



# Intermittency analysis update (2.76 TeV, 5.02 TeV)

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# Recap (Intermittency analysis)

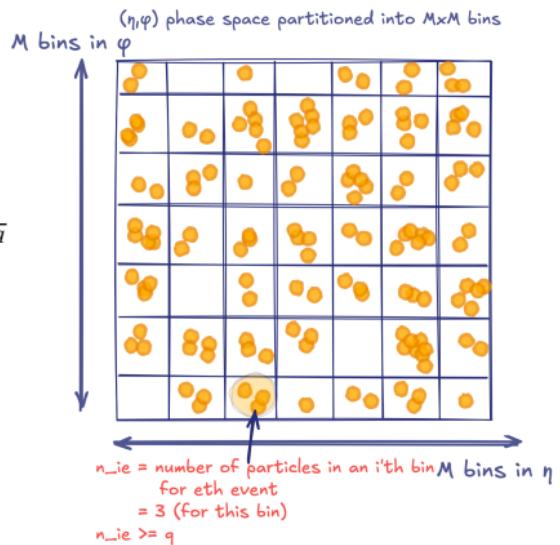
- Performed in  $(\eta, \varphi)$  phase space of  $M \times M$  bins. Hwa and Yang, 2012
  - by measuring NFM of multiplicity distributions.
- NFM:** for an  $e^{\text{th}}$  event  $F_q(M) = \frac{\langle f_q^e(M) \rangle}{\langle f_1^e(M) \rangle^q}$

$$F_q(M) \equiv \frac{\left\langle \frac{1}{M^2} \sum_{i=1}^{M^2} n_{ie} (n_{ie}-1) \dots (n_{ie}-q+1) \right\rangle}{\left\langle \frac{1}{M^2} \sum_{i=1}^{M^2} n_{ie} \right\rangle^q}$$

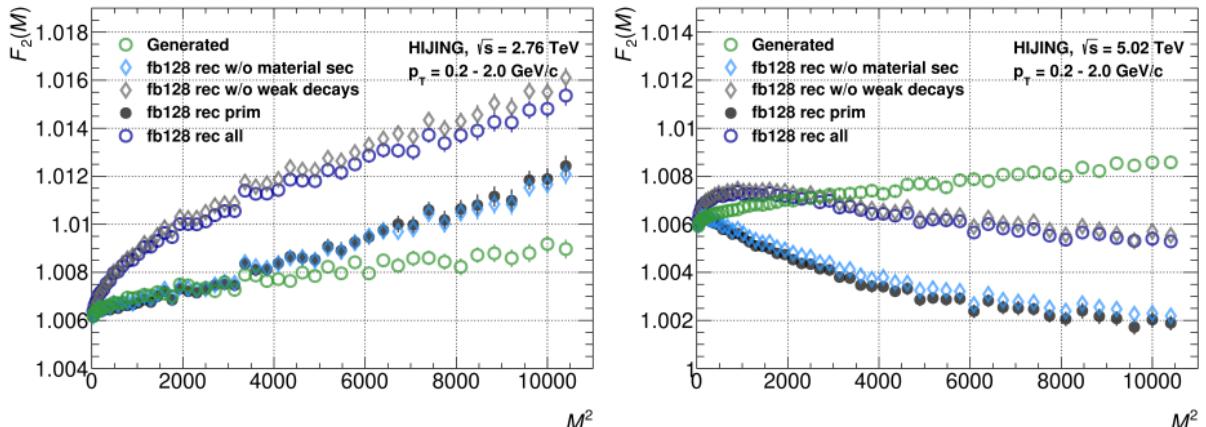
$n_{ie}$ : number of particles in an  $e^{\text{th}}$  event for an  $i^{\text{th}}$  bin.

$\langle \rangle$  is average over number of events.

- In case of scale invariant systems (typical for system near PT, CP).
  - NFM will follow a power law. **M-scaling:**  $F_q(M) \propto (M^2)^{\phi_q}$ ,  $\phi_q$  is called the intermittency index.



# Recap (previous presentation)

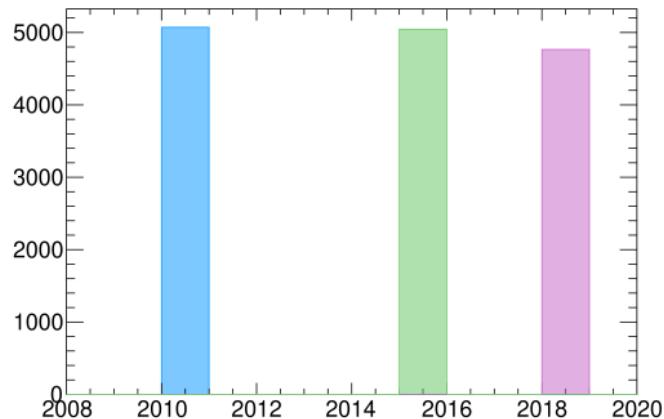


- Shifted to fb128 because of track splitting/merging effects.
- Trends different for 2.76 TeV and 5.02 TeV.

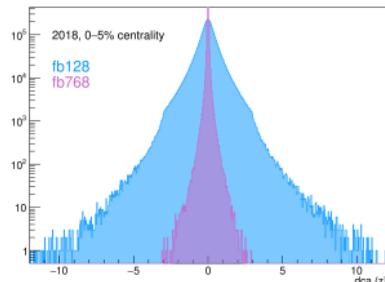
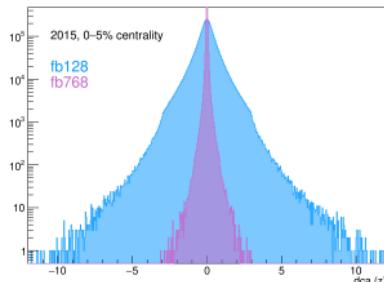
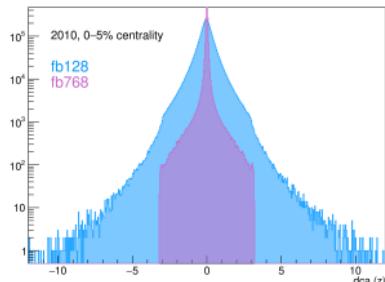
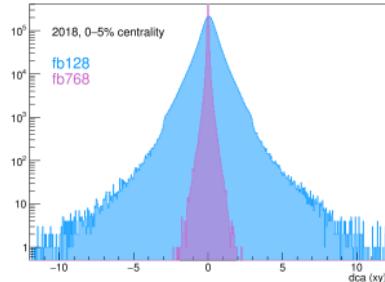
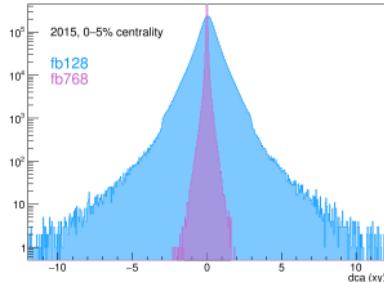
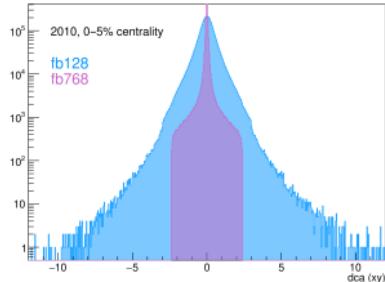
**Filterbits QA**

# Dataset

- Comparison of filterbit QA results.
- HIJING three datasets: **2010 (2.76 TeV)**: LHC11a10a\_bis, **2015 (5.02 TeV)**: LHC20j6a, **2018 (5.02 TeV)**: LHC20e3a.
- $\sim 5000$  events for each dataset.
- Centrality: 0–10%.
- $|v_z| < 10$ ,  $|\eta| < 0.8$ ,  $0 < \varphi < 2\pi$ .
- Trigger bit: kMB (2010), kINT7 (2015/2018).
- Centrality estimation: V0M.



