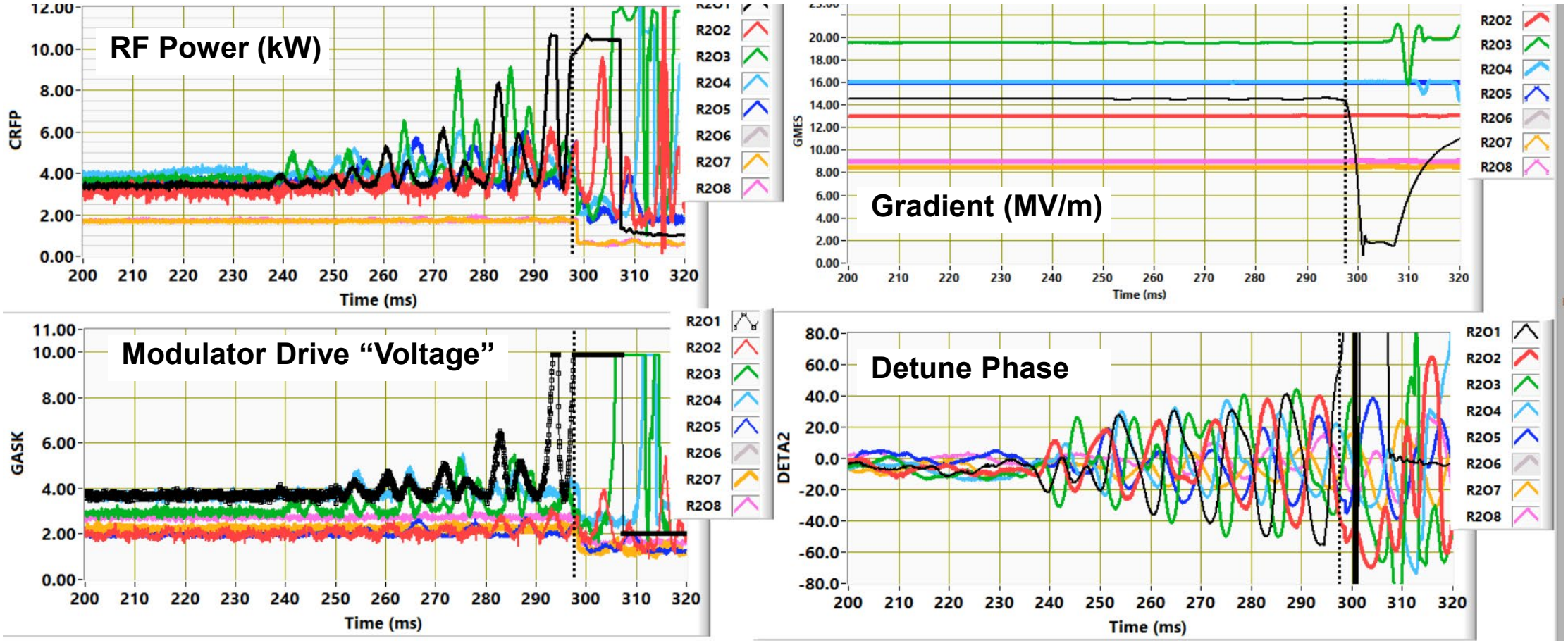
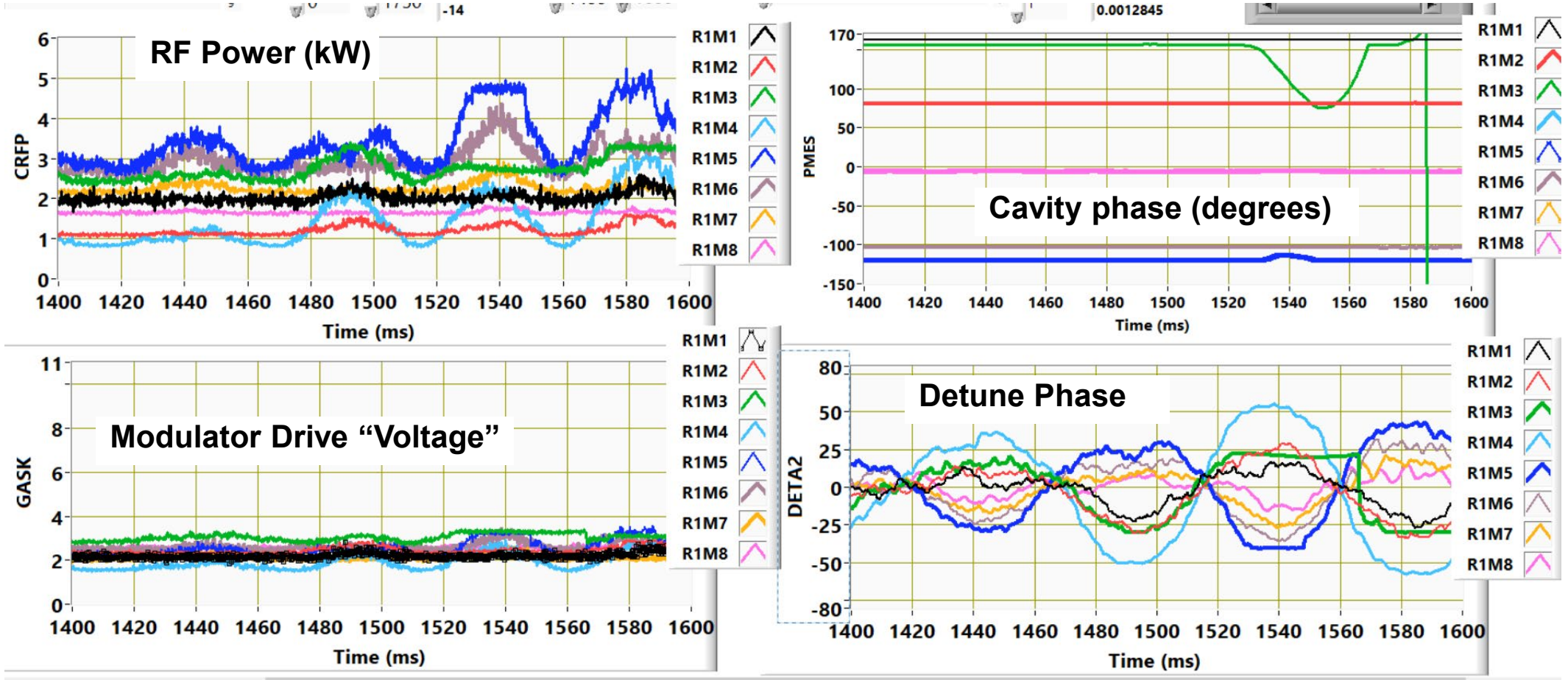
Microphonics trip FCC 2.0 firmware. Things did not trip until system saturated.



