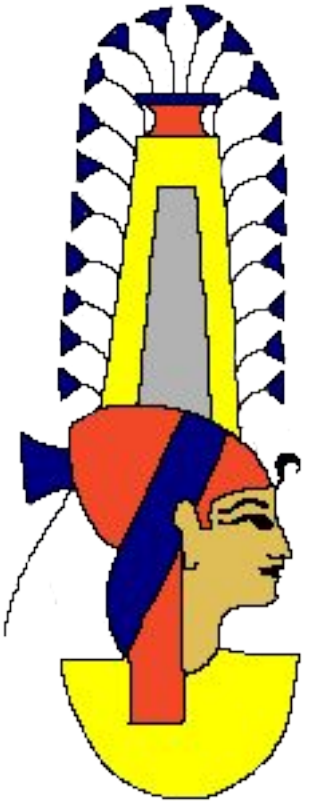
neBEM

Terminology

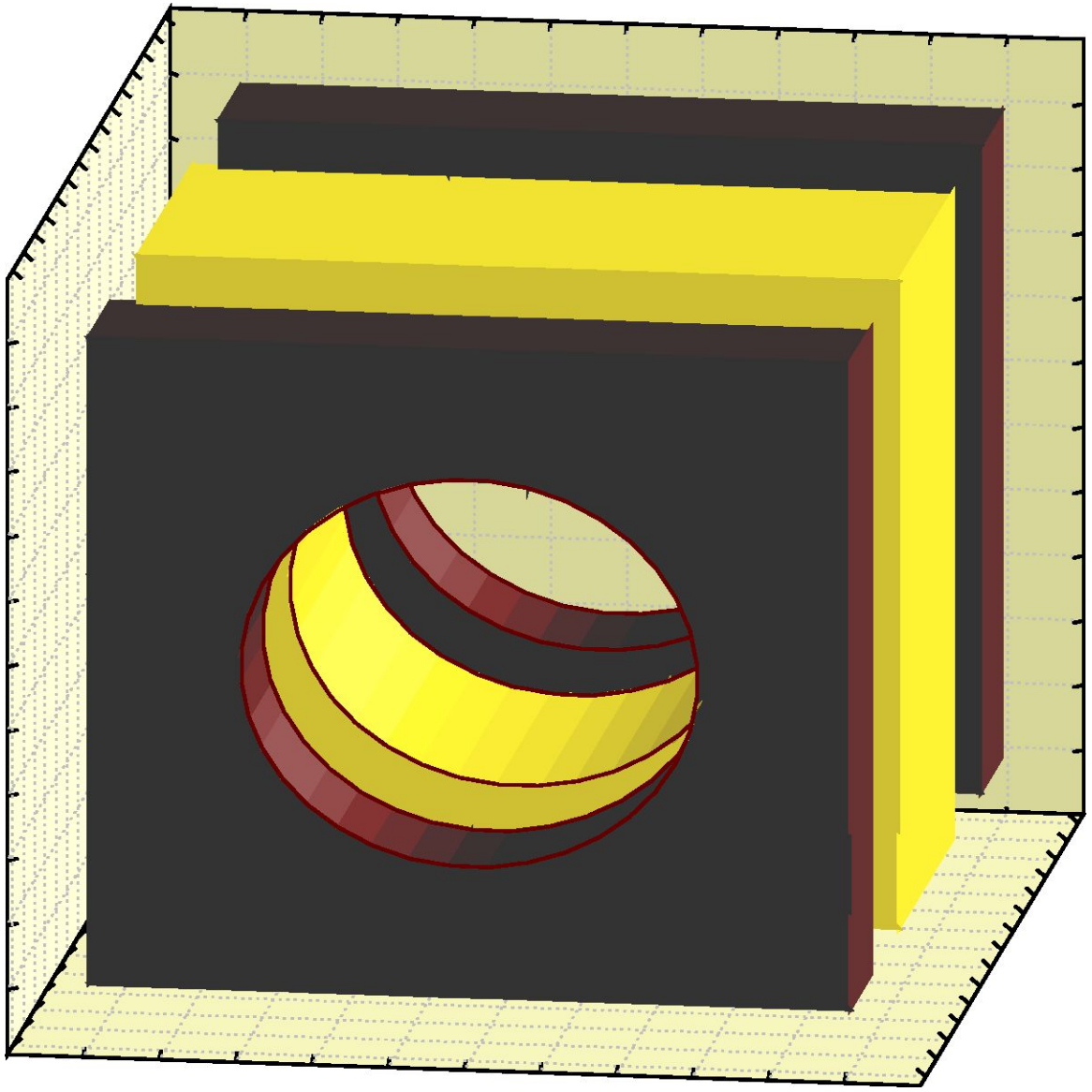
Modelling with neBEM



- Steps:
  - geometry description in terms of solid volumes;
  - surface paneling;
  - overlap identification;
  - reduction to rectangles and right-angled triangles;
  - discretisation and collocation points;
  - influence matrix;
  - solving the charges for the given boundary conditions;
  - field and potential calculation.

