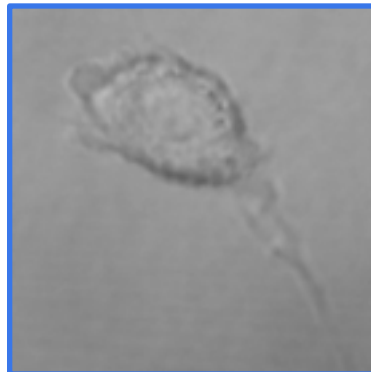
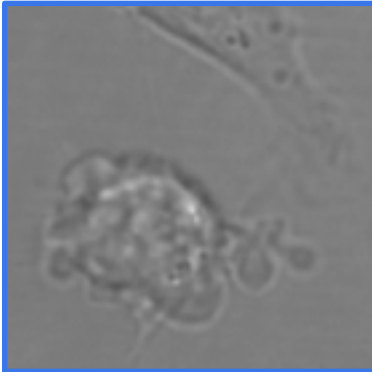
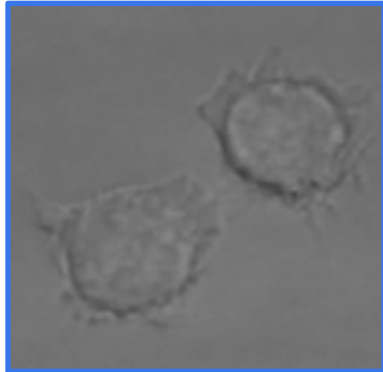
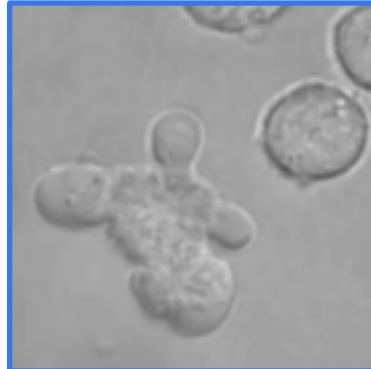
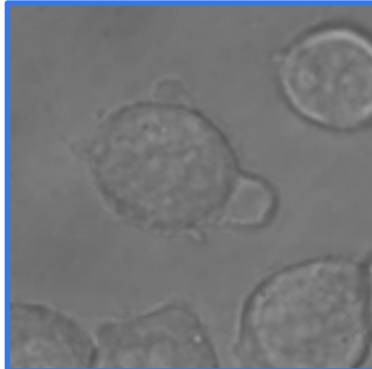
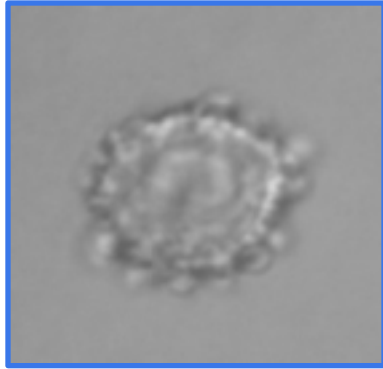


An Interactive Visual Analysis Tool for Cellular Behavior Studies Using Large Collections of Microscopy Videos

Chuan Wang, Jia-Kai Chou, Kwan-Liu Ma
Department of Computer Science

Arpad Karsai, Ying X Liu, Evgeny Ogorodnik, Victoria Tran, Gang-Yu Liu
Department of Chemistry

Background



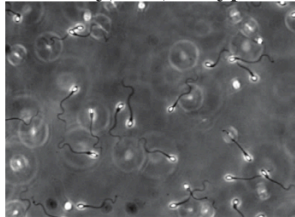
Related Work

C. D. Correa and K.-L. Ma, "Dynamic video narratives," ACM Transactions on Graphics, 2010.

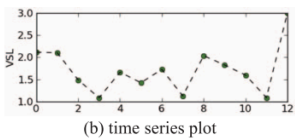


Nguyen, C. etc., "Video summagator: An Interface for Video Summarization and Navigation", CHI, 2012.

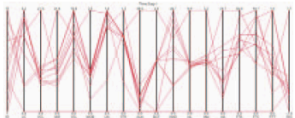
B. Duffy, etc., "Glyph-based video visualization for semen analysis," Visualization and Computer Graphics, 2013.



