Intermittency analysis update (2.76 TeV, 5.02 TeV)

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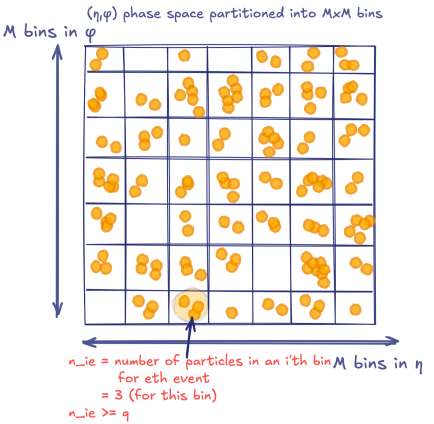
Recap (Intermittency analysis)

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

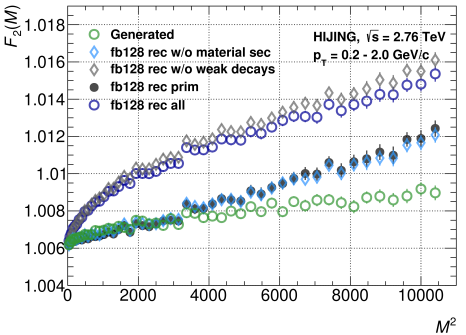
$$F_q(M) \equiv \frac{\left\langle \frac{1}{M^2} \sum_{i=1}^{M^2} n_{\text{ie}}(n_{\text{ie}}-1)\ldots(n_{\text{ie}}-q+1) \right\rangle}{\left\langle \frac{1}{M^2} \sum_{i=1}^{M^2} n_{\text{ie}} \right\rangle^q}$$

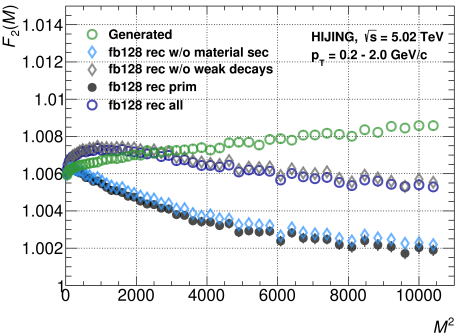
n_{ie}: number of particles in an e^{th} event for an i^{th} bin.
<> is average over number of events.



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

Recap (previous presentation)





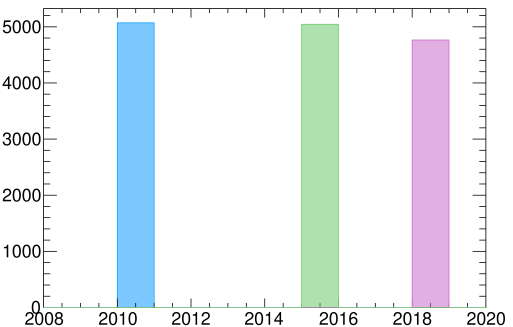
- Shifted to fb128 because of track splitting/merging effects.
- Trends different for 2.76 TeV and 5.02 TeV.

Filterbits QA

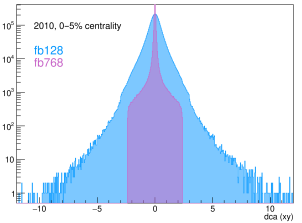
Dataset

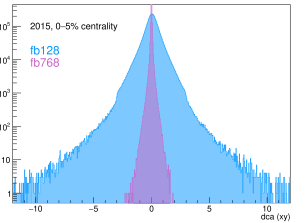
- Comparison of filterbit QA results.
- HIJING three datasets: **2010 (2.76 TeV)**: LHC11a10a_bis, **2015 (5.02 TeV)**: LHC20j6a, **2018 (5.02 TeV)**: LHC20e3a.

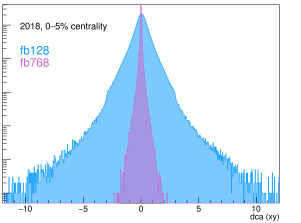
- ∼5000 events for each dataset.
- Centrality: 0–10%.
- $|v_z| < 10$, $|\eta| < 0.8$, $0 < \varphi < 2\pi$.
- Trigger bit: kMB (2010), kINT7 (2015/2018).
- Centrality estimation: V0M.

