Status of GA ARIES-AT Physics Study

V.S. Chan, M.S. Chu, R.J. La Haye, L.L. Lao, T.K. Mau,[1] T. Petrie, H.E. St.John, P. Snyder, G.M. Staebler, A.D. Turnbull, and P. West

General Atomics, San Diego, CA, U.S.A.
[1] University of California, San Diego

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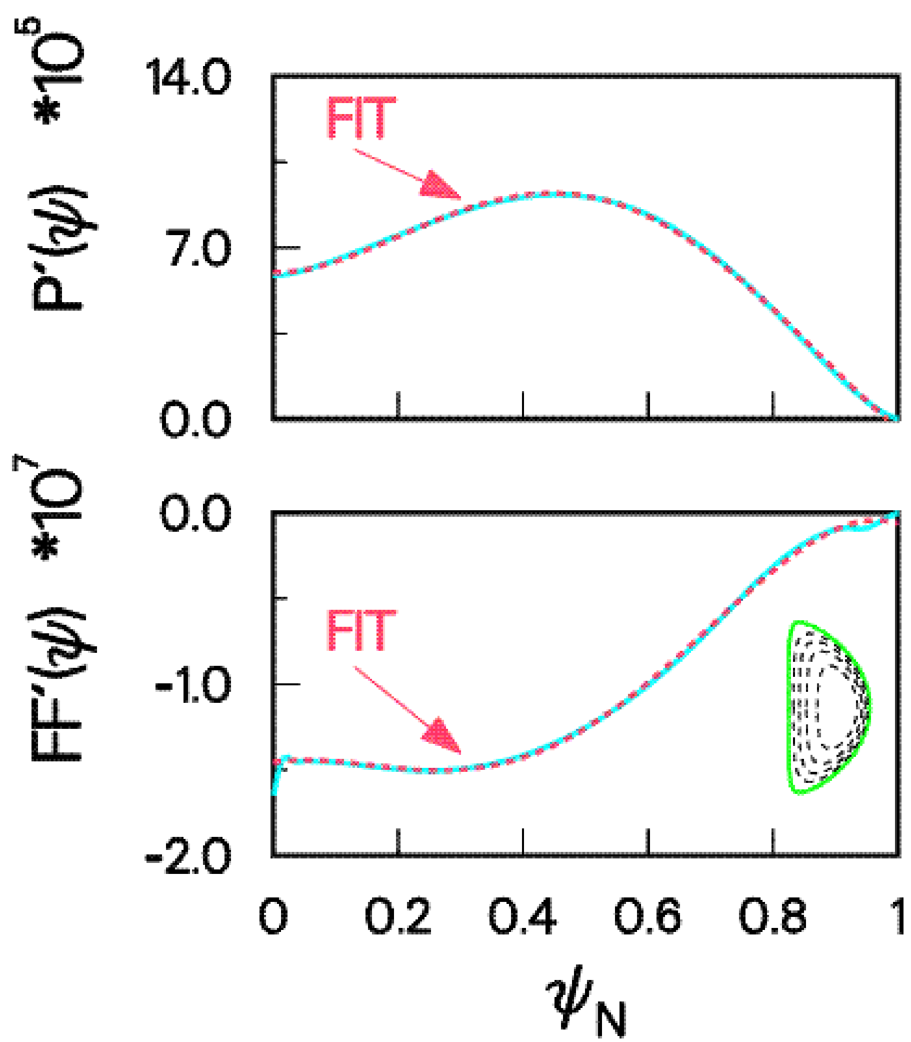
GENERAL ATOMICS

