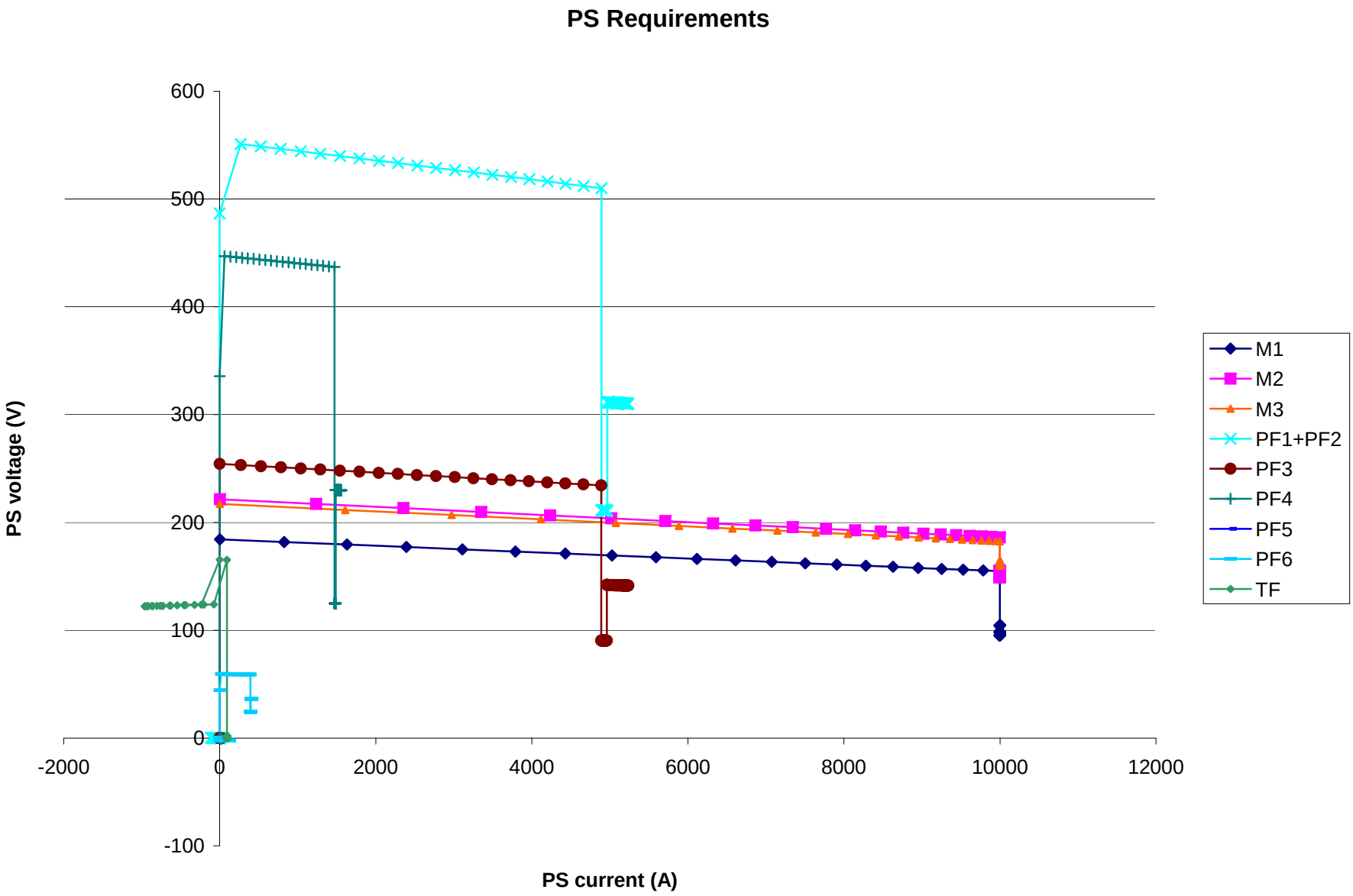
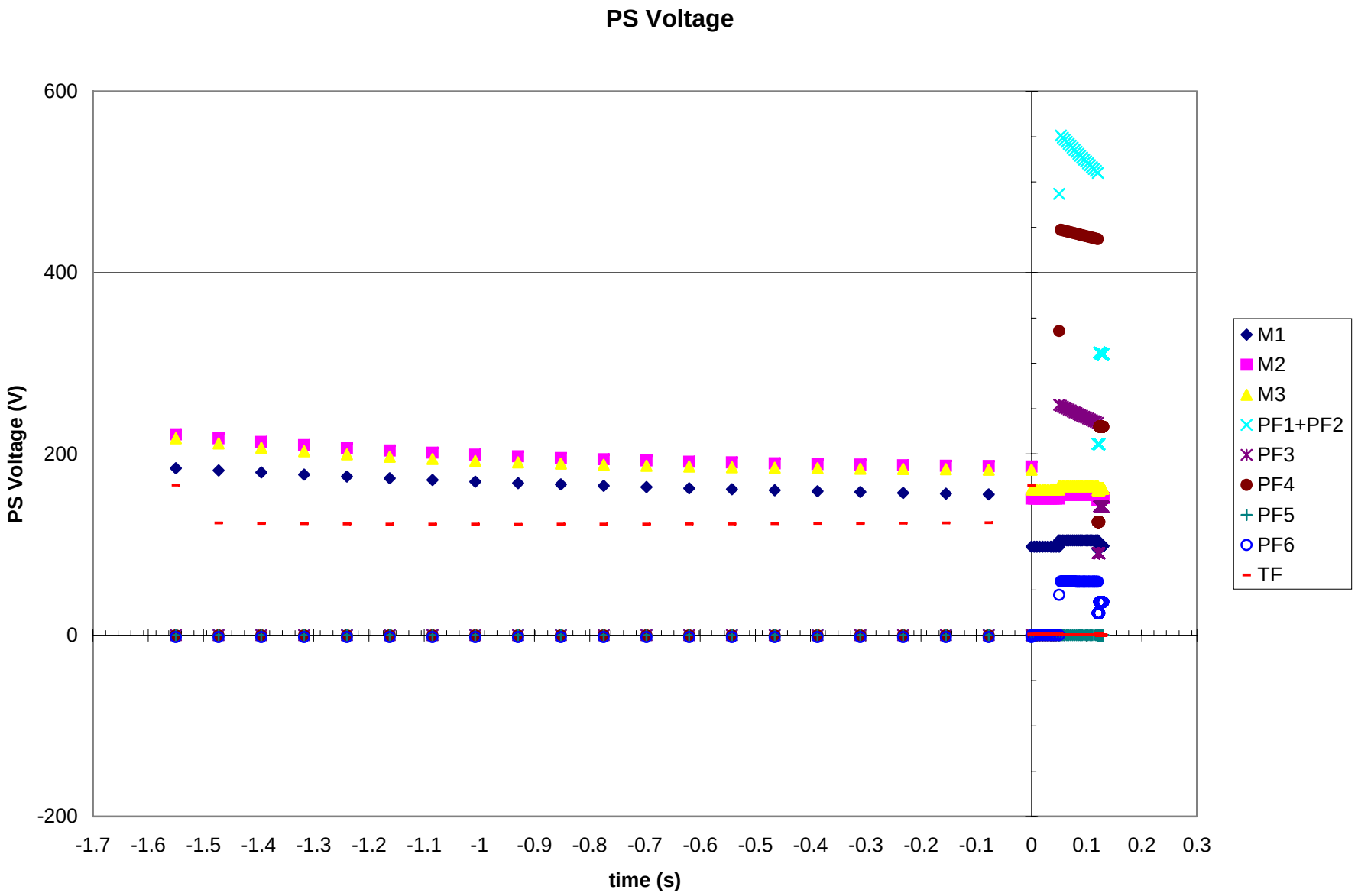
# PF1a study

