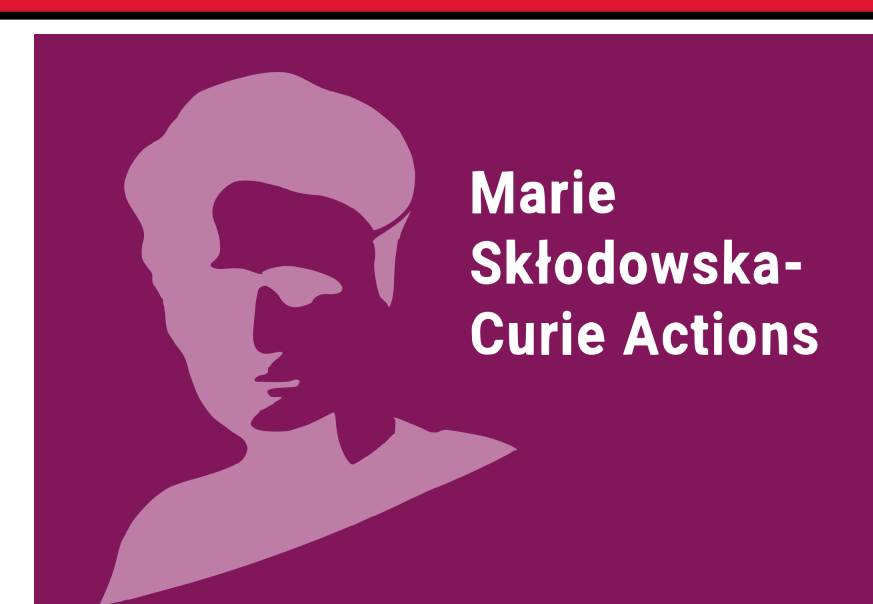
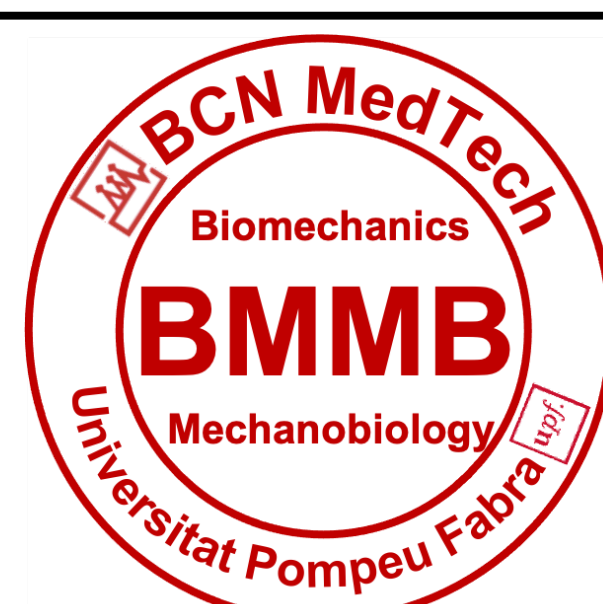


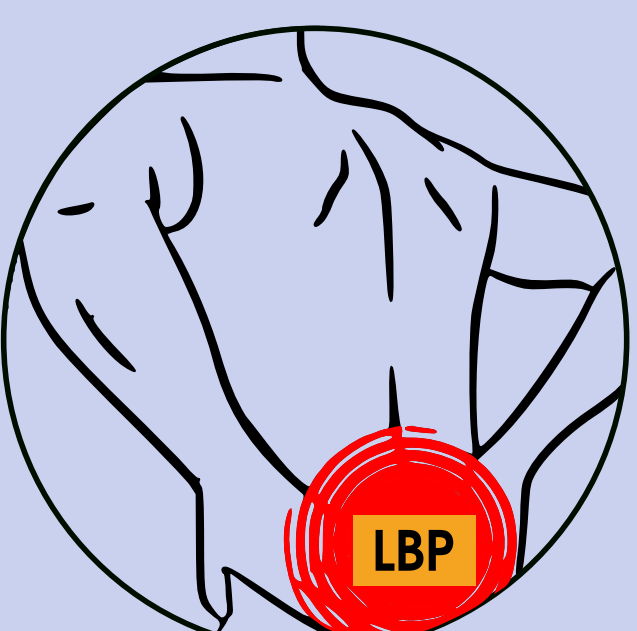
Mining of biomechanical and geometry data of IVD FE simulations

