Plots of Final-Approach Extension Maneuvers for Arrival Delay

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The following plots show examples of final-approach extension maneuvers for arrival delay. The delays are used to fill an arrival time slot and to realize the required wake-vortex spacing behind the previous arrival to the same runway. This kind of maneuver is used after a speed maneuver has reached its limit (because the aircraft is not allowed to reduce speed any further).

The original route in each plot is shown as a solid line, and the delayed routes are shown as dashed lines. The subtitle of each plot shows the aircraft type and the test results. The required delay for each route was incremented in steps of 30 seconds, and the path stretch necessary to realize each required delay was computed using a bisection algorithm (while maintaining the original altitude and speed profiles and accounting for winds). The maximum length of the final approach was limited to stay well within the TRACON boundary, and extension of final approach was not allowed for most DAL arrivals because it would interfere with DFW arrivals. The resulting maximum delay (by final extension alone) is shown in the subtitle.

The error in the resulting delay is also shown in each subtitle. This error applies to the reference trajectory computation only and should not be con-fused with flight control accuracy. These errors can be made arbitrarily small at the expense of more computation by simply adding more iterations in the bisection algorithm. The maximum error for all runs was less than 0.01 sec, and the computational time was approximately 0.014 seconds per delay so-lution. That is more than sufficient accuracy and more than fast enough for real time.

[generated using test/FinalExtensionTest.scala]

Final Approach Extension Routes

1334 (E145 E DFW/18R Arr) step: 30 sec, max delay: 8.5 min, max err: 0.00 sec
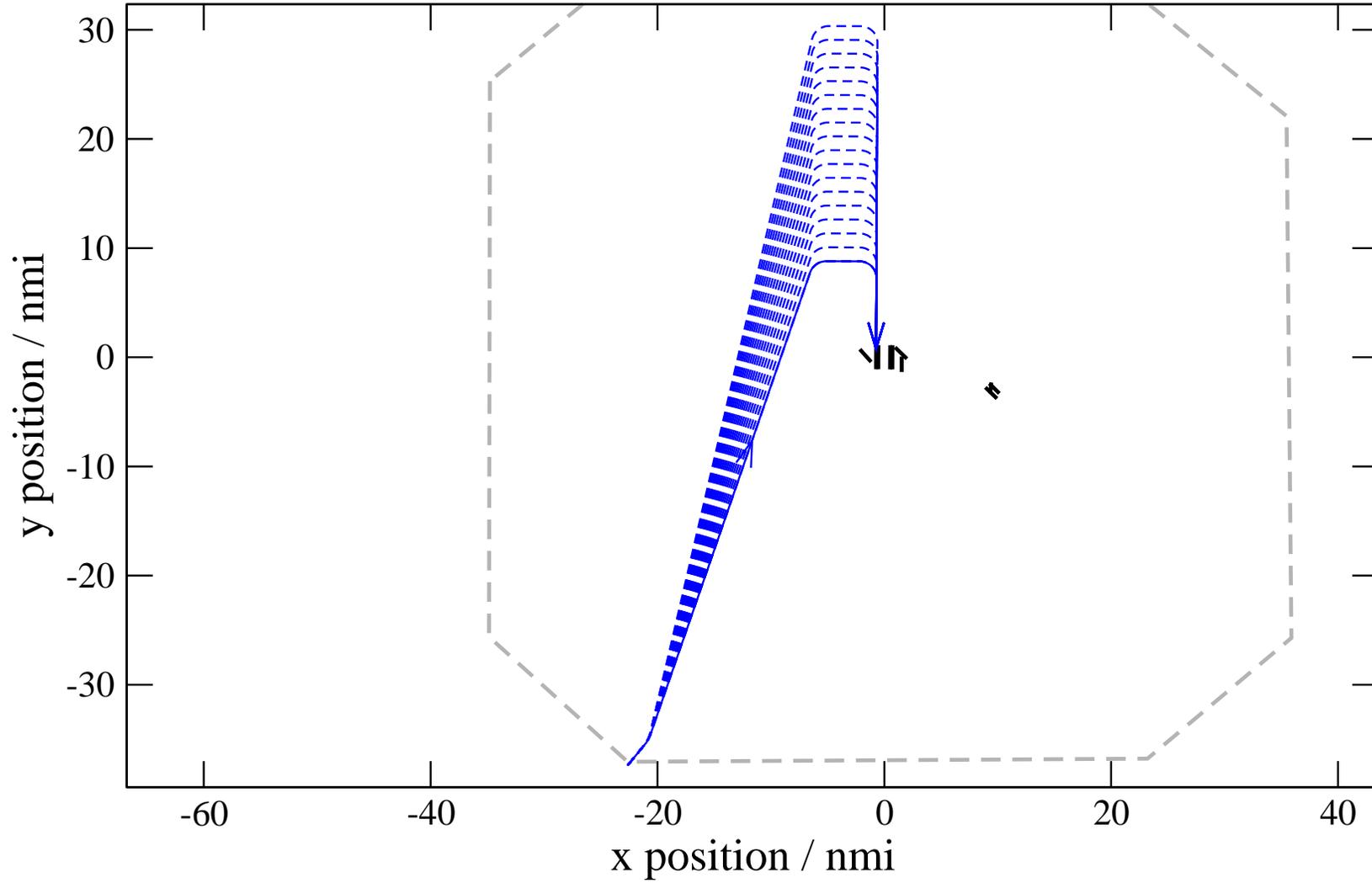
Final Approach Extension Routes

