



THE UNIVERSITY of EDINBURGH  
The Royal (Dick) School  
of Veterinary Studies



# Welfare assessment of Low Atmospheric Pressure Stunning (LAPS) in chickens

Jessica E. Martin<sup>1,2</sup>, Karen Christensen<sup>3</sup>, Yvonne Vizzier-Thaxton<sup>3</sup>, Malcolm A. Mitchell<sup>4</sup> and Dorothy E. F. McKeegan<sup>2</sup>

<sup>1</sup>The Royal (Dick) School of Veterinary Studies and The Roslin Institute, University of Edinburgh, UK

<sup>2</sup>Institute of Biodiversity, Animal Health and Comparative Medicine, College of Medical, Veterinary & Life Sciences, University of Glasgow, UK

<sup>3</sup>Centre of Excellence for Poultry Science, University of Arkansas, Fayetteville, US

<sup>4</sup>Animal Behaviour and Welfare, Animal and Veterinary Science Research Group, SRUC, Edinburgh, UK



# What is Low Atmospheric Pressure stunning (LAPS)?

- Novel approach to pre-slaughter stunning (developed in the U.S.)
- Renders birds unconscious by progressive hypobaric hypoxia
- LAPS involves gradual decompression (280s cycle) according to a prescribed curve, which is temperature dependent.

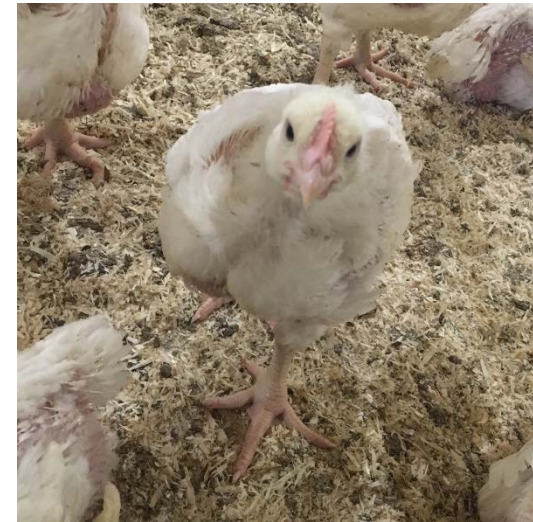
Proposed as a new alternative to controlled atmosphere stunning (CAS) systems, whilst sharing many of its welfare advantages (e.g. reliable irreversible stunning and no shackling or loading/unloading of birds while conscious).

- **US Department for Agriculture, 2010**
- **Canadian Food Inspection Agency, 2013**
- **AVMA, 2016**



# Objectives

- **Trial 1: Behavioural, brain and cardiac responses to LAPS in broiler chickens**
  - 1<sup>st</sup> Aim: Examine broiler responses to LAPS through behavioural, electroencephalogram (EEG) and electrocardiogram (ECG) recordings.
  - 2<sup>nd</sup> Aim: Effect of 2 temperature settings on broiler responses to LAPS.
  
- **Trial 2: Effects of light on responses to LAPS in broiler chickens**
  - Effect of illumination and sham treatment on broiler responses, through behavioural, electroencephalogram (EEG) and electrocardiogram (ECG) recordings.



