THE TINTIGNAC CARNYX: an acoustical studyof an early brasswind instrument

Michael Newton (1),
John Kenny (2),
John Chick (1),
Amaya Lopez-Carromero (1),
Murray Campbell (1),
Joel Gilbert (3)

(1) Acoustics and Audio Group, University of Edinburgh
(2) Royal Conservatoire of Scotland
(3) LAUM – UMR CNRS Le Mans

170th Meeting of the Acoustical Society of America

Jacksonville, Florida, 5th November 2015

Background: the Scottish Carnyx

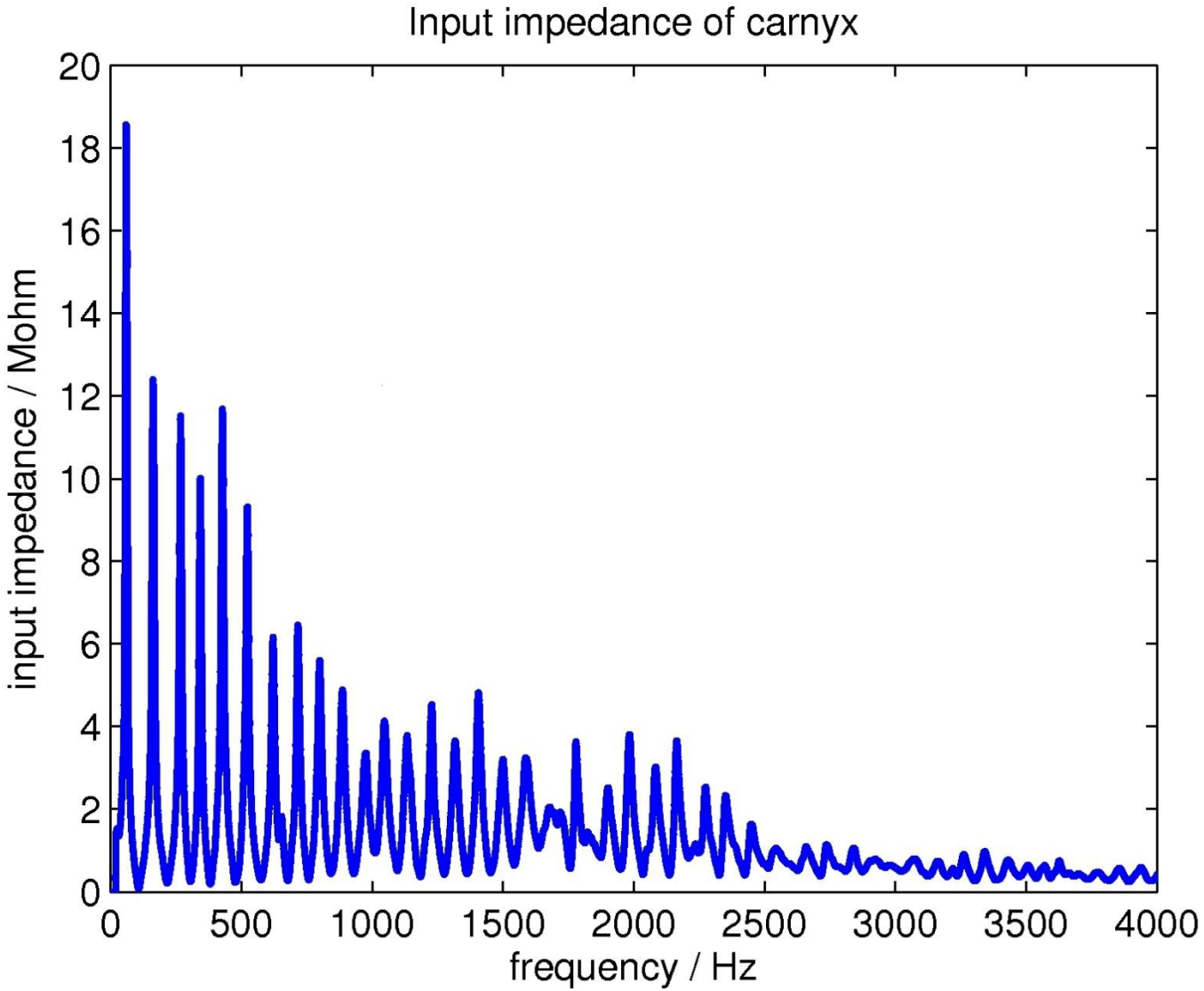
Fragment of carnyx, age ~ 2000 years

Discovered buried at Deskford, Scotland in 1816

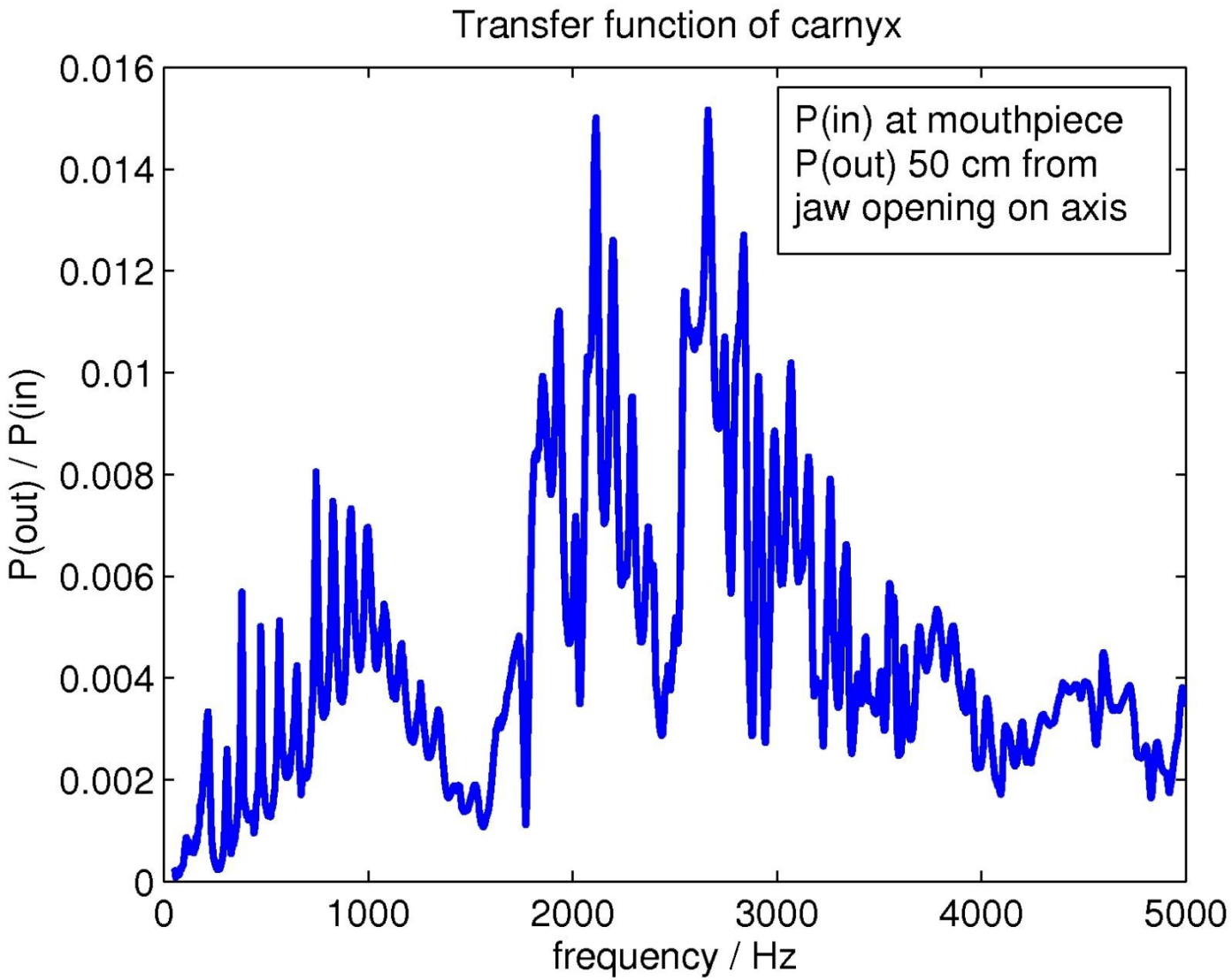
Measuring input impedance of prototype
University of Edinburgh (1992)

Final version completed by John Creed (1993), played by artificial mouth

Input impedance and transfer function of Scottish carnyx:

