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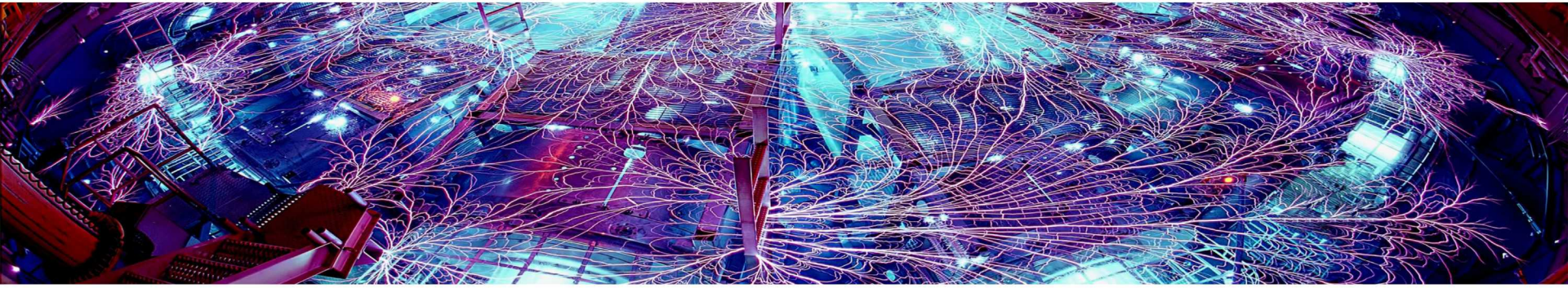

2D MHD Simulations of Magnetically Driven Striplines

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November 2018

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The Question

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- When does 2D MHD matter?
  - When an accurate scale factor is needed.
- When does the scale factor deviate from two parallel infinite plates?
  - Always.

- Note: scale factor and load inductance are fundamentally connected.

