Weekly Updates

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12/12/2019

Status

- First look of "ee" channel

    -- there is a problem on compiling (only me ?)

    -- only signal sample is analyzed quickly, without tuning.

- Gitlab repository for the CEPC note is updated

    https://gitlab.com/cepc/memo/hig2zz-c4

Compilation issue

- Usually, we compile the source file via ./build.sh script

- These days I got errors, and at the begging I thought there was an issue on the computing side, but still it was there …

- Temporally, copied and modified a script under Marlin directory, and use(call) it at the compilation. I guess it is due to some path/directory changes, around the central software for the CEPC analysis.
(I have changed the path in the script , such as ,
/home/bes/lig/higgs/ilcsoft/v01-17-05_slc6/   --> /afs/ihep.ac.cn/soft/common/gcc/v01-17-05/)

/cefs/higgs/kiuchi/Higgs2zz/Emergency_Copied_Marlin/
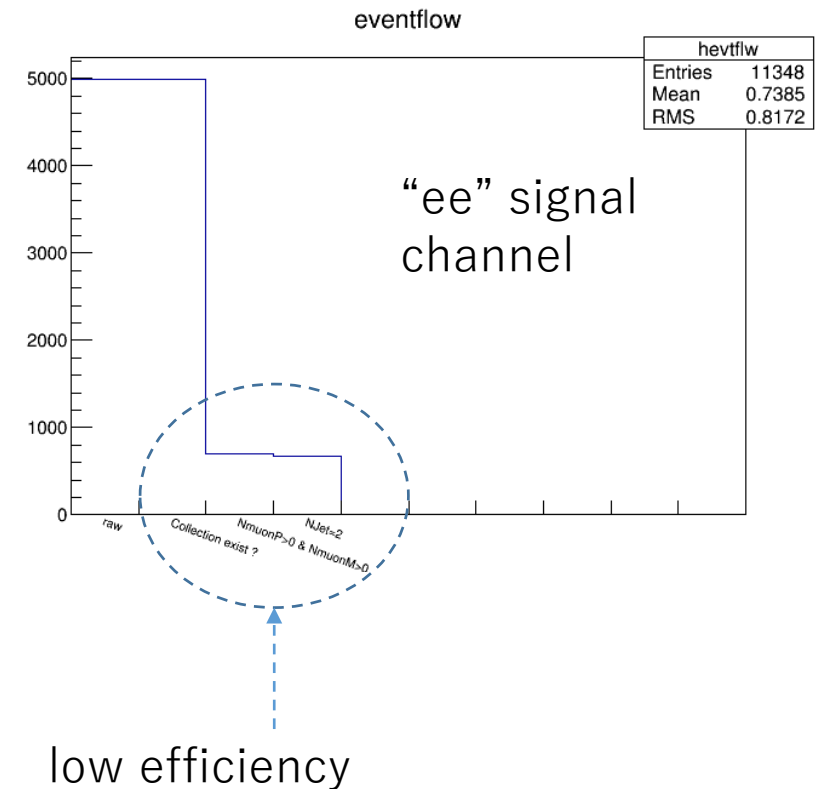
Report on the analysis of ee channel

-- Z->ee, HZZ->vv, jj combination

(-- sorry that the slide is not organized well in the following)

Lepton Isolation

```cpp
bool ISOlatedLeptonFinderProcessor::IsISOlatedLepton( ReconstructedParticle* pfo ) {

    if ( !IsCharged(pfo) )
        return false;

    if ( _usePID && !IsLepton(pfo) )
        return false;

    if ( _useImpactParameter && !PassesImpactParameterCuts(pfo) )
        return false ;

    if ( _useImpactParameterSignificance && !PassesImpactParameterSignificanceCuts(pfo) )
        return false ;

    if ( _useRectangularIsolation && !IsISOlatedRectangular(pfo) )
        return false;

    if ( _usePolynomialIsolation && !IsISOlatedPolynomial(pfo) )
        return false;

    if ( _useJetIsolation && !IsISOlatedJet(pfo) )
        return false;

    return true;

}
```

