Strategy Estimation for Las Vegas GP 2023

```
% Tyres available: C3, C4, C5 - The 3 softest in the Pirelli range.
% Race Duration: 50 laps (305.88km total distance)

% Assumption of initial tyre pace delta: 0.7s between C5 and C4, and 0.7s
% between C4 and C3. With C5 being the fastest.

% Assumption of degradation per lap: Fuel corrected laptime increase
% non-linearly as tyre wears (non-linear tyre deg model estimate)

% Fuel correction assumption for 110kg of fuel to last 50 laps and 0.035s
% laptime gain per 1kg of fuel burn.

% Initial flying lap pace assumed due to lack of race historical data.
```

Calculating Fuel Correction Factor

```
fuelQuantity = 110;   %kg
totalLapNumber = 50; %laps
lapNumber = 1:50;
timePerKg = 0.035;    %seconds

fuelConsumption = fuelQuantity/totalLapNumber;    %kg/lap

fuelCorrectionFactor = fuelConsumption .* timePerKg; %seconds/lap

fuelLapCorrections = fuelCorrectionFactor .* (lapNumber-1);
```

Defining Tyre Wear Factors

```
c5Wear = linspace(0.09,0.5,50);   %seconds
c4Wear = linspace(0.08,0.17,50); %seconds
c3Wear = linspace(0.077,0.1,50); %seconds

tyreAge = 1:50; %laps
```

Calculating Tyre Degradation Laptime Impact

```
c5InitialLaptime = 95;      %seconds
c4InitialLaptime = 95.7;    %seconds
c3InitialLaptime = 96.4;    %seconds

c5TyreDegLaptime = c5InitialLaptime + c5Wear .* (tyreAge-1);
c4TyreDegLaptime = c4InitialLaptime + c4Wear .* (tyreAge-1);
c3TyreDegLaptime = c3InitialLaptime + c3Wear .* (tyreAge-1);
```

Calculating Tyre and Fuel Effected Laptimes for Full Distance Tyre Model

```matlab
c5Laptime = c5InitialLaptime + (c5Wear .* (tyreAge-1)) - fuelLapCorrections(lapNumber);
c4Laptime = c4InitialLaptime + (c4Wear .* (tyreAge-1)) - fuelLapCorrections(lapNumber);
c3Laptime = c3InitialLaptime + (c3Wear .* (tyreAge-1)) - fuelLapCorrections(lapNumber);
```

To determine fuel corrected laptimes for individual stints, the following formula is appropriate:

```matlab
% Fuel_Corrected_Stint_Formula = TyreDegLaptime(tyreAge(1:end_of_stint)) - fuelLapCorrections(1
```

Defining Average Pit Time Loss

```matlab
pitTime = 20;   %seconds
```

Plot Laptimes for Tyre Compounds Over Full Distance.

This will be our estimated tyre model, from which we can devise strategy configurations and plot their corresponding race times.

```matlab
plot(lapNumber,c5Laptime,"Color","#D95319")
hold on
plot(lapNumber,c4Laptime,"Color","#EDB120")
plot(lapNumber,c3Laptime,"Color","#000000")
ylim([94 100])
xlabel("Lap Number")
ylabel("Fuel Corrected Laptime (s)")
title("Estimated Tyre Pace Model (Non-Linear)")
legend(["C5" "C4" "C3"],"Location","northwest")
hold off
```

