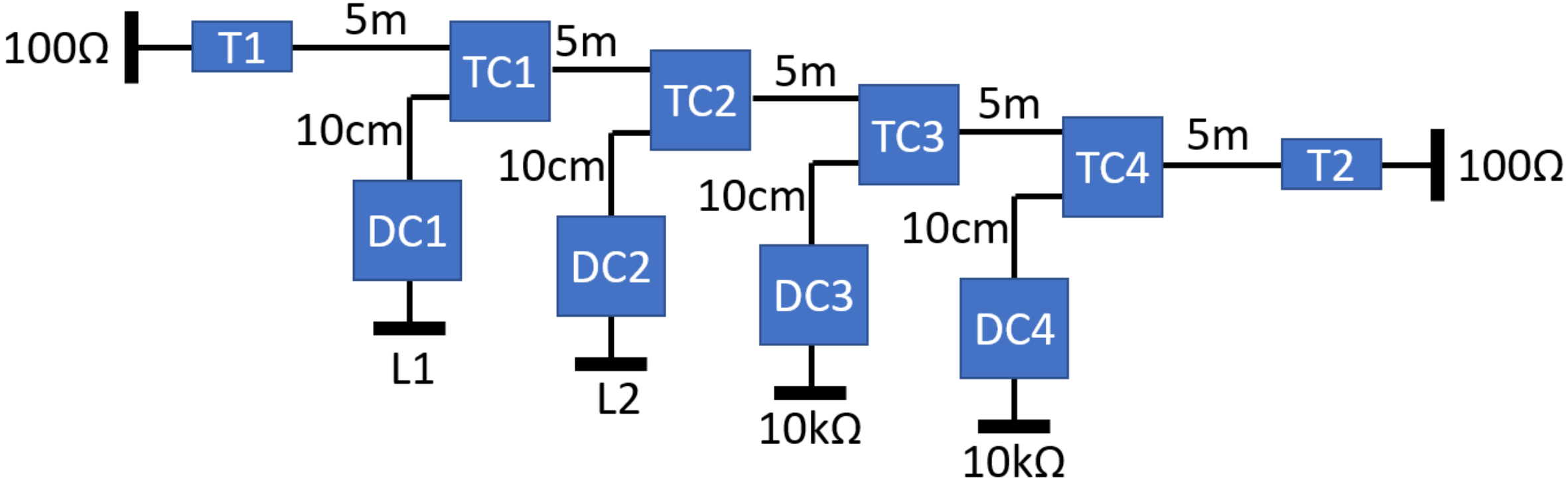
Multi-drop network measurements

Wayne Larsen CommScope

- Special Thanks to Hugh Smith in the electrical test lab in Claremont who made the measurements.

2, 3, and 4 point networks were tested

Configuration #3



What was done

- Networks were built with 2, 3, and 4 attachment points.
- Ends of network were terminated 100 Ohms differential
- 2-way and 3-way ‘couplers’ were used at all connection points including all ends

- All cables are 1-pair 100 Ohm twisted-pair solid copper conductor cables
- All Networks were 25 m long
- Terminations of ends done by applying resistors to cut-off ends of cords
- Measurements were made according to 147.8.1, 147.8.2, and 147.8.3, and measured results were compared with the requirements indicated
- ‘Mode conversion’ interpreted to mean both TCL, measured from one point, like return loss, and TCTL, measured between two points, like insertion loss