IsolatedLeptonFinderProcessor.cc

eventflow

hevtflw	
Entries	11348
Mean	0.7385
RMS	0.8172

"ee" signal channel

raw   Collection exist ?   NmuonP>0 & NmuonM>0   NJet≥2

low efficiency

Lepton Isolation

```xml
<processor name="MyIsolatedLeptonFinderProcessor" type="ISOlatedLeptonFinderProcessor">
    <!--Isolated Lepton Finder Processor-->

    ......

<parameter name="OutputCollectionIsolatedLeptons" type="string" lcioOutType="ReconstructedPa
<!--Copy of input collection but without the isolated leptons-->
<parameter name="OutputCollectionWithoutIsolatedLepton" type="string" lcioOutType="Reconstru
<!--Use impact parameter cuts for consistency with primary/secondary track-->
<parameter name="UseImpactParameter" type="bool"> false </parameter>
<!--Use impact parameter significance cuts for consistency with primary/secondary track-->
<parameter name="UseImpactParameterSignificance" type="bool">false </parameter>
<!--Use jet-based isolation-->
<parameter name="UseJetIsolation" type="bool">false </parameter>
<!--Use primitive particle ID based on calorimeter energy deposits-->
<parameter name="UsePID" type="bool"> true </parameter>
<!--Use polynomial cuts on track and cone energy-->
