Individual sperm whale coda characterization

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CENTRE int.
d' INTELLIGENCE
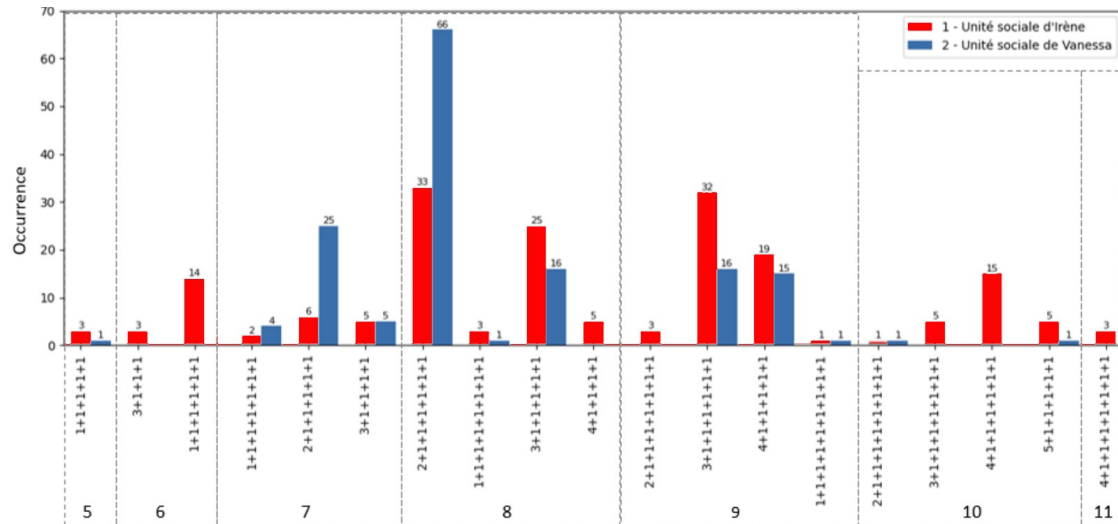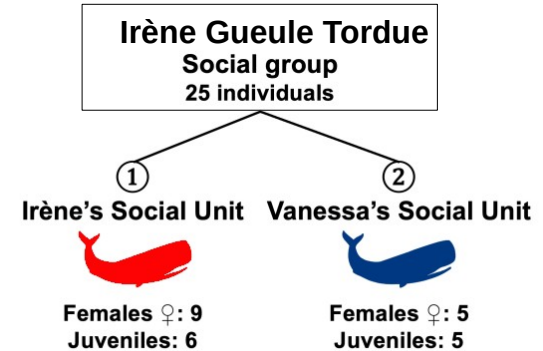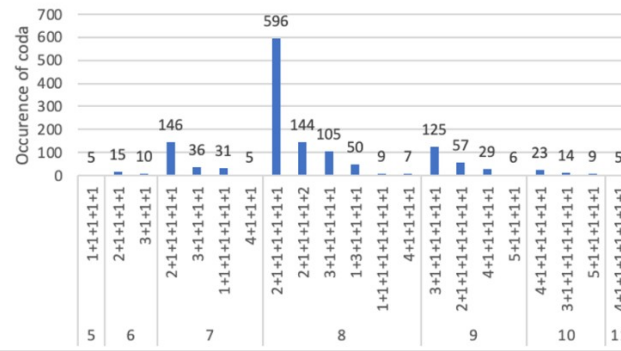ARTIFICIELLE en
ACOUSTIQUE
NATURELLE

Context

- Irene Gueule Tordue social group of Sperm Whale has been recorded since 2013

- It is known to produce a specific repertoire of coda with a predominance of the 8-click 2+ type
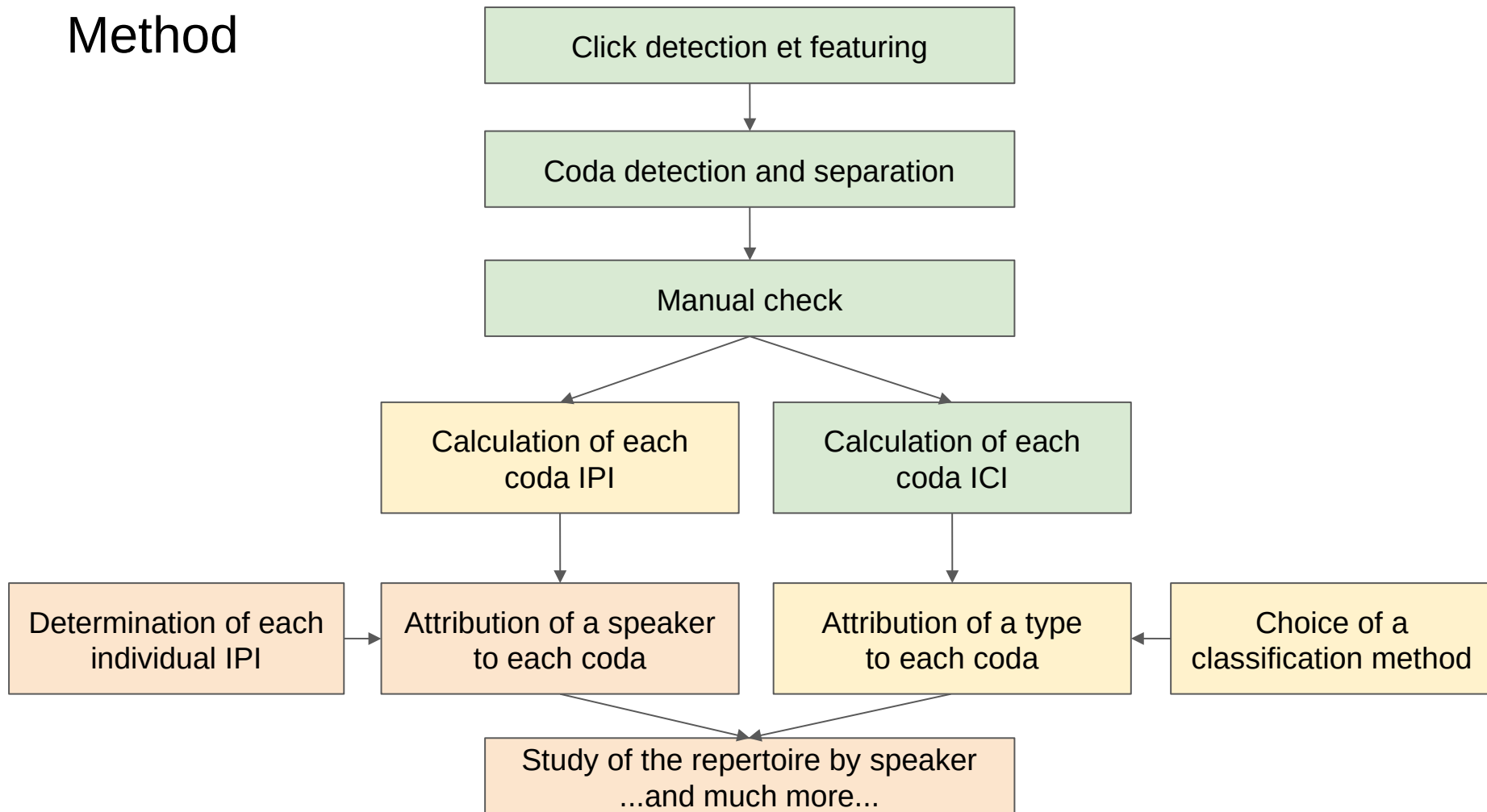
- It gradually split into two social units since 2017

