analyze_single_anemotaxis

November 3, 2025

0.1 Analysis of a single `trx.mat` file of an experiment

[1]:
```
import sys
import os
import numpy as np
import matplotlib.pyplot as plt
from matplotlib.gridspec import GridSpec
from datetime import datetime

# Set matplotlib style
%matplotlib widget
%load_ext autoreload
%autoreload 2
plt.style.use('../anemotaxis.mplstyle')
```

[2]:
```
import core.data_loader as data_loader
import core.data_processor as data_processor
import viz.plot_data as plot_data
import utils.preprocessing as preprocessing
```

[3]:
```
# Control FCF_attP2-40@UAS_TNT_2_0003
single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_150958/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240223_112627/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_145653/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_163646/
 ↪trx.mat"
```

```
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_105819/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_121446/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_151714/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_162010/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_104430/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_124423/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250711_112928/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250712_115018/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250712_131147/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250715_112915/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250801_111753/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250804_110703/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250805_103511/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250908_135226/
 ↪trx.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250908_140738/
 ↪trx.mat"
```

```
# Control Abby
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪FCF_attP2-40@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250624_143316/trx_20250624_143316.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪FCF_attP2-40@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250620_144253/trx_20250620_144253.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪FCF_attP2-40@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250626_142647/trx_20250626_142647.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪FCF_attP2-40@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250908_135226/trx_20250908_135226.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪FCF_attP2-40@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250908_140738/trx_20250908_140738.mat"

# SS01948 :
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240223_110610/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_160620/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_114359/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_153212/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_115957/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250620_114411/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250801_113341/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250804_120639/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01948@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250805_110603/trx.
 ↪mat"
```

```
# MB143B
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_152833/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_112859/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_143024/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_131239/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240614_150918/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250711_115827/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250712_124448/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_MB143B@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250715_115737/trx.
 ↪mat"

# SS00864
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_151622/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240223_122519/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_162227/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_115953/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_144626/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_123028/trx.
 ↪mat"
```

```
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250606_151520/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250610_151515/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250613_115904/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250616_112805/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250801_121925/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250802_125236/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250804_113758/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS00864@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250805_113429/trx.
 ↪mat"

# SS01696
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_155844/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240223_115010/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_170838/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_111323/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_141357/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_125815/trx.
 ↪mat"
```

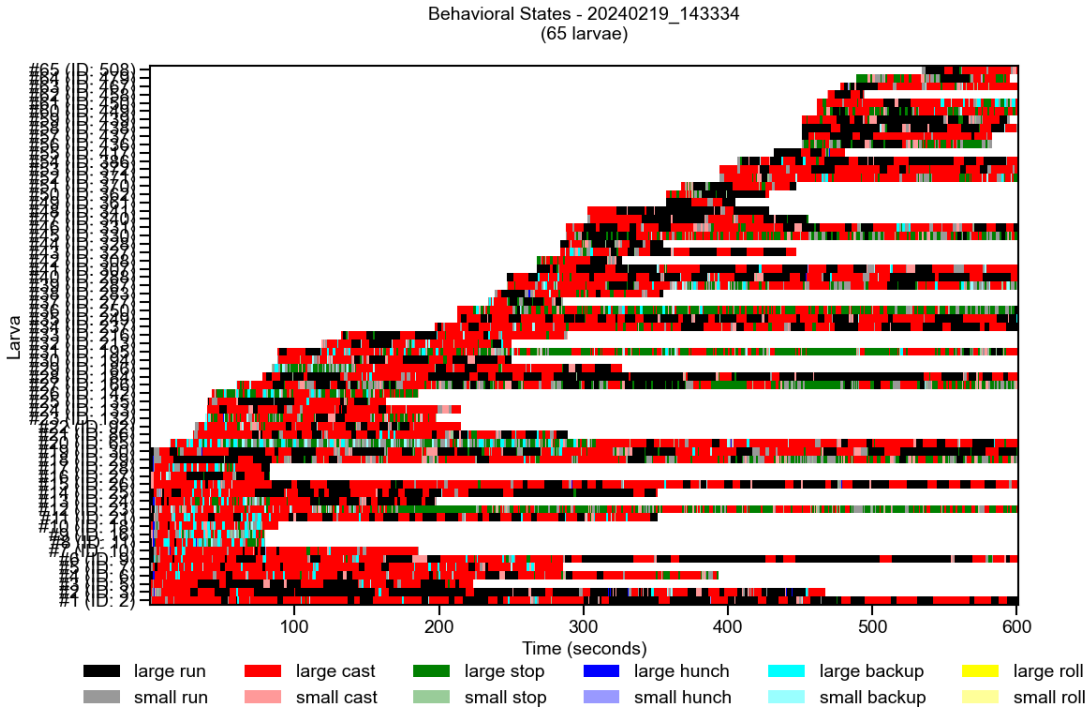
```
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250711_122648/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250712_121626/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01696@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250715_110237/trx.
 ↪mat"

# SS01757
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_145347/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240223_120812/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240226_165304/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240301_104205/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240304_150157/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240308_121454/trx.
 ↪mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/
 ↪GMR_SS01757@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20250627_112155/trx.
 ↪mat"



# SS01632
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪GMR_SS01632@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250620_150116/trx_20250620_150116.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪GMR_SS01632@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250624_151833/trx_20250624_151833.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪GMR_SS01632@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250626_144339/trx_20250626_144339.mat"
```

```
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪GMR_SS01632@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250908_142208/trx_20250908_142208.mat"
# single_path = "/Users/sharbat/Projects/anemotaxis/data/T2_Ladder_Neuron_Data/
 ↪GMR_SS01632@UAS_TNT_2_0003_p_5gradient2/p_5gradient2_2s1x600s0s#n#n#n/
 ↪20250908_143537/trx_20250908_143537.mat"



trx_data = data_loader.load_single_trx_file(single_path, show_progress=True)
```

```
Processing file: /Users/sharbat/Projects/anemotaxis/data/FCF_attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/trx.mat
Number of larvae: 65

Processing larvae:   0%|          | 0/65 [00:00<?, ?it/s]
```

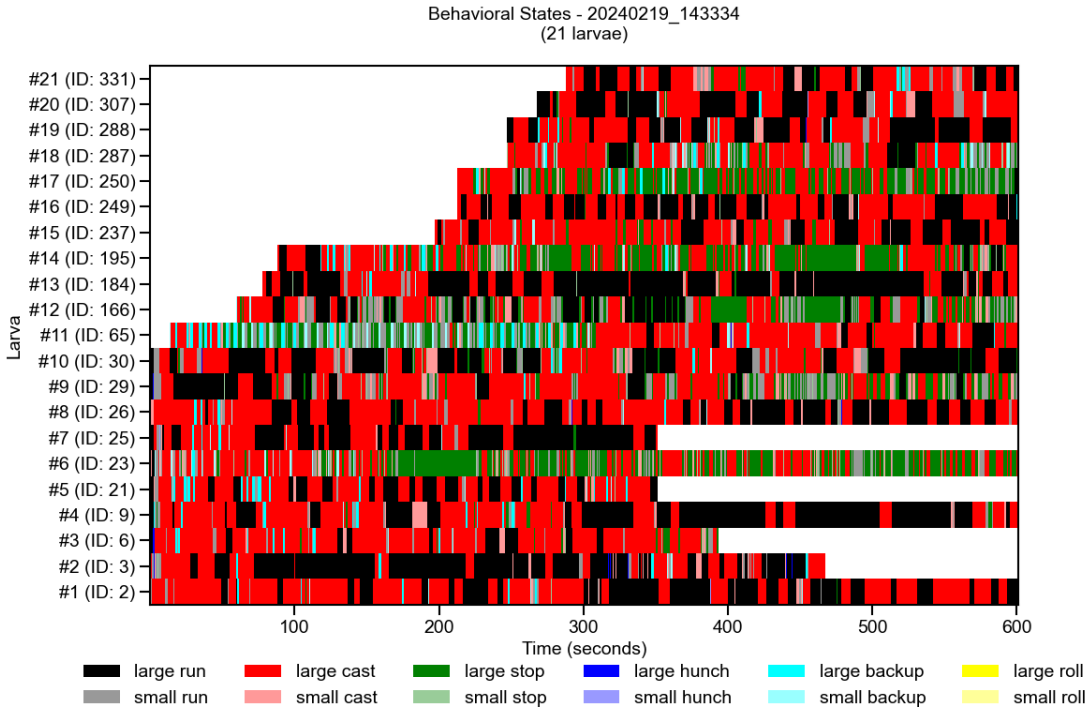
[4]:
```
# Get the parent directory of single_path and create analyses folder if it␣
 ↪doesn't exist
# this is to save analysis results and figures if needed
parent_dir = os.path.dirname(single_path)
output_dir = os.path.join(parent_dir, 'analyses')
os.makedirs(output_dir, exist_ok=True)
```

[5]:
```
results_behavior_matrix = plot_data.plot_global_behavior_matrix(trx_data)
```



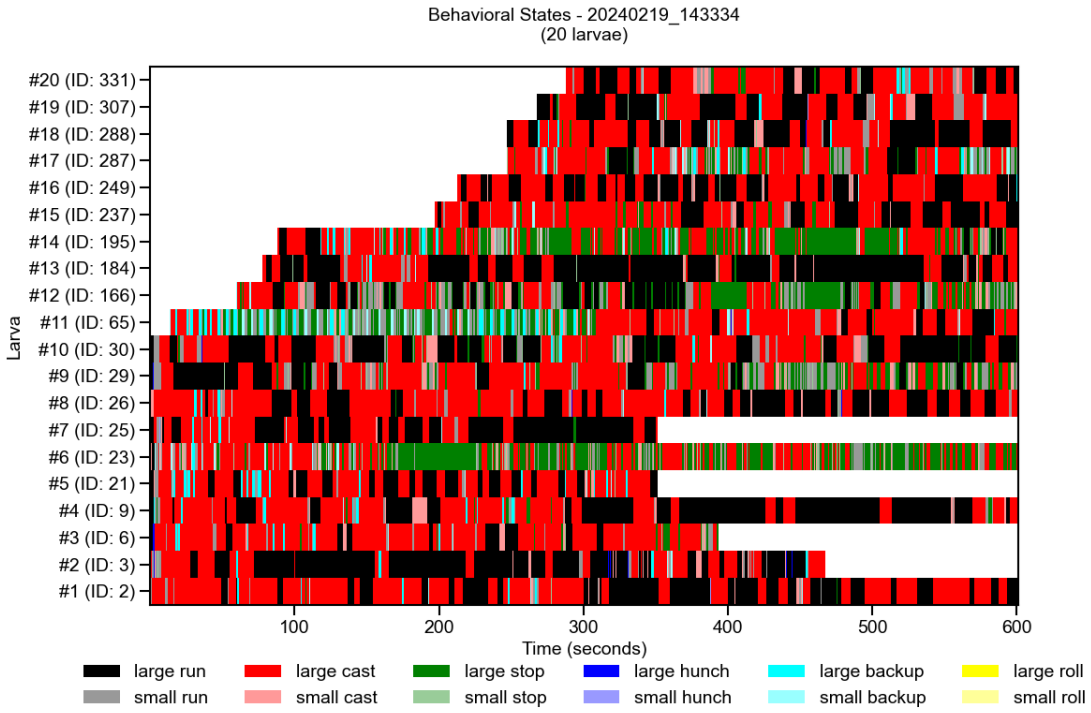
[6]:
```
min_total_duration= 300 # seconds (total duration of experiment for anemotaxis␣
 ↪is 600 seconds)
trx_filtered_by_duration = preprocessing.filter_larvae_by_duration(trx_data,␣
 ↪min_total_duration=min_total_duration)
results_filtered_behavior_matrix = plot_data.
 ↪plot_global_behavior_matrix(trx_filtered_by_duration)
```

```
Duration filtering results (threshold: 300.0s):
  - Removed 44 larvae with <300.0s total duration
  - 21 larvae remaining
```



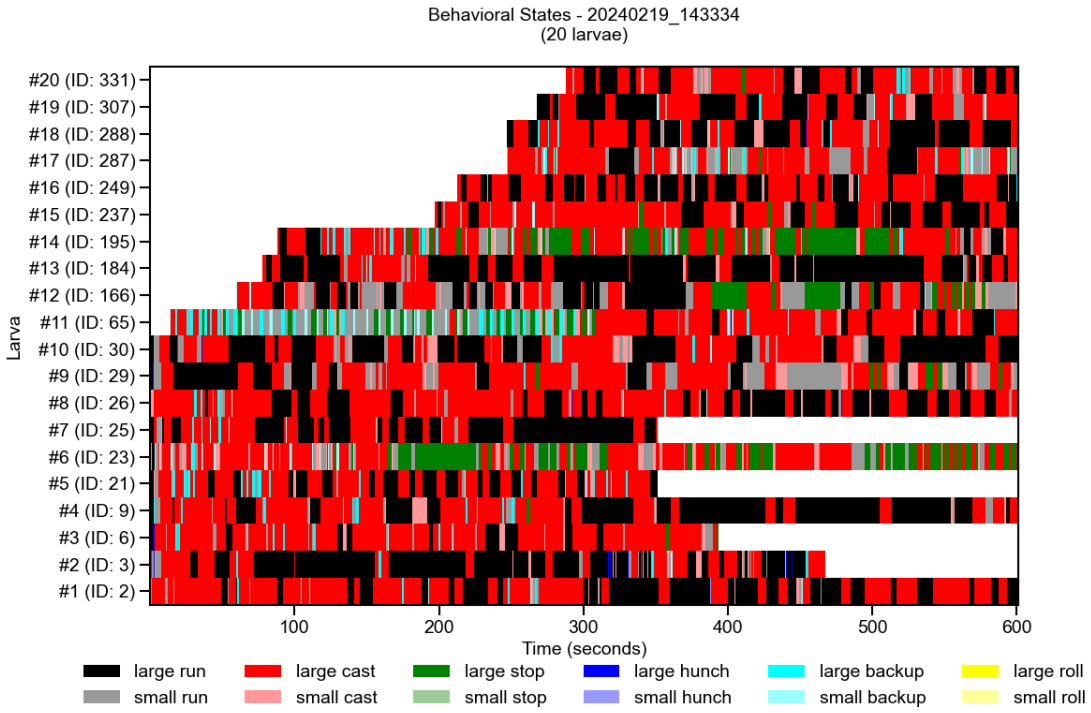
[7]:
```
max_stop_percentage = 0.5
trx_filtered_by_removing_stops = preprocessing.
 ↪filter_larvae_by_excess_stop_time(trx_filtered_by_duration,␣
 ↪max_stop_percentage=max_stop_percentage)
results_filtered_behavior_matrix = plot_data.
 ↪plot_global_behavior_matrix(trx_filtered_by_removing_stops)
```

```
Excess stop time filtering results (threshold: 50%):
  - Removed 1 larvae with >50% time in stop state
  - 20 larvae remaining
```



[8]:
```
trx_filtered_by_merging = preprocessing.
 ↪merge_short_stop_sequences(trx_filtered_by_removing_stops,␣
 ↪min_stop_duration_cast=2.0, min_stop_duration_run=3.0)
results_merged_behavior_matrix = plot_data.
 ↪plot_global_behavior_matrix(trx_filtered_by_merging)
fig_behavior = plt.gcf()  # Get current figure
fig_behavior.savefig(os.path.join(output_dir, 'behavior_matrix_filtered.pdf'),
                     bbox_inches='tight',
                     dpi=300,
                     transparent=True,
                     facecolor='none')
print(f"Behavior matrix figure saved to: {os.path.join(output_dir,␣
 ↪'behavior_matrix_filtered.pdf')}")
```

```
Merged 506 sequences with short stops:
  - 225 cast-stop-cast sequences
  - 219 run-stop-run sequences
  - 62 mixed sequences (run-stop-cast or cast-stop-run)
Total duration saved: 442.77 seconds
```




```
Behavior matrix figure saved to: /Users/sharbat/Projects/anemotaxis/data/FCF_att
P2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/behavio
r_matrix_filtered.pdf
```

[9]:
```python
# Analyze run probability by orientation and over time
run_prob_results = data_processor.analyze_run_probability_by_orientation(
    trx_filtered_by_merging, bin_width=10, sigma=2)

run_prob_time_results = data_processor.analyze_run_probability_over_time(
    trx_filtered_by_merging, window=60, step=20
)

# Analyze turn probability by orientation and over time
turn_prob_results = data_processor.analyze_turn_probability_by_orientation(
    trx_filtered_by_merging, bin_width=10, sigma=2, min_turn_amplitude=45)
turn_prob_time_results = data_processor.analyze_turn_probability_over_time(
    trx_filtered_by_merging, window=60, step=20, min_turn_amplitude=45
)

# Analyze backup probability by orientation and over time
backup_prob_results = data_processor.analyze_backup_probability_by_orientation(
    trx_filtered_by_merging, bin_width=10, sigma=2)
```

```
backup_prob_time_results = data_processor.analyze_backup_probability_over_time(
    trx_filtered_by_merging, window=60, step=20)
```

```
Larva 2 cast orientations:
  cast  1: t=   1.1-  2.3s, =   5.0°→  11.0° (Δ=  +6.1°)
  TURN  2: t=   2.8- 10.5s, =  11.5°→  70.8° (Δ= +59.4°)
  cast  3: t=  12.1- 16.3s, =  82.2°→  51.4° (Δ= -30.8°)
  TURN  4: t=  16.9- 49.0s, =  47.4°→ -73.0° (Δ=-120.4°)
  cast  5: t=  54.3- 59.5s, = -42.2°→ -30.5° (Δ= +11.7°)
  TURN  6: t=  61.4- 68.7s, = -19.1°→ -84.8° (Δ= -65.7°)
  TURN  7: t=  69.5- 87.8s, = -87.6°→  58.0° (Δ=+145.6°)
  cast  8: t=  91.8-104.3s, =  82.4°→  75.3° (Δ=  -7.1°)
  cast  9: t= 105.2-110.2s, =  77.1°→  86.9° (Δ=  +9.8°)
  TURN 10: t= 110.7-136.4s, =  83.5°→-103.0° (Δ=+173.5°)
  cast 11: t= 141.2-145.3s, = -75.4°→ -52.0° (Δ= +23.4°)
  cast 12: t= 154.3-174.5s, = -28.5°→ -30.5° (Δ=  -2.0°)
  TURN 13: t= 175.5-187.9s, = -29.2°→  96.1° (Δ=+125.2°)
  TURN 14: t= 193.2-206.5s, = 113.5°→  34.6° (Δ= -79.0°)
  cast 15: t= 210.4-216.6s, =  29.7°→  -6.0° (Δ= -35.6°)
  cast 16: t= 233.7-240.6s, =  -6.6°→ -46.7° (Δ= -40.1°)
  cast 17: t= 244.2-247.3s, = -57.0°→ -58.8° (Δ=  -1.8°)
  cast 18: t= 248.7-263.1s, = -32.0°→ -36.8° (Δ=  -4.8°)
  TURN 19: t= 268.7-300.4s, = -35.7°→ -99.4° (Δ= -63.8°)
  cast 20: t= 312.6-317.6s, = -59.8°→ -58.6° (Δ=  +1.2°)
  cast 21: t= 351.8-359.6s, = -26.2°→   5.4° (Δ= +31.6°)
  TURN 22: t= 388.4-399.9s, =  77.8°→  14.4° (Δ= -63.4°)
  cast 23: t= 421.0-426.8s, =  -2.2°→  37.7° (Δ= +39.9°)
  cast 24: t= 435.0-441.2s, =  65.7°→  39.5° (Δ= -26.2°)
  cast 25: t= 451.7-457.2s, =  27.5°→  53.1° (Δ= +25.6°)
  cast 26: t= 478.6-485.1s, =  96.4°→  65.0° (Δ= -31.4°)
  TURN 27: t= 494.6-512.5s, =  64.8°→ 123.2° (Δ= +58.4°)
  TURN 28: t= 516.9-530.7s, = 134.4°→-105.9° (Δ=+119.7°)
  TURN 29: t= 542.2-567.1s, = -78.0°→ -12.8° (Δ= +65.2°)
  TURN 30: t= 570.5-582.1s, =  -0.2°→ 105.3° (Δ=+105.5°)
  cast 31: t= 587.2-593.0s, = 126.4°→ 107.5° (Δ= -18.9°)
  Summary: 31 casts, 13 turns (41.9%)

Larva 3 cast orientations:
  cast  1: t=   0.2-  1.4s, = -29.6°→ -62.8° (Δ= -33.1°)
  TURN  2: t=   7.8- 27.7s, = -67.3°→ -12.2° (Δ= +55.0°)
  TURN  3: t=  32.8- 44.8s, =  -0.8°→  89.7° (Δ= +90.5°)
  cast  4: t=  55.2- 59.3s, =  99.5°→  94.4° (Δ=  -5.1°)
  TURN  5: t=  60.8- 71.8s, = 100.2°→  44.3° (Δ= -55.8°)
  cast  6: t=  99.9-100.6s, =  12.5°→  12.3° (Δ=  -0.2°)
  cast  7: t= 155.3-157.9s, =  71.8°→  72.9° (Δ=  +1.2°)
  cast  8: t= 160.1-165.3s, =  75.4°→  36.4° (Δ= -39.0°)
  cast  9: t= 218.6-224.4s, =  19.3°→ -10.3° (Δ= -29.7°)
```

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  cast 10: t= 273.5-278.8s,  =  18.7°→ -13.6° (Δ= -32.3°)
  cast 11: t= 299.8-304.9s,  = -36.4°→   0.9° (Δ= +37.3°)
  cast 12: t= 333.2-337.5s,  =  21.8°→  17.2° (Δ=  -4.5°)
  cast 13: t= 339.5-340.1s,  = -11.0°→ -17.9° (Δ=  -6.8°)
  cast 14: t= 348.5-357.9s,  = -15.4°→  15.5° (Δ= +30.9°)
  TURN 15: t= 361.8-371.8s,  =  24.0°→ 125.7° (Δ=+101.8°)
  TURN 16: t= 386.4-394.1s,  = 111.1°→ 175.8° (Δ= +64.7°)
  TURN 17: t= 397.2-406.6s,  =-179.5°→ -64.2° (Δ=+115.2°)
  cast 18: t= 414.7-415.8s,  = -49.0°→ -51.9° (Δ=  -2.9°)
  cast 19: t= 416.4-417.6s,  = -58.9°→ -55.7° (Δ=  +3.2°)
  cast 20: t= 418.0-423.2s,  = -59.1°→ -93.3° (Δ= -34.2°)
  TURN 21: t= 455.6-467.2s,  = -69.6°→-147.2° (Δ= -77.6°)
  Summary: 21 casts,  7 turns (33.3%)

