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Compressed EWK study(ISRC1N2)

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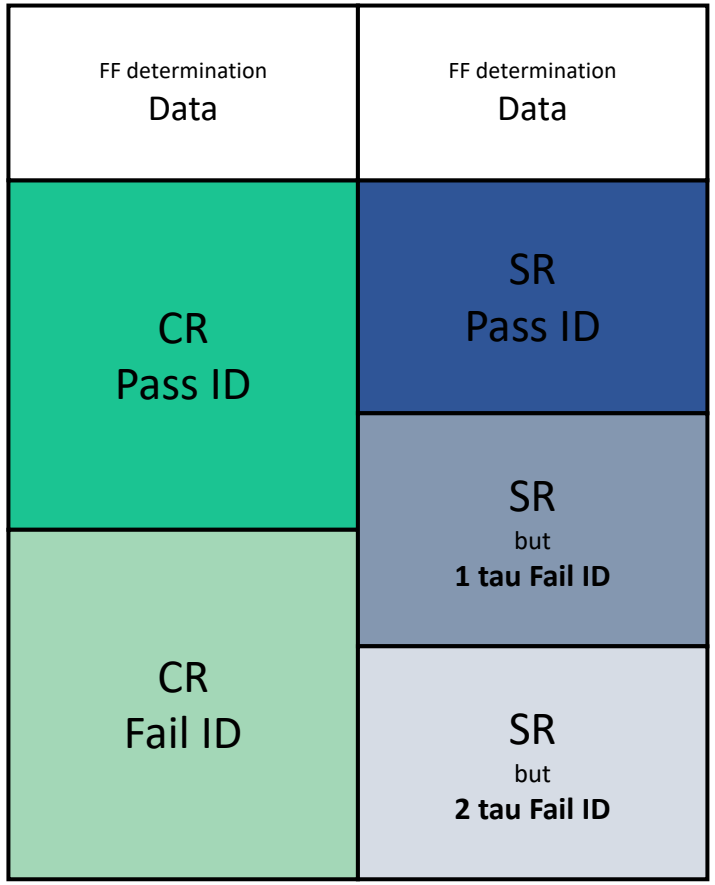
Tasklist

- Technical tool
  - Git and Docker(Pro Git, Docker Docs)
  - With a few cpp assignments to practice
    https://github.com/courseworks
- Update FF method with SS selection
- Include more signal in ML to expand exclusion limit(Ongoing)

