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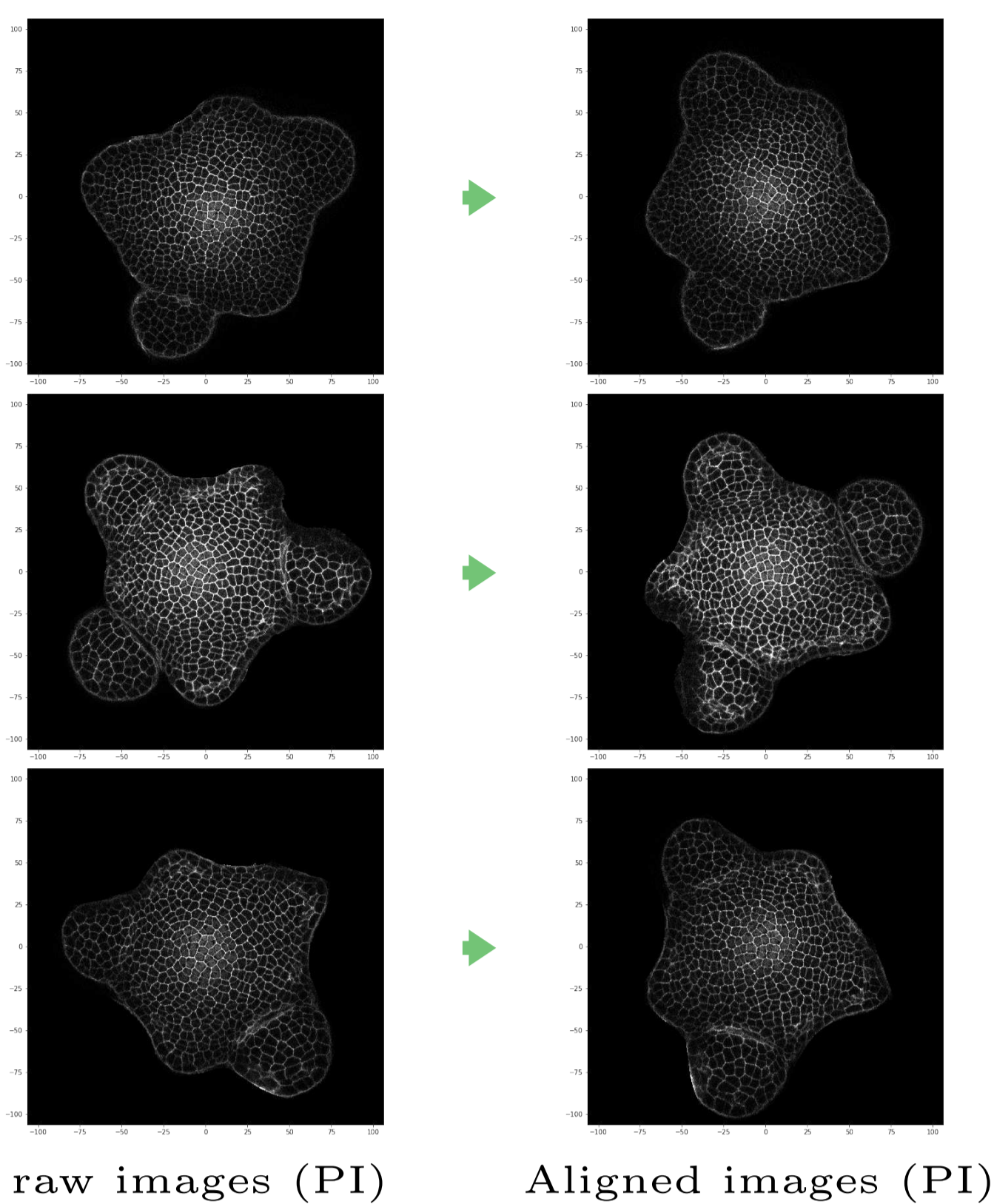
Revisiting PIN1 polarity interpretation at the SAM based on automated multi-level reconstruction of PIN1 polarities from confocal images

Landry Duguet¹, Guillaume Cerutti¹, Carlos Galvan-Ampudia¹, Etienne Farcot², Teva Vernoux¹, and Christophe Godin¹

