MY24 Rear Powertrain

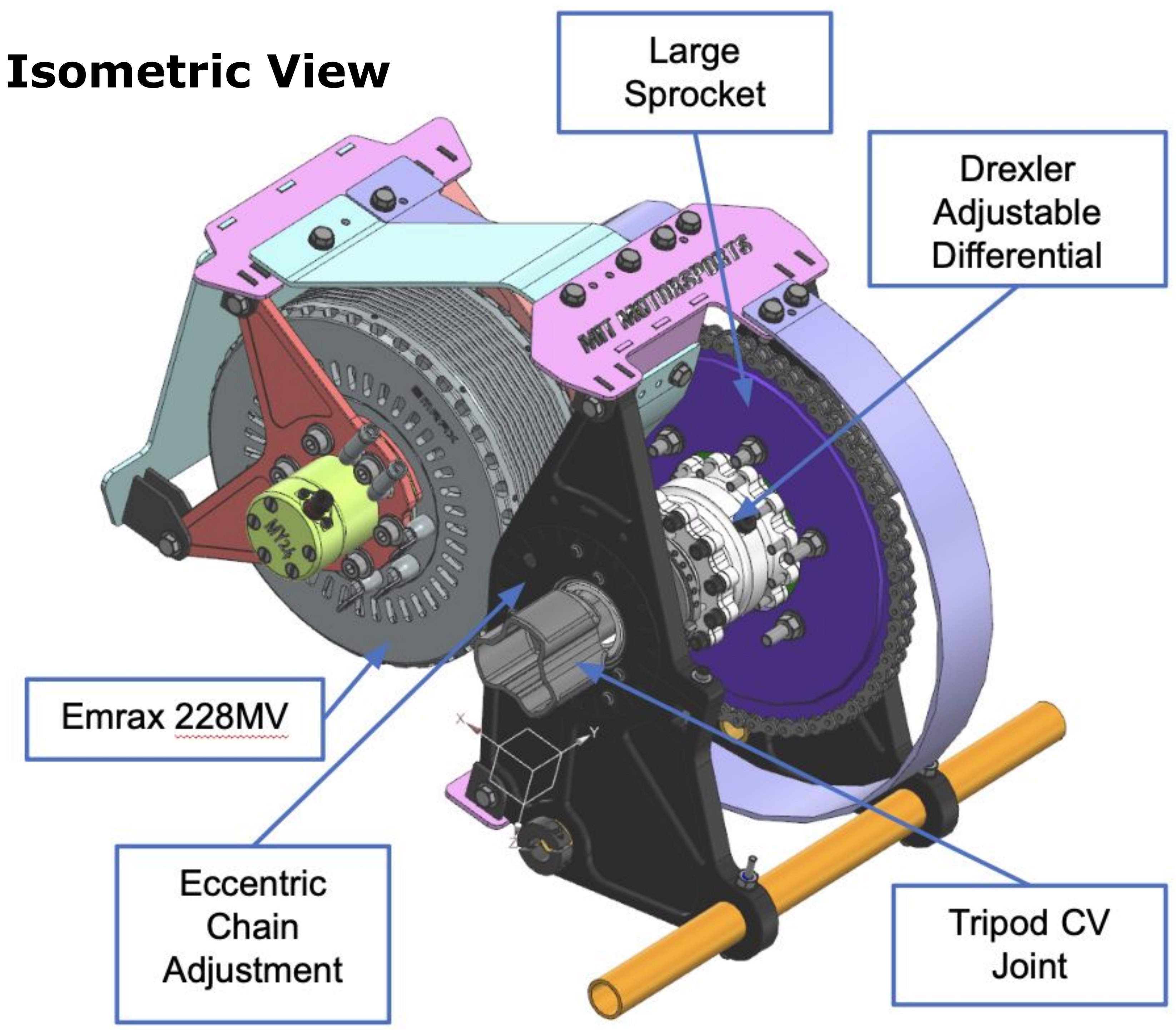
Aaron Becker

MIT MOTORSPORTS

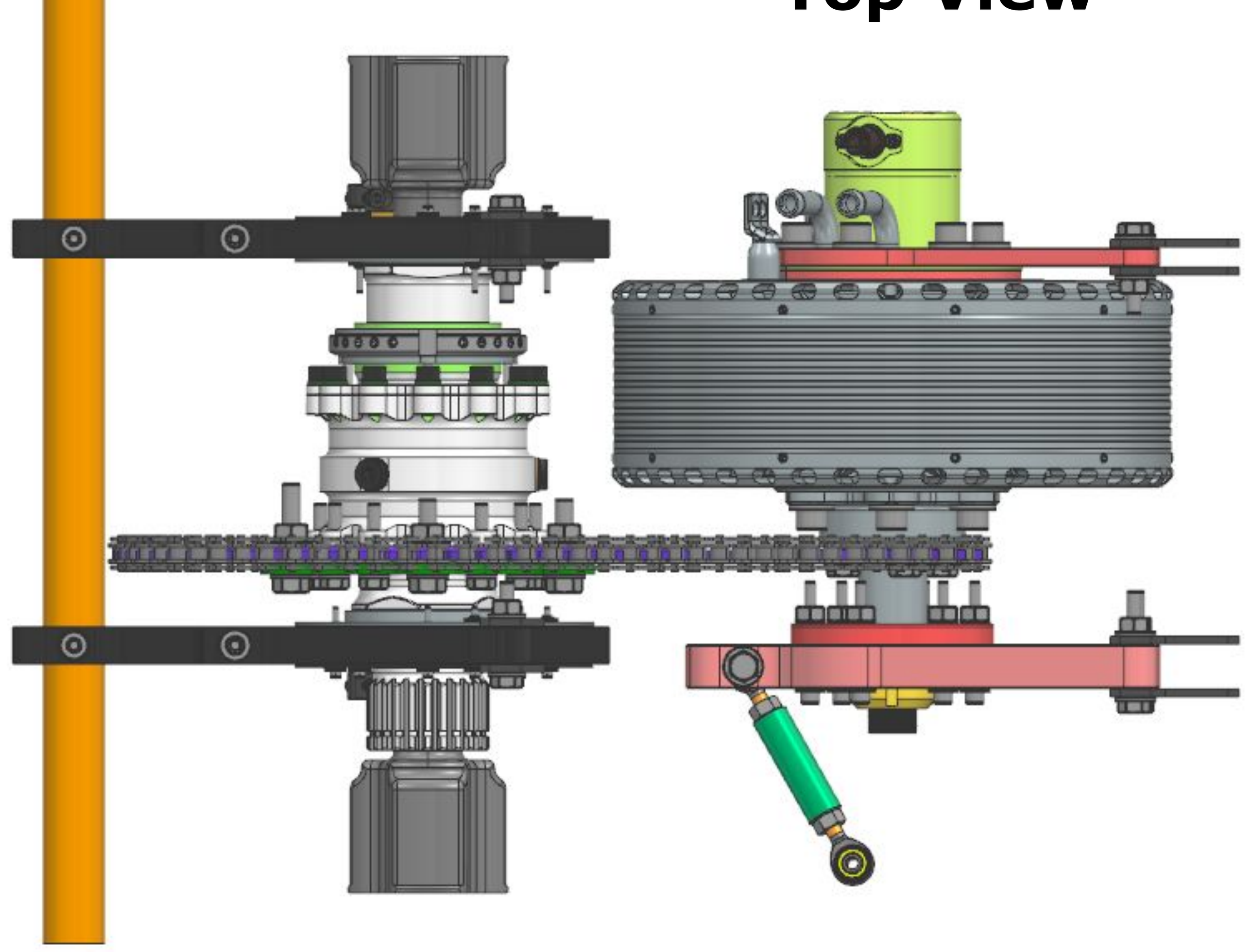
Design Overview

- Rear wheel drive vehicle uses Emrax 228 MV driven by Rinehart PM100DXR to output 240 Nm and **80 kW peak**
- Motor selected to **exceed vehicle traction and power limits** using a **custom longitudinal dynamics simulation**

