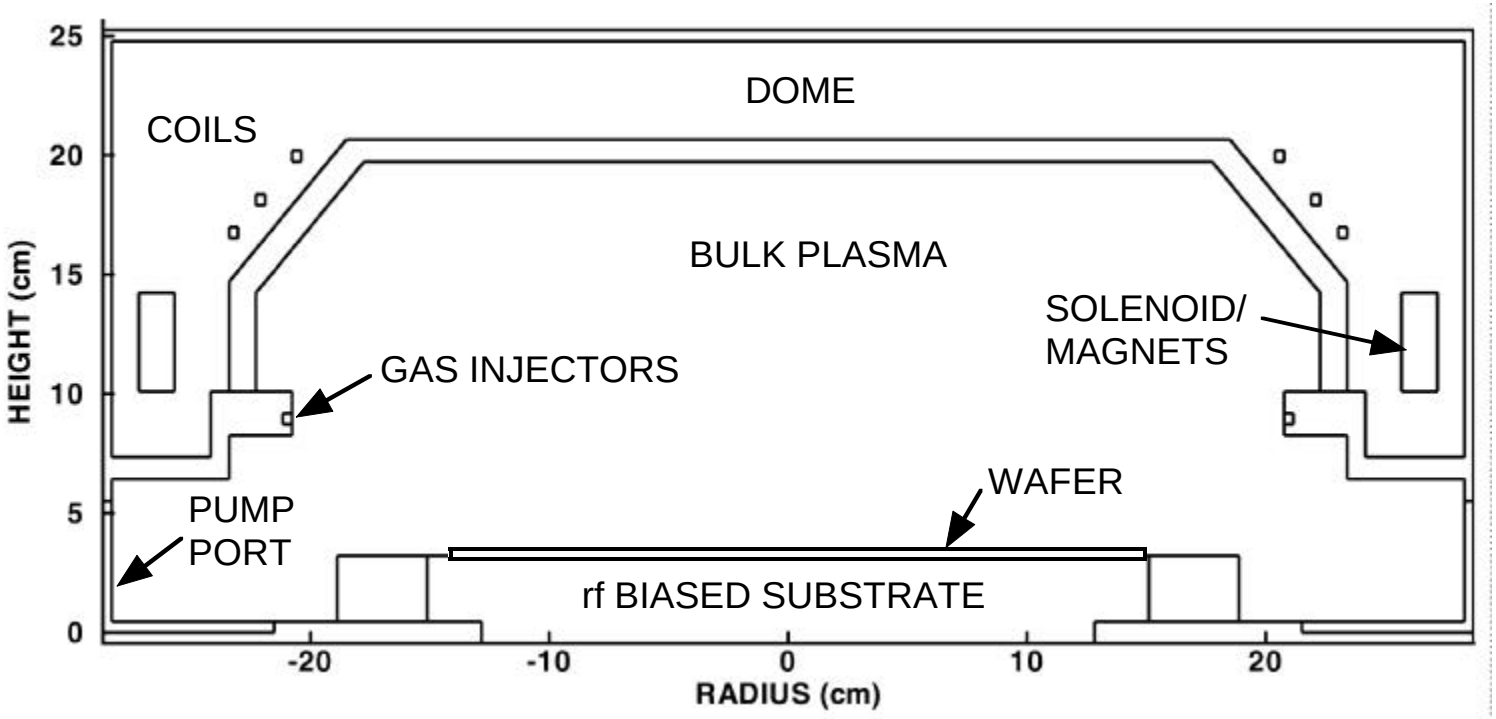
