

A. Reiman

## Plasma Configurations

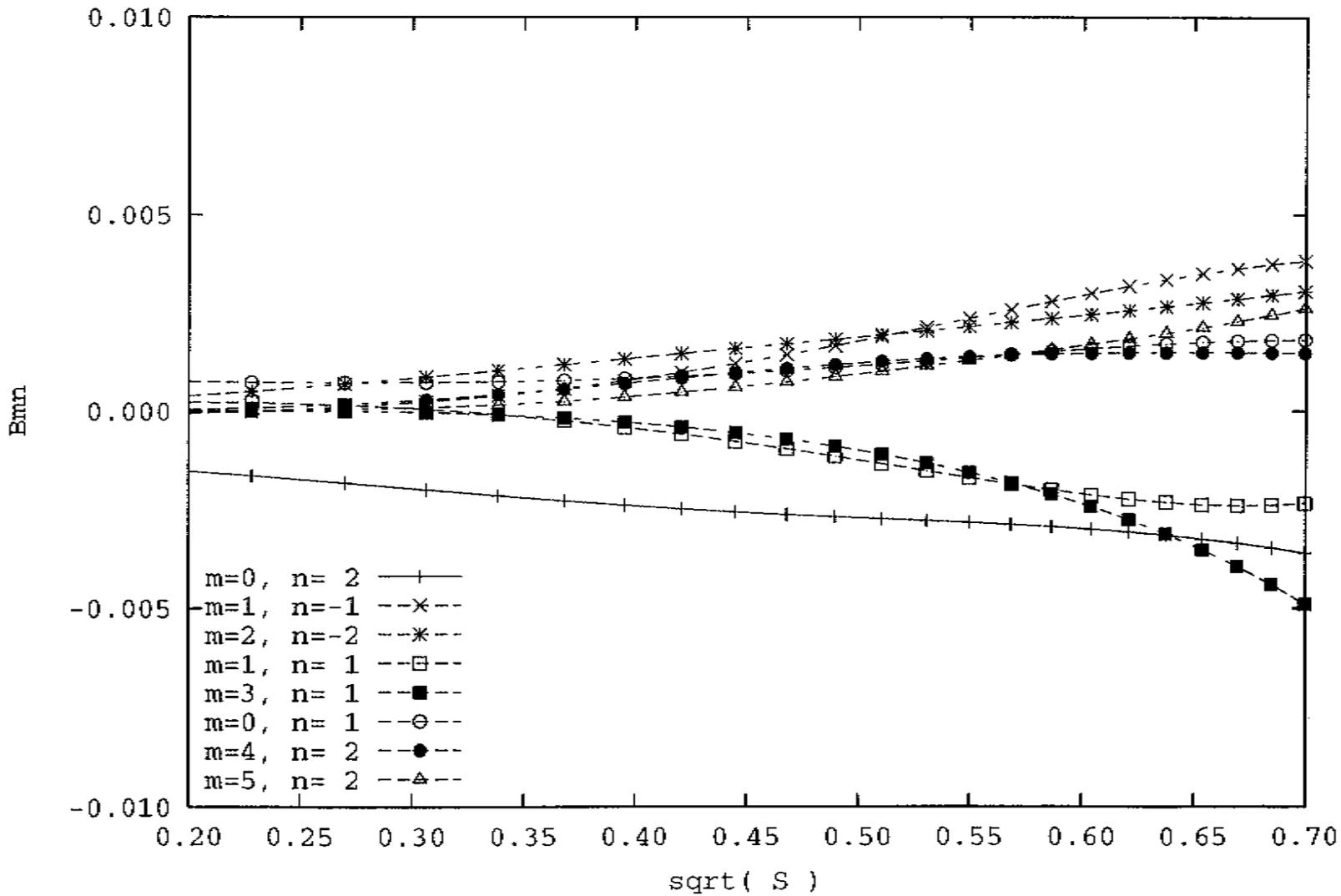
Comments on recent physics issues:

$\alpha$  confinement

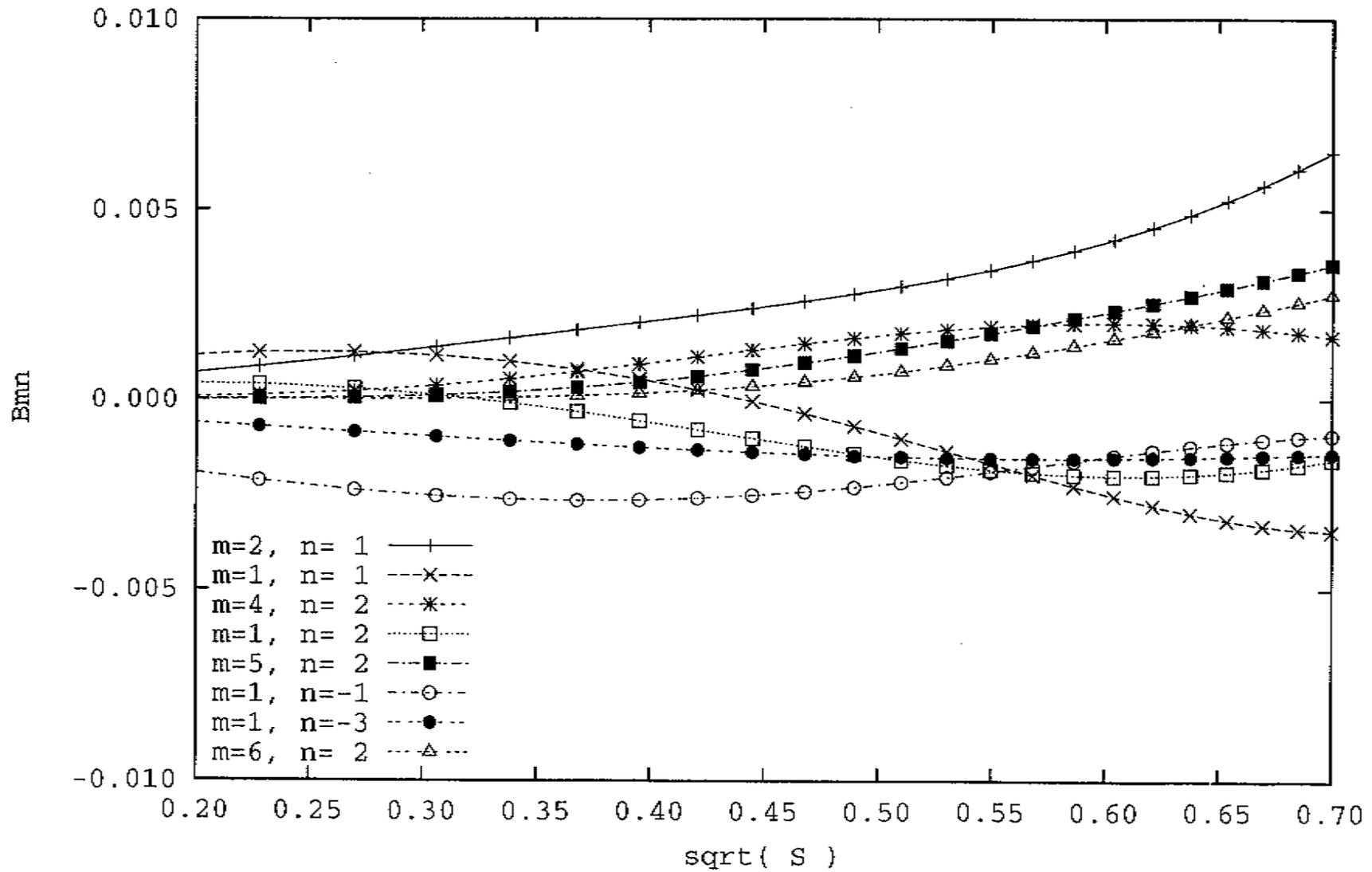
kink stability

Plans