Larva 6 cast orientations:
  cast  1: t=   3.0- 10.7s,  = 123.4°→ 128.6° (Δ=  +5.2°)
  cast  2: t=  11.9- 17.4s,  = 138.1°→ 139.0° (Δ=  +0.9°)
  TURN  3: t=  21.0- 43.4s,  = 133.9°→  -5.0° (Δ=-138.9°)
  cast  4: t=  46.2- 52.4s,  = -21.7°→ -15.8° (Δ=  +5.9°)
  TURN  5: t=  57.2- 65.9s,  = -13.7°→ -71.0° (Δ= -57.2°)
  cast  6: t=  68.3- 80.0s,  = -75.4°→ -63.5° (Δ= +11.9°)
  cast  7: t=  81.4- 85.1s,  = -63.1°→ -58.0° (Δ=  +5.1°)
  cast  8: t=  86.0- 92.0s,  = -61.0°→ -70.1° (Δ=  -9.1°)
  cast  9: t=  93.3-109.5s,  = -75.0°→ -66.3° (Δ=  +8.7°)
  cast 10: t= 110.3-112.2s,  = -67.4°→ -76.8° (Δ=  -9.4°)
  TURN 11: t= 114.8-129.5s,  = -79.0°→ -22.1° (Δ= +57.0°)
  cast 12: t= 140.2-163.3s,  =  -3.8°→ -26.4° (Δ= -22.6°)
  TURN 13: t= 165.3-181.7s,  = -24.6°→-143.8° (Δ=-119.2°)
  cast 14: t= 182.7-193.2s,  =-145.8°→-116.3° (Δ= +29.5°)
  cast 15: t= 195.5-199.9s,  =-105.4°→-104.6° (Δ=  +0.8°)
  cast 16: t= 200.8-208.4s,  =-113.7°→-144.7° (Δ= -31.0°)
  TURN 17: t= 210.0-225.0s,  =-145.0°→  81.4° (Δ=-133.6°)
  cast 18: t= 226.1-232.0s,  =  80.8°→  49.7° (Δ= -31.1°)
  cast 19: t= 254.7-264.8s,  =  67.4°→  65.5° (Δ=  -1.9°)
  cast 20: t= 265.3-272.7s,  =  65.6°→  59.3° (Δ=  -6.3°)
  cast 21: t= 273.6-286.0s,  =  60.2°→  48.1° (Δ= -12.1°)
  TURN 22: t= 292.7-309.2s,  =  20.7°→ -44.2° (Δ= -64.9°)
  cast 23: t= 313.8-327.6s,  = -51.9°→ -21.0° (Δ= +30.9°)
  cast 24: t= 328.7-357.2s,  = -15.0°→ -20.1° (Δ=  -5.1°)
  cast 25: t= 360.0-382.0s,  = -11.4°→ -22.7° (Δ= -11.3°)
  cast 26: t= 389.8-392.4s,  = -41.3°→ -49.7° (Δ=  -8.5°)
  Summary: 26 casts,  6 turns (23.1%)

Larva 9 cast orientations:
  cast  1: t=   7.2- 15.5s,  = -52.9°→ -63.0° (Δ= -10.1°)
  cast  2: t=  17.1- 21.0s,  = -70.5°→ -74.5° (Δ=  -4.0°)
  TURN  3: t=  22.5- 42.4s,  = -74.3°→  57.7° (Δ=+132.0°)
  cast  4: t=  43.6- 51.6s,  =  69.3°→  54.2° (Δ= -15.1°)
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  cast  5: t=  53.1- 59.5s,  =  46.6°→   3.3° (Δ= -43.4°)
  cast  6: t=  73.1- 77.8s,  = -22.0°→ -20.8° (Δ=  +1.2°)
  TURN  7: t=  80.2-109.0s,  = -18.4°→-151.8° (Δ=-133.4°)
  cast  8: t= 117.9-133.3s,  =-120.2°→-119.0° (Δ=  +1.2°)
  cast  9: t= 134.0-139.9s,  =-124.9°→-137.7° (Δ= -12.8°)
  TURN 10: t= 144.3-161.4s,  =-147.8°→ -34.3° (Δ=+113.5°)
  cast 11: t= 200.8-218.1s,  = -43.6°→ -50.9° (Δ=  -7.3°)
  cast 12: t= 220.0-226.1s,  = -51.4°→ -67.5° (Δ= -16.2°)
  cast 13: t= 226.9-243.5s,  = -69.0°→ -68.8° (Δ=  +0.2°)
  cast 14: t= 245.3-246.2s,  = -79.7°→ -76.0° (Δ=  +3.7°)
  cast 15: t= 252.5-260.5s,  = -84.0°→ -51.1° (Δ= +32.9°)
  TURN 16: t= 263.3-285.6s,  = -53.2°→   8.4° (Δ= +61.6°)
  cast 17: t= 291.9-298.6s,  = -10.8°→ -28.5° (Δ= -17.7°)
  cast 18: t= 334.6-348.8s,  = -51.8°→ -28.0° (Δ= +23.8°)
  cast 19: t= 360.4-366.2s,  =  -5.7°→ -29.5° (Δ= -23.8°)
  cast 20: t= 426.0-433.2s,  = -62.7°→ -36.9° (Δ= +25.8°)
  cast 21: t= 438.3-446.9s,  = -36.0°→ -70.4° (Δ= -34.4°)
  cast 22: t= 505.0-513.5s,  = -57.9°→ -97.0° (Δ= -39.2°)
  cast 23: t= 569.4-578.3s,  =-110.7°→-144.5° (Δ= -33.8°)
  cast 24: t= 583.4-591.1s,  =-145.8°→-103.2° (Δ= +42.6°)
  cast 25: t= 594.9-601.1s,  = -84.6°→-127.7° (Δ= -43.0°)
  Summary: 25 casts,  4 turns (16.0%)

Larva 21 cast orientations:
  cast  1: t=   6.1- 10.7s,  = -46.6°→ -20.5° (Δ= +26.1°)
  cast  2: t=  11.2- 14.6s,  = -26.7°→ -18.6° (Δ=  +8.1°)
  cast  3: t=  17.4- 23.1s,  = -28.1°→ -26.9° (Δ=  +1.2°)
  cast  4: t=  27.6- 29.9s,  = -33.3°→ -37.1° (Δ=  -3.8°)
  TURN  5: t=  31.3- 40.2s,  = -36.0°→ -83.5° (Δ= -47.5°)
  cast  6: t=  44.8- 57.4s,  = -96.3°→ -56.7° (Δ= +39.6°)
  cast  7: t=  64.2- 66.4s,  = -35.5°→ -33.9° (Δ=  +1.7°)
  cast  8: t=  68.2- 70.5s,  = -36.8°→ -35.5° (Δ=  +1.3°)
  cast  9: t=  77.1- 82.0s,  = -44.0°→ -44.7° (Δ=  -0.7°)
  TURN 10: t=  83.5- 95.8s,  = -55.5°→  26.5° (Δ= +82.0°)
  cast 11: t= 109.2-118.9s,  =  30.5°→  54.8° (Δ= +24.3°)
  cast 12: t= 126.7-128.8s,  =  80.8°→  79.9° (Δ=  -0.9°)
  cast 13: t= 130.5-144.7s,  =  73.3°→  85.0° (Δ= +11.7°)
  cast 14: t= 145.9-151.8s,  =  81.9°→  41.4° (Δ= -40.4°)
  cast 15: t= 155.8-161.0s,  =  23.3°→  -8.0° (Δ= -31.3°)
  cast 16: t= 171.9-179.5s,  = -33.3°→   6.5° (Δ= +39.8°)
  cast 17: t= 183.3-188.5s,  =  24.3°→  41.8° (Δ= +17.6°)
  cast 18: t= 198.2-204.1s,  =  57.8°→  21.1° (Δ= -36.7°)
  cast 19: t= 213.1-215.8s,  =   1.1°→  -5.9° (Δ=  -7.0°)
  TURN 20: t= 218.6-226.5s,  = -14.4°→  46.3° (Δ= +60.7°)
  cast 21: t= 230.1-234.4s,  =  63.4°→  52.2° (Δ= -11.2°)
  TURN 22: t= 242.7-250.0s,  =  34.4°→ -18.8° (Δ= -53.2°)
  TURN 23: t= 258.1-264.0s,  = -42.0°→-104.9° (Δ= -62.9°)
  cast 24: t= 267.6-282.6s,  =-111.9°→-151.3° (Δ= -39.4°)
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  TURN 25: t= 288.1-295.4s,  =-138.6°→ -76.4° (Δ= +62.2°)
  cast 26: t= 302.7-304.7s,  = -60.3°→ -64.7° (Δ=  -4.4°)
  cast 27: t= 308.2-315.9s,  = -72.1°→-100.0° (Δ= -27.9°)
  cast 28: t= 316.8-318.6s,  =-100.0°→-108.4° (Δ=  -8.4°)
  cast 29: t= 319.6-329.1s,  =-105.5°→-132.0° (Δ= -26.5°)
  TURN 30: t= 330.9-346.2s,  =-133.6°→ -29.4° (Δ=+104.1°)
  Summary: 30 casts,  7 turns (23.3%)

Larva 23 cast orientations:
  cast  1: t=   5.8-  6.4s,  =-163.0°→-164.1° (Δ=  -1.1°)
  cast  2: t=   8.7- 14.1s,  =-142.2°→-138.2° (Δ=  +4.0°)
  cast  3: t=  17.4- 20.3s,  =-154.7°→-163.5° (Δ=  -8.8°)
  cast  4: t=  24.9- 28.5s,  =-160.3°→-143.1° (Δ= +17.2°)
  cast  5: t=  33.1- 35.3s,  =-142.8°→-124.7° (Δ= +18.0°)
  cast  6: t=  36.8- 43.8s,  =-148.4°→-161.2° (Δ= -12.8°)
  cast  7: t=  48.6- 68.2s,  =-135.4°→-131.1° (Δ=  +4.3°)
  cast  8: t=  69.0- 79.2s,  =-143.2°→-120.2° (Δ= +23.0°)
  TURN  9: t=  81.6- 84.9s,  =-120.0°→-169.1° (Δ= -49.1°)
  cast 10: t=  85.5- 89.1s,  =-178.0°→-176.6° (Δ=  +1.4°)
  TURN 11: t=  89.9- 96.5s,  =-169.7°→  -2.9° (Δ=+166.7°)
  cast 12: t=  98.2-112.2s,  =  17.2°→  22.6° (Δ=  +5.5°)
  cast 13: t= 126.6-127.7s,  =  21.8°→  21.6° (Δ=  -0.2°)
  cast 14: t= 130.7-137.3s,  =  15.3°→  16.1° (Δ=  +0.8°)
  cast 15: t= 142.5-158.2s,  =  15.1°→  19.1° (Δ=  +4.0°)
  cast 16: t= 159.1-164.1s,  =  18.9°→   7.9° (Δ= -11.0°)
  cast 17: t= 229.7-233.3s,  =   9.5°→   8.8° (Δ=  -0.7°)
  cast 18: t= 236.4-239.1s,  =  12.1°→  14.1° (Δ=  +2.0°)
  cast 19: t= 242.3-244.9s,  =  12.0°→  10.5° (Δ=  -1.5°)
  cast 20: t= 251.8-256.0s,  =   5.9°→   2.3° (Δ=  -3.5°)
  cast 21: t= 260.2-265.9s,  =  16.5°→  11.6° (Δ=  -4.9°)
  cast 22: t= 283.0-288.4s,  =   8.3°→  -1.2° (Δ=  -9.5°)
  cast 23: t= 292.8-294.0s,  =   5.2°→  -0.4° (Δ=  -5.6°)
  cast 24: t= 316.1-337.6s,  =   5.1°→  15.5° (Δ= +10.4°)
  cast 25: t= 350.0-352.8s,  =  18.8°→  19.2° (Δ=  +0.4°)
  cast 26: t= 354.4-369.6s,  =  25.7°→  23.5° (Δ=  -2.2°)
  cast 27: t= 369.9-372.2s,  =  23.7°→  19.1° (Δ=  -4.7°)
  cast 28: t= 378.3-383.8s,  =  15.8°→  27.8° (Δ= +11.9°)
  cast 29: t= 387.2-390.6s,  =  23.0°→  20.9° (Δ=  -2.1°)
  cast 30: t= 398.5-406.0s,  =  16.3°→  13.8° (Δ=  -2.5°)
  cast 31: t= 411.0-413.0s,  =  10.0°→   5.5° (Δ=  -4.4°)
  cast 32: t= 413.4-415.1s,  =  11.1°→  12.2° (Δ=  +1.0°)
  cast 33: t= 417.9-418.1s,  =  12.8°→  13.5° (Δ=  +0.7°)
  cast 34: t= 422.8-424.2s,  =  15.4°→  17.7° (Δ=  +2.2°)
  cast 35: t= 432.8-459.8s,  =   9.3°→ -16.2° (Δ= -25.5°)
  cast 36: t= 463.4-485.3s,  = -27.7°→ -31.0° (Δ=  -3.3°)
  cast 37: t= 505.2-507.3s,  = -33.3°→ -30.8° (Δ=  +2.5°)
  cast 38: t= 528.6-528.7s,  = -37.0°→ -34.1° (Δ=  +2.9°)
  cast 39: t= 531.3-535.0s,  = -34.8°→ -34.7° (Δ=  +0.1°)
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  cast 40: t= 535.6-536.0s,  = -30.0°→ -34.9° (Δ=  -4.9°)
  cast 41: t= 537.7-540.1s,  = -37.0°→ -35.5° (Δ=  +1.5°)
  cast 42: t= 543.6-544.0s,  = -42.2°→ -37.1° (Δ=  +5.1°)
  cast 43: t= 547.0-547.6s,  = -43.4°→ -40.3° (Δ=  +3.1°)
  cast 44: t= 548.2-548.3s,  = -40.5°→ -43.1° (Δ=  -2.6°)
  cast 45: t= 549.0-549.2s,  = -43.5°→ -50.3° (Δ=  -6.7°)
  cast 46: t= 550.1-550.8s,  = -44.2°→ -48.4° (Δ=  -4.1°)
  cast 47: t= 553.4-555.3s,  = -49.1°→ -46.2° (Δ=  +2.9°)
  cast 48: t= 557.2-558.6s,  = -45.8°→ -49.9° (Δ=  -4.1°)
  cast 49: t= 562.1-564.0s,  = -57.5°→ -53.0° (Δ=  +4.5°)
  cast 50: t= 568.5-571.4s,  = -48.8°→ -49.1° (Δ=  -0.3°)
  cast 51: t= 577.6-580.5s,  = -53.5°→ -56.3° (Δ=  -2.8°)
  cast 52: t= 584.0-584.3s,  = -54.7°→ -54.7° (Δ=  -0.1°)
  cast 53: t= 585.7-590.4s,  = -54.7°→ -41.3° (Δ= +13.4°)
  cast 54: t= 593.2-593.5s,  = -42.5°→ -42.9° (Δ=  -0.3°)
  cast 55: t= 594.3-594.7s,  = -45.2°→ -44.7° (Δ=  +0.6°)
  cast 56: t= 595.4-596.7s,  = -40.4°→ -34.8° (Δ=  +5.6°)
  cast 57: t= 599.9-600.4s,  = -34.5°→ -34.8° (Δ=  -0.3°)
  Summary: 57 casts,  2 turns ( 3.5%)

Larva 25 cast orientations:
  cast  1: t=   2.8-  4.5s,  = -85.9°→ -82.6° (Δ=  +3.3°)
  cast  2: t=   9.8- 14.9s,  = -78.6°→ -36.8° (Δ= +41.8°)
  cast  3: t=  21.6- 29.1s,  =  -8.7°→ -15.8° (Δ=  -7.1°)
  cast  4: t=  30.7- 35.4s,  = -21.4°→  -4.7° (Δ= +16.7°)
  cast  5: t=  36.4- 41.3s,  =  -2.0°→  -5.2° (Δ=  -3.2°)
  cast  6: t=  42.2- 47.4s,  = -13.0°→  -1.0° (Δ= +12.1°)
  cast  7: t=  49.3- 54.2s,  =   1.1°→  -4.2° (Δ=  -5.3°)
  TURN  8: t=  55.3- 72.2s,  = -11.4°→  72.6° (Δ= +84.0°)
  cast  9: t=  92.9- 93.9s,  = 105.8°→ 103.4° (Δ=  -2.3°)
  TURN 10: t=  94.4-102.2s,  = 105.6°→  59.5° (Δ= -46.1°)
  cast 11: t= 113.5-116.6s,  =  45.4°→  35.0° (Δ= -10.4°)
  cast 12: t= 120.4-124.0s,  =  29.0°→  11.1° (Δ= -17.9°)
  TURN 13: t= 138.7-155.9s,  =  -6.0°→ -76.0° (Δ= -70.0°)
  cast 14: t= 161.0-165.5s,  = -96.8°→ -85.8° (Δ= +11.0°)
  cast 15: t= 171.9-176.2s,  = -69.3°→ -45.1° (Δ= +24.2°)
  cast 16: t= 188.7-193.1s,  = -53.5°→ -47.2° (Δ=  +6.3°)
  cast 17: t= 202.2-210.7s,  = -60.2°→ -94.6° (Δ= -34.3°)
  TURN 18: t= 213.5-220.4s,  =-108.7°→ -61.1° (Δ= +47.6°)
  cast 19: t= 244.7-251.4s,  = -39.7°→ -28.2° (Δ= +11.5°)
  cast 20: t= 334.6-342.0s,  = -83.7°→-102.9° (Δ= -19.2°)
  cast 21: t= 349.9-351.2s,  =-113.2°→-111.2° (Δ=  +2.0°)
  Summary: 21 casts,  4 turns (19.0%)

Larva 26 cast orientations:
  cast  1: t=   2.6-  6.2s,  =-161.3°→-162.8° (Δ=  -1.5°)
  cast  2: t=   6.8- 30.7s,  =-163.5°→-150.0° (Δ= +13.5°)
  cast  3: t=  32.3- 35.1s,  =-157.2°→-154.8° (Δ=  +2.3°)
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  cast  4: t=  36.3- 38.2s,  =-155.5°→-160.1° (Δ=  -4.5°)
  cast  5: t=  40.0- 43.2s,  =-168.8°→-169.9° (Δ=  -1.1°)
  cast  6: t=  43.8- 46.6s,  =-163.4°→-169.9° (Δ=  -6.5°)
  cast  7: t=  51.8- 56.1s,  =-169.0°→-168.8° (Δ=  +0.2°)
  TURN  8: t=  57.2- 83.9s,  =-172.7°→  -7.7° (Δ=+165.0°)
  cast  9: t=  98.1-101.4s,  = -13.8°→ -14.1° (Δ=  -0.2°)
  cast 10: t= 111.1-122.4s,  = -24.8°→  11.3° (Δ= +36.1°)
  TURN 11: t= 138.1-166.3s,  =   3.5°→  79.9° (Δ= +76.4°)
  cast 12: t= 175.0-182.9s,  =  55.1°→  15.1° (Δ= -40.0°)
  cast 13: t= 184.0-192.2s,  =   3.7°→ -39.7° (Δ= -43.4°)
  cast 14: t= 192.8-198.0s,  = -41.4°→ -25.9° (Δ= +15.5°)
  cast 15: t= 199.3-203.6s,  = -19.7°→   6.9° (Δ= +26.6°)
  cast 16: t= 206.3-249.3s,  =  11.8°→ -14.2° (Δ= -26.1°)
  TURN 17: t= 251.6-258.2s,  = -11.1°→  37.0° (Δ= +48.1°)
  cast 18: t= 261.1-273.1s,  =  45.8°→  25.4° (Δ= -20.4°)
  cast 19: t= 285.6-289.6s,  =  -2.2°→  -8.2° (Δ=  -6.0°)
  cast 20: t= 292.1-298.6s,  =  -2.8°→  33.6° (Δ= +36.3°)
  cast 21: t= 303.0-308.4s,  =  43.4°→  34.7° (Δ=  -8.7°)
  TURN 22: t= 313.0-326.1s,  =  26.3°→  90.3° (Δ= +64.0°)
  TURN 23: t= 328.2-355.7s,  =  98.2°→ -55.3° (Δ=-153.5°)
  TURN 24: t= 356.9-368.8s,  = -67.6°→  -7.9° (Δ= +59.6°)
  cast 25: t= 374.0-380.2s,  =   8.2°→ -24.3° (Δ= -32.5°)
  cast 26: t= 385.8-397.4s,  = -36.8°→   0.3° (Δ= +37.2°)
  cast 27: t= 403.3-408.3s,  =  17.9°→  -1.4° (Δ= -19.3°)
  cast 28: t= 439.4-445.5s,  = -41.5°→ -14.3° (Δ= +27.2°)
  cast 29: t= 467.3-471.3s,  =  33.4°→  40.1° (Δ=  +6.7°)
  cast 30: t= 479.1-486.4s,  =  51.9°→  26.9° (Δ= -25.0°)
  TURN 31: t= 511.4-523.9s,  =  17.7°→ -59.8° (Δ= -77.5°)
  cast 32: t= 538.1-544.5s,  = -97.3°→ -84.9° (Δ= +12.4°)
  TURN 33: t= 553.3-560.9s,  = -53.1°→   1.0° (Δ= +54.1°)
  TURN 34: t= 567.8-577.8s,  =  10.8°→  62.6° (Δ= +51.8°)
  TURN 35: t= 585.4-594.3s,  =  85.4°→  39.9° (Δ= -45.5°)
  cast 36: t= 596.4-601.1s,  =  40.8°→  49.3° (Δ=  +8.5°)
  Summary: 36 casts, 10 turns (27.8%)

