IRAP Status Report
For: Bill Ravenhurst
January 18, 2021
By Peter Walker

Dave Campbell's PEM Models

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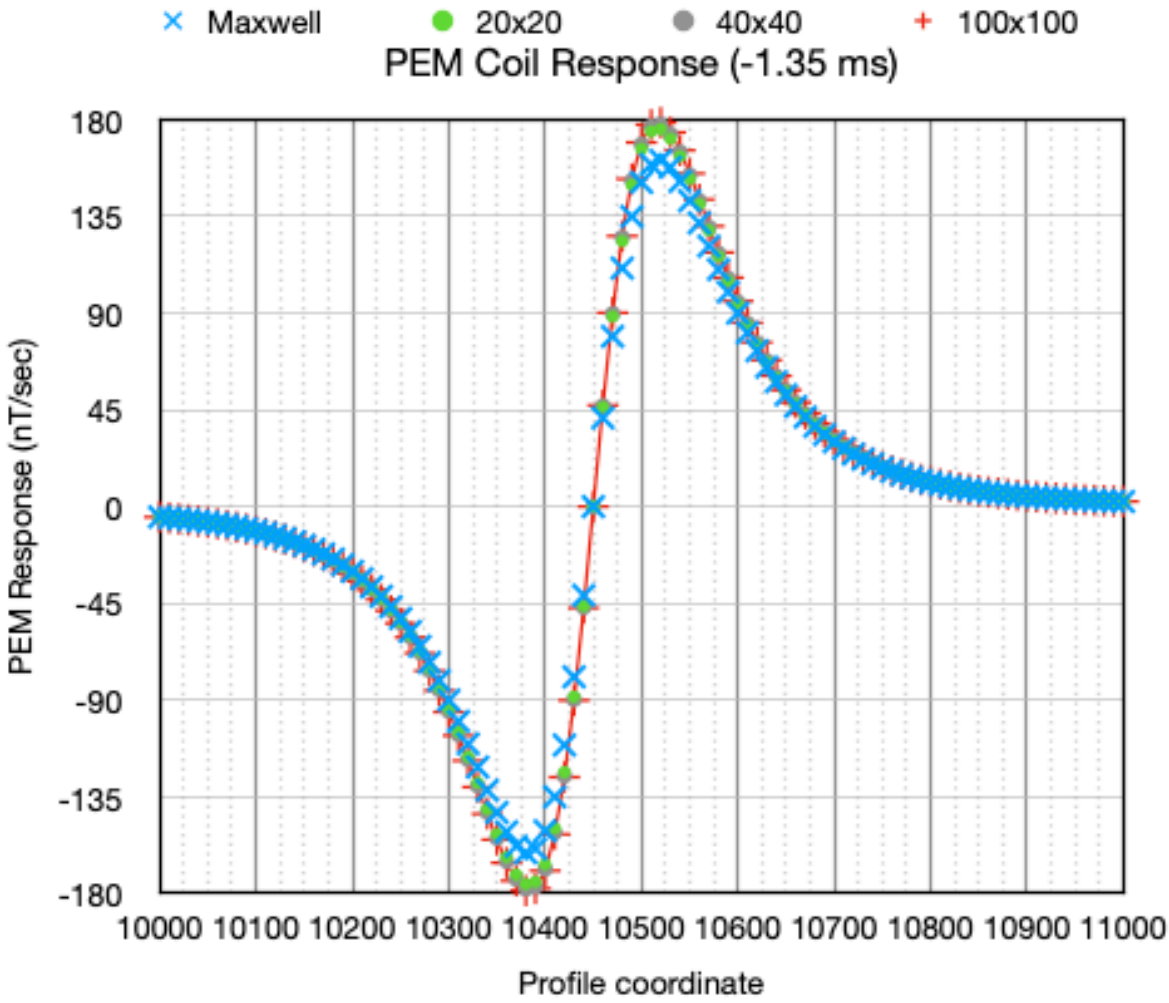
Dave Campbell produced a at of PEM models in September 2020 using the Maxwell program, some of which have been recalculated here using the IRAP model code. The IRAP models were run using 20x20, 50x50 and 100x100 node meshes. The IRAP code is now running on both the Windows and OSX platforms. While most of the runs were computed using the OSX, comparison runs on the Windows platforms, where checked, produced identical results. In my particular development environment, the Windows version is run on a virtual Windows 10 machine using Parallels cross-platform support. As my virtual machine has less available memory than the OSX machine, only the 20x20 and 50x50 models were run on the Windows machine. The code base has not yet been optimized for fast execution.