# Boozer spectrum of configuration c10

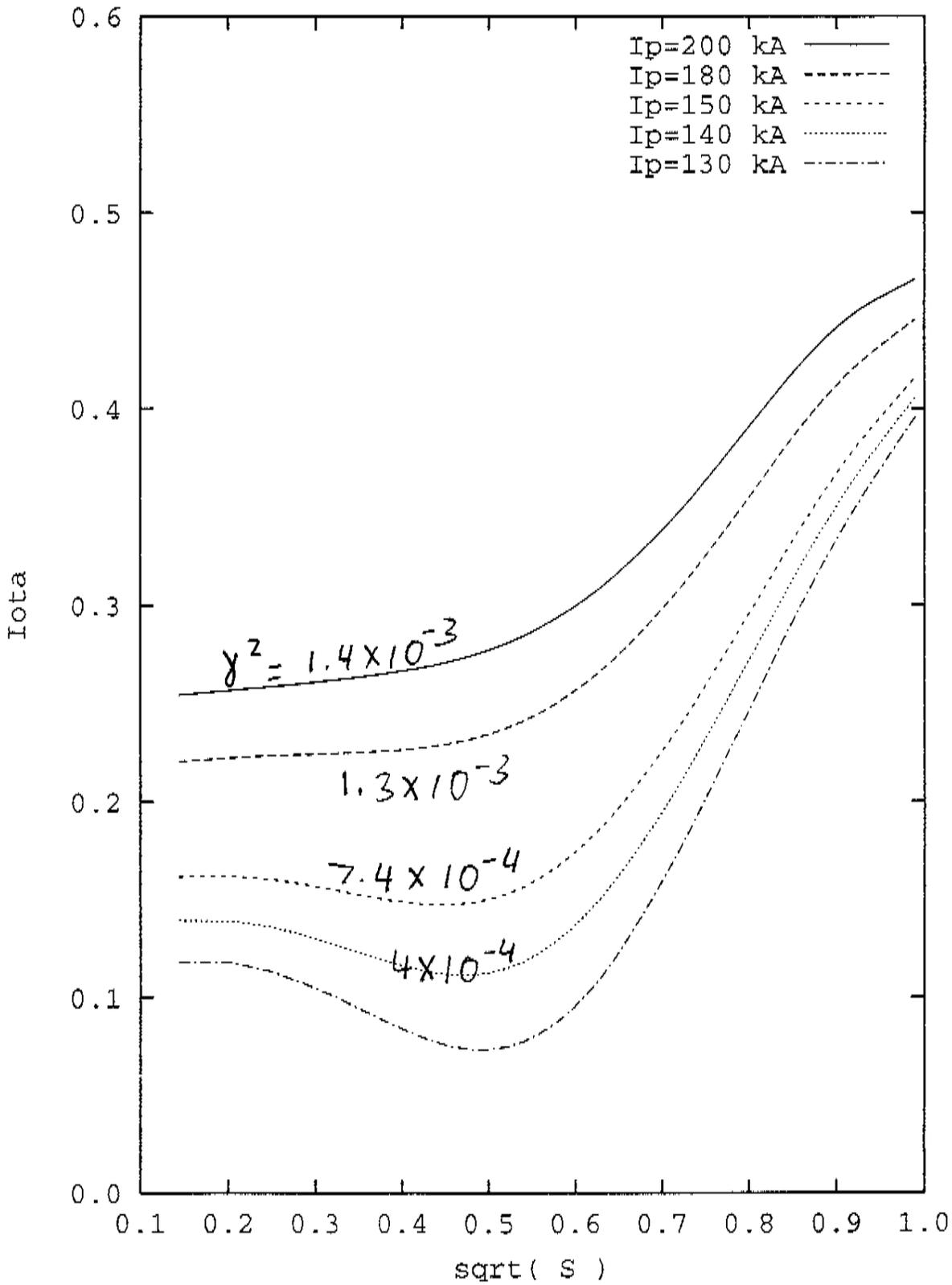


