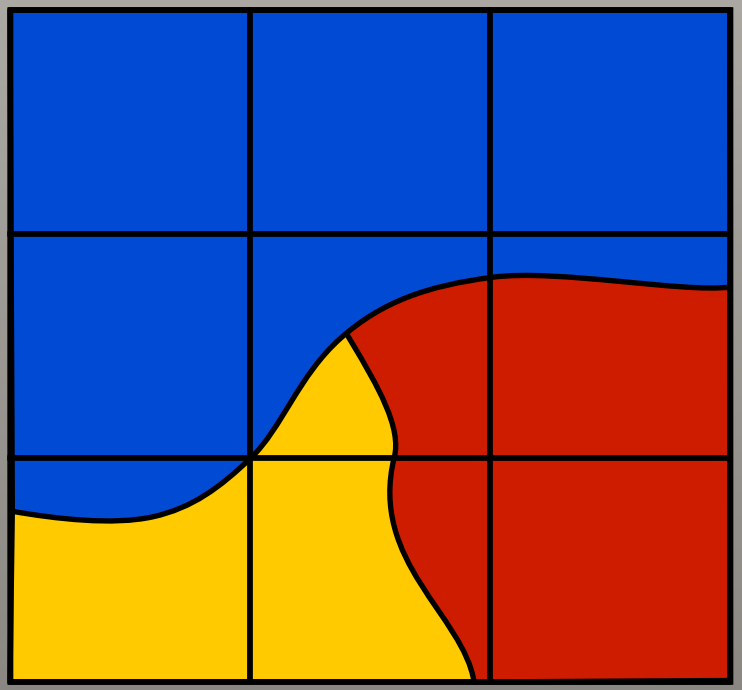
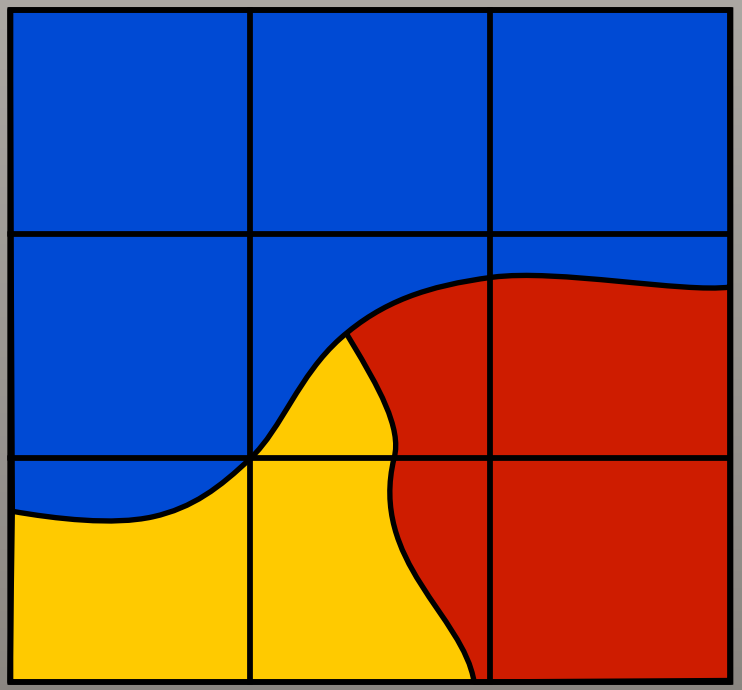
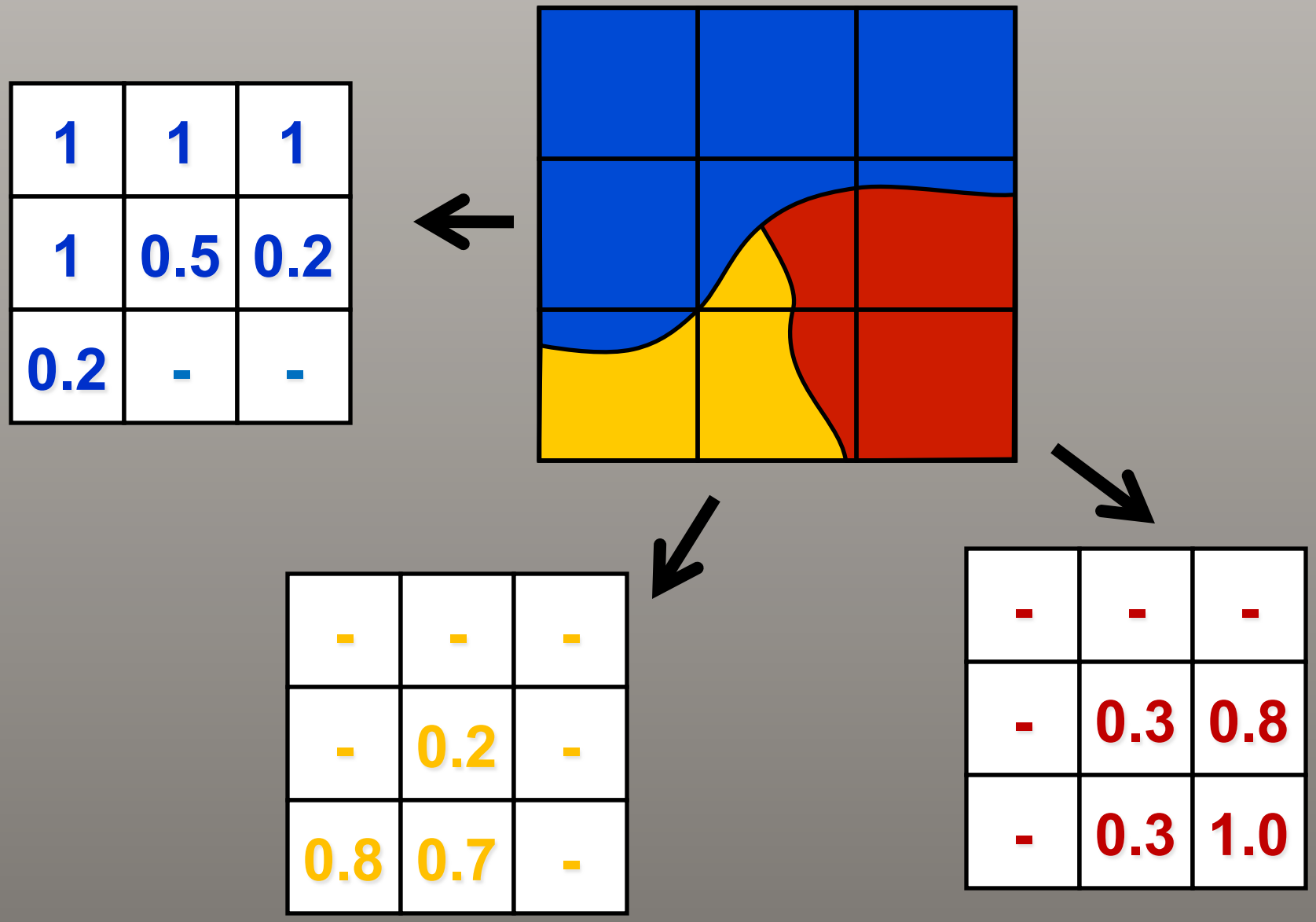
Material Interface Reconstruction in VisIt