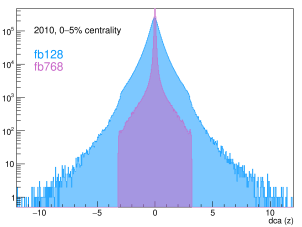


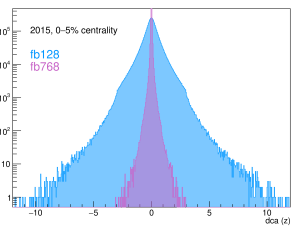
$\mathrm{DCA}_{xy,\,z}$ comparison

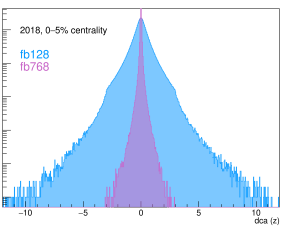












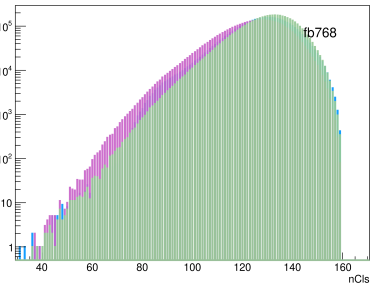
TPC #clusters comparison

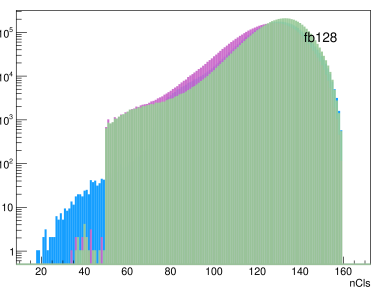
Definition of fb128.