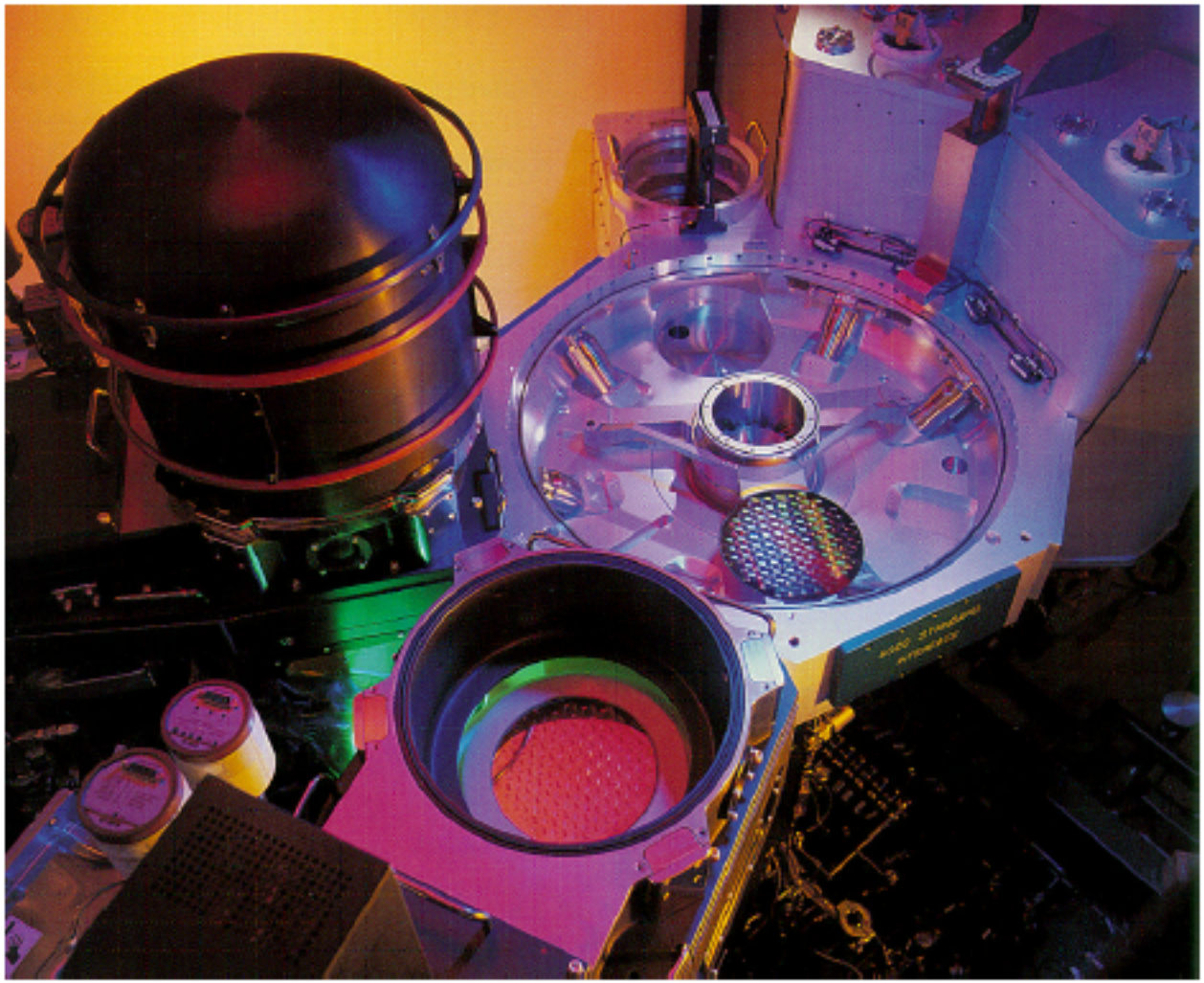
TYPICAL PLASMA PROCESSING REACTOR