OUTLINE/SUMMARY

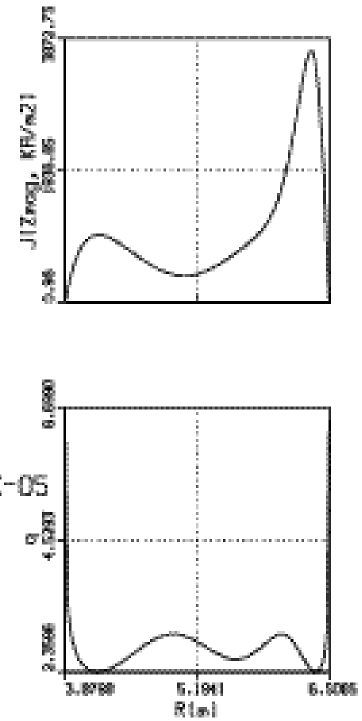
- H-mode pressure and current profiles and X-point improve ballooning stability
- A rotational drive ~ 0.1 Ω_{Alf} is essential to keep open the stability operation window against the $n = 1$ ideal kink/ballooning mode and the resistive wall mode (RWM)
- A skin time $\tau_{L/R}$ > 10 ms is crucial to keep the power requirement for the $n = 1$ RWM feedback coil at a modest level
- Self-consistent physics-based transport simulations indicate the optimized pressure and current profiles can be sustained with a peaked density profile
- Preliminary estimates indicate that 50-100 MW of ICH power may be needed to provide a rotational drive ~ 0.1 Ω_{Alf}
- High radiated fraction of the total exhausted power (> 0.5) by adding impurity such as Ar is essential to keep the peaked heat fluxes at a manageable level (< 10 MW/m^2)

PPPL COMPUTED EQUILIBRIUM IS USED AS BASE CASE

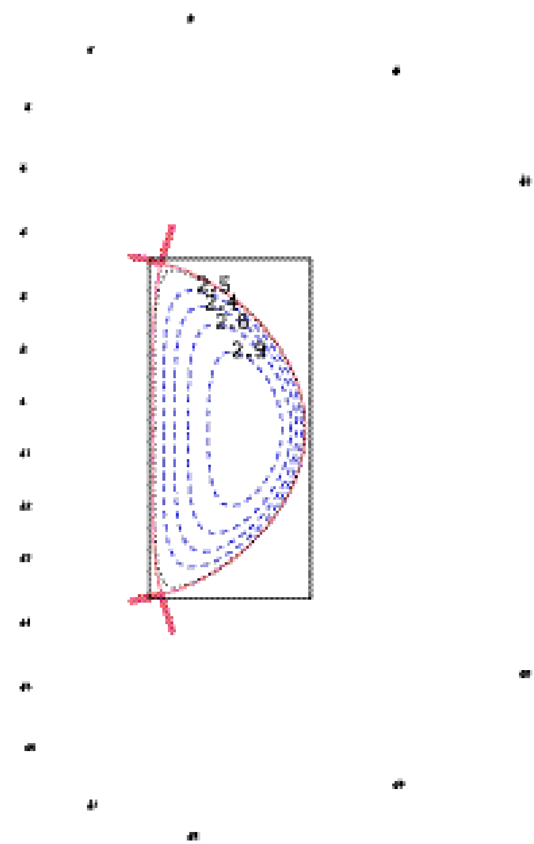
- **Pressure and current profiles from PPPL L-mode reference equilibrium EQDSK file without X-point are fitted to polynomial basis functions**
- **L- and H-mode like equilibria with X-point are then computed using EFIT by perturbing the base equilibrium obtained from the fitted profiles**



```
h EFITD 129x2d 02/05/98  h   r000509.01540?TK
date ran -  9-May-00
shot #    =        509
t(ms,us) -   1540        0
chi2(mag)-  1.494E-27
rout(cm) -      519.36
zout(cm) =        .000
a(cm)    -      131.49
elong    -       2.187
utri,ltri=     .90     .90
indent   =        .000
V,A(m3,2)-  345.1   11.05
energy(j)-  6.741E+08
betat(%) =        9.34
betap    -        2.43
betan,In -   5.66    1.65
li,y2    -     .47    -.63
error, # =  8.034E-09  41
delstar  =  2.2E-07  4.0E-05
fpols(kA)-          .0
J0n,J1n  -     .63     .00
q1,q95   -   6.54    3.16
dsep(cm) -       6.857
rm,rc(cm)-  558.1   530.5
zm,zc(cm)=     .00     .00
betapd,w =   1.21     .00
betatd,w -   4.64     .00
wdia(J)  -  3.349E+08
wtor(J)  =   .000E+00
      data used:
ip(ka)   -     12850.7
bt0(t)   -       5.911
 0 flux loops
 0 magnetic probes
 1 rogow   0 fc    0 ec
```