Z Pulse Shaping

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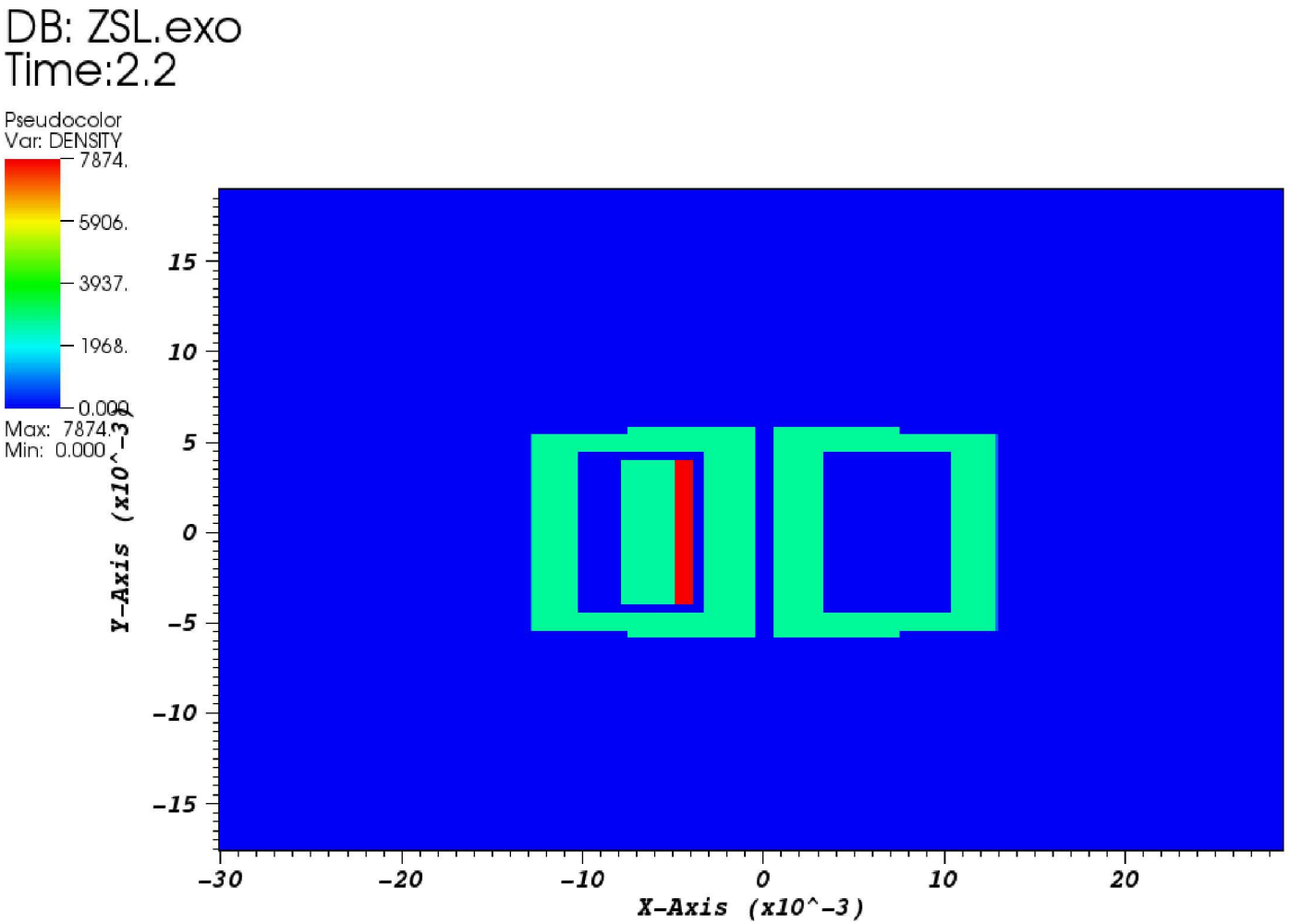
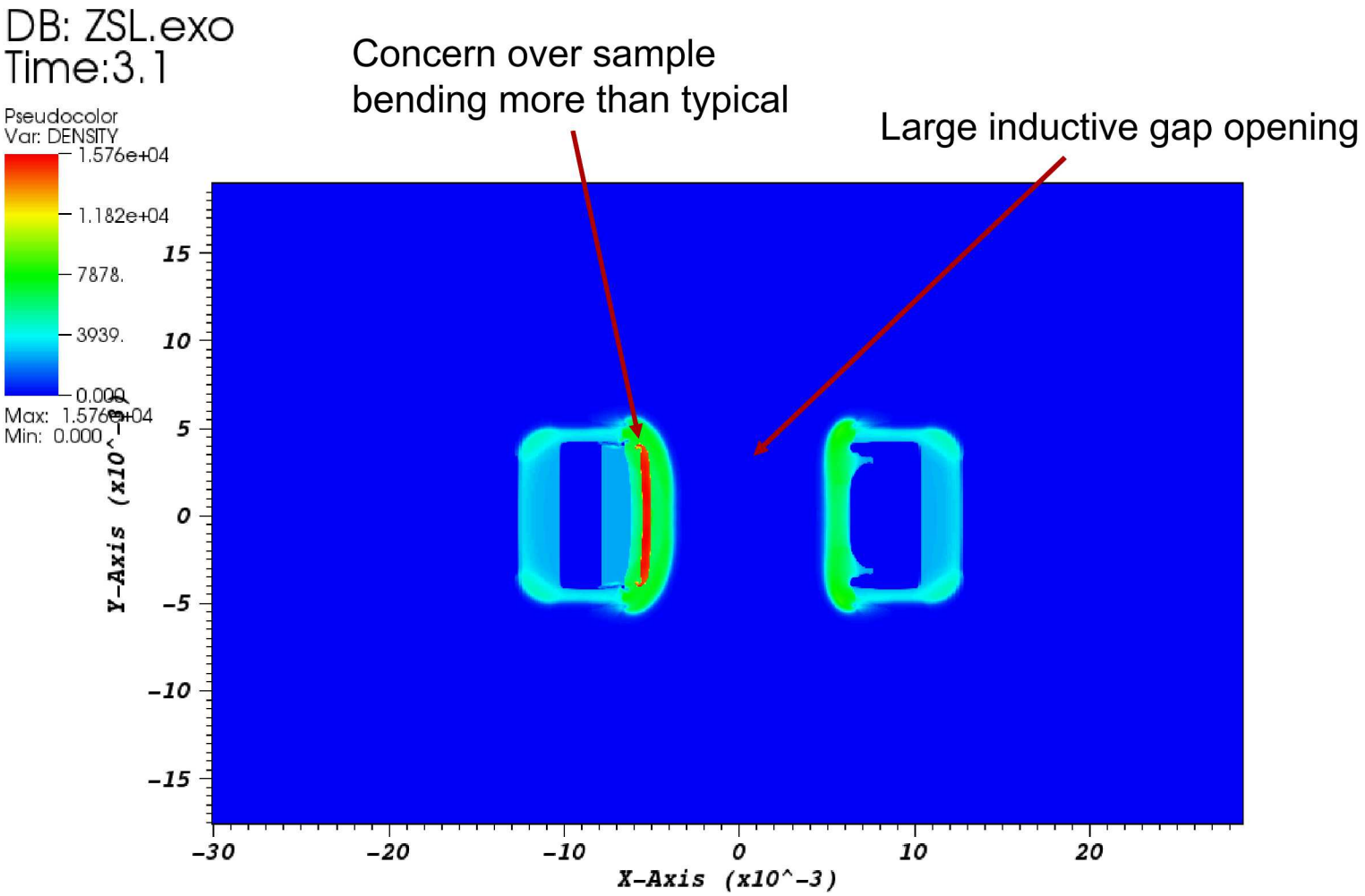
- The Z Circuit Model developed by Hutsel *et al** allows for accurate loss-free prediction of asynchronous pulse shapes given a time-varying load inductance.
- Time-varying load inductance must come from a 2D MHD simulation that accounts for AK gap opening and magnetic diffusion effects.
  - Inductance calculated from magnetic energy stored in 2D simulation domain: $L=2E/I^2$
- The AK gap opening is dependent on the time-acceleration history of the stripline, thus on the current history.

