Lipid Interactions and Membrane Curvature of Arabidopsis thaliana PIEZO1

Charline Fagnen[1,2], David Beech[2], Antreas Kalli[2,3]

[1] Université de Reims Champagne-Ardenne, UMR7369 CNRS, MEDYC, F-51095, Reims, France.
[2] Leeds Institute of Cardiovascular and Metabolic Medicine, School of Medicine, University of Leeds, Leeds, LS2 9JT, UK.
[3] Astbury Centre for Structural Molecular Biology, University of Leeds, Leeds, LS2 9JT, UK.

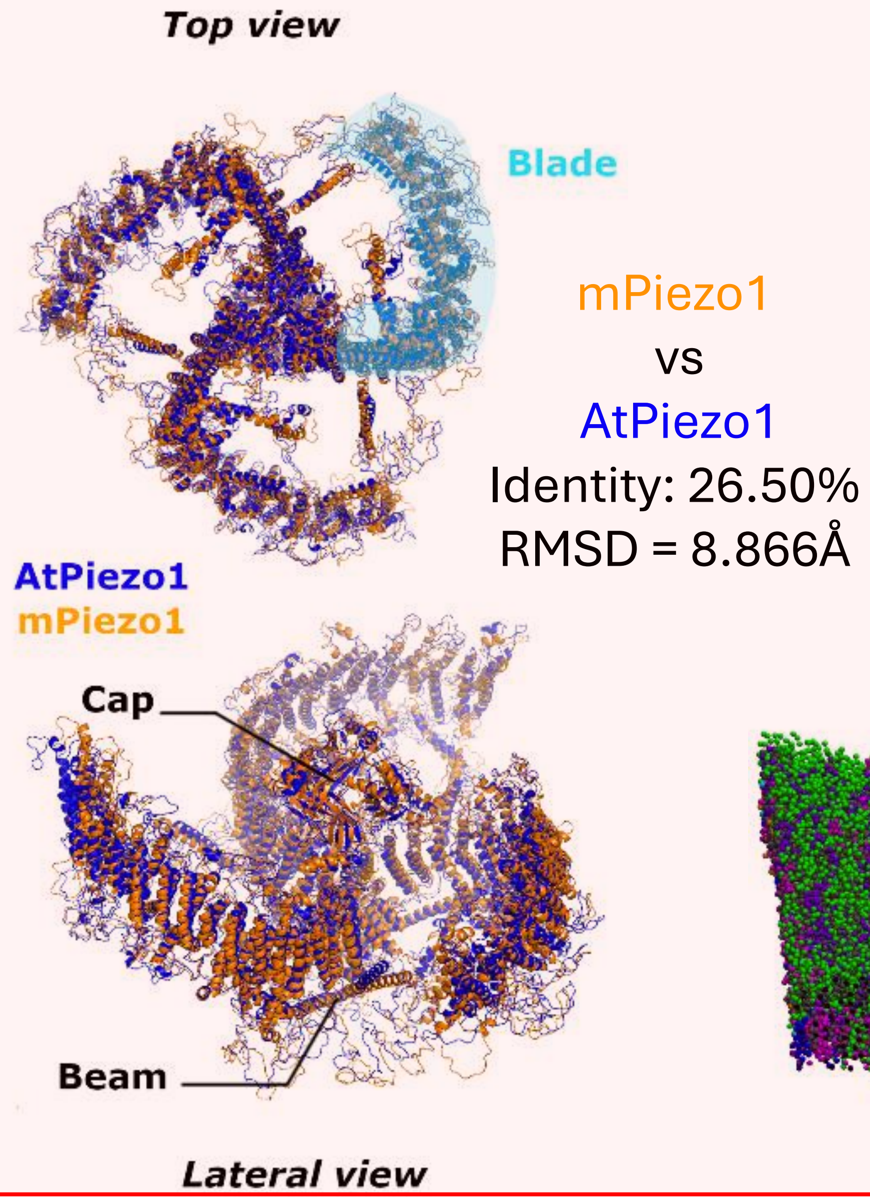
INTRODUCTION

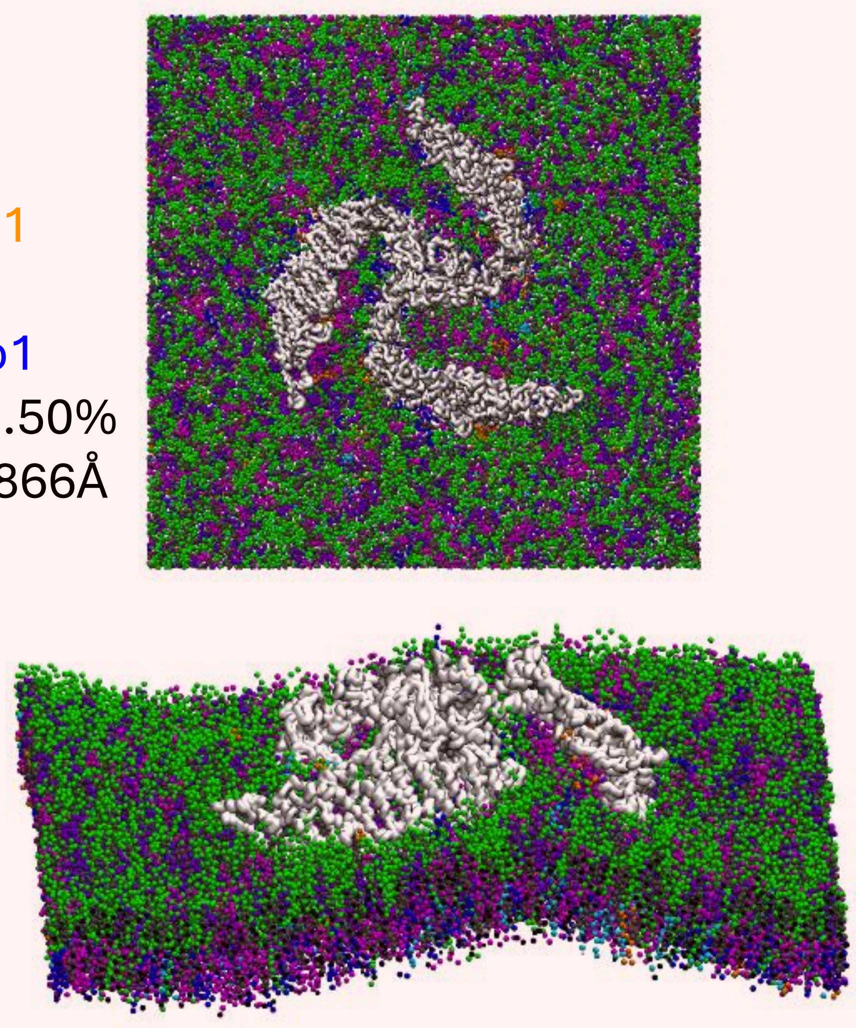
Mechanical forces are critical for plant development, growth and resilience, e.g. it has been shown that application of mechanical forces alters floral and root development in *Arabidopsis thaliana*. Fundamental understanding of the force sensing apparatuses in plants will, therefore, provide a major breakthrough in this field delivering potential advantages for agriculture and beyond.

