Muon Scale Factors for 2017 dataset: trigger, tightID, iso $<$ 0.06

Muon POG

A. De Iorio, A. O. M. Iorio, W.A. Khan, L. Lista | 11.05.2018

INFN SEZIONE DI NAPOLI

Muon Scale Factors for 2017 dataset

- Presence of single isolated lepton in final state suppresses a large amount of multi-jet QCD $\rightarrow$ choice of Isolation WP
  - Loose isolation results in large amount of multi-jet QCD events
  - Tight isolation results in loosing signal events
  - Further detailed discussion can be seen here
- SFs to be re-evaluated for $I_{\mathrm{rel}}^{\delta\beta-\mathrm{corr.}} < 0.06$ for a muon in *s*-channel [TOP-18-001]
- Using centrally produced tag and probe trees:
  - Recipe for MuonTagAndProbeTreeRun2
  - Location of TnP trees:
    `/eos/cms/store/group/phys_muon/TagAndProbe/Run2017/94X/Run(B-F)`
  - Data 2017 (Single Muon):
    `/TnPTree_17Nov2017_SingleMuon_Run2017(B-F)v1_Full_GoldenJSON.root`
  - MC 2017 (Drell-Yan):
    `/MC/TnPTree_94X_DYJetsToLL_M50_Madgraph.root`
- Trigger, ID and isolation Run dependent (BC, DC, F) SFs are evaluated as a function of transverse momentum and pseudo-rapidity for 2017 dataset

Selections on Tag & Probe

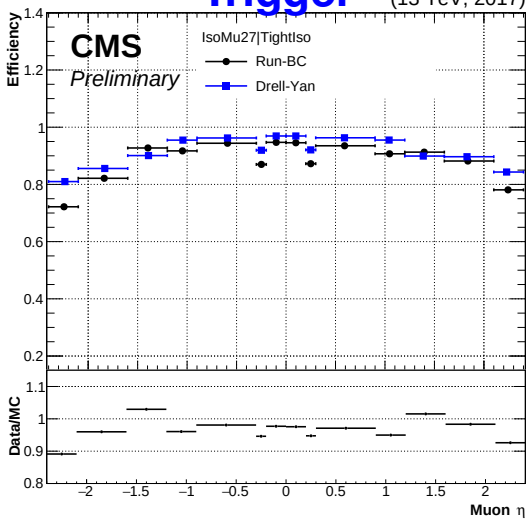
- Tag selection:
  - Muon $p_{\mathrm{T}} > 29\,\mathrm{GeV}$
  - Rel. Isolation $I_{\mathrm{rel}}^{\delta\beta-\mathrm{corr.}} < 0.05$
  - Trigger path: IsoMu27
  - ΔR(*tag*, *probe*) > 0.3
- No. of Tag and probe pairs/event = 1
- Z-mass window:
  - Trigger: 70 - 130 GeV
  - ID: 70 - 130 GeV
  - Isolation: 77 - 130 GeV
- Probe selection:

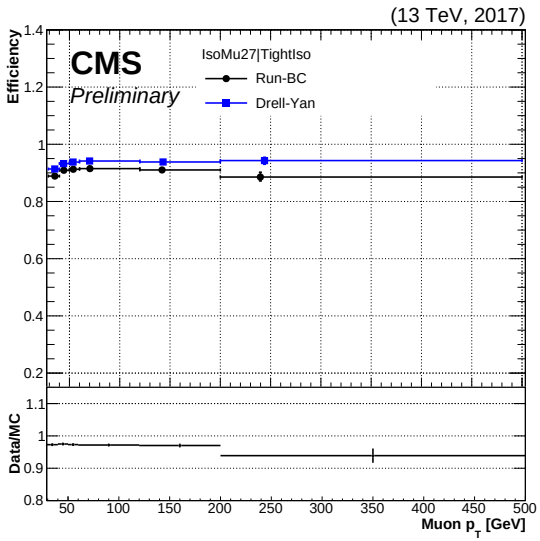
  Trigger, ID, Iso: Muon $p_{\mathrm{T}} > 20\,\mathrm{GeV}$

- Fitting Functions:
  - Trigger
    - Signal: Sum of 2 Voigtian
    - Background: Exponential
  - TightID + Isolation
    - Signal: Sum of 2 Voigtian
    - Background: CMSShape for bin 3, 4, 5
- Using the recommended binning for Trigger, TightID and Isolation efficiency extraction

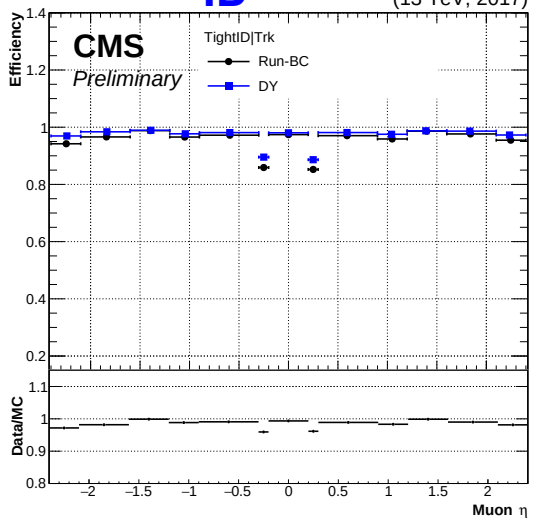
Data/MC Run-BC: Trigger, TightID, Isolation

