



Argonne_{LLC}



A U.S. Department of Energy laboratory managed by UChicago Argonne, LLC

PSAT Validation -

Example of Results

September, 2007

Aymeric Rousseau Argonne National Laboratory

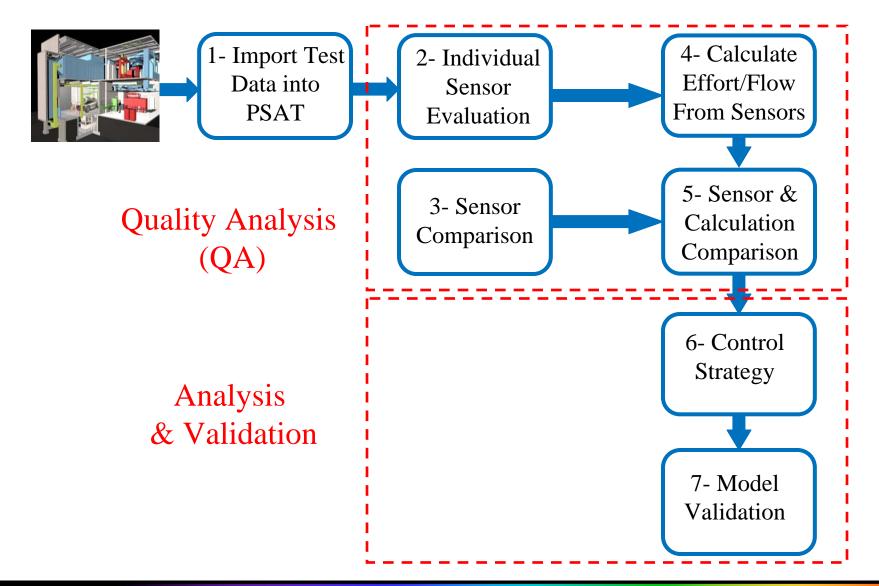




Validation Process
Conventional Vehicles
Mild Hybrids
Full Hybrids
Plug-in Hybrids



Generic Methodology: From Test to Validation

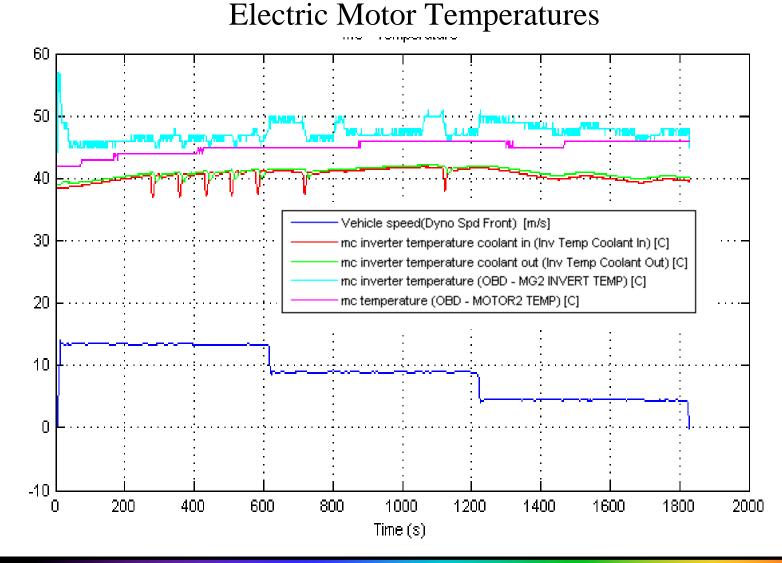




Test Data are Renamed, Rescaled and Imported into the same environment as simulation

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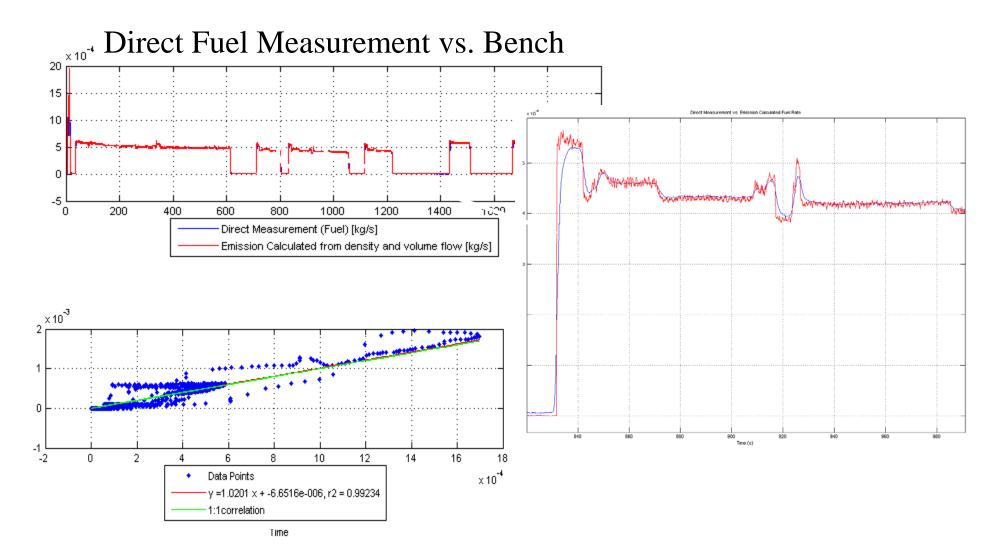
Individual Sensor are Evaluated to Find Major Issues (Range, Sign...)