$|\mathrm{dca}_{xy}| < 2.4$, $|\mathrm{dca}_{z}| < 3.0$,
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);
```



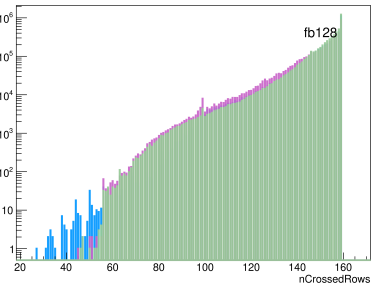


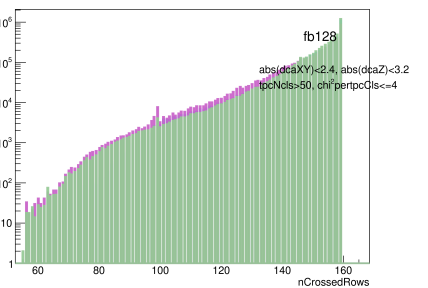
TPC #crossed rows comparison

- The method used to check filterbits in AODs:

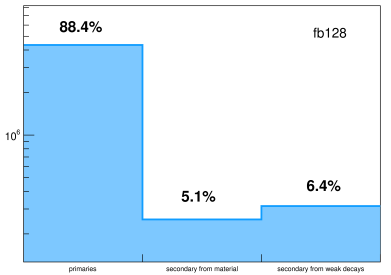
```
AliAODTrack *track =
static_cast<AliAODTrack
*>(fAOD->GetTrack(i));
track->TestFilterBit(128);
```

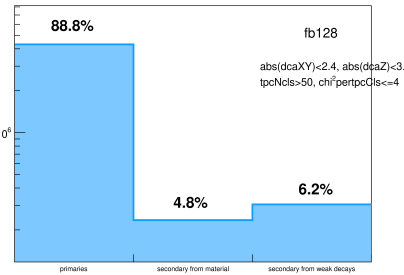
- does not work for 128.
- Applying cuts manually does work.



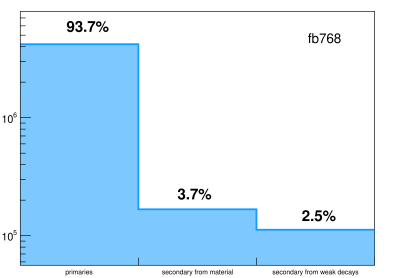


Contamination in filterbits

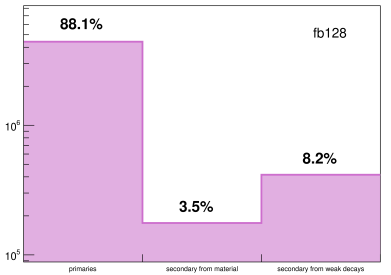


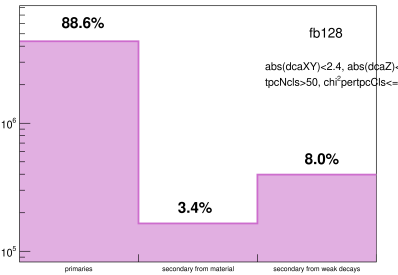


- for 2010 dataset.
- secondaries from material and weak decays both larger in fb128.

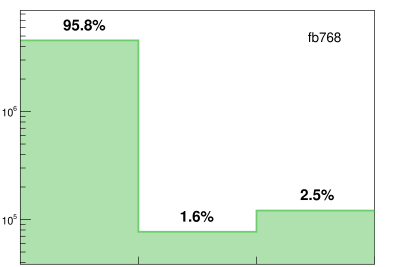


Contamination in filterbits





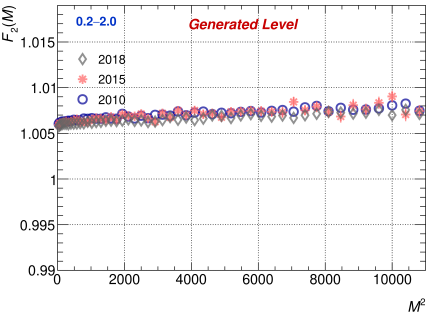
- for 2015/2018 dataset.
- secondaries from material and weak decays both larger in fb128.
- fb768 works fine with less contamination.



HIJING Closure

Dataset

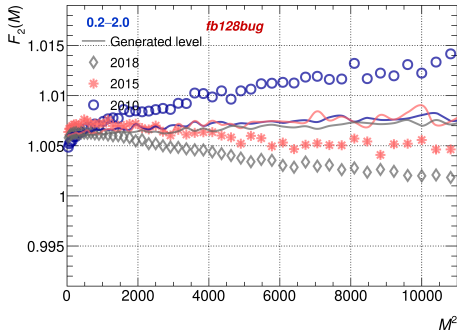
