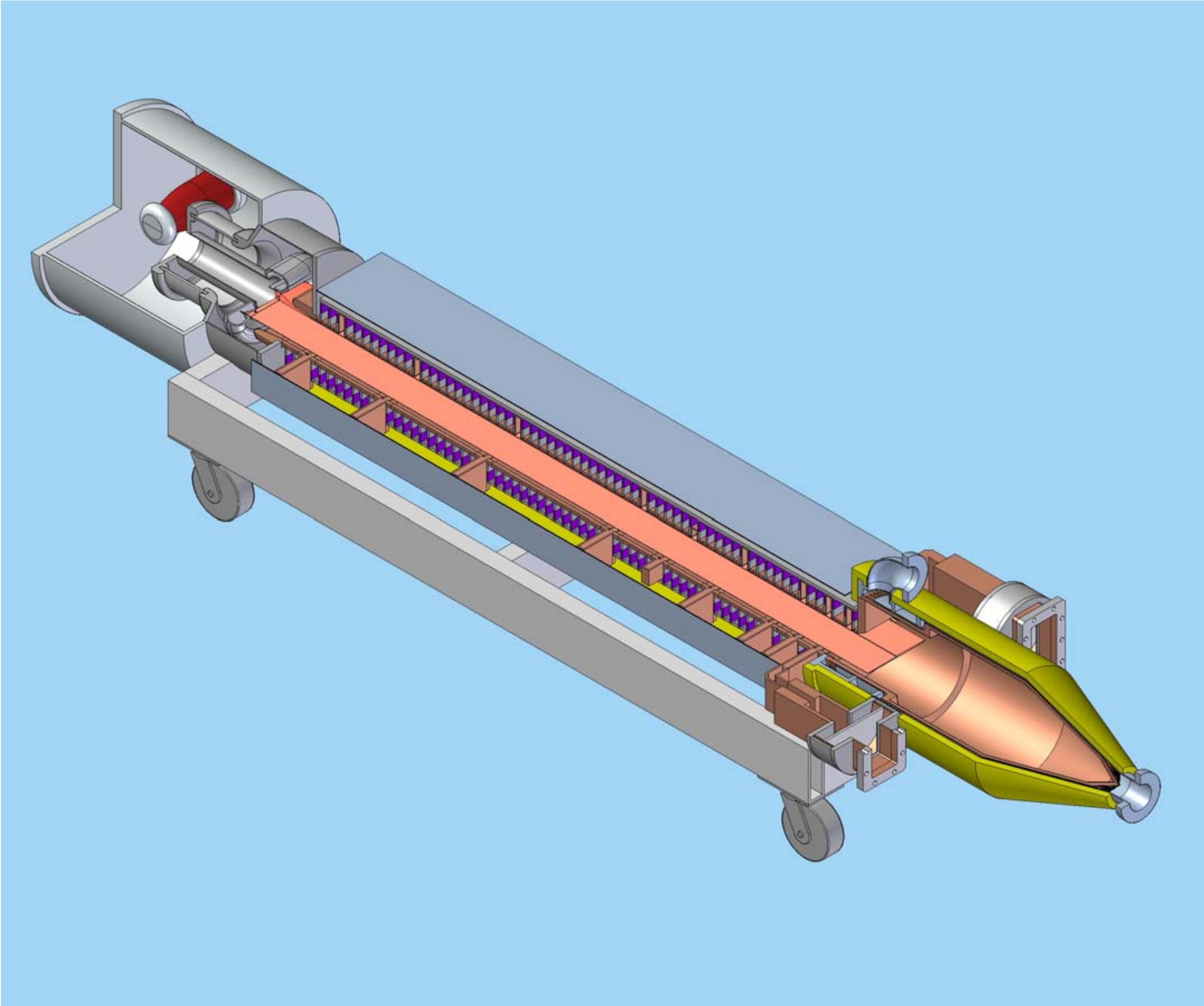
LSBK Development Status

November 18, 2008

Motivation

- Why Sheet Beam?
  - Allows higher beam current (at a given beam voltage) for RF power while still maintaining low current density for efficiency
  - Promises to be smaller and lighter than other options
  - PPM focusing eliminates power required for solenoid

ILC SBK Conceptual Design



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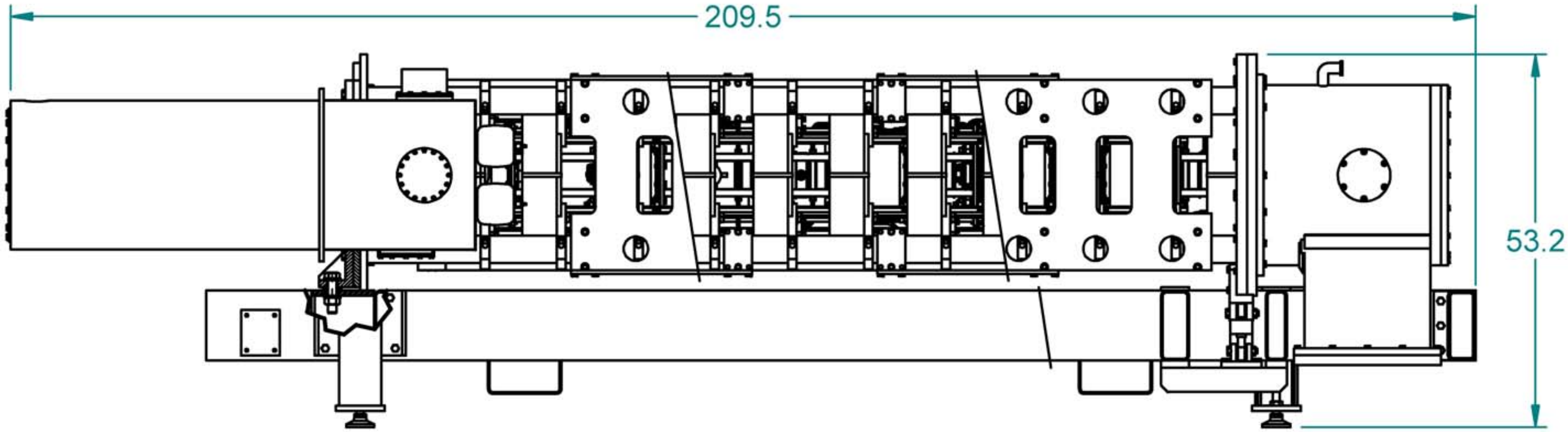
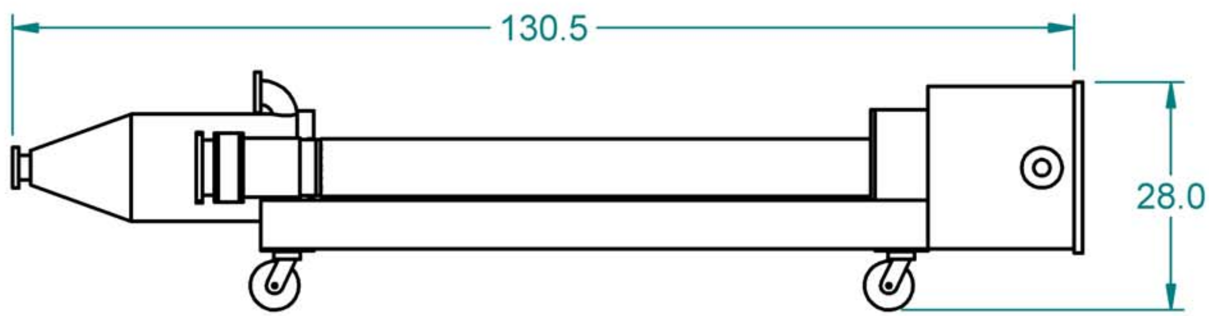
ILC SBK Conceptual Design