2004 Prius APRF Data



Redundant Sensors are Compared





Summary Table Highlights the Main Results of the Comparison

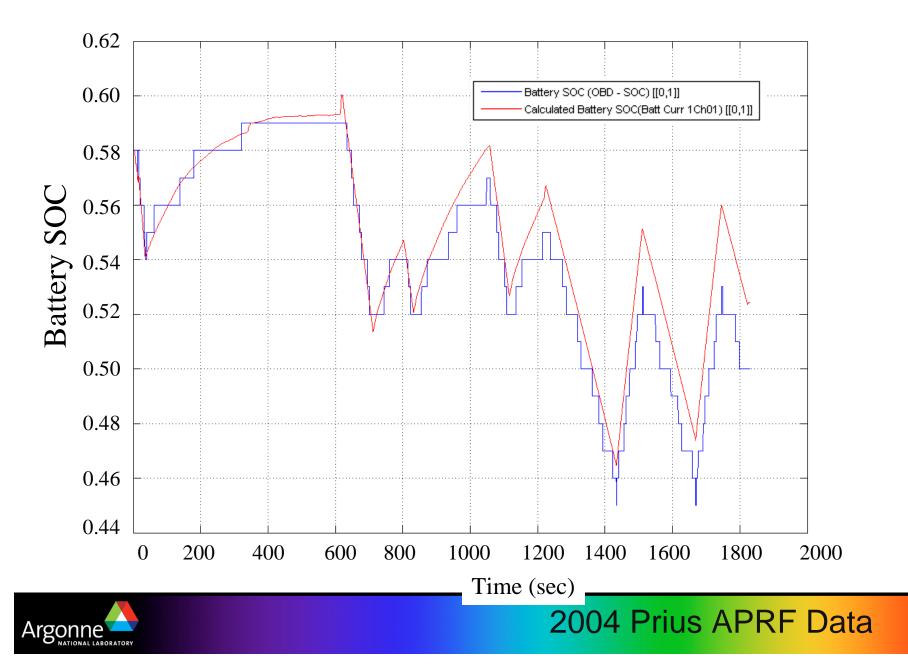
Component / Range	Compared to / Range	Absolute Difference	Relative Difference	Correlation Coefficient
Sensor(Dyno Spd Front) / [- 0.098912,13.9334] [m/s]	OBD (VEHICLE SPD) / [0,128.0917] [m/s]	71.7453 [m/s]	7.9419 [m/s]	0.99971
Sensor (Eng Spd 1Ch15) / [- 0.18268,3016.4307] [rpm]	OBD (ENGINE SPD) / [0,2976] [rpm]	20.1937 [rpm]	-0.26785 [rpm]	0.99032
	Emission Calculated from density and volume flow / [3.745e-007,0.0019567] [kg/s]	1.0226e-005 [kg/s]	-0.26594 [kg/s]	0.99234
Boost voltage in(OBD - VL) / [192,238] [volt]	Battery Voltage out(Batt_V_1Ch02) / [198.4637,244.6811] [volt]	7.1356 [volt]	0.032908 [volt]	0.98596
Sensor(Boosted_V_1Ch03) / [206.9815,506.3051] [volt]	OBD(VH) / [204,498] [volt]	3.8596 [volt]	-0.013229 [volt]	0.90283



