Chung-Yao Chao Fellowship Interview 2021

Ram Krishna Sharma, Institute of High Energy Physics
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Resume

- Education:

  - Bachelors in Physics (Honours), University of Delhi, India, 2009.

  - Masters in Physics, University of Delhi, India, 2012.

  - PhD in High Energy Physics (CMS), University of Delhi, India, 2019.

  - Post-doc from IHEP, starting from 26th December 2019 - onwards

- Research interest:

  - Higgs physics, Vector boson scattering, High Level Trigger development.

- Skill:

  - Coding: c/c++, Python, shell script, git, PHP

  - Machine learning: Tensorflow, Keras, Pandas

  - Analysis framework: ROOT, RooFit, UPROOT, CMSSW (CMS Software) Framework

  - MC Event generator: Madgraph, VBFNLO

Previous Work & Achievement

Previous Work	Achievement

Previous Work

- Physics Analysis

  - Anomalous quartic gauge coupling measurement (Phys. Lett. B,798, 134985)

    - First result from CMS on $W^+W^- \to l\nu qq$. Set best limit till date on dim-8 aQGC parameters.

  - Vector boson scattering (CADI: SMP-20-013)

  - MC generator work including polarisation study.

- Detector work

  - GEM R&D and beam test responsibility (2 publication)

Achievement

- Received Fundamental physics award from CMS 2015

- "GEM Detector Response Modelling" group convener, July 2015 - Nov 2016.

- Selected in "Summer 2017 Guests & Visitors program to the LPC, Fermilab, USA" for VBS analysis.

- Selected for Young Scientist Forum (YSF) talk at La Thuile 2019

- EGamma HLT Convener (**Present**)

Work Plan (Ongoing/planned)

- $H \rightarrow ZZ \rightarrow 4L$ **differential fiducial cross-section measurement**

  - **Additional EFT interpretation**

  - **New differential variables such as nJettiness (Which helps to veto additional jets)**

- $HH \rightarrow WW\gamma\gamma \rightarrow (4q)\gamma\gamma$ **(Ongoing work: Non-resonant production, Soon start: Resonant production of HH)**

  - **Upper limit on di-Higgs production cross-section**

  - **Constraint on Higgs tri-linear self-coupling**

  - **Additional EFT interpretation**

Main contribution

- Vector boson scattering:

  - Measurement of WV VBS cross-section.

- High mass Higgs search in $H \rightarrow ZZ \rightarrow 2L2Q$ channel.

  - Additional extension for the same to measure the anomalous Triple Gauge Coupling (aTGC).

- **Electron & photon trigger performance study for the Run-3**

- **Concentration Pre-Processing Fan-out (CPPF): Maintain & upgrade of the framework for data quality monitoring.**

Main contribution

$H \rightarrow ZZ \rightarrow 4L$ Differential fiducial cross-section measurement

- Large signal to background ratio

  - Complete 4-body mass reconstruction

  - Excellent lepton momentum resolution.

- AIM: fiducial differential cross-section:

  - Extend the study in terms of both production and decay variables of Higgs.

  - Measure set of 1D and 2D differential observables.

  - Additional theoretical interpretation using Madgraph NLO having 0, 1 and 2 jet production.

    - Working with Higgs Characterisation, SMEFT model.

- Constraint on effective Hbb, Hcc couplings from b-quark and c-quark contribution to the Hgg loop.

