4X-990318-CLN-01

TO: DISTRIBUTION
FROM: C NEUMEYER
SUBJECT: FEASIBILITY OF ROGOWSKI MEASUREMENT OF OUTBOARD DIVERTOR CURRENT

References:

[1] 11-980514-CLN-01, "Disruption Calculations"

[2] NSTX-CALC-11-01, "SPARK Plasma Disruption Calculation"

A Rogowski measurement of the outboard divertor (OBD) current has been proposed. The Rogowski would be positioned to surround the toroidal current path formed by a special copper jumper to be placed between two adjacent copper OBD plates, since it is not possible to place a Rogowski around the OBD support rings (a.k.a. "barbecue" rings).

This memo shows that the induced voltage and its integral will be measurable, but barely.

References [1] and [2] provide disruption calculation results from SPARK and LRSIM, for a stationary disruption, ramping from 1MA to 0 in 6mS. The peak current predicted in the OBD is 8.2kA (in each half plane). The model considers Cu OBD backplates and a toroidal path in the gap between them through the mounting bolts and rings. The net toroidal resistance (each half plane) is of order 1.4mΩ.

The current waveshape corresponding to this case is roughly 8.2kA/6mS, or 1.36MA/sec for 6mS.

This case represents the maximum signal which the Rogowski needs to measure.

The nominal signal is that which results from normal OH operation driving plasma current. To determine the signal, an LRSIM case was run in which the OH current is ramped to 24kA, the OH power supply is fully inverted for 5mS to simulate plasma initiation, and then the OH current is ramped to 0 in another 200mS. All other coils were open circuited, and there was no plasma included in the simulation, only passive structure.

The resultant waveforms are shown on the attached figures.

Per B. McCormack the dimensions of the Rogowski would be similar but slightly smaller than those of the Halo Current Rogowskis, for which he has calculated a

gain of 0.5V/MA/sec. Thus the gain for the OBD Rogowski would scale as follows:

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]

Based on this gain, and the results from LRSIM, the peak induced voltage and the integral of the voltage waveform for the scenarion and disruption cases is as follows:

	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

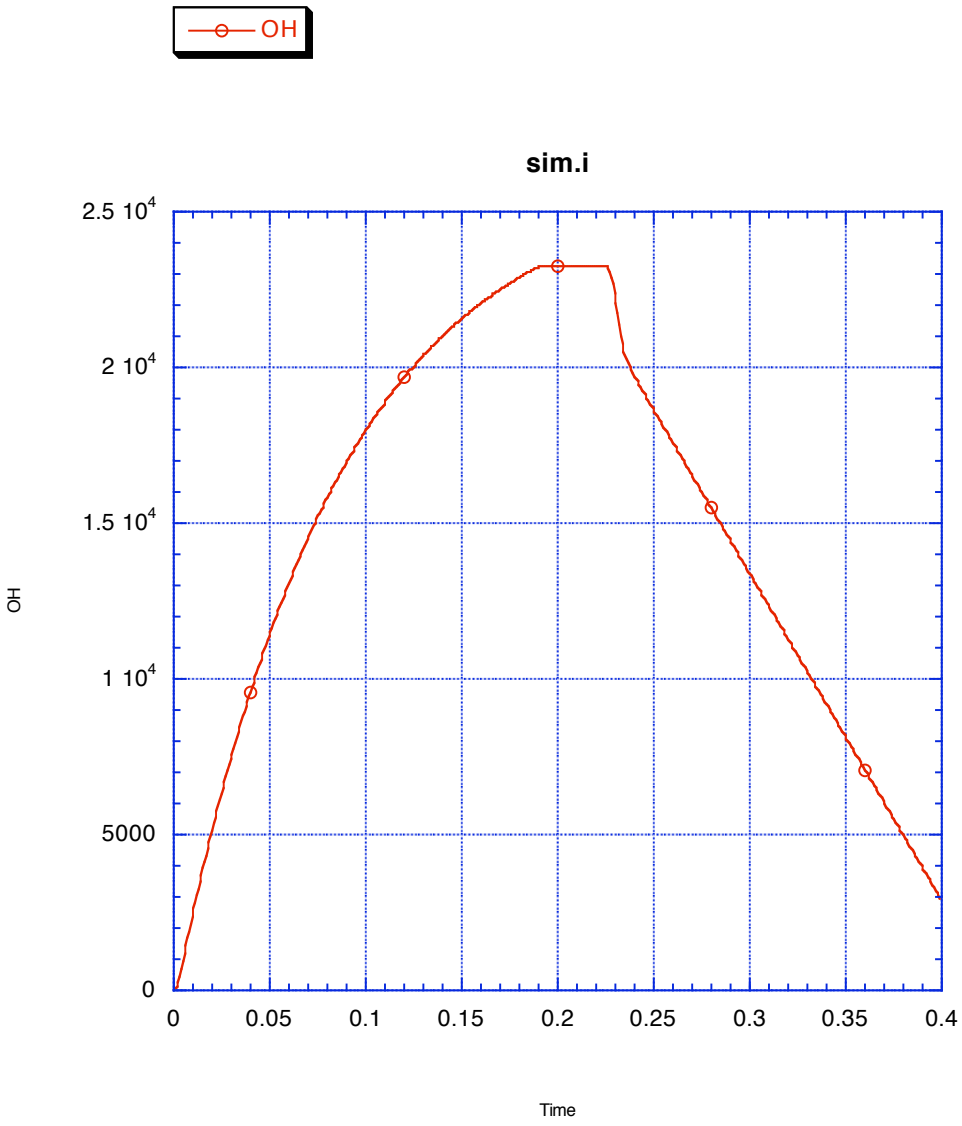
An amplifier gain of order 4000 would be needed to bring these signals into a useful range. Following shows the integrator output voltage with a gain of 4000.

