A stylized green human figure in a dynamic, forward-leaning pose, possibly representing a runner or a person in motion. The figure is composed of solid green shapes for the head, torso, and limbs, with a light gray curved line suggesting a path or trajectory behind it.

Resultant Force Calculation

Lab 2

ACCUPOWER

Introduction

- Newtons' laws of mechanics define the relationship between force and the linear motion of a particle or rigid body to which it is applied. Three such relationships are described below:
 - Law of Inertia: describes how a body moves in *the absence* of external force, stating a body will remain in its current state of motion unless acted upon by an external force.
 - Law of Acceleration: describes how a rigid body moves when an external force is applied to a body. $F=ma$.
 - Law of Reaction: describes how two masses interact with each other.

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Introduction

- In many situations, more than one force acts on a body at a given point in time.
- This situation is easily handled within Newton's laws through the calculation of a resultant force vector.
- Because each force is a vector quantity, a set of forces acting on a body can be combined through vector summation into a single resultant force vector.

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Objectives

- The objectives of this lab is to perform calculations to determine 2 and 3 dimensional resultant forces from force data acquired by a force plate.
- The data were gathered with the subject performing a single long jump.
- From the raw force data, we will calculate
 - Resultant Horizontal Force
 - Resultant Force
 - Resultant Horizontal Velocity
 - Resultant Velocity

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Theoretical Background

- AccuPower calculates center of mass (CoM) velocity using the impulse-momentum relation, i.e.
 - $F\Delta t = m\Delta v$, rearranged as
 - $\Delta V = \frac{F\Delta t}{m}$
- Where,
 - F=net force
 - Δt = Change in Time
 - M = Body mass
 - ΔV = Change in Velocity

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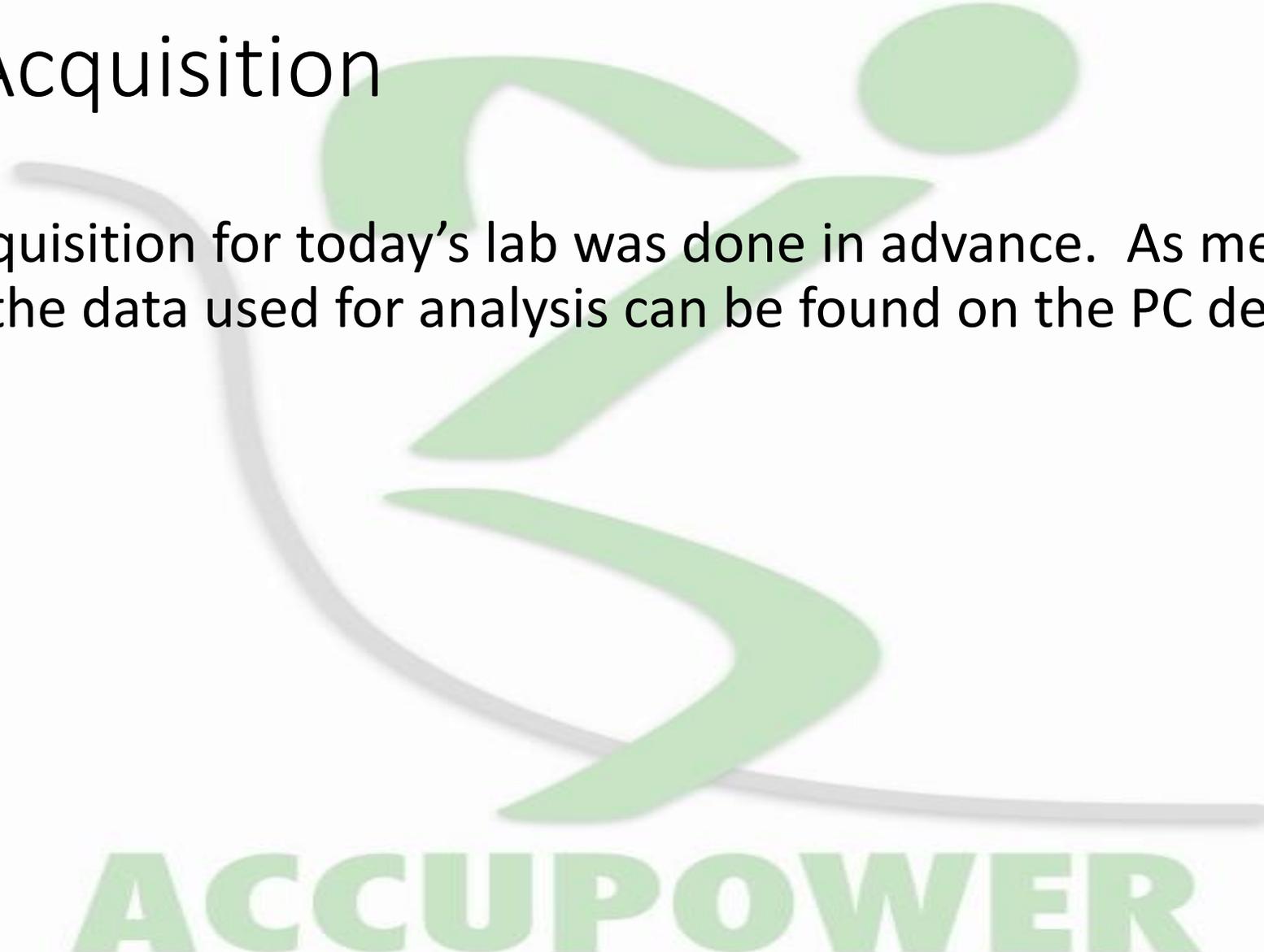
Theoretical Background