- Constraint on Higgs tri-linear self-coupling κ_λ

Qcut/NNLOPS

Qcut/minLO

Qcut/powheg
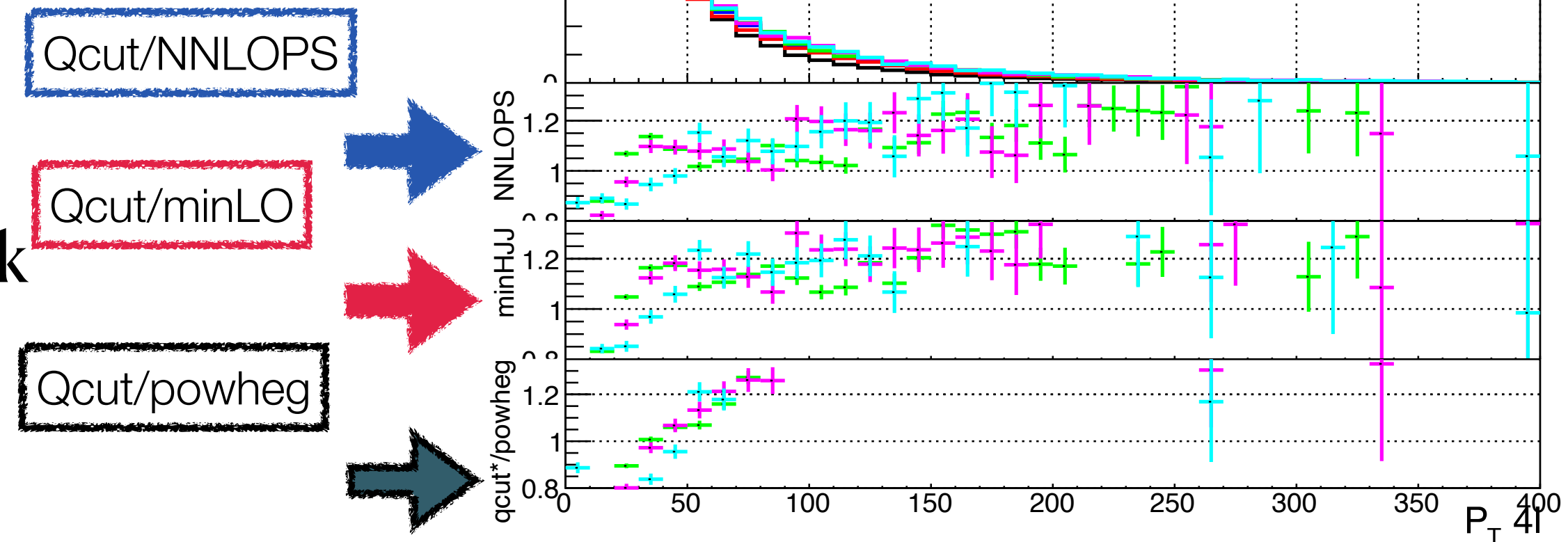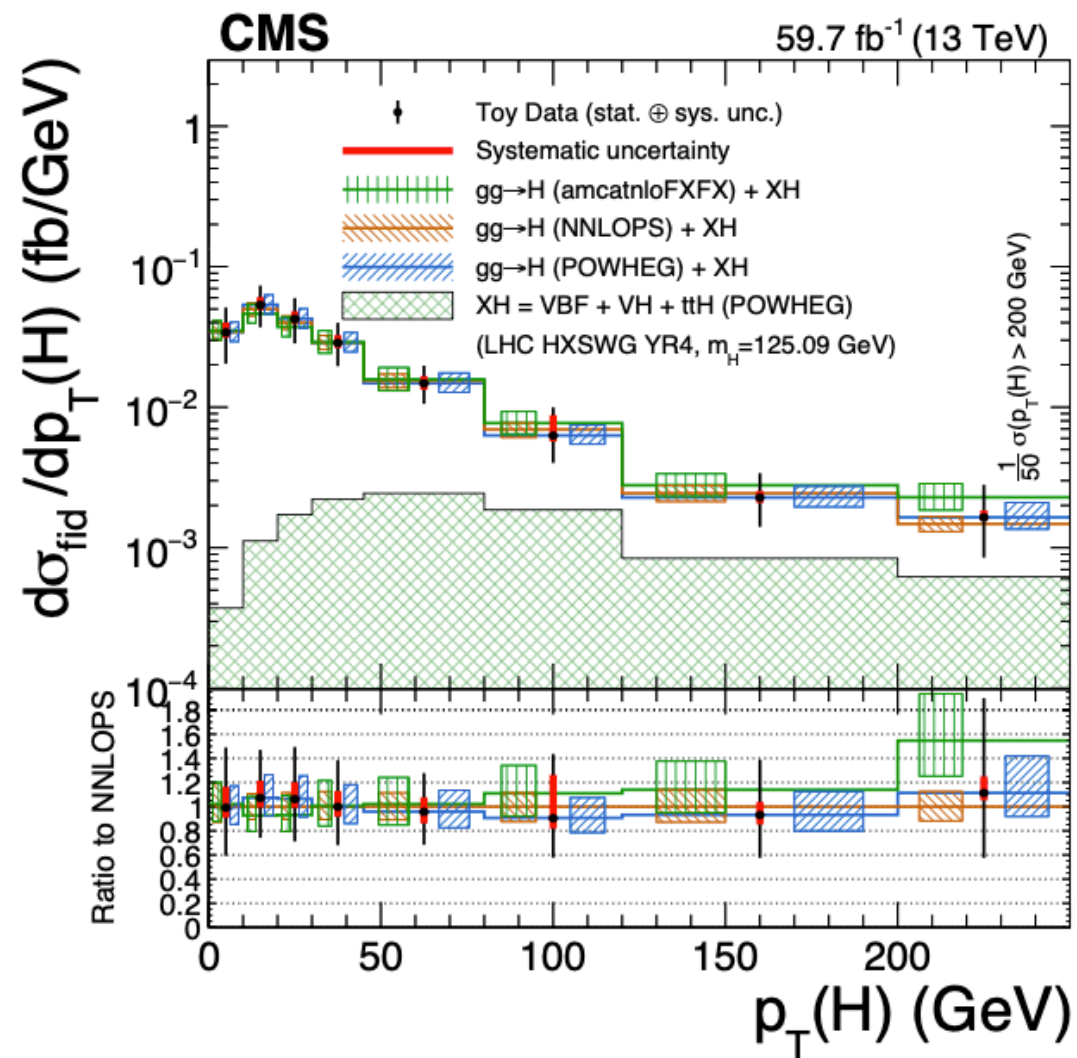
Double Higgs Study ($HH \rightarrow WW\gamma\gamma \rightarrow (4q)\gamma\gamma$)
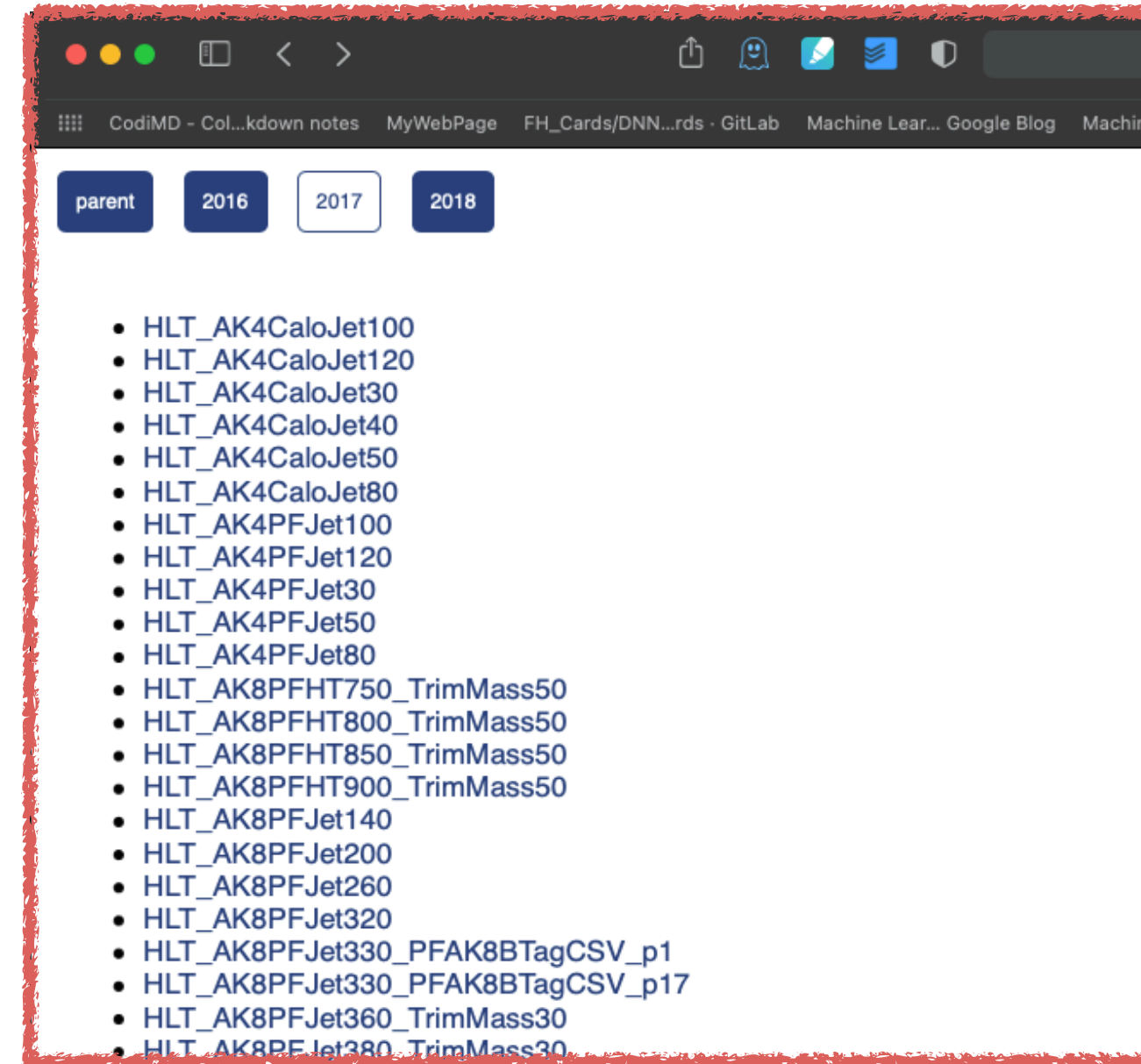
- First study in CMS.

- Important in understanding EWSB.

  - Higgs self coupling, Higgs trilinear coupling.

  - This process has a low branching ratio among HH processes ≈ 0.1%

  - Advantage: excellent diphoton mass resolution of H→ γγ

- Used DNN technique to improve the result.

  - improving ~51% over the simple cut-based analysis.

- Expected result: 95% CL upper limit on cross-section is 169.50xSM.

  - Constraint on Higgs tri-linear self-coupling, κ_λ scan

  - Additional EFT interpretation (for scanning BSM di-Higgs coupling parameters)

- Analysis status: under approval process of CMS

- Soon starting on resonant production studies of HH.


