LARF Status

3D Field and Detector Response Calculations

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July 19, 2016

Outline

Parallel Wires

Caged Geometry

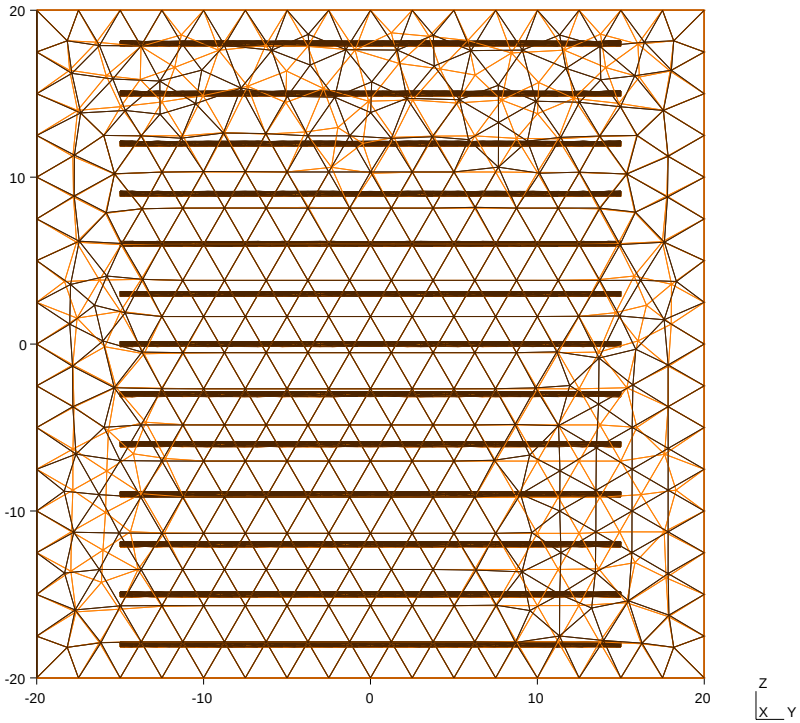
Next Steps

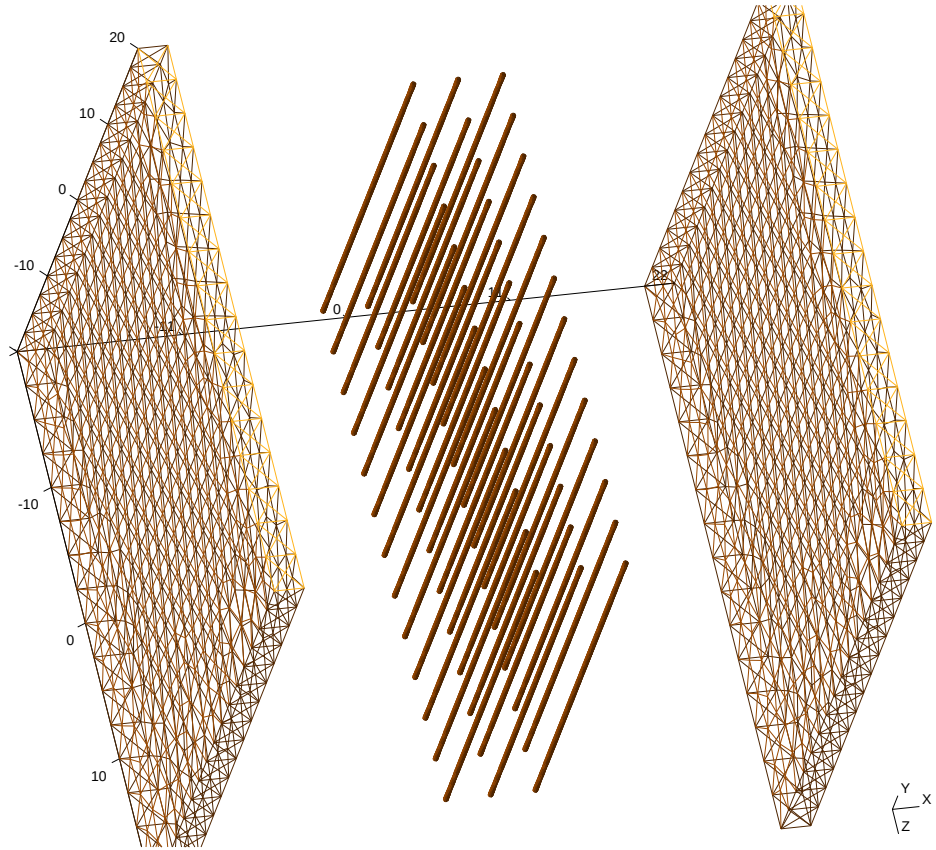
Parallel Wires - Parameters

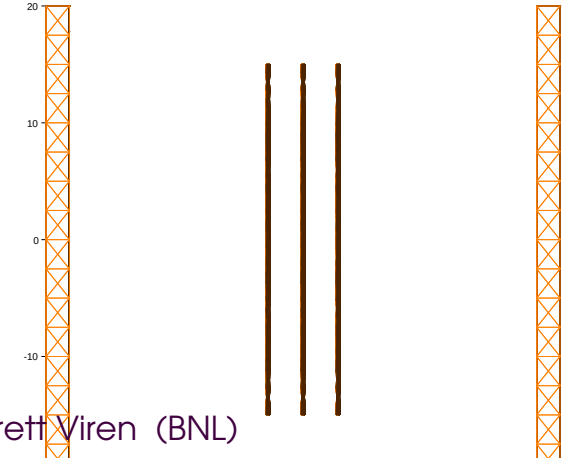
Try to match 2D calculation with 3D, parallel wires.