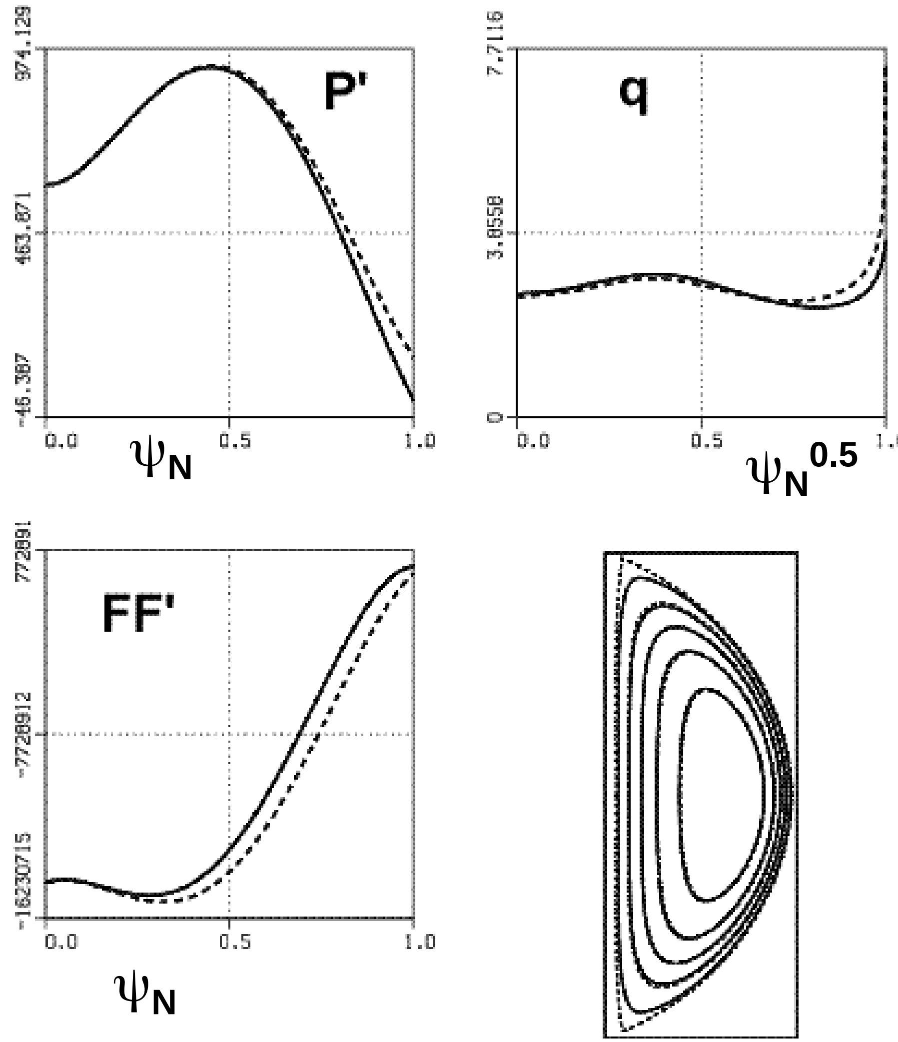



```
icp,  ivs=      0     0
kf, kp, E-     5   5   0
fpd, p, E-   .0   .0   .0
fwbp, fwq-    .0     .0
Ze(cm)    =        .000
relax     -        .500
kcf,  kcp-      4     5
```