<parameter name="UsePolynomialIsolation" type="bool">true </parameter>
<!--Use rectangular cuts on track and cone energy-->
<parameter name="UseRectangularIsolation" type="bool">true </parameter>
<!--verbosity level of this processor ("DEBUG0-4,MESSAGE0-4,WARNING0-4,ERROR0-4,SILENT")-->
<parameter name="Verbosity" type="string">DEBUG </parameter>
</processor>
```
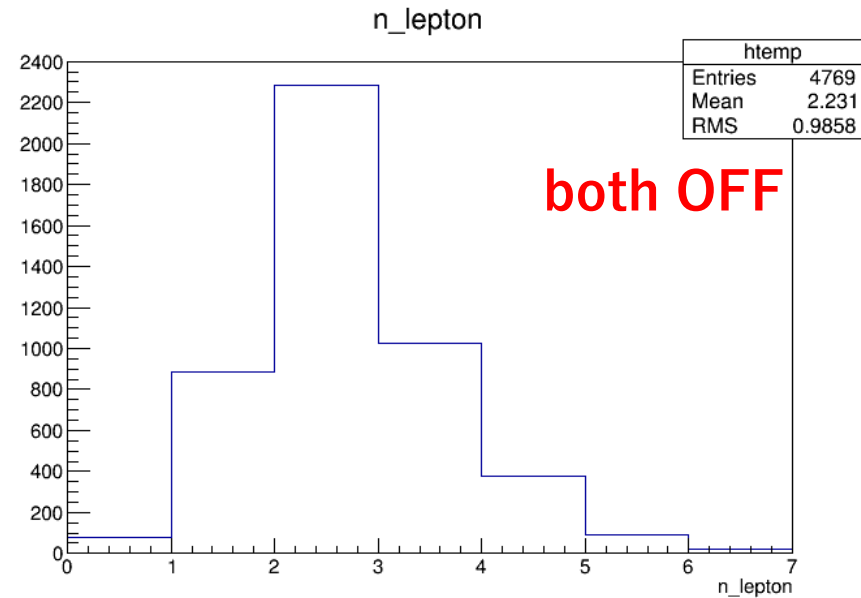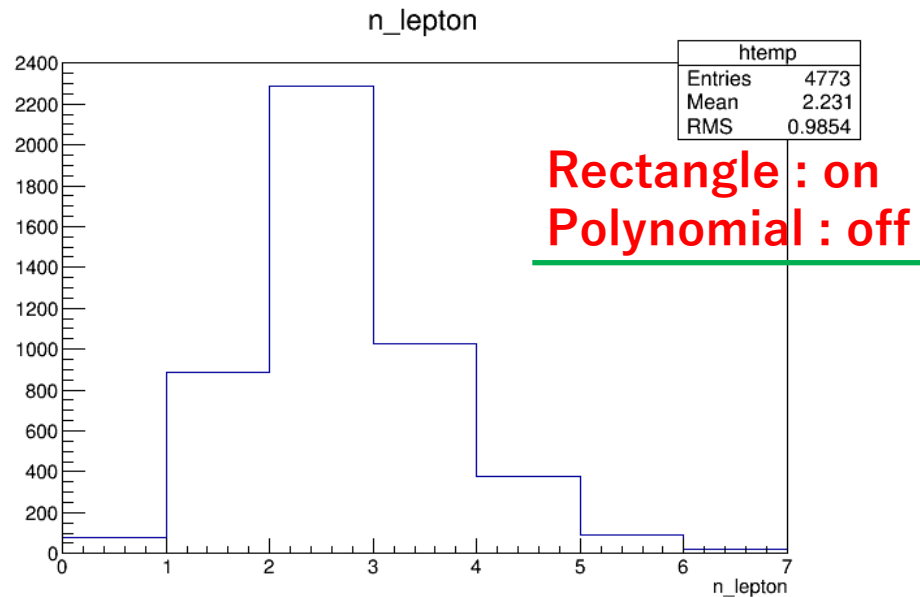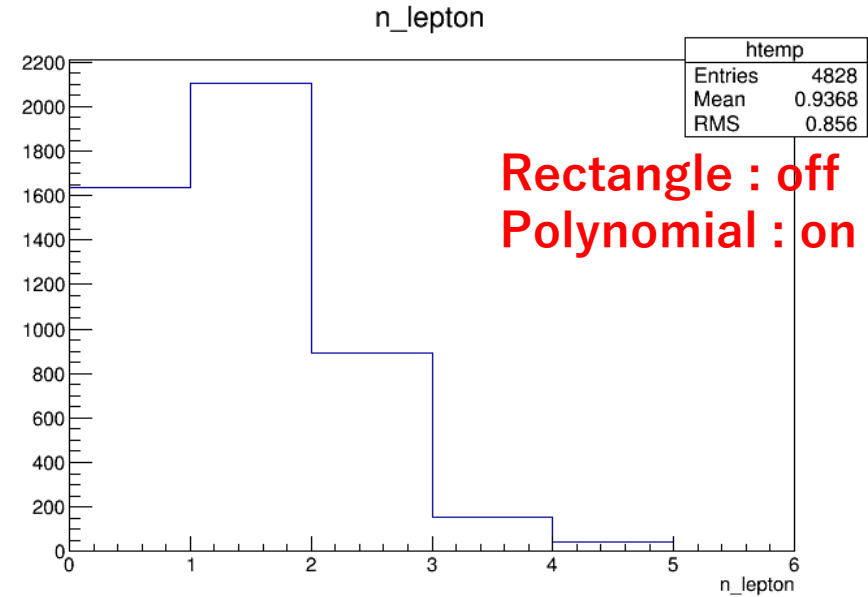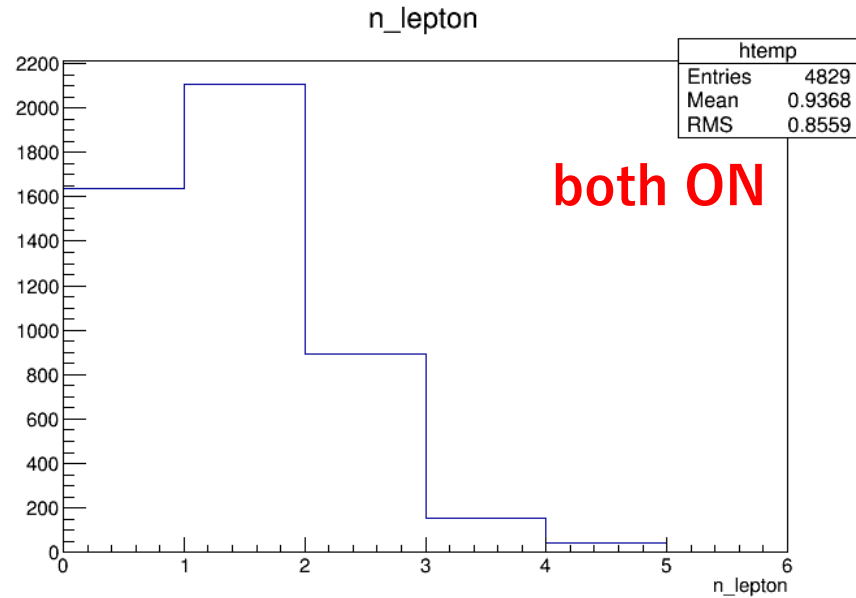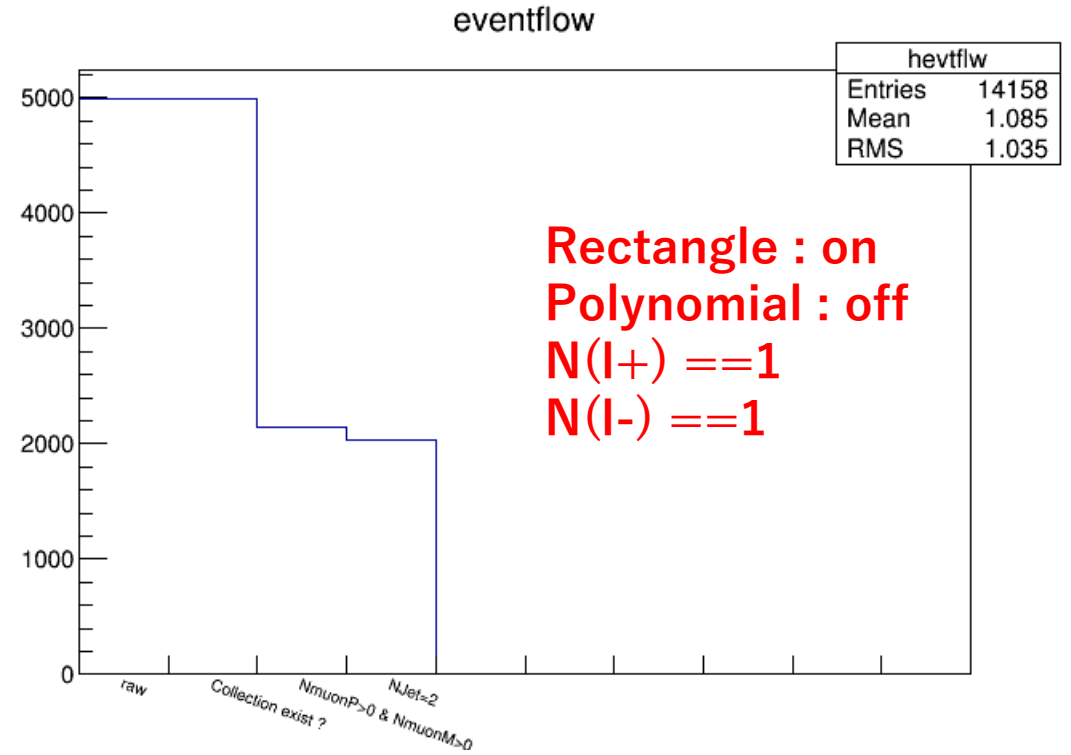
job template file