Isometric View



Top View



Analysis

Key Design Requirements

Requirement	Metric	Priority
Rules Legal	Pass SES and mech tech. I.e. include scatter shield, chain guard etc.	Critical
Peak RPM & Reliability	5520 RPM at motor spindle, 1600 RPM at wheel/differential spindle	Critical
Leaking & Leak Rate	No fluids of any kind can exit the vehicle - instant DQ	Critical
Peak Torque & Reliability	237 Nm (from motor T-S curve)	Critical
Min Clearance (greater then rules minimum)	0.25in for rotating clearances, 0.1in for static clearances. Motion analysis driven for all suspension positions	High
Torque Split	Provision for torque splitting mechanism - 4wd or differential	High

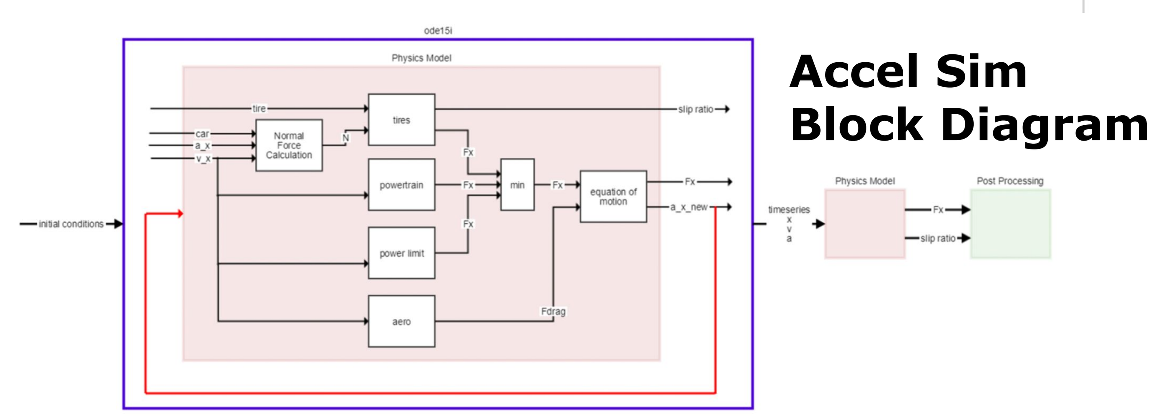
Diff Sprocket Side Bearing

Bearing	61911-2RZ	Link	0.19 Kg
Sym	Value	Unit	Desc
FOS	1.5	-	Factor of Safety
F_R	8733.20679	N	Total Radial Force w/FOS
F_A	76.518	N	Total Axial Force w/FOS
V	600	rpm	Average Diff Speed
B_ID	55	mm	Bearing ID
B_OD	80	mm	Bearing OD
B_W	13	mm	Bearing Width
M_L	2.71666667	-	Bearing Lifetime Margin
M_S	0.06666667	-	Bearing Static Margin

Diff Free Side Bearing

Bearing	61810-2RZ	Link	0.19 Kg
Sym	Value	Unit	Desc
FOS	1.5	-	Factor of Safety
F_R	3109.75301	N	Total Radial Force w/FOS
F_A	76.518	N	Total Axial Force w/FOS
V	600	rpm	Average Diff Speed
B_ID	50	mm	Bearing ID
B_OD	65	mm	Bearing OD
B_W	7	mm	Bearing Width
M_L	4.95	-	Bearing Lifetime Margin
M_S	0.46	-	Bearing Static Margin