Larva 29 cast orientations:
  cast  1: t=   7.8- 16.0s,  = 179.8°→ 171.4° (Δ=  -8.3°)
  cast  2: t=  61.0- 71.1s,  = 129.8°→ 149.9° (Δ= +20.1°)
  cast  3: t=  84.1- 92.7s,  = 156.8°→-176.1° (Δ= +27.1°)
  cast  4: t= 115.2-123.8s,  =-154.2°→-120.7° (Δ= +33.4°)
  cast  5: t= 132.8-149.1s,  =-101.0°→-143.2° (Δ= -42.2°)
  cast  6: t= 156.4-158.2s,  =-154.2°→-150.8° (Δ=  +3.4°)
  cast  7: t= 160.6-163.5s,  =-145.9°→-150.0° (Δ=  -4.1°)
  TURN  8: t= 163.9-188.4s,  =-149.7°→ 135.4° (Δ= -74.9°)
  TURN  9: t= 199.4-224.8s,  = 112.1°→  27.5° (Δ= -84.7°)
  cast 10: t= 234.5-258.8s,  =  18.6°→  45.4° (Δ= +26.7°)
  cast 11: t= 260.0-267.3s,  =  52.4°→  50.4° (Δ=  -2.0°)
  cast 12: t= 269.8-291.4s,  =  54.1°→  66.9° (Δ= +12.9°)
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  TURN 13: t= 296.0-329.1s,  =  68.8°→ -28.0° (Δ= -96.7°)
  cast 14: t= 347.4-356.3s,  = -52.5°→ -37.5° (Δ= +15.0°)
  TURN 15: t= 365.0-400.2s,  = -34.8°→  78.8° (Δ=+113.5°)
  cast 16: t= 425.4-433.2s,  =  86.0°→ 104.2° (Δ= +18.2°)
  cast 17: t= 483.0-485.4s,  = 113.9°→ 117.8° (Δ=  +3.9°)
  cast 18: t= 487.0-498.0s,  = 122.8°→ 106.9° (Δ= -15.9°)
  cast 19: t= 500.4-502.7s,  = 108.7°→ 102.1° (Δ=  -6.6°)
  cast 20: t= 505.9-509.9s,  =  99.6°→  82.7° (Δ= -16.8°)
  cast 21: t= 531.3-536.5s,  =  53.8°→  46.1° (Δ=  -7.7°)
  cast 22: t= 542.2-545.3s,  =  43.4°→  19.8° (Δ= -23.6°)
  cast 23: t= 565.0-568.4s,  =   7.4°→   9.0° (Δ=  +1.7°)
  cast 24: t= 581.4-587.5s,  =  21.9°→  32.0° (Δ= +10.1°)
  cast 25: t= 589.9-595.5s,  =  39.8°→  61.3° (Δ= +21.5°)
  Summary: 25 casts,  4 turns (16.0%)

Larva 30 cast orientations:
  cast  1: t=   6.8-  8.4s,  = 147.5°→ 148.2° (Δ=  +0.7°)
  cast  2: t=   8.6- 13.7s,  = 148.4°→ 151.4° (Δ=  +3.0°)
  cast  3: t=  19.0- 19.6s,  = 150.4°→ 149.9° (Δ=  -0.5°)
  cast  4: t=  23.5- 32.3s,  = 151.6°→-172.6° (Δ= +35.8°)
  TURN  5: t=  36.0- 54.4s,  =-173.5°→ -82.7° (Δ= +90.8°)
  cast  6: t=  79.8- 86.1s,  = -87.5°→ -80.2° (Δ=  +7.3°)
  cast  7: t=  88.7- 97.7s,  = -74.4°→ -36.4° (Δ= +38.0°)
  TURN  8: t= 115.0-127.0s,  = -32.8°→  18.1° (Δ= +50.9°)
  cast  9: t= 131.3-134.7s,  =  21.8°→  19.7° (Δ=  -2.1°)
  cast 10: t= 164.8-174.2s,  =  -7.0°→  34.7° (Δ= +41.8°)
  cast 11: t= 183.4-188.2s,  =  41.8°→  45.7° (Δ=  +3.8°)
  cast 12: t= 189.2-191.8s,  =  45.7°→  38.9° (Δ=  -6.7°)
  cast 13: t= 211.0-212.3s,  =  -7.8°→  -9.2° (Δ=  -1.3°)
  cast 14: t= 231.7-236.0s,  =  -1.0°→  -4.3° (Δ=  -3.3°)
  cast 15: t= 236.6-242.9s,  =  -3.5°→  18.3° (Δ= +21.7°)
  cast 16: t= 270.9-277.1s,  =  18.8°→  20.1° (Δ=  +1.3°)
  TURN 17: t= 285.3-320.1s,  =  10.6°→ 101.8° (Δ= +91.1°)
  cast 18: t= 364.0-375.6s,  =  29.3°→  46.6° (Δ= +17.3°)
  cast 19: t= 377.6-387.7s,  =  48.9°→  69.2° (Δ= +20.2°)
  TURN 20: t= 388.7-405.9s,  =  65.5°→   7.0° (Δ= -58.5°)
  cast 21: t= 421.8-425.6s,  = -20.7°→ -15.1° (Δ=  +5.6°)
  cast 22: t= 428.4-433.2s,  = -10.3°→  -0.3° (Δ= +10.0°)
  TURN 23: t= 434.5-465.0s,  =  -0.9°→ -65.6° (Δ= -64.7°)
  cast 24: t= 475.0-486.5s,  = -88.3°→ -69.0° (Δ= +19.4°)
  cast 25: t= 508.4-519.1s,  = -61.5°→ -25.2° (Δ= +36.3°)
  cast 26: t= 578.6-587.3s,  = -26.5°→   6.9° (Δ= +33.4°)
  Summary: 26 casts,  5 turns (19.2%)

Larva 65 cast orientations:
  cast  1: t=  14.4- 17.4s,  =  35.1°→  40.7° (Δ=  +5.6°)
  cast  2: t=  18.7- 25.0s,  =  60.9°→  54.2° (Δ=  -6.7°)
  cast  3: t=  29.8- 33.5s,  =  85.3°→  79.3° (Δ=  -6.0°)
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  cast  4: t=  39.4- 41.2s,  = 115.0°→ 116.0° (Δ=  +1.0°)
  cast  5: t=  42.7- 46.5s,  = 120.9°→ 126.6° (Δ=  +5.7°)
  cast  6: t= 207.6-211.2s,  =-171.8°→-138.0° (Δ= +33.8°)
  cast  7: t= 279.4-280.0s,  =-140.2°→-141.6° (Δ=  -1.4°)
  cast  8: t= 297.3-298.5s,  =-149.1°→-139.2° (Δ=  +9.9°)
  cast  9: t= 301.9-303.0s,  =-148.7°→-153.8° (Δ=  -5.2°)
  TURN 10: t= 308.7-343.5s,  =-151.1°→ -59.9° (Δ= +91.1°)
  TURN 11: t= 348.7-365.4s,  = -48.4°→  78.9° (Δ=+127.3°)
  cast 12: t= 366.0-369.9s,  =  81.3°→  94.2° (Δ= +13.0°)
  TURN 13: t= 372.8-389.1s,  = 102.0°→  25.4° (Δ= -76.5°)
  cast 14: t= 394.3-399.2s,  =  17.5°→  28.4° (Δ= +10.9°)
  cast 15: t= 404.1-412.7s,  =  34.0°→  57.8° (Δ= +23.9°)
  TURN 16: t= 414.9-441.1s,  =  66.9°→ -48.8° (Δ=-115.7°)
  TURN 17: t= 442.2-460.1s,  = -38.6°→ -85.1° (Δ= -46.5°)
  TURN 18: t= 464.4-475.4s,  = -93.3°→ -13.8° (Δ= +79.5°)
  TURN 19: t= 483.2-495.6s,  =   8.3°→ 101.8° (Δ= +93.5°)
  cast 20: t= 499.6-501.4s,  = 111.7°→ 110.0° (Δ=  -1.7°)
  TURN 21: t= 502.0-528.2s,  = 109.6°→   1.3° (Δ=-108.4°)
  cast 22: t= 535.0-544.2s,  =  -8.7°→  31.4° (Δ= +40.1°)
  TURN 23: t= 550.2-558.9s,  =  50.5°→  -5.6° (Δ= -56.1°)
  cast 24: t= 560.7-569.1s,  =  -3.5°→  22.2° (Δ= +25.7°)
  TURN 25: t= 585.1-601.1s,  =  45.4°→ 125.0° (Δ= +79.6°)
  Summary: 25 casts, 10 turns (40.0%)

Larva 166 cast orientations:
  cast  1: t=  60.0- 68.3s,  =  26.6°→  28.8° (Δ=  +2.2°)
  cast  2: t=  70.1- 84.5s,  =  46.2°→   3.0° (Δ= -43.2°)
  cast  3: t=  93.3-102.4s,  =  -3.0°→  17.3° (Δ= +20.4°)
  cast  4: t= 113.4-114.7s,  =  29.2°→  26.6° (Δ=  -2.6°)
  cast  5: t= 124.9-129.6s,  =  26.1°→  20.3° (Δ=  -5.8°)
  cast  6: t= 135.4-136.8s,  =  12.6°→  10.7° (Δ=  -1.9°)
  cast  7: t= 145.4-146.3s,  =  11.7°→   9.1° (Δ=  -2.6°)
  cast  8: t= 175.0-197.8s,  =  10.9°→  50.9° (Δ= +40.0°)
  cast  9: t= 218.8-221.1s,  =  75.8°→  75.8° (Δ=  -0.0°)
  cast 10: t= 238.0-245.4s,  =  67.4°→  52.2° (Δ= -15.2°)
  cast 11: t= 258.7-269.2s,  =  36.5°→  14.7° (Δ= -21.8°)
  cast 12: t= 270.9-277.2s,  =  11.3°→  -0.0° (Δ= -11.3°)
  cast 13: t= 298.7-301.0s,  = -15.7°→ -15.5° (Δ=  +0.1°)
  cast 14: t= 316.8-326.3s,  = -17.4°→ -32.7° (Δ= -15.3°)
  cast 15: t= 376.1-388.5s,  = -42.4°→ -36.4° (Δ=  +6.0°)
  TURN 16: t= 412.8-429.6s,  = -36.6°→  29.5° (Δ= +66.0°)
  cast 17: t= 433.1-436.5s,  =  28.5°→  24.0° (Δ=  -4.5°)
  cast 18: t= 490.7-498.6s,  =  31.1°→  25.5° (Δ=  -5.7°)
  cast 19: t= 505.4-514.2s,  =  13.6°→  -1.4° (Δ= -15.0°)
  cast 20: t= 519.1-532.5s,  =  -2.9°→ -22.4° (Δ= -19.4°)
  cast 21: t= 545.3-548.8s,  = -26.5°→ -21.0° (Δ=  +5.5°)
  cast 22: t= 551.1-555.0s,  = -27.7°→ -19.3° (Δ=  +8.4°)
  cast 23: t= 557.3-558.6s,  = -15.2°→ -11.6° (Δ=  +3.6°)
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  cast 24: t= 563.4-564.7s,  =  -8.8°→  -7.8° (Δ=  +1.0°)
  cast 25: t= 567.4-568.2s,  =  -4.9°→   1.5° (Δ=  +6.4°)
  cast 26: t= 600.5-600.7s,  =  23.5°→  23.6° (Δ=  +0.1°)
  Summary: 26 casts,  1 turns ( 3.8%)

Larva 184 cast orientations:
  cast  1: t=  77.7- 80.3s,  = -31.9°→   3.4° (Δ= +35.3°)
  cast  2: t=  84.4- 90.1s,  = -13.4°→ -20.8° (Δ=  -7.4°)
  cast  3: t= 106.0-108.5s,  = -30.4°→ -34.2° (Δ=  -3.8°)
  cast  4: t= 131.7-134.2s,  = -34.1°→ -39.8° (Δ=  -5.7°)
  cast  5: t= 136.5-146.6s,  = -34.9°→ -46.1° (Δ= -11.2°)
  cast  6: t= 147.5-149.9s,  = -49.7°→ -50.5° (Δ=  -0.8°)
  cast  7: t= 150.4-151.5s,  = -47.4°→ -47.0° (Δ=  +0.4°)
  TURN  8: t= 153.6-174.0s,  = -58.7°→  38.3° (Δ= +97.0°)
  cast  9: t= 176.4-177.7s,  =  42.7°→  45.7° (Δ=  +3.0°)
  cast 10: t= 180.4-183.4s,  =  42.7°→  39.0° (Δ=  -3.8°)
  cast 11: t= 183.9-192.4s,  =  44.4°→  56.8° (Δ= +12.4°)
  cast 12: t= 221.4-226.8s,  =  68.9°→  76.5° (Δ=  +7.7°)
  cast 13: t= 233.9-239.3s,  =  75.9°→  77.8° (Δ=  +1.9°)
  cast 14: t= 250.9-258.7s,  =  64.4°→  44.8° (Δ= -19.6°)
  cast 15: t= 271.1-279.1s,  =  33.7°→   1.7° (Δ= -32.0°)
  cast 16: t= 331.5-332.8s,  = -15.6°→ -17.7° (Δ=  -2.1°)
  cast 17: t= 370.7-371.8s,  = -29.0°→ -37.2° (Δ=  -8.2°)
  cast 18: t= 394.3-402.3s,  = -43.4°→ -72.0° (Δ= -28.6°)
  cast 19: t= 430.3-435.9s,  = -87.3°→ -61.2° (Δ= +26.1°)
  cast 20: t= 535.4-547.6s,  =-126.2°→-100.2° (Δ= +26.0°)
  cast 21: t= 565.0-566.6s,  =-108.4°→-116.8° (Δ=  -8.4°)
  cast 22: t= 573.9-576.1s,  =-133.6°→-142.4° (Δ=  -8.9°)
  cast 23: t= 583.0-590.6s,  =-159.7°→-128.7° (Δ= +31.0°)
  cast 24: t= 593.7-601.1s,  =-119.9°→-114.2° (Δ=  +5.7°)
  Summary: 24 casts,  1 turns ( 4.2%)

Larva 195 cast orientations:
  cast  1: t=  88.2- 89.0s,  = -14.0°→  -9.6° (Δ=  +4.4°)
  TURN  2: t=  94.4-107.5s,  =  -4.5°→ -49.5° (Δ= -45.0°)
  cast  3: t= 118.9-122.4s,  = -59.8°→ -64.8° (Δ=  -5.0°)
  cast  4: t= 123.5-126.4s,  = -60.5°→ -56.3° (Δ=  +4.1°)
  cast  5: t= 128.1-133.9s,  = -47.5°→ -52.2° (Δ=  -4.7°)
  cast  6: t= 138.9-149.4s,  = -46.0°→ -32.3° (Δ= +13.7°)
  cast  7: t= 150.1-154.9s,  = -30.4°→ -41.7° (Δ= -11.3°)
  cast  8: t= 155.5-158.5s,  = -32.6°→ -34.9° (Δ=  -2.3°)
  cast  9: t= 159.7-161.1s,  = -33.1°→ -29.3° (Δ=  +3.8°)
  cast 10: t= 163.5-166.0s,  = -29.4°→ -34.6° (Δ=  -5.3°)
  cast 11: t= 168.5-175.3s,  = -25.2°→ -17.0° (Δ=  +8.2°)
  cast 12: t= 176.8-178.5s,  = -15.6°→ -15.3° (Δ=  +0.3°)
  cast 13: t= 180.8-186.1s,  = -12.8°→ -17.9° (Δ=  -5.1°)
  cast 14: t= 192.9-193.1s,  =  -9.3°→  -8.6° (Δ=  +0.6°)
  cast 15: t= 195.6-197.4s,  =  -6.7°→  -7.4° (Δ=  -0.8°)
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  cast 16: t= 199.5-211.7s,  =  -3.4°→  -1.3° (Δ=  +2.1°)
  cast 17: t= 214.9-218.5s,  =  -6.4°→   8.9° (Δ= +15.3°)
  cast 18: t= 219.3-227.7s,  =   6.4°→   5.6° (Δ=  -0.8°)
  cast 19: t= 247.6-248.9s,  =  16.7°→  18.5° (Δ=  +1.8°)
  cast 20: t= 252.0-258.1s,  =  22.8°→  20.1° (Δ=  -2.7°)
  cast 21: t= 260.6-263.2s,  =  20.9°→  22.7° (Δ=  +1.8°)
  cast 22: t= 267.8-268.4s,  =  15.4°→  15.0° (Δ=  -0.5°)
  cast 23: t= 291.9-297.8s,  =  25.5°→  31.1° (Δ=  +5.6°)
  cast 24: t= 305.0-307.3s,  =  35.9°→  42.2° (Δ=  +6.3°)
  cast 25: t= 308.2-326.7s,  =  42.4°→  46.3° (Δ=  +4.0°)
  cast 26: t= 328.4-330.3s,  =  48.7°→  44.1° (Δ=  -4.6°)
  cast 27: t= 332.6-333.7s,  =  51.8°→  55.7° (Δ=  +4.0°)
  cast 28: t= 338.2-338.7s,  =  52.0°→  51.9° (Δ=  -0.1°)
  cast 29: t= 345.6-348.7s,  =  46.0°→  44.7° (Δ=  -1.3°)
  cast 30: t= 351.0-353.6s,  =  49.1°→  52.8° (Δ=  +3.7°)
  cast 31: t= 365.7-366.8s,  =  63.2°→  63.9° (Δ=  +0.7°)
  cast 32: t= 372.9-385.2s,  =  75.9°→  62.6° (Δ= -13.2°)
  cast 33: t= 389.9-392.7s,  =  62.5°→  62.7° (Δ=  +0.2°)
  cast 34: t= 396.6-405.0s,  =  62.8°→  56.6° (Δ=  -6.2°)
  cast 35: t= 407.4-409.0s,  =  56.4°→  68.8° (Δ= +12.4°)
  cast 36: t= 413.8-416.7s,  =  75.9°→  76.5° (Δ=  +0.6°)
  cast 37: t= 419.7-421.6s,  =  81.5°→  87.4° (Δ=  +5.9°)
  cast 38: t= 429.2-432.3s,  =  95.2°→  93.7° (Δ=  -1.6°)
  cast 39: t= 446.8-450.8s,  =  96.2°→  95.0° (Δ=  -1.2°)
  cast 40: t= 453.6-454.7s,  = 103.0°→ 107.8° (Δ=  +4.7°)
  cast 41: t= 491.7-494.9s,  = 114.5°→ 110.4° (Δ=  -4.1°)
  cast 42: t= 511.7-514.3s,  = 103.8°→ 103.3° (Δ=  -0.5°)
  cast 43: t= 517.3-518.8s,  = 102.1°→ 105.7° (Δ=  +3.7°)
  TURN 44: t= 520.9-550.3s,  = 118.8°→  29.8° (Δ= -89.0°)
  cast 45: t= 553.0-557.6s,  =  22.9°→ -11.8° (Δ= -34.7°)
  cast 46: t= 558.0-560.5s,  = -10.4°→ -21.4° (Δ= -11.0°)
  cast 47: t= 569.7-575.4s,  = -48.1°→ -48.3° (Δ=  -0.2°)
  cast 48: t= 592.9-601.1s,  = -48.2°→ -42.8° (Δ=  +5.4°)
  Summary: 48 casts,  2 turns ( 4.2%)

Larva 237 cast orientations:
  cast  1: t= 197.1-198.7s,  =  32.0°→  47.9° (Δ= +15.9°)
  cast  2: t= 201.6-202.9s,  =  67.2°→  68.4° (Δ=  +1.2°)
  TURN  3: t= 204.0-214.4s,  =  68.4°→  19.7° (Δ= -48.7°)
  cast  4: t= 216.0-220.5s,  =  15.6°→  22.7° (Δ=  +7.1°)
  cast  5: t= 227.7-235.0s,  =  25.3°→   1.5° (Δ= -23.8°)
  cast  6: t= 235.8-250.7s,  =  -3.2°→  15.5° (Δ= +18.7°)
  cast  7: t= 253.6-264.7s,  =  35.5°→  66.2° (Δ= +30.7°)
  TURN  8: t= 266.2-278.4s,  =  82.0°→ -47.0° (Δ=-128.9°)
  TURN  9: t= 279.8-337.7s,  = -74.7°→-129.9° (Δ= -55.2°)
  TURN 10: t= 341.8-355.9s,  =-145.6°→  85.6° (Δ=-128.8°)
  cast 11: t= 357.2-363.1s,  =  80.0°→  66.1° (Δ= -13.9°)
  cast 12: t= 363.3-367.2s,  =  67.7°→  50.5° (Δ= -17.3°)
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  TURN 13: t= 383.3-402.0s,  =   8.3°→ -49.9° (Δ= -58.2°)
  TURN 14: t= 411.3-428.0s,  = -70.0°→-139.8° (Δ= -69.8°)
  TURN 15: t= 430.3-438.6s,  =-157.8°→  98.6° (Δ=-103.5°)
  cast 16: t= 453.2-454.9s,  =  64.9°→  65.3° (Δ=  +0.4°)
  cast 17: t= 455.2-458.5s,  =  64.8°→  57.2° (Δ=  -7.5°)
  cast 18: t= 460.8-473.9s,  =  56.6°→  18.7° (Δ= -37.8°)
  cast 19: t= 490.1-501.2s,  = -14.6°→ -26.0° (Δ= -11.4°)
  cast 20: t= 501.8-505.9s,  = -21.7°→ -10.8° (Δ= +10.9°)
  cast 21: t= 526.3-534.7s,  = -11.3°→   6.6° (Δ= +17.8°)
  cast 22: t= 548.7-554.2s,  =  17.0°→  21.7° (Δ=  +4.7°)
  cast 23: t= 574.1-577.4s,  =  22.6°→  21.6° (Δ=  -1.0°)
  cast 24: t= 580.6-592.3s,  =  21.8°→ -23.0° (Δ= -44.8°)
  Summary: 24 casts,  7 turns (29.2%)

Larva 249 cast orientations:
  cast  1: t= 212.5-215.4s,  = -83.2°→ -42.1° (Δ= +41.1°)
  TURN  2: t= 219.3-229.0s,  = -35.3°→  18.7° (Δ= +54.0°)
  cast  3: t= 236.4-247.9s,  =  11.9°→   2.9° (Δ=  -9.1°)
  cast  4: t= 256.8-273.6s,  = -21.3°→ -20.3° (Δ=  +1.0°)
  cast  5: t= 278.5-286.2s,  = -20.8°→  10.7° (Δ= +31.4°)
  cast  6: t= 293.5-294.4s,  =  33.7°→  40.6° (Δ=  +6.9°)
  cast  7: t= 301.4-309.5s,  =  33.1°→  70.2° (Δ= +37.1°)
  cast  8: t= 315.6-321.8s,  =  80.4°→  60.0° (Δ= -20.4°)
  cast  9: t= 323.4-328.8s,  =  49.1°→  27.5° (Δ= -21.7°)
  cast 10: t= 336.1-341.3s,  =   2.6°→  25.6° (Δ= +23.0°)
  cast 11: t= 365.9-369.1s,  =  36.7°→  21.3° (Δ= -15.4°)
  cast 12: t= 386.5-391.1s,  =  -9.4°→ -12.1° (Δ=  -2.7°)
  cast 13: t= 406.1-413.1s,  = -46.9°→ -33.5° (Δ= +13.5°)
  cast 14: t= 427.9-447.3s,  = -42.2°→  -3.1° (Δ= +39.2°)
  TURN 15: t= 450.1-462.2s,  =  15.1°→ -51.9° (Δ= -67.0°)
  cast 16: t= 466.7-472.0s,  = -65.4°→ -90.7° (Δ= -25.3°)
  TURN 17: t= 490.6-510.7s,  = -93.5°→ 119.5° (Δ=-147.0°)
  TURN 18: t= 514.1-535.2s,  = 106.9°→ -31.5° (Δ=-138.4°)
  cast 19: t= 536.3-543.1s,  = -35.2°→ -21.5° (Δ= +13.7°)
  cast 20: t= 562.8-586.0s,  =   6.6°→  32.3° (Δ= +25.7°)
  cast 21: t= 600.6-601.1s,  =  45.3°→  40.1° (Δ=  -5.2°)
  Summary: 21 casts,  4 turns (19.0%)