Estefano Muñoz-Moya, Morteza Rasouligandomani, Carlos Ruiz Wills, Gemma Piella, Jérôme Noailly

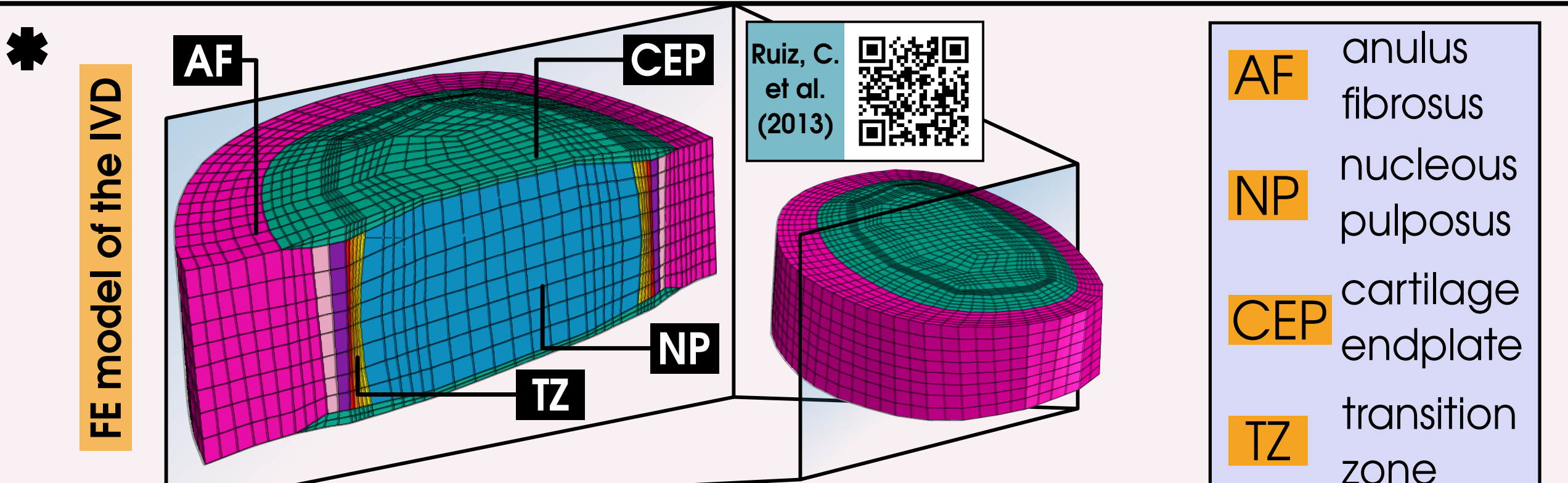
BCN MedTech, Department of Information and Communication Technologies, Universitat Pompeu Fabra, Barcelona, Spain



BACKGROUND



- 266 million individuals worldwide suffer degenerative disease of the spine [1]
- Intervertebral disc (IVD) degeneration (IDD) is a major risk factor of low back pain (LBP)
- Endplate anomalies are related to IDD, but mechanisms cannot be measured



but... Simulation results depends on IVD morphology [2]

and...