Estimated Tyre Pace Model (Non-Linear)
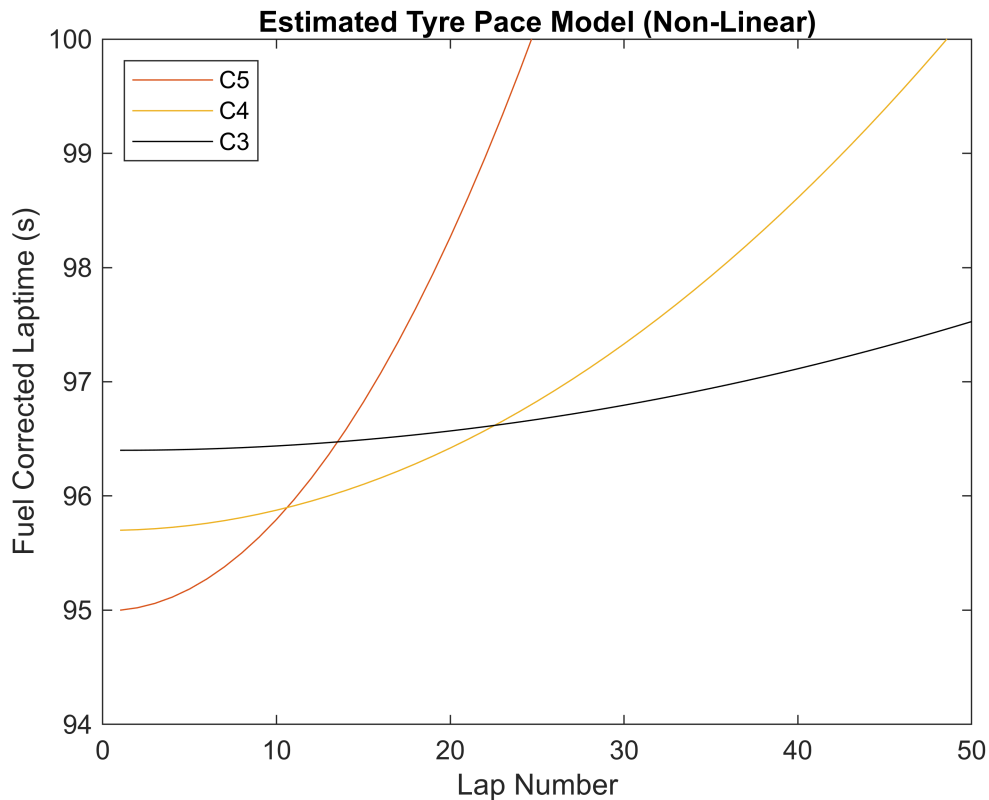
Consider a single stop strategy. C5 to C4 (Soft to Medium).

```
% Add slider to observe variable pitlap effects
pitLap = 20;

% Calculating fuel corrected stints
c5Fuel_Corrected_Stint = c5Laptime(tyreAge(1:pitLap));
c4Fuel_Corrected_Stint = c4TyreDegLaptime(tyreAge(1:(50-pitLap))) - fuelLapCorrections(lapNumbe

% Plotting lap times
plot(lapNumber(1:pitLap), c5Fuel_Corrected_Stint,"Color","#D95319")
hold on
plot(lapNumber(pitLap+1:50), c4Fuel_Corrected_Stint,"Color","#EDB120")
xline(pitLap,":")
xlabel("Lap Number")