# DCA<sub>*xy*, *z*</sub> comparison



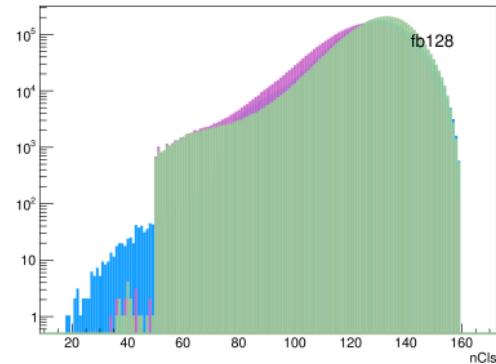
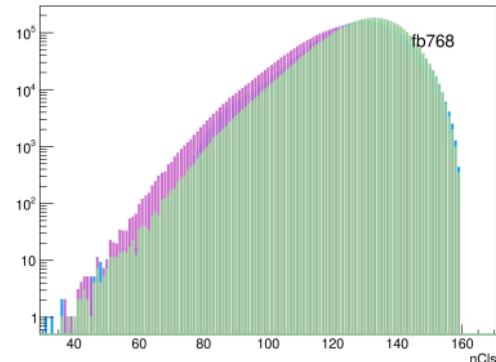
# TPC #clusters comparison

## Definition of fb128.

$|dca_{xy}| < 2.4, |dca_z| < 3.0,$   
 $\text{TPCNClusters} > 50,$   
 $\chi^2_{\text{per TPC cluster}} \leq 4.$

- The method used to check filterbits in AODs:

```
AliAODTrack *track =  
    static_cast<AliAODTrack  
*>(fAOD->GetTrack(i));  
track->TestFilterBit(128);
```

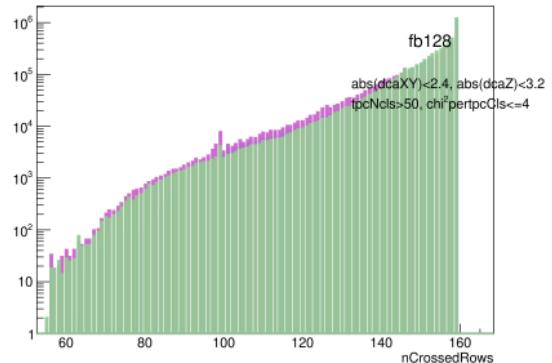
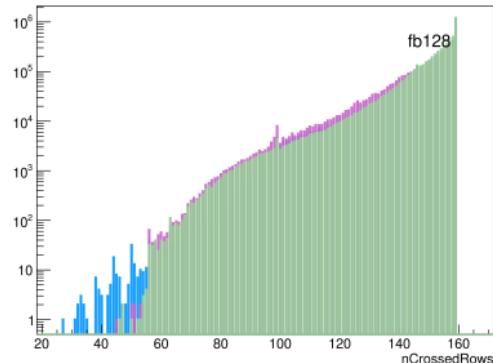


# TPC #crossed rows comparison

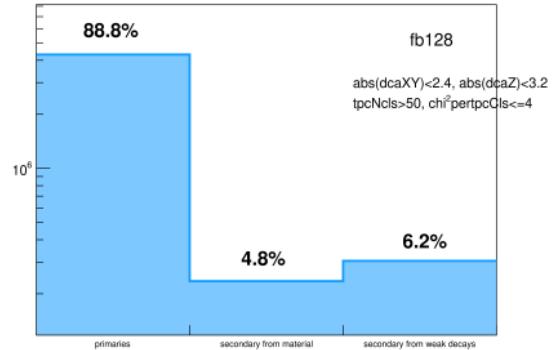
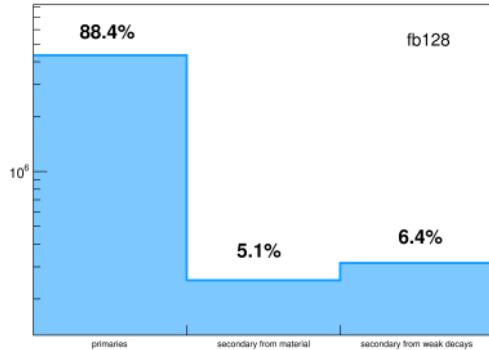
- The method used to check filterbits in AODs:

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AliAODTrack *track =  
static_cast<AliAODTrack  
*>(fAOD->GetTrack(i));  
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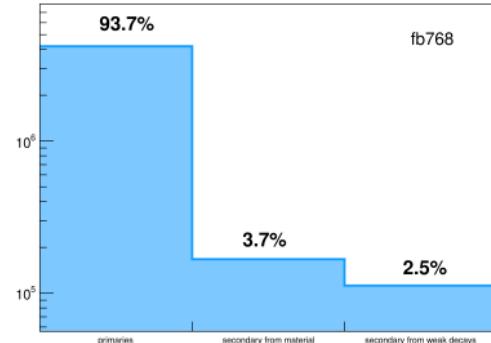
- does not work for 128.
- Applying cuts manually does work.



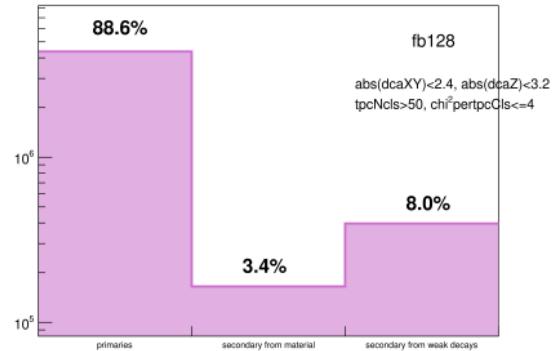
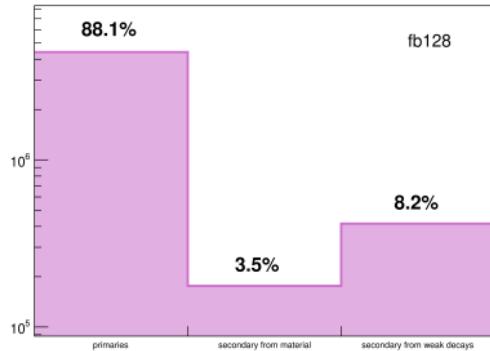
# Contamination in filterbits



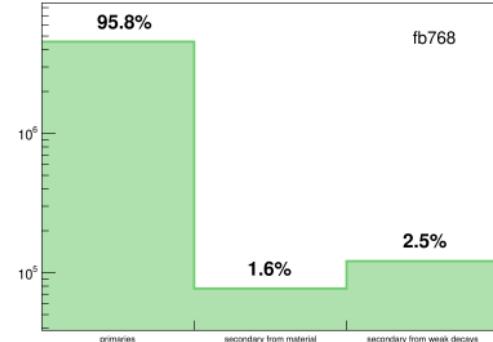
- for 2010 dataset.
- secondaries from material and weak decays both larger in fb128.