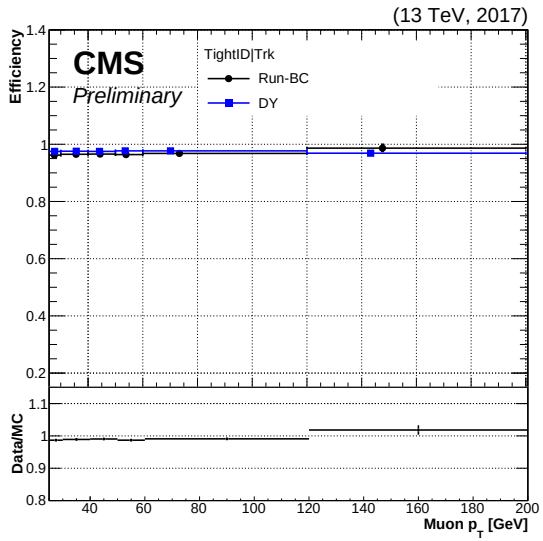
Trigger (13 TeV, 2017)



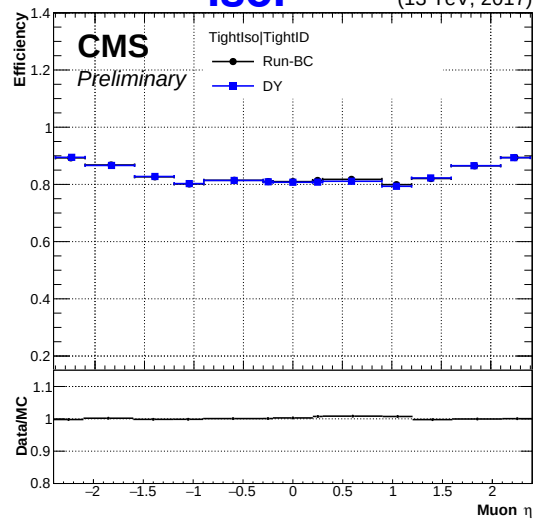


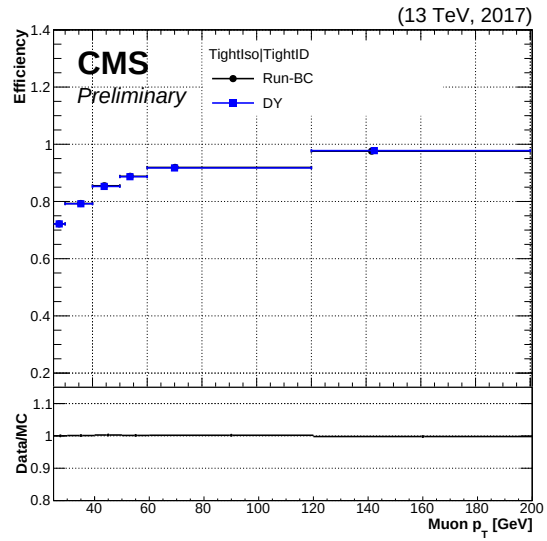
ID (13 TeV, 2017)





Iso. (13 TeV, 2017)

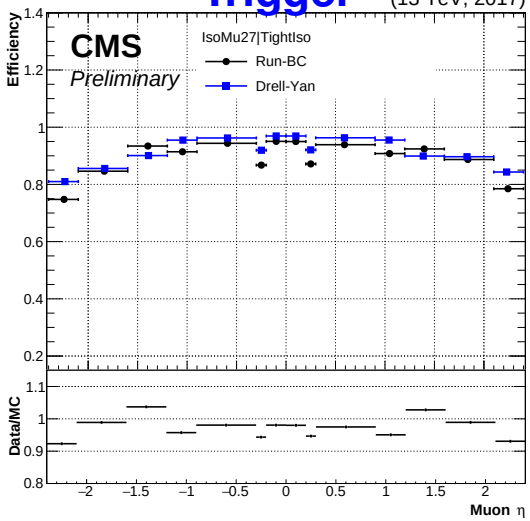




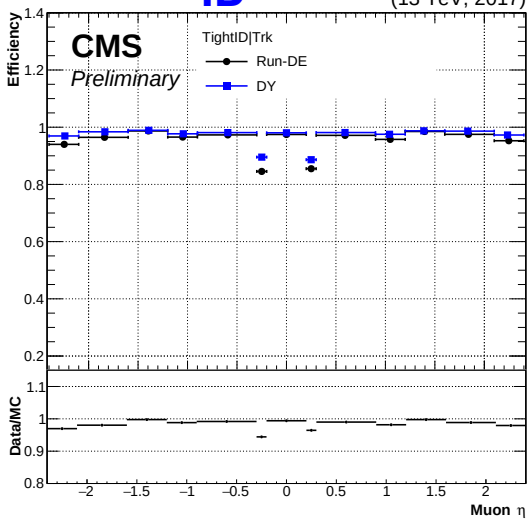
- SFs for for trigger, ID and Iso. for Run-BC are roughly ~ 1

