TileCal Energy Reconstruction Studies

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on behalf of the TileCal energy reconstruction group

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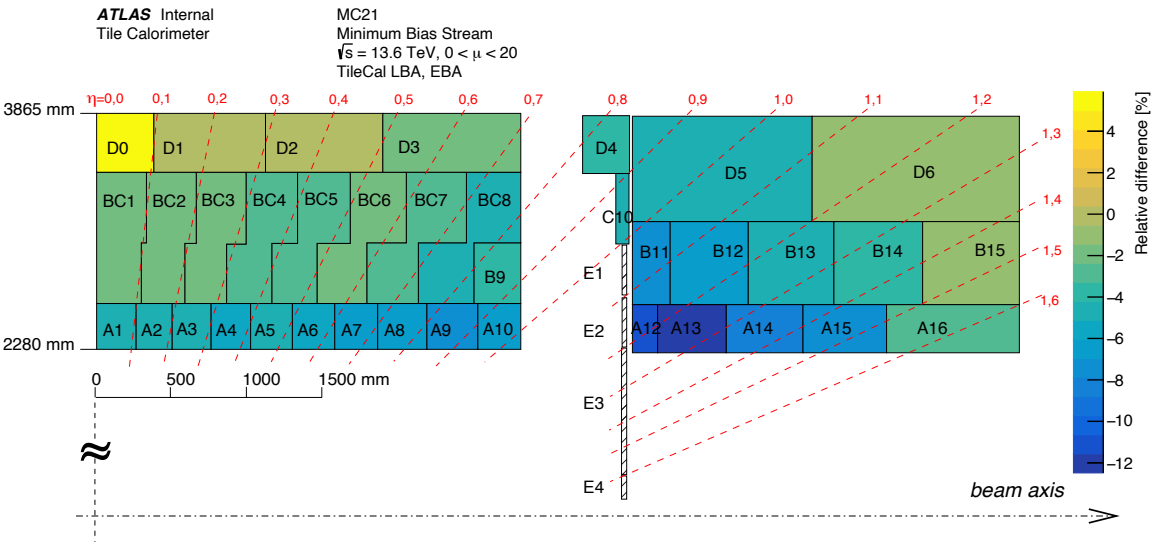
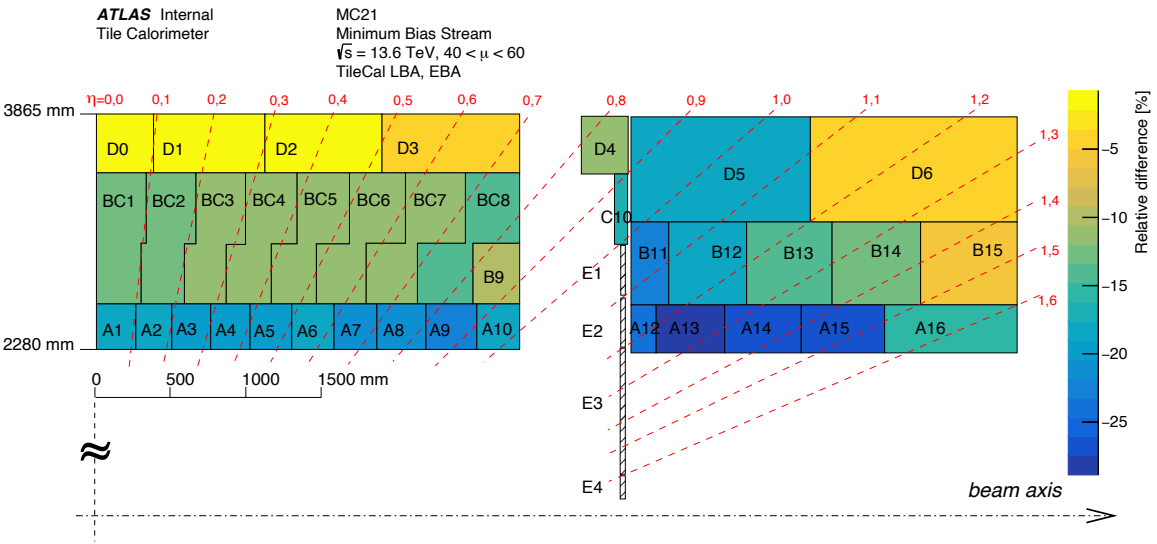
Goal of this presentation

- Follow-up from the evaluation of optimised OF2 weights under Run 3 luminosity conditions.
- Utilizing the covariance matrix in the reconstruction process has significantly improved energy estimation capabilities. Check the latest TileWeek presentation for detailed results.
- Performance analyses of OF2 using Monte Carlo data for specific $<\mu>$ ranges, both at the cell level and at the channel level. For further details: presentation from 2024/04/08.
- Calculate the covariance matrices using a robust method, as pileup in some channels may result in "outliers" that can change the weights.