Solids

- Shapes available:
  - box
  - cylinder
  - hole
  - sphere
  - toblerone
- Solids may touch, but should not overlap.

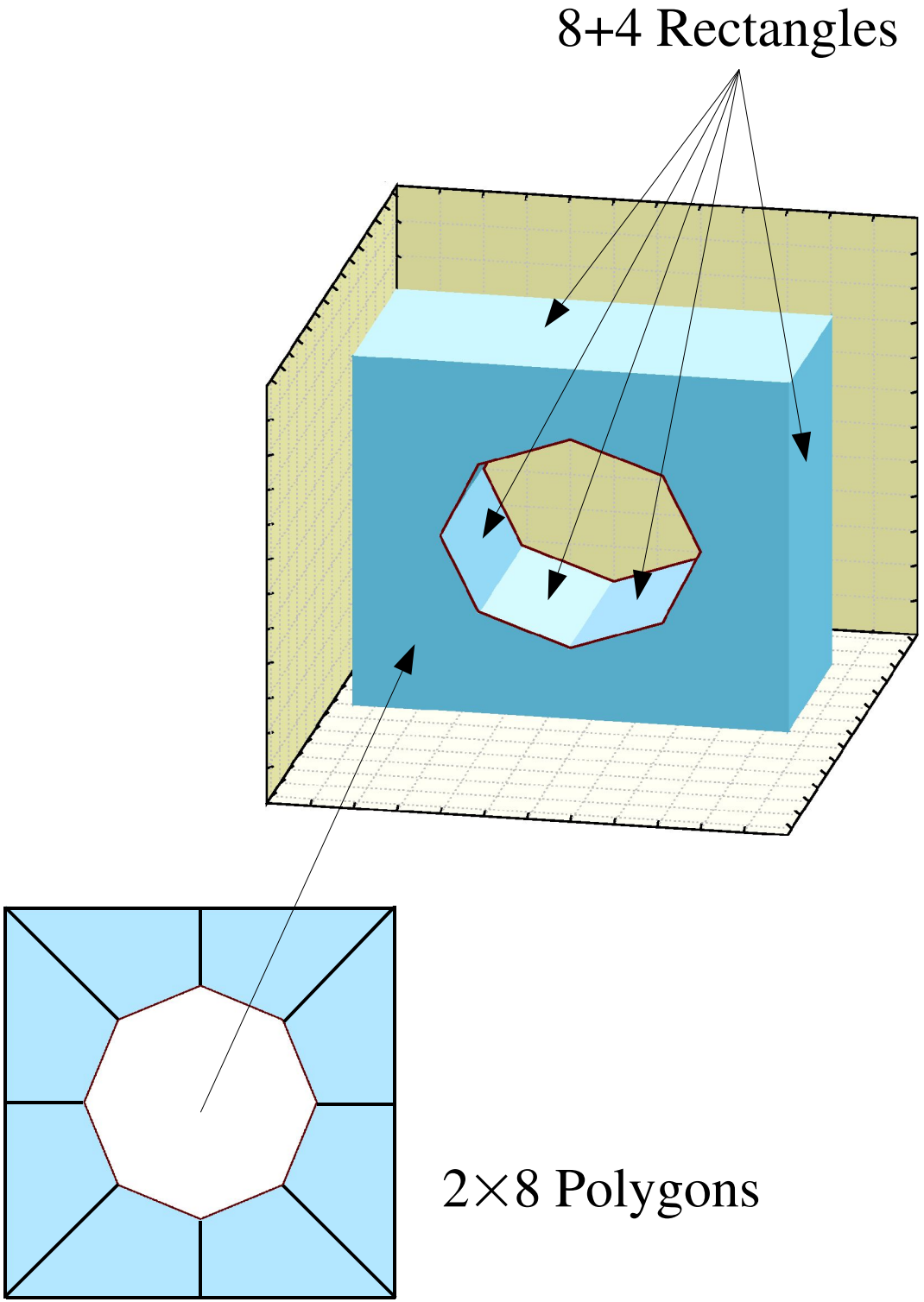


Boundary conditions

- Solids can be:
  - dielectrica:
    - with a user-specified dielectric constant
    - optionally charged
  - conductors:
    - at a user-specified potential
    - charged, at a floating potential (yet to be implemented)

