

Turbulent Pipe Flow (LES) - Verification & Validation

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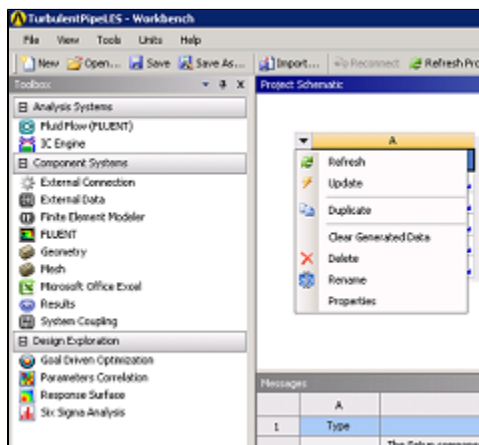
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Verification & Validation

In order to verify the LES solution to the turbulent pipe flow problem, we will compare it against the solution obtained using standard k-e model.

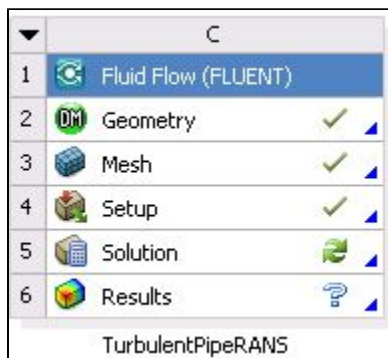
Turbulent Pipe with k-e model

In the [Workbench Project Page](#), left-click on the downward pointing arrow on the top-left corner of the [TurbulentPipeLES](#) project and select [Duplicate](#) from the drop down menu as shown in the figure below.

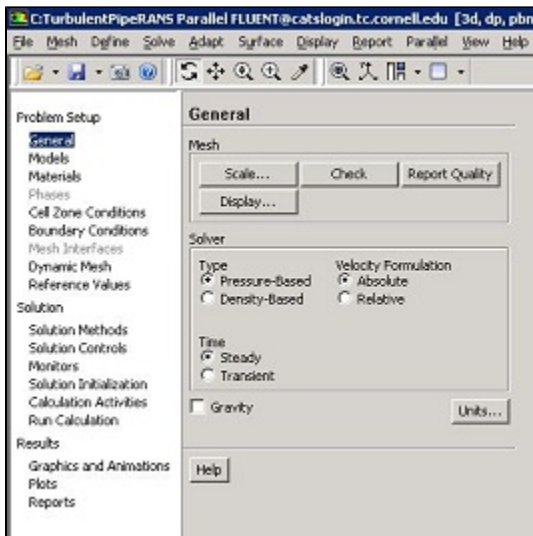


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A new project will be created. Rename this new project as [TurbulentPipeRANS](#) as shown in figure below.

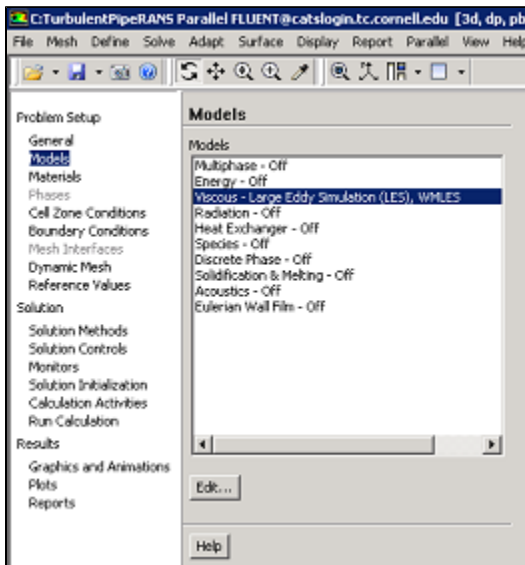


Next, double click on the [Solution](#) cell of the [TurbulentPipeRANS](#) project. This will launch the FLUENT solver. Here we will change the viscosity model to k-e model. In the FLUENT window, click on [General](#) tab on the left hand side pane. Choose [Steady](#) for [Time](#). Click [OK](#) for the pop-up warning.