What was done continued

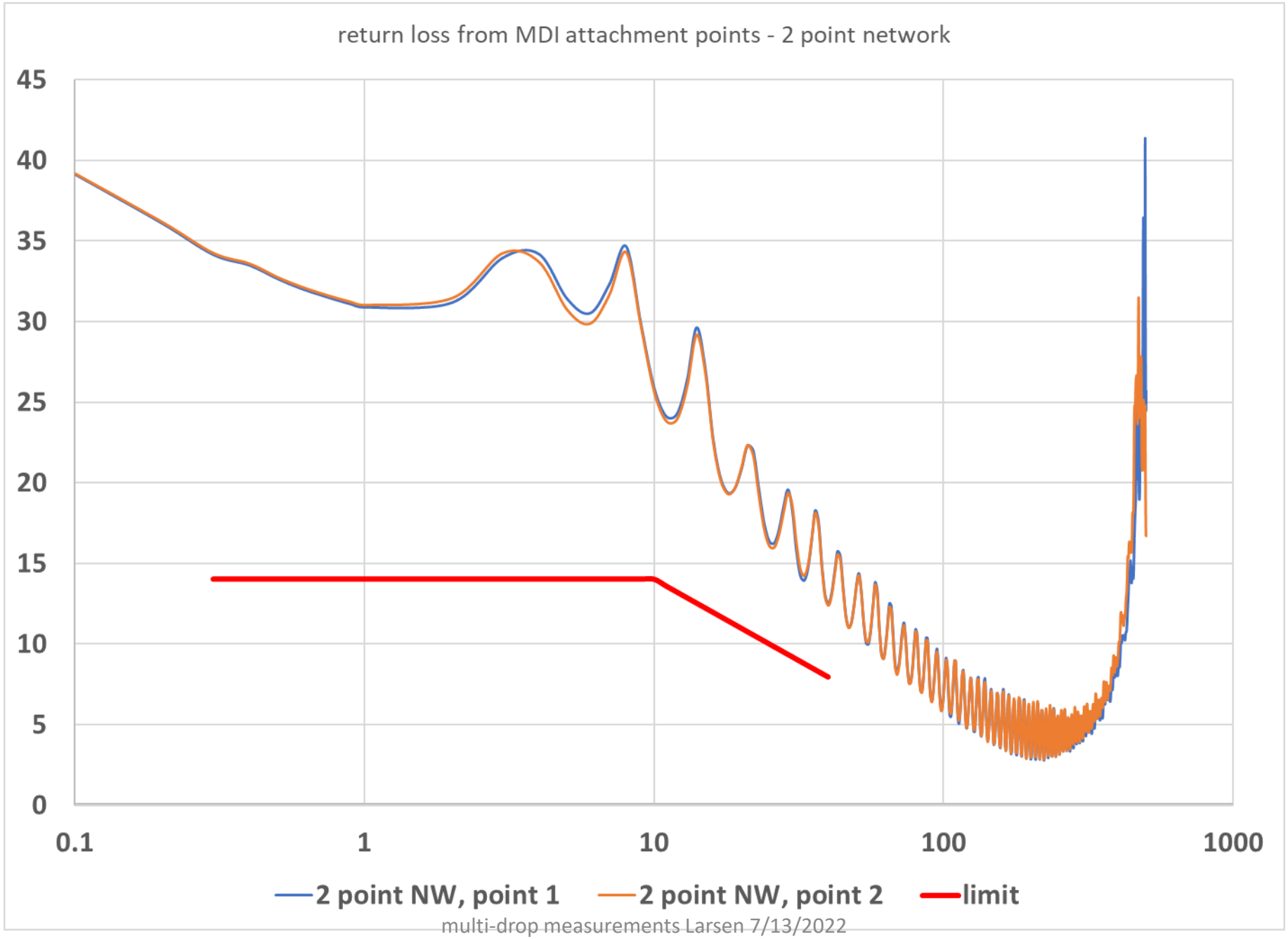
- All unused attachment points were terminated with 10K Ohms
- In each network, each MDI attachment point was measured for return loss and TCL, then each combination of two MDI attachment points was measured for return loss, TCL, insertion loss, and TCTL
- Impedances were transformed so that the ‘launch’ impedance was 50 Ohms and the ‘load’ impedance was 10K Ohms
- Measurements were made from 0.1 MHz to 500 MHz though the requirements are only 0.3-40 for RL and IL and 0.3-200 for mode conversion

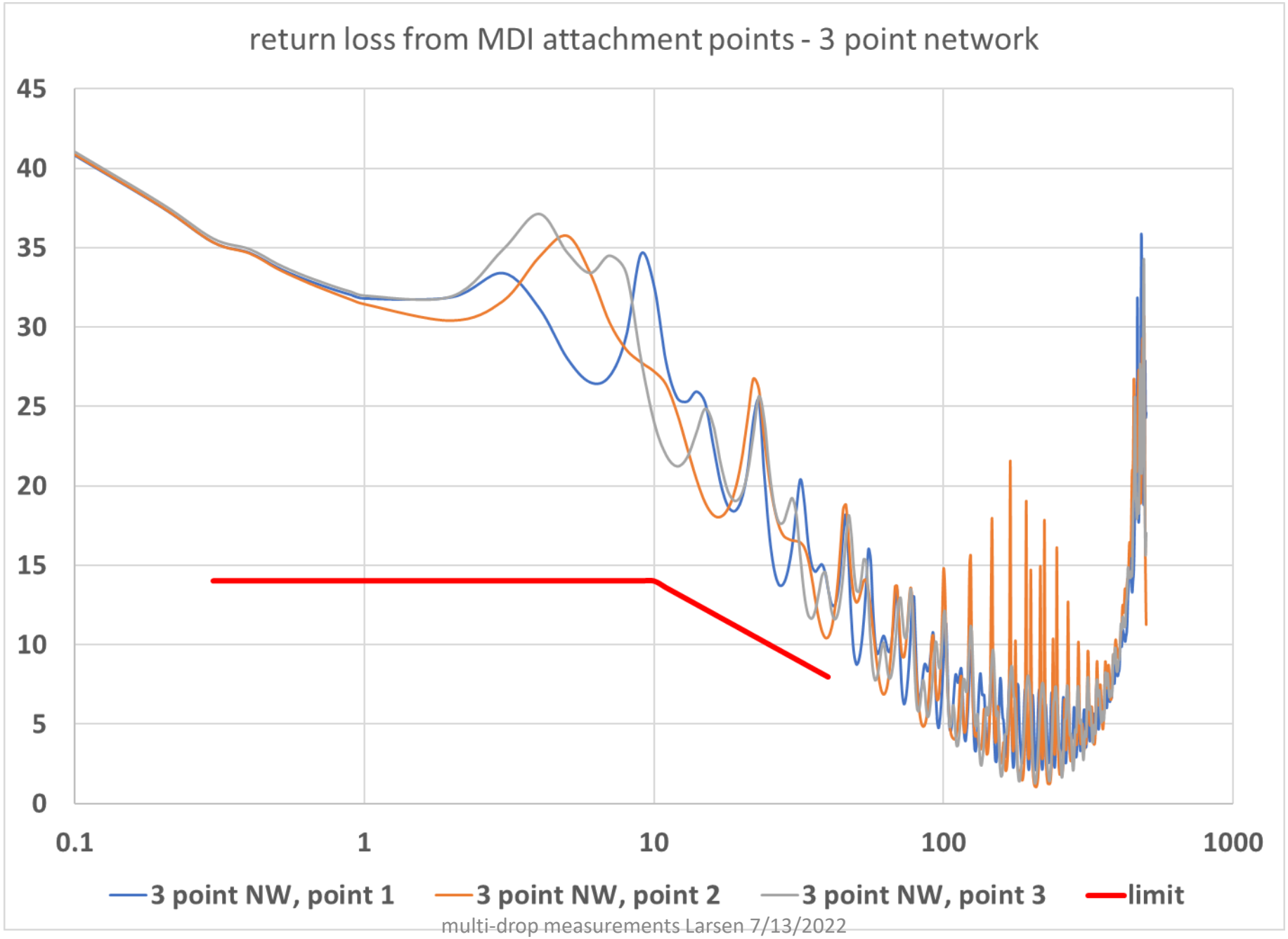
Data follows below. Highlights:

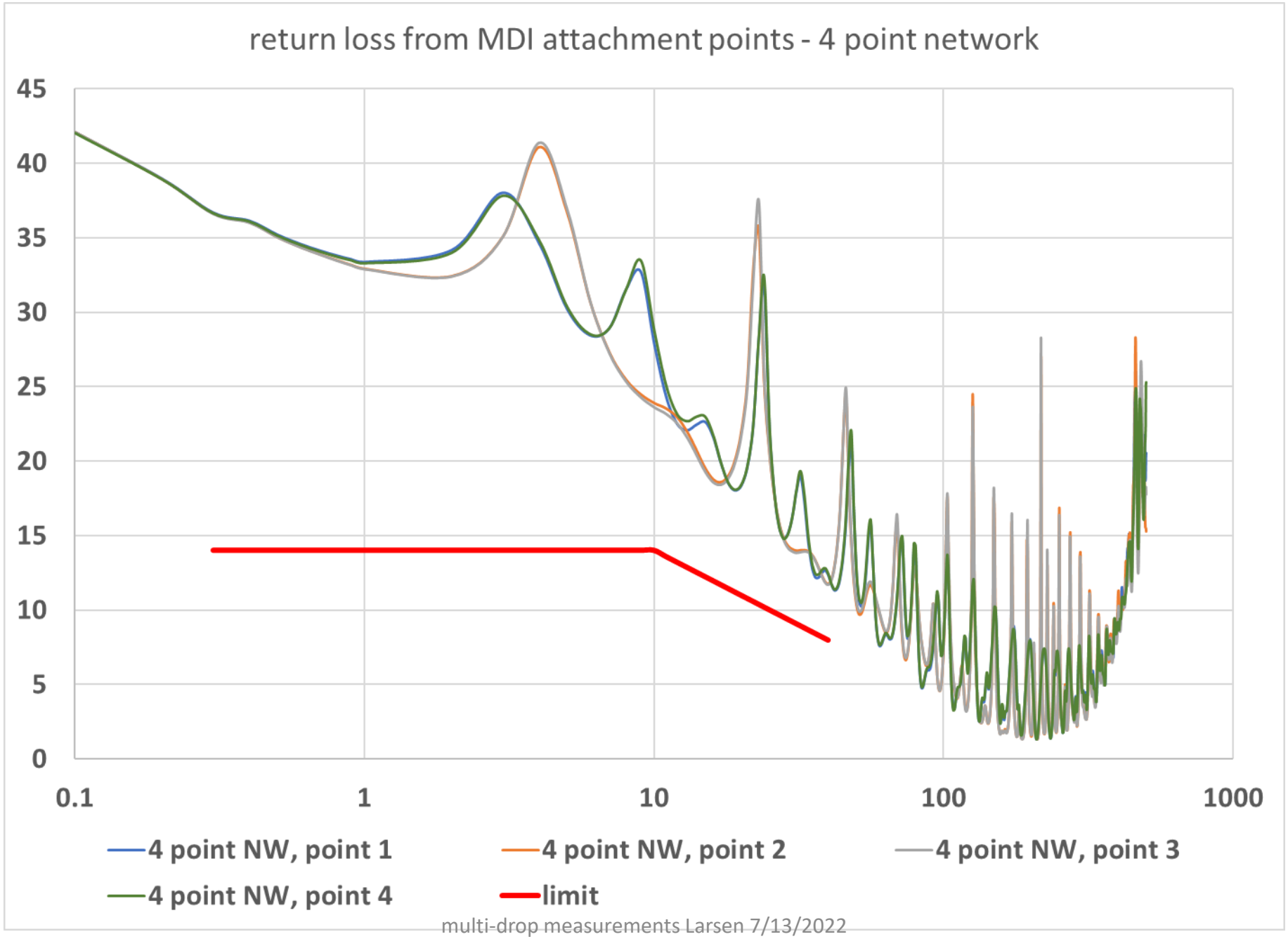
- Return loss always passes, trending worse with more attachment points
- TCL passes with 2 attachment points, fails with 3 or more
- TCTL has lots of margin
- Insertion loss:
  - Traditional s-parameter yields a consistent 23 dB loss at low f, predicable from the network terminations
  - I could not make sense of the VTF idea floating around, would need a definition
- Excel and Touchstone files of the data can be made available

