Effects of EOBT Accuracy on the On-Time Performance

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Executive Summary

- Tactical Scheduler used in ATD-2 Phase 1 prioritizes departures providing more accurate flight ready time estimates, represented by Earliest Off-Block Time (EOBT), when scheduling takeoff slots. This analysis shows the effects of EOBT accuracy on the on-time performance metrics such as A0 and A14 of outbound flights and Target Takeoff Time (TTOT) compliance.

- Departure flights at CLT in about one-month period were divided into two groups, depending on the EOBT accuracy, and the data were properly filtered.

- The outbound flights having good EOBT accuracy showed the better A0 and A14 metrics at destination airports.

- The flights having good EOBT accuracy are about 2/3 out of all flights, showing better TTOT compliance and predictability, except for runway 18C.

- The flights having bad EOBT accuracy tended to take off earlier than estimated TTOTs.

- For more detailed analyses, the flights should be categorized into four groups, depending on the relative errors between AOBT and EOBT at ready.

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- Motivation
  - Tactical Scheduler used in the ATD-2 systems has a priority rule for the order of considerations in scheduling, depending on the accuracy of earliest off-block times (EOBTs) of departures. In this rule, the 'Planning' group in which flights provide more accurate EOBTs has the higher priority when assigning the takeoff slots, compared to the 'Uncertain' group in which flights have less accurate EOBTs.
  - It is expected that the flights having more accurate EOBTs can take preferable runway slots, leading to the better on-time performance.

- Objectives of this analysis
  - To evaluate the effect of EOBT accuracy on two on-time performance metrics
    1. A0 & A14 metrics: Observed (AIBT – SIBT) distribution with different levels of EOBT accuracy
    2. TTOT compliance: Observed (ATOT – TTOT at Ready) distribution with different levels of EOBT accuracy
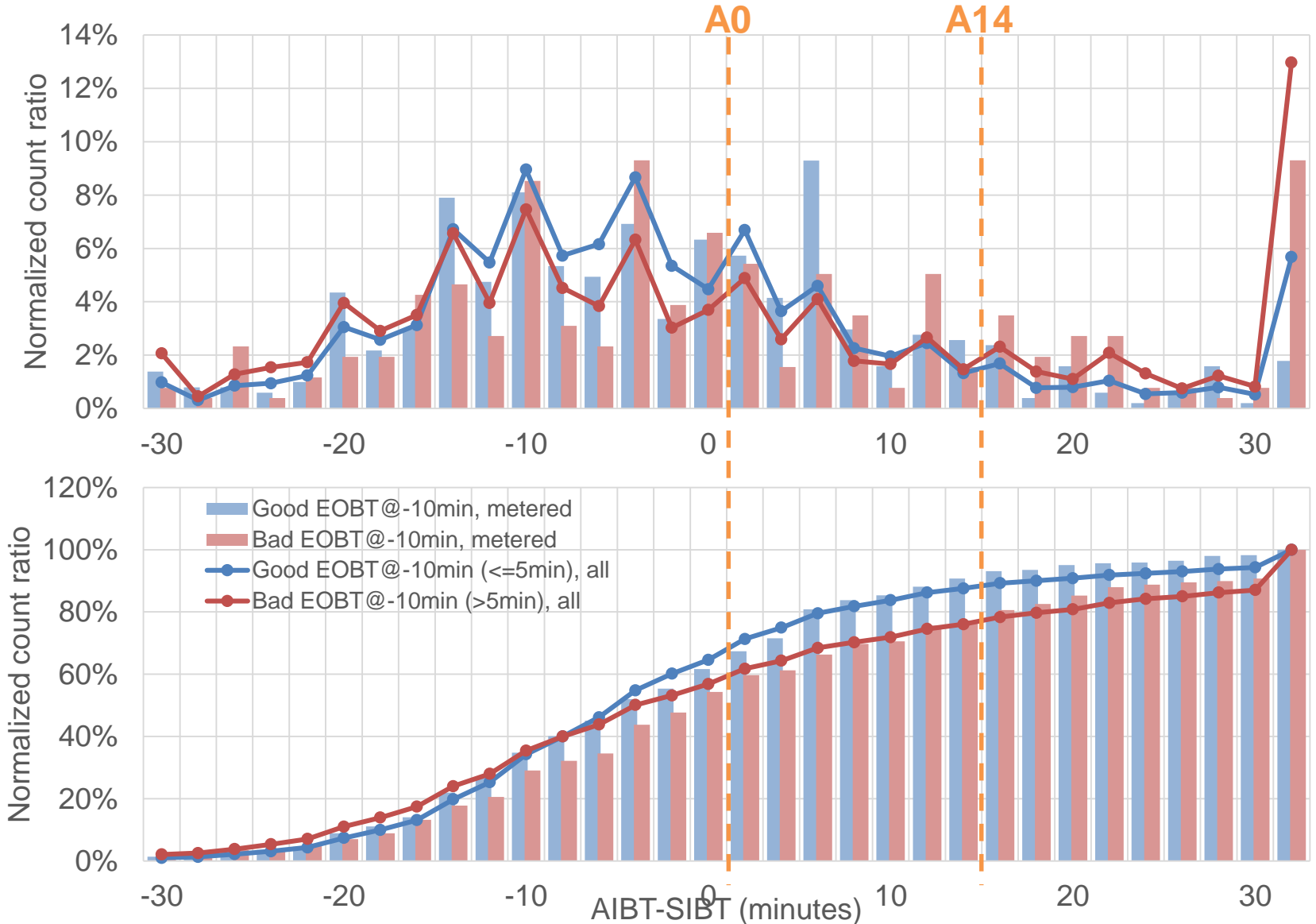 - To check if the flights having the better EOBT accuracy show the better on-time performance

Analysis Method and Data

- Analysis method
  - Divide two groups of departures, depending on the EOBT accuracy
    - Good EOBT group: |AOBT-EOBT| <= 5min
    - Bad EOBT group: |AOBT-EOBT| > 5min
  - Compare the (AIBT – SIBT) distribution between these two EOBT groups for A0 and A14 metrics
    - EOBTs at 0, 5, 10, 20, and 30min before flight ready
    - Flight ready time based on the first controller input (pushback hold or approved)
  - Compare the (ATOT – TTOT at Ready) distribution between two EOBT groups

- Flight summary data
  - Date range: 1/14/2018 – 2/18/2018, except 2/4 and 2/15 (total 33 days)
  - Used valid data having EOBT values and pushback clearance approvals
  - Filtered out FAA controlled flights (EDCT/APREQ)
  - Filtered out mis-associated flights (e. g., suspended, return to gate, or cancelled)
  - After filtering, we have <u>17,842</u> departures (67.5%).

