TOP-25-003 — First round ARC review

Ying AN, Maria Aldaya, Hugo Becerril, Abideh Jafari, Andreas Meyer

Inclusion of $t\bar{t}\gamma \rightarrow 2\ell$ CR

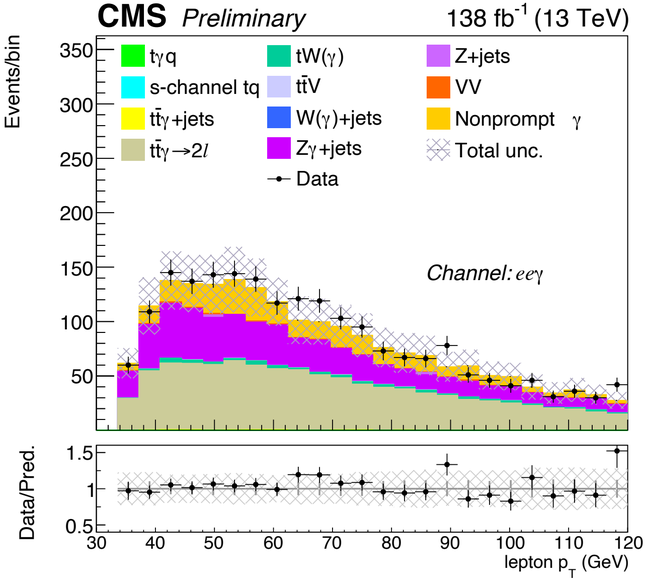
ee: selected by *EGamma/SingleElectron* dataset and single electron trigger as used in the SR

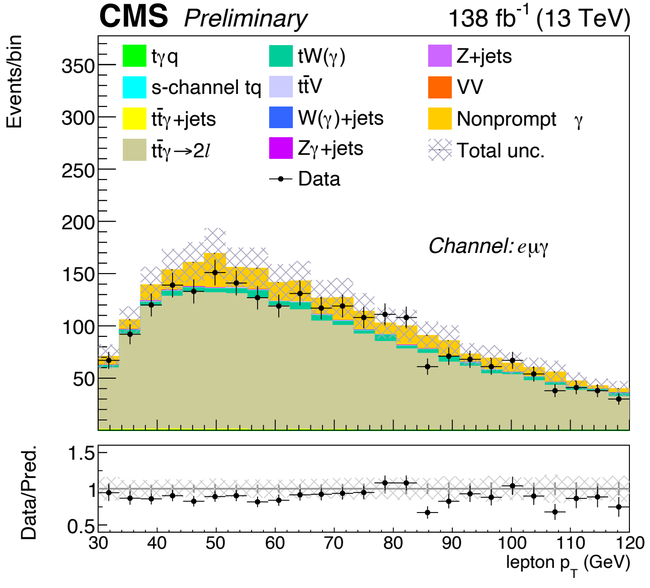
μμ: selected by *SingleMuon* dataset and single muon trigger as used in the SR

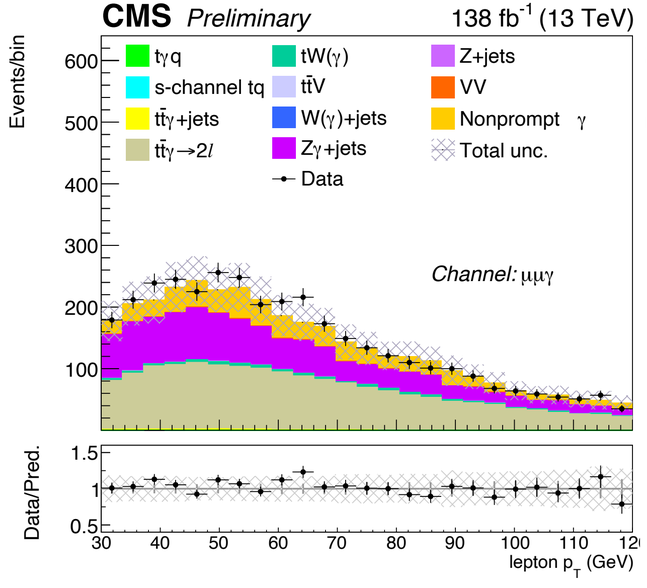
eμ: selected by *SingleMuon* dataset and single muon trigger as used in the SR (MuonEG gives similar statistics)

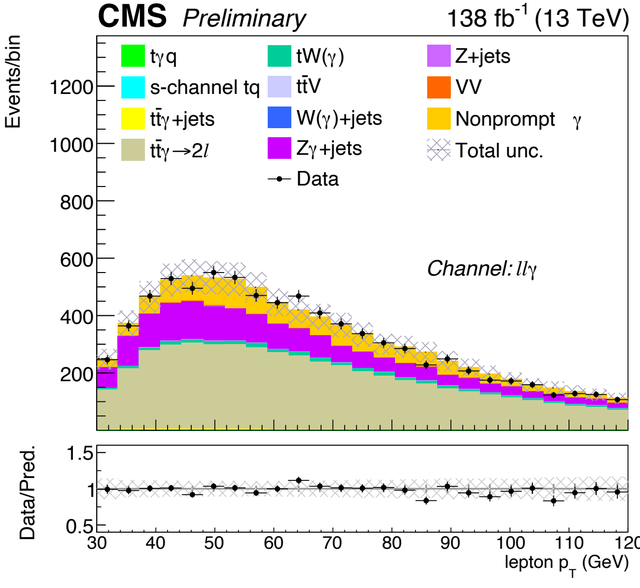
- Exactly two lepton
  - Reject events containing extra ℓ with veto lepton requirement (10 GeV)
  - Leading p_T > 30 (35) GeV for μ (e) channel
  - Subleading p_T > 15 GeV
- At least one photon
- At least two jet with at least one being b-jet
- $\Delta R(\ell,\gamma) > 0.4, \Delta R(\ell,j) > 0.4, \Delta R(\gamma,j) > 0.4$
- MET p_T > 20 GeV