Larva 287 cast orientations:
  cast  1: t= 247.4-266.5s,  =  97.0°→  93.2° (Δ=  -3.8°)
  cast  2: t= 268.3-271.2s,  =  90.5°→  96.2° (Δ=  +5.7°)
  cast  3: t= 274.9-279.5s,  = 114.1°→ 122.7° (Δ=  +8.6°)
  TURN  4: t= 282.1-314.9s,  = 129.2°→  43.5° (Δ= -85.6°)
  cast  5: t= 338.7-347.2s,  =  44.5°→  66.4° (Δ= +21.9°)
  cast  6: t= 349.0-360.0s,  =  69.6°→  83.5° (Δ= +13.9°)
  cast  7: t= 364.7-368.1s,  =  95.6°→ 100.1° (Δ=  +4.5°)
  cast  8: t= 379.1-385.0s,  = 125.8°→ 128.5° (Δ=  +2.7°)
  cast  9: t= 394.7-400.2s,  = 132.1°→ 142.4° (Δ= +10.3°)
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  cast 10: t= 413.9-421.1s,  = 139.0°→ 120.5° (Δ= -18.6°)
  cast 11: t= 423.4-427.1s,  = 114.9°→  97.0° (Δ= -18.0°)
  cast 12: t= 427.8-437.9s,  =  98.8°→  68.9° (Δ= -29.9°)
  cast 13: t= 439.2-453.2s,  =  59.4°→  62.3° (Δ=  +3.0°)
  cast 14: t= 456.5-470.0s,  =  64.6°→  79.8° (Δ= +15.2°)
  cast 15: t= 484.7-493.8s,  =  87.8°→  76.5° (Δ= -11.3°)
  cast 16: t= 496.5-509.9s,  =  66.6°→  94.3° (Δ= +27.7°)
  cast 17: t= 531.7-543.3s,  =  96.1°→ 104.3° (Δ=  +8.2°)
  cast 18: t= 545.5-560.3s,  = 110.8°→  97.9° (Δ= -12.8°)
  cast 19: t= 581.7-593.1s,  = 154.8°→ 161.9° (Δ=  +7.1°)
  Summary: 19 casts,  1 turns ( 5.3%)

Larva 288 cast orientations:
  TURN  1: t= 251.6-261.5s,  =   1.4°→ -58.6° (Δ= -60.0°)
  cast  2: t= 269.8-275.5s,  = -74.1°→ -88.2° (Δ= -14.2°)
  cast  3: t= 276.5-282.1s,  = -85.2°→ -77.7° (Δ=  +7.5°)
  TURN  4: t= 283.1-303.7s,  = -73.2°→-148.8° (Δ= -75.6°)
  TURN  5: t= 307.5-330.4s,  =-165.4°→ -72.0° (Δ= +93.3°)
  TURN  6: t= 336.6-345.8s,  = -62.8°→  -6.1° (Δ= +56.7°)
  cast  7: t= 367.5-374.7s,  =   6.4°→ -23.8° (Δ= -30.2°)
  cast  8: t= 387.8-392.9s,  = -47.6°→ -81.6° (Δ= -34.0°)
  TURN  9: t= 393.9-404.6s,  = -73.9°→   9.1° (Δ= +83.0°)
  cast 10: t= 443.0-449.5s,  = -38.8°→ -13.4° (Δ= +25.4°)
  TURN 11: t= 454.2-464.9s,  = -10.3°→ -60.2° (Δ= -49.9°)
  TURN 12: t= 471.8-493.3s,  = -72.3°→  89.6° (Δ=+161.9°)
  cast 13: t= 497.7-503.6s,  =  79.7°→  87.0° (Δ=  +7.3°)
  TURN 14: t= 504.4-512.4s,  =  91.4°→  36.7° (Δ= -54.7°)
  cast 15: t= 543.4-545.9s,  =  14.1°→  11.7° (Δ=  -2.4°)
  cast 16: t= 567.3-576.5s,  = -18.1°→   8.1° (Δ= +26.1°)
  cast 17: t= 595.9-601.1s,  =  35.1°→  19.2° (Δ= -15.9°)
  Summary: 17 casts,  8 turns (47.1%)

Larva 307 cast orientations:
  cast  1: t= 276.7-278.8s,  =  55.9°→  54.0° (Δ=  -1.9°)
  cast  2: t= 283.4-294.9s,  =  52.9°→  34.4° (Δ= -18.5°)
  cast  3: t= 314.9-321.8s,  =   9.8°→  29.4° (Δ= +19.6°)
  cast  4: t= 352.4-356.6s,  =  22.0°→  23.5° (Δ=  +1.5°)
  TURN  5: t= 357.9-380.8s,  =  23.6°→ -29.1° (Δ= -52.7°)
  cast  6: t= 405.5-413.0s,  = -84.4°→ -68.8° (Δ= +15.5°)
  TURN  7: t= 423.2-437.6s,  = -76.1°→ -30.6° (Δ= +45.5°)
  cast  8: t= 455.7-467.8s,  = -52.2°→ -23.1° (Δ= +29.1°)
  cast  9: t= 475.7-487.0s,  = -22.5°→   9.9° (Δ= +32.4°)
  TURN 10: t= 501.7-512.2s,  =  -8.6°→ -73.1° (Δ= -64.5°)
  TURN 11: t= 514.1-523.2s,  = -56.4°→   7.0° (Δ= +63.4°)
  TURN 12: t= 541.1-556.4s,  =  34.2°→  85.8° (Δ= +51.6°)
  TURN 13: t= 563.2-576.4s,  =  95.9°→  24.0° (Δ= -71.9°)
  cast 14: t= 578.7-601.1s,  =  23.5°→   9.6° (Δ= -13.9°)
  Summary: 14 casts,  6 turns (42.9%)
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Larva 331 cast orientations:
  TURN  1: t= 288.0-292.0s,  = -55.6°→   0.5° (Δ= +56.1°)
  cast  2: t= 293.6-300.3s,  =   4.3°→  23.2° (Δ= +18.9°)
  cast  3: t= 308.3-311.3s,  =  35.7°→  37.8° (Δ=  +2.1°)
  cast  4: t= 323.8-332.2s,  =  24.2°→  64.5° (Δ= +40.3°)
  cast  5: t= 336.6-339.9s,  =  77.1°→  73.2° (Δ=  -3.9°)
  cast  6: t= 342.0-352.0s,  =  77.6°→  68.2° (Δ=  -9.4°)
  cast  7: t= 360.3-375.7s,  =  59.3°→  56.9° (Δ=  -2.4°)
  TURN  8: t= 388.6-409.3s,  =  47.5°→ 144.7° (Δ= +97.2°)
  TURN  9: t= 412.1-431.7s,  = 144.7°→-148.2° (Δ= +67.0°)
  cast 10: t= 432.7-438.3s,  =-137.7°→-125.0° (Δ= +12.7°)
  cast 11: t= 463.6-480.9s,  = -88.0°→ -92.2° (Δ=  -4.1°)
  cast 12: t= 485.4-489.1s,  =-117.1°→-104.1° (Δ= +13.0°)
  cast 13: t= 500.7-504.1s,  = -91.5°→ -93.7° (Δ=  -2.2°)
  TURN 14: t= 504.4-516.9s,  = -93.5°→-160.4° (Δ= -66.9°)
  TURN 15: t= 526.8-539.4s,  =-170.2°→ 116.1° (Δ= -73.6°)
  cast 16: t= 541.9-547.5s,  = 109.4°→  92.8° (Δ= -16.6°)
  cast 17: t= 548.3-555.6s,  =  93.3°→  52.8° (Δ= -40.5°)
  cast 18: t= 561.8-569.3s,  =  42.3°→  77.6° (Δ= +35.3°)
  cast 19: t= 579.1-585.4s,  =  92.2°→  91.7° (Δ=  -0.5°)
  cast 20: t= 592.6-597.4s,  =  97.9°→ 109.9° (Δ= +12.0°)
  Summary: 20 casts,  5 turns (25.0%)

Cast & Turn Analysis Summary:
  Total casts processed: 536
  Total turns detected: 107
  Overall turn rate: 20.0%
  Min turn amplitude: 45°
  Orientation change stats:
    Mean: 27.0°
    Median: 12.9°
    Range: 0.0° - 173.5°

