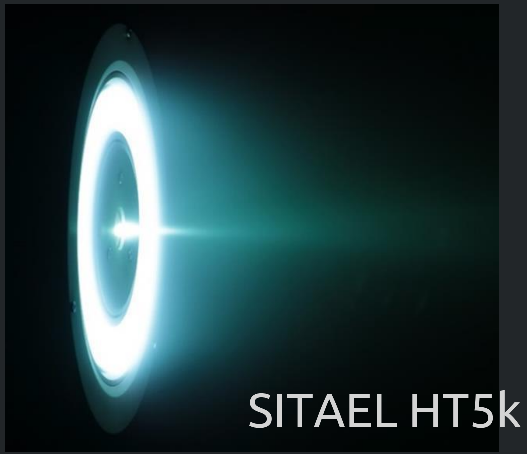
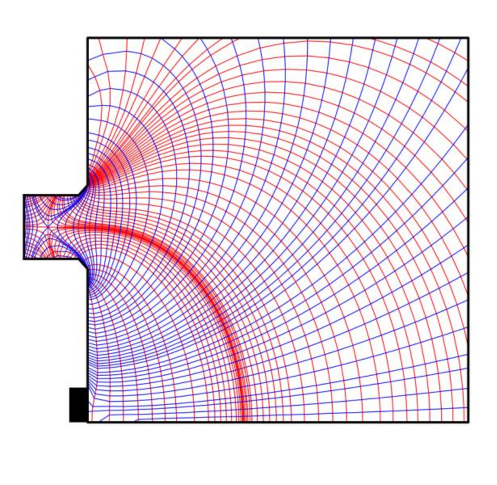
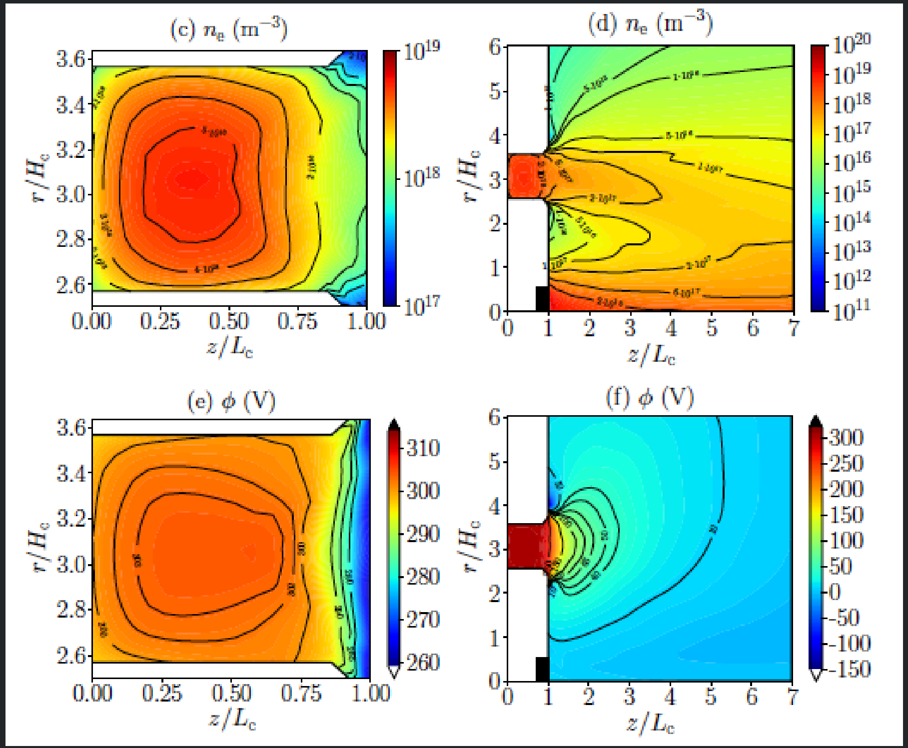
J. Perales et al.
Plasma-wall simulations in MS-HETs