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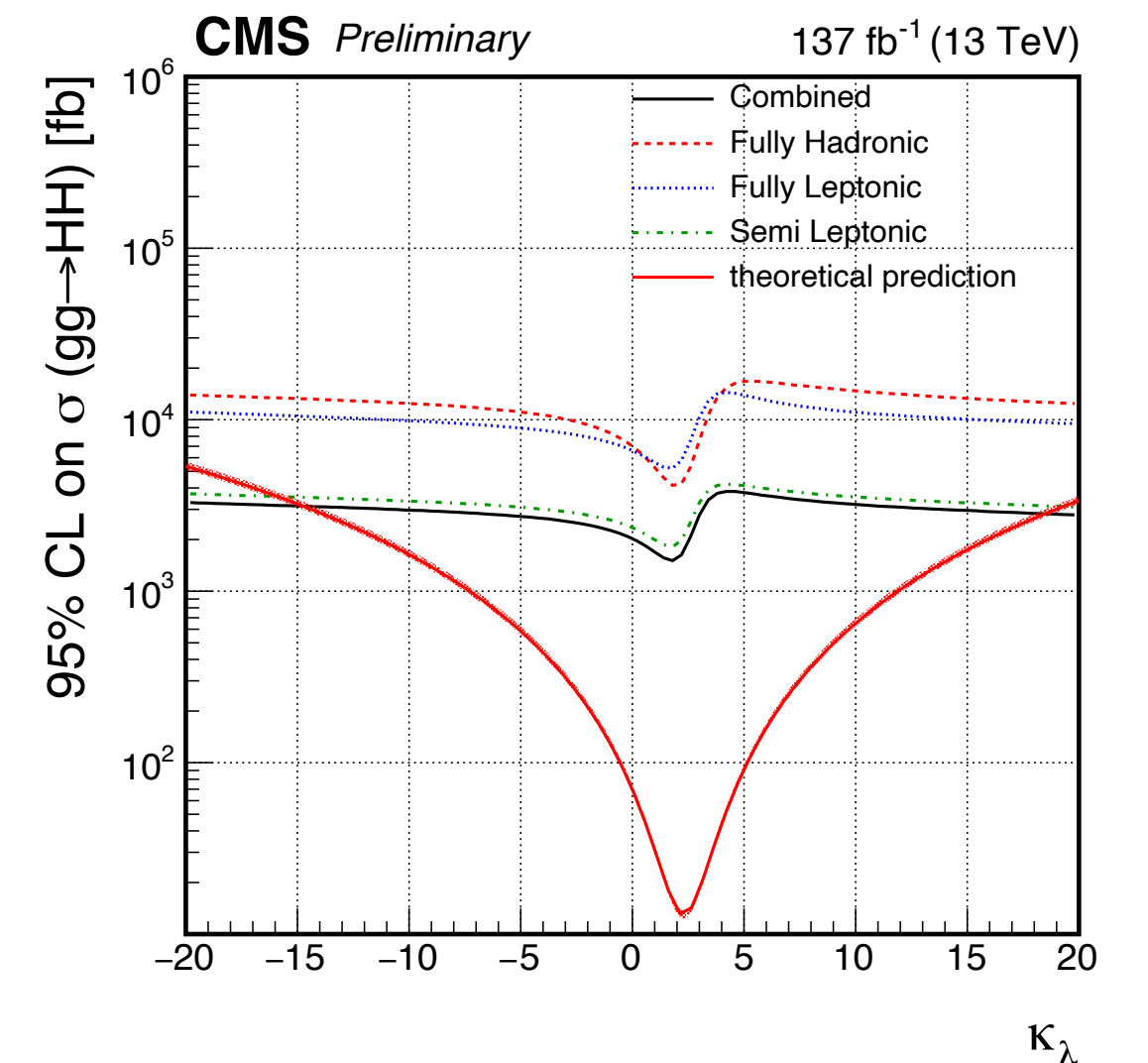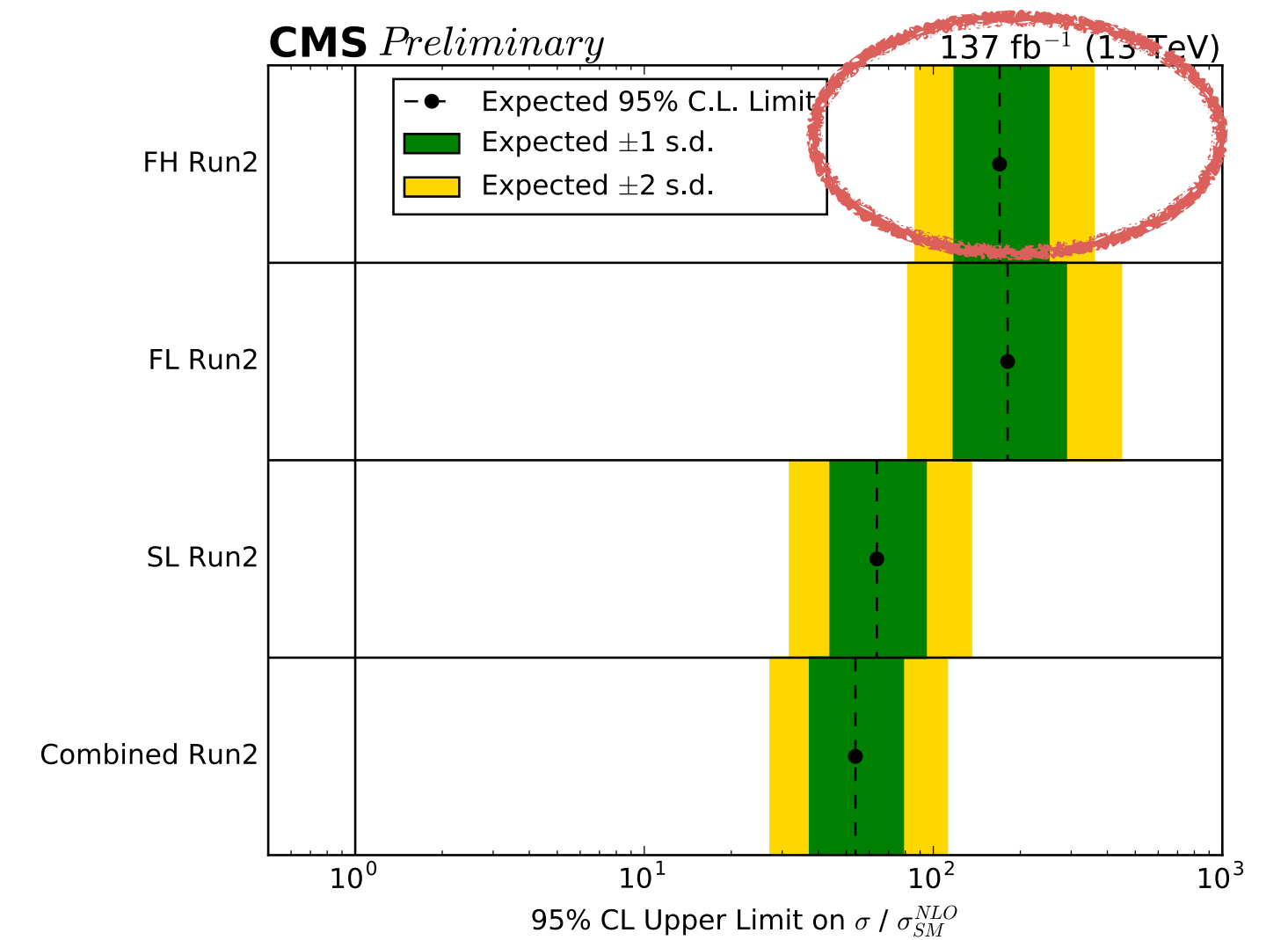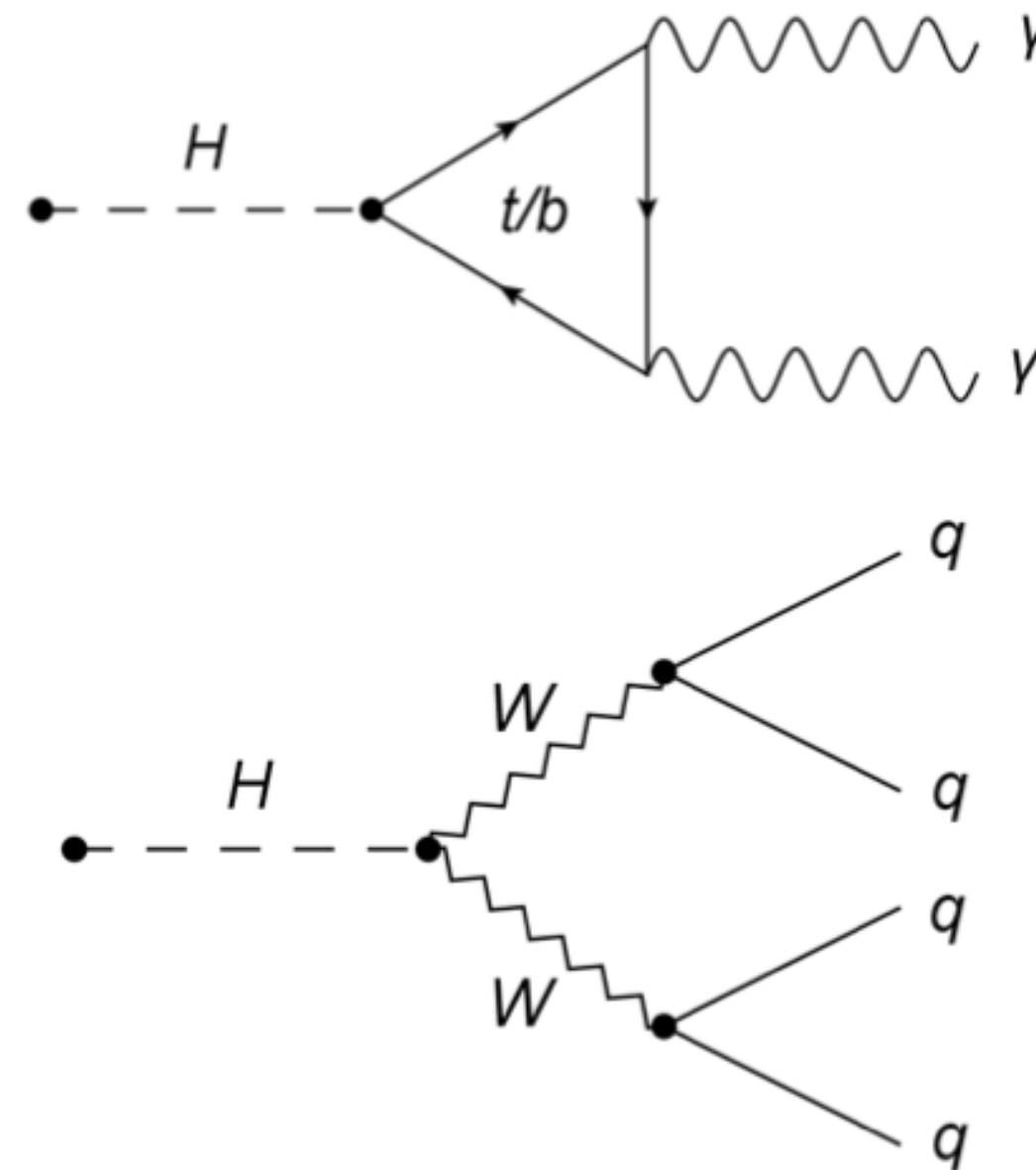
EGamma HLT Studies for Run3