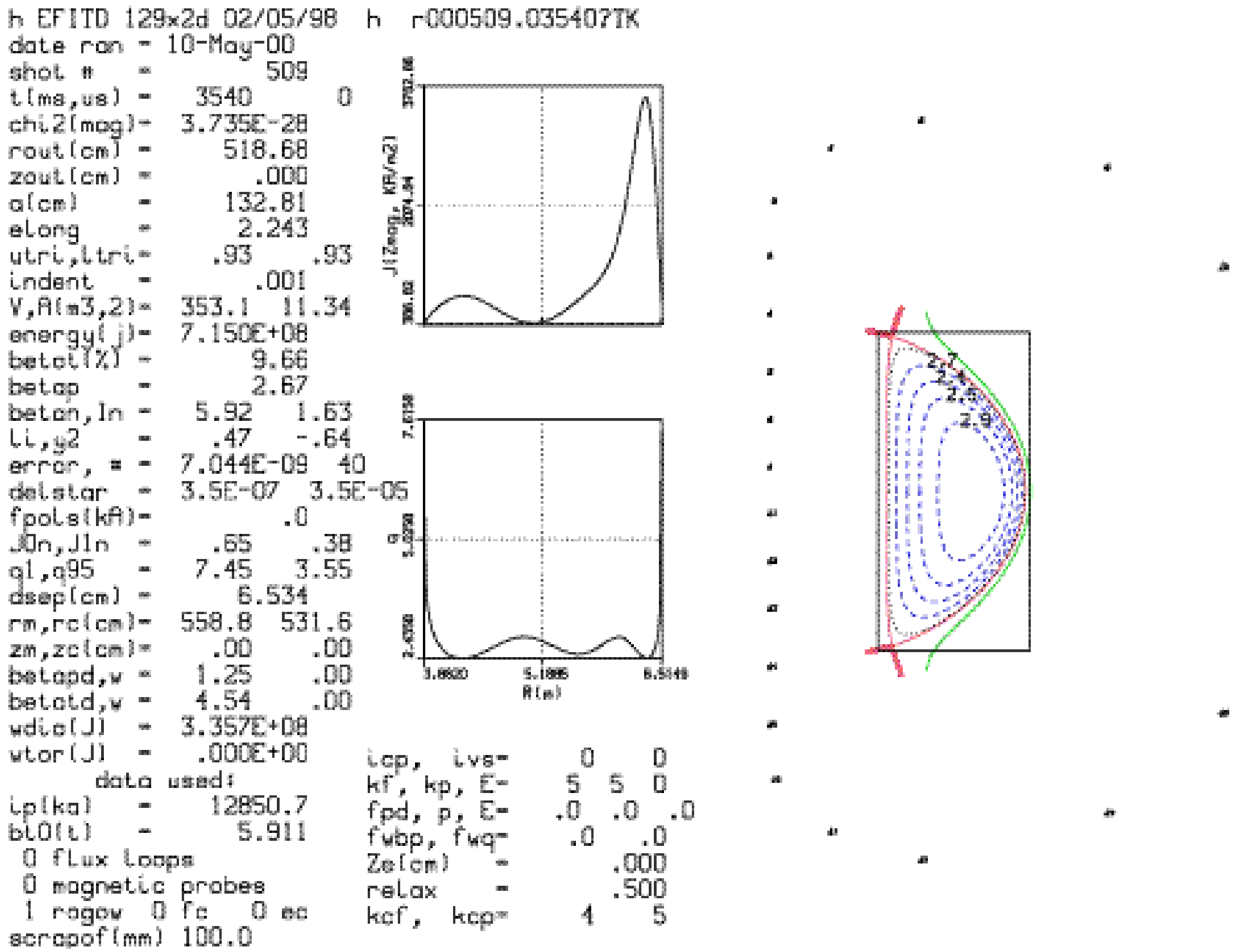


H-MODE LIKE EQUILIBRIA WITH X-POINT ARE OBTAINED BY PERTURBING THE L-MODE BASE EQUILIBRIUM

- **Core pressure and current profiles are kept as similar to the L-mode base case as possible**
- **P'(1) ~ 0.2 P'(0), $\langle J_T \rangle(1) \sim 0.38\ J_{ave}$**