- HIJING:
  - **2010 (2.76 TeV)**: LHC11a10a_bis ($\sim$ 3M events),
  - **2015 (5.02 TeV)**: LHC20j6a ($\sim$ 3.5M),
  - **2018 (5.02 TeV)**: LHC20e3a ($\sim$ 3.2M).
- 0–5% centrality, $|v_z| < 10$, $|\eta| < 0.8$, $0 < \varphi < 2\pi$.
- Trigger bit: kMB (2010), kINT7 (2015/2018).
- Centrality estimation: V0M.

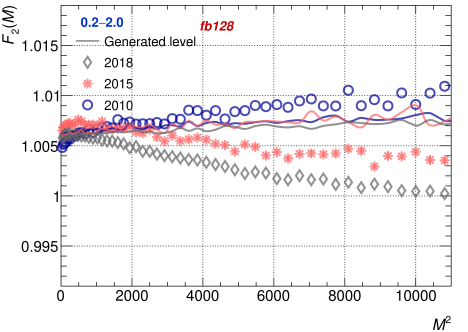


Generated Level ($0.2 \leq p_{\mathrm{T}} \leq 2.0$)

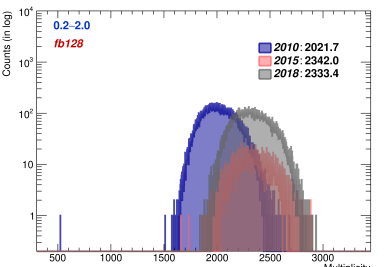
- HIJING Pileup rejection: https://twiki.cern.ch/twiki/bin/view/ALICE/AliDPGtoolsPileup.

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

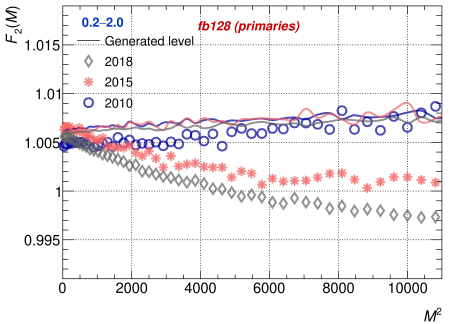


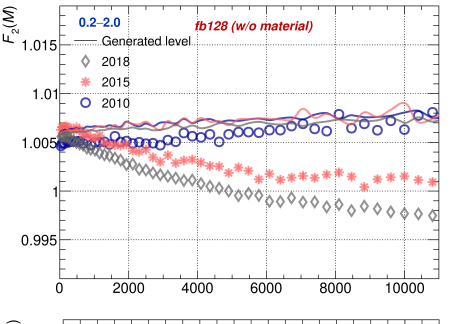


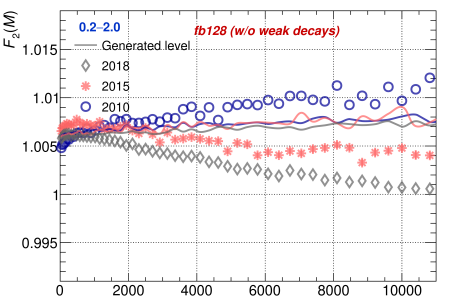
- fb128 (right) is the actual closure (with cuts in fb128 applied manually).
- Closure for 2010 better than 2015/2018.



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

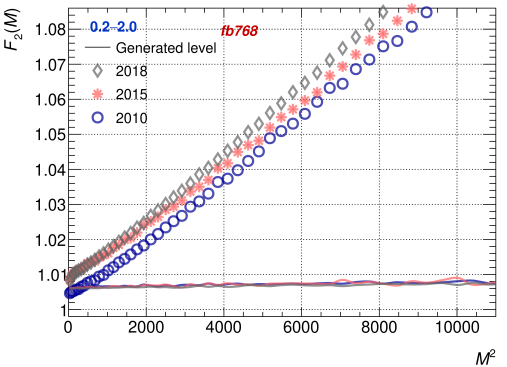


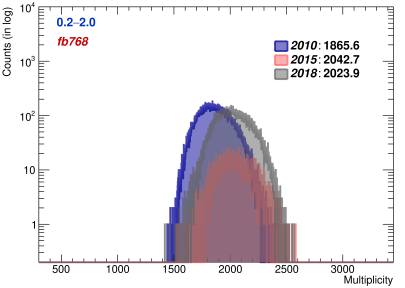




- Closure for 2010 better than 2015/2018.

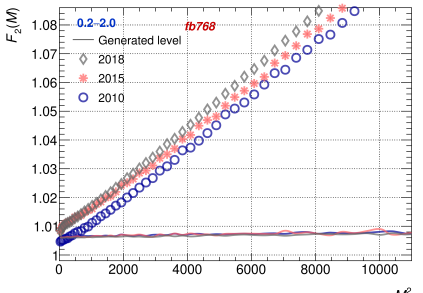
fb768 ($0.2 \leq p_T \leq 2.0$)

