EMIT Maxwell Comparisons to PEI Freespace Plate
November, 2016

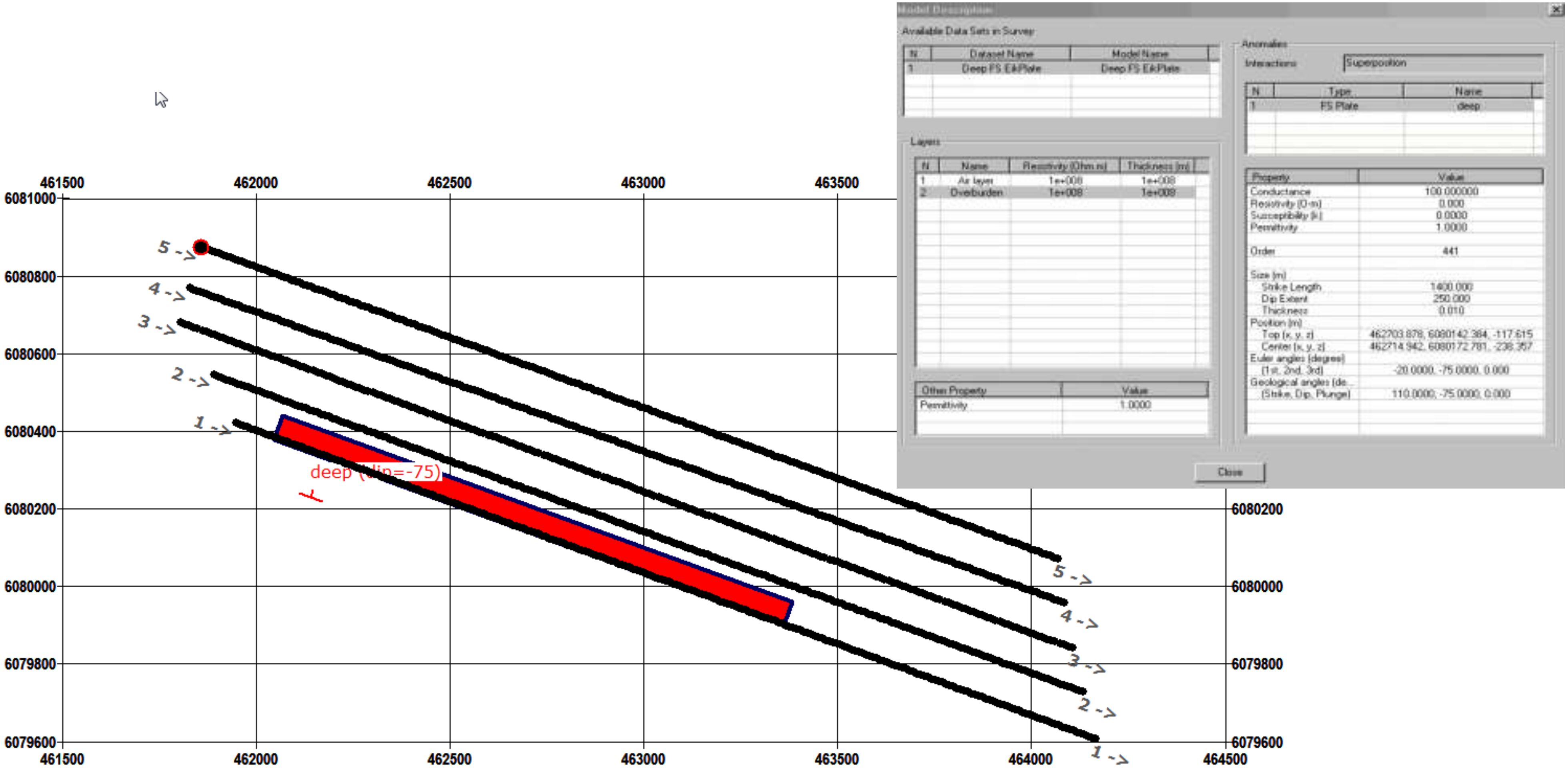
It is our understanding that the Maxwell algorithm is derived from the MultiLoop 1 formulation of Lamontagne Geophysics. PEI freespace plate (EikPlate FS) is based on the basic mathematical formulation of P.Annan in his PhD Thesis (1974). The derivation of the algorithm is a completely new implementation and does not follow the older UofT Plate algorithm of A.Dyck (1980's) or the later version by R.Groom (1994).

All plots produced in **EMIGMA V9.1**

R.W. Groom, Petros Eikon

Bob Lo, BHL Earth Sciences

Adjusted Survey to Extend Lines



Available Data Sets in Survey

N	Dataset Name	Model Name
1	Deep FS EikPlate	Deep FS EikPlate

Layers

N	Name	Resistivity (Ohm m)	Thickness (m)
1	Air layer	1e+008	1e+008
2	Overburden	1e+008	1e+008

Other Property	Value
Permittivity	1.0000

Anomalies

Interactions: Superposition

N	Type	Name
1	FS Plate	deep

Property	Value
Conductance	100.000000
Resistivity (O-m)	0.000
Susceptibility (k)	0.0000
Permittivity	1.0000
Order	441
Size (m)	
Strike Length	1400.000
Dip Extent	250.000
Thickness	0.010
Position (m)	
Top (x, y, z)	462703.878, 6080142.384, -117.615
Center (x, y, z)	462714.942, 6080172.781, -238.357
Euler angles (degree)	
(1st, 2nd, 3rd)	-20.0000, -75.0000, 0.000
Geological angles (de...	
(Strike, Dip, Plunge)	110.0000, -75.0000, 0.000