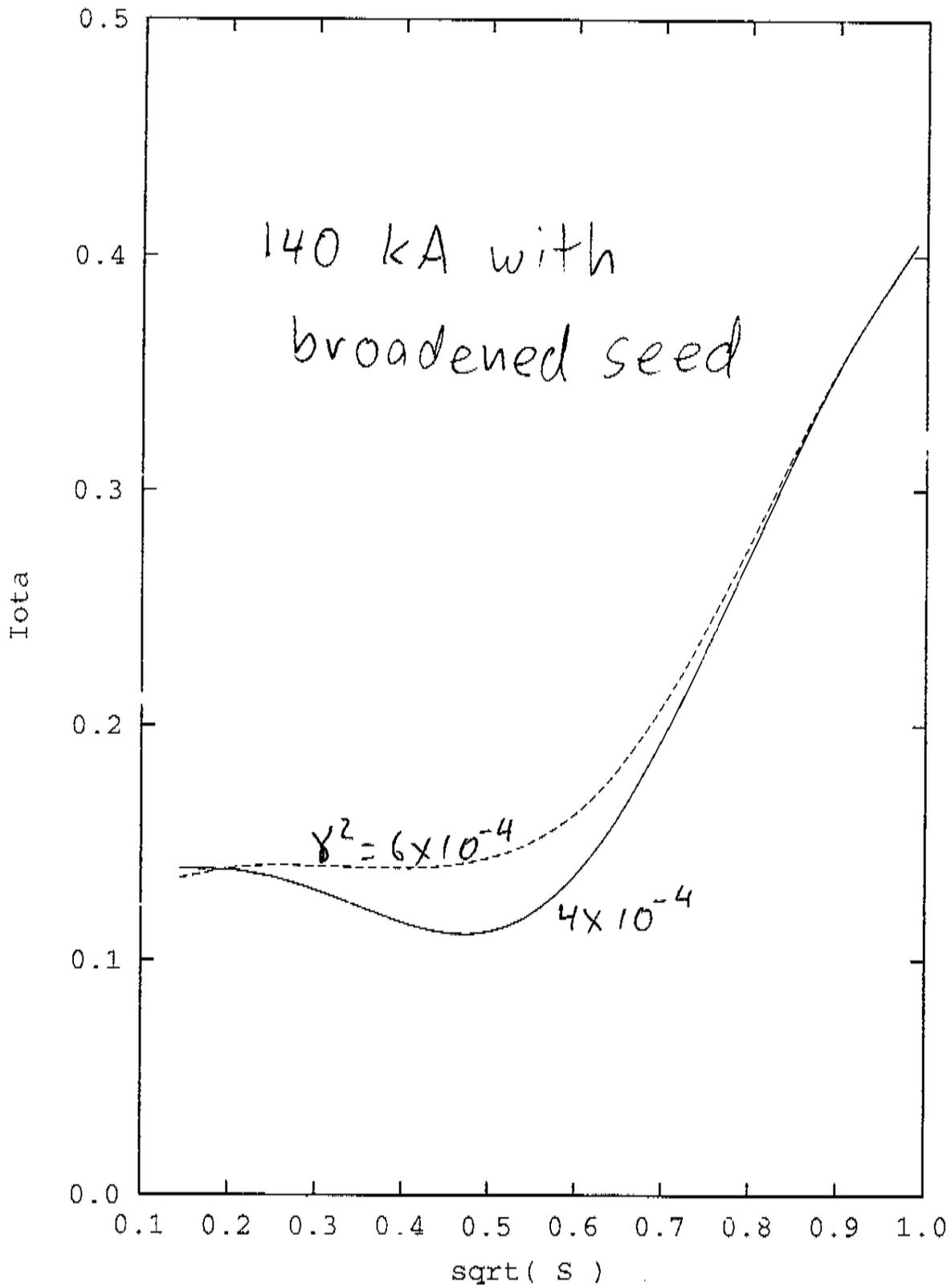
### Non-Axisymmetric Components of Bmn, QAS3\_C82