Cell-level OF2 performance evaluation

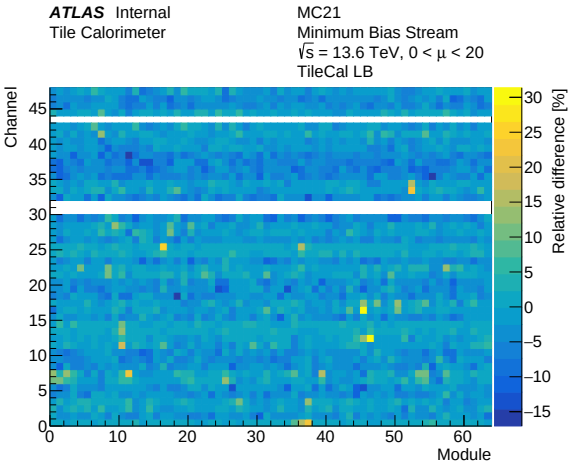


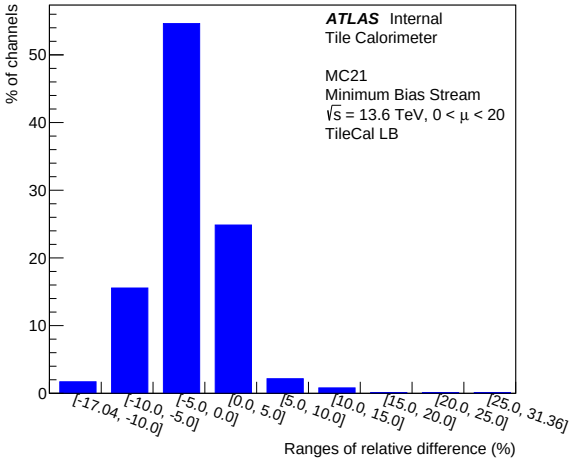
Cell-level OF2 performance evaluation



Channel-level OF2 performance evaluation

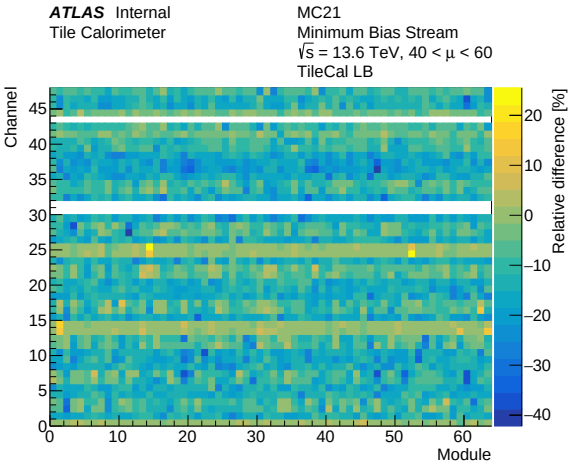
- Percentage relative difference of the RMS energy histograms calculated for OF2 and OF2 COV at the channel level, with $0 < \mu < 20$.