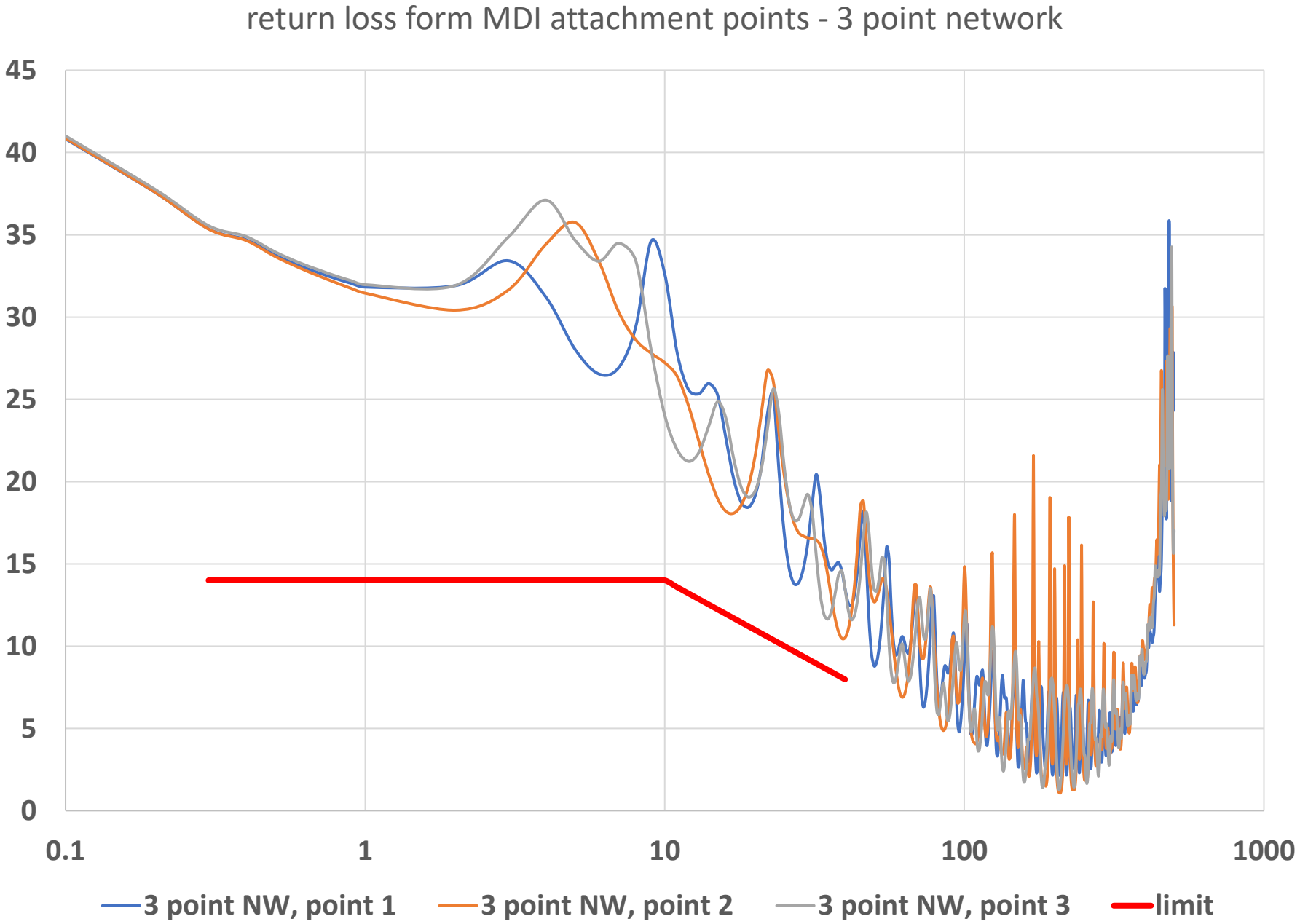
Other Remarks

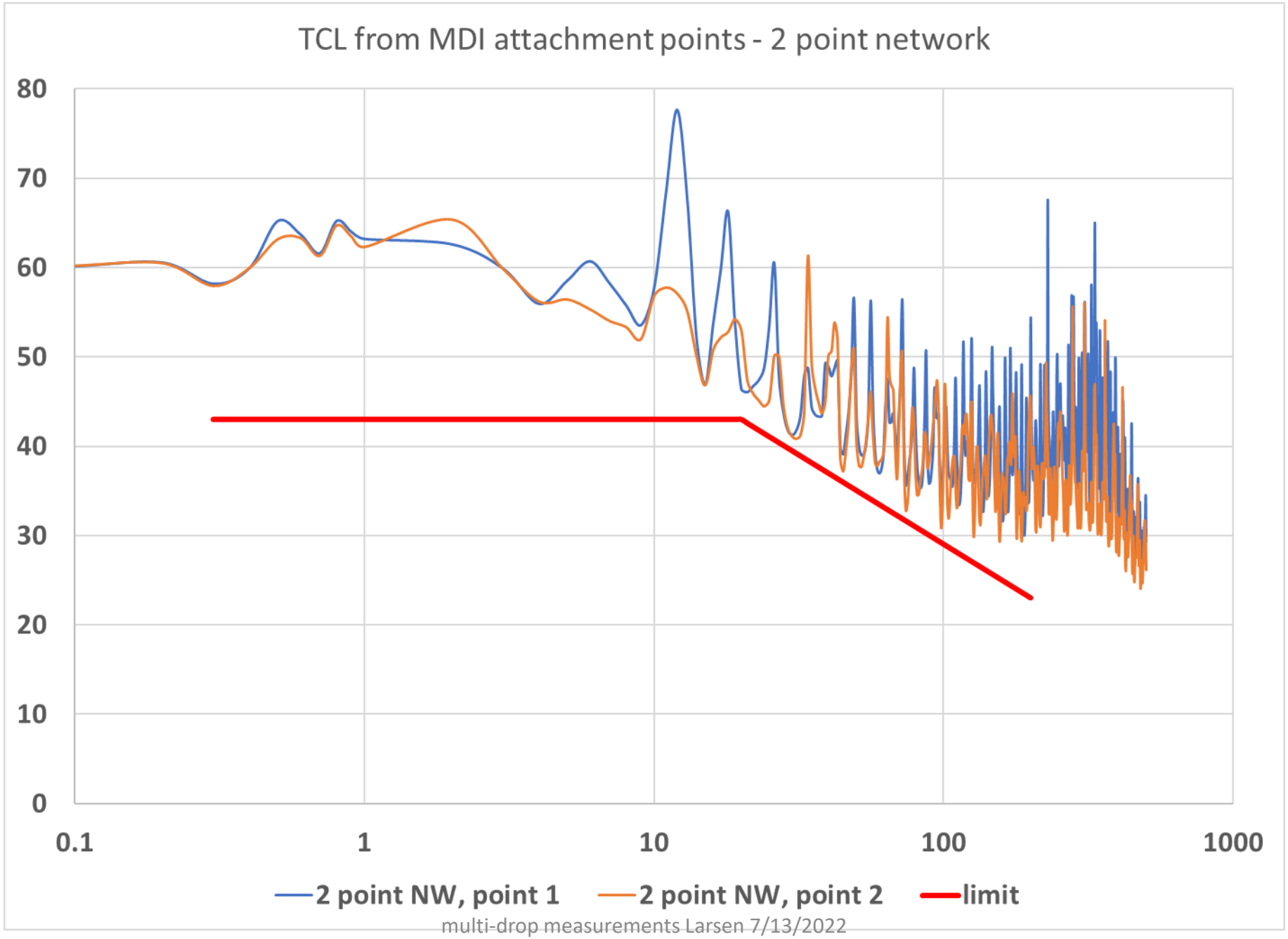
- The 3-way coupler provides a convenient way to achieve a TC
  - Could detach a drop segment from the network and test it as a separate sub-assembly, then re-attach
- Also the use of 2-way couplers at the ends and at the MDI attachment points facilitates re-arrangements for testing
- Simply implementing the requirement scheme from 147.8 is not the way
- Terminating unused MDI connection points with 10K Ohms seems right, however leaving them open might not cause a large effect
- Mode conversion
  - TCTL is good compared with requirement
  - TCL likely poor due to unbalance of 3-way coupler
  - Would like to understand why such a wide frequency requirement range for TCL and TCTL given the narrow range for RL and IL
- Further work can include developing specs for the individual elements of the network
  - Trunk cables
  - Drop cables
  - 2-way couplers
  - 3-way couplers
  - Terminators, 100 Ohm and 10K Ohm
- Further work can include further testing with more modern requirement configurations
  - Between the 100 Ohm ends with proper terminations at MDI attachment points
  - Of drop cable assemblies removed from the network
  - Between 100 Ohm points and MDI attachment points

