Ion Cyclotron and Electron Cyclotron Heating/Current Drive

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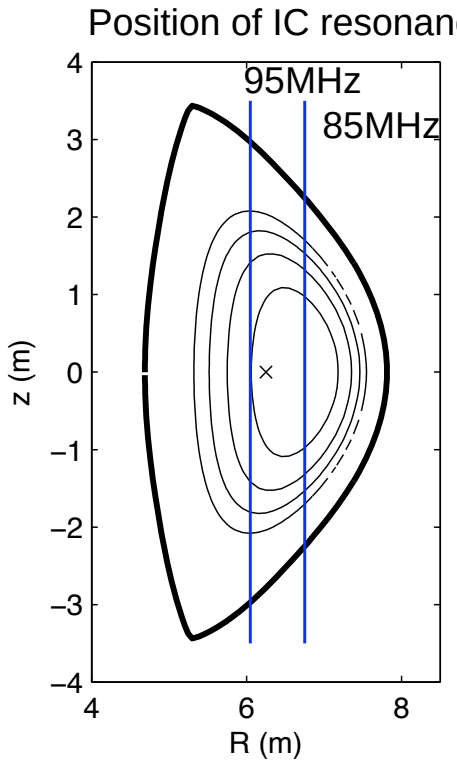
Work supported by the US DOE under DE-AC02-CH0911466

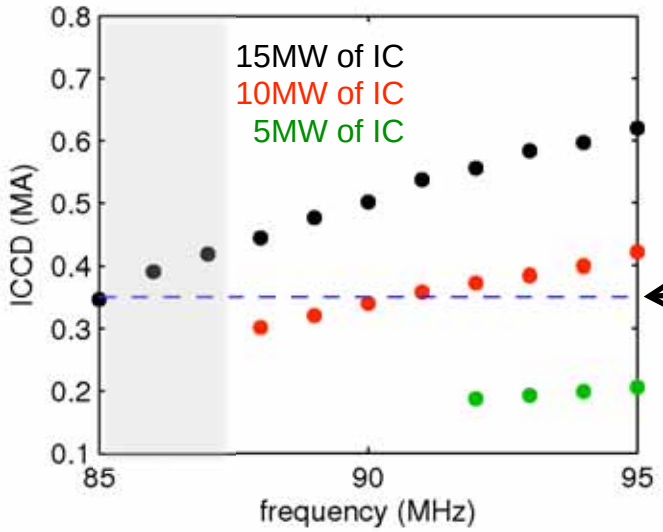
- ICRH: how much power is needed to drive 350 kA in flattop ?
- ECRH: can ECRH replace ICRH for core heating ?

  can ECRH be used to control the q-profile?