Data/MC Run-DE: Trigger, TightID, Isolation

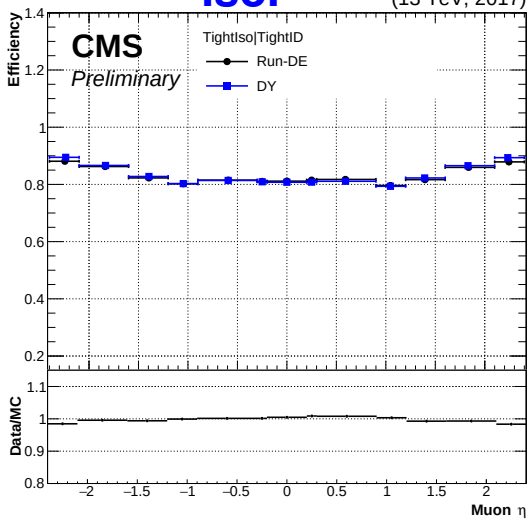
Trigger (13 TeV, 2017)



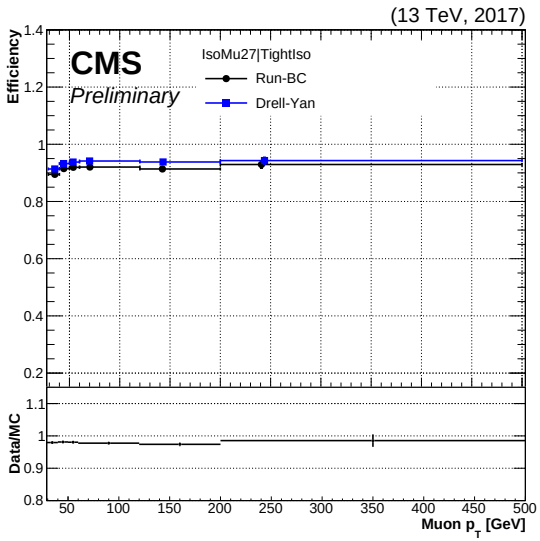
ID (13 TeV, 2017)



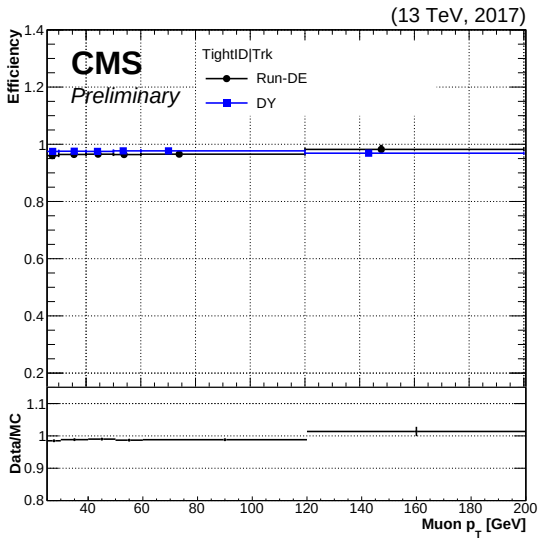
Iso. (13 TeV, 2017)



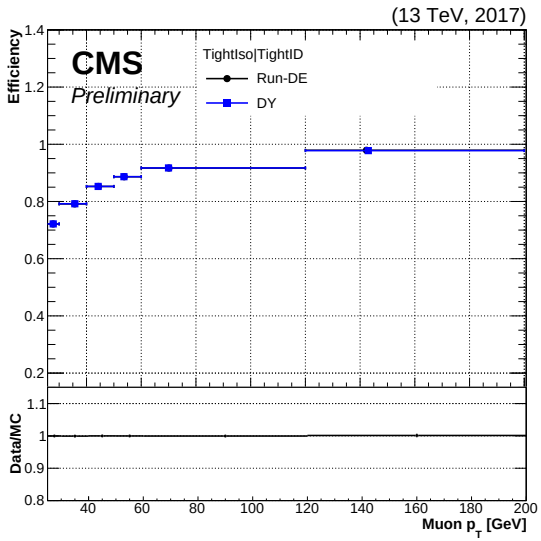
(13 TeV, 2017)



(13 TeV, 2017)



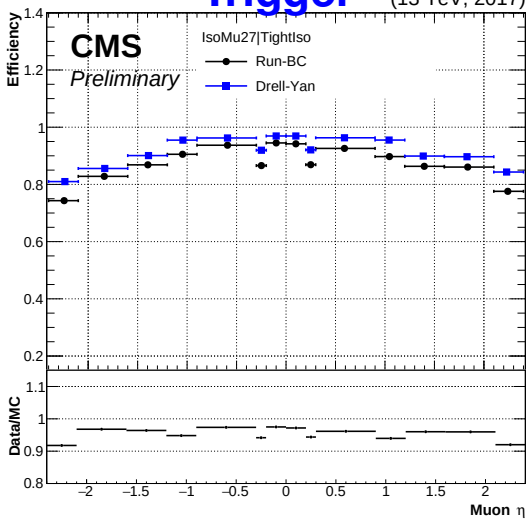
(13 TeV, 2017)



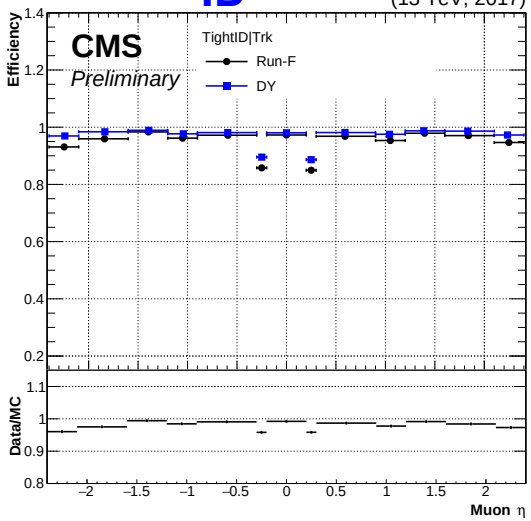
- SFs for for trigger, ID and Iso. for Run-DE are roughly ~ 1

