Effects of Plasma Instabilities on Tungsten Divertor Plate

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Modeling PMI during Disruptions

(HEIGHTS Package)

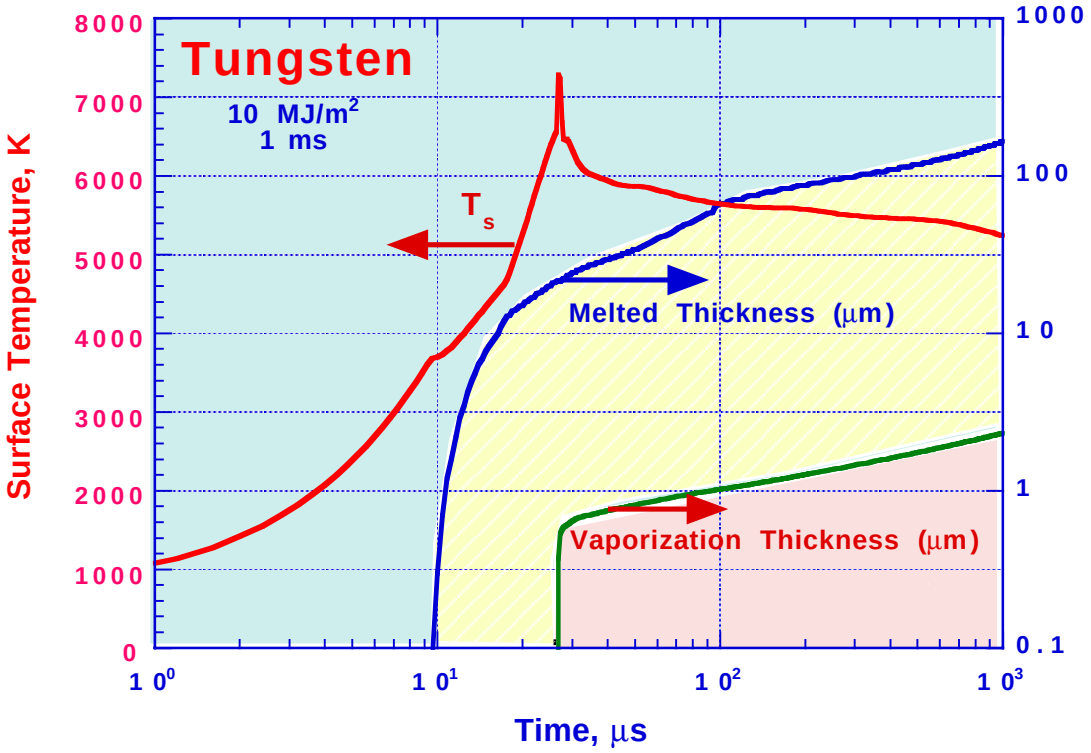
- **Plasma-Target Interaction**
  - Plasma particles energy deposition (ions + electrons)
  - Target thermal response
  - Target surface evolution (vapor + droplets)

- **Plasma-Debris Interaction**
  - Plasma energy deposition in debris
  - Debris hydrodynamic evolution
  - Debris/vapor magneto-hydrodynamics