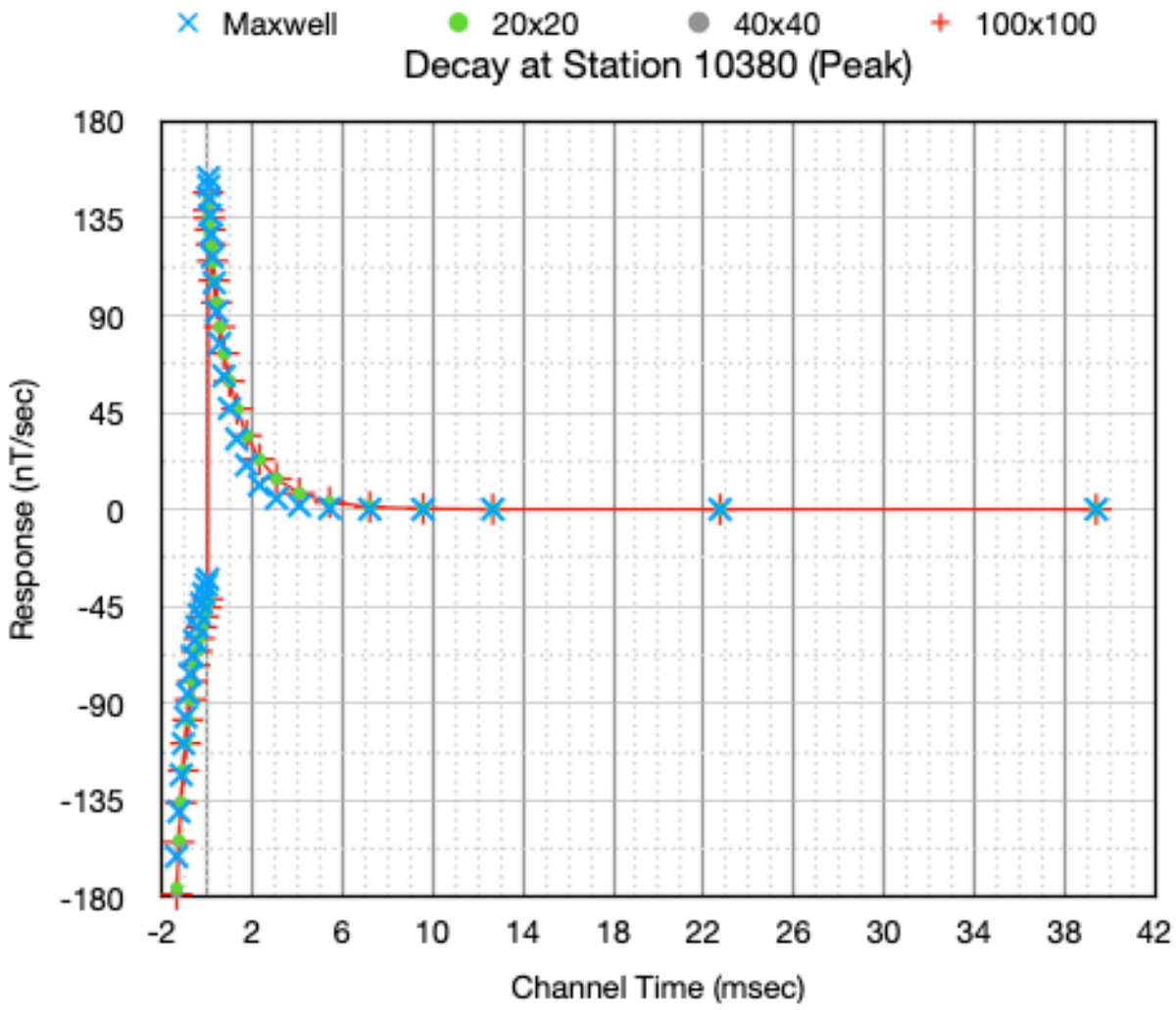
Some exemplary results are plotted in this report. The models simulated the response of buries plates at differing depth and conductances. Deeper plates produced a better match between the Maxwell and IRAP model responses.