The flights having good EOBT accuracy when flight ready show the better A0 and A14 metrics.
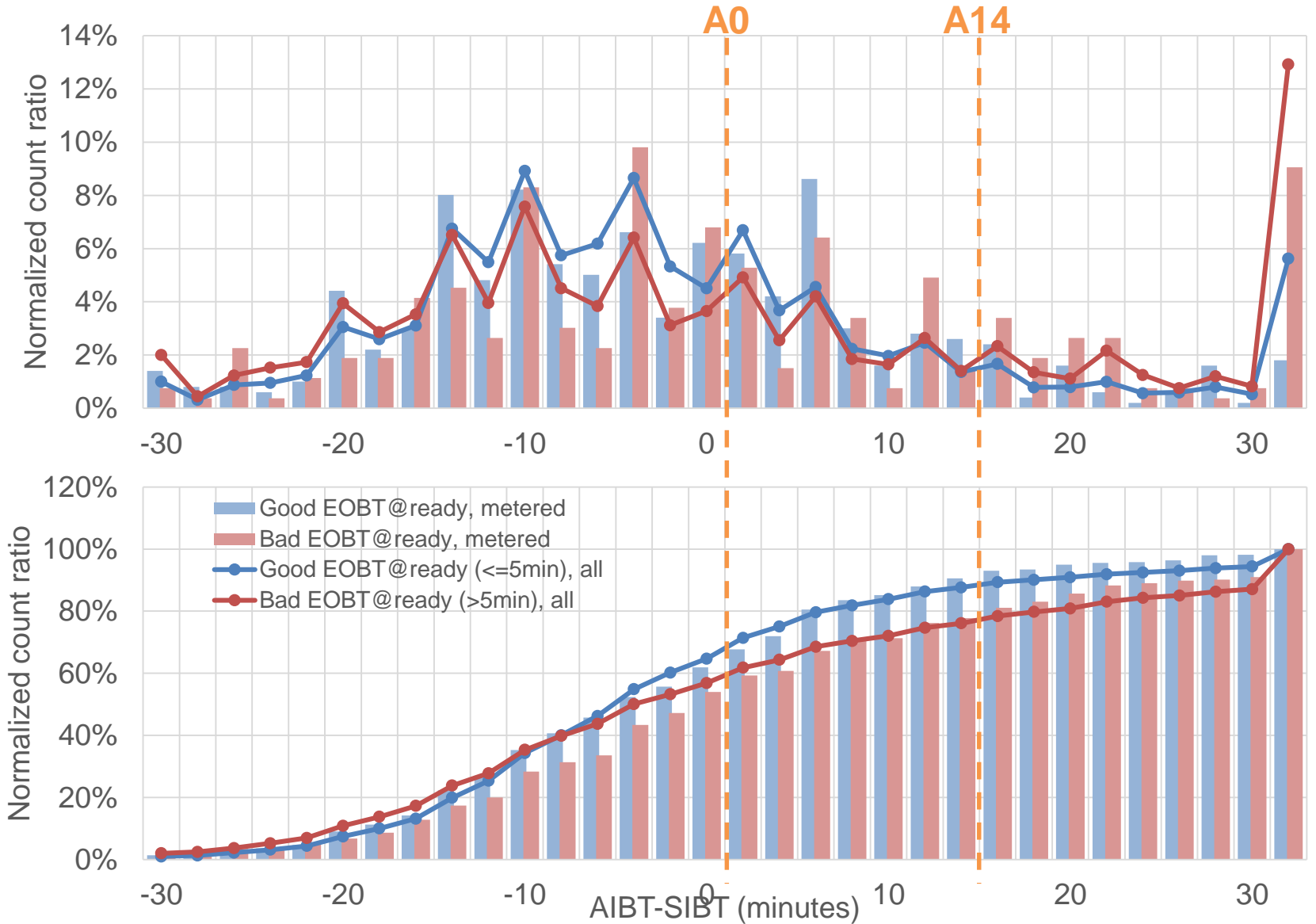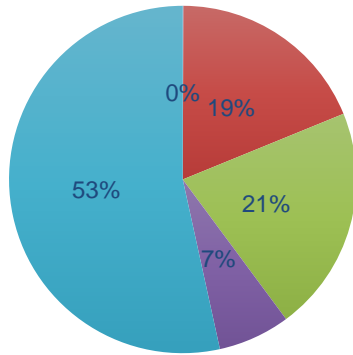
The flights having good EOBT accuracy 10 min before flight ready show the better A0 and A14 metrics.
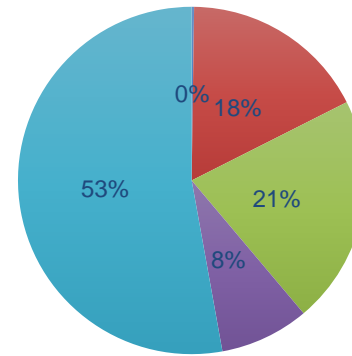

Legend:
- Good EOBT@-10min, metered
- Bad EOBT@-10min, metered
- Good EOBT@-10min (<=5min), all
- Bad EOBT@-10min (>5min), all

x-axis: AIBT-SIBT (minutes)
y-axis: Normalized count ratio

EOBT Accuracy Distribution by Concourse

- No significant difference on the concourse distribution between good and bad EOBT accuracy groups

