VMEC 2000 (Status)

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Status Summary

- **Several VMEC Upgrade issues have been previously identified**
  - **Temporal convergence with increasing radial grid, Fourier modes**
  - **Convergence for low - iota cases (e.g., C82 vacuum), $|\iota| < 0.1$**
  - **Force balance convergence with grid**
  - **Hamada condition/compare with PIES**

Progress

- **Progress since last status update**
  - **Temporal convergence greatly improved (allows spatial convergence studies to proceed)**
  - **Low-iota convergence problems fixed**
  - **Improving force balance calculation**
  - **Hamada remains to be implemented**

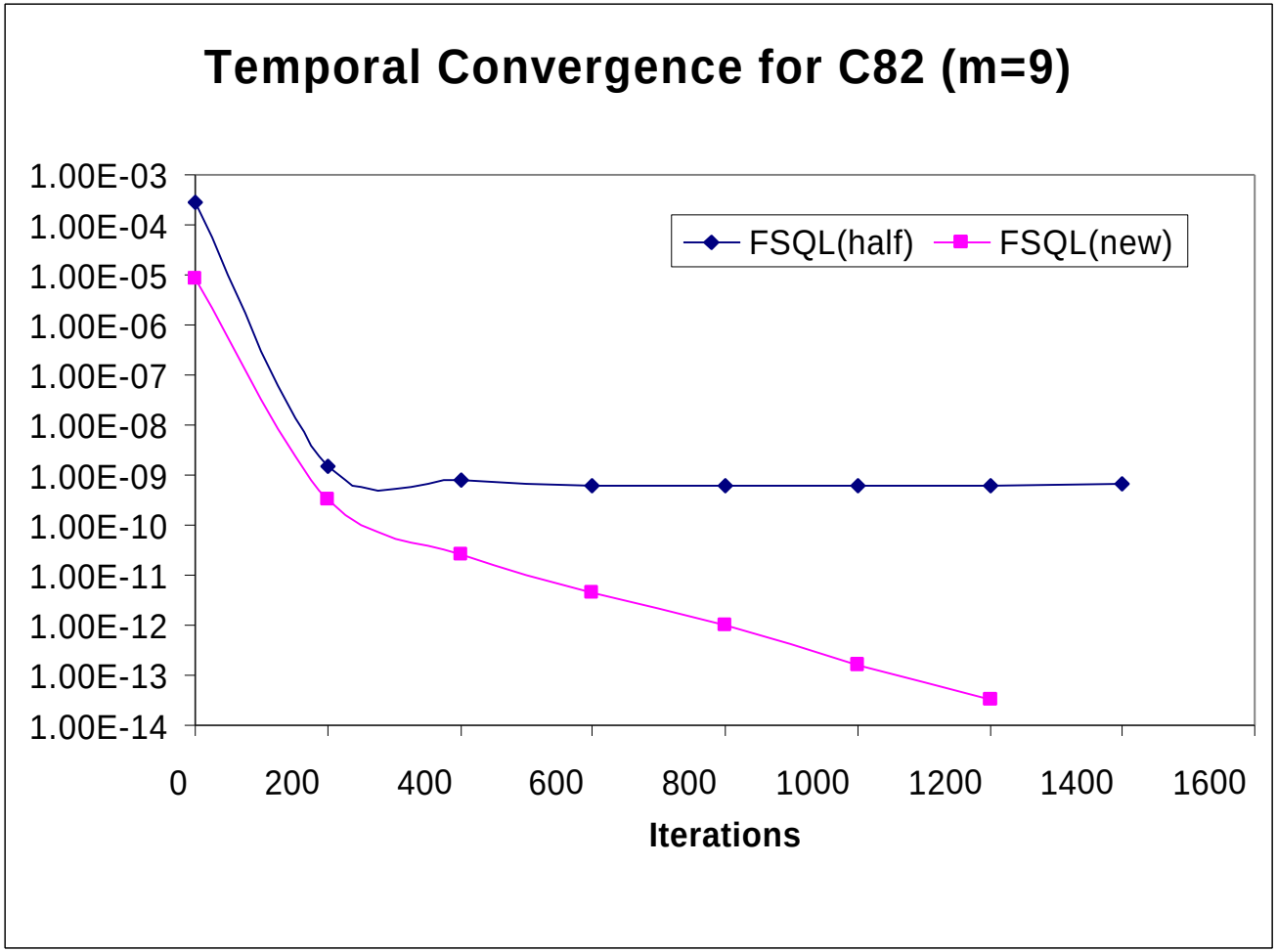
Progress Made Possible By…

- **Improved radial differencing for renormalization parameter (Lambda)**
  - **Lambda controls angular component of J X B - grad p force**
    - **Determines J * grad s = 0**
  - **Previously, "grid separation" occurred (in 3D) near magnetic axis**
  - **Now R, Z, lambda all on SAME mesh - stabilizes numerical "interchange"**