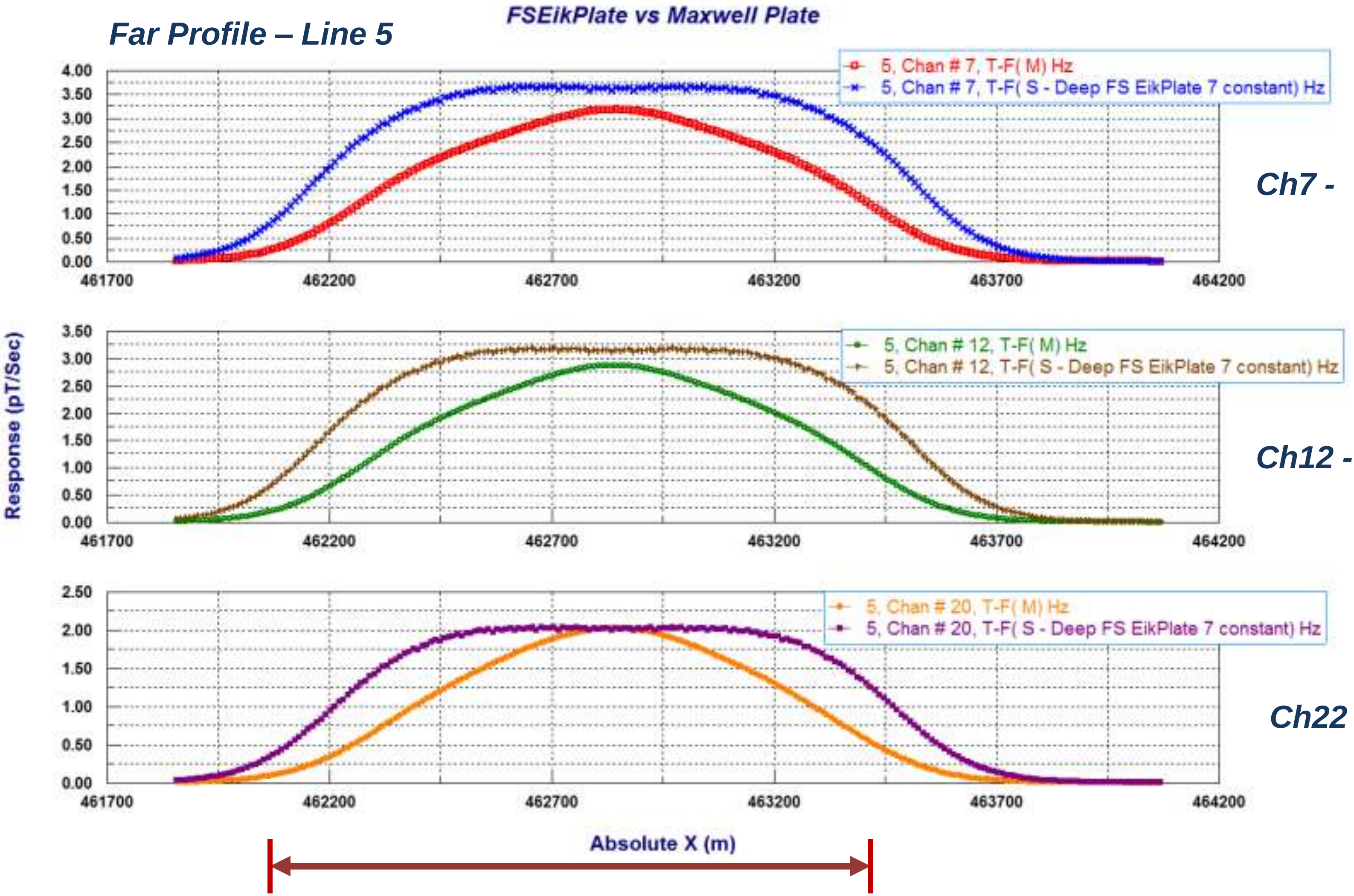
Portions of 5 flight lines. Deep target

Adjusted Survey to Extend Lines

Constant Clearance 35m above flat earth

Note: Maxwell simulation has been multiplied by loop area. EMIGMA utilizes the loop geometry in the algorithm and thus the entire Tx strength is utilized. In this example, the number of turns and current were set to “1”. This indicates that the Maxwell model either utilizes a unit dipole or the data is normalized to a unit moment.

Far Profile – Line 5



Ch7 - 0.22msec

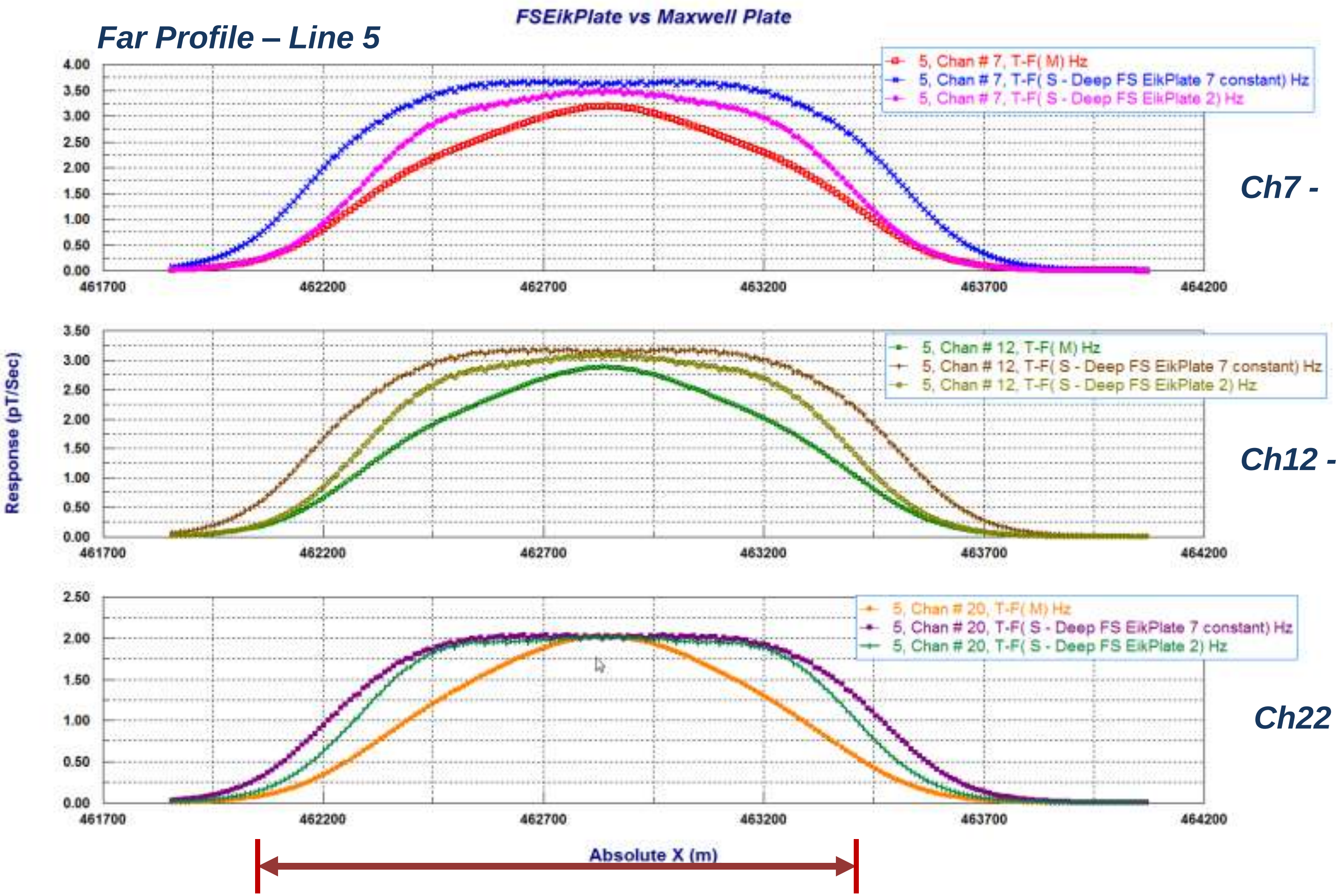
Ch12 - 0.44msec

Ch22 - 1.34msec

Adjusted Survey to Extend Lines

Constant Clearance 35m above flat earth

Below, we compare EikPlate with 7 and 2 eigenfunctions vs Maxwell solution. From Ch1 to approximately Ch15, Maxwell most closely matches 1 eigenfunction. We hypothesize that Maxwell utilizes 1 elliptical current ring or a series of elliptical current rings.