Good EOBT, all

0% 19%
53%
7% 21%

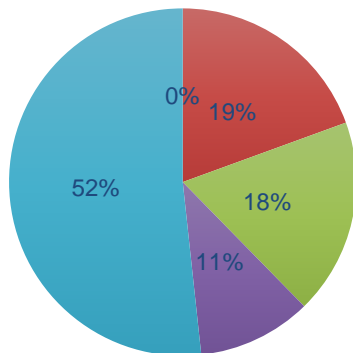■A ■B ■C ■D ■E

Bad EOBT, all

0% 18%
53%
8% 21%

■A ■B ■C ■D ■E

Good EOBT, metered

0% 19%
52%
11% 18%

■A ■B ■C ■D ■E

Bad EOBT, metered

0% 20%
44%
9% 27%

■A ■B ■C ■D ■E

(ATOT – TTOT at Ready) vs. EOBT accuracy @Ready
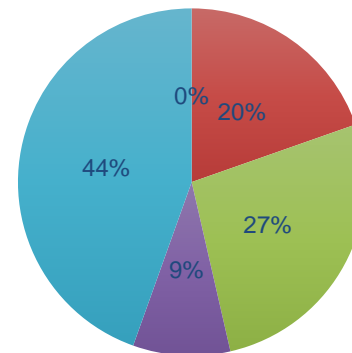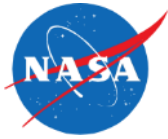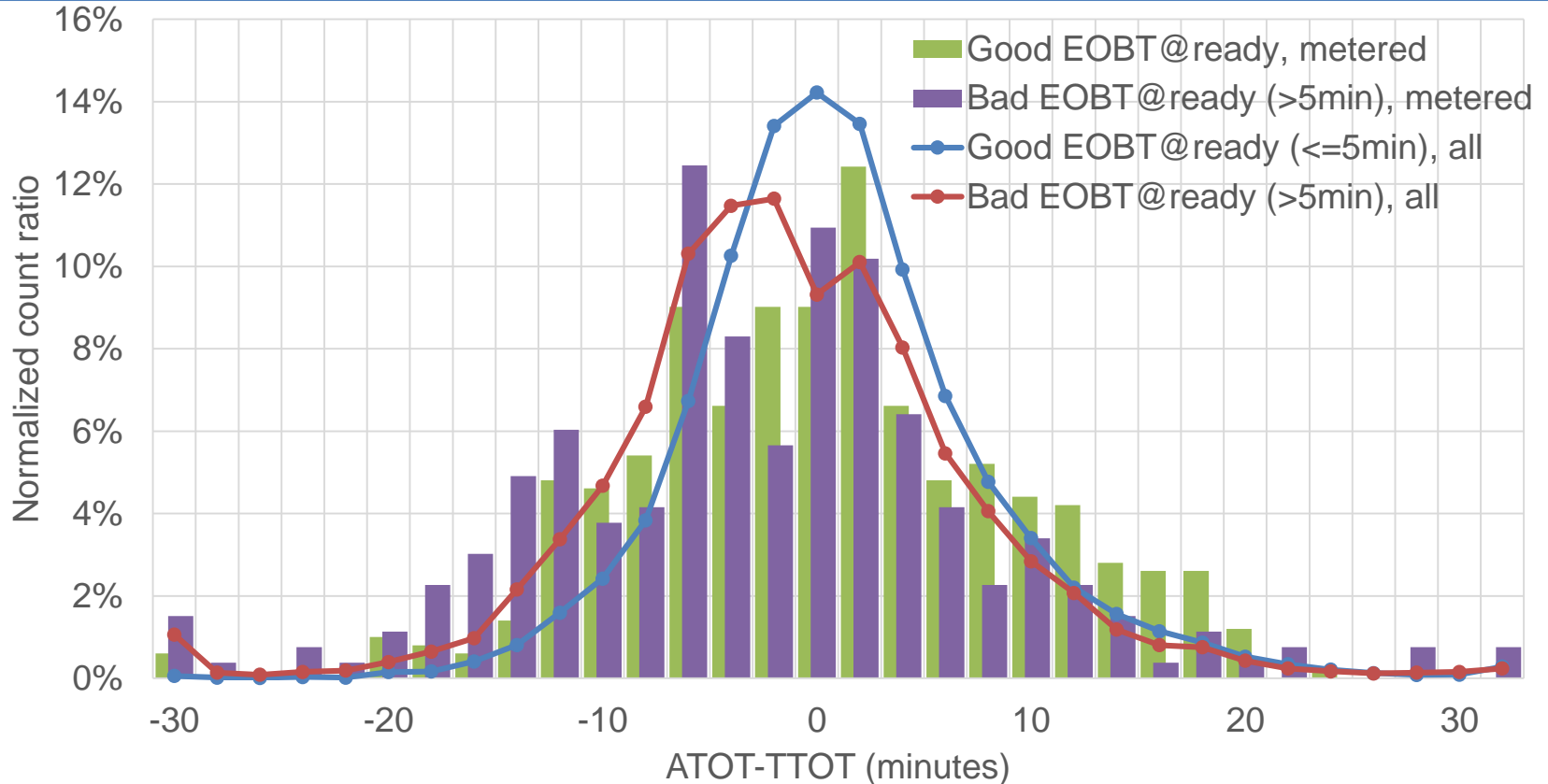
Flights having good EOBT accuracy are 2/3, with better TTOT compliance and better predictability.
Flights having bad EOBT accuracy took off earlier than estimated TTOT, but have wider distribution.

|	Good EOBT, metered	Bad EOBT, metered	Good EOBT, all flights	Bad EOBT, all flights
Count	499	265	11,988	5,839
Mean	-0.51 min	-3.21 min	-0.10 min	-3.00 min
Std. Dev.	8.90 min	13.43 min	8.08 min	17.73 min
Median	-0.67 min	-3.75 min	-0.58 min	-2.68 min

(ATOT – TTOT at Ready) by Runway, All Flights

When looking at all flights, there are no significant differences by runway. Departures for 36R take off earlier than targeted times, whereas flights for 18C show later takeoffs than TTOTs when flight is ready.
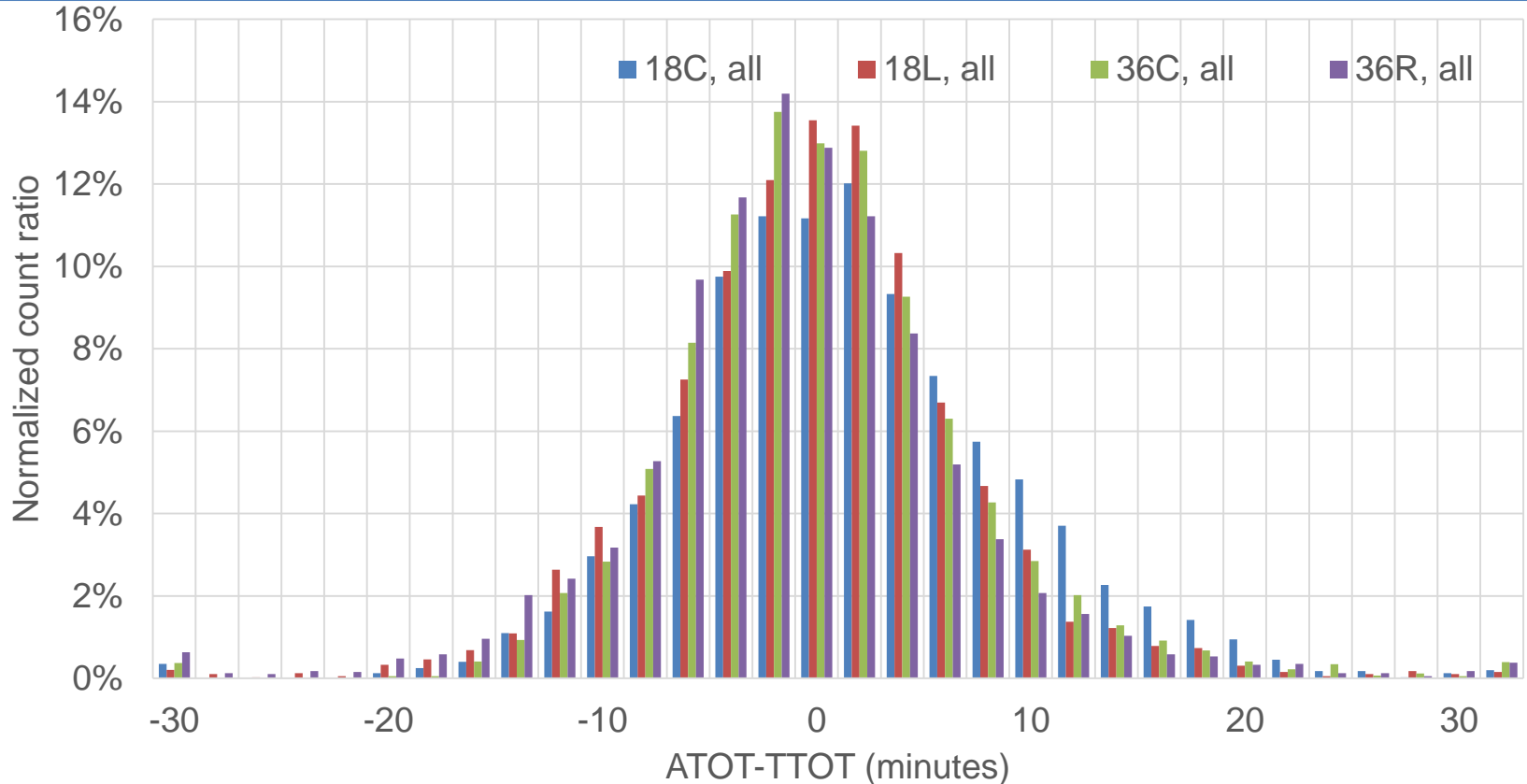
	18C, all	18L, all	36C, all	36R, all
Count	4,020	3,942	5,903	3,966
Mean	0.25 min	-1.18 min	-1.03 min	-2.16 min
Std. Dev.	12.78 min	10.04 min	12.56 min	11.20 min
Median	0.08 min	-1.05 min	-1.25 min	-2.24 min