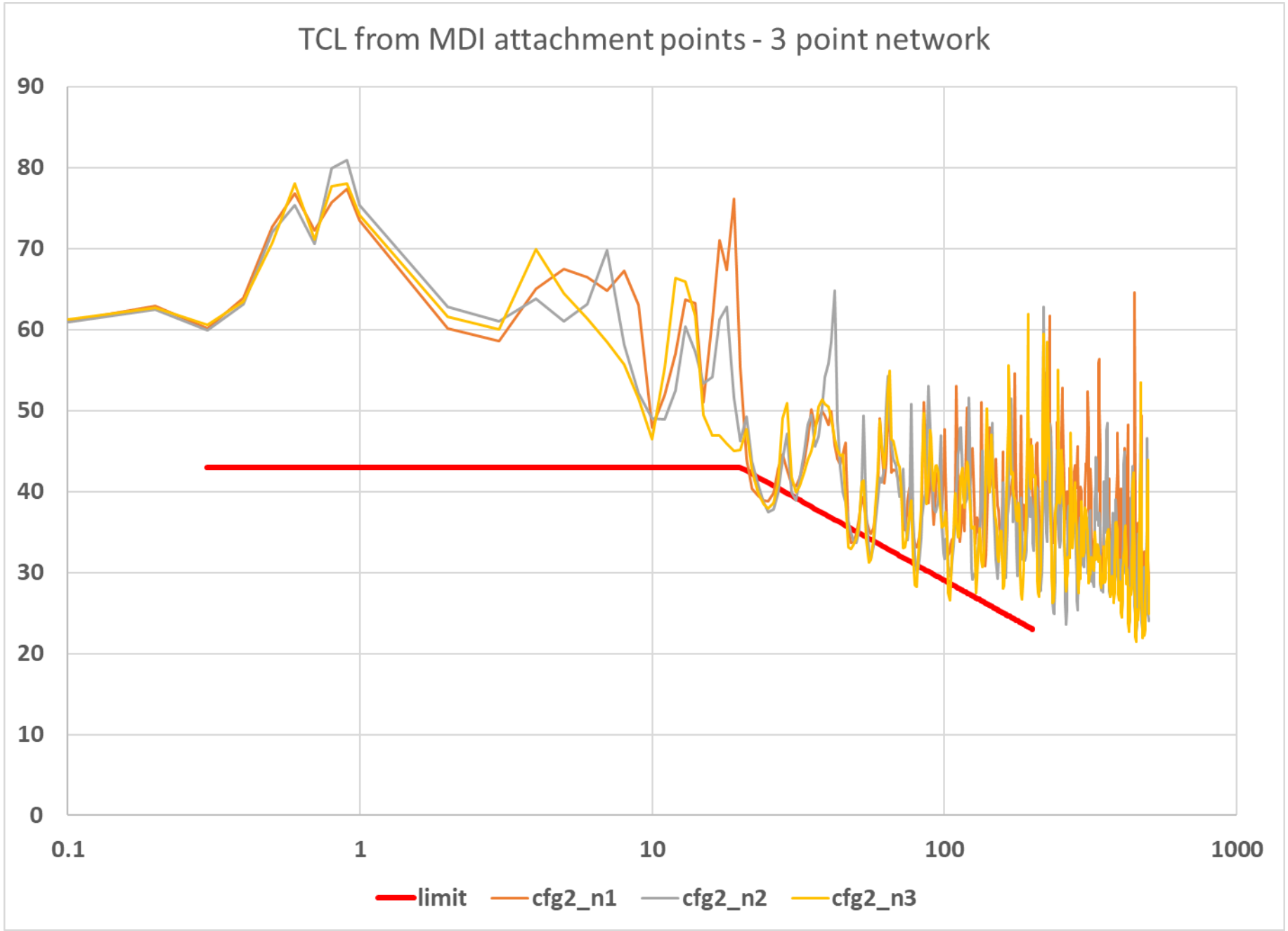

return loss from MDI attachment points - 2 point network
45
40
35
30
25
20
15
10
5
0
0.1
1
10
100
1000
2 point NW, point 1
2 point NW, point 2
limit

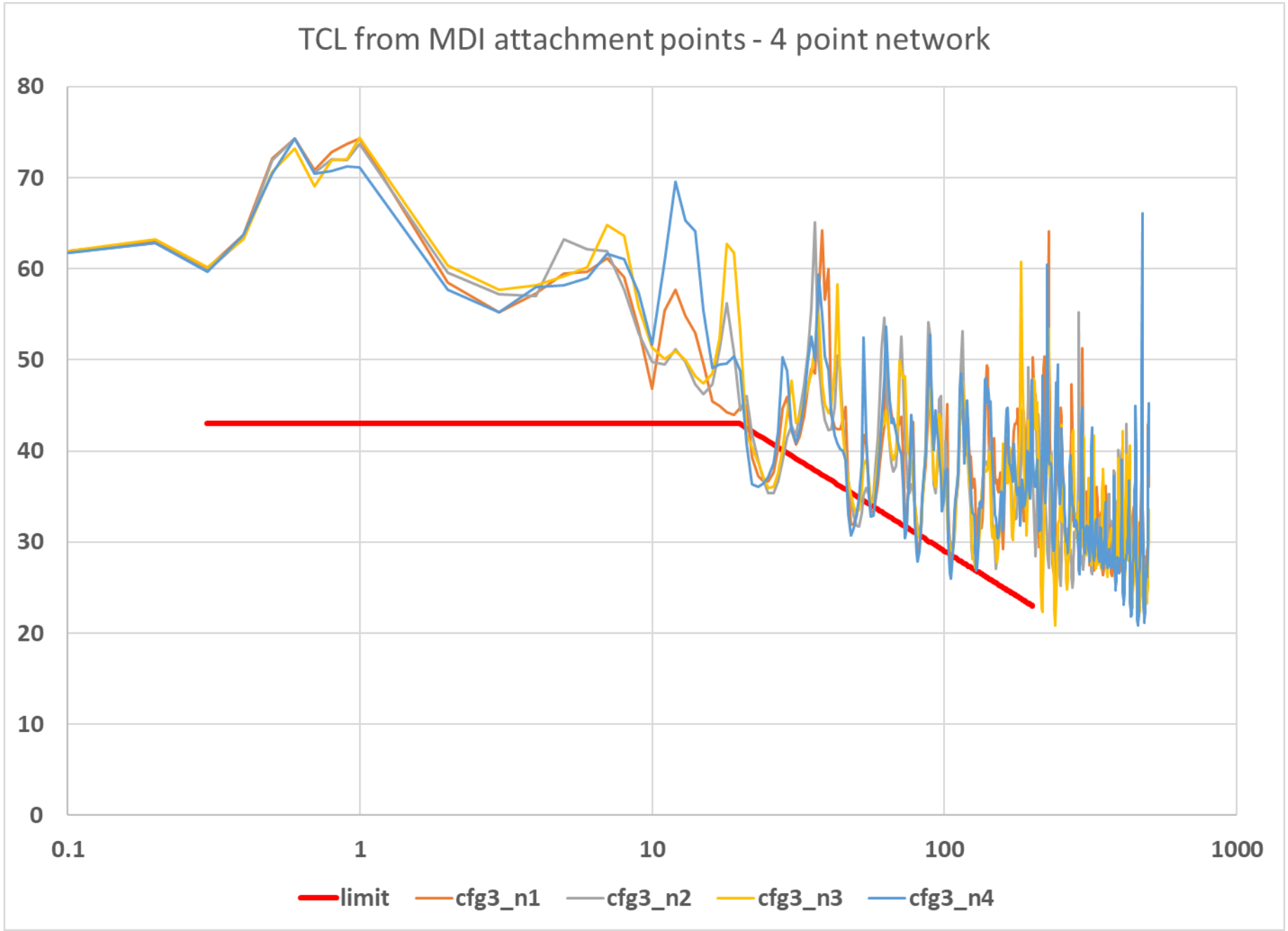

return loss from MDI attachment points - 3 point network
45
40
35
30
25
20
15
10
5
0
0.1
1
10
100
1000
3 point NW, point 1
3 point NW, point 2
3 point NW, point 3
limit