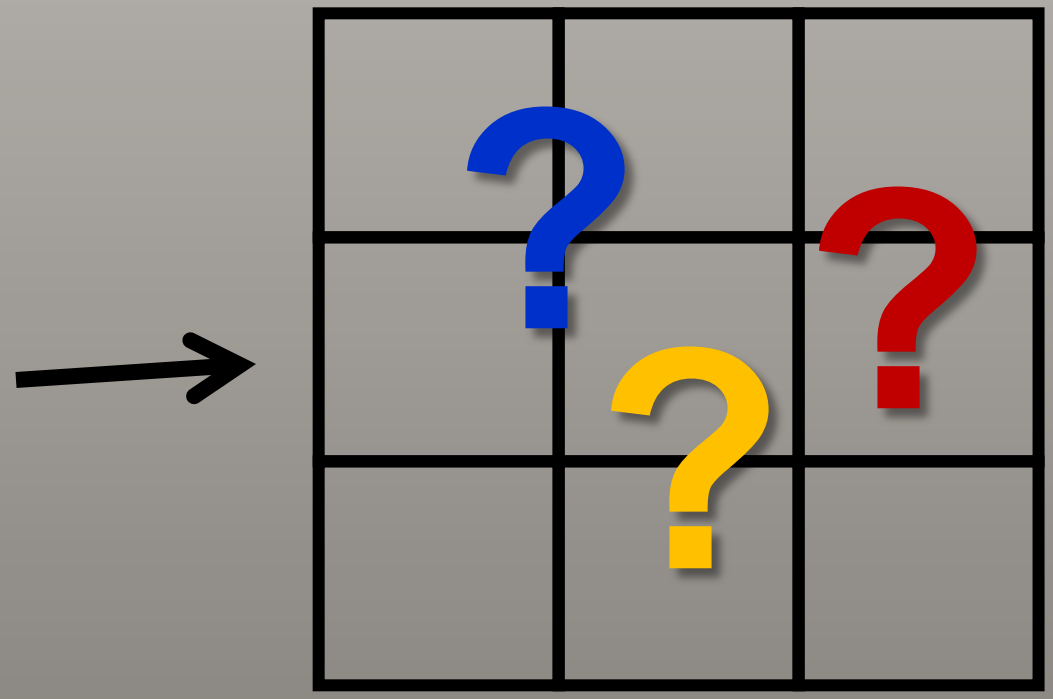
Dividing the World

Volume Fractions



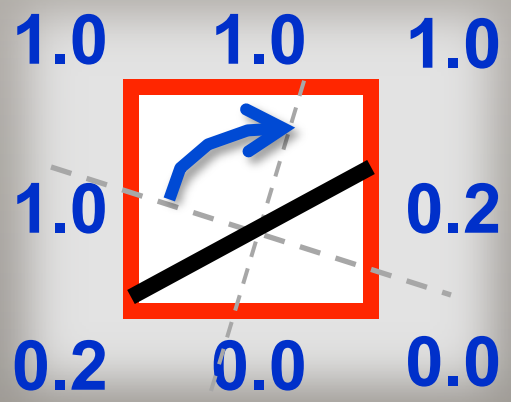
Visualization and Analysis need Geometry

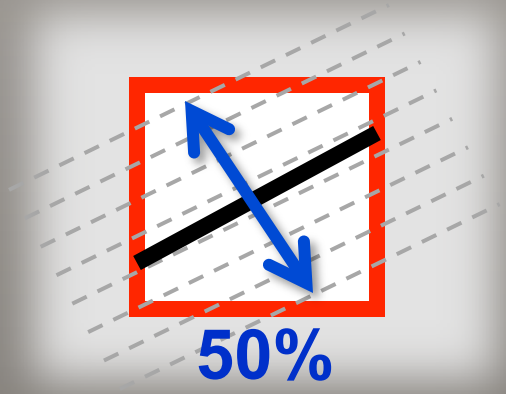
1.0 0.0 0.0	1.0 0.0 0.0	1.0 0.0 0.0
1.0 0.0 0.0	0.5 0.3 0.2	0.2 0.8 0.0
0.2 0.0 0.8	0.0 0.3 0.7	0.0 1.0 0.0



Algorithms: PLIC

1.0 0.0 0.0	1.0 0.0 0.0	1.0 0.0 0.0
1.0 0.0 0.0	0.5 0.3 0.2	0.2 0.8 0.0
0.2 0.0 0.8	0.0 0.3 0.7	0.0 1.0 0.0

