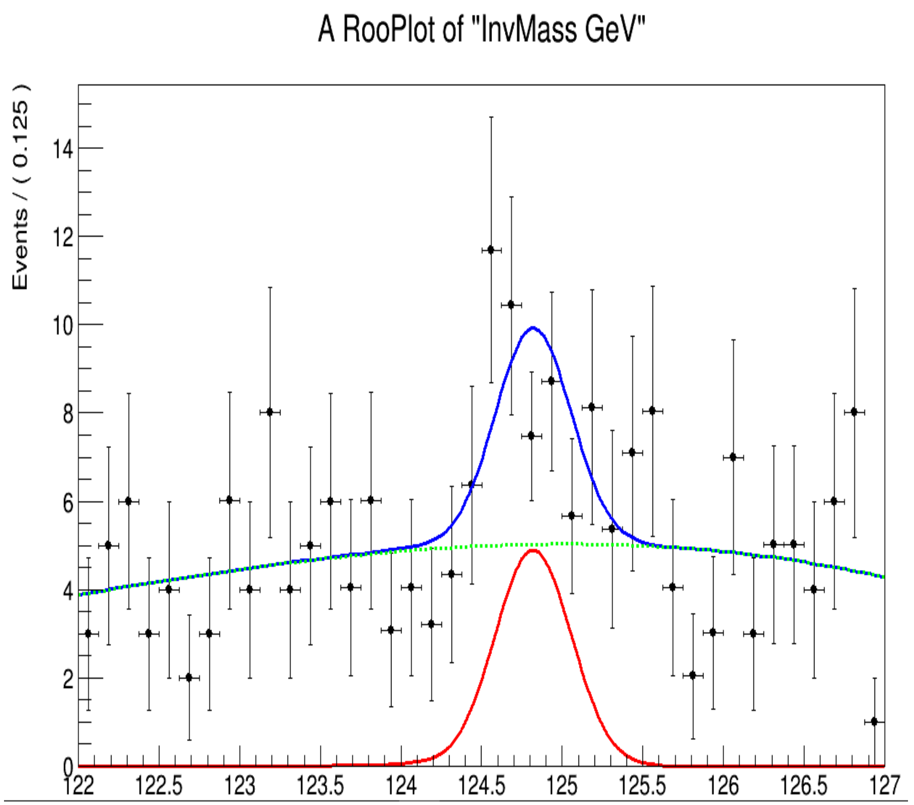
- Feng, JianHuan(UChicago), Binsong & Dan
- Fast Sim result (9%) is under validation with Full simulation.
- Expected accuracy parameterized as Photon Energy resolution (at Fast Sim level)
- Dedicated algorithms developed:
  - Converted Photon recovery: save back ~ 10-15% of statistics
  - Photon Energy Estimator: adjusted to CEPC_v1 geometry
  - Photon ID

H->di muon

- Cui Zhenwei (Wang Binlong)
- Test bed for event selection tuning
  - Cut based;
  - MVA-BDT based;
- Carefully designed BDT seems could largely improve the analysis result. Checking details

pre-section	217.7	10356245
124.2<Hmass<125.5	163.2	30050
90.7<Recoilmass<92.5	105.6	419
-55<Pzsum<52	93.3	290
29.2<Ptsum<62	88.5	269
-0.29<cosup<1	55.2	69
-1<cosum<0.20	47.5	48
0<arguu<178	46.5	42

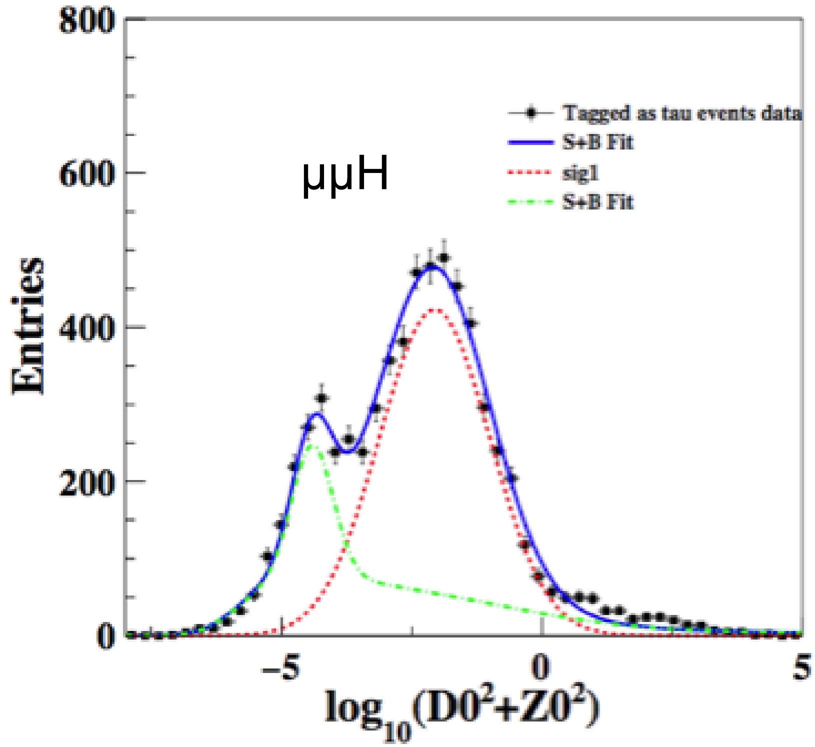
pre-section	214.2	285346
32.3<(InvMass-RecMass)<34.2	98.4	7008
215.95<(InvMass+RecMass)<216.66	79.1	158
-0.88<(cosup+cosum)<0.87	78.9	157
-1.92<(cosup-cosum)<0.40	48.9	40
-62.1<pzsum<58.5	47.9	37
10.0<ptsum<62.4	47.6	37
0<Ptuu<178	46.5	34