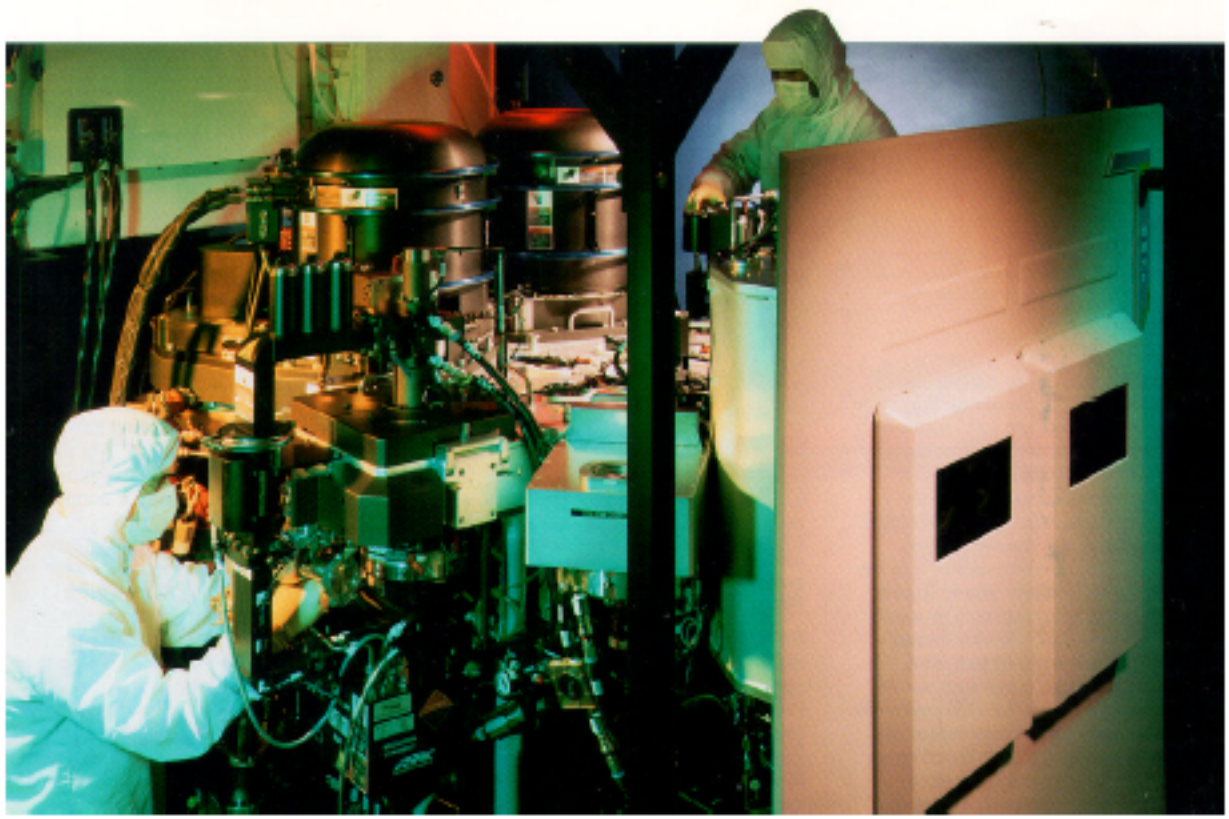
- The typical low pressue (< 10s - 100s mTorr) plasma processing reactor is powered by inductive and capactive coupling, and my have auxiliary static magnetic fields.