# Methods – Trial 1

## Behavioural, brain and cardiac responses to LAPS in broiler chickens

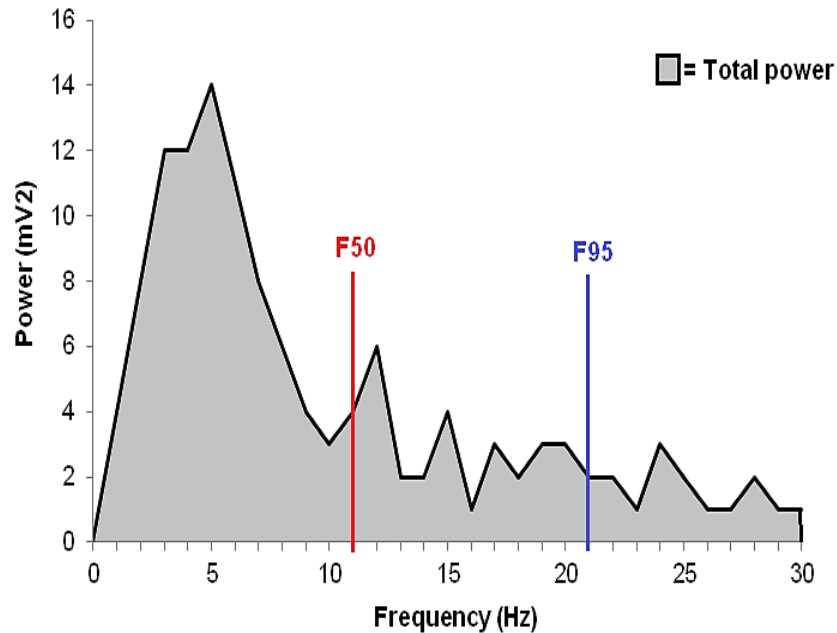
- 2 temperature settings: TS3 (13-18°C); TS4 (5-12°C)
- 30 triplets of Cobb 550 male broilers at 38-39d of age (mean weight  $2.4 \pm 0.4\text{kg}$ )
- 16 triplets assigned to TS3 and 14 triplets to TS4 (weather dependent).
- In each triplet, one bird was instrumented for recording of EEG (i.e. electrical brain activity) and ECG (heart rate) responses:
  - Birds were surgically implanted (under general anaesthetic) with EEG electrodes onto the surface of birds' skulls with two bi-polar wires inserted through the skull to sit on the dura above each hemisphere. Birds given 4d recovery post-surgery. (Lowe et al 2007; Coenen et al 2009, McKeegan et al 2011; Martin et al 2016).
  - Birds were instrumented with EKG self-adhesive electrodes on the pectoralis muscle and with custom-made telemetry logging devices inserted into lycra harnesses.
  - 2 minute baseline recordings for both EEG and ECG were taken pre-LAPS.
- Behaviour (e.g. LOP, ataxia, etc.) of all birds was recorded via an infra-red camera within the LAPS chamber.



# Methods – Trial 1

## Behavioural, brain and cardiac responses to LAPS in broiler chickens

EEG analysis: power spectra for each consecutive “artefact free” 2s epoch using Fast Fourier Transform (FFT) algorithm (1024, Hanning window, resolution 0.976 Hz bins – Spike 2), for 2 min baseline and 280s LAPS cycle.



State	Key spectral ranges
Non-responsive	F50 < 12.7Hz
General anaesthetic plane	F50 < 6.8Hz
Isoelectric (brain death)	PTOT < 170mv; F50 > 22Hz

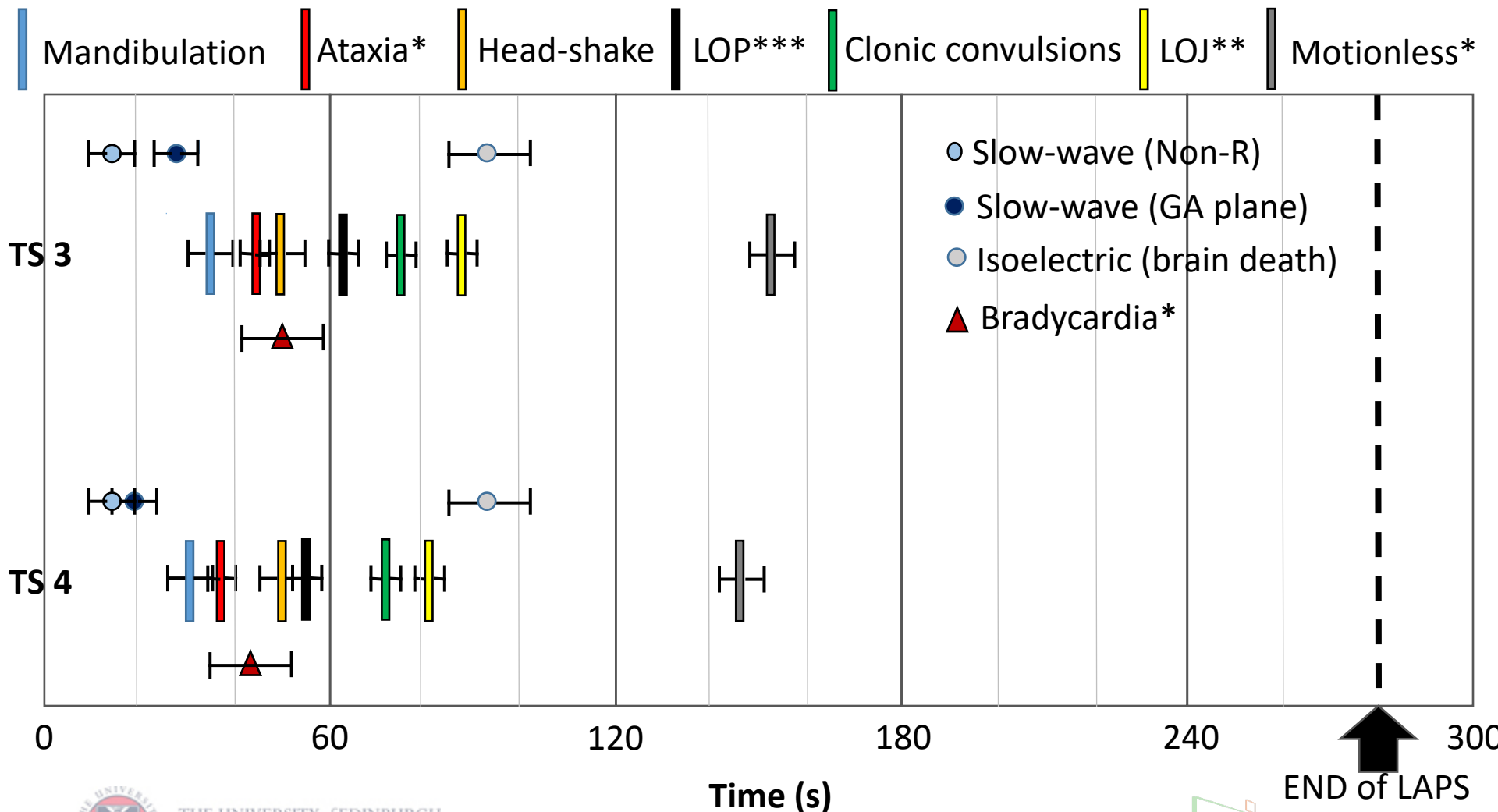
(Sandercock et al 2014; Martin et al 2016a, 2016b)