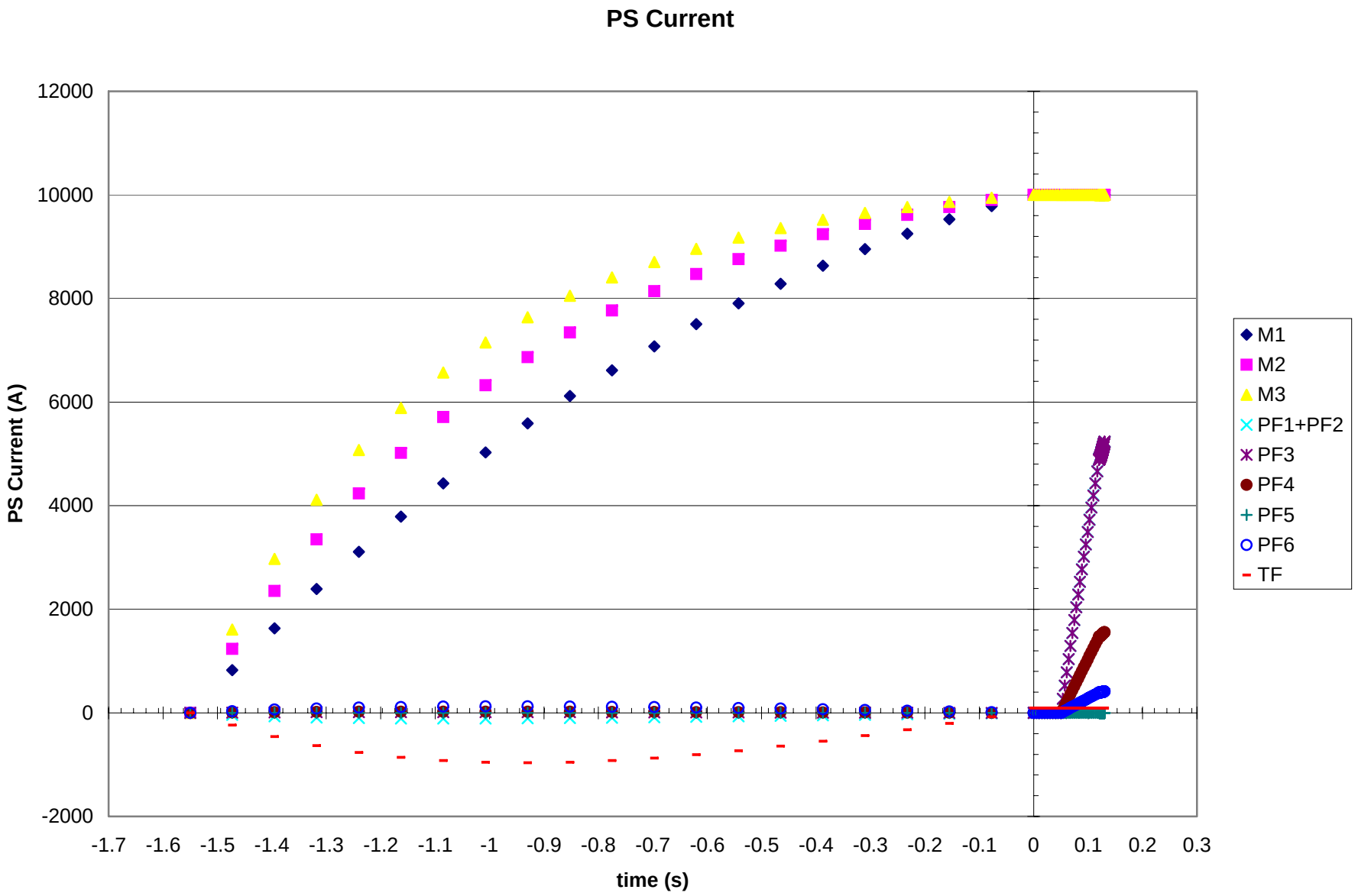
December 2004

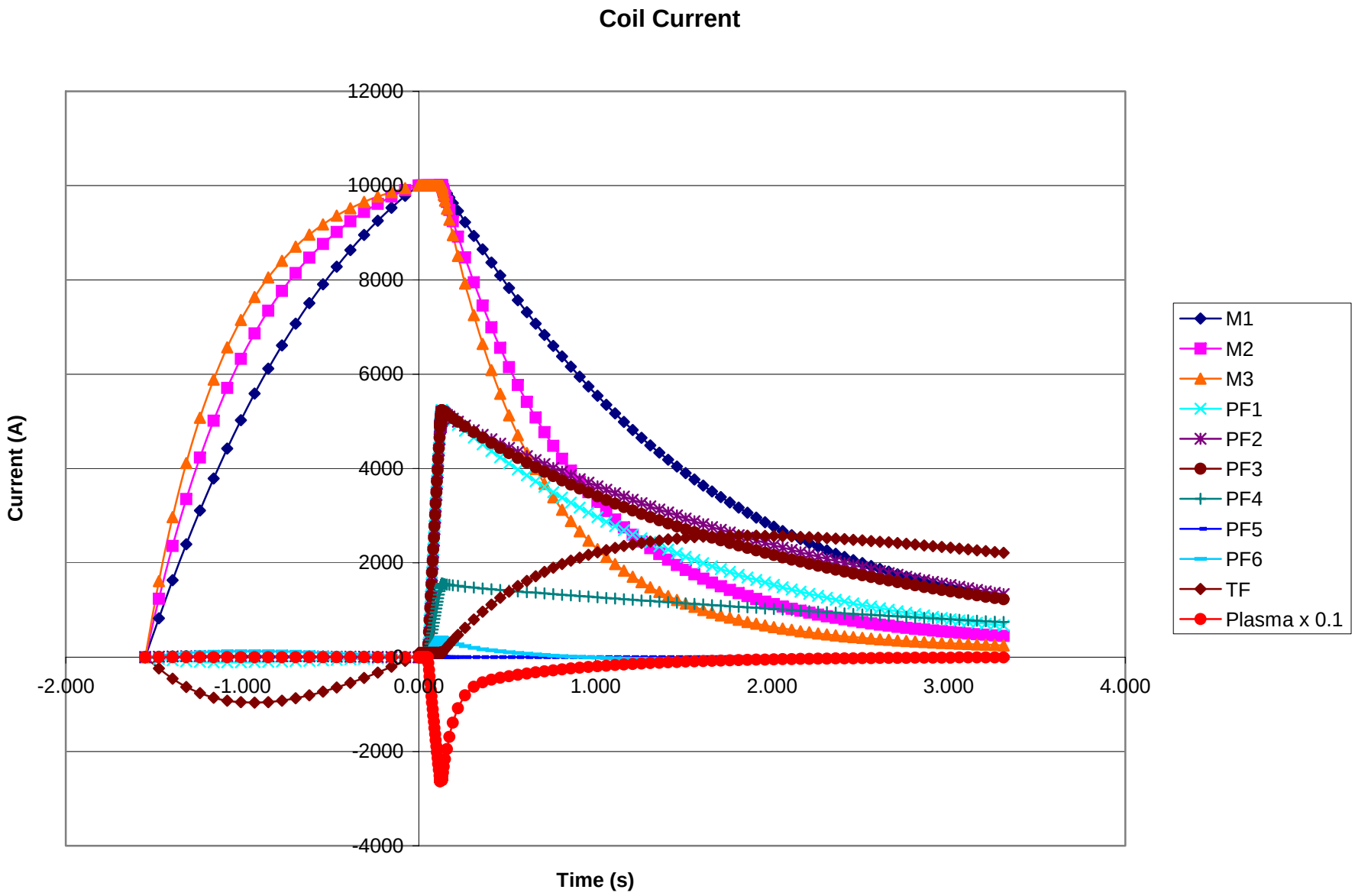
# Baseline Coil Configuration

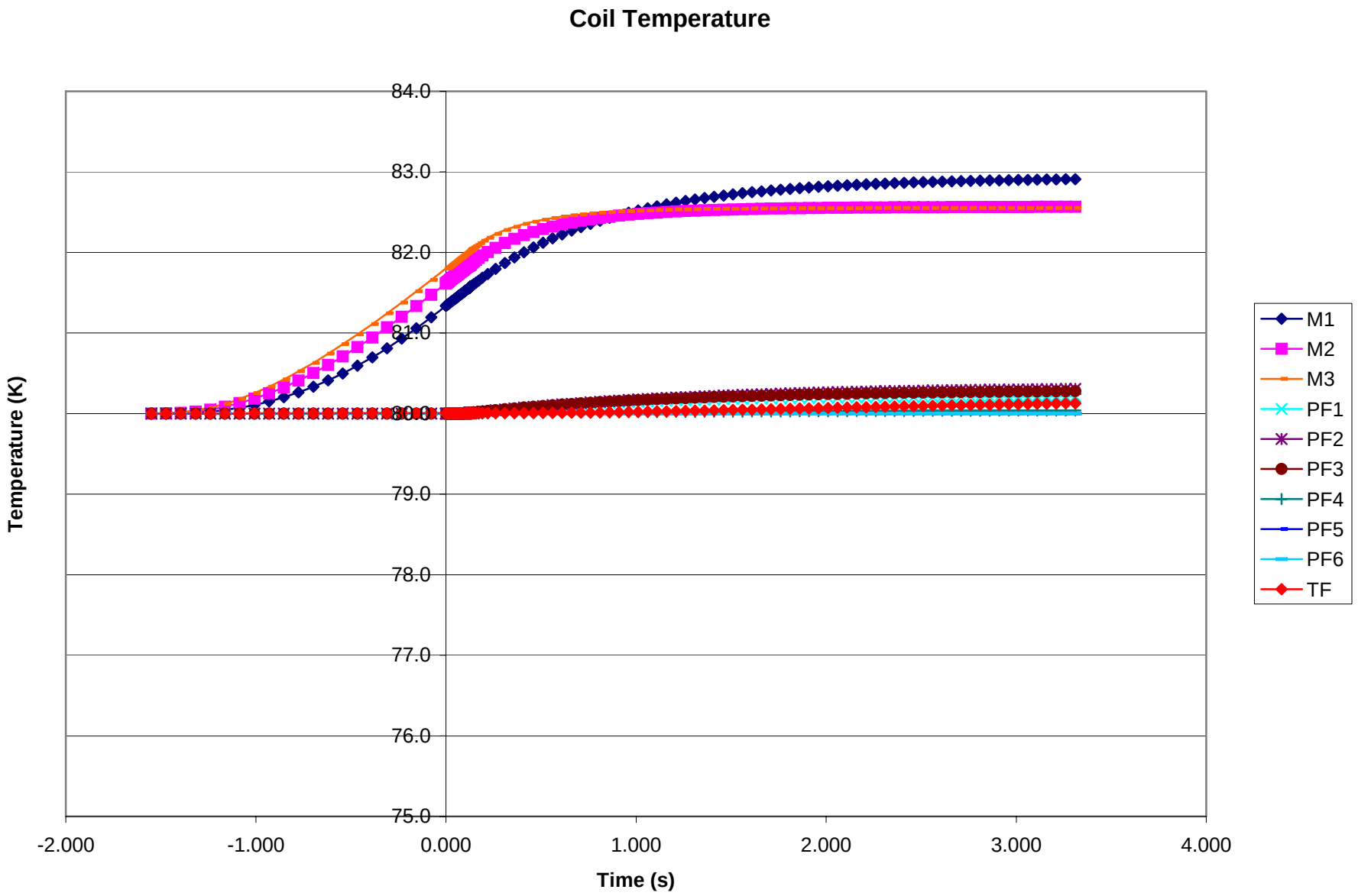
- First plasma scenario
- PF1-6 are powered independently in the model
- In actuality…
  - PF1-2 are in series.  Need to add PS voltages to get right answer.
  - PF 5 is open circuited.  Ignore PS voltage required to maintain zero current at breakpoints.


PS Requirements
PS voltage (V)
600
500
400
300
200
100
0
-100
-2000