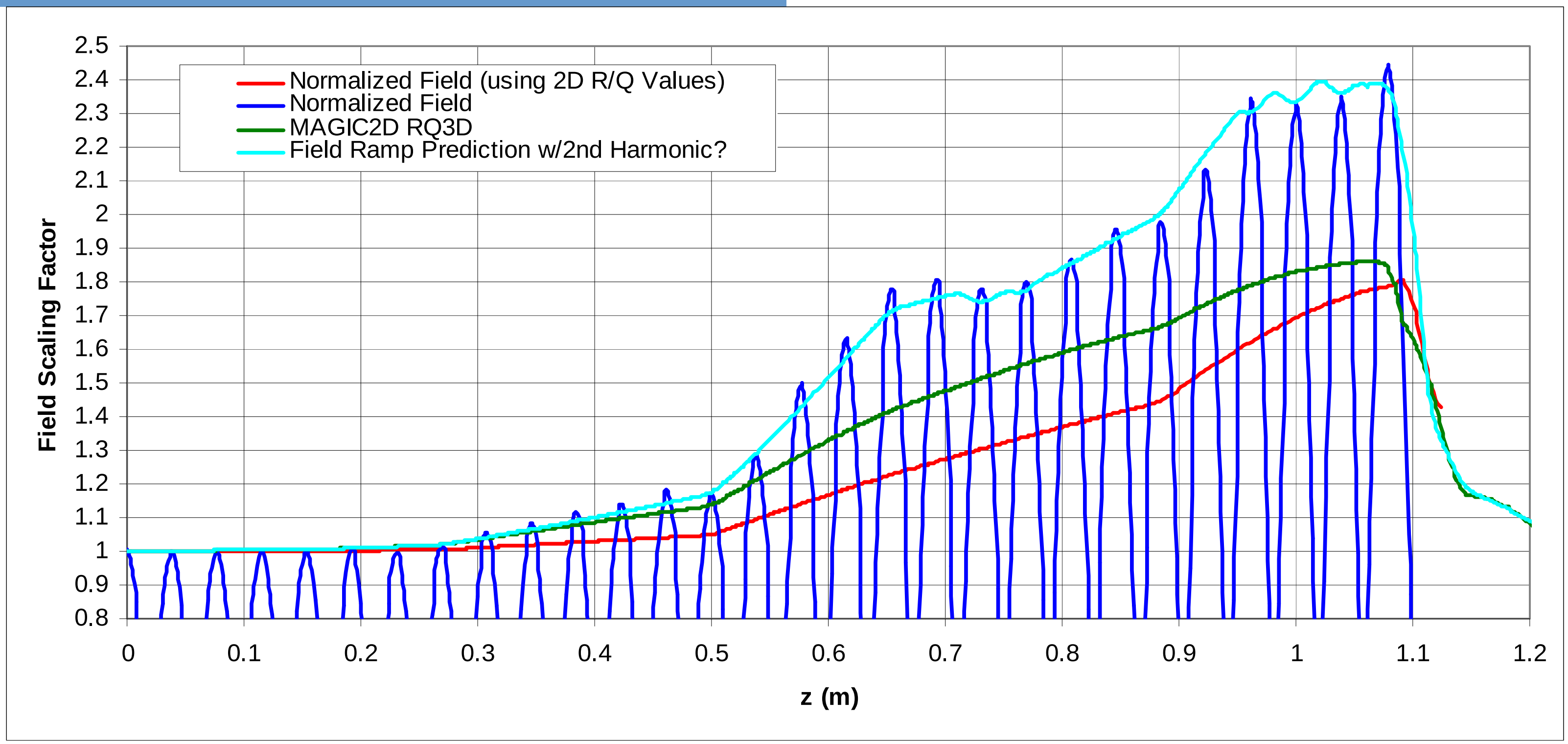
B-FACTORY KLYSTRON

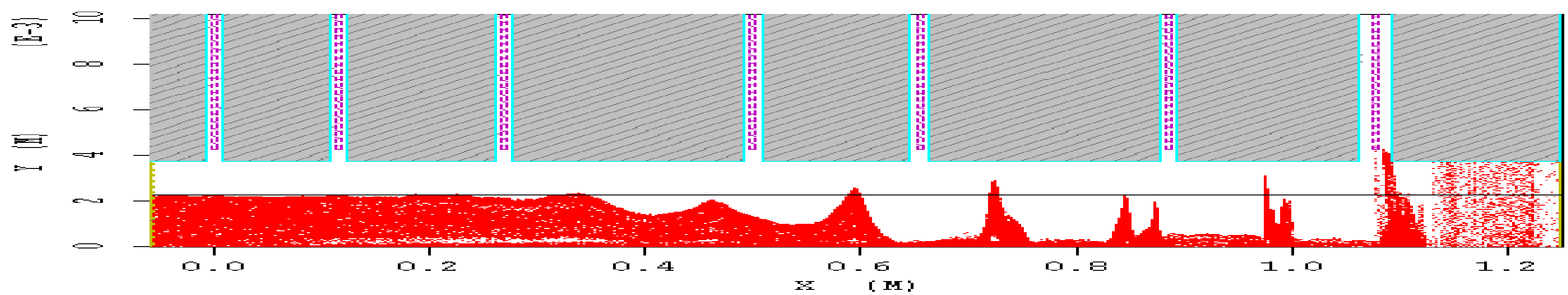


ILC SHEET BEAM KLYSTRON

- Build a flexible beam test diode to verify 3-D gun simulations.
  - Beam profile measurement capability for electrostatic and magnetic focusing cases
  - Modular design to allow quick modifications and component changes
- In parallel develop a klystron to be fabricated immediately after the beam test diode.

