Development and simulation of reactor burn control

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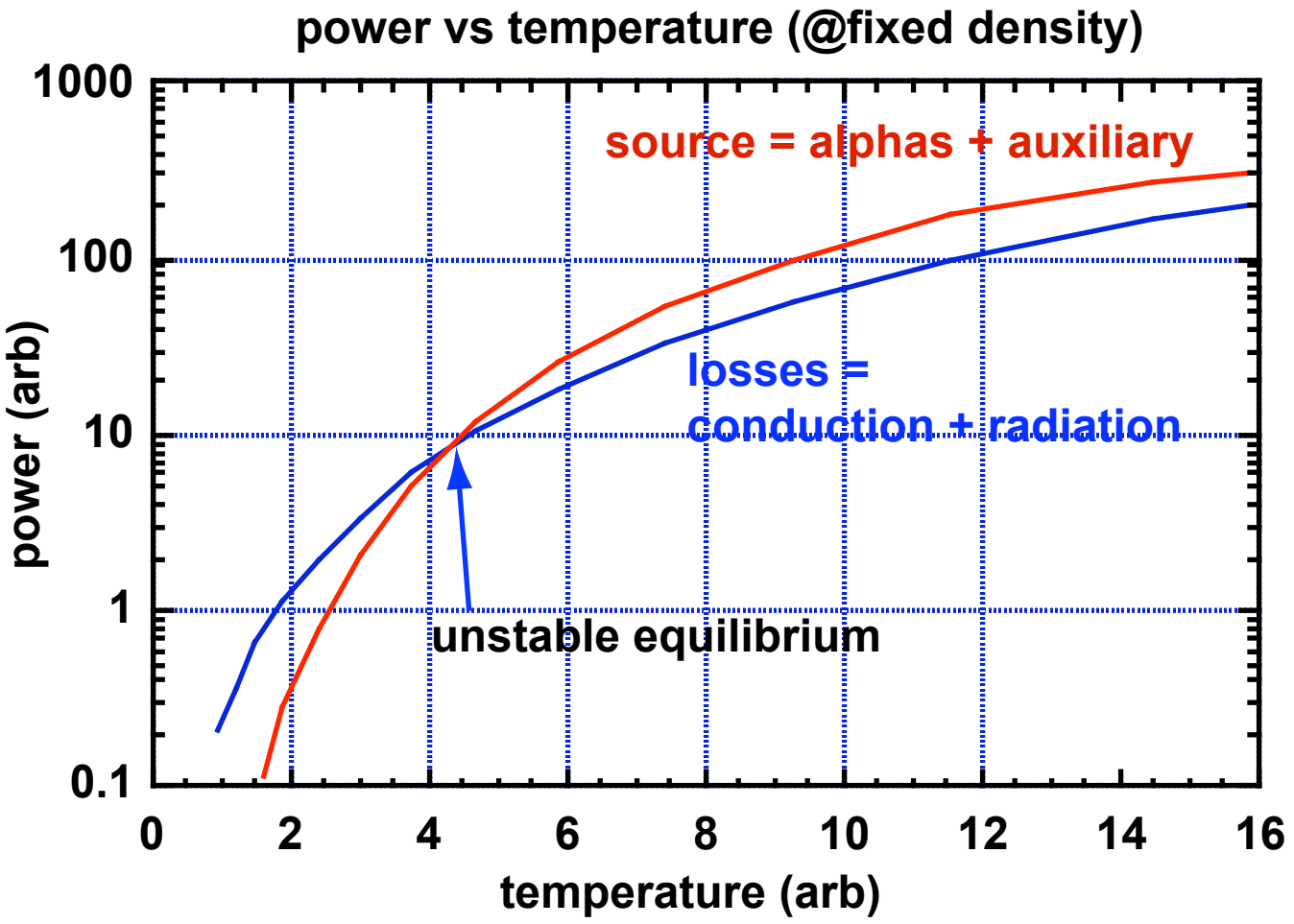
- Burn control in a reactor requires control of an inherently unstable operating point.
- It is complicated by the long α-particle slowing down time ($\geq$ 0.5 s), leading to a delay in any heating/cooling effect.
- It is also limited by the modest amount of external power available in a reactor, and by the clumsiness of some proposed controls (e.g., fuel mixture).


power vs temperature (@fixed density)
1000
100
10
1
0.1
power (arb)
source = alphas + auxiliary
losses =
conduction + radiation
unstable equilibrium
0
2
4
6
8
10
12
14
16
temperature (arb)

- What are the best actuators to use?
  - Fuel mix?
  - RF to control α-particle losses?
  - Increase overall losses (reduce confinement time)?
  - ...
- This can be simulated on DIII-D. Program NBI power proportional to pressure^2 (obviously unstable).
- Principal additional need (in addition to inventiveness) is long pulse operation to confirm stationarity of the controlled operating point. Can we get 20-30 seconds?