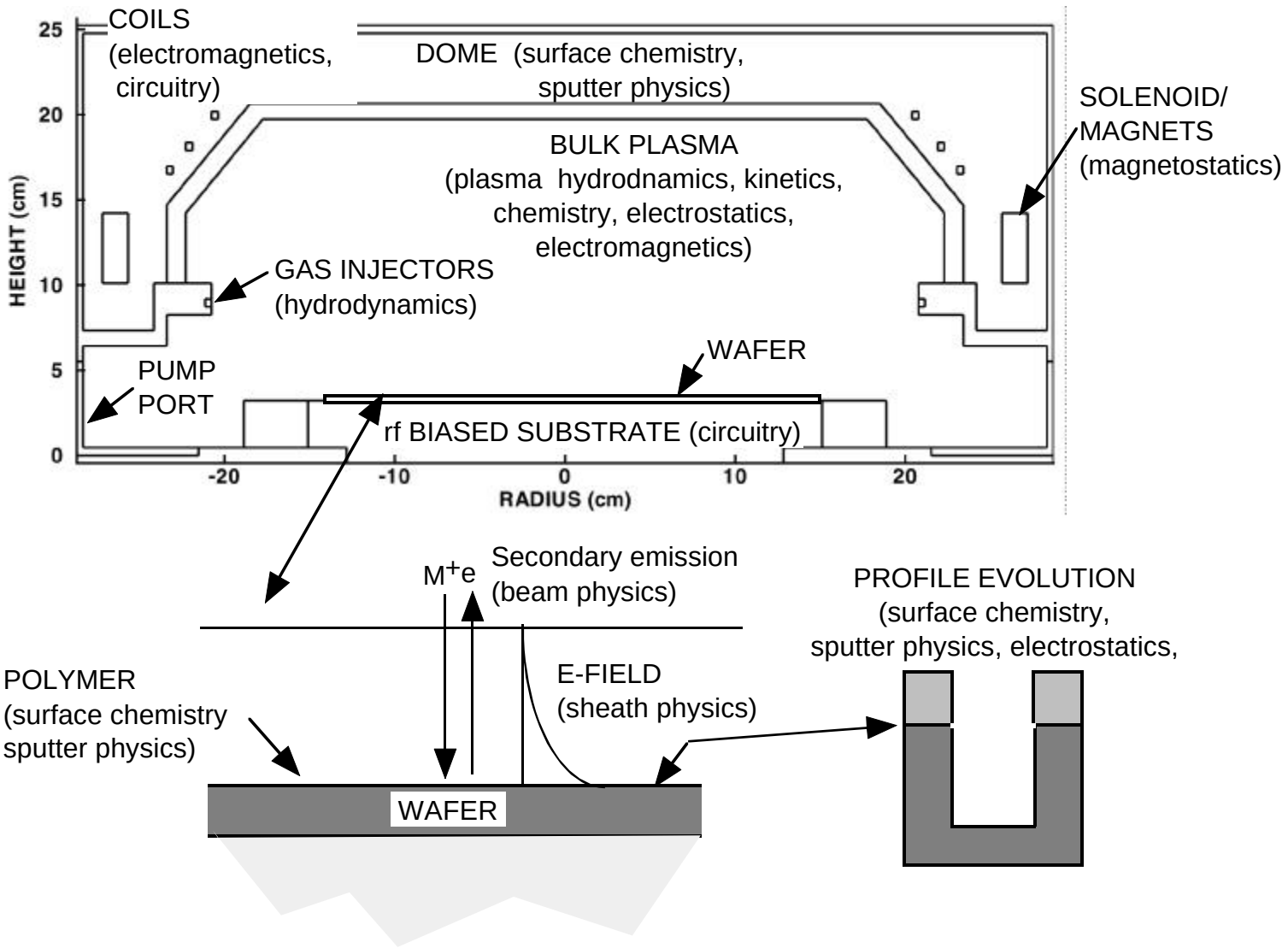
APPLIED MATERIALS DECOUPLED PLASMA SOURCE (DPS)