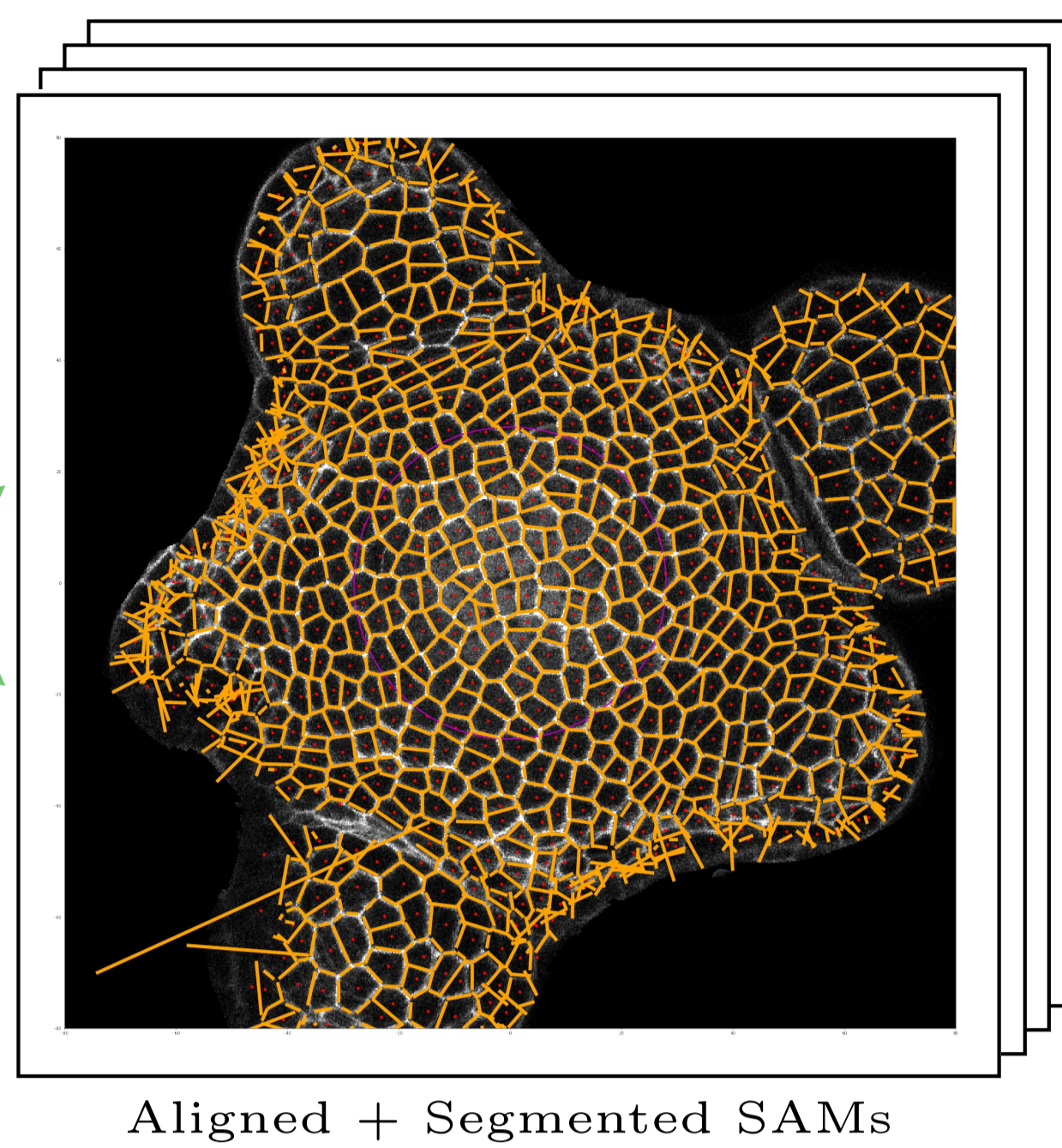
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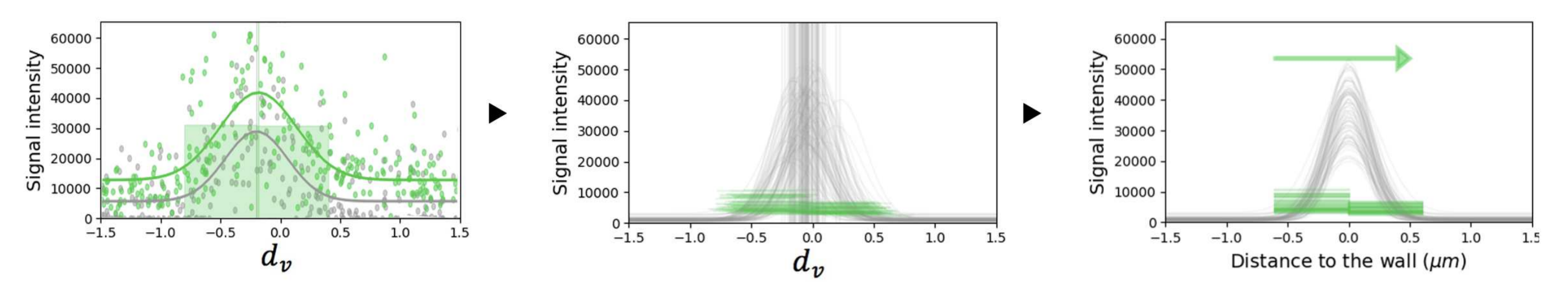
SAM alignment based on *CLV3* and *qDII* markers