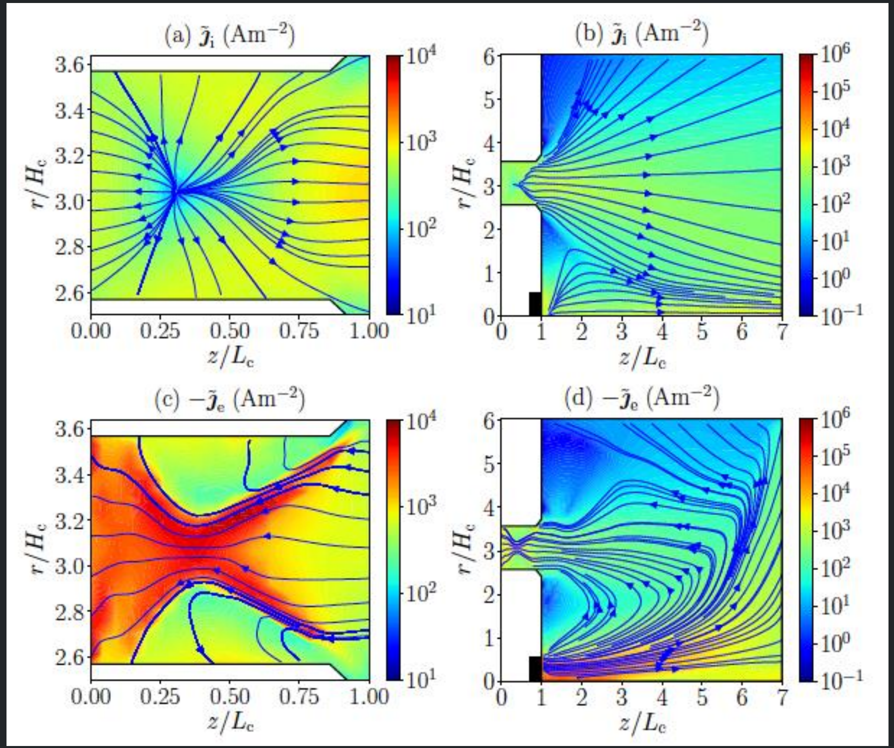
Perales et al.: Simulating plasma-wall in MS-HETs





HYPHEN MFAM





- Acceleration region is outside chamber
- Large plasma density inside chamber
- Electric potential inside is nearly flat and does not follow the B lines, due to ∇p_e
- Central cathode emits electrons and neutrals
  - Electron currents from cathode connect with ion plume and anode