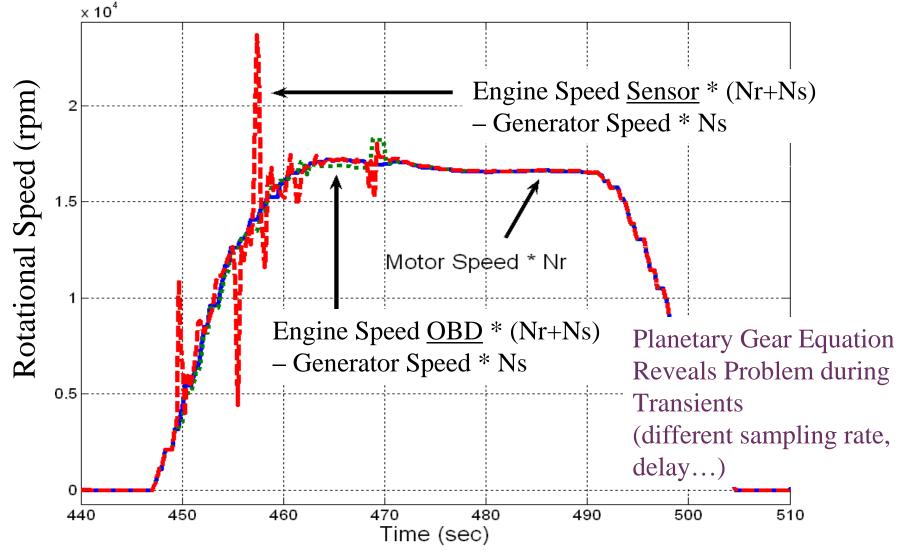
Additional Efforts/Flows are Calculated

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<pre>eng_ignition_timing_angle_test mc2_inverter_temp_coolant_out_test eng_amaifold_air_pressure_test mc2_inverter_temp_coolant_out_test eng_pwr_dmd_out_test mc2_trq_out_test eng_pwr_dmd_out_test mc2_trq_out_test eng_spd_obd_test mc2_trq_out_test eng_spd_obd_test mc2_trq_coolant_in_test eng_spd_obd_test mc_inverter_temp_coolant_out_test eng_stored_coolant_temp_out_test mc_inverter_temp_test eng_temp_coolant_in_test pc_accelec_curr_in_dc2dc_test eng_temp_oil_test pc_ess_curr_out_boost_test env_reng_ambient_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_pressvolt_test ess_temp_int_test veh_evapsys_pressvolt_test ess_temp_int_test veh_lin_spd_out_rest ess_temp_int_test veh_evapsure_test ex_eng_air_relative_hundity_dilute_test wh_brake_pressure_test ex_ex_edg_air_relative_hundity_dilute_test wh_brake_pressure_test ex_ex_edg_air_relative_hundidty_dilute_test wh_brake_pressure_test ex_edg_air_relative_hundidty_dilute_test wh_brake_pressure_test ex_edg_air_relative_hundidty_dilute_test wh_brake_pressure_test ex_end_air_relative_hundity_dilute_test wh_brake_pressure_test ex_edg_air_relative_hundity_dilute_test ex_edg_air_relative_hundity_dilute_test ex_edg_air_relative_hundity_dilute_test ex_edg_air_relative_hundity_dilute_test ex_edg_air_relative_hundity_dilute_test ex_edg_air_relative_hundity_dilute_test ex_edg_air_relative_hundity_dilute_test ex_pace_data defined_test ex_pace_data ex_pace_data ex_pace_data e</pre>				_
eng_lambda_testmc2_inverter_temp_testeng_nnifold_air_pressure_testmc2_trmp_testeng_spd_obd_testmc2_trmp_coolant_in_testeng_spd_out_testmc_inverter_temp_coolant_out_testeng_spd_out_testmc_inverter_temp_testeng_spd_out_testmc_temp_testeng_stored_coolant_temp_out_testmc_trmp_testeng_stored_coolant_temp_out_testmc_trmp_testeng_temp_anir_in_testmc_trmp_testeng_temp_coolant_out_testmc_trm_out_testeng_temp_coolant_out_testpc_accelec_curr_out_dc2dc_testeng_temp_coolant_out_testpc_ess_vurr_out_dost_testeng_temp_anbient_testpc_ess_vurr_out_dost_testenv_relative_humidity_testtime_testenv_relative_humidity_testven_evapsys_canister_closed_testess_curr_out_testven_evapsys_switch_testess_temp_int_testven_force_dyno_front_testess_temp_int_testven_force_dyno_rear_testess_temp_int_testven_force_dyno_rear_testess_temp_int_testven_force_dyno_rear_testess_temp_right_testven_tim_spd_out_rear_testess_temp_right_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_testven_tim_spd_out_rear_testess_temp_int_test				
eng_lamoda_testmc2_lnuerter_temp_testeng_manifold_air_pressure_testmc2_trq_out_testeng_spd_oud_testmc2_trq_out_testeng_spd_oud_testmc_inverter_temp_coolant_in_testeng_spd_out_testmc_inverter_temp_coolant_out_testeng_stored_coolant_temp_out_testmc_trq_in_rege_testeng_temp_air_in_testmc_trq_in_rege_testeng_temp_oolant_in_testpc_accelec_curr_in_dc2dc_testeng_temp_ool_testmc_tent_oost_testeng_temp_ool_testpc_accelec_curr_out_dc2dc_testeng_temp_ool_testtime_testeng_temp_ool_testpc_ess_curr_out_dost_testeng_temp_air_in_testpc_ess_curr_out_dc2dc_testeng_temp_oil_testvelevapsys_canister_closed_testeny_ressure_ambient_testvel_evapsys_canister_closed_testess_curr_out_testvel_evapsys_switch_testess_temp_int_testvel_evapsys_switch_testess_temp_int_testvel_force_dyno_front_testess_temp_int_testvel_fin_spd_out_testess_temp_int_testvel_fin_spd_out_testess_temp_int_testvel_fin_spd_out_testess_temp_int_testvel_fin_spd_out_testess_temp_int_testvel_temp_inside_testess_temp_int_testvel_temp_inside_testess_temp_int_testvel_temp_inside_testess_temp_int_testvel_temp_inside_testess_temp_int_testvel_temp_inside_testess_temp_out_testvel_temp_inside_testess_temp_int_testvel_temp_inside_testess_temp_int_testvel_temp_inside_teste				Г
<pre>eng_pwr_dnd_out_test nc2_tenp_test eng_pwr_dnd_out_test nc2_tenp_test eng_spd_obd_test nc_inverter_temp_coolant_in_test eng_stored_coolant_cnd_pump_status_test nc_inverter_temp_test eng_stored_coolant_value_status_test nc_tenp_test eng_temp_air_in_test nc_trq_out_test eng_temp_coolant_in_test pc_accelec_curr_in_dc2dc_test eng_temp_coolant_test pc_ess_curr_out_boost_test eng_temp_coolant_test pc_ess_curr_out_boost_test env_relative_humidity_test time_test ess_temp_int_test veh_evapsys_pressvolt_test ess_temp_int_test veh_force_dyno_rear_test ess_temp_int_test veh_force_dyno_rear_test ess_temp_int_test veh_temp_inside_test ess_temp_int_test veh_temp_inside_test ess_uet_est veh_temp_inside_test veh_temp_inside_test ess_uet_ative_humidity_dilute_test veh_temp_sure_pedal_rear_test ex_ex_ang_air_relative_humidity_dilute_test veh_tempsure_pedal_rear_test ex_ex_ang_air_relative_humidity_dilute_test veh_evapsus_entest ex_ex_ang_air_relative_humidity_dilute_test end_temp_int_est veh_temp_inside_test ex_ex_ang_air_relative_humidity_dilute_test ex_ex_ang_air_relative_humidity_dilute_test env_temp_ainside_test env_temp_int_test veh_temp_inside_test ex_pressure_test veh_temp_inside_test veh_temp_inside_test ex_pressure_test veh_temp_insi</pre>	eng_lambda_test			-