- Detune phase $DETA2 = \varphi_{PFWD} - \varphi_{PFieldProbe} - \varphi_{OFFSET}$
- With no beam loading $deltaF = f_0 Tan(DETA2)/2Q_L$
- Cavity continues to operate until the klystron drive (GASK) or the forward power saturates.

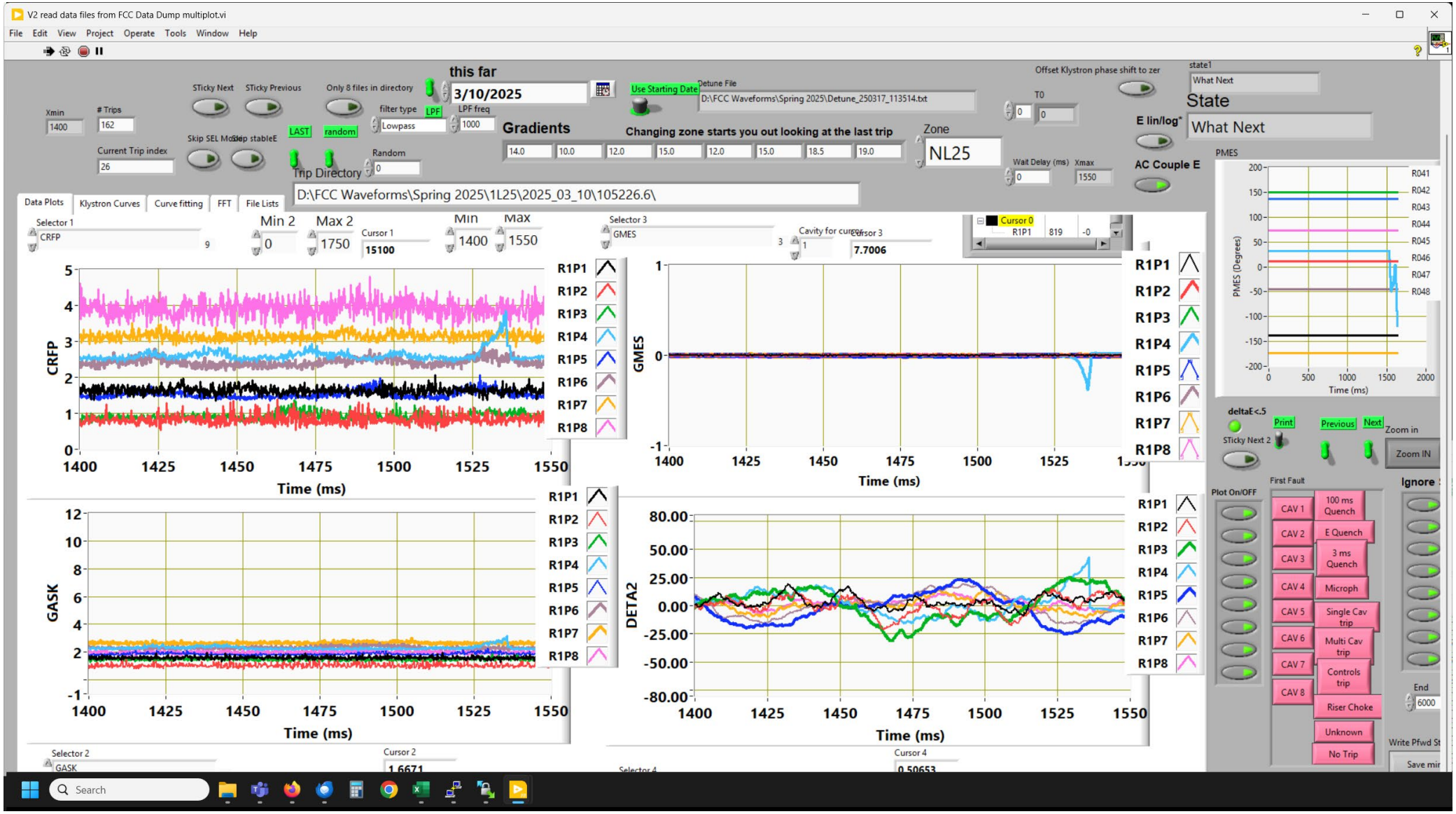
FCC3.0 software loses phase and gradient regulation before RF power saturates