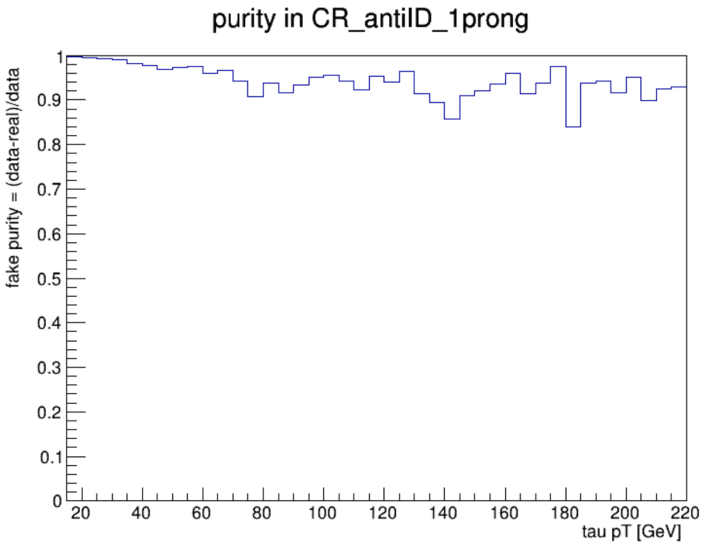
FF method

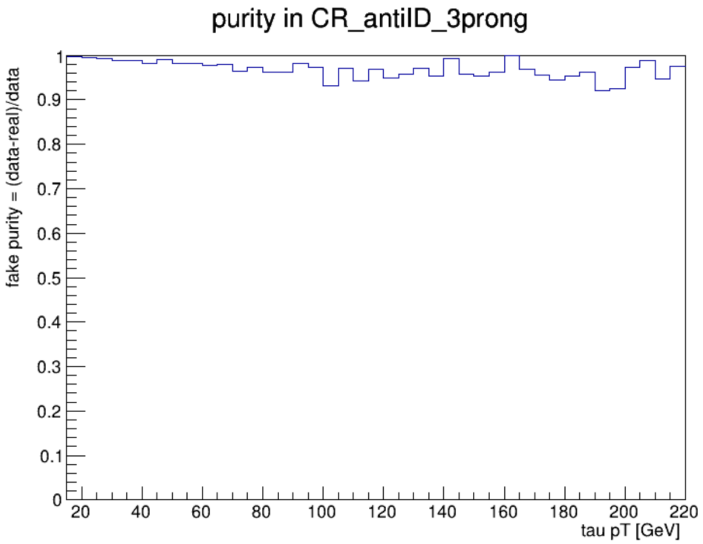
- CRs (fake factor computation)
  - METtrig
  - MET>=200
  - bveto
  - at least 1 signal lepton
  - **SS (orthogonal with LH SR)**
  - **ID: >= 1 medium tau**
  - **antiID: >= 1 VeryLoose tau, 0 medium tau**
- SRs
  - preselection
  - 2ID: >= 2 medium tau
  - 1ID1antiID: >= **2 VeryLoose tau** , 1 medium tau
  - 2antiID: >= **2 VeryLoose tau** , 0 medium tau