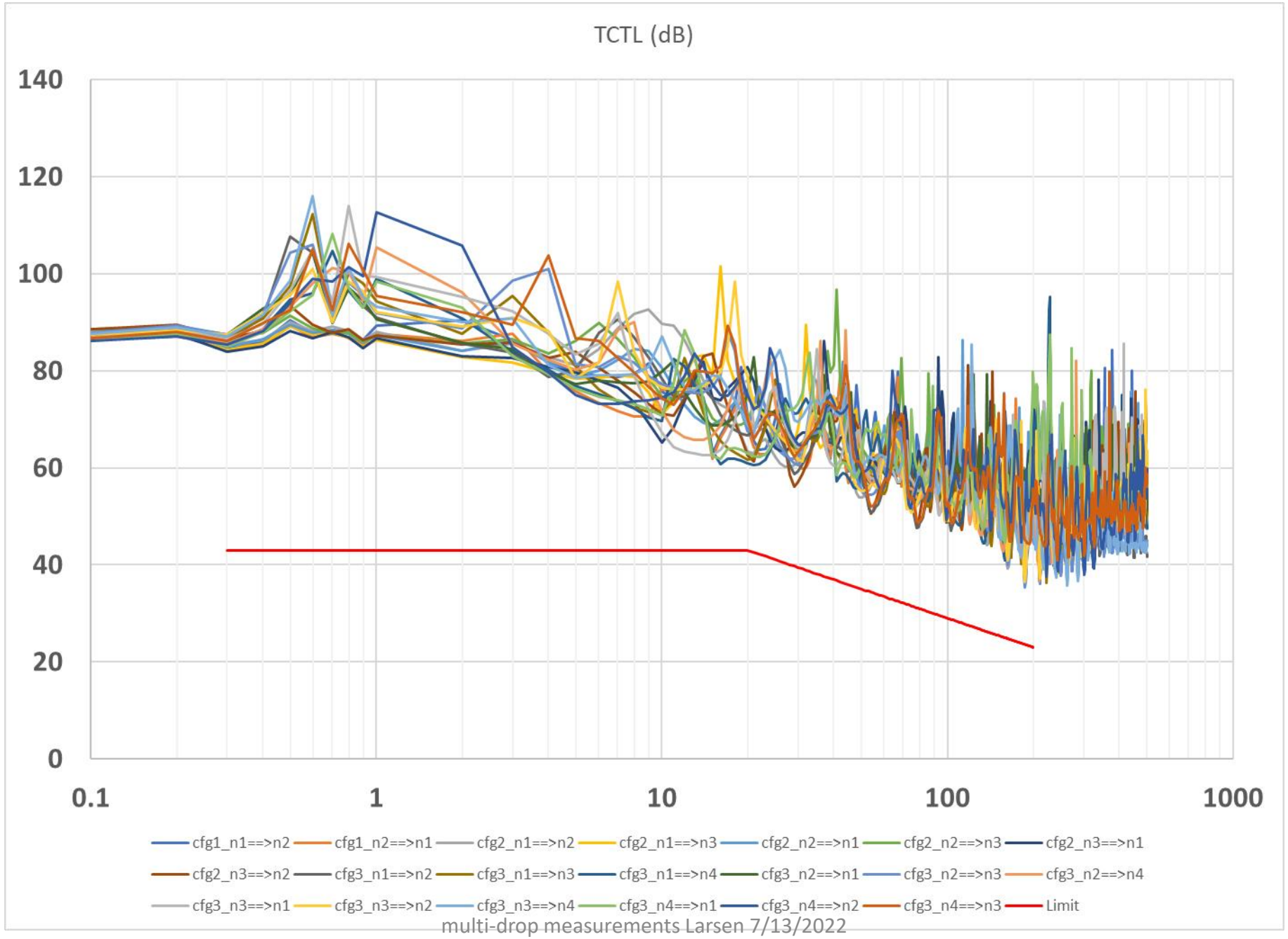

return loss from MDI attachment points - 4 point network
45
40
35
30
25
20
15
10
5
0
0.1
1
10
100
1000
4 point NW, point 1
4 point NW, point 2
4 point NW, point 3
4 point NW, point 4
limit