So far, this 3 condition (== cuts) are ON.

event selection on number of leptons is off to see the distribution

Event flow

eventflow

hevtflw	
Entries	11348
Mean	0.7385
RMS	0.8172

(default)

Rectangle : on
Polynomial : on
N(l+) ==1
N(l-) ==1

raw Collection exist ? NmuonP>0 & NmuonM>0 NJet≈2

eventflow

hevtflw	
Entries	14158
Mean	1.085
RMS	1.035

Rectangle : on
Polynomial : off
N(l+) ==1
N(l-) ==1

raw Collection exist ? NmuonP>0 & NmuonM>0 NJet≈2

Event flow

eventflow

hevtflw	
Entries	17009
Mean	1.321
RMS	1.099

Rectangle : on
Polynomial : off

N(l+) >= 1,
N(l-) >= 1

Ref: Muon Channel

eventflow

Rectangle : on
Polynomial : on

N(l+) == 1,
N(l-) == 1
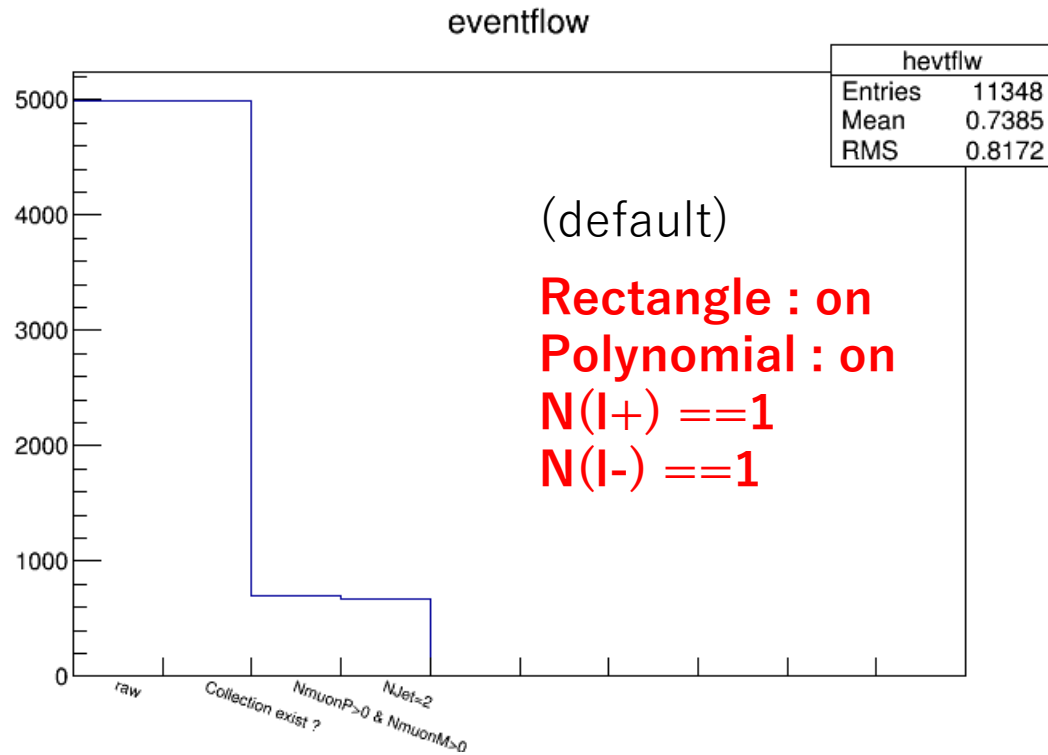
Event Selection (almost blind analysis)

