Status of GA ARIES-AT Physics Study

V.S. Chan, M.S. Chu, L.L. Lao, Y.R. Linliu, 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

ARIES Project Meeting
University of California, San Diego
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FOCUSED AREAS

- Improve equilibrium calculations to include effects of H-mode pedestal
- Improve β-limit stability calculations to include important non-ideal effects such as resistive wall modes, neo-classical tearing, and ideal intermediate *n* modes
- Use of physics based transport model to study optimized pressure and current profiles formation and sustainment
- Investigate divertor heat flux controls
- Integrated modeling of the optimized scenario with self-consistent current and transport profiles to study the robustness of the bootstrap alignment, sustainment of optimized pressure and current profiles, and stable path to high β and high bootstrap fraction operation

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GENERAL ATOMICS

STUDY PLAN

- Equilibrium issues
  - Produce equilibrium with X point (March)
  - Study equilibrium with H-mode profiles (April)
- Stability optimization
  - RWM stability boundary and rotation requirement (April)
  - NTM stability (July)
  - Edge stability against intermediate *n* modes (July)
- Transport modeling
  - Determine χ and rotation profiles required for optimized P and J (April)
  - Estimate NBI power to meet rotation requirement (June)
  - Self-consistent simulation using physics-based transport models (July)
- Edge and divertor heat flux issues
  - Wall heat flux for L- and H-mode profiles (June)
  - Radiating mantle simulation using MIST and STRAHL (June)

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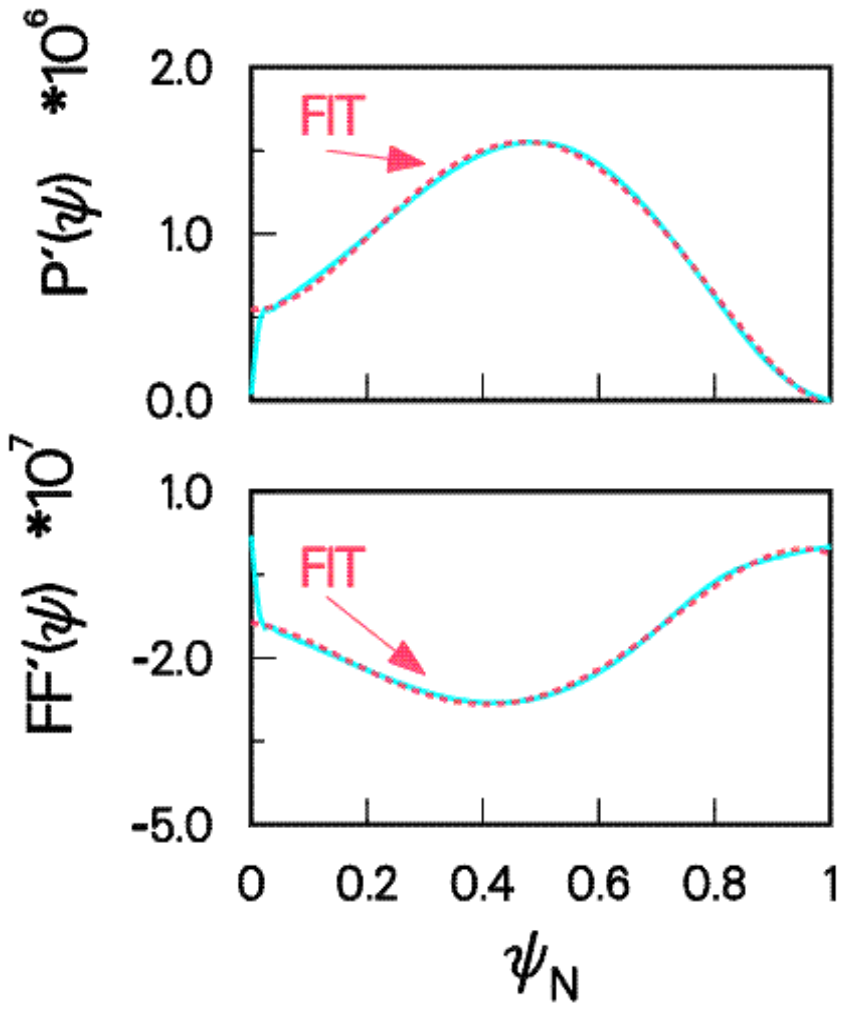
GENERAL ATOMICS

COMMENTS

- Equilibrium state appears to be sensitive to details of current profile
  - Sufficient current profile control may be crucial to maintain equilibrium
  - PPPL EQDSKs noisy near magnetic axis
- Stability still limited by ballooning modes near edge

PPPL COMPUTED EQUILIBRIA ARE USED AS BASE CASES

- Pressure and current profiles from PPPL equilibrium EQDSK files are fitted to polynomial basis functions
- Equilibria are then computed using EFIT based on fitted profiles



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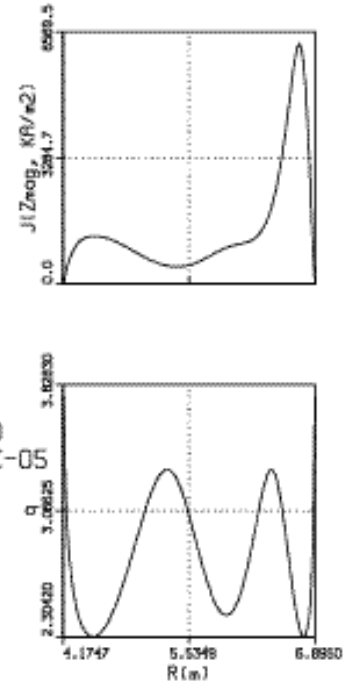
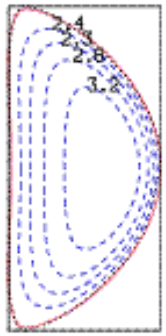
GA TOMICS

