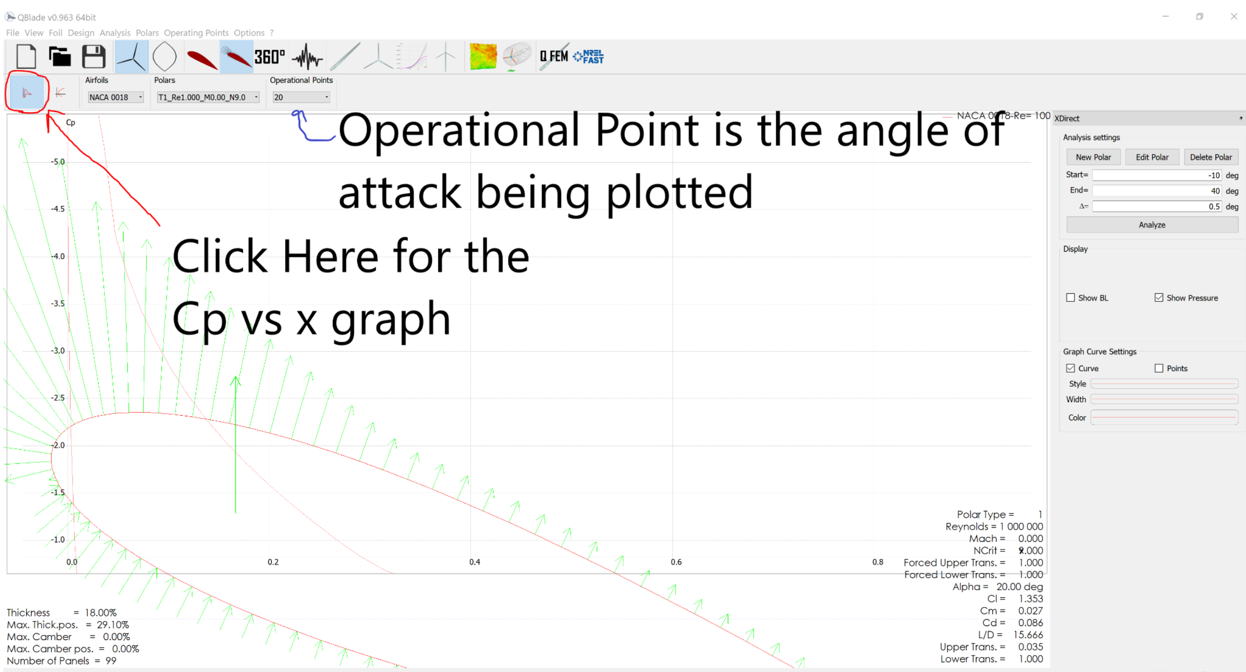
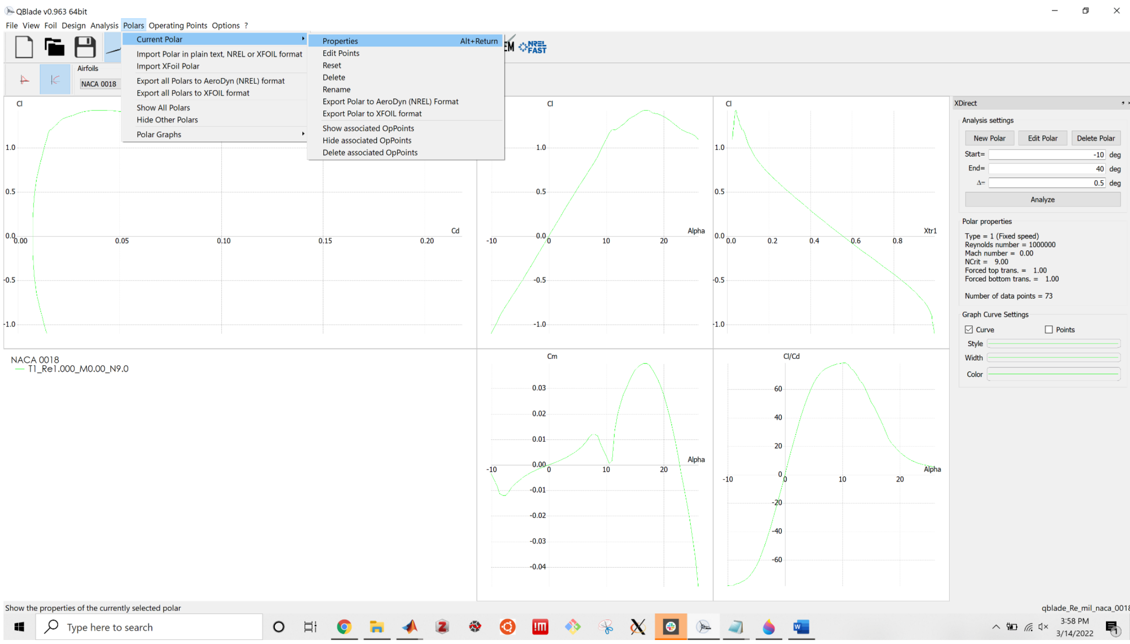
<u>Some Lab 4 Clarifications from Dario</u>