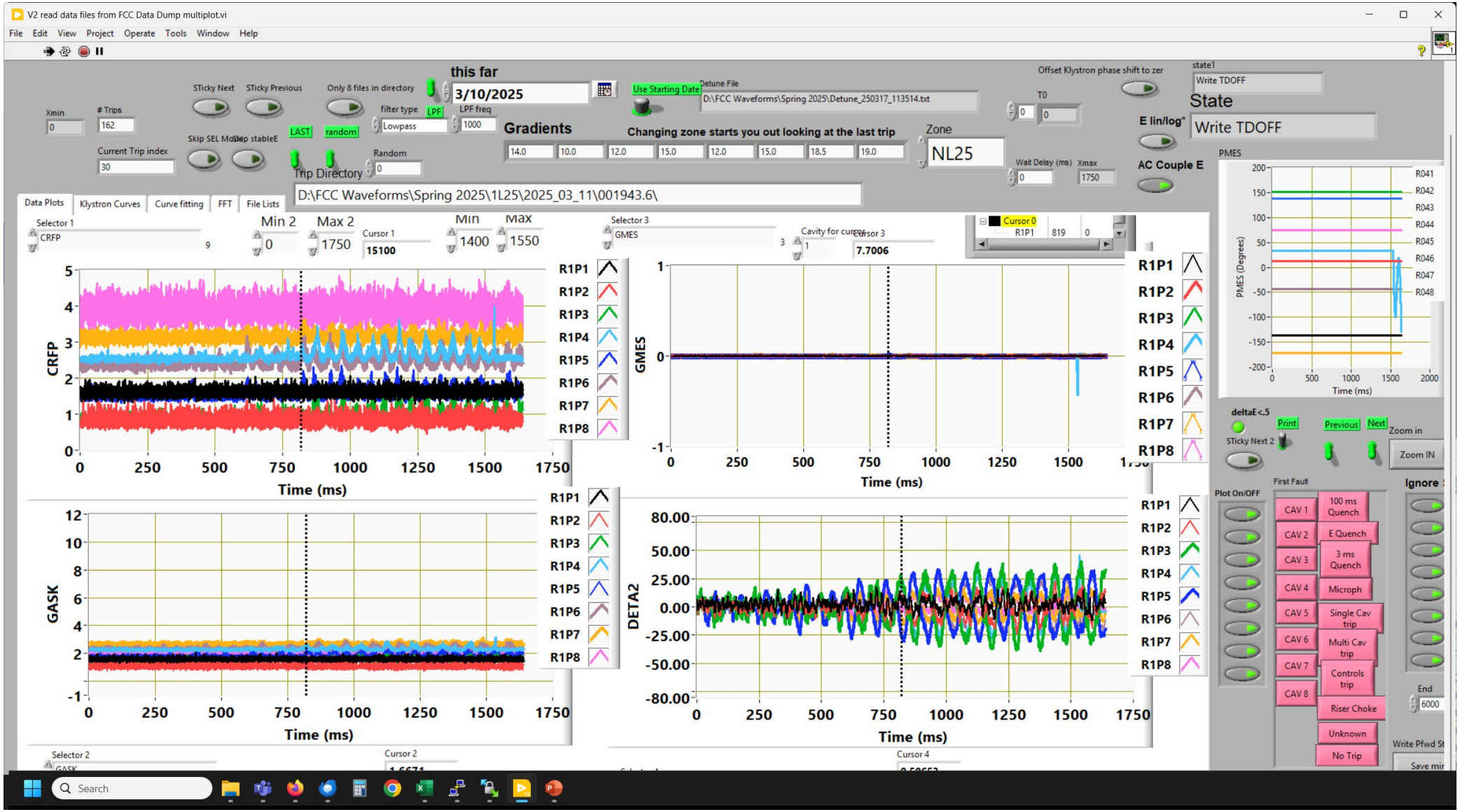


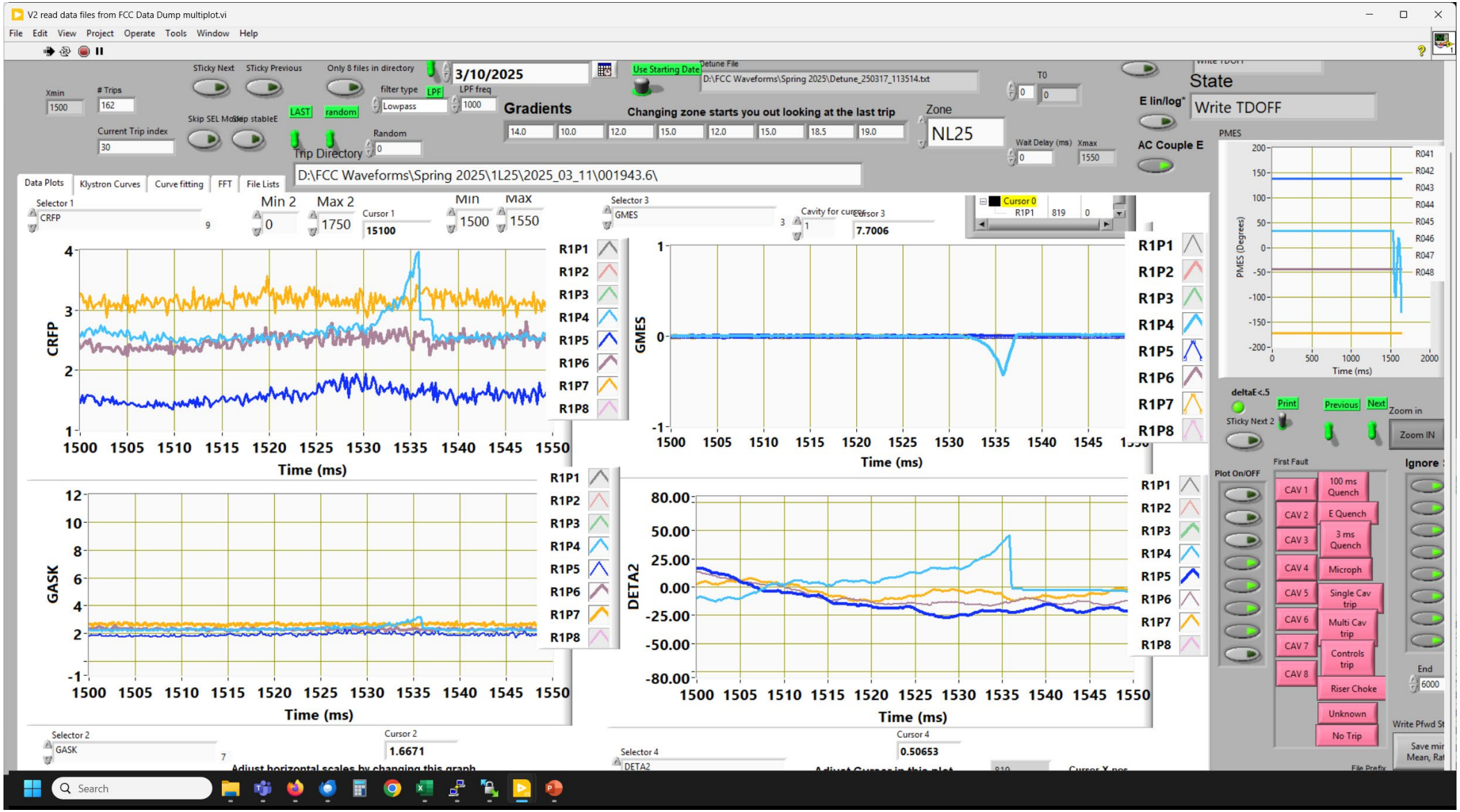
- System calculates the power required to compensate for microphonics and limits the "imaginary" drive signal when it is exceeded by a threshold.
- Cavity loses phase lock before the modulator drive saturates or before you run out of RF power.
- If the detune phase was less than 50° the fault was declared to be a controls fault.