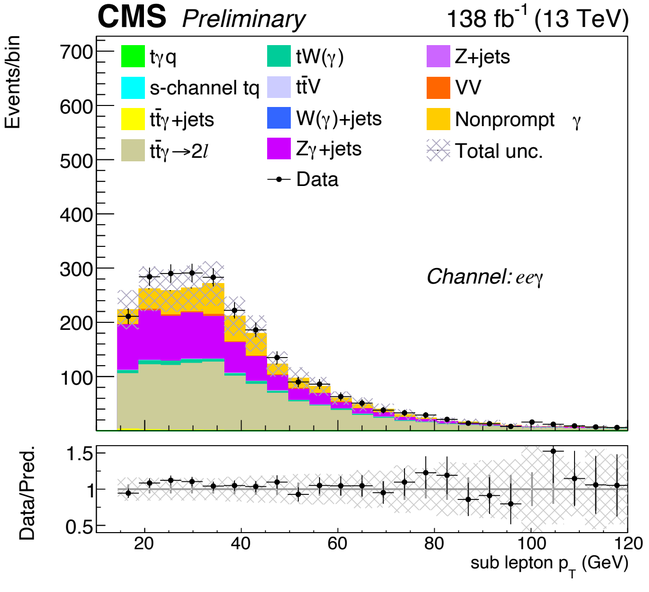
Control plots

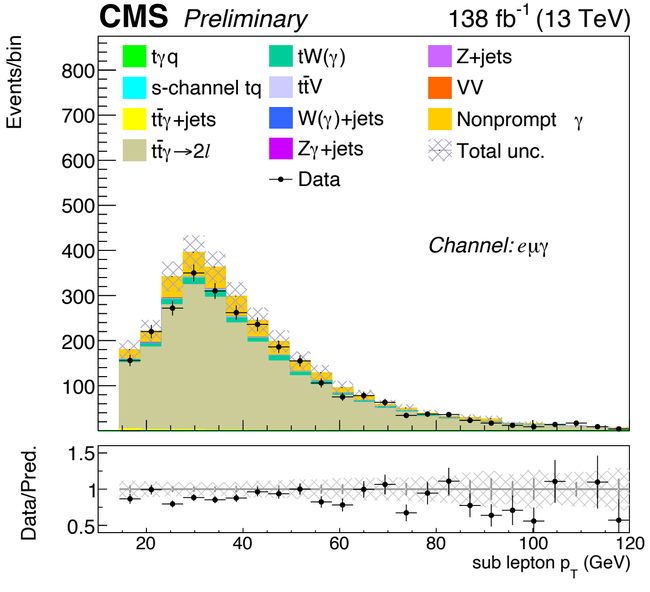


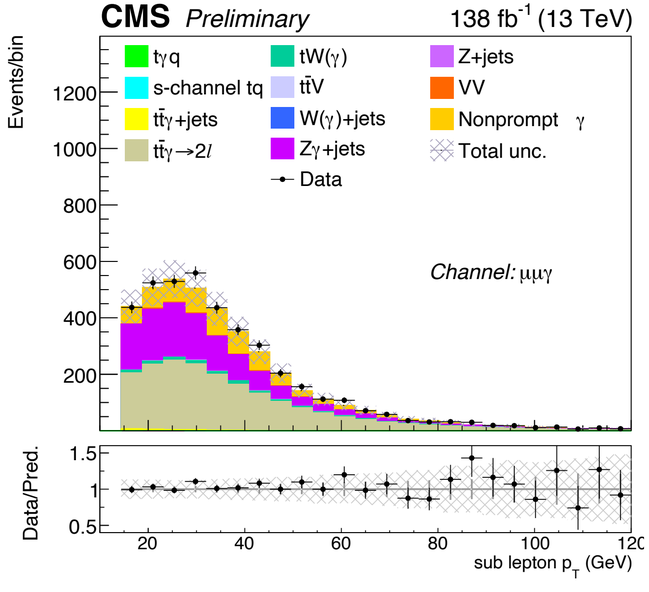


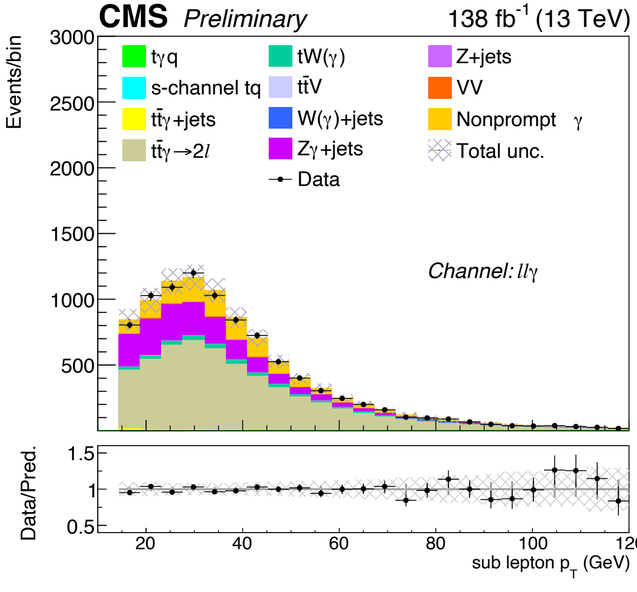




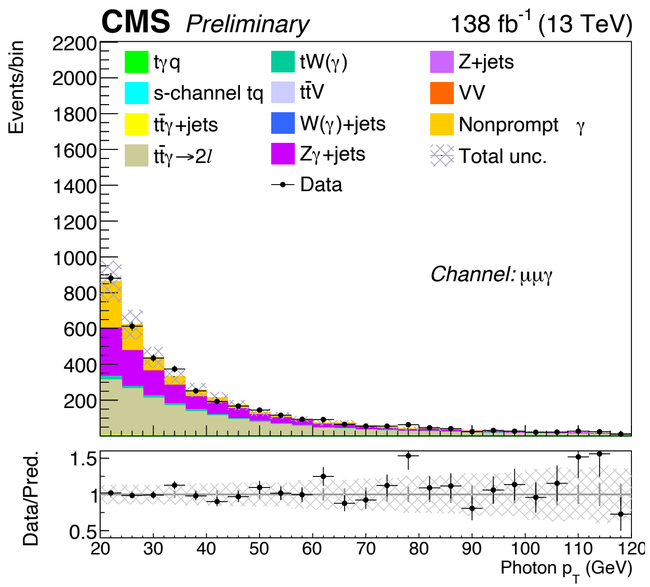


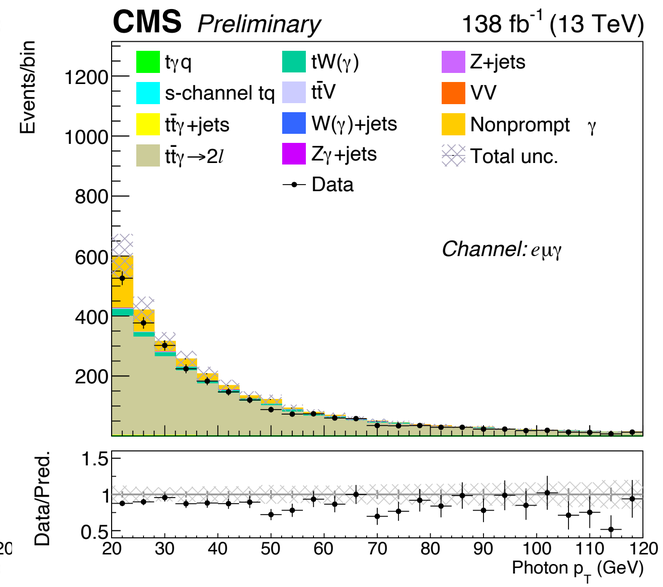


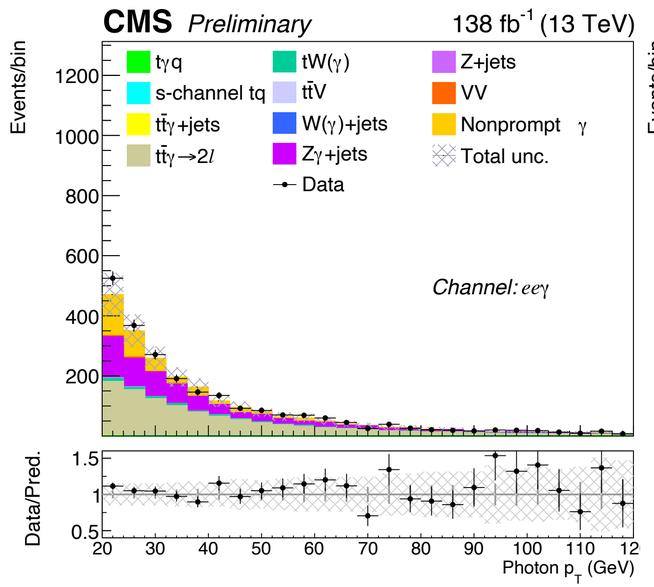


