Efficiency and Mis-Id Probability studies to identify non-colliding beam background

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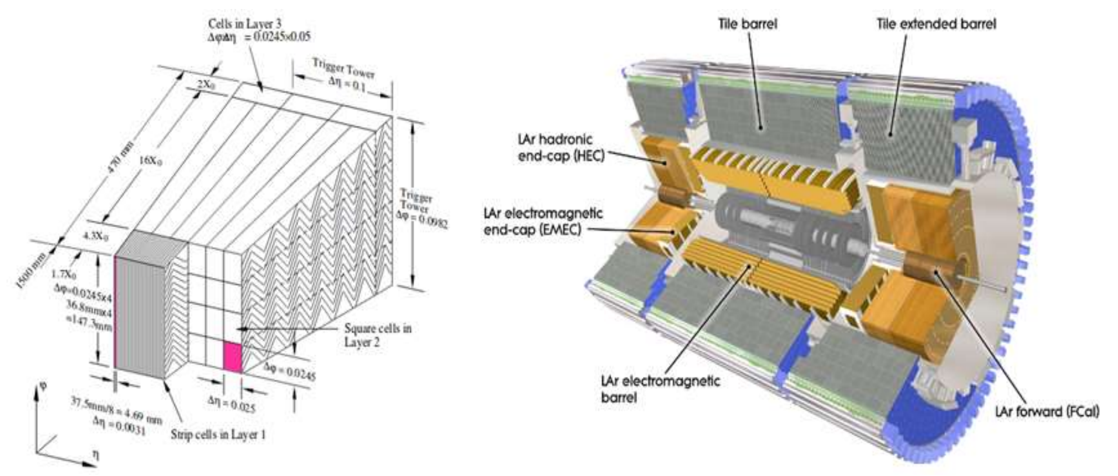
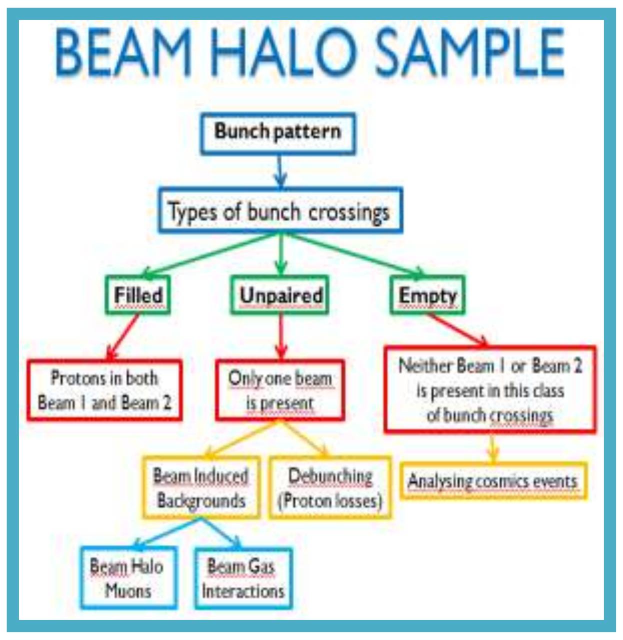
Introduction

Concept of the analysis





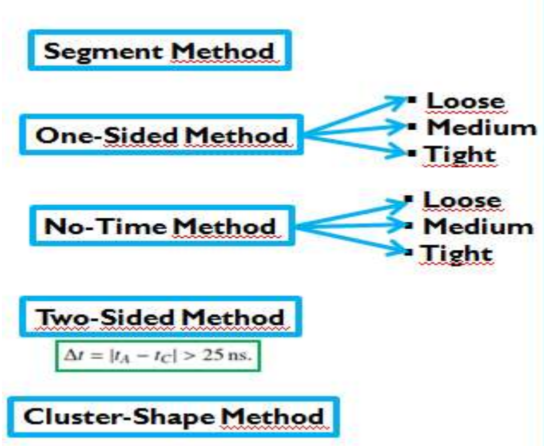
The goal of this analysis is to evaluate the performance of the beam halo tagging methods developed during Run-1 with Run-2 data. Beam halo can have similar detector signatures as some new-physics signals. Therefore, it can be a non-negligible background for some physics analysis.

