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Automatic detection of pharyngolaryngeal activities using High-Resolution Cervical Auscultation Signals

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

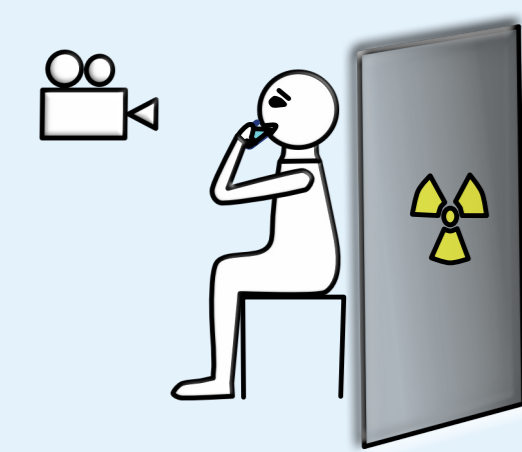
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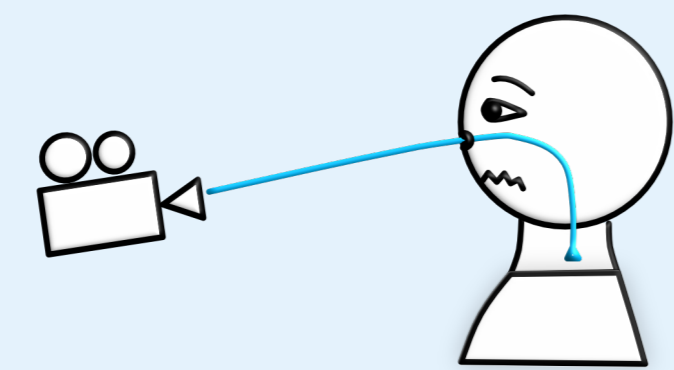
WHAT NEEDS ?

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]

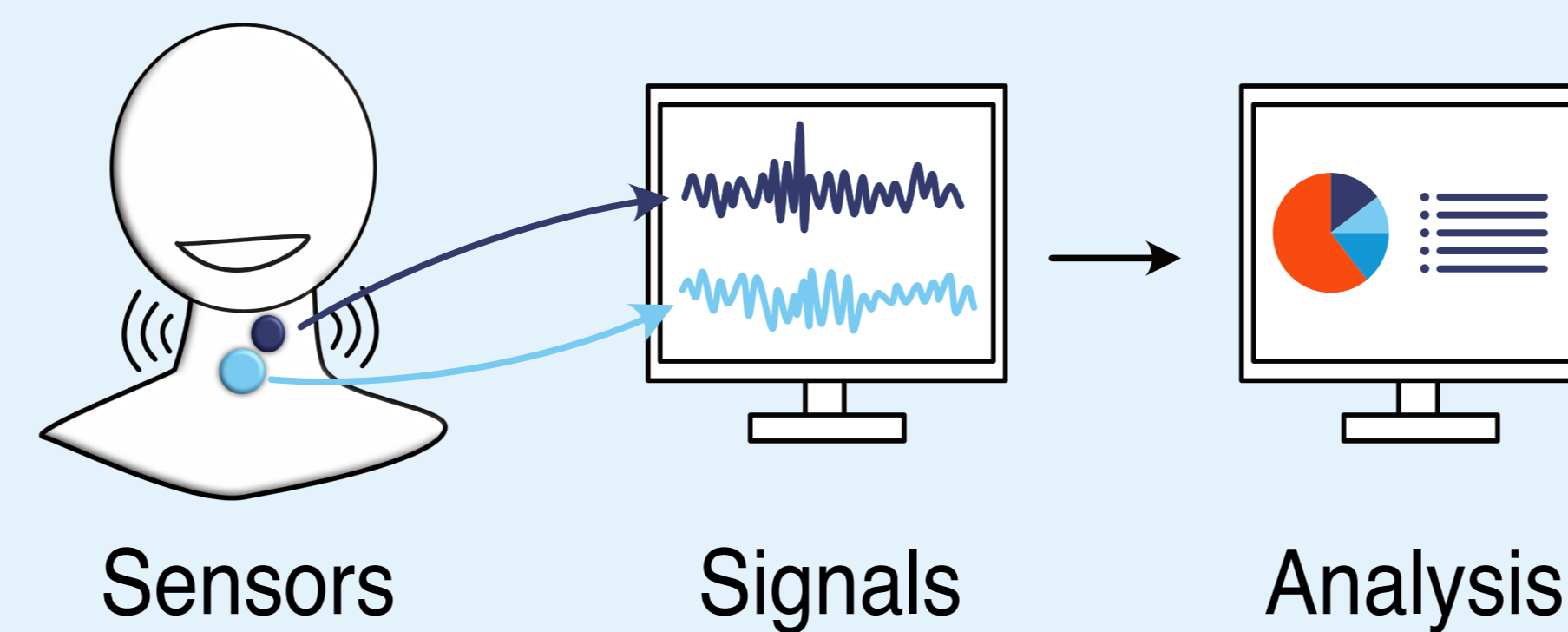


Videofluoroscopy



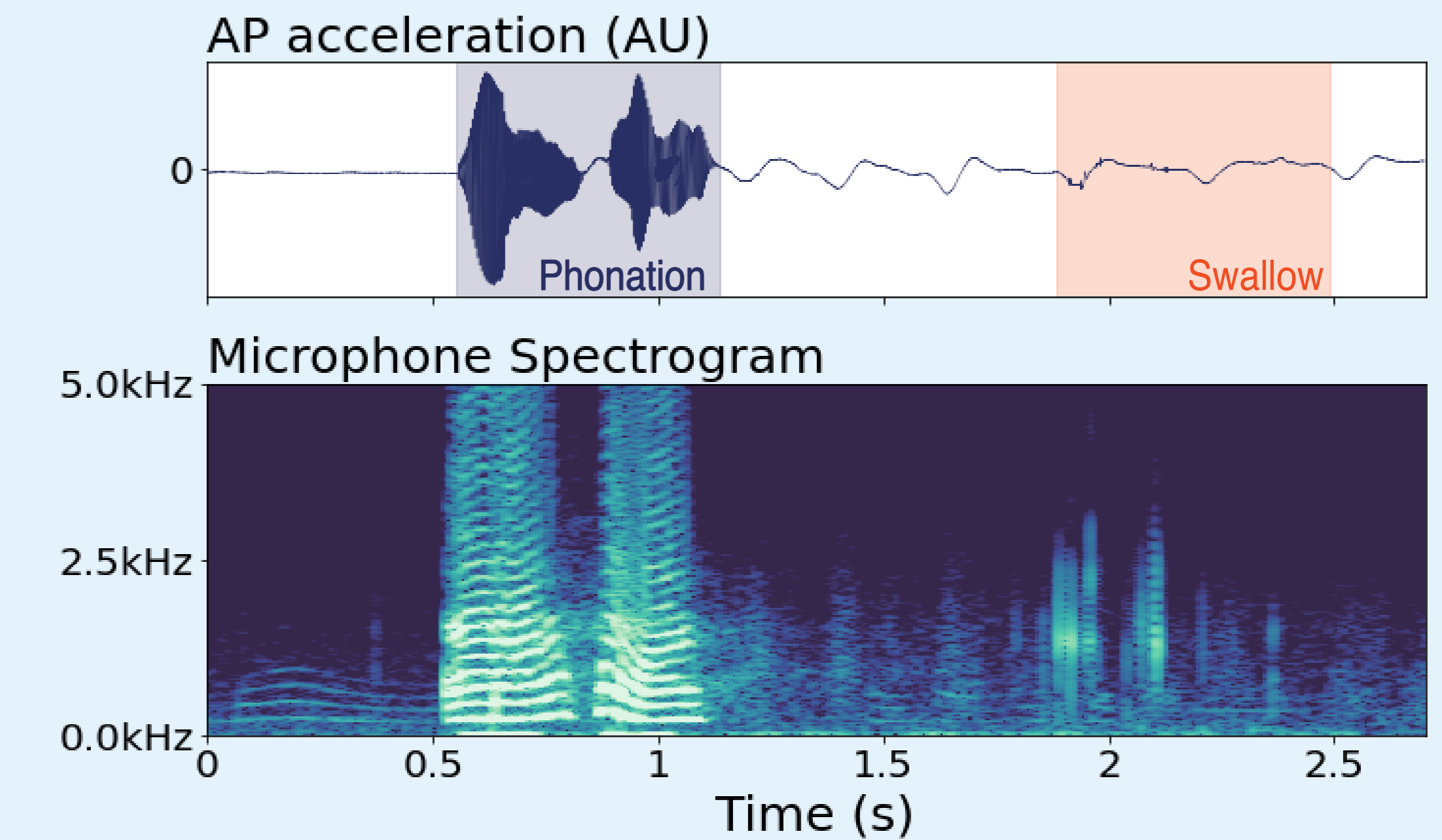
Nasofibroscopy

WHAT ALTERNATIVE ?



High-resolution cervical auscultation

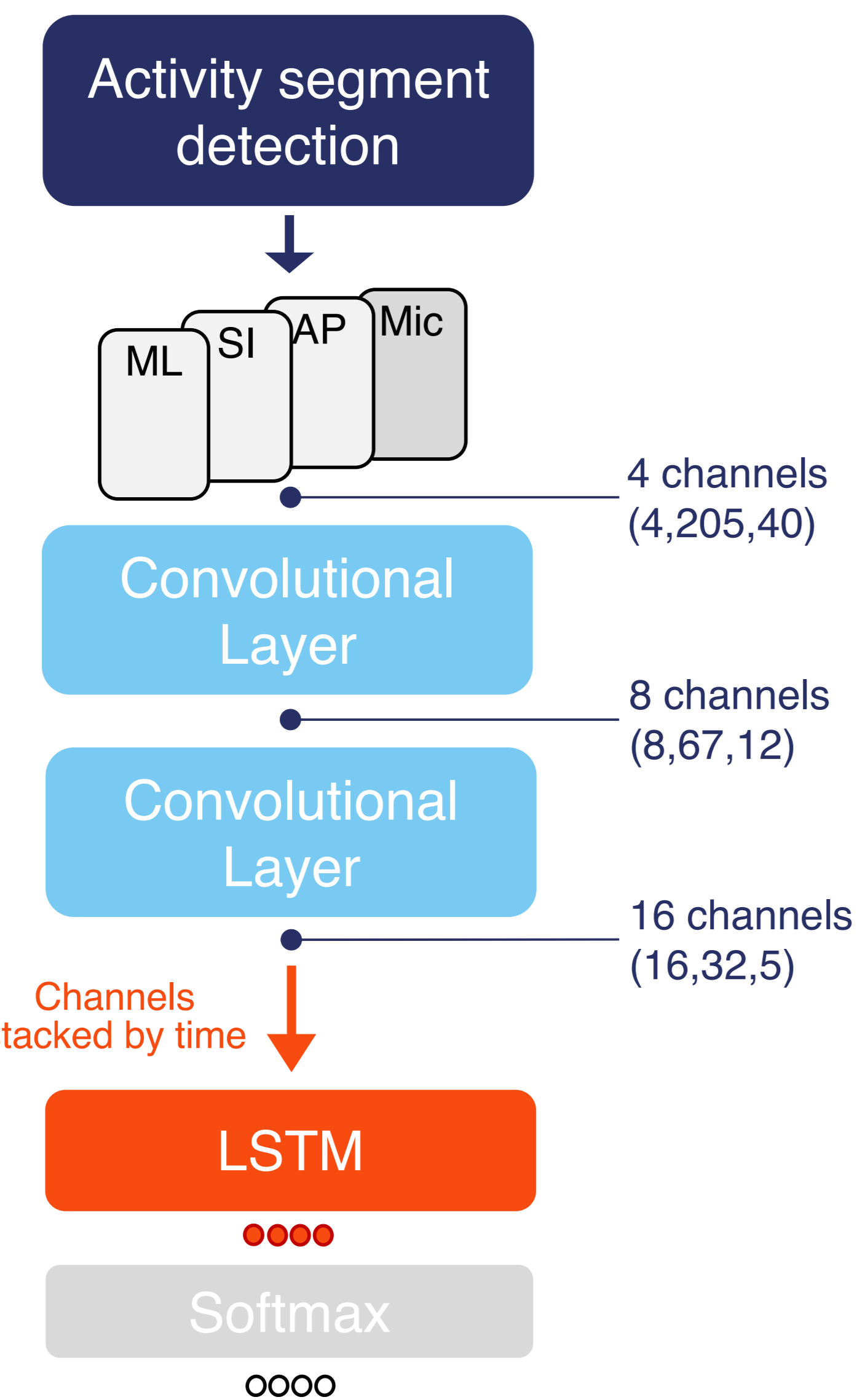
FIRST GOAL : PLA DETECTION



METHOD

Detection of peaks in acoustic signal energy

Network input
4 spectrograms from the two sensors



Output
Activity segment class

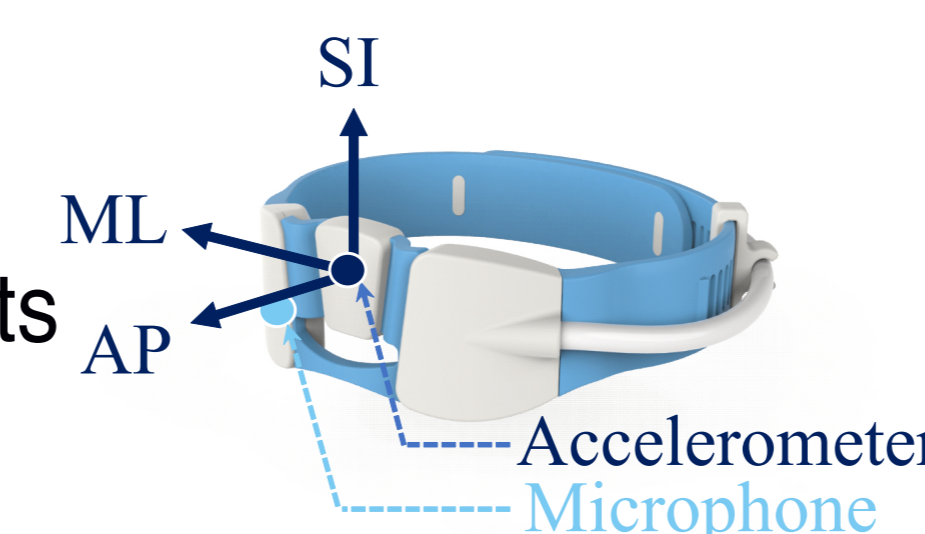
- Swallow
- Airway defense mechanism
- Phonation

DATA



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™.

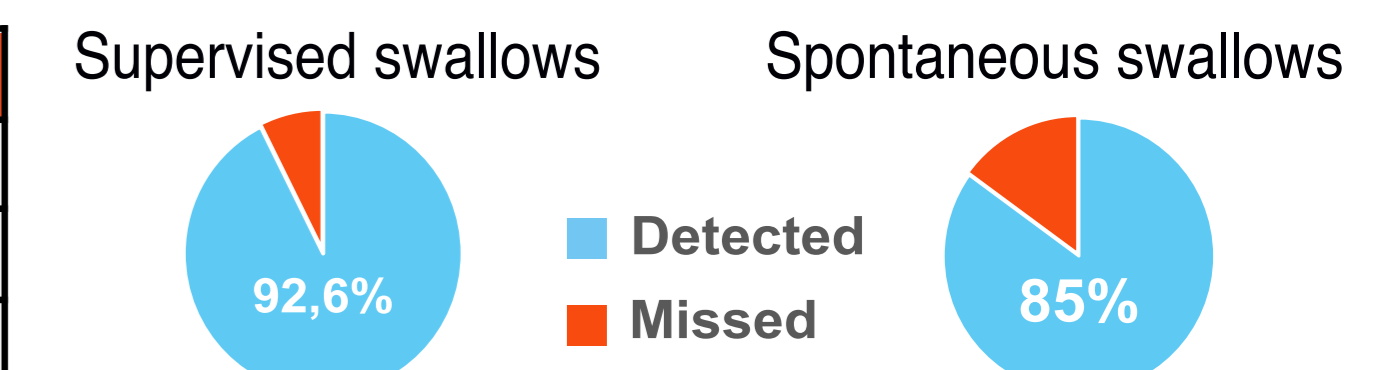
- 1704 swallow segments
- 128 airway defense mechanism (ADM) segments
- 1266 phonation segments



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	88,4%	87,9%	86,9%
ADM	90,2%	65,5%	75,5%
Phonation	93,0 %	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>