The Two Gap Gun: Concepts & Questions

Cornell ERL Phase 1B Gun: *External Review*
1/6/11

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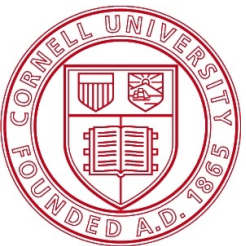


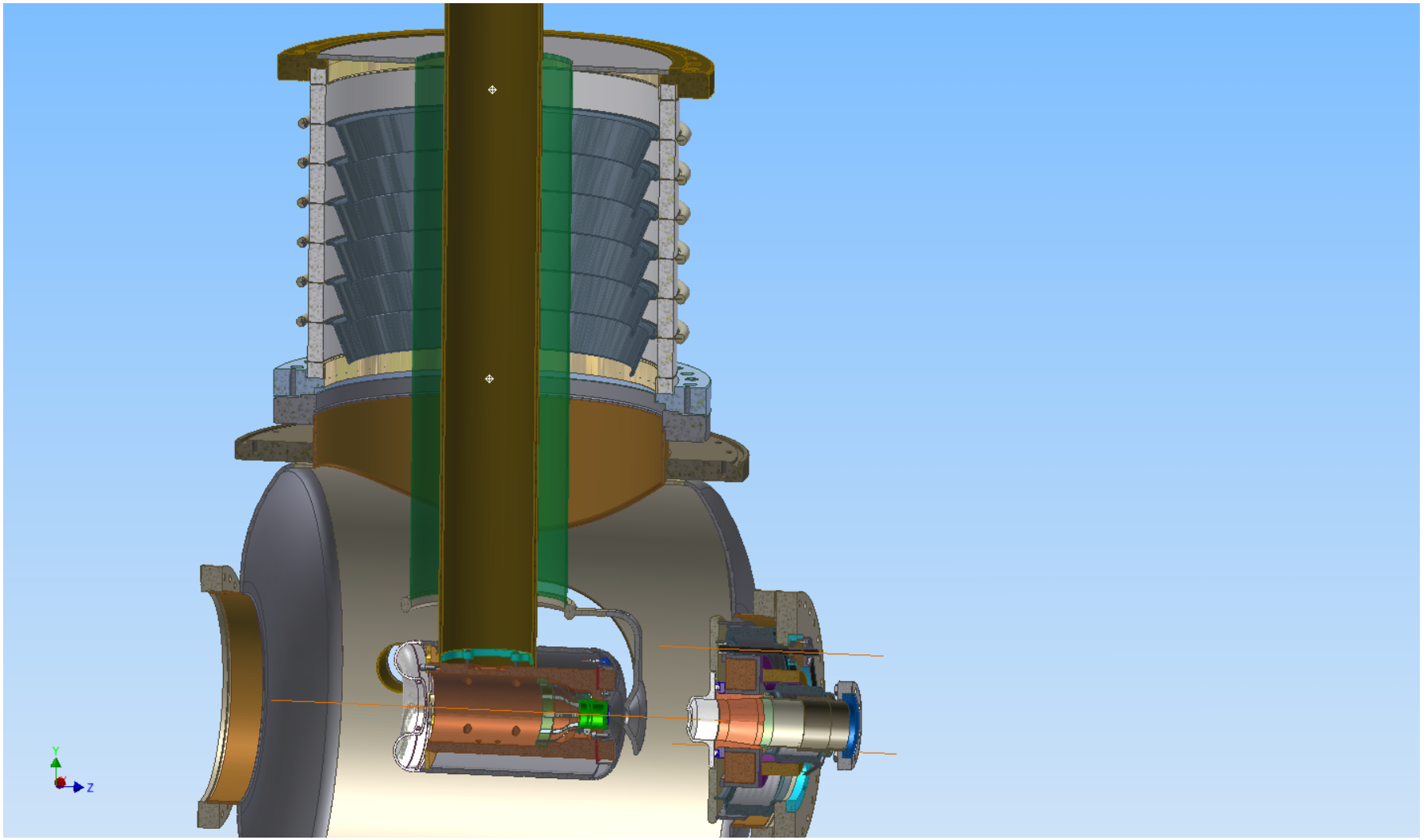
What and Why

- Traditional two electrode guns trade off between:
  - **Field at the photocathode** &
  - Focusing or **Voltage**
- Let's introduce another electrode:
  - Close to the anode,
  - Mid-to low range voltage
  - Provides strong field at the photocathode
- Move the anode 'far away'
  - Provides high voltage