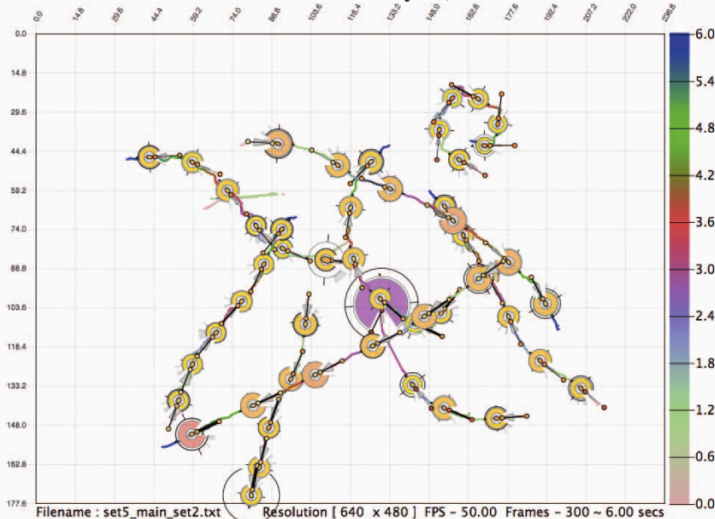
(a) single video frame



(b) time series plot



(c) parallel coordinates plot



(d) glyph-based video summarization

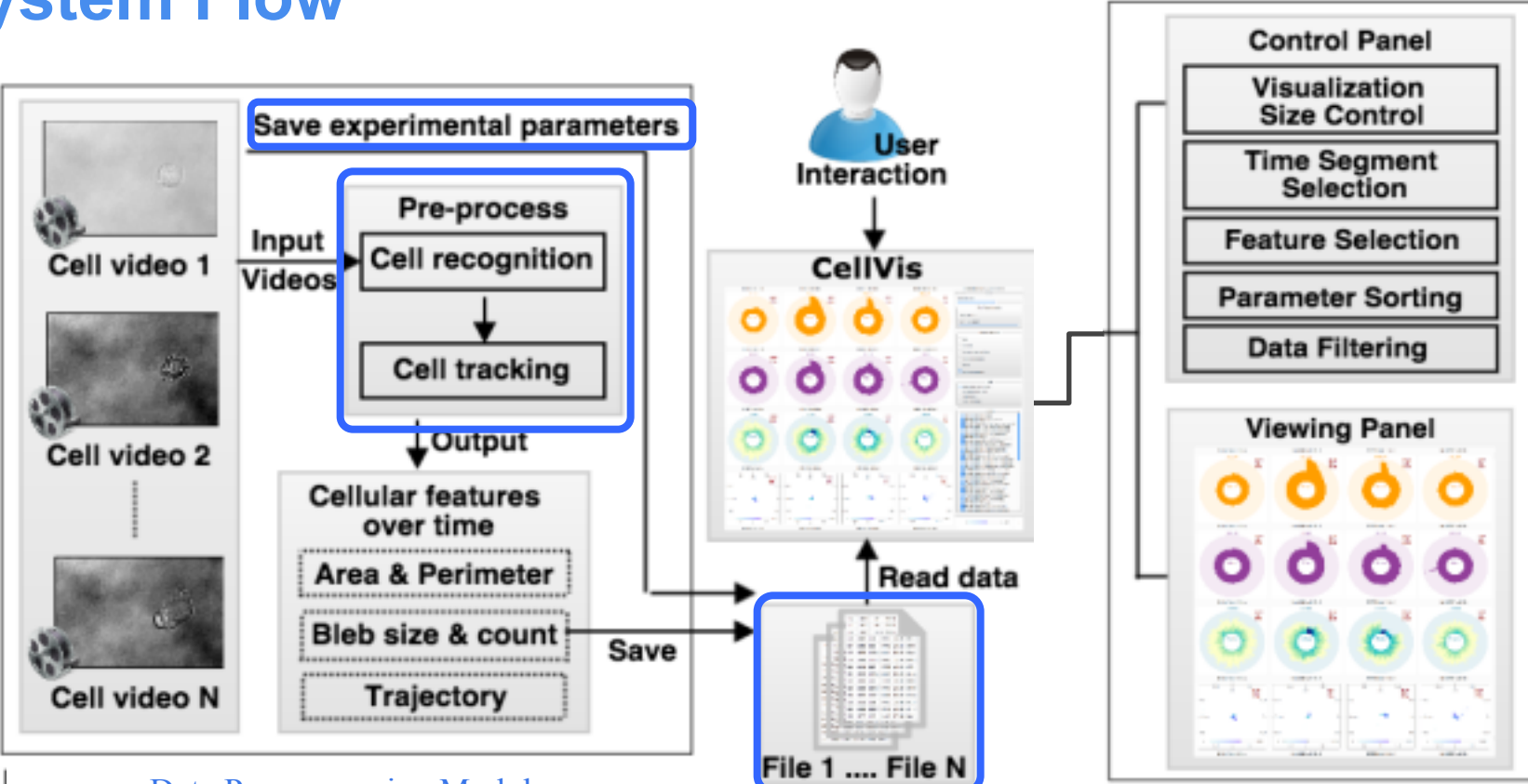
Parry, M. L. etc. "Hierarchical Event Selection for Video Storyboards with a Case Study on Snooker Video Visualization", TVCG, 2011.



Design Goals

- Provide a highly expressive visual summary of cellular features evolve over time.
- Allow easy comparison of the visual summaries across a collection of videos.
- Provide the interactivity and flexibility for data manipulation.