(ATOT – TTOT at Ready) by Runway, Metered Flights

For metered flights, departures for 18C tend to take off later than targeted times, whereas flights for 18L/36R (dual use runways for departures and arrivals) take off earlier than TTOTs when flight is ready.
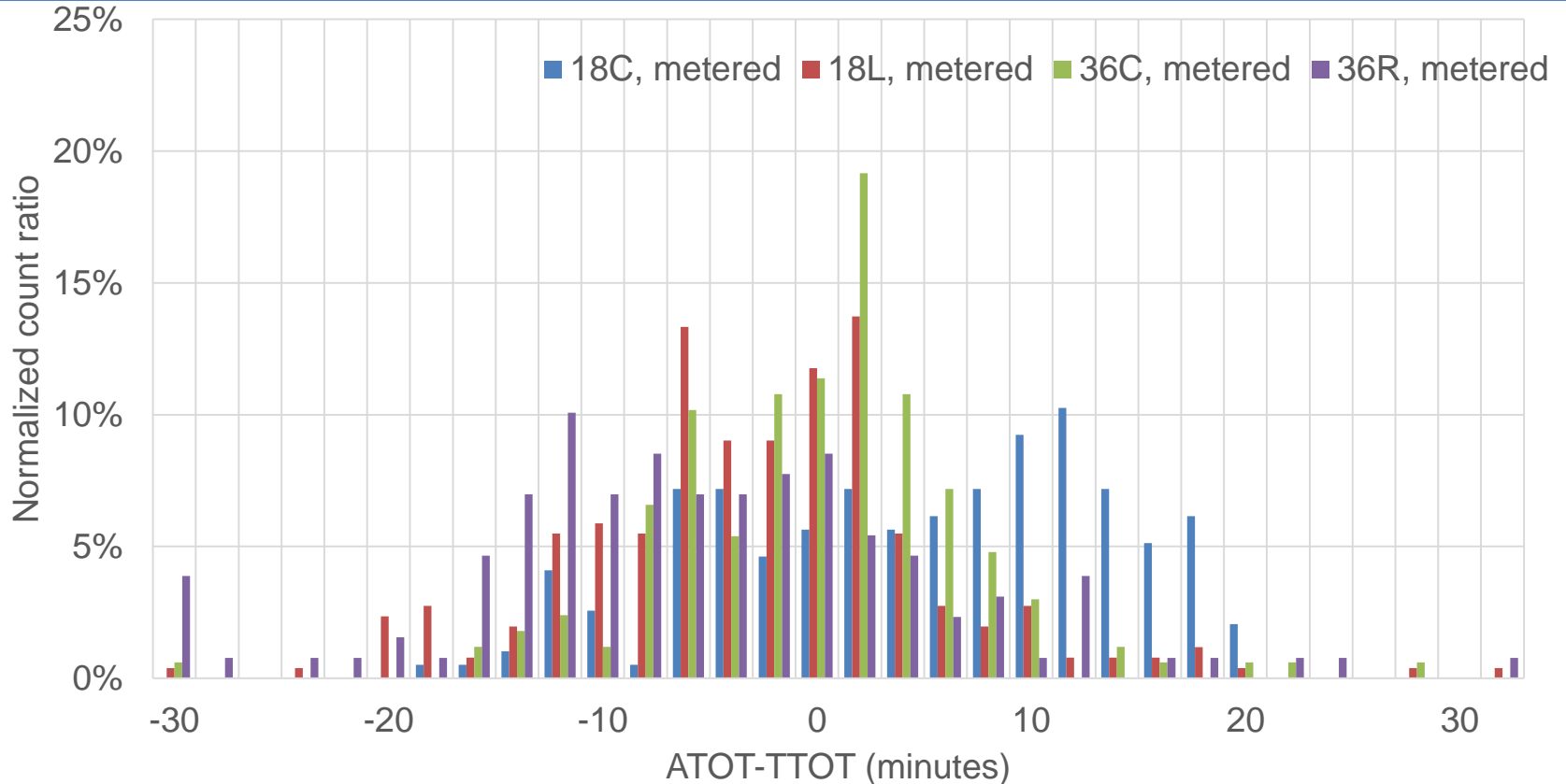

	18C, metered	18L, metered	36C, metered	36R, metered
Count	195	255	167	129
Mean	3.92 min	-3.57 min	-1.06 min	-5.46 min
Std. Dev.	9.00 min	8.39 min	7.12 min	16.74 min
Median	5.02 min	-3.70 min	-0.48 min	-7.00 min

