Report Outline:
Physics Basis of ARIES-AT

(Sept 18, 2000)

1.0 **Introduction [sj]**

1.1 physics goals,

- more <u>aggressive</u> and more <u>complete</u> than ARIES-RS
- aggressive: better optimization of plasma shape, profiles, edge density, and current drive systems
- complete: includes transport analysis, RWM, NTM, edge physics

1.2 relation to ARIES-RS,

- β 5.0 → 9.2,
- (κ,δ): (1.9, .76) → (2.2, .86)
- etc

1.3 overview

2.0 MHD Stability and Self-Generated Currents [ck]

2.1 Plasma equilibrium shapes, profiles [ck]

2.2 Bootstrap model [ck]

2.3 Stability to Ballooning Modes(including shape dependence) [ck]

2.4 Stability to Kink Modes (including wall distance) [ck]

2.5 Stability/Current-drive tradeoff [ck]

2.6 Effects of H-mode like pressure and current profiles [ga]

- Small modification to pressure profiles makes them more H-mode like improves ballooning stability
- Finite edge pressure gradient and current of 20% to 30% of central values

2.7 Resistive Wall Mode Stabilization [ga]

- Separate calculations for rotation and for active stabilization.
- Rotation by itself requires 0.1 V_A (from MARS analysis)
- It is <u>thought</u> that an improved feedback coil design can get rid of rotation requirement entirely
- Feedback coils outside the blanket but inside the vacuum vessel
- 16 coils
- stabilization shell same separation as vertical stabilizing shell with 1 cm tungston

2.8 Neoclassical Tearing Mode Stabilization [ga]

- 5/2 mode is unstable
- replacing missing bootstrap current with local current drive <u>not</u> very effective
- Need to change current profile to make Δ' more negative
- Refer to Lower Hybrid and ECCD stabilization experiments.

2.9 Edge stability/ELMs [ga]

- Intermediate-n of 15 or higher with oscillatory behavior causing ELM
- Relation of edge pedistal size and grassy ELMs

3.0 Plasma Equilibrium and Control [ck]

3.1 Free-boundary equilibrium and PF coil solutions [ck]

3.2 Vertical Stability and Control [ck]

4.0 Current Drive [tkm]

4.1 System overview [tkm]

4.2 ICRF/FW system for on-axis CD [tkm]

- Justify why FW is used and give results

4.3 LHW system for off axis [tkm]

- Justify why LH is used.
- Mention NTM stabilization and quote experimental results from COMPASS

4.4 HHFW, NBI, ECCD backup systems [tkm]

- NBI primarily for rotation, ECCD for NTM stabilization, and HHFW (needs development) is used for current profile control.

4.5 Overall efficiencies and scaling [tkm]

- Efficiency as function of temperature.

5.0 Transport Analysis and Energy Confinement [ga]

5.1 GLF23 transport analysis (including radial electric field) [ga]

- Density profile input to calculation.
- Temperature profile comes from GLF23 calculation (typically agrees to about 20% with experimental data)
- Pressure (ie, n×T) in reasonable agreement with those assumed from stability.
- H89p = 2.1 (above neoclassical minimum)
- Strict requirement on density profile for optimized solution. Must be <u>peaked</u>. Only depends weakly on rotation profile.

- Bootstrap alignment is not as good for peaked density.

5.2 Rotational drive [ga]

- Baseline does not require rotation. However, rotation does provide some flexibility.
- NBI and RF rotation being quantified.
- Perkins analysis gives 50-100 MW of ICH power for rotational drive
- NBI power needed to produce rotational power required for RWM stabilization is also quite high.

5.3 Particle fueling (including density limit, and fueling) [sj]

- Demonstrate that a reasonable pellet fueling story exists using a combination of high speed and inside or vertical launch
- Refer to Osborn paper and Schmidt/Jardin for this.
- Needs more experimental study.

6.0 Power and Particle Exhaust [ga]

6.1 General considerations

- Neon,Argon and/or Krypton radiating just inside the last closed flux surface.
- About half the power is radiated inside the last closed flux surface.

6.2 Divertor heat load

- Petrie working on a radiative divertor scheme to reduce both the peak and the average heat flux.
- Interacting with Najmabadi

6.3 MIST impurity modeling

- GA calculating Zeff as function of radius.
- Will give this to T.K. for analysis of effect on CD
- Should take into account H-mode edge.

7.0 Plasma Operating Regime and Startup [rm]

7.1 POPCON analysis[rm]

- Ron miller will generate.

7.2 Plasma startup (including H-mode threshold and heating requirements)[ga&tkm]

- 0D analysis of non-inductive startup being performed similar to what was done for ARIES-ST

8.0 Summary [sj]