Linear interpolation filtering applied  
(Martin et al 2016a, 2016b)



# Results – Trial 1

Behavioural, brain and cardiac responses to LAPS in broiler chickens



# Summary – Trial 1

## Behavioural, brain and cardiac responses to LAPS in broiler chickens

- Temperature effects for key behavioural latencies indicating unconsciousness, with shorter latencies at colder temperatures.
- No temperature effects on EEG indicators of loss of consciousness or brain death.
- Temperature effect for latency to bradycardia, with shorter latencies at colder temperatures.
- Collectively all measures indicate complete loss of consciousness displayed in all birds by 70s (mean 59.2s) and brain death by 140s (mean 87.7s) .



# Methods – Trial 2

## Effects of light on responses to LAPS in broiler chickens

- 2x2 factorial design: LAPS/dark, LAPS/light, SHAM/dark, and SHAM/light
- All LAPS cycles at TS4 only
- 20 pairs of Cobb 550 male broilers at 44-45d of age per treatment (mean weight  $3.0 \pm 0.4\text{kg}$ )
- In each pair, one bird was instrumented for recording of EEG (i.e. electrical brain activity) and ECG (heart rate) responses.
- Behaviour (e.g. LOP, ataxia, etc.) of all birds was recorded via an infra-red camera within the LAPS chamber.