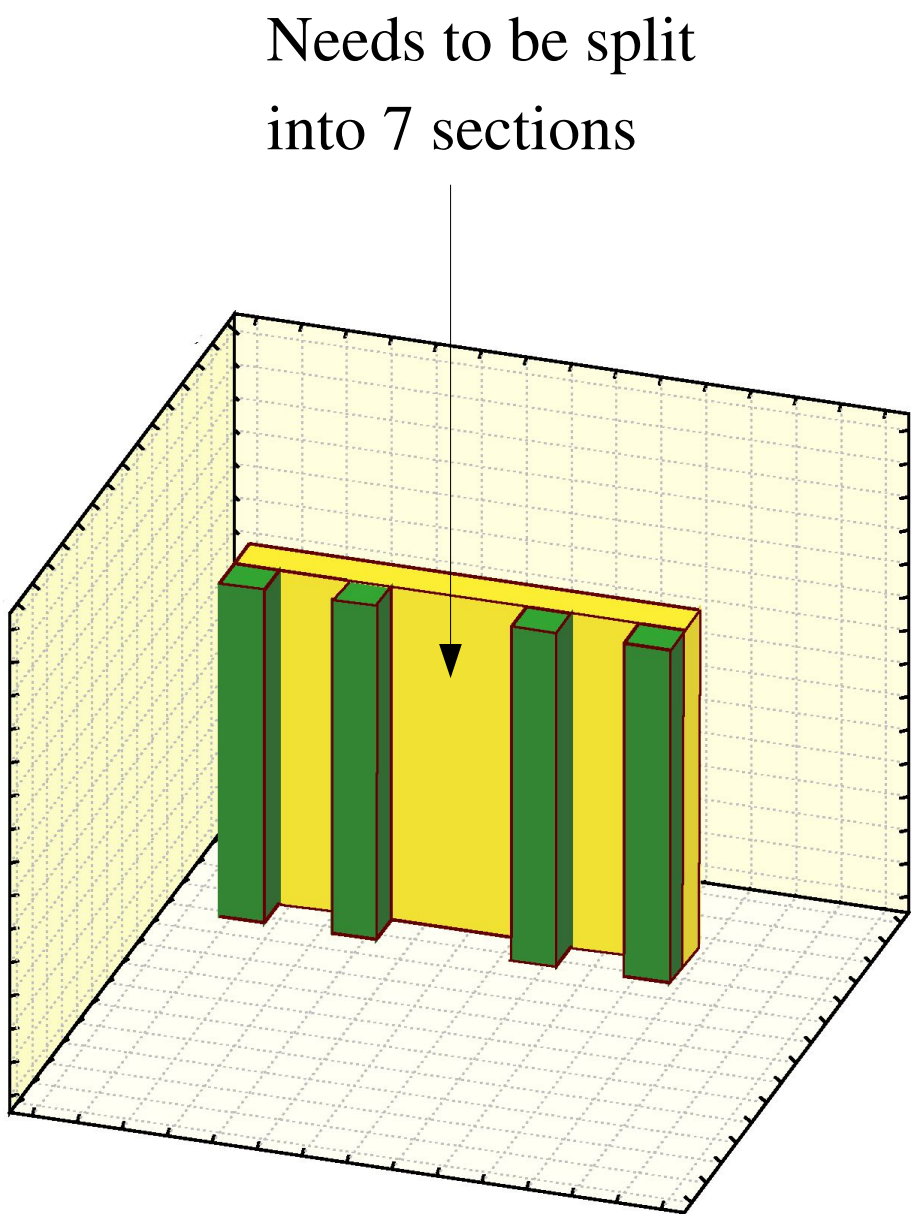
Surface panels

- neBEM works by placing charges on the surfaces and interfaces of the solids and thus needs a list of panels that cover the solids.



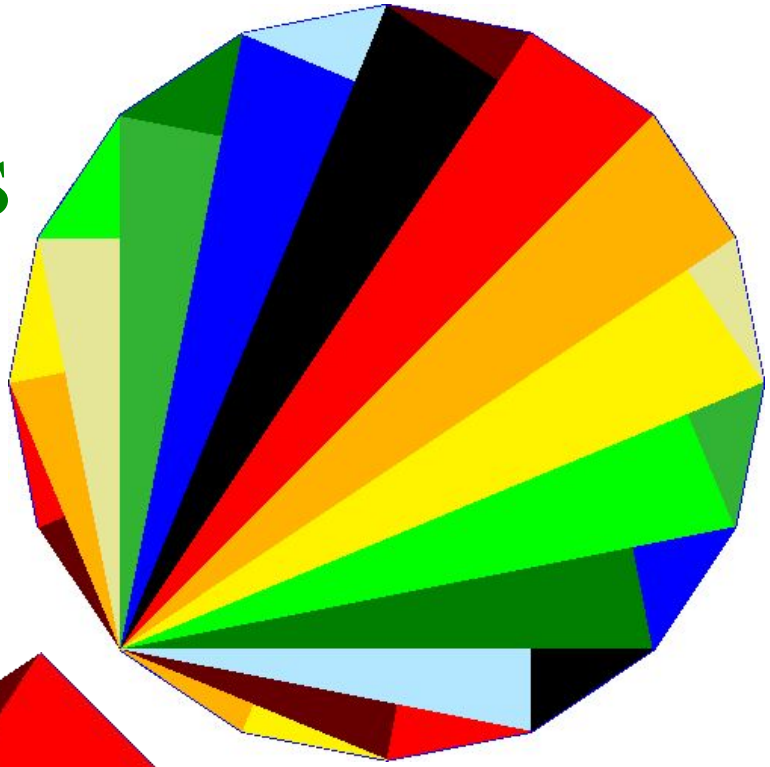
Identifying overlaps

- Contact surfaces need to be identified to avoid degeneracy in the influence matrix.
- This usually entails splitting panels.
- A boundary condition is set for each panel.