Alignment & Segmentation

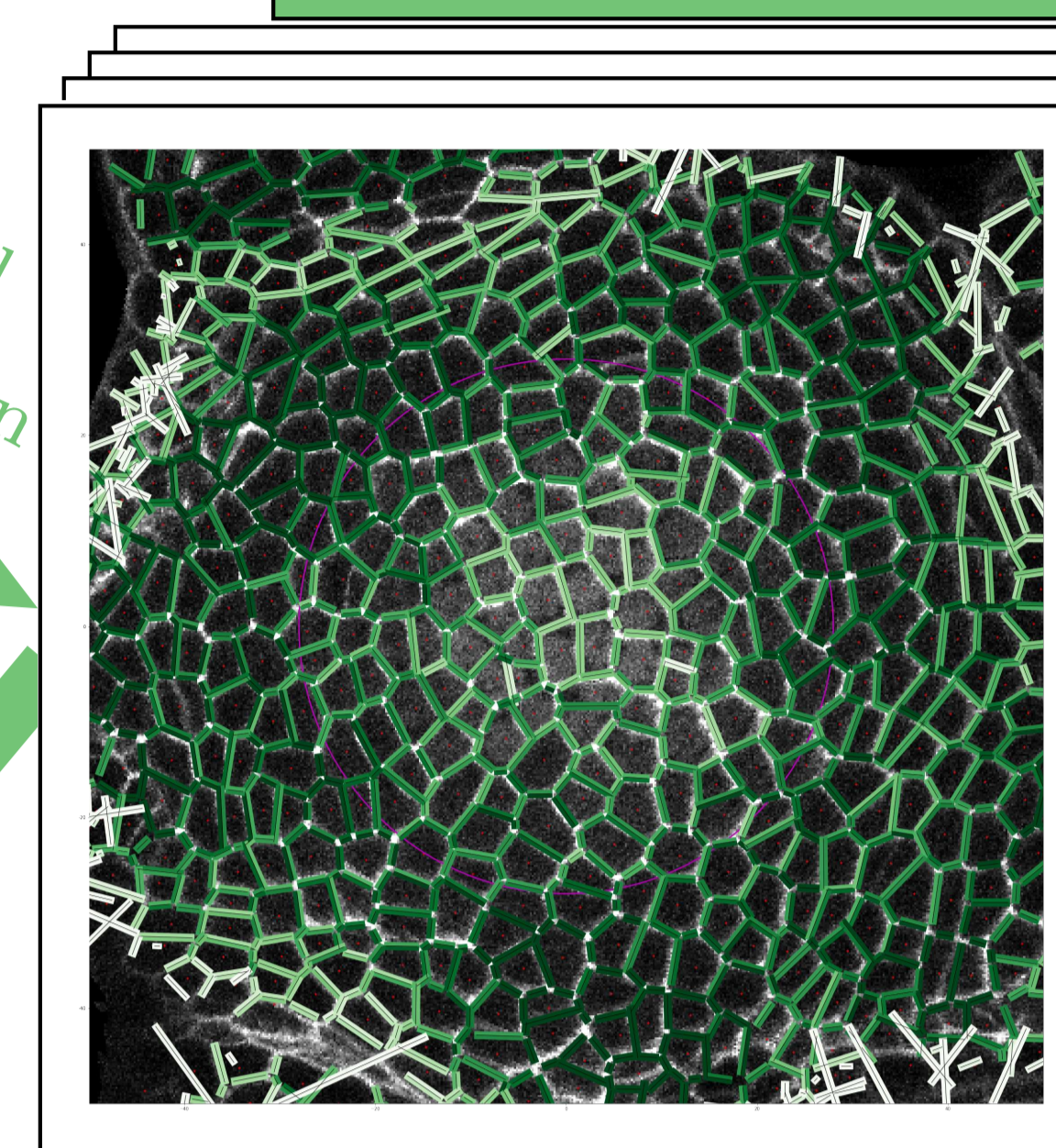


Aligned + Segmented SAMs



Automated PIN1 extraction method [Galvan-Ampudia et al. (2020)] based on pPIN1::PIN1-GFP and PI (cell wall) markers. The method infers a PIN1 level to both sides of the cell wall.