* doi 10.1103/PhysRevAccelBeams.21.030401

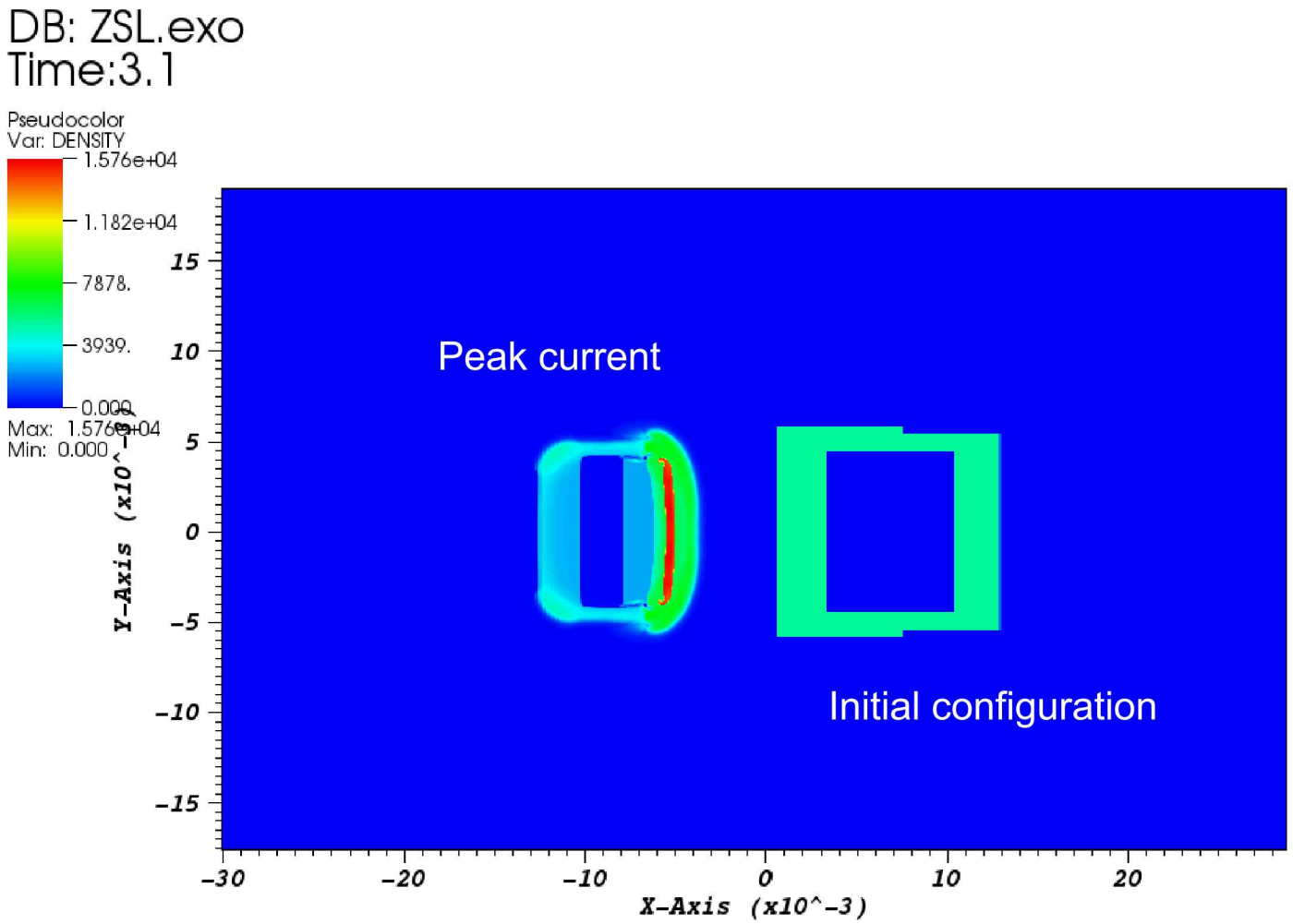
2D MHD


DB: ZSL.exo
Time:2.2
Pseudocolor
Var: DENSITY
7874.
5906.
3937.
1968.
0.000
Max: 7874.
Min: 0.000
Y-Axis (x10^-3)
15
10
5
0
-5
-10
-15
-30
-20
-10
0
10
20
X-Axis (x10^-3)