TESLA TECHNOLOGY COLLABORATION

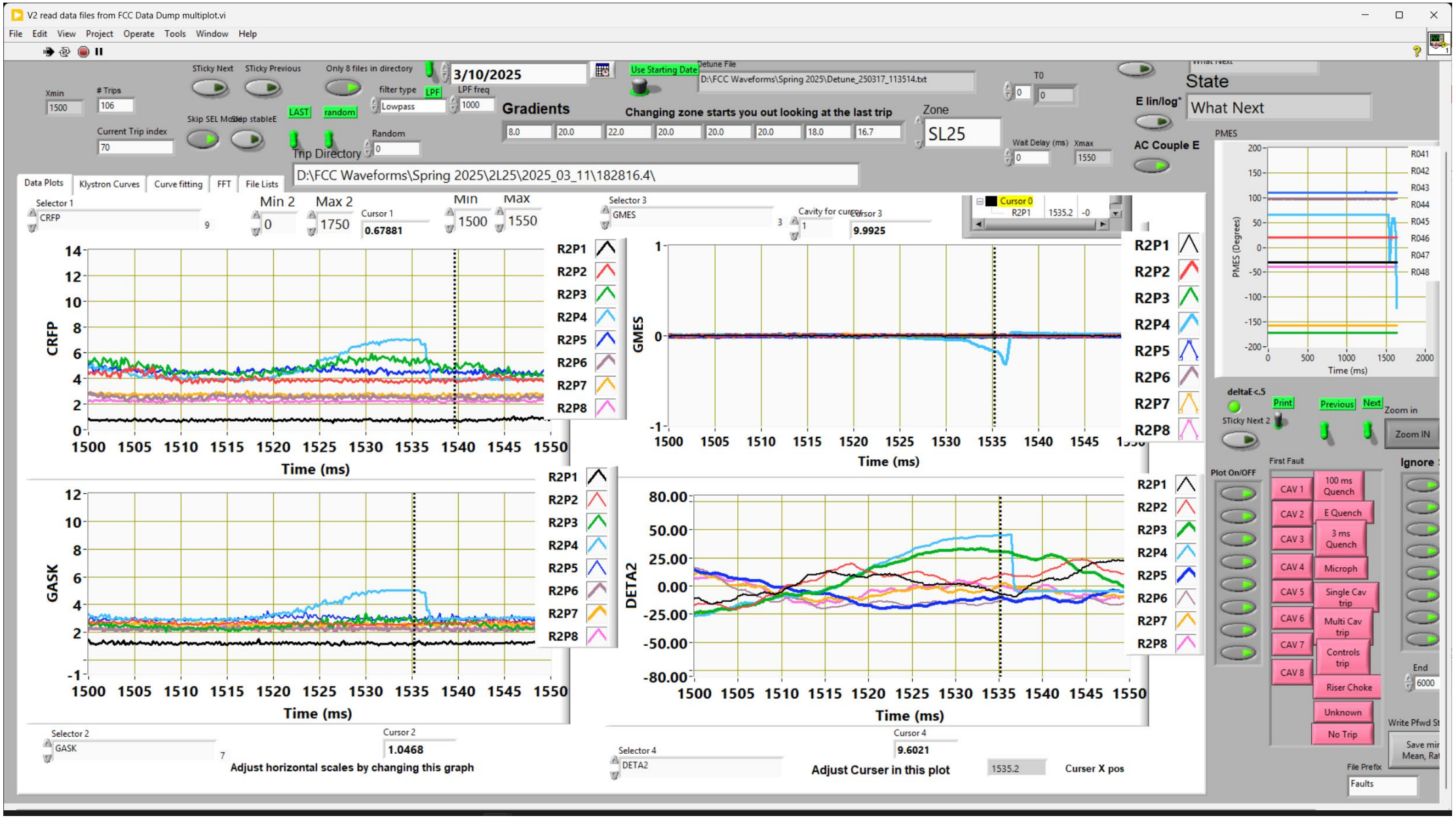
Jefferson Lab

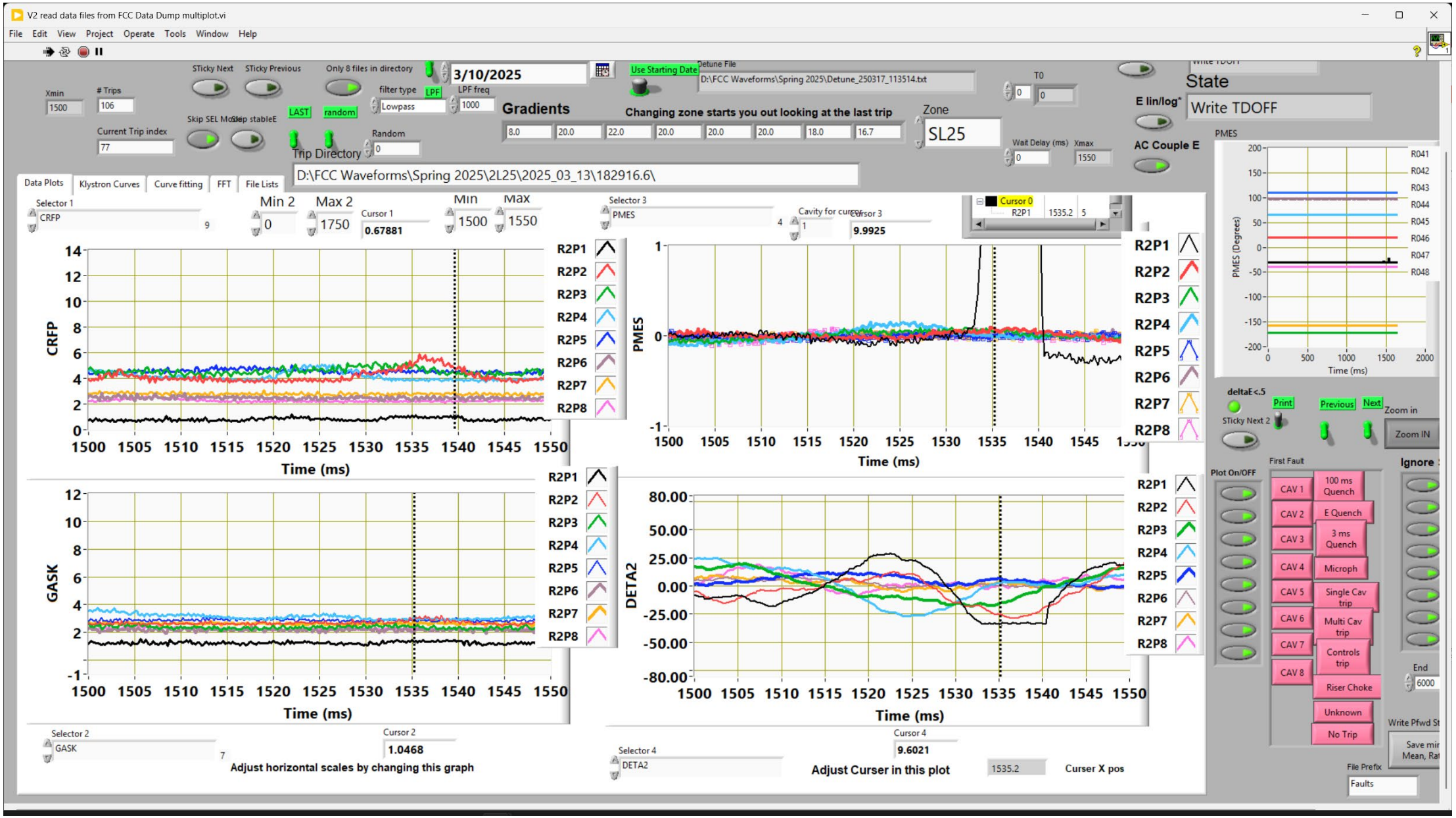

V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
this far
3/10/2025
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Gradients
Changing zone starts you out looking at the last trip
Zone
NL25
State
What Next
Trip Directory
D:\FCC Waveforms\Spring 2025\1L25\2025_03_10\105226.6\
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
CRFP
GMES
GASK
DETA2
Time (ms)
PMES
PMES (Degrees)
R1P1
R1P2
R1P3
R1P4
R1P5
R1P6
R1P7
R1P8
R041
R042
R043
R044
R045
R046
R047
R048
deltaE<.5
Print
Previous
Next
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Search