This project will focus on understanding the activation of PIEZO1 in *Arabidopsis thaliana* (AtPIEZO1). PIEZO1 is a protein found in many organisms, including humans, mice, and plants. It belongs to the PIEZO family of mechanosensitive ion channels, which are known for their ability to sense mechanical stimuli and convert them into electrophysiological and calcium signals.

PIEZO channels have been extensively studied in mice and other mammals, and they were shown to be critical of their force sensing mechanisms. They are also expressed in plants but understanding of their function in plants is much more limited. Recent studies have shown that AtPIEZO1 is critical for the development of *Arabidopsis thaliana*, **but a mechanistic/molecular understanding of how AtPIEZO1 functions is lacking**.

METHODS





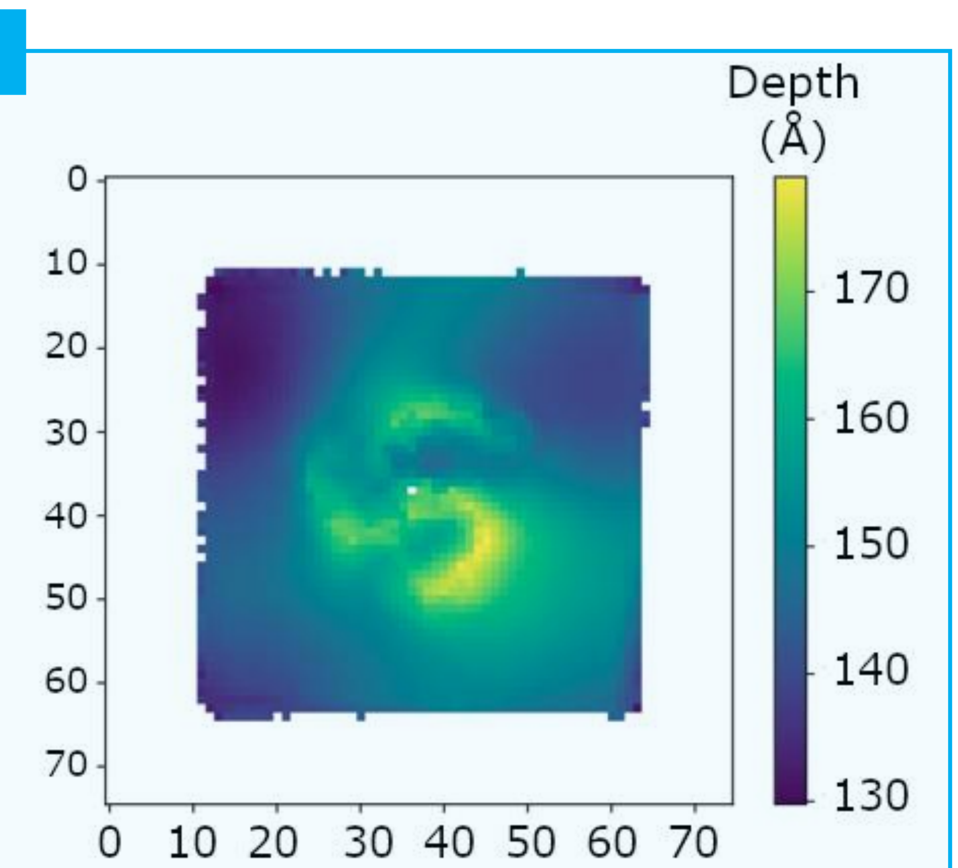
Membrane composition[1,2,3]