eventflow

hevtflw_sel	
Entries	90828
Mean	2.591
RMS	2.691

Roughly estimated scaling factor is already applied.
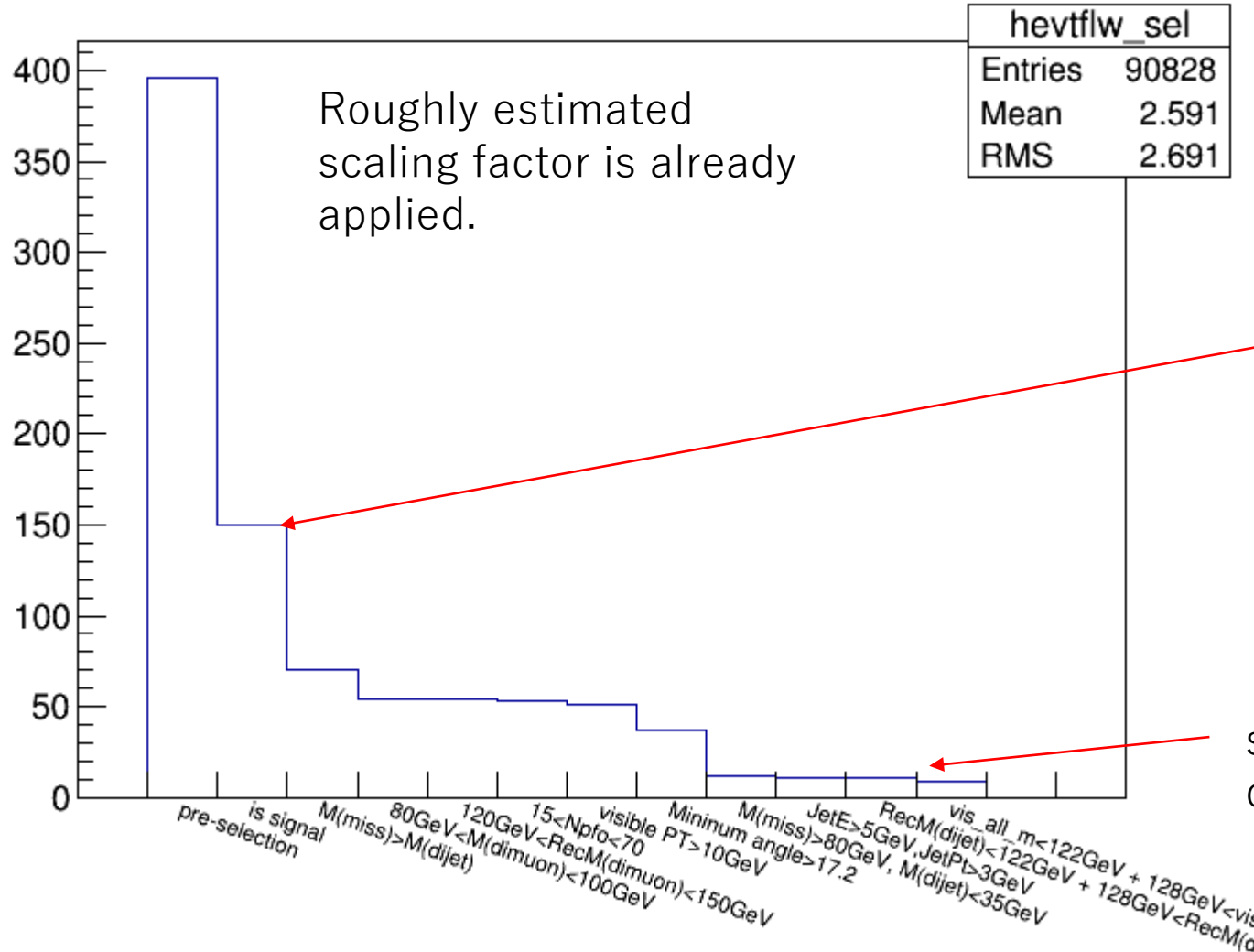
Ref: Muon channel

Cut	Signal	ZH background	2f
Expected	1000	1140511	8
$Pre-selection$	616	30524	
$Signal\ or\ not$	211	30307	
$M_{missing} > M_{dijet}$	107	1605	
M_{dimuon}	95	726	
M_{dimuon}^{rec}	95	707	
$N(pfo)$	94	336	
$Pt_{visible}$	89	312	
$Angle_{min}$	85	298	
$M_{missing}\ and\ M_{dijet}$	62	80	
$Single\ Jet$	54	67	

signal efficiency is too low, need to optimize the cut positions at each stage.

pre-selection, is signal, M(miss)>M(dijet), 80GeV<M(dimuon)<100GeV, 120GeV<RecM(dimuon)<150GeV, 15<Npfo<70, visible PT>10GeV, Minimum angle>17.2, M(miss)>80GeV, M(dijet)<35GeV, JetE>5GeV,JetPt>3GeV, RecM(dijet)<122GeV + 128GeV<vis, vis_all_m<122GeV + 128GeV<RecM(a

```python
def select_higgs_to_zz(t,combine_opt):

    h_evtflw.Fill(1)

    if ( combine_opt == 1 ):
        index = select_zpole_muon(t)

        # Select ZZ*->nunu,jj ( Z->nunu, Z*->jj ) events : Mass(missing) > Mass(dijet)
        if ( ZZ_Selection == 1 ):
            if not ( t.vis_all_rec_m > t.dijet_m[0] ):
                return False
        if ( ZZ_Selection == 2 ):
            if not ( t.vis_all_rec_m < t.dijet_m[0] ):
                return False
        h_evtflw.Fill(2)

    if not ( t.dimuon_m[index] > 80.0 and t.dimuon_m[index] < 100.0 ):
        return False
    h_evtflw.Fill(3)

    if not ( t.dimuon_rec_m[index] > 120.0 and t.dimuon_rec_m[index] < 150.0 ):
        return False
    h_evtflw.Fill(4)

    if ( ZZ_Selection == 1 ):
        if not ( t.n_col_reco > 15 and t.n_col_reco < 70 ):
```

At each stage, just before the cut applied, put histogram to show the distribution.