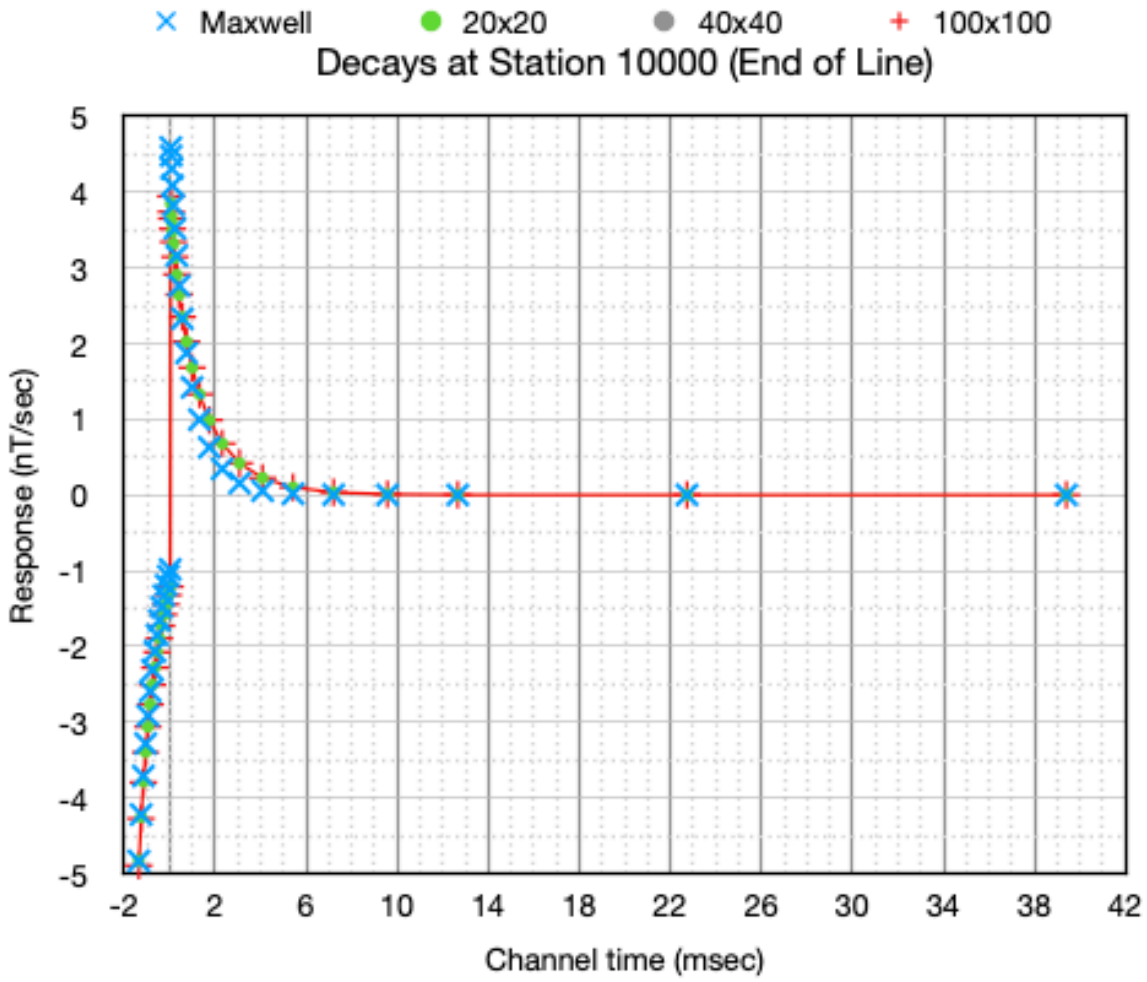
The fist model consists of a vertical 100x100 m square 100 S plate offset from a loop using the V_1x1_450_100_100 model geometry. The 50 msec PEM dB/dt response was computed for a square loop width y-edges at 10000 E and 10400E on a centred profile at 10000 N using a 1.5 msec ramp. The plate was centred on the line at 10450 E, with a vertical dip and striking perpendicular to the line. Since the PEM dB/dt response measures the EMF, in Maxwell the loop vertices are arranged in a clockwise fashion to achieve the required sign reversal. In the IRAP code, the bespoke PEM dB/dt responses are computed with the correct sign when the loop vertices are arranged in a counterclockwise order.

