Progress on Disruption Simulations for FIRE

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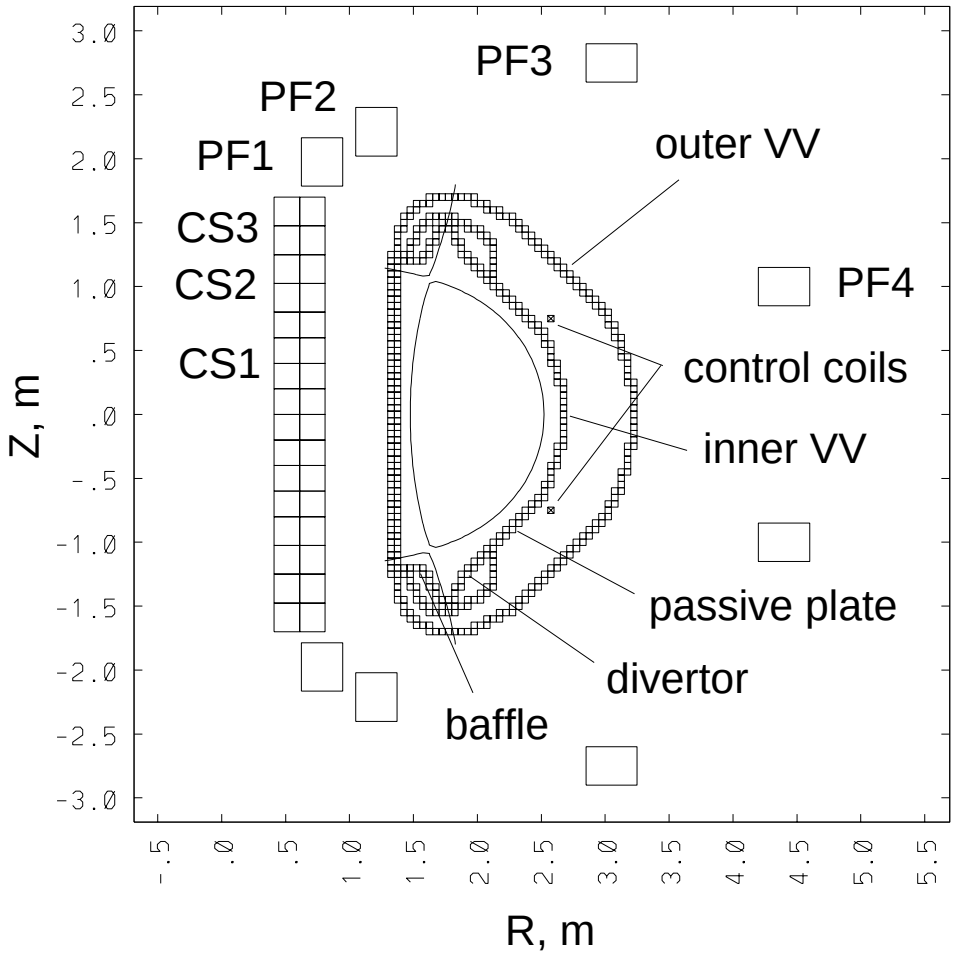
Disruption Simulations/Numerical and Structure Modelling

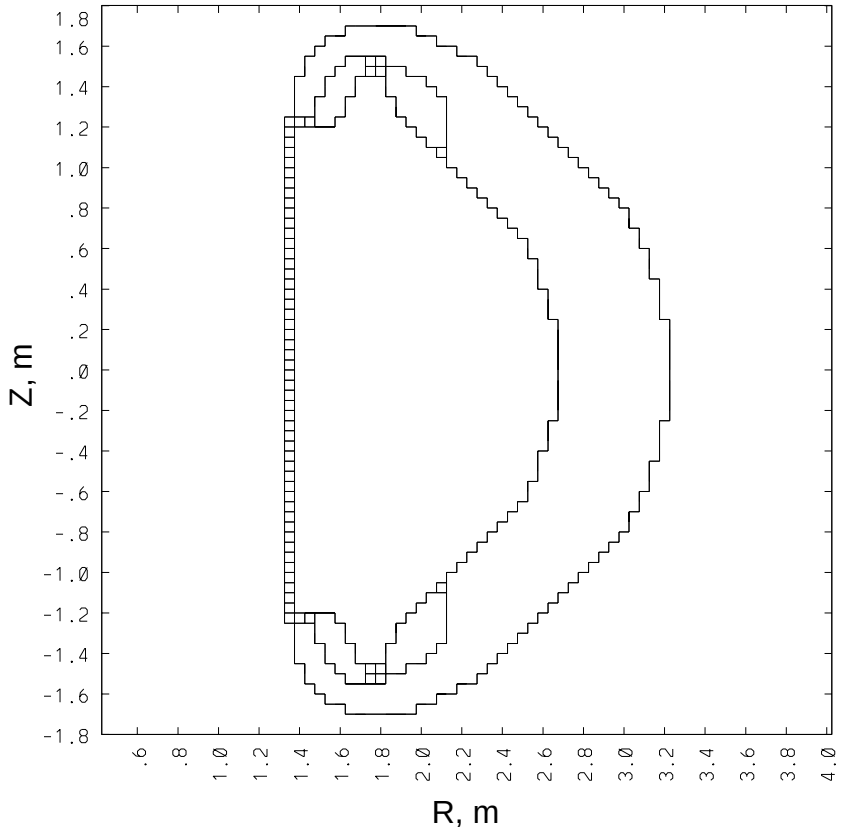
- structure model
  - outer VV, upper and lower, 1.5 cm SS with ρ=90x10**(-8)
  - inner VV, upper and lower, 1.5 cm SS with ρ=90x10**(-8)
  - inboard and outboard passive plates, upper and lower, 1.5 cm Cu with ρ=2.5x10**(-8)
  - divertor, upper and lower, 1.5 cm Cu with ρ=2.5x10**(-8) and zero net current constraint
  - baffle, upper and lower, 1.5 cm Cu with ρ=2.5x10**(-8) and zero net current constraint
  - outboard midplane outer VV, 1.5 cm SS with ρ=9000x10**(-8)
  - outboard midplane inner VV, 1.5 cm SS with ρ=9000x10**(-8)
  - internal control coils
- poloidal current pathes for diamagnetic and halo current flow
- restrict region on computational grid where plasma can exist
- limiter contour to represent PFC surfaces