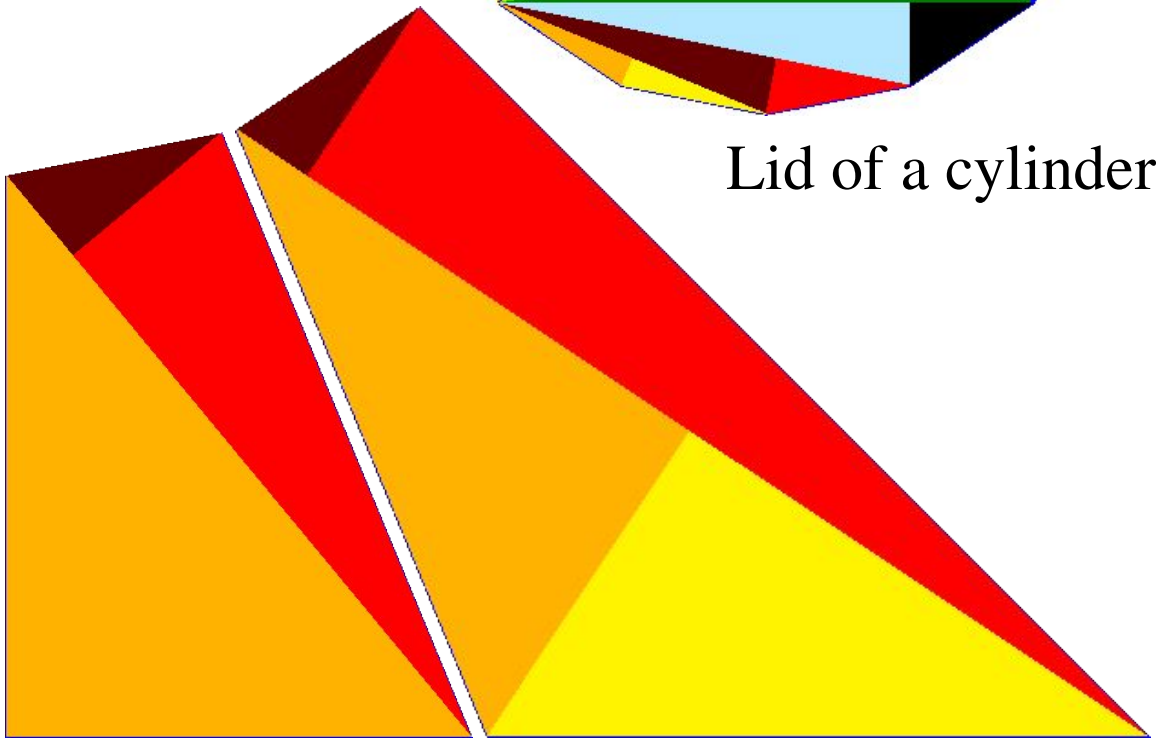
Rectangles and Triangles

- neBEM has exact potential functions for charges uniformly distributed over:
  - rectangles;
  - right-angled triangles.



Lid of a cylinder

- All panels need to be reduced to these shapes. Inside neBEM they are called "*primitives*".