<pre>eng_spd_out_test nc_inverter_temp_coolant_in_test eng_spd_out_test nc_inverter_temp_coolant_out_test eng_stored_coolant_temp_out_test nc_trq_in_regen_test eng_stored_coolant_ualve_status_test nc_trq_in_regen_test eng_temp_coolant_out_test nc_trq_in_regen_test eng_temp_coolant_out_test nc_trq_in_dc2dc_test eng_temp_coolant_out_test pc_accelec_curr_in_dc2dc_test eng_temp_oil_test pc_ess_curr_out_dc2dt_test env_relative_humidity_test time_test ess_temp_int_test veh_evapsys_canister_closed_test ess_temp_int_test veh_evapsys_witch_test i ess_temp_int_test veh_force_dyno_front_test ess_temp_int_test veh_force_dyno_front_test ess_temp_int_test veh_in_spd_out_reat ess_temp_int_test veh_in_spd_out_test ess_temp_int_test veh_in_spd_out_test veh_in_spd_out_test ess_temp_int_test veh_in_spd_out_test veh_in_spd_out_test ess_temp_int_test veh_in_spd_out_test ve</pre>				
<pre>eng_spd_out_test</pre>	eng pwi_ana_oac_cesc			
<pre>a eng_stored_coolant_cmd_pump_status_test mc_inverter_temp_test eng_stored_coolant_temp_out_test mc_trq_in_regen_test eng_temp_air_in_test mc_trq_out_test eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_doost_test eno_pressure_ambient_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_evap_test ess_temp_in_test veh_force_dyno_front_test ess_temp_nid_test veh_lin_spd_out_rear_test ess_temp_right_test veh_tess ex_eng_air_relative_humidity_dilute_test wh_brake_pressure_pedal_rear_test </pre>	ΕΠΑ ΣΡΑ ΟΡΑ ΓΕΣΕ			
<pre>chg_stored_coolant_twd_pump_status_test nc_trnp_test eng_stored_coolant_valve_status_test nc_trn_incest eng_temp_air_in_test nc_trn_out_test eng_temp_coolant_in_test pc_accelec_curr_in_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_boost_test eng_temp_coolant_intest pc_ess_curr_out_boost_test eng_temp_coolant_intest pc_ess_volt_out_boost_test enu_relative_humidity_test time_test ess_scurr_out_test veh_evapsys_canister_closed_test ess_scurr_out_test veh_evapsys_switch_test i ess_temp_in_test veh_force_dyno_front_test ess_temp_nid_test veh_lin_spd_out_test ess_temp_nid_test veh_lin_spd_out_test ess_temp_inght_test veh_test veh_test ess_temp_inght_test veh_test veh_test ess_temp_inght_test veh_t</pre>	geng_spd_out_test			
<pre>eng_stored_coolant_valve_status_test mc_trq_in_regen_test eng_temp_air_in_test mc_trq_out_test eng_temp_coolant_out_test pc_accelec_curr_in_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_boost_test eng_temp_coolant_out_test pc_ess_curr_out_boost_test env_pressure_ambient_test pc_ess_volt_out_boost_test env_relative_humidity_test time_test ess_curr_out_test veh_evapsys_canister_closed_test ess_clast veh_evapsys_pressvolt_test ess_temp_in_test veh_evapsys_switch_test I ess_temp_in_test veh_force_dyno_front_test ess_temp_ind_test veh_in_spd_out_rear_test ess_temp_out_test veh_lin_spd_out_rear_test ess_temp_inght_test veh_in_spd_out_test ess_temp_inght_test veh_in_spd_out_rear_test ess_temp_inght_test veh_brake_pressure_pedal_rear_test exs_back_pressure_test wh_brake_pressure_test</pre>	eng_scorea_cooranc_cma_pump_scacas_cesc			
<pre>eng_temp_air_in_test mc_trq_out_test eng_temp_air_in_test pc_accelec_curr_in_dc2dc_test eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_oil_test pc_ess_curr_out_bcost_test env_pressure_ambient_test pc_ess_volt_out_bcost_test env_relative_humidity_test time_test ess_delta_Ah_test veh_evapsys_cranister_closed_test ess_temp_ini_test veh_evapsys_switch_test ess_temp_ini_test veh_force_dyno_front_test ess_temp_ini_test veh_lin_spd_out_rear_test ess_temp_out_test veh_in_spd_out_test ess_temp_right_test veh_temp_inside_test est_exs_bck_pressure_test vh_brake_pressure_test end_end_text veh_evapsure_test ex_end_air_relative_humidity_dilute_test vh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_evapsure_test ex_end_air_relative_humidity_dilute_test veh_evapsure_test ex_end_air_evapsure_test veh_pressure_test ex_end_air_evapsure_test veh_evapsure_test ex_end_air_evapted_test veh_evapsure_test ex_end_air_evapted_test veh_evapsure_test ex_end_air_evapted_test veh_evapsure_test ex_end_air_evapted_test veh_evapsure_test ex_end_air_evapted_test veh_evapted_test ex_end_ai</pre>	eng_scored_cooranc_cemp_ouc_cesc			
<pre>eng_temp_coolant_in_test pc_accelec_curr_in_dc2dc_test eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_dc2dc_test eng_temp_coolant_out_test pc_ess_curr_out_dc2dc_test env_temp_ambient_test pc_ess_volt_out_boost_test env_relative_humidity_test time_test env_relative_humidity_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_evap_test ess_temp_int_test veh_evapsys_switch_test ess_temp_out_test veh_force_dyno_rear_test ess_temp_out_test veh_lin_spd_out_rear_test ess_temp_right_test veh_temp_inside_test est_volt_out_test veh_temp_inside_test est_volt_out_test veh_temp_inside_test est_mt_out_test veh_temp_inside_test est_ex_eng_air_relative_humidity_dilute_test wh_brake_pressure_test est_ex_eng_air_relative_humidity_dilute_test veh_temp_inside_test est_ex_eng_air_relative_humidity_dilute_test veh_temp_inside_test est_ex_eng_air_relative_humidity_dilute_test veh_temp_inside_test est_ex_eng_air_extend est_ex_end est_extend est_ex_end est_ex_e</pre>	End Proten contaire Aatae Pracas cese		= -	