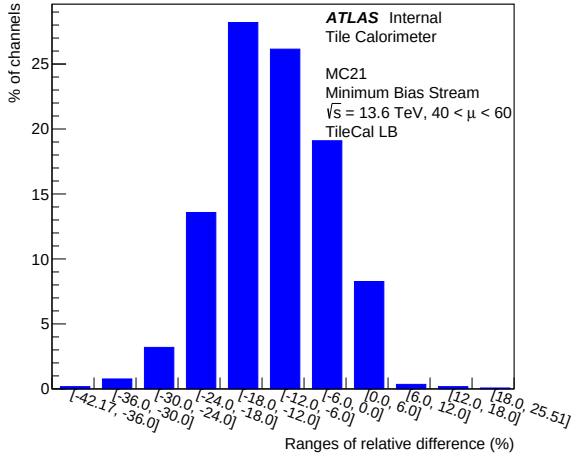




Channel-level OF2 performance evaluation

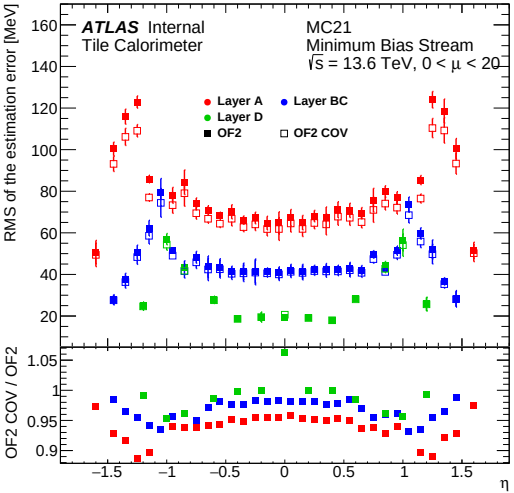
- Percentage relative difference of the RMS energy histograms calculated for OF2 and OF2 COV at the channel level, with $40 < \mu < 60$.

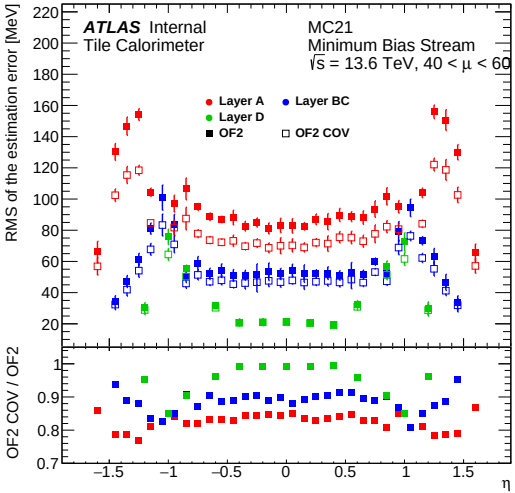




OF2 performance evaluation

- RMS of the estimation error for two scenarios: low luminosity, with $0 < \mu < 20$ (on the left), and moderate luminosity, with $40 < \mu < 60$ (on the right).



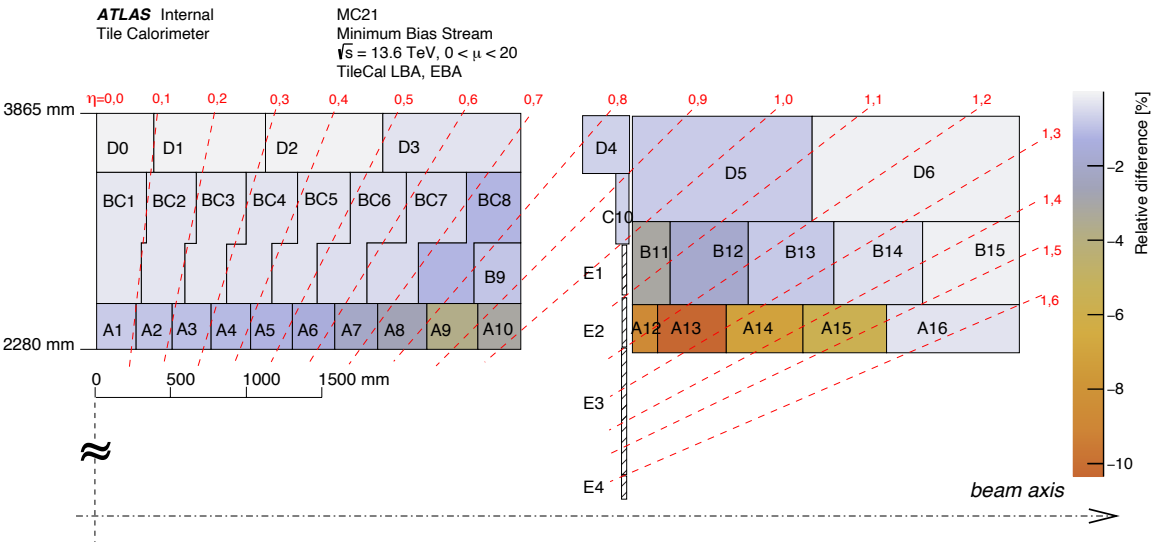


Robust estimation of covariance matrices (MCDE)