All cast orientations (chronological):
  Larva  3, cast: t=   0.2s,  = -29.6°, Δ= -33.1°
  Larva  2, cast: t=   1.1s,  =   5.0°, Δ=  +6.1°
  Larva 26, cast: t=   2.6s,  =-161.3°, Δ=  -1.5°
  Larva  2, TURN: t=   2.8s,  =  11.5°, Δ= +59.4°
  Larva 25, cast: t=   2.8s,  = -85.9°, Δ=  +3.3°
  Larva  6, cast: t=   3.0s,  = 123.4°, Δ=  +5.2°
  Larva 23, cast: t=   5.8s,  =-163.0°, Δ=  -1.1°
  Larva 21, cast: t=   6.1s,  = -46.6°, Δ= +26.1°
  Larva 26, cast: t=   6.8s,  =-163.5°, Δ= +13.5°
  Larva 30, cast: t=   6.8s,  = 147.5°, Δ=  +0.7°
  Larva  9, cast: t=   7.2s,  = -52.9°, Δ= -10.1°
  Larva  3, TURN: t=   7.8s,  = -67.3°, Δ= +55.0°
  Larva 29, cast: t=   7.8s,  = 179.8°, Δ=  -8.3°
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Larva 30, cast: t=   8.6s,  = 148.4°, Δ=  +3.0°
Larva 23, cast: t=   8.7s,  =-142.2°, Δ=  +4.0°
Larva 25, cast: t=   9.8s,  = -78.6°, Δ= +41.8°
Larva 21, cast: t=  11.2s,  = -26.7°, Δ=  +8.1°
Larva  6, cast: t=  11.9s,  = 138.1°, Δ=  +0.9°
Larva  2, cast: t=  12.1s,  =  82.2°, Δ= -30.8°
Larva 65, cast: t=  14.4s,  =  35.1°, Δ=  +5.6°
Larva  2, TURN: t=  16.9s,  =  47.4°, Δ=-120.4°
Larva  9, cast: t=  17.1s,  = -70.5°, Δ=  -4.0°
Larva 21, cast: t=  17.4s,  = -28.1°, Δ=  +1.2°
Larva 23, cast: t=  17.4s,  =-154.7°, Δ=  -8.8°
Larva 65, cast: t=  18.7s,  =  60.9°, Δ=  -6.7°
Larva 30, cast: t=  19.0s,  = 150.4°, Δ=  -0.5°
Larva  6, TURN: t=  21.0s,  = 133.9°, Δ=-138.9°
Larva 25, cast: t=  21.6s,  =  -8.7°, Δ=  -7.1°
Larva  9, TURN: t=  22.5s,  = -74.3°, Δ=+132.0°
Larva 30, cast: t=  23.5s,  = 151.6°, Δ= +35.8°
Larva 23, cast: t=  24.9s,  =-160.3°, Δ= +17.2°
Larva 21, cast: t=  27.6s,  = -33.3°, Δ=  -3.8°
Larva 65, cast: t=  29.8s,  =  85.3°, Δ=  -6.0°
Larva 25, cast: t=  30.7s,  = -21.4°, Δ= +16.7°
Larva 21, TURN: t=  31.3s,  = -36.0°, Δ= -47.5°
Larva 26, cast: t=  32.3s,  =-157.2°, Δ=  +2.3°
Larva  3, TURN: t=  32.8s,  =  -0.8°, Δ= +90.5°
Larva 23, cast: t=  33.1s,  =-142.8°, Δ= +18.0°
Larva 30, TURN: t=  36.0s,  =-173.5°, Δ= +90.8°
Larva 26, cast: t=  36.3s,  =-155.5°, Δ=  -4.5°
Larva 25, cast: t=  36.4s,  =  -2.0°, Δ=  -3.2°
Larva 23, cast: t=  36.8s,  =-148.4°, Δ= -12.8°
Larva 65, cast: t=  39.4s,  = 115.0°, Δ=  +1.0°
Larva 26, cast: t=  40.0s,  =-168.8°, Δ=  -1.1°
Larva 25, cast: t=  42.2s,  = -13.0°, Δ= +12.1°
Larva 65, cast: t=  42.7s,  = 120.9°, Δ=  +5.7°
Larva  9, cast: t=  43.6s,  =  69.3°, Δ= -15.1°
Larva 26, cast: t=  43.8s,  =-163.4°, Δ=  -6.5°
Larva 21, cast: t=  44.8s,  = -96.3°, Δ= +39.6°
Larva  6, cast: t=  46.2s,  = -21.7°, Δ=  +5.9°
Larva 23, cast: t=  48.6s,  =-135.4°, Δ=  +4.3°
Larva 25, cast: t=  49.3s,  =   1.1°, Δ=  -5.3°
Larva 26, cast: t=  51.8s,  =-169.0°, Δ=  +0.2°
Larva  9, cast: t=  53.1s,  =  46.6°, Δ= -43.4°
Larva  2, cast: t=  54.3s,  = -42.2°, Δ= +11.7°
Larva  3, cast: t=  55.2s,  =  99.5°, Δ=  -5.1°
Larva 25, TURN: t=  55.3s,  = -11.4°, Δ= +84.0°
Larva  6, TURN: t=  57.2s,  = -13.7°, Δ= -57.2°
Larva 26, TURN: t=  57.2s,  =-172.7°, Δ=+165.0°
Larva 166, cast: t=  60.0s,  =  26.6°, Δ=  +2.2°
Larva  3, TURN: t=  60.8s,  = 100.2°, Δ= -55.8°
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Larva 29, cast: t=  61.0s,  = 129.8°, Δ= +20.1°
Larva  2, TURN: t=  61.4s,  = -19.1°, Δ= -65.7°
Larva 21, cast: t=  64.2s,  = -35.5°, Δ=  +1.7°
Larva 21, cast: t=  68.2s,  = -36.8°, Δ=  +1.3°
Larva  6, cast: t=  68.3s,  = -75.4°, Δ= +11.9°
Larva 23, cast: t=  69.0s,  =-143.2°, Δ= +23.0°
Larva  2, TURN: t=  69.5s,  = -87.6°, Δ=+145.6°
Larva 166, cast: t=  70.1s,  =  46.2°, Δ= -43.2°
Larva  9, cast: t=  73.1s,  = -22.0°, Δ=  +1.2°
Larva 21, cast: t=  77.1s,  = -44.0°, Δ=  -0.7°
Larva 184, cast: t=  77.7s,  = -31.9°, Δ= +35.3°
Larva 30, cast: t=  79.8s,  = -87.5°, Δ=  +7.3°
Larva  9, TURN: t=  80.2s,  = -18.4°, Δ=-133.4°
Larva  6, cast: t=  81.4s,  = -63.1°, Δ=  +5.1°
Larva 23, TURN: t=  81.6s,  =-120.0°, Δ= -49.1°
Larva 21, TURN: t=  83.5s,  = -55.5°, Δ= +82.0°
Larva 29, cast: t=  84.1s,  = 156.8°, Δ= +27.1°
Larva 184, cast: t=  84.4s,  = -13.4°, Δ=  -7.4°
Larva 23, cast: t=  85.5s,  =-178.0°, Δ=  +1.4°
Larva  6, cast: t=  86.0s,  = -61.0°, Δ=  -9.1°
Larva 195, cast: t=  88.2s,  = -14.0°, Δ=  +4.4°
Larva 30, cast: t=  88.7s,  = -74.4°, Δ= +38.0°
Larva 23, TURN: t=  89.9s,  =-169.7°, Δ=+166.7°
Larva  2, cast: t=  91.8s,  =  82.4°, Δ=  -7.1°
Larva 25, cast: t=  92.9s,  = 105.8°, Δ=  -2.3°
Larva  6, cast: t=  93.3s,  = -75.0°, Δ=  +8.7°
Larva 166, cast: t=  93.3s,  =  -3.0°, Δ= +20.4°
Larva 25, TURN: t=  94.4s,  = 105.6°, Δ= -46.1°
Larva 195, TURN: t=  94.4s,  =  -4.5°, Δ= -45.0°
Larva 26, cast: t=  98.1s,  = -13.8°, Δ=  -0.2°
Larva 23, cast: t=  98.2s,  =  17.2°, Δ=  +5.5°
Larva  3, cast: t=  99.9s,  =  12.5°, Δ=  -0.2°
Larva  2, cast: t= 105.2s,  =  77.1°, Δ=  +9.8°
Larva 184, cast: t= 106.0s,  = -30.4°, Δ=  -3.8°
Larva 21, cast: t= 109.2s,  =  30.5°, Δ= +24.3°
Larva  6, cast: t= 110.3s,  = -67.4°, Δ=  -9.4°
Larva  2, TURN: t= 110.7s,  =  83.5°, Δ=+173.5°
Larva 26, cast: t= 111.1s,  = -24.8°, Δ= +36.1°
Larva 166, cast: t= 113.4s,  =  29.2°, Δ=  -2.6°
Larva 25, cast: t= 113.5s,  =  45.4°, Δ= -10.4°
Larva  6, TURN: t= 114.8s,  = -79.0°, Δ= +57.0°
Larva 30, TURN: t= 115.0s,  = -32.8°, Δ= +50.9°
Larva 29, cast: t= 115.2s,  =-154.2°, Δ= +33.4°
Larva  9, cast: t= 117.9s,  =-120.2°, Δ=  +1.2°
Larva 195, cast: t= 118.9s,  = -59.8°, Δ=  -5.0°
Larva 25, cast: t= 120.4s,  =  29.0°, Δ= -17.9°
Larva 195, cast: t= 123.5s,  = -60.5°, Δ=  +4.1°
Larva 166, cast: t= 124.9s,  =  26.1°, Δ=  -5.8°
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Larva 23, cast: t= 126.6s,  =  21.8°, Δ=  -0.2°
Larva 21, cast: t= 126.7s,  =  80.8°, Δ=  -0.9°
Larva 195, cast: t= 128.1s,  = -47.5°, Δ=  -4.7°
Larva 21, cast: t= 130.5s,  =  73.3°, Δ= +11.7°
Larva 23, cast: t= 130.7s,  =  15.3°, Δ=  +0.8°
Larva 30, cast: t= 131.3s,  =  21.8°, Δ=  -2.1°
Larva 184, cast: t= 131.7s,  = -34.1°, Δ=  -5.7°
Larva 29, cast: t= 132.8s,  =-101.0°, Δ= -42.2°
Larva  9, cast: t= 134.0s,  =-124.9°, Δ= -12.8°
Larva 166, cast: t= 135.4s,  =  12.6°, Δ=  -1.9°
Larva 184, cast: t= 136.5s,  = -34.9°, Δ= -11.2°
Larva 26, TURN: t= 138.1s,  =   3.5°, Δ= +76.4°
Larva 25, TURN: t= 138.7s,  =  -6.0°, Δ= -70.0°
Larva 195, cast: t= 138.9s,  = -46.0°, Δ= +13.7°
Larva  6, cast: t= 140.2s,  =  -3.8°, Δ= -22.6°
Larva  2, cast: t= 141.2s,  = -75.4°, Δ= +23.4°
Larva 23, cast: t= 142.5s,  =  15.1°, Δ=  +4.0°
Larva  9, TURN: t= 144.3s,  =-147.8°, Δ=+113.5°
Larva 166, cast: t= 145.4s,  =  11.7°, Δ=  -2.6°
Larva 21, cast: t= 145.9s,  =  81.9°, Δ= -40.4°
Larva 184, cast: t= 147.5s,  = -49.7°, Δ=  -0.8°
Larva 195, cast: t= 150.1s,  = -30.4°, Δ= -11.3°
Larva 184, cast: t= 150.4s,  = -47.4°, Δ=  +0.4°
Larva 184, TURN: t= 153.6s,  = -58.7°, Δ= +97.0°
Larva  2, cast: t= 154.3s,  = -28.5°, Δ=  -2.0°
Larva  3, cast: t= 155.3s,  =  71.8°, Δ=  +1.2°
Larva 195, cast: t= 155.5s,  = -32.6°, Δ=  -2.3°
Larva 21, cast: t= 155.8s,  =  23.3°, Δ= -31.3°
Larva 29, cast: t= 156.4s,  =-154.2°, Δ=  +3.4°
Larva 23, cast: t= 159.1s,  =  18.9°, Δ= -11.0°
Larva 195, cast: t= 159.7s,  = -33.1°, Δ=  +3.8°
Larva  3, cast: t= 160.1s,  =  75.4°, Δ= -39.0°
Larva 29, cast: t= 160.6s,  =-145.9°, Δ=  -4.1°
Larva 25, cast: t= 161.0s,  = -96.8°, Δ= +11.0°
Larva 195, cast: t= 163.5s,  = -29.4°, Δ=  -5.3°
Larva 29, TURN: t= 163.9s,  =-149.7°, Δ= -74.9°
Larva 30, cast: t= 164.8s,  =  -7.0°, Δ= +41.8°
Larva  6, TURN: t= 165.3s,  = -24.6°, Δ=-119.2°
Larva 195, cast: t= 168.5s,  = -25.2°, Δ=  +8.2°
Larva 21, cast: t= 171.9s,  = -33.3°, Δ= +39.8°
Larva 25, cast: t= 171.9s,  = -69.3°, Δ= +24.2°
Larva 26, cast: t= 175.0s,  =  55.1°, Δ= -40.0°
Larva 166, cast: t= 175.0s,  =  10.9°, Δ= +40.0°
Larva  2, TURN: t= 175.5s,  = -29.2°, Δ=+125.2°
Larva 184, cast: t= 176.4s,  =  42.7°, Δ=  +3.0°
Larva 195, cast: t= 176.8s,  = -15.6°, Δ=  +0.3°
Larva 184, cast: t= 180.4s,  =  42.7°, Δ=  -3.8°
Larva 195, cast: t= 180.8s,  = -12.8°, Δ=  -5.1°
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Larva  6, cast: t= 182.7s,  =-145.8°, Δ= +29.5°
Larva 21, cast: t= 183.3s,  =  24.3°, Δ= +17.6°
Larva 30, cast: t= 183.4s,  =  41.8°, Δ=  +3.8°
Larva 184, cast: t= 183.9s,  =  44.4°, Δ= +12.4°
Larva 26, cast: t= 184.0s,  =   3.7°, Δ= -43.4°
Larva 25, cast: t= 188.7s,  = -53.5°, Δ=  +6.3°
Larva 30, cast: t= 189.2s,  =  45.7°, Δ=  -6.7°
Larva 26, cast: t= 192.8s,  = -41.4°, Δ= +15.5°
Larva 195, cast: t= 192.9s,  =  -9.3°, Δ=  +0.6°
Larva  2, TURN: t= 193.2s,  = 113.5°, Δ= -79.0°
Larva  6, cast: t= 195.5s,  =-105.4°, Δ=  +0.8°
Larva 195, cast: t= 195.6s,  =  -6.7°, Δ=  -0.8°
Larva 237, cast: t= 197.1s,  =  32.0°, Δ= +15.9°
Larva 21, cast: t= 198.2s,  =  57.8°, Δ= -36.7°
Larva 26, cast: t= 199.3s,  = -19.7°, Δ= +26.6°
Larva 29, TURN: t= 199.4s,  = 112.1°, Δ= -84.7°
Larva 195, cast: t= 199.5s,  =  -3.4°, Δ=  +2.1°
Larva  6, cast: t= 200.8s,  =-113.7°, Δ= -31.0°
Larva  9, cast: t= 200.8s,  = -43.6°, Δ=  -7.3°
Larva 237, cast: t= 201.6s,  =  67.2°, Δ=  +1.2°
Larva 25, cast: t= 202.2s,  = -60.2°, Δ= -34.3°
Larva 237, TURN: t= 204.0s,  =  68.4°, Δ= -48.7°
Larva 26, cast: t= 206.3s,  =  11.8°, Δ= -26.1°
Larva 65, cast: t= 207.6s,  =-171.8°, Δ= +33.8°
Larva  6, TURN: t= 210.0s,  =-145.0°, Δ=-133.6°
Larva  2, cast: t= 210.4s,  =  29.7°, Δ= -35.6°
Larva 30, cast: t= 211.0s,  =  -7.8°, Δ=  -1.3°
Larva 249, cast: t= 212.5s,  = -83.2°, Δ= +41.1°
Larva 21, cast: t= 213.1s,  =   1.1°, Δ=  -7.0°
Larva 25, TURN: t= 213.5s,  =-108.7°, Δ= +47.6°
Larva 195, cast: t= 214.9s,  =  -6.4°, Δ= +15.3°
Larva 237, cast: t= 216.0s,  =  15.6°, Δ=  +7.1°
Larva  3, cast: t= 218.6s,  =  19.3°, Δ= -29.7°
Larva 21, TURN: t= 218.6s,  = -14.4°, Δ= +60.7°
Larva 166, cast: t= 218.8s,  =  75.8°, Δ=  -0.0°
Larva 249, TURN: t= 219.3s,  = -35.3°, Δ= +54.0°
Larva 195, cast: t= 219.3s,  =   6.4°, Δ=  -0.8°
Larva  9, cast: t= 220.0s,  = -51.4°, Δ= -16.2°
Larva 184, cast: t= 221.4s,  =  68.9°, Δ=  +7.7°
Larva  6, cast: t= 226.1s,  =  80.8°, Δ= -31.1°
Larva  9, cast: t= 226.9s,  = -69.0°, Δ=  +0.2°
Larva 237, cast: t= 227.7s,  =  25.3°, Δ= -23.8°
Larva 23, cast: t= 229.7s,  =   9.5°, Δ=  -0.7°
Larva 21, cast: t= 230.1s,  =  63.4°, Δ= -11.2°
Larva 30, cast: t= 231.7s,  =  -1.0°, Δ=  -3.3°
Larva  2, cast: t= 233.7s,  =  -6.6°, Δ= -40.1°
Larva 184, cast: t= 233.9s,  =  75.9°, Δ=  +1.9°
Larva 29, cast: t= 234.5s,  =  18.6°, Δ= +26.7°
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Larva 237, cast: t= 235.8s,  =  -3.2°, Δ= +18.7°
Larva 249, cast: t= 236.4s,  =  11.9°, Δ=  -9.1°
Larva 23, cast: t= 236.4s,  =  12.1°, Δ=  +2.0°
Larva 30, cast: t= 236.6s,  =  -3.5°, Δ= +21.7°
Larva 166, cast: t= 238.0s,  =  67.4°, Δ= -15.2°
Larva 23, cast: t= 242.3s,  =  12.0°, Δ=  -1.5°
Larva 21, TURN: t= 242.7s,  =  34.4°, Δ= -53.2°
Larva  2, cast: t= 244.2s,  = -57.0°, Δ=  -1.8°
Larva 25, cast: t= 244.7s,  = -39.7°, Δ= +11.5°
Larva  9, cast: t= 245.3s,  = -79.7°, Δ=  +3.7°
Larva 287, cast: t= 247.4s,  =  97.0°, Δ=  -3.8°
Larva 195, cast: t= 247.6s,  =  16.7°, Δ=  +1.8°
Larva  2, cast: t= 248.7s,  = -32.0°, Δ=  -4.8°
Larva 184, cast: t= 250.9s,  =  64.4°, Δ= -19.6°
Larva 288, TURN: t= 251.6s,  =   1.4°, Δ= -60.0°
Larva 26, TURN: t= 251.6s,  = -11.1°, Δ= +48.1°
Larva 23, cast: t= 251.8s,  =   5.9°, Δ=  -3.5°
Larva 195, cast: t= 252.0s,  =  22.8°, Δ=  -2.7°
Larva  9, cast: t= 252.5s,  = -84.0°, Δ= +32.9°
Larva 237, cast: t= 253.6s,  =  35.5°, Δ= +30.7°
Larva  6, cast: t= 254.7s,  =  67.4°, Δ=  -1.9°
Larva 249, cast: t= 256.8s,  = -21.3°, Δ=  +1.0°
Larva 21, TURN: t= 258.1s,  = -42.0°, Δ= -62.9°
Larva 166, cast: t= 258.7s,  =  36.5°, Δ= -21.8°
Larva 29, cast: t= 260.0s,  =  52.4°, Δ=  -2.0°
Larva 23, cast: t= 260.2s,  =  16.5°, Δ=  -4.9°
Larva 195, cast: t= 260.6s,  =  20.9°, Δ=  +1.8°
Larva 26, cast: t= 261.1s,  =  45.8°, Δ= -20.4°
Larva  9, TURN: t= 263.3s,  = -53.2°, Δ= +61.6°
Larva  6, cast: t= 265.3s,  =  65.6°, Δ=  -6.3°
Larva 237, TURN: t= 266.2s,  =  82.0°, Δ=-128.9°
Larva 21, cast: t= 267.6s,  =-111.9°, Δ= -39.4°
Larva 195, cast: t= 267.8s,  =  15.4°, Δ=  -0.5°
Larva 287, cast: t= 268.3s,  =  90.5°, Δ=  +5.7°
Larva  2, TURN: t= 268.7s,  = -35.7°, Δ= -63.8°
Larva 29, cast: t= 269.8s,  =  54.1°, Δ= +12.9°
Larva 288, cast: t= 269.8s,  = -74.1°, Δ= -14.2°
Larva 166, cast: t= 270.9s,  =  11.3°, Δ= -11.3°
Larva 30, cast: t= 270.9s,  =  18.8°, Δ=  +1.3°
Larva 184, cast: t= 271.1s,  =  33.7°, Δ= -32.0°
Larva  3, cast: t= 273.5s,  =  18.7°, Δ= -32.3°
Larva  6, cast: t= 273.6s,  =  60.2°, Δ= -12.1°
Larva 287, cast: t= 274.9s,  = 114.1°, Δ=  +8.6°
Larva 288, cast: t= 276.5s,  = -85.2°, Δ=  +7.5°
Larva 307, cast: t= 276.7s,  =  55.9°, Δ=  -1.9°
Larva 249, cast: t= 278.5s,  = -20.8°, Δ= +31.4°
Larva 65, cast: t= 279.4s,  =-140.2°, Δ=  -1.4°
Larva 237, TURN: t= 279.8s,  = -74.7°, Δ= -55.2°
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Larva 287, TURN: t= 282.1s,  = 129.2°, Δ= -85.6°
Larva 23, cast: t= 283.0s,  =   8.3°, Δ=  -9.5°
Larva 288, TURN: t= 283.1s,  = -73.2°, Δ= -75.6°
Larva 307, cast: t= 283.4s,  =  52.9°, Δ= -18.5°
Larva 30, TURN: t= 285.3s,  =  10.6°, Δ= +91.1°
Larva 26, cast: t= 285.6s,  =  -2.2°, Δ=  -6.0°
Larva 331, TURN: t= 288.0s,  = -55.6°, Δ= +56.1°
Larva 21, TURN: t= 288.1s,  =-138.6°, Δ= +62.2°
Larva  9, cast: t= 291.9s,  = -10.8°, Δ= -17.7°
Larva 195, cast: t= 291.9s,  =  25.5°, Δ=  +5.6°
Larva 26, cast: t= 292.1s,  =  -2.8°, Δ= +36.3°
Larva  6, TURN: t= 292.7s,  =  20.7°, Δ= -64.9°
Larva 23, cast: t= 292.8s,  =   5.2°, Δ=  -5.6°
Larva 249, cast: t= 293.5s,  =  33.7°, Δ=  +6.9°
Larva 331, cast: t= 293.6s,  =   4.3°, Δ= +18.9°
Larva 29, TURN: t= 296.0s,  =  68.8°, Δ= -96.7°
Larva 65, cast: t= 297.3s,  =-149.1°, Δ=  +9.9°
Larva 166, cast: t= 298.7s,  = -15.7°, Δ=  +0.1°
Larva  3, cast: t= 299.8s,  = -36.4°, Δ= +37.3°
Larva 249, cast: t= 301.4s,  =  33.1°, Δ= +37.1°
Larva 65, cast: t= 301.9s,  =-148.7°, Δ=  -5.2°
Larva 21, cast: t= 302.7s,  = -60.3°, Δ=  -4.4°
Larva 26, cast: t= 303.0s,  =  43.4°, Δ=  -8.7°
Larva 195, cast: t= 305.0s,  =  35.9°, Δ=  +6.3°
Larva 288, TURN: t= 307.5s,  =-165.4°, Δ= +93.3°
Larva 21, cast: t= 308.2s,  = -72.1°, Δ= -27.9°
Larva 195, cast: t= 308.2s,  =  42.4°, Δ=  +4.0°
Larva 331, cast: t= 308.3s,  =  35.7°, Δ=  +2.1°
Larva 65, TURN: t= 308.7s,  =-151.1°, Δ= +91.1°
Larva  2, cast: t= 312.6s,  = -59.8°, Δ=  +1.2°
Larva 26, TURN: t= 313.0s,  =  26.3°, Δ= +64.0°
Larva  6, cast: t= 313.8s,  = -51.9°, Δ= +30.9°
Larva 307, cast: t= 314.9s,  =   9.8°, Δ= +19.6°
Larva 249, cast: t= 315.6s,  =  80.4°, Δ= -20.4°
Larva 23, cast: t= 316.1s,  =   5.1°, Δ= +10.4°
Larva 21, cast: t= 316.8s,  =-100.0°, Δ=  -8.4°
Larva 166, cast: t= 316.8s,  = -17.4°, Δ= -15.3°
Larva 21, cast: t= 319.6s,  =-105.5°, Δ= -26.5°
Larva 249, cast: t= 323.4s,  =  49.1°, Δ= -21.7°
Larva 331, cast: t= 323.8s,  =  24.2°, Δ= +40.3°
Larva 26, TURN: t= 328.2s,  =  98.2°, Δ=-153.5°
Larva 195, cast: t= 328.4s,  =  48.7°, Δ=  -4.6°
Larva  6, cast: t= 328.7s,  = -15.0°, Δ=  -5.1°
Larva 21, TURN: t= 330.9s,  =-133.6°, Δ=+104.1°
Larva 184, cast: t= 331.5s,  = -15.6°, Δ=  -2.1°
Larva 195, cast: t= 332.6s,  =  51.8°, Δ=  +4.0°
Larva  3, cast: t= 333.2s,  =  21.8°, Δ=  -4.5°
Larva  9, cast: t= 334.6s,  = -51.8°, Δ= +23.8°
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Larva 25, cast: t= 334.6s,  = -83.7°, Δ= -19.2°
Larva 249, cast: t= 336.1s,  =   2.6°, Δ= +23.0°
Larva 331, cast: t= 336.6s,  =  77.1°, Δ=  -3.9°
Larva 288, TURN: t= 336.6s,  = -62.8°, Δ= +56.7°
Larva 195, cast: t= 338.2s,  =  52.0°, Δ=  -0.1°
Larva 287, cast: t= 338.7s,  =  44.5°, Δ= +21.9°
Larva  3, cast: t= 339.5s,  = -11.0°, Δ=  -6.8°
Larva 237, TURN: t= 341.8s,  =-145.6°, Δ=-128.8°
Larva 331, cast: t= 342.0s,  =  77.6°, Δ=  -9.4°
Larva 195, cast: t= 345.6s,  =  46.0°, Δ=  -1.3°
Larva 29, cast: t= 347.4s,  = -52.5°, Δ= +15.0°
Larva  3, cast: t= 348.5s,  = -15.4°, Δ= +30.9°
Larva 65, TURN: t= 348.7s,  = -48.4°, Δ=+127.3°
Larva 287, cast: t= 349.0s,  =  69.6°, Δ= +13.9°
Larva 25, cast: t= 349.9s,  =-113.2°, Δ=  +2.0°
Larva 23, cast: t= 350.0s,  =  18.8°, Δ=  +0.4°
Larva 195, cast: t= 351.0s,  =  49.1°, Δ=  +3.7°
Larva  2, cast: t= 351.8s,  = -26.2°, Δ= +31.6°
Larva 307, cast: t= 352.4s,  =  22.0°, Δ=  +1.5°
Larva 23, cast: t= 354.4s,  =  25.7°, Δ=  -2.2°
Larva 26, TURN: t= 356.9s,  = -67.6°, Δ= +59.6°
Larva 237, cast: t= 357.2s,  =  80.0°, Δ= -13.9°
Larva 307, TURN: t= 357.9s,  =  23.6°, Δ= -52.7°
Larva  6, cast: t= 360.0s,  = -11.4°, Δ= -11.3°
Larva 331, cast: t= 360.3s,  =  59.3°, Δ=  -2.4°
Larva  9, cast: t= 360.4s,  =  -5.7°, Δ= -23.8°
Larva  3, TURN: t= 361.8s,  =  24.0°, Δ=+101.8°
Larva 237, cast: t= 363.3s,  =  67.7°, Δ= -17.3°
Larva 30, cast: t= 364.0s,  =  29.3°, Δ= +17.3°
Larva 287, cast: t= 364.7s,  =  95.6°, Δ=  +4.5°
Larva 29, TURN: t= 365.0s,  = -34.8°, Δ=+113.5°
Larva 195, cast: t= 365.7s,  =  63.2°, Δ=  +0.7°
Larva 249, cast: t= 365.9s,  =  36.7°, Δ= -15.4°
Larva 65, cast: t= 366.0s,  =  81.3°, Δ= +13.0°
Larva 288, cast: t= 367.5s,  =   6.4°, Δ= -30.2°
Larva 23, cast: t= 369.9s,  =  23.7°, Δ=  -4.7°
Larva 184, cast: t= 370.7s,  = -29.0°, Δ=  -8.2°
Larva 65, TURN: t= 372.8s,  = 102.0°, Δ= -76.5°
Larva 195, cast: t= 372.9s,  =  75.9°, Δ= -13.2°
Larva 26, cast: t= 374.0s,  =   8.2°, Δ= -32.5°
Larva 166, cast: t= 376.1s,  = -42.4°, Δ=  +6.0°
Larva 30, cast: t= 377.6s,  =  48.9°, Δ= +20.2°
Larva 23, cast: t= 378.3s,  =  15.8°, Δ= +11.9°
Larva 287, cast: t= 379.1s,  = 125.8°, Δ=  +2.7°
Larva 237, TURN: t= 383.3s,  =   8.3°, Δ= -58.2°
Larva 26, cast: t= 385.8s,  = -36.8°, Δ= +37.2°
Larva  3, TURN: t= 386.4s,  = 111.1°, Δ= +64.7°
Larva 249, cast: t= 386.5s,  =  -9.4°, Δ=  -2.7°
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Larva 23, cast: t= 387.2s,  =  23.0°, Δ=  -2.1°
Larva 288, cast: t= 387.8s,  = -47.6°, Δ= -34.0°
Larva  2, TURN: t= 388.4s,  =  77.8°, Δ= -63.4°
Larva 331, TURN: t= 388.6s,  =  47.5°, Δ= +97.2°
Larva 30, TURN: t= 388.7s,  =  65.5°, Δ= -58.5°
Larva  6, cast: t= 389.8s,  = -41.3°, Δ=  -8.5°
Larva 195, cast: t= 389.9s,  =  62.5°, Δ=  +0.2°
Larva 288, TURN: t= 393.9s,  = -73.9°, Δ= +83.0°
Larva 65, cast: t= 394.3s,  =  17.5°, Δ= +10.9°
Larva 184, cast: t= 394.3s,  = -43.4°, Δ= -28.6°
Larva 287, cast: t= 394.7s,  = 132.1°, Δ= +10.3°
Larva 195, cast: t= 396.6s,  =  62.8°, Δ=  -6.2°
Larva  3, TURN: t= 397.2s,  =-179.5°, Δ=+115.2°
Larva 23, cast: t= 398.5s,  =  16.3°, Δ=  -2.5°
Larva 26, cast: t= 403.3s,  =  17.9°, Δ= -19.3°
Larva 65, cast: t= 404.1s,  =  34.0°, Δ= +23.9°
Larva 307, cast: t= 405.5s,  = -84.4°, Δ= +15.5°
Larva 249, cast: t= 406.1s,  = -46.9°, Δ= +13.5°
Larva 195, cast: t= 407.4s,  =  56.4°, Δ= +12.4°
Larva 23, cast: t= 411.0s,  =  10.0°, Δ=  -4.4°
Larva 237, TURN: t= 411.3s,  = -70.0°, Δ= -69.8°
Larva 331, TURN: t= 412.1s,  = 144.7°, Δ= +67.0°
Larva 166, TURN: t= 412.8s,  = -36.6°, Δ= +66.0°
Larva 23, cast: t= 413.4s,  =  11.1°, Δ=  +1.0°
Larva 195, cast: t= 413.8s,  =  75.9°, Δ=  +0.6°
Larva 287, cast: t= 413.9s,  = 139.0°, Δ= -18.6°
Larva  3, cast: t= 414.7s,  = -49.0°, Δ=  -2.9°
Larva 65, TURN: t= 414.9s,  =  66.9°, Δ=-115.7°
Larva  3, cast: t= 416.4s,  = -58.9°, Δ=  +3.2°
Larva 23, cast: t= 417.9s,  =  12.8°, Δ=  +0.7°
Larva  3, cast: t= 418.0s,  = -59.1°, Δ= -34.2°
Larva 195, cast: t= 419.7s,  =  81.5°, Δ=  +5.9°
Larva  2, cast: t= 421.0s,  =  -2.2°, Δ= +39.9°
Larva 30, cast: t= 421.8s,  = -20.7°, Δ=  +5.6°
Larva 23, cast: t= 422.8s,  =  15.4°, Δ=  +2.2°
Larva 307, TURN: t= 423.2s,  = -76.1°, Δ= +45.5°
Larva 287, cast: t= 423.4s,  = 114.9°, Δ= -18.0°
Larva 29, cast: t= 425.4s,  =  86.0°, Δ= +18.2°
Larva  9, cast: t= 426.0s,  = -62.7°, Δ= +25.8°
Larva 287, cast: t= 427.8s,  =  98.8°, Δ= -29.9°
Larva 249, cast: t= 427.9s,  = -42.2°, Δ= +39.2°
Larva 30, cast: t= 428.4s,  = -10.3°, Δ= +10.0°
Larva 195, cast: t= 429.2s,  =  95.2°, Δ=  -1.6°
Larva 184, cast: t= 430.3s,  = -87.3°, Δ= +26.1°
Larva 237, TURN: t= 430.3s,  =-157.8°, Δ=-103.5°
Larva 331, cast: t= 432.7s,  =-137.7°, Δ= +12.7°
Larva 23, cast: t= 432.8s,  =   9.3°, Δ= -25.5°
Larva 166, cast: t= 433.1s,  =  28.5°, Δ=  -4.5°
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Larva 30, TURN: t= 434.5s,  =  -0.9°, Δ= -64.7°
Larva  2, cast: t= 435.0s,  =  65.7°, Δ= -26.2°
Larva  9, cast: t= 438.3s,  = -36.0°, Δ= -34.4°
Larva 287, cast: t= 439.2s,  =  59.4°, Δ=  +3.0°
Larva 26, cast: t= 439.4s,  = -41.5°, Δ= +27.2°
Larva 65, TURN: t= 442.2s,  = -38.6°, Δ= -46.5°
Larva 288, cast: t= 443.0s,  = -38.8°, Δ= +25.4°
Larva 195, cast: t= 446.8s,  =  96.2°, Δ=  -1.2°
Larva 249, TURN: t= 450.1s,  =  15.1°, Δ= -67.0°
Larva  2, cast: t= 451.7s,  =  27.5°, Δ= +25.6°
Larva 237, cast: t= 453.2s,  =  64.9°, Δ=  +0.4°
Larva 195, cast: t= 453.6s,  = 103.0°, Δ=  +4.7°
Larva 288, TURN: t= 454.2s,  = -10.3°, Δ= -49.9°
Larva 237, cast: t= 455.2s,  =  64.8°, Δ=  -7.5°
Larva  3, TURN: t= 455.6s,  = -69.6°, Δ= -77.6°
Larva 307, cast: t= 455.7s,  = -52.2°, Δ= +29.1°
Larva 287, cast: t= 456.5s,  =  64.6°, Δ= +15.2°
Larva 237, cast: t= 460.8s,  =  56.6°, Δ= -37.8°
Larva 23, cast: t= 463.4s,  = -27.7°, Δ=  -3.3°
Larva 331, cast: t= 463.6s,  = -88.0°, Δ=  -4.1°
Larva 65, TURN: t= 464.4s,  = -93.3°, Δ= +79.5°
Larva 249, cast: t= 466.7s,  = -65.4°, Δ= -25.3°
Larva 26, cast: t= 467.3s,  =  33.4°, Δ=  +6.7°
Larva 288, TURN: t= 471.8s,  = -72.3°, Δ=+161.9°
Larva 30, cast: t= 475.0s,  = -88.3°, Δ= +19.4°
Larva 307, cast: t= 475.7s,  = -22.5°, Δ= +32.4°
Larva  2, cast: t= 478.6s,  =  96.4°, Δ= -31.4°
Larva 26, cast: t= 479.1s,  =  51.9°, Δ= -25.0°
Larva 29, cast: t= 483.0s,  = 113.9°, Δ=  +3.9°
Larva 65, TURN: t= 483.2s,  =   8.3°, Δ= +93.5°
Larva 287, cast: t= 484.7s,  =  87.8°, Δ= -11.3°
Larva 331, cast: t= 485.4s,  =-117.1°, Δ= +13.0°
Larva 29, cast: t= 487.0s,  = 122.8°, Δ= -15.9°
Larva 237, cast: t= 490.1s,  = -14.6°, Δ= -11.4°
Larva 249, TURN: t= 490.6s,  = -93.5°, Δ=-147.0°
Larva 166, cast: t= 490.7s,  =  31.1°, Δ=  -5.7°
Larva 195, cast: t= 491.7s,  = 114.5°, Δ=  -4.1°
Larva  2, TURN: t= 494.6s,  =  64.8°, Δ= +58.4°
Larva 287, cast: t= 496.5s,  =  66.6°, Δ= +27.7°
Larva 288, cast: t= 497.7s,  =  79.7°, Δ=  +7.3°
Larva 65, cast: t= 499.6s,  = 111.7°, Δ=  -1.7°
Larva 29, cast: t= 500.4s,  = 108.7°, Δ=  -6.6°
Larva 331, cast: t= 500.7s,  = -91.5°, Δ=  -2.2°
Larva 307, TURN: t= 501.7s,  =  -8.6°, Δ= -64.5°
Larva 237, cast: t= 501.8s,  = -21.7°, Δ= +10.9°
Larva 65, TURN: t= 502.0s,  = 109.6°, Δ=-108.4°
Larva 288, TURN: t= 504.4s,  =  91.4°, Δ= -54.7°
Larva 331, TURN: t= 504.4s,  = -93.5°, Δ= -66.9°
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Larva  9, cast: t= 505.0s,  = -57.9°, Δ= -39.2°
Larva 23, cast: t= 505.2s,  = -33.3°, Δ=  +2.5°
Larva 166, cast: t= 505.4s,  =  13.6°, Δ= -15.0°
Larva 29, cast: t= 505.9s,  =  99.6°, Δ= -16.8°
Larva 30, cast: t= 508.4s,  = -61.5°, Δ= +36.3°
Larva 26, TURN: t= 511.4s,  =  17.7°, Δ= -77.5°
Larva 195, cast: t= 511.7s,  = 103.8°, Δ=  -0.5°
Larva 249, TURN: t= 514.1s,  = 106.9°, Δ=-138.4°
Larva 307, TURN: t= 514.1s,  = -56.4°, Δ= +63.4°
Larva  2, TURN: t= 516.9s,  = 134.4°, Δ=+119.7°
Larva 195, cast: t= 517.3s,  = 102.1°, Δ=  +3.7°
Larva 166, cast: t= 519.1s,  =  -2.9°, Δ= -19.4°
Larva 195, TURN: t= 520.9s,  = 118.8°, Δ= -89.0°
Larva 237, cast: t= 526.3s,  = -11.3°, Δ= +17.8°
Larva 331, TURN: t= 526.8s,  =-170.2°, Δ= -73.6°
Larva 23, cast: t= 528.6s,  = -37.0°, Δ=  +2.9°
Larva 23, cast: t= 531.3s,  = -34.8°, Δ=  +0.1°
Larva 29, cast: t= 531.3s,  =  53.8°, Δ=  -7.7°
Larva 287, cast: t= 531.7s,  =  96.1°, Δ=  +8.2°
Larva 65, cast: t= 535.0s,  =  -8.7°, Δ= +40.1°
Larva 184, cast: t= 535.4s,  =-126.2°, Δ= +26.0°
Larva 23, cast: t= 535.6s,  = -30.0°, Δ=  -4.9°
Larva 249, cast: t= 536.3s,  = -35.2°, Δ= +13.7°
Larva 23, cast: t= 537.7s,  = -37.0°, Δ=  +1.5°
Larva 26, cast: t= 538.1s,  = -97.3°, Δ= +12.4°
Larva 307, TURN: t= 541.1s,  =  34.2°, Δ= +51.6°
Larva 331, cast: t= 541.9s,  = 109.4°, Δ= -16.6°
Larva  2, TURN: t= 542.2s,  = -78.0°, Δ= +65.2°
Larva 29, cast: t= 542.2s,  =  43.4°, Δ= -23.6°
Larva 288, cast: t= 543.4s,  =  14.1°, Δ=  -2.4°
Larva 23, cast: t= 543.6s,  = -42.2°, Δ=  +5.1°
Larva 166, cast: t= 545.3s,  = -26.5°, Δ=  +5.5°
Larva 287, cast: t= 545.5s,  = 110.8°, Δ= -12.8°
Larva 23, cast: t= 547.0s,  = -43.4°, Δ=  +3.1°
Larva 23, cast: t= 548.2s,  = -40.5°, Δ=  -2.6°
Larva 331, cast: t= 548.3s,  =  93.3°, Δ= -40.5°
Larva 237, cast: t= 548.7s,  =  17.0°, Δ=  +4.7°
Larva 23, cast: t= 549.0s,  = -43.5°, Δ=  -6.7°
Larva 23, cast: t= 550.1s,  = -44.2°, Δ=  -4.1°
Larva 65, TURN: t= 550.2s,  =  50.5°, Δ= -56.1°
Larva 166, cast: t= 551.1s,  = -27.7°, Δ=  +8.4°
Larva 195, cast: t= 553.0s,  =  22.9°, Δ= -34.7°
Larva 26, TURN: t= 553.3s,  = -53.1°, Δ= +54.1°
Larva 23, cast: t= 553.4s,  = -49.1°, Δ=  +2.9°
Larva 23, cast: t= 557.2s,  = -45.8°, Δ=  -4.1°
Larva 166, cast: t= 557.3s,  = -15.2°, Δ=  +3.6°
Larva 195, cast: t= 558.0s,  = -10.4°, Δ= -11.0°
Larva 65, cast: t= 560.7s,  =  -3.5°, Δ= +25.7°
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  Larva 331, cast: t= 561.8s,  =  42.3°, Δ= +35.3°
  Larva 23, cast: t= 562.1s,  = -57.5°, Δ=  +4.5°
  Larva 249, cast: t= 562.8s,  =   6.6°, Δ= +25.7°
  Larva 307, TURN: t= 563.2s,  =  95.9°, Δ= -71.9°
  Larva 166, cast: t= 563.4s,  =  -8.8°, Δ=  +1.0°
  Larva 29, cast: t= 565.0s,  =   7.4°, Δ=  +1.7°
  Larva 184, cast: t= 565.0s,  =-108.4°, Δ=  -8.4°
  Larva 288, cast: t= 567.3s,  = -18.1°, Δ= +26.1°
  Larva 166, cast: t= 567.4s,  =  -4.9°, Δ=  +6.4°
  Larva 26, TURN: t= 567.8s,  =  10.8°, Δ= +51.8°
  Larva 23, cast: t= 568.5s,  = -48.8°, Δ=  -0.3°
  Larva  9, cast: t= 569.4s,  =-110.7°, Δ= -33.8°
  Larva 195, cast: t= 569.7s,  = -48.1°, Δ=  -0.2°
  Larva  2, TURN: t= 570.5s,  =  -0.2°, Δ=+105.5°
  Larva 184, cast: t= 573.9s,  =-133.6°, Δ=  -8.9°
  Larva 237, cast: t= 574.1s,  =  22.6°, Δ=  -1.0°
  Larva 23, cast: t= 577.6s,  = -53.5°, Δ=  -2.8°
  Larva 30, cast: t= 578.6s,  = -26.5°, Δ= +33.4°
  Larva 307, cast: t= 578.7s,  =  23.5°, Δ= -13.9°
  Larva 331, cast: t= 579.1s,  =  92.2°, Δ=  -0.5°
  Larva 237, cast: t= 580.6s,  =  21.8°, Δ= -44.8°
  Larva 29, cast: t= 581.4s,  =  21.9°, Δ= +10.1°
  Larva 287, cast: t= 581.7s,  = 154.8°, Δ=  +7.1°
  Larva 184, cast: t= 583.0s,  =-159.7°, Δ= +31.0°
  Larva  9, cast: t= 583.4s,  =-145.8°, Δ= +42.6°
  Larva 23, cast: t= 584.0s,  = -54.7°, Δ=  -0.1°
  Larva 65, TURN: t= 585.1s,  =  45.4°, Δ= +79.6°
  Larva 26, TURN: t= 585.4s,  =  85.4°, Δ= -45.5°
  Larva 23, cast: t= 585.7s,  = -54.7°, Δ= +13.4°
  Larva  2, cast: t= 587.2s,  = 126.4°, Δ= -18.9°
  Larva 29, cast: t= 589.9s,  =  39.8°, Δ= +21.5°
  Larva 331, cast: t= 592.6s,  =  97.9°, Δ= +12.0°
  Larva 195, cast: t= 592.9s,  = -48.2°, Δ=  +5.4°
  Larva 23, cast: t= 593.2s,  = -42.5°, Δ=  -0.3°
  Larva 184, cast: t= 593.7s,  =-119.9°, Δ=  +5.7°
  Larva 23, cast: t= 594.3s,  = -45.2°, Δ=  +0.6°
  Larva  9, cast: t= 594.9s,  = -84.6°, Δ= -43.0°
  Larva 23, cast: t= 595.4s,  = -40.4°, Δ=  +5.6°
  Larva 288, cast: t= 595.9s,  =  35.1°, Δ= -15.9°
  Larva 26, cast: t= 596.4s,  =  40.8°, Δ=  +8.5°
  Larva 23, cast: t= 599.9s,  = -34.5°, Δ=  -0.3°
  Larva 166, cast: t= 600.5s,  =  23.5°, Δ=  +0.1°
  Larva 249, cast: t= 600.6s,  =  45.3°, Δ=  -5.2°