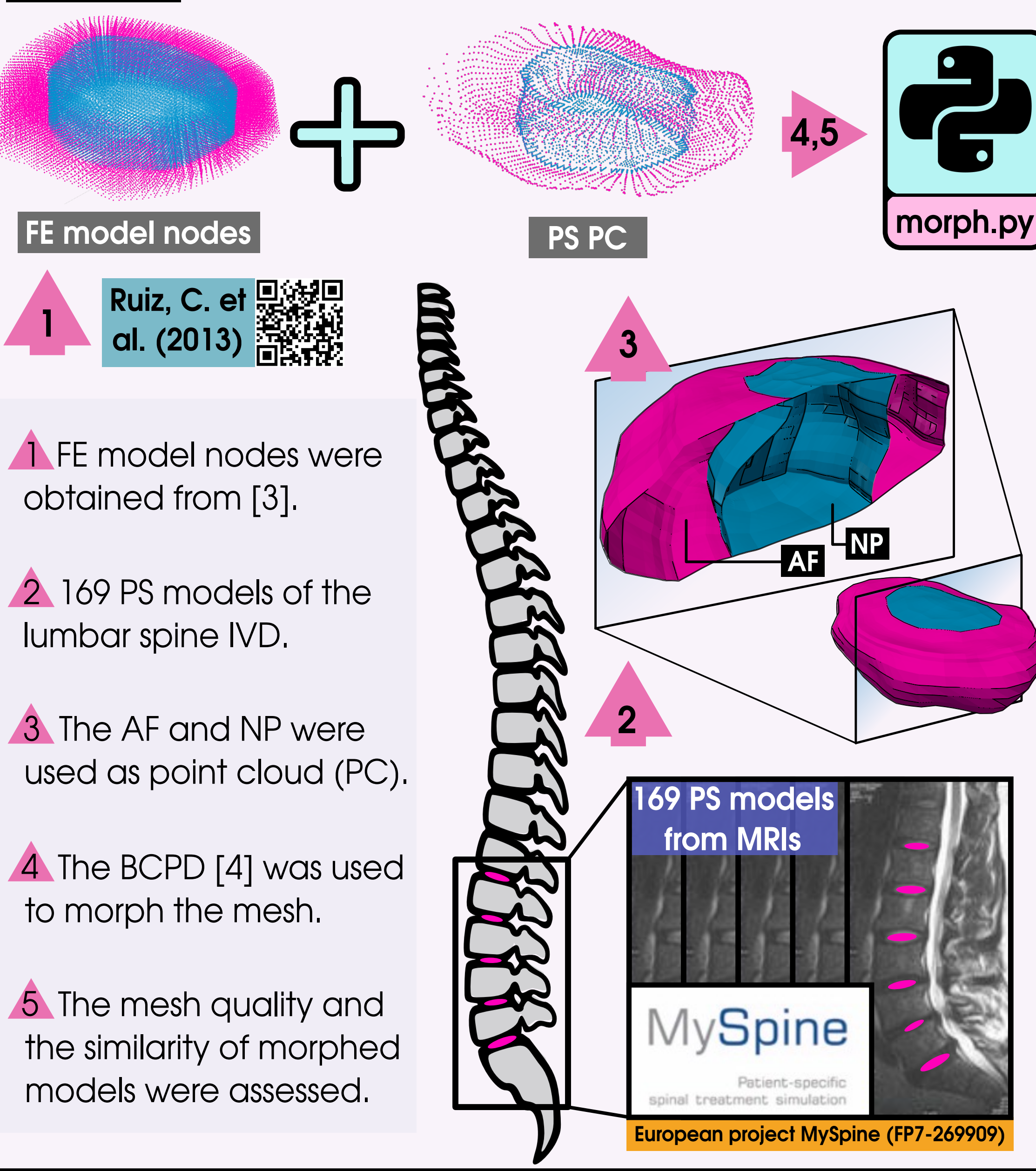
- There is no cohort of different IVD morphologies
- We do not know whether morphology can be a risk factor for IDD
- How could we automate the process for any patient?