Lipids	Inner (%)	Outer (%)
CHOL	34	48
PIPC	6	32
PIPE	34	6
PIPG	14	
PIPI	6	
DIPS	6	
PNCE		14

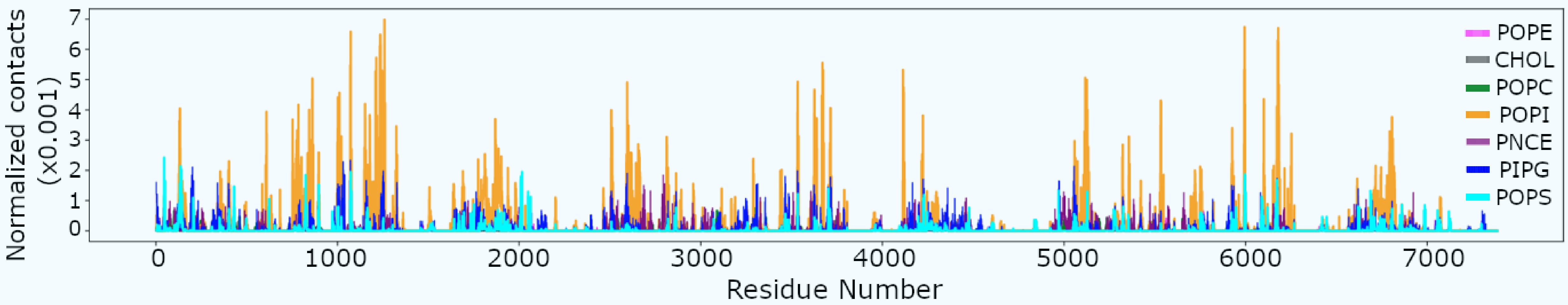
RESULTS

Our simulations above with the AtPIEZO1 in the tonoplast membrane reveal a non-symmetric topology. The depth of the membrane around two of the blades was similar (30-40 Å), but it was deeper around the last blade (50 Å). Additionally, the depth in the membrane of the AtPIEZO1 is smaller compared to mouse PIEZO1 in which a ~70 Å depth in the membrane was observed. Given that the **depth of the membrane around PIEZO1 is linked with activation and force sensing**, a more **asymmetric** and shallower topology for the AtPIEZO1 may result in a different activation mechanism.

In orange, the phosphatidylinositol (PI) lipids show the highest interaction rate (indicated by higher peaks) in two areas around residues 1200 and 1800. The PI lipids have been shown to interact with ionic channels including PIEZO1 and regulate their function[4,5,6]. **PS, and PG lipids also interact strongly with regions of AtPIEZO1.** As anionic lipids were shown to regulate mouse and human PIEZO1 activation and dynamics, we hypothesize that these three anionic lipids may also regulate AtPIEZO1. Note that PG lipids are present in the tonoplast but not mouse or human plasma membranes.



Depth of the lower leaflet of tonoplast membrane in the presence of the AtPIEZO1 channel. X and Y axes show the bilayer x and y dimensions.



Normalized average number of lipids contacts between the AtPIEZO1 residues and the tonoplast membrane lipids.

CONCLUSION

✓ **AtPIEZO1 interacts strongly with specific lipids in simulations -> PI, PS and PG lipids,**
✓ **AtPIEZO1 membrane footprint may be asymmetrical -> Different activation mechanism.**

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