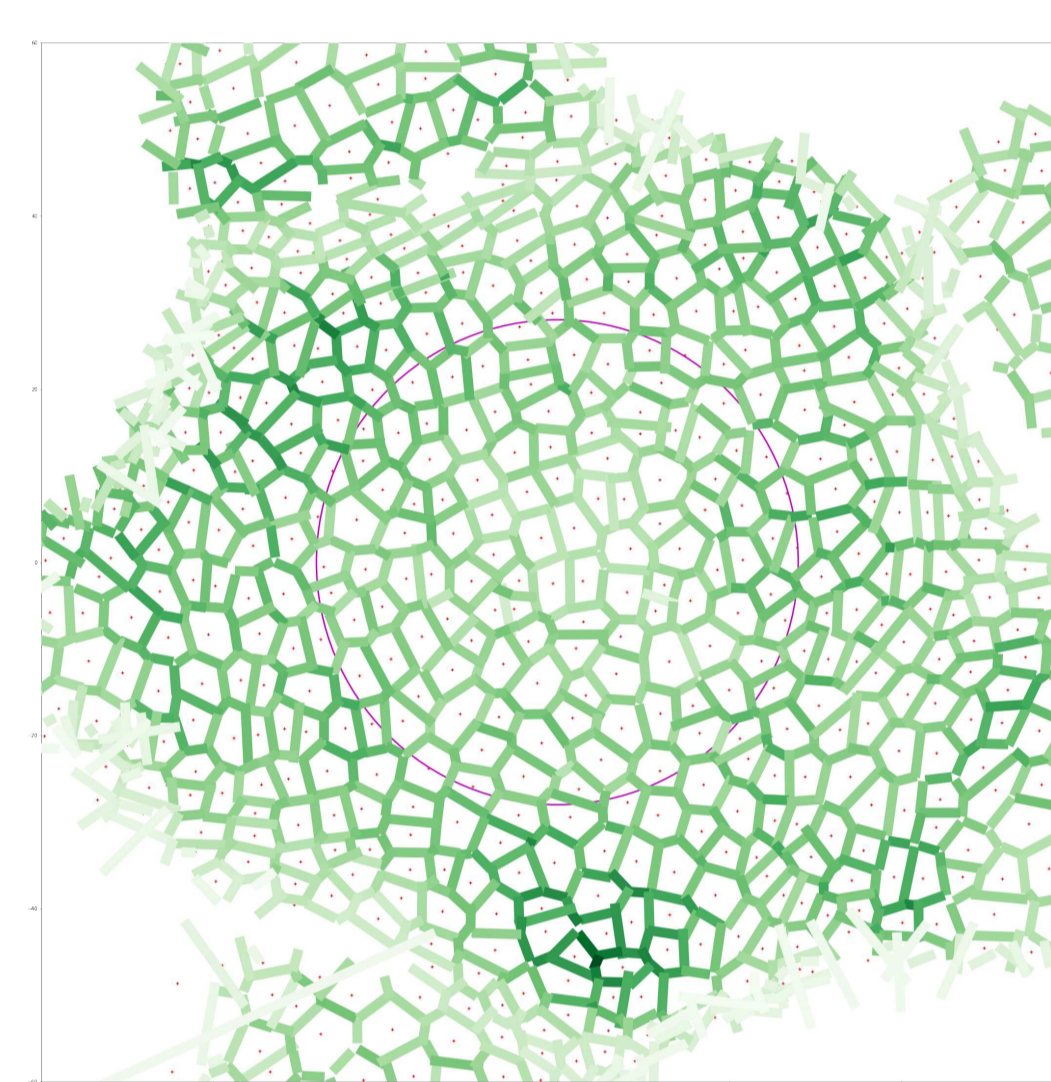
PIN1 at membranes



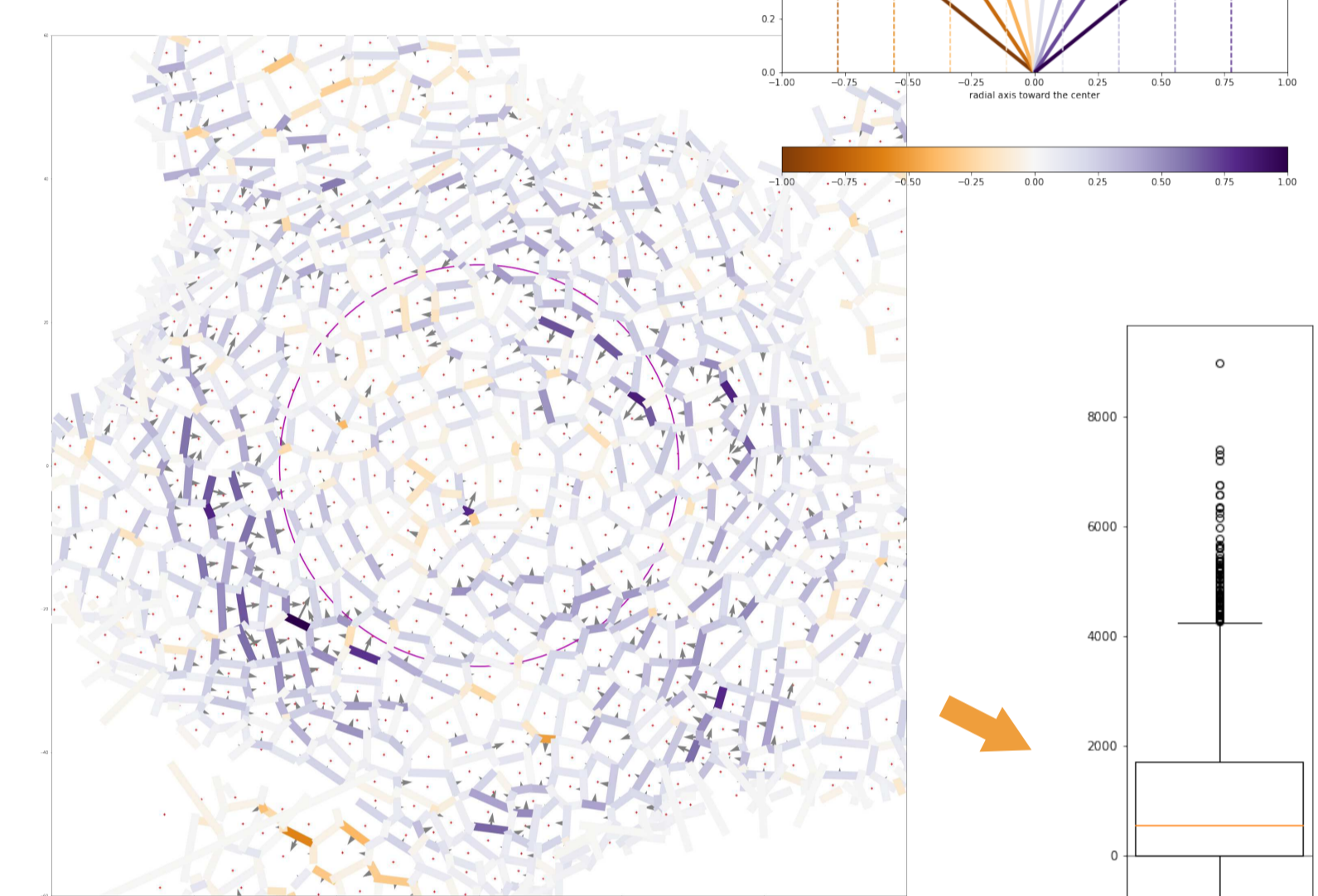
- P_{ij} : PIN1 level in the membrane of cell i facing cell j .
- PIN1 total wall values $P_{ij}^T = P_{ij} + P_{ji}$.
- PIN1 net wall values $\Delta P_{ij} = P_{ij} - P_{ji}$.
- PIN1 net wall vectors $\Delta \mathbf{P}_{ij} = \Delta P_{ij} \hat{\mathbf{n}}_{ij}$