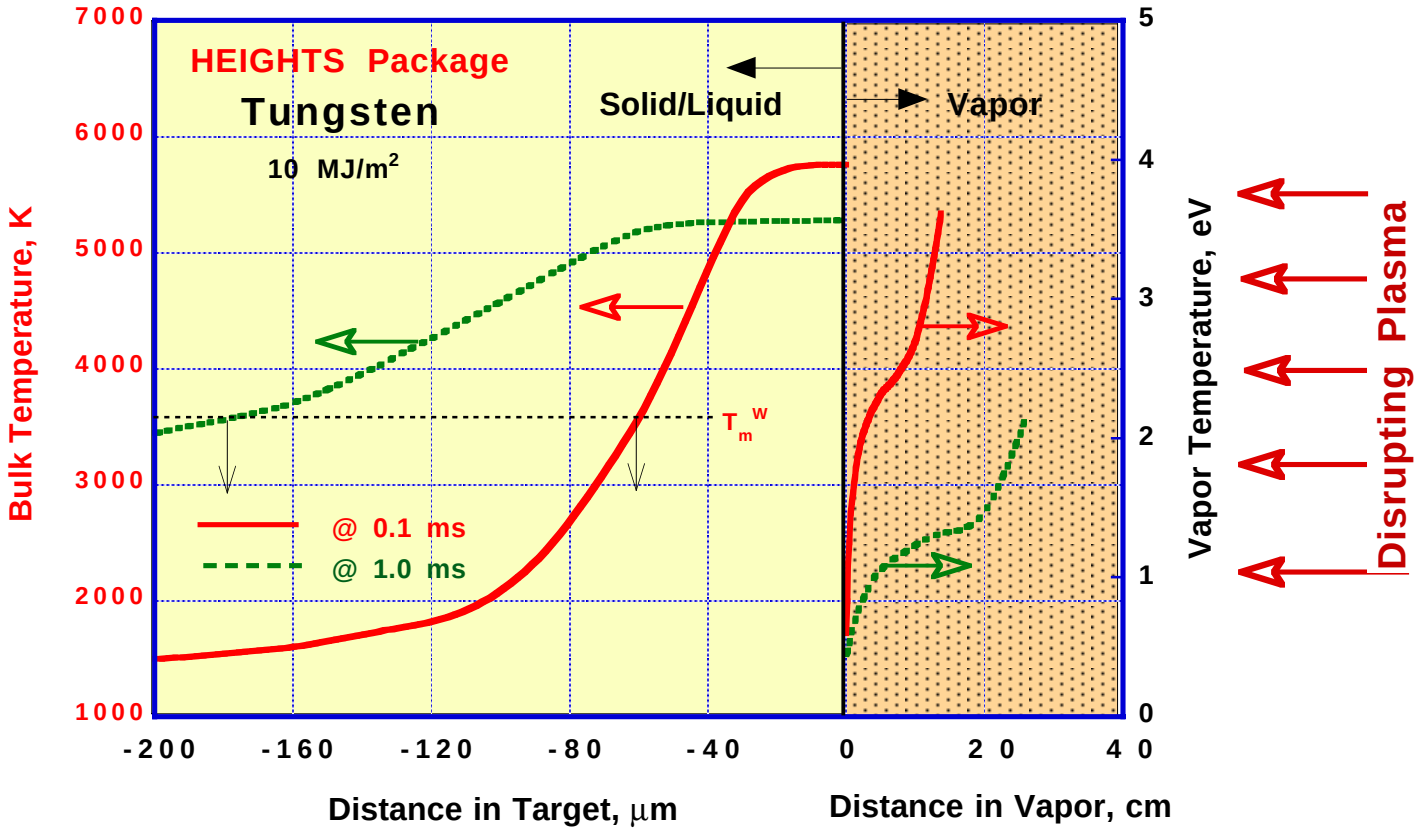
- **Photon Radiation and Transport**
  - Optical properties are calculated for real plasma conditions
  - Emission and absorption are calculated for all kind of radiation
  - Photon transport is calculated for continuum and line radiation

- **Plasma-Melt Layer Interaction**
  - Splashing due to bubble formation and evaporation
  - Splashing due to growth of hydrodynamic instabilities
  - Erosion due to run-off the solid structure