OBJECTIVES

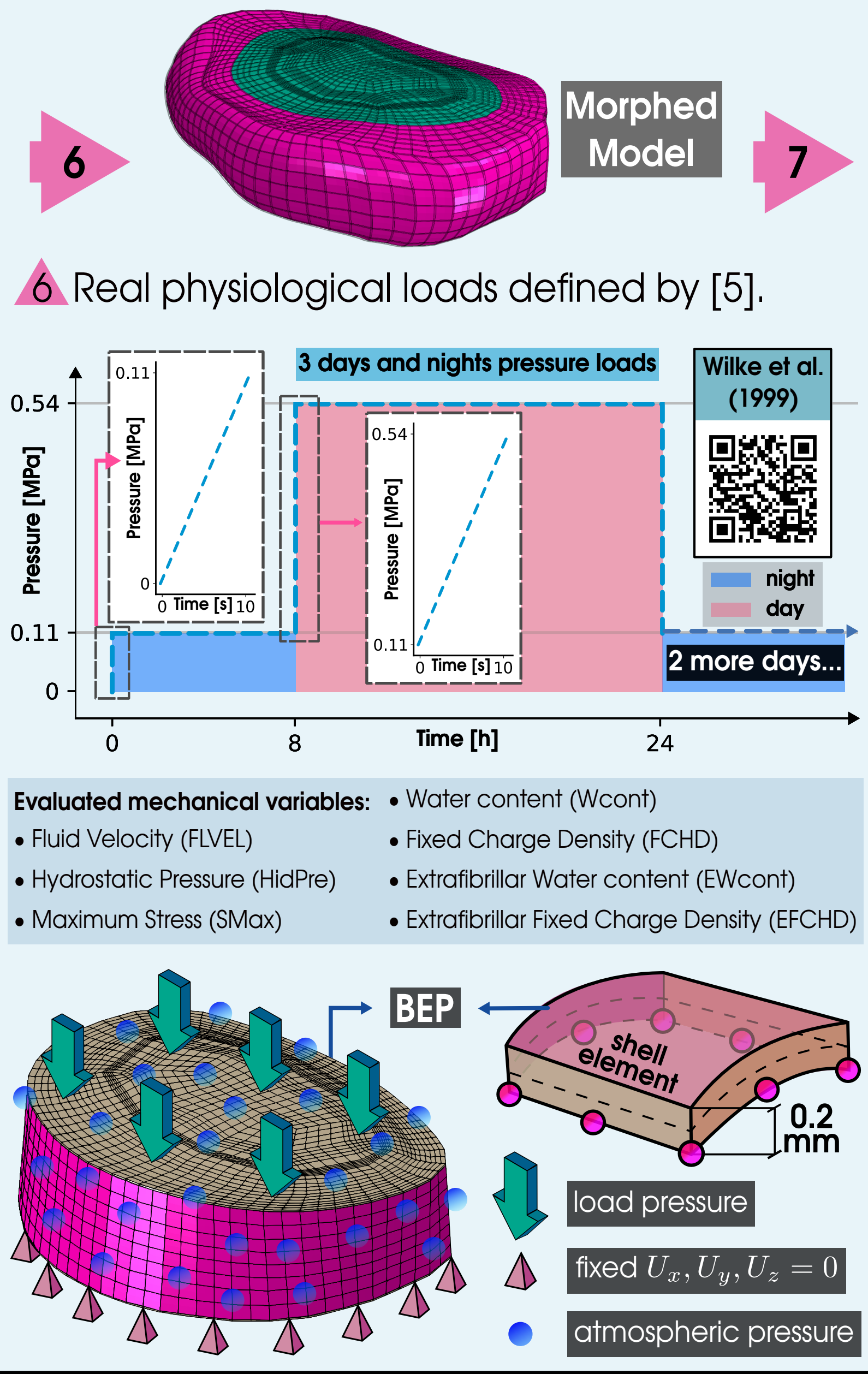
- Establish a procedure and algorithms to adapt a IVD structured FE mesh to patient-specific models
- Identify the morphological features best explaining the mechanical responses to decipher their influence on IDD