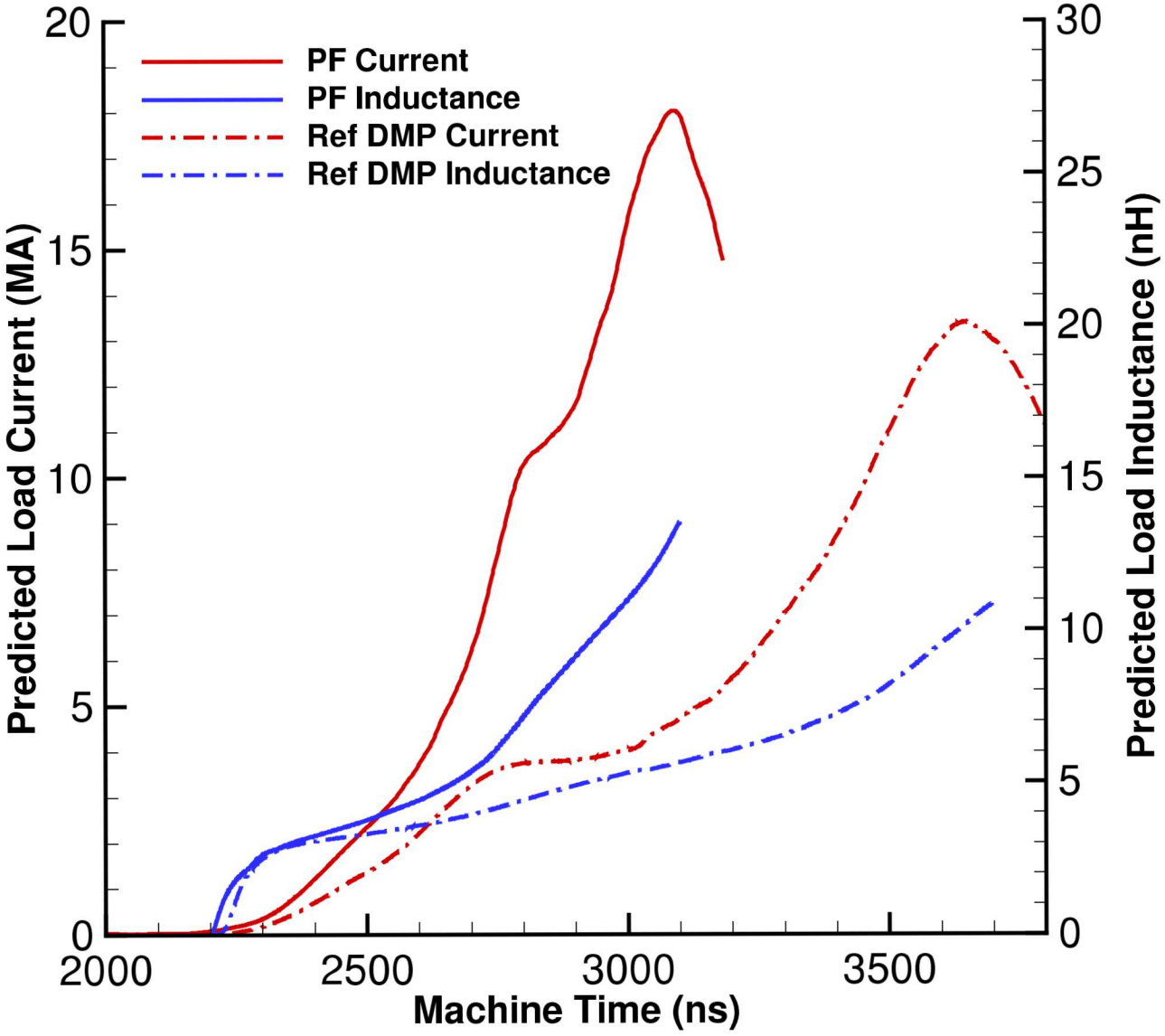
2D MHD


DB: ZSL.exo
Time:3.1
Pseudocolor
Var: DENSITY
1.576e+04
1.182e+04
7878.
3939.
0.000
Max: 1.576e+04
Min: 0.000
Concern over sample bending more than typical
Large inductive gap opening
Y-Axis (x10^-3)
X-Axis (x10^-3)
15
10
5
0
-5
-10
-15
-30
-20
-10
0
10
20