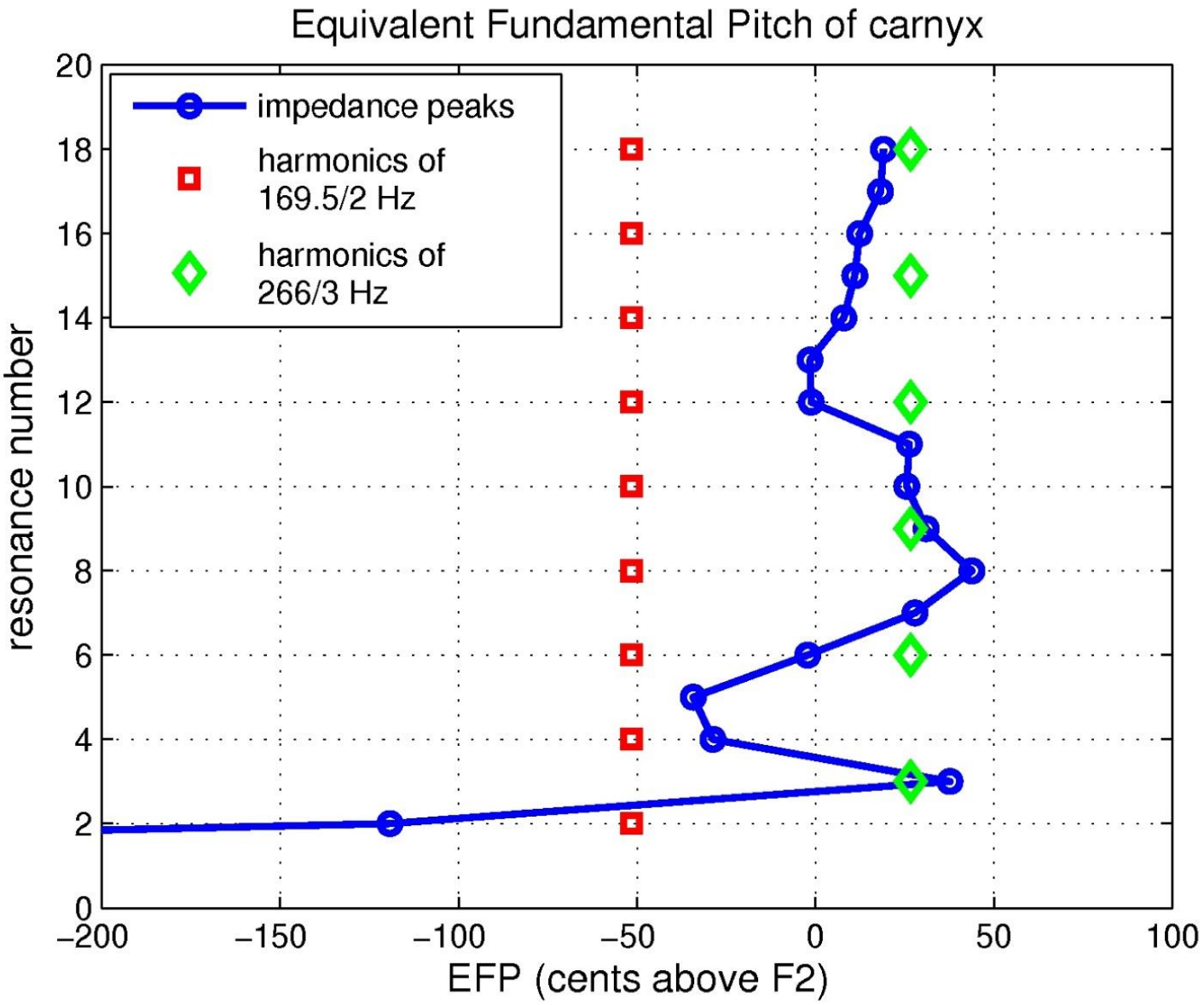


At least 30 significant modes: cutoff frequency ~ 2500Hz



Pressure transfer function from mouthpiece to outside mouth measured in aechoic room

Deep minima around 1500Hz and 2500Hz (cf brass mutes)



Equivalent fundamental pitch $EFP(n) = f_n / n$.
Possible support of E3 (f = 169.5Hz) and C4 (f = 266Hz)

Musical properties of the Scottish carnyx

- Many inharmonically related modes
- High transfer function → large dynamic range
- High brassiness potential
- Wide mouthpiece throat → strong coupling to vocal tract modes