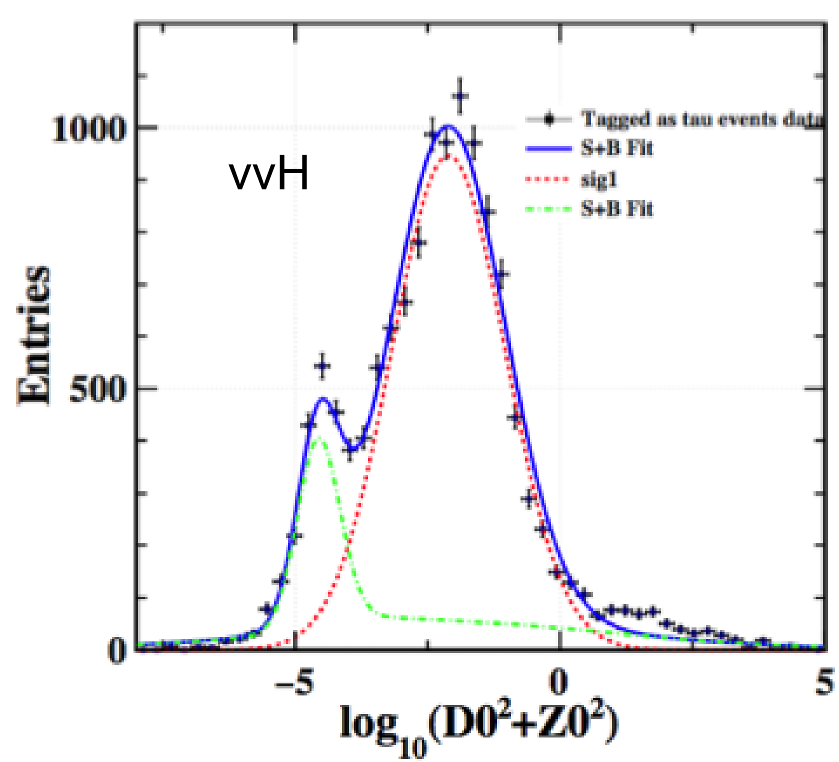


H->di-tau

- Yu Dan
- Test bed for PFA: a straight forward tau finder use #Track & #Photon & MVA information has been developed & Tested on inclusive Higgs sample
  - Eff: 98.5%
  - Purity: 74% (remaining is mainly $H \rightarrow WW/ZZ \rightarrow$ lepton/tau events)
- Goal:
  - Develop tau finder in Jet environment;
  - Tag tau decay modes;
  - Explore differential measurements with Tau decay final states

H->di tau



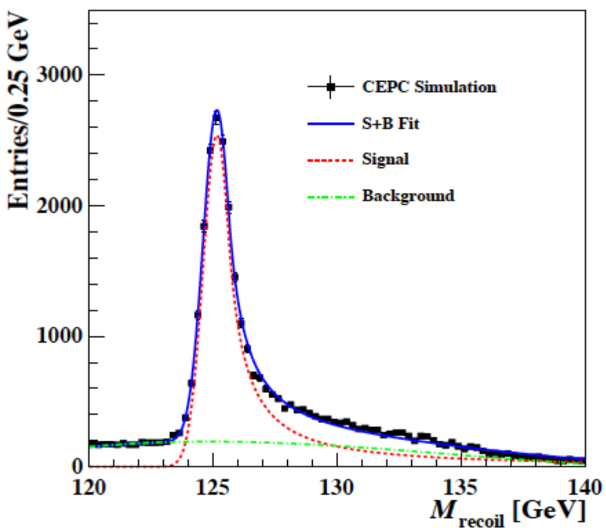


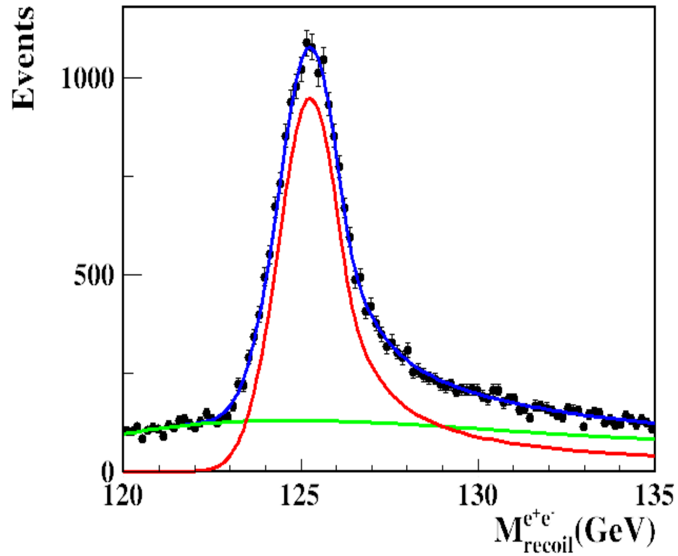
- Without other SM background, relative accuracy
  - μμH channel: 2.6%
  - vvH channel: 1%
- *Common background samples will soon be provided...*