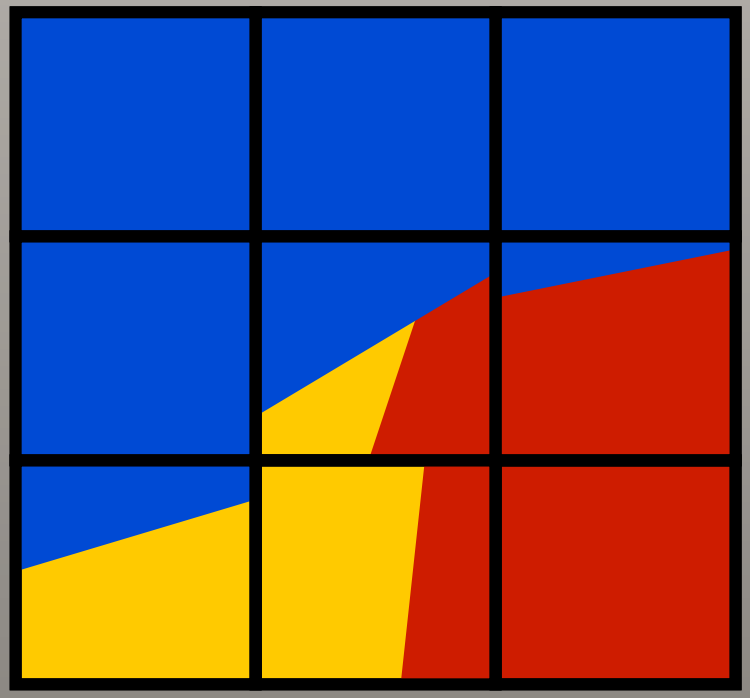




- Repeat for each material
  - Guess a slope
  - Find the intercept

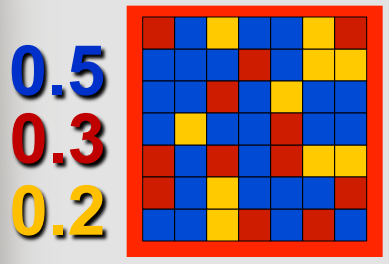
Algorithms: PLIC

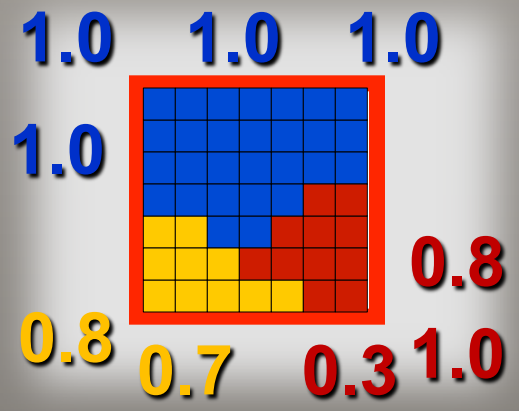
- order dependence with >2 materials
- not smooth
- no inter-zone connectivity
- guarantees accurate volume fractions in reconstruction



Algorithms: Discrete

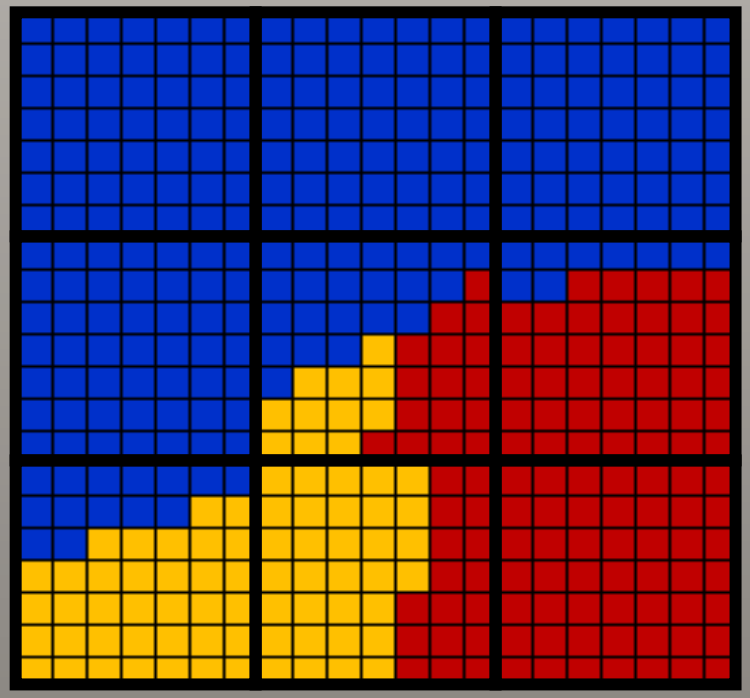
1.0 0.0 0.0	1.0 0.0 0.0	1.0 0.0 0.0
1.0 0.0 0.0	0.5 0.3 0.2	0.2 0.8 0.0
0.2 0.0 0.8	0.0 0.3 0.7	0.0 1.0 0.0





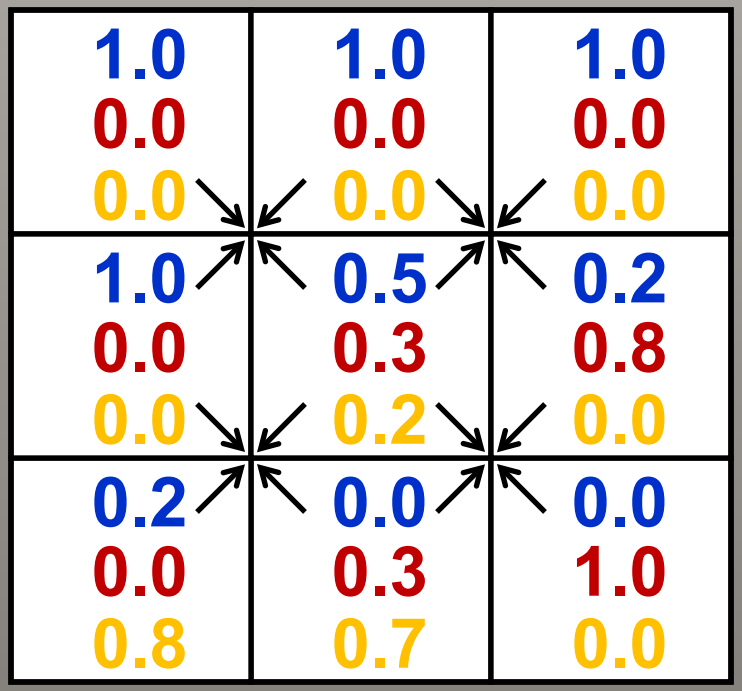
Algorithms: Discrete

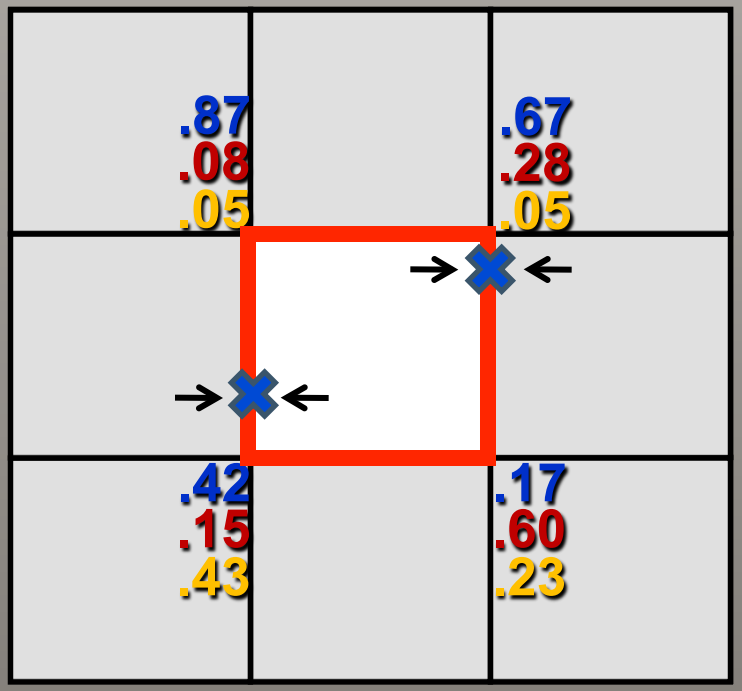
- rectilinear grids only
- supports many materials
- bounded volume fraction accuracy
- iteration is expensive
- many output cells
- connectivity is always axis-aligned