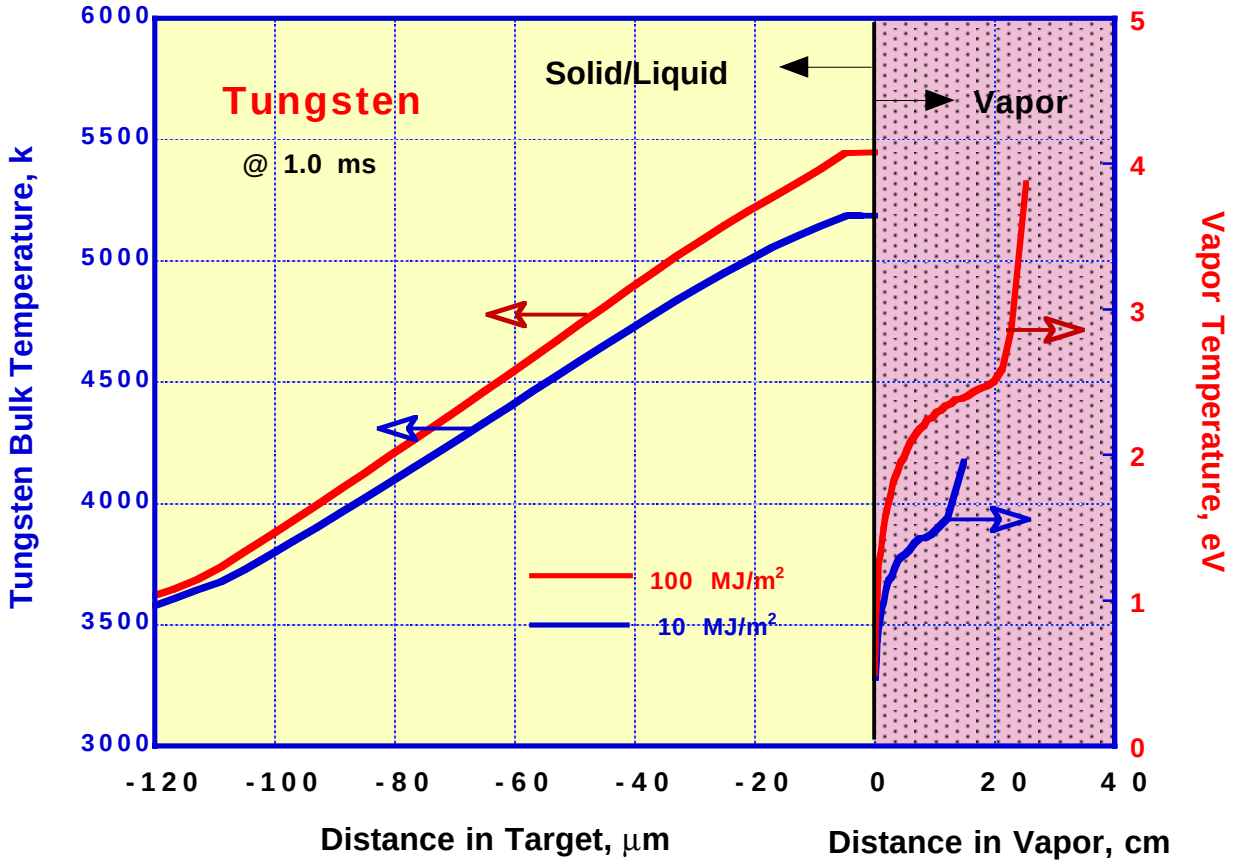
HEIGHTS Analysis of Tungsten Target Thermal Evolution during Plasma Energy Deposition



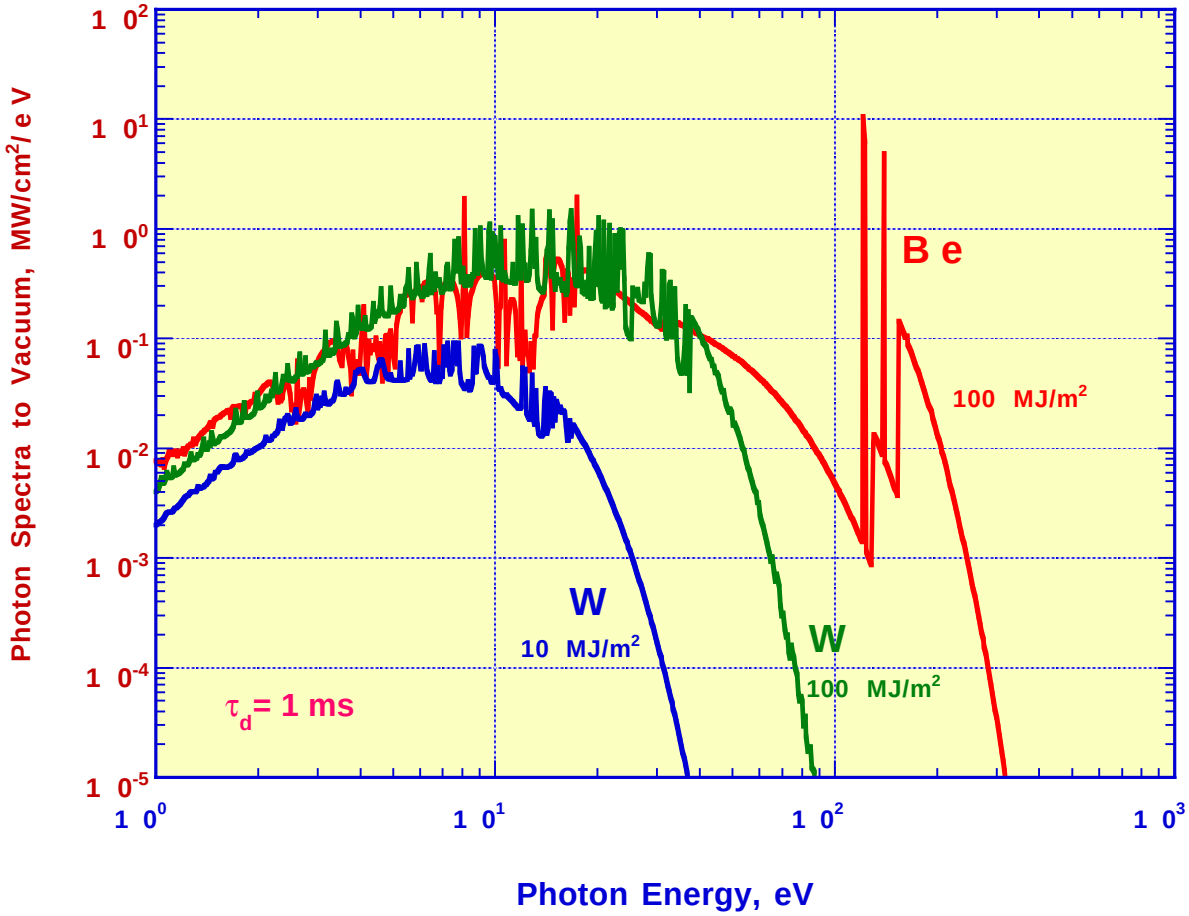
HEIGHTS Analysis of a Tungsten target Response due to Plasma Energy Deposition