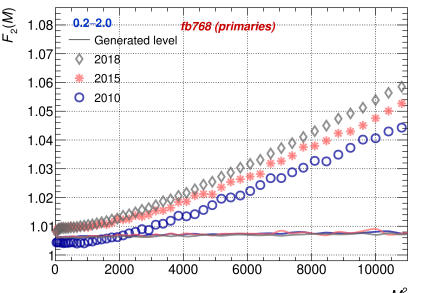


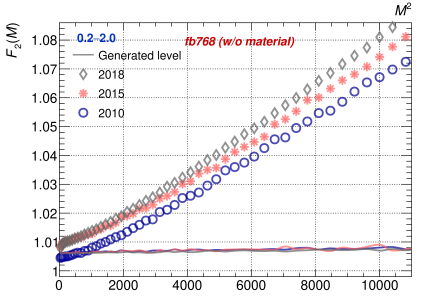


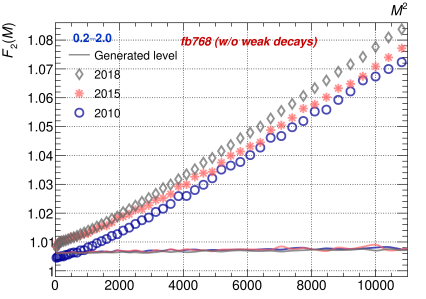
- fb768 does not show good closure for 2010, 2015/2018.
- the trends for all the datasets are alike.
- stricter cuts can improve the closure.

fb768 ($0.2 \leq p_{\mathrm{T}} \leq 2.0$)



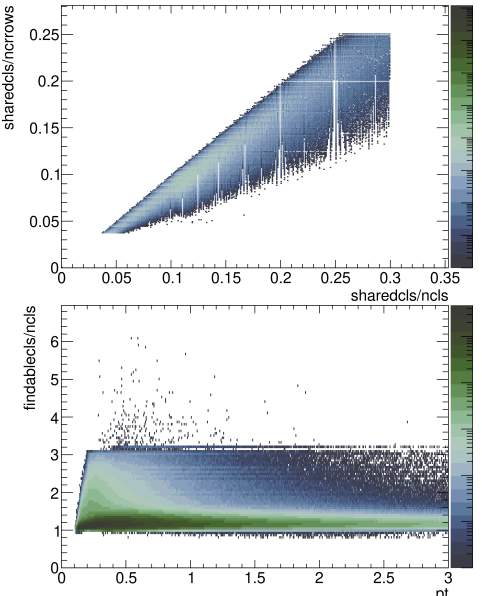






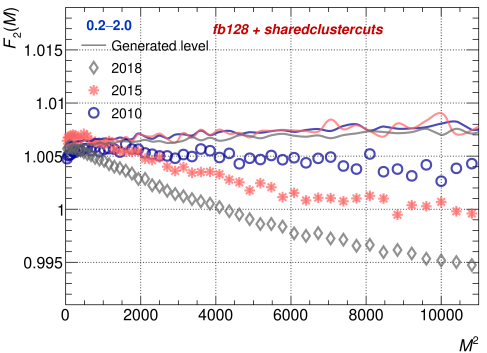
TPC clusters cuts

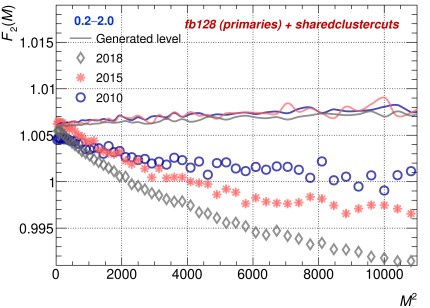
- An additional set of cuts to reduce track spltting/merging effects.
- #sharedclusters/#clusters ≤ 0.3.
- #sharedclusters/#crossedRows ≤ 0.25.
- #findableclusters/#clusters ≥ 0.8.



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

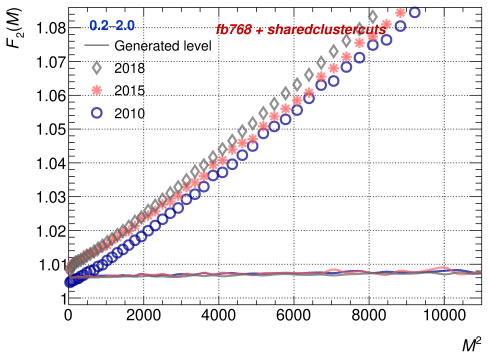
fb128 ($0.2 \leq p_T \leq 2.0$) with TPC clusters cuts

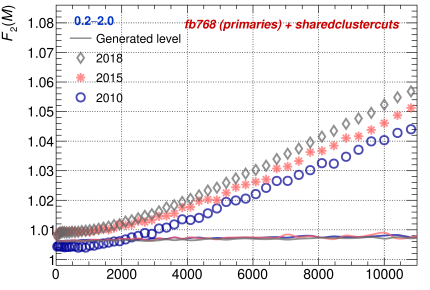




- Closure worsens for all the datasets.

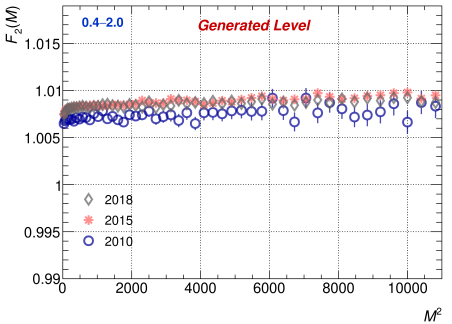
fb768 ($0.2 \leq p_{\mathrm{T}} \leq 2.0$) with TPC clusters cuts

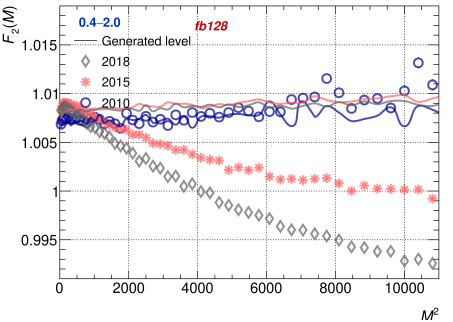




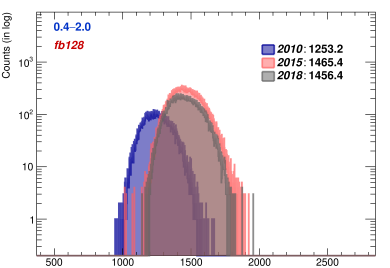