APPLIED MATERIALS DECOUPLED PLASMA SOURCE (DPS)



PHYSICS TO BE ADDRESSED



WALK THROUGH: Ar/Cl_2 ICP TOOL

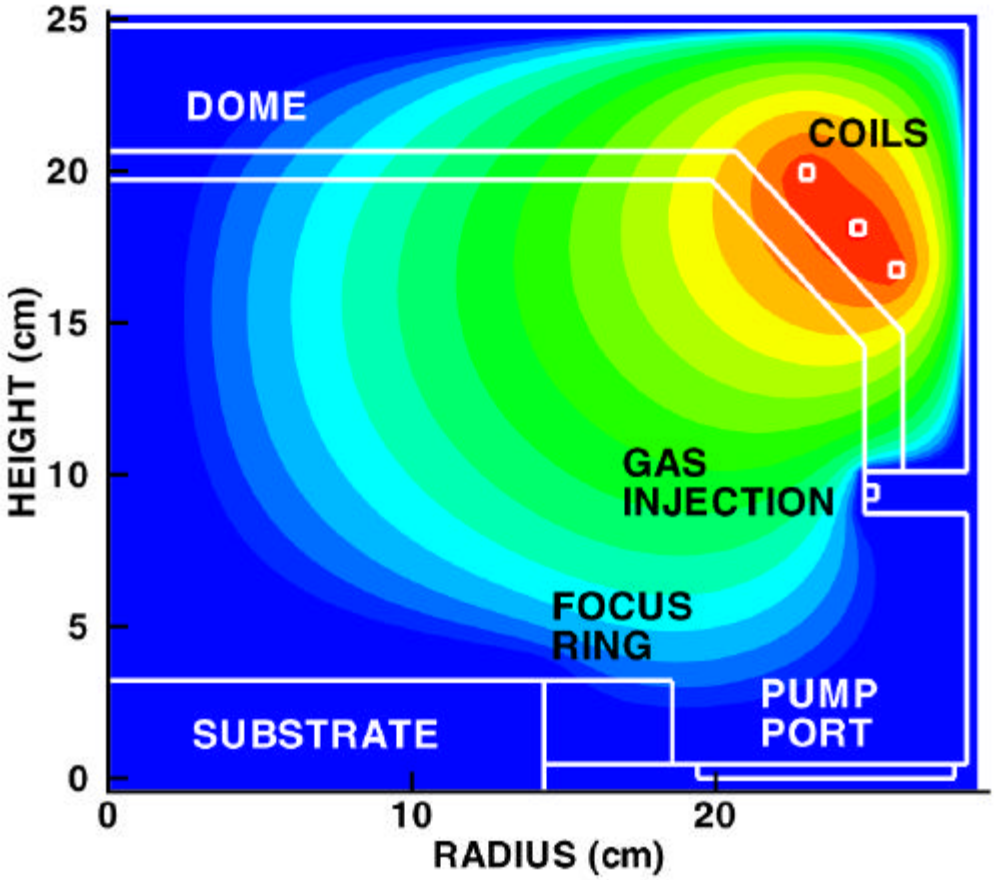
- **The general properties of an Ar/Cl_2 inductively coupled plasma tool will be examined.**

- **The inductively coupled electromagnetic fields have a skin depth of 3-4 cm.**