The test function TestCroneSolver_MaxwellModel_DaveCampbell_2020_09_22 was used to generate IRAP results for this model. The table below illustrates the convergence of the two methods. Responses are in nT/sec for Station 10000. Ch22 is the first positive channel, and the Maxwell response is larger than the IRAP response, whereas later in the off-time, the IRAP response closely matches the Maxwell response. This is consistent with behaviour seen earlier, and is interpreted to mean the Maxwell self inductance is smaller than the IRAP self inductance. Results are plotted on the following pages.

Method	CH 7	Ch22	Ch28
IRAP 20x20	-160.95	142.88	95.72
IRAP 50x50	-175.49	145.67	95.92
IRAP 100x100	-177.71	146.94	95.95
Maxwell	160.96	153.79	91.64


Maxwell
20x20
40x40
100x100
PEM Coil Response (-1.35 ms)
PEM Response (nT/sec)
180
135
90
45
0
-45
-90
-135
-180
10000 10100 10200 10300 10400 10500 10600 10700 10800 10900 11000
Profile coordinate

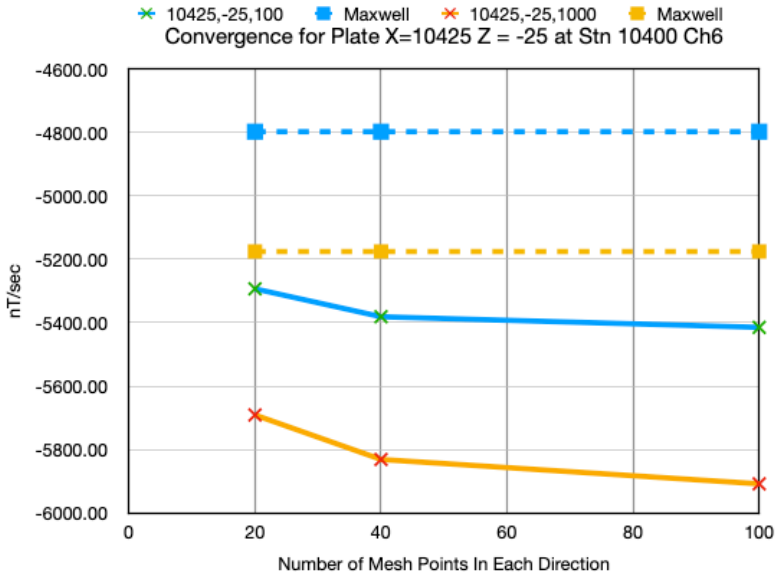

Maxwell
20x20
40x40
100x100
Decay at Station 10380 (Peak)
Response (nT/sec)
180
135
90
45
0
-45
-90
-135
-180
-2
2
6
10
14
18
22
26
30
34
38
42
Channel Time (msec)