- In 2023, the separation is complete and the repertoires of codas recorded in the 2 subunits are significantly different
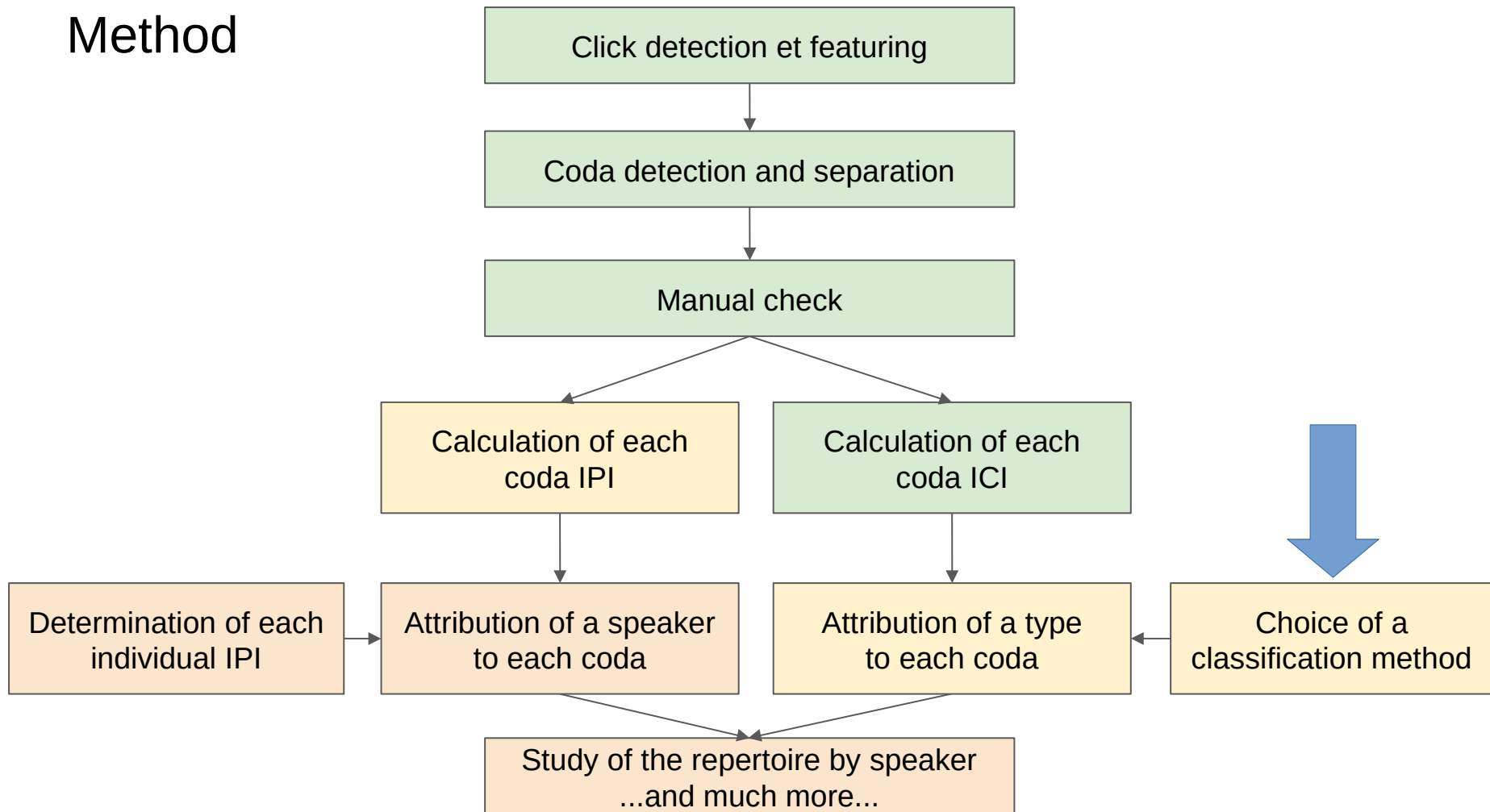
- Is this difference du to different individual repertoires ?
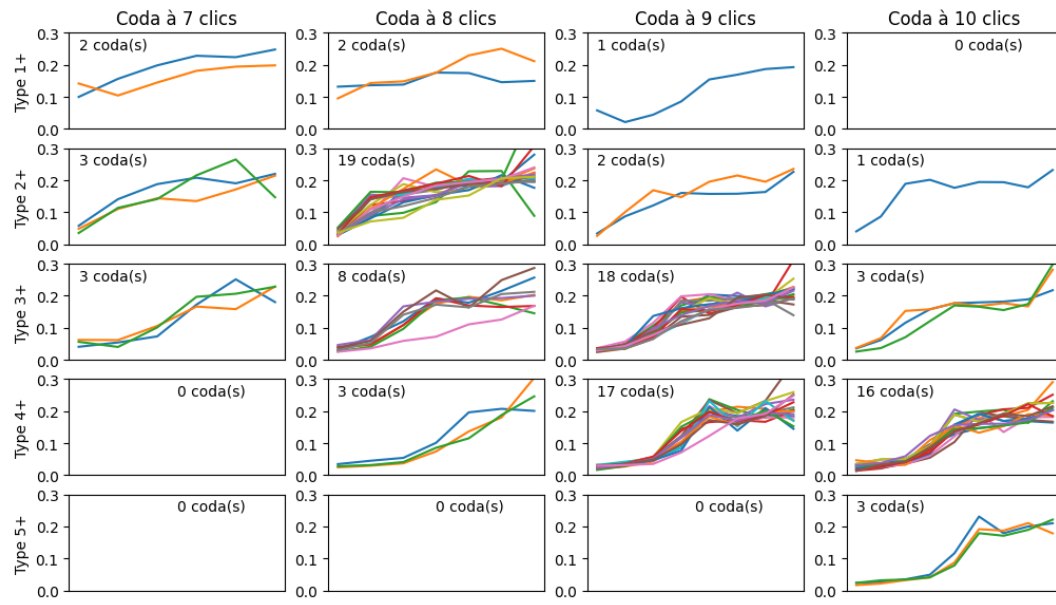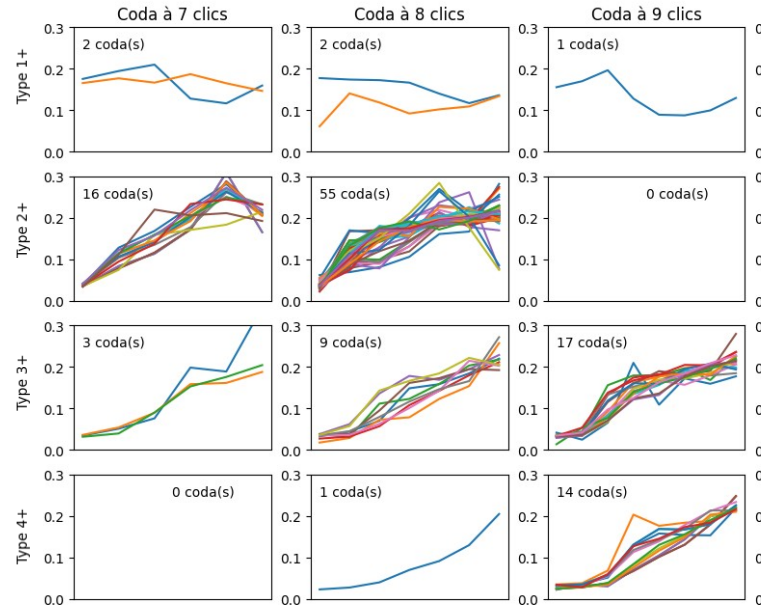
Method

Method

```
        ┌─────────────────────────────┐
        │   Click detection et featuring│
        └─────────────────────────────┘
                      │
                      ▼
        ┌─────────────────────────────┐
        │  Coda detection and separation│
        └─────────────────────────────┘
                      │
                      ▼
        ┌─────────────────────────────┐
        │        Manual check          │
        └─────────────────────────────┘
```

Calculation of each coda IPI	Calculation of each coda ICI

Determination of each individual IPI	Attribution of a speaker to each coda	Attribution of a type to each coda	Choice of a classification method

Study of the repertoire by speaker
...and much more...