METHODS

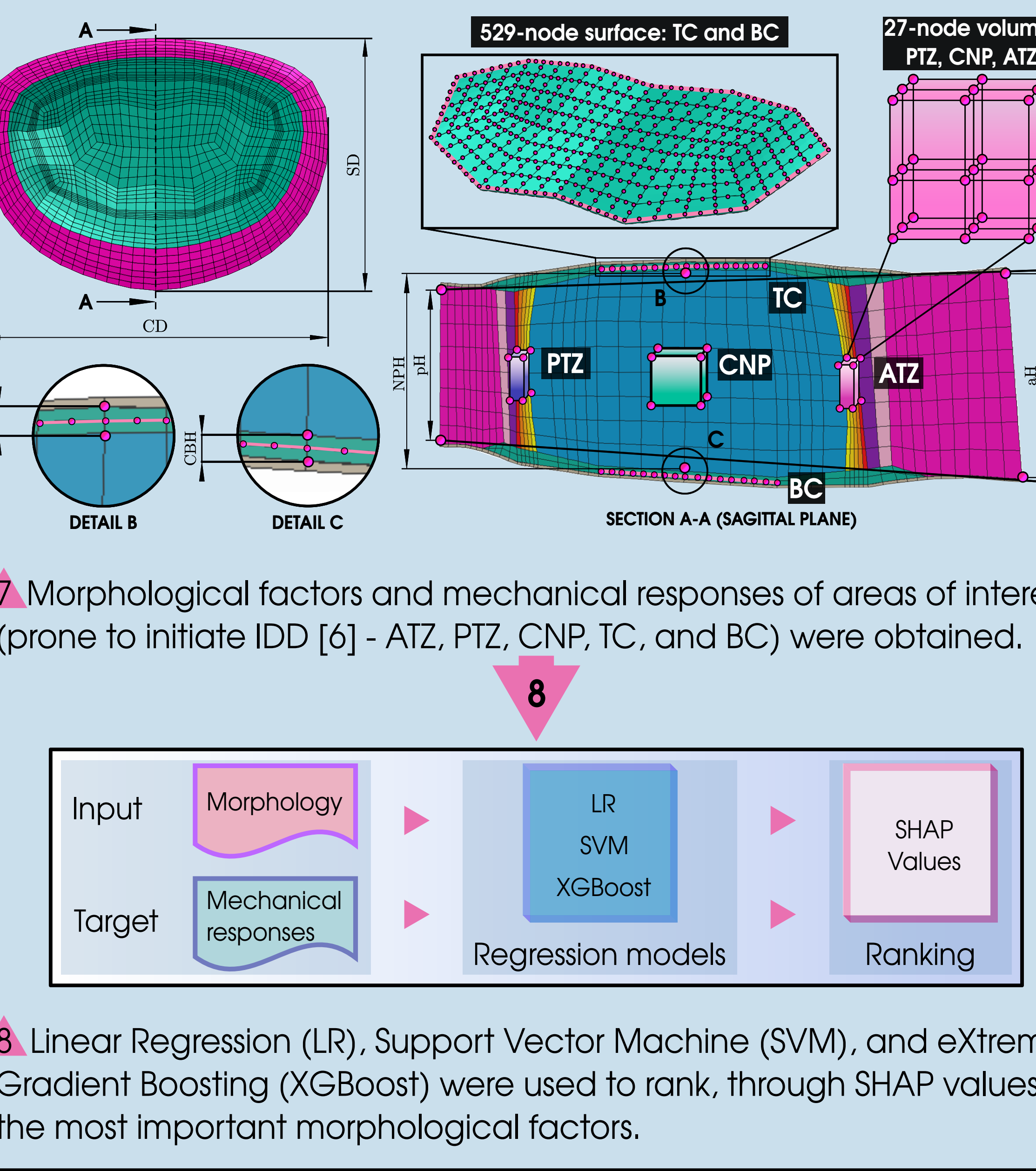
Morphing Algorithm



Mechanical Simulations