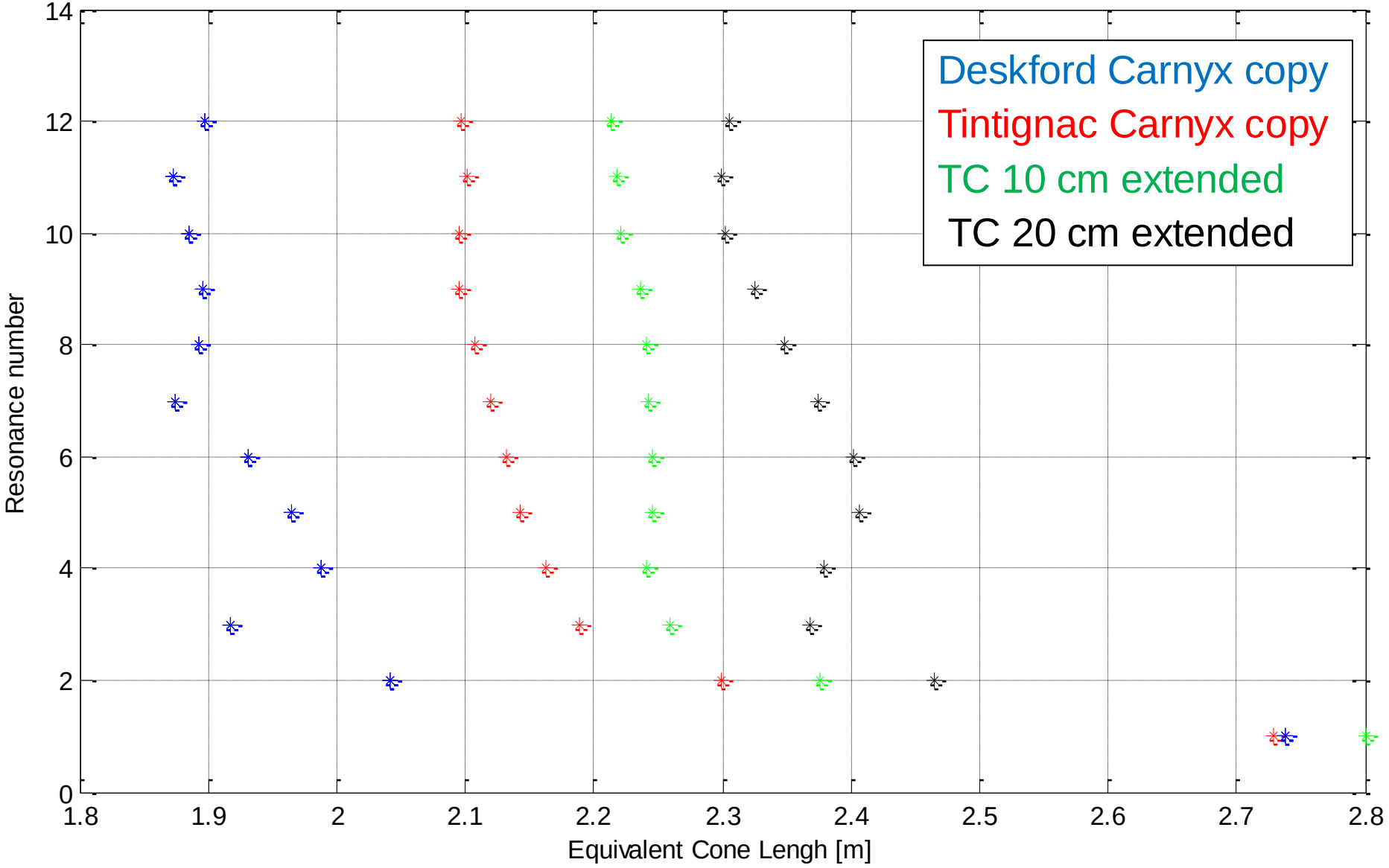
The Tintignac Carnyx

Excavations (2004) at the site of Tintignac (Naves, Corrèze, France)

Fragments of seven carnyx found in a pit

Playing tests and impedance measurements at LAUM of Tintignac carnyx reconstruction in brass by Jean Boisserie