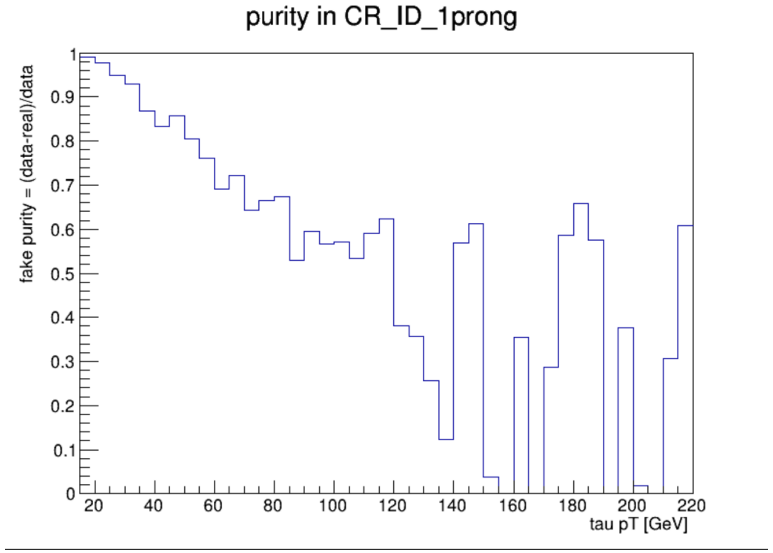


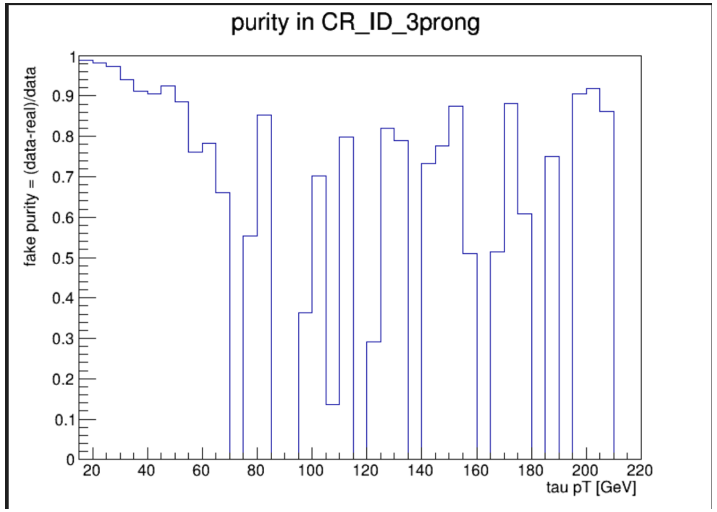
- **Binned in prongness, tau eta, tau pT**
  - Eta bins
    - 2 bins: central [0,1.37], forward [1.52,2.5]
    - 3 bins: eta0,1,2 for [0,1), [1, 1.37], [1.52,2.5]
- **Auto binning:**
  - > 10% of events in nominator and denominator
  - Add bins to bin i until it is not consistent anymore with bin i - 1
    - Relative stat uncertainty on ratio smaller than 50%
    - >10% events in nominator and denominator

FF method

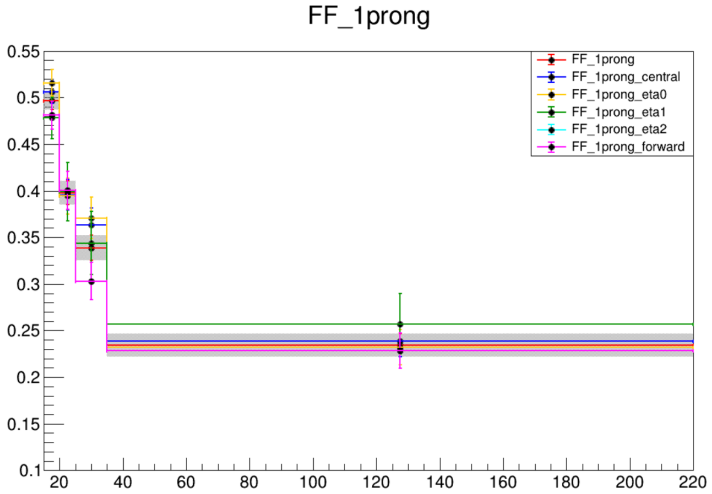

purity in CR_antiID_1prong
fake purity = (data-real)/data
tau pT [GeV]

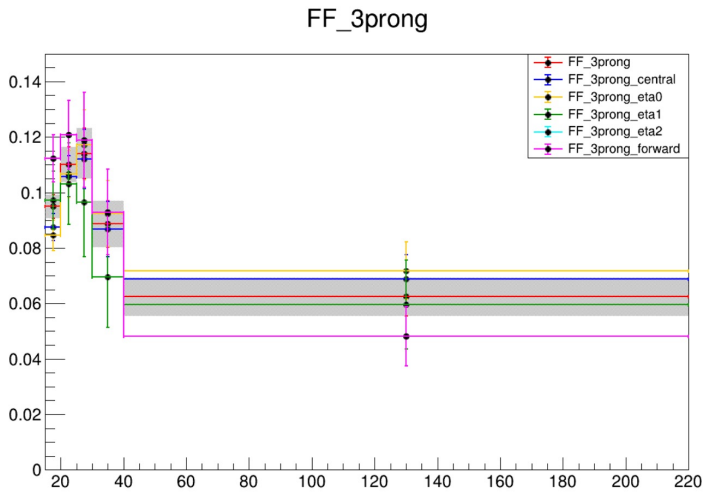

purity in CR_antiID_3prong
fake purity = (data-real)/data
tau pT [GeV]


purity in CR_ID_1prong
fake purity = (data-real)/data
tau pT [GeV]