HEIGHTS Analysis of Tungsten Response to Different Energy Deposition



HEIGHTS Analysis of Emitted Photon Radiation Spectra of Beryllium and Tungsten Vapor



Splashing and Shielding in Tungsten

- **Continuous heating of Tungsten target-surface by radiation power starts a splashing wave that emits macroscopic droplets leaving the surface after certain threshold time.**

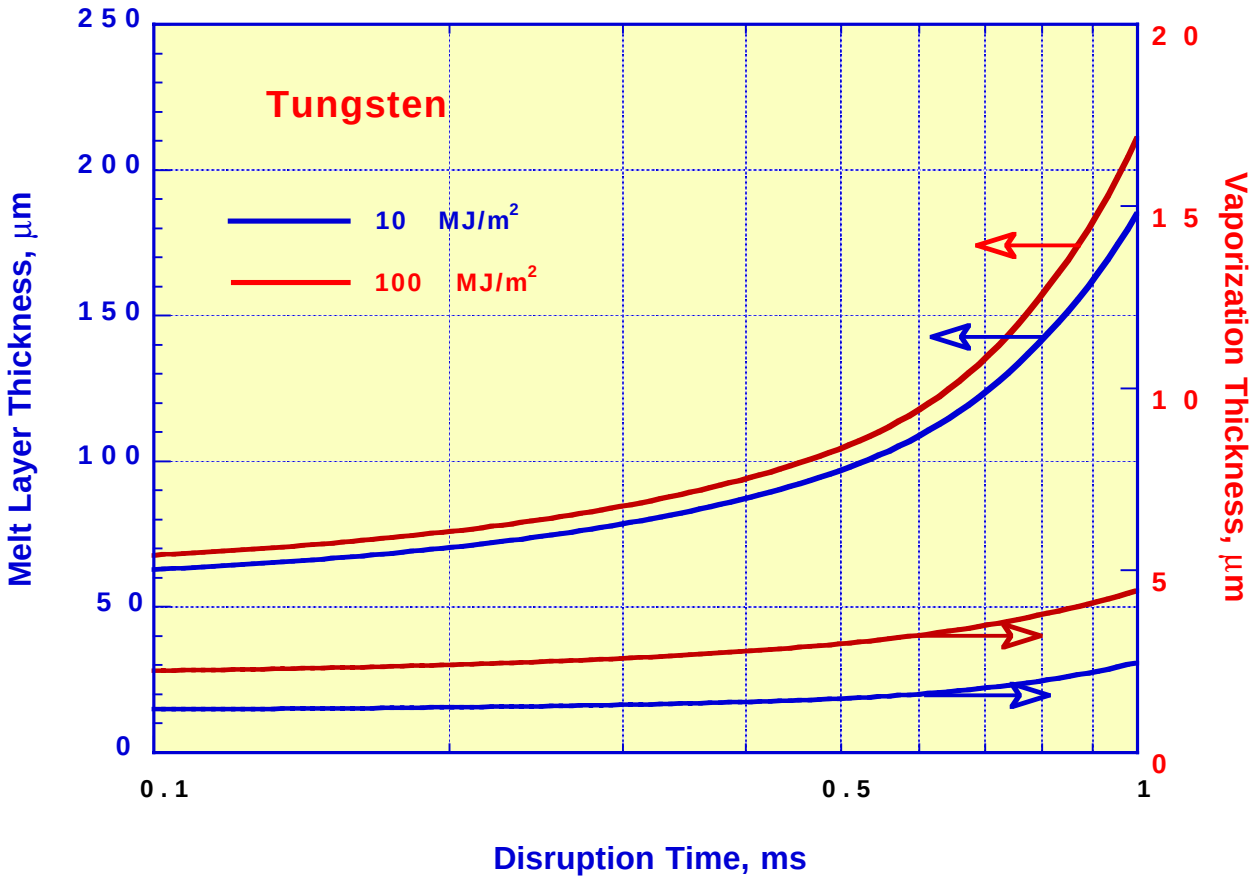
- **The time to start a splashing wave depends on the magnitude of radiation power to target surface.**