Automated PIN1 extraction

Cell level averaging



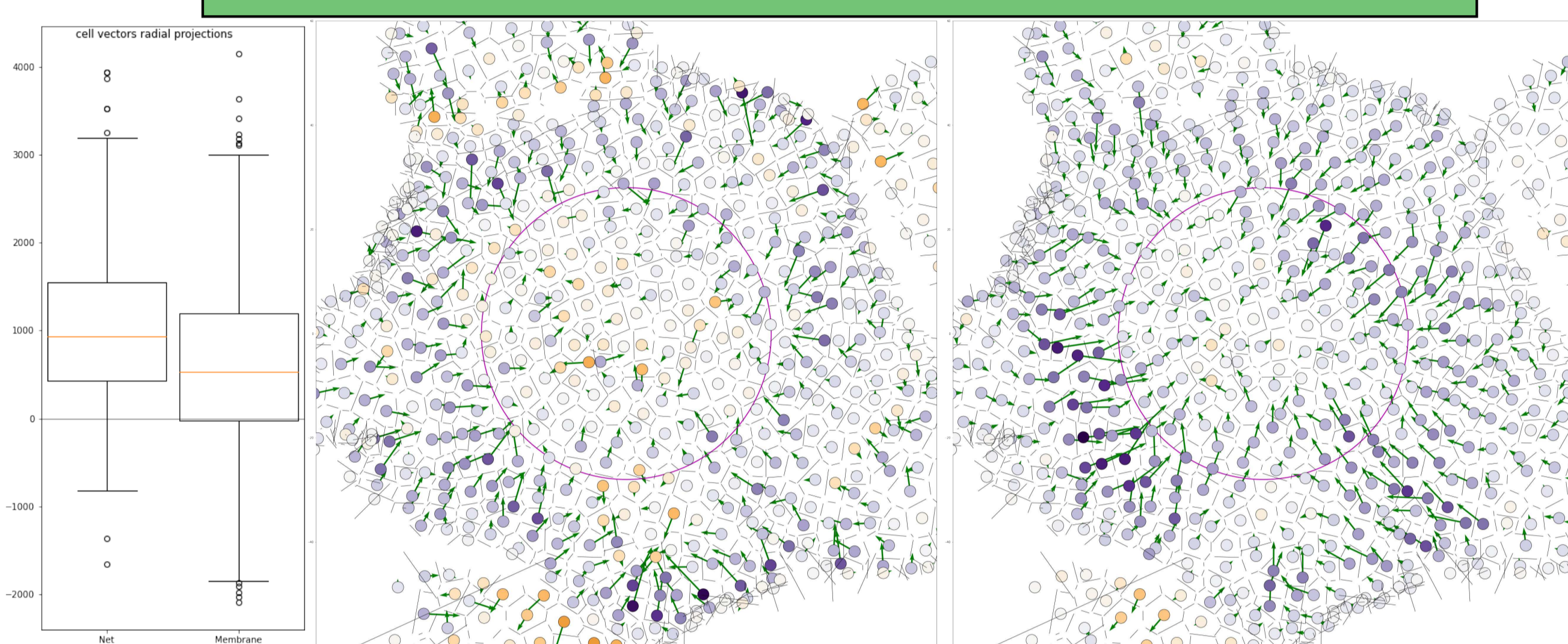
PIN1 wall mean values



PIN1 wall net vectors and radial projections

Spatial averaging

PIN1 cell vectors



PIN1 Internal $\Delta \mathbf{P}_i = \sum_{i \sim j} P_{ij} \hat{\mathbf{n}}_{ij} a_{ij}$