# Contamination in filterbits



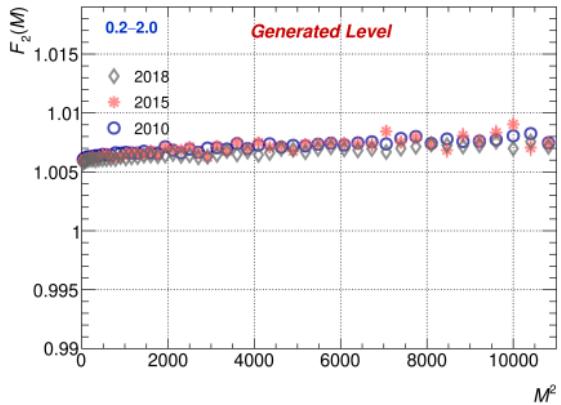
- for 2015/2018 dataset.
- secondaries from material and weak decays both larger in fb128.
- fb768 works fine with less contamination.



**HIJING Closure**

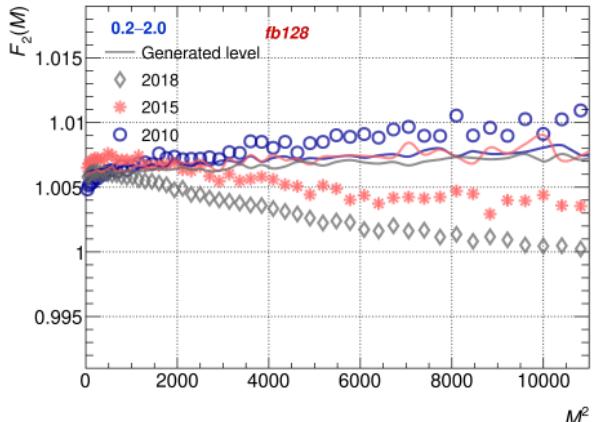
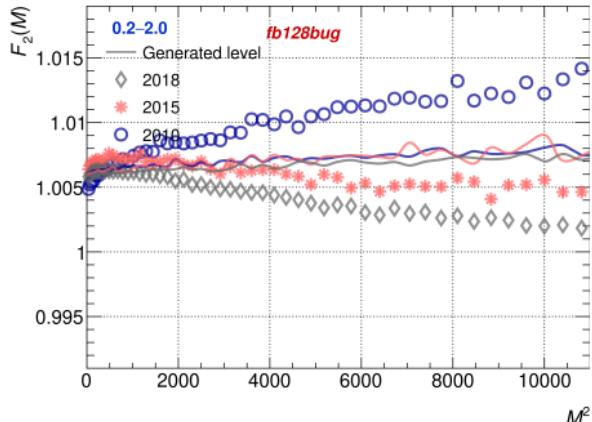
# Dataset

- HIJING:
  - **2010 (2.76 TeV)**: LHC11a10a\_bis ( $\sim 3\text{M}$  events),
  - **2015 (5.02 TeV)**: LHC20j6a ( $\sim 3.5\text{M}$ ),
  - **2018 (5.02 TeV)**: LHC20e3a ( $\sim 3.2\text{M}$ ).
- 0–5% centrality,  $|v_z| < 10$ ,  $|\eta| < 0.8$ ,  $0 < \varphi < 2\pi$ .
- Trigger bit: kMB (2010), kINT7 (2015/2018).
- Centrality estimation: V0M.
- HIJING Pileup rejection: <https://twiki.cern.ch/twiki/bin/view/ALICE/AliDPGtoolsPileup>.

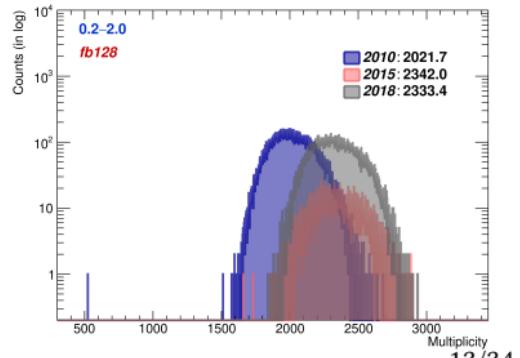


Generated Level ( $0.2 \leq p_T \leq 2.0$ )

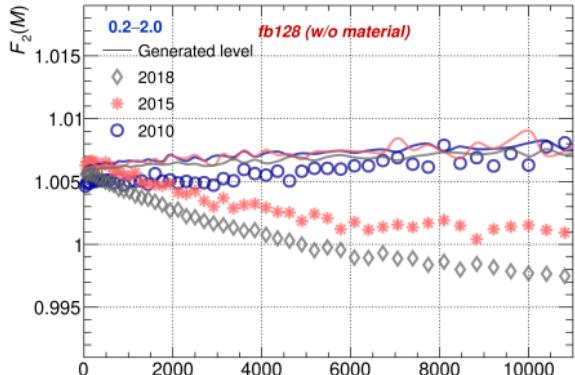
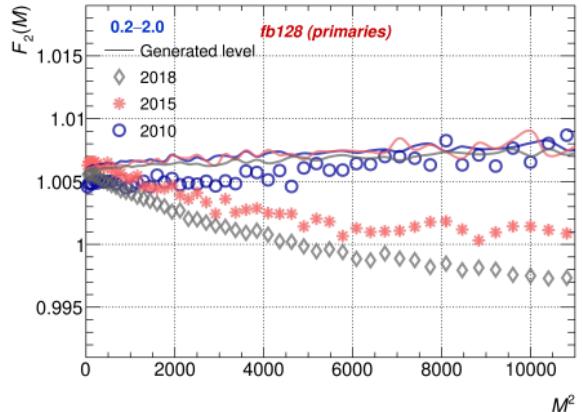
# fb128 ( $0.2 \leq p_T \leq 2.0$ )



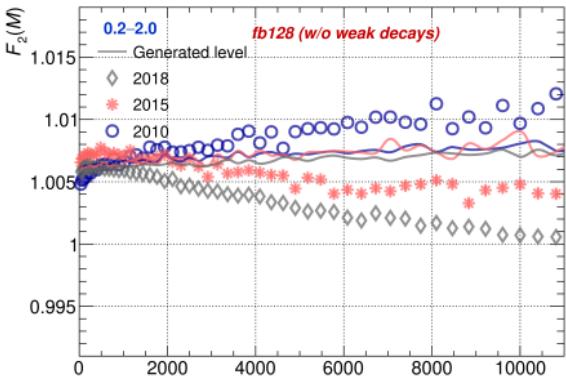
- *fb128* (right) is the actual closure (with cuts in *fb128* applied manually).
- Closure for 2010 better than 2015/2018.



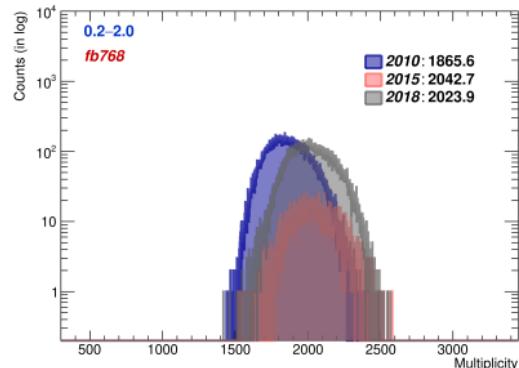
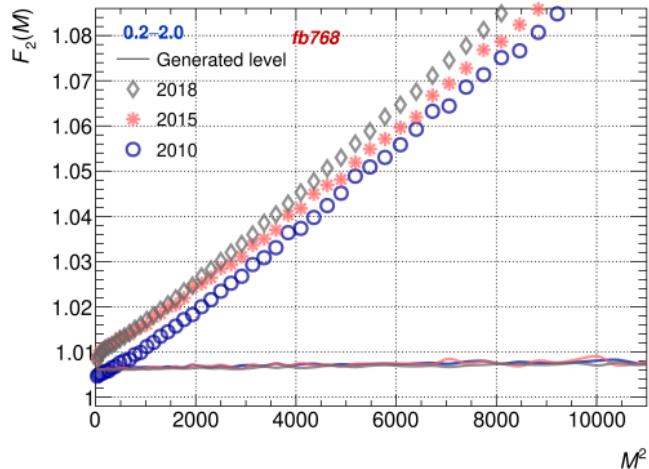
# $\text{fb128} (0.2 \leq p_T \leq 2.0)$



- Closure for 2010 better than 2015/2018.