1439 (DC10 C DFW/17C Arr) step: 30 sec, max delay: 3.0 min, max err: 0.00 sec
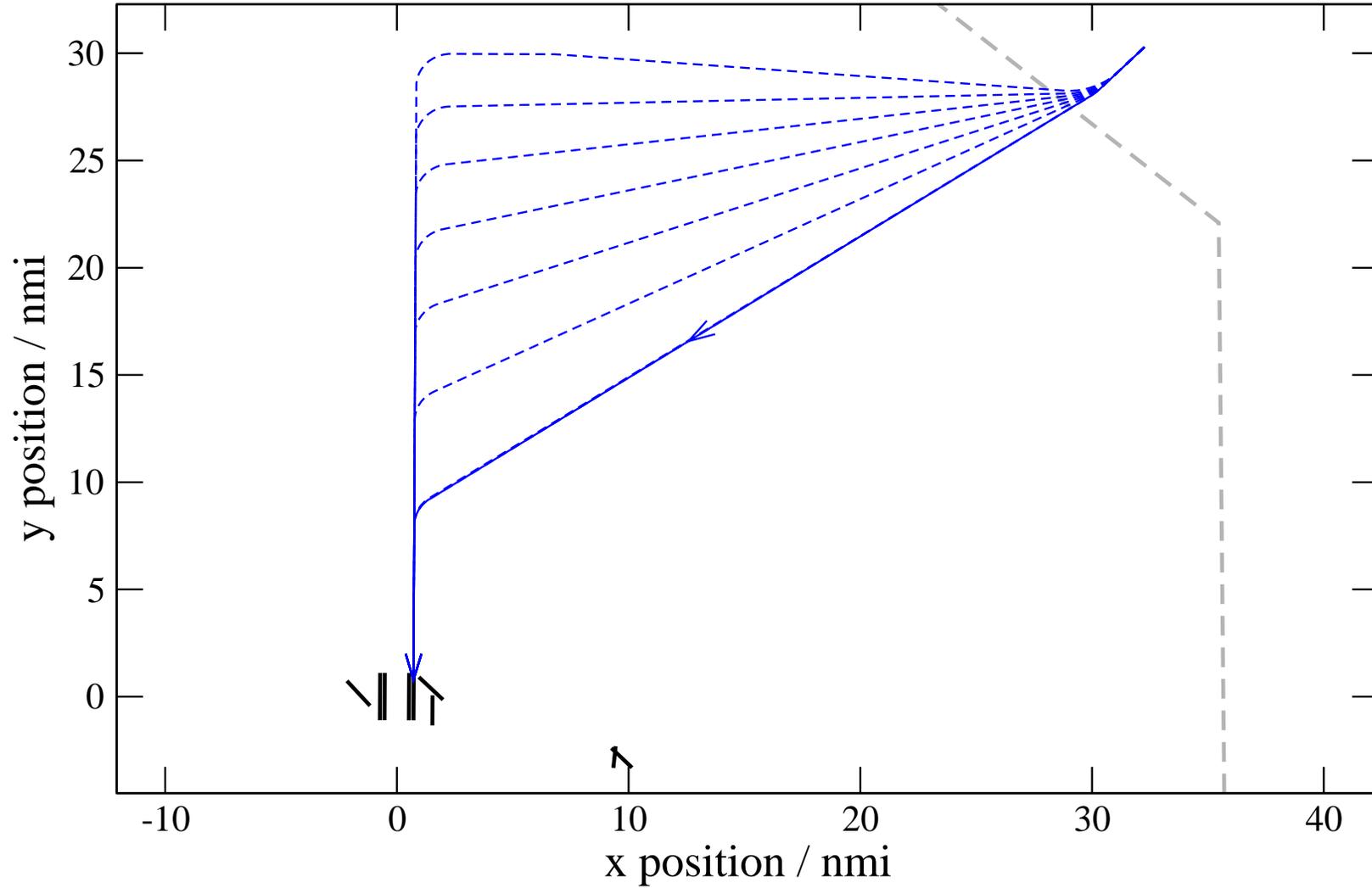
Final Approach Extension Routes