RF Simulations-Magic 2D





10MW+

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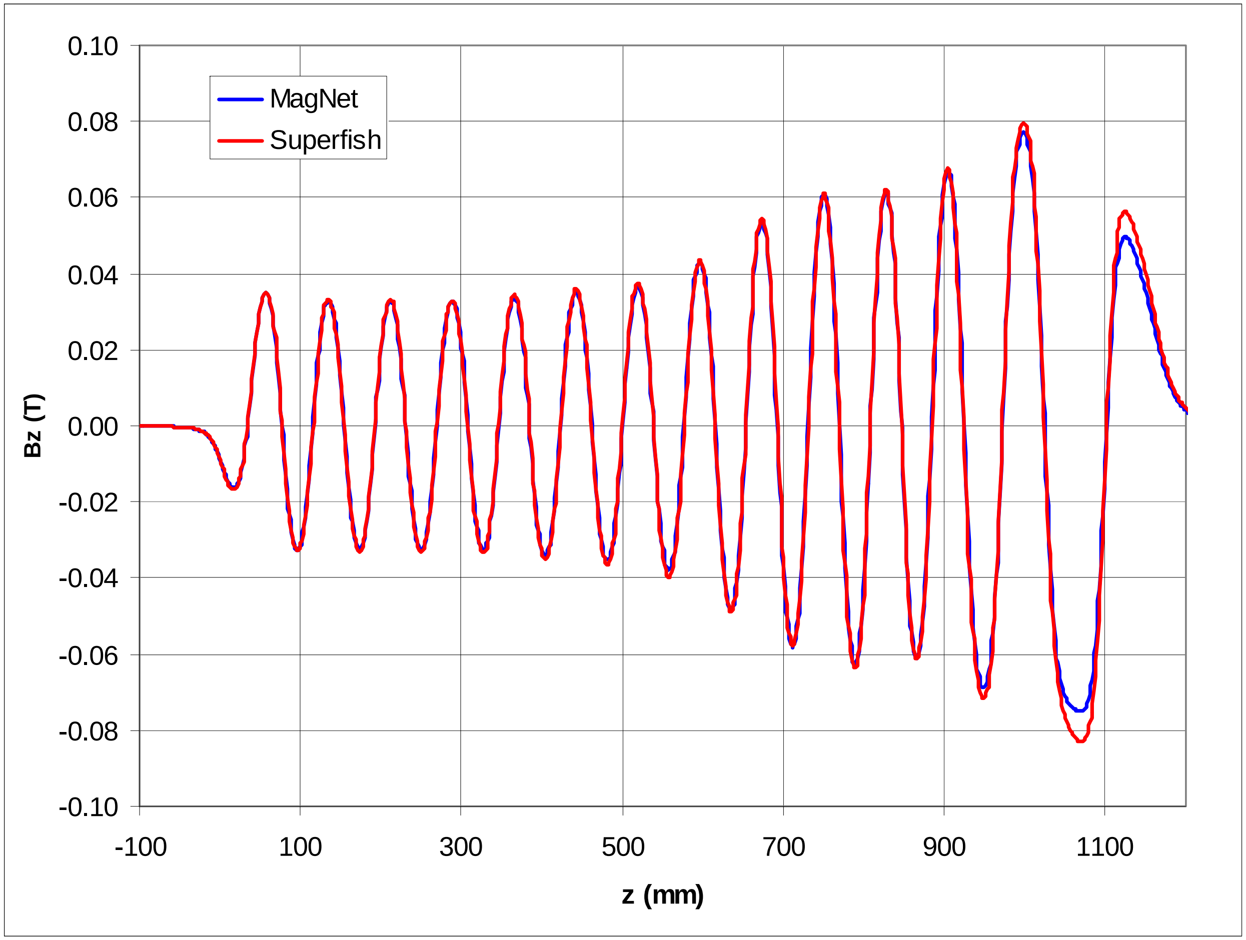
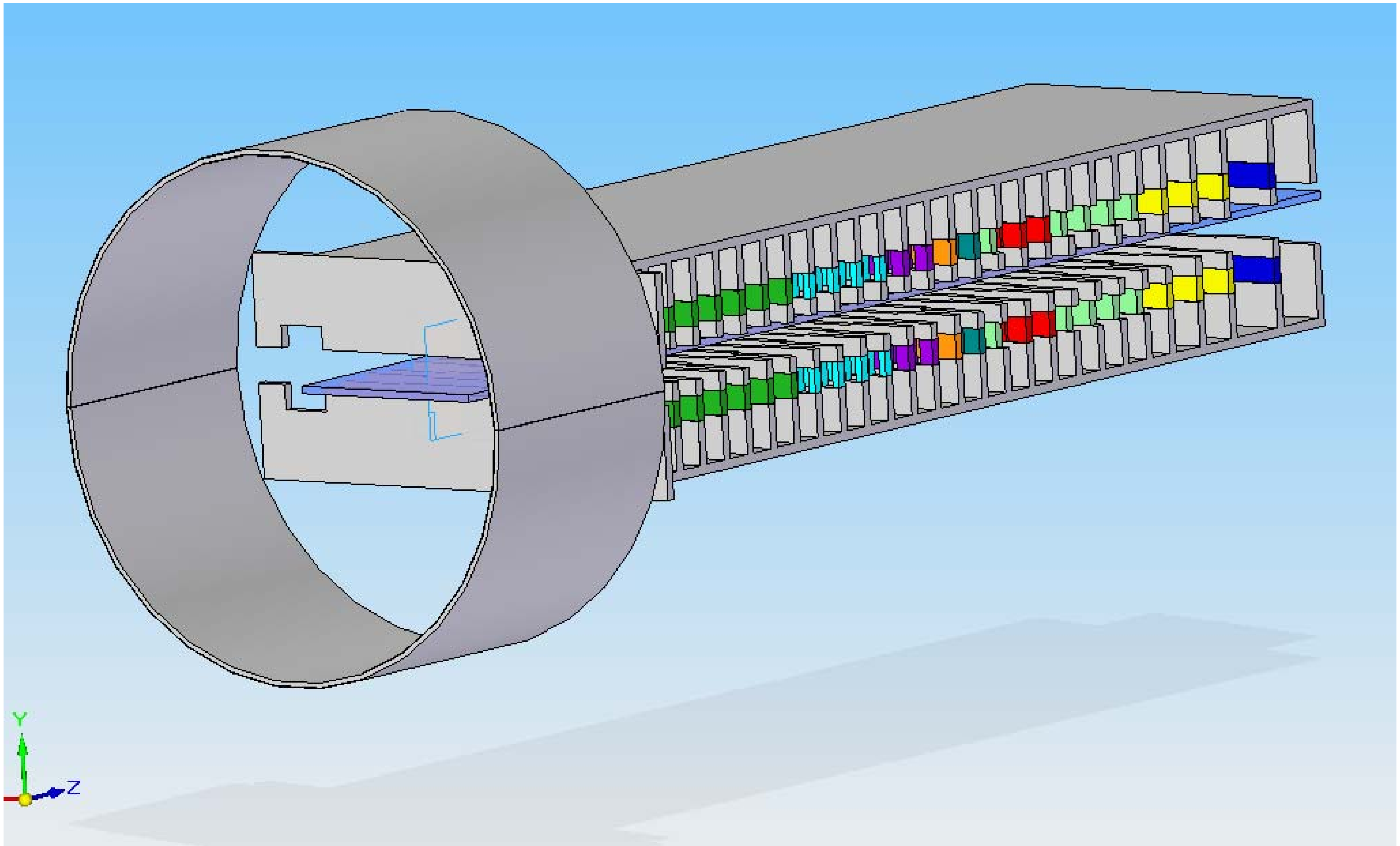
2D to 3D Magnetics

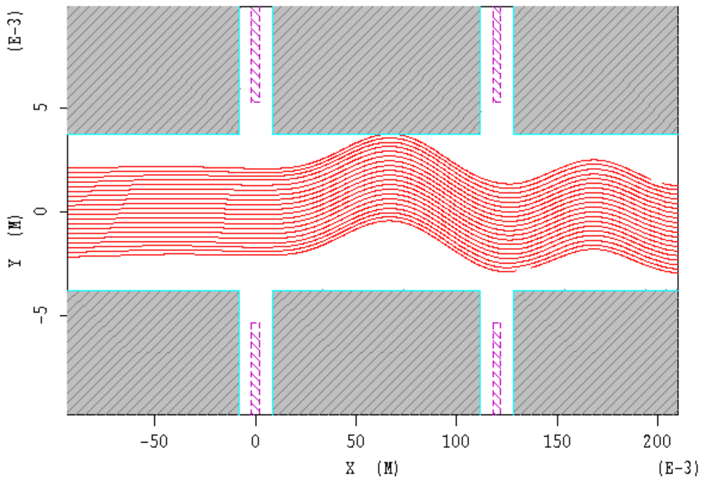


3D Magnetics Model

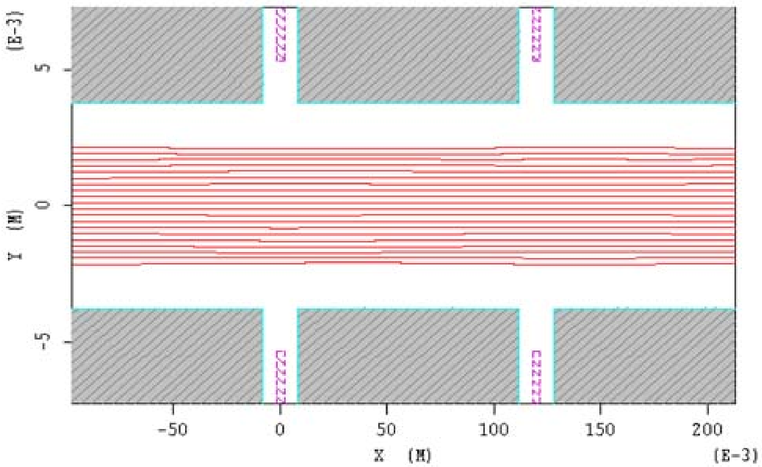


TE Mode Discovered

0.3kG Solenoid



1.0kG Solenoid



TE mode beam-coupling

- In all klystrons, TE modes exist in the drift tube that may couple to the electron beam and cause unstable off-axis beam motion

- For round-beam klystrons these modes are, in general:
  - not strongly coupled
  - cannot propagate in the drift region at the operational frequency
  - are contained and determined by the cavities (and therefore can be tuned)
  - and are mitigated further by the high magnetic field confinement.

- For a flat-beam klystron the TE modes can be particularly troublesome due to the design trade-offs generally assumed. In the current ILC SBK design these modes are
  - strongly coupled to the beam
  - propagate in the drift tube at the operational frequency
  - determined by the region between cavities
  - difficult to load
  - not mitigated with the weak PPM field of the current design.