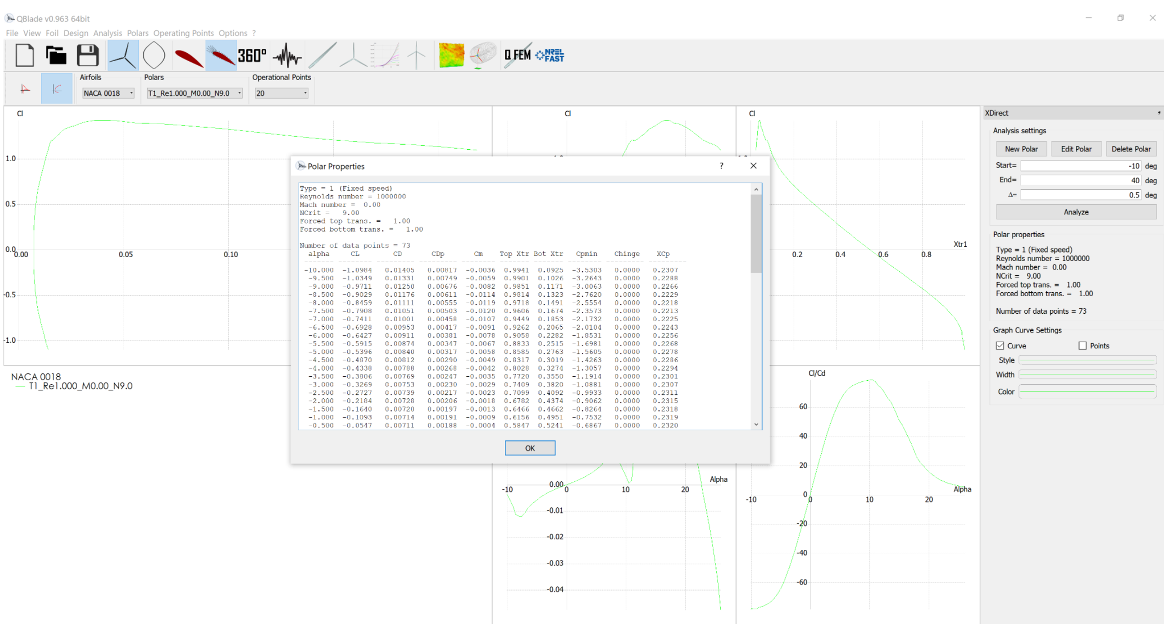
- **Please start the analysis for this lab earlier than the day or two before this lab is due! That way you can ask for help from the AI's in case you get stuck**
- When we say Plot Cp , we mean Plot Cp versus x (like what is shown in QBlade)
    - so is Cp at each pressure tap location experimentally
    - x here is the dimensionless horizontal length (so it goes between 0 and 1 in QBlade, to get the comparable parameter from experimental data divide the x position of your pressure tap by the chord length)
    - When saving the data from QBlade, it will save it as two columns of data, one is x and one is Cp
        - the x column will either go from 0 -> 1 and back to -> 0, or from 1 -> 0 and back to -> 1
        - Be sure to check the data against the Cp plot in Qblade to see if the data goes from front to back or back to front, and if it goes over the top of the airfoil first or the bottom of the airfoil first!
- Where to find Cp graph in Qblade
    - go to View -> Oppoint View
    - To save the data, right click the graph
        - Cp Graph -> export graph
            - SAVE AS A TXT FILE
                - the CSV format does not save things well, makes it hard to read the data, so save as a txt file



- Where to find Cd/Cl data in Qblade
    - go to Polars->Current Polars -> Properties

- copy paste this text into a txt file and you have all the data you need to make the Cl vs alpha and Cd versus alpha plots (Dario recommends this as the easiest way to export all the data you need for the Cl, Cd plots)
    - You only need the Alpha, Cl and Cd columns from this data, you can ignore the rest
- Alternatively, you could also right click on the plot you want the data of and click export graph
    - this will save only the data used for that plot, for example only Cl and alpha





- Some pointers in integrating along the airfoil to get force
    - F = integral (P dA)
    - So basically, you want to approximate this integral numerically
        - which boils down to approximating the area element dA in this integral, and multiplying it by the pressure at that point (or something more accurate like using the trapezoidal rule), which gives the force magnitude F, then multiplying F by the unit surface normals [xn, yn] to get the force as a vector, [Fx, Fy]
            - Fy is the lift component of the force, Fx is the drag component of the force
        - This is done for each pressure tap on the top and bottom of the airfoil, then added together to find the total lift and total drag
    - NACA airfoil geometries are parametrized, so if you know where you are along it in x (the horizontal length from the leading edge), you can find the vertical position of the airfoil at that point x, i.e. there is a relationship between airfoil thickness t and x, t = t(x)
        - **Equation for a symmetrical 4-digit NACA airfoil** [edit]

          The formula for the shape of a NACA 00xx foil, with "xx" being replaced by the percentage of thickness to chord, is[4]

          $$y_t = 5t\left[0.2969\sqrt{x} - 0.1260x - 0.3516x^2 + 0.2843x^3 - 0.1015x^4\right],$$ [5][6]

          where:

          x is the position along the chord from 0 to 1.00 (0 to 100%),

          y_t is the half thickness at a given value of *x* (centerline to surface),

          t is the maximum thickness as a fraction of the chord (so *t* gives the last two digits in the NACA 4-digit denomination divided by 100).
        - https://en.wikipedia.org/wiki/NACA_airfoil#Equation_for_a_symmetrical_4-digit_NACA_airfoil
        - You can use this to better approximate the area dA, by getting a lot of small dx intervals and finding the corresponding dy intervals
    - so you can use this to, given two adjacent (x,y) positions of two taps, get the dl (arc length) btwn them by getting a bunch of points in between these two positions and adding up ((x_i+1 - x_i)^2 + (y_i+1 - y_i)^2) btwn them to get dl
        - dA = dl * s
        - where s is the span of the airfoil (given in lab manual as s = 47cm)