Choice of a coda classification method

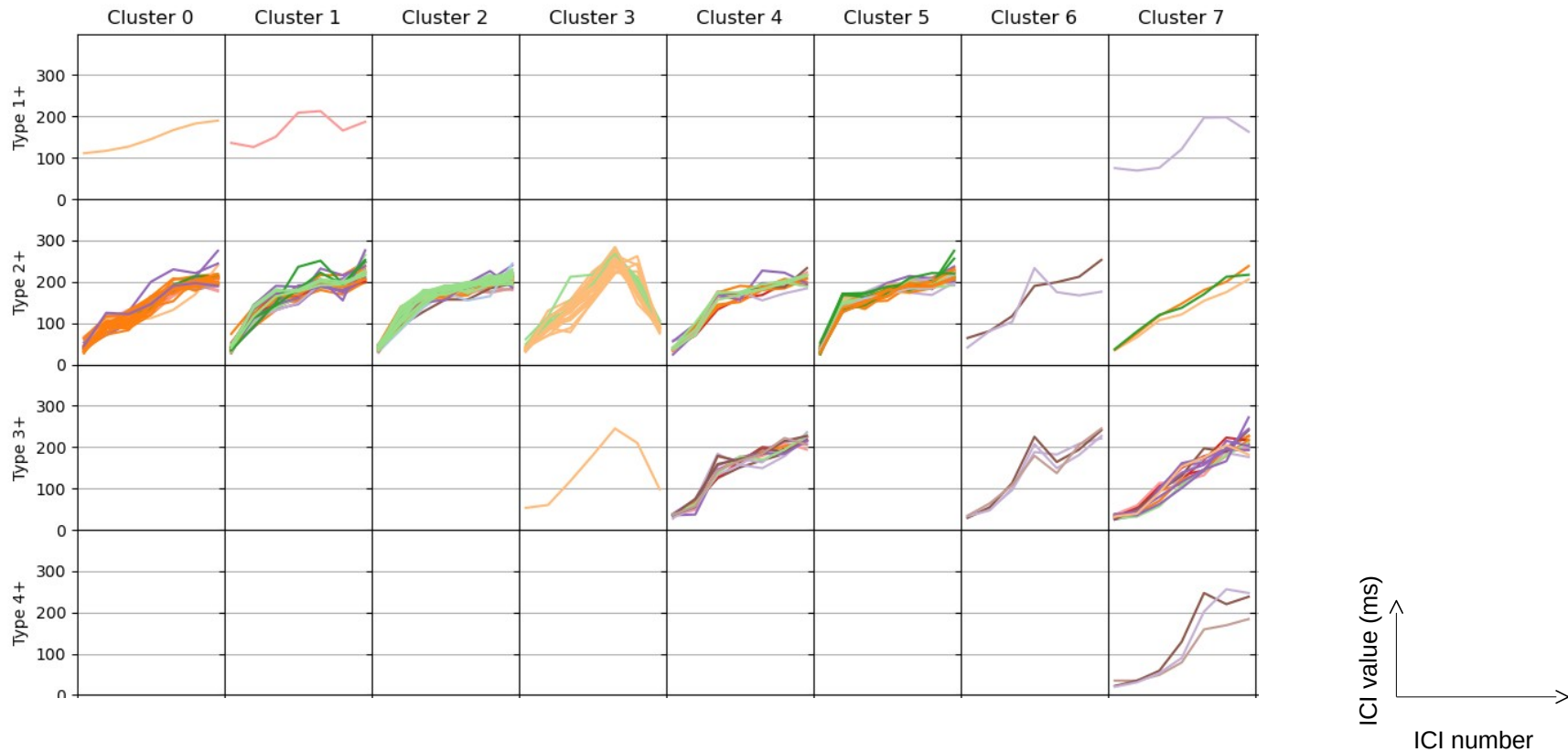• Coda type $n_1+n_2+...+n_i$

Choice of a coda classification method

- k-Means clustering
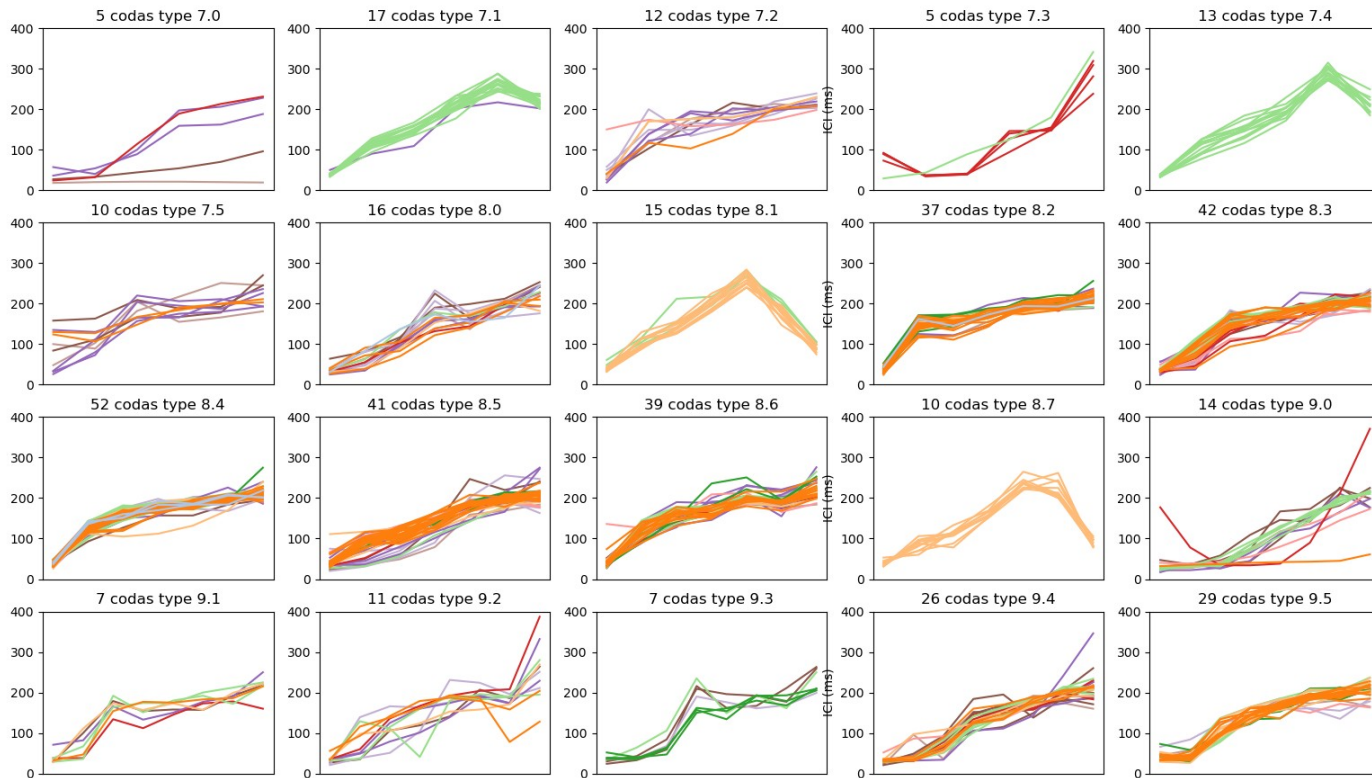
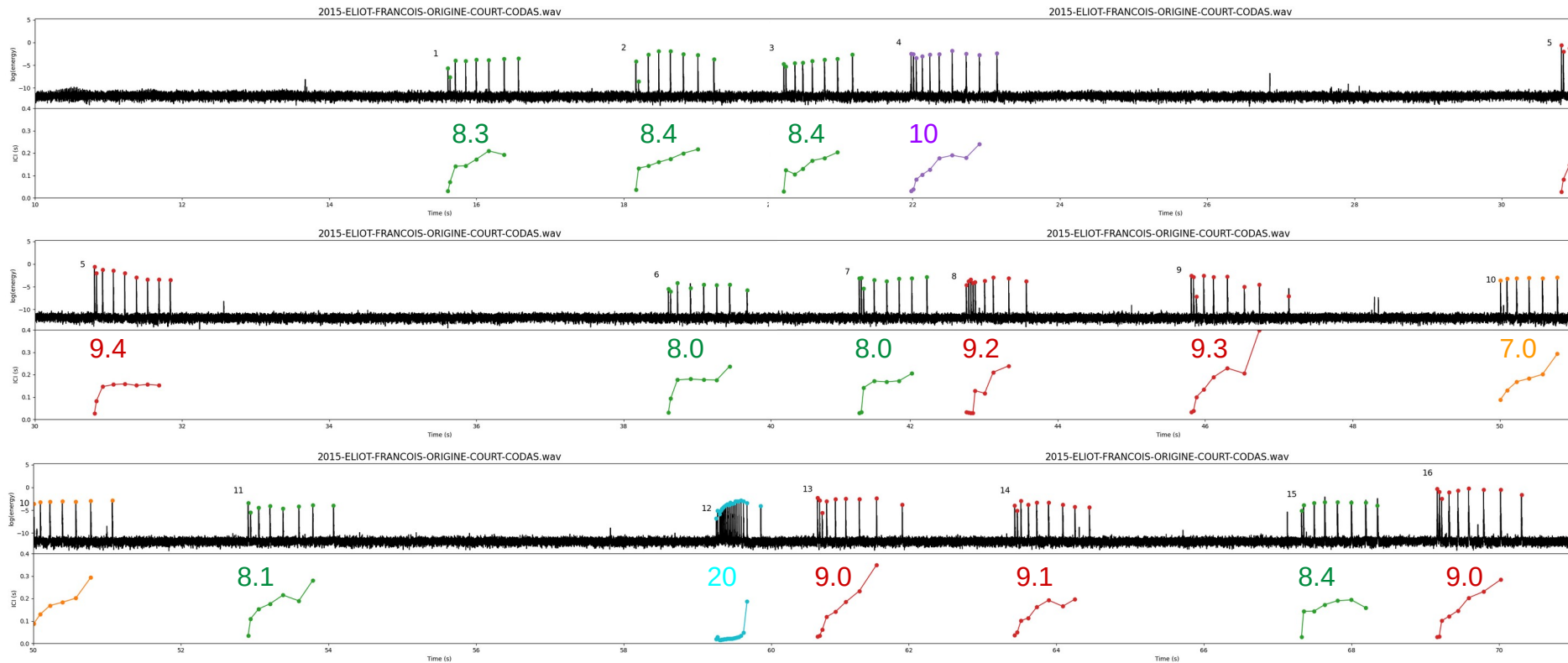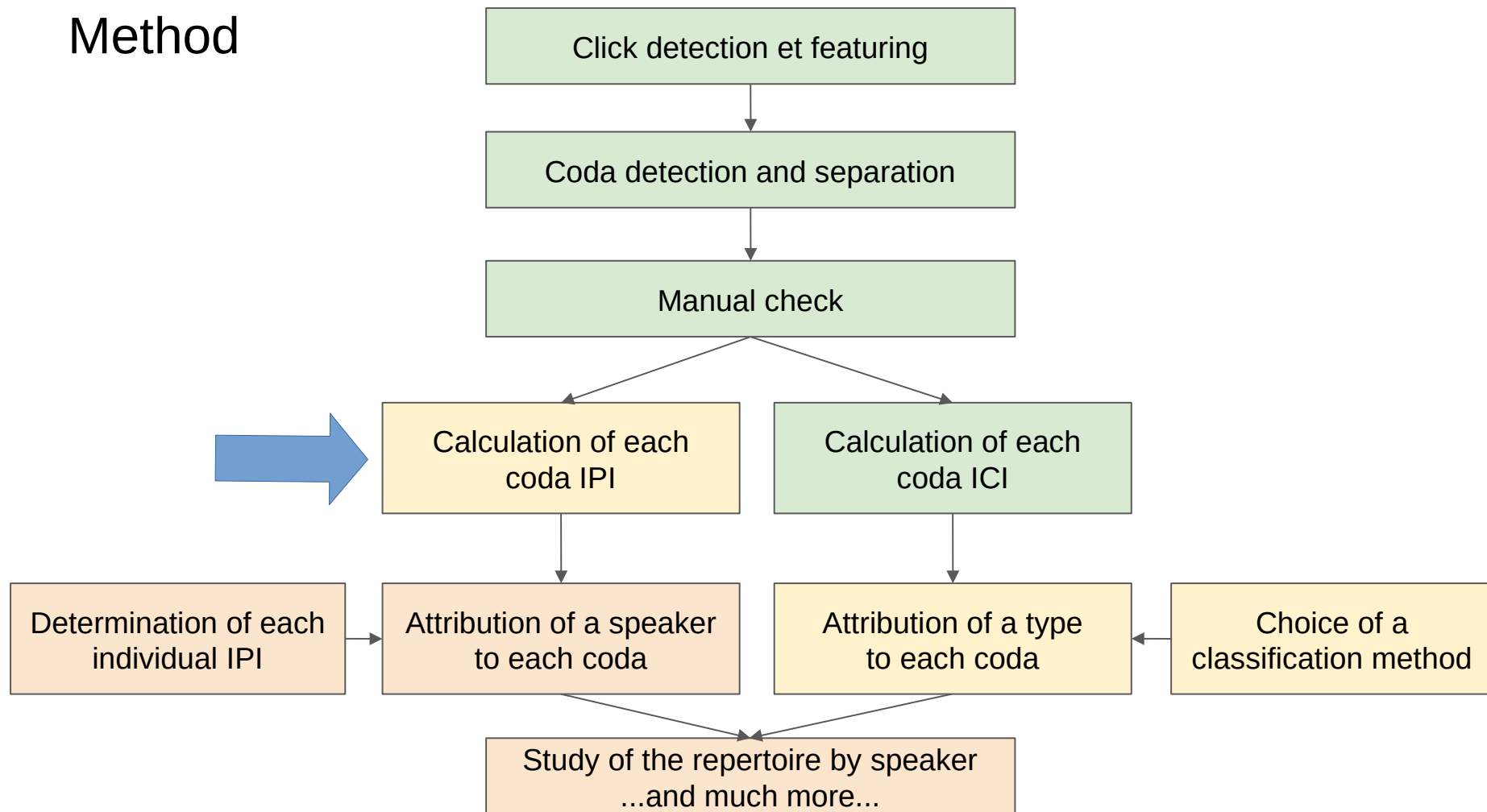# Choice of a coda classification method

• comparison Type versus clustering

Choice of a coda classification method

- an example of file analysis with k-Means clustering

Method

```
┌─────────────────────────────────────┐
│      Click detection et featuring    │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│      Coda detection and separation   │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│             Manual check             │
└─────────────────────────────────────┘
```

```
┌──────────────────────┐      ┌──────────────────────┐
│  Calculation of each │      │  Calculation of each │
│       coda IPI       │      │       coda ICI       │
└──────────────────────┘      └──────────────────────┘
           │                              │
           ▼                              ▼
```

| Determination of each individual IPI	Attribution of a speaker to each coda	Attribution of a type to each coda	Choice of a classification method

Study of the repertoire by speaker
...and much more...