Algorithms: Isovolume

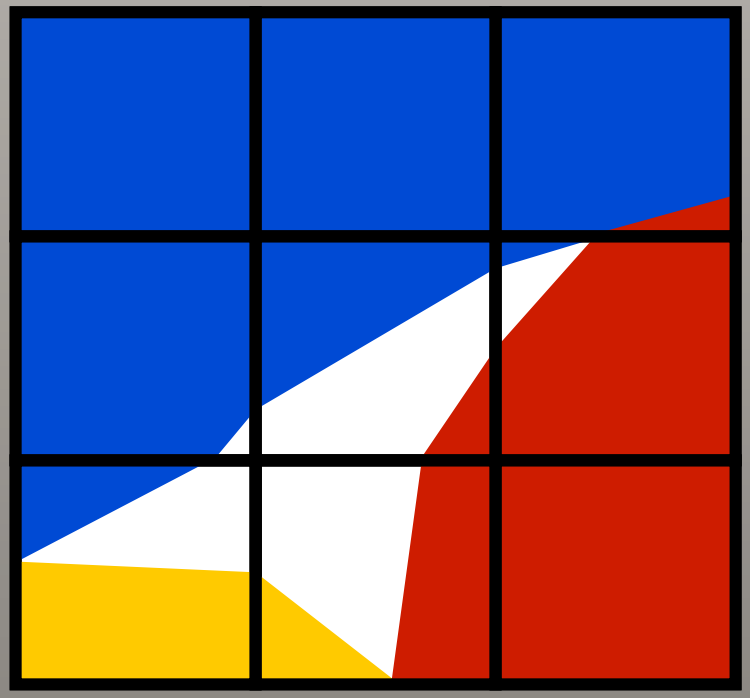
- For each material:
  - average VFs to nodes
  - find intersections
  - fill with material





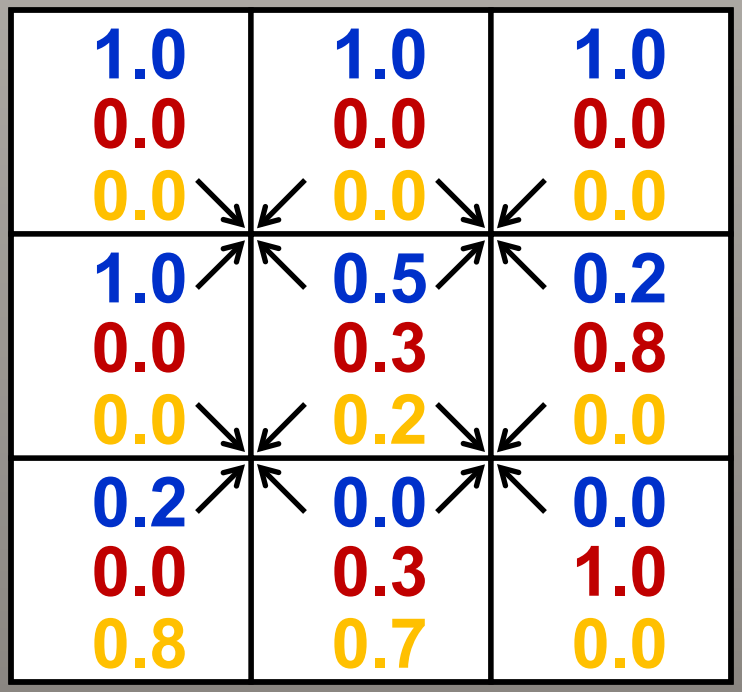
Other Algorithms: Isovolume

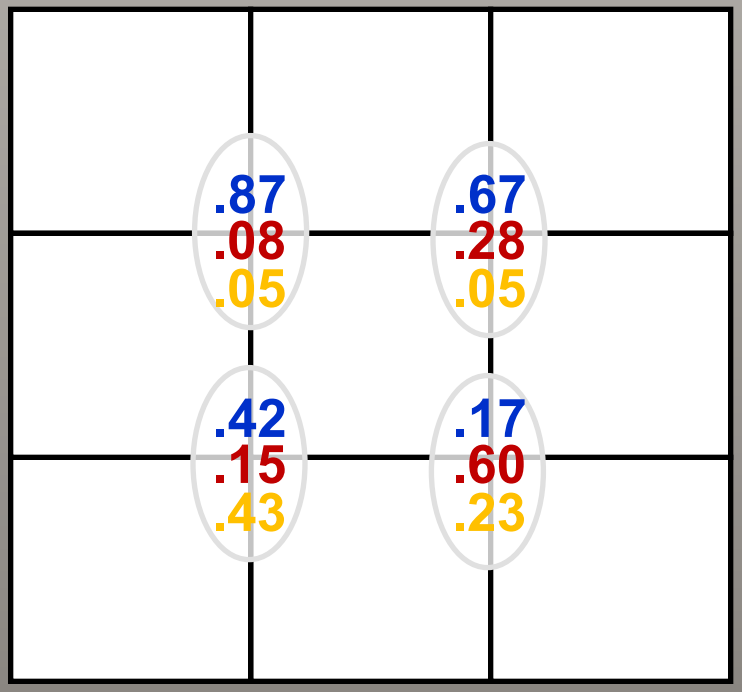
- only works for 2 materials
  - holes for 3+ mats
- smooth, continuous between cells
- no inter-material connectivity
- no guarantee of volume fraction accuracy



Algorithms: VisIt “Equi-surface”

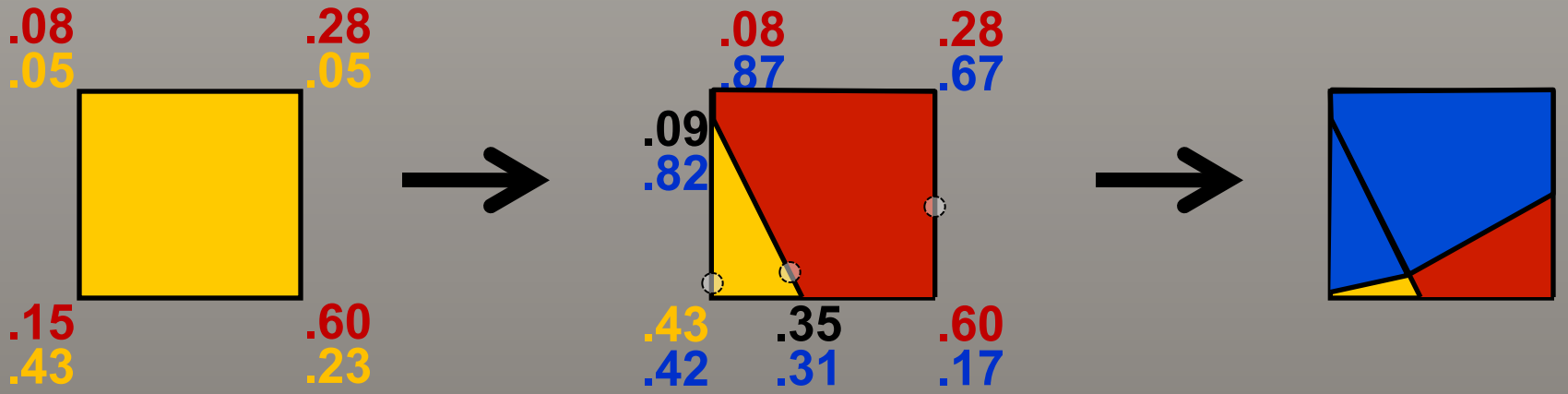
- Average volume fractions (VFs) to nodes