Plasma, Structure, and Coil Model

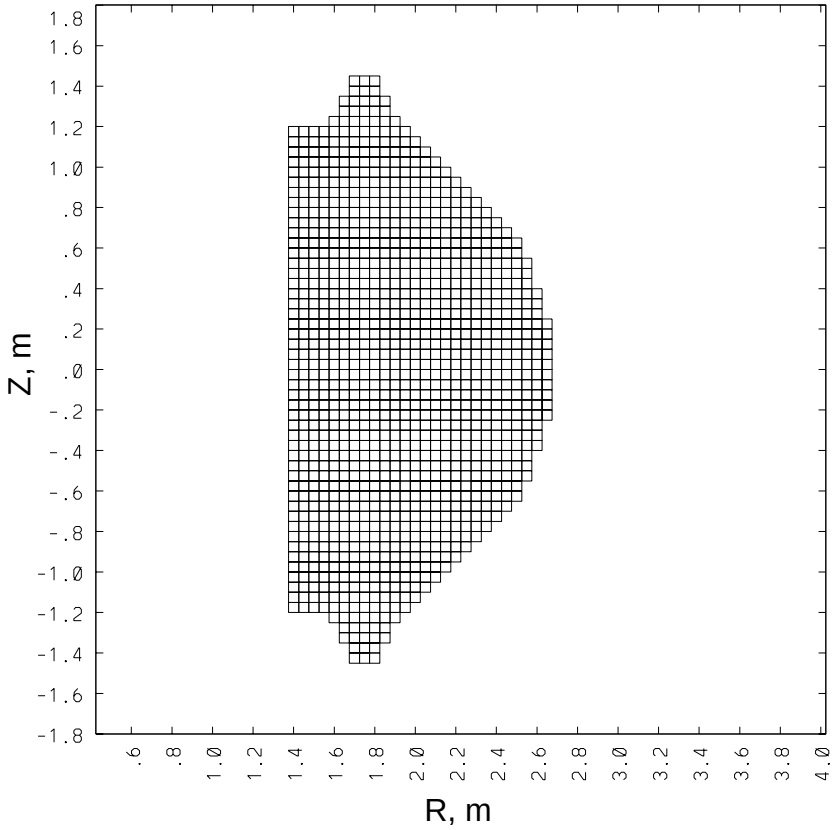


Poloidal Current Pathes and Allowed Plasma Zone

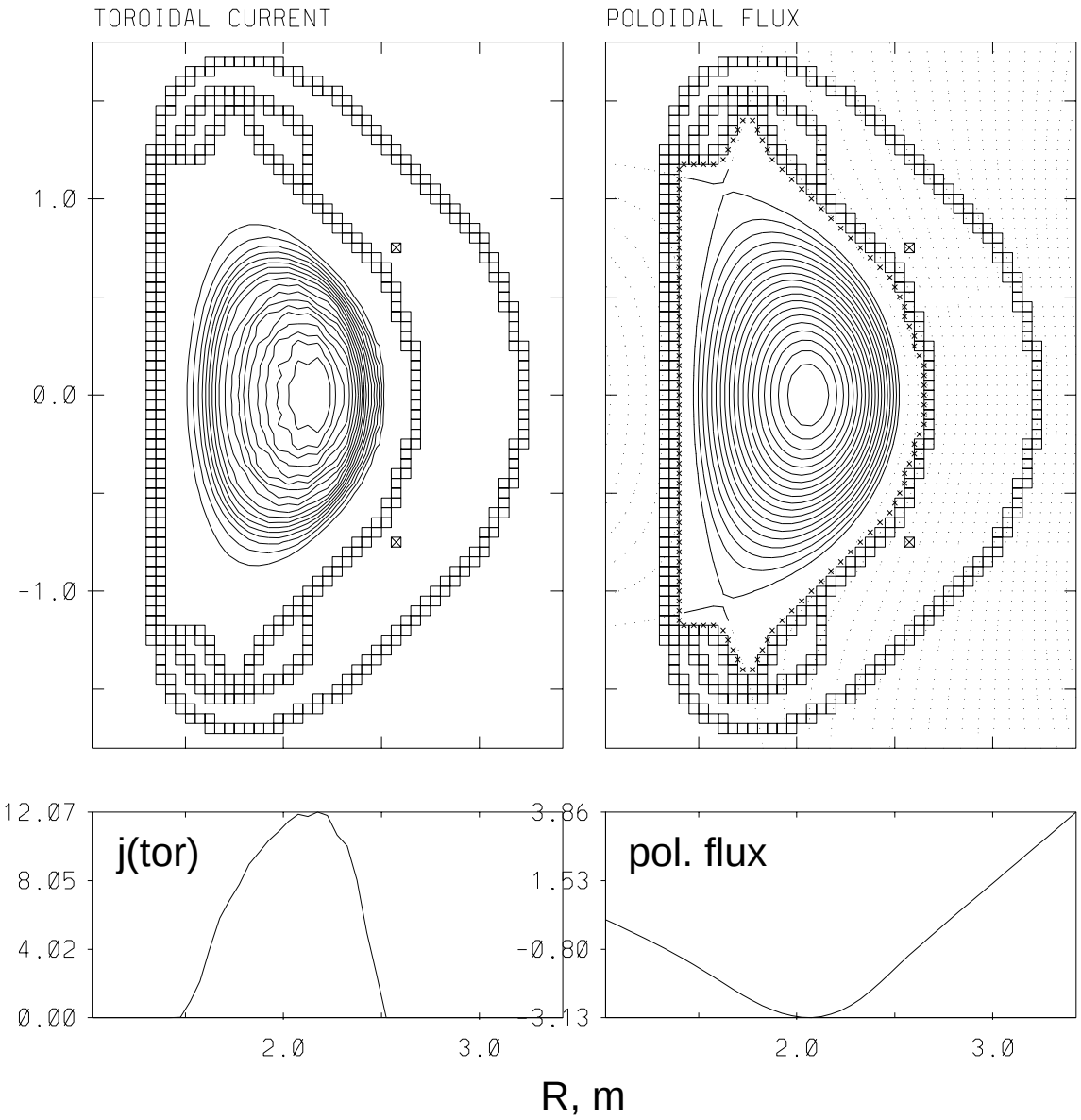
poloidal pathes used poloidal current calculation