ylabel("Fuel Corrected Lap Times (s)")
ylim([93 98.5])
title("C5 to C4 1 Stop Strategy")
legend(["C5" "C4" "Pit Lap"],"Location","northeast")
hold off
```
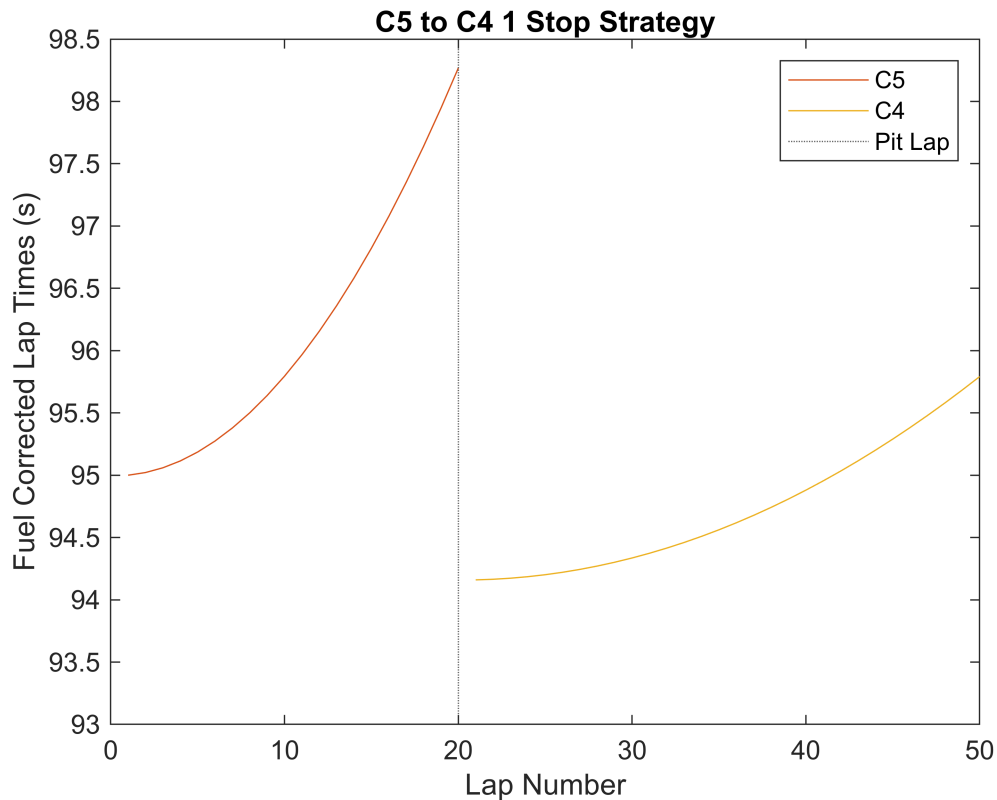
C5 to C4 1 Stop Strategy


```matlab
% Sum fuel corrected stint times with the pit stop time to determine
% overall race time.
totalRaceTimeC5C4_sec = seconds(sum(c5Fuel_Corrected_Stint) + sum(c4Fuel_Corrected_Stint) + pit
```

```
totalRaceTimeC5C4_sec = duration
    4785 sec
```

```matlab
totalRaceTimeC5C4_min = minutes(minutes(totalRaceTimeC5C4_sec))
```

```
totalRaceTimeC5C4_min = duration
    79.749 min
```