Suppressing the TE mode

- Given that there is an existing RF design (i.e., the ILC-SBK vacuum-envelope) that we would like to maintain without alteration:
  - We have discovered that loss alone will not eliminate the instability.
  - Increasing the magnetic field alone DOES seem to eliminate the instability – though we are continuing to study this.

Suppressing the TE mode

- If alterations to the vacuum-envelope design are allowed then there are items that may be altered to address the TE mode coupling.
  - Change cavity spacing – this becomes very difficult due to the multitude of pair wise cavity interactions
  - Reducing the drift tube width – this increases the cutoff frequency of TE modes but makes it very difficult to attain our stated goal of a plug-compatible ILC design (Vb, Ib and Jc).
  - Change drift tube height – increasing the height improves stability quickly but at the expense of cavity coupling and difficulty of finding a solution to beam confinement, however a solution may exist.

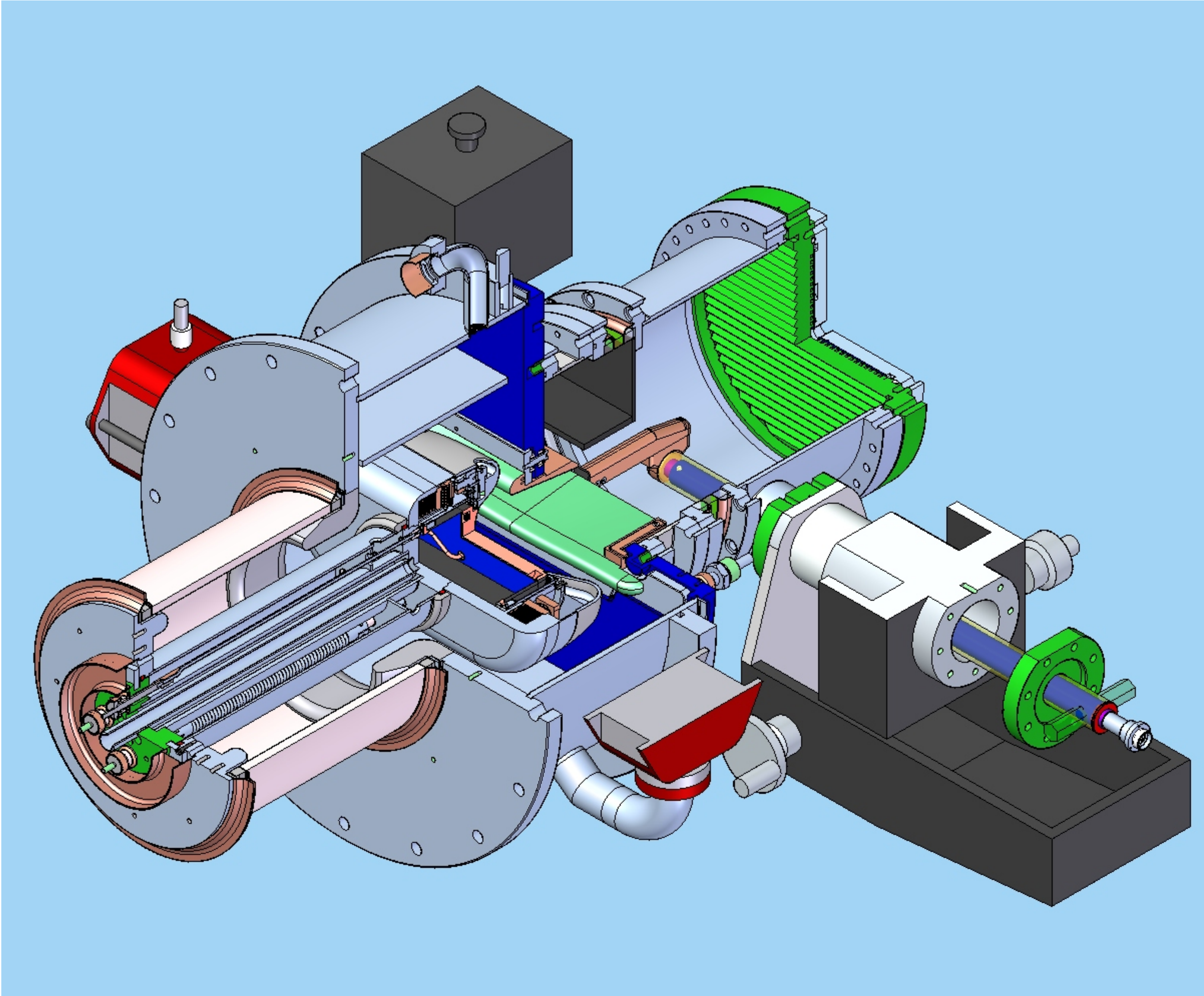
Recap of the TE mode

- It is preferable not to alter the RF design. If so then altering the magnetic field is the best choice to date.
- If an alteration to the RF design is allowed then opening the RF drift tube seems to be perhaps the only practical way to address the TE modes. This would also require (as in point 1 above) re-investigation for a new magnetic focusing scheme. Altering the RF design would also result in a very substantial delay in the production of the tube.
- Because of these two points, our main focus will be on the magnetic circuit

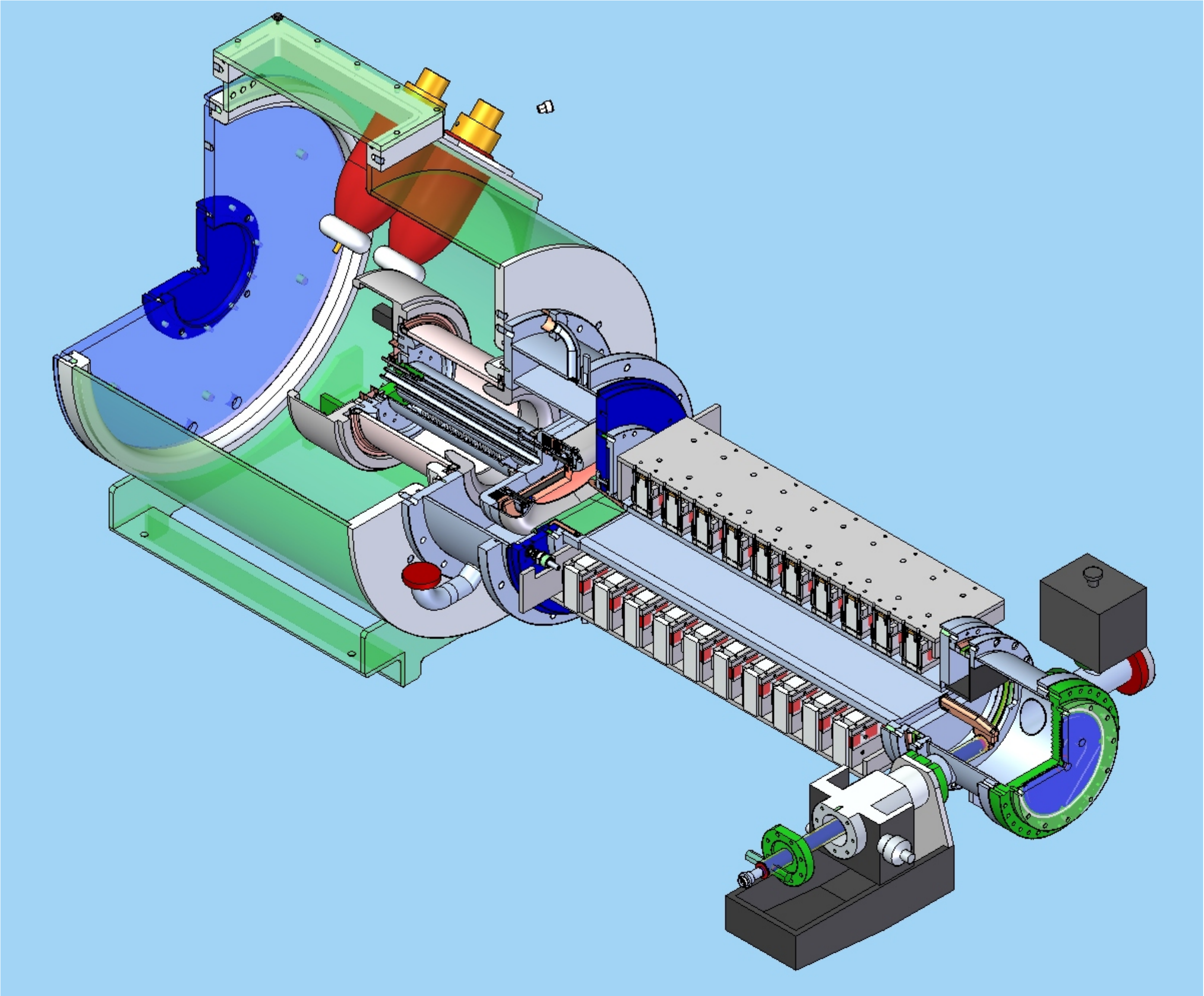
Beam, RF and Interaction Status

- Electron gun:
  - Simulations complete
- Beam Transport:
  - 3D magnetics design complete for diode
  - Klystron magnetics in progress
- RF circuit:
  - Cavity loading design complete
- RF-Beam Interaction:
  - TE mode discovered, studies underway for suppression