PIN1 Net $\Delta \mathbf{P}_i = \sum_{i \sim j} \Delta P_{ij} a_{ij}$

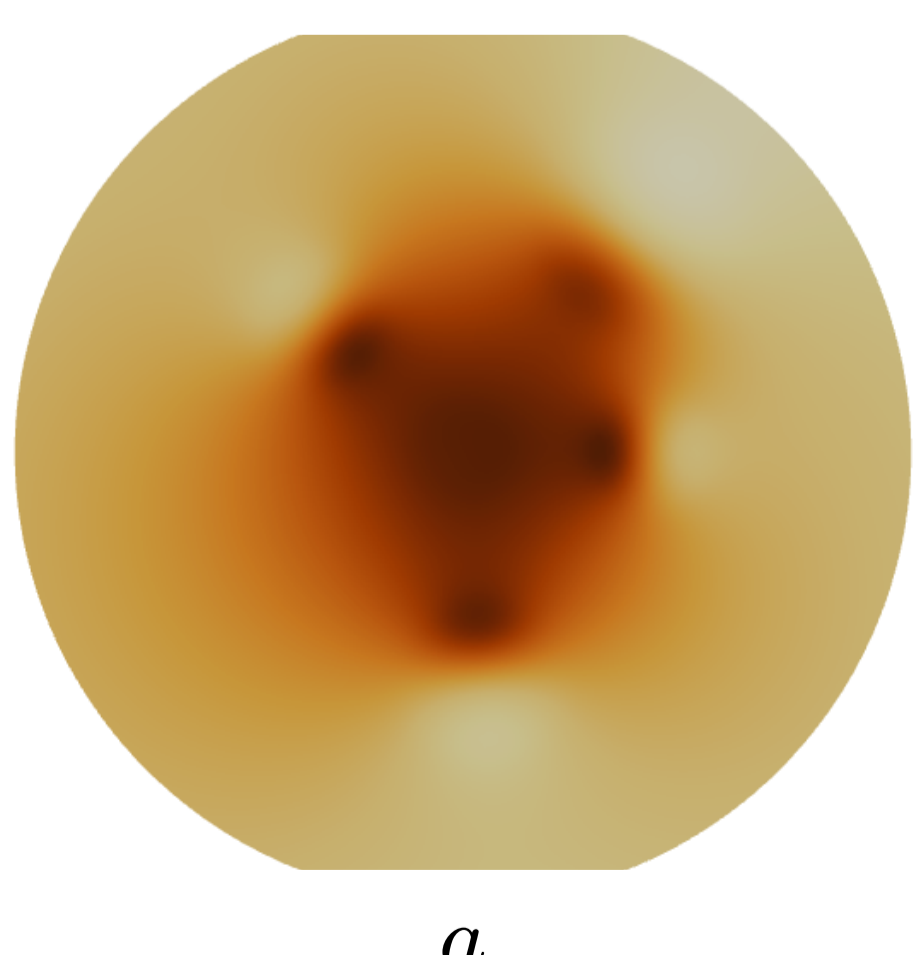
- 97.8% of PIN1 net cell vectors are oriented toward the center (in the peripheral zone).
- Only 47.8% of PIN1 internal cell vectors are oriented toward the center (in the CZ).
- PIN1 net cell vectors are more oriented toward the center than PIN1 internal cell vectors regarding both number and strength.
- Both cell vectors have a low intensity in the central zone, and a global convergence toward the center.

- (P_{ij}^T) are 30.6% lower in the central zone (CZ).
- 73.4% (global), 63.2% (CZ), 80.8% (peripheral zone) of $(\Delta \mathbf{P}_{ij})$ are oriented toward the center.

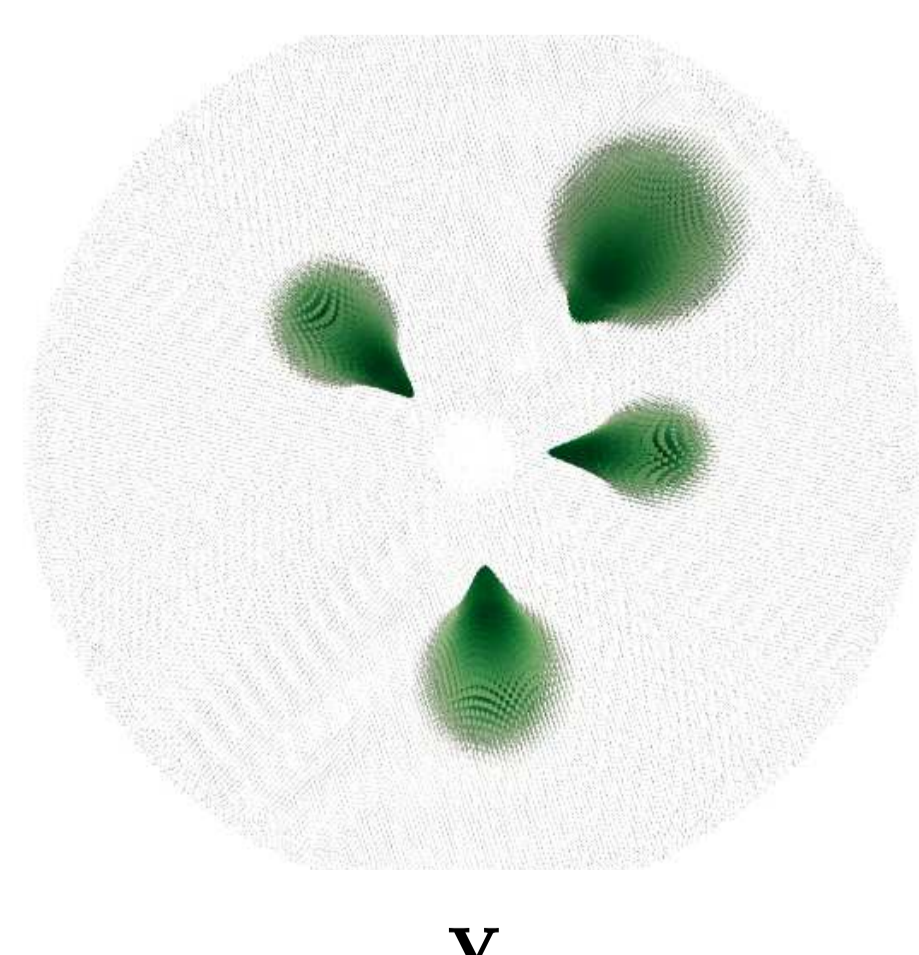
Modeling PIN1 polarity fields

- a : auxin continuous concentration.
- \mathbf{v} : PIN1 abstracted vector field.
- Dynamics: a diffuses and is transported by \mathbf{v} .