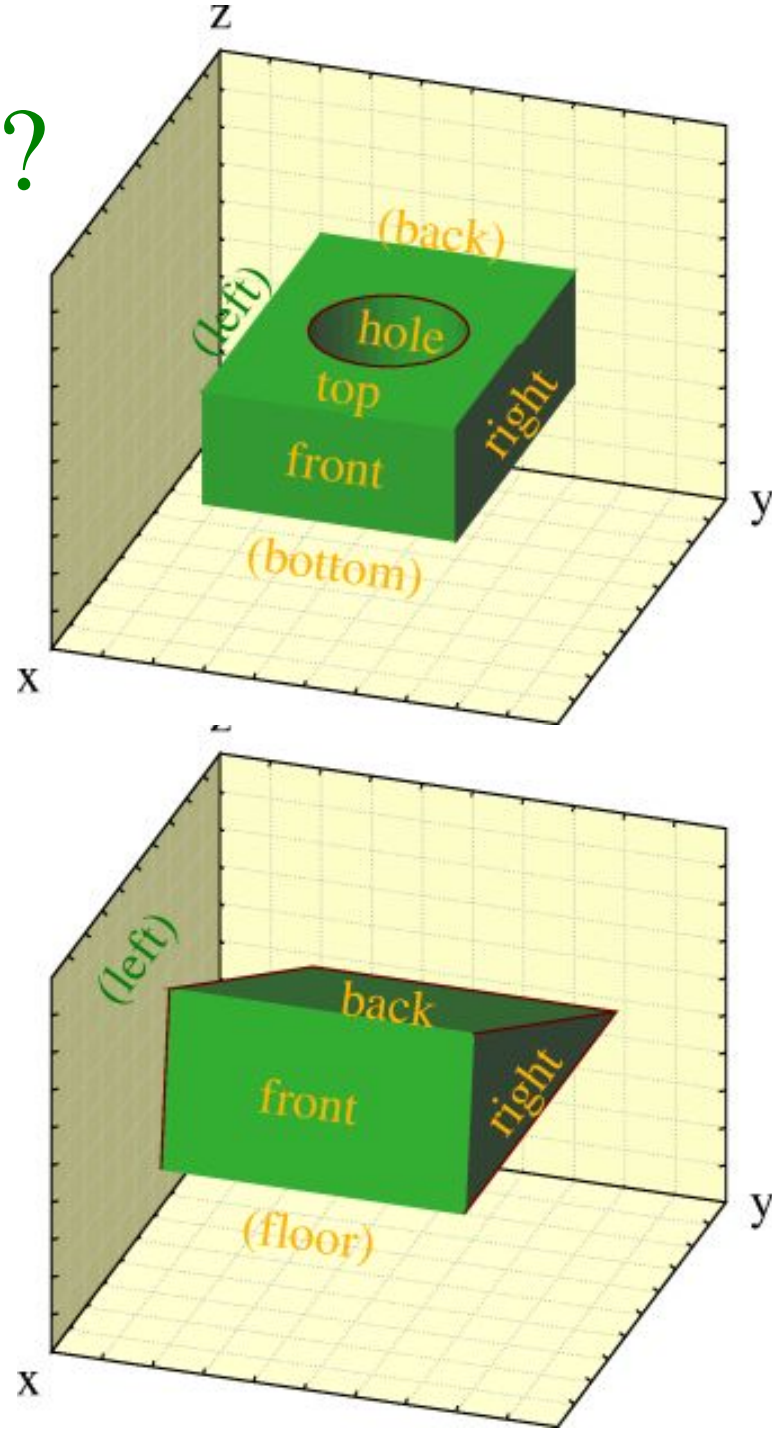
Parts of the lid of a hole

Discretisation

- Primitives can be large objects over which one expects the charge density to vary substantially.
- Since the neBEM Green's functions assume a uniform charge density, primitives can't be used directly.
- The neBEM strategy is to sub-divide the primitives into "*elements*", in a process called "*discretisation*".

Automatic discretisation ?

- The level of discretisation is under user control, per face of the solids.
- neBEM may one day attempt to discretise automatically.



Collocation points

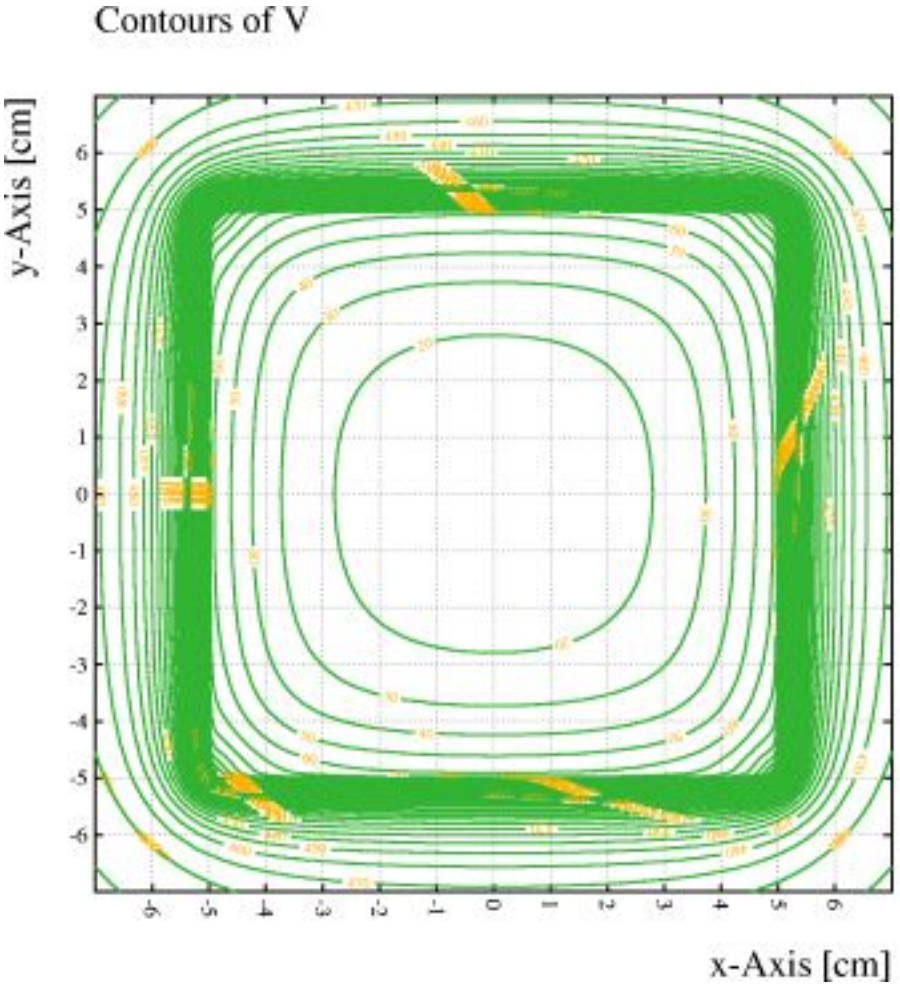
- In neBEM parlance, "*collocation points*" are the locations where the boundary conditions are evaluated when calculating the influence matrix.

