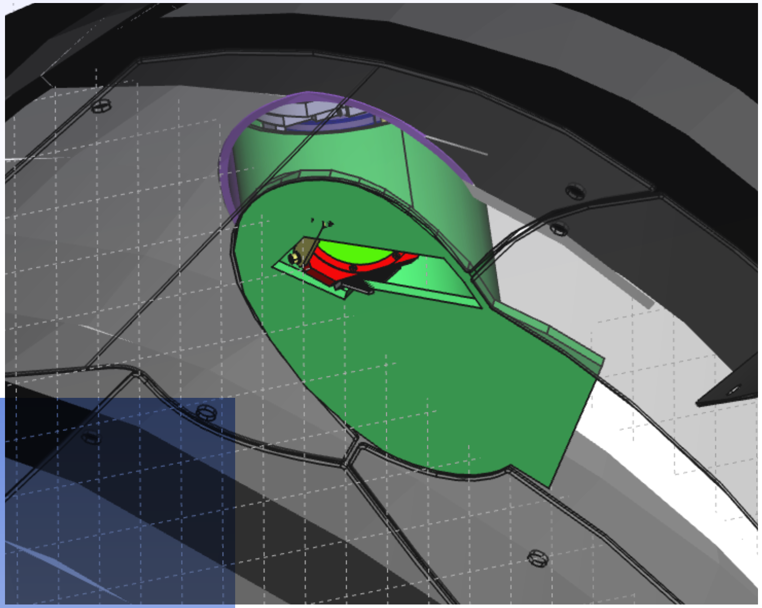
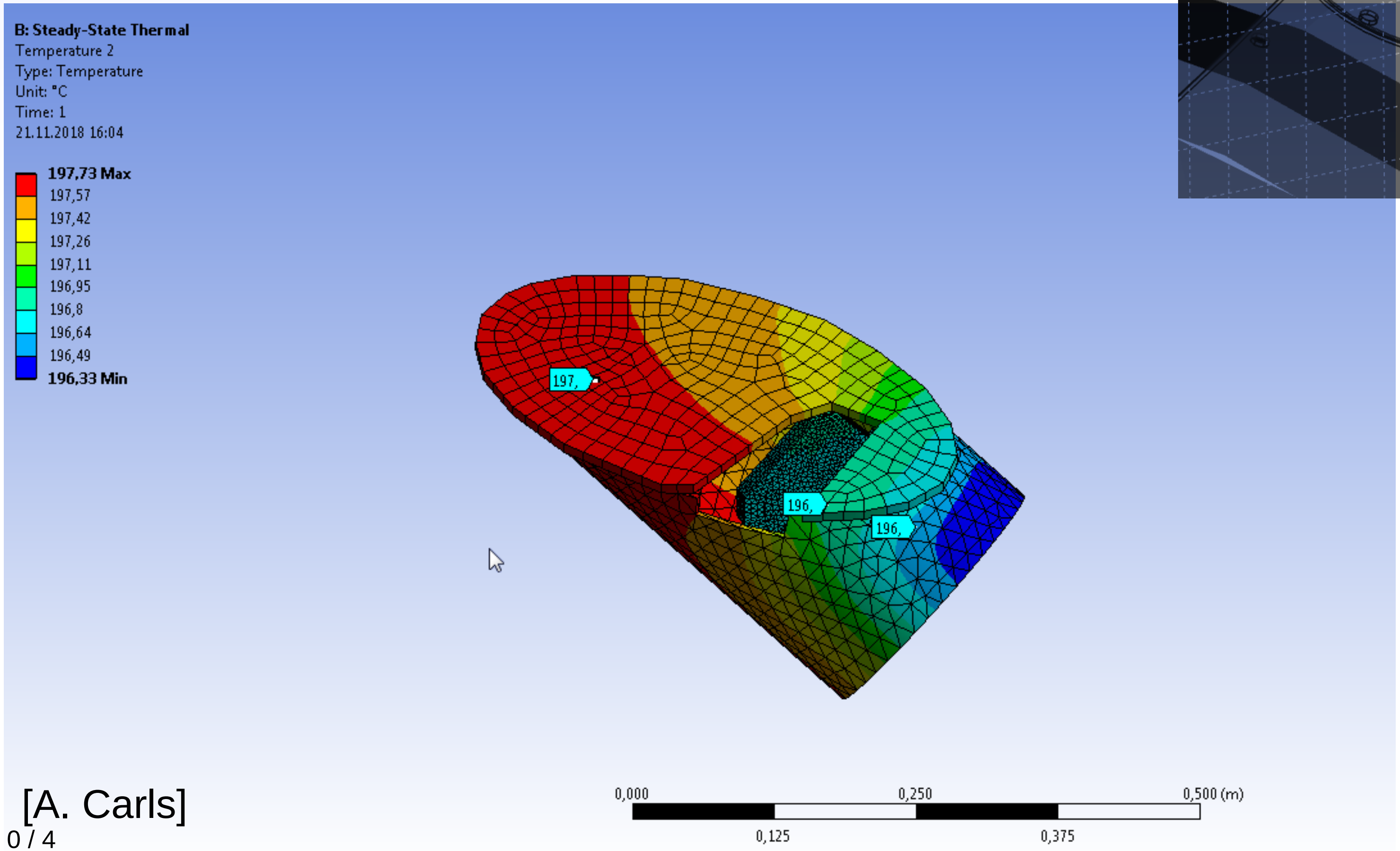
AEM21