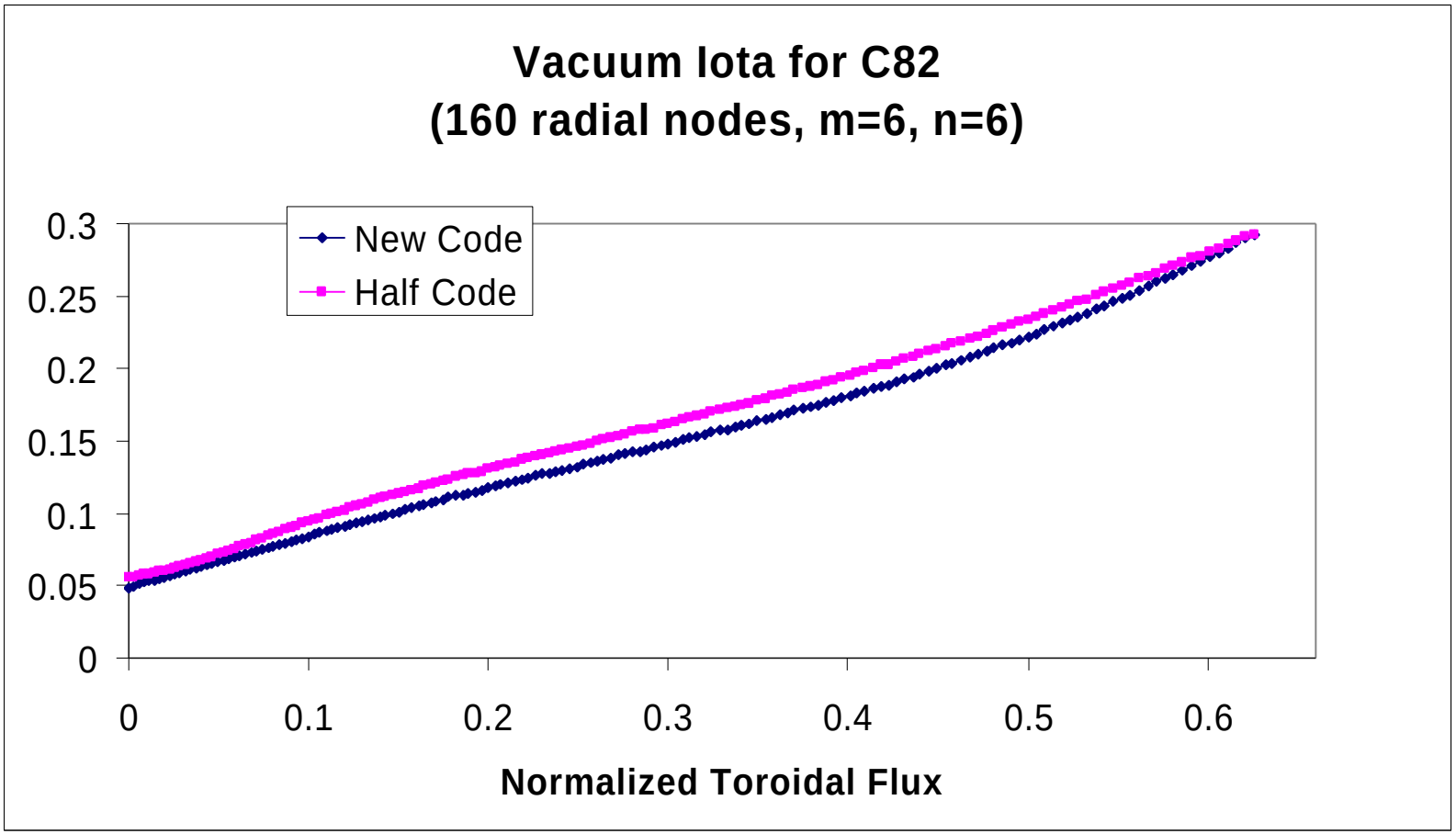
Progress (cont'd)…

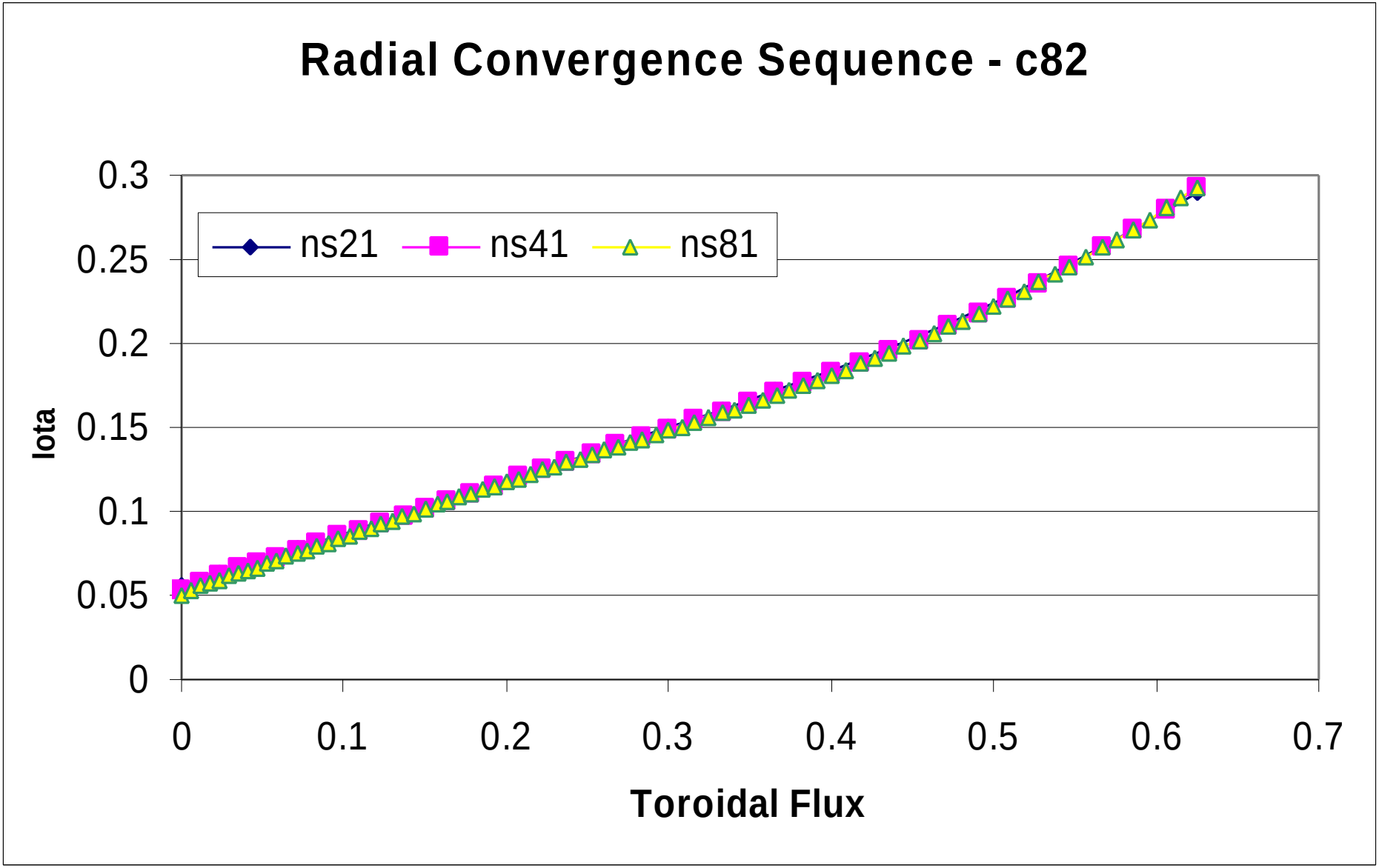
- **Increased radial resolution near axis**
  - **Radial "zoning" previously same as toroidal flux, F**
    - **Poor near-axis resolution**
  - **New zoning law: F(s) = s*(1+a*s)/(1+a)**
    - **a = 0.5 packs more grid points near axis without loosing s-zoning behavior near edge (large volume regions)**
    - **previous law corresponds to a = 0**

Improved Temporal Convergence



Iota profiles are *Similar*, though not *Identical* (stability?)