1448 (LJ45 F DFW/17C Arr) step: 30 sec, max delay: 7.5 min, max err: 0.00 sec
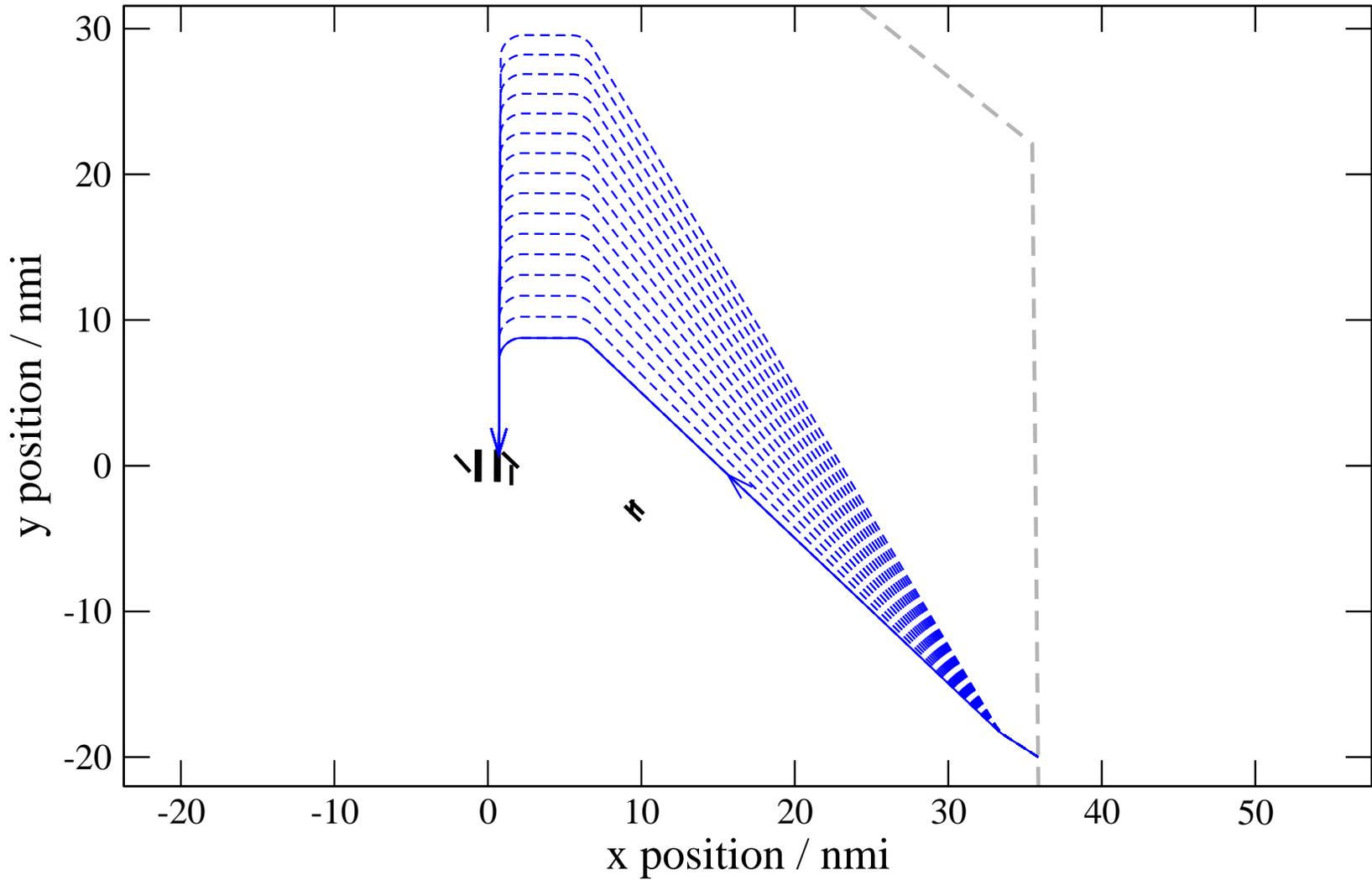
Final Approach Extension Routes

1512 (BE20 F DFW/18R Arr) step: 30 sec, max delay: 4.0 min, max err: 0.00 sec
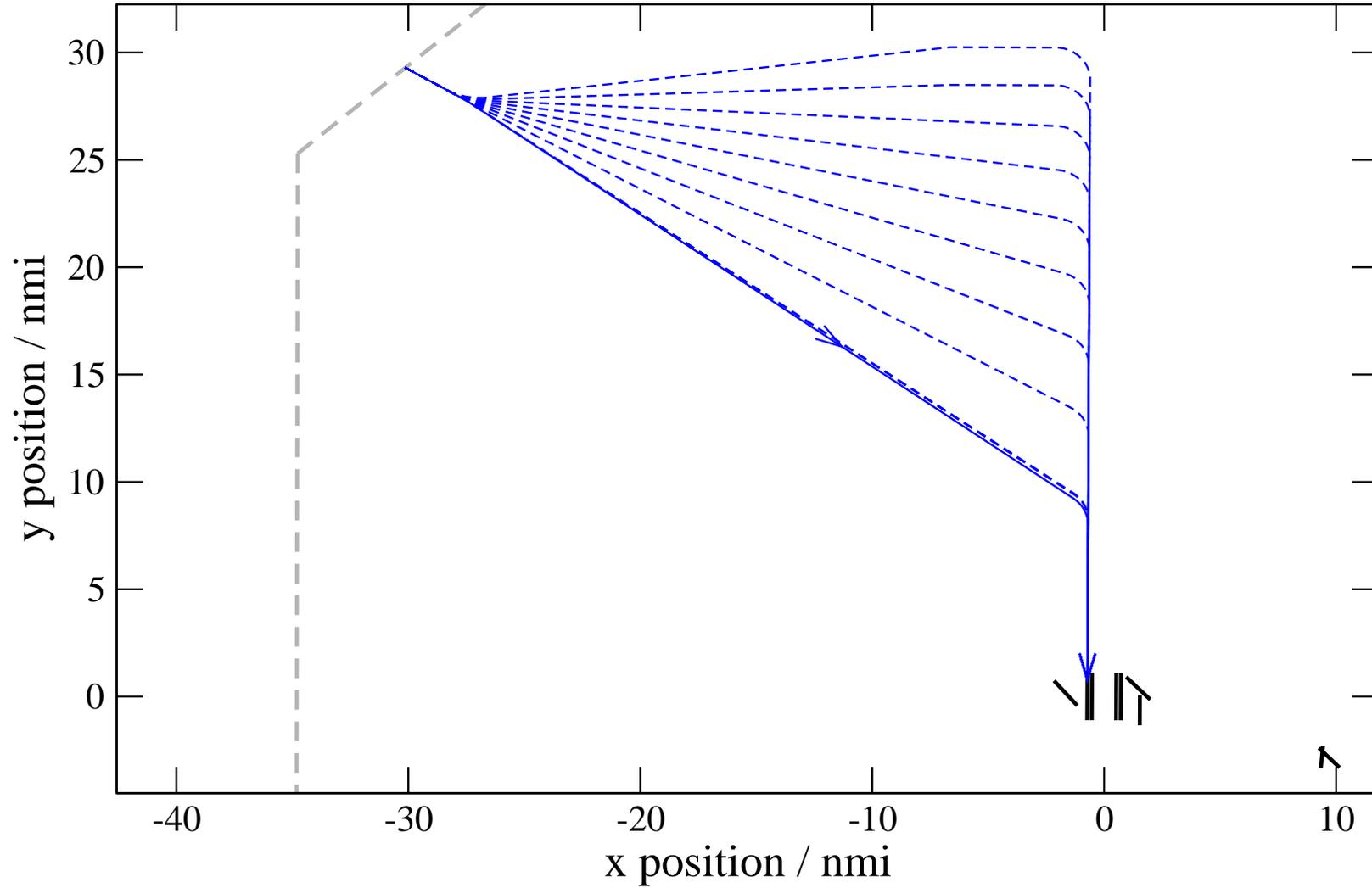
Final Approach Extension Routes