Consider a single stop strategy, C5 to C3 (Soft to Hard).

```matlab
% Add slider to observe variable pitlap effects
pitLap = 18;

% Calculating fuel corrected stints
c5Fuel_Corrected_Stint = c5Laptime(tyreAge(1:pitLap));
c3Fuel_Corrected_Stint = c3TyreDegLaptime(tyreAge(1:(50-pitLap))) - fuelLapCorrections(lapNumbe

% Plotting lap times
plot(lapNumber(1:pitLap), c5Fuel_Corrected_Stint,"Color","#D95319")
hold on
plot(lapNumber(pitLap+1:50), c3Fuel_Corrected_Stint,"Color","#000000")
xline(pitLap,":")
```
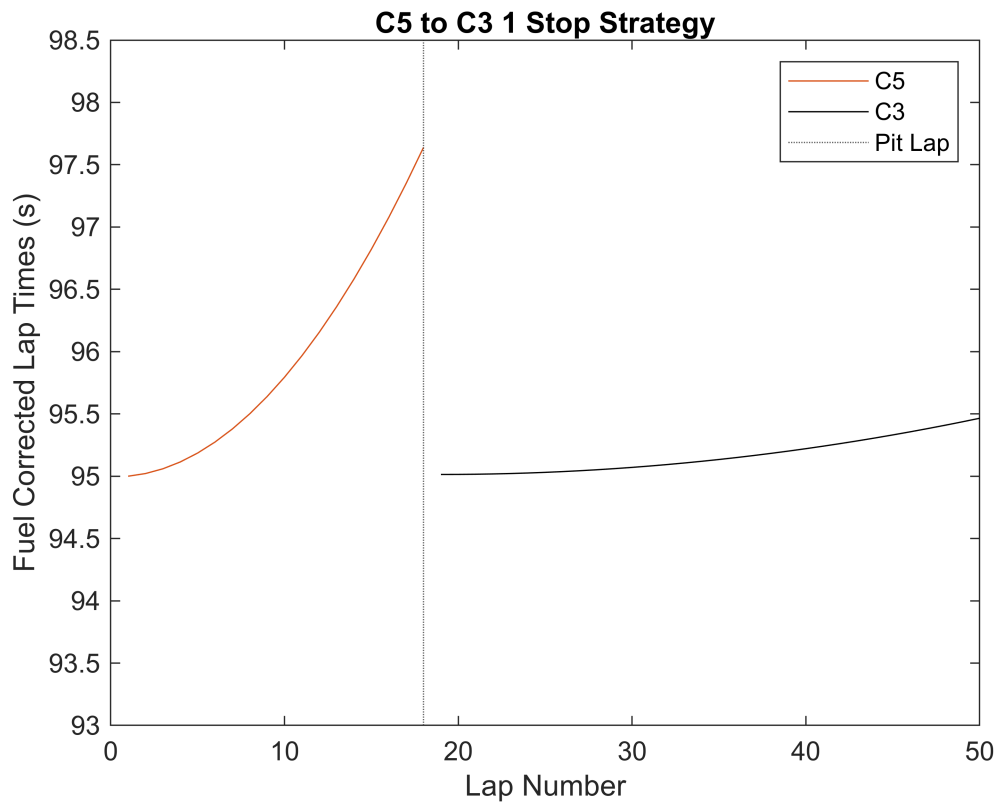
```
xlabel("Lap Number")
ylabel("Fuel Corrected Lap Times (s)")
ylim([93 98.5])
title("C5 to C3 1 Stop Strategy")
legend(["C5" "C3" "Pit Lap"],"Location","northeast")
hold off
```



```
% Sum fuel corrected stint times with the pit stop time to determine
% overall race time.
totalRaceTimeC5C3_sec = seconds(sum(c5Fuel_Corrected_Stint) + sum(c3Fuel_Corrected_Stint) + pit
```

```
totalRaceTimeC5C3_sec = duration
    4792.3 sec
```

```
totalRaceTimeC5C3_min = minutes(minutes(totalRaceTimeC5C3_sec))
```

```
totalRaceTimeC5C3_min = duration
    79.871 min
```