- **Absorption of the fields produces power deposition in the plasma.**

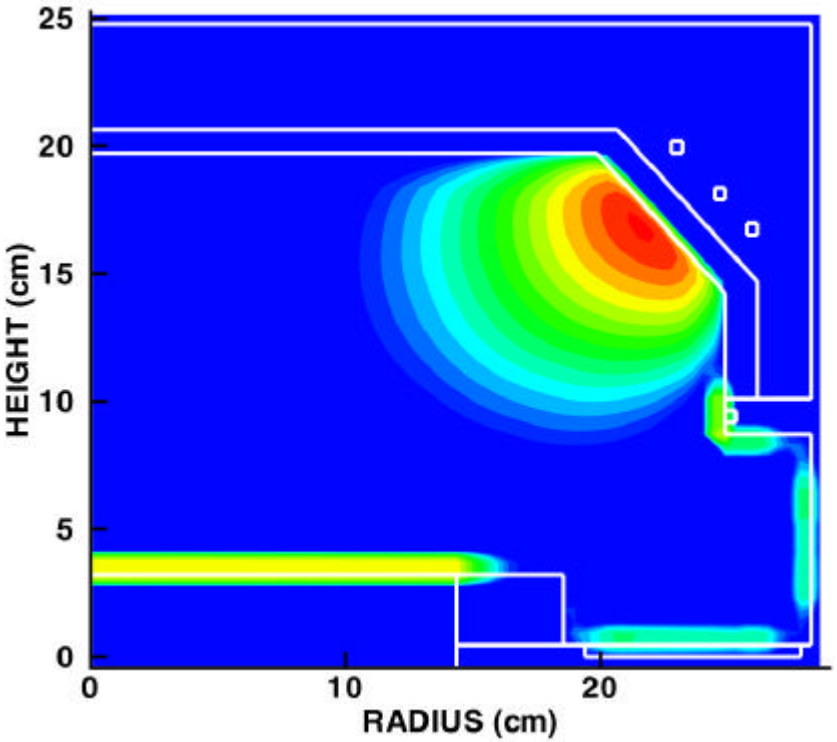
- **Electric Field (max = 6.3 V/cm)**

- **Ar/Cl_2 = 80/20**
- **20 mTorr**
- **1000 W ICP**
- **250 V bias, 2 MHz (260 W)**

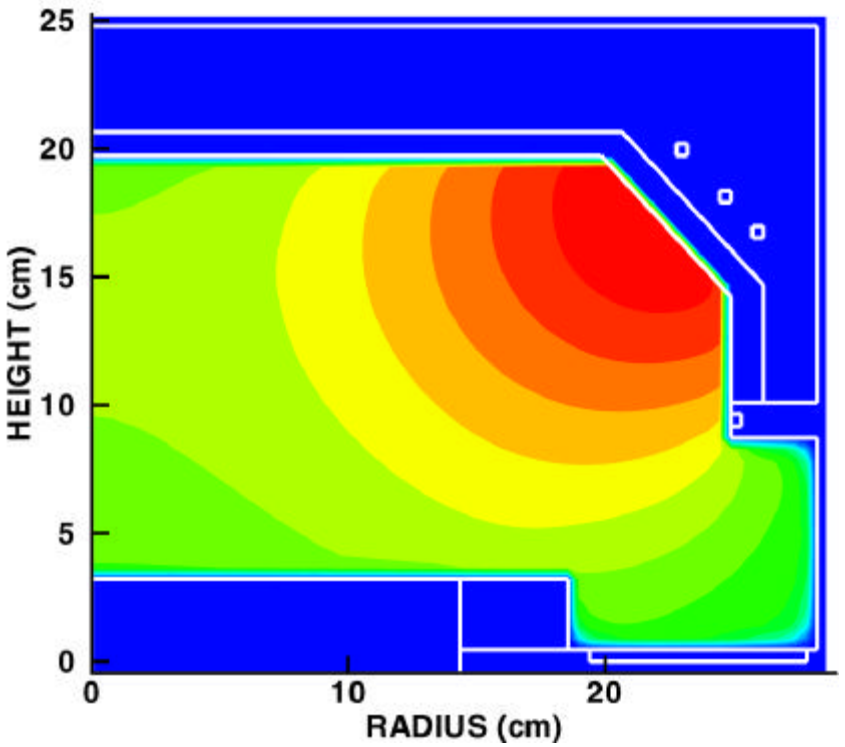


Ar/Cl_2 ICP TOOL: POWER AND ELECTRON TEMPERATURE

- **Power deposition from the inductive fields results in electron heating.**
- **At 2 MHz, power from the capacitive fields produces ion acceleration with little electron heating.**



Power Deposition (max = 0.91 W/cm^3)