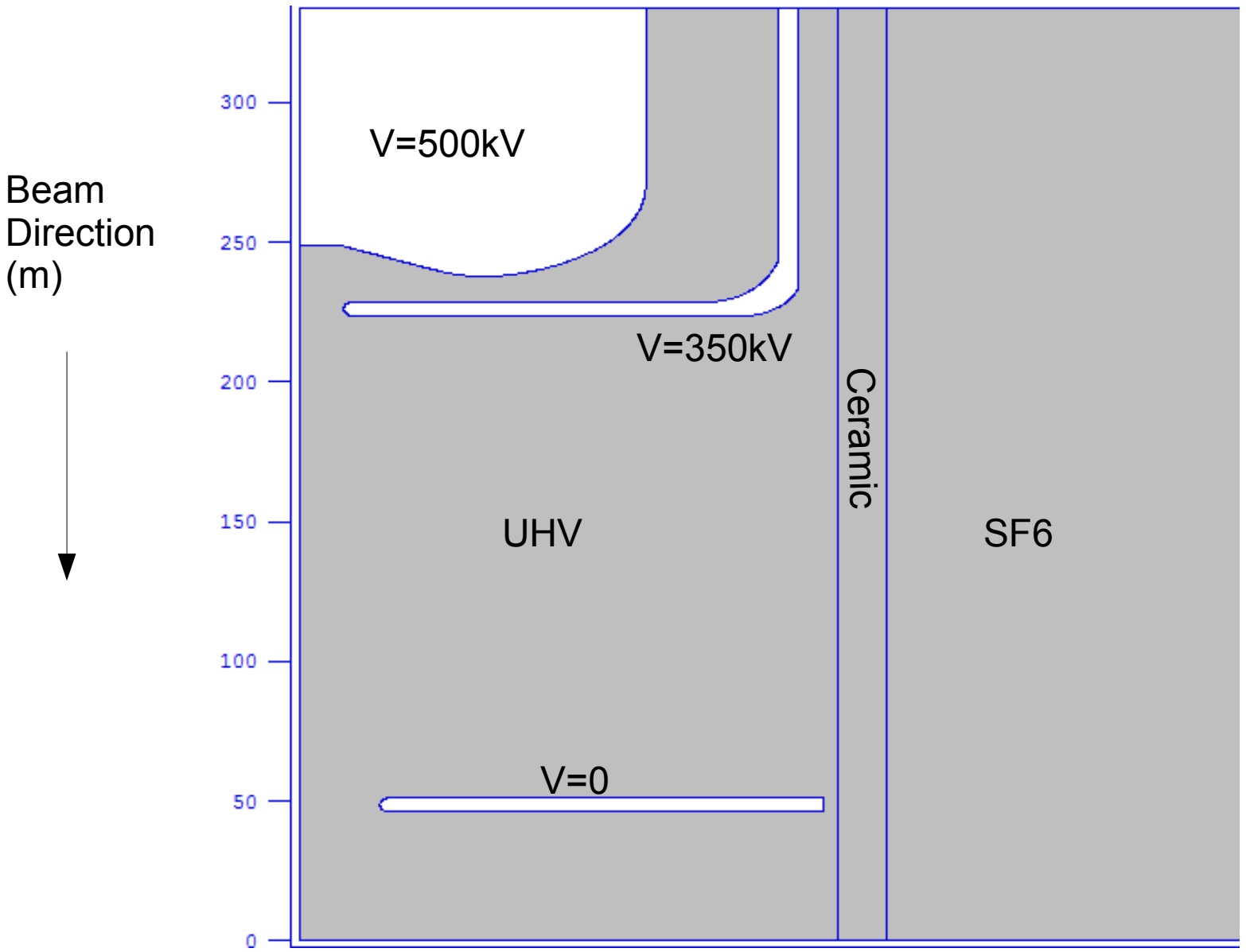
How?

- Here are two possibilities for layout.
  - 1)For simplicity, make ceramic and stalk horizontal.
    - Don't use a load lock, use a sturdy photocathode.
    - All cylindrically symmetric.
  - 2) Drop a secondary electrode into the existing design.
    - Must break cylindrical symmetry.
    - Can load lock.
- I'll focus on #1.