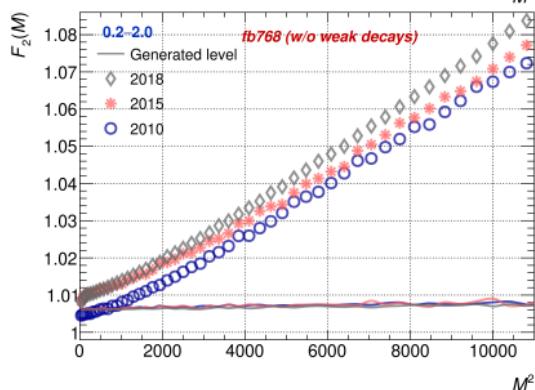
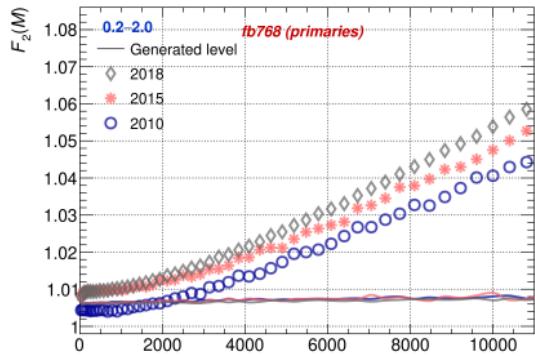
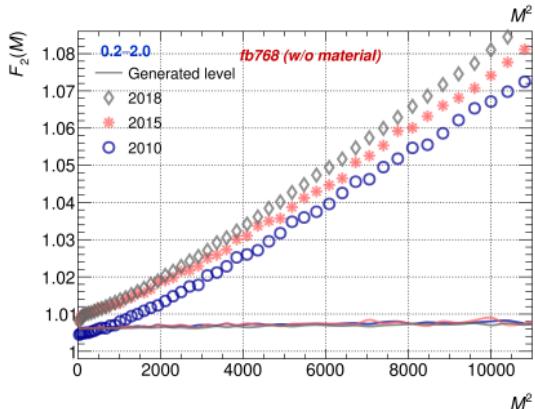
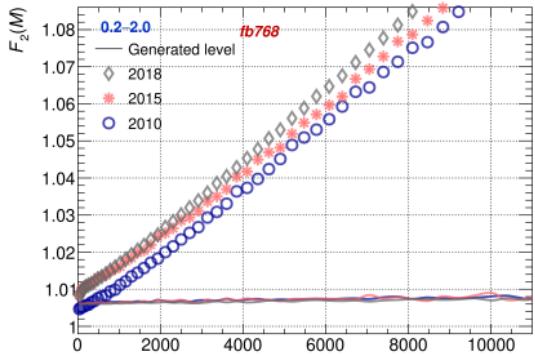


## $fb768$ ( $0.2 \leq p_T \leq 2.0$ )



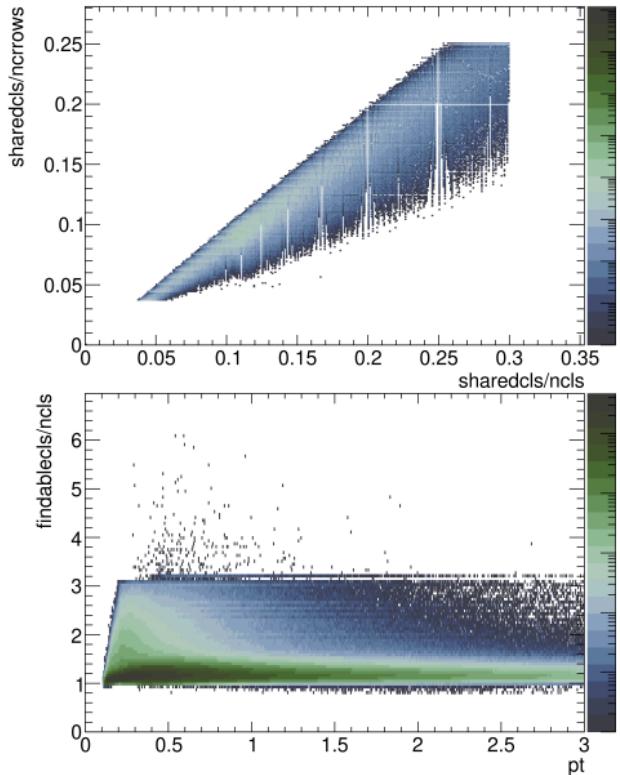
- $fb768$  does not show good closure for 2010, 2015/2018.
- the trends for all the datasets are alike.
- stricter cuts can improve the closure.

# $\text{fb768 } (0.2 \leq p_T \leq 2.0)$



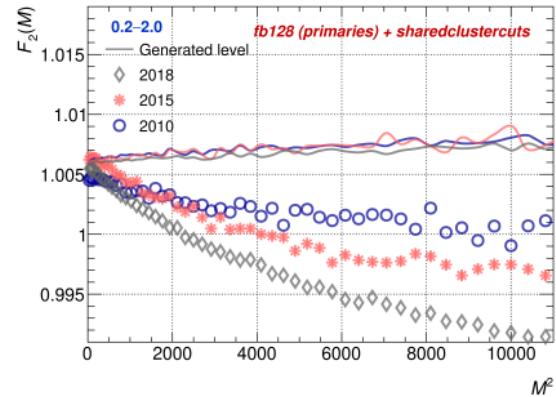
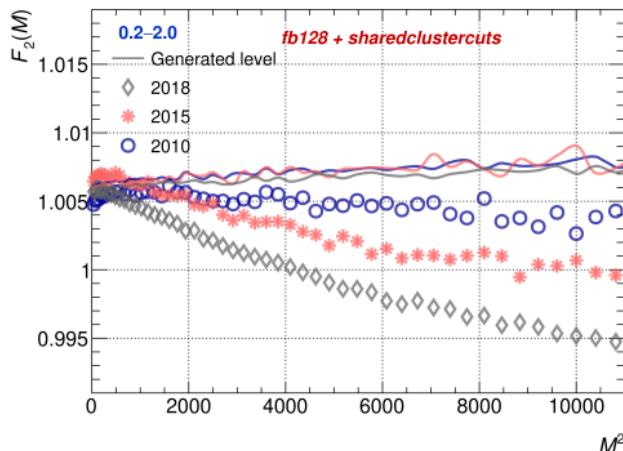
# TPC clusters cuts

- An additional set of cuts to reduce track splitting/merging effects.
- $\#\text{sharedclusters}/\#\text{clusters} \leq 0.3$ .
- $\#\text{sharedclusters}/\#\text{crossedRows} \leq 0.25$ .
- $\#\text{findableclusters}/\#\text{clusters} \geq 0.8$ .