Turns per orientation bin:
  -175.0°:  4 turns (mean Δ = 111.2°)
  -165.0°:  2 turns (mean Δ = 130.0°)
  -155.0°:  2 turns (mean Δ =  97.3°)
```

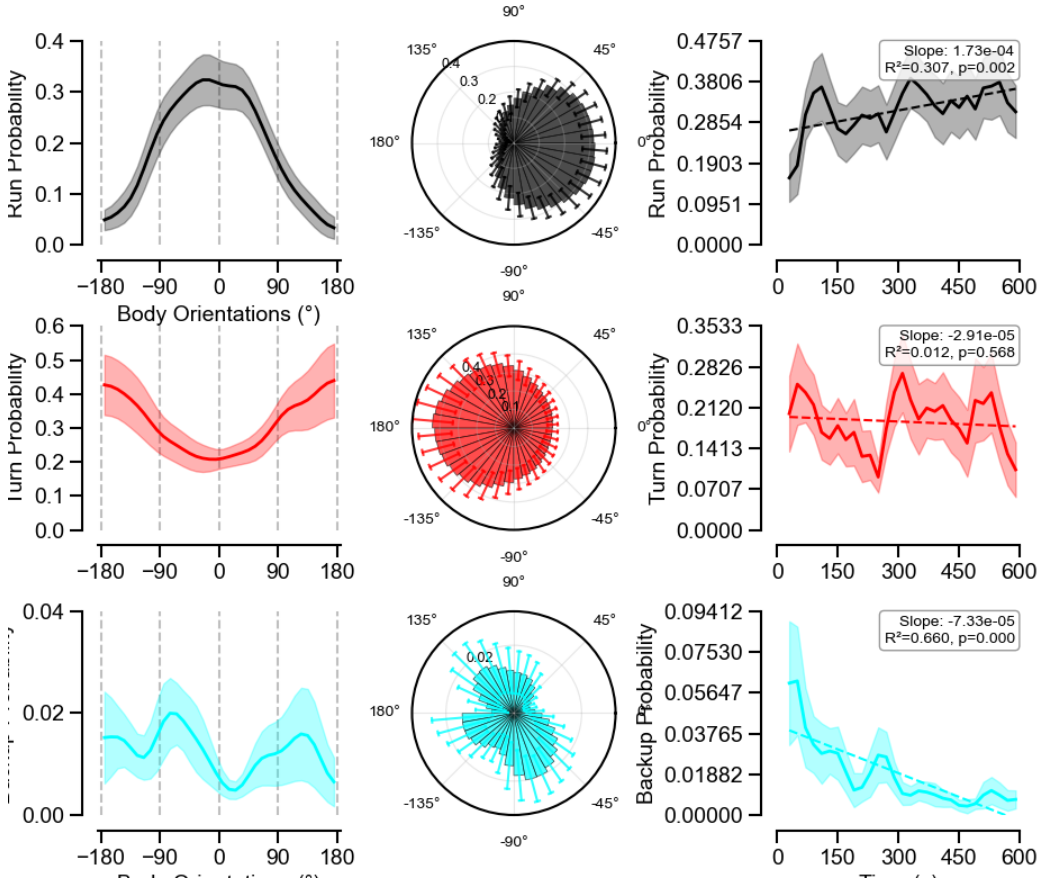
```
-145.0°:  4 turns (mean Δ = 112.7°)
-135.0°:  2 turns (mean Δ =  83.2°)
-115.0°:  1 turns (mean Δ =  49.1°)
-105.0°:  1 turns (mean Δ =  47.6°)
 -95.0°:  3 turns (mean Δ =  97.8°)
 -85.0°:  1 turns (mean Δ = 145.6°)
 -75.0°:  9 turns (mean Δ =  82.8°)
 -65.0°:  4 turns (mean Δ =  62.2°)
 -55.0°:  6 turns (mean Δ =  69.0°)
 -45.0°:  2 turns (mean Δ =  95.1°)
 -35.0°:  7 turns (mean Δ =  63.2°)
 -25.0°:  2 turns (mean Δ = 122.2°)
 -15.0°:  7 turns (mean Δ =  71.3°)
  -5.0°:  6 turns (mean Δ =  73.4°)
   5.0°:  4 turns (mean Δ =  72.0°)
  15.0°:  5 turns (mean Δ =  69.4°)
  25.0°:  4 turns (mean Δ =  70.8°)
  35.0°:  2 turns (mean Δ =  52.4°)
  45.0°:  3 turns (mean Δ =  99.1°)
  55.0°:  1 turns (mean Δ =  56.1°)
  65.0°:  5 turns (mean Δ =  75.6°)
  75.0°:  1 turns (mean Δ =  63.4°)
  85.0°:  3 turns (mean Δ = 116.0°)
  95.0°:  3 turns (mean Δ =  93.4°)
 105.0°:  5 turns (mean Δ =  85.0°)
 115.0°:  4 turns (mean Δ =  79.3°)
 125.0°:  1 turns (mean Δ =  85.6°)
 135.0°:  2 turns (mean Δ = 129.3°)
 145.0°:  1 turns (mean Δ =  67.0°)
```

[10]:
```python
# Create figure with asymmetric spacing - polar plots closer to left
fig = plt.figure(figsize=(10, 8))
gs = GridSpec(3, 3, figure=fig,
              left=0.08, right=0.90,
              top=0.93, bottom=0.07,
              wspace=0.4,               # Reduced overall spacing
              hspace=0.4,
              width_ratios=[0.6, 0.6, 0.6])  # Left wide, middle narrow, right␣
 ↪wide

# Row 1: Run analysis
ax1 = fig.add_subplot(gs[0, 0])
ax2 = fig.add_subplot(gs[0, 1], projection='polar')
ax7 = fig.add_subplot(gs[0, 2])
```

```
plot_data.plot_orientation_histogram(run_prob_results, plot_type='run', ax =␣
 ↪ax1)
plot_data.plot_orientation_histogram_polar(run_prob_results, plot_type='run',␣
 ↪ax=ax2, bar_style=True, tick_fontsize=10)
ax2_pos = ax2.get_position()
ax2.set_position([ax2_pos.x0 - 0.04, ax2_pos.y0, ax2_pos.width, ax2_pos.height])


plot_data.plot_metric_over_time(run_prob_time_results, plot_type='run', ax=ax7,␣
 ↪show_xlabel=False)


# Row 2: Turn analysis
ax3 = fig.add_subplot(gs[1, 0])
ax4 = fig.add_subplot(gs[1, 1], projection='polar')
ax8 = fig.add_subplot(gs[1, 2])

plot_data.plot_orientation_histogram(turn_prob_results, plot_type='turn',␣
 ↪ax=ax3, ylabel='Turn Probability', show_xlabel=False)

plot_data.plot_orientation_histogram_polar(turn_prob_results, plot_type='turn',␣
 ↪ax=ax4, bar_style=True, tick_fontsize=10)
ax4_pos = ax4.get_position()
ax4.set_position([ax4_pos.x0 - 0.04, ax4_pos.y0, ax4_pos.width, ax4_pos.height])

plot_data.plot_metric_over_time(turn_prob_time_results, plot_type='turn',␣
 ↪ax=ax8, show_xlabel=False)

# Row 3: Backup analysis
ax5 = fig.add_subplot(gs[2, 0])
ax6 = fig.add_subplot(gs[2, 1], projection='polar')
ax9 = fig.add_subplot(gs[2, 2])


plot_data.plot_orientation_histogram(backup_prob_results, ax=ax5,␣
 ↪ylabel='Backup Probability', color = 'cyan',show_xlabel=True)

plot_data.plot_orientation_histogram_polar(backup_prob_results,␣
 ↪plot_type='backup', ax=ax6, bar_style=True, tick_fontsize=10)
ax6_pos = ax6.get_position()
ax6.set_position([ax6_pos.x0 - 0.04, ax6_pos.y0, ax6_pos.width, ax6_pos.height])
plot_data.plot_metric_over_time(backup_prob_time_results, plot_type='backup',␣
 ↪ax=ax9, show_xlabel=True)

fig.savefig(os.path.join(output_dir, 'behavioral_analysis_summary.pdf'),
            bbox_inches='tight',
```

```
            dpi=300,
            transparent=True,       # Transparent background
            facecolor='none')       # No face color

print(f"Saved to: {output_dir}")
```

```
Saved to: /Users/sharbat/Projects/anemotaxis/data/FCF_attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses
```



[11]:
```
# Analyze turn amplitude by orientation and over time
turn_amp_results = data_processor.analyze_turn_amplitudes_by_orientation(
    trx_filtered_by_merging, bin_width=20, sigma=0.1, min_turn_amplitude=45
)
turn_amp_time_results = data_processor.analyze_turn_amplitudes_over_time(
    trx_filtered_by_merging, window=60, step=20, min_turn_amplitude=45
)


# Analyze run velocity by orientation and over time
```

```
velocity_results = data_processor.analyze_run_velocity_by_orientation(
    trx_filtered_by_merging, bin_width=15, sigma=2
)

velocity_results_pooled = data_processor.
 ↪analyze_run_velocity_by_orientation_pooled(
    trx_filtered_by_merging, bin_width=15, sigma=2
)
velocity_time_results = data_processor.analyze_run_velocity_over_time(
    trx_filtered_by_merging, window=60, step=20
)
```

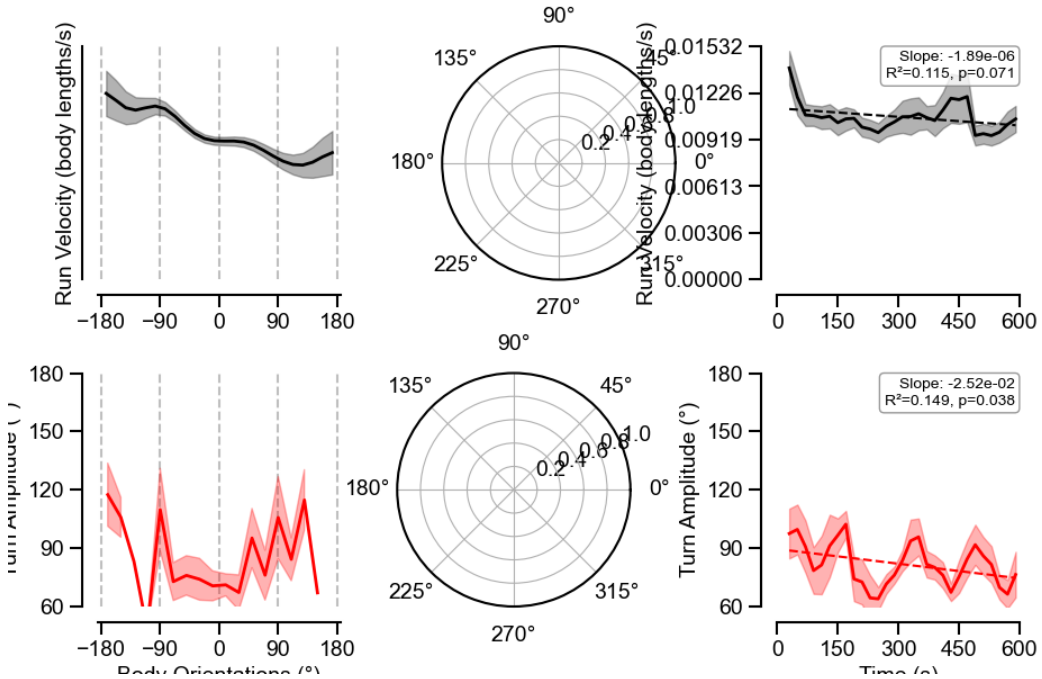
```
/Users/sharbat/Projects/anemotaxis/src/core/data_processor.py:1023:
RuntimeWarning: Mean of empty slice
  mean_hist = np.nanmean(hist_arrays, axis=0)
/Users/sharbat/Projects/anemotaxis/src/core/data_processor.py:1024:
SmallSampleWarning: After omitting NaNs, one or more axis-slices of one or more
sample arguments is too small; corresponding elements of returned arrays will be
NaN. See documentation for sample size requirements.
  se_hist = stats.sem(hist_arrays, axis=0, nan_policy='omit')
```

[12]:
```
# Create combined figure with asymmetric spacing - polar plots closer to left
fig_combined = plt.figure(figsize=(10, 6))
gs_combined = GridSpec(2, 3, figure=fig_combined,
                       left=0.08, right=0.90,
                       top=0.93, bottom=0.10,
                       wspace=0.4,               # Reduced overall spacing
                       hspace=0.4,
                       width_ratios=[0.6, 0.6, 0.6])  # Left wide, middle␣
 ↪narrow, right wide

# Row 1: Run Velocity Analysis
ax_vel1 = fig_combined.add_subplot(gs_combined[0, 0])
ax_vel2 = fig_combined.add_subplot(gs_combined[0, 1], projection='polar')
ax_vel3 = fig_combined.add_subplot(gs_combined[0, 2])