Data/MC Run-F: Trigger, TightID, Isolation

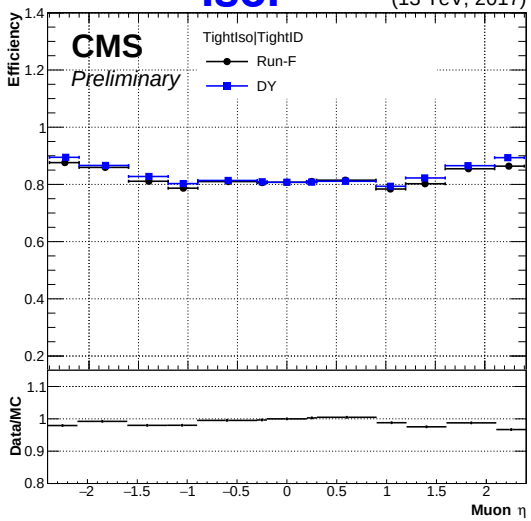
Trigger (13 TeV, 2017)



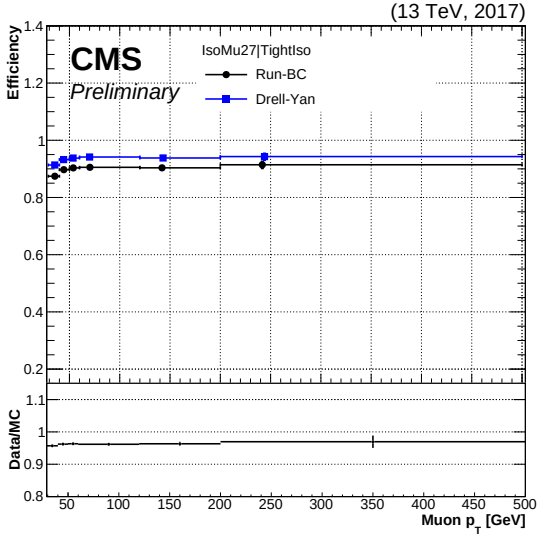
ID (13 TeV, 2017)



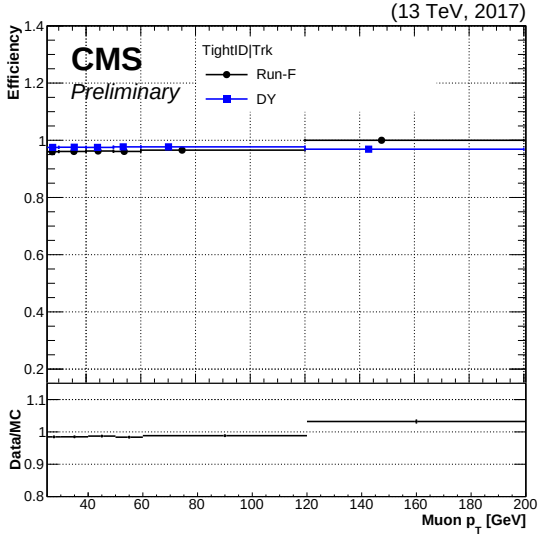
Iso. (13 TeV, 2017)



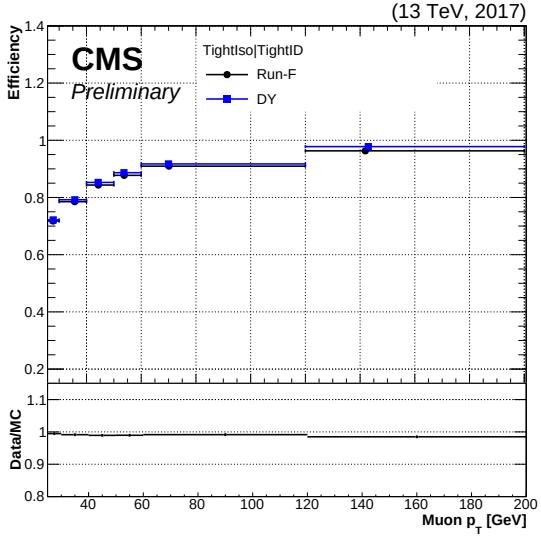
(13 TeV, 2017)



(13 TeV, 2017)



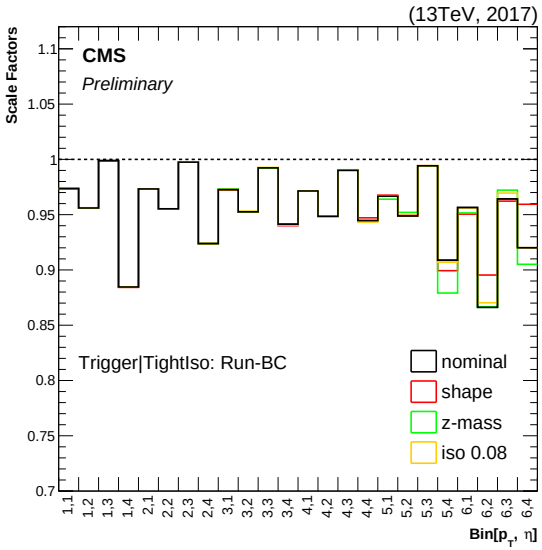
(13 TeV, 2017)