EQUILIBRIA ARE COMPUTED USING EFIT

```
h EFITD 129x2d 02/05/98  h  r000316.006807a
date ran - 20-Mar-00
shot #   -         316
t(ms,us) -     680       0
chi2(mag)-  6.142E-27
rout(cm) -      550.97
zout(cm) -        .000
a(cm)    -      138.53
elong    -       2.085
utri,ltri-      .76     .76
indent   -         .018
V,A(m3,2)-   397.9   11.96
energy(j)-  1.786E+09
betat(%) -       11.76
betap    -        2.64
beton,In -    6.85    1.72
li,y2    -     .41     -.64
error, # -  9.101E-09   70
delstar  -  5.9E-07   1.7E-05
fpols(kA)-          .0
JOn,J1n  -     .59      .00
q1,q95   -    3.76    2.98
dsep(cm) -     -45.000
rm,rc(cm)-   593.7   567.3
zm,zc(cm)-     .00     .00
betapd,w -    1.19     .00
betatd,w -    5.27     .00
wdia(J)  -  8.008E+08
wtor(J)  -   .000E+00
      data used:
ip(ka)   -     19013.6
bt0(t)   -       7.982
 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
```



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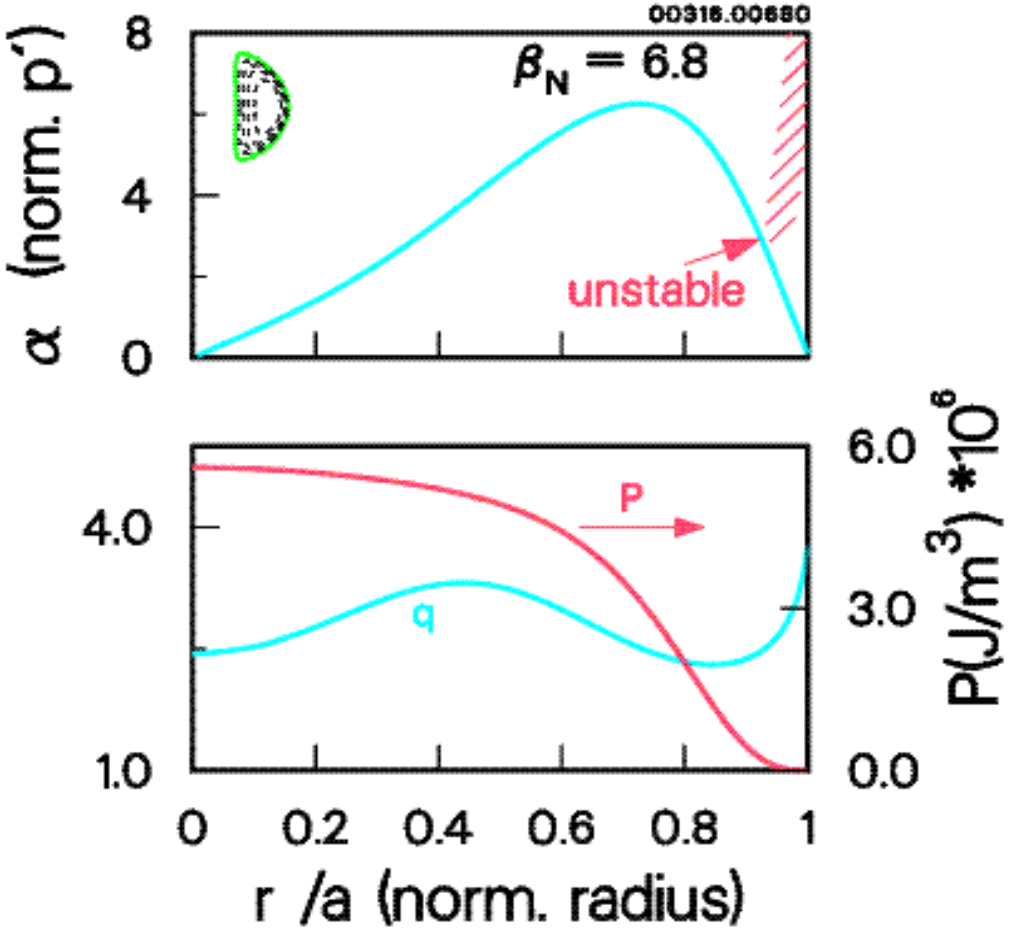
GENERAL ATOMICS

MHD STABILITY IS LIMITED BY BALLOONING MODES IN THE PLASMA OUTER REGION

- Low *n* modes are stabilized by a close fitting conducting wall
- $\kappa = 2.1$, $\delta = 0.8$, $q_{95} = 3.0$, $q_{min} = 2.3$, $\beta_T = 11.8\%$, 19 MA, 8 T



EQUILIBRIUM STATE IS SENSITIVE TO DETAILS OF CURRENT PROFILE

- **Sufficient current profile control may be crucial to maintain equilibrium state**