Of course, preparing it at the other place is also fine.

```python
def fill_histograms(t,num,combine_opt):

    index = 0
    if (is_sel(t,num,combine_opt) ):
        # Distribution after pre-selectioon ( muon_p>=1, m
        h_m_dimuon_raw.Fill( t.dimuon_m[index] )
        h_mrec_dimuon_raw.Fill( t.dimuon_rec_m[index] )
        h_m_dijet_raw.Fill( t.dijet_m[0] )
        h_mrec_dijet_raw.Fill( t.dijet_rec_m[0] )
        h_m_visible_raw.Fill( t.vis_ex_dimuon_m )
        h_m_missing_raw.Fill( t.vis_all_rec_m )
        h_vis_all_pt_raw.Fill( t.vis_all_pt )
        h_vis_all_m_raw.Fill( t.vis_all_m )
```

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About the CEPC note

Comment 1

-- the definition of "Signal" is

μμννjj, and if we define as it,

the number of signal is ~ 150? at maximum.
At any rate, the table contains at least two kinds of "signal",

μμHZZ , and μμννjj (or μμννjj+μμjjνν)

This should not be confused.

4   Event Selection of $Z(\to\mu\mu)H(ZZ^*\to\nu\nu qq)$

4.1 $Z(\to \mu^+\mu^-)$, $H(Z\to\nu\bar{\nu}, Z^*\to q\bar{q})$

4.1.1   Event selection (Cut-based)

Table 5: Cut flow table for $\mu\mu\nu\nu qq$ channel

cut	signal	zh background	2f background	4f background	$\frac{S}{\sqrt{S+B}}$	Sig. Eff.
Raw events	1212	12557950	8828594187	1180400980		
$Pre-selection$	817	31794	4170834	735206		
$Signal\ or\ not$	270	31571	4170834	735206		
$M_{miss} > M_{dijets}$	138	2132	1945599	240838		
$80GeV < M_{\mu^+\mu^-} < 100GeV$	127	1254	1338593	48117		
$120GeV < M_{Recoil} < 150GeV$	126	1227	152297	15384		
$15 < N_{pfo}$	125	506	5953	760		
$10GeV < Pt_{visible}$	118	462	783	321		
$Min\ angle > 17.2°$	109	429	582	194		
$M_{miss} > 80GeV, M_{dijets} < 35GeV$	79	90	553	78		
$Pt_{jet1,2} > 3GeV, E_{jet1,2} > 5GeV$	68	72	0	8		

Table 6: Remained backgrounds after all of cuts applied. It is better to list the channel which has more than 1 event. The number of 1 should be determined by analysis status. (if N(bg) ¿ 1000, 1 is too small)

name	scale	final
e2e2h_ww	0.0818403	12
nnh_zz	0.0683871	55

Comment 2

-- It is better to have those 2D plot, to show two concentrations. (mmvvjj & mmjjvv)