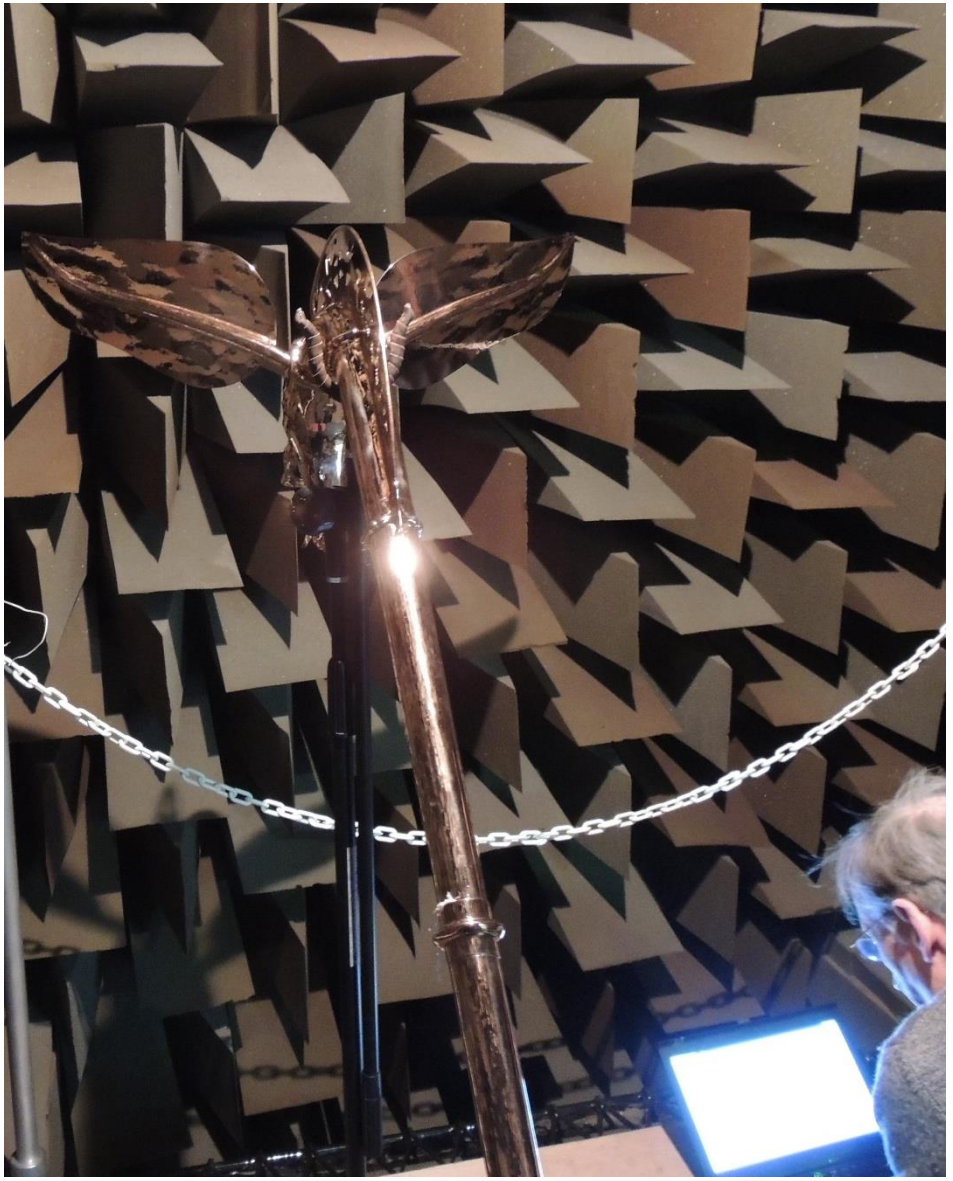
Equivalent cone length ECL(n) = nc/2f



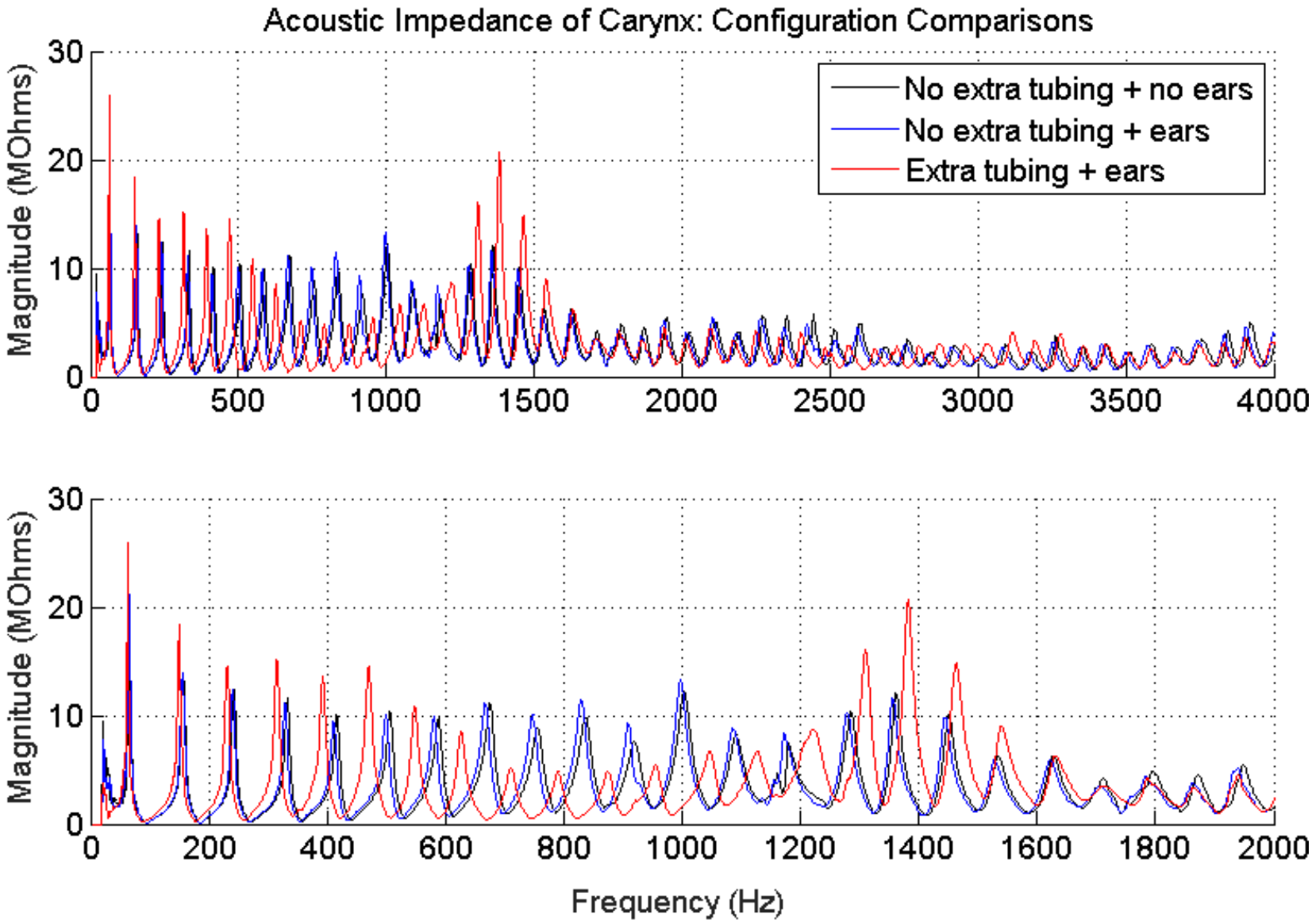
ECL shows deviations of mode frequencies from exact harmonics