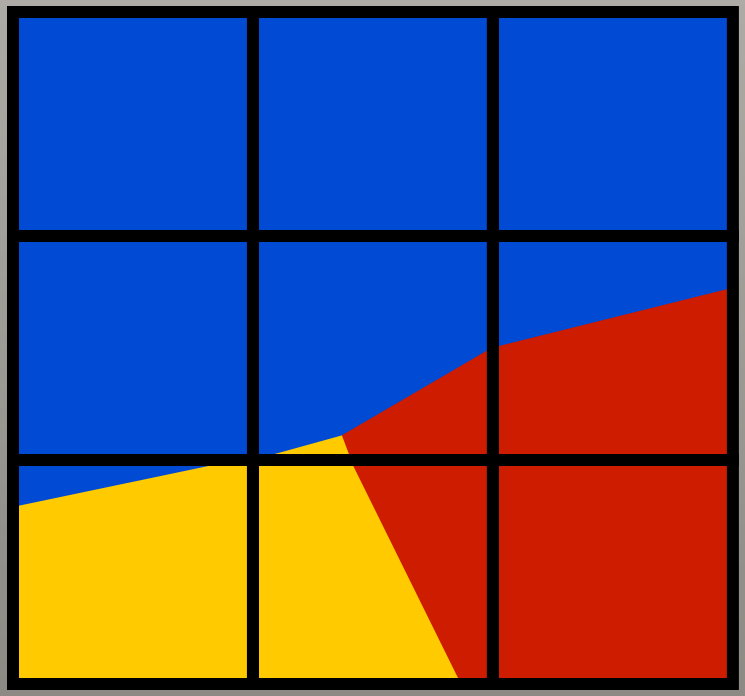
Algorithms: VisIt "Equi-surface"

- Step through each material, generating boundaries where material VFs are pair-wise ***equal to each other***



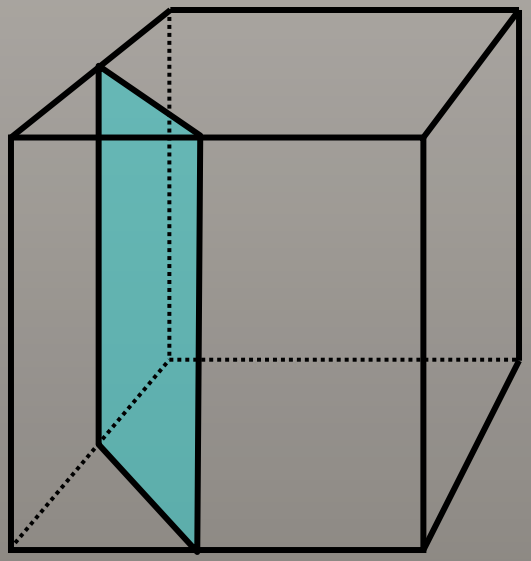
Algorithms: VisIt “Equi-surface”

- any number of materials
- smooth, continuous between cells AND between materials
- no guarantee of volume fraction accuracy