eng_temp_coolant_out_test pc_accelec_curr_out_dc2dc_test eng_temp_oil_test pc_ess_curr_out_boost_test env_pressure_ambient_test pc_ess_volt_out_boost_test env_relative_humidity_test time_test env_relative_humidity_test veh_evapsys_canister_closed_test env_relative_humidity_test veh_evapsys_canister_closed_test env_relative_humidity_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_pressvolt_test ess_delta_Ah_test veh_evapsys_switch_test ess_delta_Ah_test veh_evapsys_switch_test ess_temp_in_test veh_force_dyno_front_test ess_temp_ind_test veh_force_dyno_rear_test ess_temp_mid_test veh_lin_spd_out_rear_test ess_temp_out_test veh_trap_out_test ess_temp_ingt_test veh_trap_out_test ess_temp_right_test veh_trap_out_test ess_temp_right_test veh_trap_out_test ess_temp_relative_humidity_dilute_test wh_brake_pressure_pedal_front_test ex_eng_air_relative_humidity_dilute_test wh_brake_pressure_test	jeng_temp_air_in_test			
<pre>eng_temp_coolant_out_test pc_accerte_cont_out_accut_test eng_temp_coll_test pc_ess_curr_out_boost_test env_relative_humidity_test pc_ess_curr_out_boost_test env_relative_humidity_test time_test env_temp_ambient_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_evap_test ess_delta_Ah_test veh_evapsys_switch_test ess_temp_in_test veh_force_dyno_front_test ess_temp_out_test veh_lin_spd_out_rear_test ess_temp_out_test veh_temp_inside_test ess_volt_out_test veh_temp_inside_test ess_tentp_relative_humidity_dilute_test wh_brake_pressure_test ex_eng_air_relative_humidity_dilute_test wh_brake_pressure_test ess_temp_int_end_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_end_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_end_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_end_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test ess_temp_int_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test est_end_end_end_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test est_end_end_end_test veh_brake_pressure_test ex_end_air_relative_humidity_dilute_test veh_brake_pressure_test est_end_end_end_test veh_brake_pressure_test ex_end_end_end_test veh_brake_pressure_test est_end_end_end_test veh_brake_pressure_test est_end_end_end_test veh_brake_pressure_test est_end_end_end_end_test veh_brake_pressure_test est_end_end_end_end_test veh_brake_pressure_test est_end_end_end_end_end_test veh_brake_pressure_</pre>				
env_pressure_test pc_ess_volt_out_boost_test env_pressure_test pc_ess_volt_out_boost_test env_relative_humidity_test time_test env_temp_ambient_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_evap_test ess_delta_Ah_test veh_evapsys_pressvolt_test ess_cc_test veh_evapsys_switch_test ess_temp_in_test veh_force_dyno_front_test ess_temp_ind_test veh_force_dyno_rear_test ess_temp_id_test veh_lin_spd_out_rear_test ess_temp_out_test veh_lin_spd_out_rear_test ess_temp_out_test veh_lin_spd_out_rear_test ess_temp_ingh_test veh_lin_spd_out_rear_test ess_temp_out_test veh_lin_spd_out_reat ess_temp_ingh_test veh_lin_spd_out_reat ess_temp_right_test veh_lin_spd_out_reat ess_temp_right_test veh_lin_spd_out_test ess_volt_out_test wh_brake_pressure_pedal_front_test ex_eng_air_relative_humidity_dilute_test wh_brake_pressure_test	eng_cemp_cooranc_ouc_cesc			
env_pressure_ambient_test pc_ess_cont_out_boost_test env_relative_humidity_test time_test env_temp_ambient_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_evap_test ess_delta_Ah_test veh_evapsys_pressvolt_test ess_soc_test veh_evapsys_switch_test ess_temp_in_test veh_evapsys_switch_test ess_temp_int_test veh_force_dyno_front_test ess_temp_left_test veh_force_dyno_rear_test ess_temp_out_test veh_lin_spd_out_reat_test ess_temp_right_test veh_temp_inside_test ess_temp_right_test veh_temp_inside_test ess_temp_right_test wh_brake_pressure_pedal_front_test ess_temp_air_relative_humidity_dilute_test wh_brake_pressure_test	eng_cemp_orr_cesc			
env_temp_ambient_test evs_curr_out_test veh_evapsys_canister_closed_test ess_curr_out_test veh_evapsys_evap_test ess_delta_Ah_test veh_evapsys_pressvolt_test ess_soc_test veh_evapsys_switch_test ess_temp_in_test veh_force_dyno_front_test ess_temp_nid_test veh_force_dyno_rear_test ess_temp_out_test veh_lin_spd_out_rear_test ess_temp_right_test veh_temp_inside_test veh_temp_inside_test ess_temp_right_test veh_temp_inside_test ess_temp_right_test veh_temp_inside_test ess_temp_right_test veh_temp_inside_test ess_uolt_out_test veh_temp_ensure_pedal_front_test ex_eng_air_relative_humidity_dilute_test	env_pressure_anotenc_cesc			
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Calculated and Measured Signals are Compared