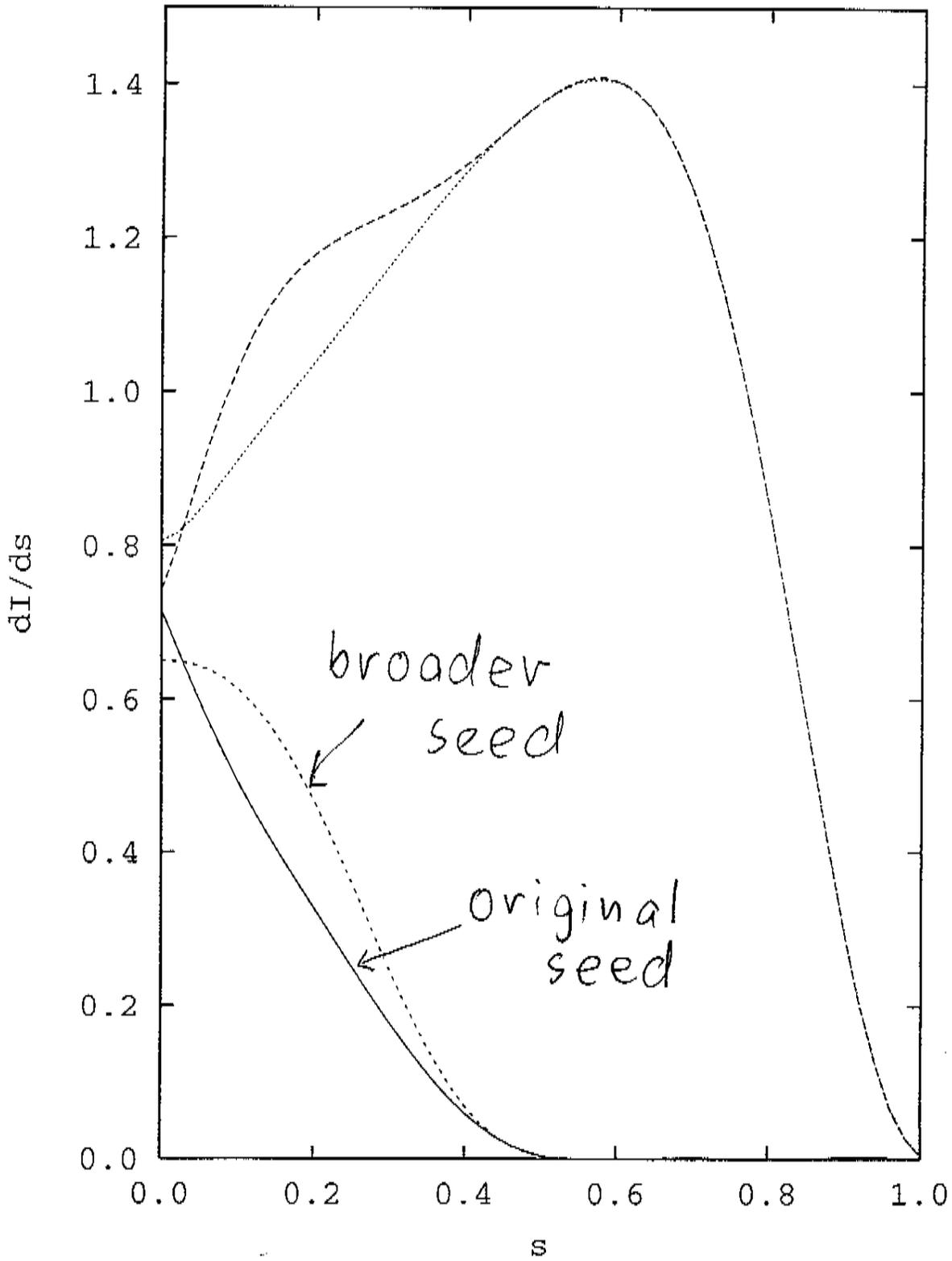


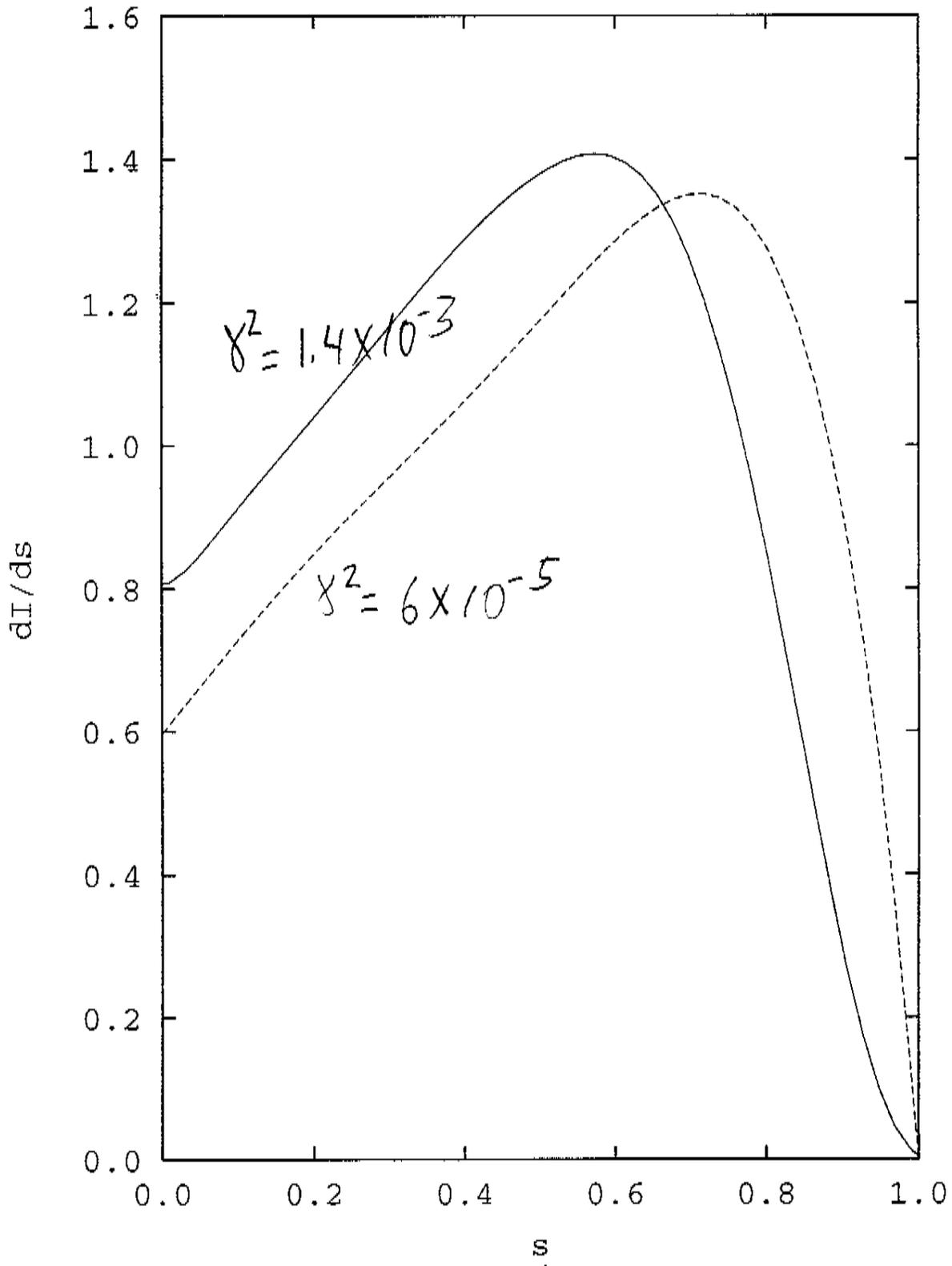
## Recent Kink Issues

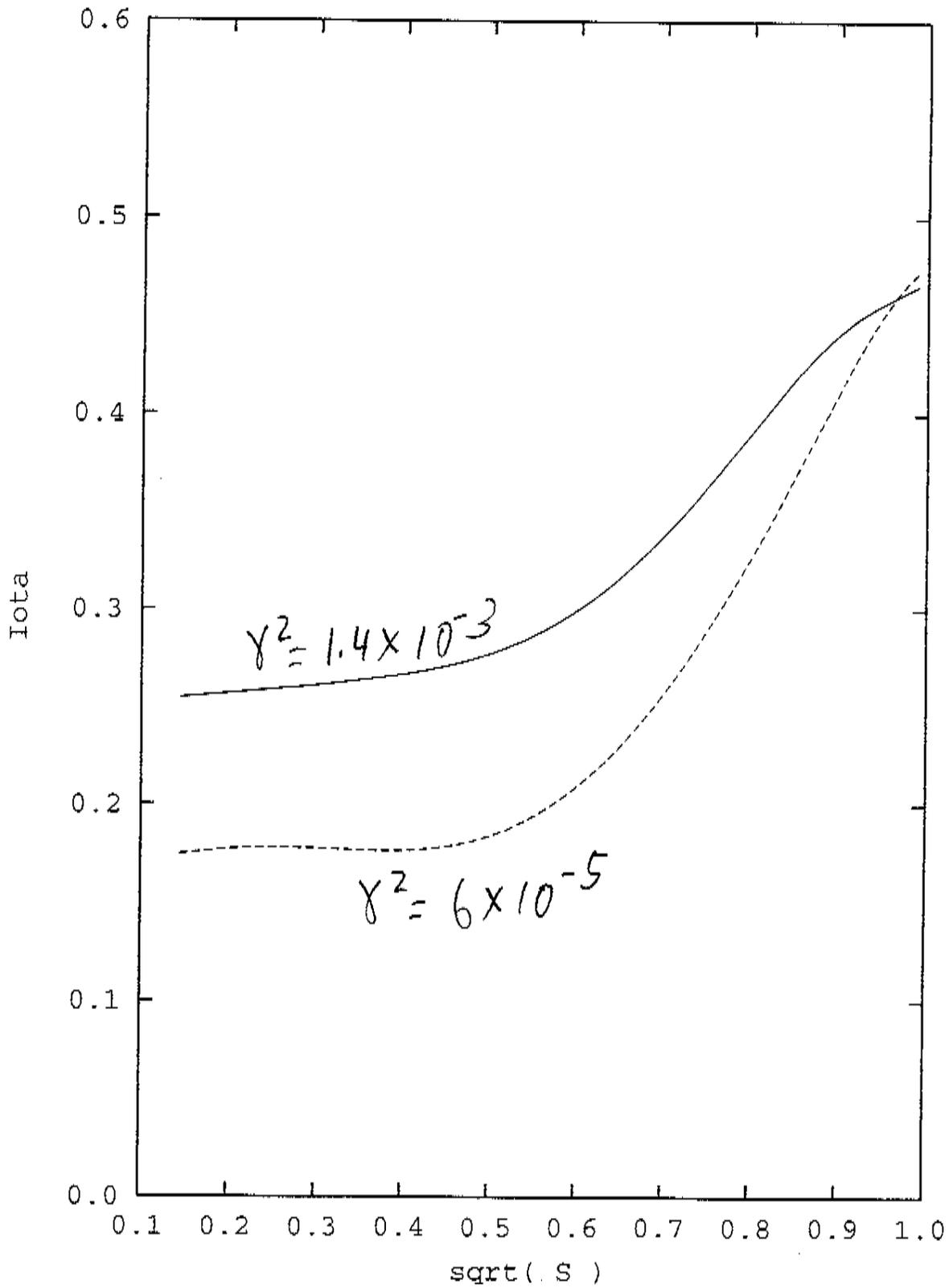
- Restabilization of c10 via optimizer led to c76. Increased ripple, higher coil current density.
- Targeting ripple reduction to annulus between  $r = .7$  and  $r = .8$  decreases ripple there almost to c10 level. (configuration c82).  
Ripple and coil current density somewhat higher than c10.
- Can we trade off poloidal flux to relax kink constraint, improving ripple & coil current density?  
Study effects of varying magnitude of current, current profile.