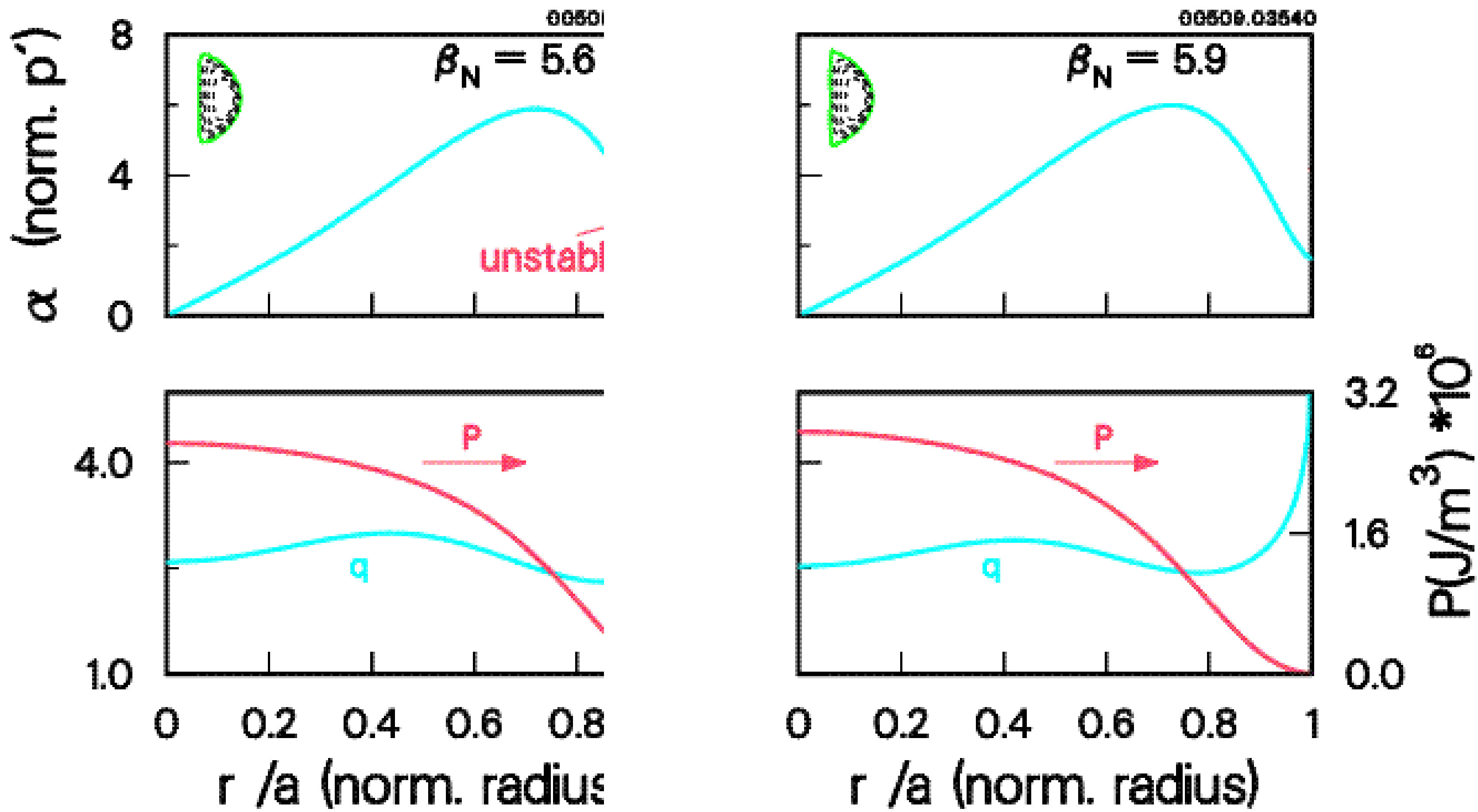


H-MODE LIKE EQUILIBRIUM WITH X-POINT IS COMPUTED USING EFIT



BALLOONING STABILITY IS IMPROVED BY H-MODE LIKE PRESSURE AND CURRENT PROFILES AND X-POINT

- Low *n* modes are stabilized by a close fitting conducting wall

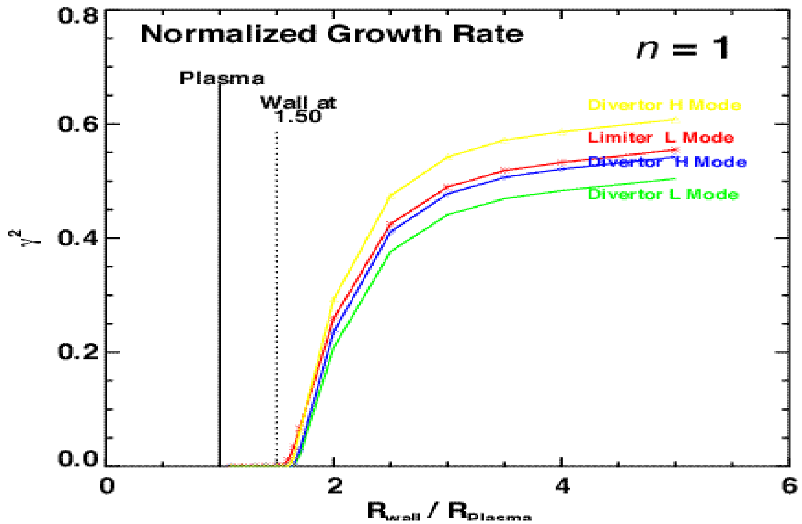


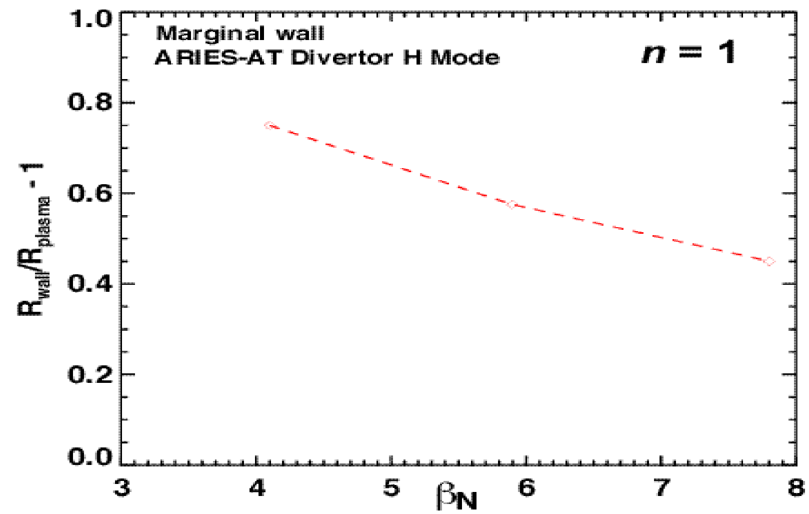
GENERAL ATOMICS