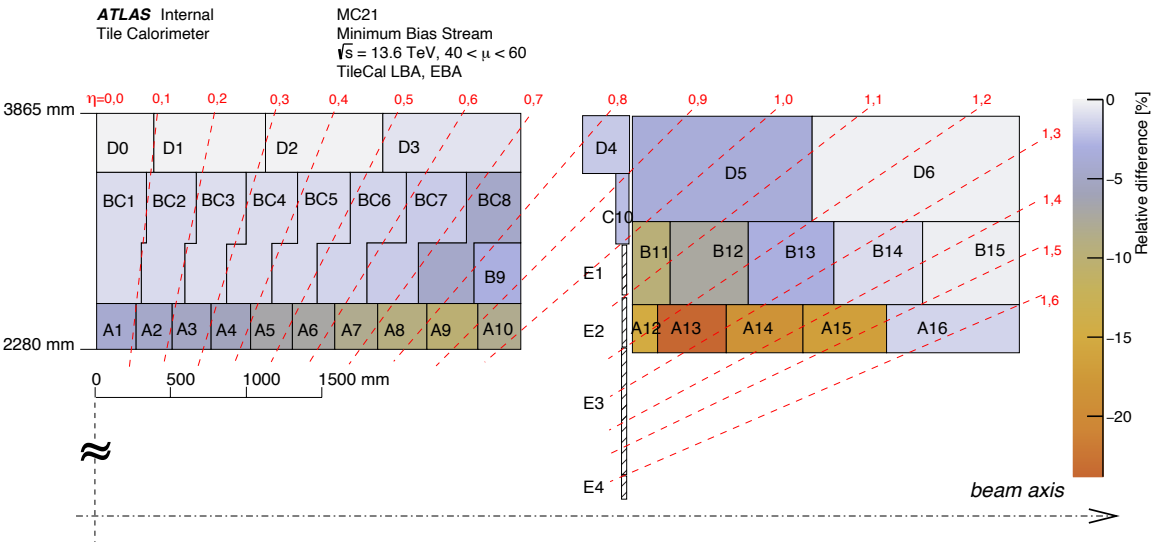
- **Robust Estimators**:
  - Robust estimators remain insensitive to variations in measurements that deviate from expected behaviour. See TRobustEstimator class reference for further details.
- **Algorithm Overview**:
  - The algorithm [1] computes robust estimates of multivariate location and scatter.
  - These estimates are then utilized to calculate robust distances for all data vectors.
  - Data vectors with significantly large robust distances are identified as outliers.
- **Algorithm Operation**:
  - The algorithm employs the Minimum Covariance Determinant (MCDE) objective.
  - It aims to identify a subset of h observations (out of n) with the lowest determinant for the classical covariance matrix.
  - The MCDE estimator of location is computed as the average of these h points.
  - The MCDE estimate of scatter is determined based on their covariance matrix.

Peter J. Rousseeuw and Katrien Van Driessen.
A fast algorithm for the minimum covariance determinant estimator.
Technometrics, 1999.
doi: 10.1080/00401706.1999.10485670.

Cell-level OF2 performance evaluation

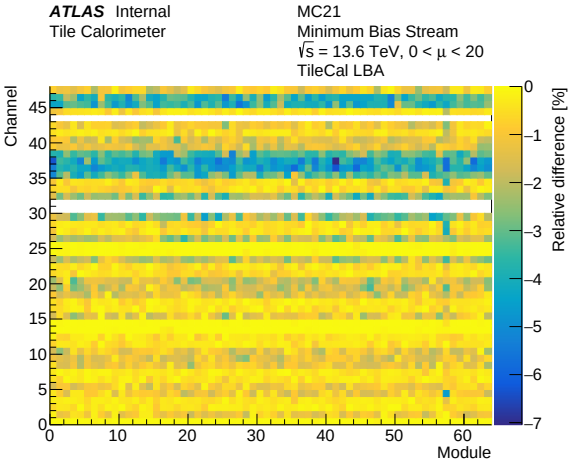


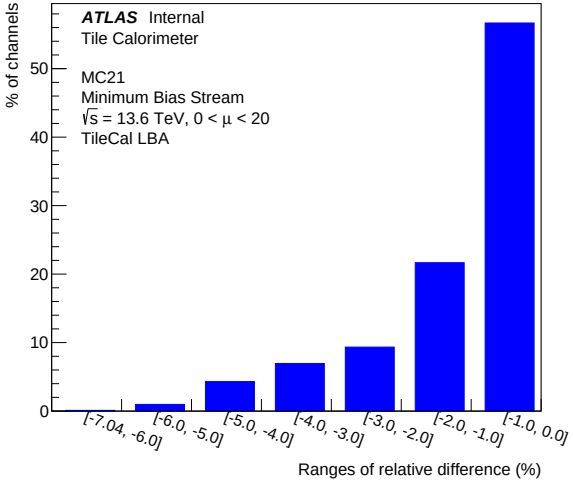
Cell-level OF2 performance evaluation



Channel-level OF2 performance evaluation

- Percentage relative difference of the RMS energy histograms calculated for OF2 and OF2 MCDE at the channel level, with $0 < \mu < 20$.