Ch7 - 0.22msec

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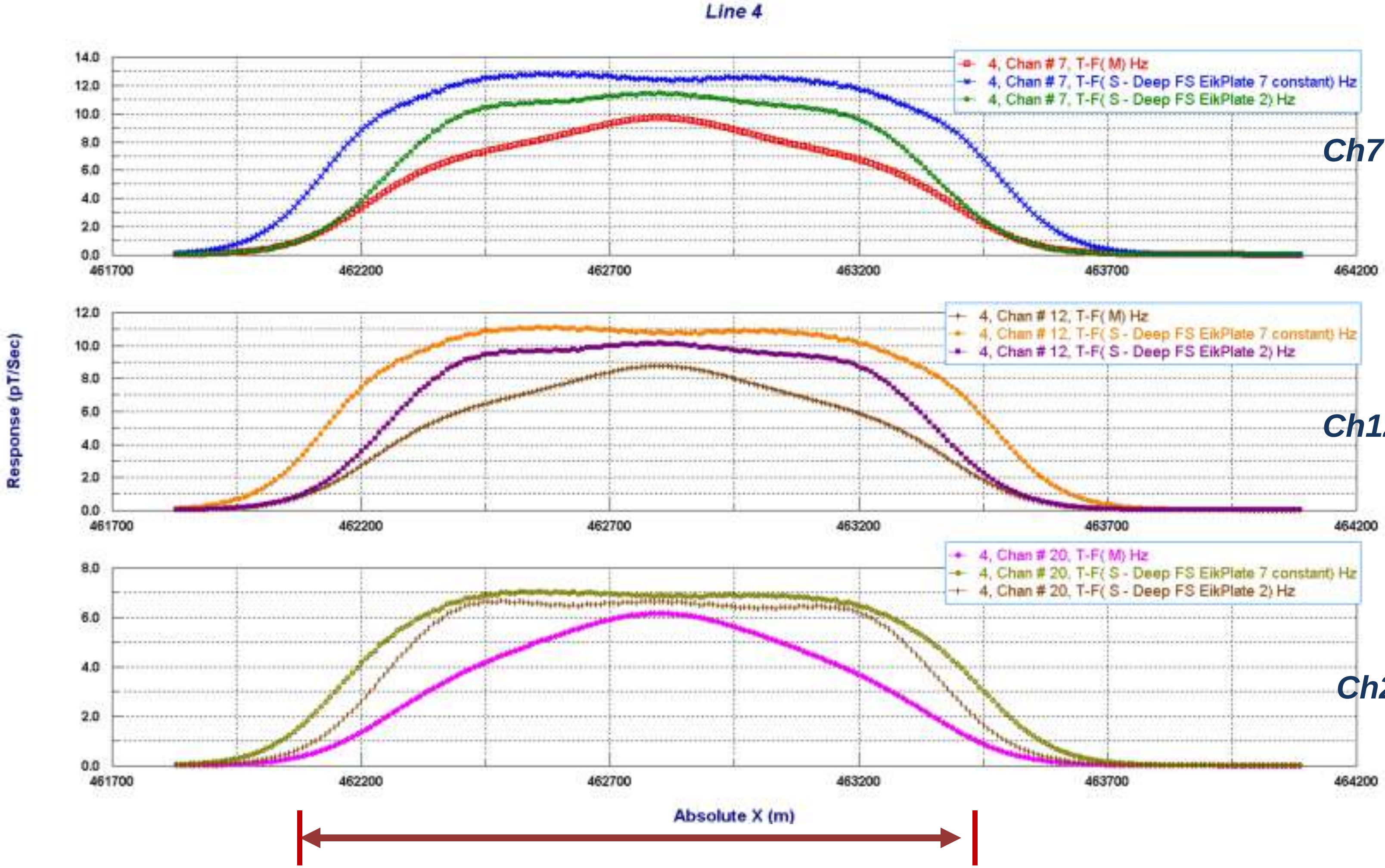
Far Profile – Line 4



Ch7 - 0.22msec

Ch12 - 0.44msec

Ch22 - 1.34msec

Adjusted Survey to Extend Lines

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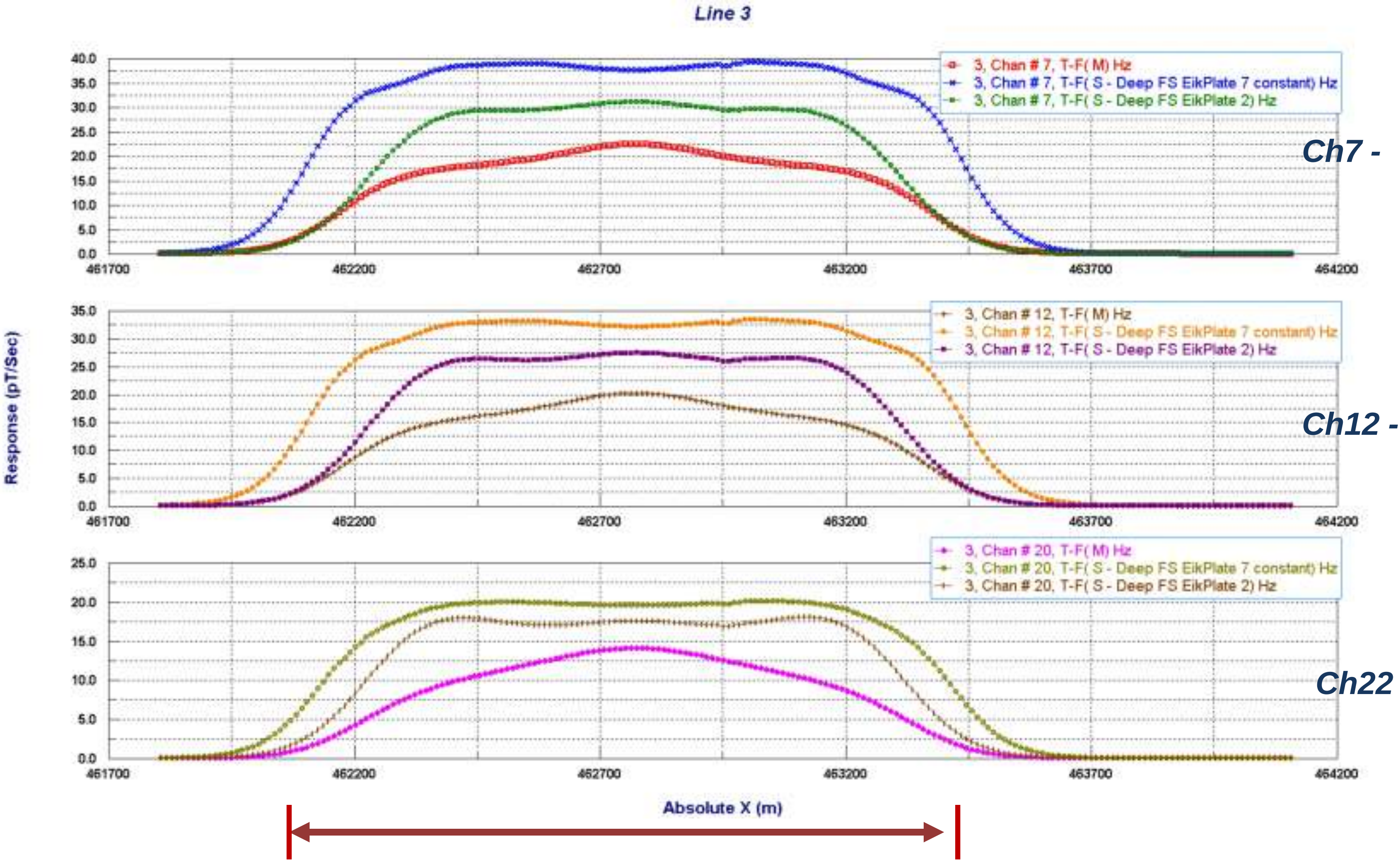
Far Profile – Line 3