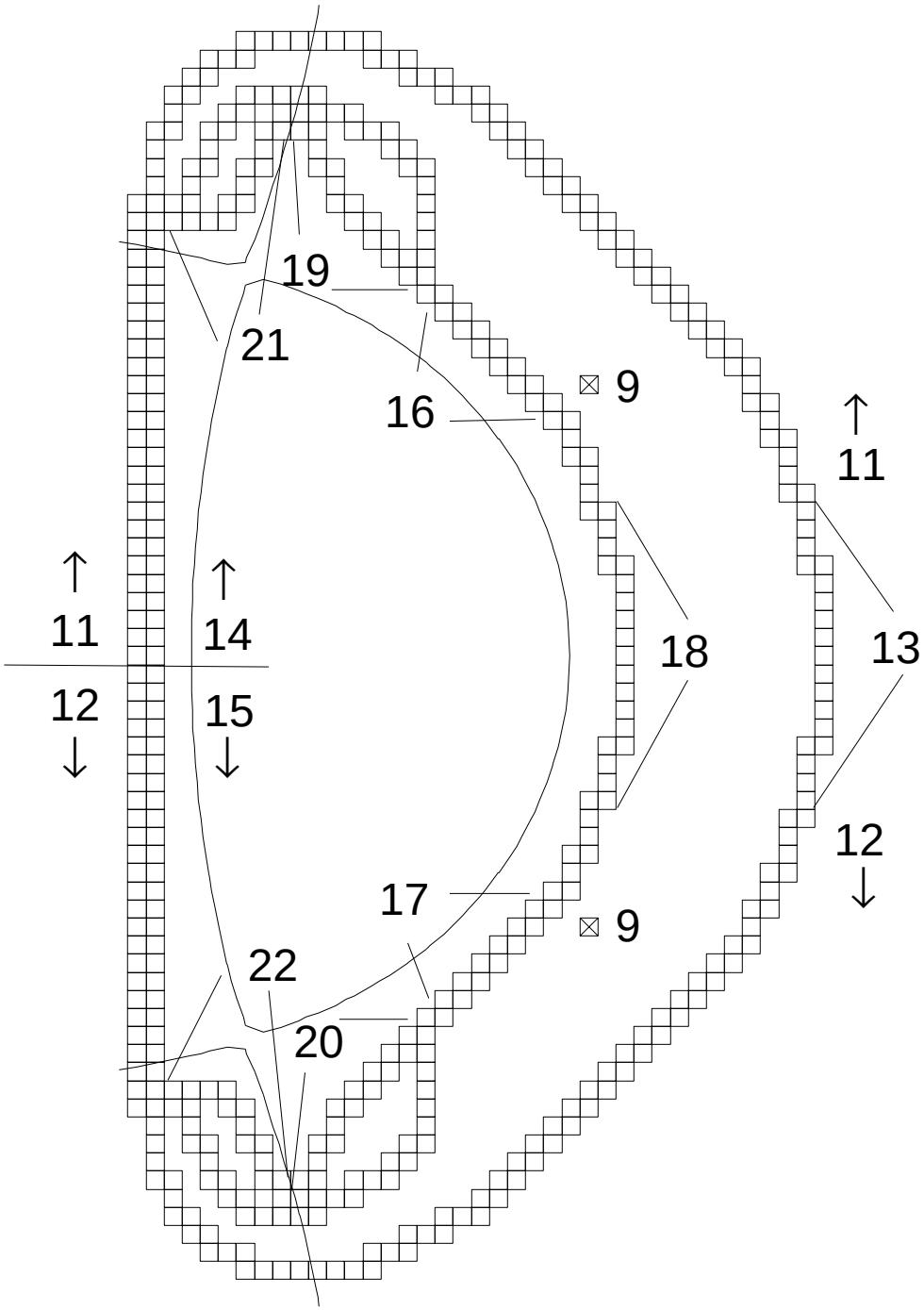
zones on computational grid where plasma can exist



FIRE Plasma and Structure Model



FIRE Structure Grouping for Disruption Modelling



11 - outer VV upper

12 - outer VV lower

13 - outer VV outb mid

14 - inner VV upper

15 - inner VV lower

16 - passive plate upper

17 - passive plate lower

18 - inner VV outb mid

19 - divertor upper

20 - divertor lower

21 - baffle upper

22 - baffle lower

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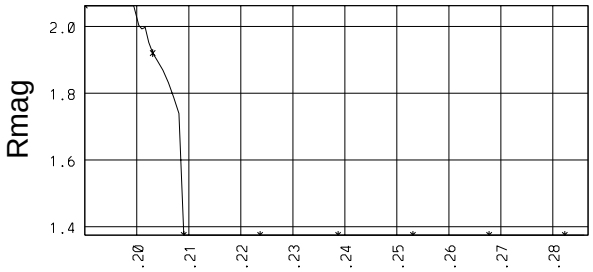
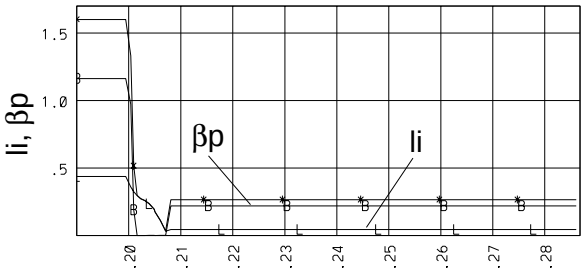
Disruption Simulation/Numerical and Structure Modelling

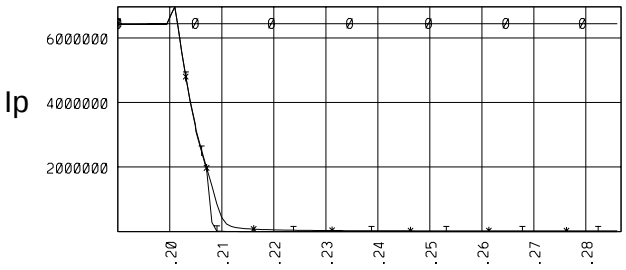
- using prescribed pressure and density profiles, and rapidly drop the pressure to induce the disruption over 1 ms
  - plasma temperature drops to 15-30 eV
  - plasma becomes very paramagnetic as βp goes to zero and then plasma contribution to toroidal flux goes to zero as Ip goes to zero
- use hyper-resistivity to cause rapid broadening of plasma current profile, which causes initial increase in plasma current by 10%
- initiate halo by prescribing halo temperature (5 eV) and halo width (as % of flux in plasma)
- plasma moves inward and shrinks from beta drop and plasma current drop
  - magnetic geometry (separatrix with x-point) is preserved for some time into disruption
  - current in halo is contributing to plasma force balance
- feedback systems for plasma radial and vertical position, and Ip are left on throughout the disruption
  - feedback systems would normally remain on only as long Ip was above the feedback permissable Ip(minimum)

