

# PSAT Training

## Part 04A

# How to Use PSAT: Define Simulation

Aymeric Rousseau, Phil Sharer,  
Sylvain Pagerit

## ***Argonne National Laboratory***



Office of Science  
U.S. Department of Energy

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# Outline

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- **Launch PSAT**
- **Define the vehicle**
- **Select the type of simulation**
- **Run the simulation**
- **Model building**



## ***2 – Launch PSAT***

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- **Map the network drive**
- **Launch PSAT**





# **3 – Define the Vehicle**

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- **Select the Drivetrain configuration**
- **Define Component Characteristics**
- **View Component Characteristics**
- **Save your choices**
- **Select the parameters to be monitored**

# Select the Drivetrain Configuration

The screenshot displays the PSAT v6.0 - Powertrain System Analysis toolkit interface. The main window is titled "Vehicle File: Configuration: par\_2wd\_p2\_au". The interface is divided into several sections:

- Configuration List:** A table showing available configurations. A mouse cursor is pointing at the "par\_2wd\_p2\_au" entry.
- Configuration Tree:** A hierarchical tree view on the left showing folders for "Conventional", "Fuel Cell Only", "Electric", "Parallel Hybrid", "2 wheel drive", "4 wheel drive", and "2x2 wheel drive". Under "2 wheel drive", there are sub-folders for "dm: Manual Transmission" and "au: Automatic Transmission".
- Options:** A section on the left with checkboxes for "Motor Controller", "Power Converter", and "Torque Coupling".
- Drivetrain Diagram:** A schematic diagram at the bottom showing the flow of power from the "Starter" and "Engine" through the "Mechanical Accessory", "Clutch", "Gearbox", "Differential", "Wheel", and "Vehicle". It also includes a "Battery" connected to a "Motor" and a "DC/DC" converter, which is connected to an "Electrical Accessory".

A green arrow points from the "par\_2wd\_p2\_au" entry in the Configuration List to the "Mechanical Accessory" component in the drivetrain diagram. A text overlay "Double-click / Drag&drop" is positioned above the arrow.

Configuration List	Description
par_2wd_p2_au	2 wheel-drive pre-transmission parallel configuration with automatic transmission
par_2wd_p2_au_2ess	2 wheel-drive pre-transmission parallel configuration with automatic transmission and 2 energy storage systems

# Select the Drivetrain Configuration

The screenshot displays the PSAT v6.0 - Powertrain System Analysis toolkit interface. The main window shows a tree view on the left under 'Configuration' with folders for Conventional, Fuel Cell Only, Electric, and Parallel Hybrid. The 'Parallel Hybrid' folder is expanded to show '2 wheel drive' and '4 wheel drive' options. The '2 wheel drive' folder is further expanded to show 'dm: Manual Transmission' and 'au: Automatic Transmission'. The 'au: Automatic Transmission' folder is expanded to show 'Starter\_motor\_alternator', 'Pre-transmission', 'Post-transmission', and 'Motor wheels'. The '4 wheel drive' folder is expanded to show 'ct: CVT: Continuously Variable Transmission' and '2x2 wheel drive'.

Below the tree view, there is a 'Configuration List' table with two rows:

Configuration List	Description
par_2wd_p2_au	2 wheel-drive pre-transmission parallel configuration with automatic transmission
par_2wd_p2_au_2ess	2 wheel-drive pre-transmission parallel configuration with automatic transmission and 2 energy storage systems

At the bottom of the interface, there is a diagram showing the drivetrain components. The components are arranged in a sequence: Battery, Motor, DC/DC, Electrical Accessory, Torque Coupling, Clutch, Gearbox, Differential, Wheel, and Vehicle. The 'Torque Coupling' component is highlighted with a red circle, and a green arrow points to it from the text 'Select the options'.