- Closure improves for all the datasets.
- Similar trend across datasets.
- $0.2 \leq p_{\mathrm{T}} \leq 0.4$ has different efficiency for 2.76 TeV and 5.02 TeV.
  - note that $F_{\mathrm{q}}(M)$ are robust againts detector efficiencies (widely studied: https://alice-notes.web.cern.ch/node/996.
- Should check $0.4 \leq p_{\mathrm{T}} \leq 2.0$.

Generated and fb128 ($0.4 \leq p_{\mathrm{T}} \leq 2.0$)

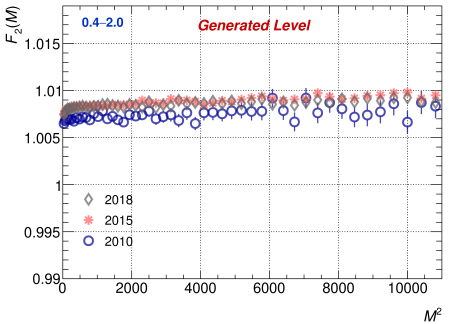


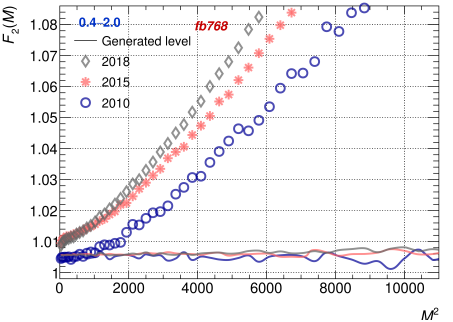


- Closure for 2010 better than 2015/2018.

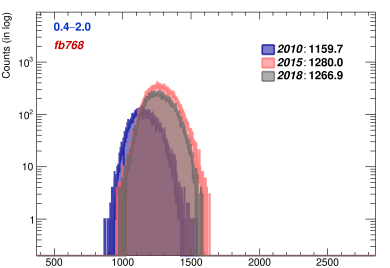


Generated and fb768 ($0.4 \leq p_T \leq 2.0$)

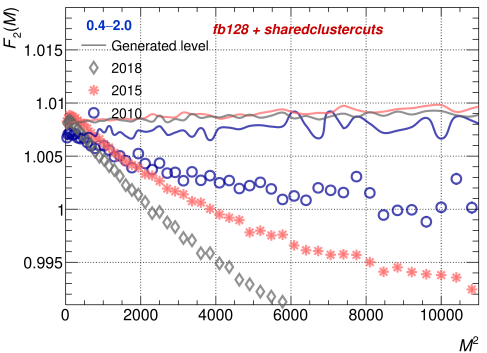


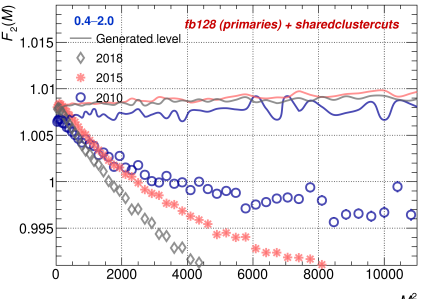


- Closure not good for all datasets.



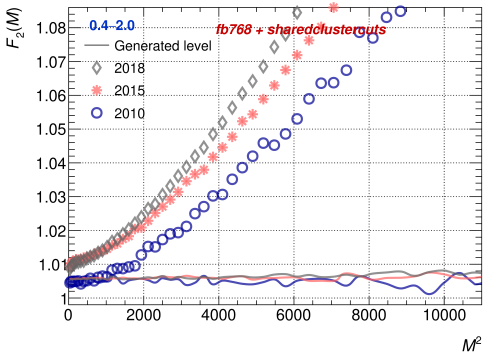
fb128 ($0.4 \leq p_{\mathrm{T}} \leq 2.0$) with TPC clusters cuts

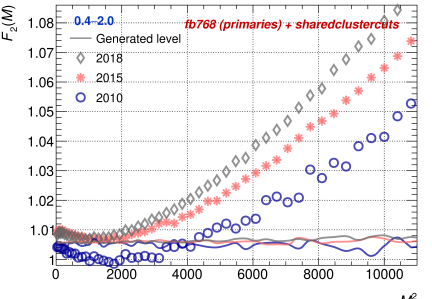




- Closure deteriorates for all the datasets.

fb768 ($0.4 \leq p_{\mathrm{T}} \leq 2.0$) with TPC clusters cuts





- Closure improves with TPC clusters cuts for fb128

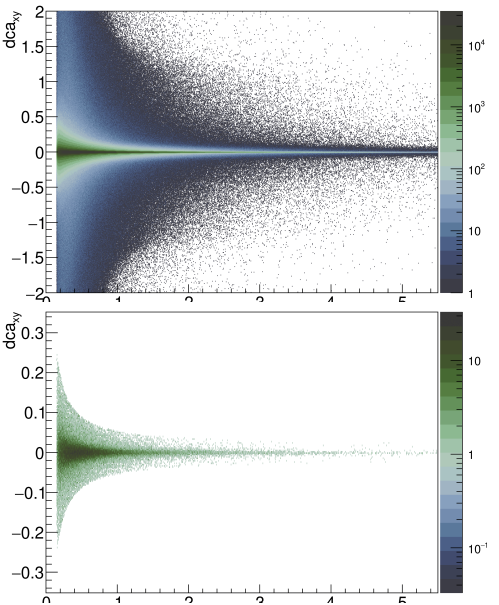