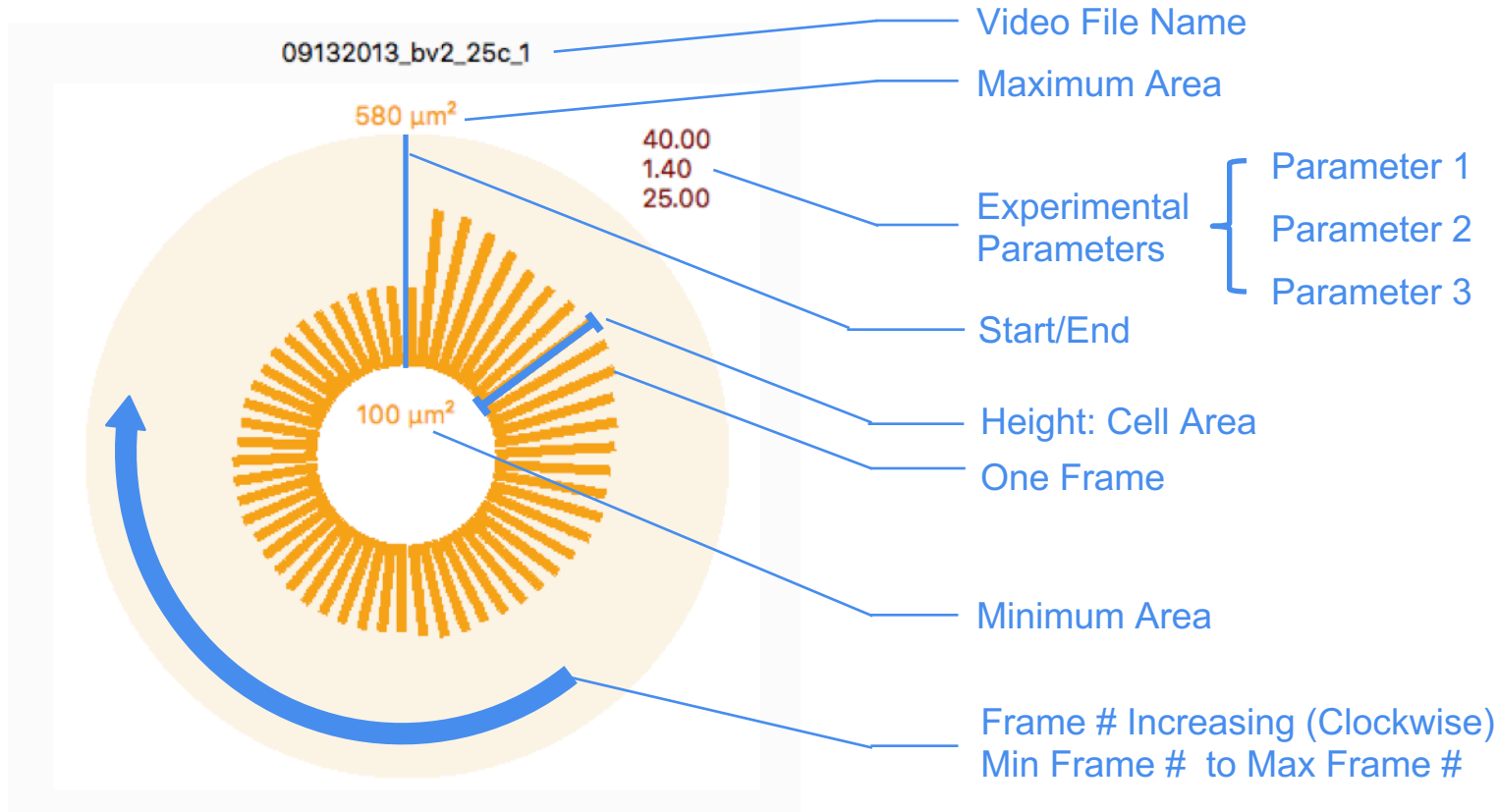
System Flow



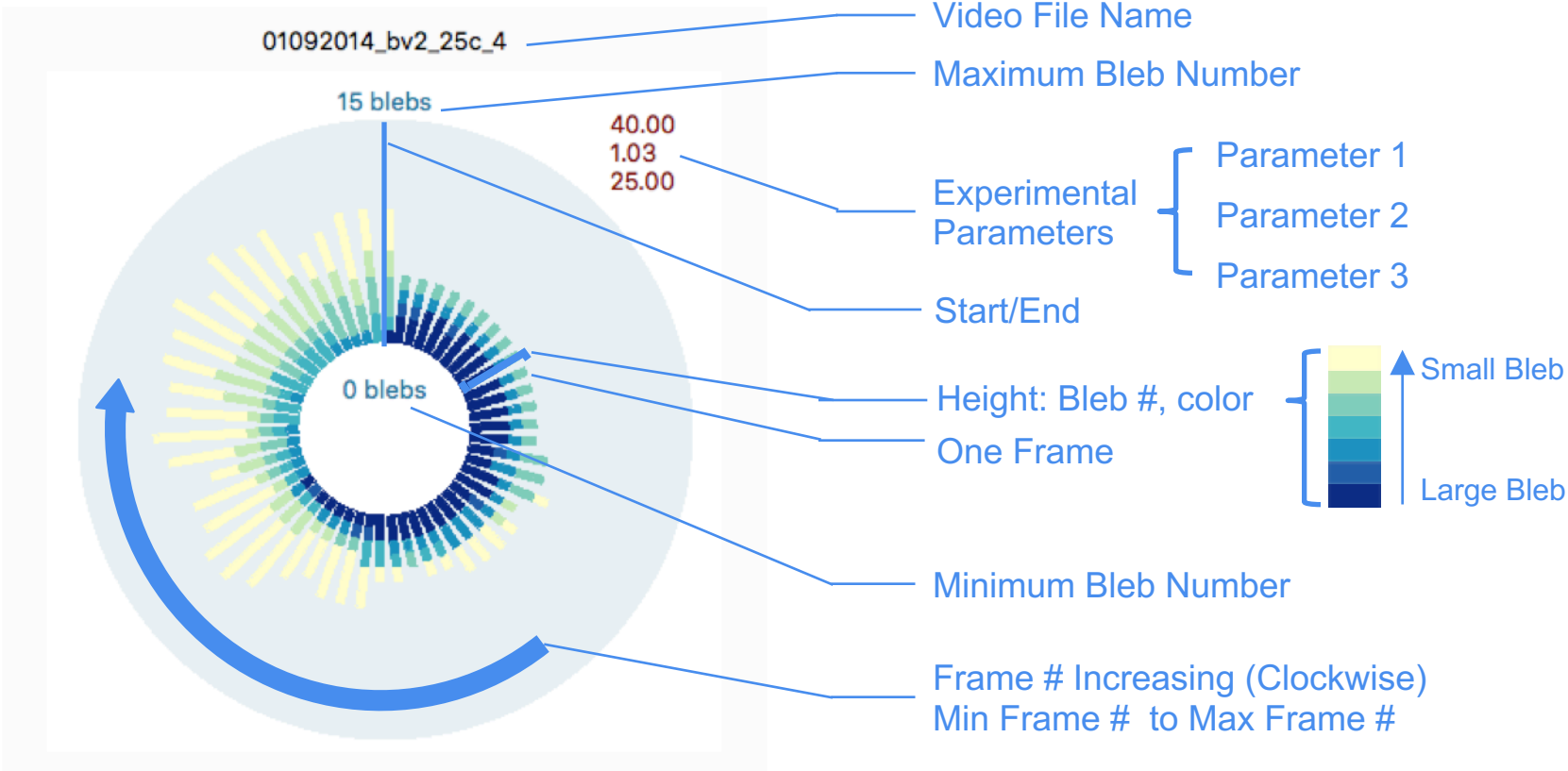
Data Pre-processing Module

Visualization Module

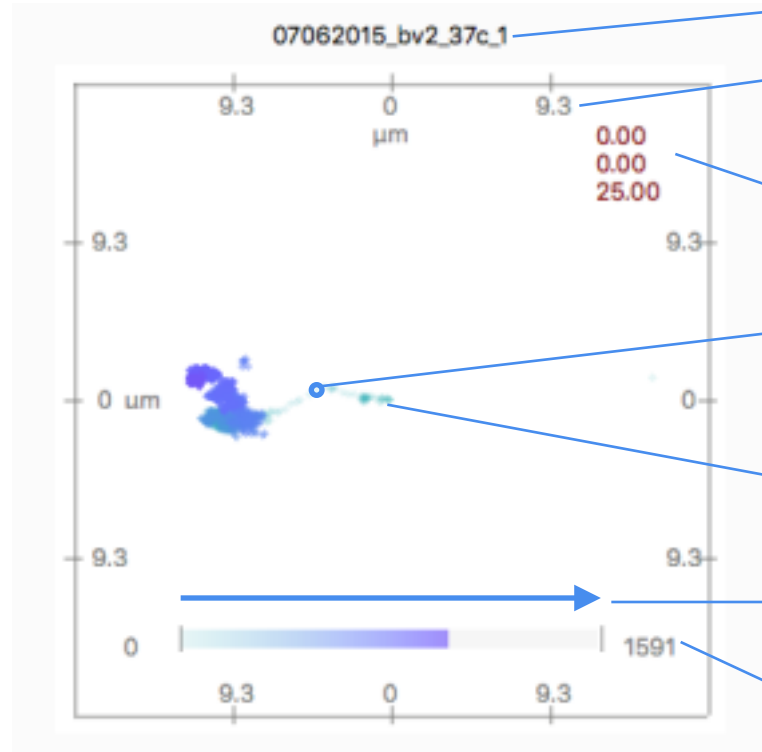
Area Change Over Time (50 Frames)



Bleb Change Over Time (50 Frames)