$$\frac{\partial a(x, t)}{\partial t} = \underbrace{\Delta a(x, t)}_{\text{Diffusion}} - \underbrace{\nabla \cdot (\mathbf{v}(x) a(x, t))}_{\text{Advection at speed } \mathbf{v}}$$



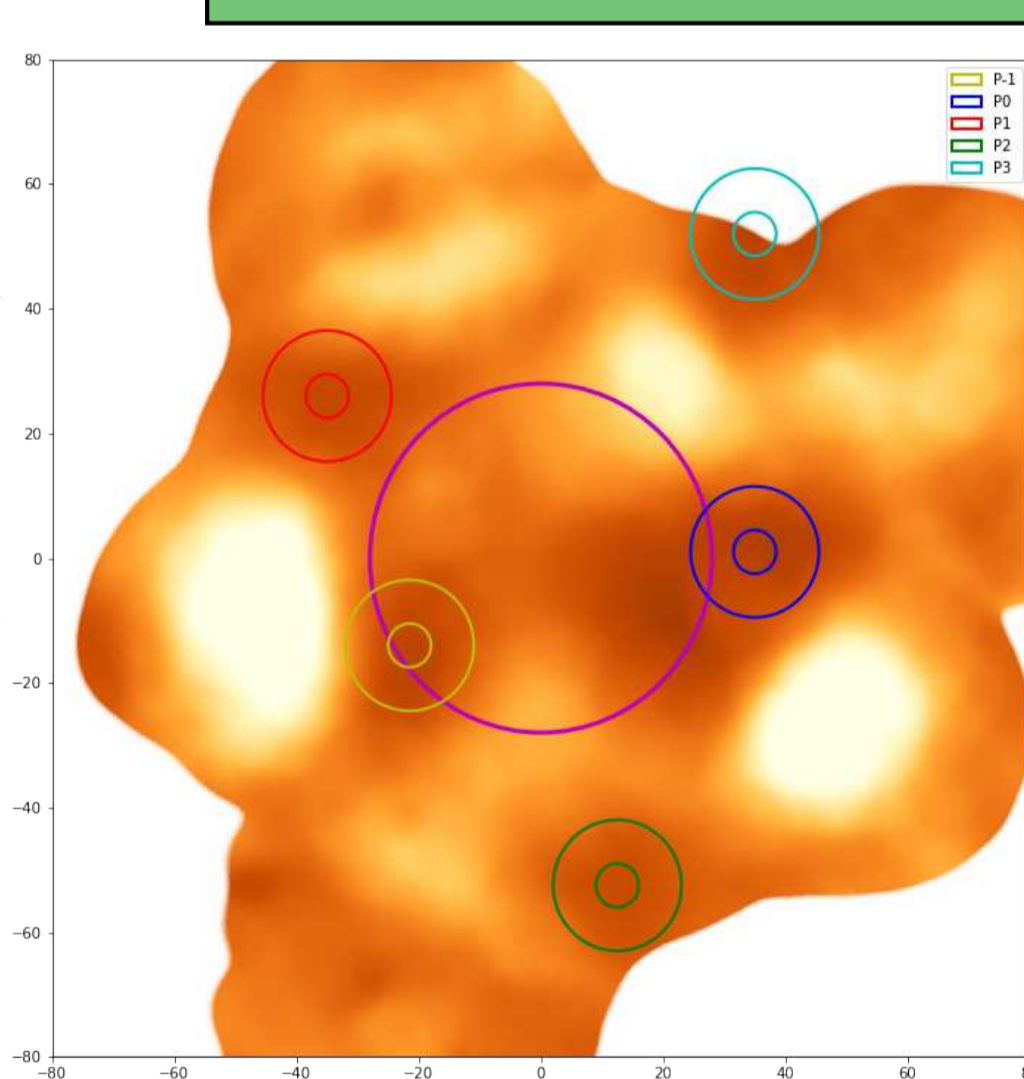
a



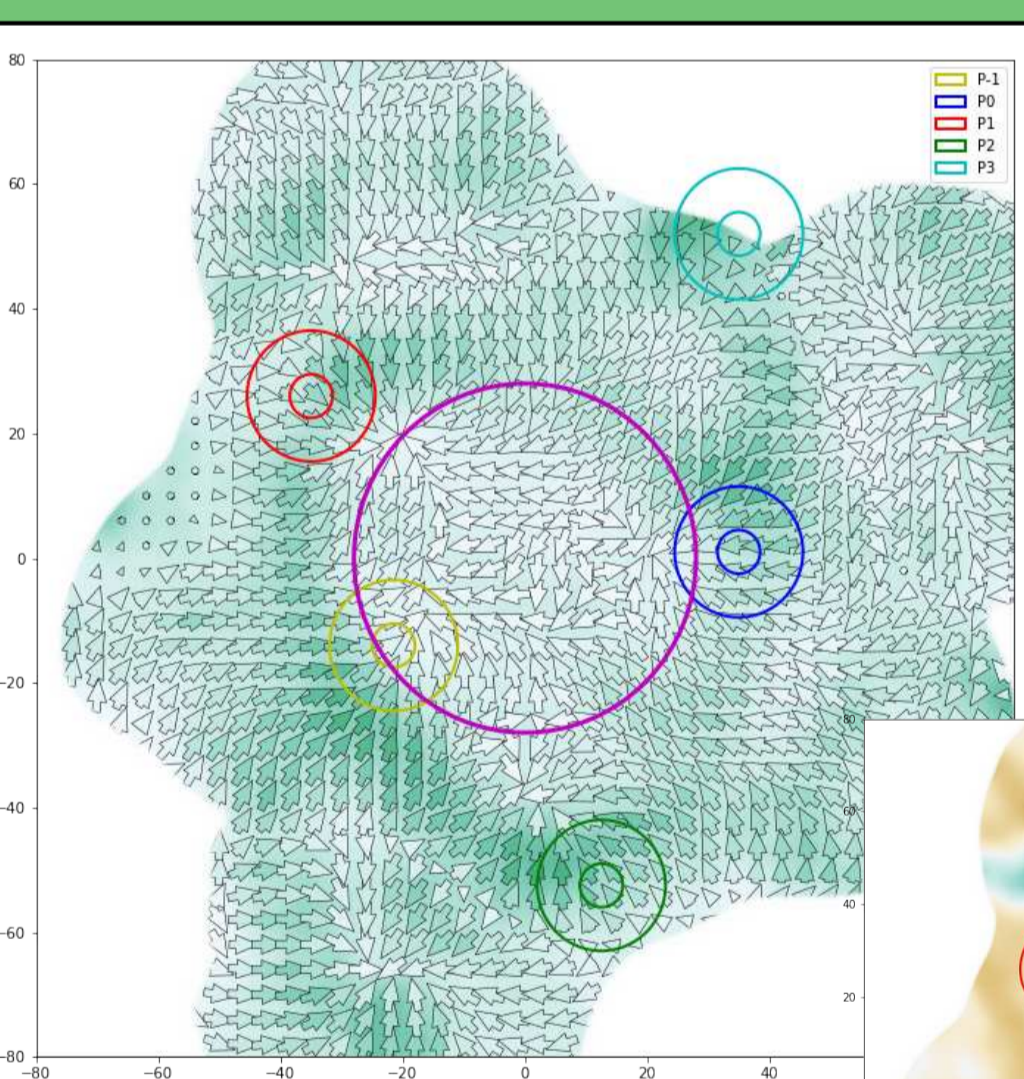
\mathbf{v}

- \mathbf{v} : uniformly pointing to the center, lower in the CZ.
- Localized upregulations of \mathbf{v} creates maxima and minima of a .