# Draft Workplan for Plasma Configuration Group

## I. Configuration improvements

- A. Investigate reduced current configurations to ease kink stabilization constraint. Try targeting ripple both as before and in an annular region. Ku. 3/10
- B. Use 2D bootstrap code to generate self consistent current profiles for study of kink and ballooning stability dependence on profiles. Can kink stabilization be eased by proper choice of profiles? Kessel, Ku. 3/10
- C. Use bootstrap coupled to optimizer to determine optimal profiles. Ku. 3/31
- D. Investigate effect of varying  $n$  and  $T$  profiles on self-consistent bootstrap current. What is the range of currents consistent with bootstrap? How small a current is it reasonable for us to use? Is there an optimal choice of the  $n$  &  $T$  profiles? Study uses 2D bootstrap to study trends, 3D to confirm profile effects of particular interest. Kessel. 3/24
- E. Pending outcome of IB, ID, and III, reop-

optimize to generate new reference configuration. Ku and Kessel 3/31

- F. Further studies target iota profile effects via external transform and optimization of NESCOIL sheet currents. 4/30 Ku and Kessel

Feedback needed from transport group for these studies:

- A transport run possibly every week or two (both thermal and energetic ion);
- At least one alpha particle calculation, and possibly several
- Thermal transport calculations with self-consistent electric field.