Migration Trajectory



Video File Name

Scale Reference

Experimental Parameters

- Parameter 1
- Parameter 2
- Parameter 3

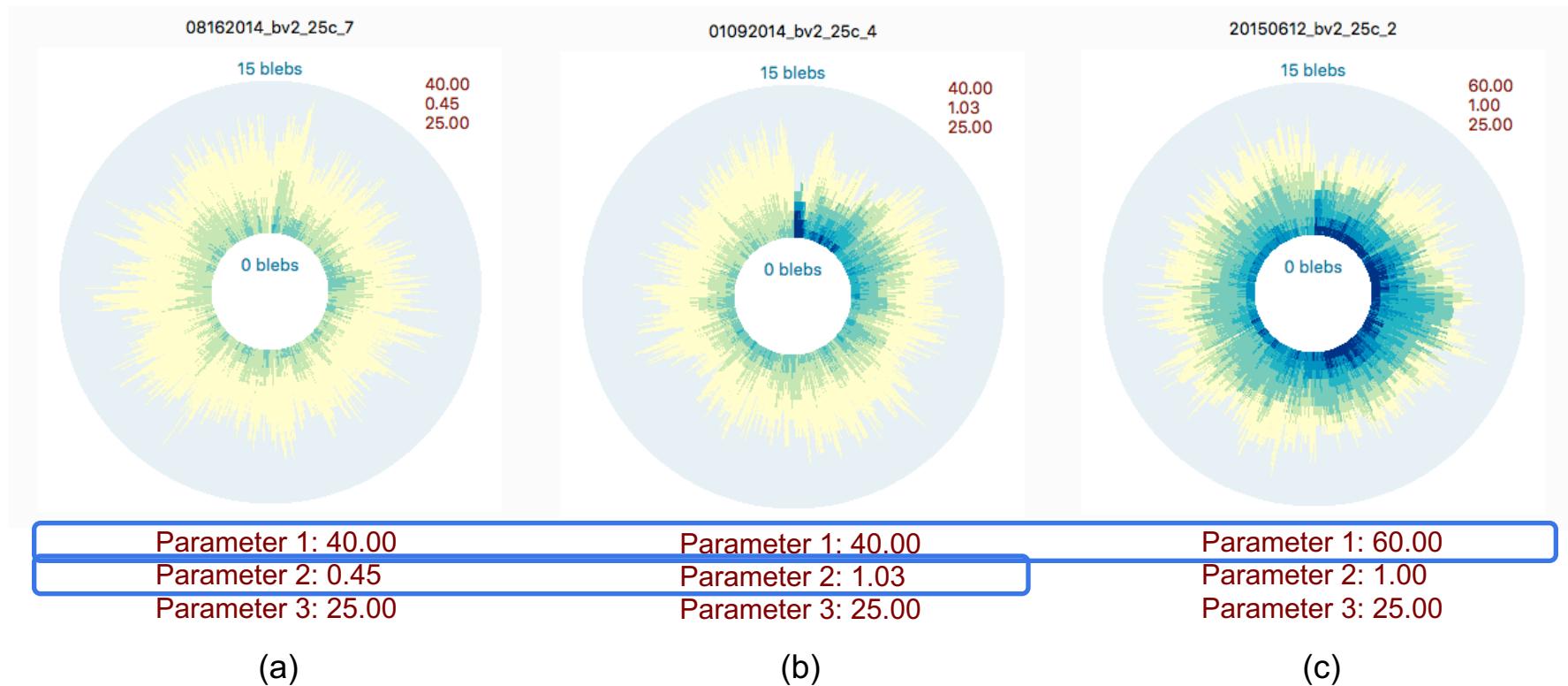
Color: Frame # (time)
One Dot: One Frame

Starting Position (Always Centered)