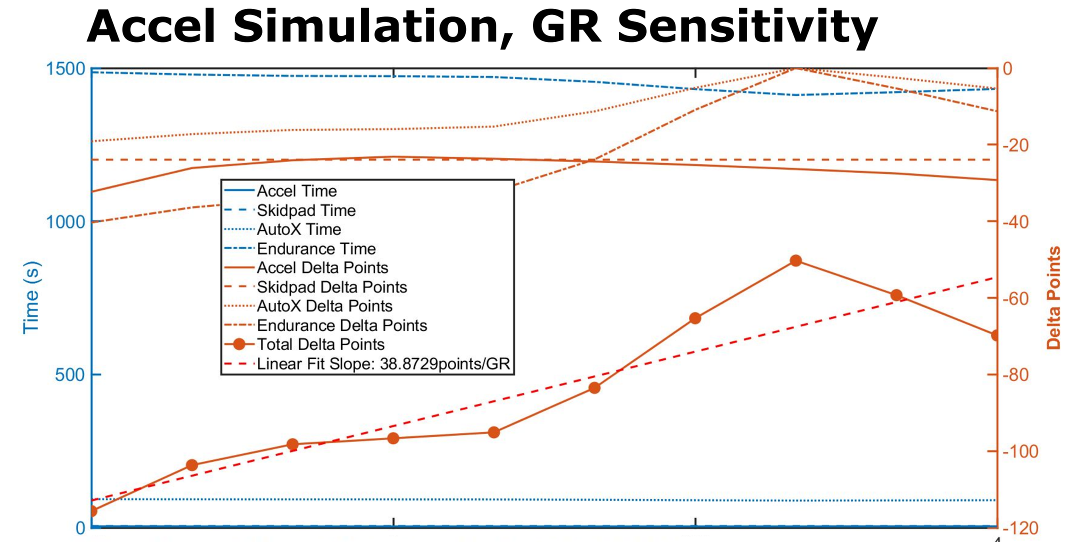
Accel Sim Block Diagram



Analysed MoS

Motor Hub Shear	0.77	unitless
Motor Hub Bolt VM	5.88	unitless
Small Sprocket Bolt VM	0.14	unitless
Diff-Sprocket Lower Truss VM	4.02	unitless
Diff-Sprocket Upper Truss VM	2.86	unitless
Diff-Free Lower Truss VM	14.76	unitless
Diff-Free Upper Truss VM	11.10	unitless
Diff-Sprocket Eccentric Shear	8.57	unitless
Diff-Sprocket Eccentric Bearing	0.66	unitless
Diff-Sprocket Bearing Shear	5.14	unitless
Diff-Sprocket Bearing Bearing	0.11	unitless
Diff-Free Eccentric Shear	14.73	unitless
Diff-Free Eccentric Bearing	1.72	unitless
Diff-Free Bearing Shear	17.60	unitless
Diff-Free Bearing Bearing	2.37	unitless
Motor Plate Bearing Shear	24.99	unitless
Motor Plate Bearing Bearing	39.51	unitless

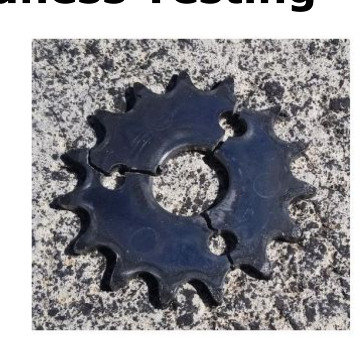
Accel Simulation, GR Sensitivity



Loadcase: 1377 MPa (includes 1.5 FOS)

Sprocket Hardness Testing

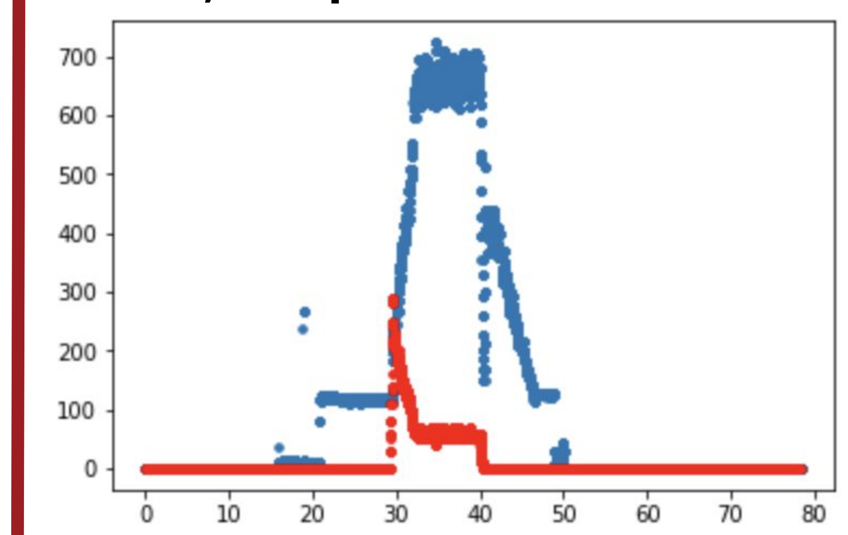
Brand	Purchase Date	Tested Hardness	Tensile Strength
McMaster	February 2018	44 HRA	414 MPa
JR Racecar	April 2018	81 HRA	2200 MPa
JR Racecar	March 2019	55 HRA	627 MPa
ProTaper	March 2019	74 HRA	1650 MPa