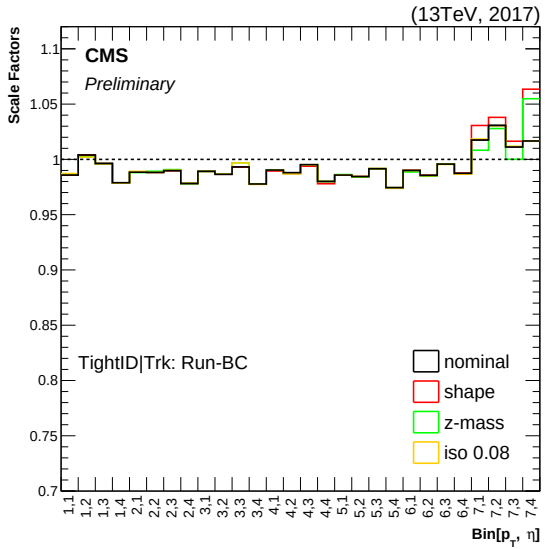


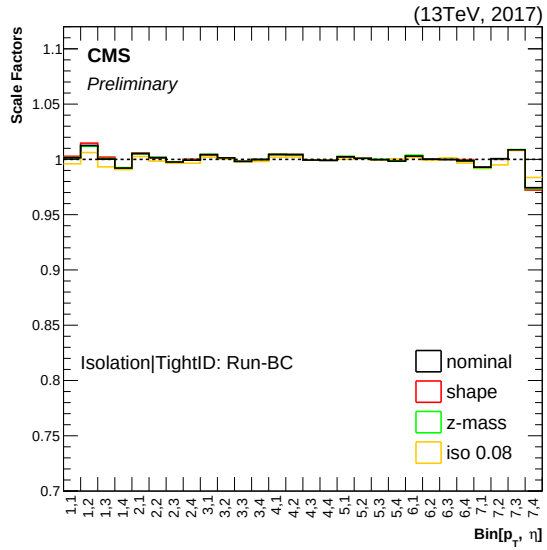
- SFs for for trigger, ID and Iso. for Run-F are roughly ~ 1

Systematic Uncertainties: Run-BC

- Z-mass window: Upper edge 130 $\rightarrow$ 124 GeV for mass uncertainty
- Fitting function:
  Isolation: vpvPlusExpo $\rightarrow$ voigtPlusExpo
  ID: CMSShape $\rightarrow$ CMSShape by changing the parameters
  Trigger: vpvPlusExpo $\rightarrow$ vpvPlusExpo by changing the parameters
- Isolation 0.06 $\rightarrow$ 0.08 uncertainty due to the choice of isolation working point