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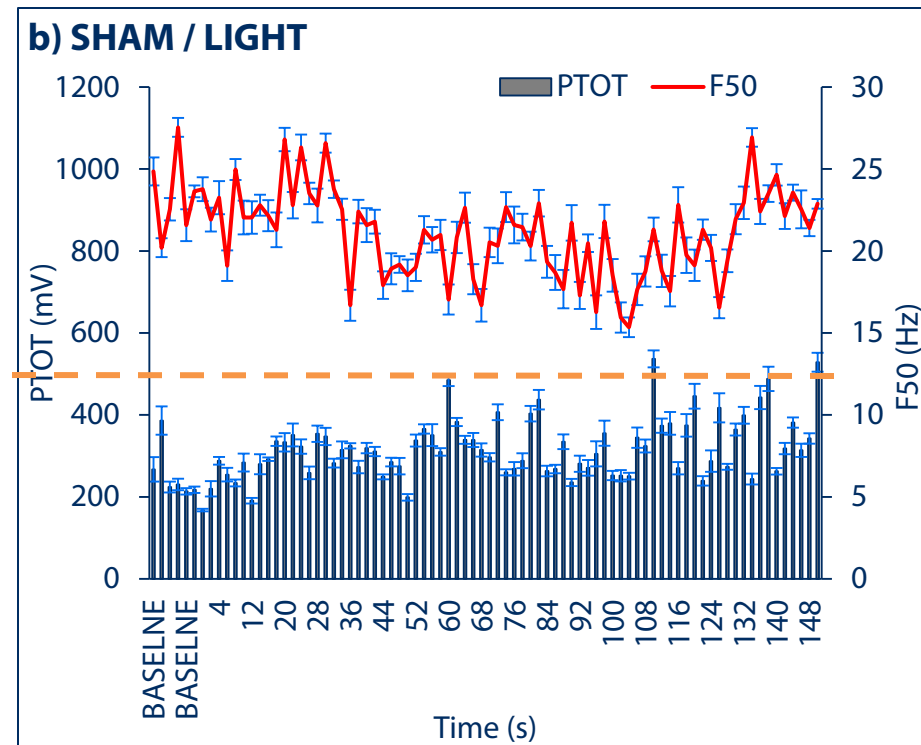
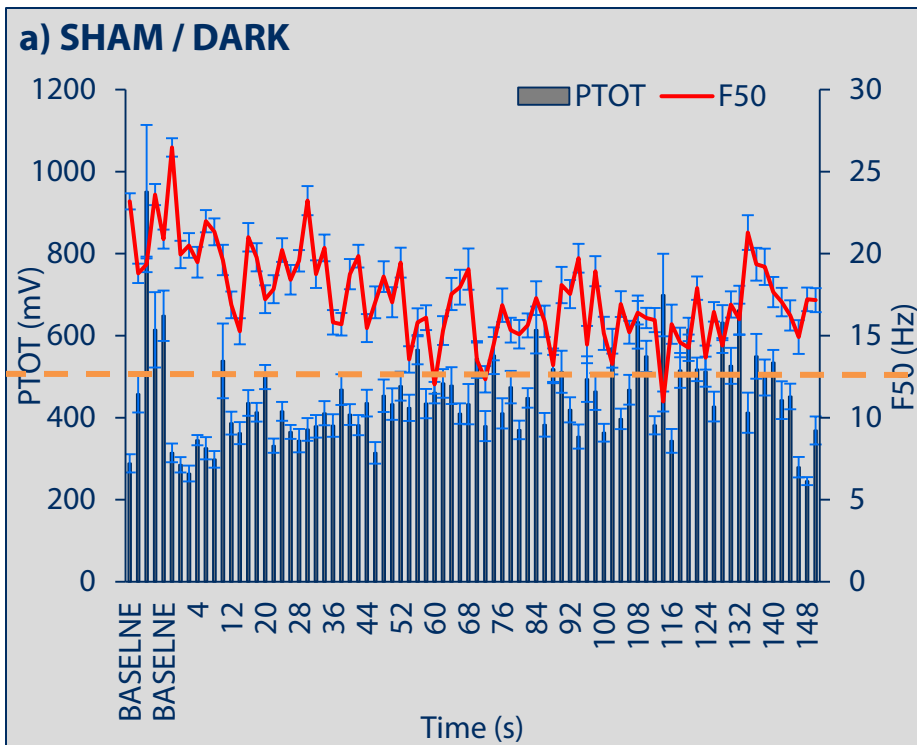
All work conducted under EU Directive 2010/63 and authorized by the University of Arkansas Institutional Animal Care and Use Committee.