Mechanical Design-Electrostatic Diode



Mechanical Design-Magnetic Diode and Oil Tank



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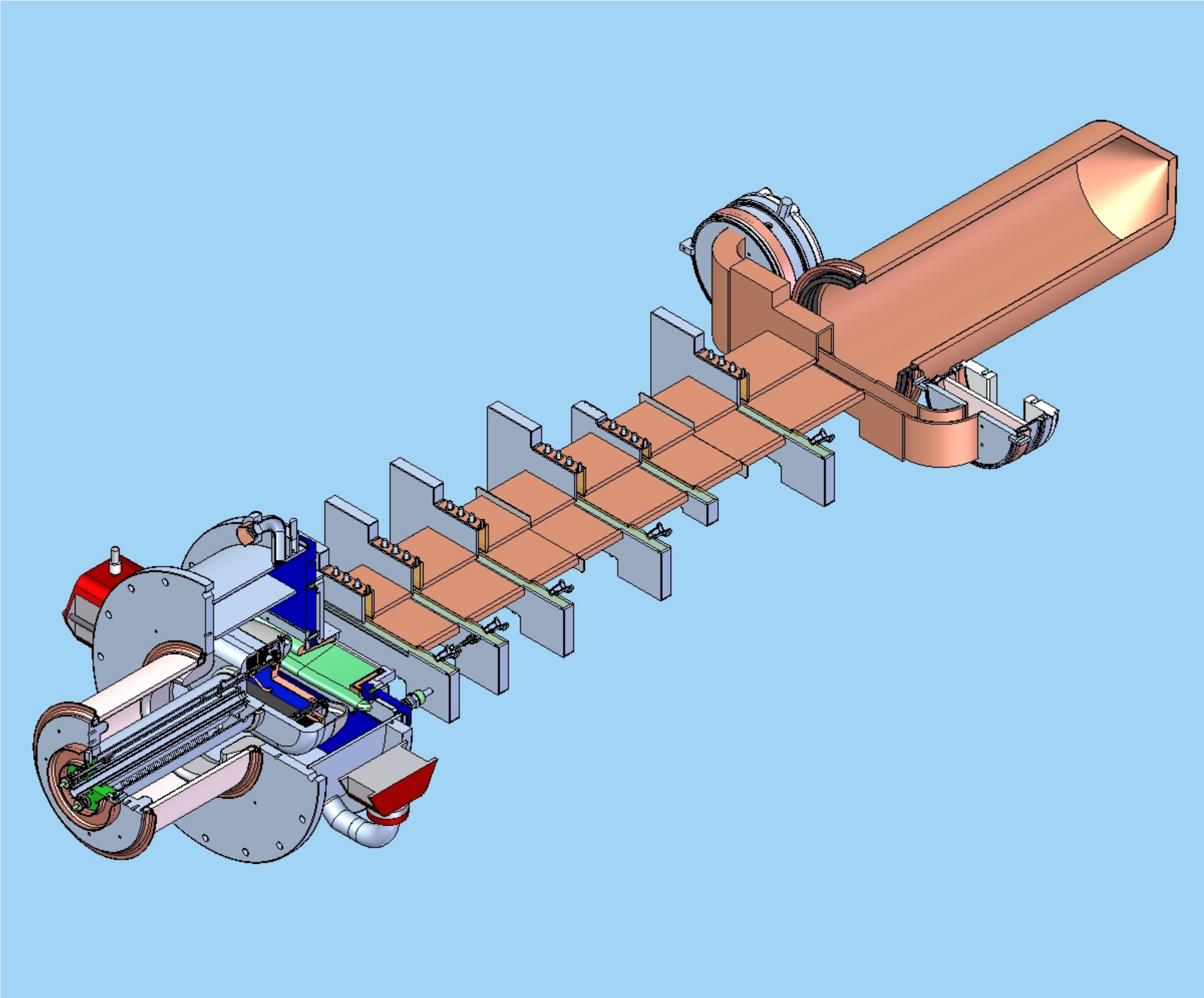
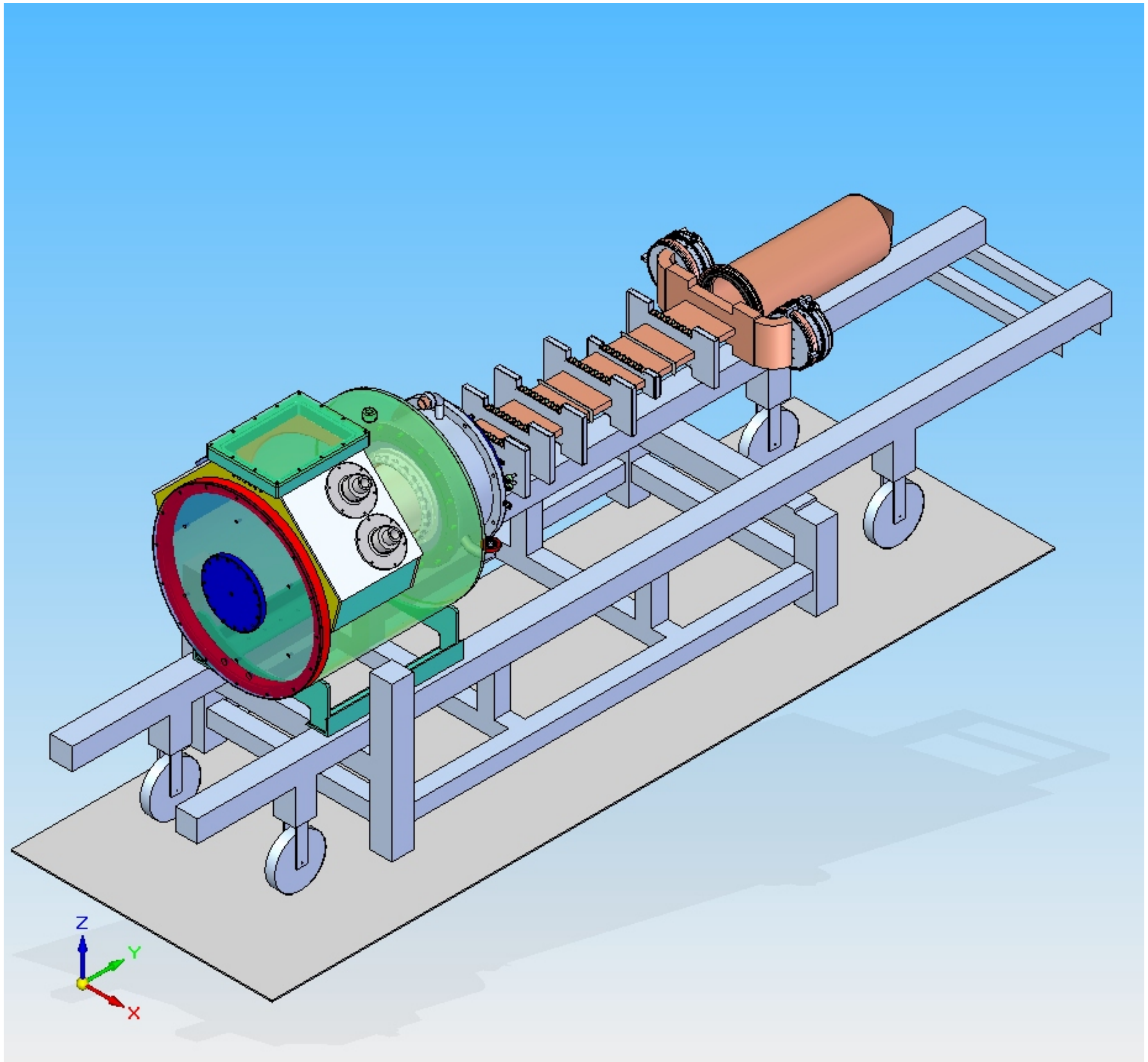
Mechanical Design-Klystron