- Accurate calculation of CoM velocity is critical to accurately calculate power and other discrete values in the AccuPower analysis.
- The user must ensure that
 - an accurate body weight is captured during the weigh process
 - the test subject is standing still (CoM Velocity = Zero) at the appropriate times during data collection.
- Recall that impulse-momentum calculates *change in velocity*; for this reason, a known point of zero CoM velocity is necessary to accurately calculate CoM velocity.

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Data Acquisition

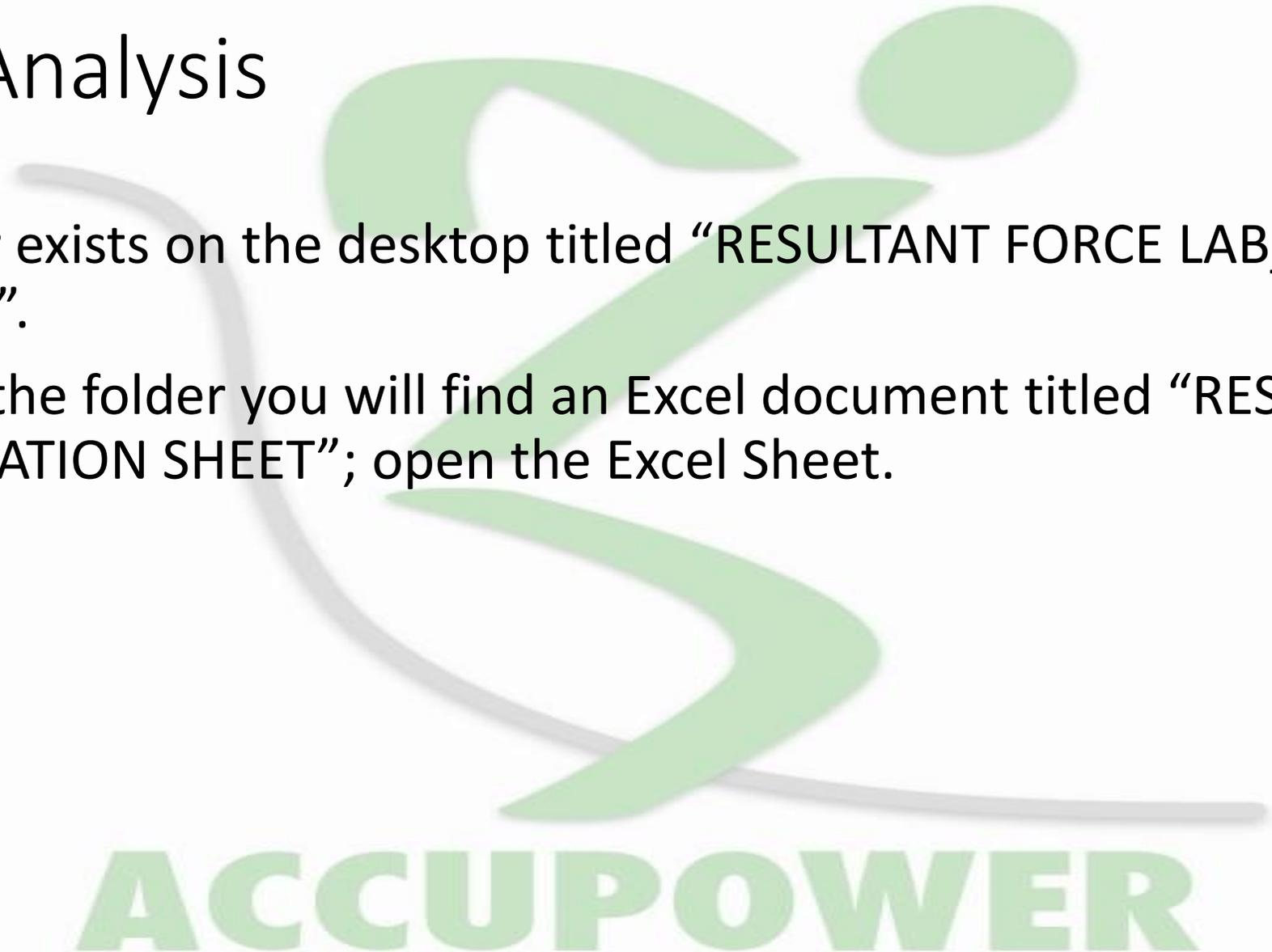
- Data acquisition for today's lab was done in advance. As mentioned earlier, the data used for analysis can be found on the PC desktop.