1620 (DC10 C DFW/17C Arr) step: 30 sec, max delay: 4.0 min, max err: 0.00 sec
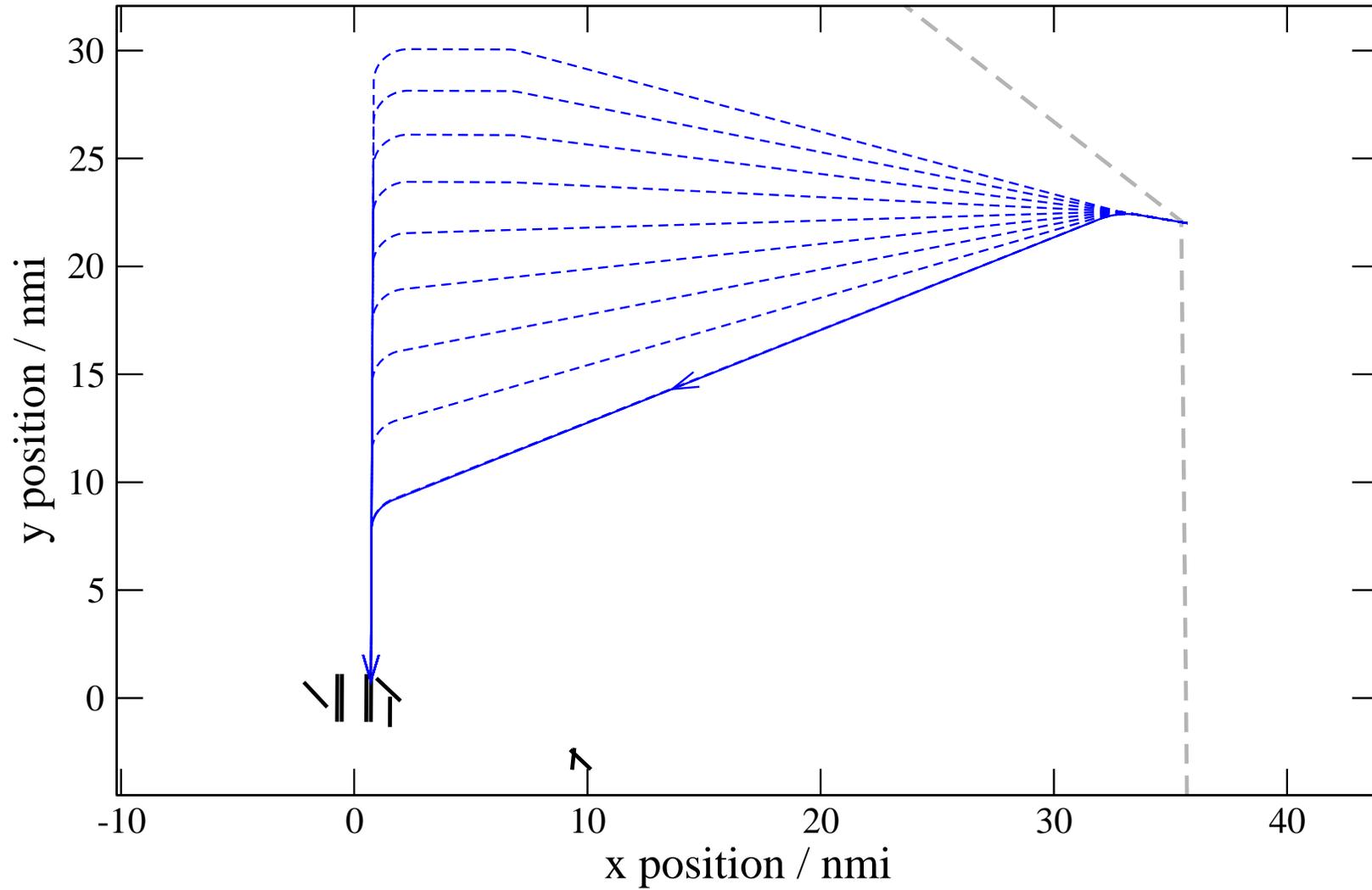
Final Approach Extension Routes

1809 (A306 C DFW/17C Arr) step: 30 sec, max delay: 2.0 min, max err: 0.00 sec
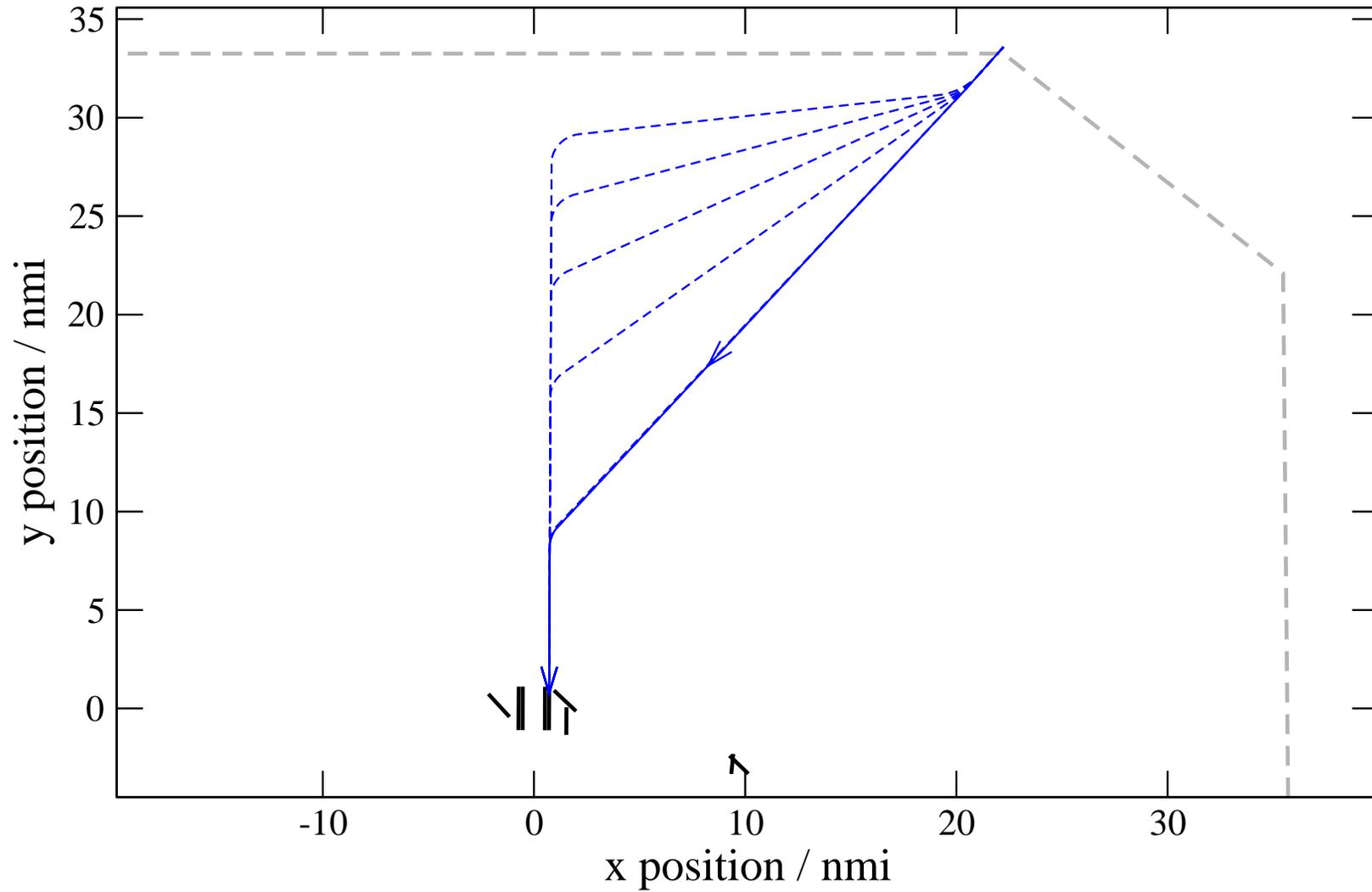
Final Approach Extension Routes

1911 (E145 E DFW/18R Arr) step: 30 sec, max delay: 2.0 min, max err: 0.00 sec
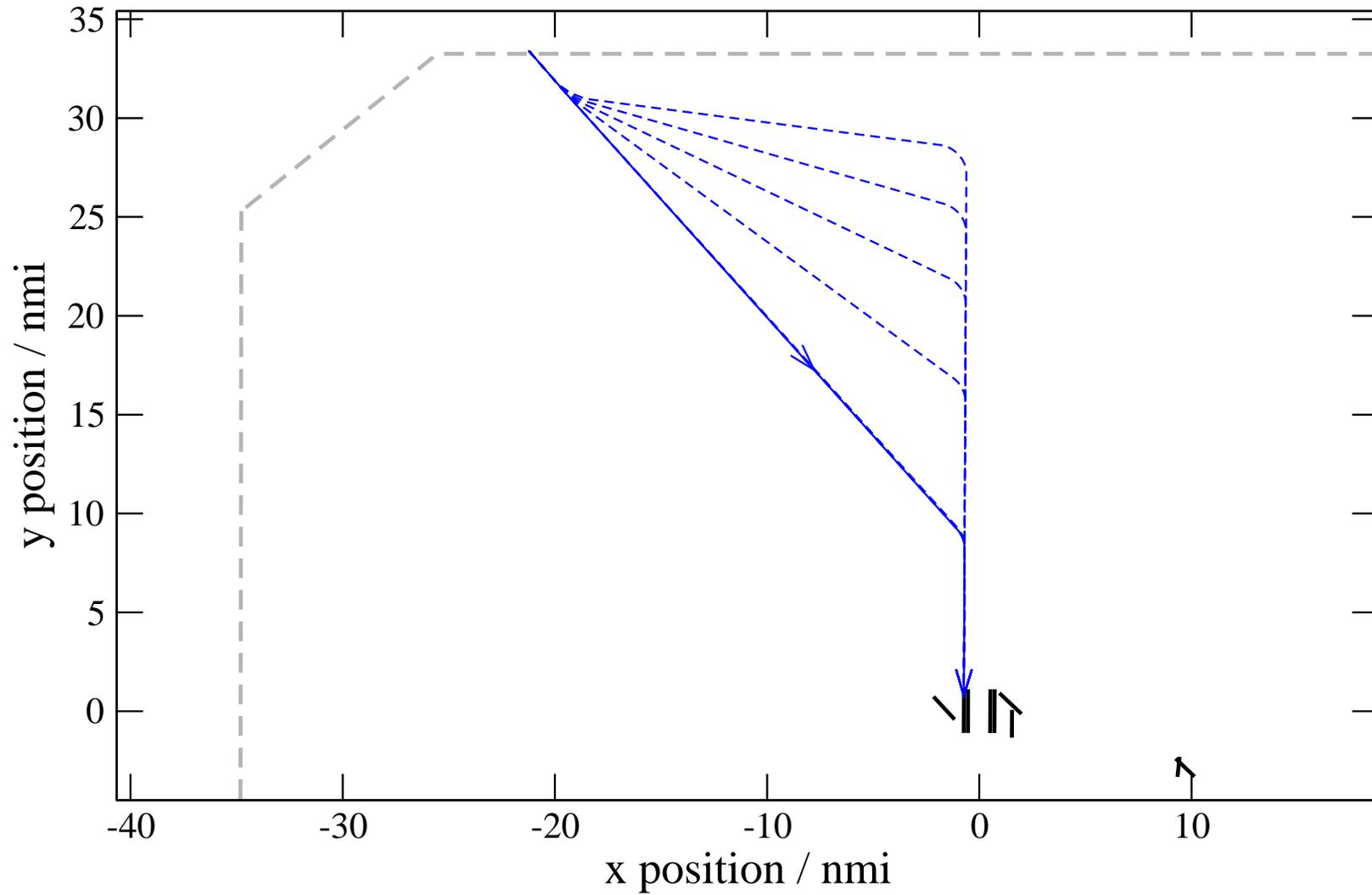
Final Approach Extension Routes

1922 (E135 E DFW/17C Arr) step: 30 sec, max delay: 8.5 min, max err: 0.00 sec
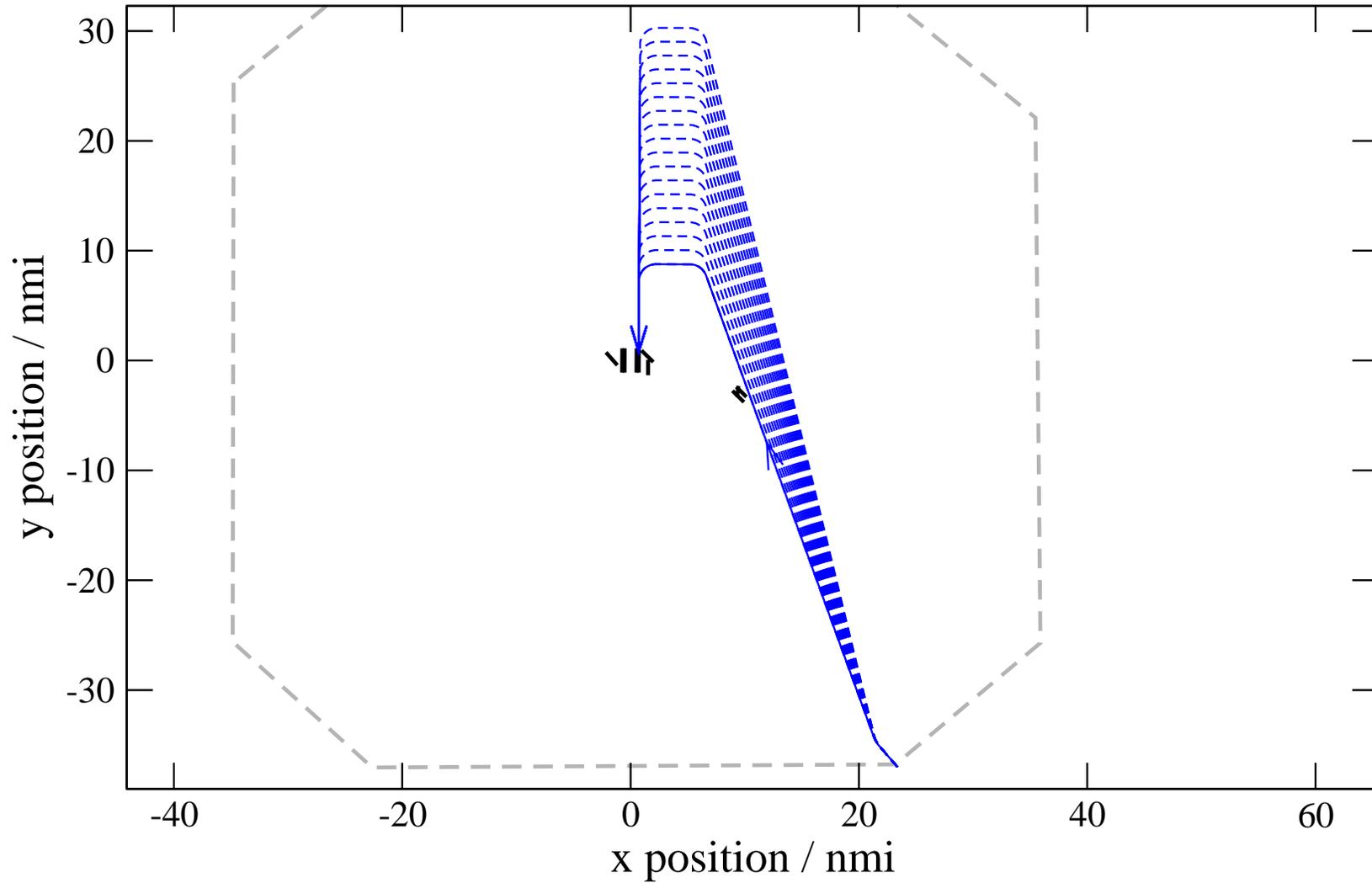
Final Approach Extension Routes

2118 (B763 C DFW/17C Arr) step: 30 sec, max delay: 8.0 min, max err: 0.00 sec
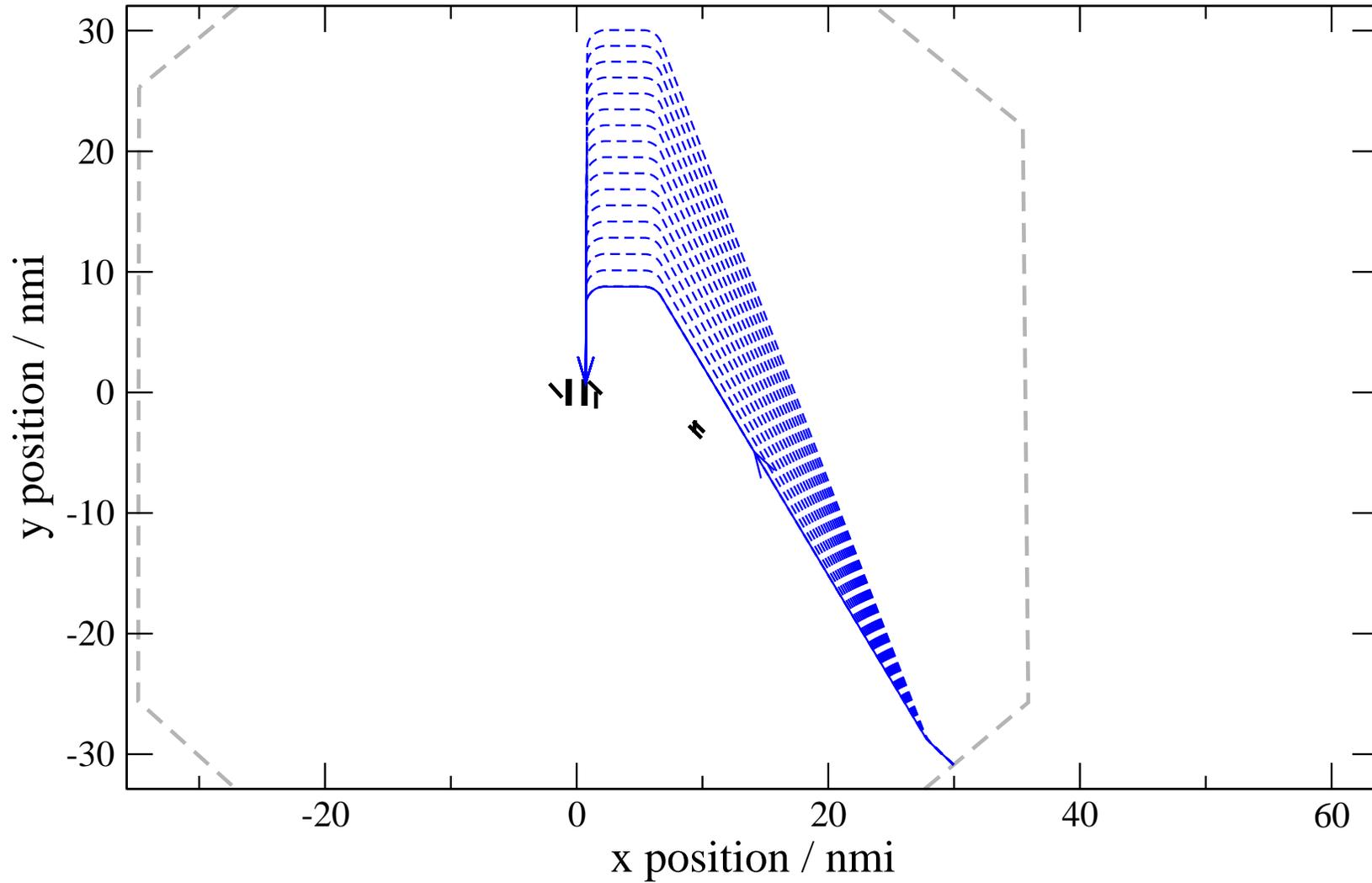
Final Approach Extension Routes

25 (E135 E DFW/18R Arr) step: 30 sec, max delay: 8.5 min, max err: 0.00 sec
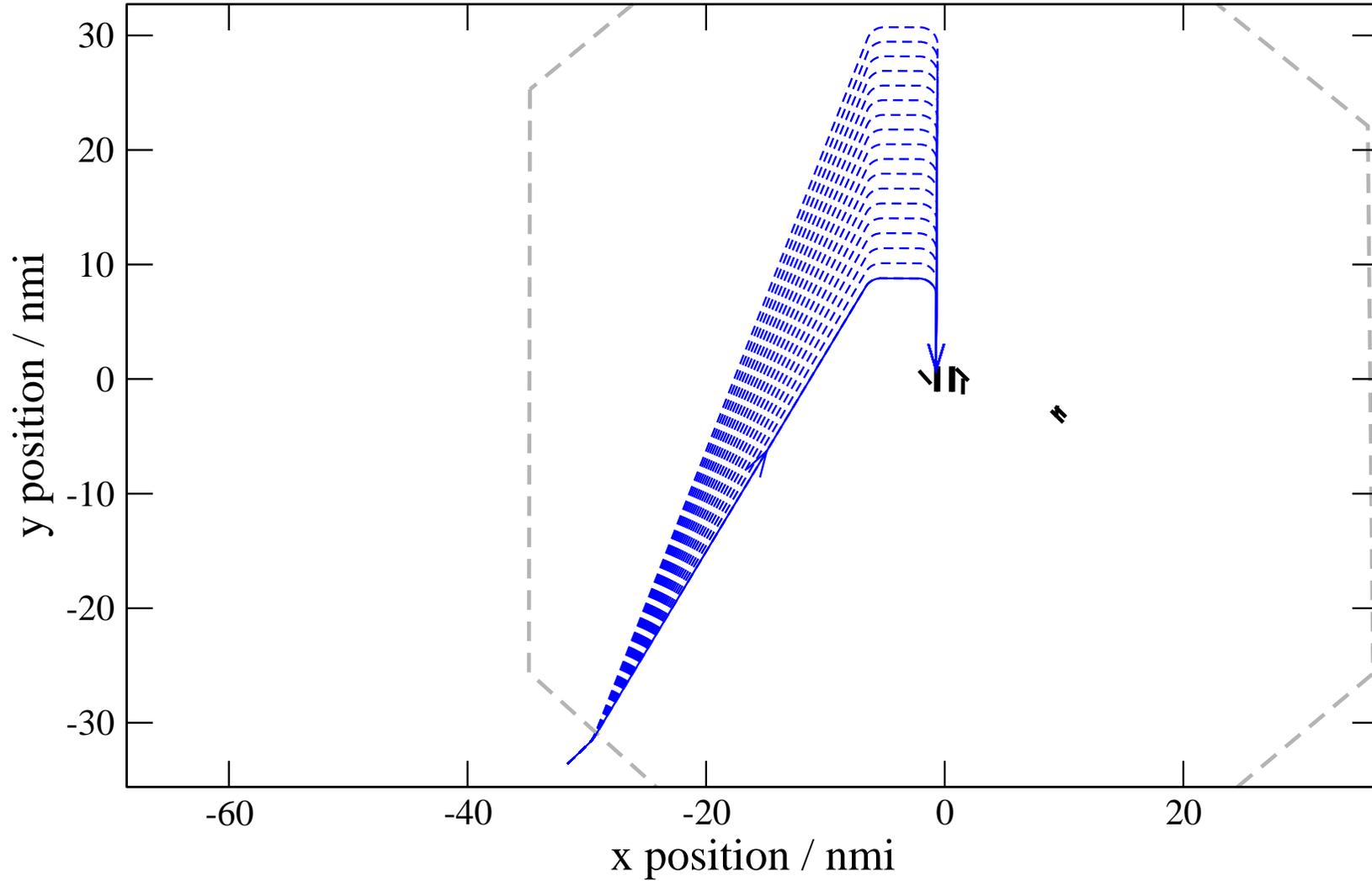
Final Approach Extension Routes

54 (E135 E DFW/17C Arr) step: 30 sec, max delay: 8.0 min, max err: 0.00 sec