Mechanical Design-Klystron on Surplus BFK Stand



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Gun Hardware Prior to Assembly

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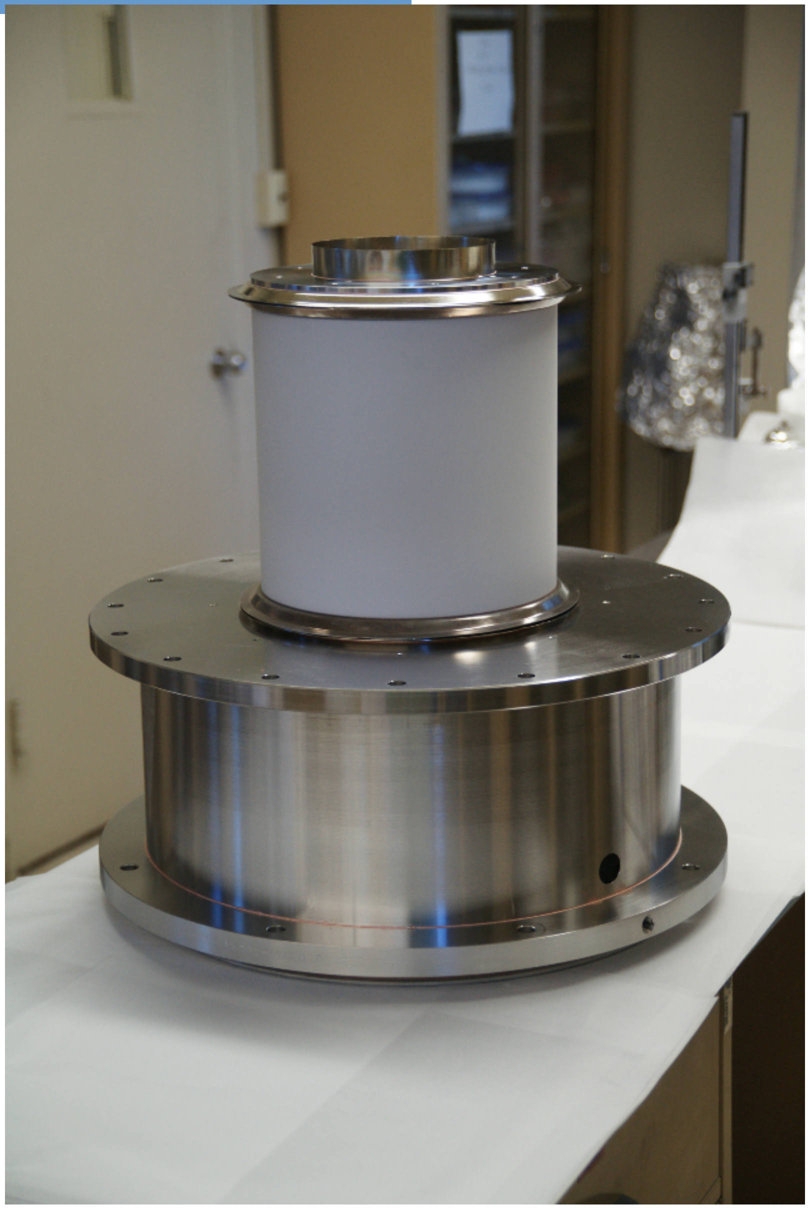
Anode Can Assembly