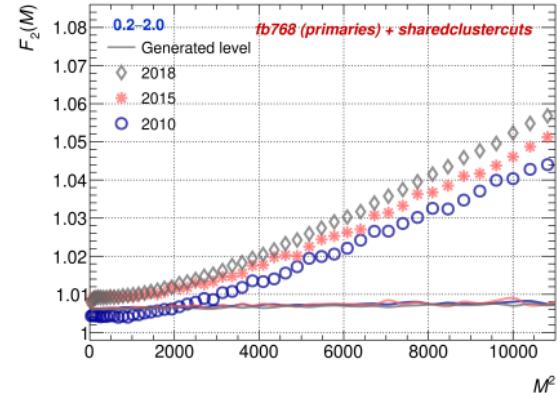
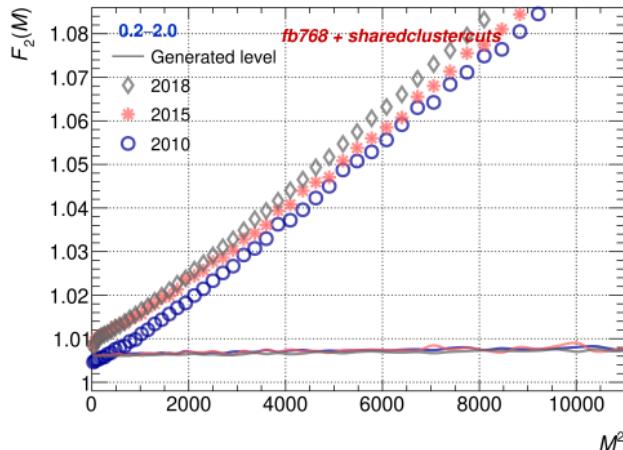
cuts taken from analysis note: <https://alice-notes.web.cern.ch/node/1653>.

# $\text{fb128} (0.2 \leq p_T \leq 2.0) \text{ with TPC clusters cuts}$



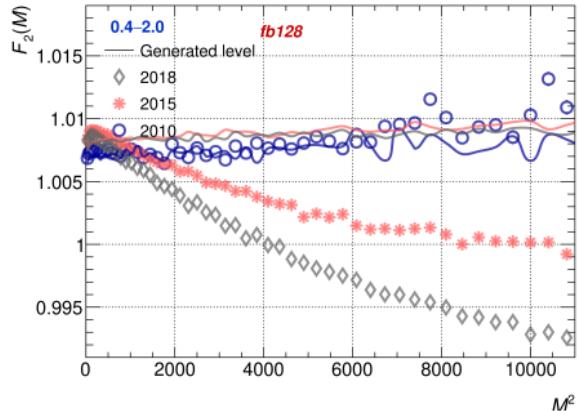
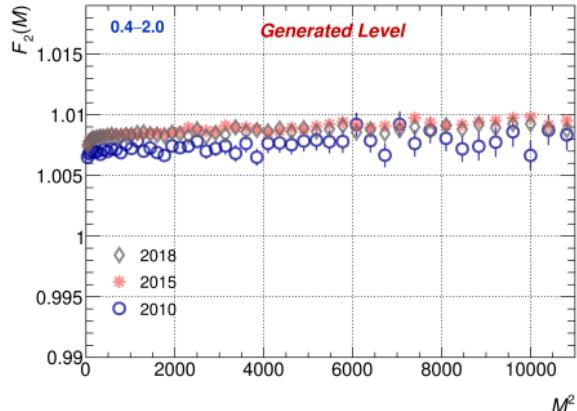
- Closure worsens for all the datasets.

# fb768 ( $0.2 \leq p_T \leq 2.0$ ) with TPC clusters cuts

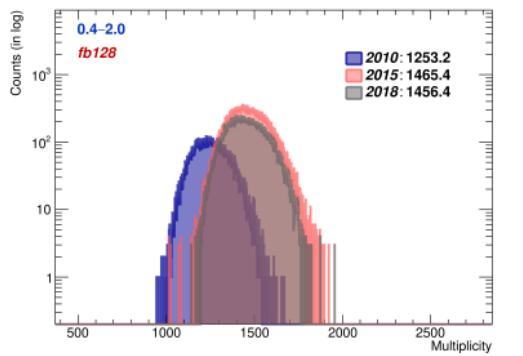


- Closure improves for all the datasets.
- Similar trend across datasets.
- $0.2 \leq p_T \leq 0.4$  has different efficiency for 2.76 TeV and 5.02 TeV.
  - note that  $F_q(M)$  are robust against detector efficiencies (widely studied):  
<https://alice-notes.web.cern.ch/node/996>.
- Should check  $0.4 \leq p_T \leq 2.0$ .

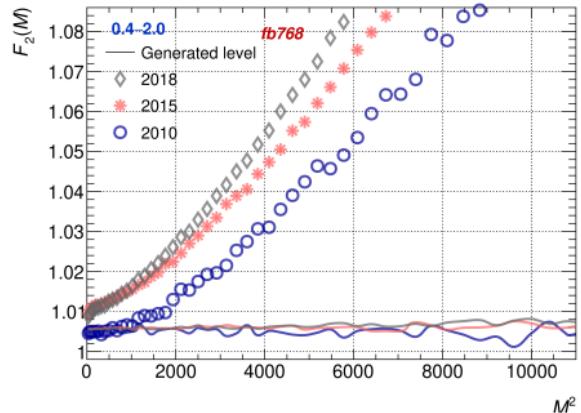
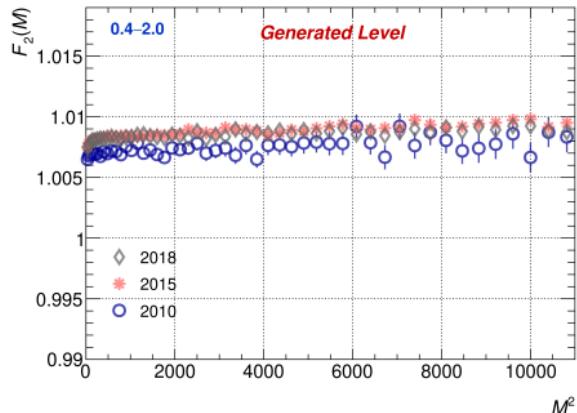
# Generated and fb128 ( $0.4 \leq p_T \leq 2.0$ )



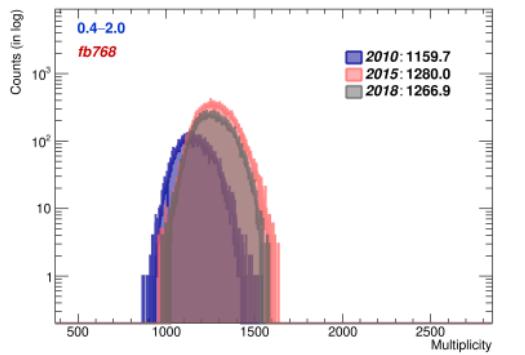
- Closure for 2010 better than 2015/2018.



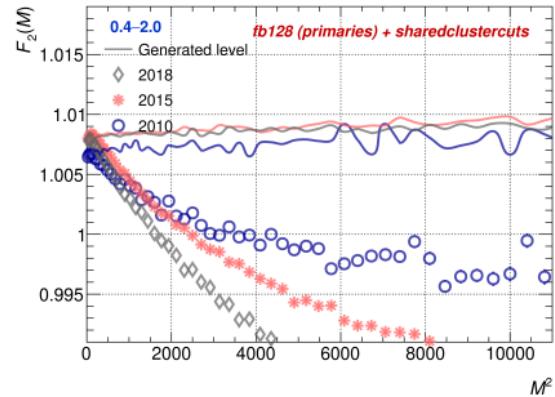
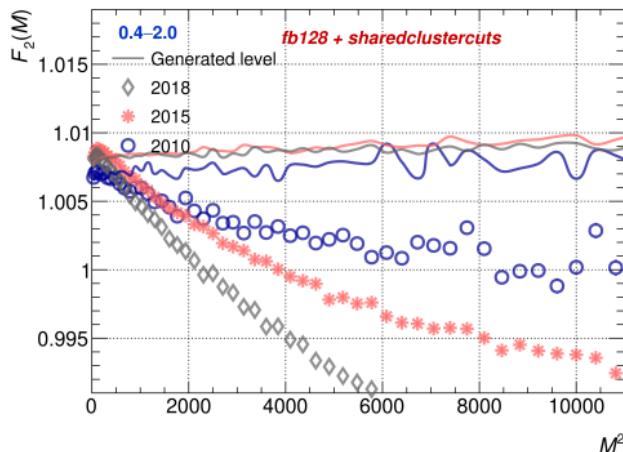
# Generated and fb768 ( $0.4 \leq p_T \leq 2.0$ )



- Closure not good for all datasets.