Consider a single stop strategy. C4 to C3 (Medium to Hard).

```
% Add slider to observe variable pitlap effects
pitLap = 24;

% Calculating fuel corrected stints
c4Fuel_Corrected_Stint = c4Laptime(tyreAge(1:pitLap));
```

5

```
c3Fuel_Corrected_Stint = c3TyreDegLaptime(tyreAge(1:(50-pitLap))) - fuelLapCorrections(lapNumbe

% Plotting lap times
plot(lapNumber(1:pitLap), c4Fuel_Corrected_Stint,"Color","#EDB120")
hold on
plot(lapNumber(pitLap+1:50), c3Fuel_Corrected_Stint,"Color","#000000")
xline(pitLap,":")
xlabel("Lap Number")
ylabel("Fuel Corrected Lap Times (s)")
ylim([93 98.5])
title("C4 to C3 1 Stop Strategy")
legend(["C4" "C3" "Pit Lap"],"Location","northeast")
hold off
```
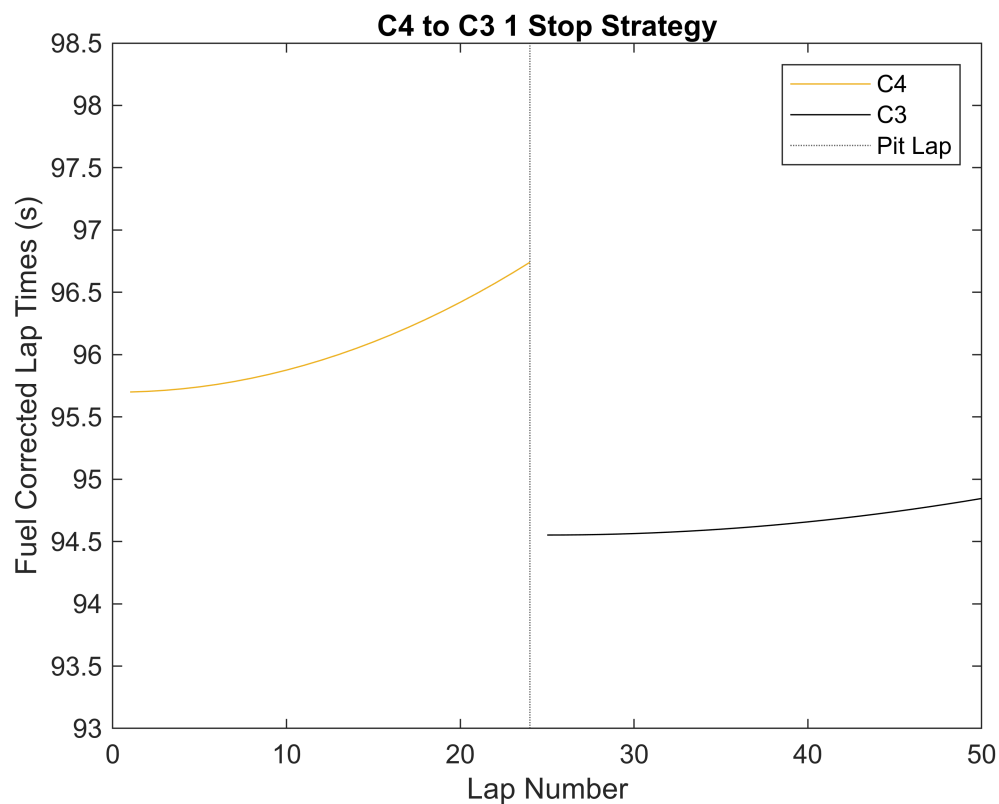


```
% Sum fuel corrected stint times with the pit stop time to determine
% overall race time.
totalRaceTimeC4C3_sec = seconds(sum(c4Fuel_Corrected_Stint) + sum(c3Fuel_Corrected_Stint) + pit
```

totalRaceTimeC4C3_sec = *duration*
    4786.5 sec

```
totalRaceTimeC4C3_min = minutes(minutes(totalRaceTimeC4C3_sec))   %minutes
```