Ch7 - 0.22msec

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Ch22 - 1.34msec

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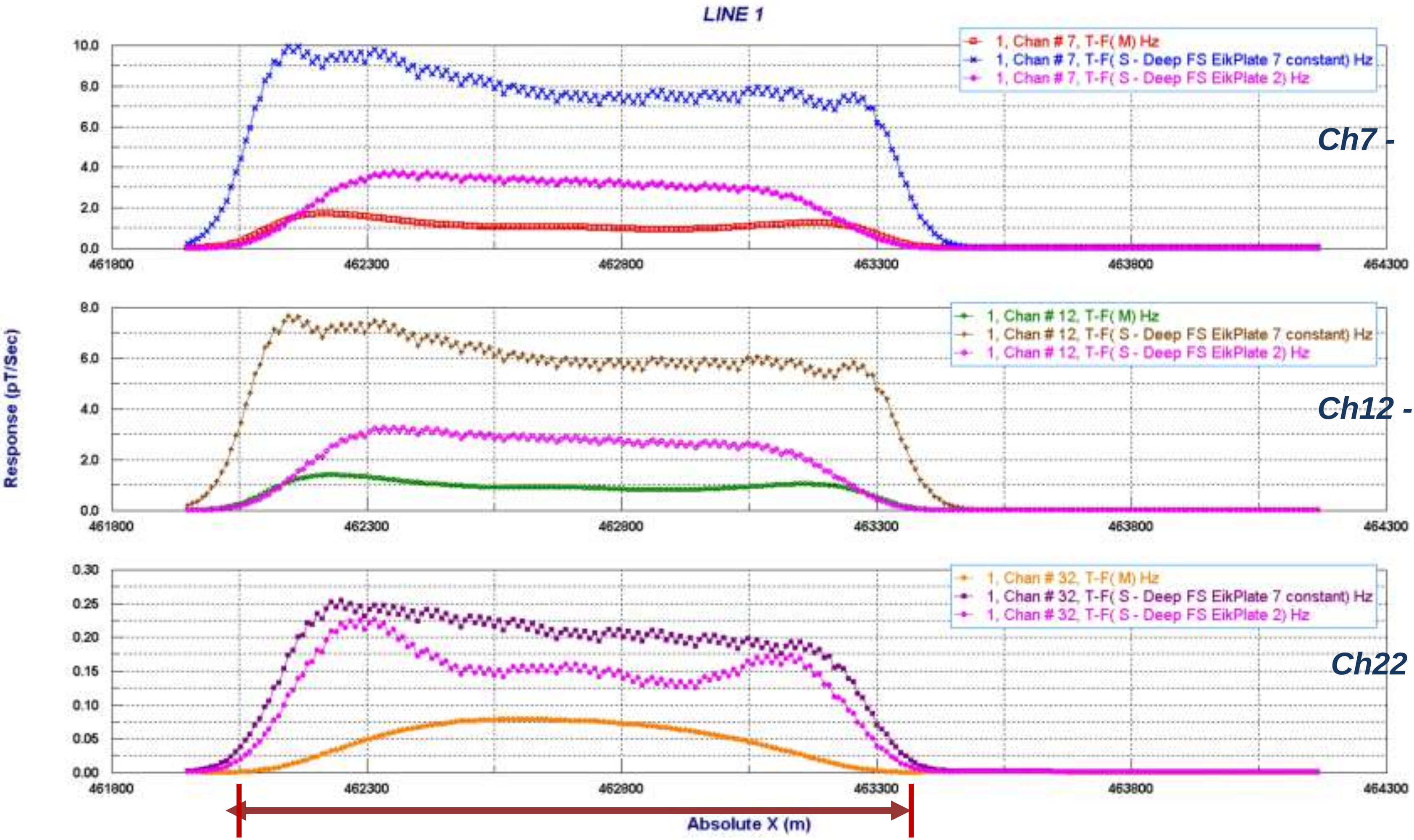
Far Profile – Line 1