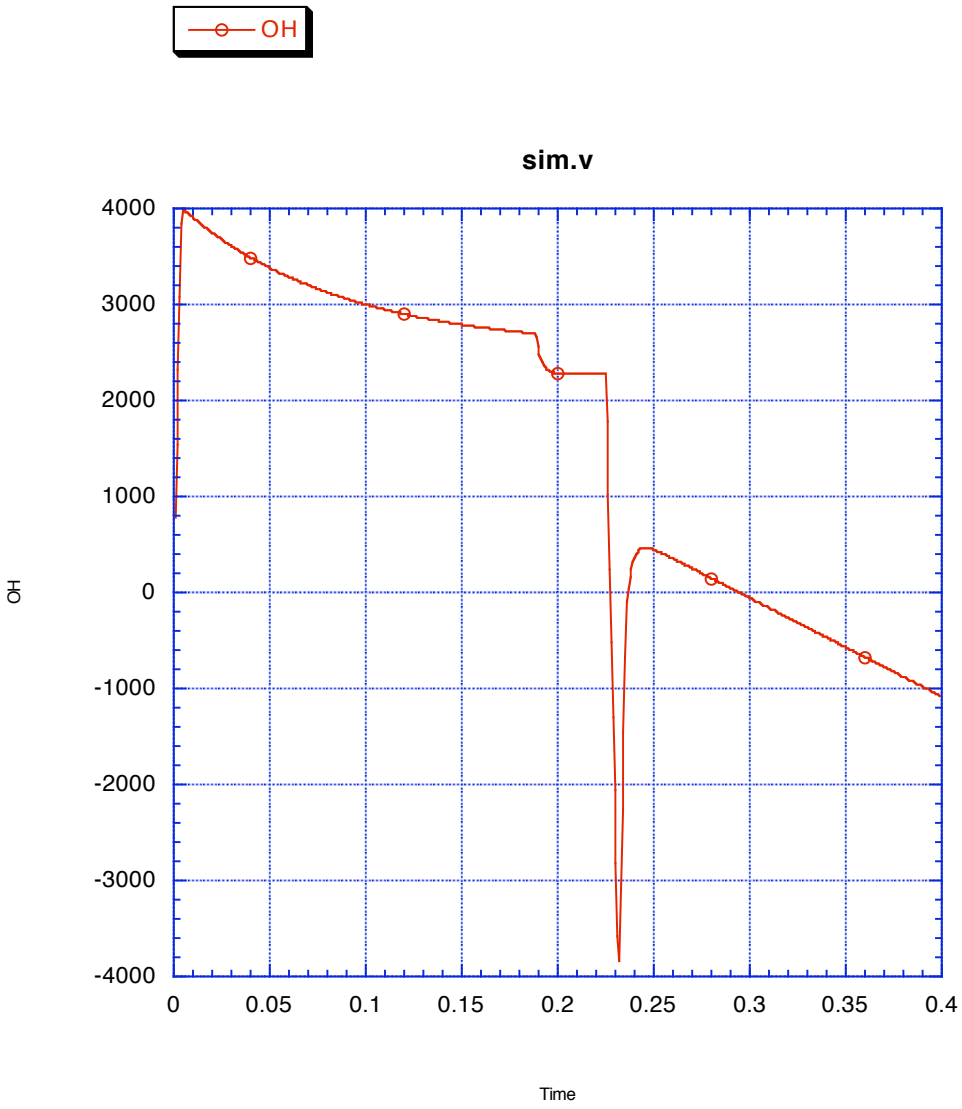
	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