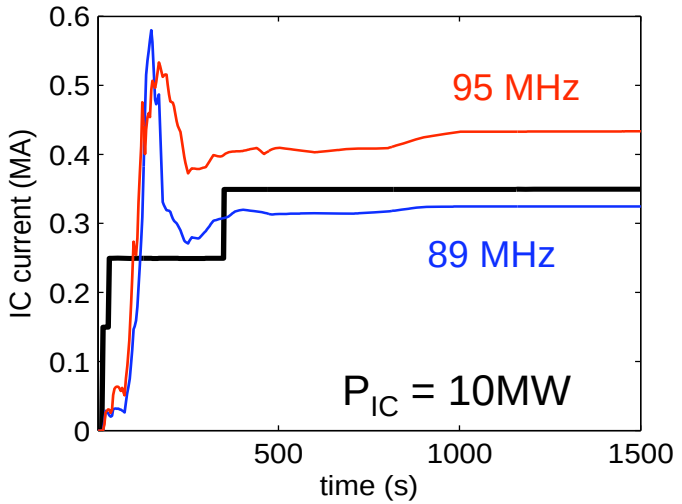
10MW of IC @ f>90MHz can drive ~400kA



R_0=6.25 m
a = 1.5625 m
B_T = 6 T

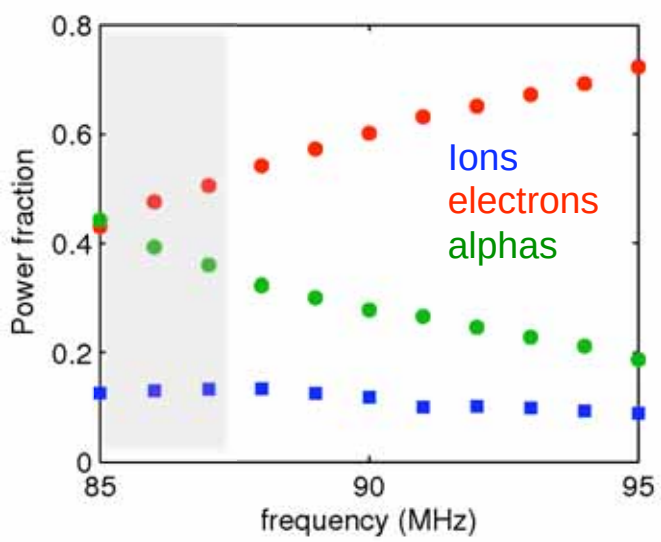


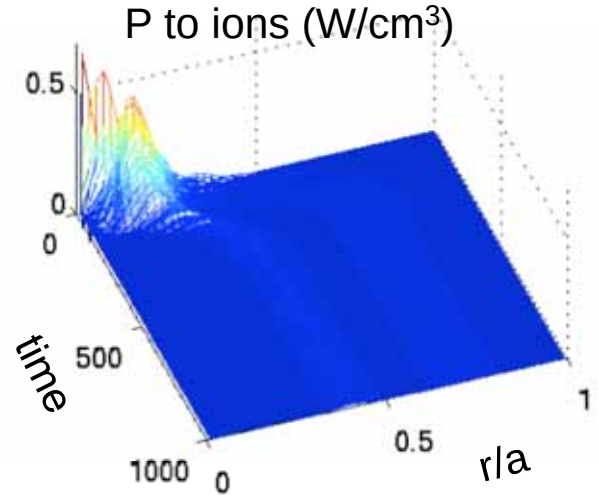
P_{IC}^{MAX} = 20MW

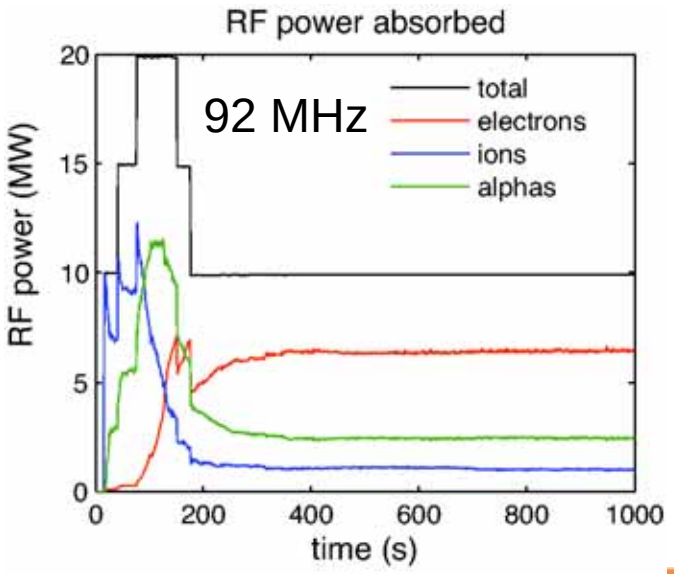


- Use TORIC full wave analysis
- n=27
- Scan frequency [85,95]MHz

92-94 MHz provide good core electron heating in flattop and ion heating at startup