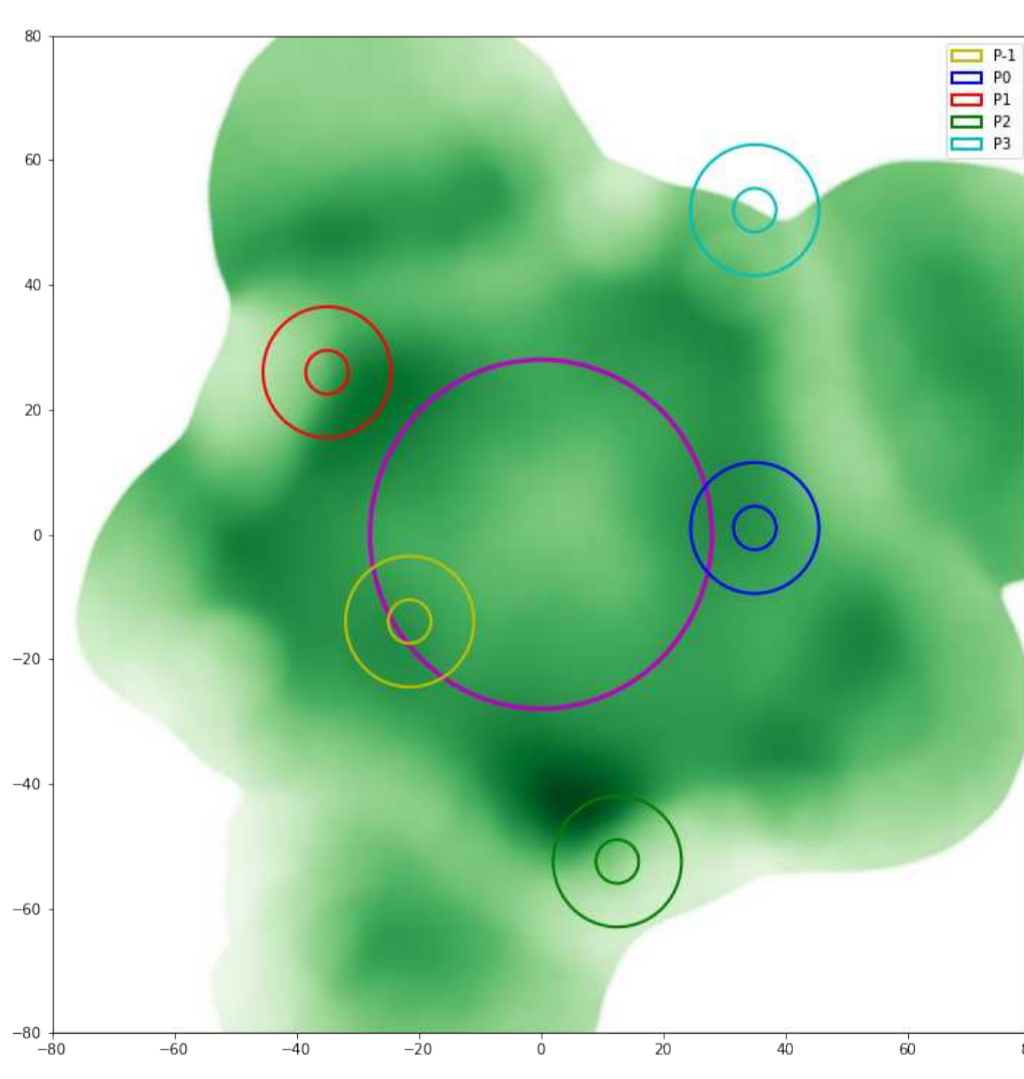
Continuous maps



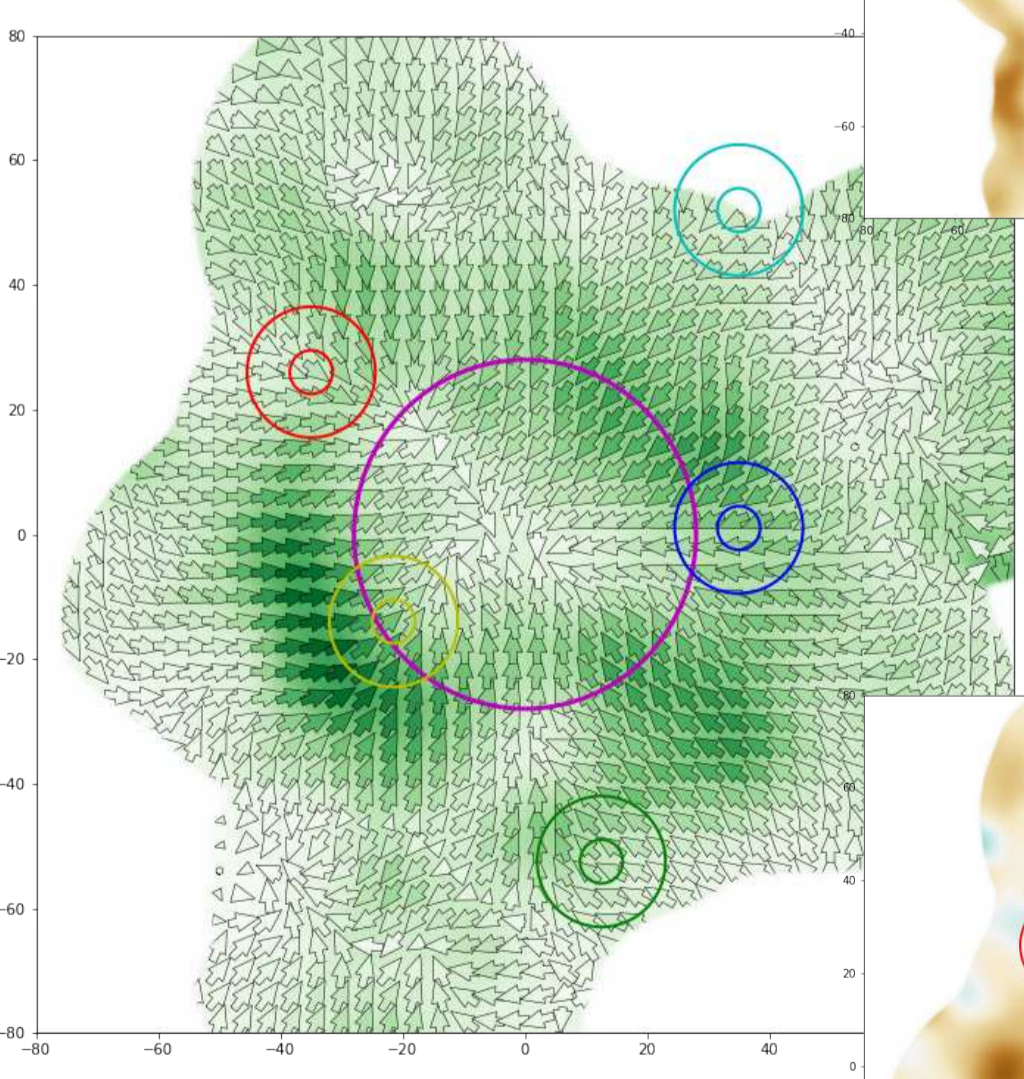
Auxin



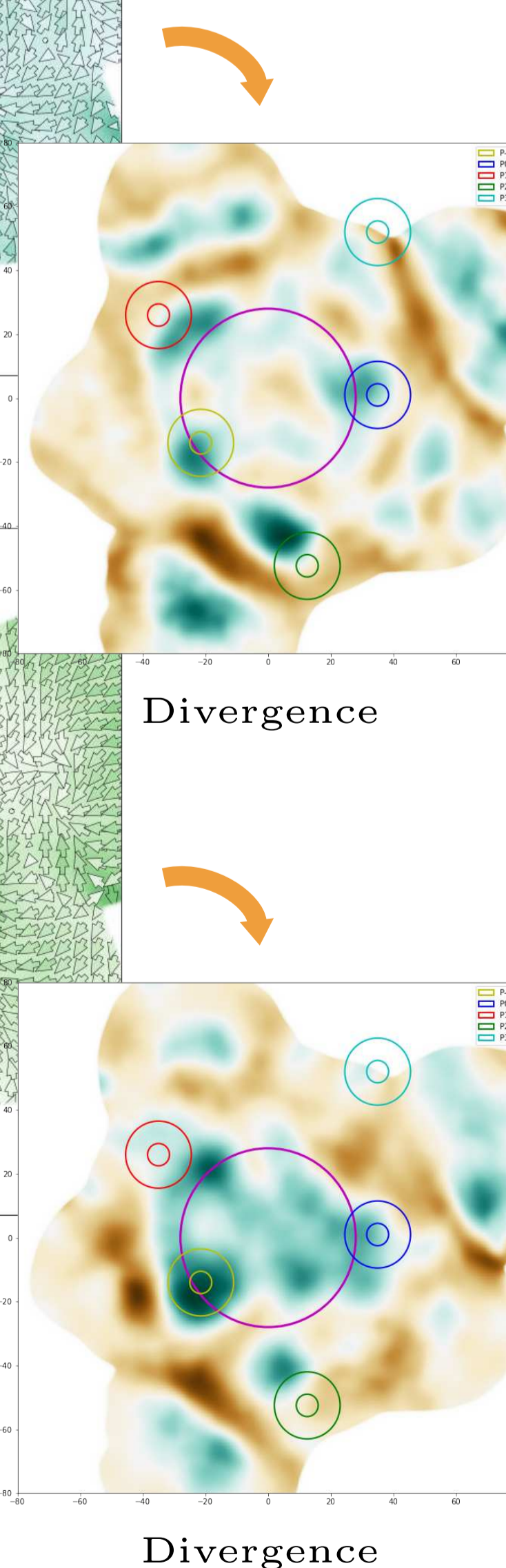
PIN1 Internal



PIN1 total



PIN1 net



Divergence

Divergence

- Primordia are located in the highest convergence zones.
- Continuous maps allow to compare different signals, individuals, and time points.

New hypothesis: accumulations shape due to PIN1 level regulation

Quantification of different PIN1 quantities at different scales leads to enrich our characterization of the SAM. PIN1 level is upregulated close to primordia. It is sufficient to make auxin accumulate according to the modeling. Future work: track PIN1 during primordia development, include temporal aspects to the PIN1 modeling.