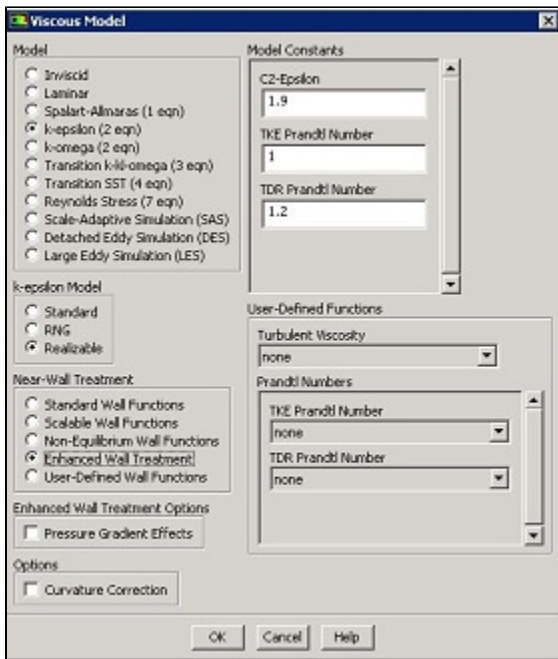
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Next click on **Models>Viscous** on the left hand side pane as shown below. Choose **Edit...**



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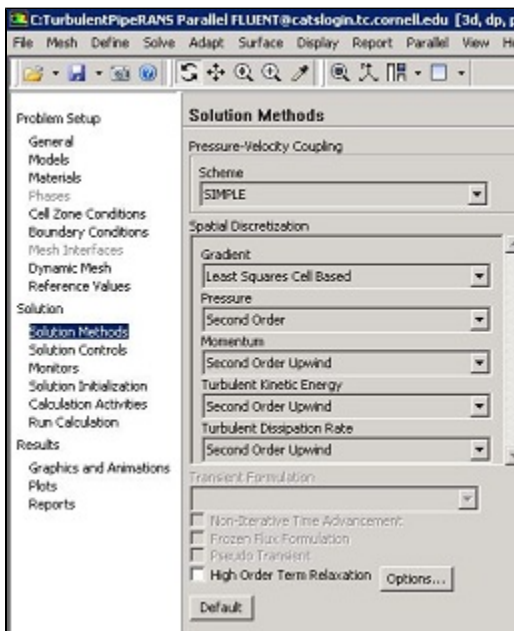
In the **Viscous Model** window, choose **k-epsilon (2 eqn)** for **Model**. Choose **Realizable** for **k-epsilon Model**. Choose **Enhanced Wall Treatment** for **Near-Wall Treatment**. Click **OK** as shown in the figure below.



[Higher Resolution Image](#)

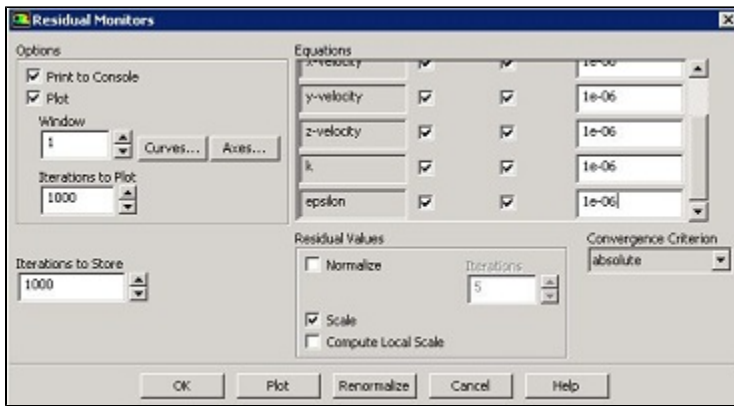
Click on **Boundary Conditions** tab on the left hand side pane. Choose **Outlet** and click **Edit...** Change the **Turbulence Specification Method** to **Intensity and Hydraulic Diameter**. Set **Backflow Turbulent Intensity** to **10%** and **Backflow Hydraulic Diameter** to **0.0127m**. Click **OK**.