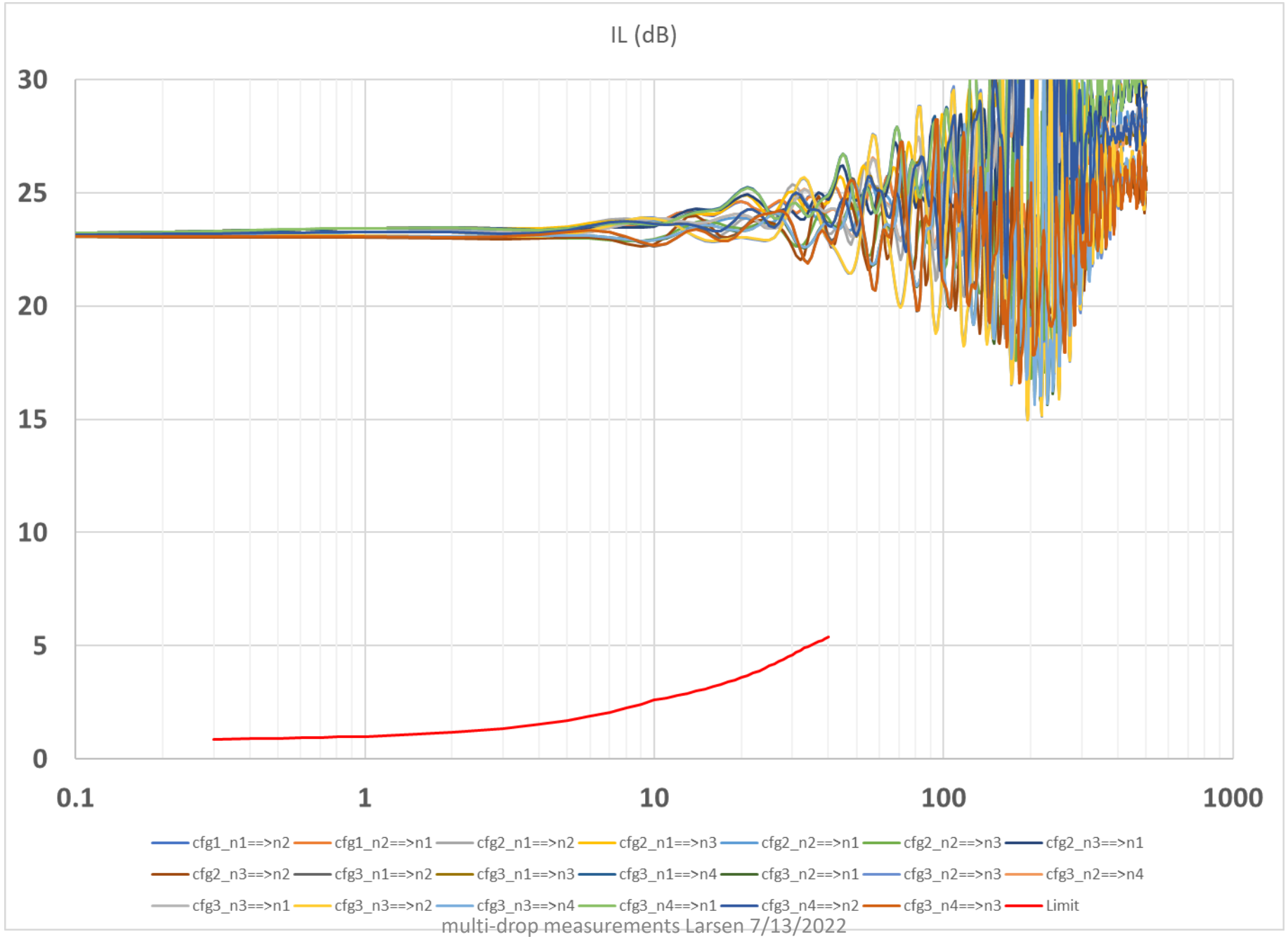

return loss form MDI attachment points - 3 point network
45
40
35
30
25
20
15
10
5
0
0.1
1
10
100
1000
3 point NW, point 1
3 point NW, point 2
3 point NW, point 3
limit


TCL from MDI attachment points - 2 point network
80
70
60
50
40
30
20
10
0
0.1
1
10
100
1000
2 point NW, point 1
2 point NW, point 2
limit


TCL from MDI attachment points - 3 point network
90
80
70
60
50
40
30
20
10
0
0.1
1
10
100
1000
limit
cfg2_n1
cfg2_n2
cfg2_n3


TCL from MDI attachment points - 4 point network
80
70
60
50
40
30
20
10
0
0.1
1
10
100
1000
limit
cfg3_n1
cfg3_n2
cfg3_n3
cfg3_n4


TCTL (dB)
140
120
100
80
60
40
20
0
0.1
1
10
100
1000
cfg1_n1==>n2
cfg1_n2==>n1
cfg2_n1==>n2
cfg2_n1==>n3
cfg2_n2==>n1
cfg2_n2==>n3
cfg2_n3==>n1
cfg2_n3==>n2
cfg3_n1==>n2
cfg3_n1==>n3
cfg3_n1==>n4
cfg3_n2==>n1
cfg3_n2==>n3
cfg3_n2==>n4
cfg3_n3==>n1
cfg3_n3==>n2
cfg3_n3==>n4
cfg3_n4==>n1
cfg3_n4==>n2
cfg3_n4==>n3
Limit


IL (dB)
30
25
20
15
10
5
0
0.1
1
10
100
1000
cfg1_n1==>n2
cfg1_n2==>n1
cfg2_n1==>n2
cfg2_n1==>n3
cfg2_n2==>n1
cfg2_n2==>n3
cfg2_n3==>n1
cfg2_n3==>n2
cfg3_n1==>n2
cfg3_n1==>n3
cfg3_n1==>n4
cfg3_n2==>n1
cfg3_n2==>n3
cfg3_n2==>n4
cfg3_n3==>n1
cfg3_n3==>n2
cfg3_n3==>n4
cfg3_n4==>n1
cfg3_n4==>n2
cfg3_n4==>n3
Limit