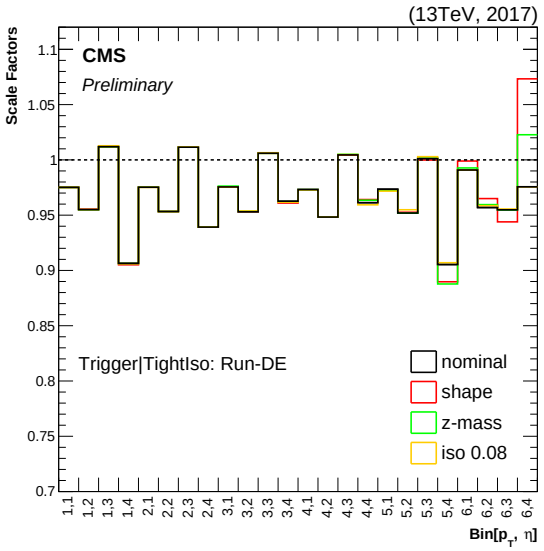


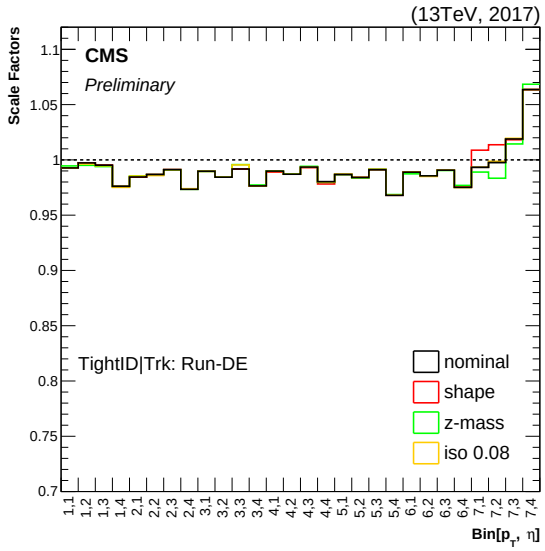


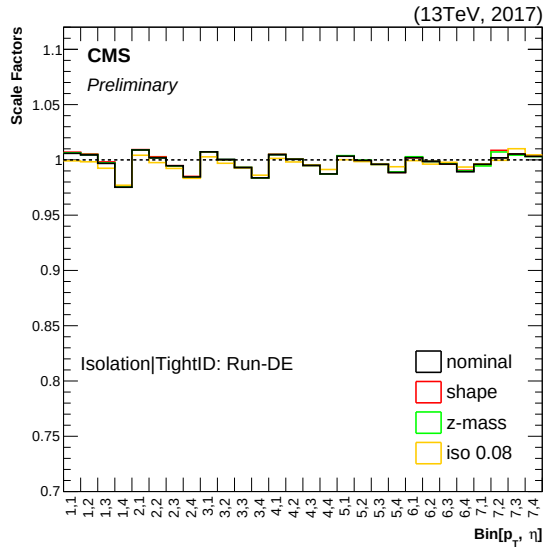


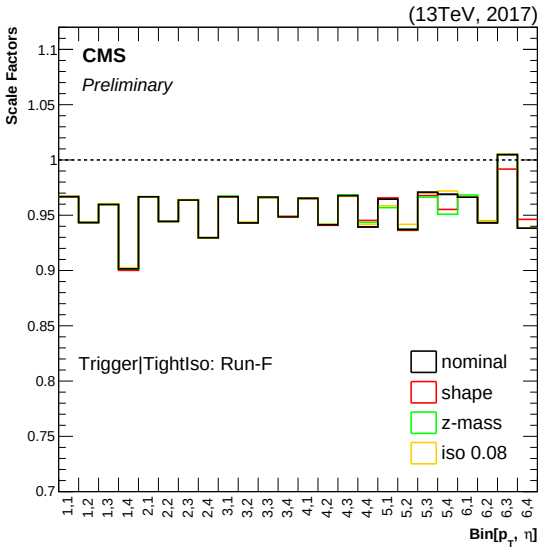
- Variation effecting more when moving to higher eta and p_{T} regions

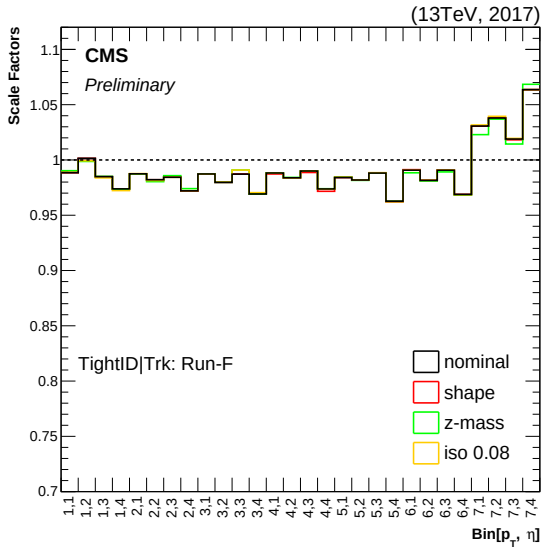
Systematic Uncertainties: Run-DE, F

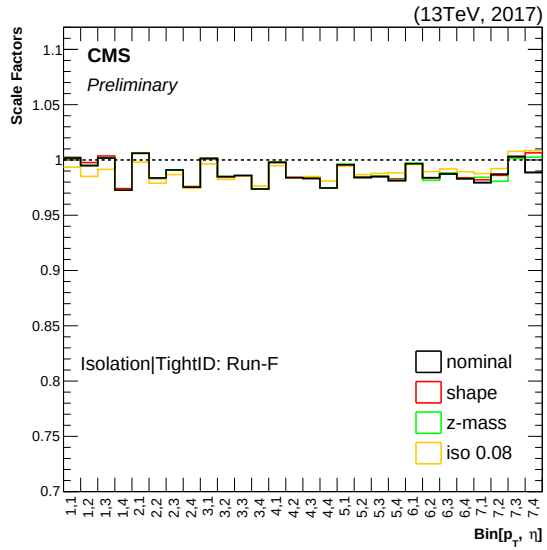












- Variations effecting more when moving to higher eta and p_{T} regions

Systematic Uncertainties: Shape, Z-mass, Isolation

Variable	Data	SF	$\Delta(mass)\%$	$\Delta(shape)\%$	$\Delta(iso)\%$	Total(%)
	BC	0.95	0.18	0.23	0.04	0.30
TRI	DE	0.97	0.16	0.37	0.02	0.40
	F	0.95	0.09	0.07	0.04	0.12
	BC	1.00	0.01	0.02	0.15	0.15
ISO	DE	1.00	0.03	0.05	0.11	0.12
	F	0.99	0.04	0.10	0.07	0.13
	BC	0.99	0.06	0.24	0.01	0.25
ID	DE	0.99	0.05	0.10	0.01	0.11
	F	0.99	0.03	0.02	0.01	0.04
			0.27	0.53	0.20	0.63

- On average the SF $\sim$ 1.0 statistical unc. varying from bin to bin
- Total systematic uncertainty to be quoted on top statistical Unc. is around $<$ 1.0%
- Variation is small except for bins at high p_{T}, eta $\rightarrow$ shape unc. largest impact

Conclusions and Outlook:

- Muon SFs for trigger, ID and isolation are extracted using $I_{\mathrm{rel}}^{\delta\beta-\mathrm{corr.}} < 0.06$ as a working point for 2017 data
- Muon SFs are roughly around 1.0 stat. unc varies from bin to bin
- Systematic uncertainty is around $<$ 1.0% to be quoted on top of statistical uncertainty
- In general, systematic uncertainty is small except for few bins at high eta
  - Fitting function $\rightarrow$ largest impact in the high η/p_{T} bins
- Cross-checked the Muon POG provided SFs for $I_{\mathrm{rel}}^{\delta\beta-\mathrm{corr.}} < 0.15$ difference $\sim$ 1%