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Data Analysis

- A folder exists on the desktop titled “RESULTANT FORCE LAB_LJ FORCES”.
- Within the folder you will find an Excel document titled “RESULTANT CALCULATION SHEET”; open the Excel Sheet.



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Data Analysis

- On opening the document, you will notice a series of numbers in columns A-D. Those numbers reflect the force-time history for all three directional forces from a Single Long Jump trial.
 - F_x and F_y are horizontal forces and F_z is vertical reaction force.
- In cell A5, you will notice the body weight of the subject, in pounds. Corresponding to that, Cell I6 has the body weight converted to mass, units of measure the slug.
- Recalling the Law of Acceleration, we need to know body mass for calculations of velocity.

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Data Analysis: Calculate Resultant Horizontal Force

- You will note in column F, we have a column header “Res Fxy”. In this column, we will calculate resultant horizontal force.
- The equation for calculating resultant force is $= \sqrt{Fx^2 + Fy^2}$.
- To make the calculation with Excel, type in the following equation into Cell F9:
 - =sqrt((B9*B9)+(C9*C9)). The answer will be the resultant horizontal force for that instance in time.
 - Proceed to fill column F with the same calculation through row 438, which is the point of takeoff.

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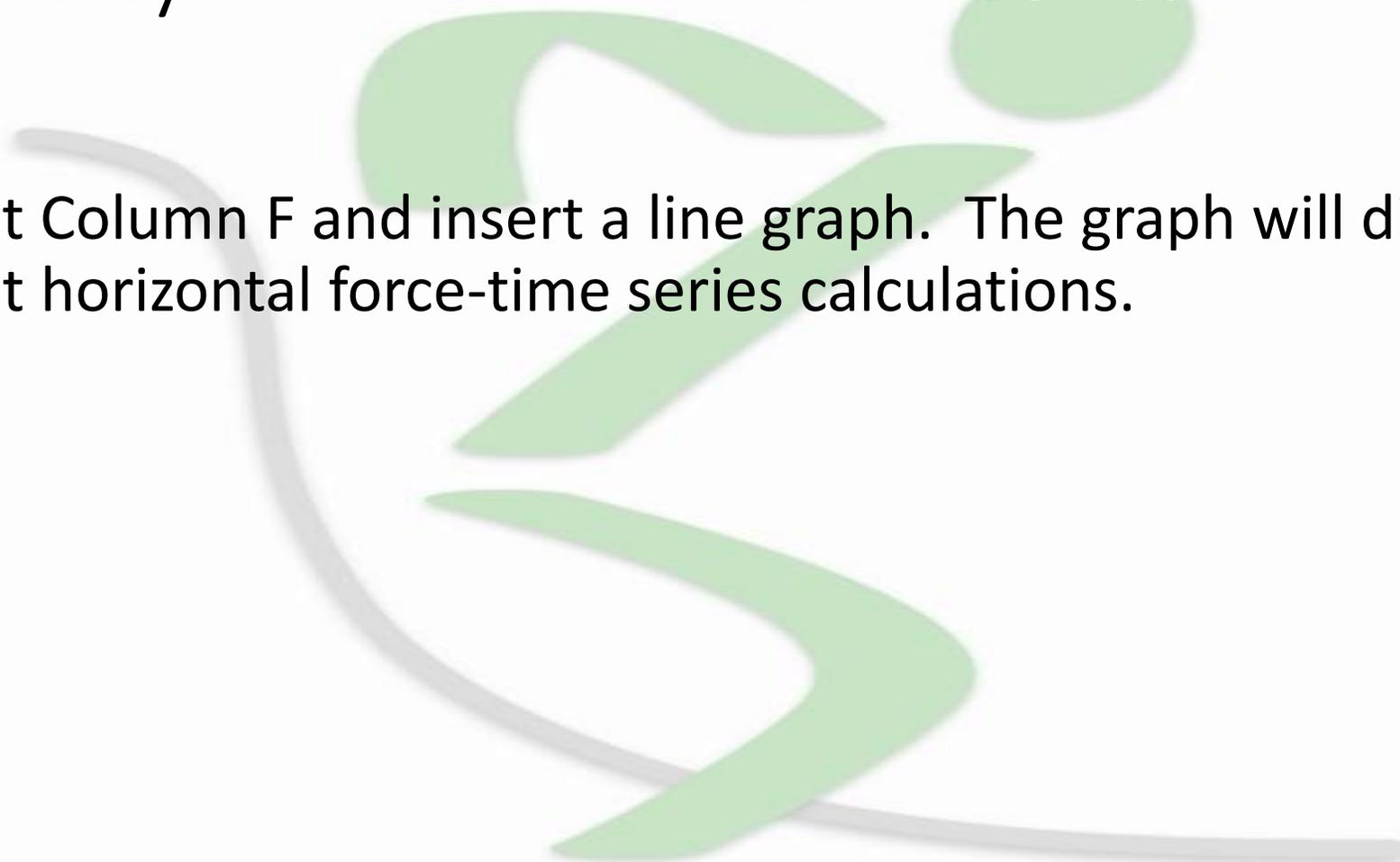
Data Analysis: Calculate Resultant Force

- Column G is set aside for calculating Resultant force, as noted by Fxyz.
- The equation for calculating resultant force is $= \sqrt{Fx^2 + Fy^2 + Fz^2}$.
To do so with Excel, type in the following equation into Cell F9:
 - =sqrt((B9*B9)+(C9*C9)+(D9*D9)). The answer will be the resultant force for that instance in time.
 - Proceed to fill column G with the same calculation through row 438, which is the point of takeoff.

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Data Analysis: Resultant Horizontal Force Graph

- Highlight Column F and insert a line graph. The graph will display the resultant horizontal force-time series calculations.