0
2000
4000
6000
8000
10000
12000
PS current (A)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF


PS Voltage
PS Voltage (V)
600
400
200
0
-200
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
time (s)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF

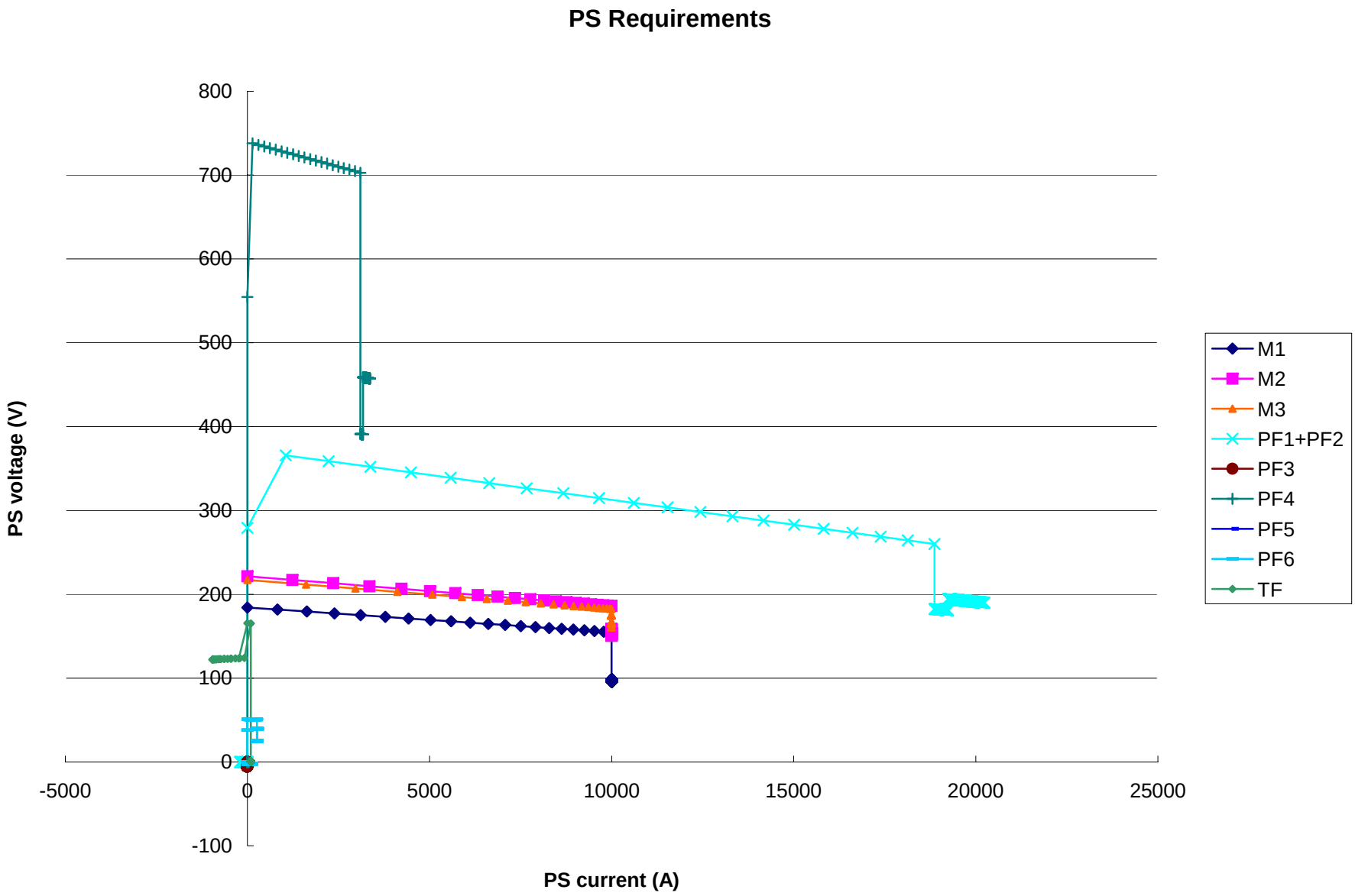

PS Current
PS Current (A)
12000
10000
8000
6000
4000
2000
0
-2000
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
time (s)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF

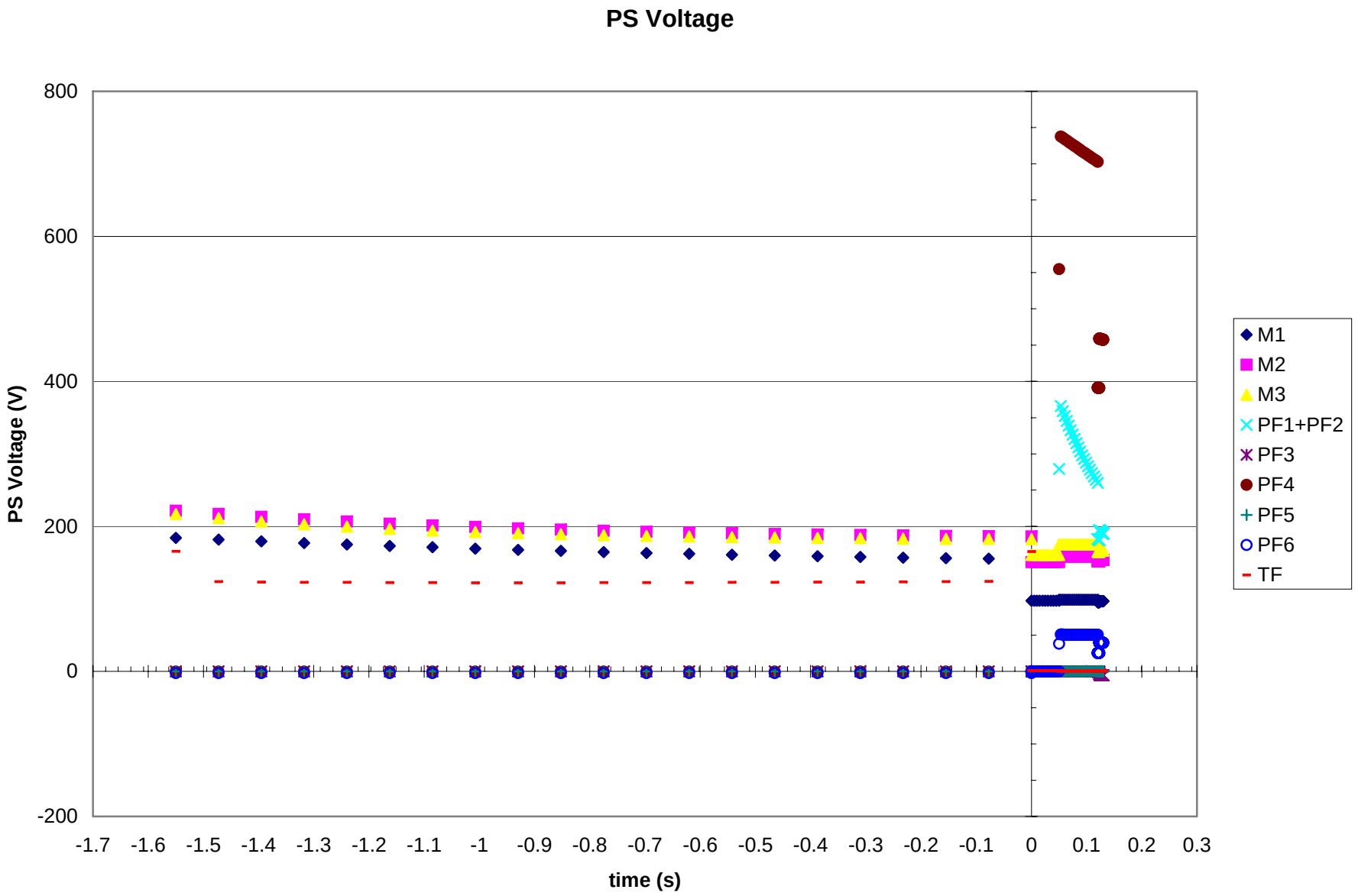

Coil Current
Current (A)
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
Time (s)
M1
M2
M3
PF1
PF2
PF3
PF4
PF5
PF6
TF
Plasma x 0.1

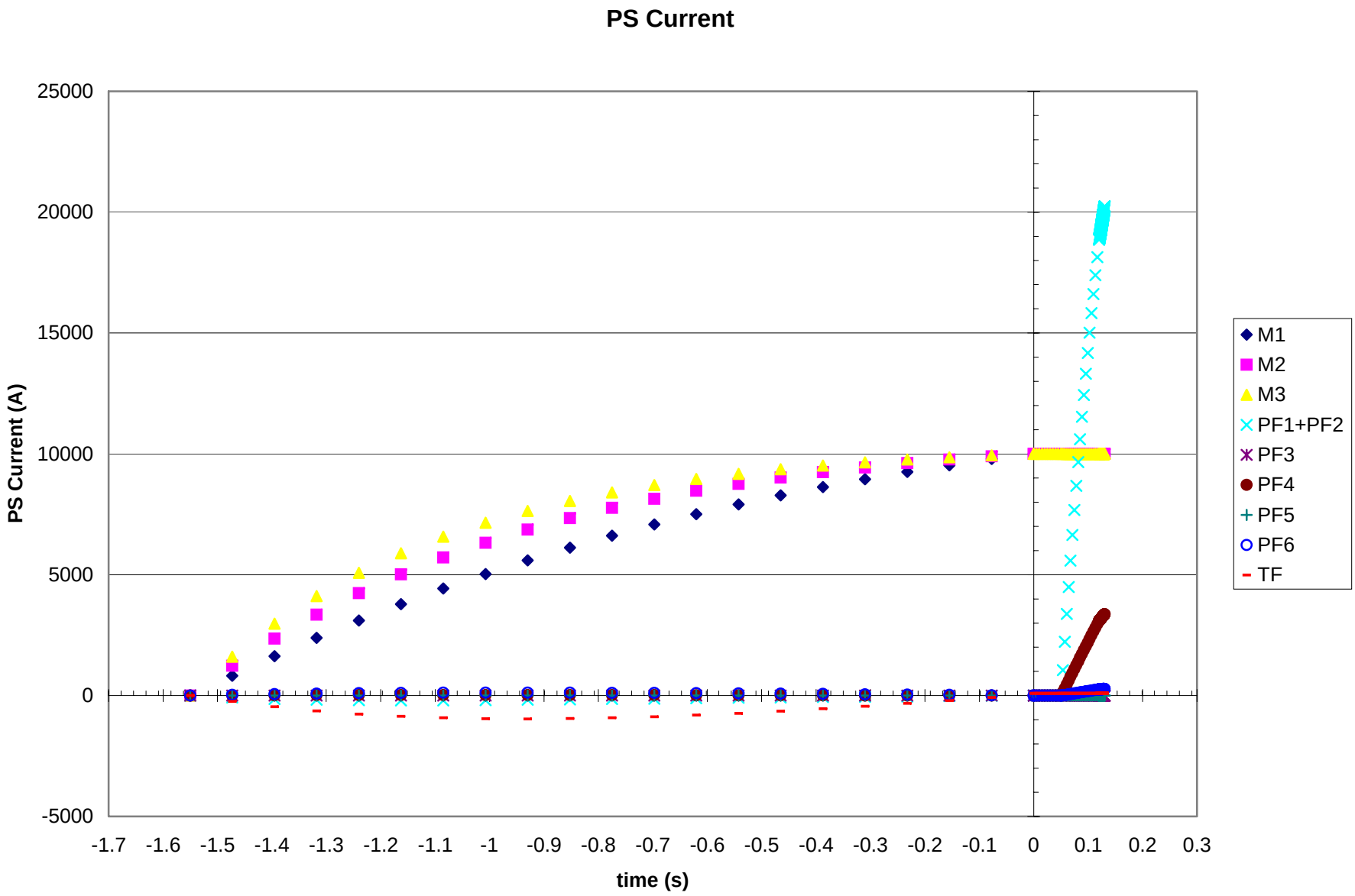

Coil Temperature
Temperature (K)
84.0
83.0
82.0
81.0
80.0
79.0
78.0
77.0
76.0
75.0
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
Time (s)
M1
M2
M3
PF1
PF2
PF3
PF4
PF5
PF6
TF