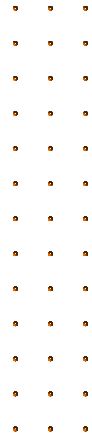
planes	13 wires in each plane, all parallel.
wires	3mm pitch and gap, 0.15mm radius, 30mm length, 1.5mm meshing.
cathode	-500 V (and ground) planes at +20 mm (-20 mm), 2.5mm meshing.
precision	Double the BEM Gaussian quadrature orders.
resolution	raster grid at 500x10x500.

Parallel Wires

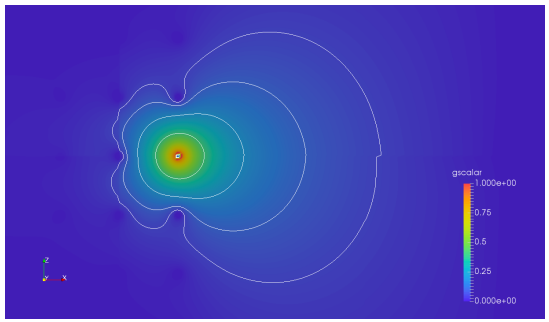




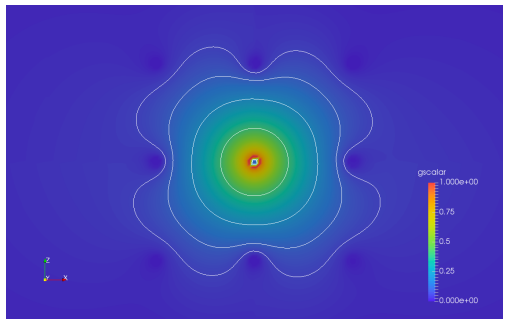




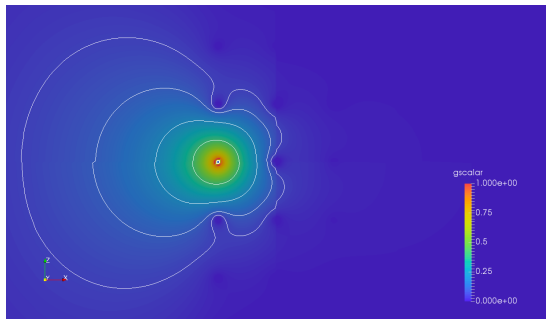
Parallel Wires - Slice Through Weighting Potentials