Using Sensors from Different Sources may Lead to Added Uncertainties





2004 Prius APRF Data

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Abstract					
The intend of this report is to as Facility (APRF).	ssess the data quality of the P	rius 2004 vehicle test data	a performed at Argonne Nation.	al Laboratory Advanced Po	wertrain Research
Table of Contents					
1. Introduction					
2. QA Level 1 - Individual Sen Driver	sor Evaluation				
Engine					
Motor Controler 1					
Motor Controler 2					
Energy Storage System					
Electrical Accessory Wheel					
Vehicle					
3. QA Level 2 - Sensor Comp	arison		\mathbf{k}		
Vehicle			97 U		
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Parameters are Selected Based on Detailed QA

- Signals with low correlation coefficients or that appeared suspicious from the visual check are scrutinized.
- Sensors installed by test engineers are preferred to OBD or dynamometer signals.
- Ensure consistency in the mathematical relationships.
- Signals from the OBD were not recognized (issue with units or with meaning).





Validation Process
Conventional Vehicles
Mild Hybrids
Full Hybrids
Plug-in Hybrids



Correlated Conventional Vehicles

Vehicle	Source	UDDS PSAT (mpg)	HWFET PSAT (mpg)	UDDS Adjusted (mpg)	HWFET Adjusted (mpg)	UDDS Delta EPA (%)	HWFET Delta EPA (%)
Civic DX	EPA			29.00	38.00		
	Adjusted Values	34.62	49.35	31.16	38.49	7.4	1.3
Focus ZTW auto	EPA			25.00	31.00		
	Adjusted Values	27.44	39.07	24.70	30.47	-1.2	-1.7
Accord DX	EPA			24.00	34.00		
	Adjusted Values	27.62	44.09	24.86	34.39	3.6	1.1
Taurus	EPA			20.00	27.00		
	Adjusted Values	23.19	39.01	20.87	30.43	4.4	12.7
Equinox	EPA			19.00	25.00		
	Adjusted Values	21.01	32.00	18.91	24.96	-0.5	-0.2
F150	EPA			15.00	19.00		
	Adjusted Values	17.63	25.83	15.87	20.15	5.8	6.0

Vehicle test data was not available except for the Equinox





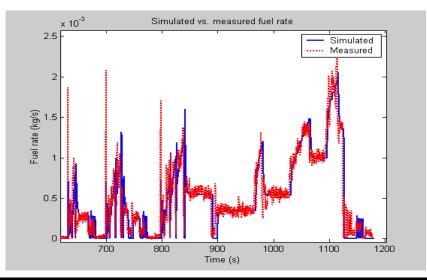
Validation Process
Conventional Vehicles
Mild Hybrids
Full Hybrids
Plug-in Hybrids



Ford P2000 Validation Results

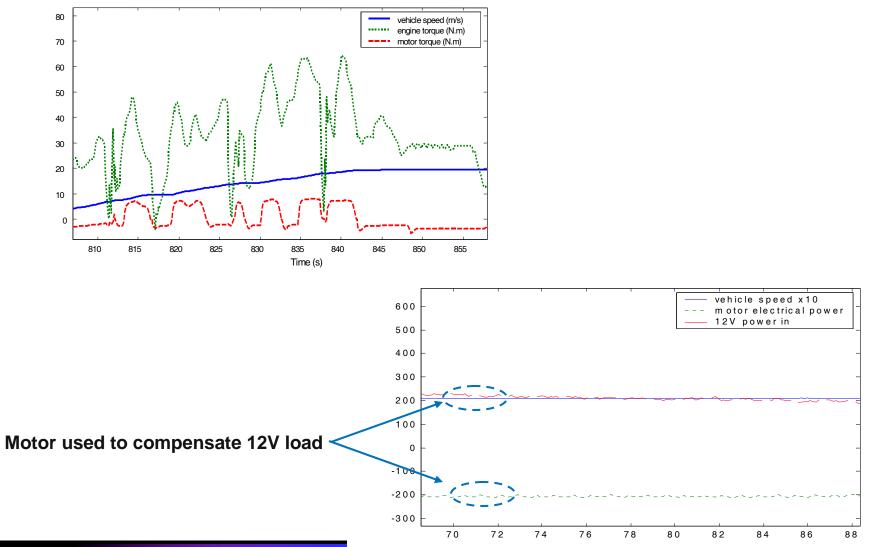
Cycle	Cons test mpg	Cons simul mpg	Diff in %	SOC init	SOCf test	SOCf simul	Diff in %
Japan 10-15	50.31	51.77	2.91	73	74	75	1.35
NEDC	52.45	52.89	0.85	74	76	77.5	1.97