Disruption Simulation for FIRE



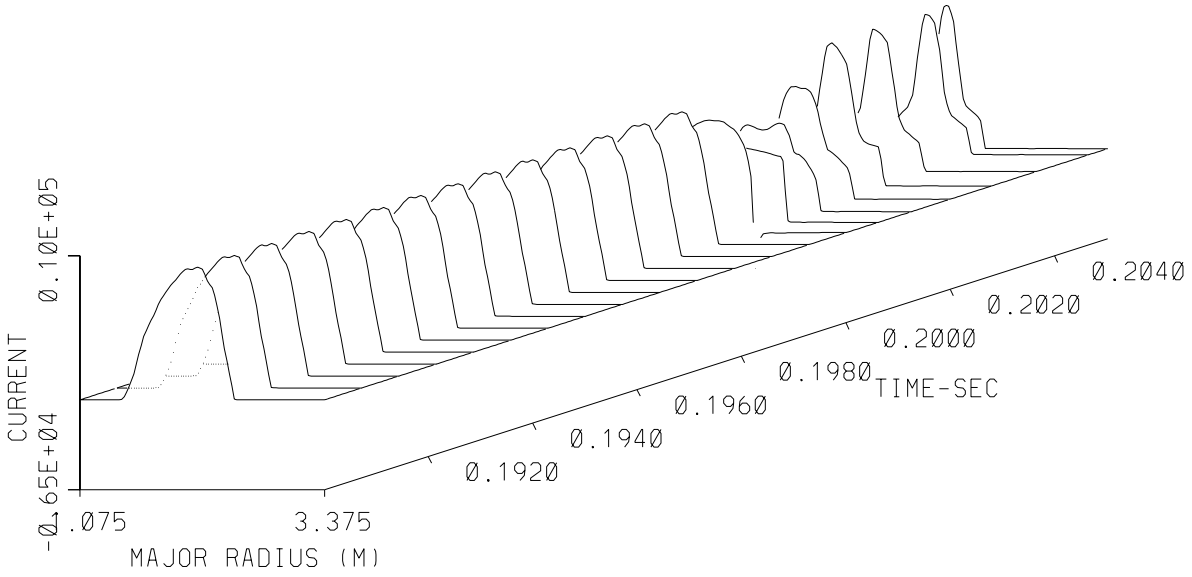


time, s



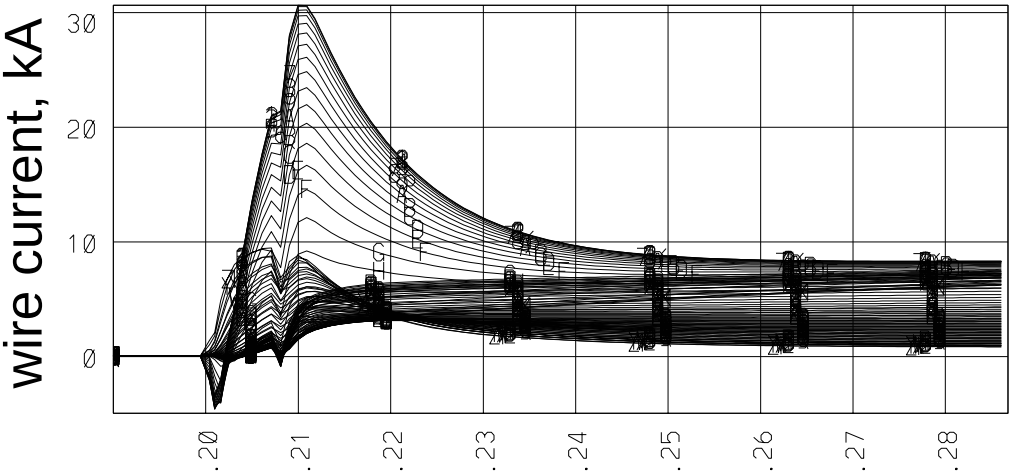
time, s

jφ

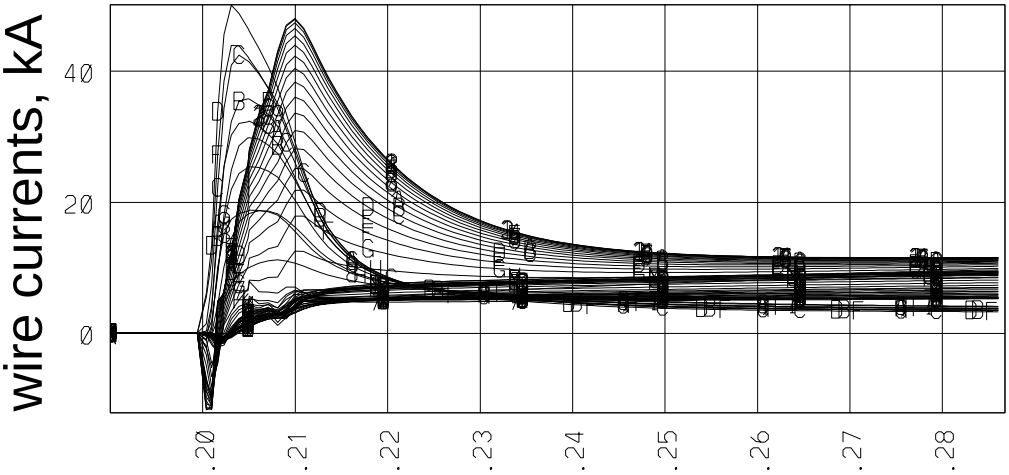