U plane



V plane

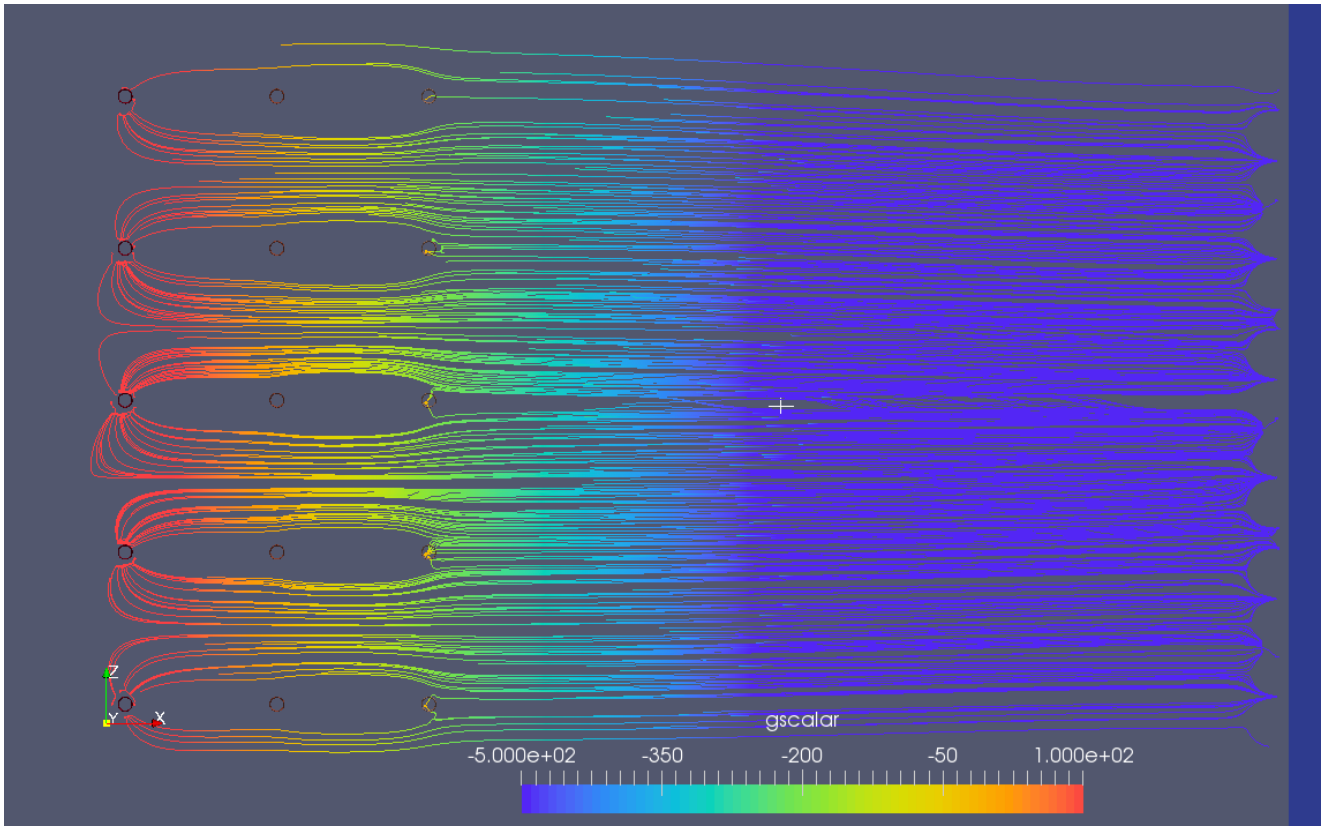


W plane

- X-Z slice through plane of symmetry (Y=0).
- Color shows weighting potential: 0-100%.
- Lines: 5%, 10%, 20%, 40% weights.
- Gaussian quadrature imprecision visible in some jaggy contous lines.
- Small spatial fluctuations near wires, but somewhat obscured.
  - Note: inside wire is $\sim$0V, square shape is pixelization.

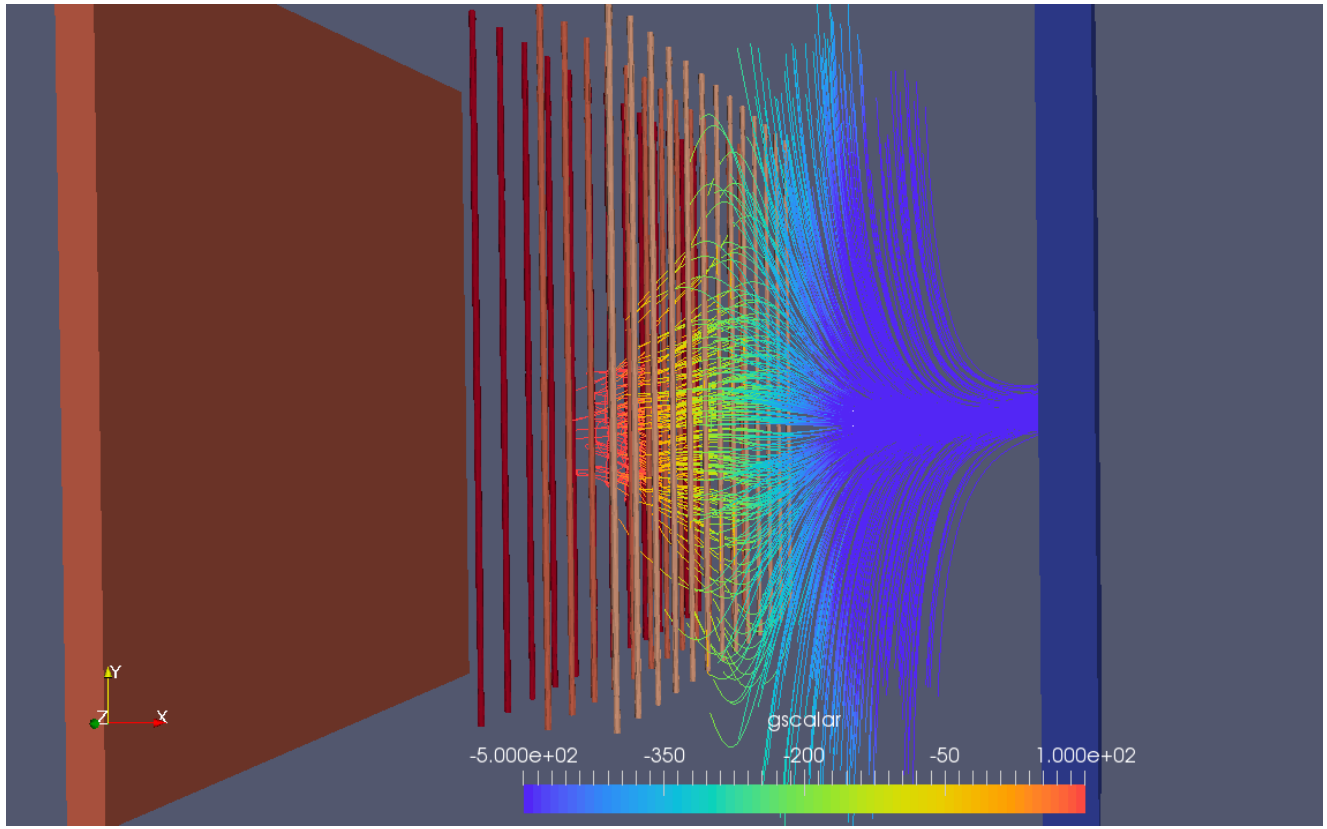
Visual comparison with Bo's 2D fields show good agreement.
For now, consider this enough validation to move forward.