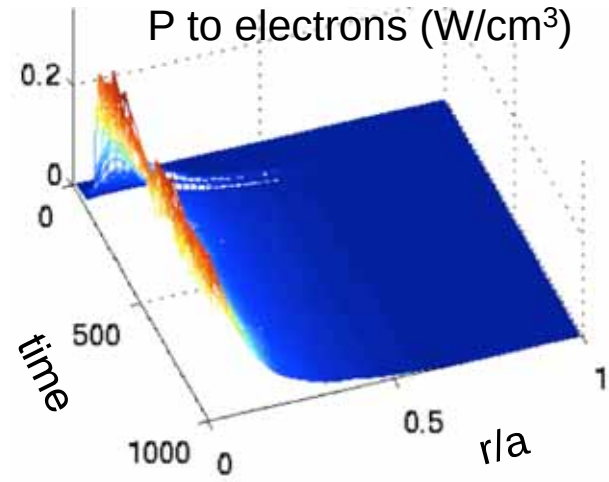




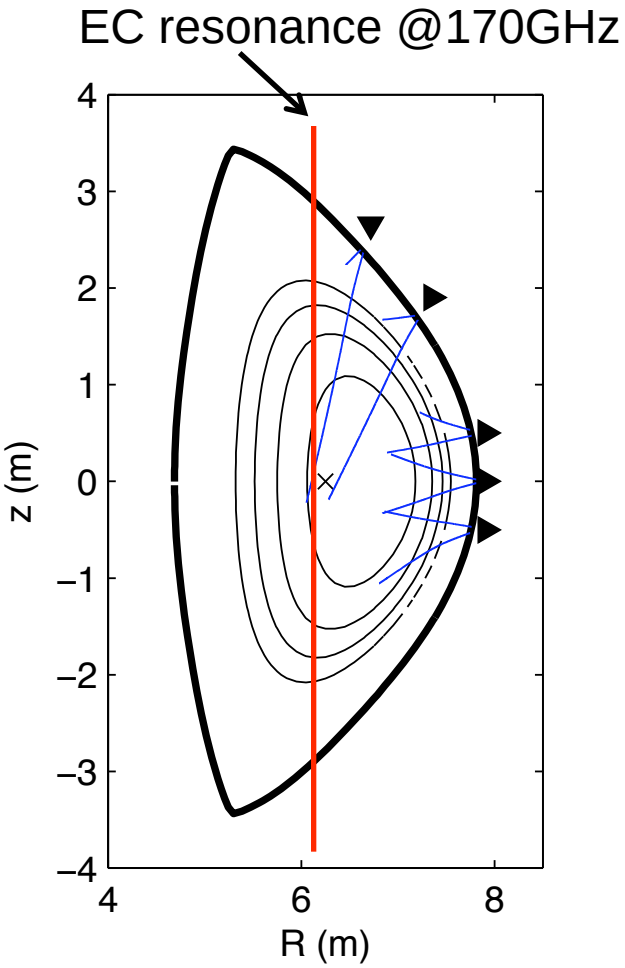


Thermal ions: ~10.6%
D ~9%
^{4}He~1.64%
^{18}Ar~0.08%

Alphas: ~24.5%
Thermal electrons: 64.7%
64.58% from FW
0.12% from IBW

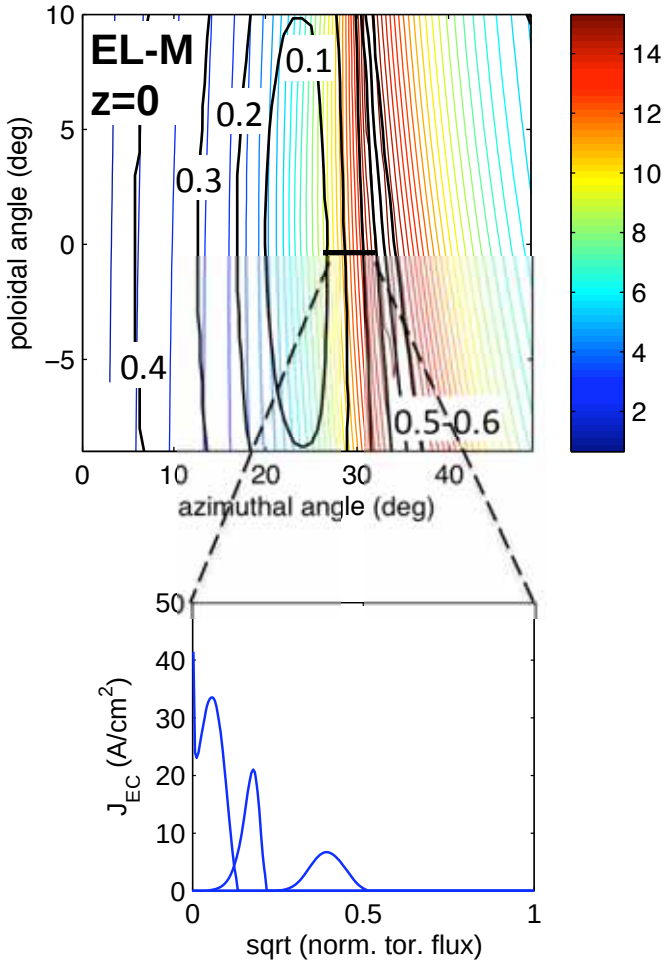


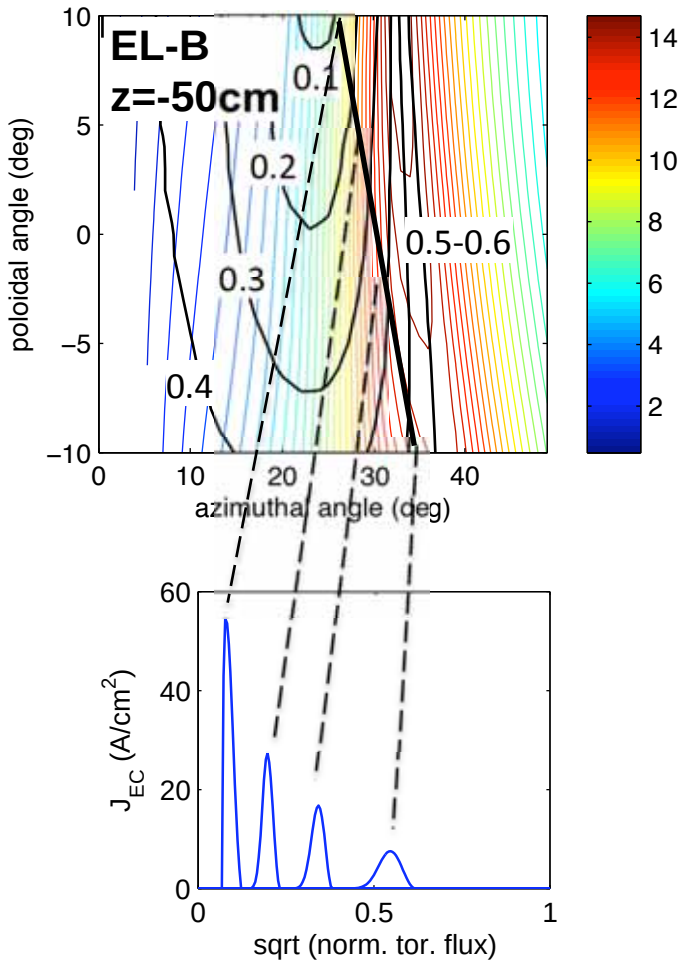
Electron Cyclotron H/CD
Explore close-to-vertical injection to maximize radial accessibility



- Use GENRAY ray-tracing code
- ECRH frequency f=170GHz (same as ITER)
- 3 midplane launchers at z=0 and ± 50 cm
  - assume 20 deg poloidal span (±10)
    45 deg toroidal span
- Upper launcher, 60 deg and 80 deg
- Scan poloidal and toroidal angle
  - assume 50 deg poloidal span
    60 deg toroidal span