Criterias Of Event Selection

good run selection
L1_J10_UNPAIRED_ISO, L1_J10_UNPAIRED_NONISO
$N_{vtx} = 0$
noise cleaning applied to all jets with $p_T > 20\,\mathrm{GeV}$ $HECf > 0.5$ AND $\lvert HECQ\rvert > 0.5$ $\lvert \mathrm{negative}E\rvert > 60\,\mathrm{GeV}$ $HECf > 1 - \lvert HECQ\rvert$ $EMf > 0.9$ AND $\lvert LArQ\rvert > 0.8$ AND $\lvert\eta\rvert < 2.8$
larError, tileError
jet $p_{T,1} > 20\,\mathrm{GeV}$, $\lvert\eta_1\rvert < 3.0$

Table 1: Beam halo selection in unpaired bunches.

Methods



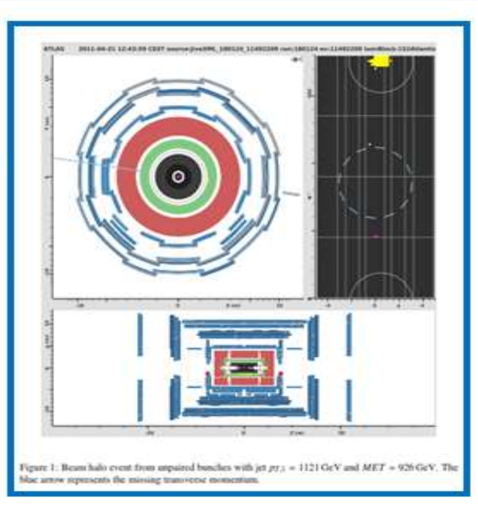


Figure 1: Beam halo event from unpaired bunches with jet $p_{T,1}$ = 1121 GeV and MET = 926 GeV. The blue arrow represents the missing transverse momentum.

method	selection
segment	beam halo segment ($\Delta\theta$ cut)
segment early	beam halo segment early segment
segment AC	beam halo segment on both sides segments matched in ϕ one early segment early, one in-time segment time difference of the segments
no-time	beam halo segment calorimeter cluster matched to the segment in ϕ and r cluster time compared to the expected time for A→C and C→A directions
one-sided	beam halo segment calorimeter cluster matched to the segment in ϕ and r early or in-time segment (allows to reconstruct the beam halo direction) cluster time compared to the expected time for the reconstructed direction
two-sided	beam halo segment on both sides calorimeter cluster matched to both segments in ϕ and r one early segment early, one in-time segment time difference of the segments
cluster-shape	beam halo segment calorimeter cluster matched to the segment in ϕ and r cut on σ_r/σ_r of the cluster

Table 2: Beam halo identification methods.

Results

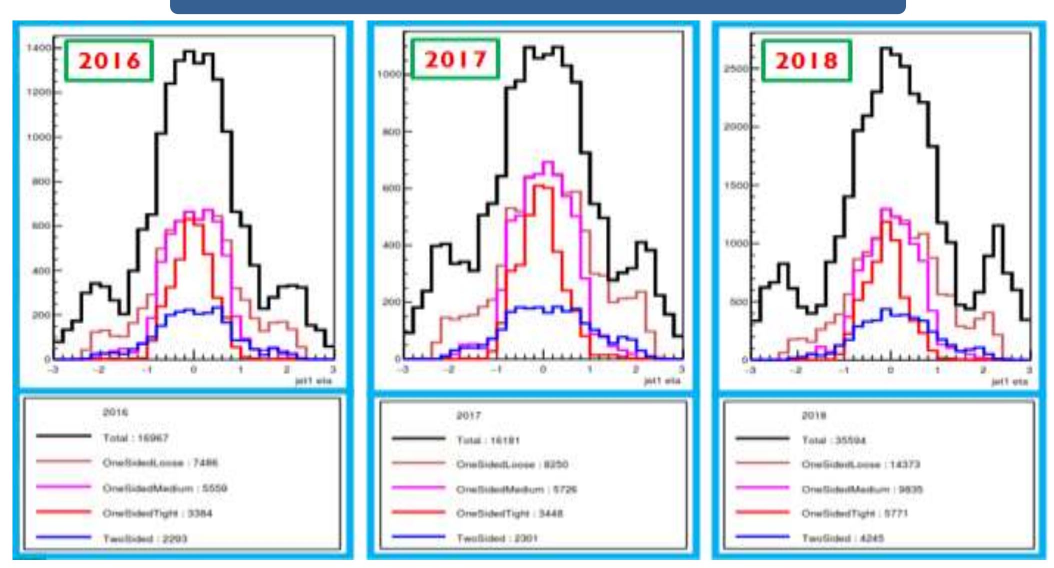
$$\epsilon = \frac{N_{\mathrm{tagged}}}{N_{\mathrm{beam\ halo}}}$$