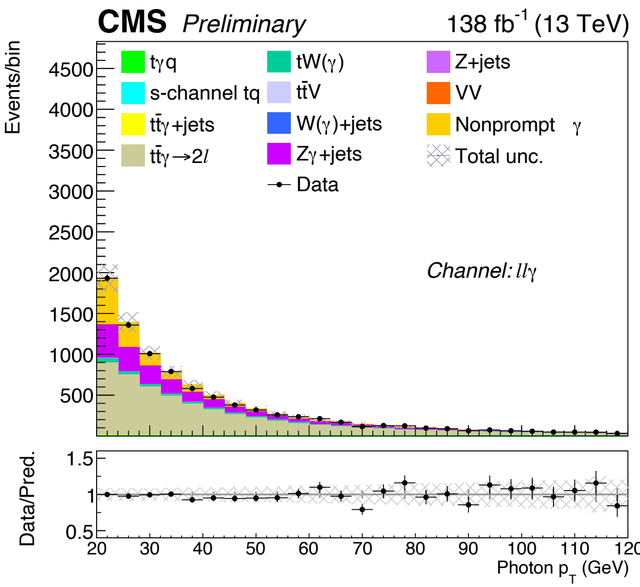


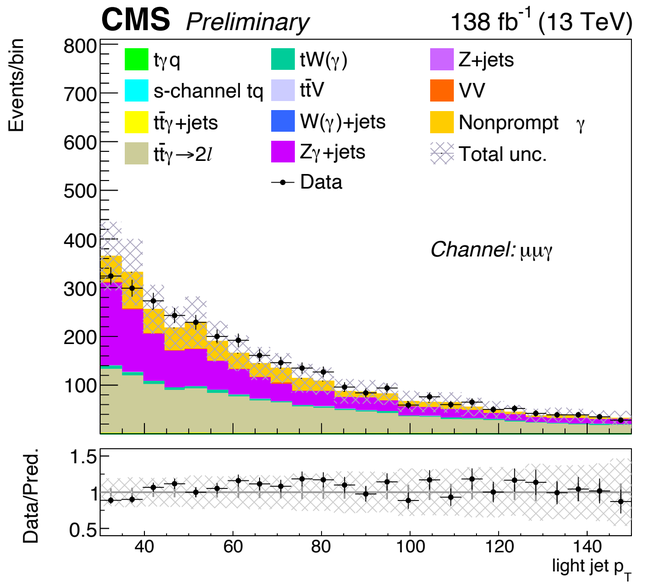
Control plots

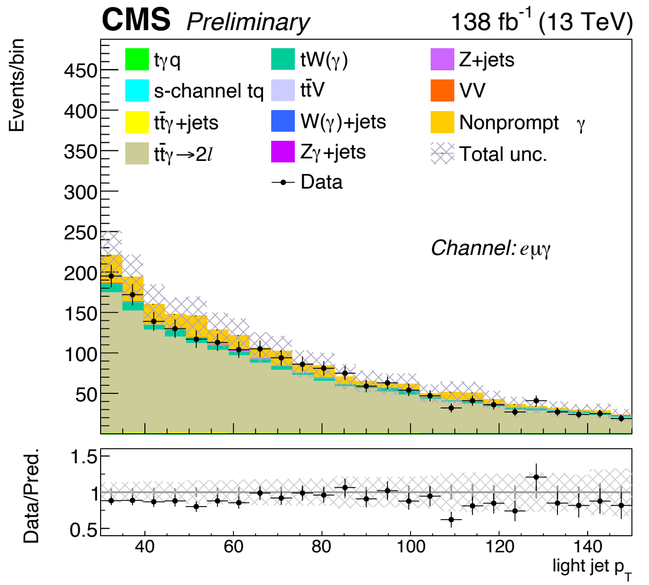


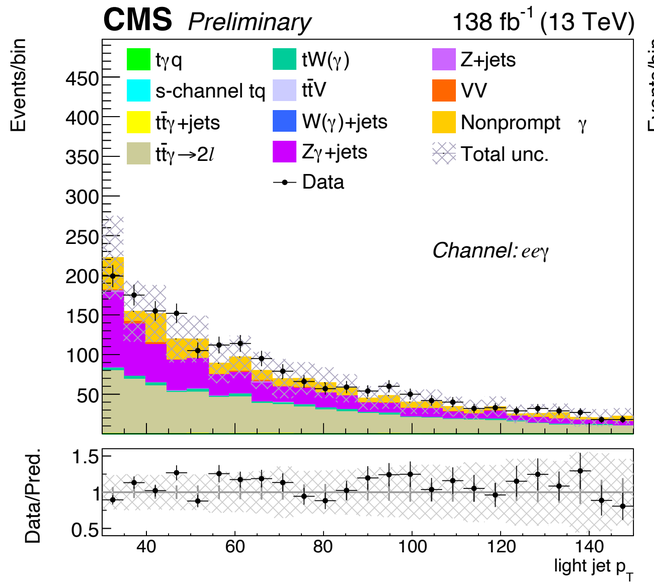


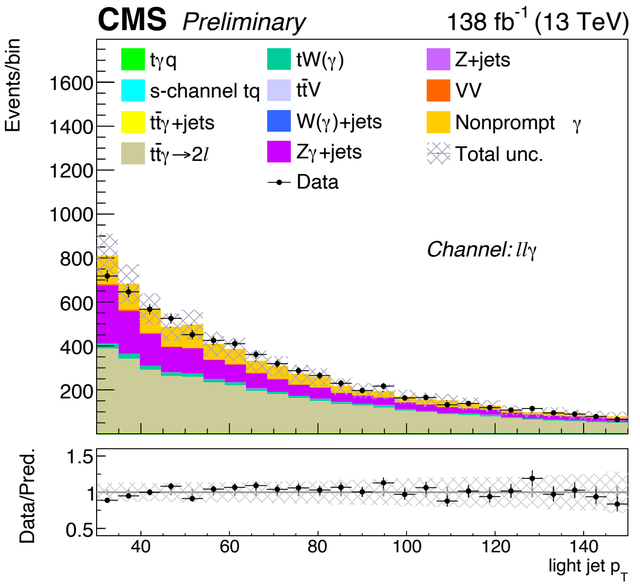




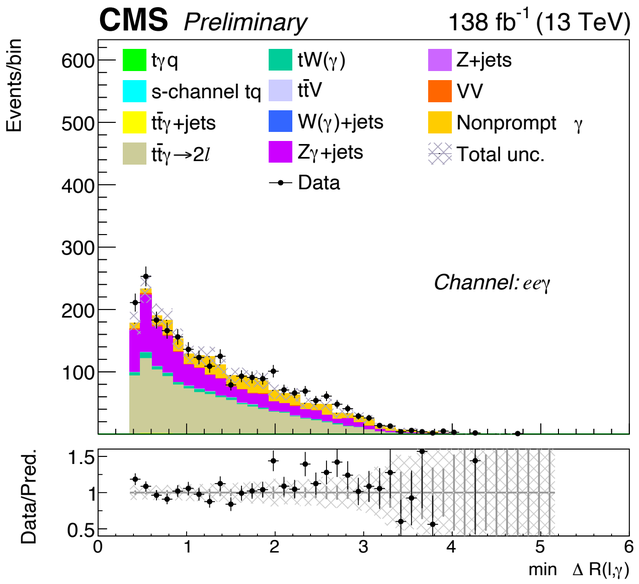