Channel-level OF2 performance evaluation

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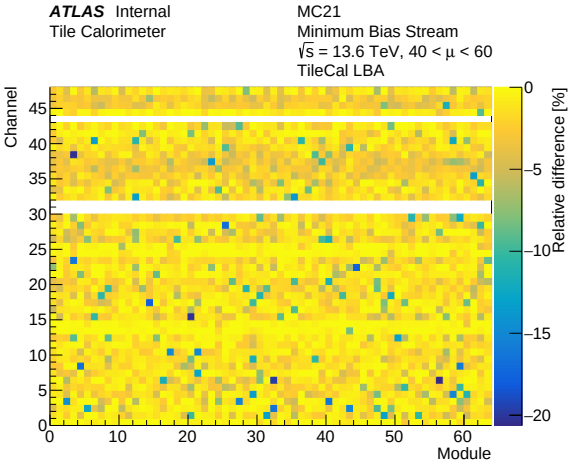
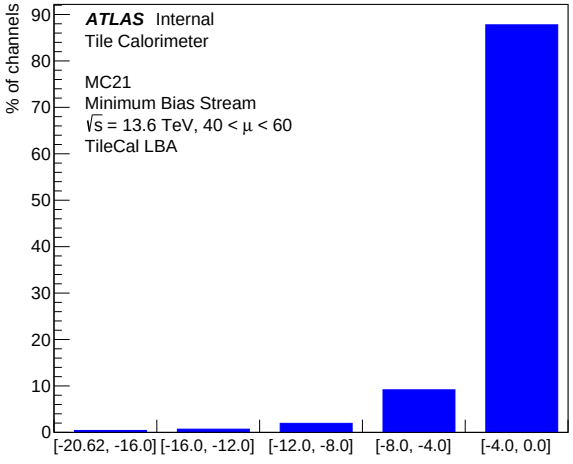
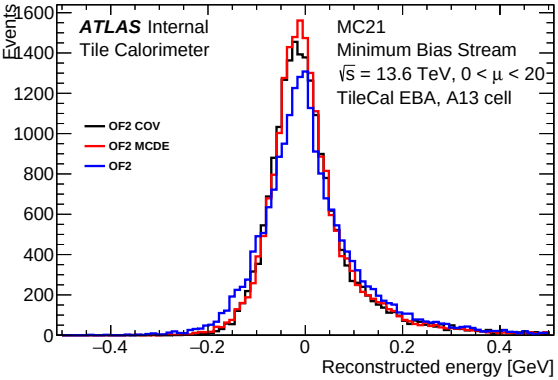
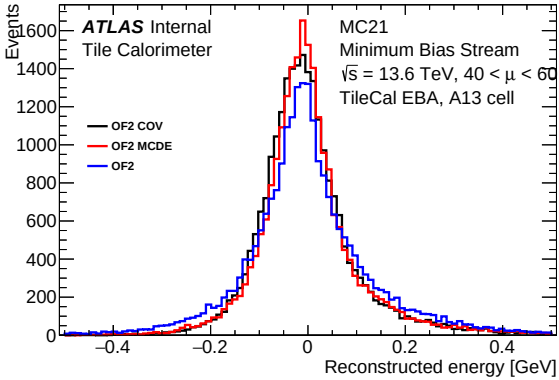




OF2 performance evaluation

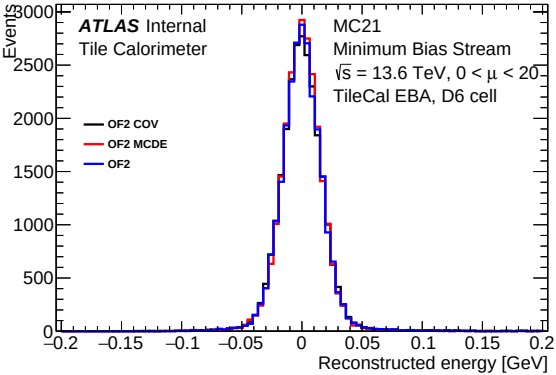
- Energy reconstructions for two scenarios considering A13 cell: low luminosity, with $0 < \mu < 20$ (on the left), and moderate luminosity, with $40 < \mu < 60$ (on the right).