Second copy of Tintignac Carnyx in bronze

The Tintignac bronze carnyx in the lab

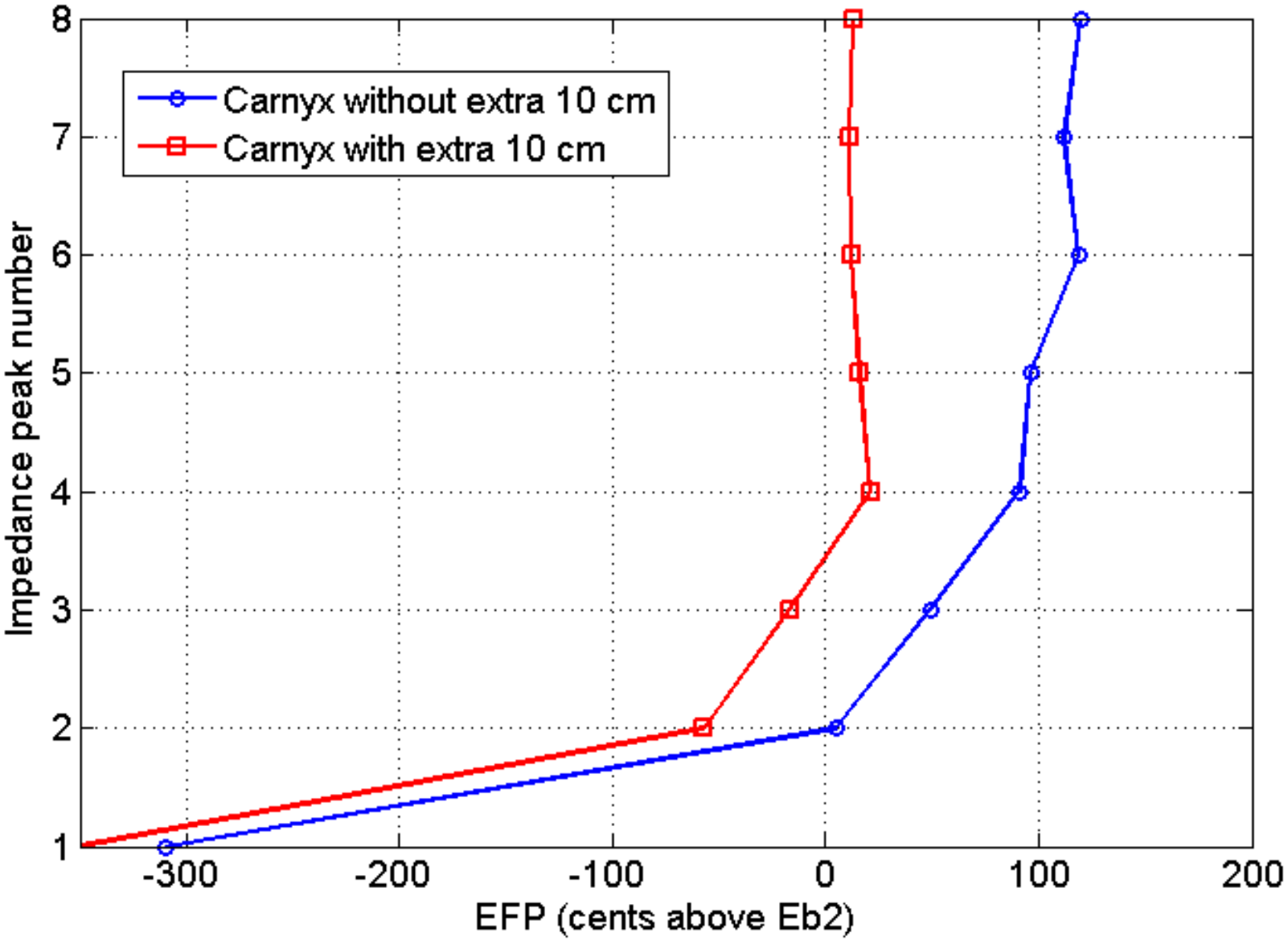


Input impedance measurements
on the bronze carnyx at Edinburgh



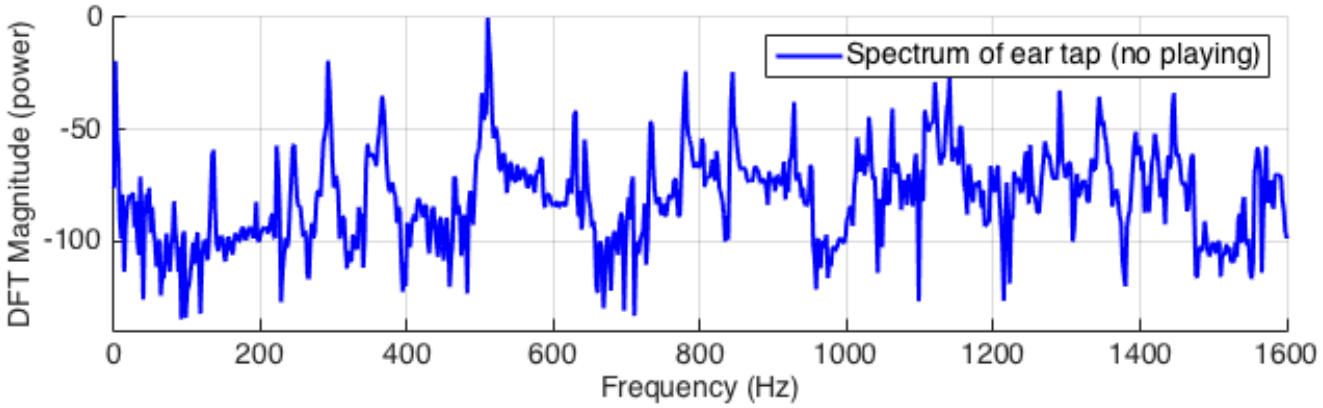
Adding ears makes little difference to input impedance