Maxwell
20x20
40x40
100x100
Decays at Station 10000 (End of Line)
Response (nT/sec)
5
4
3
2
1
0
-1
-2
-3
-4
-5
-2
2
6
10
14
18
22
26
30
34
38
42
Channel time (msec)

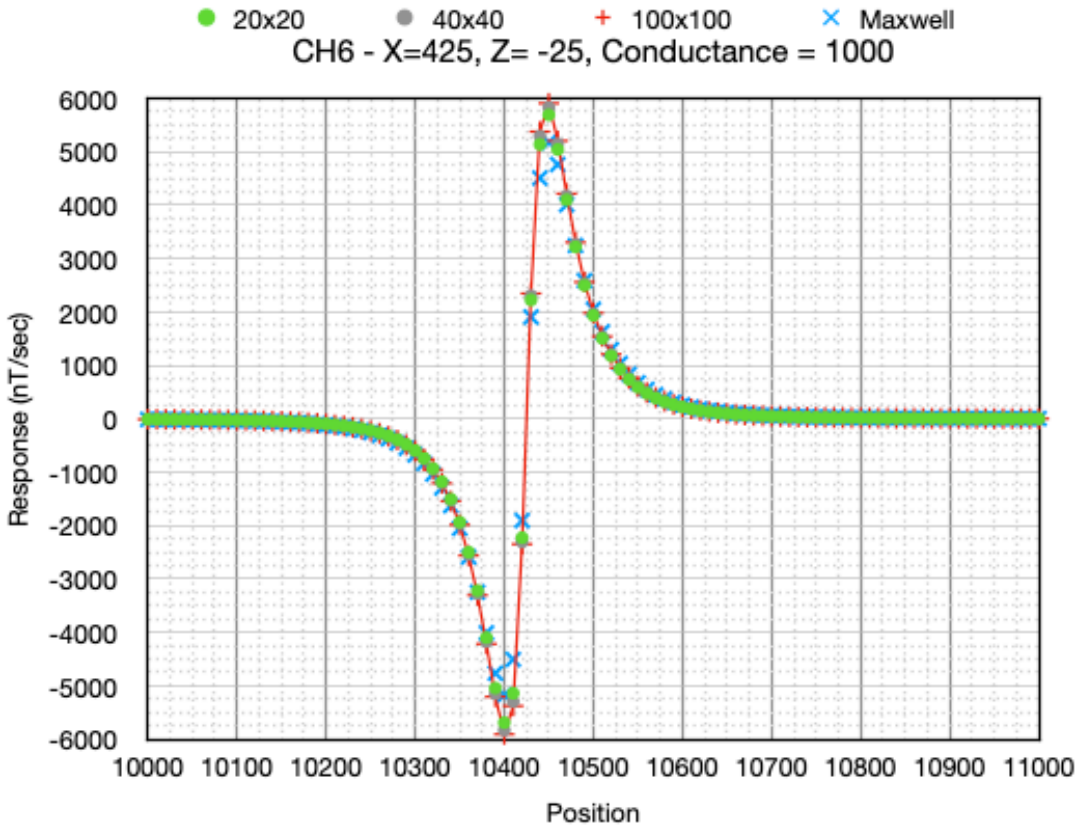
The next models are a batch of 6 vertical plates, one of which was shown in the foregoing section. Dave Campbell competed the Maxwell calculations for these models on Sept 29, 2020. Three plate locations with x and z top coordinates (425, -25), (450,-50) and (450,-100) were computed for conductances of 100 and 1000 S.