Select the options

# Define Component Characteristics

PSAT v6.0 - Powertrain System Analysis toolkit

File Simulation Setup PSAT-PRO Units Help

Simulation Import Data Data Analysis Matlab

Vehicle File: Configuration: par\_2wd\_p2\_au

1. Vehicle 2. Simulation Setup 3. Run Simulations

1. Drivetrain Configuration 2. Drivetrain Components 3. Controller / Strategy 4. Simulation Output

Component / Model / Technology	Initialization File	Description	Scaling File	Description
Electrical Accessory	eng_ci_10800_246_Cummins	Initialize the 10.8L 246kW Cummins diesel engine	eng_s_lin	Scale the engine
Engine	eng_ci_12000_321_Caterpillar_DM6006	Initialize the Caterpillar C-12 430 hp (12L, 321 kW) diesel engine		
map_hot	eng_ci_12700_330_Detroit_Diesel_S60	Initialize the Detroit Diesel Corp. Series 60 12.7L (330kW) diesel engine		
ci	eng_ci_1500_37	Initialize a 1.47L (37kW) diesel engine Data interpreted from "Inter"		
cng	eng_ci_15000_324_Caterpillar_C15	Initialize the Caterpillar C-15 (rated power: 324kW) diesel engine		
h2	eng_ci_1700_75_aclass_ANL	Initialize the Mercedes A-Class 1.7L (75kW) diesel engine Data from		
lng	eng_ci_1700_75_aclass_ANL	Initialize the Mercedes A-Class 1.7L (75kW) diesel engine Data from		
si	eng_ci_1700_75_aclass_ANL	Initialize the Mercedes A-Class 1.7L (75kW) diesel engine Data from		
neuralnet_ANL	eng_ci_1700_75_MY2	Initialize a diesel engine Data from		
	eng_ci_1800_75	Initialize a 1.8L		

Double-click / Drag&drop

Component	Model	Technology	Initialization File	Scaling File
Vehicle				
Exhaust Aftertreatment				
Power Converter: Electrical Accessory				
Electrical Accessory				
Engine	map_hot	ci	eng_ci_1700_75_aclass_ANL	
Torque Coupling: Motor Controller				

Component Parameters Initialization Parameters Scaling Parameters Building Component

Model	Technology	Initialization File	Scaling File
map_hot	ci	eng_ci_1700_75_aclass_ANL	

Remove Scaling

Calculation File(s)

eng\_calculation

Add Calculation File

Component Characteristic Graphs

Engine Hot Efficiency Map... (Torque) - Points

BSFC Hot Map (Torque) - Points

Fuel Hot Map (Torque) - Points

Engine Hot Efficiency Ma...

Vehicle Mass

Total Component Mass: 189

Mass of Fuel:

Cargo Mass:

Vehicle Mass: 239

Unit: kg

# Perform Parametric Study

The screenshot displays the PSAT v6.0 - Powertrain System Analysis toolkit interface. The main window is titled "Vehicle File: Configuration: par\_2wd\_p2\_au". The interface is divided into several sections:

- Component / Model / Technology Table:** Lists various engine models and their descriptions. For example, "eng\_ci\_1700\_75\_aclass\_paper" is described as "Initialize the Mercedes A-Class 1.7L (75KW) diesel engine Data fr".
- Component List:** A tree view showing the vehicle hierarchy, including "Final Drive", "Wheel Axle", "Vehicle", "Exhaust Aftertreatment", "Power Converter: Electrical Accessory", "Electrical Accessory", "Engine" (selected), and "Torque Coupling: Motor Controller".
- Parameter Table:** A table for "Initialization Parameters" with columns for "Parameter Name", "Default", "Value 1", "Value 2", and "Unit". The "eng.init.inertia" row is highlighted with a red circle, showing a default value of 0.11, and two parametric values of 0.13 and 0.15 with a unit of kg.m^2.
- Vehicle Mass Summary:** A section at the bottom showing "Total Component Mass" as 189, "Mass of Fuel" as an empty field, "Cargo Mass" as an empty field, and "Vehicle Mass" as 239. The unit is specified as "kg".