Parallel Wires - Steps



- Uses ParaView's build in R-K stepper, color still shows potential.
- This is looking down the Y-axis, but actually 3D steps.
- Each stepping goes for fixed length and then quits, tracks terminating around the cyan, explained next.

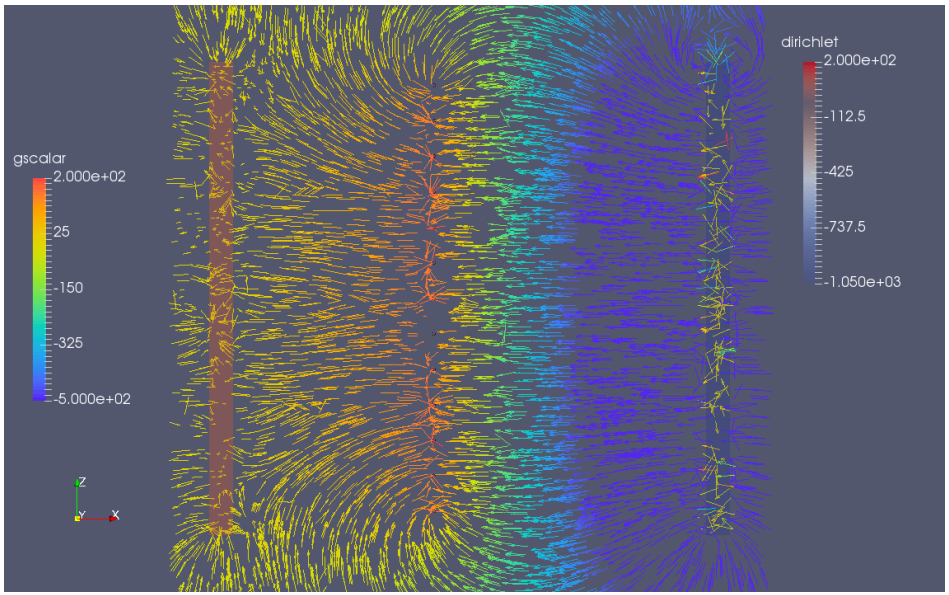
Parallel Wires - Steps Side Vie...WHOOPS!

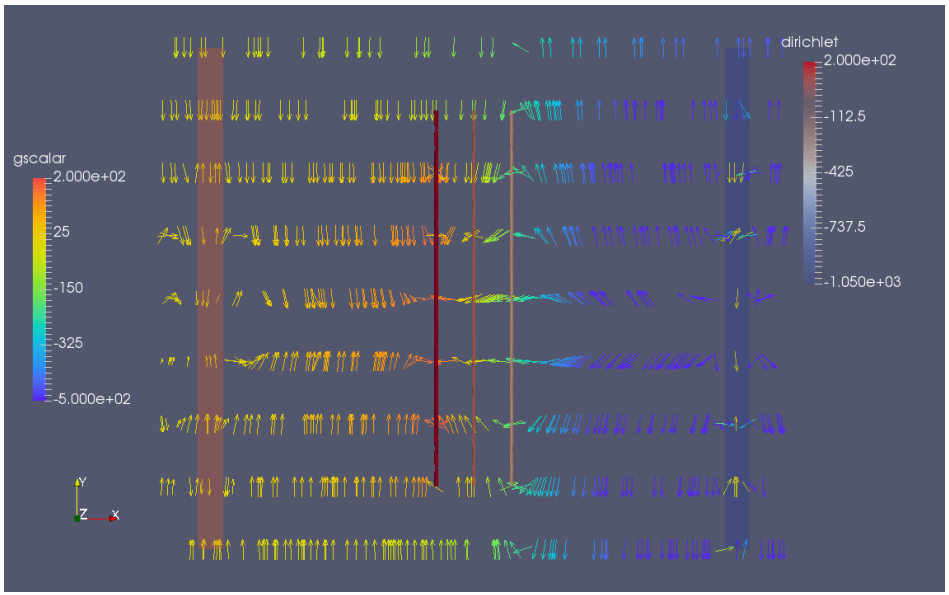


- Side view of same scene.
- But, what's with this divergence in the vertical direction?
  - → Bug in gradient! I was not respecting voxel dimensions!
  - → Artificial 50× magnification in vertical derivative.

ParaView visualization makes bugs like this (painfully) obvious!