Monte Carlo Samples for Top Group

- ST FCNC:
  - Updating cards 2014 to 2017 $\rightarrow$ testing them locally
  - Iterating with Prep-Ops for cross-checks with data-cards to commit $\rightarrow$ creating gridpacks
  - Preparing MccM requests $\rightarrow$ Present them in MccM meetings for central production
- TT FCNC: Lot of jumping around with $\mathrm{t\bar{t}}$ data cards, inconsistencies in structure for future reference
- Also cross-checked the time taken if we add $\mathrm{t\bar{t}}$ + 3j process

```
generate p p > t t
add process p p > t t  j
add process p p > t t  j j
add process p p > t t  j j j
```

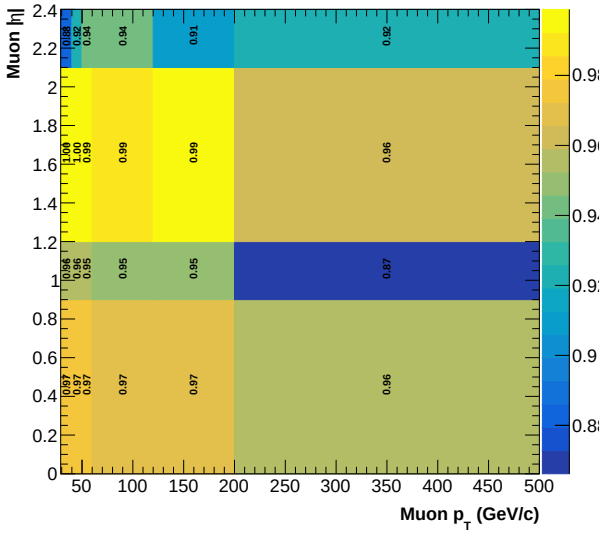
- Submitted the same jobs on two different queue:

  2nw(main job) + 8nh(subprocess jobs)
  1nw(main job) + 8nh(subprocess jobs)
- Time taken: 2.5 days job successfully completed $\rightarrow$ use 1nw queue if additional jets
- Phase II Upgrade Studies samples: All single-top and $\mathrm{t\bar{t}}$ cards updated to 14 TeV setting and new grid-packs were created
- Initially there were some computing problem in GenOnly campaign but last week things got fixed now they seem to run fine
- In total there are about 65 different samples produced from scratch
- Ongoing $\rightarrow$ $\mathrm{t\bar{t}}$ samples with SHERPA $\rightarrow$ taking ages

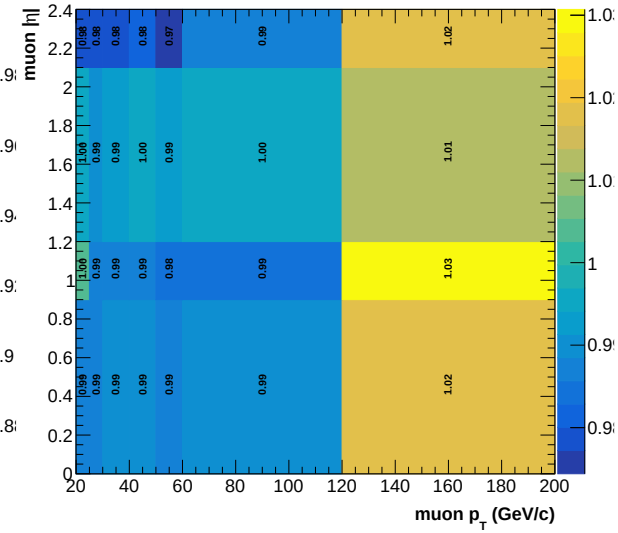
Backup

Systematic Uncertainties: Run-BC, DE

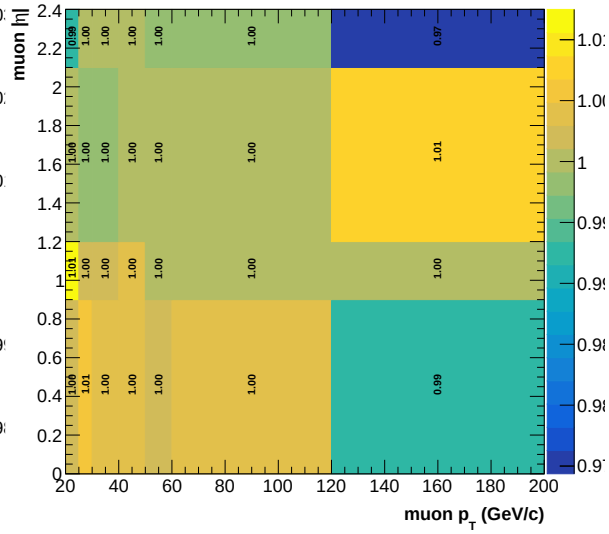
TRI SF: Run BC, 13 TeV (2017)



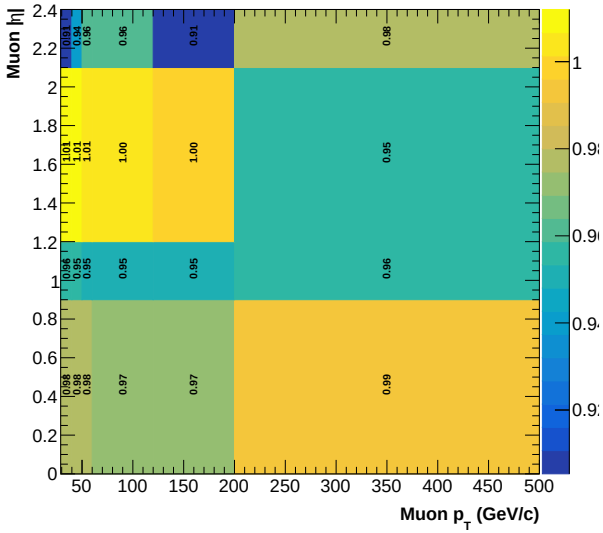
ID SF: Run BC, 13 TeV (2017)