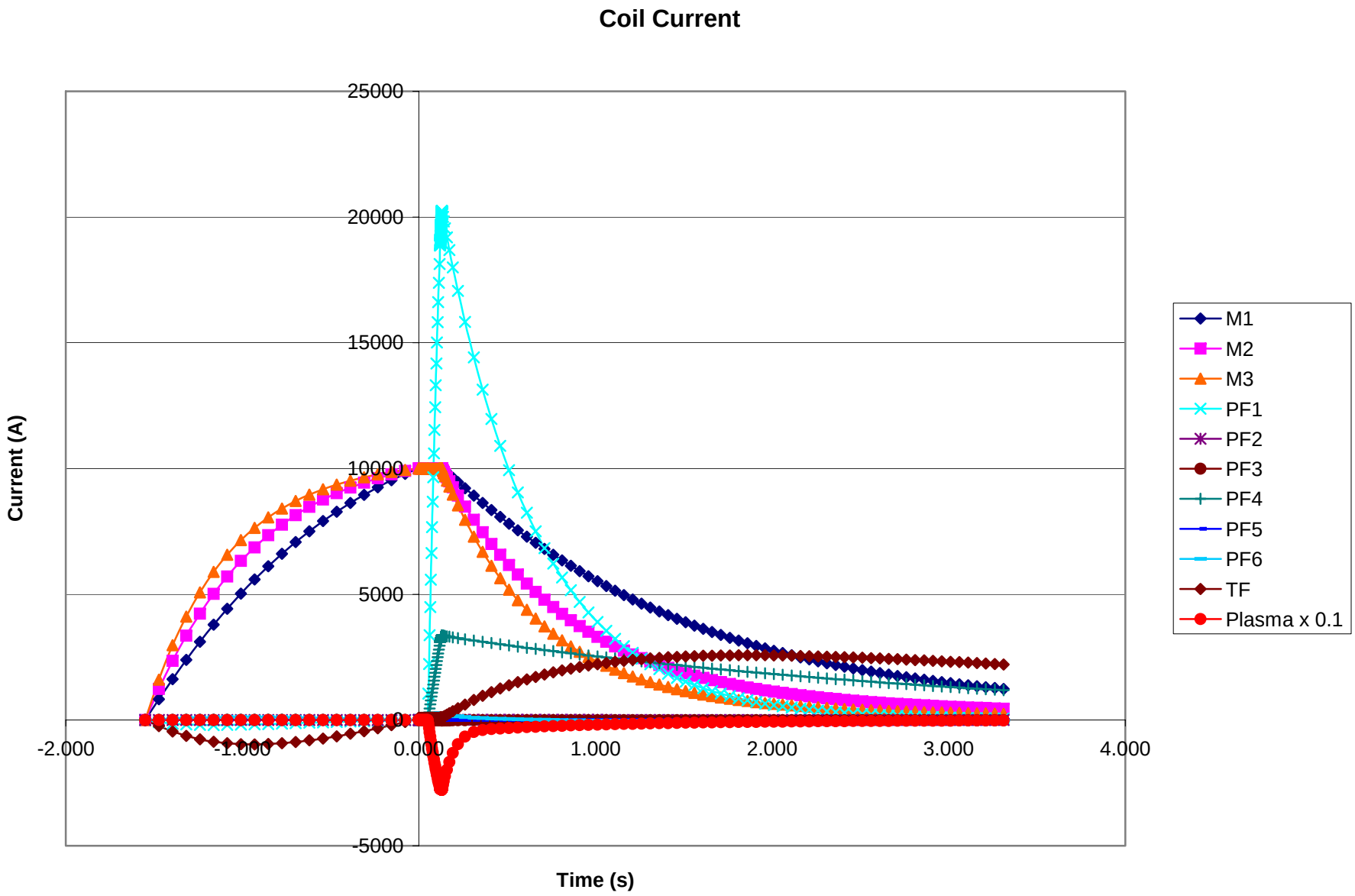
# New configuration with NSTX PF1

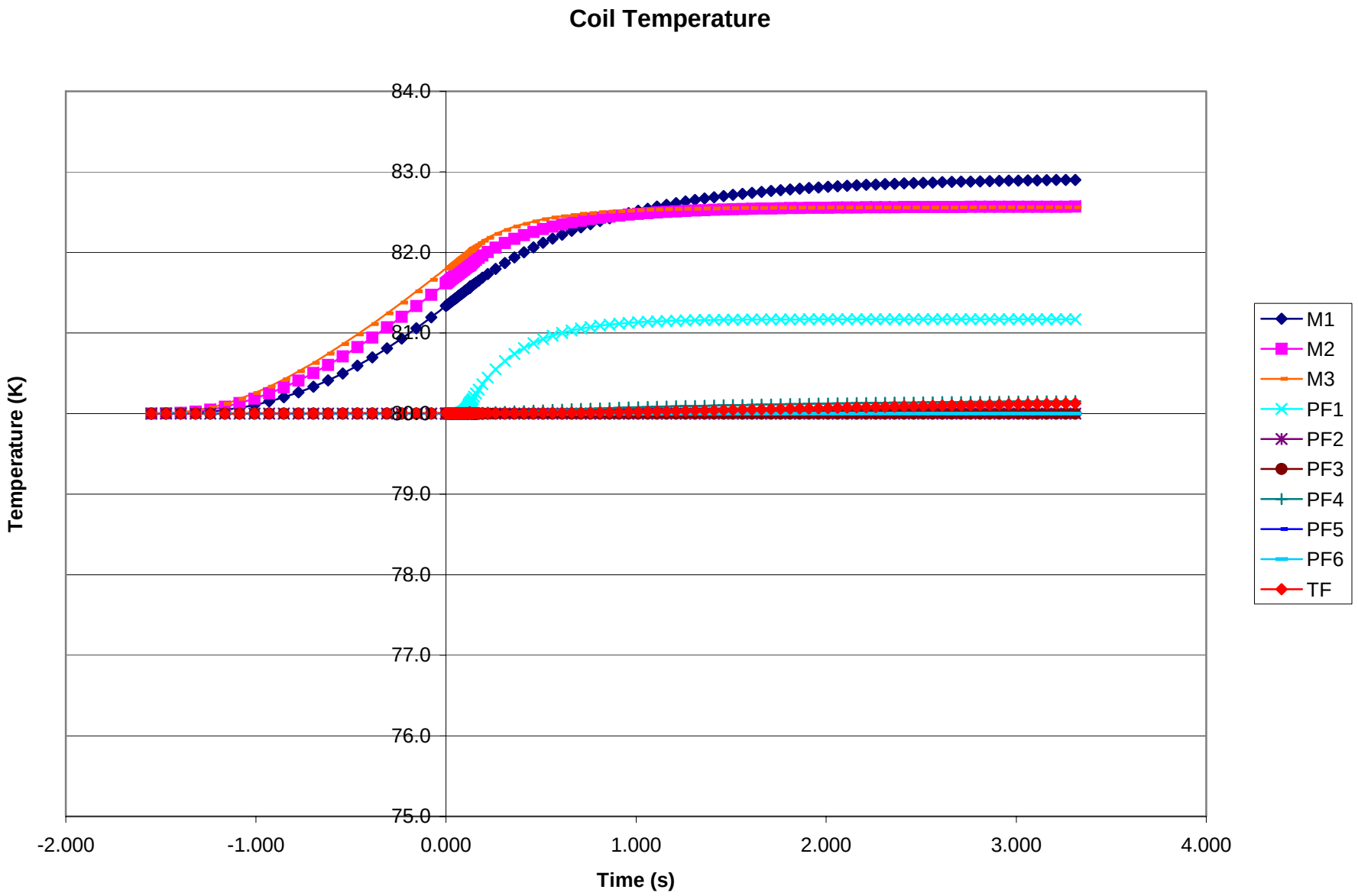
- PF1 centroid located 0.4m off midplane
  - Calculated single turn mutual inductance between plasma and new PF1 based on circular loop at 1.4m. Used same mutual between PF1 and modular coils. New calculation required.
- PF2-3 gone
  - In the model, power supplies targeted for zero current.
- Same scenario.  Plasma IR drop of 1V assumed. Loop voltage is 2V.