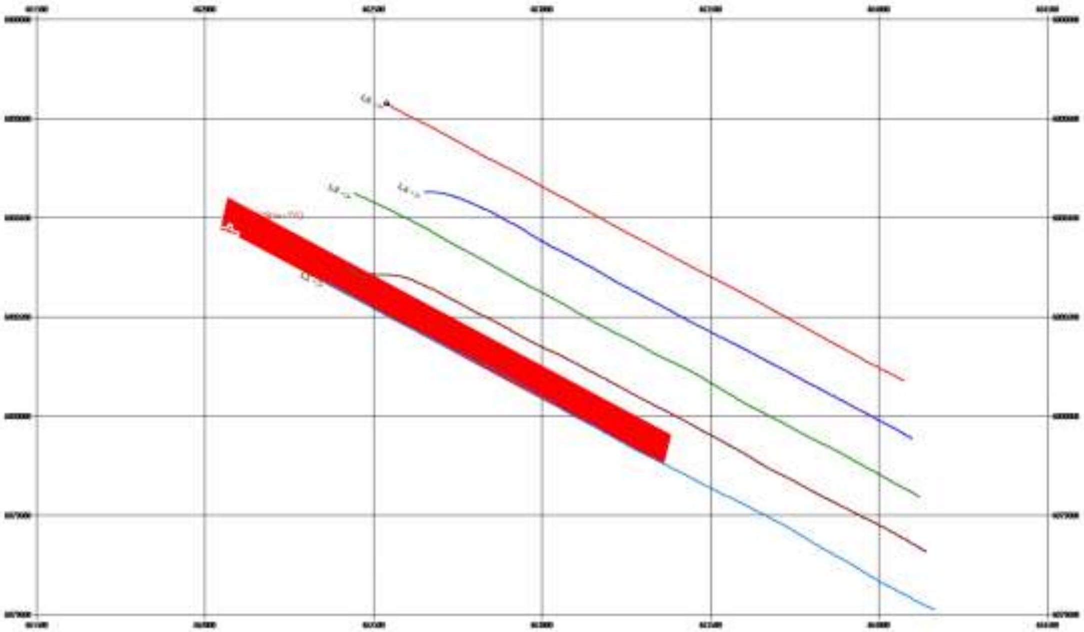


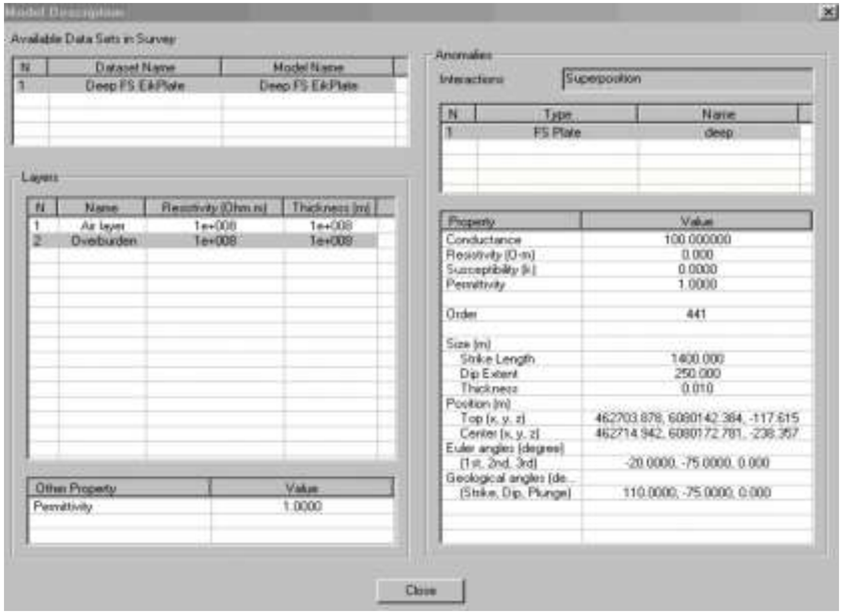
Ch7 - 0.22msec

Ch12 - 0.44msec

Ch22 - 1.34msec

Survey 1 and Target 1





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Geological angles (de...	
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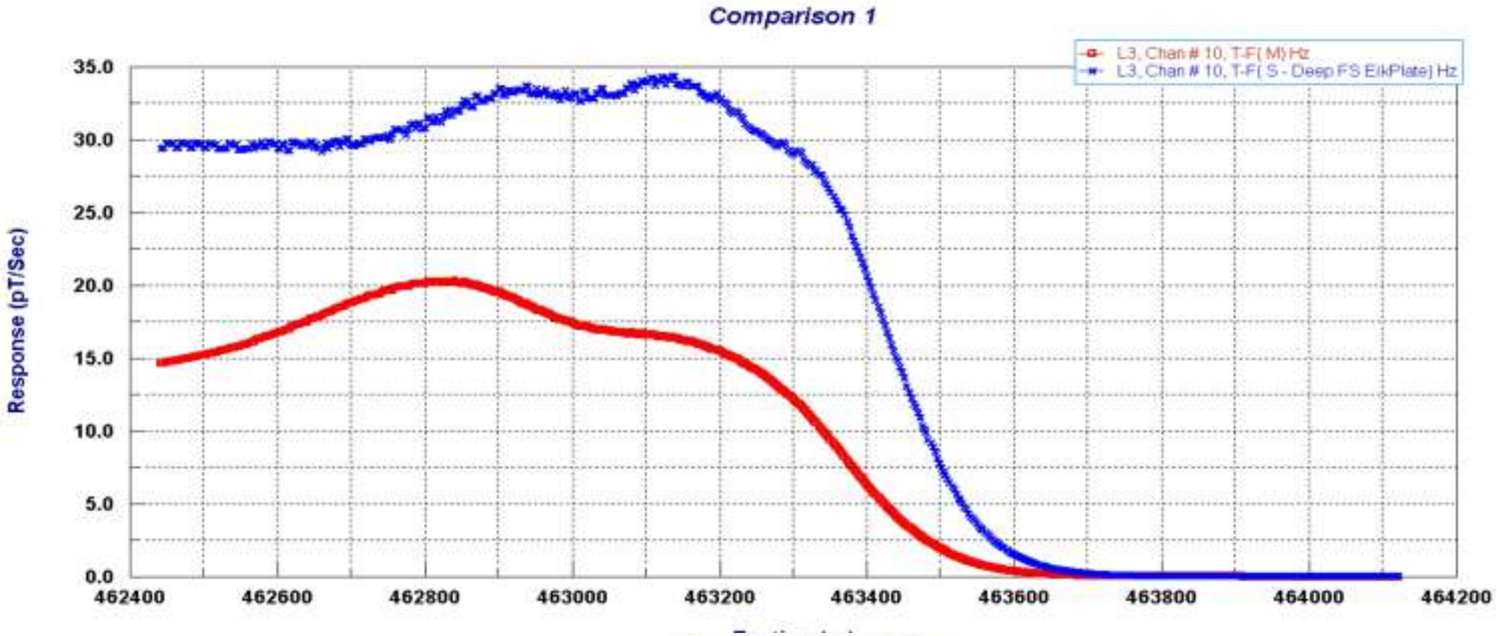
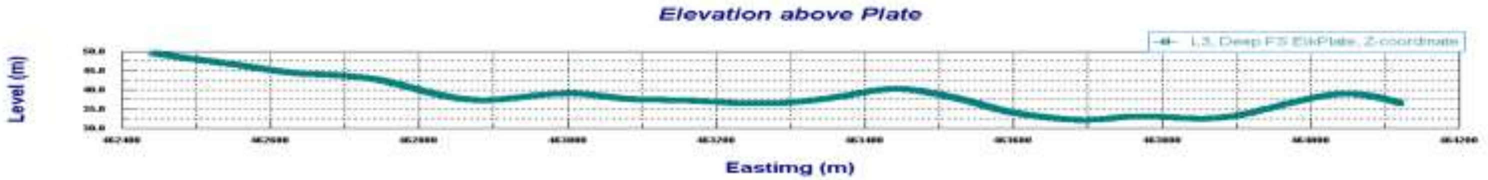
Portions of 5 flight lines. Deep target

Survey and Target 1

Notes: pT/sec ≡ pV/m^2 , unit current is used , Tx area 962m^2 or 35m radius

FS EikPlate here utilizes 7 eigenfunctions of the solution matrix.



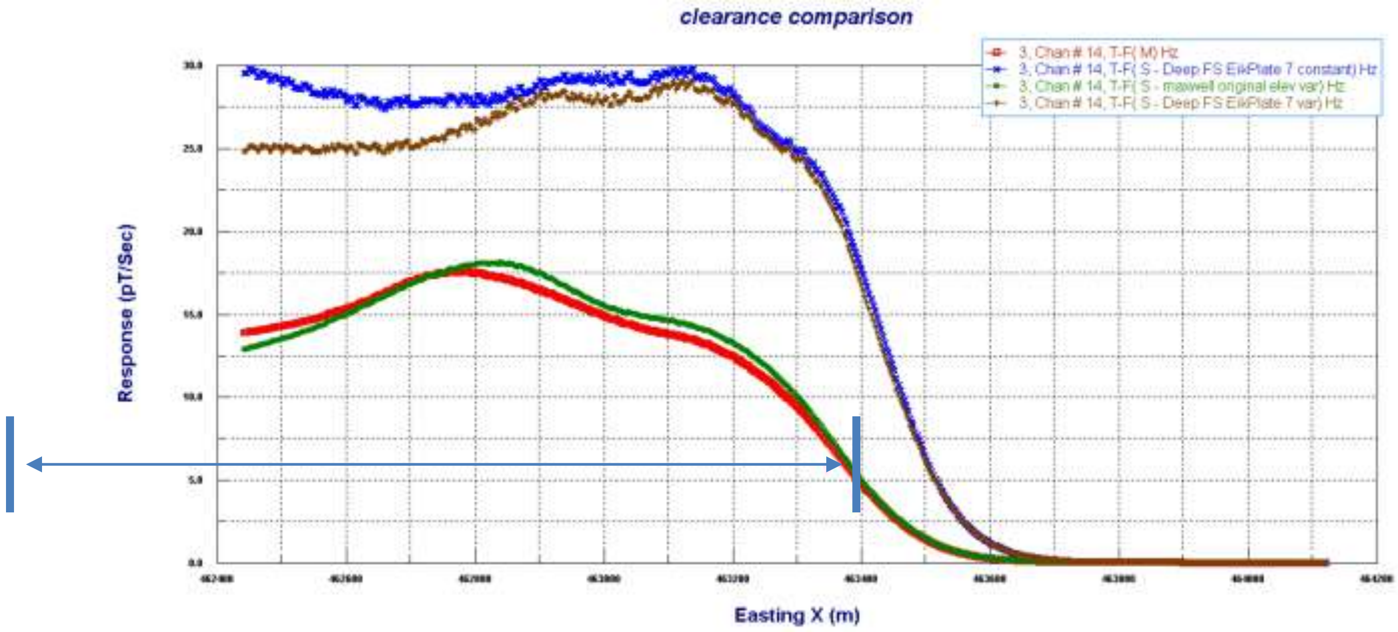


L3 – Ch 10 – 0.335msec

Two things to note: EiKP responds sooner on the east and does not drop off to the west. It is important to note that while the elevation increase somewhat to the west, the profile also turns and runs closer to the target.