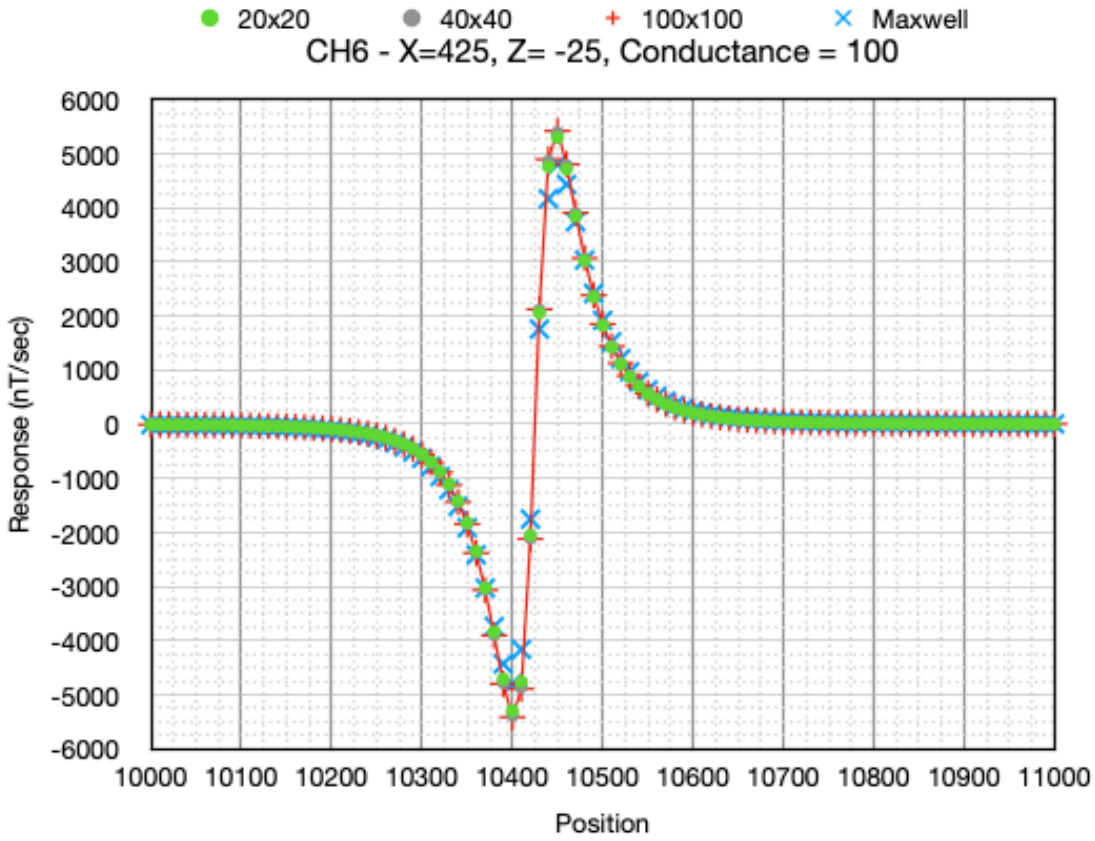
The table below summarizes the calculations for the CH6 (as labelled in the xyz file output) for the peak locations in each model. Models are denoted with the triplet as follows: PlateX, PlateDepth, Conductance. X-Coord refers to the profile location with the maximum response.

Model	X-coord	100x100	40x40	20x20	Maxwell
450,100,1000	10380	-193	-191	-187	-200
450,100,100	10380	-179	-178	-175	-186
450,50,1000	10410	-1126	-1114	-1091	-1121
450,50,100	10410	-1039	-1034	-1020	-1043
425,25,1000	10400	-5908	-5831	-5691	-5175
425,25,100	10400	-5414	-5381	-5293	-4798



The convergence of the CH6 (per the xyz file) solution at station 10400 for the shallow plate is plotted to the left. The corresponding profiles are plotted on the next page.


20x20
40x40
100x100
Maxwell
CH6 - X=425, Z= -25, Conductance = 1000
Response (nT/sec)
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
10000 10100 10200 10300 10400 10500 10600 10700 10800 10900 11000
Position


20x20
40x40
100x100
Maxwell
CH6 - X=425, Z= -25, Conductance = 100
Response (nT/sec)
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
10000 10100 10200 10300 10400 10500 10600 10700 10800 10900 11000
Position