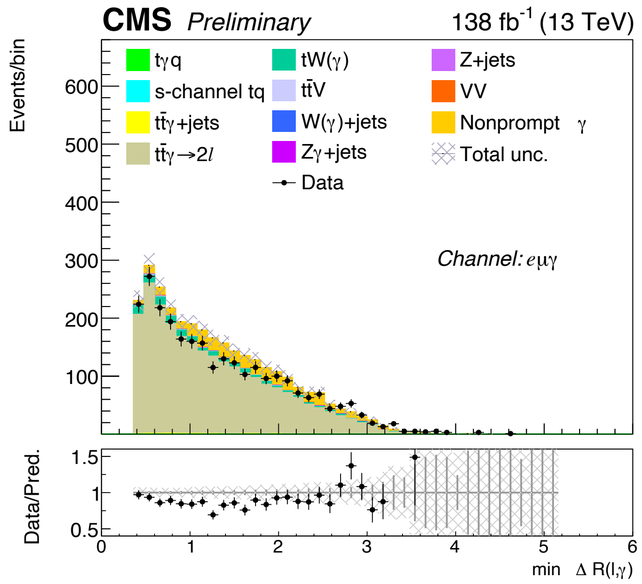


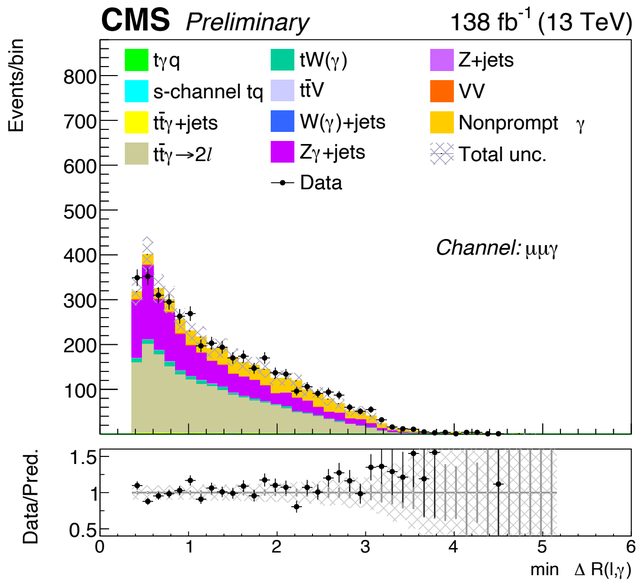


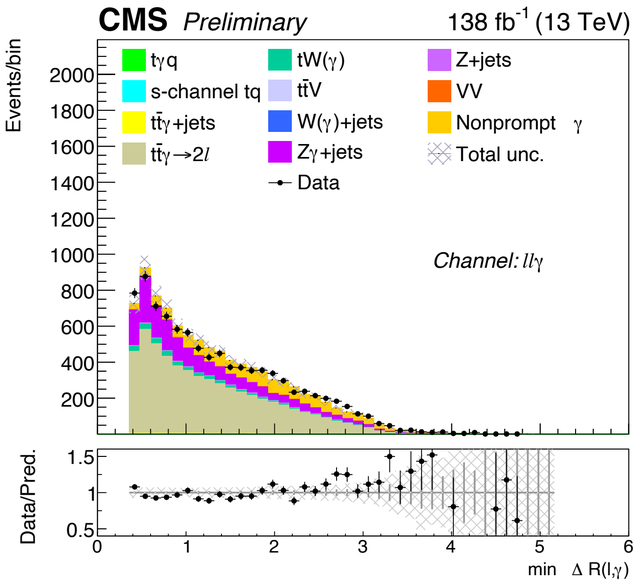


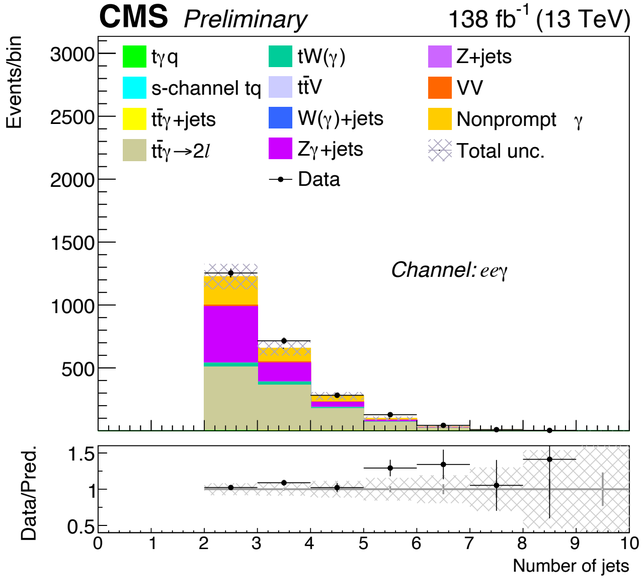
Control plots

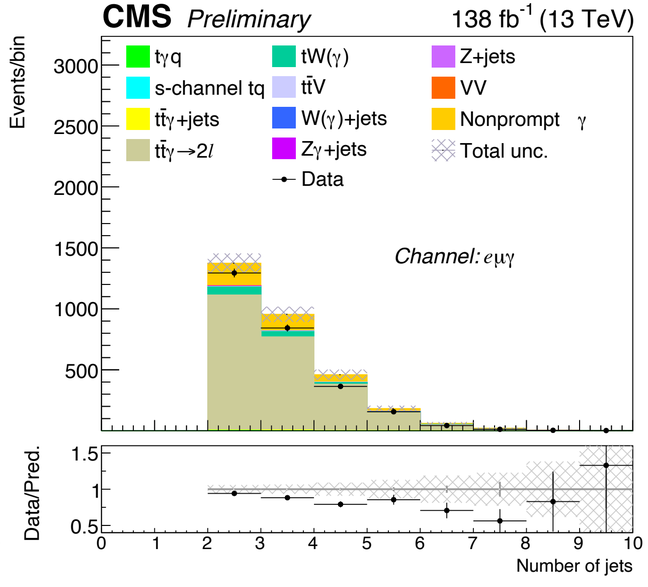


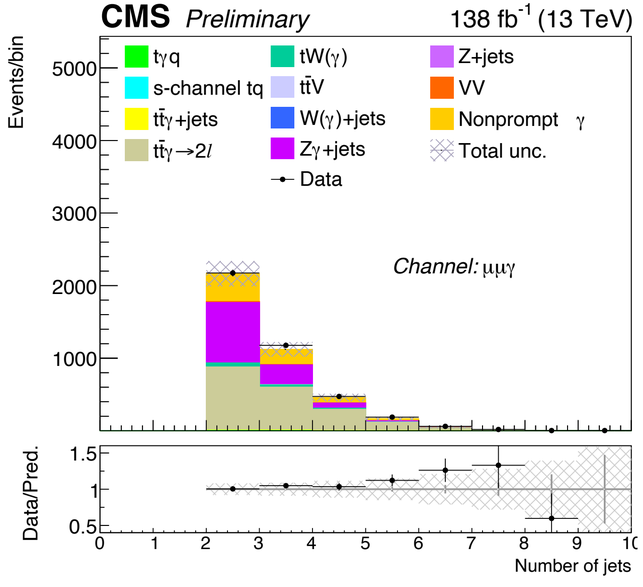