LOW *n* MODES ARE STABILIZED BY A CONDUCTING WALL

- **Low *n* modes computed using GATO**

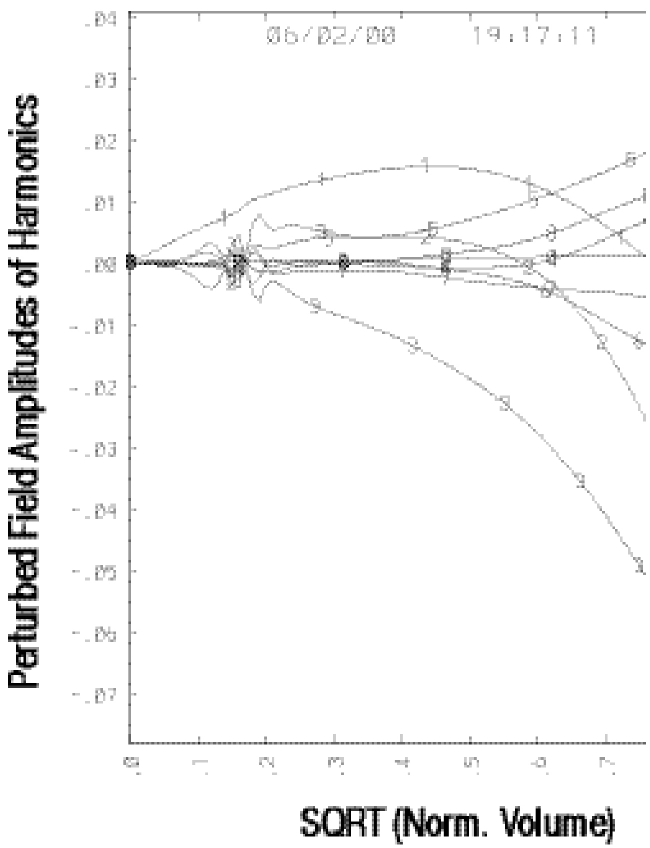
	Marginal Wall $n = 1$	Marginal Wall $n = 2$
L-Mode Limiter $\beta_N = 5.6$	1.525	1.450
L-Mode Divertor $\beta_N = 5.6$	1.600	1.475
H-Mode Divertor $\beta_N = 5.8$	1.550	1.475
H-Mode Divertor $\beta_N = 5.9$	1.575	1.450