Fuel Rate Comparison on NEDC



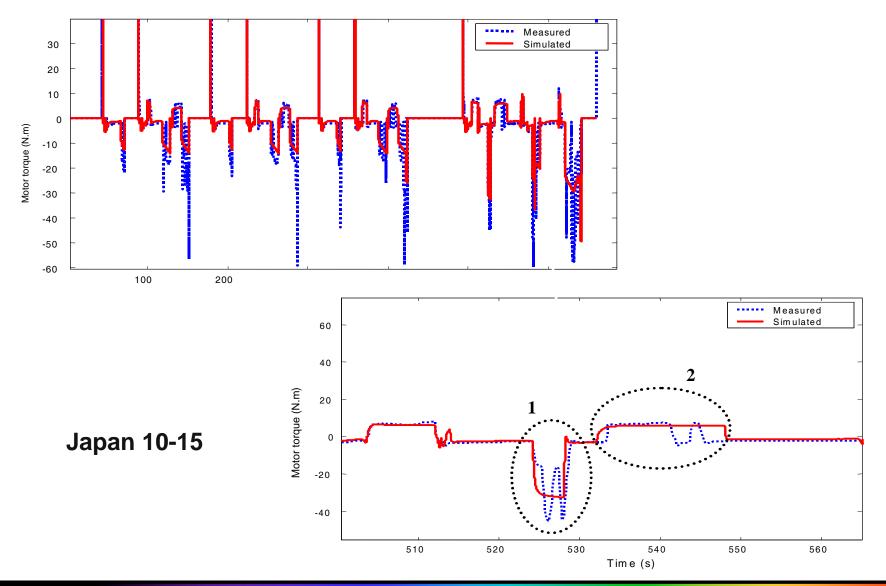


Honda Insight Validation





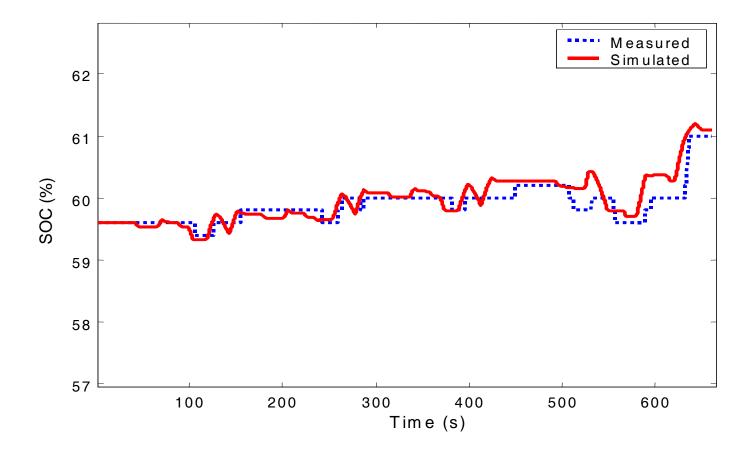
Honda Insight Validation





Honda Insight Validation

Japan 10-15 SOC Comparison





Honda Insight Validation Results

Cycle	Cons test mpg	Cons simul mpg	Diff in %	SOC init	SOCf test	SOCf simul	Diff in %
Japan 10-15	57.9	58.8	1.5	0.596	0.610	0.611	0.4
NEDC	60.6	60.2	0.6	0.600	0.602	0.583	3.6
HWFET	74.2	75.3	1.4	0.590	0.588	0.589	0.2
UDDS	58.3	57.8	0.8	0.728	0.706	0.720	2.0





Validation Process
Conventional Vehicles
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GM Precept Correlation



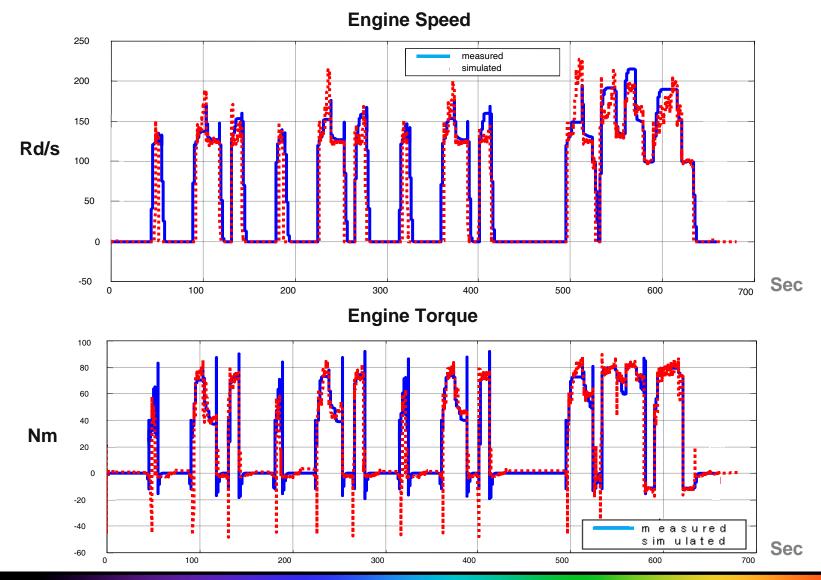
Combined

Test/Simulated Consumptions: 79.6 / 76 mpg

Small SOC difference in Simulation



Japan Prius Validation



Argonne National Laboratory

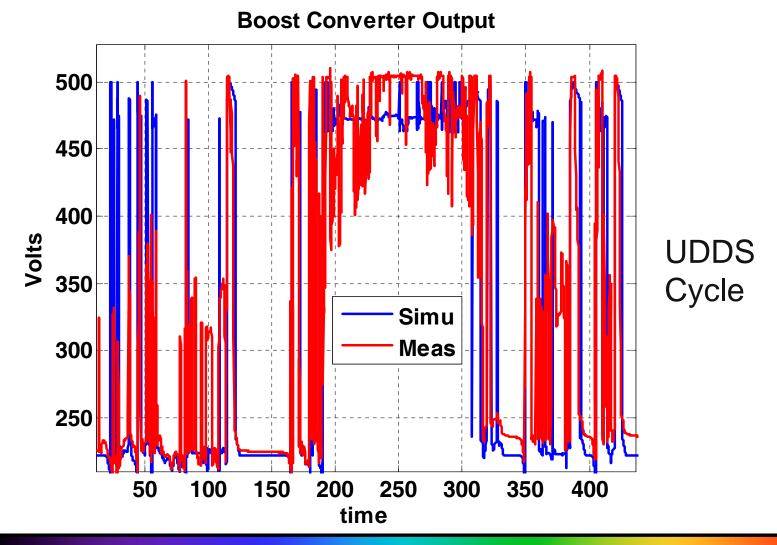


Japan Prius Validation Results

Cycle	Cons test mpg	Cons simul mpg	Diff in %	SOC init	SOCf test	SOCf simul	Diff in %
Japan 10-15	44.9	45.1	0.4	0.600	0.580	0.583	0.5
Japan 10-15	48.8	50.7	3.9	0.610	0.575	0.561	2.3
EUDC	44.0	43.8	0.4	0.610	0.605	0.593	2.0
HWFET	48.2	46.7	3.2	0.550	0.571	0.573	0.3