(ATOT – TTOT at Ready) vs. EOBT accuracy @Ready for Runway 18C

For 36R, metered departures having bad EOBTs at ready show better TTOT compliance. Takeoff time prediction for 36R looks too optimistic, while actual flights may experience congestion while taxiing.
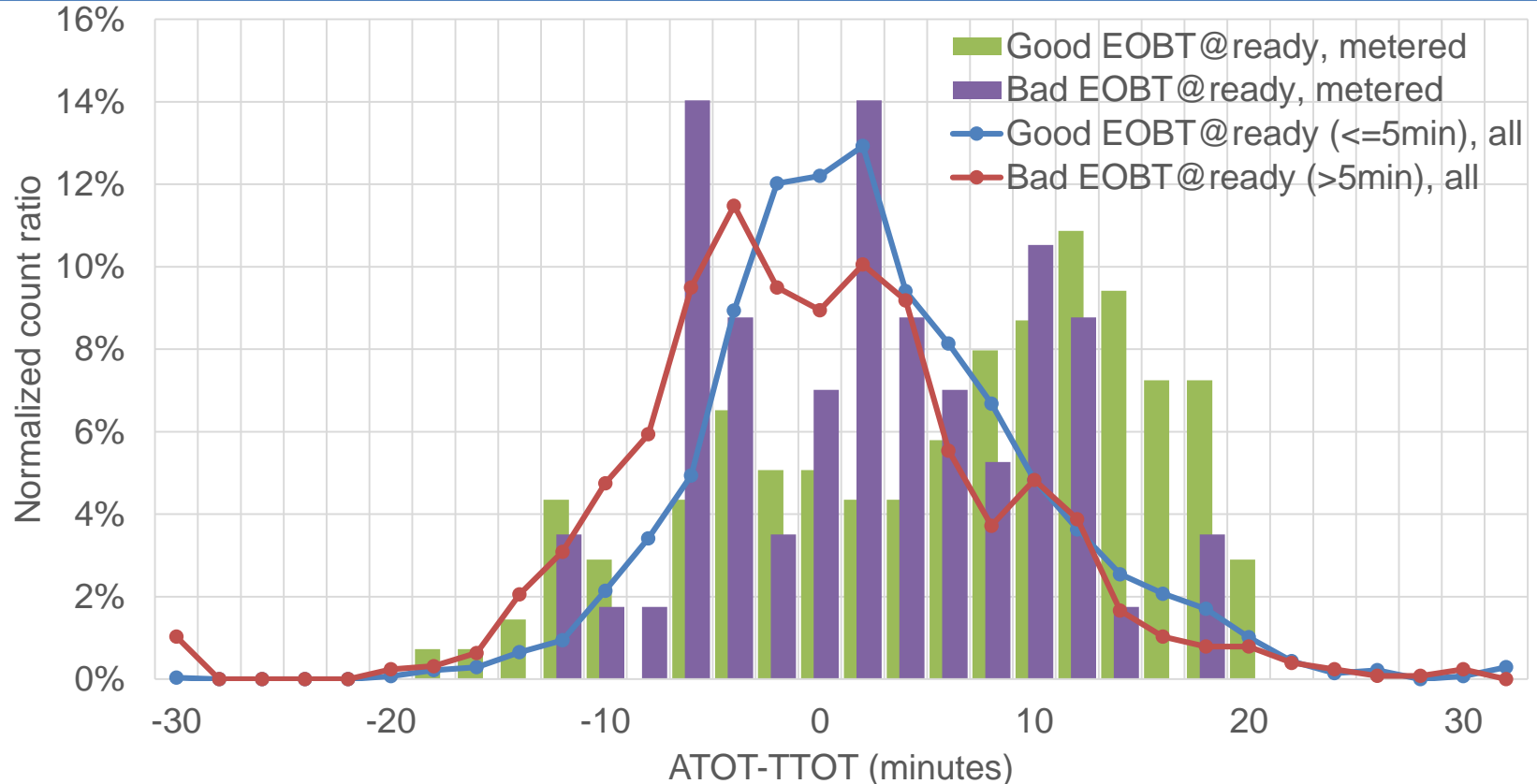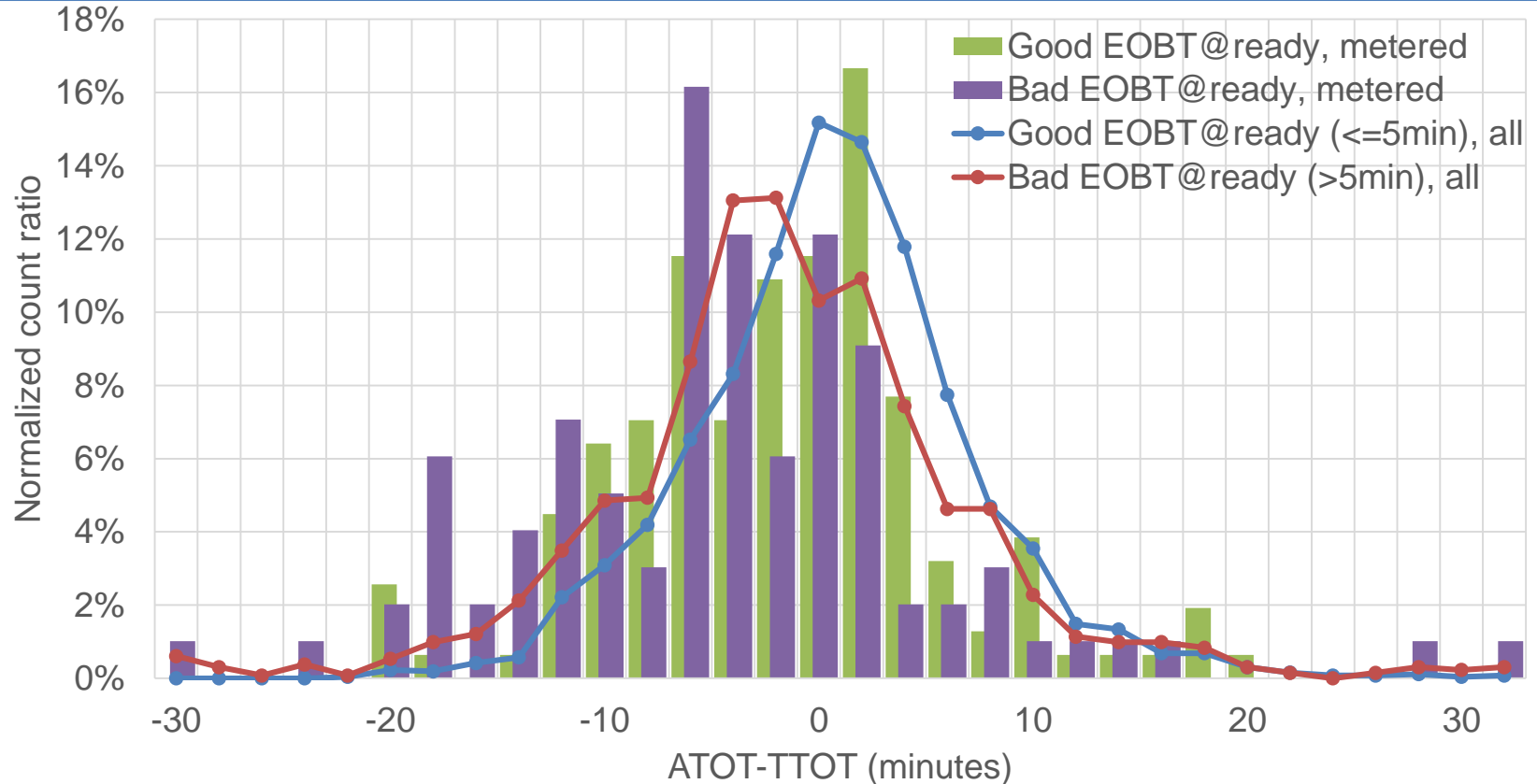

Runway 18C	Good EOBT, metered	Bad EOBT, metered	Good EOBT, all flights	Bad EOBT, all flights
Count	138	57	2,753	1,263
Mean	4.95 min	1.44 min	1.25 min	-1.94 min
Std. Dev.	9.39 min	7.49 min	11.00 min	15.78 min
Median	6.83 min	0.50 min	0.68 min	-1.82 min