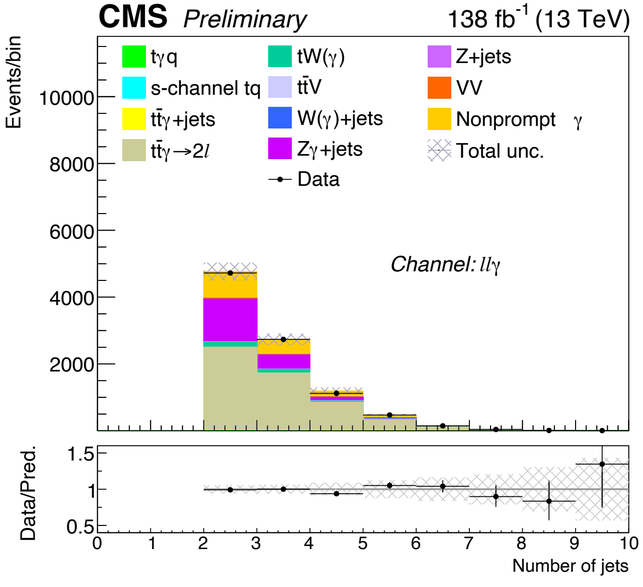












Fit with 2ℓ CR

2ℓ CR: N_{jets} distribution from combination of ee, eμ, and μμ channels

b-veto CR: $m_{\ell\gamma}$ in electron and muon respectively

SR: unrolled BDT score and ΔR(ℓ,γ) in electron and muon respectively

The observed results with 2ℓ CR included:

- Observed signal strength from simultaneous fit

  r_tgQ : +1.130 -0.080/+0.081

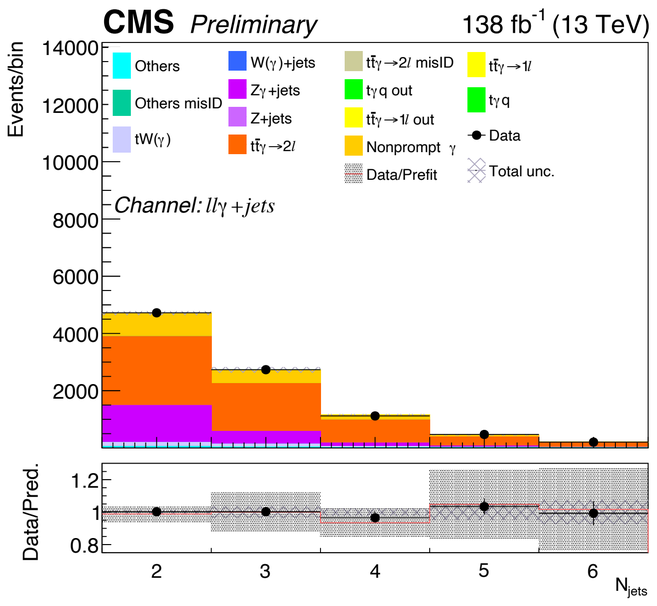
  r_ttg : +1.038 -0.060/+0.059

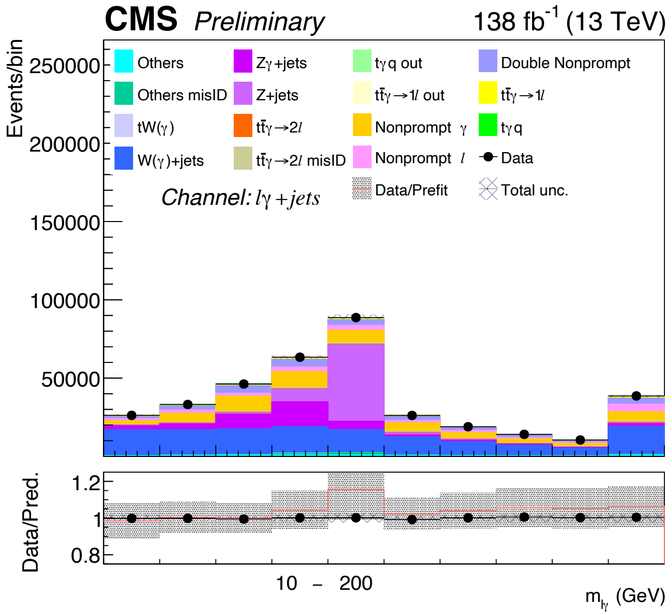
The observed results without 2ℓ CR included:

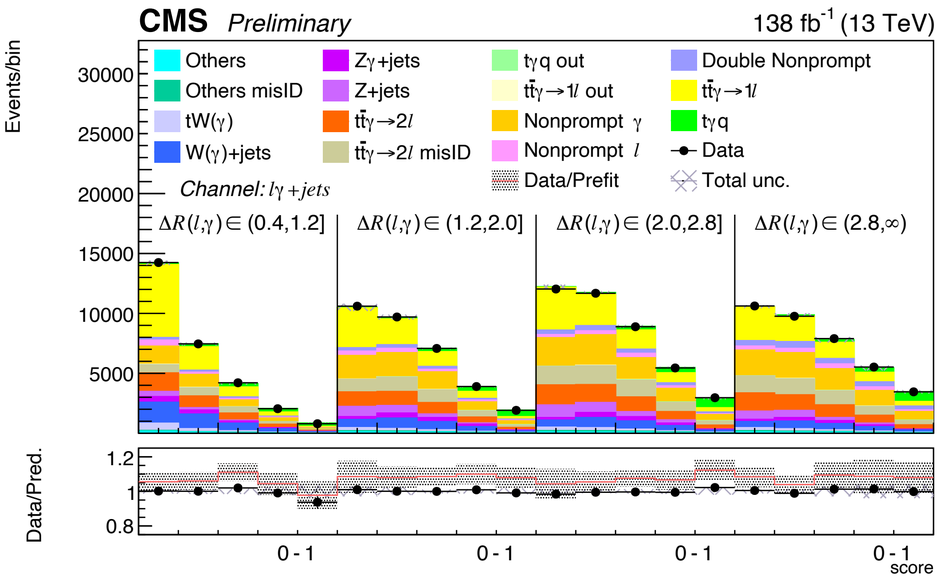
- Observed signal strength from simultaneous fit