Testing and Validation

Wheel speed sensors (on left and right differential outputs)
High-accuracy 64 counts/revolution sensing disc
Up to **6000 RPM** max speed
Weather-proofed for all testing conditions

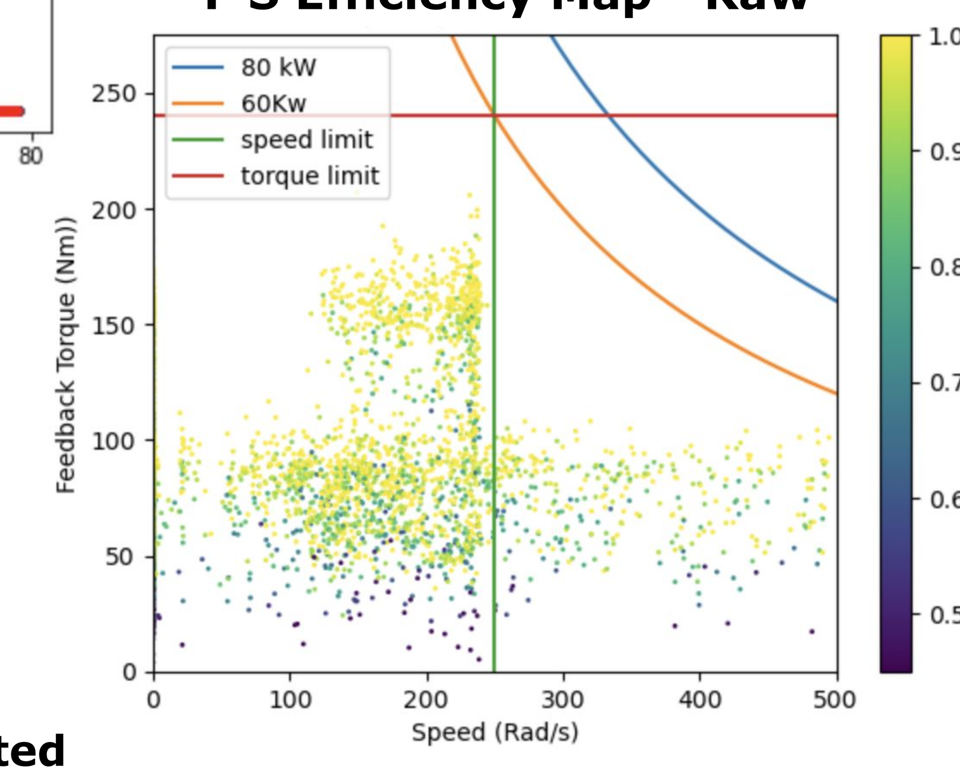
Power, Torque Data - Accel Launch



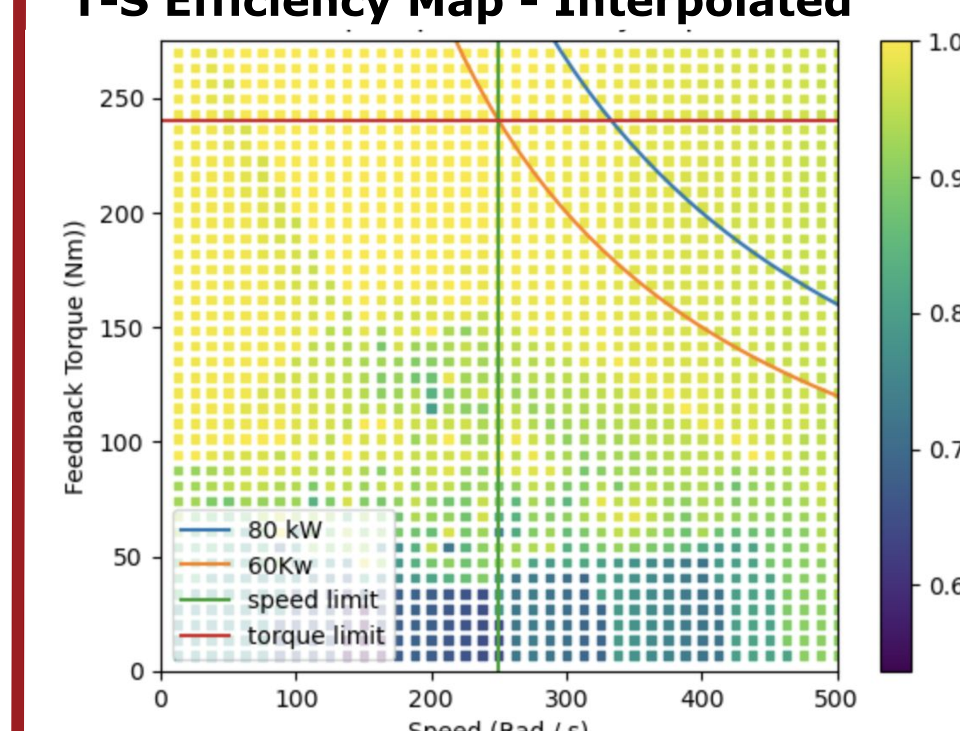
(Above) **Power - W/100**, **Torque Nm** from accel launch

Efficiency map versus torque-speed data collected (right)
Max speed (green)
Max torque (red)
80 kW power limit
60 kW power limit

T-S Efficiency Map - Raw