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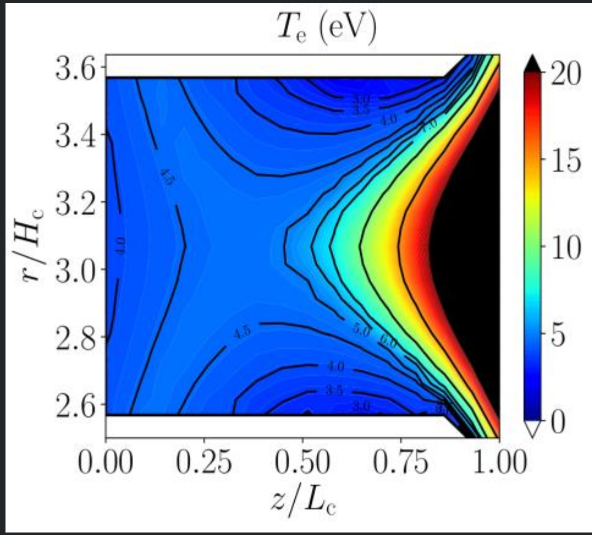
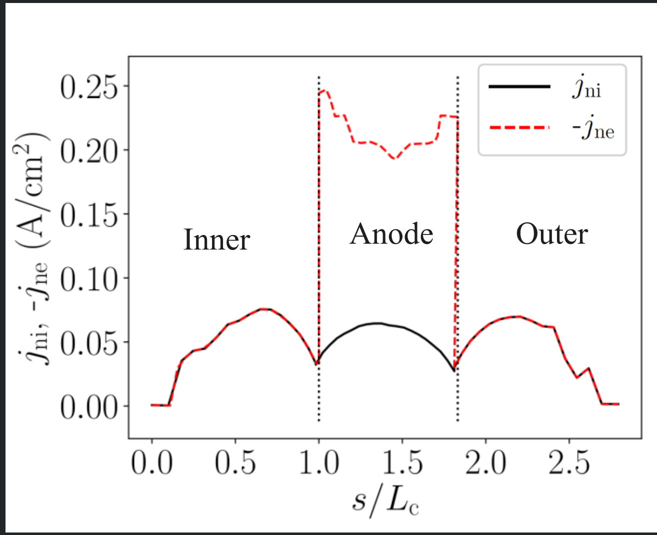
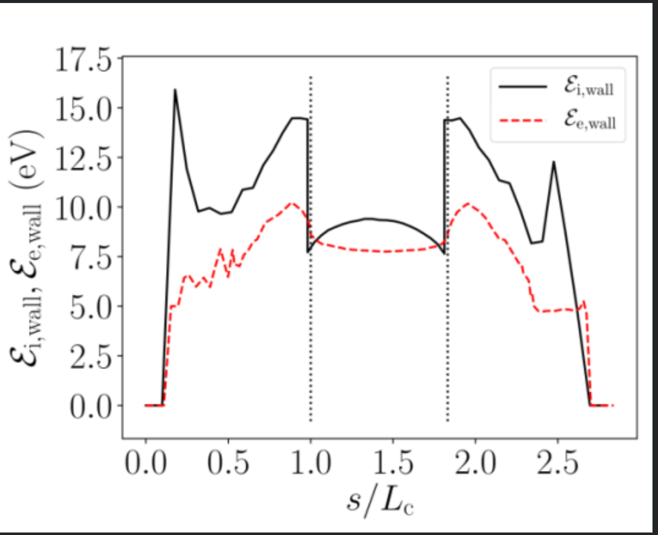
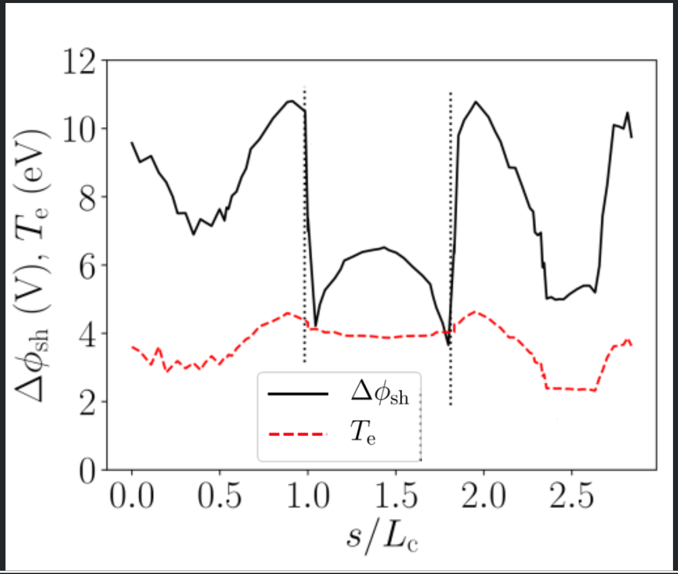


- Near isothermal magnetic lines
- T_e low inside chamber:
  - Low sheath potential falls
    - Sheaths are conventional → electric field points towards wall
      - Except around chamfers?
  - Low impact energy of ions and electrons:
    - low power losses
    - no erosion