PS Requirements
PS voltage (V)
800
700
600
500
400
300
200
100
0
-100
-5000
0
5000
10000
15000
20000
25000
PS current (A)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF


PS Voltage
PS Voltage (V)
800
600
400
200
0
-200
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
time (s)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF

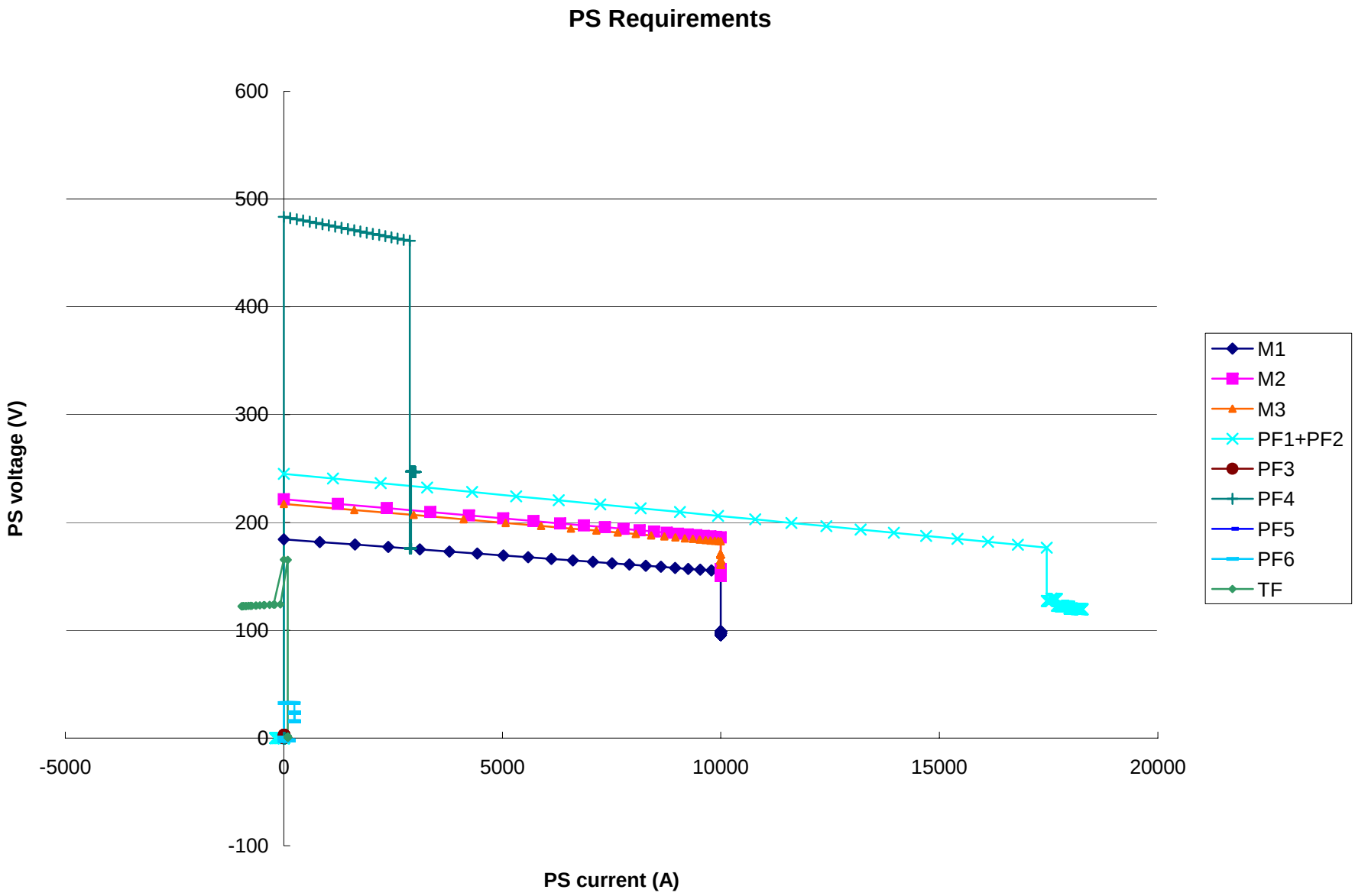

PS Current
PS Current (A)
25000
20000
15000
10000
5000
0
-5000
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
time (s)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF

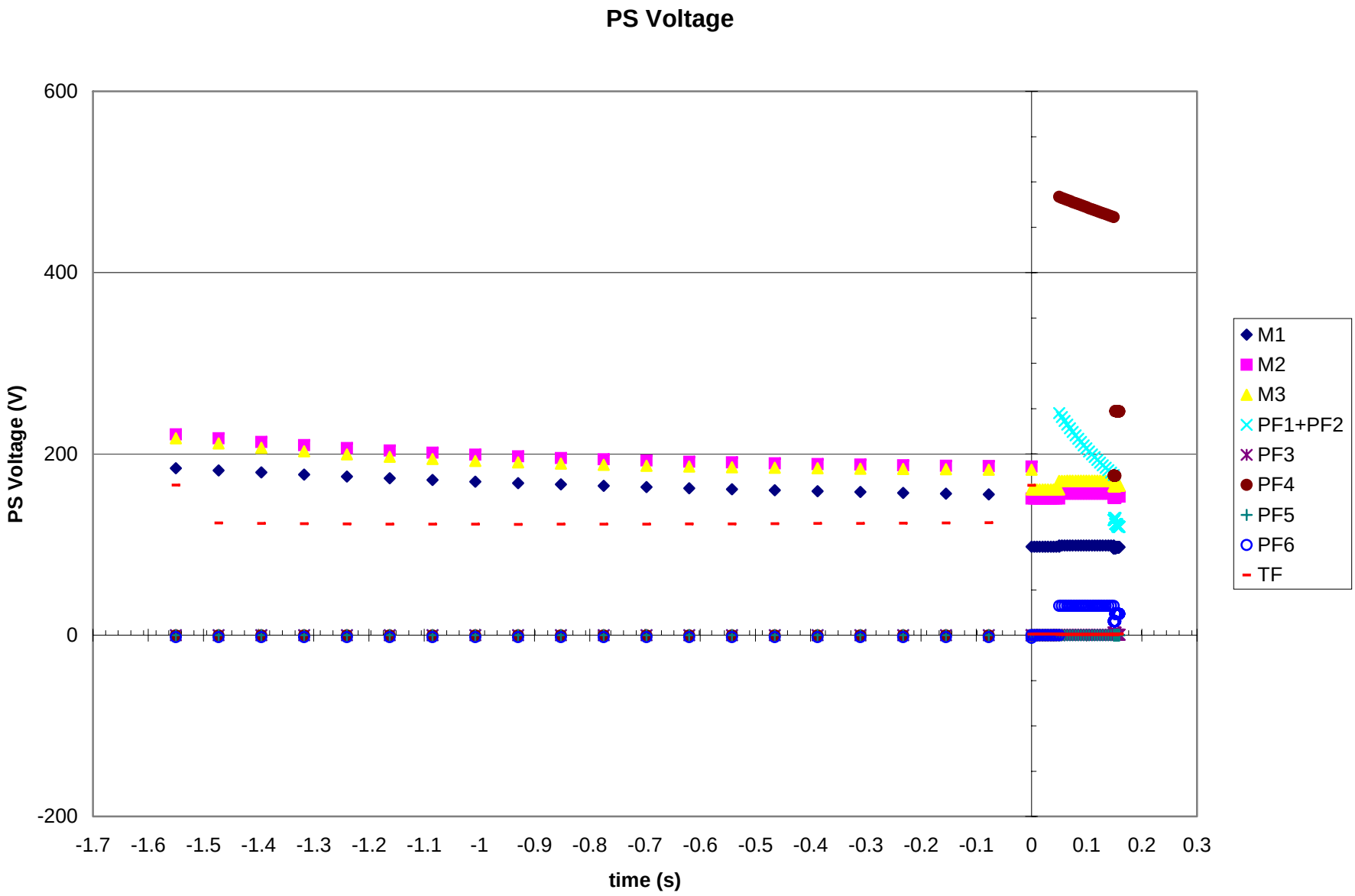

Coil Current
Current (A)
25000
20000
15000
10000
5000
0
-5000
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
Time (s)
M1
M2
M3
PF1
PF2
PF3
PF4
PF5
PF6
TF
Plasma x 0.1

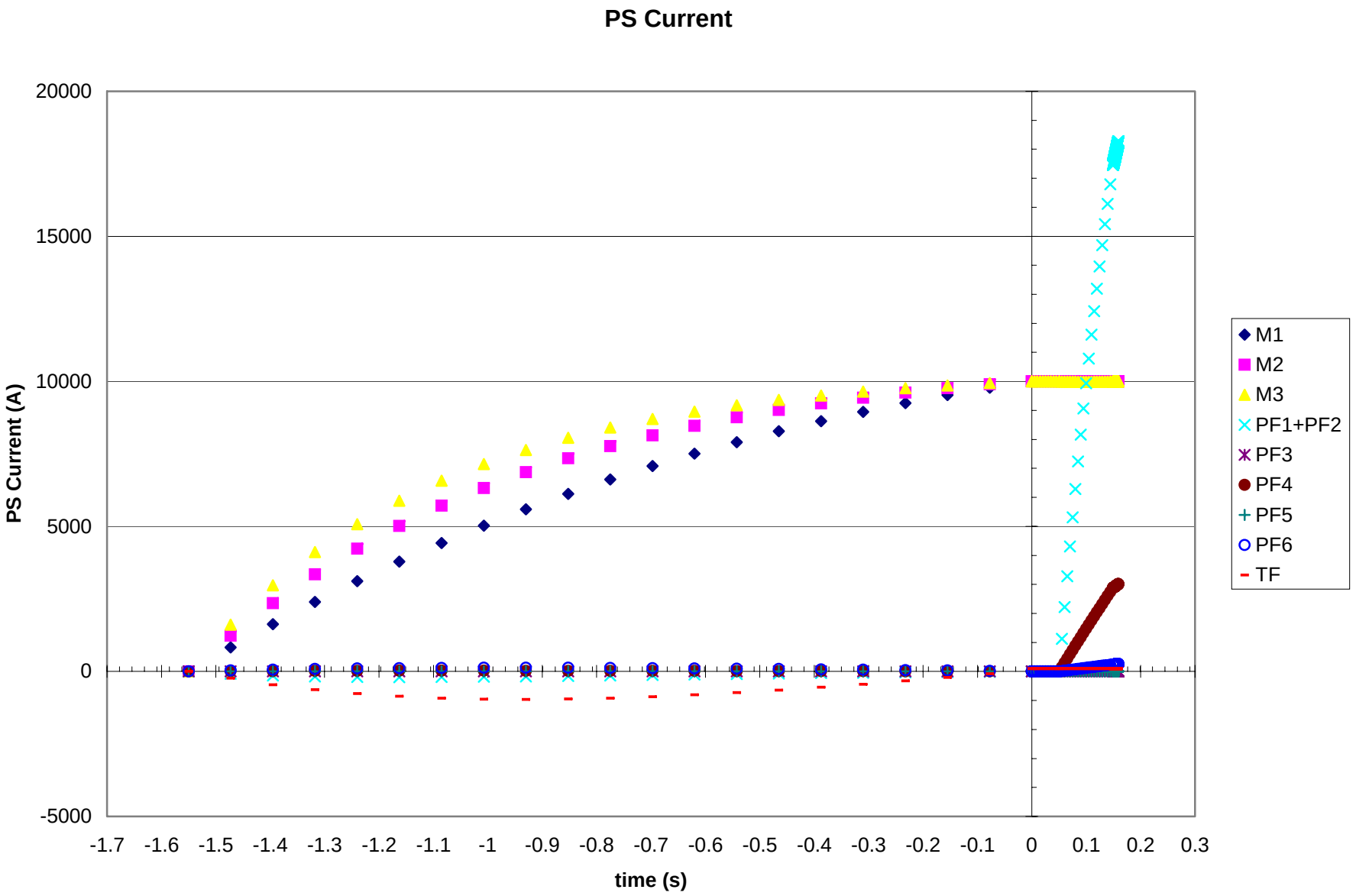

Coil Temperature
Temperature (K)
84.0
83.0
82.0
81.0
80.0
79.0
78.0
77.0
76.0
75.0
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
Time (s)
M1
M2
M3
PF1
PF2
PF3
PF4
PF5
PF6
TF