Calculation of a coda IPI

- Calculation of IPI requires a large amount of clicks

The "Leaky" Bent-Horn Model

Time delay of p1/2:
$T_{1/2}$ = t1 + t2 = $f(\theta)$

Time delay of p1:
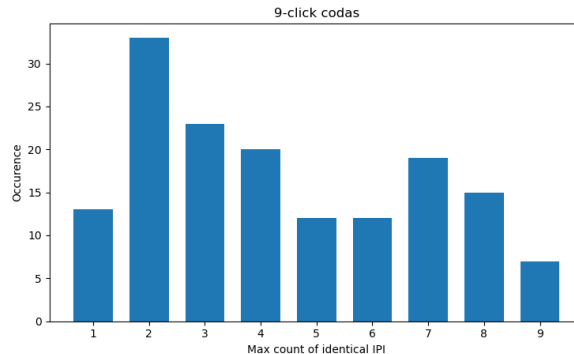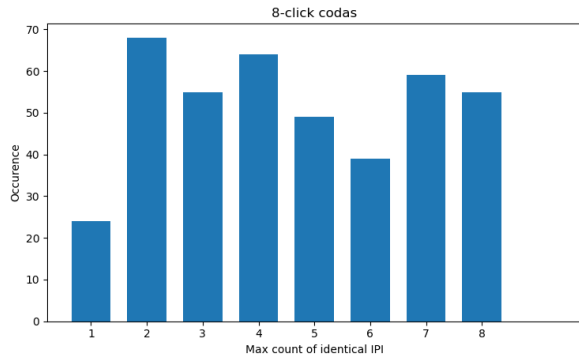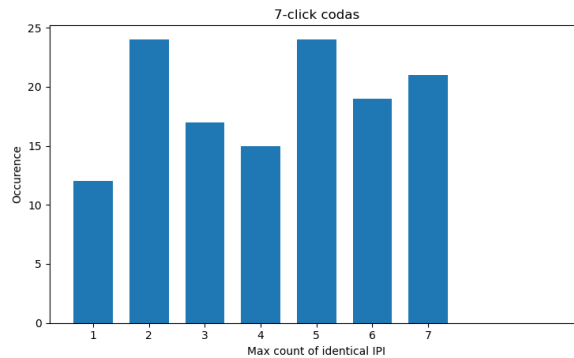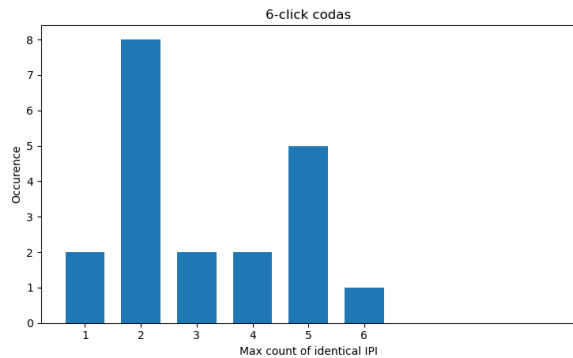T_1 = t1 + t3 + t4 = $g(\alpha)$
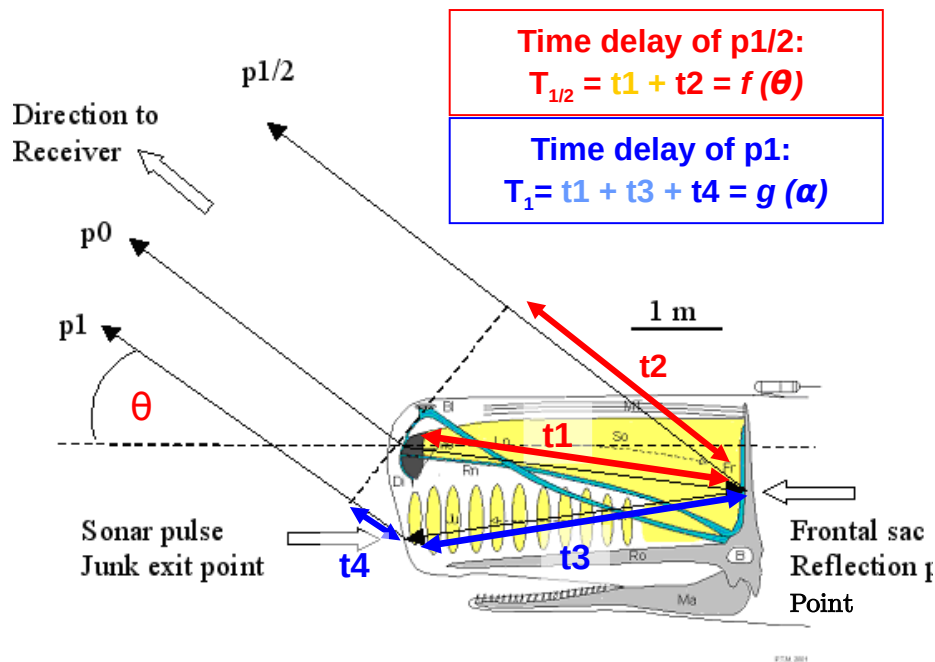
Zimmer, Madsen, Teloni & Tyack 2005, JASA 2005
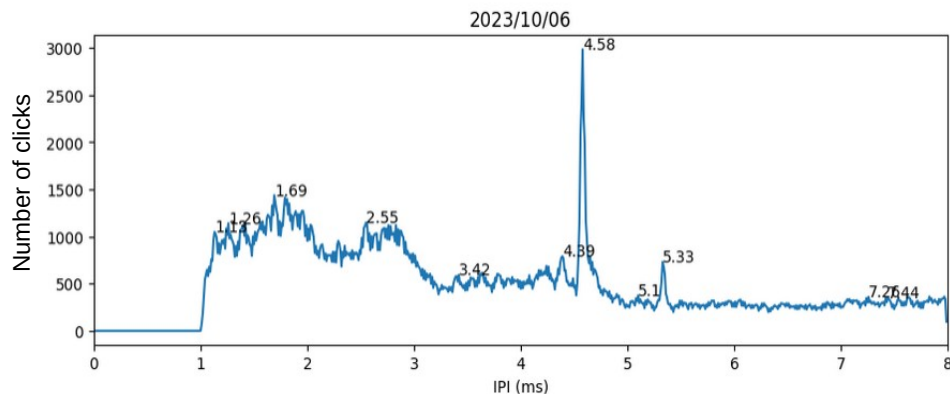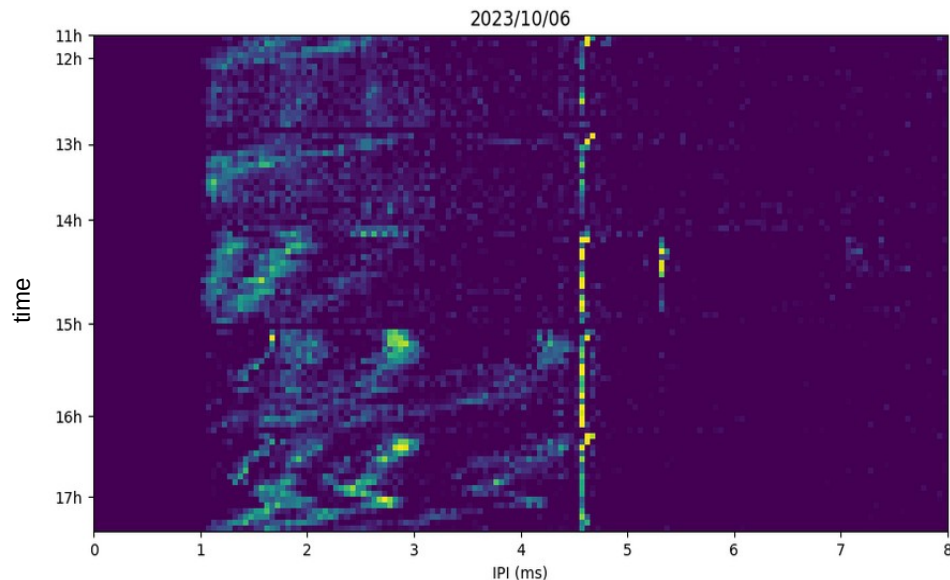
Calculation of a coda IPI