Disruption Simulation for FIRE

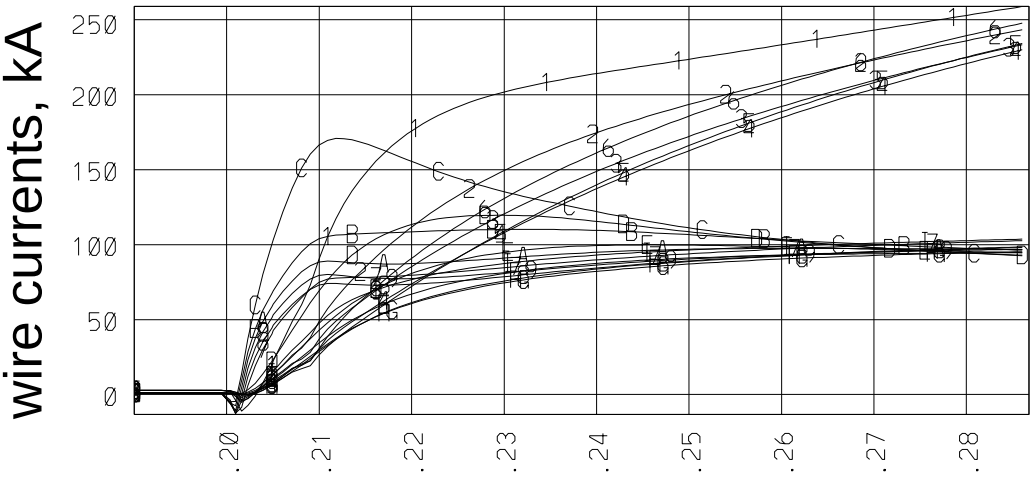
outer VV, upper



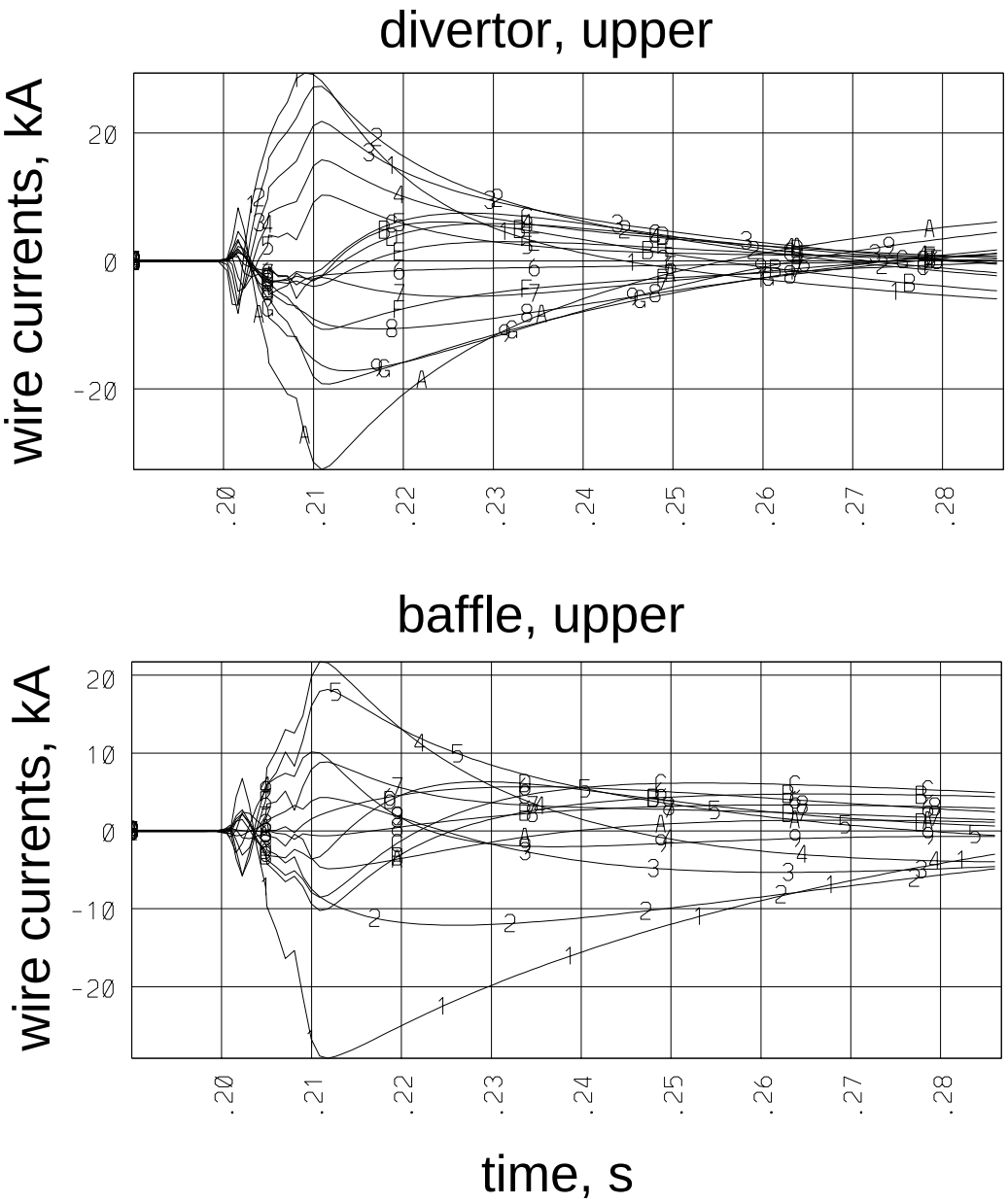
inner VV, upper



inb. and outb. passive plates, upper