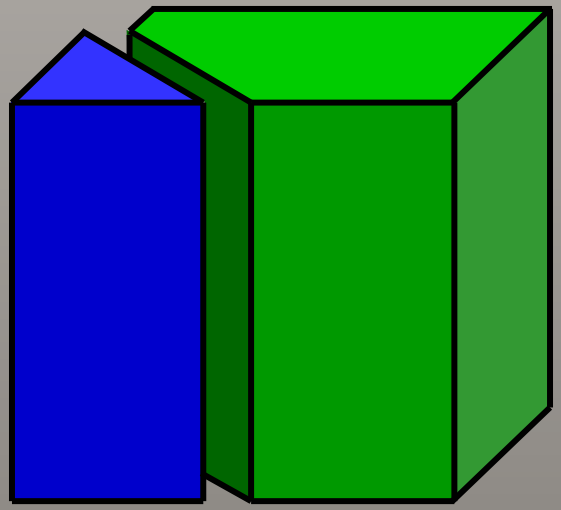


Clipping

Input Cell +
Splitting Plane

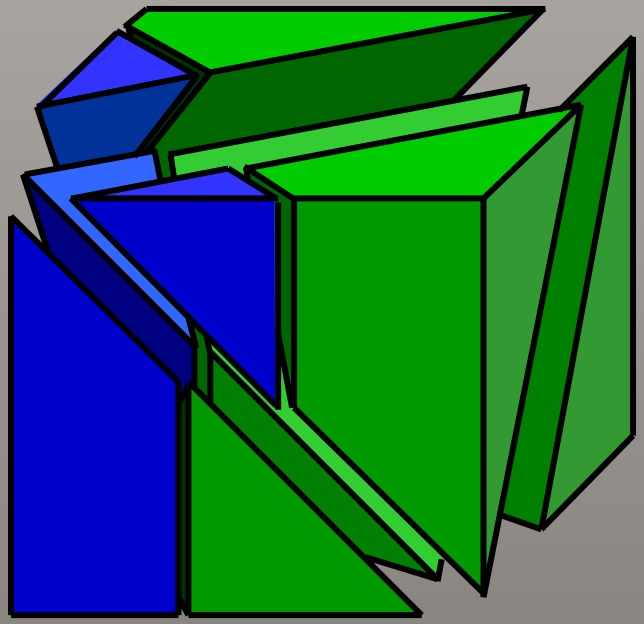


“Optimal” Split



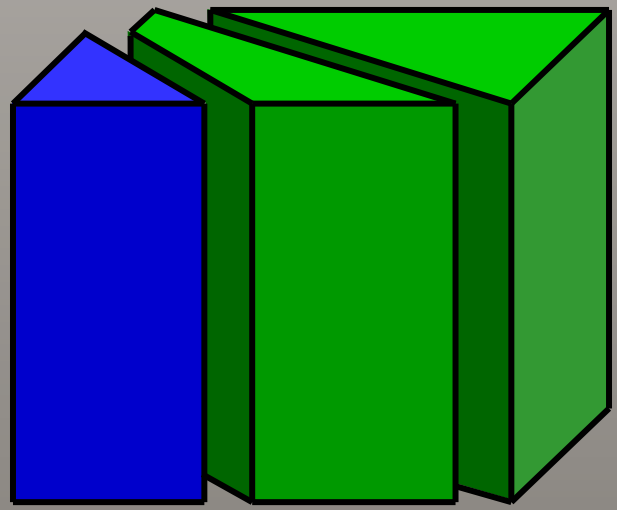
Clipping

Option (A):
Tetrahedra everywhere



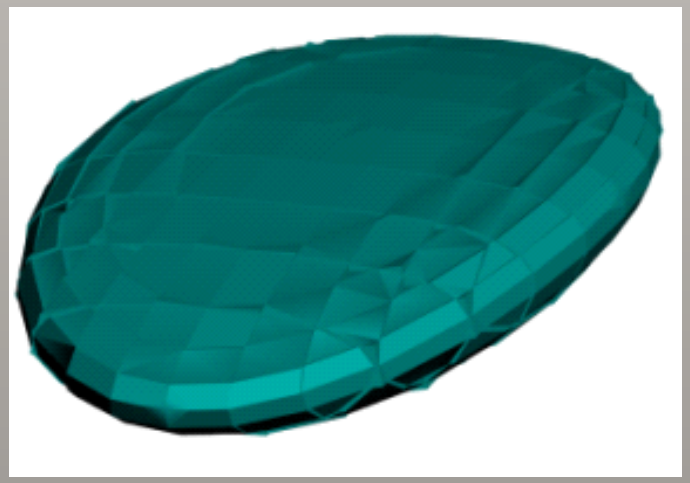
17 output tetrahedra

Option (B):
Use more shape types

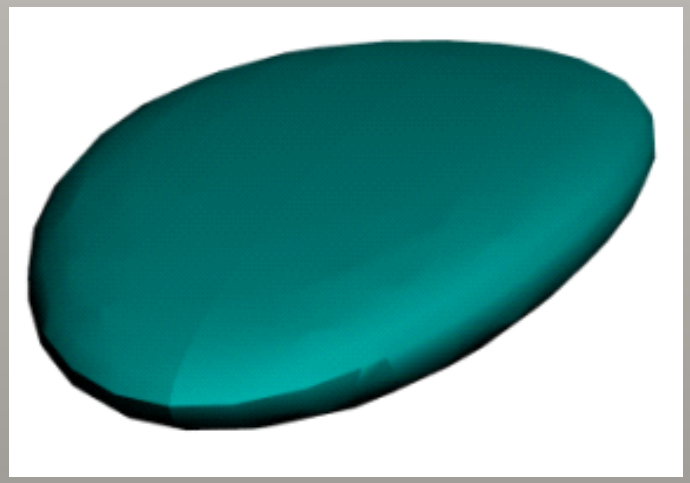