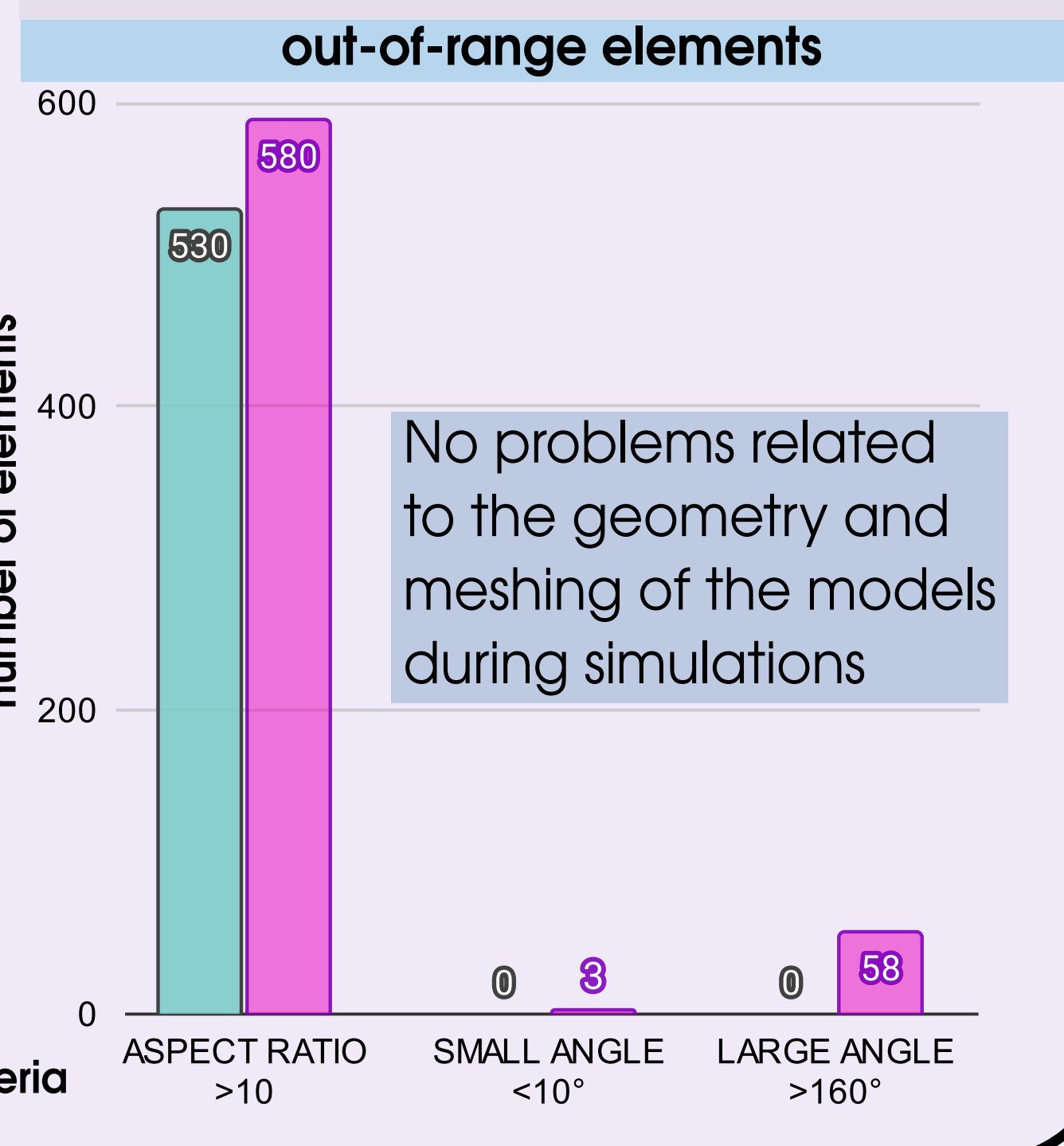
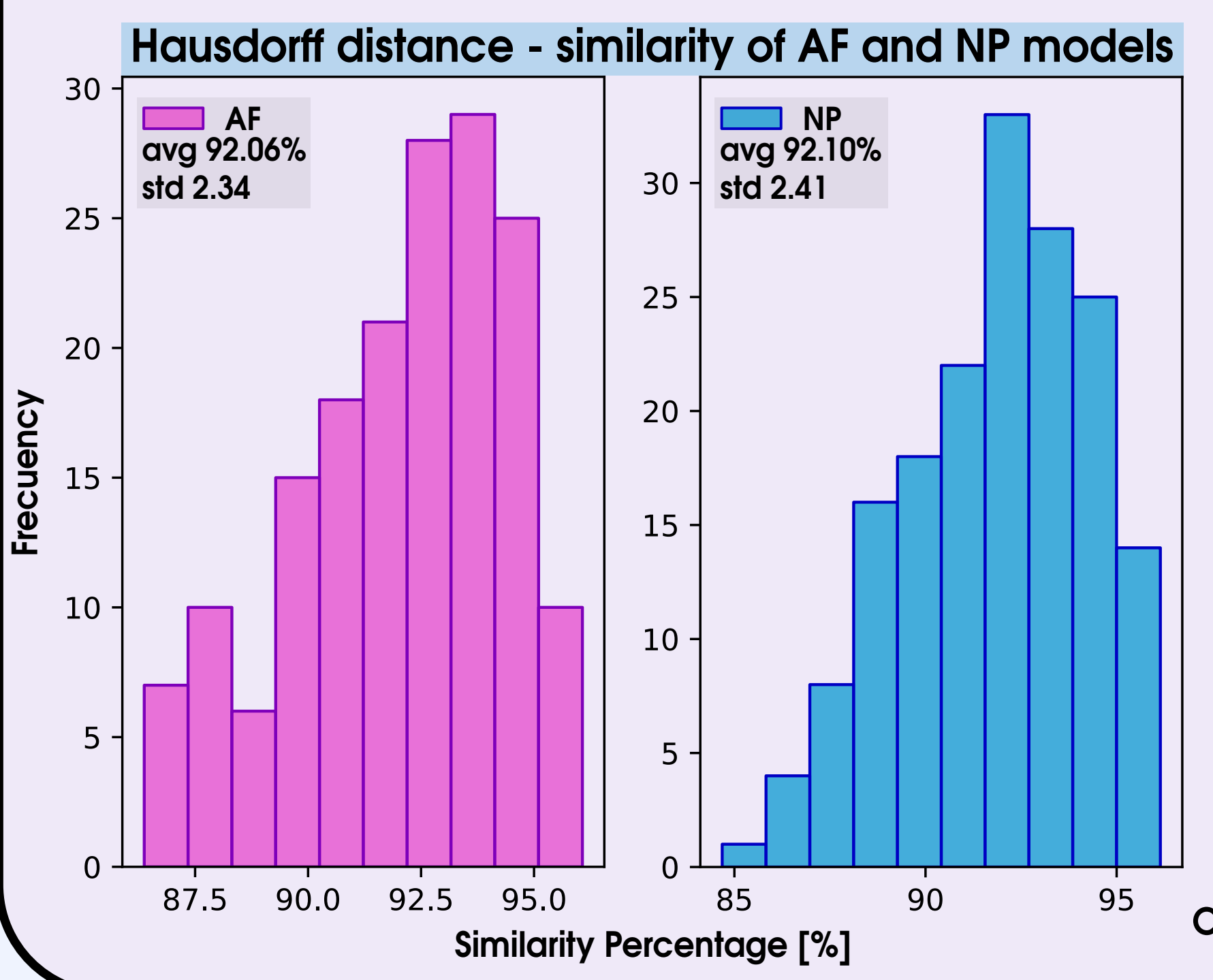