Disruption Simulation for FIRE



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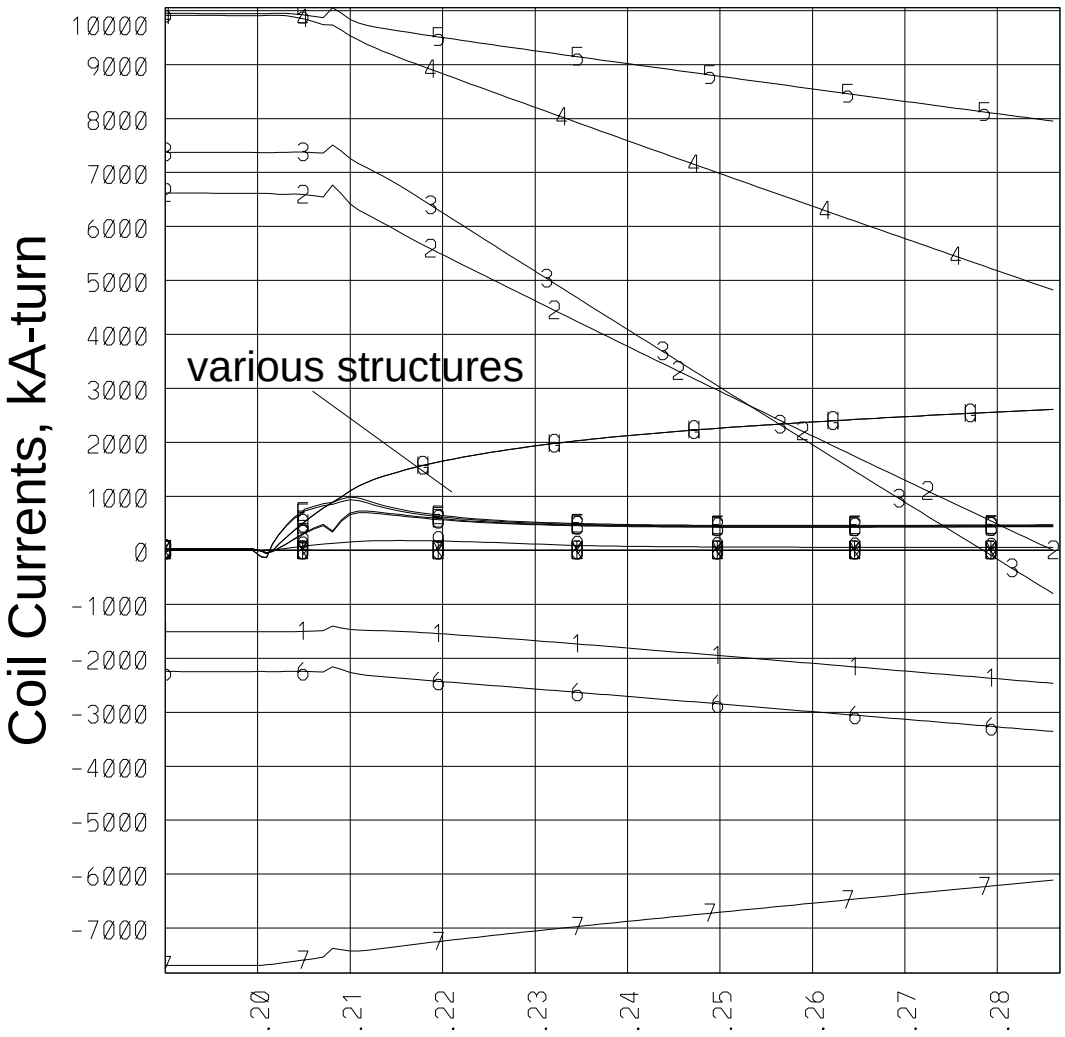
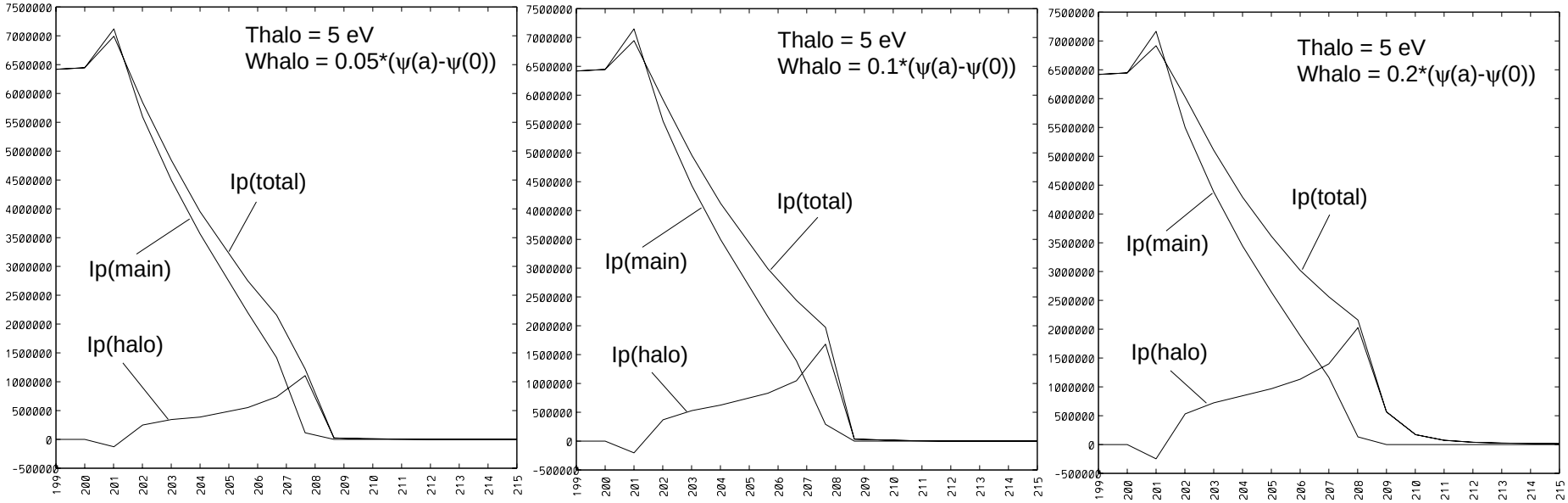
Disruption Simulation for FIRE