(ATOT – TTOT at Ready) vs. EOBT accuracy @Ready for Runway 18L

For runway 18L, departures having good EOBT accuracy show better TTOT compliance, with smaller variations.
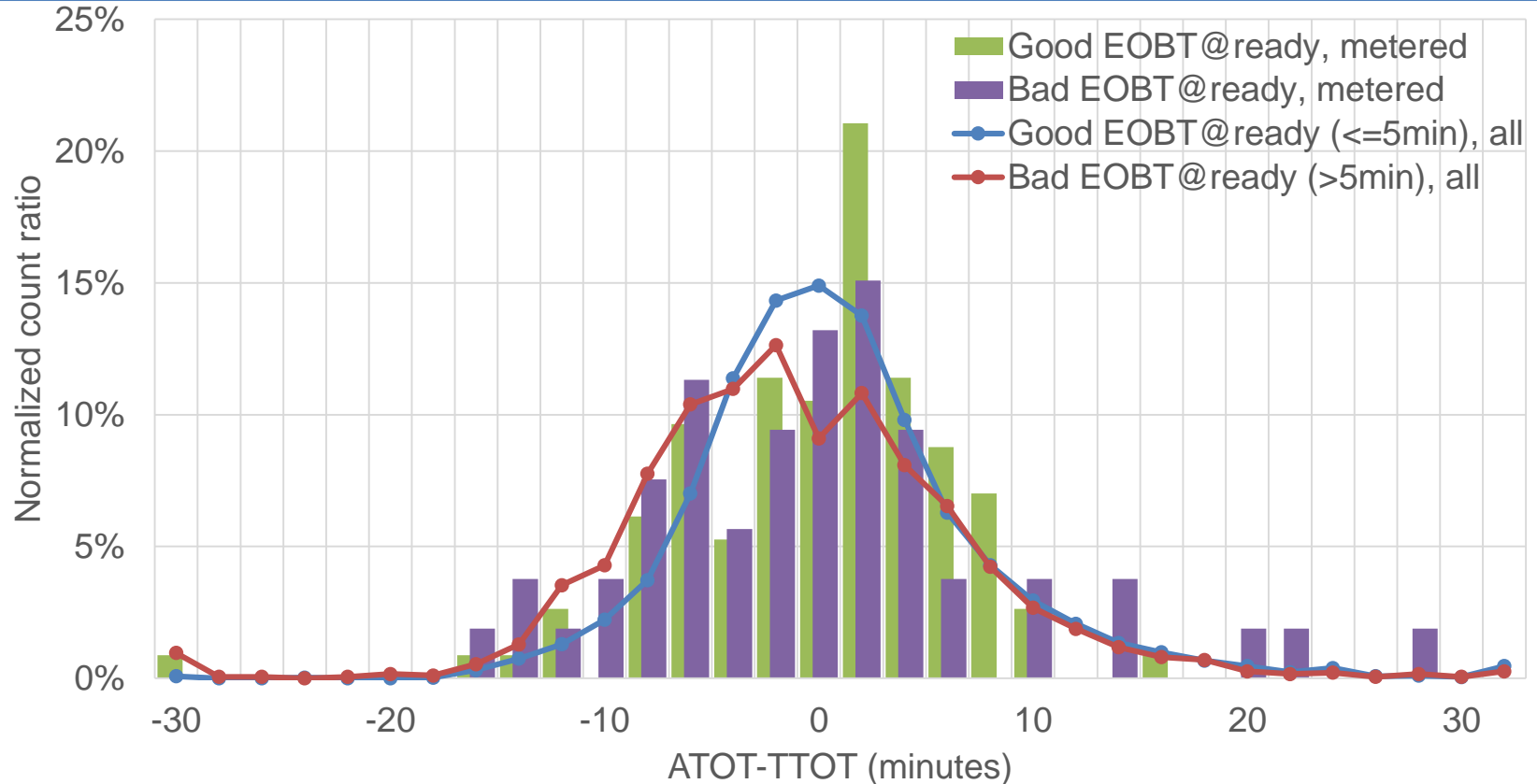

Runway 18L	Good EOBT, metered	Bad EOBT, metered	Good EOBT, all flights	Bad EOBT, all flights
Count	156	99	2,622	1,318
Mean	-2.48 min	-5.28 min	-0.36 min	-2.81 min
Std. Dev.	7.32 min	9.64 min	6.47 min	14.65 min
Median	-2.38 min	-5.65 min	-0.42 min	-2.65 min

(ATOT – TTOT at Ready) vs. EOBT accuracy @Ready for Runway 36C

For runway 36C, departures having good EOBT accuracy show better TTOT compliance, with smaller variations.
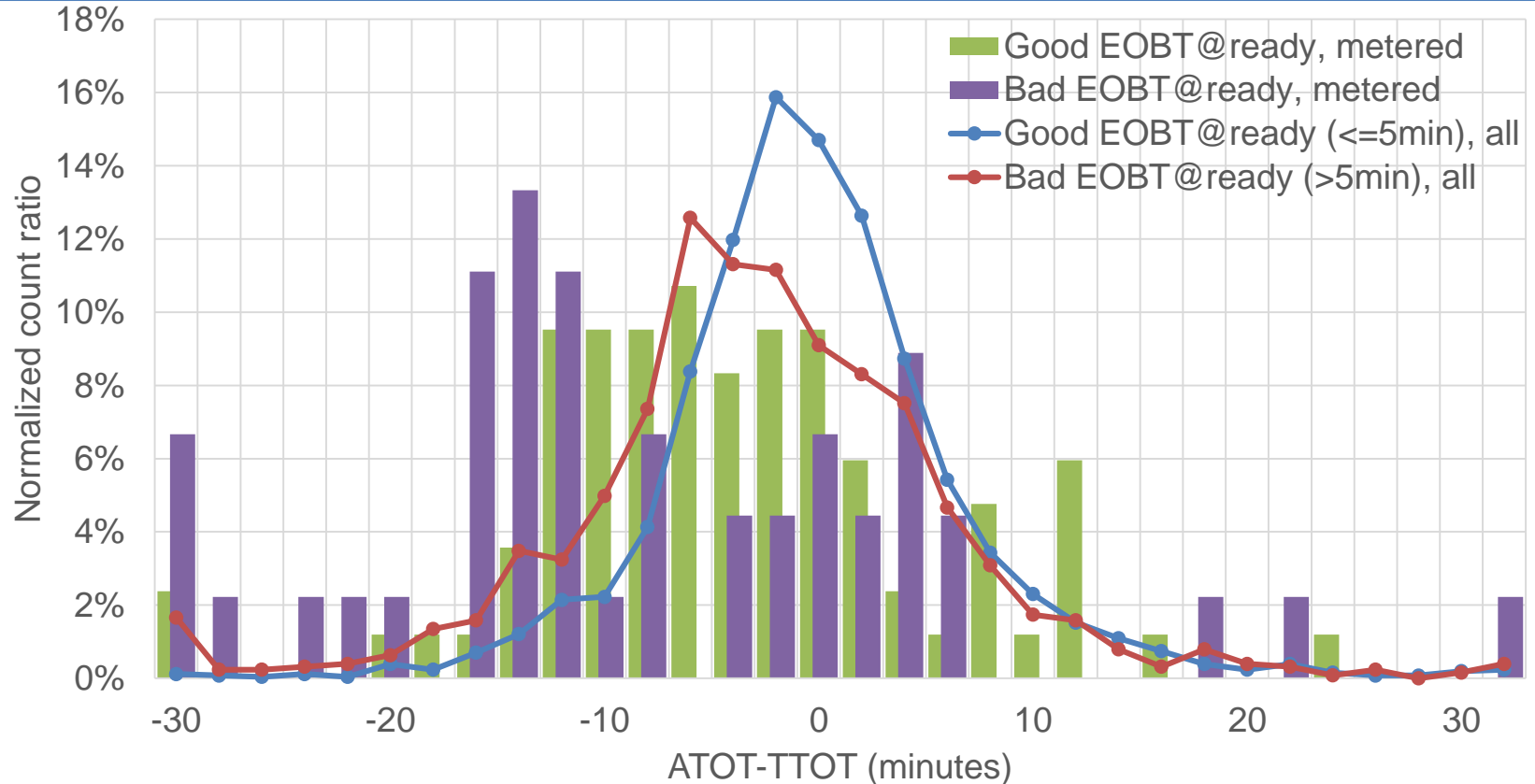