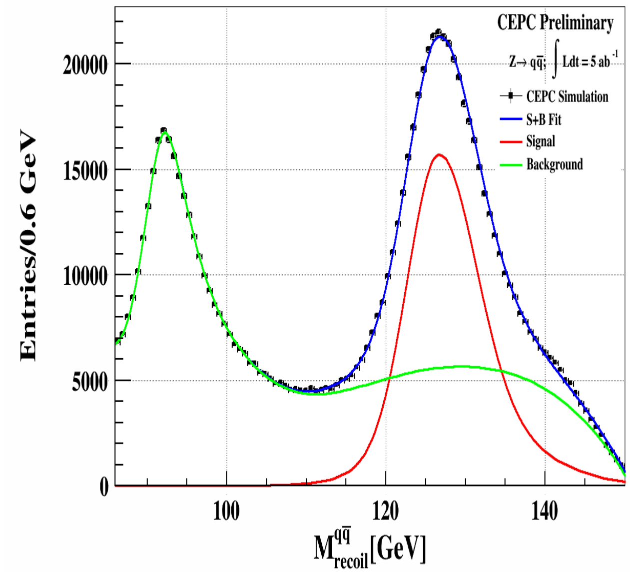
Higgs exotic

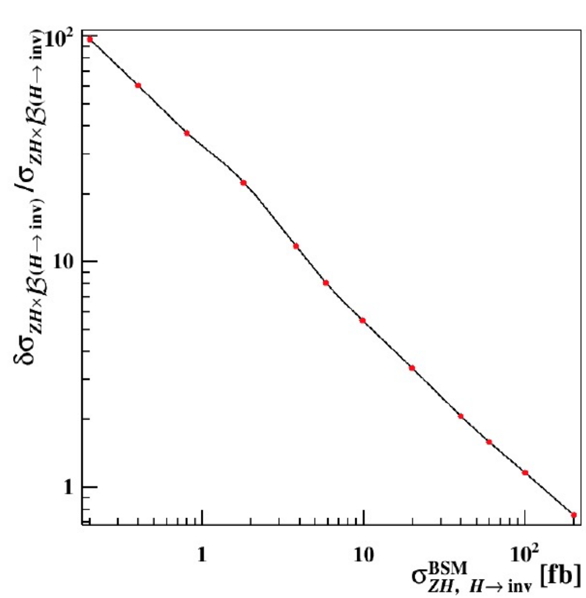
- Higgs → invisible via recoil mass spectrum
  - Di lepton channel: Zhenxing, Moxin (IHEP) & Jaiwei, Kevin (Hongkong)
  - Di jet channel: Moxin
- Higgs → leptonic exotic mode
  - H → ee: Wanglei @ PKU
- Higgs → hadronic mode
  - H → Flavor changing quark pairs: samples ready, no analysis effort
    - H → tc, tu
    - H → bs, bd
  - H → semi invisible: Jiawei, Kevin (Hongkong) & Zhenxing