# Linear plot
plot_data.plot_orientation_histogram(velocity_results_pooled, ax=ax_vel1,␣
 ↪show_xlabel=False, ylabel='Run Velocity (body lengths/s)')
ax_vel1.set_ylim(0.005,0.015)
# ax_vel1_y_ticks = [0.01, 0.011, 0.012, 0.013, 0.014]
# ax_vel1.set_yticks(ax_vel1_y_ticks)

# Polar plot
# plot_data.plot_orientation_histogram_polar(velocity_results_pooled,␣
 ↪ax=ax_vel2, bar_style=True, tick_fontsize=10)
```

```
# ax_vel2_pos = ax_vel2.get_position()
# ax_vel2.set_position([ax_vel2_pos.x0 - 0.04, ax_vel2_pos.y0, ax_vel2_pos.
 ↪width, ax_vel2_pos.height])

# Time series plot
plot_data.plot_metric_over_time(
    velocity_time_results, color = 'black',ylabel='Run Velocity (body lengths/
 ↪s)',
    show_individuals=False, show_error=True, ax=ax_vel3, show_xlabel=False
)

# Row 2: Turn Amplitude Analysis
ax_amp1 = fig_combined.add_subplot(gs_combined[1, 0])
ax_amp2 = fig_combined.add_subplot(gs_combined[1, 1], projection='polar')
ax_amp3 = fig_combined.add_subplot(gs_combined[1, 2])

# Set minimum amplitude
min_amp = 60

# Check if we have ANY valid (non-NaN) data
if turn_amp_results and 'mean_hist' in turn_amp_results:
    mean_hist = np.array(turn_amp_results['mean_hist'])
    has_data = np.any(~np.isnan(mean_hist))
else:
    has_data = False


# Linear plot
plot_data.plot_orientation_histogram(turn_amp_results, ax=ax_amp1, ylabel='Turn␣
 ↪Amplitude (°)',
                                     show_xlabel=True, min_amplitude=min_amp,␣
 ↪plot_type='turn_amplitude')

# Polar plot - only if there's valid data
# plot_data.plot_orientation_histogram_polar(turn_amp_results, ax=ax_amp2,␣
 ↪bar_style=True,
#                                      tick_fontsize=10, min_amplitude=min_amp,␣
 ↪plot_type='turn_amplitude')
ax_amp2_pos = ax_amp2.get_position()
ax_amp2.set_position([ax_amp2_pos.x0 - 0.04, ax_amp2_pos.y0, ax_amp2_pos.width,␣
 ↪ax_amp2_pos.height])

# Time series plot
plot_data.plot_metric_over_time(
    turn_amp_time_results, plot_type='turn_amplitude',
    show_individuals=False, show_error=True, ax=ax_amp3, show_xlabel=True,
```

```
    min_amplitude=min_amp
)


# Save the combined figure
fig_combined.savefig(os.path.join(output_dir, 'velocity_amplitude_analysis.
  ↪pdf'),
                     bbox_inches='tight',
                     dpi=300,
                     transparent=True,
                     facecolor='none')
print(f"Combined velocity & amplitude figure saved to: {os.path.
  ↪join(output_dir, 'velocity_amplitude_analysis.pdf')}")

plt.show()
```

```
Combined velocity & amplitude figure saved to: /Users/sharbat/Projects/anemotaxi
s/data/FCF_attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/velocit
y_amplitude_analysis.pdf
```

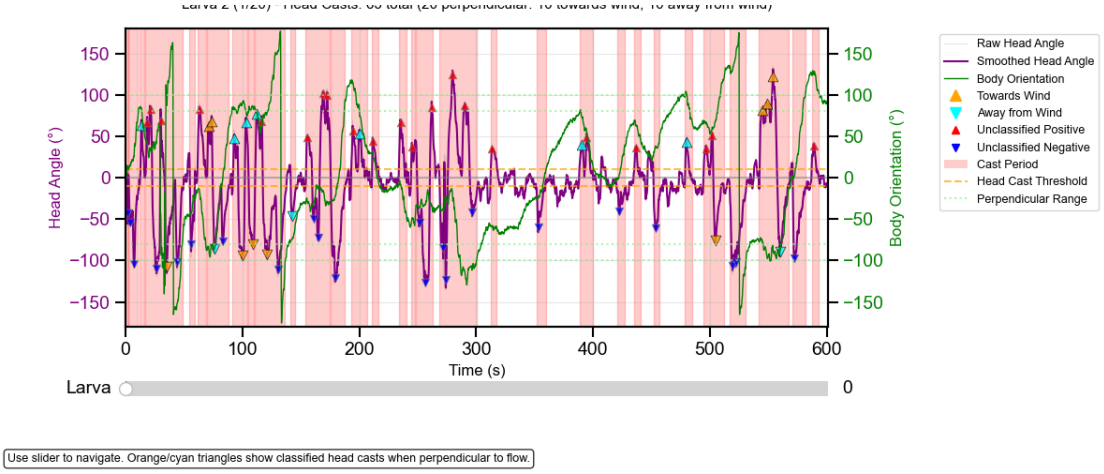


[13]:
```
# Detect head casts with new method
cast_events_data = data_processor.detect_head_casts_in_casts(
    trx_filtered_by_merging,
    peak_threshold=10.0,
```

```
    peak_prominence=10.0,
    smooth_sigma=10
)

# Plot with individual subplots
fig = plot_data.plot_cast_detection_results(
    trx_filtered_by_merging,
    cast_events_data,
    figsize=(12,5),
    save_path=os.path.join(output_dir, 'cast_detection_all_larvae.pdf'),
    time_range=None  # Full time range
)
```

```
 Head Cast Detection Summary (with Turn Detection)
================================================================================
Larva  2: 31 cast periods (13 turns),  63 head casts (20 perpendicular: 10
towards [50.0%], 10 away [50.0%])
Larva  3: 21 cast periods ( 7 turns),  24 head casts ( 8 perpendicular:  2
towards [25.0%],  6 away [75.0%])
Larva  6: 26 cast periods ( 6 turns),  59 head casts ( 6 perpendicular:  1
towards [16.7%],  5 away [83.3%])
Larva  9: 25 cast periods ( 4 turns),  42 head casts ( 9 perpendicular:  4
towards [44.4%],  5 away [55.6%])
Larva 21: 30 cast periods ( 7 turns),  37 head casts (10 perpendicular:  4
towards [40.0%],  6 away [60.0%])
Larva 23: 55 cast periods ( 2 turns),  34 head casts ( 3 perpendicular:  3
towards [100.0%],  0 away [0.0%])
Larva 25: 21 cast periods ( 4 turns),  23 head casts ( 6 perpendicular:  1
towards [16.7%],  5 away [83.3%])
Larva 26: 36 cast periods (10 turns),  66 head casts (10 perpendicular:  4
towards [40.0%],  6 away [60.0%])
Larva 29: 25 cast periods ( 4 turns),  34 head casts ( 6 perpendicular:  4
towards [66.7%],  2 away [33.3%])
Larva 30: 26 cast periods ( 5 turns),  32 head casts ( 6 perpendicular:  2
towards [33.3%],  4 away [66.7%])
Larva 65: 25 cast periods (10 turns),  38 head casts ( 9 perpendicular:  3
towards [33.3%],  6 away [66.7%])
Larva 166: 26 cast periods ( 1 turns),  17 head casts ( 1 perpendicular:  0
towards [0.0%],  1 away [100.0%])
Larva 184: 24 cast periods ( 1 turns),  24 head casts ( 4 perpendicular:  2
towards [50.0%],  2 away [50.0%])
Larva 195: 48 cast periods ( 2 turns),  20 head casts ( 4 perpendicular:  1
towards [25.0%],  3 away [75.0%])
Larva 237: 24 cast periods ( 7 turns),  39 head casts ( 6 perpendicular:  4
towards [66.7%],  2 away [33.3%])
Larva 249: 21 cast periods ( 4 turns),  32 head casts ( 4 perpendicular:  2
towards [50.0%],  2 away [50.0%])
Larva 287: 19 cast periods ( 1 turns),  30 head casts (14 perpendicular:  7
```

```
towards [50.0%],  7 away [50.0%])
Larva 288: 17 cast periods ( 8 turns),  24 head casts ( 6 perpendicular:  3
towards [50.0%],  3 away [50.0%])
Larva 307: 14 cast periods ( 6 turns),  25 head casts ( 3 perpendicular:  0
towards [0.0%],  3 away [100.0%])
Larva 331: 20 cast periods ( 5 turns),  36 head casts (18 perpendicular: 11
towards [61.1%],  7 away [38.9%])
--------------------------------------------------------------------------------
TOTAL:     534 cast periods (107 turns), 699 head casts (153 perpendicular)
Overall:   68 towards [44.4%], 85 away [55.6%]
Mean across larvae: 40.9% ± 5.3% towards, 59.1% ± 5.3% away (n=20 larvae)
Average head casts per larva: 35.0
Average head casts per cast period: 1.3
Turn rate: 20.0% (107/534 casts)
  Saved: /Users/sharbat/Projects/anemotaxis/data/FCF_attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/cast_de
tection_all_larvae.pdf
```



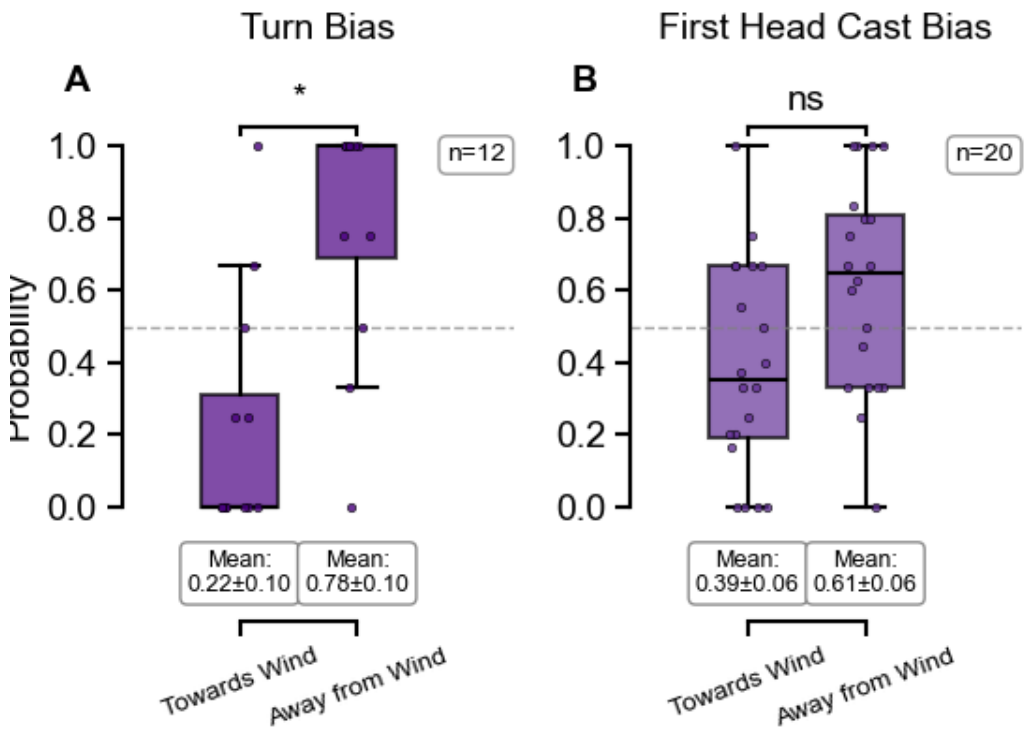
[14]:
```python
# Analyze first head cast bias
bias_results_first = data_processor.analyze_head_cast_bias(
    cast_events_data,
    analysis_type='first'
)

# NEW: Analyze turn bias from perpendicular orientations
bias_results_turn = data_processor.analyze_head_cast_bias(
    cast_events_data,
    analysis_type='turn'
)

# Create 1x2 figure layout for first head cast bias and turn bias only
```

```
fig_bias = plt.figure(figsize=(6, 4))  # Reduced width for 2 plots
gs_bias = GridSpec(1, 2, figure=fig_bias,
                   left=0.10, right=0.90,  # Adjusted margins
                   top=0.85, bottom=0.15,
                   wspace=0.3)  # Spacing for 2 plots

# Plot turn bias (first panel)
ax_bias1 = fig_bias.add_subplot(gs_bias[0, 0])
plot_data.plot_head_cast_bias_perpendicular(
    bias_results_turn,
    ax=ax_bias1,
    title='Turn Bias'
)
ax_bias1.text(-0.15, 1.05, 'A', transform=ax_bias1.transAxes,
              fontsize=14, fontweight='bold', va='top', ha='left')

# Plot first head cast bias (second panel)
ax_bias2 = fig_bias.add_subplot(gs_bias[0, 1])
plot_data.plot_head_cast_bias_perpendicular(
    bias_results_first,
    ax=ax_bias2,
    title='First Head Cast Bias'
)
ax_bias2.text(-0.15, 1.05, 'B', transform=ax_bias2.transAxes,
              fontsize=14, fontweight='bold', va='top', ha='left')
ax_bias2.set_ylabel('')  # Remove y-label for second plot

# Save the combined figure
fig_bias.savefig(os.path.join(output_dir, 'head_cast_bias_first_and_turn.pdf'),
                 bbox_inches='tight',
                 dpi=300,
                 transparent=True,
                 facecolor='none')
print(f"First head cast bias and turn bias figure saved to: {os.path.
  ↪join(output_dir, 'head_cast_bias_first_and_turn.pdf')}")

plt.show()
```

```
 First Head Cast Bias Analysis
============================================================
Larva  2:  9 first perpendicular head casts ( 3 towards [33.3%],  6 away
[66.7%])
Larva  3:  5 first perpendicular head casts ( 2 towards [40.0%],  3 away
[60.0%])
Larva  6:  2 first perpendicular head casts ( 0 towards [0.0%],  2 away
[100.0%])
Larva  9:  4 first perpendicular head casts ( 3 towards [75.0%],  1 away
```

```
[25.0%])
Larva 21:  5 first perpendicular head casts ( 1 towards [20.0%],  4 away
[80.0%])
Larva 23:  1 first perpendicular head casts ( 1 towards [100.0%],  0 away
[0.0%])
Larva 25:  6 first perpendicular head casts ( 1 towards [16.7%],  5 away
[83.3%])
Larva 26:  2 first perpendicular head casts ( 1 towards [50.0%],  1 away
[50.0%])
Larva 29:  3 first perpendicular head casts ( 2 towards [66.7%],  1 away
[33.3%])
Larva 30:  3 first perpendicular head casts ( 1 towards [33.3%],  2 away
[66.7%])
Larva 65:  5 first perpendicular head casts ( 1 towards [20.0%],  4 away
[80.0%])
Larva 166:  1 first perpendicular head casts ( 0 towards [0.0%],  1 away
[100.0%])
Larva 184:  3 first perpendicular head casts ( 2 towards [66.7%],  1 away
[33.3%])
Larva 195:  1 first perpendicular head casts ( 0 towards [0.0%],  1 away
[100.0%])
Larva 237:  3 first perpendicular head casts ( 2 towards [66.7%],  1 away
[33.3%])
Larva 249:  3 first perpendicular head casts ( 2 towards [66.7%],  1 away
[33.3%])
Larva 287:  8 first perpendicular head casts ( 3 towards [37.5%],  5 away
[62.5%])
Larva 288:  4 first perpendicular head casts ( 1 towards [25.0%],  3 away
[75.0%])
Larva 307:  2 first perpendicular head casts ( 0 towards [0.0%],  2 away
[100.0%])
Larva 331:  9 first perpendicular head casts ( 5 towards [55.6%],  4 away
[44.4%])

  Statistical Tests (n=17 larvae with  2 events):
    Wilcoxon signed-rank test: p=0.0738
      No significant bias detected (Wilcoxon p   0.05)
------------------------------------------------------------
TOTAL: 79 first perpendicular head casts
Overall: 31 towards [39.2%], 48 away [60.8%]
Mean across larvae: 38.7% ± 6.5% towards, 61.3% ± 6.5% away (n=20 larvae)

  Turn Head Cast Bias Analysis
============================================================
Larva  2:  4 turns ( 1 towards [25.0%],  3 away [75.0%])
Larva  3:  1 turns ( 0 towards [0.0%],  1 away [100.0%])
Larva  6:  1 turns ( 0 towards [0.0%],  1 away [100.0%])
Larva  9:  1 turns ( 0 towards [0.0%],  1 away [100.0%])
```

```
Larva 25:  2 turns ( 0 towards [0.0%],  2 away [100.0%])
Larva 26:  2 turns ( 0 towards [0.0%],  2 away [100.0%])
Larva 65:  3 turns ( 0 towards [0.0%],  3 away [100.0%])
Larva 237:  3 turns ( 2 towards [66.7%],  1 away [33.3%])
Larva 249:  2 turns ( 1 towards [50.0%],  1 away [50.0%])
Larva 288:  4 turns ( 1 towards [25.0%],  3 away [75.0%])
Larva 307:  2 turns ( 0 towards [0.0%],  2 away [100.0%])
Larva 331:  1 turns ( 1 towards [100.0%],  0 away [0.0%])

  Statistical Tests (n=8 larvae with  2 events):
    Wilcoxon signed-rank test: p=0.0312
      Significant bias away from wind (Wilcoxon p < 0.05)
------------------------------------------------------------
TOTAL: 26 perpendicular turns
Overall: 6 towards [23.1%], 20 away [76.9%]
Mean across larvae: 22.2% ± 9.6% towards, 77.8% ± 9.6% away (n=12 larvae)

=== MEDIANS AND QUARTILES ===
Towards Wind - Median: 0.000, Q1: 0.000, Q3: 0.312
Away from Wind - Median: 1.000, Q1: 0.688, Q3: 1.000

=== MEDIANS AND QUARTILES ===
Towards Wind - Median: 0.354, Q1: 0.192, Q3: 0.667
Away from Wind - Median: 0.646, Q1: 0.333, Q3: 0.808
First head cast bias and turn bias figure saved to: /Users/sharbat/Projects/anem
otaxis/data/FCF_attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/head_ca
st_bias_first_and_turn.pdf
```



[15]:
```
# # Analyze first head cast bias (POOLED)
# bias_results_first = data_processor.analyze_head_cast_bias_pooled(
#     cast_events_data,
#     analysis_type='first'
# )

# # Analyze last head cast bias (POOLED)
# bias_results_last = data_processor.analyze_head_cast_bias_pooled(
#     cast_events_data,
#     analysis_type='last'
# )

# # Analyze all head cast bias (POOLED)
# bias_results_all = data_processor.analyze_head_cast_bias_pooled(
#     cast_events_data,
#     analysis_type='all'
# )

# # Analyze turn bias from perpendicular orientations (POOLED)
# bias_results_turn = data_processor.analyze_head_cast_bias_pooled(
#     cast_events_data,
#     analysis_type='turn'
# )
```

```
# # Create 1x4 figure layout for all four bias analyses
# fig_bias = plt.figure(figsize=(12, 4))  # Increased width for 4 plots
# gs_bias = GridSpec(1, 4, figure=fig_bias,
#                    left=0.06, right=0.95,  # Adjusted margins
#                    top=0.85, bottom=0.15,
#                    wspace=0.25)  # Reduced spacing for 4 plots

# # Panel A: Turn bias (first panel)
# ax_bias1 = fig_bias.add_subplot(gs_bias[0, 0])
# plot_data.plot_head_cast_bias_perpendicular(
#     bias_results_turn,
#     ax=ax_bias1,
#     title='Turn Bias (Pooled)'
# )
# ax_bias1.text(-0.15, 1.05, 'A', transform=ax_bias1.transAxes,
#               fontsize=14, fontweight='bold', va='top', ha='left')

# # Panel B: First head cast bias (second panel)
# ax_bias2 = fig_bias.add_subplot(gs_bias[0, 1])
# plot_data.plot_head_cast_bias_perpendicular(
#     bias_results_first,
#     ax=ax_bias2,
#     title='First Head Cast Bias (Pooled)'
# )
# ax_bias2.text(-0.15, 1.05, 'B', transform=ax_bias2.transAxes,
#               fontsize=14, fontweight='bold', va='top', ha='left')
# ax_bias2.set_ylabel('')  # Remove y-label for middle plots

# # Panel C: All head cast bias (third panel)
# ax_bias3 = fig_bias.add_subplot(gs_bias[0, 2])
# plot_data.plot_head_cast_bias_perpendicular(
#     bias_results_all,
#     ax=ax_bias3,
#     title='All Head Cast Bias (Pooled)'
# )
# ax_bias3.text(-0.15, 1.05, 'C', transform=ax_bias3.transAxes,
#               fontsize=14, fontweight='bold', va='top', ha='left')
# ax_bias3.set_ylabel('')  # Remove y-label for middle plots

# # Panel D: Last head cast bias (fourth panel)
# ax_bias4 = fig_bias.add_subplot(gs_bias[0, 3])
# plot_data.plot_head_cast_bias_perpendicular(
#     bias_results_last,
#     ax=ax_bias4,
#     title='Last Head Cast Bias (Pooled)'
# )
```

```
# ax_bias4.text(-0.15, 1.05, 'D', transform=ax_bias4.transAxes,
#               fontsize=14, fontweight='bold', va='top', ha='left')
# ax_bias4.set_ylabel('')  # Remove y-label for rightmost plot

# # Save the combined figure
# fig_bias.savefig(os.path.join(output_dir,␣
 ↪'head_cast_bias_perpendicular_combined_pooled.pdf'),
#                  bbox_inches='tight',
#                  dpi=300,
#                  transparent=True,
#                  facecolor='none')
# print(f"Combined head cast bias figure (pooled) saved to: {os.path.
 ↪join(output_dir, 'head_cast_bias_perpendicular_combined_pooled.pdf')}")

# plt.show()
```

[16]:
```
# In your notebook cell, replace the existing head cast analysis with:

# Analyze head casts by cast start orientation - separated by turn success
head_cast_orientation_results = data_processor.
 ↪analyze_head_casts_by_orientation(
    trx_filtered_by_merging,
    bin_width=20,
    peak_threshold=10.0,
    peak_prominence=10.0,
    smooth_sigma=10,
    large_casts_only=True,
    separate_by_turn_success=True,  # NEW PARAMETER
    min_turn_amplitude=45
)

# Create combined figure for head cast analysis
fig_head_casts = plt.figure(figsize=(10, 4))
gs_head_casts = GridSpec(1, 3, figure=fig_head_casts,
                         left=0.08, right=0.90,
                         top=0.93, bottom=0.15,
                         wspace=0.4,
                         width_ratios=[0.6, 0.6, 0.6])