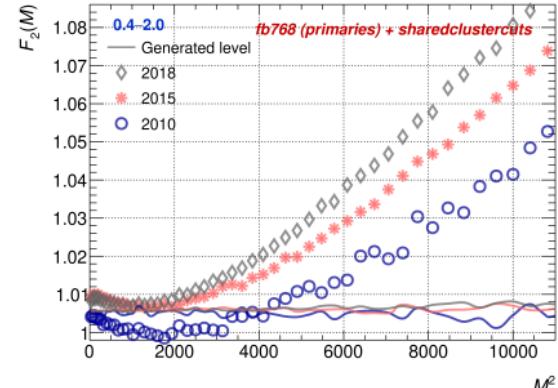
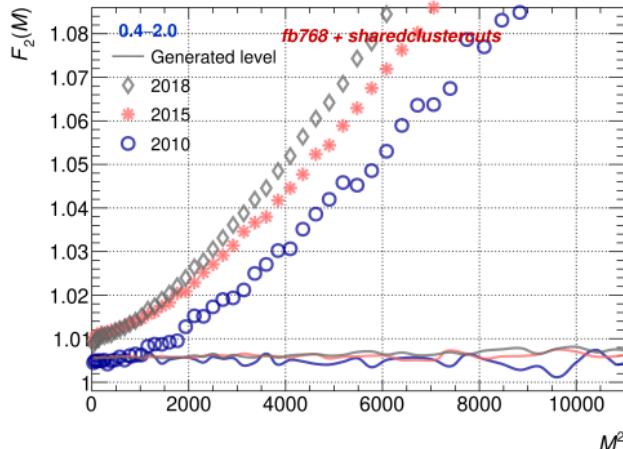


# $\text{fb128} (0.4 \leq p_T \leq 2.0) \text{ with TPC clusters cuts}$



- Closure deteriorates for all the datasets.

# fb768 ( $0.4 \leq p_T \leq 2.0$ ) with TPC clusters cuts



- Closure improves with TPC clusters cuts for fb128

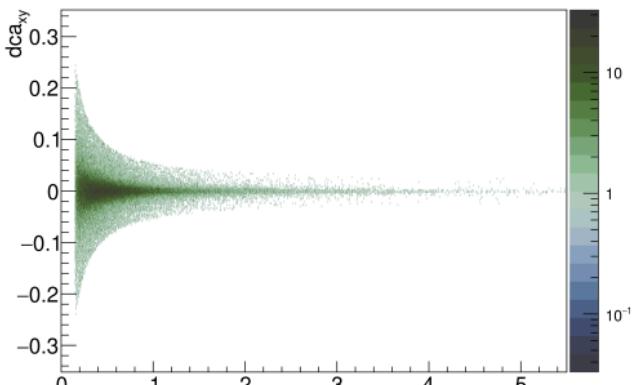
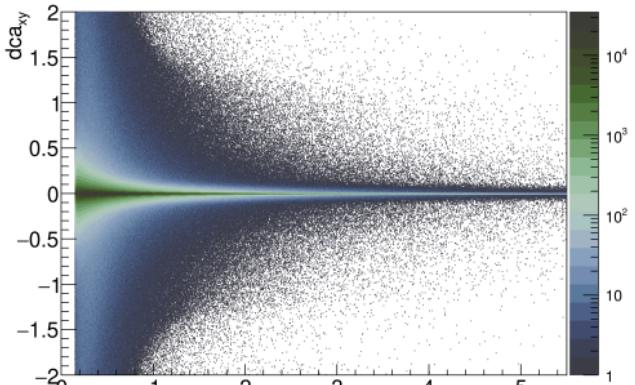
# $p_T$ dependent DCA cuts

- An additional set of cuts to improve the closure.
- 2015/2018 data: Maximum  $DCA_{xy}$  cut:  $0.028 + 0.04 * p_T^{(1.01)}$

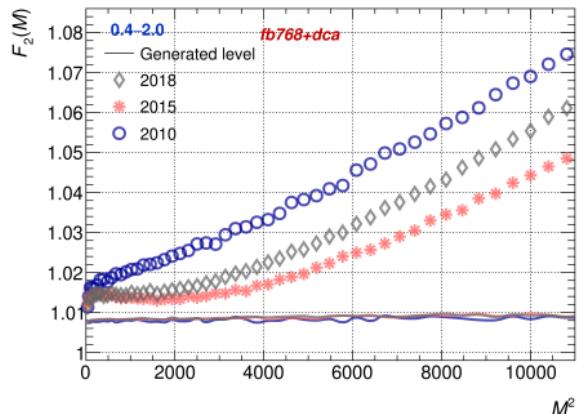
cut taken from analysis note: <https://alice-notes.web.cern.ch/node/1653>.

- 2010 data: Maximum  $DCA_{xy}$  cut:  
 $0.0182 + \frac{0.035}{p_T^{(1.01)}}$

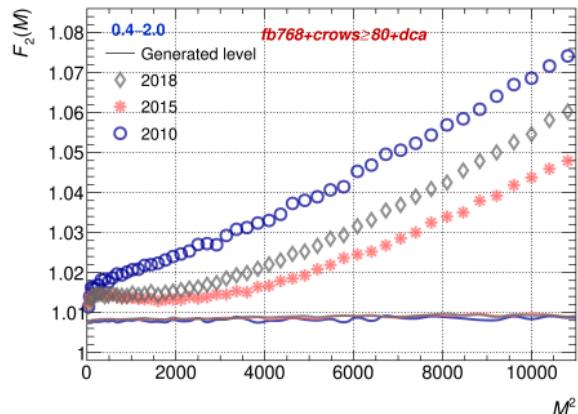
cut taken from analysis note: <https://alice-notes.web.cern.ch/node/736>.