Multiple Values / Parametric Study Type:  Individual Parameters  All Combinations

Parametric studies are performed when more than one parameter is entered

# Define the Vehicle Mass

The test mass can be overwritten

If so, it appears beside the vehicle mass

Parameter Name	Default	Value 1	Value 2	Value 3	Value 4	Unit	Description
veh.init.frontal_area	1.8					m2	
veh.init.coeff_drag	0.38						
veh.init.cg_height	0.5						
veh.init.ratio_weight_front	0.6						
veh.init.ratio_weight_rear	0.4						
veh.init.mass	1683	1600				kg	

Vehicle Mass	Total Component Mass	Mass of Fuel	Cargo Mass	Vehicle Mass	Unit
1600	1490	56.781	136	1600	kg

# Select the Control Strategy

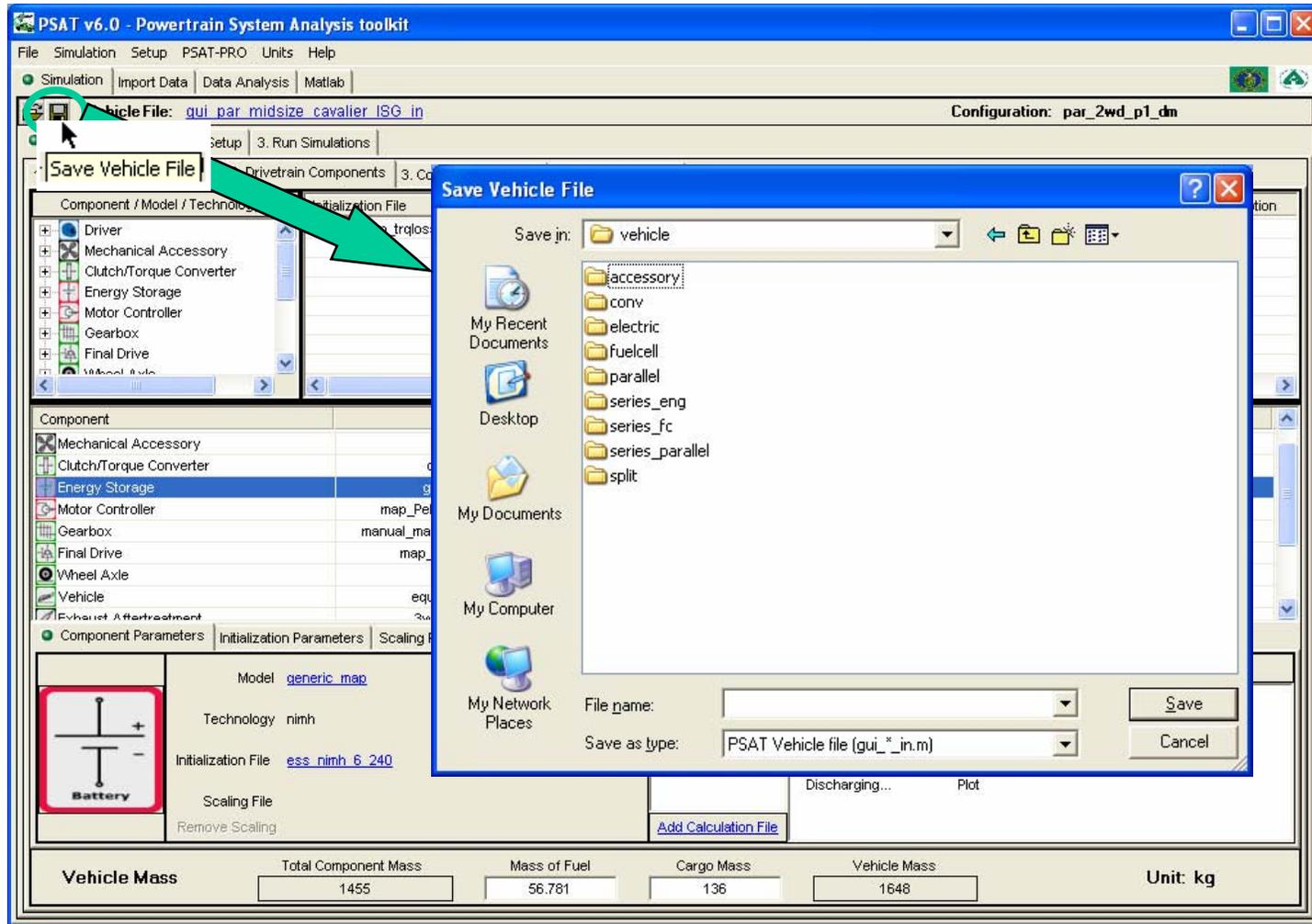
1 – Select each part of the control

- a – Propelling (when vehicle accel)
- b – Regen (when vehicle decel)
- c - Shifting