p_{T} dependent DCA cuts

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

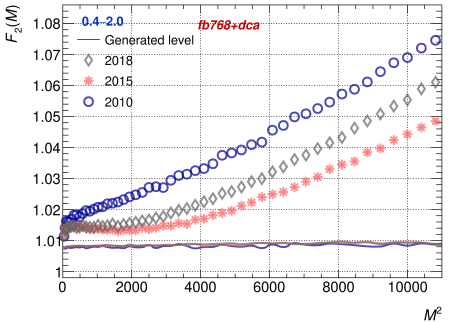
cut taken from analysis note: https://alice-notes.web.cern.ch/node/1653.

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

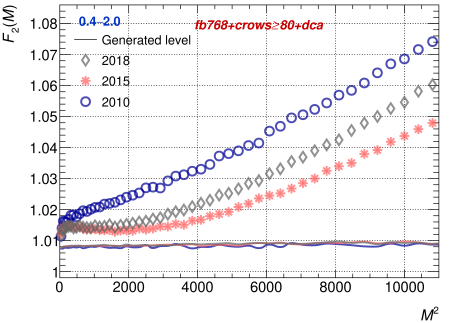
cut taken from analysis note: https://alice-notes.web.cern.ch/node/736.



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

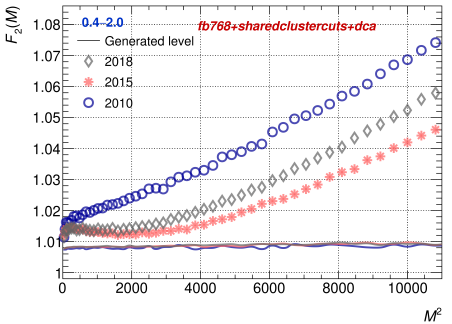


fb768 with DCA cut

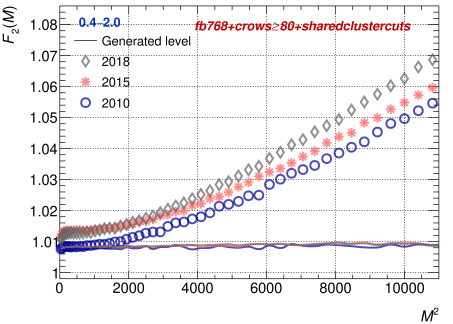


fb768 wih DCA cut and tpc #crossed rows >= 80

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

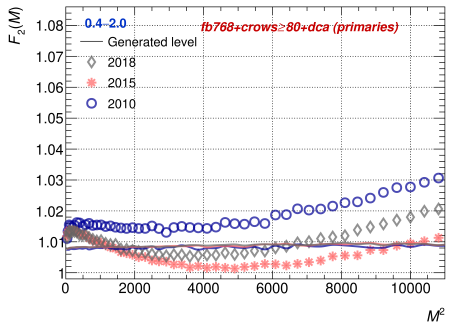


fb768 with DCA cut and sharedclusters cuts

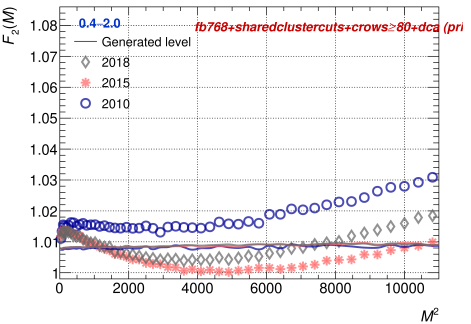


fb768 wih shared clusters cuts and tpc #crossed rows >= 80

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



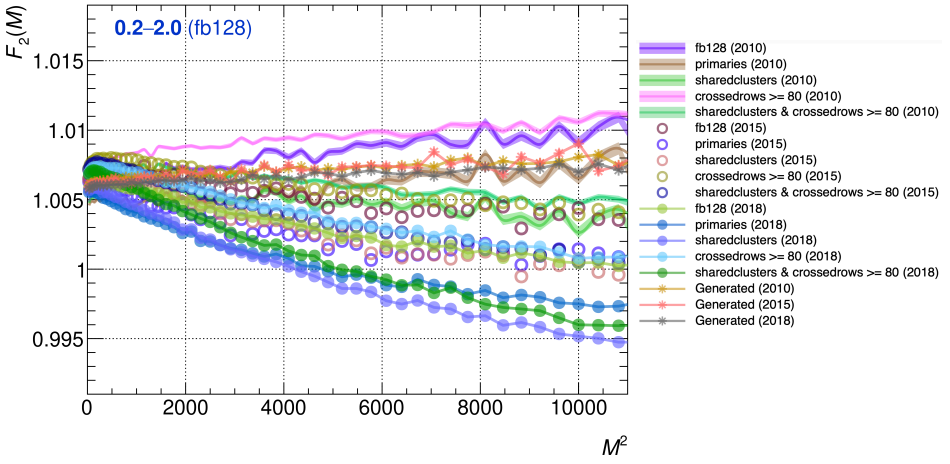
fb768 with DCA cut and tpc #crossed rows >= 80

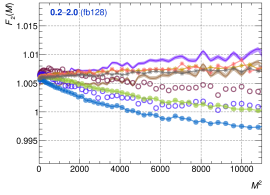


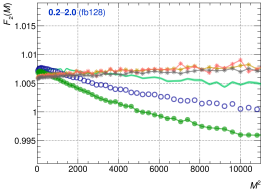
fb768 wih DCA cut, shared clusters cuts and tpc #crossed rows >= 80

