

# Use of SLP to identify disordered thoraco-abdominal breathing patterns in COPD

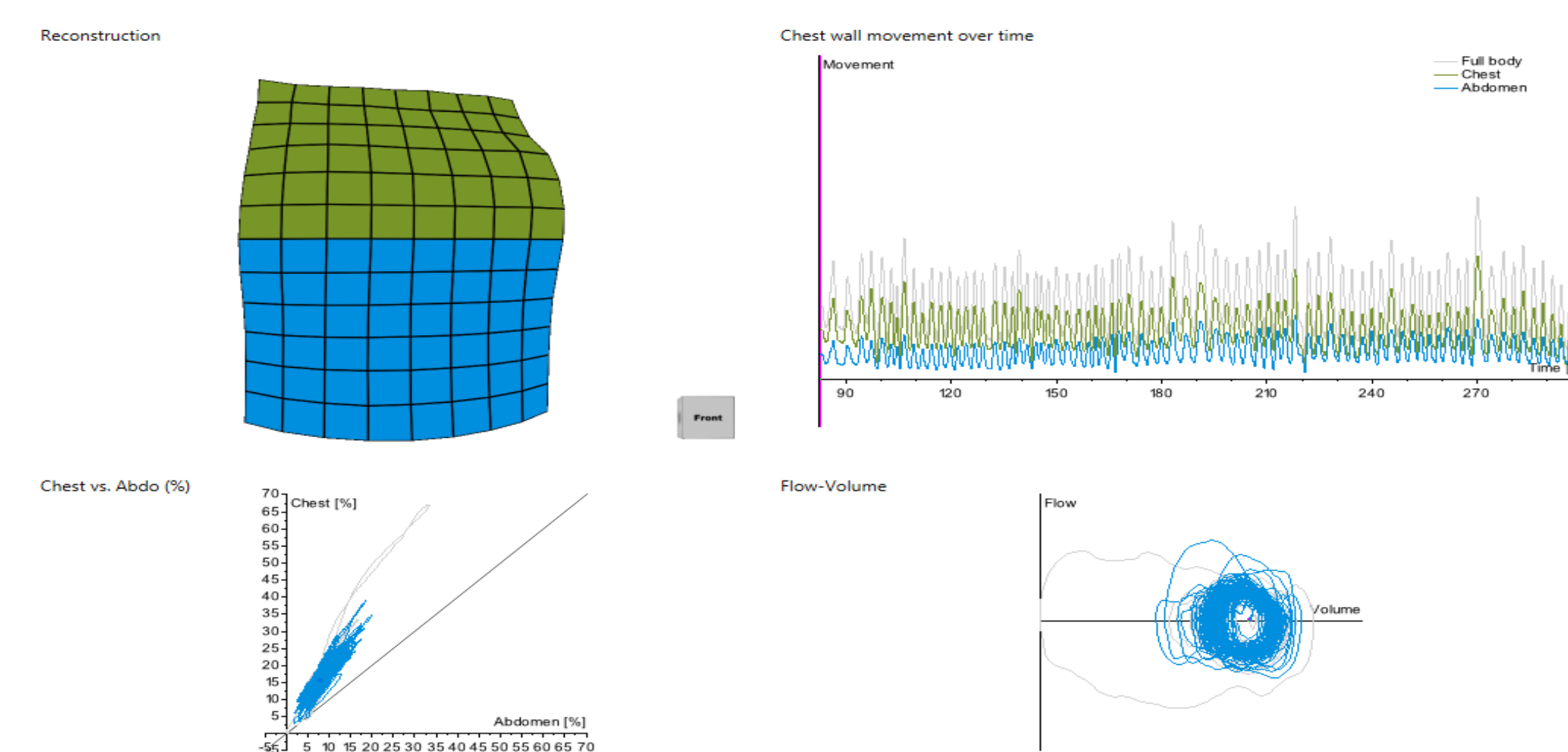
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## Introduction

- Structured Light Plethysmography (SLP) and the SLP-based, the Thora3Di™, utilise a non-invasive, non-contact imaging method of recording anterior-ribcage and abdominal wall movements,
- SLP projects a grid of light onto the subject's chest and abdomen, the movement of the grid allows both the analysis of thoraco-abdominal movements (TAM), the compartment volume change and relationship and respiratory pattern indices during Tidal Breathing (TB).
- We present a novel method of breaking down the surface motion of tidal breathing that we believe to be able to characterise a subject's healthy, diseased, or highly trained state.