Visualizing Bugs

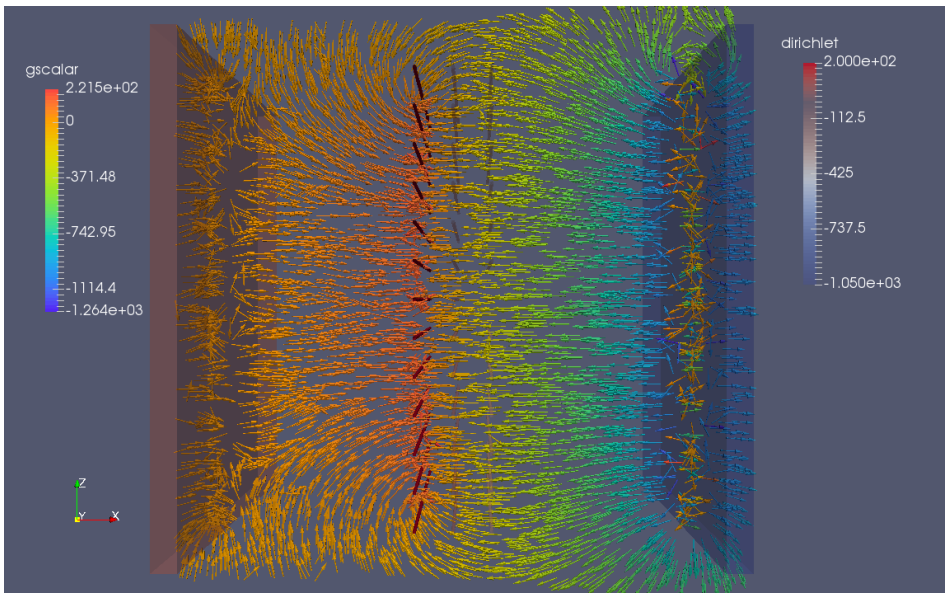


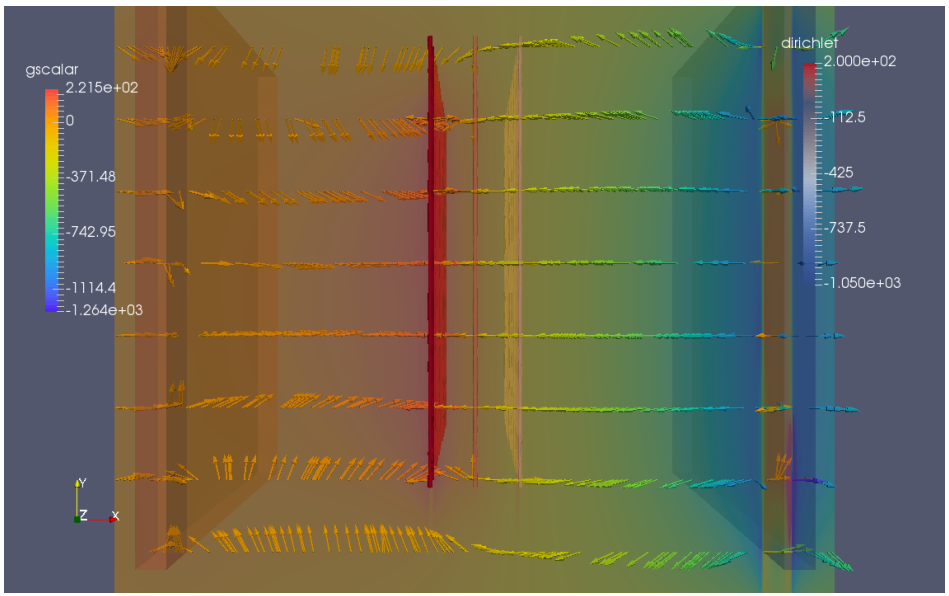


- Color of arrows is potential.
- X-Z and X-Y slices with vector field drawn as arrows.
- Clearly vector field in Y direction is wrong.
- Voxels are 0.1mm in X and Z, 5mm in Y $\Rightarrow$ 50$\times$ mistake.

Anyway, ParaView is very useful to find dumb bugs.