totalRaceTimeC4C3_min = *duration*
    79.775 min

Consider a 2 stop strategy. C5, C5, C4 (Soft, Soft, Medium).

```
% Add sliders to observe variable pitlap effects
pitLap1 = 14;
pitLap2 = 29;

% Calculating fuel corrected stints
c5Fuel_Corrected_Stint1 = c5Laptime(tyreAge(1:pitLap1));
c5Fuel_Corrected_Stint2 = c5TyreDegLaptime(tyreAge(1:pitLap2-pitLap1)) - fuelLapCorrections(lap
c4Fuel_Corrected_Stint = c4TyreDegLaptime(tyreAge(1:(50-pitLap2))) - fuelLapCorrections(lapNumb

% Plotting lap times
plot(lapNumber(1:pitLap1), c5Fuel_Corrected_Stint1,"Color","#D95319")
hold on
plot(lapNumber(pitLap1+1:pitLap2), c5Fuel_Corrected_Stint2,"Color","#D95319")
plot(lapNumber(pitLap2+1:50), c4Fuel_Corrected_Stint,"Color","#EDB120")
xline(pitLap1,":")
xline(pitLap2,":")
xlabel("Lap Number")
ylabel("Fuel Corrected Lap Times (s)")
ylim([93 98.5])
title("C5, C5, C4 2 Stop Strategy")
legend(["C5" "" "C4" "Pit Lap" ""],"Location","northeast")
hold off
```
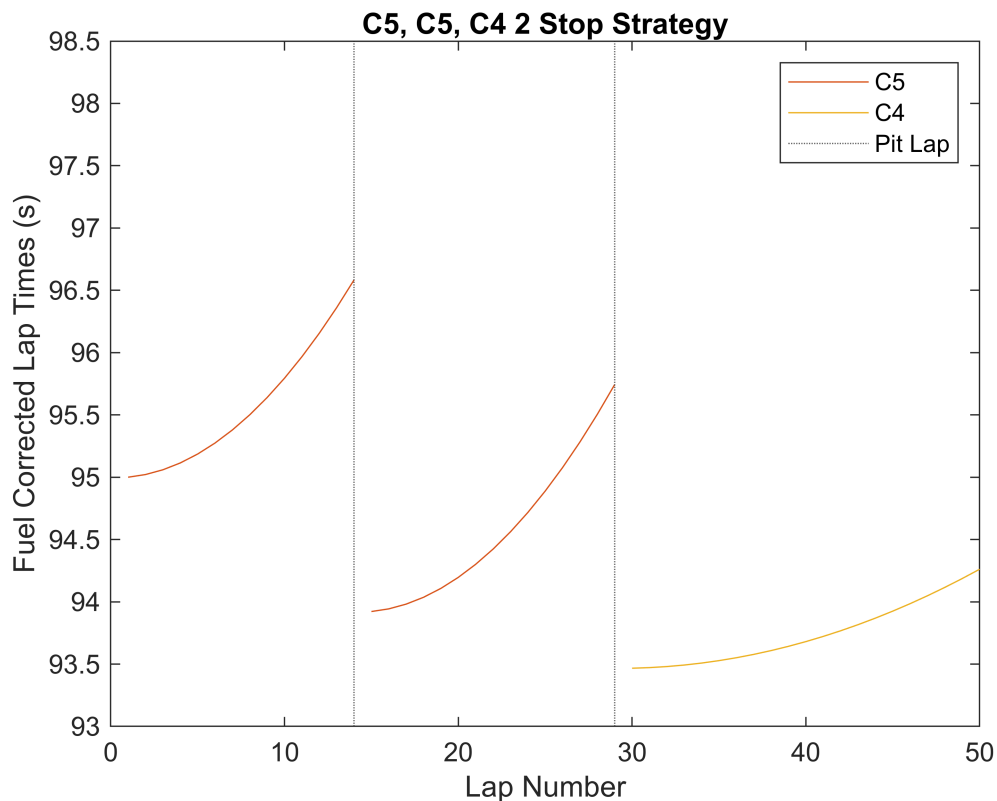
```
% Sum fuel corrected stint times with the pit stop time to determine
% overall race time.
totalRaceTimeC5C5C4_sec = seconds(sum(c5Fuel_Corrected_Stint1) + sum(c5Fuel_Corrected_Stint2) -
```

totalRaceTimeC5C5C4_sec = *duration*
    4765.4 sec

```
totalRaceTimeC5C5C4_min = minutes(minutes(totalRaceTimeC5C5C4_sec))   %minutes
```