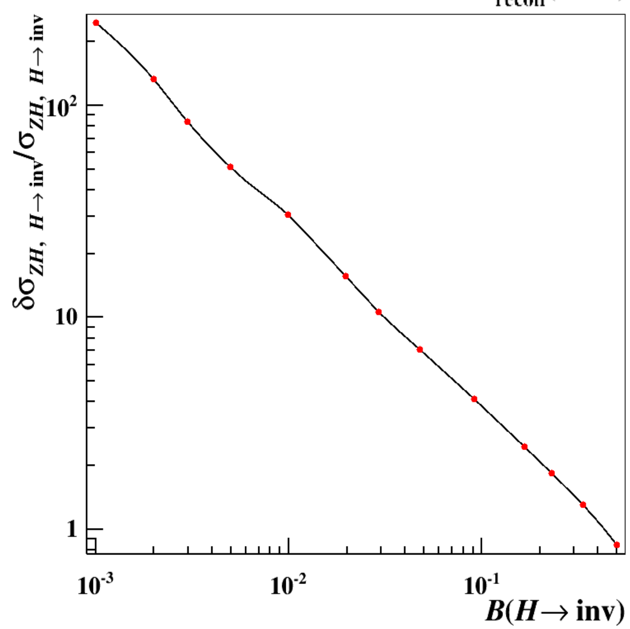
Higgs invisible decay
uuH, eeH, qqH





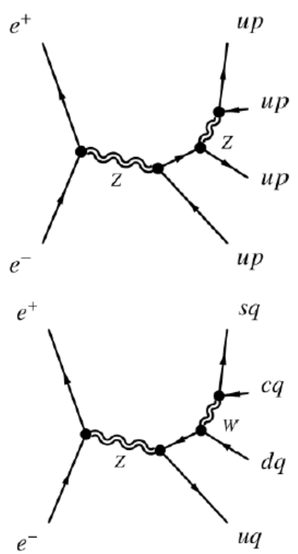




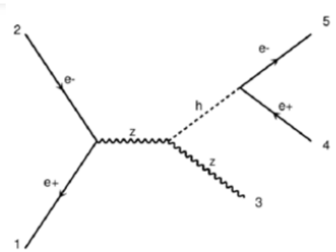


ZZ line shape used to control background

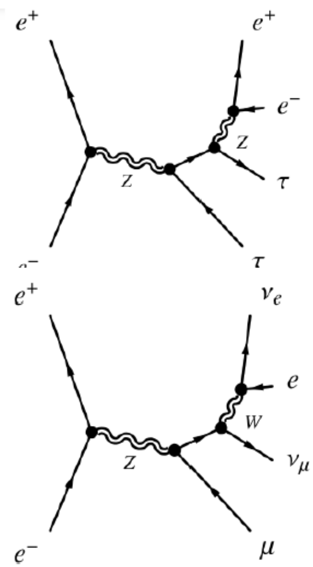
Higgs leptonic decay



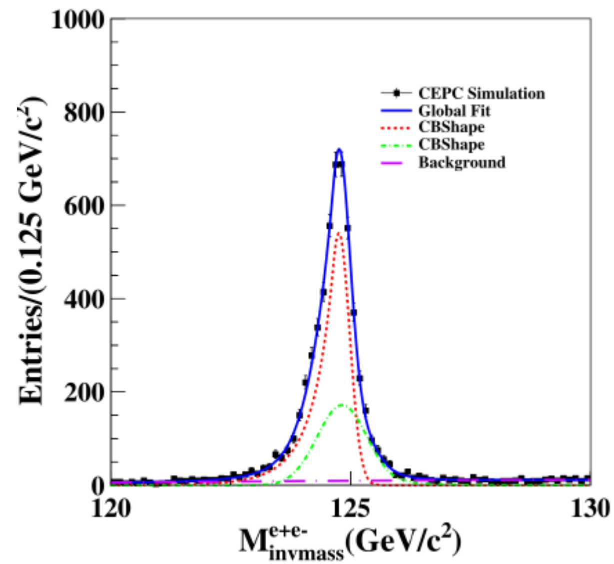
signal:Madgraph->Pythia->Mokka->Marlin



MC sample	parton level
signal sample	Madgraph
ZZ	Whizard
WW	Whizard
signal Z	Whizard
signal W	Whizard
single Z or W	Whizard
ZZ or WW	Whizard



bkg:Whizard->Pythia->Mokka->Marlin



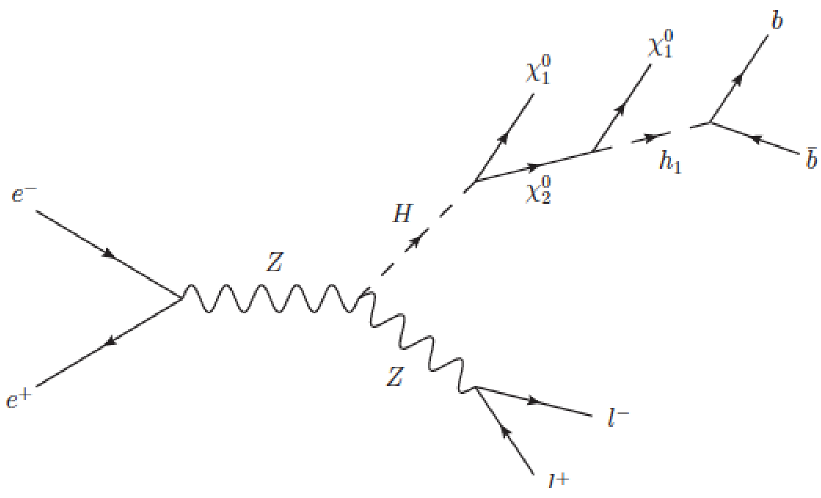
The limit results is 0.1665‰ at 95% confidence level

leptonic decay channel	BR upper limit at 95%	collaboration	Journal
h->ee	0.19%	CMS	Phys. Lett. B 744, 184
h->μμ	0.15%	CMS	Phys. Lett. B 744, 184
	0.16%	ATLAS	Phys. Lett. B 738, 68
h->eμ	0.036%	CMS	CMS-PAS-HIG-14-040
h->eτ	0.69%	CMS	CMS-PAS-HIG-14-040
	1.04%	ATLAS	unpublished
h->μτ	1.51%	CMS	Phys. Lett. B 749, 337
	1.43%	ATLAS	unpublished

- H → ee: SM Branching ratio ~ o(10^{-9})
- Uplimit at CEPC: one order of magnitude better than current LHC result
- To explore: H → eμ, μτ

http://indico.ihep.ac.cn/event/5592/contribution/12/material/slides/0.pdf

H->Exotic, hadronic



Benchmark Points

Scan over the parameter space for sensitivity:

1. Fix $m_{\tilde{\chi}_1^0} = 0$ GeV and make exclusion contours on the m_{h^0} and $m_{\tilde{\chi}_2^0}$ plane with the range:

   10 GeV < m_{h^0} < 60 GeV (15,25,35,45,55 GeV)

   10 GeV < $m_{\tilde{\chi}_2^0}$ < 125 GeV (20,40,60,80,100,120 GeV)

2. Fix $m_{h^0} = 30$ GeV and make exclusion contours on the $m_{\tilde{\chi}_1^0}$ and $m_{\tilde{\chi}_2^0}$ plane, with the range:

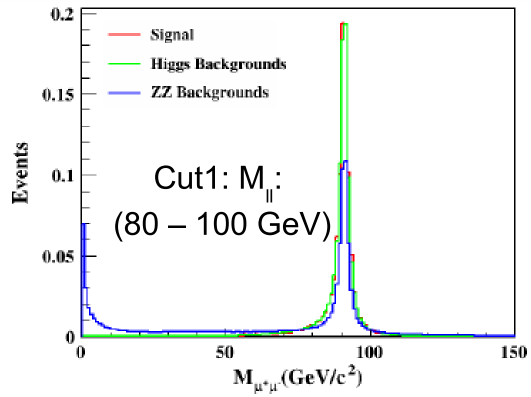
   0 GeV < $m_{\tilde{\chi}_1^0}$ < 60 GeV (5,15,25,35,45,55 GeV)
   10 GeV < $m_{\tilde{\chi}_2^0}$ < 125 GeV (20,40,60,80,100,120 GeV)