Strategy Type	Model	Initialization File
Propelling	p_par_1mc_conso_start_alter	p_par_1mc_conso_start_alter
Braking	b_par_pretx_1axle_1mc	b_par_pretx_1axle_1mc
Shifting	s_dm_veh_accel_speed	tx_shift_n_gen

Parameter	Default	Value 1	Value 2	Value 3	Value 4	Unit	Description
eng_time_min_stay_on	2					s	
eng_time_min_stay_off	2					s	
eng_soc_ess_below_turn_on	0.2					[0,1]	
eng_soc_ess_above_turn_off	0.6					[0,1]	
ess_soc_target	0.65					[0,1]	
ess_soc_charge_intermediate_pwr	0.45					[0,1]	
ess_soc_discharge_intermediate_pwr	0.8					[0,1]	
eng_soc_ess_below_turn_on	0.2					[0,1]	
ess_percent_pwr_charged	0.5					[0,1]	
ess_percent_pwr_discharged	0.5					[0,1]	

# Save the Modified Vehicle



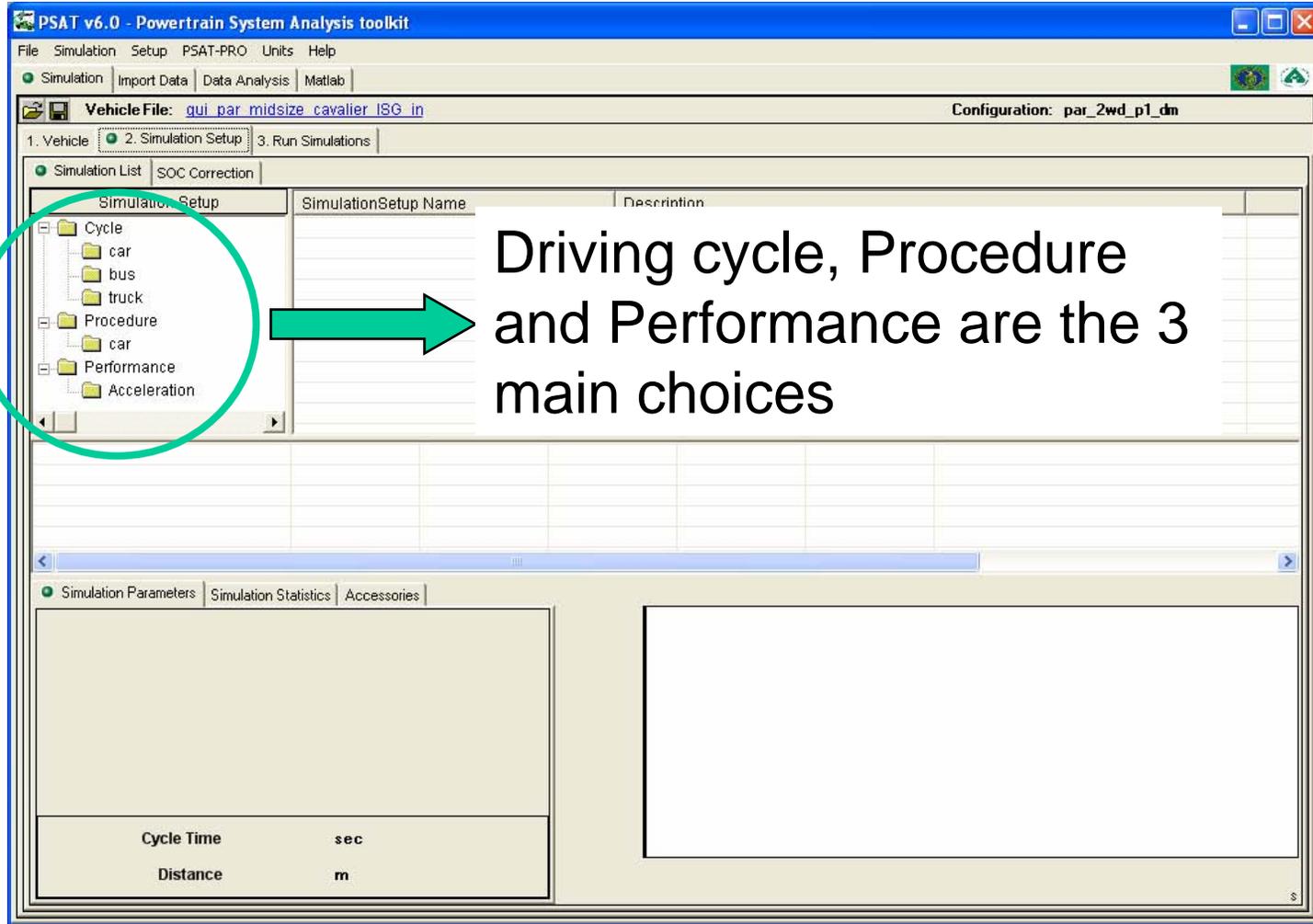
# ***4 – Select the Type of Simulation***