# fb768 ( $0.4 \leq p_T \leq 2.0$ ) with multiple cuts

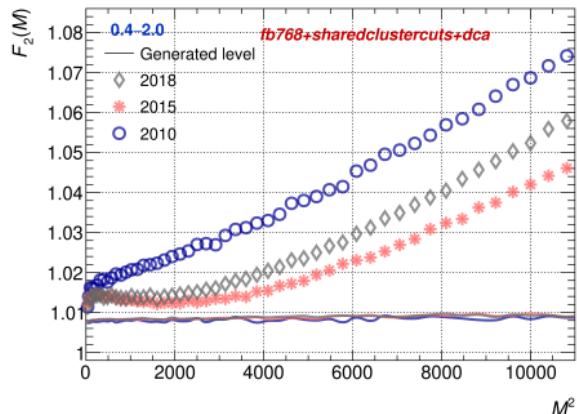


fb768 with DCA cut

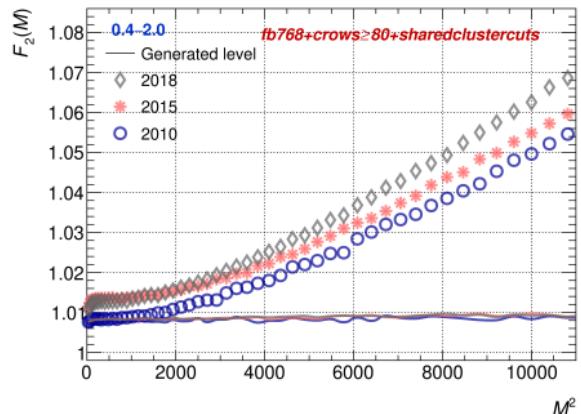


fb768 wih DCA cut and tpc #crossed rows  $\geq 80$

# fb768 ( $0.4 \leq p_T \leq 2.0$ ) with multiple cuts

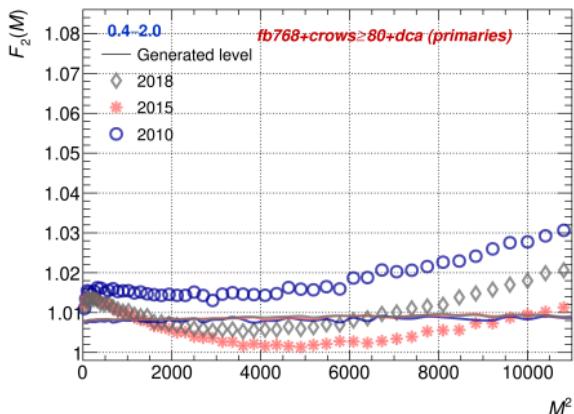


fb768 with DCA cut and  
sharedclusters cuts

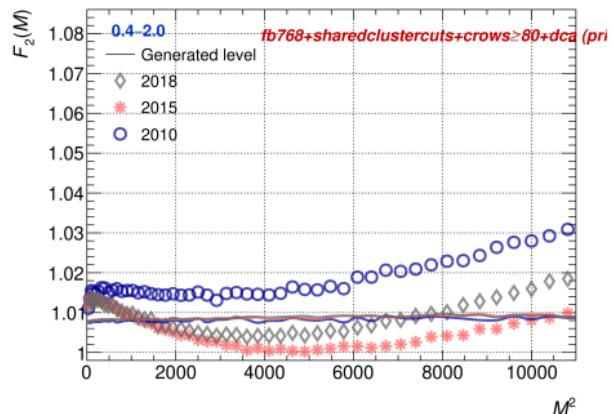


fb768 wih shared clusters cuts and tpc  
#crossed rows  $\geq 80$

# fb768 ( $0.4 \leq p_T \leq 2.0$ ) with multiple cuts (primaries only)



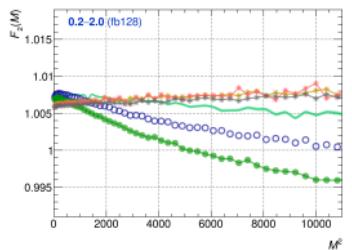
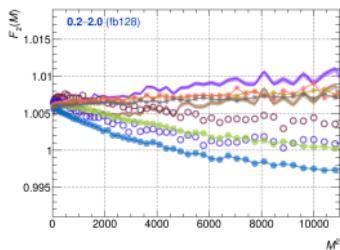
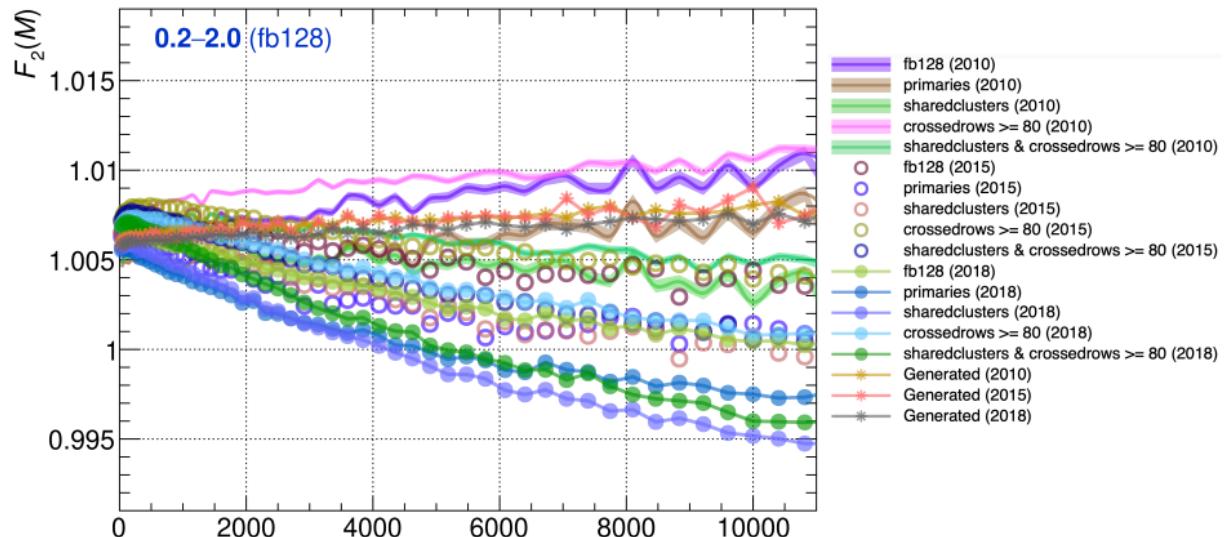
fb768 with DCA cut and tpc #crossed rows  $\geq 80$



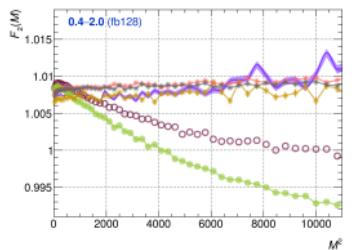
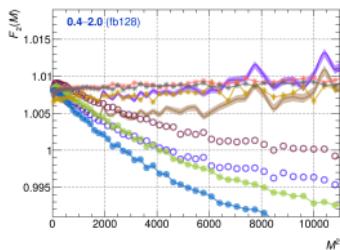
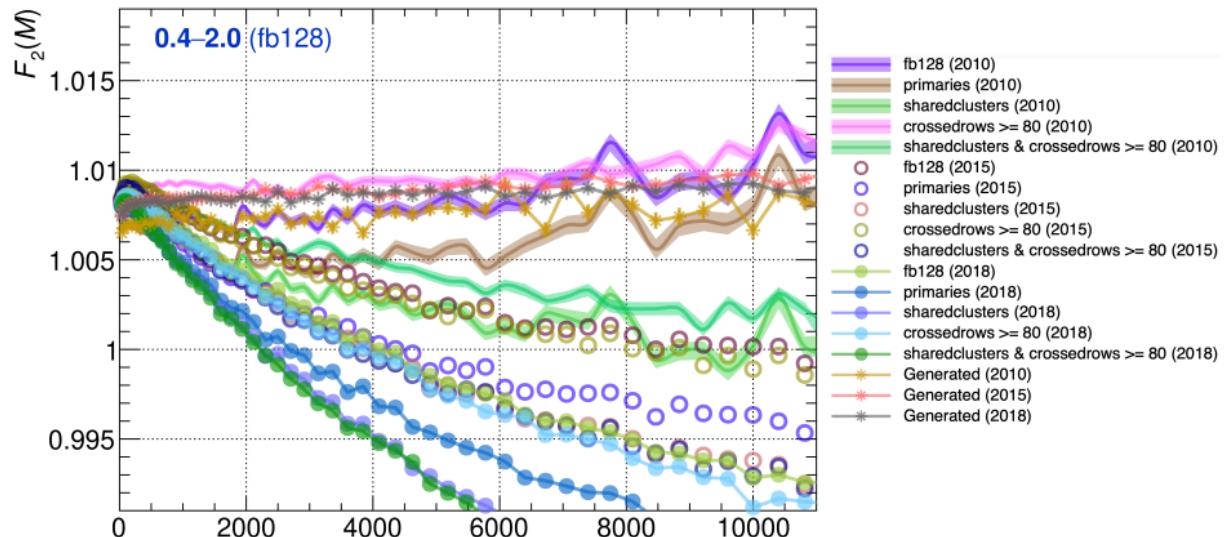
fb768 with DCA cut, shared clusters cuts and tpc #crossed rows  $\geq 80$

- Best closure for fb768 with DCA cut, shared clusters cuts and tpc #crossed rows  $\geq 80$ .
- Similar trends for 2.76 TeV and 5.02 TeV, all the datasets.