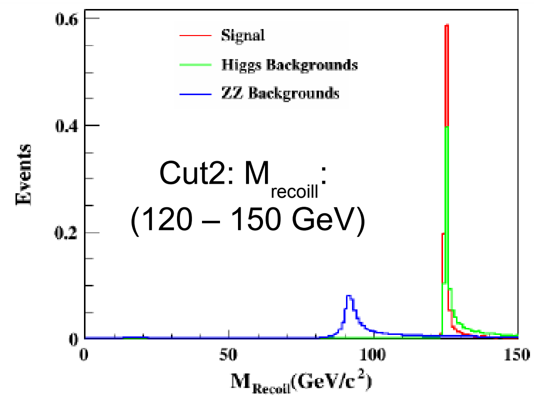
Suggested by prof. Liu

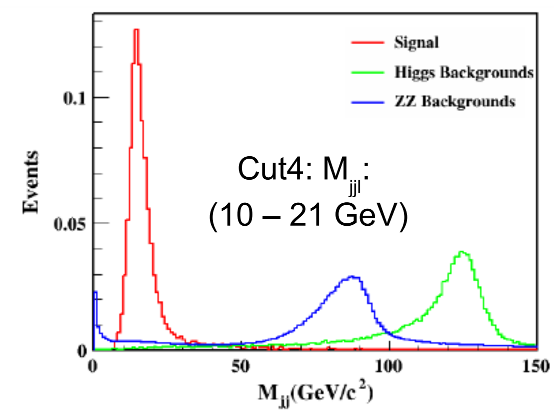
- Typical process at NMSSM & 2HDM...
- Joint efforts of Hongkong Cluster & IHEP: Main analyzers, Jiawei, Kevin & Zhenxing
  - Initialized at PreCDR, one parameter point explored with Fast Sim (Kevin)
  - Full Simulation exploration during IAS meeting (Zhenxing visited Hongkong)
  - Continue by Jiawei & Kevin (Jiawei stayed at IHEP for 3 weeks)

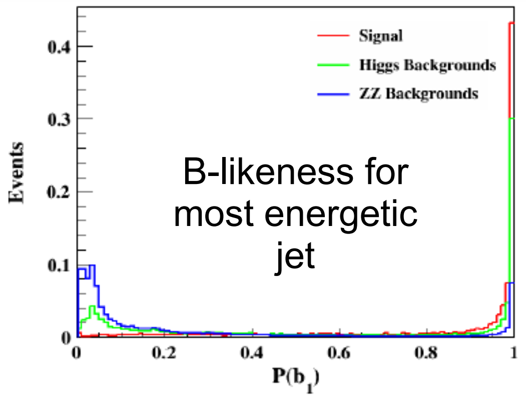
H->Exotic, hadronic

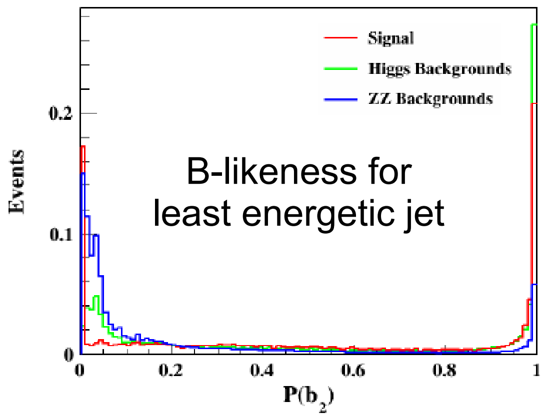
Para: M(LSP) = 0; M(h0) = 15 GeV; M(NLSP) = 20 GeV











	Object found	Cut 1 m_{ll}	Cut 2 m_{rec}	Cut 3 b likeness	Cut 4 m_{jj}
Signal	17	15	15	12	10
ZH BGs	34093	30732	30030	16026	4
ZZ BGs	538790	281198	30825	4274	20

Cut3: sum(B-likeness) > 0.9

- 95% CL. Uplimt set to be 5E-4; will be significantly improved by including di-electron/tau channel...
- ISR effect not included in the Signal sample. sigma(ZH) refered to SM Xsec of 200 fb. Effect on uplimit setting could be ignored
- Todo: a full scan over proposed parameter space