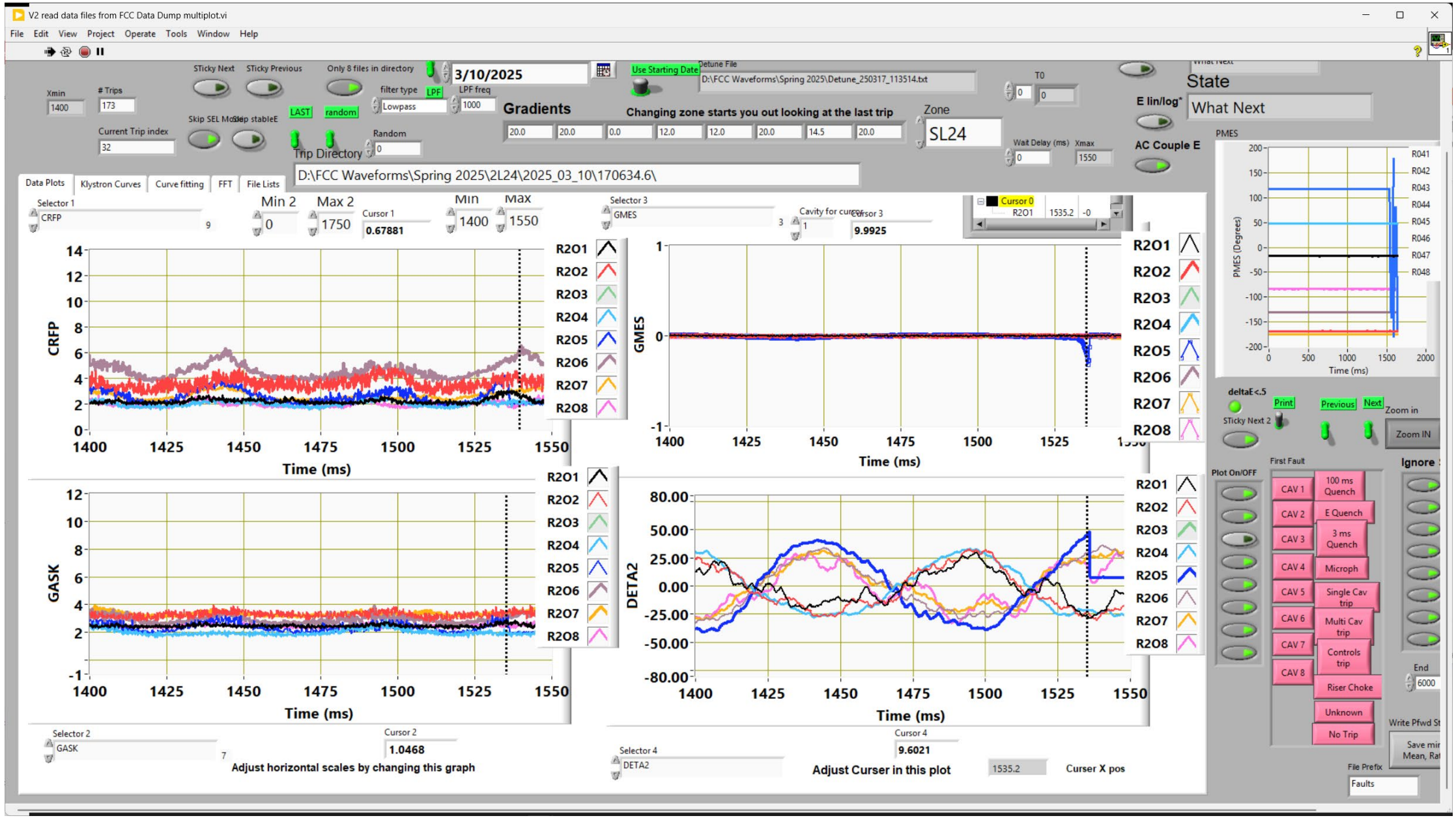

V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
this far
3/10/2025
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Offset Klystron phase shift to zer
state1
Write TDOFF
State
Write TDOFF
Xmin
Trips
162
Current Trip index
30
STicky Next
STicky Previous
Only 8 files in directory
filter type
Lowpass
LPF
LPF freq
1000
LAST
random
Random
Gradients
Changing zone starts you out looking at the last trip
14.0 10.0 12.0 15.0 12.0 15.0 18.5 19.0
Zone
NL25
T0
Wait Delay (ms)
Xmax
1750
E lin/log
AC Couple E
Trip Directory
D:\FCC Waveforms\Spring 2025\1L25\2025_03_11\001943.6\
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
Selector 1
CRFP
Min 2
Max 2
0
1750
Cursor 1
15100
Min
Max
1400
1550
CRFP
Time (ms)
R1P1
R1P2
R1P3
R1P4
R1P5
R1P6
R1P7
R1P8
Selector 3
GMES
Cavity for cursor
Cursor 3
7.7006
Cursor 0
R1P1 819 0
GMES
Time (ms)
PMES
PMES (Degrees)
Time (ms)
R041
R042
R043
R044
R045
R046
R047
R048
deltaE<.5
Print
Previous
Next
STicky Next 2
Zoom in
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Ignore
End
6000
Write Pfwd St
Save mir
GASK
DETA2
Selector 2
Cursor 2
Cursor 4
Search


V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
Xmin
1500
Trips
162
Current Trip index
30
STicky Next
STicky Previous
Skip SEL Mode
Skip stableE
LAST
random
Only 8 files in directory
3/10/2025
filter type
LPF
Lowpass
LPF freq
1000
Random
0
Trip Directory
D:\FCC Waveforms\Spring 2025\1L25\2025_03_11\001943.6\
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Gradients
Changing zone starts you out looking at the last trip
14.0
10.0
12.0
15.0
12.0
15.0
18.5
19.0
Zone
NL25
T0
Wait Delay (ms)
Xmax
1550
E lin/log
AC Couple E
State
Write TDOFF
PMES
PMES (Degrees)
Time (ms)
R041
R042
R043
R044
R045
R046
R047
R048
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
Selector 1
CRFP
Min 2
0
Max 2
1750
Cursor 1
15100
Min
1500
Max
1550
CRFP
Time (ms)
Selector 3
GMES
Cavity for curser
Cursor 3
7.7006
Cursor 0
R1P1
819
GMES
Time (ms)
R1P1
R1P2
R1P3
R1P4
R1P5
R1P6
R1P7
R1P8
GASK
Time (ms)
DETA2
Time (ms)
Selector 2
GASK
Cursor 2
1.6671
Selector 4
DETA2
Cursor 4
0.50653
deltaE<.5
Print
Previous
Next
STicky Next 2
Zoom in
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Ignore
End
6000
Write Pfwd St
Save mir
Mean, Rat
File Prefix
Search


V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
Xmin
1400
Trips
138
Current Trip index
4