Survey comparison to elevation

Comparison to variable clearance to constant clearance – Line3 – ch14 – 0.583msec

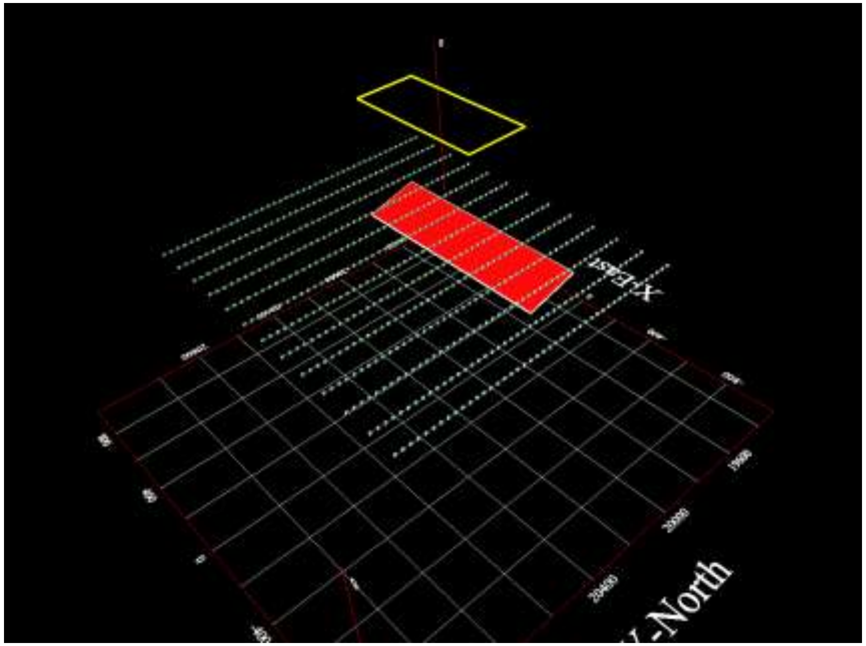


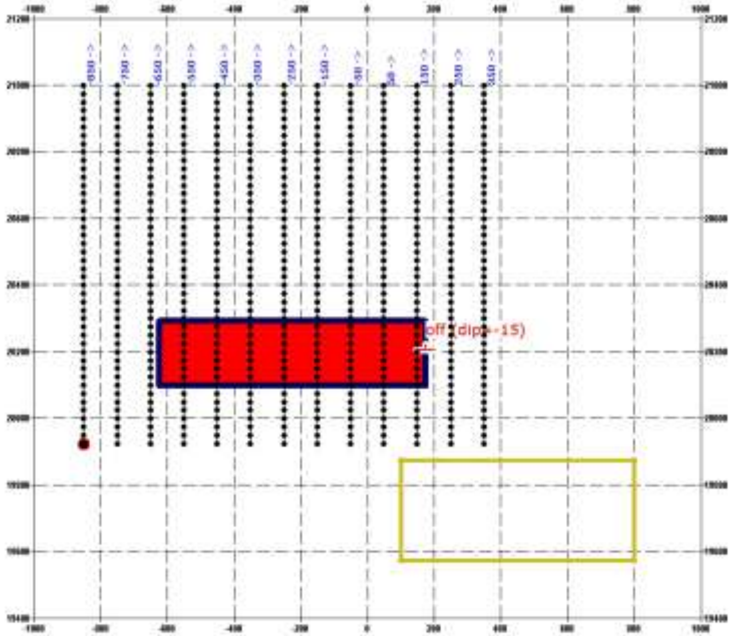
Maxwell Variable
EMIGMA variable
Maxwell constant
EMIGMA variable

While there are response changes with clearance, they are not significant in the comparison between algorithms. This is particulary true when the system is off the target on the edge of the target.

Maxwell response independent of geometry of source field
[no migration]

"Maxwell" is not by definition a modeling or simulation algorithm. Rather, it is more like an imaging tool. The application does not attempt to solve any governing differential equation for scattering of fields from a conductor. It does, however, utilize the solution the ordinary differential equation which governs the decay of a current ring injected with a pulse of current. Our previous examples, alluded at this issue but we will now try to demonstrate this more precisely.





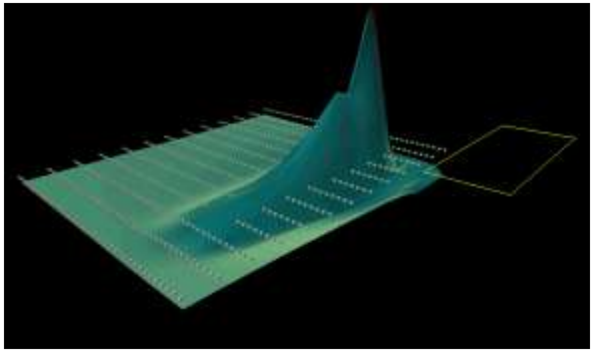
Tx, plate and data points

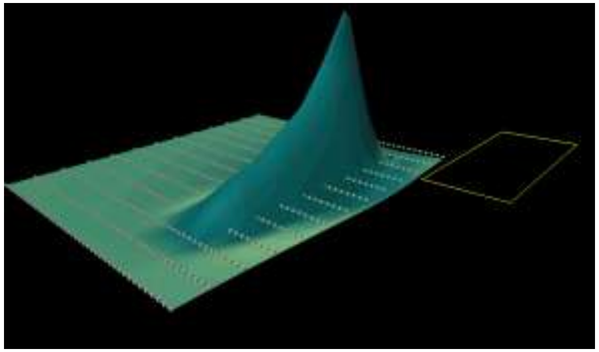
Plate: 800m x 200m, 50S
depth to top = 50m

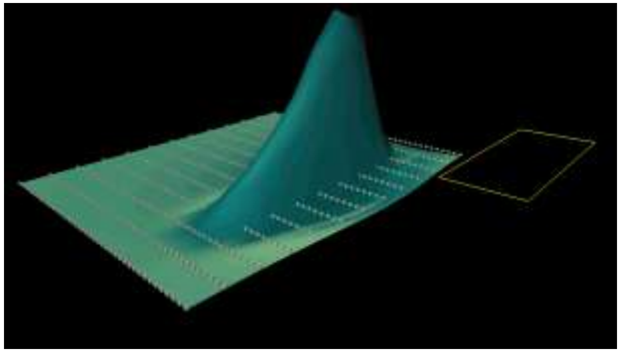
In this case, we use a standard impulse system at 30Hz with a moderately short turn-off and standard off-time windows distributed logarithmically. Intuitively, we would expect the response to be focused over the east side of the target in early time and migrate towards the west as time progresses.

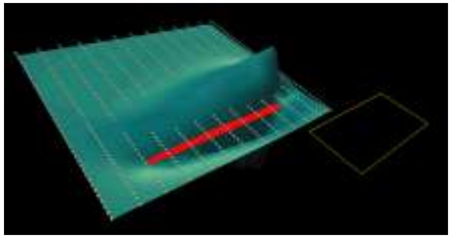
Maxwell response independent of geometry of source field
[no migration]

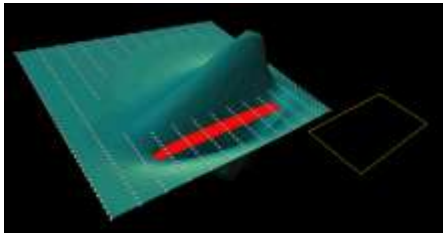
With these figures, we examine the response of the PEI implementation of the Annan formulation for freespace.

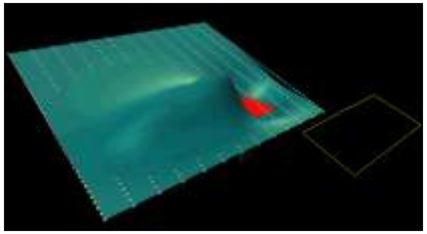

Hz early time

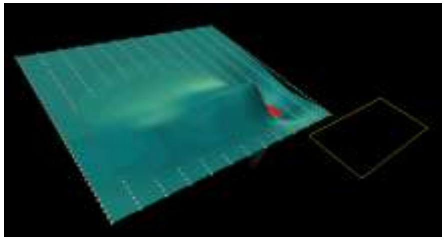

Hz mid time


Hz late time


Hx early time


Hx late time

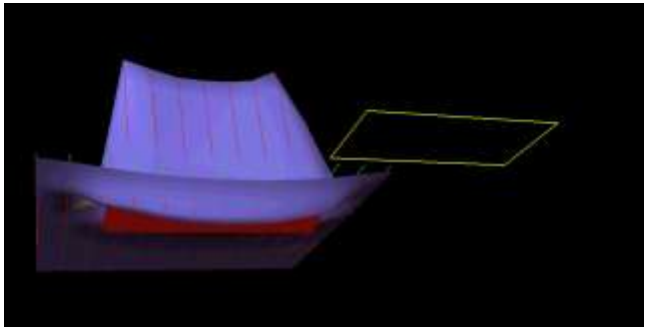

Hy early time


Hy late time

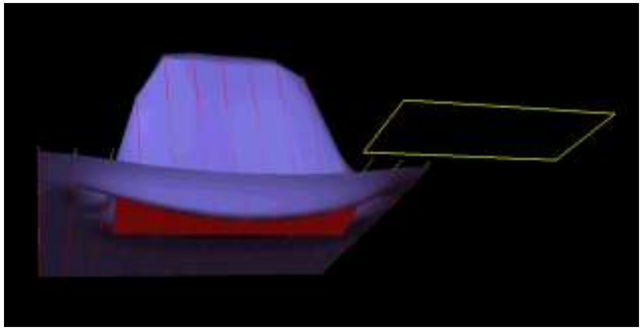
Here, we observe early time responses focused on the east part of the anomaly with responses migrating to the west as time progresses.