N_{tagged} is the number of tagged events

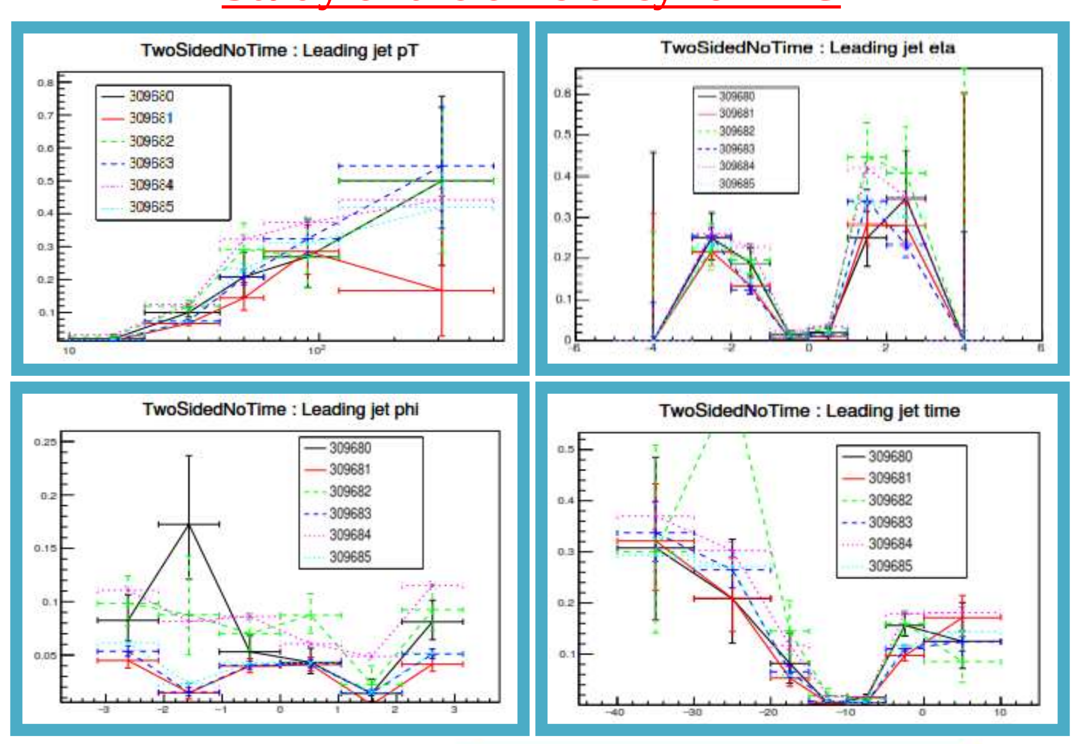
$N_{\mathrm{beam\ halo}}$ is the total number of events in the beam halo sample.