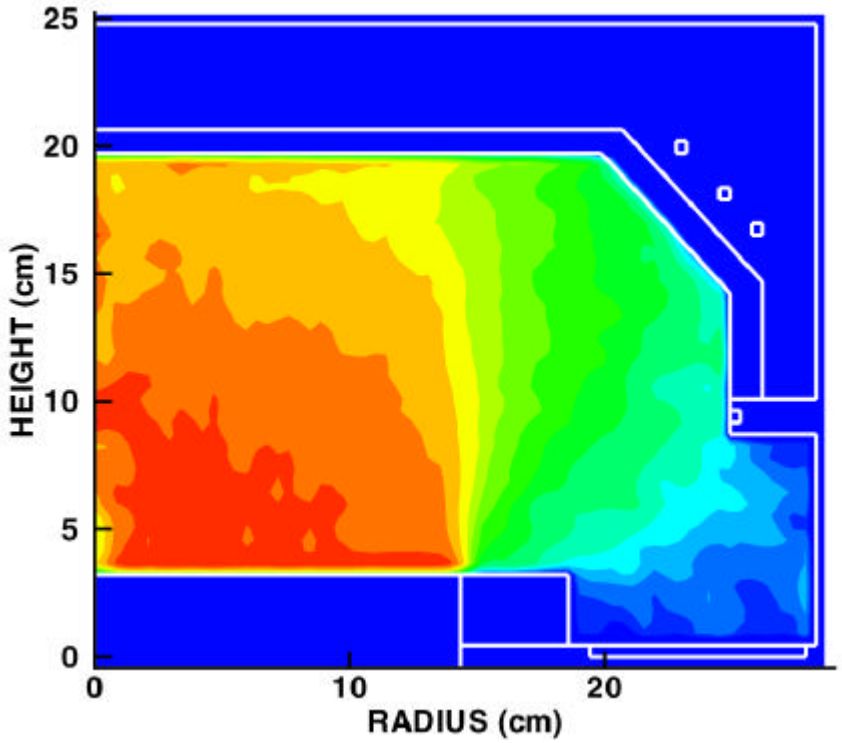


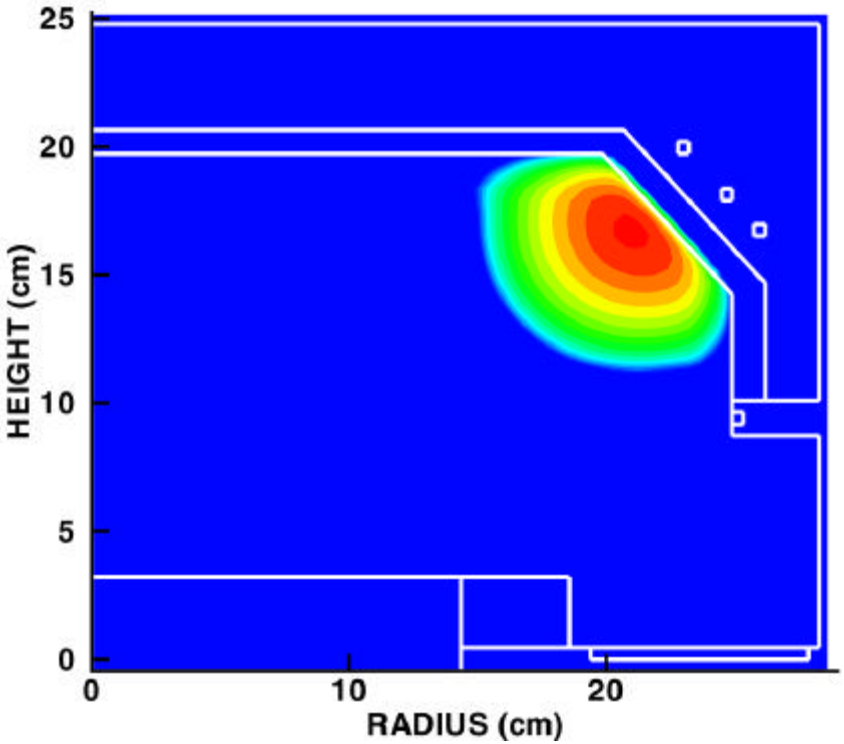
Electron Temperature (max = 5 eV)