Next, click on **Solution Methods** tab on the left hand side pane. Choose **Second Order Upwind** for **Turbulent Kinetic Energy** and **Turbulent Dissipation Rate**.



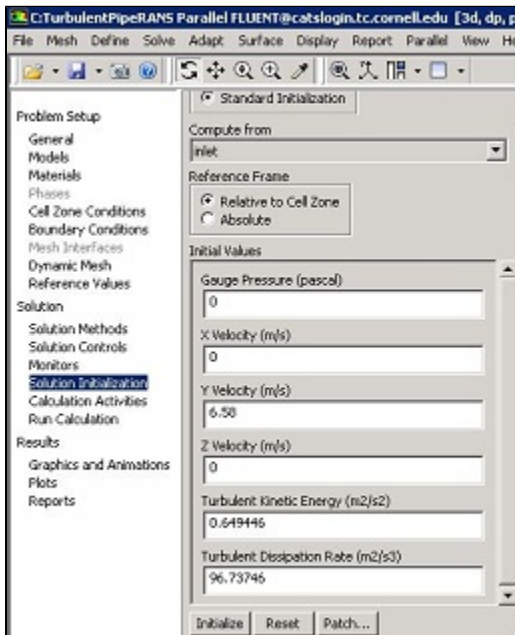
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Click on **Monitors > Residual** and click **Edit...** Set **1e-06** for **k** and **epsilon**. In order to get faster convergence, choose **1e-05** for **continuity** and click **OK**.



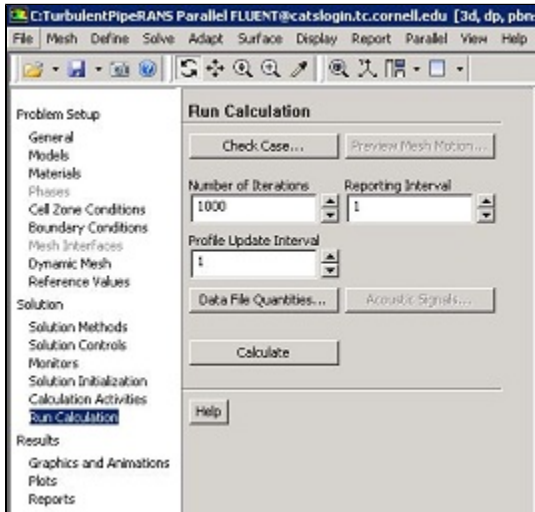
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Click on **Solution Initialization** and click **Compute from** and choose **inlet**. Click **initialize** as shown below.



[Higher Resolution Image](#)

Click on **Run Calculation** and set **Number of Iterations** to **1000**. Click **Calculate** as shown below.

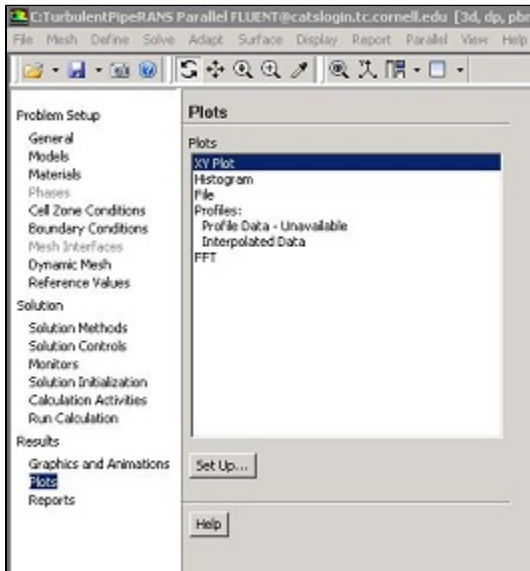


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The solution converges in about 600 iterations.