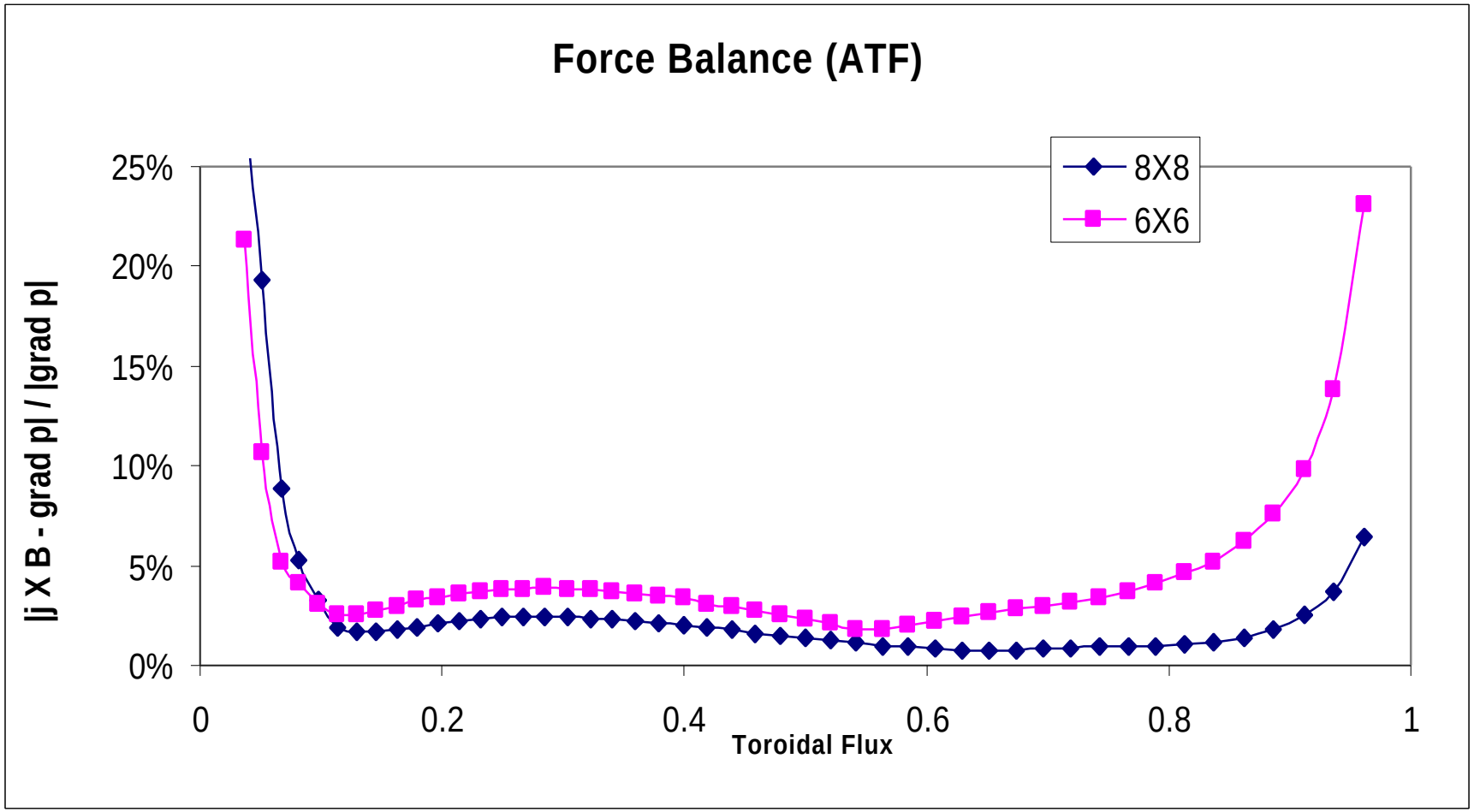



Radial Convergence Sequence - c82
ns21
ns41
ns81
Iota
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Toroidal Flux

Why the interest in more modes and grid points?

- **Increased spatial resolution needed for improved force balance**
  - **Reduce discrepancy between VMEC and PIES?**
  - **Better estimates for ballooning, kink stability**
  - **Needed to accurately compute parallel currents for island estimates**

Force balance vs. poloidal modes



Summary

- **VMEC 2000 is now available**
  - **Much improved temporal (retained good spatial) convergence**
  - **Adequate for doing mode, radial convergence studies on currents for comparison with PIES**
  - **Retained speed (only 15% slower per iter, converges in much fewer iters!)**
  - **Output now consistent with previous code -> stability, transport codes will work**

Goals for Next Project Meeting

- **Compute parallel currents**
  - **compare with PIES**
  - **need for island widths**
- **Verify free boundary still working**
  - **begin free boundary flexibility analysis**
- **Implement Hamada condition check**
- **Assess impact on stability (and transport) of new VMEC**