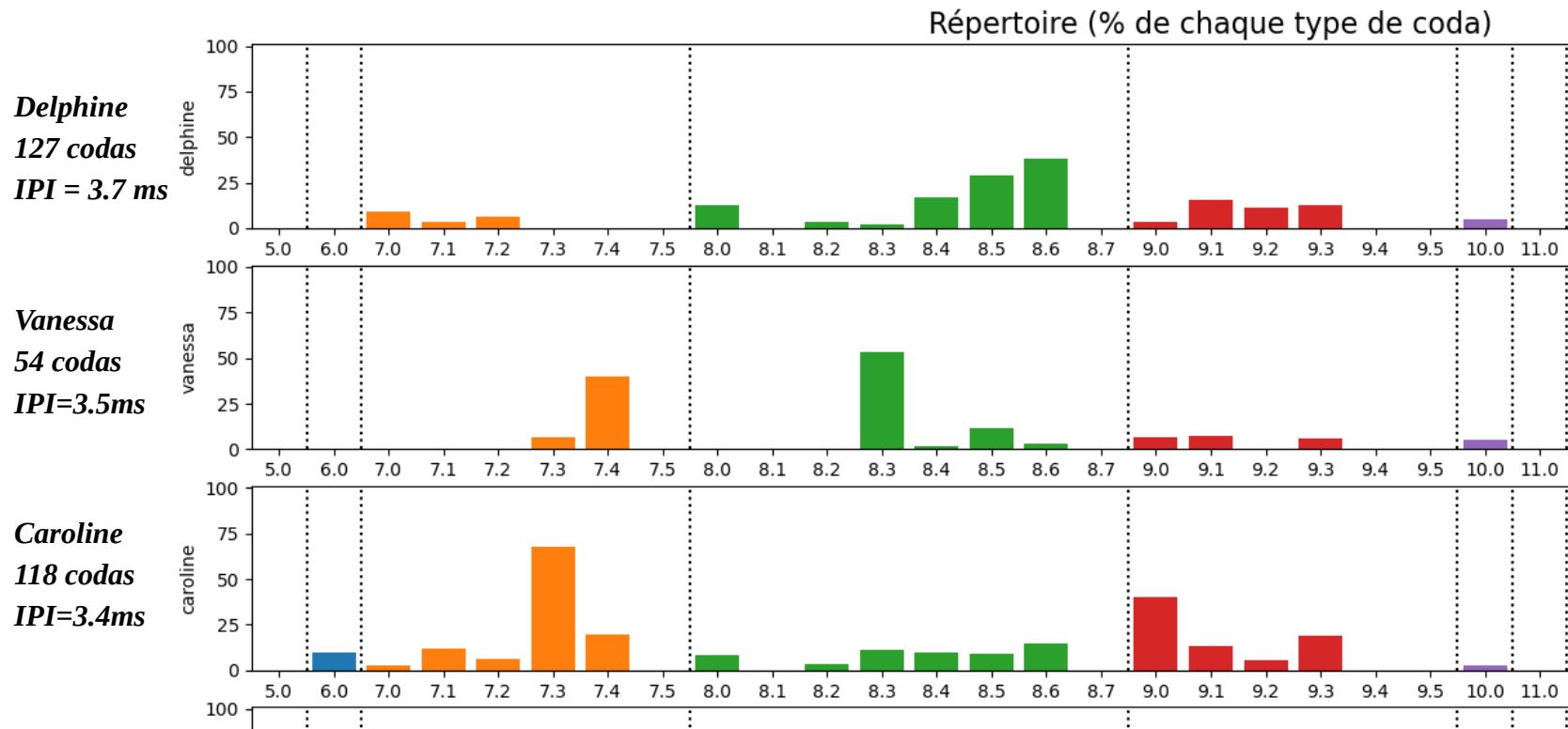- Number of click in a coda is too low for a robust IPI estimation

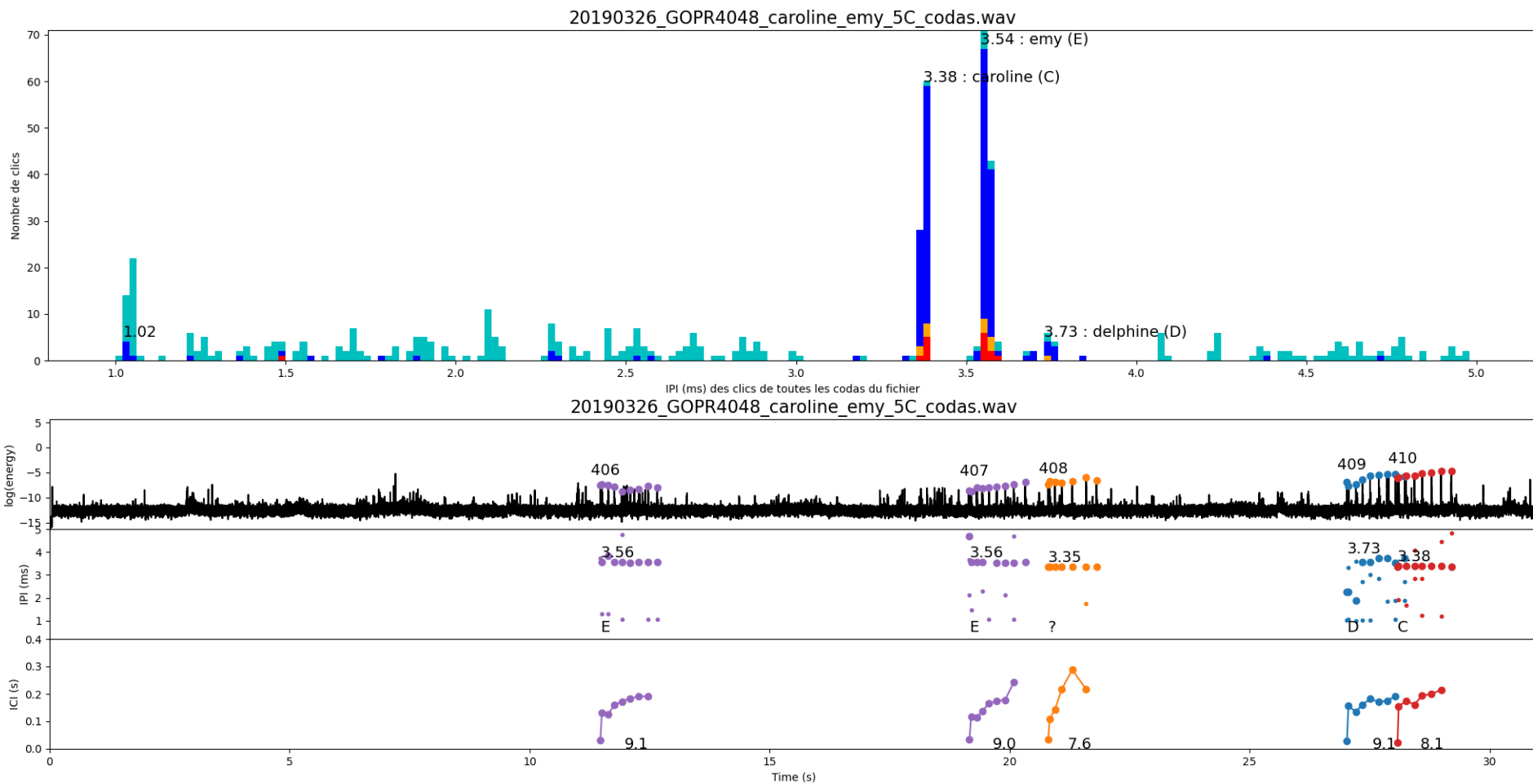73 % of the codas have 3 or more clicks with the same IPI
→speaker identification

