



HELLENIC INSTITUTE OF ACOUSTICS
e-mail: helina.secretariat@gmail.com, www.helina.gr

TECHNICAL RESPONSE TO THE GUARDIAN REPORT by Nicola K.S. Davis (16/10/2017)

with reference to the paper

PROJECT ANCIENT ACOUSTICS PART 2 OF 4: LARGE SCALE ACOUSTICAL MEASUREMENTS IN THE ODEON OF HERODES ATTICUS AND THE THEATRES OF EPIDAUROS AND ARGOS, by Niels Hoekstra, Bareld Nicolai, Bas Peeters, Constant Hak and Remy Wenmaekers (23rd ICSV, Athens, 10-14/7/2016).

1. The report makes reference to results were published in 4 papers in the ICSV23 Congress, in Athens 2016. Of those the first 2 (Part 1 and Part2) are relevant to this discussion.
2. Additional results were later presented by the same authors in the Acoustics '17 Conference, Acoustical Society of America – European Acoustics Association, Boston, June 2017. The presentation was entitled “Falling coins, striking matches and whispering voices to demonstrate the acoustics of an open air amphitheatre”, by Constant Hak, Niels Hoekstra, Bareld Nicolai, and Remy Wenmaekers
3. The study covers 3 theatres: the theatre of Epidaurus, the Odeon of Herodes and the theatre of Argos. However, only Epidaurus has retained the original Hellenistic era structure without any Roman-era modifications, hence being a typical “Ancient Greek Theatre”. For these theatres, there are a number of earlier publications presented in Conference, Journals and the “The Acoustics of Ancient Theatre” Conference organized by Helina:
(<http://www.ancientacoustics2011.upatras.gr/extra.html>).
4. **According to the report, the journalist’s reference to “not good acoustics” refer mostly to tests with coins, match lightning and whispering, that C. Hak of Eindhoven University of Technology made. Such tests do not conform to any acoustic standard and do not conform to accepted scientific “good acoustics” measuring principles. They just refer to informal tests visitors often make when visiting the theatre.**
5. With respect to the important issue of speech intelligibility, measured by the authors via the Speech Transmission Index (STI), it is clearly that this will depend on source signal level and ambient noise, especially at the more distant listener position, at more than 60 m from the stage.

6. The authors measured STI in 2 ways: (a) omni and (b) “calibrated speech source” for normal vocal speech 60 dB(A), for maximum vocal effort 82.3 dB(A). The signal level for the “normal vocal speech” at 60m, would be less than 25dB (A), i.e. below the level of low background noise, assuming a measurement with no other interferences.
7. The paper (Part 2) conclusion adopted by the Guardian report, refers only to STI results for 60 dB(A) speech source (Fig. 6a). For this case, STI falls to less than 0.1 for the 60m distance.
8. **For 82.3 dB(A) speech source, (“shouting” or “maximum vocal effort”) the STI are results are into the “Good” to “Excellent” category; the STI ranges from 0.9 (close position) to 0.6 for the 60m position. These results do not differ significantly to other past measurements in the theatre by other researchers.**
9. Such speech level is more likely to be employed by actors than the “normal vocal speech” level.
10. **In the same paper, Fig.6b shows results for “infinitely high Signal to Noise Ratio” (“acoustics only” case), where STI is around 0.9 (“Excellent”) irrespective the source-receiver distance, i.e. identical to the results from previous studies presented in Conferences and paper publications. However, the paper and Guardian report does not make any reference to such results.**
11. **In the papers it is not described what type of measurement post processing produces the results for “Perfect” speech intelligibility, i.e. the “infinitely high Signal to Noise Ratio” (“acoustics only” case).**
12. In the paper, there are references to T_{20} non-uniform distribution across positions at Epidaurus. Reference to T_{20} for such open theatres it is not providing any indication for good or bad acoustics, but as the authors mention, can be only utilized for modeling purposes.
13. **Given that differences in measurement methodology and response post processing between the above paper and past publications are very possible, it is useful if the authors made public their measurements. Note that such measurements were openly available for one of the referenced past studies of the theatre acoustics.**
14. In the subsequent June 2017 publications by the same authors – although only available as presentation handout – the question if the Epidaurus theatre has extraordinary acoustics for “classical plays performed there”, the authors indicate that this is true for “more than 10000 silent people, when players speak very loudly” hence in part refutes the article perspective.