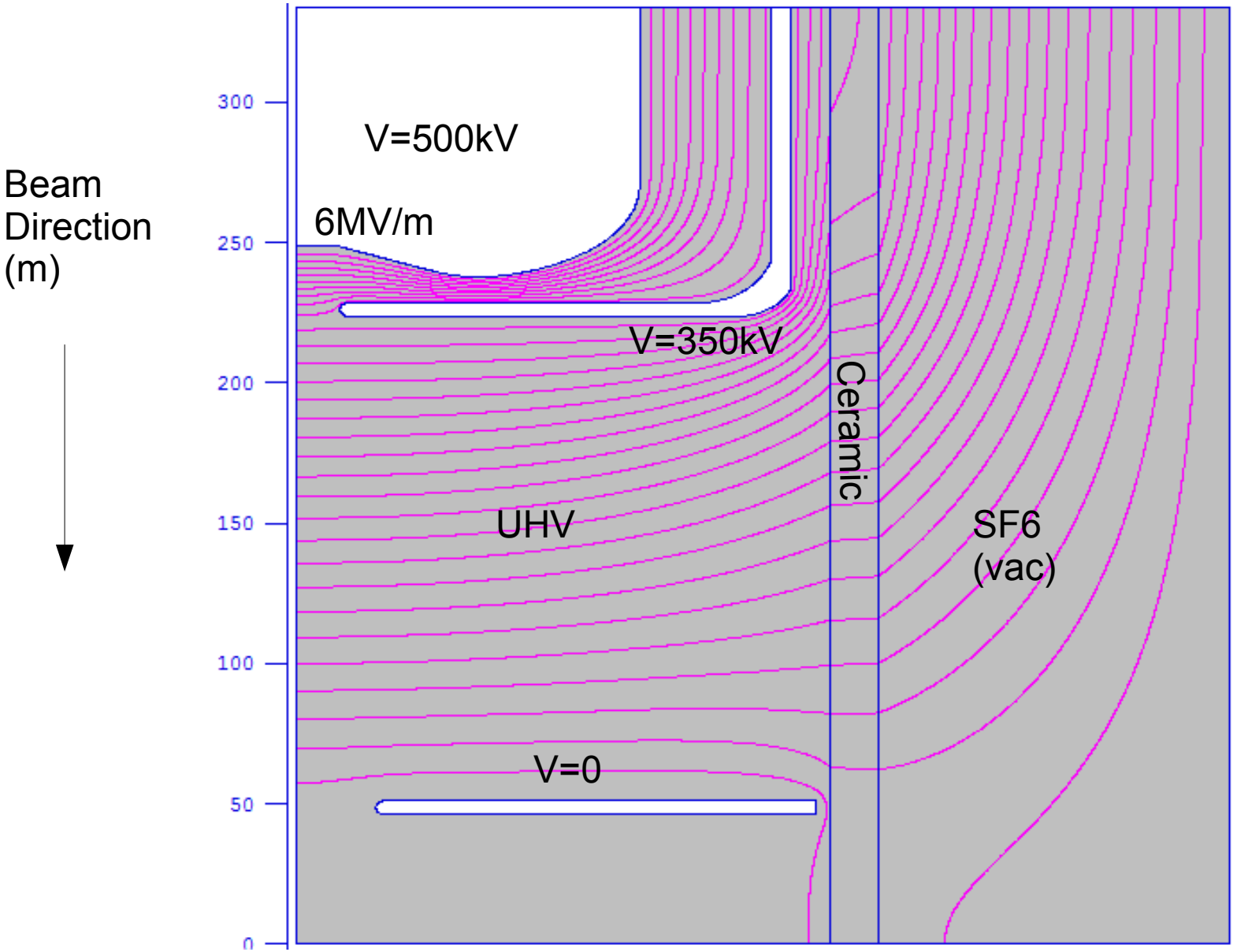
Asymmetric Design



Horizontal Layout



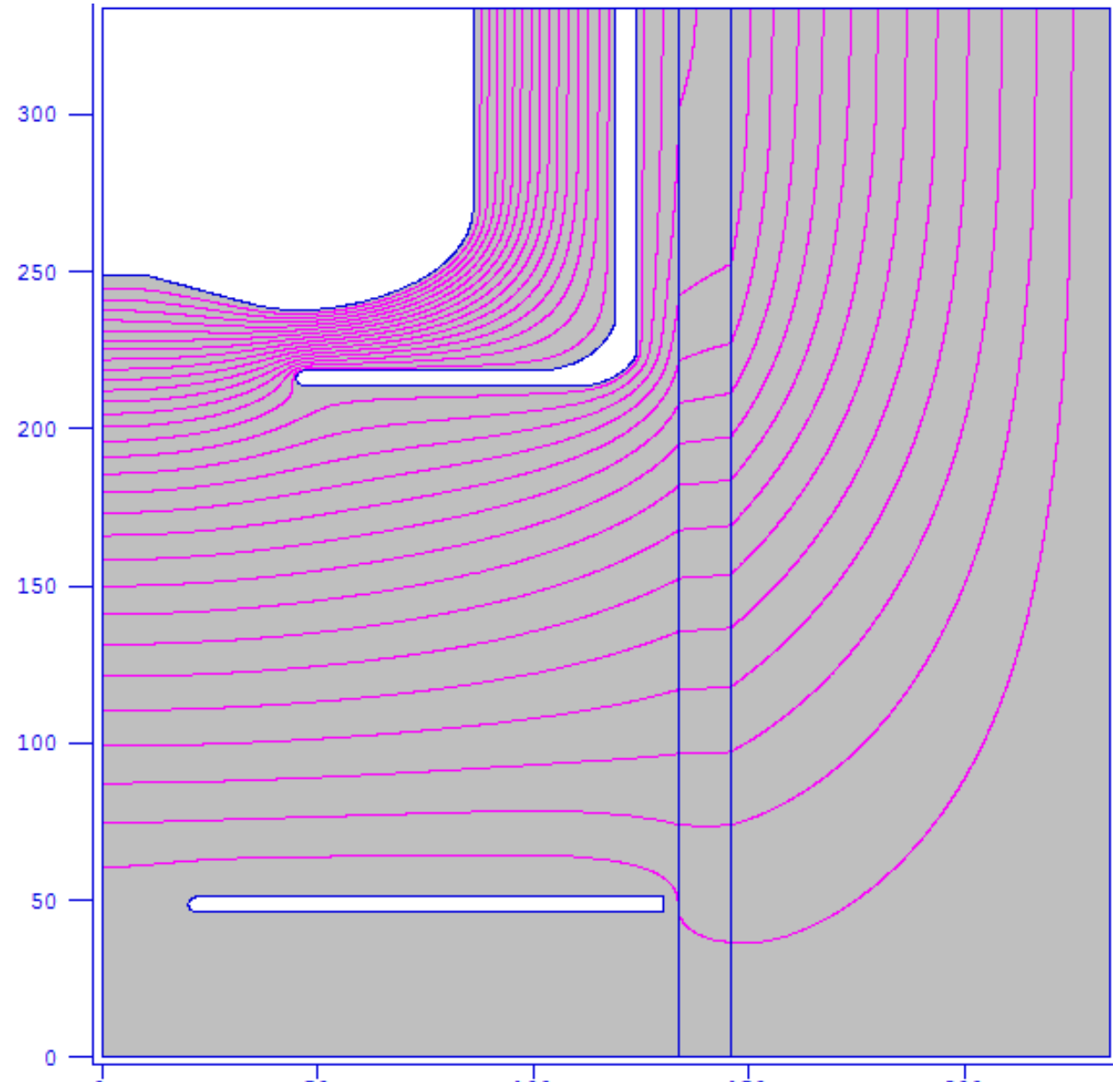
Horizontal Layout



Discussion

- Did what it should—large field on photocathode, with only 150 kV.
  - Tolerable fields between first two electrodes <20MV/m. (Could be improved)
  - Field next to ceramic <10MV/m
- Both anodes defocus.
  - Shaping or curving ground anode negligible.
  - Strong defocusing from first anode.
    - Traced electrons from r=3mm are defocused; strike ground anode or ceramic.
    - Must pull back anode arm.

One Possible Geometry



- Retracted anode
- Increased gap
- V1=250 kV
- *Epc=4 MV/m*
- Focusing borderline @ r=3mm

Discussion

- Solutions of this type with Epc>4MV/m are defocusing up to r=3mm.
  - Must either pull back arm or increase gap to smooth equipotential bulge.
  - Increasing voltage difference also increases defocusing.
- Anode proximity is essential
  - Anode shaping may not help the photocathode field?

Conclusions

- 1st anode defocusing must be alleviated
  - Likely only anode proximity matters
- Can focus at 4MV/m, with more than 500 kV total voltage.
- Large gap/voltage should be optimized via emittance tracking; much room for space charge growth.