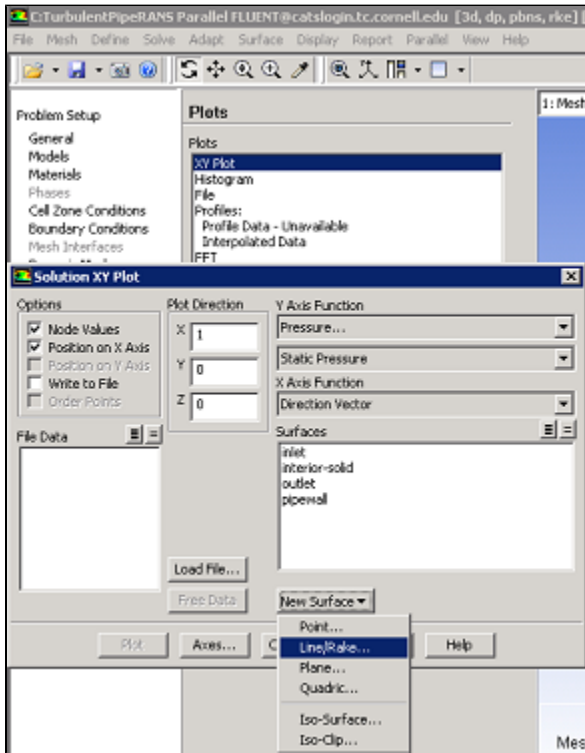
Create Line

Click on **Plots > XY Plot > Set Up...** as shown below.



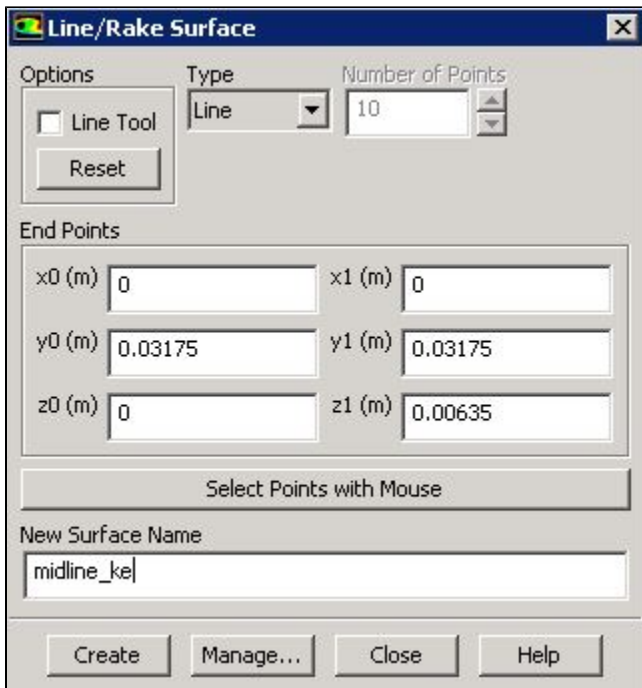
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In the **Solution XY Plot**, choose **New Surface > Line/Rake...** as shown below.

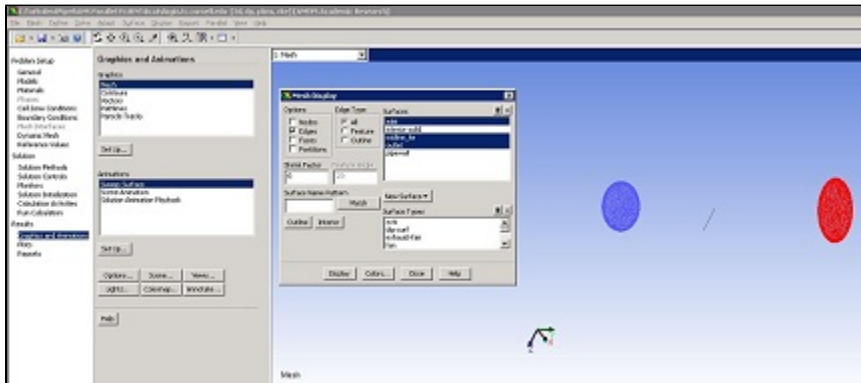


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Choose the coordinates of the two points that define the line as below and name the line as **midline_ke** and click **Create** and **Close** the window.