Maxwell response independent of geometry of source field
[no migration]

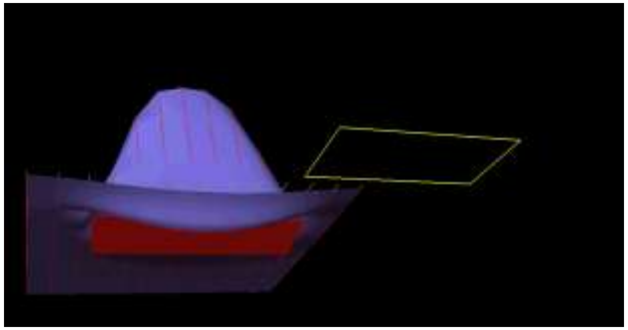
With these figures, we examine the response of the Maxwell approximation.



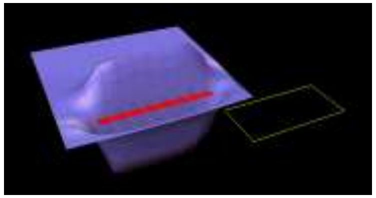
Hz early time



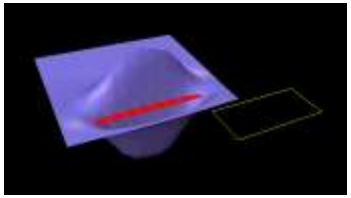
Hz mid time



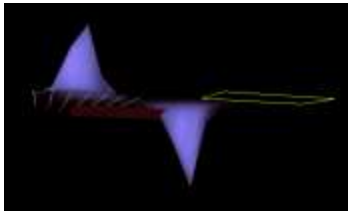
Hz late time



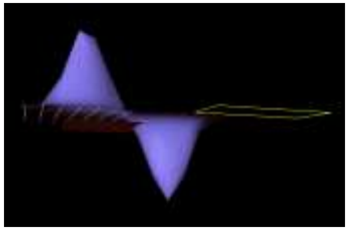
Hx early time



Hx late time



Hy early time

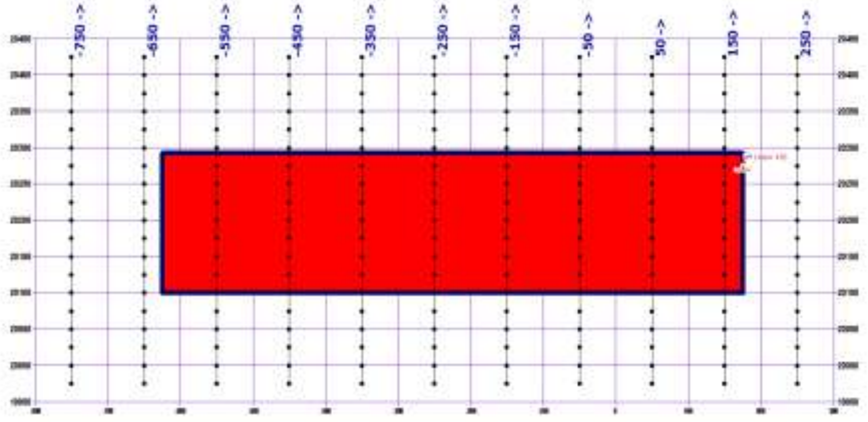


Hy late time

The responses stay fixed in position with time. The a priori emplacement of a current ring centered on the plate is not a numerical solution as in PEI's implementation of the Annan formulation. The Annan formulation proposes an algorithm which solves for a complex current distribution which is dependent upon the specifics of the source field distribution over the plate with time and the size, orientation and conductance of the plate

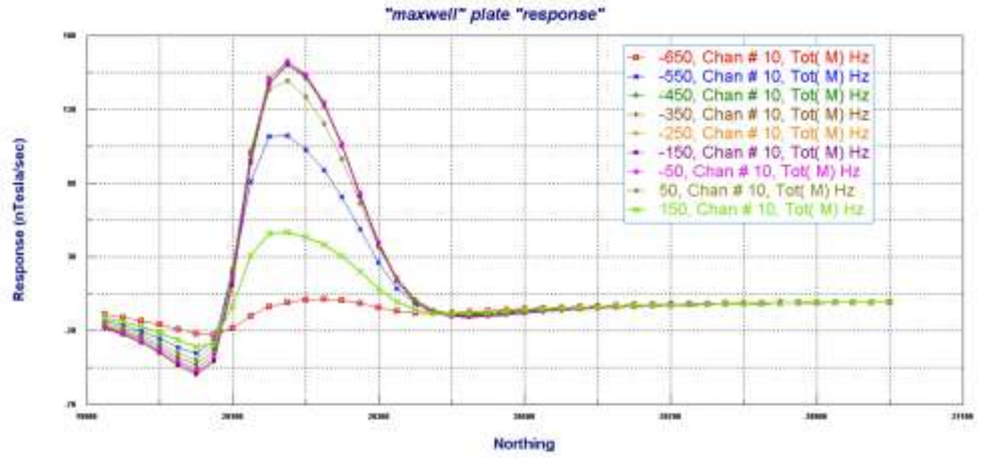
Maxwell response independent of geometry of source field
[no migration]

Hz response at early and mid-time, for 9 profiles starting at -650 (just off the plate) to 150 (almost off the plate).



Tx, plate and data points

early time



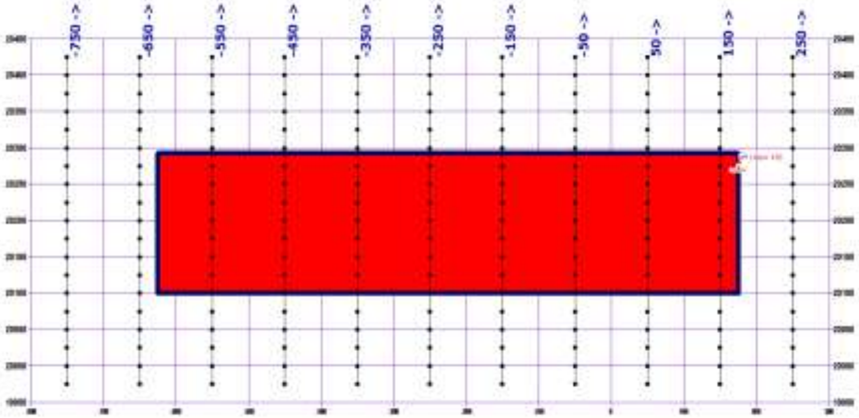
mid- time

At early time (Ch1 - .08msec), the response is very similar for all profiles crossing the plate. L150 is somewhat smaller and the strength of the induced currents appear slightly higher to the east and west edes as indicated by the response on L550W and L50E. The remaining lines over the center area of the plates are almost identical.