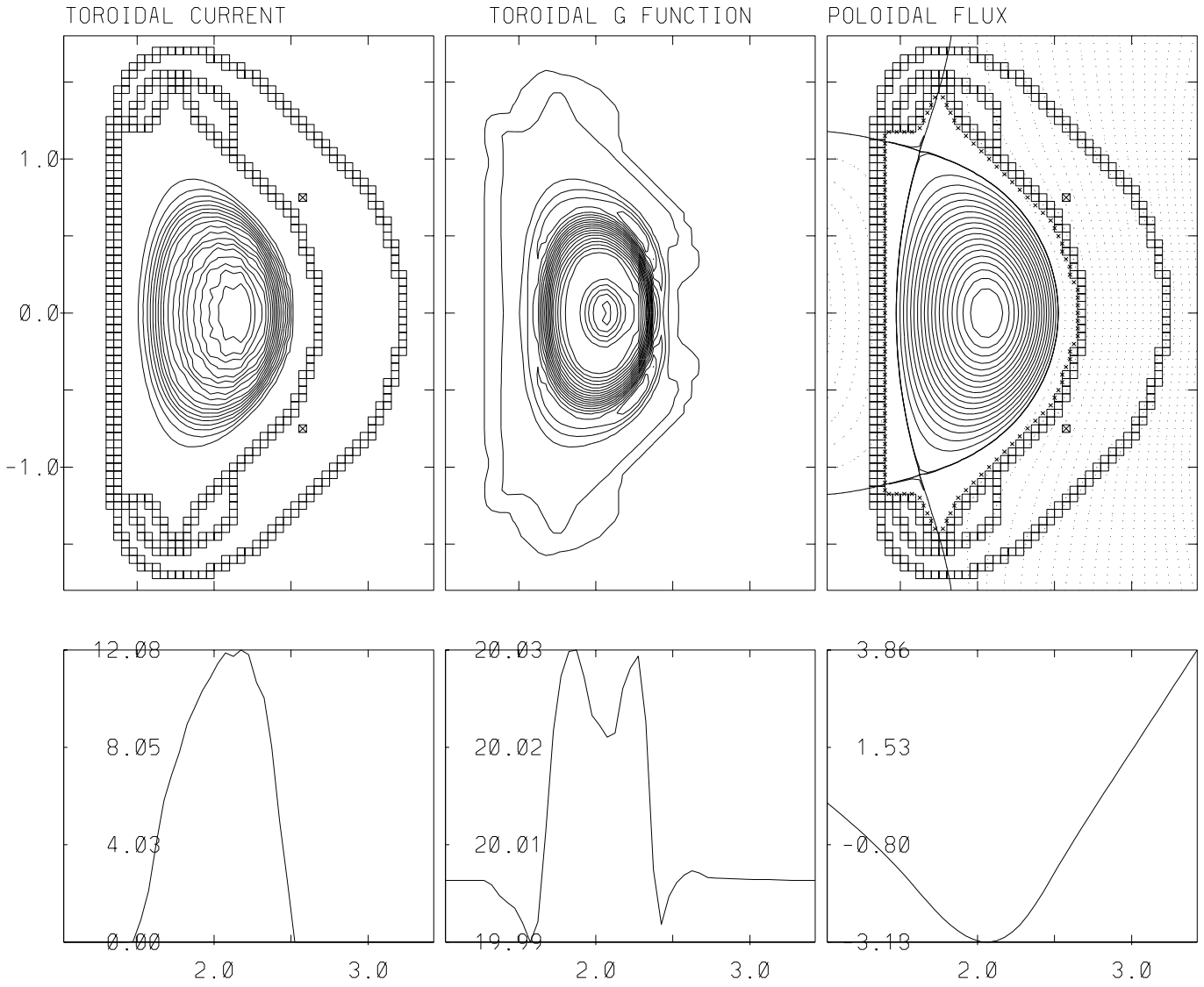


1 - CS1 (divided by 10)
2 - CS2
3 - CS3
4 - PF1
5 - PF2
6 - PF3
7 - PF4

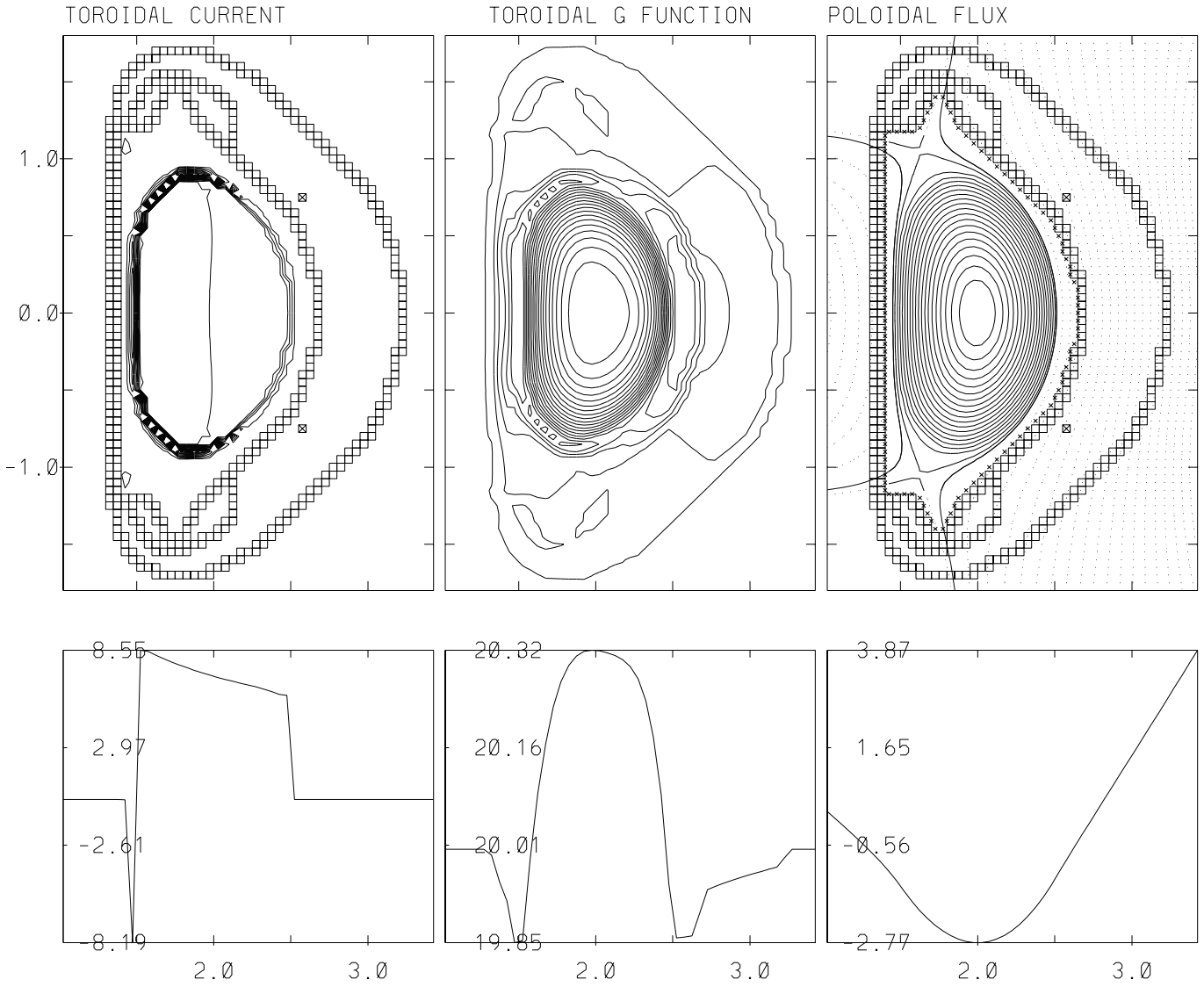
toroidal current in main plasma and halo plasma during disruption