3 output shapes

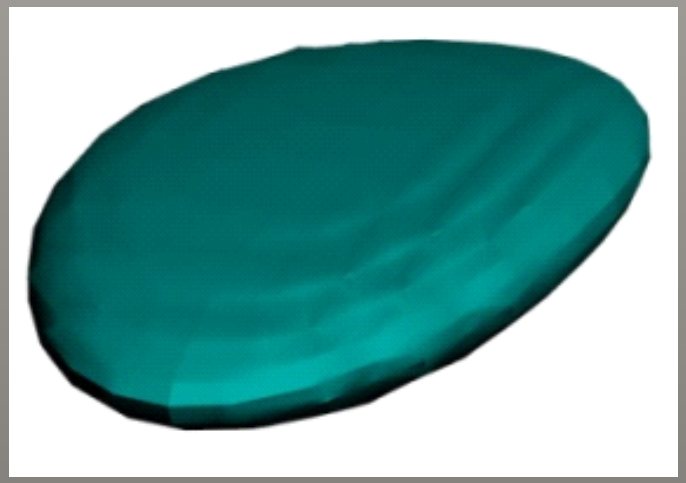
Results on a 3D data set



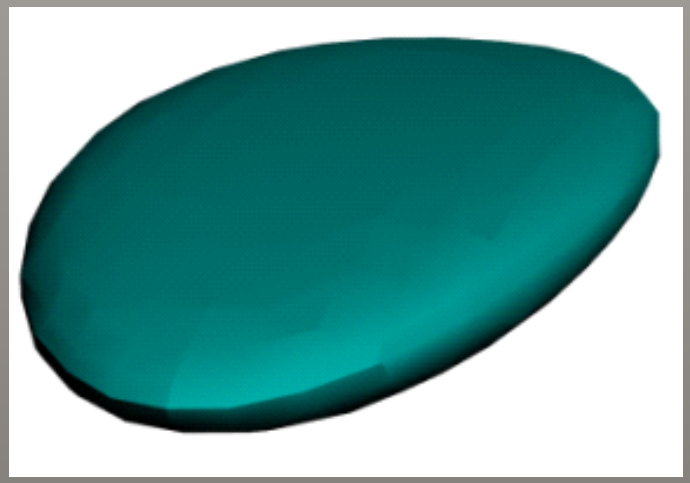
PLIC



Isovol



Equi-T

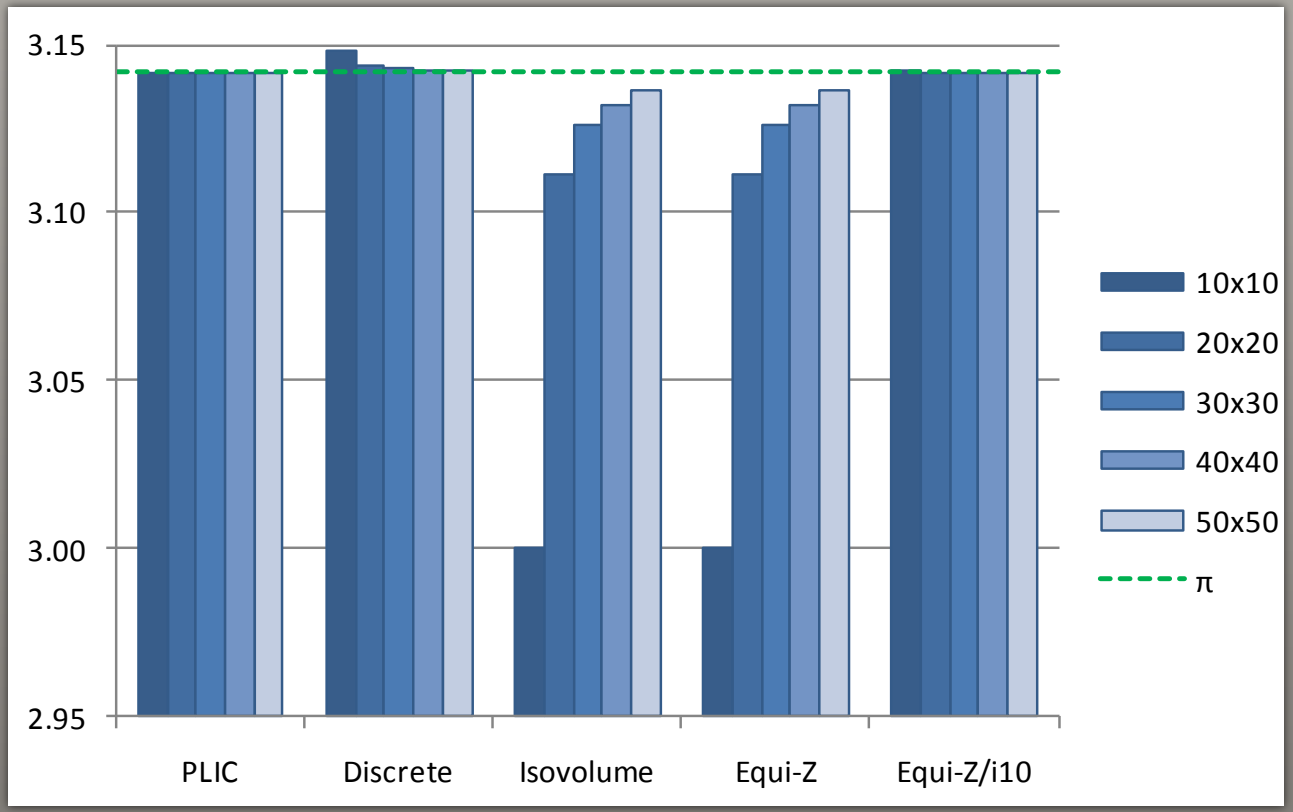


Equi-Z

"Unstructured Ovoid" data set

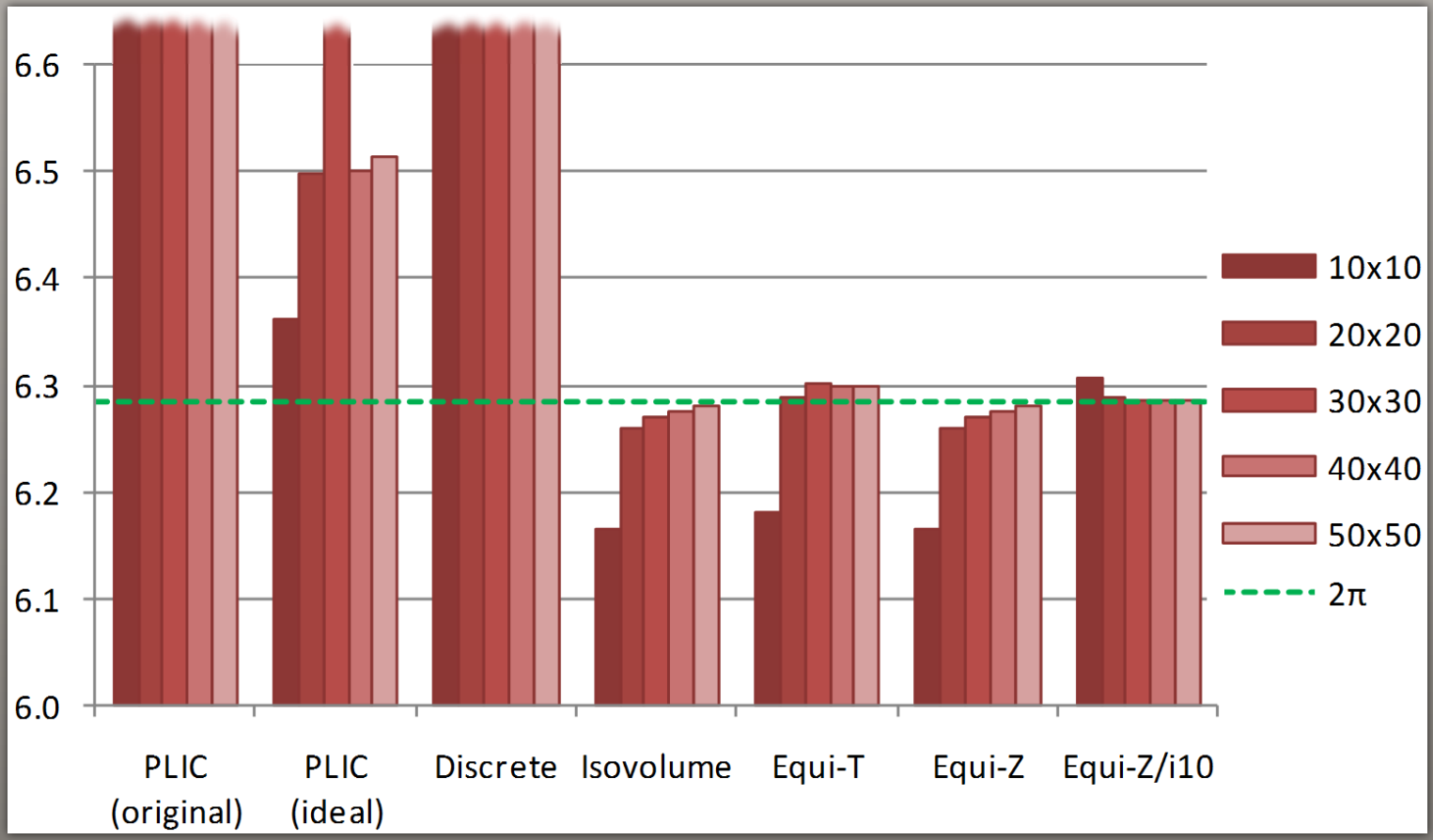
Volume Accuracy

- Unit-circle data set at increasing resolutions
  - correct area, for all resolutions, is π