  r_tgQ : +1.125 -0.084/+0.087

  r_ttg : +1.044 -0.067/+0.070







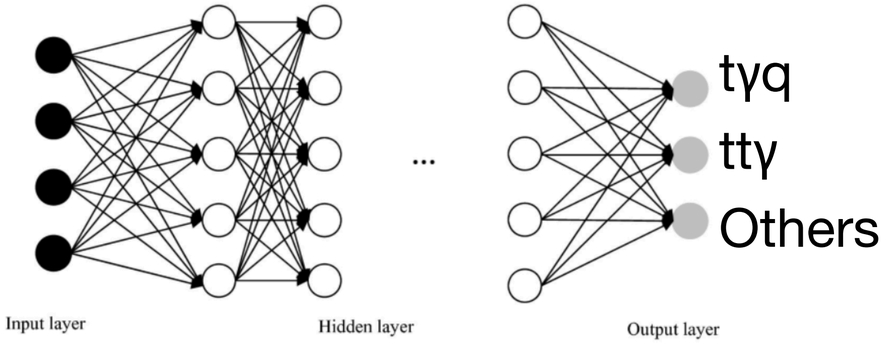
DNN train — previous study

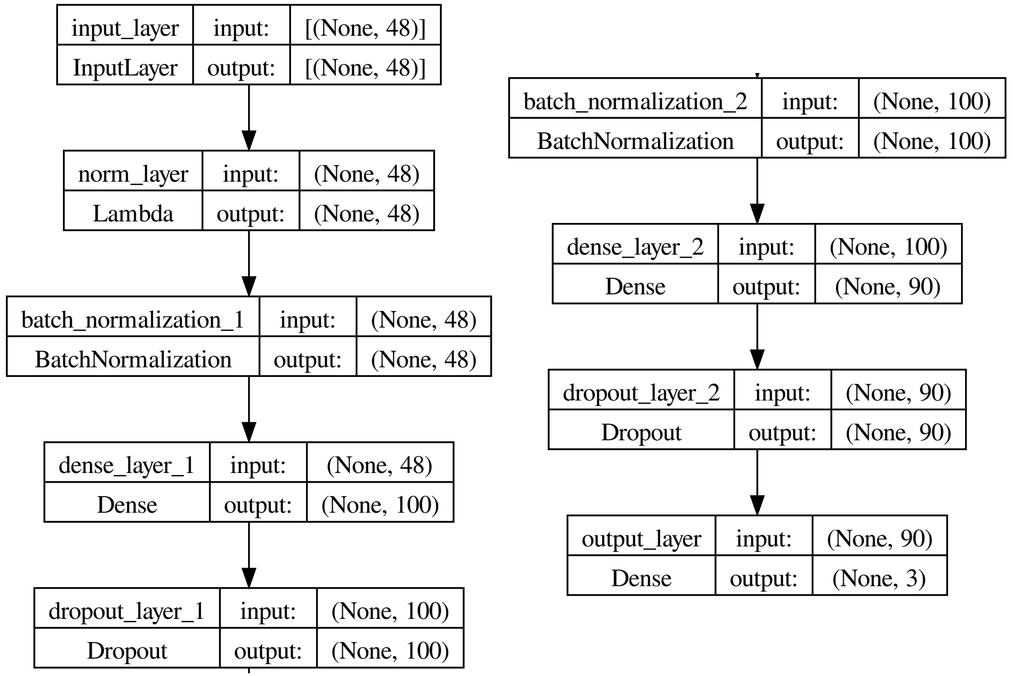
Multiclass classifier with 3 output nodes: tγq, ttγ and others

- Model trained in the SR region
- Includes both muon and electron events
- One model is trained for three years by using part of events in three years' samples randomly
- 48 input variables identified

Hyper-parameters are tuned

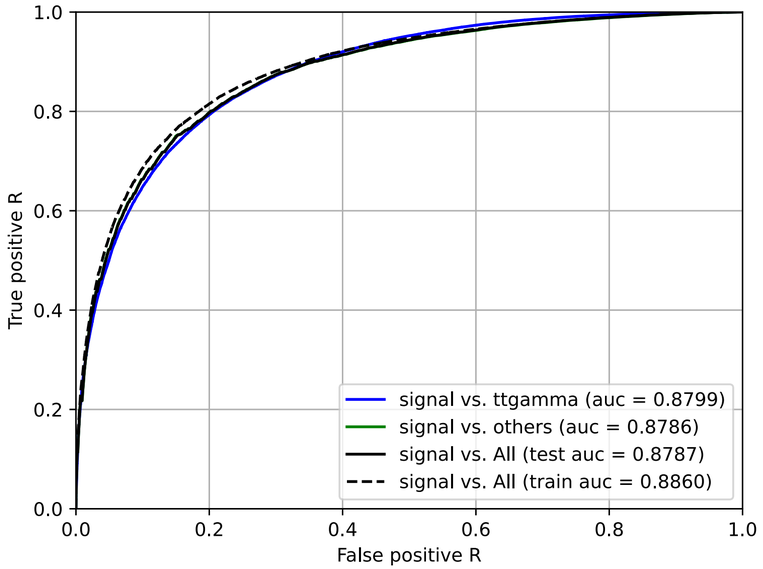
- Number of hidden layers
- Number of neurons in every layer
- dropout
- batchsize
- class weights for tγq, ttγ and backgrounds
- epochs