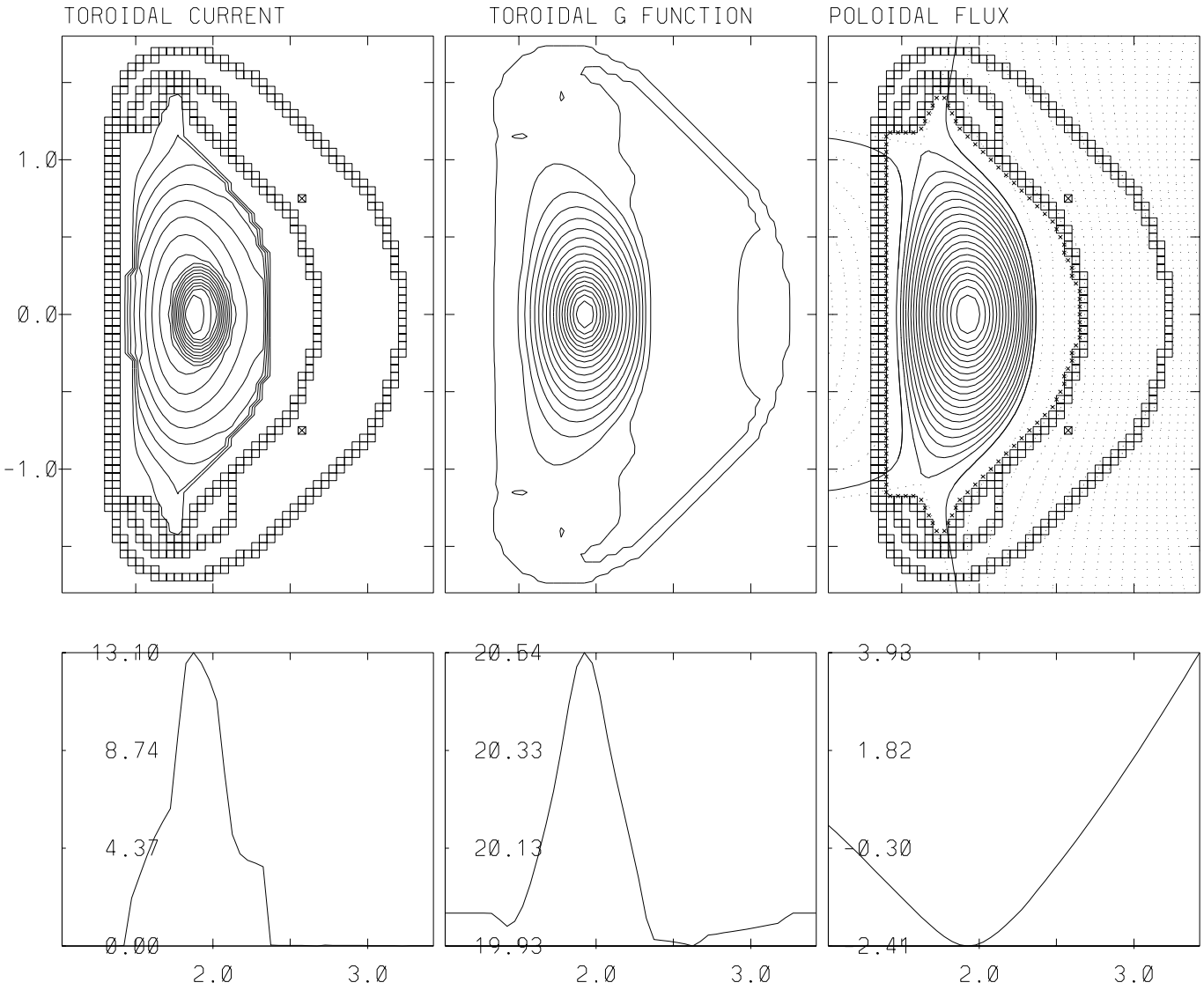
Contours before disruption



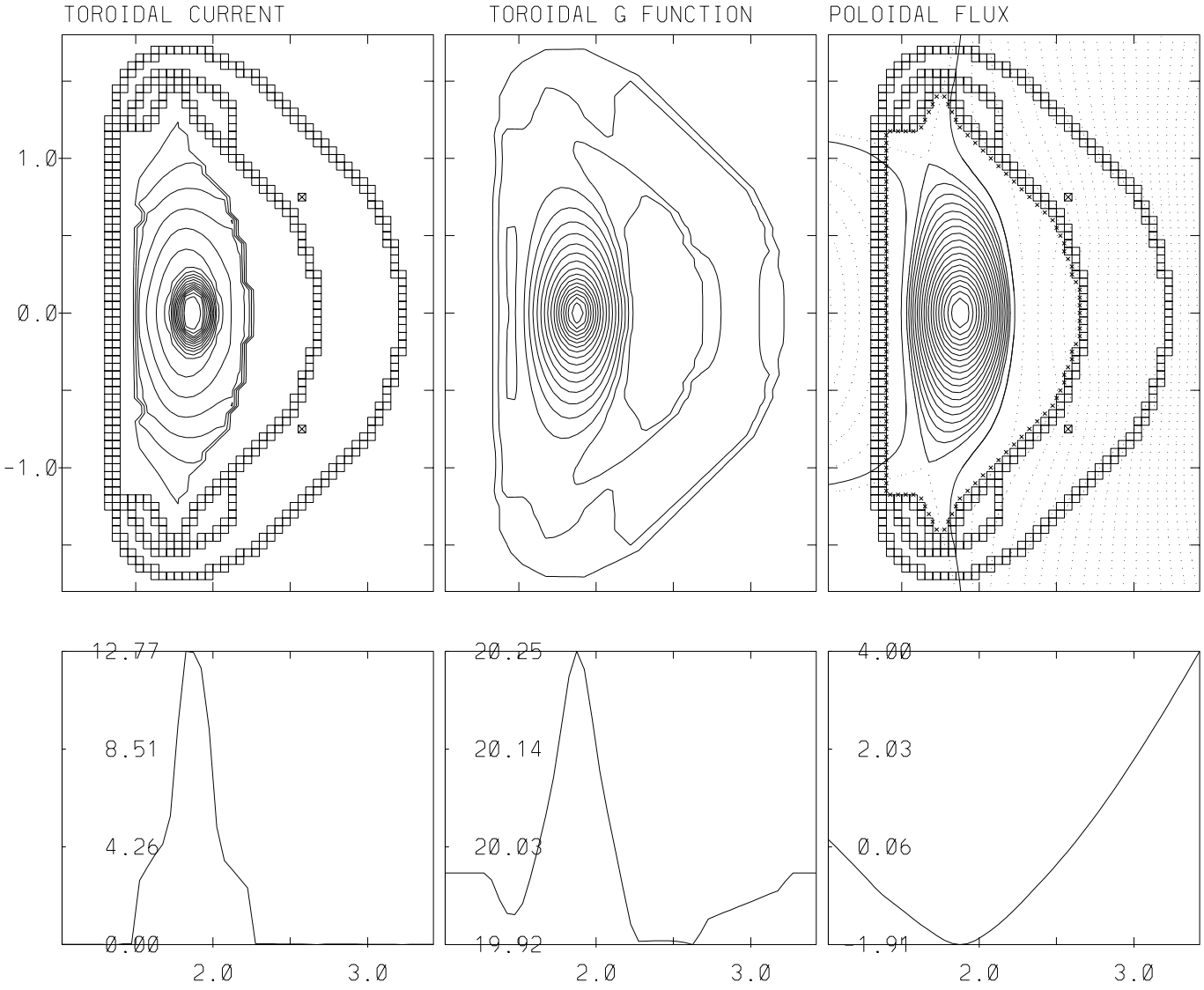
Contours 1 ms into disruption



Contours 2.5 ms into disruption



Contours 4.5 ms into disruption



Disruption Simulation/Numerical and Structure Modelling

- future work
  - need to reduce plasma mass and examine convergence behavior
  - re-write subroutines to dump out structure related and plasma related data in a usable form

    wire currents, fields, and forces according to groupings

    both toroidal current and poloidal current effects

    plasma to wall current flow

    various plasma properties
  - try disruption with plasma near midplane (ΔZ = 1-5 cm)
  - try VDE disruption sequence (drift and disrupt)
  - structure updates (i.e. Cu on inboard wall)