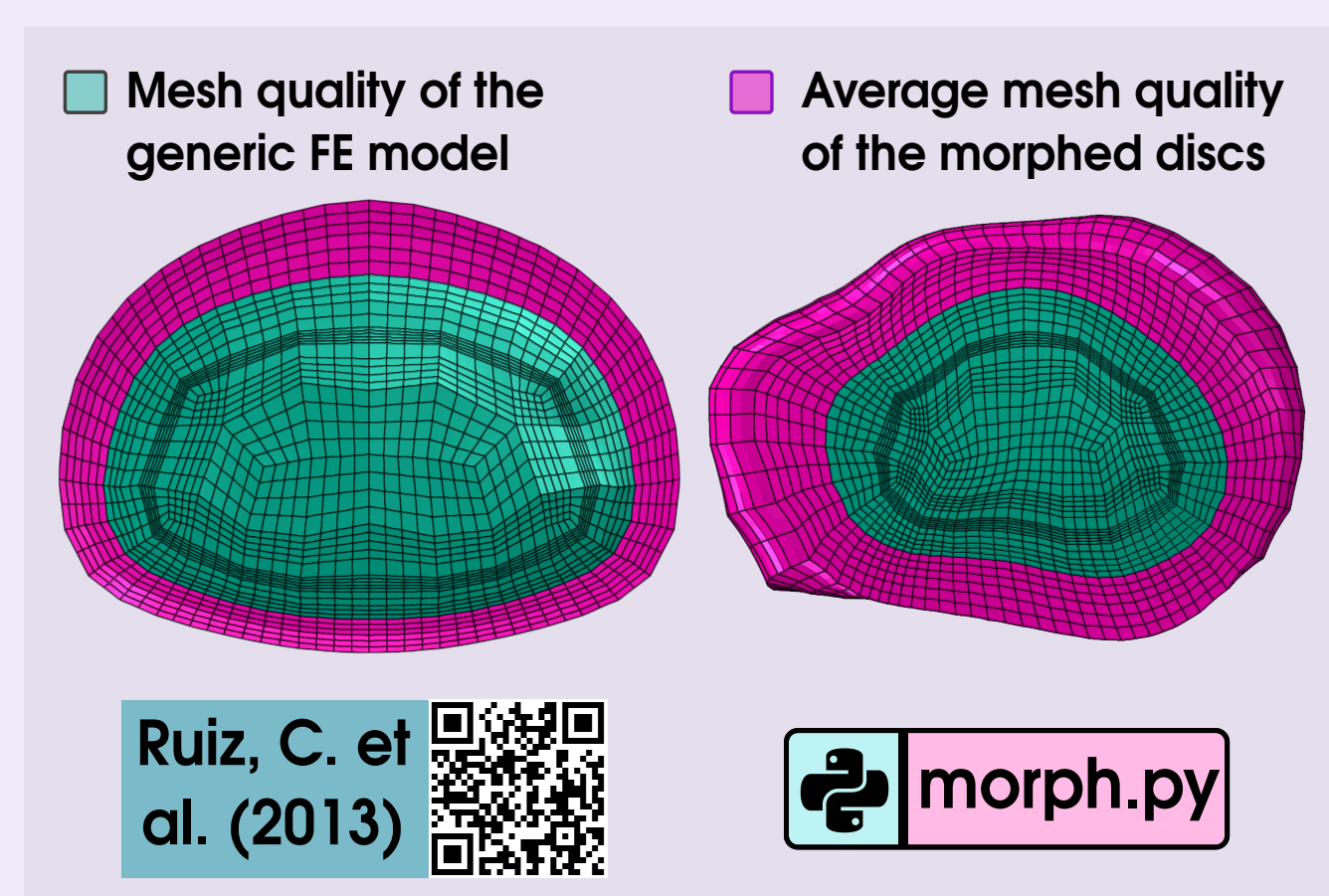
Key Morphological Factors using Machine Learning (ML)