Thora3di™ capture of thoraco-abdominal wall, using Structured Light Plethysmography (SLP). Image shows a 4m 47.8s recording: 3D reconstruction, Chest vs Abdominal compartments, Konno Mead graph for Chest V Abdomen and Tidal breathing flow volume loop.

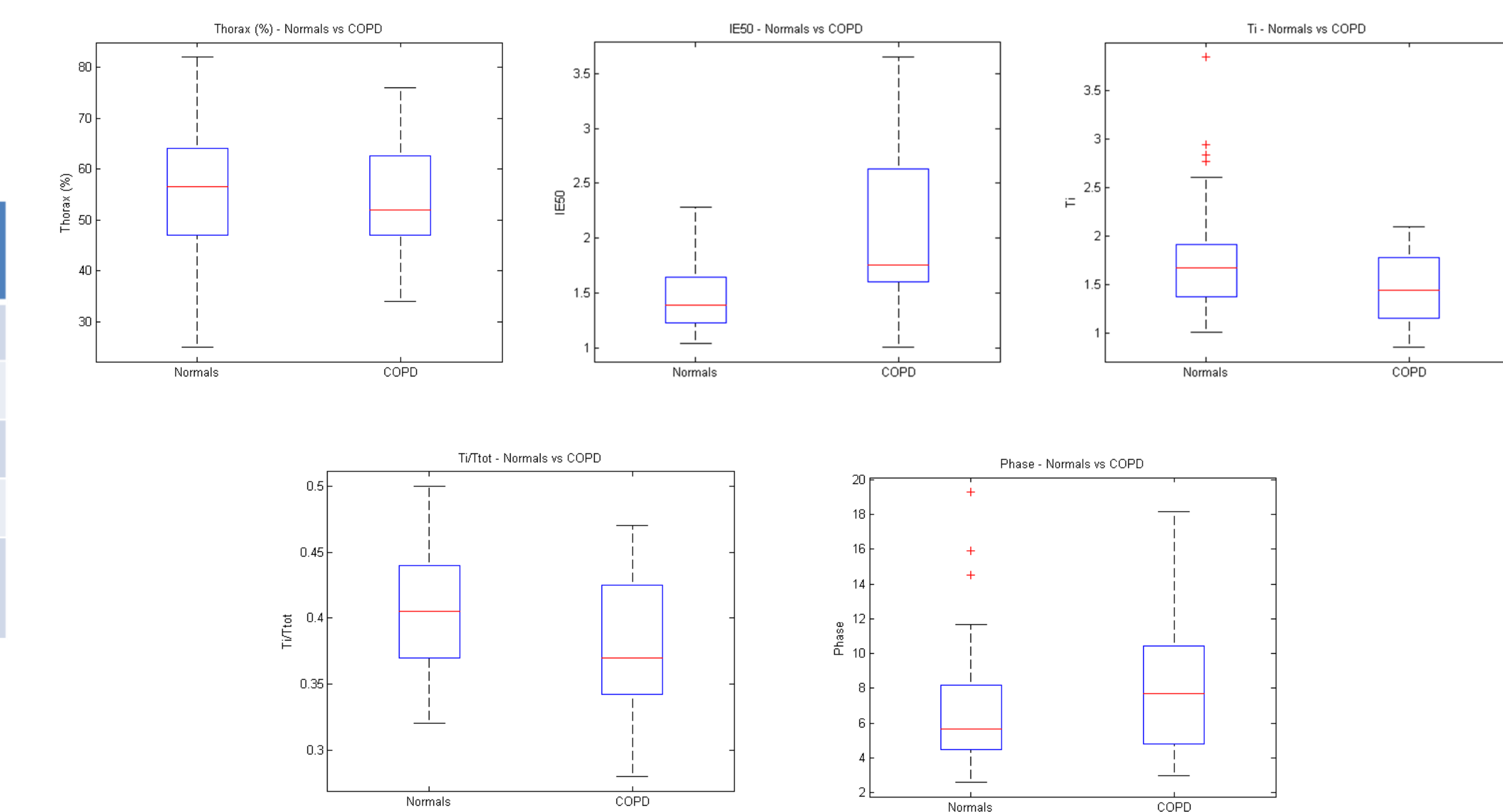
## Methods

- TAM were interrogated from 20 tidal breaths in Normal subjects and Patients with COPD.
- Data were collected as per Thora3Di™ (PneumaCare Ltd) user manual.
- The following outputs were recorded:
  - Thorax relative expired contribution (%), relative to Total (thoracic and abdominal) Contribution
  - Respiratory pattern indices (inspiratory time, Ti; total respiratory cycle length, Ttot; inspiratory duty cycle, Ti/Ttot), and the IE50 ratio (ratio of inspiratory to expiratory flow at 50% of tidal volume),
  - Breath Phase (degrees).
- Analysis 1
  - 58 Normal (m=32, f=26) and 21 COPD (m=12, f=9)
- Analysis 2, (subjects over 40 yrs),
  - 31 Normal (m=12, f=19) and 21 COPD (m=12, f=9),
- The Mann-Whitney U test was performed to compare groups.