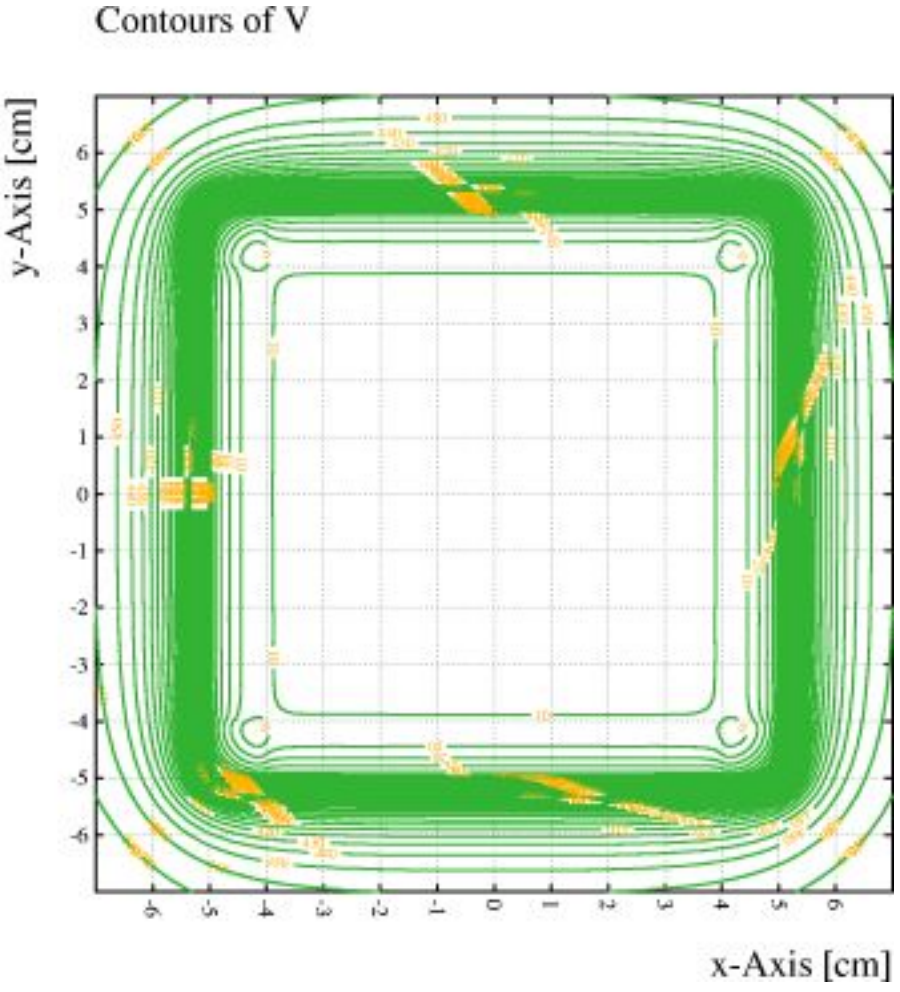
- At these points, one can expect the boundary conditions to be respected nearly exactly.

- Each element has precisely 1 collocation point, and this point is located in the centre of the element.

Importance of discretisation

- Compare $n = 1$ and $n = 10$:





Influence matrix

- The "*influence matrix*" expresses the way the potential at each of the collocation points comes about as sum of the potentials generated by all elements:

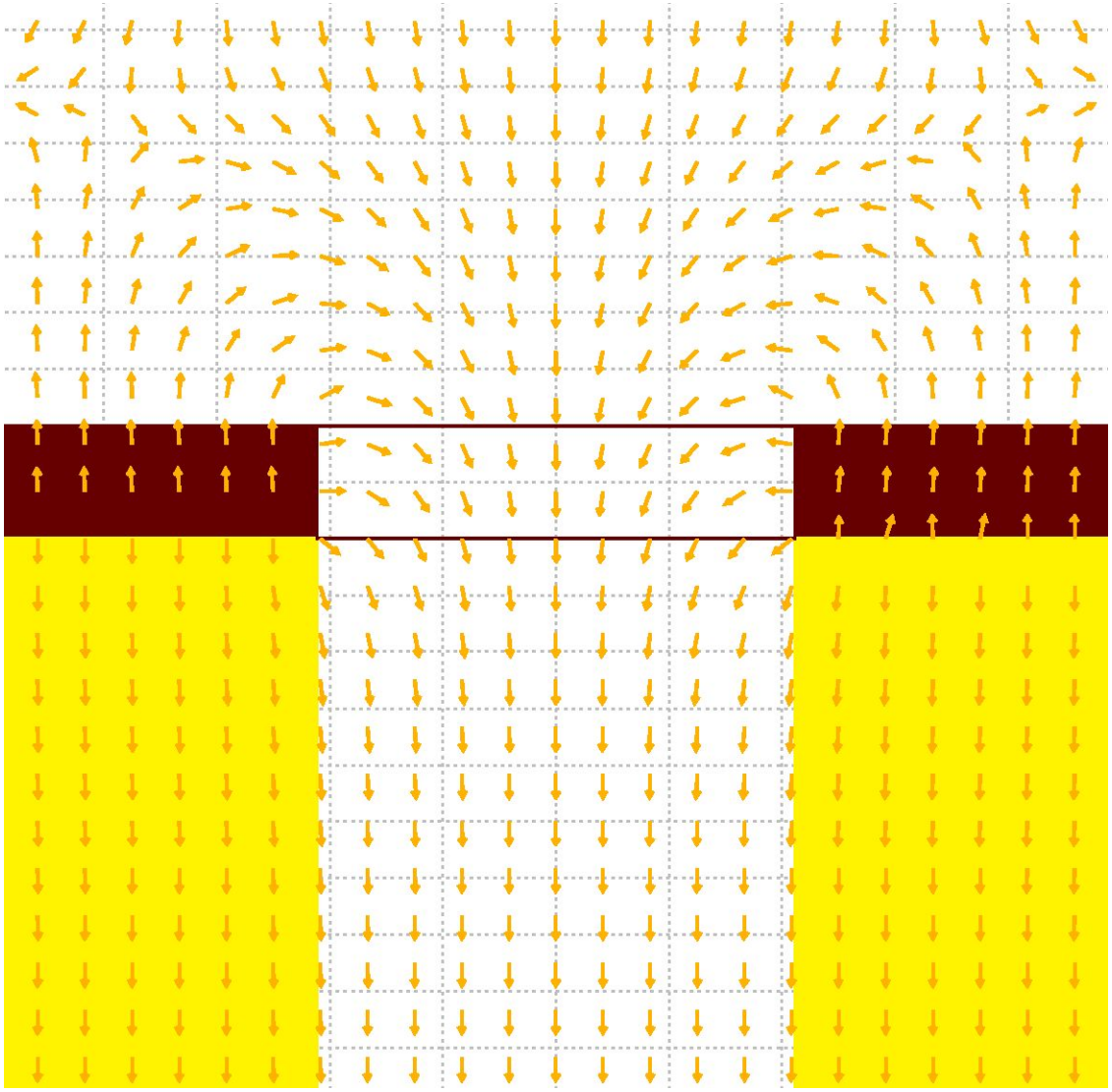
$$V_i = V_0 + \sum_j C_{ij}^{-1} q_j$$

$$\sum_i q_i = 0$$

- The capacitance equation is solved to obtain the charge density of each of the elements.