Frame # Increasing
Min Frame # to Max Frame #

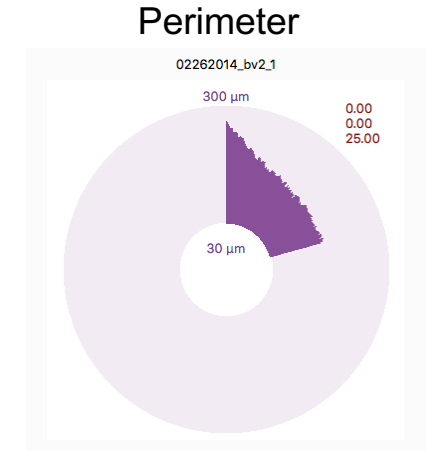
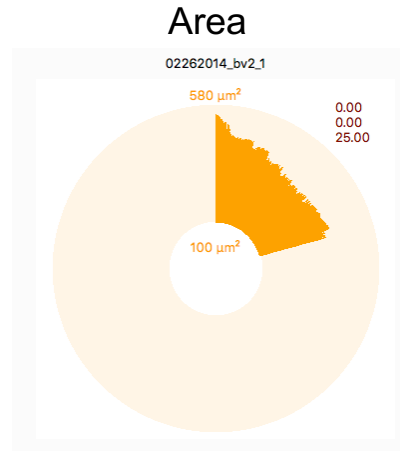
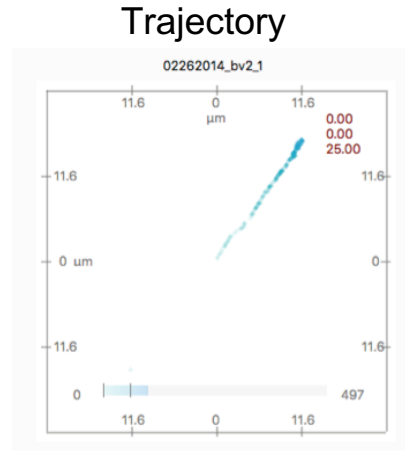
Video Length (frames)

Different Blebbing Behaviors

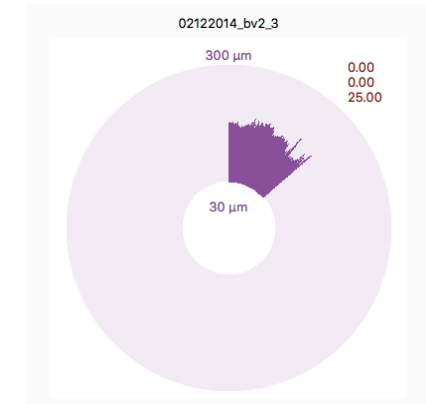
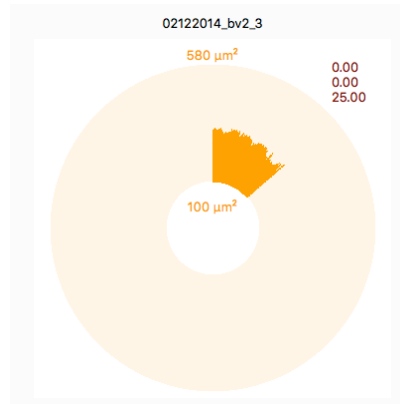
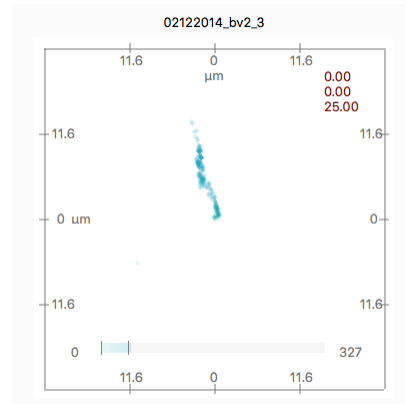