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- **Select a driving cycle**
- **Run multi-cycle simulation**
- **Run procedure**
- **Run road load match/performance**
- **SOC correction**



# Simulation Setup



PSAT v6.0 - Powertrain System Analysis toolkit

File Simulation Setup PSAT-PRO Units Help

Simulation Import Data Data Analysis Matlab

Vehicle File: [gui\\_par\\_midsize\\_cavalier\\_ISG\\_in](#) Configuration: [par\\_2wd\\_p1\\_dm](#)

1. Vehicle 2. Simulation Setup 3. Run Simulations

Simulation List SOC Correction

Simulation Setup	SimulationSetup Name	Description
Cycle		
car		
bus		
truck		
Procedure		
car		
Performance		
Acceleration		

Driving cycle, Procedure and Performance are the 3 main choices

Simulation Parameters Simulation Statistics Accessories

Cycle Time	sec
Distance	m

# Select a Driving Cycle

The screenshot shows the PSAT v6.0 - Powertrain System Analysis toolkit interface. The 'Simulation Setup' tab is active, displaying a list of simulation setups. A green arrow points to the 'UDDS' entry, with the text 'Double-click / Drag&drop' next to it. Below the list is a table with columns: Cycle, repeat #, Scale, Grade, Steady Speed, Std Spd Durat..., and Description.

Cycle	repeat #	Scale	Grade	Steady Speed	Std Spd Durat...	Description
UDDS	1	1	0			US EPA - Urban Dynamometer Driving Schedule (UDDS)

At the bottom of the interface, there are two empty boxes for simulation parameters. The left box contains the following text:

Cycle Time	sec
Distance	m

# Run Procedure

1 – Select Procedure

The screenshot displays the PSAT v6.0 - Powertrain System Analysis toolkit interface. The main window shows a configuration for 'par\_2wd\_p1\_dm'. A table lists simulation setups, with 'FTP Procedure (City)' selected. A table below shows cycle details for 'FTP Procedure (City)'. A simulation plot shows 'Cycle Speed (mile/h)' over time, with a legend indicating 'Engine ON' is 1. A summary box at the bottom left shows 'Cycle Time 3344 sec' and 'Distance 14.8993 mile'.

SimulationSetup Name	Description
FTP Procedure (City)	
HWY Procedure (Highway)	
City unadjusted Proced...	

Cycle	repeat #	Scale	Grade	Steady Speed	Std Spd Durat...	Description
US06	1	1	0			US EPA - Urban Dynamometer Driving Schedule (U...
Procedure						
FTP Procedure (City)						

Simulation plot

Cycle Speed (mile/h) 0  
Cycle Grade 0  
Engine ON 1

Cycle Time 3344 sec  
Distance 14.8993 mile

2 – Double-click or drag and drop

3 - Select cycle to view vehicle speed trace

# Run Acceleration

PSAT v6.0 - Powertrain System Analysis toolkit

File Simulation Setup PSAT-PRO Units Help

Simulation Import Data Data Analysis Matlab

Vehicle File: [qui\\_par\\_midsize\\_cavalier\\_ISG\\_in](#) Configuration: [par\\_2wd\\_p1\\_dm](#)

1. Vehicle 2. Simulation Setup 3. Run Simulations

Simulation List SOC Correction

Simulation Setup

truck  
Procedure  
car  
Performance  
Acceleration

Simulation Setup Name  
Speed  
Time  
Distance

How long does it takes to reach a desired speed?