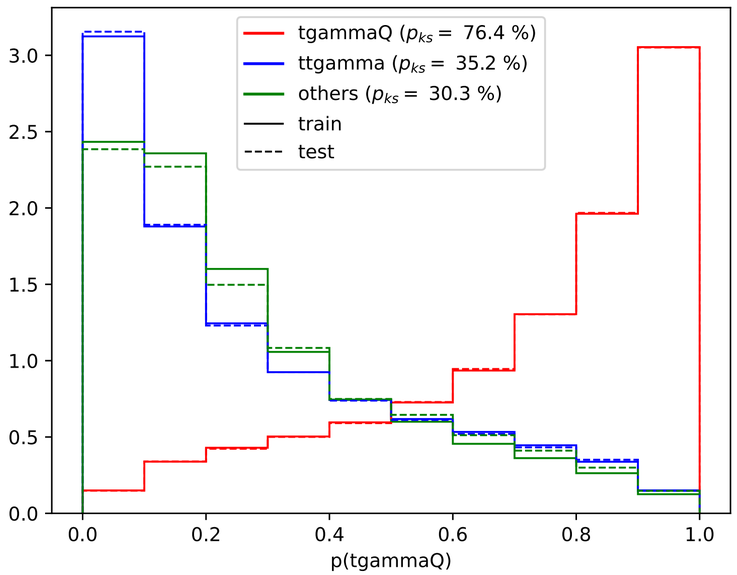


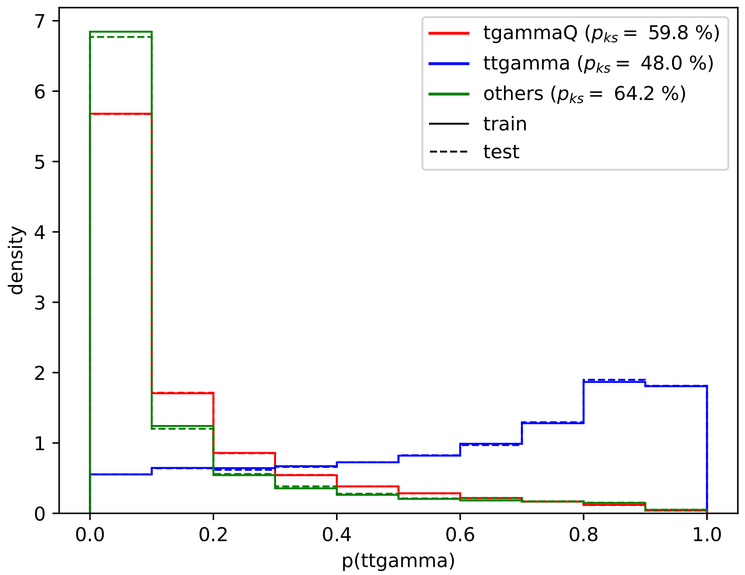


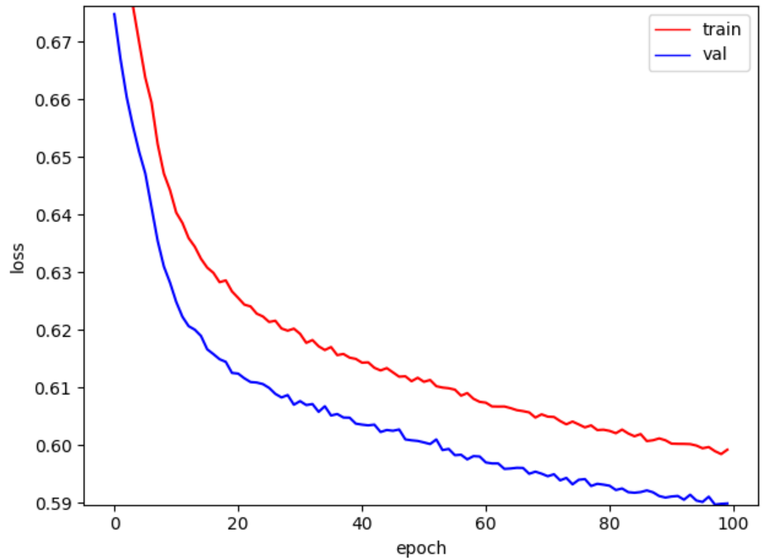
DNN train — previous study

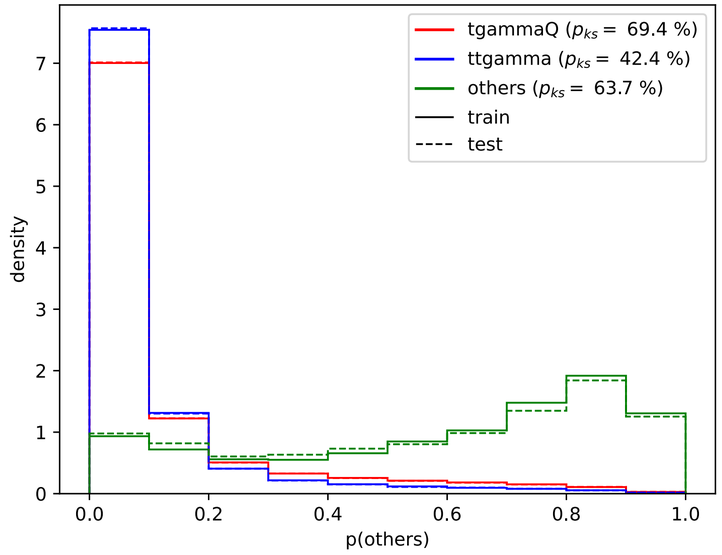
- Three output nodes for tγq, ttγ, and others











DNN results— previous study

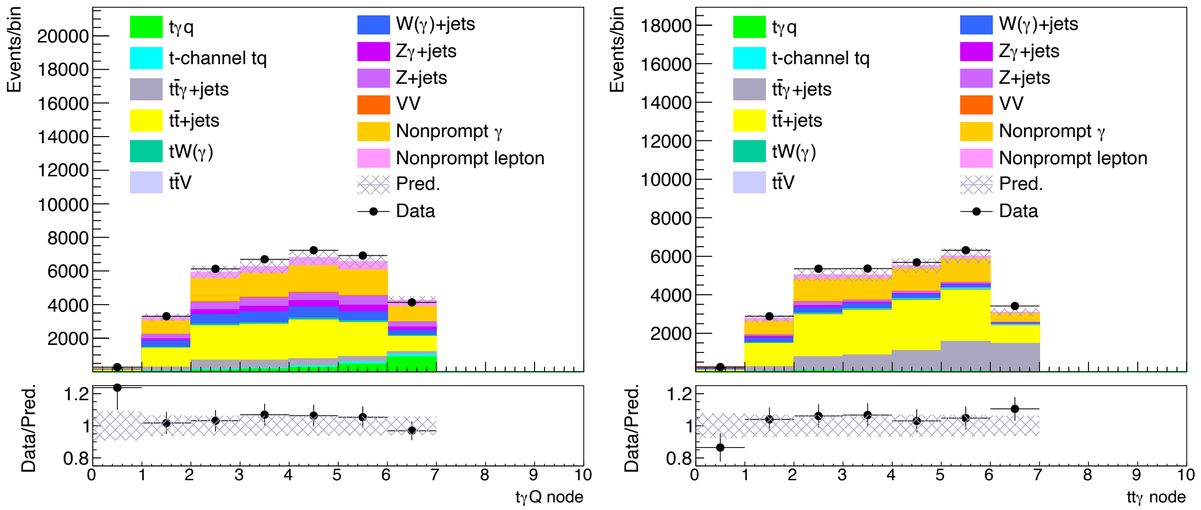
- Events are classified to three output nodes by max-score splitting
- Fit variables in SR are tγq, ttγ and others output nodes, which means
  - SR is split into three categories → DNN cut applied per-event → kinematic cut applied for variable used in the train

The expected results by fitting DNN from 2018 MC with limited systematic uncertainties in LnN style:

- Expected signal strength from simultaneous fit

  r_tgQ : +1.000 -0.117/+0.129

  r_ttg : +1.000 -0.106/+0.118



The expected results by fitting BDT from 2018 MC with all systematic uncertainties:

- Expected signal strength from simultaneous fit

  r_tgQ : +1.000 -0.106/+0.111

  r_ttg : +1.000 -0.077/+0.088

DNN results— previous study

- Events are classified to three output nodes by max-score splitting
- Fit variables in SR are tγq, ttγ and others output nodes, which means
  - SR is split into three categories → **DNN cut applied per-event → kinematic cut applied for variable used in the train**

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- Expected signal strength from simultaneous fit

  r_tgQ : +1.000 -0.106/+0.111

  r_ttg : +1.000 -0.077/+0.088

Disadvantage of DNN:

- We do not want to make any cuts on the differential fitting variables
- Increase the number of channels in differential fit leading the complexity of fit

Conclusion:

- No obvious improvement from DNN fitting
- DNN fit not really suitable for differential fit
- **Stick to use BDT**

Discussion

- We receive quite a lot of comments on paper draft. To modify the paper accordingly, we should set the journal goal. Do you think we can set it to ROPP?

- The IPM group plans to have a “light pre-approval”, do we need to inform ARCs to review their work also?

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Dear Ying, Hugo, Nadjieh, and Maria,

We would like to let you know that AN-24-092 (by Seddigheh Tizchang et al. from
Araku University and IPM) is progressing well, and we are planning to have a
"light" pre-approval soon to add this analysis to TOP-25-003 as previously agreed.
Does that still work for you?

Thanks,
Jack and Efe
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