27 % of the codas have less than 3 clicks with the same IPI → no speaker identification
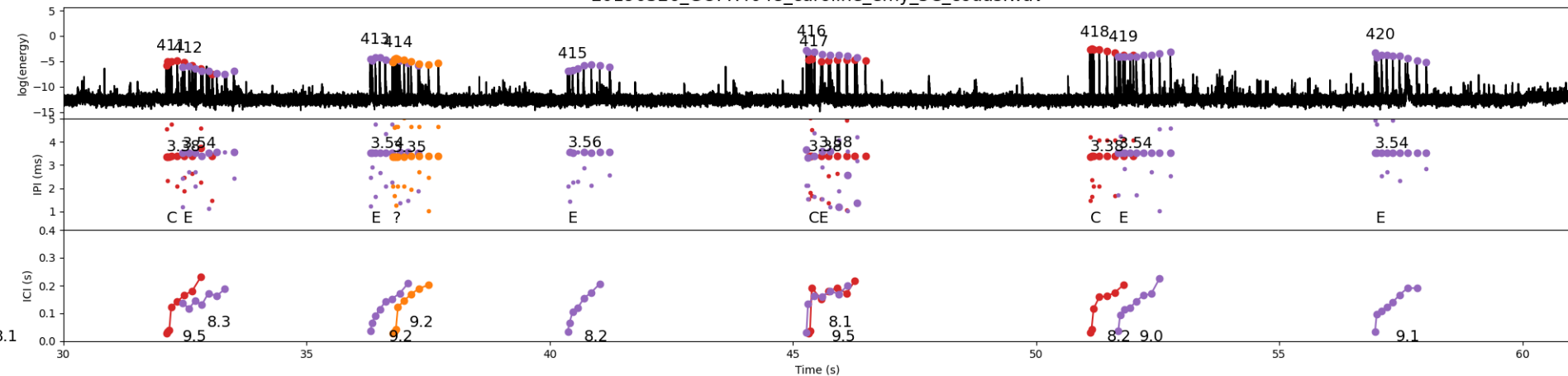
Preliminary results on individual repertoires

- 3 individuals selected for stable and different IPI: Delphine, Vanessa, Caroline

Delphine
127 codas
IPI = 3.7 ms

Vanessa
54 codas
IPI=3.5ms

Caroline
118 codas
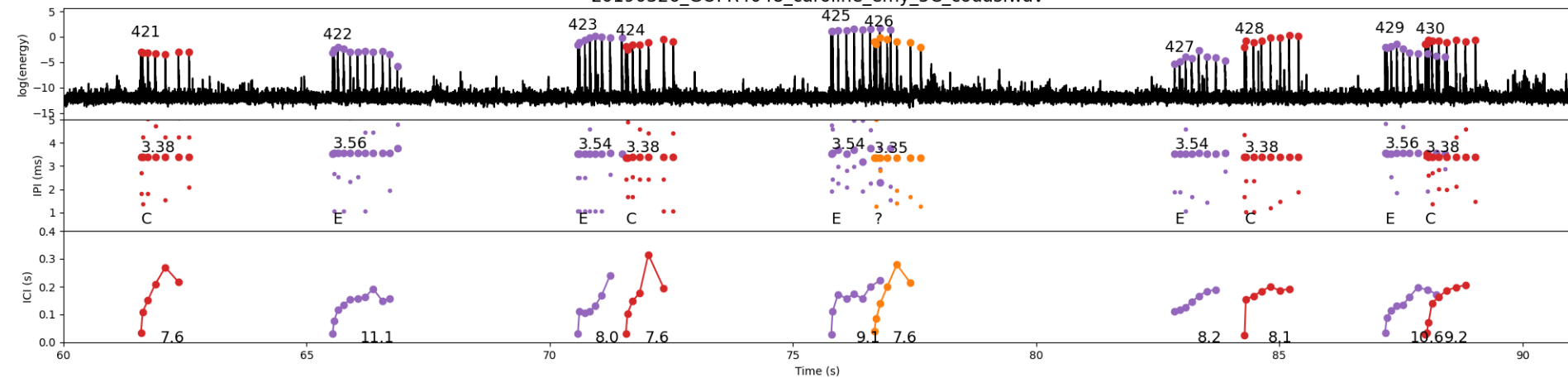*IPI=3.4ms*

Répertoire (% de chaque type de coda)
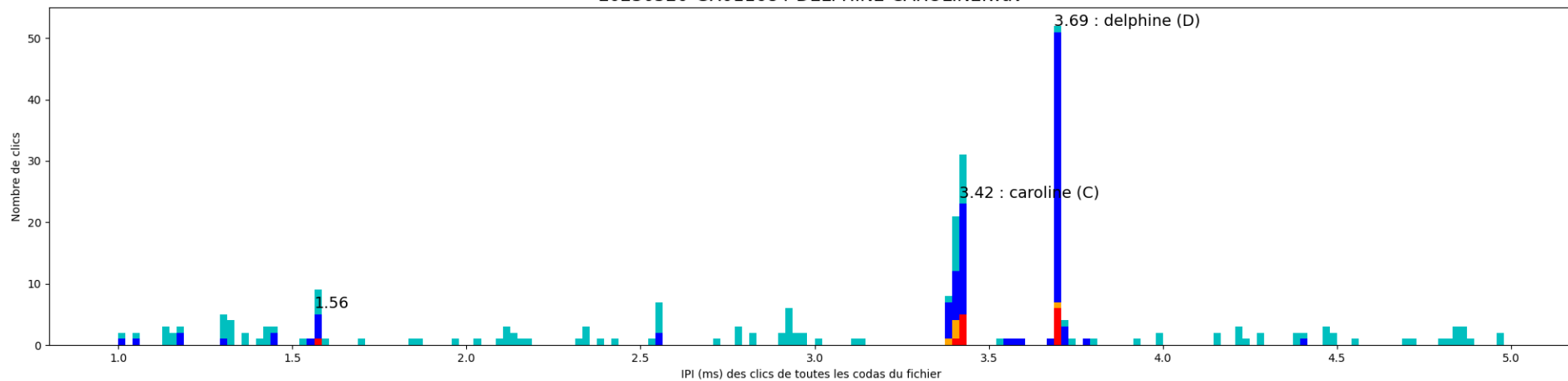
Preliminary results on dialogues

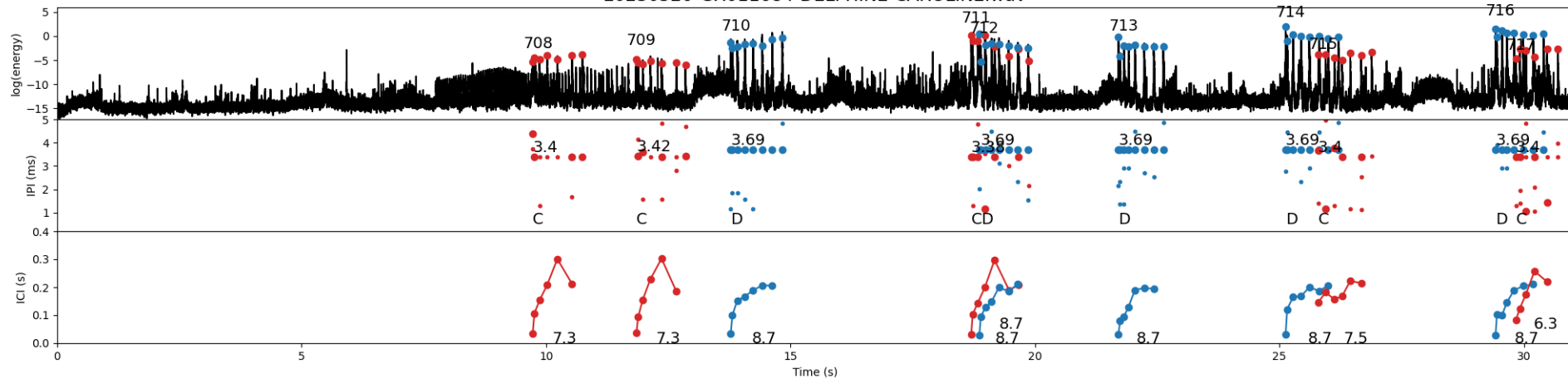20190326_GOPR4048_caroline_emy_5C_codas.wav