Cycle	repeat #	Scale	Grade	Steady Speed	Std Spd Durat...	Description
UDDS	1	1	0			US EPA - Urban Dynamometer Driving Schedule (U
<b>Procedure</b>						
FTP Procedure (City)						
<b>Acceleration Test</b>						
	Shifting Time					
	0.2					
<b>Speed</b>						
	From	To	Unit			
Launch Speed Of	0.0	55.9	mile/h			

Simulation Parameters Simulation Statistics Accessories

Speed From 0.0 To 55.9 mile/h

Cycle Time 80 sec  
Distance 3.3088 mile

Simulation plot

Cycle Speed [mile/h] 0  
Cycle Grade 0  
Engine ON 1

# Run Gradeability

PSAT v6.0 - Powertrain System Analysis toolkit

File Simulation Setup PSAT-PRO Units Help

Simulation Import Data Data Analysis Matlab

Vehicle File: [qui\\_par\\_midsize\\_cavalier\\_ISG\\_in](#) Configuration: [par\\_2wd\\_p1\\_dm](#)

1. Vehicle 2. Simulation Setup 3. Run Simulations

Simulation List SOC Correction

Simulation Setup

- truck
- Procedure
  - car
  - Performance
  - Acceleration

Acceleration  
Gradeability Test  
Coast Down

What is the maximum grade at a desired vehicle speed?

Cycle	repeat #	Scale	Grade	Steady Speed	Std Spd Durat...	Description
UDDS	1	1	0			US EPA - Urban Dynamometer Driving Schedule (U
<b>Procedure</b>						
FTP Procedure (City)						
<b>Gradeability Test</b>						
Grade at	Speed	Unit				
	65.0	mile/h				

Simulation Parameters Simulation Statistics Accessories

Gradeability Speed 65.0 mile/h

Cycle Time 80 sec  
Distance 1.0737 mile

Simulation plot

Time (s)	Cycle Speed (m/h)	Cycle Grade	Engine ON
0	0	0	1
14	0	0	1
20	65	0	1
28	65	0	1
42	65	0	1
56	65	0	1
70	65	0	1

# Run Coastdown

Use to define the target ABC coefficient of the dynamometer or compare with the ones provided

Cycle	repeat #	Scale	Units	Steady Speed	Std Spd Durat...	Description
UDDS	1	1	0			US EPA - Urban Dynamometer Driving Schedule (U
<b>Procedure</b>						
FTP Procedure (City)						
<b>Coast Down</b>	<b>Launch Speed</b>	<b>Unit</b>				
Launch Speed Of	60.0	mile/h				

Simulation Parameters

Launch Speed: 60.0 mile/h

Cycle Time: 300 sec  
Distance: 4.6578 mile

Simulation plot

Parameter	Value
Cycle Speed [mile/h]	0
Cycle Grade	0
Engine ON	1

# Run SOC Correction

PSAT v6.0 - Powertrain System Analysis toolkit

File Simulation Setup PSAT-PRO Units Help

Simulation Import Data Data Analysis Matlab

Vehicle File: qui\_par\_midsize\_cavalier\_18G\_in Configuration: par\_2wd\_p1\_dm

1. Vehicle 2. Simulation Setup 3. Run Simulations

Simulation List: SOC Correction

Enable SOC Correction

SOC Correction Algorithms	Variable
<input checked="" type="checkbox"/> Linear Approximation	ess.init_soc_init
<input checked="" type="checkbox"/> Dichotomy	
<input checked="" type="checkbox"/> Energy Storage	

Algorithm: Dichotomy

Variable: ess.init\_soc\_init

Number of Iteration: 15

Tolerance: 0.5 %

Dichotomy case: the value of the initial variable is modified until  $SOC_{init} = SOC_{final} \pm \text{Tolerance}$