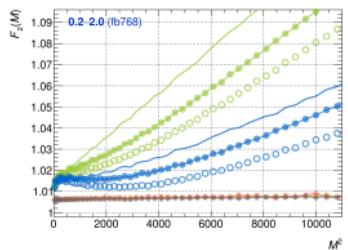
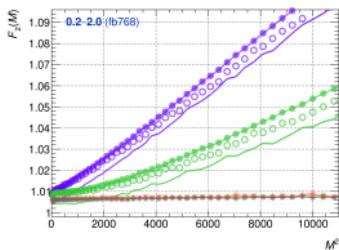
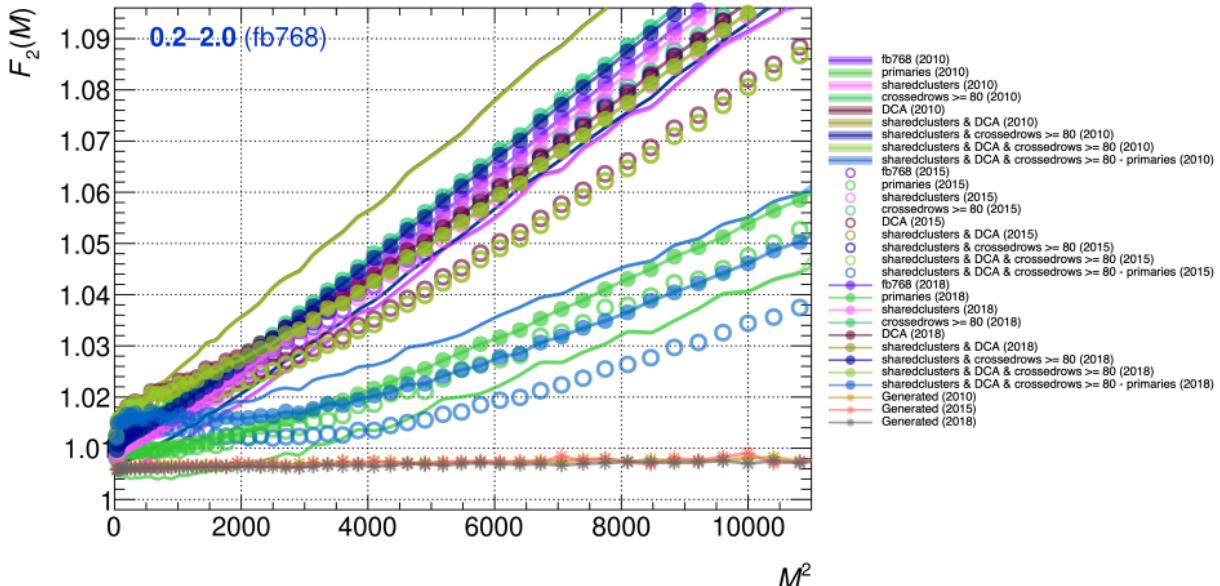
# Final fb128 ( $0.2 \leq p_T \leq 2.0$ )



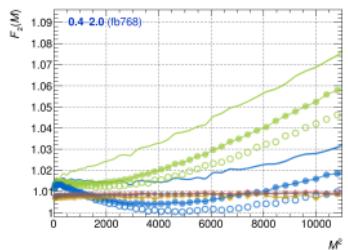
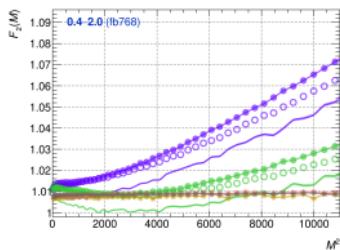
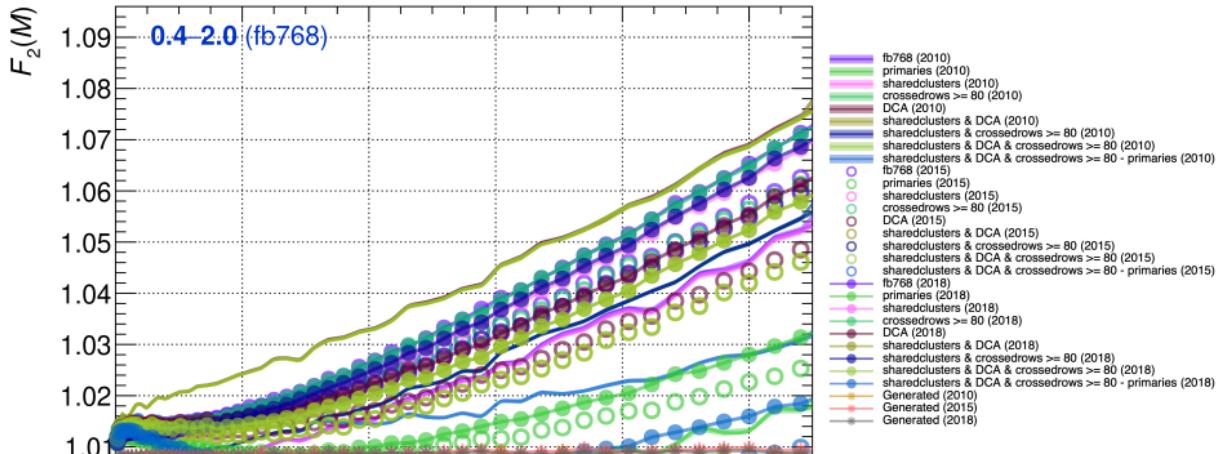
# Final fb128 ( $0.4 \leq p_T \leq 2.0$ )



## Final fb768 ( $0.2 \leq p_T \leq 2.0$ )



# Final fb768 ( $0.4 \leq p_T \leq 2.0$ ) ✓



# Conclusions

# Conclusions

- filterbits (128 and 768) studied for Pb–Pb HIJING datasets of 2010 (2.76 TeV), 2015 (5.02 TeV) and 2018 (5.02 TeV):
  - QA within  $|v_z| < 10$ ,  $|\eta| < 0.8$ , 0–10% central events of each dataset.
  - closure behaviour of  $F_q(M)$  within  $|v_z| < 10$ ,  $|\eta| < 0.8$ ,  $p_T$  ranges: 0.2–2.0 and 0.4–2.0, and most central 0–5% events.
- fb128 method unreliable in AODs. Manual cuts work but show higher contamination (material + weak decays) across datasets. Good baseline closure for 2010 but trends alike.
- fb768 cleaner but poorer closure baseline.
- TPC shared cluster cuts used to mitigate track splitting/merging effects:  
 $\#sharedclusters/\#clusters \leq 0.3$ ,  $\#sharedclusters/\#crossedRows \leq 0.25$ , and  
 $\#findableclusters/\#clusters \geq 0.8$ . fb768 closure improves consistently with TPC clusters cuts, worsens for fb128.
- $p_T$  dependent DCA<sub>xy</sub> cuts used:
  - Combined with  $\#crossedRows \geq 80$  and shared-clusters cuts → best performance for fb768.

**Thank you**