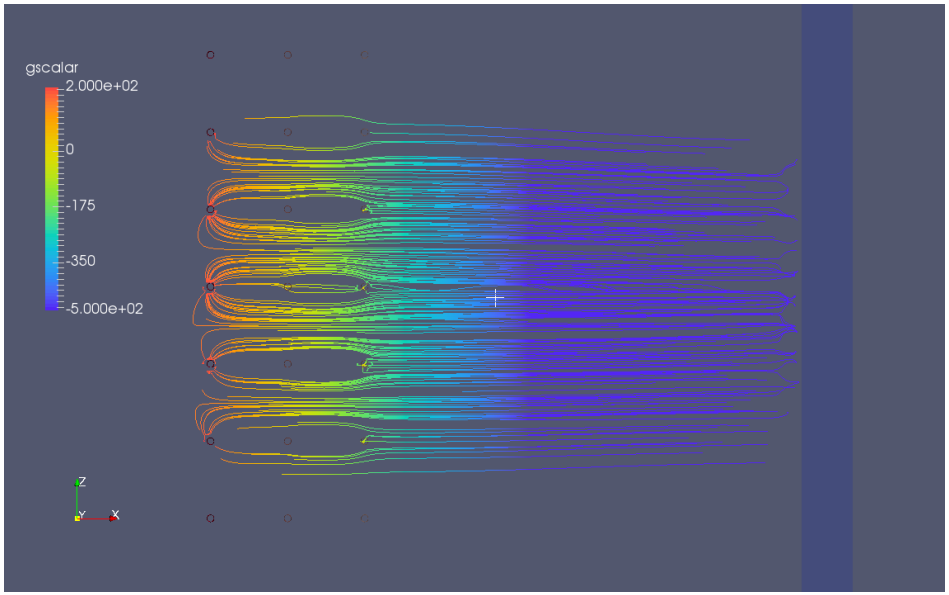
After gradient fix - vector field

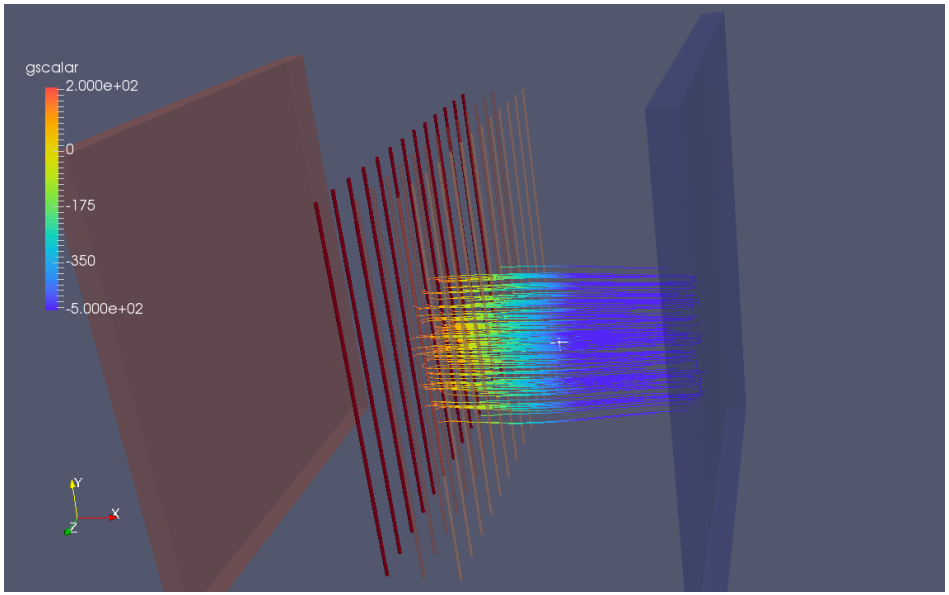




- Much more reasonable looking vectors.
- Still some divergence toward top/bottom, but it's reasonable.
  - This will limit the amount of "useful" volume to look at (next topic).

After gradient fix - Recheck Steps





- The steps no longer go wild in vertical direction.

Feel things are okay enough to move on to real 3D.

Caged Geometry Overview

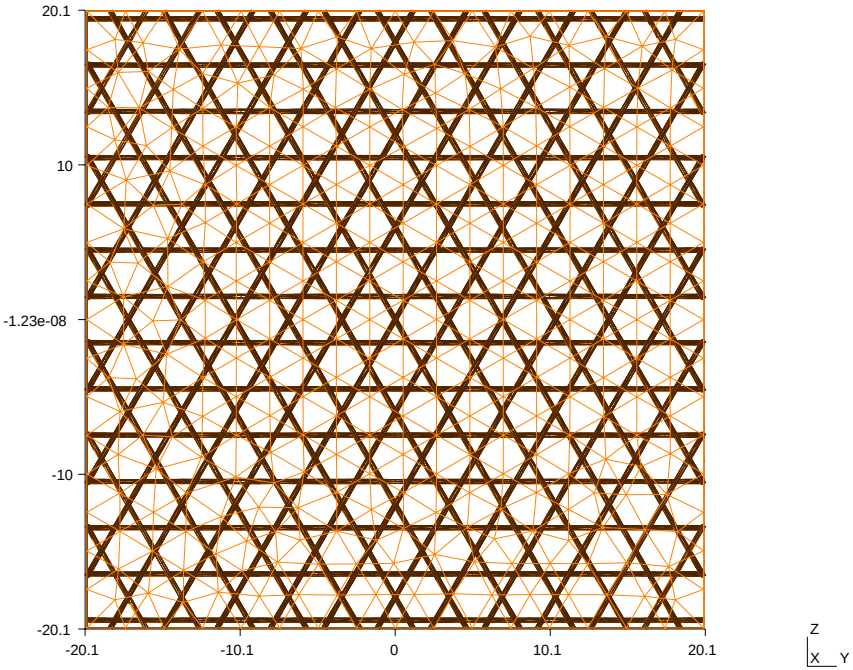
New geometry features:

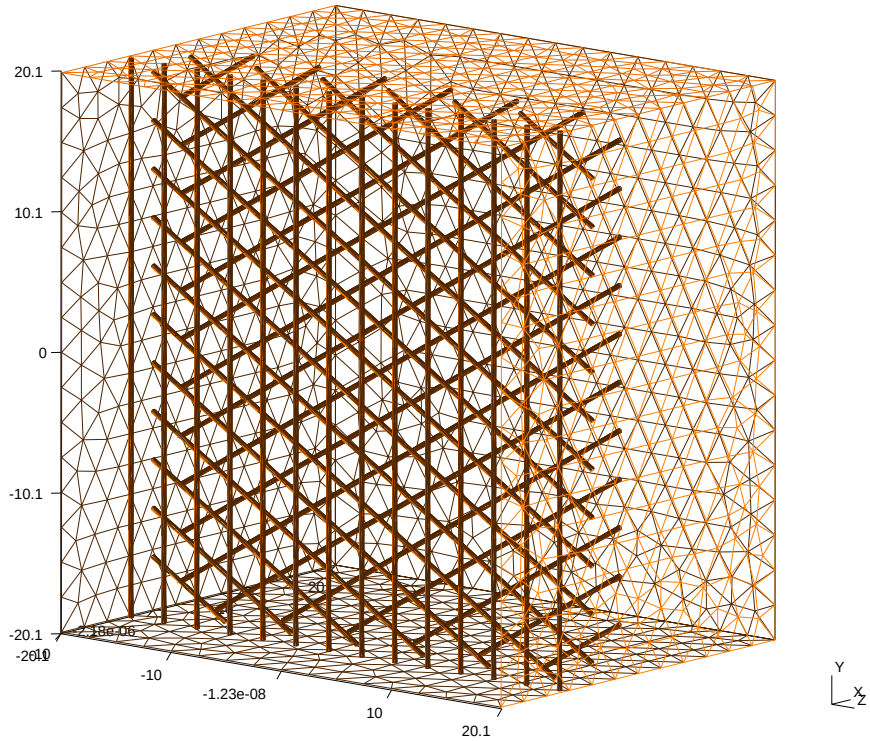
- Planar (instead of finite thickness) cathode.
- No "ground plane" (since there isn't one!)
- Wrap volume in mini "field cage".
- Bounded, fully filled wire planes.

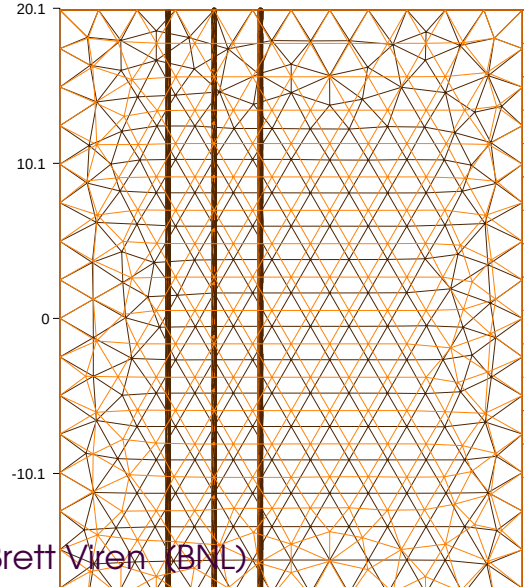
Motivation for changes:

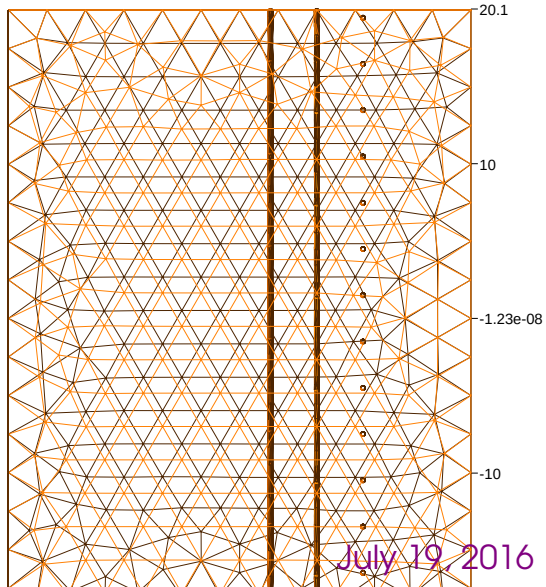
- Generically more realistic.
- Cage should make field more uniform.
- Better use of precious expensive N^2 triangles.
  - Get rid of useless back side of cathode, ground plane
- Add more wires in anticipation of Xin's requirements
- Can maybe use it look at detector edge effects.