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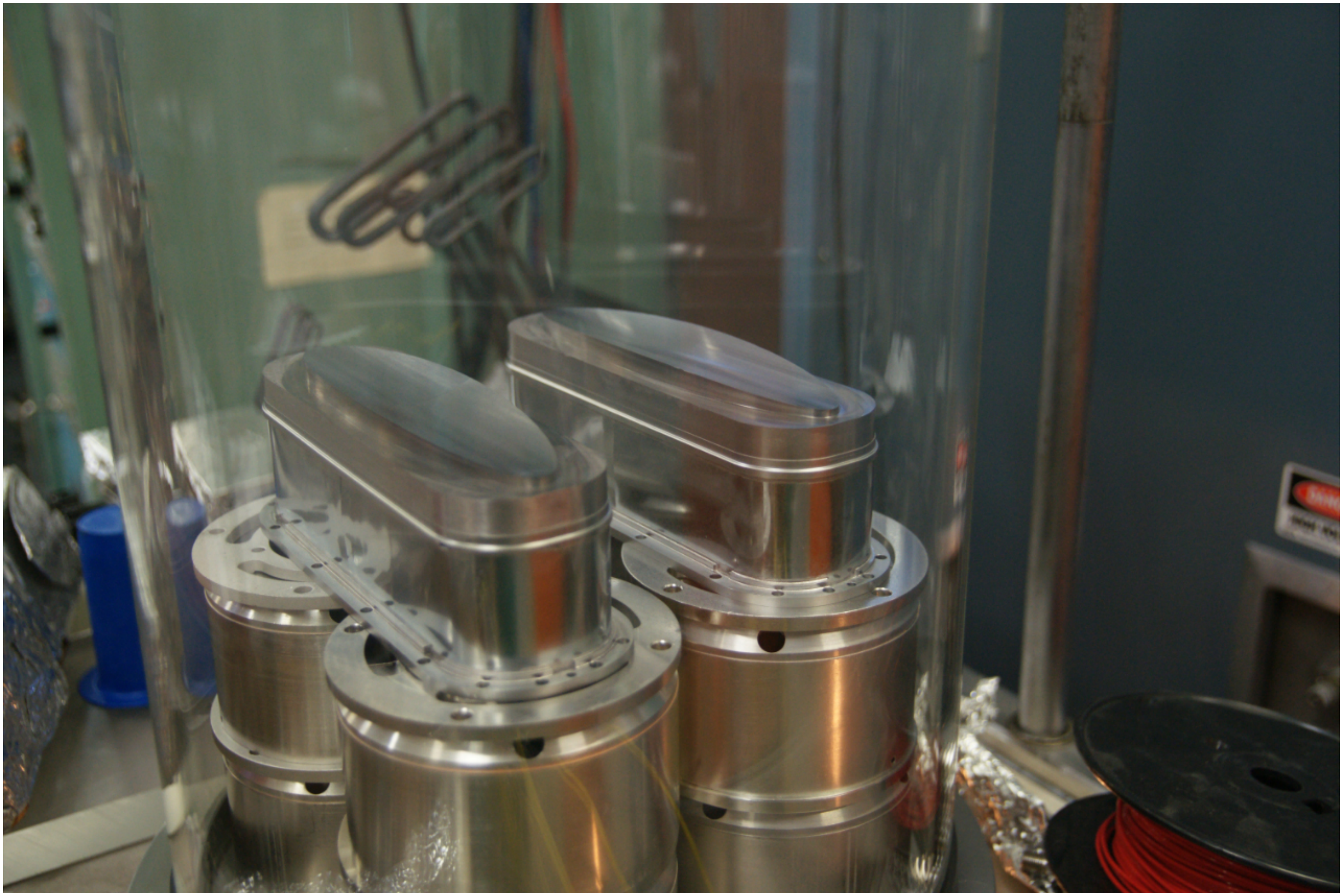
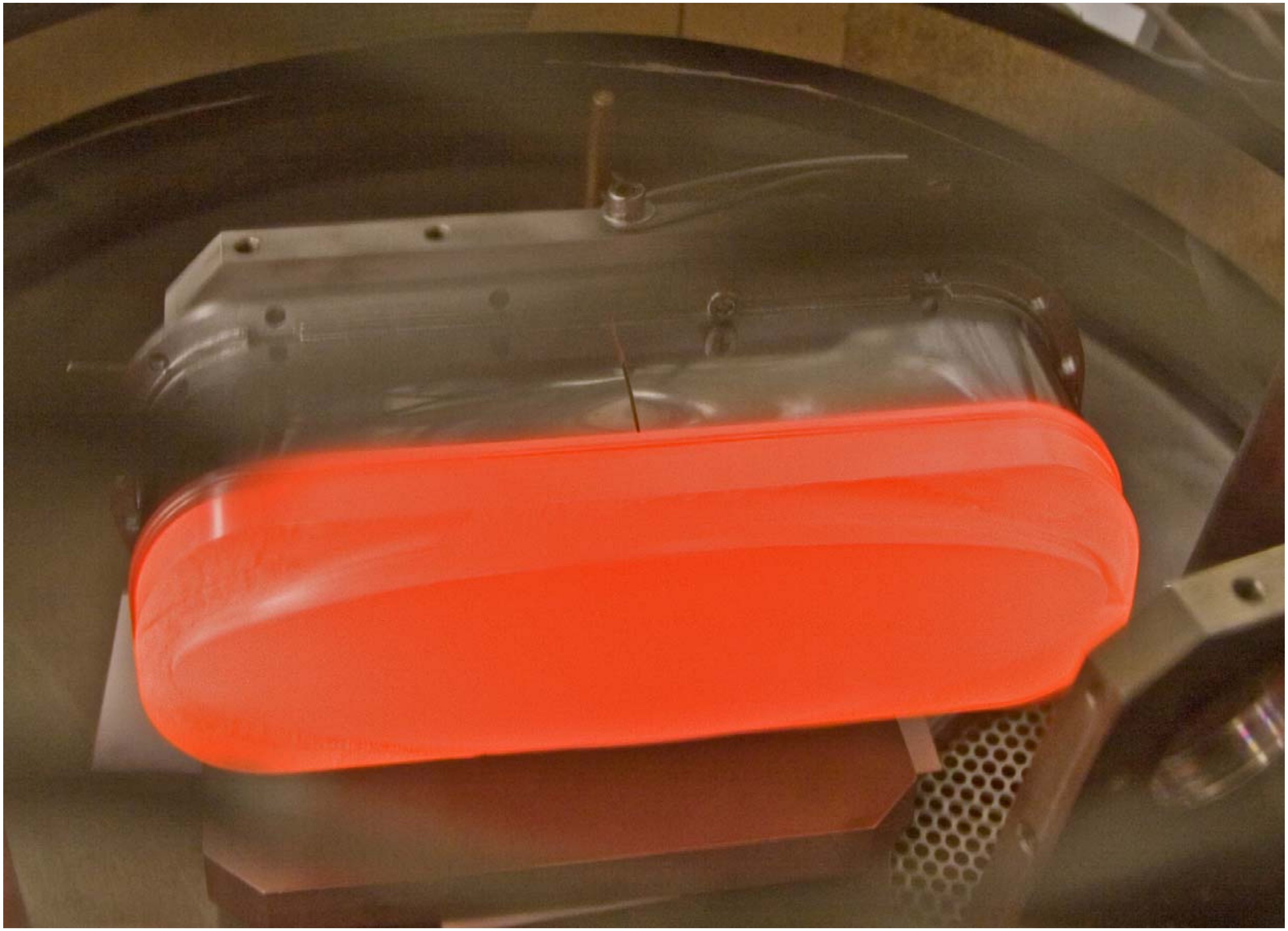
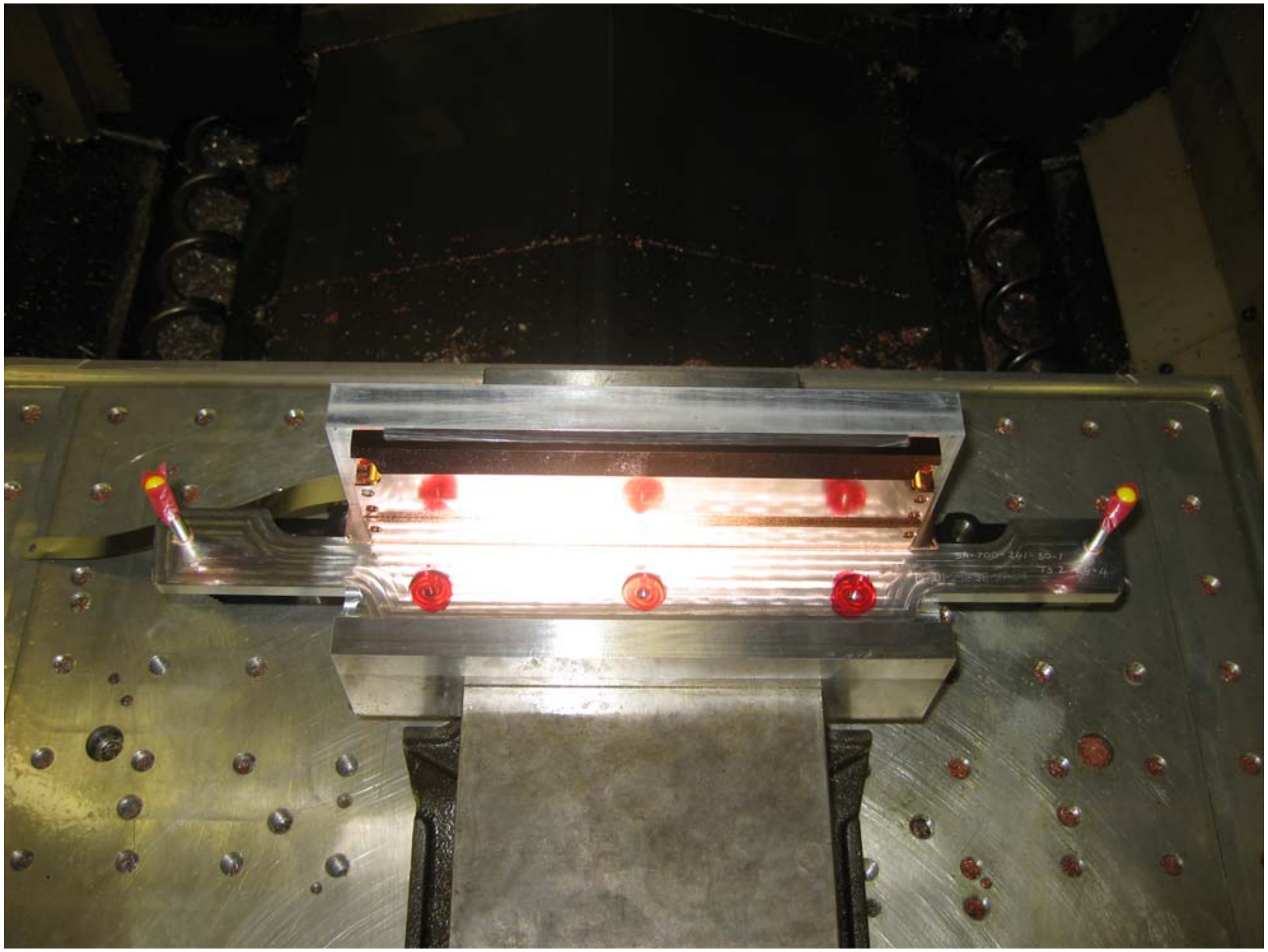
Two Cathodes in Storage Bell Jar