Fuel Economy

Δ SOC

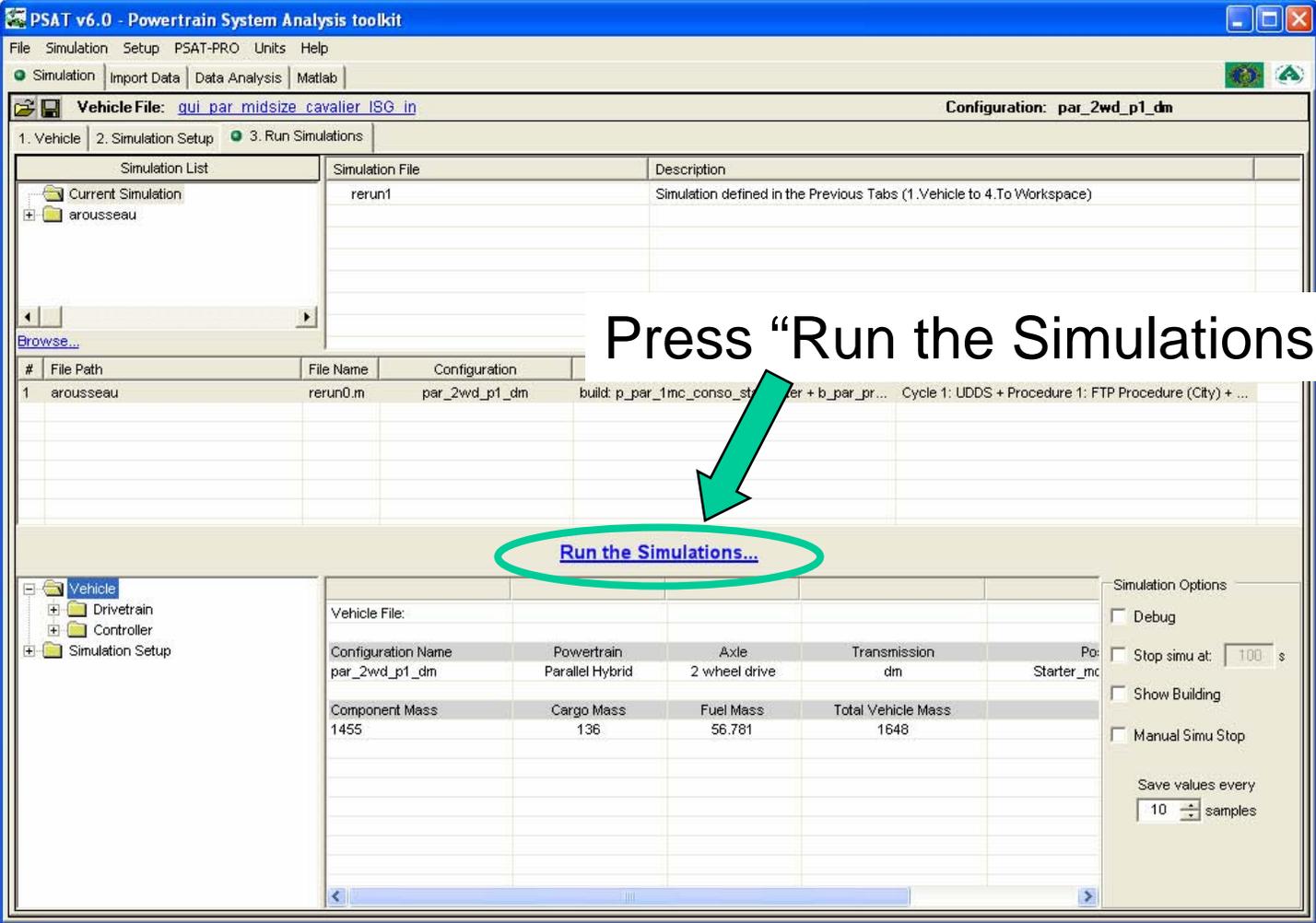
Dichotomy

# ***5 – Run the Simulation***

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- **Select the rerun file**
- **Chose options**
- **Select the solver**

# Launch the Simulation from the GUI



# 6 – *Model Building*

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- **Allows a very large number of drivetrain configurations**