Caged Geometry

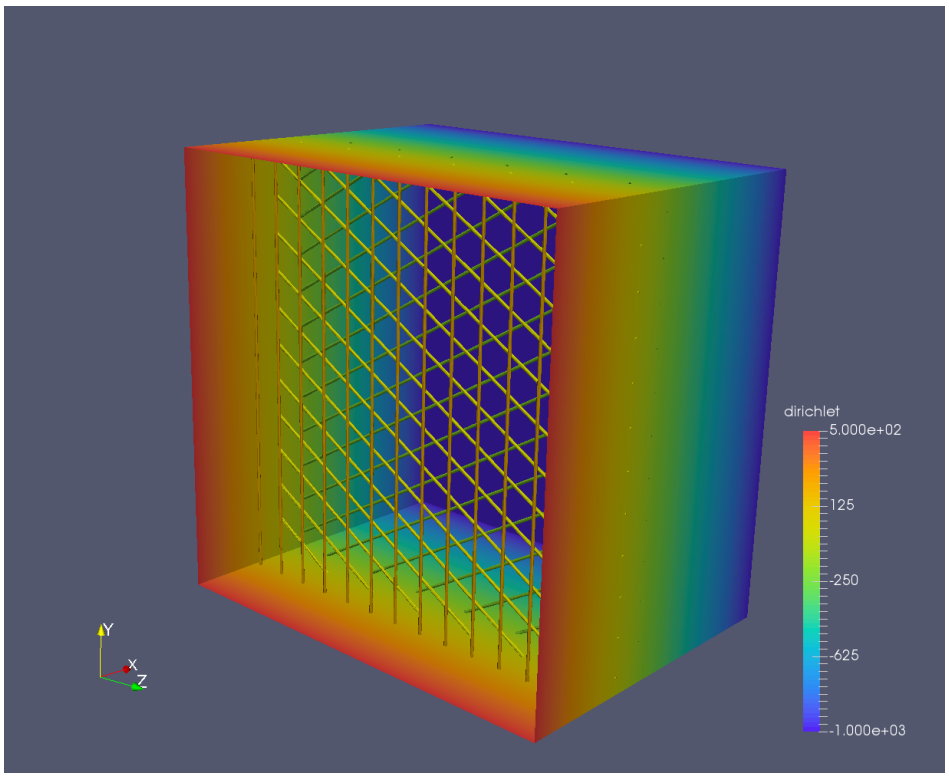




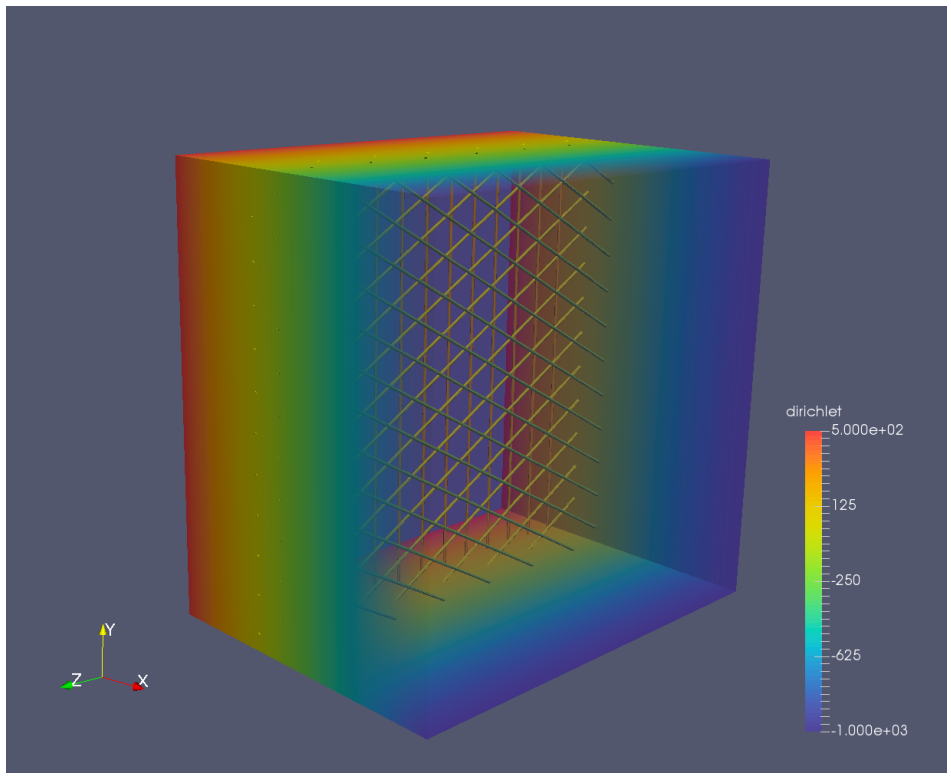




Caged Surface Potentials



Looking from behind wire plane.



Looking through transparent cathode.

500 V/cm over 30 cm (V-plane at 0 cm)

→ To check: problems with overlapping wires/cage?

Next Steps

Caged:

1. Wait for field calculation jobs to finish and validate.
2. Step through field to generate instantaneous currents:
   - Focus on on central wire from U, V, W planes.
   - Start steps across entire $X = 20 - \epsilon$ plane
   - Look steps staying away from cage.
   - Collect steps in U/V/W wire "region" for average response
     - And look at response as function of run along wire.
   - Etc for steps 1, 2, 3, ... wires over.
   - Give to Xin family of wire vs. time waveforms to apply on data.

Etc:

- Wrap up some presentation materials for Leon to present at uB meeting.

Computing Limitiations

Problems:

- Need to increase precision
  - → Just $\times 2 \Rightarrow$ couple hours for each field, may need $\times 4+$
    - Gaussian quadrature order.
    - Number and size of triangles.
    - Spatial sampling resolution.
- Resolution of spatial sampling also limited by system memory.

Possible solutions:

- Time/precision trade-off tuning
  - → but this also takes a long time.
- Smarter spatial sampling - needed for larger volumes.
  - Batch+stich spatial sampling, spread over more nodes.
  - Non-uniform sampling, more densely near boundaries.
  - → requires fresh development, breaks code assumptions
- Exploit more computers
  - RACF requires non-trivial software install, running monopolizes entire node (but those 16 cores and 24GB RAM per node will be put to use!)
  - Install Condor on 3rd floor workstations?