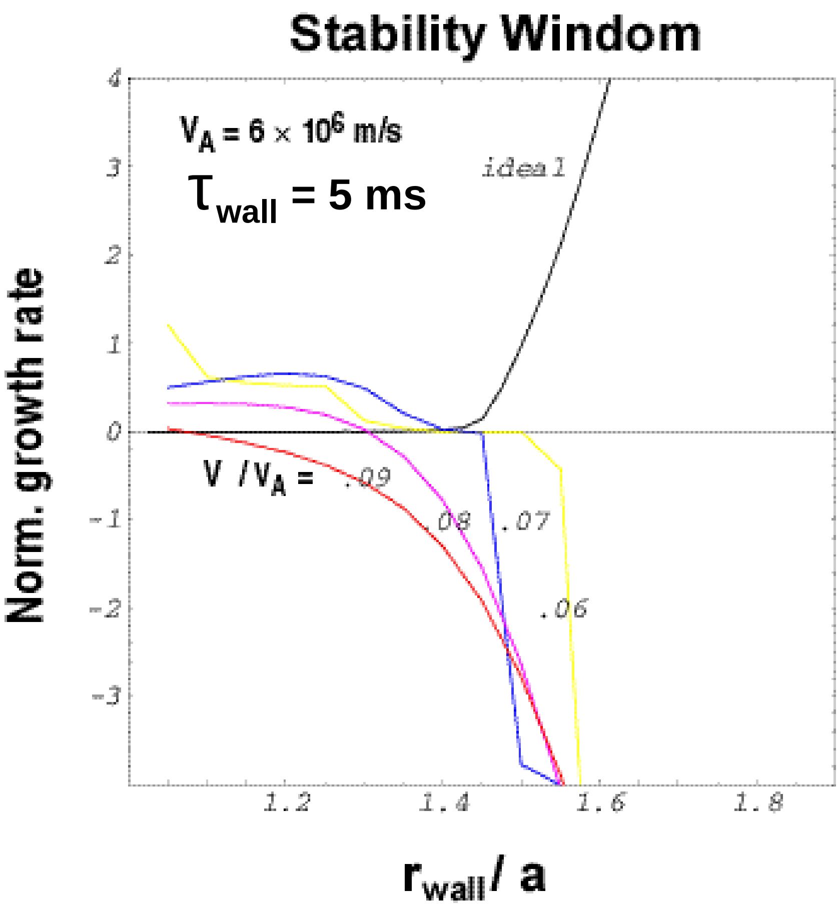




ROTATIONAL DR
STABILITY WINDOW

- *n* = 1 stability computed us





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PRELIMINARY ESTIMATES INDICATE THAT 50-100 MW OF ICH POWER IS NEEDED TO DRIVE A ROTATION ~ 0.1 Ω_{ALF}

- **From Perkins et al (2000 EPS)**

$$\Omega(\phi) = \int d\phi T \,/\, qV' \langle n M R^2 \chi \ddot{U} \Psi^2 \rangle$$

ICH	r / a = 0.17	r / a = 0.34
$V(0)/V_A$	$\frac{2.1 \times 10^{-3}}{P(MW)\tau_E(s)}$	$\frac{1.1 \times 10^{-3}}{P(MW)\tau_E(s)}$

- **Detailed physics remains to be explored experimentally. Some indications from C-MOD**