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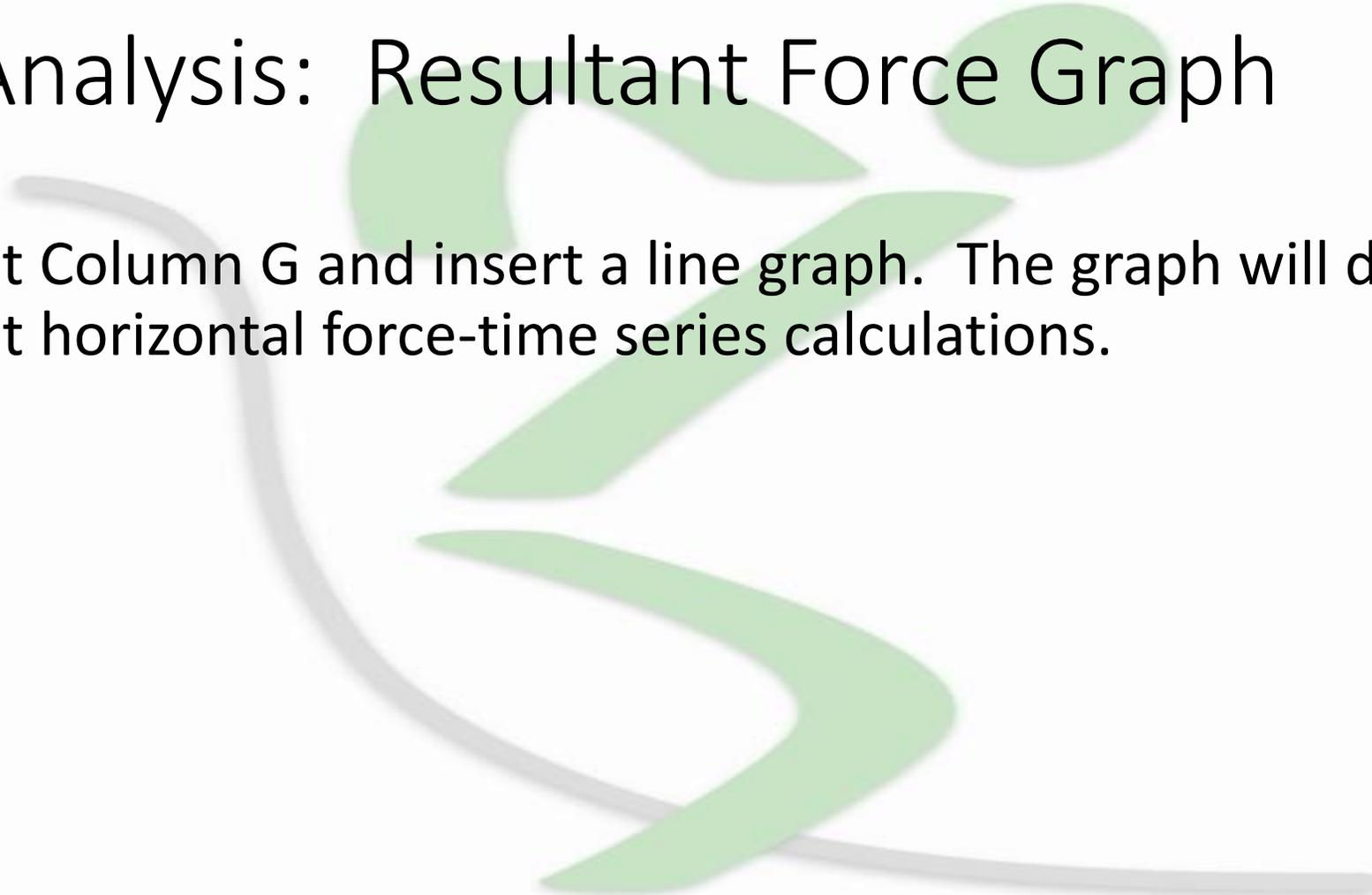
Data Analysis

- Open AccuPower Software, icon found on the desktop.
- Use File>Open and navigate to the folder for this lab (desktop) and open the file Subject 1.
 - Locate the Resultant graph panel tab above the graph.
 - Locate the Time series data for XY Resultant.
 - Locate the Peak resultant force in the AccuPower Graph, and in your manual calculations. The values should be identical.

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Data Analysis: Resultant Force Graph