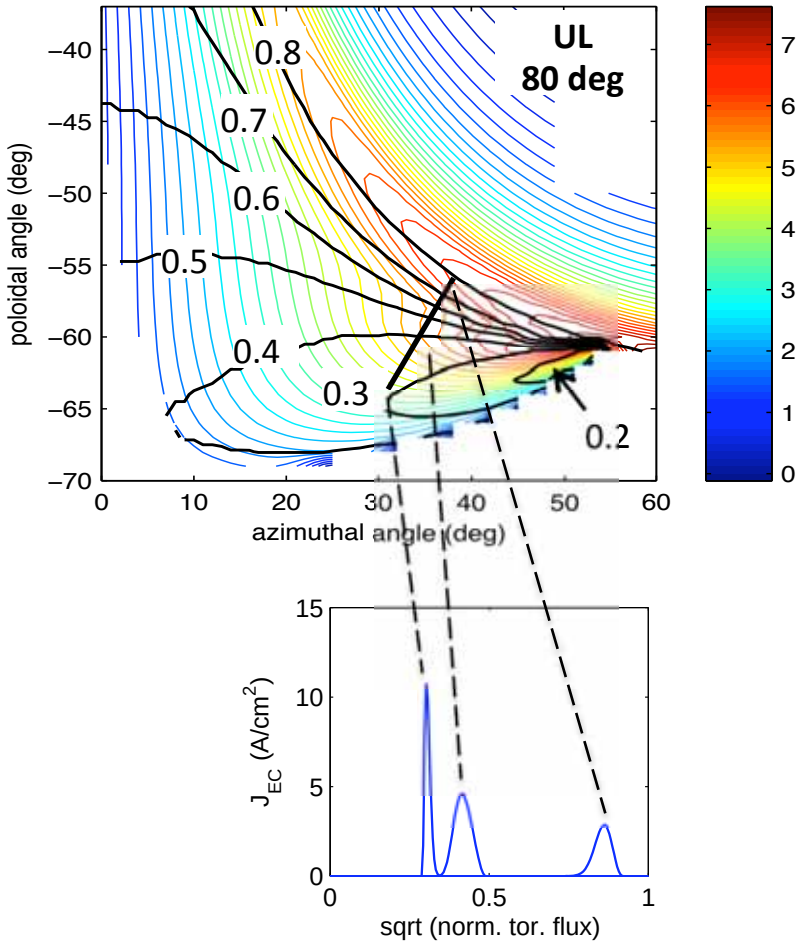
Mid-launcher has good core accessibility r/a<0.4
Off-midplane have good accessibility r/a=0.3-0.6

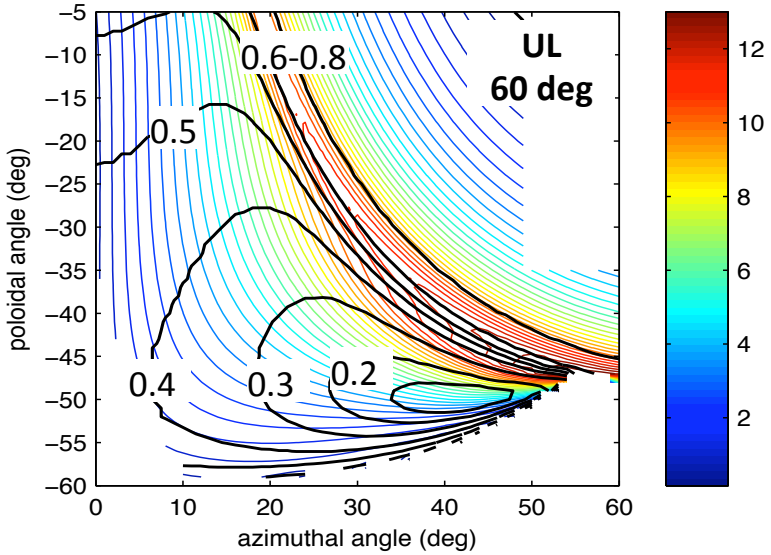




Equatorial launcher has max efficiency for toroidal steering ~32 deg

Almost constant CD efficiency at r/a>0.4 makes upper launcher suitable for q-profile control





For toroidal steering ~35-40 deg comparable CD efficiency in r/a=0.3-0.8

Work in progress

Use EC profiles in TSC simulation

- Steering combination for core heating
  - FW 40 A/kW
  - EC 15 A/kW equatorial launcher
  - ECCD ~ 200kA for 20MW of EC power
  - Will likely need 40MW EC to get 400kA
- Steering combination for core and off-axis heating
  - 7-10 A/kW upper launcher
  - Combined with LH
  - EC only ?