Gap opening can be significant



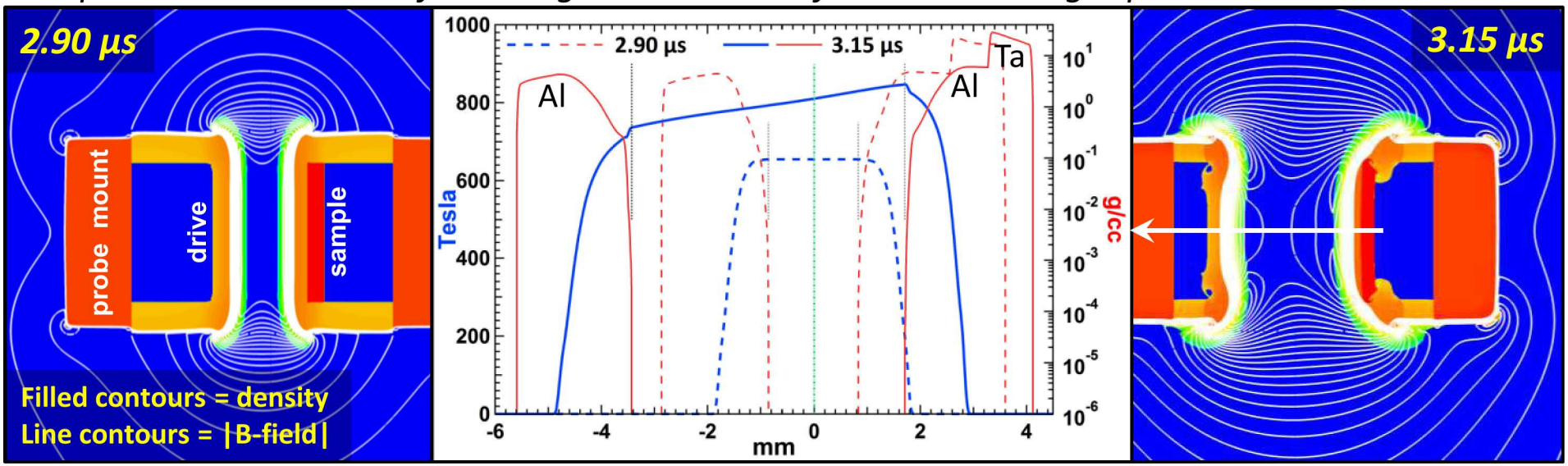
Two shock-ramp pulse shapes



Asymmetries

- Scale factor is needed to calculate load current from drive magnetic field, however magnetic field can differ between anode and cathode due to mass loading.
- This can change the interpretation of the drive velocimetry.

Snapshots with line-outs from Alegra simulation of Z2434 mid-height position



Images courtesy of Jean-Paul Davis, SNL

3D Problems

- Seidel *et al** performed 3D computational development on the Z stripline in order to increase drive uniformity in the z-direction across the full height of the panel, thus improving uniformity across a single sample.
- Drive non-uniformity across a single sample adds significant uncertainty to the analysis due to 2D effects perpendicular to the plane of the 2D simulation (thus a 3D effect).

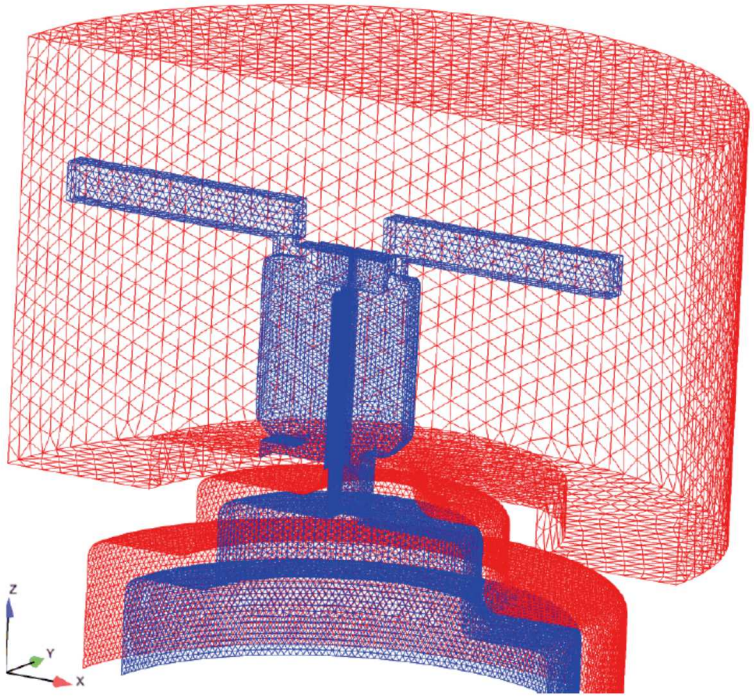


Figure 11. Surface mesh for Emphasis/UTDEM simulation of a double-sided ICE stripline load.