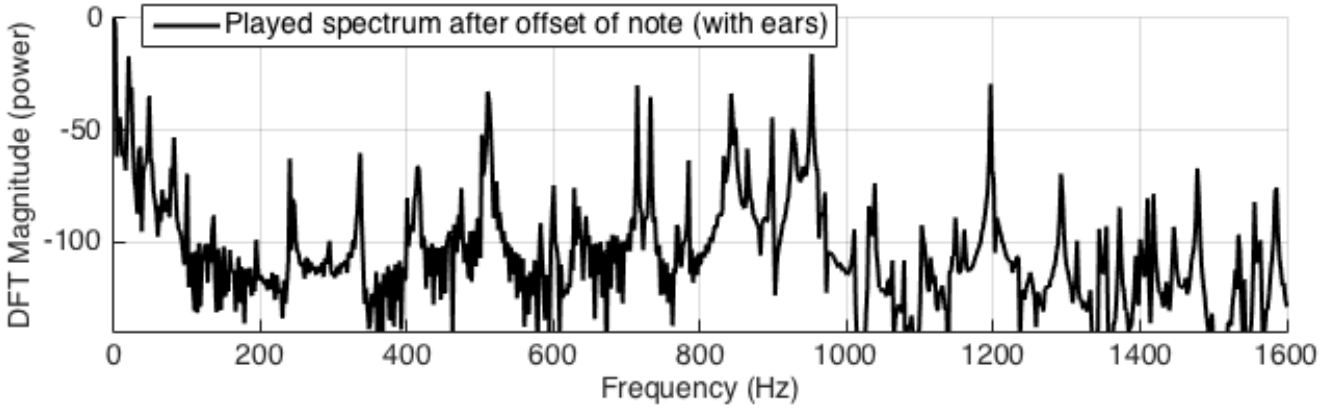
Adding extra 10 cm section lowers resonance frequencies and boosts amplitudes around 1.4 kHz

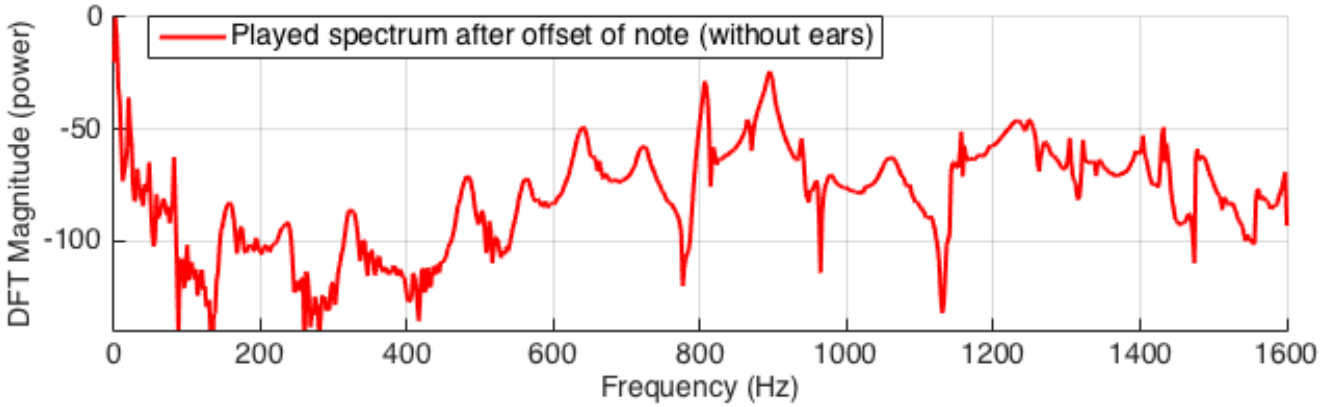


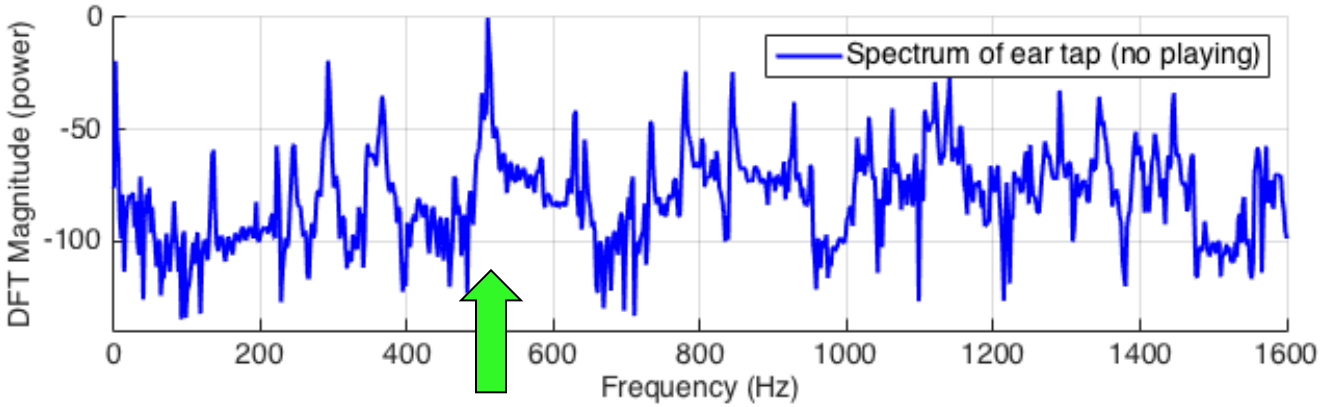
As predicted, the EFP curve with the additional tube section is closer (above n = 2) to the vertical line indicating exactly harmonic resonances.