STicky Next
STicky Previous
Only 8 files in directory
3/10/2025
filter type
LPF
LPF freq
Lowpass
1000
Skip SEL Mode
Skip stableE
LAST
random
Random
0
Trip Directory
D:\FCC Waveforms\Spring 2025\1L26\2025_03_10\224427.9\
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Gradients
Changing zone starts you out looking at the last trip
11.0
10.0
0.0
15.0
14.5
15.5
15.0
16.5
Zone
NL26
T0
Wait Delay (ms)
Xmax
1550
E lin/log*
AC Couple E
State
Check Fault
PMES
PMES (Degrees)
Time (ms)
R041
R042
R043
R044
R045
R046
R047
R048
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
Selector 1
CRFP
Min 2
0
Max 2
1750
Cursor 1
1.764
Min
1400
Max
1550
CRFP
Time (ms)
R1Q1
R1Q2
R1Q3
R1Q4
R1Q5
R1Q6
R1Q7
R1Q8
Selector 3
GMES
Cavity for cursor
Cursor 3
14.001
Cursor 0
R1Q1
1536
11
GMES
Time (ms)
GASK
Time (ms)
DETA2
Time (ms)
Selector 2
GASK
Cursor 2
1.6223
Adjust horizontal scales by changing this graph
Selector 4
DETA2
Cursor 4
11.508
Adjust Curser in this plot
1536
Curser X pos
deltaE<.5
STicky Next 2
Print
Previous
Next
Zoom in
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Ignore
End
6000
Write Pfwd St
Save mir
Mean, Rat
File Prefix
Faults


V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
Xmin
1500
Trips
106
Current Trip index
70
STicky Next
STicky Previous
Skip SEL Mode
Skip stableE
Only 8 files in directory
LAST
random
Random
3/10/2025
filter type
Lowpass
LPF
LPF freq
1000
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Gradients
Changing zone starts you out looking at the last trip
8.0
20.0
22.0
20.0
20.0
20.0
18.0
16.7
Zone
SL25
T0
Wait Delay (ms)
Xmax
1550
E lin/log
AC Couple E
State
What Next
Trip Directory
D:\FCC Waveforms\Spring 2025\2L25\2025_03_11\182816.4\
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
Selector 1
CRFP
Min 2
Max 2
0
1750
Cursor 1
0.67881
Min
Max
1500
1550
CRFP
Time (ms)
R2P1
R2P2
R2P3
R2P4
R2P5
R2P6
R2P7
R2P8
Selector 3
GMES
Cavity for cursor
Cursor 3
9.9925
Cursor 0
R2P1
1535.2
-0
GMES
Time (ms)
PMES
PMES (Degrees)
Time (ms)
R041
R042
R043
R044
R045
R046
R047
R048
deltaE<.5
Print
Previous
Next
STicky Next 2
Zoom in
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Ignore
End
6000
Write Pfwd St
Save mir Mean, Ra
File Prefix
Faults
Selector 2
GASK
Cursor 2
1.0468
GASK
Time (ms)
Adjust horizontal scales by changing this graph
Selector 4
DETA2
Cursor 4
9.6021
DETA2
Time (ms)
Adjust Curser in this plot
1535.2
Curser X pos