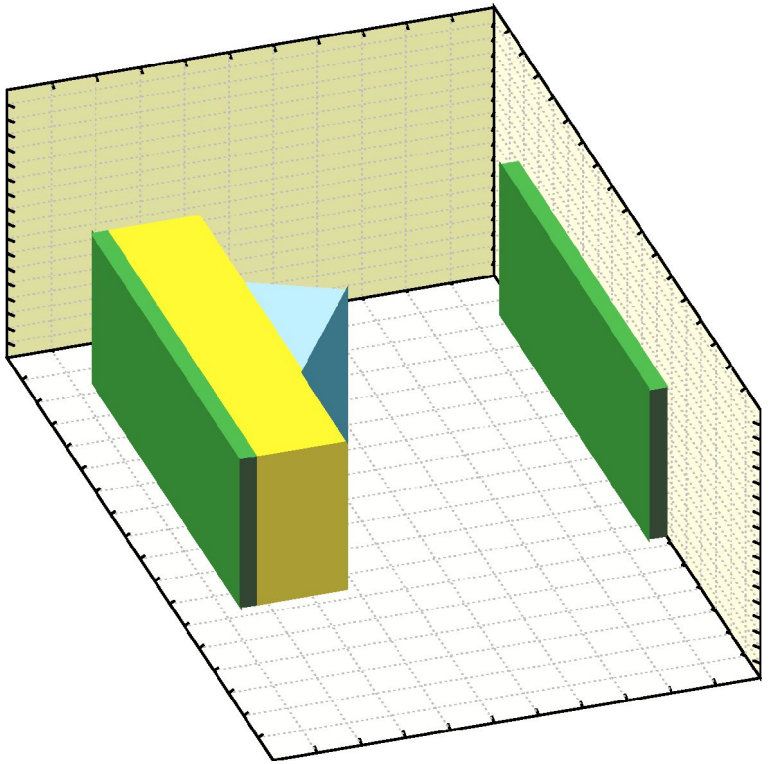
Field calculation

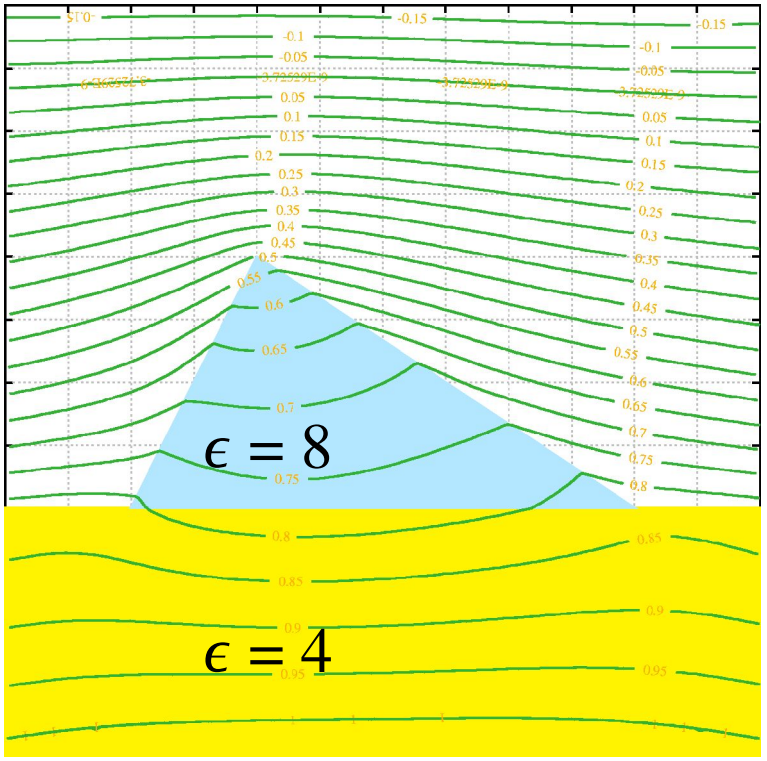
- Field at the entrance of a thick GEM:

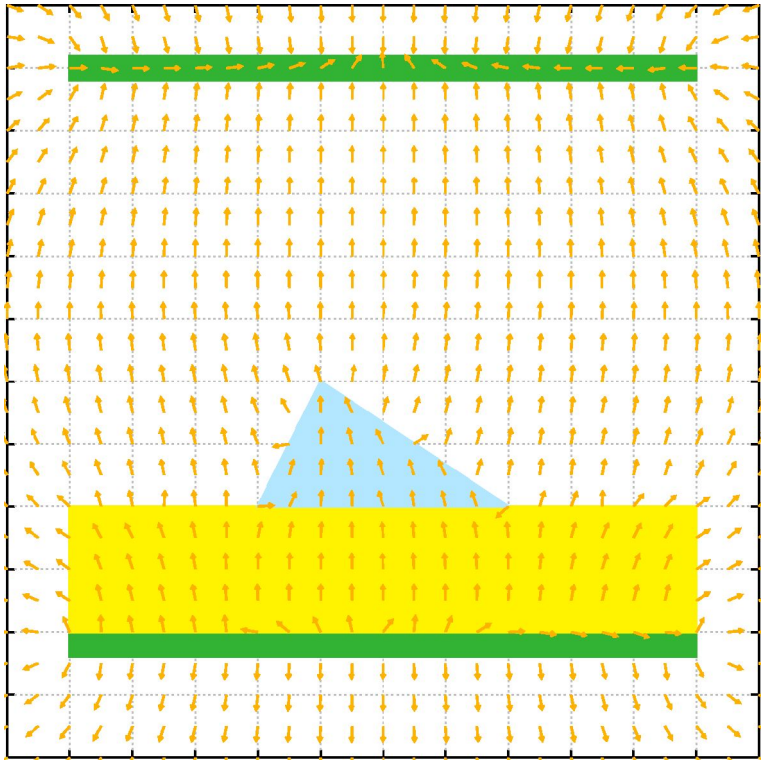


Field calculation

- Dielectric ridge on a dielectric surface







Warning

- “The Finite Element Method is a very useful tool which can make a good engineer better, but it can make a bad engineer dangerous.”
  [Robert D. Cook, Professor of Mechanical Engineering University of Wisconsin, Madison]

- It is not particularly difficult to obtain incorrect results with the Boundary Element Method: read the manual and be sure you understand how the method works !

Questions ?

- For files and documentation:
  http://cern.ch/nebem

- The authors of neBEM love to hear from the users:

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