Cellular Responses to Stimulus Location

Stimuli on Cell Body



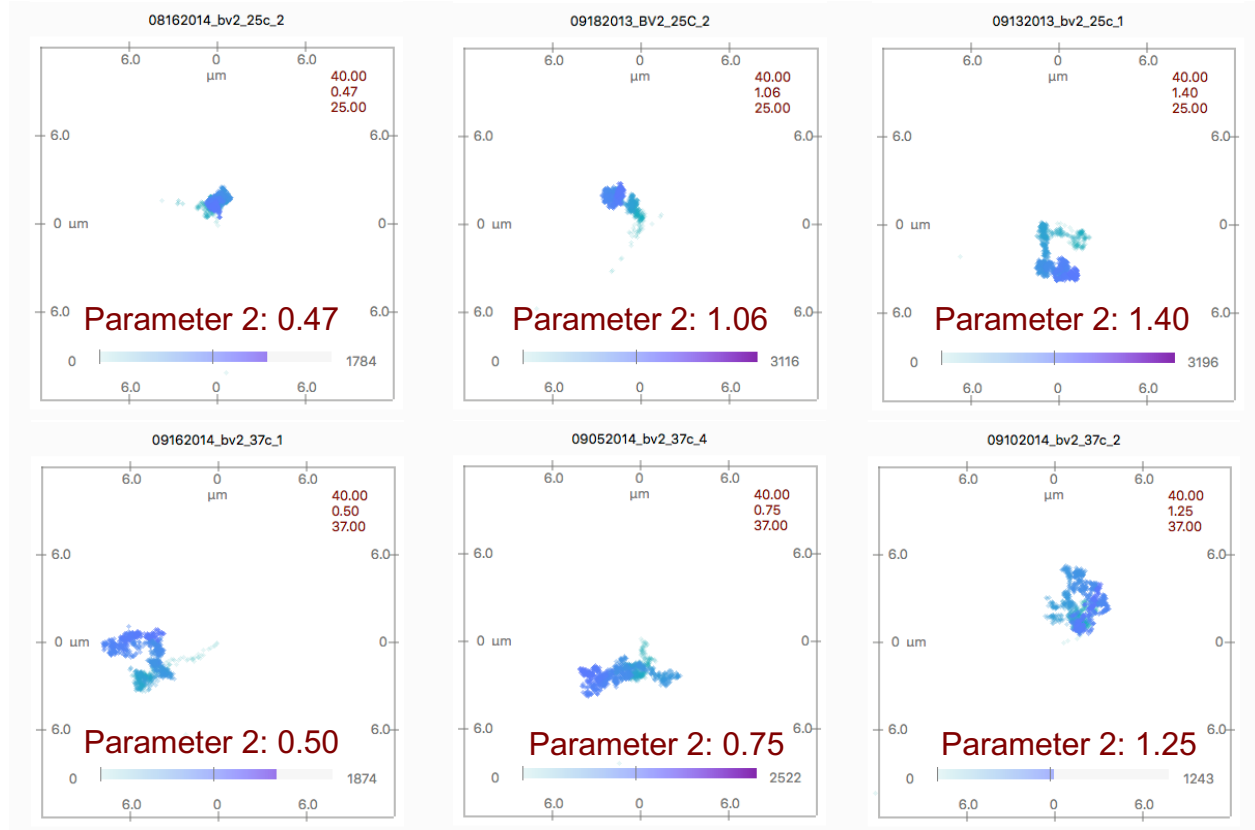
Stimuli on Cell Periphery



Dynamics of Cellular Motility

Increasing Stimulus Level →

Room
Temperature



37 °C

Increasing
Temperature ↓

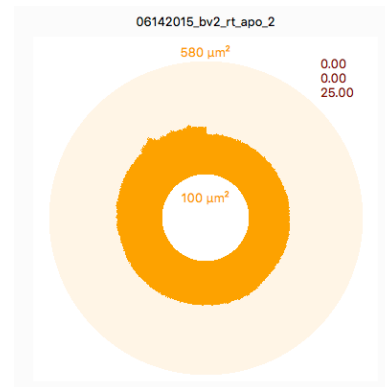
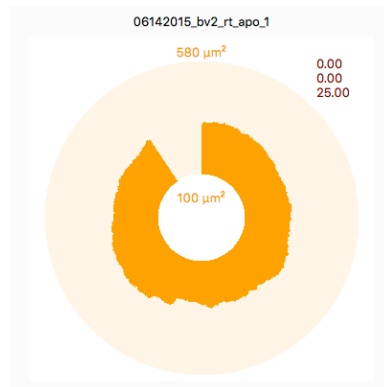
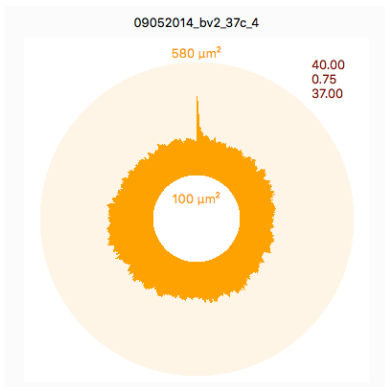
Is A Cell Healthy or Apoptotic?

Healthy

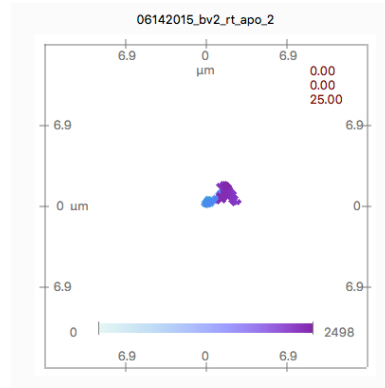
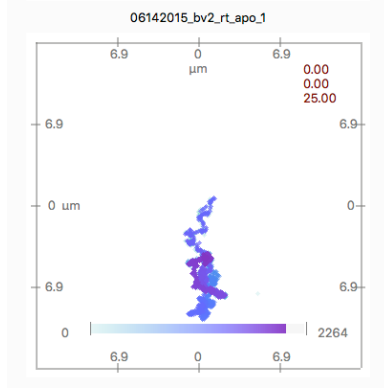
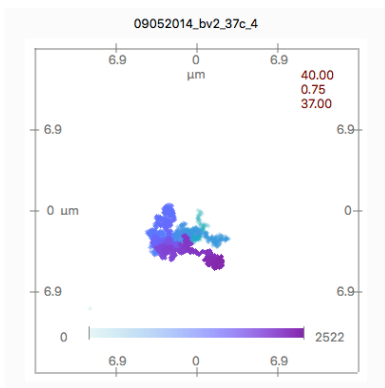
Apoptotic (dying)

Dead

Area



Trajectory



Summary & Future Work

- Summarize multi-dimensional information extracted from a large collection of videos.
- Enable scientists to study dynamics of cellular features change over time.
- Allows quick data review and hypotheses verification via comparison, qualitatively and quantitatively.
- Case studies demonstrate the effectiveness.

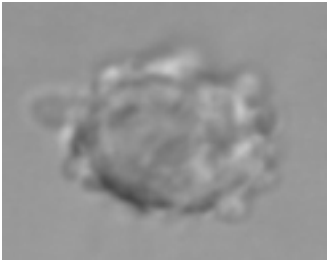
- More Features (cell roundness, cell Symmetry, ...)
- Other types of videos (e.g. urbanization, satellite time-lapse)