Feedback will also be needed from coil group after smaller NESCOIL coupled to optimizer.

## II. Optimizer improvements.

- A. Test 2D bootstrap module in optimizer. Ku. a few days.
- B. Merge with Oak Ridge optimizer? ORNL optimizer has had major improvements:
  - Completely restructured.
  - Sanchez fast ballooning module.

- NESCOIL module.
  - 3D bootstrap module.
  - Fast transformation to Boozer coordinates.
- C. Energetic Particle Transport Target Function. We need this from the transport group. A high priority.
- D. Thermal transport reduction objectives. Need input from transport group on how to improve our transport objective function.
- E. Coil objectives. Use curvature or some other feature as a proxy for coil properties? Also, couple NESCOIL to optimizer.
- F. Massively parallel optimizer. A massively parallel version has been developed by Ethier and Zarnstorff. It needs to be merged with the version presently being used. (Ethier, Zarnstorff and Ku) Will hopefully decrease turnaround time for our optimization studies.
- III. Bootstrap validation. It has been claimed that recent calculations of bootstrap current by Lin and White may disagree with our 3D bootstrap

code. Kessel and Monticello work with White and Lin to resolve possible discrepancy. 3/17

IV. CAS3D. We need to use this to calculate vertical stability. First we will have to verify that it is working properly. If it is not, we will need to work with Carolin Nuehrenberg and Peter Merkel to identify and fix the problems.

- A. Verification of CAS3D code benchmarks against axisymmetric (with PEST) and non axisymmetric (with TERPSICHORE) cases for free boundary external kink. Redi, Fu, Monticello Mid April
- B. Completion of CAS3D benchmarks against axisymmetric case for vertical instability (TSC) and initial results for QAS configurations. Redi, Monticello, Kessel Early June
- C. If necessary, study configuration modifications to improve vertical stability. Ku, Redi, Monticello.

V. Validation of Kink Stability Calculations.

- A. Convergence studies to confirm validity of

our earlier results (which we are relying on as a guide to our intuition about kink stability). Fu, Boozer.

- B. Benchmarking of Terpsichore against CAS3D calculations (once CAS3D is working). Same as IVB. Redi, Fu, Monticello.
- C. Benchmarking between Terpsichore pseudoplasma and Green's function approaches. As a first step, the Terpsichore calculation of external kinks using Green's function needs to be fixed. Merkel and Cooper visits will overlap from 4/18 to 5/1, and they will try to get this working.
- D. Robustness studies of kink stability vs profile changes. Fu.

## VI. Ballooning stability.

- A. Investigate whether  $p'$  reductions at the edge get so big that things start to unravel. Kessel.
- B. Stability repairs if necessary. Ku and Kessel.
- C. Ku uses Cooper visit (4/11 - 5/1) to consult on any ballooning code issues.
- D. ballooning validation: There have been no indications of problems with our bal-

looning calculations, and we believe they are reliable. Nevertheless, it would be prudent to have ballooning calculations for any proposed reference design confirmed by the Oak Ridge group.

- VII. Reconstruction Assessments Ku assesses quasisymmetry and stability of configurations for engineering group.
  
- VIII. For Snowmass: aspect ratio dependence of configuration properties, and effect of less stringent poloidal flux constraint appropriate for reactors. The study of the aspect ratio dependence needs to take into account the fact that the eased poloidal flux constraint at lower aspect ratio allows greater flexibility in the iota profile, as well as the fact that the bootstrap current decreases at lower aspect ratio. Can we obtain more attractive configurations if we apply less stringent constraints than necessary for POP experiment? Would be desirable for Snowmass. Not a near term priority.