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

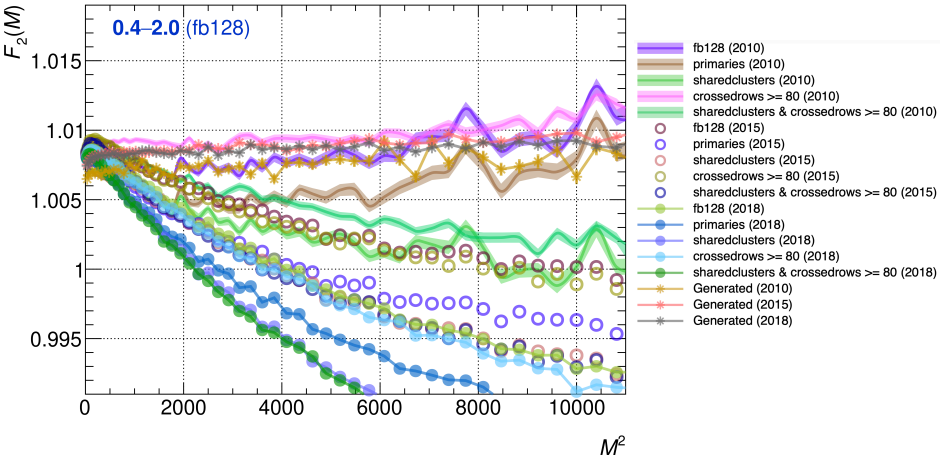
Final fb128 ($0.2 \leq p_T \leq 2.0$)

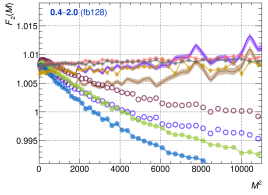


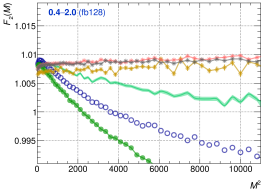




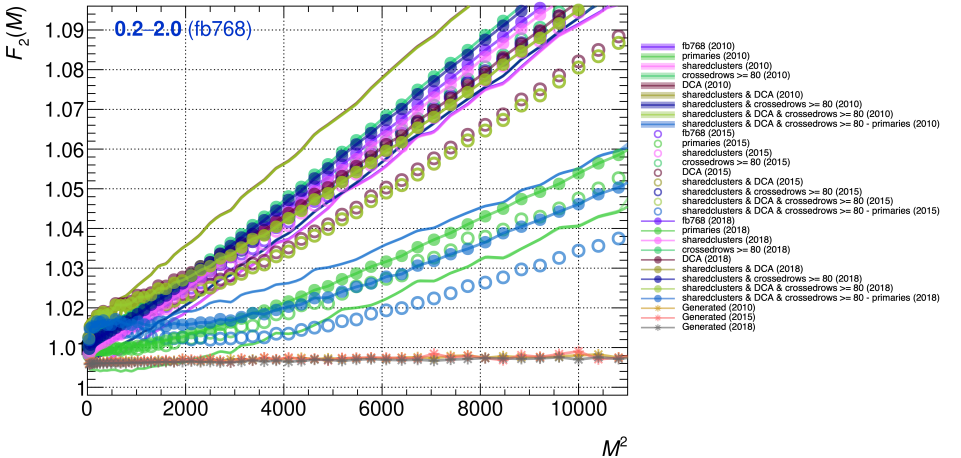
Final fb128 ($0.4 \leq p_T \leq 2.0$)

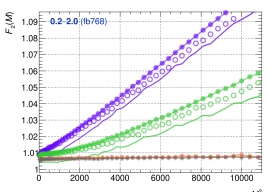


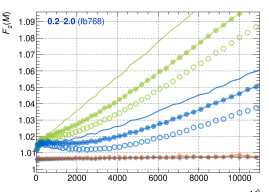




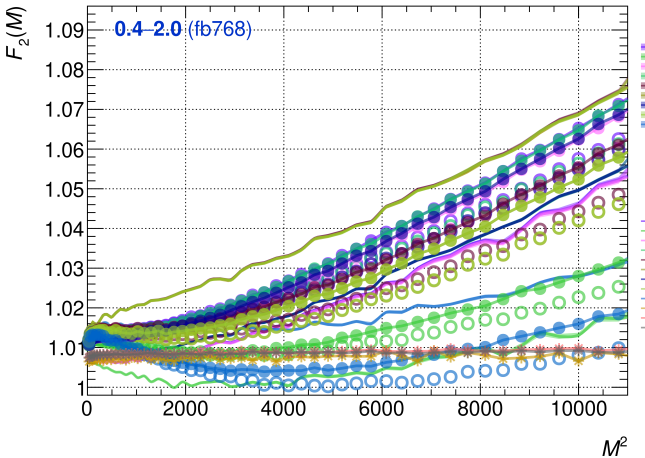
Final fb768 ($0.2 \leq p_T \leq 2.0$)

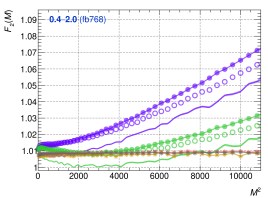


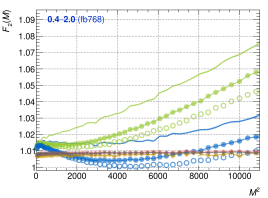




Final fb768 ($0.4 \leq p_T \leq 2.0$) ✅







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 $F_{\mathrm{q}}(M)$ 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 ≤ 0.3, #sharedclusters/#crossedRows ≤ 0.25, and #findableclusters/#clusters ≥ 0.8. fb768 closure improves consistently with TPC clusters cuts, worsens for fb128.
- p_{T} dependent $\mathrm{DCA}_{\mathrm{xy}}$ cuts used:
  - Combined with #crossedRows ≥ 80 and shared-clusters cuts $\longrightarrow$ best performance for fb768.

Thank you