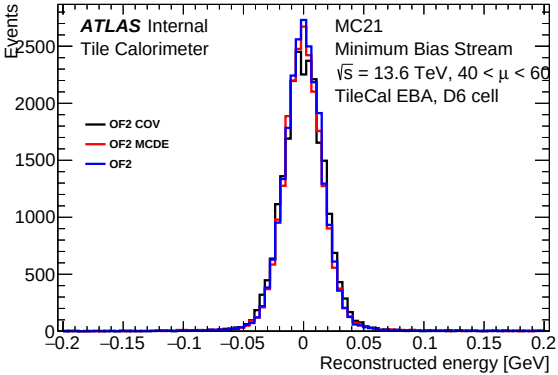




OF2 performance evaluation

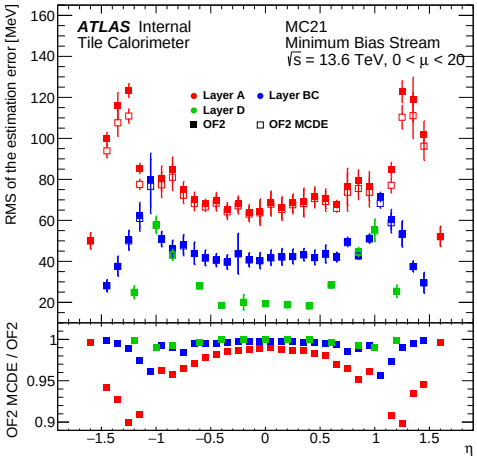
- Energy reconstructions for two scenarios considering D6 cell: low luminosity, with $0 < \mu < 20$ (on the left), and moderate luminosity, with $40 < \mu < 60$ (on the right).

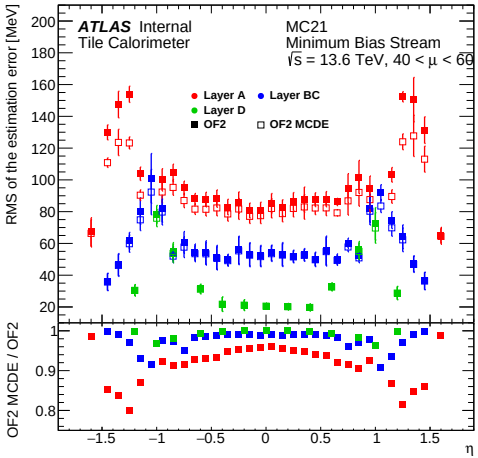




OF2 performance evaluation

- RMS of the estimation error for two scenarios using MCDE: low luminosity, with $0 < \mu < 20$ (on the left), and moderate luminosity, with $40 < \mu < 60$ (on the right).





Next Steps

- Points that require further investigation:
  - Influence of event quantity on robust covariance matrix computation;

- Next steps:
  - Perform similar analyses for the weights already stored in the DB.
  - Compute the noise constants (using the overlay MC samples) associated with the optimised OF2 weights and store them in the DB.
  - Exploration of physics objects for analyzing the performance of the optimized OF2 method.

Thank you!

Backup

Qualification project summary

Project Info	This project is connected to the effort aiming to improve the Tile energy estimation performance considering the Run3 LHC operation onwards. Currently, we are able to provide the optimized Optimal Filter (OF) weights that are now properly stored in the database for use in Athena reconstructions. Unlike the current version of the Tile OF method, the optimized OF weights takes into account the noise covariance matrix to compute the OF weights. Therefore, this Qualification Project proposal aims to perform several studies within the context of the TileCal energy reconstruction performance. Firstly, efficiency comparisons between the different OF versions in terms of the energy estimation at cell level using both MC (overlay samples) and real data (Zero bias stream) are envisaged. In this context, the agreement between MC and real data for different $<\mu>$ ranges will also be assessed. Secondly, following the discussions within the Tile community, this Qualification Project should address the impact of using the OF optimized weights on physics objects, requesting the reconstruction of dijets samples and to assess, for example, the performance on jet resolutions parameters using both OF strategies (with and without optimized weights). Moreover, this QT should also address the computation of the noise constants for the optimized OF method which also are stored in the database for building the topoclusters. Finally, the maintenance of the OF weights as well as the noise constants are also expected within this Qualification Project work plan. The reports will be shown at the regular Tile Performance meetings (also the Performance studies meetings) and Tile weeks sessions. The OTP task ID associated to this project is 532956 and the subtask ID is 556832.
Supervisors	Helena Santos (technical) and Bernardo Sotto-Maior Peralva (local)

Progress:

3.84%