totalRaceTimeC5C5C4_min = *duration*
    79.424 min

Consider a 2 stop strategy. C5, C4, C4 (Soft, Medium, Medium).

```
% Add sliders to observe variable pitlap effects
pitLap1 = 14;
pitLap2 = 32;

% Calculating fuel corrected stints
c5Fuel_Corrected_Stint = c5Laptime(tyreAge(1:pitLap1));
c4Fuel_Corrected_Stint1 = c4TyreDegLaptime(tyreAge(1:pitLap2-pitLap1)) - fuelLapCorrections(lap
c4Fuel_Corrected_Stint2 = c4TyreDegLaptime(tyreAge(1:(50-pitLap2))) - fuelLapCorrections(lapNum

% Plotting lap times
plot(lapNumber(1:pitLap1), c5Fuel_Corrected_Stint,"Color","#D95319")
hold on
plot(lapNumber(pitLap1+1:pitLap2), c4Fuel_Corrected_Stint1,"Color","#EDB120")
plot(lapNumber(pitLap2+1:50), c4Fuel_Corrected_Stint2,"Color","#EDB120")
xline(pitLap1,":")
xline(pitLap2,":")
xlabel("Lap Number")
ylabel("Fuel Corrected Lap Times (s)")
ylim([93 98.5])
title("C5, C4, C4 2 Stop Strategy")
legend(["C5" "C4" "" "Pit Lap" ""],"Location","northeast")
hold off
```
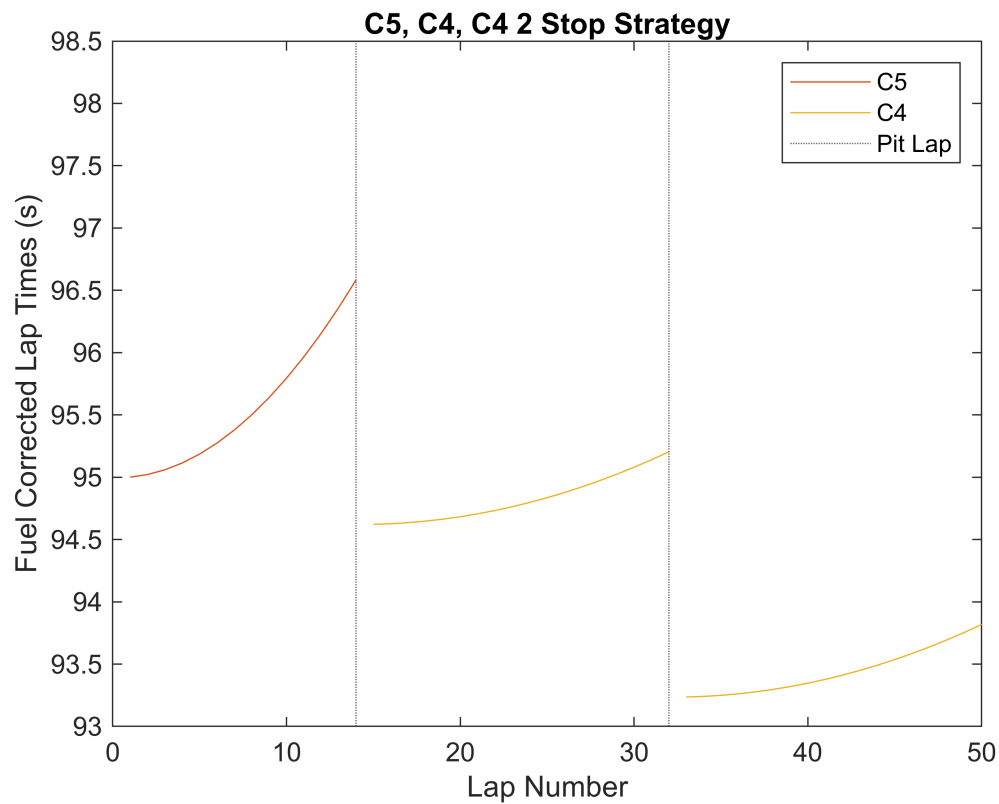
C5, C4, C4 2 Stop Strategy

```
% Sum fuel corrected stint times with the pit stop time to determine
% overall race time.
totalRaceTimeC5C4C4_sec = seconds(sum(c5Fuel_Corrected_Stint) + sum(c4Fuel_Corrected_Stint1) +
```

totalRaceTimeC5C4C4_sec = *duration*
    4767 sec

```
totalRaceTimeC5C4C4_min = minutes(minutes(totalRaceTimeC5C4C4_sec))  %minutes
```

totalRaceTimeC5C4C4_min = *duration*
    79.449 min