* doi 10.1109/PPC.2009.5386320

3D Problems Revisited

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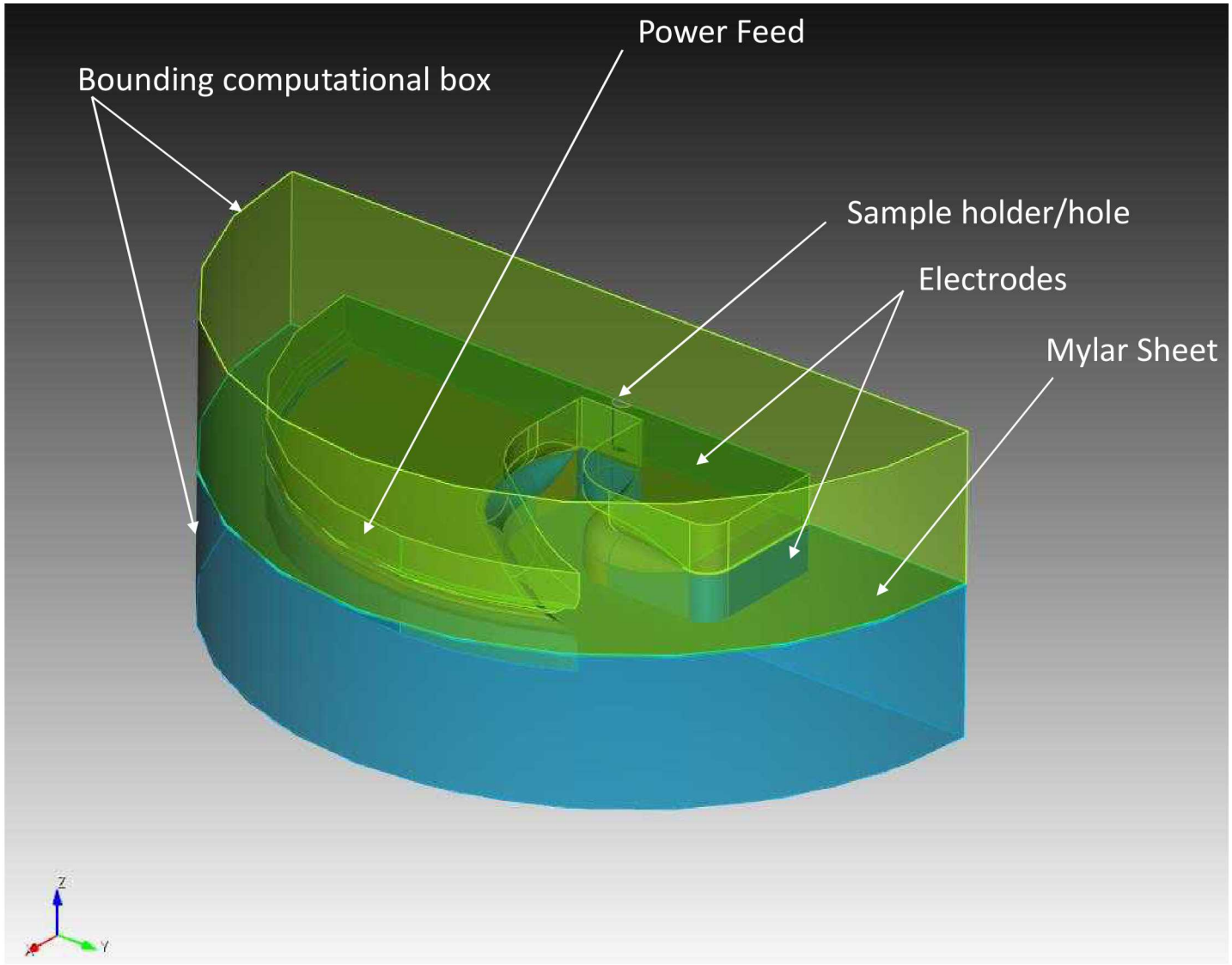
- We have begun a spiritual repeat of this effort for the Thor accelerator, as strong z-axis sample drive non-uniformities have been measured.
- This problem is trickier on Thor due to the panel containing only a single sample height, and the short is fairly close to the sample.
- Improving drive uniformity will likely cost pressure accessibility.

3D Problems Revisited



Thor simulations courtesy Bob Campbell, SNL