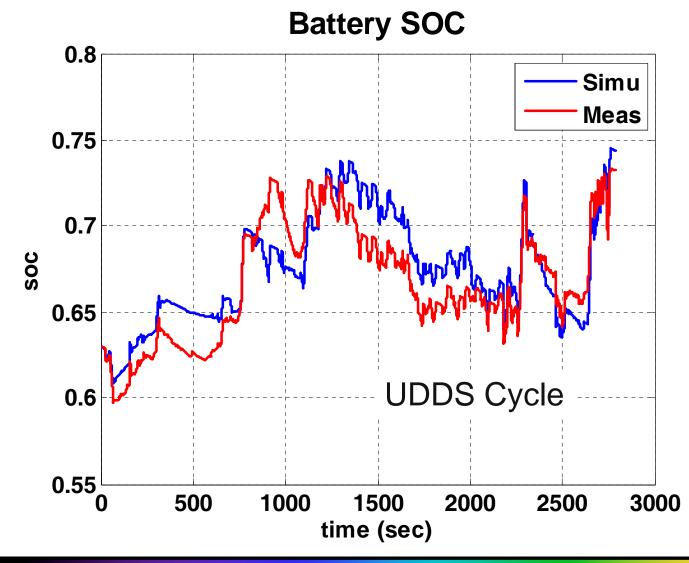


2004 Prius - Boost Converter Output Voltage Follows Test Trends





2004 Prius - Example of SOC Comparison with Final Model





2004 Prius Fuel Economy Comparison

Drive Cycle	APRF Test ⁽¹⁾	PSAT
UDDS	71	73
HWFET	67	66.2
US06	42	45.3
Japan1015	75	78.1
NEDC	69	68.5

(1) Several averaged test results





Validation Process
Conventional Vehicles
Mild Hybrids
Full Hybrids
Plug-in Hybrids



Plug-in Prius Hymotion – Vehicle Configuration and Specification

Vehicle Mass	1586 kg
High Capacity Battery	5 kWh, Li-ion
A, B, C (SI Unit)	88.6, 0.14, 0.36
Test of date	10/30/2006



Low Capacity Battery

Prius 1.3 kWh NiMH 230 VDC Battery Pack

High Capacity Battery

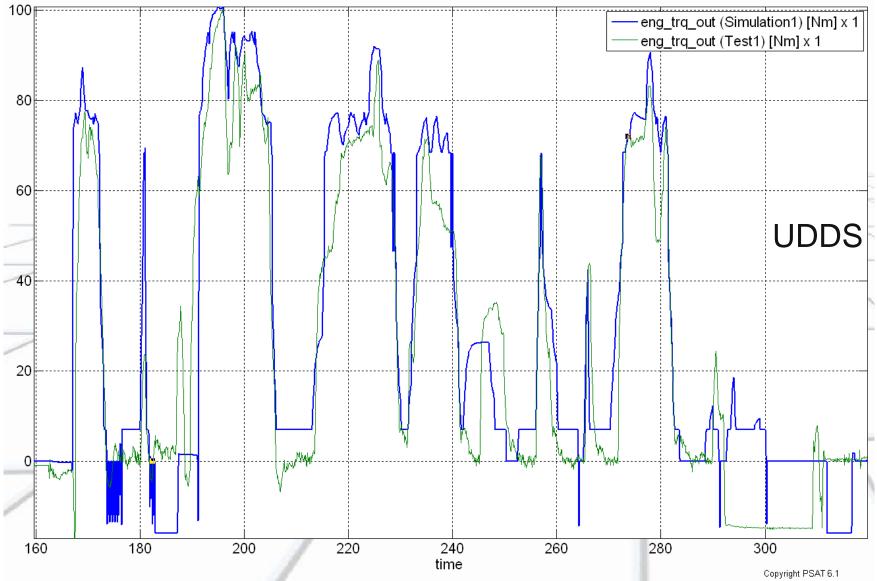
Hymotion 5kWh System

Power Converter to 230VDC

115 VDC Li-Ion

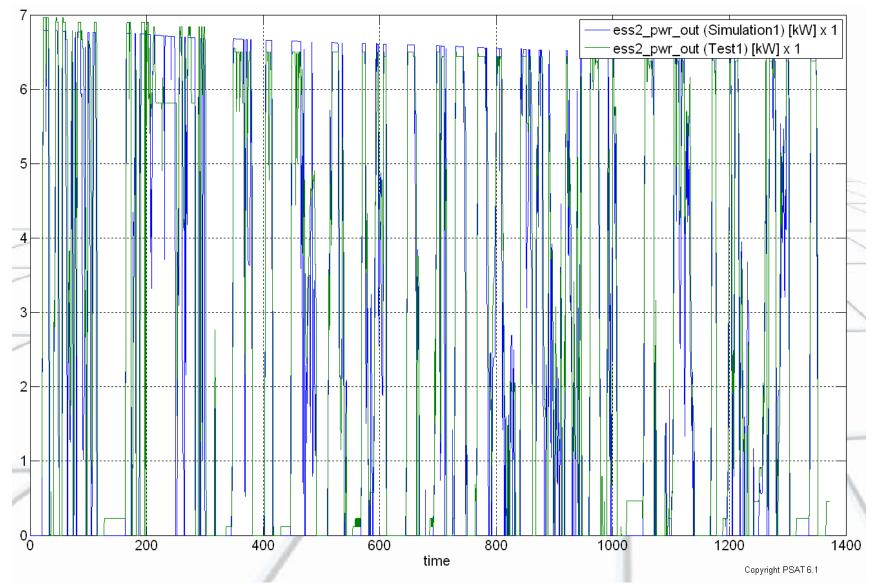


Engine Torque Comparison





High Capacity Battery Power



Charge Depleting Mode Comparison – UDDS

	Unit	Test	Simulation	Absolute Difference	Relative Difference
Fuel Economy	mile/gallon	176.7	192.3	15.2	8.8%
Elec. Consumption	Wh/km	86.3	83.8	2.5	2.8%
SOC Init	%	62	62	0	0
SOC Final	%	62	62.8	0.8	1.3%
System Efficiency	%	56.0	55.2	0.8	1.4%

Test 60610104



Charge Sustaining Mode Comparison – UDDS

	Unit	Test	Simulation	Absolute Difference	Relative Difference
Fuel Economy	mile/gallon	64.5	65.6	1.1	1.7%
SOC Init	%	62	62	0	0
SOC Final	%	62	61.8	0.2	0.3%
System Efficiency	%	41.6	39.1	2.5	6%

Test 60610106