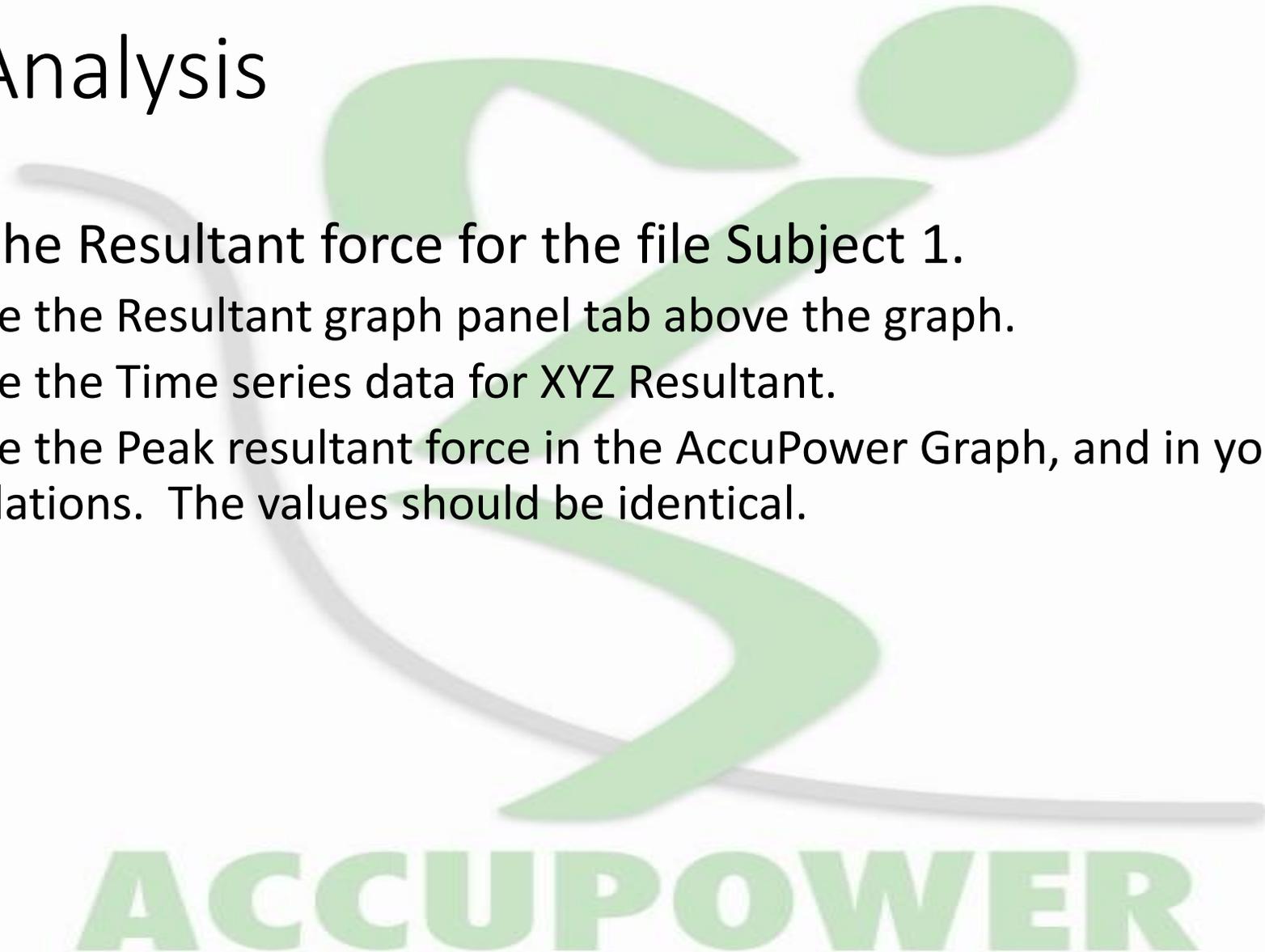
- Highlight Column G and insert a line graph. The graph will display the resultant horizontal force-time series calculations.



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Data Analysis

- Locate the Resultant force for the file Subject 1.
 - Locate the Resultant graph panel tab above the graph.
 - Locate the Time series data for XYZ Resultant.
 - Locate the Peak resultant force in the AccuPower Graph, and in your manual calculations. The values should be identical.



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Data Analysis

- You will note in column I, we have a column header “Res Vxy”. In this column, we will calculate resultant horizontal velocity.
- The equation for calculating resultant velocity is based from the Second Law, $F=ma$, rearranged to $F\Delta t = m\Delta v$. To do so with Excel, type in the following equation into Cell I10:
 - `=I9+((F10)/(200*I6))`.
- Proceed to fill column F with the same calculation through row 438, which is the point of takeoff.

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Data Analysis

- Column J is set aside for calculating vertical velocity, V_z . The equation for calculating resultant velocity is based from the Second Law, $F=ma$, rearranged to $F \Delta t = m \Delta v$.
- To do so with Excel, type in the following equation into Cell J9:
 - `=J9+((D10)/(200*I6))`. The answer will be vertical velocity for that instance in time.
- Proceed to fill column F with the same calculation through row 438, which is the point of takeoff.

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Data Analysis

- You will note in column K, we have a column header “Res Vxyz”. In this column, we will calculate resultant velocity. The equation for calculating resultant force is $= \sqrt{V_{xy}^2 + V_z^2}$.
- To do so with Excel, type in the following equation into Cell F9:
 - =sqrt((I10*I10)+(J10*J10)). The answer will be the resultant velocity for that instance in time.
- Proceed to fill column F with the same calculation through row 438, which is the point of takeoff.

ACCUPOWER

Data Analysis

- Highlight Column I and insert a graph. The graph will display the resultant horizontal velocity-time series calculations.
- Open AccuPower Software, icon found on the desktop. Use File>Open and navigate to the folder for this lab (desktop) and open the file Subject 1.
 - Locate the velocity graph panel tab above the graph.
 - Locate the Time series data for XY Resultant.
 - Locate the Peak XY Velocity in the AccuPower Graph, and in your manual calculations. The values should be identical.