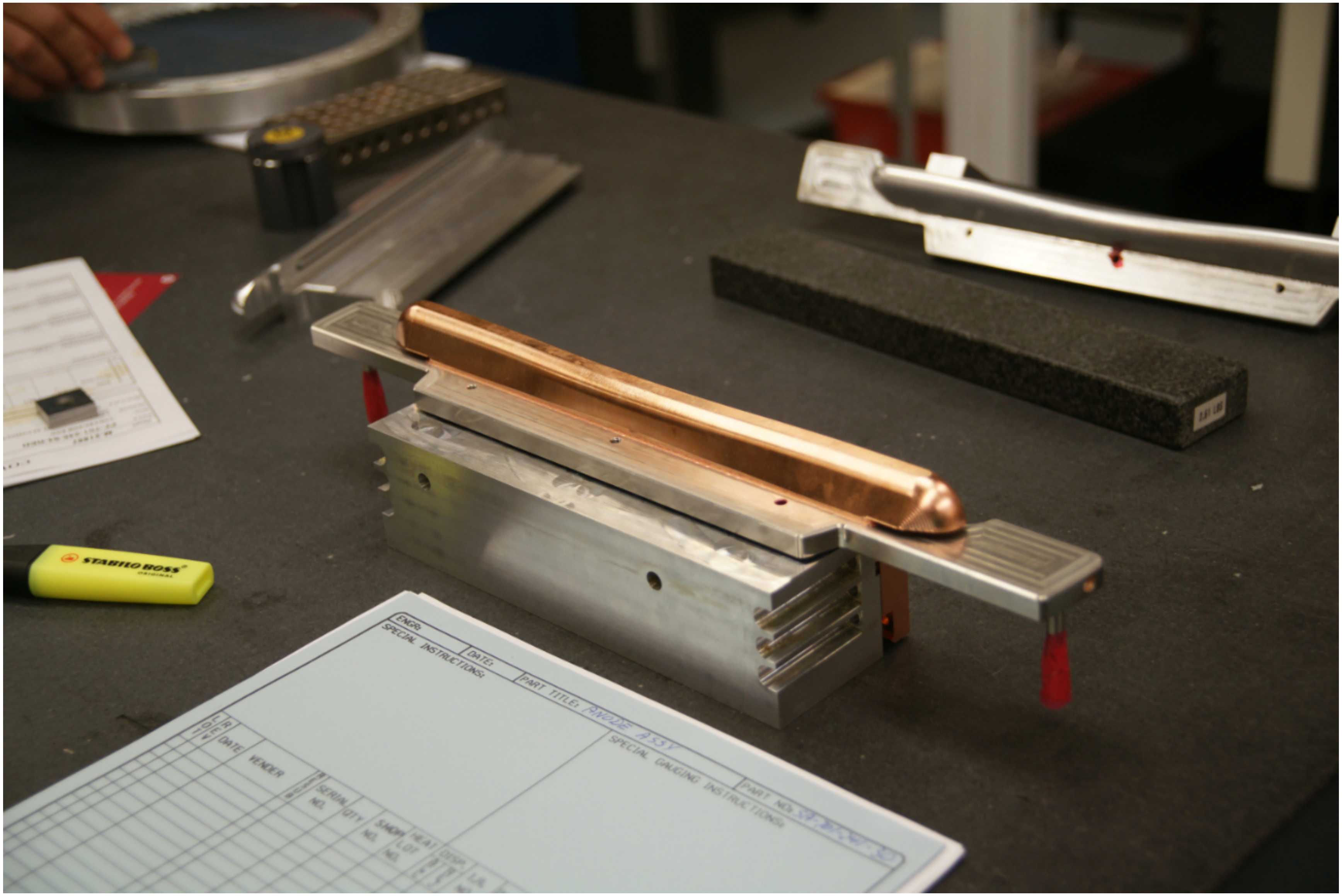
Bell Jar Firing Cathode



Anode Half in Final Machining



Machined Anode Assy in QC



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Focus Electrode Rough Machining

Finish Machined Focus Electrode

Beam Probe/Faraday Cup

Lapping Sealing Surface of BSD Collector

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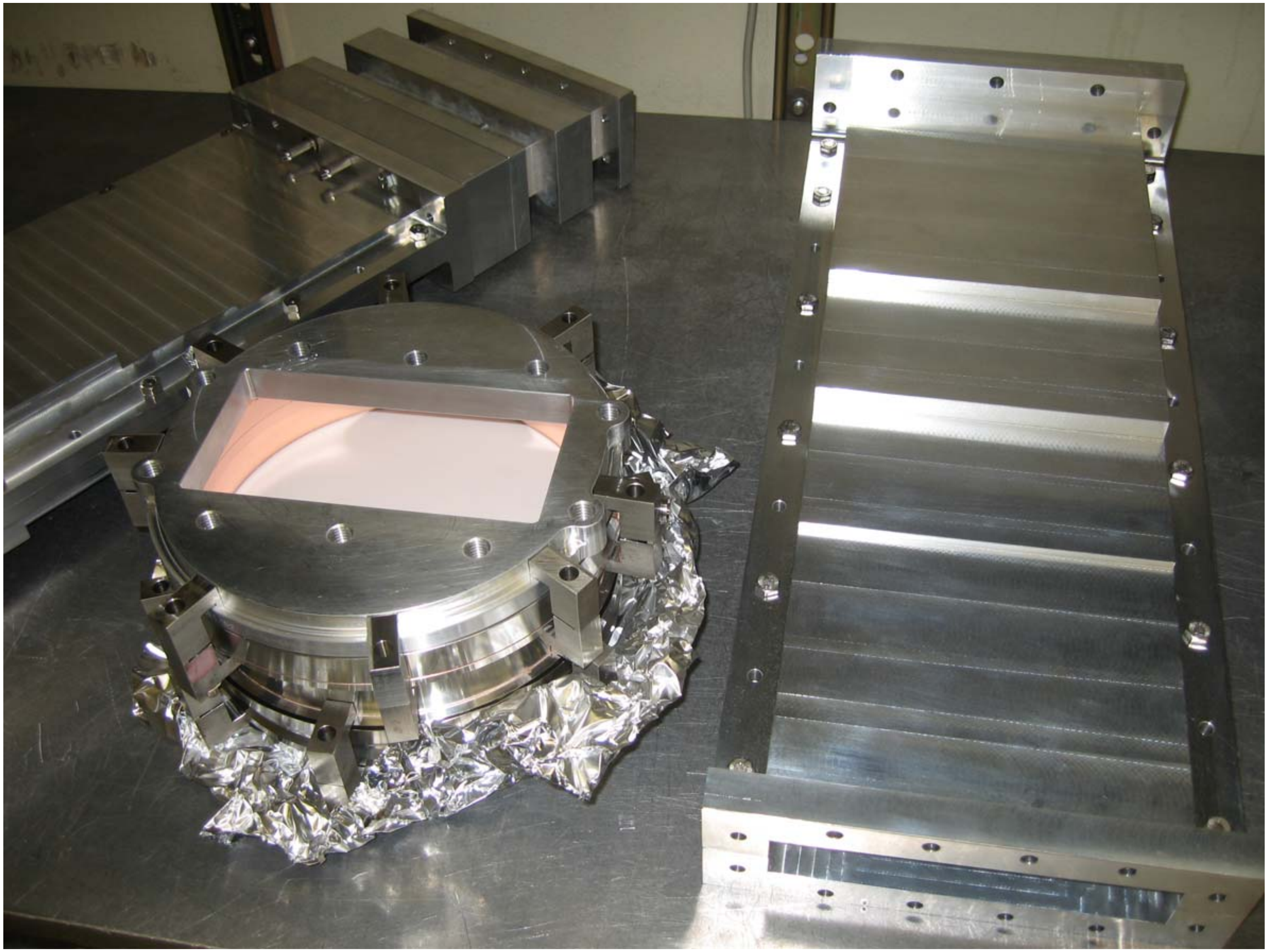
O/P Window and Cold Test Tapers



Gun Oil Tank

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Mechanical Design Status

- Electron gun:
  - Three cathodes in house
  - FE machining in progress
  - Assembly beginning
- Anode assembly:
  - Brazed assemblies in final machining
- Beam diagnostic:
  - Sub assembly brazing complete
  - Assembly of vacuum chamber beginning
- Klystron design on hold for TE mode resolution

Modified Plan

- Finish and test diode to verify Michelle gun and transport simulations (2/2009)
- Continue study of oscillation vs. magnetic field for full tube
- Continue study of alternate mode suppression techniques in parallel
- Start design for oscillation suppressing magnetics
- Fabricate and test klystron (1/2010)