## Results

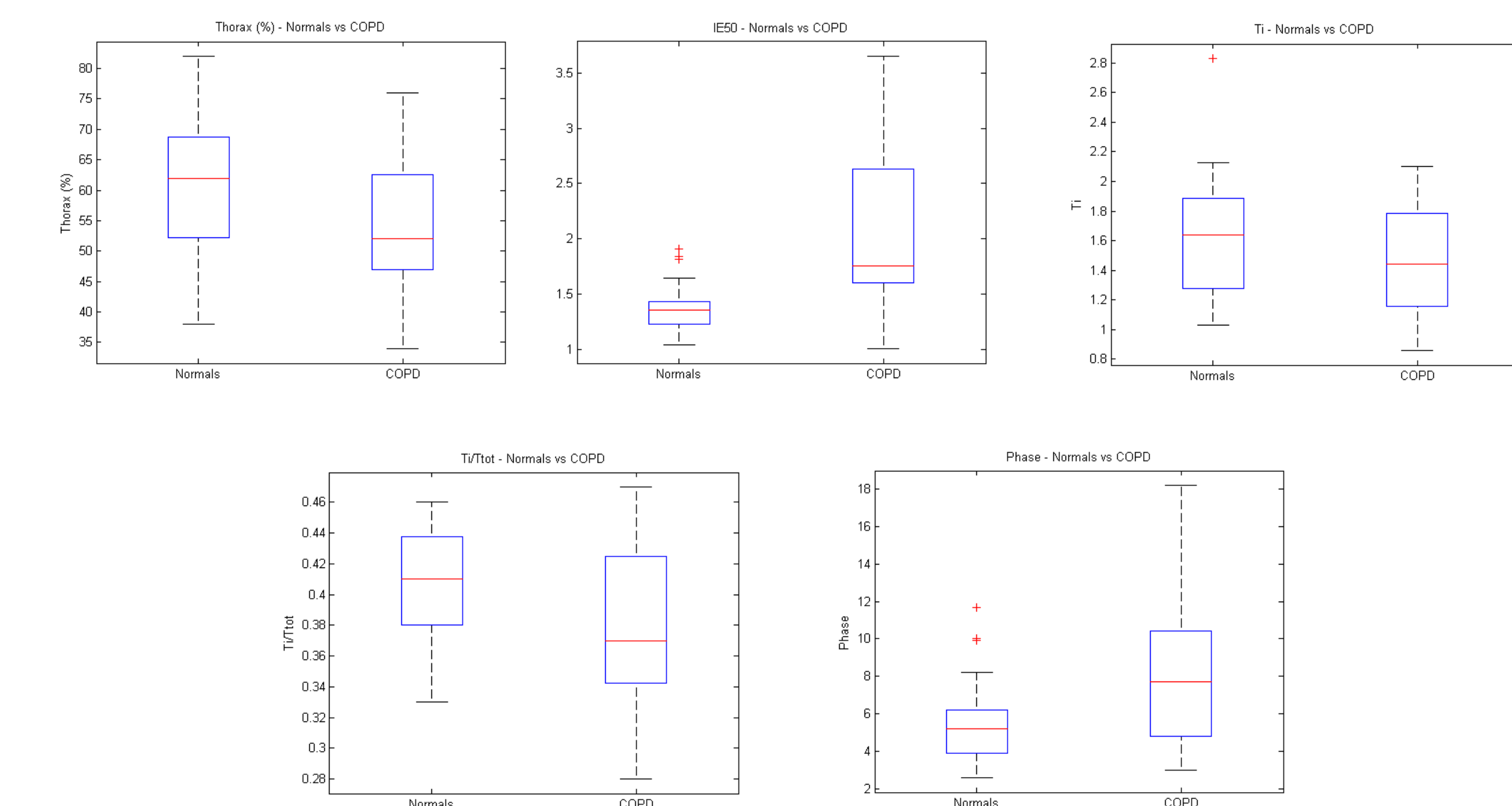
### Analysis 1 – All ages

| Parameter       | Normals (n=58) - Median | COPD (n=21) - Median | p-value        |
|-----------------|-------------------------|----------------------|----------------|
| Thorax (%)      | 57                      | 52                   | p=0.706        |
| IE50            | 1.39                    | 1.76                 | <b>p=0.001</b> |
| Ti              | 1.67                    | 1.44                 | <b>p=0.048</b> |
| Ti/Ttot         | 0.41                    | 0.37                 | p=0.055        |
| Phase (degrees) | 5.7                     | 7.7                  | p=0.085        |



### Analysis 2 – Subjects over 40 years

| Parameter       | Normals (n=31) - Median | COPD (n=21) - Median | p-value        |
|-----------------|-------------------------|----------------------|----------------|
| Thorax (%)      | 62                      | 52                   | p=0.056        |
| IE50            | 1.36                    | 1.76                 | <b>p=0.001</b> |
| Ti              | 1.64                    | 1.44                 | p=0.189        |
| Ti/Ttot         | 0.41                    | 0.37                 | p=0.068        |
| Phase (degrees) | 5.2                     | 7.7                  | <b>p=0.006</b> |