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- Mass and electric current balance:

$$I_{\mathrm{prod}} = I_{\mathrm{i}\infty} + I_{\mathrm{iD}} + I_{\mathrm{iA}} + I_{\mathrm{iC}},$$

$$\eta_{\mathrm{u}} = \frac{\dot m_{\mathrm{i}\infty}}{\dot m}, \qquad \eta_{\mathrm{cur}} = \frac{I_{\mathrm{i}\infty}}{I_{\mathrm{d}}}, \qquad \eta_{\mathrm{ch}} = \frac{e \dot m_{\mathrm{i}\infty}}{m_{\mathrm{i}} I_{\mathrm{i}\infty}},$$

Case	V_s (V)	$\dot m_A$ (mg/s)	I_{prod} (A)	$I_{i\infty}/I_{prod}$	I_{iD}/I_{prod}	I_{iA}/I_{prod}	η_u	η_{cur}
1	300	14	27.6	0.42	0.39	0.18	0.94	0.77
2	400	14	33.0	0.36	0.42	0.21	0.94	0.78
3	300	10	17.4	0.45	0.37	0.17	0.91	0.79
4	350	10	18.6	0.42	0.38	0.19	0.90	0.79
5	400	10	18.1	0.44	0.37	0.18	0.92	0.85

- Mass and electric current balance:

$$P = P_{\infty} + P_{\mathrm{D}} + P_{\mathrm{A}} + P_{\mathrm{inel}},$$

$$\eta_{\mathrm{ene}} = \frac{P_{\infty}}{P}, \qquad \eta_{\mathrm{div}} = \frac{P_{z\infty}}{P_{\infty}}, \qquad \eta_{\mathrm{disp}} = \frac{F^2}{2 \dot m P_{z\infty}},$$

Case	V_s (V)	$\dot m_A$ (mg/s)	P (kW)	η	P_{inel}/P	P_D/P	P_A/P	P_∞/P ($=\eta_{ene}$)	η_{div}	η_{disp}
1	300	14	4.43	0.57	0.15	0.07	0.05	0.74	0.89	0.87
2	350	14	5.73	0.57	0.13	0.07	0.04	0.74	0.86	0.90
3	300	10	2.91	0.56	0.14	0.06	0.05	0.74	0.88	0.85
4	350	10	3.40	0.56	0.13	0.06	0.05	0.75	0.85	0.88
5	400	10	3.76	0.57	0.11	0.05	0.04	0.78	0.84	0.86

- Comparison with unshielded HETs
  - Similar particle fluxes to chamber lateral walls: lower temperature but higher plasma density
  - Larger fluxes to anode
  - Much lower energy losses
  - Erosion in chamber seems negligible