# Results – Trial 2 (sham effects)

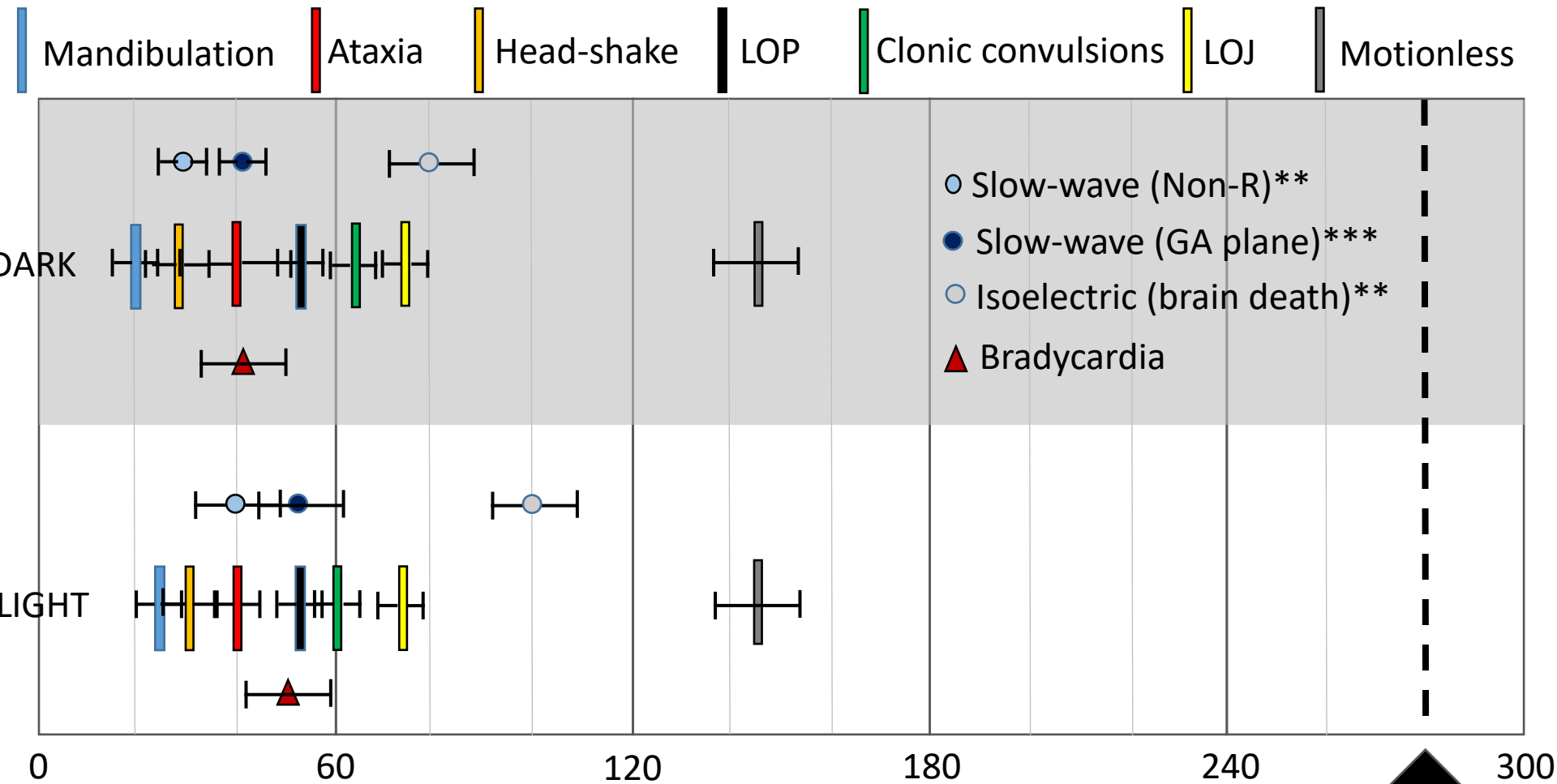
## Effects of light on responses to LAPS in broiler chickens

- In **SHAM** treatments birds:
  - displayed “conscious” behaviours (e.g. stand/sitting) and did not display LOP, ataxia or motionless.
  - displayed sleep-like EEG waveforms (illumination<sup>\*\*\*</sup>)
  - bradycardia and brain death absent



# Results – Trial 2 (Illumination effects)

Effects of light on responses to LAPS in broiler chickens



# Summary – Trial 2

## Effects of light on responses to LAPS in broiler chickens

- Sham effects for key behavioural latencies indicating loss of consciousness and bradycardia, with neither observed in sham treatment birds.
- Illumination effects in sham treatments, with birds in the dark displaying sleep-like EEG waveforms earlier and for longer periods.
- During LAPS, illumination had no effect on key behavioural latencies indicating loss of consciousness or latency to bradycardia
- Illumination effects for EEG spectral latencies within LAPS, with shorter latencies observed in the dark compared to the light.
- Collectively all measures indicate complete loss of consciousness displayed in all birds by 60s (mean 55s) and brain death by 180s (mean 95s) .



# Overall conclusions

- Consistent sequence of behaviours in LAPS: ataxia, loss of posture, clonic/tonic convulsions and motionless
- Maintenance of slow-wave EEG patterns in the early part of LAPS (while birds are still conscious) is strongly suggestive that LAPS is non-aversive.
- Effects of LAPS/sham primarily related to the presence/absence of hypoxia
- Recommendation that LAPS is carried out in darkness, as is currently the case commercially.
- Collectively, these results add to a growing body of evidence that behavioural and EEG responses to LAPS are consistent and indicative of a process that is largely equivalent to controlled atmosphere stunning with anoxic gases.
- This evidence has recently been presented to EFSA to facilitate approval of the method in the EU regulatory framework.

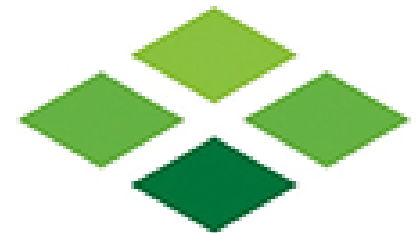


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