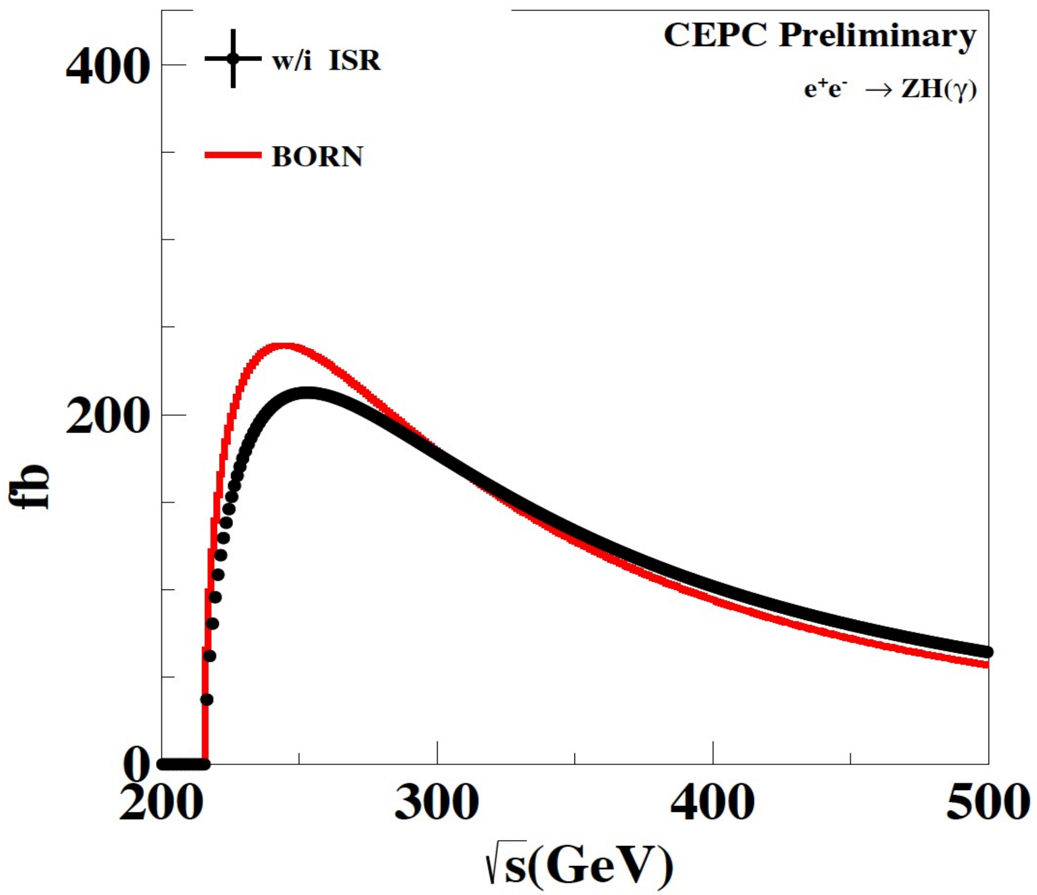
Core: absolute measurements of Higgs

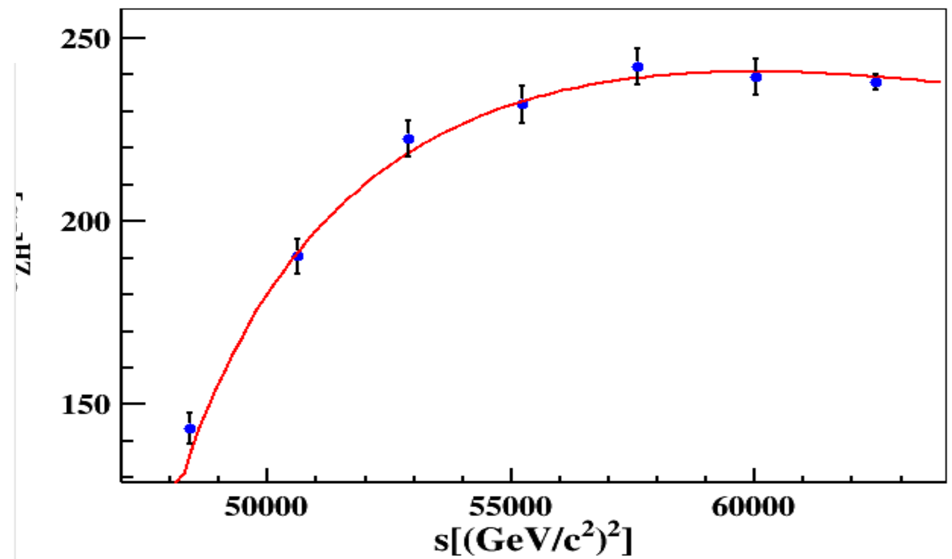
	PreCDR	Now
σ(ZH)	0.51%	0.50%
σ(ZH)*Br(H→bb)	0.28%	0.21%
σ(ZH)*Br(H→cc)	2.1%	2.5%
σ(ZH)*Br(H→gg)	1.6%	1.7%
σ(ZH)*Br(H→WW)	1.5%	1.2%
σ(ZH)*Br(H→ZZ)	4.3%	4%
σ(ZH)*Br(H→ττ)	1.2%	1.0%
σ(ZH)*Br(H→γγ)	9.0%	9.0%
σ(ZH)*Br(H→μμ)	17%	17%
σ(vvH)*Br(H→Zγ)	-	-
σ(vvH)*Br(H→bb)	2.8%	2.8%
Higgs Mass/MeV	5.9	5.0
σ(ZH)*Br(H→inv)		
Br(H→ee)		
Br(H→bbχχ, 4b)	$<10^{-3}$	95%. CL = 3e-4

It's time to consider systematics

- All possible resources of systematic uncertainties should be investigated and evaluated
- Beam energy:
  - O(MeV)@240GeV
  - O(0.1MeV)@91GeV
- Integrated luminosity O(10-3)
- Jet correlation/hard gluon emission
- ... ...

ISR and Born cross section





0.5% precision need not only MC, but a reasonable data taking plan

Detector optimization

- Understand the motivation and carefully modify/edit the geometry accordingly
- Validate the detector geometry
- **Tune/optimize the reconstruction** & Understand the detector performance
  - Single particle level: reconstruction/PID efficiency
  - Overlap particle level: separation performance, essential for PFA
  - Multi-particle object: Tau & Jets
  - *Tech. oriented, Time consuming & need strong experts (see Manqi's talk)*
- Iteration of the benchmark physics analyses

Summary

- Profound understanding of detector performance with PFA. Details in Manqi's talk
- Lots of analyses covered by full simulation, more to be covered
- Systematics under consideration
  - Beam energy/Luminosity/MC(theoretical inputs) ...
  - Jet clustering algorithm
  - Tracking, PID and jet flavor tagging
  - Data driven method for the syst. Control is under discussion
- Plan for CDR:
  - Serval detector geometries and performance curves
  - Reasonable experimental strategy

Backup

Non Higgs Topic

- EM measurements:
  - TGC (韩爽)
  - Wmass + Width
  - Neutrino generation
  - A_{FB}
- New Physics (李强)
- Systematic controls （朱凯，白羽，李刚）
- Reconstruction oriented
- Detector optimization
  - Calorimeter (赵航，陈石)