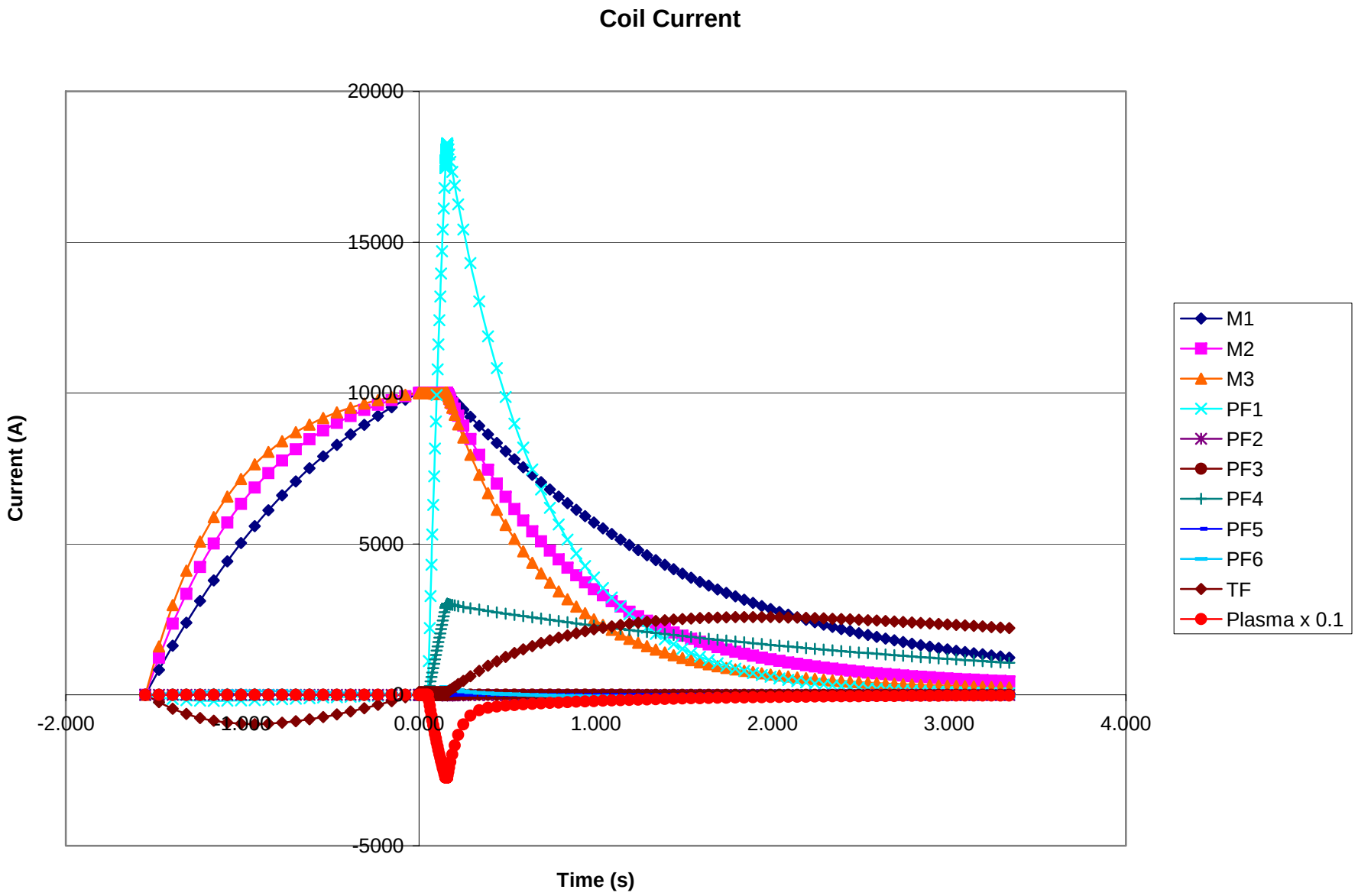
# Problems…

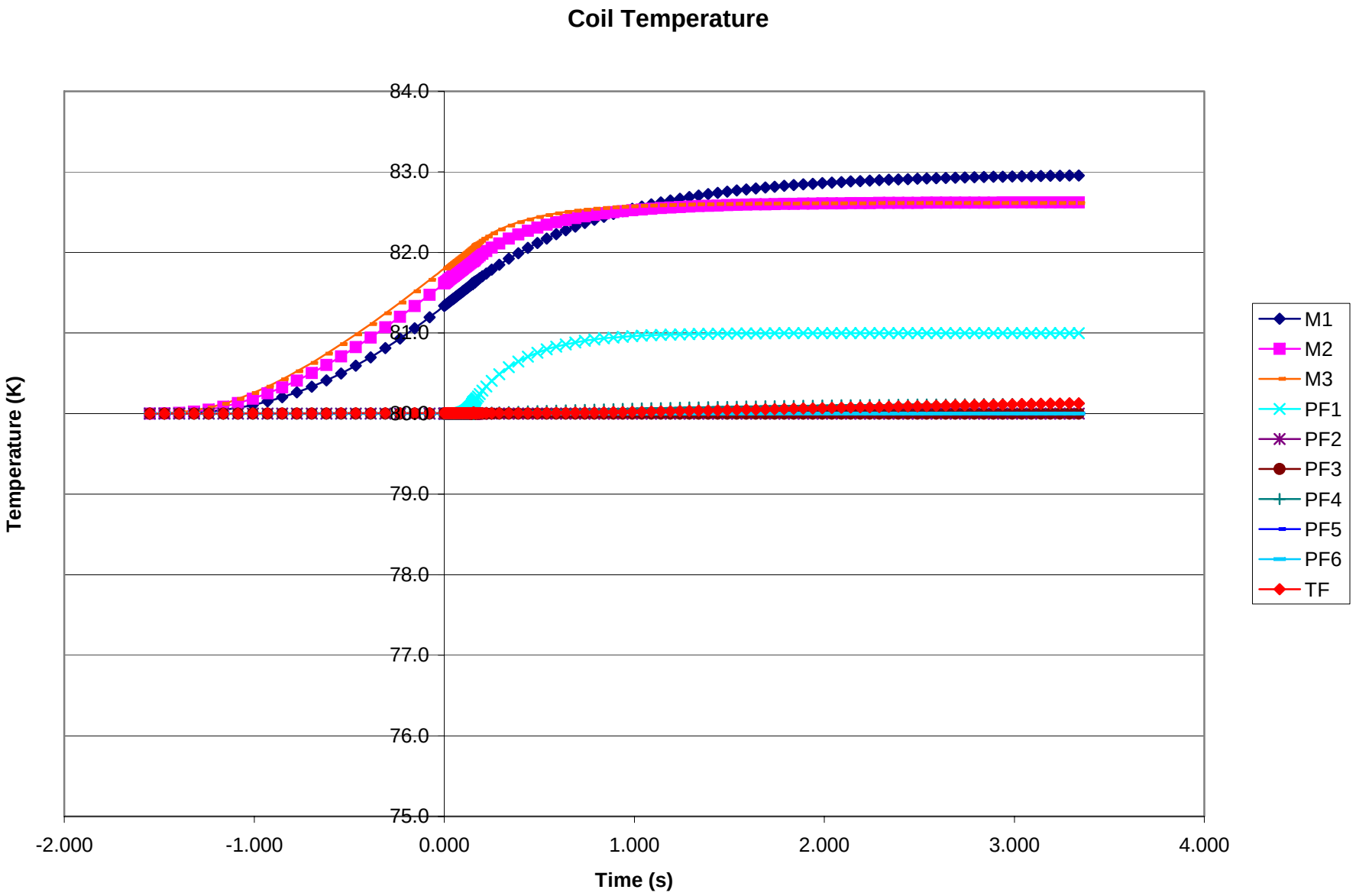
- PF4 requires 4kA and 738V compared to the 5kA and 500V available from the UCLA supply
  - Decrease resistive consumption from 1V to 0.6V
  - Increase current ramp time from 70ms to 100ms (solves PF4 problem)
  - Net change in Vs is -0.01 Vs
- PF1/2 requires 21kA and 370V compared to the 5kA and 600V available from 2 Robicon-5 PS in series
  - Move Robicon-10 (10kA and 200V) from PF6 to TF
  - Put all four Robicon-5 units (5kA and 300V) in parallel for PF1/2 creating a 20kA 300V PS
  - Buy a new 50V 300A supply for PF6 (or better yet, get rid of the TF circuit and keep the Robicon-10 for PF6)


PS Requirements
PS voltage (V)
600
500
400
300
200
100
0
-100
-5000
0
5000
10000
15000
20000
PS current (A)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF


PS Voltage
PS Voltage (V)
600
400
200
0
-200
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
time (s)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF


PS Current
PS Current (A)
20000
15000
10000
5000
0
-5000
-1.7
-1.6
-1.5
-1.4
-1.3
-1.2
-1.1
-1
-0.9
-0.8
-0.7
-0.6
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
time (s)
M1
M2
M3
PF1+PF2
PF3
PF4
PF5
PF6
TF


Coil Current
20000
15000
10000
5000
0
-5000
Current (A)
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
Time (s)
M1
M2
M3
PF1
PF2
PF3
PF4
PF5
PF6
TF
Plasma x 0.1


Coil Temperature
Temperature (K)
84.0
83.0
82.0
81.0
80.0
79.0
78.0
77.0
76.0
75.0
-2.000
-1.000
0.000
1.000
2.000
3.000
4.000
Time (s)
M1
M2
M3
PF1
PF2
PF3
PF4
PF5
PF6
TF

# Results

- PF1 – max I, V is 18.3kA  and 240V compared to 20kA and 300V
- PF4 – max I, V is 3.0kA and 483V compared to 5kA and 500V
- PF6 – max I, V is 253A and 32V which can be provided by 3 car batteries (or by getting rid of the TF circuit and using the Robicon-10)