Runway 36C	Good EOBT, metered	Bad EOBT, metered	Good EOBT, all flights	Bad EOBT, all flights
Count	114	53	3,866	1,867
Mean	-1.03 min	-1.14 min	-0.15 min	-2.83 min
Std. Dev.	6.29 min	8.70 min	7.07 min	19.63 min
Median	0.14 min	-1.38 min	-0.85 min	-2.55 min

(ATOT – TTOT at Ready) vs. EOBT accuracy @Ready for Runway 36R

For runway 36R, departures having good EOBT accuracy show better TTOT compliance, with smaller variations.
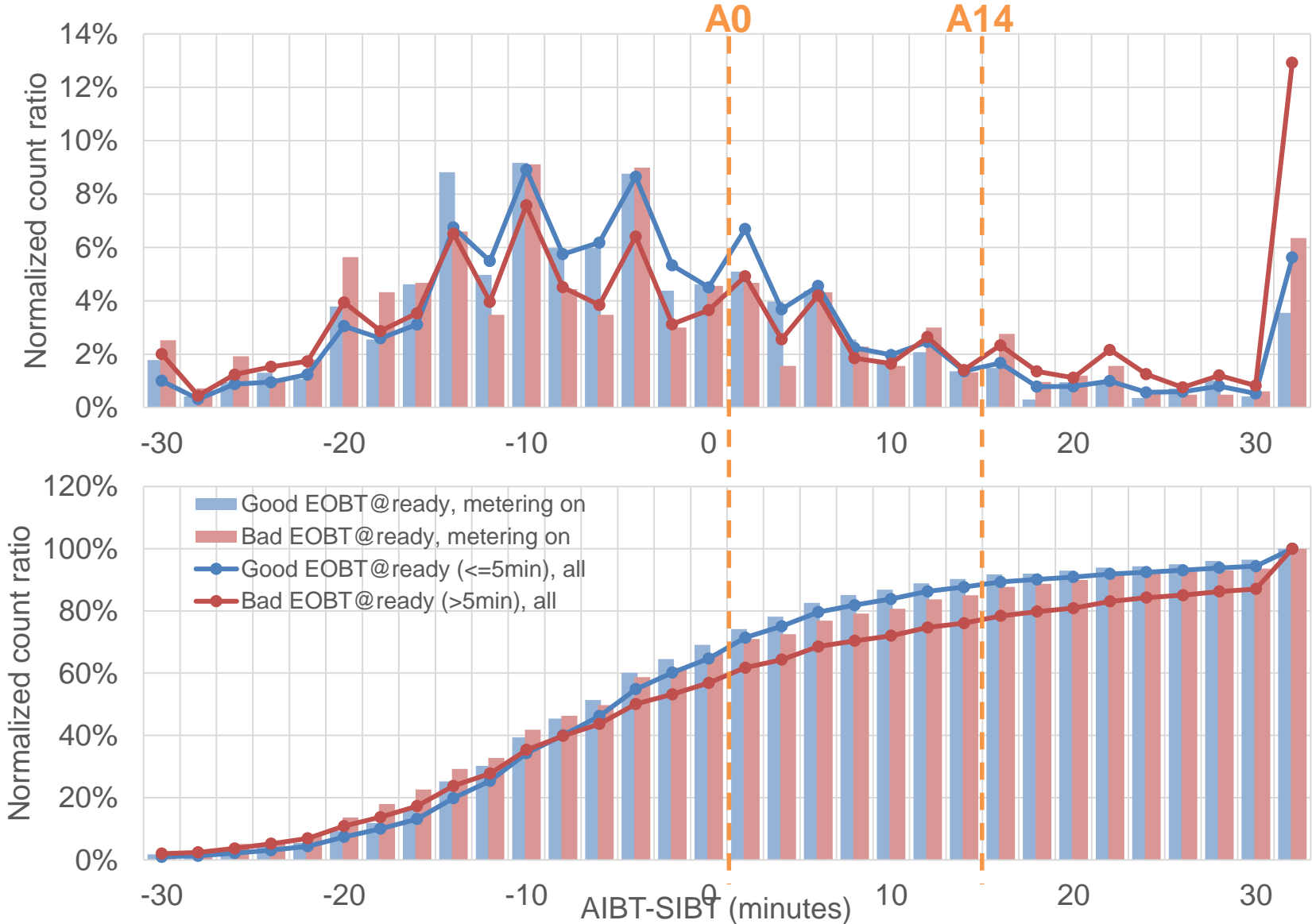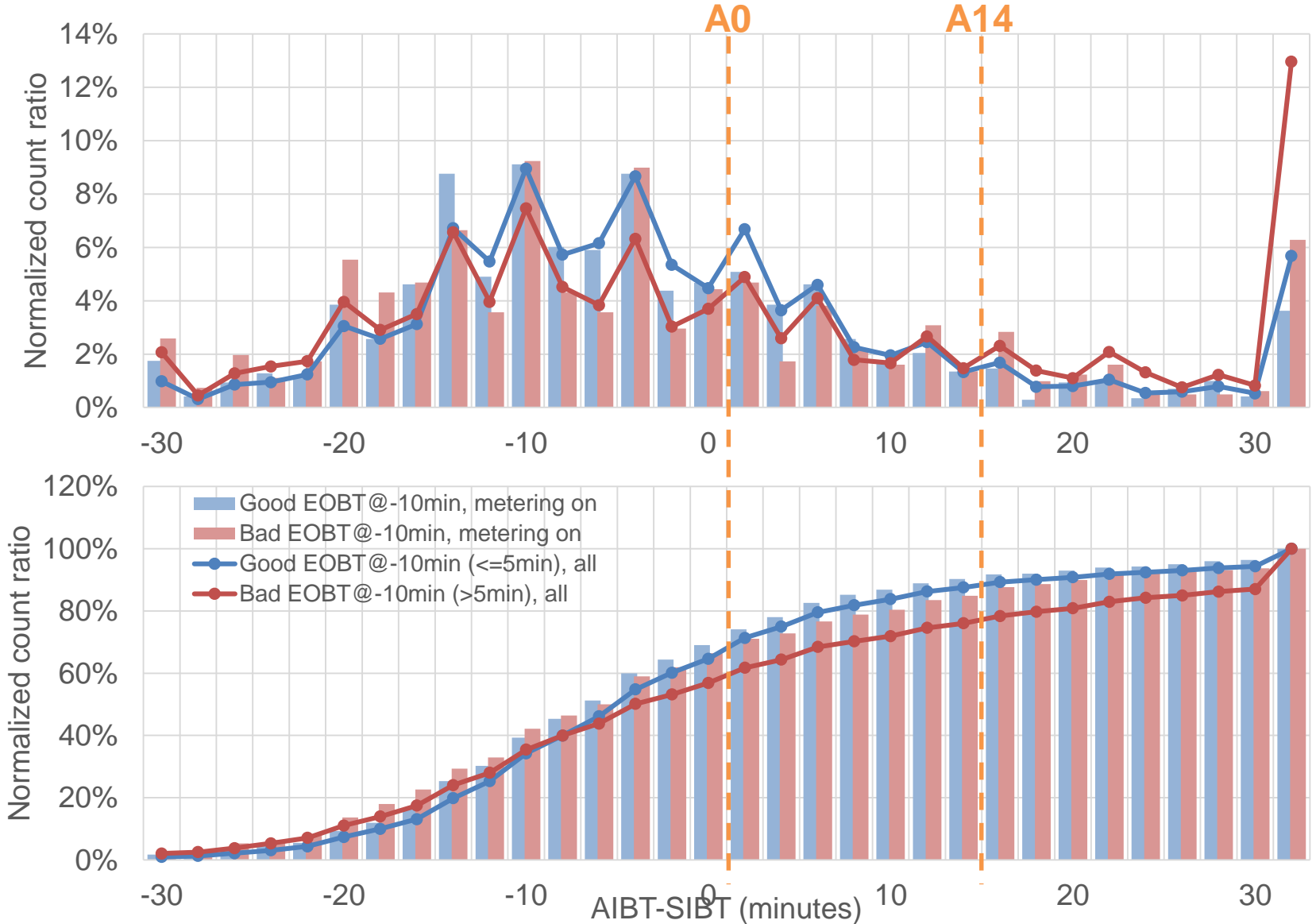