Per R. Marsala this is difficult but feasible, assuming that there is not a lot of background noise.

cc:

D Gates C Kessel S Kaye H Kugel R Marsala J Menard
B McCormack D Mueller M Ono M Williams NSTX File


OH
sim.i
2.5 10^4
2 10^4
1.5 10^4
1 10^4
5000
0
OH
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time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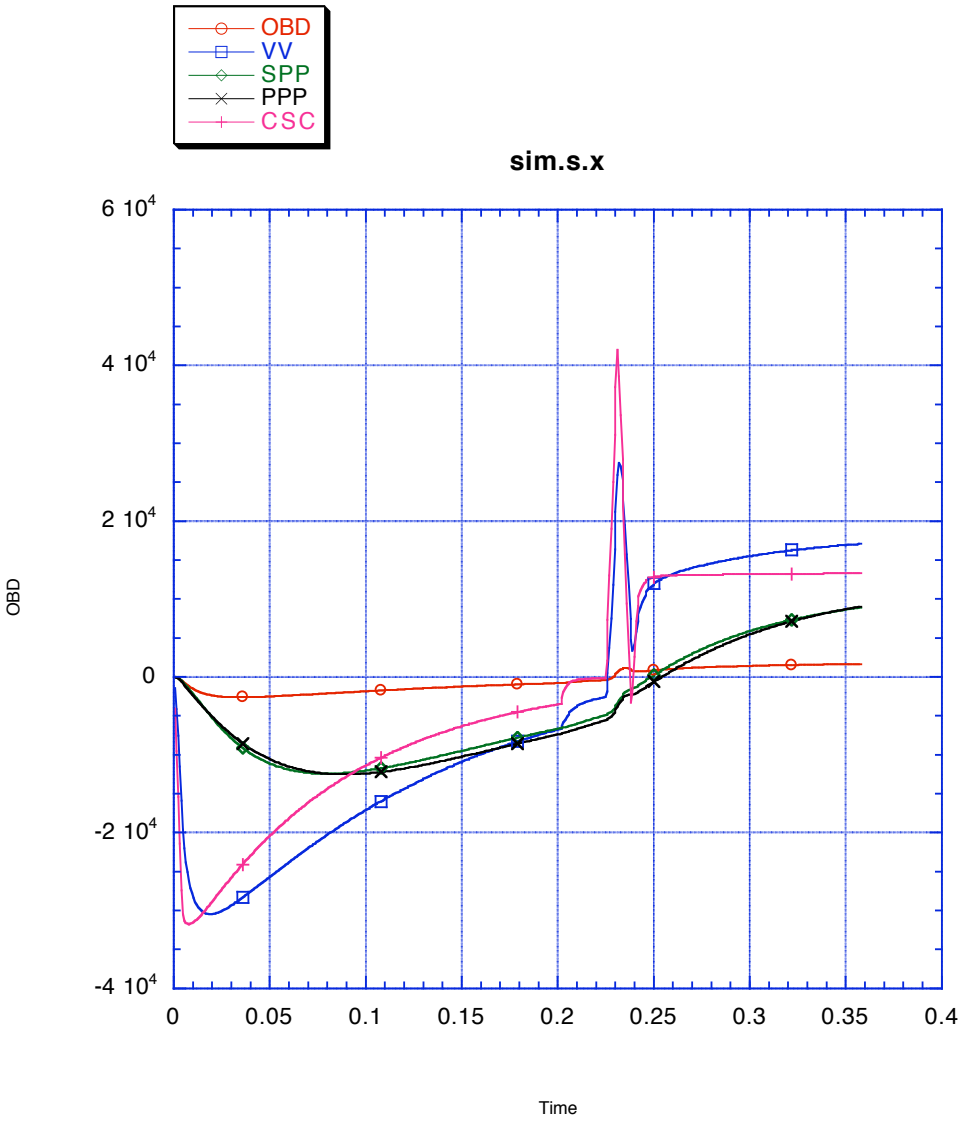
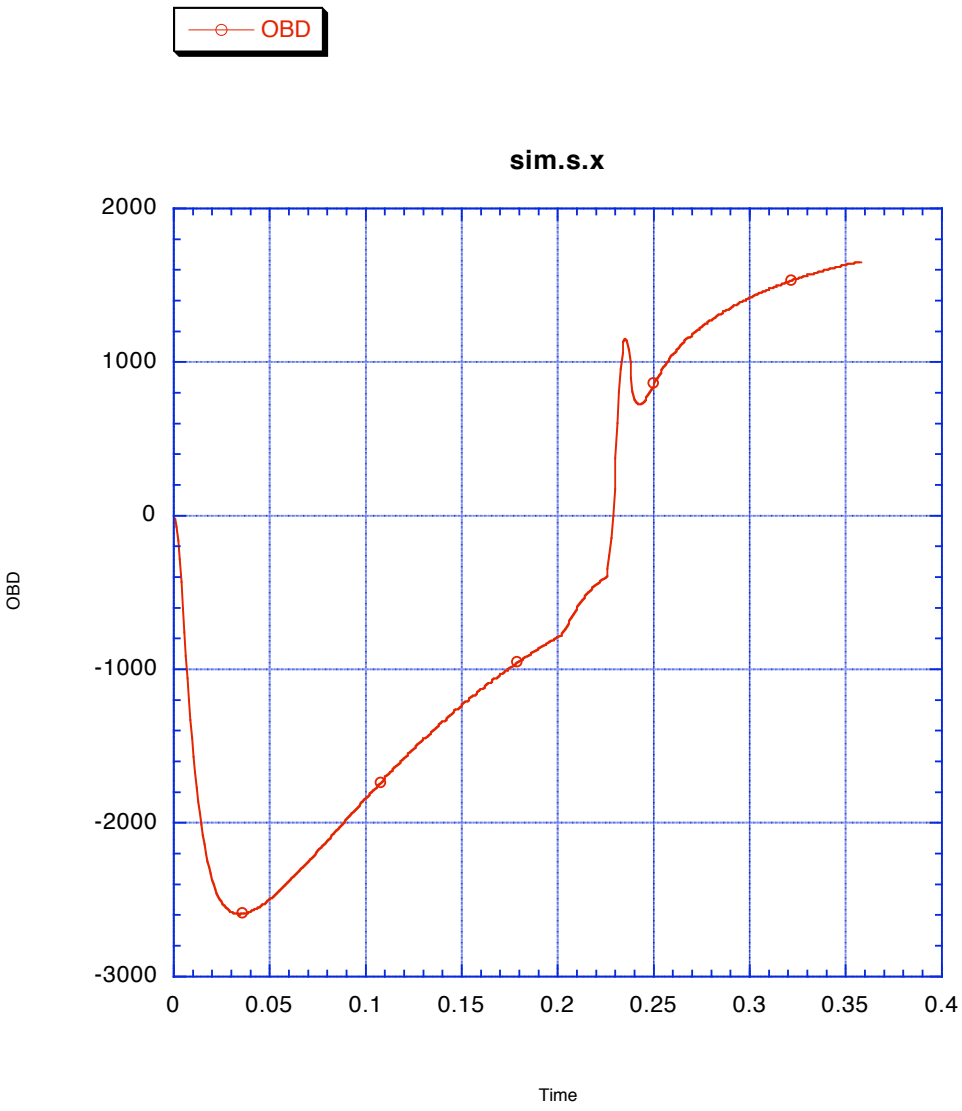
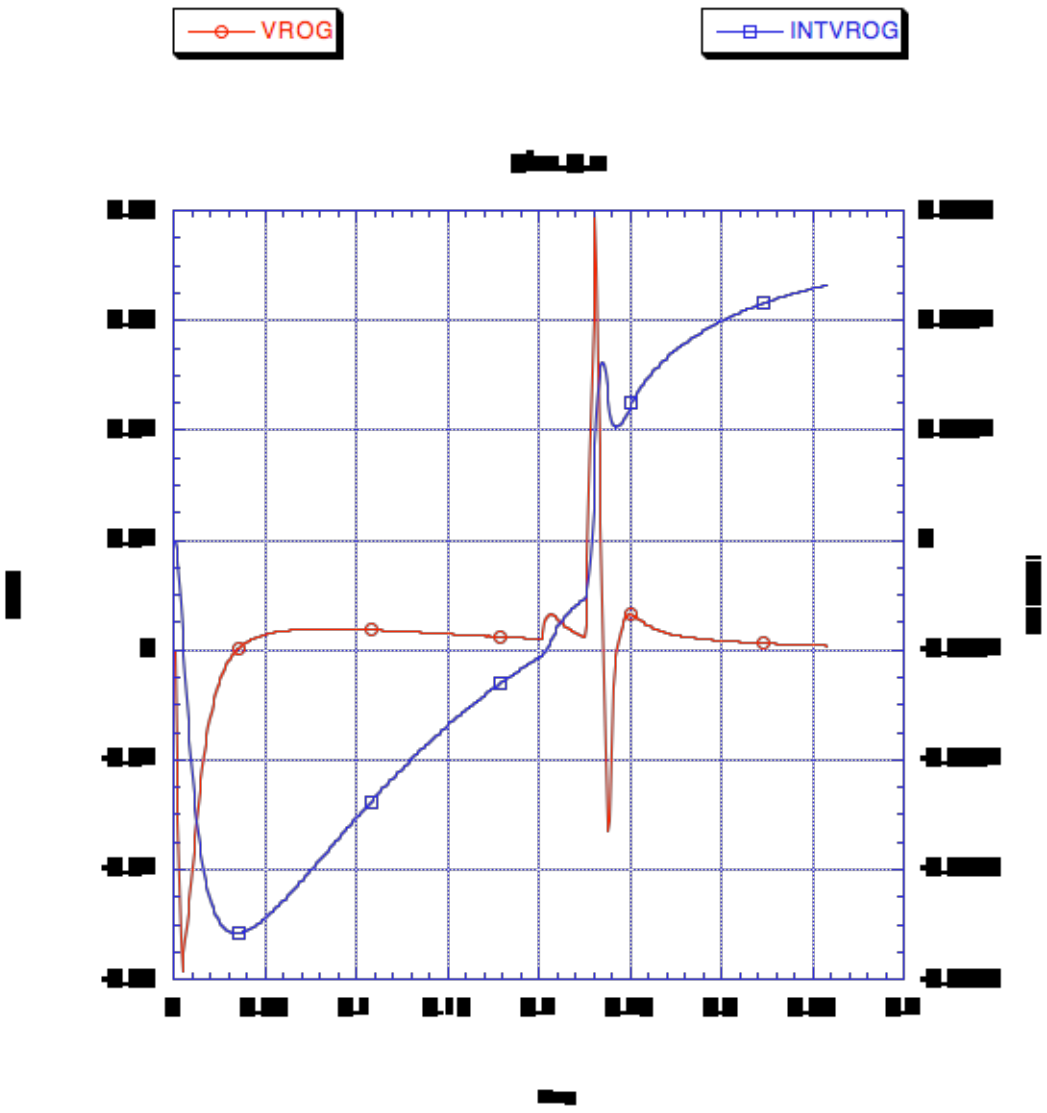
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
OH
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time


OBD
VV
SPP
PPP
CSC
sim.s.x
6 10^4
4 10^4
2 10^4
0
-2 10^4
-4 10^4
OBD
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time


OBD
sim.s.x
2000
1000
0
-1000
-2000
-3000
OBD
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
Time


VROG
INTVROG