CEPC Higgs Analysis: Status at Aug 2015

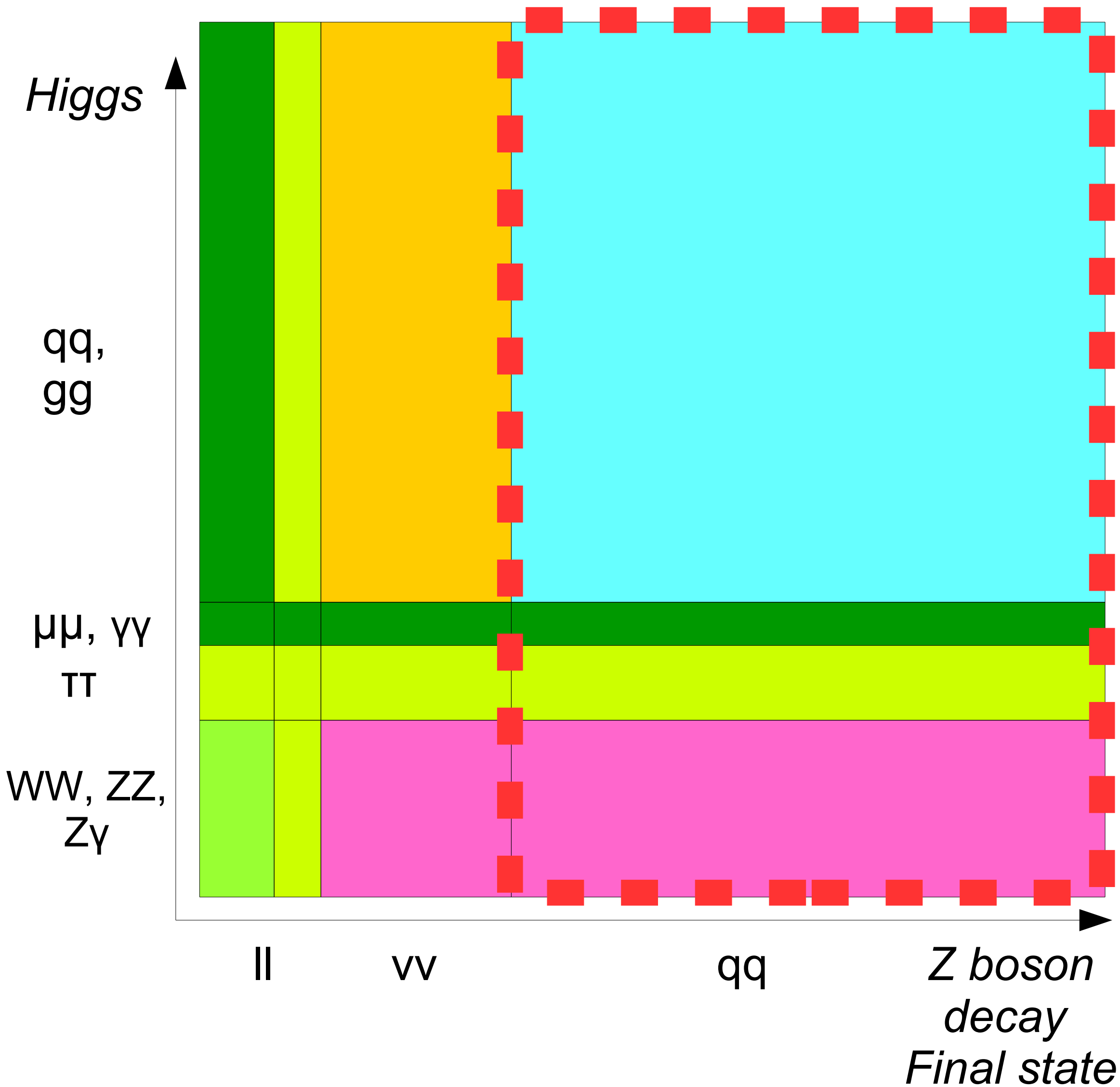
<table>
<tr><th></th><th>di-muon</th><th>di-electron</th><th>di-neutrino</th><th>di-jets</th><th>di-taus</th></tr>
<tr><td>$\sigma(ZH)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td>-</td><td style="background:#00ffff"></td><td></td></tr>
<tr><td>M_H</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td></td><td></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to bb)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#ffff00"></td><td style="background:#00ffff"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to cc)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#ffff00"></td><td style="background:#00ffff"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to gg)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#ffff00"></td><td style="background:#00ffff"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to WW)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#ffff00"></td><td style="background:#ffff00"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to ZZ)$</td><td style="background:#ffff00"></td><td style="background:#ffff00"></td><td style="background:#00ffff"></td><td style="background:#ffff00"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to \tau\tau)$</td><td style="background:#ffff00"></td><td style="background:#ffff00"></td><td style="background:#ffff00"></td><td style="background:#ffff00"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to \gamma\gamma)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td></td></tr>
<tr><td>$\sigma(ZH)*Br(H\to \mu\mu)$</td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td style="background:#00cc00"></td><td></td></tr>
<tr><td>$\sigma(\nu\nu H)*Br(H\to bb)$</td><td>-</td><td>-</td><td style="background:#00ffff"></td><td>-</td><td></td></tr>
<tr><td>$Br(H\to invisible)$</td><td style="background:#00cc00"></td><td style="background:#ffff00"></td><td>-</td><td style="background:#ffff00"></td><td></td></tr>
<tr><td>$Br(H\to exotic)$</td><td style="background:#00ffff"></td><td style="background:#00ffff"></td><td></td><td></td><td></td></tr>
</table>