## Conclusions

- There are significant differences in respiratory pattern indices between the Normal and COPD groups for all ages that can be identified using SLP.
- For the Over-40 age group, there is a strong significant difference between groups for IE50 and Breath Phase Angle.
- Further work in ongoing exploring the relationship between these indices, and in particular IE50 and Phase, with respect to age, severity and disease states.

## Bibliography

- SLP: A Zero-Contact Non-Invasive Method for Pulmonary Function Testing Richard Iles, Rich Wareham, Jonathan Cameron, Juliet Usher-Smith, Ward Hills, Willem de Boer, Joan Lasenby BMVC 2010 <http://bmvc10.dcs.aber.ac.uk/proc/conference/paper85/index.html>
- Non Invasive Measurement Of Respiratory Rate: Comparison Between The Embletta® (GOLD) RespiBand Device and Thora3Di, R. Iles, A. Khalid, K. Kimber, W. De Boer, R. Wilson; ATS 2014
- Using A Machine Learning Prediction Model And Structured Light Plethysmography Diagnosed Lung To Predict Physician Disease From Tidal Breathing. R. Iles, X. Zhang, A. Khalid, W. De Boer; R. Wilson ATS 2014
- Non Invasive Assessment Of The Effect Of Implantable Phrenic Nerve Stimulation in Two Paediatric Patients Using Structured Light Plethysmography. S. Morley, A. Khalid, K. Kimber, W. De Boer, R. Wilson, R. Iles ATS 2014