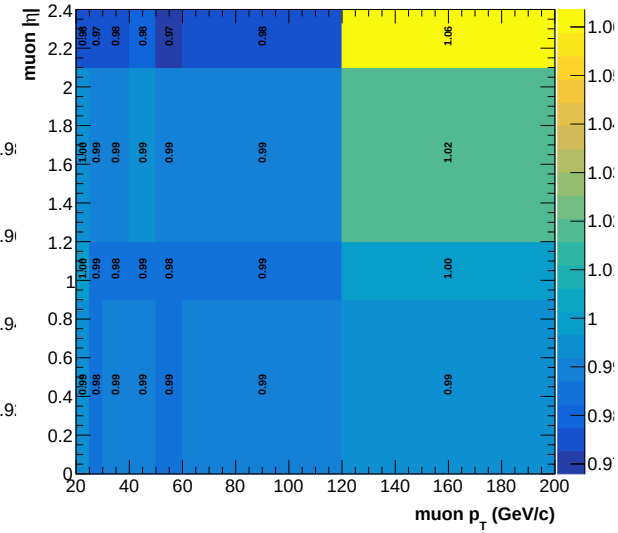
ISO SF: Run BC, 13 TeV (2017)



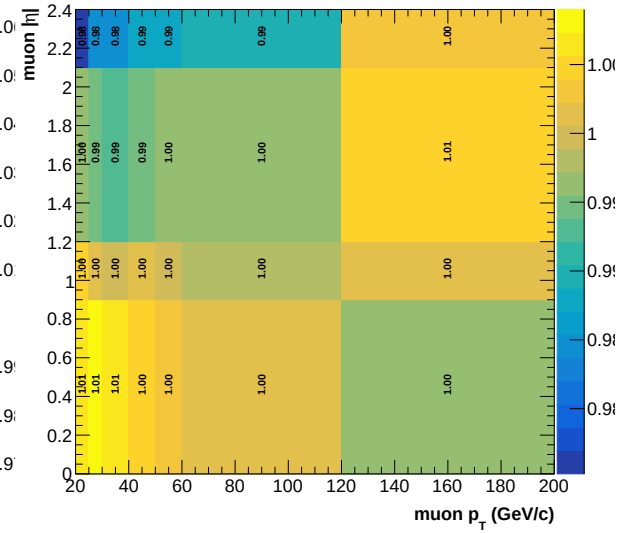
TRI SF: Run DE, 13 TeV (2017)



ID SF: Run DE, 13 TeV (2017)

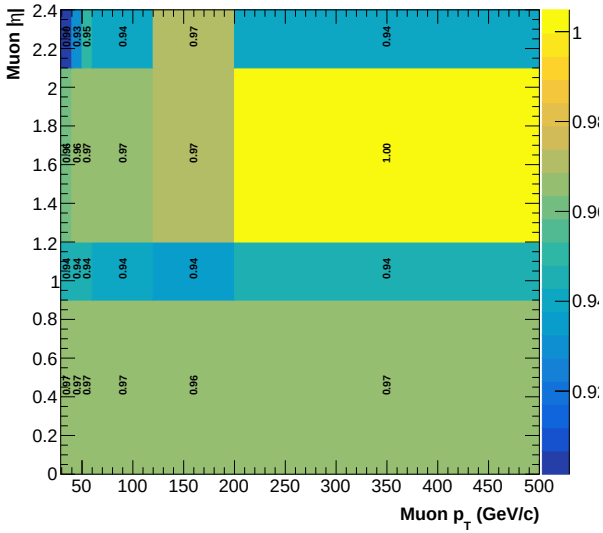


ISO SF: Run DE, 13 TeV (2017)

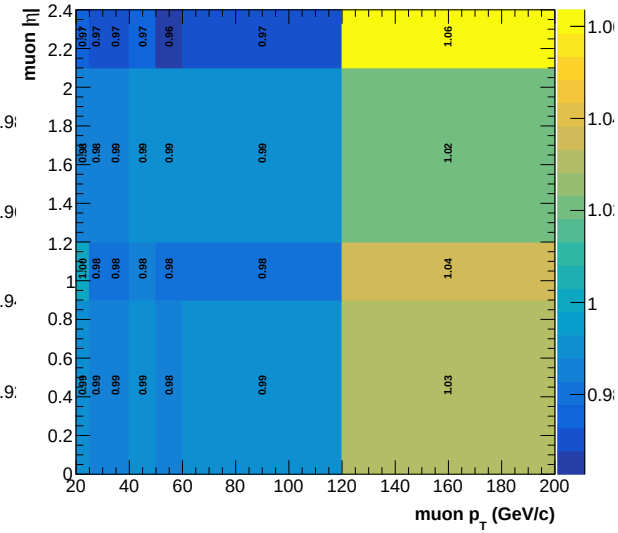


Systematic Uncertainties: Run-F

TRI SF: Run F, 13 TeV (2017)



ID SF: Run F, 13 TeV (2017)



ISO SF: Run F, 13 TeV (2017)