Signal with CEPC Full Simulation, Bkgrd with Fast Simulation (green)

CEPC Fast Simulation (cyan)

Extrapolated from ILC/FCC-ee results (yellow)

Newly formed Working groups



振兴 + 树正 + 李直

白羽（庞通）+ 周宁（博扬）+ 杨柳

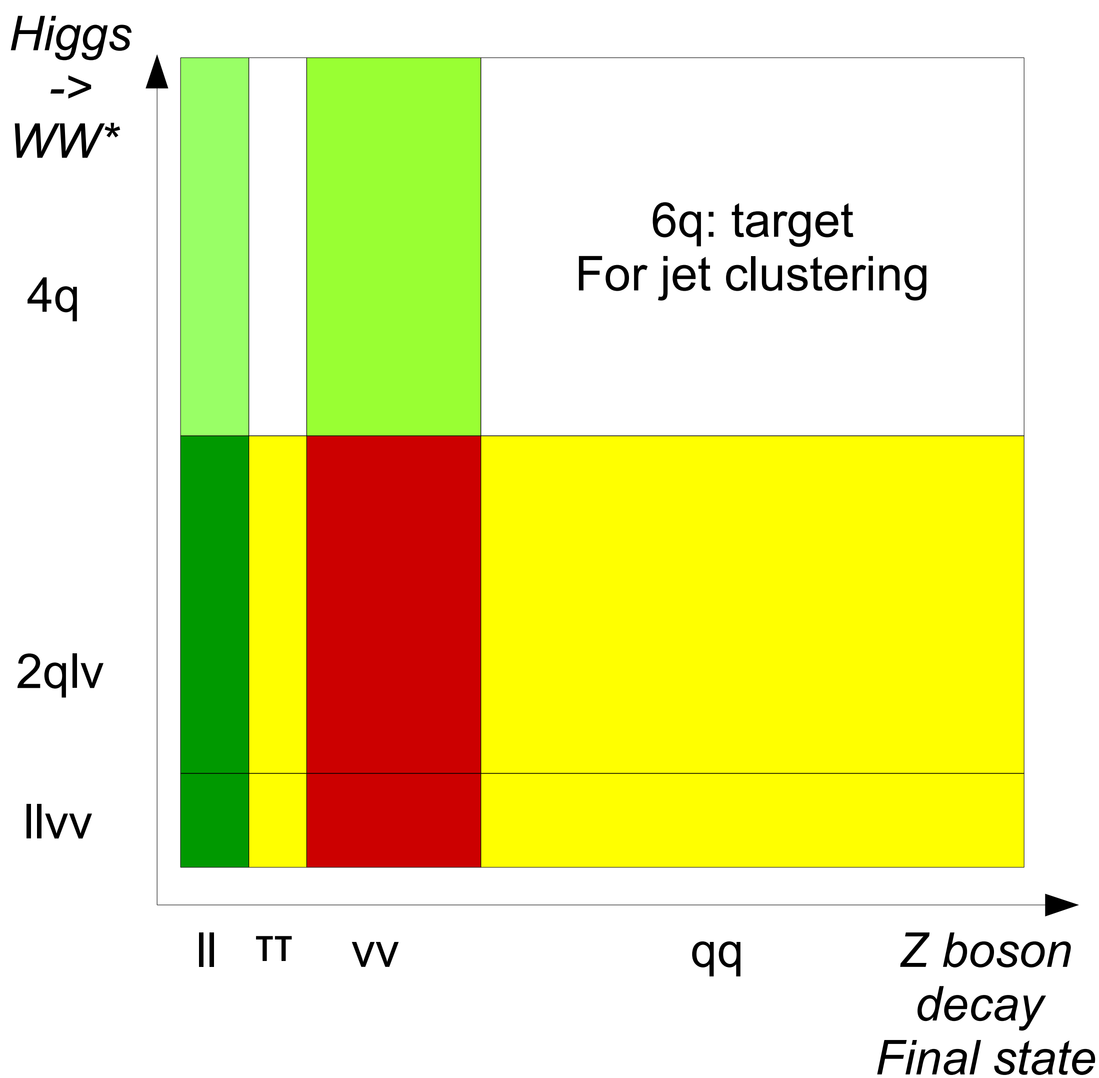
迪开 + 李直 + 梁浩 + 振兴

王峰 + 俊机 + 滨松 + 立波 + 彧骞 + 陈石 + 于淼 + 杨柳

于丹 + **王磊** + 立波 + 赵航

王峰 + **莫欣**

H -> WW* && H->ZZ*



Suggested Priority:

Repeat zhenxin's analysis

1: Z(νν) + H(llνν, 2qlν) (iso lepton)
(王峰 + 立波)
Di lepton: dR & mass, flavor classification,
Bkg: WW, ZZ, isrZ

2: νν + 4q; ll + 4q
JER (peak at 125 GeV);
mixed with Higgs backgrounds
Z->νν/ll & H->2q, H->ZZ* -> 4q
B-tagging can be used to veto 40% of ZZ;
(+ 彧骞)
Bkg: Higgs noise

3: qq + 2qlν/llνν, Jet Clustering +
Iso lepton

vvH

Channel	bb	cc	gg	Oth Higgs
Truth	7419.1	326.6	971.0	329.9
Mean	7419.0	325.0	969.4	330.0
RMS (fitTo)	88.1	28.4	38.8	-
RMS (ToyMC)	87.1	30.1	39.6	-
Relative error	1.23%	9.3%	4.2%	-
1/sqrt(Truth)	1.16%	5.5%	3.2%	-