- Webpage for checking the trigger pre-scale

  - Contains list of all pre-scale used in run2 (2016-2018 data taking)

  - For each trigger, it contains information of run number and the pre-scale used.

    - JSON file can be downloaded for interesting triggers/run.

  - https://ram1123.github.io/display_TriggerPreScale/

- Trigger performance comparison for Run2 and Run3.

  - Preliminary results show roughly same behaviour of triggers in Run-3.

  - Working on the improvement of the performance in Run-3

    - By tuning the various cuts used in the trigger path.

Webpage for Trigger pre-scale: Run2

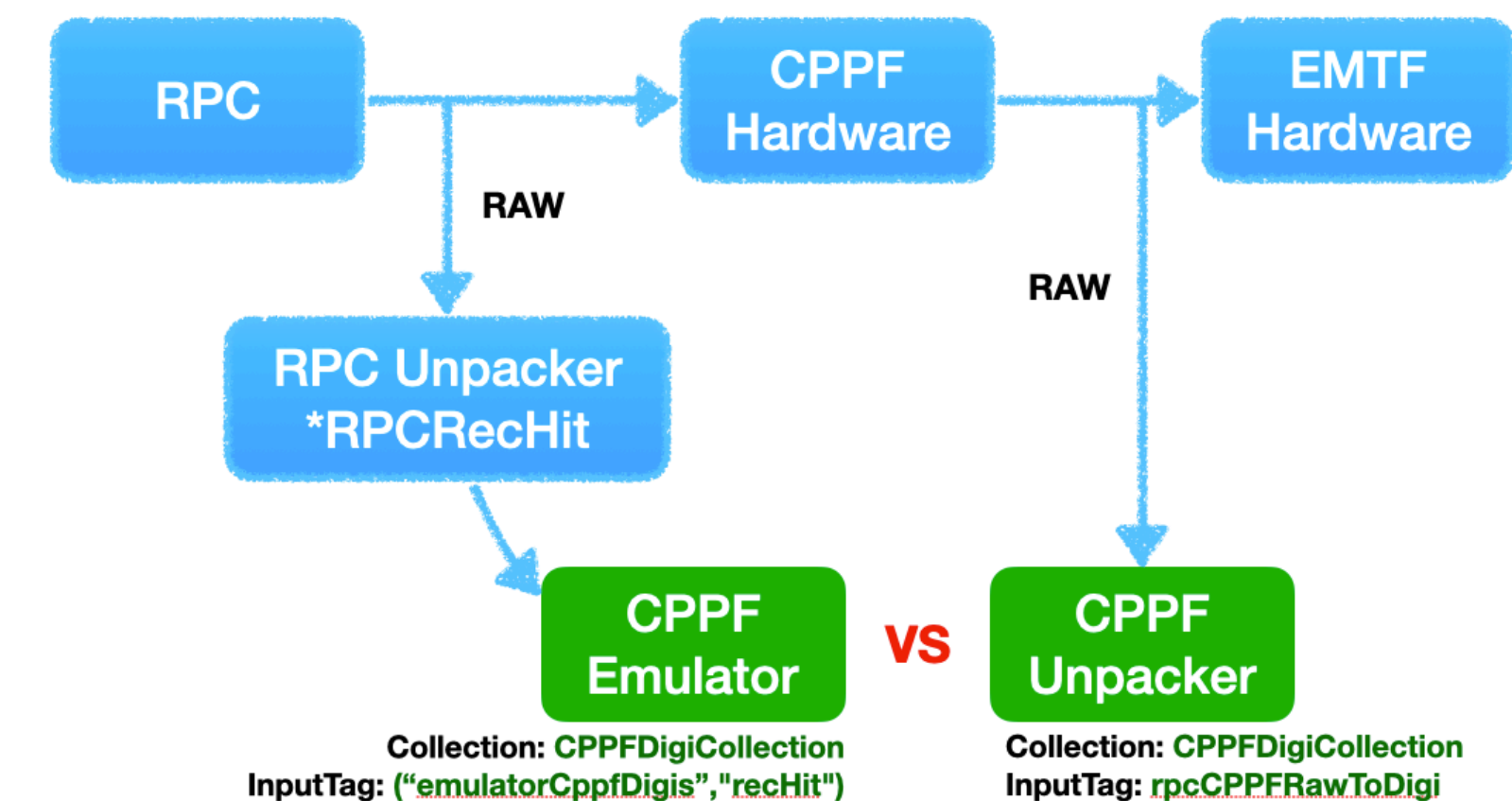**Trigger performance comparison**
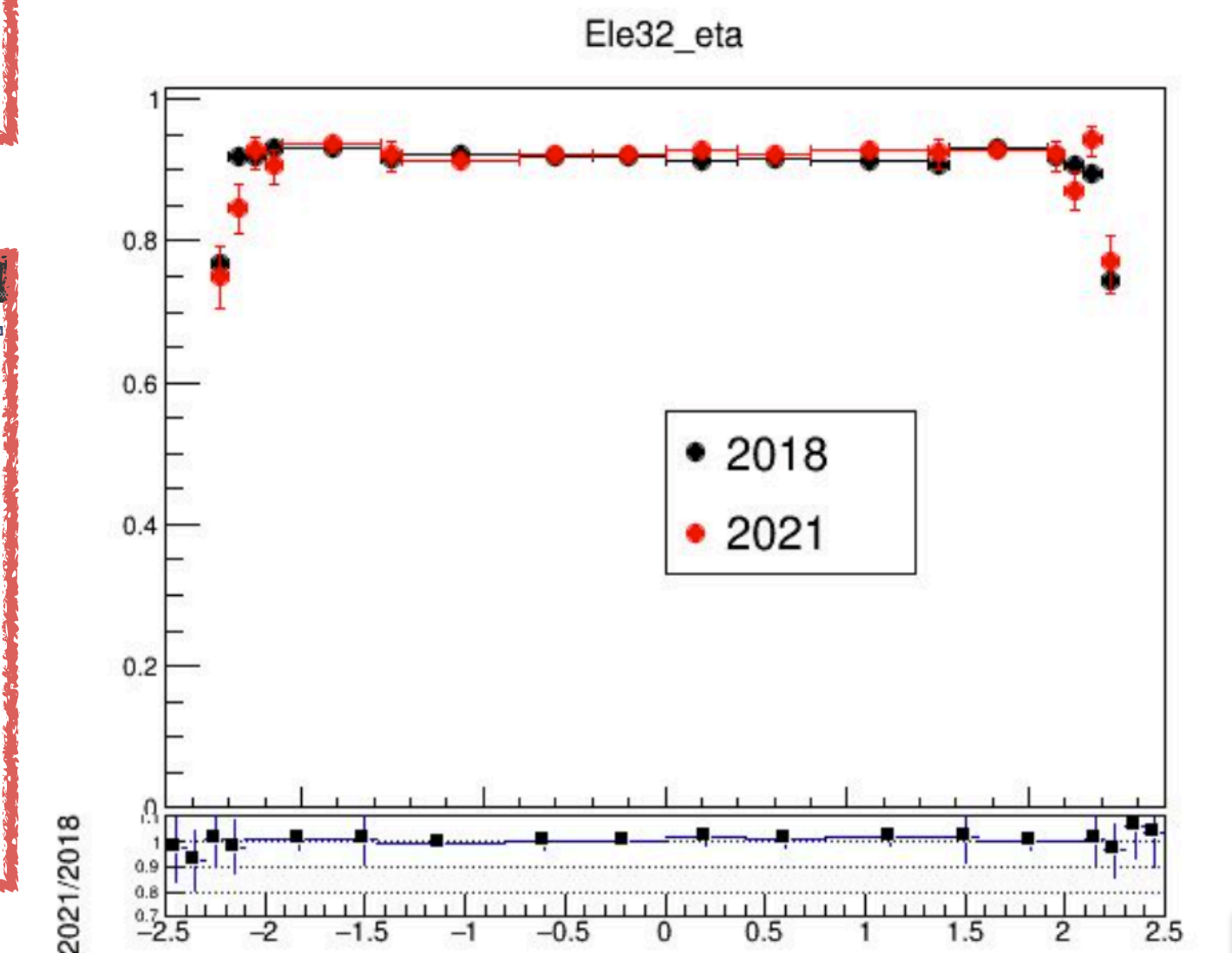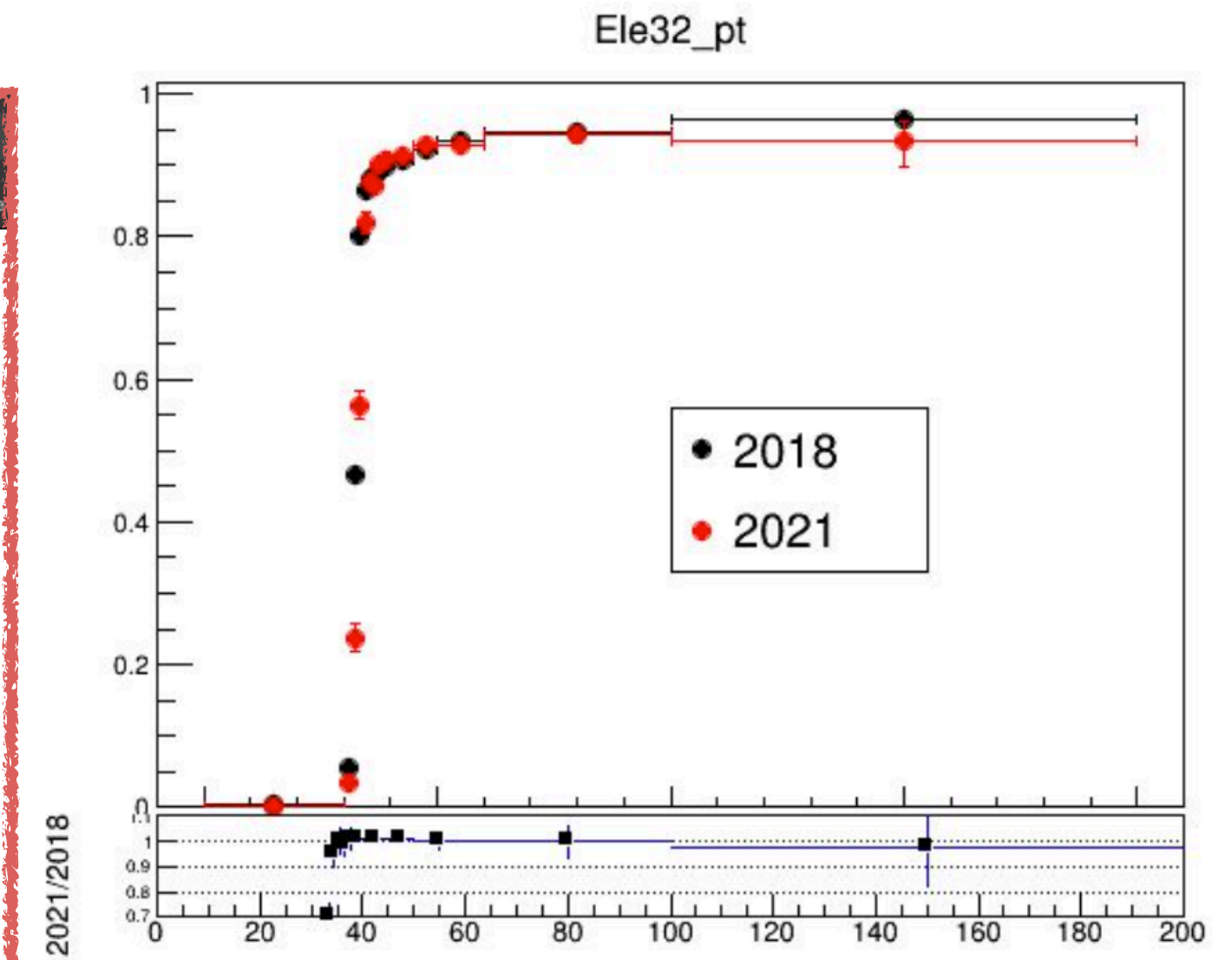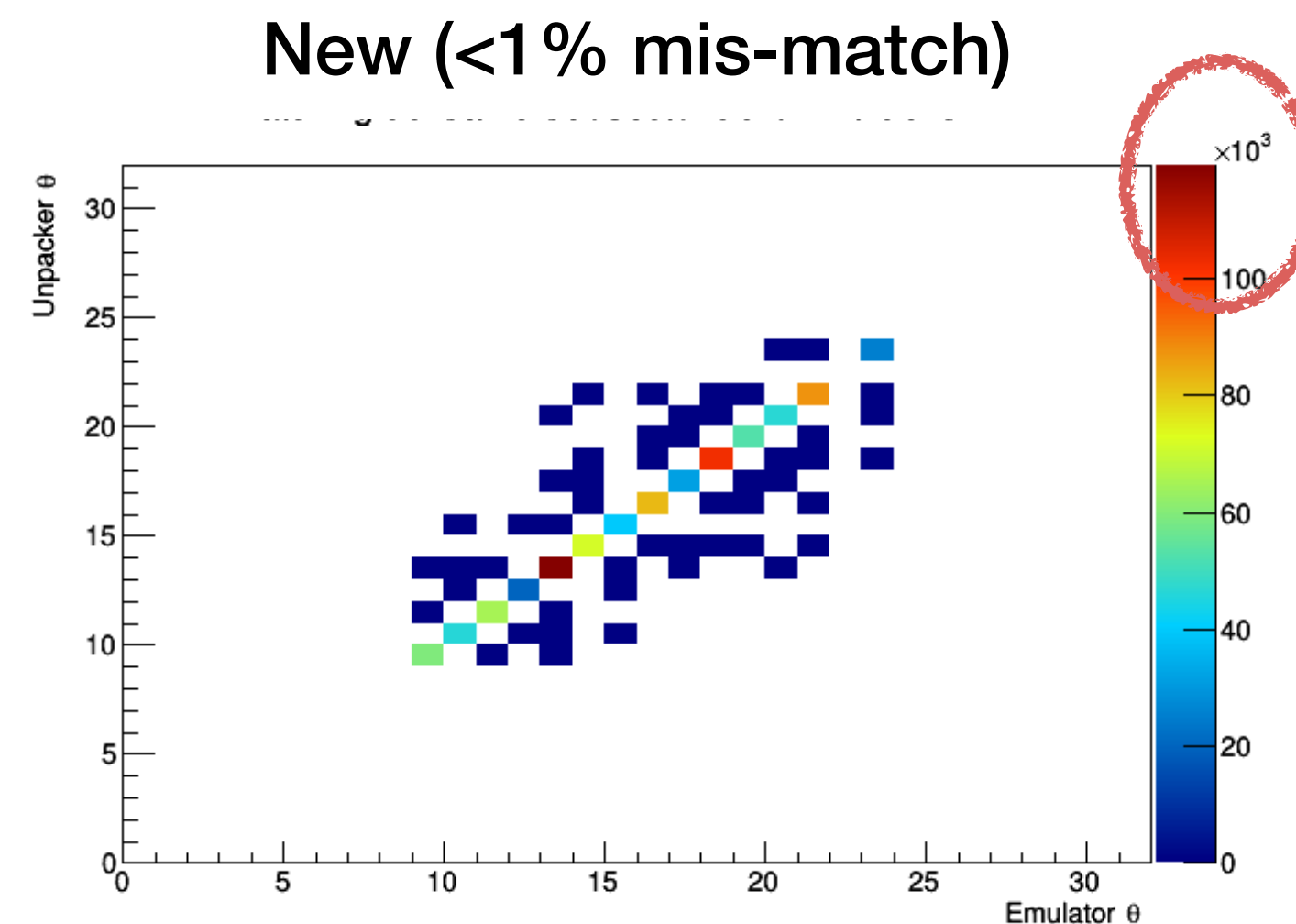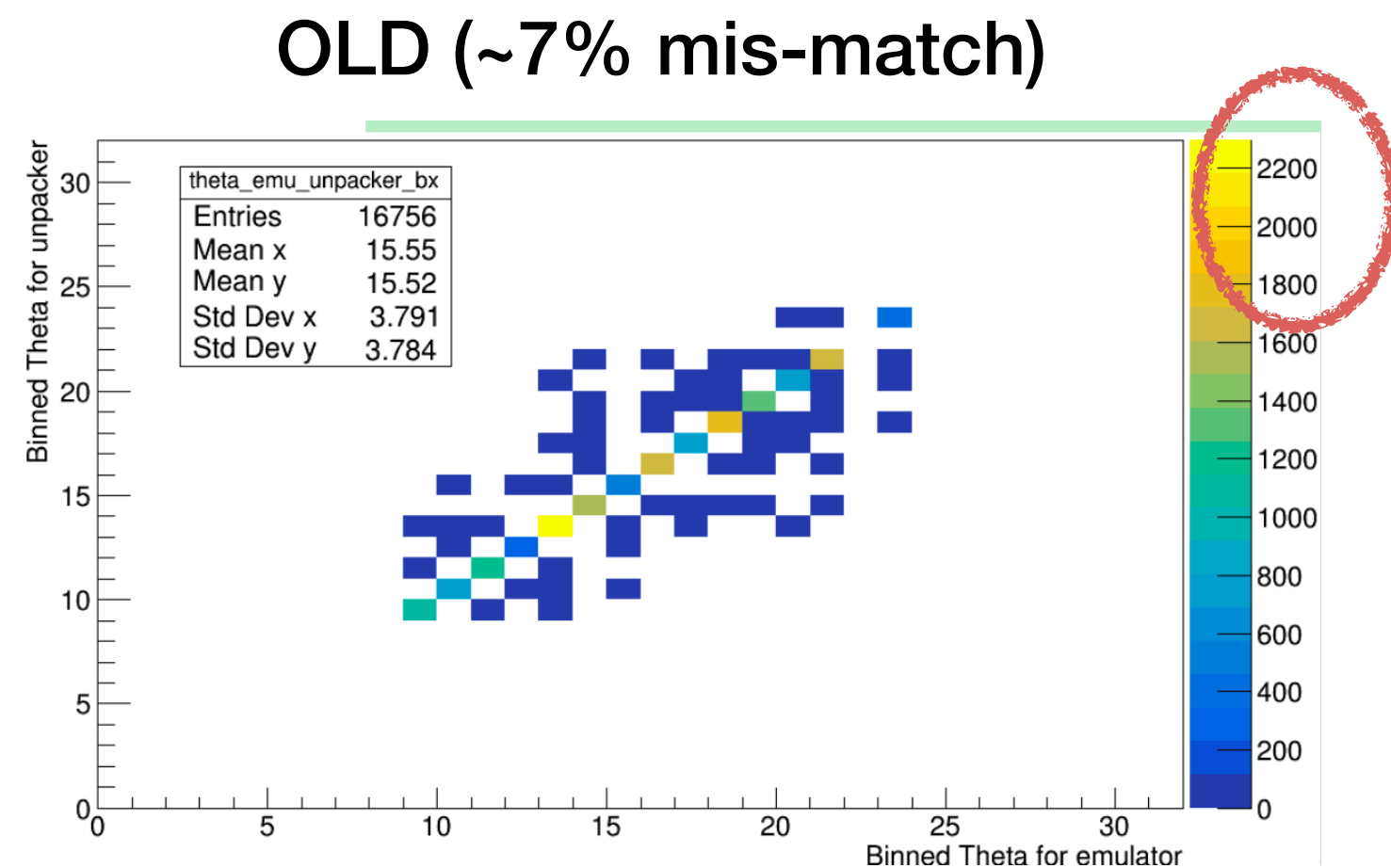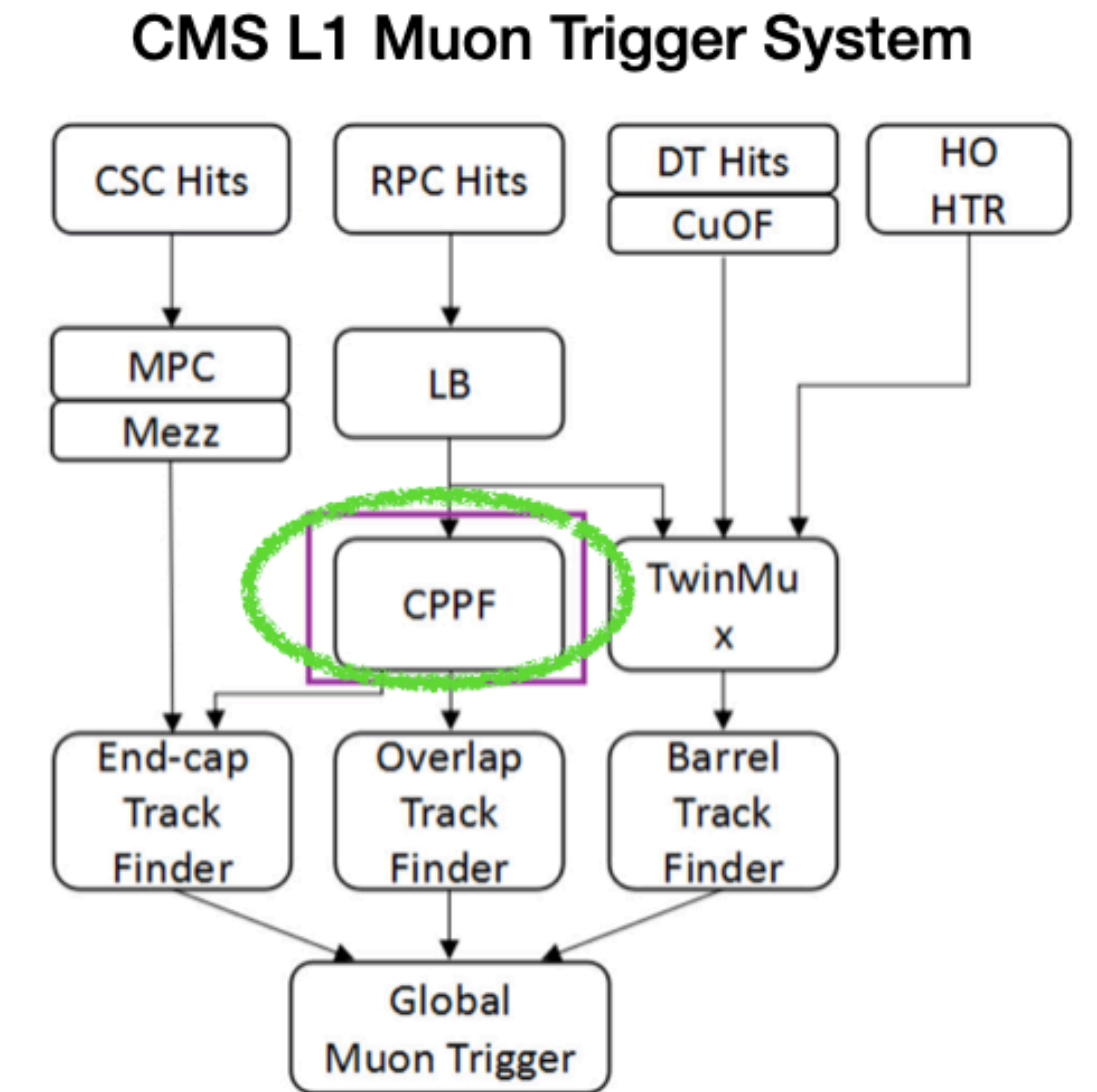
Vector Boson Scattering