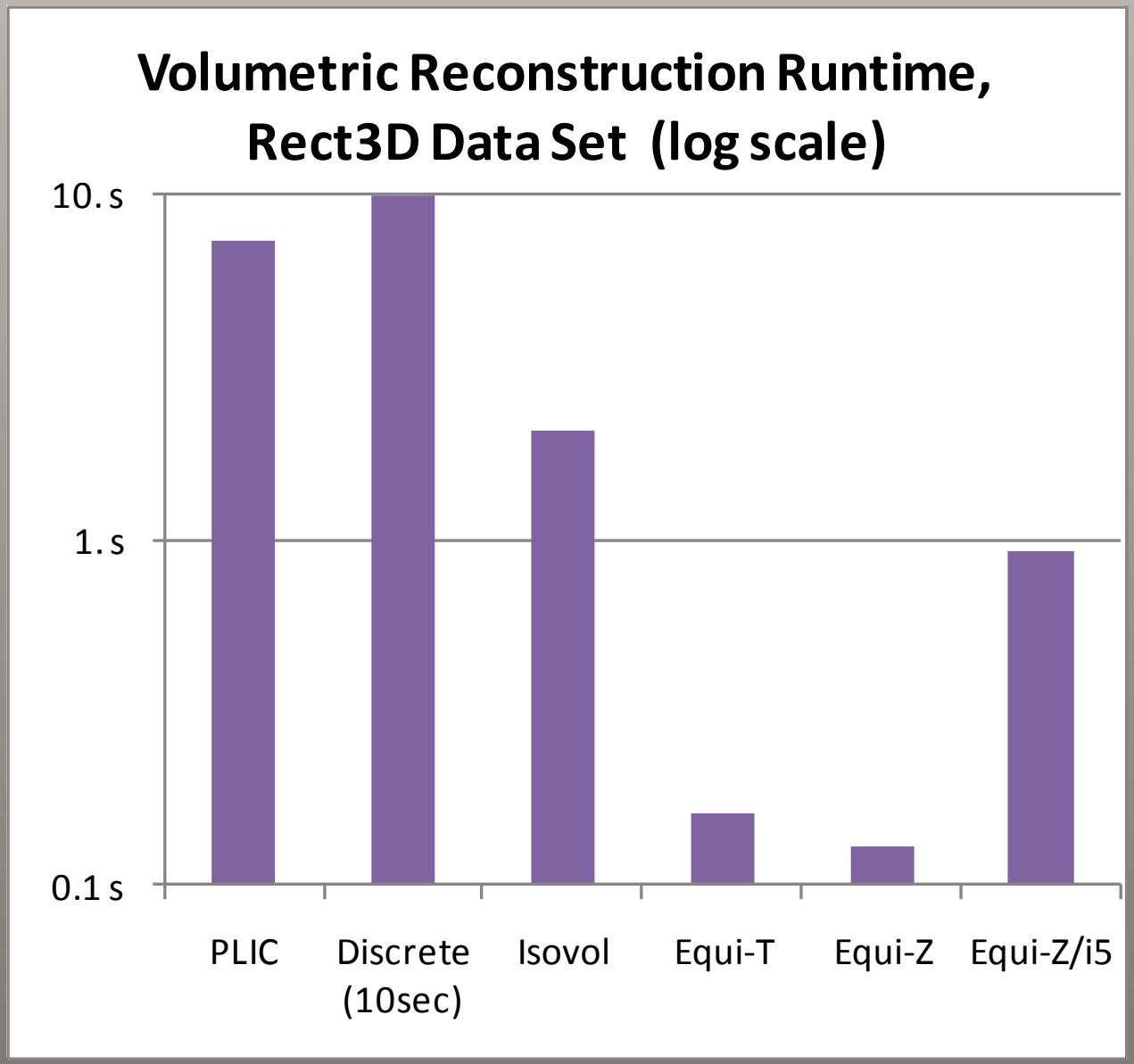


Surface Accuracy

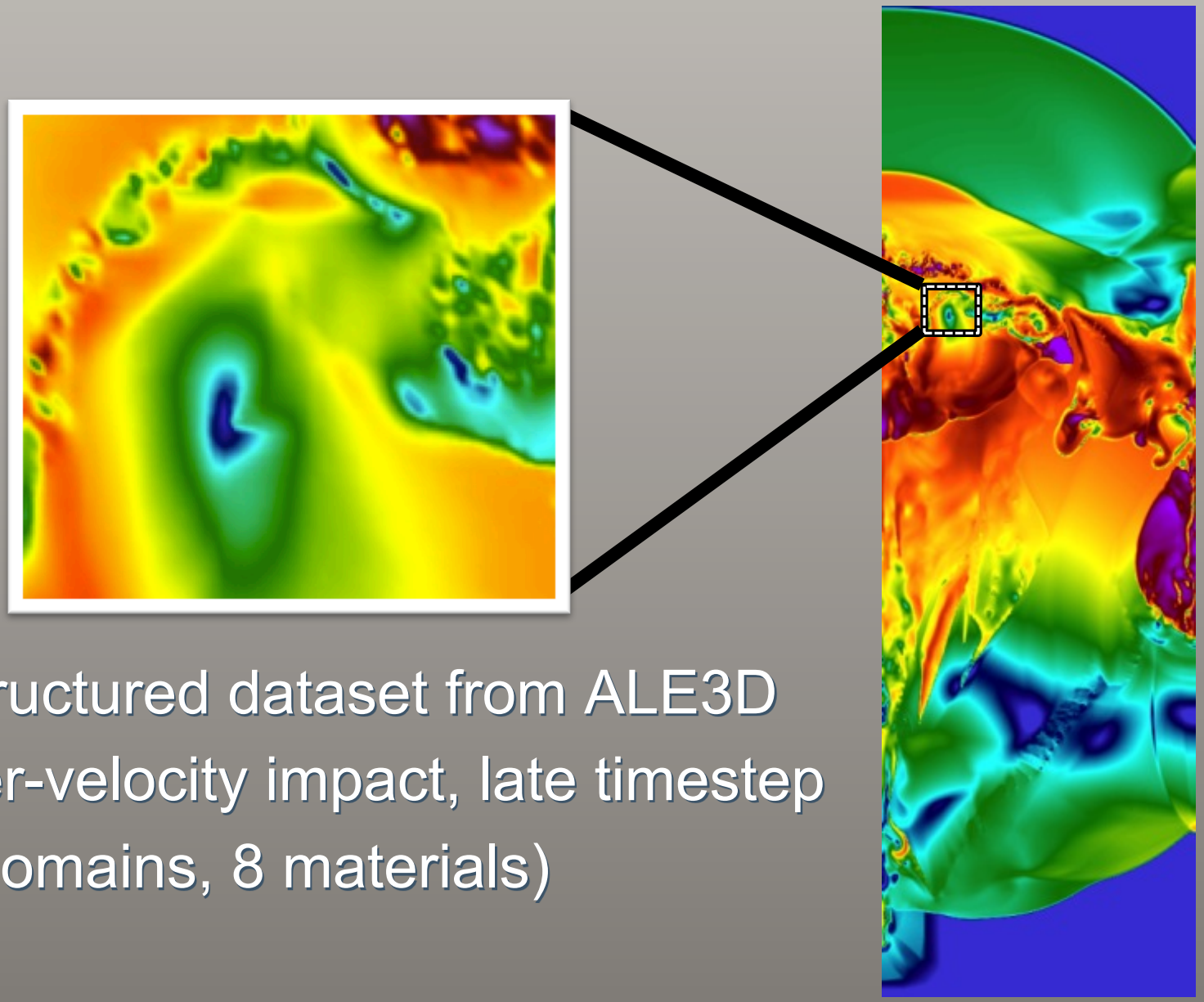
- Unit-circle data set at increasing resolutions
  - correct perimeter, for all resolutions, is 2π



Runtime Performance



Real Data Set



Unstructured dataset from ALE3D

Hyper-velocity impact, late timestep

(64 domains, 8 materials)

←Isovol

PLIC→

←Equi-Z

Equi-Z/i30→