- **The magnitude of radiation power to target surface depends on the complex evolution of plasma/photon/vapor interaction and is very time consuming.**

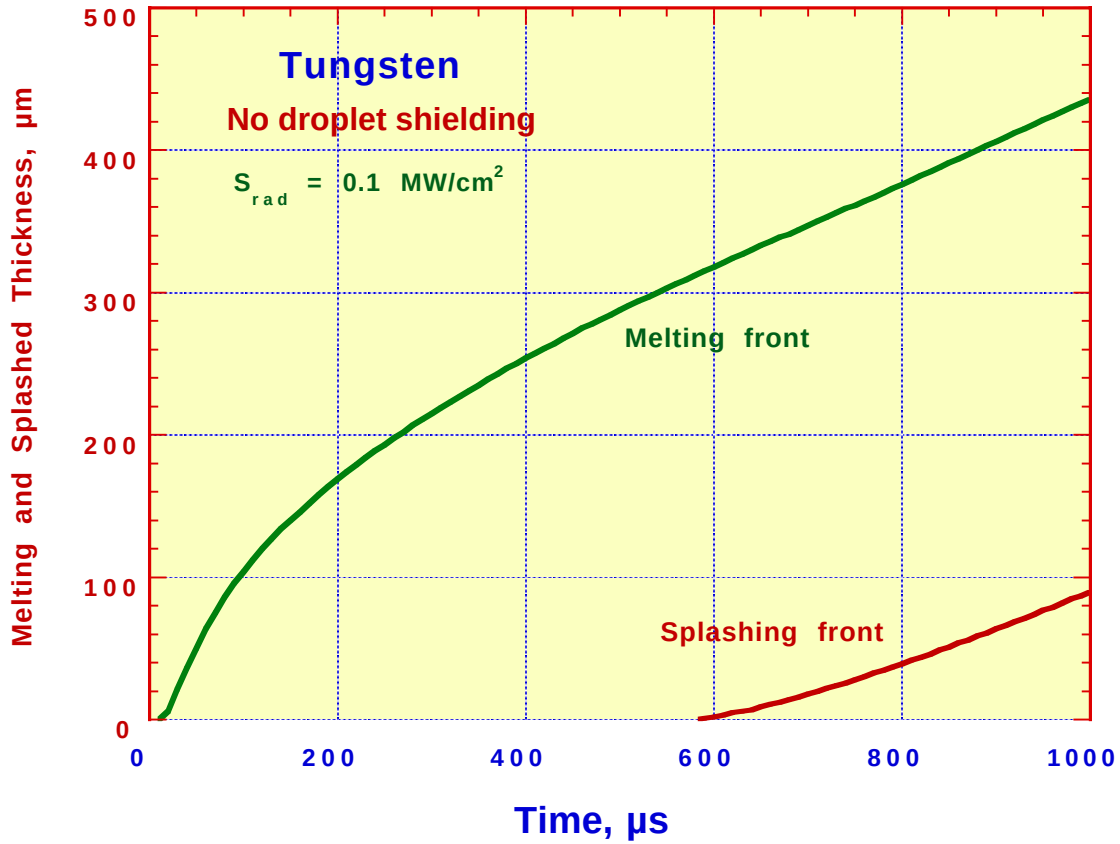
- **Current calculations of radiation power to Tungsten surface indicate level of radiation power < 0.5 MW/cm^2 and slightly independent of incoming plasma energy.**

- **When splashing occurs, mixture of the vapor and droplet exists and is moving away from target surface. Screening of target surface by droplets-cloud can further decrease radiation power to target surface. This effect "droplets-shielding" is currently being evaluated.**

HEIGHTS Analysis of Tungsten Melting and Vaporization Thicknesses at Different Disruption Times



HEIGHTS Analysis of Tungsten Splashing and Melting Thickness for 100 kW/cm^2 Radiation Power to Surface



HEIGHTS Analysis of a Tungsten Splashing Erosion for Different Radiation Power to Surface