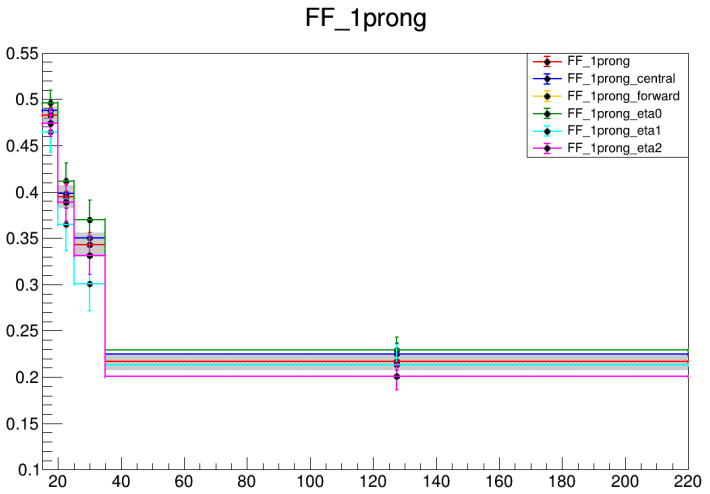

purity in CR_ID_3prong
fake purity = (data-real)/data
tau pT [GeV]

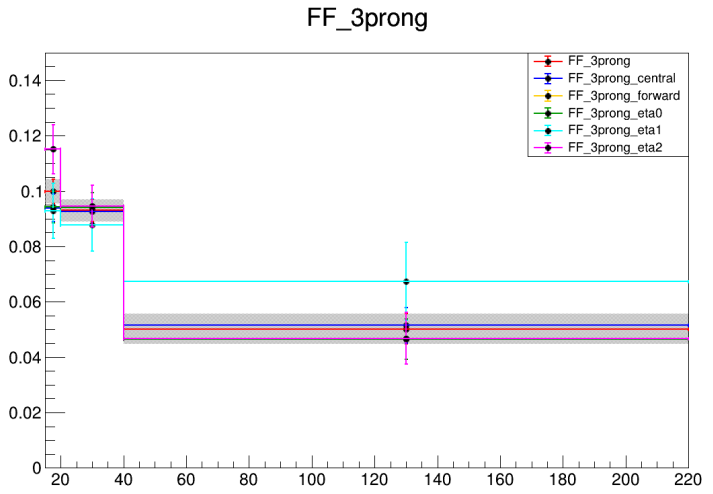
FF method





Updated result



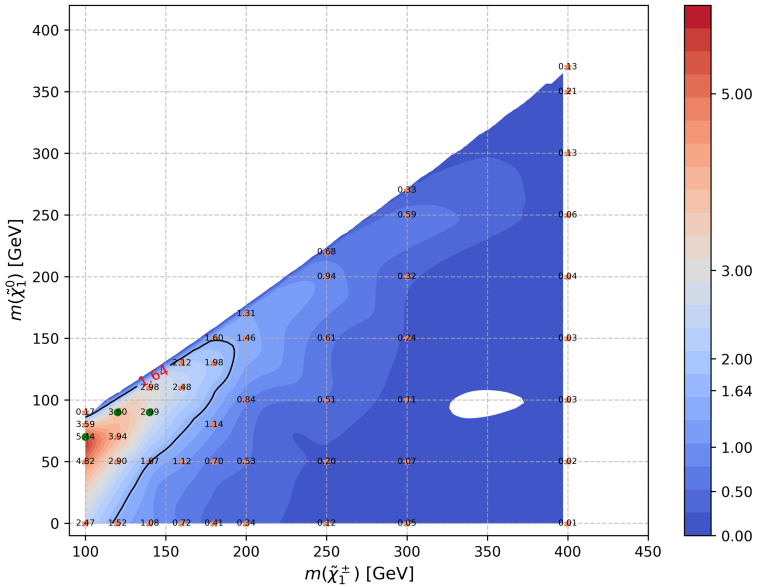


Previous result

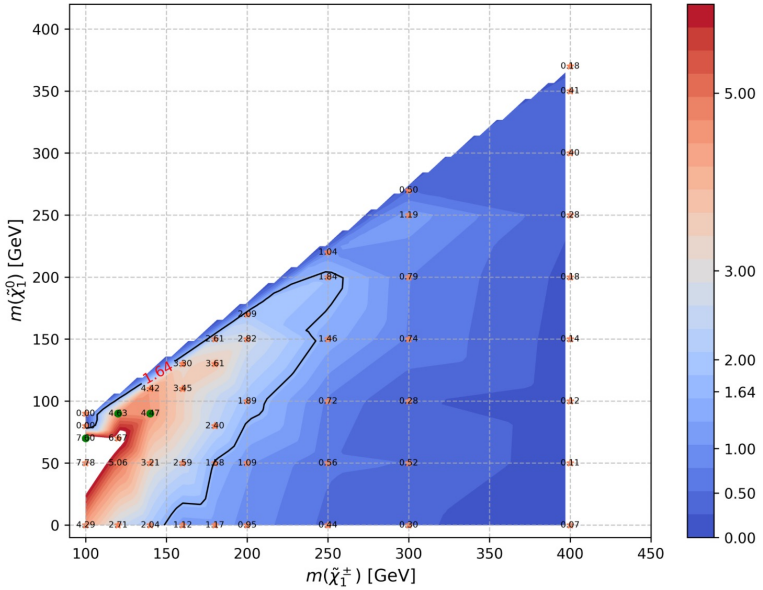
SR(HH)

Include signal: 100_70, 120_90, 140_90

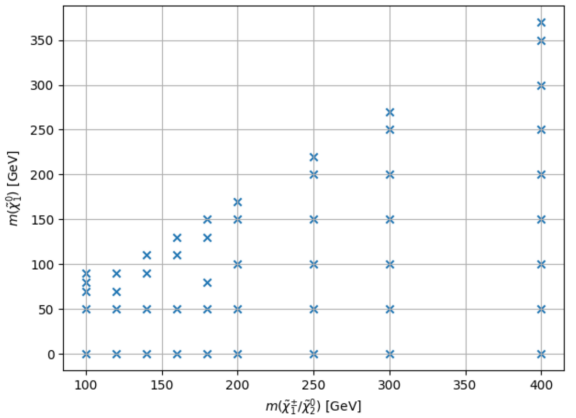
Previous result(Run2 only with 100_70)



Run2+partial Run3 and with more signal points



For now, signal only include 2TFilter



include more signal to see if it can expand the limit

TODO

1. include 1TFilter signal in the sensitivity map

2. apply the same process in the LH channel

3. compare the Run2+partial Run3 result with only Run2 result

Backup

C1N2 ISR signal region optimization

- Preselection for HH and LH channel
- BDT method for signal region optimization