- Thermal calculation with free floating pot and mirror shows both rising to 200'C in steady state radiation exchange.
- Probably too much heat exchange from pot to port.
- 200'C on mirror is acceptable, although lower would be better for optics if easily possible.

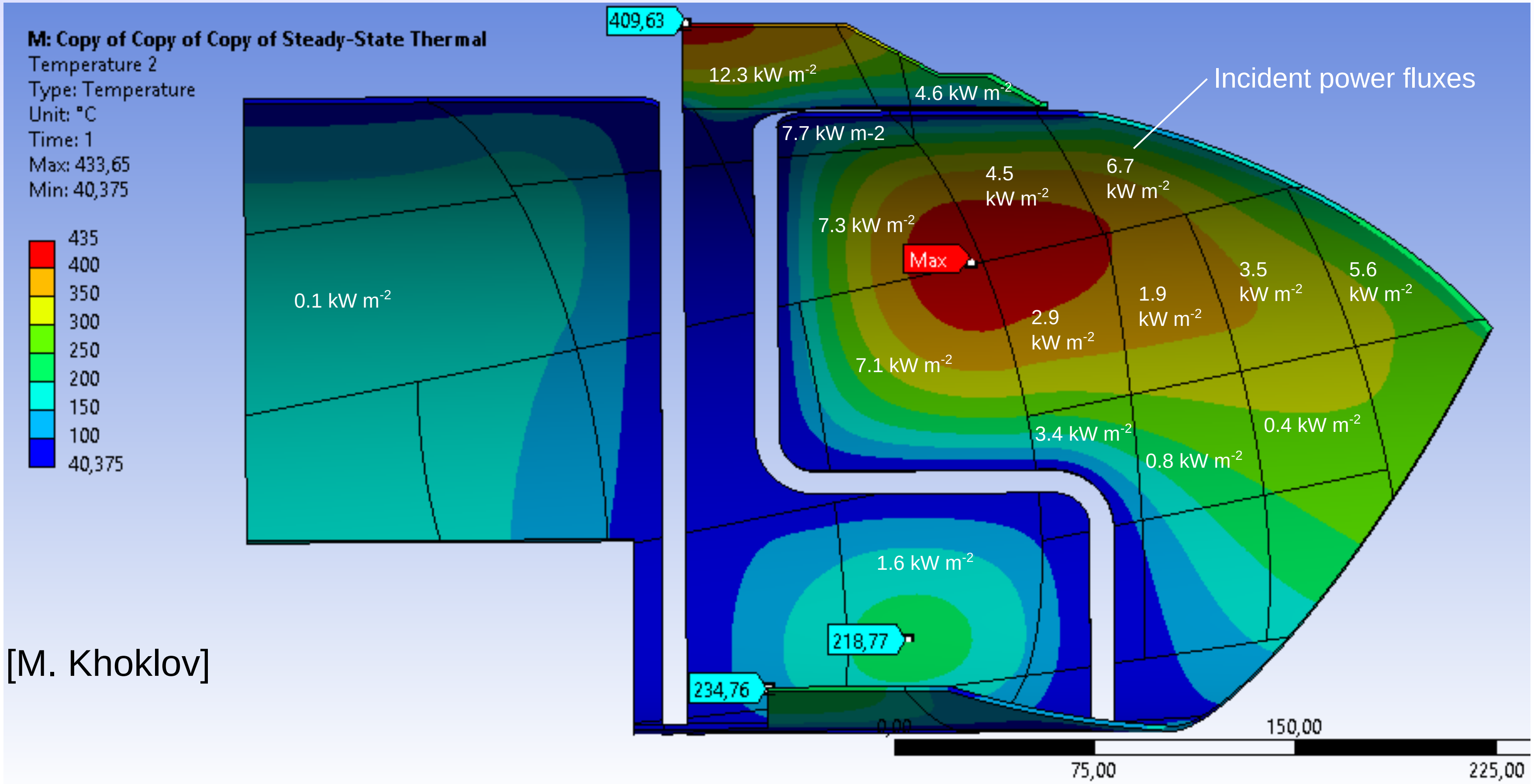




[A. Carls]

AEM21 Conductive analysis

Steady-state calculation using only incident radiation and conduction (no emitted radiation):



[M. Khoklov]

These calculated temperatures would radiate more than the incident power. (Assuming ε ~ 0.3 for SS) e.g.