Runway 36R	Good EOBT, metered	Bad EOBT, metered	Good EOBT, all flights	Bad EOBT, all flights
Count	84	45	2,564	1,264
Mean	-4.94 min	-6.44 min	-1.31 min	-4.17 min
Std. Dev.	9.29 min	25.51 min	6.92 min	16.23 min
Median	-5.43 min	-12.13 min	-1.68 min	-3.86 min

- The outbound flights having good EOBT accuracy showed the better A0 and A14 metrics at destination airports.

- There was no significant difference on the airport terminal distribution between good and bad EOBT accuracy groups.

- The flights having good EOBT accuracy are about 2/3 out of all flights, showing better TTOT compliance and predictability, except for runway 18C.

- The flights having bad EOBT accuracy tended to take off earlier than estimated TTOTs.

- For more detailed analyses, the departures should be categorized into 4 groups, depending on the relative errors between AOBT and EOBT at ready:
  1. Good EOBT group 1: -5min <= (AOBT – EOBT) < 0
  2. Good EOBT group 2: 0 <= (AOBT – EOBT) <= 5min
  3. Bad EOBT group 1: (AOBT – EOBT) < -5min
  4. Bad EOBT group 2: (AOBT – EOBT) > 5min

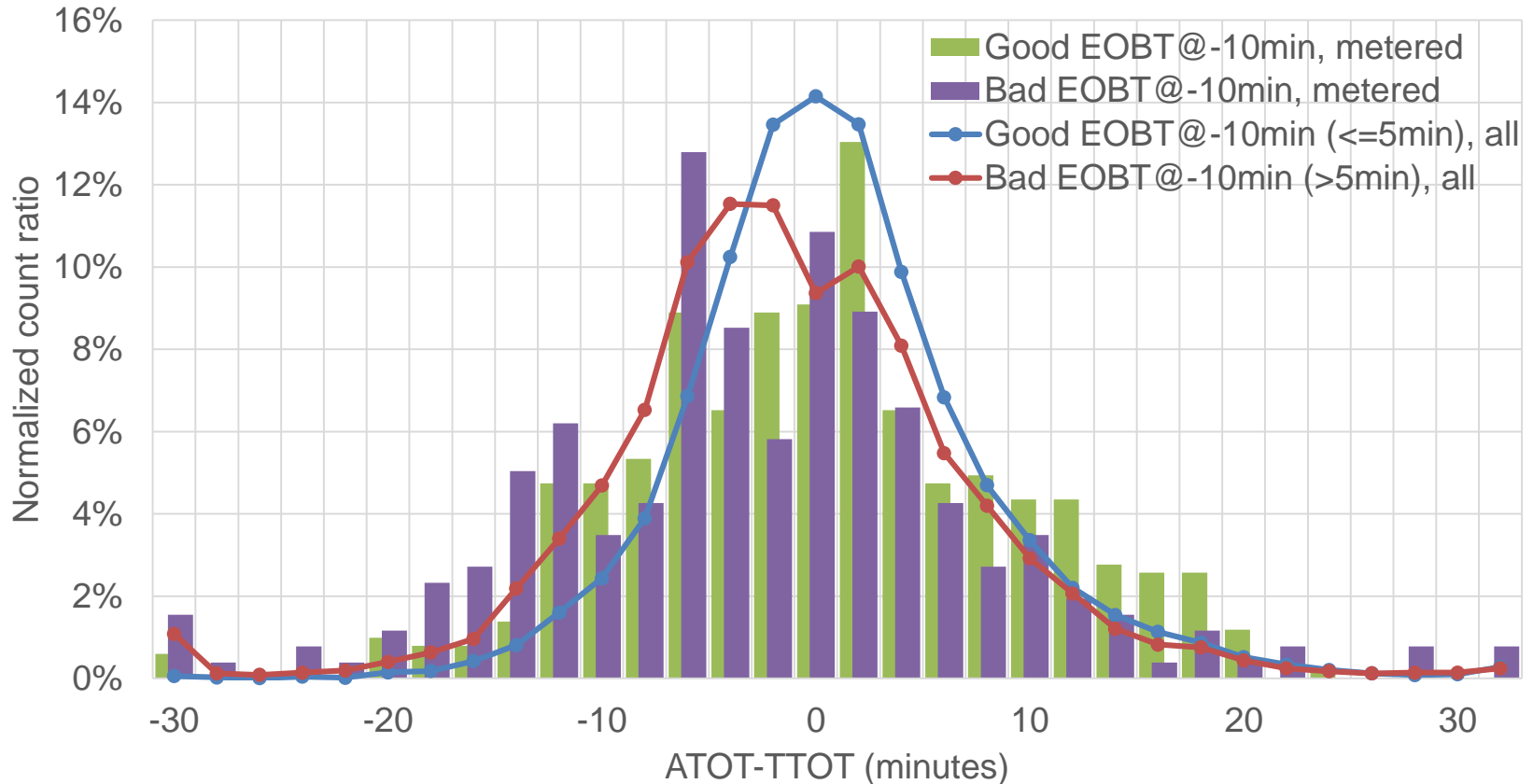# Backup

A0 and A14 vs. EOBT Accuracy @Ready

(ATOT – TTOT at Ready) vs. EOBT accuracy @-10min Before Ready

	Good EOBT, metered	Bad EOBT, metered	Good EOBT, all flights	Bad EOBT, all flights
Count	506	258	12,114	5,713
Mean	-0.55 min	-3.20 min	-0.14 min	-2.97 min
Std. Dev.	8.88 min	13.56 min	8.08 min	17.89 min
Median	-0.64 min	-3.78 min	-0.62 min	-2.67 min