- First study in CMS with opposite sign WW (Semi-leptonic decay).

    - Without Higgs, vector boson scattering cross section would violate unitarity at the TeV scale.

    - Vector boson scattering at the LHC probes triple and quartic gauge couplings

- Included WW and WZ both channels.

    - In case of hadronic decay of W/Z boson, its hard to distinguish between the two.

- Used both resolved and boosted category of hadronic decay.

- Used DNN to improve significance.

- Expected significance ~4.6σ
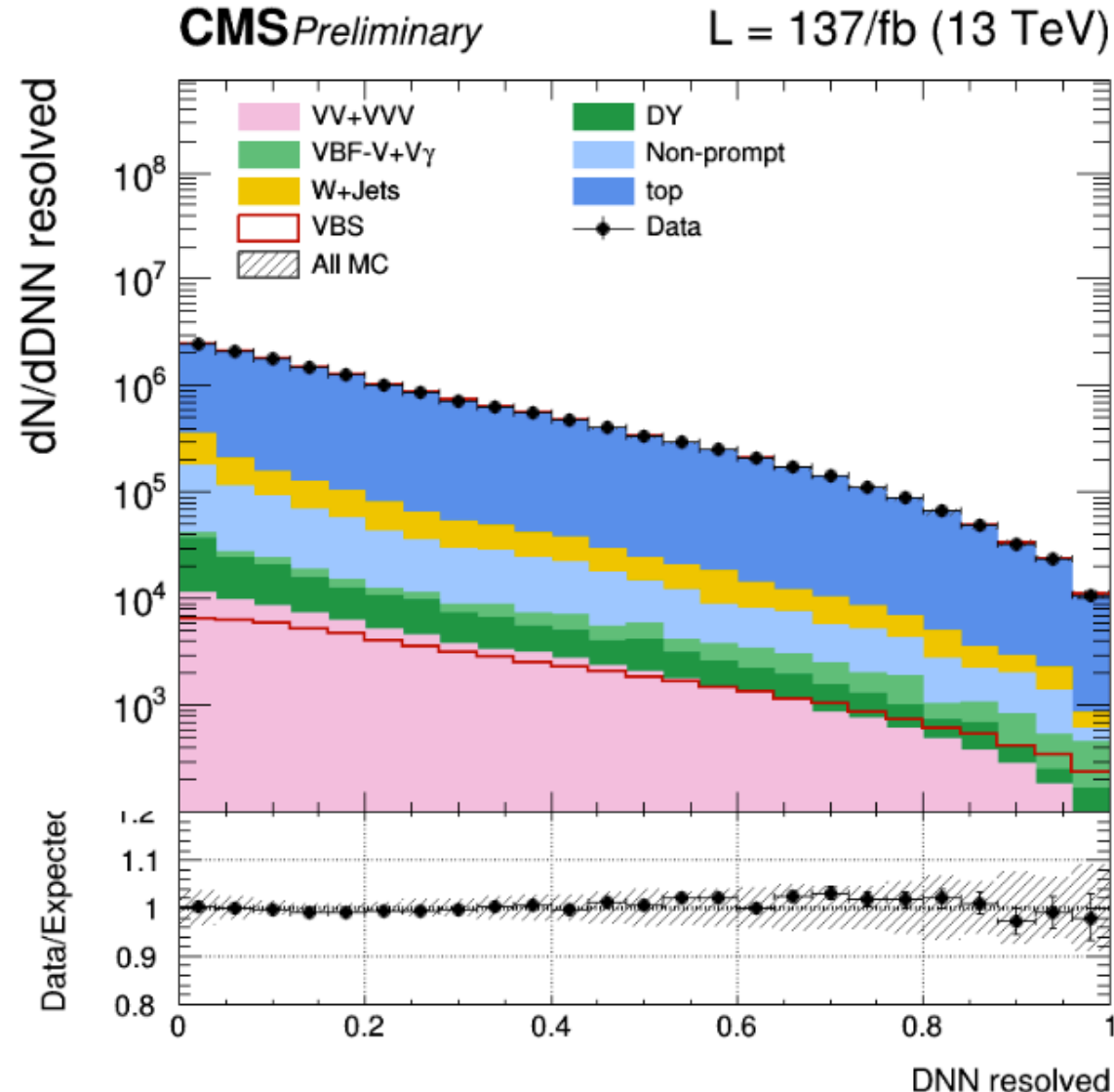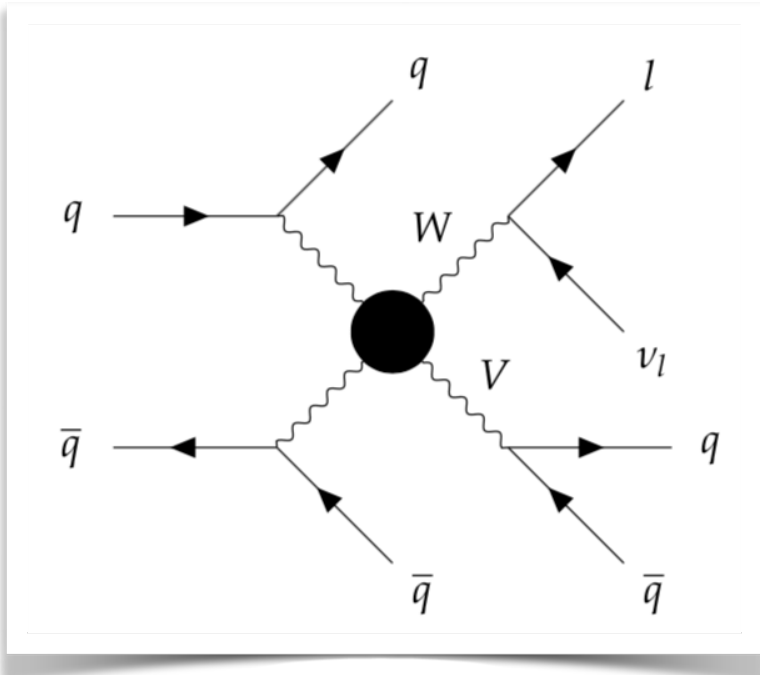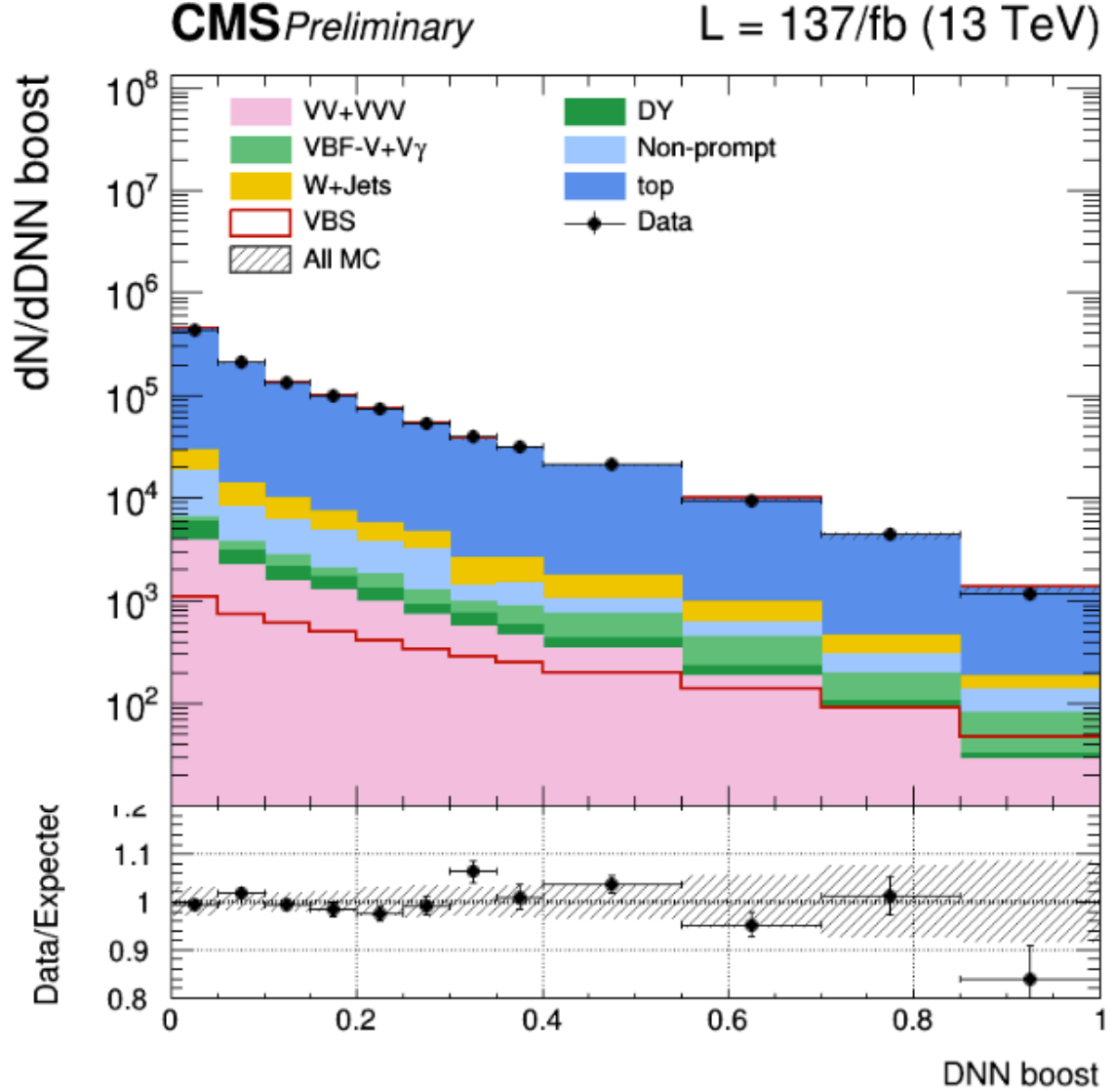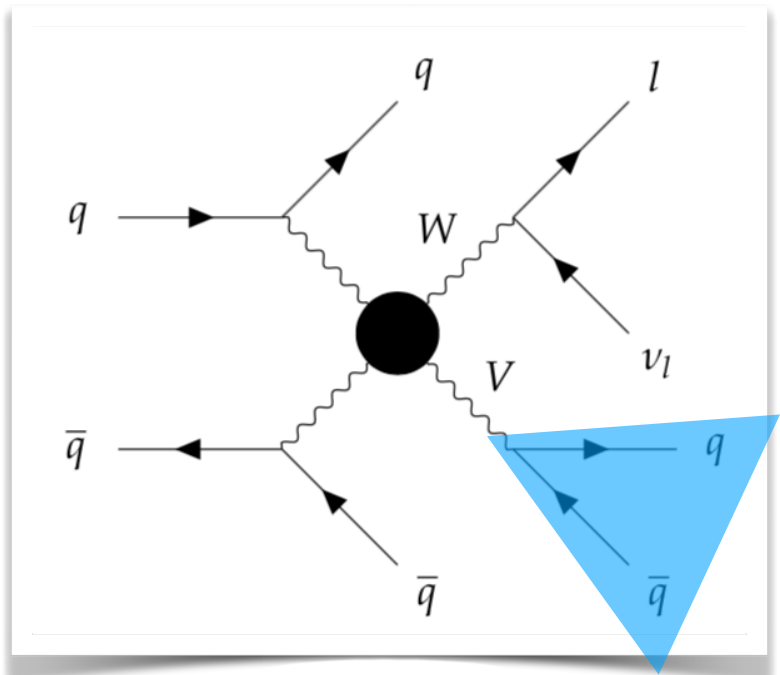
CPPF

- CPPF stands for Concentration Pre-Processing Fan-out.

  - Its a μTCA based card deployed at CMS for Level-1 trigger.

  - This covers the RPC overlap and endcap region.

  - Provides pre-processing algorithm for the track finding.

- Recent work: Improve performance of CPPF unpacker (hardware info) & emulator (emulation of hardware).

  - Earlier the discrepancies ~7%, now reduced to <1%.

CMS L1 Muon Trigger System

OLD (~7% mis-match)

New (<1% mis-match)

Thank you