  - Figure of merit: AUC
  - 5-fold Cross-Validation

HH Pre-selection	LH Pre-selection
>= 2 medium taus	>= 1 medium taus
0 base lepton	>=1 base lepton, >=1 signal lepton
MET ≥ 200; pass MET trigger	MET ≥ 200; pass MET trigger
1≤nJet	1≤nJet
Opposite-sign hadronic-hadronic tau pair	Opposite-sign lepton-hadronic tau pair
bveto	bveto
jet pt>100 GeV	jet pt>100 GeV
$\mathbf{M_{\tau\tau}^{reco} < 40\ GeV\ or\ M_{\tau\tau}^{reco} > 130\ GeV}$	$\mathbf{M_{\tau\tau}^{reco} < 40\ GeV\ or\ M_{\tau\tau}^{reco} > 130\ GeV}$

Penalty function to balance the AUC and overfit

$$\mathcal{F} = AUC_{validation} - 0.3 \times AUC_{gap}$$

$$AUC_{gap} = |AUC_{train} - AUC_{validation}|$$

Grid Search for the best model

Hyperparameter	Scan Range
NTrees	200, 300, 400
MaxDepth	4, 6, 8
MinNode	1, 3, 5
Learning rate	0.01, 0.03, 0.05, 0.08, 0.1