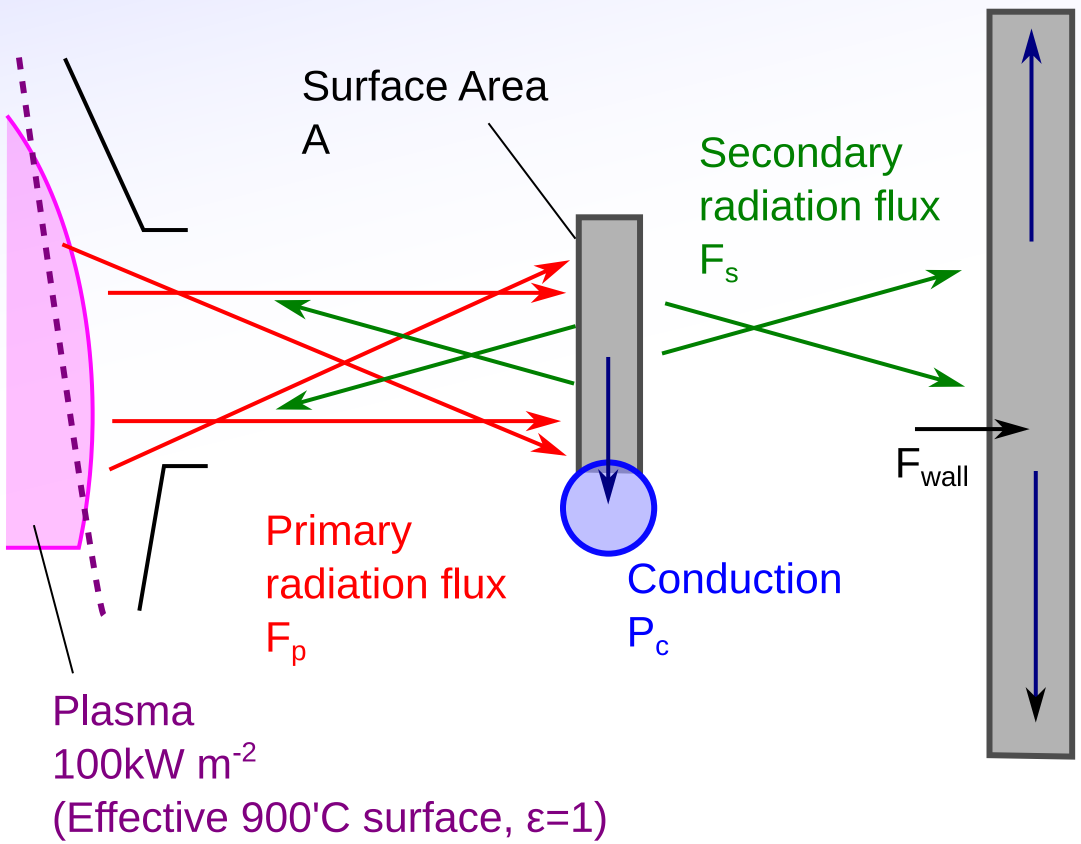
7.3 kW m^{-2} --> 390°C

4.5 kW m^{-2} --> 314°C

With conduction to water cooling too, temperatures should lower.

Thermal balance

The steady-state temperature of a structure in vacuum can be found from the balance of heat flux to/from the surface:



Absorbed primary power:

$P_p = \varepsilon_a F_p A$

$\varepsilon_{a,e}$ = emissivity (absorbed, emitted)

Radiated secondary power:

$P_s = F_s \, 2 A$

$F_s = \sigma \varepsilon_e T^4$

σ = Stephan Boltzmann's constant

Steady state power balance (no cooling)

$P_p = P_s$

$\varepsilon_a F_p A = 2A \sigma \varepsilon_e T^4$

$T = (½ F_p (\varepsilon_a/\varepsilon_e) / \sigma)^{1/4}$

Emissivity

Strong dependence on relative emissivity of absorbtion and re-radiation.

Best case: Plasma radiation as black-body: $\varepsilon_a/\varepsilon_e = 1$ (Independant of emissivity)
Worst case:
Plasma radiation in X-Ray / VUV: $\varepsilon_a \sim 1$
Radiation from stainless steel (unpolished): $e_e \sim 0.4$ (Ranges 0.4 - 0.6)
---> $\varepsilon_a/\varepsilon_e < 3$

$$T = (\tfrac{1}{2} F_p (\varepsilon_a/\varepsilon_e) / \sigma)^{1/4}$$

	$\varepsilon_a/\varepsilon_e = 1$		$\varepsilon_a/\varepsilon_e = 3$	
F_p [W m^{-2}]	T [°C]	F_{wall} [W m^{-2}]	T [°C]	F_{wall} [W m^{-2}]
100	700	50	1000	300
50	550	25	800	150
20	400	10	600	60
10	300	5	450	30
5	200	2.5	350	15
1	50	0.5	150	3