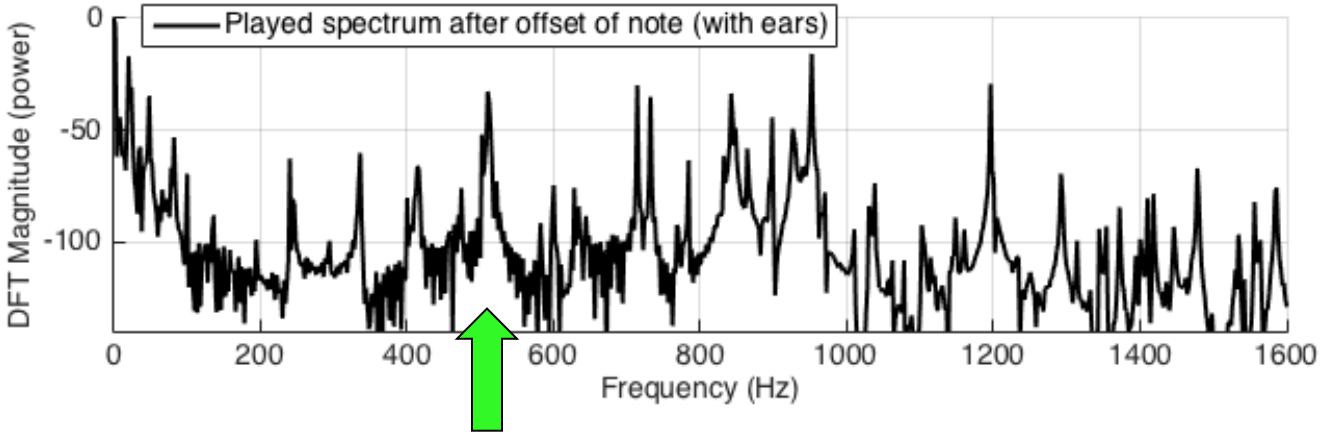
Vibration of the ears excited by playing the carnyx

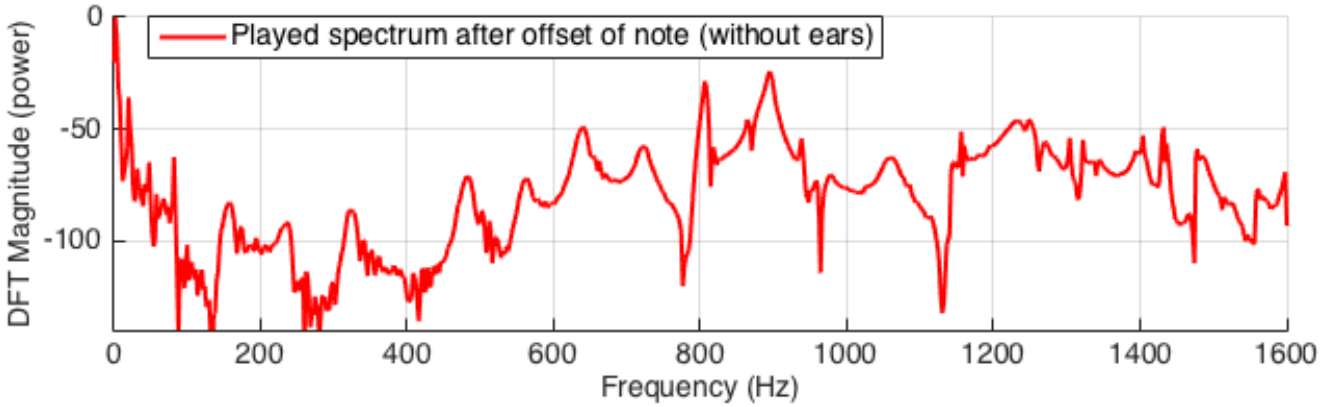

Spectrum of ear tap (no playing)
DFT Magnitude (power)
0
-50
-100
0
200
400
600
800
1000
1200
1400
1600
Frequency (Hz)


Played spectrum after offset of note (with ears)
DFT Magnitude (power)
0
-50
-100
0
200
400
600
800
1000
1200
1400
1600
Frequency (Hz)


Played spectrum after offset of note (without ears)
DFT Magnitude (power)
0
-50
-100
0
200
400
600
800
1000
1200
1400
1600
Frequency (Hz)







Evidence of structural resonances ringing after note end e.g. at 510 Hz

ACKNOWLEDGEMENTS

The Tintignac Carnyx reconstruction project has relied on the expert contributions of

- **Archaeologist**: Christophe Maniquet
- **Builder**: Jean Boisserie (make copies in brass and in bronze)
- **Acousticians**: Emmanuel Brasseur, Jean-Pierre Dalmont, Joel Gilbert

The research leading to these results has received funding from the People Programme (Marie Curie Actions) of the European Union's Seventh Framework Programme FP7/2007-2013/ under REA grant agreement No. 605867 supporting the BATWOMAN ITN Project.

THANK YOU FOR YOUR ATTENTION