-- Can we see that for vv channel ? and if it is, can we divide that to two regions, like the other channels ?
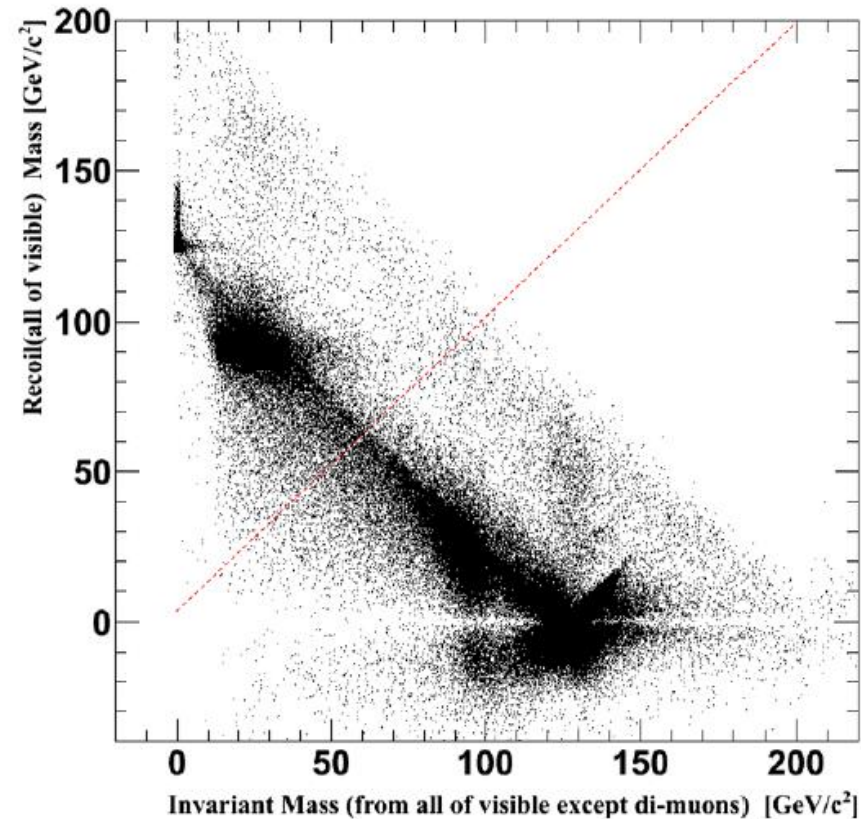

Figure 5: Missing mass vs Invariant Mass except dimuons. Would be Missins mass vs dijet invariant mass.

Comment 3

-- I propose to have histograms at each cut stage basically. If it has 30 cuts,,, and we know that some of them is too apparent, then we can skip it, but probably,,, such cut chain should be considered again.

-- and better to have arrows when we make histograms. Let's prepare a macro (program) to draw arrows semi-automatically.
I just afraid the amount of histograms and possible changes in future, if we have received some comments to do so.
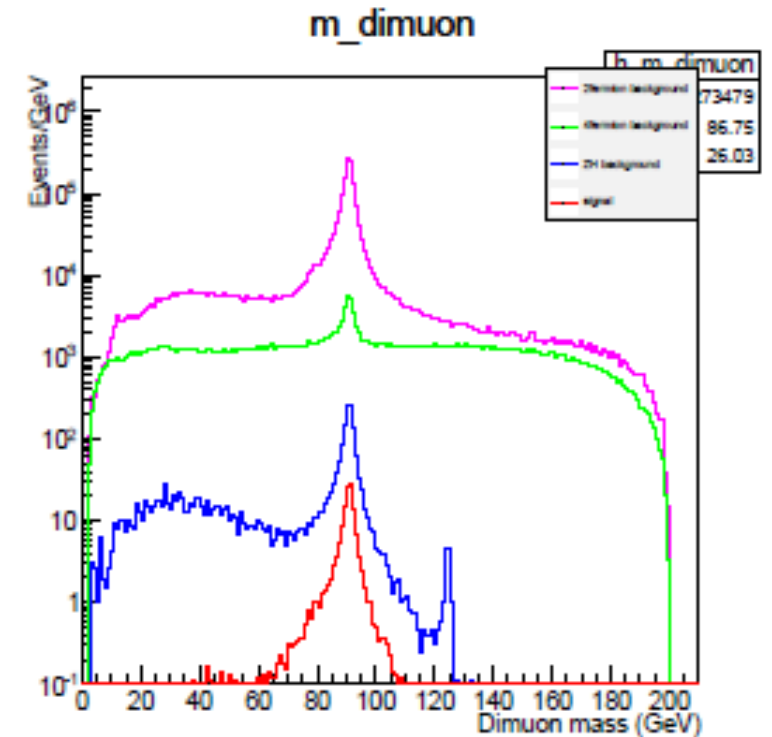
Actually, Lingteng put arrows manually on slide. That's good and I also do it normally, but sometimes, like this case, I also have prepared a macro to draw/set the position of arrows.

Next step

-- Further study of "ee" channel

    -- to see if there is significant problem or not. will check the MC truth info. as suggested by Manqi

    -- I(we) could share the root files after pre-selection, in case we can do the later stage's event selection in parallel. (possibly, vveeqq/vvqqee is the next promising channel, but we need to see the eevvqq first)