Study of the efficiency for DATA

Efficiency vs. Leading jet eta



Study of the efficiency for MC

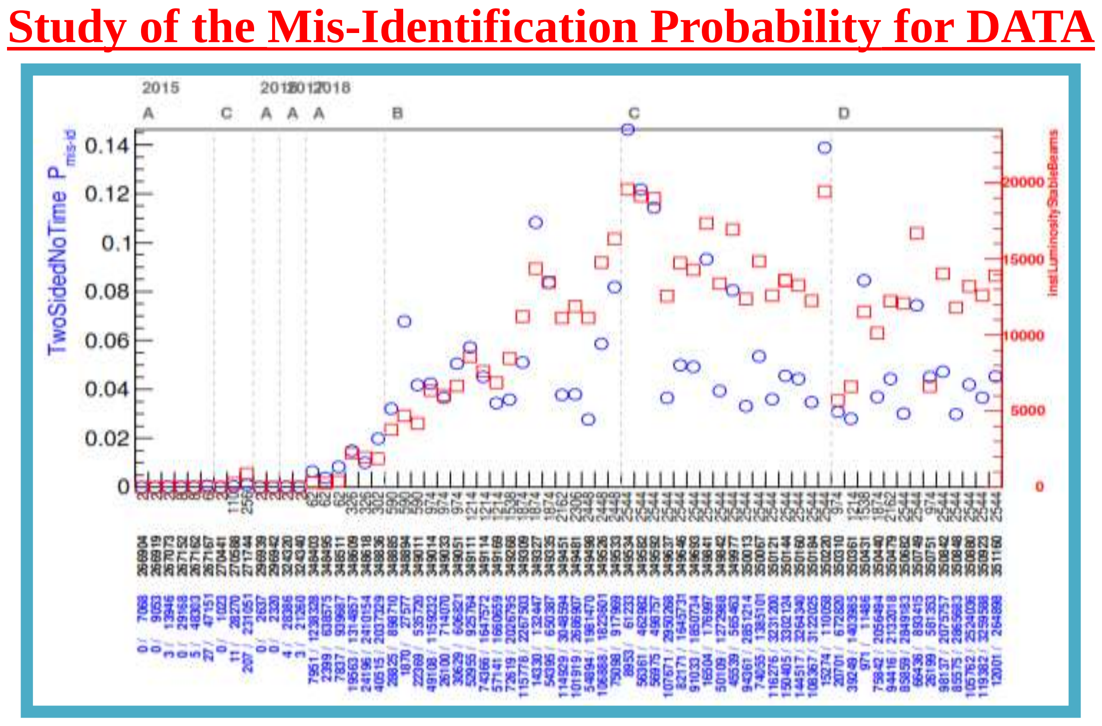


$$P_{\mathrm{mis}} = \frac{N_{\mathrm{tagged}}}{N_{\mathrm{dijet}}}$$

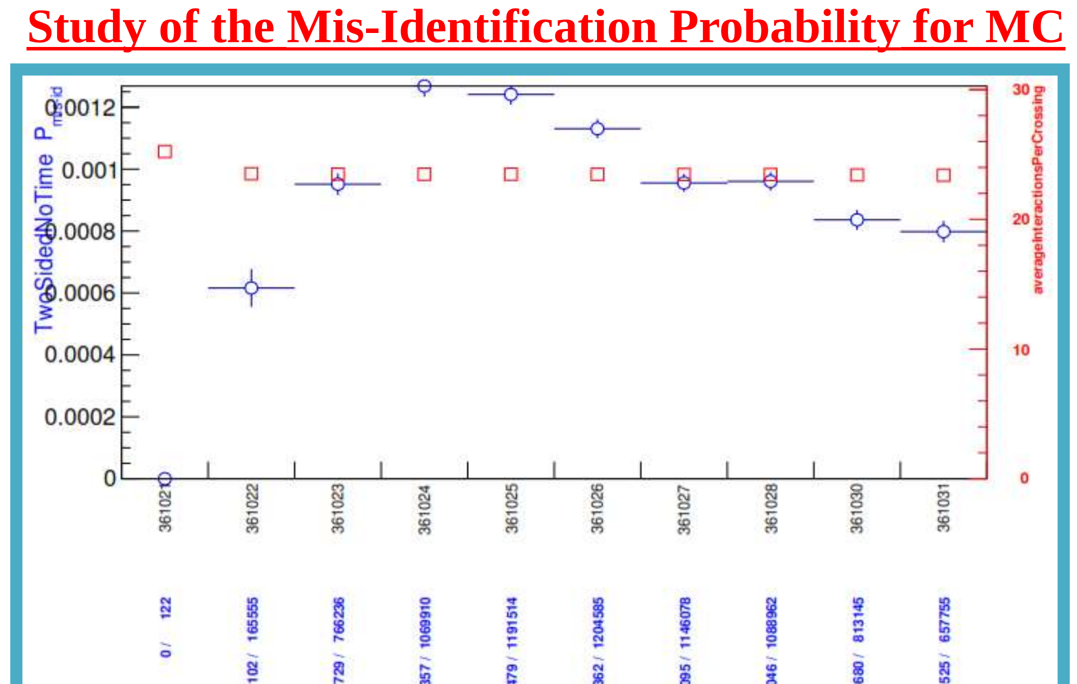
N_{tagged} is the number of tagged events