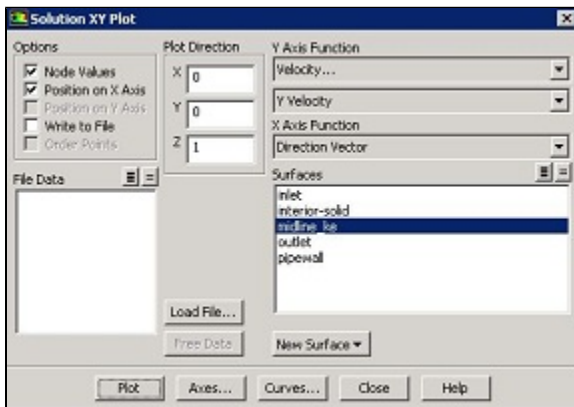


The line can be viewed by clicking **Graphics and Animations > Mesh > Set Up....**

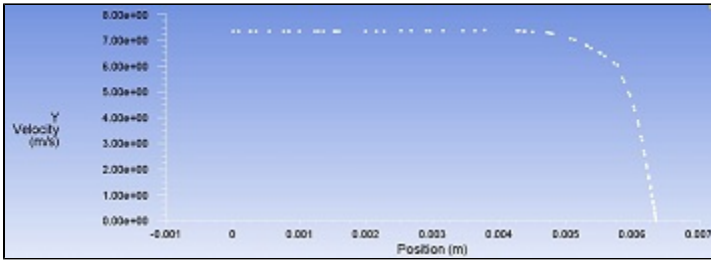


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Go back to the **Solution XY Plot** window by clicking **Plots > XY Plot > Set Up....** In this window, choose **Velocity...** and **Y Velocity** for **Y-Axis Function**. Also, choose **0, 0, 1** as the **Plot Direction**. Finally, choose **midline_ke** under **Surfaces**, and click **Plot**.



[Higher Resolution Image](#)



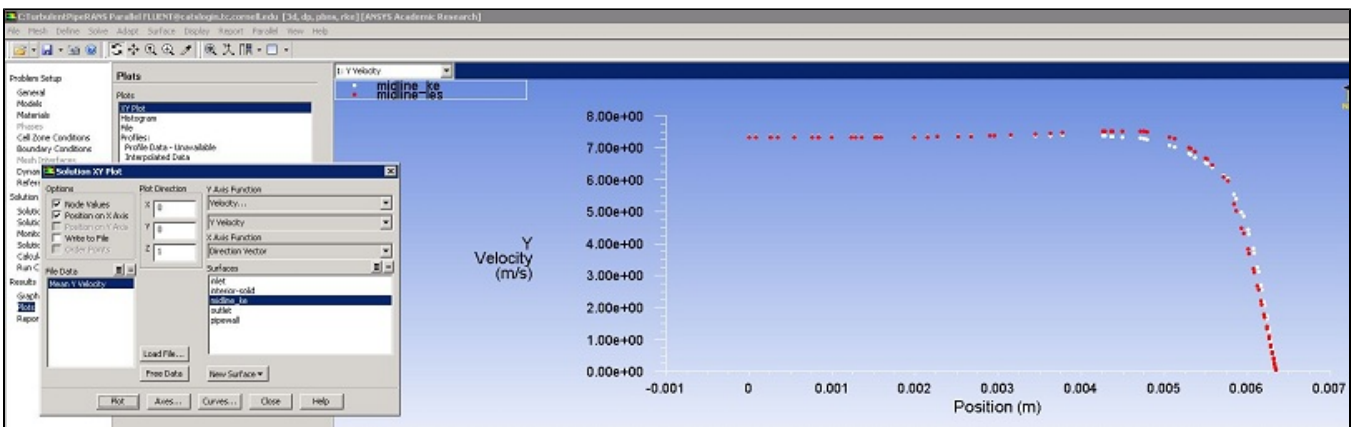
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To compare the solution from LES simulation with that from the k-e model, click **Load File...** in the **Solution XY Plot** and choose the saved file **MeanYVel_**



LES.xy from the previous section as shown in the figure below.
[Click Here for Higher Resolution](#)

In the **Solution XY Plot** select **Mean Y Velocity** under **File Data** and click **Plot**. The figure below shows the comparison of the mean Y velocity from k-e and LES simulations, both the results are very close which validates the solution procedure for the LES simulation.



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