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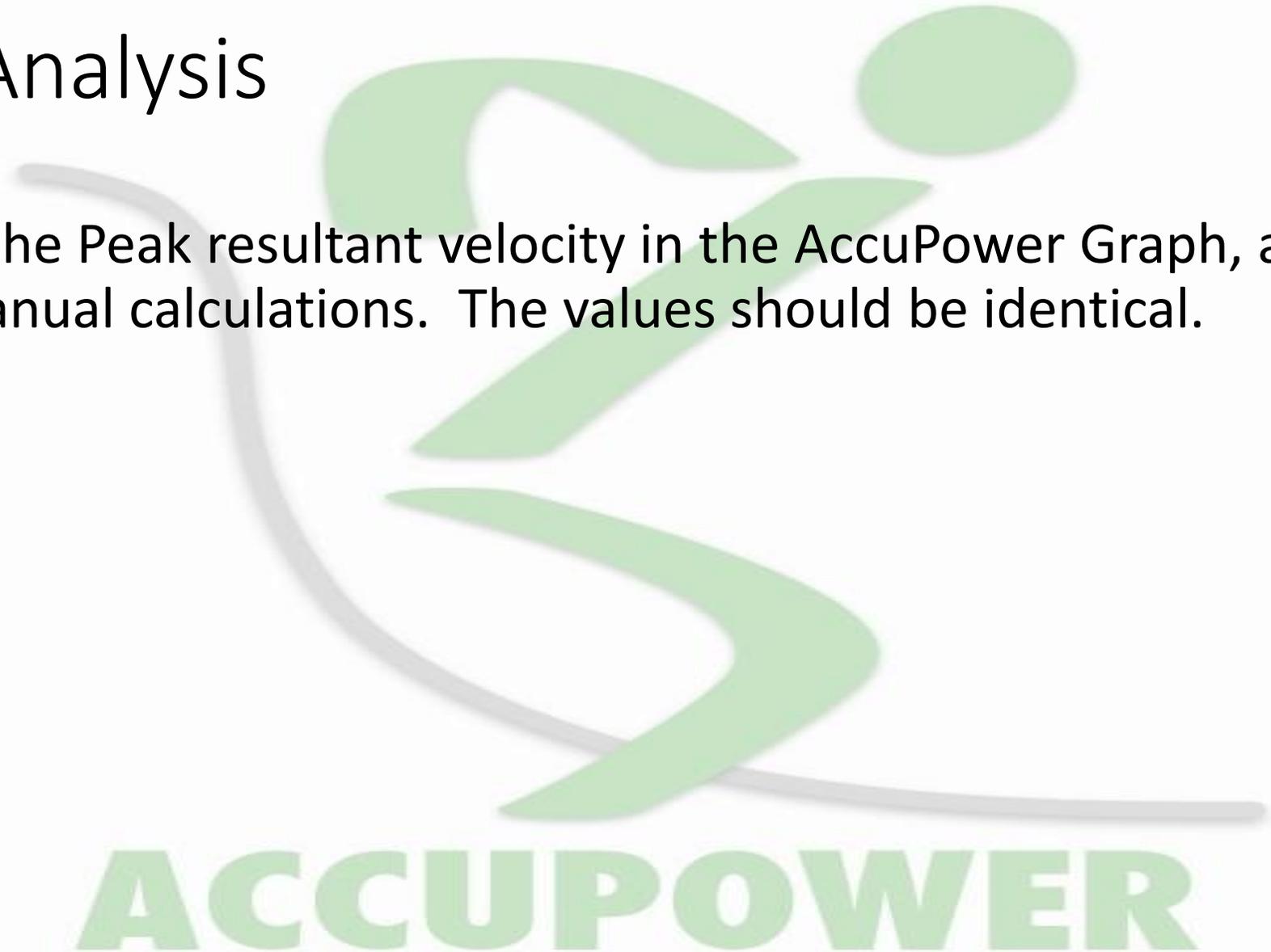
Data Analysis

- Highlight Column K and insert a graph. The graph will display the resultant velocity-time series calculations.
- Open AccuPower Software, icon found on the desktop. Use File>Open and navigate to the folder for this lab (desktop) and open the file Subject 1.
 - Locate the Velocity graph panel tab above the graph.
 - Locate the Time series data for XYZ Resultant.

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Data Analysis

- Locate the Peak resultant velocity in the AccuPower Graph, and in your manual calculations. The values should be identical.



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