RESULTS

Morphing process

- No significant differences in mesh quality between the generic and the average of the morphed models
- The Hausdorff distance: the similarity between the PC and the FEM was about 92%



Influence of morphology on mechanical response - PTZ CNP ATZ

Step	Load day	Creep day	Creep day	Creep day	Creep day	Creep day	Creep day
PTZ	Model	LR	LR	SVM:Li	LR	SVM:RBF	SVM:RBF
	r ²	0.66	0.42	0.78	0.38	0.40	0.40
	MSE	2.34e-10	1.01e-03	5.98e-04	2.18e-05	8.40e-05	1.02e-04
	PH	0.59	0.98	0.91	0.81	0.84	0.87
	AFV	0.012	1	0.22	1	1	1
	AFPZSA	1	0.52	1	0.45	0.54	0.53
	NPP	0.25	0.74	0.1	0.83	0.55	0.47
CNP	Model	LR	XGBoost	XGBoost	XGBoost	XGBoost	XGBoost
	r ²	0.73	0.60	0.70	0.72	0.74	0.73
	MSE	3.49e-12	1.12e-04	9.94e-05	2.14e-06	8.17e-06	1.04e-05
	MH	0.48	1	1	1	1	1
	AFV	0.3	0.33	0.54	0.2	0.23	0.22
	SD	0.28	0.031	0.66	0.083	0.09	0.079
	CTV	0.81	0.33	0.45	0.2	0.2	0.19
ATZ	Model	LR	LR	LR	LR	LR	LR
	r ²	0.72	0.67	0.86	0.68	0.68	0.68
	MSE	8.78e-11	3.76e-04	3.20e-04	5.88e-06	2.33e-05	2.85e-05
	NPSA	0.55	1	0.83	1	1	1
	AFAZSA	0.61	0.33	0.91	0.33	0.33	0.33
	CTSA	0.69	0.43	0.37	0.5	0.5	0.5
	NPV	0.21	0.47	0.028	0.52	0.52	0.52
Targets	FLVEL	HidPre	SMax	WCont	FCHD	EFCHD	EWCont

- Mechanical variables affect the transport of metabolites, which regulate cell viability [7]
- The local heights strongly influence the local mechanical responses

Conclusions

An automatic morphing algorithm tool was successfully developed

PS FE simulations seem cornerstone to assess mechanoregulatory variables in critical regions

A repository of 169 IVD models has the same topology

Mechanical variables are strongly influenced by their local morphological factors and the CEP shape of the IVD

references

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acknowledgments



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