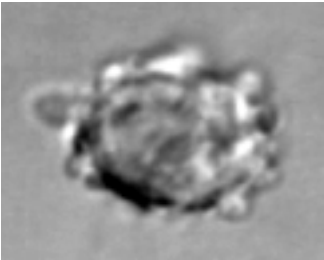
- Other types of multi-dimensional data



Appendix: Data Preprocessing



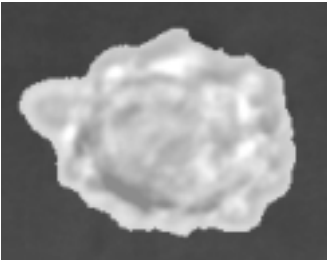
Original Image



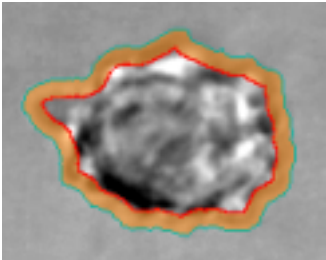
Histogram Equalization



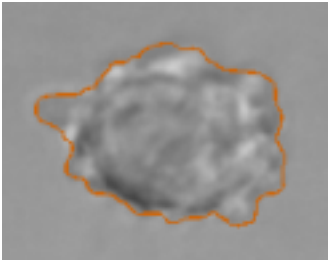
Texture Analysis



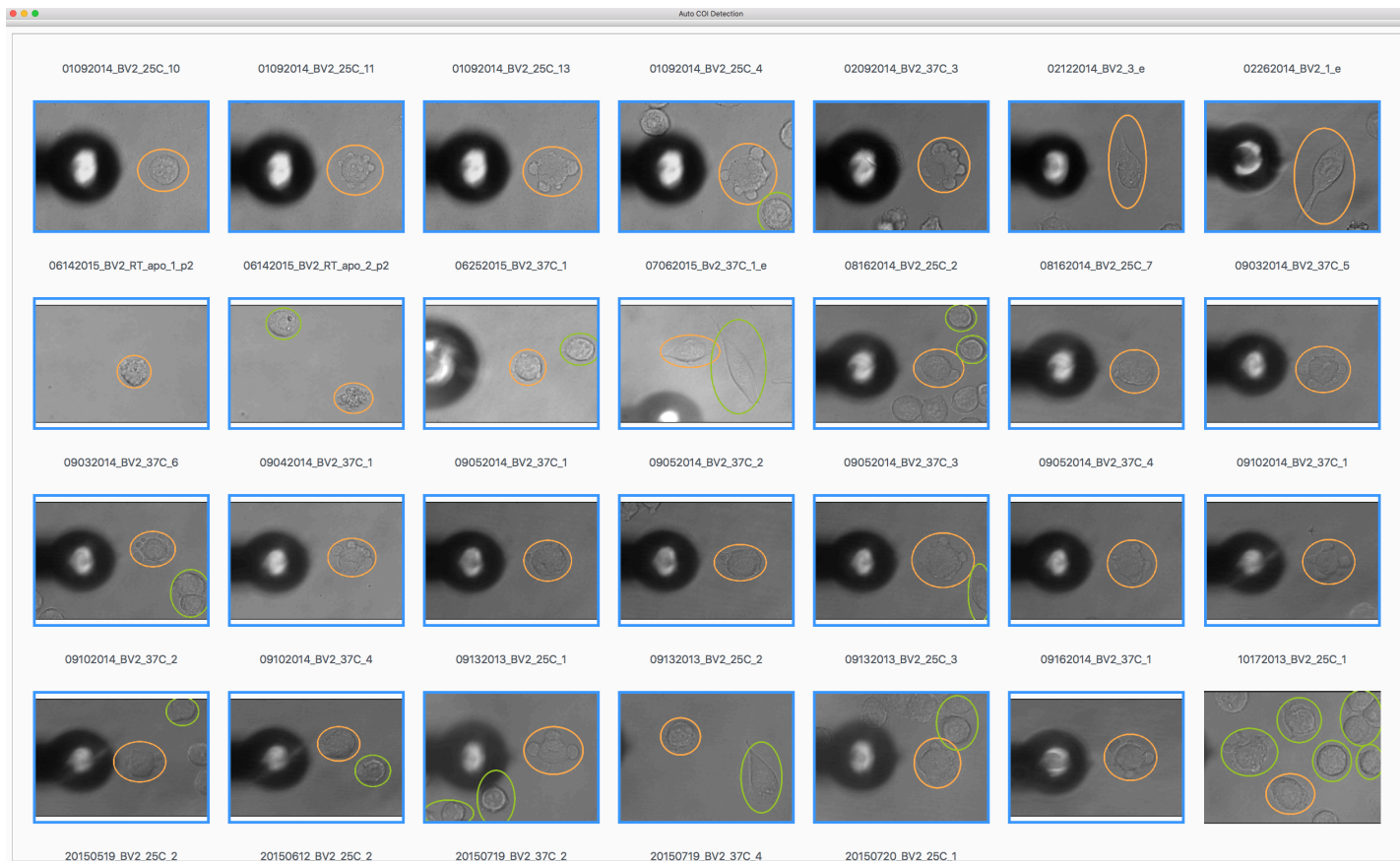
Histogram Equalization



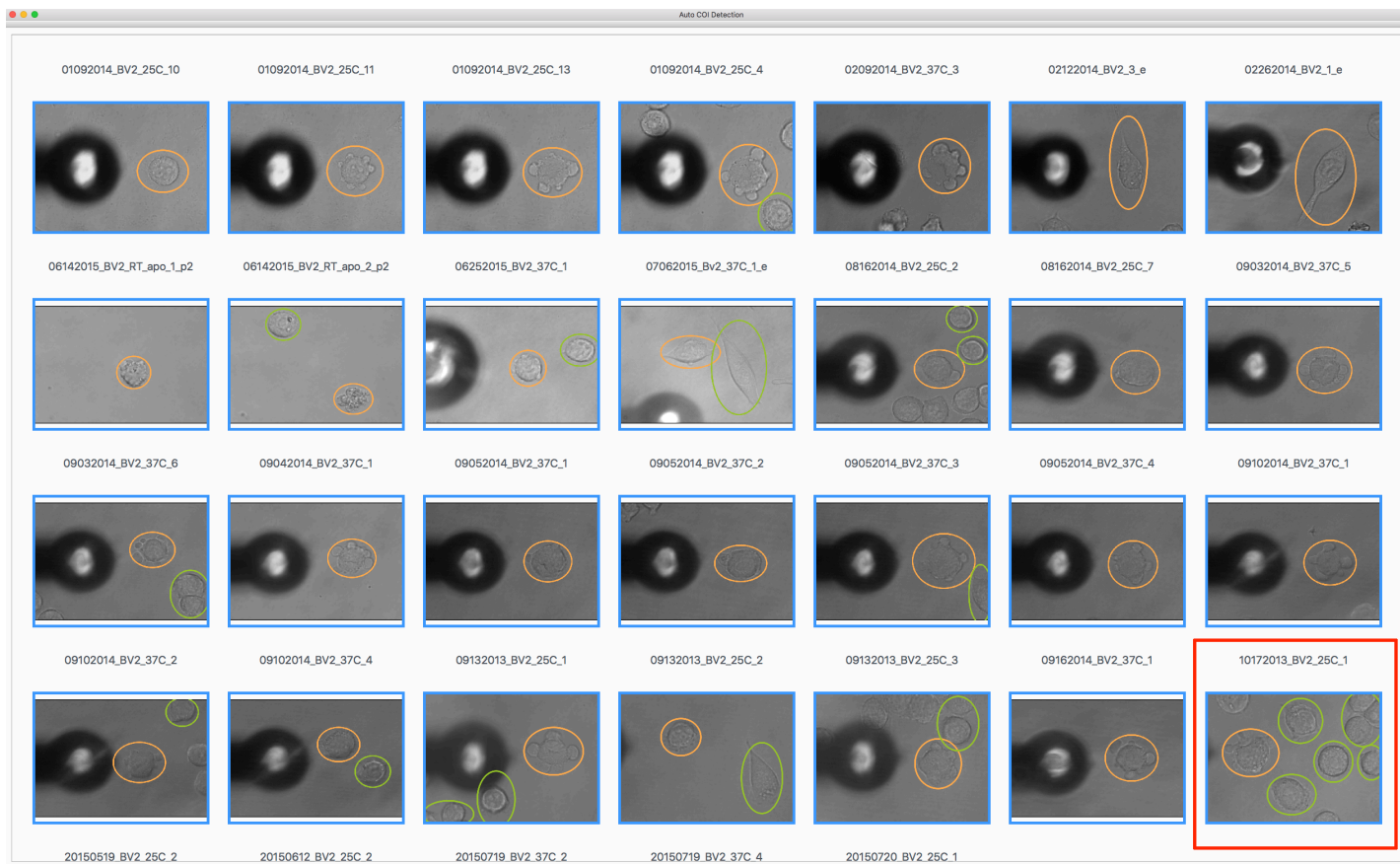
Random Walk



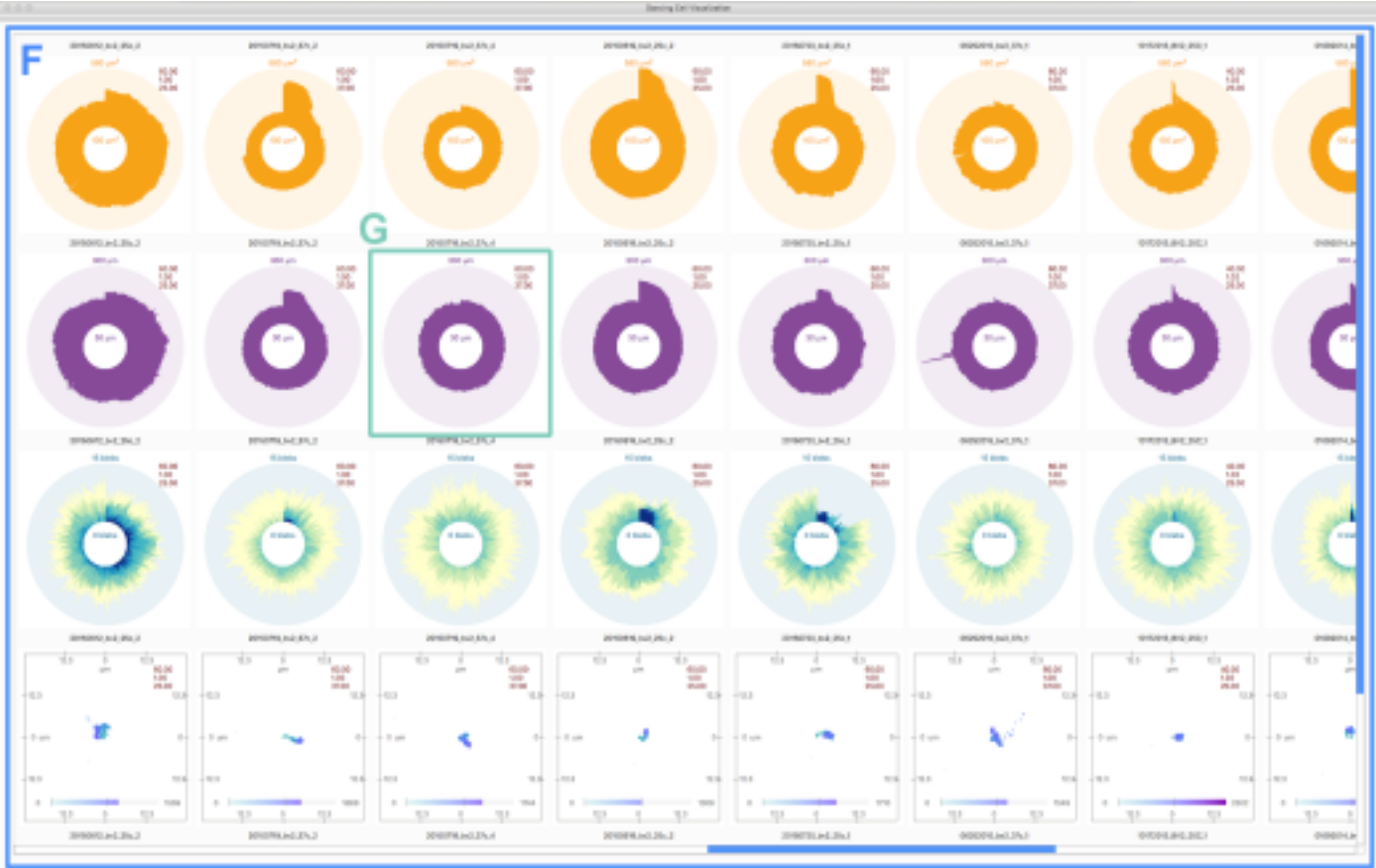
Appendix: Post-verification Interface



Appendix: Post-verification Interface



Appendix: User Interface



View Size: 300 **A**

Time Range Selection

Frame Start: 0 **B**

Frame End: 2500

Property Selection

Area **C**

Perimeter

Blob Number and Size

Centroid Trajectory

Shape

Show All Properties

Sort

Parameter 1 **D**

Parameter 2

Parameter 3

Parameter 4

File List

- 01000014_bv2_256_10
- 01000014_bv2_256_11
- 01000014_bv2_256_13
- 01000014_bv2_256_4
- 02000014_bv2_376_3
- 02120014_bv2_3
- 02120014_bv2_5
- 02120014_bv2_7_1_000_1
- 02120014_bv2_7_1_000_2
- 02020014_bv2_376_3
- 07000014_bv2_376_3
- 08120014_bv2_256_2
- 08120014_bv2_256_7
- 00010014_bv2_376_5
- 00010014_bv2_376_6
- 00040014_bv2_376_5
- 00040014_bv2_376_5
- 00040014_bv2_376_5

E