# Row 1: Head Cast Analysis
ax_hc1 = fig_head_casts.add_subplot(gs_head_casts[0, 0])
ax_hc2 = fig_head_casts.add_subplot(gs_head_casts[0, 1], projection='polar')
ax_hc3 = fig_head_casts.add_subplot(gs_head_casts[0, 2])

# Linear plot with turn success separation
plot_data.plot_head_cast_orientation_by_turn_success(
    head_cast_orientation_results,
```

```
    ax=ax_hc1,
    show_xlabel=True,
    ylabel='Head Cast Number',
    ylim=[0,8]
)

# Polar plot (use all casts for polar representation)
plot_data.plot_orientation_histogram_polar(head_cast_orientation_results,
                                           ax=ax_hc2,
                                           plot_type='head_cast',
                                           bar_style=True,
                                           tick_fontsize=10)
ax_hc2_pos = ax_hc2.get_position()
ax_hc2.set_position([ax_hc2_pos.x0 - 0.04, ax_hc2_pos.y0, ax_hc2_pos.width,␣
 ↪ax_hc2_pos.height])

# Time series plot (analyze head casts over time - this uses a different␣
 ↪function)
head_cast_time_results = data_processor.analyze_head_casts_over_time(
    trx_filtered_by_merging,
    window=60,
    step=20,
    peak_threshold=20.0,
    peak_prominence=3.0,
    smooth_sigma=4.0,
    large_casts_only=True
)

plot_data.plot_metric_over_time(
    head_cast_time_results, plot_type='head_cast', ylabel='Head Cast Rate (per␣
 ↪second)',
    show_individuals=False, show_error=True, ax=ax_hc3, show_xlabel=False
)

# Save the head cast analysis figure
fig_head_casts.savefig(os.path.join(output_dir,␣
 ↪'head_cast_analysis_by_turn_success.pdf'),
                       bbox_inches='tight',
                       dpi=300,
                       transparent=True,
                       facecolor='none')
print(f"Head cast analysis figure saved to: {os.path.join(output_dir,␣
 ↪'head_cast_analysis_by_turn_success.pdf')}")

plt.show()
```

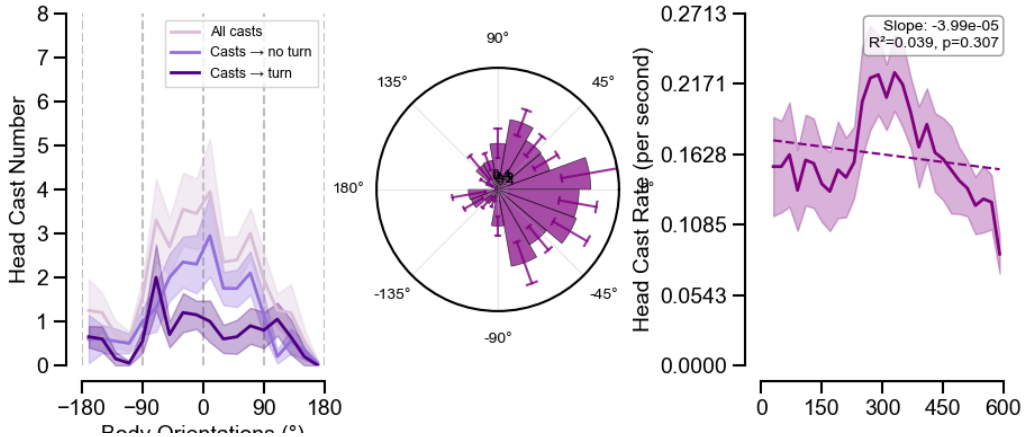
```
Head Cast Detection Summary (with Turn Detection)
```

```
================================================================================
Larva  2: 31 cast periods (13 turns),  63 head casts (20 perpendicular: 10
towards [50.0%], 10 away [50.0%])
Larva  3: 21 cast periods ( 7 turns),  24 head casts ( 8 perpendicular:  2
towards [25.0%],  6 away [75.0%])
Larva  6: 26 cast periods ( 6 turns),  59 head casts ( 6 perpendicular:  1
towards [16.7%],  5 away [83.3%])
Larva  9: 25 cast periods ( 4 turns),  42 head casts ( 9 perpendicular:  4
towards [44.4%],  5 away [55.6%])
Larva 21: 30 cast periods ( 7 turns),  37 head casts (10 perpendicular:  4
towards [40.0%],  6 away [60.0%])
Larva 23: 55 cast periods ( 2 turns),  34 head casts ( 3 perpendicular:  3
towards [100.0%],  0 away [0.0%])
Larva 25: 21 cast periods ( 4 turns),  23 head casts ( 6 perpendicular:  1
towards [16.7%],  5 away [83.3%])
Larva 26: 36 cast periods (10 turns),  66 head casts (10 perpendicular:  4
towards [40.0%],  6 away [60.0%])
Larva 29: 25 cast periods ( 4 turns),  34 head casts ( 6 perpendicular:  4
towards [66.7%],  2 away [33.3%])
Larva 30: 26 cast periods ( 5 turns),  32 head casts ( 6 perpendicular:  2
towards [33.3%],  4 away [66.7%])
Larva 65: 25 cast periods (10 turns),  38 head casts ( 9 perpendicular:  3
towards [33.3%],  6 away [66.7%])
Larva 166: 26 cast periods ( 1 turns),  17 head casts ( 1 perpendicular:  0
towards [0.0%],  1 away [100.0%])
Larva 184: 24 cast periods ( 1 turns),  24 head casts ( 4 perpendicular:  2
towards [50.0%],  2 away [50.0%])
Larva 195: 48 cast periods ( 2 turns),  20 head casts ( 4 perpendicular:  1
towards [25.0%],  3 away [75.0%])
Larva 237: 24 cast periods ( 7 turns),  39 head casts ( 6 perpendicular:  4
towards [66.7%],  2 away [33.3%])
Larva 249: 21 cast periods ( 4 turns),  32 head casts ( 4 perpendicular:  2
towards [50.0%],  2 away [50.0%])
Larva 287: 19 cast periods ( 1 turns),  30 head casts (14 perpendicular:  7
towards [50.0%],  7 away [50.0%])
Larva 288: 17 cast periods ( 8 turns),  24 head casts ( 6 perpendicular:  3
towards [50.0%],  3 away [50.0%])
Larva 307: 14 cast periods ( 6 turns),  25 head casts ( 3 perpendicular:  0
towards [0.0%],  3 away [100.0%])
Larva 331: 20 cast periods ( 5 turns),  36 head casts (18 perpendicular: 11
towards [61.1%],  7 away [38.9%])
--------------------------------------------------------------------------------
TOTAL:     534 cast periods (107 turns), 699 head casts (153 perpendicular)
Overall:   68 towards [44.4%], 85 away [55.6%]
Mean across larvae: 40.9% ± 5.3% towards, 59.1% ± 5.3% away (n=20 larvae)
Average head casts per larva: 35.0
Average head casts per cast period: 1.3
Turn rate: 20.0% (107/534 casts)
```

```
  Head Casts by Turn Success Analysis (Min turn: 45°)
================================================================================
Larva  2: 31 casts (13 turns, 18 non-turns, 41.9%)
           Head casts: 37 in successful turns, 26 in unsuccessful, 63 total
Larva  3: 21 casts ( 7 turns, 14 non-turns, 33.3%)
           Head casts: 15 in successful turns,  9 in unsuccessful, 24 total
Larva  6: 26 casts ( 6 turns, 20 non-turns, 23.1%)
           Head casts: 19 in successful turns, 40 in unsuccessful, 59 total
Larva  9: 25 casts ( 4 turns, 21 non-turns, 16.0%)
           Head casts: 11 in successful turns, 31 in unsuccessful, 42 total
Larva 21: 30 casts ( 7 turns, 23 non-turns, 23.3%)
           Head casts:  8 in successful turns, 29 in unsuccessful, 37 total
Larva 23: 55 casts ( 2 turns, 53 non-turns,  3.6%)
           Head casts:  1 in successful turns, 33 in unsuccessful, 34 total
Larva 25: 21 casts ( 4 turns, 17 non-turns, 19.0%)
           Head casts:  6 in successful turns, 17 in unsuccessful, 23 total
Larva 26: 36 casts (10 turns, 26 non-turns, 27.8%)
           Head casts: 25 in successful turns, 41 in unsuccessful, 66 total
Larva 29: 25 casts ( 4 turns, 21 non-turns, 16.0%)
           Head casts: 14 in successful turns, 20 in unsuccessful, 34 total
Larva 30: 26 casts ( 5 turns, 21 non-turns, 19.2%)
           Head casts: 13 in successful turns, 19 in unsuccessful, 32 total
Larva 65: 25 casts (10 turns, 15 non-turns, 40.0%)
           Head casts: 27 in successful turns, 11 in unsuccessful, 38 total
Larva 166: 26 casts ( 1 turns, 25 non-turns,  3.8%)
           Head casts:  0 in successful turns, 17 in unsuccessful, 17 total
Larva 184: 24 casts ( 1 turns, 23 non-turns,  4.2%)
           Head casts:  4 in successful turns, 20 in unsuccessful, 24 total
Larva 195: 48 casts ( 2 turns, 46 non-turns,  4.2%)
           Head casts:  6 in successful turns, 14 in unsuccessful, 20 total
Larva 237: 24 casts ( 7 turns, 17 non-turns, 29.2%)
           Head casts: 20 in successful turns, 19 in unsuccessful, 39 total
Larva 249: 21 casts ( 4 turns, 17 non-turns, 19.0%)
           Head casts:  9 in successful turns, 23 in unsuccessful, 32 total
Larva 287: 19 casts ( 1 turns, 18 non-turns,  5.3%)
           Head casts:  4 in successful turns, 26 in unsuccessful, 30 total
Larva 288: 17 casts ( 8 turns,  9 non-turns, 47.1%)
           Head casts: 14 in successful turns, 10 in unsuccessful, 24 total
Larva 307: 14 casts ( 6 turns,  8 non-turns, 42.9%)
           Head casts: 11 in successful turns, 14 in unsuccessful, 25 total
Larva 331: 20 casts ( 5 turns, 15 non-turns, 25.0%)
           Head casts: 14 in successful turns, 22 in unsuccessful, 36 total
--------------------------------------------------------------------------------
SUMMARY:
  Total cast events: 534
  Successful turns: 107 (20.0%)
  Unsuccessful casts: 427 (80.0%)
```

```
  Head casts in successful turns: 258
  Head casts in unsuccessful casts: 441
  Total head casts: 699
  Mean head casts per successful turn: 2.4
  Mean head casts per unsuccessful cast: 1.0
 Head Cast Detection Summary (with Turn Detection)
================================================================================
Larva  2: 31 cast periods (13 turns), 117 head casts (36 perpendicular: 18
towards [50.0%], 18 away [50.0%])
Larva  3: 21 cast periods ( 7 turns),  44 head casts (13 perpendicular:  5
towards [38.5%],  8 away [61.5%])
Larva  6: 26 cast periods ( 6 turns), 125 head casts (13 perpendicular:  6
towards [46.2%],  7 away [53.8%])
Larva  9: 25 cast periods ( 4 turns),  90 head casts (18 perpendicular:  7
towards [38.9%], 11 away [61.1%])
Larva 21: 30 cast periods ( 7 turns),  71 head casts (16 perpendicular:  6
towards [37.5%], 10 away [62.5%])
Larva 23: 55 cast periods ( 2 turns), 108 head casts ( 3 perpendicular:  3
towards [100.0%],  0 away [0.0%])
Larva 25: 21 cast periods ( 4 turns),  46 head casts (11 perpendicular:  5
towards [45.5%],  6 away [54.5%])
Larva 26: 36 cast periods (10 turns), 122 head casts (18 perpendicular:  8
towards [44.4%], 10 away [55.6%])
Larva 29: 25 cast periods ( 4 turns),  91 head casts (20 perpendicular:  9
towards [45.0%], 11 away [55.0%])
Larva 30: 26 cast periods ( 5 turns),  85 head casts (15 perpendicular:  2
towards [13.3%], 13 away [86.7%])
Larva 65: 25 cast periods (10 turns),  89 head casts (19 perpendicular:  6
towards [31.6%], 13 away [68.4%])
Larva 166: 26 cast periods ( 1 turns),  57 head casts ( 1 perpendicular:  0
towards [0.0%],  1 away [100.0%])
Larva 184: 24 cast periods ( 1 turns),  44 head casts ( 4 perpendicular:  1
towards [25.0%],  3 away [75.0%])
Larva 195: 48 cast periods ( 2 turns),  75 head casts (16 perpendicular:  9
towards [56.2%],  7 away [43.8%])
Larva 237: 24 cast periods ( 7 turns),  95 head casts (18 perpendicular:  9
towards [50.0%],  9 away [50.0%])
Larva 249: 21 cast periods ( 4 turns),  74 head casts (13 perpendicular:  7
towards [53.8%],  6 away [46.2%])
Larva 287: 19 cast periods ( 1 turns),  71 head casts (34 perpendicular: 14
towards [41.2%], 20 away [58.8%])
Larva 288: 17 cast periods ( 8 turns),  51 head casts (14 perpendicular:  9
towards [64.3%],  5 away [35.7%])
Larva 307: 14 cast periods ( 6 turns),  59 head casts ( 9 perpendicular:  0
towards [0.0%],  9 away [100.0%])
Larva 331: 20 cast periods ( 5 turns),  58 head casts (29 perpendicular: 15
towards [51.7%], 14 away [48.3%])
--------------------------------------------------------------------------------
```

```
TOTAL:     534 cast periods (107 turns), 1572 head casts (320 perpendicular)
Overall:   139 towards [43.4%], 181 away [56.6%]
Mean across larvae: 41.7% ± 4.9% towards, 58.3% ± 4.9% away (n=20 larvae)
Average head casts per larva: 78.6
Average head casts per cast period: 2.9
Turn rate: 20.0% (107/534 casts)
Head cast analysis figure saved to: /Users/sharbat/Projects/anemotaxis/data/FCF_
attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/head_ca
st_analysis_by_turn_success.pdf
```



[17]:
```python
# 1. Analyze NI over time
ni_time_results = data_processor.analyze_navigational_index_over_time(
    trx_filtered_by_merging, window=60, step=10, t_max=600
)

# 2. Analyze single NI values per larva
ni_single_results = data_processor.analyze_navigational_index_single_values(
    trx_filtered_by_merging, window=60, step=10, t_max=600
)

# 3. Plot time series
fig_time = plot_data.plot_navigational_index_over_time(
    ni_time_results,
    save_path=os.path.join(output_dir, 'ni_over_time.pdf')
)

# 4. Plot box plots
fig_box = plot_data.plot_navigational_index_boxplot(
    ni_single_results,
    save_path=os.path.join(output_dir, 'ni_boxplot.pdf')
)
```

Figure saved to /Users/sharbat/Projects/anemotaxis/data/FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/ni_over_time.pdf

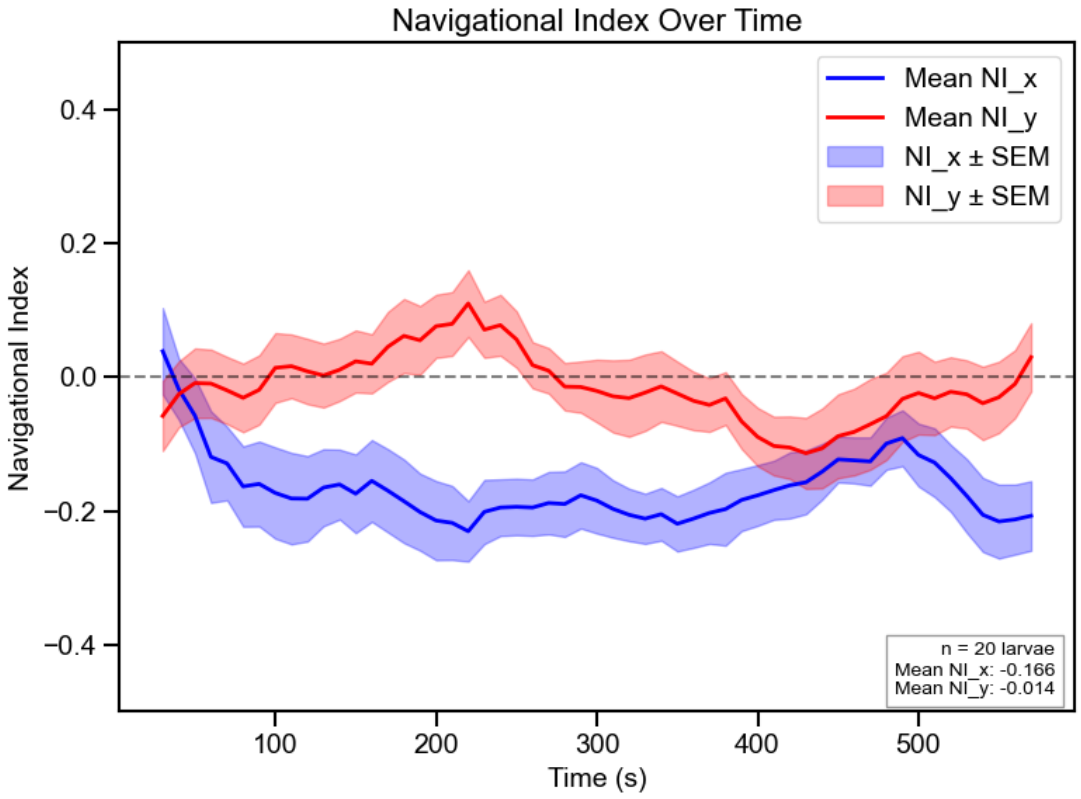
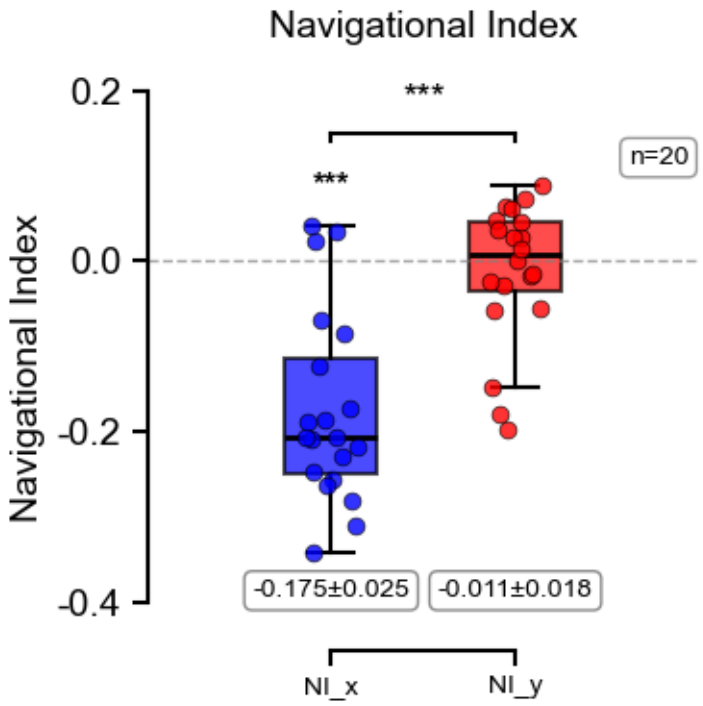


Figure saved to /Users/sharbat/Projects/anemotaxis/data/FCF_attP2-40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/ni_boxplot.pdf




```
=== NAVIGATIONAL INDEX ANALYSIS ===
Number of larvae: 20
Mean NI_x: -0.175 (p=0.0000, ***)
Mean NI_y: -0.011 (p=0.5384, ns)
Paired comparison NI_x vs NI_y: p=0.0001
RESULT: NI_x and NI_y are significantly different from each other
```

[18]:
```
# In analyze_single_anemotaxis.ipynb, replace the save_analysis_results call␣
↪with:
saved_file = data_loader.save_analysis_results(
    output_dir,
    single_path,
    trx_filtered_by_merging,

    # Orientation-based analyses (consistent naming)
    run_prob_results=run_prob_results,
    turn_prob_results=turn_prob_results,
    turn_amp_results=turn_amp_results,
    backup_prob_results=backup_prob_results,
    velocity_results=velocity_results,

    # Time-based analyses (consistent naming)
```

```
    run_prob_time_results=run_prob_time_results,
    turn_prob_time_results=turn_prob_time_results,
    turn_amp_time_results=turn_amp_time_results,
    backup_prob_time_results=backup_prob_time_results,
    velocity_time_results=velocity_time_results,

    # Head cast analyses
    # cast_events_data=cast_events_data,
    bias_results_first=bias_results_first,
    # bias_results_last=bias_results_last,
    # bias_results_all=bias_results_all,
    bias_results_turn=bias_results_turn,
    head_cast_orientation_results=head_cast_orientation_results,
    head_cast_time_results=head_cast_time_results,

    # NI results
    ni_time_results=ni_time_results,
    ni_single_results=ni_single_results
)
```

```
 Saving run_prob_results…
 Saving turn_prob_results…
 Saving turn_amp_results…
 Saving backup_prob_results…
 Saving velocity_results…
 Saving run_prob_time_results…
 Saving turn_prob_time_results…
 Saving turn_amp_time_results…
 Saving backup_prob_time_results…
 Saving velocity_time_results…
 Saving bias_results_first…
 Saving bias_results_turn…
 Saving head_cast_orientation_results…
 Saving head_cast_time_results…
 Saving ni_time_results…
 Saving ni_single_results…
 Analysis results saved to: /Users/sharbat/Projects/anemotaxis/data/FCF_attP2-
40@UAS_TNT_2_0003/p_5gradient2_2s1x600s0s#n#n#n/20240219_143334/analyses/analysi
s_results_20251103_111645.h5
```

[19]:
```
# # Export notebook as PDF
# from nbconvert import PDFExporter
# from IPython.display import Javascript, display
# import time

# # First, save the notebook automatically
# print(" Saving notebook...")
```

```
# display(Javascript('IPython.notebook.save_notebook()'))
# time.sleep(2)  # Wait for save to complete

# try:
#     # Get the current notebook path
#     notebook_path = "/Users/sharbat/Projects/anemotaxis/scripts/
 ↪analyze_single_anemotaxis.ipynb"
#     pdf_output_path = os.path.join(output_dir, 'analyze_single_anemotaxis.
 ↪pdf')

#     # Export using nbconvert directly
#     exporter = PDFExporter()
#     (body, resources) = exporter.from_filename(notebook_path)

#     with open(pdf_output_path, 'wb') as f:
#         f.write(body)

#     print(f" Notebook PDF saved to: {pdf_output_path}")

# except Exception as e:
#     print(f" PDF export failed: {e}")
#     print(" Alternative: Use Jupyter's File menu > Download as > PDF via␣
 ↪LaTeX")
```

[ ]:

[ ]: