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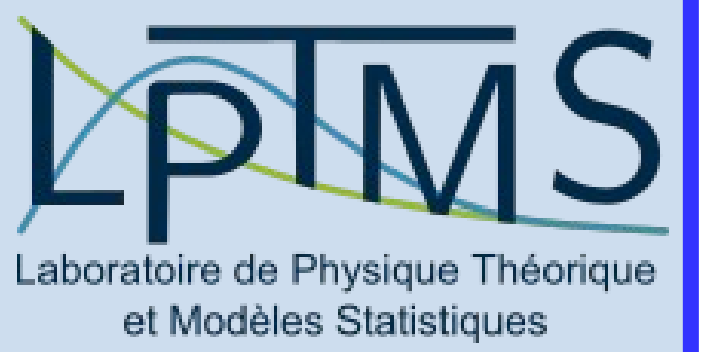


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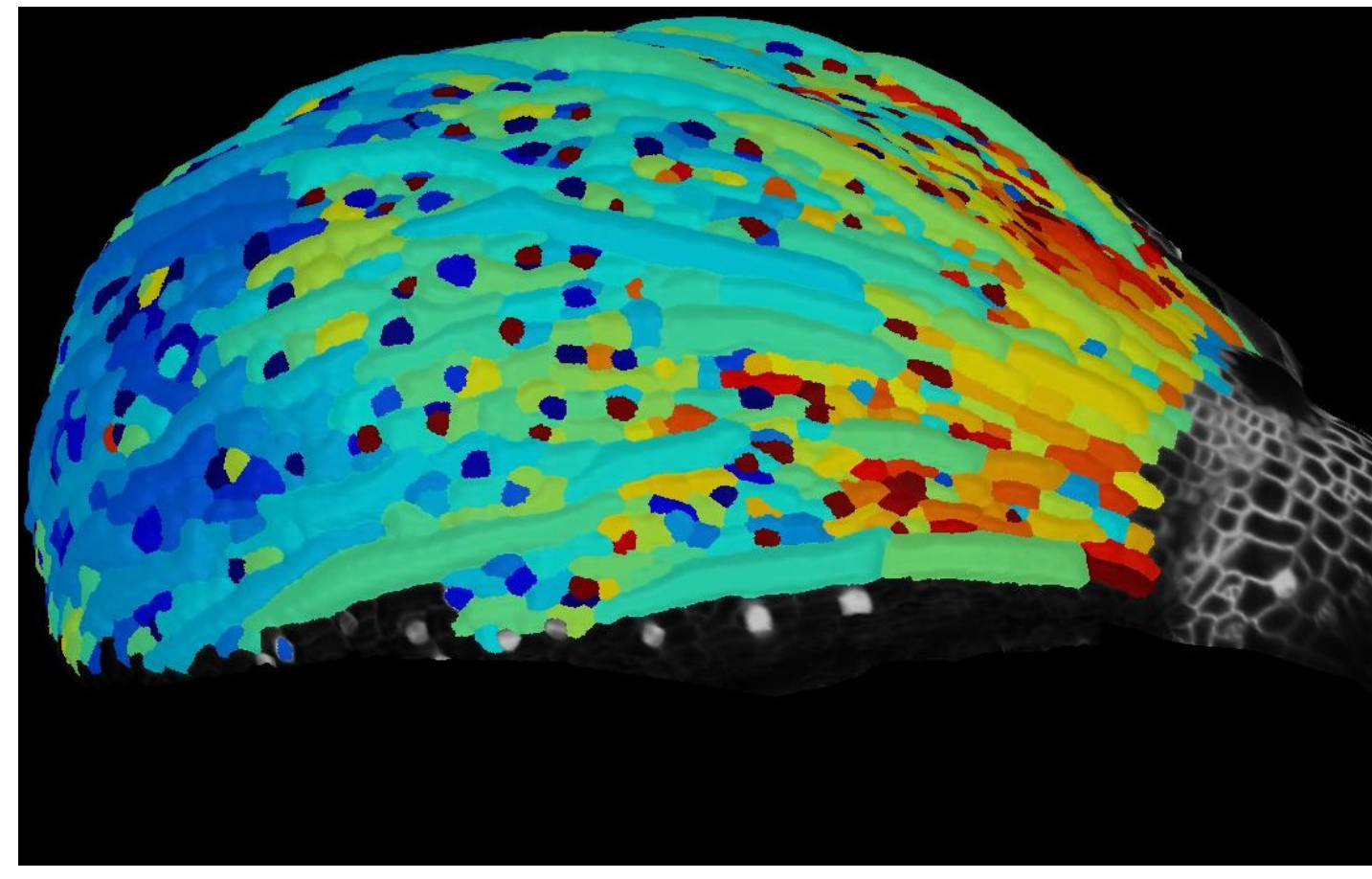
# Tissue growth couples temporal and spatial fluctuations

Antoine Fruleux, Lilan Hong, Adrienne H. K. Roeder, Chun-Biu Li & Arezki Boudaoud



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## Cellular variability v.s. organ robustness



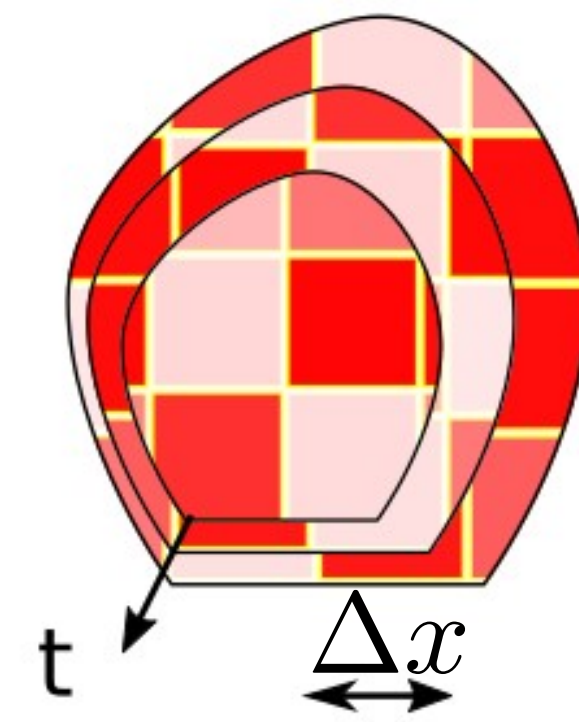
cellular variability  
↕  
robust organ shapes

Cell growth is heterogeneous in space and time.

→ how to grow robust organ shapes ?

## Spatiotemporal averaging

Morphogenesis sums growth over space & time



growth  
spatiotemporal averaging  
↓ Law of large numbers  
robust organ size/shape

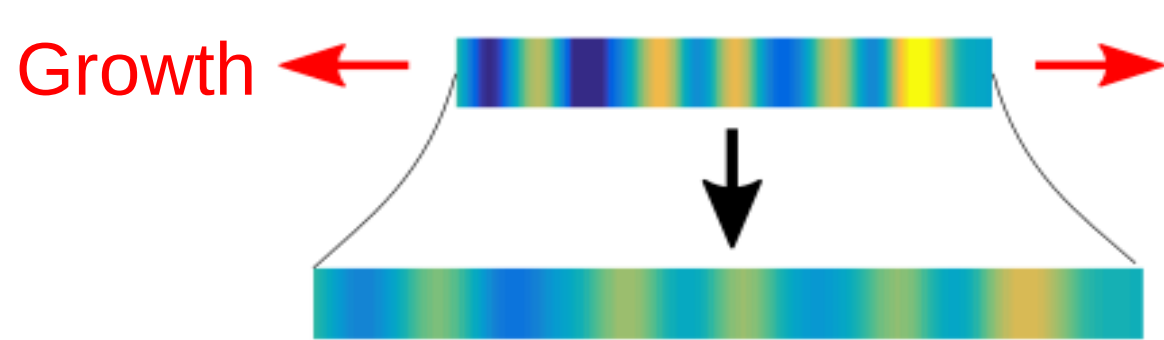
e.g. area increase:

$$\Delta A \simeq t \langle \gamma \rangle A \pm \Delta \gamma \sqrt{\frac{At \Delta t}{\Delta x^2}}$$

$\Delta x$ , fluctuations' spatial extend  
 $1/\Delta t$ , fluctuations' renewal rate

## But, are growth fluctuations stretched toward large space scales ?

Growth + time persistence = fluctuation stretching



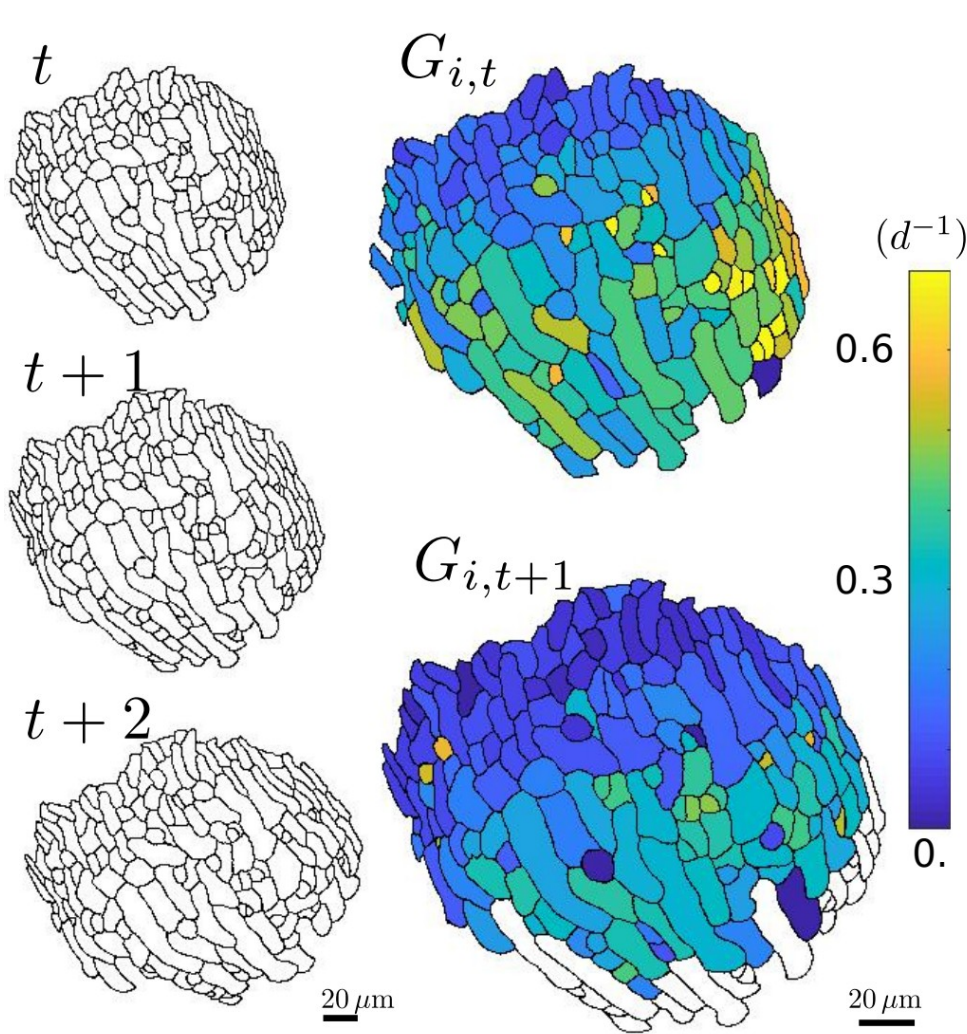
→ Enlargement of fluctuation's space scale

Consequences on morphogenesis

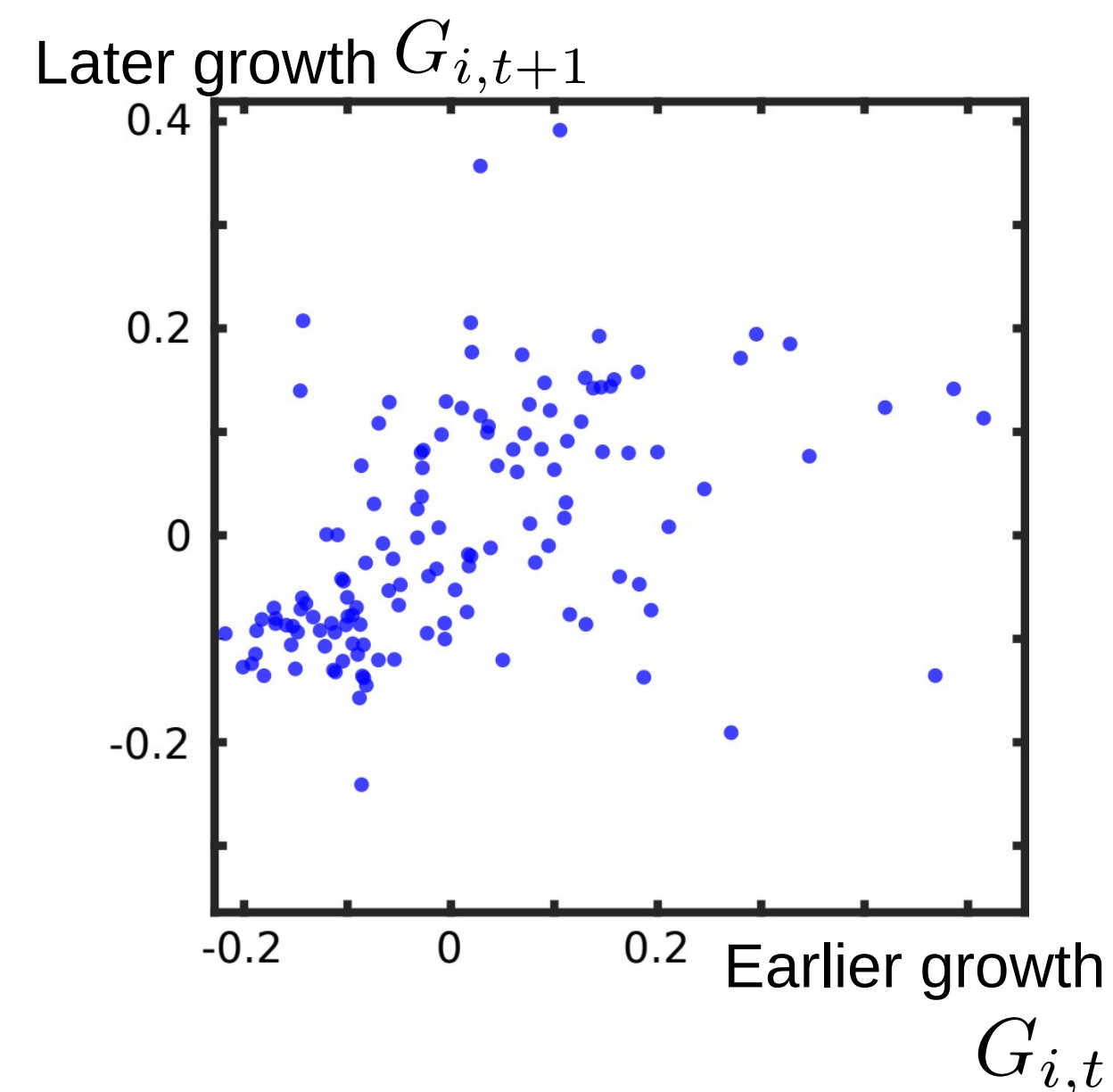
- Spatiotemporal averaging to be reconsidered
- Coupling between level of growth, and growth fluctuations' renewal rate & spatial extend

## Assessing growth time variability

Cells' areal growth rate



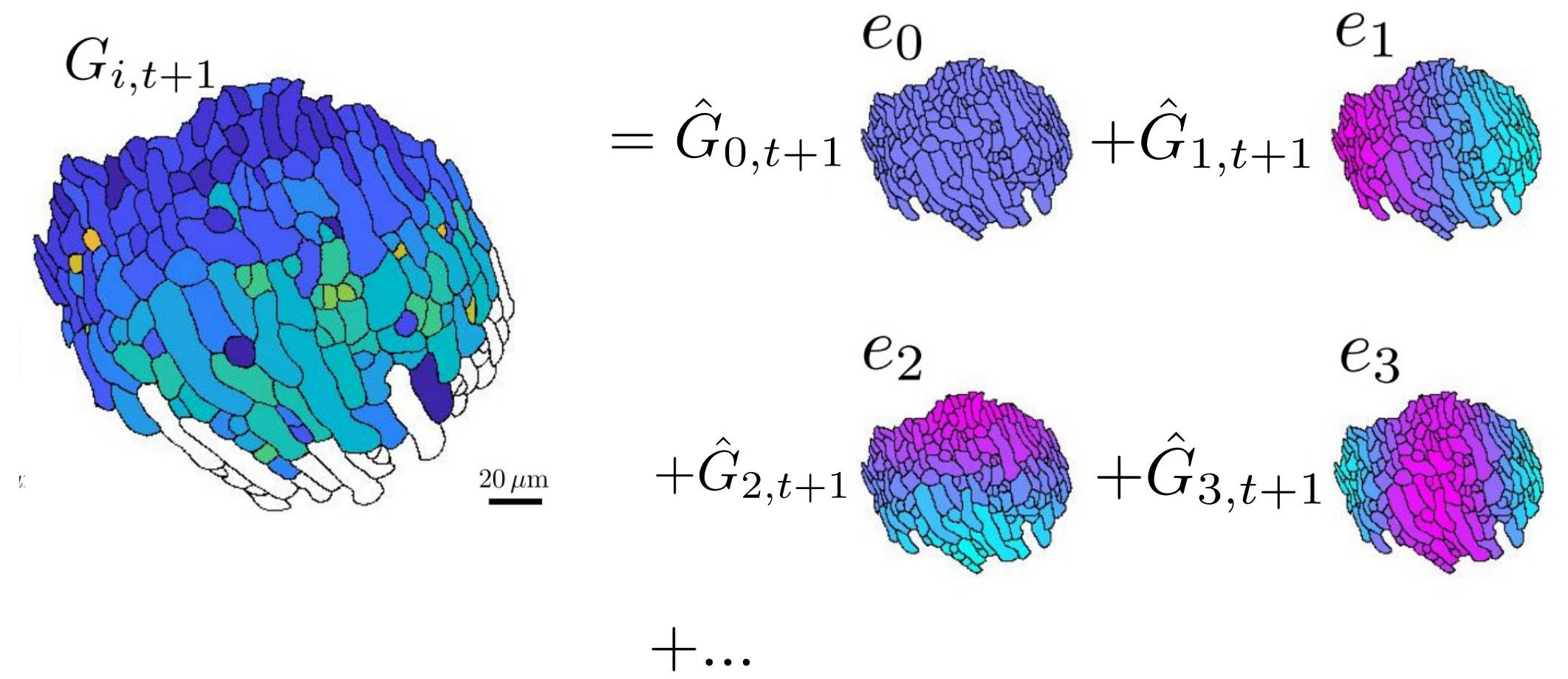
Time correlation



→  $\Gamma_t$ , time correlation coefficient

## Assessing growth space variability

Harmonic decomposition of growth space variations

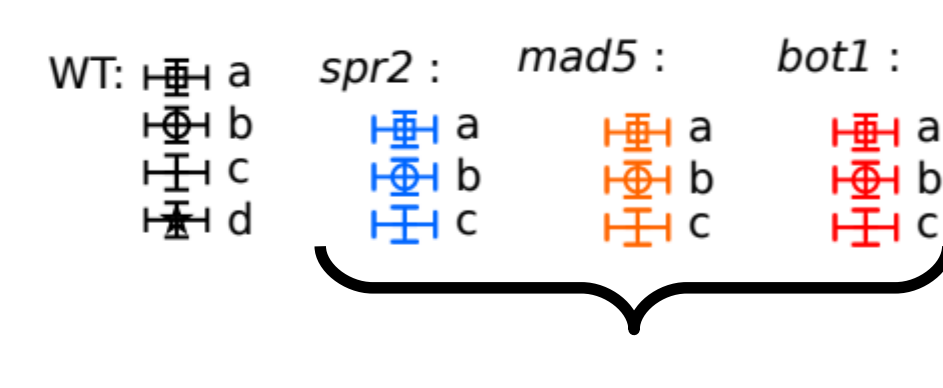


- $\bar{G}_t$ , tissue's growth rate
- $\Delta G_t$ , amplitude of growth fluctuations
- $\alpha_t$ , space correlation exponent

## Data statistics

Data sets

Lighting condition 1



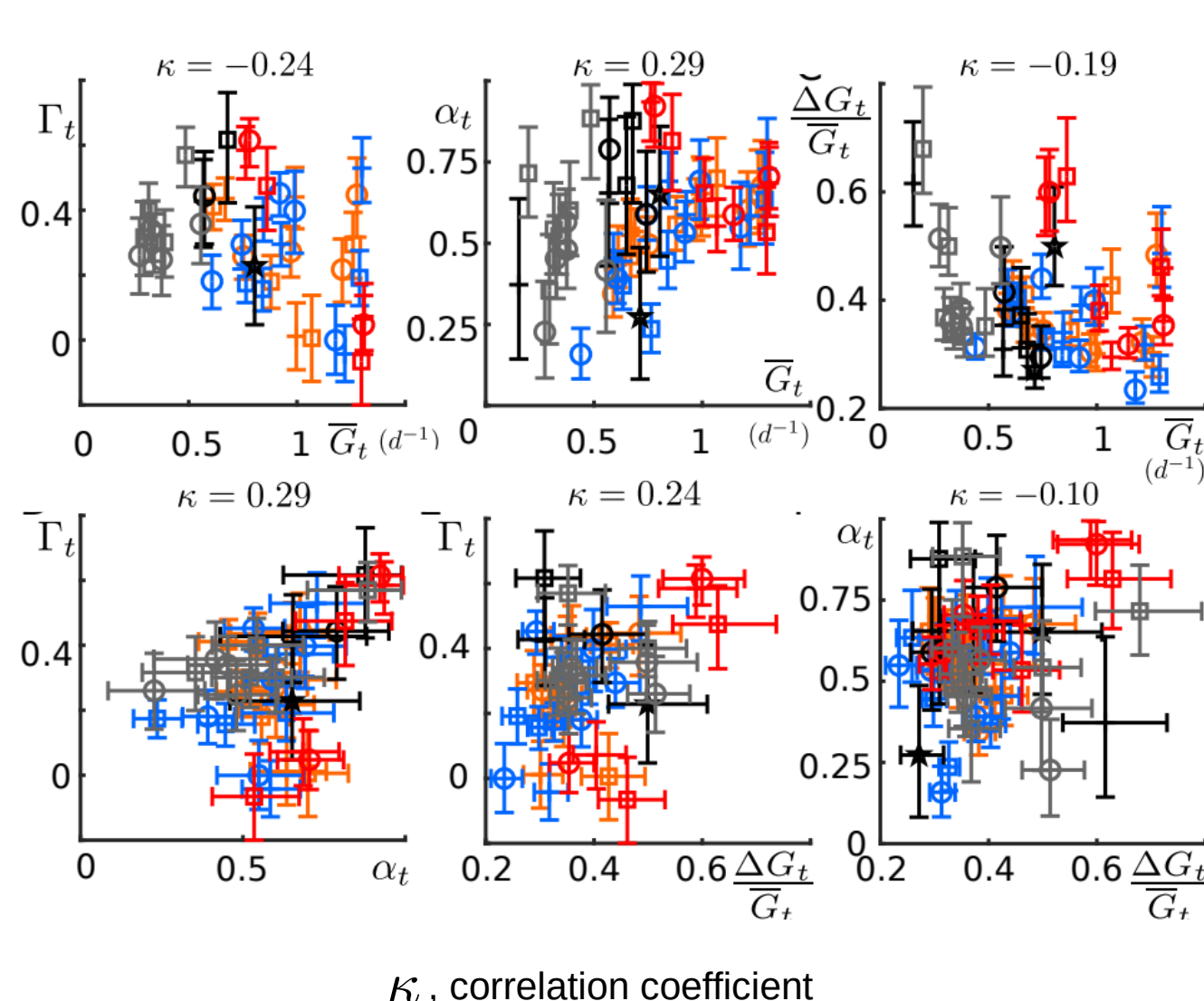
Cell wall mutants

Lighting condition 2



Distinct tissues followed in time

Generic correlation analysis



$\kappa$ , correlation coefficient

→ no clear pairwise correlations among growth parameters

## Testing fluctuation stretching

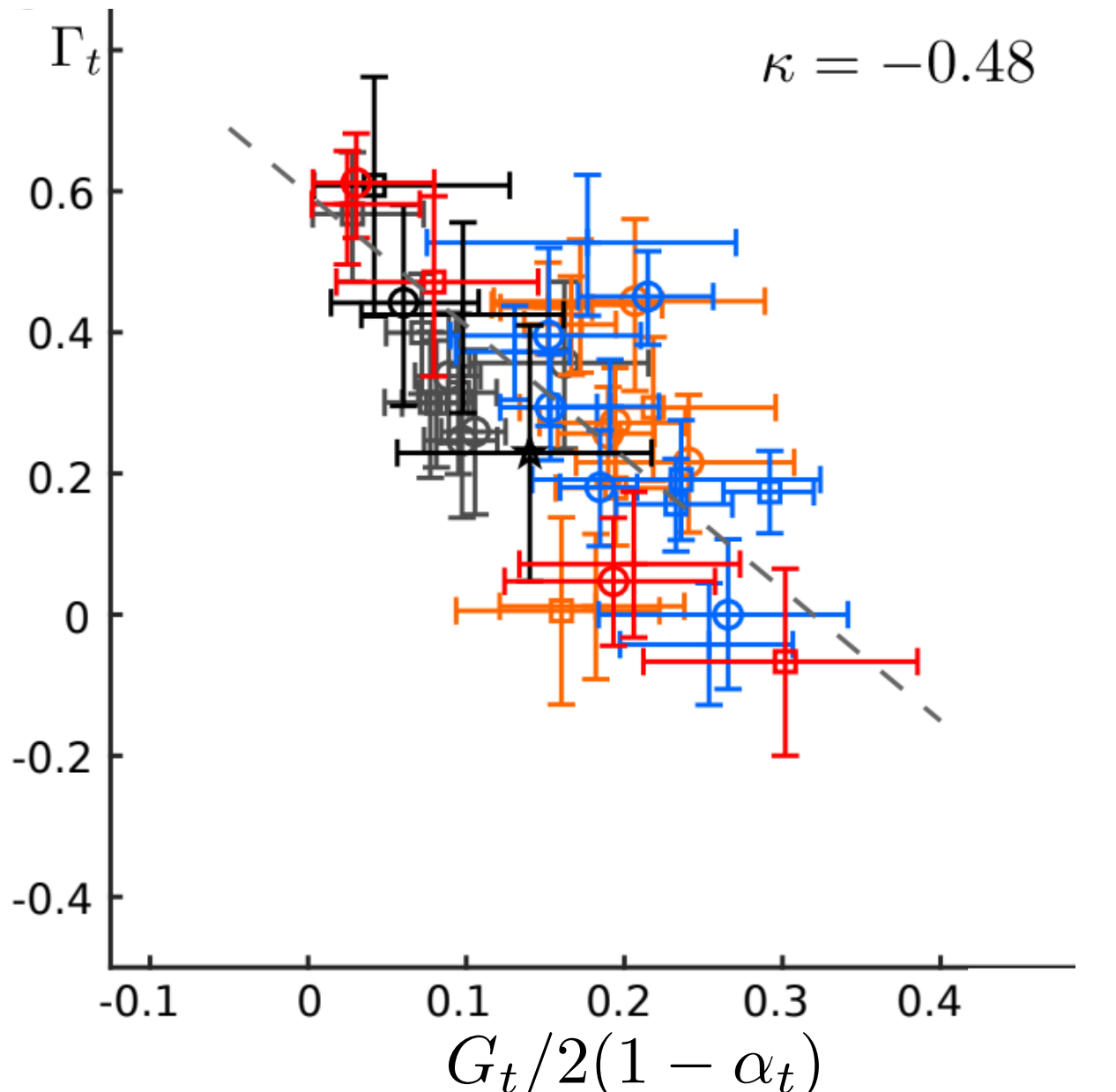
In theory

- $\bar{G}_t$ , tissue's growth
- $\alpha_t$ , space correlation

fluctuation stretching

induced renewal rate :  
 $1/\Delta t = G_t/2(1 - \alpha_t)$

Time correlation v.s. renewal rate



→ evidence for fluctuation stretching

## Results :

- quantification of space & time variability
- coupling between level of growth and its space & time variability
- evidence for fluctuation stretching

## Perspectives :

- Considering different tissue types
- Compare plant & animal tissues
- Limiting scale ?