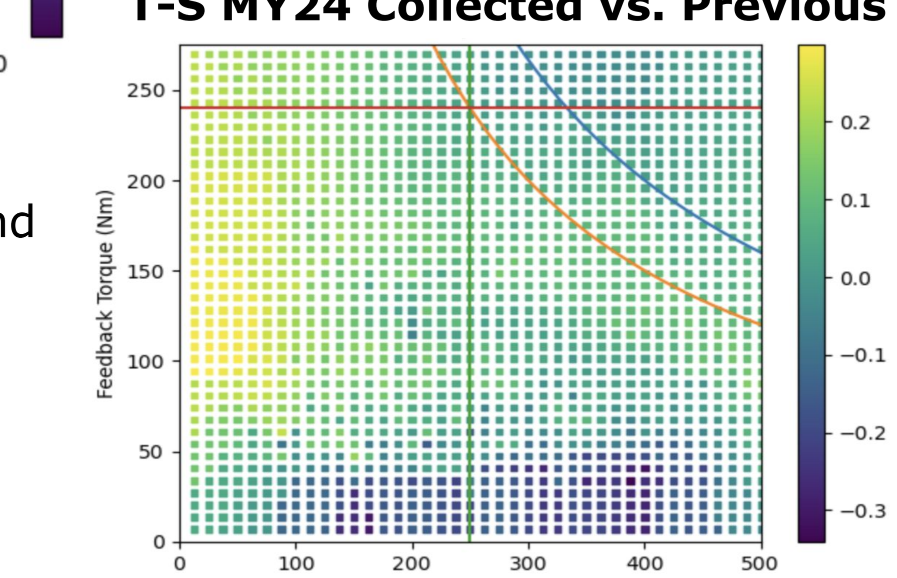


T-S Efficiency Map - Interpolated



Interpolated across full torque-speed range
Low-torque, low speed regimes are least efficient
Affects race strategy, power limiting, and validates gear ratio selection
Switched to 3.5 from 3.8 gear ratio (data + driver feedback)

T-S MY24 Collected vs. Previous



Quantified difference from previously collected (MY18/19) and manufacturer-provided data
Found largest discrepancies in:

- Low-torque regimes (less efficient than predicted)
- Low-speed regimes (more efficient than predicted)