20190326_GOPR4048_caroline_emy_5C_codas.wav

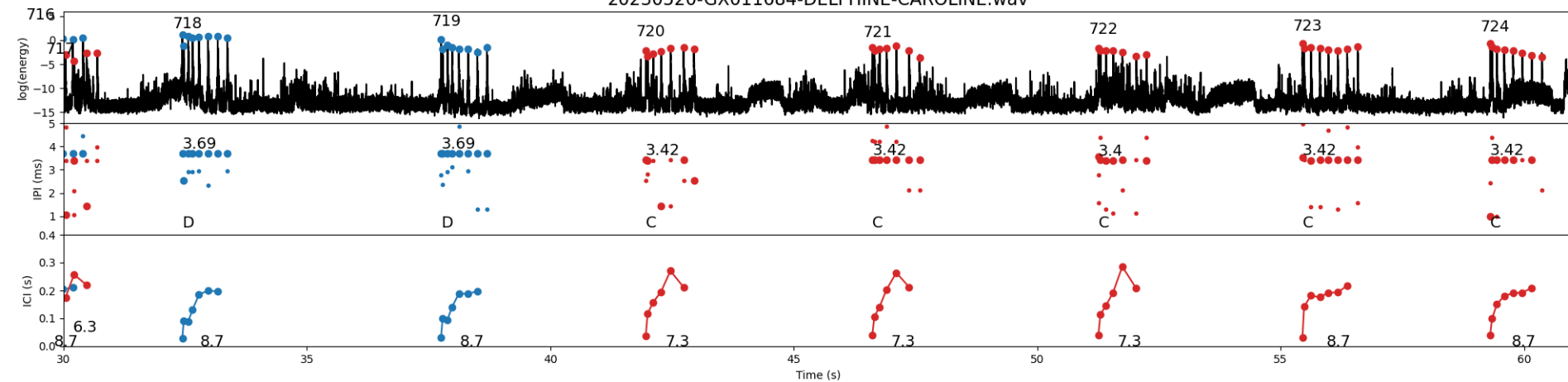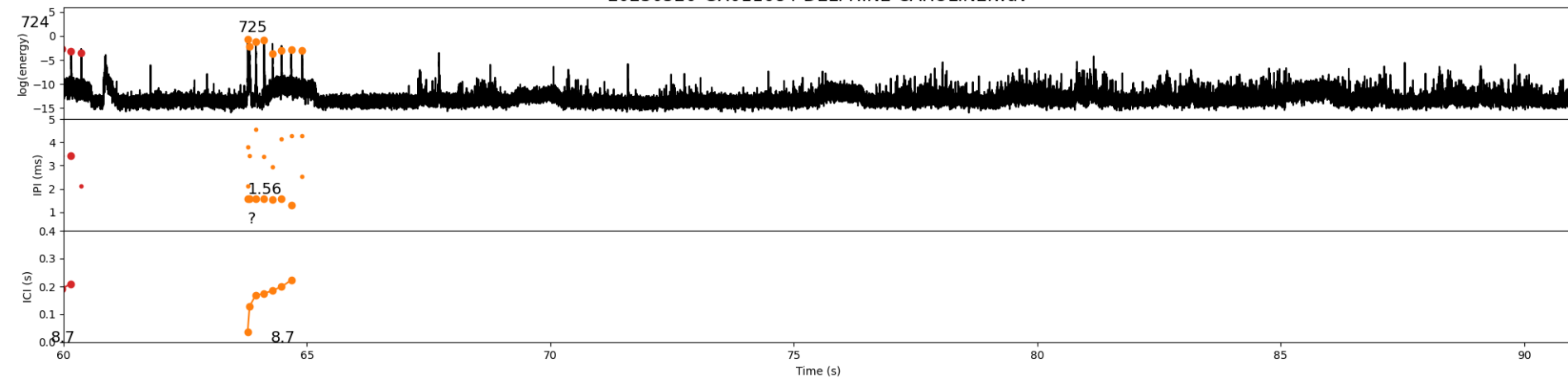20230520-GX011684-DELPHINE-CAROLINE.wav

20230520-GX011684-DELPHINE-CAROLINE.wav

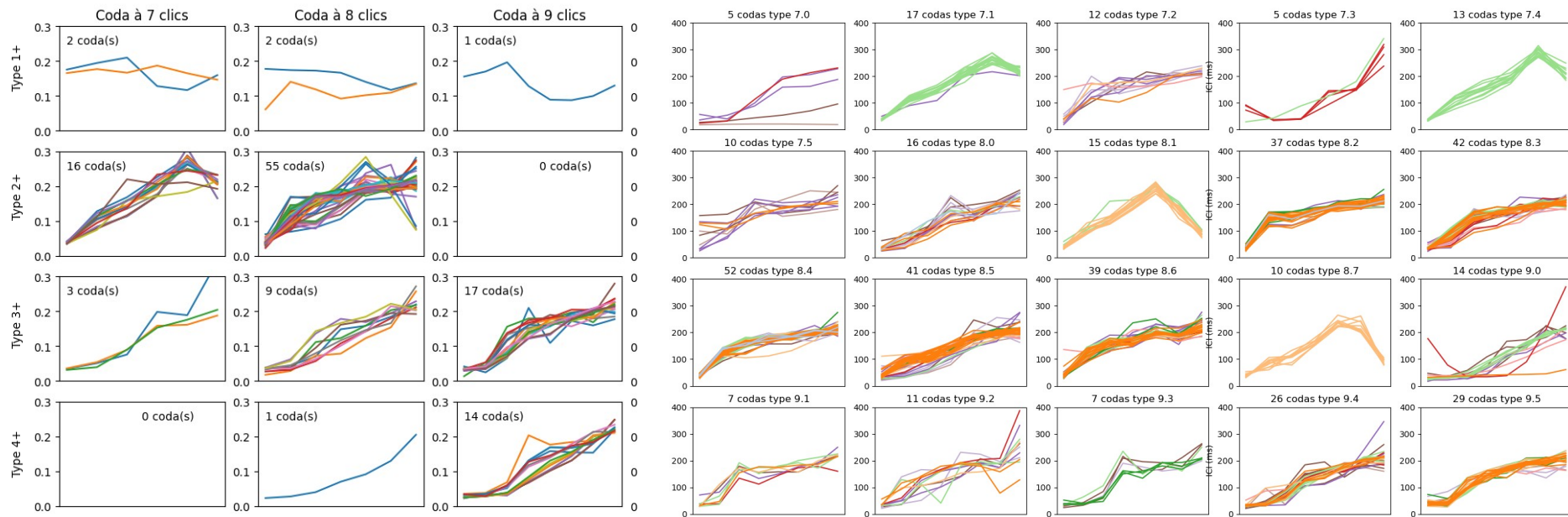20230520-GX011684-DELPHINE-CAROLINE.wav

Perspectives

• Towards an explicit coda classification ?

Perspectives

- Improve the 73 % coda IPI detection or
- Use other clues to identify the speaker → TDOA
(Walter Zimmer ; Lara Berkenbaum (PhD))

t=44.519, az=0.170, el=0.994, x=3.246, y=12.651, n=14738