V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
Xmin
1500
Trips
106
Current Trip index
77
STicky Next
STicky Previous
Only 8 files in directory
3/10/2025
filter type
Lowpass
LPF
LPF freq
1000
LAST
random
Random
0
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Gradients
Changing zone starts you out looking at the last trip
8.0
20.0
22.0
20.0
20.0
20.0
18.0
16.7
Zone
SL25
T0
Wait Delay (ms)
Xmax
1550
State
Write TDOFF
E lin/log
AC Couple E
Trip Directory
D:\FCC Waveforms\Spring 2025\2L25\2025_03_13\182916.6\
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
Selector 1
CRFP
Min 2
0
Max 2
1750
Cursor 1
0.67881
Min
1500
Max
1550
CRFP
Time (ms)
R2P1
R2P2
R2P3
R2P4
R2P5
R2P6
R2P7
R2P8
Selector 3
PMES
Cavity for curser
Cursor 3
9.9925
Cursor 0
R2P1
1535.2
PMES
Time (ms)
PMES
R041
R042
R043
R044
R045
R046
R047
R048
PMES (Degrees)
Time (ms)
deltaE <.5
STicky Next 2
Print
Previous
Next
Zoom in
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Ignore
End
6000
Write Pfwd St
Save mir
Mean, Rat
File Prefix
Faults
GASK
Selector 2
GASK
Cursor 2
1.0468
Adjust horizontal scales by changing this graph
DETA2
Selector 4
DETA2
Cursor 4
9.6021
Adjust Curser in this plot
1535.2
Curser X pos


V2 read data files from FCC Data Dump multiplot.vi
File Edit View Project Operate Tools Window Help
Xmin
1400
Trips
173
Current Trip index
32
STicky Next
STicky Previous
Skip SEL Mode
Skip stableE
LAST
random
Only 8 files in directory
3/10/2025
filter type
Lowpass
LPF
LPF freq
1000
Random
0
Trip Directory
D:\FCC Waveforms\Spring 2025\2L24\2025_03_10\170634.6\
Use Starting Date
Detune File
D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt
Gradients
Changing zone starts you out looking at the last trip
20.0 20.0 0.0 12.0 12.0 20.0 14.5 20.0
Zone
SL24
T0
Wait Delay (ms)
Xmax
1550
State
What Next
E lin/log
AC Couple E
PMES
PMES (Degrees)
Time (ms)
R041 R042 R043 R044 R045 R046 R047 R048
Data Plots
Klystron Curves
Curve fitting
FFT
File Lists
Selector 1
CRFP
Min 2
0
Max 2
1750
Cursor 1
0.67881
Min
1400
Max
1550
Selector 3
GMES
Cavity for cursor
Cursor 3
9.9925
Cursor 0
R2O1 1535.2 -0
CRFP
GMES
GASK
DETA2
Time (ms)
R2O1 R2O2 R2O3 R2O4 R2O5 R2O6 R2O7 R2O8
deltaE<.5
STicky Next 2
Print
Previous
Next
Zoom in
Zoom IN
Plot On/OFF
First Fault
CAV 1
CAV 2
CAV 3
CAV 4
CAV 5
CAV 6
CAV 7
CAV 8
100 ms Quench
E Quench
3 ms Quench
Microph
Single Cav trip
Multi Cav trip
Controls trip
Riser Choke
Unknown
No Trip
Ignore
End
6000
Write Pfwd St
Save mir Mean, Ra
File Prefix
Faults
Selector 2
GASK
Cursor 2
1.0468
Adjust horizontal scales by changing this graph
Selector 4
DETA2
Cursor 4
9.6021
Adjust Curser in this plot
1535.2
Curser X pos

V2 read data files from FCC Data Dump multiplot.vi

File Edit View Project Operate Tools Window Help

Xmin 700 | # Trips 122 | Current Trip index 51 | Skip SEL Mode | Skip stableE | LAST | random | Random 0

STicky Next | STicky Previous | Only 8 files in directory | filter type Lowpass | LPF | LPF freq 1000

3/10/2025 | Use Starting Date | Detune File D:\FCC Waveforms\Spring 2025\Detune_250317_113514.txt