- **Ar/Cl_2 = 80/20, 20 mTorr, 1000 W ICP, 250 V , 2 MHz bias (260 W)**

Ar/Cl_2 ICP TOOL: IONIZATION

- **Electron impact ionization by the bulk electrons heated by the inductively coupled fields dominates.**
- **Ionization by sheath accelerated beam electrons is less important due to their long mean-free-paths at the low operating pressure.**





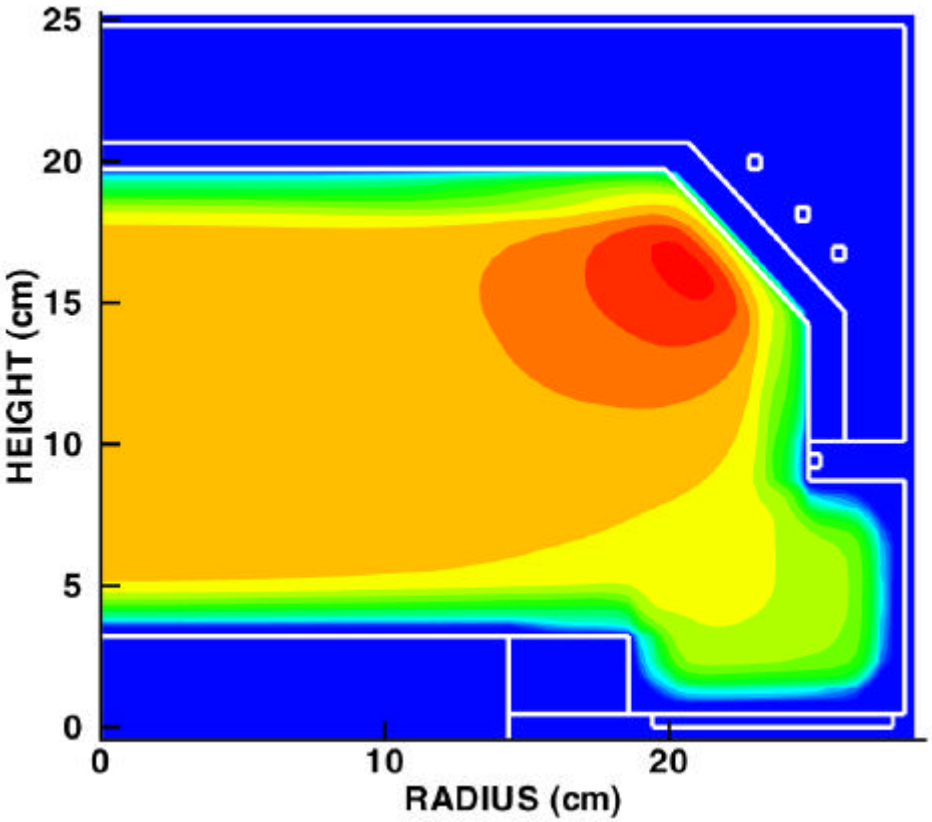
Beam ionization (max = 1.3 x 10^{14} /cm^3-s)

Bulk ionization (max = 5.4 x 10^{15} /cm^3-s)

- **Ar/Cl_2 = 80/20, 20 mTorr, 1000 W ICP, 250 V , 2 MHz bias (260 W)**

Ar/Cl_2 ICP TOOL: POSITIVE ION DENSITY

- **The diffusion of plasma from the remote sources produces a fairly uniform positive ion density in the vicinity of the substrate.**
- **In general, better uniformity is obtained with a bias than without.**



Positive Ion Density
(max = 1.8 x 10^{11} /cm^3-s)

- **Ar/Cl_2 = 80/20, 20 mTorr, 1000 W ICP, 250 V , 2 MHz bias (260 W)**