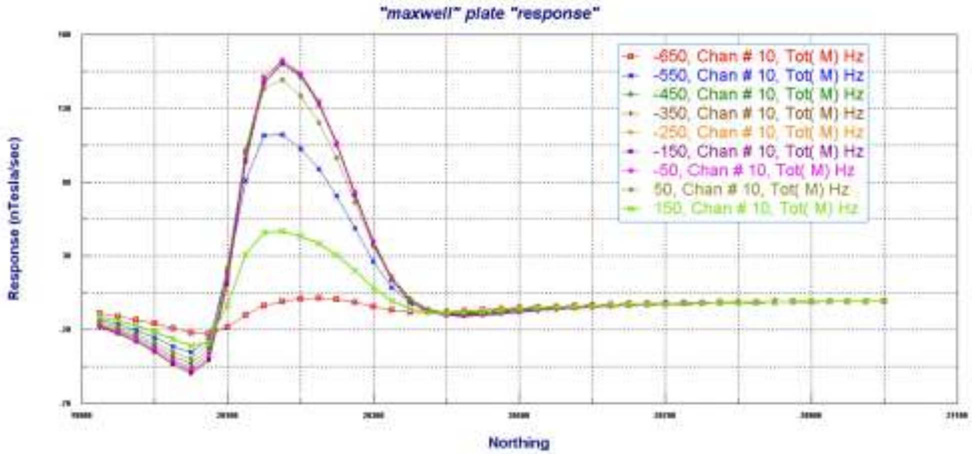
The mide-time (Ch19 0.62msec), there has been no migration to the western portion of the plate, rather in appears the current at the east and west edges are decreasing relative to the currents at the center. Which is again contrary intuition.

Maxwell response independent of geometry of source field
[no migration]

Hz response at early and mid-time, for 9 profiles starting at -650 (just off the plate) to 150 (almost off the plate)

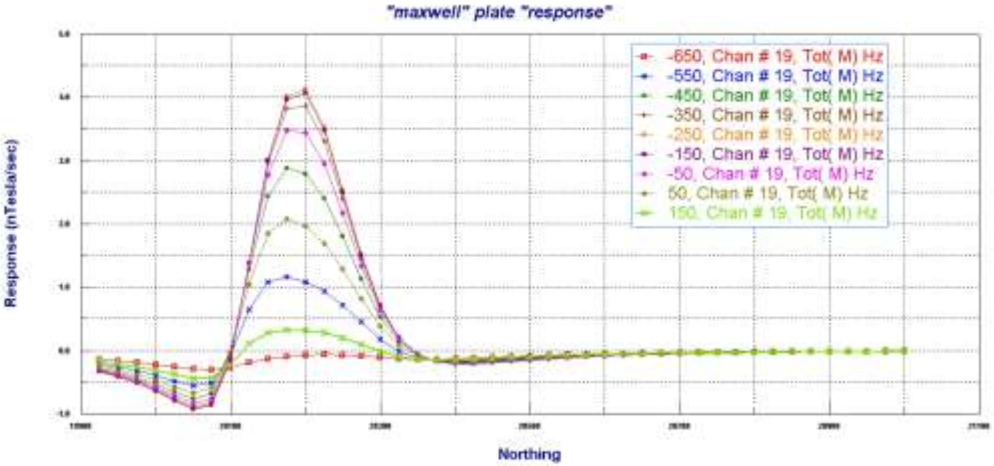


Tx, plate and data points



mid- time

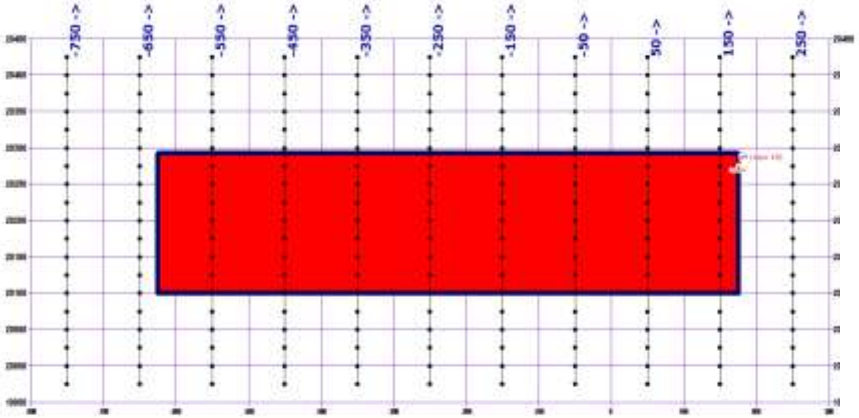
As we move to late time, the strength of the current is obviously centered on the plate with the response dropping off regularly as we move to either the west or the east.



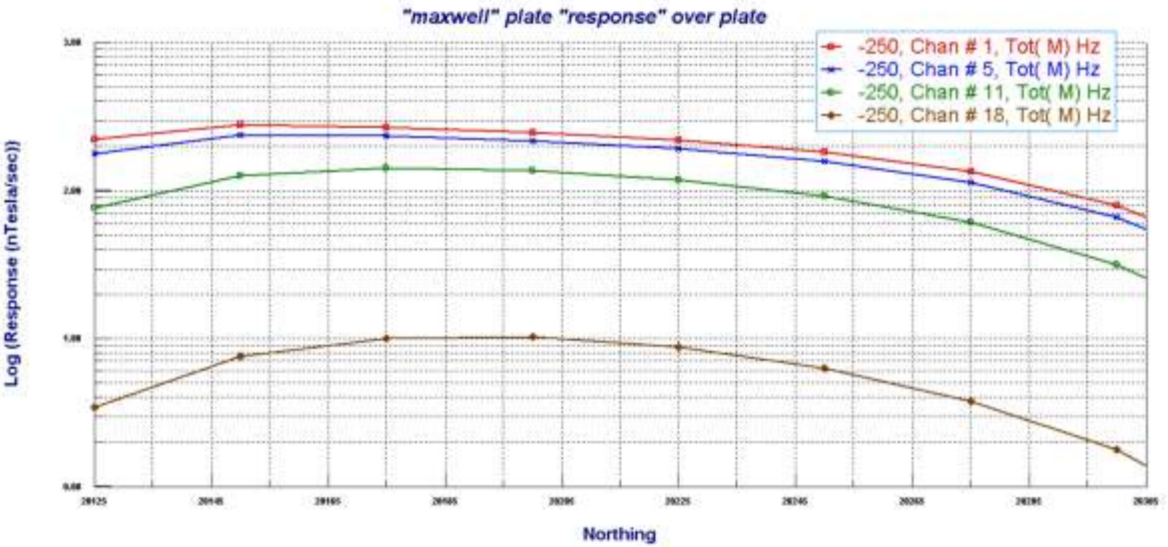
late- time

Maxwell response independent of geometry of source field
[no down dip migration]

Hz response at early and mid-time, for the centre profile (L250W).



Tx, plate and data points



Hz over plate

We have plotted Ch 1,5,11,18 at the stations over the plate for the center line. In order to compare relative variations N-S, we have plotted the amplitude logarithmically.

There is no obvious migration of currents down dip.

Maxwell response independent of geometry of source field
[no down dip migration]

Summary Target off Center: In this scenario, Maxwell obviously misrepresent both the E-W location of the target. From the Maxwell representations, one would observe the target to be much further to the west than it is actually located.

The representation of the target NS, is also obviously mislocated plus the target would have to be interpreted as smaller in the NS direction and deeper than it is actually located.

It would seem that simple visual observation would be a better interpretation tool.