Gradients: 14.2 | 14.3 | 14.0 | 14.1 | 15.8 | 16.1 | 12.3 | 7.7

Changing zone starts you out looking at the last trip

Zone NL10

T0 0 0 | Wait Delay (ms) 0 | Xmax 750

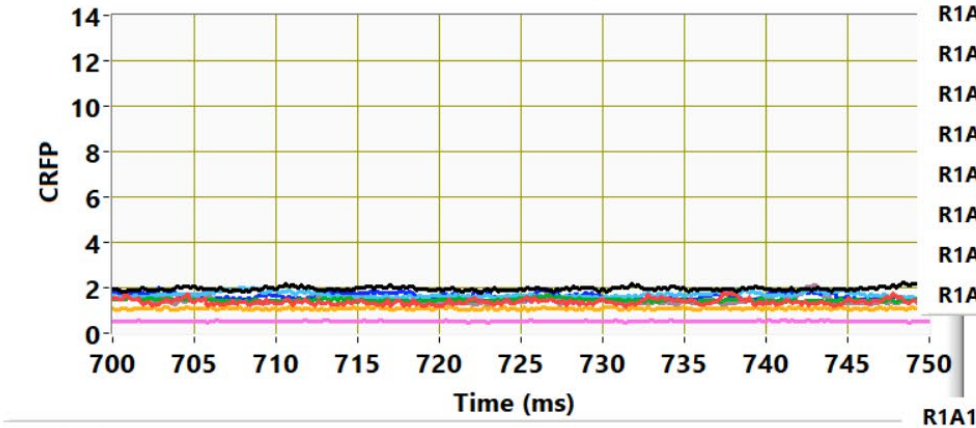
E lin/log* | AC Couple E

State: Check Fault

Trip Directory: D:\FCC Waveforms\Spring 2025\1L10\2025_03_13\184525.5\

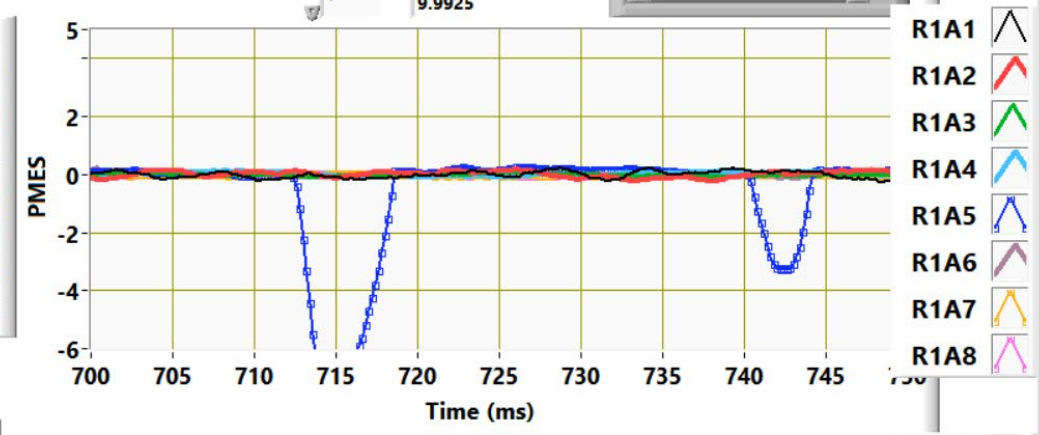
Data Plots | Klystron Curves | Curve fitting | FFT | File Lists

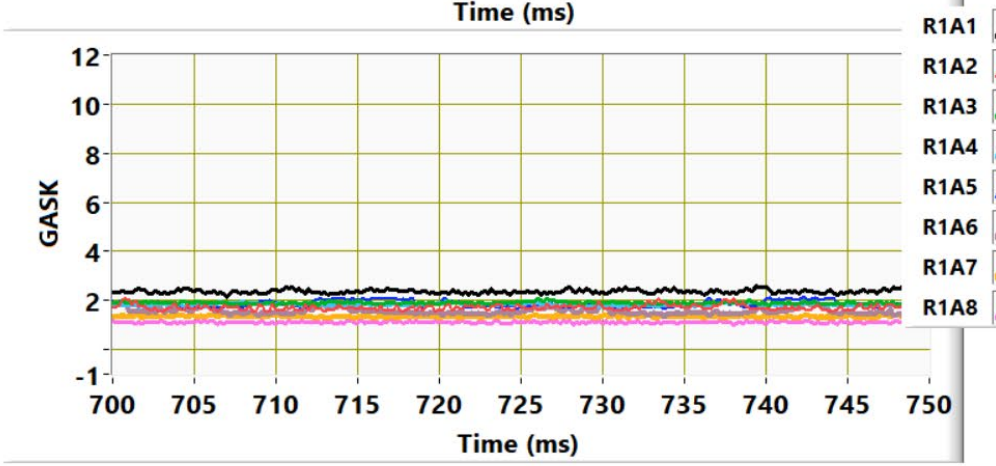
Selector 1: CRFP 11 | Min 2: 0 | Max 2: 850 | Cursor 1: 0.67881

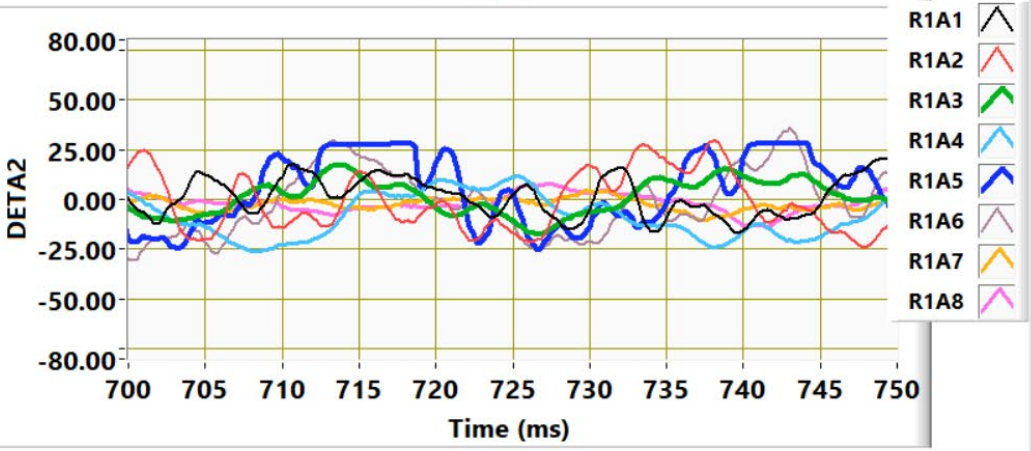


Selector 3: PMES 4 | Cavity for cursor 1 | Cursor 3: 9.9925 | Min 700 | Max 750

Cursor 0 R1A1 819 -0







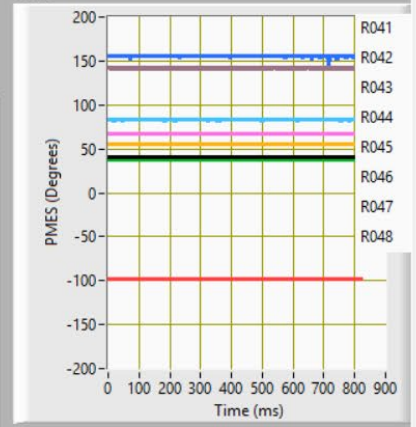
Selector 2: GASK 7 | Cursor 2: 1.0468

Adjust horizontal scales by changing this graph

Selector 4: DETA2 | Cursor 4: 9.6021

Adjust Curser in this plot | 819 | Curser X pos

PMES



deltaE<.5 | Print | Previous | Next | Zoom in | STicky Next 2 | Zoom IN

Plot On/OFF | First Fault | Ignore

CAV 1 | CAV 2 | CAV 3 | CAV 4 | CAV 5 | CAV 6 | CAV 7 | CAV 8

100 ms Quench | E Quench | 3 ms Quench | Microph | Single Cav trip | Multi Cav trip | Controls trip | Riser Choke | Unknown | No Trip

End 6000

Write Pfwd St | Save mir Mean, Rat

File Prefix: Faults