N_{dijet} is the total number of events in the beam halo free sample

Study of the Mis-Identification Probability for DATA



Study of the Mis-Identification Probability for MC



Conclusion

The Systematic Errors For Efficiency in DATA

	Tagged events	Efficiency [%]	Stat. error [%]	Total [%]	Comp. 1	Comp. 2	Systematic error Comp. 3	Comp. 4
Segment	42879	88.2	0.15	5.9	-3.1	1.3	0.4	-4.9
SegmentEarly	15213	31.3	0.21	7.7	-5.3	2.1	-0.1	-5.3
SegmentACNoTime	35010	72.0	0.20	6.1	-3.8	1.0	0.6	-4.6
SegmentAC	13724	28.2	0.21	6.2	-4.5	0.9	0.4	-4.2
NoTimeLoose	27221	56.0	0.23	17.0	-13.5	7.0	-1.6	-7.6
NoTimeMedium	19650	40.4	0.22	16.2	-14.1	3.7	-1.5	-7.0
NoTimeTight	11649	24.0	0.19	11.1	-9.8	3.3	-0.9	-4.0
OneSidedLoose	24522	50.4	0.23	15.3	-12.2	6.2	-2.1	-6.6
OneSidedMedium	18121	37.3	0.22	15.7	-13.5	4.3	-1.8	-6.6
OneSidedTight	10658	21.9	0.19	10.6	-9.2	3.7	-1.1	-3.6
TwoSidedNoTime	11077	22.8	0.19	6.9	-5.3	3.5	-0.7	-2.4
TwoSided	7685	15.8	0.17	6.6	-5.3	2.6	-0.5	-3.0

The Events in the AODs For The Mid Prob in DATA

total events in the AODs: 1459056603

Segment	81102295	80632072	9.9e-01
SegmentEarly	81102295	40465432	5.0e-01
SegmentACNoTime	81102295	37514996	4.6e-01
SegmentAC	81102295	8413429	1.0e-01
NoTimeLoose	81102295	27200296	3.4e-01
NoTimeMedium	81102295	1820420	2.2e-02
NoTimeTight	81102295	285276	3.5e-03
OneSidedLoose	81102295	12395976	1.5e-01
OneSidedMedium	81102295	729308	9.0e-03
OneSidedTight	81102295	100117	1.2e-03
TwoSidedNoTime	81102295	3206035	4.0e-02
TwoSided	81102295	450067	5.5e-03
NoTimeTight&&TwoSided	81102295	1460	1.8e-05

The Events in the AODs For The Mid Prob in MC

total events in the AODs: 20000000

Segment	8103862	6580377	8.1e-01
SegmentEarly	8103862	1066360	1.3e-01
SegmentACNoTime	8103862	198362	2.4e-02
SegmentAC	8103862	33033	4.1e-03
NoTimeLoose	8103862	471949	5.8e-02
NoTimeMedium	8103862	22096	2.7e-03
NoTimeTight	8103862	7484	9.2e-04
OneSidedLoose	8103862	226646	2.8e-02
OneSidedMedium	8103862	9749	1.2e-03
OneSidedTight	8103862	3238	4.0e-04
TwoSidedNoTime	8103862	8375	1.0e-03
TwoSided	8103862	1217	1.5e-04
NoTimeTight&&TwoSided	8103862	12	1.5e-06

- **I worked on the beam-induced background (BIB) offline code and had to validate the flags that say that a given event has beam-induced background overlapped to a physics event.**

- **The goals of this analysis was:**
  - ✓ **Test the main available flags**
  - ✓ **Identify the working flags and their efficiency**
  - ✓ **Run on the BIB Monte Carlo sample**
  - ✓ **Run on a standard ATLAS run physics stream and background stream**

References

•**ATL-COM-DAPR-2012-001:** Beam Background Identification Method

•https://twiki.cern.ch/twiki/bin/viewauth/Atlas/NonCollisionBackgroundsRunTwo/