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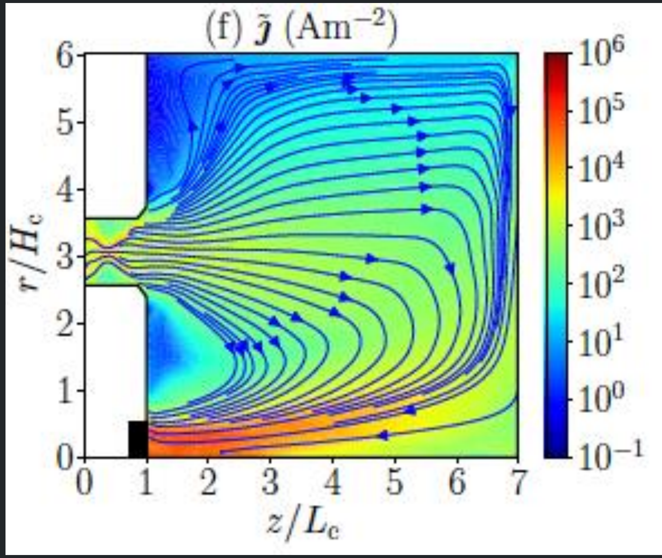
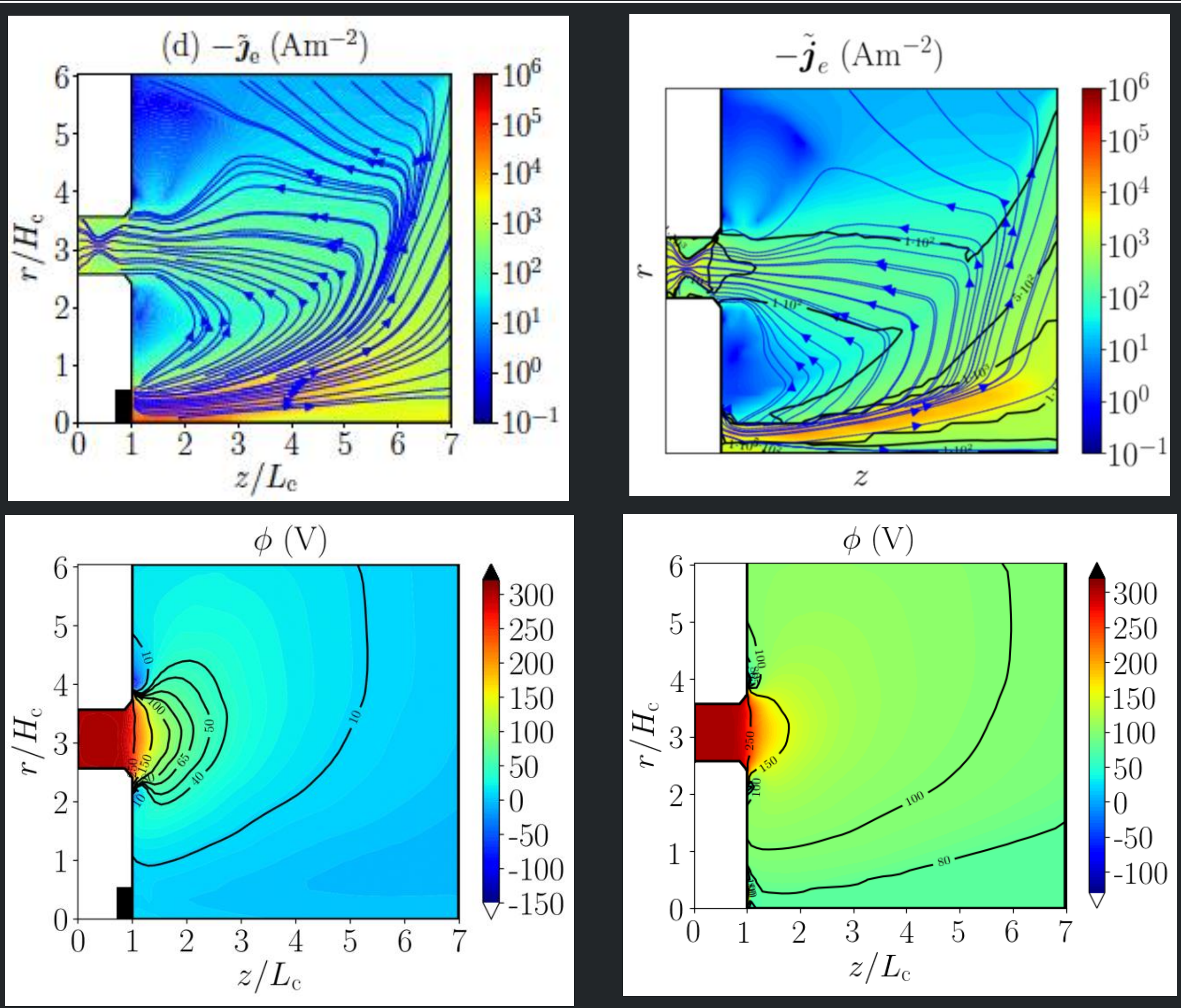
Aspects under investigation

(beyond anomalous transport ‘tailoring’)

- Central cathode: electrical bridge with ion plume much facilitated by neutral emission
- Simulation of far (weakly-collisional) plume:
  - Effects of finite plume size and residual magnetic field?
  - Downstream BCs: local vs. global ?





Cathode with neutral emission Cathode without neutral emiss