

# AUTOMATIC DETECTION OF PHARYNGOLARYNGEAL ACTIVITIES USING HIGH-RESOLUTION CERVICAL AUSCULTATION SIGNALS

Lila GRAVELLIER<sup>1,2</sup>, Maxime LE COZ<sup>2</sup>  
Jérôme FARINAS<sup>1</sup>, Julien PINQUIER<sup>1</sup>

<sup>1</sup>IRIT, Université de Toulouse, CNRS, Toulouse INP, UT3, Toulouse, France

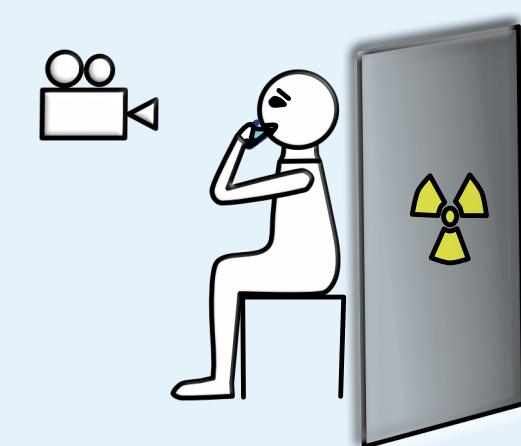
<sup>2</sup>Swallis Medical, Toulouse, France

TOULOUSE 2023

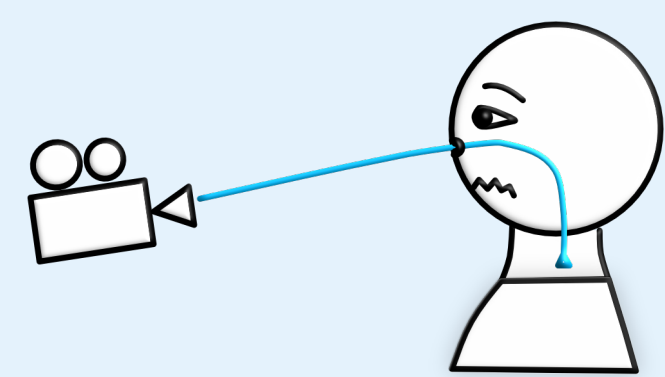
## WHAT NEEDS ?

Swallowing disorders (dysphagia)

- Affects 8% of the world's population [1]
- Need for large-scale screening
- Current reference tests can be invasive/costly/inaccessible [2]

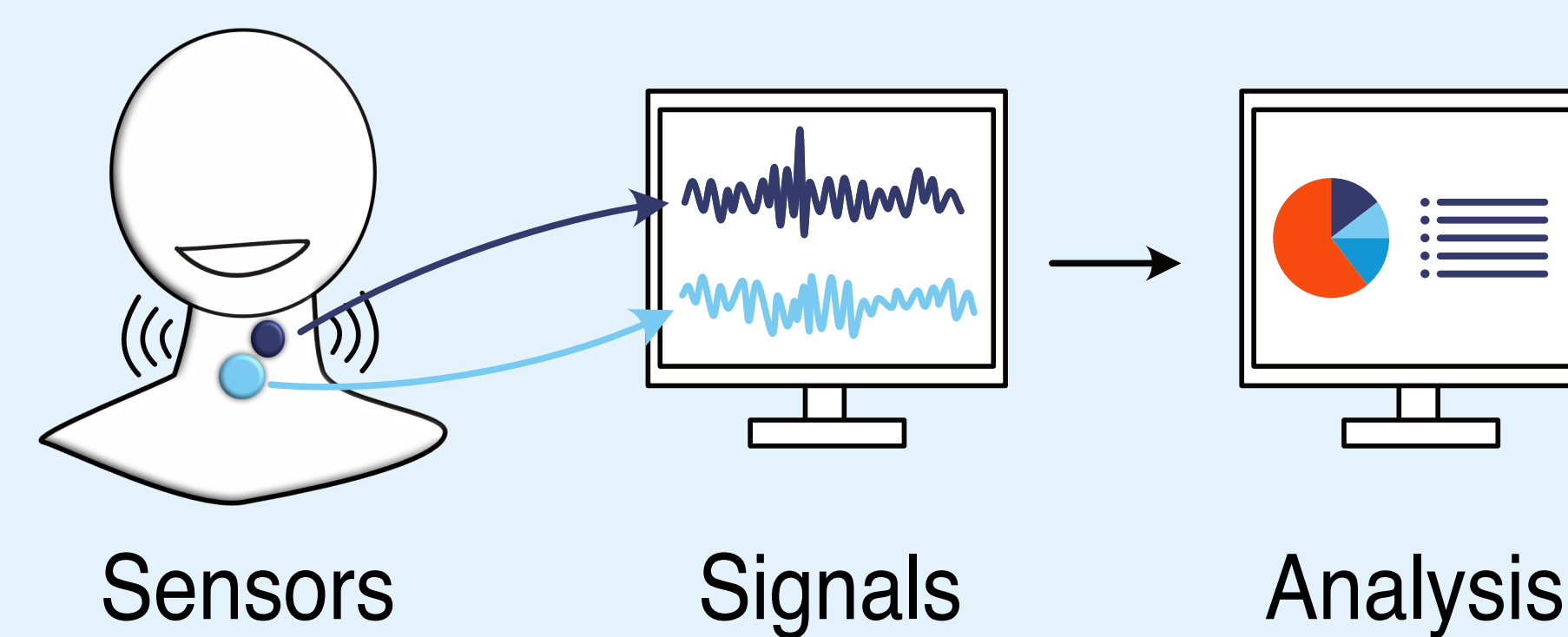


Videofluoroscopy



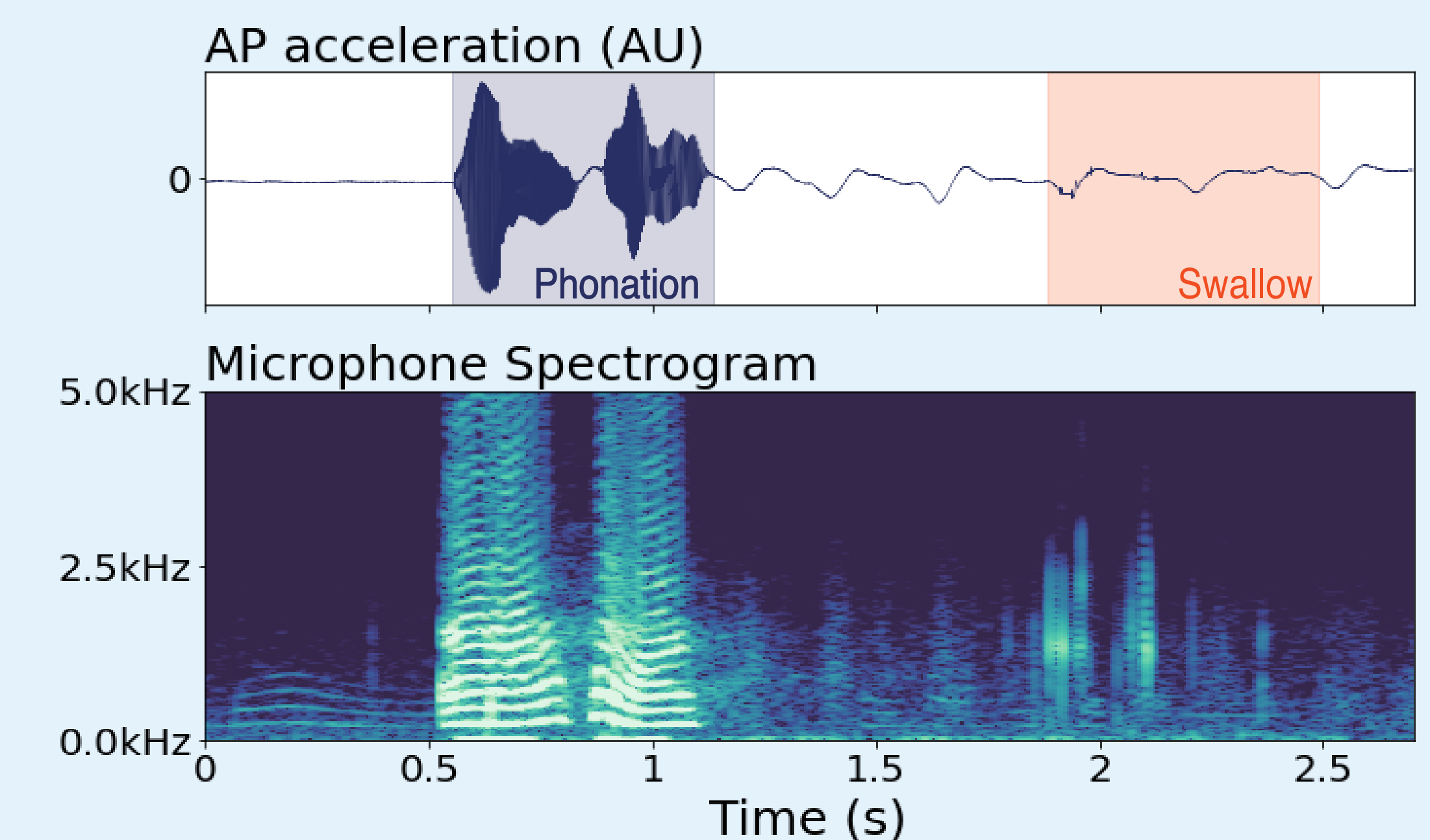
Nasofibroscope

## WHAT ALTERNATIVE ?



High-resolution cervical auscultation

## FIRST GOAL : PLA DETECTION

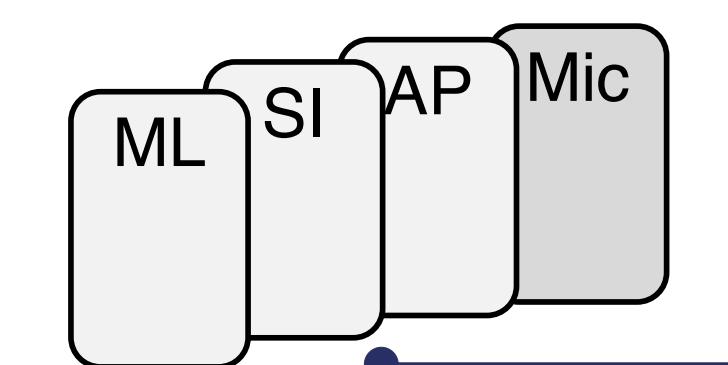


## METHOD

Detection of peaks in acoustic signal energy

**Network input**  
4 spectrograms from the two sensors

Activity segment detection



4 channels  
(4,205,40)

Convolutional Layer

8 channels  
(8,67,12)

Convolutional Layer

16 channels  
(16,32,5)

Channels stacked by time

LSTM

Softmax

**Output**  
Activity segment class

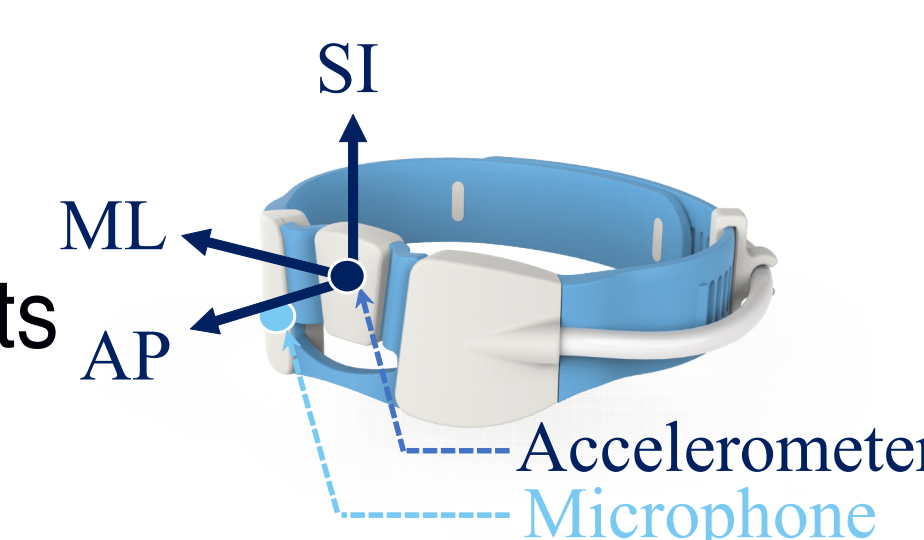
- Swallow
- Airway defense mechanism
- Phonation

## DATA

42 people  
19 males, 23 females  
22 to 57 years old  
age = 34 ans  
IDDSI [2]

Supervised protocol for healthy subjects including swallowing of different volumes and textures as well as other pharyngolaryngeal activities (PLA). The signals were recorded with the Swallis DSA<sup>TM</sup>.

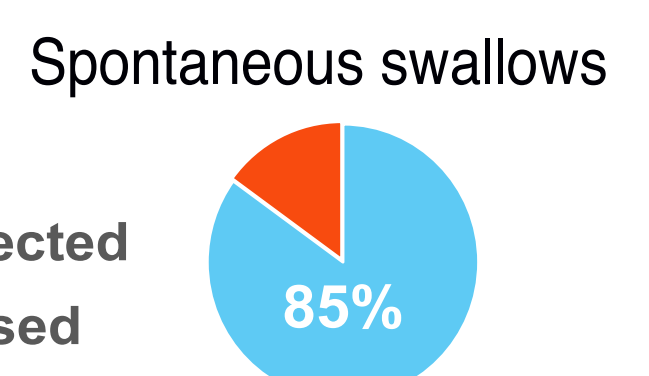
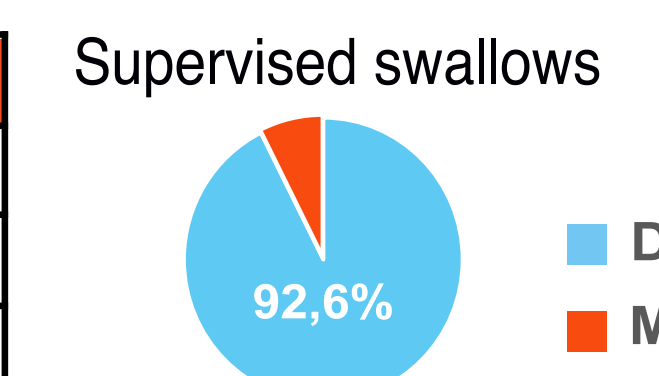
- 1704 swallow segments
- 128 airway defense mechanism (ADM) segments
- 1266 phonation segments



## SCORES

Results after 14-folds cross-validation on the 5.4 hours corpus.

PLA	Fscore
Swallows	84.7%
Airway defense mechanisms	84.1%
Phonation	86.8%



## DISCUSSION AND PERSPECTIVES

### Key benefits

- Signal structuration
- Risk indicators for dysphagia (swallowing frequency, number of Swallow+ADM ...)
- Swallowing evaluation in ecological conditions
- Real-time observation of events

### Towards an even more robust detection...

... under noisy conditions (restaurants): with babble noise augmentation during the training

... during mastication: by identifying these moments and filter them with signal processing techniques

## ONGOING RESEARCH

- Improvements on the model structure
- Evaluation on ecological data (meals)
- Evaluation on old healthy subjects (61 to 89 y.o.)

PLA	Same data, model improvements	Ecological meals, same population	Same protocol, older subjects
Swallows	<b>88,4%</b>	87,9%	86,9%
ADM	<b>90,2%</b>	65,5%	75,5%
Phonation	<b>93,0 %</b>	92,5%	94,0%

Fscore

[1] Birchall, O., Bennett, M., Lawson, N., Cotton, S. M., & Vogel, A. P. (2021). Instrumental Swallowing Assessment in Adults in Residential Aged Care Homes : A Scoping Review. Journal of the American Medical Directors Association, 22(2), 372-379.e6. <https://doi.org/10.1016/j.jamda.2020.08.028>

[2] Cichero, J. A. Y., Steele, C., Duivesteyn, J., Clavé, P., Chen, J., Kayashita, J., Dantas, R., Lecko, C., Speyer, R., Lam, P., & Murray, J. (2013). The Need for International Terminology and Definitions for Texture-Modified Foods and Thickened Liquids Used in Dysphagia Management : Foundations of a Global Initiative. Current Physical Medicine and Rehabilitation Reports, 1(4), 280-291. <https://doi.org/10.1007/s40141-013-0024-z>